2002 ENGINES

Engine Mechanical 4.8L, 5.3L, & 6.0L (Unit Repair) - SUV

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

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Application	Specification	
	Metric	English
Accelerator Control Cable Bracket Bolts	10 N·m	89 lb in
Camshaft Retainer Bolts	25 N·m	18 lb ft
Camshaft Sensor Bolt	25 N·m	18 lb ft
Camshaft Sprocket Bolts	35 N·m	26 lb ft
Connecting Rod Bolts-Early Design (First Pass)	20 N·m	15 lb ft
Connecting Rod Bolts-Early Design (Final Pass)	60 degrees	
Connecting Rod Bolts-Later Design (First Pass)	20 N·m	15 lb ft
Connecting Rod Bolts-Later Design (Final Pass)	75 degrees	
Coolant Temperature Gauge Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt (Installation Pass-to Ensure the Balancer is Completely Installed)	330 N·m	240 lb ft
Crankshaft Balancer Bolt (First Pass-Install a NEW Bolt After the Installation Pass and Tighten as Described in the First and Final Passes)	50 N·m	37 lb ft
Crankshaft Balancer Bolt (Final Pass)	140 degrees	
Crankshaft Bearing Cap Bolts (Inner Bolts-First Pass in Sequence)	20 N·m	15 lb ft
Crankshaft Bearing Cap Bolts (Inner Bolts-Final Pass in Sequence)	80 degrees	
Crankshaft Bearing Cap Bolts (Outer Bolts-First Pass in Sequence)	20 N·m	15 lb ft
Crankshaft Bearing Cap Bolts (Outer Bolts-Final Pass in Sequence)	51 degrees	
Crankshaft Bearing Cap Side Bolts	25 N·m	18 lb ft
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft
Crankshaft Position Sensor Bolt	25 N·m	18 lb ft
Cylinder Head Bolts (First Pass all M11 Bolts in Sequence)	30 N·m	22 lb ft
Cylinder Head Bolts (Second Pass all M11 Bolts in Sequence)	90 degrees	
Cylinder Head Bolts (Final Pass all M11 Bolts in Sequence-Excluding the Medium Length Bolts at the Front and Rear of Each Cylinder Head)	90 degrees	
Cylinder Head Bolts (Final Pass M11 Medium Length Bolts at the Front and Rear of Each Cylinder Head in Sequence)	50 degrees	
Cylinder Head Bolts (M8 Inner Bolts in Sequence)	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Engine Block Coolant Drain Plugs	60 N·m	44 lb ft
Engine Block Heater	40 N·m	30 lb ft
Engine Block Oil Gallery Plugs	60 N·m	44 lb ft
Engine Coolant Air Bleed Pipe and Cover Bolts	12 N·m	106 lb in
Engine Flywheel Bolts (First Pass)	20 N·m	15 lb ft
Engine Flywheel Bolts (Second Pass)	50 N·m	37 lb ft
Engine Flywheel Bolts (Final Pass)	100 N·m	74 lb ft
Engine Front Cover Bolts	25 N·m	18 lb ft
Engine Rear Cover Bolts	25 N·m	18 lb ft
Engine Service Lift Bracket M10 Bolts	50 N·m	37 lb ft
Engine Service Lift Bracket M8 Bolt	25 N·m	18 lb ft
Engine Sight Shield Bolts	10 N·m	89 lb in
Engine Sight Shield Bracket Bolts	5 N·m	45 lb in
Engine Valley Cover Bolts	25 N·m	18 lb ft

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Fig. 1: Fastener Tightening Specifications (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

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Application	Specification	
	Metric	English
Exhaust Gas Recirculation (EGR) Valve Bolts (First Pass)	10 N·m	89 lb in
EGR Valve Bolts (Final Pass)	30 N·m	22 lb ft
EGR Valve Pipe-to-Cylinder Head Bolts	50 N·m	37 lb ft
EGR Valve Pipe-to-Exhaust Manifold Bolts	30 N·m	22 lb ft
EGR Valve Pipe-to-Intake Manifold Bolt	10 N·m	89 lb in
Exhaust Manifold Bolts (First Pass)	15 N·m	11 lb ft
Exhaust Manifold Bolts (Final Pass)	25 N·m	18 lb ft
Exhaust Manifold Heat Shield Bolts	9 N·m	80 lb in
Evaporative Emission (EVAP) Purge Solenoid Bolt	10 N·m	89 lb in
Fuel Rail Bolts	10 N·m	89 lb in
Fuel Rail Crossover Tube Bolts	3.8 N·m	34 lb in
Fuel Rail Stop Bracket Bolt	50 N·m	37 lb ft
Ignition Coil-to-Bracket Bolts	8 N·m	71 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Intake Manifold Bolts (First Pass in Sequence)	5 N·m	44 lb in
Intake Manifold Bolts (Final Pass in Sequence)	10 N·m	89 lb in
Intake Manifold Wiring Harness Stud	10 N·m	89 lb in
Knock Sensors	20 N·m	15 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Level Sensor	13 N·m	115 lb in
Oil Pan Baffle Bolts	12 N·m	106 lb in
Oil Pan Closeout Cover Bolt (Left Side)	9 N·m	80 lb in
Oil Pan Closeout Cover Bolt (Right Side)	9 N·m	80 lb in
Oil Pan Cover Bolts	12 N·m	106 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M8 Bolts (Oil Pan-to-Engine Block and Oil Pan-to-Front Cover)	25 N·m	18 lb ft
Oil Pan M6 Bolts (Oil Pan-to-Rear Cover)	12 N·m	106 lb in
Oil Pressure Sensor	20 N·m	15 lb ft
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen Nuts	25 N·m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in
Spark Plugs-New Cylinder Heads	20 N·m	15 lb ft
Spark Plugs-All Subsequent Installations	15 N·m	11 lb ft
Throttle Body Nuts	10 N·m	89 lb in
Throttle Body Studs	6 N·m	53 lb in
Valve Lifter Guide Bolts	12 N·m	106 lb in
Valve Rocker Arm Bolts	30 N·m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Water Inlet Housing Bolts	15 N·m	11 lb ft
Water Pump Bolts (First Pass)	15 N·m	11 lb ft
Water Pump Bolts (Final Pass)	30 N·m	22 lb ft
Water Pump Cover Bolts	15 N·m	11 lb ft

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Fig. 2: Fastener Tightening Specifications (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

ENGINE MECHANICAL SPECIFICATIONS (LR4 VIN V)

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Application	Metric	English
General Data		
Engine Type	V8	
Displacement	4.8 L	293 CID
Bore	96.000–96.018 mm	3.779–3.78 in
Stroke	83.0 mm	3.268 in
Compression Ratio	9.45:1	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.524 mm	0.06 in
Lubrication System		
Oil Capacity (without Oil Filter Change)	4.73 Liters	5.0 Quarts
Oil Capacity (with Oil Filter Change)	5.68 Liters	6.0 Quarts
Oil Pressure (Minimum—Hot)	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Type	5W-30	
Camshaft		
Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
Camshaft Journal Diameter	54.99–55.04 mm	2.164–2.166 in
Camshaft Journal Diameter Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift (Intake)	6.82 mm	0.268 in
Camshaft Lobe Lift (Exhaust)	6.96 mm	0.274 in
Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Bore Diameter	56.505–56.525 mm	2.224–2.225 in
Connecting Rod Bearing Bore Out-of-Round	0.004–0.008 mm	0.00015–0.0003 in
Connecting Rod Bearing Clearance (Production)	0.023–0.065 mm	0.0009–0.0025 in
Connecting Rod Bearing Clearance (Service Limit)	0.023–0.076 mm	0.0009–0.003 in
Connecting Rod Side Clearance	0.11–0.51 mm	0.0043–0.02 in
Crankshaft		
Crankshaft Bearing Clearance (Production)	0.020–0.052 mm	0.0008–0.0021 in
Crankshaft Bearing Clearance (Service)	0.020–0.065 mm	0.0008–0.0025 in
Crankshaft Connecting Rod Journal Diameter (Production)	53.318–53.338 mm	2.099–2.1 in
Crankshaft Connecting Rod Journal Diameter (Service Limit)	53.308 mm (Minimum)	2.0987 in (Minimum)
Crankshaft Connecting Rod Journal Taper (Production)	0.005 mm (Maximum for one half of the Journal Length)	0.0002 in (Maximum for one half of the Journal Length)
Crankshaft Connecting Rod Journal Taper (Service Limit)	0.02 mm (Maximum)	0.00078 in (Maximum)
Crankshaft Connecting Rod Journal Out-of-Round (Production)	0.005 mm	0.0002 in
Crankshaft Connecting Rod Journal Out-of-Round (Service Limit)	0.01 mm	0.0004 in
Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in
Crankshaft Main Journal Diameter (Production)	64.993–65.007 mm	2.558–2.5593 in
Crankshaft Main Journal Diameter (Service Limit)	64.993 mm (Minimum)	2.558 in (Minimum)
Crankshaft Main Journal Out-of-Round (Production)	0.003 mm	0.0001 in
Crankshaft Main Journal Out-of-Round (Service Limit)	0.008 mm	0.0003 in
Crankshaft Main Journal Taper (Production)	0.01 mm	0.0004 in
Crankshaft Main Journal Taper (Service Limit)	0.02 mm	0.00078 in

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Fig. 3: Engine Mechanical Specifications - LR4 VIN V (1 Of 3)
Courtesy of GENERAL MOTORS CORP.

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Application	Metric	English
Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below the Tooth Diameter)	0.7 mm (Maximum)	0.028 in (Maximum)
Crankshaft Runout (at Rear Flange)	0.05 mm (Maximum)	0.002 in (Maximum)
Crankshaft Thrust Wall Runout	0.025 mm	0.001 in
Crankshaft Thrust Wall Width (Production)	26.14–26.22 mm	1.029–1.0315 in
Crankshaft Thrust Wall Width (Service)	26.2 mm (Maximum)	1.0315 in (Maximum)
Cylinder Bore		
Cylinder Bore Diameter (Production)	96.0–96.018 mm	3.779–3.78 in
Cylinder Head		
Cylinder Head Engine Block Deck Flatness (Measured within a 156 mm (6.1 in) area)	0.08 mm	0.003 in
Cylinder Head Engine Block Deck Flatness (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
Cylinder Head Exhaust Manifold Deck Flatness	0.13 mm	0.005 in
Cylinder Head Height (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm (Minimum)	4.732 in (Minimum)
Cylinder Head Intake Manifold Deck Flatness	0.08 mm	0.0031 in
Engine Block		
Camshaft Bearing Bore Diameters	55.063–55.088 mm	2.168–2.169 in
Engine Block Cylinder Head Deck Surface Flatness (Measured within a 156 mm (6.1 in) area)	0.11 mm	0.004 in
Engine Block Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
Engine Block Cylinder Head Deck Height (Measuring from the Centerline of Crankshaft to the Deck Face)	234.57–234.82 mm	9.235–9.245 in
Main Bearing Bore Diameter (Production)	69.871–69.889 mm	2.750–2.751 in
Main Bearing Bore Diameter Out-of-Round	0.006 mm	0.0002 in
Valve Lifter Bore Diameter (Production)	21.417–21.443 mm	0.843–0.844 in
Intake Manifold		
Intake Manifold Cylinder Head Deck Flatness (Measured within a 200 mm (7.87 in) Area that Includes Two Runner Port Openings)	3.0 mm	0.118 in
Oil Pan and Front/Rear Cover Alignment		
Oil Pan to Rear of Engine Block Alignment (at Transmission Bellhousing Mounting Surface)	0.0–0.25 mm (Maximum)	0.0–0.01 in (Maximum)
Front Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Rear Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Piston		
Piston Outside Diameter (at Size Point)	95.962–95.980 mm	3.778–3.779 in
Piston to Bore Clearance (Production)	0.020–0.056 mm	0.0008–0.0022 in
Piston to Bore Clearance (Service Limit)	0.020–0.081 mm (Maximum)	0.0008–0.0032 in (Maximum)
Piston Pin		
Piston Pin Clearance to Piston Bore (Production)	0.007–0.020 mm	0.00027–0.00078 in
Piston Pin Clearance to Piston Bore (Service Limit)	0.007–0.021 mm (Maximum)	0.00027–0.00082 in (Maximum)
Piston Pin Diameter	23.997–24.0 mm	0.9447–0.9448 in
Piston Pin Fit in Connecting Rod	0.020–0.043 mm (Interference)	0.00078–0.00169 in (Interference)
Piston Rings		
Piston Compression Ring End Gap (Production—Top) (Measured in Cylinder Bore)	0.23–0.44 mm	0.009–0.017 in

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Fig. 4: Engine Mechanical Specifications - LR4 VIN V (2 Of 3)
Courtesy of GENERAL MOTORS CORP.

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Application	Metric	English
Piston Compression Ring End Gap (Production—2nd) (Measured in Cylinder Bore)	0.44–0.70 mm	0.0173–0.0275 in
Piston Oil Ring End Gap (Production) (Measured in Cylinder Bore)	0.18–0.75 mm	0.007–0.0295 in
Piston Compression Ring End Gap (Service—Top) (Measured in Cylinder Bore)	0.23–0.50 mm (Maximum)	0.009–0.02 in (Maximum)
Piston Compression Ring End Gap (Service—2nd) (Measured in Cylinder Bore)	0.44–0.76 mm (Maximum)	0.0173–0.03 in (Maximum)
Piston Oil Ring End Gap-Service Limit (Measured in Cylinder Bore)	0.18–0.81 mm (Maximum)	0.007–0.032 in (Maximum)
Piston Compression Ring Groove Clearance (Production—Top)	0.04–0.085 mm	0.00157–0.003346 in
Piston Compression Ring Groove Clearance (Production—2nd)	0.04–0.078 mm	0.00157–0.0031 in
Piston Oil Ring Groove Clearance (Production)	0.012–0.20 mm	0.0005–0.0078 in
Piston Compression Ring Groove Clearance (Service—Top)	0.04–0.085 mm (Maximum)	0.00157–0.003346 in (Maximum)
Piston Compression Ring Groove Clearance (Service—2nd)	0.04–0.078 mm (Maximum)	0.00157–0.0031 in (Maximum)
Piston Oil Ring Groove Clearance (Service Limit)	0.012–0.20 mm (Maximum)	0.0005–0.0078 in (Maximum)
Valve System		
Valve Face Angle	45 degrees	
Valve Guide Installed Height (Aluminum Head-Measured from the Cylinder Head Spring Seat Surface to the Top of the Valve Guide)	17.32 mm	0.682 in
Valve Lash	Net Lash-No Adjustment	
Valve Lift (Exhaust)	11.85 mm	0.466 in
Valve Lift (Intake)	11.6 mm	0.457 in
Valve Lifter	Hydraulic Roller	
Valve Margin	1.25 mm	0.05 in
Valve Rocker Arm Ratio	1.70:1	
Valve Seat Angle	46 degrees	
Valve Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
Valve Seat Width (Exhaust)	1.78 mm	0.07 in
Valve Seat Width (Intake)	1.02 mm	0.04 in
Valve Spring Free Length	52.9 mm	2.08 in
Valve Spring Installed Height (Exhaust)	45.75 mm	1.8 in
Valve Spring Installed Height (Intake)	45.75 mm	1.8 in
Valve Spring Pressure (Closed)	340 N at 45.75 mm	76 lb at 1.8 in
Valve Spring Pressure (Open)	980 N at 33.55 mm	220 lb at 1.32 in
Valve Stem Clearance (Production—Exhaust)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Production—Intake)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Service—Exhaust)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Clearance (Service—Intake)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Diameter (Production)	7.955–7.976 mm	0.3132–0.314 in
Valve Stem Diameter (Service)	7.95 mm (Minimum)	0.313 in (Minimum)
Valve Stem Oil Seal Installed Height (Measured from the Valve Spring Shim to Top Edge of Seal Body - First Design Seal)	18.1–19.1 mm	0.712–0.752 in

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Fig. 5: Engine Mechanical Specifications - LR4 VIN V (3 Of 3)
Courtesy of GENERAL MOTORS CORP.

ENGINE MECHANICAL SPECIFICATIONS (LM7 VIN T/L59 VIN Z)

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Application	Metric	English
General Data		
Engine Type	V8	
Displacement	5.3 L	325 CID
Bore	96.000–96.018 mm	3.779–3.78 in
Stroke	92.0 mm	3.622 in
Compression Ratio	9.45:1	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.524 mm	0.06 in
Lubrication System		
Oil Capacity (without Oil Filter Change)	4.73 Liters	5.0 Quarts
Oil Capacity (with Oil Filter Change)	5.68 Liters	6.0 Quarts
Oil Pressure (Minimum—Hot)	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Type	5W-30	
Camshaft		
Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
Camshaft Journal Diameter	54.99–55.04 mm	2.164–2.166 in
Camshaft Journal Diameter Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift (Intake)	6.82 mm	0.268 in
Camshaft Lobe Lift (Exhaust)	6.96 mm	0.274 in
Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Bore Diameter	56.505–56.525 mm	2.224–2.225 in
Connecting Rod Bearing Bore Out-of-Round	0.004–0.008 mm	0.00015–0.0003 in
Connecting Rod Bearing Clearance (Production)	0.023–0.065 mm	0.0009–0.0025 in
Connecting Rod Bearing Clearance (Service Limit)	0.023–0.076 mm	0.0009–0.003 in
Connecting Rod Side Clearance	0.11–0.51 mm	0.00433–0.02 in
Crankshaft		
Crankshaft Bearing Clearance (Production)	0.020–0.052 mm	0.0008–0.0021 in
Crankshaft Bearing Clearance (Service)	0.020–0.065 mm	0.0008–0.0025 in
Crankshaft Connecting Rod Journal Diameter (Production)	53.318–53.338 mm	2.099–2.1 in
Crankshaft Connecting Rod Journal Diameter (Service Limit)	53.308 mm (Minimum)	2.0987 in (Minimum)
Crankshaft Connecting Rod Journal Taper (Production)	0.005 mm (Maximum for one half of the Journal Length)	0.0002 in (Maximum for one half of the Journal Length)
Crankshaft Connecting Rod Journal Taper (Service Limit)	0.02 mm (Maximum)	0.00078 in (Maximum)
Crankshaft Connecting Rod Journal Out-of-Round (Production)	0.005 mm	0.0002 in
Crankshaft Connecting Rod Journal Out-of-Round (Service Limit)	0.01 mm	0.0004 in
Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in
Crankshaft Main Journal Diameter (Production)	64.993–65.007 mm	2.558–2.5593 in
Crankshaft Main Journal Diameter (Service Limit)	64.993 mm	2.558 in
Crankshaft Main Journal Out-of-Round (Production)	0.003 mm	0.0001 in
Crankshaft Main Journal Out-of-Round (Service Limit)	0.008 mm	0.0003 in
Crankshaft Main Journal Taper (Production)	0.01 mm	0.0004 in
Crankshaft Main Journal Taper (Service Limit)	0.02 mm	0.00078 in

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Fig. 6: Engine Mechanical Specifications - LM7 VIN T/L59 VIN Z (1 Of 3)
Courtesy of GENERAL MOTORS CORP.

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Application	Metric	English
Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below the Tooth Diameter)	0.7 mm (Maximum)	0.028 in (Maximum)
Crankshaft Runout (at Rear Flange)	0.05 mm (Maximum)	0.002 in (Maximum)
Crankshaft Thrust Wall Runout	0.025 mm	0.001 in
Crankshaft Thrust Wall Width (Production)	26.14–26.32 mm	1.029–1.0315 in
Crankshaft Thrust Wall Width (Service)	26.2 mm (Maximum)	1.0315 in (Maximum)
Cylinder Bore		
Cylinder Bore Diameter (Production)	96.0–96.018 mm	3.779–3.78 in
Cylinder Head		
Cylinder Head Engine Block Deck Flatness (Measured within a 156 mm (6.1 in) area)	0.08 mm	0.003 in
Cylinder Head Engine Block Deck Flatness (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
Cylinder Head Exhaust Manifold Deck Flatness	0.13 mm	0.005 in
Cylinder Head Height (Measured from the Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm	4.732 in
Cylinder Head Intake Manifold Deck Flatness	0.08 mm	0.003 in
Engine Block		
Camshaft Bearing Bore Diameters	55.063–55.088 mm	2.168–2.169 in
Engine Block Cylinder Head Deck Surface Flatness (Measured within a 156 mm (6.1 in) area)	0.11 mm	0.004 in
Engine Block Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
Engine Block Cylinder Head Deck Height (Measuring from the Centerline of Crankshaft to the Deck Face)	234.57–234.82 mm	9.235–9.245 in
Main Bearing Bore Diameter (Production)	69.871–69.889 mm	2.750–2.751 in
Main Bearing Bore Diameter Out-of-Round	0.006 mm	0.0002 in
Valve Lifter Bore Diameter (Production)	21.417–21.443 mm	0.843–0.844 in
Intake Manifold		
Intake Manifold Cylinder Head Deck Flatness (Measured within a 200 mm (7.87 in) Area that Includes Two Runner Port Openings)	0.3 mm	0.118 in
Oil Pan and Front/Rear Cover Alignment		
Oil Pan to Rear of Engine Block Alignment (at Transmission Bellhousing Mounting Surface)	0.0–0.25 mm (Maximum)	0.0–0.01 in (Maximum)
Front Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Rear Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Piston		
Piston Outside Diameter (at Size Point)	95.957–95.980 mm	3.774–3.779 in
Piston to Bore Clearance (Production)	0.020–0.061 mm	0.0008–0.0024 in
Piston to Bore Clearance (Service Limit)	0.020–0.086 mm (Maximum)	0.0008–0.0034 in (Maximum)
Piston Pin		
Piston Pin Clearance to Piston Bore (Production)	0.007–0.020 mm	0.00027–0.00078 in
Piston Pin Clearance to Piston Bore (Service Limit)	0.007–0.021 mm (Maximum)	0.00027–0.00082 in (Maximum)
Piston Pin Diameter	23.997–24.0 mm	0.9447–0.9448 in
Piston Pin Fit in Connecting Rod	0.020–0.043 mm (Interference)	0.00078–0.00169 in (Interference)

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Fig. 7: Engine Mechanical Specifications - LM7 VIN T/L59 VIN Z (2 Of 3)
Courtesy of GENERAL MOTORS CORP.

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Application	Metric	English
Piston Rings		
Piston Compression Ring End Gap (Production—Top) (Measured in Cylinder Bore)	0.23–0.44 mm	0.009–0.017 in
Piston Compression Ring End Gap (Production—2nd) (Measured in Cylinder Bore)	0.44–0.70 mm	0.0173–0.0275 in
Piston Oil Ring End Gap (Production) (Measured in Cylinder Bore)	0.18–0.75 mm	0.007–0.0295 in
Piston Compression Ring End Gap (Service—Top) (Measured in Cylinder Bore)	0.23–0.50 mm (Maximum)	0.009–0.02 in (Maximum)
Piston Compression Ring End Gap (Service—2nd) (Measured in Cylinder Bore)	0.44–0.76 mm (Maximum)	0.0173–0.03 in (Maximum)
Piston Oil Ring End Gap-Service Limit (Measured in Cylinder Bore)	0.18–0.81 mm (Maximum)	0.007–0.032 in (Maximum)
Piston Compression Ring Groove Clearance (Production—Top)	0.04–0.085 mm	0.00157–0.003346 in
Piston Compression Ring Groove Clearance (Production—2nd)	0.04–0.078 mm	0.00157–0.0031 in
Piston Oil Ring Groove Clearance (Production)	0.012–0.20 mm	0.0005–0.0078 in
Piston Compression Ring Groove Clearance (Service—Top)	0.04–0.085 mm (Maximum)	0.00157–0.003346 in (Maximum)
Piston Compression Ring Groove Clearance (Service—2nd)	0.04–0.078 mm (Maximum)	0.00157–0.0031 in (Maximum)
Piston Oil Ring Groove Clearance (Service Limit)	0.012–0.20 mm (Maximum)	0.0005–0.0078 in (Maximum)
Valve System		
Valve Face Angle	45 degrees	
Valve Guide Installed Height (Measured from the Cylinder Head Spring Seat Surface to the Top of the Valve Guide)	17.32 mm	0.682 in
Valve Lash	Net Lash - No Adjustment	
Valve Lift (Exhaust)	11.85 mm	0.466 in
Valve Lift (Intake)	11.6 mm	0.457 in
Valve Lifter	Hydraulic Roller	
Valve Margin	1.25 mm	0.05 in
Valve Rocker Arm Ratio	1.70:1	
Valve Seat Angle	46 degrees	
Valve Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
Valve Seat Width (Exhaust)	1.78 mm	0.07 in
Valve Seat Width (Intake)	1.02 mm	0.04 in
Valve Spring Free Length	52.9 mm	2.08 in
Valve Spring Installed Height (Exhaust)	45.75 mm	1.8 in
Valve Spring Installed Height (Intake)	45.75 mm	1.8 in
Valve Spring Pressure (Closed)	340 N at 45.75 mm	76 lb at 1.8 in
Valve Spring Pressure (Open)	980 N at 33.55 mm	220 lb at 1.32 in
Valve Stem Clearance (Production—Exhaust)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Production—Intake)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Service—Exhaust)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Clearance (Service—Intake)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Diameter (Production)	7.955–7.976 mm	0.3132–0.314 in
Valve Stem Diameter (Service)	7.95 mm (Minimum)	0.313 in (Minimum)
Valve Stem Oil Seal Installed Height (Measured from the Valve Spring Shim to Top Edge of Seal Body - First Design Seal)	18.1–19.1 mm	0.712–0.752 in

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Fig. 8: Engine Mechanical Specifications - LM7 VIN T/L59 VIN Z (3 Of 3)
Courtesy of GENERAL MOTORS CORP.

ENGINE MECHANICAL SPECIFICATIONS (LQ4 VIN U/LQ9 VIN N)

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Application	Metric	English
General Data		
Engine Type	V8	
Displacement	6.0 L	364 CID
Bore	101.618–101.636 mm	4.0007–4.0014 in
Stroke	92.0 mm	3.622 in
Compression Ratio – LQ4 VIN U	9.40:1	
Compression Ratio – LQ9 VIN N	10.0:1	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.524 mm	0.06 in
Lubrication System		
Oil Capacity (without Oil Filter Change)	4.73 Liters	5.0 Quarts
Oil Capacity (with Oil Filter Change)	5.68 Liters	6.0 Quarts
Oil Pressure (Minimum—Hot)	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Type	5W-30	
Camshaft		
Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
Camshaft Journal Diameter	54.99–55.04 mm	2.164–2.166 in
Camshaft Journal Diameter Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift (Intake)	6.96 mm	0.274 in
Camshaft Lobe Lift (Exhaust)	7.13 mm	0.281 in
Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Bore Diameter	56.505–56.525 mm	2.224–2.225 in
Connecting Rod Bearing Bore Out-of-Round - LQ4	0.004–0.008 mm	0.00015–0.0003 in
Connecting Rod Bearing Bore Out-of-Round - LQ9	0.006 mm	0.00023 in
Connecting Rod Bearing Clearance (Production)	0.023–0.065 mm	0.0009–0.0025 in
Connecting Rod Bearing Clearance (Service Limit)	0.023–0.076 mm	0.0009–0.003 in
Connecting Rod Side Clearance	0.11–0.51 mm	0.00433–0.02 in
Crankshaft		
Crankshaft Bearing Clearance (Production)	0.020–0.052 mm	0.0008–0.0021 in
Crankshaft Bearing Clearance (Service)	0.020–0.065 mm	0.0008–0.0025 in
Crankshaft Connecting Rod Journal Diameter (Production)	53.318–53.338 mm	2.099–2.1 in
Crankshaft Connecting Rod Journal Diameter (Service Limit)	53.308 mm (Minimum)	2.0987 in (Minimum)
Crankshaft Connecting Rod Journal Taper (Production)	0.005 mm (Maximum for one half of the Journal Length)	0.0002 in (Maximum for one half of the Journal Length)
Crankshaft Connecting Rod Journal Taper (Service Limit)	0.02 mm (Maximum)	0.00078 in (Maximum)
Crankshaft Connecting Rod Journal Out-of-Round (Production)	0.005 mm	0.0002 in
Crankshaft Connecting Rod Journal Out-of-Round (Service Limit)	0.01 mm	0.0004 in
Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in
Crankshaft Main Journal Diameter (Production)	64.993–65.007 mm	2.558–2.5593 in
Crankshaft Main Journal Diameter (Service Limit)	64.993 mm	2.558 in
Crankshaft Main Journal Out-of-Round (Production)	0.003 mm	0.0001 in
Crankshaft Main Journal Out of Round (Service Limit)	0.008 mm	0.0003 in
Crankshaft Main Journal Taper (Production)	0.01 mm	0.0004 in

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Fig. 9: Engine Mechanical Specifications - LQ4 VIN U/LQ9 VIN N (1 Of 4)
Courtesy of GENERAL MOTORS CORP.

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Application	Metric	English
Crankshaft Main Journal Taper (Service Limit)	0.02 mm	0.00078 in
Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below the Tooth Diameter)	0.7 mm (Maximum)	0.028 in (Maximum)
Crankshaft Runout (at Rear Flange)	0.05 mm (Maximum)	0.02 in (Maximum)
Crankshaft Thrust Wall Runout	0.025 mm	0.001 in
Crankshaft Thrust Wall Width (Production)	26.14–26.22 mm	1.029–1.0315 in
Crankshaft Thrust Wall Width (Service)	26.2 mm (Maximum)	1.0315 in (Maximum)
Cylinder Bore		
Cylinder Bore Diameter (Production)	101.618–101.636 mm	4.0007–4.0014 in
Cylinder Head		
Cylinder Head Engine Block Deck Flatness (Measured within a 156 mm (6.1 in) area)	0.08 mm	0.003 in
Cylinder Head Engine Block Deck Flatness (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
Cylinder Head Exhaust Manifold Deck Flatness	0.13 mm	0.005 in
Cylinder Head Height (Measured from the Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm (Minimum)	4.732 in (Minimum)
Cylinder Head Intake Manifold Deck Flatness	0.08 mm	0.003 in
Engine Block		
Camshaft Bearing Bore Diameters	55.063–55.088 mm	2.168–2.169 in
Engine Block Cylinder Head Deck Surface Flatness (Measured within a 156 mm (6.1 in) area)	0.11 mm	0.004 in
Engine Block Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
Engine Block Cylinder Head Deck Height (Measuring from the Centerline of Crankshaft to the Head Deck)	234.57–234.82 mm	9.235–9.245 in
Main Bearing Bore Diameter (Production)	69.871–69.889 mm	2.750–2.751 in
Main Bearing Bore Diameter Out-of-Round	0.006 mm	0.0002 in
Valve Lifter Bore Diameter (Production)	21.417–21.443 mm	0.843–0.844 in
Intake Manifold		
Intake Manifold Cylinder Head Deck Flatness (Measured within a 200 mm Area that Includes Two Runner Port Openings)	0.3 mm	0.118 in
Oil Pan and Front/Rear Cover Alignment		
Oil Pan to Rear of Engine Block Alignment (at Transmission Bellhousing Mounting Surface)	0.0–0.25 mm (Maximum)	0.0–0.01 in (Maximum)
Front Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Rear Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Piston		
Piston Diameter - LQ4 Measured at Size Point	101.58–101.598 mm	3.999–3.999 in
Piston Diameter - LQ9 Measured Over Skirt Coating	101.611–101.642 mm	4.000–4.001 in
Piston-to-bore Clearance - LQ4 Production	0.02–0.056 mm	0.0008–0.0022 in
Piston-to-bore Clearance - LQ4 Service Limit	0.02–0.081 mm	0.0008–0.0032 in
Piston-to-bore Clearance - LQ9 Production	0.024–0.025 mm	0.00094–0.00098 in
Piston-to-bore Clearance - LQ9 Service Limit With Skirt Coating Worn Off	0.024–0.080 mm	0.00094–0.0031 in
Piston Pin		
Piston Pin Diameter - Press Fit Pin	23.997–24.0 mm	0.9447–0.9448 in
Piston Pin Diameter - Full-Floating Pin	23.952–23.955 mm	0.943–0.943 in
Piston Pin Fit in Connecting Rod - Press Fit Pin	0.020–0.043 mm (Interference)	0.00078–0.00169 in (Interference)
Piston Pin Fit in Connecting Rod - Full-Floating Pin Production	0.007–0.020 mm	0.00027–0.00078 in

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Fig. 10: Engine Mechanical Specifications - LQ4 VIN U/LQ9 VIN N (2 Of 4)
Courtesy of GENERAL MOTORS CORP.

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Application	Metric	English
Piston Pin Fit in Connecting Rod - Full-Floating Pin Service Limit	0.007–0.022 mm	0.00027–0.00086 in
Piston Pin to Piston Bore Clearance - LQ4 Production	0.007–0.020 mm	0.00027–0.00078 in
Piston Pin to Piston Bore Clearance - LQ4 Service Limit	0.007–0.021 mm	0.00027–0.00082 in
Piston Pin to Piston Bore Clearance - LQ9 Production Measured at Pin End	0.002–0.010 mm	0.00008–0.0004 in
Piston Pin to Piston Bore Clearance - LQ9 Service Limit Measured at Pin End	0.002–0.015 mm	0.00008–0.0006 in
Piston Rings		
Piston Compression Ring End Gap - LQ4 Production - Top Measured in Cylinder Bore	0.31–0.52 mm	0.0122–0.02 in
Piston Compression Ring End Gap - LQ4 Production - 2nd Measured in Cylinder Bore	0.51–0.77 mm	0.02–0.03 in
Piston Oil Ring End Gap - LQ4 Production Measured in Cylinder Bore	0.31–0.87 mm	0.0122–0.034 in
Piston Compression Ring End Gap - LQ4 Service - Top Measured in Cylinder Bore	0.31–0.59 mm	0.0122–0.023 in
Piston Compression Ring End Gap - LQ4 Service - 2nd Measured in Cylinder Bore	0.51–0.84 mm	0.02–0.033 in
Piston Oil Ring End Gap - LQ4 Service Measured in Cylinder Bore	0.31–0.94 mm	0.0122–0.037 in
Piston Compression Ring End Gap - LQ9 Production - Top Measured in Cylinder Bore	0.31–0.52 mm	0.0122–0.020 in
Piston Compression Ring End Gap - LQ9 Production - 2nd Measured in Cylinder Bore	0.51–0.77 mm	0.020–0.030 in
Piston Oil Ring End Gap - LQ9 Production Measured in Cylinder Bore	0.31–0.87 mm	0.0122–0.034 in
Piston Compression Ring End Gap - LQ9 Service - Top Measured in Cylinder Bore	0.31–0.59 mm	0.0122–0.023 in
Piston Compression Ring End Gap - LQ9 Service - 2nd Measured in Cylinder Bore	0.51–0.84 mm	0.020–0.033 in
Piston Oil Ring End Gap - LQ9 Service Measured in Cylinder Bore	0.31–0.94 mm	0.0122–0.037 in
Piston Compression Ring Groove Clearance - LQ4 Production - Top	0.04–0.08 mm	0.00157–0.0031 in
Piston Compression Ring Groove Clearance - LQ4 Production - 2nd	0.039–0.079 mm	0.0015–0.0031 in
Piston Oil Ring Groove Clearance - LQ4 Production	0.015–0.2 mm	0.0006–0.0079 in
Piston Compression Ring Groove Clearance - LQ4 Service - Top	0.04–0.08 mm	0.00157–0.0031 in
Piston Compression Ring Groove Clearance - LQ4 Service - 2nd	0.039–0.079 mm	0.0015–0.0031 in
Piston Oil Ring Groove Clearance - LQ4 Service	0.015–0.2 mm	0.0006–0.0079 in
Piston Compression Ring Groove Clearance - LQ9 Production - Top	0.035–0.080 mm	0.0014–0.0031 in
Piston Compression Ring Groove Clearance - LQ9 Production - 2nd	0.034–0.079 mm	0.0013–0.0030 in
Piston Oil Ring Groove Clearance - LQ9 Production	0.012–0.20 mm	0.00047–0.00078 in
Piston Compression Ring Groove Clearance - LQ9 Service - Top	0.035–0.080 mm	0.0014–0.0031 in
Piston Compression Ring Groove Clearance - LQ9 Service - 2nd	0.034–0.079 mm	0.0013–0.0030 in
Piston Oil Ring Groove Clearance - LQ9 Service	0.012–0.20 mm	0.00047–0.0078 in
Valve System		
Valve Face Angle	45 degrees	
Valve Lash	Net Lash-No Adjustment	
Valve Lift (Exhaust)	12.16 mm	0.479 in
Valve Lift (Intake)	11.79 mm	0.464 in
Valve Lifter	Hydraulic Roller	
Valve Margin	1.25 mm	0.05 in
Valve Rocker Arm Ratio	1.70:1	
Valve Seat Angle	46 degrees	
Valve Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
Valve Seat Width (Exhaust)	1.78 mm	0.07 in

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Fig. 11: Engine Mechanical Specifications - LQ4 VIN U/LQ9 VIN N (3 Of 4)
Courtesy of GENERAL MOTORS CORP.

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Application	Metric	English
Valve Seat Width (Intake)	1.02 mm	0.04 in
Valve Spring Free Length	52.9 mm	2.08 in
Valve Spring Installed Height (Exhaust)	45.75 mm	1.8 in
Valve Spring Installed Height (Intake)	45.75 mm	1.8 in
Valve Spring Pressure (Closed)	340 N at 45.75 mm	76 lb at 1.8 in
Valve Spring Pressure (Open)	980 N at 33.55 mm	220 lb at 1.32 in
Valve Stem Clearance (Production—Exhaust)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Production—Intake)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Service—Exhaust)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Clearance (Service—Intake)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Diameter (Production—Exhaust)	7.955–7.976 mm	0.3132–0.314 in
Valve Stem Diameter (Production—Intake)	7.955–7.976 mm	0.3132–0.314 in
Valve Stem Diameter (Service—Exhaust)	7.95 mm (Minimum)	0.313 in (Minimum)
Valve Stem Diameter (Service—Intake)	7.95 mm (Minimum)	0.313 in (Minimum)
Valve Stem Oil Seal Installed Height (Measured from the Valve Spring Seat to Top Edge of Seal Body - First Design Seal)	18.1–19.1 mm	0.712–0.752 in

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Fig. 12: Engine Mechanical Specifications - LQ4 VIN U/LQ9 VIN N (4 Of 4)
Courtesy of GENERAL MOTORS CORP.

SEALERS, ADHESIVES, AND LUBRICANTS

Application	Type of Material	GM Part Number	
		United States	Canada
Coolant Sensor Threads	Sealant	12346004	10953480
Cylinder Head Core Hole Plugs	Threadlock	12345382	10953489
Cylinder Head Expansion Plugs – Aluminum	Threadlock	12345382	10953489
Engine Block Front Oil Gallery Plug	Threadlock	12345382	10953489
Engine Block Plug Sealing Washers	Sealant	12346004	10953480
Engine Flywheel Bolt Threads	Threadlock	12345382	10953489
Engine Oil	5W-30 Oil	12345610	993193
Engine Oil Supplement	Fluorescent Dye	12345795	10953470
Exhaust Manifold Bolt Threads	Threadlock	12345493	10953488
Fuel Rail Bolt Threads	Threadlock	12345382	10953489
Ignition Coil and Bracket Bolts	Threadlock	12345382	10953489
Ignition Coil Bracket Bolts	Threadlock	12345382	10953489
Intake Manifold Bolt Threads	Threadlock	12345382	10953489
Oil Pan Surface at Front and Rear Covers	Sealant	12378190	—
Oil Pressure Sensor Threads	Sealant	12346004	10953480
Thread Repair Component Cleaner	Cleaner	12346139	10953463
Thread Repair Component Cleaner	Cleaner	12377981	10953463
Thread Repair Cutting Oil	Lubricant	1052864	992881

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Fig. 13: Sealers, Adhesives, and Lubricants
Courtesy of GENERAL MOTORS CORP.

THREAD REPAIR SPECIFICATIONS

Engine Block-Front View

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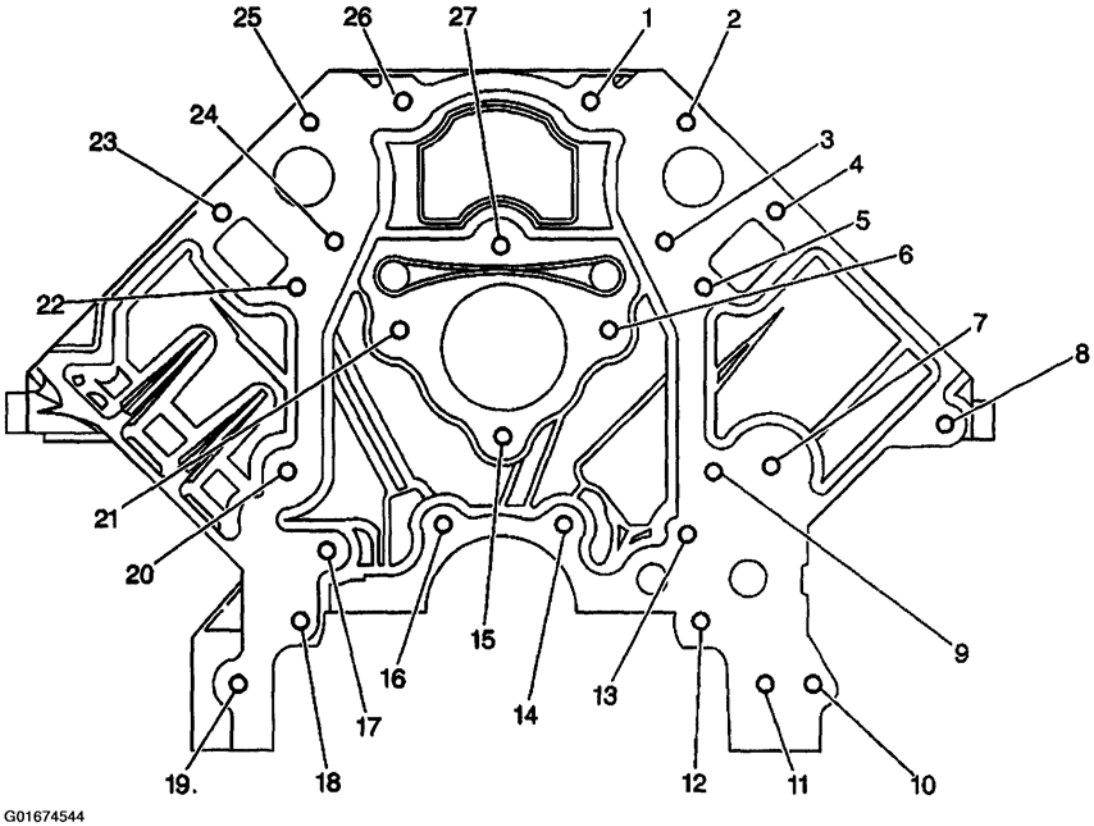


Fig. 14: Engine Block - Front View
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 15: Engine Block - Front View Hole Thread Sizes
Courtesy of GENERAL MOTORS CORP.

Engine Block-Rear View

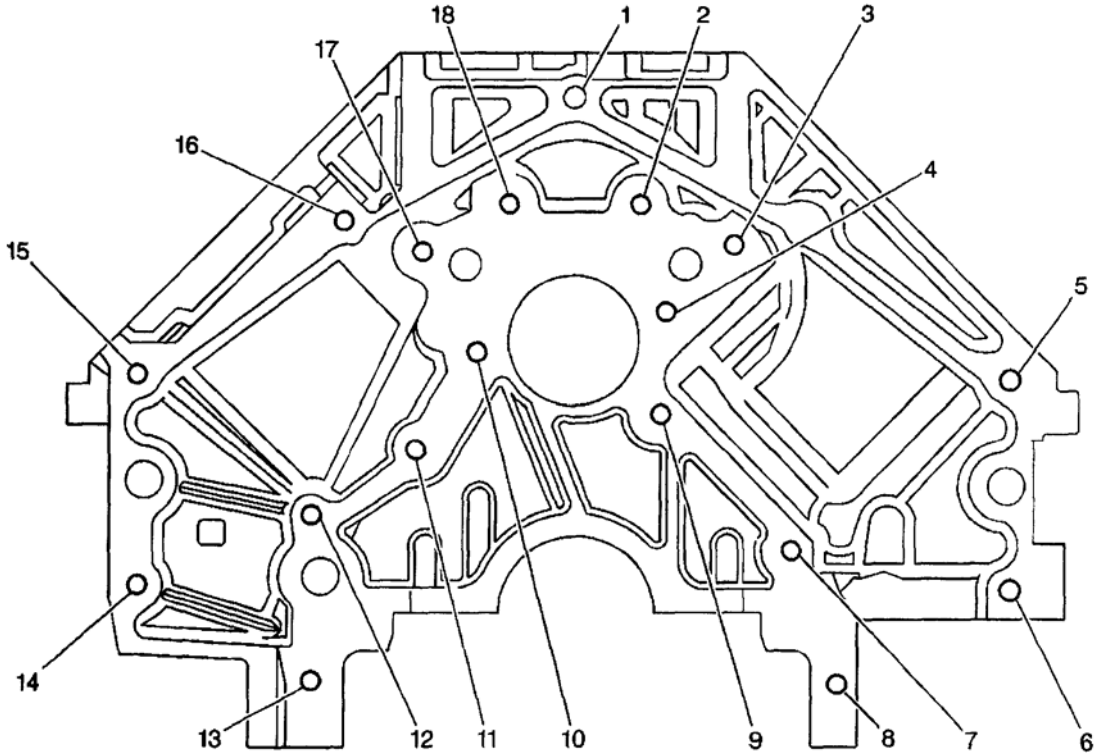


Fig. 16: Engine Block - Rear View
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 17: Engine Block - Rear View Hole Thread Sizes

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Courtesy of GENERAL MOTORS CORP.

Engine Block-Left Side View

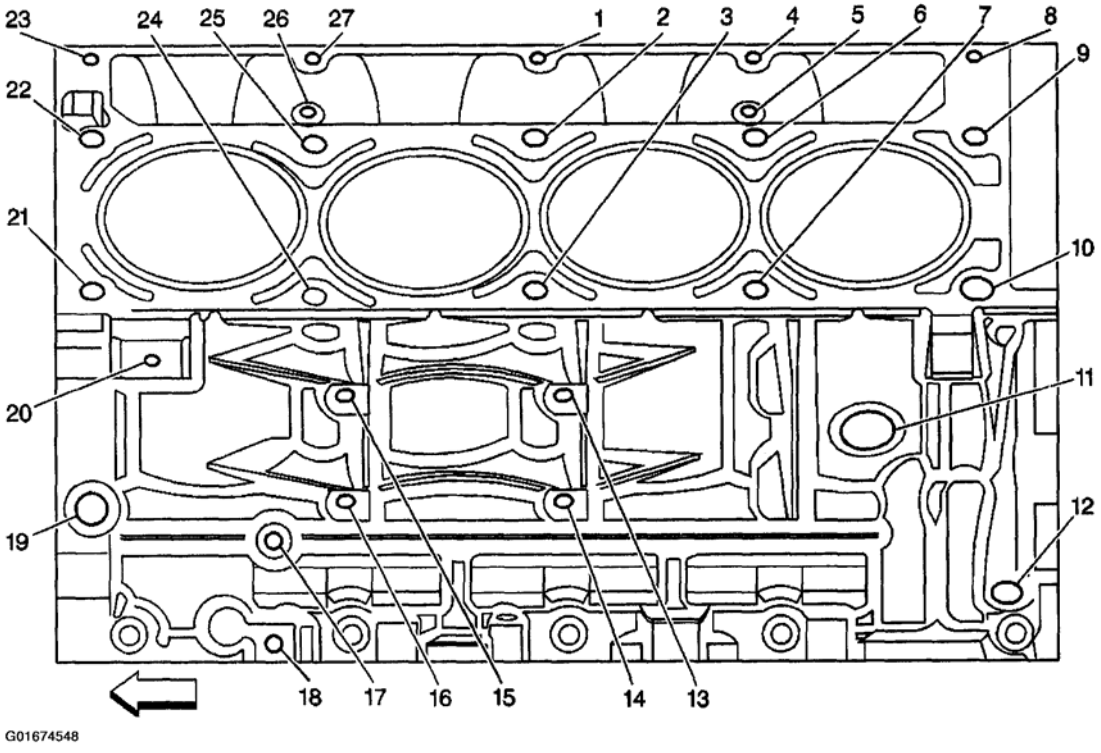


Fig. 18: Engine Block - Left Side View
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 19: Engine Block - Left Side View Hole Thread Sizes (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
13–16	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	29.0 (1.14)	23.0 (0.905)
17–18	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0 (0.826)	16.0 (0.629)
19	M16 x 1.5	—	—	—	—	—	—	—
20	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0 (1.06)	21.5 (0.846)
21	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
22	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0 (2.72)	60.0 (2.36)
23	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
24–25	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
26	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	16.0 (0.629)
27	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)

- Bolt holes 2, 3, 6, 7, 10, 21, 24, and 25 have a 85 mm (3.34 in) counterbore included in the 124.0 mm (4.88 in) drill depth.
- Bolt holes 9 and 22 have a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.

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Fig. 20: Engine Block - Left Side View Hole Thread Sizes (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

Engine Block-Right Side View

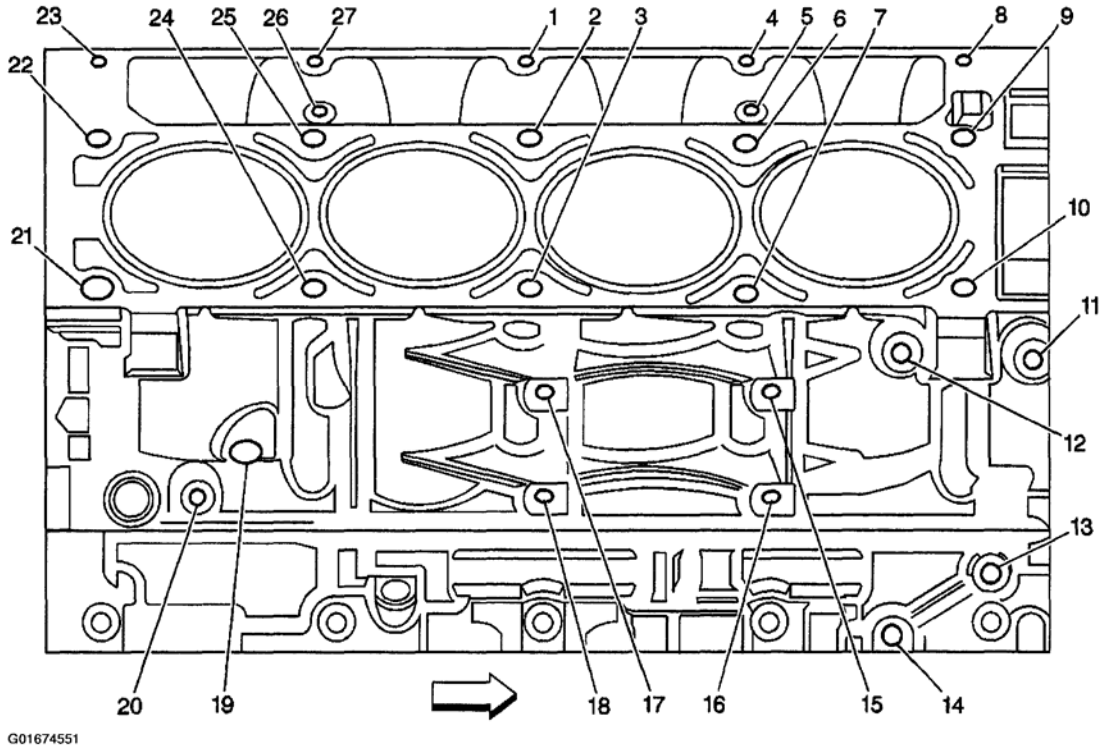


Fig. 21: Engine Block - Right Side View
Courtesy of GENERAL MOTORS CORP.

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Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
2–3	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
5	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	15.0 (0.590)
6–7	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
9	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0 (2.72)	60.0 (2.36)
10	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
11–14	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0 (1.06)	21.5 (0.846)
15–18	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	29.0 (1.14)	23.0 (0.905)

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Fig. 22: Engine Block - Right Side View Hole Thread Sizes (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
19	M16 x 1.5	—	—	—	—	—	—	—
20	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
21	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
22	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0 (2.72)	60.0 (2.36)
23	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
24–25	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
26	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	15.0 (0.590)
27	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)

- Bolt holes 2, 3, 6, 7, 10, 21, 24, and 25 have a 85 mm (3.34 in) counterbore included in the 124.0 mm (4.88 in) drill depth.
- Bolt holes 9 and 22 have a 29 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.

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Fig. 23: Engine Block - Right Side View Hole Thread Sizes (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

Engine Block-Bottom View

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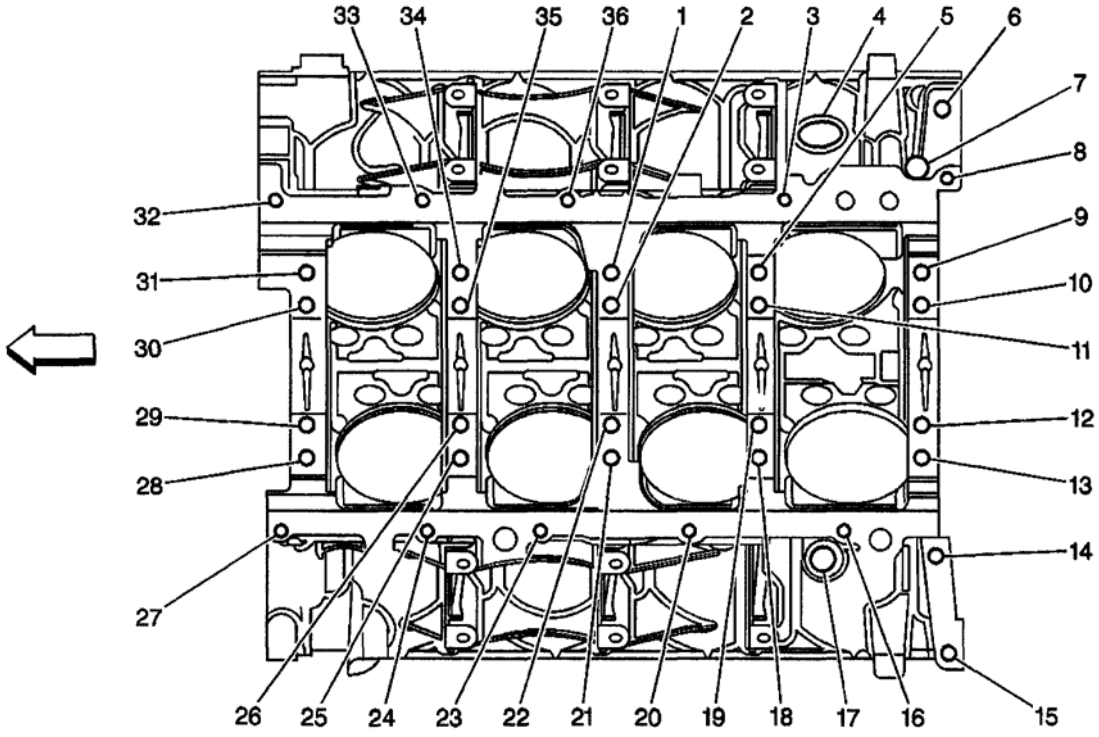


Fig. 24: Engine Block - Bottom View
Courtesy of GENERAL MOTORS CORP.

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
2	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
3	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
4	M28 x 1.25	—	—	—	—	—	—	—
5	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
6	N/A	—	—	—	—	—	—	—
7	M16 x 1.5	—	—	—	—	—	—	—
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
9	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1 0)
10–12	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
13	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)

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Fig. 25: Engine Block - Bottom View Hole Thread Sizes (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

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

- Bolt holes 2, 10, 11, 12, 19, 22, 26, 29, 30, and 35 have a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.
- Bolt holes 1, 5, 9, 13, 18, 21, 25, 28, 31, and 34 have a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap.
- Bolt holes 14 and 15 have a 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap.

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Fig. 26: Engine Block - Bottom View Hole Thread Sizes (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

Engine Block-Top View

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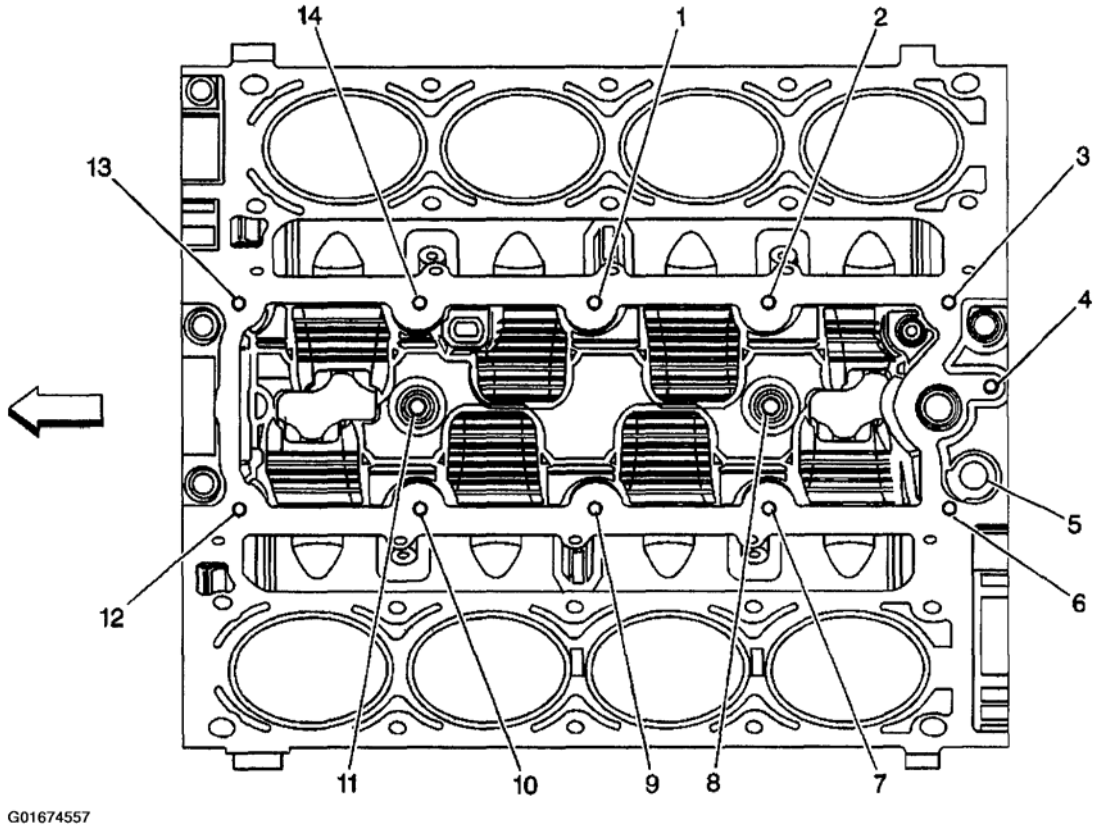


Fig. 27: Engine Block - Top View
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 28: Engine Block - Top View Hole Thread Sizes
Courtesy of GENERAL MOTORS CORP.

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Cylinder Head-Top View

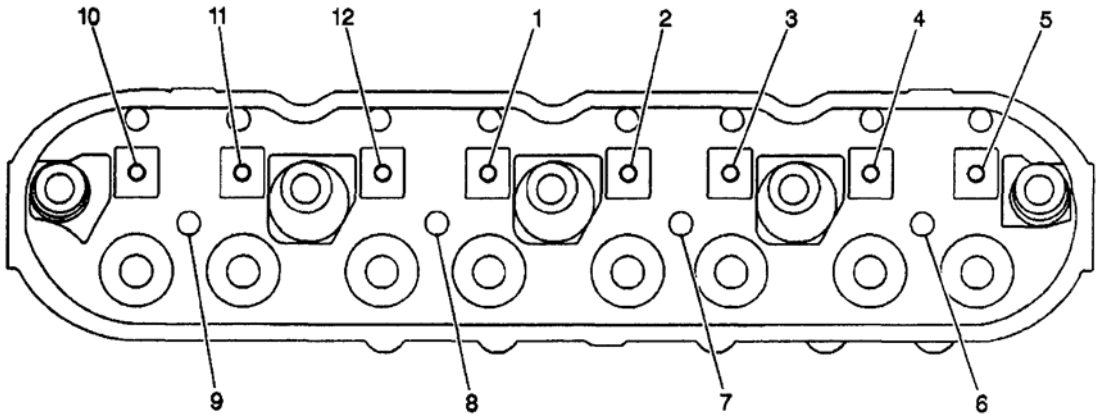


Fig. 29: Cylinder Head - Top View
Courtesy of GENERAL MOTORS CORP.

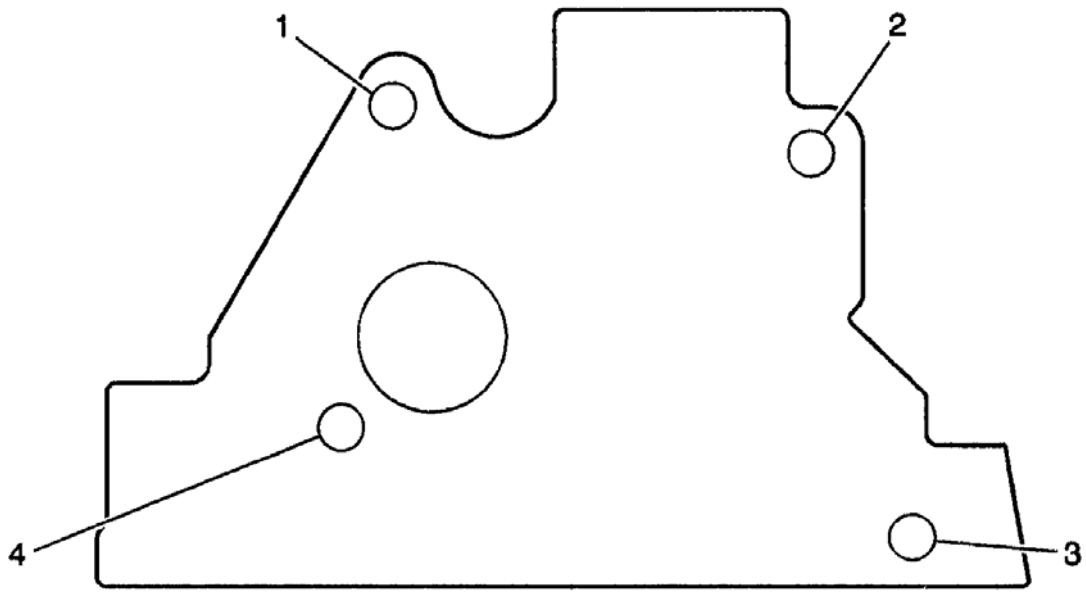
Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1–5	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
6–9	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	20.05 (0.789)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

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Fig. 30: Cylinder Head - Top View Hole Thread Sizes
Courtesy of GENERAL MOTORS CORP.

Cylinder Head-End View

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Fig. 31: Cylinder Head - End View (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 32: Cylinder Head - End View Hole Thread Sizes
Courtesy of GENERAL MOTORS CORP.

Cylinder Head-Exhaust Manifold Deck View

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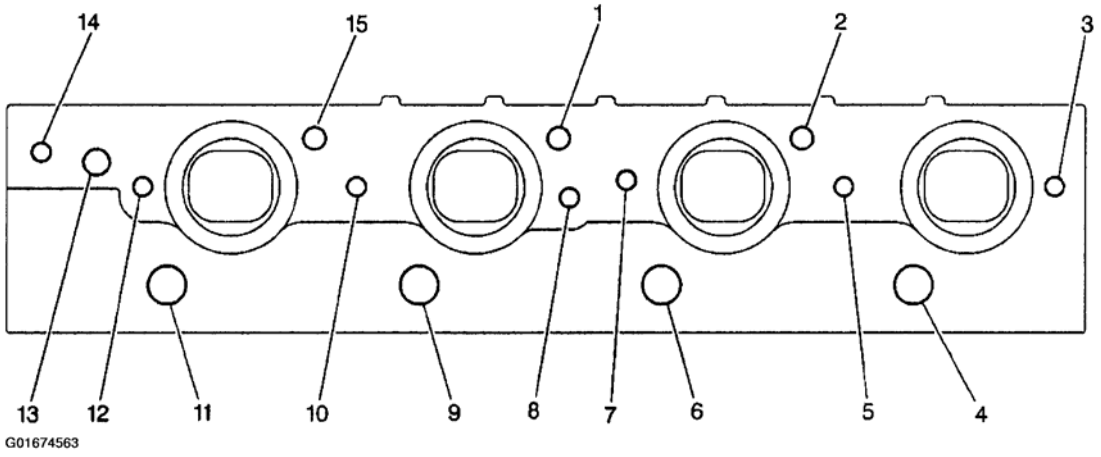


Fig. 33: Cylinder Head - Exhaust Manifold Deck View
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 34: Cylinder Head - Exhaust Manifold Deck View Hole Thread Sizes
Courtesy of GENERAL MOTORS CORP.

Cylinder Head-Intake Manifold Deck View

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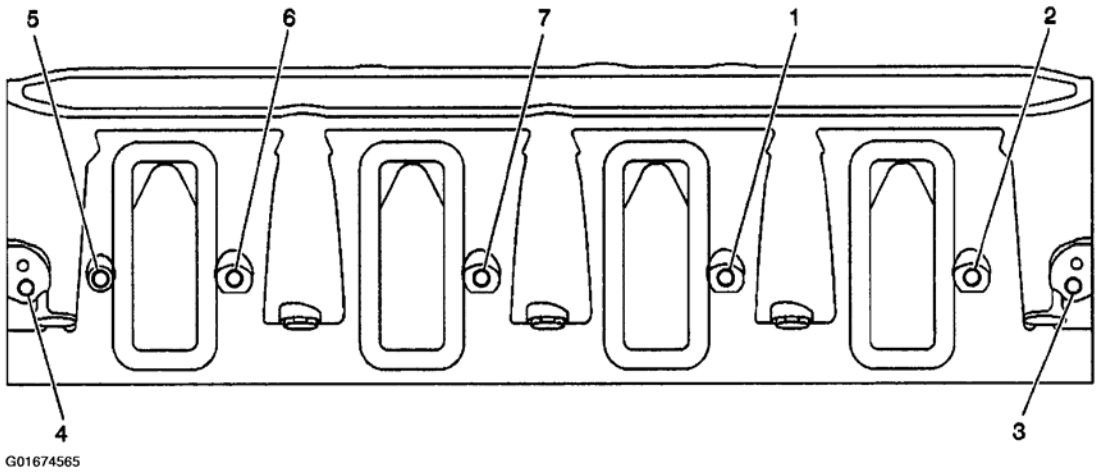


Fig. 35: Cylinder Head - Intake Manifold Deck View
Courtesy of GENERAL MOTORS CORP.

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

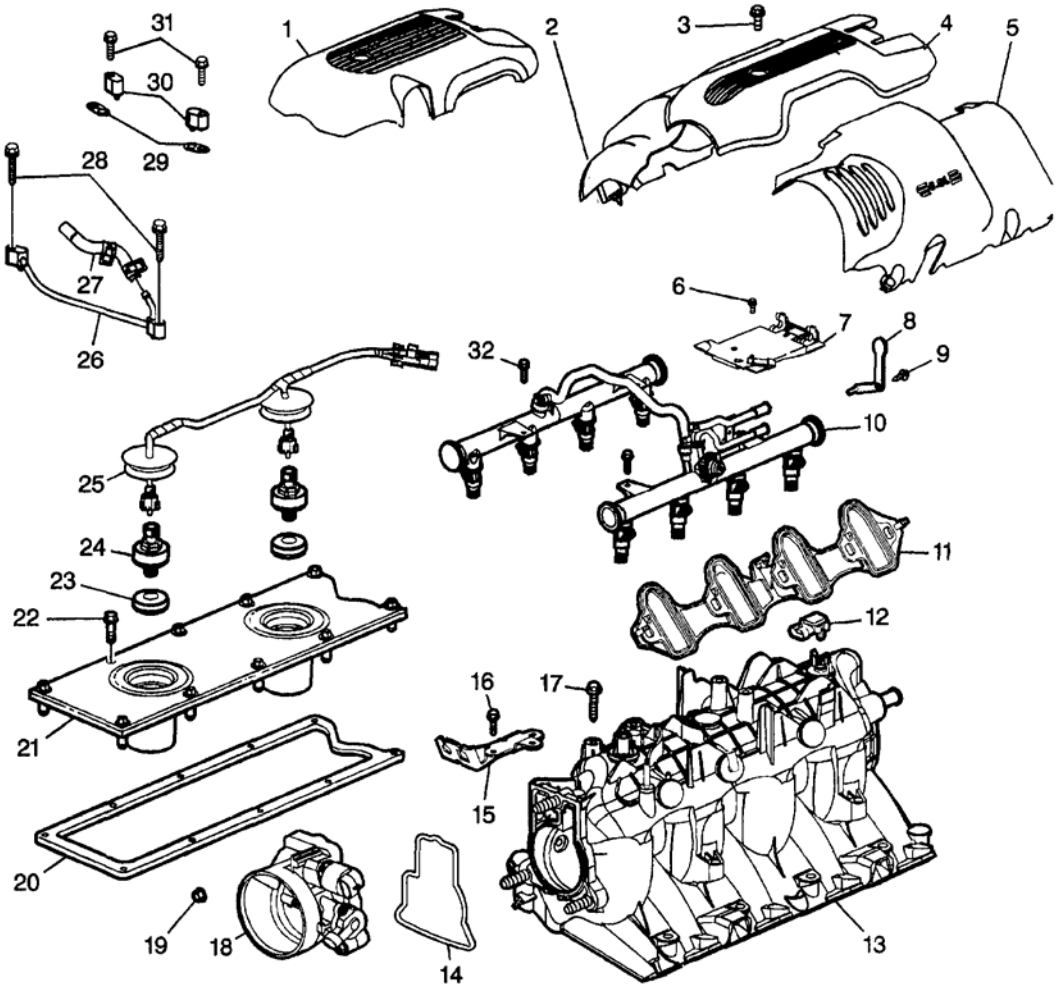
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Fig. 36: Cylinder Head - Intake Manifold Deck View Hole Thread Sizes
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

DISASSEMBLED VIEWS

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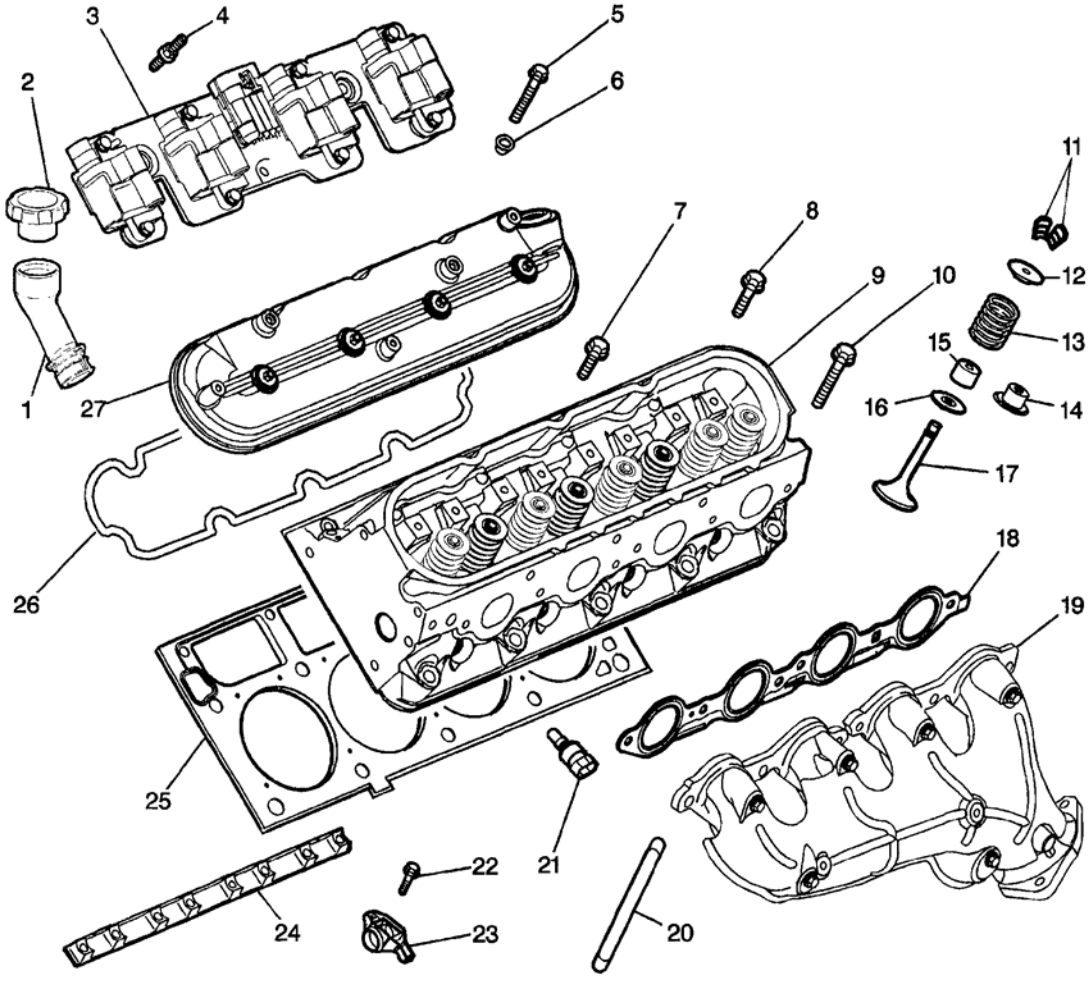
(1) Engine Sight Shield – 4.8/5.3 L
(2) Engine Sight Shield – Right Side 6.0 L
(3) Engine Sight Shield Bolt
(4) Engine Sight Shield – Center 6.0 L
(5) Engine Sight Shield – Left Side 6.0 L
(6) Engine Sight Shield Bracket Bolt
(7) Engine Sight Shield Bracket
(8) Fuel Rail Stop Bracket
(9) Fuel Rail Stop Bracket Bolt
(10) Fuel Rail – with Injectors
(11) Intake Manifold Gasket
(12) Manifold Absolute Pressure (MAP) Sensor
(13) Intake Manifold
(14) Throttle Body Gasket
(15) Throttle Cable Bracket
(16) Throttle Cable Bracket Bolt
(17) Intake Manifold Bolt
(18) Throttle Body
(19) Throttle Body Nut
(20) Valley Cover Gasket
(21) Valley Cover
(22) Valley Cover Bolt
(23) Knock Sensor Oil Seal
(24) Knock Sensor
(25) Knock Sensor Wire Harness
(26) Engine Coolant Air Bleed Pipe
(27) Engine Coolant Air Bleed Pipe Hose
(28) Engine Coolant Air Bleed Pipe Bolt
(29) Engine Coolant Air Bleed Pipe/Cover Gasket
(30) Engine Coolant Air Bleed Pipe Cover
(31) Engine Coolant Air Bleed Pipe/Cover Bolt
(32) Fuel Rail Bolt

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Fig. 37: Intake Manifold/Upper Engine Disassembled View

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

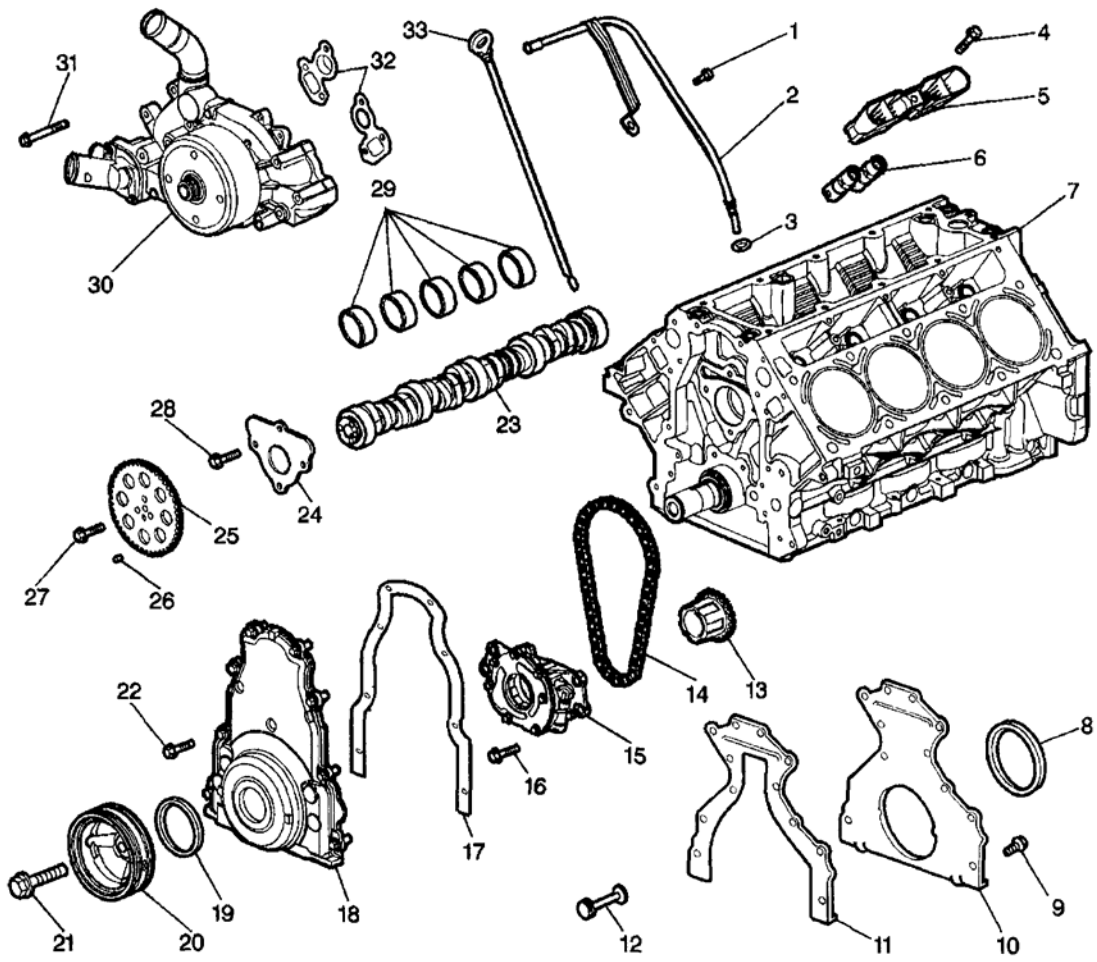
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Fig. 38: Cylinder Head/Upper Engine Disassembled View

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

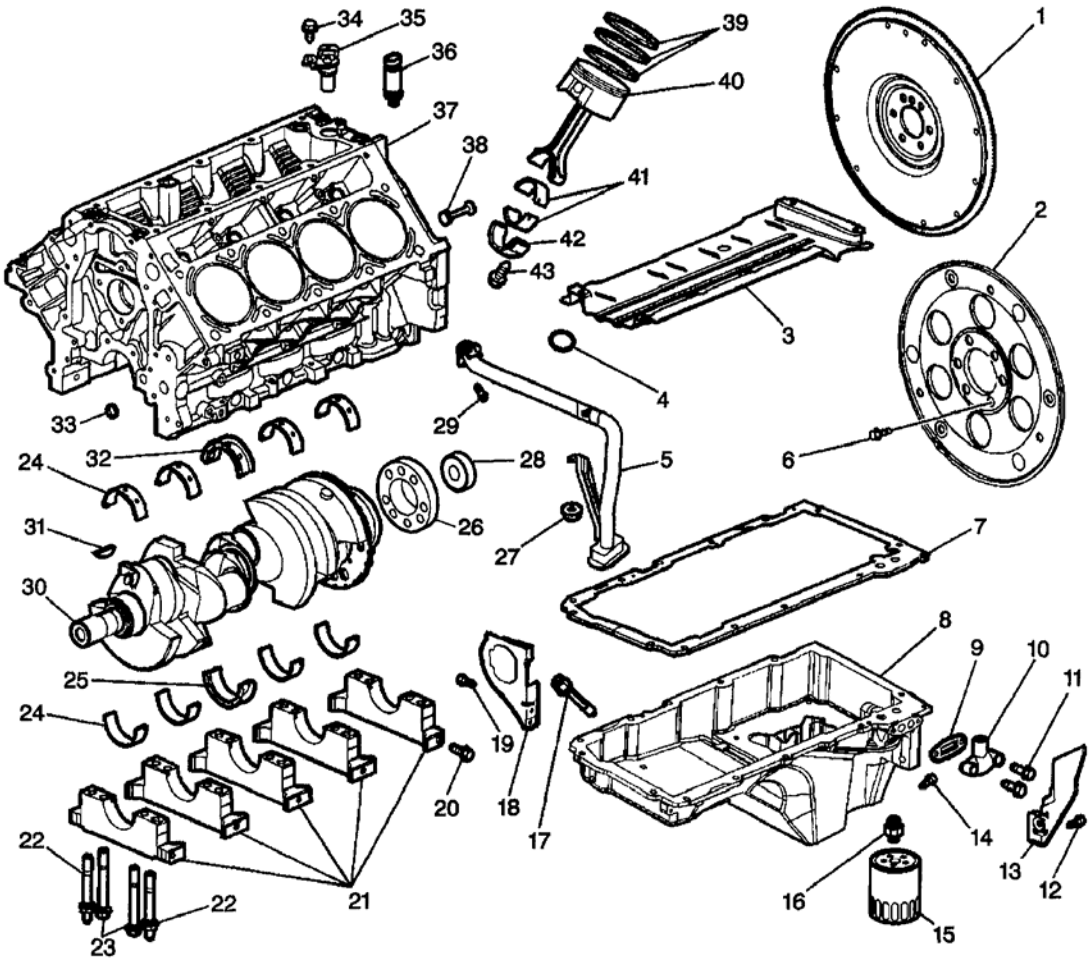
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Fig. 39: Lower Front of Engine Disassembled View

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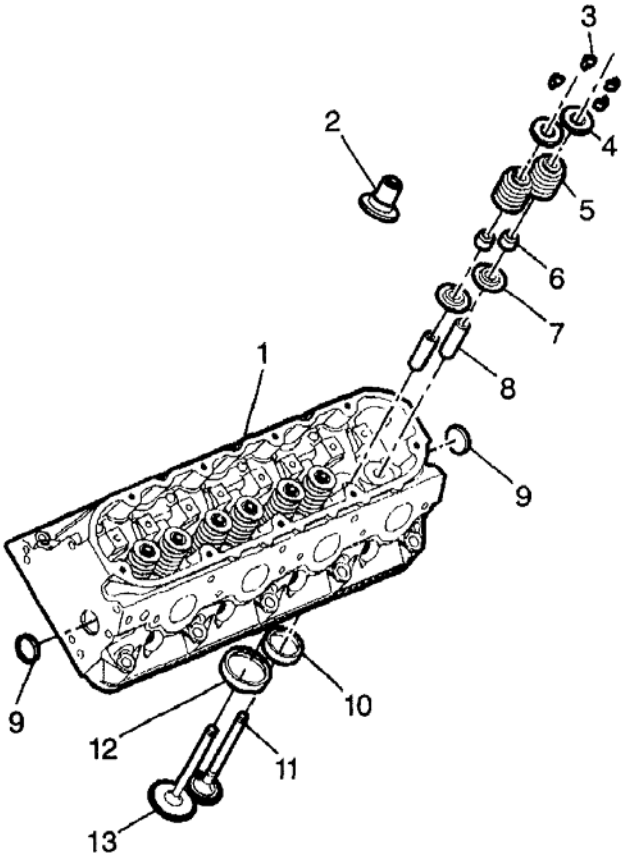
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(1) Flywheel – Manual Transmission
(2) Flywheel – Automatic Transmission
(3) Crankshaft Oil Deflector
(4) Oil Pump Screen O-ring Seal
(5) Oil Pump Screen
(6) Flywheel Bolt
(7) Oil Pan Gasket
(8) Oil Pan
(9) Oil Pan Cover Gasket
(10) Oil Pan Cover
(11) Oil Pan Cover Bolt
(12) Oil Pan Closeout Cover Bolt – Left Side
(13) Oil Pan Closeout Cover – Left Side
(14) Oil Pan Drain Plug
(15) Oil Filter
(16) Oil Filter Adapter
(17) Oil Level Sensor
(18) Oil Pan Closeout Cover – Right Side
(19) Oil Pan Closeout Cover Bolt – Right Side
(20) Crankshaft Bearing Cap Side Bolt
(21) Crankshaft Bearing Caps
(22) Crankshaft Bearing Cap Bolt/Stud
(23) Crankshaft Bearing Cap Bolt
(24) Crankshaft Bearing
(25) Crankshaft Thrust Bearing – Lower
(26) Spacer
(27) Oil Pump Screen Nut
(28) Clutch Pilot Bearing
(29) Oil Pump Screen Bolt
(30) Crankshaft
(31) Crankshaft Sprocket Key
(32) Crankshaft Thrust Bearing – Upper
(33) Engine Block Front Oil Gallery Plug
(34) Camshaft Position Sensor Bolt
(35) Camshaft Position Sensor
(36) Oil Pressure Sensor
(37) Engine Block
(38) Engine Block Rear Oil Gallery Plug
(39) Piston Rings
(40) Piston and Connecting Rod Assembly
(41) Connecting Rod Bearings
(42) Connecting Rod Cap
(43) Connecting Rod Bolt

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Fig. 40: Lower Engine Assembly Disassembled View
Courtesy of GENERAL MOTORS CORP.



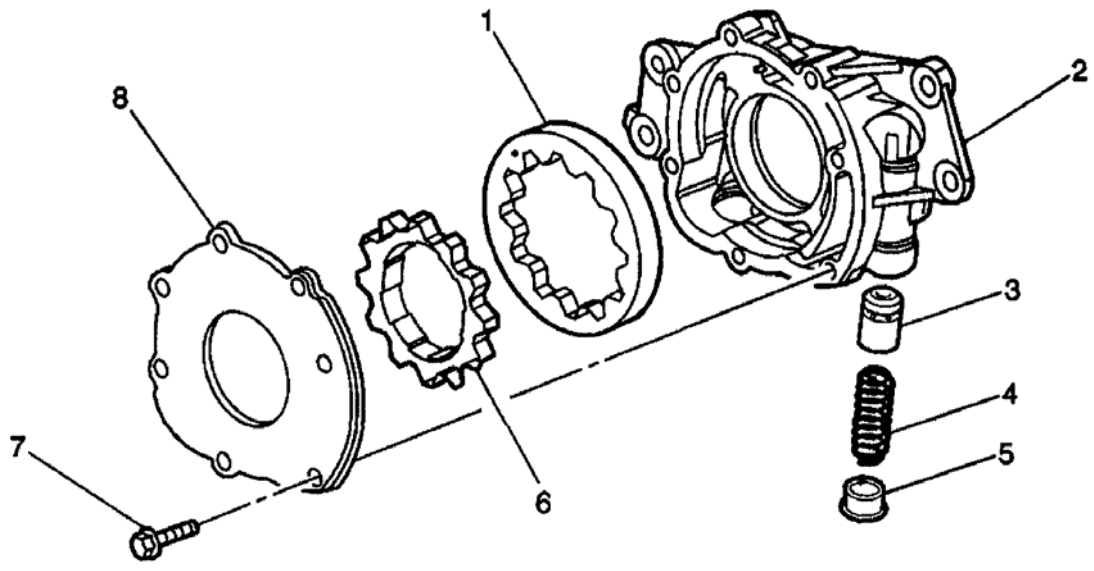
(1) Cylinder Head
(2) Valve Stem Oil Seal and Shim Assembly – Second Design
(3) Valve Stem Keys
(4) Valve Spring Cap
(5) Valve Spring
(6) Valve Stem Oil Seal – First Design
(7) Valve Spring Shim – First Design
(8) Valve Guide
(9) Cylinder Head Expansion Plugs
(10) Exhaust Valve Seat
(11) Exhaust Valve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

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Fig. 41: Cylinder Head Assembly Disassembled View - Aluminum

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Courtesy of GENERAL MOTORS CORP.



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

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Fig. 42: Oil Pump Assembly Disassembled View
Courtesy of GENERAL MOTORS CORP.

Engine Identification

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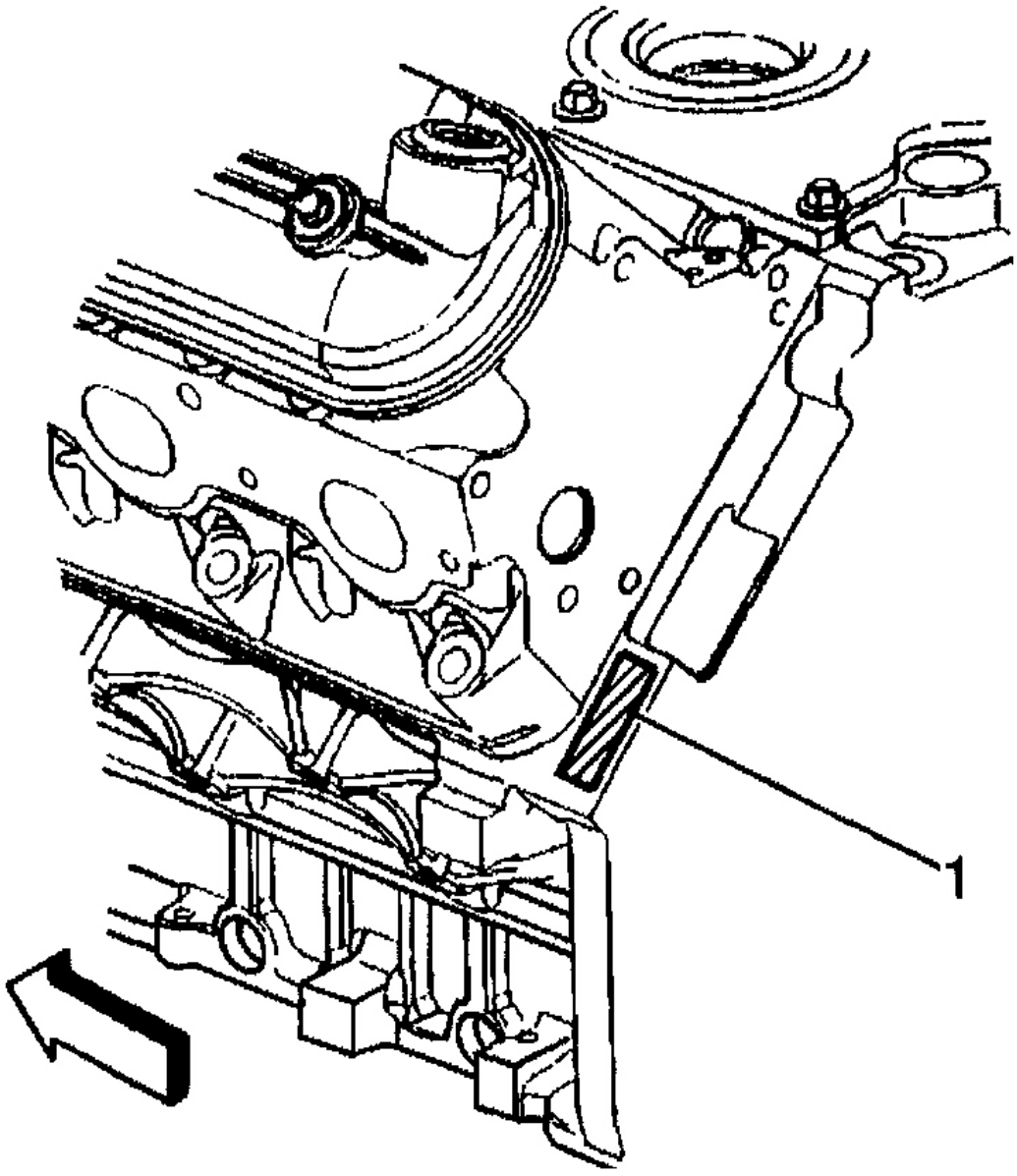


Fig. 43: Locating Engine Identification Label On Cylinder Head
Courtesy of GENERAL MOTORS CORP.

The engine identification numbers and bar-coded label (1) for the 4.8/5.3/6.0 liter engines are located at the left rear of the engine block. A second bar-coded label may be located on the right side of the oil pan.

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REPAIR INSTRUCTIONS

DRAINING FLUIDS AND OIL FILTER REMOVAL

Tools Required

J 41712 Oil Pressure Sensor Socket

IMPORTANT: In order to completely drain the oil, the bottom of the oil pan must be level during the oil drain procedure.

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

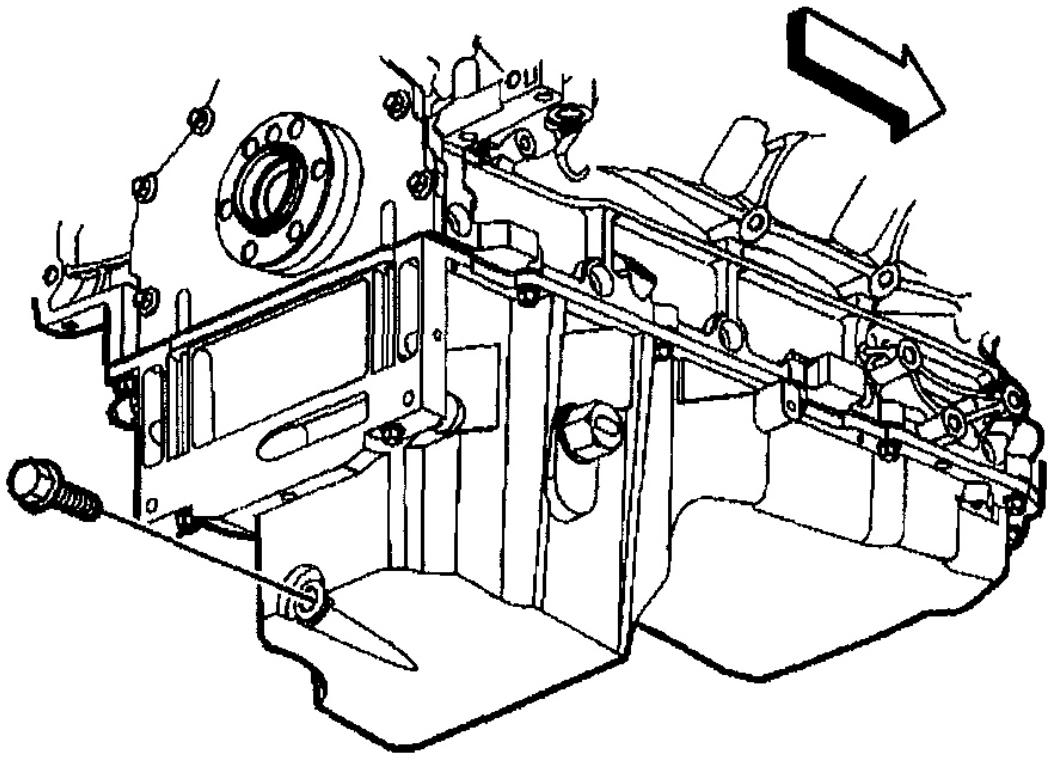
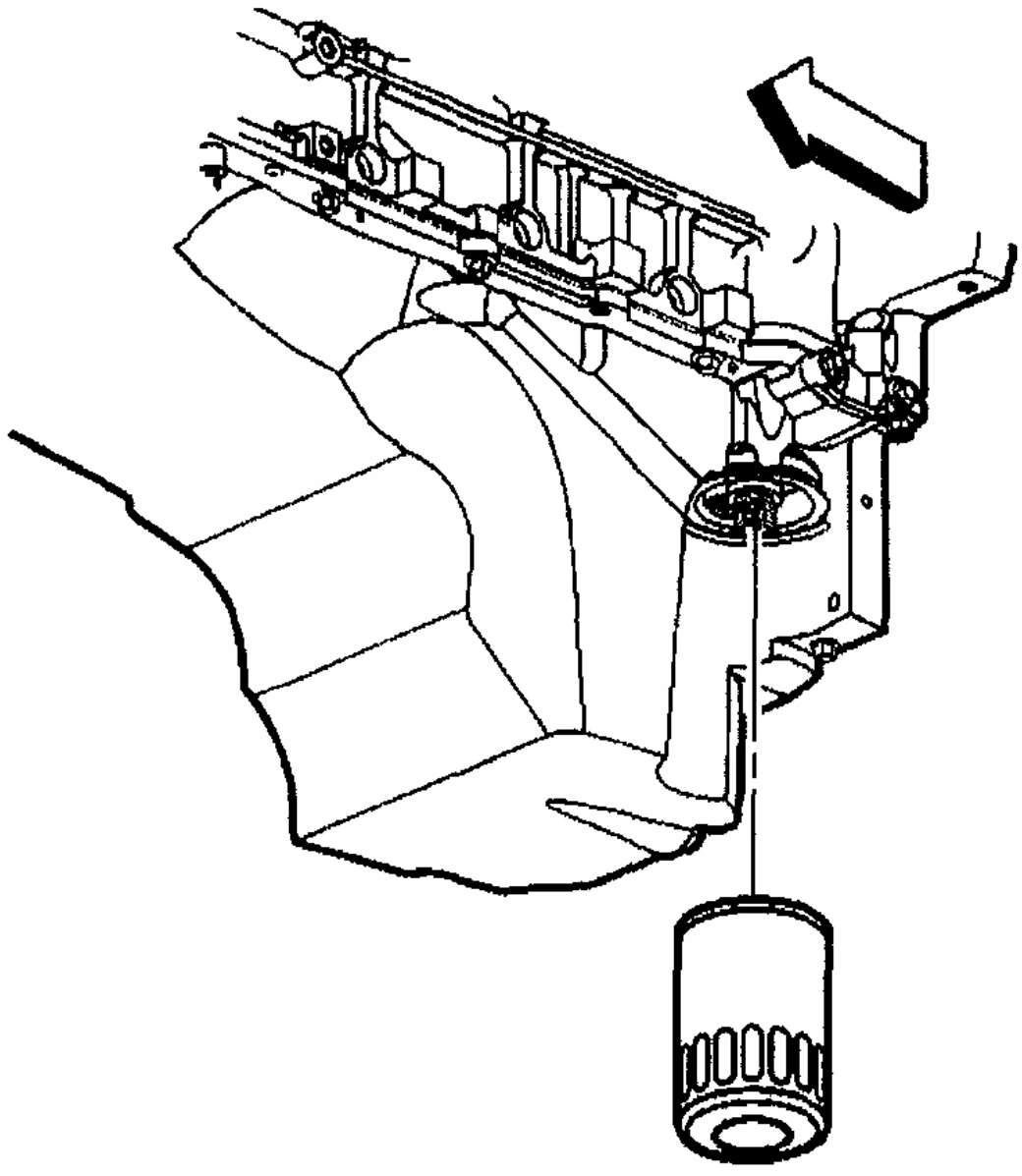


Fig. 44: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine oil filter.

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Fig. 45: Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

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

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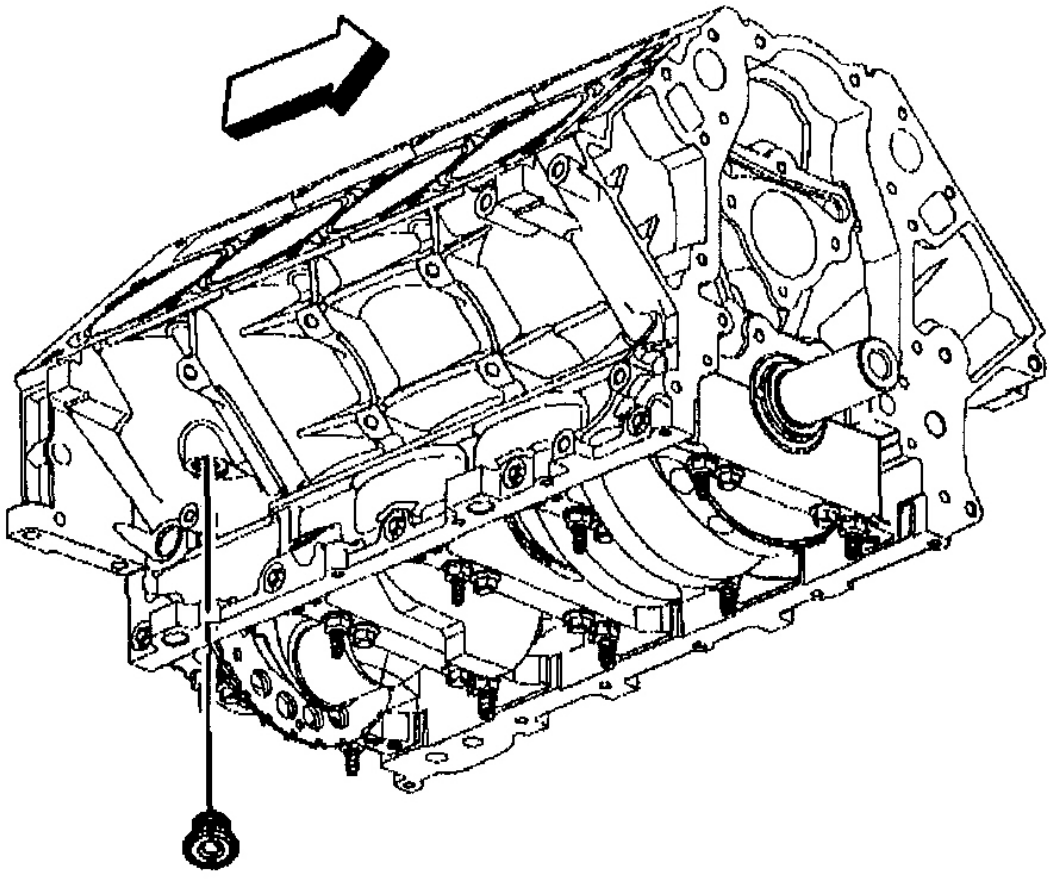
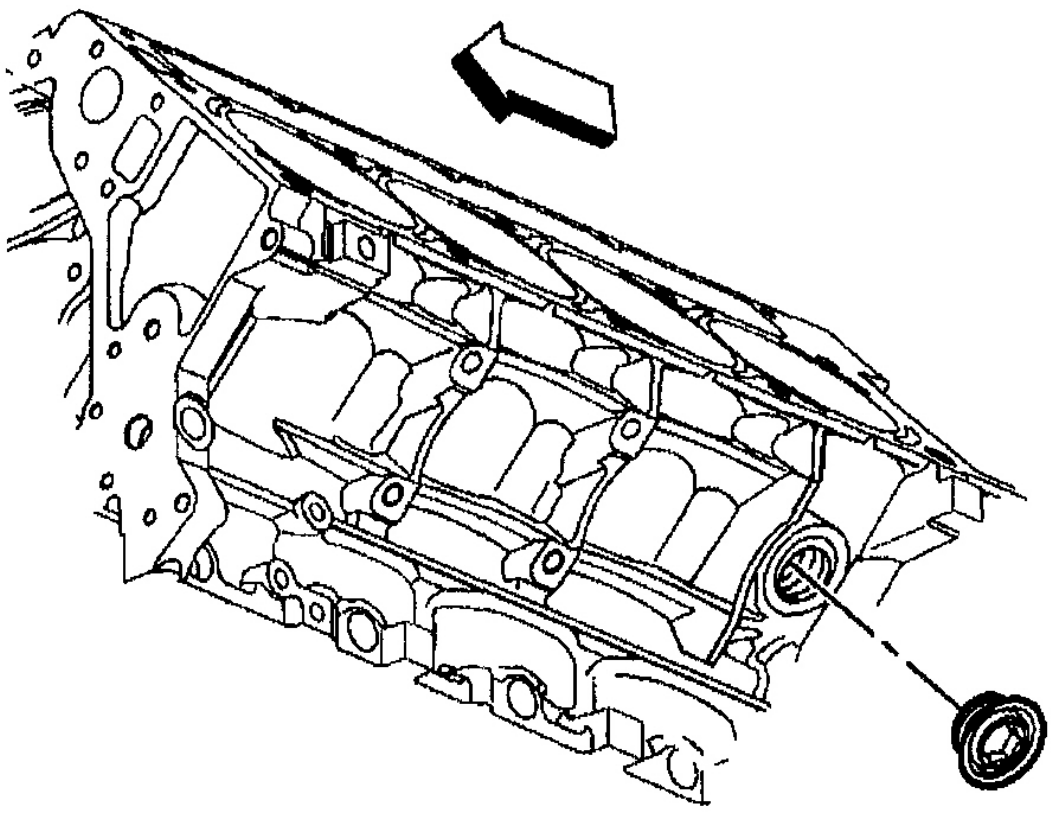


Fig. 46: Engine Block Coolant Drain Plug (Right Rear)
Courtesy of GENERAL MOTORS CORP.

4. Remove the left rear engine block coolant drain plug, if applicable, and allow the coolant to drain.

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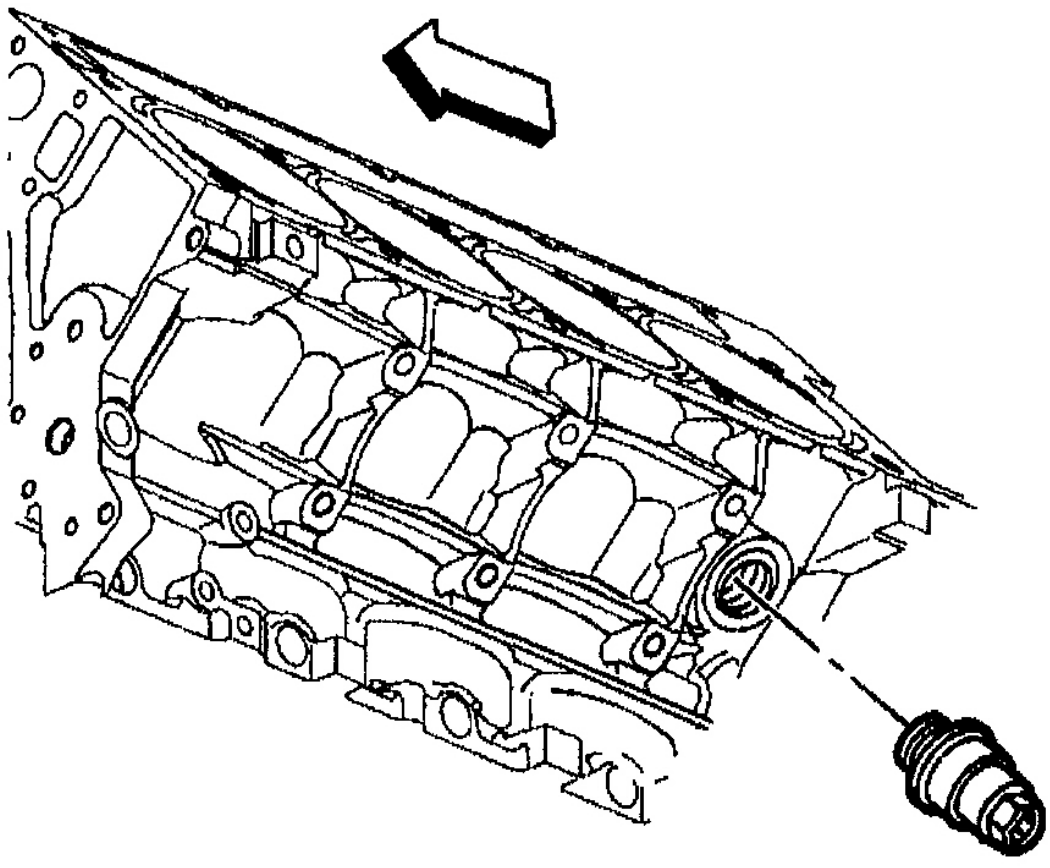


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Fig. 47: Engine Block Coolant Drain Plug (Left Rear)
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 48: Engine Block Coolant Heater
Courtesy of GENERAL MOTORS CORP.

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

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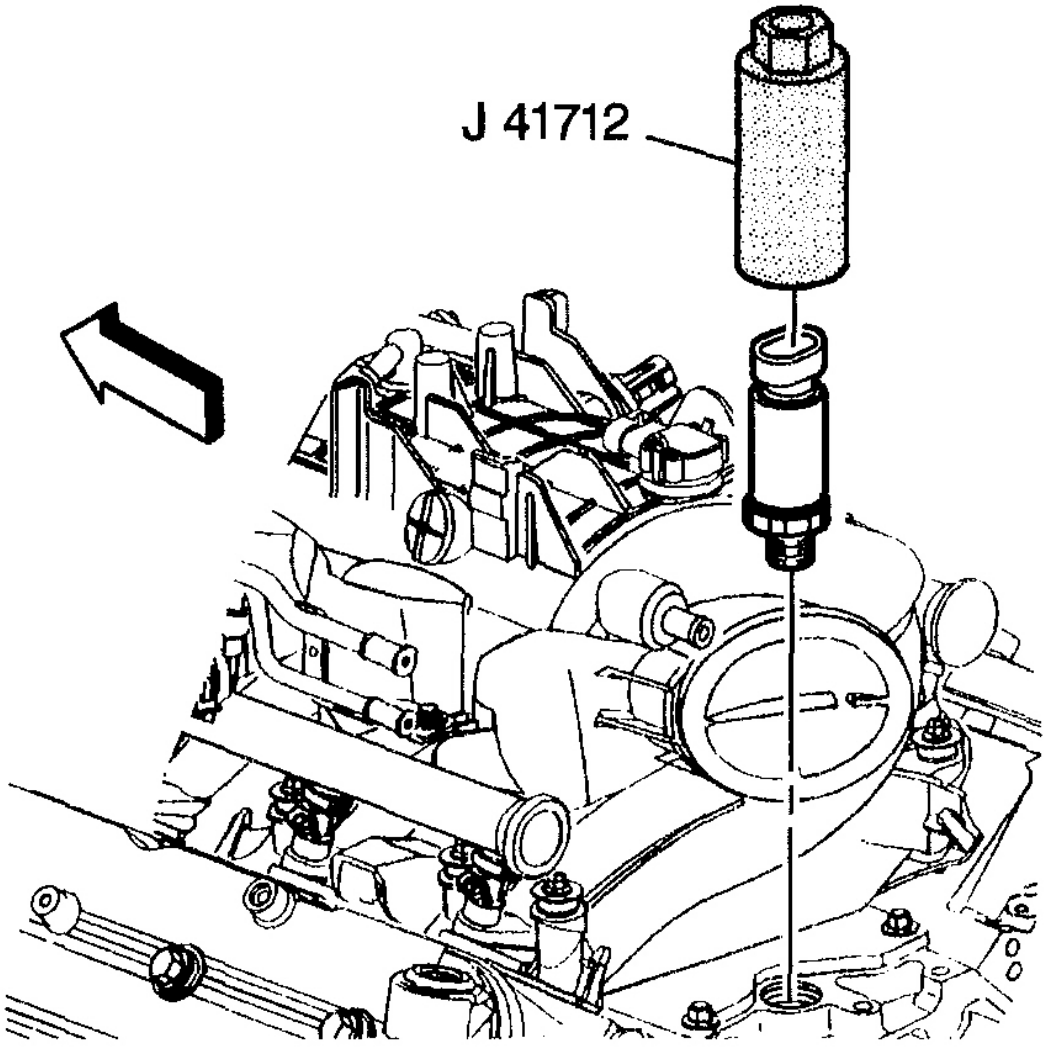


Fig. 49: Removing Oil Pressure Sensor Using J 41712
Courtesy of GENERAL MOTORS CORP.

CRANKSHAFT BALANCER REMOVAL

Tools Required

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

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NOTE: **Refer to FASTENER NOTICE in Cautions and Notices.**

IMPORTANT:

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

1. Install the J 42386-A and bolts.

   Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation.

   Tighten

   Tighten the J 42386-A bolts to 50 N.m (37 lb ft).

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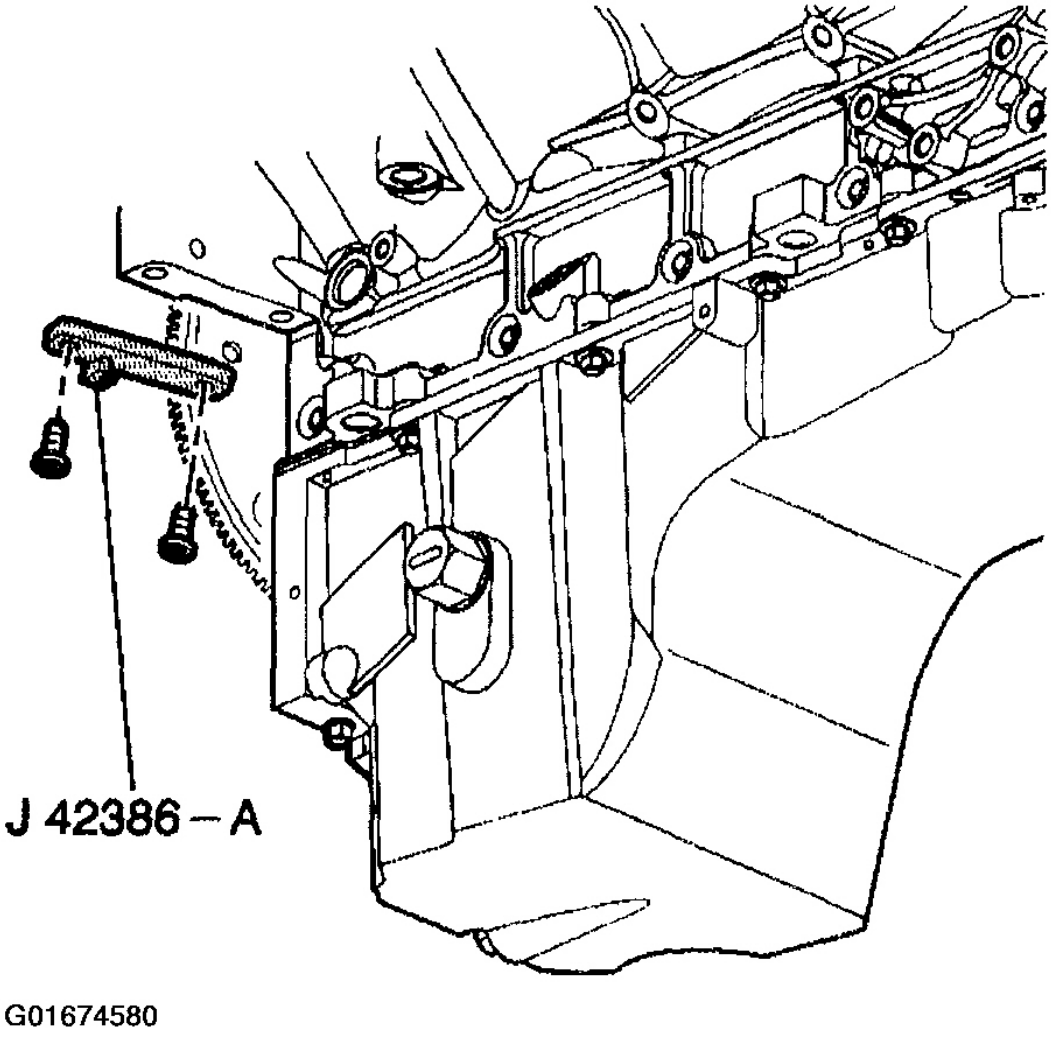
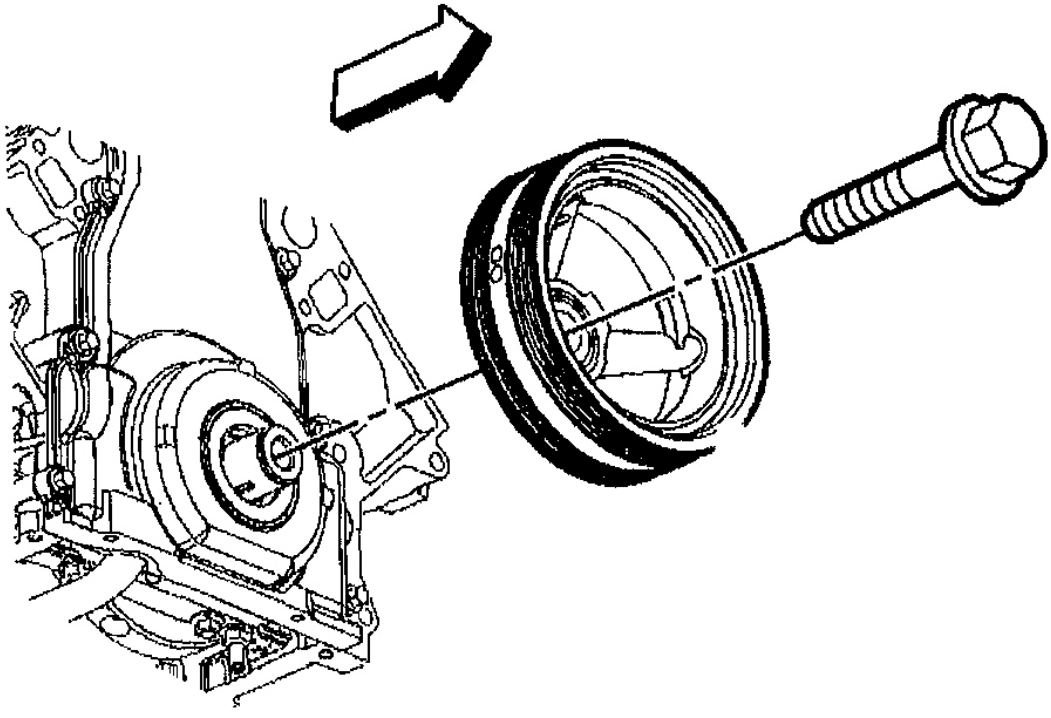


Fig. 50: J 42386
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft balancer bolt.

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

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Fig. 51: Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

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

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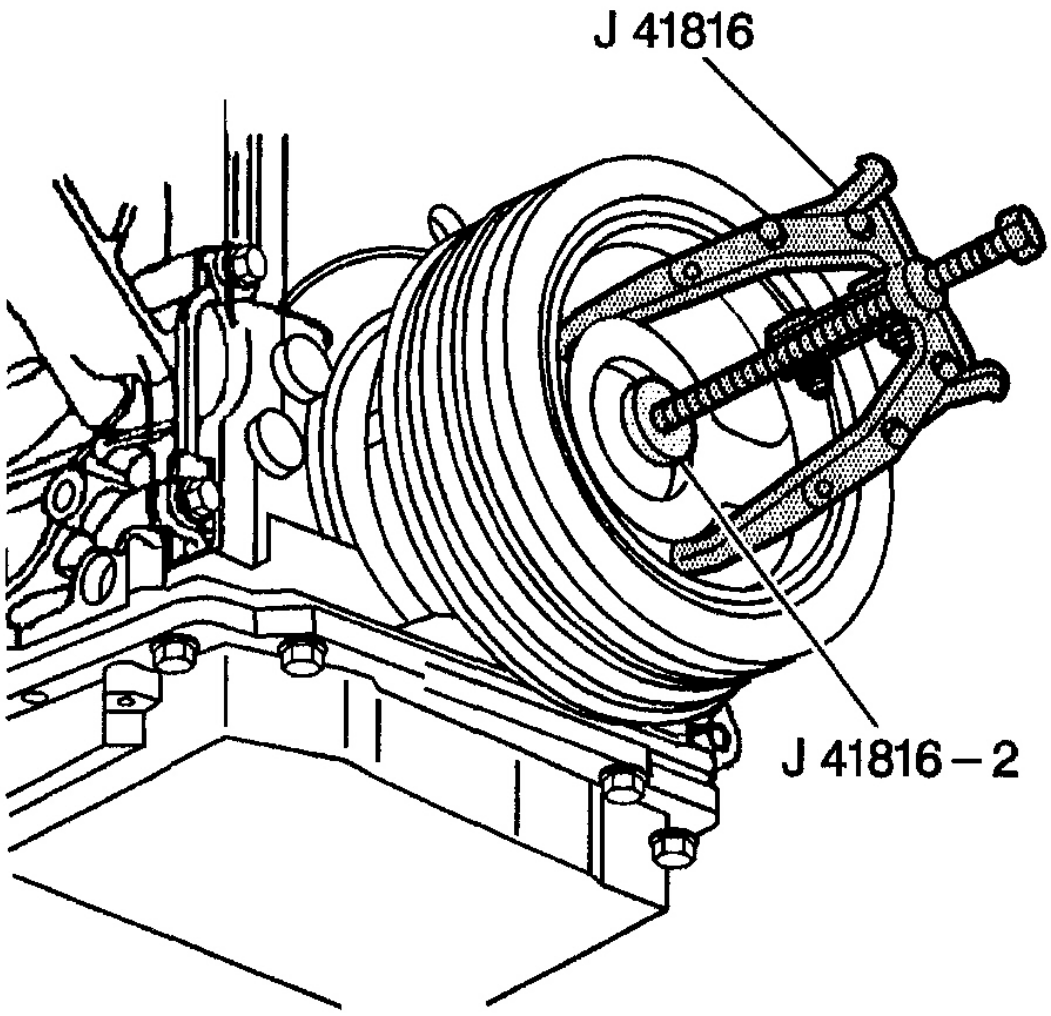


Fig. 52: Removing Crankshaft Balancer Using J 41816 & J 41816-2
Courtesy of GENERAL MOTORS CORP.

ENGINE FLYWHEEL REMOVAL

IMPORTANT: The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange or spacer, if applicable, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a three stage tightening process.

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

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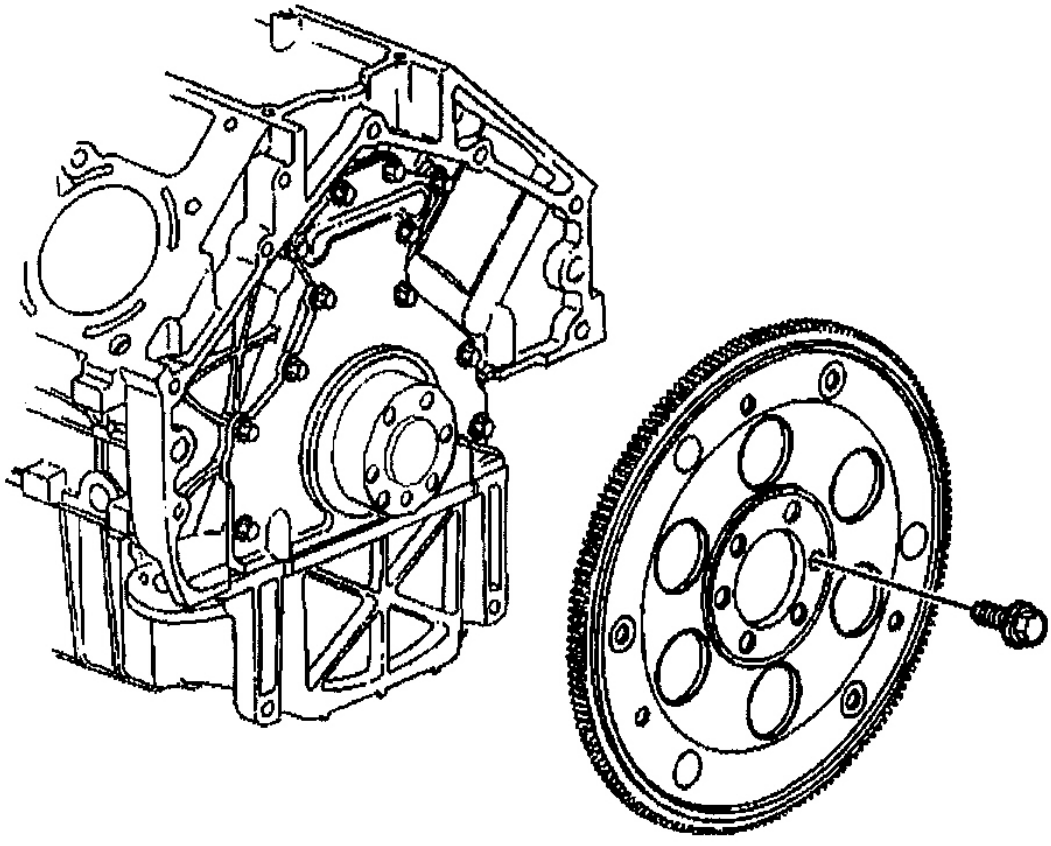


Fig. 53: Engine Flywheel (Automatic Transmission)
Courtesy of GENERAL MOTORS CORP.

3. Remove the manual transmission engine flywheel, if applicable.

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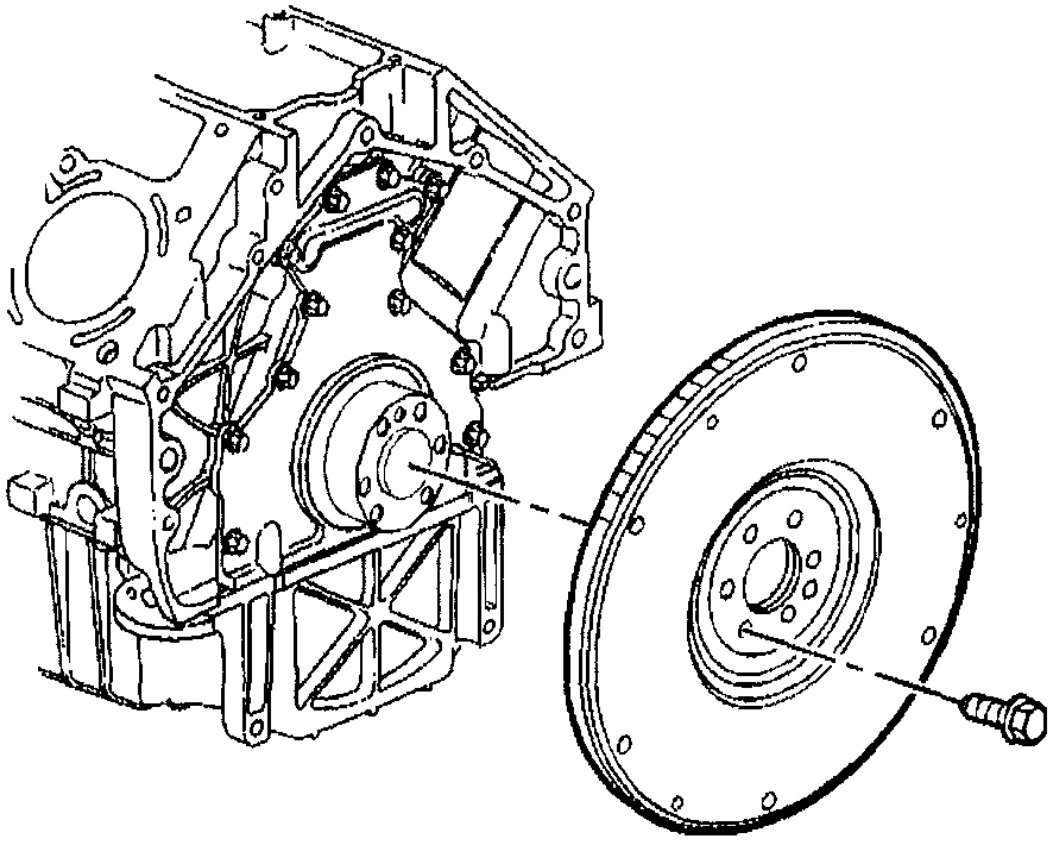


Fig. 54: Engine Flywheel (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

4. Install two M11x1.5 mm bolts (1) into the threaded holes of the spacer, if applicable.
5. Rotate the bolts clockwise to remove the spacer.

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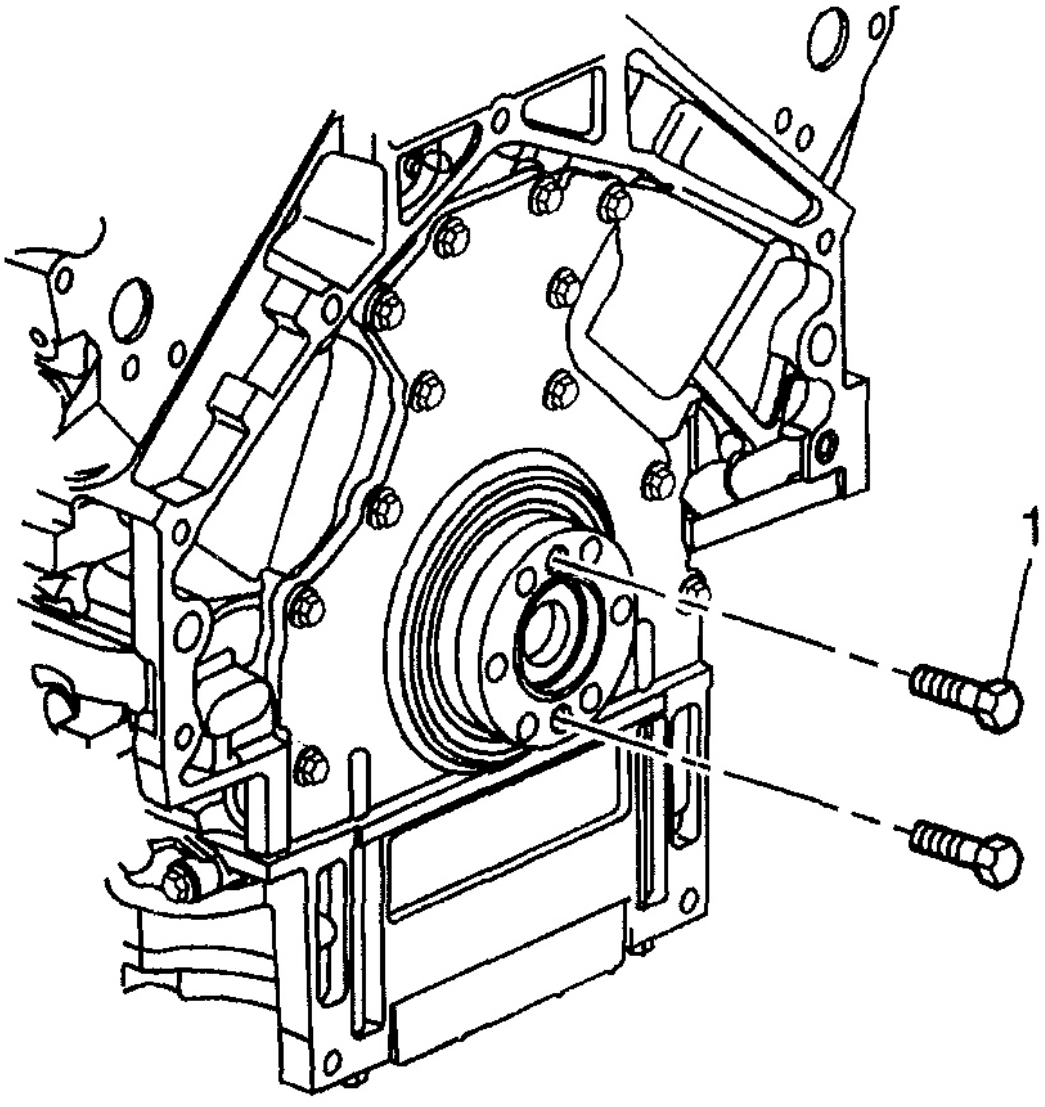
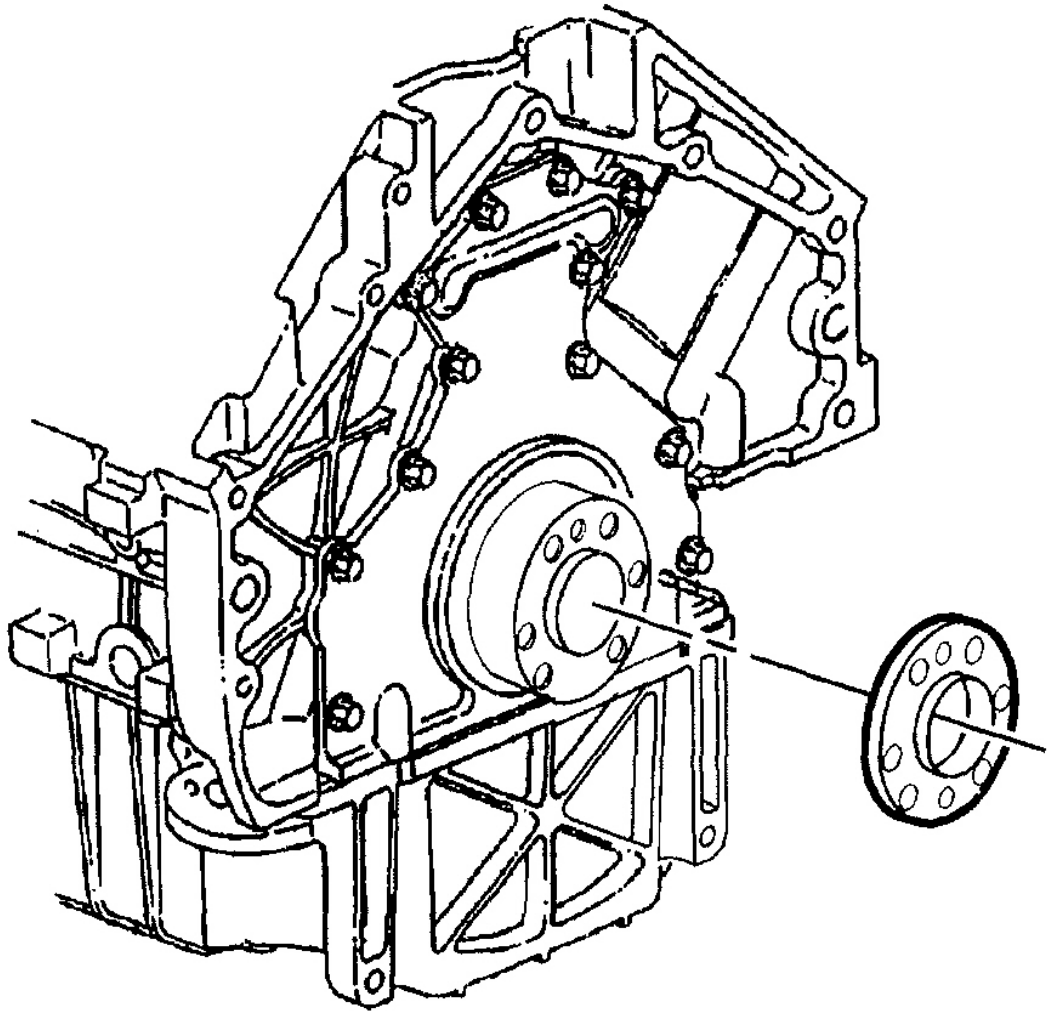


Fig. 55: Installing Bolts Into Spacer Threaded Holes
Courtesy of GENERAL MOTORS CORP.

6. Remove the spacer from the rear of the crankshaft, if applicable.

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Fig. 56: Crankshaft Spacer
Courtesy of GENERAL MOTORS CORP.

CLUTCH PILOT BEARING REMOVAL

Tools Required

J 43276 Clutch Pilot Bearing Remover

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

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43276-1 tool body.

IMPORTANT: The flywheel spacer, if applicable, must be removed prior to clutch pilot bearing removal.

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

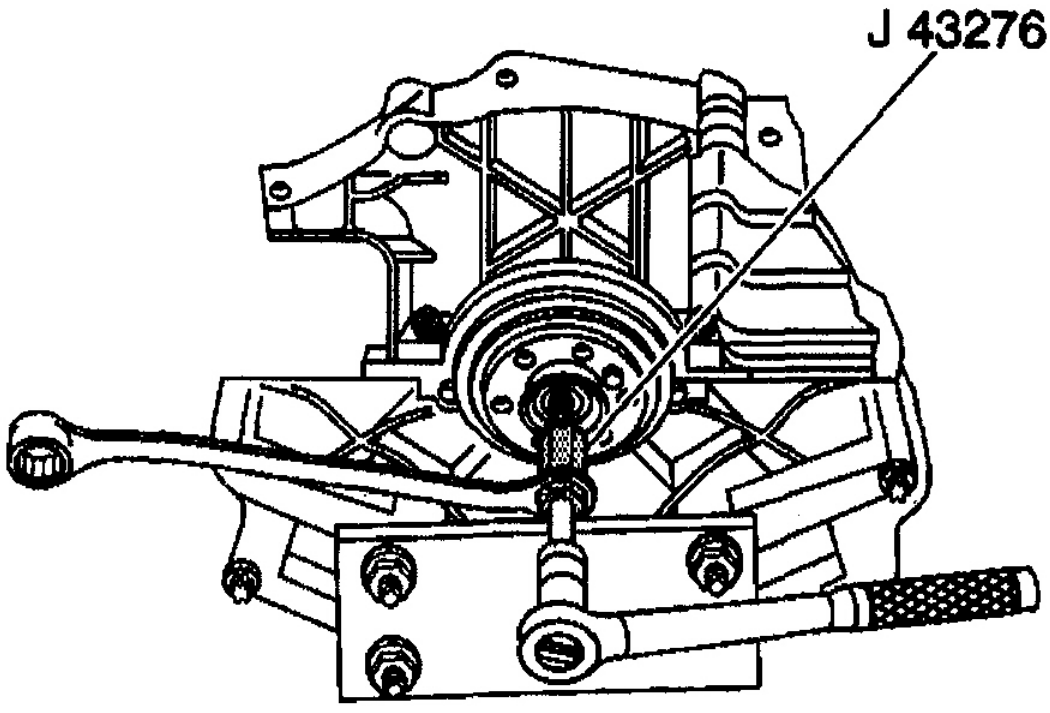


Fig. 57: Removing Clutch Pilot Bearing Using J 43276
Courtesy of GENERAL MOTORS CORP.

2. Discard the pilot bearing.

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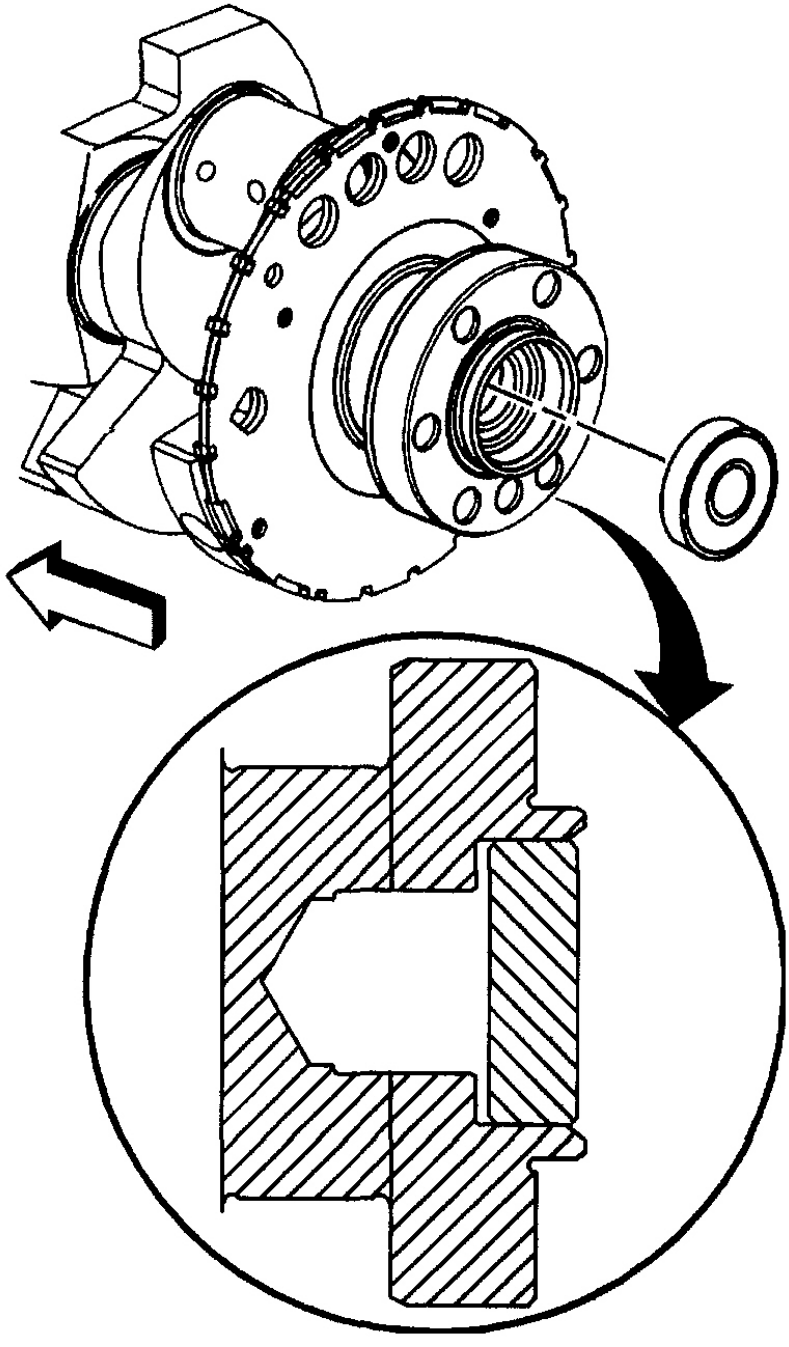


Fig. 58: Pilot Bearing Removed
Courtesy of GENERAL MOTORS CORP.

OIL LEVEL INDICATOR AND TUBE REMOVAL

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

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

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

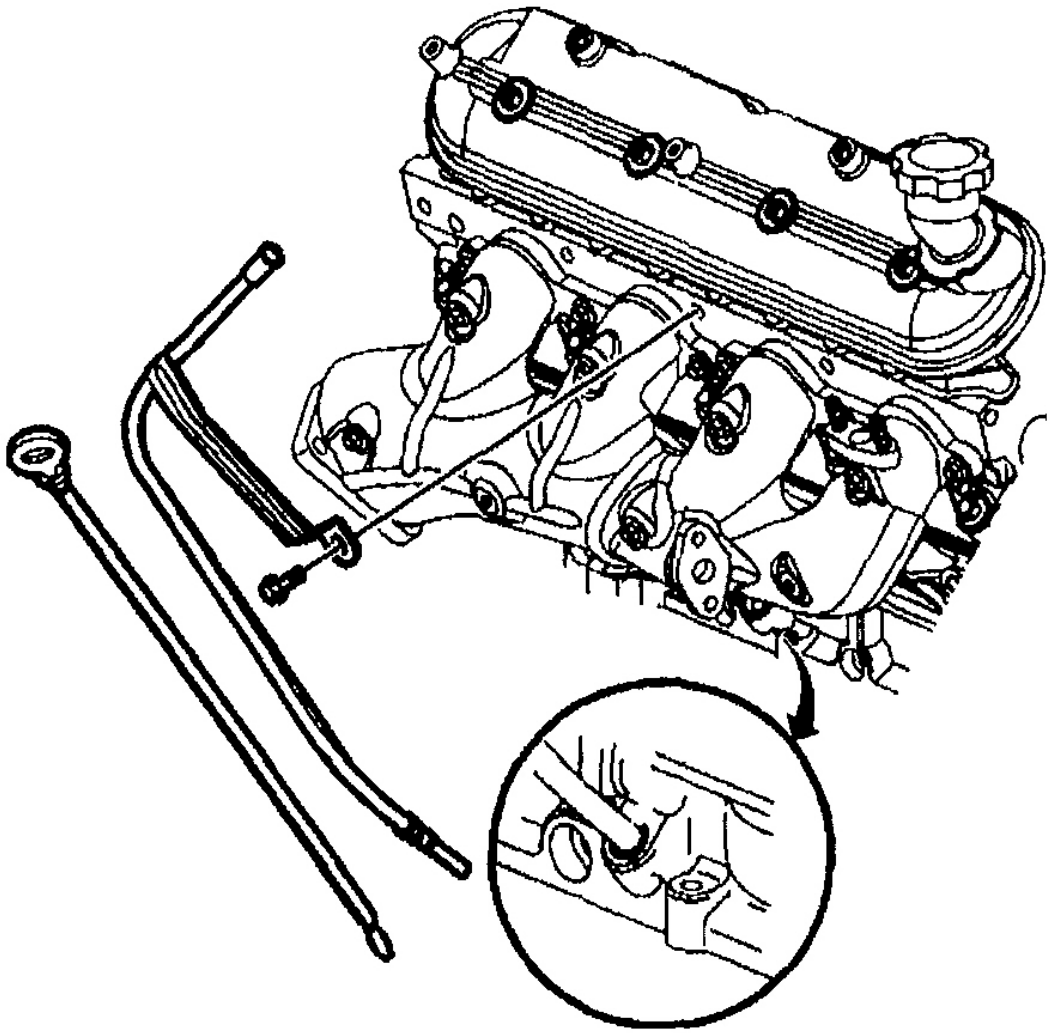


Fig. 59: Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

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EXHAUST MANIFOLD REMOVAL - LEFT

1. Remove the spark plug wires from the spark plugs.

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

2. Remove the exhaust manifold, bolts, and gasket.
3. Discard the gasket.

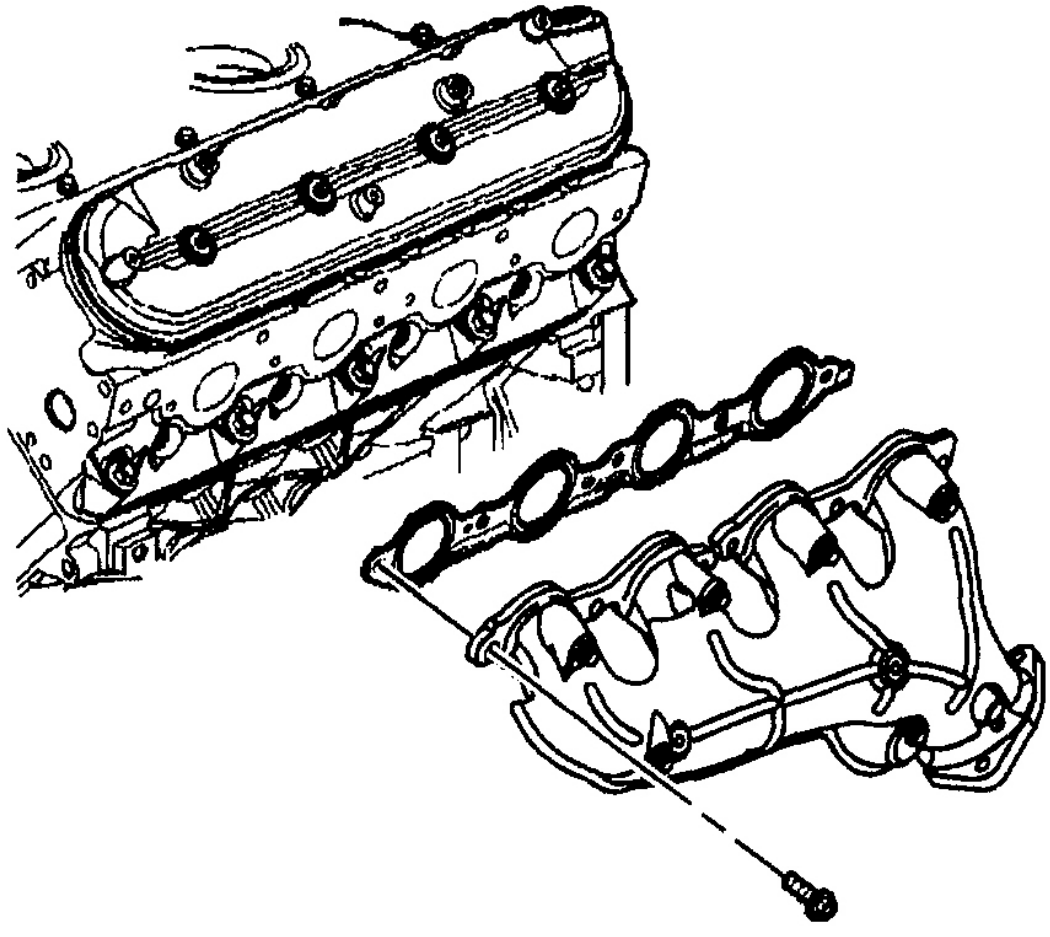


Fig. 60: Left Exhaust Manifold & Gasket
Courtesy of GENERAL MOTORS CORP.

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

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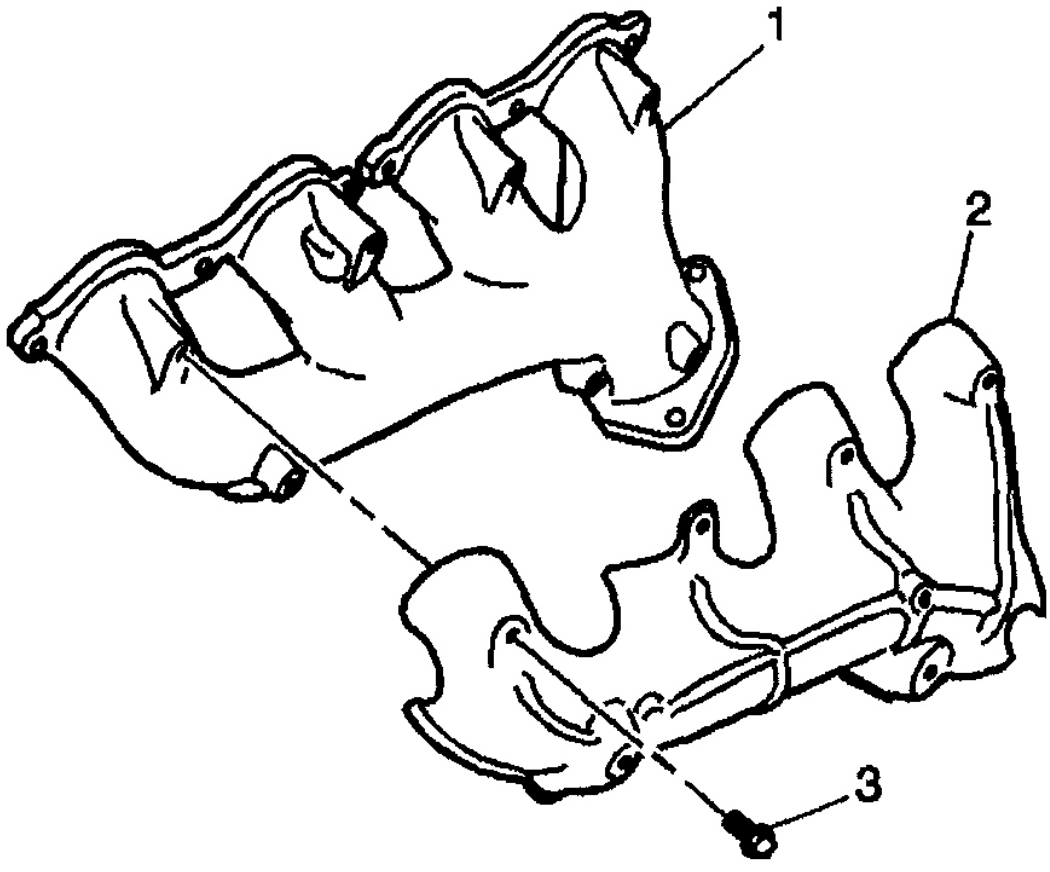


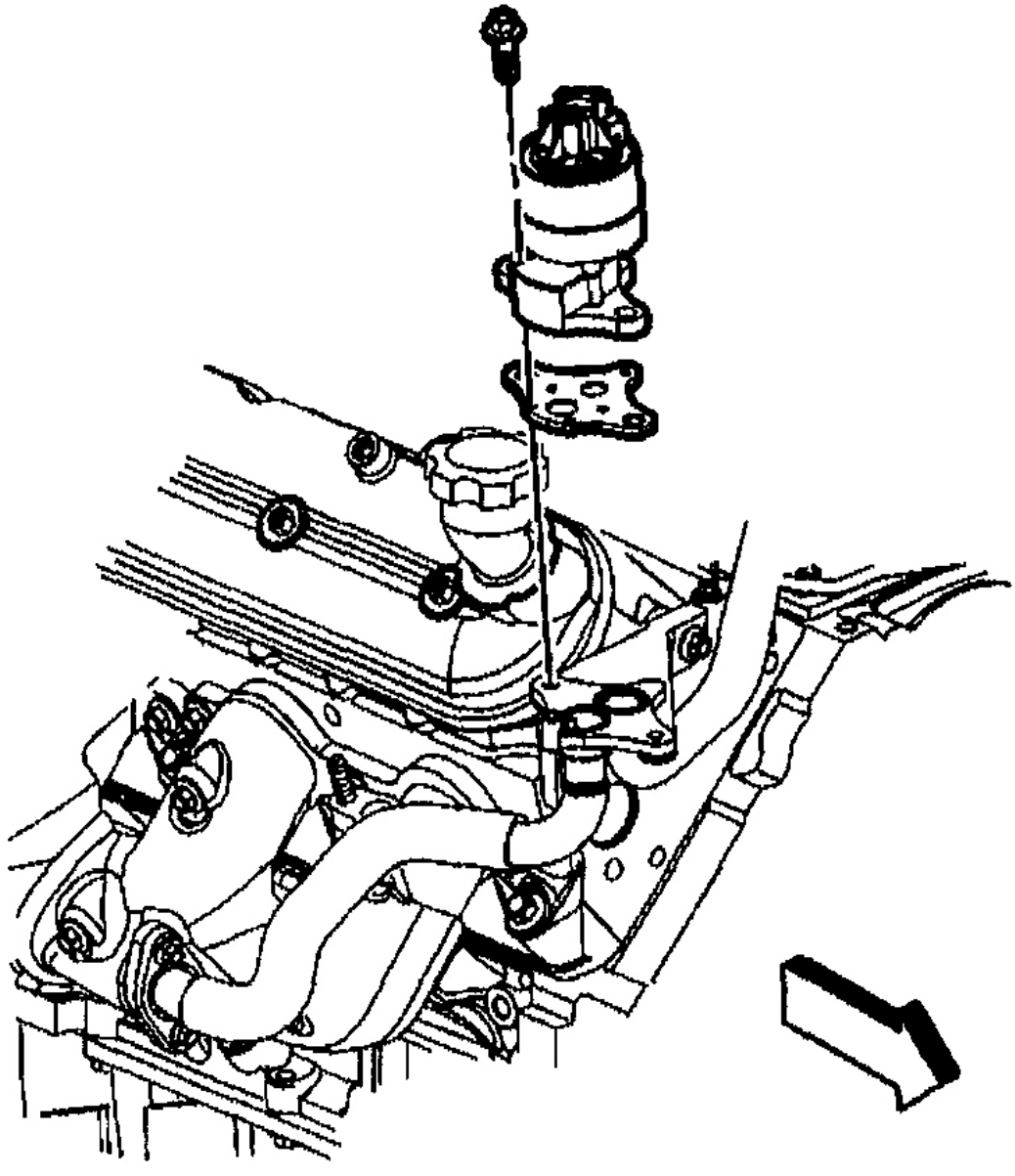
Fig. 61: Left Exhaust Manifold, Heat Shield & Bolt
Courtesy of GENERAL MOTORS CORP.

EXHAUST MANIFOLD REMOVAL - RIGHT

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

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

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Fig. 62: EGR Valve, Gasket & Bolt
Courtesy of GENERAL MOTORS CORP.

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

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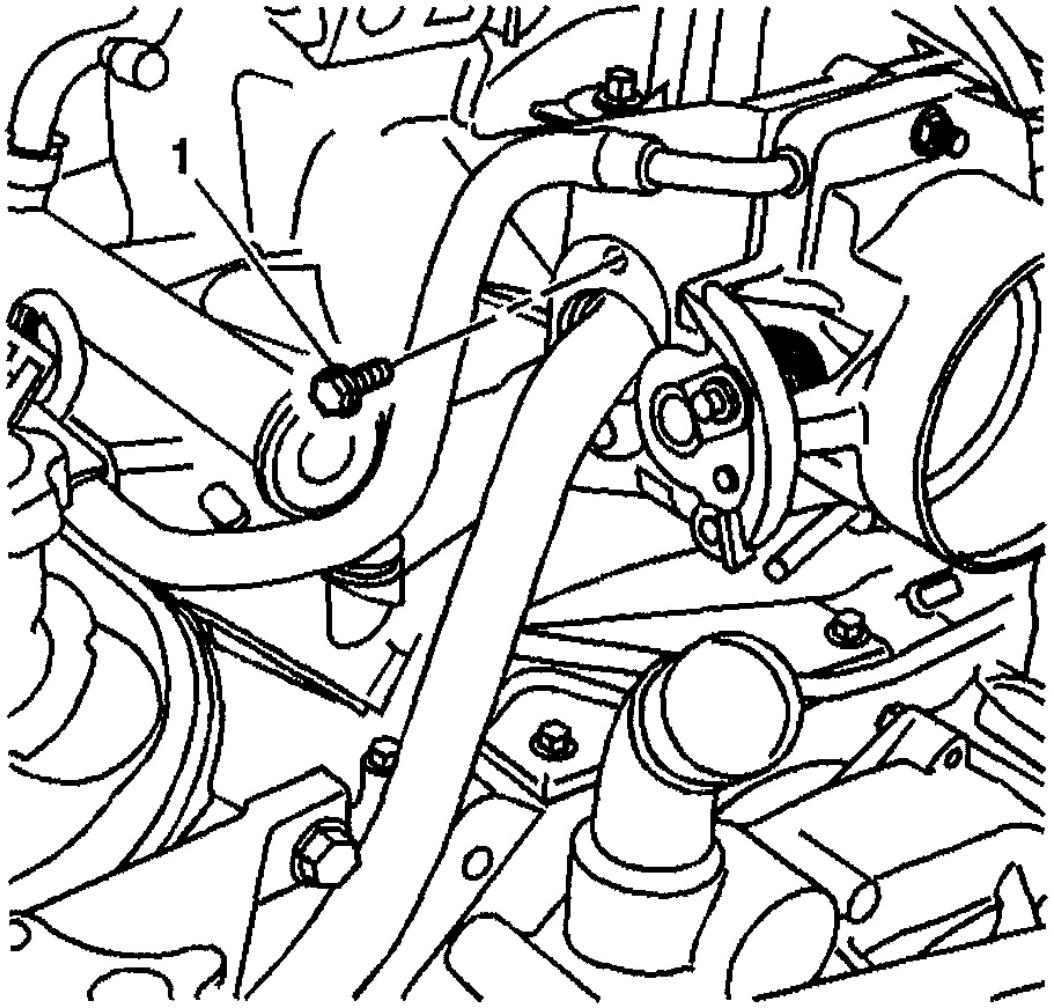


Fig. 63: EGR Pipe-To-Intake Manifold Bolt
Courtesy of GENERAL MOTORS CORP.

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

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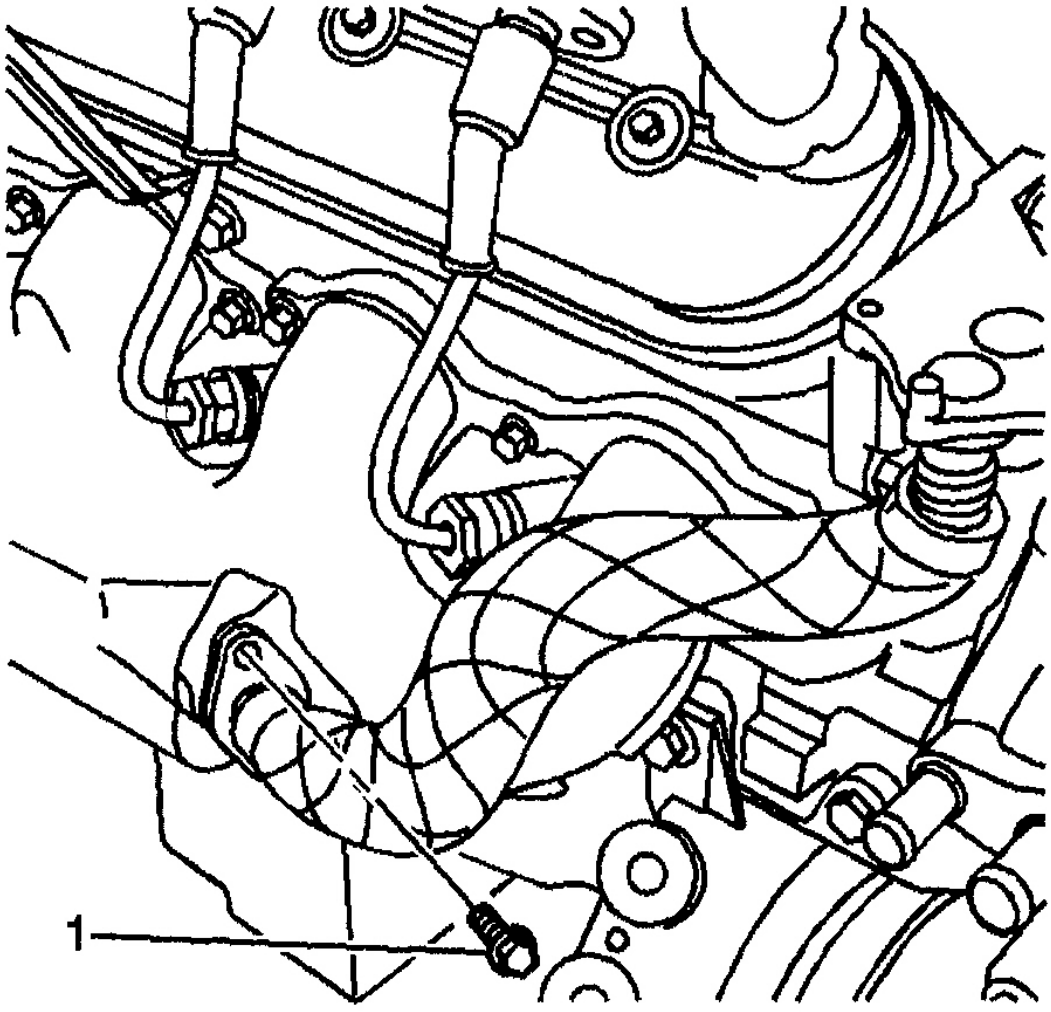


Fig. 64: EGR Pipe-To-Exhaust Manifold Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the EGR pipe bolts (3) from the cylinder head.
5. Remove the EGR pipe assembly.

   With mild force, pull the EGR pipe (2) from the intake manifold.

6. Remove the O-ring seal (1) from the EGR pipe assembly.
7. Discard the exhaust manifold gasket (4) and O-ring seal (1).

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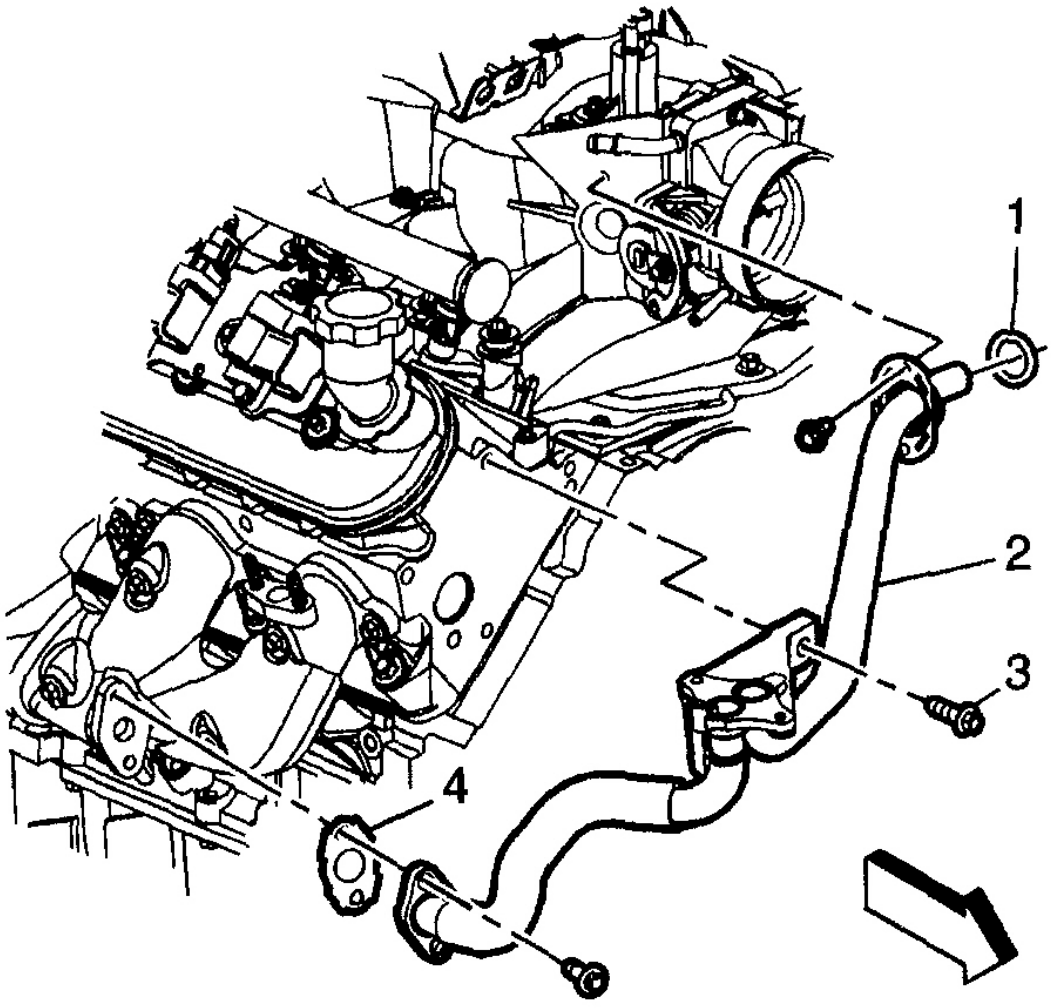


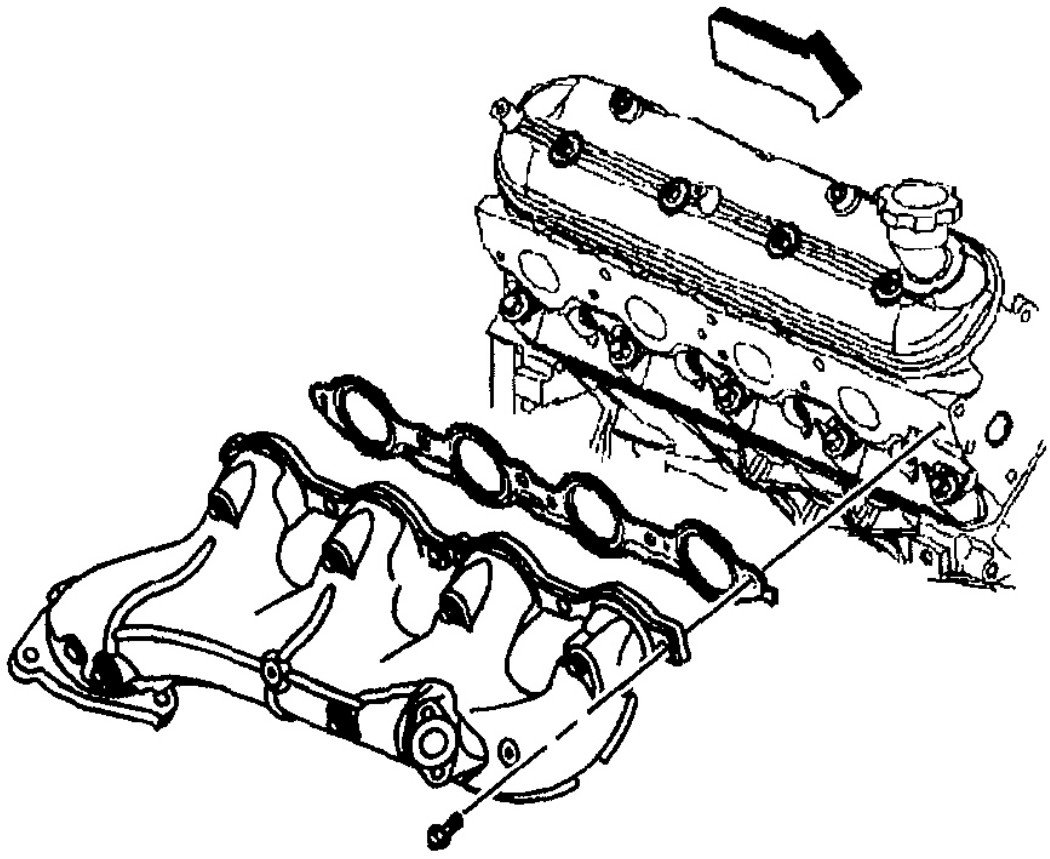
Fig. 65: EGR Pipe Assembly
Courtesy of GENERAL MOTORS CORP.

8. Remove the spark plug wires from the spark plugs.

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

9. Remove the exhaust manifold, bolts, and gasket.
10. Discard the gasket.

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Fig. 66: Right Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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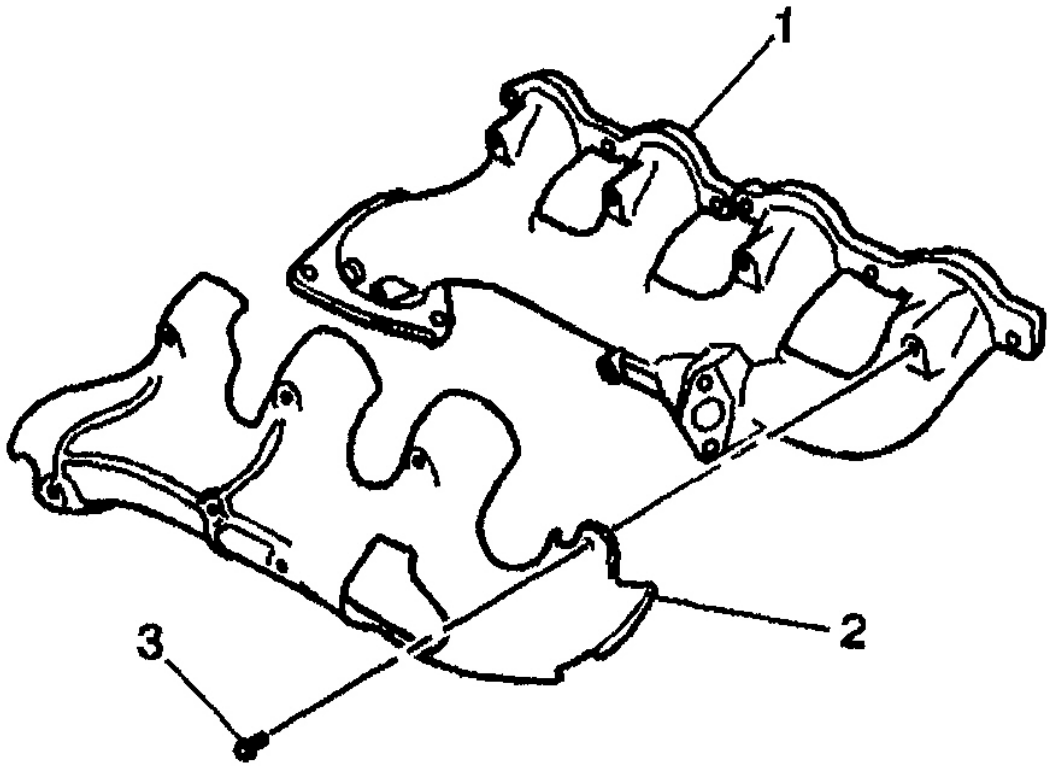


Fig. 67: Right Exhaust Manifold, Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

WATER PUMP REMOVAL

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

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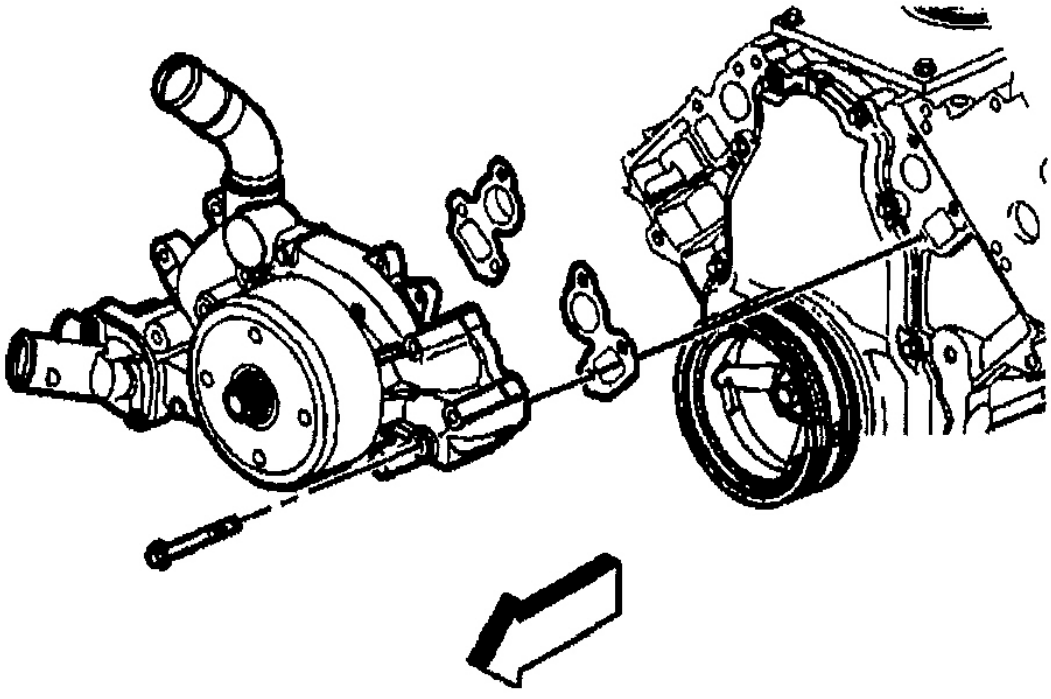


Fig. 68: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

THROTTLE BODY REMOVAL

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

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

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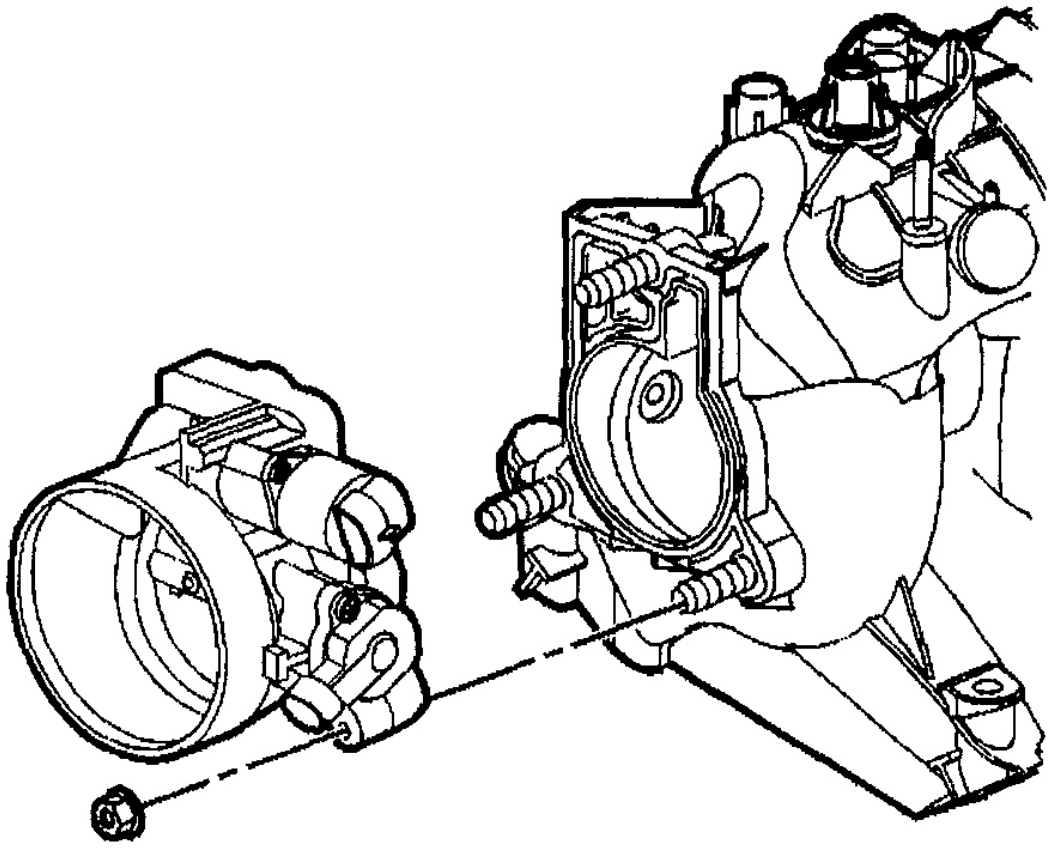


Fig. 69: Throttle Body & Nuts
Courtesy of GENERAL MOTORS CORP.

5. Remove the throttle body gasket (1).
6. Discard the gasket.
7. Remove the throttle body studs, if required.

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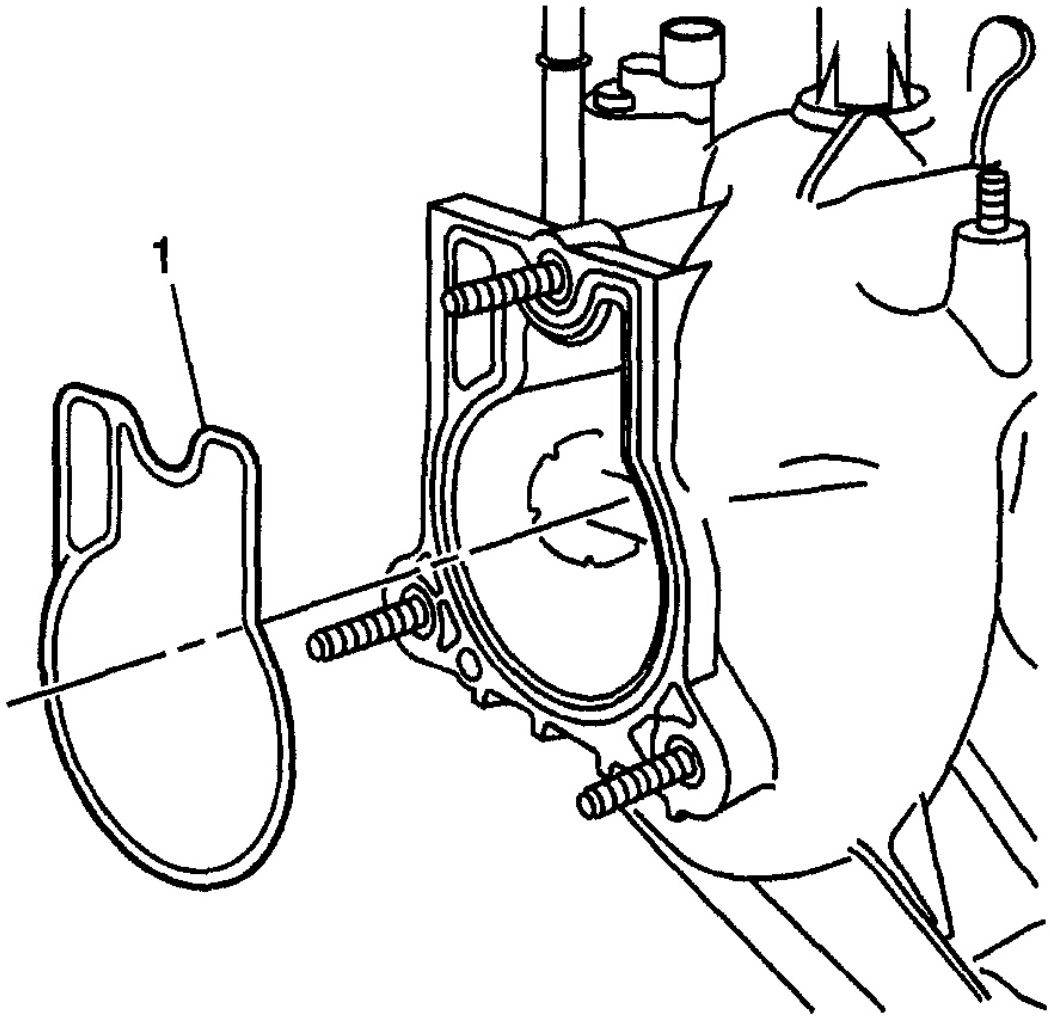


Fig. 70: Throttle Body Gasket
Courtesy of GENERAL MOTORS CORP.

FUEL RAIL AND INJECTORS REMOVAL

CAUTION: Refer to FUEL RAIL STOP BRACKET INSTALLATION CAUTION in Cautions and Notices.

NOTE:

- **Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the**

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fuel rail components.

- **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.**

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

1. Remove the fuel rail stop bracket and bolt, if required.

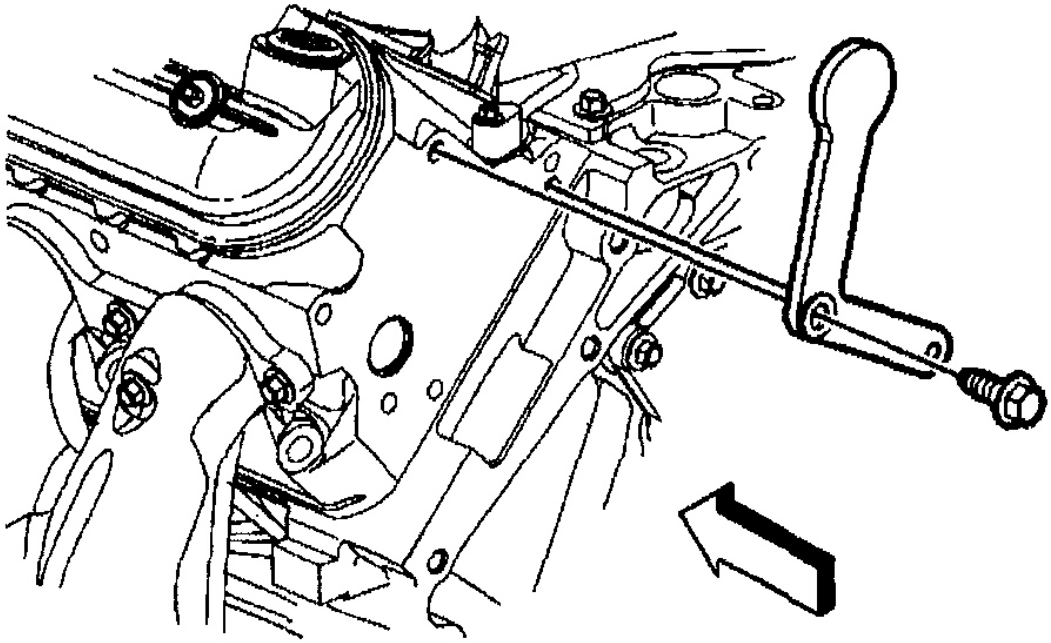


Fig. 71: Fuel Rail Stop Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the vacuum hose from the fuel pressure regulator.
3. Loosen the crossover tube-to-right fuel rail retaining bolt.
4. Remove the fuel rail bolts.

IMPORTANT: Do not separate the fuel injectors from the fuel rail unless component service is required.

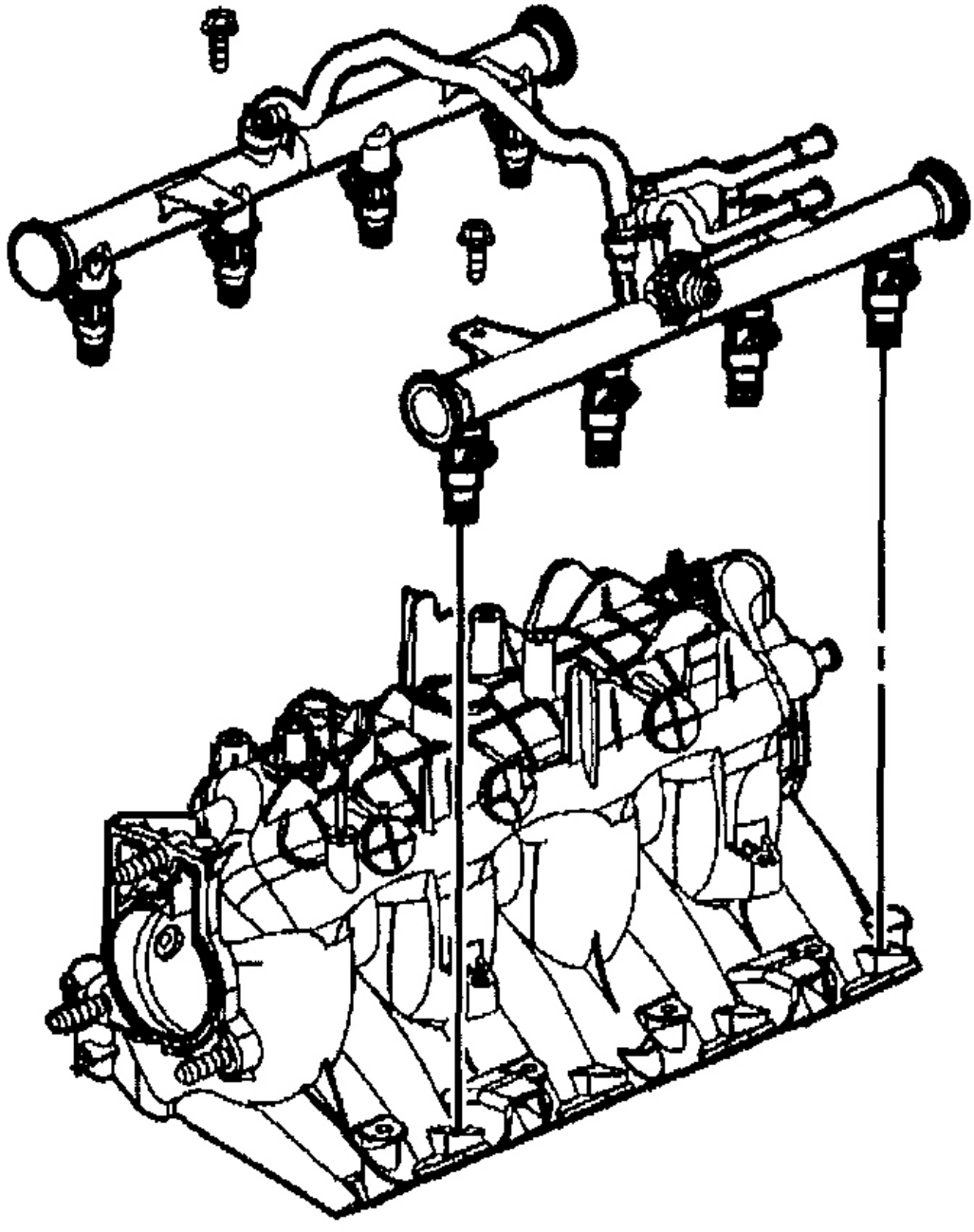
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Use cleanliness and care when handling the fuel system components.

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

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

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Fig. 72: Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

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INTAKE MANIFOLD REMOVAL

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

DO NOT reuse the intake manifold-to-cylinder head gaskets.

1. Remove the Positive Crankcase Ventilation (PCV) hose (1) and valve (2).

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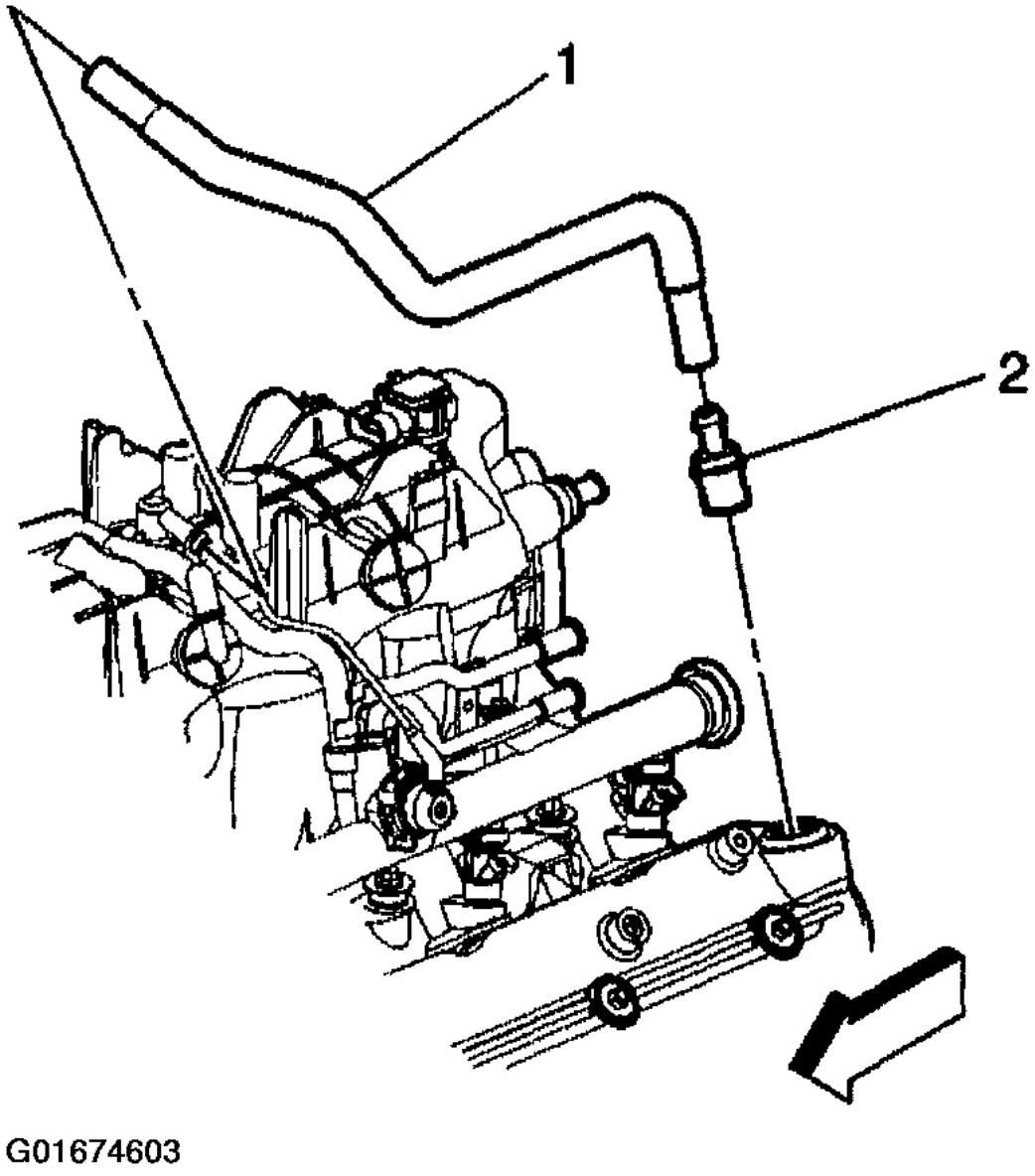


Fig. 73: PCV Hose & Valve
Courtesy of GENERAL MOTORS CORP.

2. Remove the Manifold Absolute Pressure (MAP) sensor (1), if required.
3. Remove the engine coolant air bleed clamp and hose from the throttle body.

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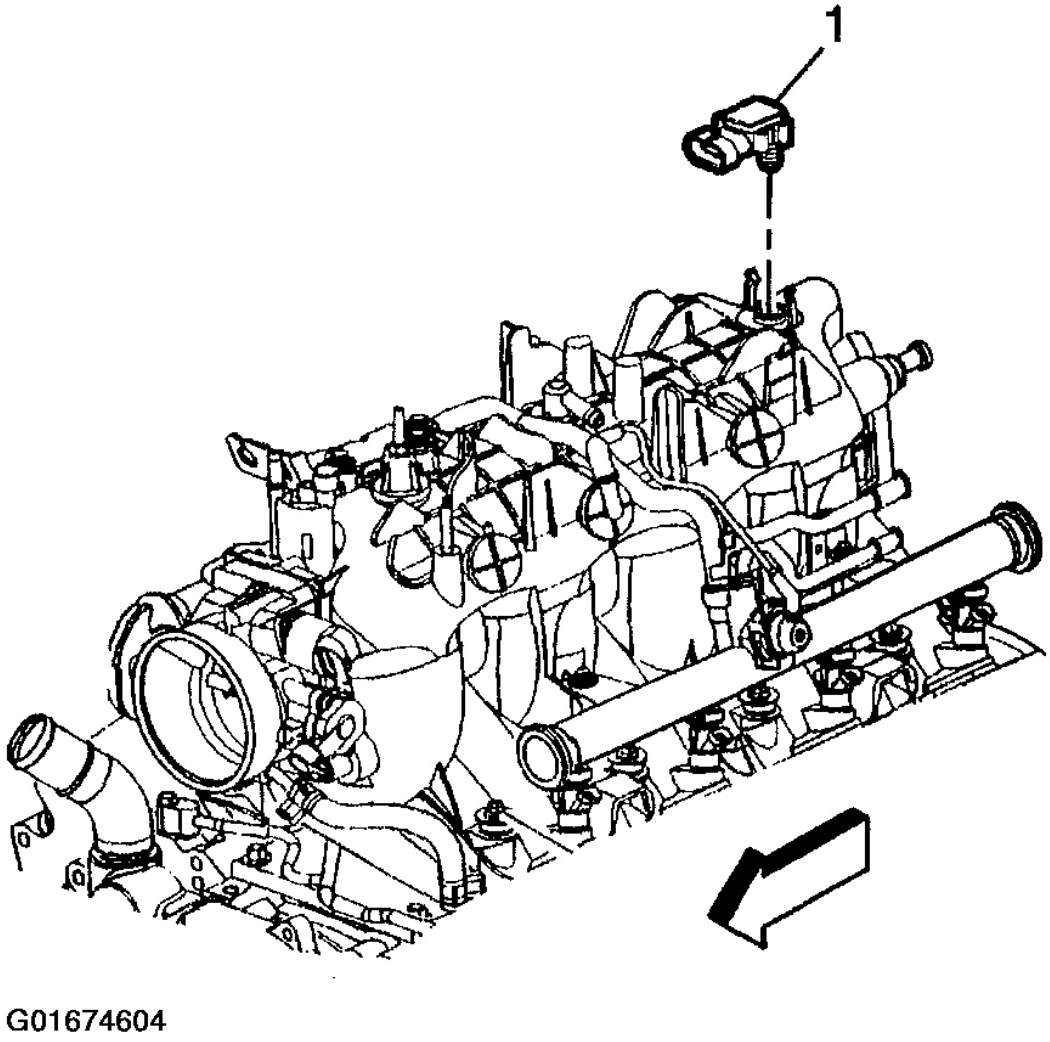


Fig. 74: MAP Sensor
Courtesy of GENERAL MOTORS CORP.

4. Remove the accelerator control cable bracket (2) and bolts (1), if required.

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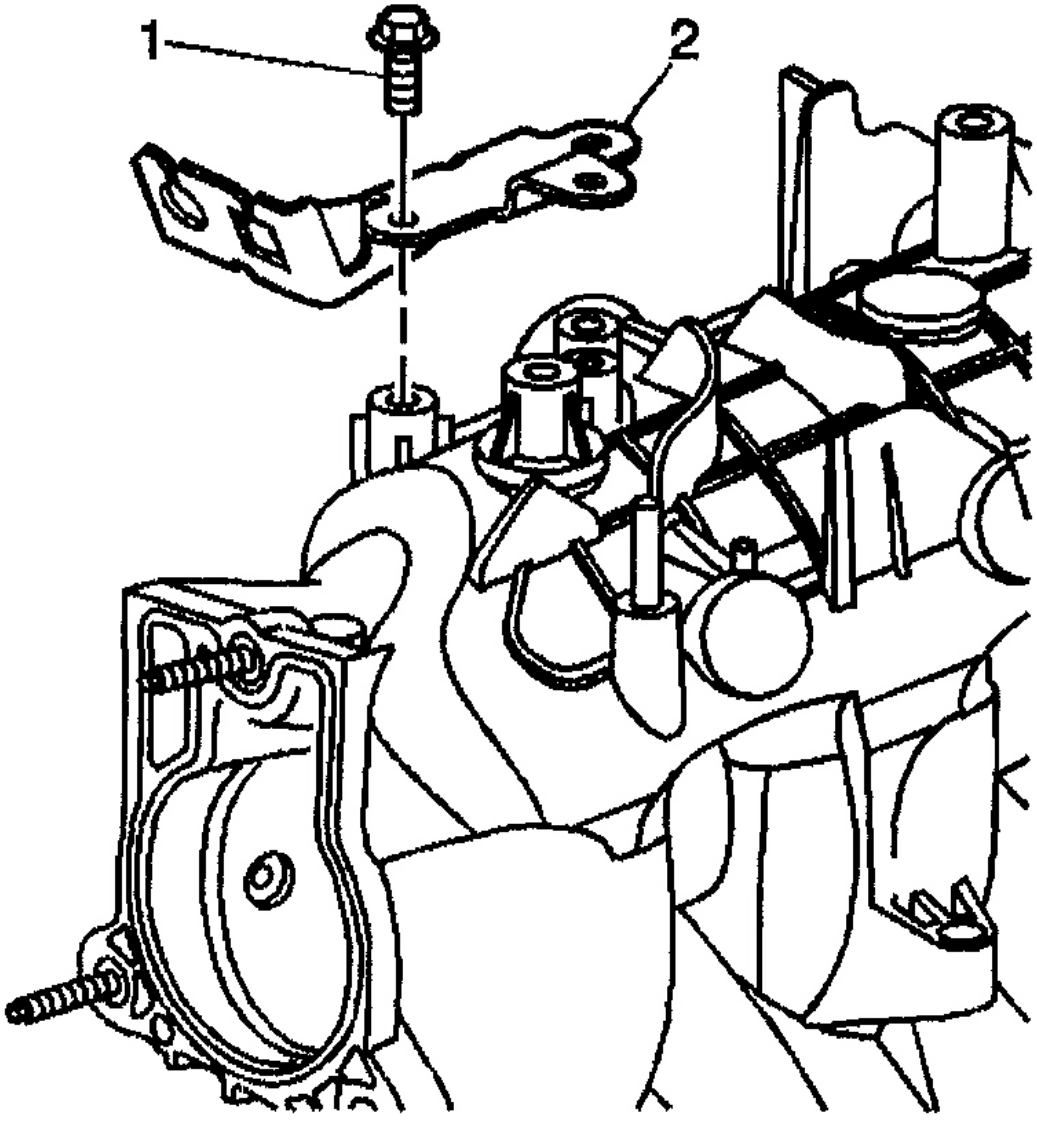


Fig. 75: Accelerator Control Cable Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the Evaporative Emission (EVAP) solenoid (3), bolt (2), and isolator (1).

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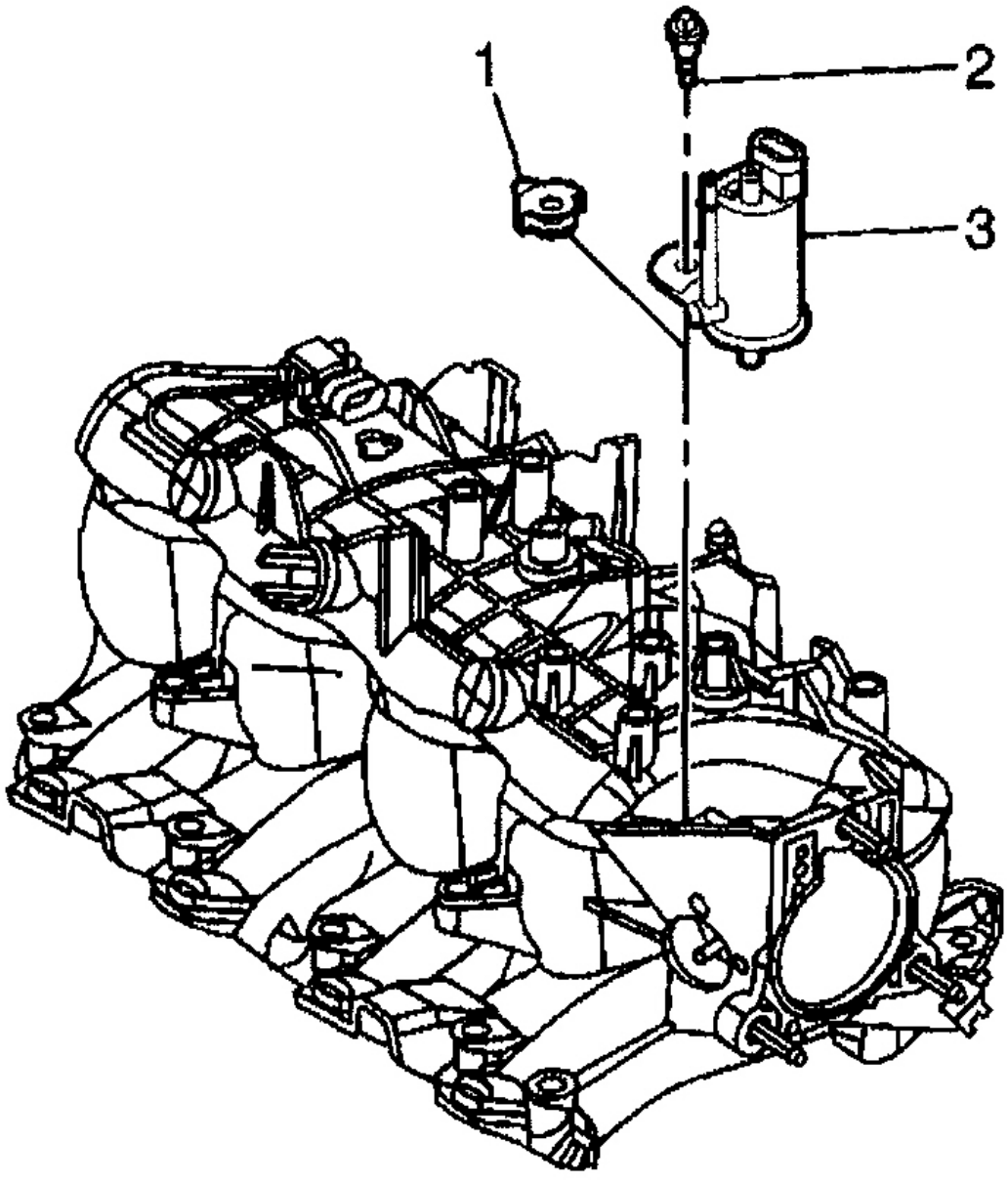


Fig. 76: EVAP Solenoid, Isolator & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the intake manifold bolts.
7. Remove the intake manifold with gaskets.

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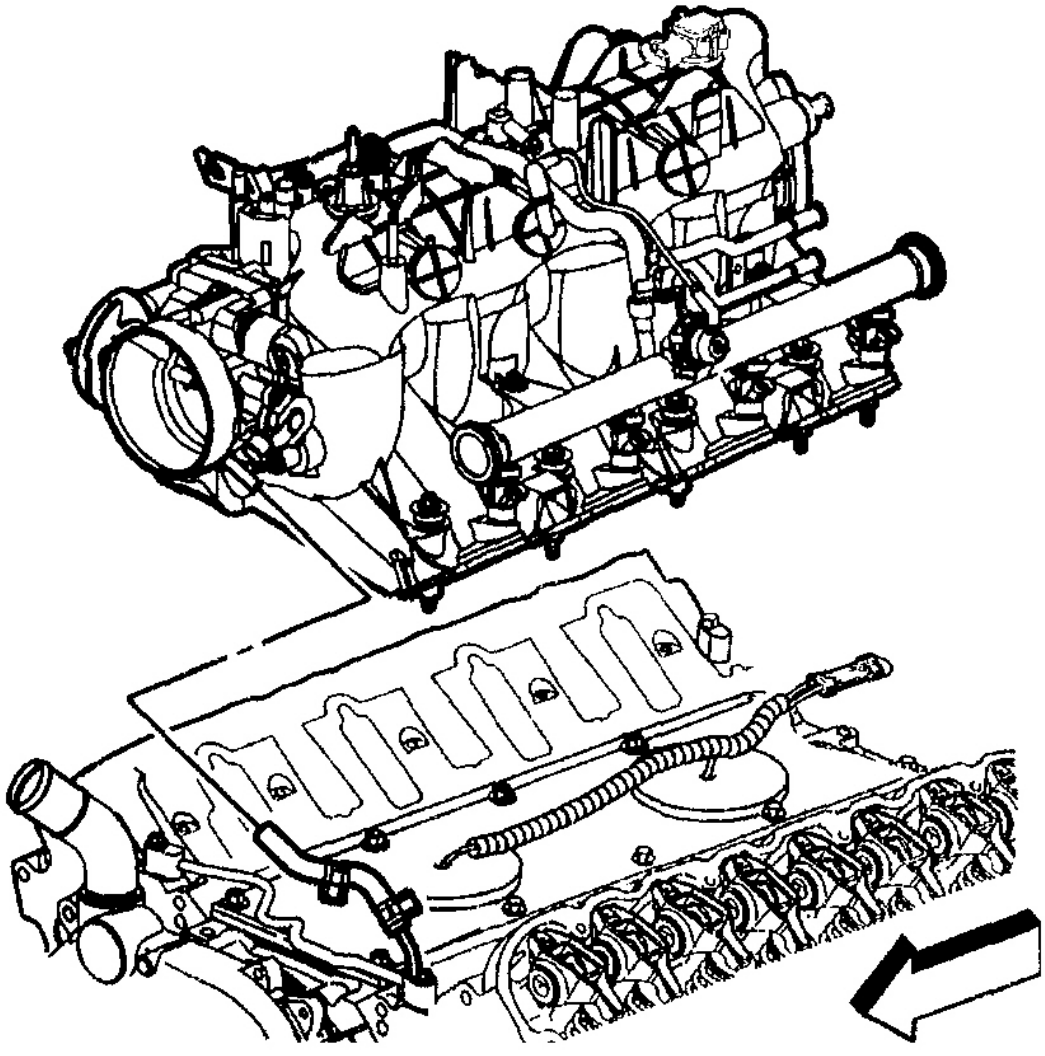


Fig. 77: Intake Manifold
Courtesy of GENERAL MOTORS CORP.

8. Separate the intake manifold-to-cylinder head gaskets (1) from the manifold.
9. Discard the intake manifold gaskets.

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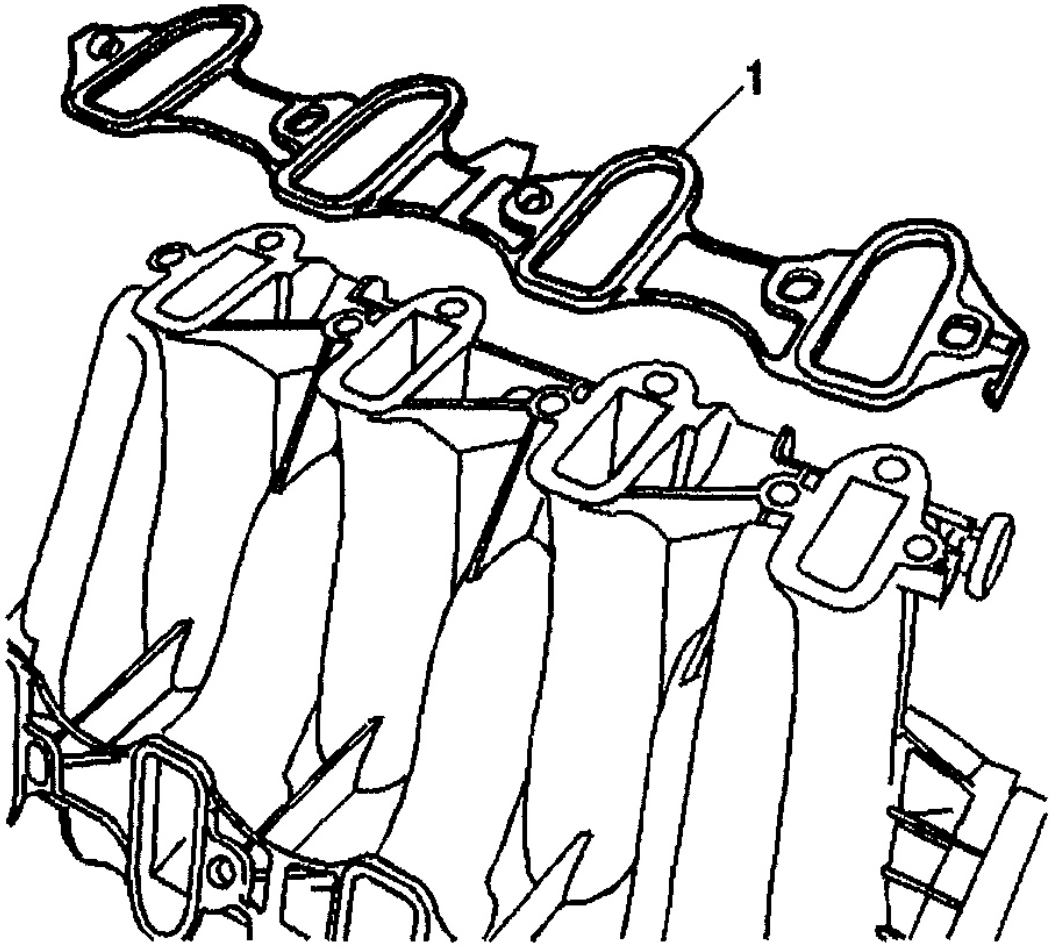


Fig. 78: Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

COOLANT AIR BLEED PIPE REMOVAL

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

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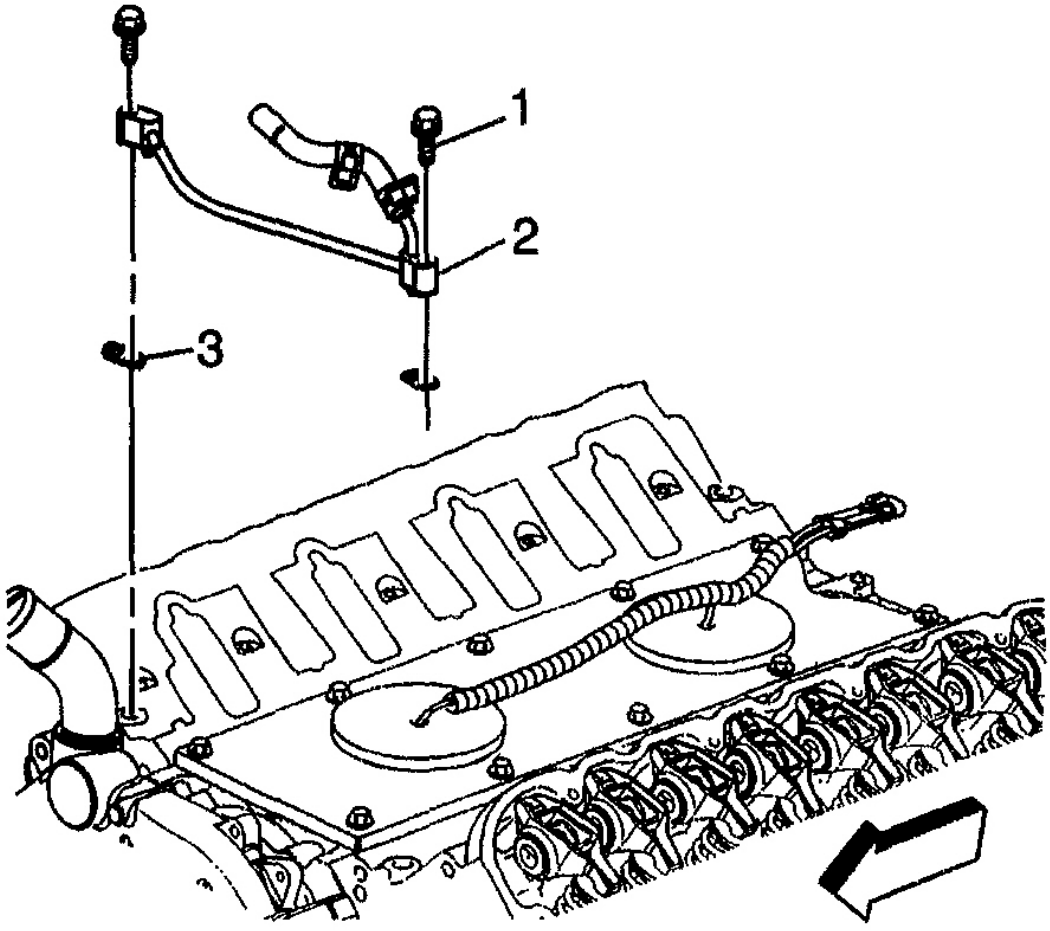


Fig. 79: Engine Coolant Air Bleed Pipe, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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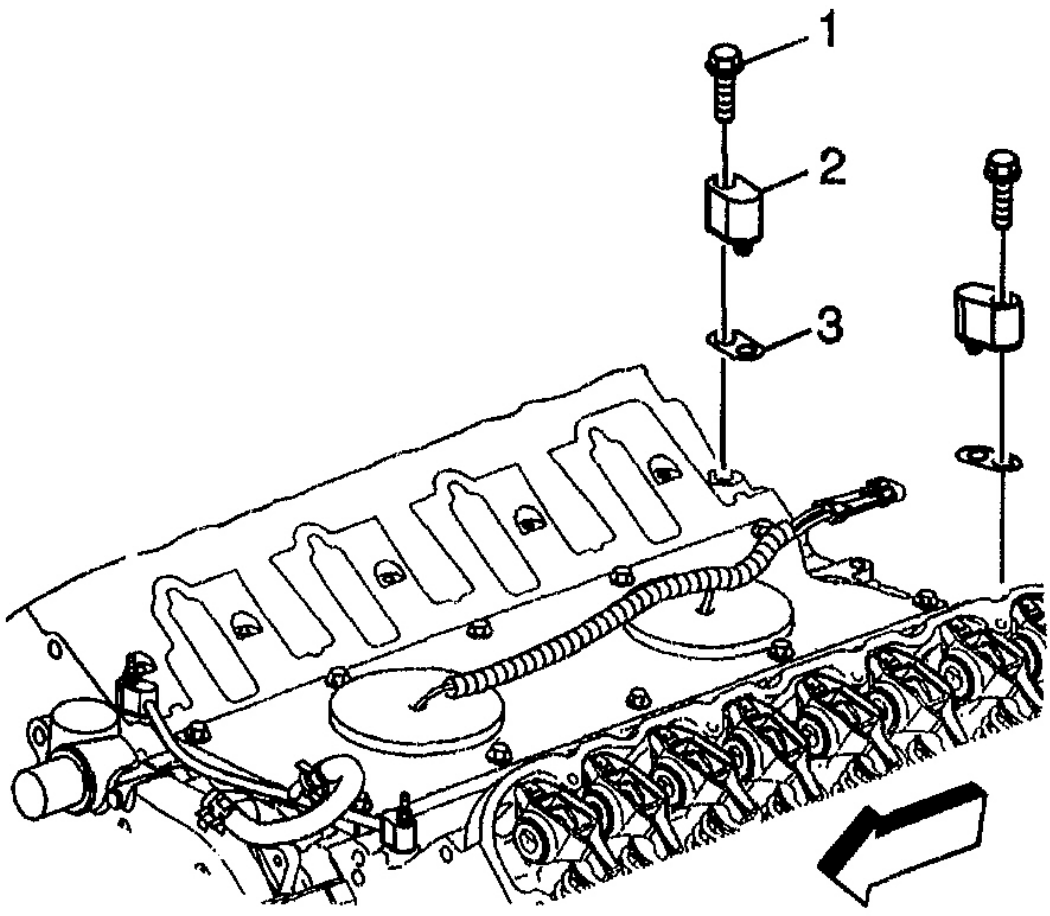


Fig. 80: Engine Coolant Air Bleed Pipe Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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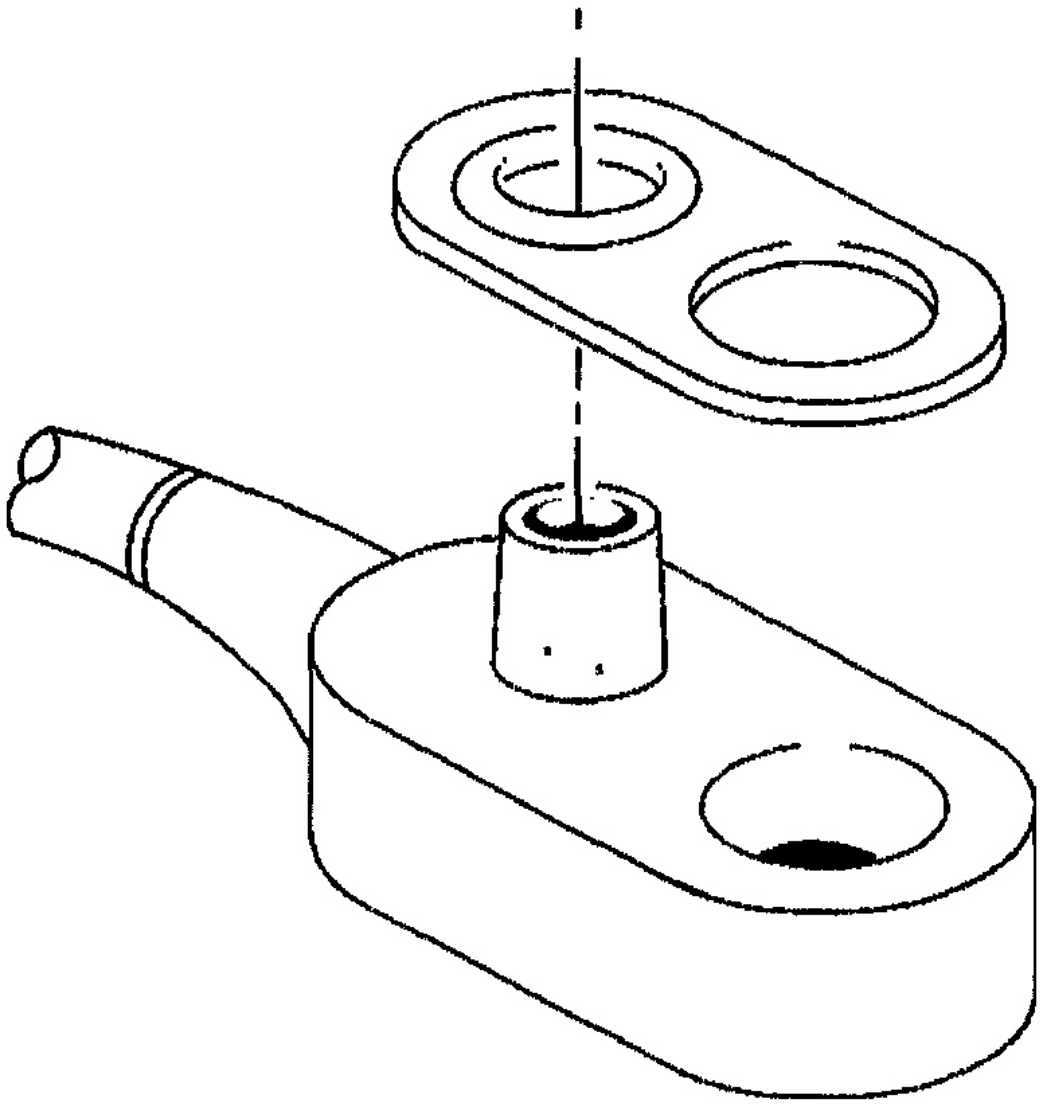


Fig. 81: Engine Coolant Air Bleed Pipe Cover Gasket
Courtesy of GENERAL MOTORS CORP.

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

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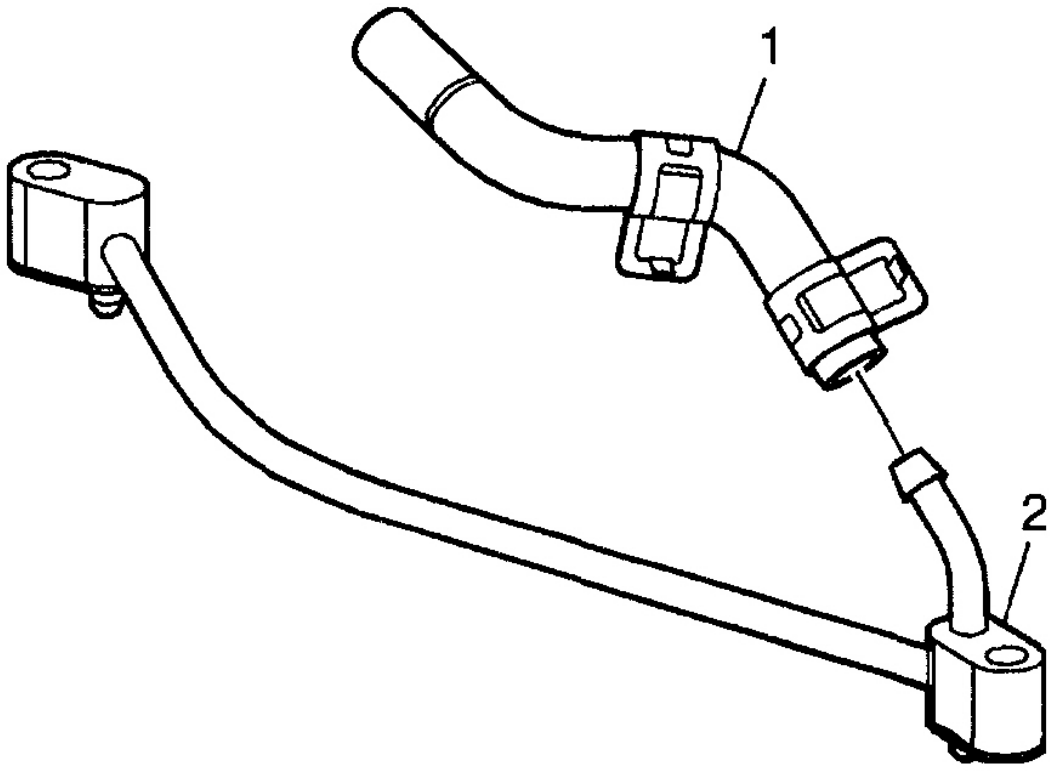


Fig. 82: Engine Coolant Air Bleed Pipe & Hose
Courtesy of GENERAL MOTORS CORP.

ENGINE VALLEY COVER REMOVAL

1. Remove the knock sensor wire harness.

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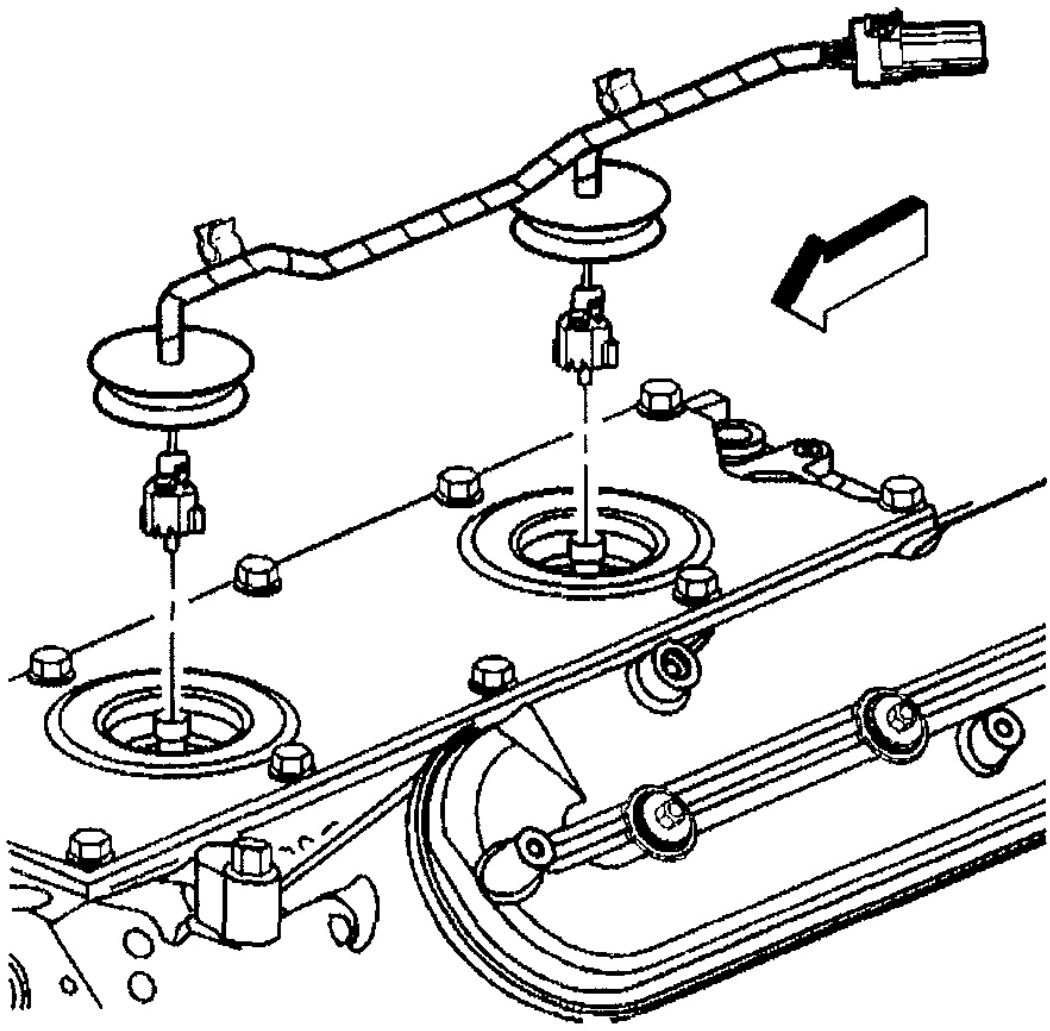


Fig. 83: Knock Sensor Wire Harness
Courtesy of GENERAL MOTORS CORP.

2. Remove the knock sensors.

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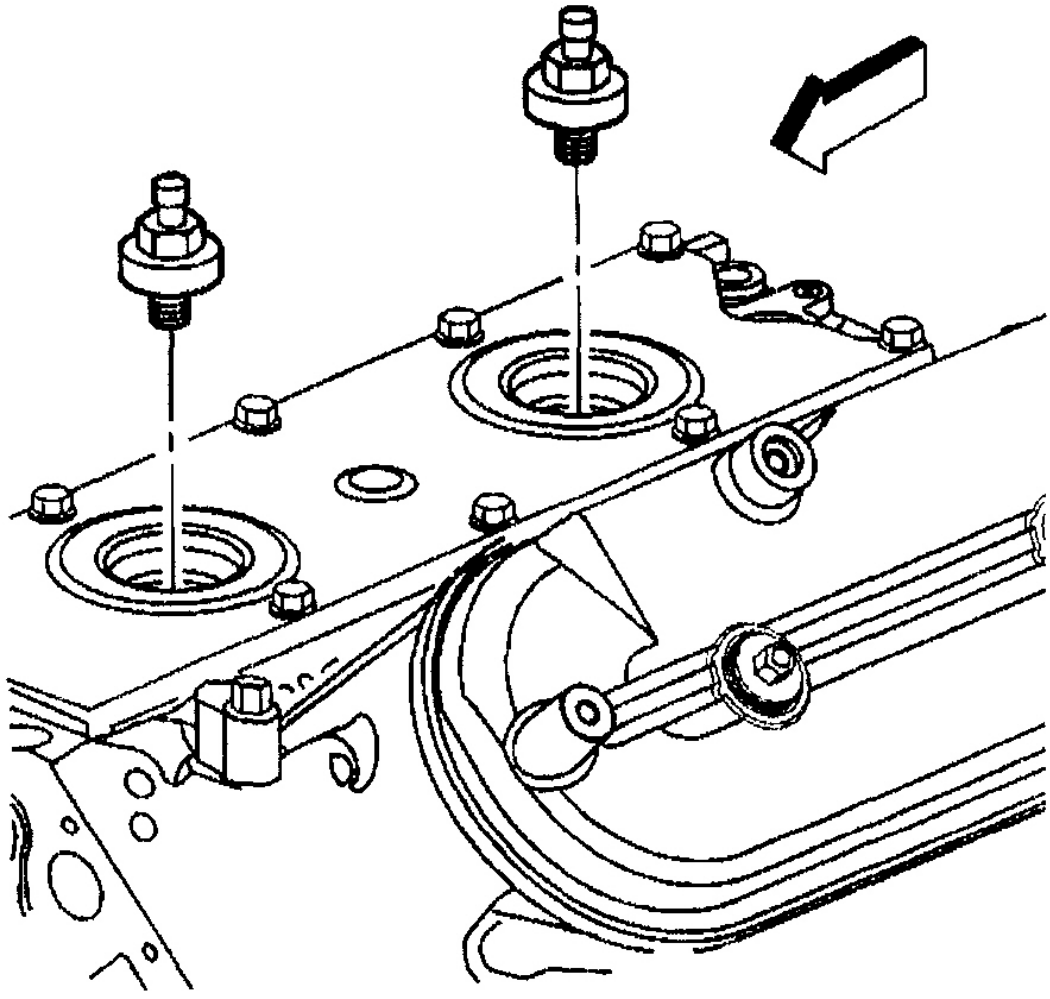


Fig. 84: Knock Sensors
Courtesy of GENERAL MOTORS CORP.

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

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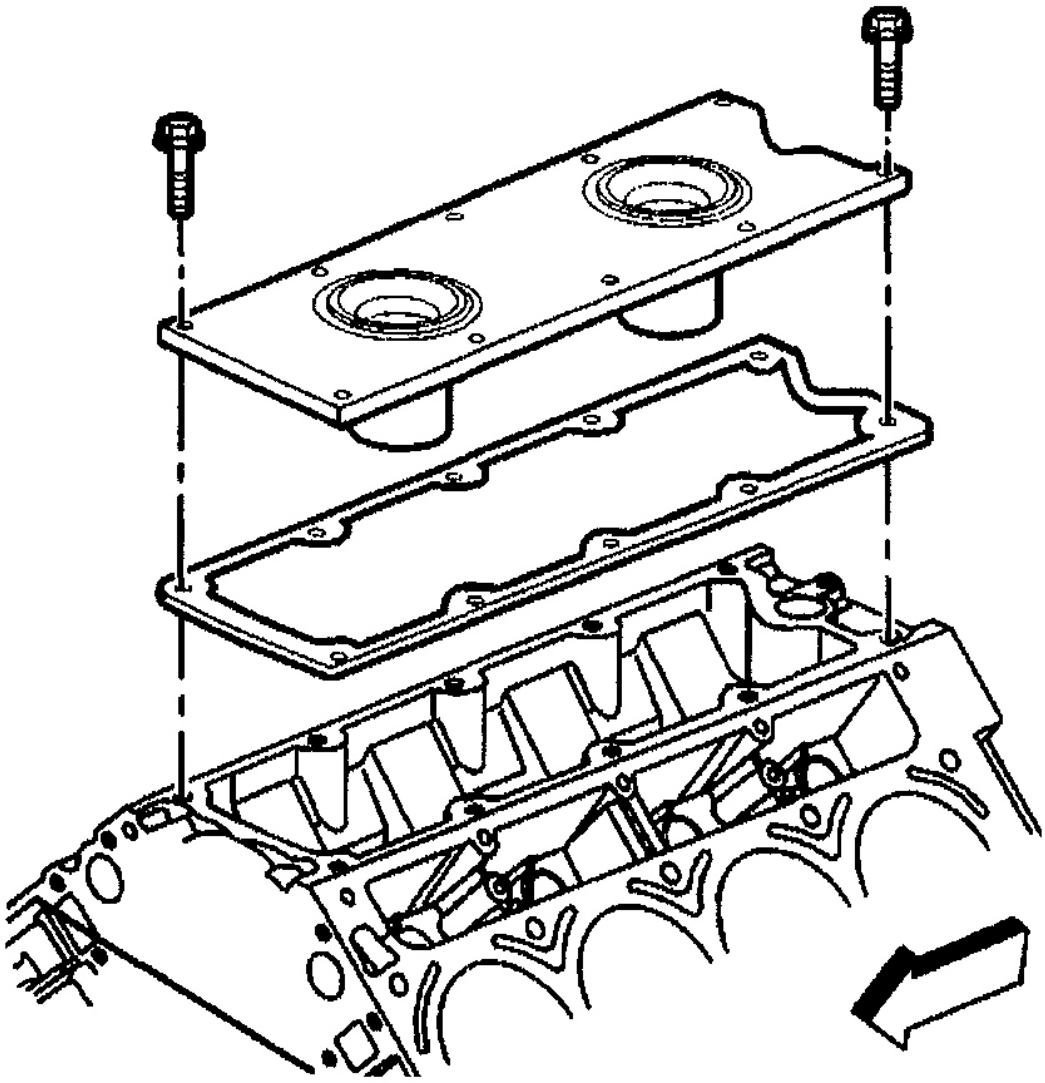


Fig. 85: Valley Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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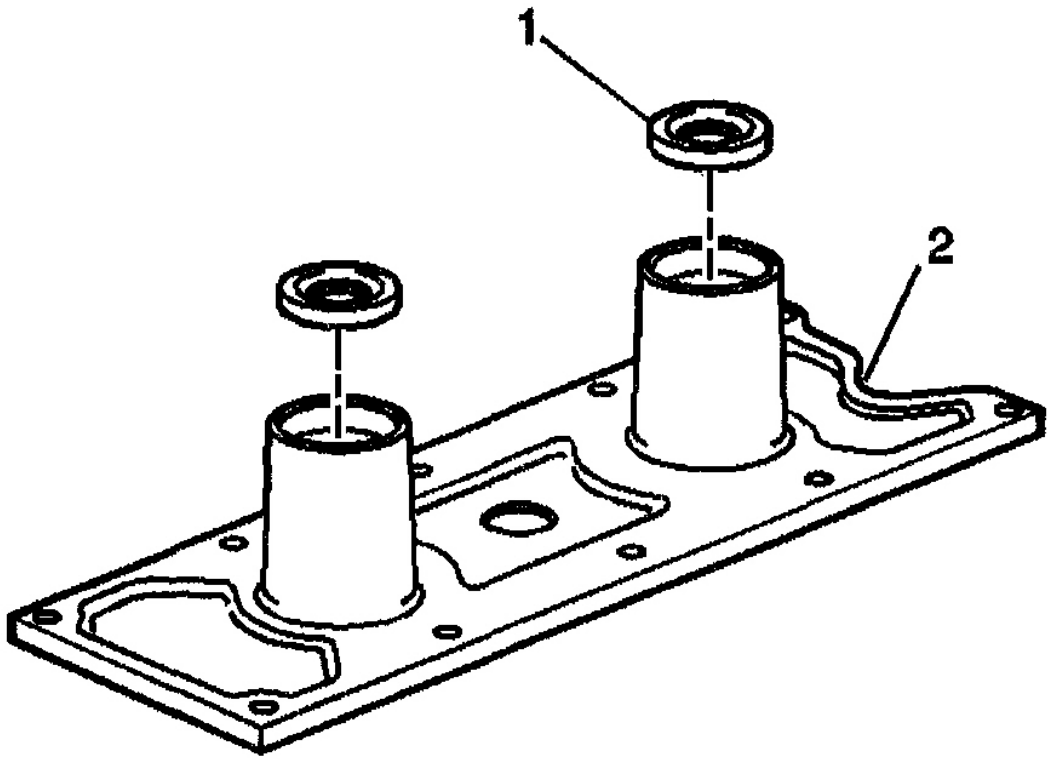


Fig. 86: Knock Sensor Oil Seals & Cover
Courtesy of GENERAL MOTORS CORP.

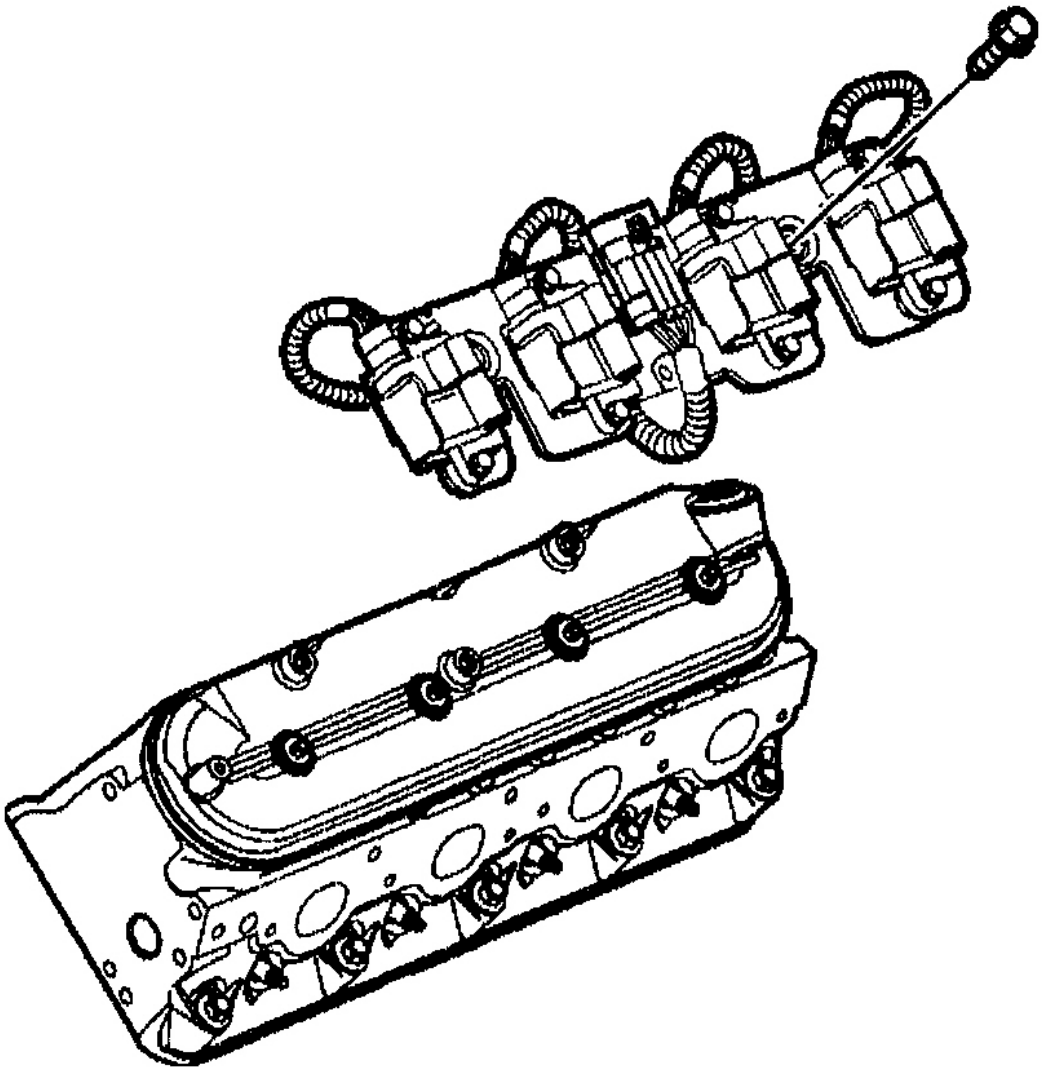
VALVE ROCKER ARM COVER REMOVAL - LEFT

IMPORTANT: Do not remove the ignition coils and bracket from the valve rocker arm cover unless required.

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

1. Remove the ignition coil bracket bolts from the rocker arm cover, if required.
2. Remove the ignition coil and bracket assembly from the cover.

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Fig. 87: Ignition Coil Bracket & Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

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

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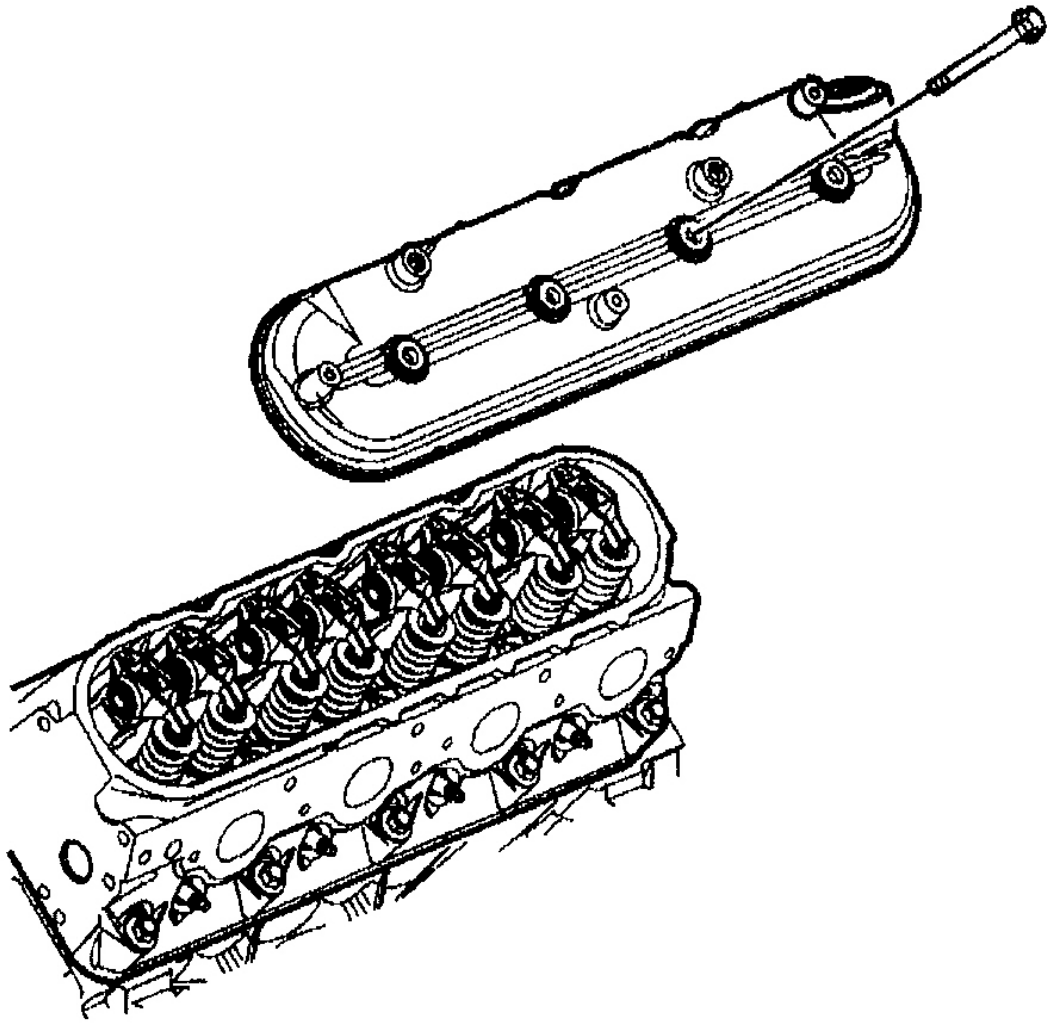


Fig. 88: Valve Rocker Arm Cover & Bolt (Left)
Courtesy of GENERAL MOTORS CORP.

5. Remove the gasket (1) from the cover.
6. Discard the gasket.

The bolt grommets may be reused if not damaged.

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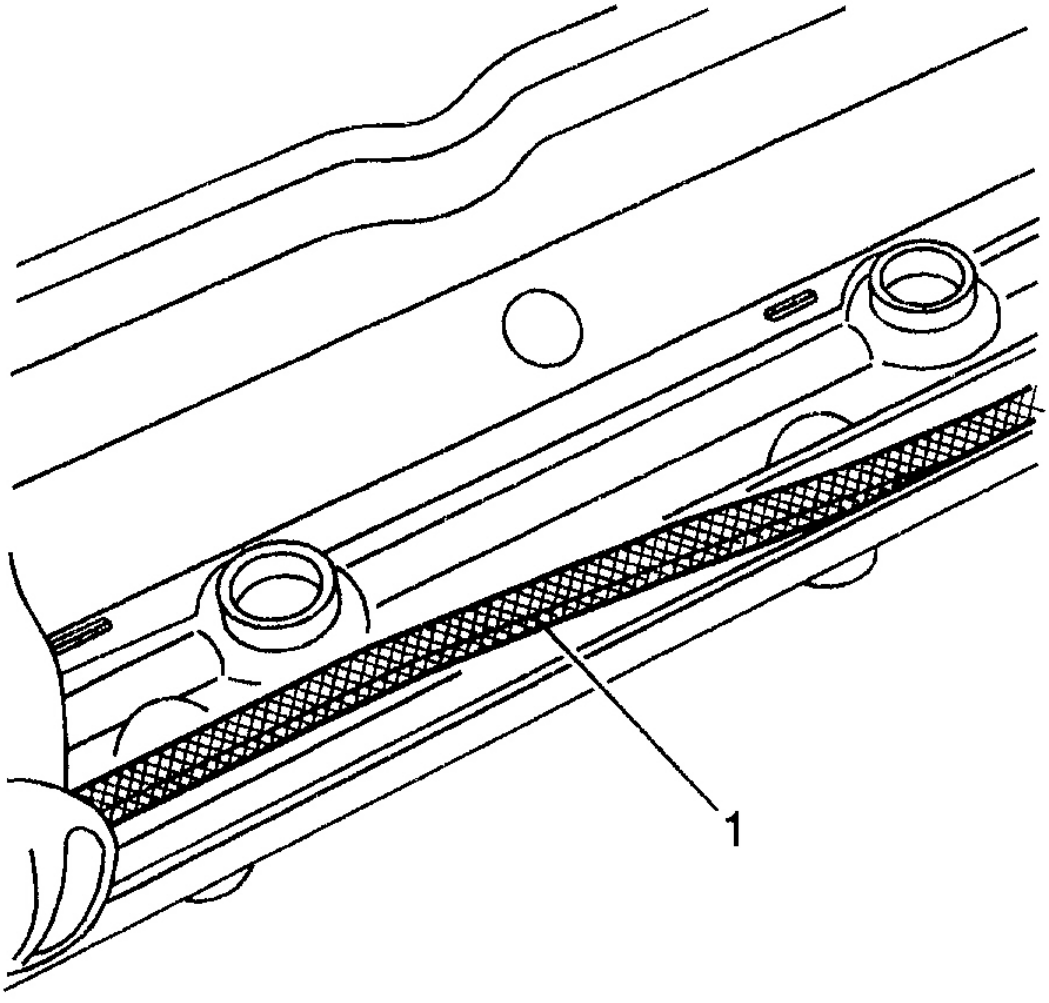


Fig. 89: Valve Rocker Arm Cover Gasket (Left)
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM COVER REMOVAL - RIGHT

IMPORTANT: Do not remove the ignition coils from the valve rocker arm cover unless required.

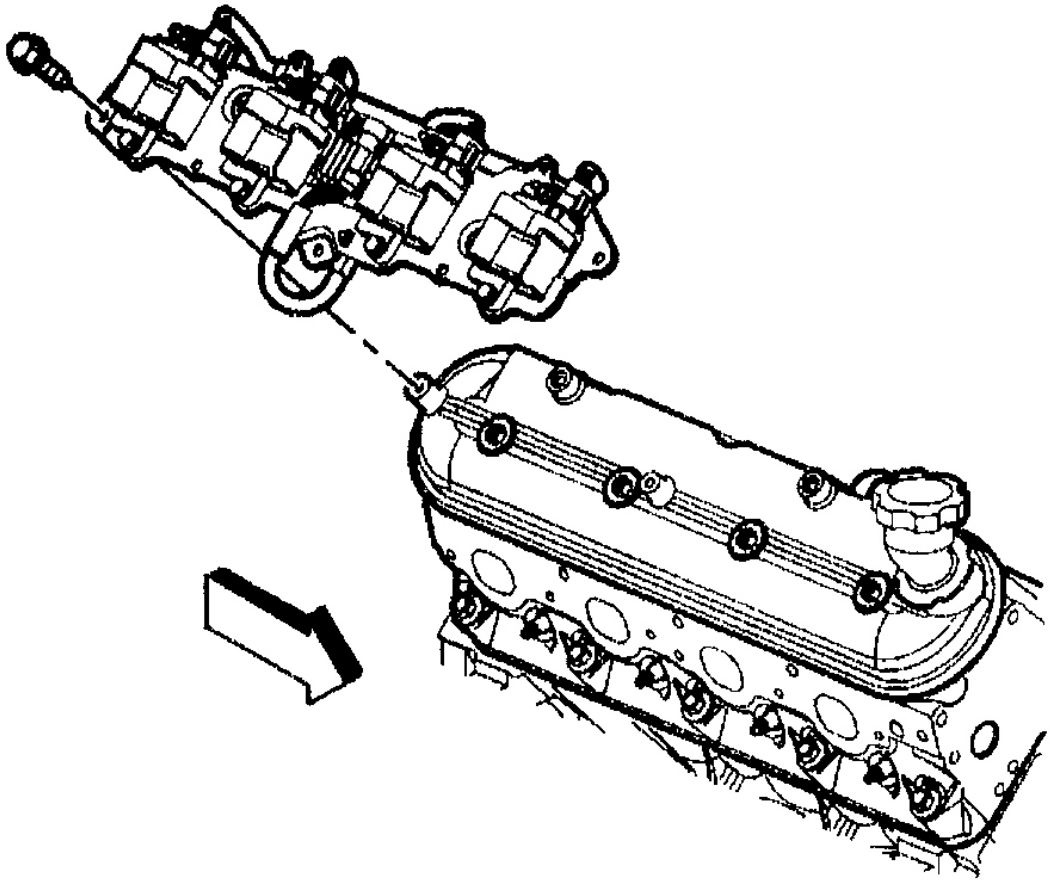
Do not remove the oil fill tube from the cover unless service is required.

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

1. Remove the ignition coil bracket bolts from the rocker arm cover, if required.

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2. Remove the ignition coil and bracket assembly from the cover.

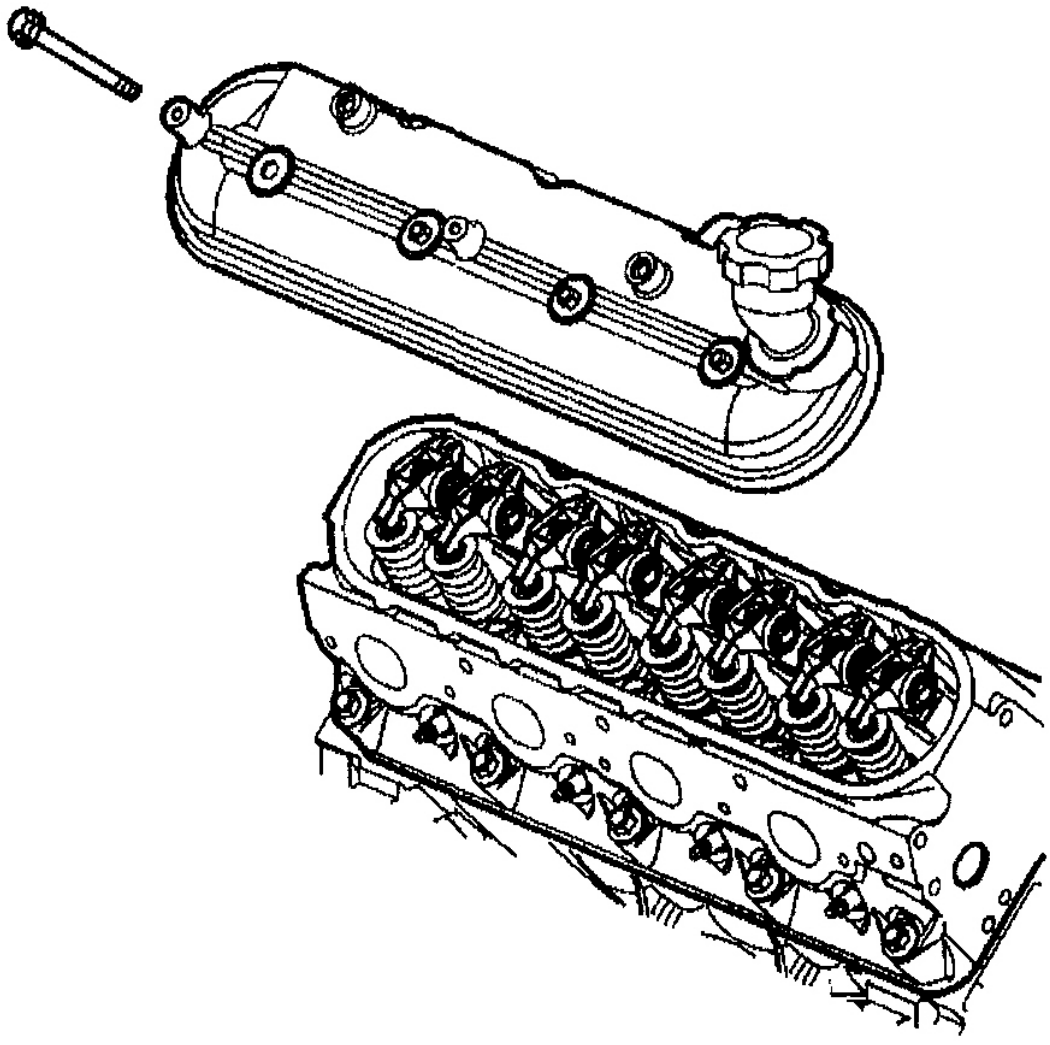


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Fig. 90: Ignition Coil & Bracket (Right)
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 91: Valve Rocker Arm Cover & Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

5. Remove the gasket (1) from the cover.
6. Discard the gasket.

The bolt grommets may be reused if not damaged.

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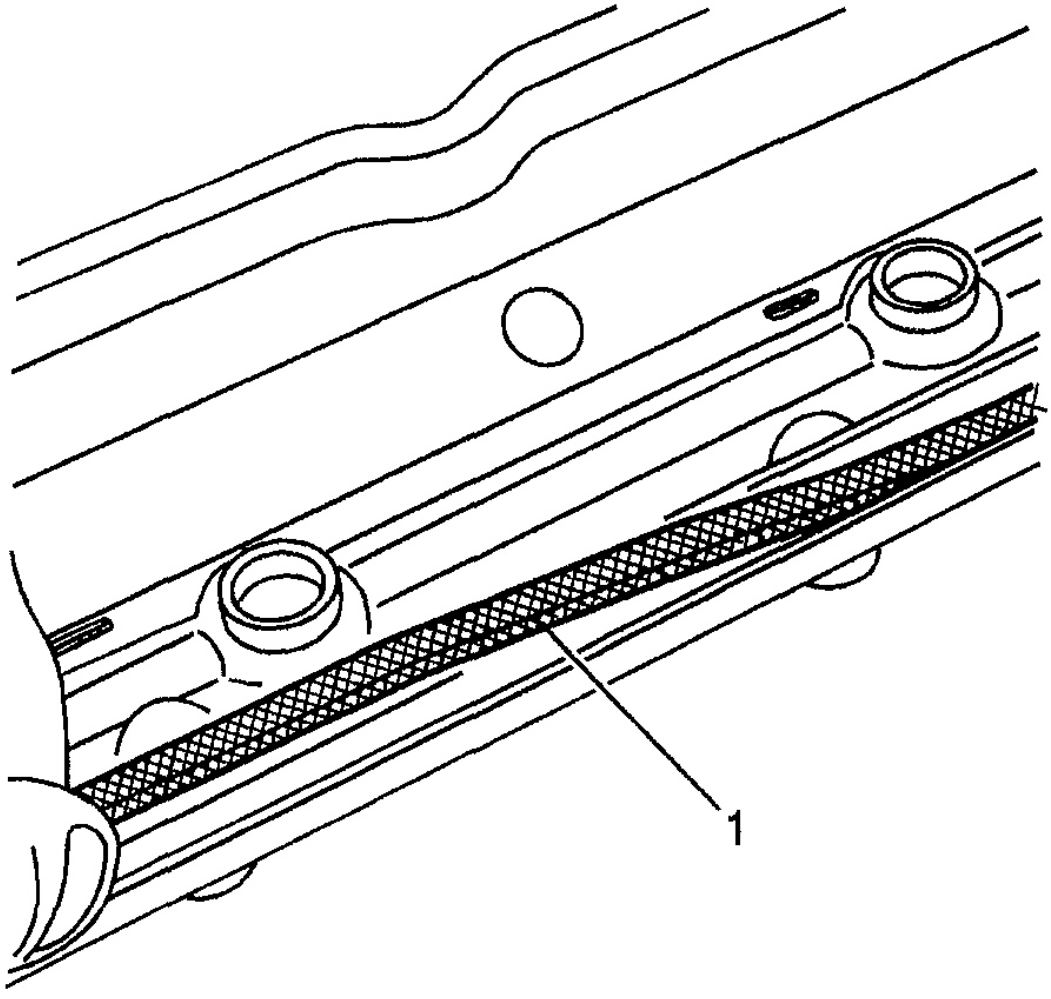
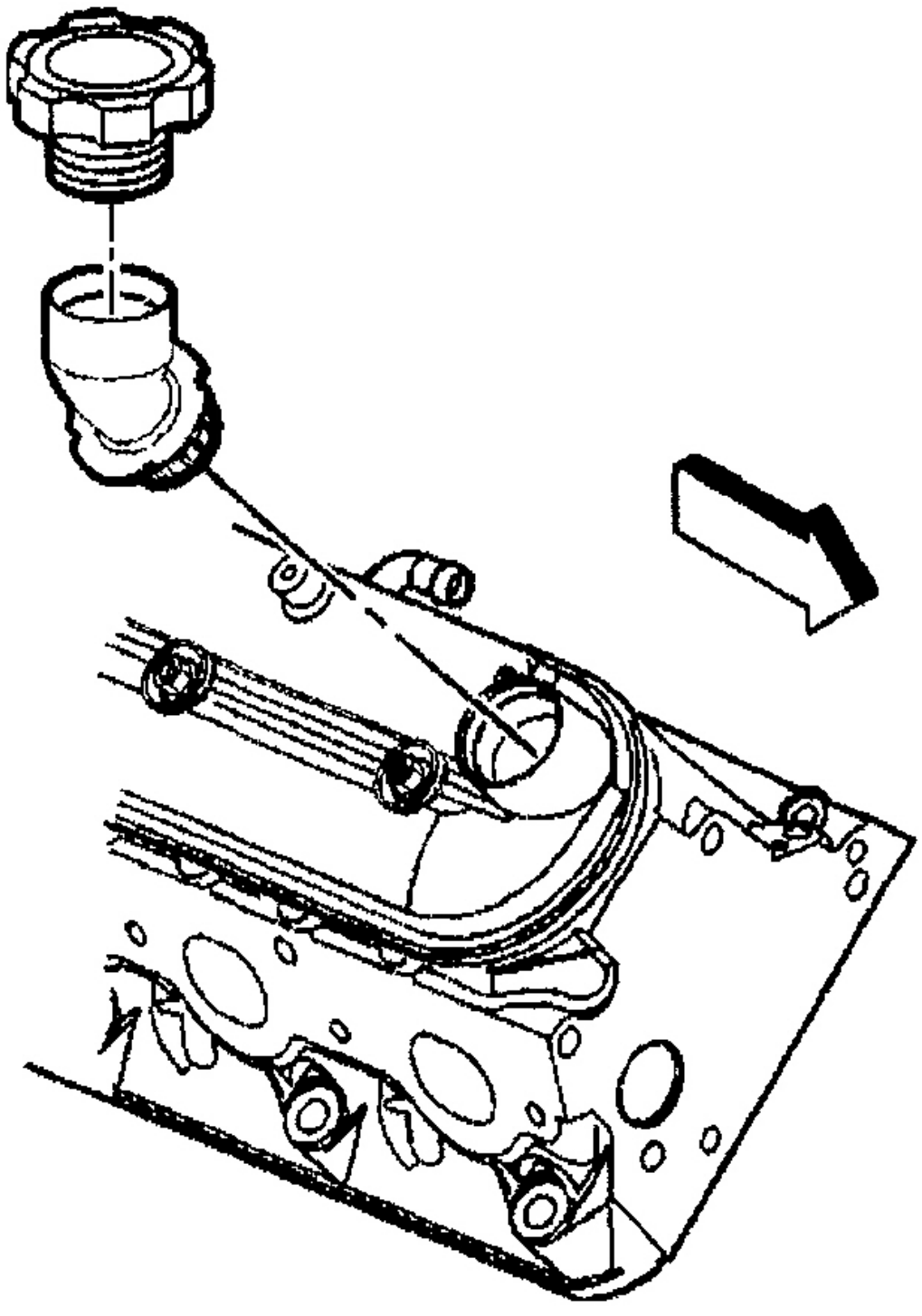


Fig. 92: Valve Rocker Arm Cove Gasket (Right)
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil fill cap from the oil fill tube.
8. Remove the oil fill tube, if required.
9. Discard the oil fill tube.

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Fig. 93: Oil Fill Tube & Cap
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM AND PUSH ROD REMOVAL

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

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

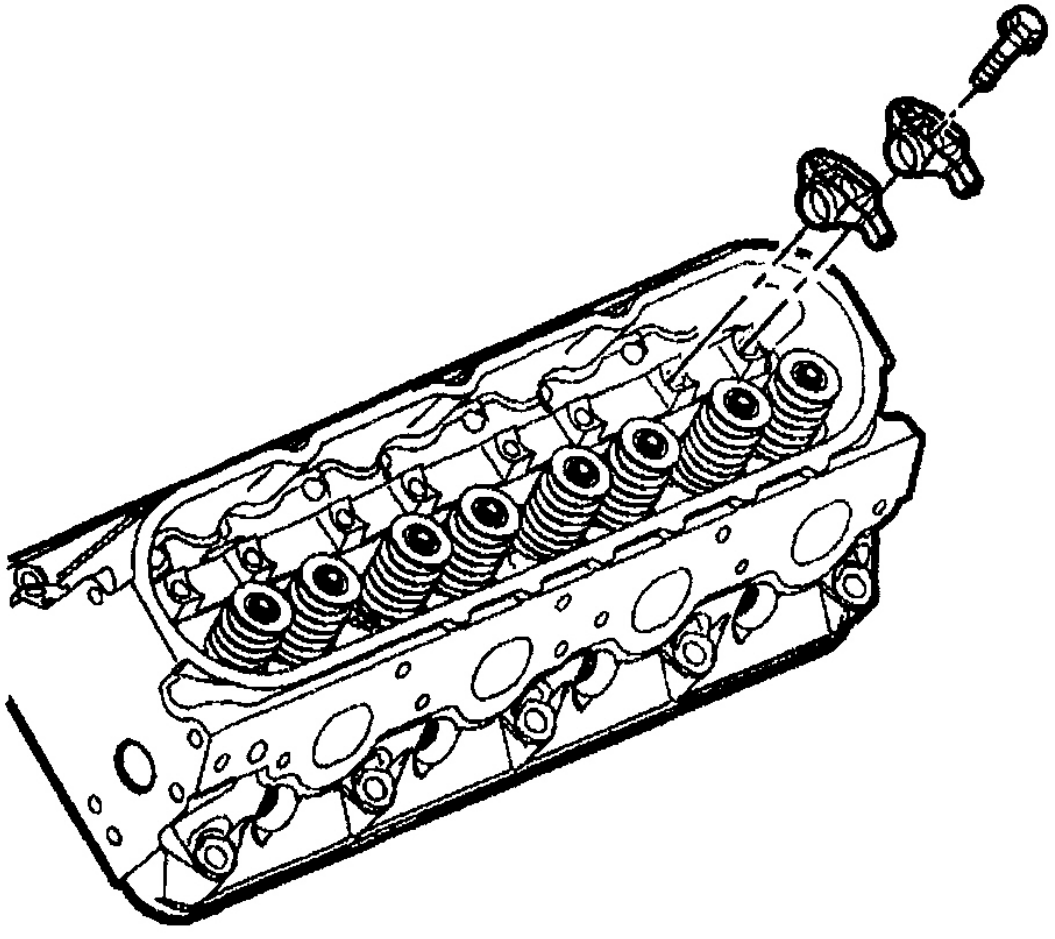


Fig. 94: Valve Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

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3. Remove the valve rocker arm pivot support.

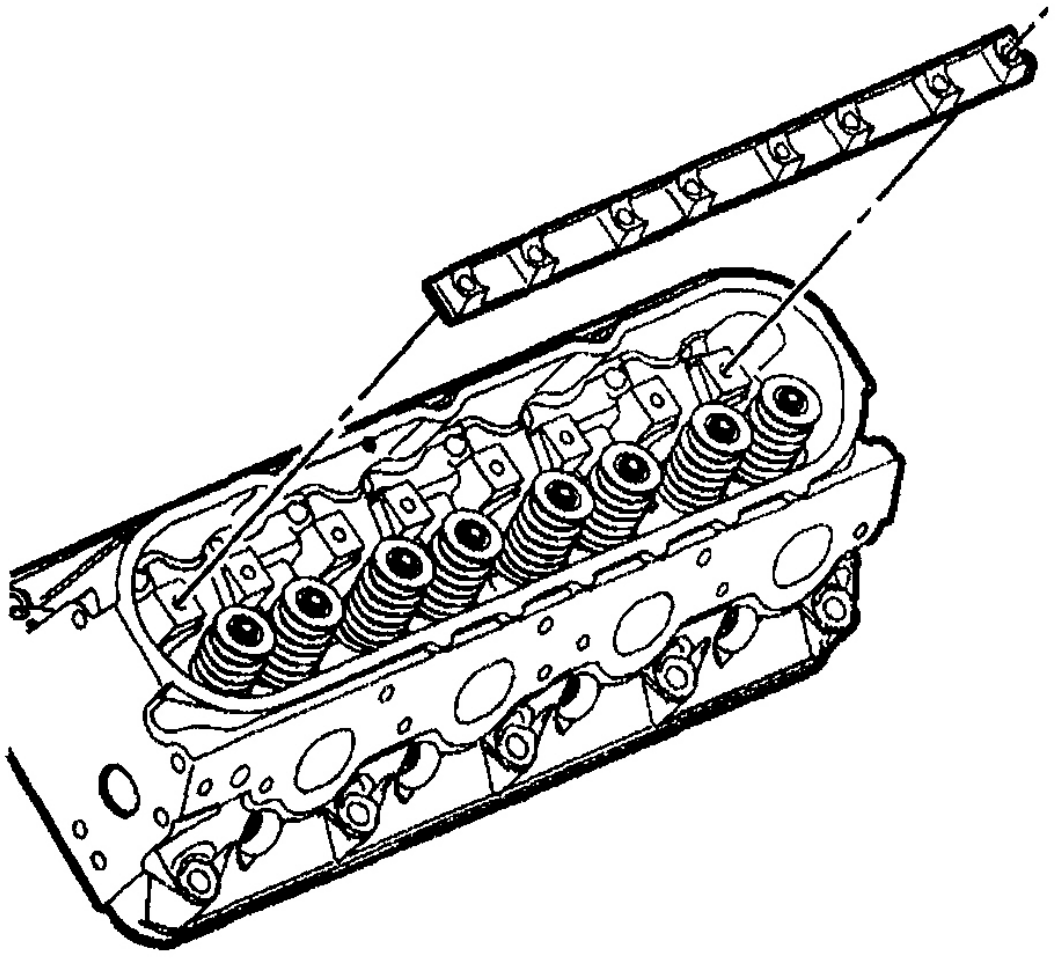
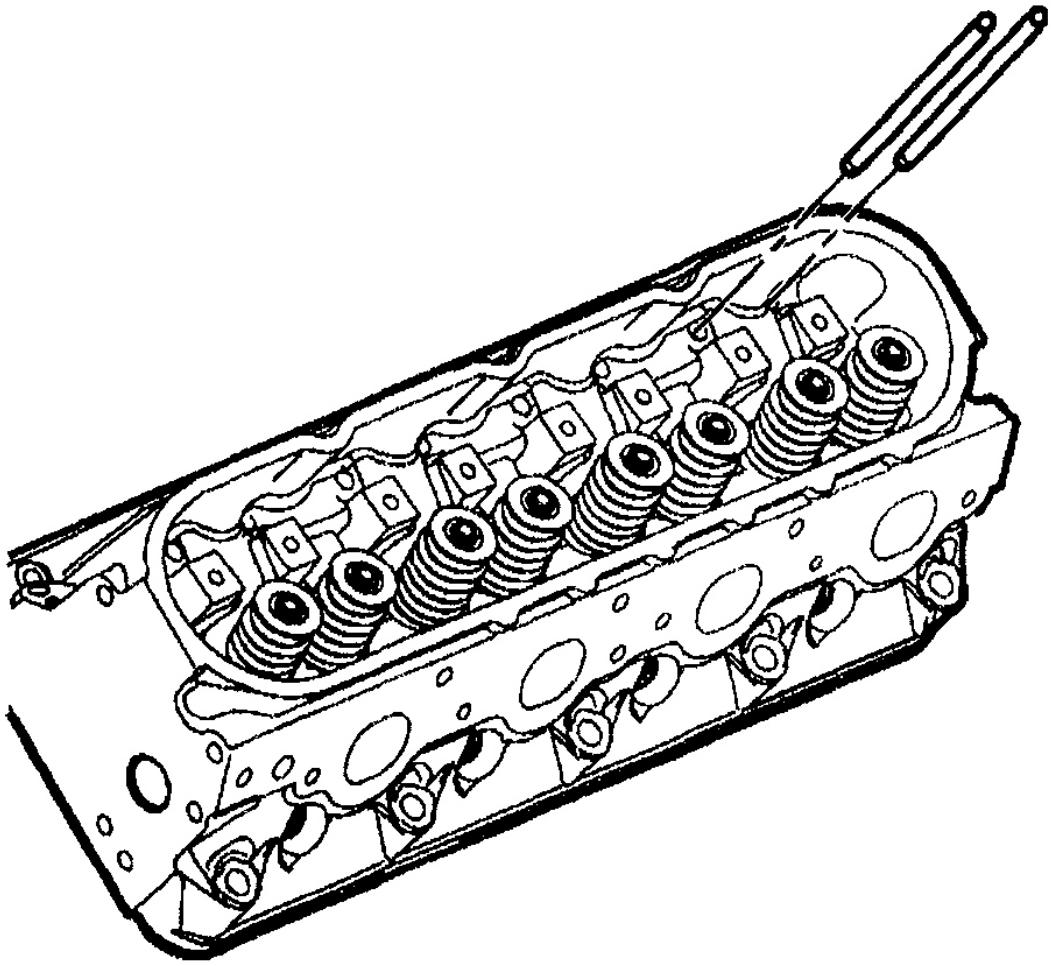


Fig. 95: Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

4. Remove the pushrods.

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Fig. 96: Pushrods
Courtesy of GENERAL MOTORS CORP.

CYLINDER HEAD REMOVAL - LEFT

1. Remove the spark plugs from the cylinder head.

IMPORTANT: The cylinder head bolts are NOT reusable. Install NEW cylinder head bolts during assembly.

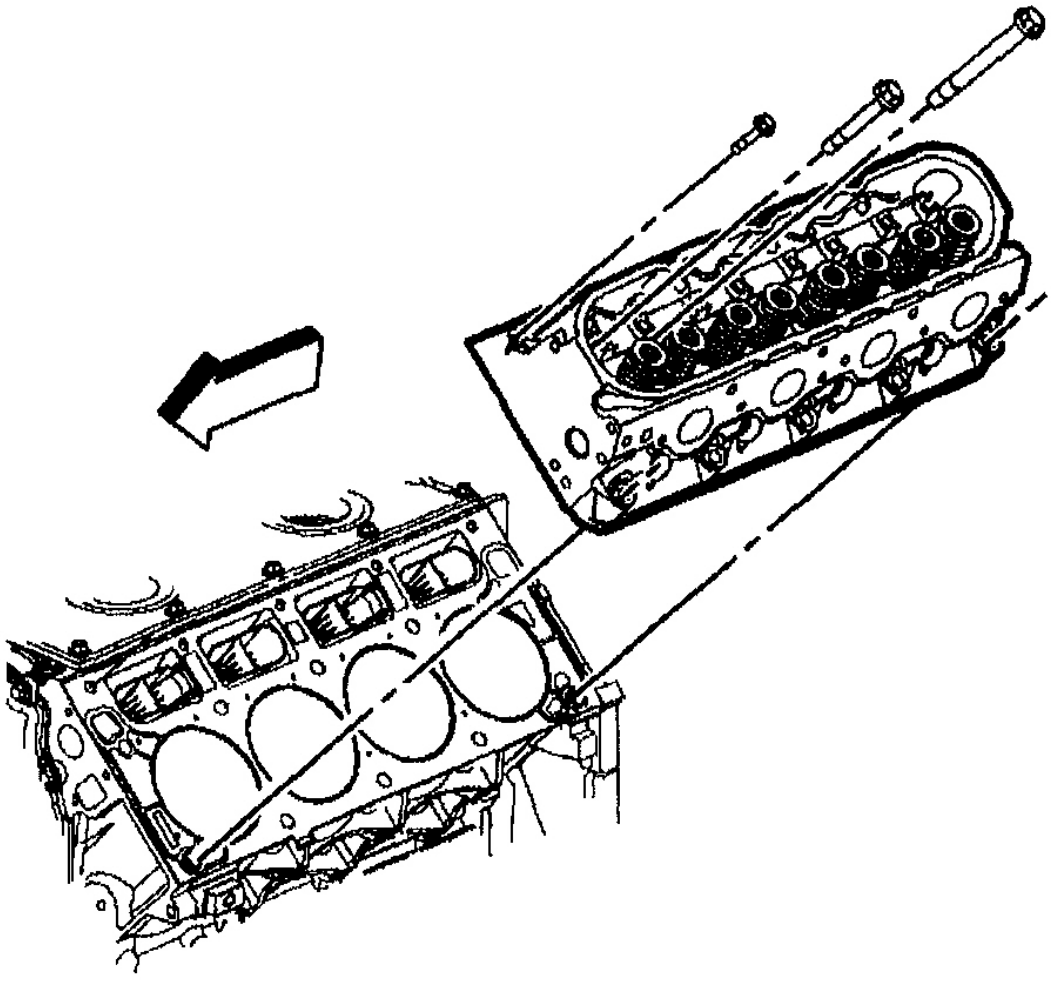
2. Remove the cylinder head bolts.

NOTE: After removal, place the cylinder head on two wood blocks to prevent

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damage.

3. Remove the cylinder head.



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Fig. 97: Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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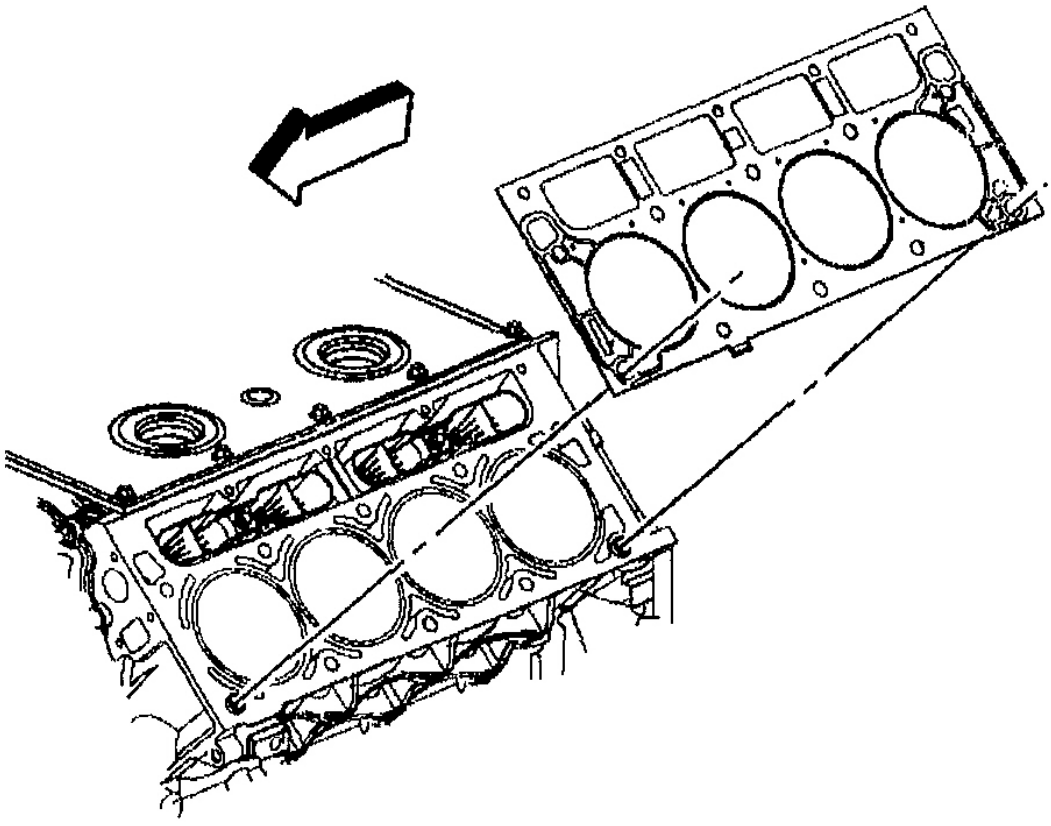


Fig. 98: Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

CYLINDER HEAD REMOVAL - RIGHT

1. Remove the spark plugs from the cylinder head.

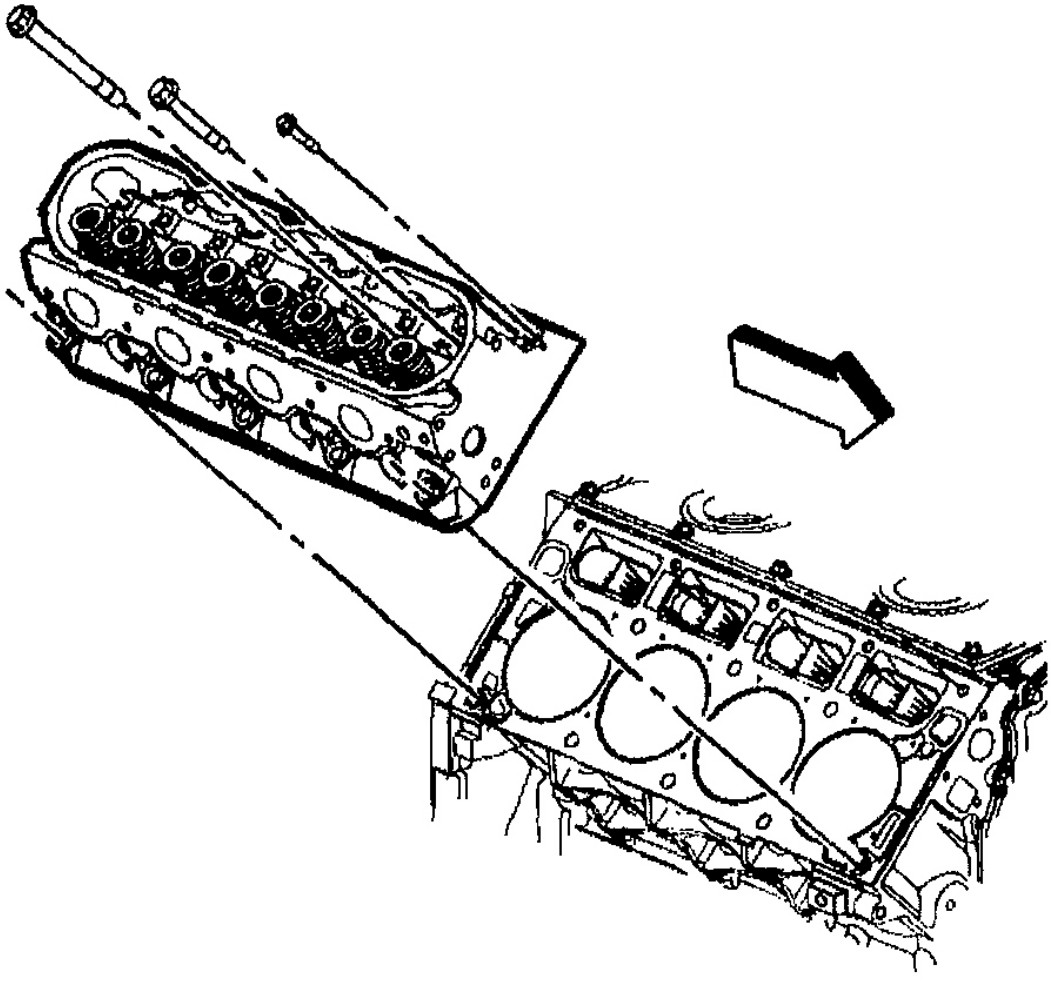
IMPORTANT: The cylinder head bolts are NOT reusable. Install NEW cylinder head bolts during assembly.

2. Remove the cylinder head bolts.

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

3. Remove the cylinder head.

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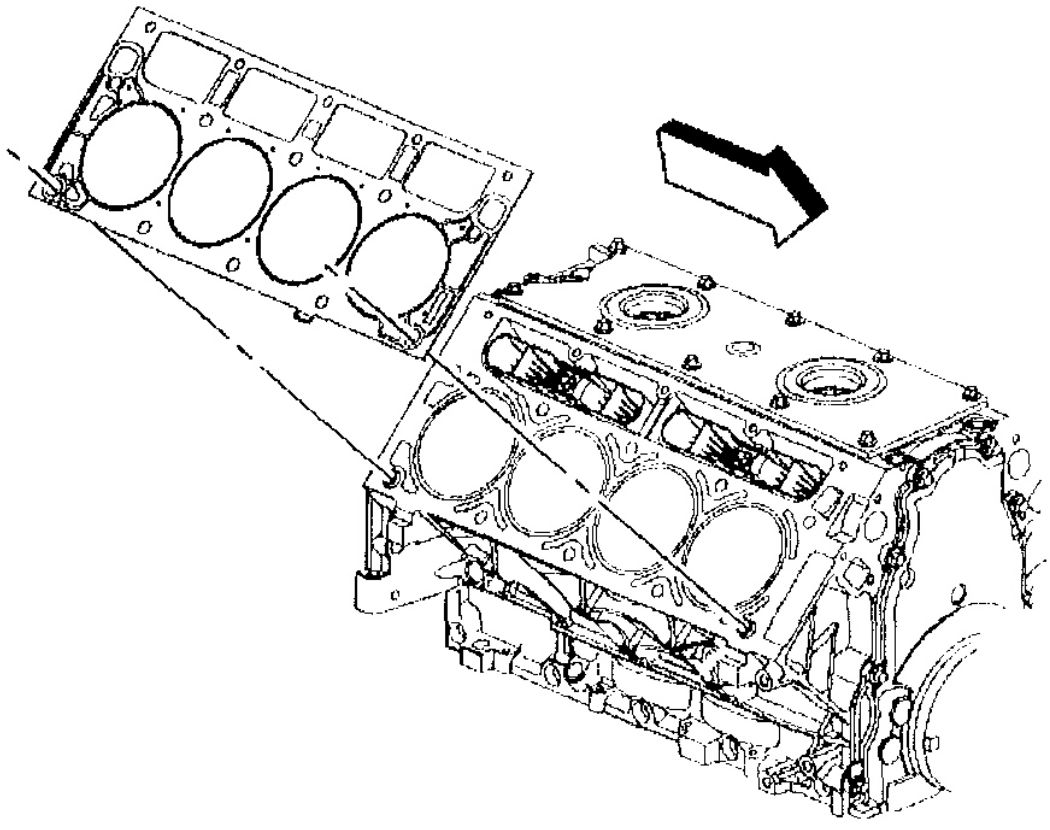


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Fig. 99: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 100: Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

VALVE LIFTER REMOVAL

Tools Required

J 3049-A Valve Lifter Remover

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

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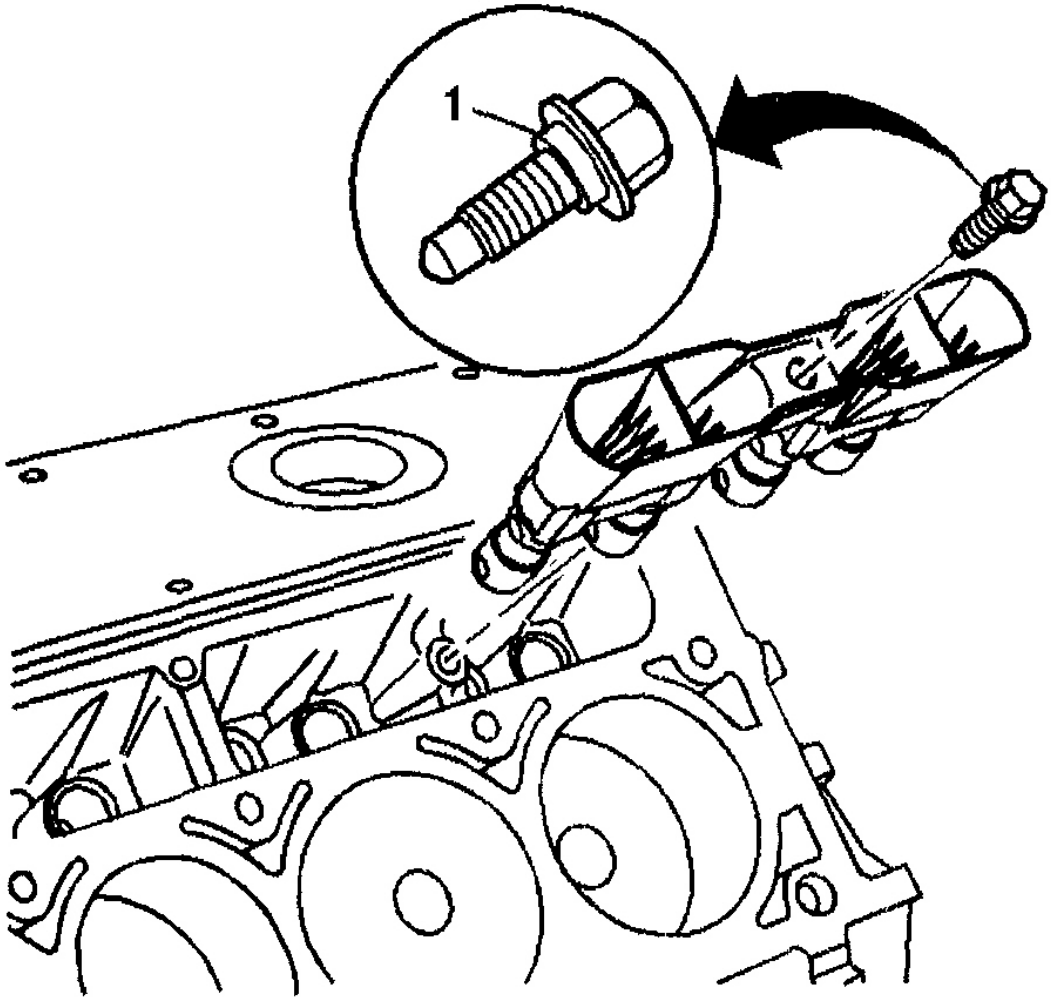


Fig. 101: Valve Lifter Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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

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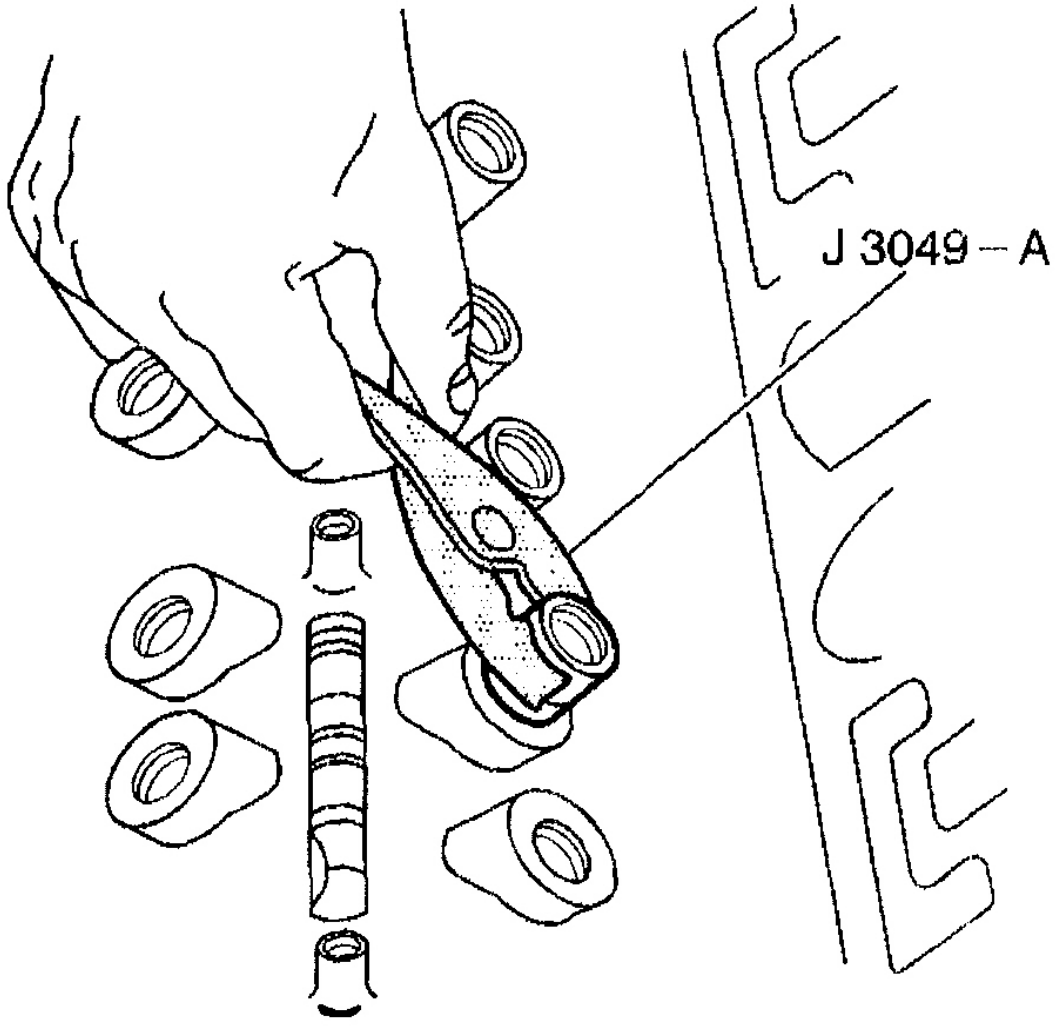


Fig. 102: Removing Valve Lifters Using J 3049-A
Courtesy of GENERAL MOTORS CORP.

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

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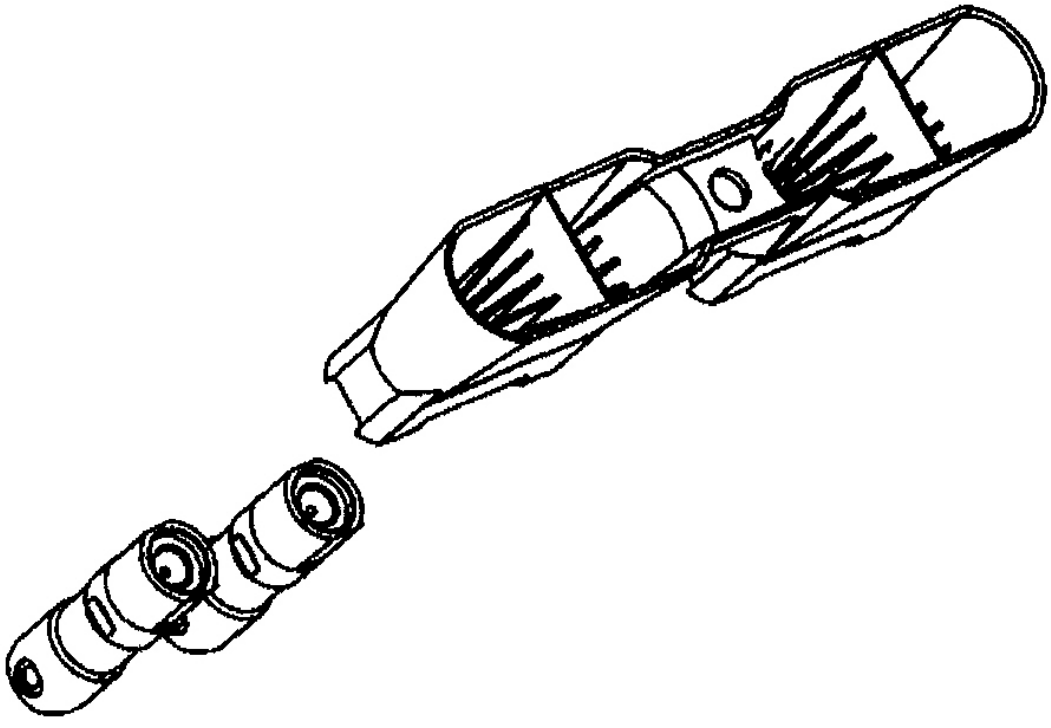
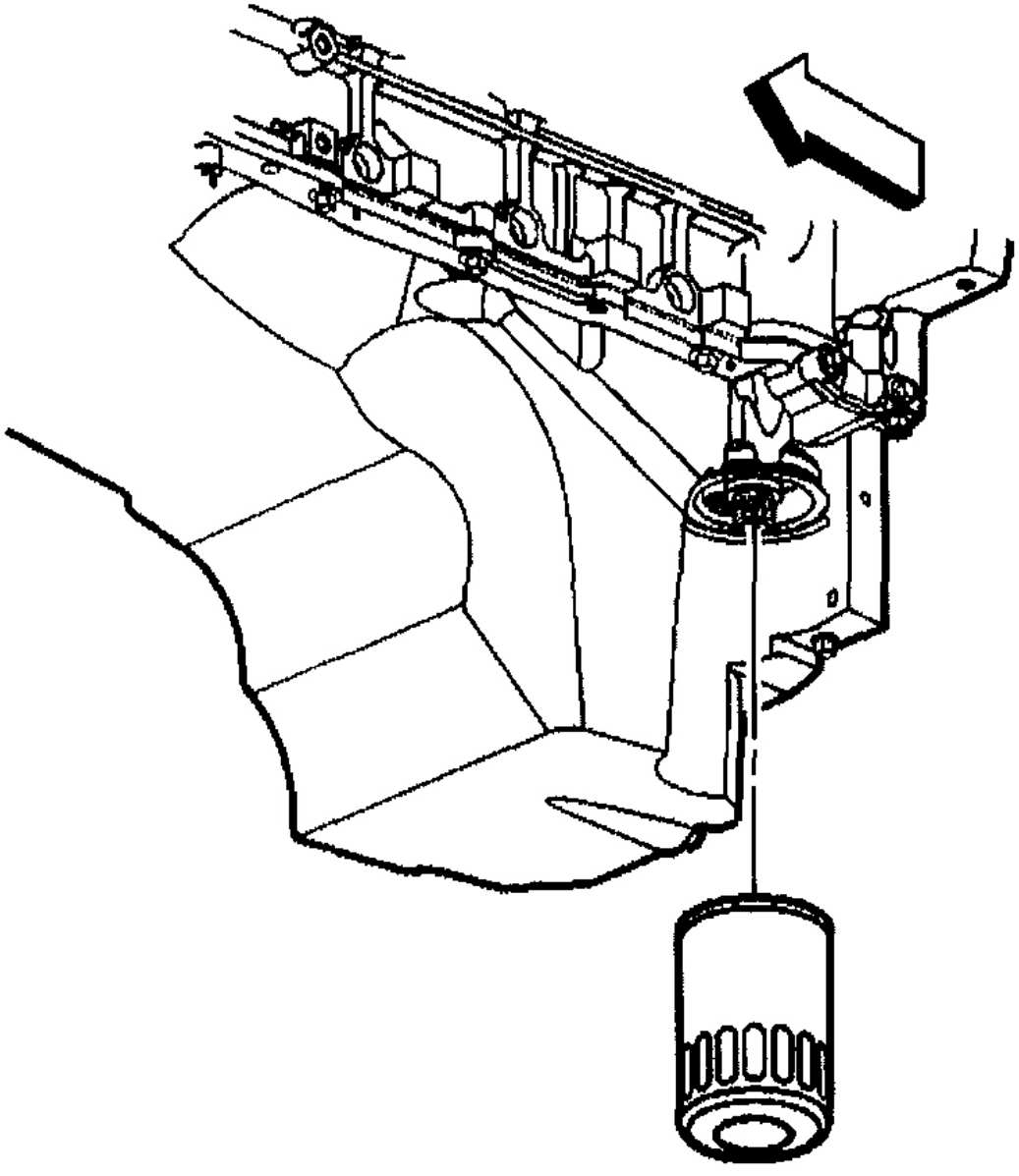


Fig. 103: Valve Lifters & Guide
Courtesy of GENERAL MOTORS CORP.

OIL FILTER, ADAPTER AND PAN COVER REMOVAL

1. Remove the oil filter.

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Fig. 104: Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pan cover (2), bolts (1), and gasket (3), if applicable.
3. Discard the gasket.

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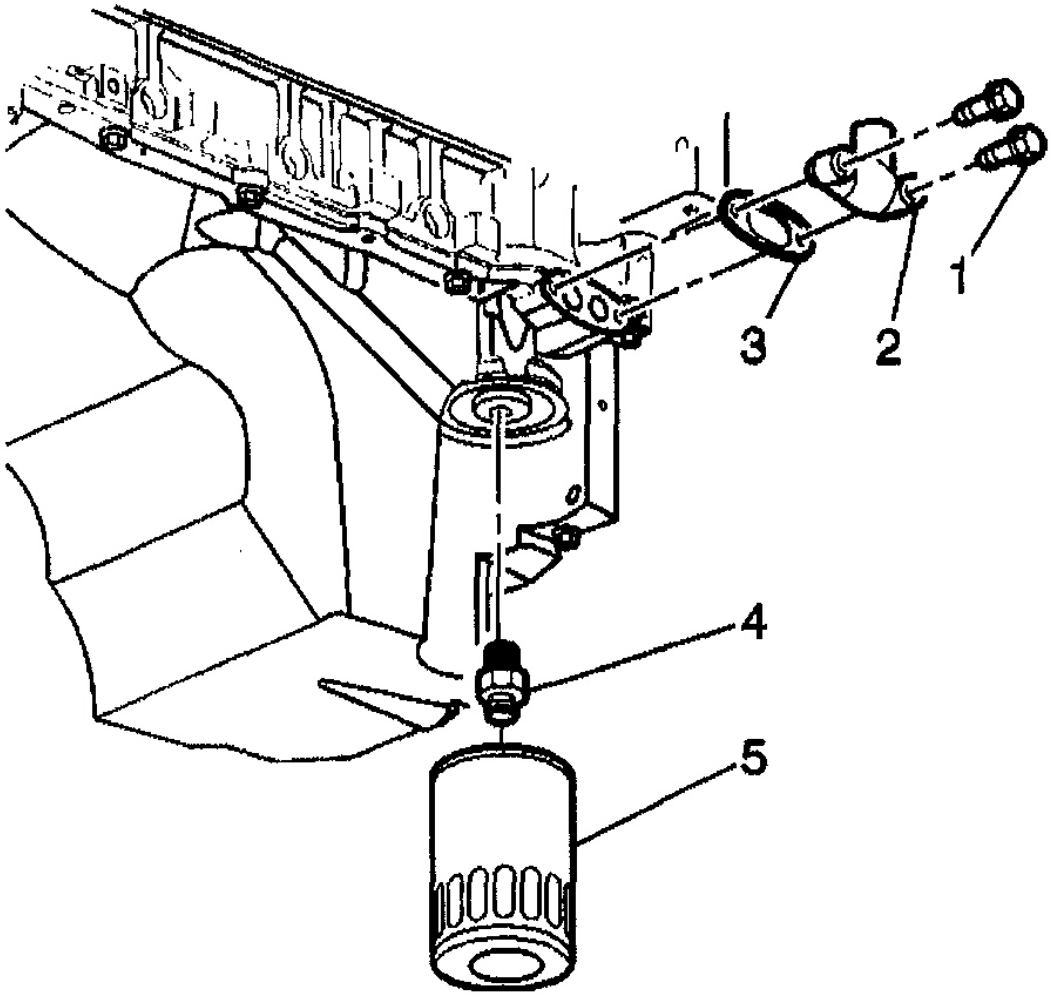


Fig. 105: Oil Pan Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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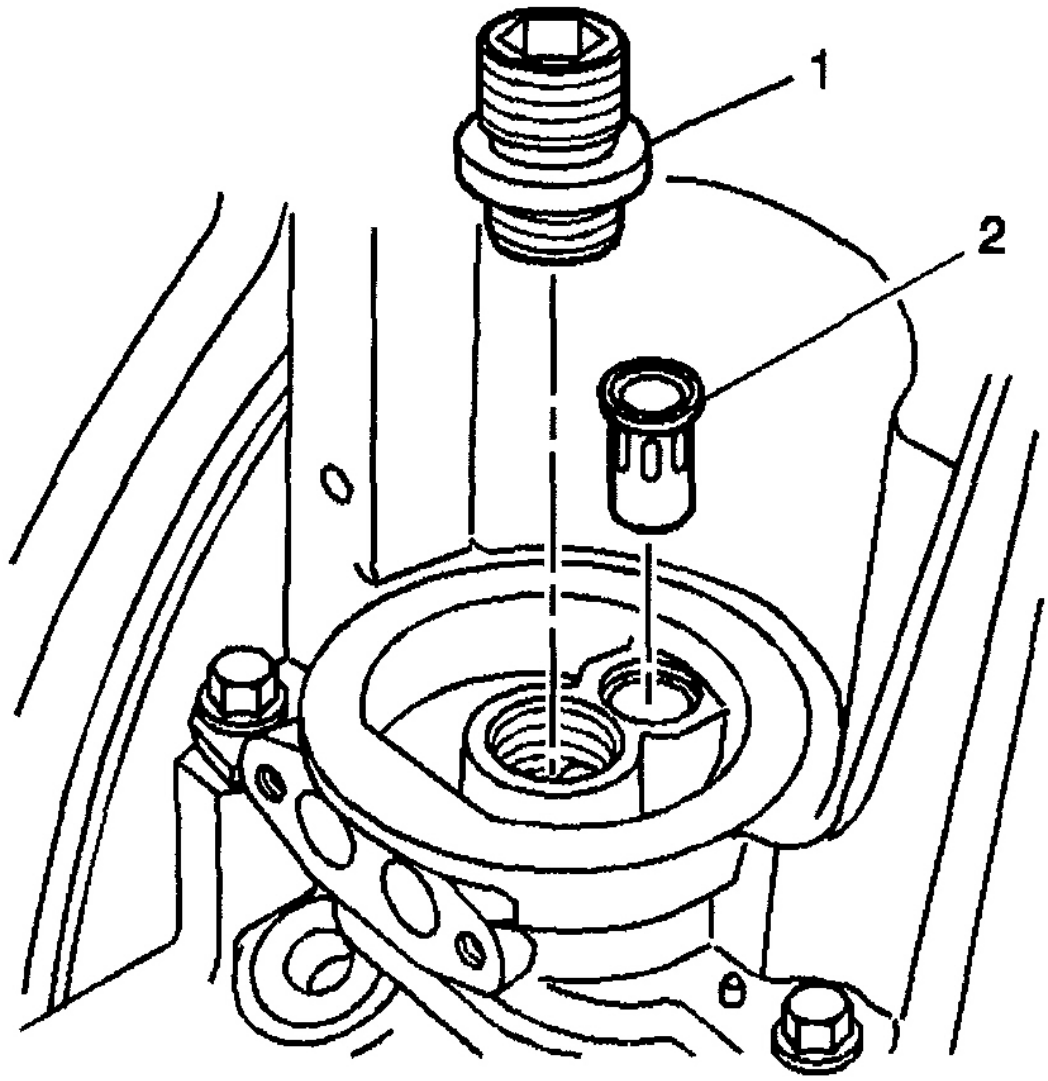


Fig. 106: Oil Filter Fitting & Bypass Valve
Courtesy of GENERAL MOTORS CORP.

OIL PAN REMOVAL

IMPORTANT: The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.

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

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

1. Remove the left closeout cover and bolt.

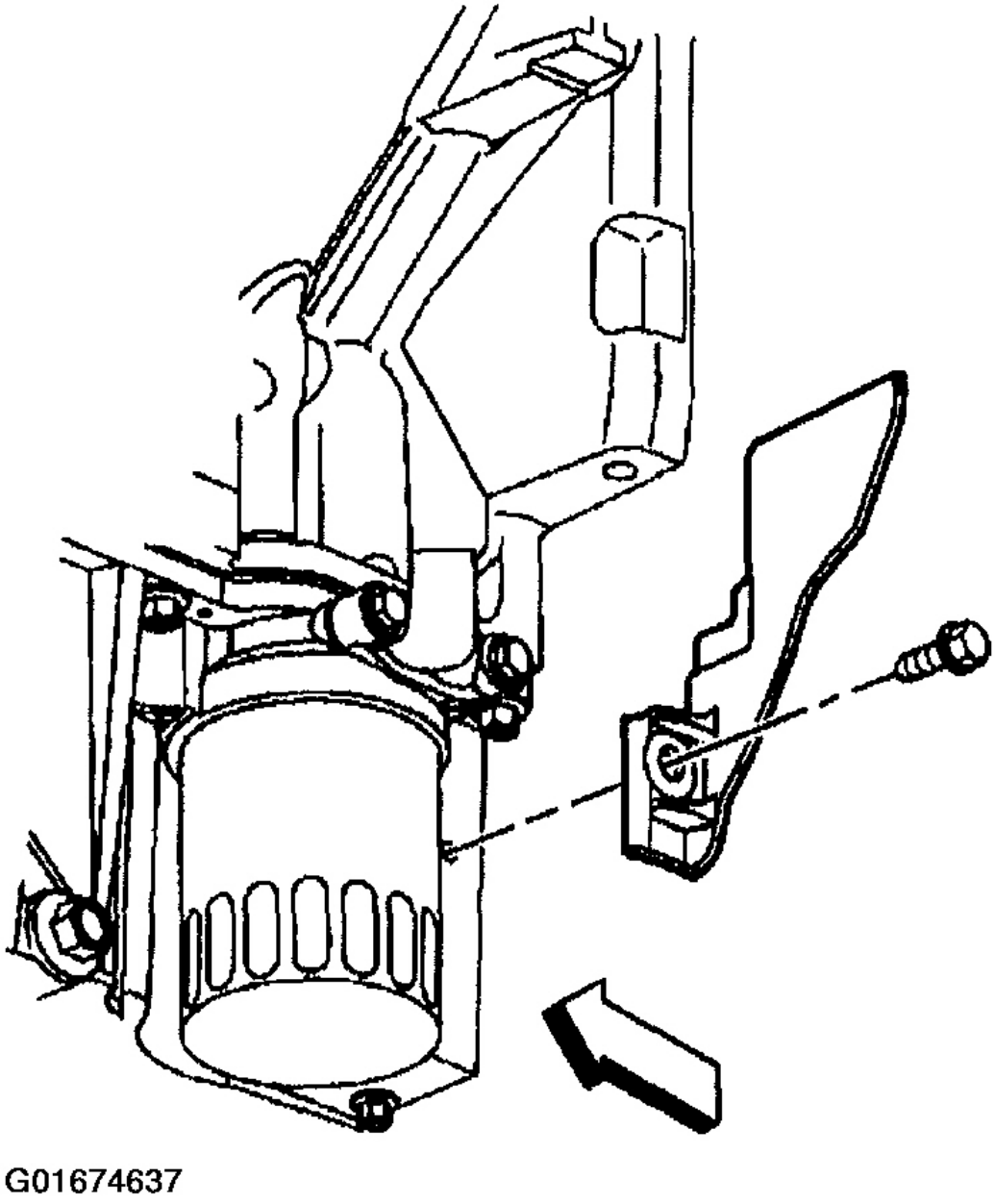


Fig. 107: Left Closeout Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

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2. Remove the right closeout cover and bolt.

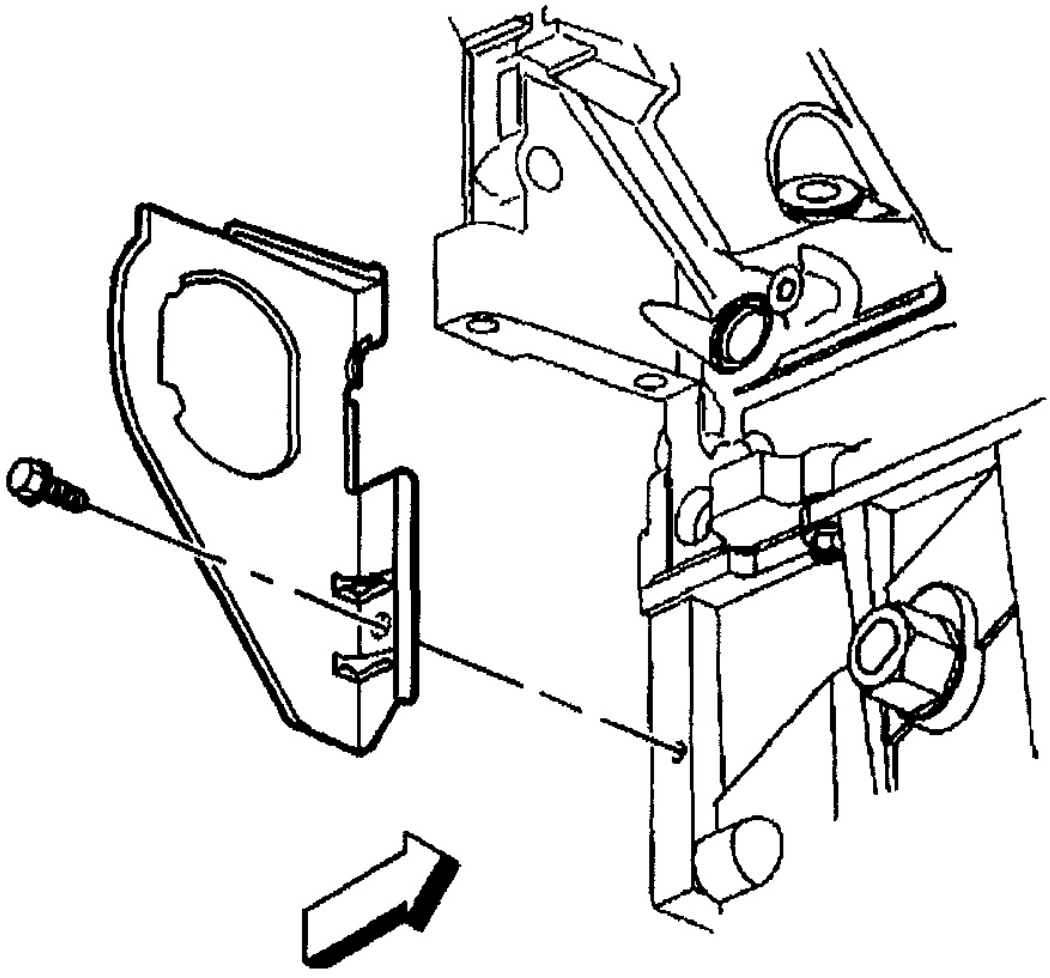
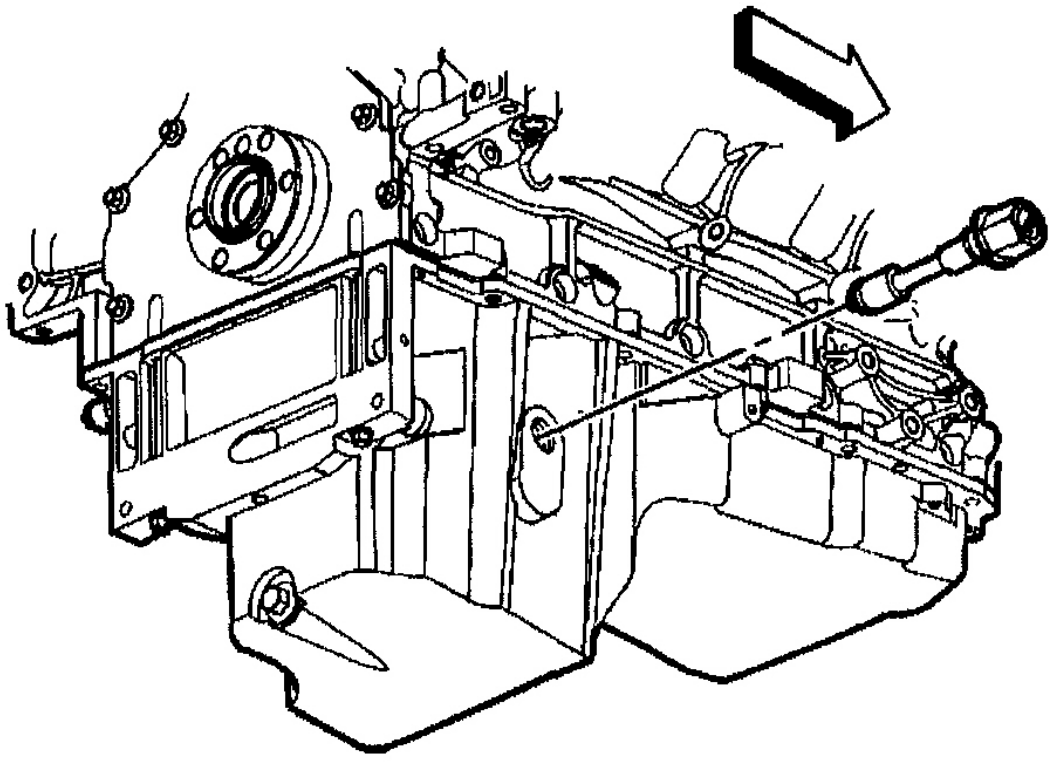


Fig. 108: Right Closeout Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil level sensor from the oil pan, if required.

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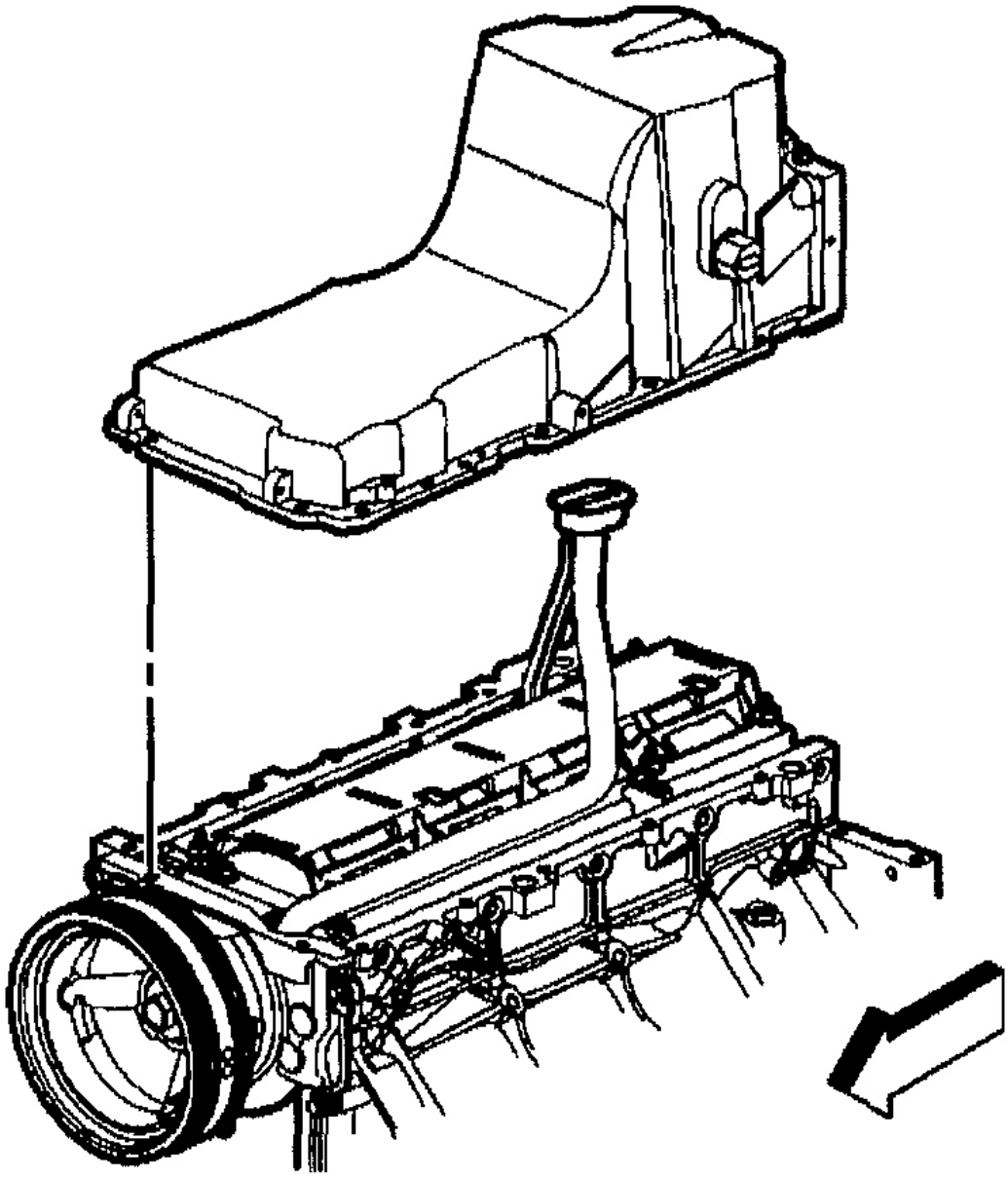


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Fig. 109: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 110: Oil Pan
Courtesy of GENERAL MOTORS CORP.

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

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Use care not to gouge, score, or damage the oil pan sealing surface.

6. Drill (3) out the oil pan gasket retaining rivets (2), if required.
7. Remove the gasket (1) from the pan.
8. Discard the gasket and rivets.

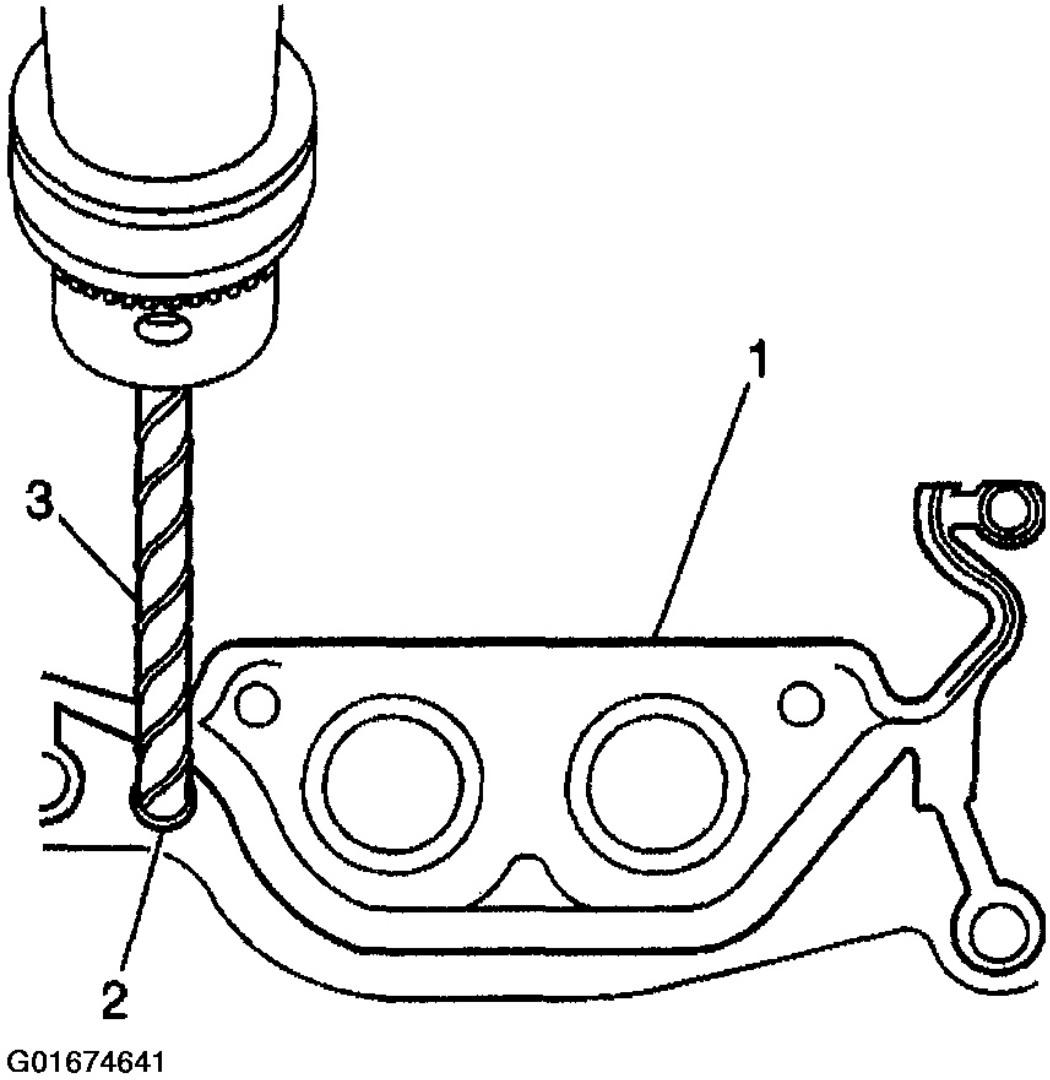
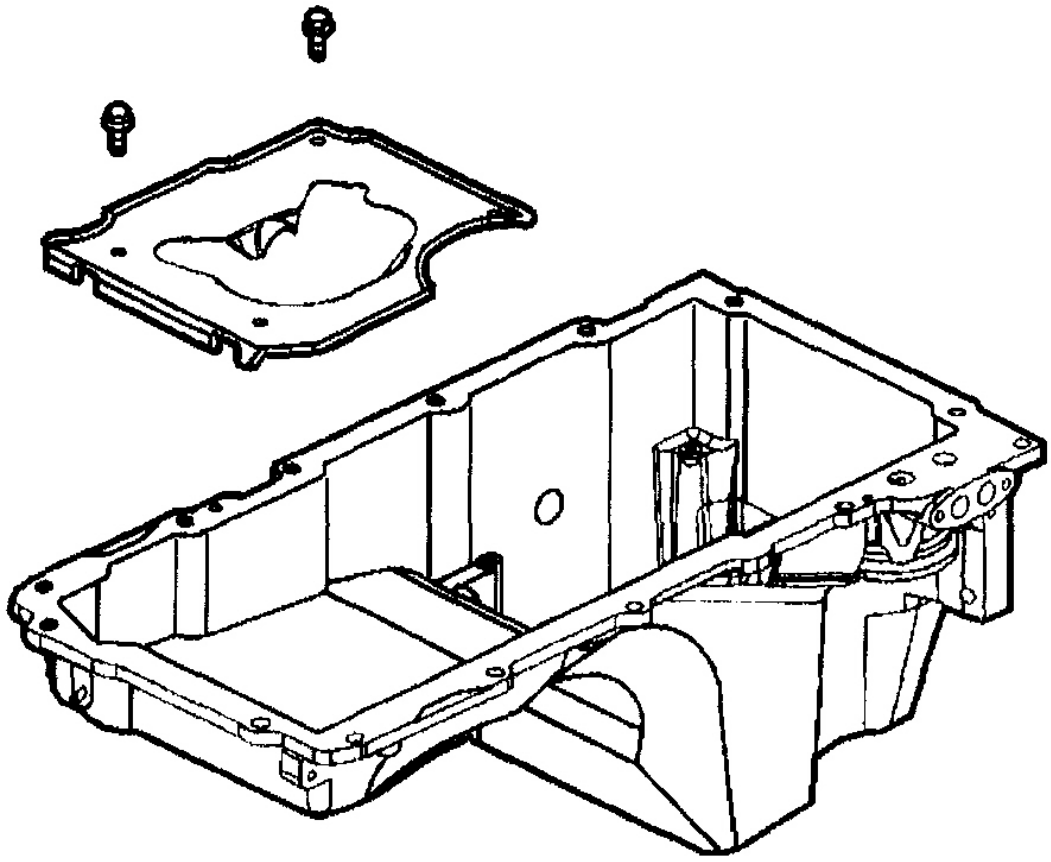


Fig. 111: Drilling Out Oil Pan Gasket Retaining Rivets
Courtesy of GENERAL MOTORS CORP.

9. Remove the oil pan baffle bolts and baffle, if required.

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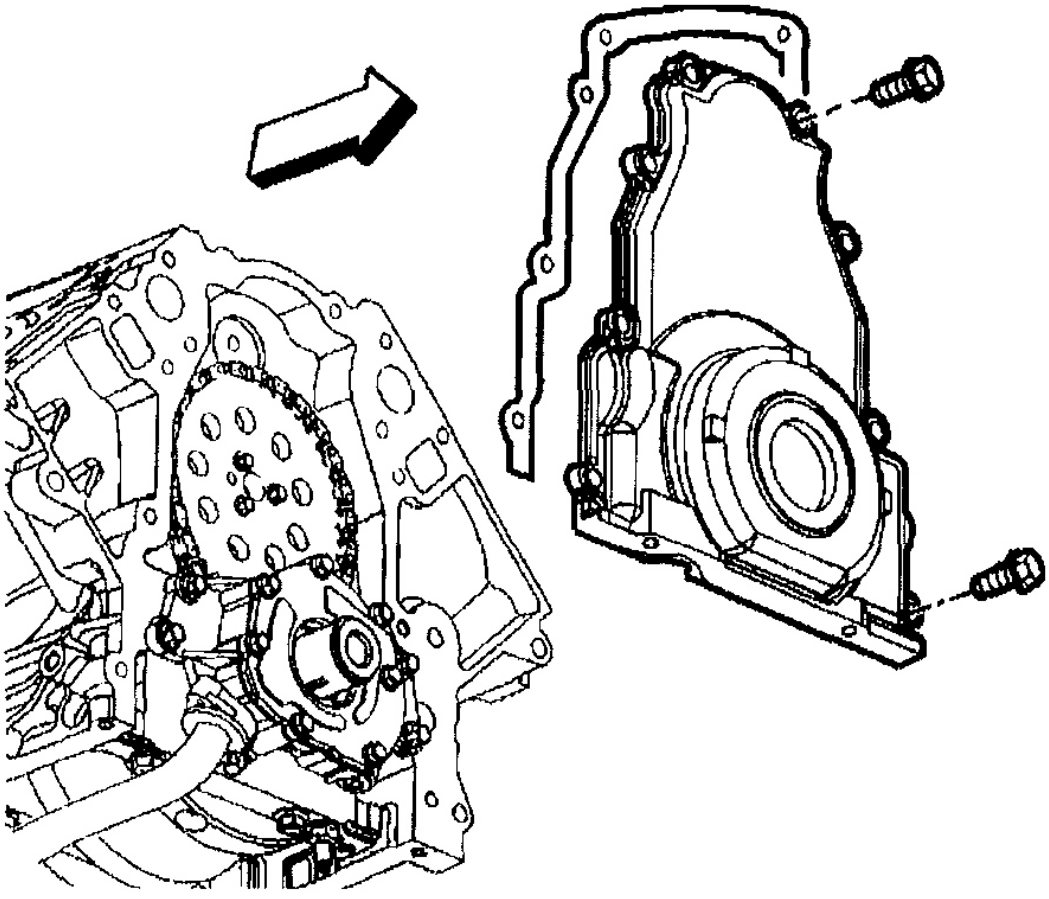
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Fig. 112: Oil Pan Baffle & Bolts
Courtesy of GENERAL MOTORS CORP.

ENGINE FRONT COVER REMOVAL

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

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Fig. 113: Engine Front Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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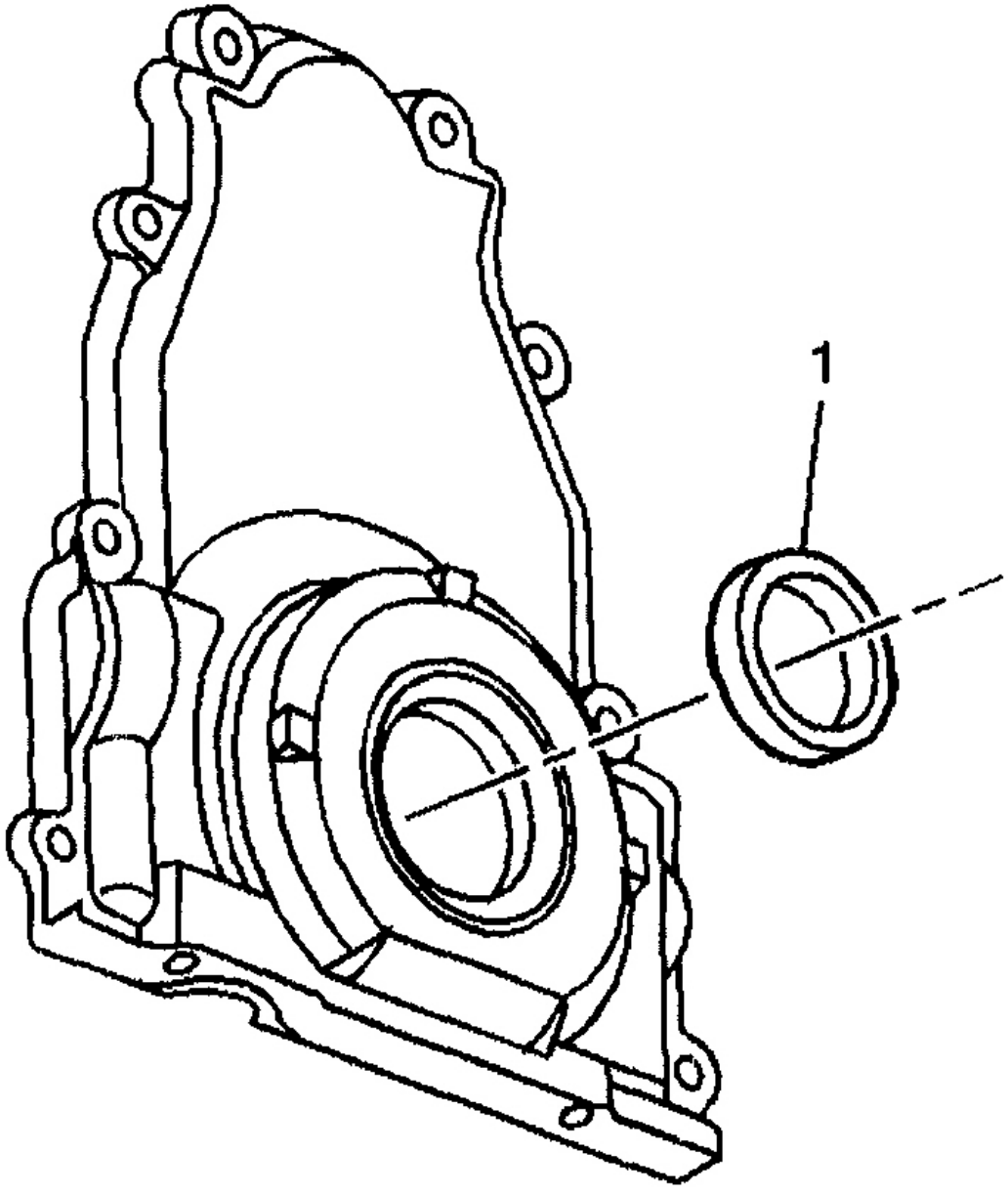
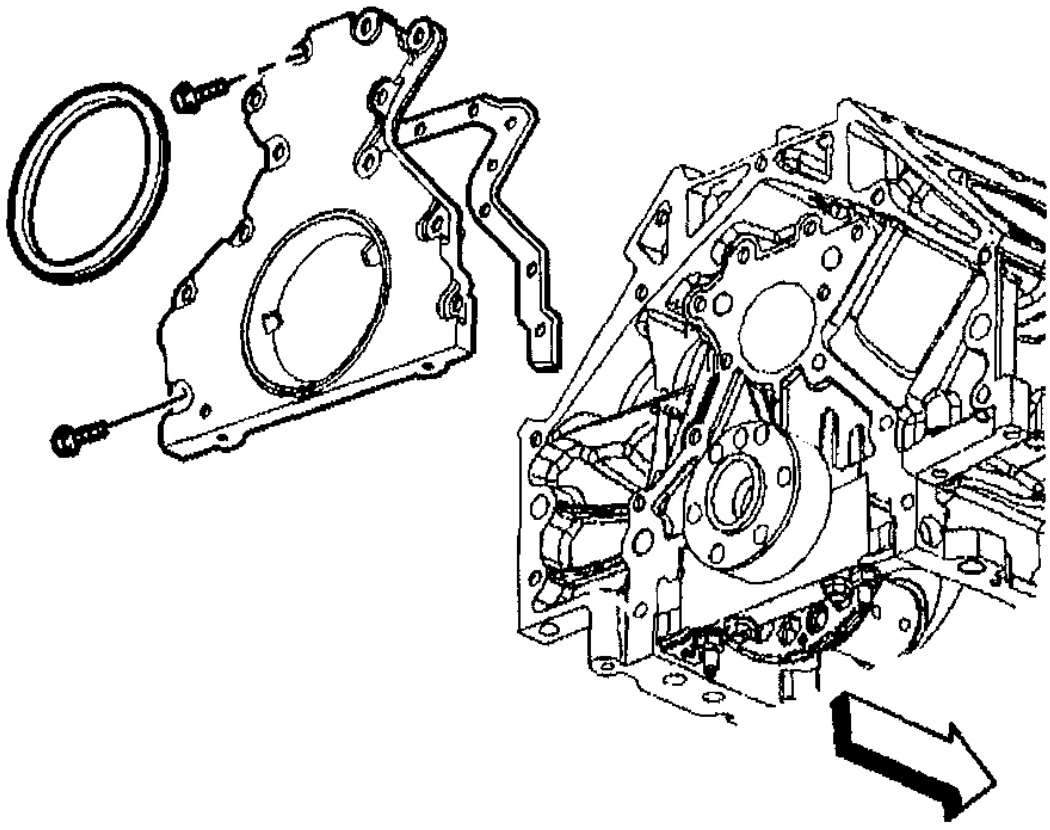


Fig. 114: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

ENGINE REAR COVER REMOVAL

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



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Fig. 115: Rear Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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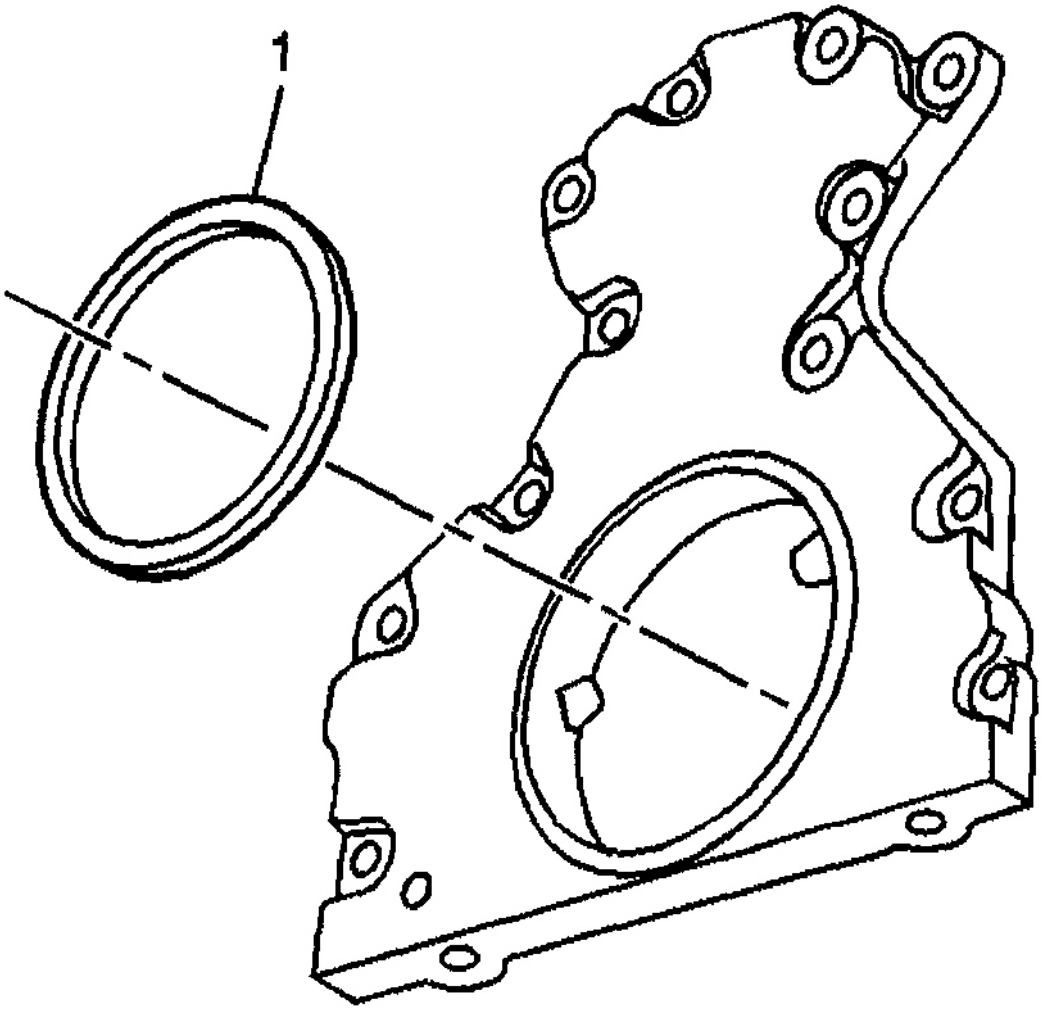


Fig. 116: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

OIL PUMP, PUMP SCREEN AND DEFLECTOR REMOVAL

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

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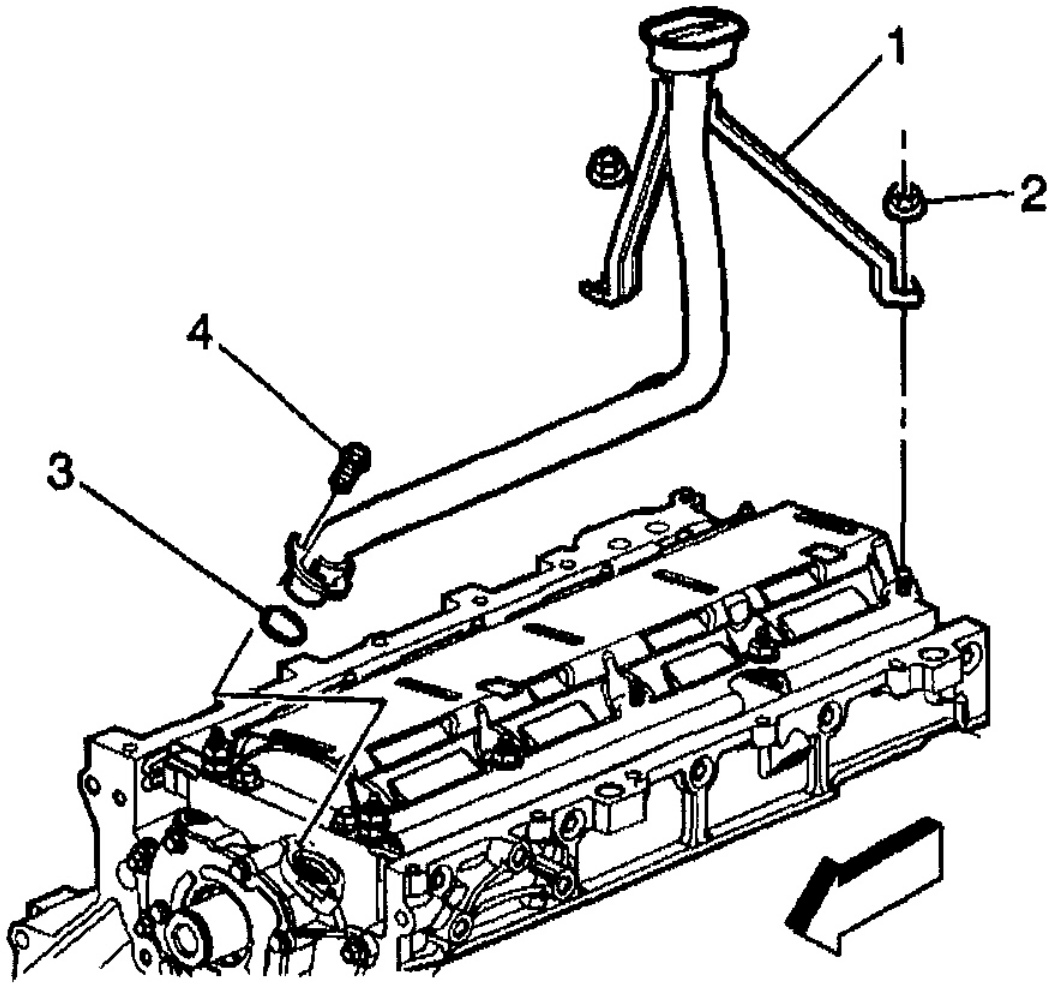


Fig. 117: Oil Pump Screen, Bolt, Nuts & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

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

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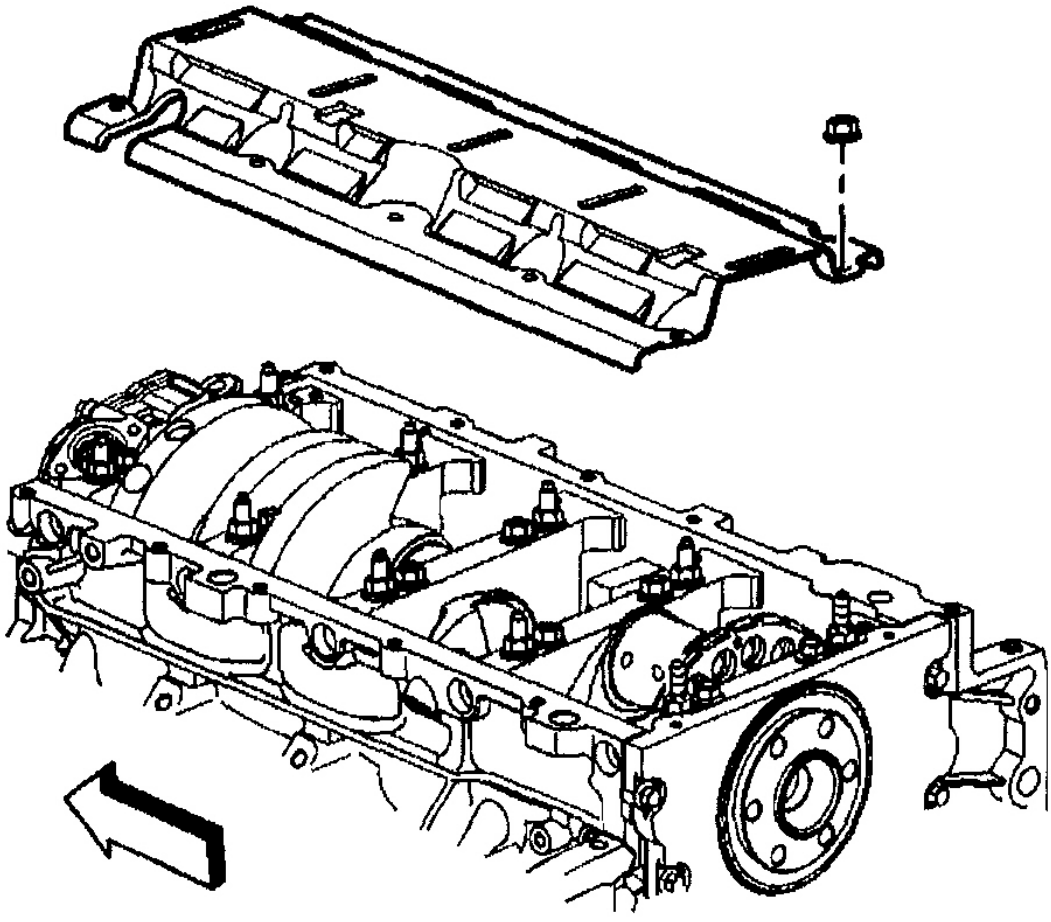


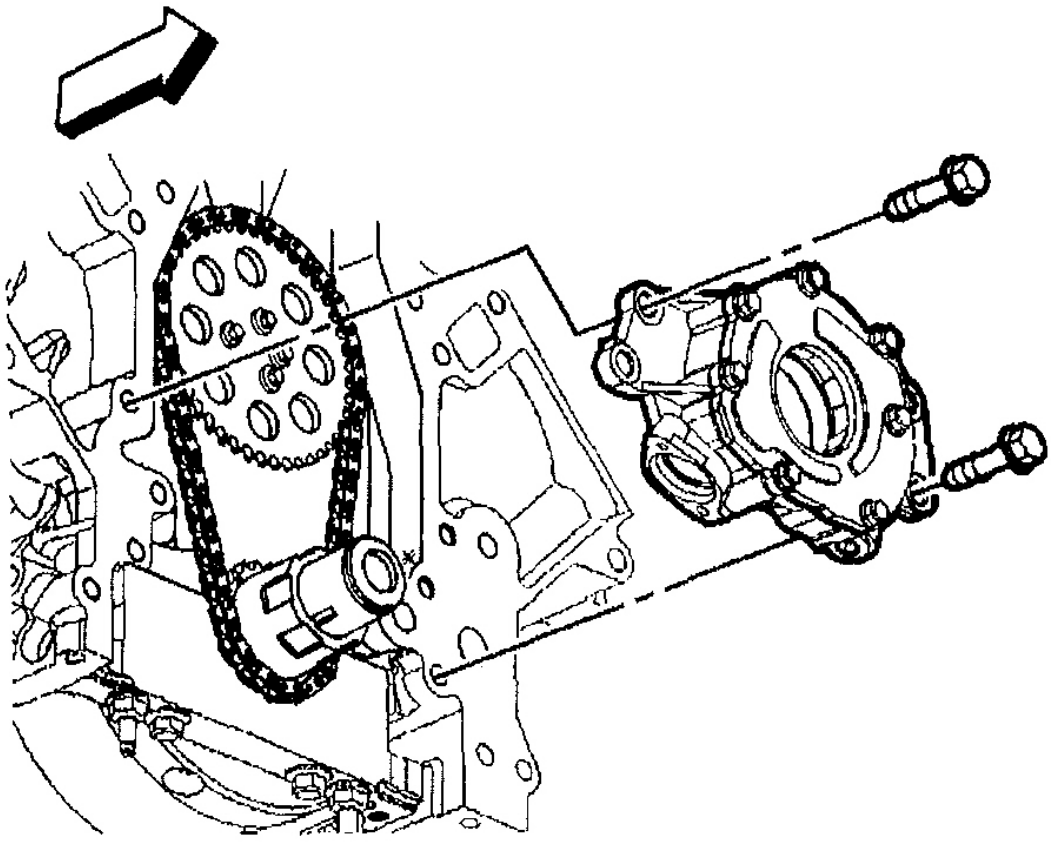
Fig. 118: Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pump bolts.

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

8. Remove the oil pump.

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Fig. 119: Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

TIMING CHAIN AND SPROCKETS REMOVAL

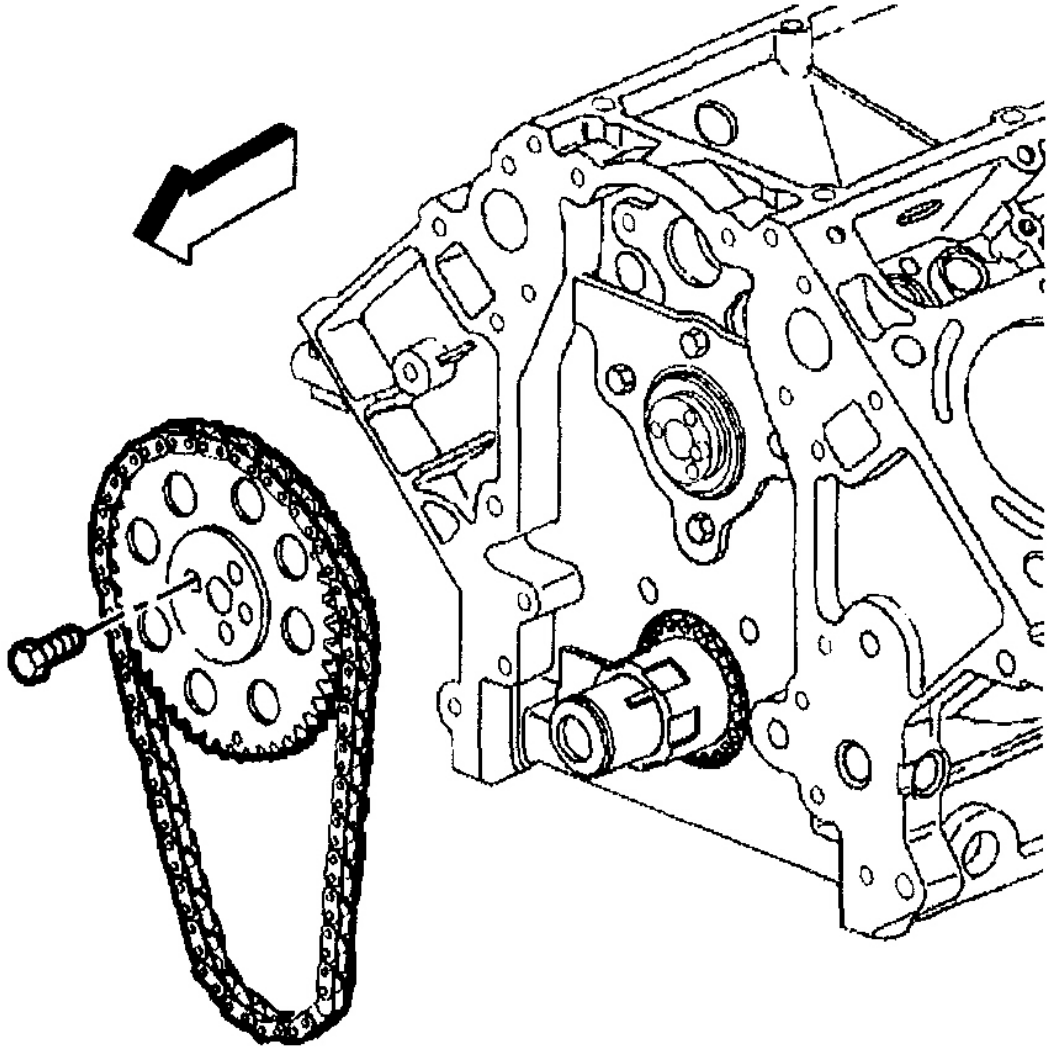
Tools Required

- J 8433-1 Puller Bar
- J 41558 Crankshaft Sprocket Remover
- J 41816-2 Crankshaft End Protector

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

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

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Fig. 120: Camshaft Sprocket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Use the J 8433-1, the J 41816-2, and the J 41558 in order to remove the crankshaft sprocket.

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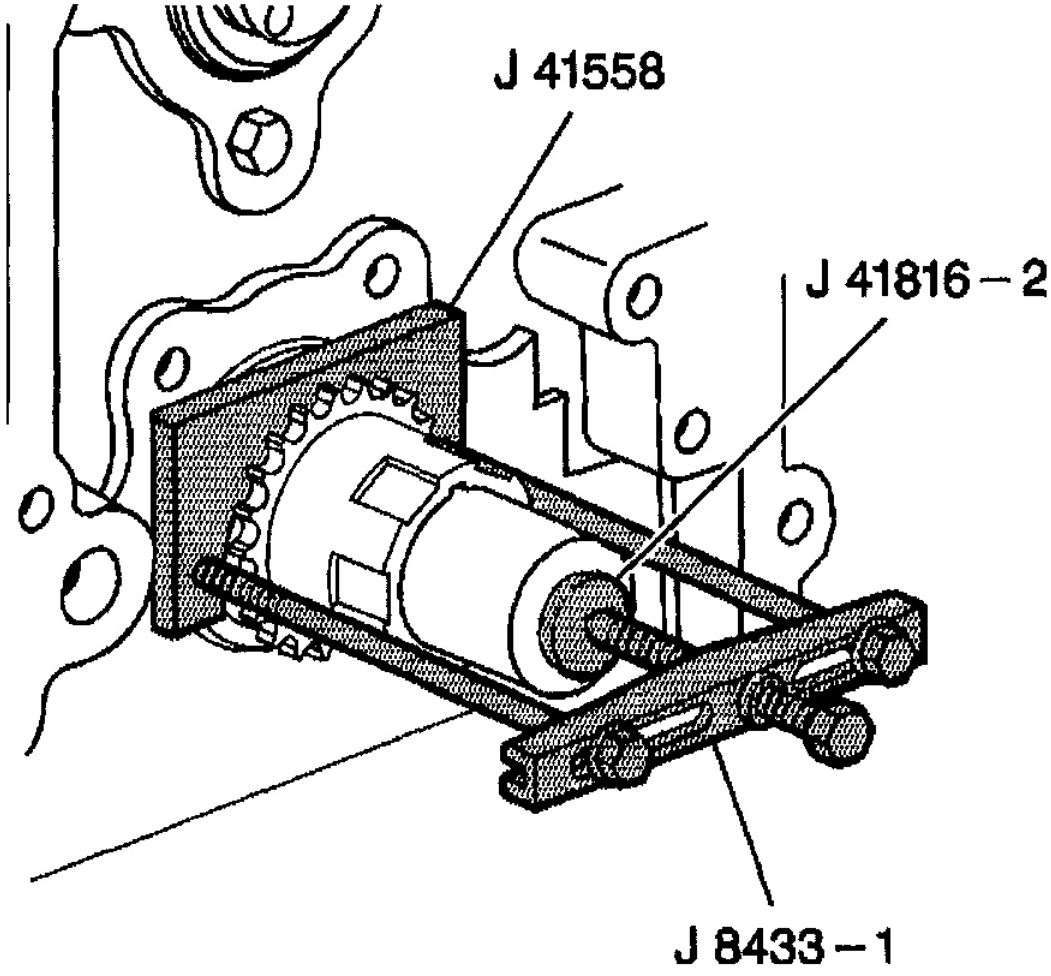
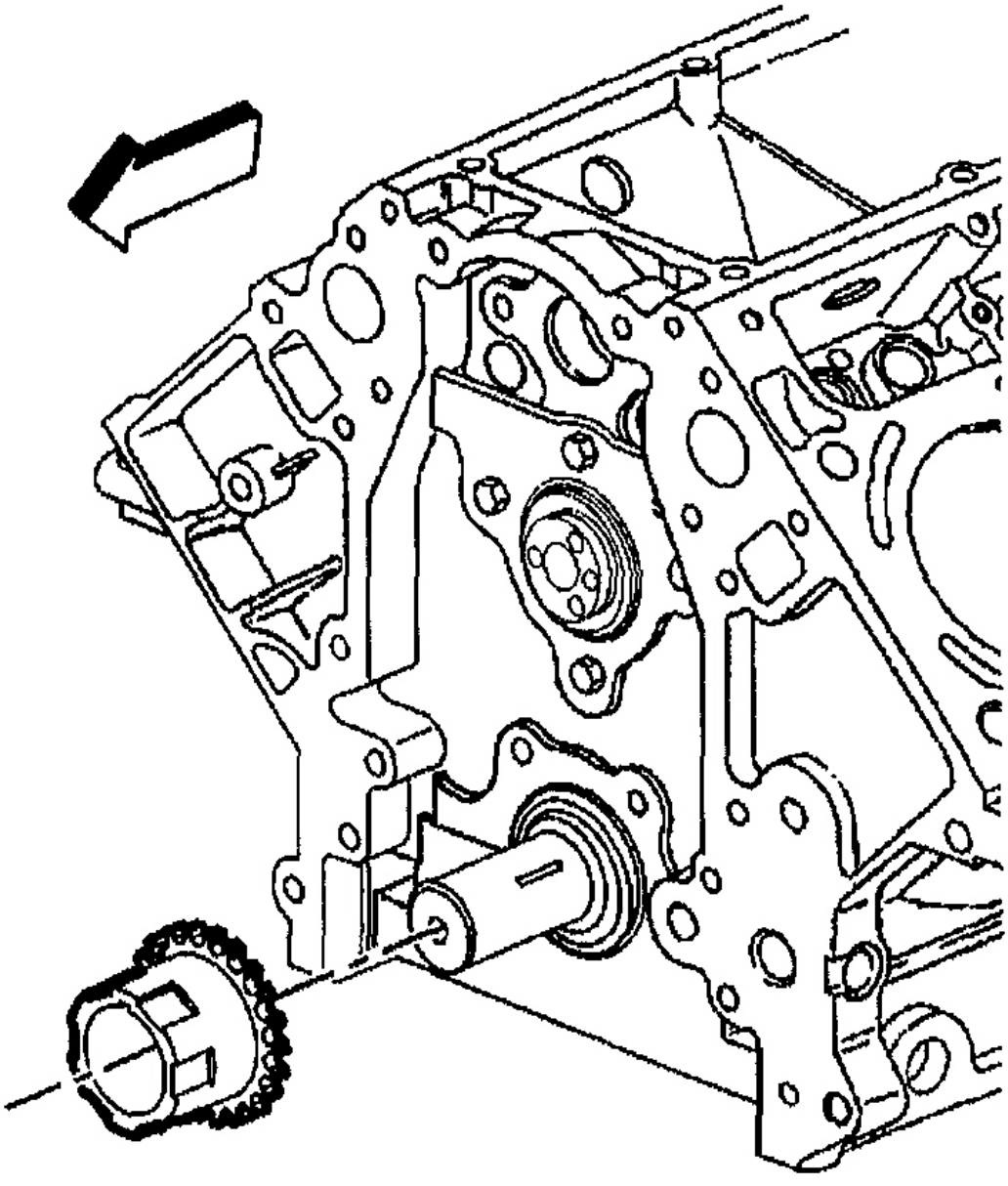


Fig. 121: Removing Crankshaft Sprocket Using J 8433-1, J 41816-2 & J 41558
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft sprocket.

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Fig. 122: Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft sprocket key, if required.

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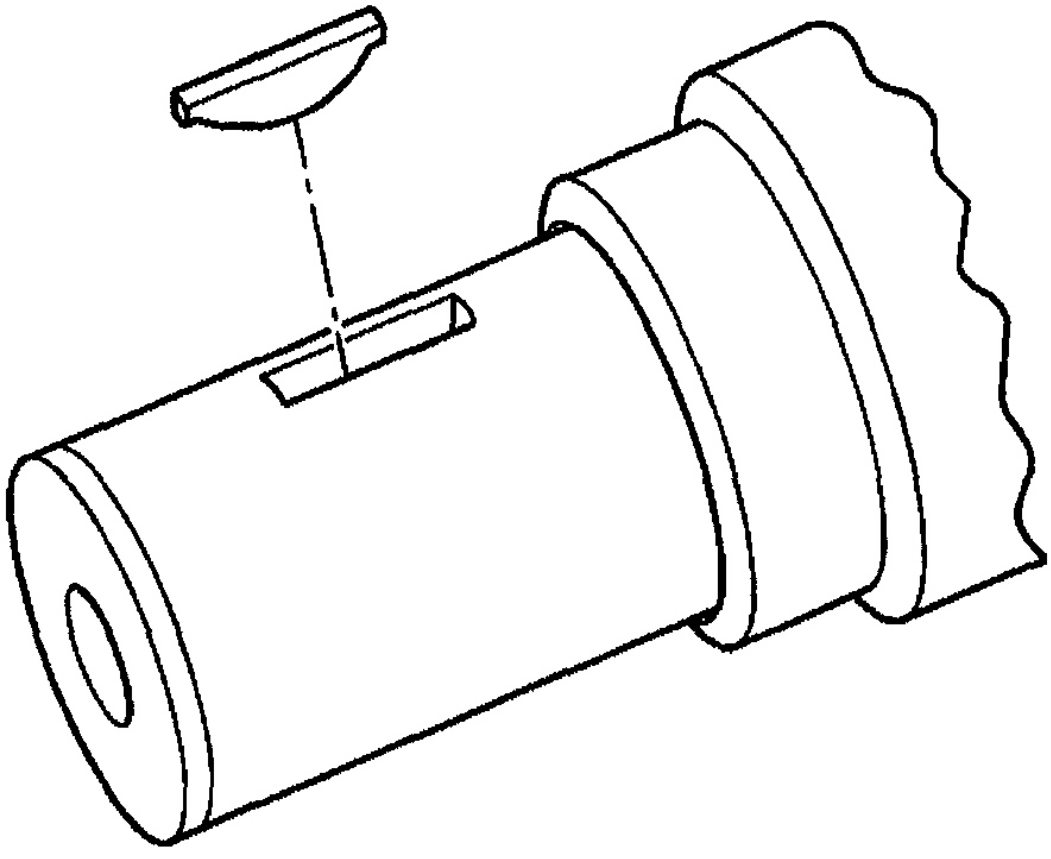


Fig. 123: Crankshaft Sprocket Key
Courtesy of GENERAL MOTORS CORP.

CAMSHAFT REMOVAL

1. Remove the camshaft sensor bolt and the sensor.

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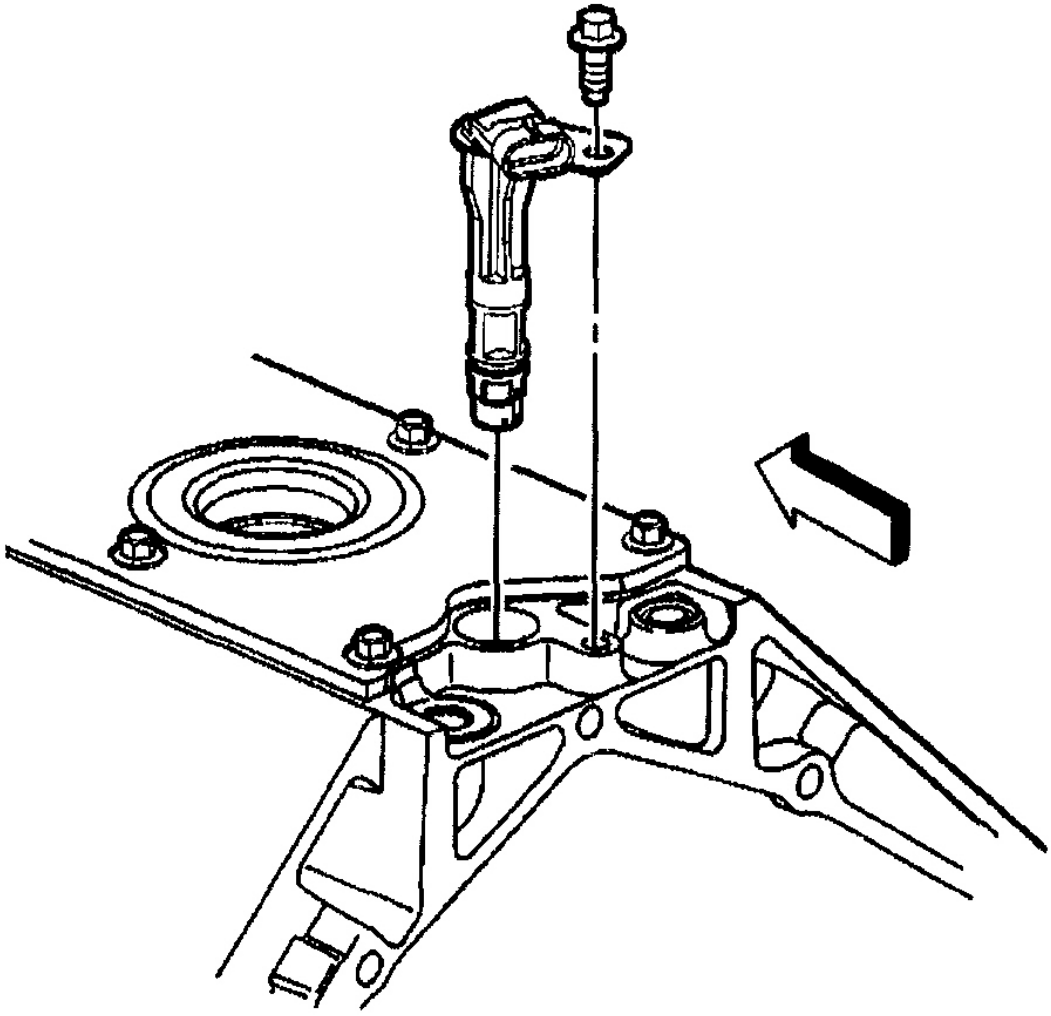
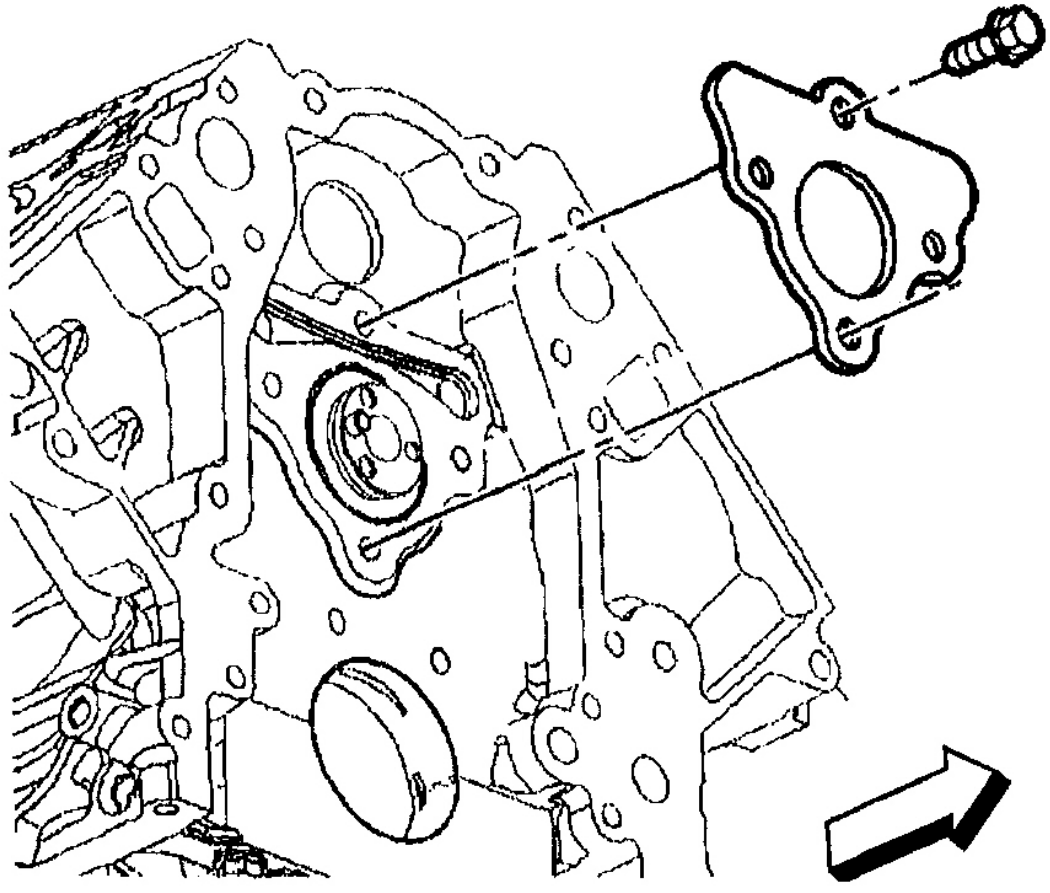


Fig. 124: Camshaft Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the camshaft retainer bolts and the retainer.

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Fig. 125: Camshaft Retainer Bolts & Retainer
Courtesy of GENERAL MOTORS CORP.

NOTE: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Remove the camshaft.
    3.1. Install the 3 M8-1.25 x 100 mm bolts in the camshaft front bolt holes.
    3.2. Using the bolts as a handle, carefully rotate and pull the camshaft out of the engine block.
    3.3. Remove the bolts from the front of the camshaft.

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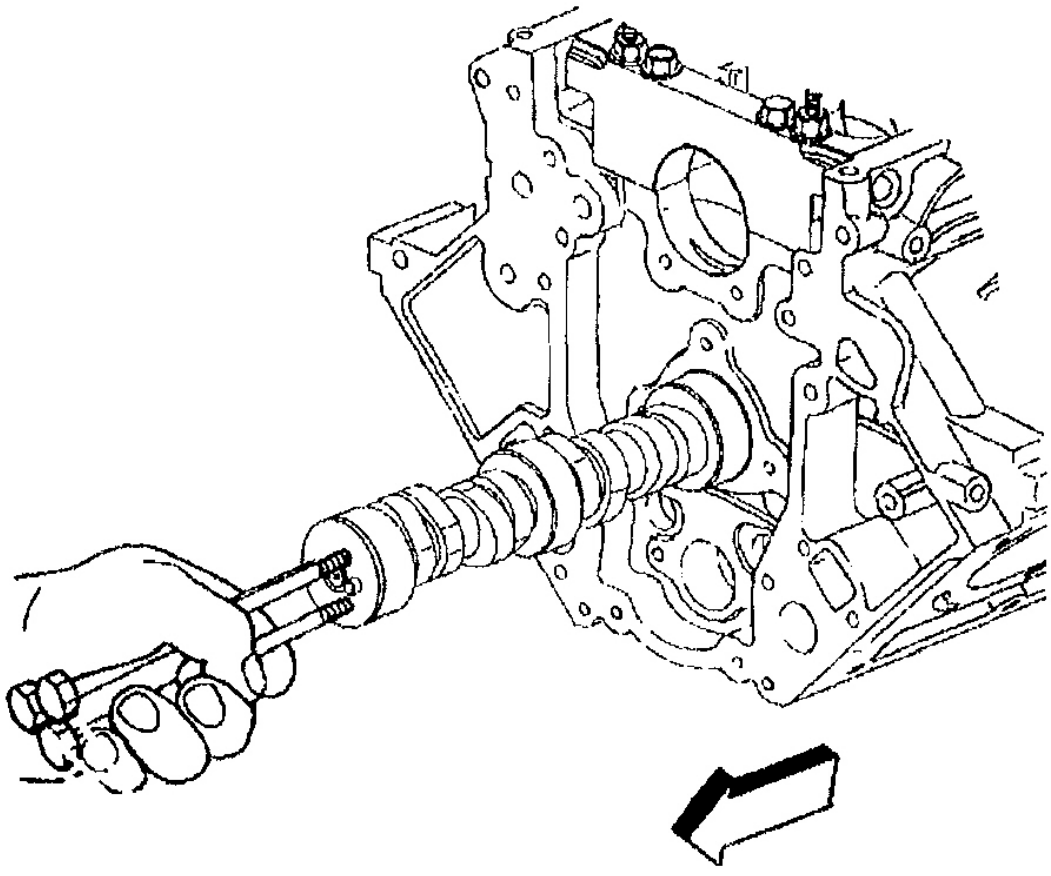


Fig. 126: Removing Camshaft Using Bolts
Courtesy of GENERAL MOTORS CORP.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Tools Required

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

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

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

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1.3. Use the J 24270 or equivalent in order to remove a cylinder ring ridge.
1.4. Turn the crankshaft so the piston is at the top of the stroke.
1.5. Remove the cloth.
1.6. Remove the cutting debris from the cylinder and piston.

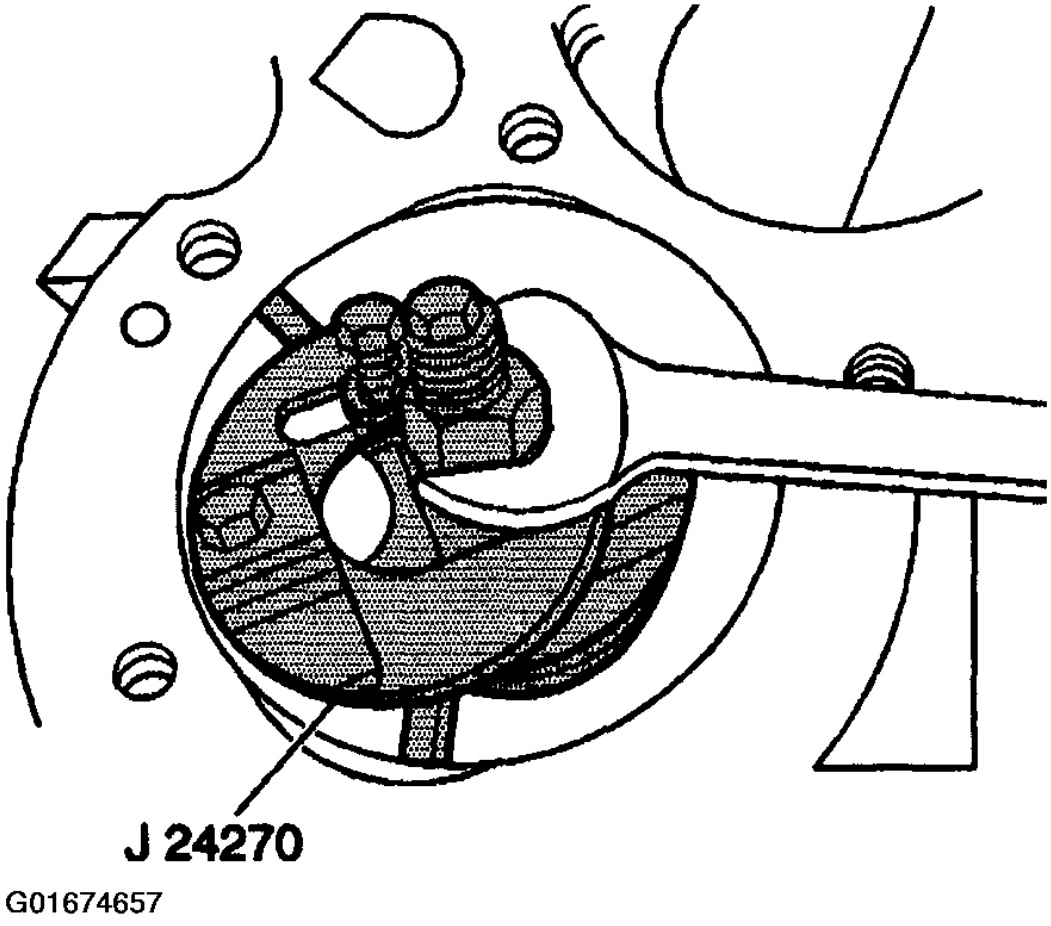


Fig. 127: Removing Cylinder Bore Ring Ridge Using J 24270
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Using a paint stick or etching tool, place matchmarks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps MUST be assembled to their original position and direction.

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

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

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2. Remove the connecting rod bolts.

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

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

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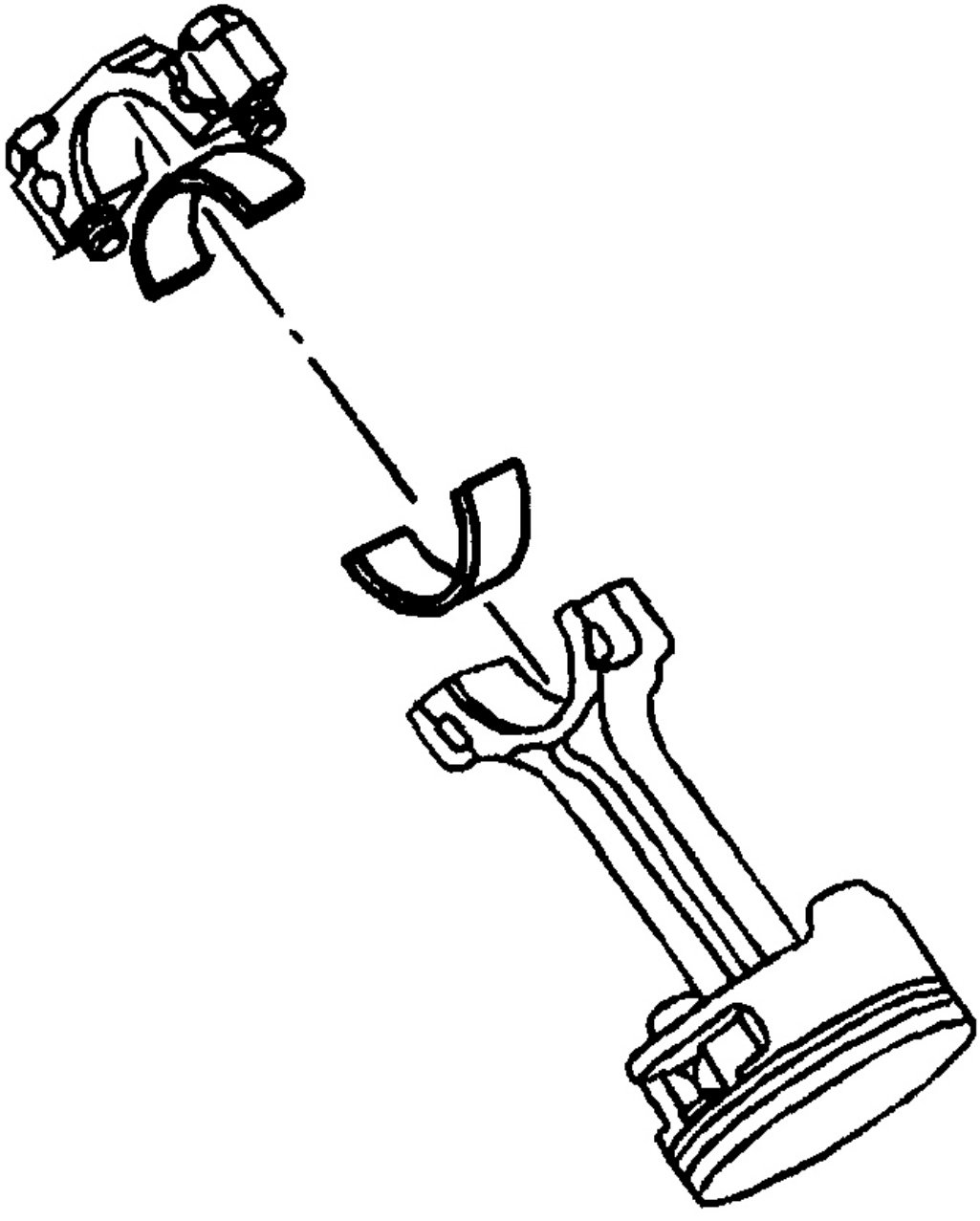


Fig. 128: Connecting Rod, Bearing & Piston
Courtesy of GENERAL MOTORS CORP.

4. Install the J 41556 to the connecting rod.

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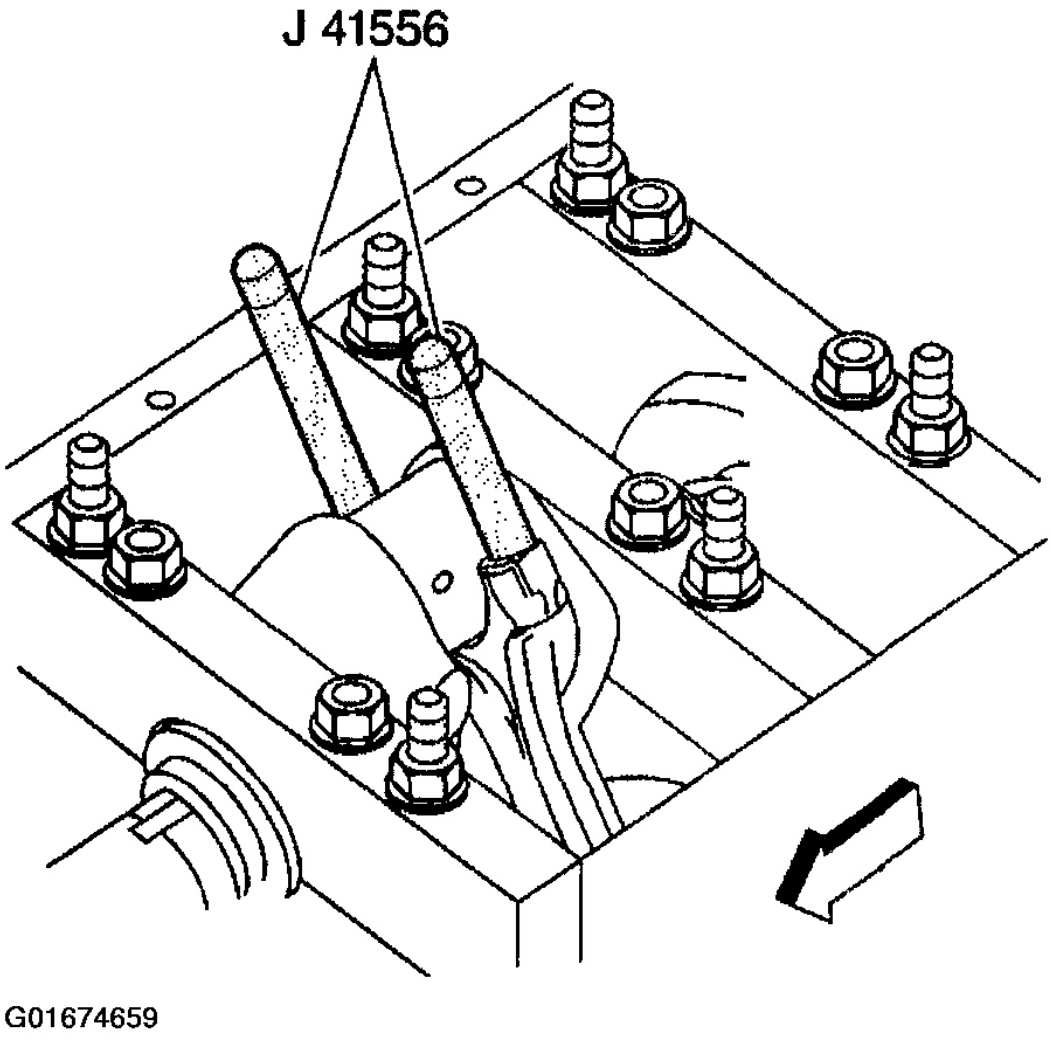
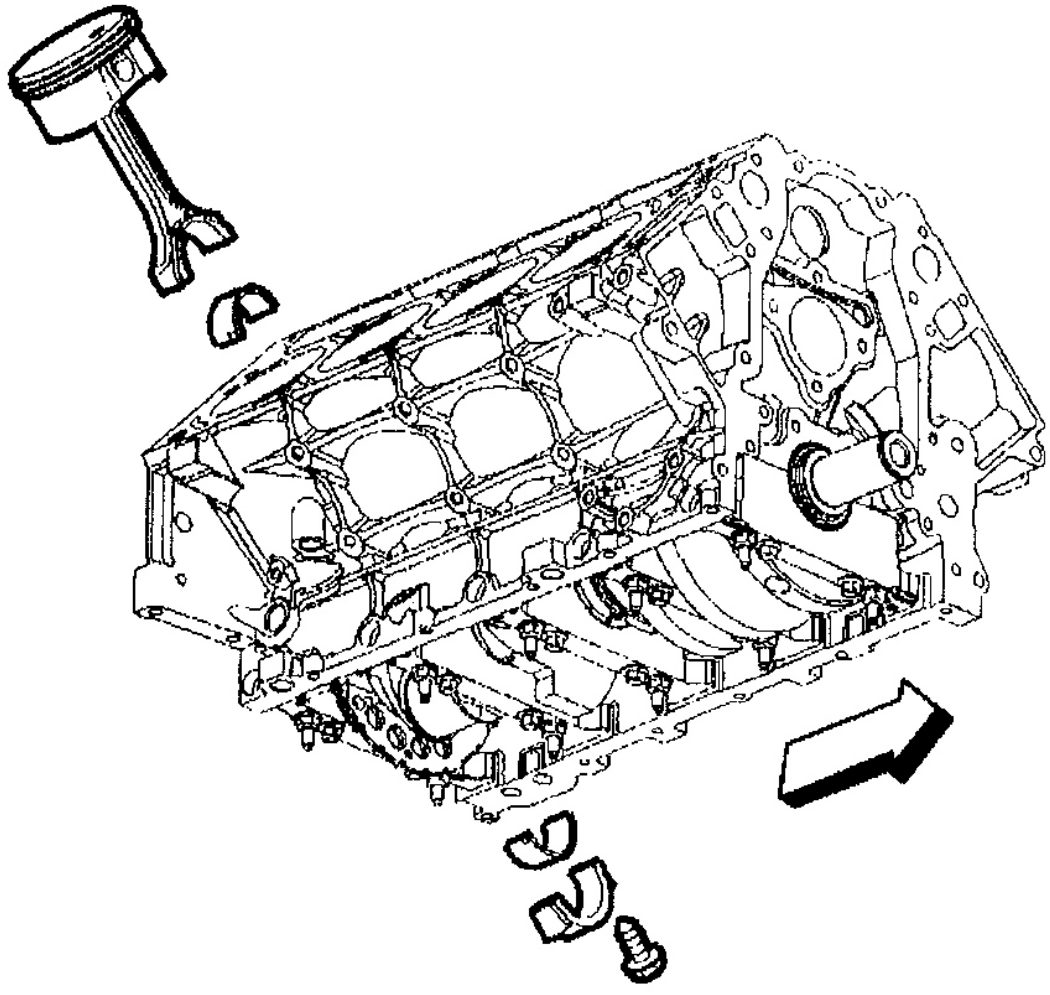


Fig. 129: J 41556 Installed On Connecting Rod
Courtesy of GENERAL MOTORS CORP.

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

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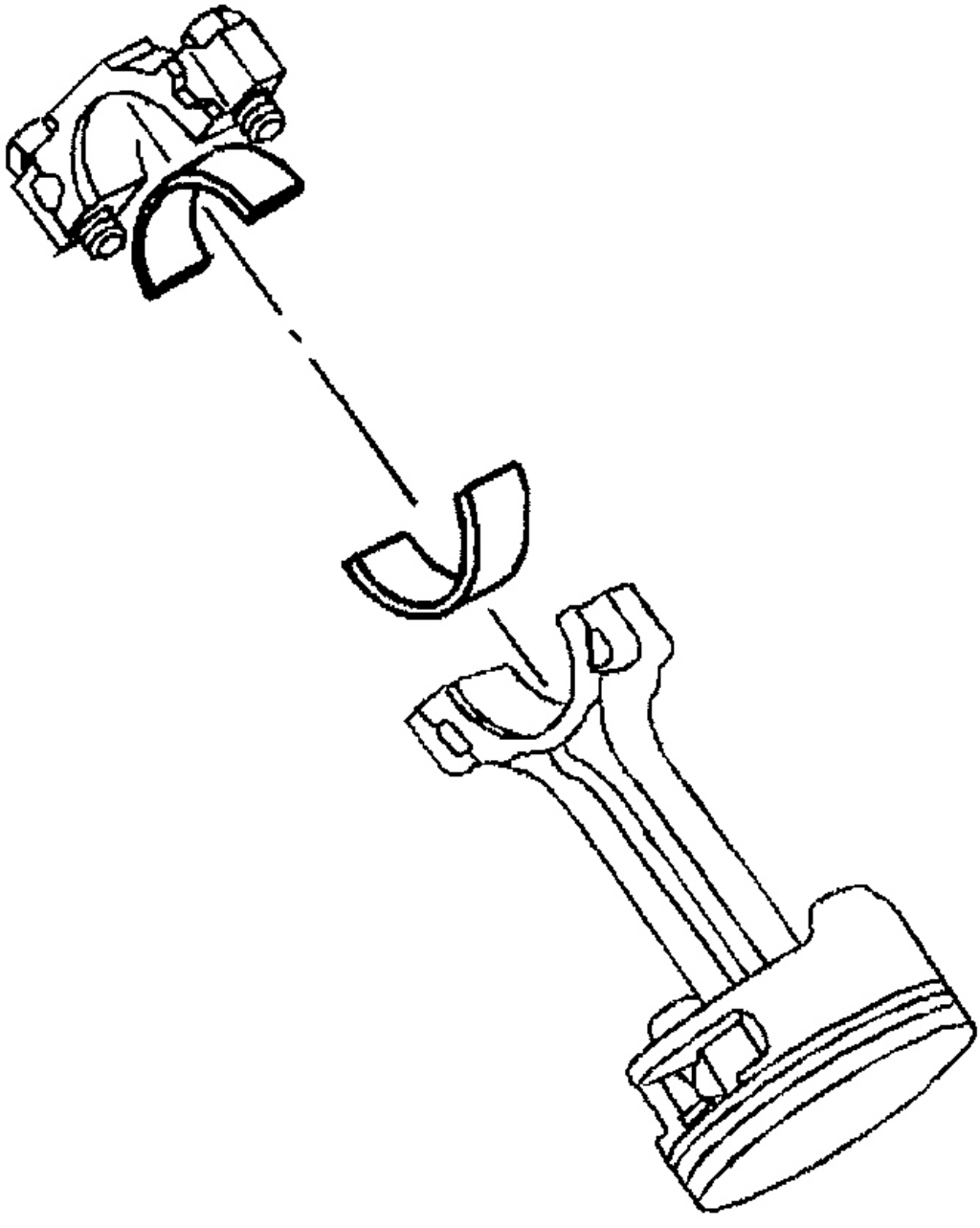


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Fig. 130: Piston & Connecting Rod Assembly Removed
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 131: Connecting Rod, Bearing & Piston
Courtesy of GENERAL MOTORS CORP.

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CRANKSHAFT AND BEARINGS REMOVAL

Tools Required

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

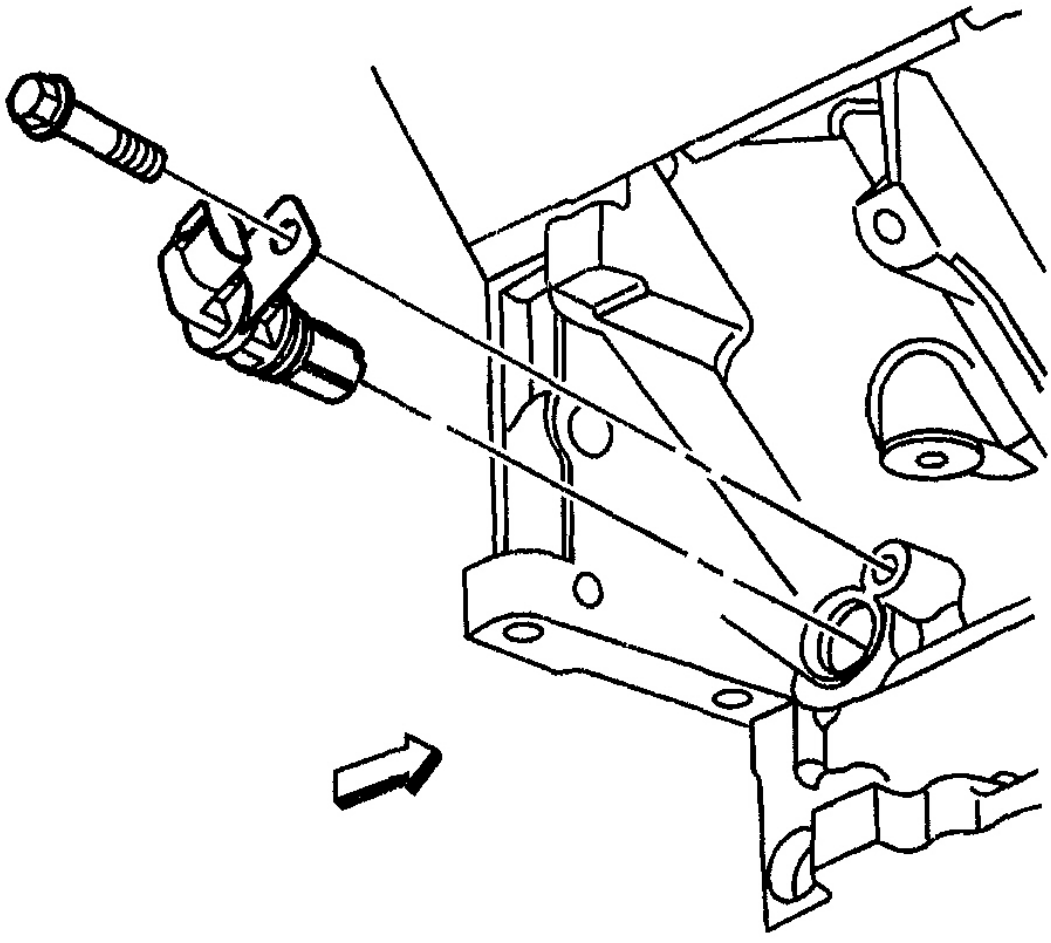
IMPORTANT: The crankshaft bearing caps are machined with the engine block for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps MUST be installed to their original position and direction.

Do not reuse the bearing cap M8 side bolts.

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

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

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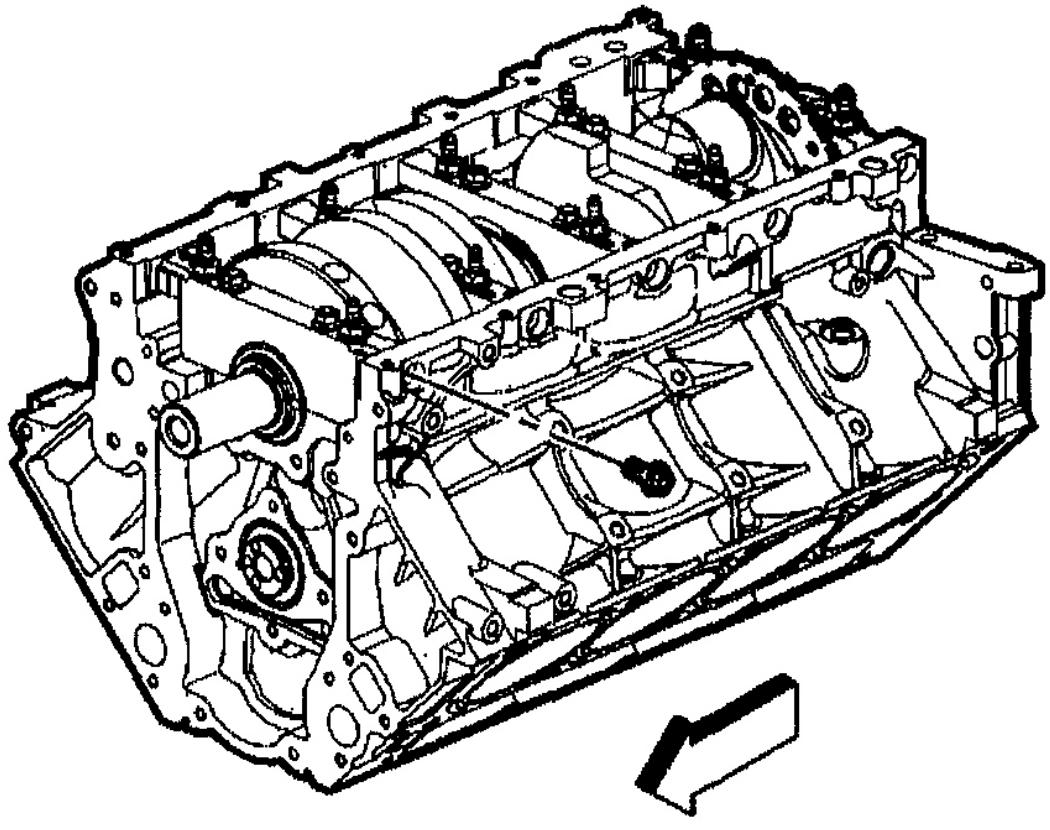
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Fig. 132: Crankshaft Position Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft bearing cap M8 side bolts.
4. Remove the bearing cap M10 bolts and bolt/studs.

   Note the M10 bolt/stud locations.

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Fig. 133: Bearing Cap M10 Bolts And Bolt/Studs
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

5. Install the J 41818.

   Tighten

   Tighten the J 41818 bolts to 11 N.m (100 lb in).

6. Install the J 6125-1B to the J 41818 in order to remove the crankshaft bearing caps.

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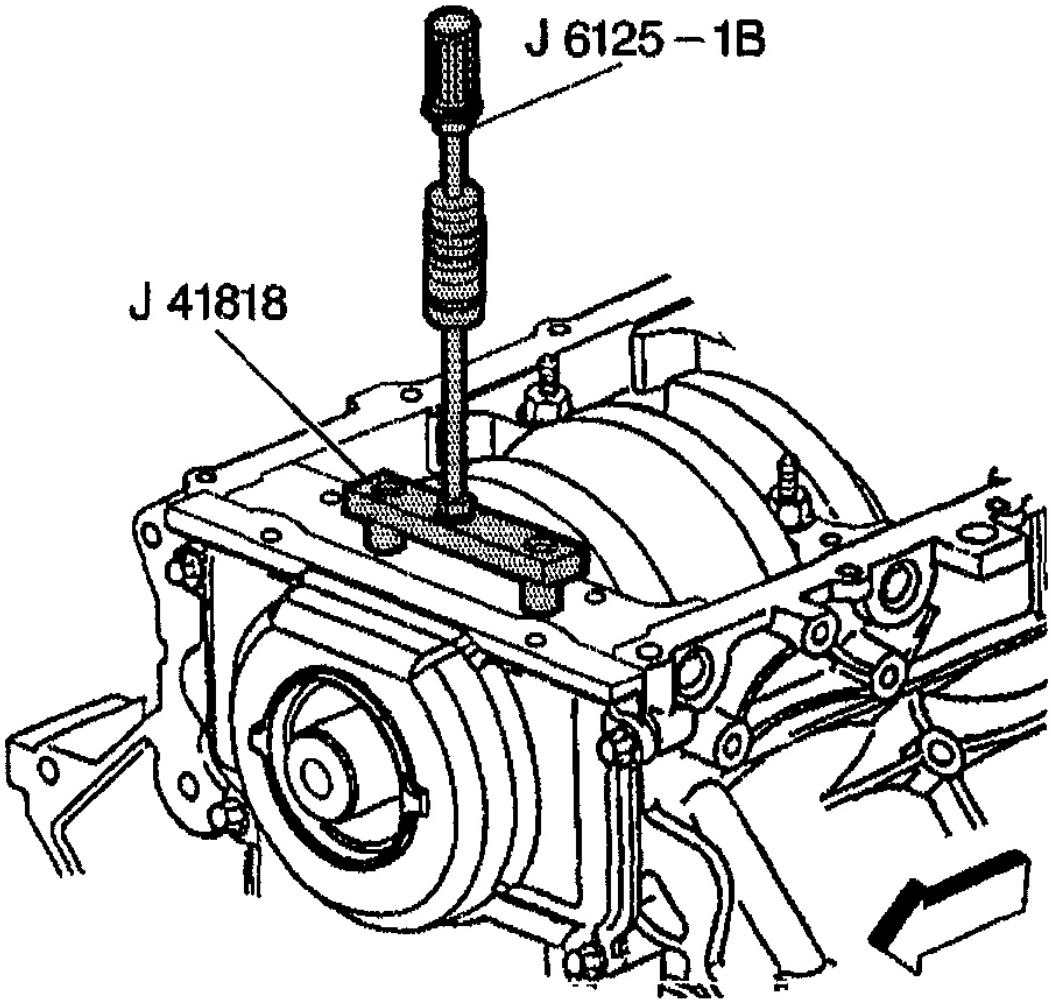
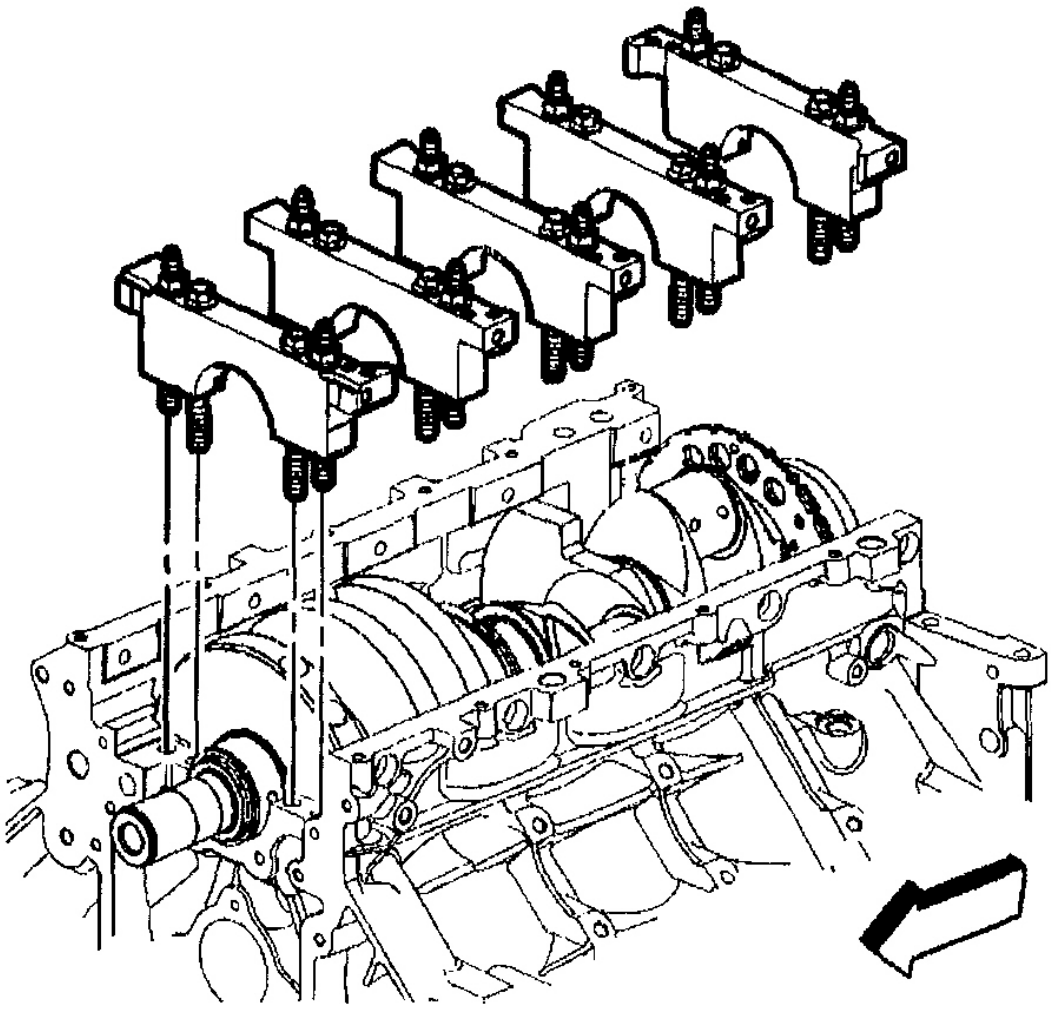


Fig. 134: Removing Crankshaft Bearing Caps Using J 6125-1B & J 41818
Courtesy of GENERAL MOTORS CORP.

7. Remove the bearing caps.

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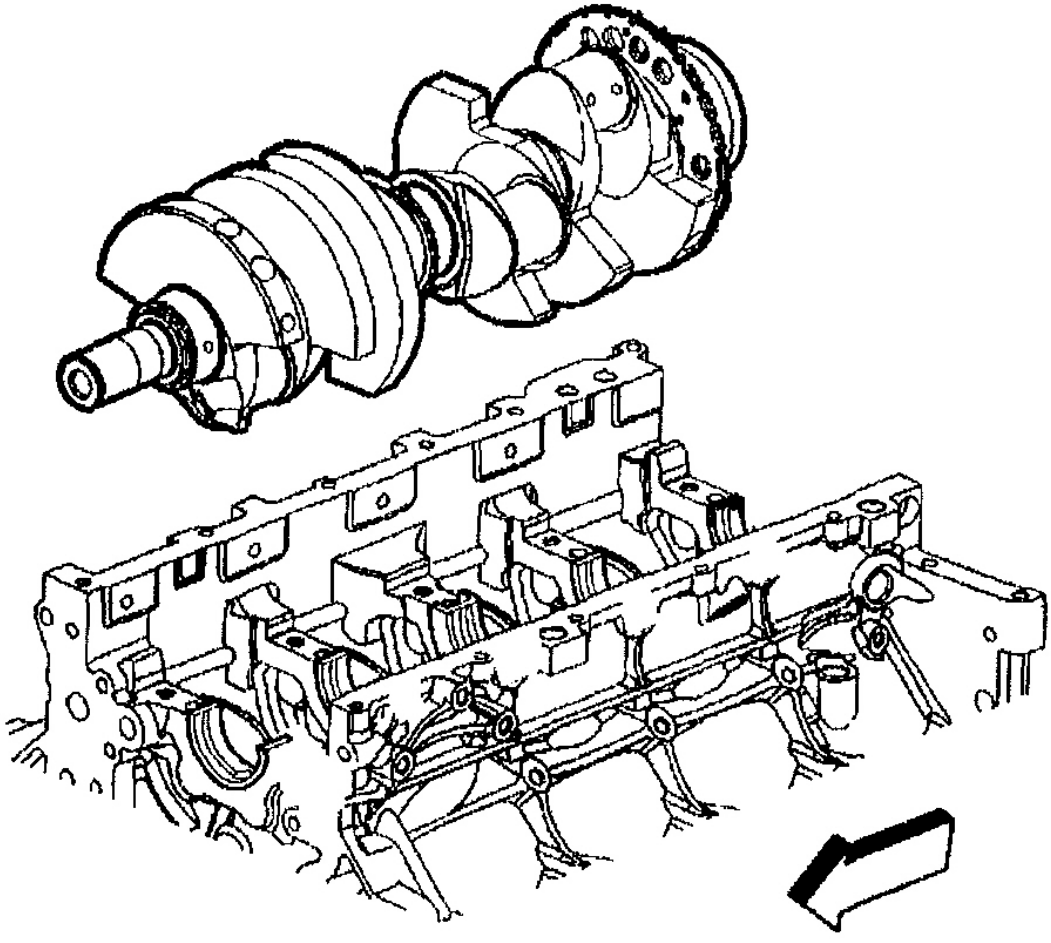


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Fig. 135: Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft.

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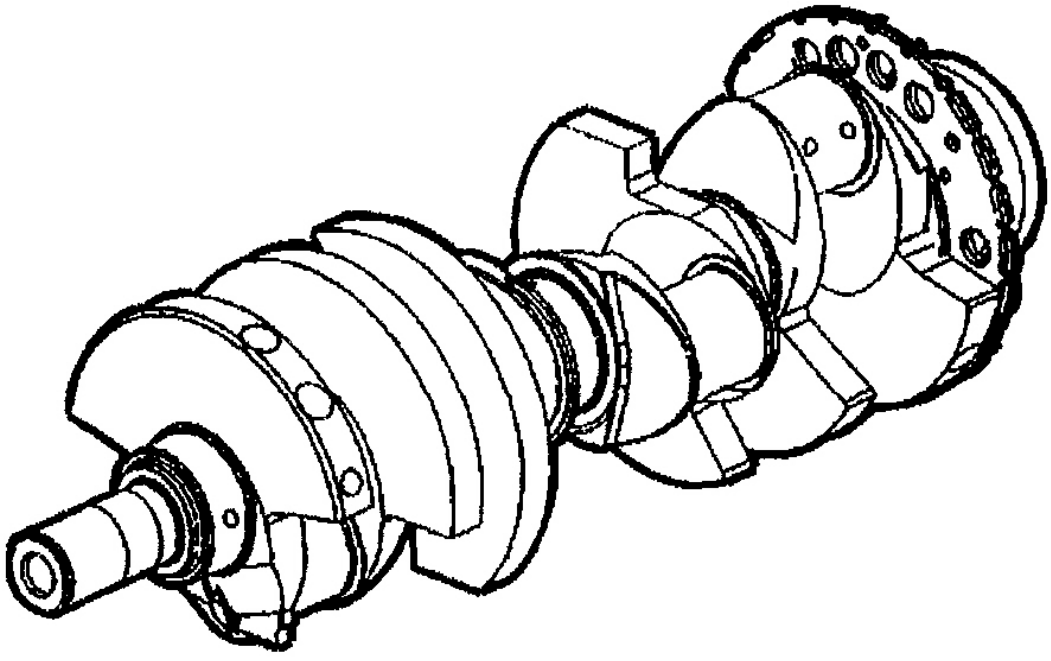
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Fig. 136: Crankshaft
Courtesy of GENERAL MOTORS CORP.

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

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

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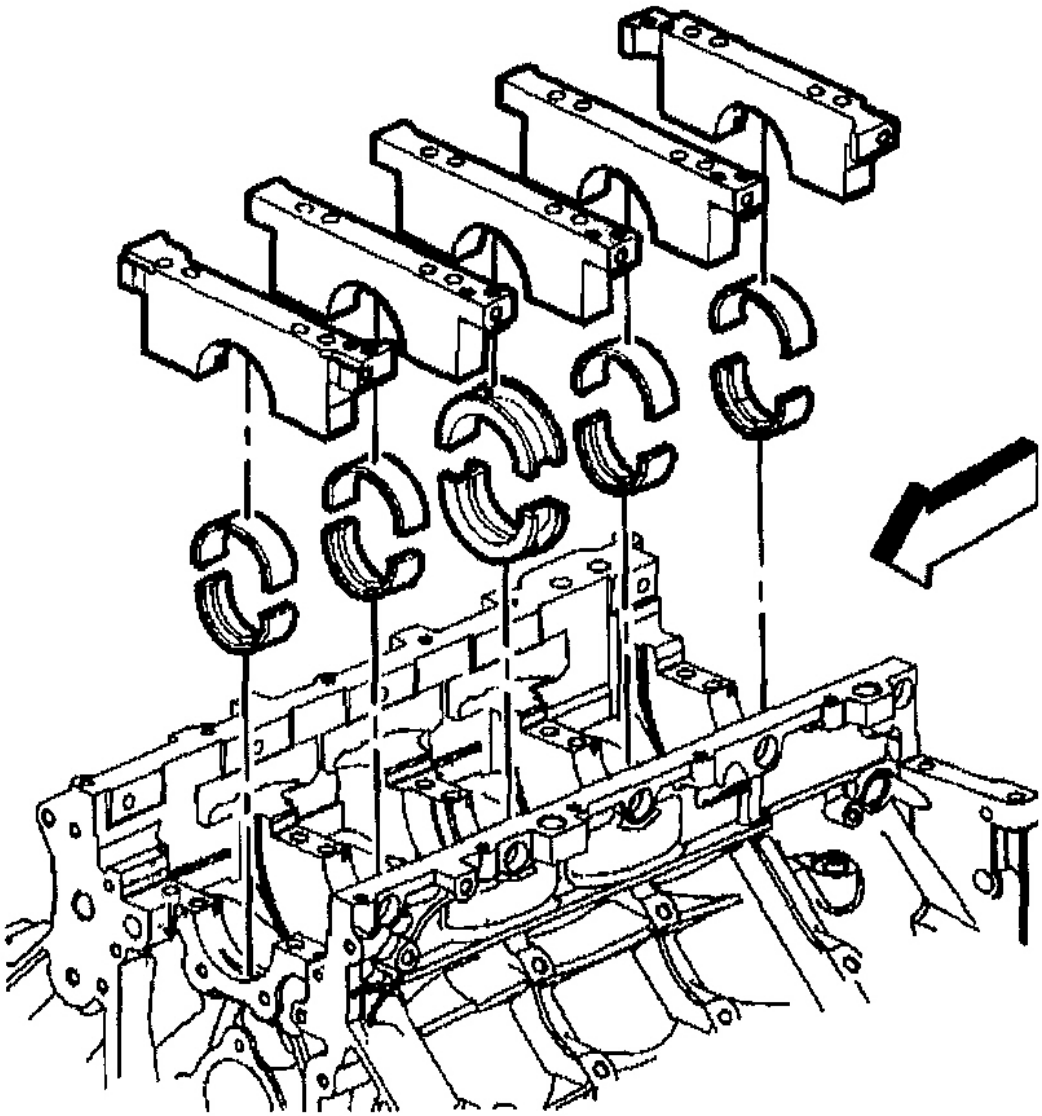


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Fig. 137: Crankshaft Removed
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 138: Crankshaft Bearings & Caps
Courtesy of GENERAL MOTORS CORP.

ENGINE BLOCK PLUG REMOVAL

Tools Required

J 41712 Oil Pressure Sensor Socket

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

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

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

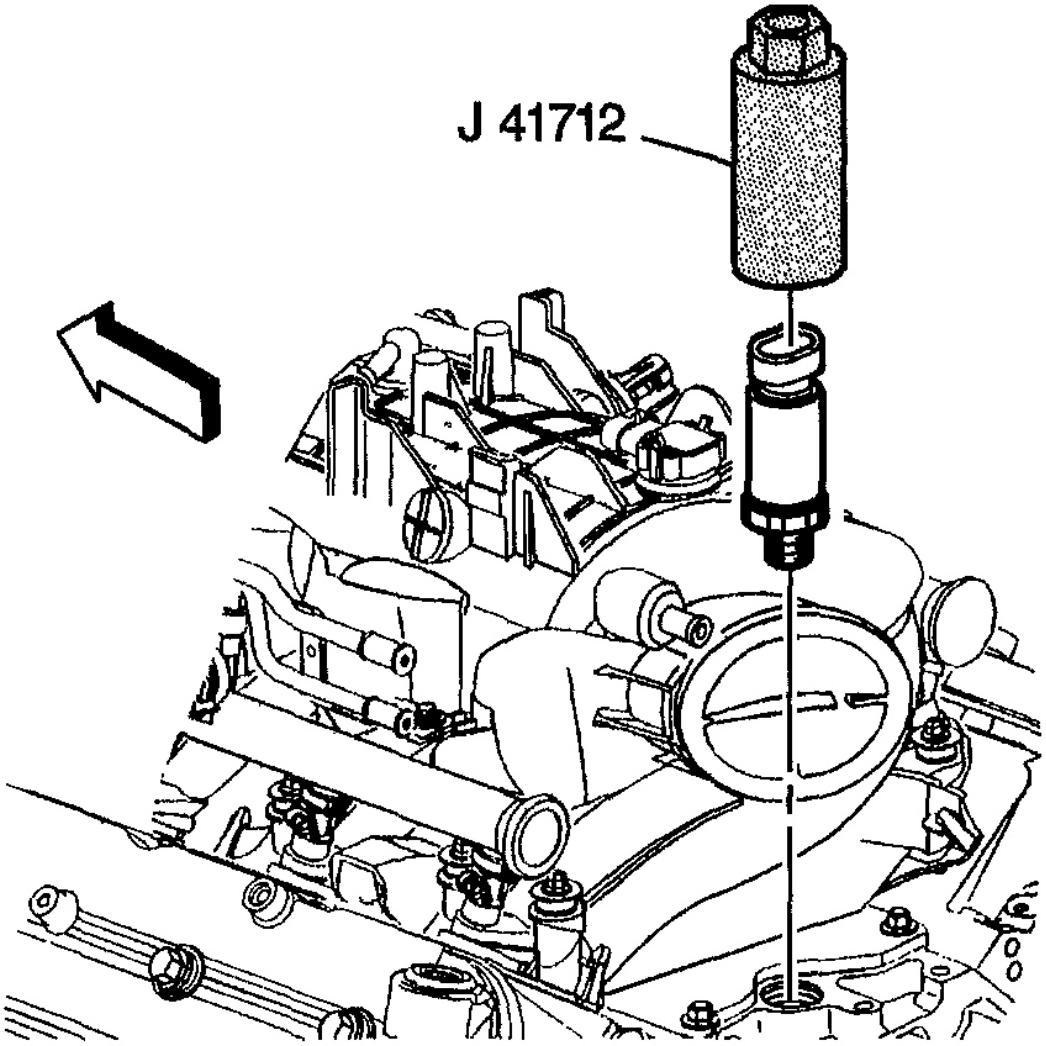
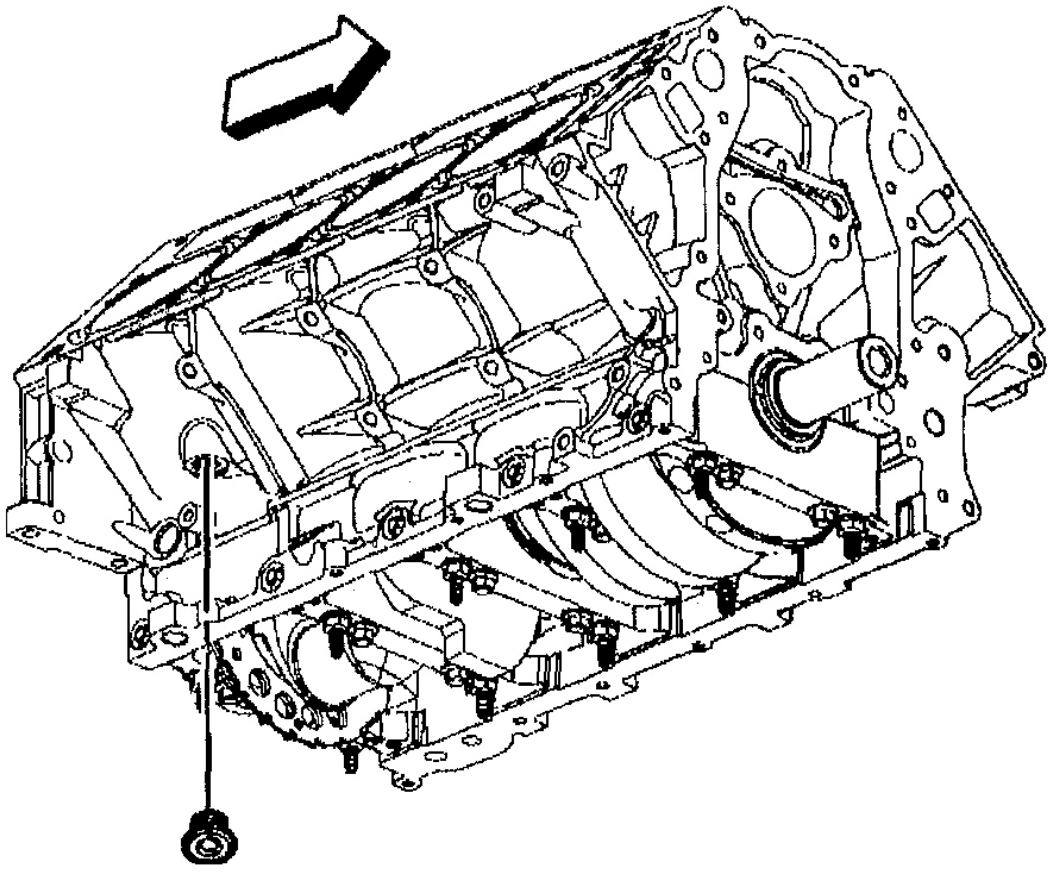


Fig. 139: Removing Oil Pressure Sensor Using J 41712
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine block right rear coolant plug.

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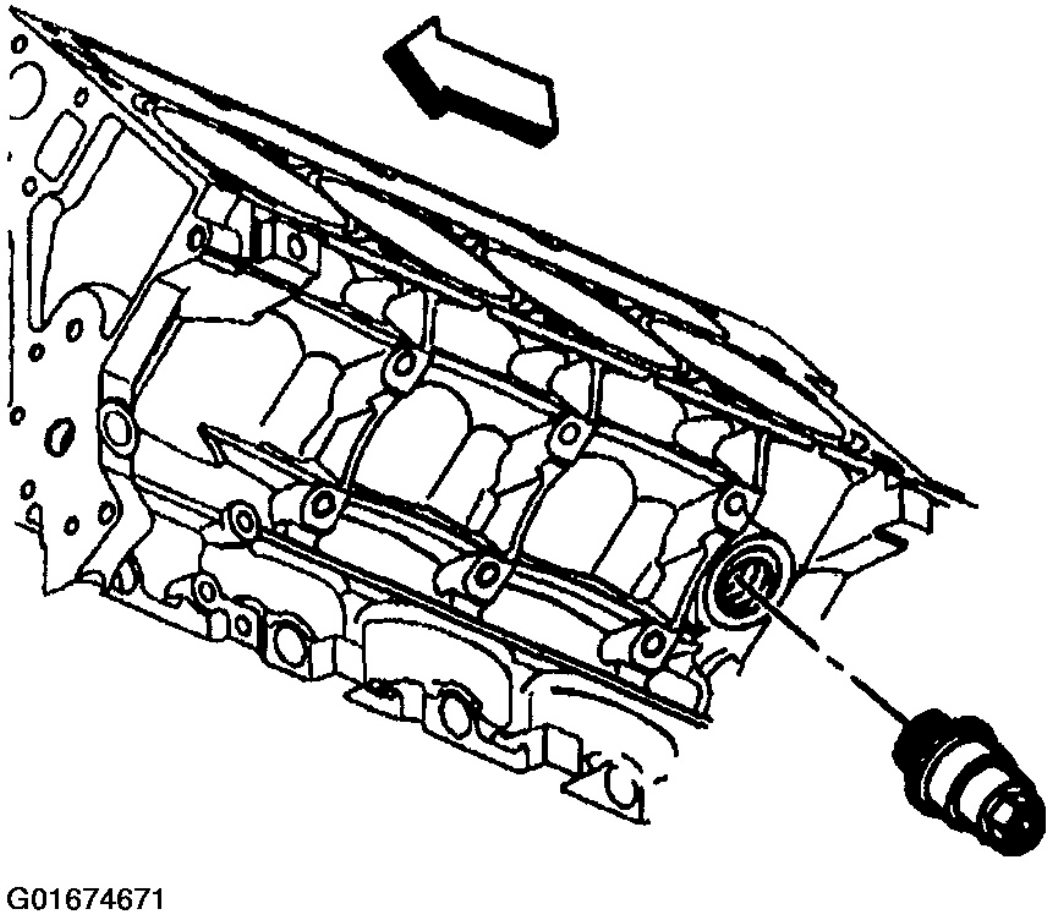


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Fig. 140: Engine Block Coolant Plug (Right Rear)
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine block coolant heater, if applicable.

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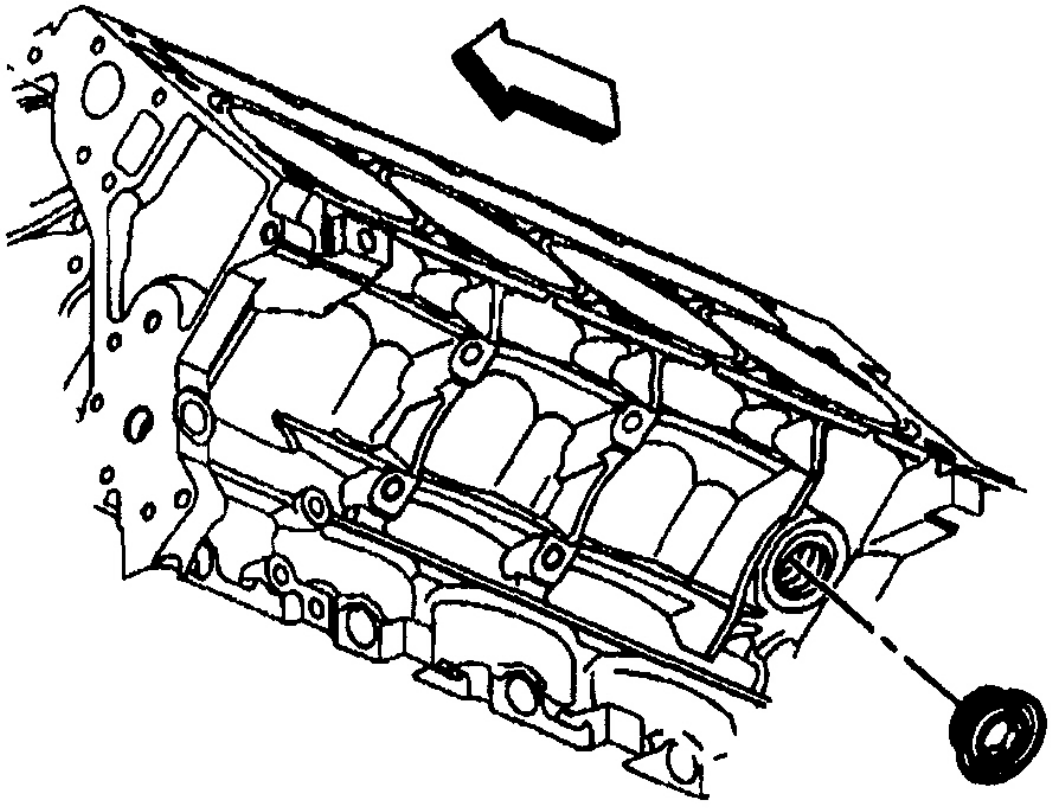


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Fig. 141: Engine Block Coolant Heater
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine block left rear coolant plug, if applicable.

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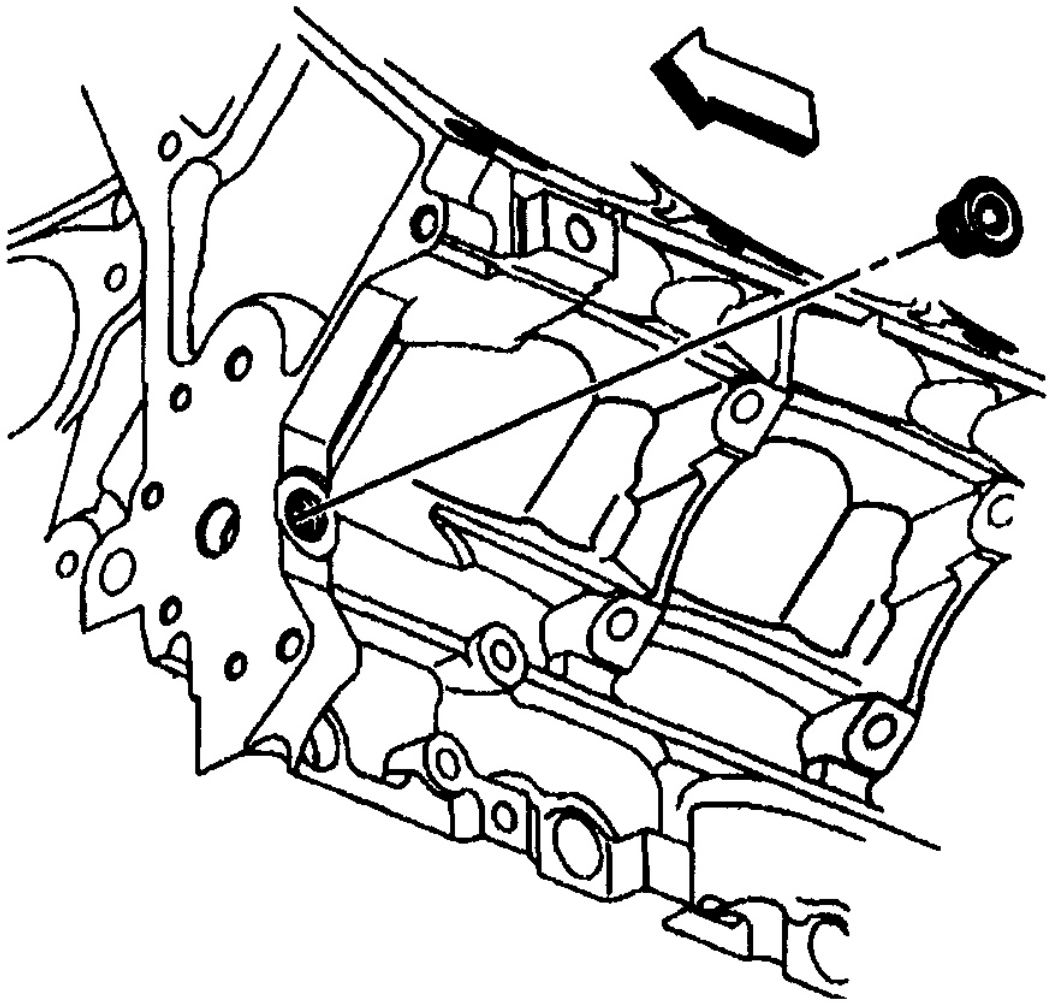


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Fig. 142: Engine Block Coolant Plug (Left Rear)
Courtesy of GENERAL MOTORS CORP.

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

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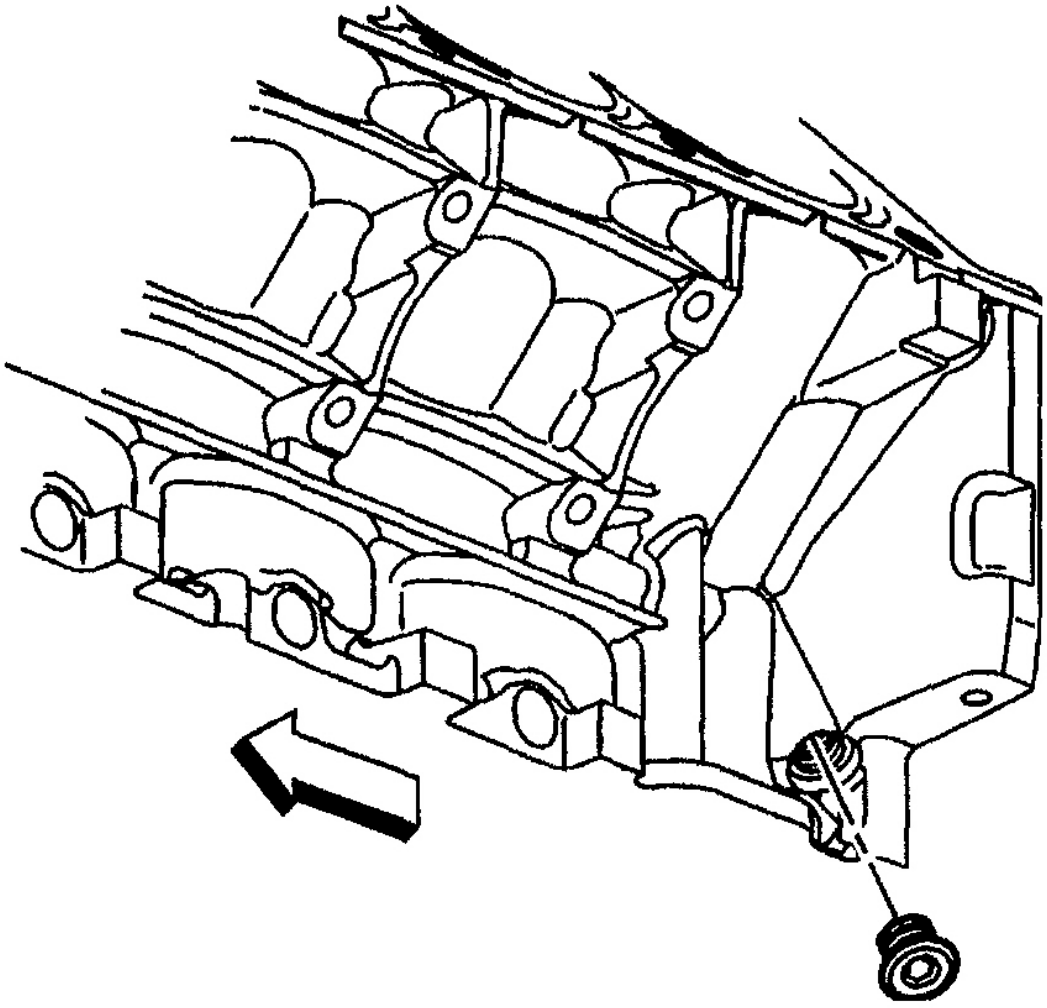
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Fig. 143: Engine Block Oil Gallery Plug (Left Front)
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine block left rear oil gallery plug.
7. Inspect the block plug sealing washers.

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

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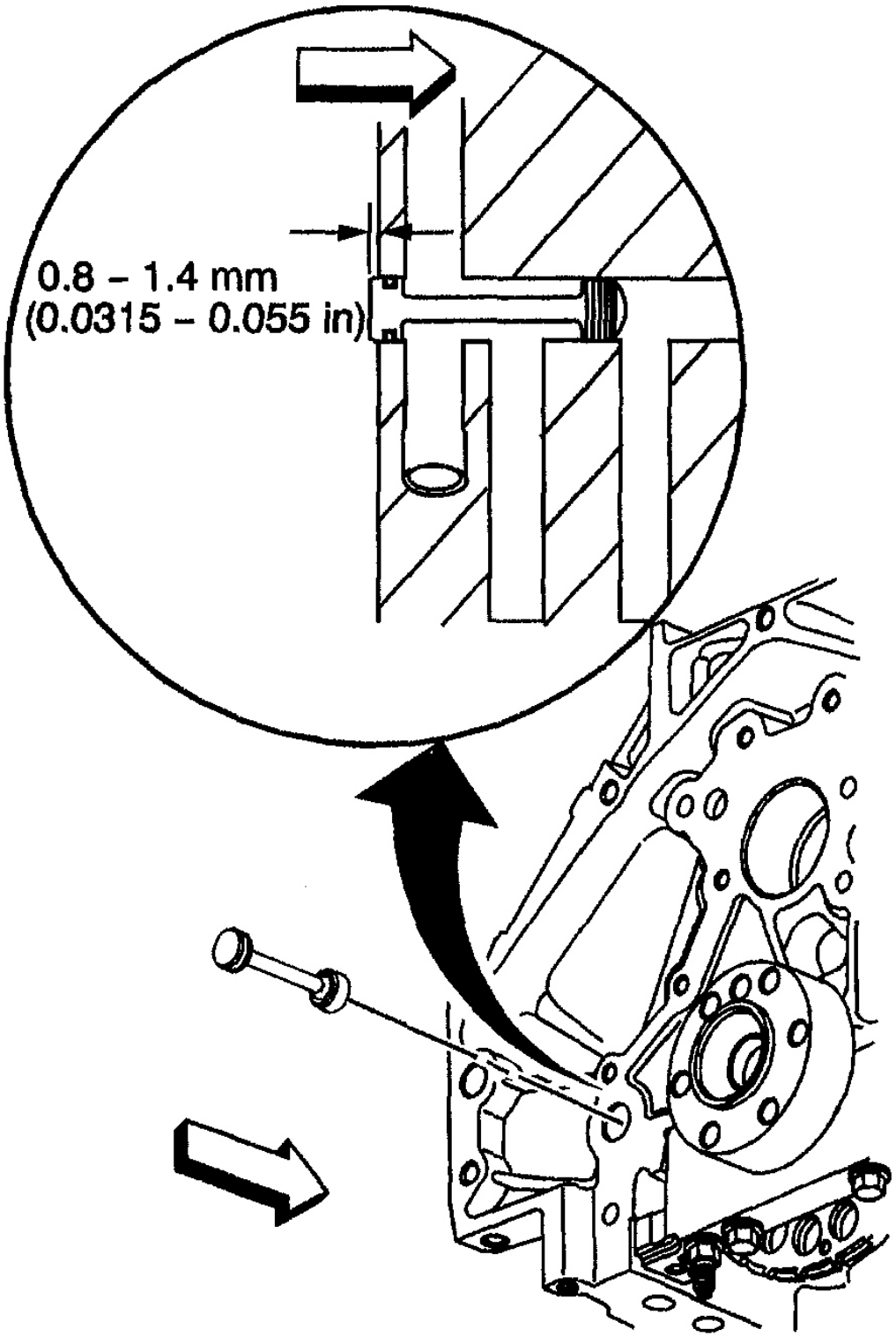
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Fig. 144: Engine Block Oil Gallery Plug (Left Rear)
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine block rear oil gallery plug.
9. Inspect the O-ring seal of the rear oil gallery plug.

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

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Fig. 145: Engine Block Oil Gallery Plug (Rear)
Courtesy of GENERAL MOTORS CORP.

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

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

10. Remove the engine block front oil gallery plug.

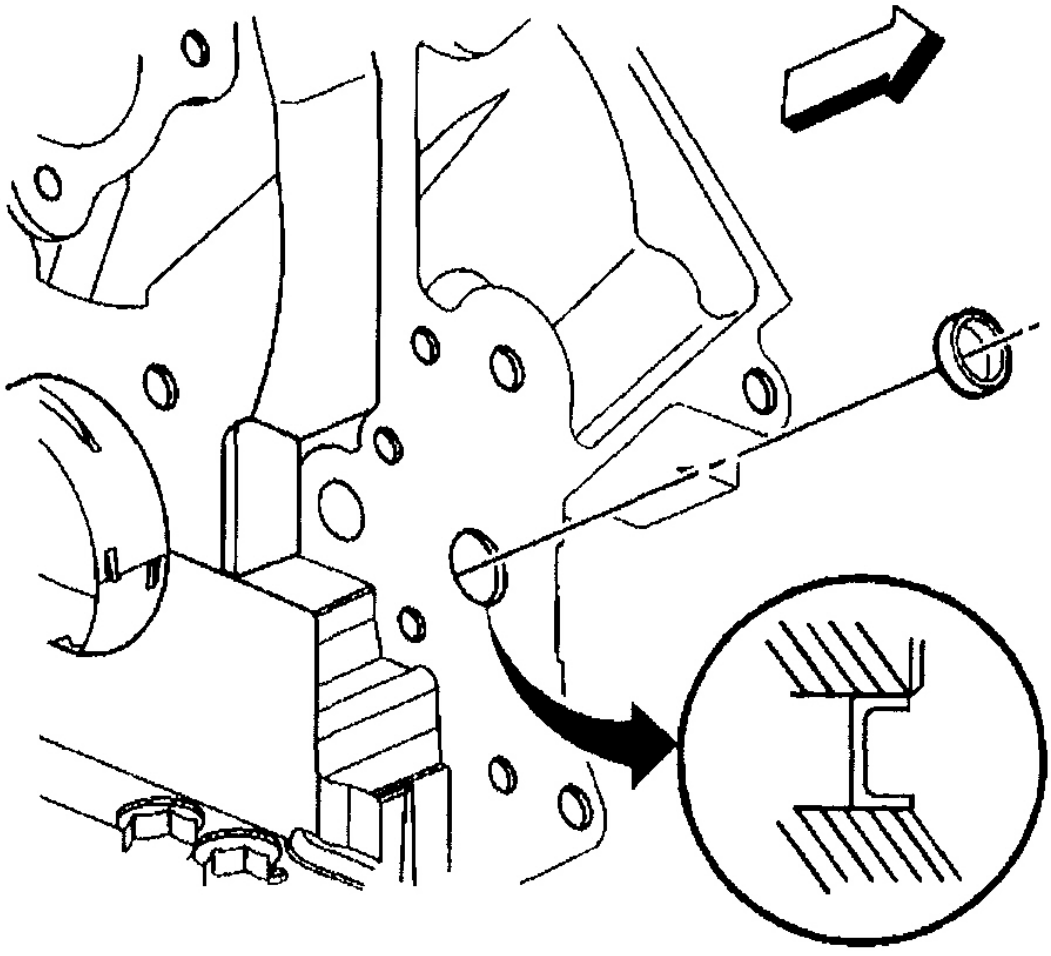


Fig. 146: Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

ENGINE BLOCK CLEANING AND INSPECTION

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Tools Required

J 42385-100 Thread Repair Kit

1. Clean the following areas:

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

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

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

  Refer to **Cleanliness and Care** .

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

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

  Refer to **Replacing Engine Gaskets** .

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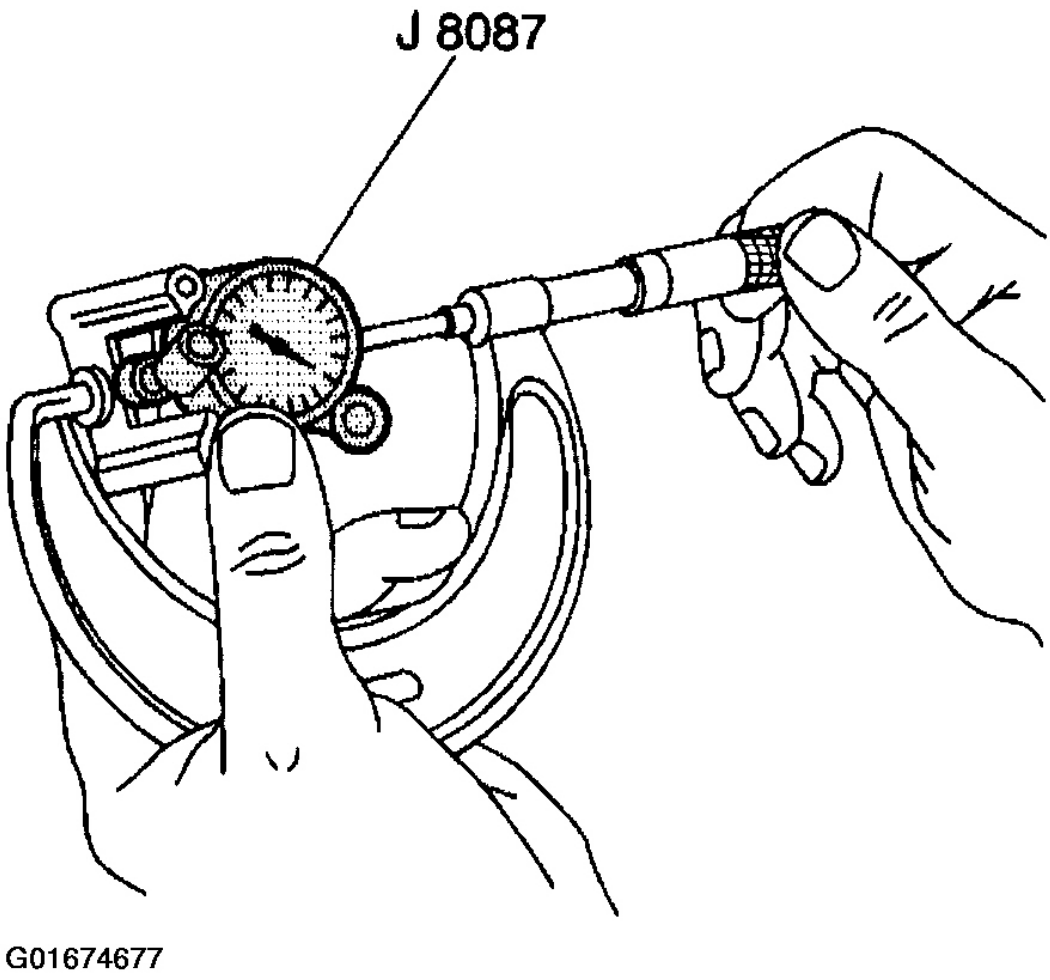


Fig. 147: Measuring J 8087
Courtesy of GENERAL MOTORS CORP.

- The coolant passages
- The oil galleries
- The main bearing caps
- The engine block cylinder head bolt holes for threadlocking material

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

2. Inspect the following areas:
   - The cylinder walls for excessive scratches, gouging, or ring ridge
   - The cylinder bores for excessive ring ridge at the top of the cylinder

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- The coolant jacket for cracks
- The valve lifter bores for excessive scoring or wear
- The crankshaft bearing webs for cracks
- The gasket sealing surfaces for excessive scratches or gouging

  Refer to **Replacing Engine Gaskets** .

- The oil galleries for restrictions
- All threaded bolt holes for damage

3. Measure the following areas:
   - The cylinder bores for taper
   - The cylinder bores for excessive ring ridge at the top of the cylinder

MEASURING THE CYLINDER FOR TAPER, OUT-OF-ROUND, AND OVERSIZE

1. Adjust the micrometer to a dimension slightly smaller than the bore size.

   Adjust the micrometer to 96.0 mm (3.78 in) for 4.8/5.3 liter engines.

   Adjust the micrometer to 101.62 mm (4.0 in) for 6.0 liter engines.

2. Insert the bore gage into the micrometer and zero the bore gage dial.
3. Use a bore gage and measure the cylinder bore for taper, out-of-round, and oversize.

   Slide the bore gage up and down throughout the length of the cylinder bore. Check the bore both parallel and perpendicular to the centerline of the crankshaft at the top, center, and bottom of the bore.

   A 4.8/5.3 L cylinder bore that measures 96.000-96.018 mm (3.779-3.78 in) may be honed and serviced with a standard size piston.

   A 6.0 L cylinder bore that measures 101.618-101.636 mm (4.0007-4.0014 in) may be honed and serviced with a standard size piston.

   A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston.

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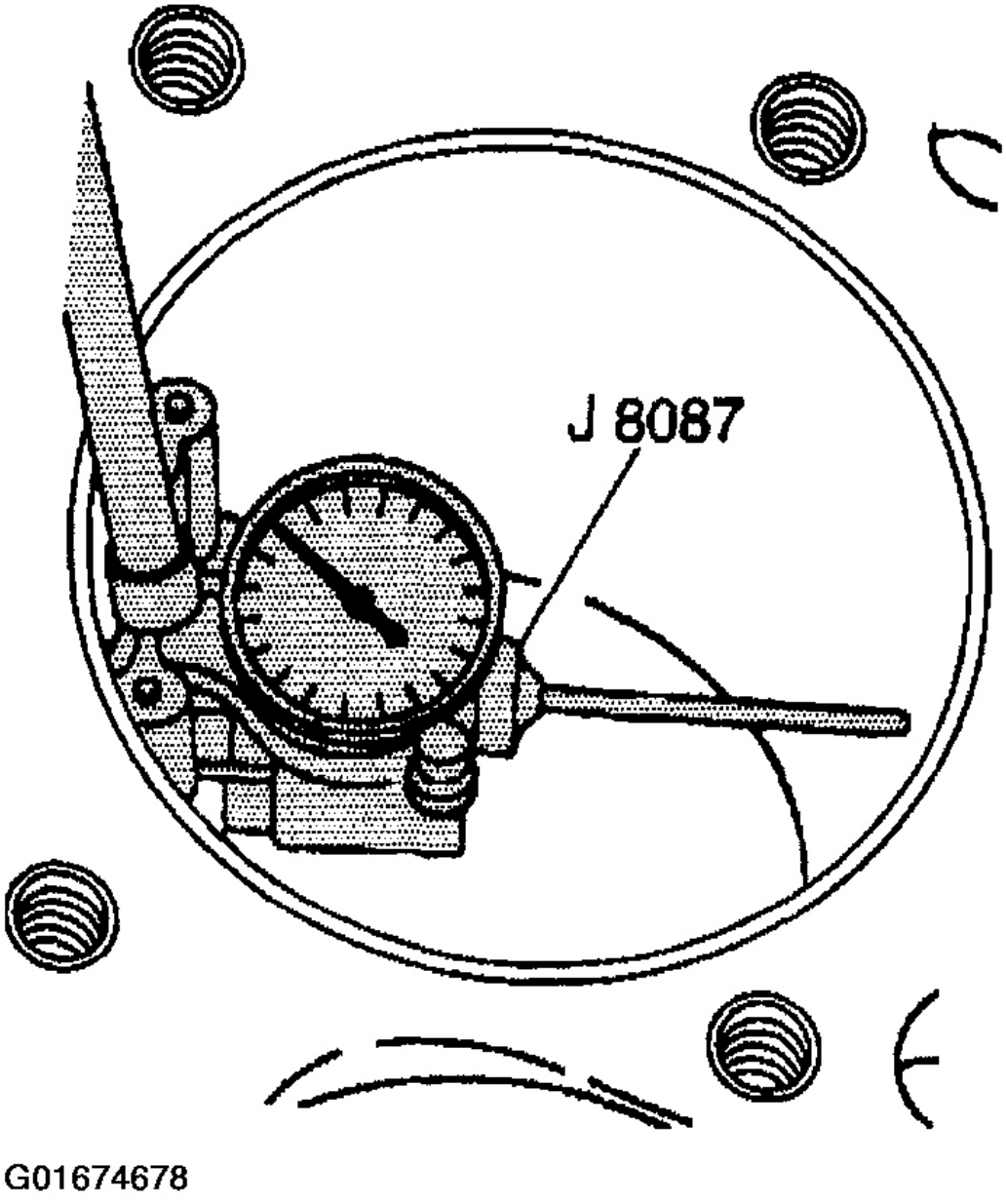


Fig. 148: Measuring Cylinder Bore Using J 8087
Courtesy of GENERAL MOTORS CORP.

CYLINDER BORING AND HONING

Boring Procedure

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IMPORTANT: A 0.5 mm (0.02 in) oversize service piston and a piston ring set are available for the 4.8/5.3/6.0 liter engines.

1. Measure all pistons with a micrometer to determine the cylinder bore diameter.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned (tilted) and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, make sure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure

1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.
2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.

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

3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100 grit stone.
4. Perform final cylinder honing with a 240 grit stone and obtain a 45 degree cross hatch pattern. A 240 grit stone is preferred for final honing. If a 240 grit stone is not available, a 220 grit stone may be used as a substitute.
5. When honing to eliminate taper in the cylinder, make full strokes the complete length of the bore. Repeatedly check the measurement at the top, the middle, and the bottom of the bore.

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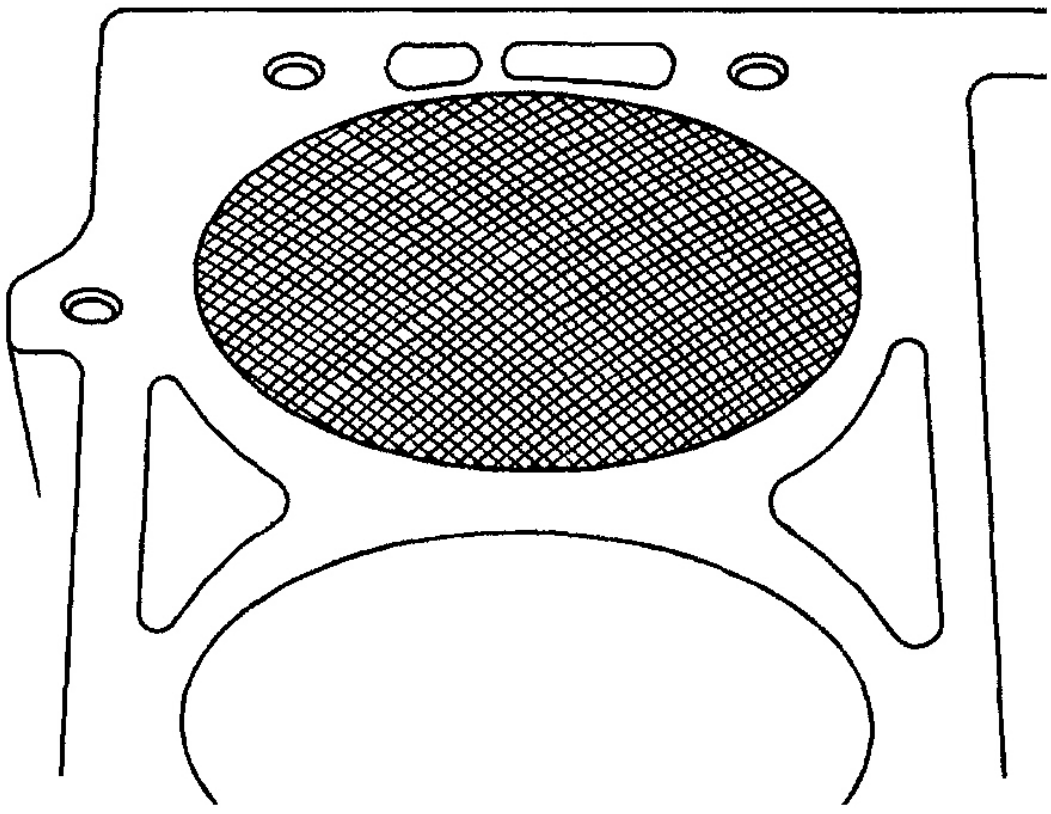


Fig. 149: Cylinder Bore Area
Courtesy of GENERAL MOTORS CORP.

6. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
7. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
8. When finished, the reconditioned cylinder bores should have less than or meet the specified out-of-round and taper requirements.
9. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.
10. Perform final measurements of the piston and the cylinder bore.
11. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.

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

DEGLAZING PROCEDURE

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

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

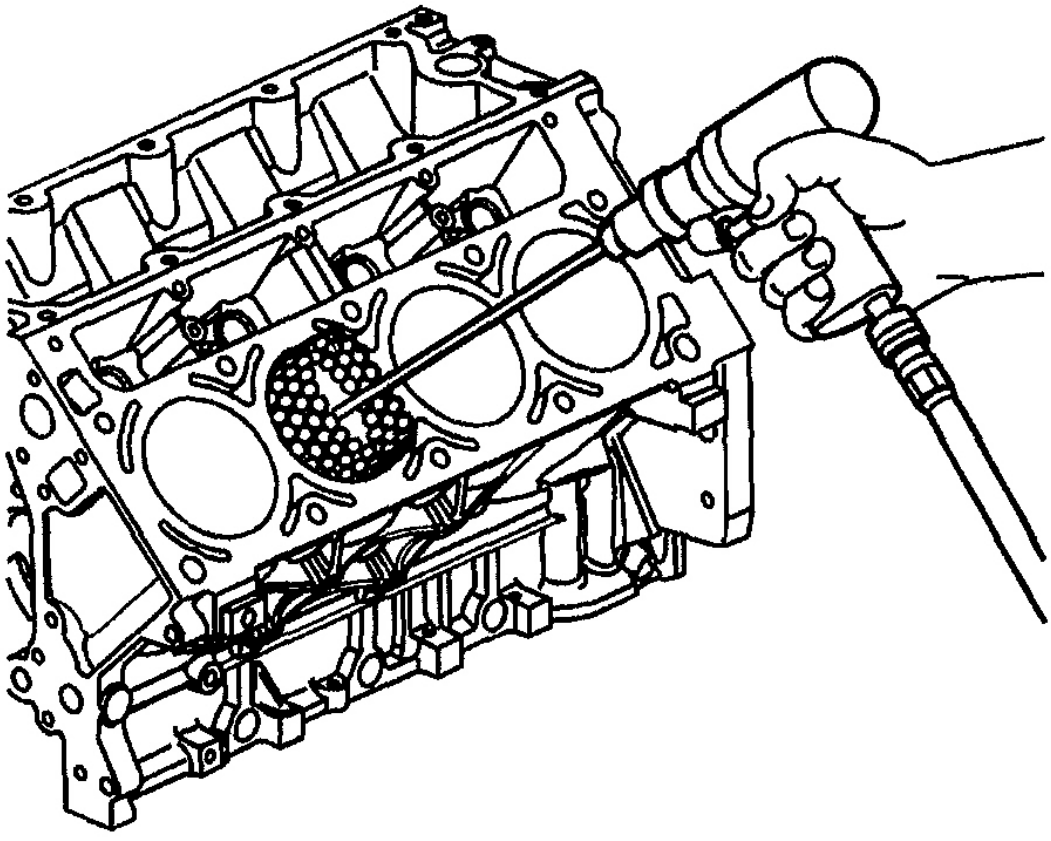


Fig. 150: Deglazing Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

CRANKSHAFT AND BEARINGS CLEANING AND INSPECTION

Tools Required

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- J 6125-1B Slide Hammer
- J 7872 Magnetic Base Dial Indicator Set
- J 36660-A Torque Angle Meter
- J 41818 Crankshaft Bearing Cap Remover

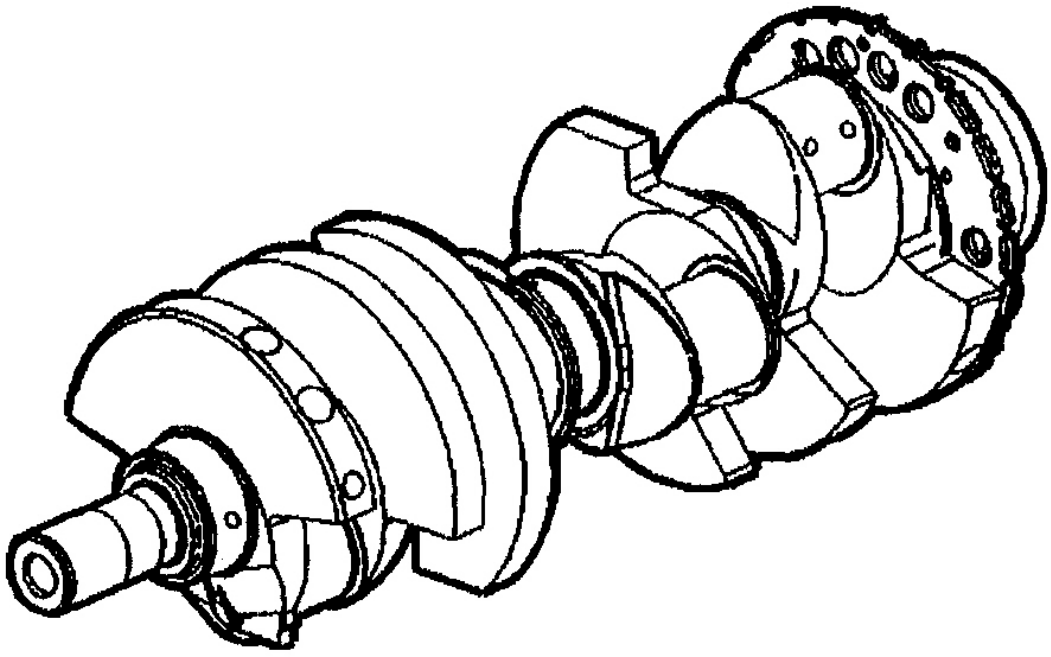
Cleaning Procedure

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

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

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

3. Dry the crankshaft with compressed air.



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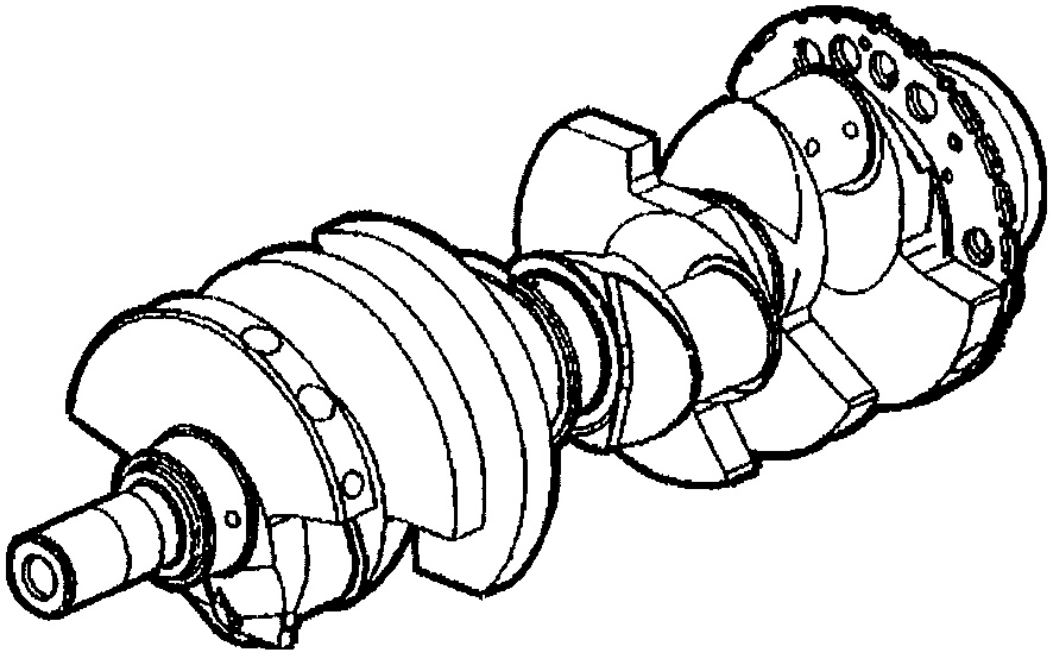
Fig. 151: Crankshaft Removed
Courtesy of GENERAL MOTORS CORP.

Inspection Procedure

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

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

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



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Fig. 152: Crankshaft Removed
Courtesy of GENERAL MOTORS CORP.

3. Inspect the crankshaft journals for wear (1).

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

4. Inspect the crankshaft journals for grooves or scoring (2).
5. Inspect the crankshaft journals for scratches or wear (3).

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

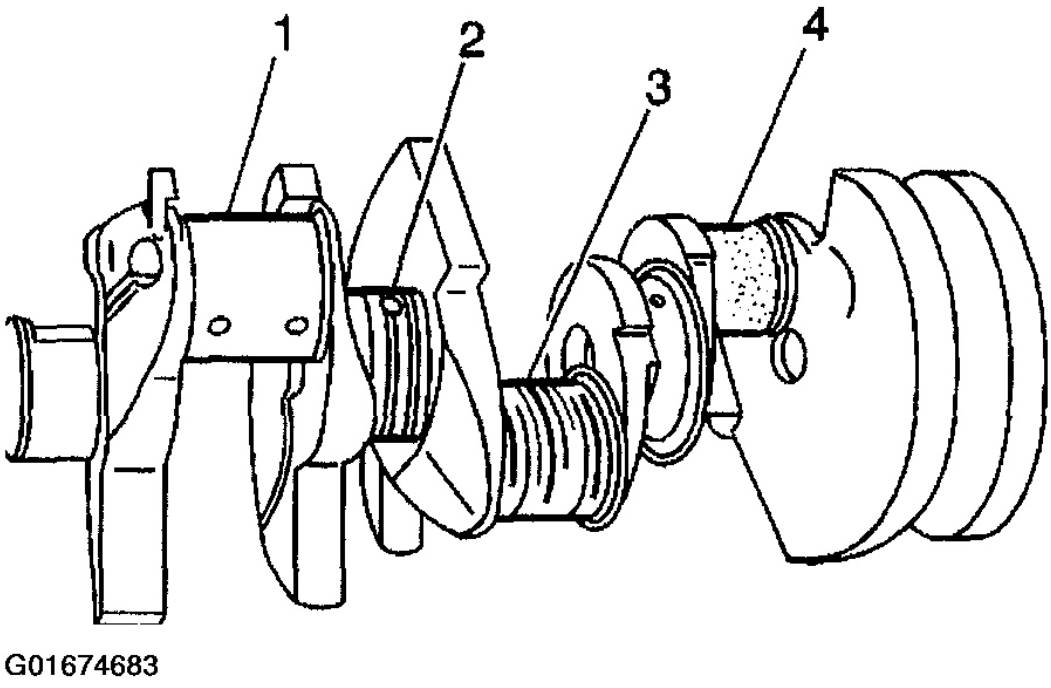


Fig. 153: Crankshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

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

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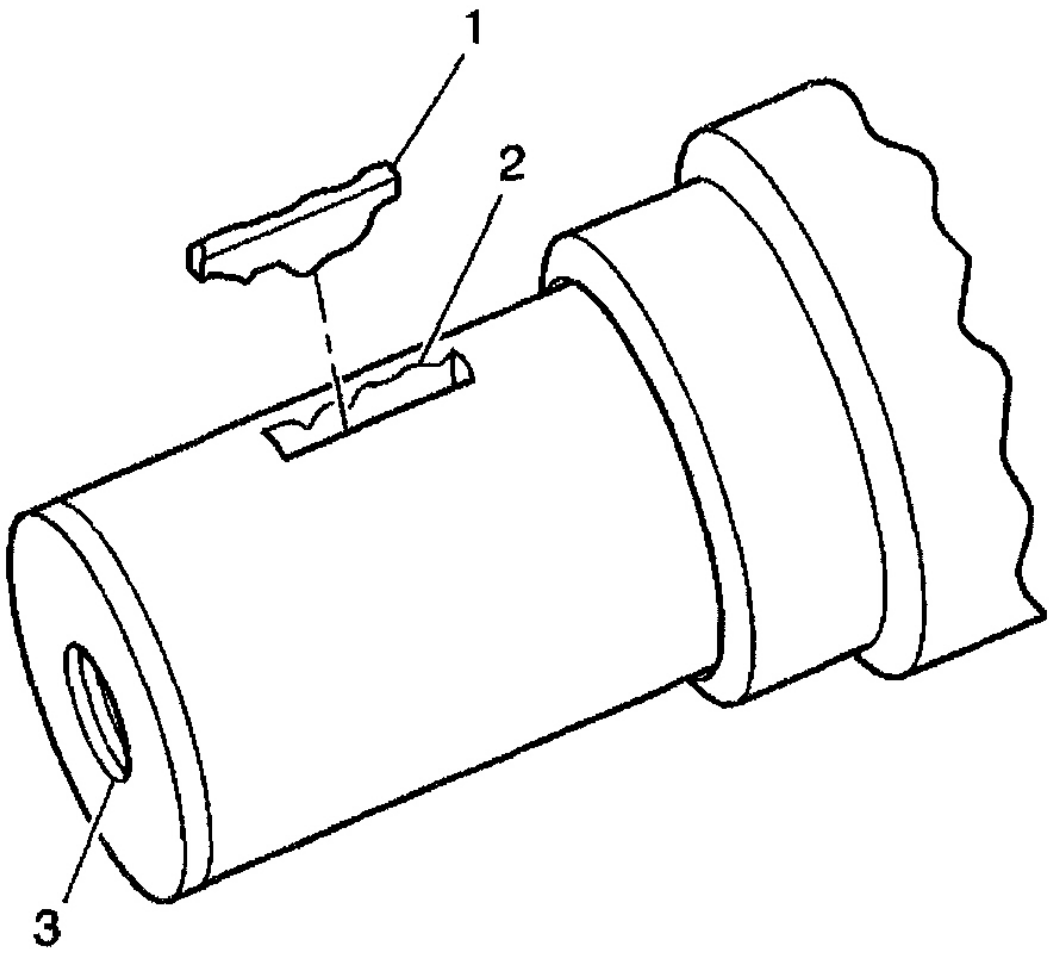


Fig. 154: Crankshaft Key, Keyway & Threaded Hole
Courtesy of GENERAL MOTORS CORP.

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

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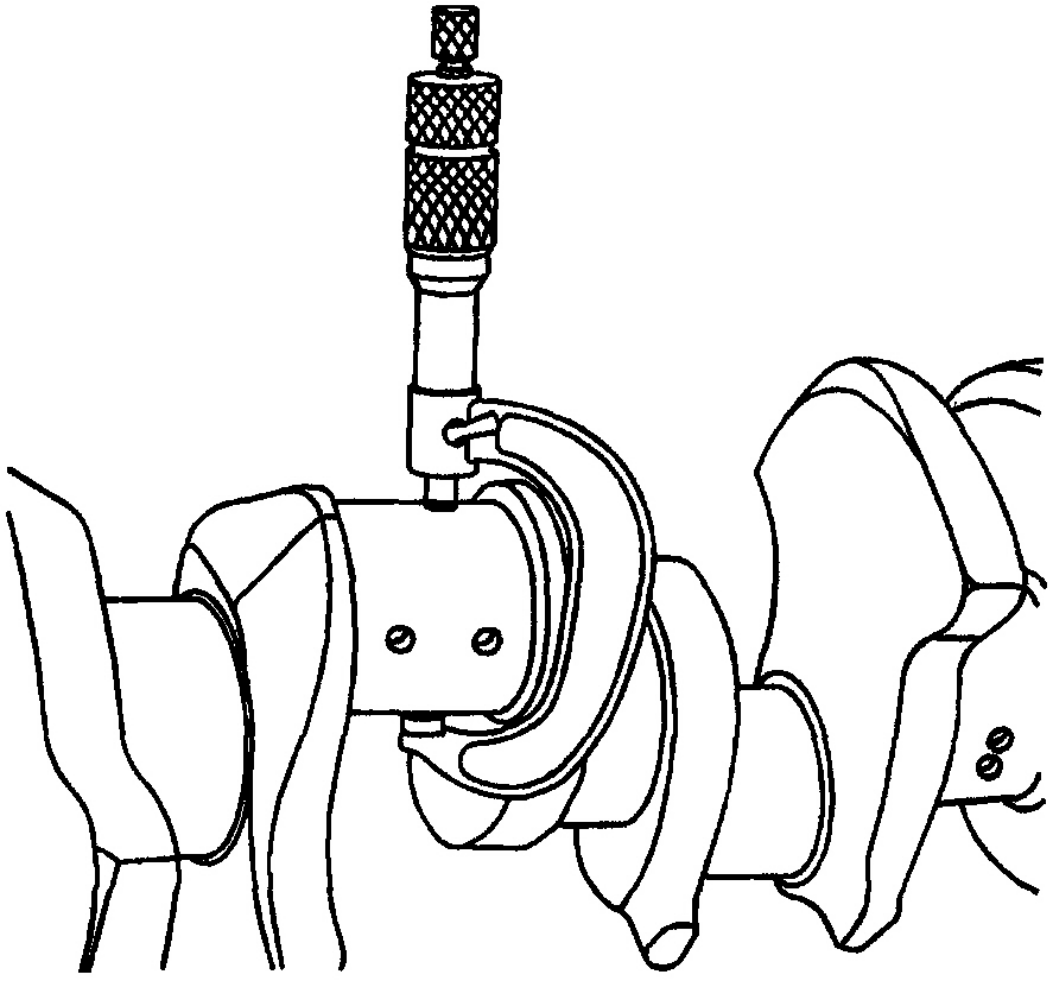


Fig. 155: Measuring Crankpins
Courtesy of GENERAL MOTORS CORP.

10. Measure the crankshaft thrust wall width.

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

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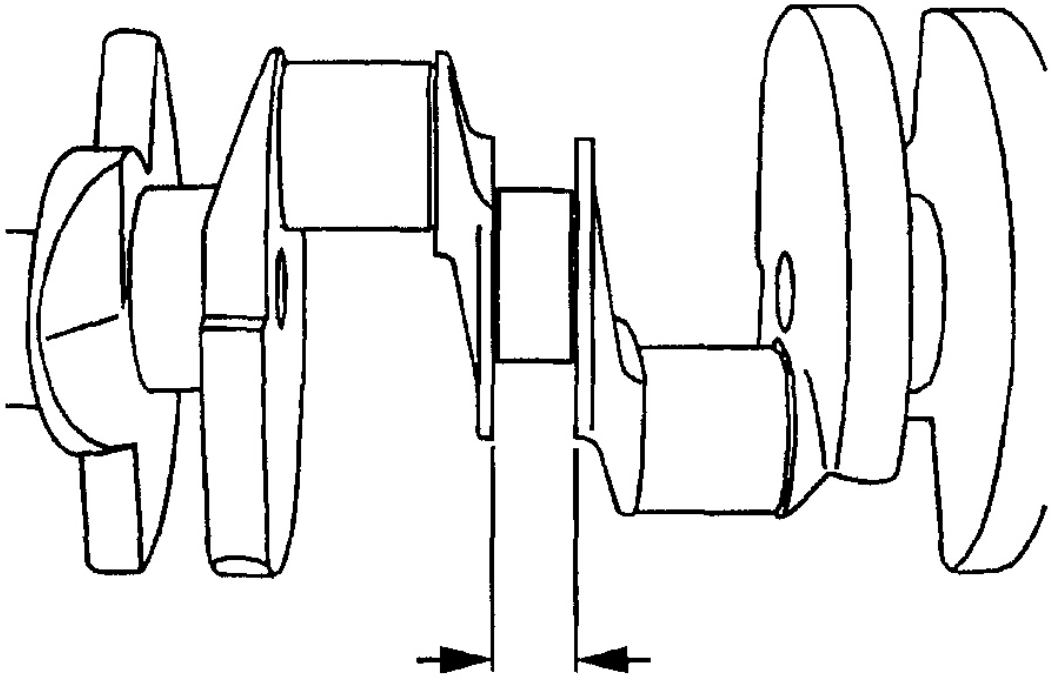


Fig. 156: Measuring Crankshaft Thrust Wall Width
Courtesy of GENERAL MOTORS CORP.

11. Measure the crankshaft runout.

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

12. Use the J 7872 in order to measure the crankshaft runout at the front and rear intermediate journals.
13. Use the J 7872 in order to measure the runout of the crankshaft rear flange.
14. Use the J 7872 in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.

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

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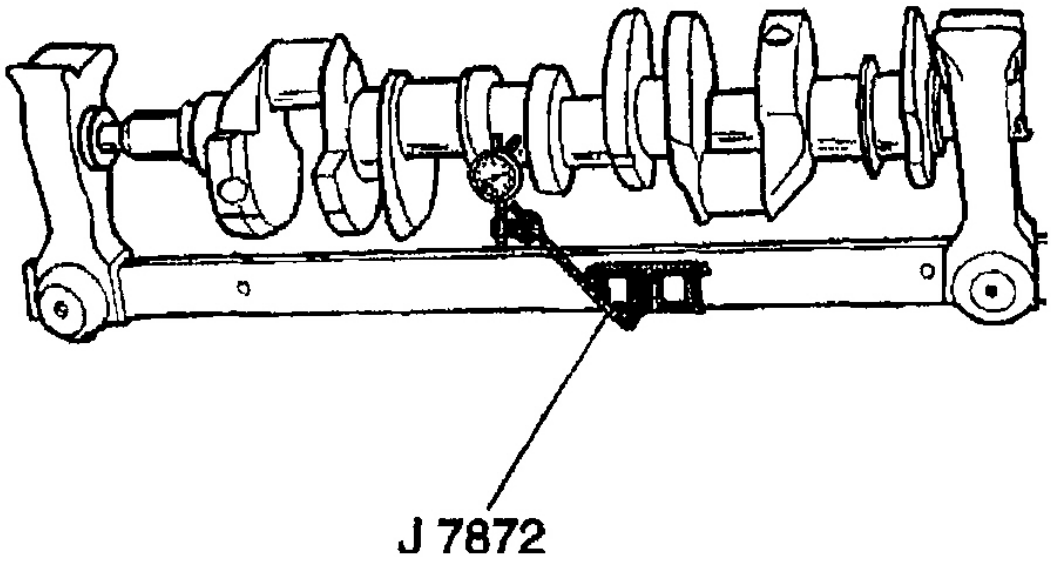
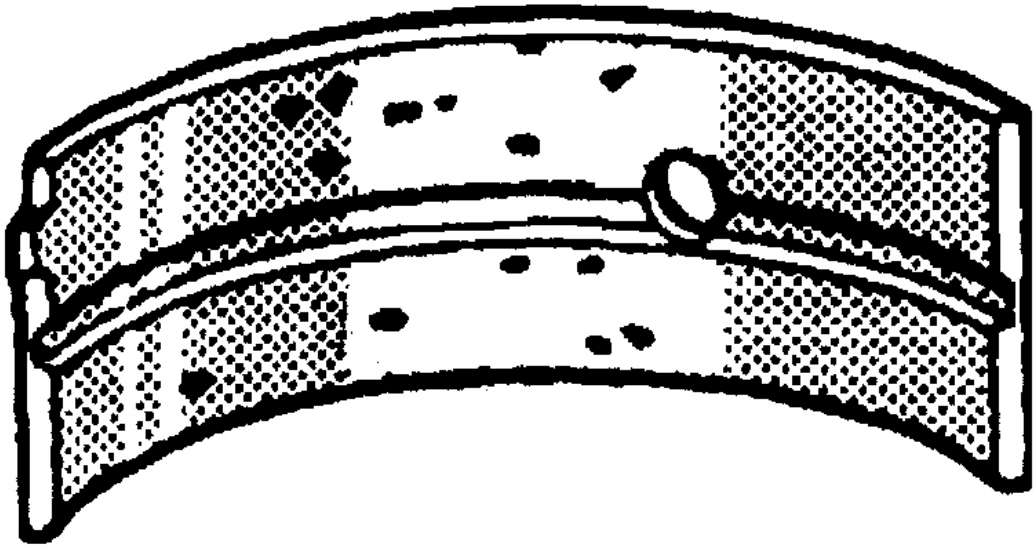


Fig. 157: Measuring Crankshaft Rear Flange & Crankshaft Position Reluctor Ring Using J 7872
Courtesy of GENERAL MOTORS CORP.

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

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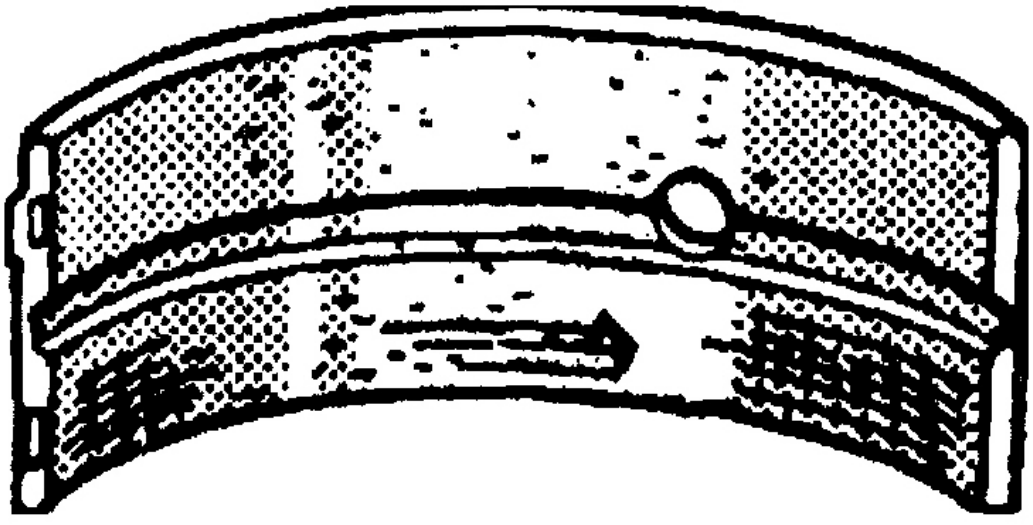


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Fig. 158: Crankshaft Bearing W/Craters
Courtesy of GENERAL MOTORS CORP.

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

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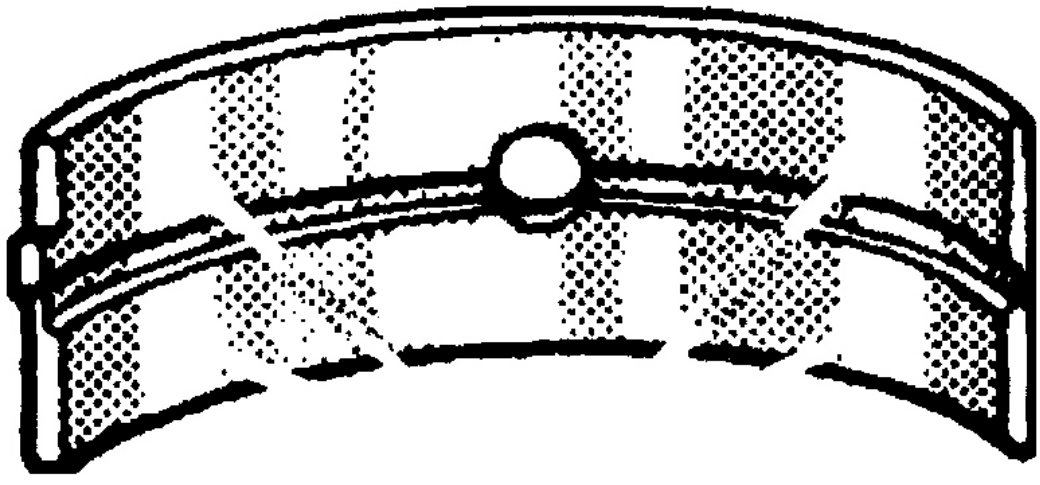
Fig. 159: Crankshaft Bearings W/Excessive Scoring, Dirt & Debris
Courtesy of GENERAL MOTORS CORP.

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

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

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

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Fig. 160: Crankshaft Bearing W/Polished Sections
Courtesy of GENERAL MOTORS CORP.

Measuring Main Bearing Clearance

IMPORTANT: The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block for proper clearance and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.

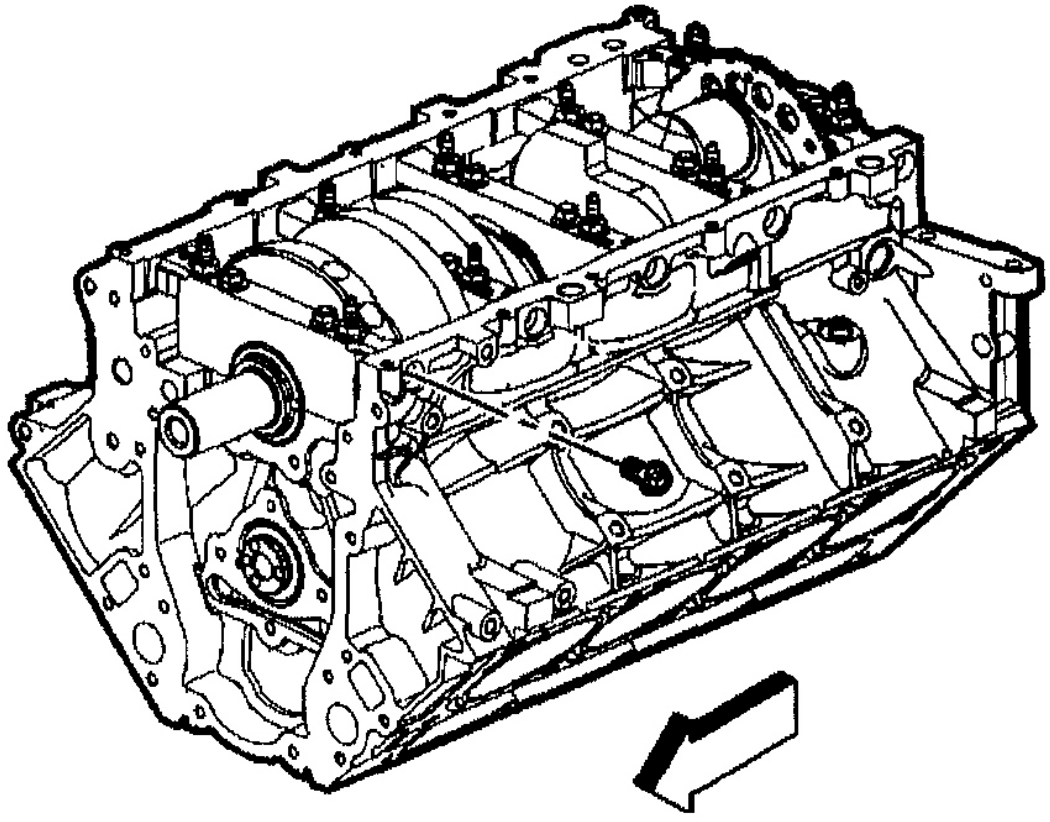
Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.

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

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

1. Remove the bearing cap M8 side bolts.

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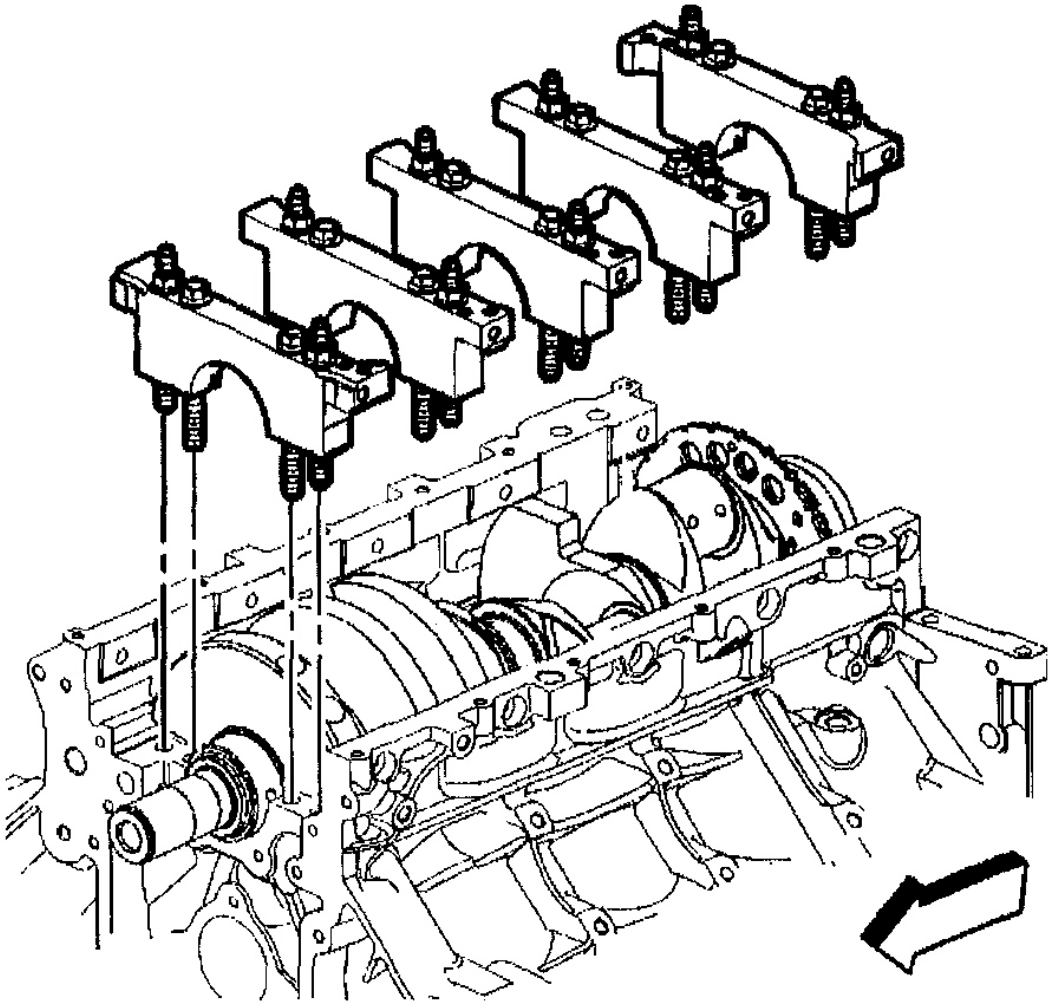


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Fig. 161: Bearing Cap M8 Side Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the bearing cap M10 bolts and studs.

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Fig. 162: Bearing Cap M10 Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the J 41818 to the bearing cap.

   Tighten

   Tighten the J 41818 bolts to 11 N.m (100 lb in).

4. Install the J 6125-1B to the J 41818 in order to remove the bearing cap.

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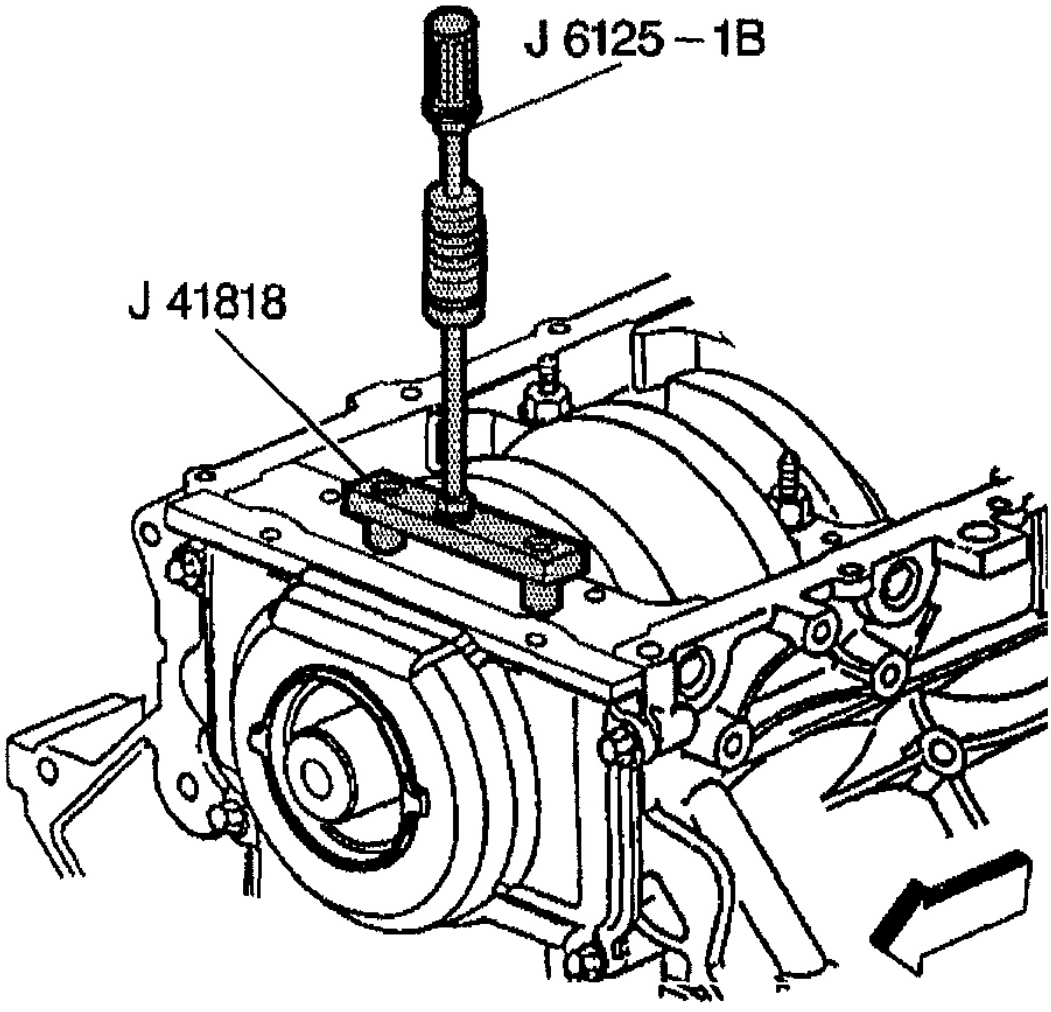
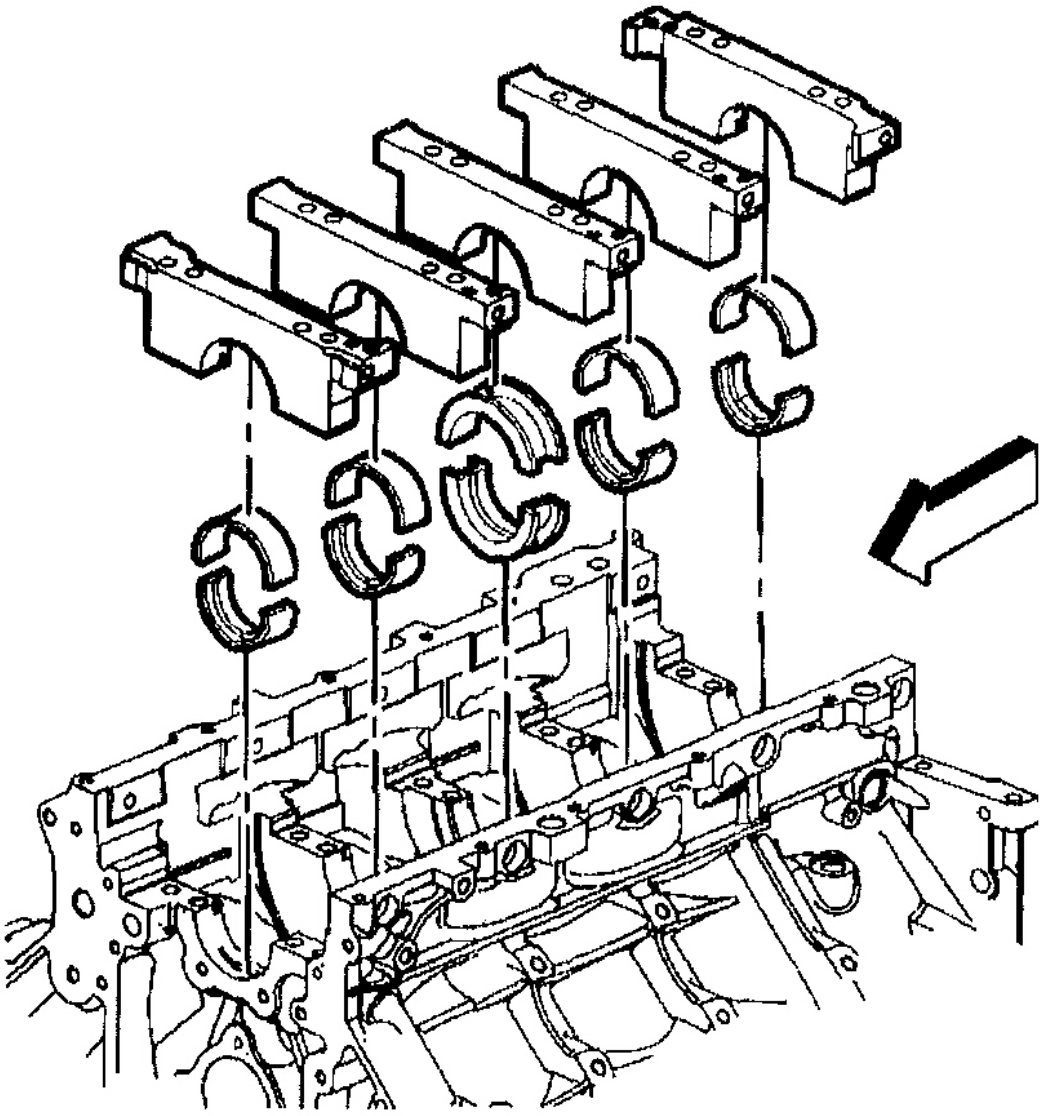


Fig. 163: Removing Bearing Cap Using J 41818 & J 6125-1B
Courtesy of GENERAL MOTORS CORP.

5. Remove the bearing cap and lower bearing.

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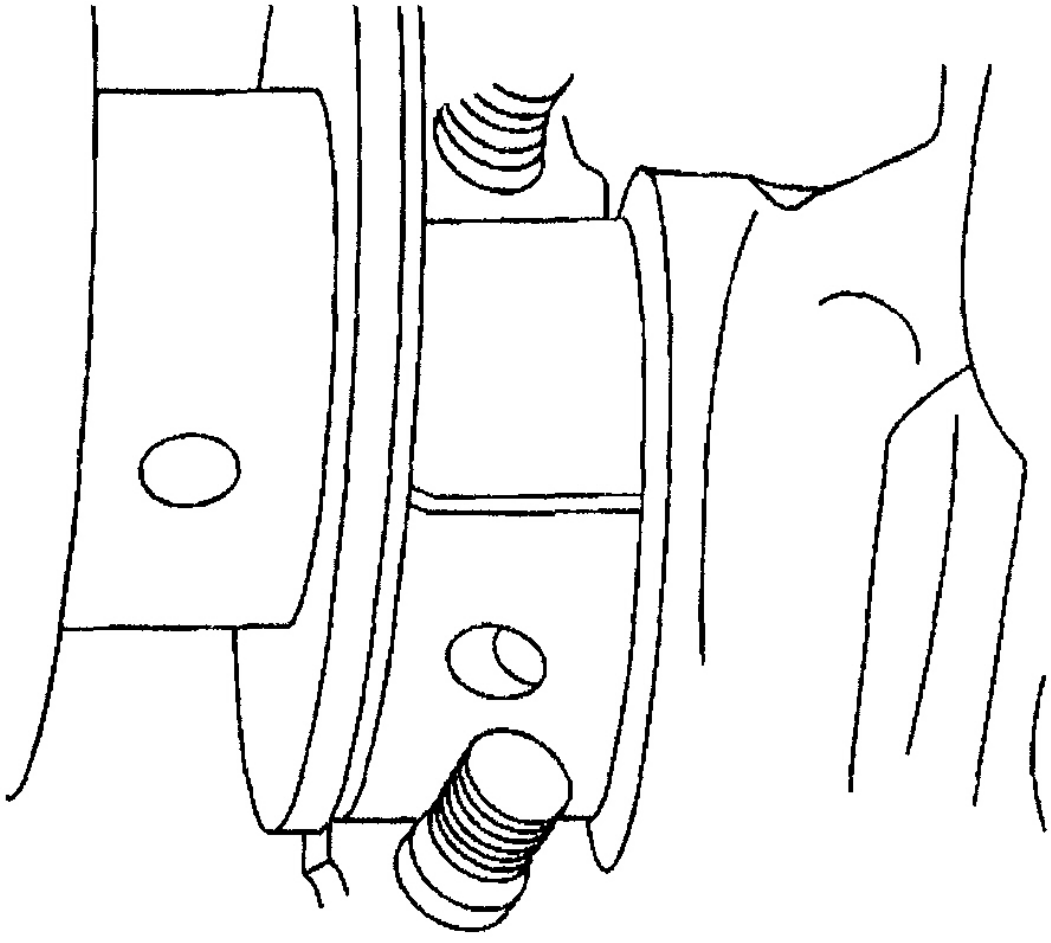


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Fig. 164: Bearing Cap & Lower Bearings
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 165: Gaging Plastic Installed Onto Crankshaft Journal
Courtesy of GENERAL MOTORS CORP.

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

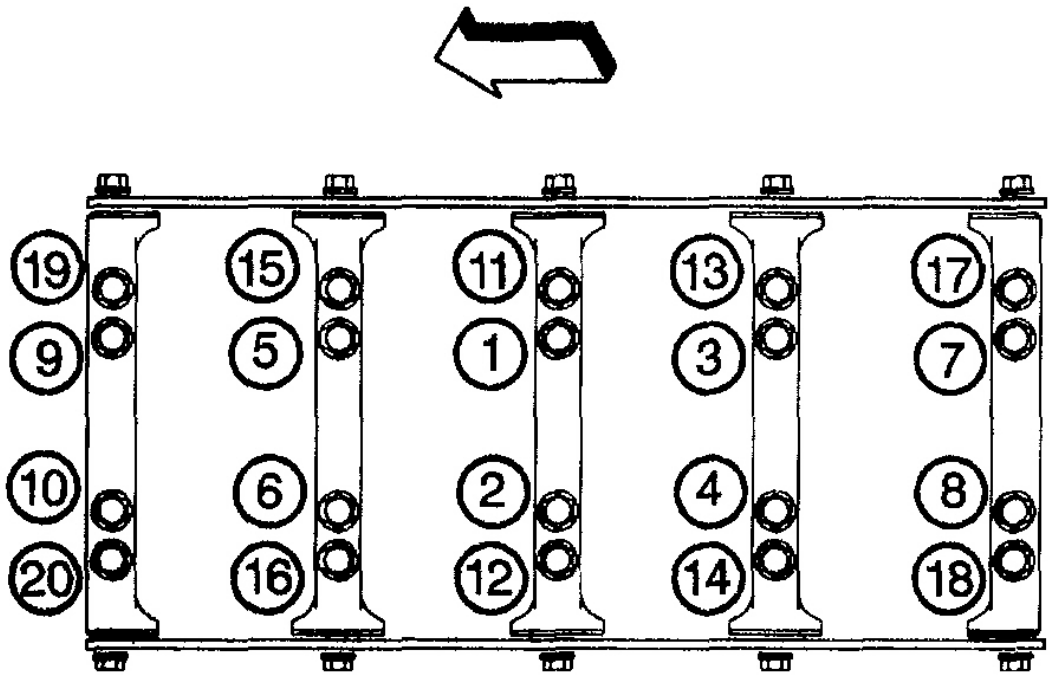
Tighten

7.1. Tighten the inner bolts (1-10) a first pass in sequence to 20 N.m (15 lb ft).
7.2. Tighten the inner bolts (1-10) a final pass in sequence to 80 degrees using the J 36660-A.
7.3. Tighten the outer bolt/studs (11-20) a first pass in sequence to 20 N.m (15 lb ft).
7.4. Tighten the outer bolt/studs (11-20) a final pass in sequence to 53 degrees using the J 36660-A.
7.5. Tighten the side cap bolts to 25 N.m (18lb ft).

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

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same bearing cap.



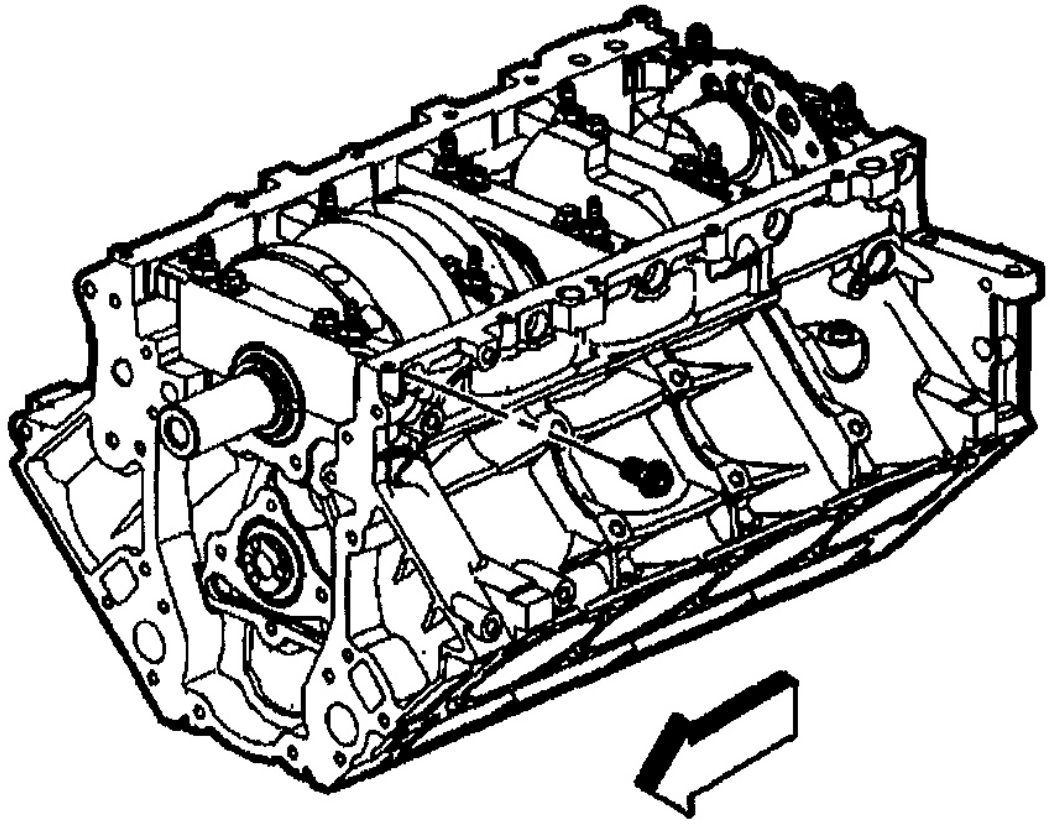
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Fig. 166: Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

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

8. Remove the bearing cap M8 side bolts.

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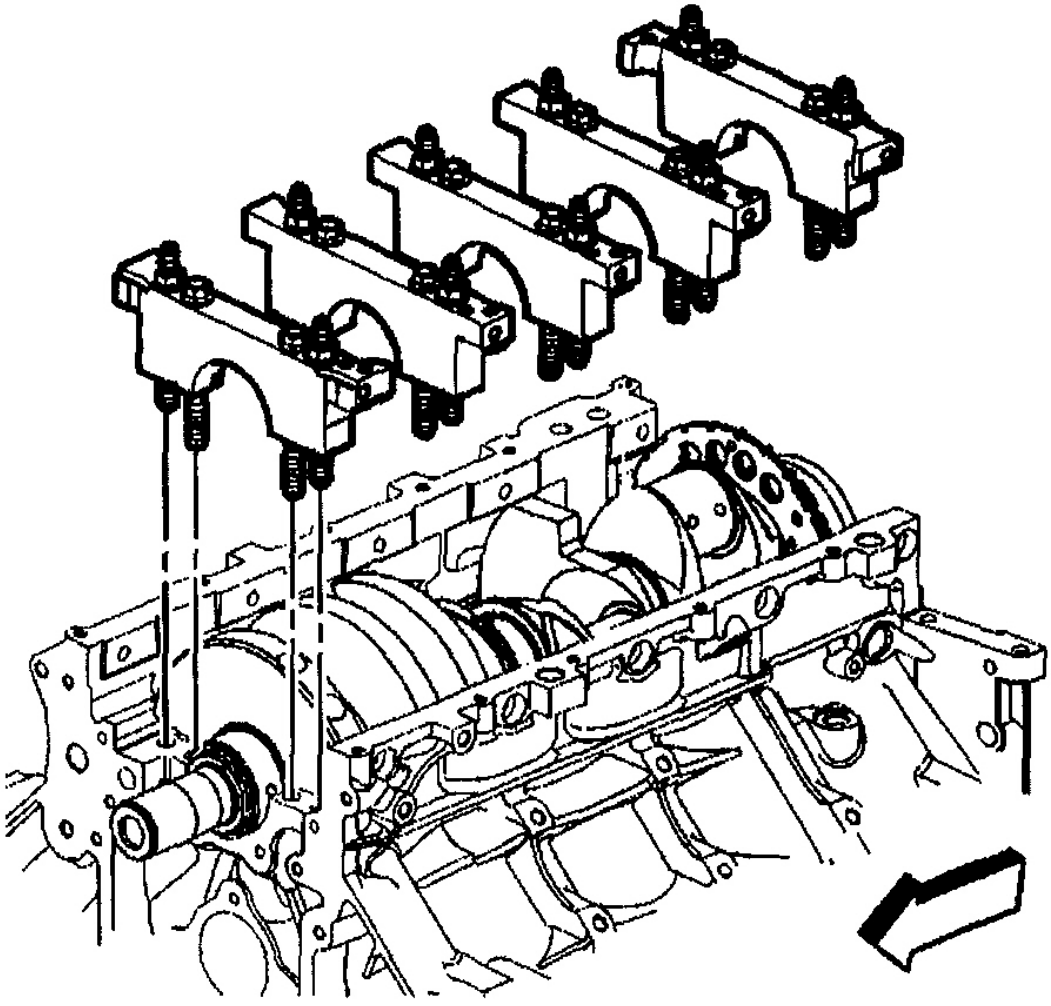


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Fig. 167: Bearing Cap M8 Side Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the bearing cap bolts and bolt/studs.

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Fig. 168: Bearing Cap, Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

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

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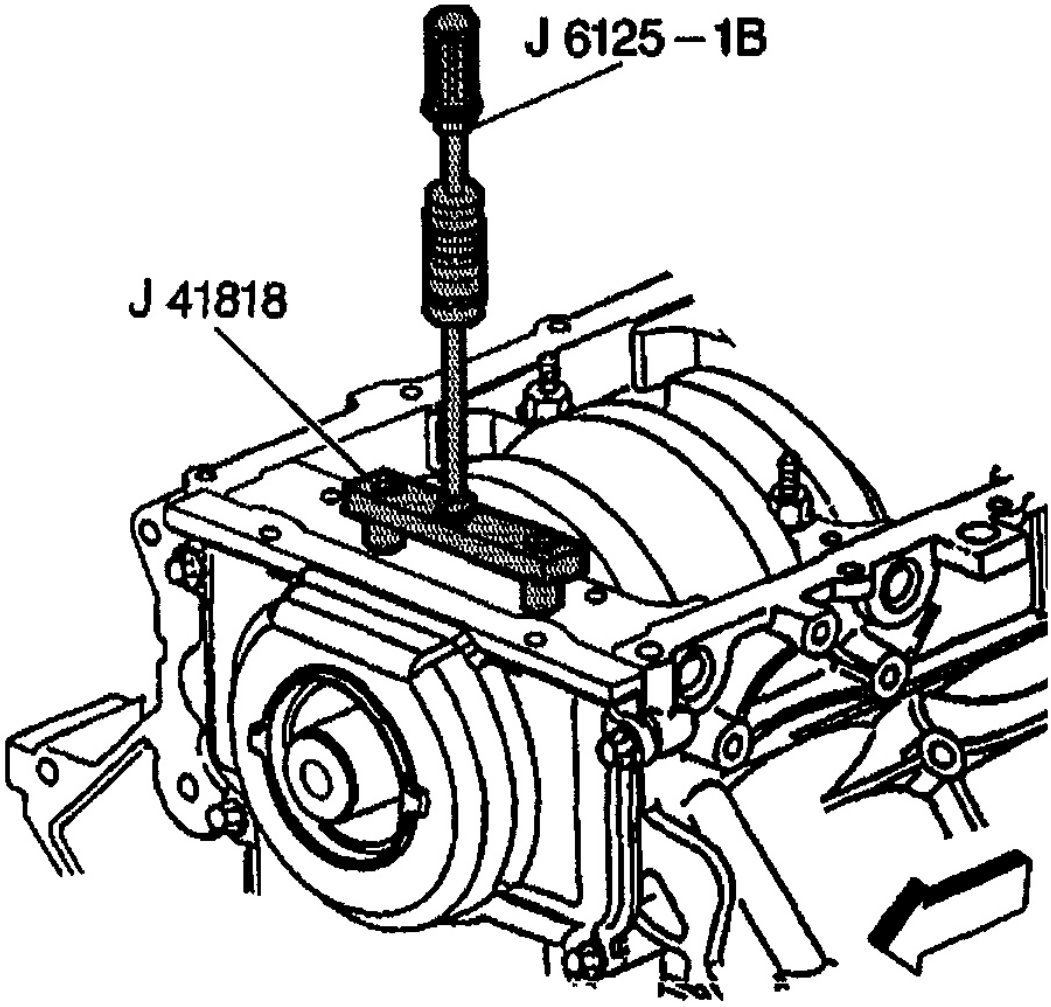
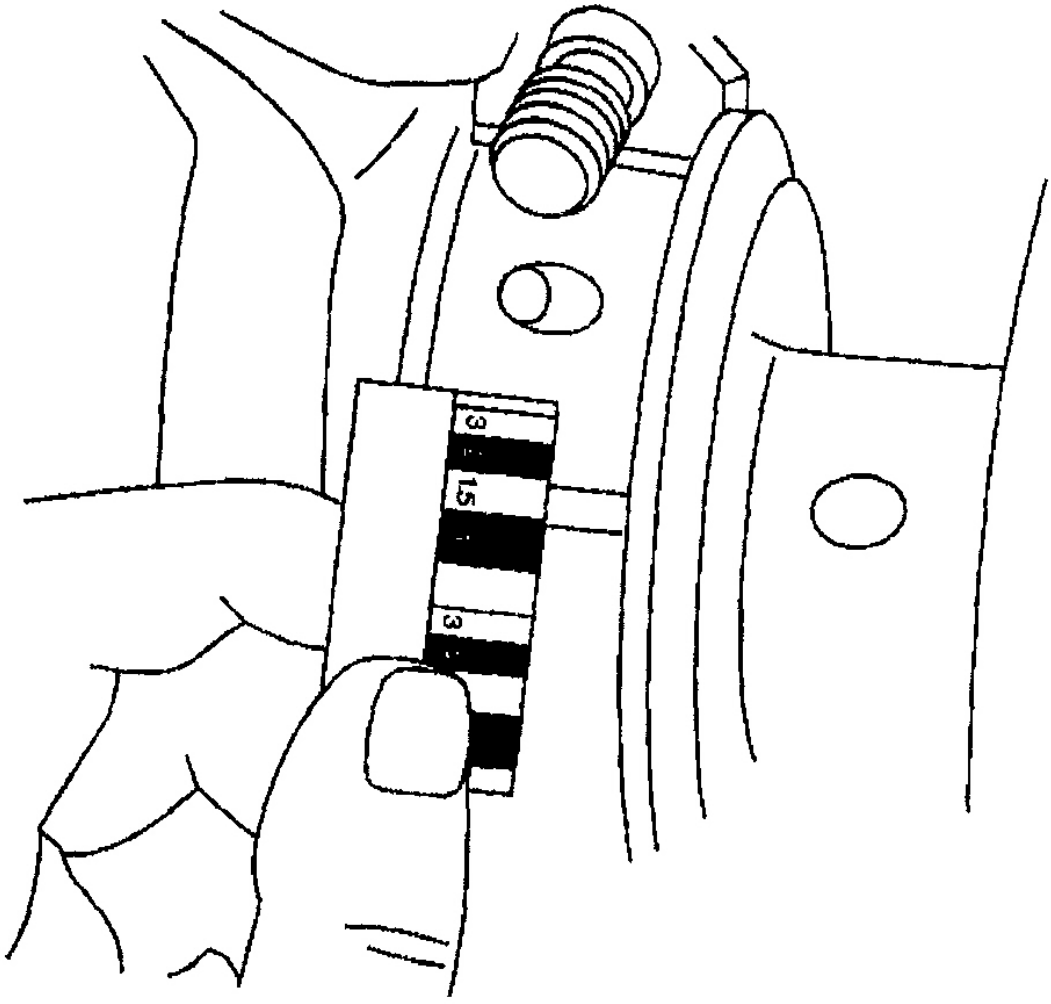


Fig. 169: Removing Bearing Cap Using J 41818 & J 6125-1B
Courtesy of GENERAL MOTORS CORP.

11. Measure the gaging plastic at its widest area using the scale supplied with the plastic gaging kit.
    - If the gaging plastic shows irregularity in the journal exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
    - If the bearing clearance is greater than 0.052 mm (0.0021 in), select and install an undersized bearing set, and measure the clearance with gaging plastic.
    - If clearance cannot be brought to specifications, replace the crankshaft or grind the crankshaft for use with the next undersized bearing.

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Fig. 170: Measuring Gaging Plastic At Widest Area Using Scale Supplied With Plastic Gaging Kit
Courtesy of GENERAL MOTORS CORP.

12. Measure the crankshaft end play.

    12.1. Thrust the crankshaft forward or rearward.

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

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

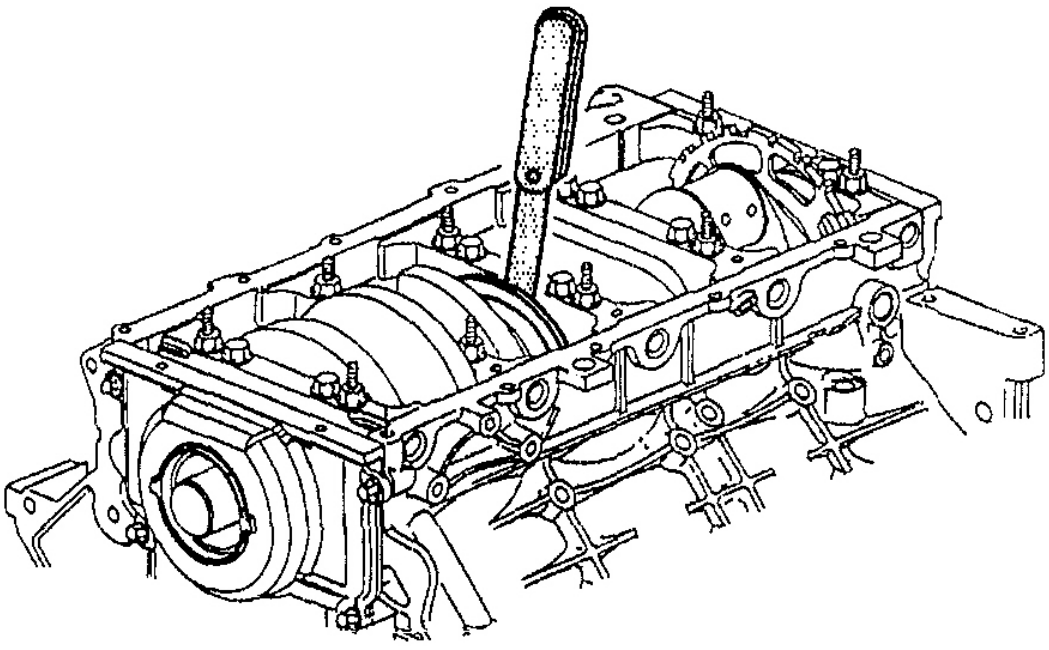
    12.3. If the bearing clearance is not within specifications:

    - Inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be

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removed with a fine stone.

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



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Fig. 171: Measuring Crankshaft End Play
Courtesy of GENERAL MOTORS CORP.

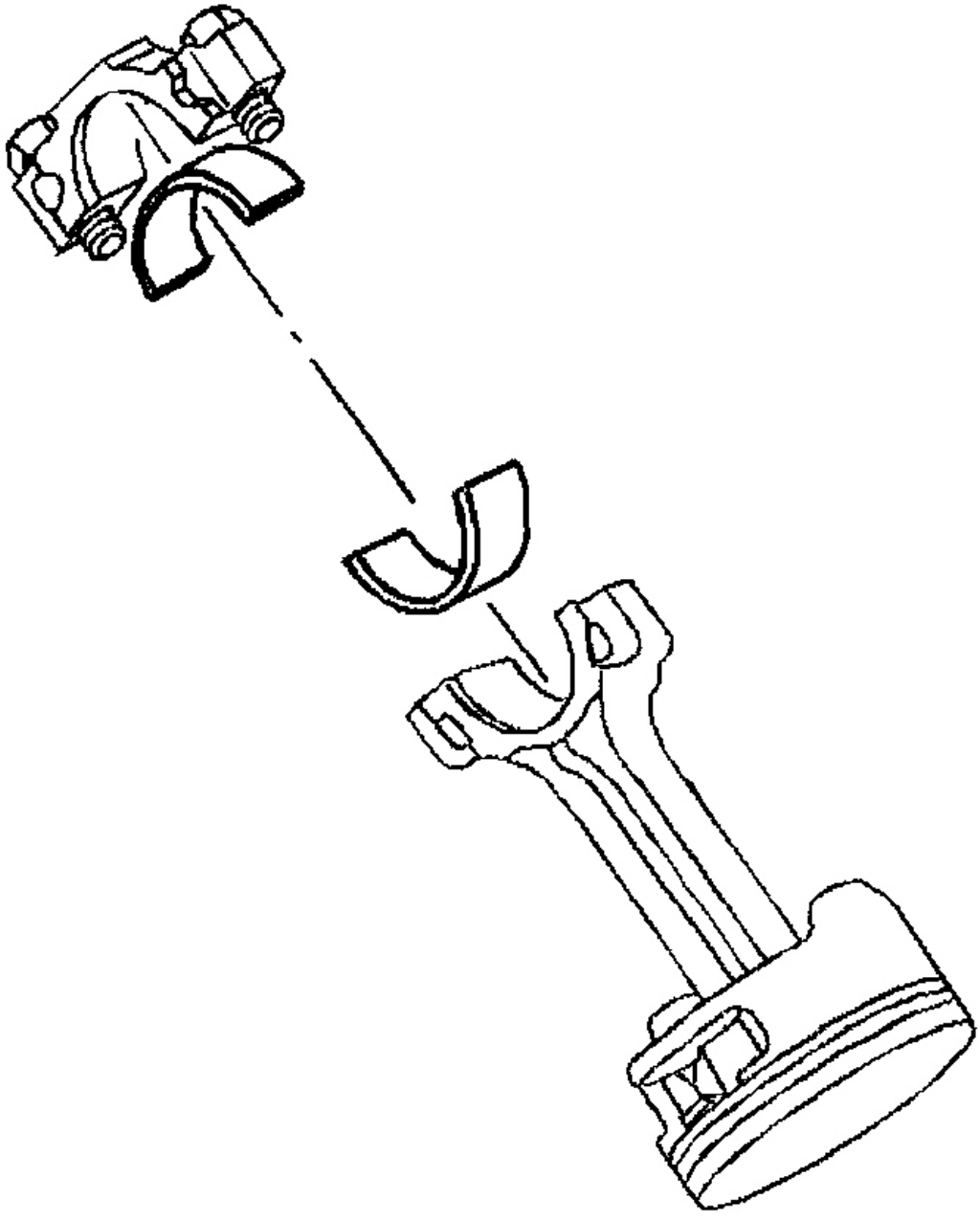
Measuring Connecting Rod Bearing Clearance

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

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

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

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Fig. 172: Bearing Cap, Bearing Half & Bolts
Courtesy of GENERAL MOTORS CORP.

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

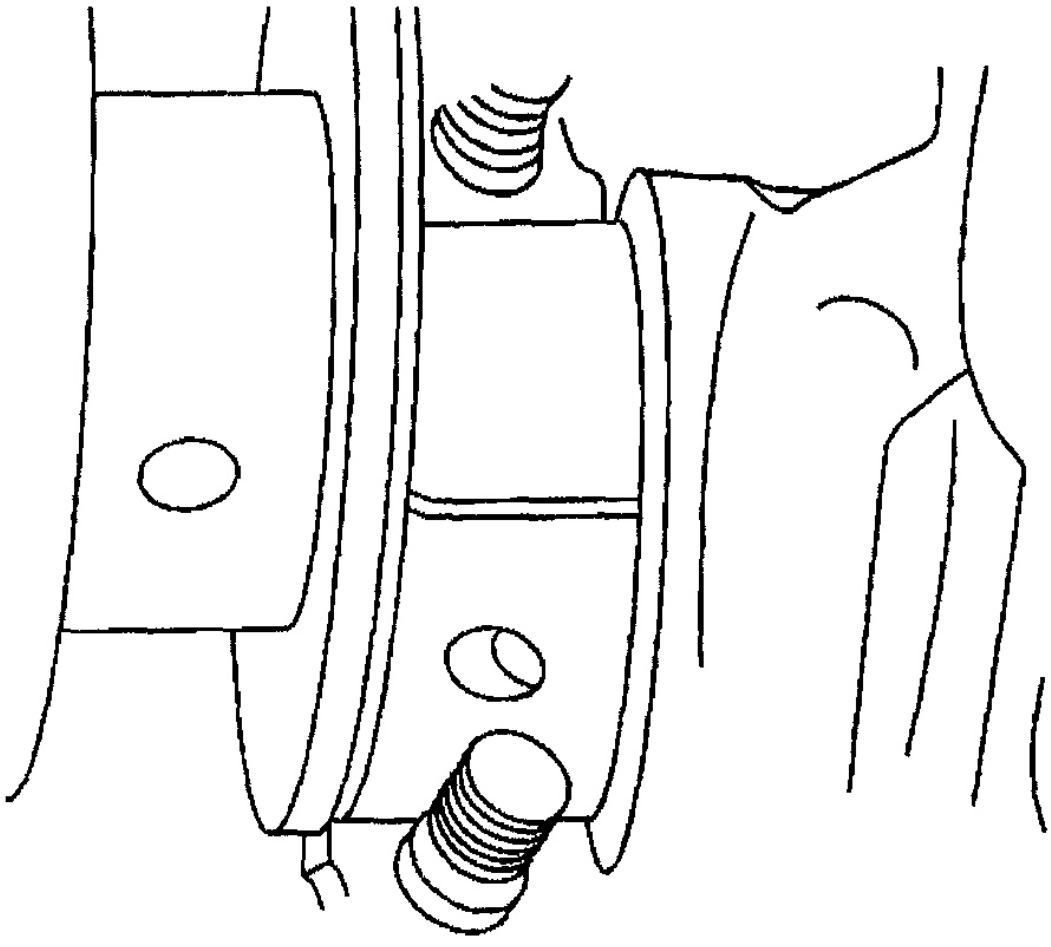


Fig. 173: Gaging Plastic Installed Onto Connecting Rod Bearing Journal
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the bearing cap, bearing, and bolts.

Tighten

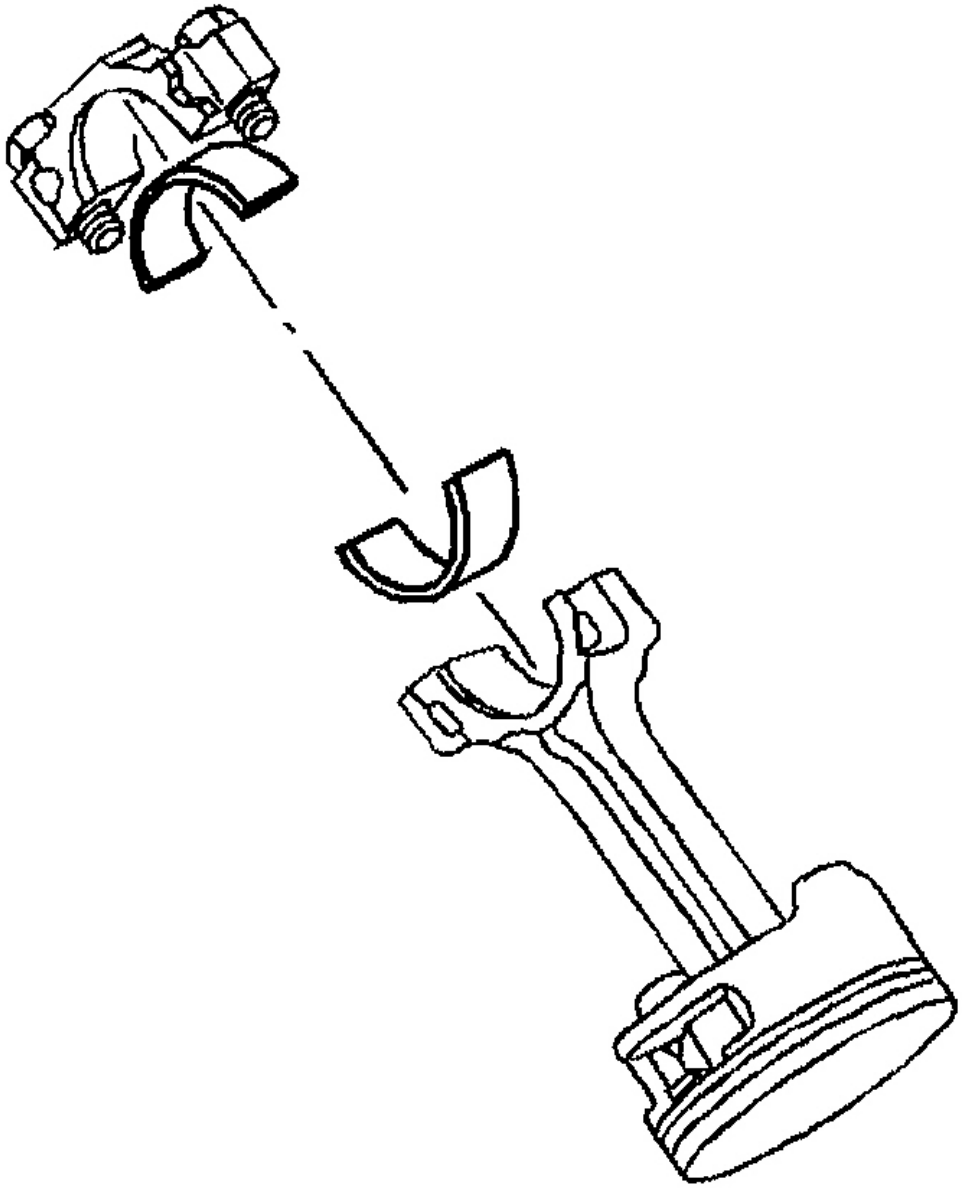
3.1. Tighten the connecting rod bolts first pass to 20 N.m (15lb ft).
3.2. Tighten the first design connecting rod bolts a final pass to 60 degrees using the J 36660-A.

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3.3 Tighten the second design connecting rod bolts a final pass to 75 degrees using the J36660-A.

Refer to **Piston, Connecting Rod, and Bearing Installation** .

4. Remove the bearing cap, bearing, and bolts.



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Fig. 174: Bearing Cap, Bearing & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Measure the gaging plastic at its widest area using the scale supplied with the plastic gaging kit.

   The connecting rod bearing clearance should be 0.023-0.076 mm (0.0009-0.003 in).

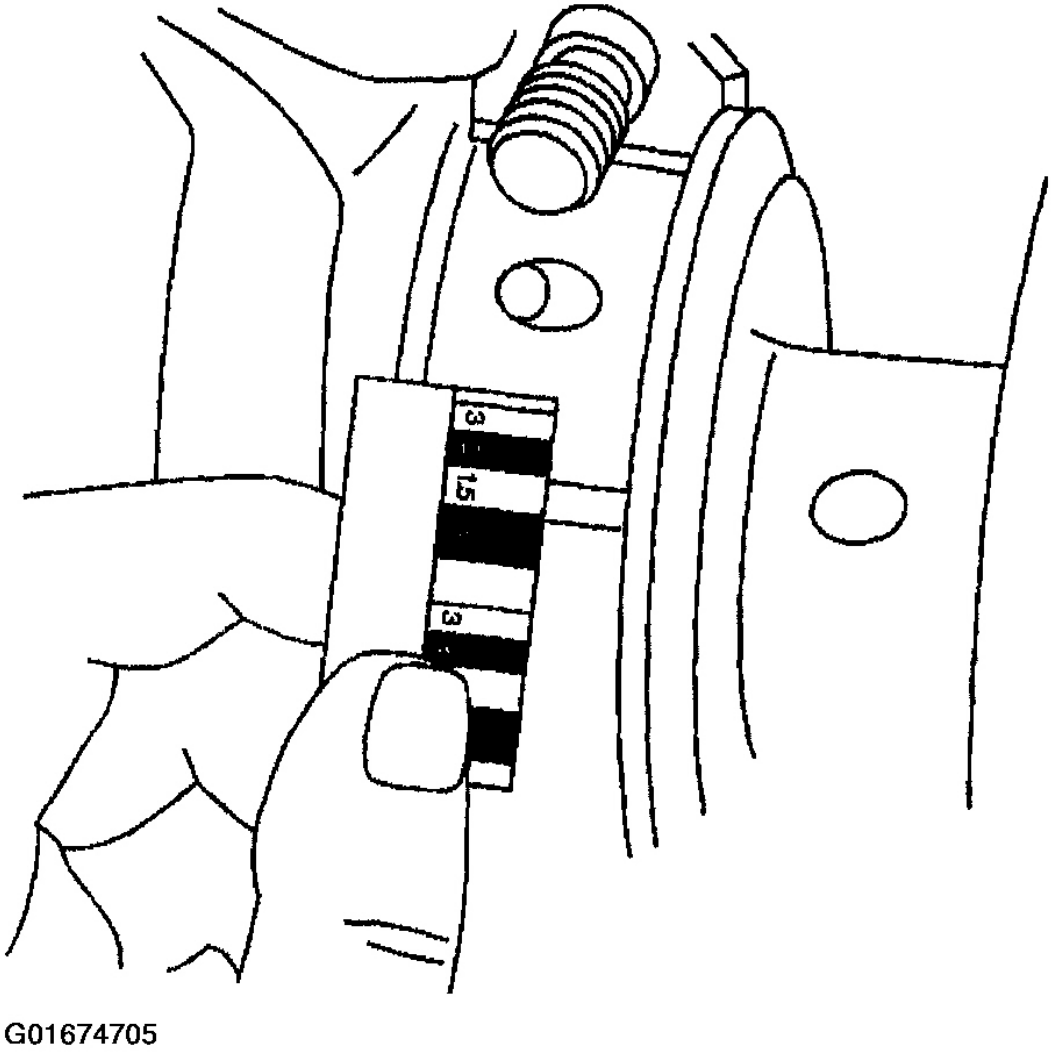


Fig. 175: Measuring Gaging Plastic At Widest Area Using Scale Supplied With Plastic Gaging Kit
Courtesy of GENERAL MOTORS CORP.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

1. Clean the crankshaft balancer in solvent.

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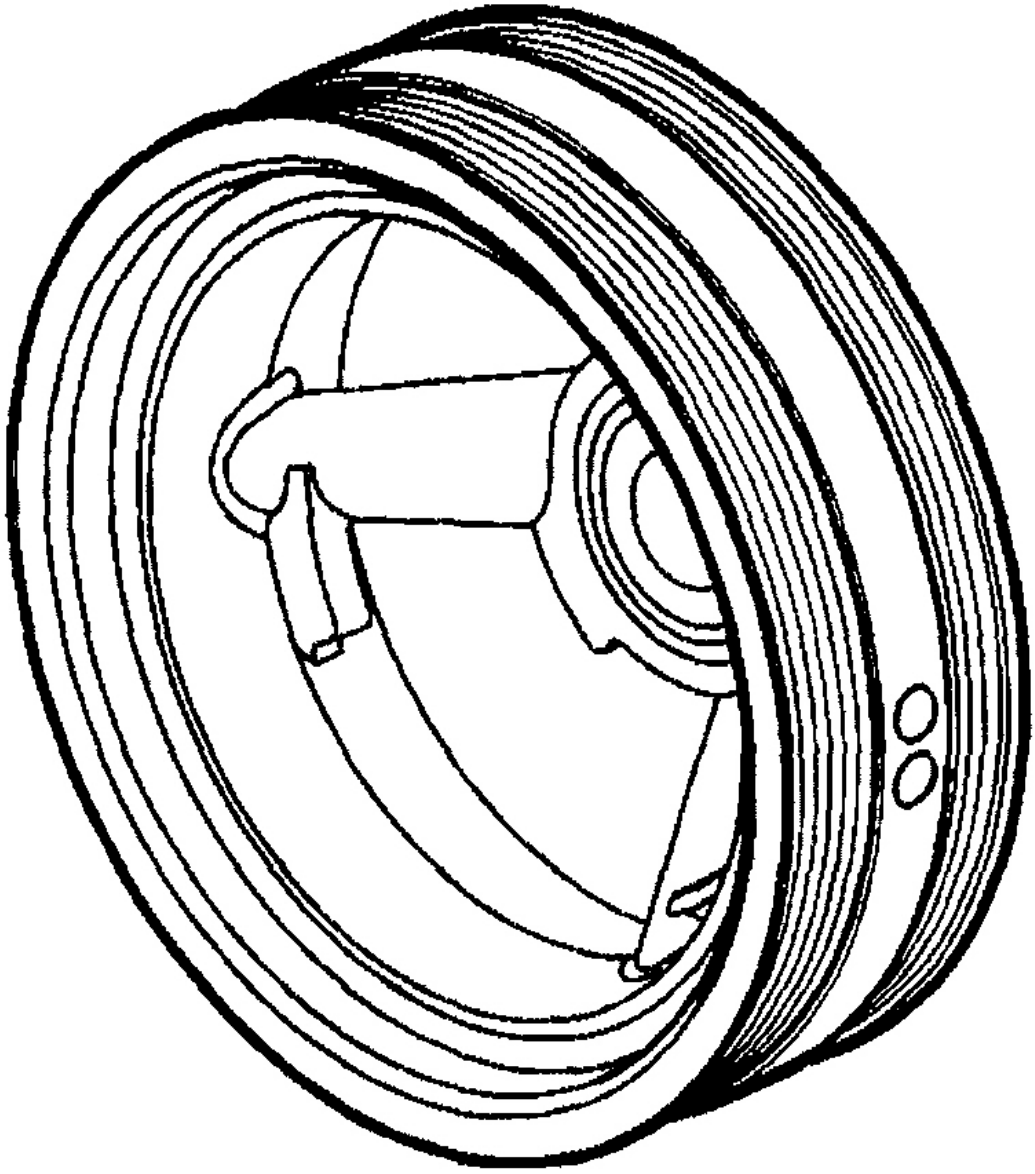
2. Clean the belt grooves of all dirt or debris with a wire brush.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following:
   - Worn, grooved, or damaged hub seal surface

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

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

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

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Fig. 176: Inspecting Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

- Dirty or damaged belt grooves

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

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Minor imperfections may be removed with a fine file.

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

ENGINE FLYWHEEL CLEANING AND INSPECTION

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 in solvent.
2. Dry the flywheel with compressed air.
3. Inspect the manual transmission flywheel for the following:
   - Pitted surfaces (1)
   - Grooves or scoring (2)
   - Rusted surface (3)
   - Damaged ring gear teeth (4)

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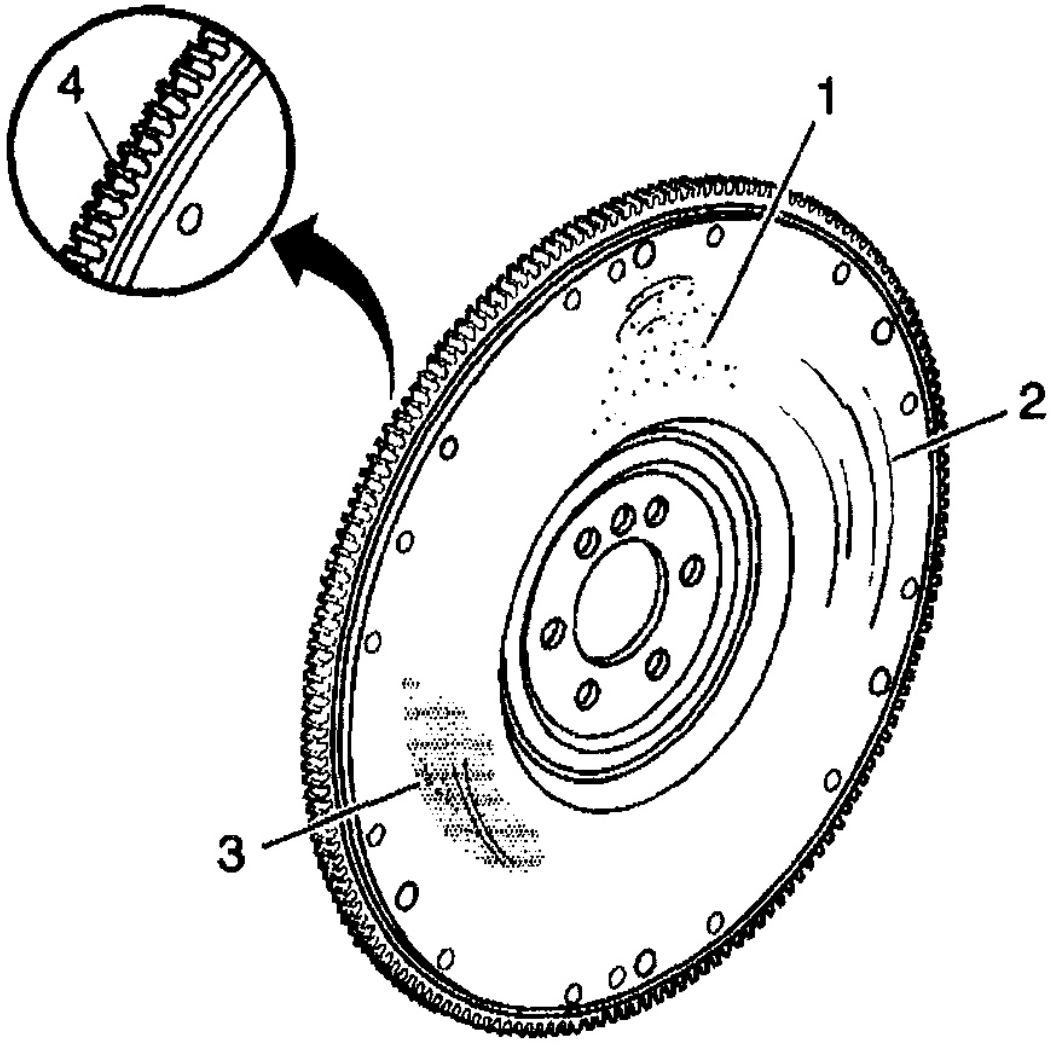


Fig. 177: Manual Transmission Flywheel Inspection Areas
Courtesy of GENERAL MOTORS CORP.

- Loose or improperly positioned ring gear

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

- Missing, bent, or damaged pressure plate locating pins

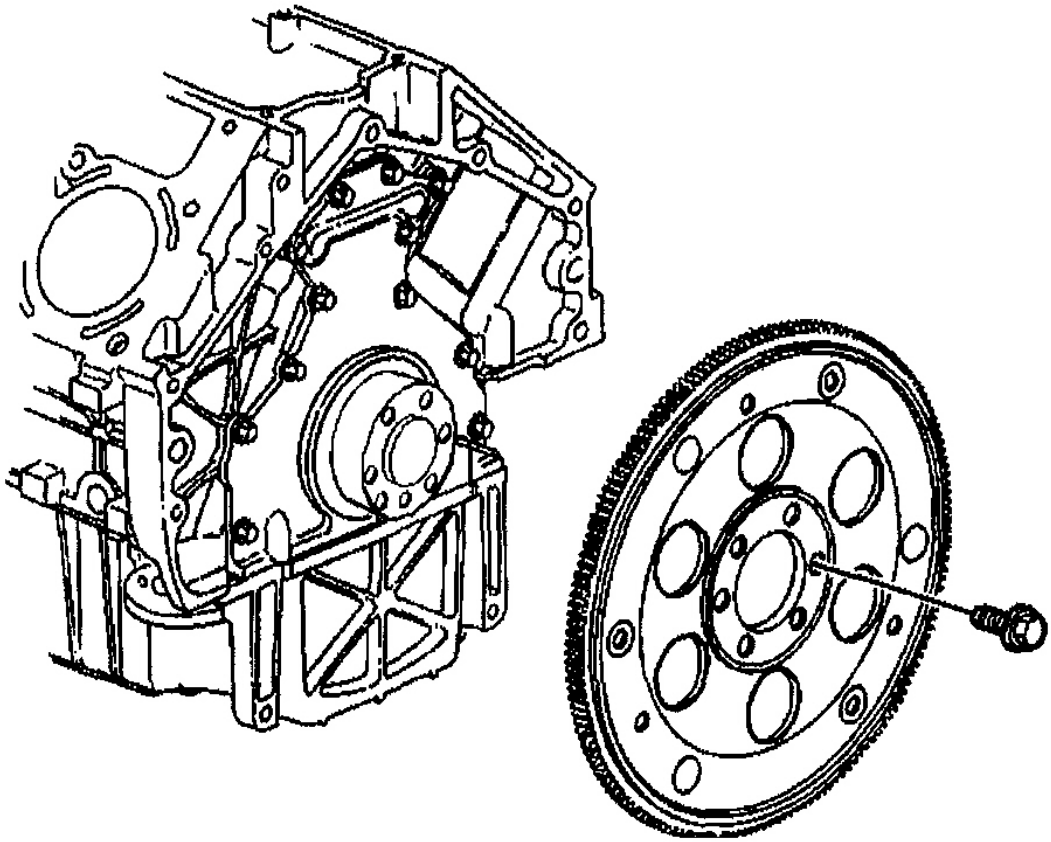
  The two locating pins are installed into the flywheel and spaced 170 degrees apart.

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

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

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



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Fig. 178: Automatic Transmission Flywheel Inspection Areas
Courtesy of GENERAL MOTORS CORP.

PISTON AND CONNECTING ROD DISASSEMBLE

IMPORTANT: Certain 6.0 L LQ9 engines will use a full-floating piston and pin design. In those applications, the pin is retained in the piston by retaining clips.

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Press Fit Piston Pin

Tools Required

J 24086-C Piston Pin Remover/Installer

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

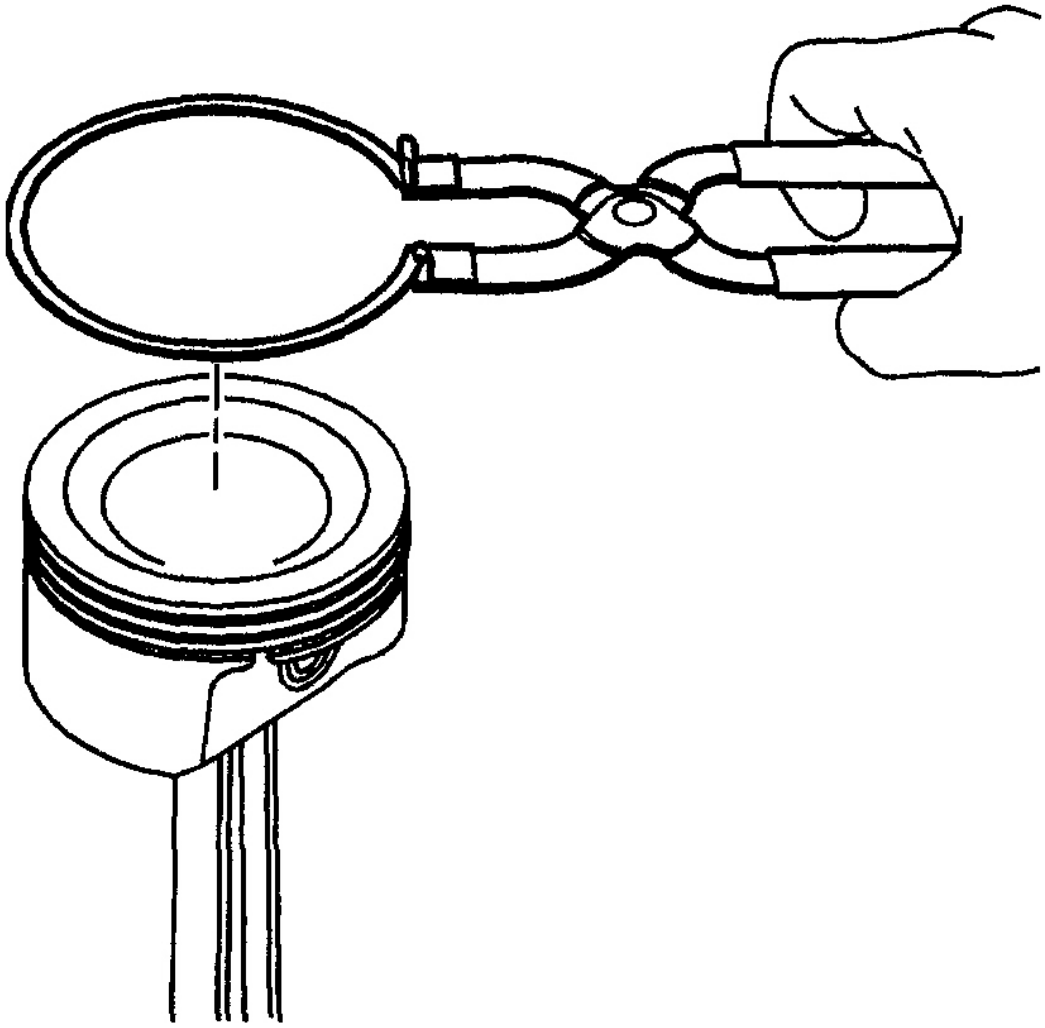


Fig. 179: Removing Piston Ring
Courtesy of GENERAL MOTORS CORP.

2. Install fork insert J 24086-920A into fixture J 24086-10.

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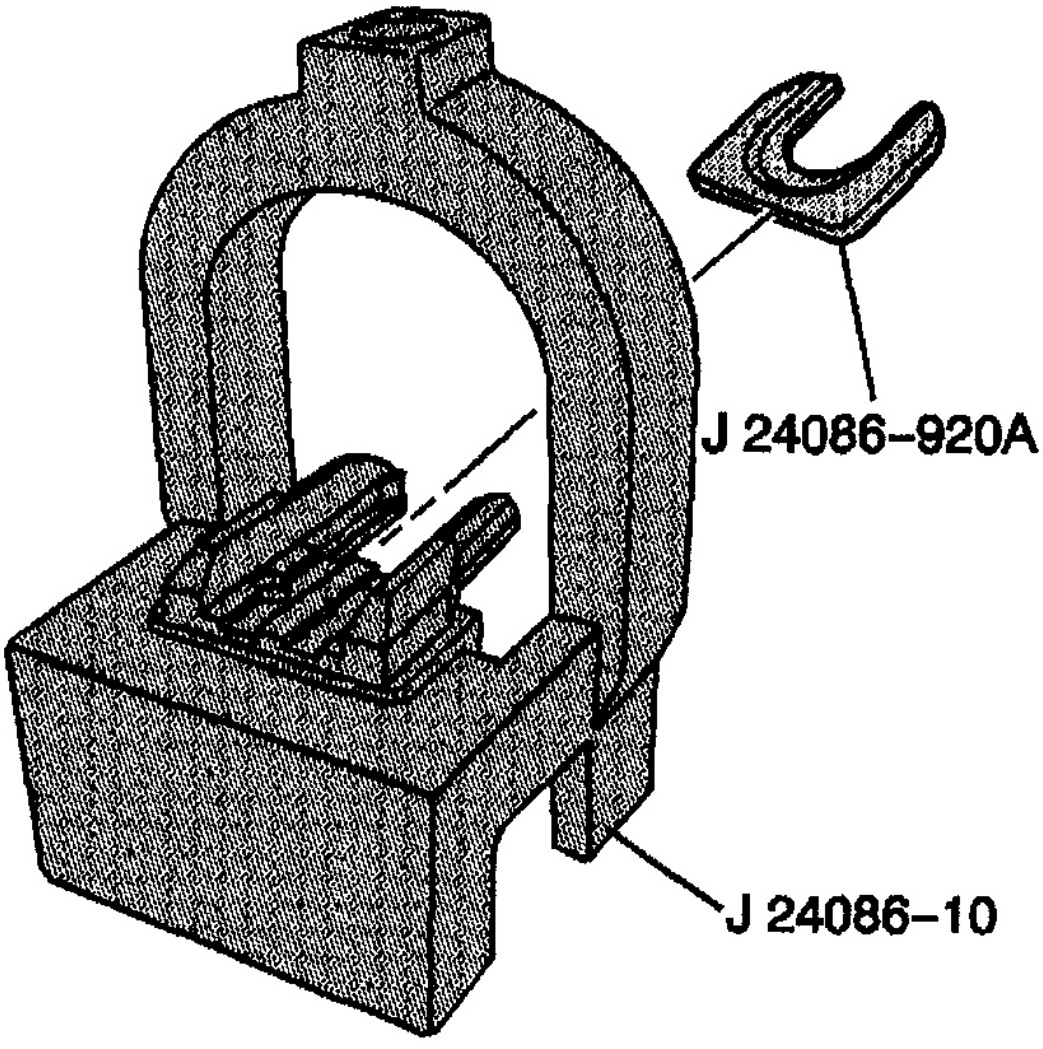


Fig. 180: J 24086-920A & J 24086-10
Courtesy of GENERAL MOTORS CORP.

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

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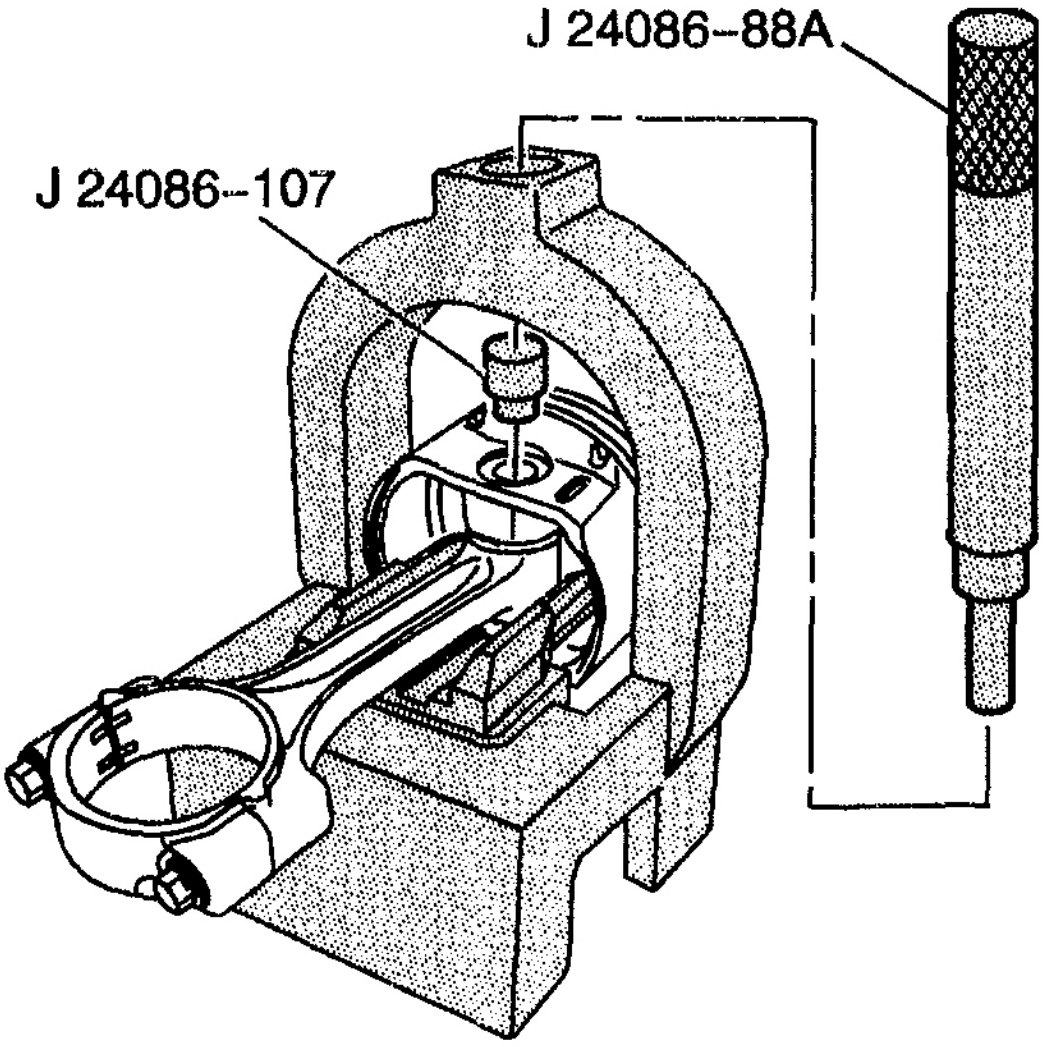


Fig. 181: Installing J 24086-107 Into Piston Pin & J 24086-88A Through Fixture & Into J 24086-107
Courtesy of GENERAL MOTORS CORP.

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

5. Press the piston pin from the piston and connecting rod assembly.

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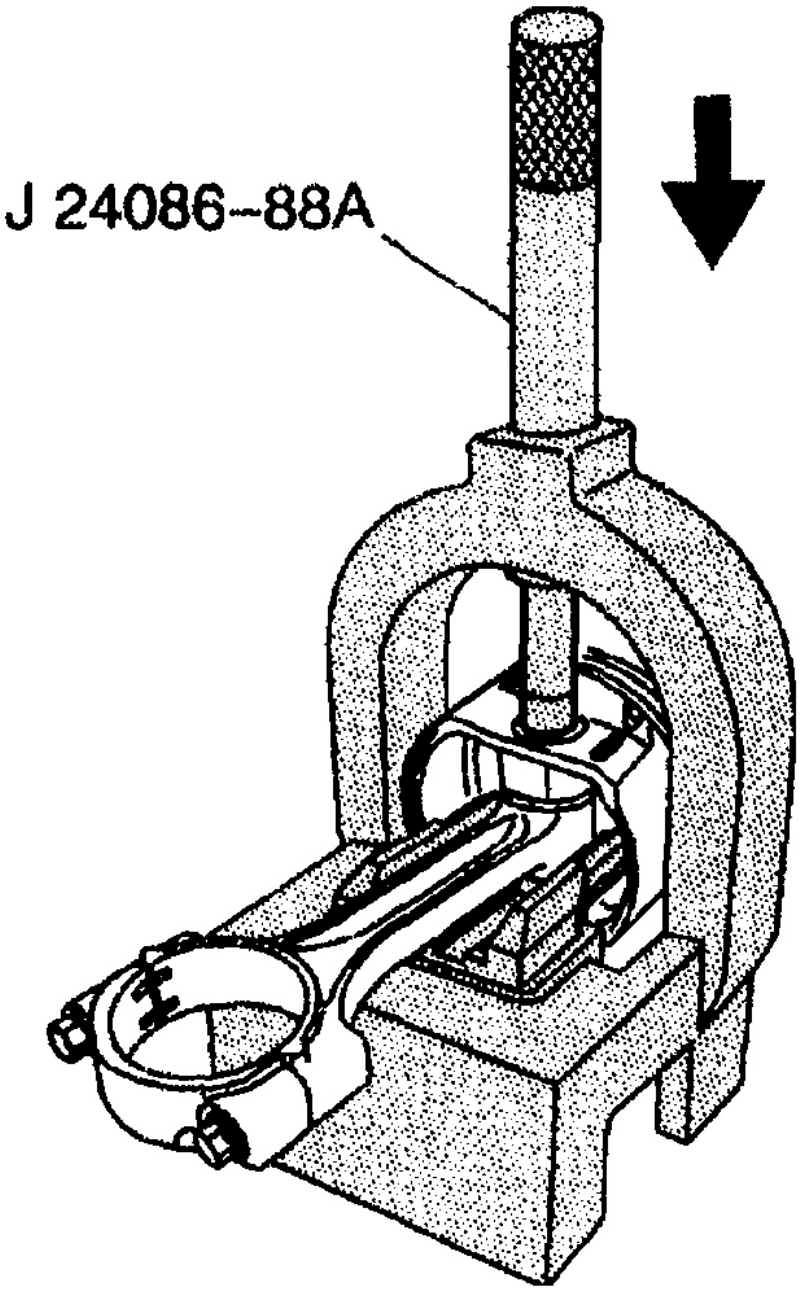


Fig. 182: Pressing Piston Pin From Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS CORP.

Full Floating Piston Pin

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

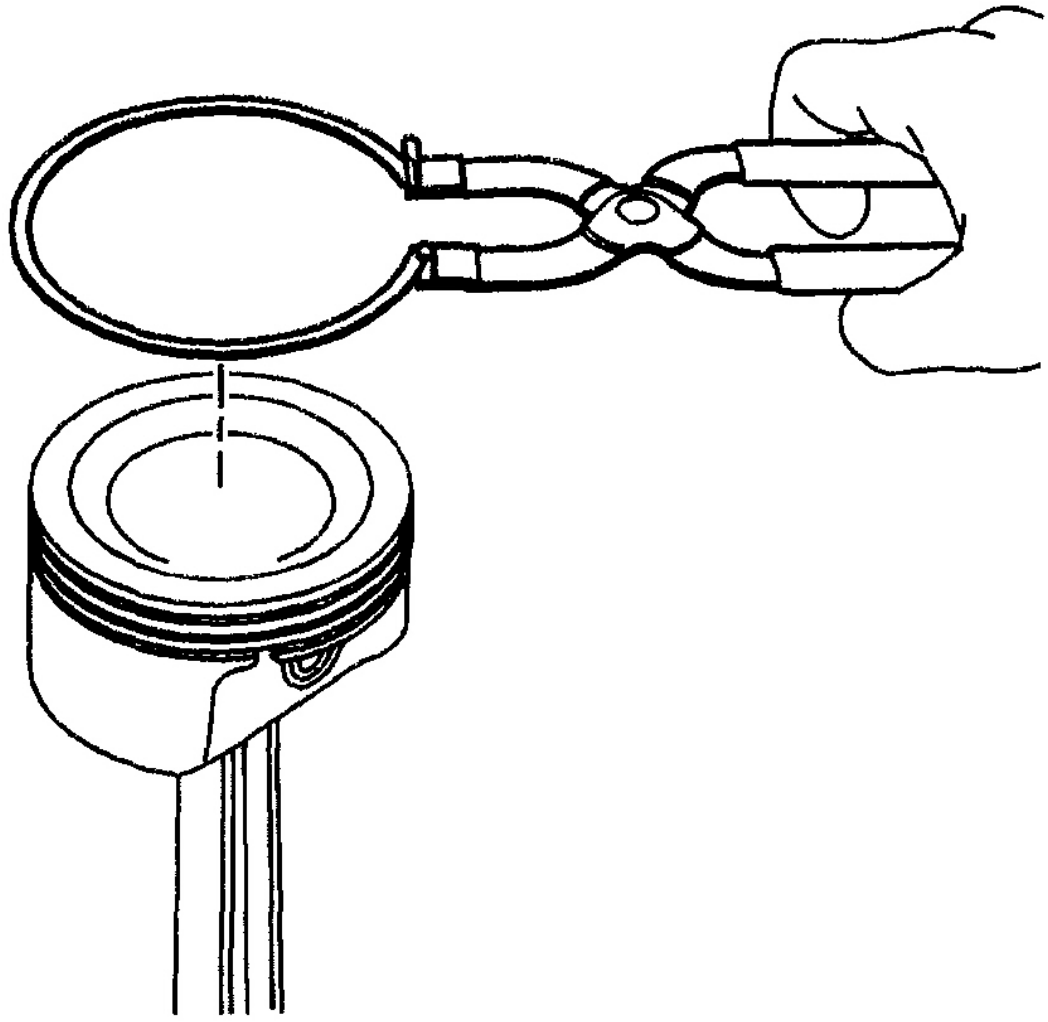


Fig. 183: Removing Piston Rings
Courtesy of GENERAL MOTORS CORP.

2. Remove the piston pin retaining clips.
3. Remove the pin from the piston and connecting rod.
4. The piston and pin are a matched set and are not to be serviced separately. Mark, sort, or organize the piston and the matching piston pin. Refer to **Separating Parts** .

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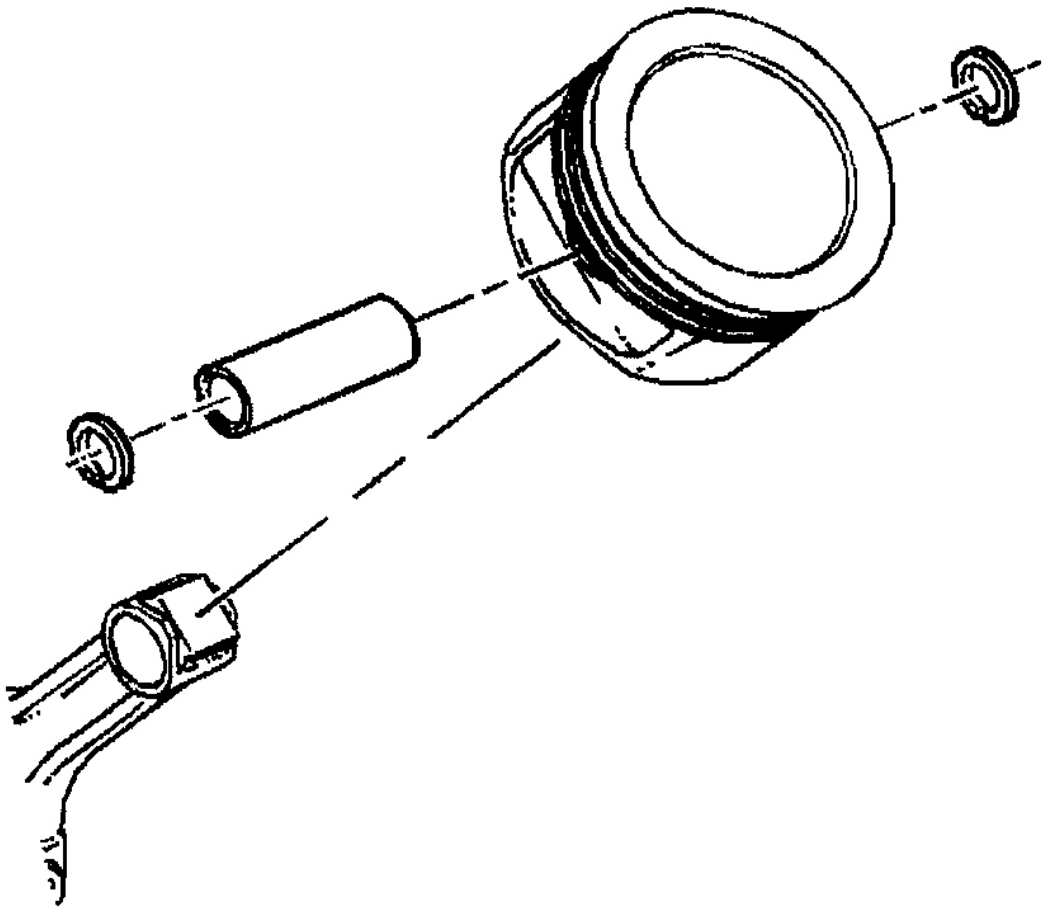


Fig. 184: Piston, Pin & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

PISTON, CONNECTING ROD, AND BEARINGS CLEANING AND INSPECTION

Piston and Pin

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

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

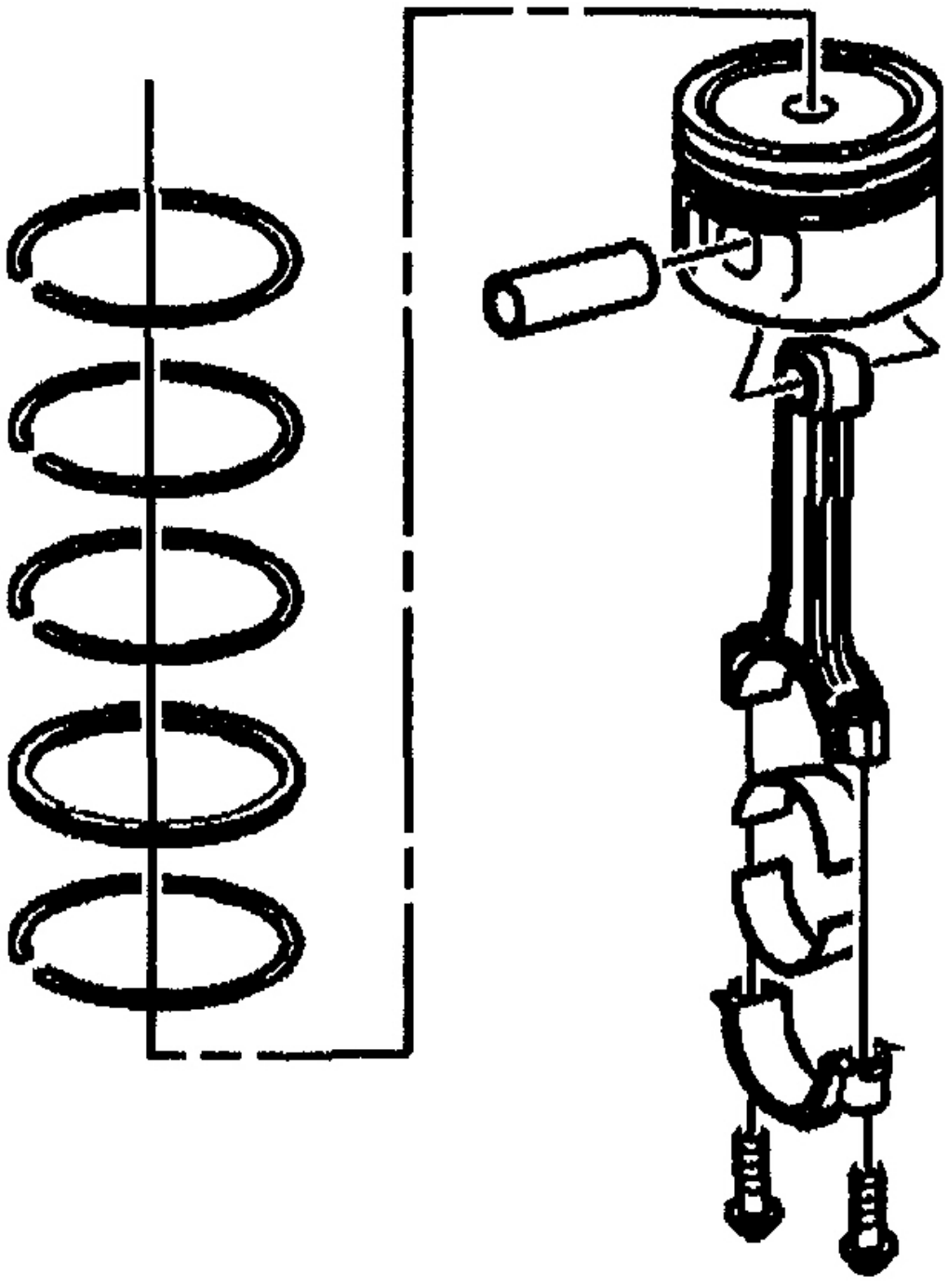
Do not wire brush any part of the piston.

1. Clean the varnish from the piston and the pin with cleaning solvent.

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2. Dry the piston and the pin with compressed air.

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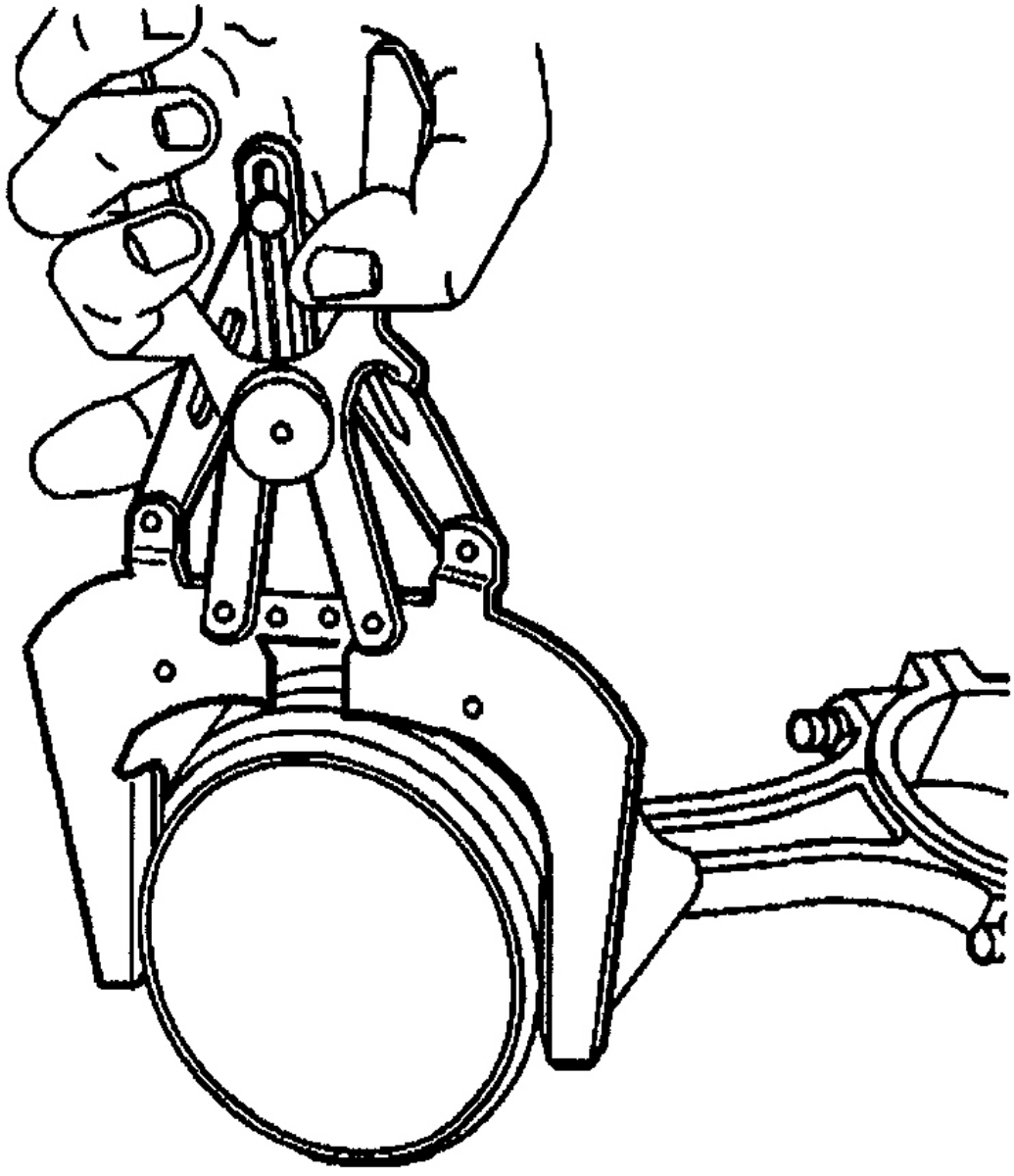


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Fig. 185: Piston, Connecting Rod & Bearings
Courtesy of GENERAL MOTORS CORP.

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



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Fig. 186: Cleaning Piston Ring Grooves
Courtesy of GENERAL MOTORS CORP.

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

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

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

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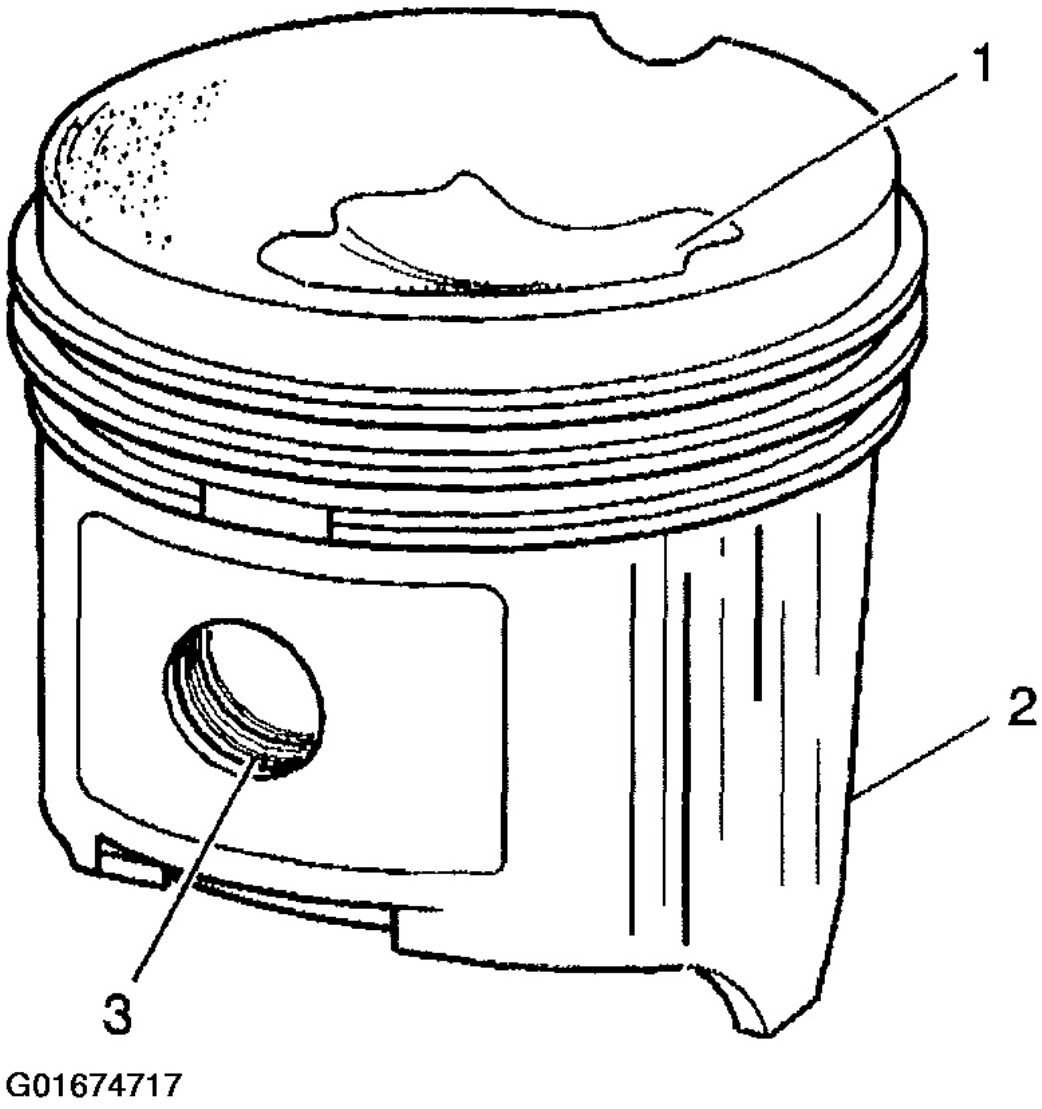
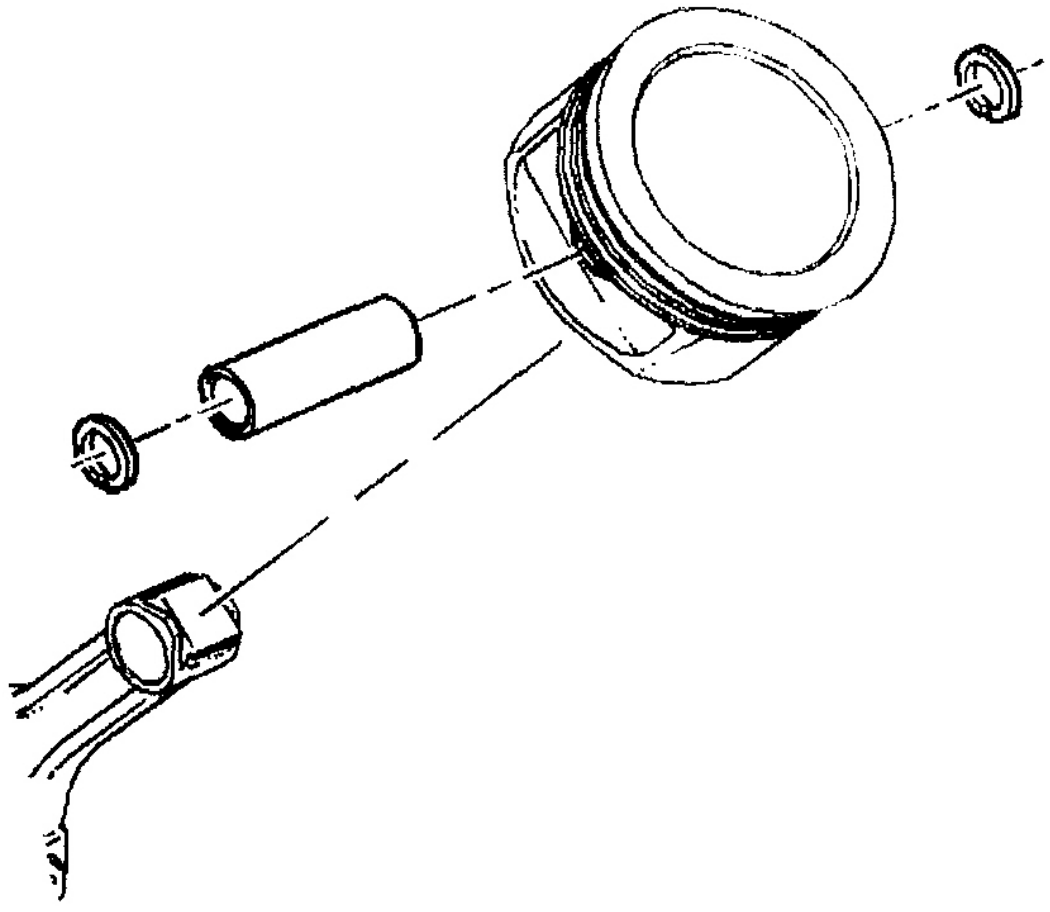


Fig. 187: Piston Inspection Areas
Courtesy of GENERAL MOTORS CORP.

6. For certain 6.0 L applications, inspect for bent pin retaining clips or damage to the clip groove of the piston.

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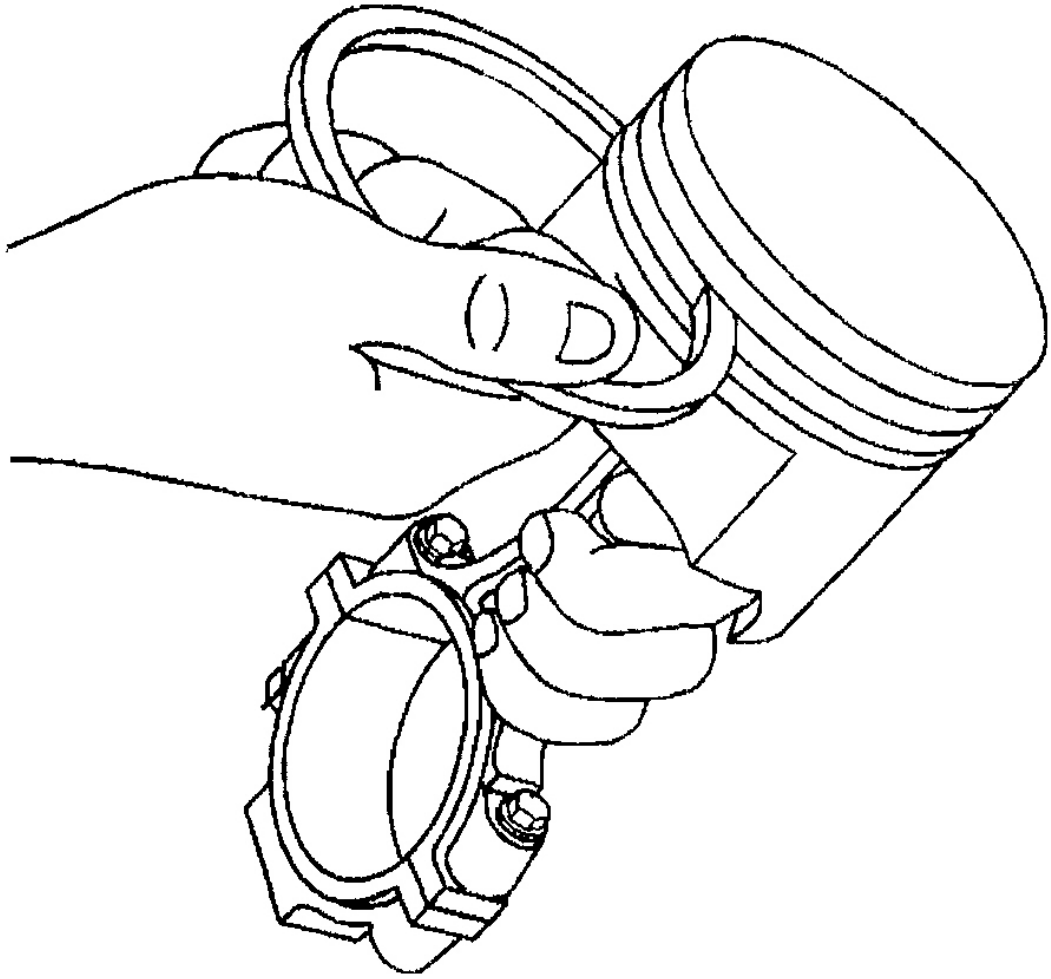
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Fig. 188: Piston, Connecting Rod & Bearings
Courtesy of GENERAL MOTORS CORP.

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

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

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Fig. 189: Installing Piston Ring
Courtesy of GENERAL MOTORS CORP.

8. Measure the piston ring side clearance with a feeler gage.
9. If side clearance is not within specifications, try another piston ring set. Refer to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)** .
10. If proper piston ring-to-piston ring groove side clearance cannot be achieved, replace the piston and pin assembly.

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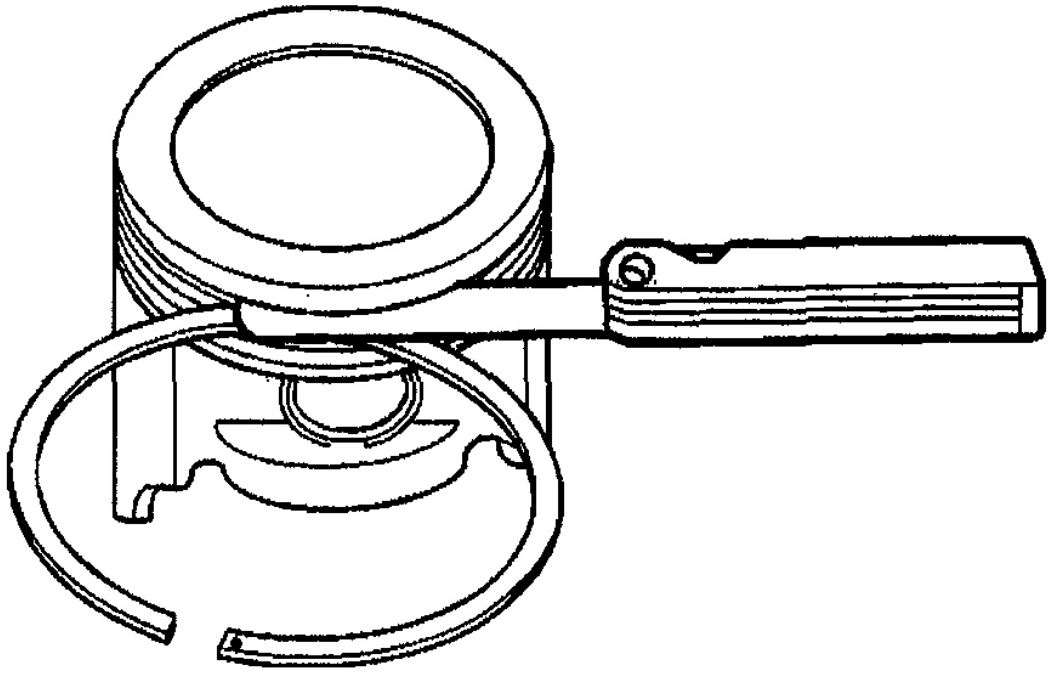
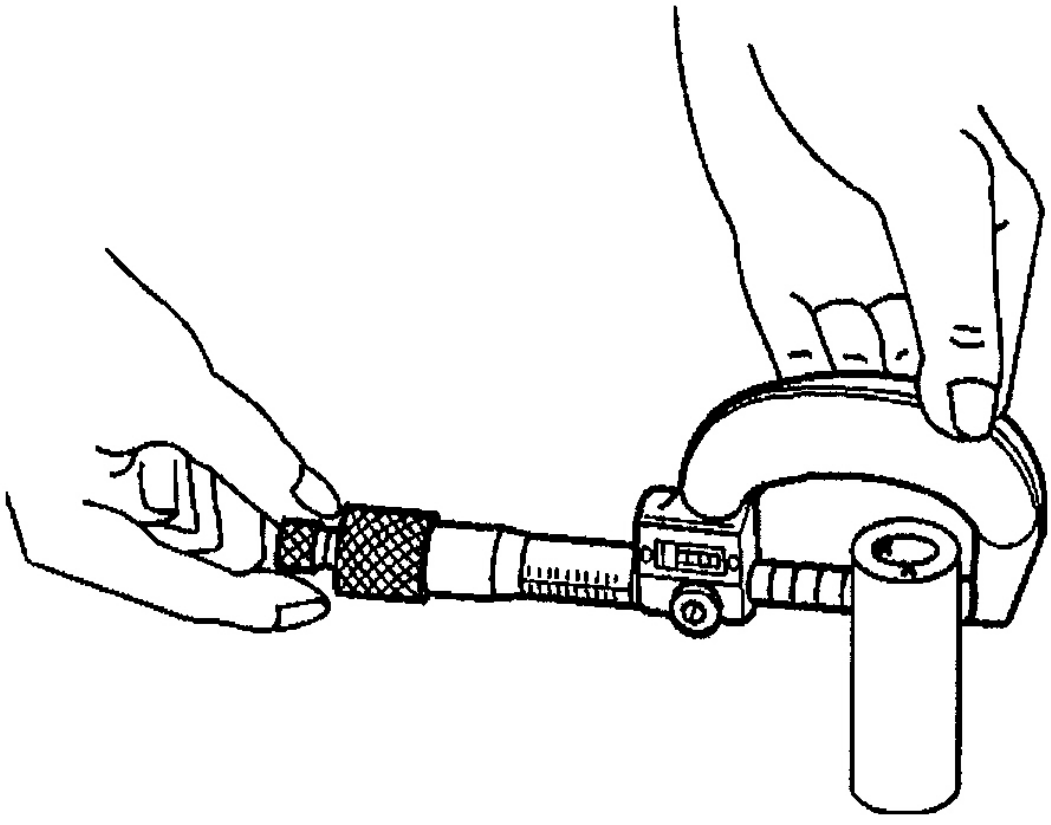


Fig. 190: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS CORP.

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

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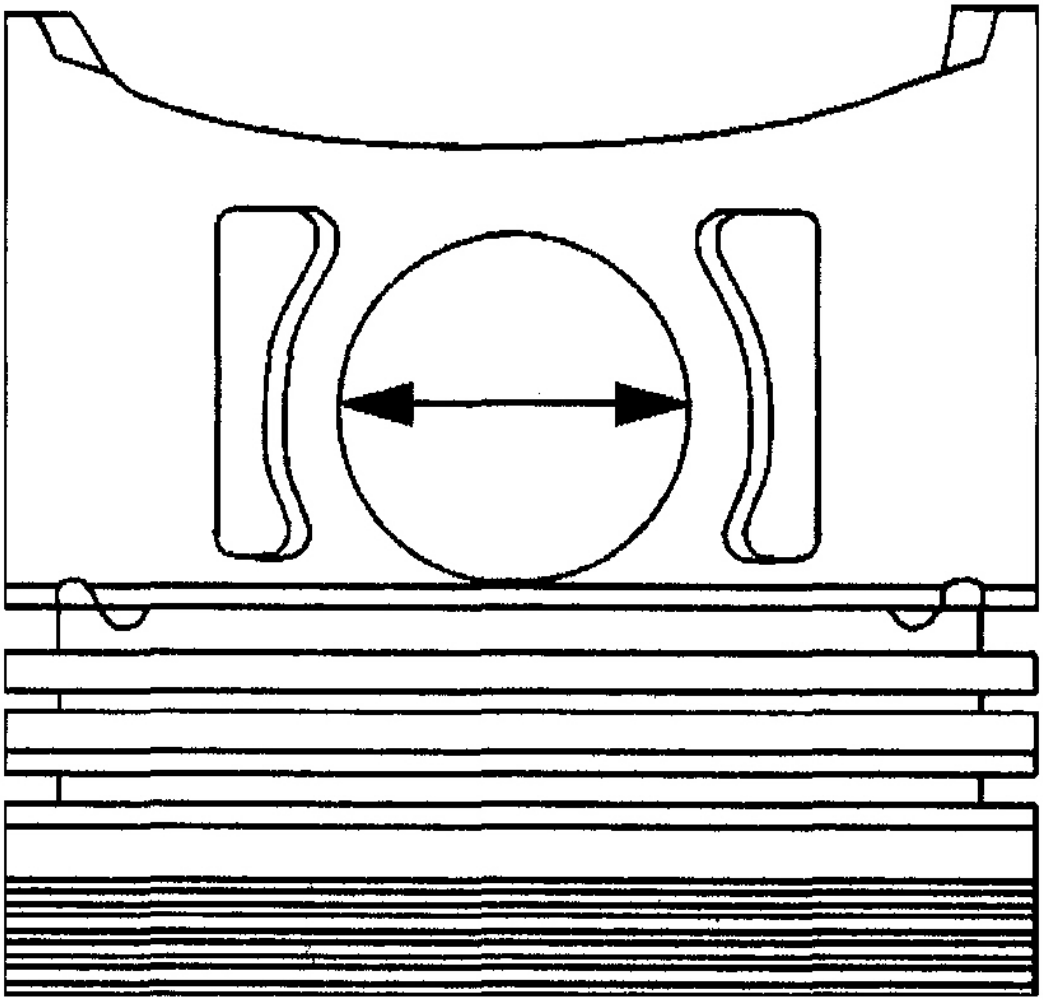
Fig. 191: Measuring Piston Pin
Courtesy of GENERAL MOTORS CORP.

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

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

13. To determine the proper piston pin-to-bore clearance, subtract the piston pin diameter from the piston pin bore diameter. Refer to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)** .

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Fig. 192: Measuring Piston Pin Bore
Courtesy of GENERAL MOTORS CORP.

Connecting Rod and Bearings

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

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

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

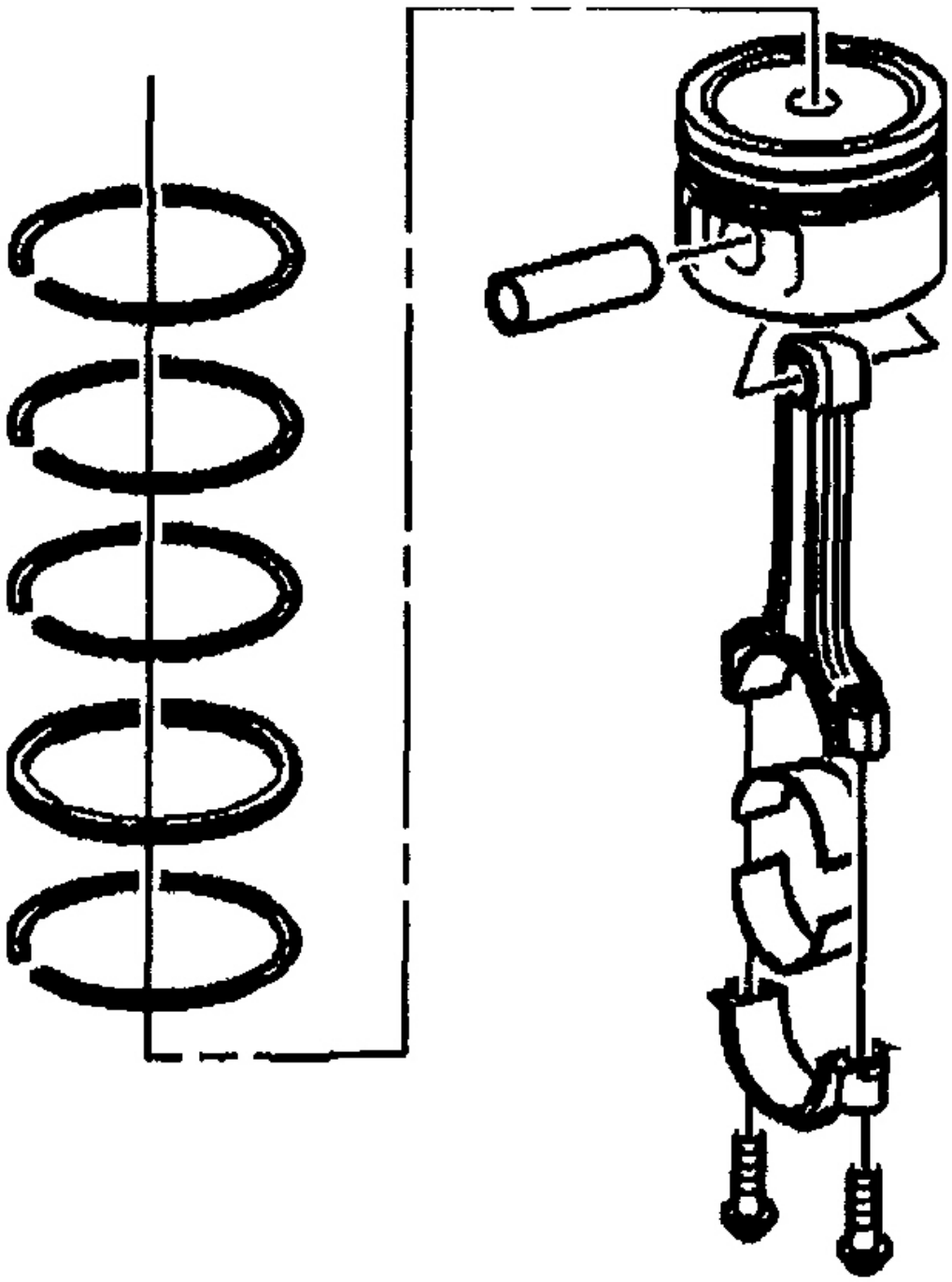
IMPORTANT: Replace the connecting rod if the bolt hole threads are damaged. Do not attempt to repair the bolt hole threads of the connecting rod.

2. Clean the connecting rod threaded bolts holes.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

3. Dry the connecting rod with compressed air.

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Fig. 193: Piston, Connecting Rod & Bearings
Courtesy of GENERAL MOTORS CORP.

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

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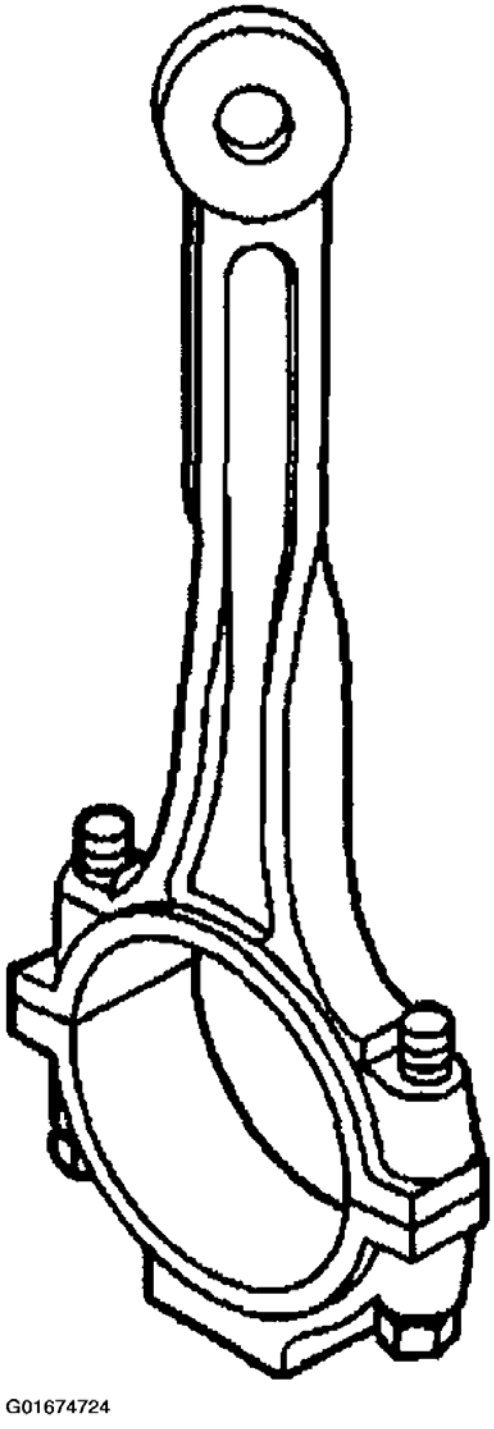


Fig. 194: Twisted Connecting Rod
Courtesy of GENERAL MOTORS CORP.

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

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

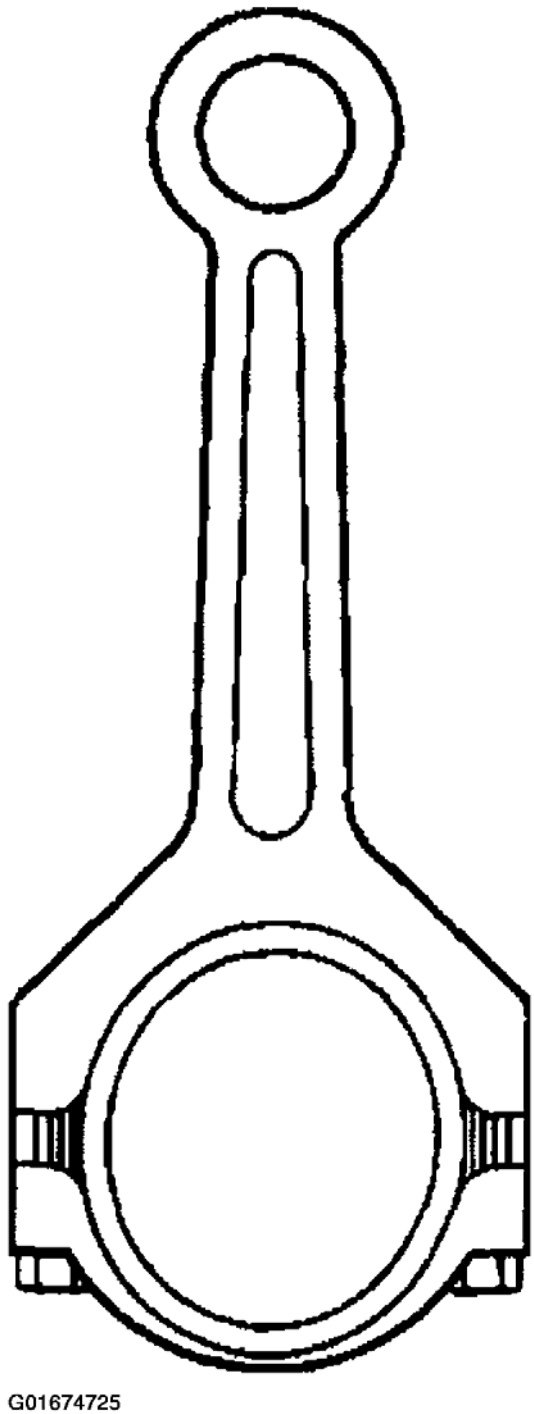


Fig. 195: Connecting Rod Removed
Courtesy of GENERAL MOTORS CORP.

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

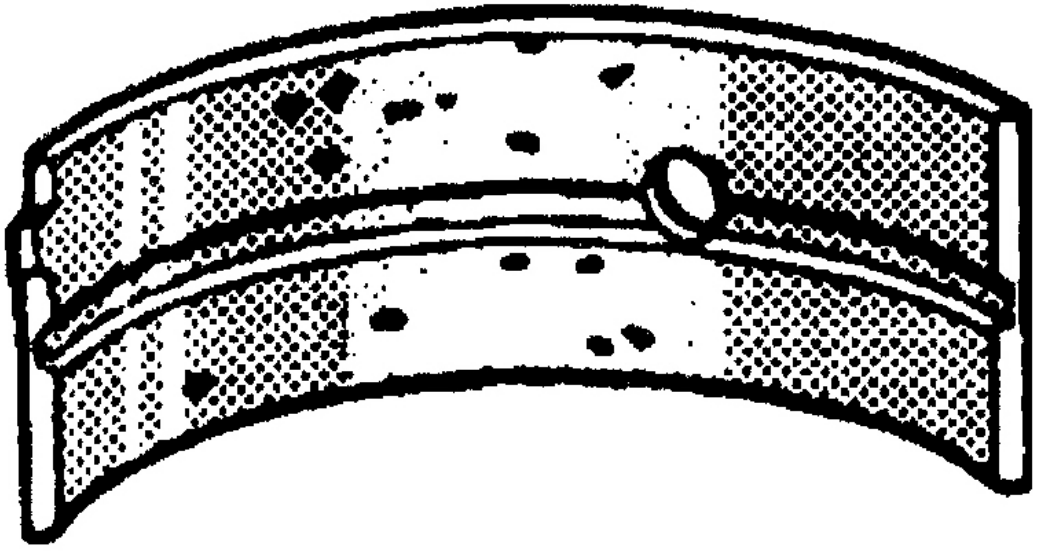
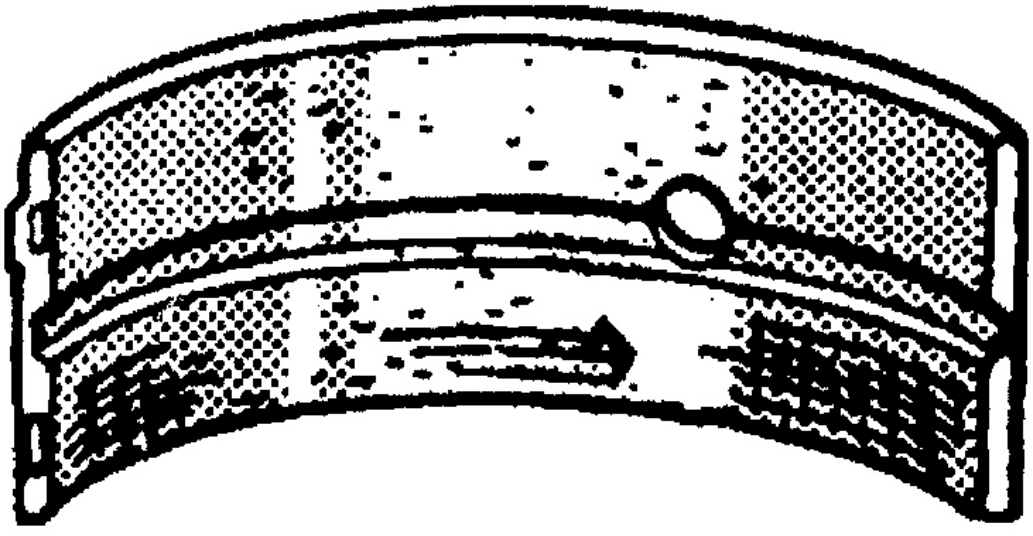


Fig. 196: Connecting Rod Bearing W/Craters
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 197: Connecting Rod Bearing W/Excessive Scoring, Dirt & Debris
Courtesy of GENERAL MOTORS CORP.

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

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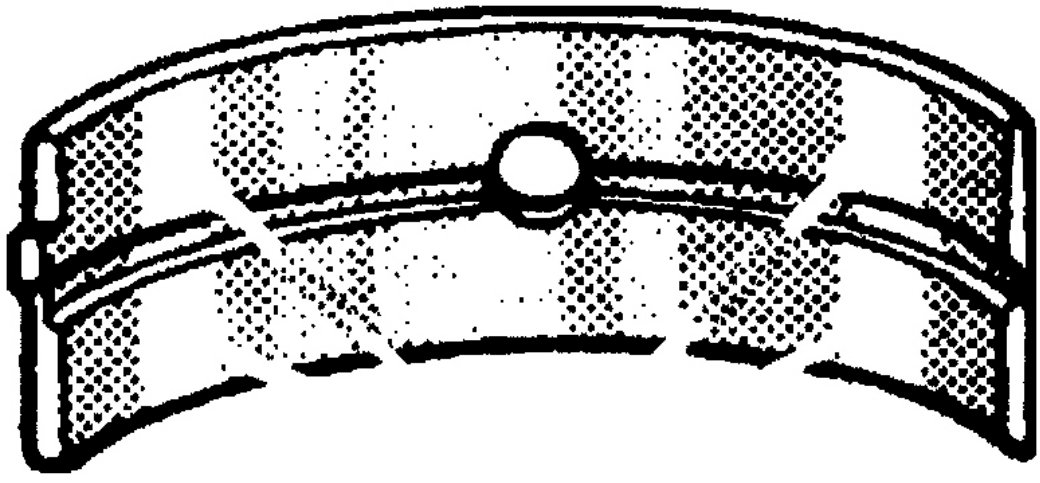


Fig. 198: Connecting Rod Bearing W/Polished Sections
Courtesy of GENERAL MOTORS CORP.

Measuring Piston Ring End Gap

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

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

1. Place the piston ring into the cylinder bore.
2. Push the piston ring into the bore 6.5 mm (0.25 in) below the piston ring travel area.
3. Insert a feeler gage and measure the piston ring end gap. Refer to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)** .

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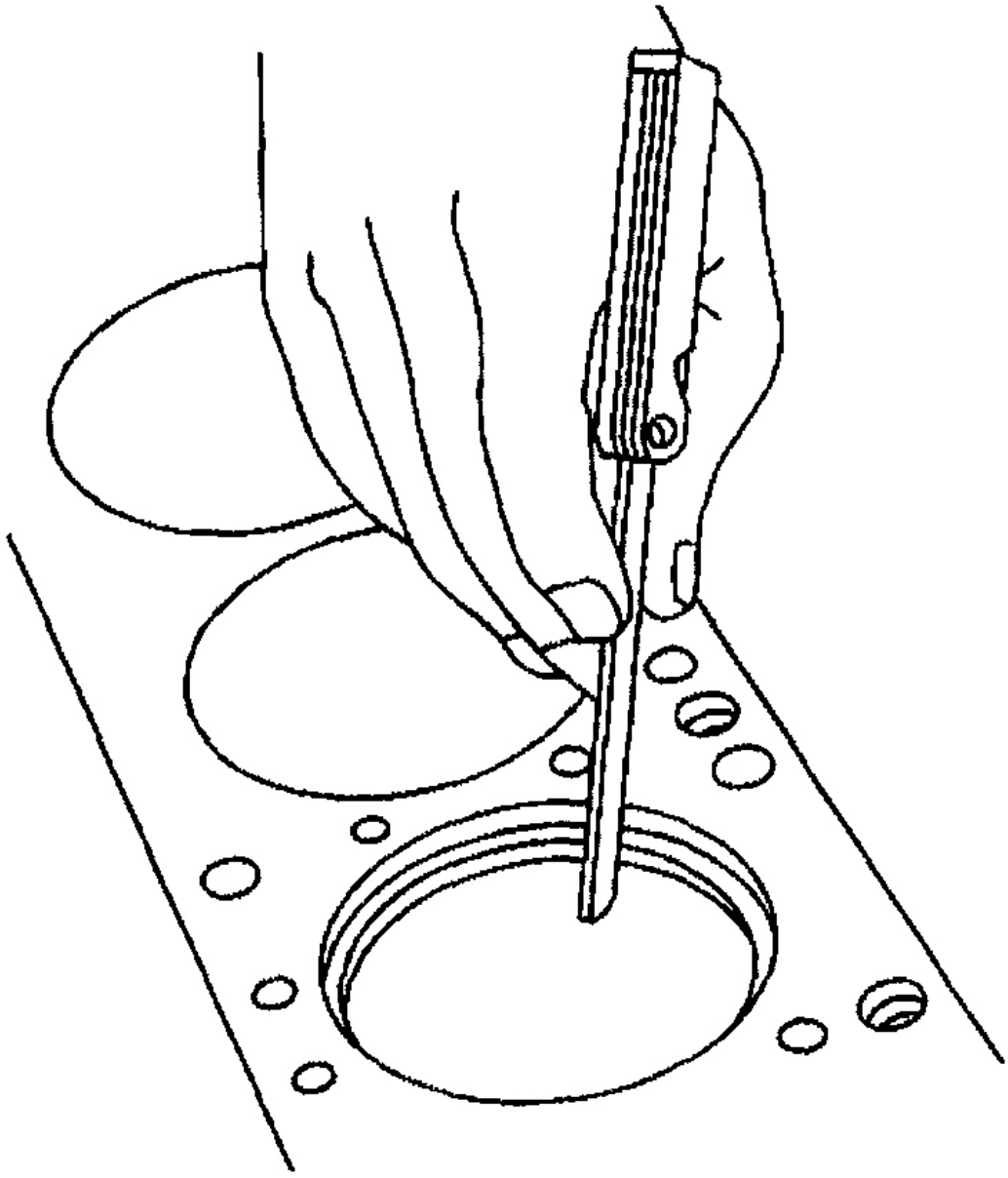


Fig. 199: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS CORP.

PISTON AND CONNECTING ROD ASSEMBLE

IMPORTANT:

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- **Assemble the piston for the specific cylinder with the connecting rod for the corresponding crankshaft journal.**
- **Certain 6.0 L LQ9 engines will use a full-floating piston and pin design. In those applications, the pin is retained in the piston by retaining clips.**

Press Fit Piston Pin

Tools Required

- **J 24086-C** Piston Pin Remover/Installer Set
- **J 24086-9** Adjustable Installer
- **J 24086-10** Piston Pin Remover/Installer Base

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

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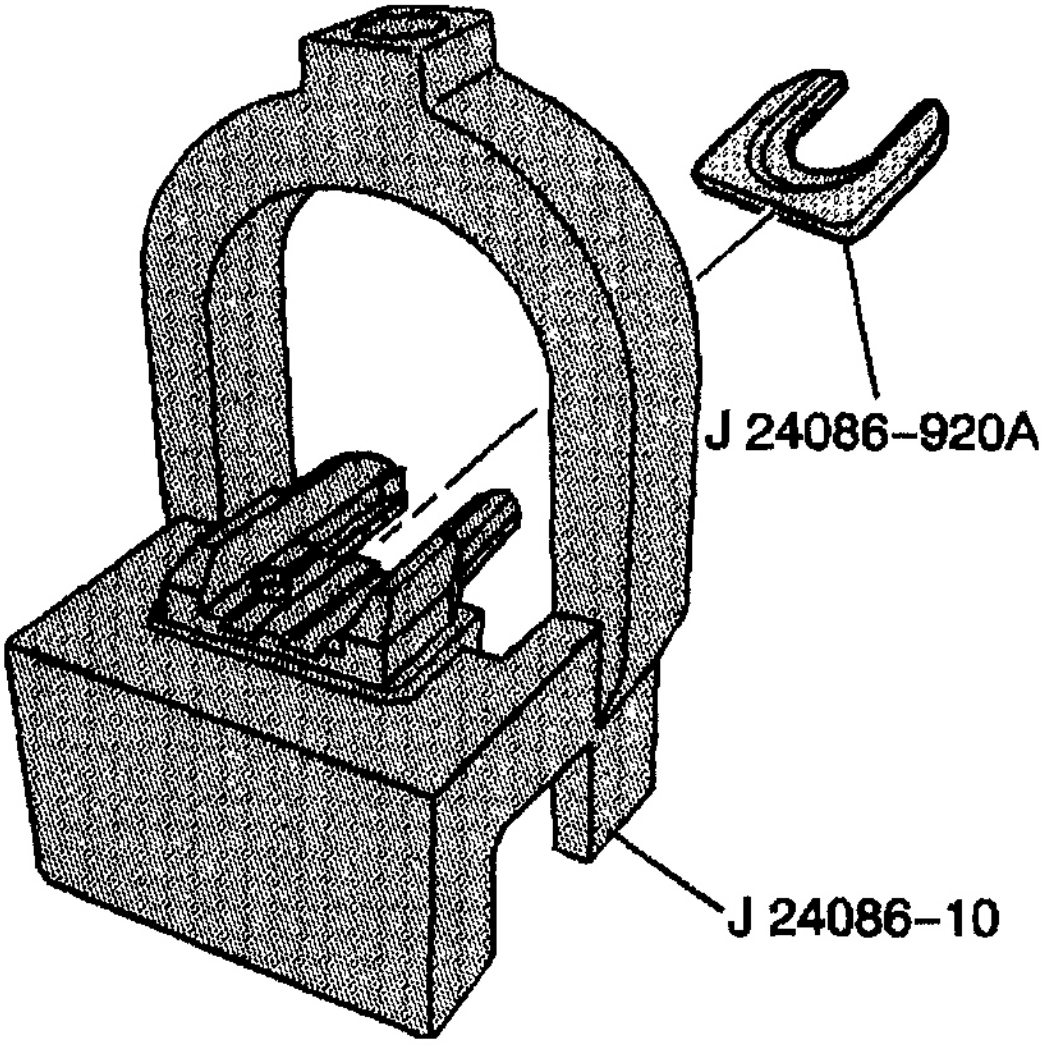


Fig. 200: J 24086-920A & J 24086-10
Courtesy of GENERAL MOTORS CORP.

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

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

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

   Mild heating of the connecting rod will ease in piston and pin assembly.

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

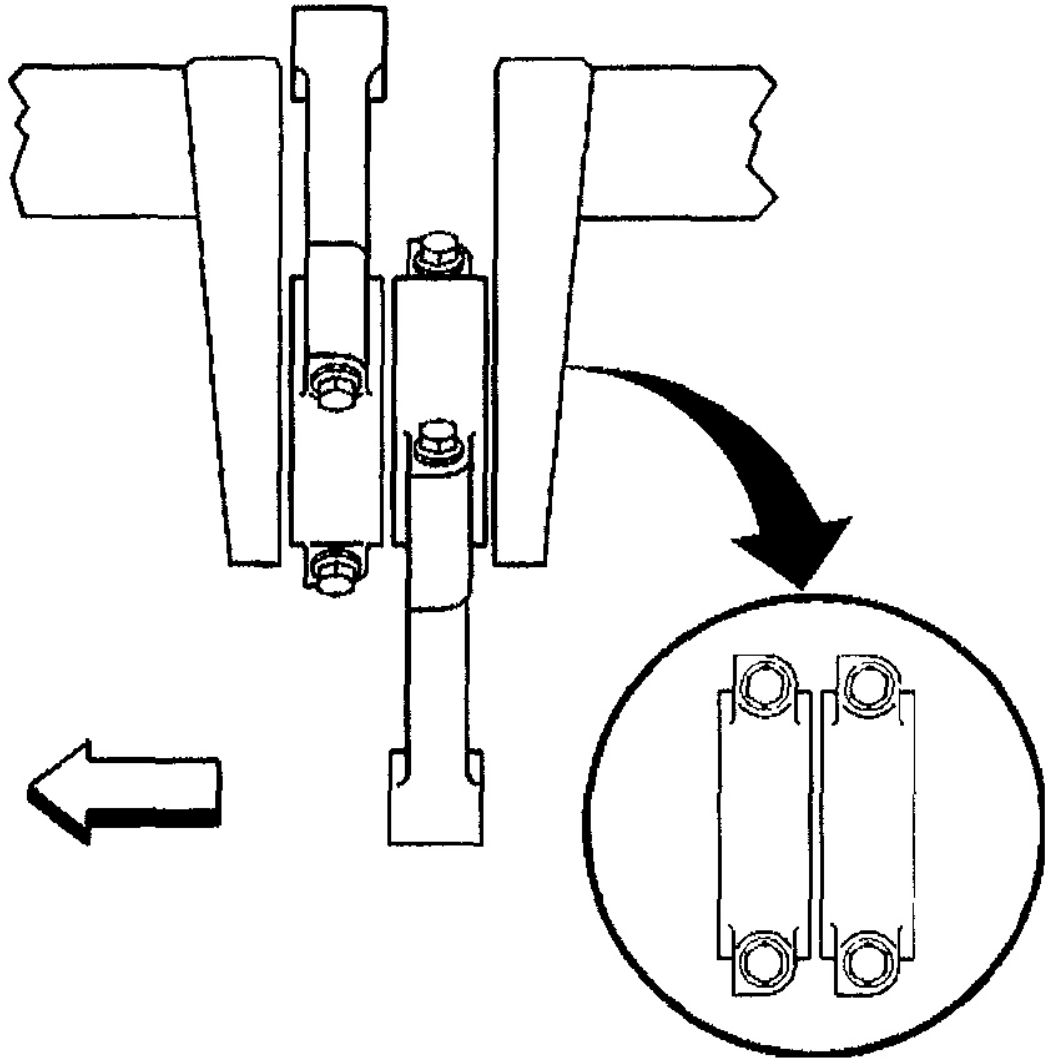


Fig. 201: Piston & Connecting Rod Proper Assembled Position
Courtesy of GENERAL MOTORS CORP.

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

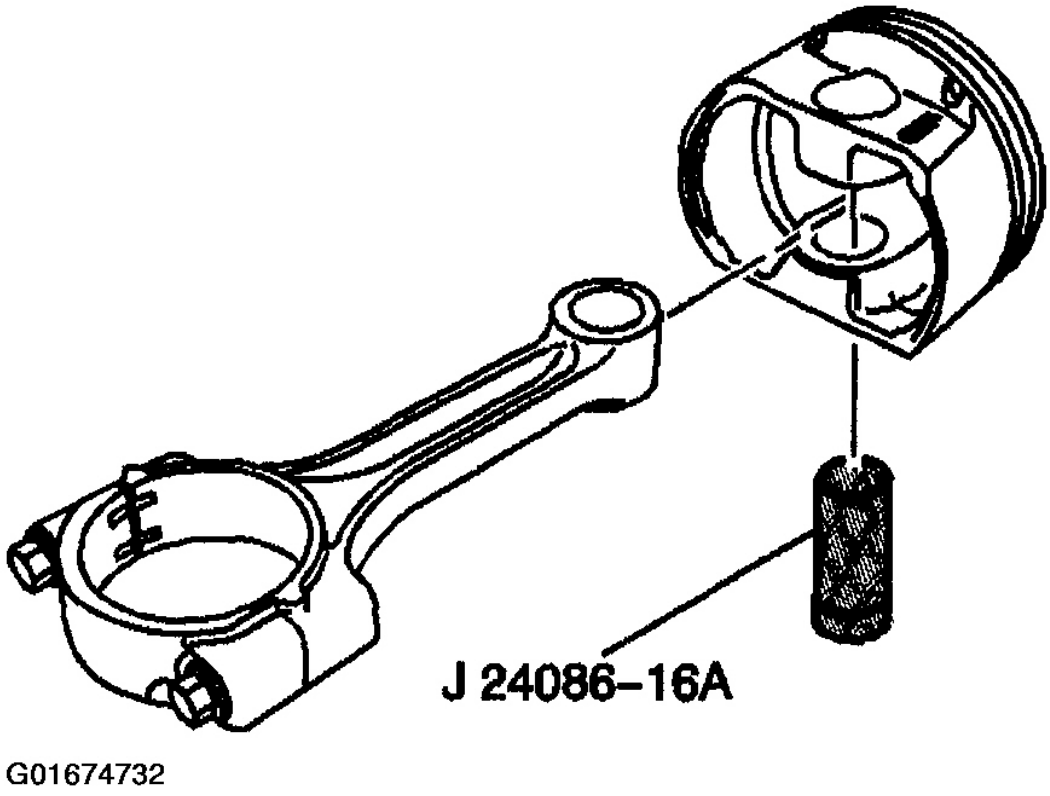


Fig. 202: Piston, Connecting Rod & Adapter J 24086-16A
Courtesy of GENERAL MOTORS CORP.

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

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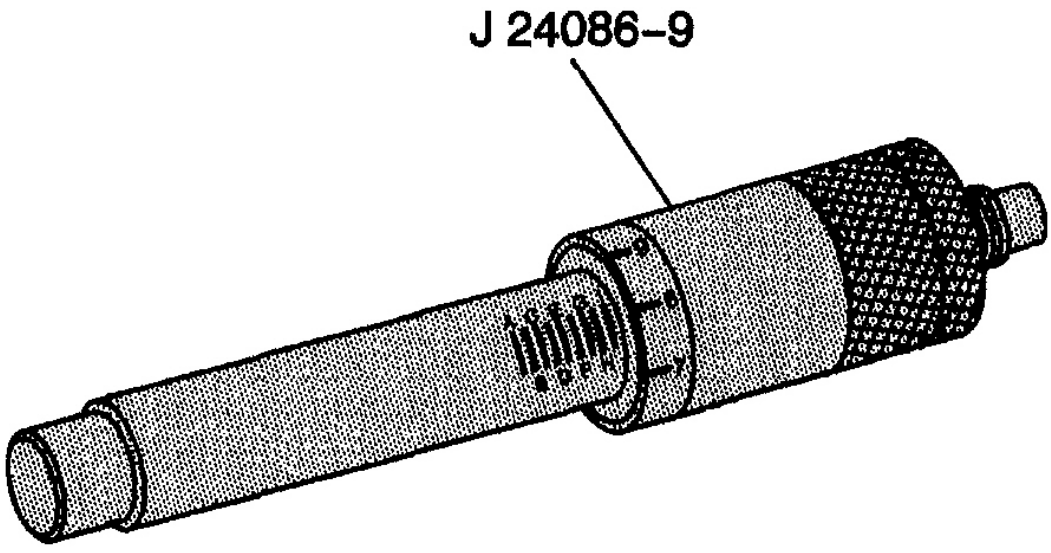


Fig. 203: J 24086-9
Courtesy of GENERAL MOTORS CORP.

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

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

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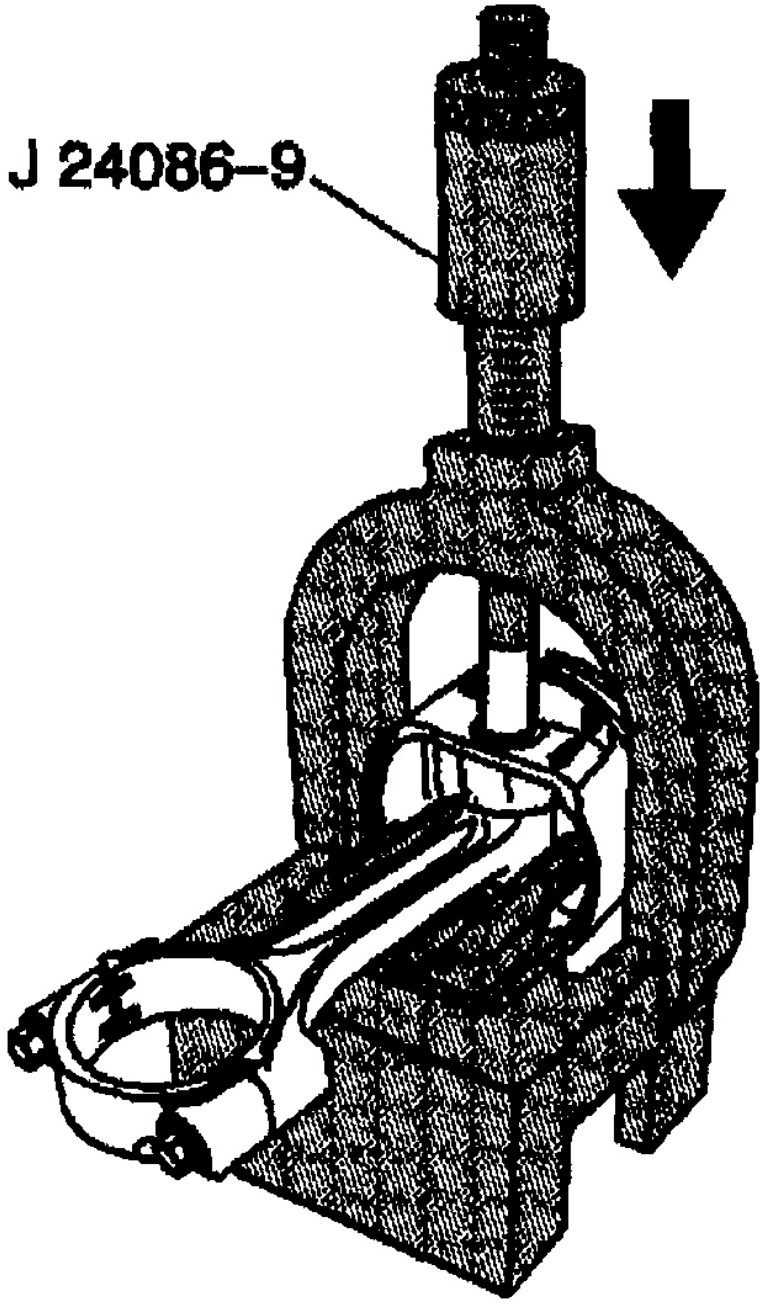


Fig. 204: Pressing Piston Pin Using J 24086-9
Courtesy of GENERAL MOTORS CORP.

8. Measure the piston (1), pin (3), and connecting rod (2) for proper assembly.

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8.1. Place the piston and connecting rod assembly onto a table or other flat surface.

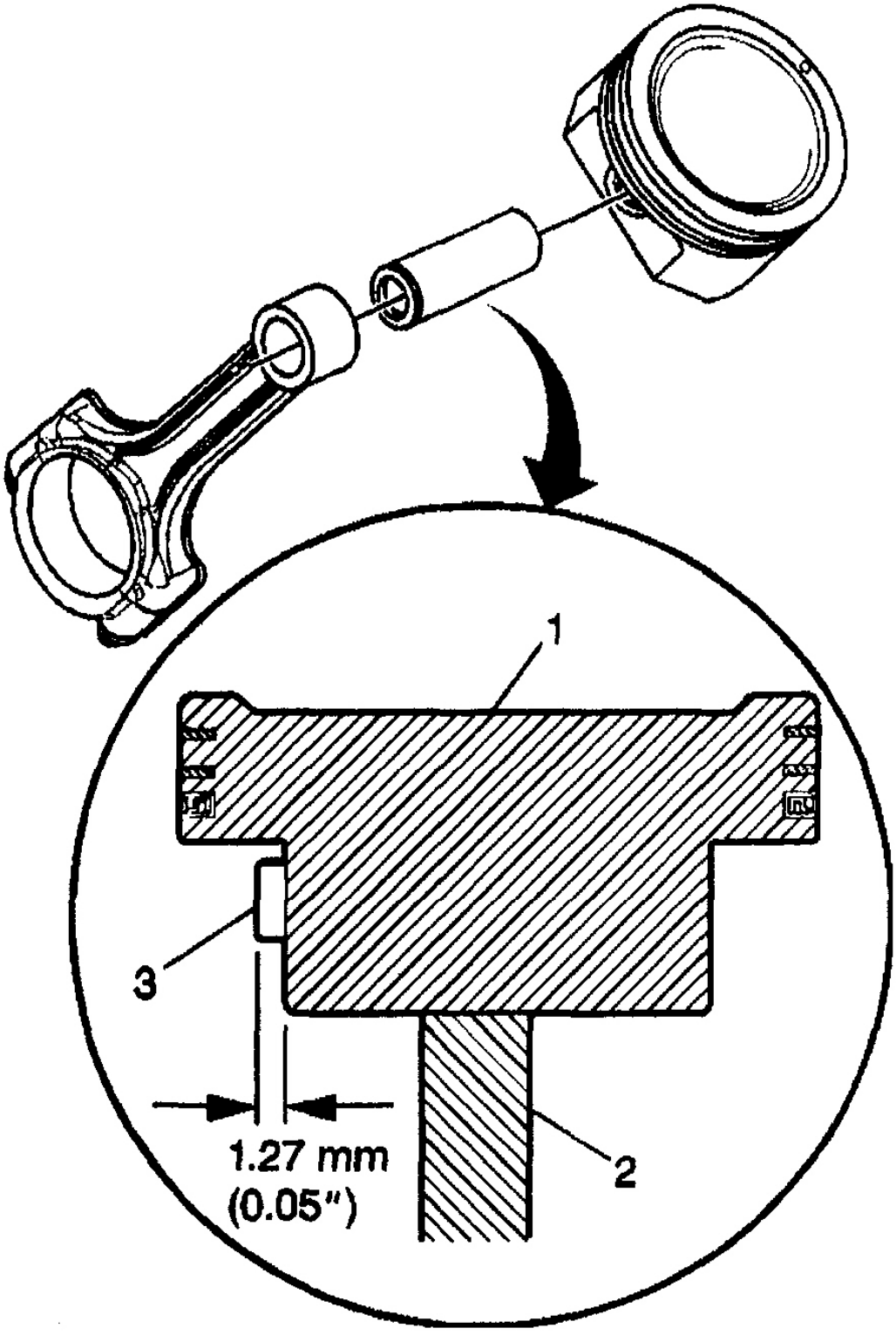
Lay the flat top of the piston (1) onto the table surface.

8.2. Slide the connecting rod (2) and pin (3) to one side and hold firmly against the inside of the piston (1).

8.3. Measure the pin (3) for proper installation.

A properly installed piston pin should protrude 1.27 mm (0.05 in) from the side of the piston.

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Fig. 205: Piston, Pin & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When installing the piston rings onto the piston, use a ring expanding plier type tool. Do not roll the piston rings into the grooves of the piston.

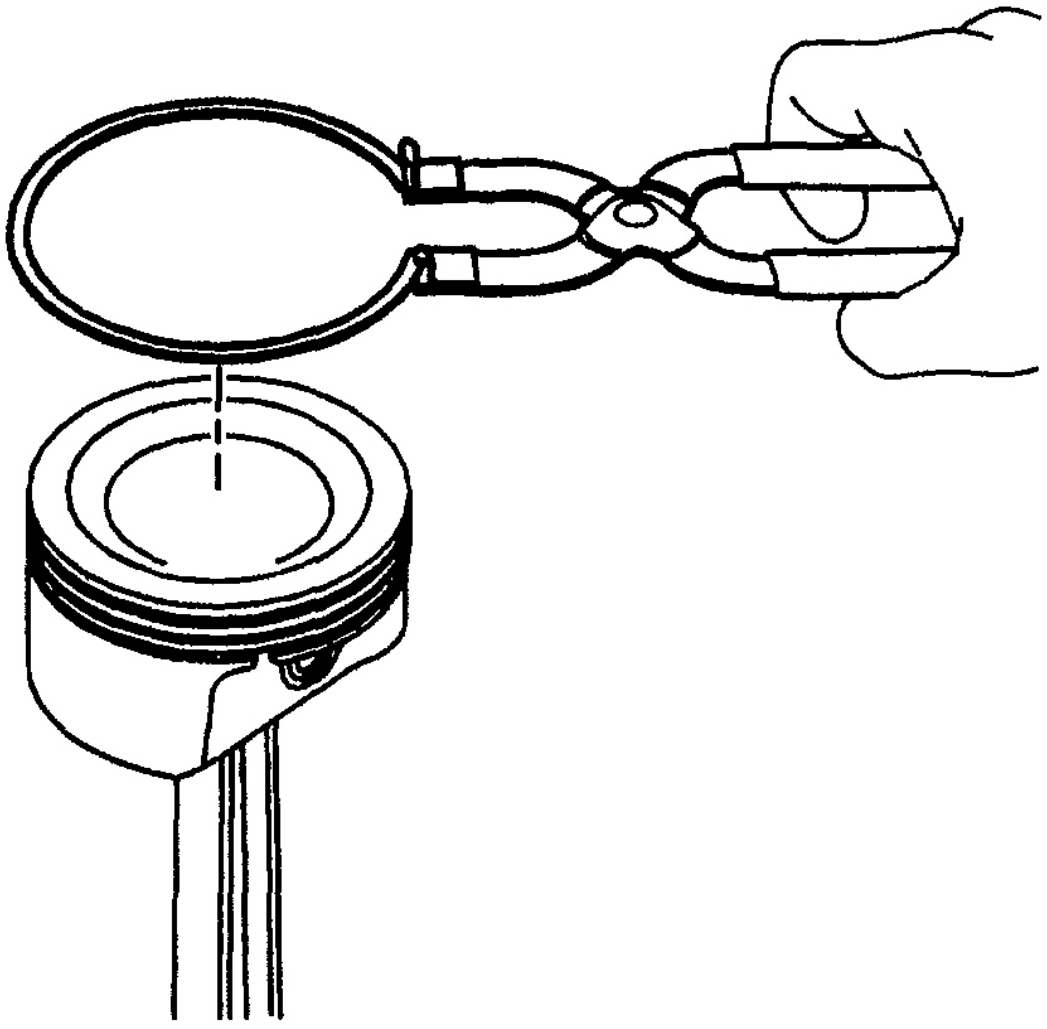
Use caution and care to expand the piston rings only slightly larger than the Outside Diameter (OD) of the piston.

9. Using piston ring pliers, install the piston rings onto the piston.
    9.1. Install the oil control ring spacer in the groove.
    9.2. Install the lower oil control ring.

    The oil control rings do not have a dimple or orientation mark and may be installed in either direction.

    9.3. Install the upper oil control ring.
    9.4. Stagger the three oil control ring end gaps a minimum of 90 degrees.

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Fig. 206: Installing Piston Rings
Courtesy of GENERAL MOTORS CORP.

9.5. Using piston ring pliers, install the lower compression ring.

The lower compression ring has a dimple or orientation mark and must face the top of the piston.

9.6. Using piston ring pliers, install the upper compression ring.

The upper compression ring does not have a dimple or orientation mark and may be installed in either direction.

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9.7. Stagger the compression ring end gaps a minimum of 25 mm (1.0 in).

Full-Floating Piston Pin

IMPORTANT: With the piston and connecting rod properly assembled, both the flat flange area of the connecting rod and the alignment mark on the top of the piston will be facing the front of the engine.

1. Install the pin to the piston and connecting rod.
2. Install the retaining clips.

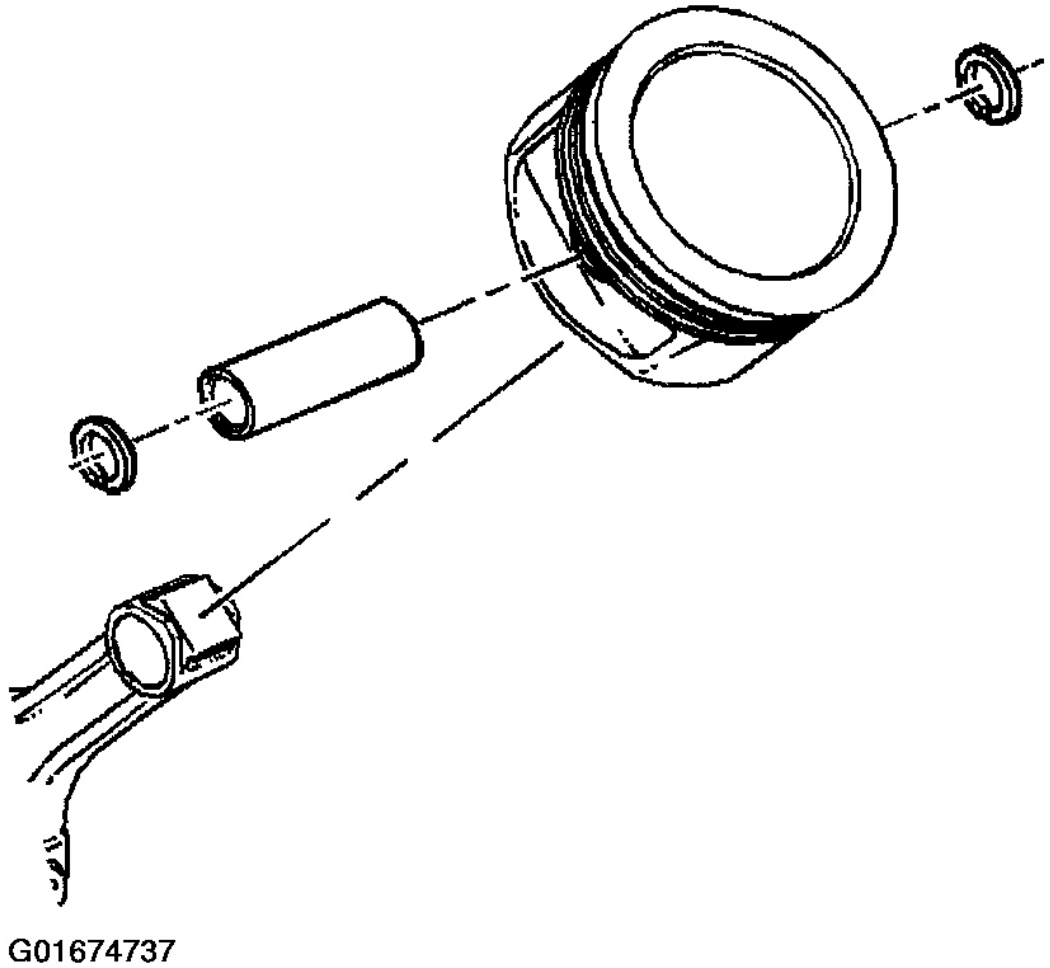


Fig. 207: Installing Pin To Piston & Connecting Ring
Courtesy of GENERAL MOTORS CORP.

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IMPORTANT: When installing the piston rings onto the piston, use a ring expanding plier type tool. Do not roll the piston rings into the grooves of the piston.

Use caution and care to expand the piston rings only slightly larger than the Outside Diameter (OD) of the piston.

3. Using piston ring pliers, install the piston rings onto the piston.
    3.1. Install the oil control ring spacer in the groove.
    3.2. Install the lower oil control ring.

    The oil control rings do not have a dimple or orientation mark and may be installed in either direction.

    3.3. Install the upper oil control ring.
    3.4. Stagger the three oil control ring end gaps a minimum of 90 degrees.

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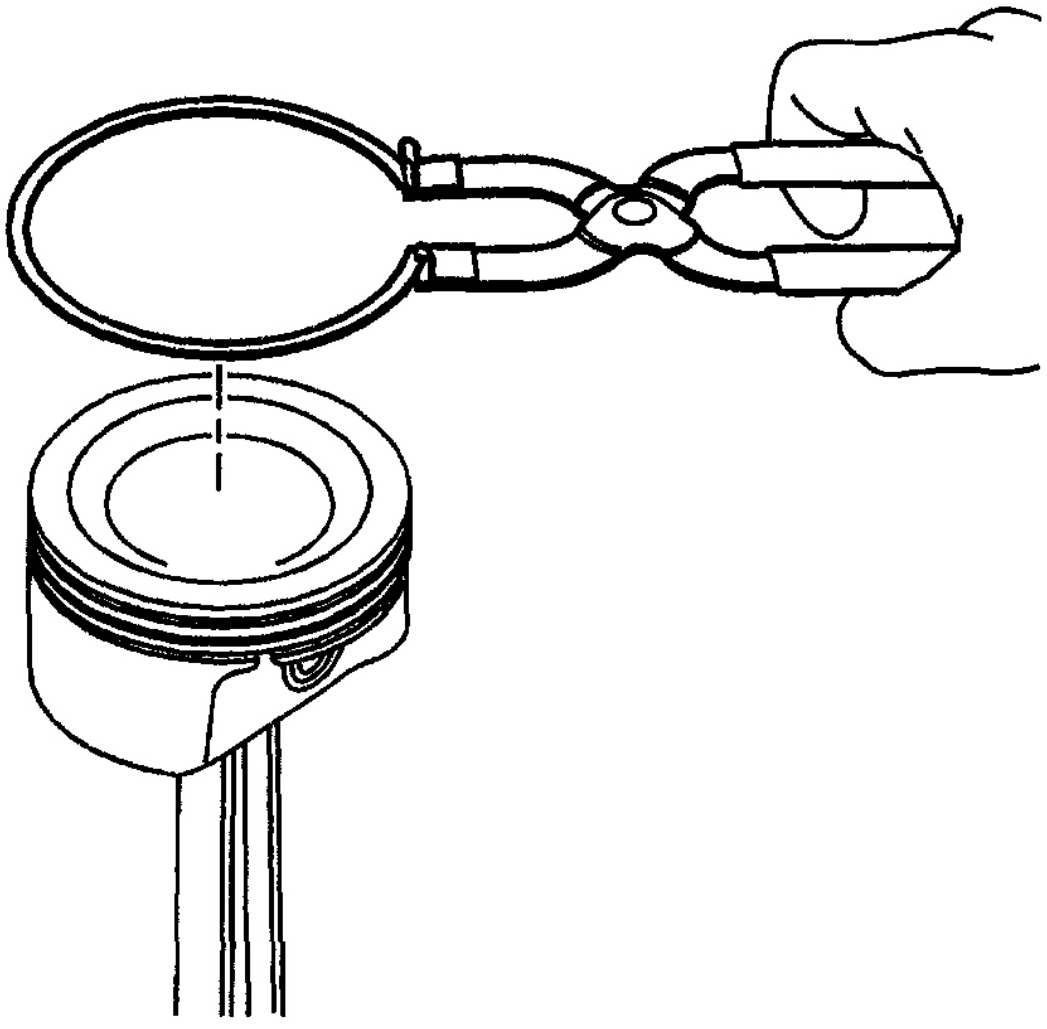


Fig. 208: Installing Piston Ring
Courtesy of GENERAL MOTORS CORP.

3.5. Using piston ring pliers, install the lower compression ring.

The lower compression ring has a dimple or orientation mark and must face the top of the piston.

3.6. Using piston ring pliers, install the upper compression ring.

The upper compression ring does not have a dimple or orientation mark and may be installed in either direction.

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3.7. Stagger the compression ring end gaps a minimum of 25 mm (1.0 in).

CAMSHAFT BEARING REMOVAL

Tools Required

J 33049 Camshaft Bearing Remover/Installer

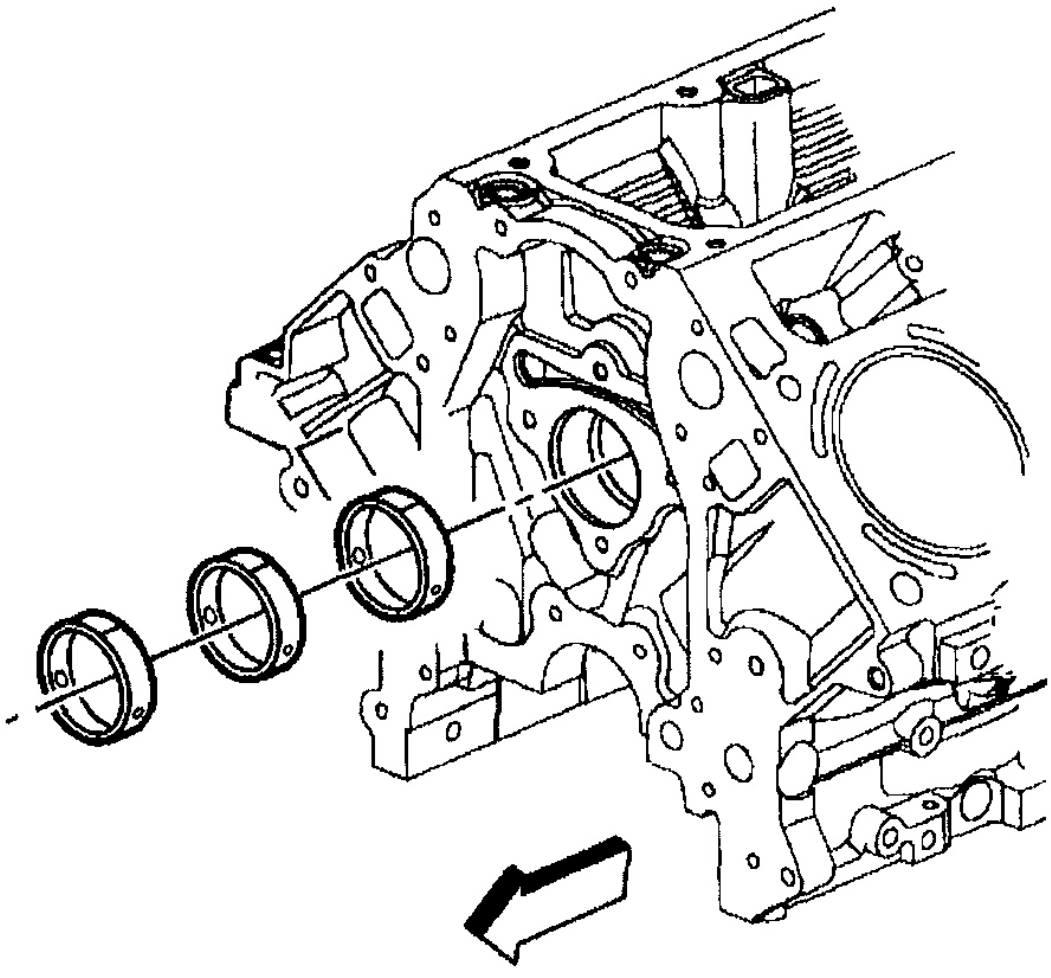
IMPORTANT: A loose camshaft bearing may be caused by an enlarged, out of round or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores.

   Refer to **Camshaft and Bearings Cleaning and Inspection** .

2. Repair or replace the components as required.

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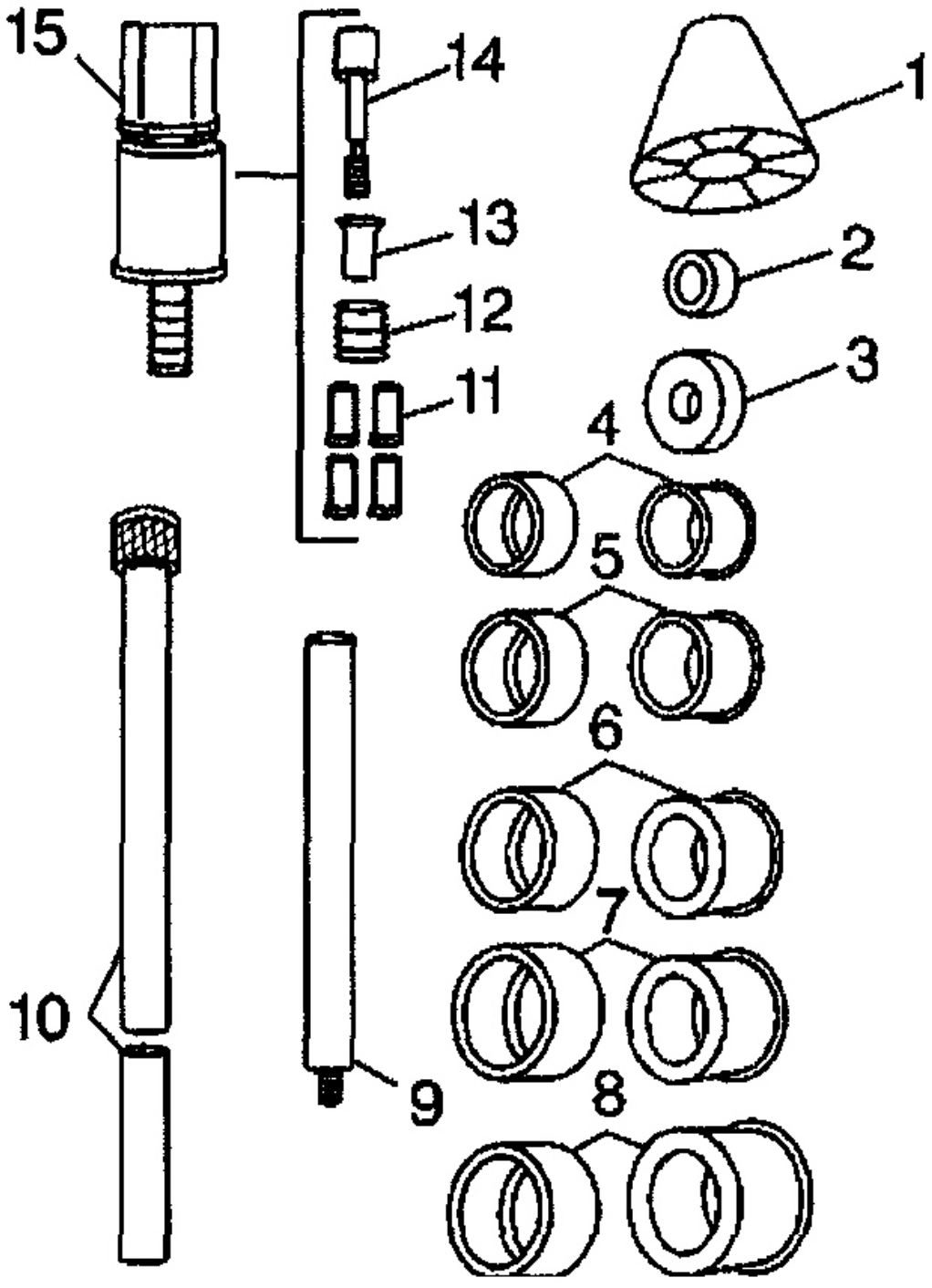


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Fig. 209: Camshaft Bearings & Engine Block
Courtesy of GENERAL MOTORS CORP.

3. Select the expanding driver (4-8) and washer (2 or 3) from the tool usage information.
4. Assemble the tool.

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Fig. 210: Expanding Driver Tool Components
Courtesy of GENERAL MOTORS CORP.

5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing to align the tool.
8. Drive the bearing from the block bore.

IMPORTANT: To remove the front camshaft bearing, operate the tool from the rear of the block using the guide cone (1) in the rear camshaft bearing bore.

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

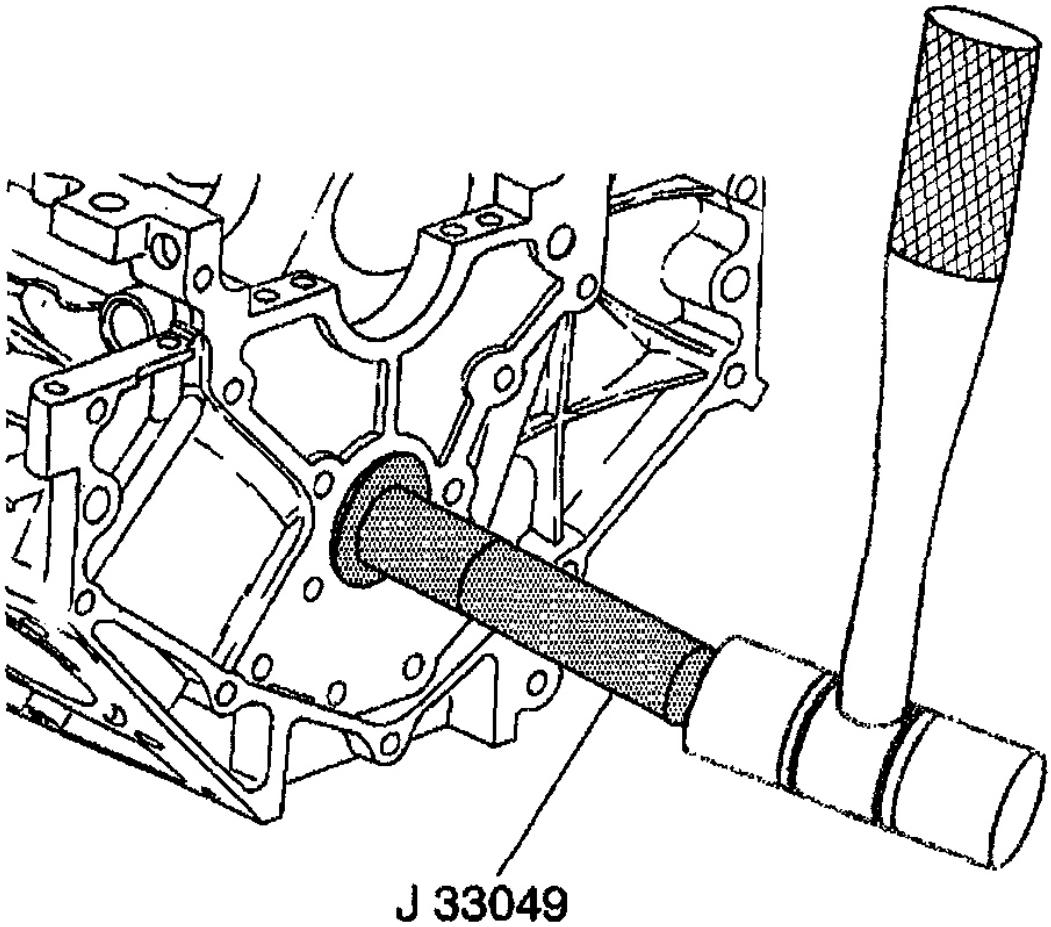


Fig. 211: Driving Bearing From Block Bore

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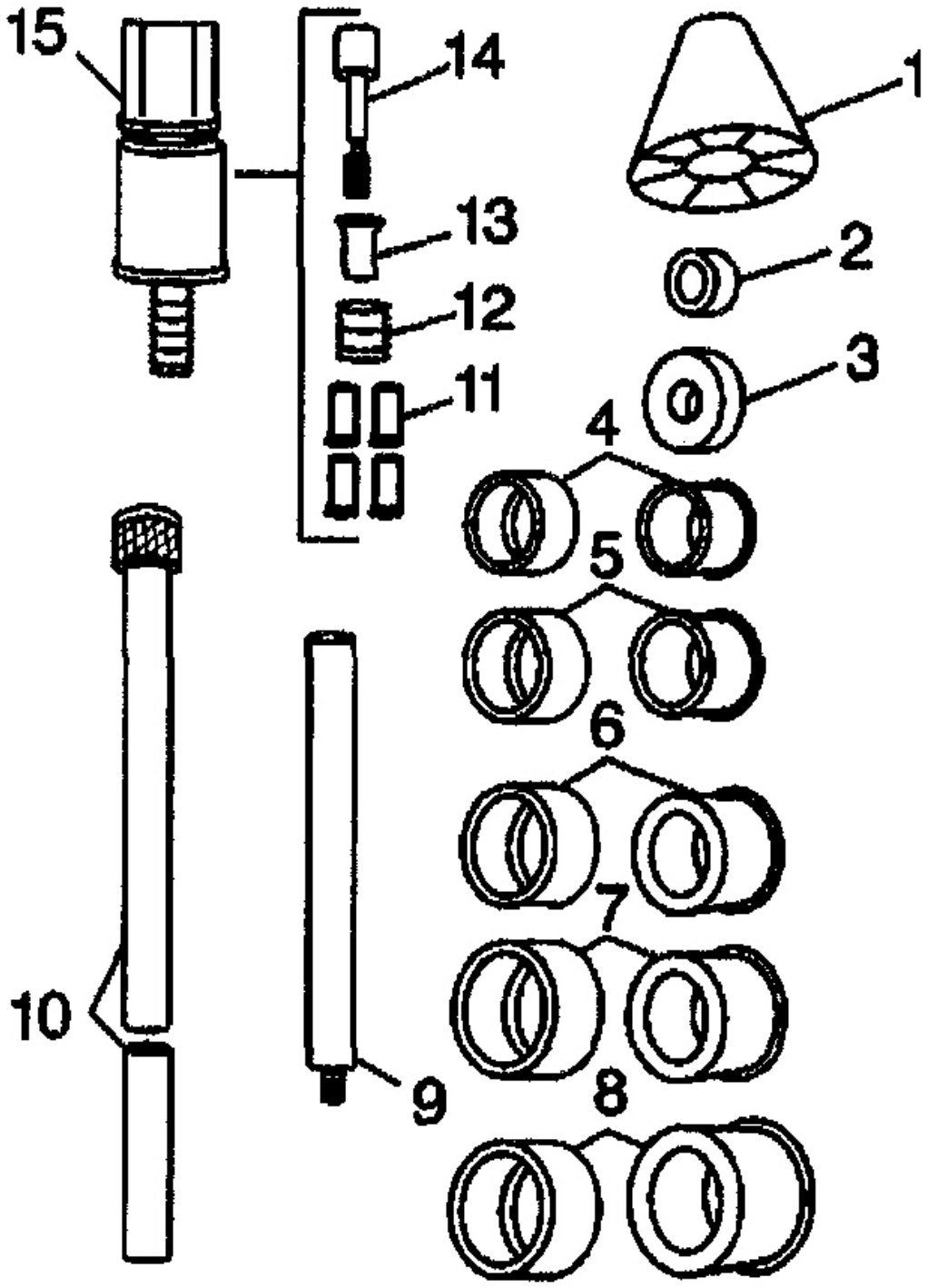
Courtesy of GENERAL MOTORS CORP.

Tool Usage Information

Bearing, Expander, and Expander Driver Information

- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4-8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).
- Expander bearing driver number one inside diameter is 28.575-37,465 mm (1.125-1.475 in) and is used with the expander assembly and the small washer.
- Expander bearing driver number two inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used with number one expanding driver and the small washer.
- Expander bearing driver number three inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with number two expanding driver and the large washer.

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Fig. 212: Expander Bearing Driver Components
Courtesy of GENERAL MOTORS CORP.

- Expander bearing driver number four inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with number three expanding driver and the large washer.
- Expander bearing driver number five inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with number four expanding driver and the large washer.
- Expander bearing driver number six inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with number five expanding driver and the large washer.

Tool Assembly and Operation

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

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

Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.

2. Place the expanding driver onto the expander assembly.
3. Check to insure that the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. Place the guide cone over the driving bar (with the small end of the cone facing the driver assembly).
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly (with driving washer) onto the driving bar.

It may be necessary to install the driver bar extension for removal of the inner bearings.

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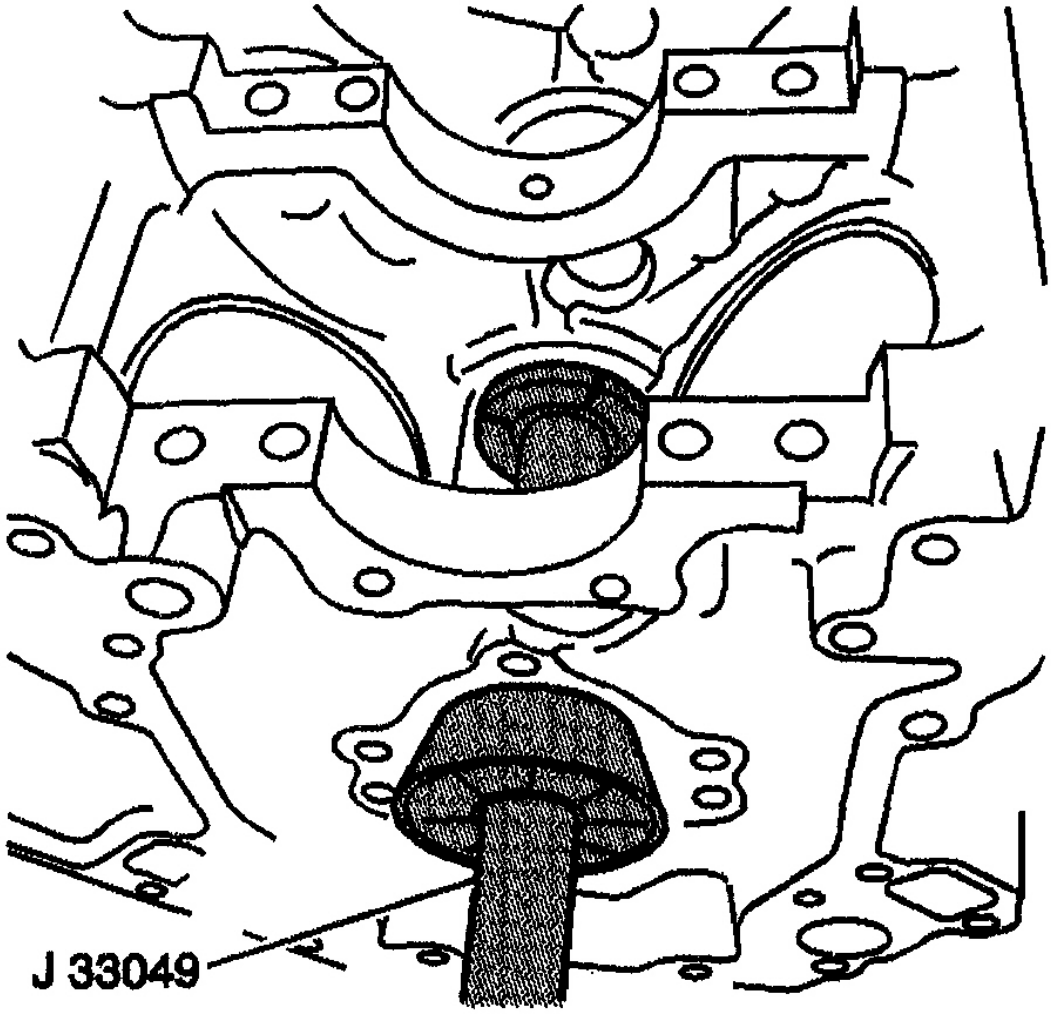


Fig. 213: Driving Bar Tool Installed
Courtesy of GENERAL MOTORS CORP.

7. Insert the tool into a inner camshaft bearing and tighten until snug.

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

   On some engine blocks the nut on the expander assembly is inaccessible except from either end. In this case you must use a socket and extension to enlarge and reduce the expander assembly.

8. Slide the nylon cone into the front or rear camshaft bearing (this will properly align the tool).
9. Drive the bearing out of or into the engine block.

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10. Repeat the procedure for the additional inner bearings.
11. For the two end bearings (front and rear), remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

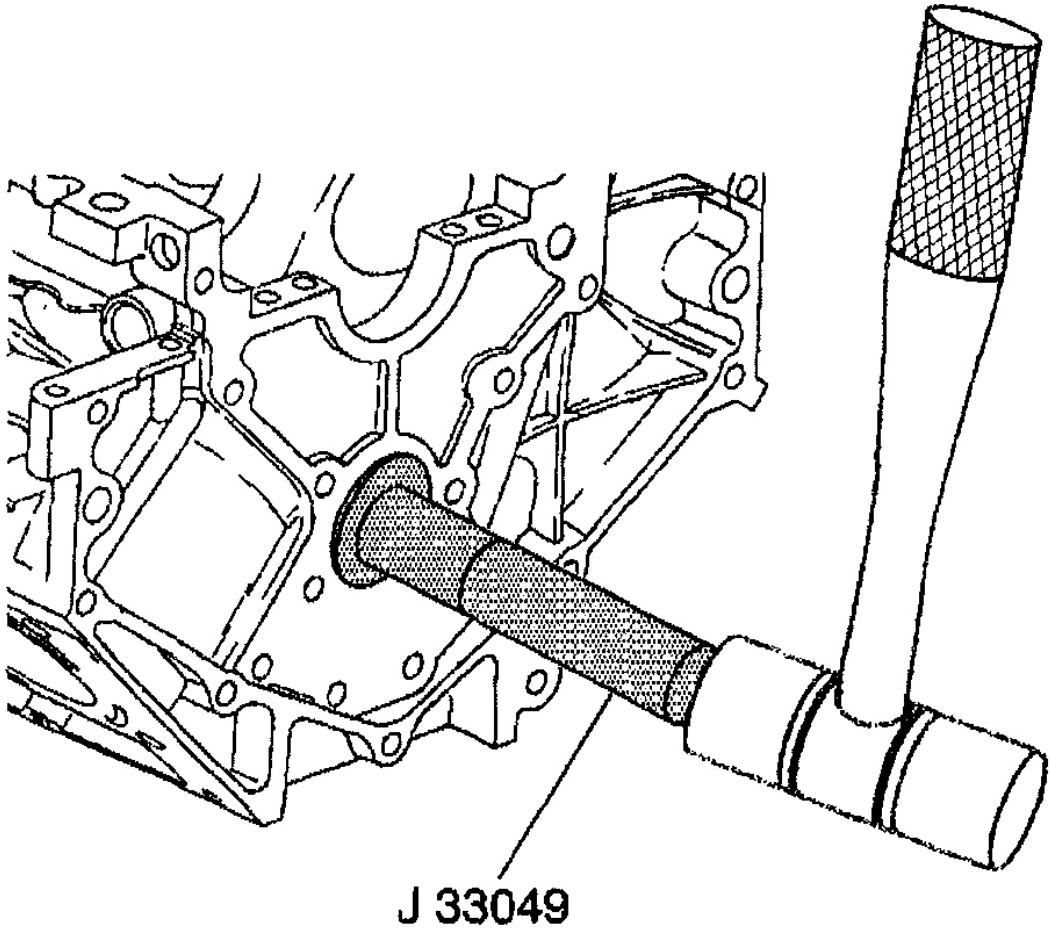


Fig. 214: Driving Bearing Out Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

Tools Required

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

1. Clean the components in solvent.
2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the threaded bolt holes (3) in the front of the camshaft for damaged threads or debris.
6. Inspect the camshaft sprocket pin (4) for damage.
7. Inspect the camshaft position reluctor ring for nicks or damage.

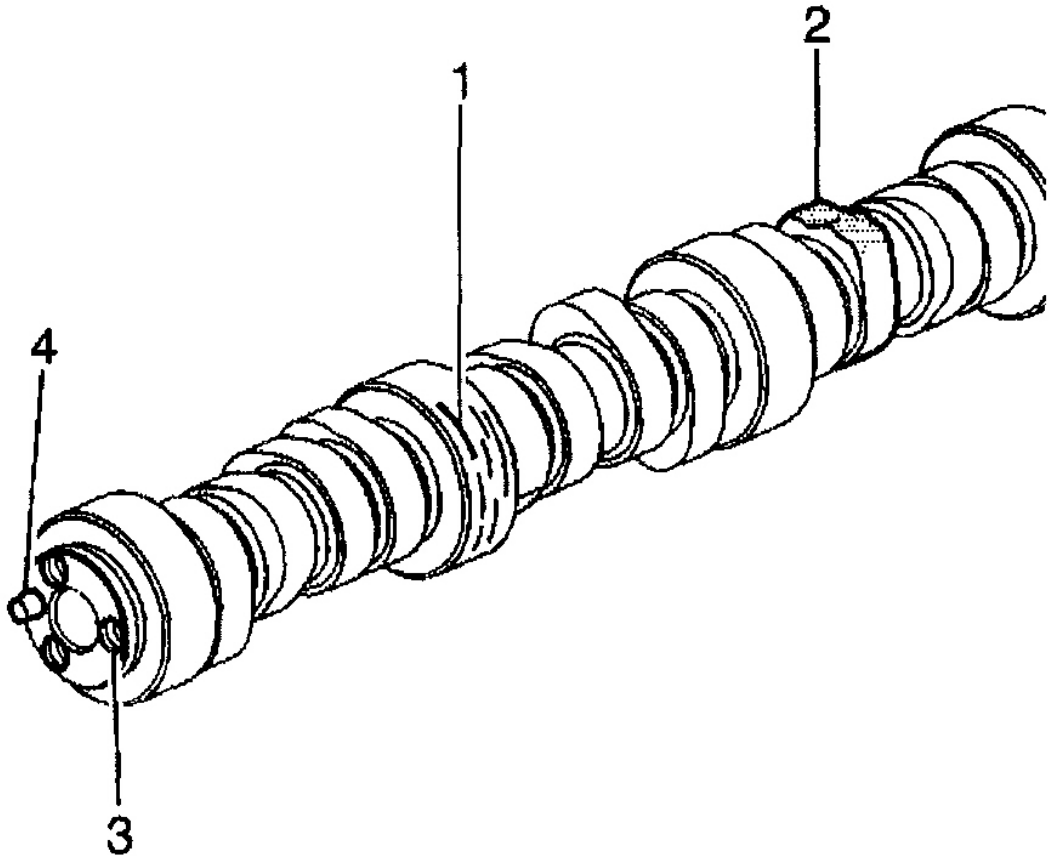


Fig. 215: Camshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

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

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

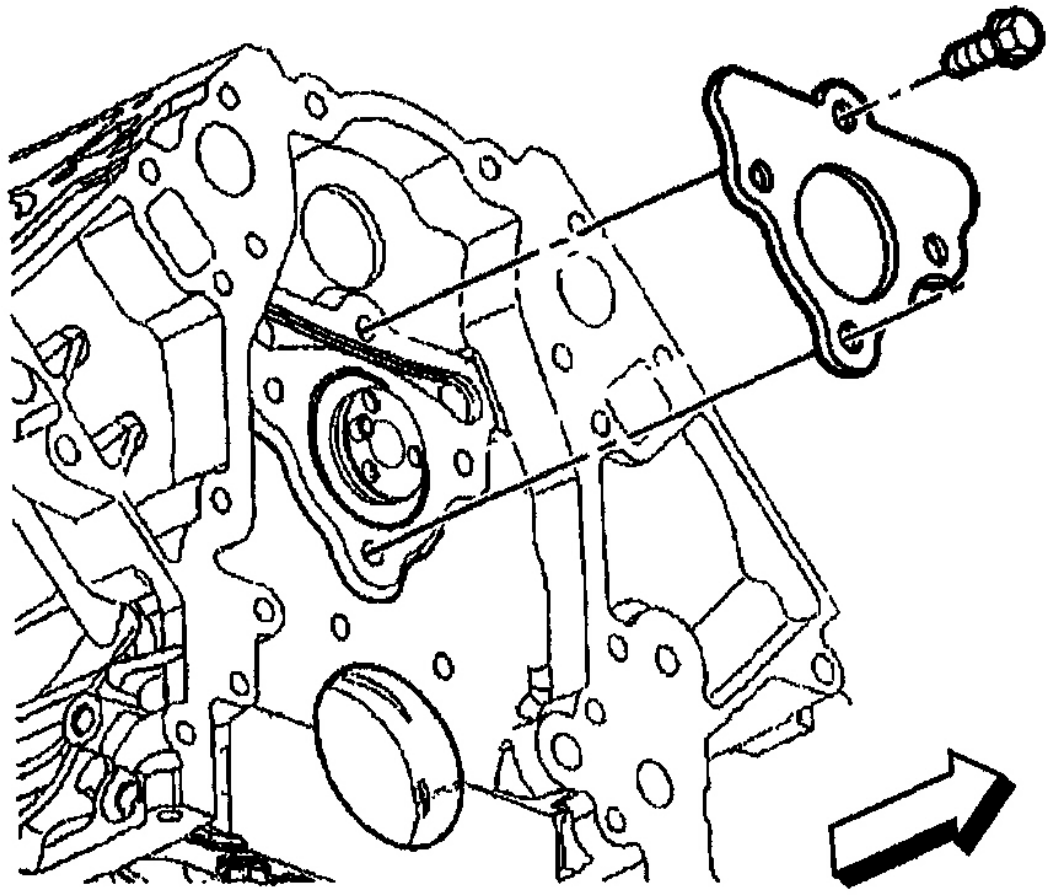
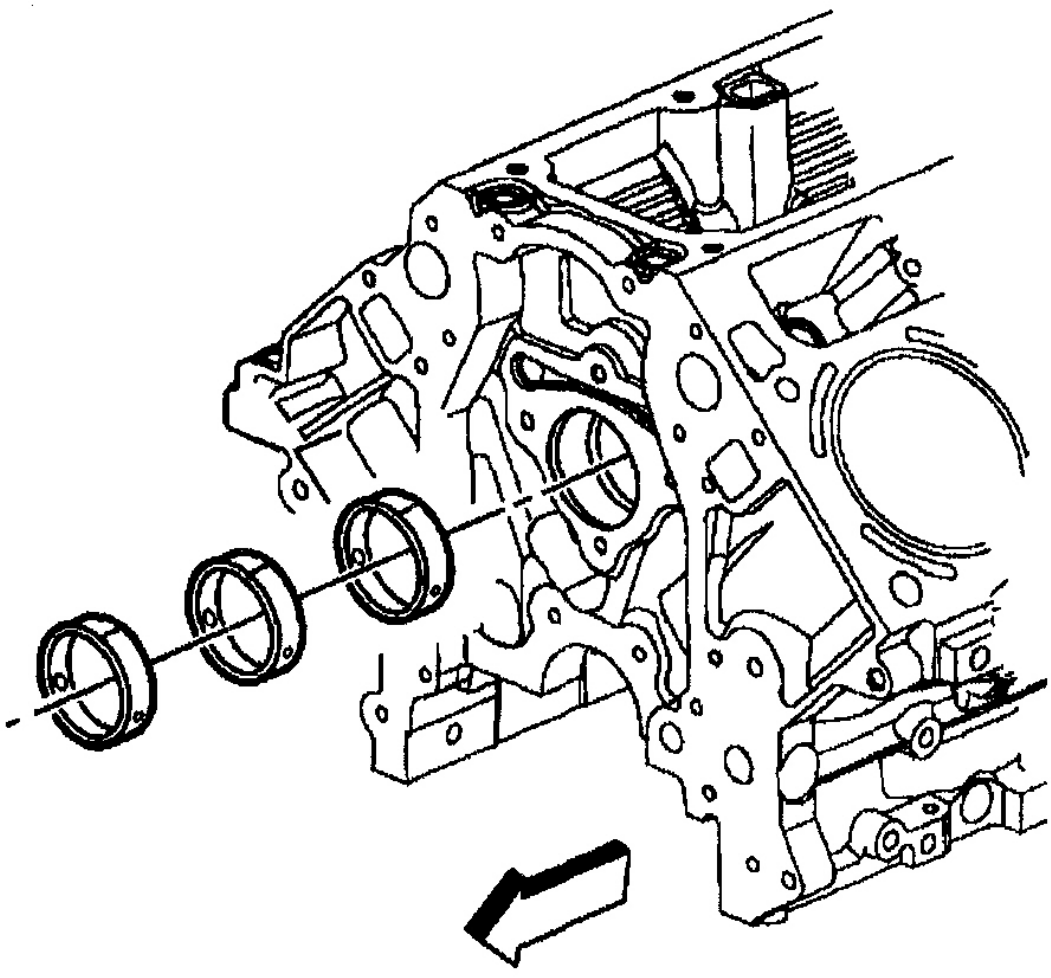


Fig. 216: Camshaft Retainer Plate & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Inspect the camshaft bearings for proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in their engine block bearing bores.
10. Inspect the camshaft bearings for excessive wear or scoring.

    Bearings with excessive scoring or wear must be replaced.

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Fig. 217: Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

11. Measure the camshaft journals for wear and out-of-round with a micrometer.
    - If the camshaft bearing journals are more than 0.025 mm (0.001 in) out-of-round, replace the camshaft.
    - If the camshaft bearing journal diameter is less that 54.99 mm (2.164 in), replace the camshaft.

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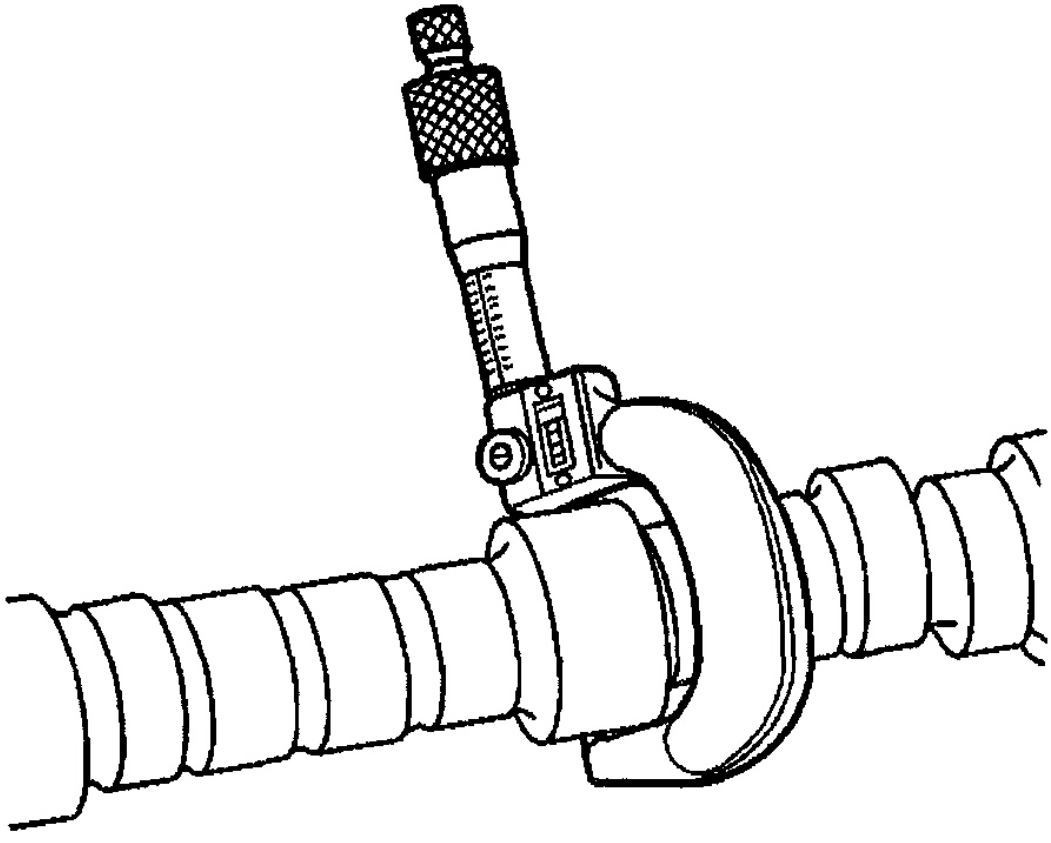


Fig. 218: Measuring Camshaft Journals For Wear & Out-Of-Round
Courtesy of GENERAL MOTORS CORP.

12. Measure the camshaft lobes for wear with a micrometer.
    - A 4.8/5.3 L camshaft with an intake lobe that measures 46.169 mm (1.817 in) or less must be replaced.
    - A 4.8/5.3 L camshaft with an exhaust lobe that measures 46.199 mm (1.818 in) or less must be replaced.
    - A 6.0 L camshaft with an intake lobe that measures 46.31 mm (1.823 in) or less must be replaced.
    - A 6.0 L camshaft with an exhaust lobe that measures 46.31 mm (1.823 in) or less must be replaced.

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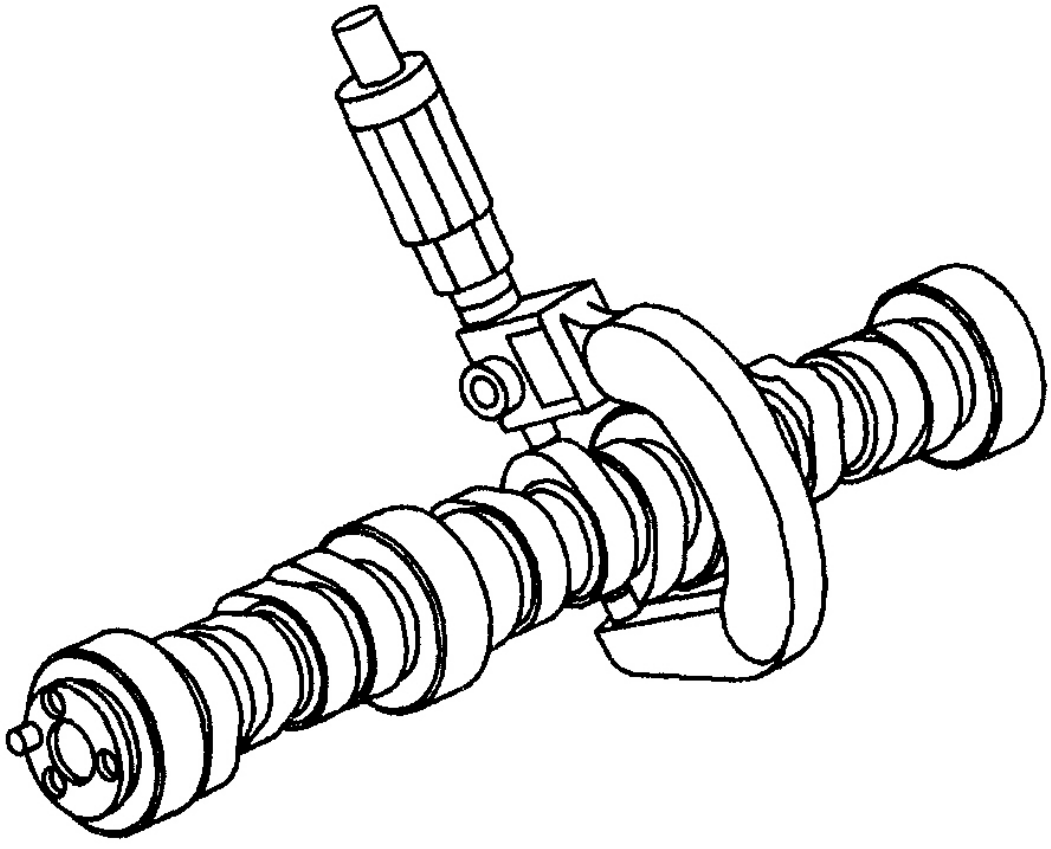


Fig. 219: Measuring Camshaft Lobes For Wear
Courtesy of GENERAL MOTORS CORP.

13. Measure the camshaft runout.
    13.1. Mount the camshaft in wooden V blocks or between centers on a fixture.
    13.2. Check the runout of the intermediate camshaft bearing journals using the **J 7872.**
    13.3. If camshaft runout exceeds 0.05 mm (0.002 in), the camshaft is bent and should be replaced.

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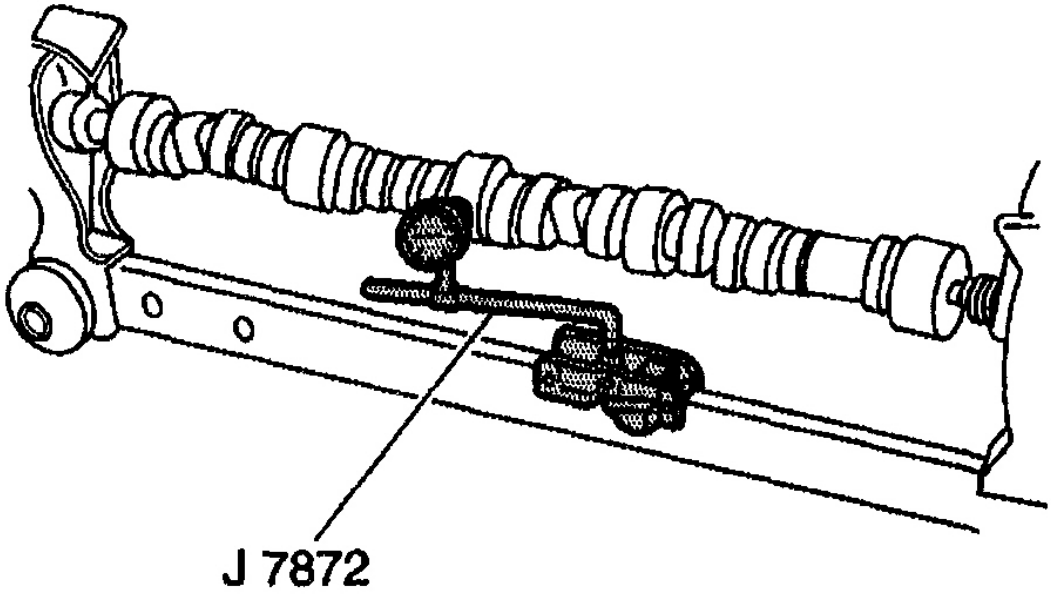


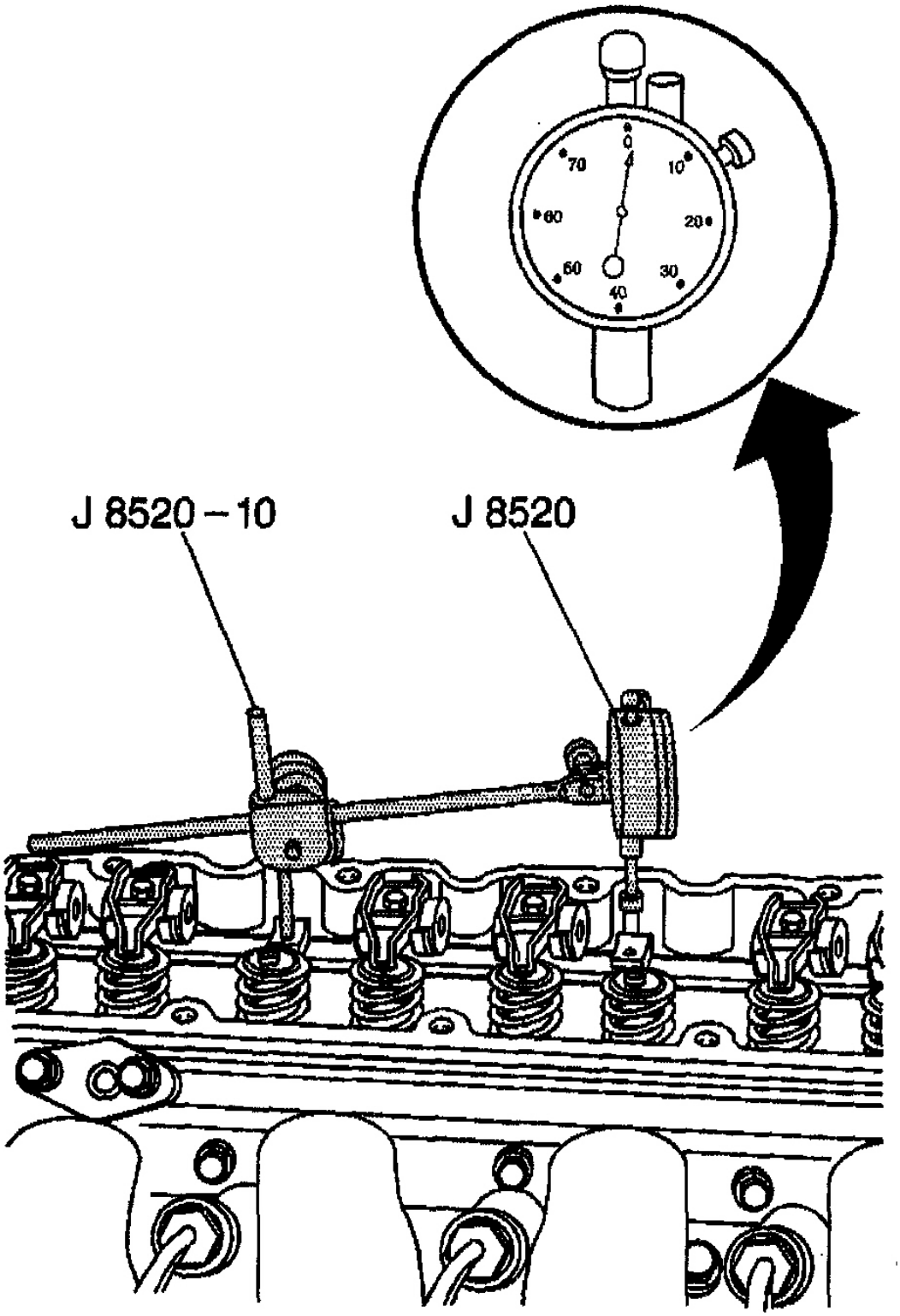
Fig. 220: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

Measuring Camshaft Lobe Lift

IMPORTANT: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Measure camshaft lobe lift using **J 8520.**
2. Remove the valve rocker arms and bolts
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520** and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise until the dial indicator obtains its highest and lowest readings.
8. Compare the total lift shown to specifications:
   - The proper lobe lift for 4.8/5.3 L intake lobes is 6.82 mm (0.268 in).
   - The proper lobe lift for 4.8/5.3 L exhaust lobes is 6.96 mm (0.274 in).
   - The proper lobe lift for 6.0 L intake lobes is 6.96 mm (0.274 in).
   - The proper lobe lift for 6.0 L exhaust lobes is 7.13 mm (0.281 in).

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Fig. 221: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS CORP.

CAMSHAFT BEARING INSTALLATION

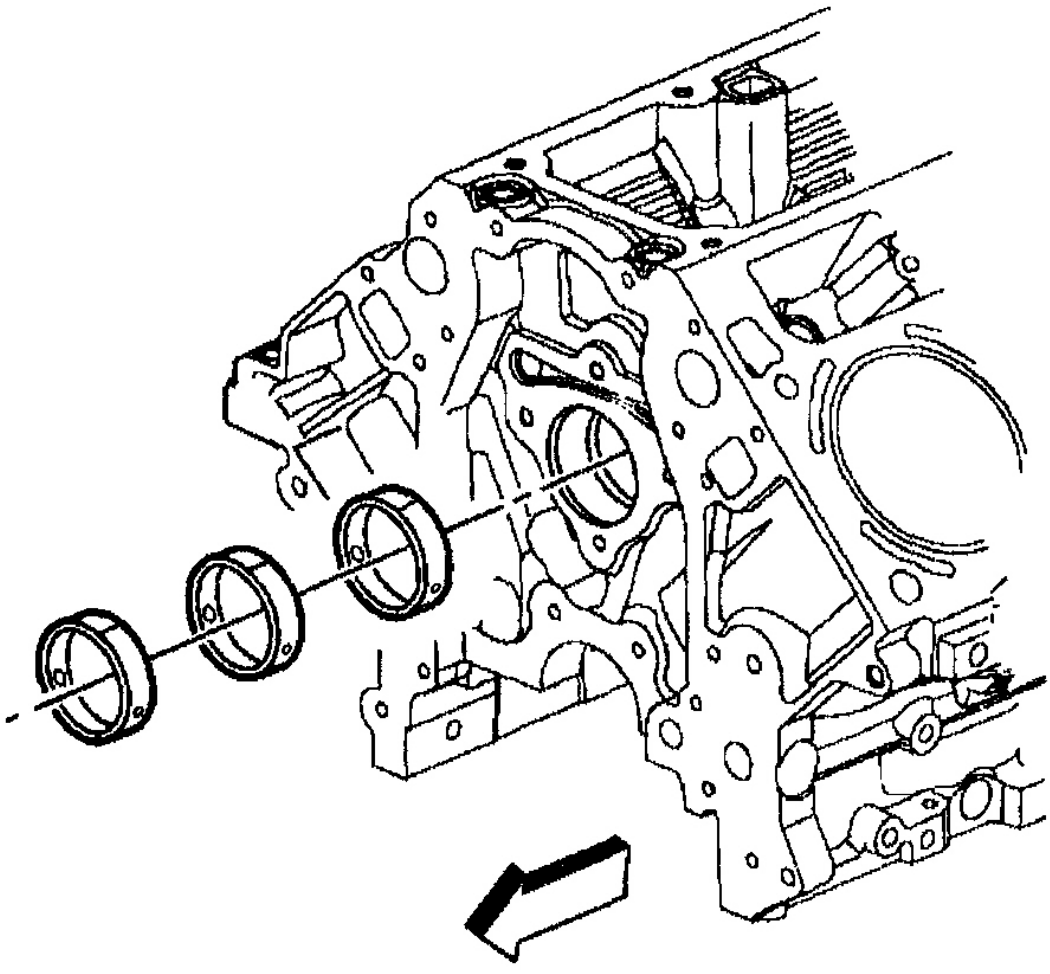
Tools Required

J 33049 Camshaft Bearing Remover/Installer

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

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores.
2. Repair or replace the components as required.

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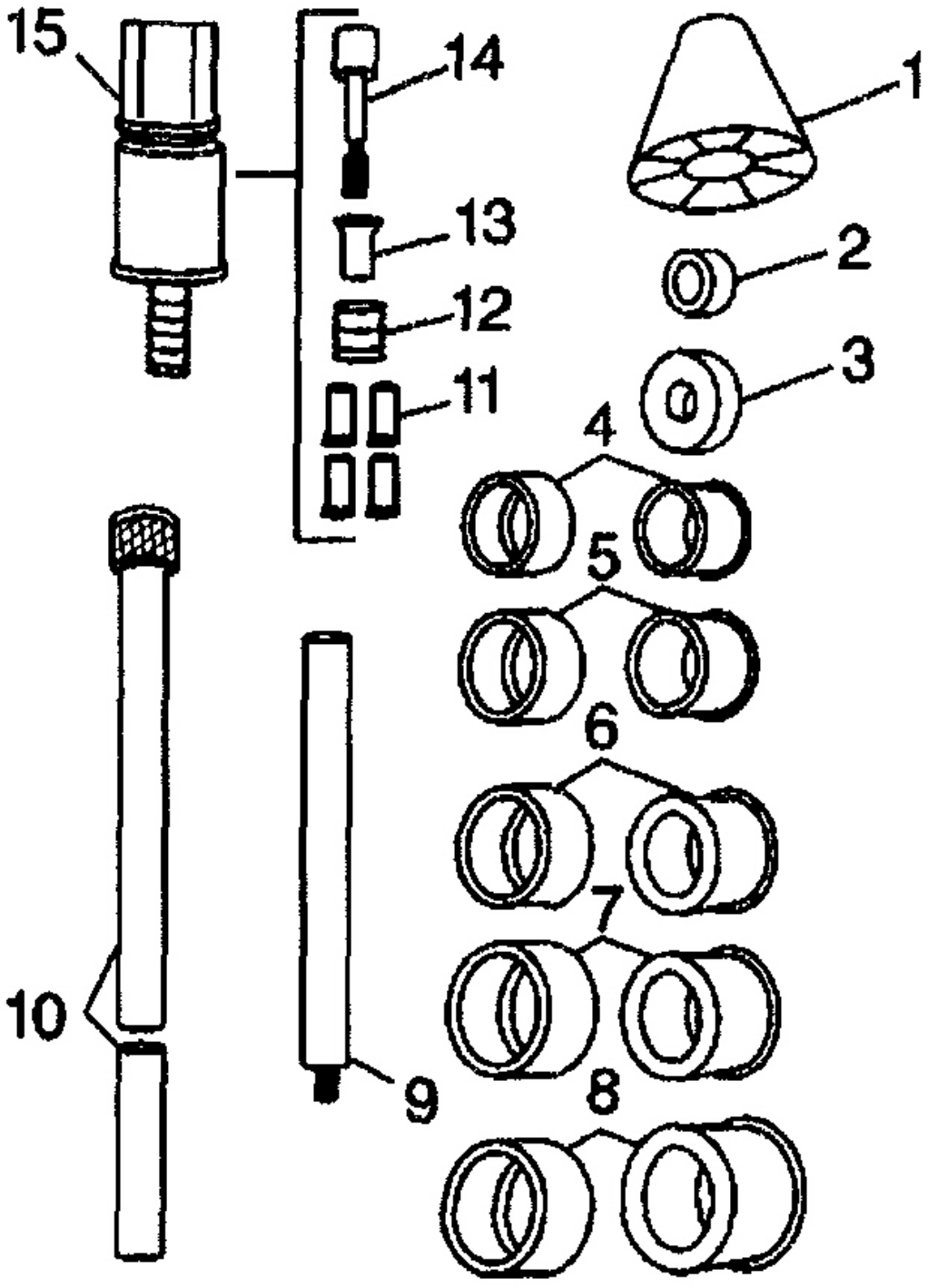


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Fig. 222: Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

3. Select the expanding driver (4-8) and washer (2,3) from the tool usage information. Refer to **Camshaft Bearing Removal** .
4. Assemble the tool.

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Fig. 223: Expander Bearing Driver Components
Courtesy of GENERAL MOTORS CORP.

5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly nut until snug.
7. Push the guide cone into the front camshaft bearing to align the tool.
8. Drive the bearing from the block bore.

IMPORTANT: To remove the front camshaft bearing, operate the tool from the rear of the block using the guide cone in the rear camshaft bearing bore.

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

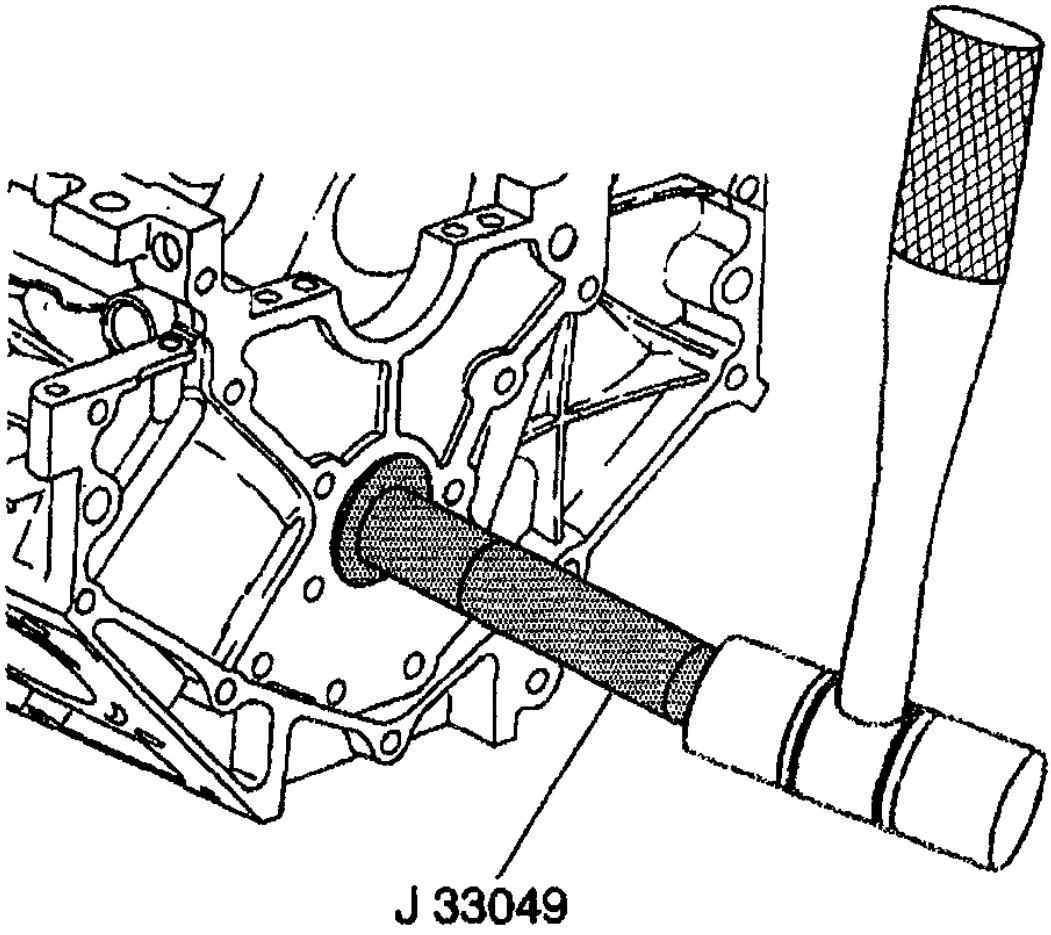


Fig. 224: Driving Bearing From Block Bore

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Courtesy of GENERAL MOTORS CORP.

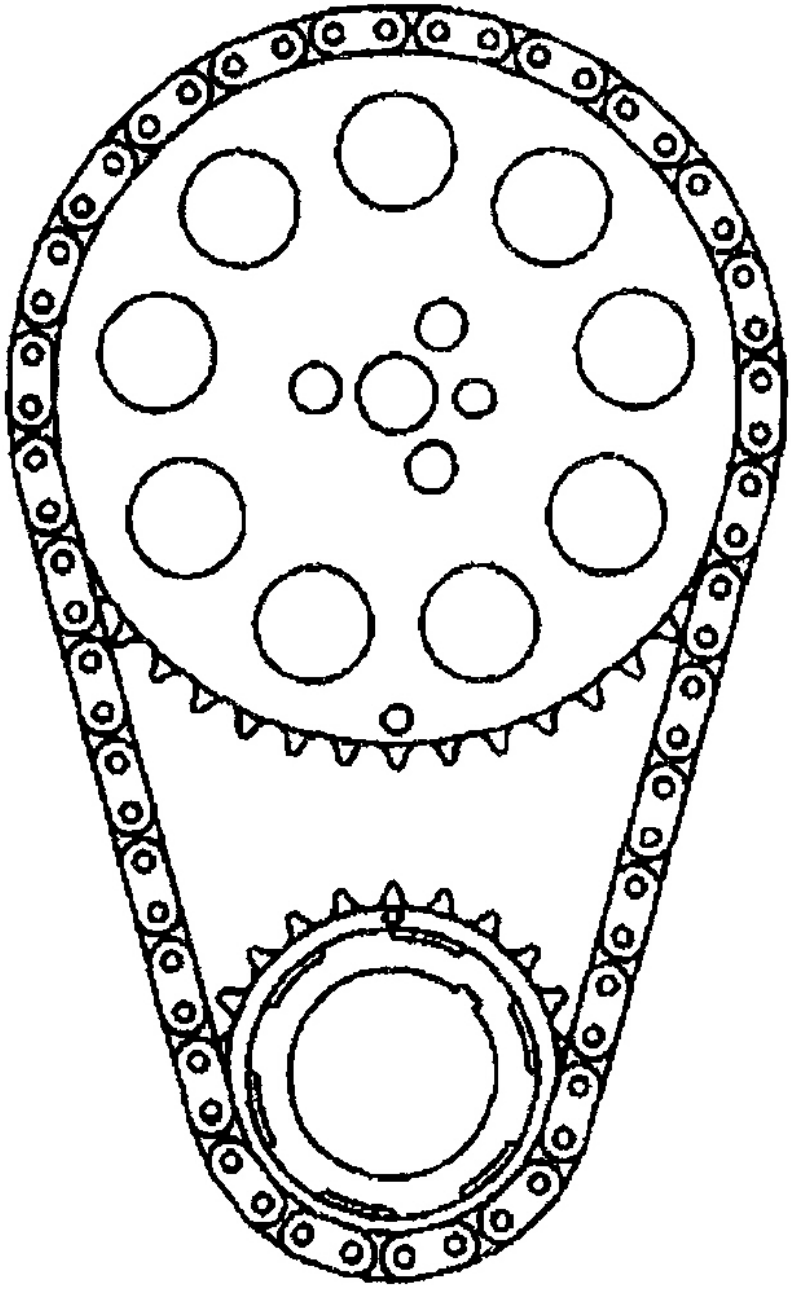
TIMING CHAIN AND SPROCKETS CLEANING AND INSPECTION

1. Clean the components with cleaning solvent.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

2. Dry the components with compressed air.
3. Inspect the timing chain for binding or wear.

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Fig. 225: Timing Chain
Courtesy of GENERAL MOTORS CORP.

4. Inspect the camshaft and crankshaft sprockets for:

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- Worn teeth (1)
- Damaged teeth (2)
- Chipped teeth (3)
- Worn valleys between the sprocket teeth

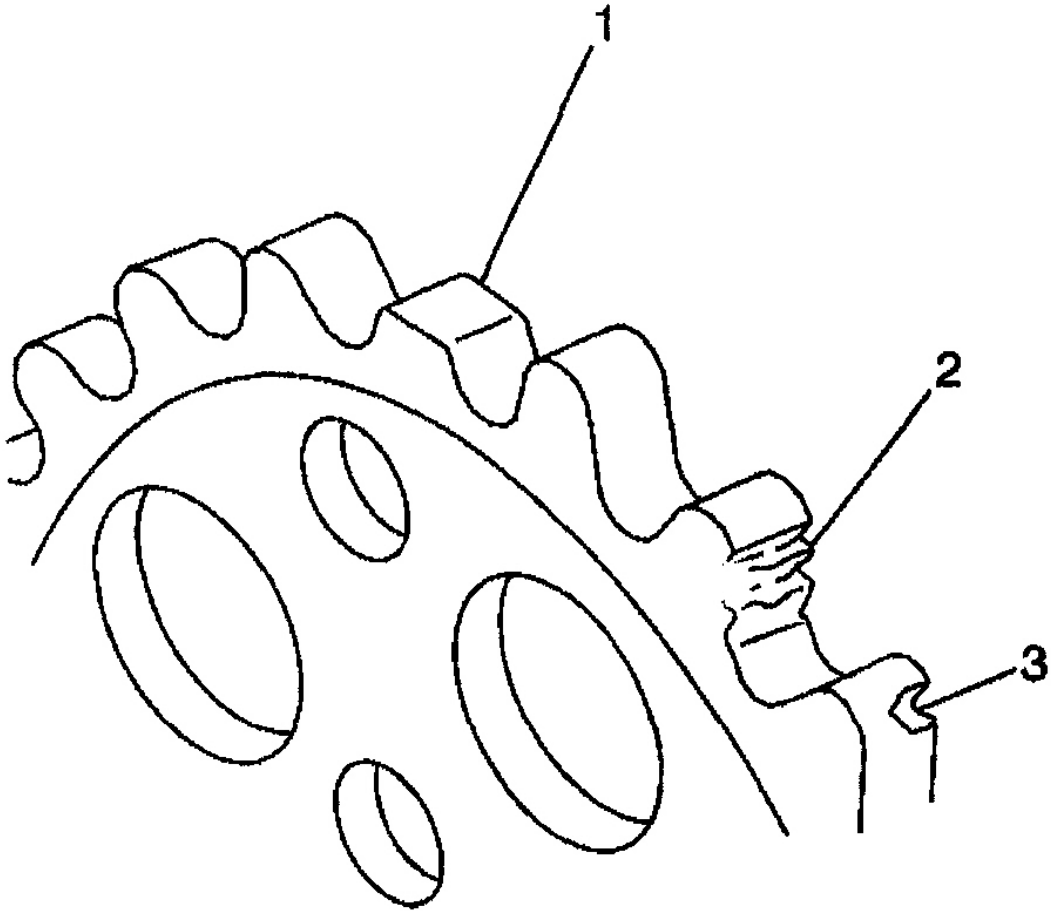
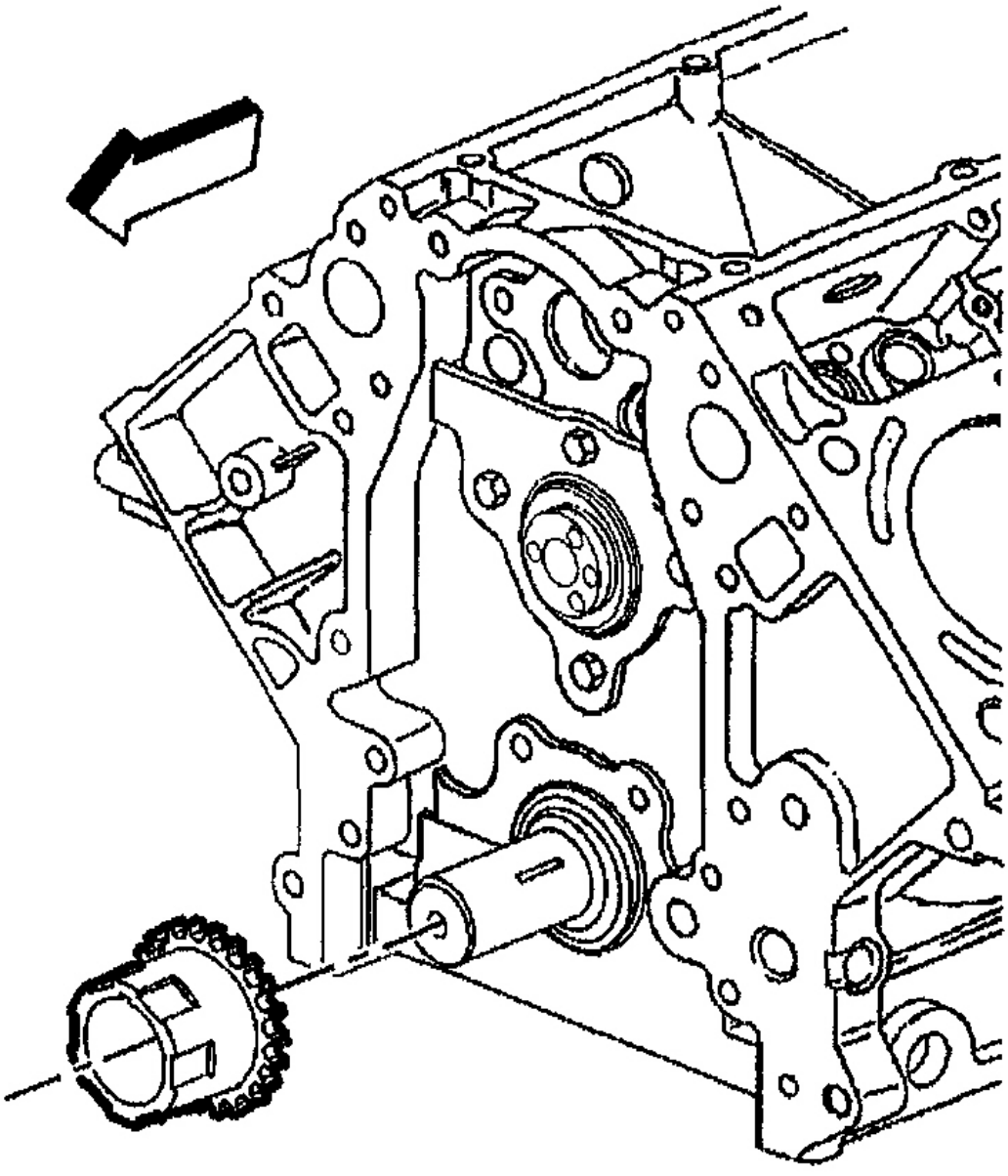


Fig. 226: Timing Chain Sprocket Inspection Areas
Courtesy of GENERAL MOTORS CORP.

5. Inspect the crankshaft sprocket keyway for wear.
6. Inspect the crankshaft sprocket oil pump drive splines for wear.

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Fig. 227: Crankshaft Sprocket Oil Pump Drive
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM AND PUSH RODS CLEANING AND INSPECTION

IMPORTANT: Parts that are to be reused must be marked, sorted or organized for assembly

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1. Mark, sort, or organize the components for assembly. Refer to **Separating Parts** .
2. Clean the components with cleaning solvent.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

3. Dry the components with compressed air.
4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.

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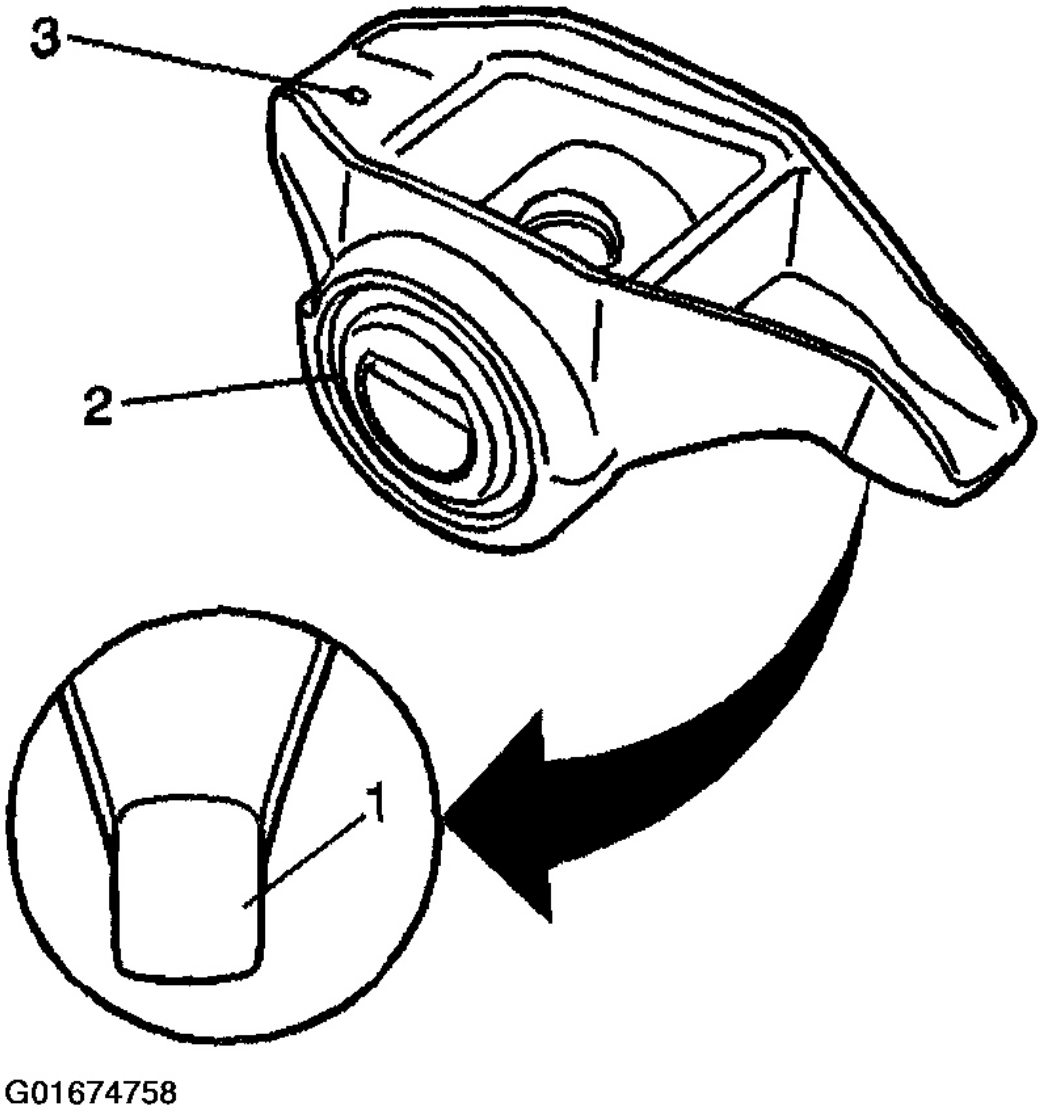


Fig. 228: Valve Rocker Arm Bearing, Pushrod Socket & Valve Stem Mating Surface
Courtesy of GENERAL MOTORS CORP.

6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.

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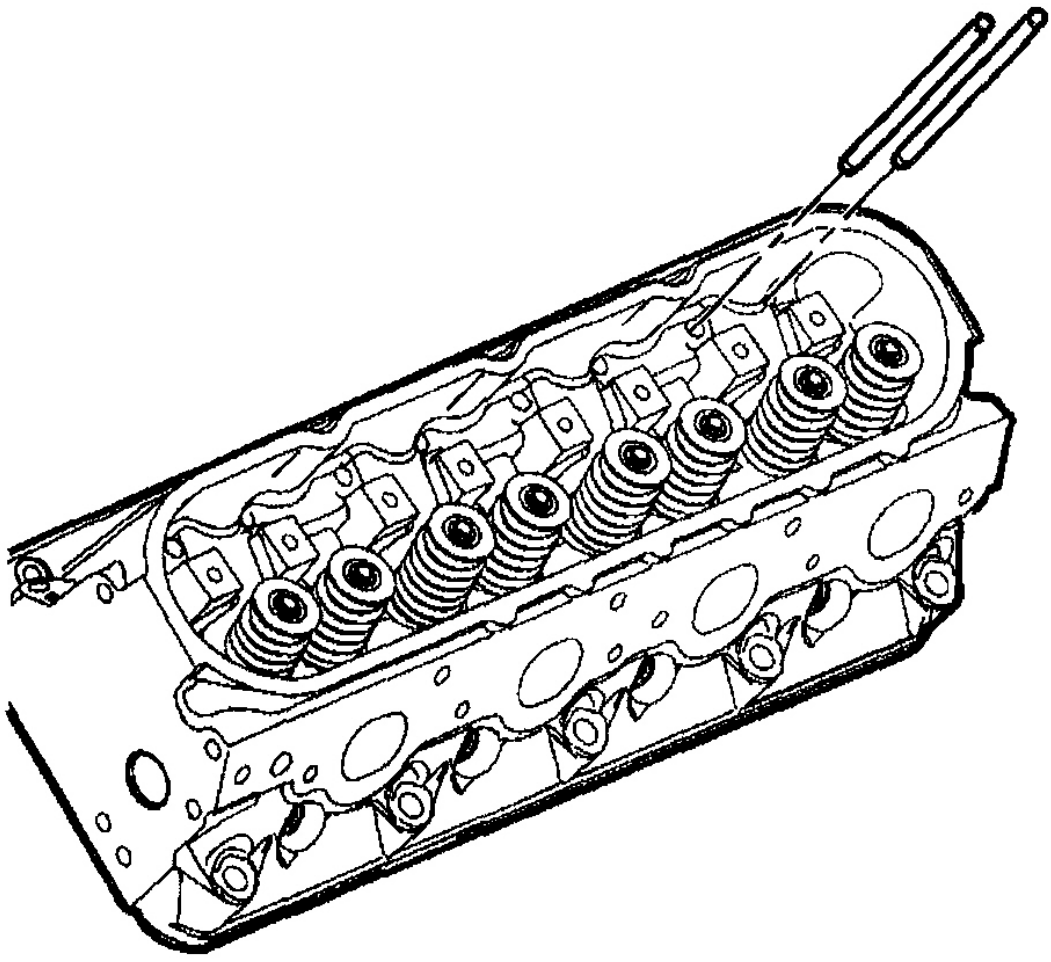


Fig. 229: Pushrods
Courtesy of GENERAL MOTORS CORP.

9. Inspect the pivot supports for cracks, wear, or other damage.

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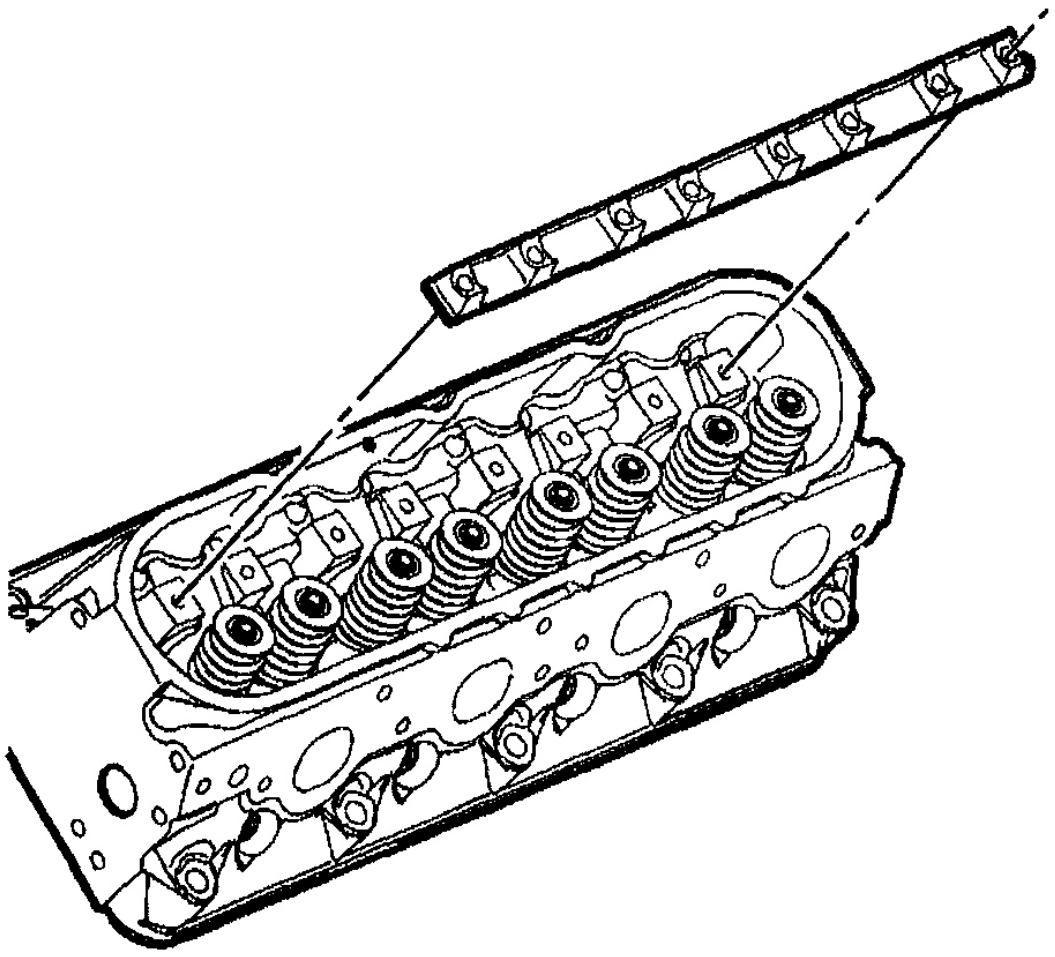


Fig. 230: Pivot Supports
Courtesy of GENERAL MOTORS CORP.

VALVE LIFTERS AND GUIDES CLEANING AND INSPECTION

IMPORTANT: Components that are to be reused must be marked, sorted or organized for assembly.

1. Mark, sort, or organize the components for assembly. Refer to **Separating Parts** .
2. Clean the components in cleaning solvent.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

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3. Dry the components with compressed air.
4. Inspect the valve lifters for the following:
    - Bent or broken clip (1)
    - Worn pushrod socket (2)
    - Scuffed or worn sides (3)

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

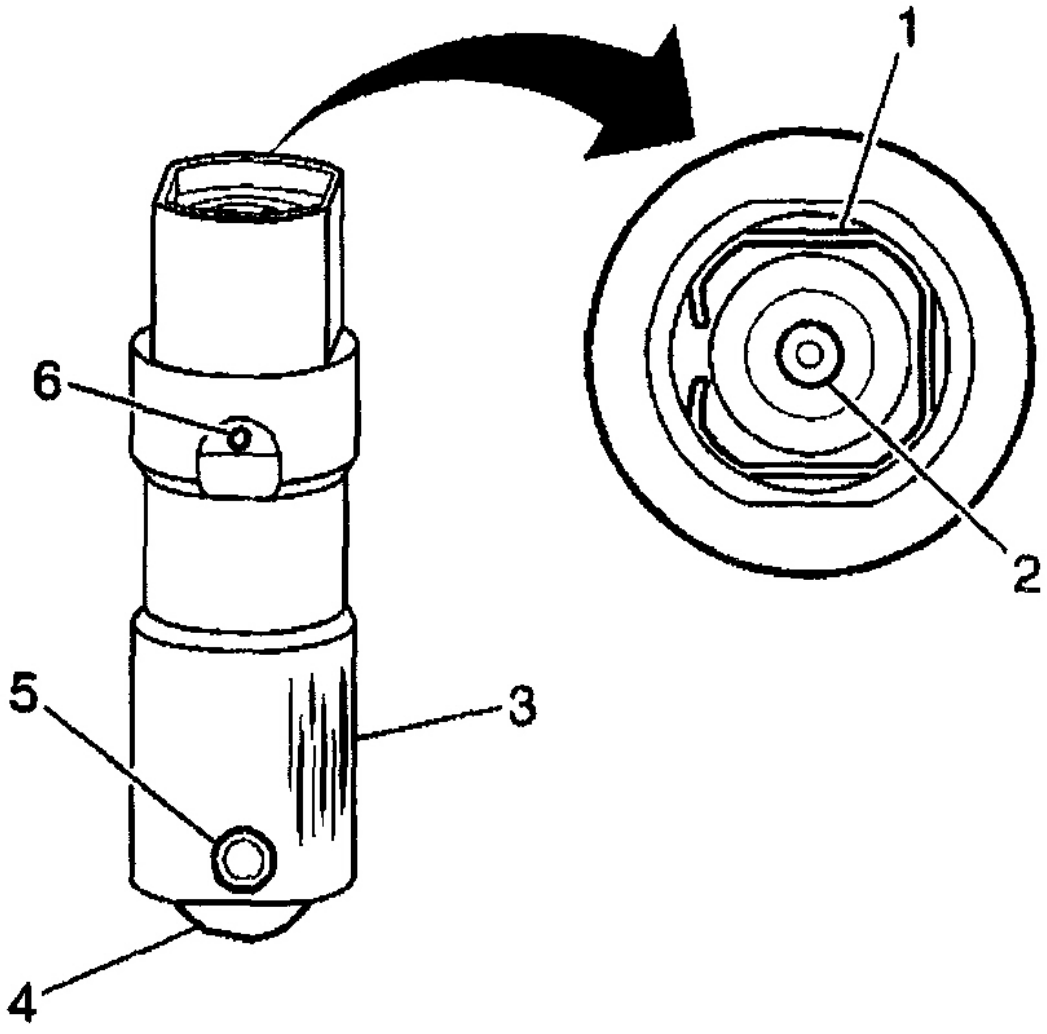


Fig. 231: Valve Lifters Inspection Areas
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- Flat spots on the roller (4)
- Loose or damaged pin (5)
- Plugged oil hole (6)
- Worn or damaged roller bearing

The roller should rotate freely with no binding or roughness.

5. Inspect the valve lifter guides for the following:
   - For cracks or damage
   - Excessive wear in the lifter mounting bores

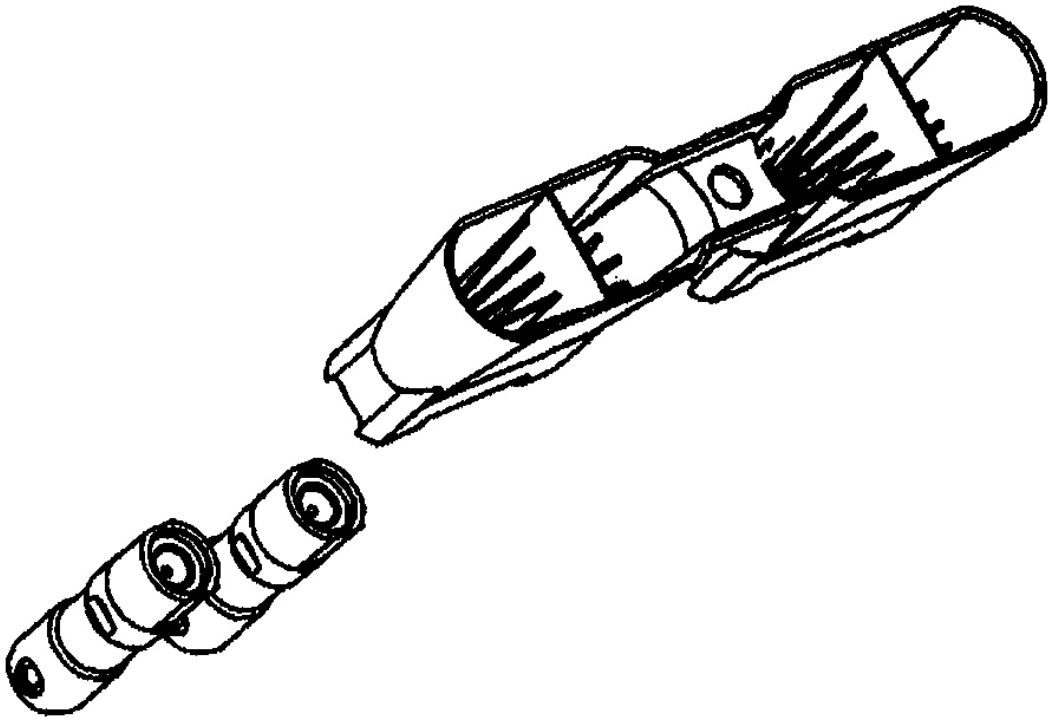


Fig. 232: Valve Lifter Guide Inspection Areas
Courtesy of GENERAL MOTORS CORP.

CYLINDER HEAD DISASSEMBLE

Tools Required

J 8062 Valve Spring Compressor

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IMPORTANT: Remove the spark plugs from the cylinder head with the components at room temperature.

Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.

Do not remove the cylinder head expansion plugs (9), aluminum heads only, unless service is required.

Do not attempt to replace worn valve guides (8). Worn valve guides should be reamed and sleeved for proper clearance to the valve stem.

A second design valve stem oil seal and shim assembly may be used on later engines.

A separate spring shim is not required with the second design seal and shim assembly.

1. Remove the spark plugs from the cylinder heads.

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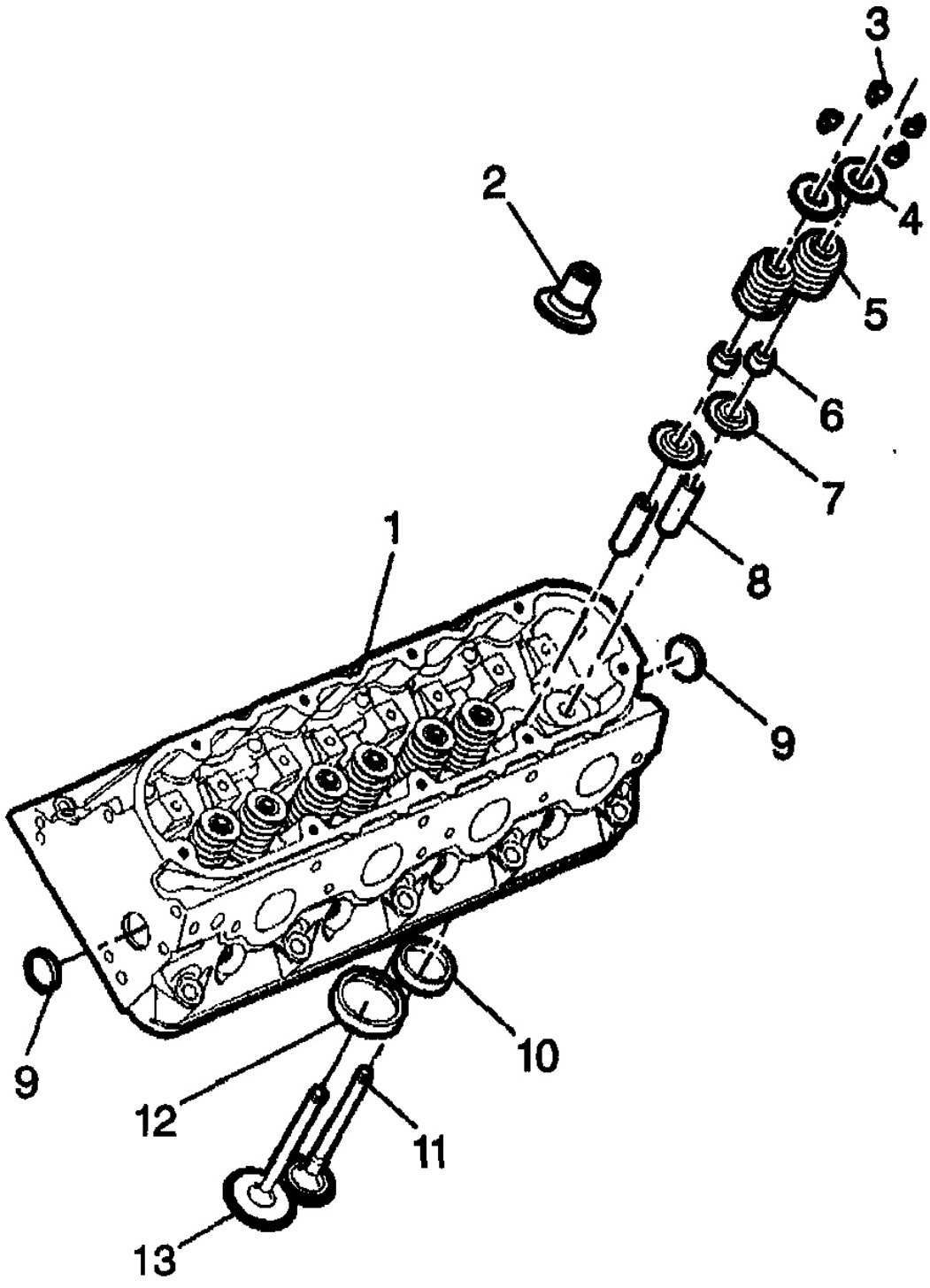


Fig. 233: Valve Components

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Courtesy of GENERAL MOTORS CORP.

2. Use the **J 8062** in order to compress the valve spring.

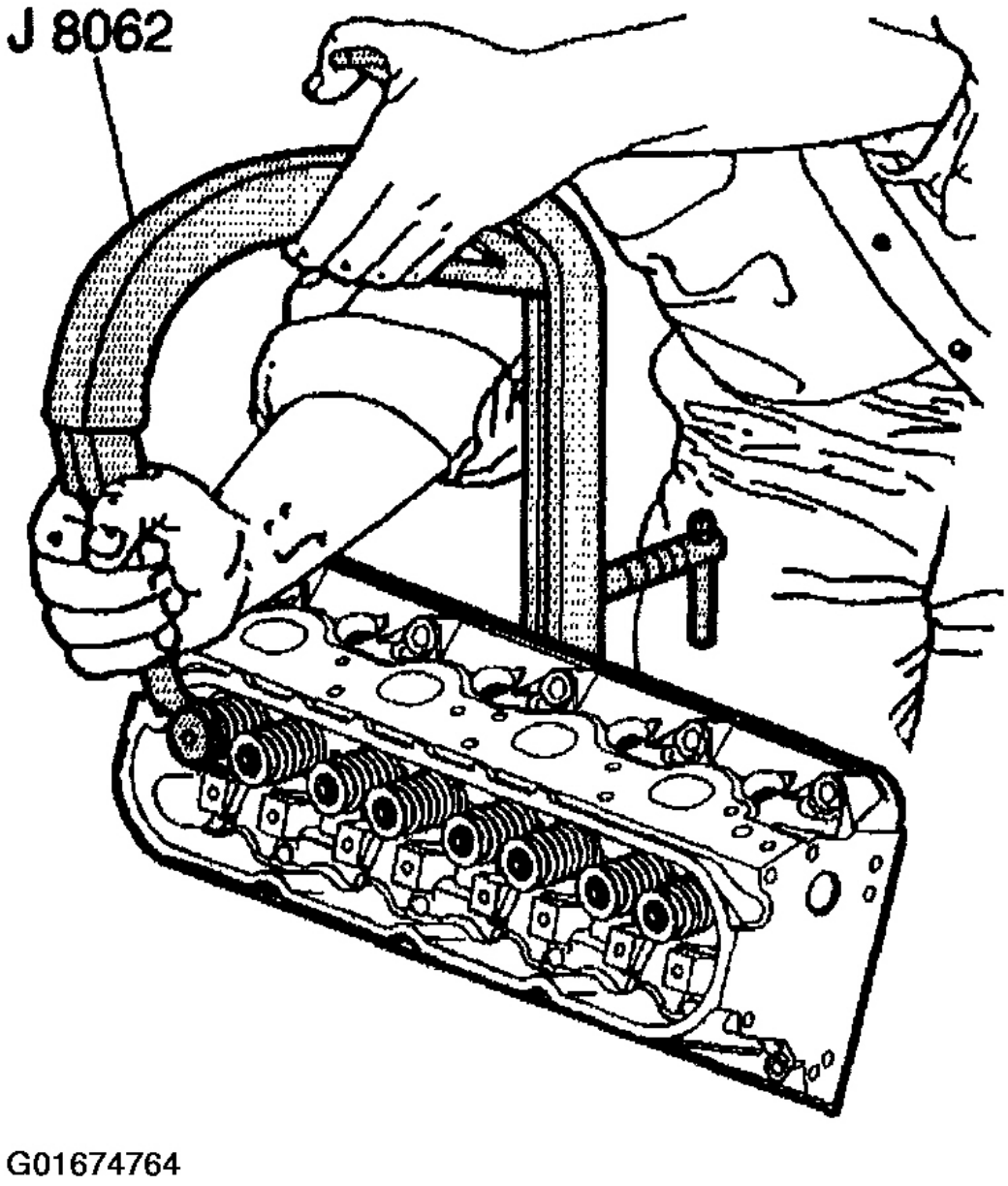


Fig. 234: Compressing Valve Spring Using J 8062
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve stem keys (3).

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4. Remove the valve spring cap (4).
5. Remove the valve spring (5).
6. Remove the valves (11 and 13).
7. Remove the valve stem oil seal (6), first design.
8. Remove the valve spring shim (7), first design.
9. Remove the valve stem oil seal and shim assembly, second design. Refer to **Separating Parts** .

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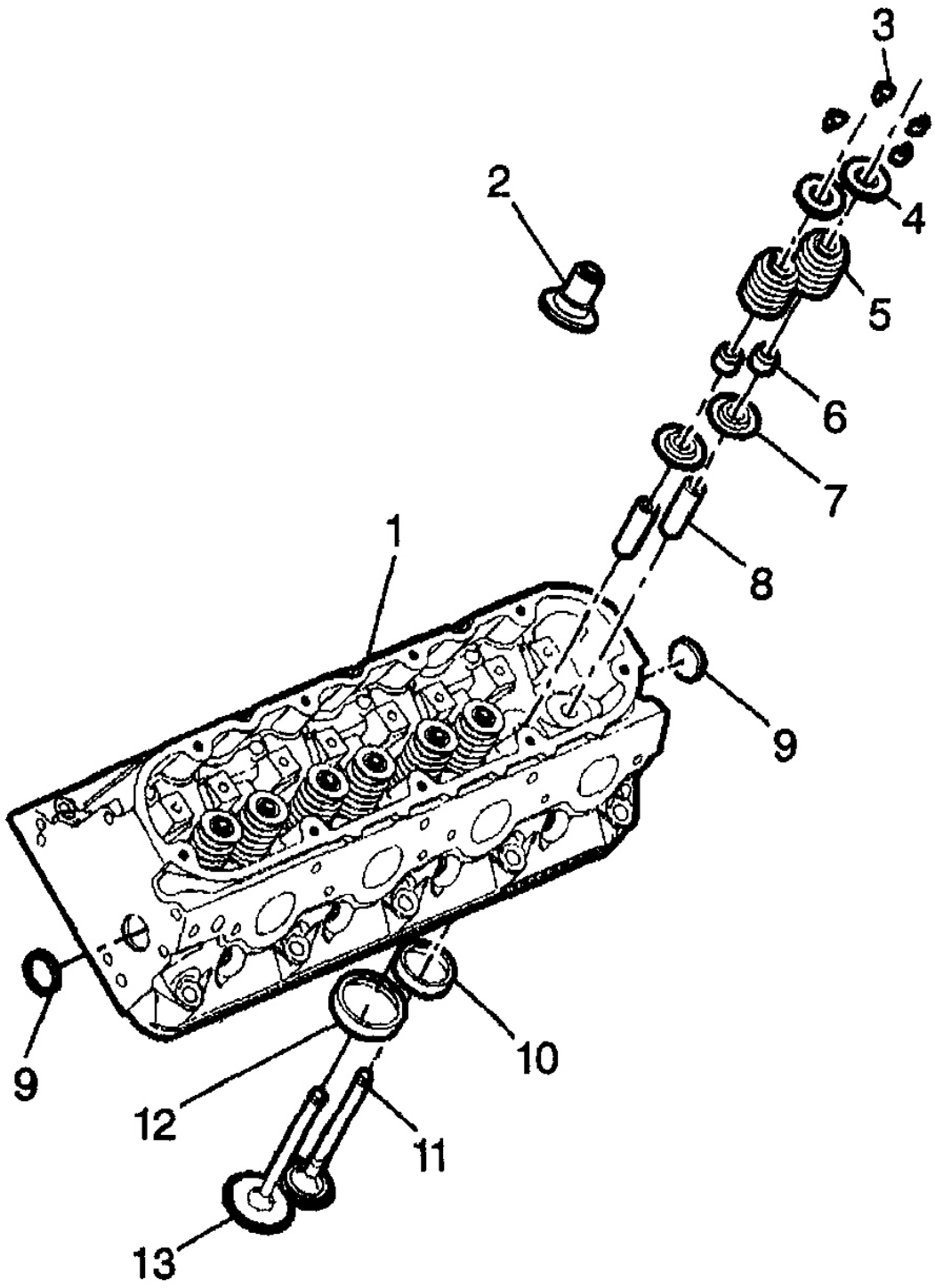


Fig. 235: Valve Components

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Courtesy of GENERAL MOTORS CORP.

10. Remove the cylinder head expansion plugs (1), if required.

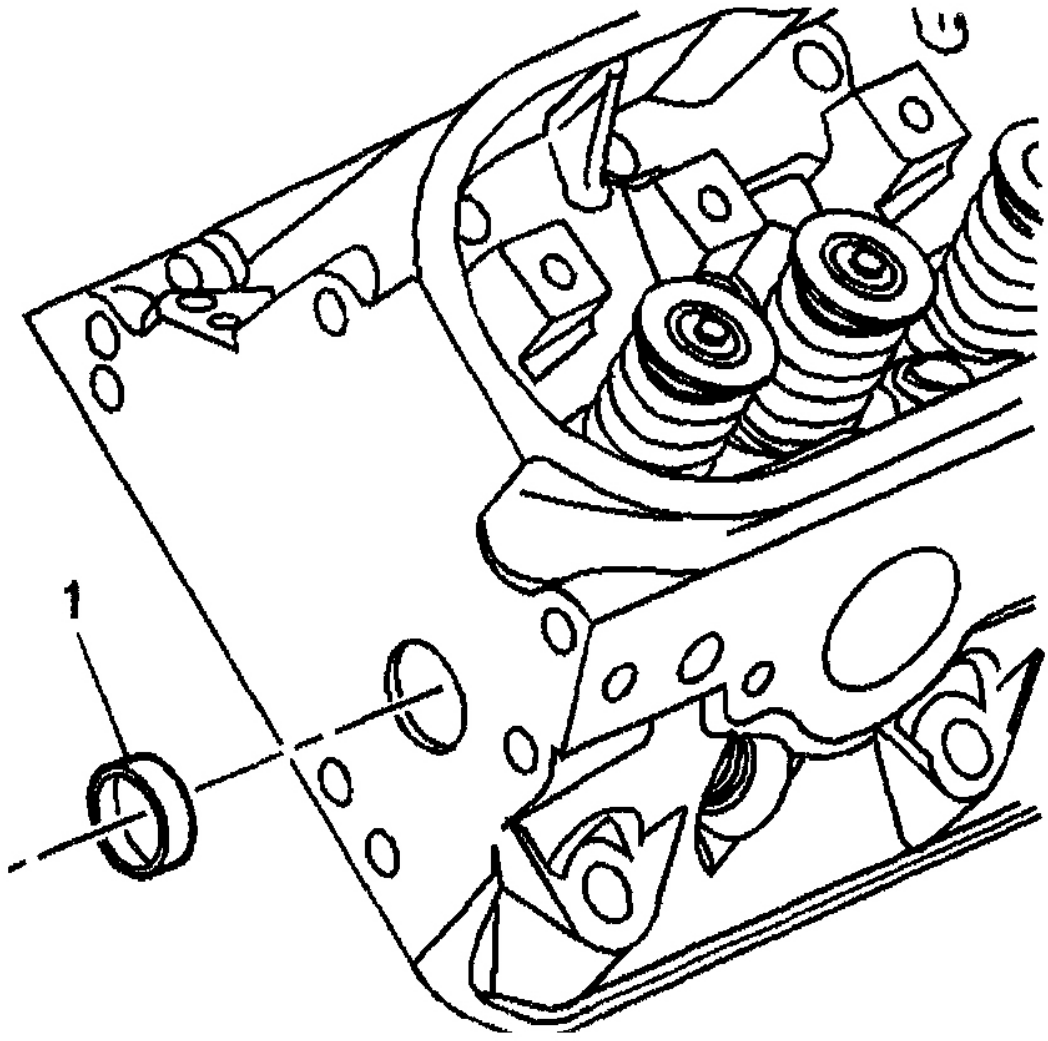
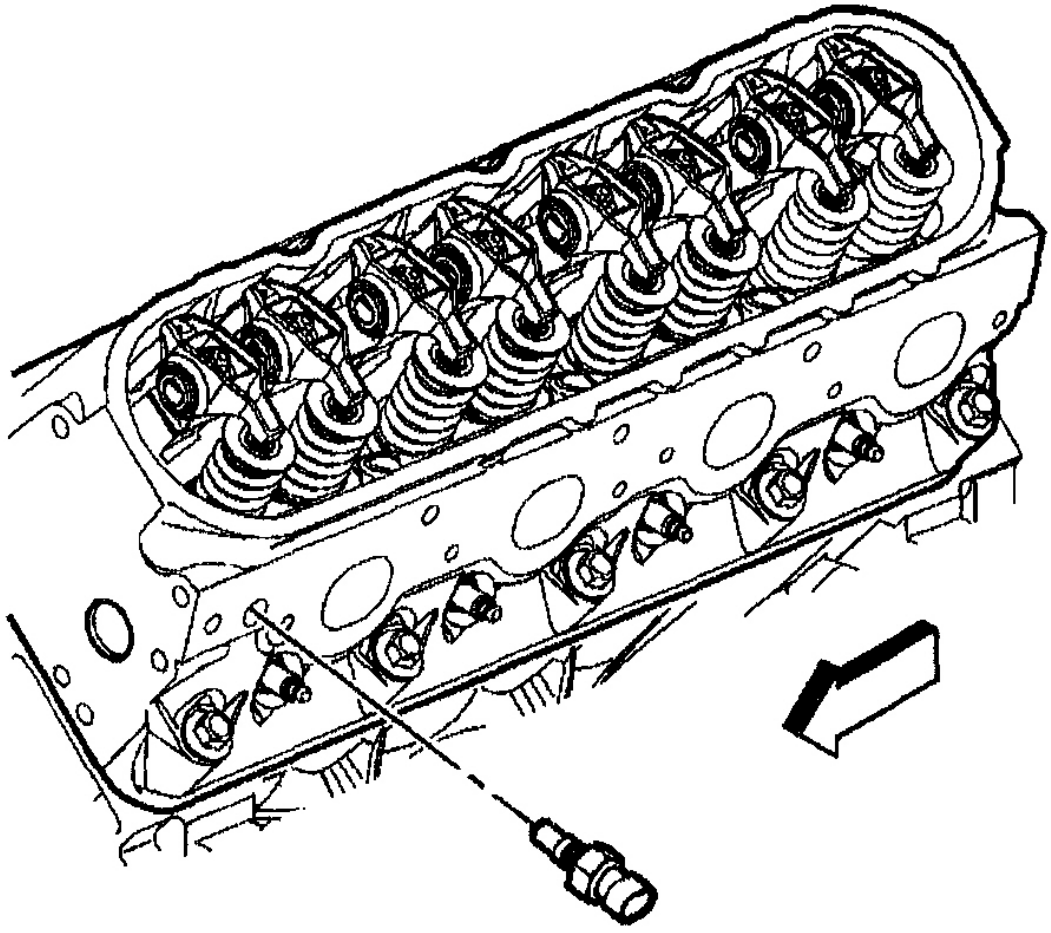


Fig. 236: Cylinder Head Expansion Plug
Courtesy of GENERAL MOTORS CORP.

11. Remove the coolant sensor from the left cylinder head, if required.

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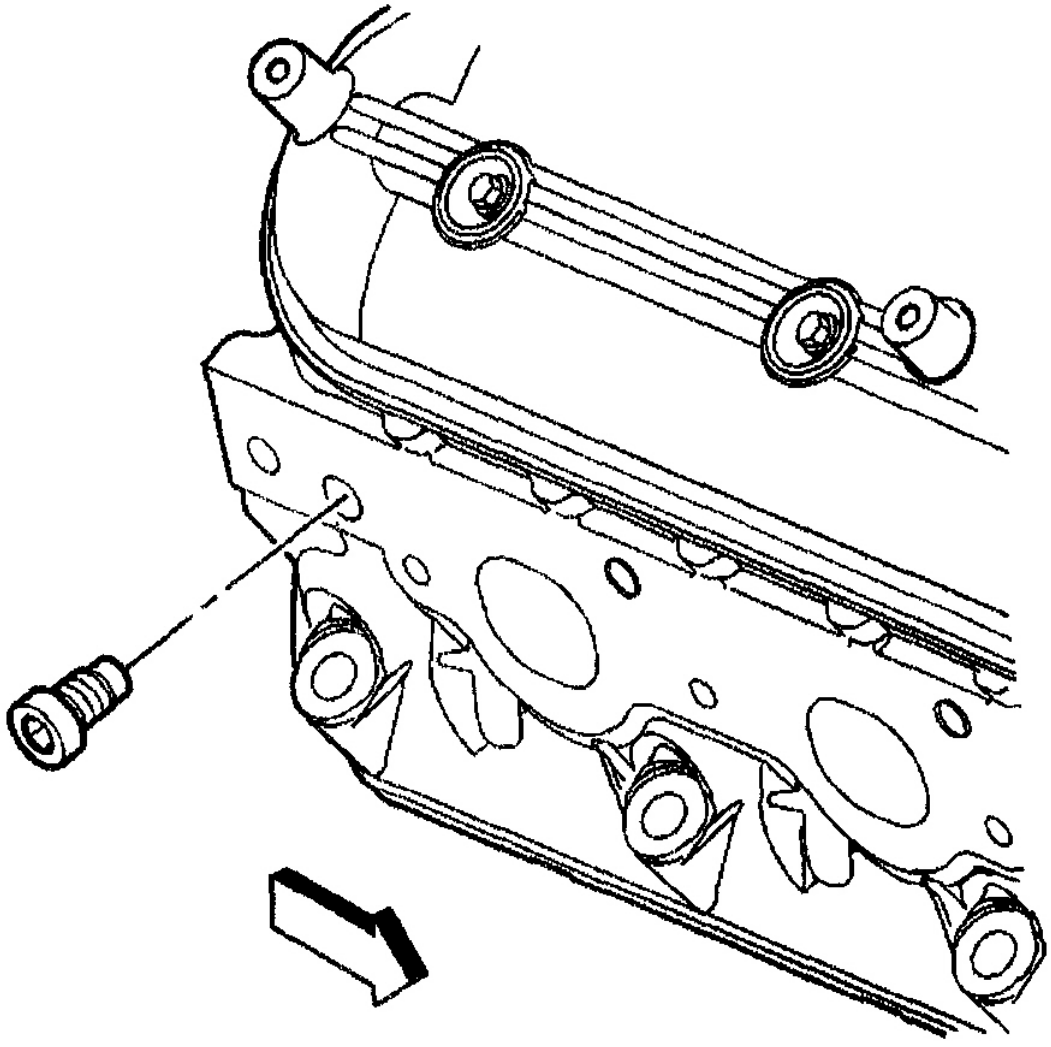


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Fig. 237: Coolant Sensor (Left Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

12. Remove the coolant plug from the right cylinder head, if required.

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Fig. 238: Coolant Plug (Right Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

CYLINDER HEAD CLEANING AND INSPECTION

Tools Required

- **J 8089** Carbon Removing Brush
- **J 9666** Valve Spring Tester

IMPORTANT: When cleaning an cylinder head in a thermal type oven, do not exceed 204° C

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(400° F).

1. Clean the following components:

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

IMPORTANT: Be careful not to scuff the chamber.

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

  Refer to **Replacing Engine Gaskets** .

- Valve stems and heads on a buffing wheel
- Bolt hole threads. Remove all dirt, debris, or threadlocking material from the bolt holes.

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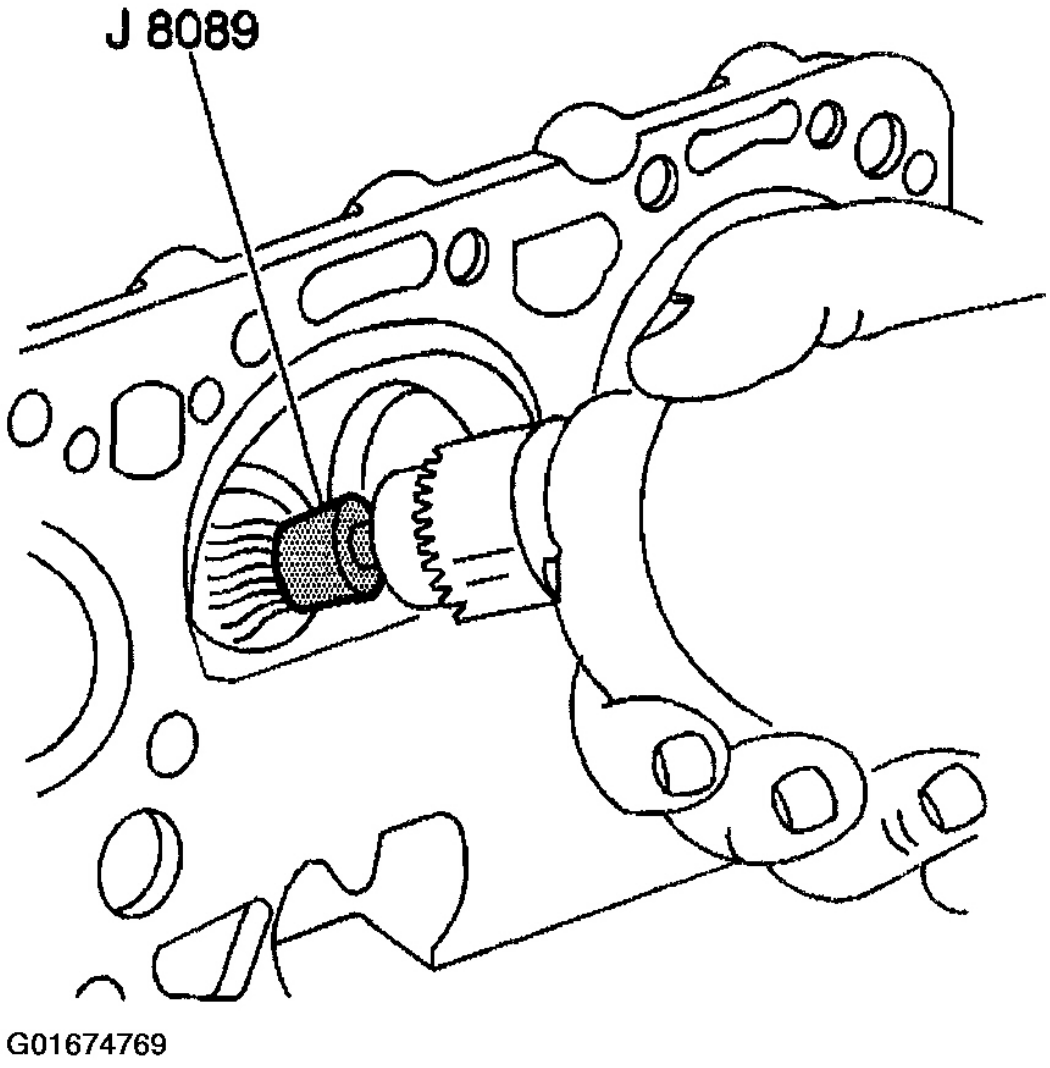


Fig. 239: Removing Carbon From Combustion Chamber Using J 8089
Courtesy of GENERAL MOTORS CORP.

2. Inspect the following:
   2.1. Worn or loose valve seats (10 or 12)
   2.2. The cylinder head for cracks in the exhaust ports and combustion chambers
   2.3. The cylinder head for external cracks in the water chambers
   2.4. The gasket surfaces for excessive scratches or gouging. Refer to **Replacing Engine Gaskets** .
   2.5. The bolt hole threads for debris or damaged threads. Refer to **Thread Repair** or **Thread Repair Specifications** .

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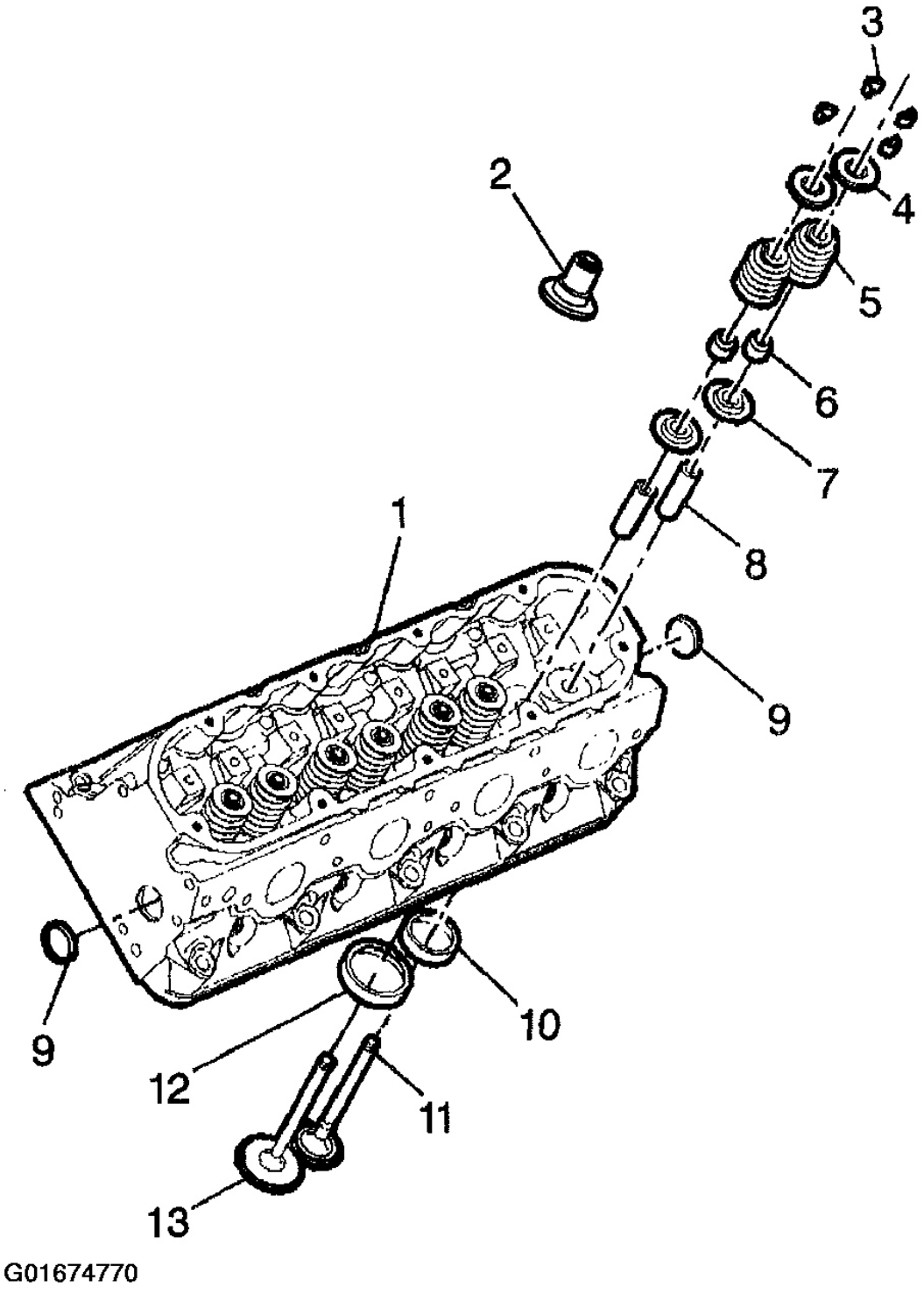


Fig. 240: Valve Components
Courtesy of GENERAL MOTORS CORP.

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3. Inspect the cylinder head for warpage. Refer to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)** .

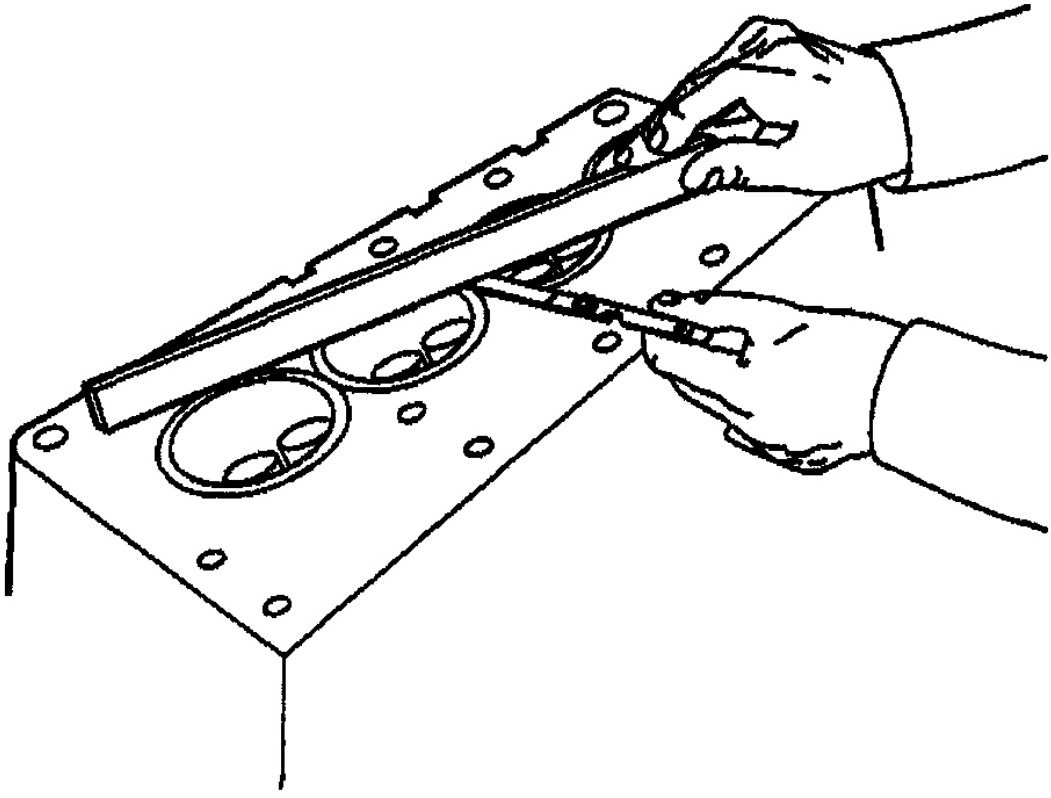


Fig. 241: Inspecting Cylinder Head For Warpage
Courtesy of GENERAL MOTORS CORP.

4. Inspect the valve springs for squareness.

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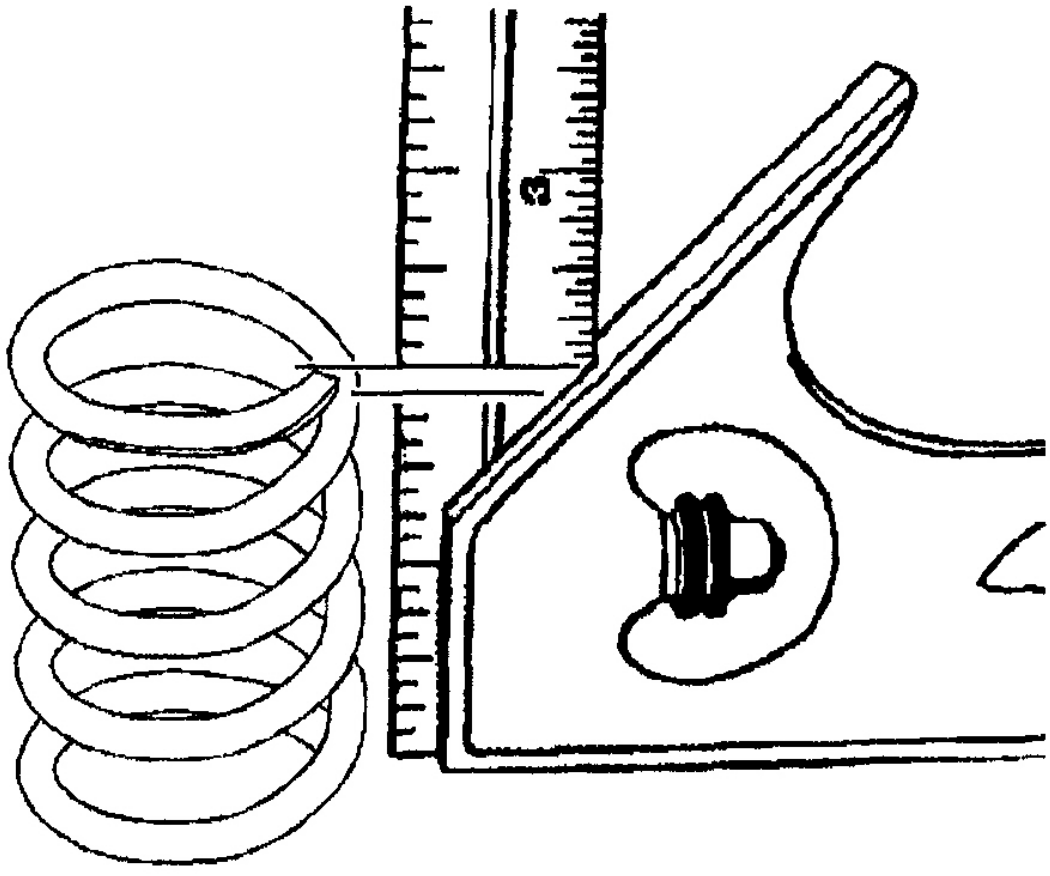


Fig. 242: Inspecting Valve Springs For Squareness
Courtesy of GENERAL MOTORS CORP.

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

   Replace the spring if the spring tension is less than 310 N (70 lb) at 45.75 mm (1.80 in).

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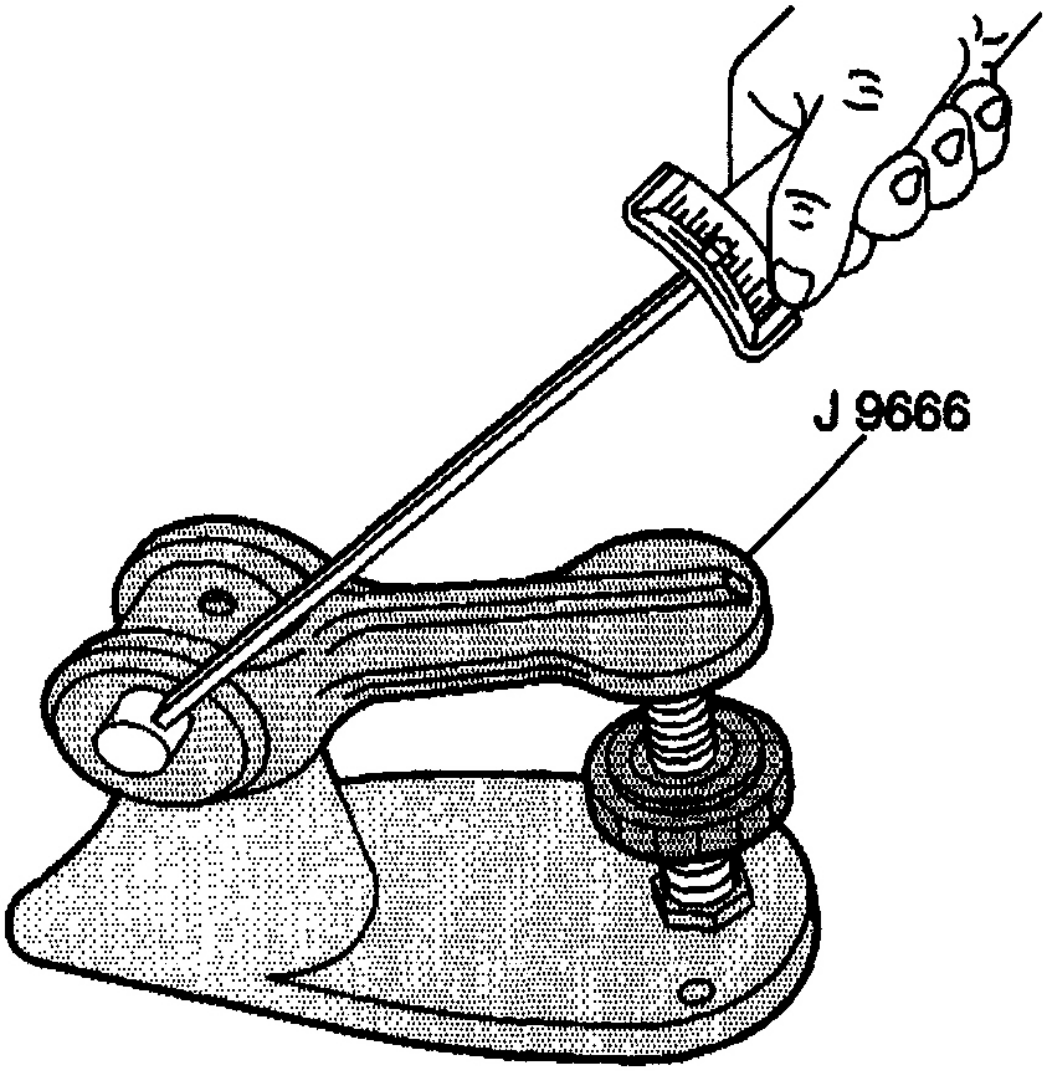


Fig. 243: Measuring Valve Spring Tension Using J 9666
Courtesy of GENERAL MOTORS CORP.

VALVE GUIDE REAMING/VALVE AND SEAT GRINDING

Tools Required

J 37378-1 Valve Guide Reamer

Valve Guide Reaming

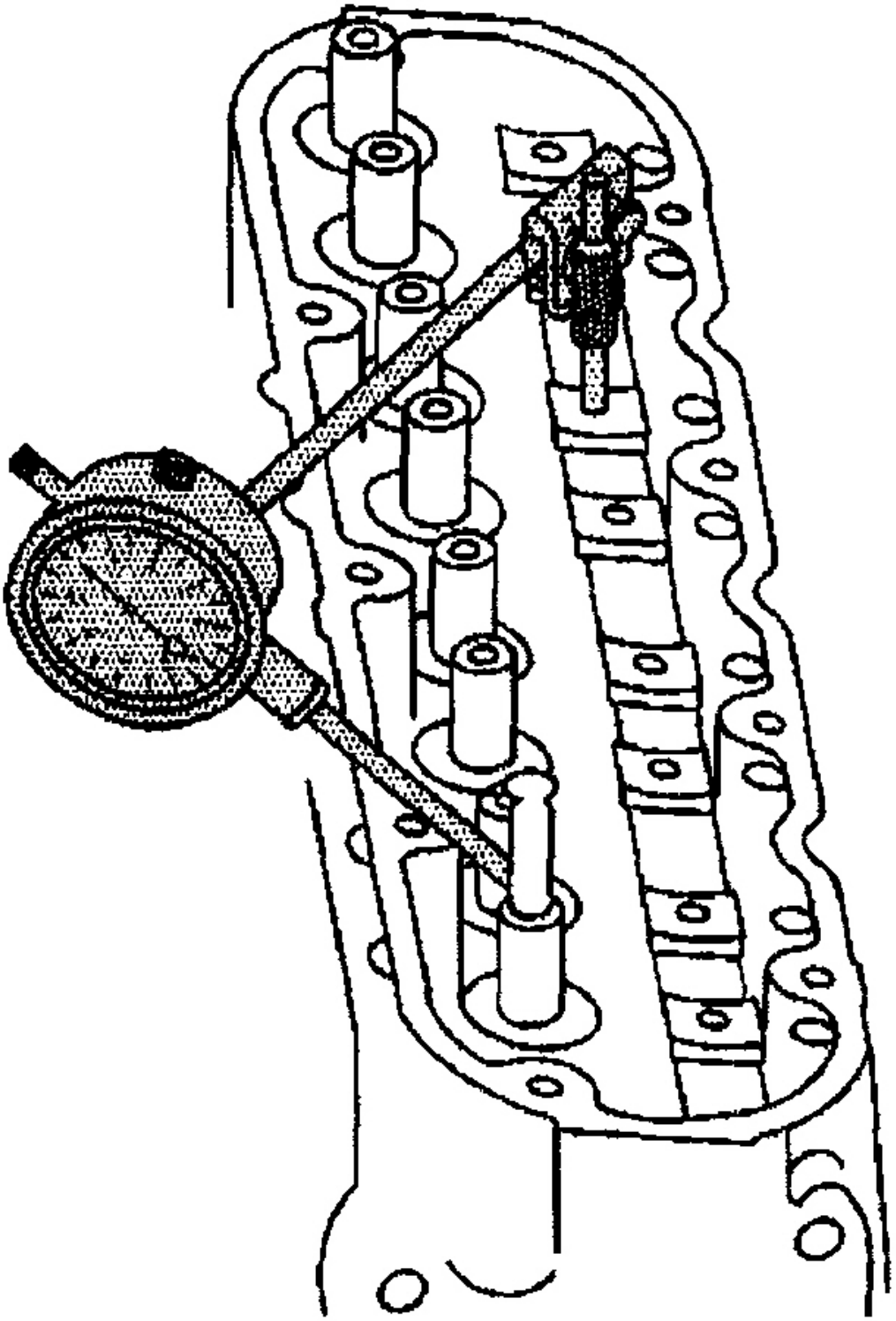
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IMPORTANT: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

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

1. Measure the valve stem-to-guide clearance using a dial indicator. Position the tip of the dial indicator at the top of the valve guide.

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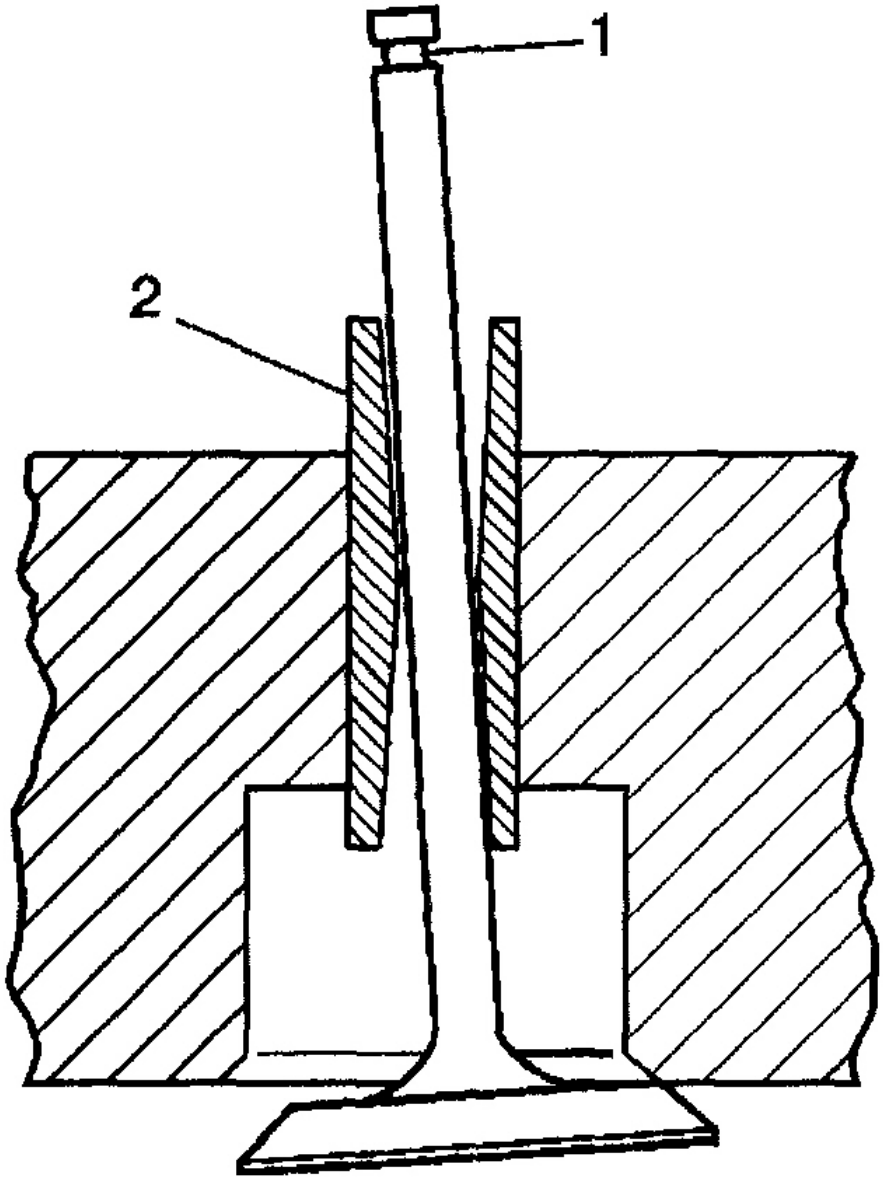
Fig. 244: Measuring Valve Stem-To-Guide Clearance
Courtesy of GENERAL MOTORS CORP.

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

2. A valve stem (1) and guide (2) with excessive clearance must be replaced or the components replaced.

Refer to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)** .

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Fig. 245: Valve Stem & Guide W/Excessive Clearance
Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve stems for excessive scoring, wear, or warpage.
    - A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
    - A valve guide that is worn and has excessive stem-to-guide clearance should be reamed and valves

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with oversize stems installed.

4. Measure the valve stem diameter. A valve stem with a diameter less than 7.95 mm (0.313 in) must be replaced.

   If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the valve guide must be reamed oversize and a valve with oversize stem installed.

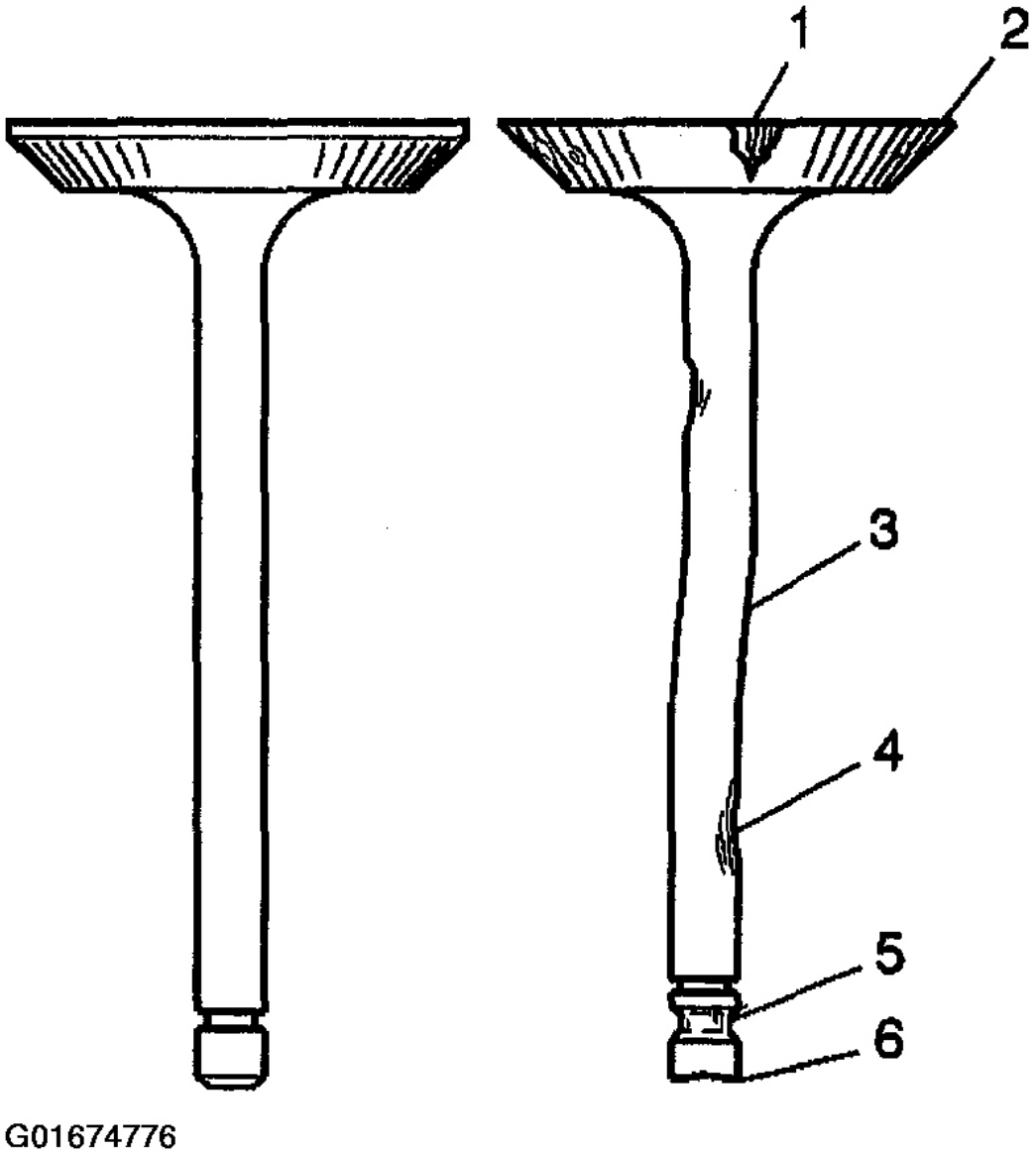


Fig. 246: Valve Stems Inspection Areas
Courtesy of GENERAL MOTORS CORP.

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5. Ream the valve guide using the **J 37378-1.**
6. Clean the guide bore of all metal shavings and debris.

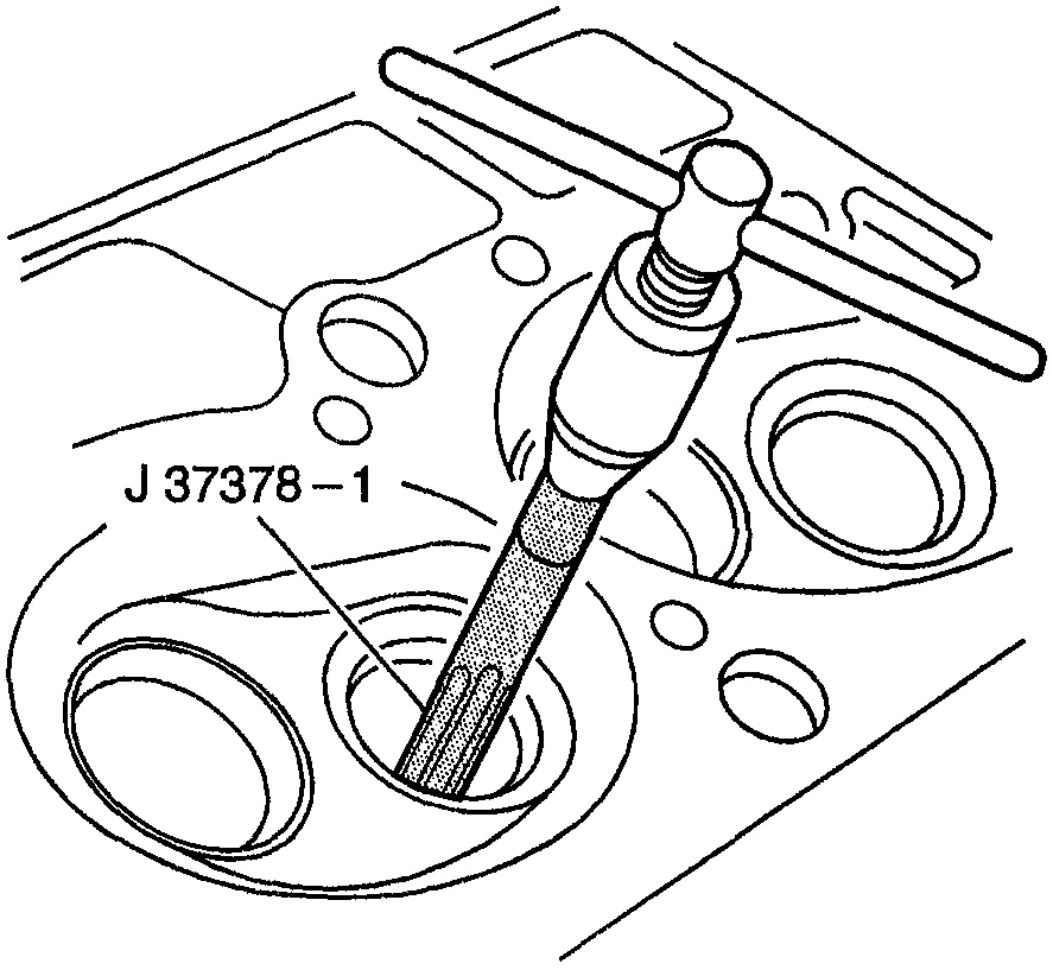
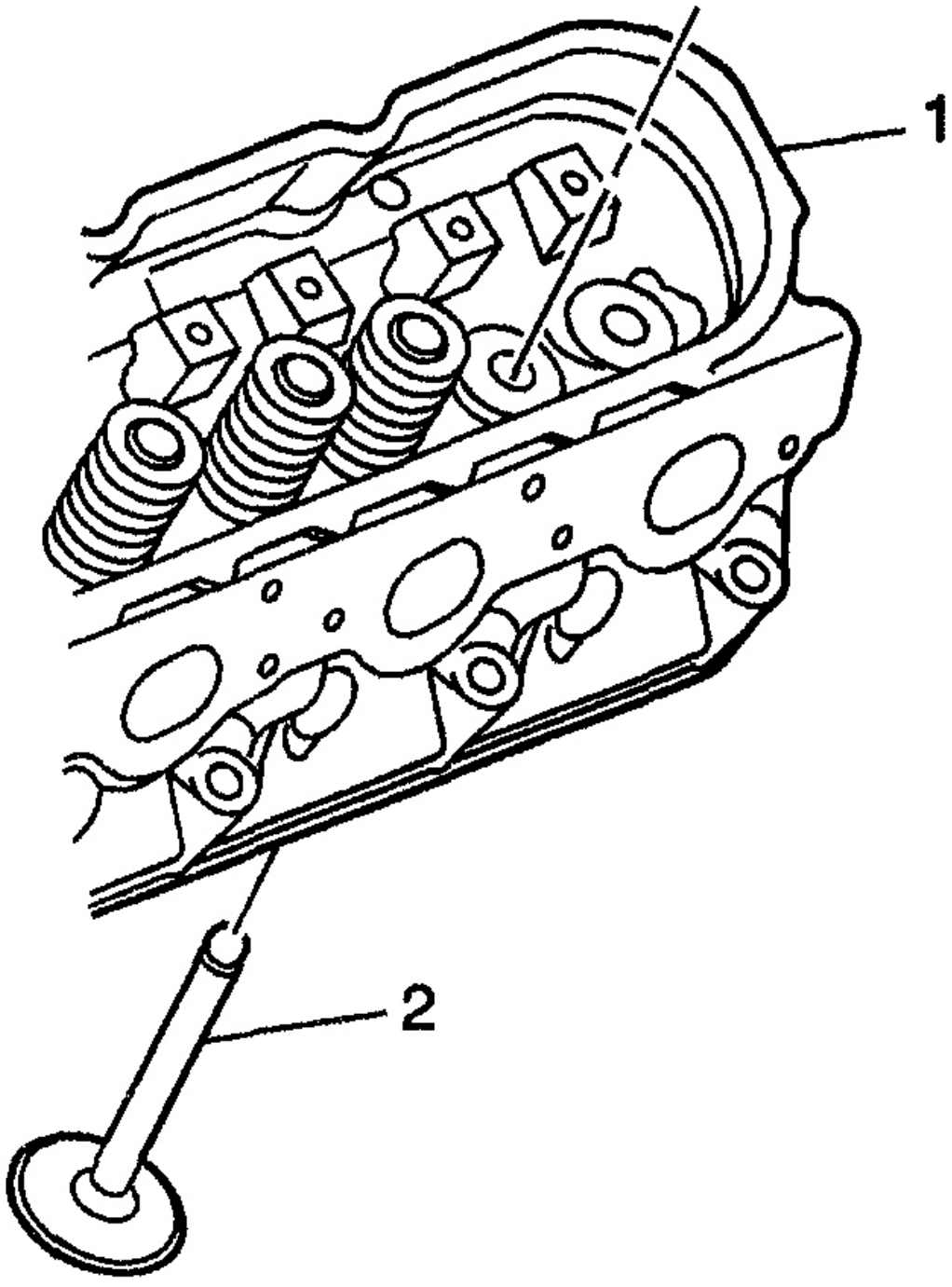


Fig. 247: Reaming Valve Guide Using J 37378-1
Courtesy of GENERAL MOTORS CORP.

7. Install the valve (2) (with oversize stem) into the cylinder head (1).
8. Inspect the valve for the proper fit.

   Move the valve back and forth in the guide. The valve should move freely with no resistance or drag.

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Fig. 248: Valve & Cylinder Head
Courtesy of GENERAL MOTORS CORP.

Valve and Seat Grinding

Important:

- Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.
- Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.
- The recommendations of the manufacturer of the equipment should be followed carefully to obtain the proper results. Regardless of what type of equipment is used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

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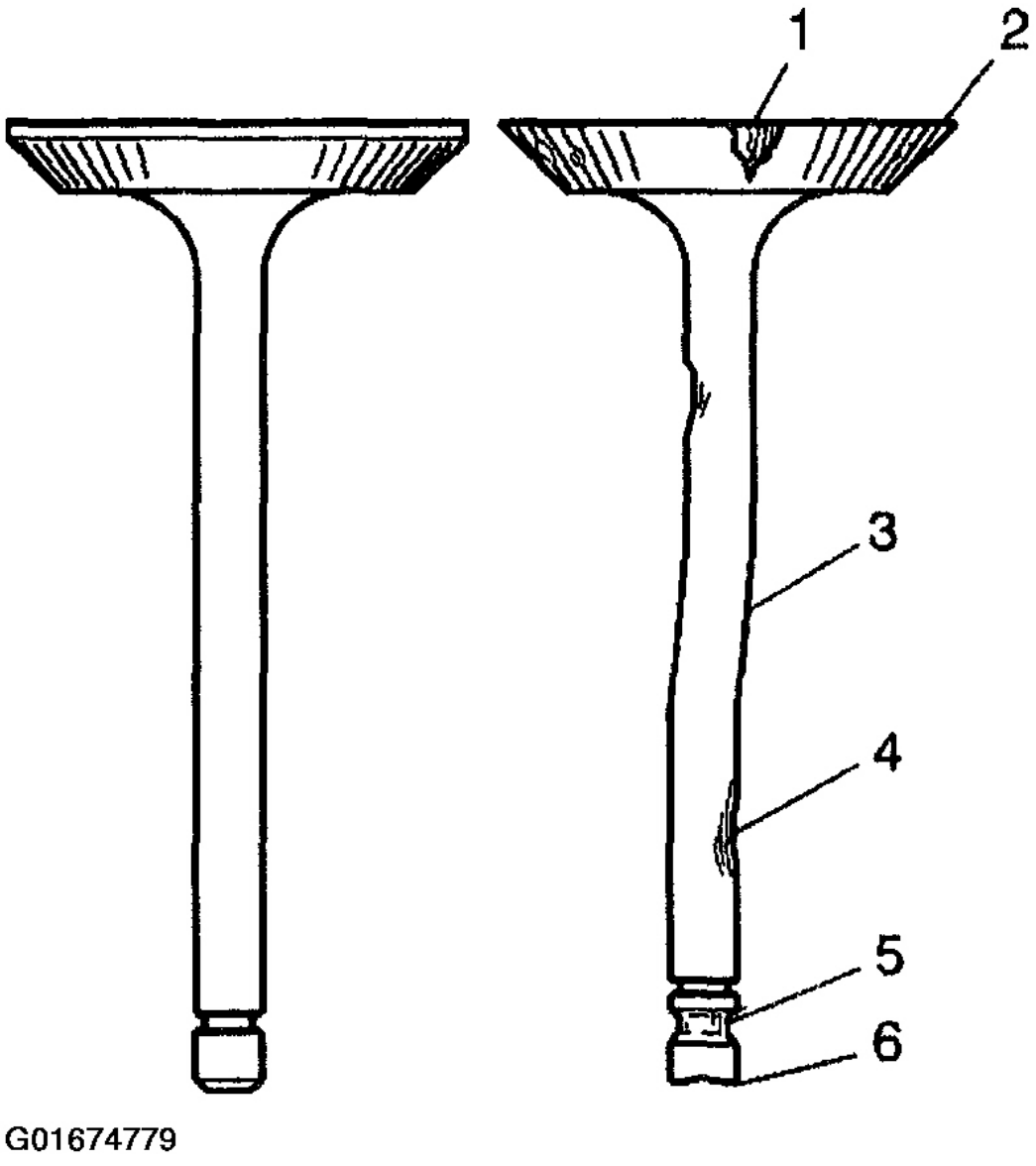


Fig. 249: Valve Stems Inspection Areas
Courtesy of GENERAL MOTORS CORP.

- Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1.25 mm (0.05 in) after grinding, replace the valve.
- Several different types of equipment are available for refacing valves. The recommendation of the

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manufacturer of the equipment should be carefully followed to obtain the proper results.

- DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.

1. Inspect the valve for the following:
    - Burnt or eroded areas (1)
    - A worn margin (2)
    - A bent stem (3)
    - A worn or scored stem (4)
    - A worn key groove (5)
    - A worn stem tip (6)
2. Inspect the valve face for the following:
    - Worn or no margin (1 or 4)
    - Pitted surfaces (2)
    - Burnt or eroded areas (3)

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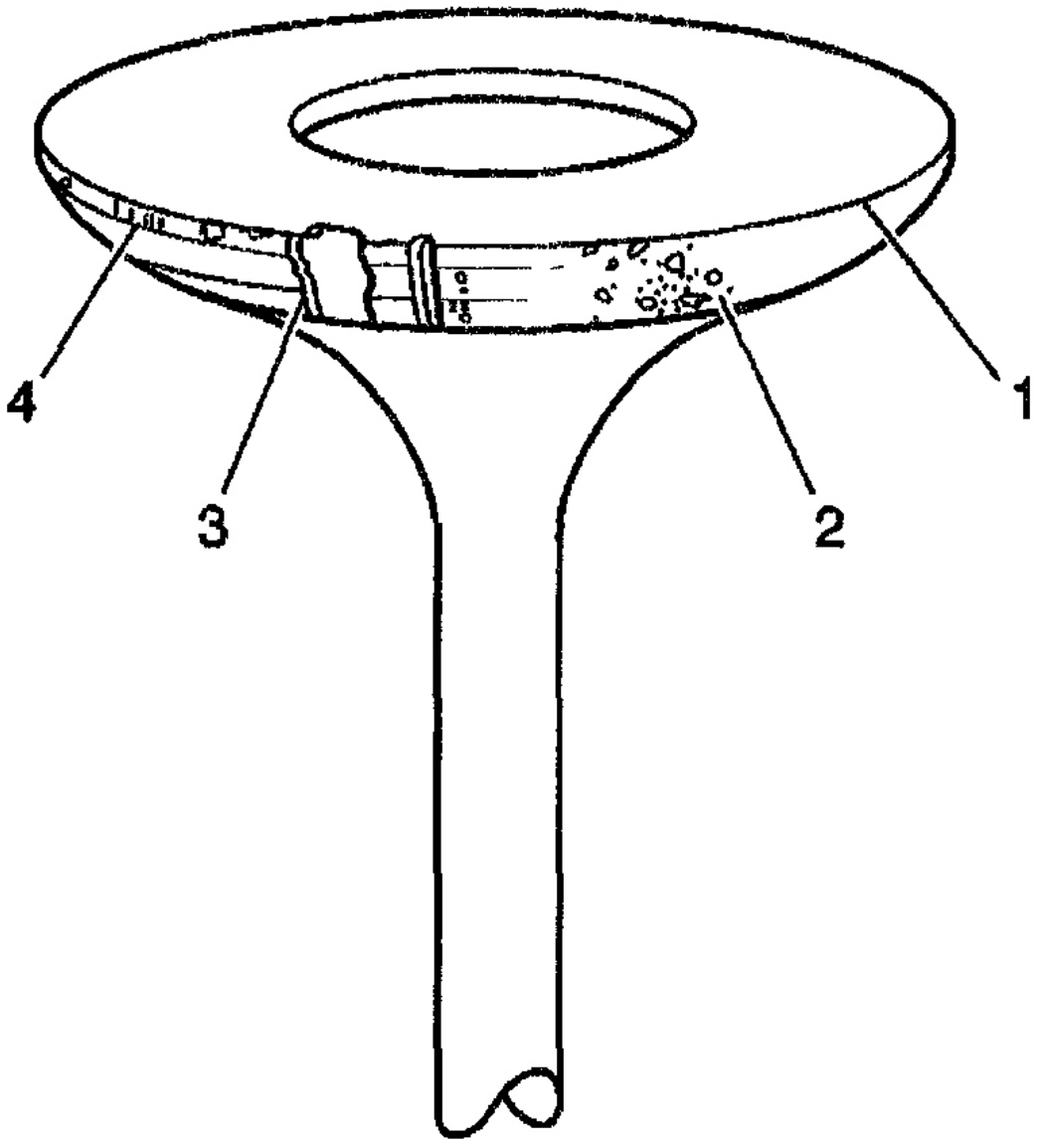


Fig. 250: Valve Face Inspection Areas
Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve margin.

   The exhaust valve may be refaced if the margin is greater than 1.25 mm (0.05 in) thick before grinding.

4. Reface pitted exhaust valves on a suitable valve refacing machine.

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5. Replace the valve if the margin is less than 1.25 mm (0.05 in) thick after grinding.
6. If the valve face has been ground, it may be necessary to shim the valve spring to obtain the proper spring installed height. Refer to **Cylinder Head Disassemble** .

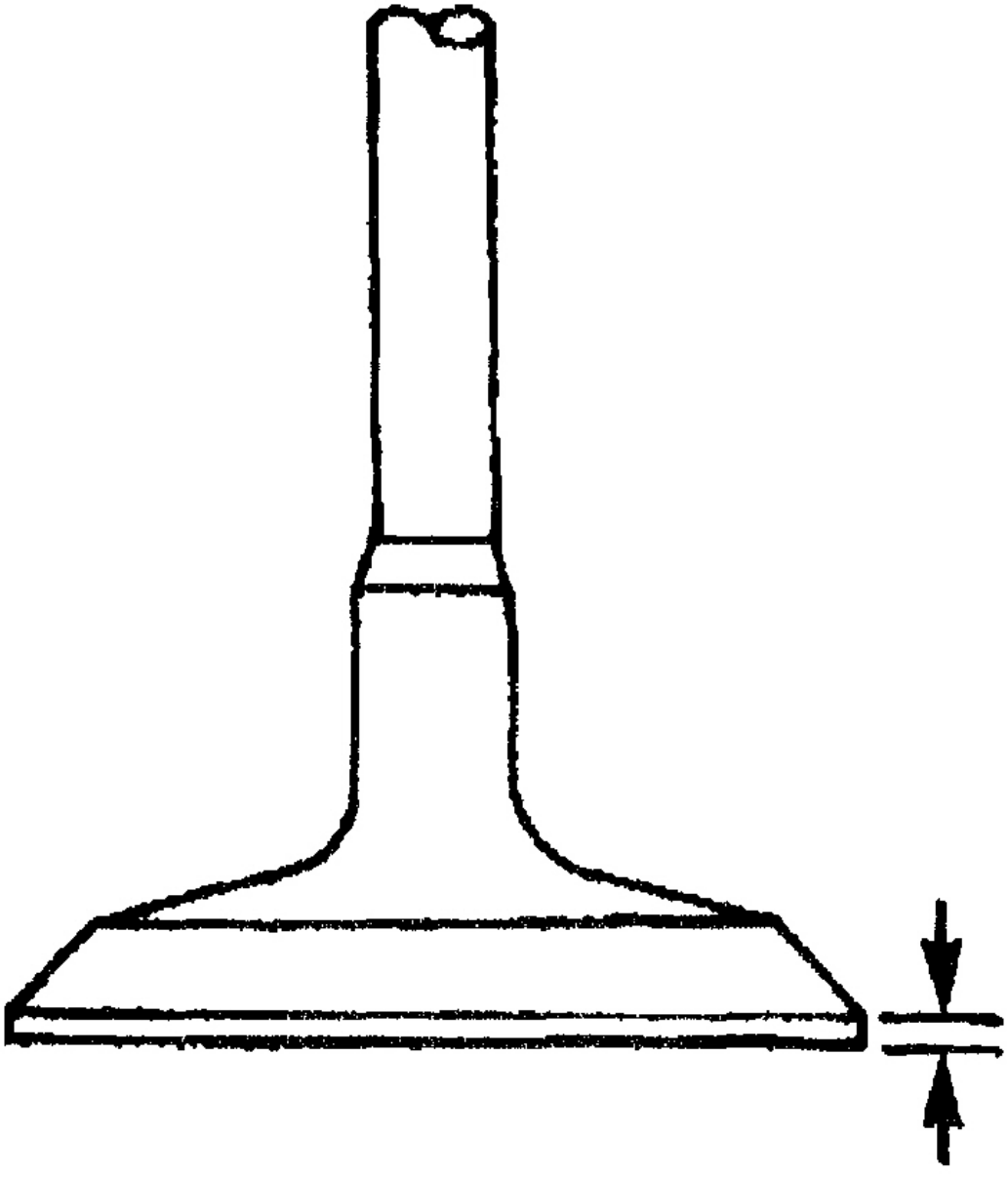


Fig. 251: Inspecting Valve Margin
Courtesy of GENERAL MOTORS CORP.

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7. Inspect for a loose valve seat (9 or 11) in the cylinder head (1). The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide (7) bores with a suitable tool. Remove all carbon or dirt from the bores.

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

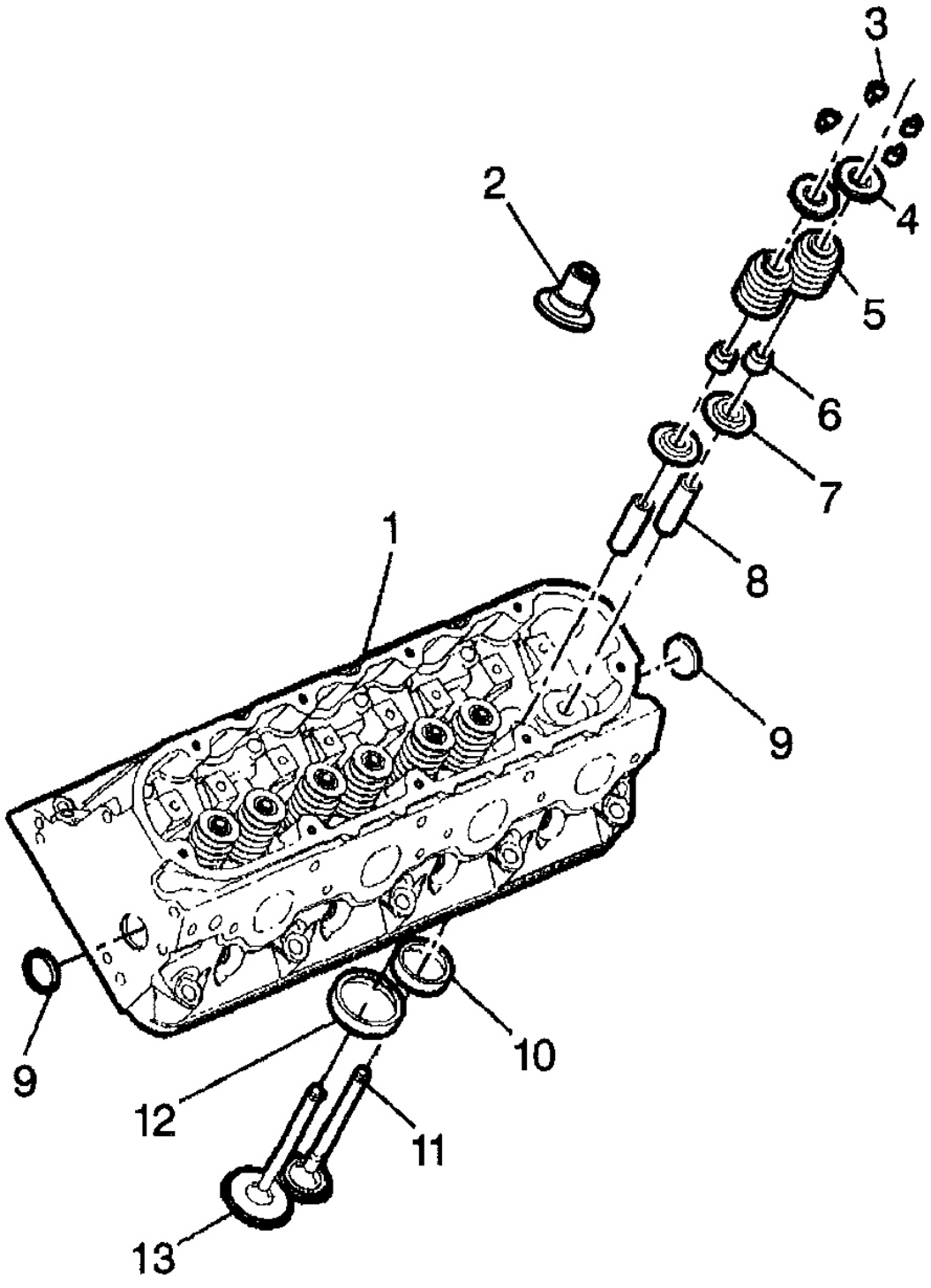
9. Grind the valve seat.

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

10. Inspect the valve seats.
    - The valve seats should be concentric to within 0.05 mm (0.0021 in) total indicator reading.
    - If the valve seat has been ground, it may be necessary to shim the valve spring to attain the proper spring installed height.

      Refer to **Cylinder Head Disassemble** .

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Fig. 252: Valve Components
Courtesy of GENERAL MOTORS CORP.

CYLINDER HEAD ASSEMBLE

Tools Required

- **J 8062** Valve Spring Compressor
- **J 42078** Valve Stem Oil Seal Installer

1. Clean the cylinder head valve spring seat and/or shim area.

IMPORTANT: When reusing the valves and related components, install the parts to their original location.

2. Install the valves (11 and 13) into the proper guides. Refer to **Separating Parts** .
3. Install the valve spring shim (7), first design.
4. Install the valve stem oil seal and shim assembly, second design.

J 42078 is not required for installation of the second design seal and shim assembly. A separate spring shim is not required with the second design seal and shim assembly.

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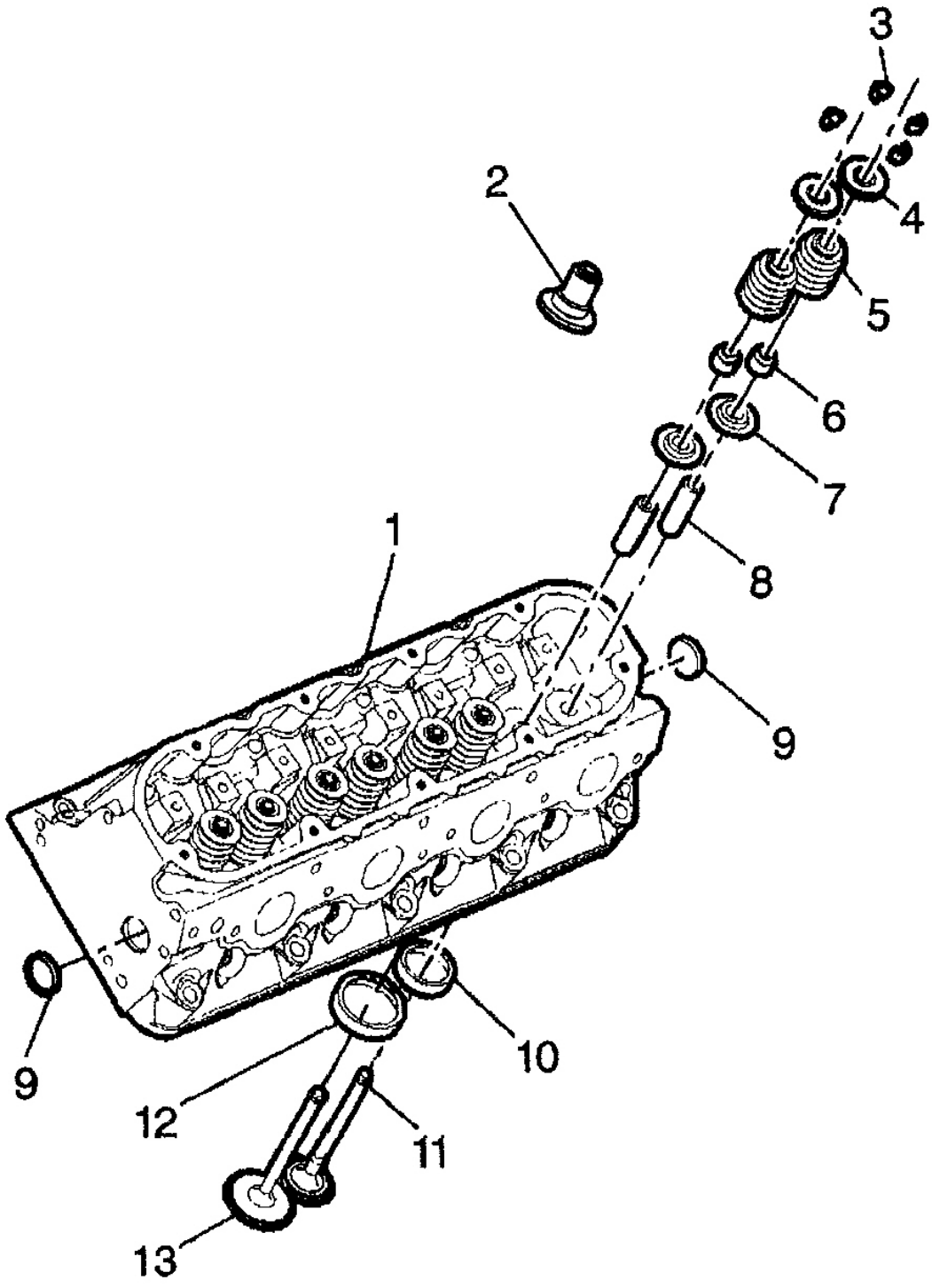


Fig. 253: Valve Components

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Courtesy of GENERAL MOTORS CORP.

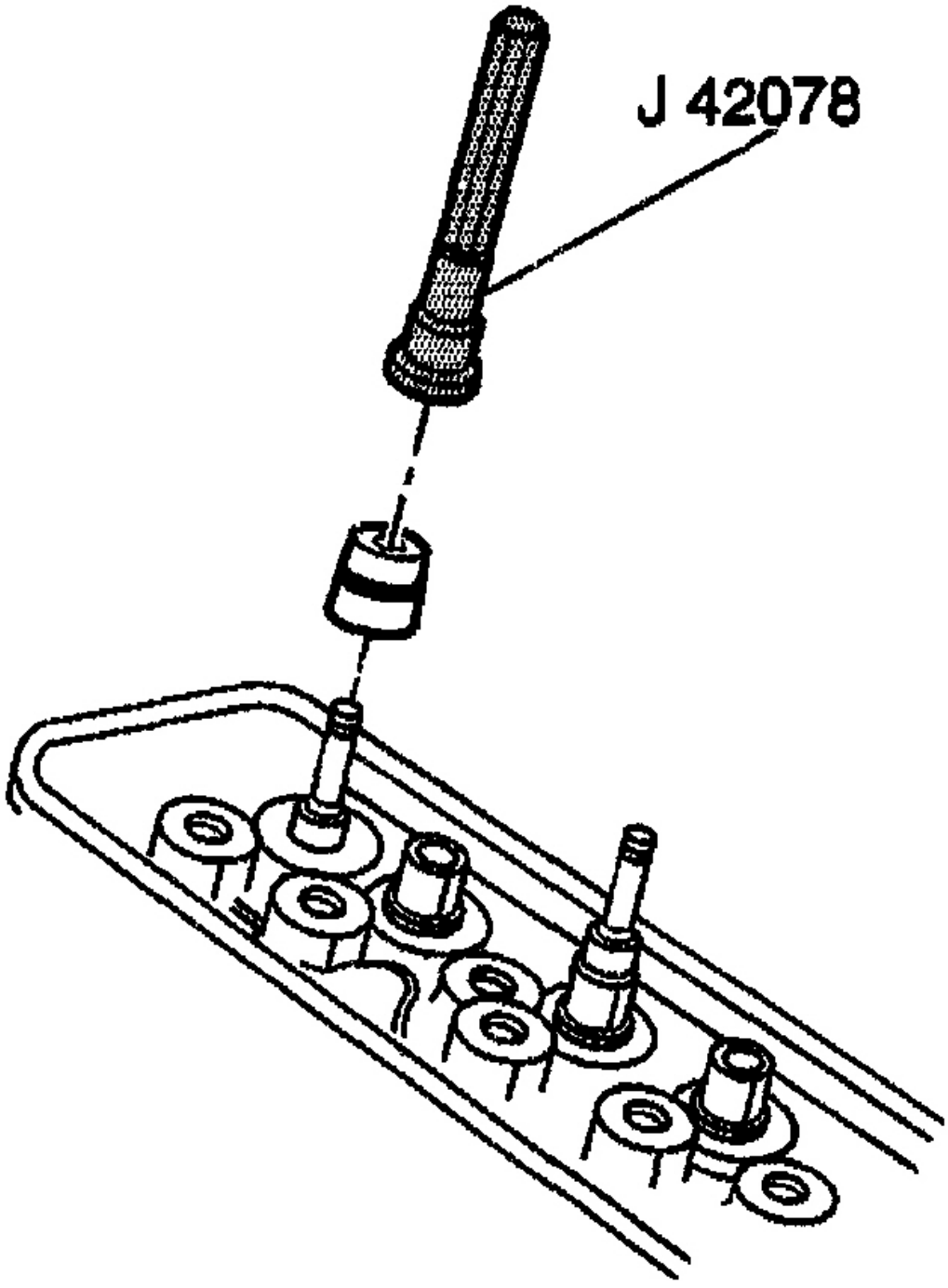
IMPORTANT: The valve stem oil seal alignment and position on the valve guide is critical.

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

5. Install the valve stem oil seal, first design, onto the guide.
   5.1. Lubricate the valve guide and valve stem oil seal with clean engine oil.
   5.2. Install the valve stem oil seal, first design, onto the valve stem. Push the seal down until the seal contacts the valve guide.
   5.3. Use the **J 42078** in order to install the valve stem oil seal.

   Push or lightly tap the tool until the tool bottoms against the valve spring shim.

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Fig. 254: Installing Valve Stem Oil Using J 42078
Courtesy of GENERAL MOTORS CORP.

6. Measure the valve stem oil seals, first design, for the properly installed height.

   There should be a 18.1-19.1 mm (0.712-0.752 in) gap between the top edge of the oil seal body and the valve spring shim surface.

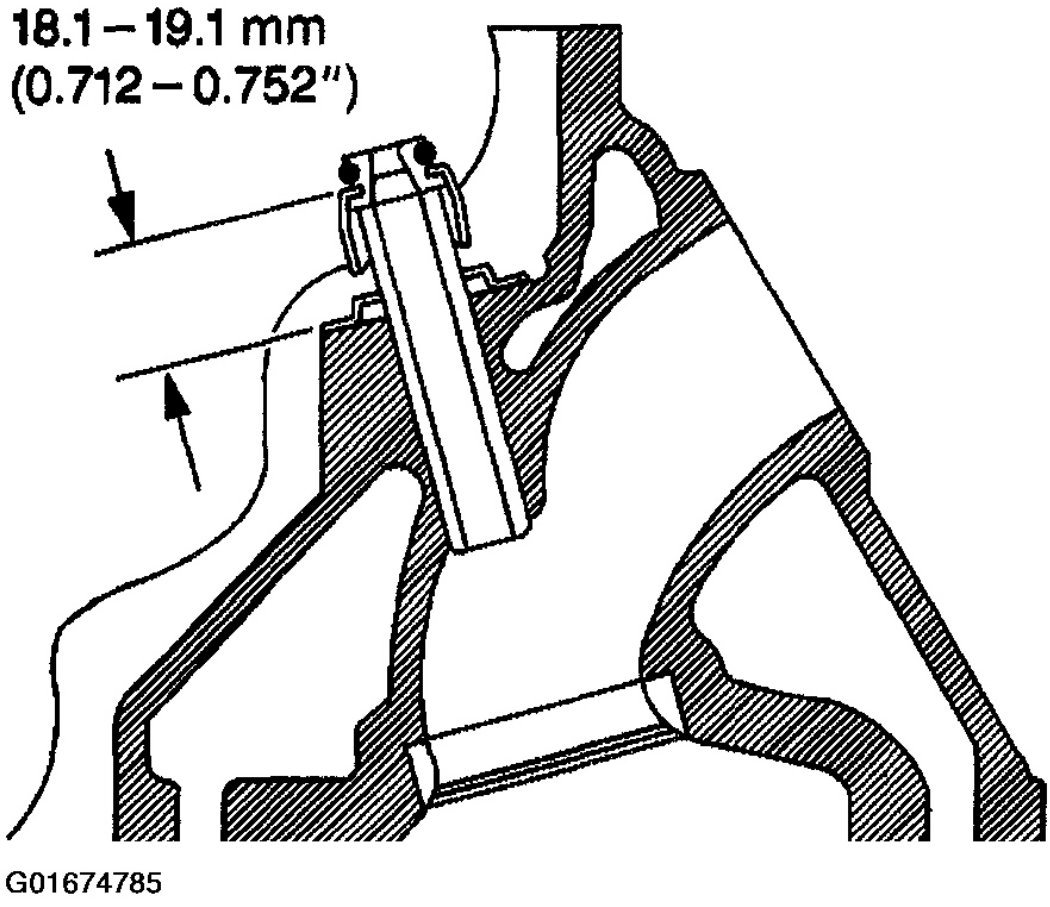


Fig. 255: Measuring Valve Stem Oil Seals
Courtesy of GENERAL MOTORS CORP.

7. Install the valve spring (5).
8. Install the valve spring cap (4).

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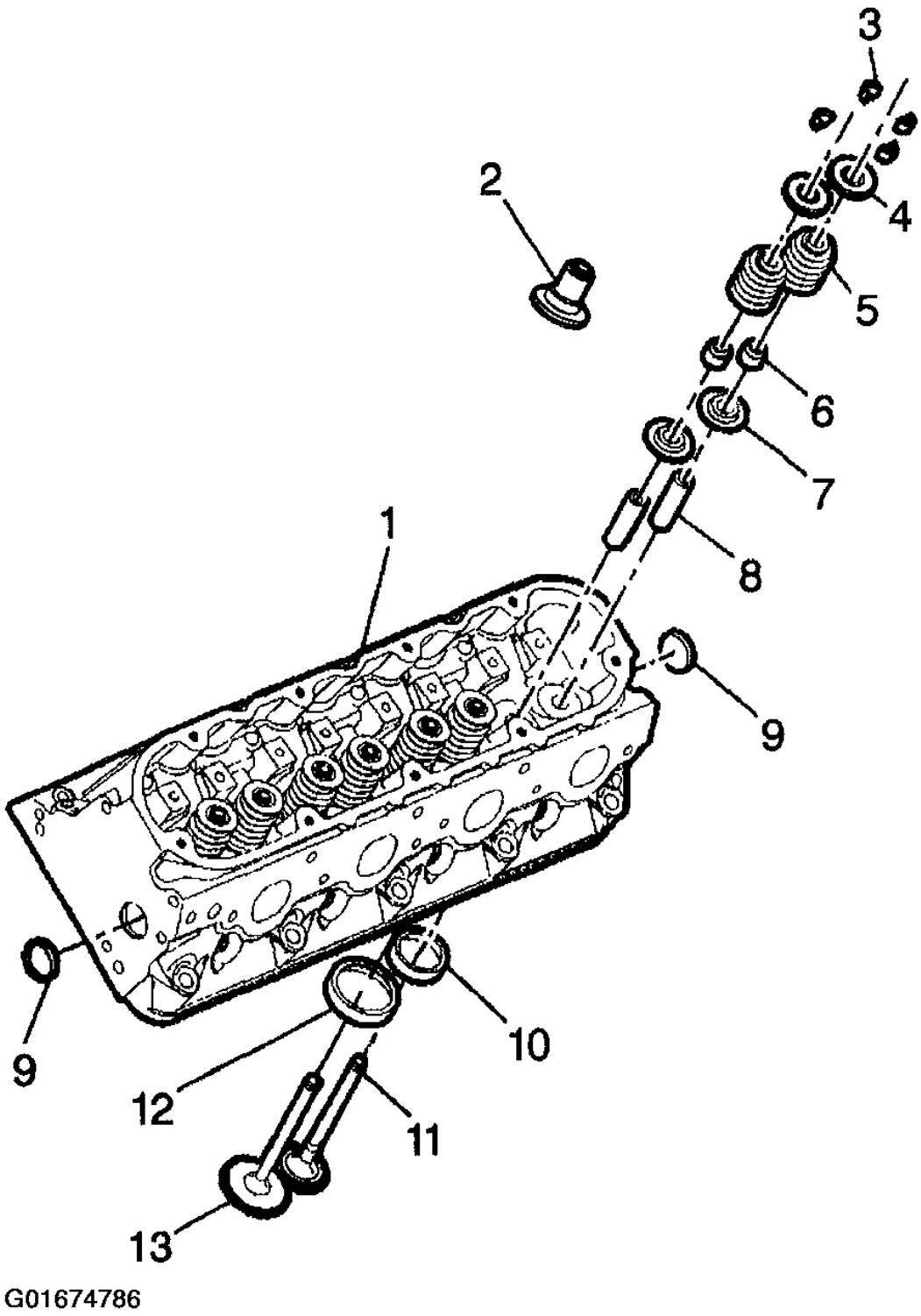


Fig. 256: Valve Components

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Courtesy of GENERAL MOTORS CORP.

9. Compress the valve spring using the **J 8062.**
10. Install the valve stem keys.
    - 10.1. Use grease to hold the keys in place and remove the **J 8062.**
    - 10.2. Make sure the keys seat properly in the groove of the valve stem.
    - 10.3. Tap the end to the valve stem with a plastic faced hammer to seat the keys, if necessary.

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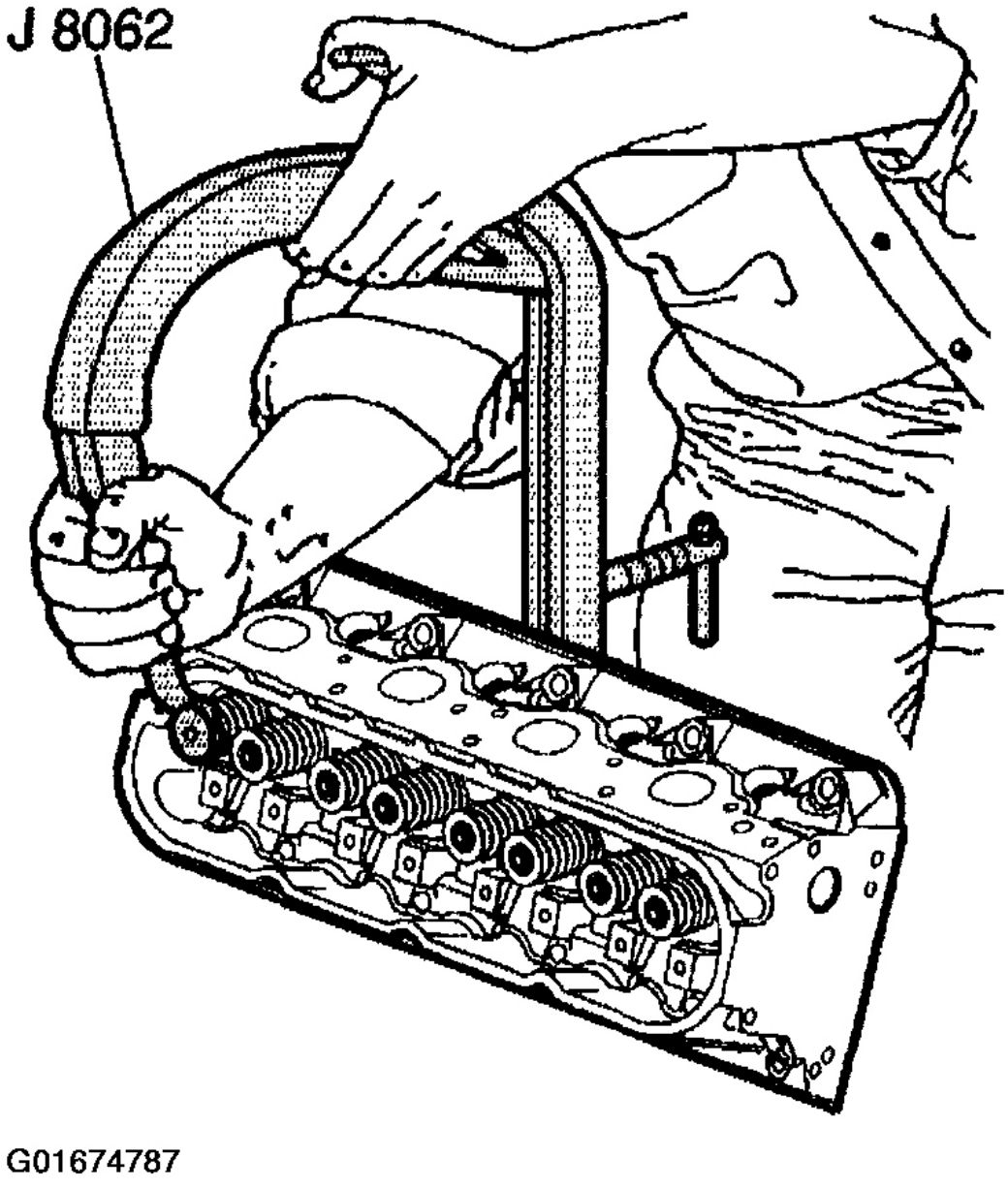


Fig. 257: Compressing Valve Spring Using J 8062
Courtesy of GENERAL MOTORS CORP.

11. Measure the valve spring installed height using a ruler. Measure from the base of the spring to the top of the spring.

    If the installed height exceeds 46.25 mm (1.82 in), install a valve seat spring shim of approximately 0.5 mm (0.02 in) thick.

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Do not shim the valve spring to obtain less than the specified height.

Do not assemble the components without a spring shim on the cylinder head, aluminum head.

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

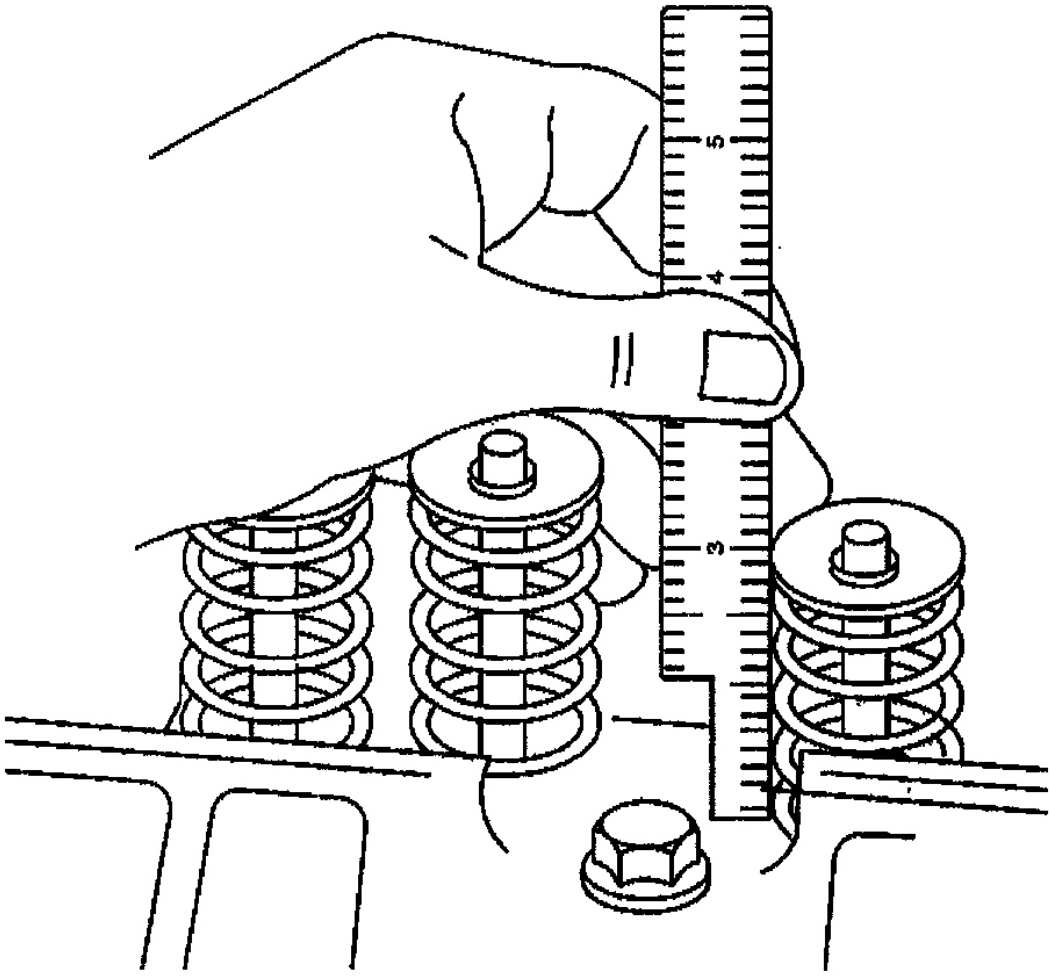


Fig. 258: Measuring Valve Spring Installed
Courtesy of GENERAL MOTORS CORP.

13. Install sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the coolant sensor.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

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14. Install the coolant sensor into the left cylinder head.

Tighten

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

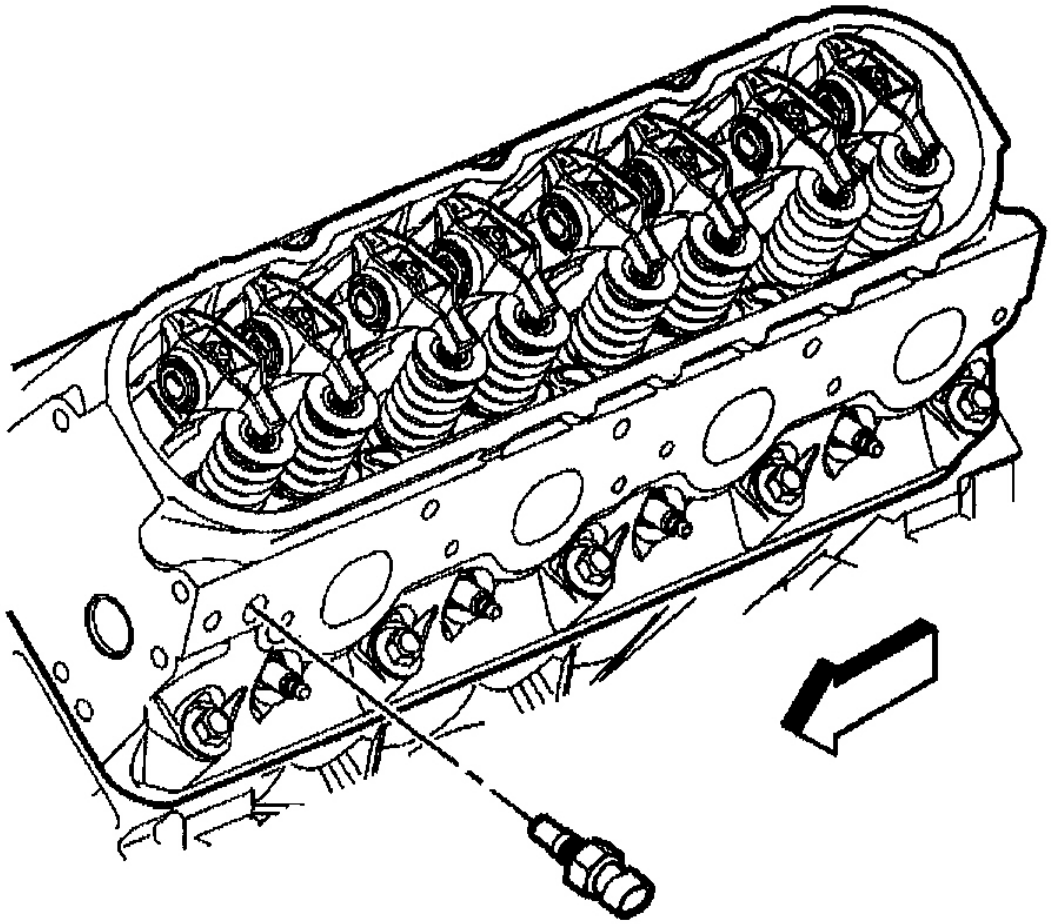


Fig. 259: Coolant Sensor (Left Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

15. Install the coolant plug to the right cylinder head.

Tighten

Tighten the coolant plug to 20 N.m (15 lb ft).

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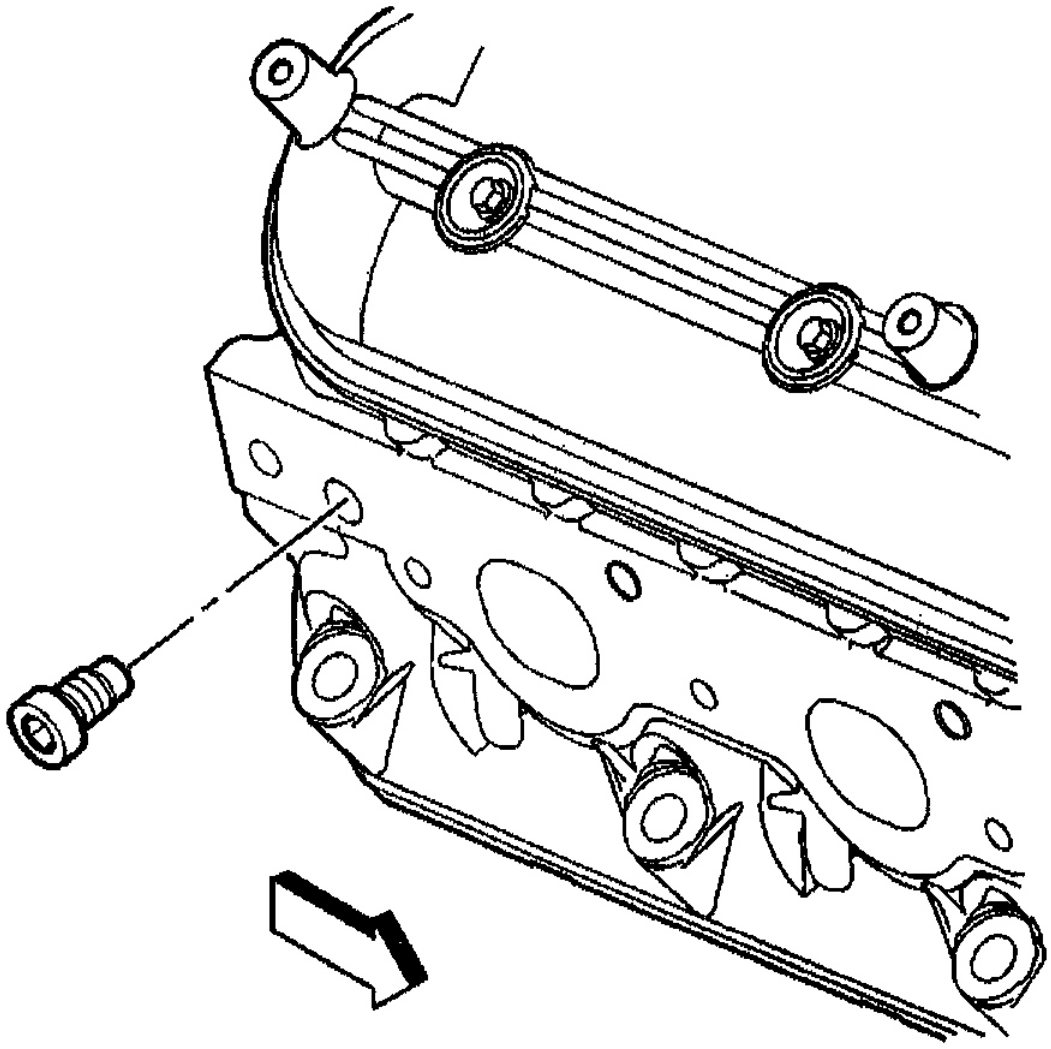


Fig. 260: Coolant Plug (Right Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

16. Apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the sides of the cylinder head expansion plugs (1), if applicable.
17. Install the expansion plugs into the cylinder head, aluminum head.

    A properly installed plug should be slightly below flush with the face of the head.

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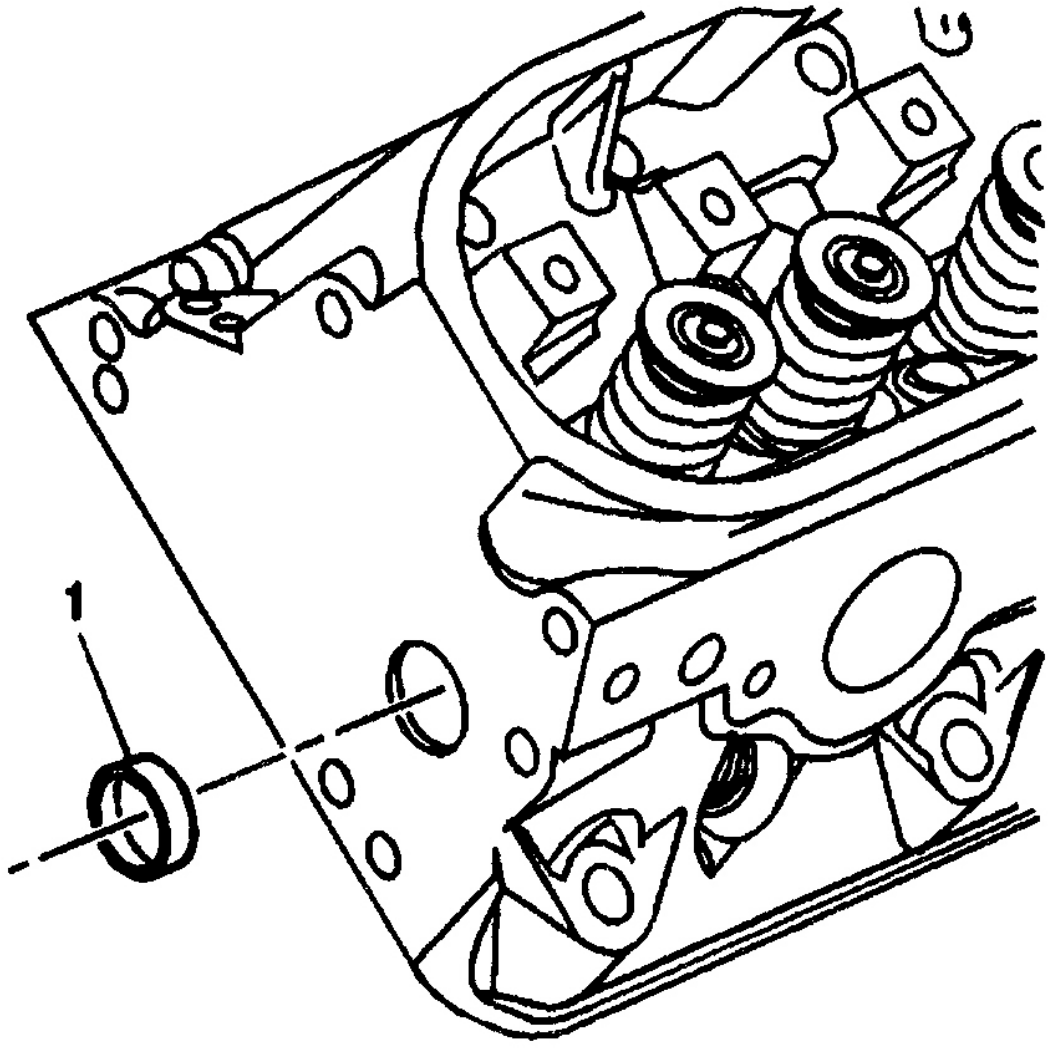


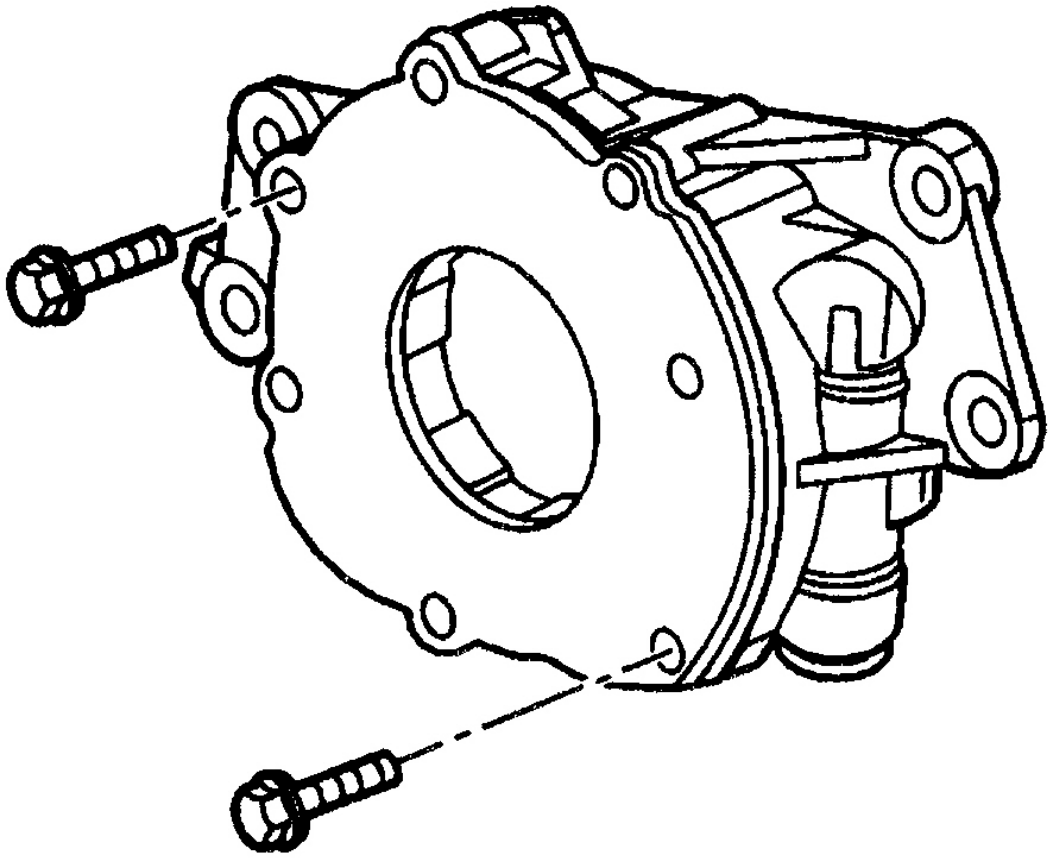
Fig. 261: Expansion Plugs
Courtesy of GENERAL MOTORS CORP.

OIL PUMP DISASSEMBLE

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

1. Remove the oil pump cover bolts.

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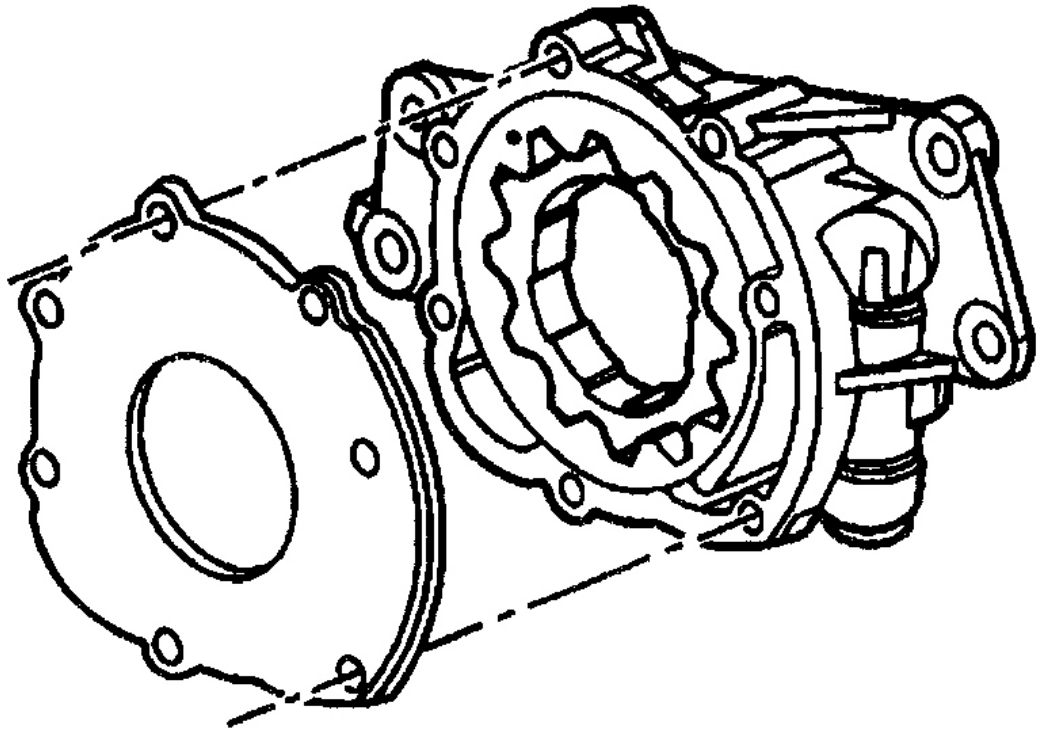


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Fig. 262: Oil Pump Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pump cover.

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Fig. 263: Oil Pump Cover
Courtesy of GENERAL MOTORS CORP.

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

3. Remove the drive gear.

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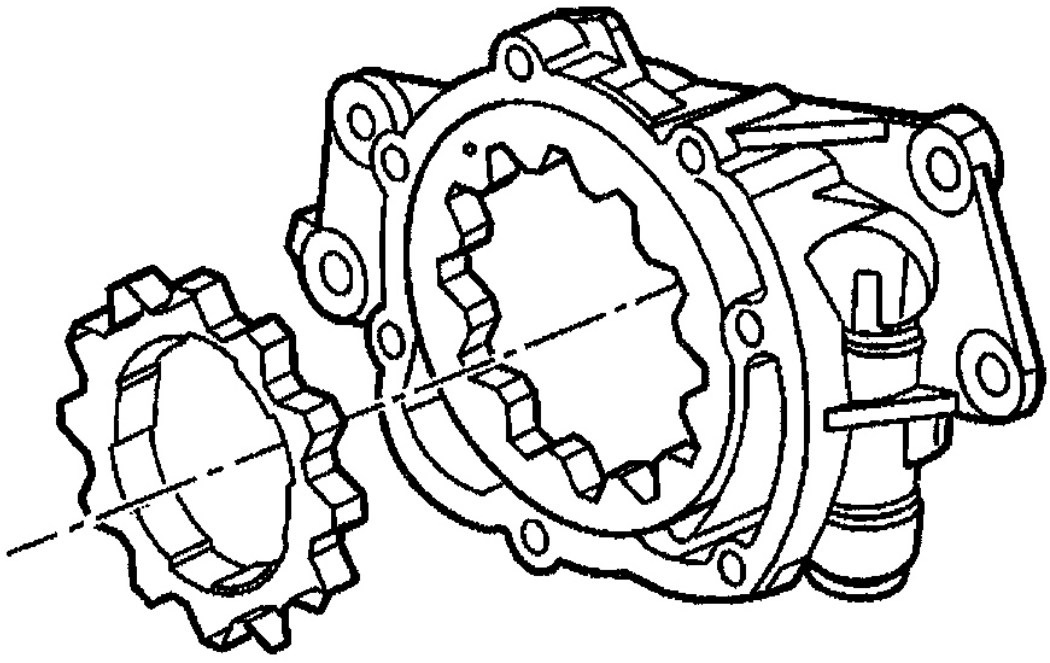
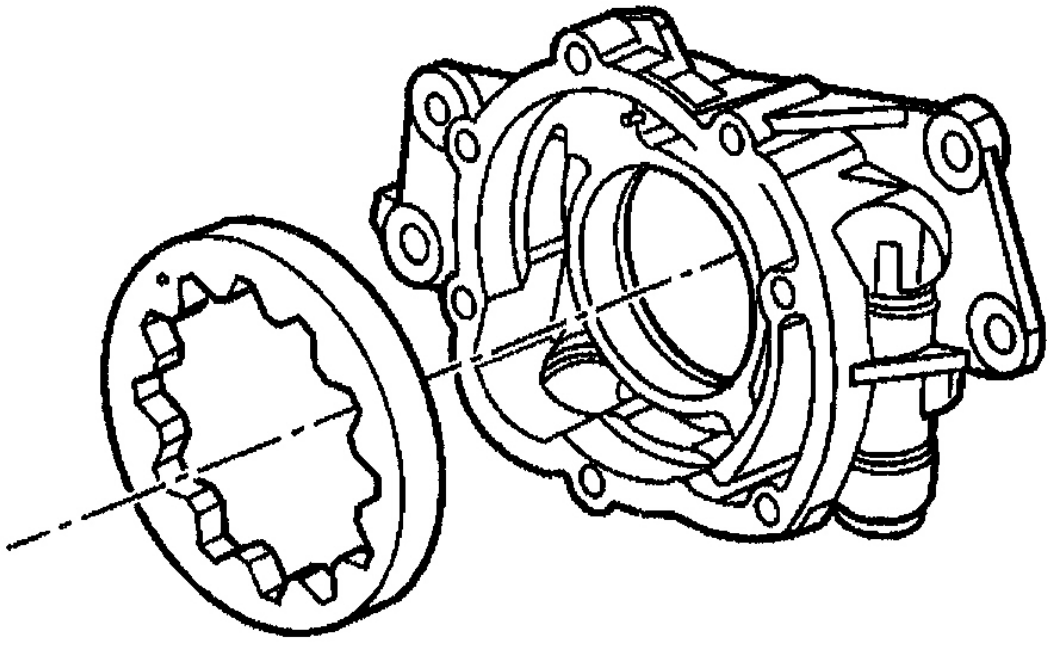


Fig. 264: Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

4. Remove the driven gear.

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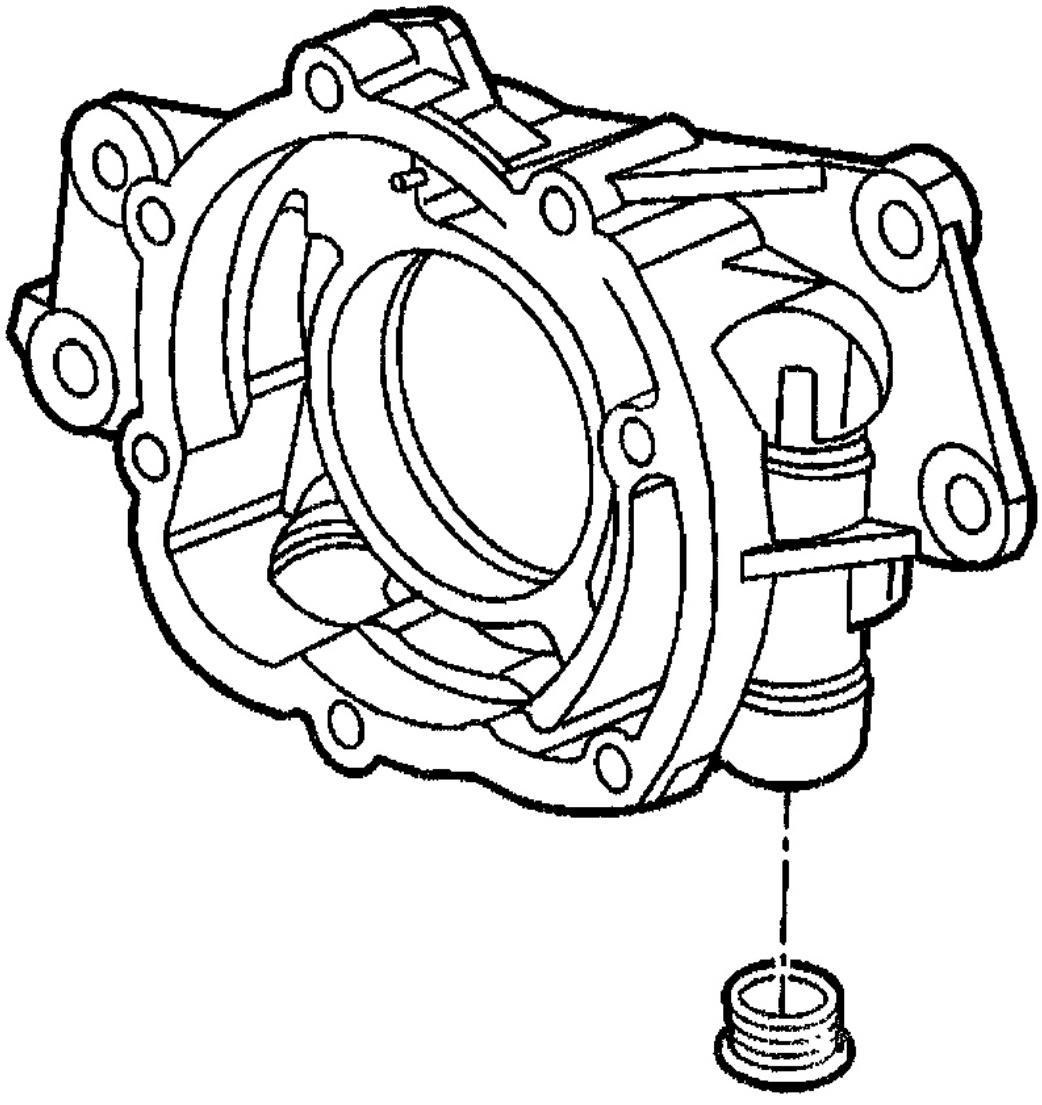


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Fig. 265: Oil Pump Driven Gear
Courtesy of GENERAL MOTORS CORP.

5. Remove the pressure relief valve plug.

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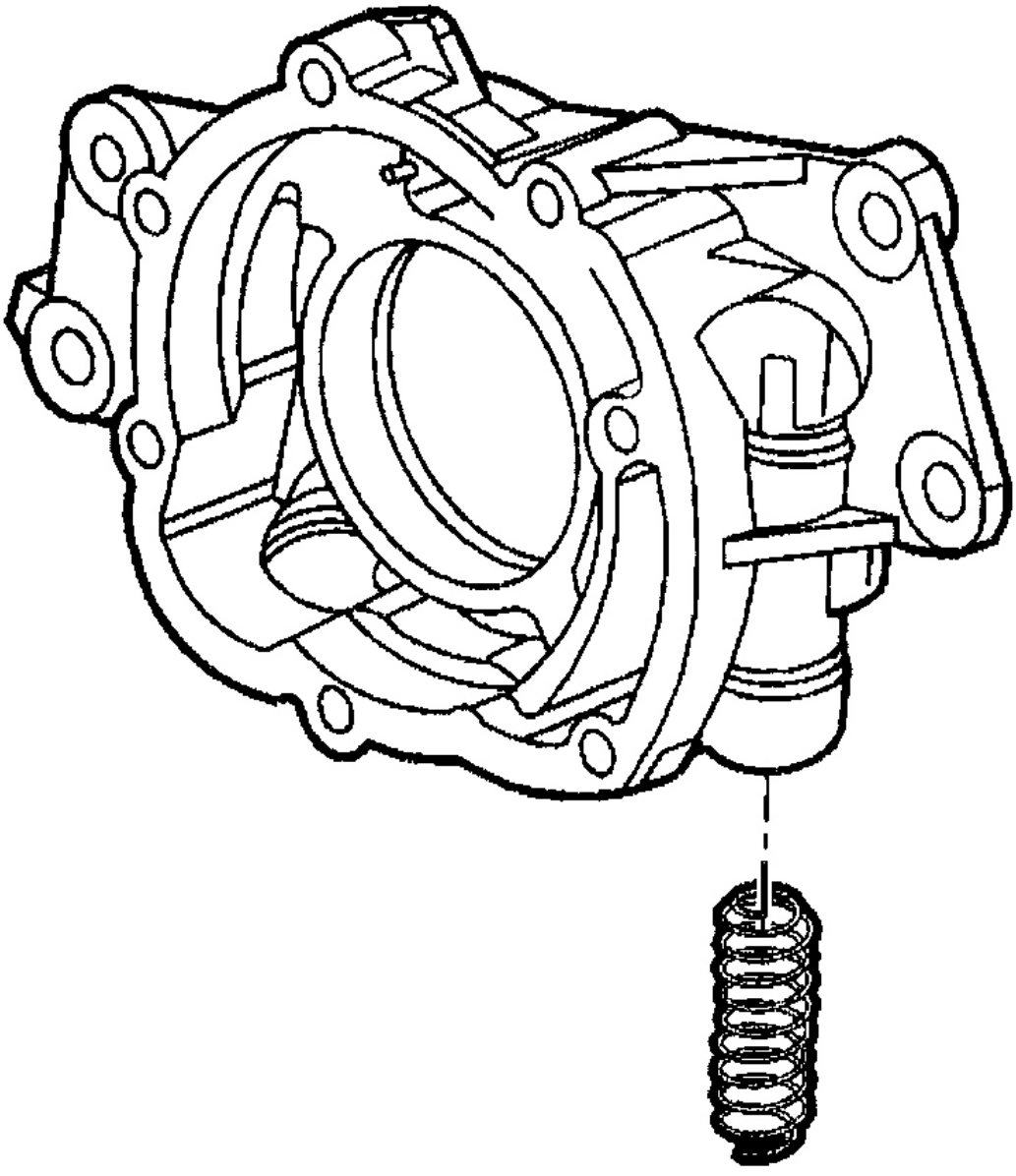


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Fig. 266: Oil Pump Pressure Relief Valve Plug
Courtesy of GENERAL MOTORS CORP.

6. Remove the pressure relief valve spring.

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Fig. 267: Oil Pump Pressure Relief Valve Spring
Courtesy of GENERAL MOTORS CORP.

7. Remove the pressure relief valve.
8. Inspect the oil pump components. Refer to **Oil Pump Cleaning and Inspection** .

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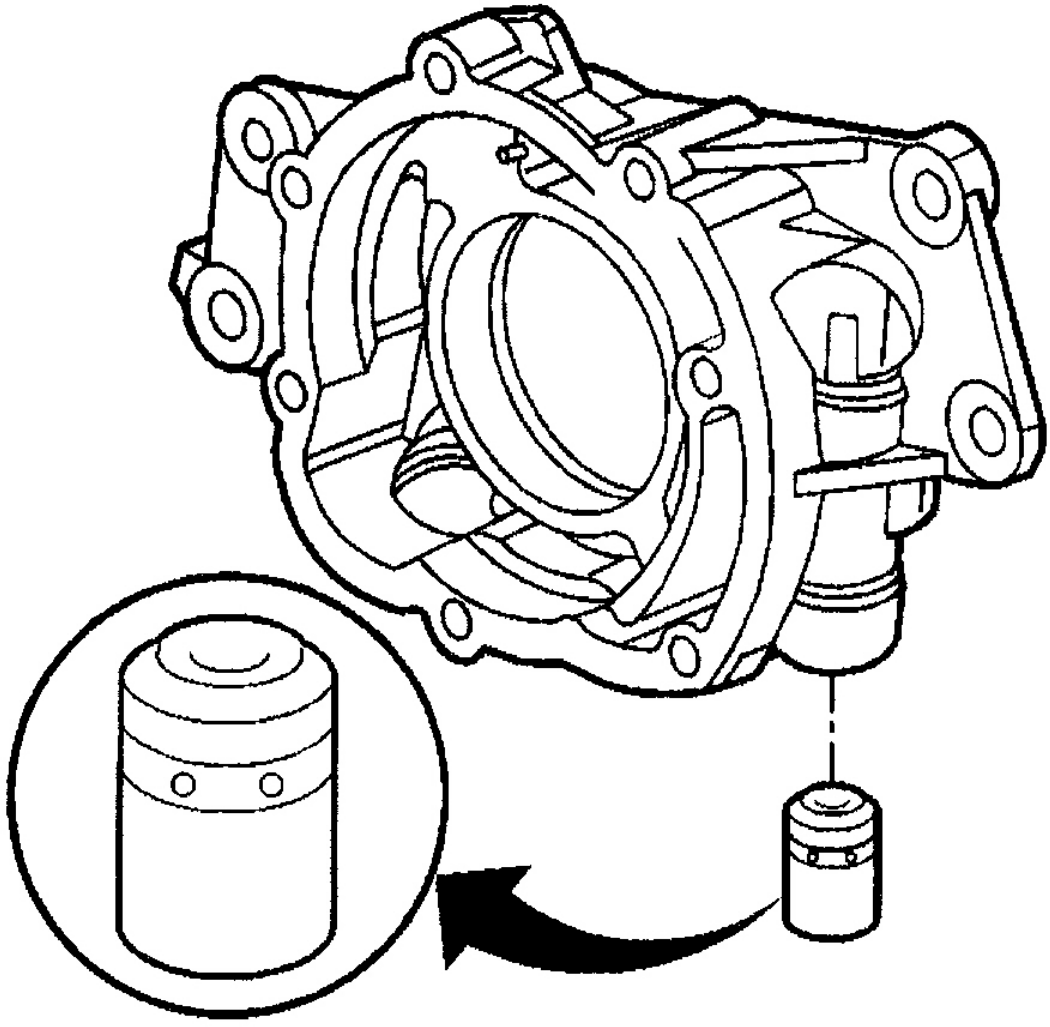


Fig. 268: Oil Pump Pressure Relief Valve
Courtesy of GENERAL MOTORS CORP.

OIL PUMP CLEANING AND INSPECTION

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

The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.

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1. Clean the parts in solvent.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

2. Dry the parts with compressed air.
3. Inspect the oil pump housing and the cover for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.
5. Inspect the oil pump housing for damaged bolt hole threads.

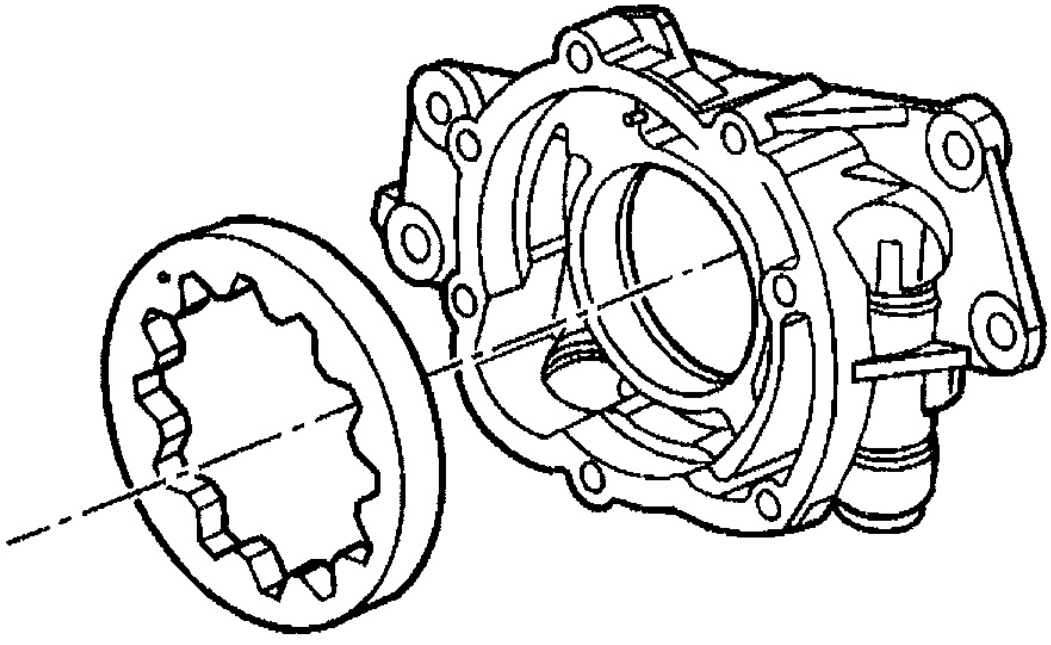


Fig. 269: Oil Pump Driven Gear
Courtesy of GENERAL MOTORS CORP.

6. Inspect the relief valve plug and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.

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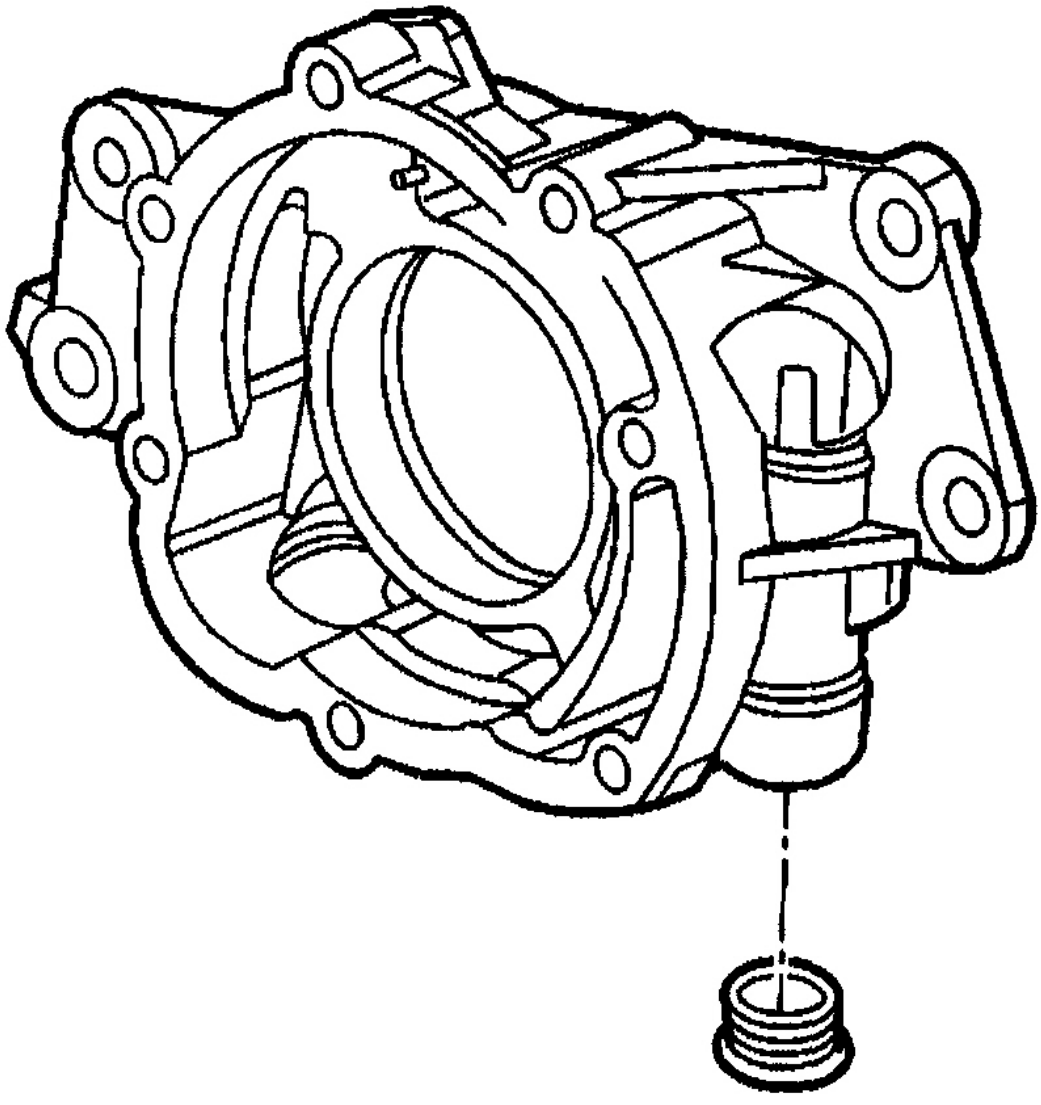


Fig. 270: Oil Pump Relief Valve Plug
Courtesy of GENERAL MOTORS CORP.

8. Inspect the drive gear and driven gear for chipping, galling or wear.

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

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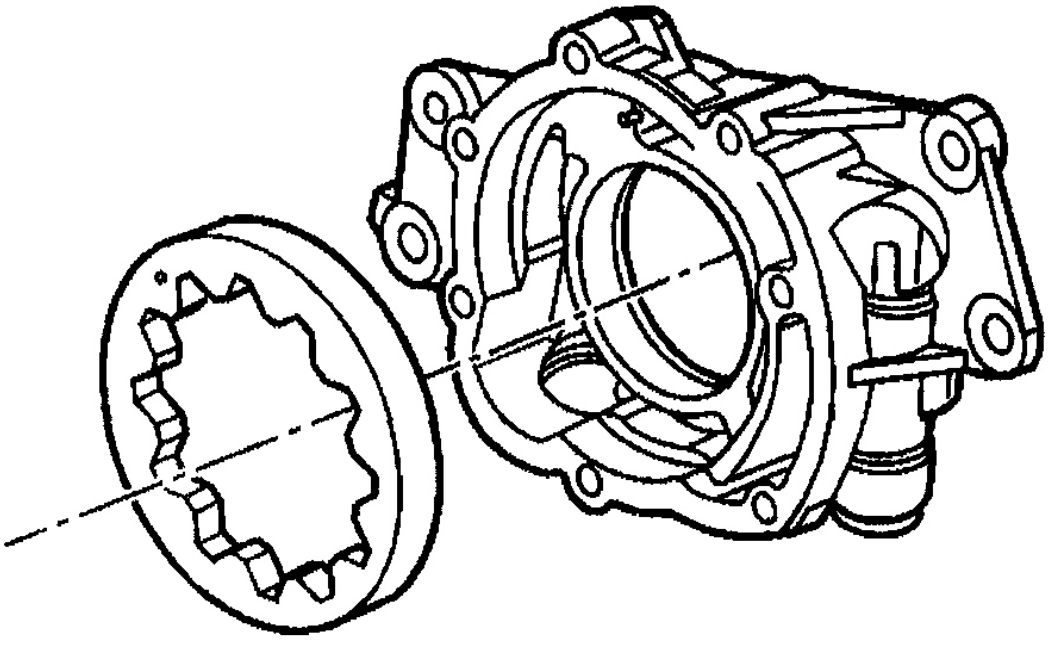


Fig. 271: Oil Pump Driven Gear
Courtesy of GENERAL MOTORS CORP.

9. Inspect the drive gear splines for excessive wear.

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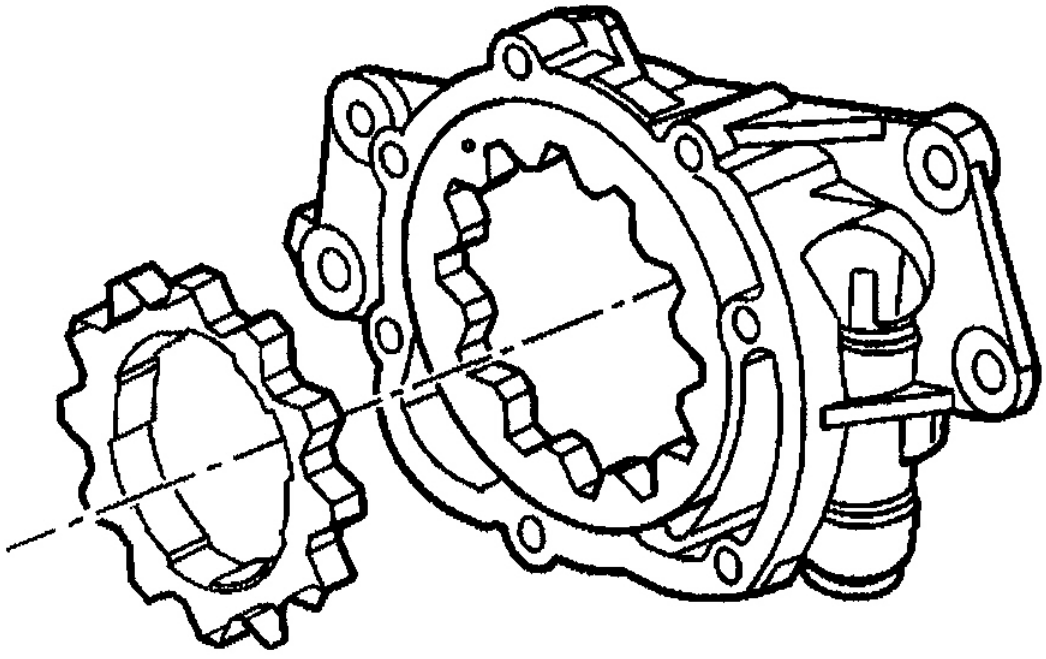


Fig. 272: Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

10. Inspect the pressure relief valve and bore for scoring or wear.

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

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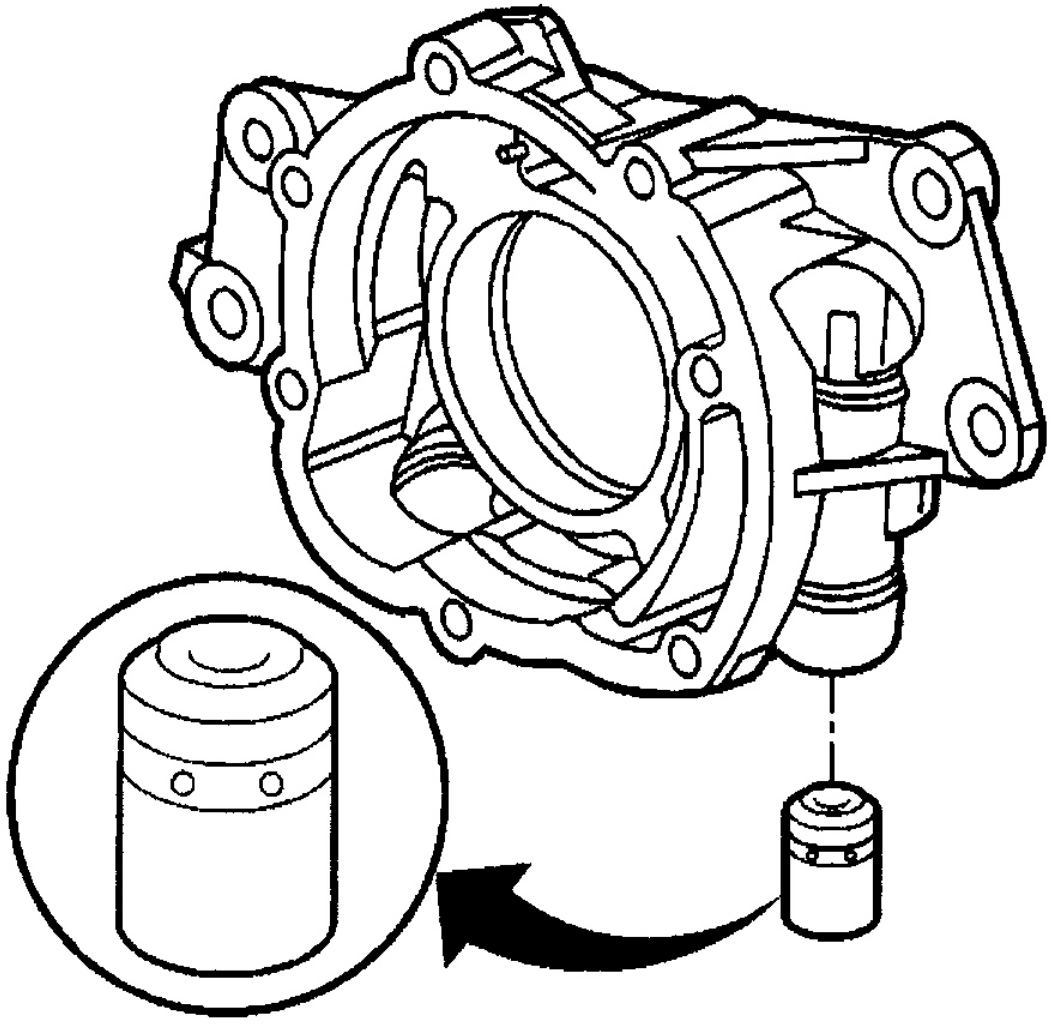
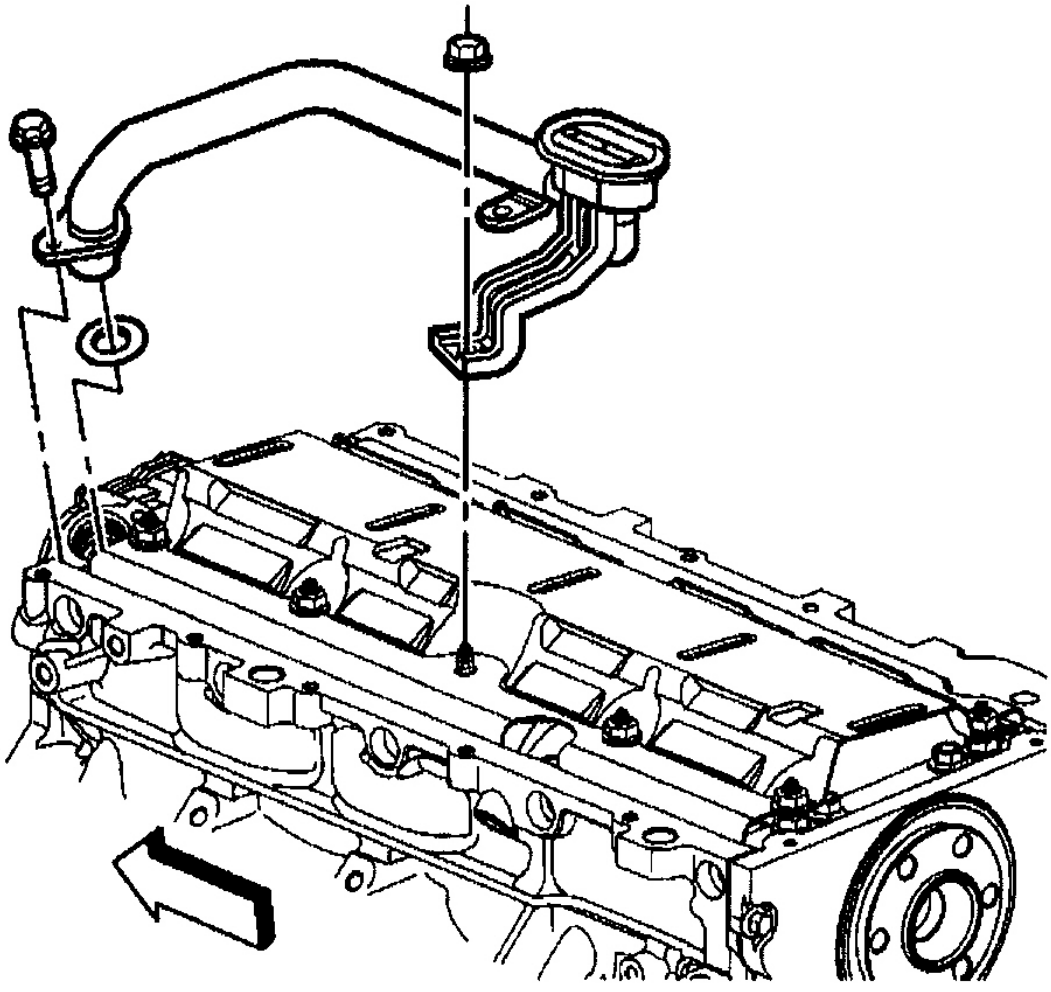


Fig. 273: Oil Pump Pressure Relief Valve
Courtesy of GENERAL MOTORS CORP.

11. Inspect the oil pump screen for debris or restrictions.
12. Inspect the oil pump screen for broken or loose wire mesh.

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Fig. 274: Oil Pump Screen
Courtesy of GENERAL MOTORS CORP.

OIL PUMP ASSEMBLE

IMPORTANT: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear into the pump housing.

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

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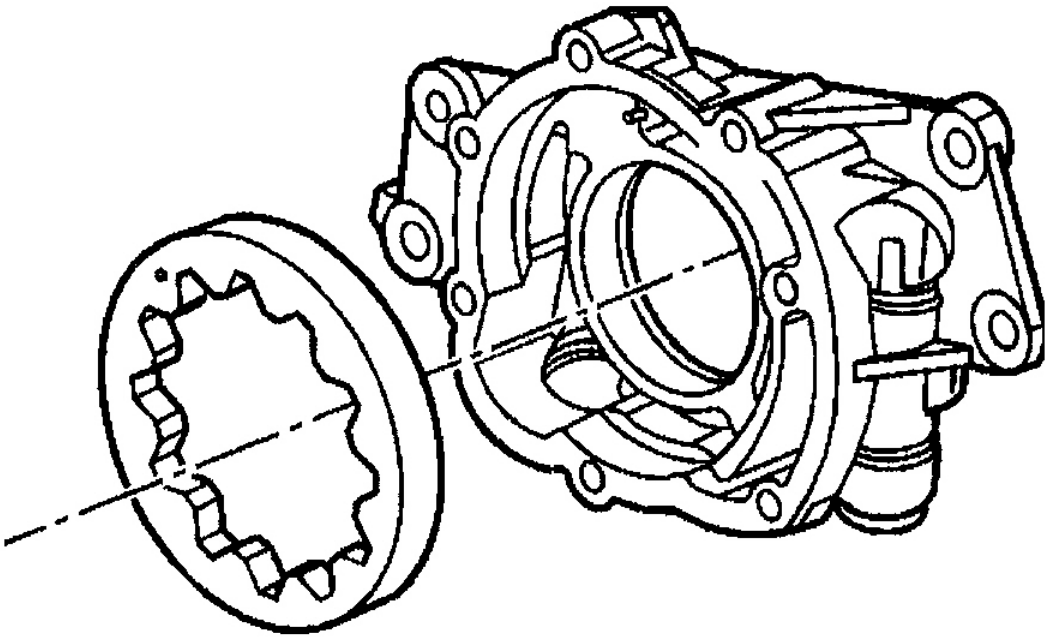


Fig. 275: Oil Pump Driven Gear
Courtesy of GENERAL MOTORS CORP.

2. Install the drive gear into the pump housing.

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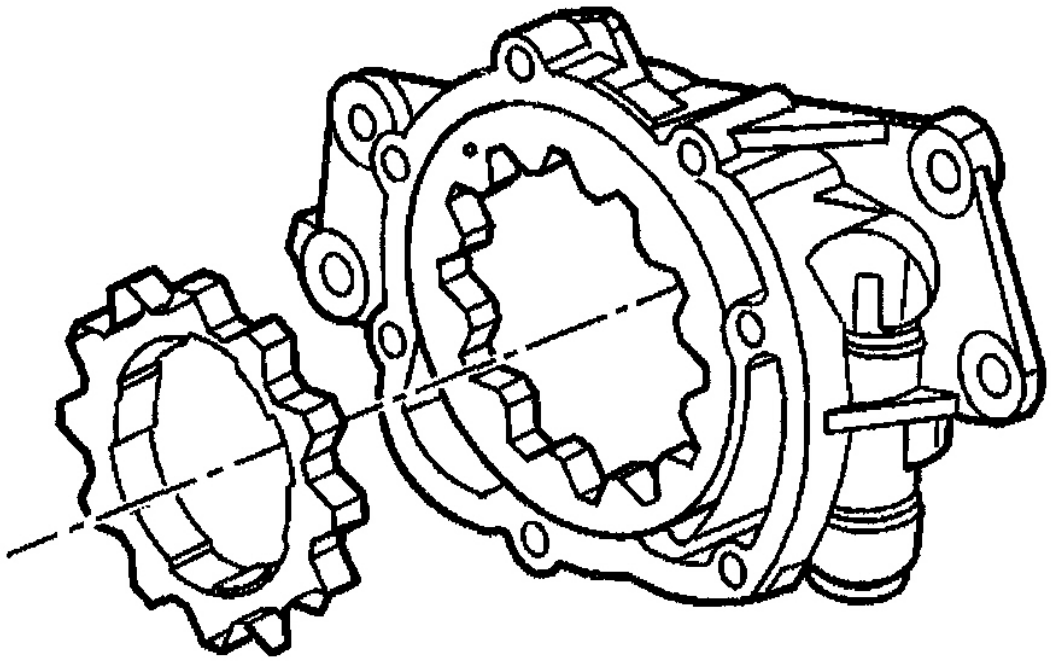
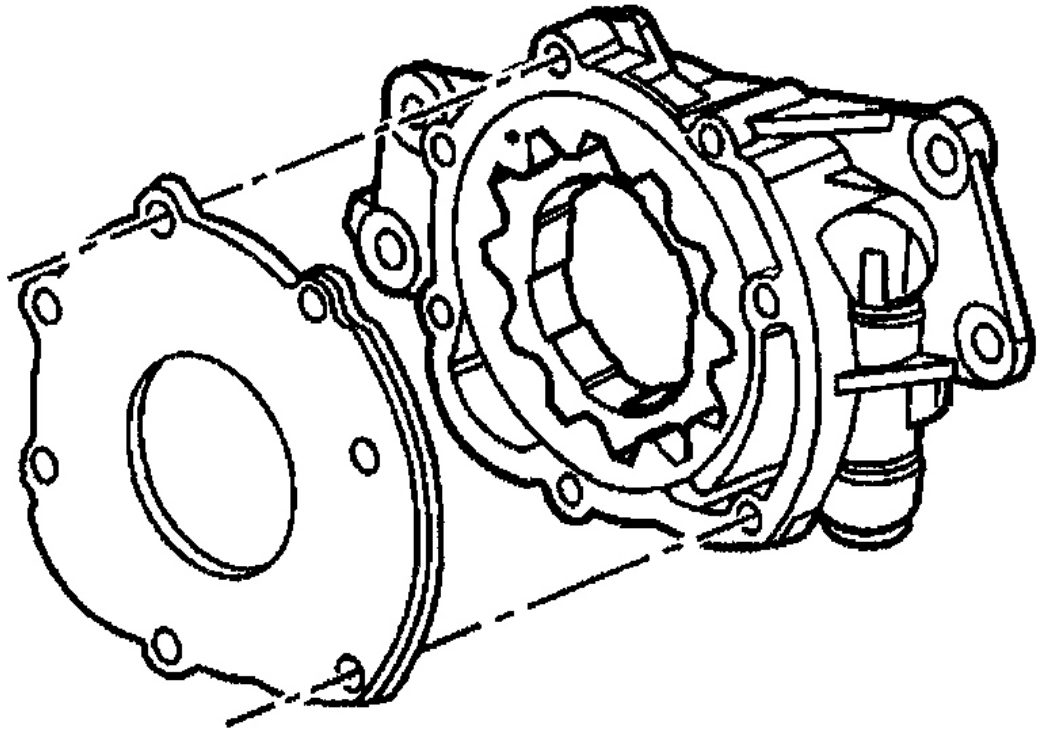


Fig. 276: Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

3. Install the oil pump cover.

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Fig. 277: Oil Pump Cover
Courtesy of GENERAL MOTORS CORP.

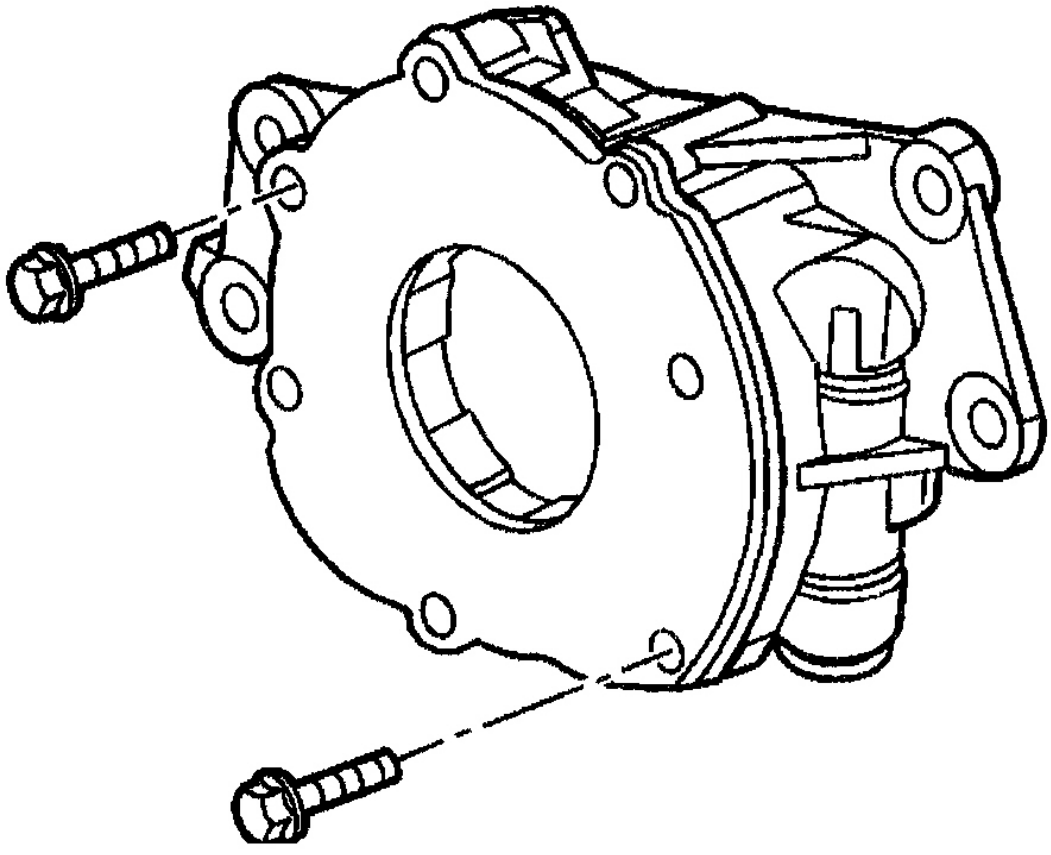
NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

4. Install the pump cover bolts.

Tighten

Tighten the oil pump cover bolts to 12 N.m (106 lb in).

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Fig. 278: Oil Pump Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the regulator valve.

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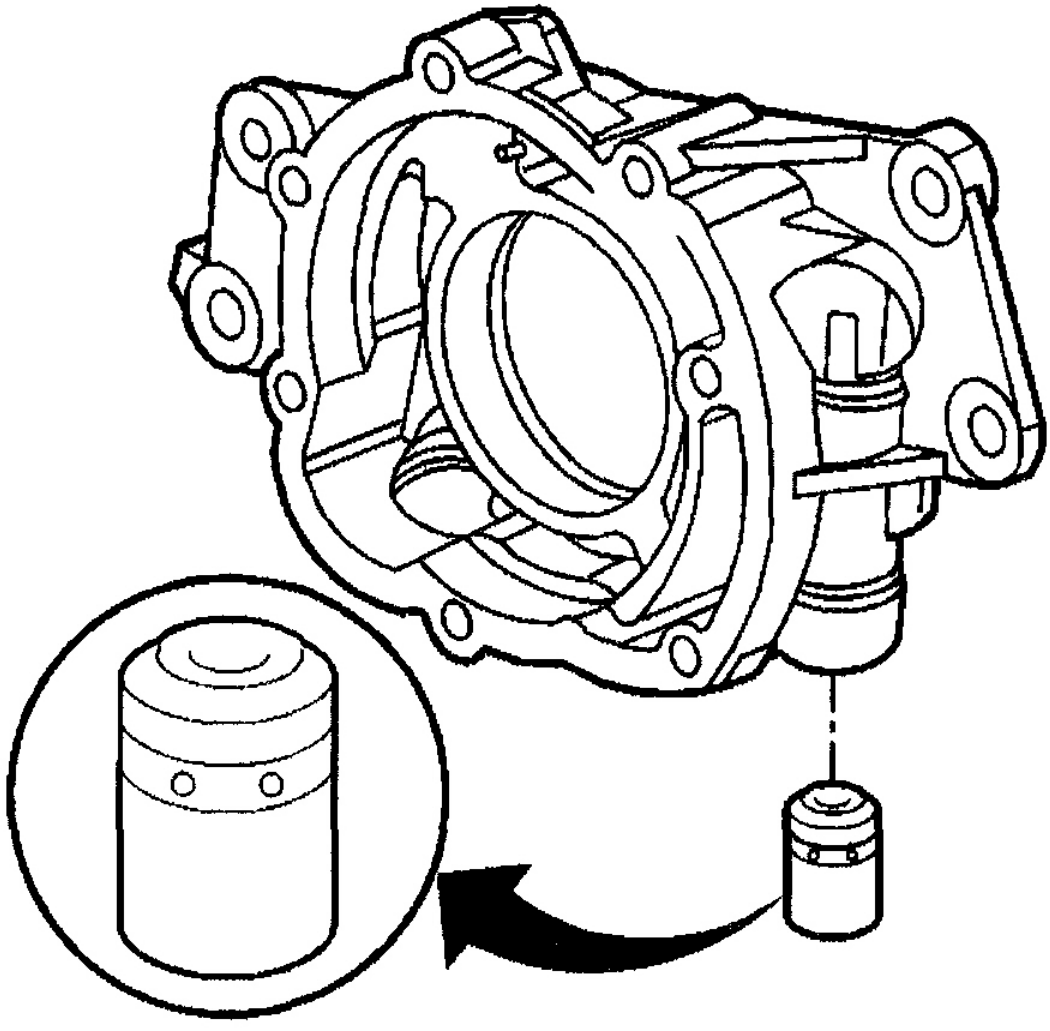
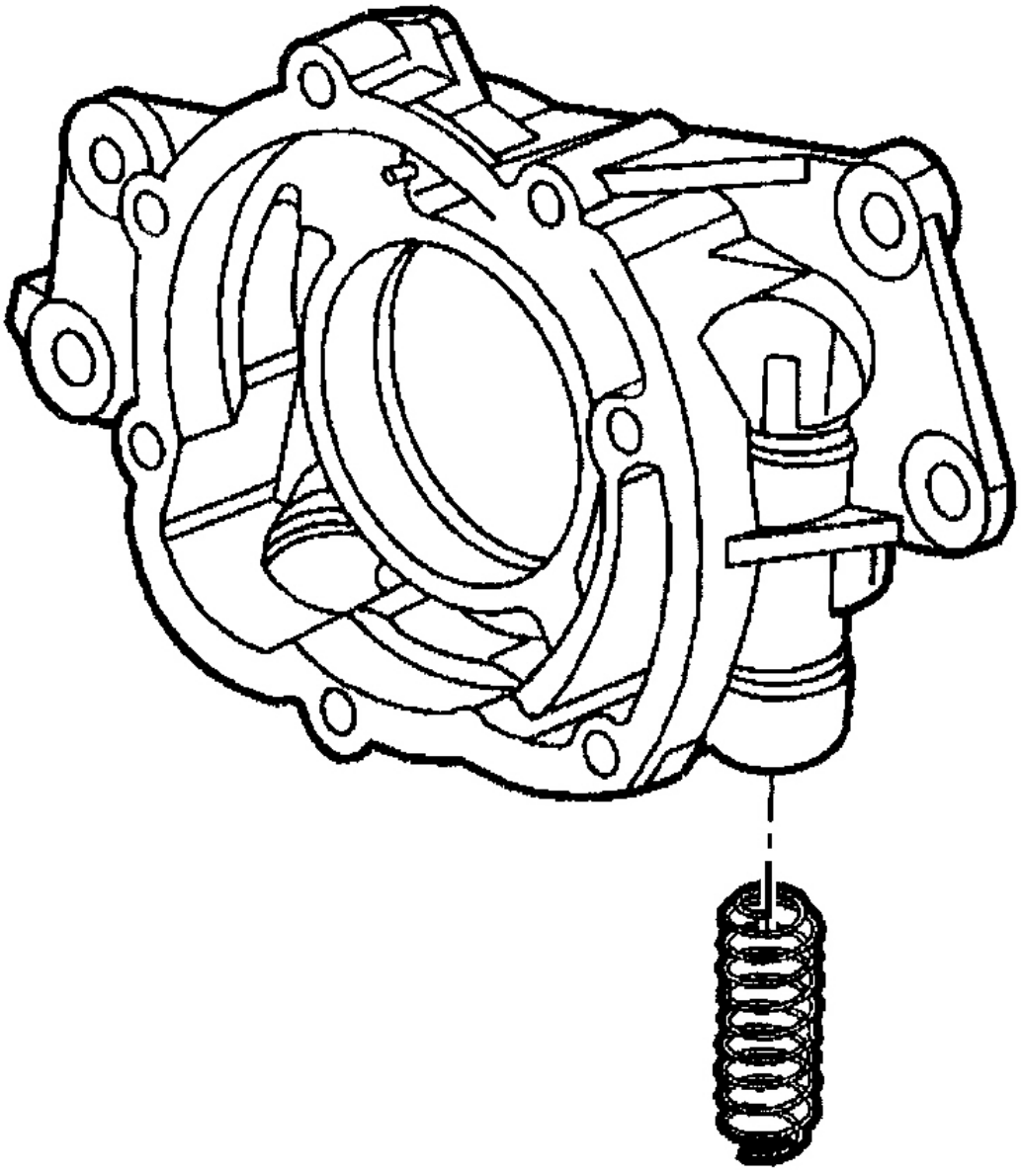


Fig. 279: Oil Pump Pressure Relief Valve
Courtesy of GENERAL MOTORS CORP.

6. Install a NEW regulator valve spring.

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Fig. 280: Oil Pump Pressure Relief Valve Spring
Courtesy of GENERAL MOTORS CORP.

7. Install the pressure relief valve plug.

Tighten

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Tighten the pressure relief valve plug to 12 N.m (106 lb in).

8. Inspect the oil pump for smoothness of operation by rotating the drive gear.

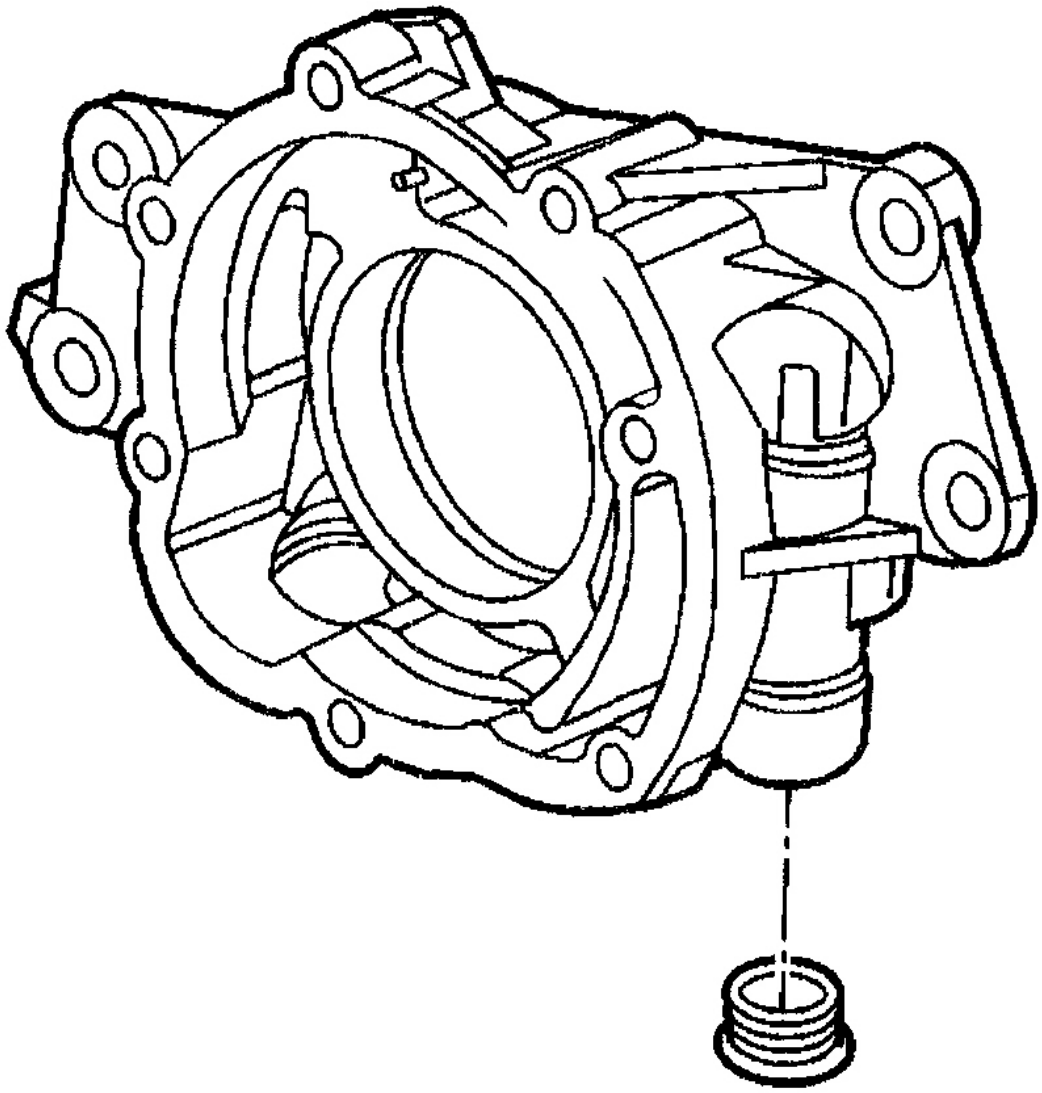


Fig. 281: Oil Pump Pressure Relief Valve Plug
Courtesy of GENERAL MOTORS CORP.

ENGINE FRONT COVER CLEANING AND INSPECTION

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IMPORTANT: Do not reuse the crankshaft oil seal. Install a NEW crankshaft oil seal during assembly.

Do not reuse the front cover-to-engine block gasket. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (1) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the cover-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

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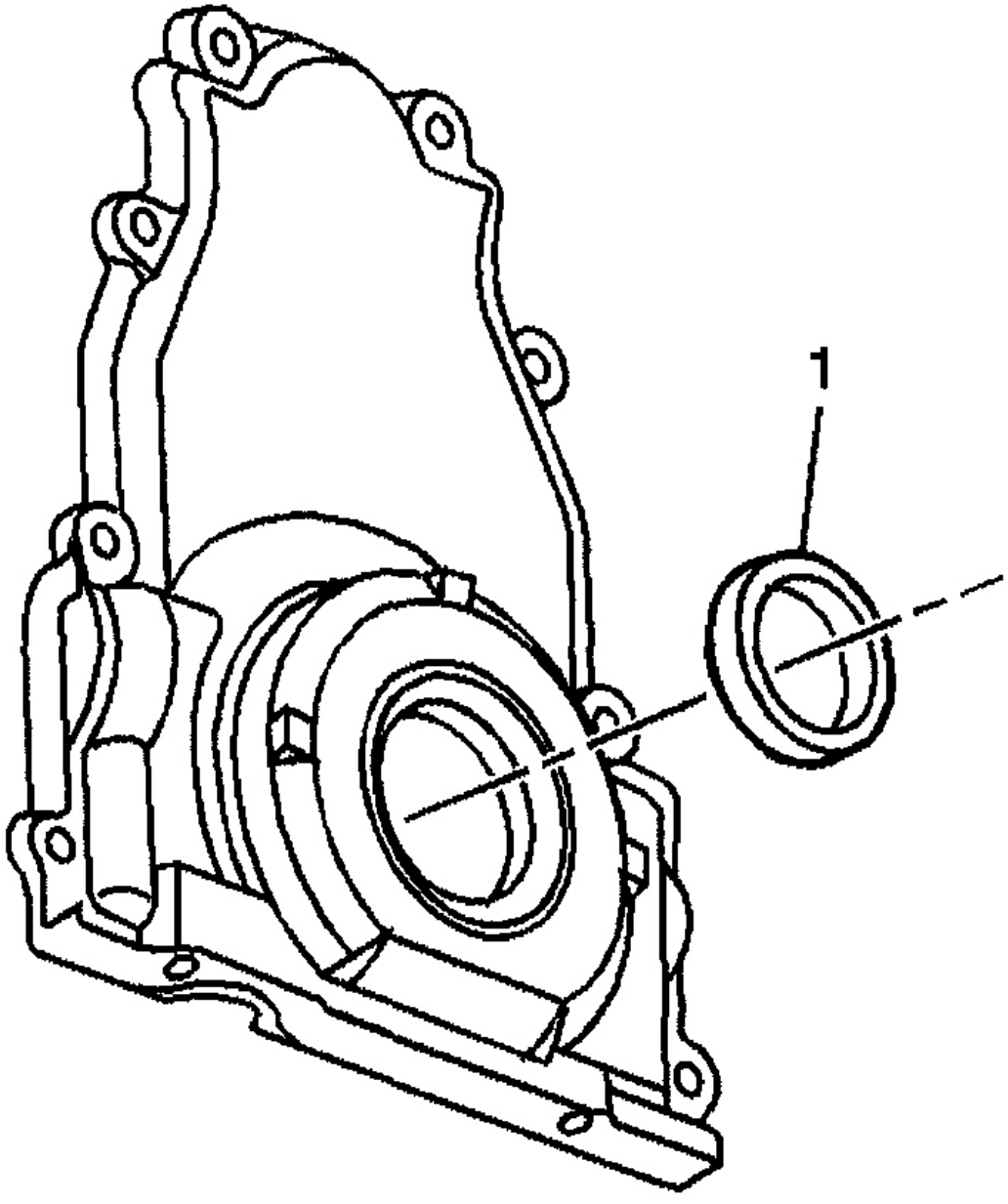


Fig. 282: Crankshaft Front Cover Oil Seal
Courtesy of GENERAL MOTORS CORP.

ENGINE REAR COVER CLEANING AND INSPECTION

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IMPORTANT: Do not reuse the crankshaft oil seal. Install a NEW crankshaft oil seal during assembly.

Do not reuse the rear cover-to-engine block gasket. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (1) from the rear cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the cover-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

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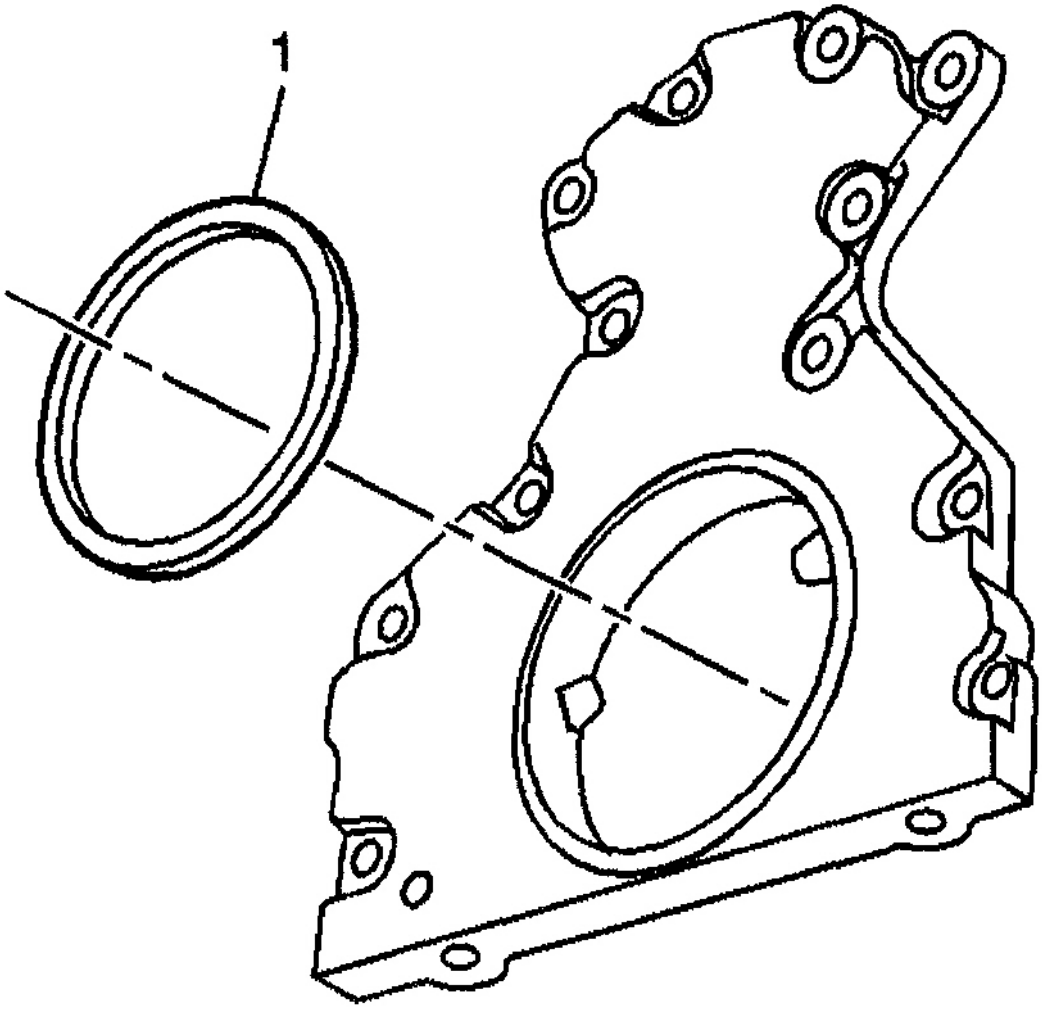


Fig. 283: Crankshaft Rear Cover Oil Seal
Courtesy of GENERAL MOTORS CORP.

ENGINE VALLEY COVER CLEANING AND INSPECTION

IMPORTANT: Do not reuse the valley cover knock sensor oil seals. Install NEW oil seals during assembly.

Do not reuse the valley cover gasket. Install a NEW gasket during assembly.

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

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2. Clean the valley cover in solvent.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

3. Dry the valley cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging. Refer to **Replacing Engine Gaskets** .
5. Inspect the valley cover oil seal bores for excessive scratches or gouging.

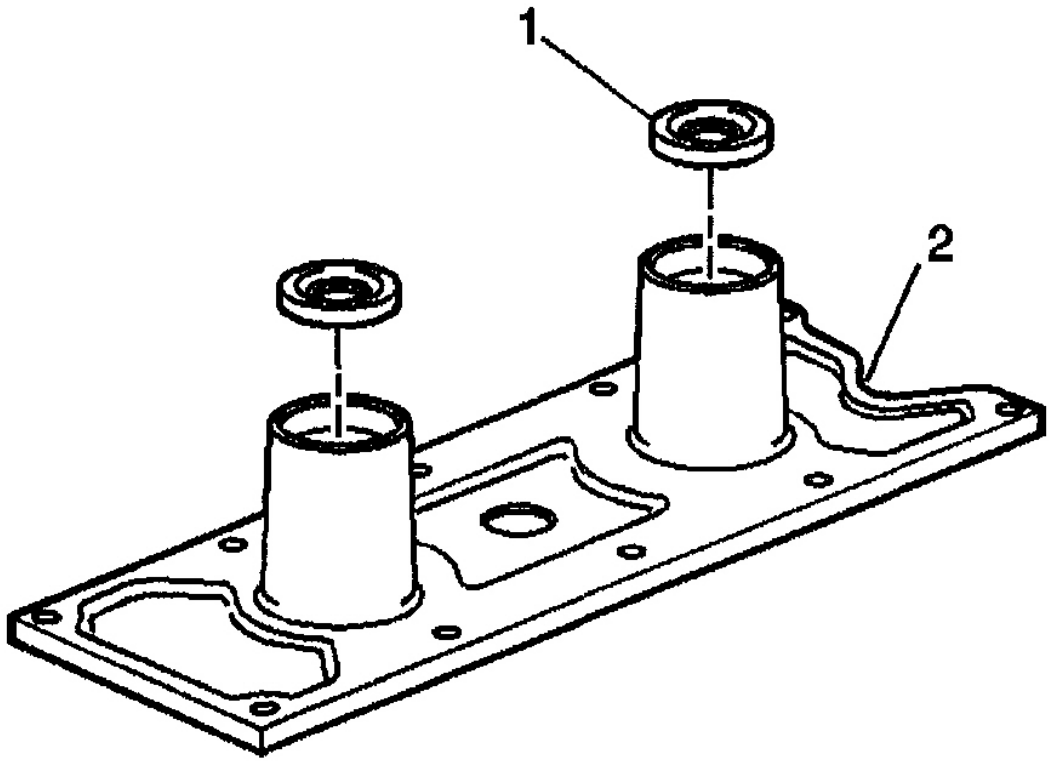


Fig. 284: Knock Sensor Oil Seals & Valley Cover
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM COVER CLEANING AND INSPECTION

IMPORTANT: Do not reuse the valve rocker arm cover gasket. Install a NEW gasket during assembly.

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Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.

Do not remove the oil fill tube or crankcase vent valve grommet from the covers unless service is required.

If the oil fill tube or crankcase vent valve grommet have been removed from the rocker arm covers, install a NEW tube or grommet during assembly.

1. Remove the ignition coil and bracket assembly, bolts, and wire harness from the left cover, if required.

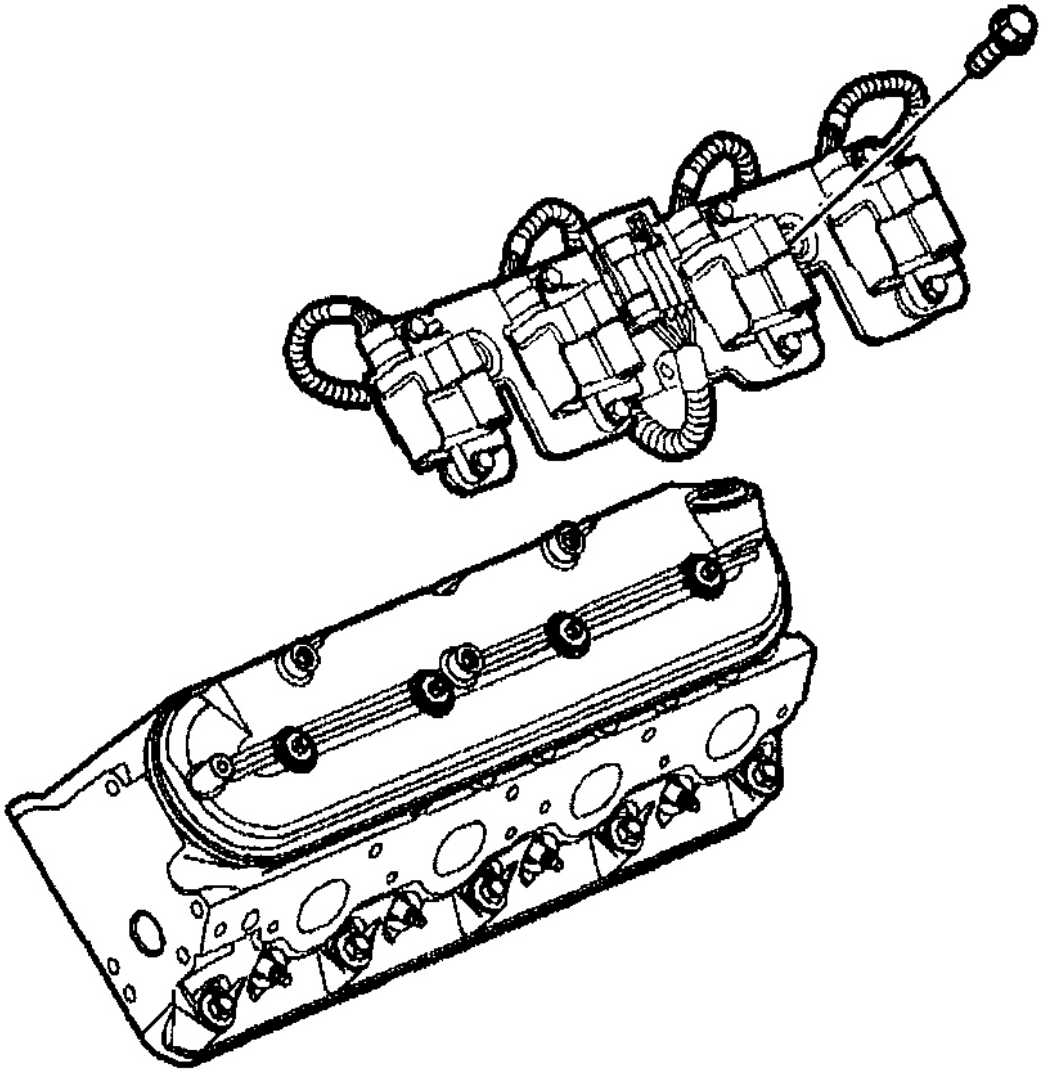


Fig. 285: Ignition Coil & Bracket Assembly (Left)

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Courtesy of GENERAL MOTORS CORP.

2. Remove the ignition coil and bracket assembly, bolts, and wire harness from the right cover, if required.

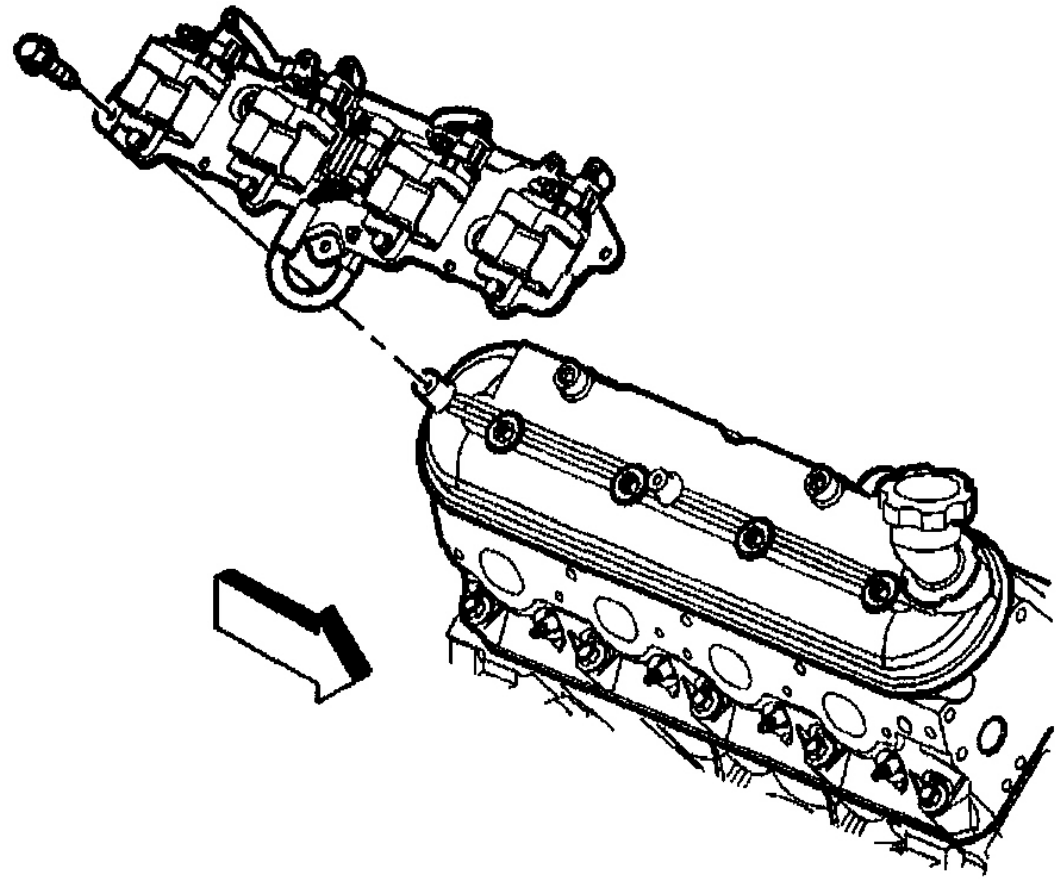
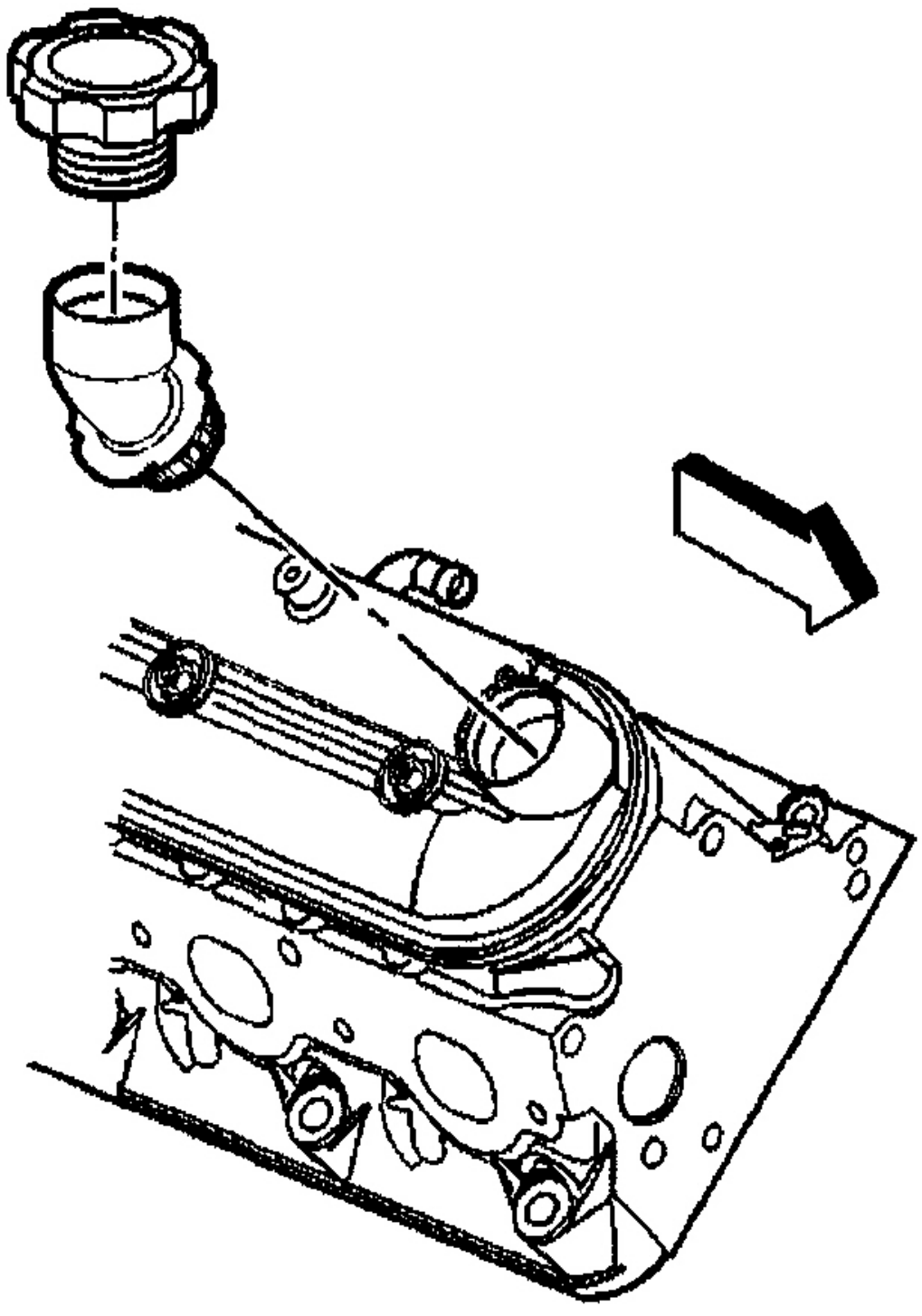


Fig. 286: Ignition Coil & Bracket Assembly (Right)
Courtesy of GENERAL MOTORS CORP.

3. Inspect the tube for a loose fit or damage.
4. Remove the oil fill cap and tube from the right cover, if required.

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Fig. 287: Oil Fill Cap & Tube
Courtesy of GENERAL MOTORS CORP.

5. Remove the gaskets (1) from the covers.
6. Remove the cover mounting bolts, with grommets.

   Cover mounting bolts and grommets that are not damaged may be reused during assembly.

7. Clean the covers in solvent.

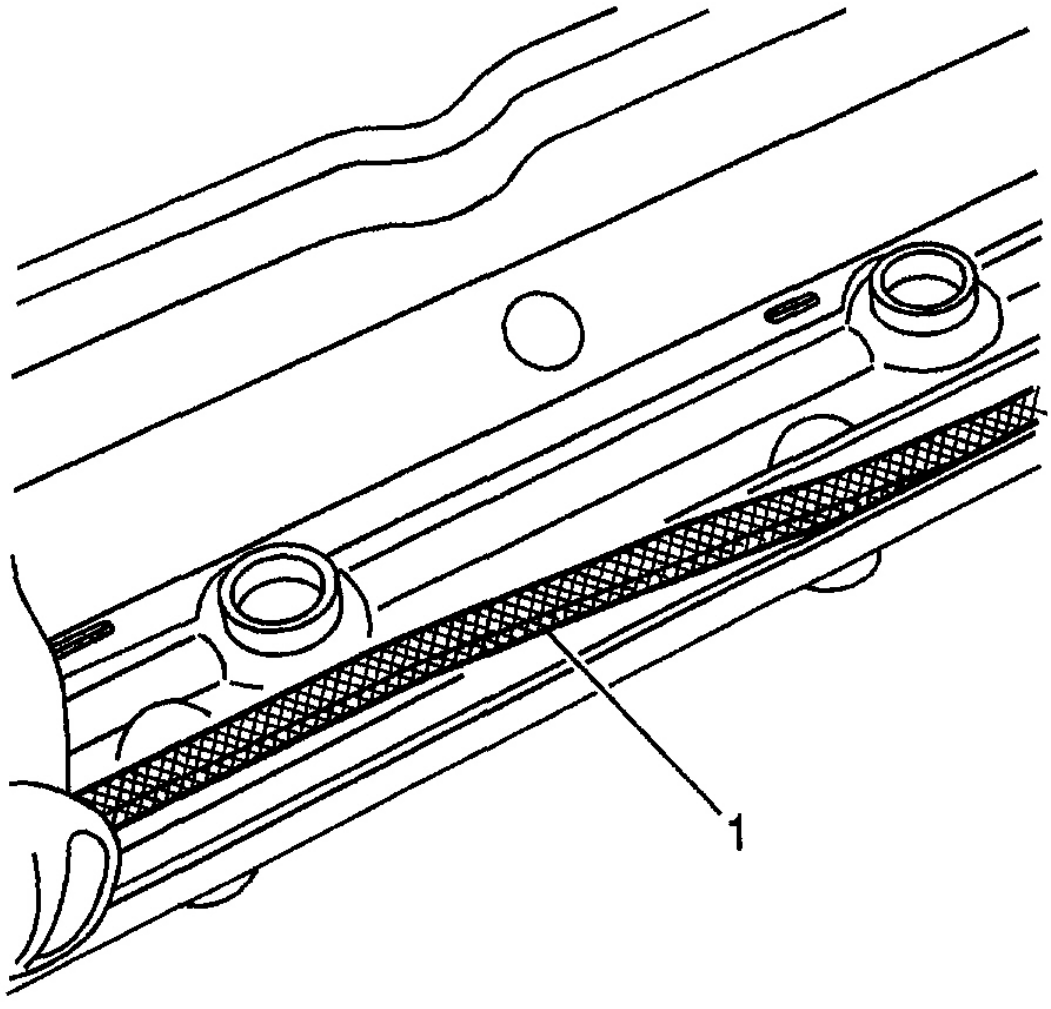
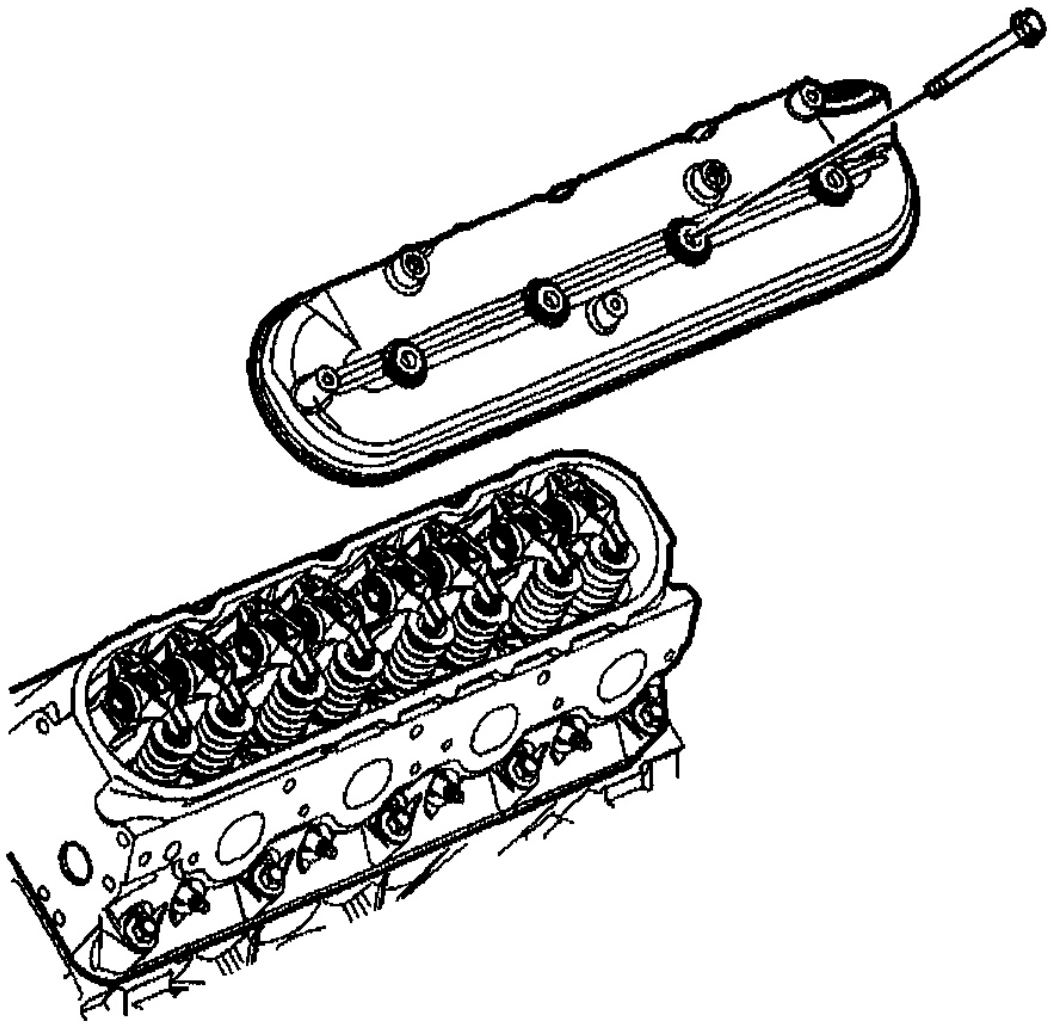


Fig. 288: Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

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CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

8. Dry the covers with compressed air.
9. Inspect the ventilation system passages for restrictions.
10. Inspect the gasket grooves for damage.
11. Inspect the coil bracket threaded bolt holes for damage or debris.



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Fig. 289: Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

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OIL PAN CLEANING AND INSPECTION

IMPORTANT: Do not reuse the oil pan cover gasket. Install a NEW cover gasket during assembly.

Do not reuse the oil pan to engine block gasket. Install a NEW gasket during assembly.

When installing a NEW oil pan gasket, it is not necessary to install the rivets that retain the NEW gasket to the pan.

1. Remove the oil level sensor from the pan.

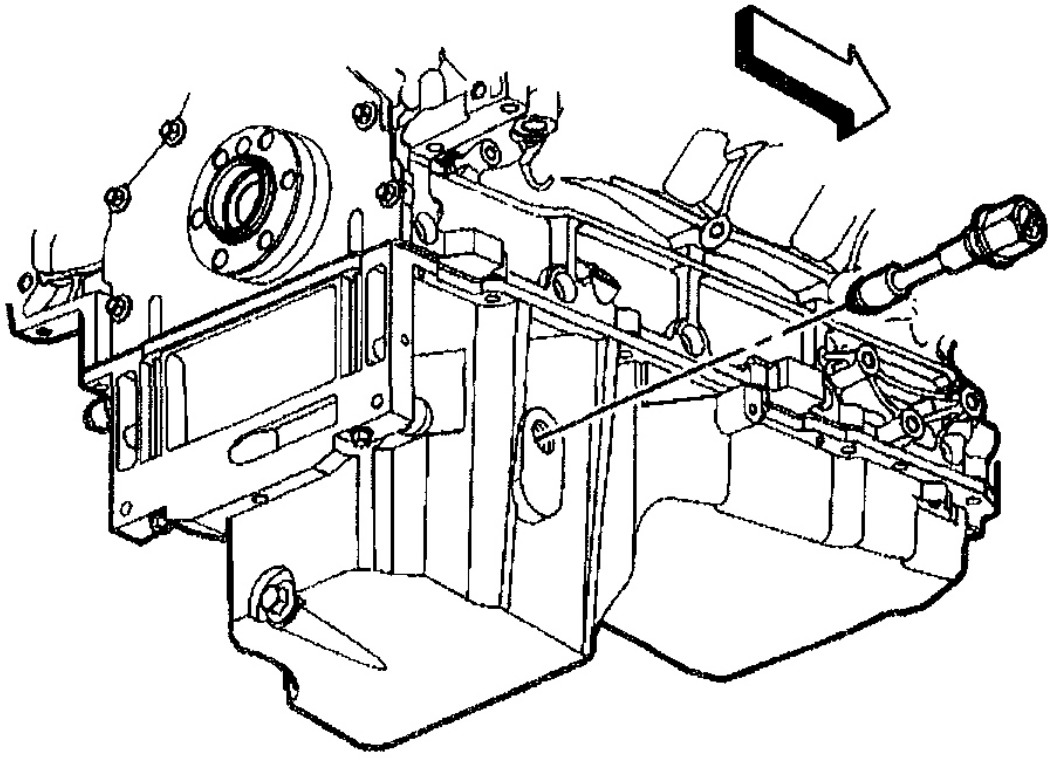


Fig. 290: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pan cover (2), gasket (3), and bolts (1), if required.

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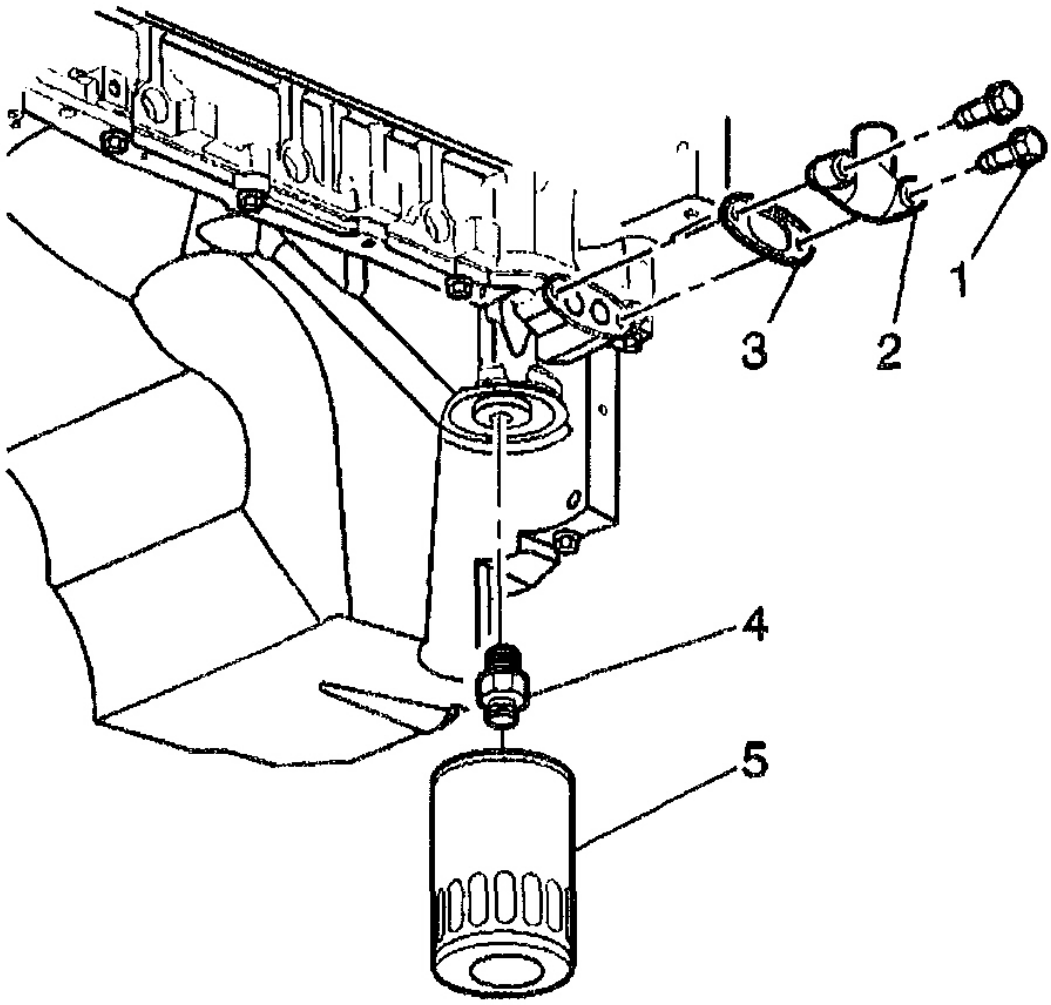


Fig. 291: Oil Pan Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan drain plug and O-ring seal.

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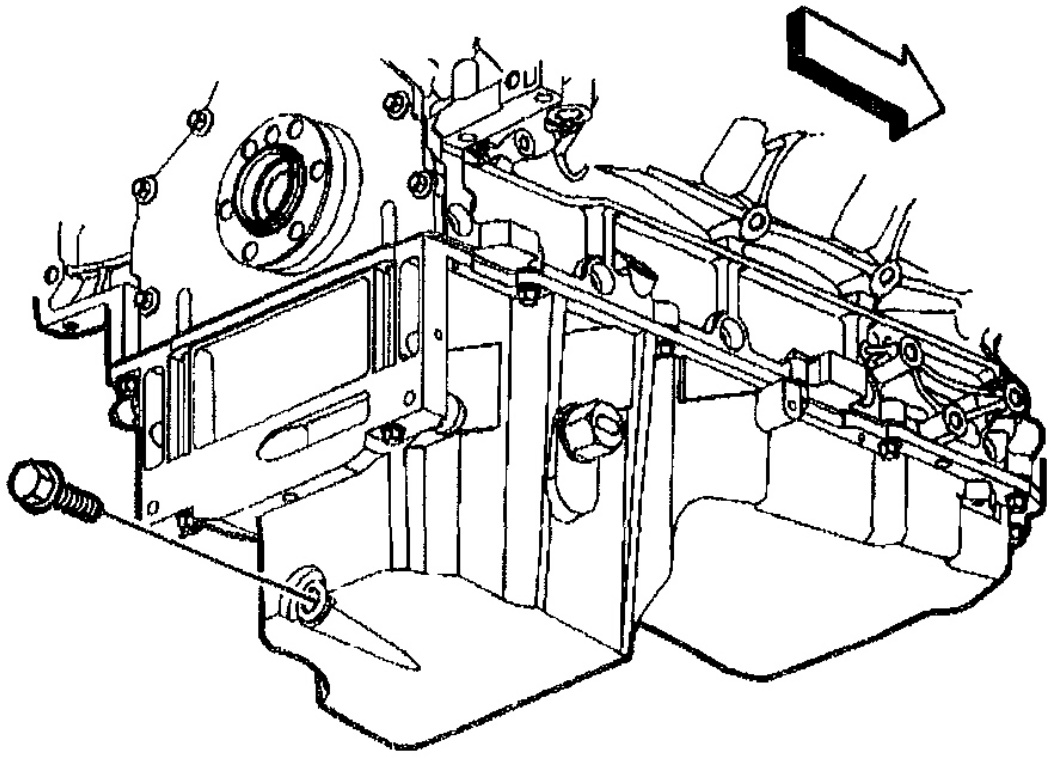


Fig. 292: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pan baffle and bolts.
5. Clean the oil pan in solvent. Be sure to thoroughly clean all of the oil passages and recesses of the pan.
6. Clean the oil pan gasket surfaces. Refer to **Replacing Engine Gaskets** .

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

7. Dry the oil pan with compressed air.
8. Inspect the gasket sealing surfaces for excessive scratches or gouging. Refer to **Replacing Engine Gaskets** .

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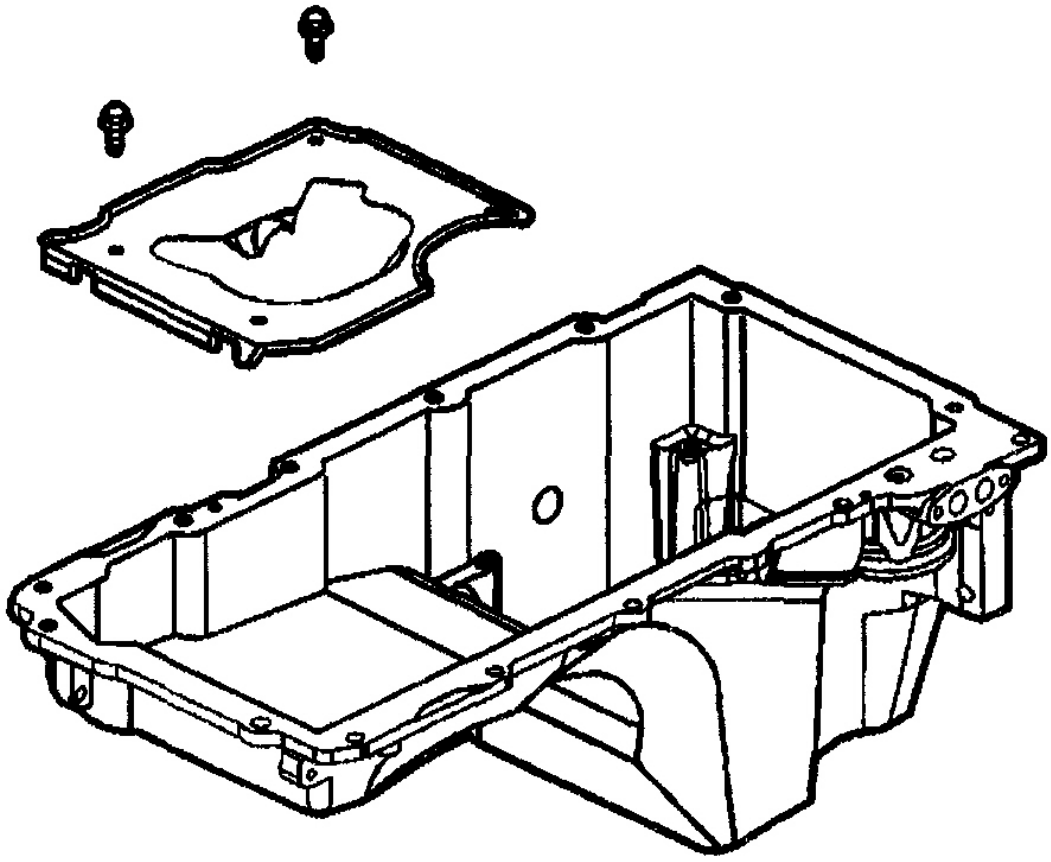


Fig. 293: Oil Pan Baffle & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Inspect the oil level sensor seal surface and threads for damage.

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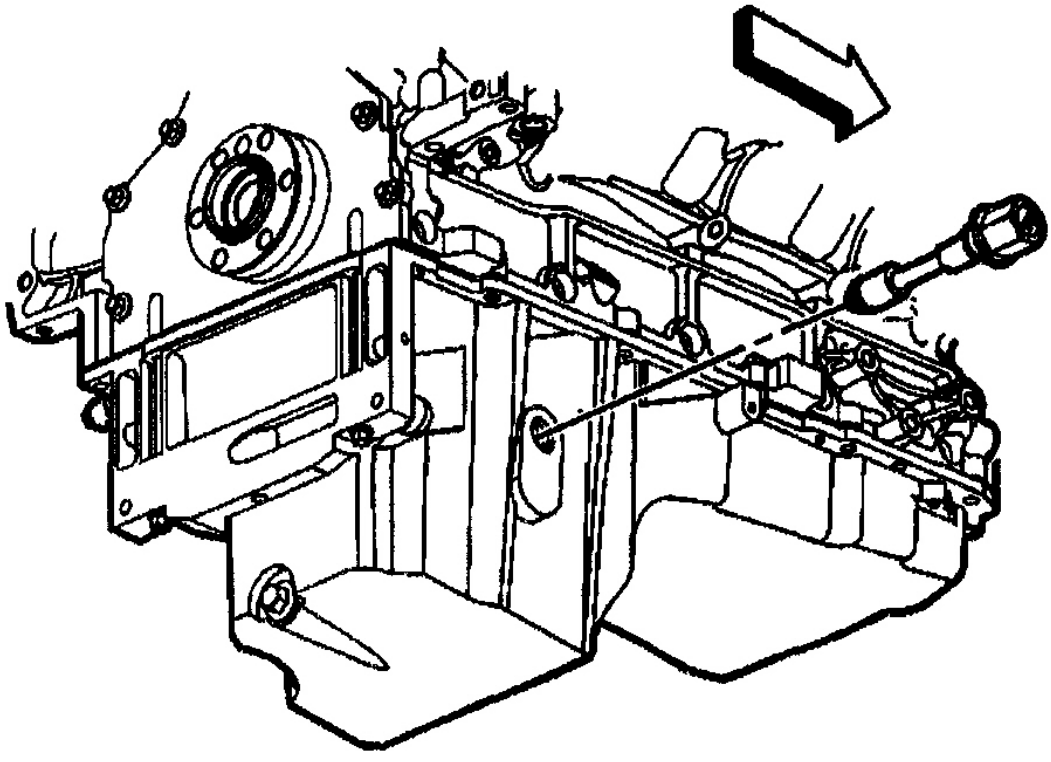
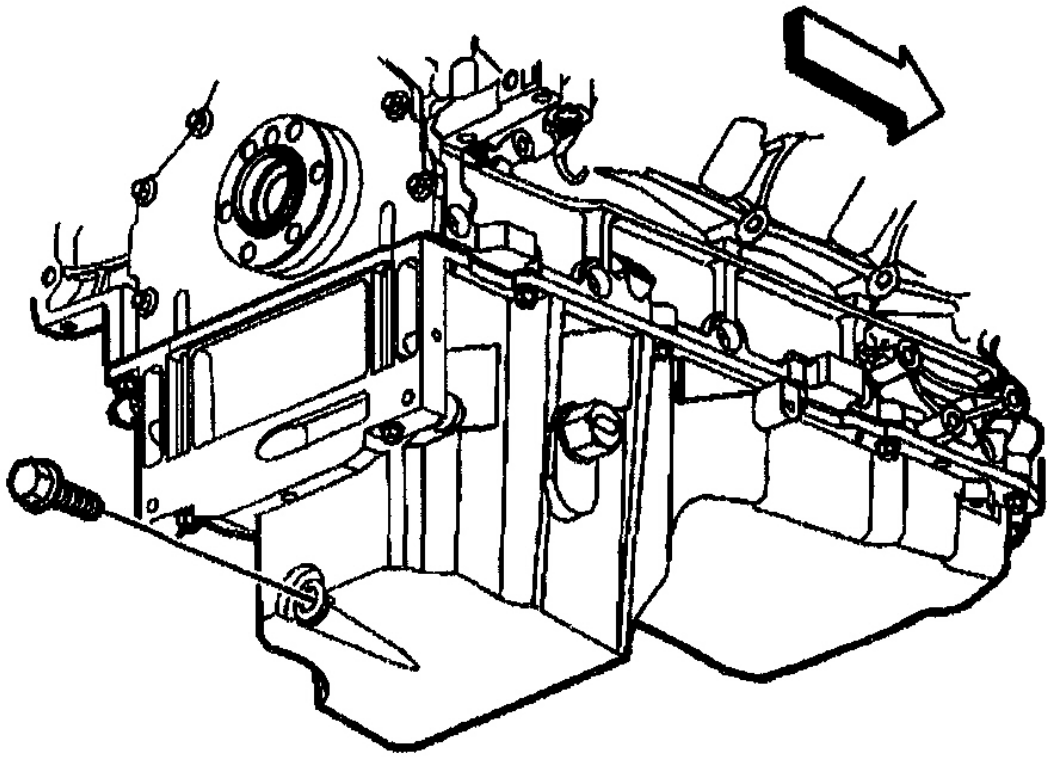


Fig. 294: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

10. Inspect the oil pan drain plug and threaded drain hole for damaged threads.

    The drain plug O-ring seal may be reused if not cut or damaged.

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Fig. 295: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

11. Inspect the oil filter sealing surface for scratches or gouging.
12. Inspect the oil filter fitting (1) for a loose fit or damaged threads.
13. Inspect the oil passages for restrictions.
14. Inspect the oil filter bypass valve (2) for proper operation.

Lightly depress the bypass valve. The valve spring should reseat the valve to the proper position.

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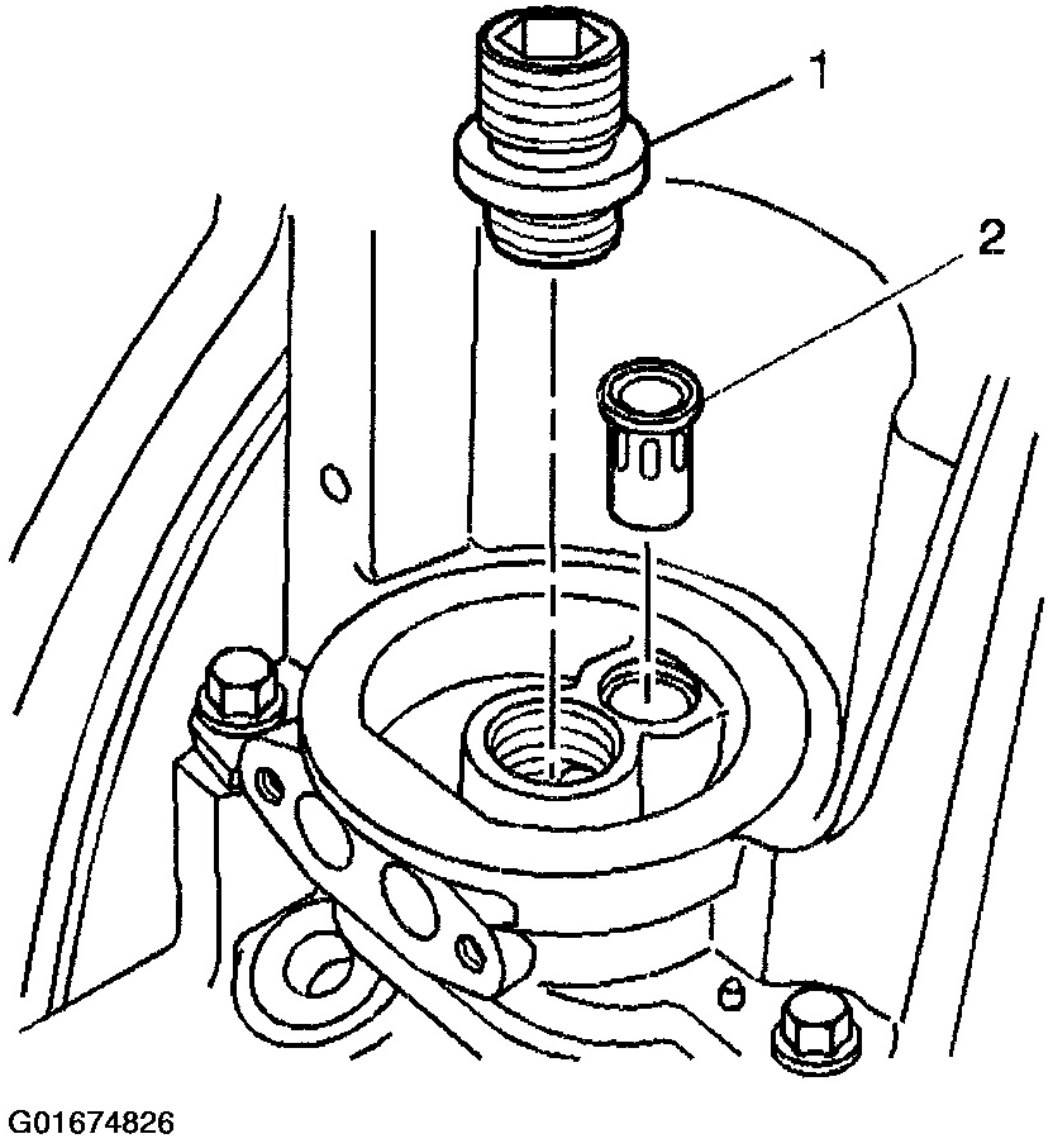


Fig. 296: Oil Filter Fitting & Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

INTAKE MANIFOLD CLEANING AND INSPECTION

Cleaning Procedure

IMPORTANT: Do not reuse the intake manifold-to-cylinder head sealing gaskets.

1. Remove the Manifold Absolute Pressure (MAP) sensor (1) from the rear of the intake. The MAP sensor is

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to be reinstalled upon completion of the cleaning and inspection procedures.

2. Inspect the sealing grommet on the MAP sensor. The grommet should not be torn or damaged.

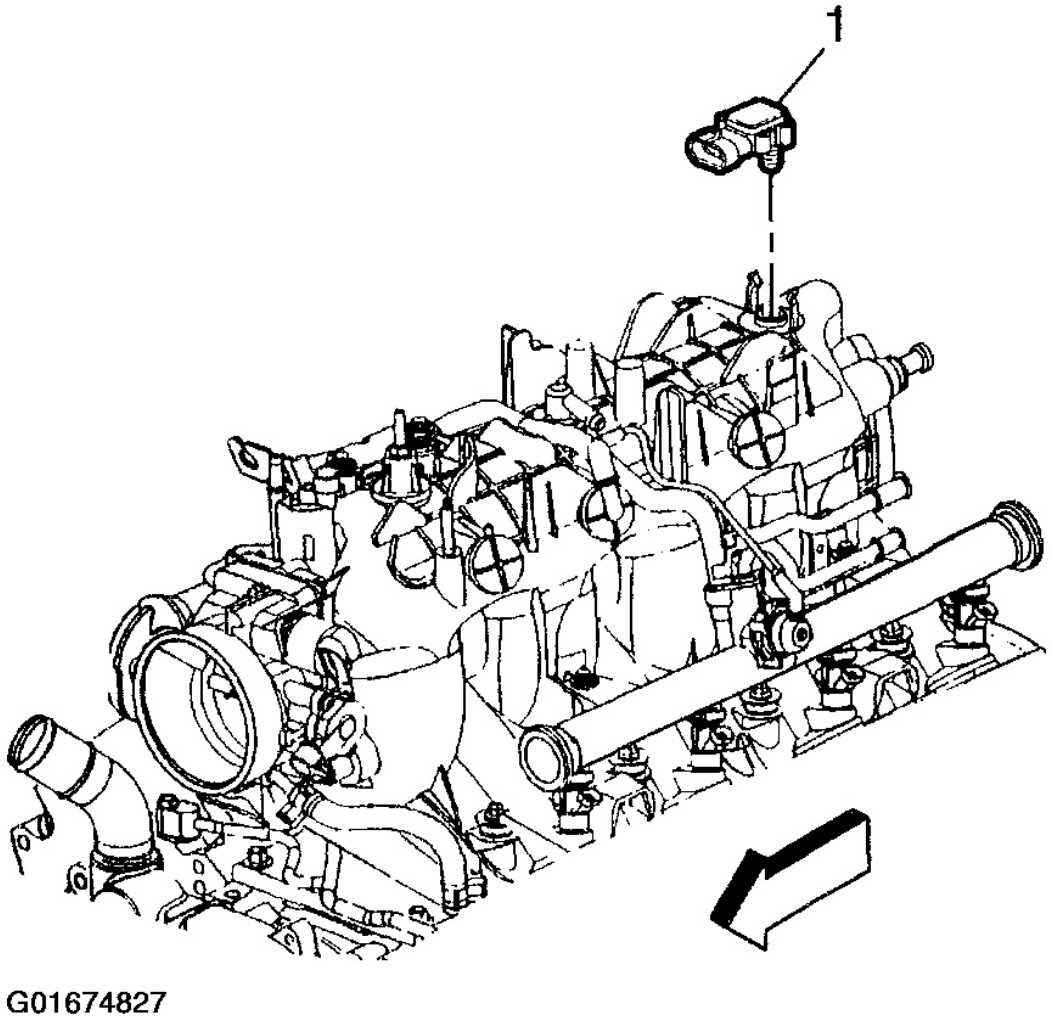


Fig. 297: MAP Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the intake manifold-to-cylinder head gaskets (1).

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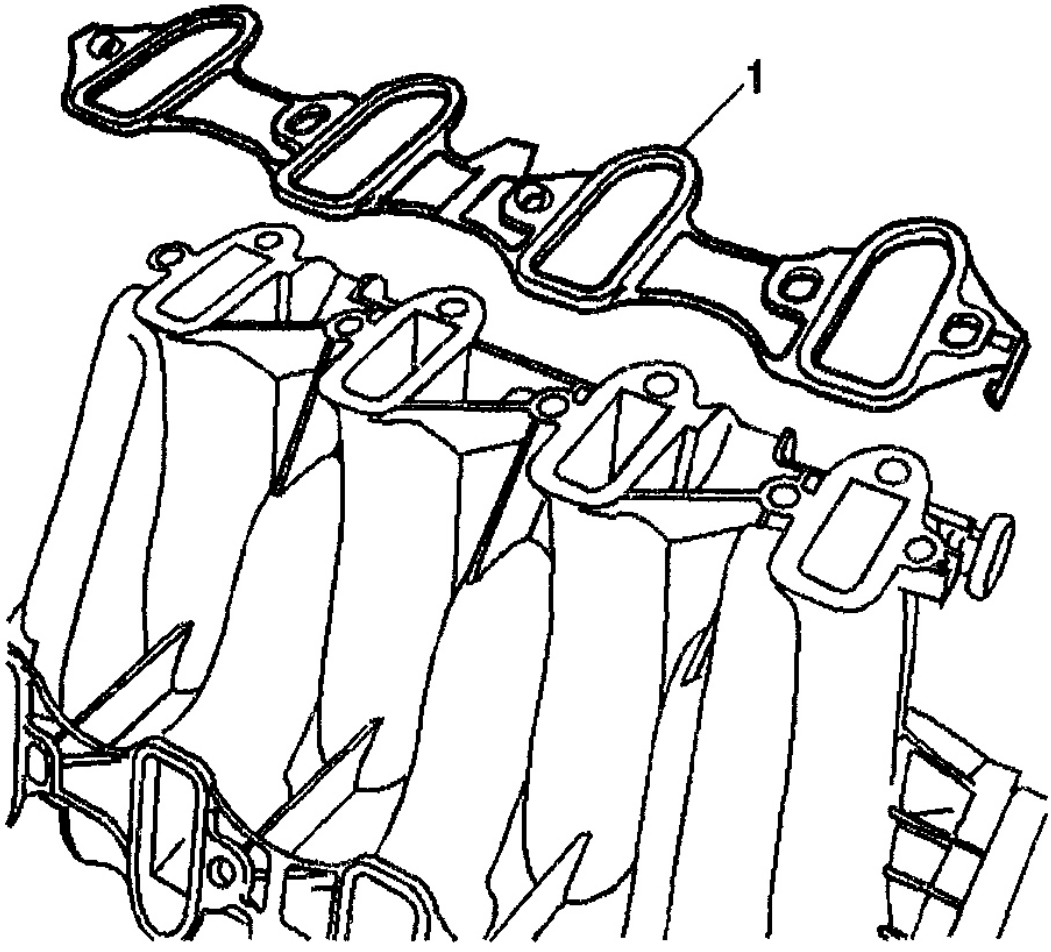
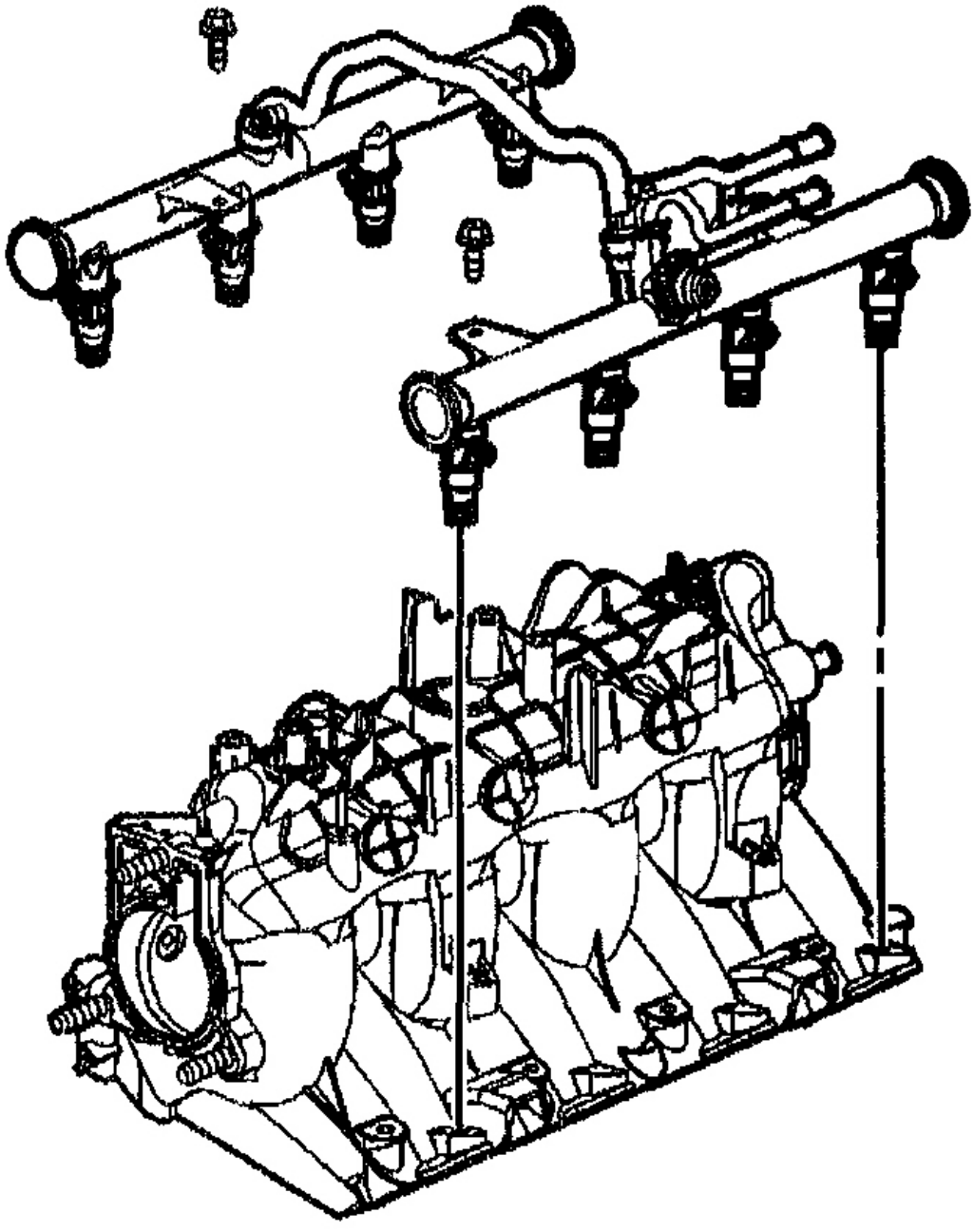


Fig. 298: Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

4. Remove the fuel rail with injectors. Refer to **Fuel Rail and Injectors Removal** .

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Fig. 299: Fuel Rail With Injects
Courtesy of GENERAL MOTORS CORP.

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5. Remove the throttle body and gasket. Refer to **Throttle Body Removal** .

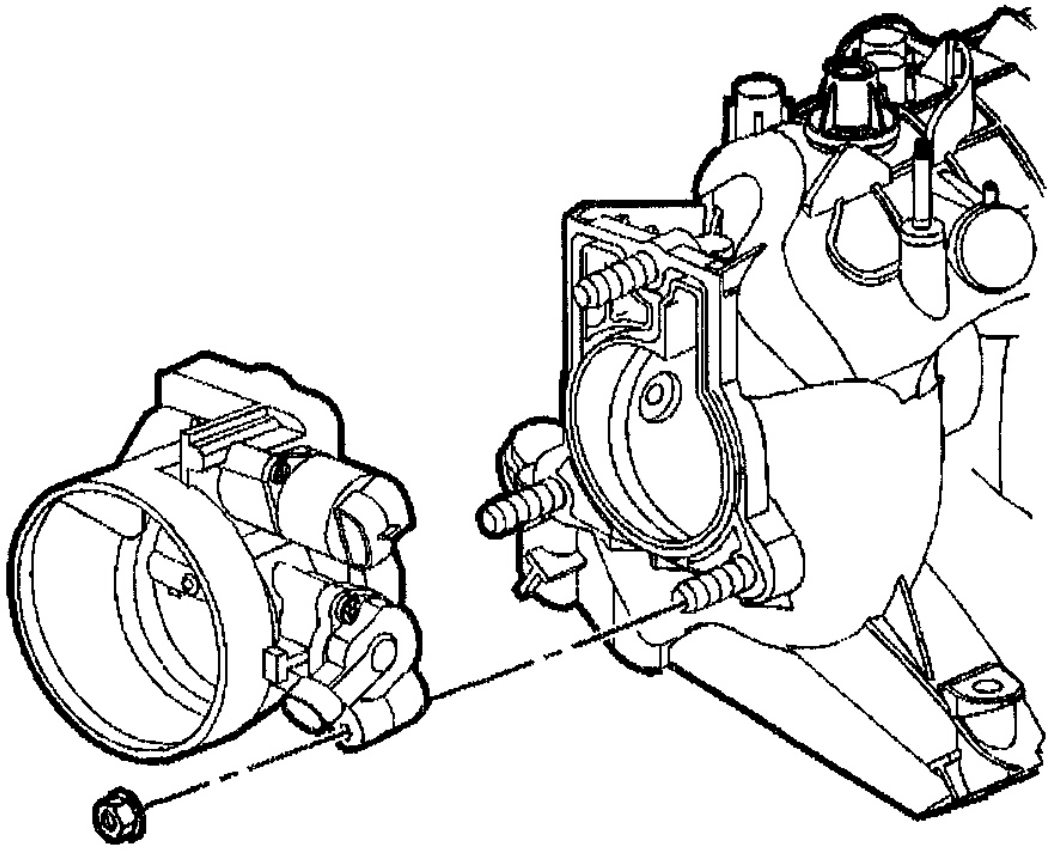


Fig. 300: Throttle Body & Nut
Courtesy of GENERAL MOTORS CORP.

6. Remove the Evaporative Emissions (EVAP) purge solenoid (3), bolt (2), and isolator (1).
7. Clean the intake manifold in solvent.
   - Clean the intake manifold gasket surfaces.
   - Clean the intake manifold internal passages.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

8. Dry the intake manifold with compressed air.

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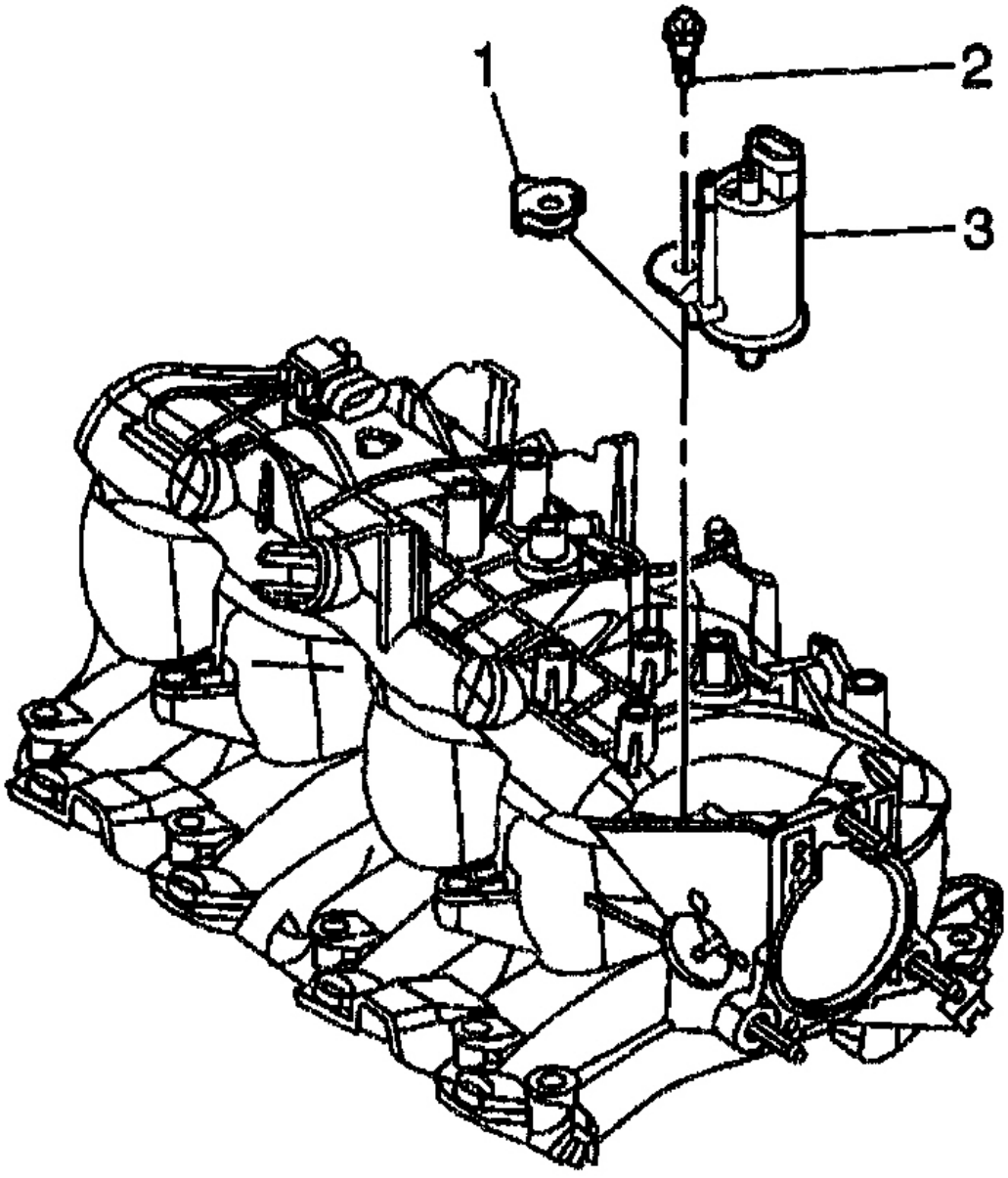


Fig. 301: EVAP Purge Solenoid, Bolt & Isolator
Courtesy of GENERAL MOTORS CORP.

Inspection Procedure

1. Inspect the throttle body studs and threaded inserts for looseness or damaged threads.

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2. Inspect the wire harness stud and threaded insert for looseness or damaged threads.

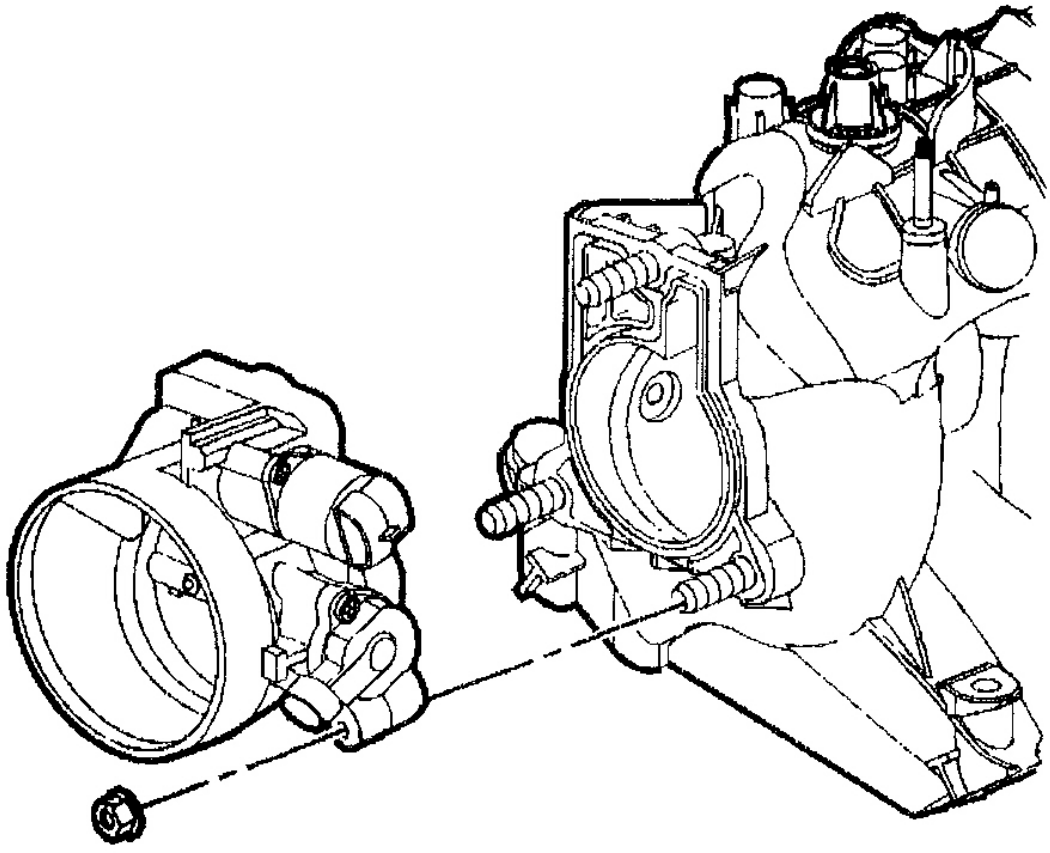
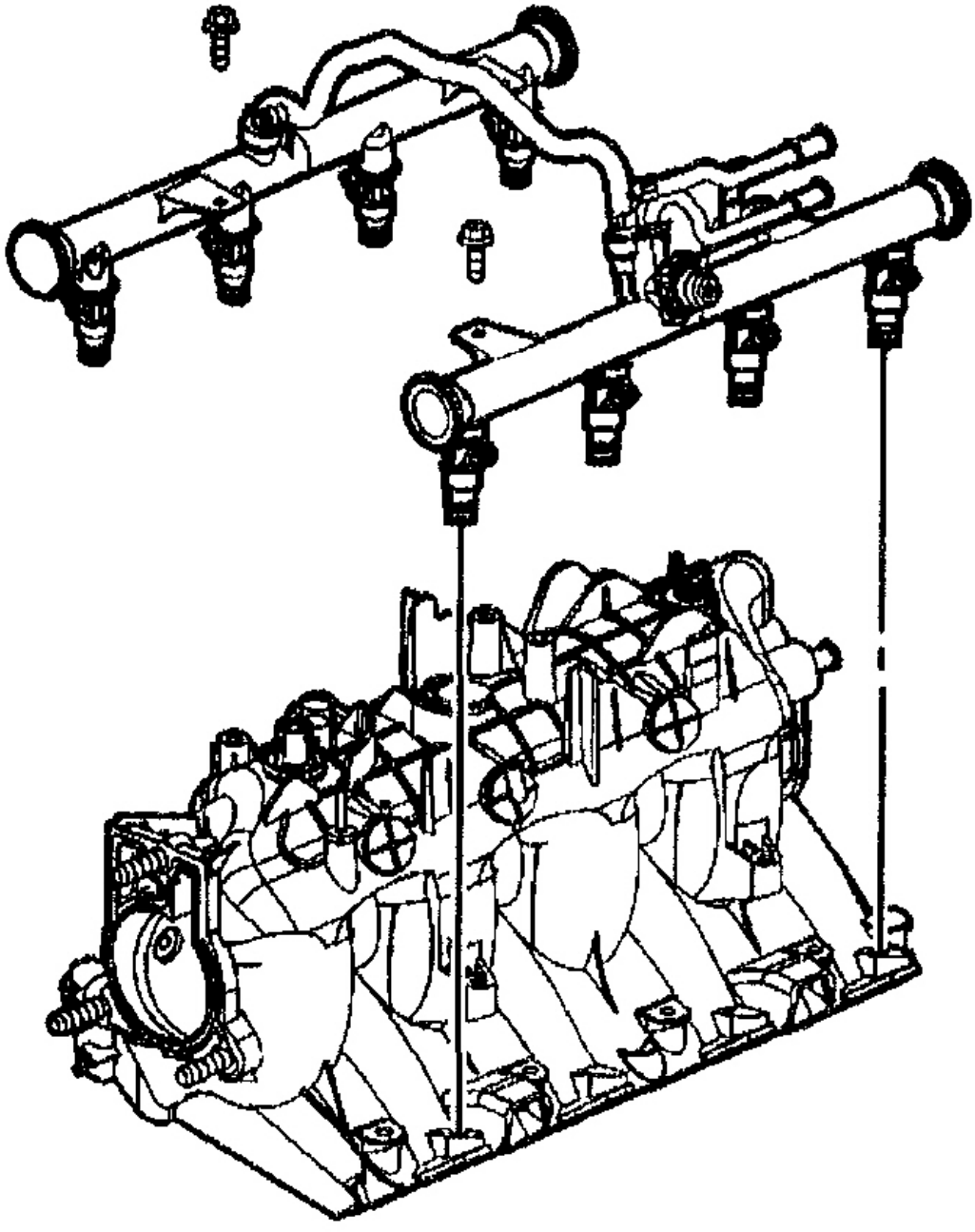


Fig. 302: Throttle Body & Nut
Courtesy of GENERAL MOTORS CORP.

3. Inspect the fuel rail bolt inserts for looseness or damaged threads.
4. Inspect the intake manifold vacuum passages for debris or restrictions.

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Fig. 303: Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

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5. Inspect for damaged or broken vacuum fittings, damaged MAP sensor (1) mounting bore, or broken MAP sensor retaining tabs.
6. Inspect the composite intake manifold assembly for cracks or other damage.

   Inspect the areas between the intake runners.

7. Inspect all the gasket sealing surfaces for damage.

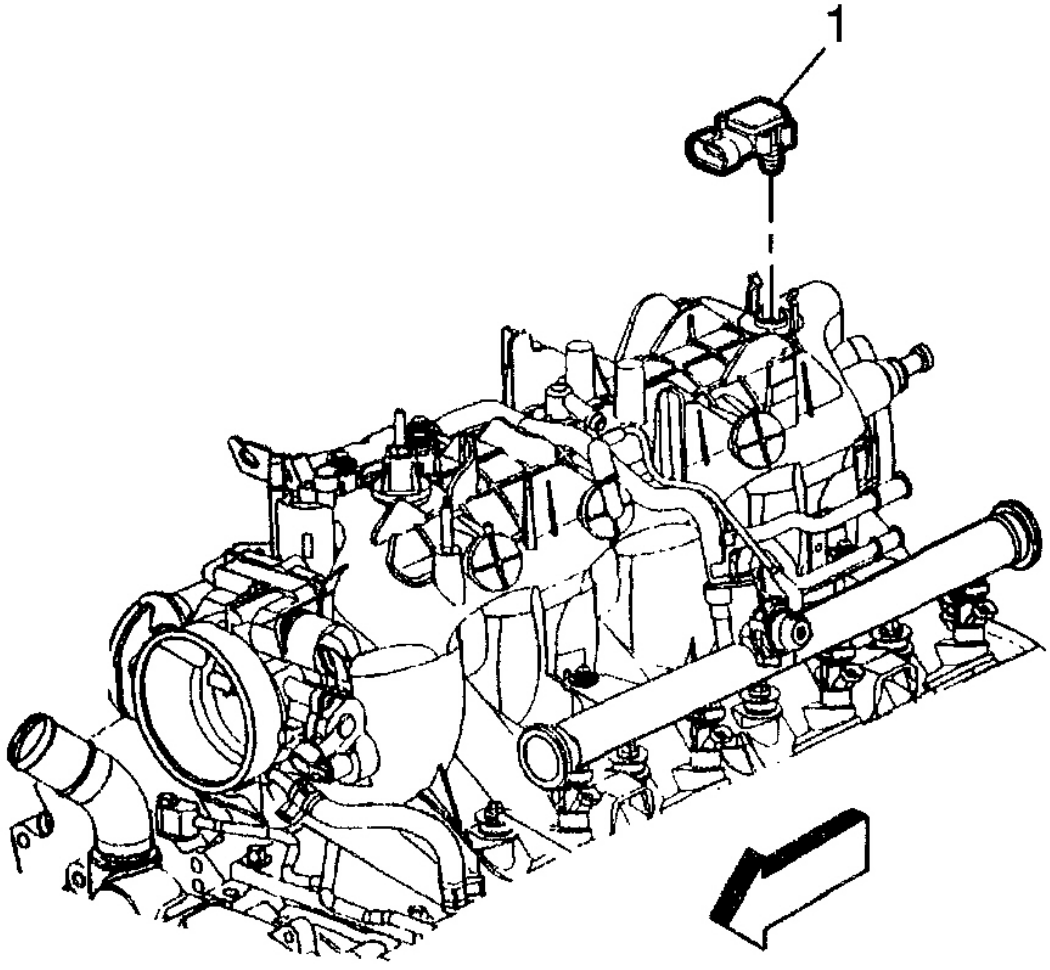


Fig. 304: MAP Sensor
Courtesy of GENERAL MOTORS CORP.

8. Inspect the fuel injector bores for excessive scoring or damage.
9. Inspect the intake manifold cylinder head deck for warpage.

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9.1. Locate a straight edge across the intake manifold cylinder head deck surface.

Position the straight edge across a minimum of two runner port openings.

9.2. Insert a feeler gage between the intake manifold and the straight edge.

A intake manifold with warpage in excess of 3 mm (0.118 in) over a 200 mm (7.87 in) area is warped and should be replaced.

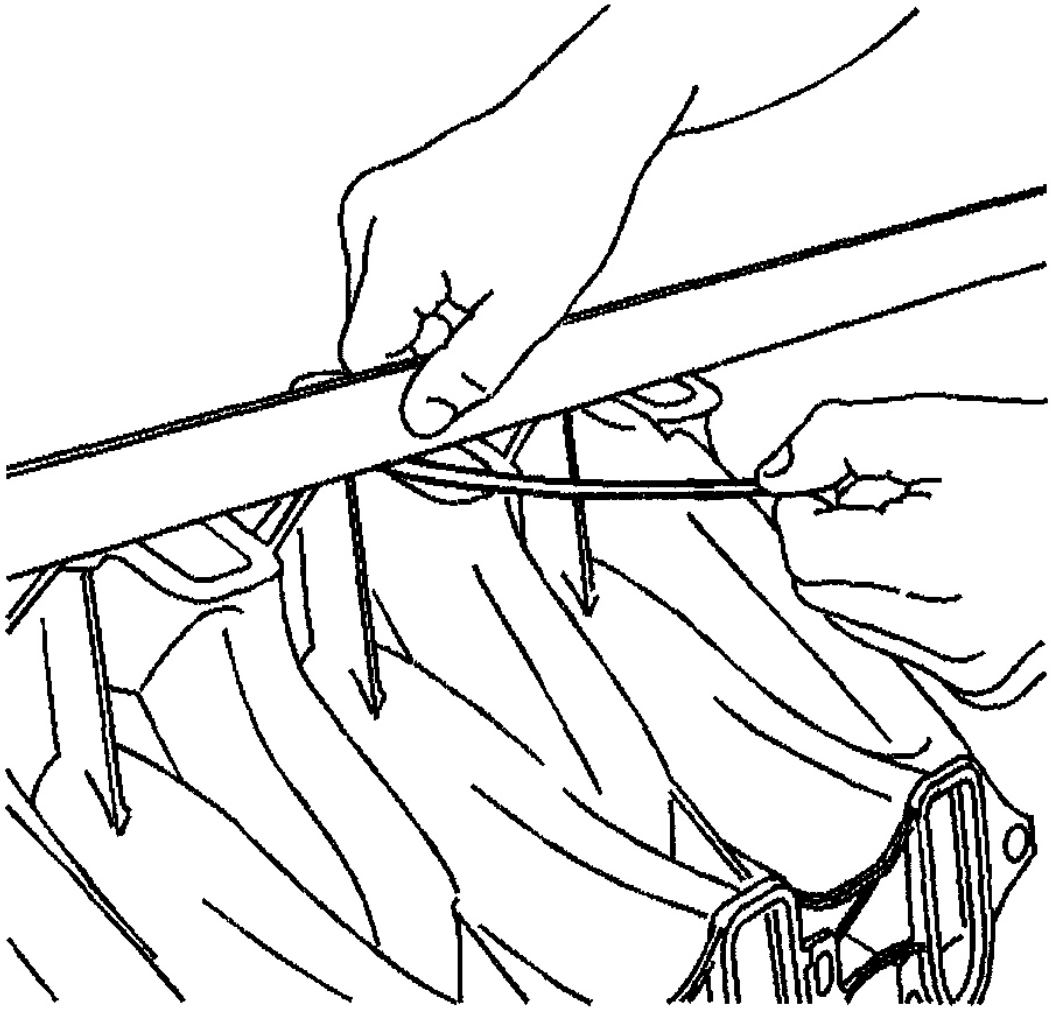


Fig. 305: Inspecting Intake Manifold Cylinder Head Deck For Warpage
Courtesy of GENERAL MOTORS CORP.

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10. Install the MAP sensor (1).

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

11. Install the EVAP solenoid, bolt, and isolator.

Tighten

Tighten the EVAP solenoid bolt to 10 N.m (89 lb in).

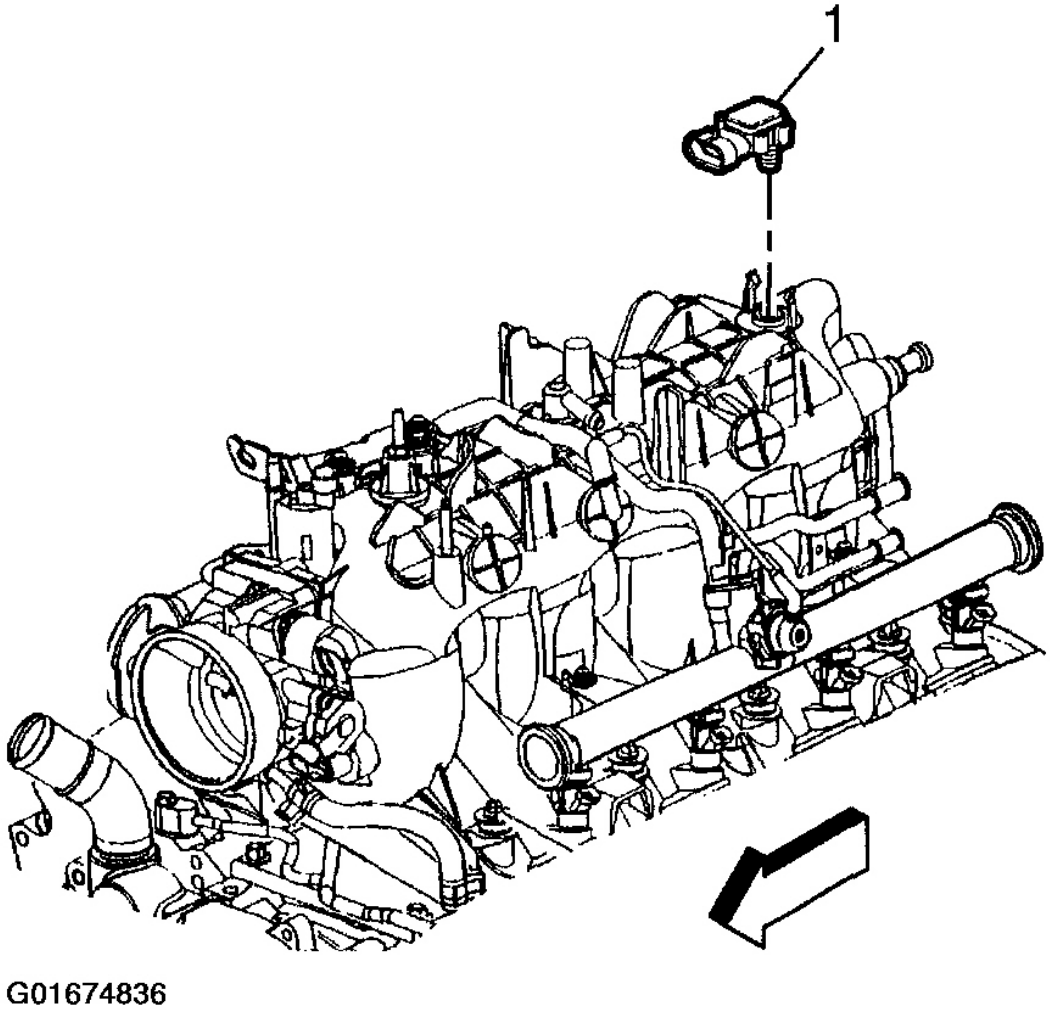


Fig. 306: MAP Sensor
Courtesy of GENERAL MOTORS CORP.

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EXHAUST MANIFOLD CLEANING AND INSPECTION

IMPORTANT: Do not reuse the exhaust manifold-to-cylinder head gaskets. Upon installation of the exhaust manifold. Install a NEW gasket. A improperly installed gasket or leaking exhaust system may effect On-Board Diagnostics (OBD) II system performance.

1. Clean the exhaust manifold (1) and heat shield (2) in solvent.
2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect the right side manifold Exhaust Gas Recirculation (EGR) flange sealing surface for excessive scratches or gouging, if applicable.

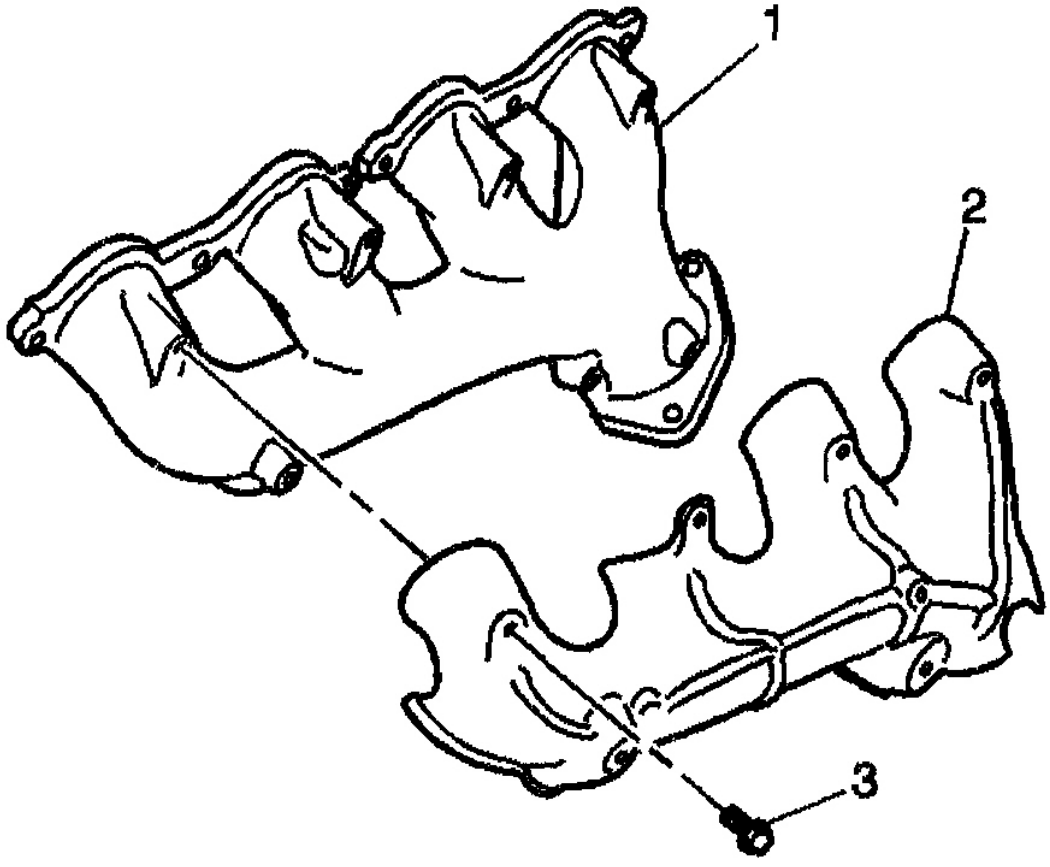


Fig. 307: Exhaust Manifold, Heat Shield & Bolt
Courtesy of GENERAL MOTORS CORP.

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5. Inspect the right side manifold EGR flange bolt hole threads for damage.
6. Inspect for a loose or damaged heat shield (2).
7. Inspect the take down studs for damaged threads.
8. Use a straight edge and a feeler gage and measure the exhaust manifold cylinder head deck for warpage.

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

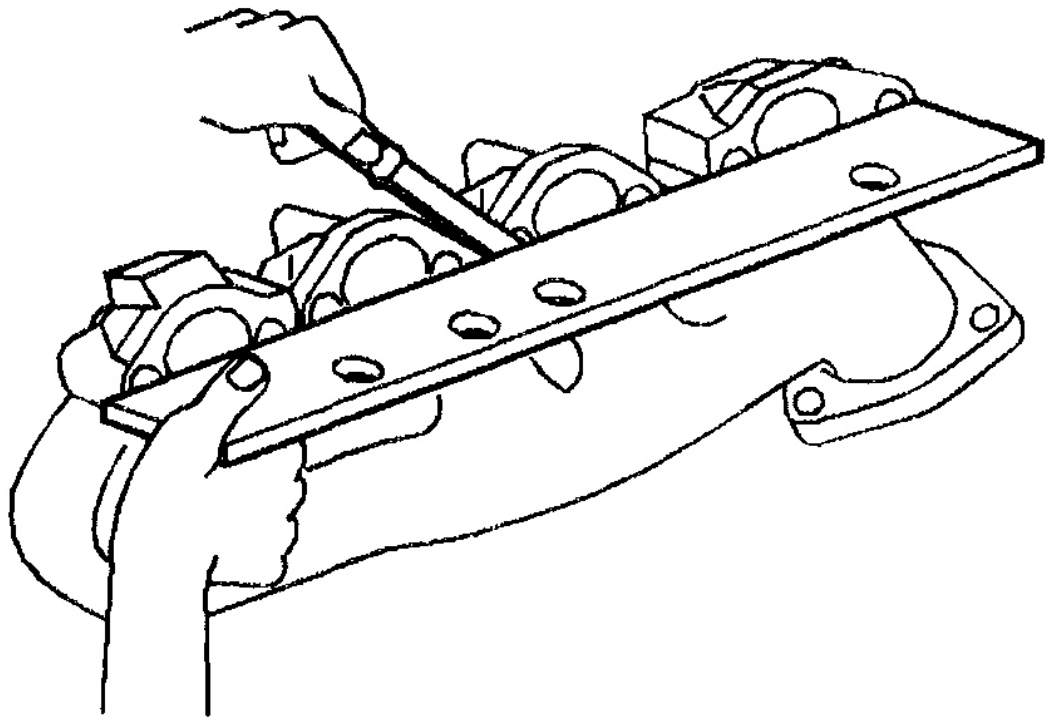


Fig. 308: Measuring Exhaust Manifold Cylinder Head Deck For Warpage
Courtesy of GENERAL MOTORS CORP.

COOLANT AIR BLEED PIPE CLEANING AND INSPECTION

IMPORTANT: Do not reuse the engine coolant air bleed pipe and cover gaskets. Upon installation of the pipe and covers, install NEW gaskets.

1. Remove the sealing gaskets from the pipe.
2. Remove the sealing gaskets from the covers.

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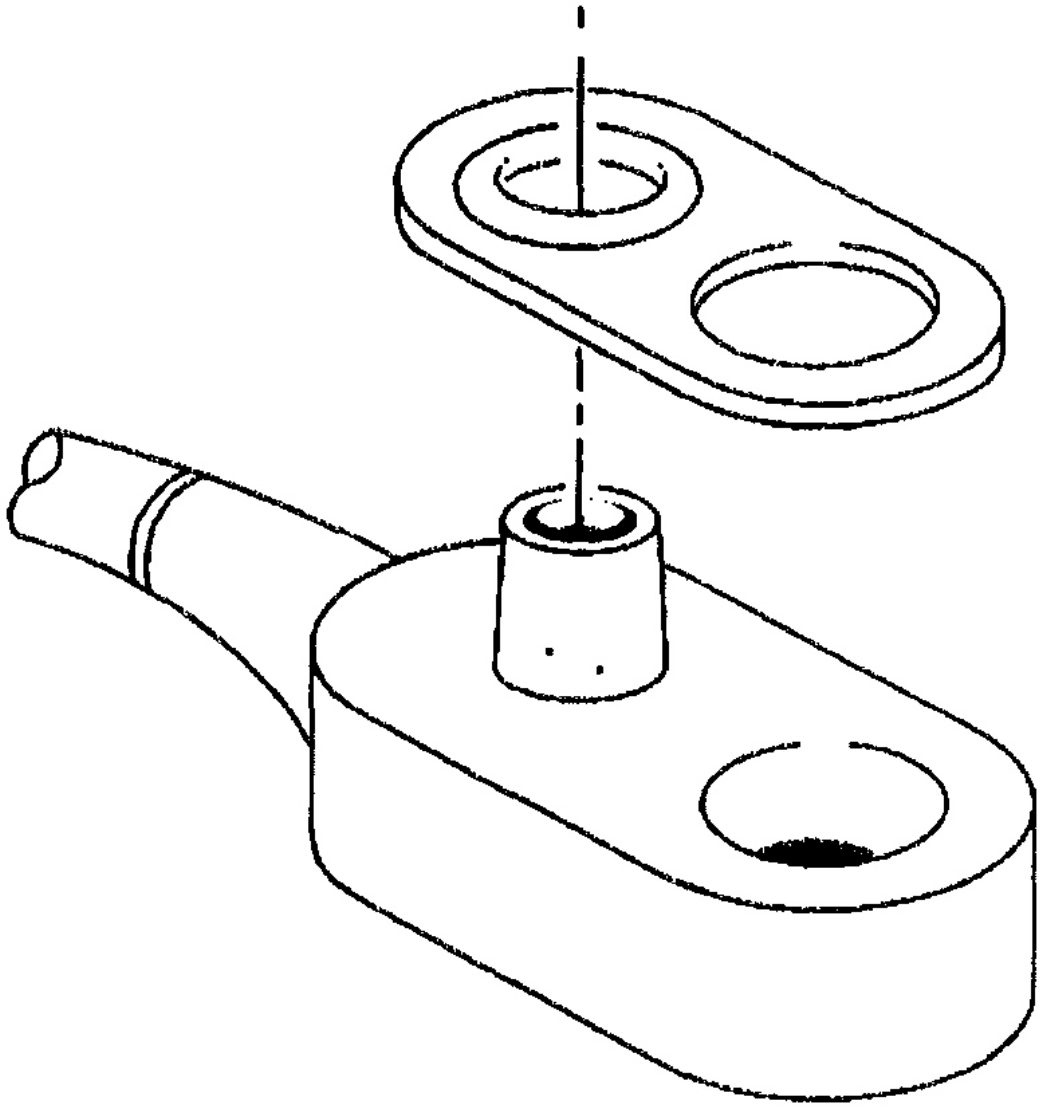


Fig. 309: Coolant Air Bleed Pipe Sealing Gasket
Courtesy of GENERAL MOTORS CORP.

3. Clean the pipe (2), hose (1), and covers in solvent.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

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4. Dry the pipe and covers with compressed air.
5. Inspect the pipe and covers for damage or restrictions.
6. Inspect the gasket and hose sealing surfaces for damage.
7. Inspect the hose (1) for restrictions, cracking or wear.

   The hose may be reused if not damaged.

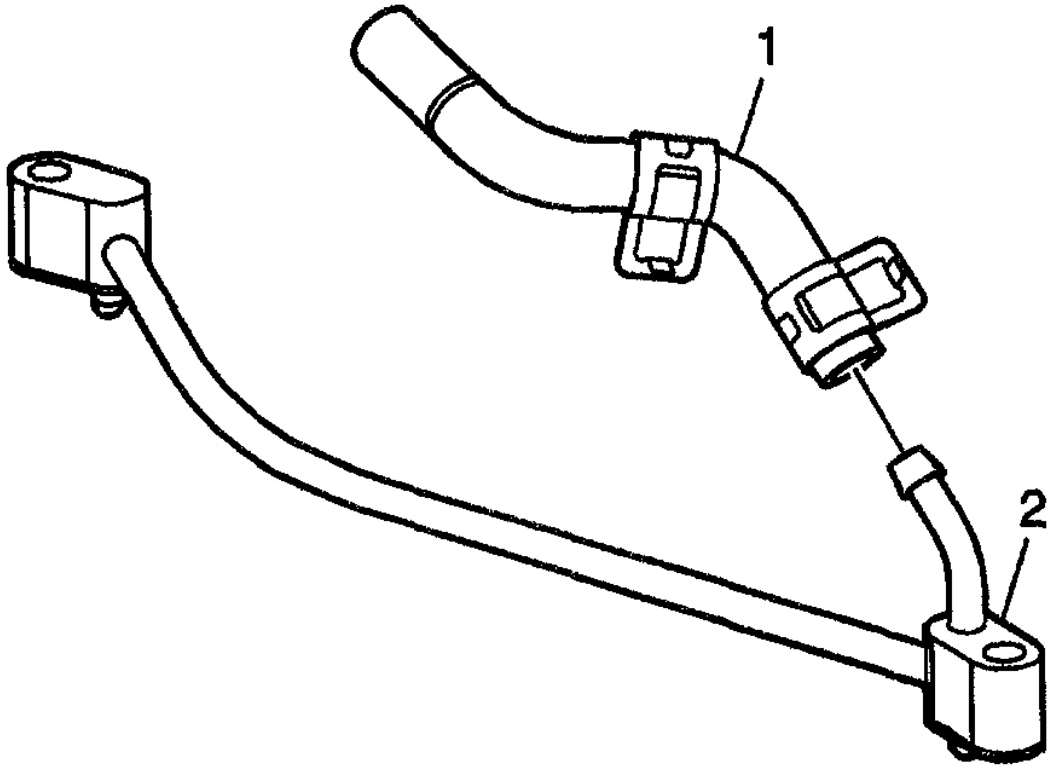


Fig. 310: Coolant Air Bleed Hose & Pipe
Courtesy of GENERAL MOTORS CORP.

WATER PUMP CLEANING AND INSPECTION

1. Remove the old gasket from the water pump sealing surfaces. Refer to **Replacing Engine Gaskets** .
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump for the following:
   - Gasket and hose sealing surfaces for excessive scratches or gouging
   - Restrictions within the internal coolant passages

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- Excessive side-to-side play in the pulley shaft
- Leakage at the water outlet housing or rear cover gasket
- Leakage at the water pump vent hole

  A stain around the vent hole is acceptable. If leakage occurs (dripping) with the engine running and the cooling system pressurized, replace the water pump.

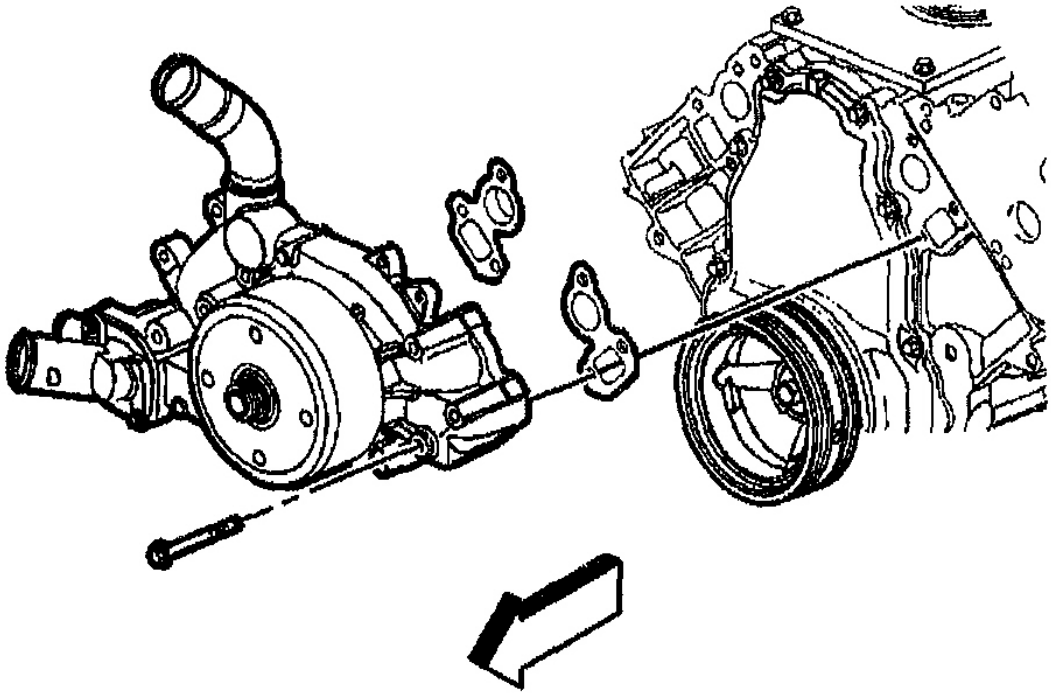
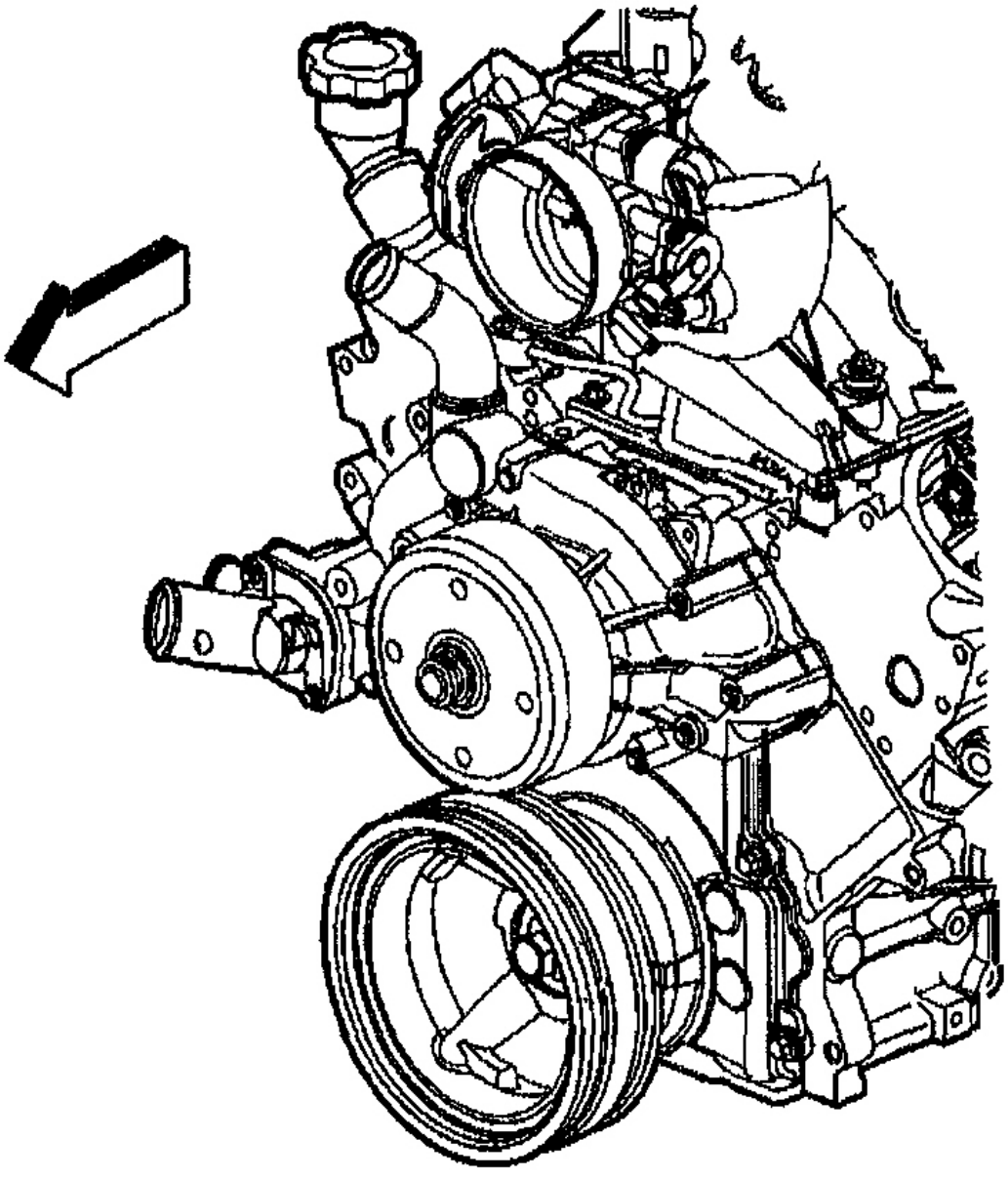


Fig. 311: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

4. Inspect the water pump pulley for wear or damage in the belt tracking area.

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Fig. 312: Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

THREAD REPAIR

Tools Required

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- **J 42385-100** Head/Main Bolt Thread Repair Kit
- **J 42385-200** General Threads Kit
- **J 42385-300** Fixtures/Hardware Kit

General Thread Repair

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

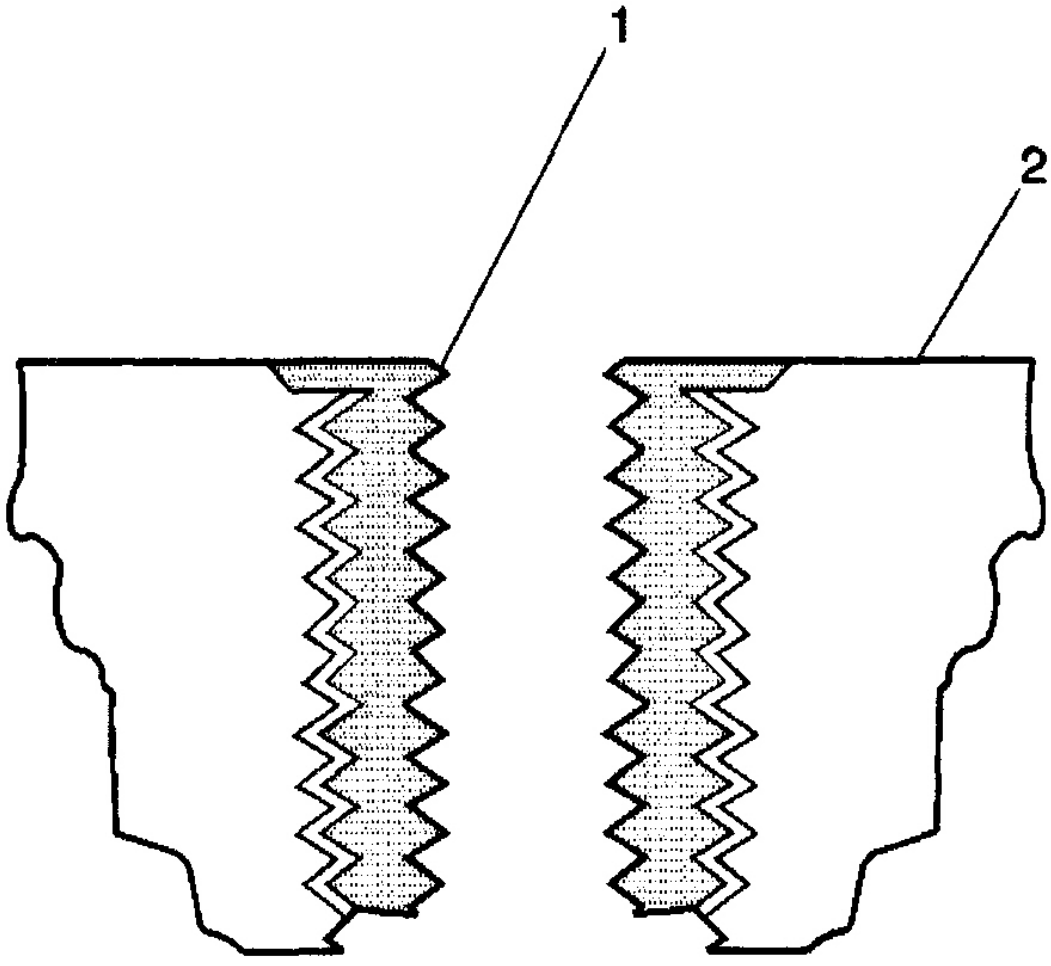


Fig. 313: Base Material & Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

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CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

IMPORTANT: The use of a cutting type fluid GM P/N United States 1052864, GM P/N Canada 992881, WD 40(R), or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures.

Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Drill out the threads of the damaged hole (1).
    - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
    - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
    - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).
2. Using compressed air, clean out any chips.

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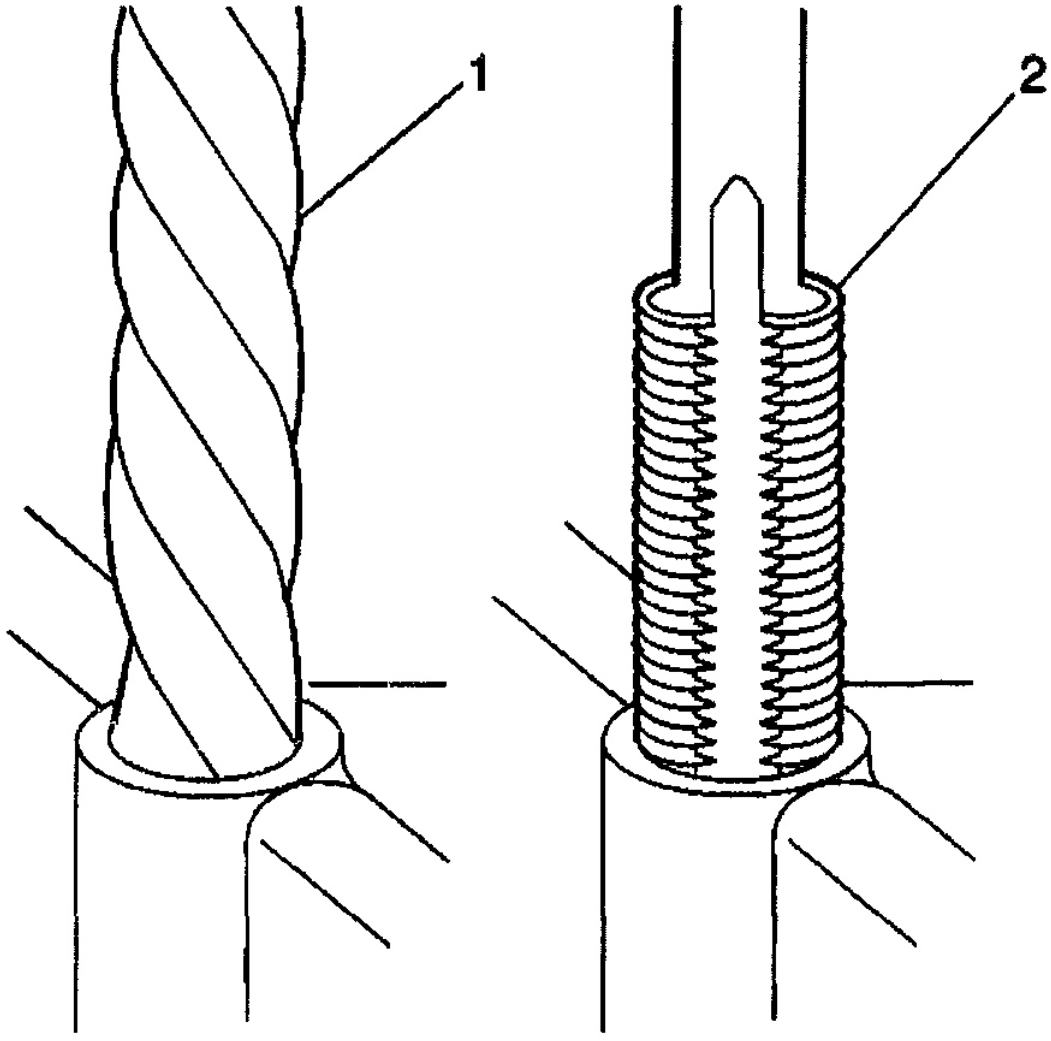


Fig. 314: Drilling & Tapping Damaged Bolt Hole
Courtesy of GENERAL MOTORS CORP.

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

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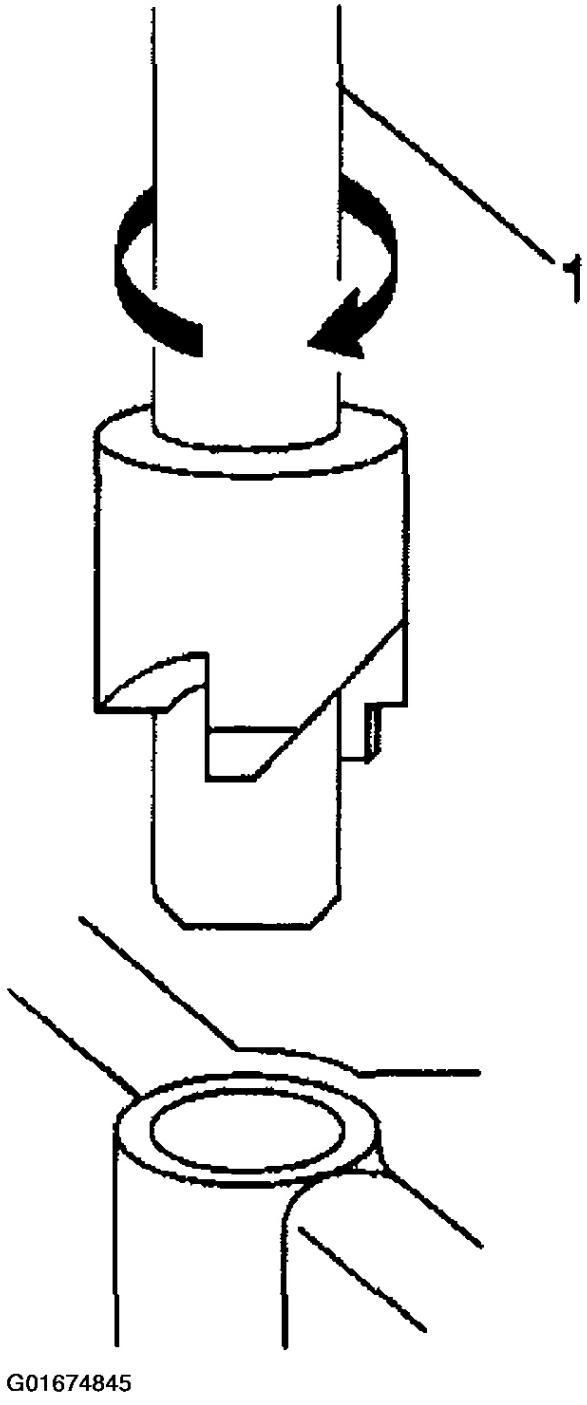


Fig. 315: Counterboring Bolt Hole
Courtesy of GENERAL MOTORS CORP.

5. Using a tap wrench (2), tap the threads of the drilled hole.

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

6. Using compressed air, clean out any chips.
7. Spray cleaner GM P/N United States 12346139, GM P/N Canada 10953463, GM P/N United States 12377981, GM P/N Canada 10953463, or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.

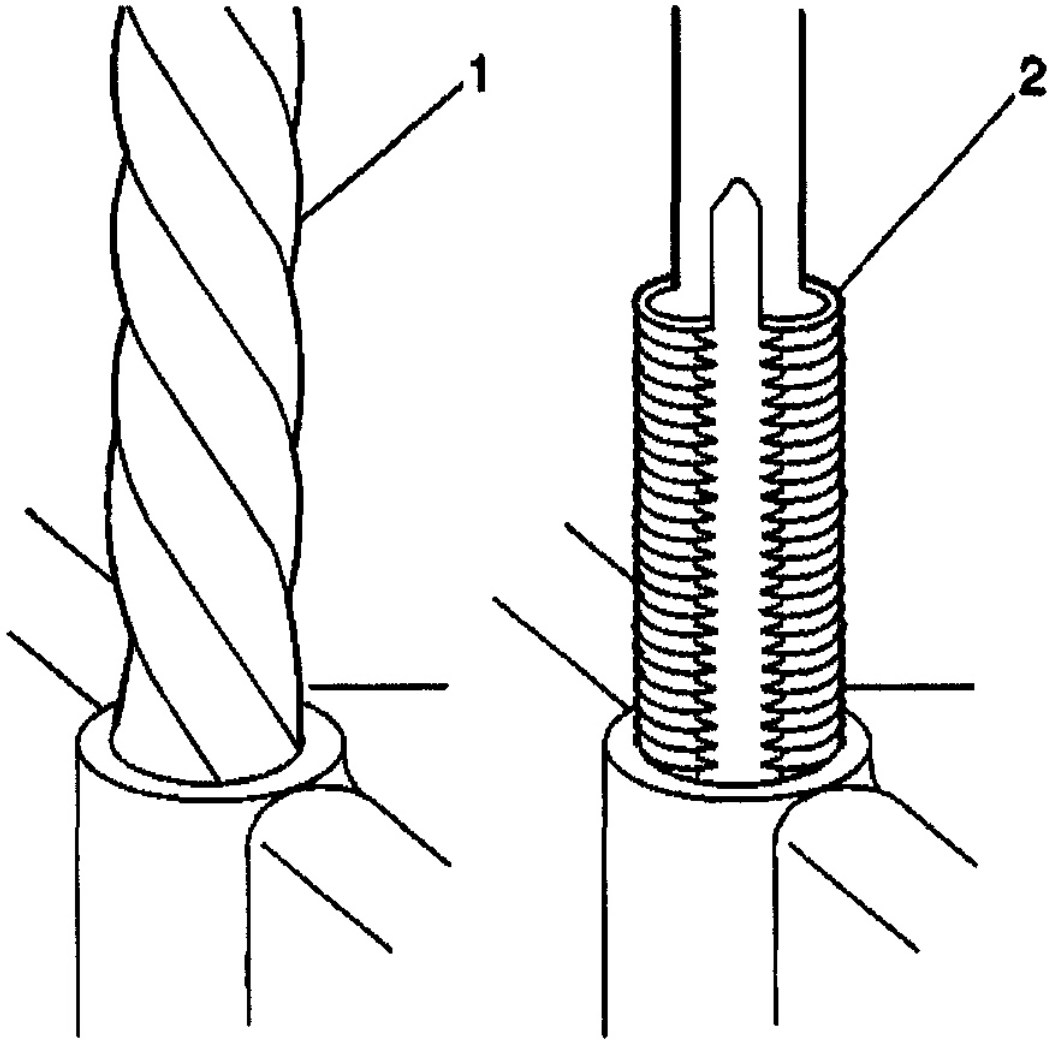


Fig. 316: Drilling & Tapping Bolt Hole
Courtesy of GENERAL MOTORS CORP.

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IMPORTANT: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

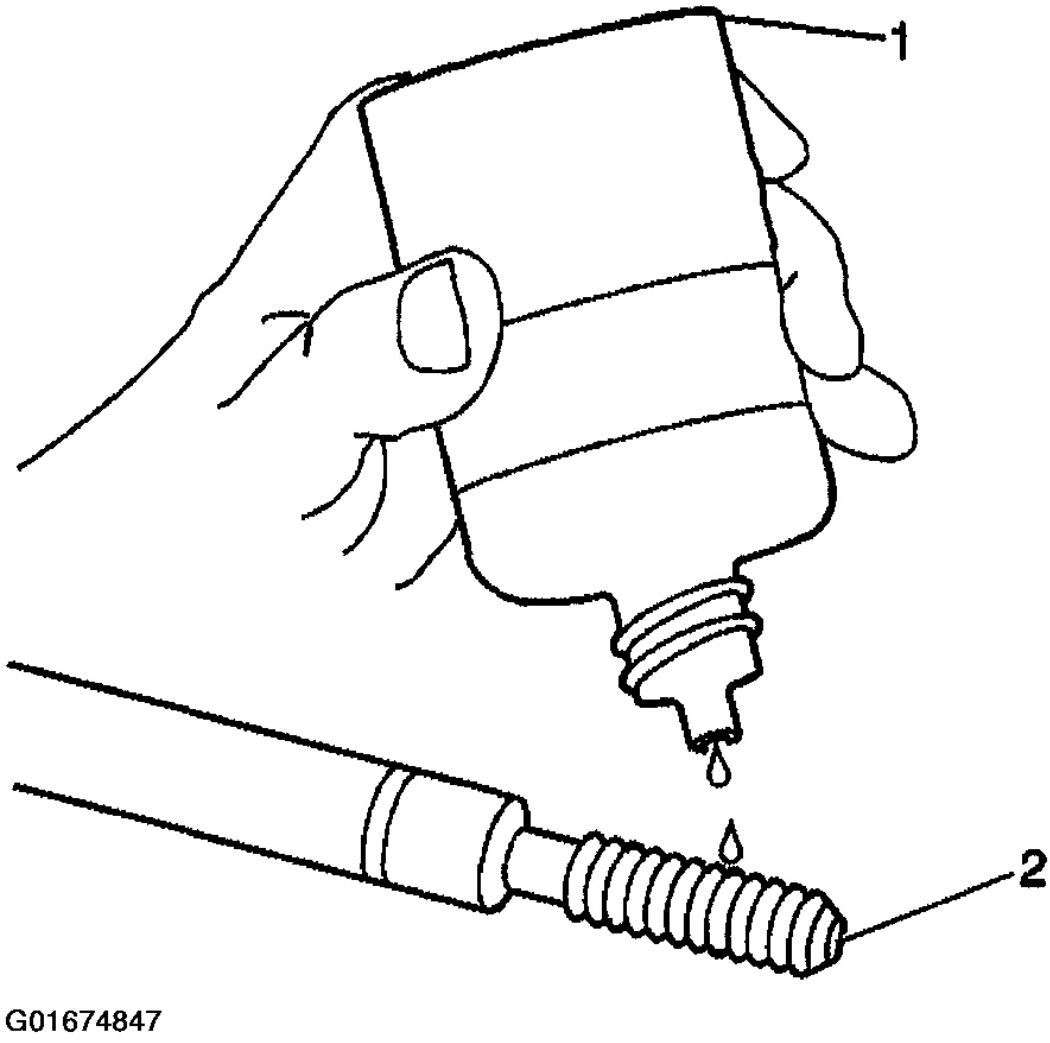


Fig. 317: Lubricating Installer Tool Threads
Courtesy of GENERAL MOTORS CORP.

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

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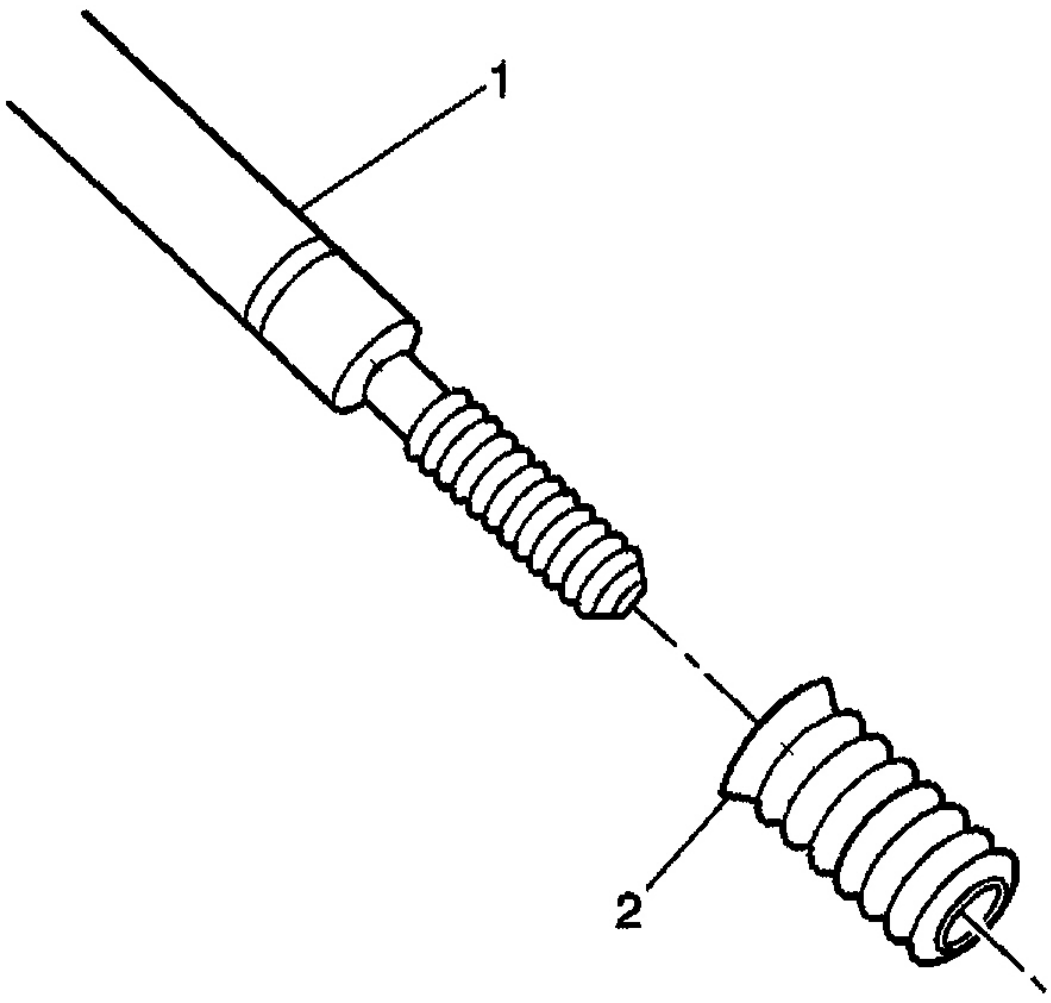


Fig. 318: Driver Tool & Insert
Courtesy of GENERAL MOTORS CORP.

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

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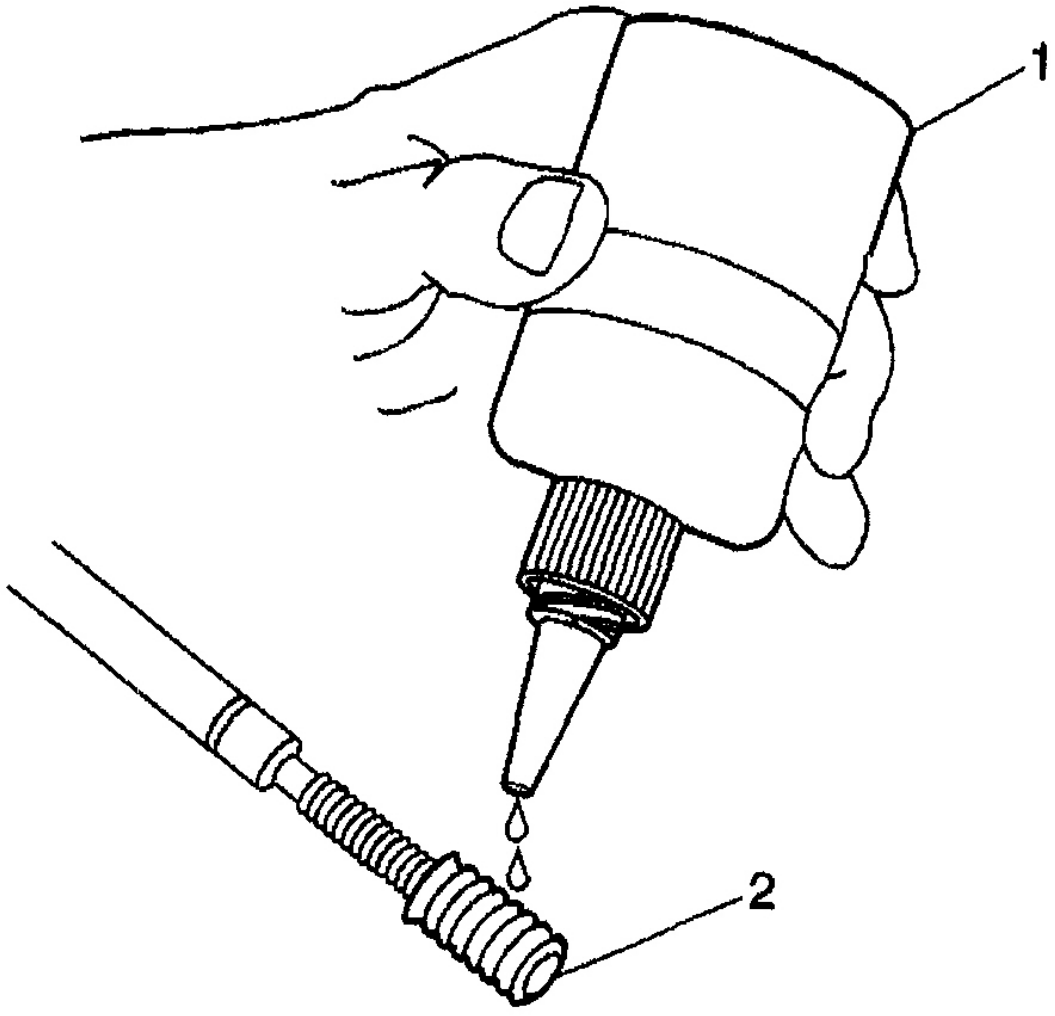


Fig. 319: Applying Threadlock To Insert On Driver Tool
Courtesy of GENERAL MOTORS CORP.

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

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

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

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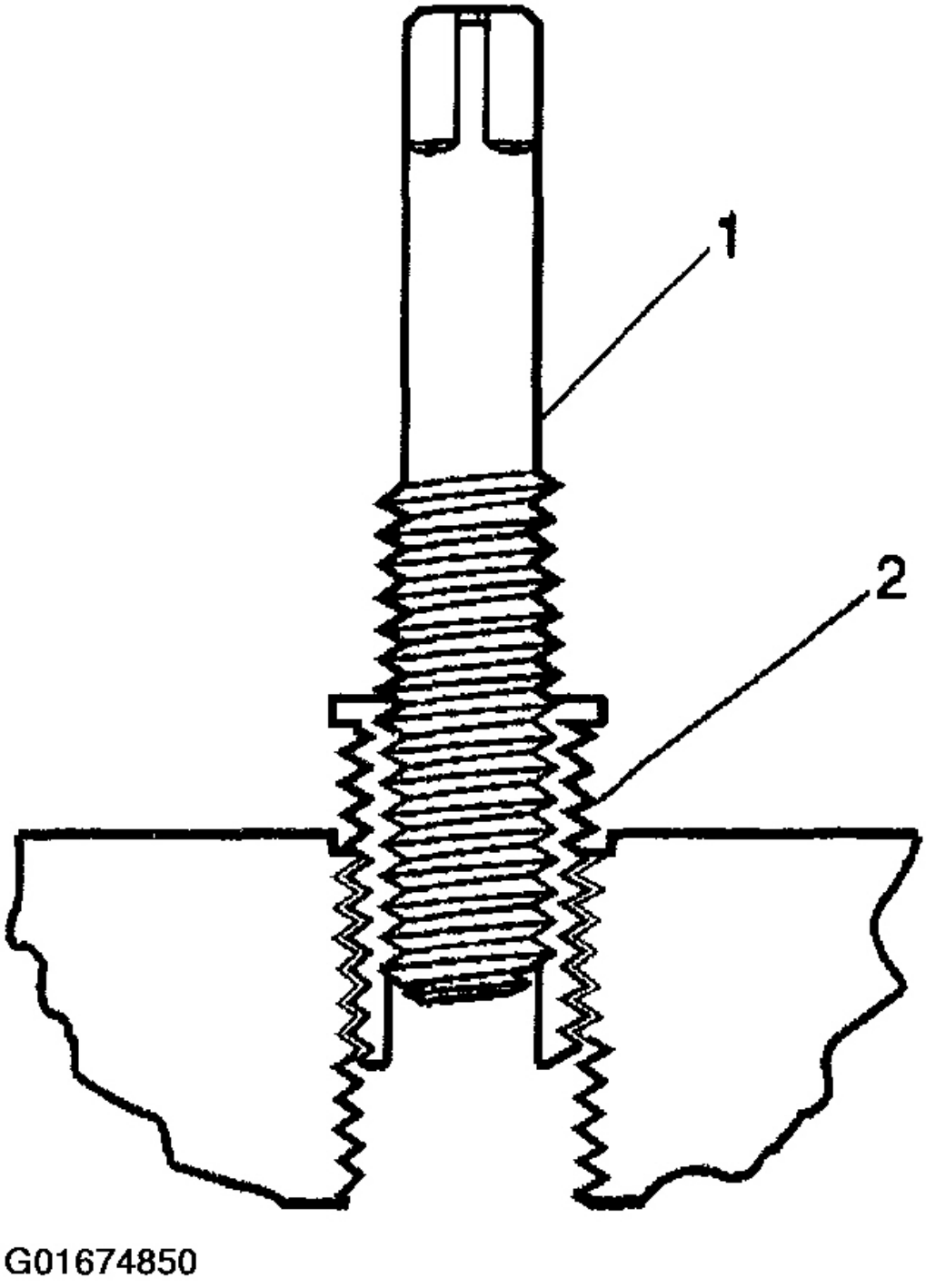


Fig. 320: Installer Tool & Insert In Bolt Hole

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Courtesy of GENERAL MOTORS CORP.

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

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

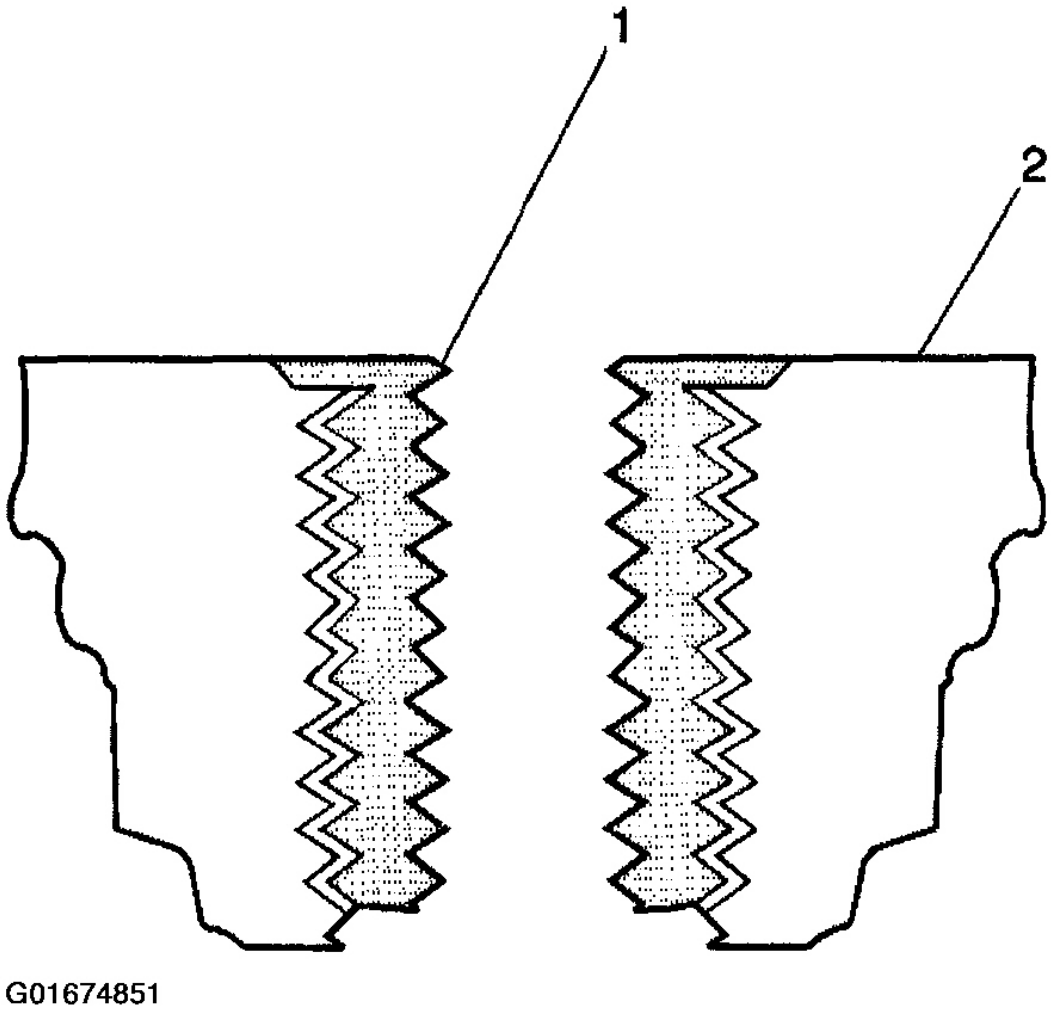


Fig. 321: Insert-To-Base Material Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

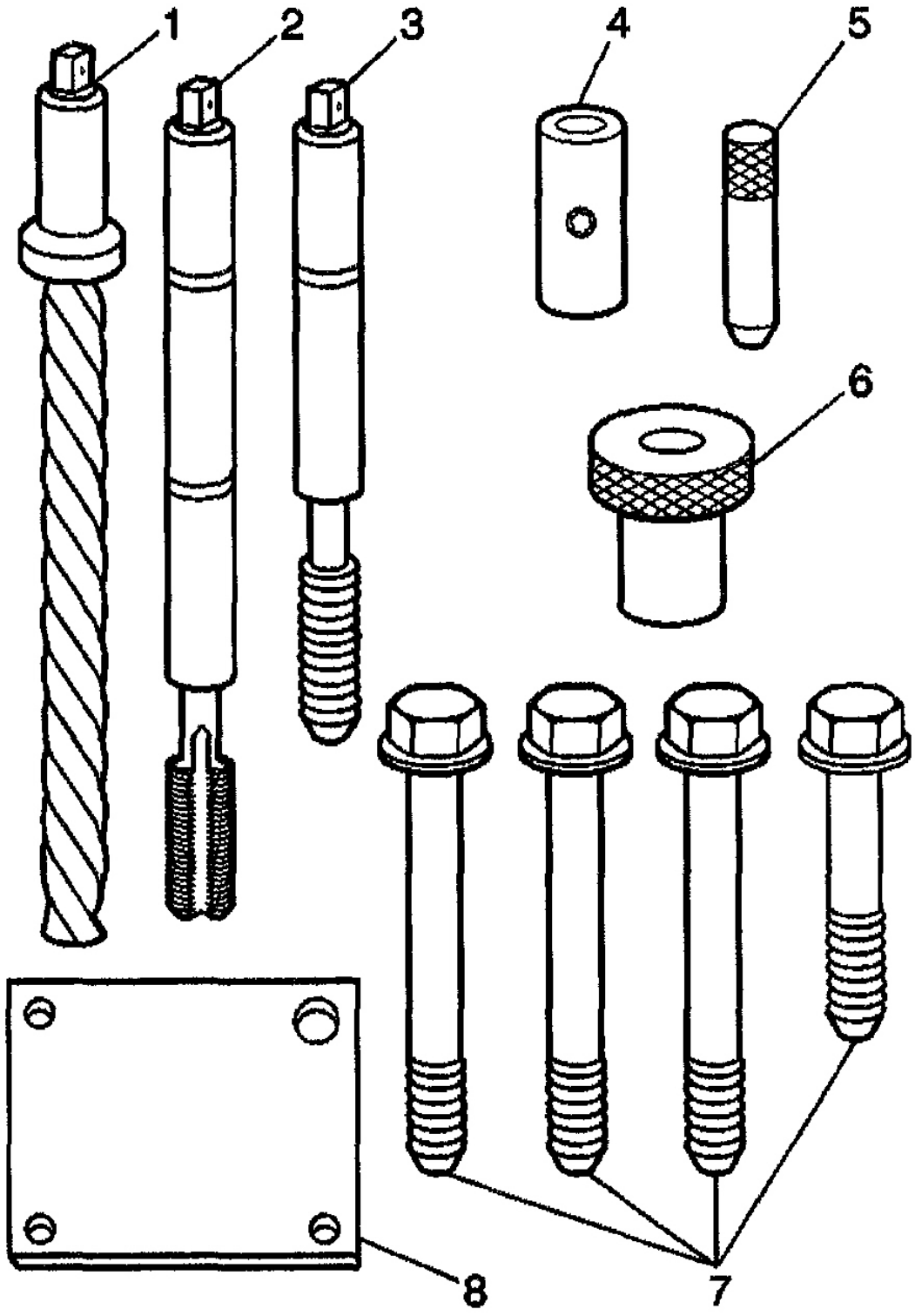
Cylinder Head Bolt Hole Thread Repair

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

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

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Fig. 322: Cylinder Head Bolt Hole Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

IMPORTANT: The use of a cutting type fluid GM P/N United States 1052864, GM P/N Canada 992881, WD 40(R), or equivalent, is recommended when performing the drilling and tapping procedures.

Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

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

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

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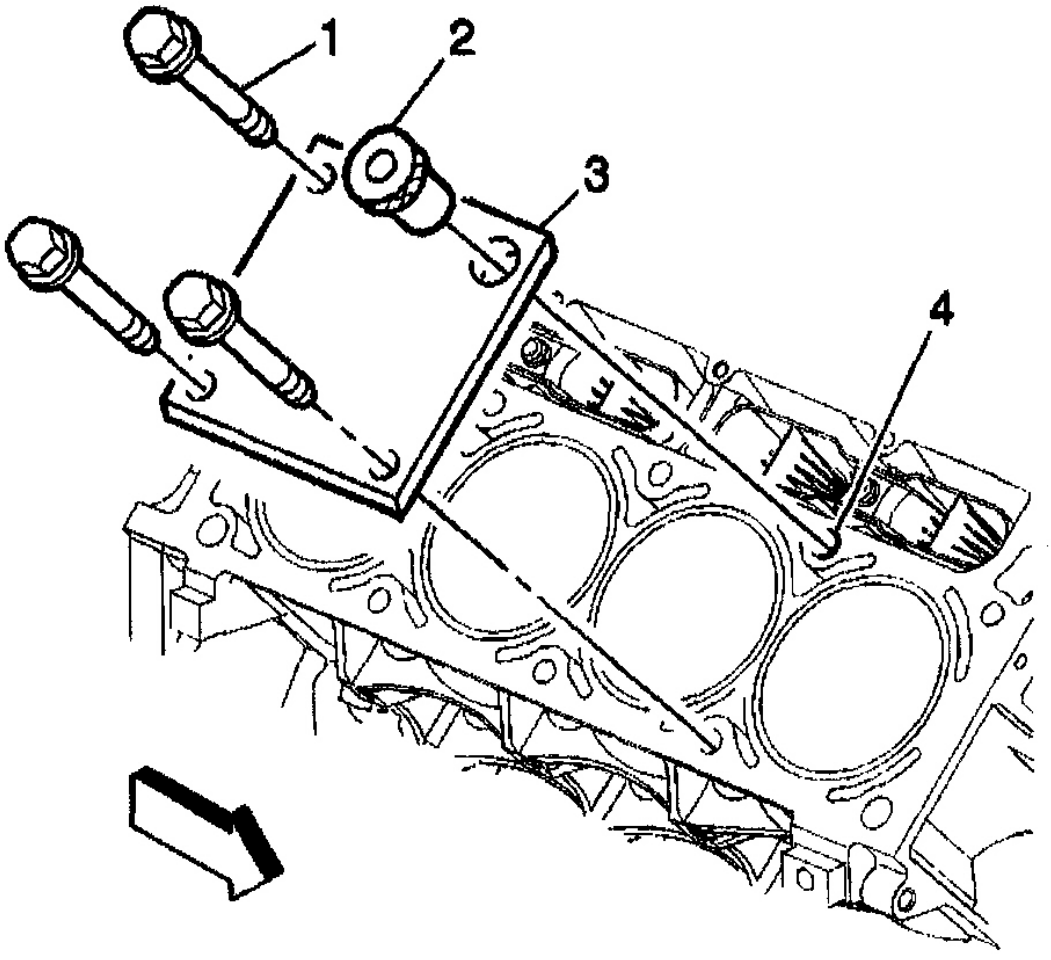
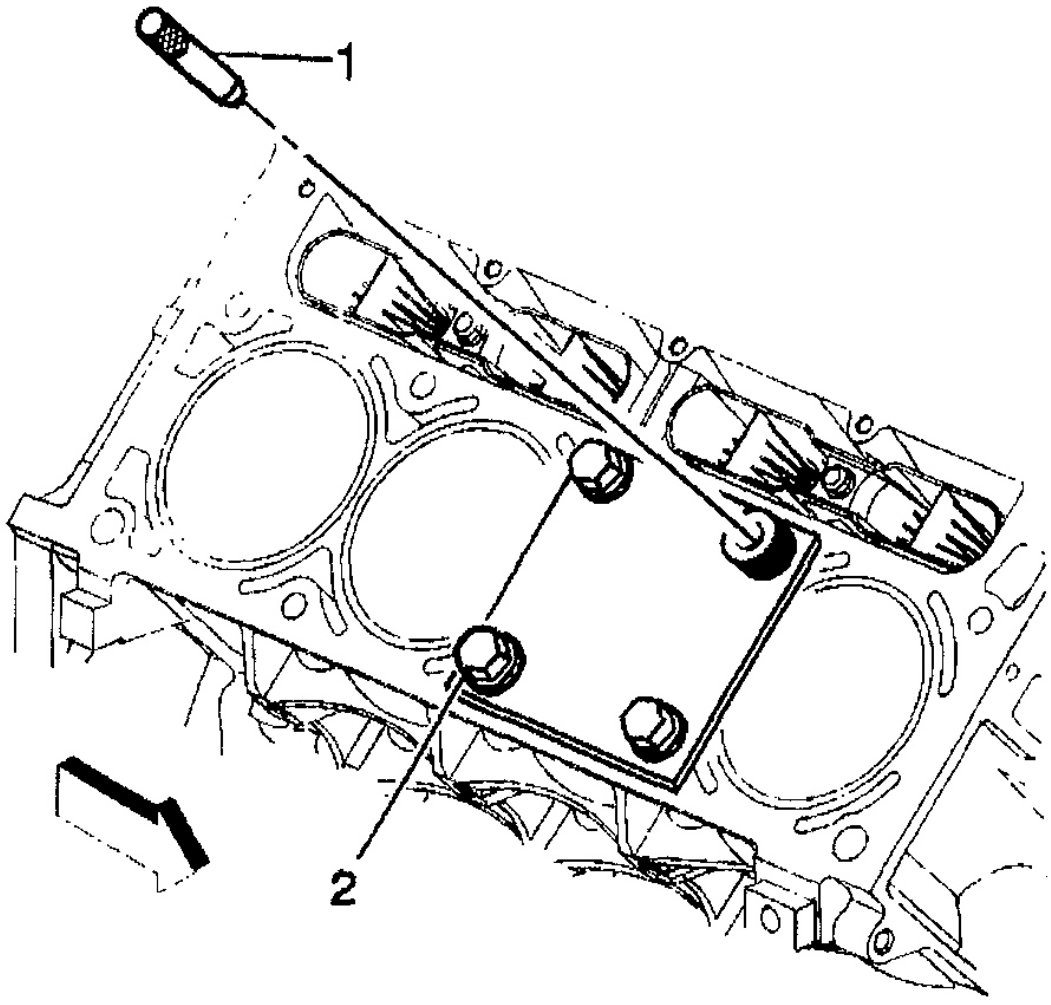


Fig. 323: Fixture Plate, Bolts & Bushing
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.

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Fig. 324: Alignment Pin & Fixture Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

6. Cylinder head bolt holes 1-8 are the deep holes and will be drilled without the drill sleeve.

   Cylinder head bolt holes 9 and 10 are the shallower holes, drilling MUST be done with the drill sleeve in place.

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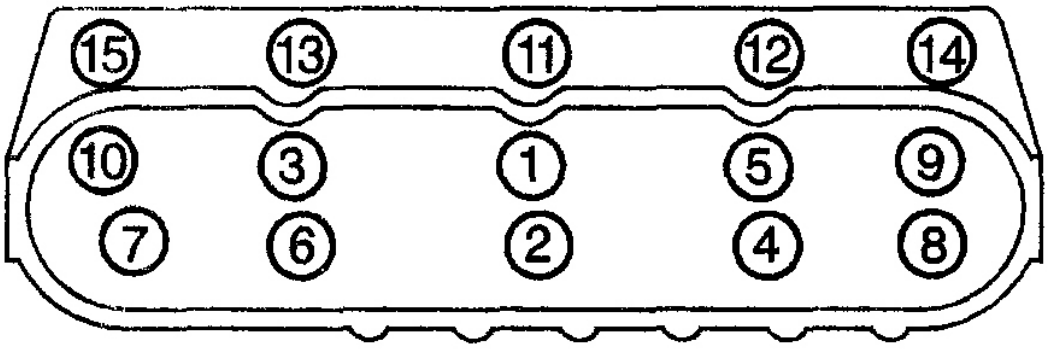
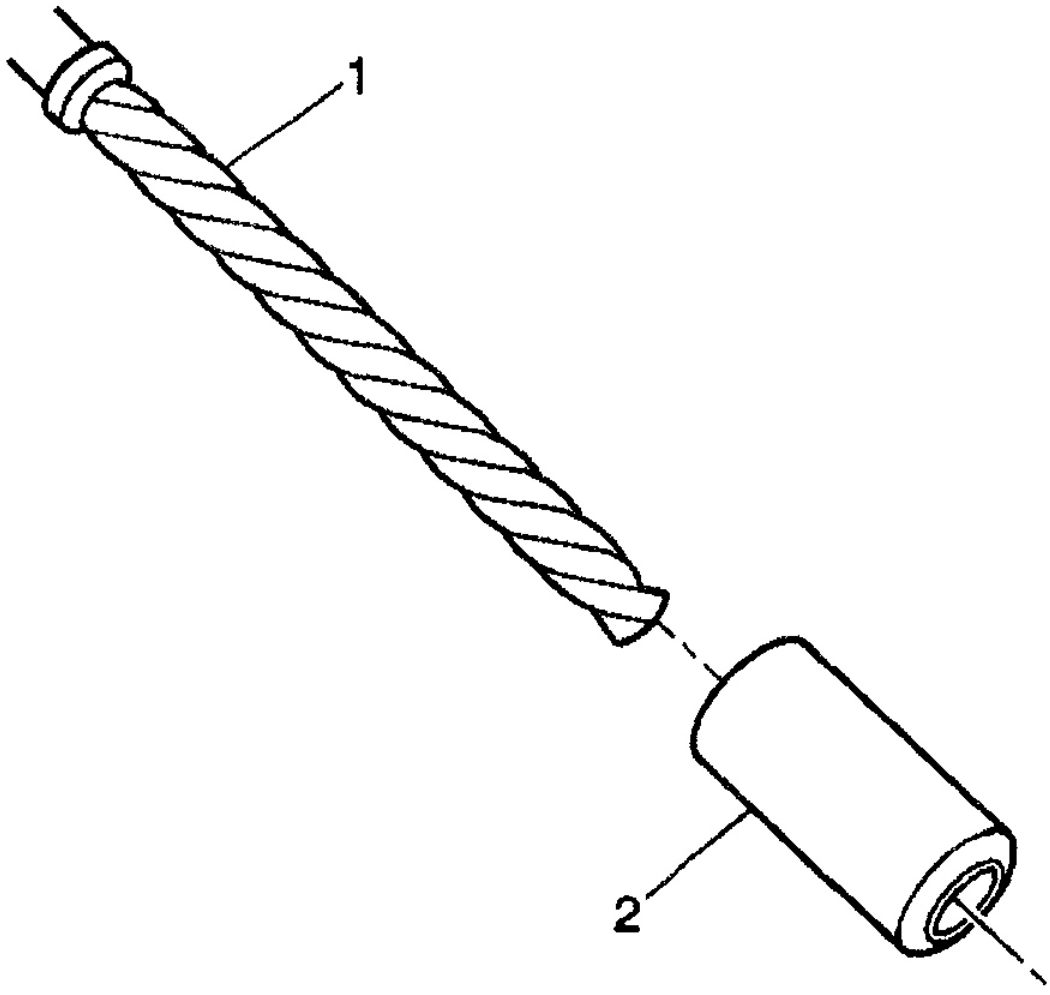


Fig. 325: Cylinder Head Bolt Identification
Courtesy of GENERAL MOTORS CORP.

7. Install the sleeve (2) onto the drill (1), if required.

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Fig. 326: Drill & Sleeve
Courtesy of GENERAL MOTORS CORP.

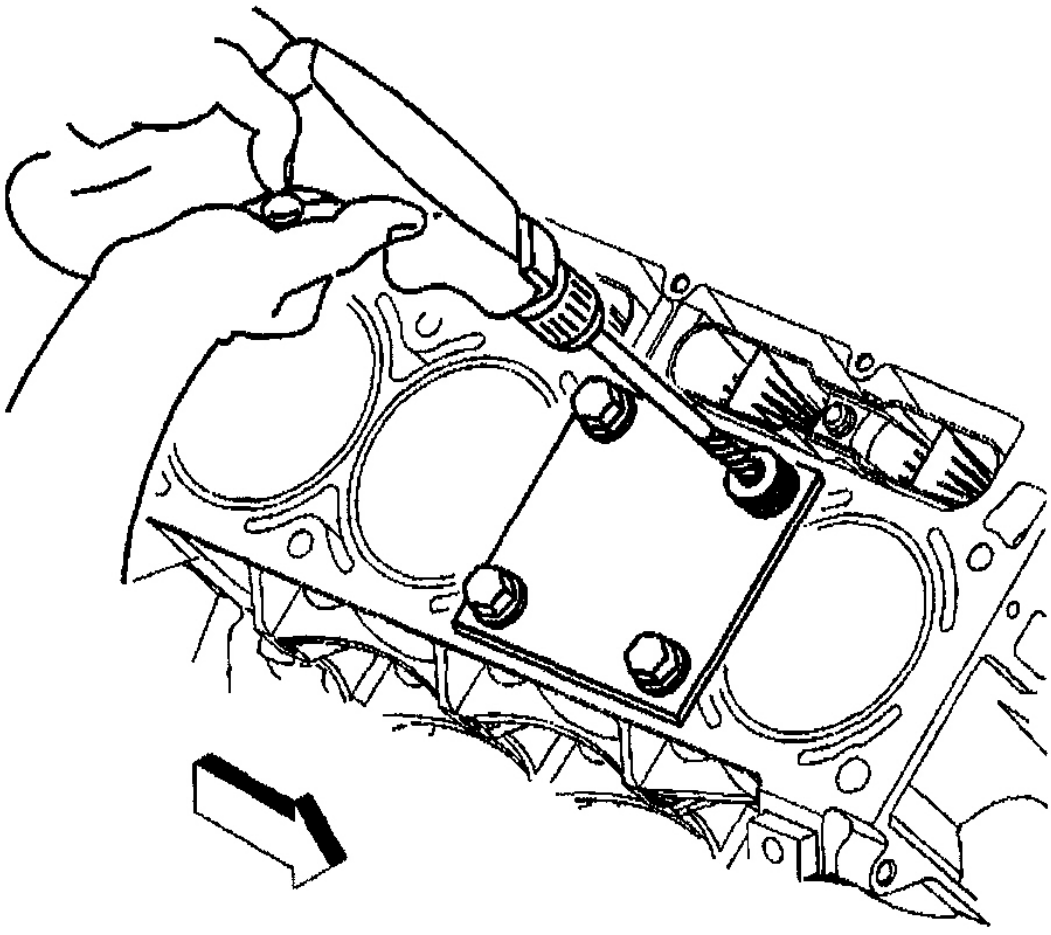
IMPORTANT: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

8. Drill out the threads of the damaged hole.

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

9. Using compressed air, clean out any chips.

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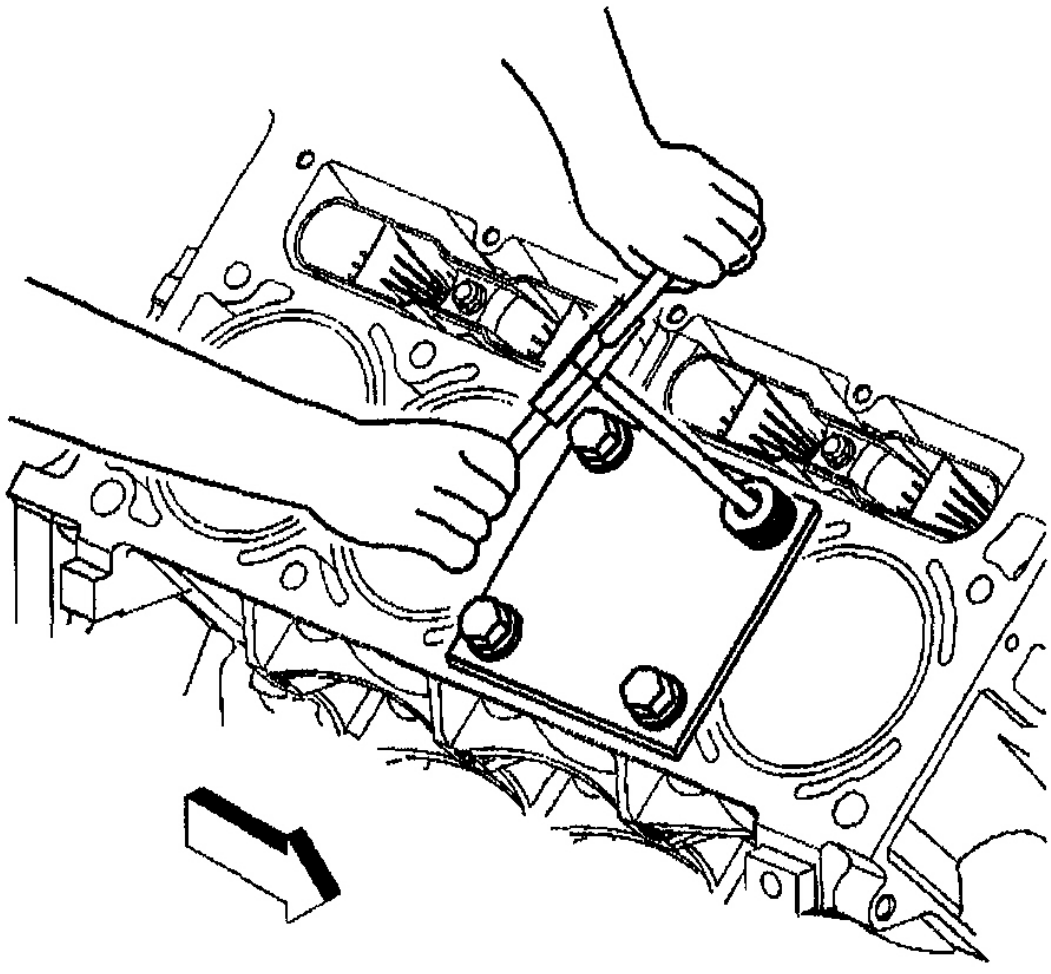


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Fig. 327: Drilling Out Threads Of Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

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

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Fig. 328: Tapping Threads Of Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

11. In order to tap the new threads to the proper depth, rotate the tap into the hole until the marks (1 or 4) on the tap align with the top of the drill bushing (3).

    For the deeper cylinder head bolt holes (1-8), rotate the tap until the upper mark on the tap (4) aligns with the top of the drill bushing.

    For the shallower cylinder head bolt holes (9 and 10), rotate the tap until the lower mark on the tap (1) aligns with the top of the drill bushing.

12. Remove the fixture plate (2), bushing (3), and bolts.
13. Using compressed air, clean out any chips.

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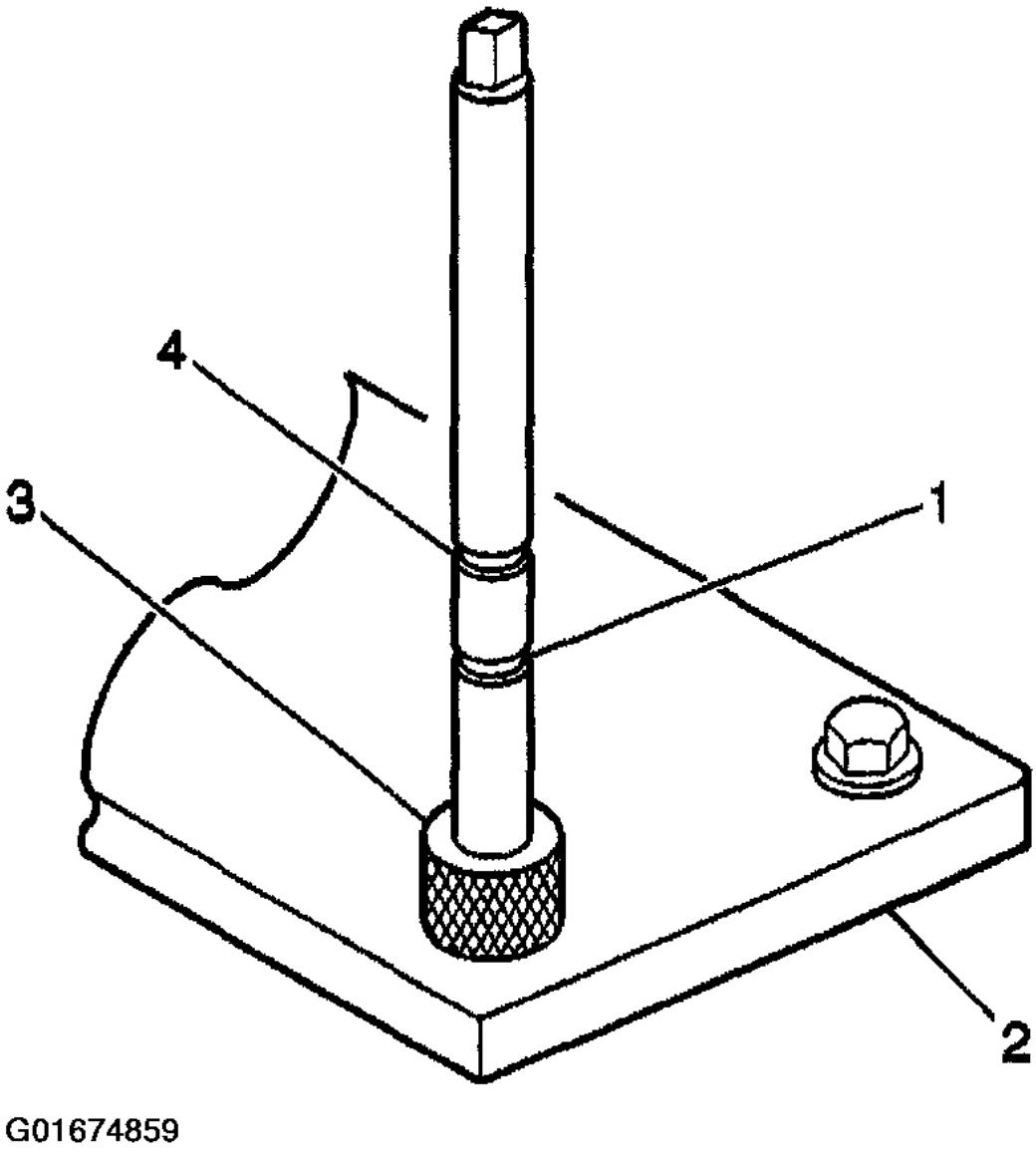


Fig. 329: Fixture Plate, Bushing & Depth Marks
Courtesy of GENERAL MOTORS CORP.

14. Spray cleaner GM P/N United States 12346139, GM P/N Canada 10953463, GM P/N United States 12377981, GM P/N Canada 10953463, or equivalent, into the hole.
15. Using compressed air, clean any cutting oil and chips out of the hole.

IMPORTANT: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

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16. Lubricate the threads of the installer tool (2) with the driver oil (1).

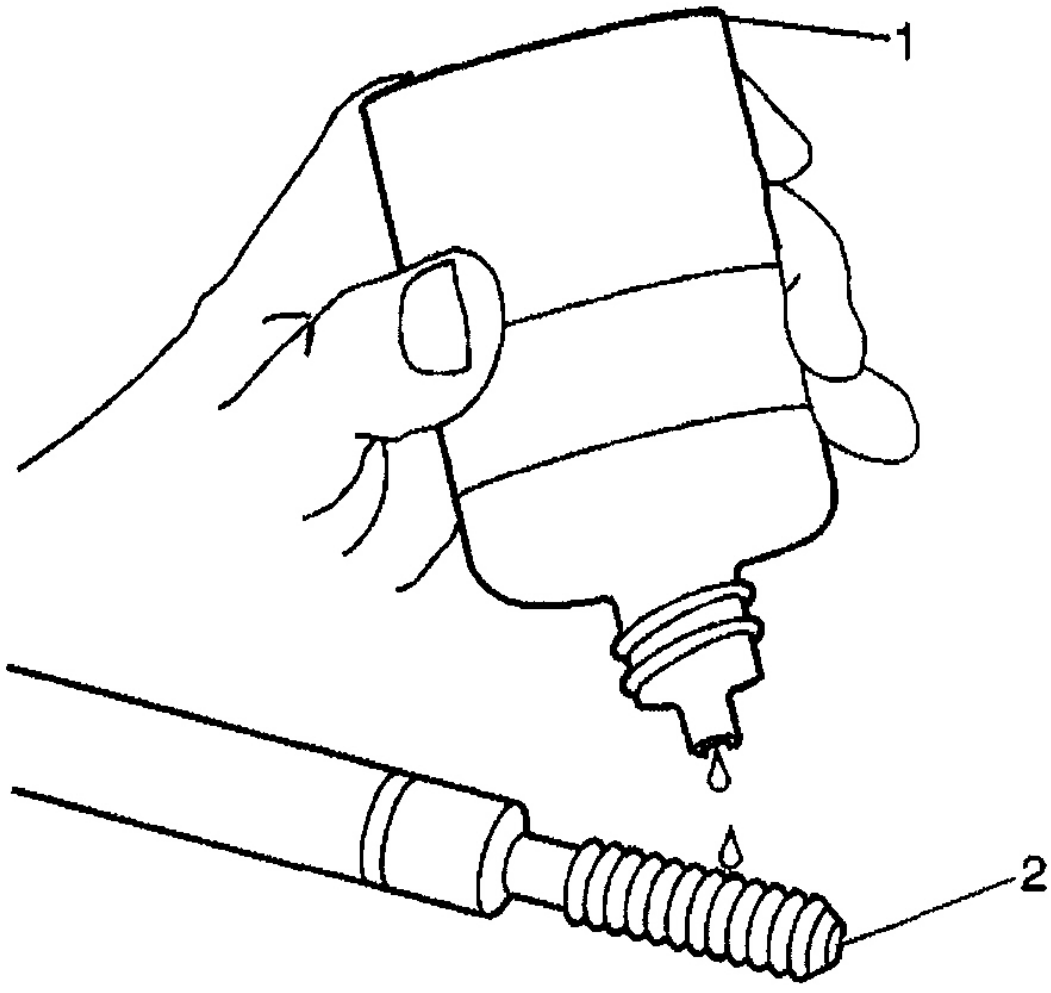


Fig. 330: Lubricating Installer Tool Threads
Courtesy of GENERAL MOTORS CORP.

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

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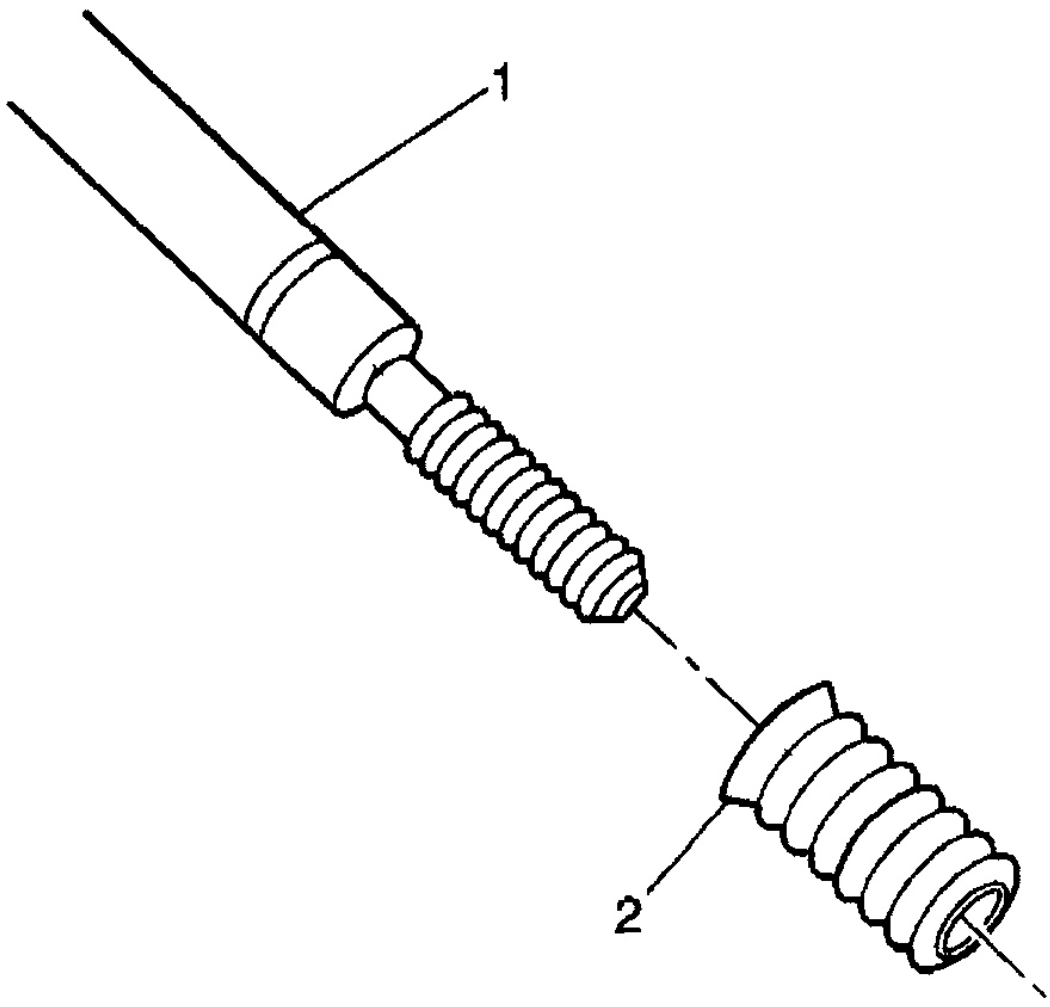


Fig. 331: Driver Tools & Insert
Courtesy of GENERAL MOTORS CORP.

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

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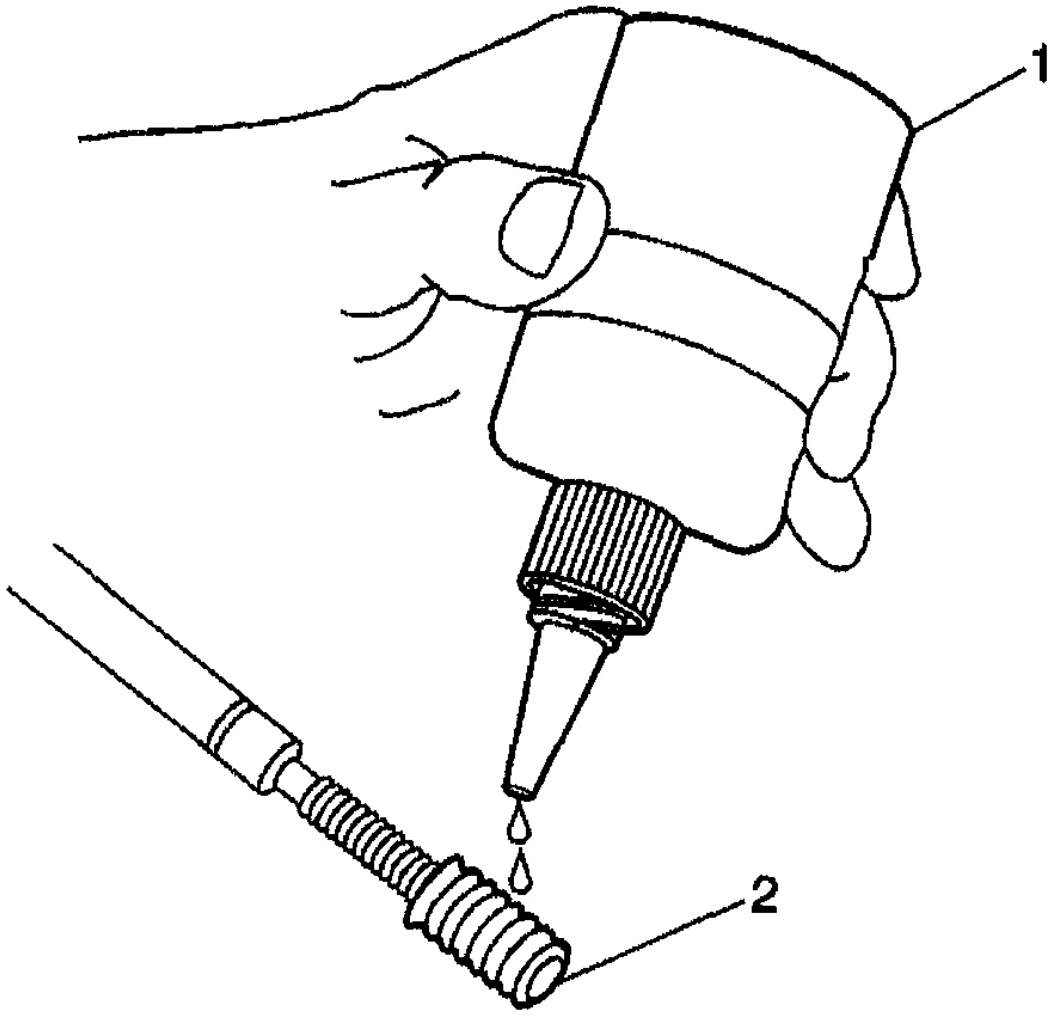


Fig. 332: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

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

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

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

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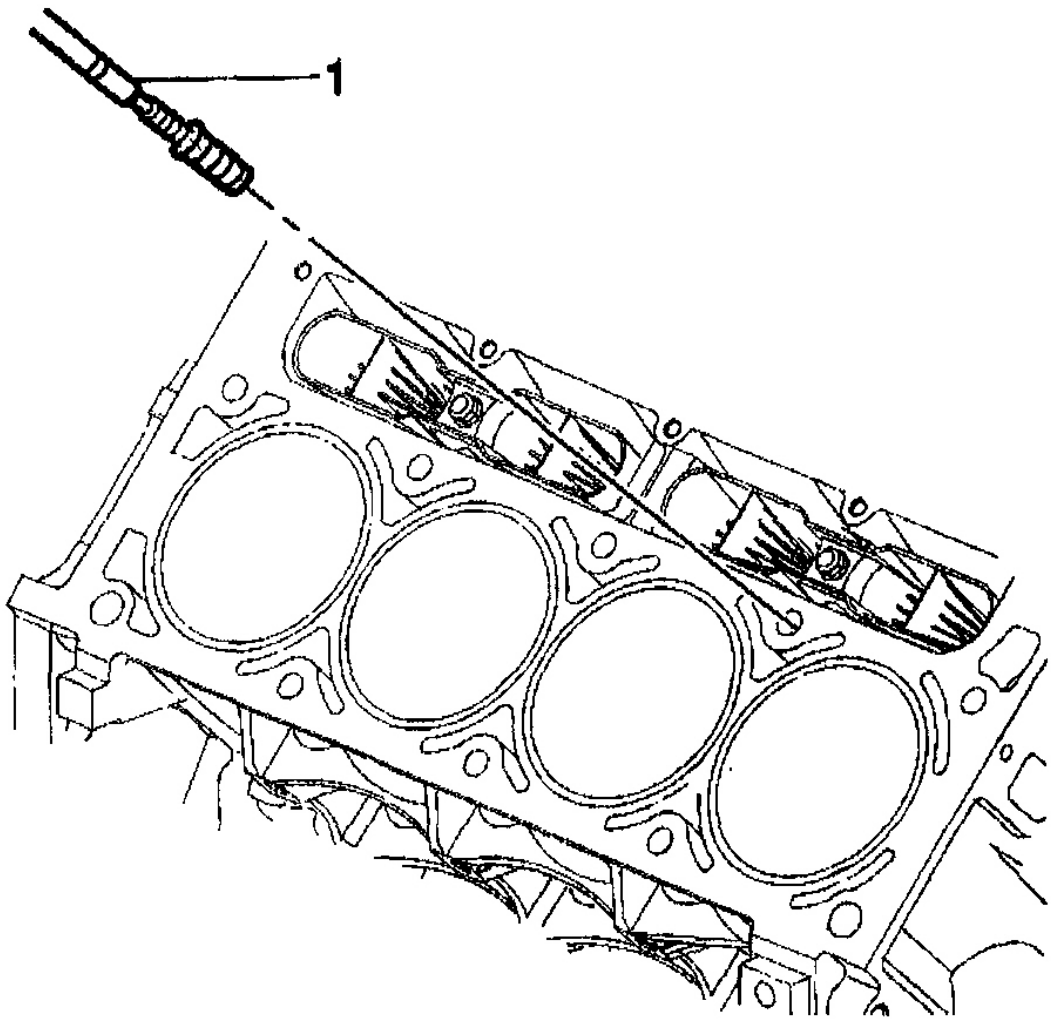


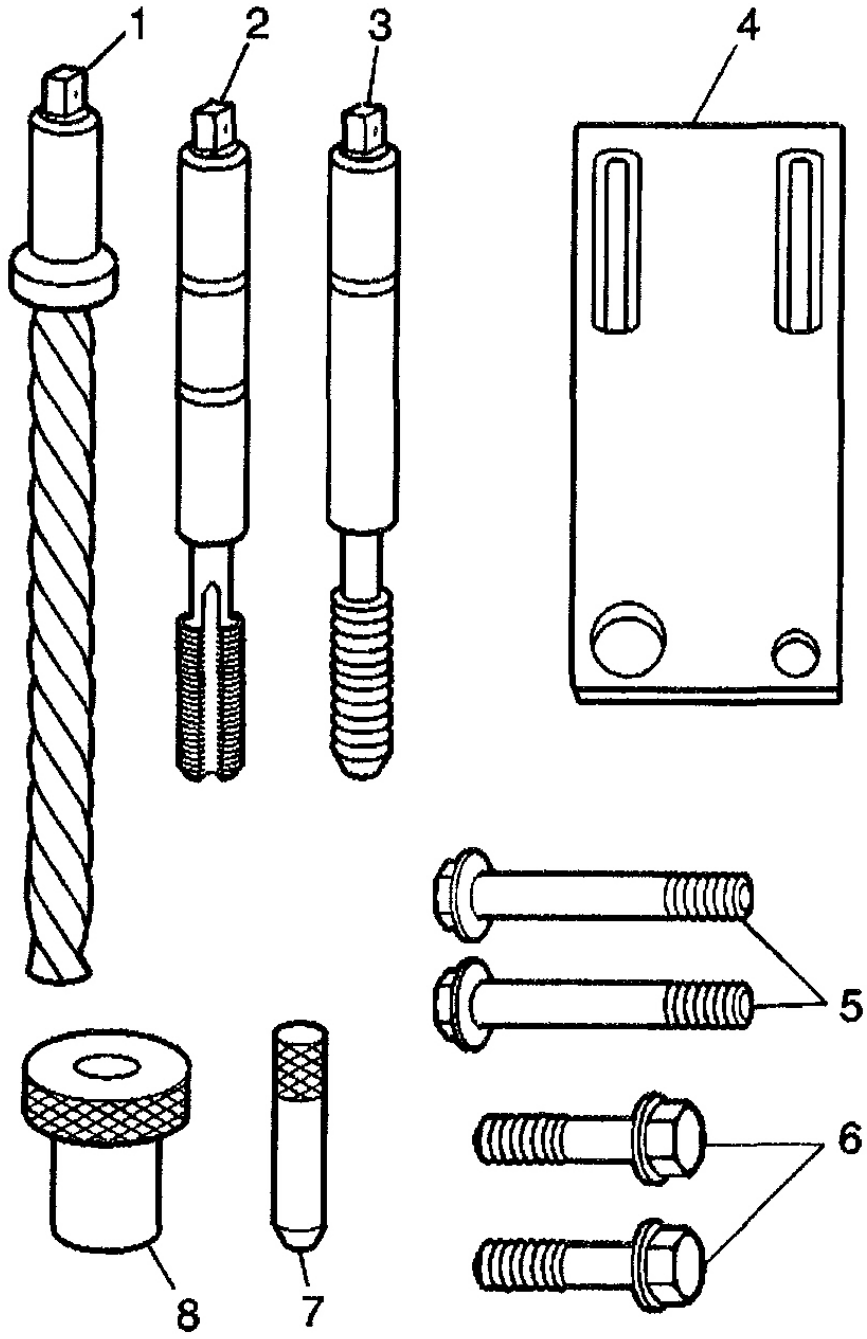
Fig. 333: Installing Insert & Driver Into Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

Main Cap Bolt Hole Thread Repair

1. The main cap bolt hole thread repair kit consists of the following items:
   - The drill (1)
   - The tap (2)
   - The installer (3)
   - The fixture plate (4)
   - The long bolts (5)

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- The short bolts (6)
- The alignment pin (7)
- The bushing (8)



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Fig. 334: Main Cap Bolt Hole Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

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

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

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

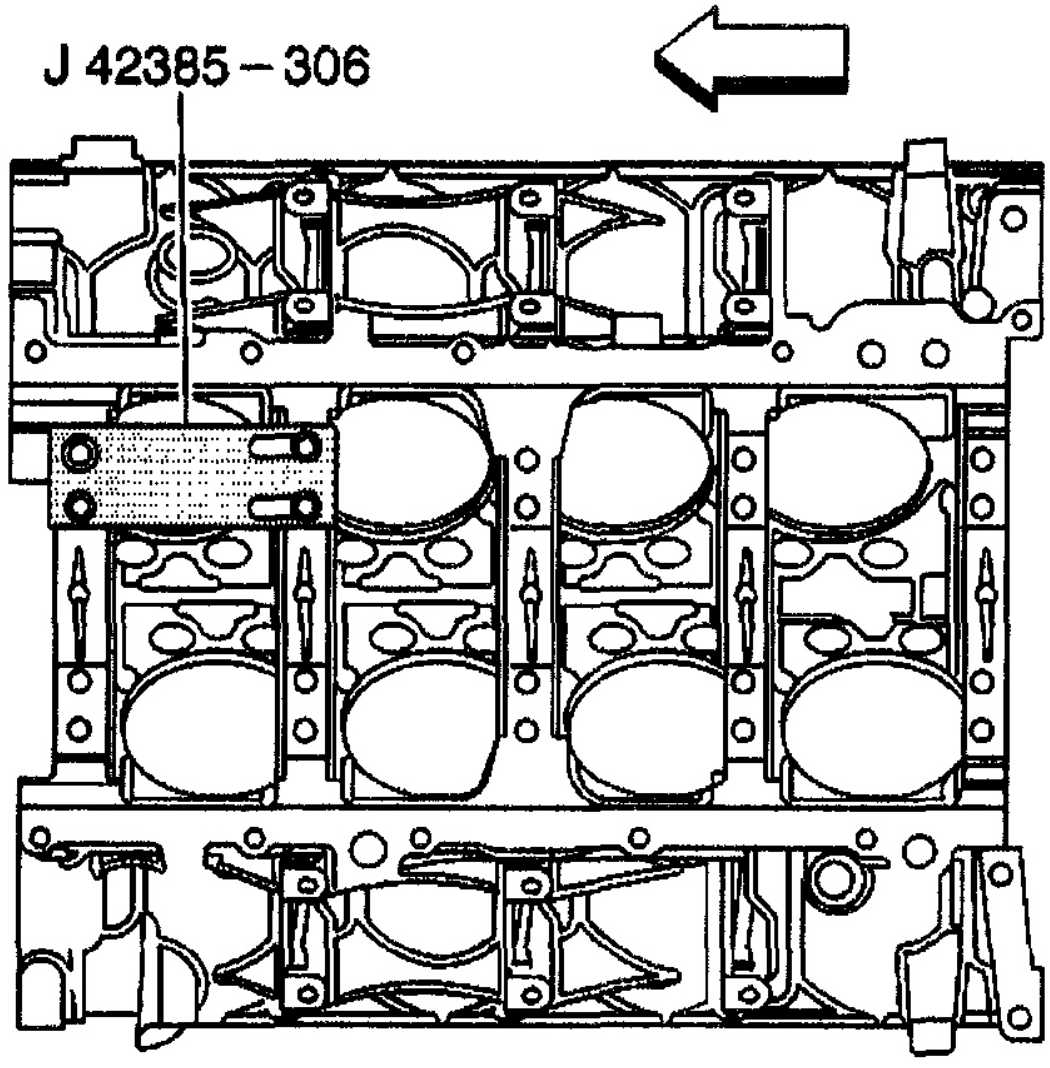


Fig. 335: Fixture Plate
Courtesy of GENERAL MOTORS CORP.

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4. Drill out the damaged hole.

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

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

5. Using compressed air, clean out any chips.

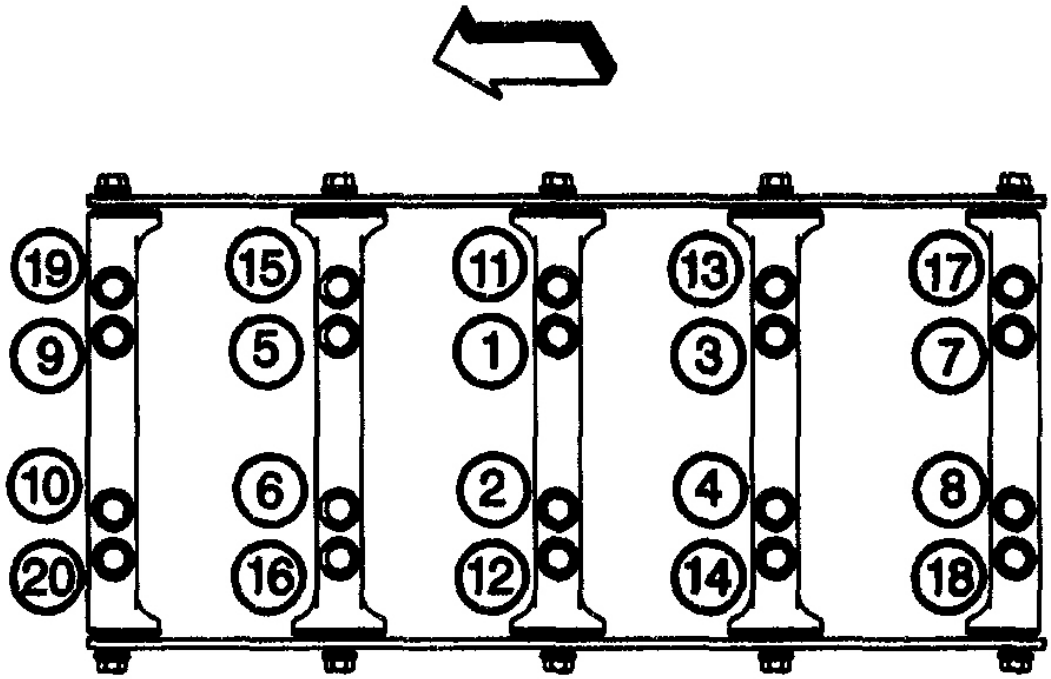


Fig. 336: Main Cap Bolt Hole Identification
Courtesy of GENERAL MOTORS CORP.

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

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

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

   For the shallower main cap holes (11-20), rotate the tap until the lower mark (1) on the tap aligns with top

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of the bushing (3).

7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N United States 12346139, GM P/N Canada 10953463, or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.

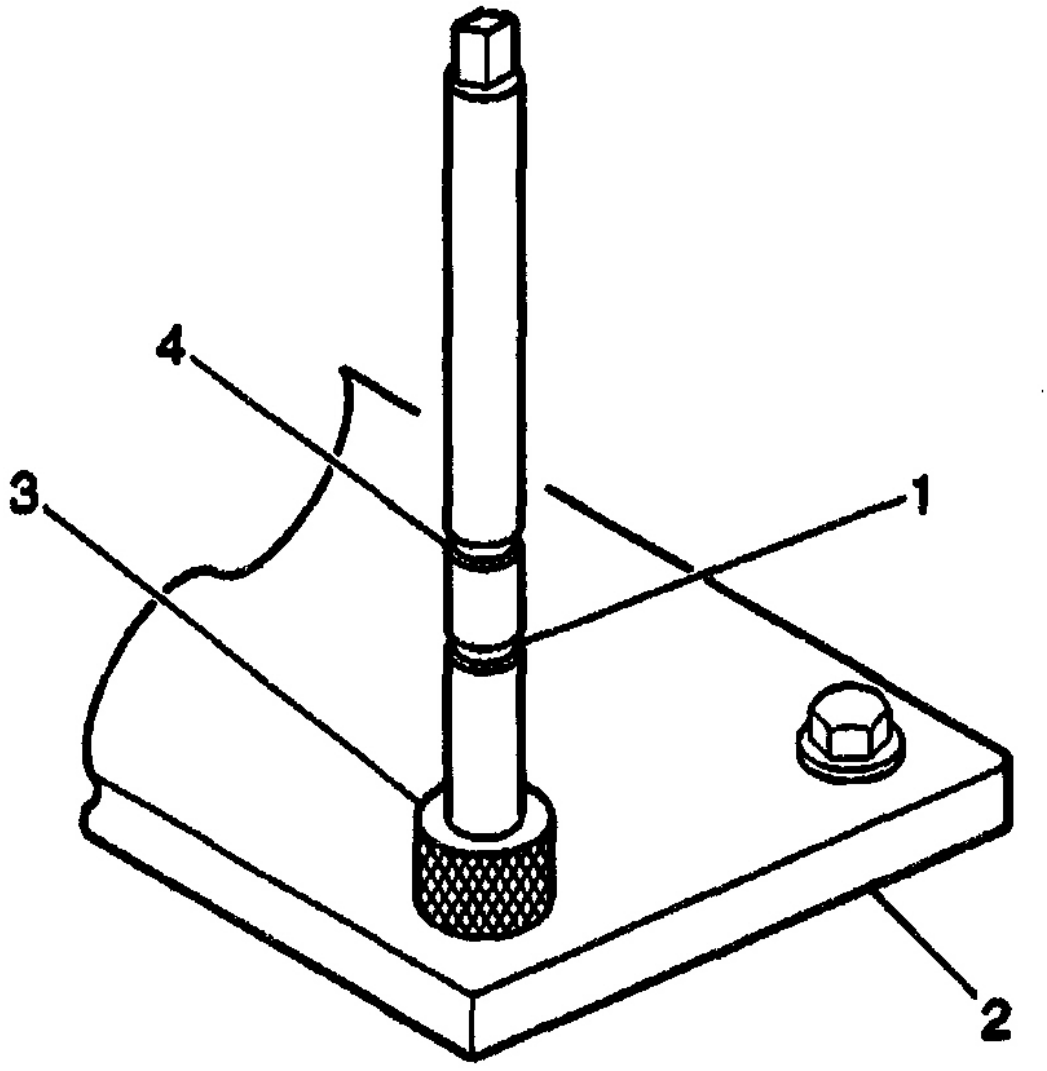


Fig. 337: Fixture Plate, Bushing & Depth Marks
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not allow oil or other foreign material to contact the outside diameter

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(OD) of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).

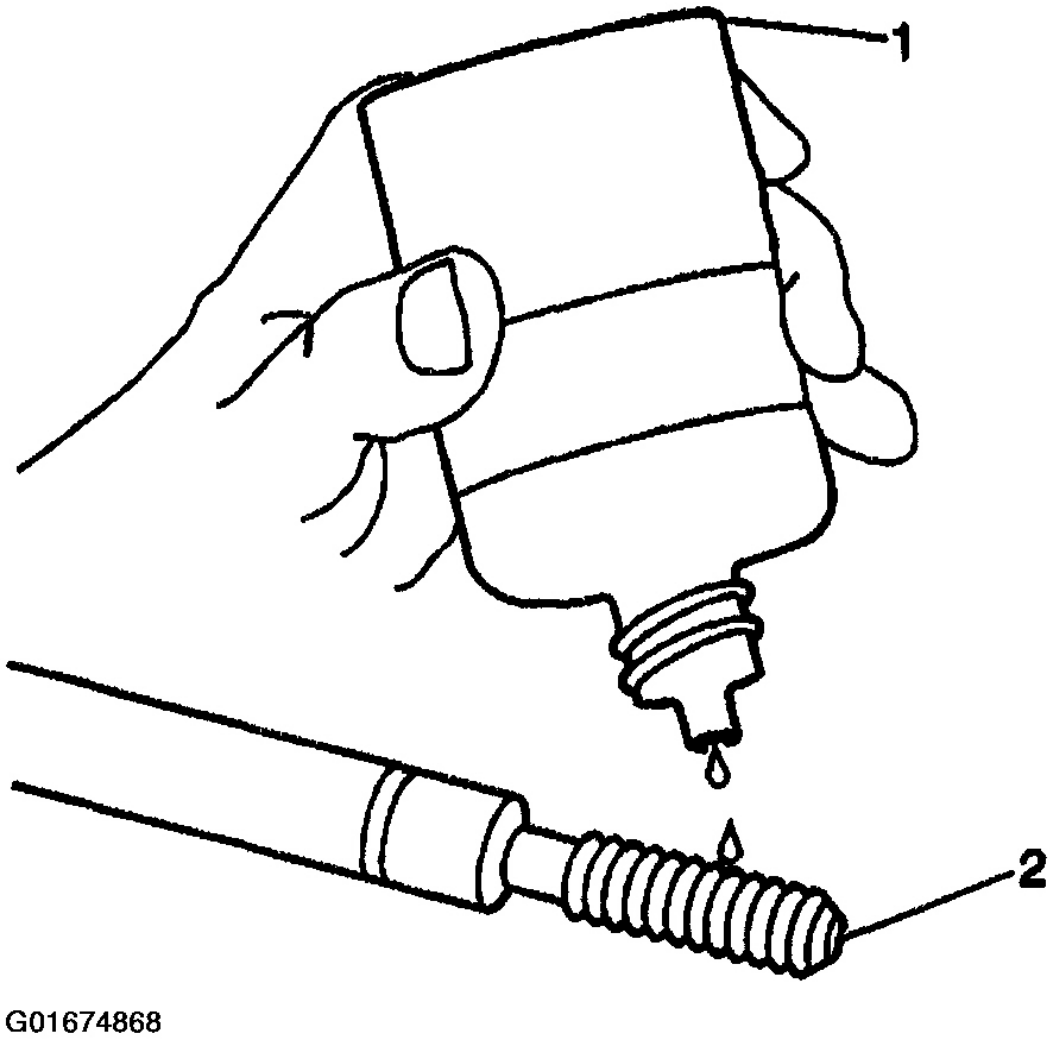


Fig. 338: Lubricating Installer Tool Threads
Courtesy of GENERAL MOTORS CORP.

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

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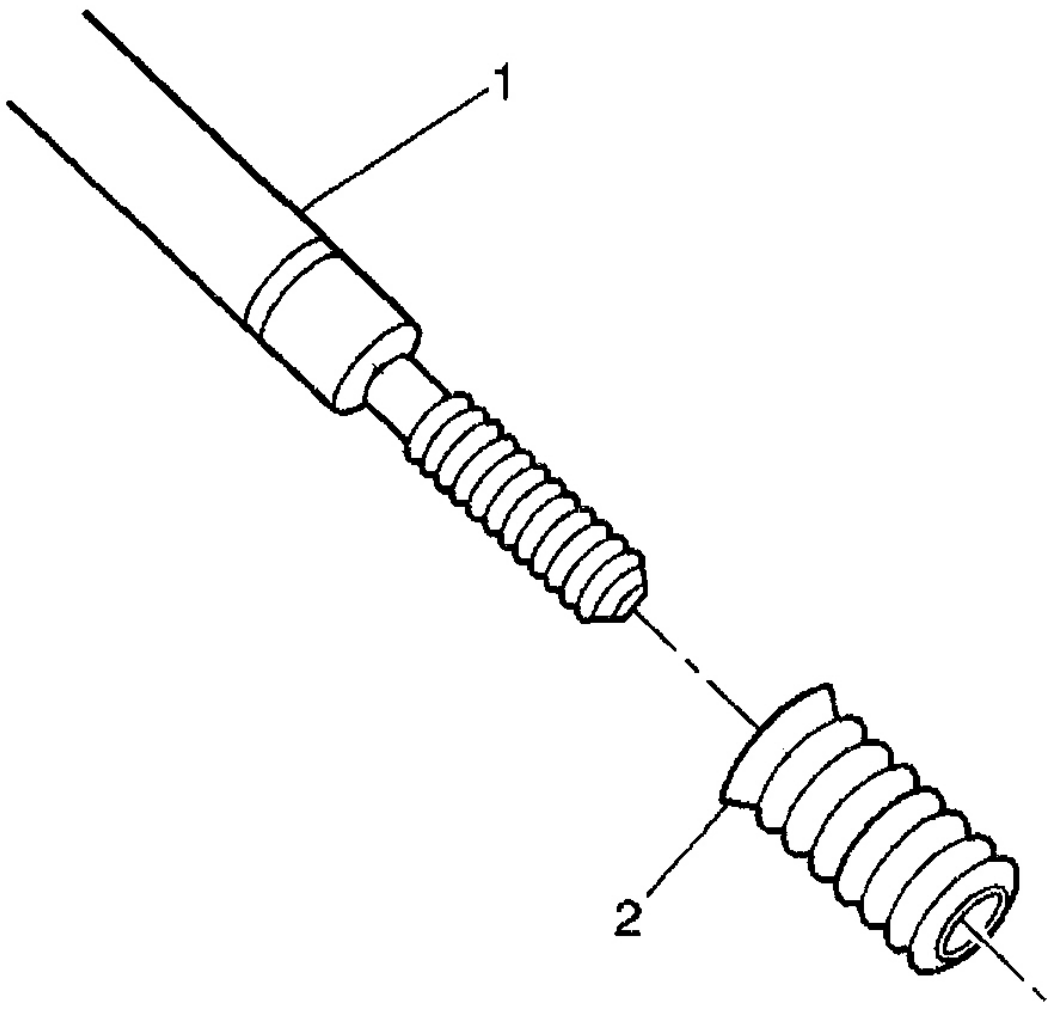


Fig. 339: Driver Tool & Insert
Courtesy of GENERAL MOTORS CORP.

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

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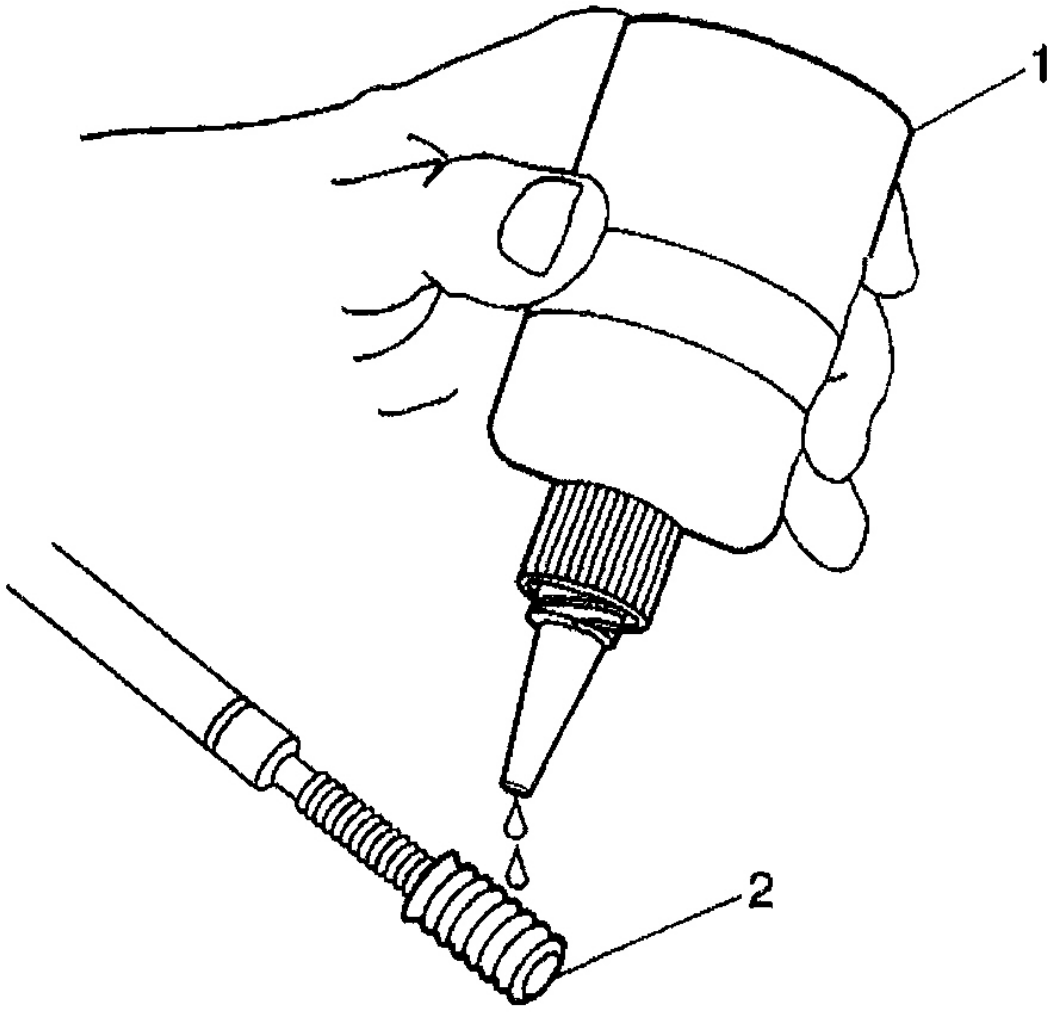


Fig. 340: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

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

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

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threads.

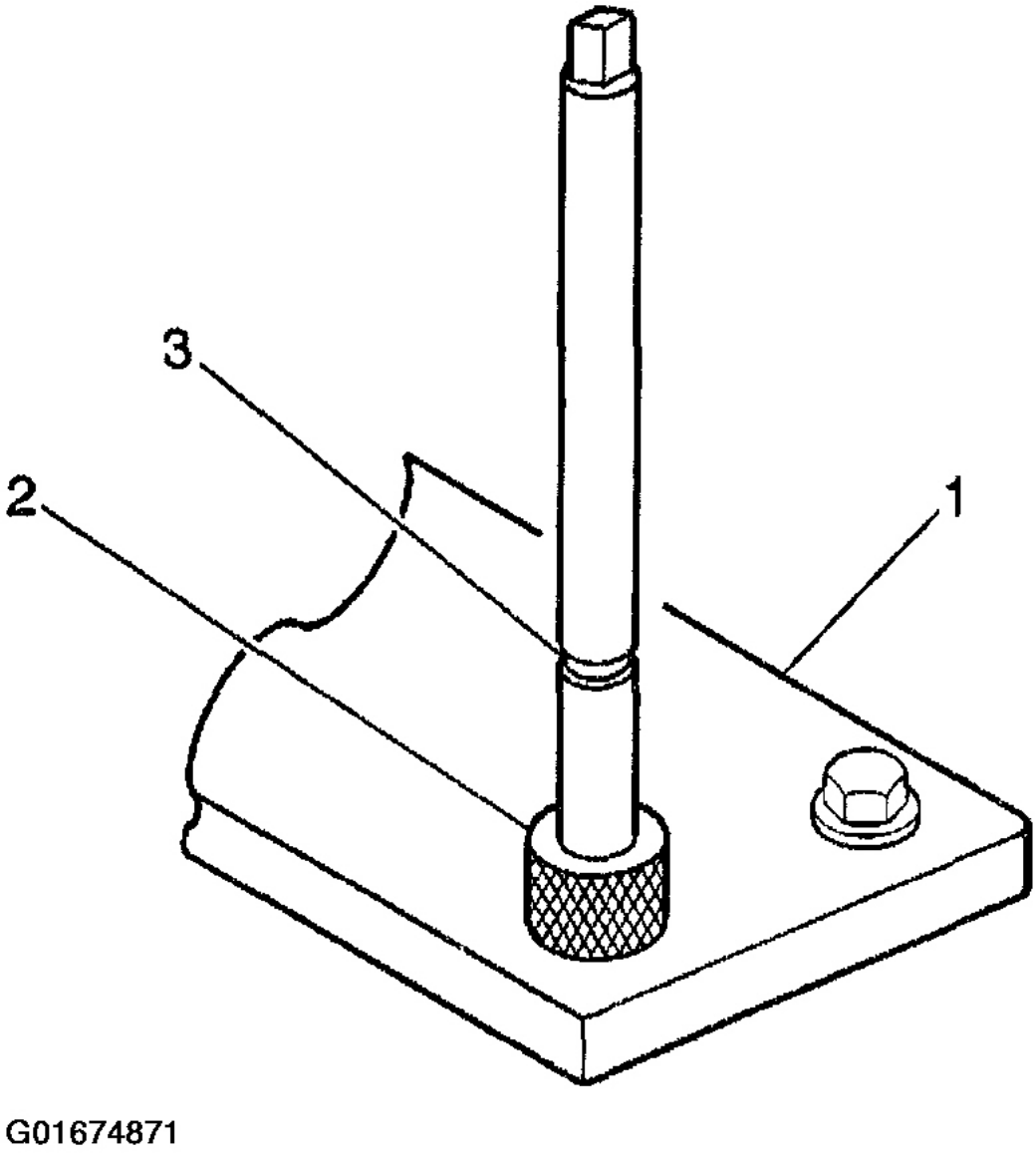


Fig. 341: Fixture Plate, Bushing & Depth Marks
Courtesy of GENERAL MOTORS CORP.

SERVICE PRIOR TO ASSEMBLY

- Dirt or debris will cause premature wear of the rebuilt engine. Clean all the components. Refer to **Cleanliness and Care** .

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- Use the proper tools to measure components when checking for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position and direction. Refer to **Separating Parts** .
- During assembly, lubricate all the moving parts with clean engine oil. This will provide initial lubrication when the engine is first started.

ENGINE BLOCK PLUG INSTALLATION

Tools Required

J 41712 Oil Pressure Sensor Socket or equivalent

IMPORTANT:

- **Engine block plug, oil gallery and coolant, sealing washers may be reused if not bent, scored or otherwise damaged.**
- **Apply the proper amount and type of sealant to the sealing washer as recommended in the service procedure.**

1. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the engine block coolant heater sealing washer, if applicable. Refer to **Sealers, Adhesives, and Lubricants** .

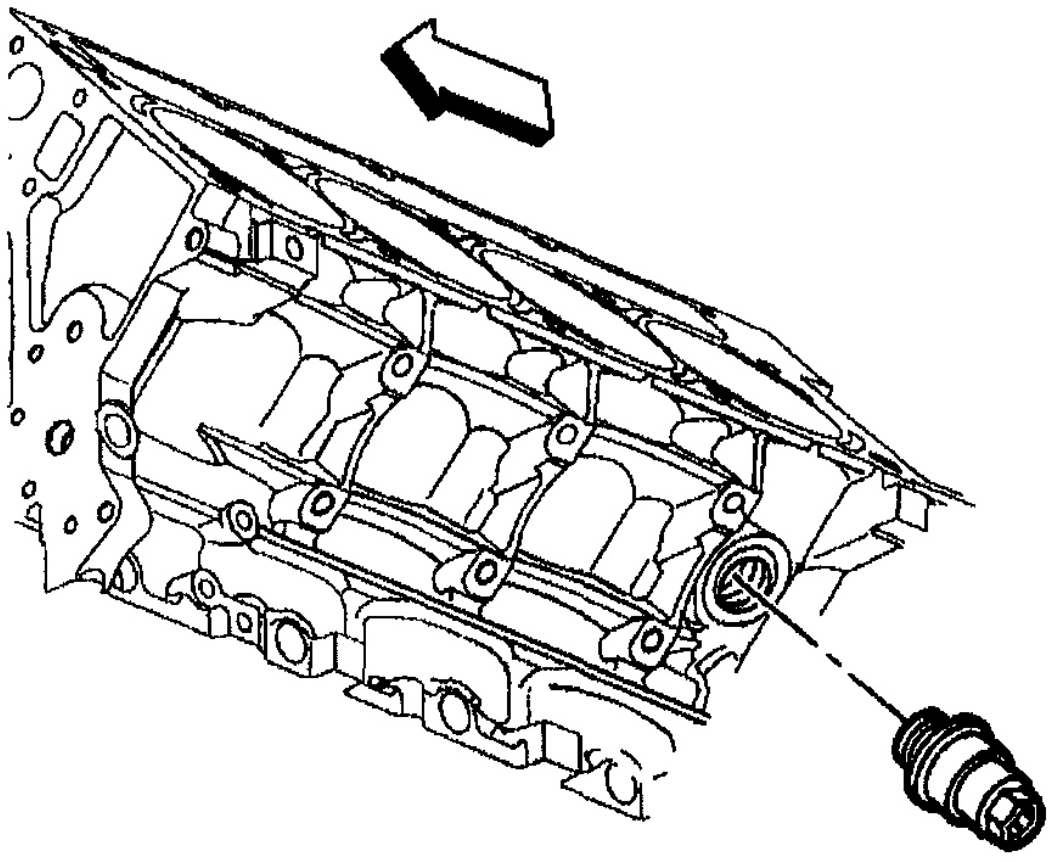
   NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

2. Install the engine block coolant heater to the engine block, if applicable.

   Tighten

   Tighten the block coolant heater to 40 N.m (30 lb ft).

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Fig. 342: Engine Block Coolant Heater
Courtesy of GENERAL MOTORS CORP.

3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the engine block left rear coolant drain plug sealing washer, if applicable.
4. Install the engine block left rear coolant drain plug, if applicable.

Tighten

Tighten the block left rear coolant drain plug to 60 N.m (44 lb ft).

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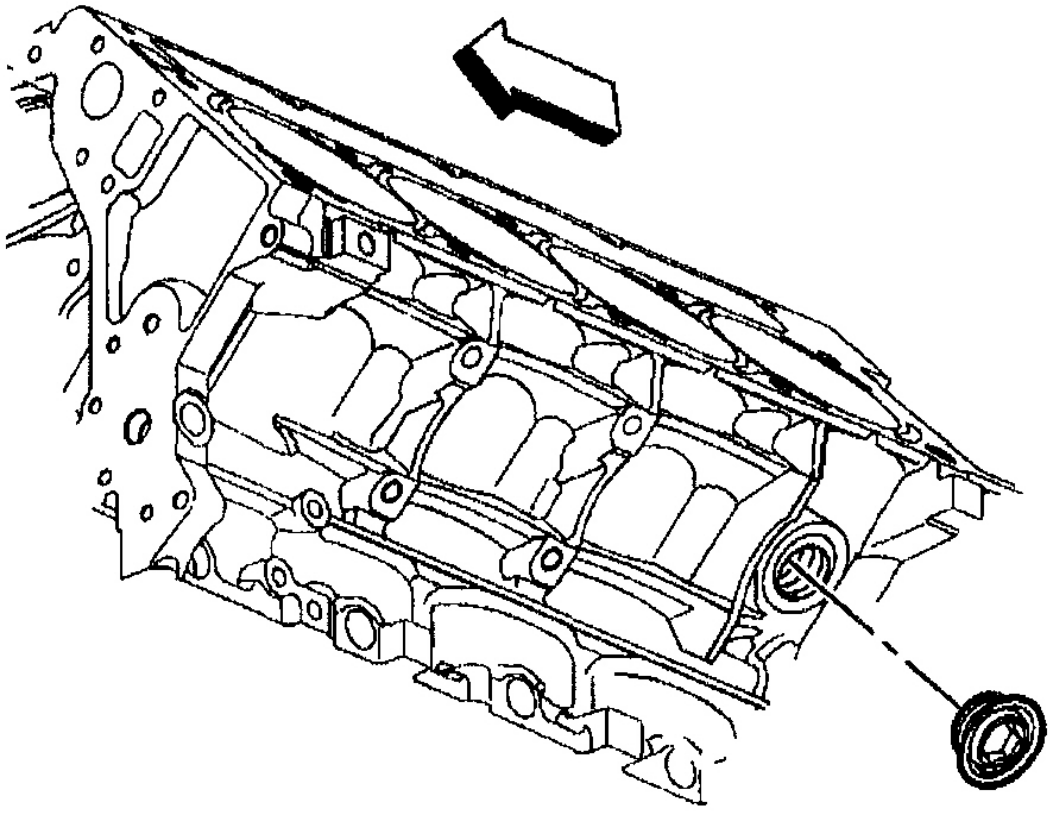


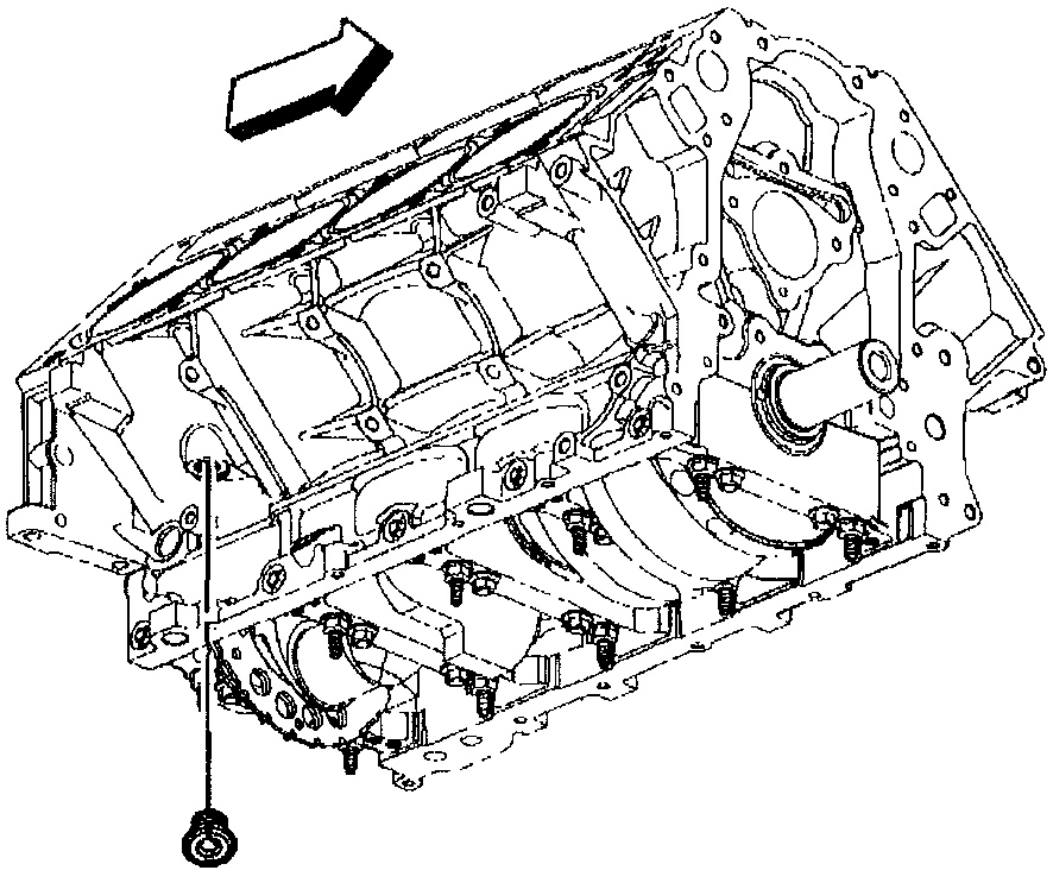
Fig. 343: Engine Block Coolant Drain Plug (Left Rear)
Courtesy of GENERAL MOTORS CORP.

5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the engine block right rear coolant drain plug sealing washer.
6. Install the engine block right rear coolant drain plug.

Tighten

Tighten the block right rear coolant drain plug to 60 N.m (44 lb ft).

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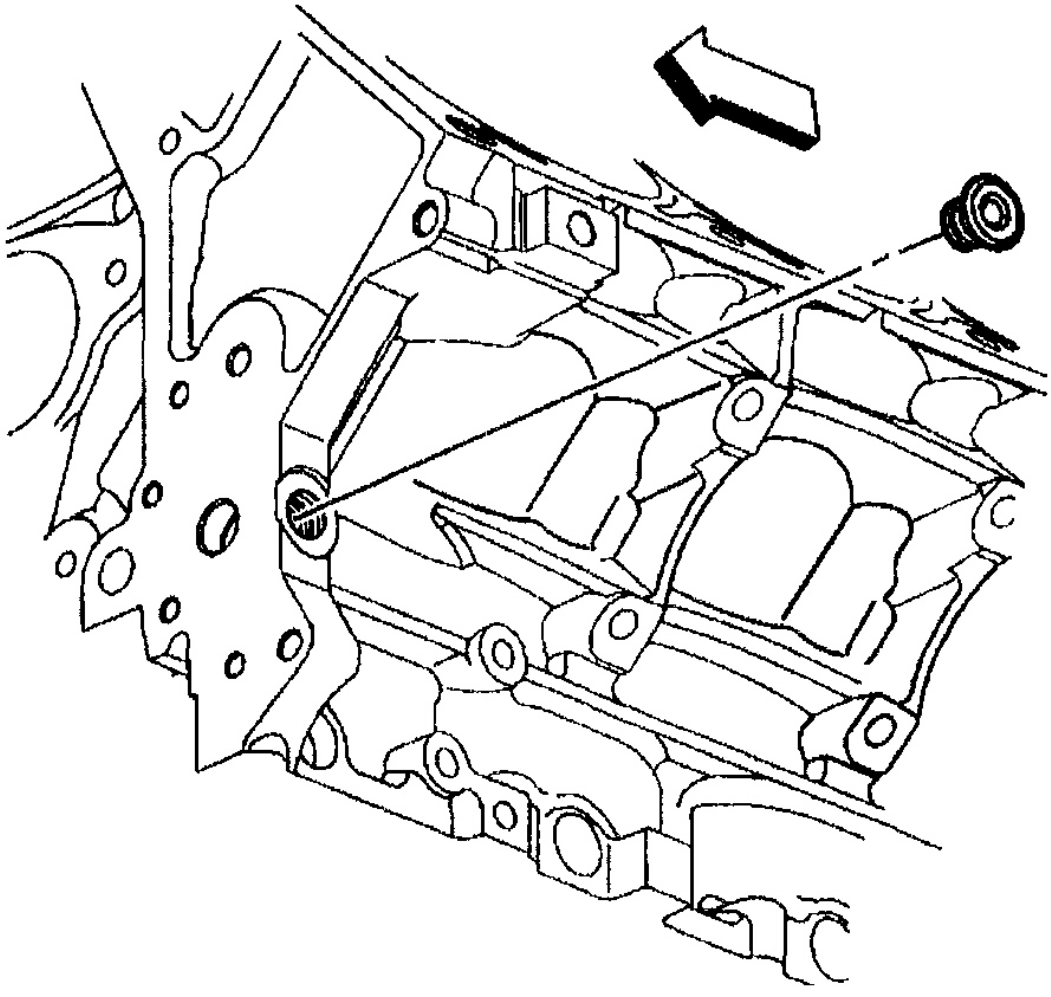
Fig. 344: Engine Block Coolant Drain Plug (Right Rear)
Courtesy of GENERAL MOTORS CORP.

7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the engine block left front oil gallery plug sealing washer.
8. Install the engine block left front oil gallery plug.

Tighten

Tighten the block left front oil gallery plug to 60 N.m (44 lb ft).

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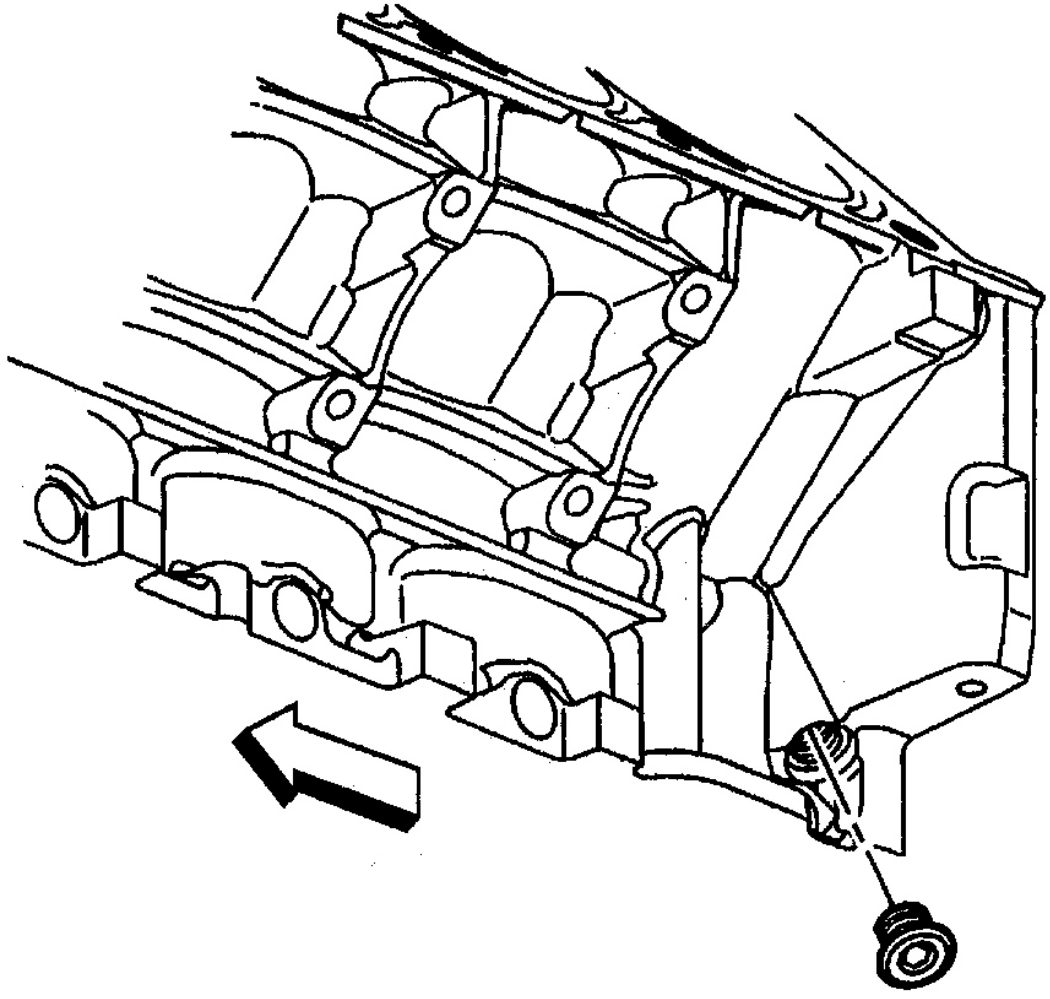
Fig. 345: Engine Block Oil Gallery Plug (Left Front)
Courtesy of GENERAL MOTORS CORP.

9. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the engine block left rear oil gallery plug sealing washer.
10. Install the engine block left rear oil gallery plug.

Tighten

Tighten the block left rear oil gallery plug to 60 N.m (44 lb ft).

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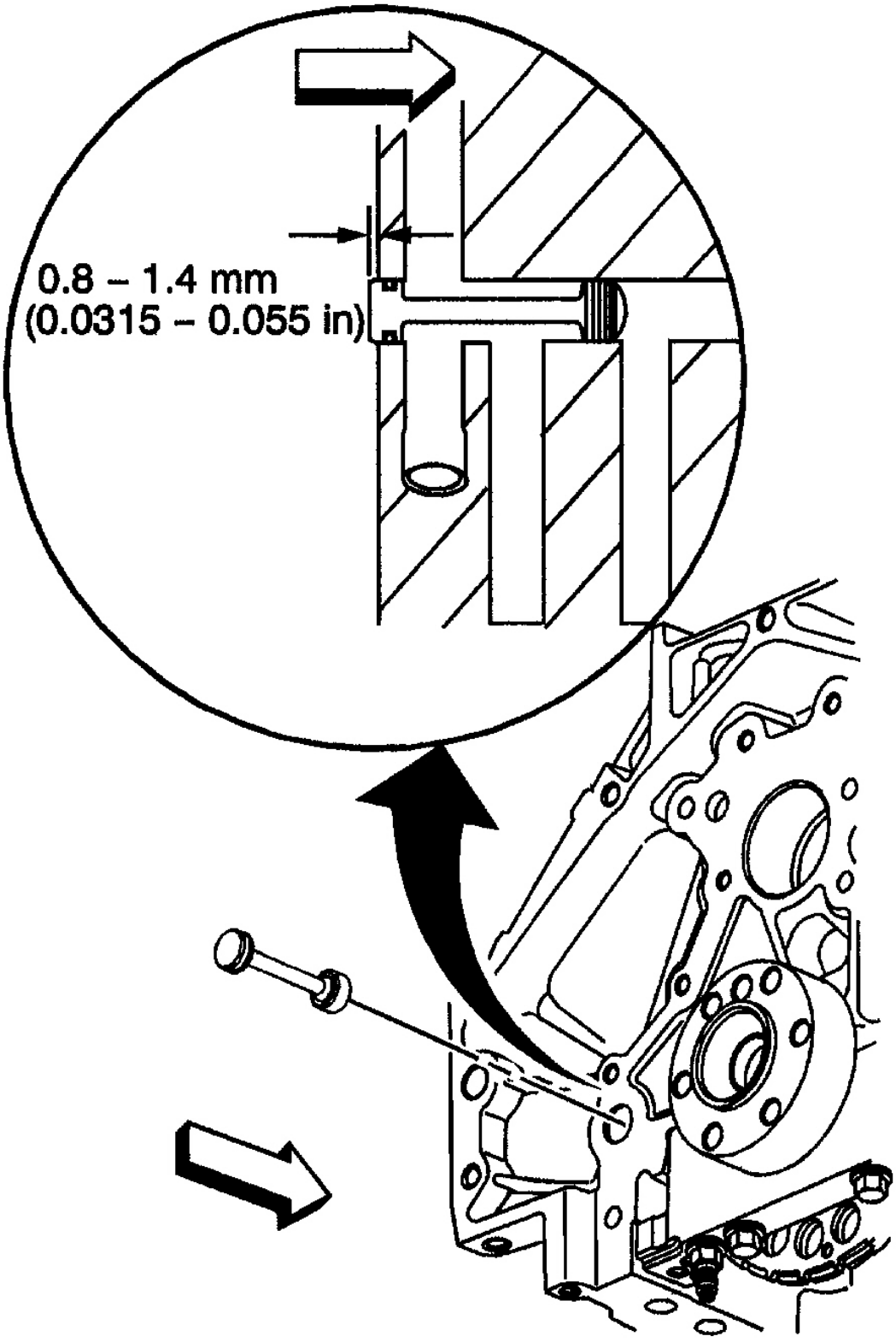


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Fig. 346: Engine Block Oil gallery Plug (Left Rear)
Courtesy of GENERAL MOTORS CORP.

11. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be reused.
12. Lubricate the O-ring seal with clean engine oil.
13. Install the block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8-1.4 mm (0.0315-0.055 in) beyond the rear face of the block.

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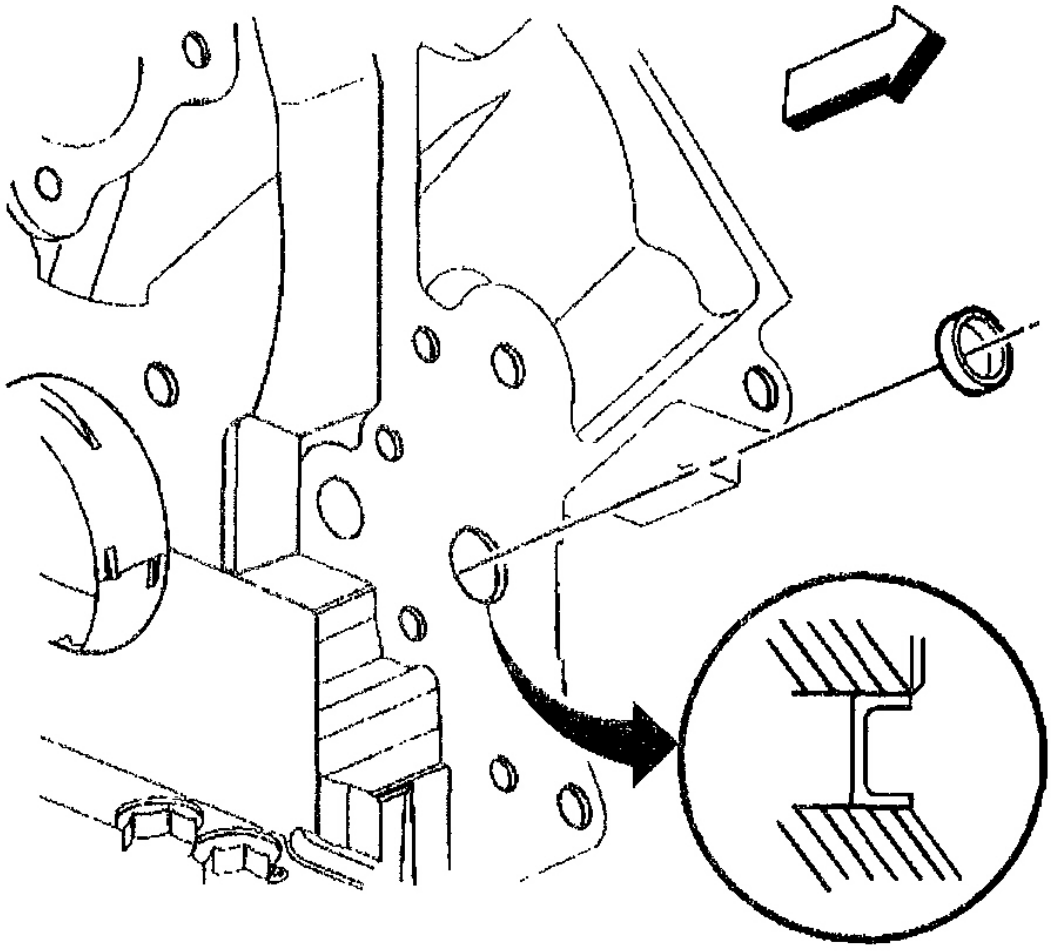
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Fig. 347: Installing Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The engine block front oil gallery plug should not be removed unless service is required.

14. Apply sealant GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the sides of the NEW front oil gallery plug.
15. Install a NEW engine block front oil gallery plug, if required. Install the front oil gallery plug into the oil gallery bore 2.2-2.8 mm (0.0086-0.011 in) below flush.



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Fig. 348: Installing Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

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16. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the oil pressure sensor.
17. Use the **J 41712** or equivalent in order to install the oil pressure sensor.

Tighten

Tighten the oil pressure sensor to 20 N.m (15 lb ft).

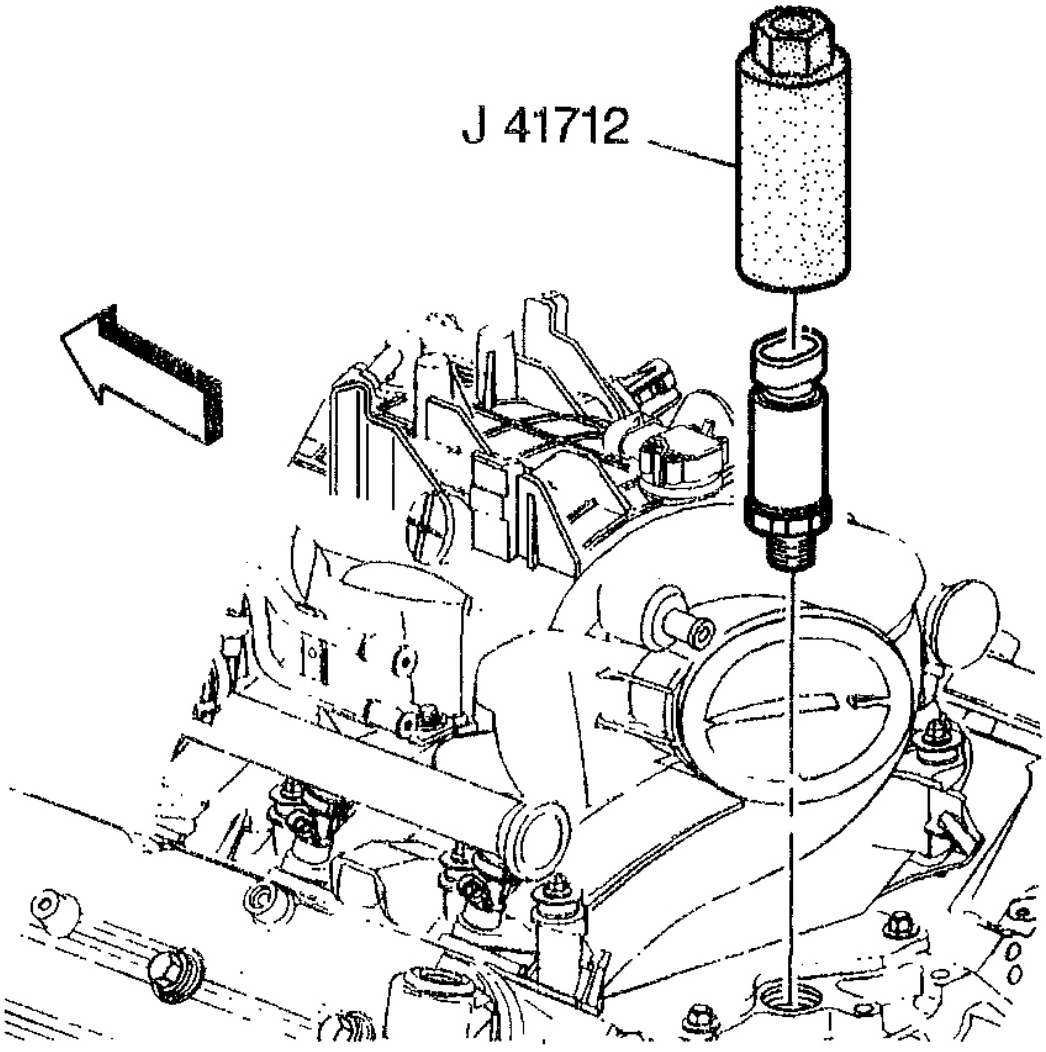


Fig. 349: Installing Oil Pressure Sensor Using J 41712
Courtesy of GENERAL MOTORS CORP.

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CRANKSHAFT AND BEARINGS INSTALLATION

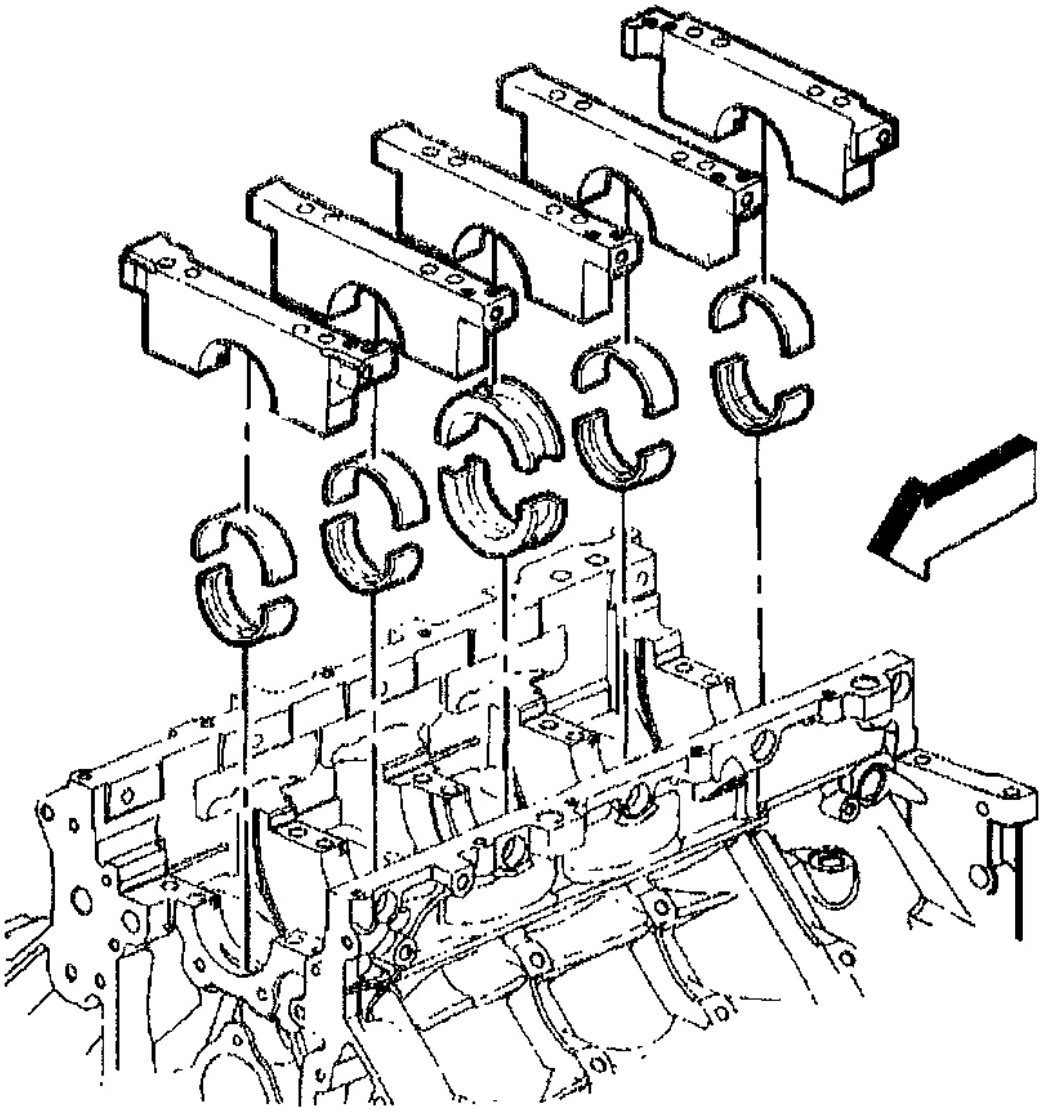
Tools Required

J 36660-A Torque Angle Meter

Important:

- Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may effect crankshaft position sensor signals and/or On-Board Diagnostics (OBD) II system performance.
- Crankshaft bearing caps must be installed to the proper location and direction.
- When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.

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Fig. 350: Crankshaft Bearing Caps & Bearings
Courtesy of GENERAL MOTORS CORP.

- Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.
- To prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.

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

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1. Install the crankshaft thrust bearings to the engine block and center bearing cap.
2. Install the remaining crankshaft bearings to the engine block and bearing caps.
3. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

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

4. Install the crankshaft.

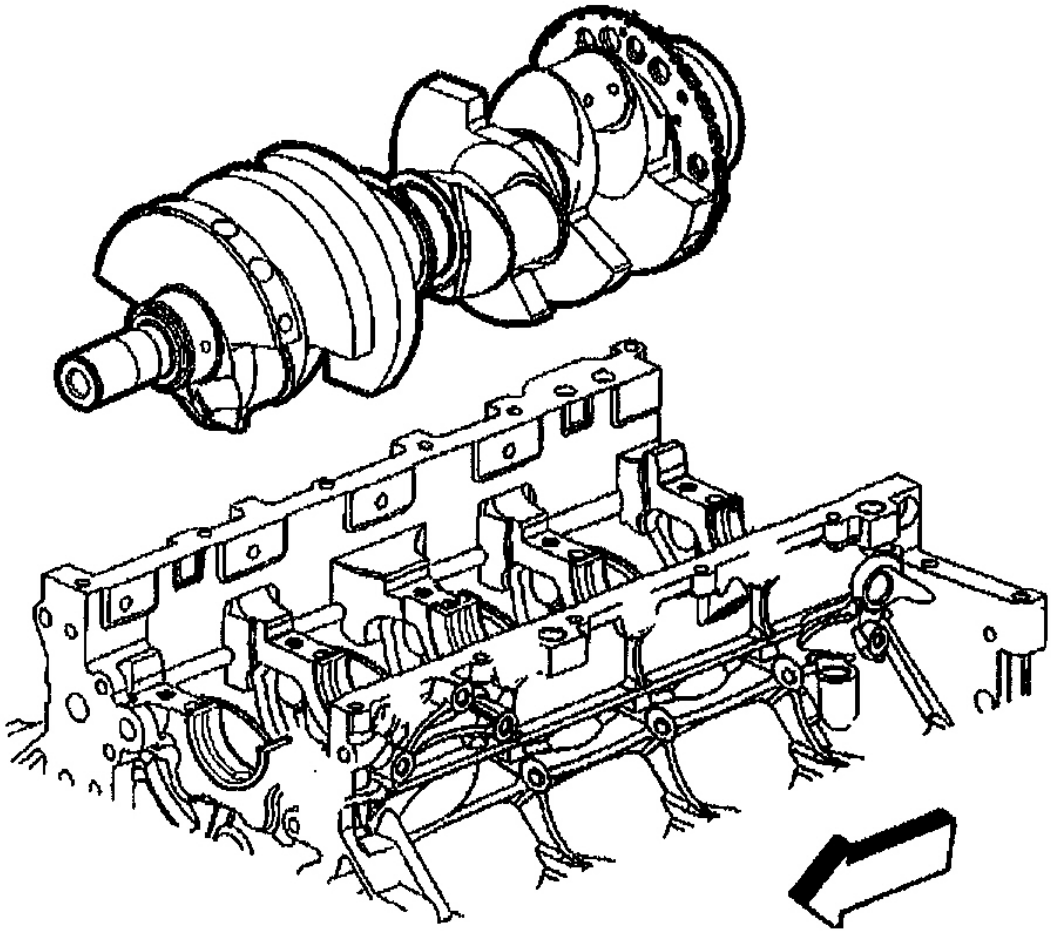
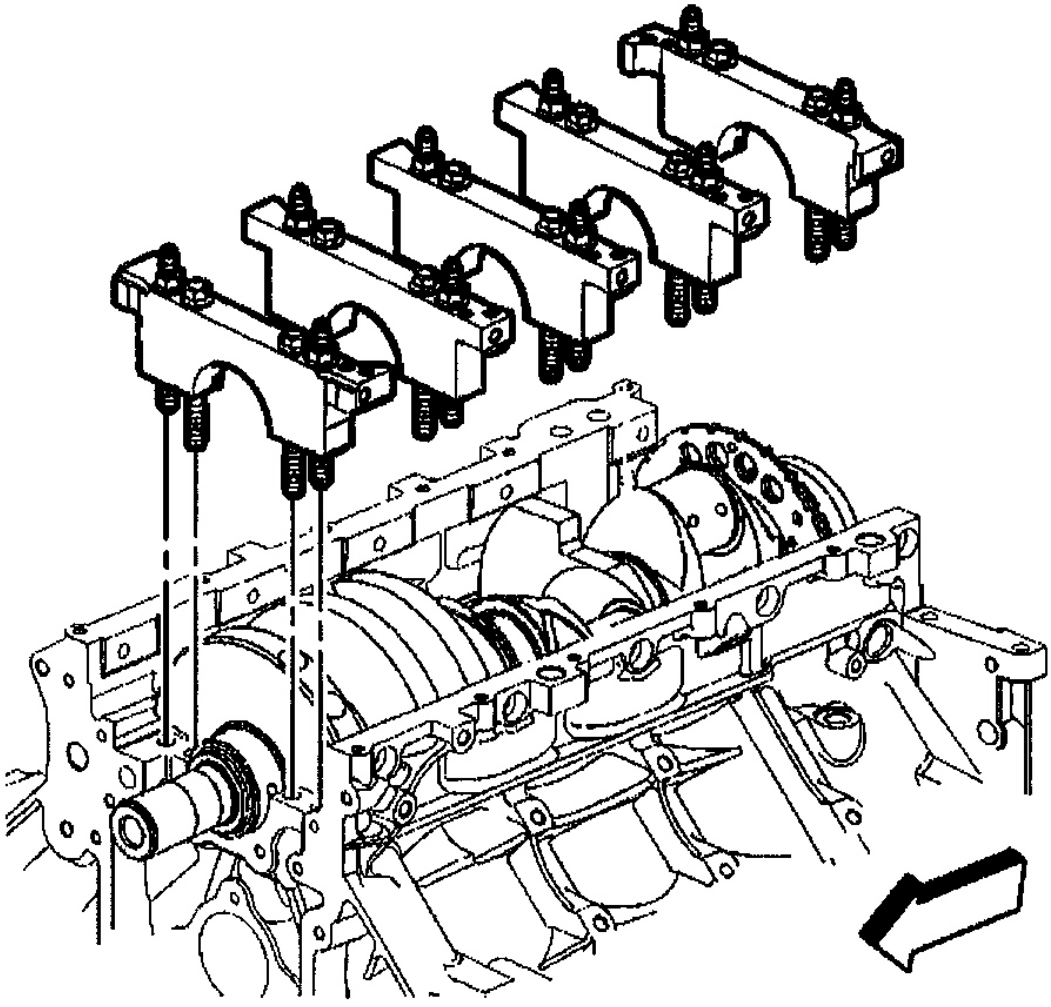


Fig. 351: Crankshaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The bearing caps must be installed in the proper location and direction.

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5. Install the crankshaft bearing caps, with bearings, into the engine block.
6. Start the M10 bolts and bolt/studs.
7. Tap the bearing caps into place with a plastic-faced hammer.

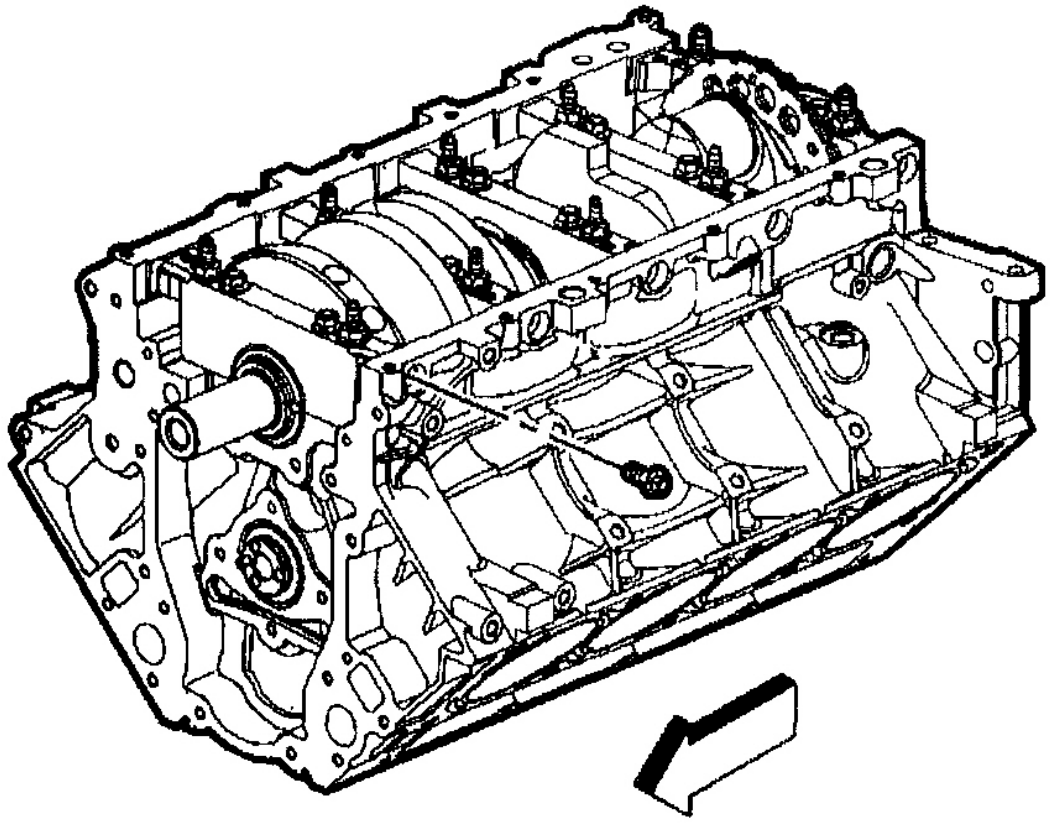


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Fig. 352: Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Install the NEW M8 bearing cap side bolts.

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Fig. 353: Bearing Cap Side Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

9. Tighten the bearing cap bolts and studs.

Tighten

Tighten the inner M10 bearing cap bolts first pass in sequence to 20 N.m (15 lb ft).

IMPORTANT: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.

10. Using a plastic faced hammer, tap the crankshaft rearward then forward to align the thrust bearings.

Tighten

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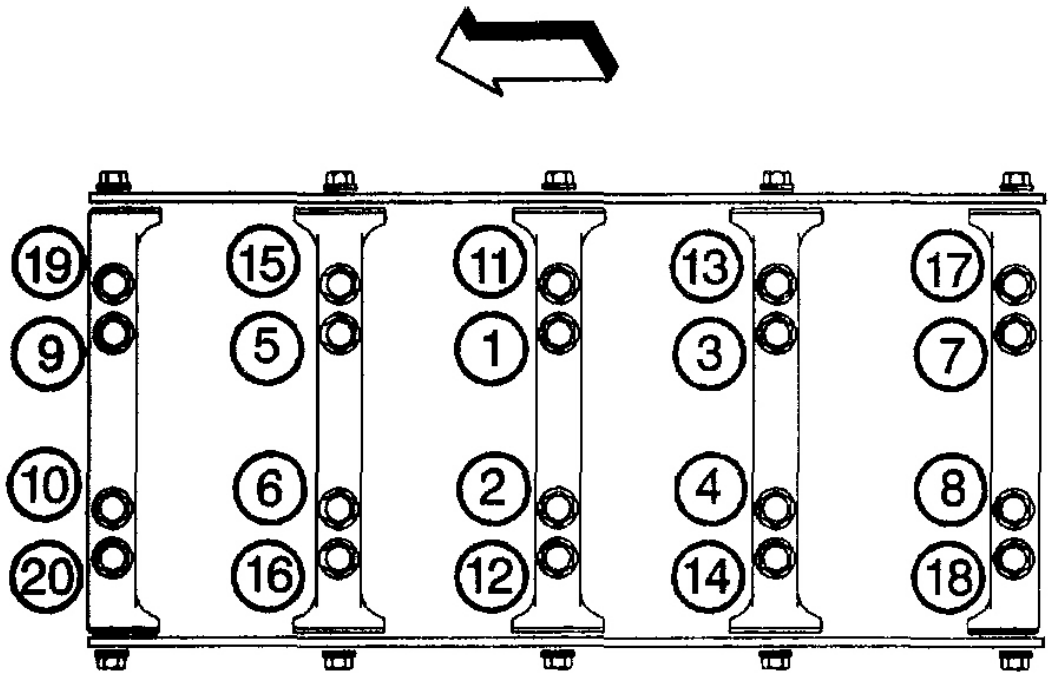
10.1. Tighten the inner M10 bolts final pass in sequence 80 degrees using the **J 36660-A** .

10.2. Tighten the outer M10 bolts/studs first pass in sequence to 20 N.m (15 lb ft).

10.3. Tighten the outer M10 bolts/studs final pass in sequence 53 degrees using the **J 36660-A** .

10.4. Tighten the bearing cap side M8 bolts to 25 N.m (18 lb ft).

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



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Fig. 354: Crankshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

11. Install the crankshaft position sensor.

11.1. Inspect the crankshaft position sensor O-ring seal. If the O-ring seal is not cut or damaged, it may be used.

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

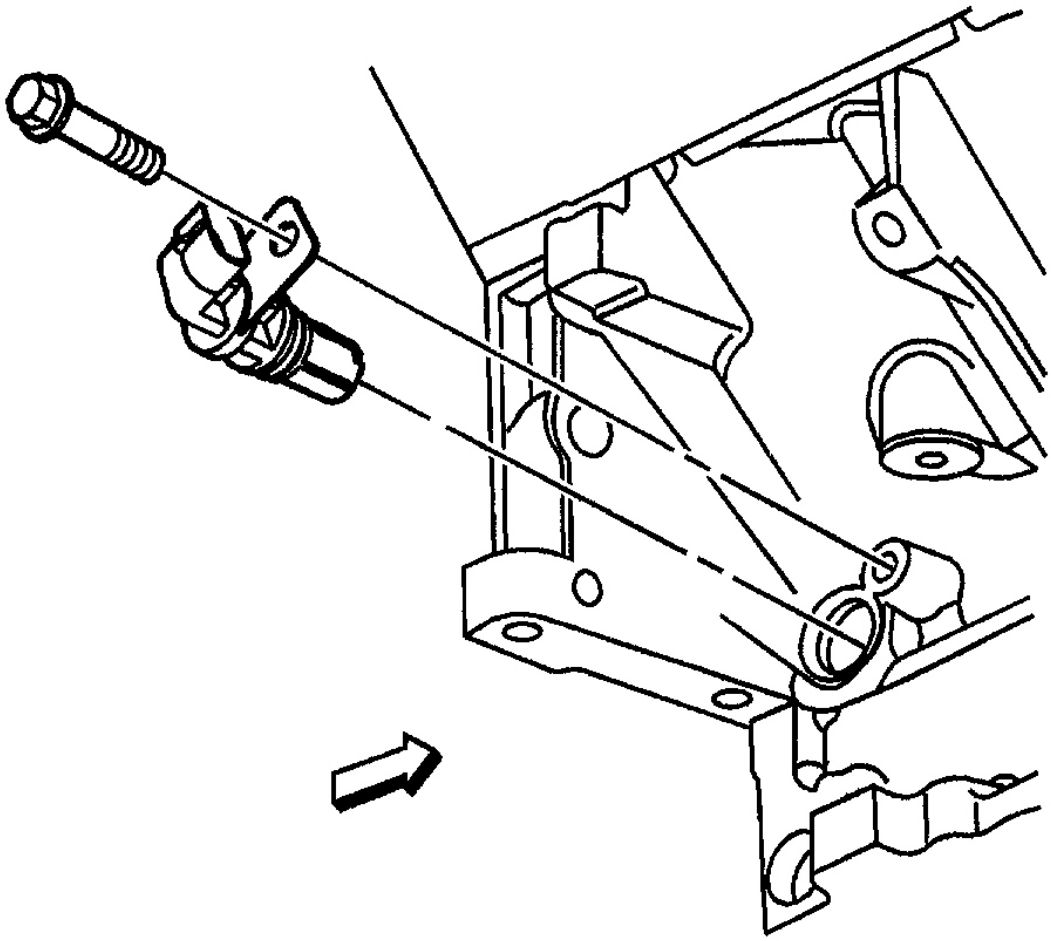
11.3. Install the sensor. Align the notch in the sensor retaining bracket with the bolt hole in the block.

11.4. Install the sensor bolt.

Tighten

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Tighten the crankshaft position sensor bolt to 25 N.m (18 lb ft).



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Fig. 355: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

12. Measure the crankshaft end play.

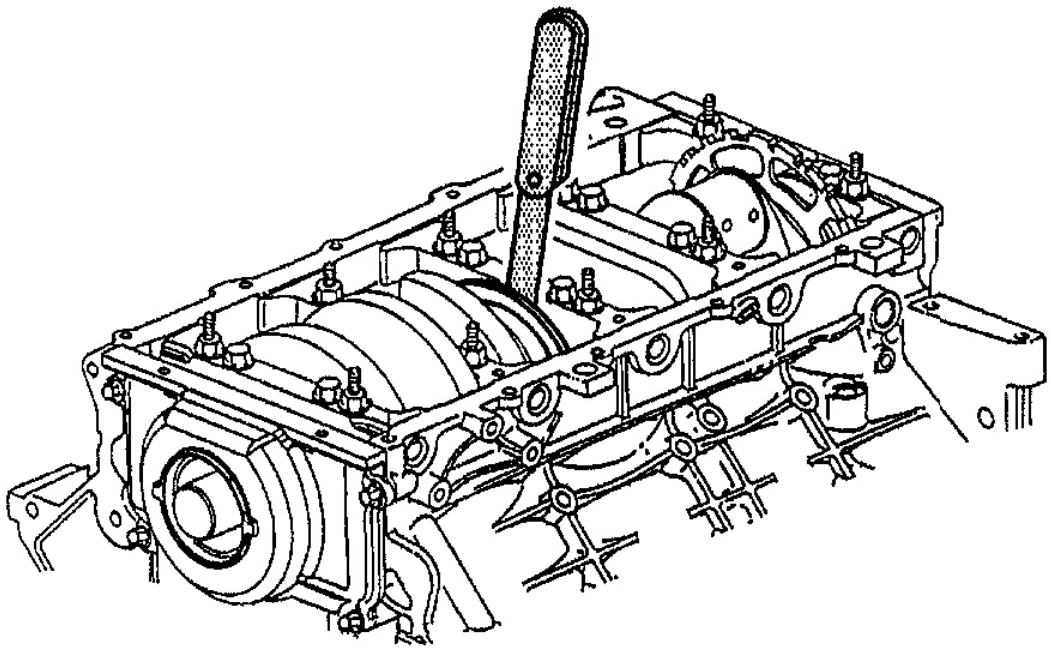
    12.1. Thrust the crankshaft forward or rearward.

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

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

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

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Fig. 356: Measuring Crankshaft End Play
Courtesy of GENERAL MOTORS CORP.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Tools Required

- **J 8037** Piston Ring Compressor
- **J 36660-A** Torque Angle Meter
- **J 41556** Connecting Rod Guide

Piston Selection

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

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

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

1. Inspect the engine block cylinder bore for scoring or other damage.

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2. Inspect the piston and the piston pin. Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** .
3. With the micrometer at a right angle to the piston, measure the piston. Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** .
4. Record the piston diameter.

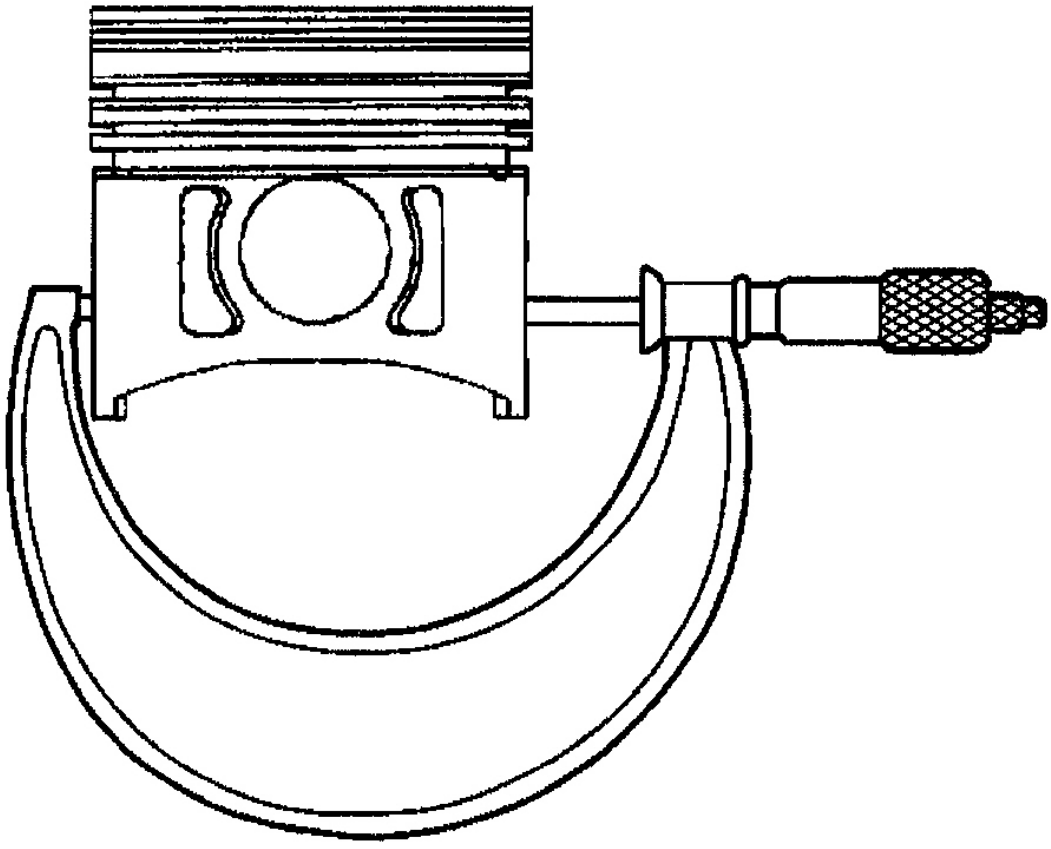


Fig. 357: Measuring Piston Diameter
Courtesy of GENERAL MOTORS CORP.

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

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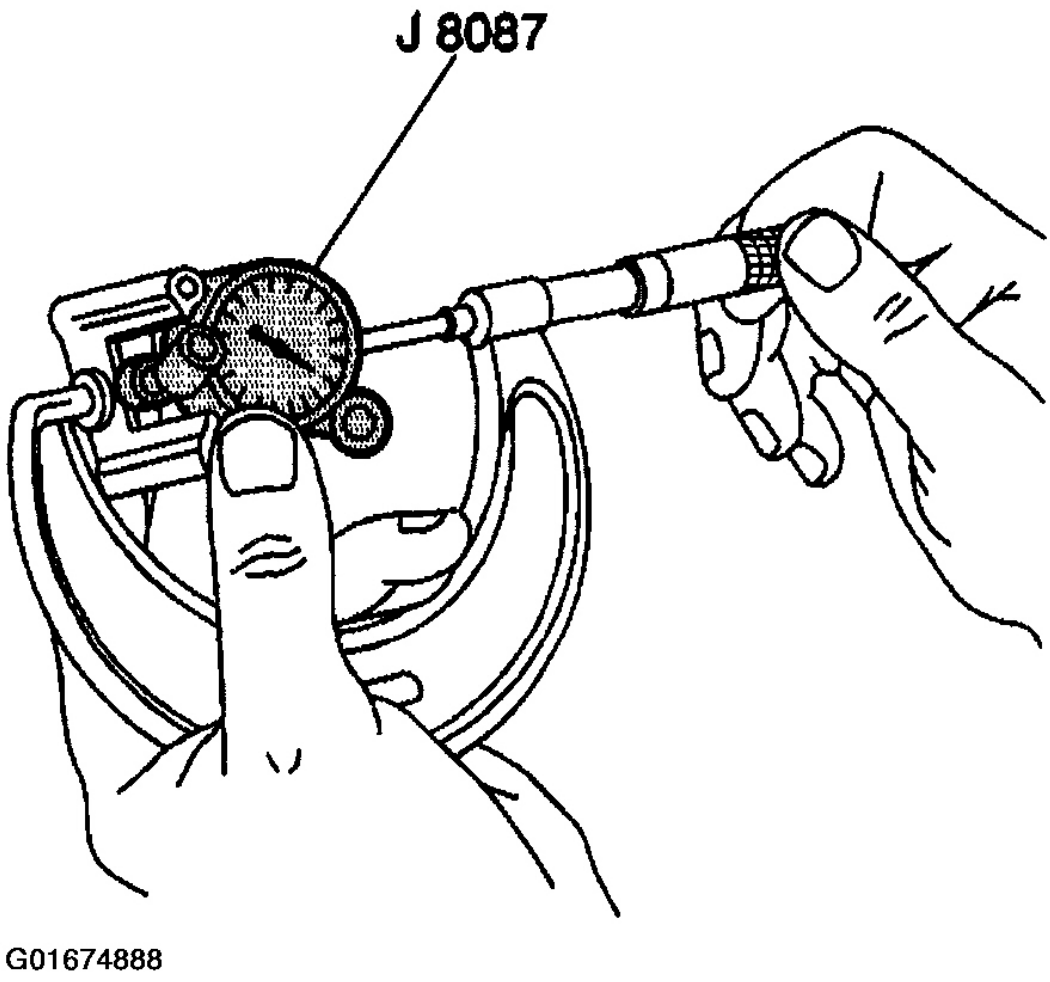


Fig. 358: Bore Gage & Micrometer
Courtesy of GENERAL MOTORS CORP.

7. Use a bore gage and measure the cylinder bore diameter. Measure at a point 64 mm (2.5 in) from the top of the cylinder bore.
8. Record the cylinder bore diameter.
9. Subtract the piston diameter from the cylinder bore diameter in order to determine the piston-to-bore clearance. Refer to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)** .
10. If the proper clearance cannot be obtained, select another piston and measure the clearances.

    If the proper fit cannot be obtained, the cylinder bore may require boring and honing for an oversize piston or engine block replacement.

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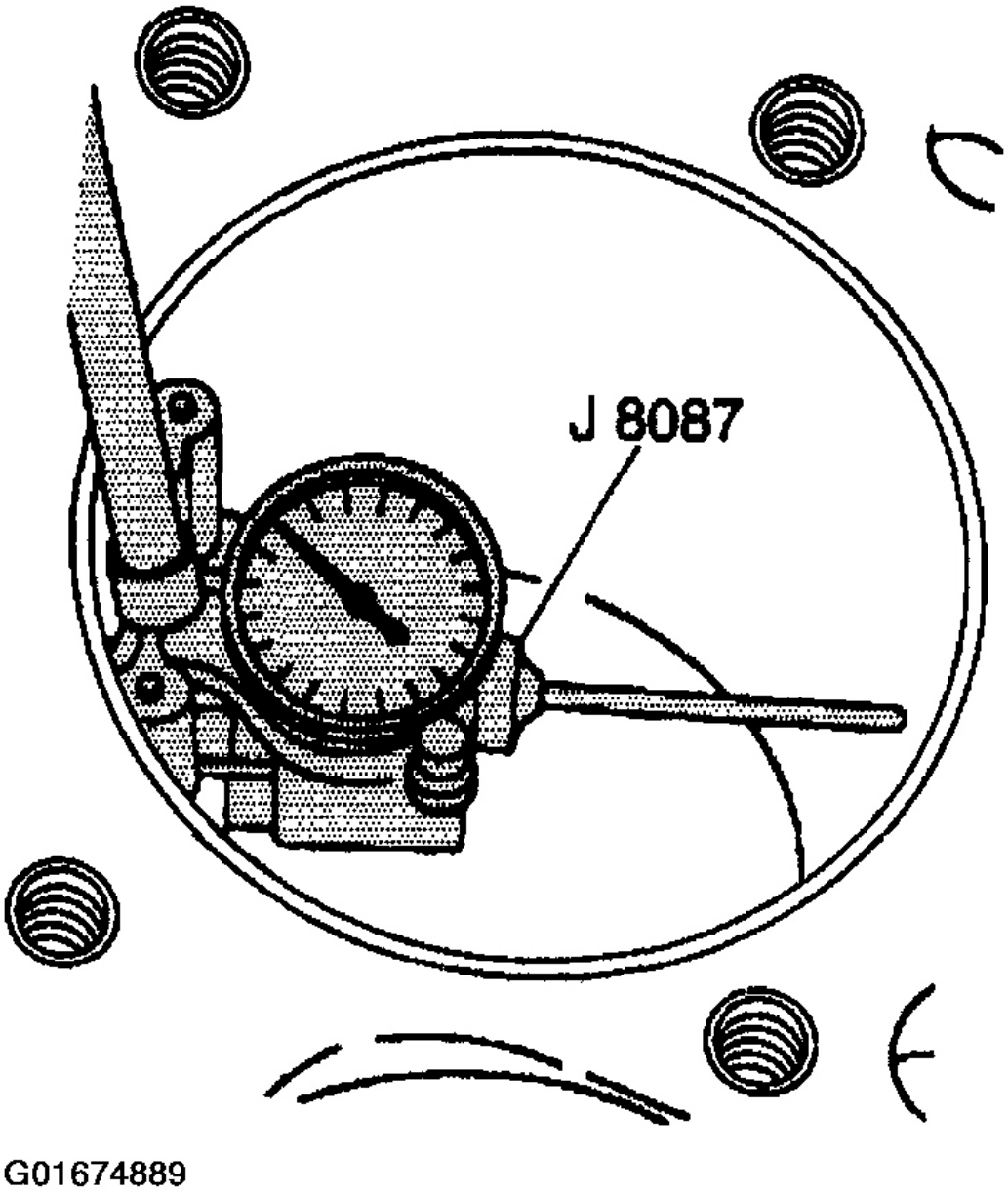


Fig. 359: Measuring Cylinder Bore Diameter
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

IMPORTANT: The piston and cylinder bore have been measured and the bore has been sized for the proper clearance. Install the piston and connecting rod assembly into

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the proper cylinder bore.

The piston alignment mark MUST face the front of the engine block.

1. Lightly lubricate the following components with clean engine oil:
   - The piston
   - The piston rings
   - The cylinder bore
   - The bearing surfaces
2. Stagger the oil control ring end gaps a minimum of 90 degrees.
3. Stagger the compression ring end gaps a minimum of 25 mm (1.0 in).

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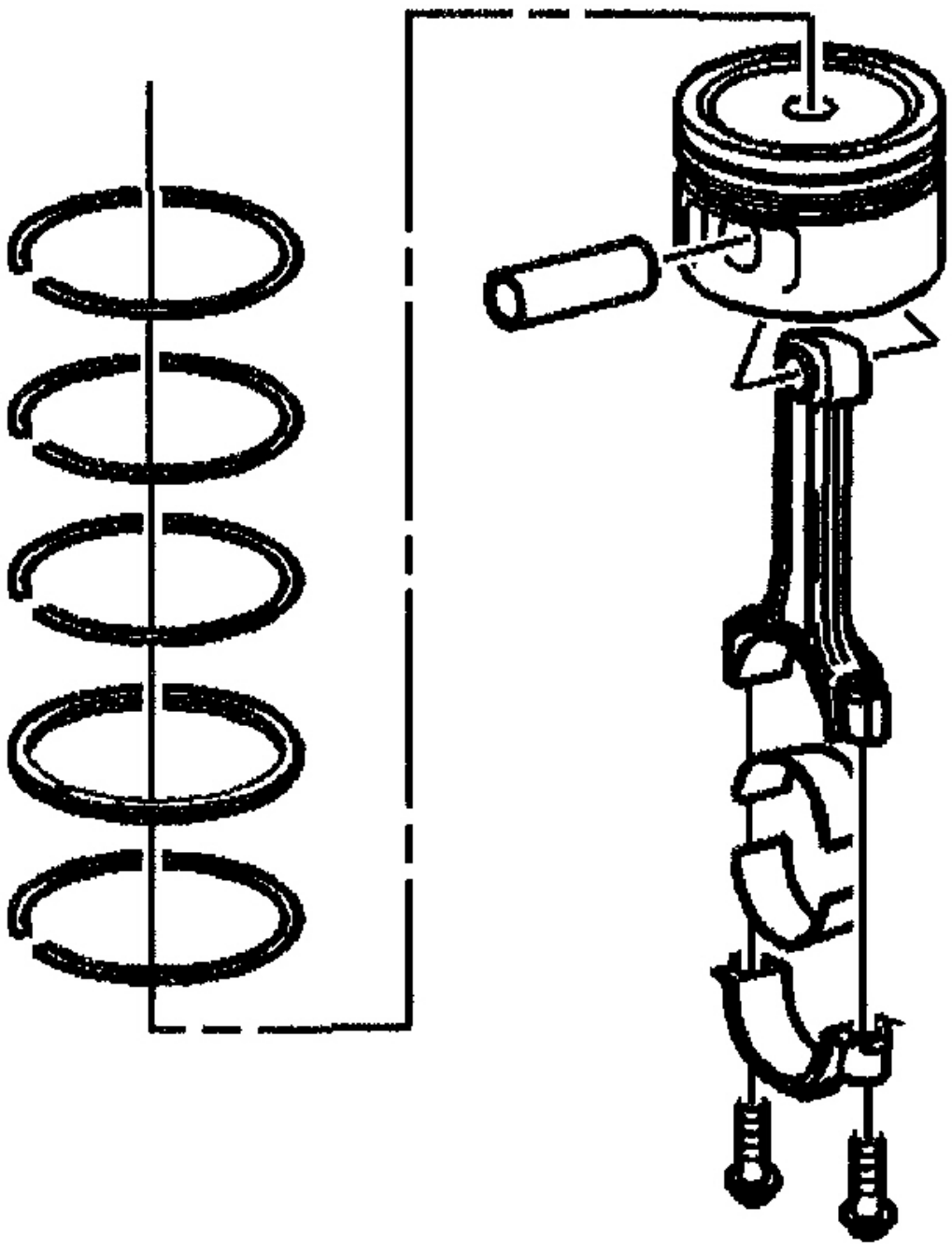


Fig. 360: Piston Components

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Courtesy of GENERAL MOTORS CORP.

4. Install the **J 41556** to the connecting rod.
5. Install the **J 8037** onto the piston and compress the piston rings.

IMPORTANT: The piston alignment mark MUST facing the front of the engine block.

6. Install the piston and connecting rod assembly into the proper cylinder bore.
   6.1. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all of the piston rings enter the cylinder bore.
   6.2. Use the **J 41556** to guide the connecting rod end onto the crankshaft journal.

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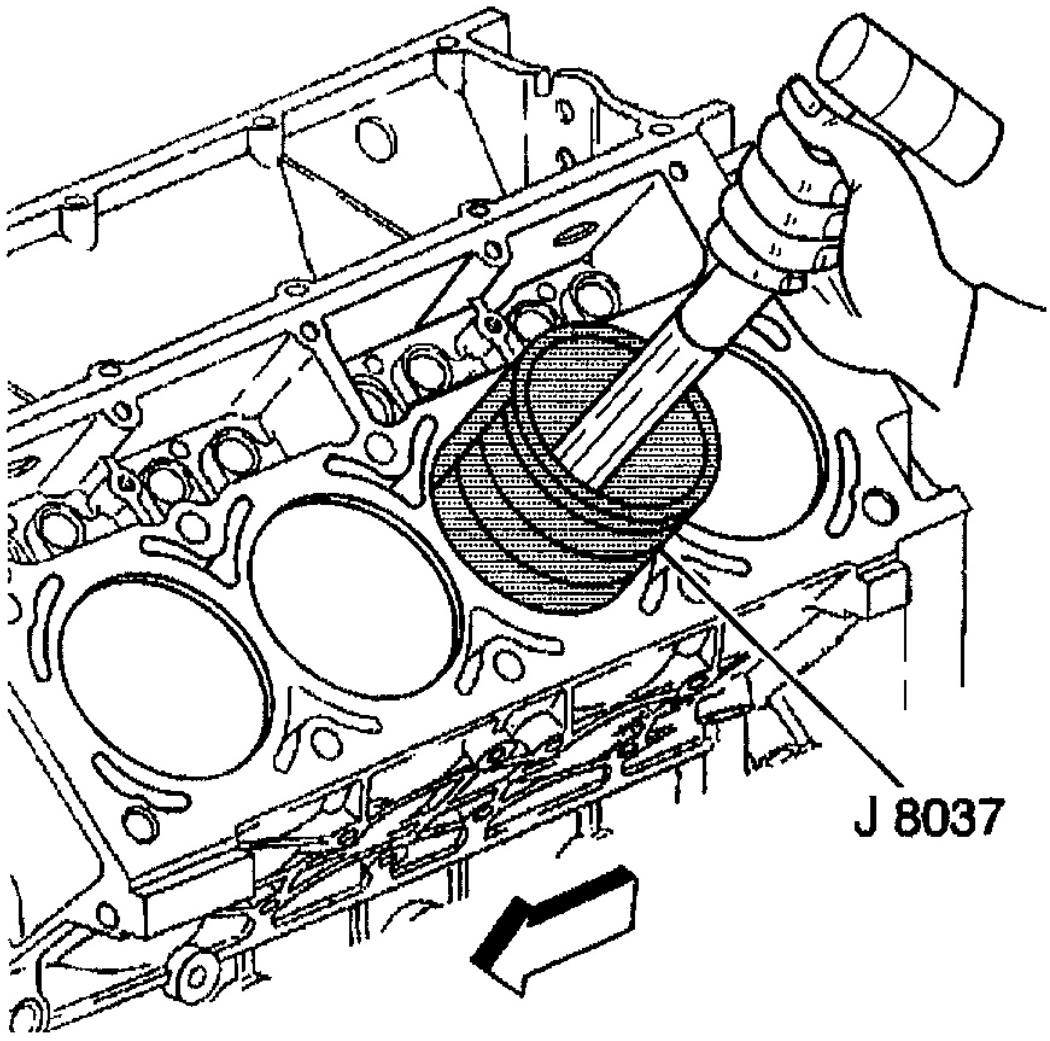


Fig. 361: Tapping Piston Into Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

7. Remove the **J 41556** .

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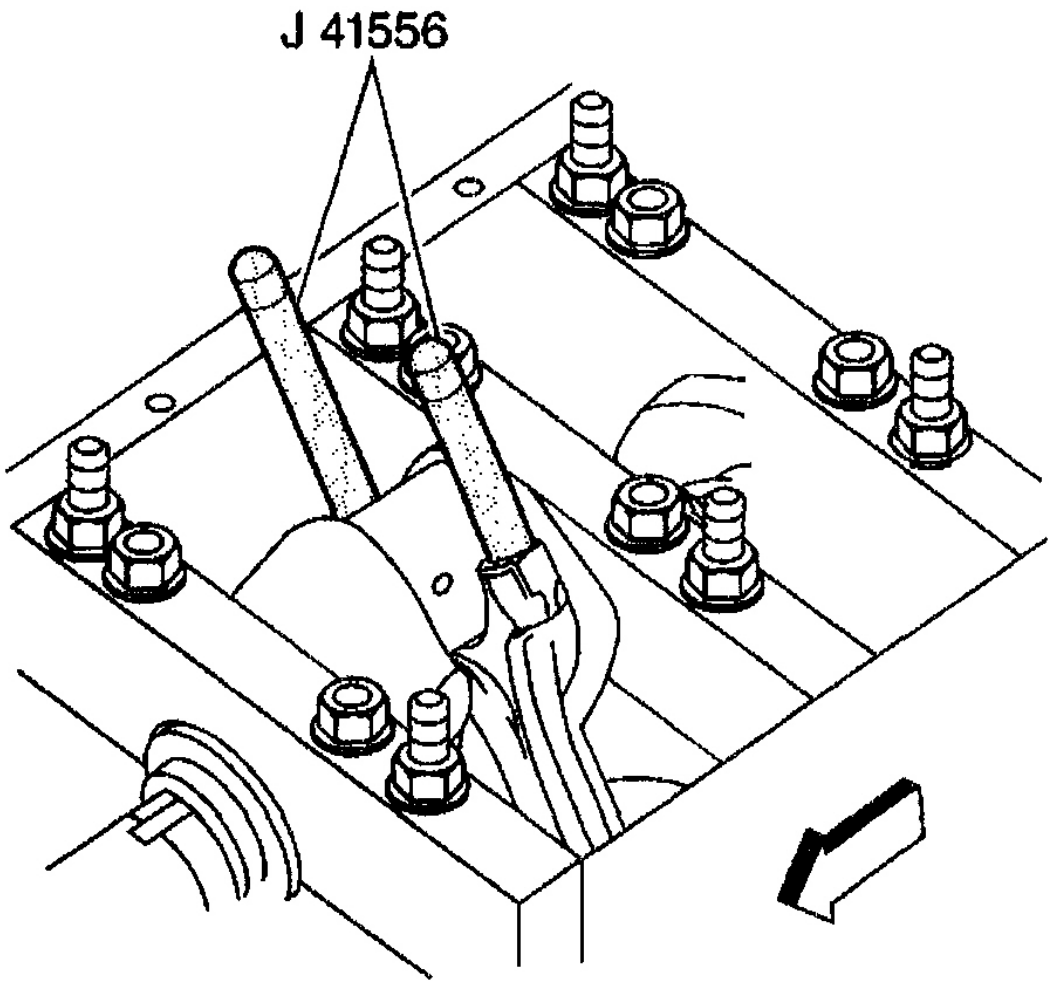


Fig. 362: J 41556
Courtesy of GENERAL MOTORS CORP.

8. Identify the type of connecting rod bolt.
    - The early design connecting rod bolt (1) can be identified by no collar/retaining sleeve on the bolt shank.
    - The later design connecting rod bolt (2) can be identified by a ferrule/retaining sleeve (3) on the bolt shank.

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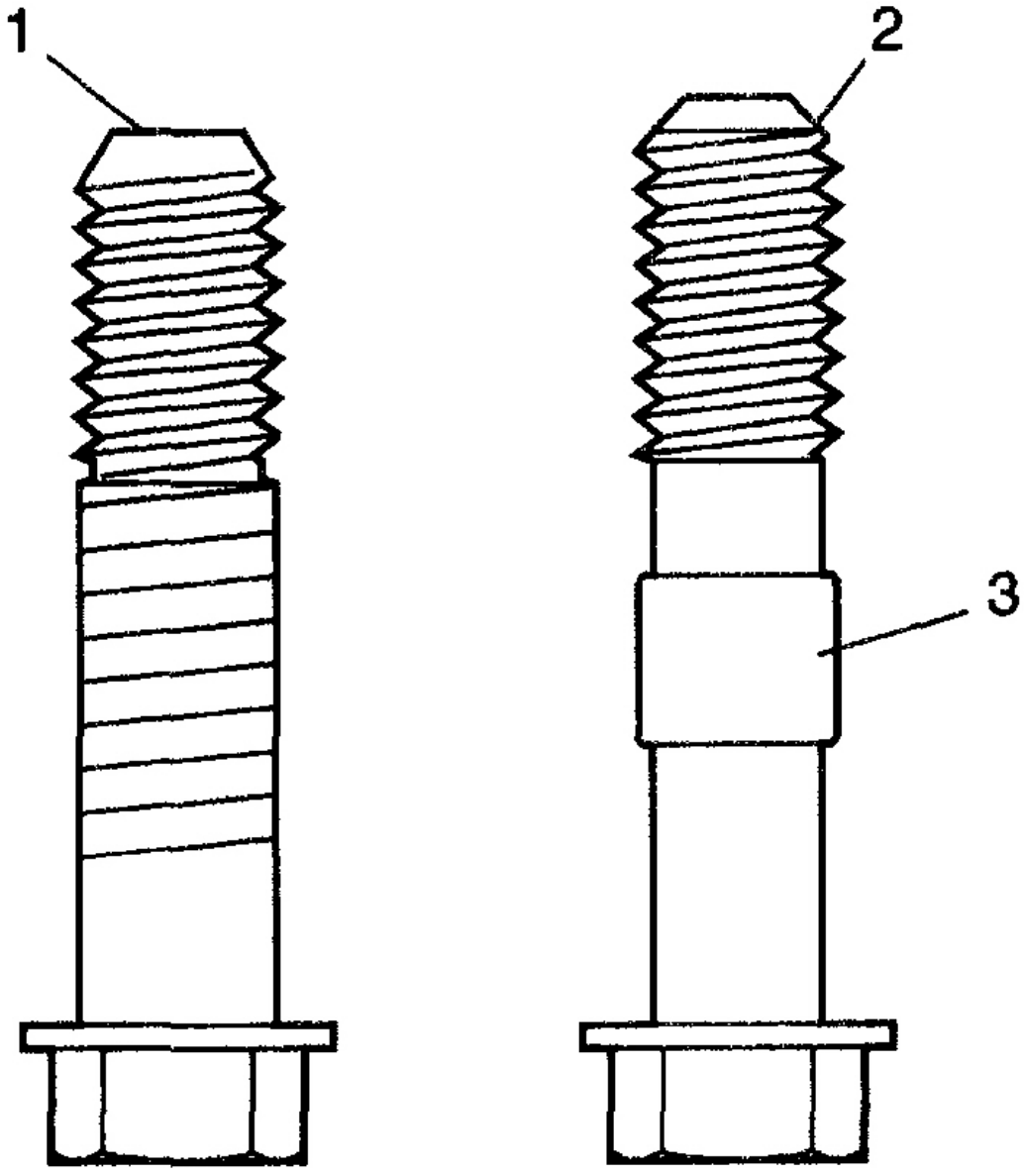


Fig. 363: Early & Later Connecting Rod Bolt Designs
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

Important:

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- When replacing connecting rod bolts, both bolts MUST be of the same design for each connecting rod assembly.

  The use of different design connecting rod bolts on the same connecting rod assembly may lead to uneven clamp loads and/or connecting rod bearing bore distortion.

- Position the connecting rod cap onto the connecting rod properly.

  Align the flat side of the connecting rod cap with the flat side of the connecting rod.

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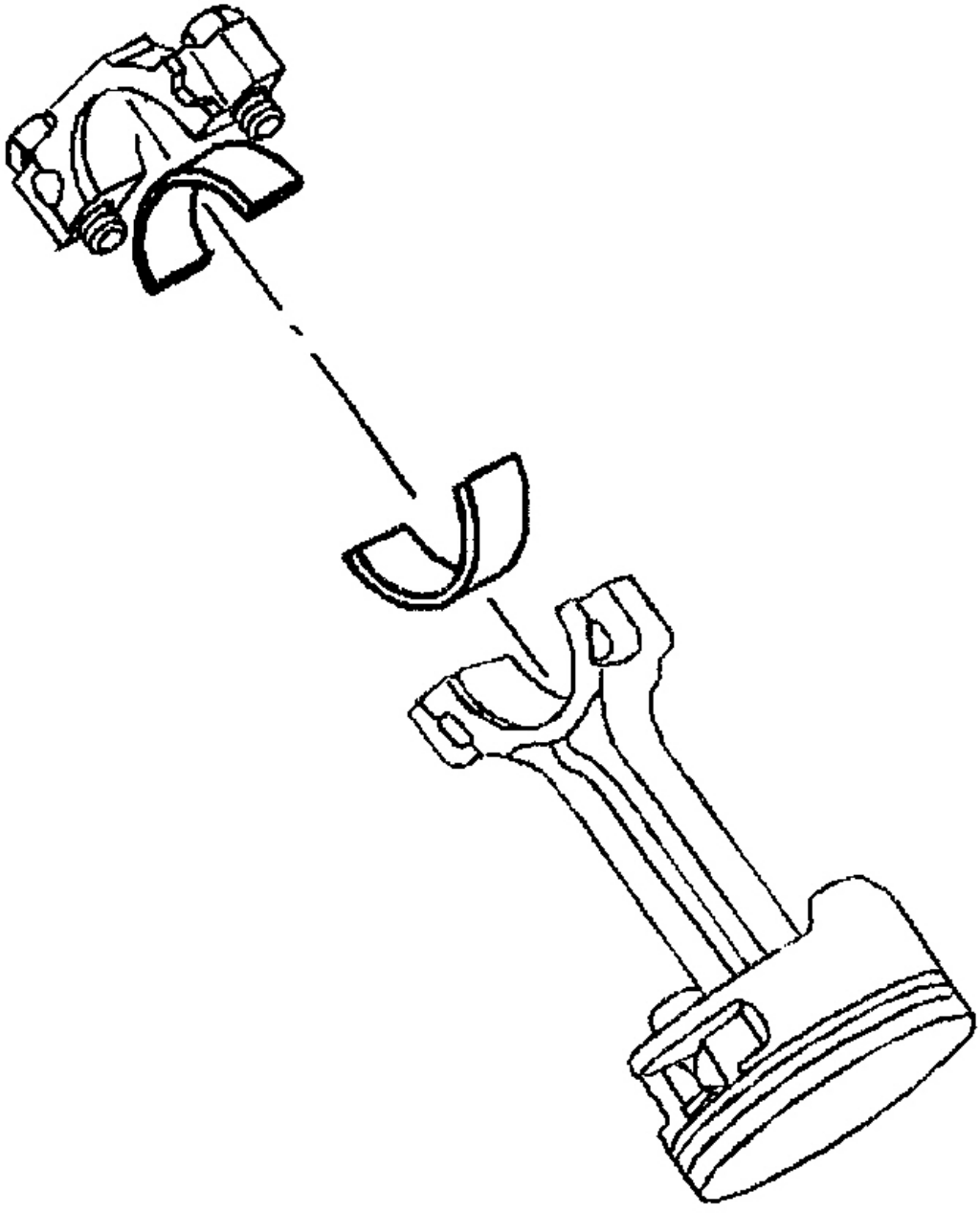


Fig. 364: Bearing Cap, Piston & Bearings
Courtesy of GENERAL MOTORS CORP.

9. Install the bearing, cap, and bolts.

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Tighten

9.1. Tighten the early design bolts a first pass evenly to 20 N.m (15 lb ft).

9.2. Tighten the early design bolts a final pass to 60 degrees using the **J 36660-A** .

9.3. Tighten the later design bolts a first pass evenly to 20 N.m (15 lb ft).

9.4. Tighten the later design bolts a final pass to 75 degrees using the **J 36660-A** .

10. Inspect the connecting rods for proper orientation onto the crankshaft journal.
11. With the pistons and connecting rods installed, use a soft faced mallet and lightly tap each connecting rod assembly parallel to the crankpin to make sure that the rods have side clearance.
12. Measure the connecting rod side clearance using a feeler gage or a dial indicator. Connecting rod side clearance should be within 0.11-0.51 mm (0.0043-0.02 in).

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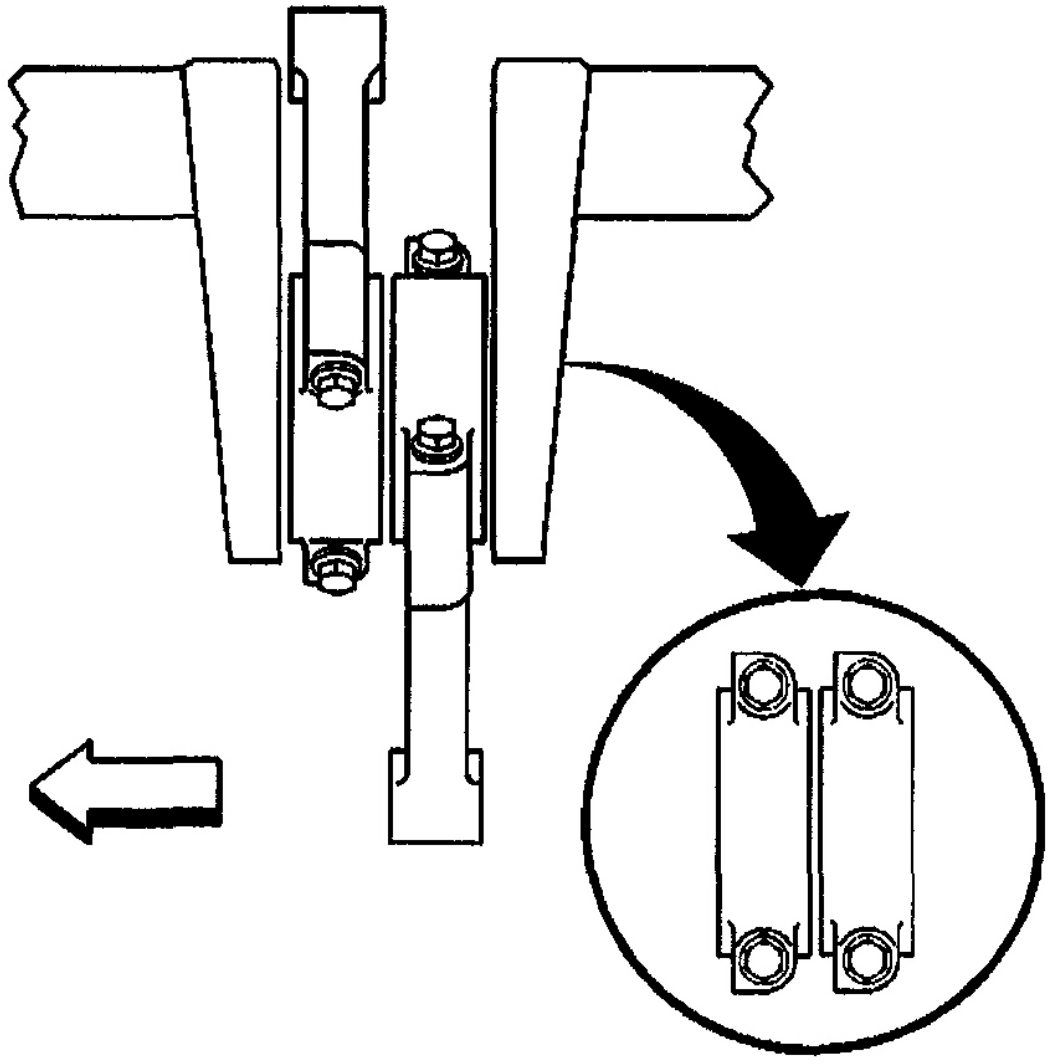


Fig. 365: Connecting Rod Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

Camshaft Installation

IMPORTANT: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install 3 M8-1.25 x 100 mm (M8-1.25 x 4.0 in) bolts into the camshaft front bolt holes.

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NOTE: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolts as a handle, carefully install the camshaft into the engine block.
4. Remove the 3 bolts from the front of the camshaft.

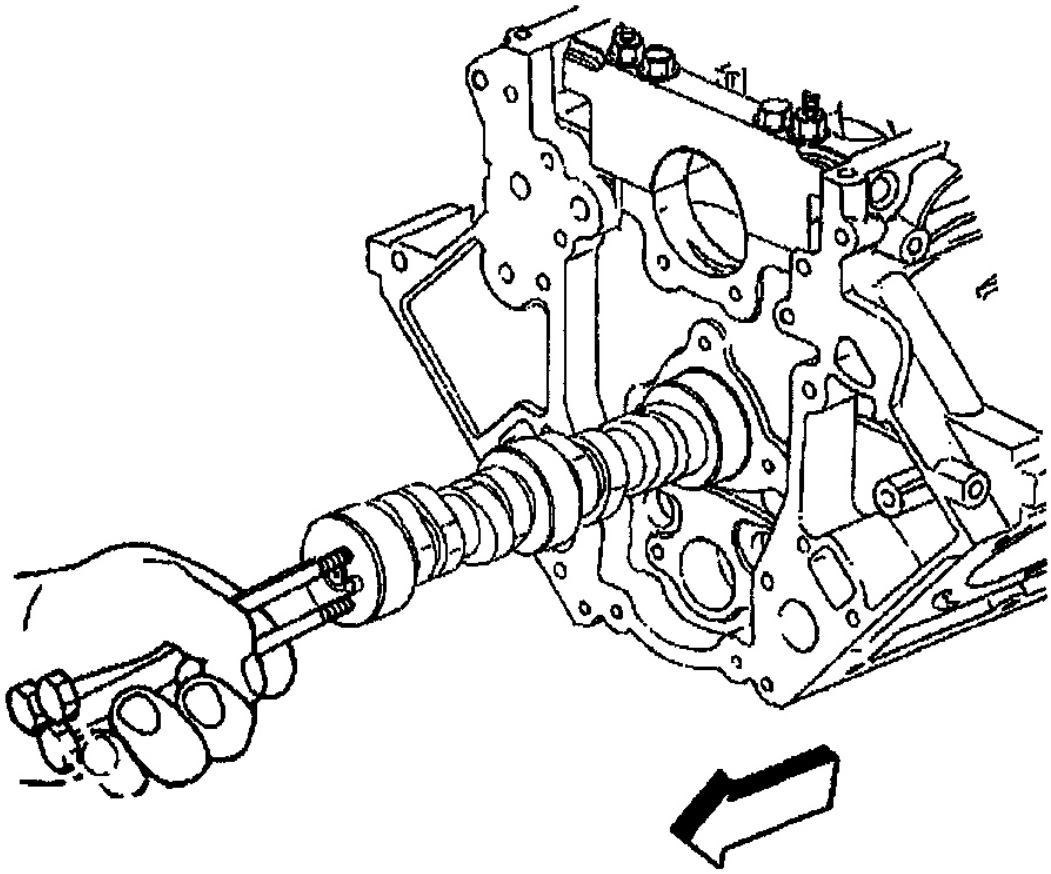


Fig. 366: Installing Camshaft Into Engine Block Using Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

IMPORTANT: Install the retainer plate with the sealing gasket facing the engine block.

The gasket surface on the engine block should be clean and free of dirt or debris.

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5. Install the camshaft retainer and the bolts.

   Tighten

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

6. Inspect the camshaft sensor O-ring seal. If the O-ring seal is not cut or damaged, it may be reused.
7. Lubricate the O-ring seal with clean engine oil.

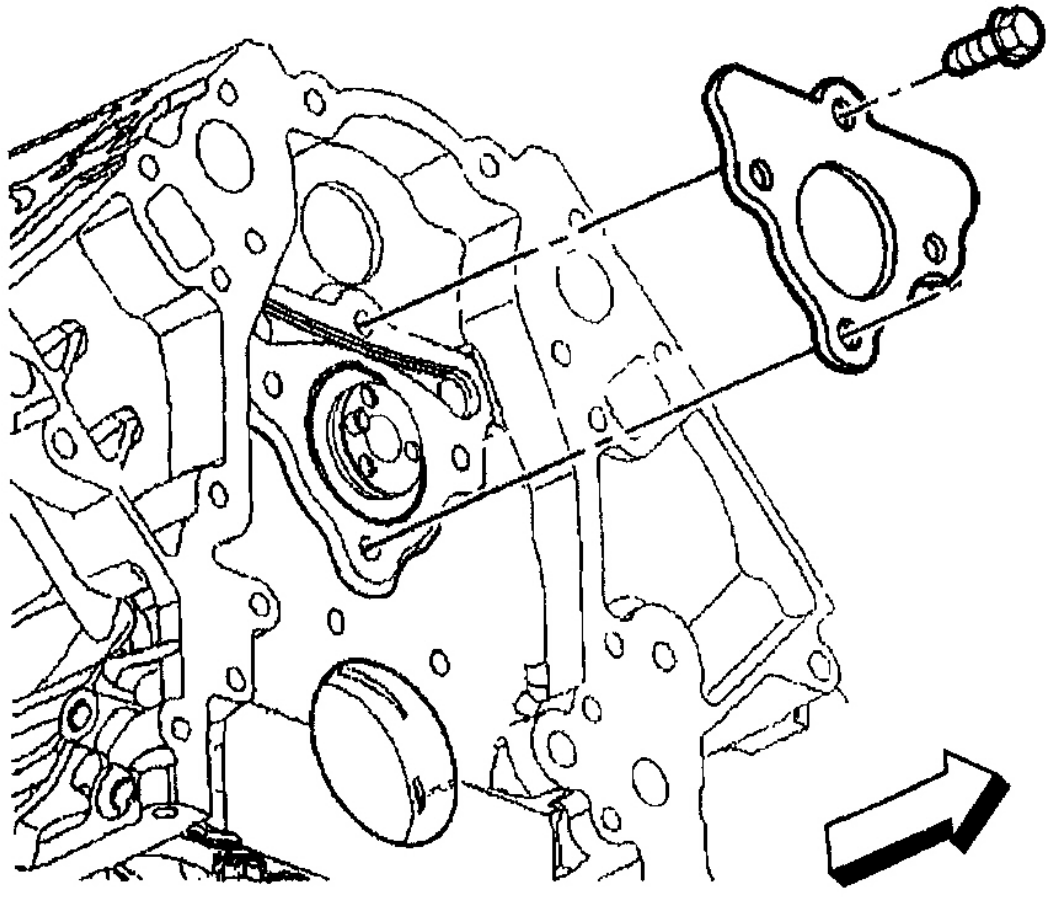


Fig. 367: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the camshaft sensor and bolt.

   Tighten

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Tighten the camshaft sensor bolt to 25 N.m (18 lb ft).

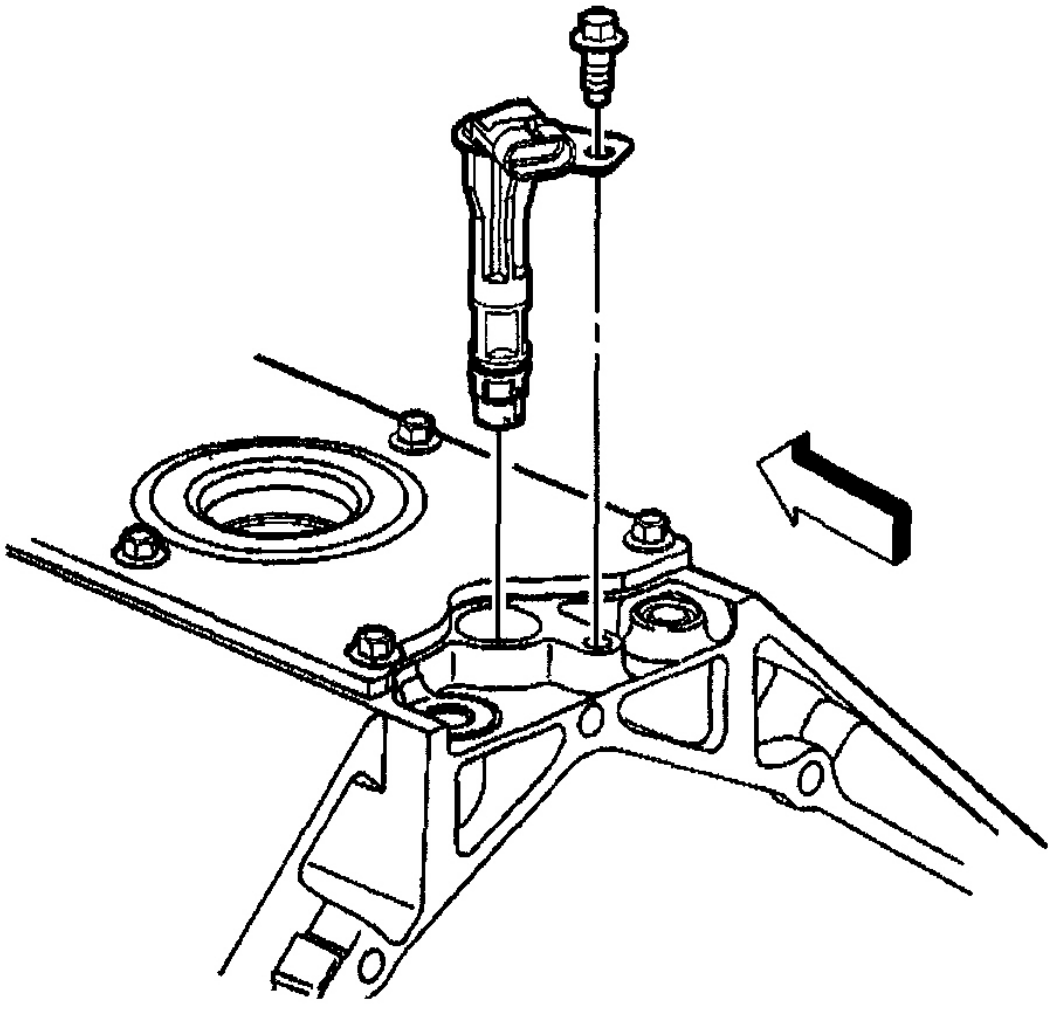


Fig. 368: Camshaft Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

TIMING CHAIN AND SPROCKETS INSTALLATION

Tools Required

J 41665 Crankshaft Balancer and Sprocket Installer

1. Install the key into the crankshaft keyway, if previously removed.

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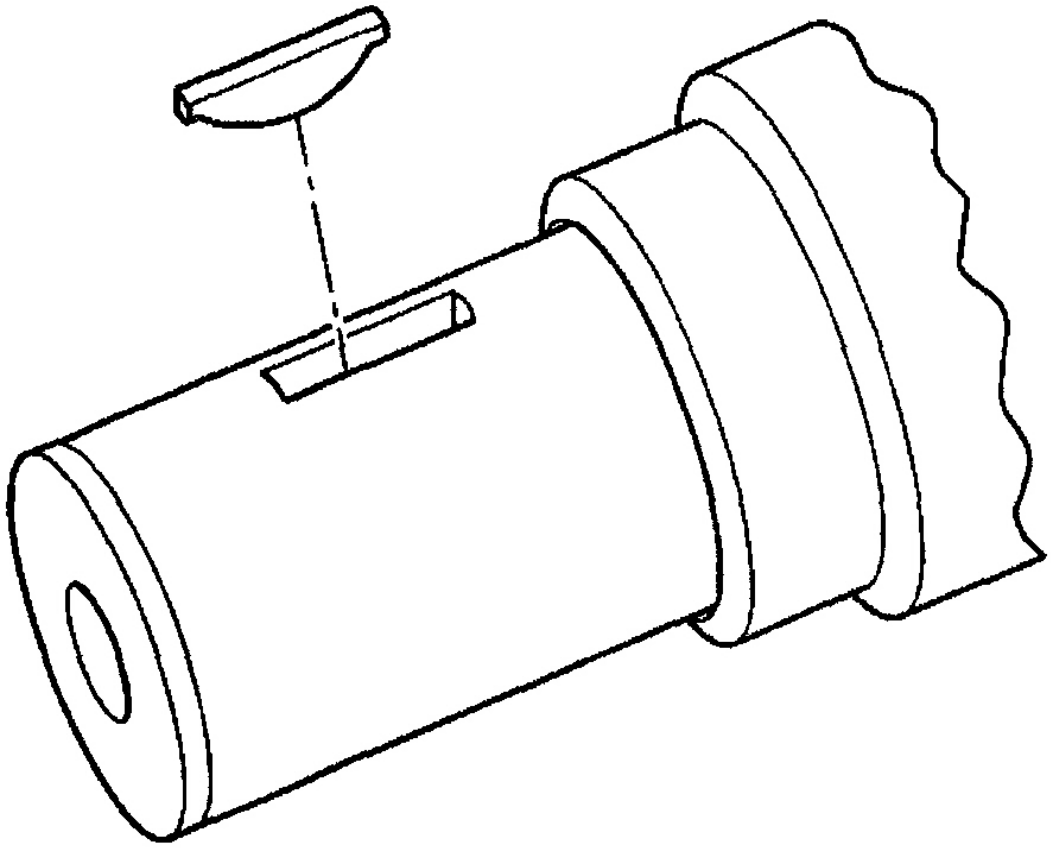


Fig. 369: Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (1) into the keyway until both ends of the key bottom onto the crankshaft.

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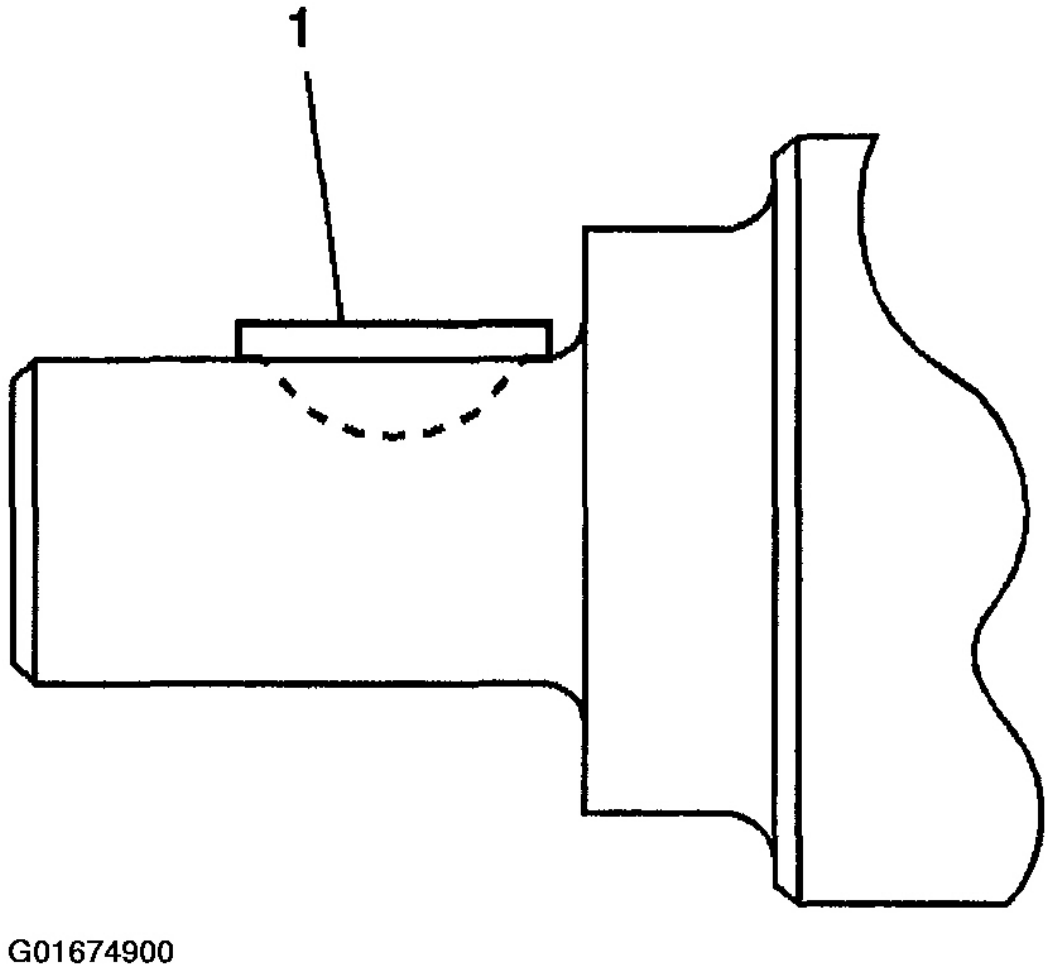


Fig. 370: Crankshaft Key Installed
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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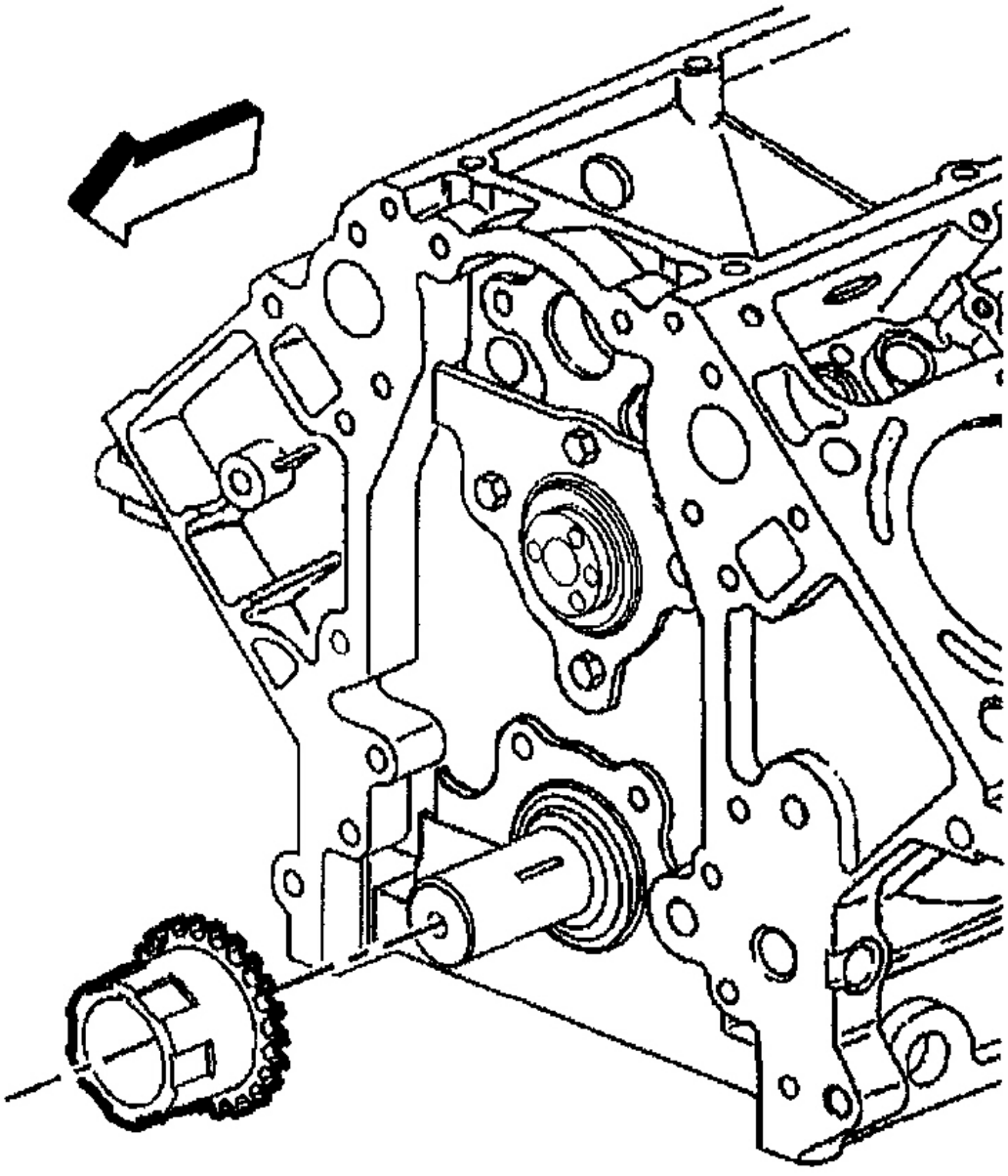


Fig. 371: Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41665** in order to install the crankshaft sprocket.

   Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

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5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

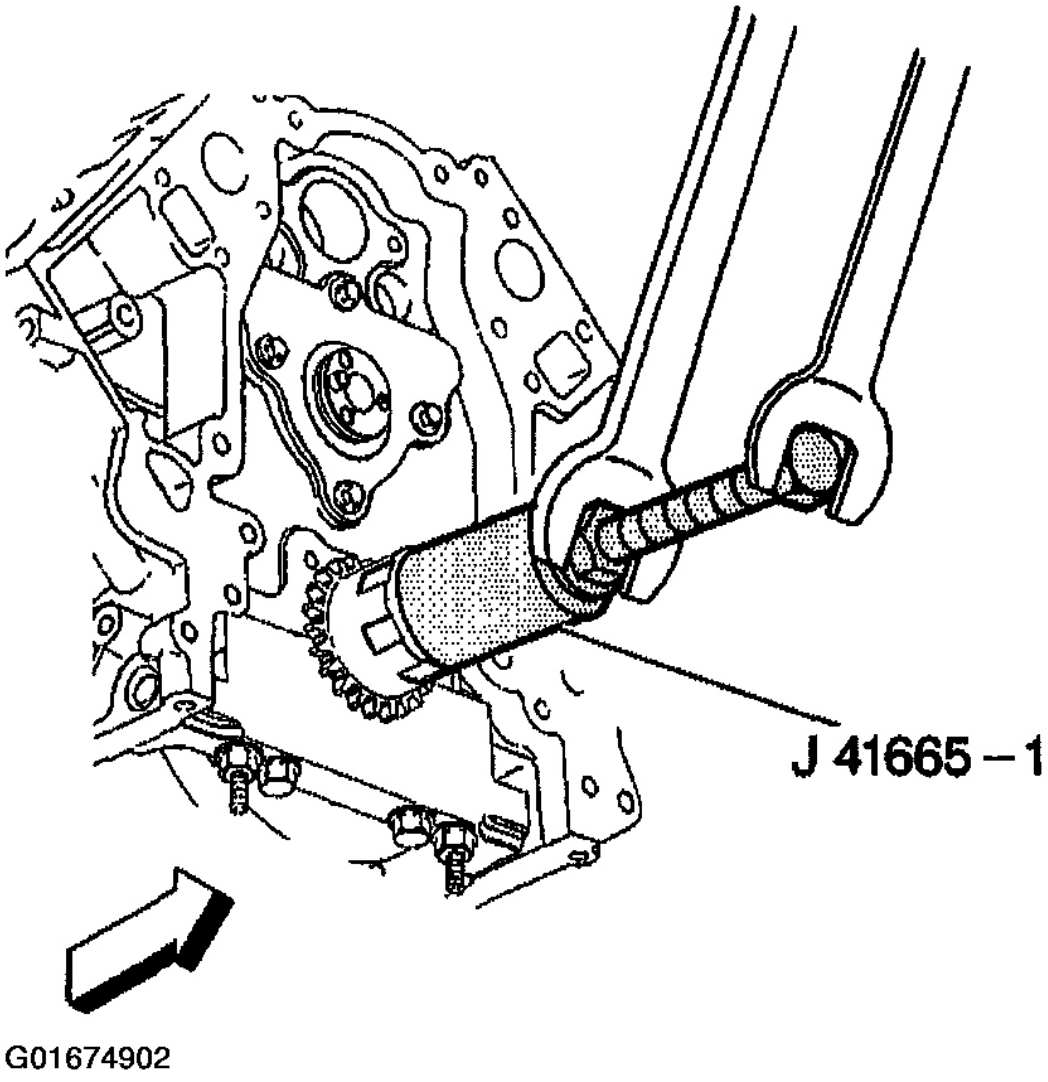


Fig. 372: Installing Crankshaft Sprocket Using J 41665
Courtesy of GENERAL MOTORS CORP.

Important:

- Properly locate the camshaft sprocket locating pin with the camshaft sprocket alignment hole.
- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.

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

6. Install the camshaft sprocket and timing chain.

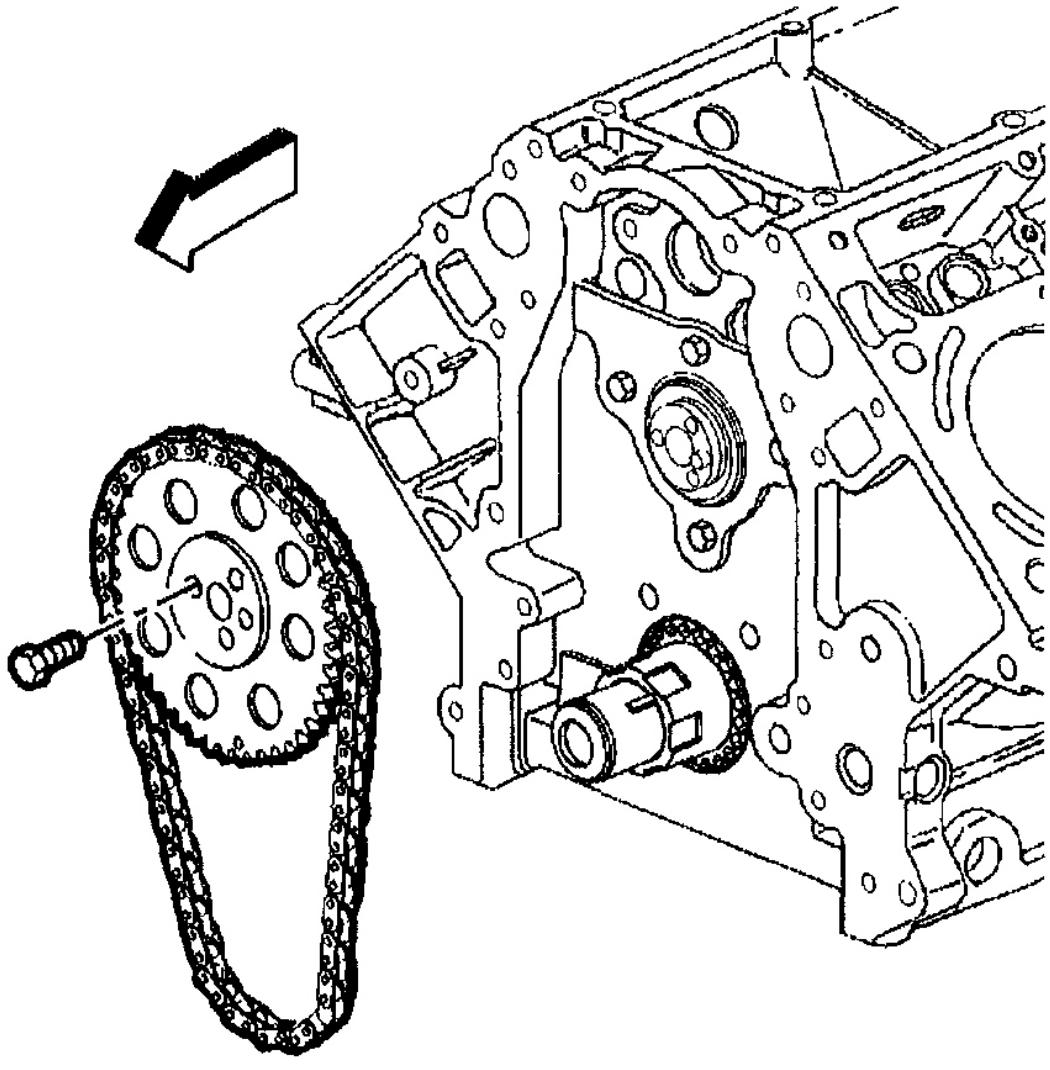


Fig. 373: Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

7. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

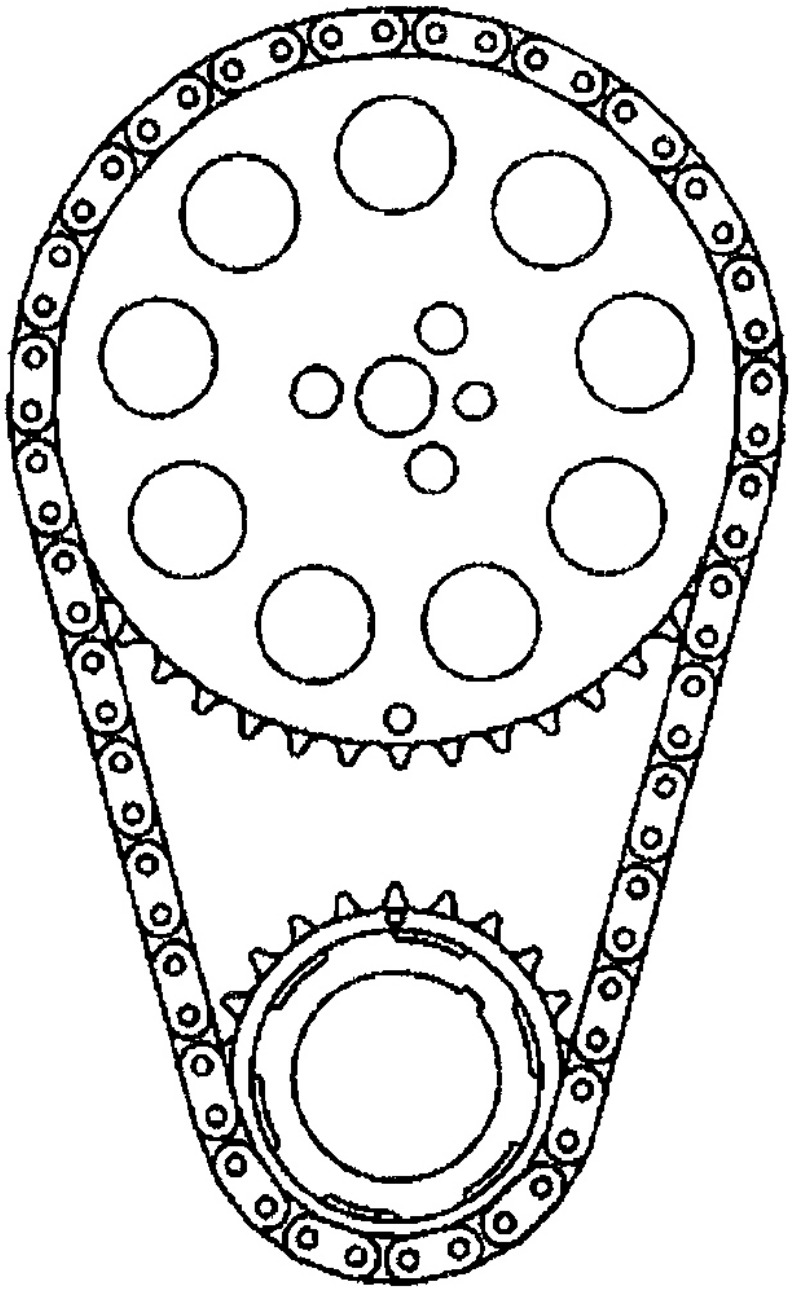
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8. Install the camshaft sprocket bolts.

   Tighten

   Tighten the camshaft sprocket bolts to 35 N.m (26 lb ft).

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Fig. 374: Camshaft & Crankshaft Sprockets Timing Marks
Courtesy of GENERAL MOTORS CORP.

OIL PUMP, PUMP SCREEN AND DEFLECTOR INSTALLATION

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IMPORTANT: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

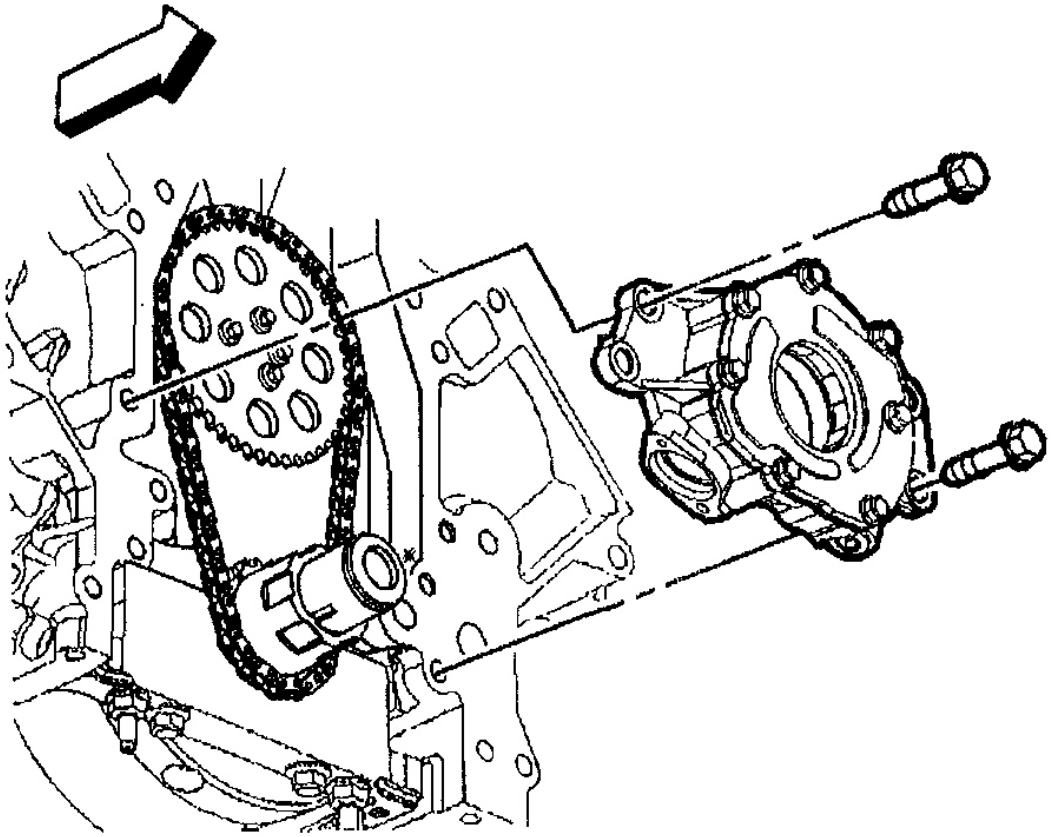
1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump.
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the oil pump bolts.

Tighten

Tighten the oil pump bolts to 25 N.m (18 lb ft).



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Fig. 375: Oil Pump & Bolts

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Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector.

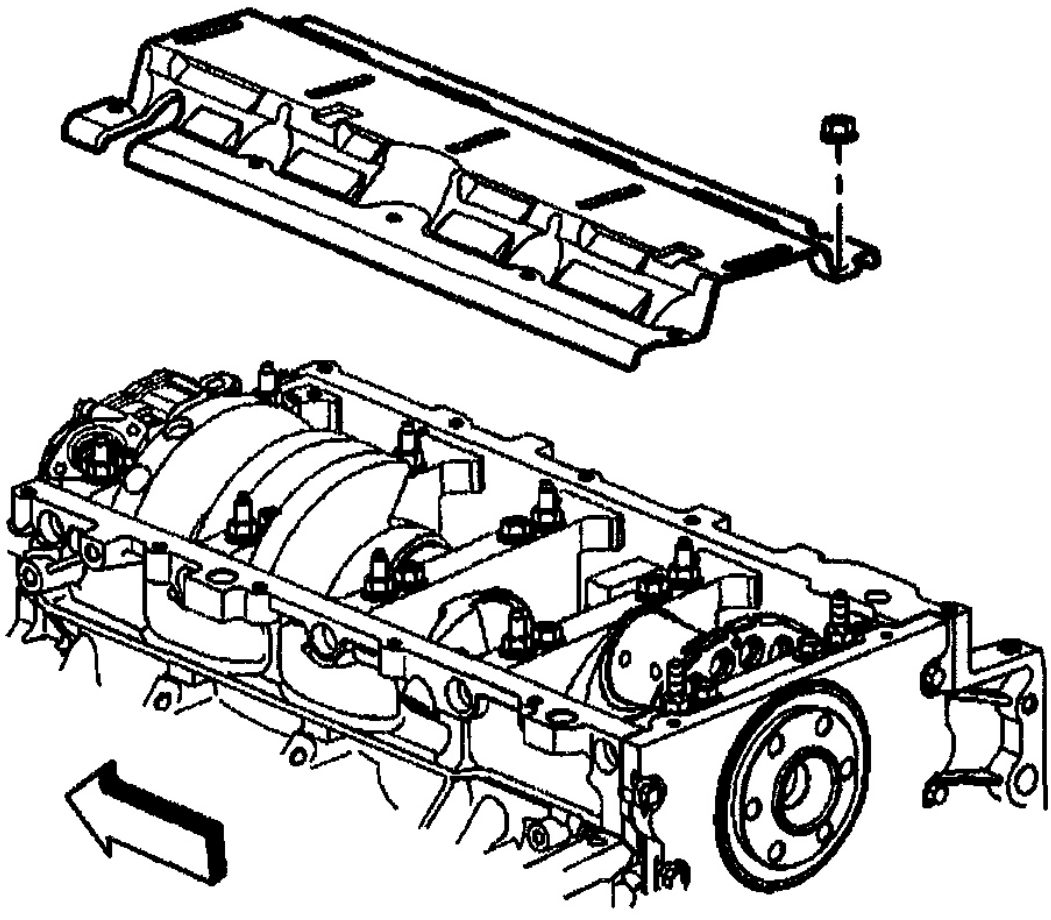


Fig. 376: Crankshaft Oil Deflector
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal (3) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

IMPORTANT: Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.

Align the oil pump screen mounting brackets with the correct crankshaft bearing cap studs.

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7. Install the oil pump screen (1).
8. Install the oil pump screen bolt (4) and the deflector nuts (2).

Tighten

8.1. Tighten the oil pump screen bolt (4) to 12 N.m (106 lb in).
8.2. Tighten the crankshaft oil deflector nuts (2) to 25 N.m (18 lb ft).

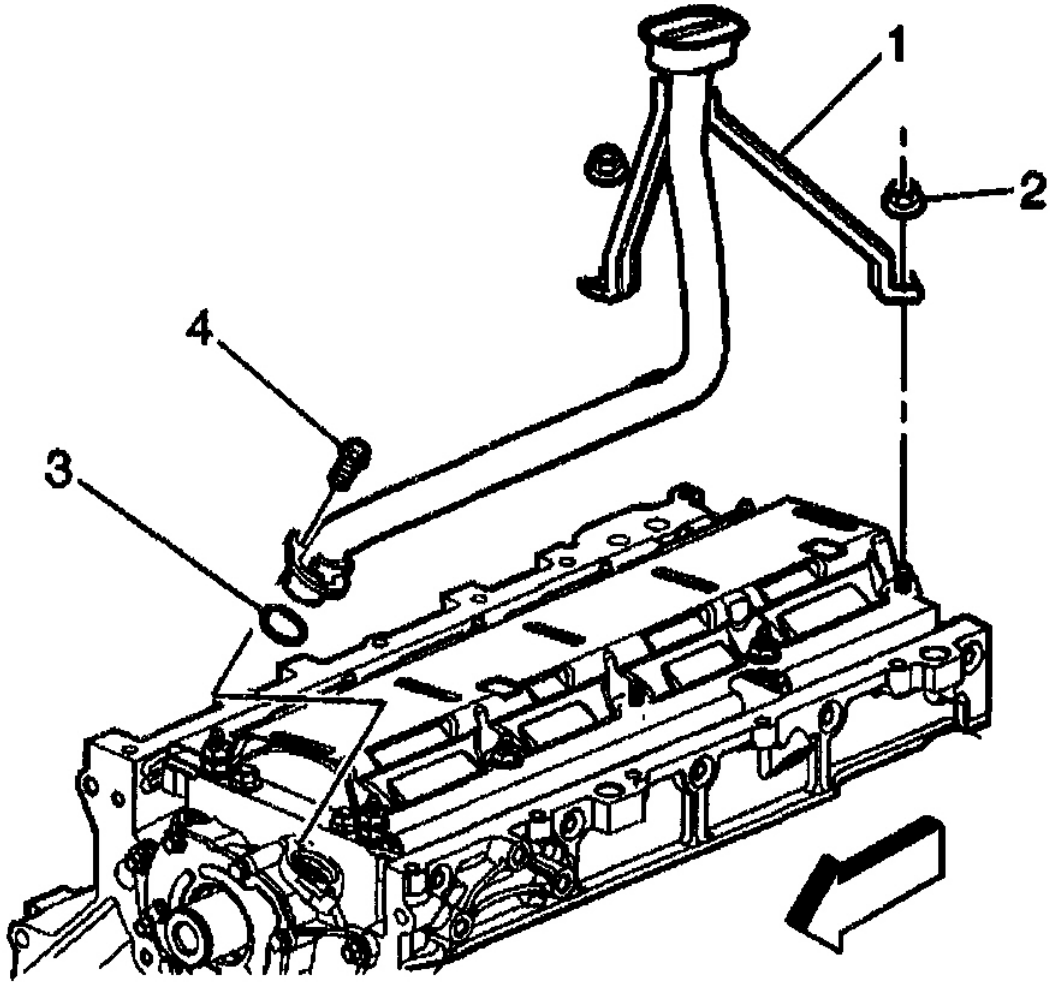


Fig. 377: Oil Pump Screen & Components
Courtesy of GENERAL MOTORS CORP.

ENGINE REAR COVER INSTALLATION

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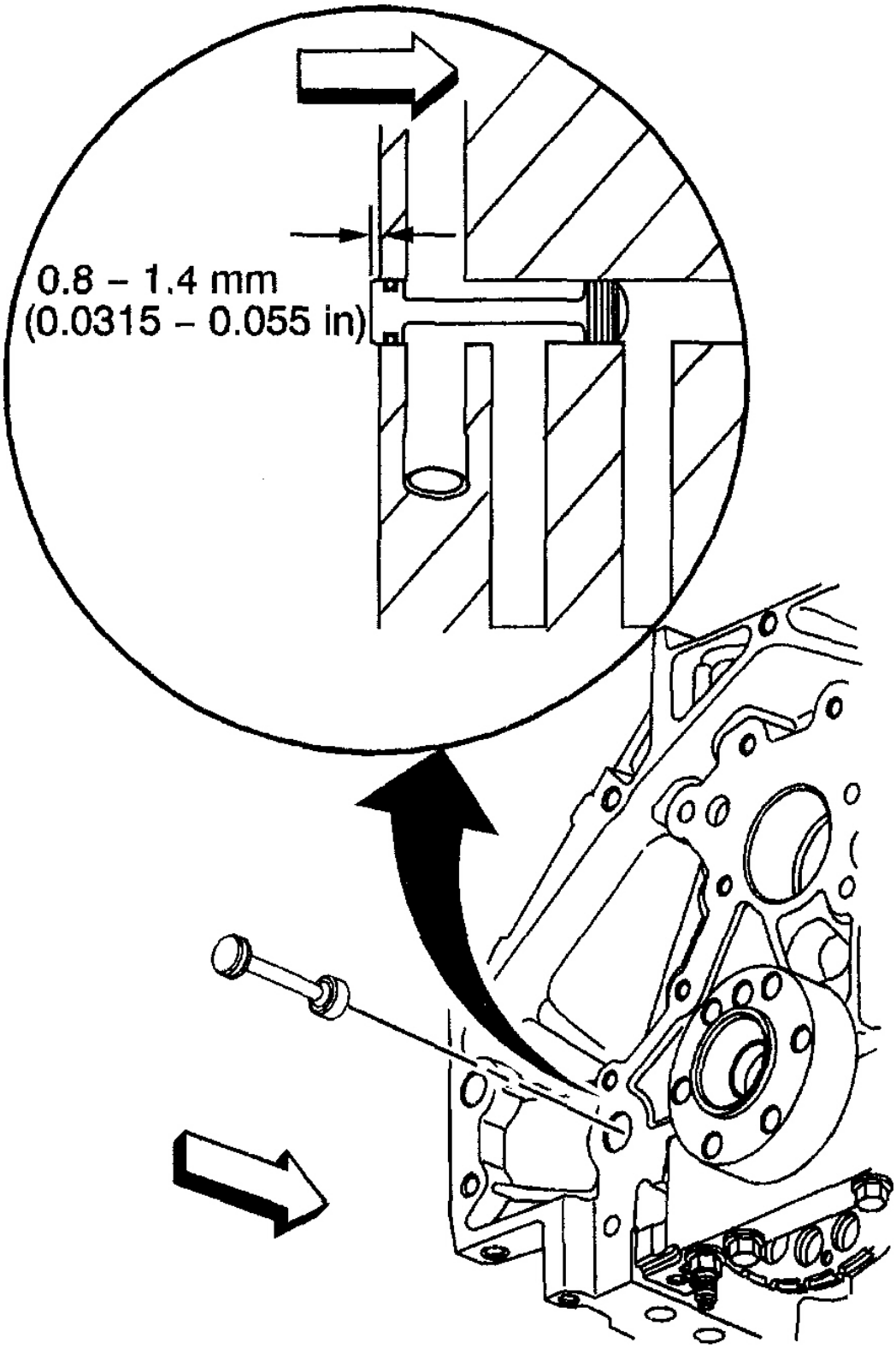
Tools Required

- **J 41480** Front/Rear Cover Alignment - Oil Pan Surface
- **J 41476** Front/Rear Cover Alignment - Crankshaft Oil Seal Area

Important:

- Do not reuse the crankshaft rear oil seal or the engine rear cover gasket.
- Do not apply any type sealant to the rear cover gasket, unless specified.
- The special tools in this procedure are used to properly align the engine rear cover at the oil pan surface and to center the crankshaft rear oil seal.
- The crankshaft rear oil seal will be installed after the rear cover has been installed and aligned. Install the rear cover without the crankshaft oil seal.
    - The crankshaft rear oil seal MUST be centered in relation to the crankshaft.
    - The oil pan sealing surface at the rear cover and engine block MUST be aligned within specifications.
    - An improperly aligned rear cover may cause premature rear oil seal wear and/or engine assembly oil leaks.

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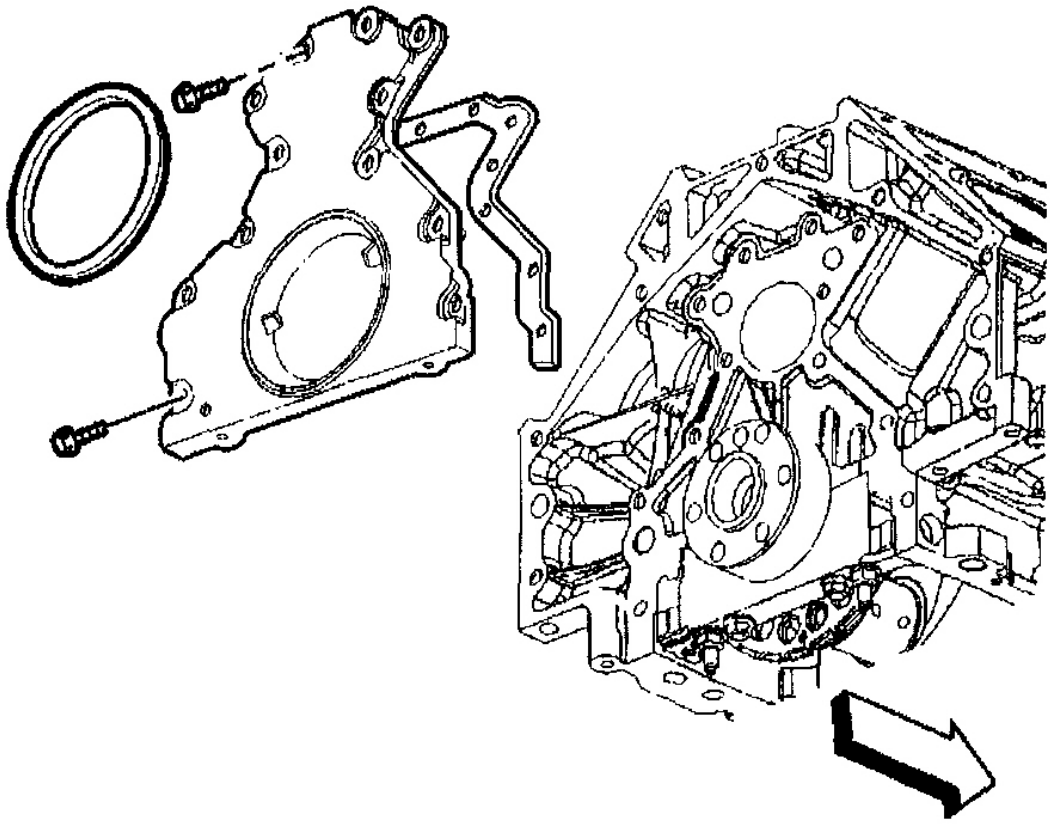


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Fig. 378: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Inspect the rear oil gallery plug for proper installation.
2. Install the rear cover gasket, rear cover and bolts.
3. Tighten the bolts finger tight. Do not overtighten.



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Fig. 379: Engine Rear Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

IMPORTANT: Start the J 41480 tool-to-rear cover bolts. Do not tighten the bolts at this time.

4. Install the **J 41480** and bolts.

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Tighten

Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

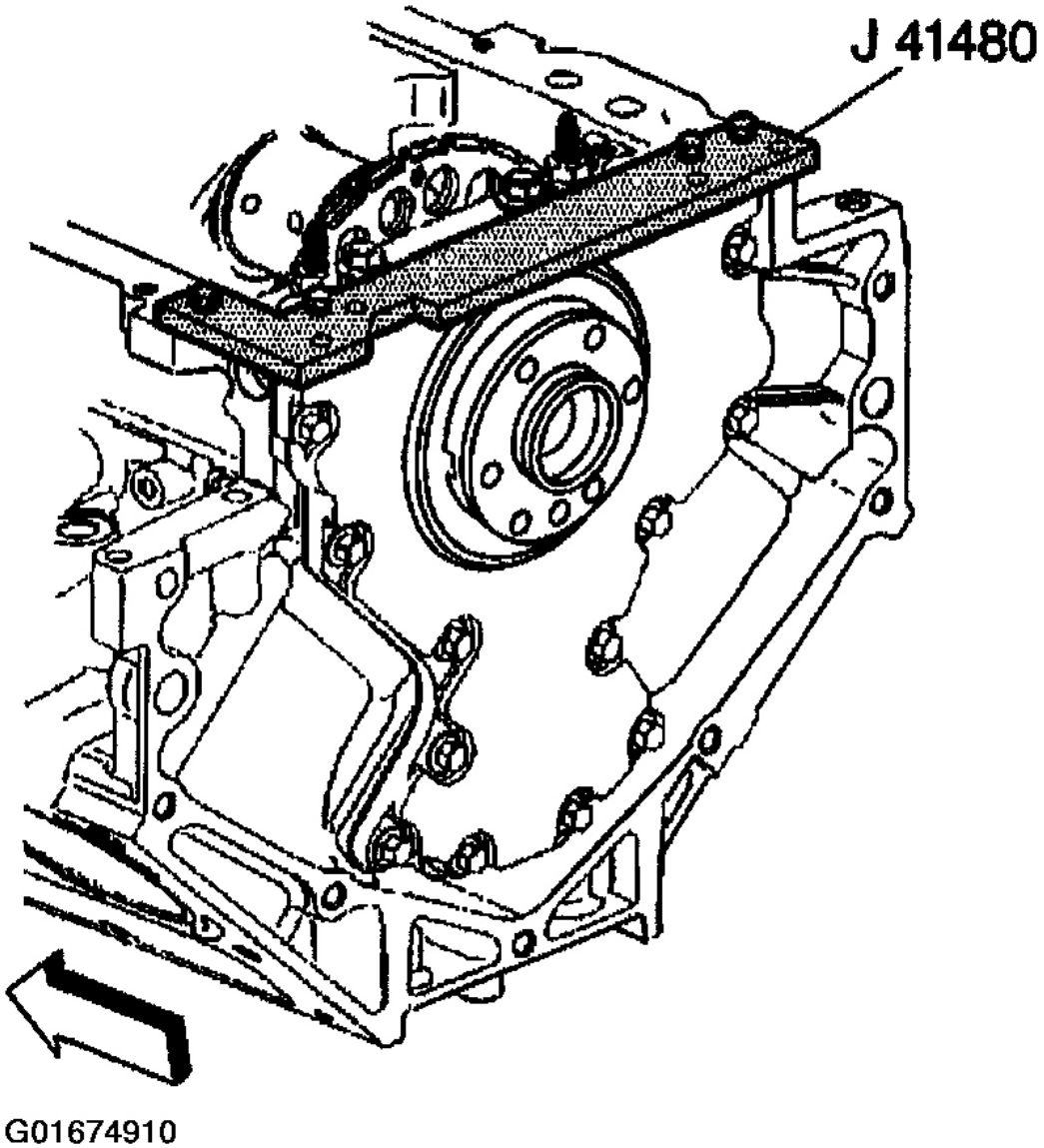


Fig. 380: J 41480 Installed On Engine Block
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: To properly align the rear cover, the J 41476 must be installed onto the rear of the crankshaft with the tool mounting bolts parallel to the oil pan

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surface.

5. Rotate the crankshaft until 2 opposing flywheel bolt holes are parallel to the oil pan surface.

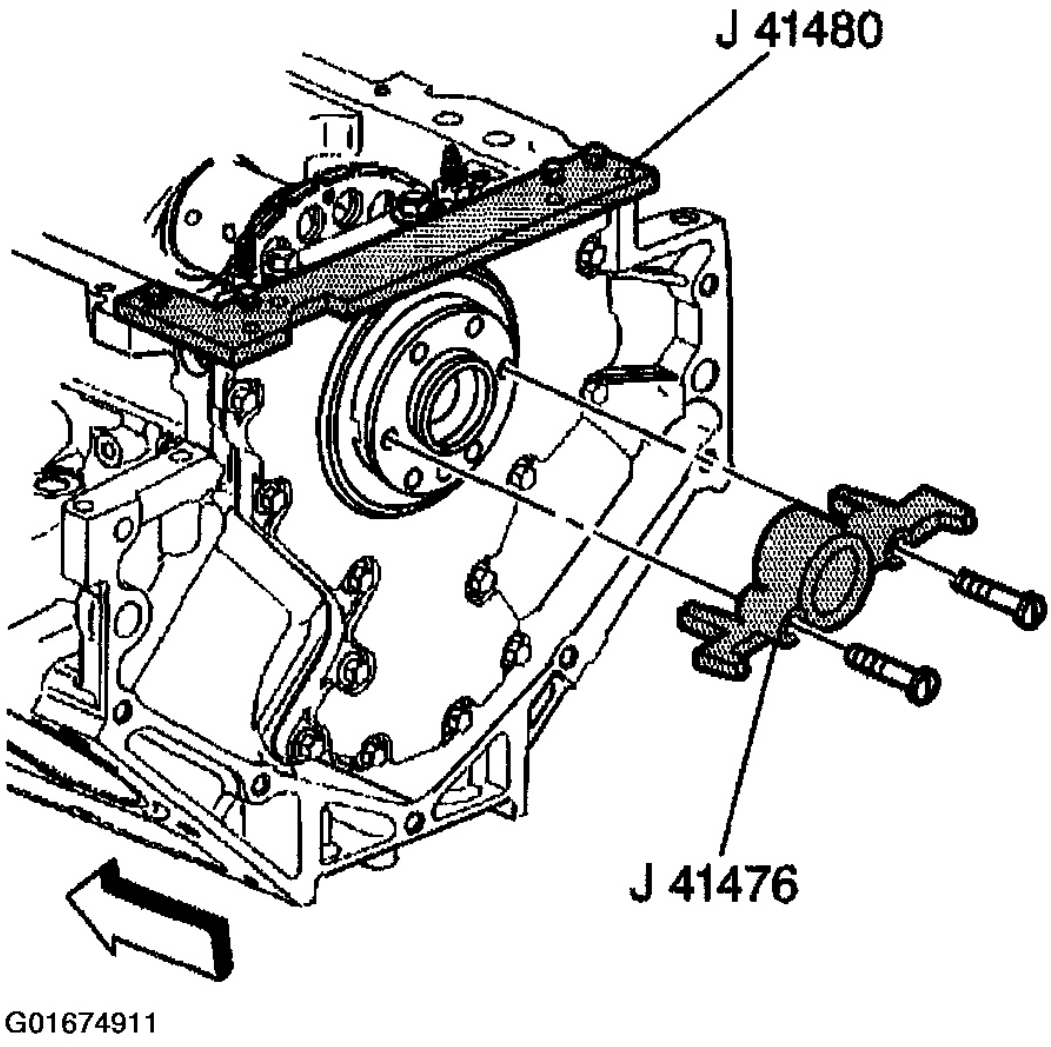


Fig. 381: J 41480 & J 41476 Removed
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The tapered legs of the alignment tool must enter the rear cover oil seal bore.

6. Install the **J 41476** and bolts onto the rear of the crankshaft.

Tighten

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6.1. Tighten the tool mounting bolts until snug. Do not overtighten.

6.2. Tighten the **J 41480** tool-to-rear cover bolts evenly to 12 N.m (106 lb in).

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

7. Remove the tools.

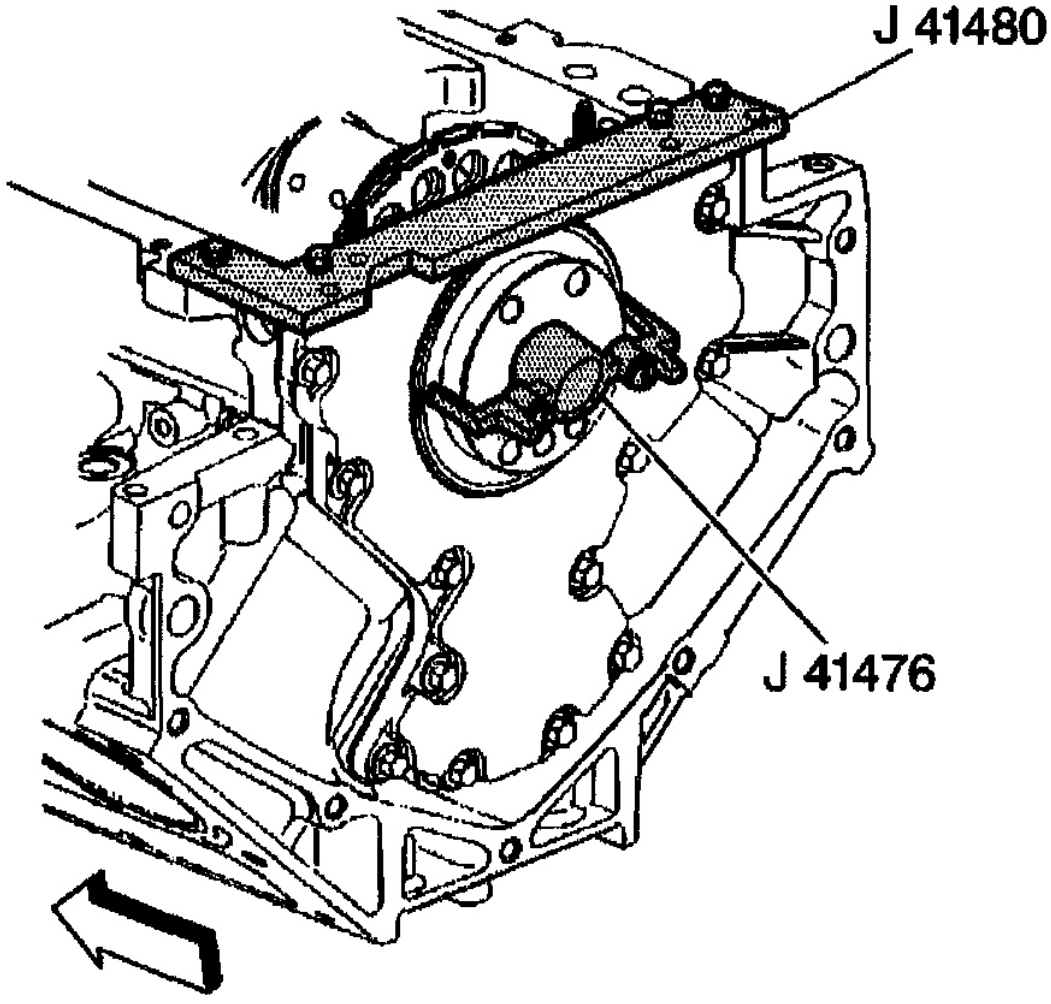


Fig. 382: J 41480 & J 41476 Installed To Crankshaft
Courtesy of GENERAL MOTORS CORP.

8. Measure the rear cover-to-engine block oil pan surface for flatness.

8.1. Place a straight edge onto the engine block and rear cover oil pan sealing surfaces.

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Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

8.2. Insert a feeler gage between the rear cover and the straight edge. The cover must be flush with the oil pan or no more than 0.5 mm (0.02 in) below flush.

9. If the rear cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
10. If the correct rear cover-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear cover.

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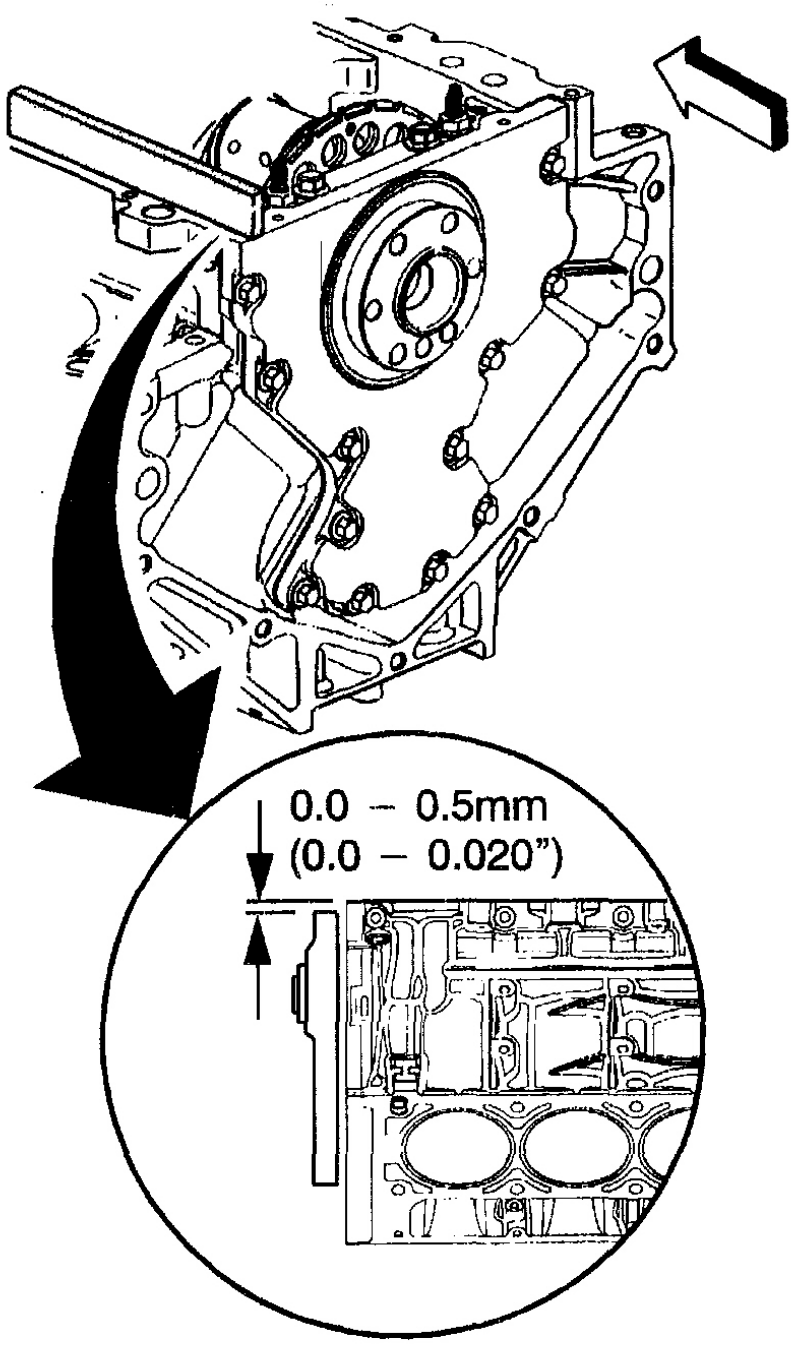


Fig. 383: Rear Cover-To-Engine Block Alignment
Courtesy of GENERAL MOTORS CORP.

CRANKSHAFT REAR OIL SEAL INSTALLATION

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Tools Required

J 41479 Crankshaft Rear Oil Seal Installer

IMPORTANT:

- **The flywheel spacer (if applicable) must be removed prior to oil seal installation.**
- **Do not lubricate the oil seal inside diameter (ID) or the crankshaft surface.**
- **Do not reuse the crankshaft rear oil seal.**

1. Lubricate the outside diameter (OD) of the oil seal (1) with clean engine oil.

   DO NOT allow oil or other lubricants to contact the seal surface.

2. Lubricate the rear cover oil seal bore with clean engine oil.

   DO NOT allow oil or other lubricants to contact the crankshaft surface.

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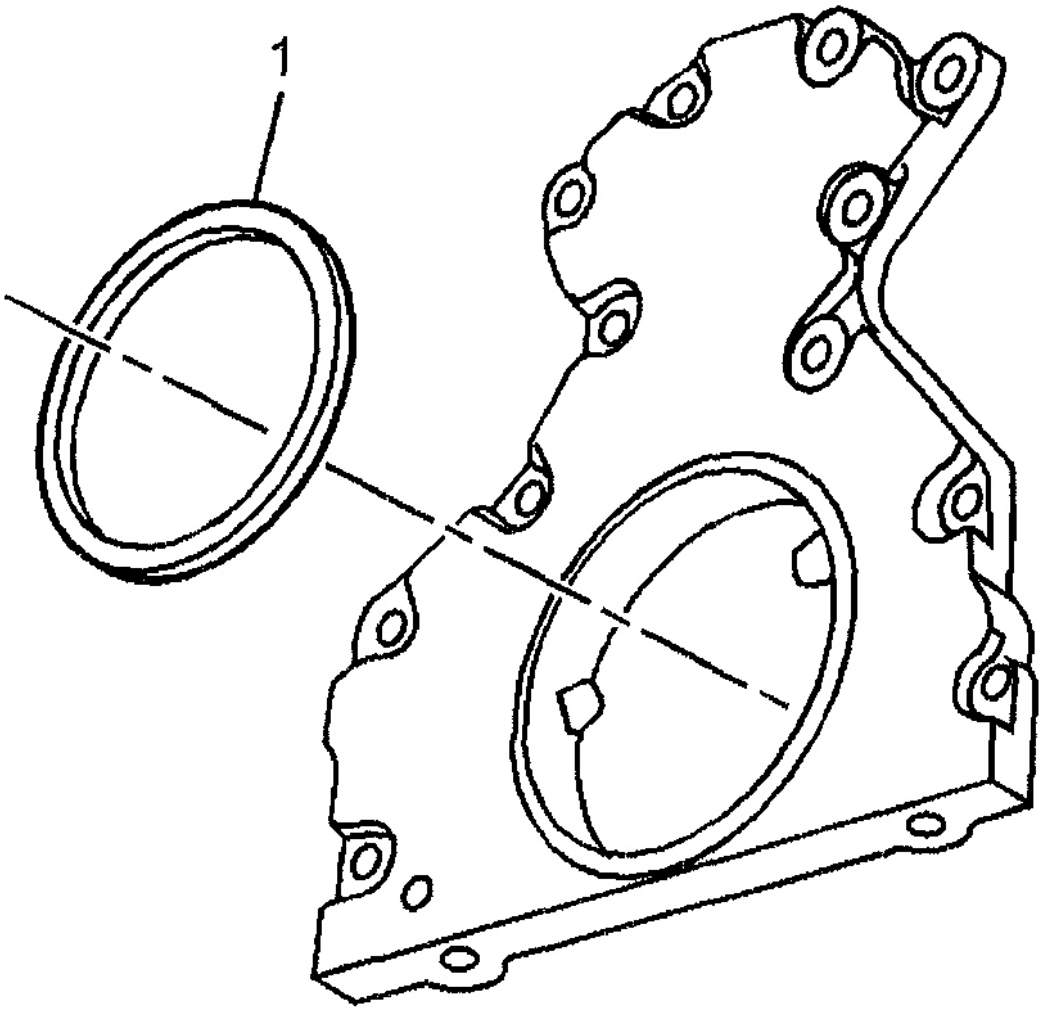


Fig. 384: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Install the **J 41479** cone (2) and bolts onto the rear of the crankshaft.
4. Tighten the bolts until snug. Do not overtighten.
5. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear cover bore.
6. Thread the **J 41479** threaded rod into the tapered cone until the tool (1) contacts the oil seal.
7. Align the oil seal onto the tool (1).
8. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.
9. Remove the tool.

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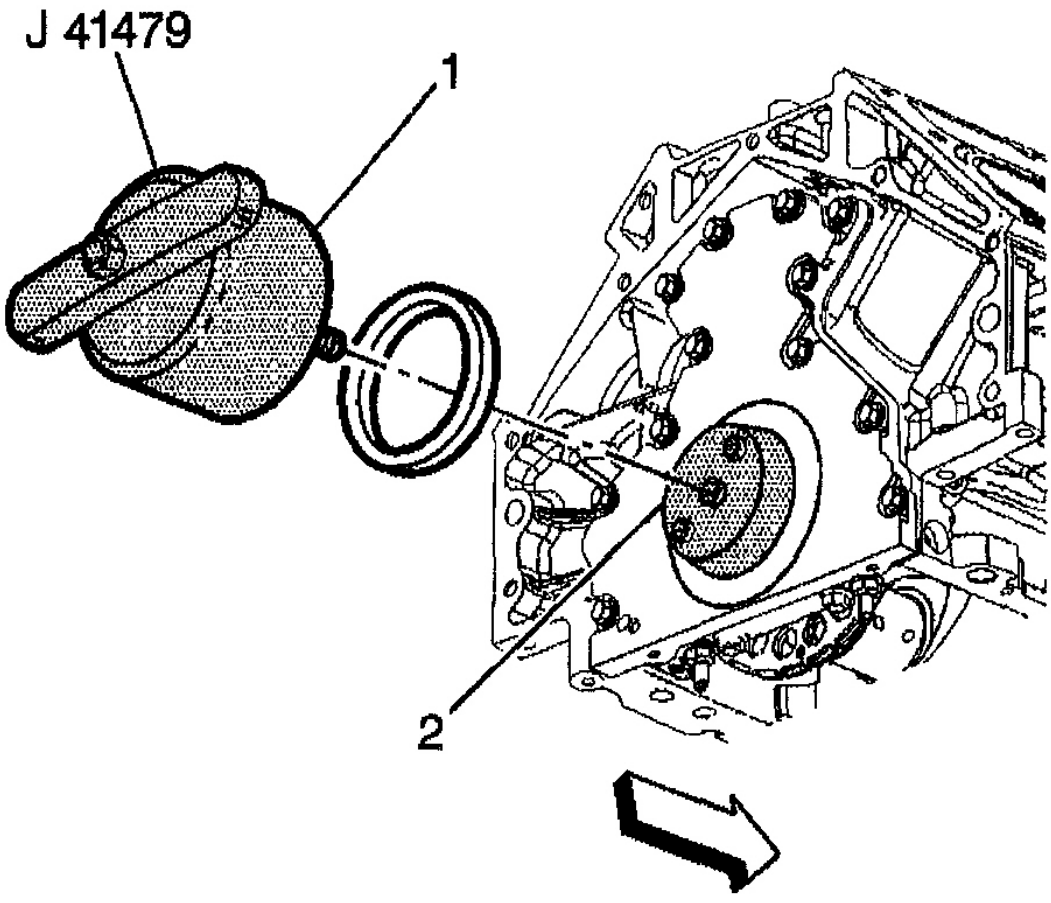


Fig. 385: Installing Crankshaft Rear Oil Seal Using J 41479
Courtesy of GENERAL MOTORS CORP.

ENGINE FRONT COVER INSTALLATION

Tools Required

- **J 41480** Front/Rear Cover Alignment - Oil Pan Surface
- **J 41476** Front/Rear Cover Alignment - Crankshaft Oil Seal Area

Important:

- Do not reuse the crankshaft oil seal or the engine front cover gasket.
- Do not apply any type sealant to the front cover gasket, unless specified.
- The special tools in this procedure are used to properly align the engine front cover at the oil pan surface

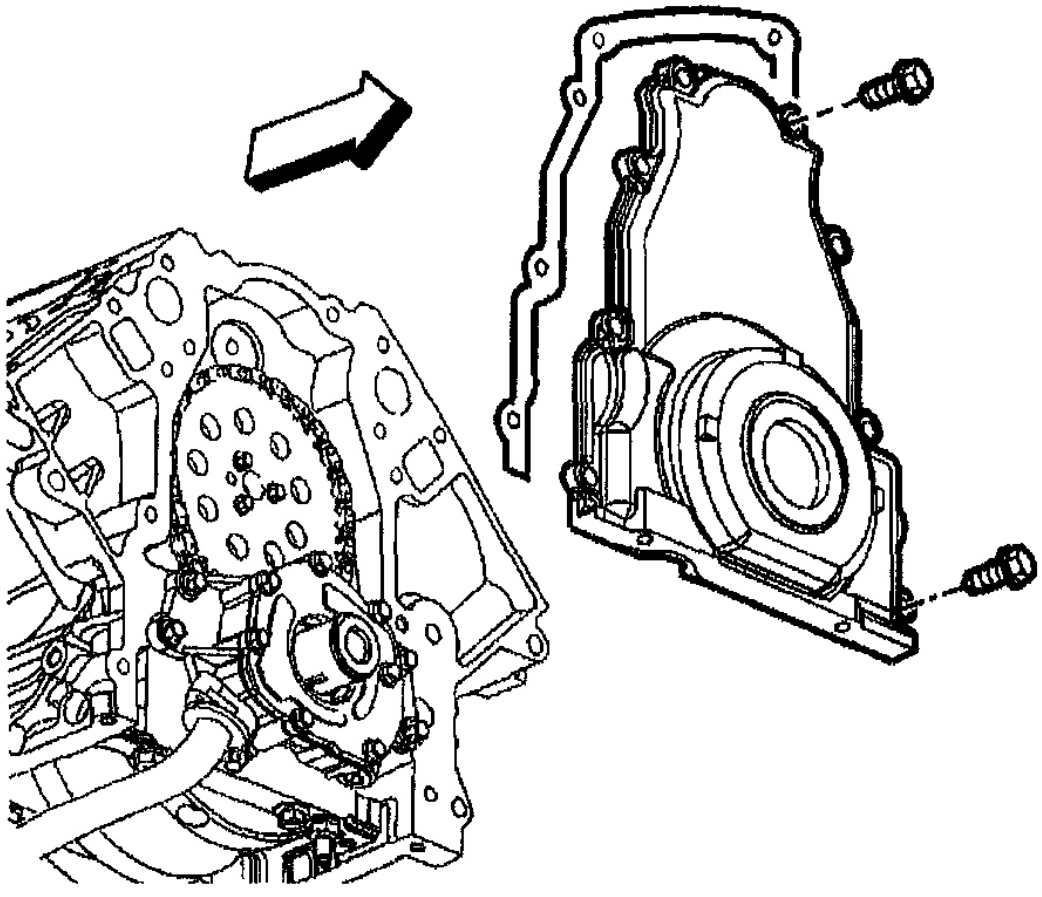
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and to center the crankshaft front oil seal.

- All gasket surfaces should be free of oil or other foreign material during assembly.

  The crankshaft front oil seal MUST be centered in relation to the crankshaft.

- The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.
- An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.



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Fig. 386: Engine Front Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the front cover gasket, cover, and bolts onto the engine.
2. Tighten the cover bolts finger tight. Do not overtighten.

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NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

IMPORTANT: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

3. Install the **J 41480** .

Tighten

Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

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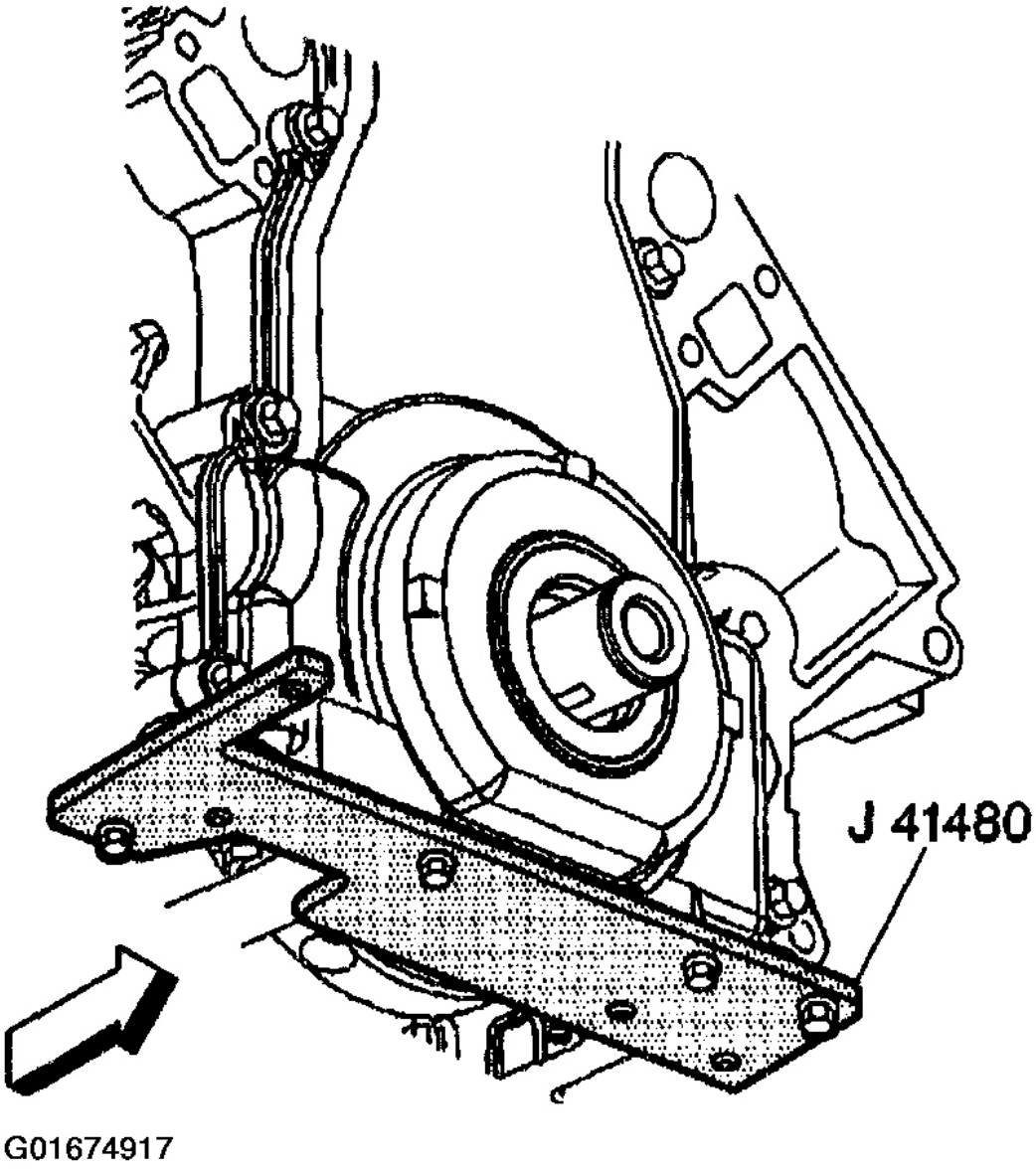


Fig. 387: J 41480
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

4. Install the **J 41476** .
5. Install the crankshaft balancer bolt.

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Tighten

5.1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
5.2. Tighten the **J 41480** .
5.3. Tighten the engine front cover bolts to 25 N.m (18 lb ft).

6. Remove the tools.

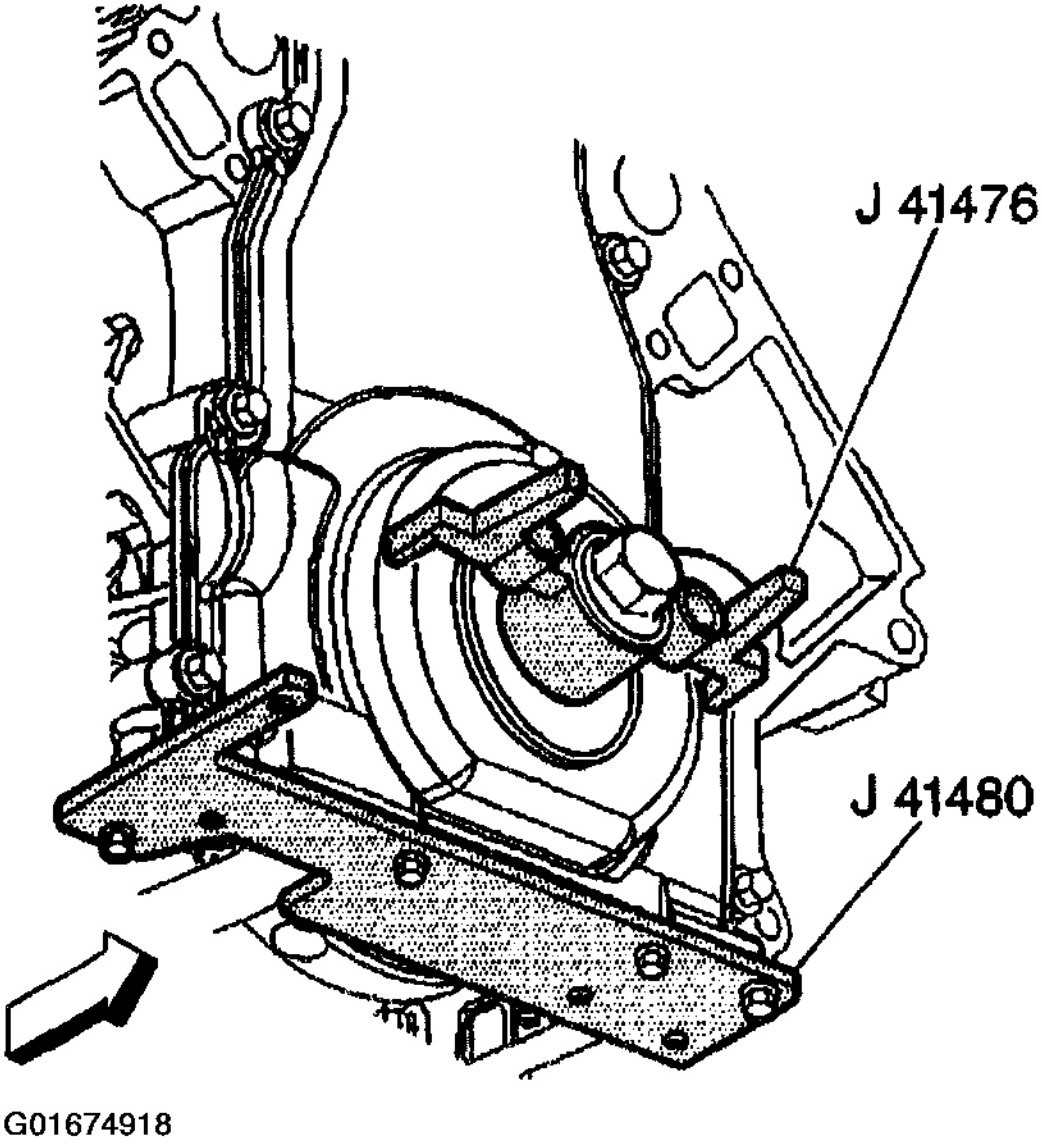


Fig. 388: J 41480 & J 41476
Courtesy of GENERAL MOTORS CORP.

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7. Measure the oil pan surface flatness, front cover-to-engine block.
    7.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

    Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    7.2. Insert a feeler gage between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no more than 0.5 mm (0.02 in) below flush.
8. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
9. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

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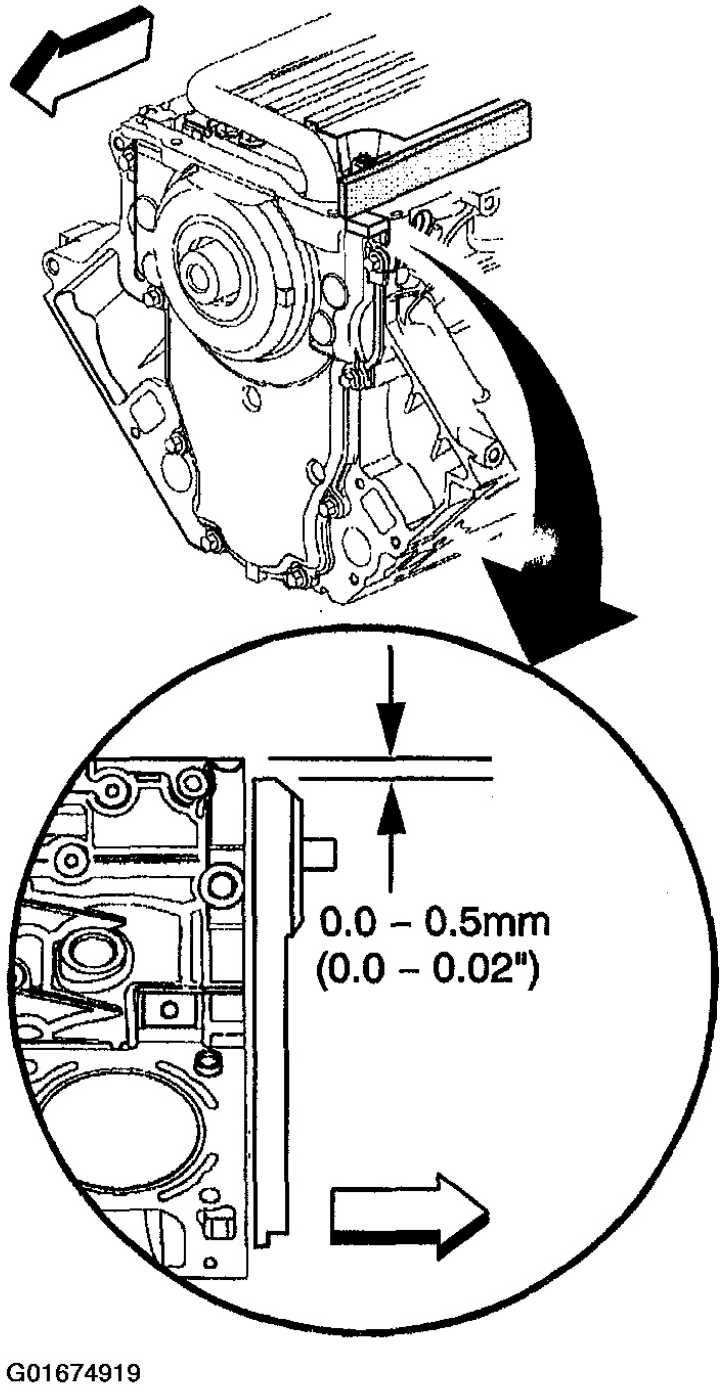


Fig. 389: Front Cover-To-Engine Block Alignment
Courtesy of GENERAL MOTORS CORP.

CRANKSHAFT FRONT OIL SEAL INSTALLATION

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Tools Required

J 41478 Crankshaft Front Oil Seal Installer

IMPORTANT: Do not lubricate the oil seal sealing surface.

Do not reuse the crankshaft front oil seal.

1. Lubricate the outer edge of the oil seal (1) with clean engine oil.
2. Lubricate the front cover oil seal bore with clean engine oil.

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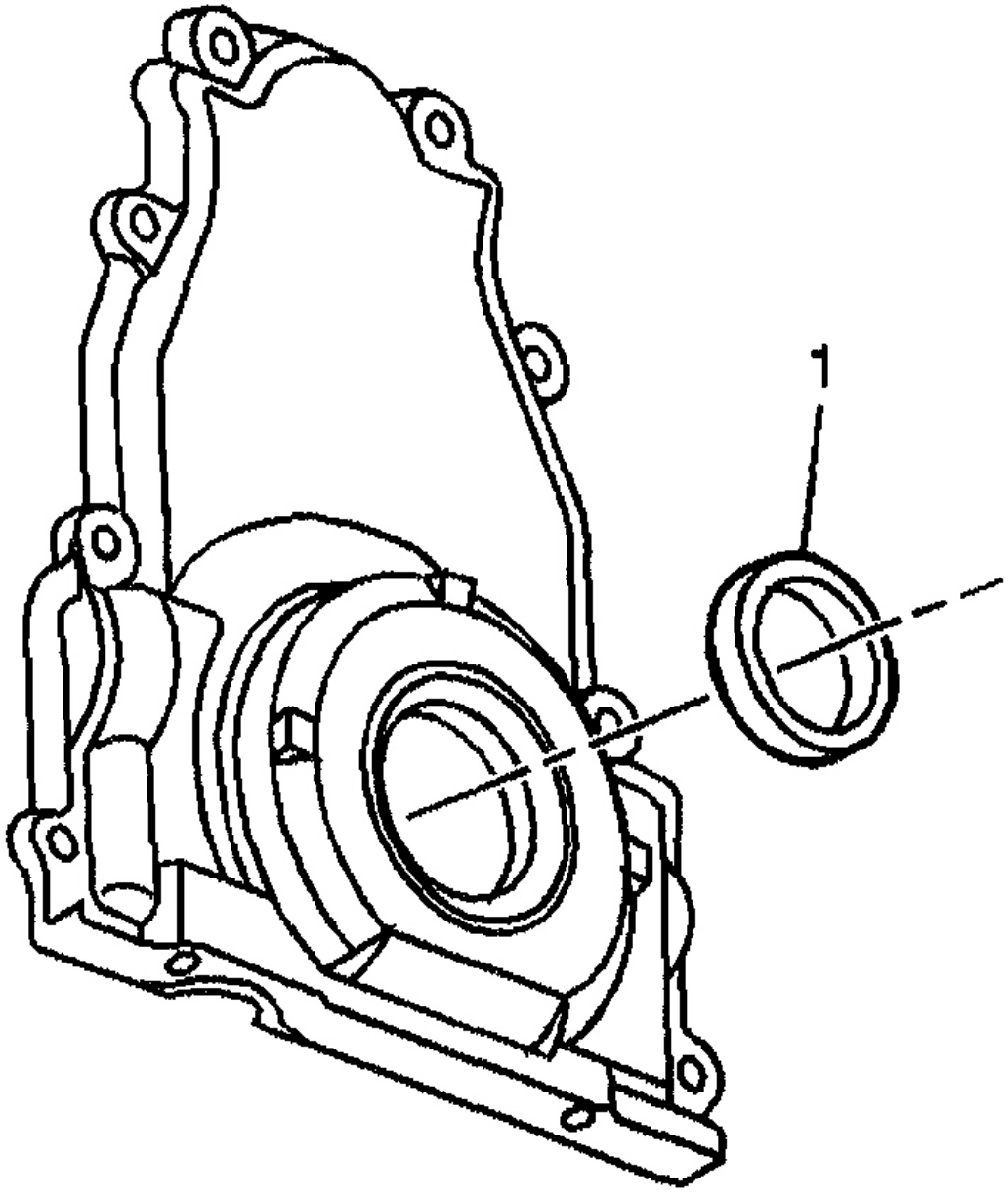


Fig. 390: Engine Front Cover Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft front oil seal onto the **J 41478** guide.
4. Install the **J 41478** threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft.

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5. Use the **J 41478** in order to install the oil seal into the cover bore.

   5.1. Use a wrench and hold the hex on the installer bolt.

   5.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.

   5.3. Remove the tool.

   5.4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

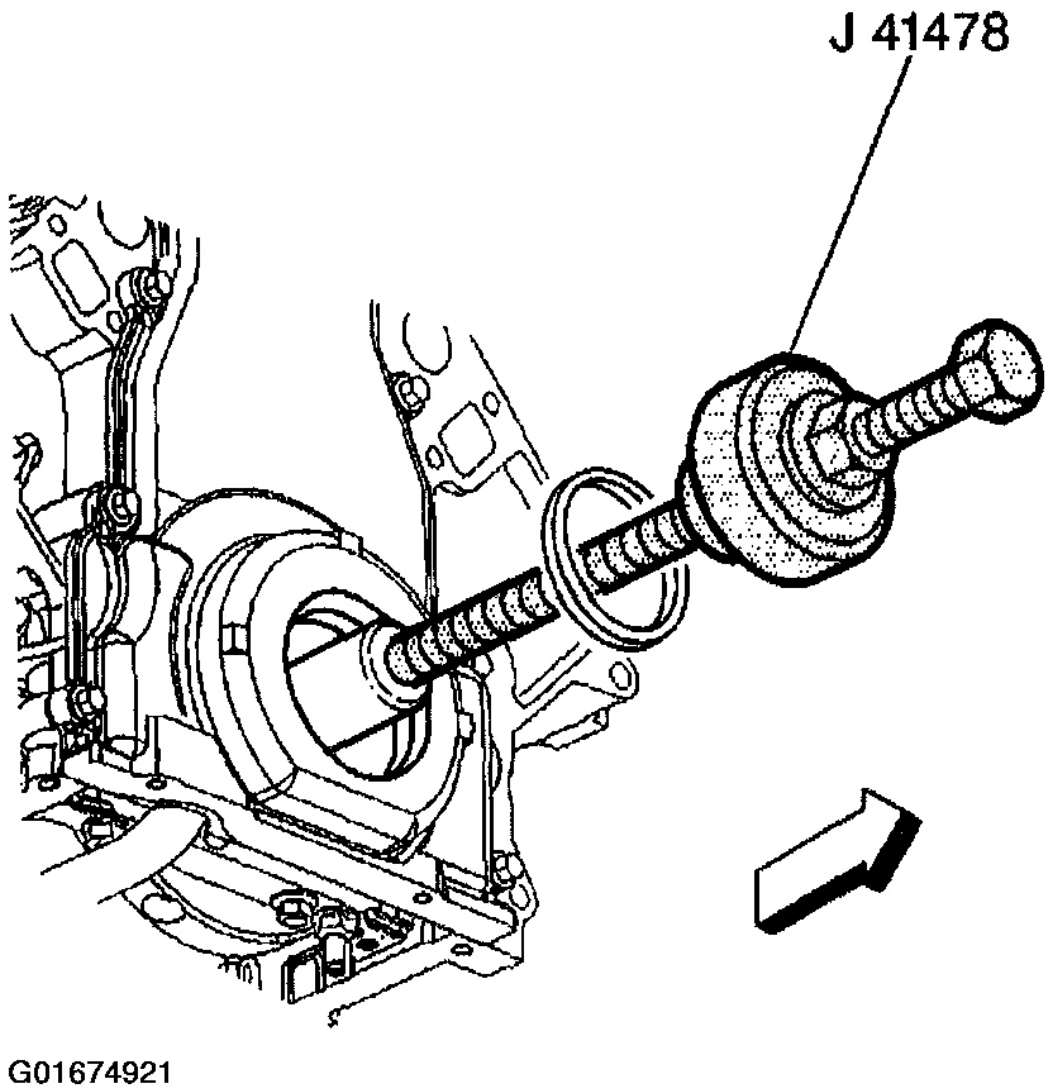


Fig. 391: Using J 41478 To Install The Oil Seal Into The Cover Bore
Courtesy of GENERAL MOTORS CORP.

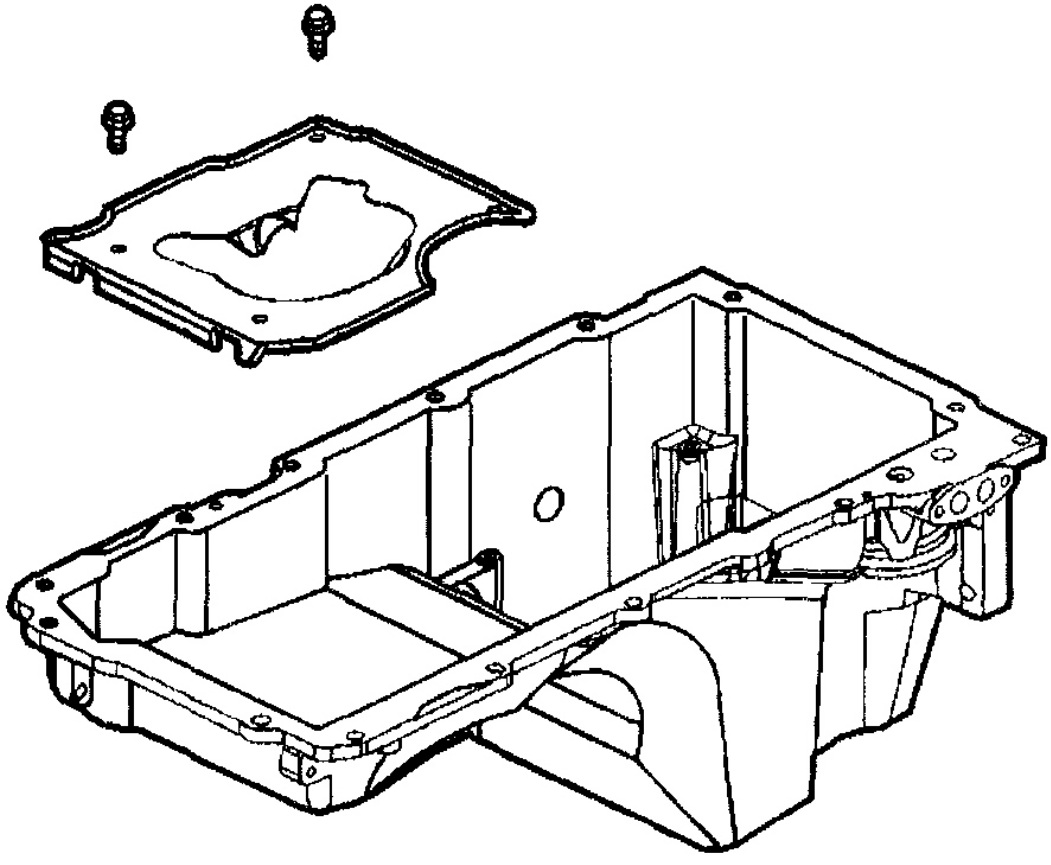
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OIL PAN INSTALLATION

Important:

- The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.
- Do not reuse the oil pan gasket.
- It is not necessary to rivet the NEW gasket to the oil pan.
- It is not necessary to remove the oil level sensor prior to oil pan installation.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.



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Fig. 392: Oil Pan Baffle & Bolts

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Courtesy of GENERAL MOTORS CORP.

1. Install the oil pan baffle and bolts, if previously removed.

   Tighten

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

2. Apply a 5 mm (0.2 in) bead of sealant GM P/N United States 12378190, or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to **Sealers, Adhesives, and Lubricants** .

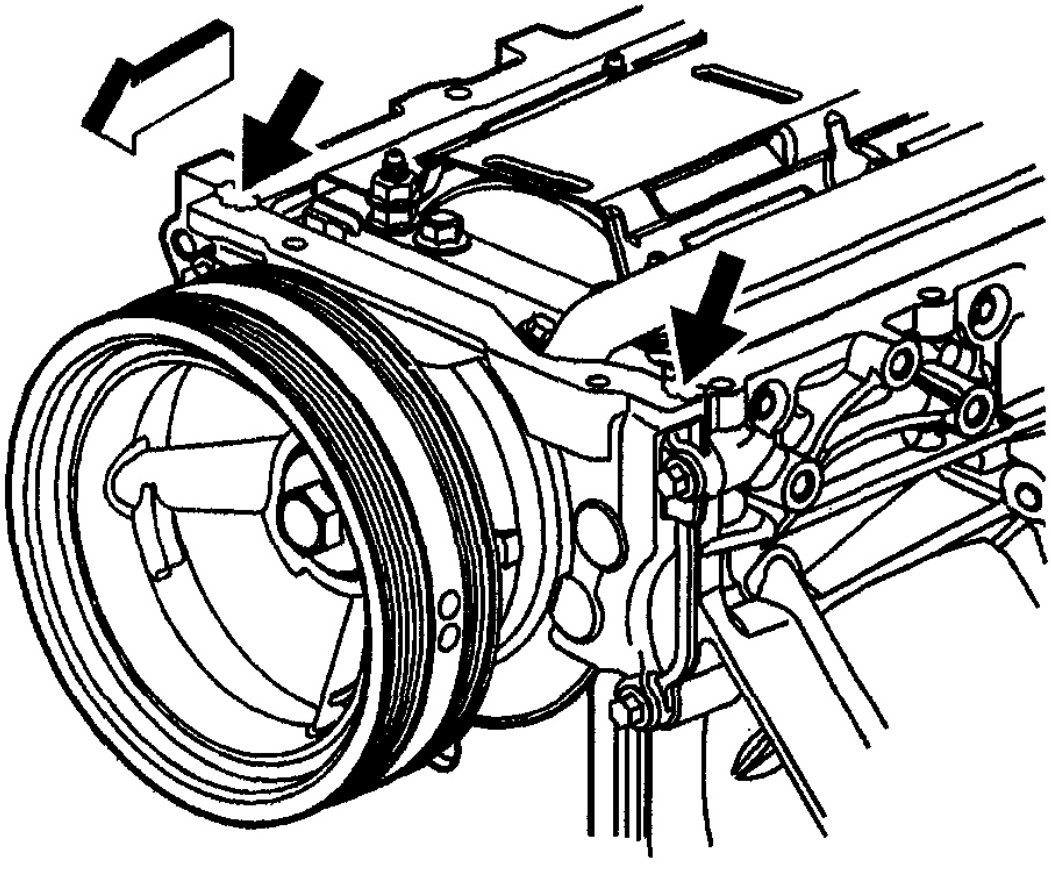


Fig. 393: Applying Sealant To Engine Block Front Cover Gasket Tabs
Courtesy of GENERAL MOTORS CORP.

3. Apply a 5 mm (0.2 in) bead of sealant GM P/N United States 12378190, or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the rear cover gasket that protrude

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into the oil pan surface.

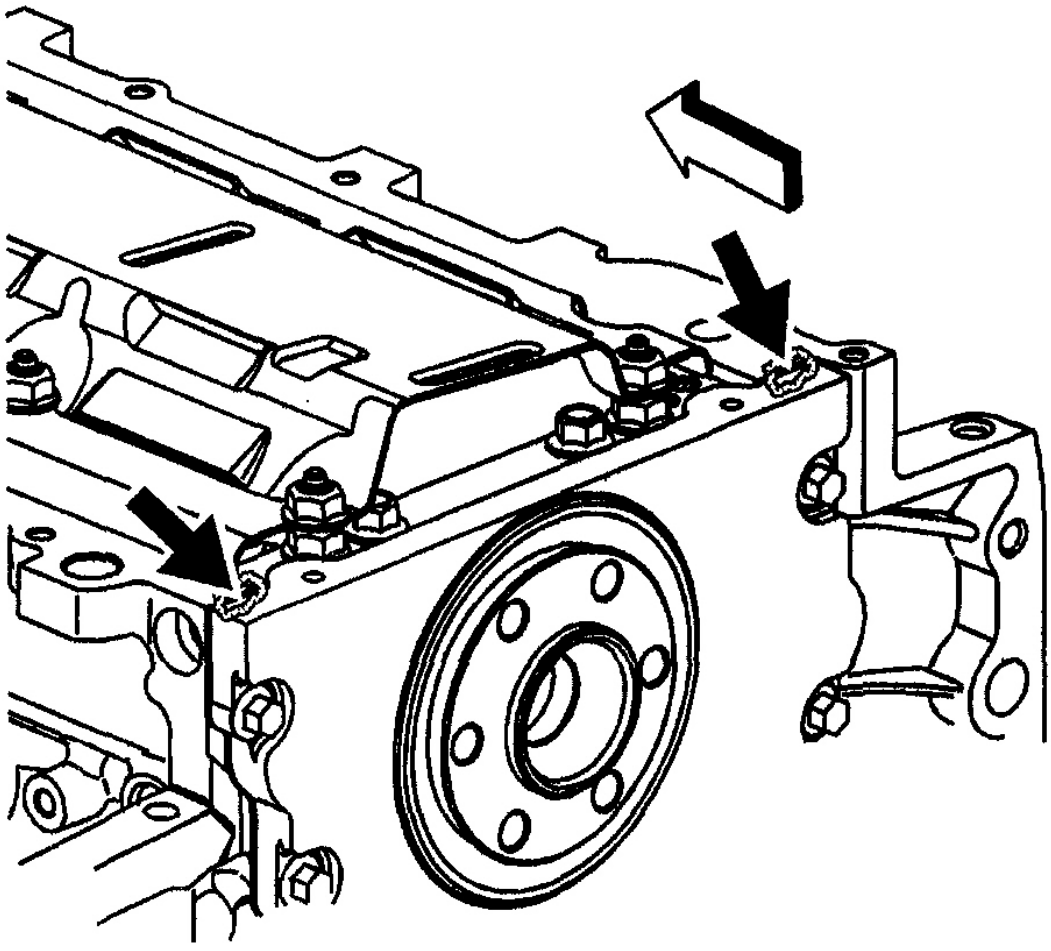


Fig. 394: Applying Sealant To Engine Block Rear Cover Gasket Tabs
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Be sure to align the oil gallery passages in the oil pan and engine block properly with the oil pan gasket.

4. Pre-assemble the oil pan gasket to the pan.
    4.1. Install the gasket onto the oil pan.
    4.2. Install the oil pan bolts to the pan and through the gasket.
5. Install the oil pan, gasket and bolts to the engine block.
6. Tighten bolts finger tight. Do not overtighten.

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7. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.

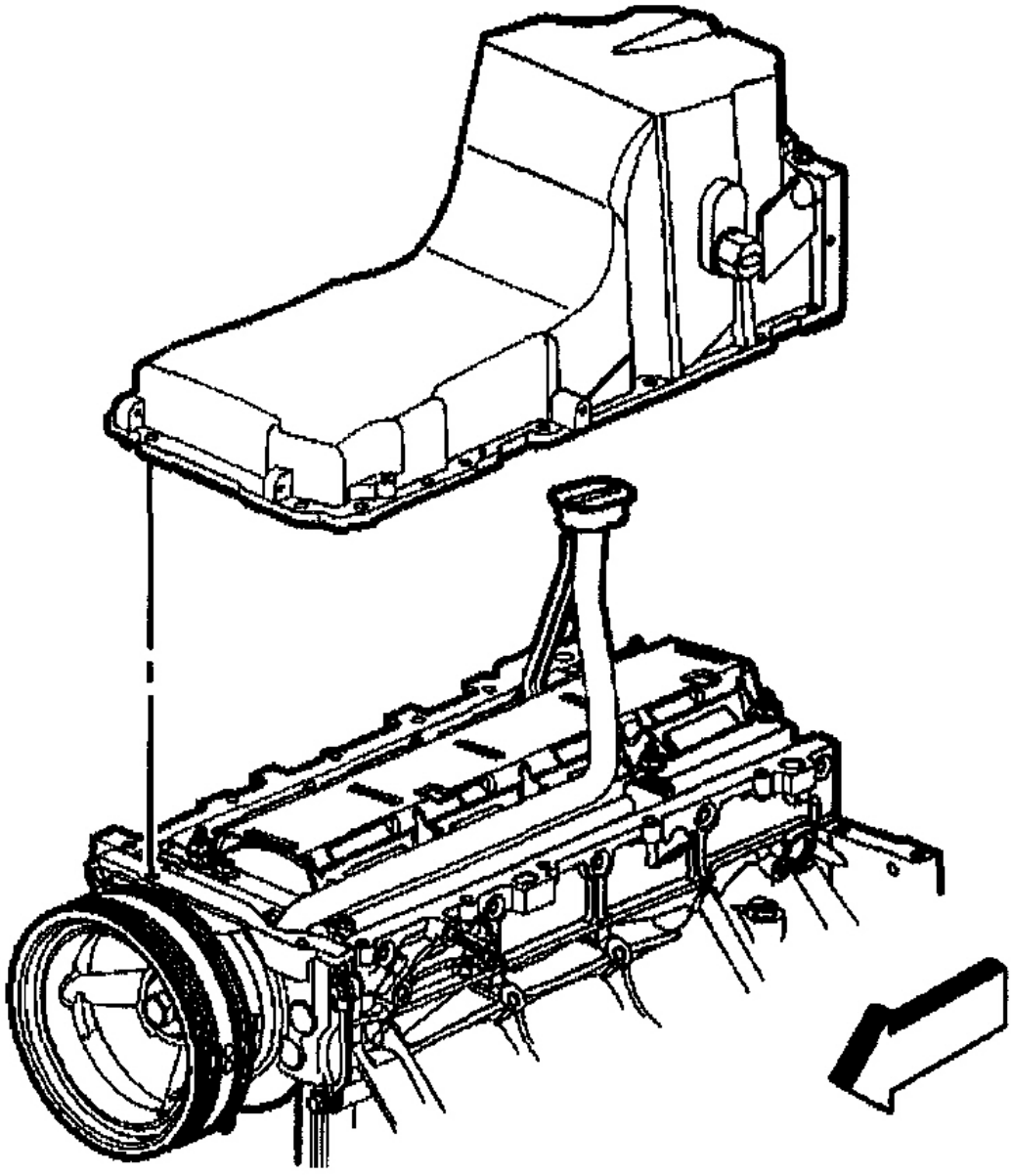


Fig. 395: Oil Pan
Courtesy of GENERAL MOTORS CORP.

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8. Align the oil pan until the rear of engine block and rear of oil pan are flush or even.

Tighten

8.1. Tighten the oil pan-to-block and oil pan-to-front cover bolts to 25 N.m (18 lb ft).

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

9. Measure the oil pan-to-engine block alignment.

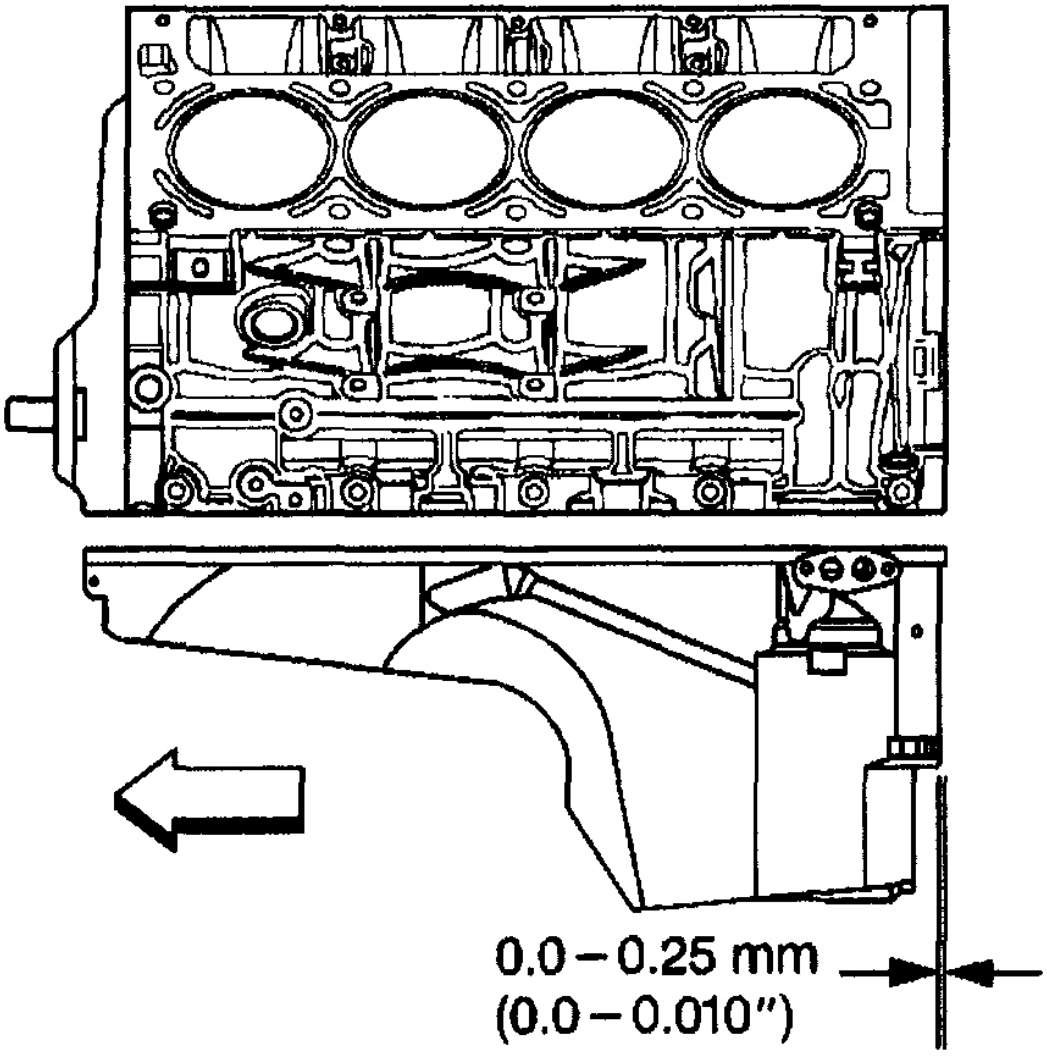
9.1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

IMPORTANT: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

9.2. Insert a feeler gage between the straight edge and the oil pan transmission housing mounting surface and check to make sure that there is no more than a 0.25 mm (0.01 in) gap between the pan and straight edge.

9.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

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Fig. 396: Oil Pan Alignment
Courtesy of GENERAL MOTORS CORP.

10. Install the oil level sensor.

Tighten

Tighten the oil level sensor to 13 N.m (115 lb in).

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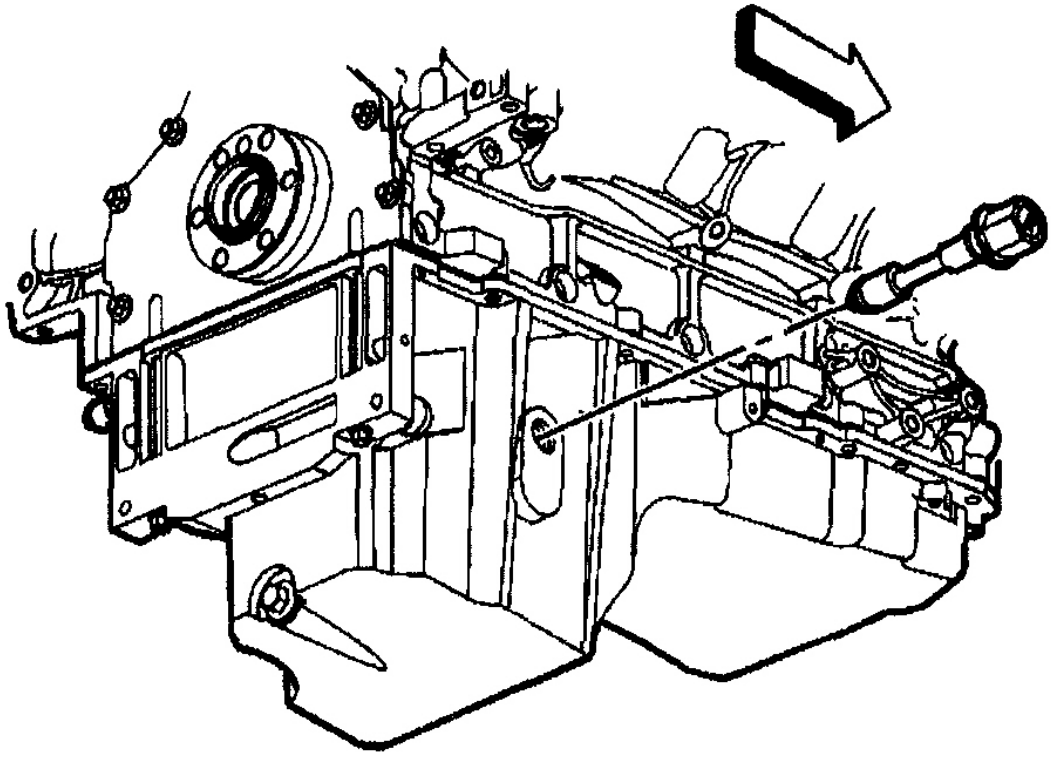


Fig. 397: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

OIL FILTER, ADAPTER, PAN COVER INSTALLATION

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

1. Install the oil pan cover (2), bolts (1), and a NEW oil pan cover gasket (3).

   Tighten

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

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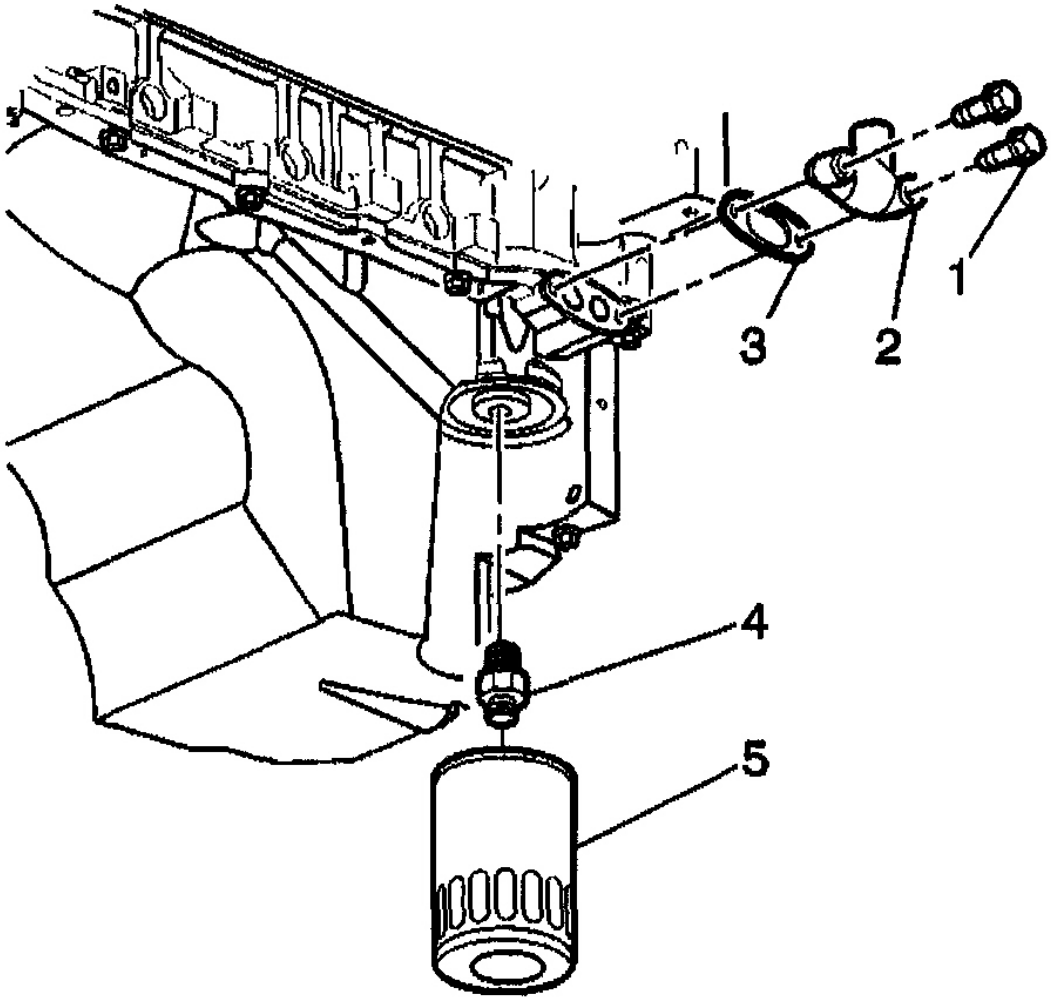


Fig. 398: Oil Pan Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install a new oil filter bypass valve (2) into the oil pan (if required).
3. Install the oil filter fitting (1).

Tighten

Tighten the oil filter fitting to 55 N.m (40 lb ft).

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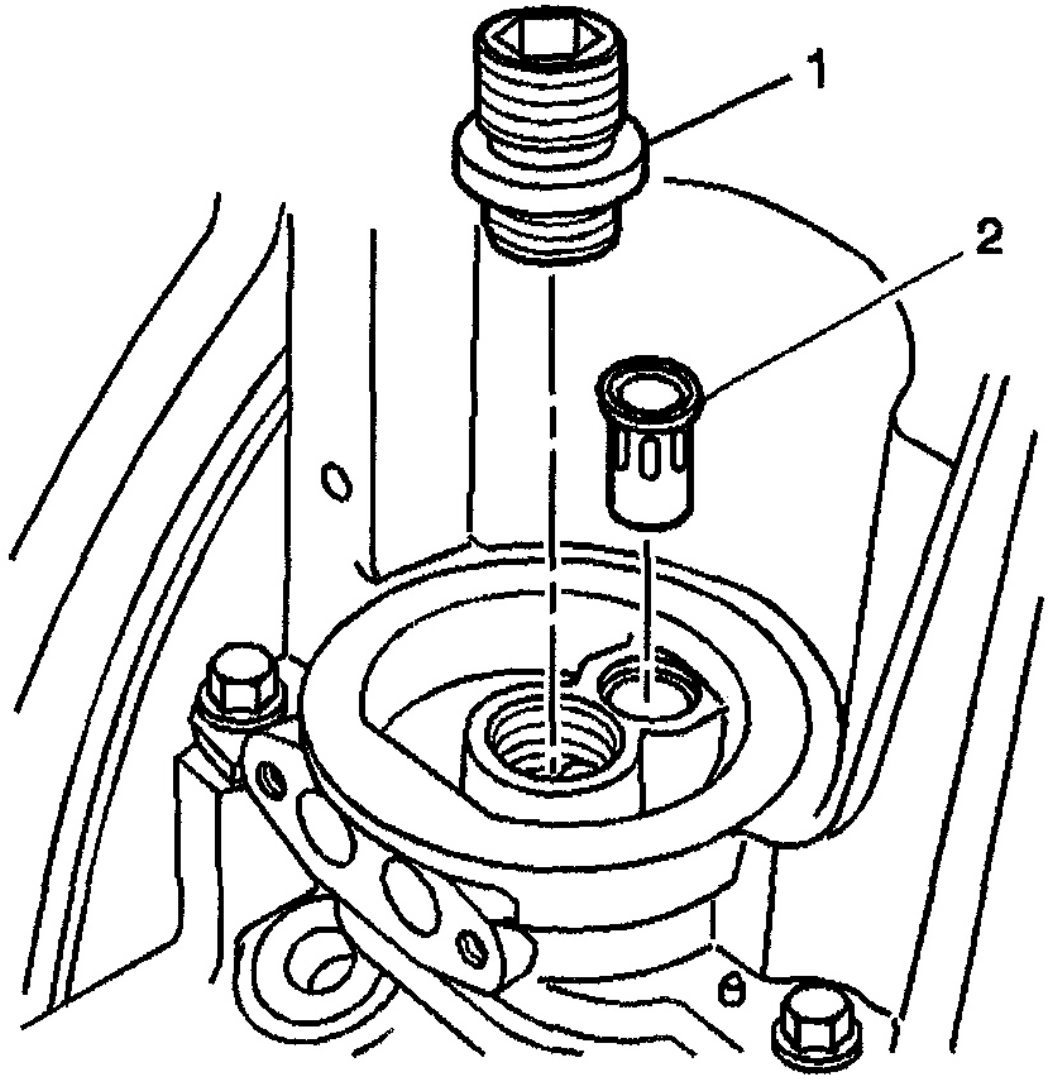


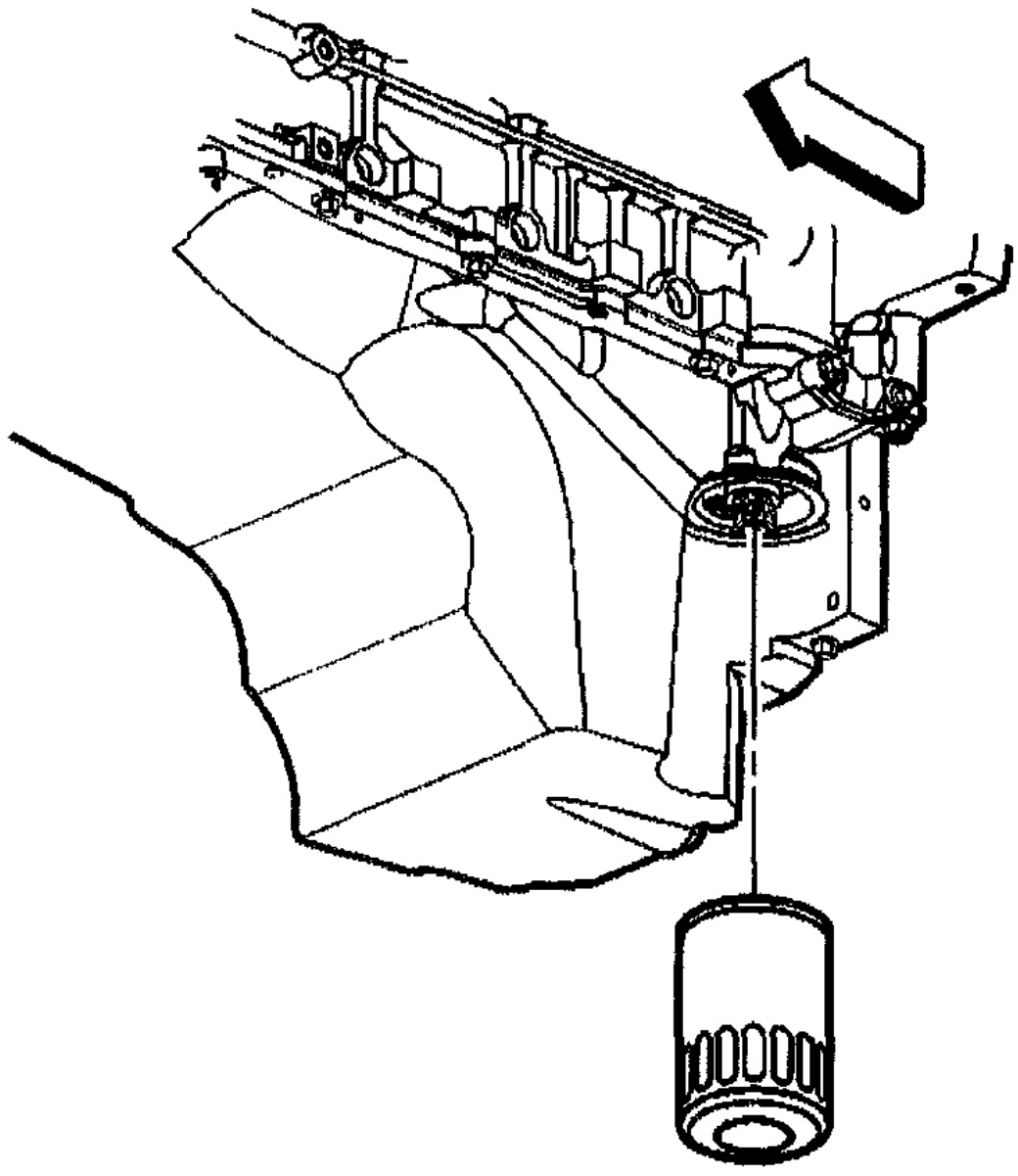
Fig. 399: Oil Filter Fitting & Bypass Valve
Courtesy of GENERAL MOTORS CORP.

4. Lubricate the oil filter seal with clean engine oil.
5. Install the oil filter.

Tighten

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

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Fig. 400: Oil Filter
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pan drain plug.

Tighten

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

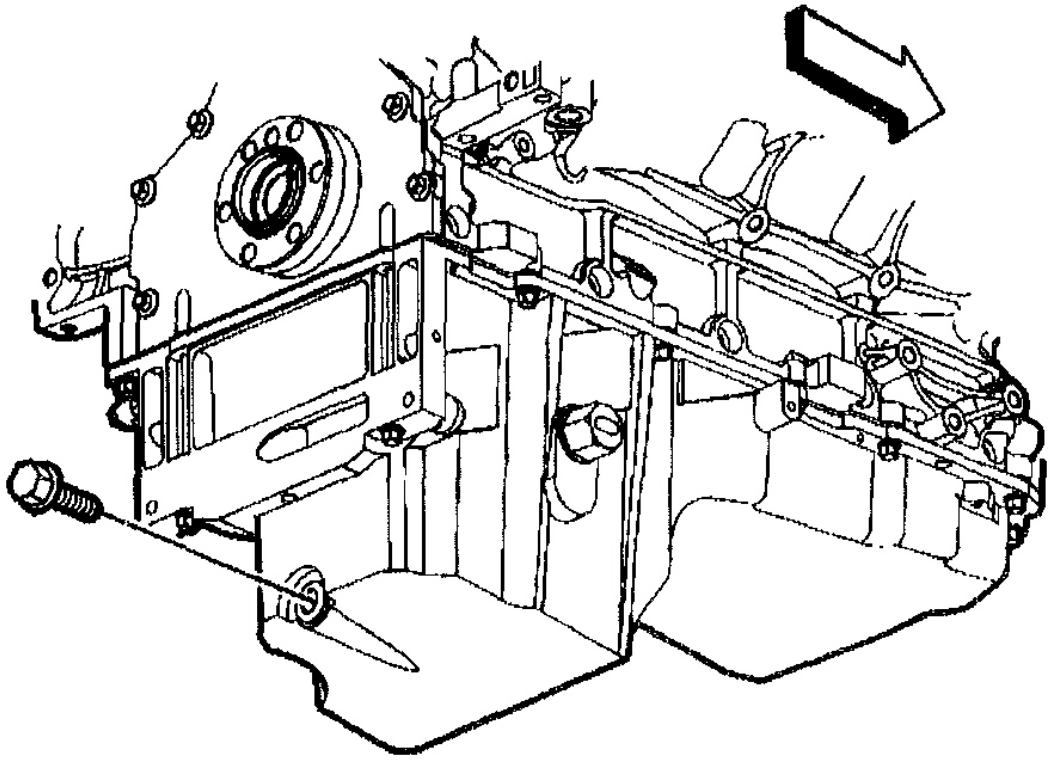


Fig. 401: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

VALVE LIFTER INSTALLATION

IMPORTANT: When reusing valve lifters, install the lifters to their original locations.

If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the valve lifters and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides.

   Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

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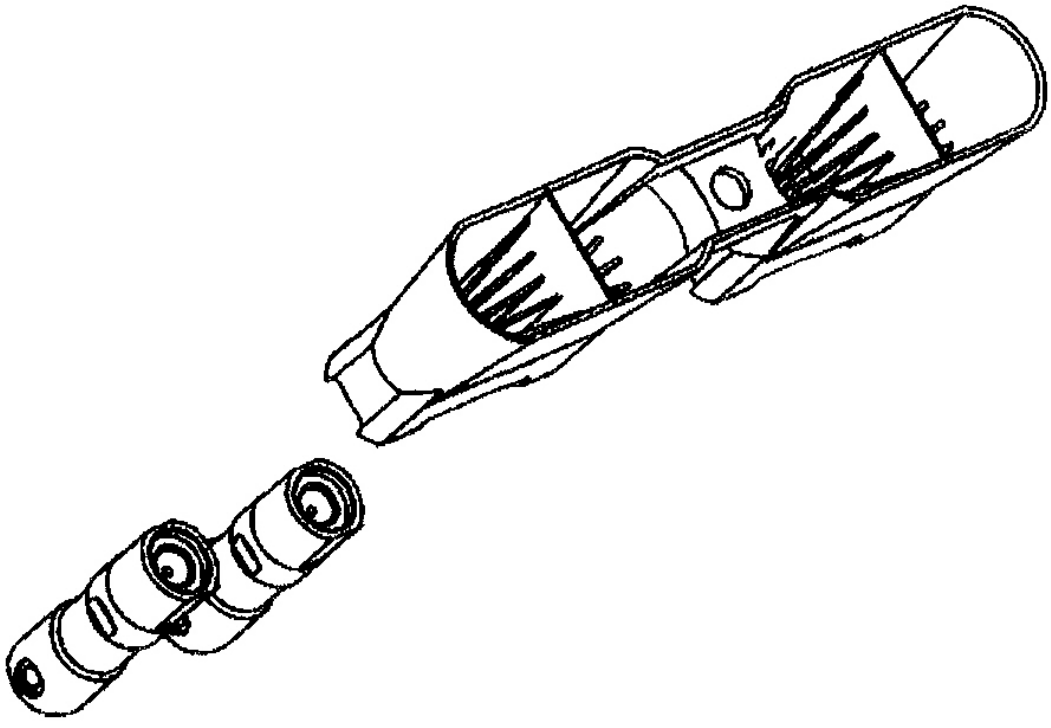


Fig. 402: Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

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

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

4. Install the valve lifter guide bolt (1).

Tighten

Tighten the valve lifter guide bolt to 12 N.m (106 lb in).

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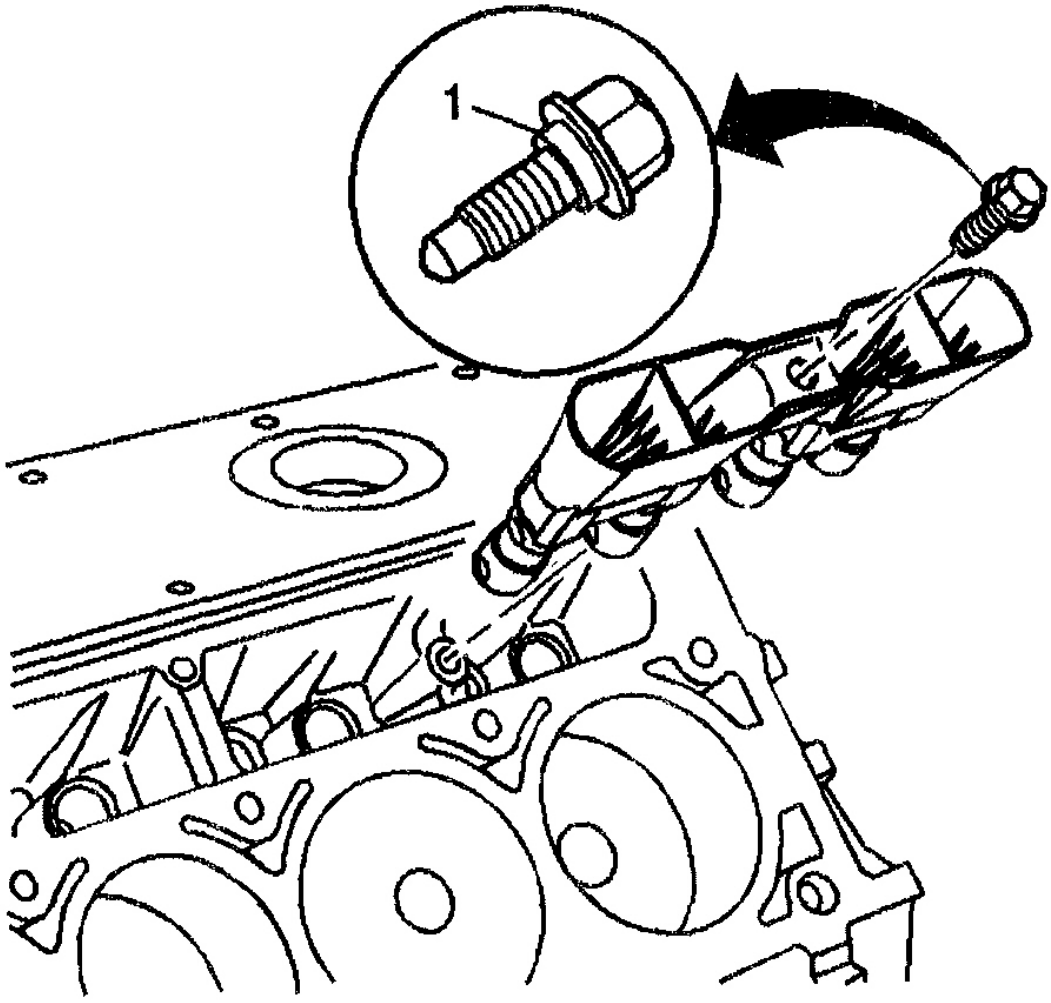


Fig. 403: Valve Lifter Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

CYLINDER HEAD INSTALLATION - LEFT

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

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.

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Tools Required

- **J 36660-A** Torque Angle Meter
- **J 42385-100** Thread Repair Kit

Important:

- Do not reuse the cylinder head bolts. Install NEW cylinder head bolts during assembly.
- Do not use any type sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets must be installed in the proper direction and position.

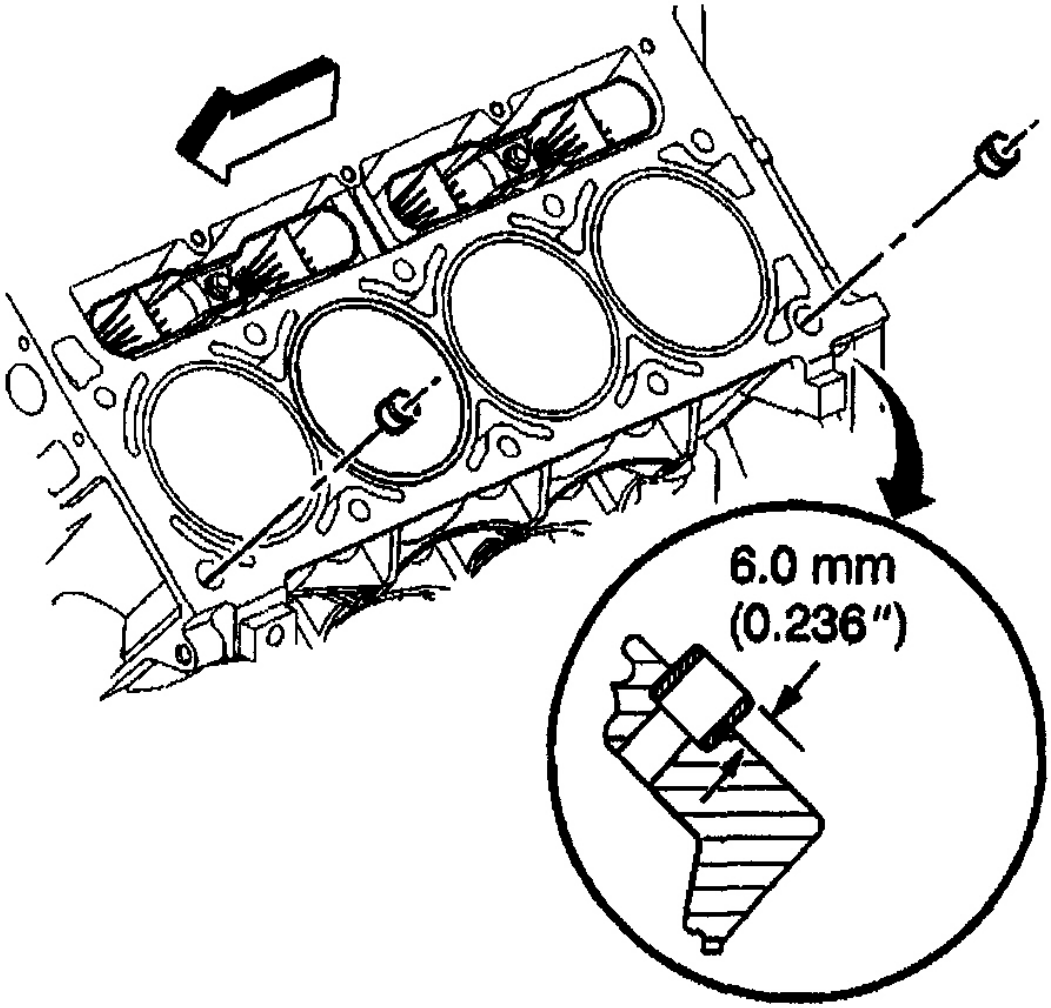


Fig. 404: Cylinder Head Gasket Locating Pins

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Courtesy of GENERAL MOTORS CORP.

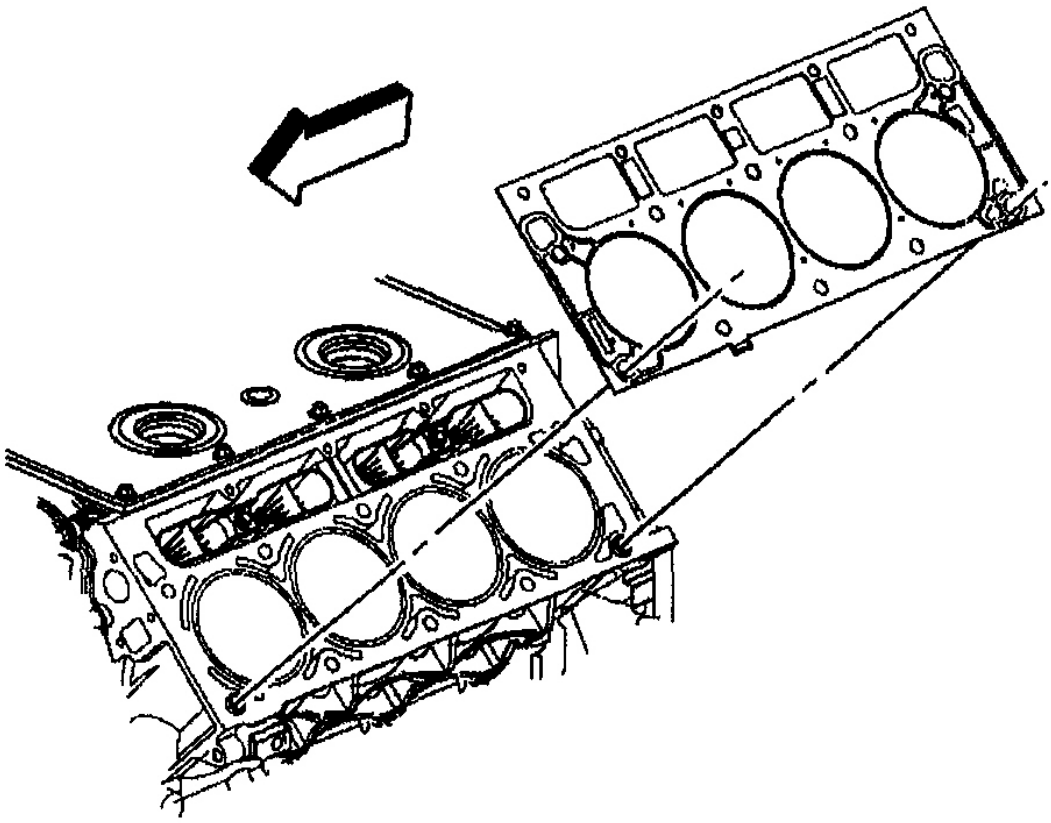
1. Clean the engine block cylinder head bolt holes, if required.

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

2. Spray cleaner GM P/N United States 12346139, GM P/N Canada 10953463, GM P/N United States 12377981, GM P/N Canada 10953463, or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.

IMPORTANT: When properly installed, the tab on the left cylinder head gasket will be located left of center or closer to the front of the engine.

5. Install the NEW left cylinder head gasket onto the locating pins.



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Fig. 405: Left Cylinder Head Gasket

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Courtesy of GENERAL MOTORS CORP.

6. Install the cylinder head onto the locating pins and the gasket.
7. Install the NEW cylinder head bolts.

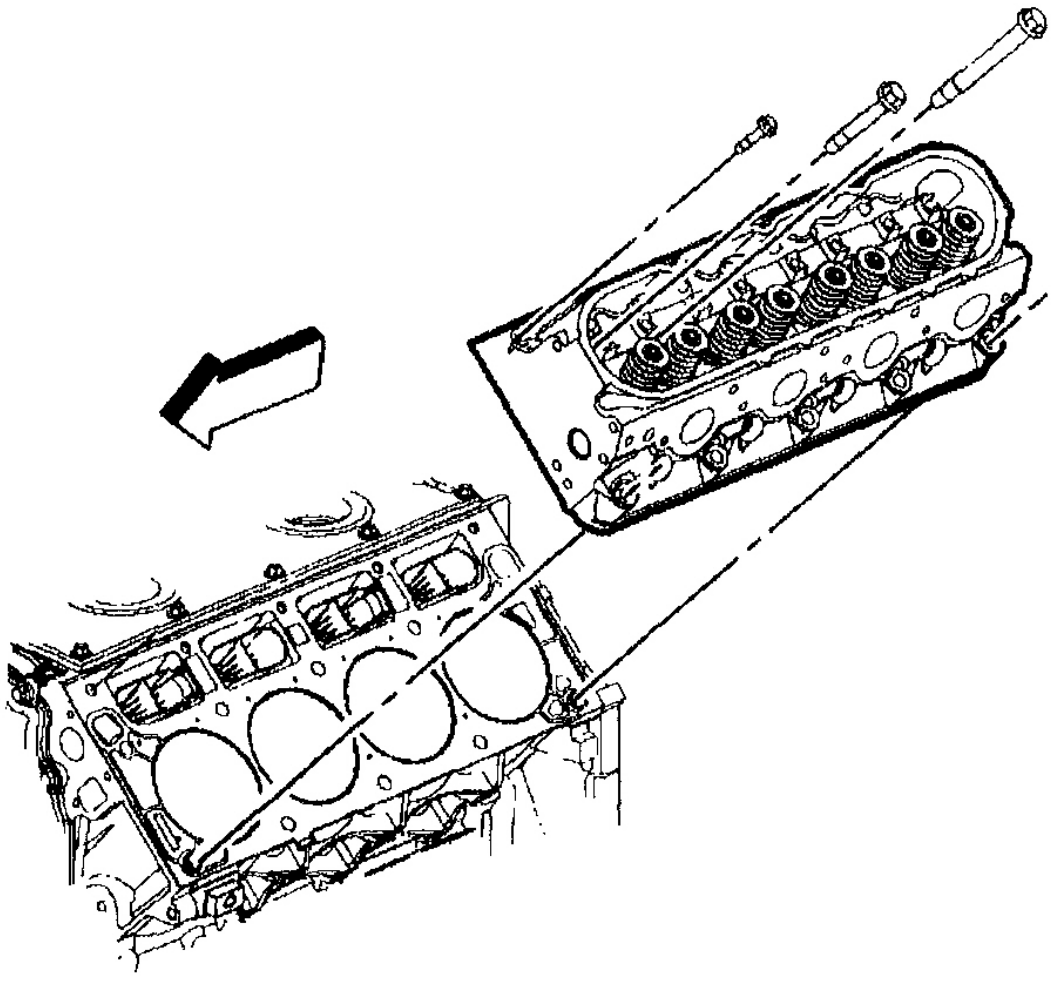


Fig. 406: Left Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

8. Tighten the cylinder head bolts.

Tighten

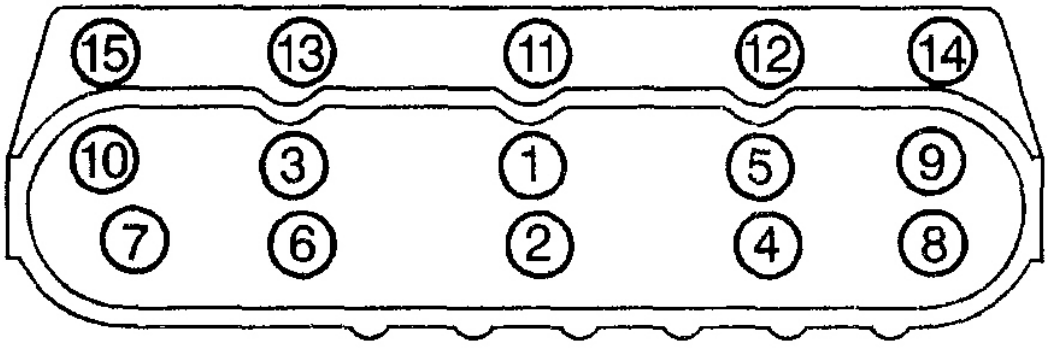
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8.1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).

8.2. Tighten the M11 cylinder head bolts a second pass in sequence to 90 degrees using the **J 36660-A** .

8.3. Tighten the M11 cylinder head bolts (1,2,3,4,5,6,7,8) to 90 degrees and the M11 cylinder head bolts (9 and 10) to 50 degrees a final pass in sequence to using the **J 36660-A** .

8.4. Tighten the M8 cylinder head bolts (11,12,13,14,15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.



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Fig. 407: Left Cylinder Head Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

9. The cylinder head gasket displacement can be verified by markings visible on the top side of the left gasket locating tab.

   Some 4.8/5.3 L head gaskets may have 48 or 53 stamped onto the locating tab.

   Some 6.0 L head gaskets may have 60 stamped onto the locating tab.

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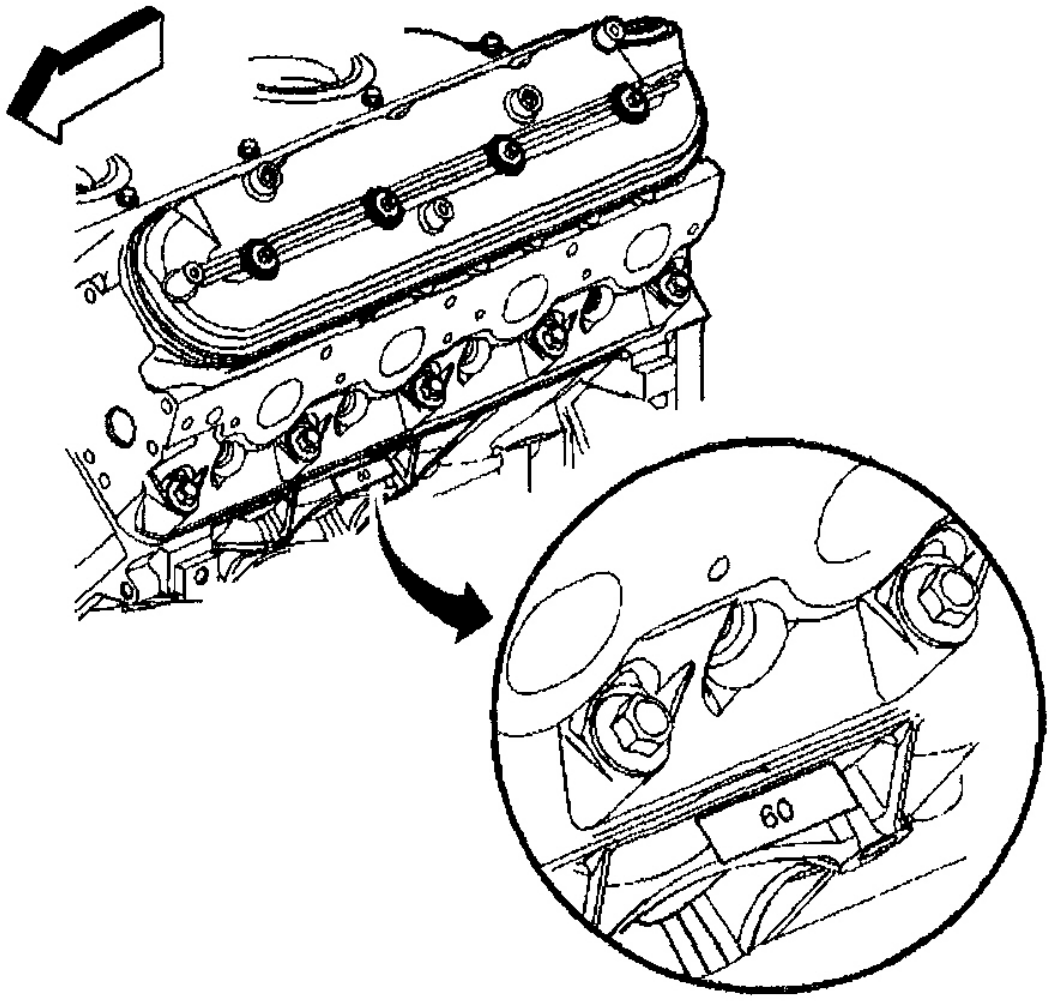


Fig. 408: Left Gasket Locating Tab
Courtesy of GENERAL MOTORS CORP.

CYLINDER HEAD INSTALLATION - RIGHT

CAUTION: Refer to SAFETY GLASSES CAUTION in Cautions and Notices.

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.

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Tools Required

- **J 36660-A** Torque Angle Meter
- **J 42385-100** Thread Repair Kit

Important:

- Do not reuse the cylinder head bolts. Install NEW cylinder head bolts during assembly.
- Do not use any type sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets must be installed in the proper direction and position.

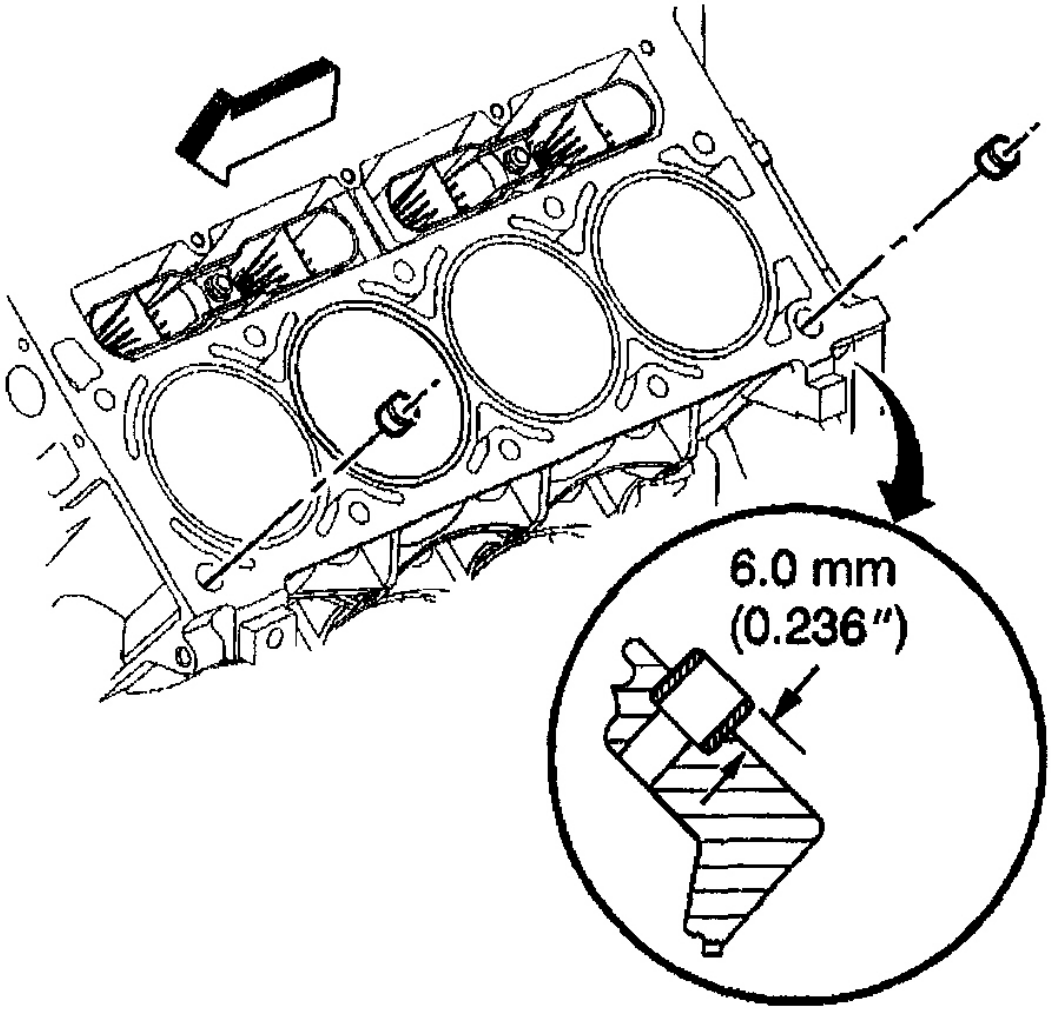


Fig. 409: Cylinder Head Gasket Locating Pins

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Courtesy of GENERAL MOTORS CORP.

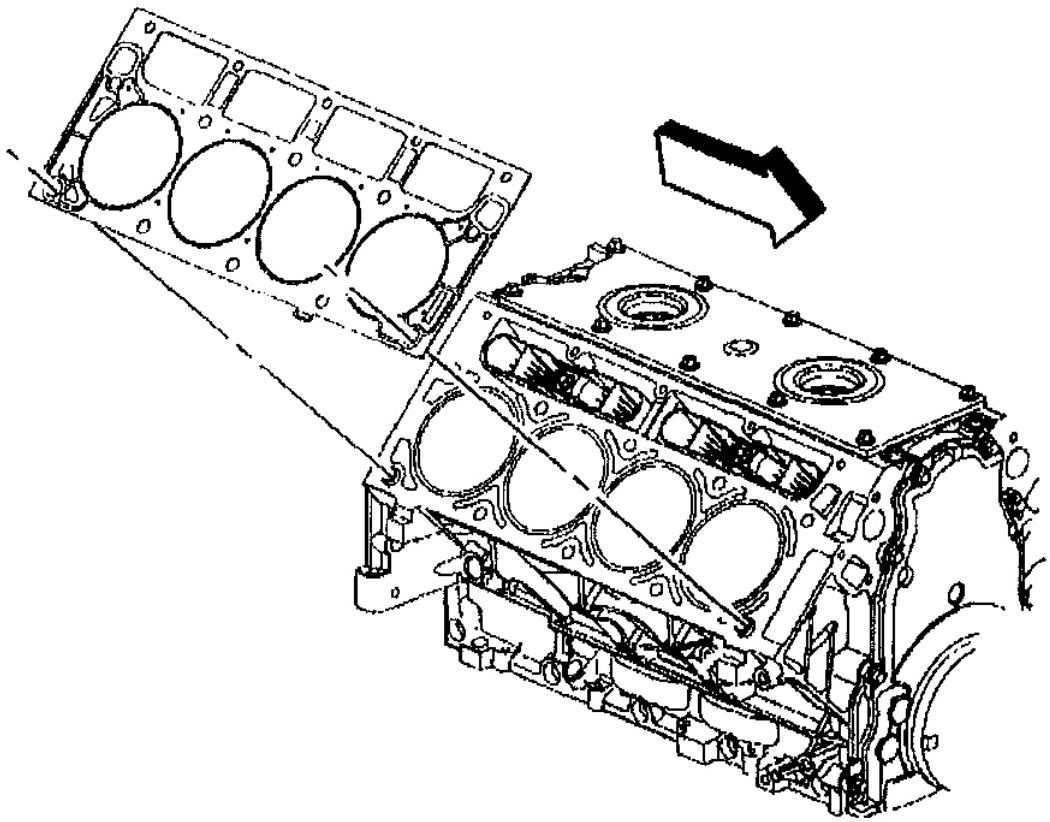
1. Clean the engine block cylinder head bolt holes, if required.

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

2. Spray cleaner GM P/N United States 12346139, GM P/N Canada 10953463, GM P/N United States 12377981, GM P/N Canada 10953463, or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.

IMPORTANT: When properly installed, the tab on the right cylinder head gasket will be located right of center or closer to the front of the engine.

5. Install the NEW right cylinder head gasket onto the locating pins.



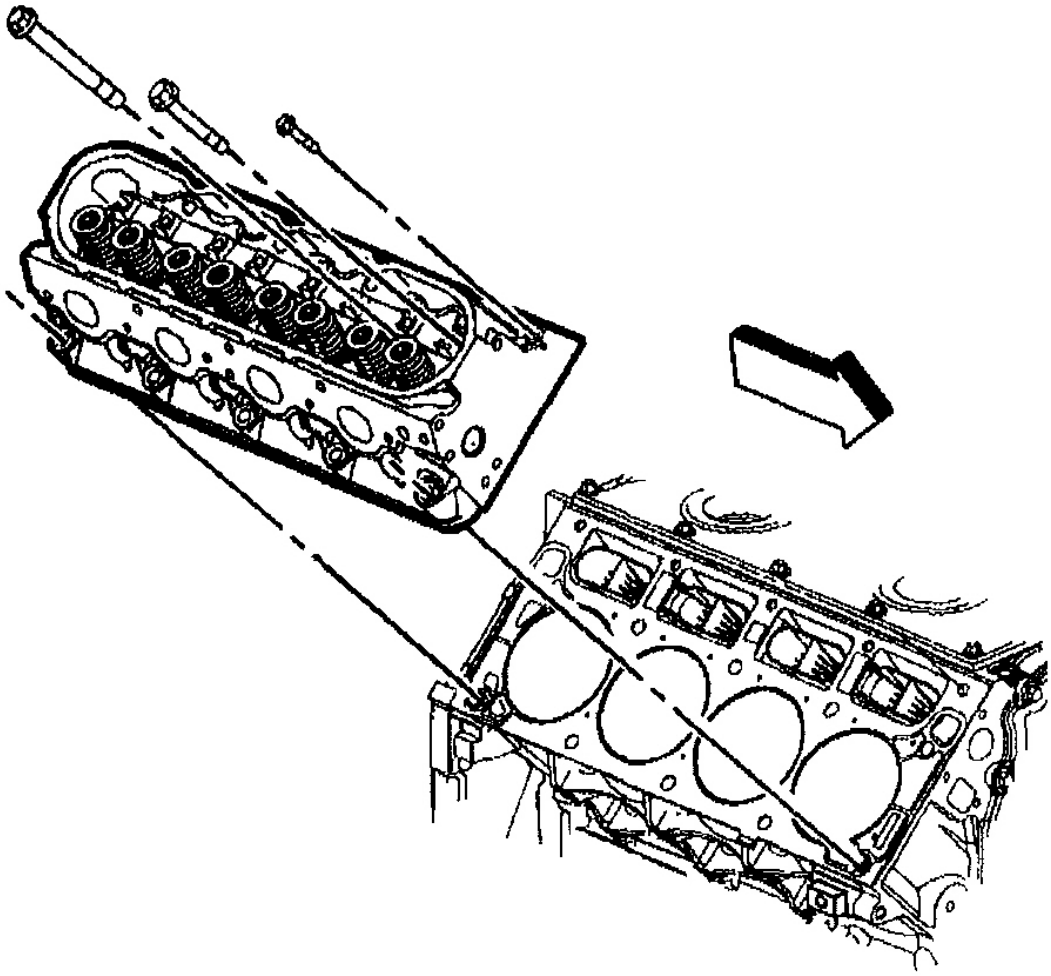
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Fig. 410: Right Cylinder Head Gasket

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Courtesy of GENERAL MOTORS CORP.

6. Install the cylinder head onto the locating pins and the gasket.
7. Install the NEW cylinder head bolts.



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Fig. 411: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

8. Tighten the cylinder head bolts.

Tighten

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8.1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).

8.2. Tighten the M11 cylinder head bolts a second pass in sequence to 90 degrees using the **J 36660-A** .

8.3. Tighten the M11 cylinder head bolts (1,2,3,4,5,6,7,8) to 90 degrees and the M11 cylinder head bolts (9 and 10) to 50 degrees a final pass in sequence to using the **J 36660-A** .

8.4. Tighten the M8 cylinder head bolts (11,12,13,14,15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

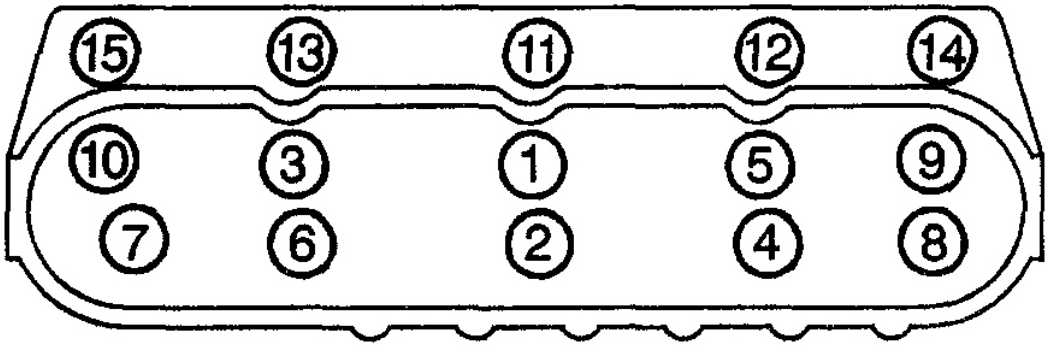


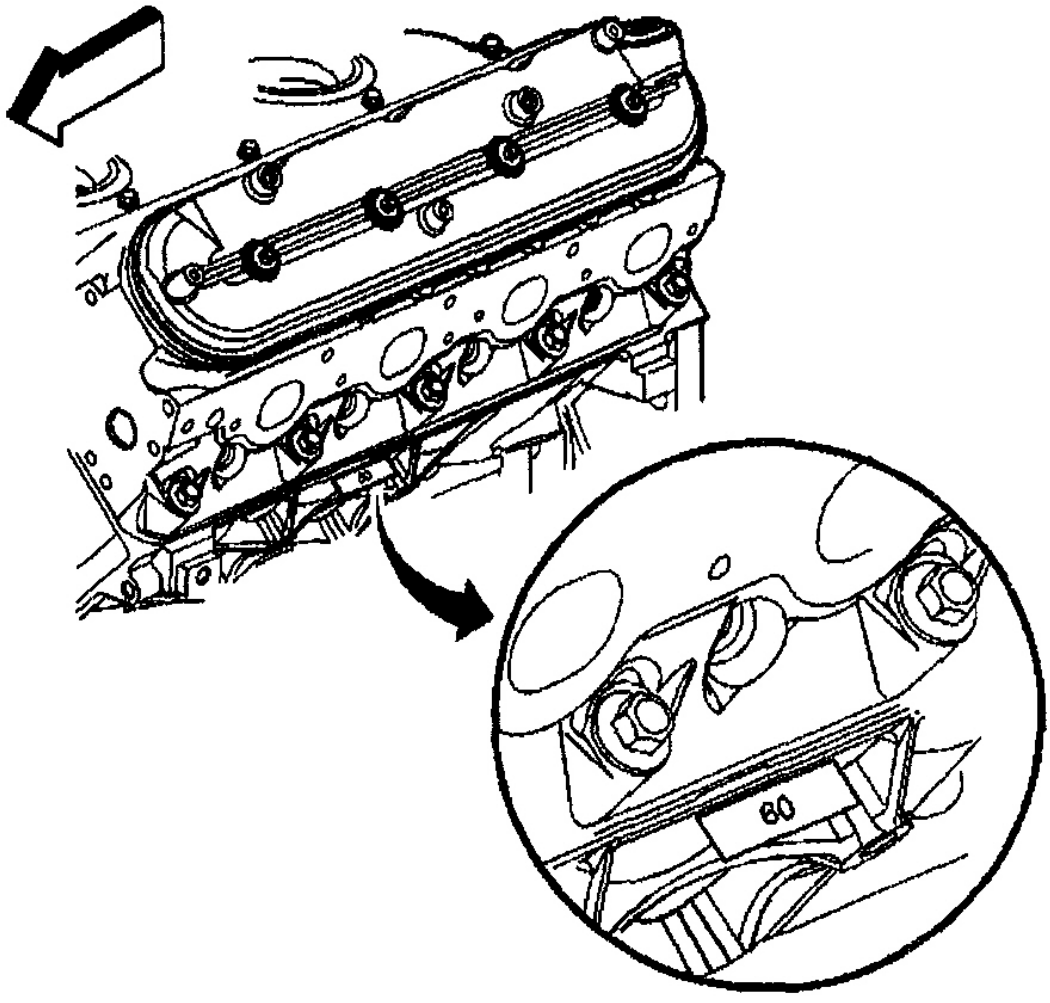
Fig. 412: Right Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

9. The cylinder head gasket displacement can be verified by markings visible on the underside of the right gasket locating tab.

   Some 4.8/5.3 L head gaskets may have 48 or 53 stamped onto the locating tab.

   Some 6.0 L head gaskets may have 60 stamped onto the locating tab.

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Fig. 413: Right Gasket Locating Tab
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM AND PUSH ROD INSTALLATION

IMPORTANT: When reusing the valve train components, always install the components to the original location and position.

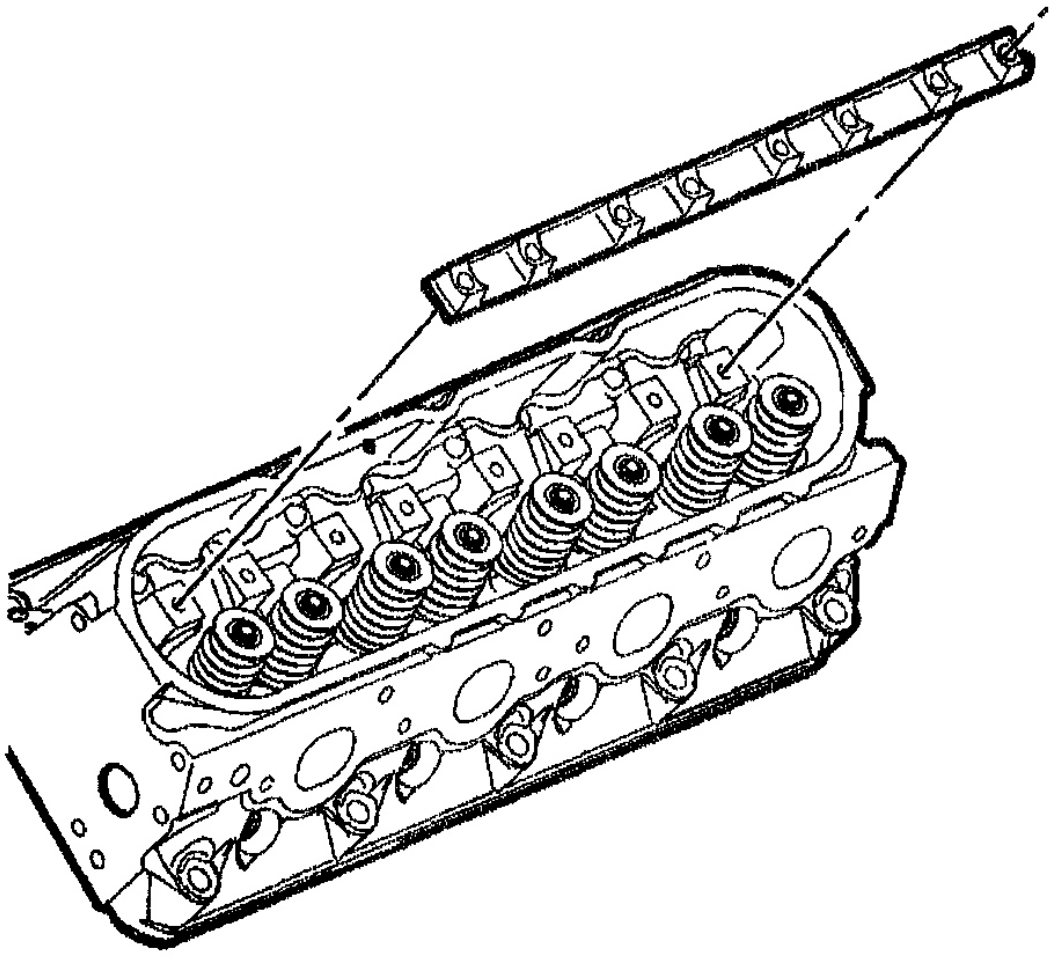
Valve lash is net build, no valve adjustment is required.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.

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Lubricate the flange or washer surface of the bolt that will contact the valve rocker arm.

3. Install the valve rocker arm pivot support.



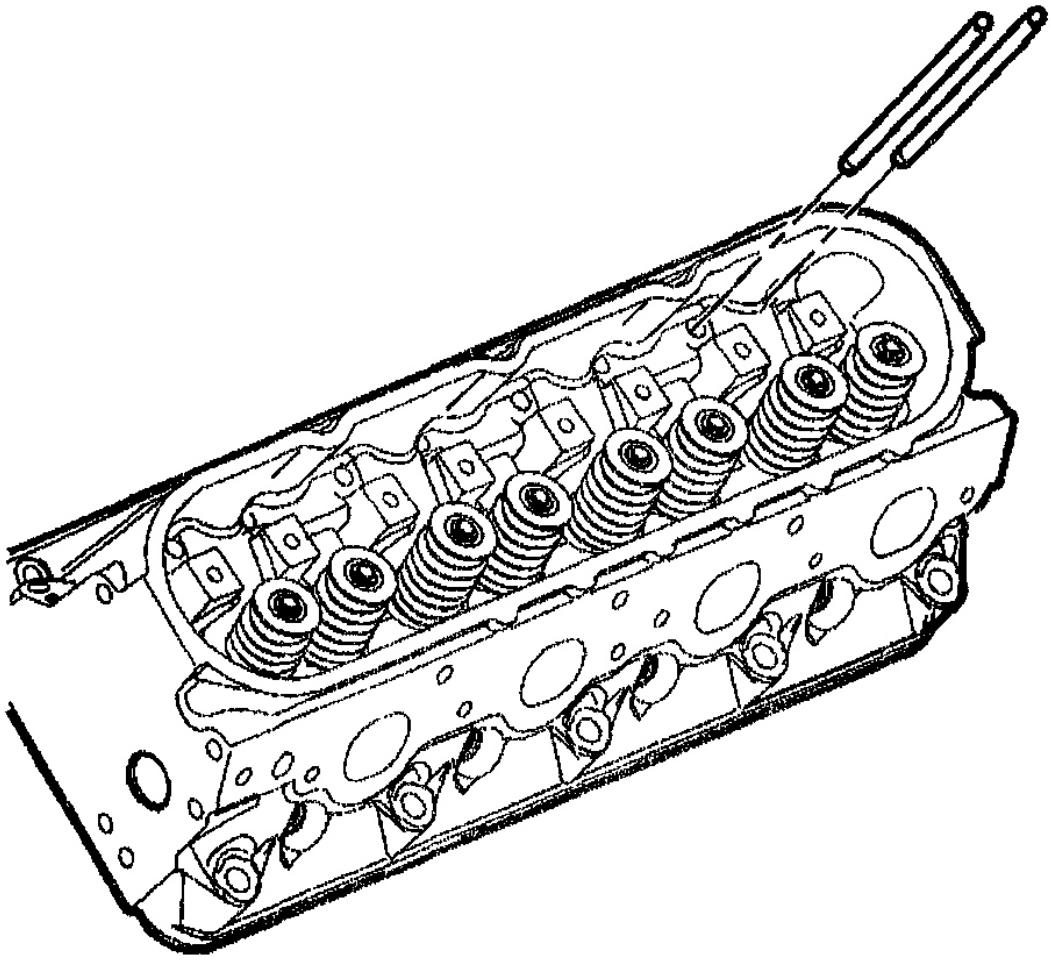
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Fig. 414: Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

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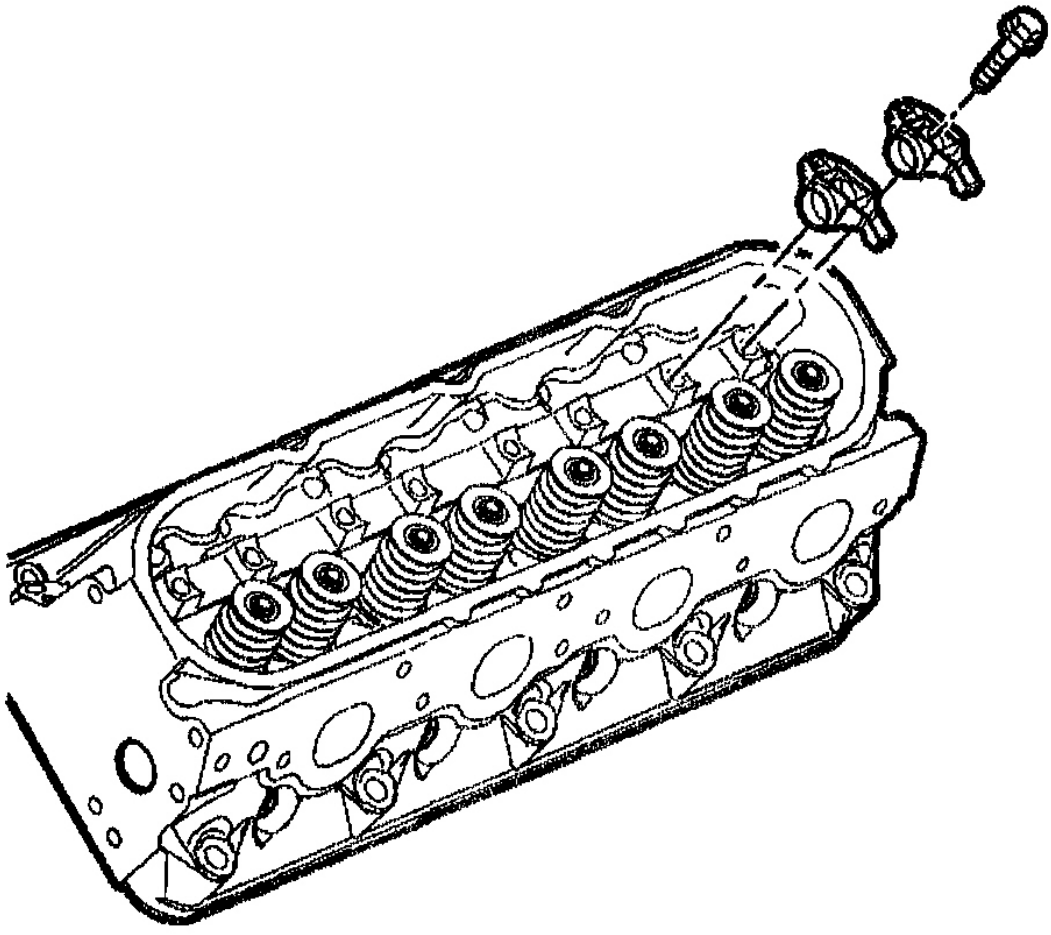
Fig. 415: Pushrods
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the pushrods seat properly to the ends of the rocker arms.

DO NOT tighten the rocker arm bolts at this time.

5. Install the rocker arms and bolts.

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Fig. 416: Valve Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft until number one piston is at top dead center of compression stroke.

   In this position, cylinder number one rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

   The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

   Cylinders 1, 3, 5 and 7 are left bank.

   Cylinders 2, 4, 6, and 8 are right bank.

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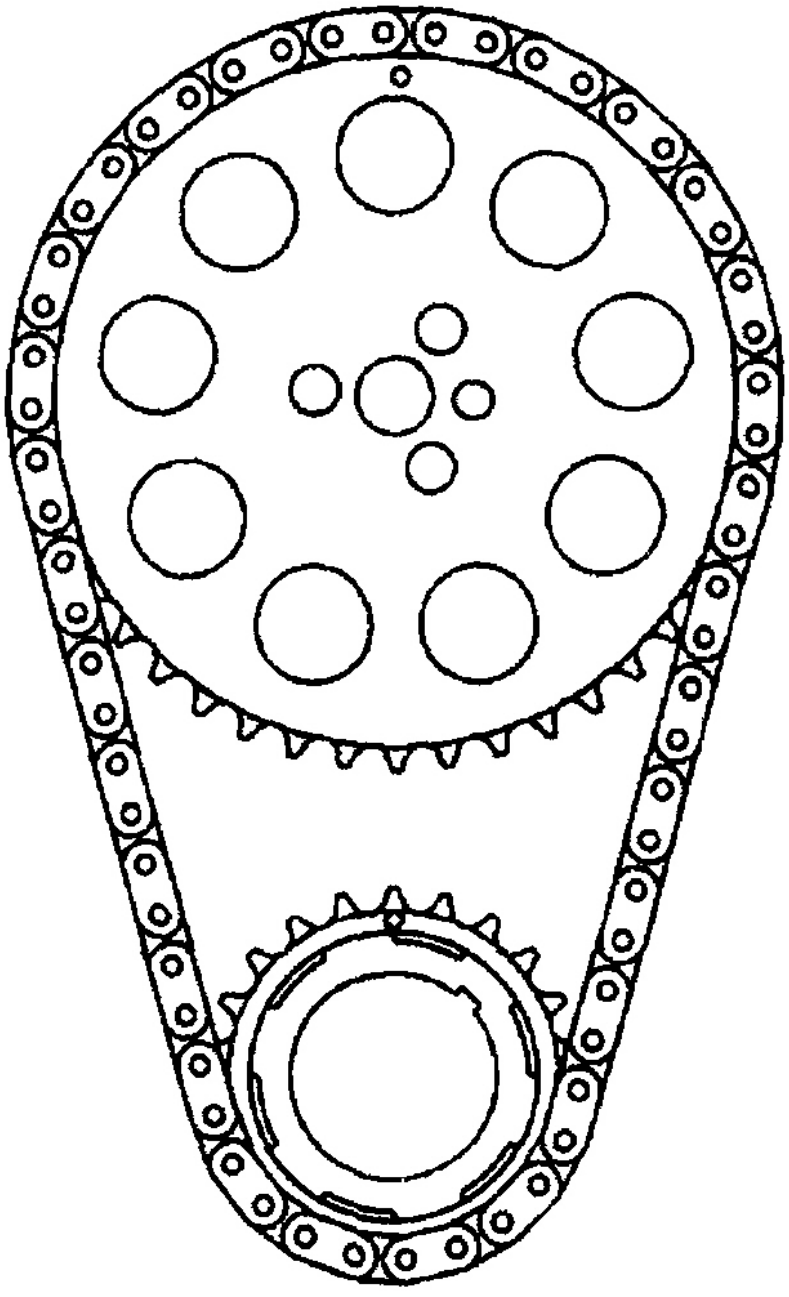
NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

7. With the engine in the number one firing position, tighten the following valve rocker arm bolts:

   Tighten

   - Tighten exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft).
   - Tighten intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft).

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Fig. 417: Crankshaft & Camshaft Sprockets
Courtesy of GENERAL MOTORS CORP.

8. Rotate the crankshaft 360 degrees.

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9. Tighten the following valve rocker arm bolts:

   Tighten

   - Tighten exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft).
   - Tighten intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft).

VALVE ROCKER ARM COVER INSTALLATION - LEFT

Important:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.
- If the vapor vent grommet has been removed from the valve rocker arm cover, install a NEW vapor vent gourmet during assembly.

1. Install a NEW cover gasket (1) into the valve rocker arm cover.

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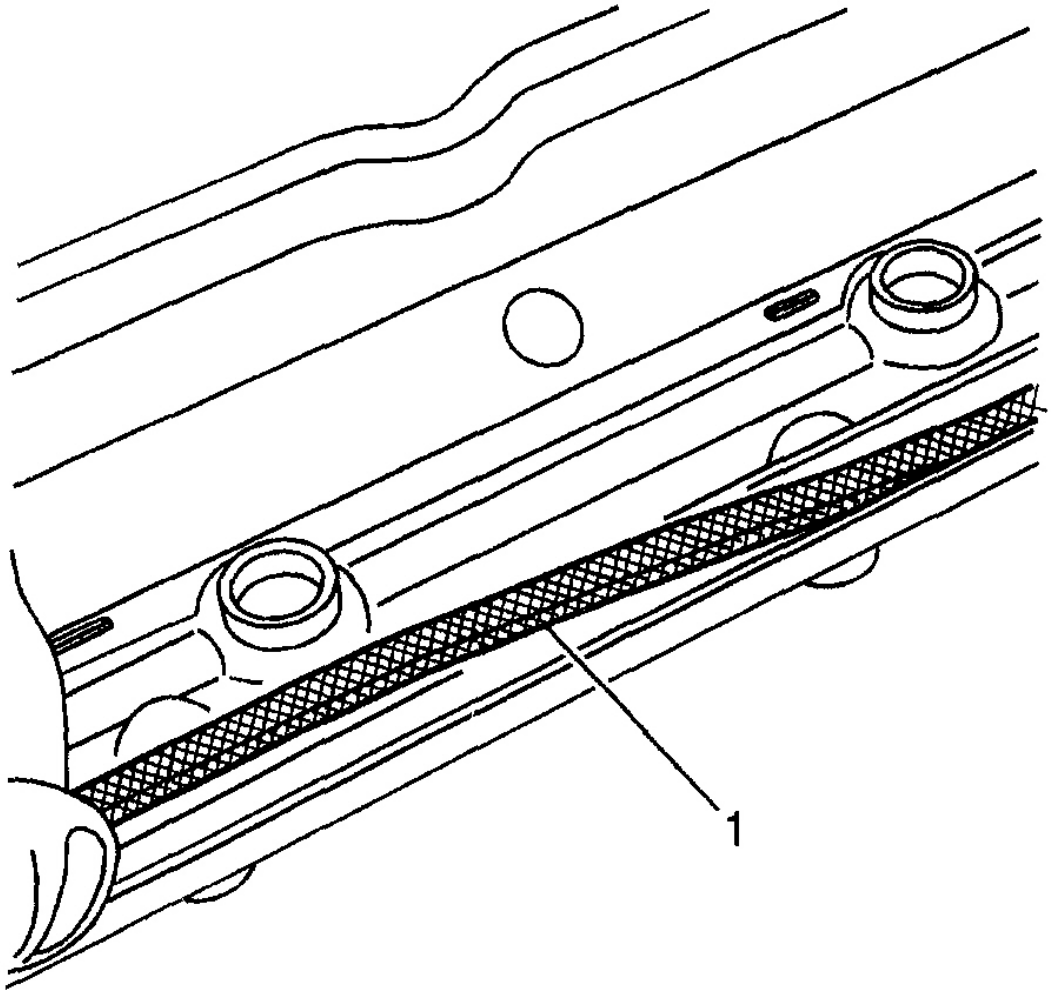


Fig. 418: Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the valve rocker arm cover onto the cylinder head.

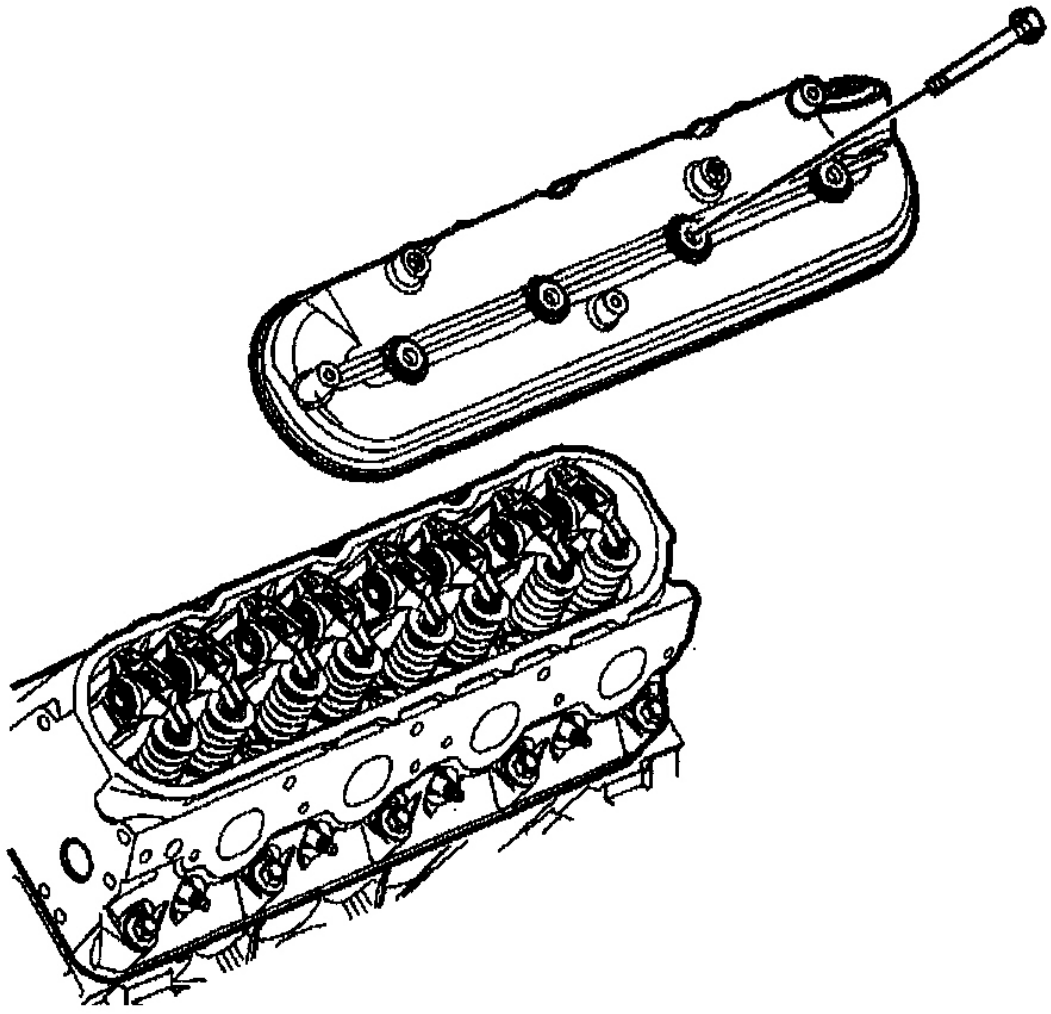
NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the cover bolts with grommets.

Tighten

Tighten the valve rocker arm cover bolts to 12 N.m (106 lb in).

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Fig. 419: Valve Rocker Arm Cover & Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

4. Apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the bracket bolts.
5. Install the ignition coils and bracket assembly and bolts.

Tighten

Tighten the ignition coil and bracket assembly bolts to 12 N.m (106 lb in).

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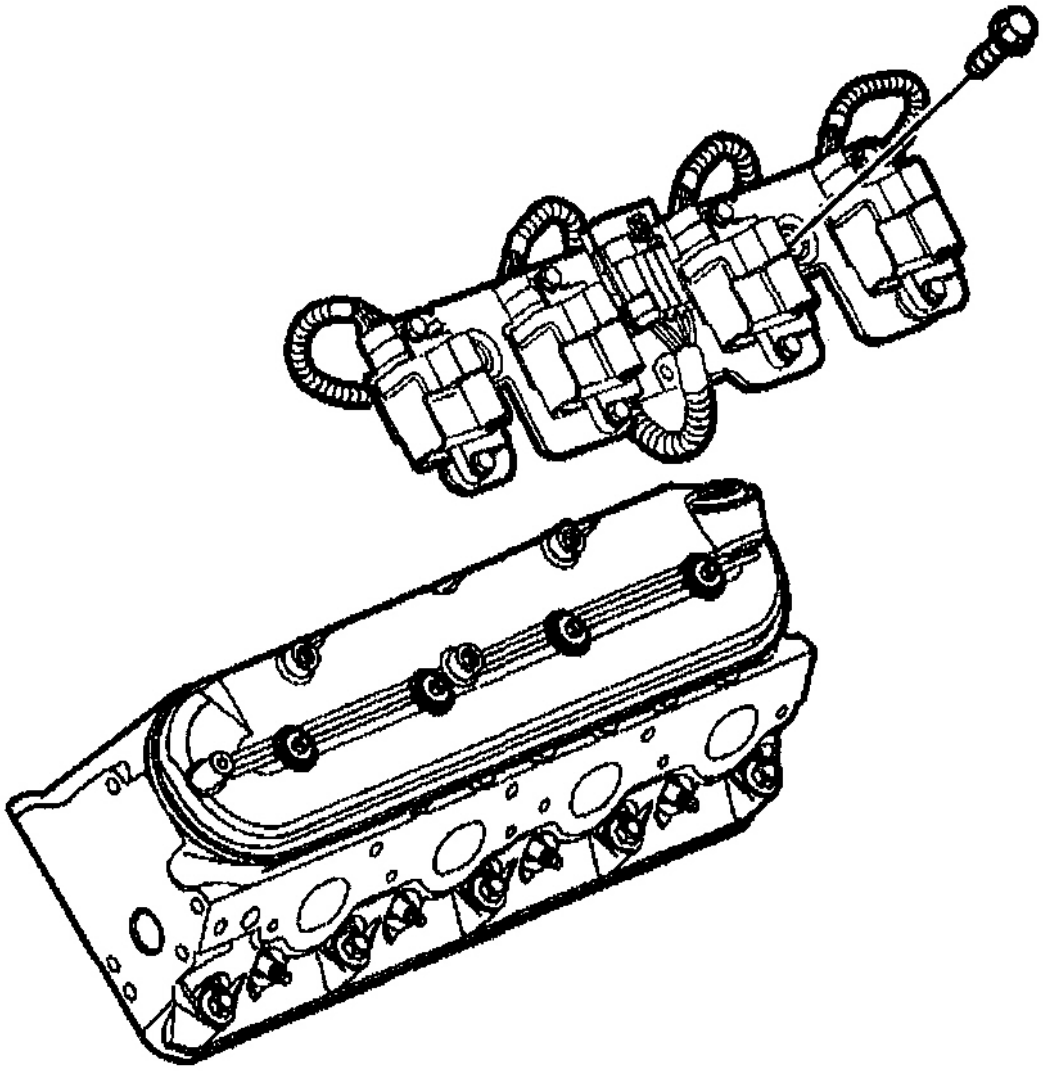


Fig. 420: Ignition Coil & Bracket Assembly & Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM COVER INSTALLATION - RIGHT

Important:

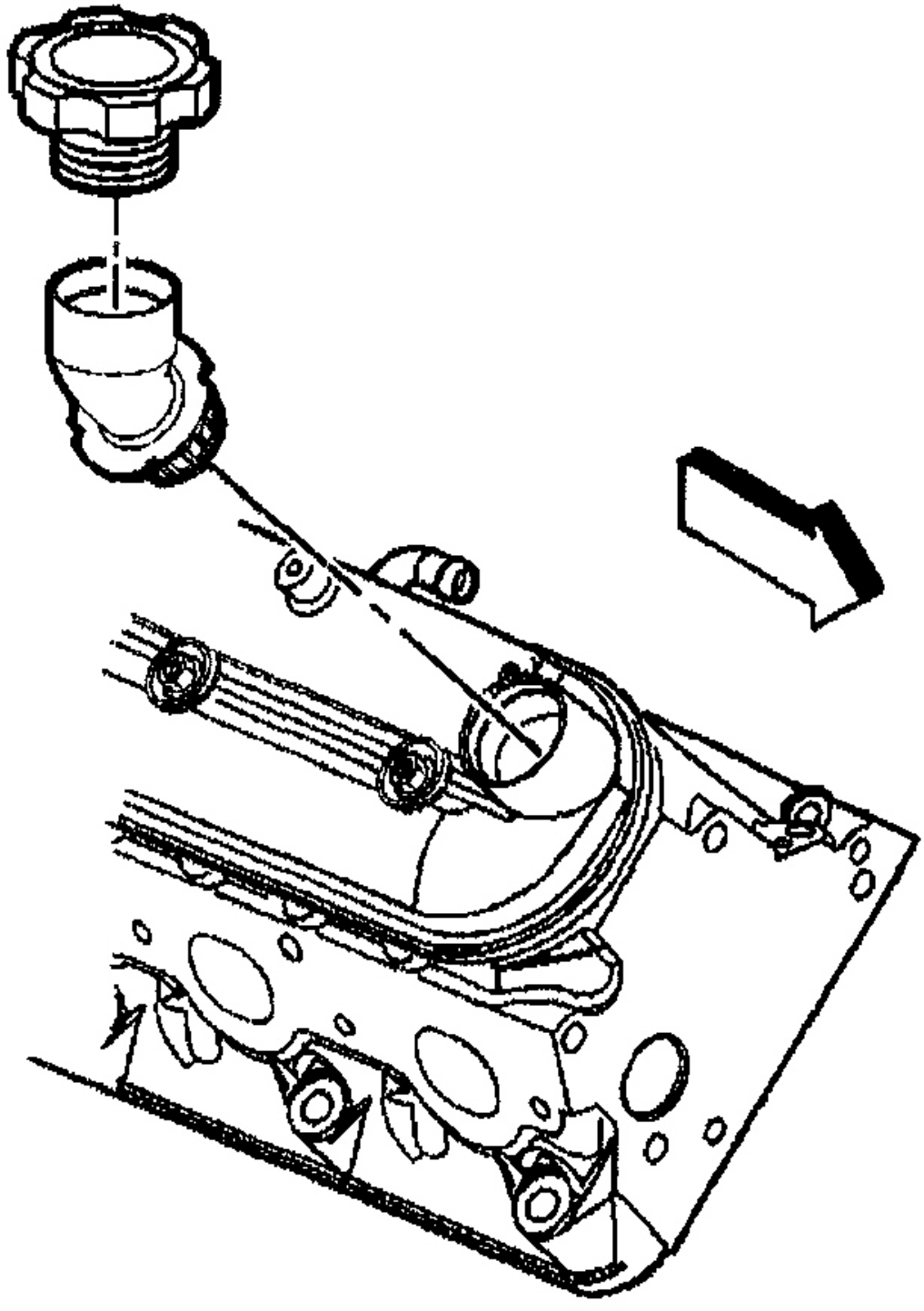
- All gasket surfaces should be free of oil or other foreign material during assembly.
- Do not reuse the valve rocker arm cover gasket.
- Do not remove the ignition coils and bracket from the valve rocker arm cover unless required.

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- The valve rocker arm cover bolt grommets may be reused.
- If the oil fill tube has been removed from the valve rocker arm cover, install a NEW oil fill tube during assembly.

1. Lubricate the O-ring seal of the NEW oil fill tube with clean engine oil.

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Fig. 421: Oil Fill Tube & Cap
Courtesy of GENERAL MOTORS CORP.

2. Insert the NEW oil fill tube into the rocker arm cover and rotate the tube clockwise until locked in the proper position.
3. Install the oil fill cap into the tube and rotate clockwise until locked in the proper position.
4. Install a NEW cover gasket (1) into the valve rocker arm cover.

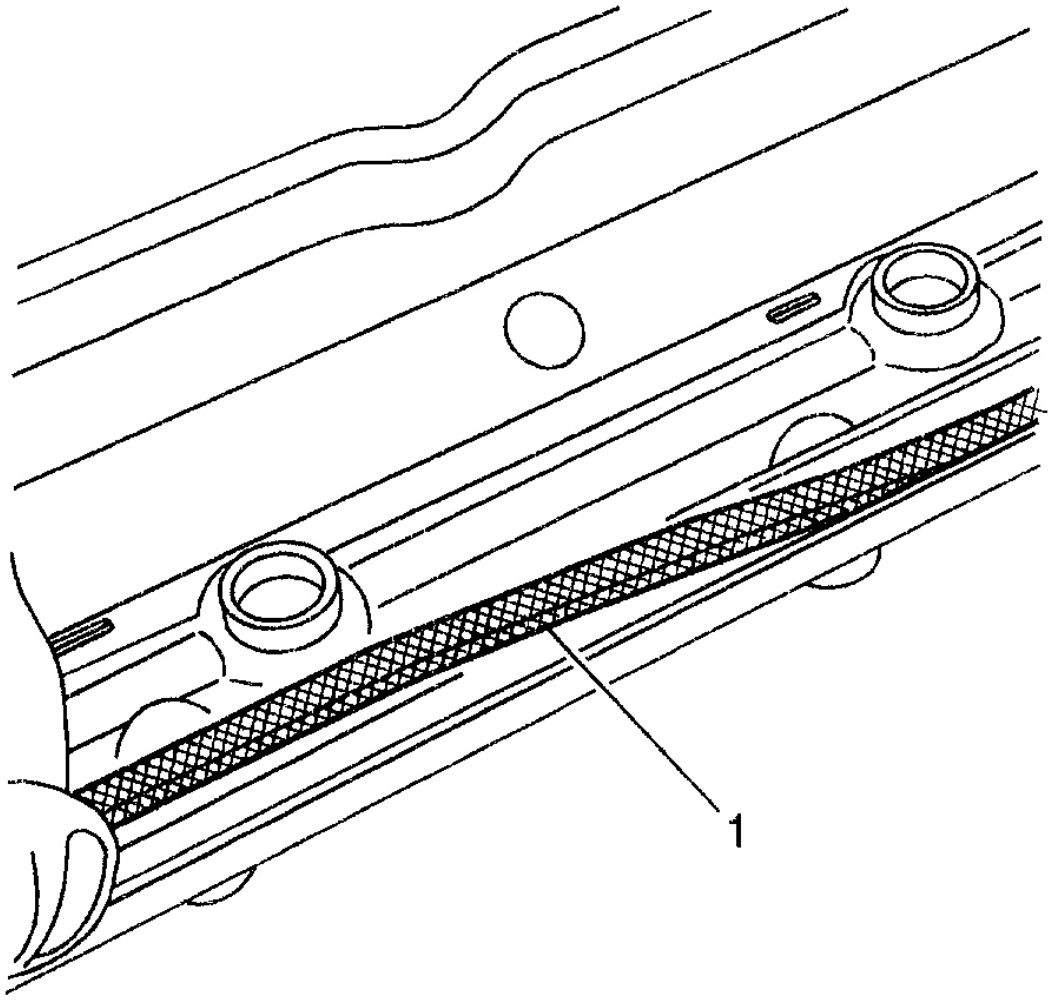


Fig. 422: Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

5. Install the valve rocker arm cover onto the cylinder head.

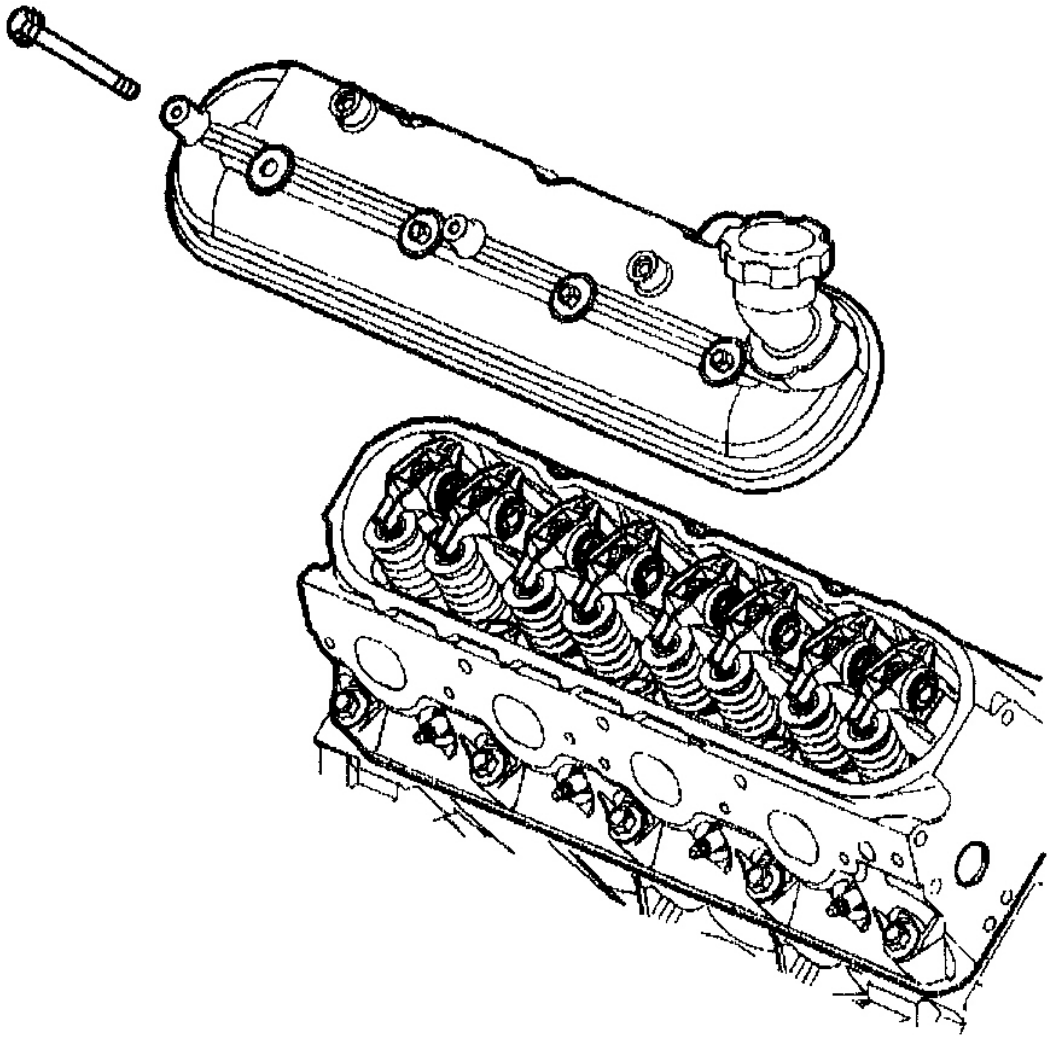
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NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

6. Install the cover bolts with grommets.

Tighten

Tighten the valve rocker arm cover bolts to 12 N.m (106 lb in).



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Fig. 423: Valve Rocker Cover & Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

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7. Apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the bracket bolts.
8. Install the ignition coil and bracket assembly and bolts.

Tighten

Tighten the ignition coil and bracket assembly studs to 12 N.m (106 lb in).

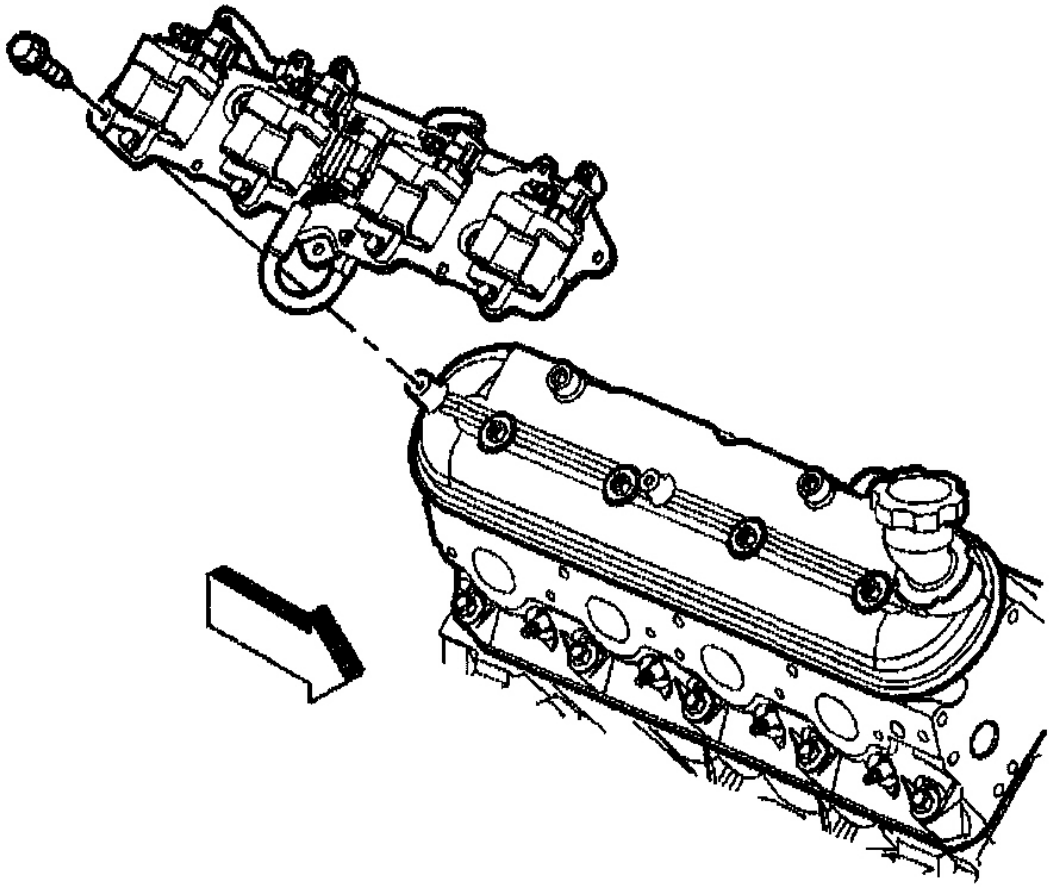


Fig. 424: Ignition Coil & Bracket Assembly & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

ENGINE VALLEY COVER INSTALLATION

IMPORTANT: All gasket surfaces should be free of oil or other foreign material during assembly.

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1. Install NEW knock sensor oil seals (1) into the valley cover (2).

   Lubricate the seal surfaces with clean engine oil.

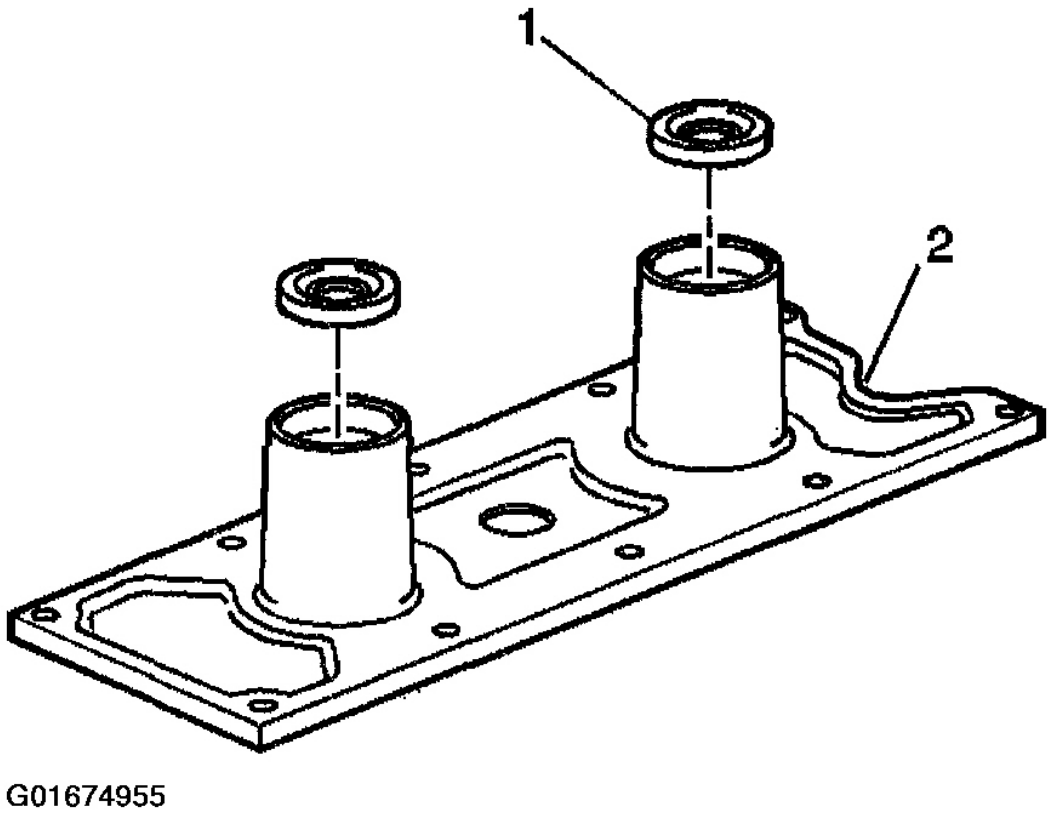


Fig. 425: Knock Sensor Oil Seal & Valley Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the valley cover and NEW gasket.

   NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the valley cover bolts.

   Tighten

   Tighten the valley cover bolts to 25 N.m (18 lb ft).

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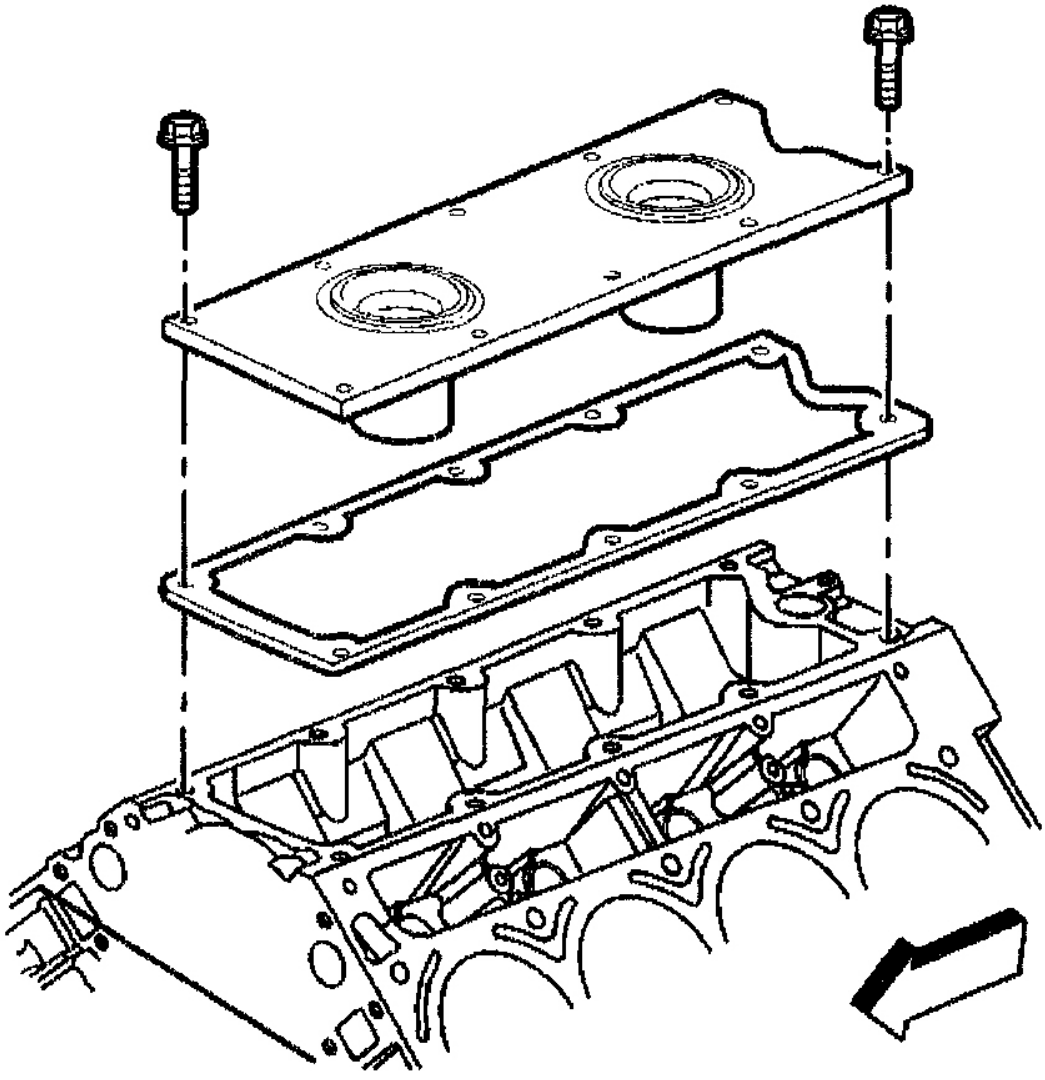


Fig. 426: Engine Valley Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the knock sensors.

Tighten

Tighten the knock sensors to 20 N.m (15 lb ft).

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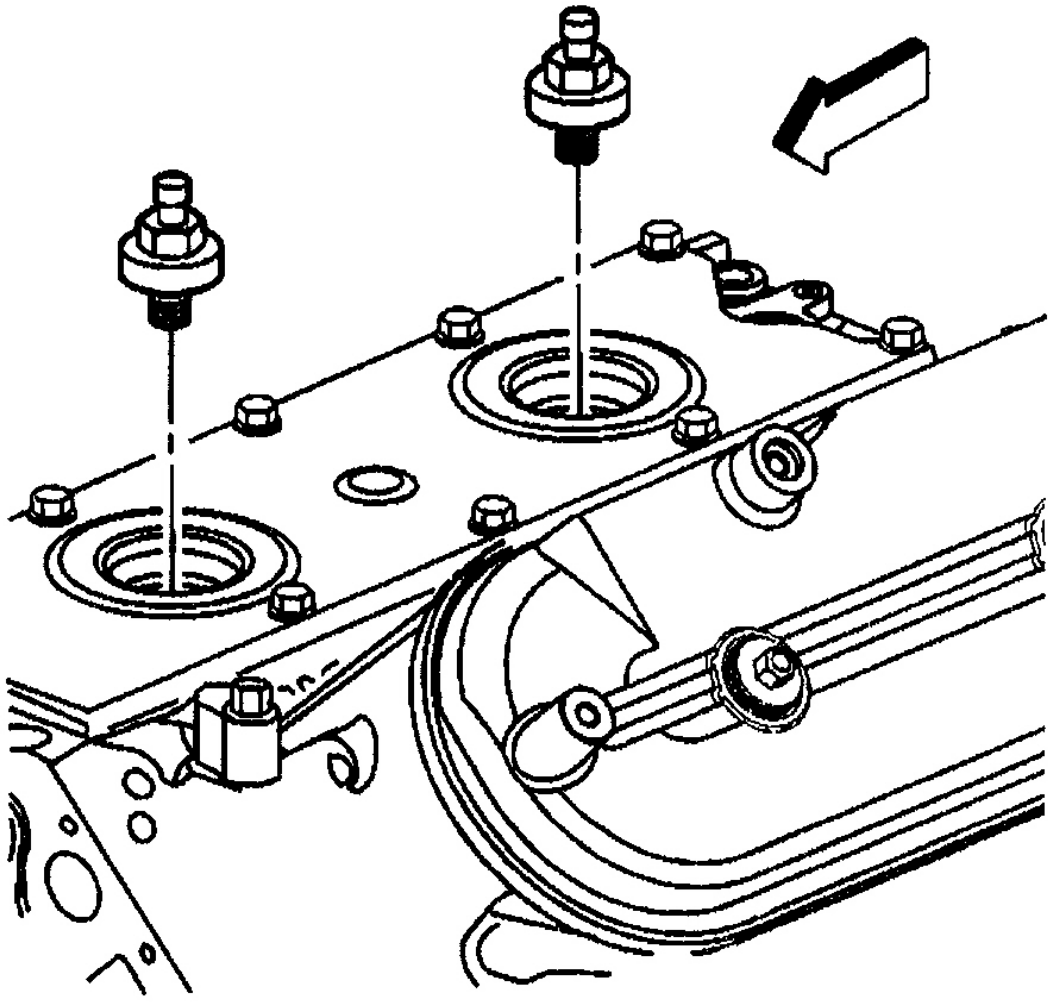


Fig. 427: Knock Sensors
Courtesy of GENERAL MOTORS CORP.

5. Install the knock sensor wire harness.

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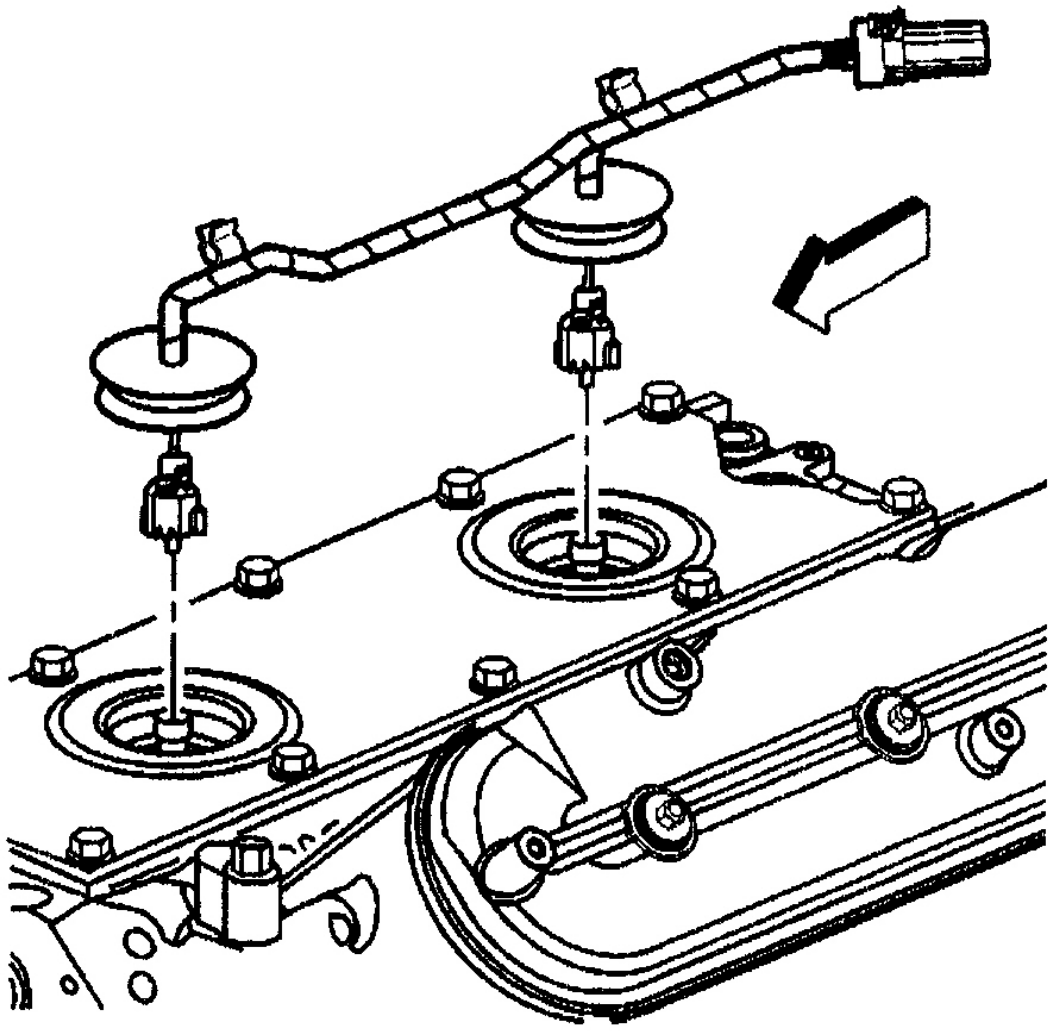


Fig. 428: Knock Sensor Wire Harness
Courtesy of GENERAL MOTORS CORP.

COOLANT AIR BLEED PIPE INSTALLATION

IMPORTANT: Install the pipe gaskets properly onto the pipe and covers.

Position the gasket O-ring seal onto the nipple portion of the pipe.

1. Install the gaskets onto the engine coolant air bleed pipe and covers.

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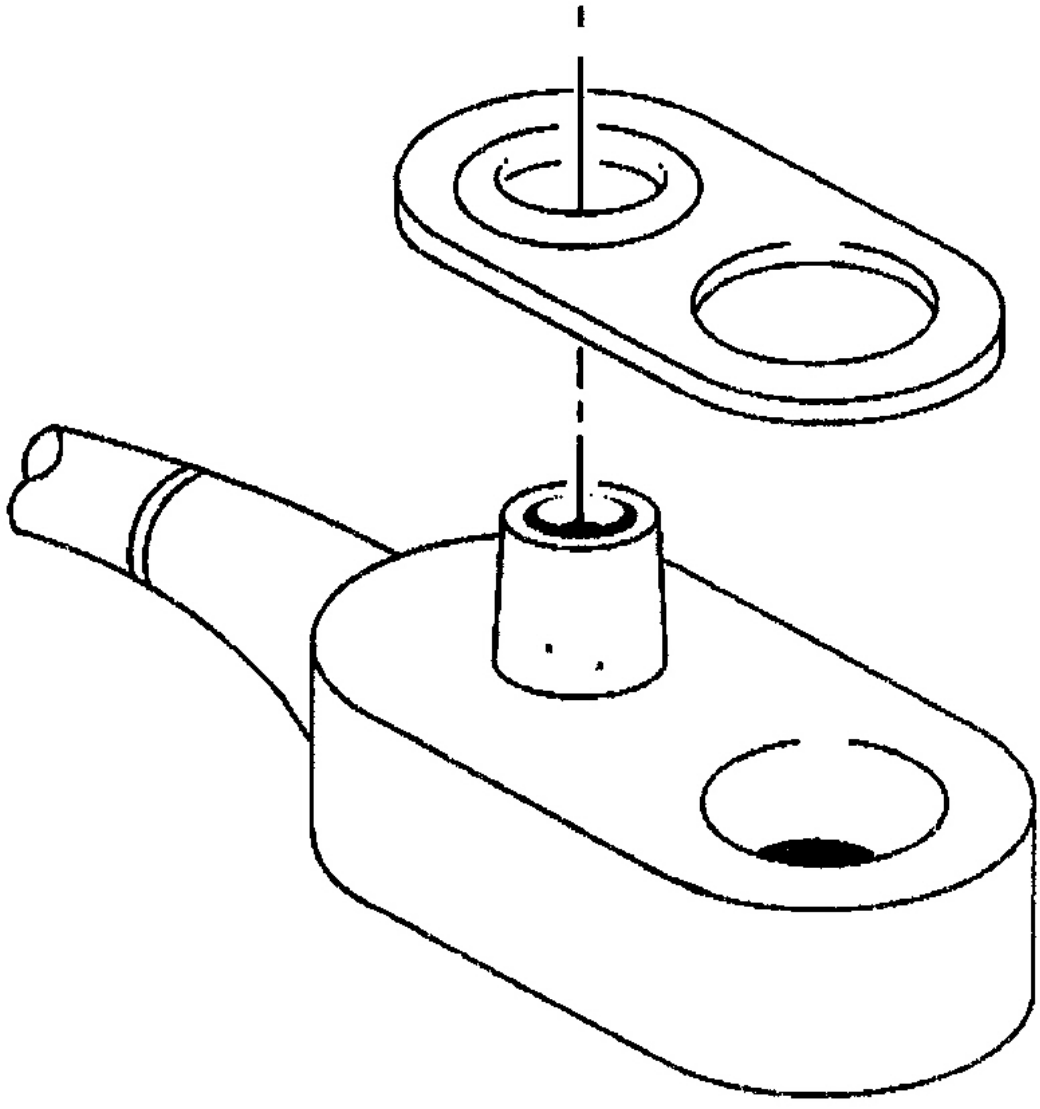


Fig. 429: Engine Coolant Air Bleed Pipe Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the pipe (2) and gaskets (3) onto the cylinder heads.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the pipe bolts (1).

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Install the two pipe studs to the front of the engine.

Tighten

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

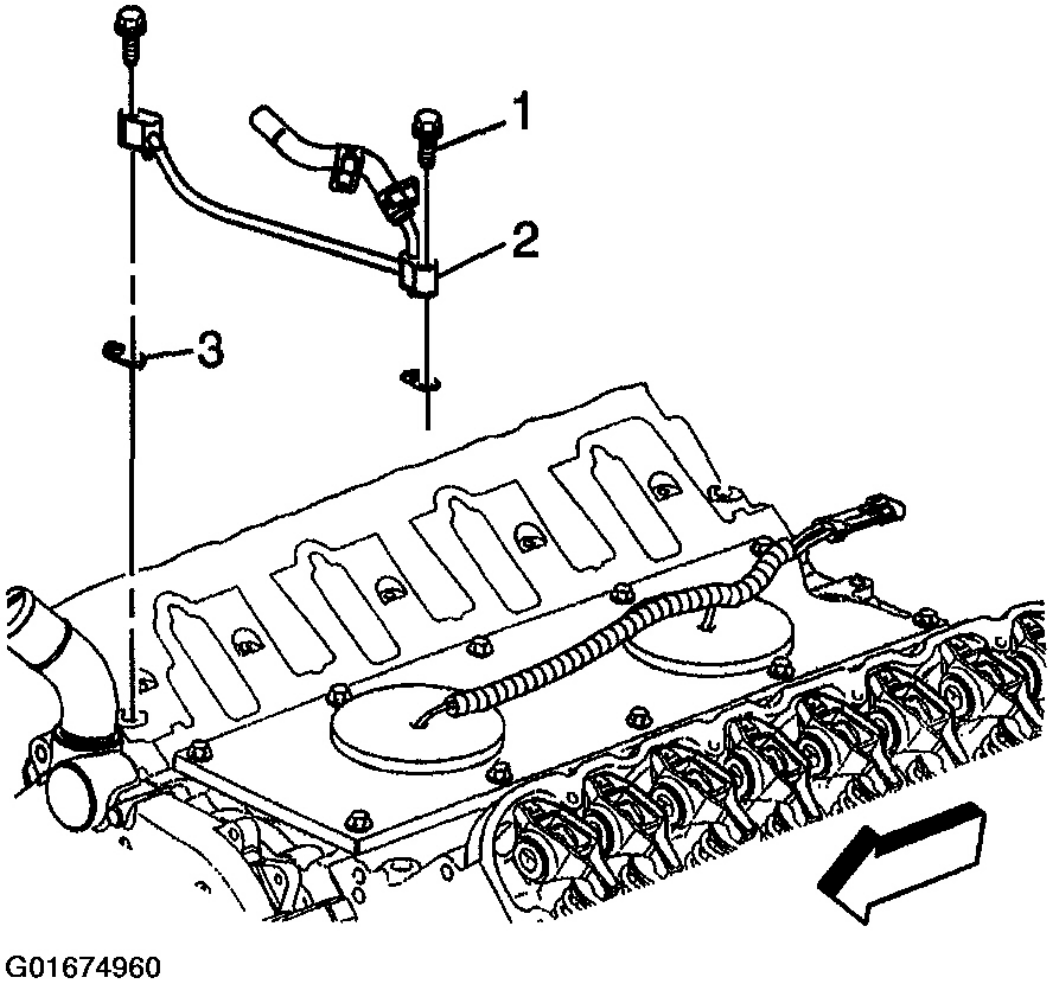


Fig. 430: Coolant Air Bleed Pipe, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the covers (2), gaskets (3), and bolts (1) onto the rear of the engine.

Tighten

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

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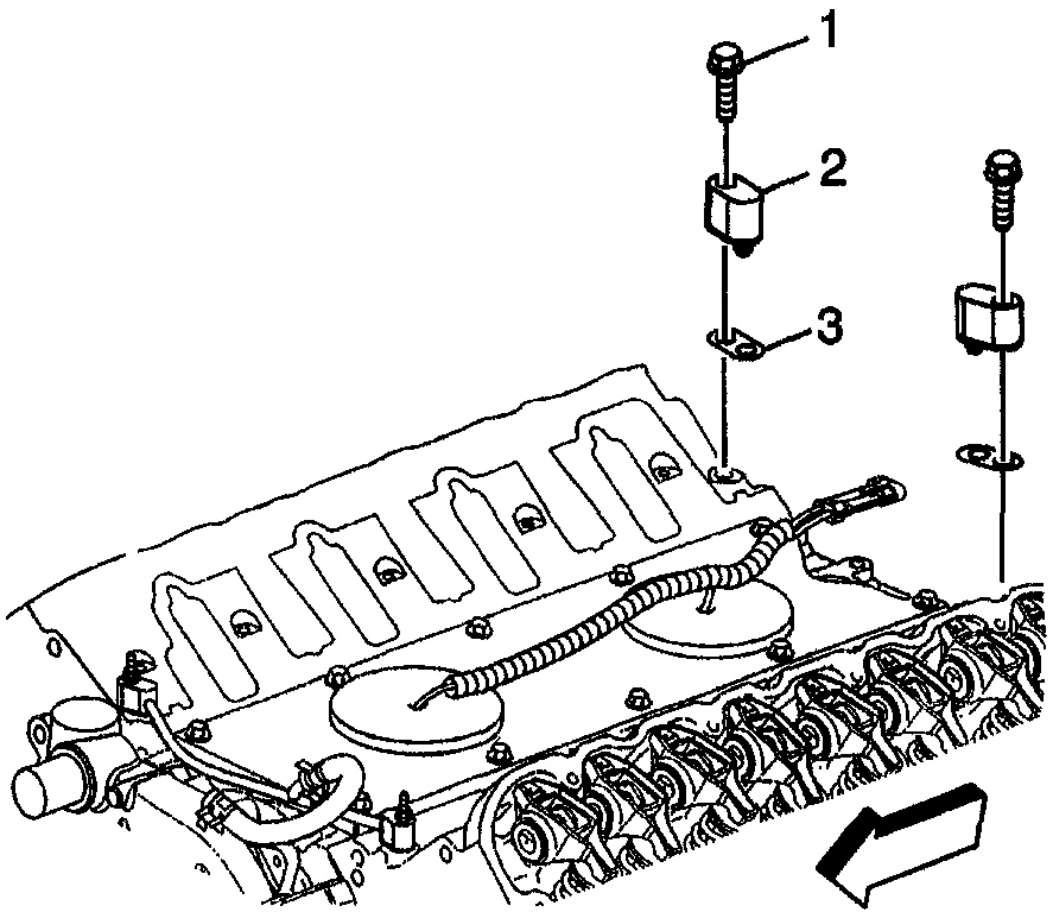


Fig. 431: Coolant Air Bleed Pipe Covers, Gaskets & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the hose and clamp (1) onto the pipe (2).

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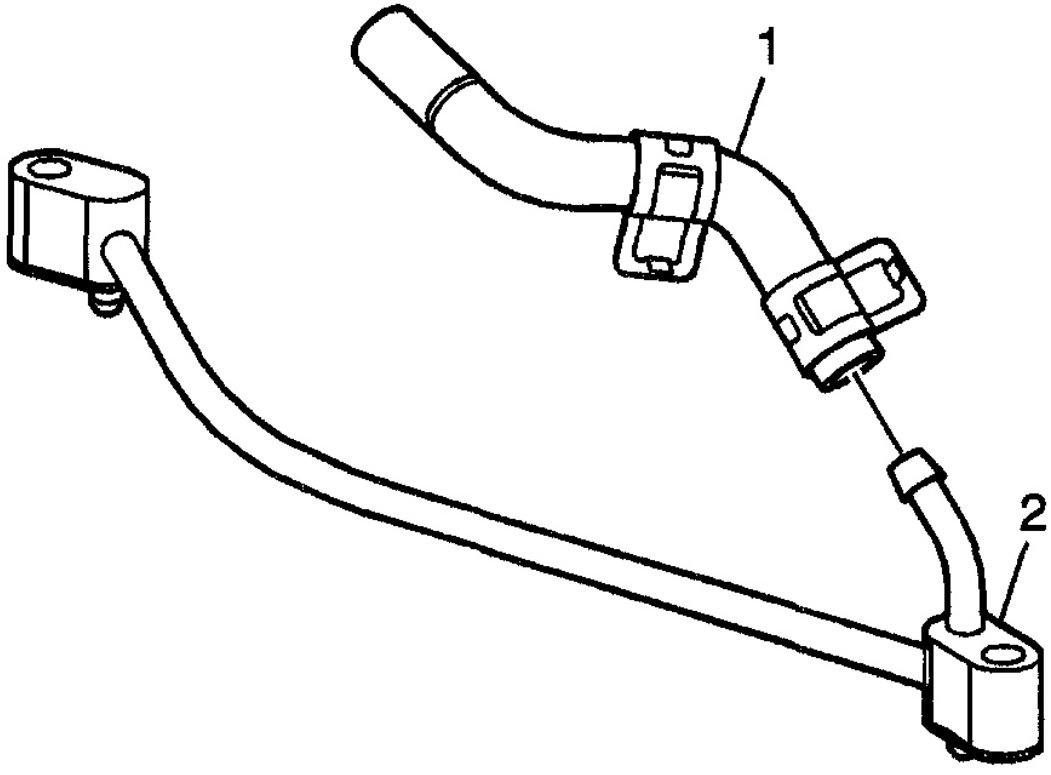


Fig. 432: Coolant Air Bleed Hose, Clamp & Pipe
Courtesy of GENERAL MOTORS CORP.

INTAKE MANIFOLD INSTALLATION

Important:

- The intake manifold, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.
- DO NOT reuse intake manifold gaskets. Install NEW intake manifold-to-cylinder head gaskets.

1. Install NEW intake manifold-to-cylinder head gaskets (1).

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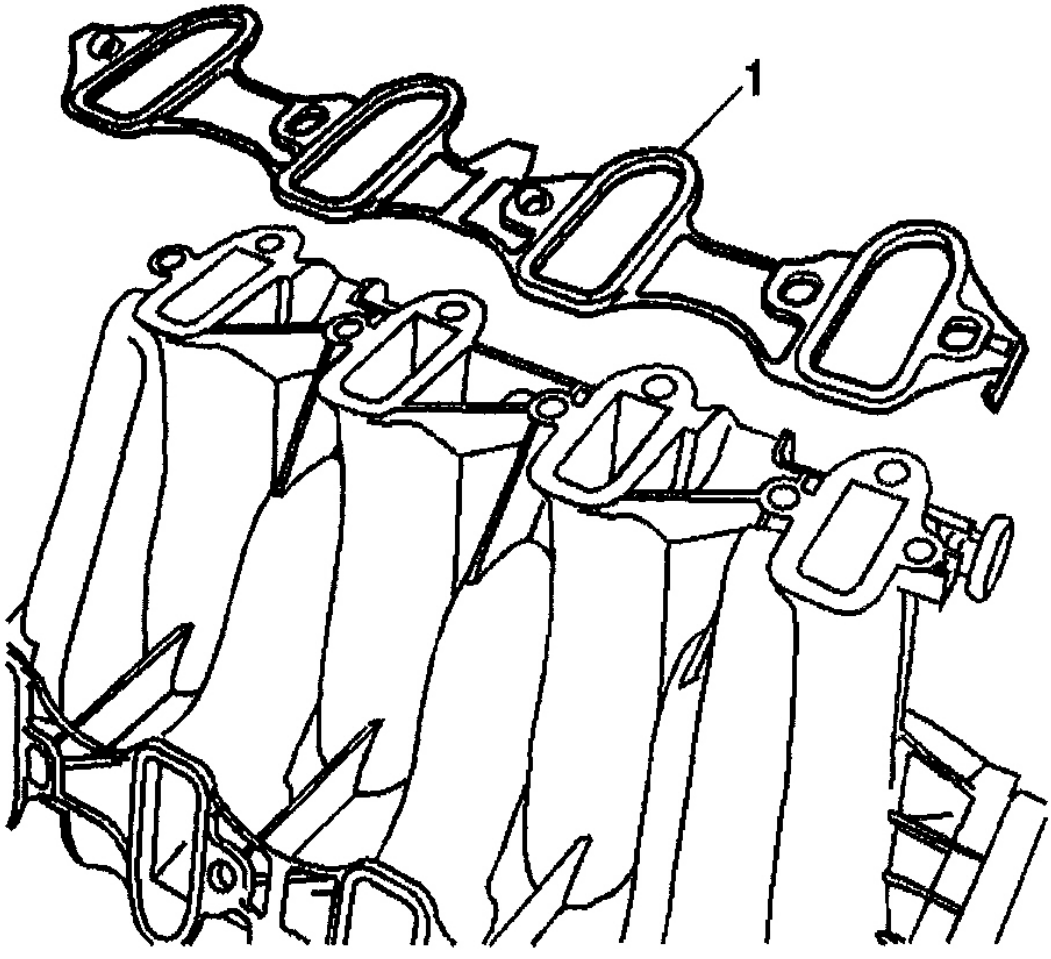


Fig. 433: Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold.
3. Apply a 5 mm (0.20 in) band of threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the intake manifold bolts. Refer to **Sealers, Adhesives, and Lubricants** .

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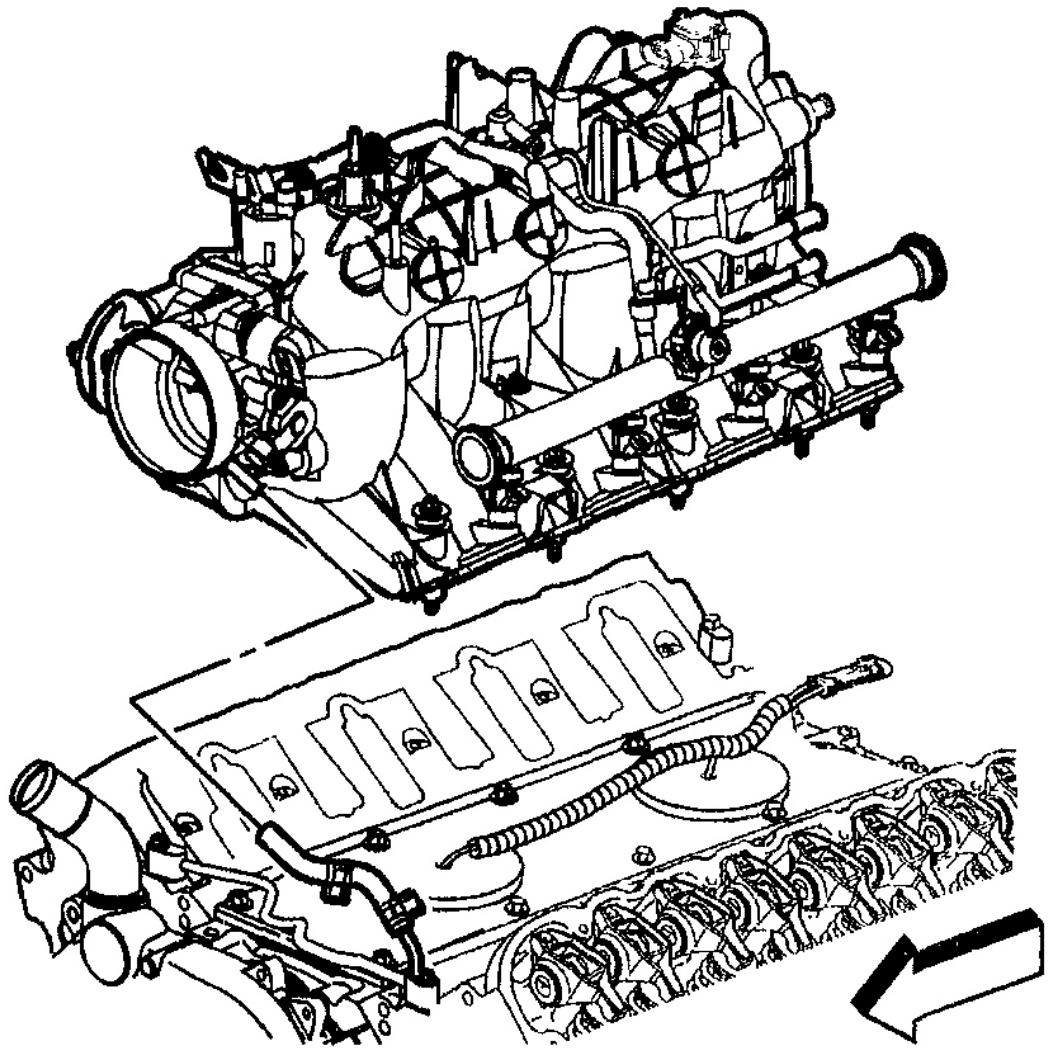


Fig. 434: Intake Manifold
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

4. Install the intake manifold bolts.

Tighten

4.1. Tighten intake manifold bolts first pass in sequence to 5 N.m (44 lb in).

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4.2. Tighten intake manifold bolts final pass in sequence to 10 N.m (89 lb in).

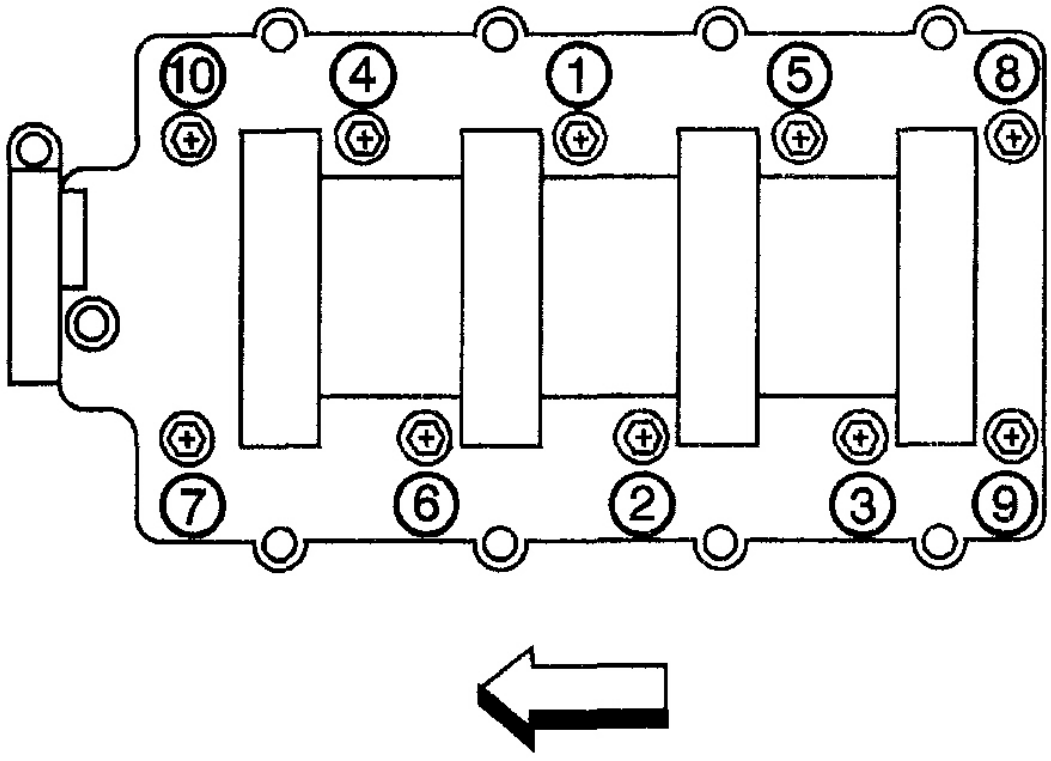


Fig. 435: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

5. Install the Manifold Absolute Pressure (MAP) sensor (1), if previously removed.

   The electrical connector end of the sensor should be facing the front of the engine.

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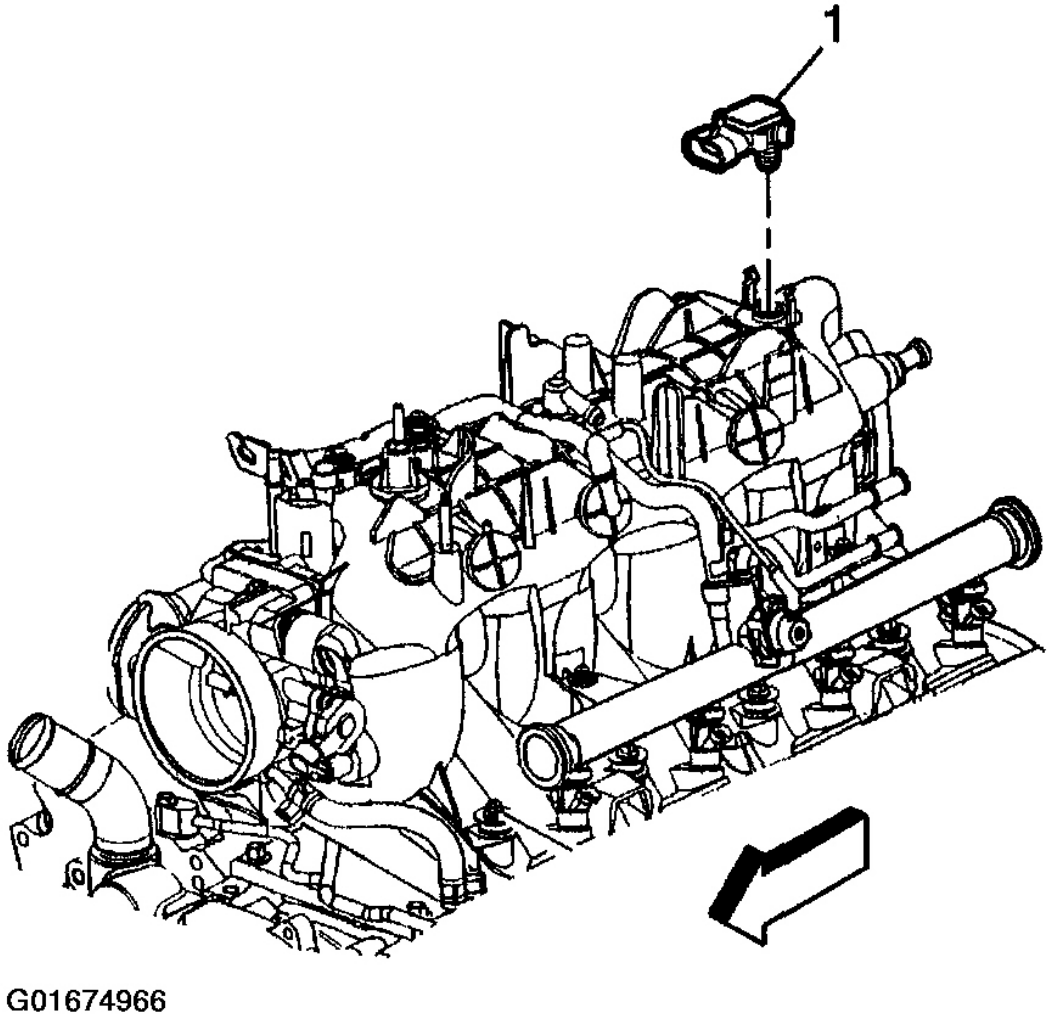


Fig. 436: MAP Sensor
Courtesy of GENERAL MOTORS CORP.

6. Install the Positive Crankcase Ventilation (PCV) valve (2) and hose (1).
7. Install the engine coolant air bleed hose and clamp onto the throttle body.

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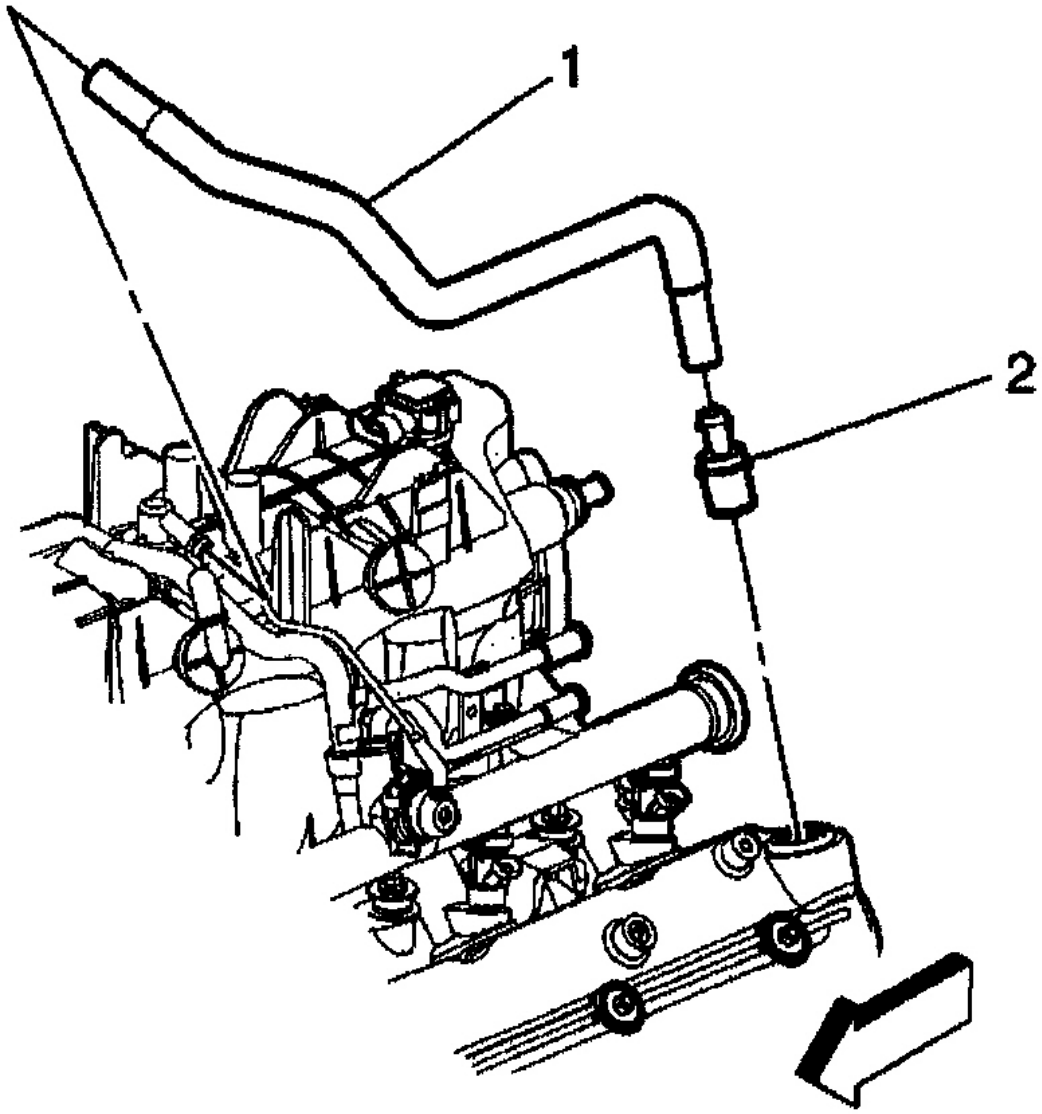


Fig. 437: PCV Valve & Hose
Courtesy of GENERAL MOTORS CORP.

8. Install the accelerator control cable bracket (2) and bolts (1), if applicable.

Tighten

Tighten the accelerator control cable bracket bolts to 10 N.m (89 lb in).

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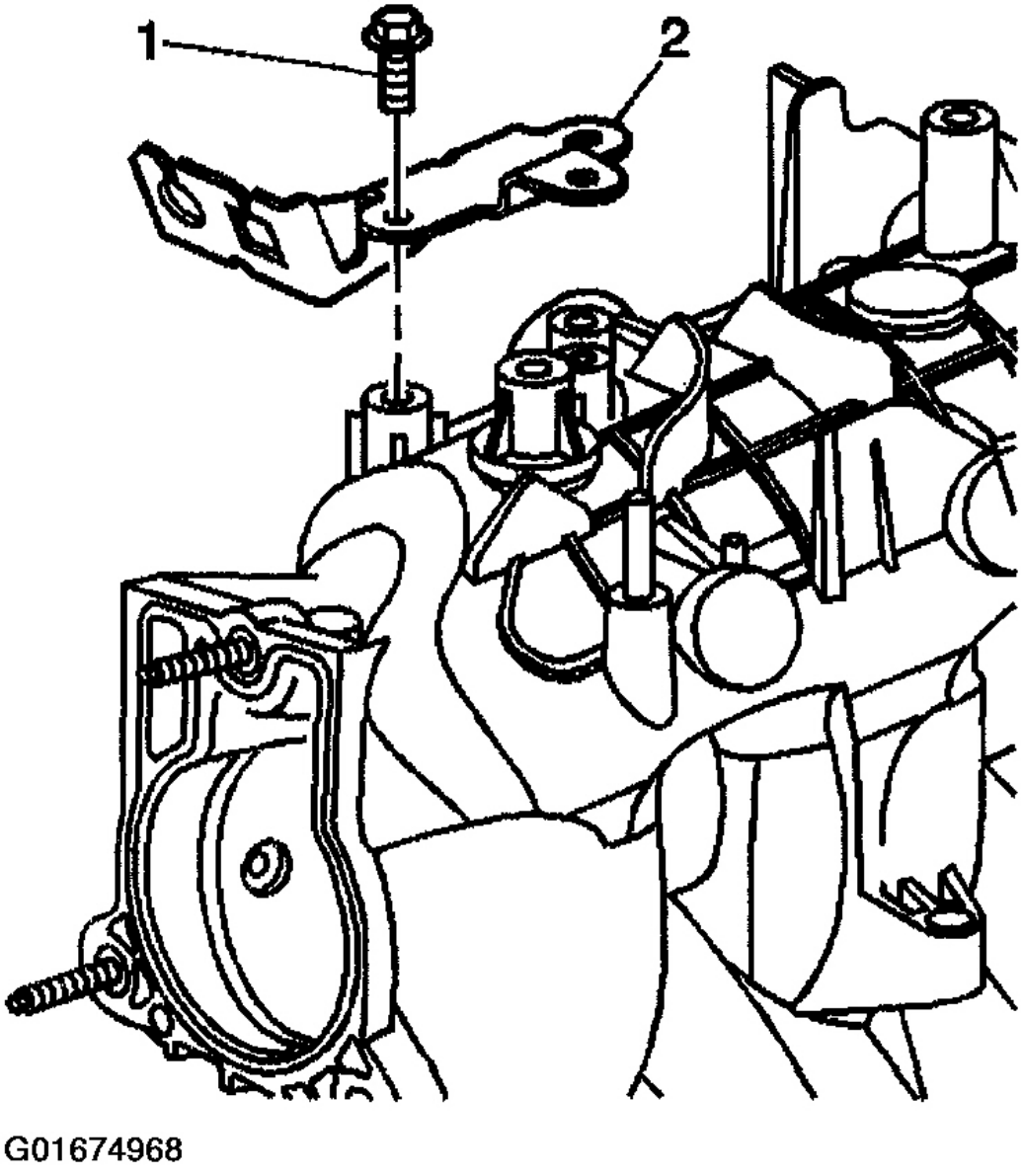


Fig. 438: Accelerator Control Cable Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Install the evaporative emission (EVAP) purge solenoid (3), bolt (2), and isolator (1).

Tighten

Tighten the solenoid bolt to 10 N.m (89 lb in).

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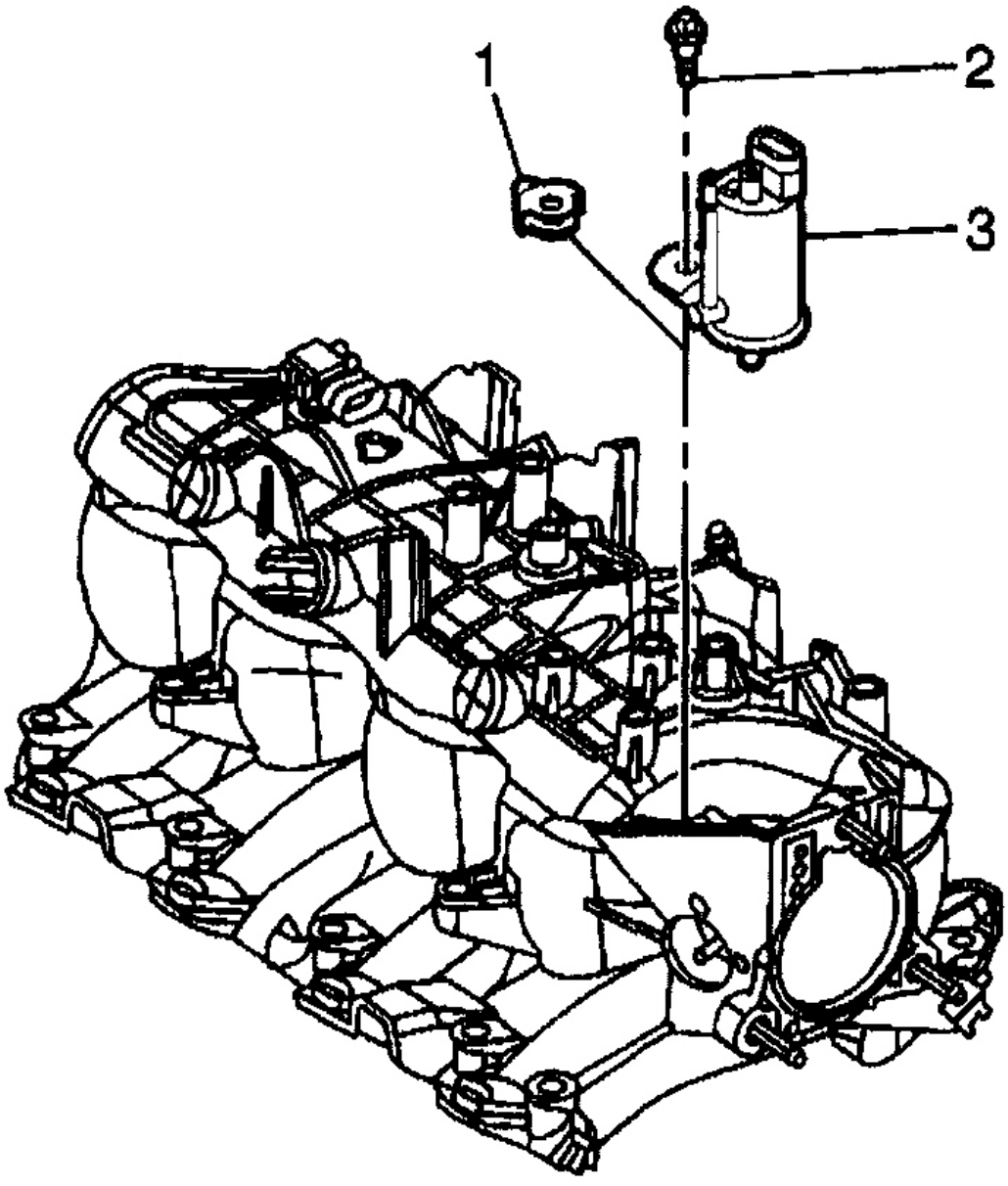


Fig. 439: EVAP Purge Solenoid, Bolt & Isolator
Courtesy of GENERAL MOTORS CORP.

FUEL RAIL AND INJECTORS INSTALLATION

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CAUTION: Refer to FUEL RAIL STOP BRACKET INSTALLATION CAUTION in Cautions and Notices.

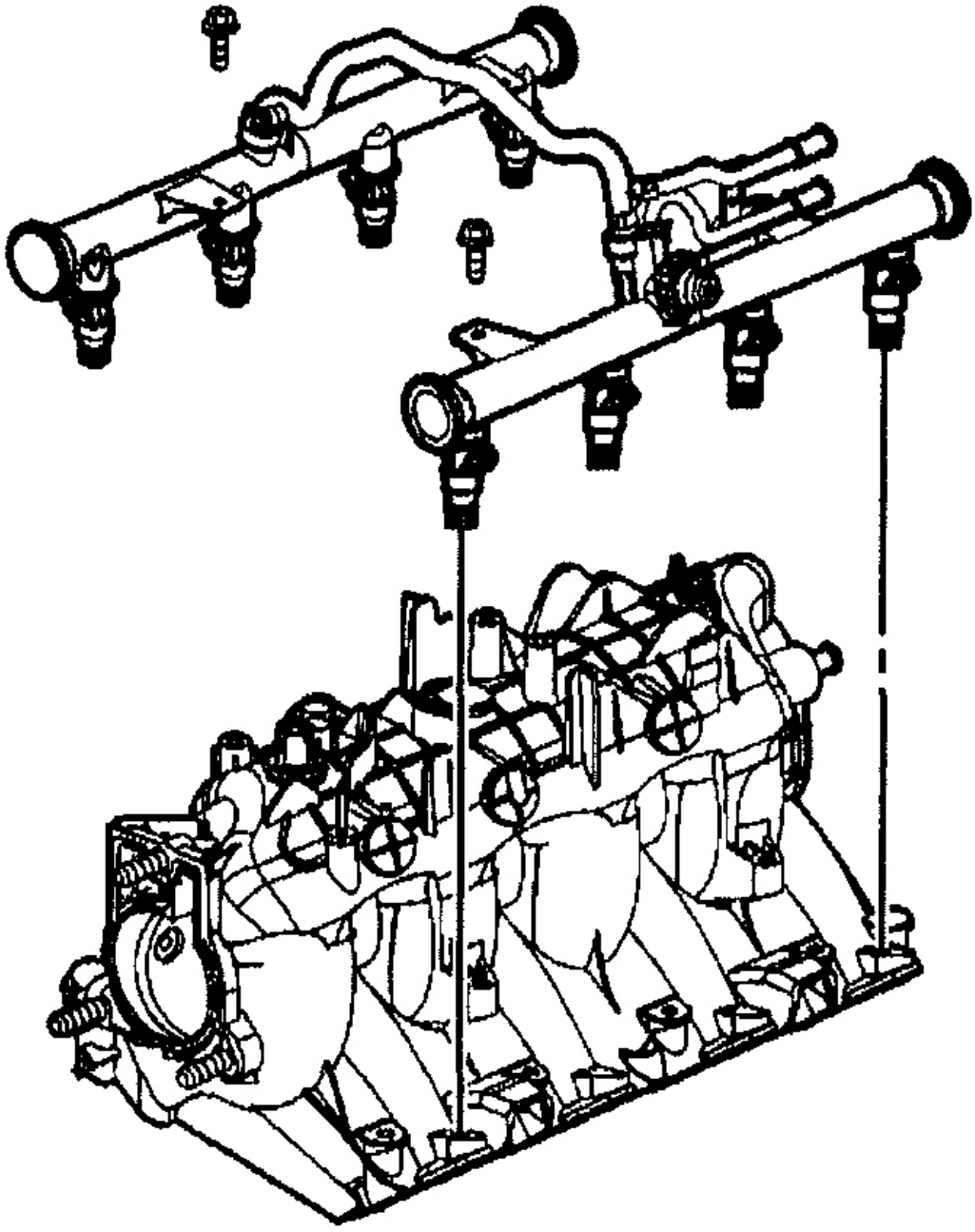
IMPORTANT: DO NOT reuse fuel injector O-ring seals. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals with clean engine oil.
2. Install the O-ring seals onto the fuel injectors.
3. Install a new O-ring seal to the right side of the crossover tube.
4. Assemble the crossover tube and bolt to the right fuel rail.
5. Install the fuel rail, with fuel injectors, into the intake manifold.

   Press evenly on both sides of the fuel rail until all of the injectors are seated in their bores.

6. Apply a 5 mm (0.2 in) band of threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the fuel rail bolts. Refer to **Sealers, Adhesives, and Lubricants** .

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Fig. 440: Fuel Rail & Injectors Assembly
Courtesy of GENERAL MOTORS CORP.

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NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

7. Install the fuel rail bolts.

Tighten

7.1. Tighten the fuel rail bolts to 10 N.m (89 lb in).
7.2. Tighten the crossover tube right side retaining bolt to 3.8 N.m (34 lb in).

8. Install the fuel rail stop bracket and bolt.

Tighten

Tighten the fuel rail stop bracket bolt to 50 N.m (37 lb ft).

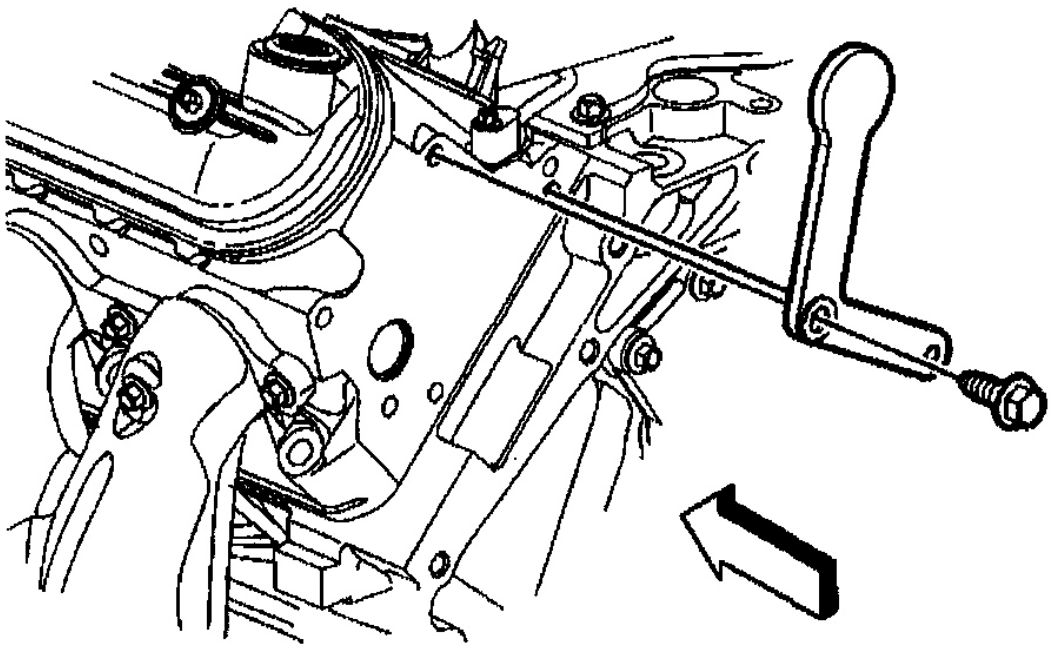


Fig. 441: Fuel Rail Stop Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

THROTTLE BODY INSTALLATION

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

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1. Install the throttle body studs (if required).

   Tighten

   Tighten the throttle body studs to 6 N.m (53 lb in).

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

2. Install the throttle body gasket (1) to the intake manifold.

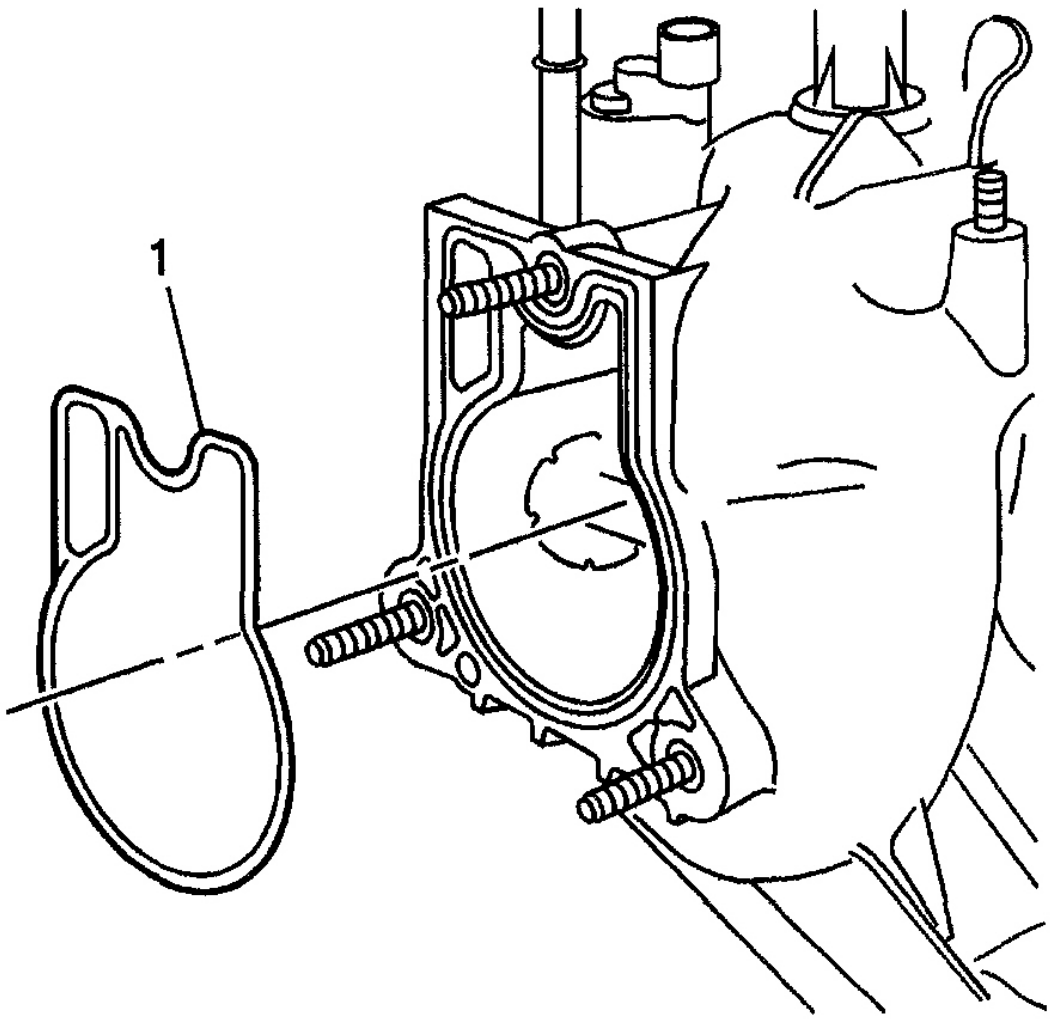


Fig. 442: Throttle Body Gasket

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Courtesy of GENERAL MOTORS CORP.

3. Install the throttle body and nuts.

   Tighten

   Tighten the throttle body nuts to 10 N.m (89 lb in).

4. Install the engine coolant air bleed hose and clamp to the throttle body.

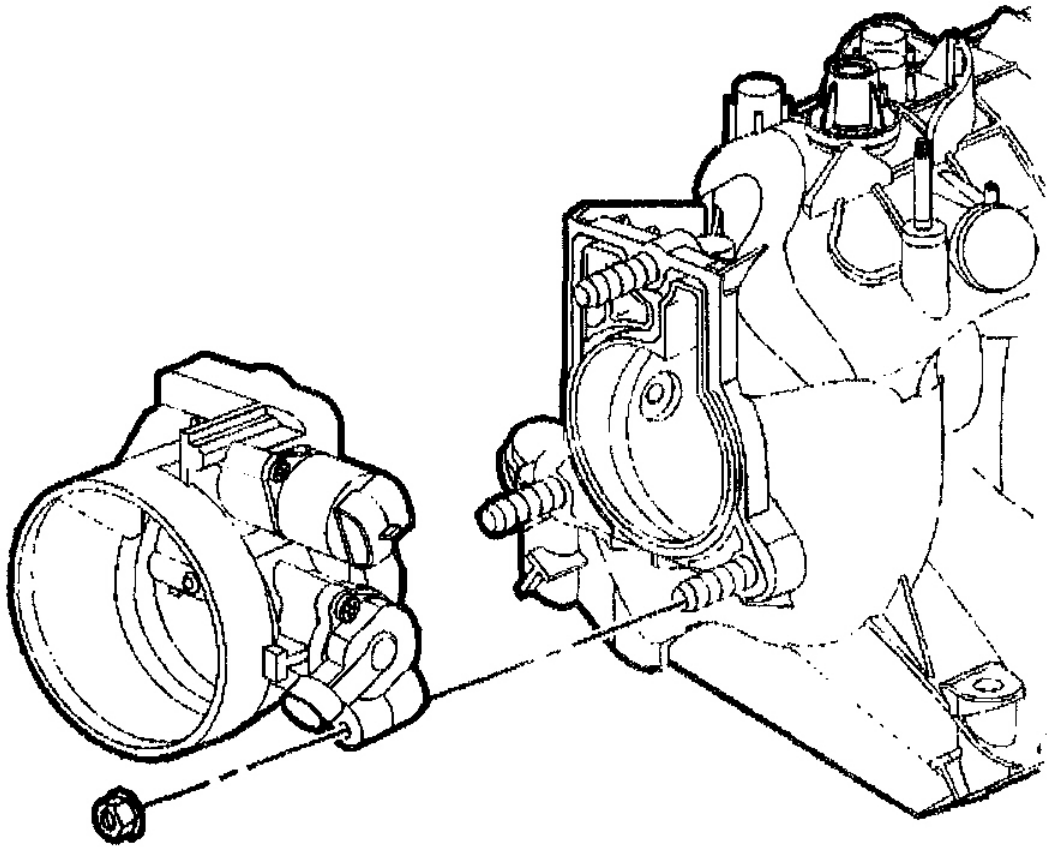


Fig. 443: Throttle Body & Nut
Courtesy of GENERAL MOTORS CORP.

WATER PUMP INSTALLATION

NOTE: **DO NOT use cooling system seal tabs, or similar compounds, unless otherwise instructed. The use of cooling system seal tabs, or similar compounds, may**

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restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

IMPORTANT: All gasket surfaces to be free of oil or other foreign material during assembly.

1. Install the water pump and NEW gaskets.

   NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

2. Install the water pump bolts.

   Tighten

   2.1. Tighten the water pump bolts first pass to 15 N.m (11 lb ft).
   2.2. Tighten the water pump bolts final pass to 30 N.m (22 lb ft).

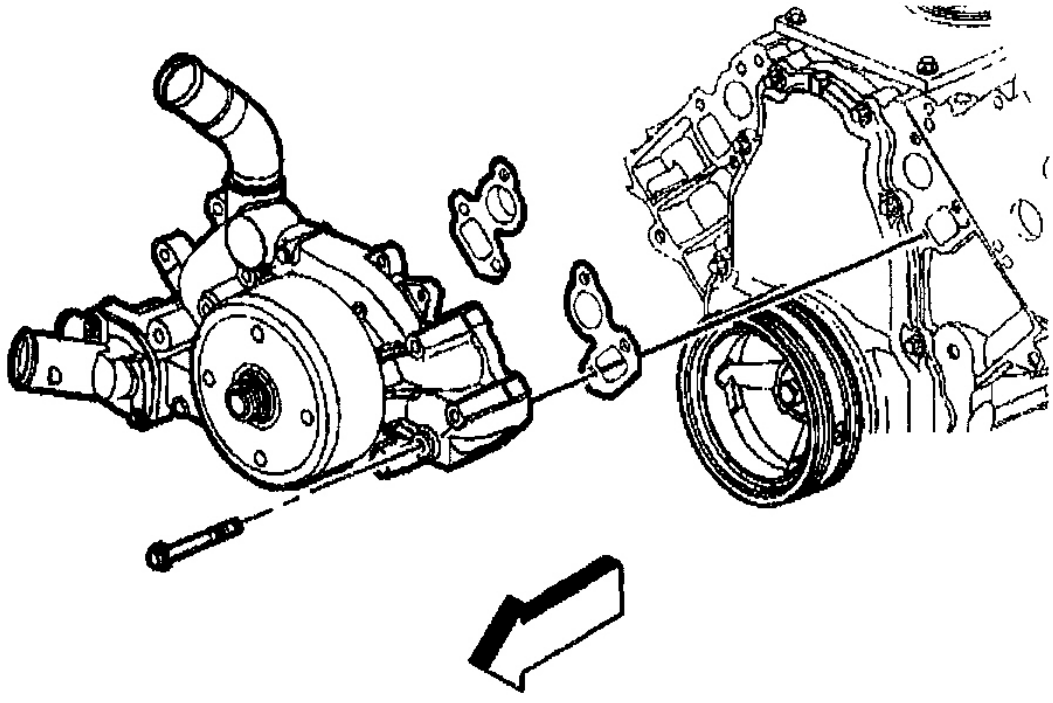


Fig. 444: Water Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

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EXHAUST MANIFOLD INSTALLATION - LEFT

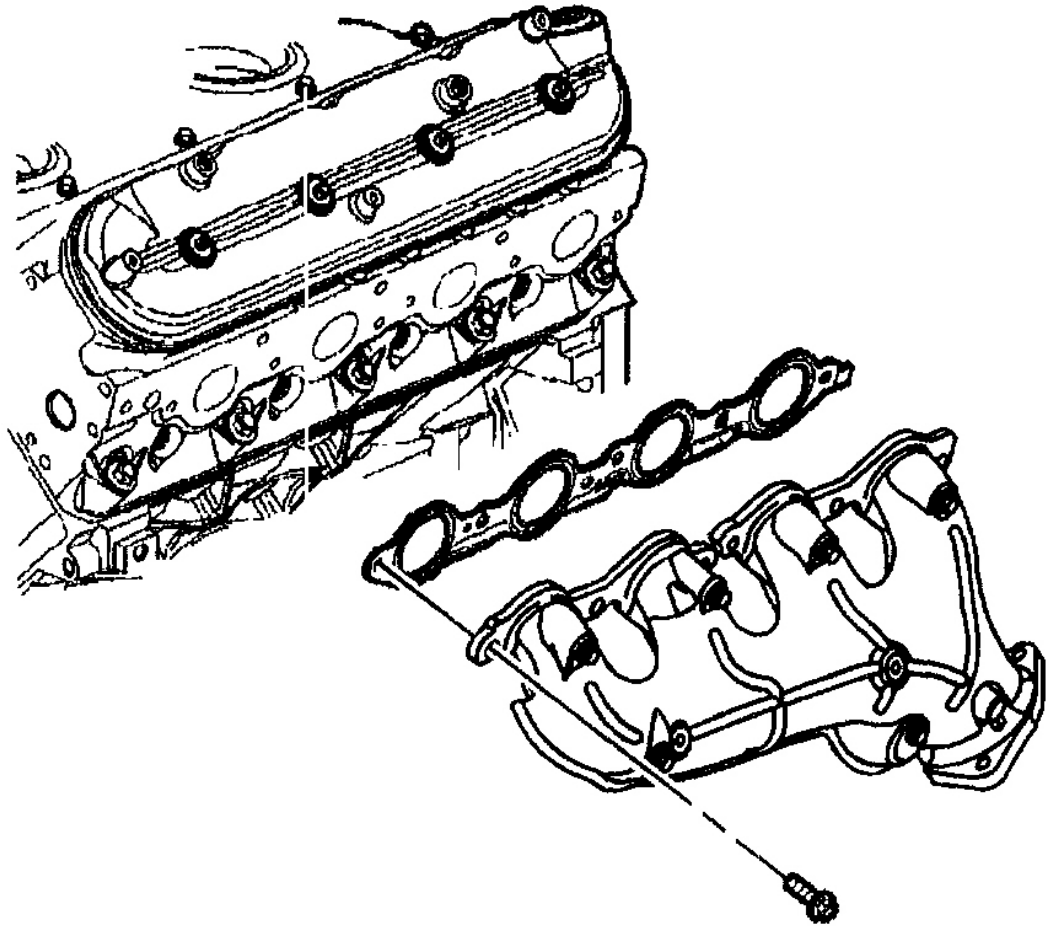
Important:

- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or On-Board Diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.

IMPORTANT: Do not apply sealant to the first three threads of the bolt.

1. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N United States 12345493, GM P/N Canada 10953488, or equivalent, to the threads of the exhaust manifold bolts. Refer to **Sealers, Adhesives, and Lubricants** .
2. Install the exhaust manifold and NEW exhaust manifold gasket.

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Fig. 445: Left Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the exhaust manifold bolts.

Tighten

3.1. Tighten the exhaust manifold bolts a first pass to 15 N.m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward the outside bolts.

3.2. Tighten the exhaust manifold bolts a final pass to 25 N.m (18 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward

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the outside bolts.

4. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.
5. Install the heat shield (2) and bolts (3).

Tighten

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

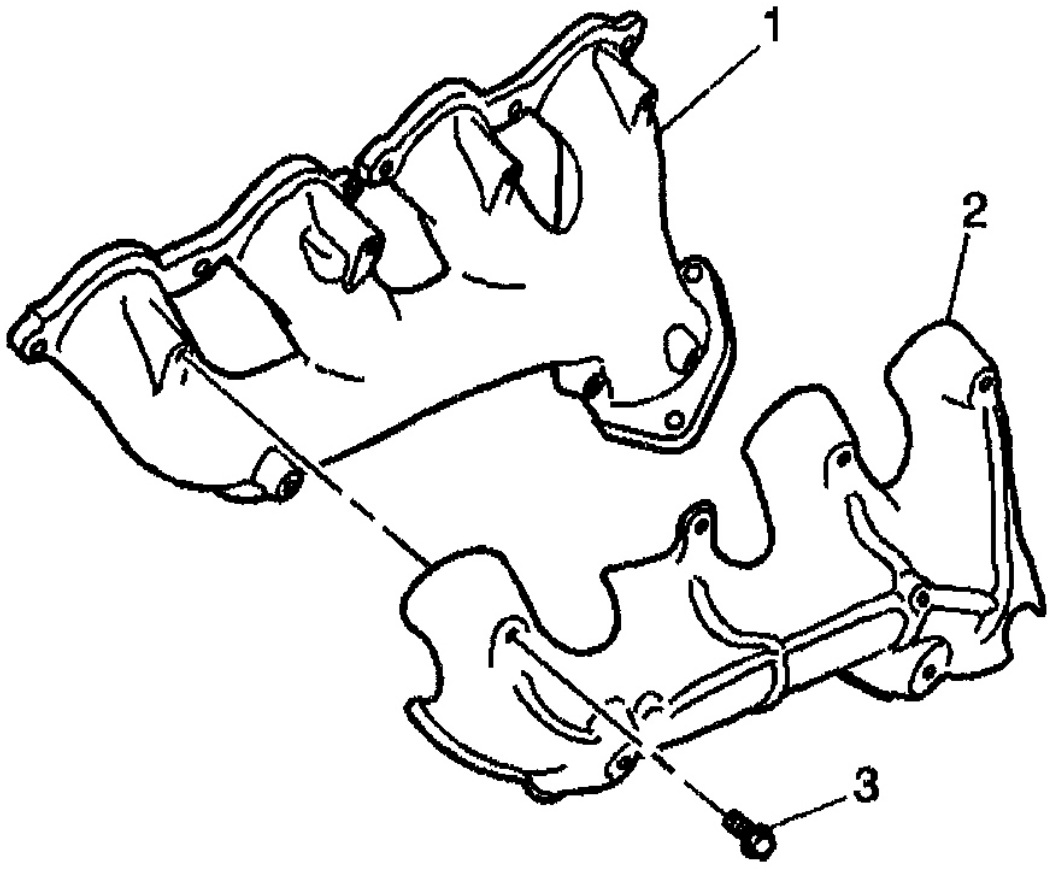


Fig. 446: Left Exhaust Manifold, Heatshield & Bolt
Courtesy of GENERAL MOTORS CORP.

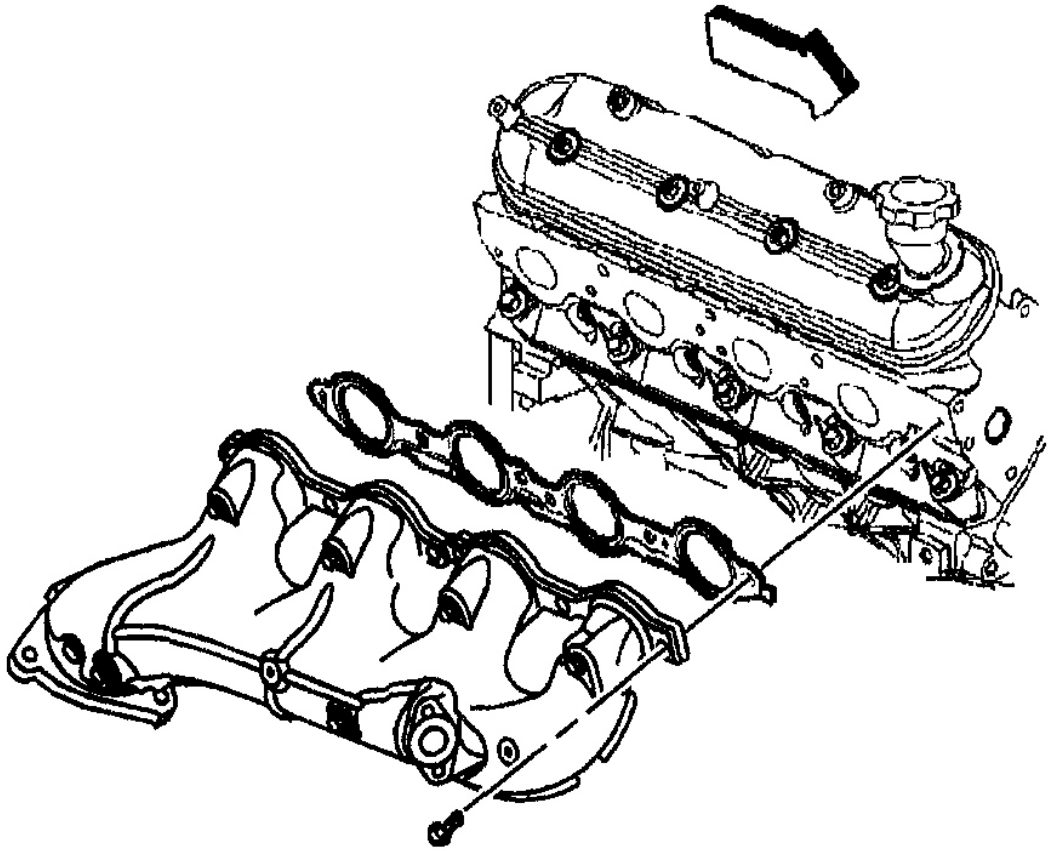
EXHAUST MANIFOLD INSTALLATION - RIGHT

Important:

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- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or On-Board Diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.
- Do not reuse Exhaust Gas Recirculation (EGR) valve and pipe gaskets or seals during assembly. Install NEW gaskets and O-ring seal.

1. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N United States 12345493, GM P/N Canada 10953488, or equivalent, to the threads of the exhaust manifold bolts. Refer to **Sealers, Adhesives, and Lubricants** .
2. Install the exhaust manifold gasket and exhaust manifold.



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Fig. 447: Right Exhaust Manifold, Gasket & Bolt
Courtesy of GENERAL MOTORS CORP.

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NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

3. Install the exhaust manifold bolts.

   Tighten

   3.1. Tighten the exhaust manifold bolts first pass to 15 N.m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward the outside bolts.

   3.2. Tighten the exhaust manifold bolts final pass to 25 N.m (18 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward the outside bolts.

4. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the front of the right cylinder head.
5. Install the heat shield (2) and bolts (3).

   Tighten

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

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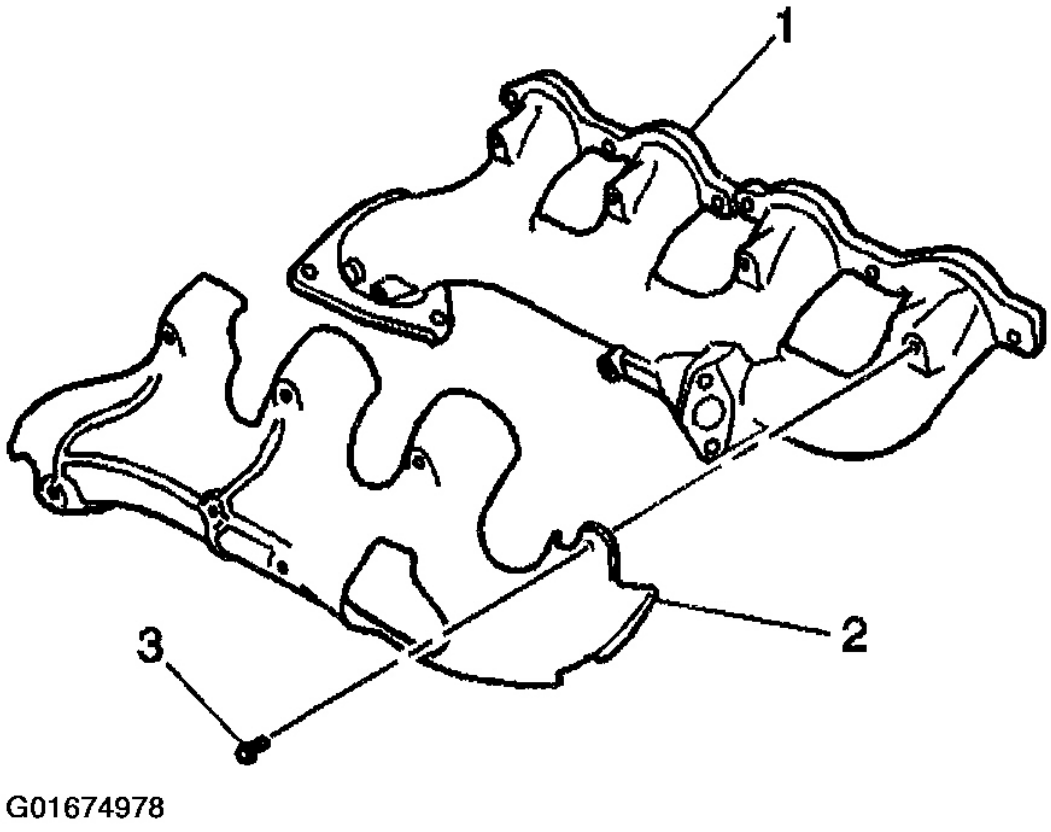


Fig. 448: Right Exhaust Manifold, Heat Shield & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Apply a light coating of clean engine oil to a NEW O-ring seal (1) and install the seal onto the EGR pipe (2), if applicable.
7. Insert the EGR pipe into the intake manifold.

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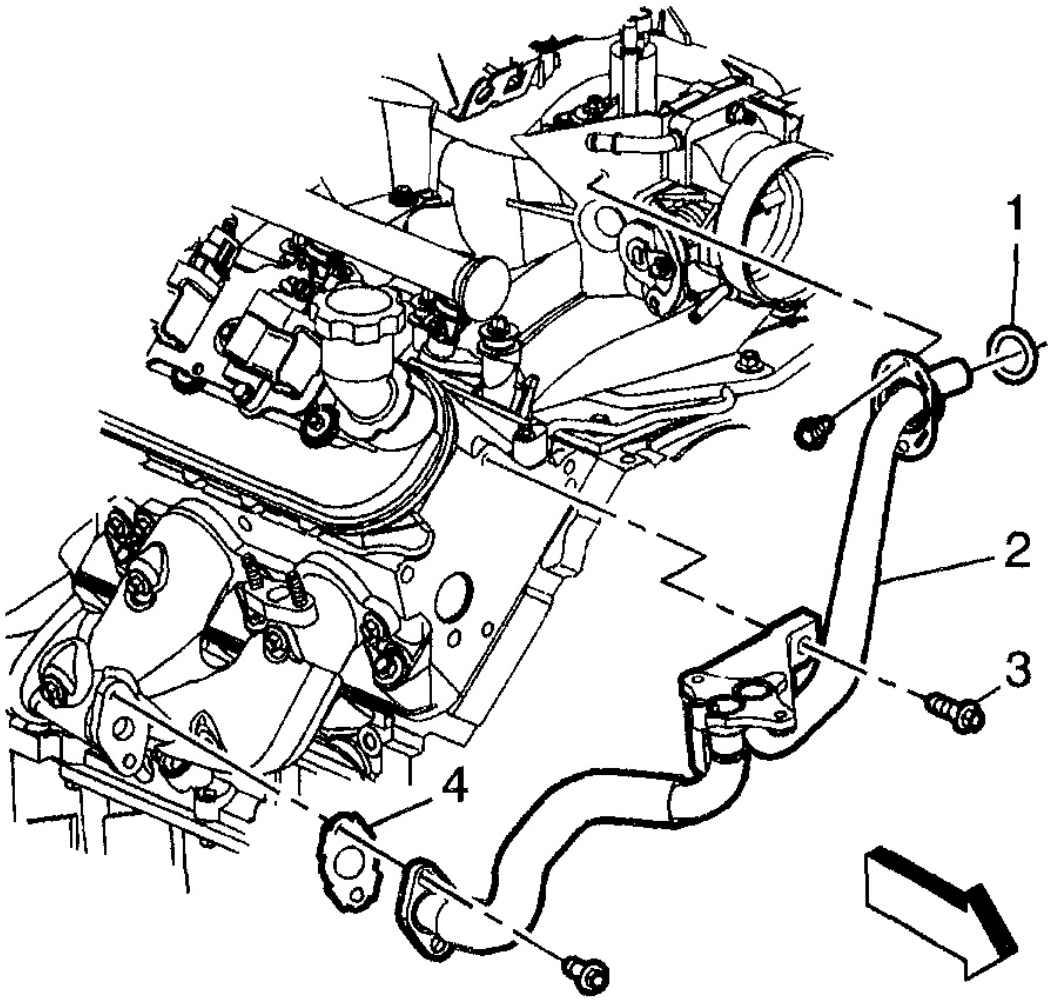


Fig. 449: EGR Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Start the EGR pipe to intake manifold bolt (1).

   Do not tighten the bolt at this time.

9. Install the EGR pipe to cylinder head bolts.

   Do not tighten the bolts at this time.

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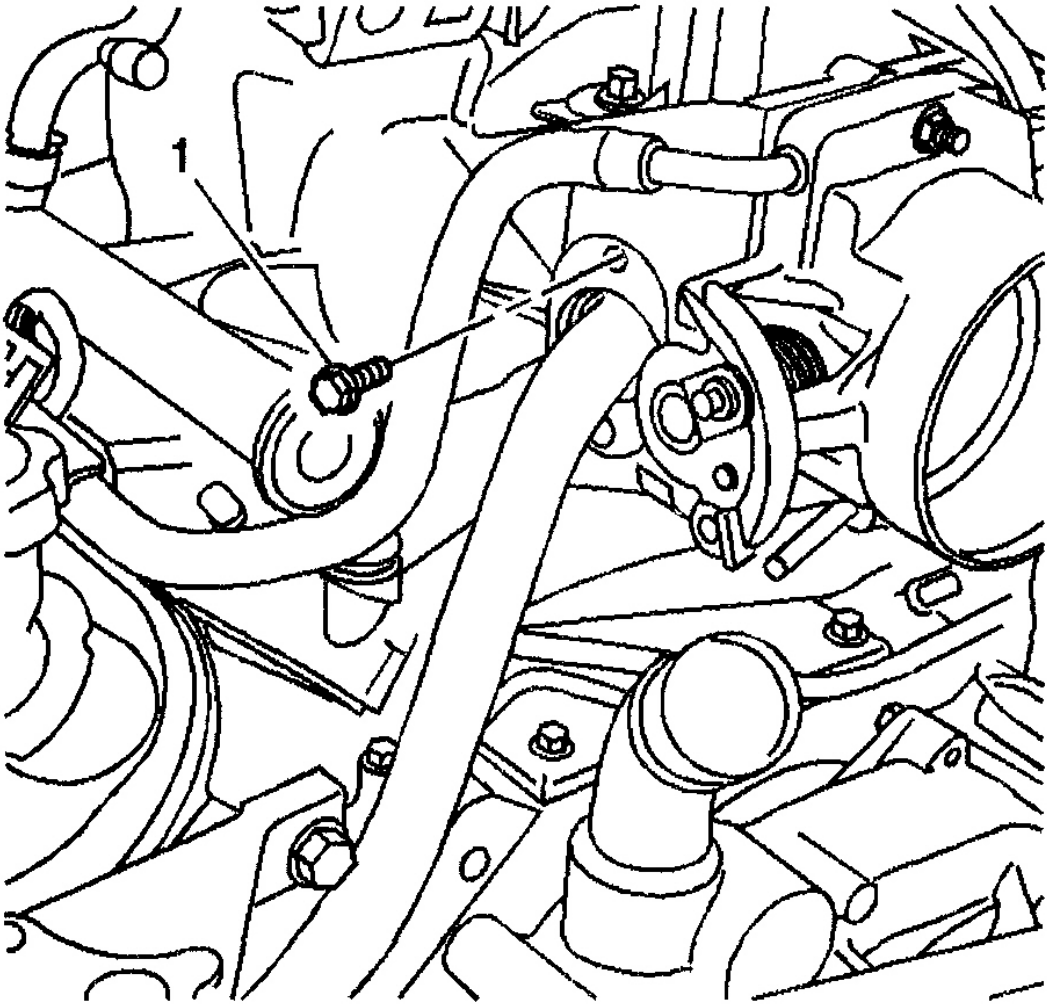


Fig. 450: EGR Pipe-To-Intake Manifold Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install a NEW EGR pipe exhaust manifold gasket and bolts (1).

Tighten

10.1. Tighten the EGR pipe to intake manifold bolt to 10 N.m (89 lb in).
10.2. Tighten the EGR pipe to cylinder head bolts to 50 N.m (37 lb ft).
10.3. Tighten the EGR pipe to exhaust manifold bolts to 30 N.m (22 lb ft).

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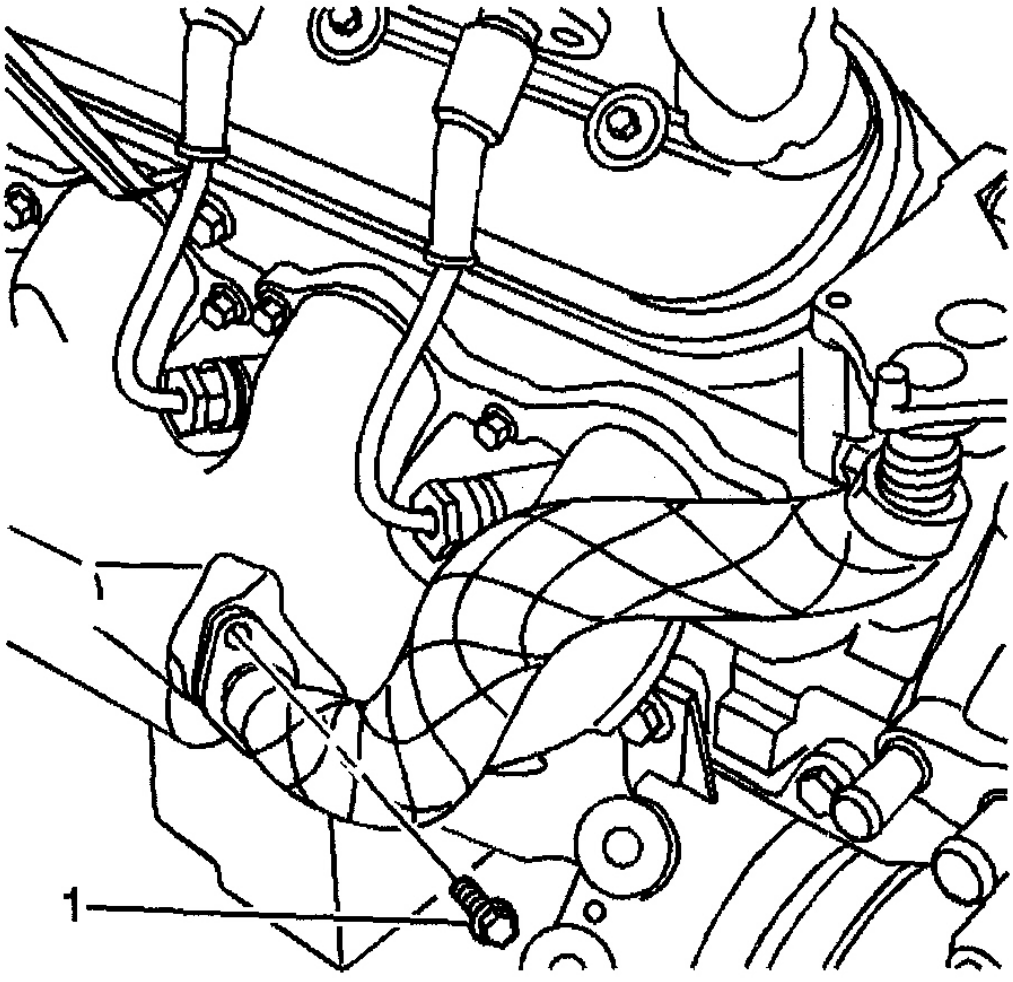


Fig. 451: EGR Pipe Exhaust Manifold Gasket & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Install the EGR valve, a NEW gasket, and bolts.

Tighten

11.1. Tighten the EGR valve bolts a first pass to 10 N.m (89 lb in).
11.2. Tighten the EGR valve bolts a second pass to 25 N.m (18 lb ft).

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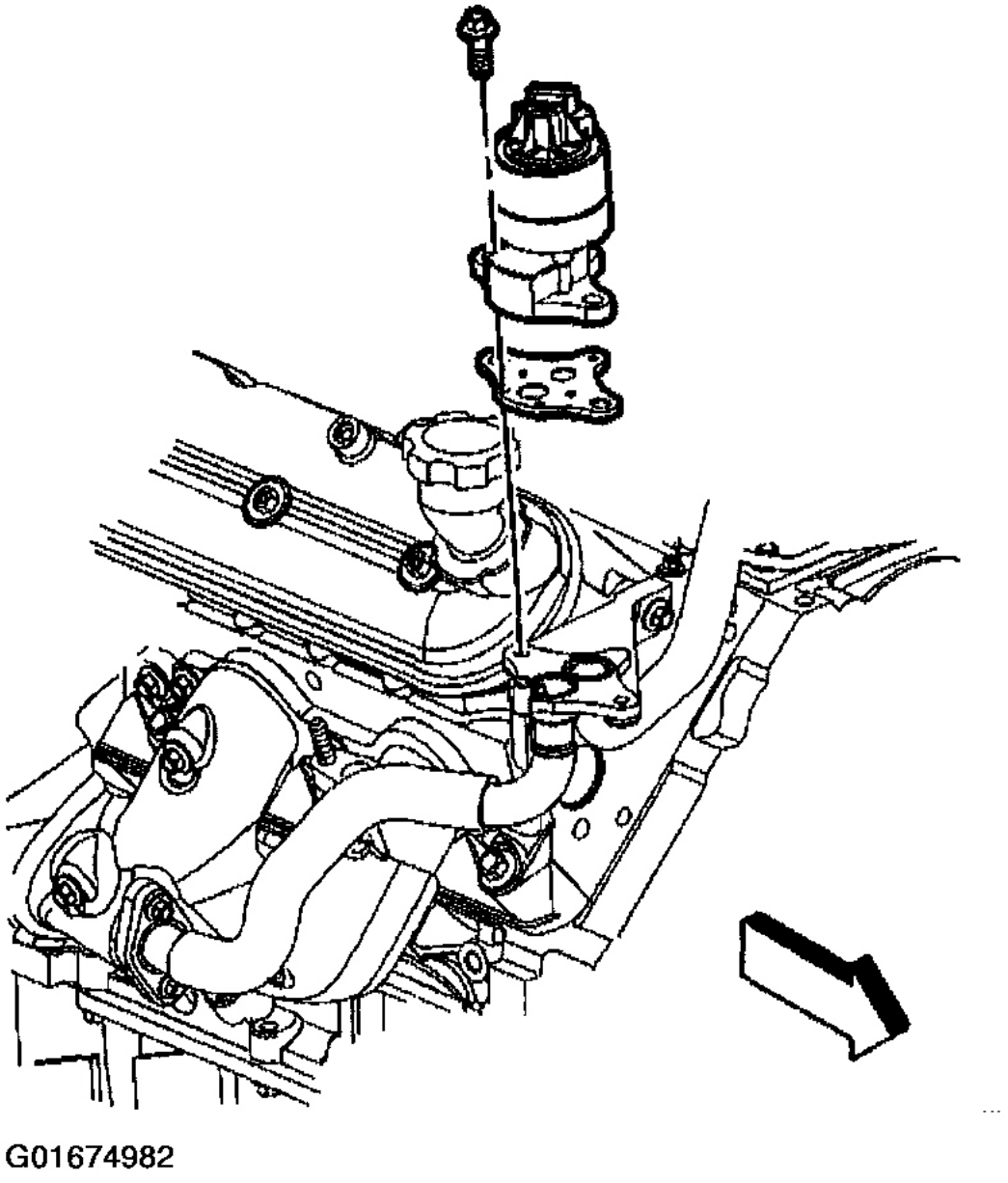


Fig. 452: EGR Valve, Gasket & Bolt
Courtesy of GENERAL MOTORS CORP.

OIL LEVEL INDICATOR AND TUBE INSTALLATION

1. Inspect the O-ring seal for cuts or damage. If the oil level indicator tube O-ring seal is not cut or damaged, it may be reused.

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2. Lubricate the O-ring seal with clean engine oil.
3. Install the O-ring seal onto the oil level indicator tube.
4. Install the oil level indicator tube into the engine block and rotate into proper position.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

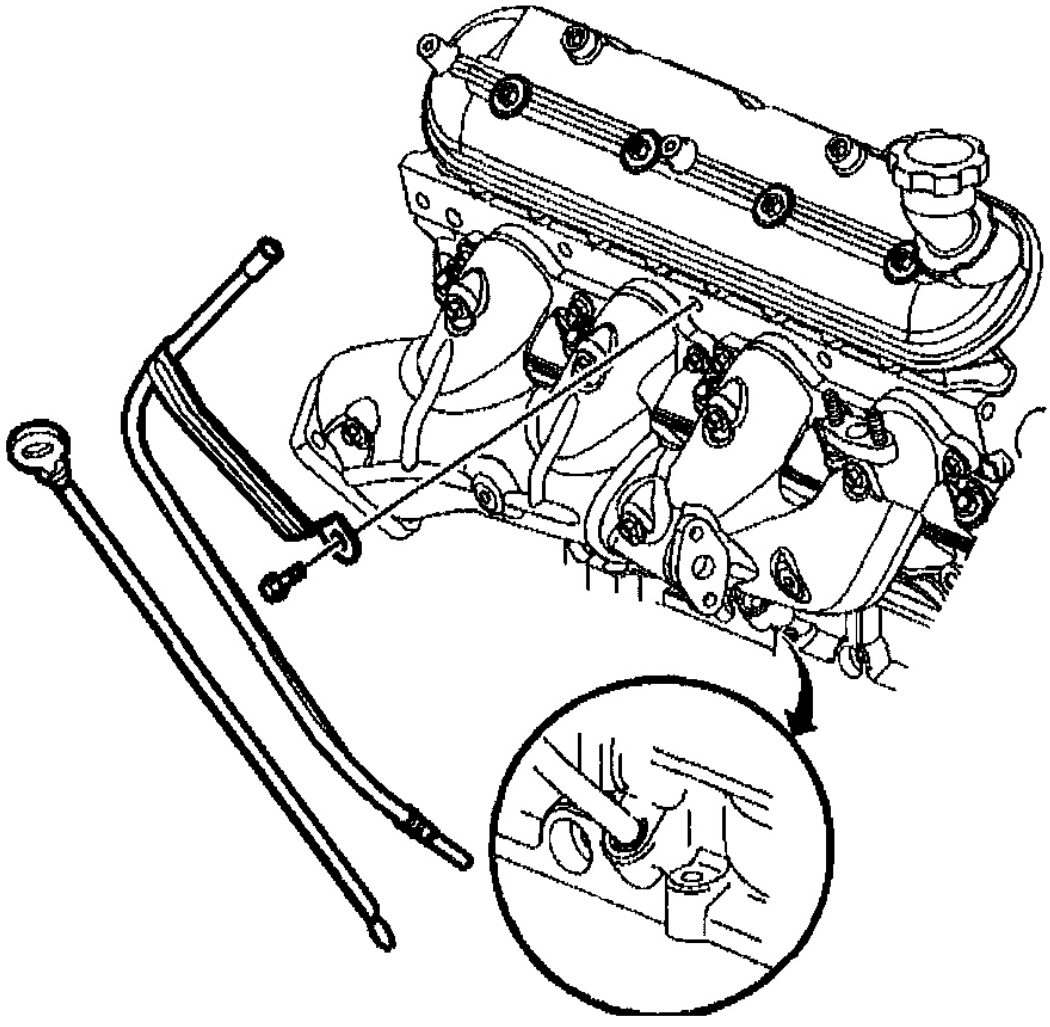
5. Install the tube bolt.

   Tighten

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

6. Install the oil level indicator into the tube.

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Fig. 453: Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

CLUTCH PILOT BEARING INSTALLATION

Tools Required

J 38836 Pilot Bushing Installer/Clutch

IMPORTANT: The flywheel spacer (if applicable) must be removed prior to pilot bearing installation.

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1. Install a 5/8 inch washer (1) onto the **J 38836** or equivalent.
2. Install the new pilot bearing (2) onto the tool.

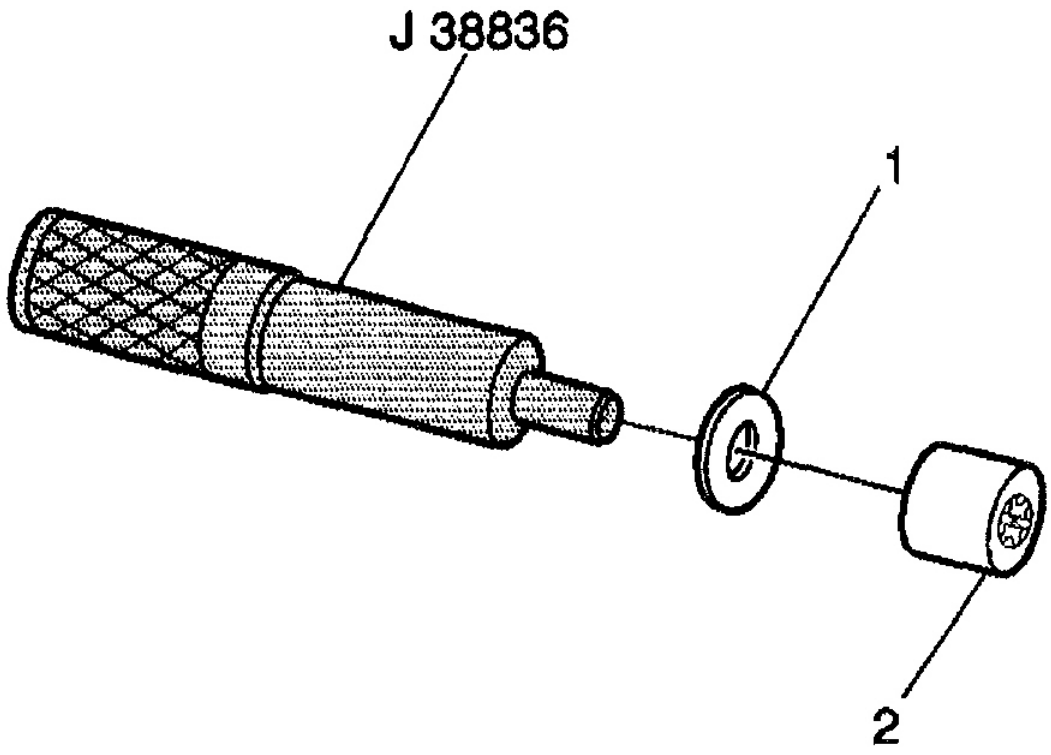


Fig. 454: J 38836, Washer & Pilot Bearing
Courtesy of GENERAL MOTORS CORP.

3. Install the new pilot bearing into the crankshaft using the **J 38836** .

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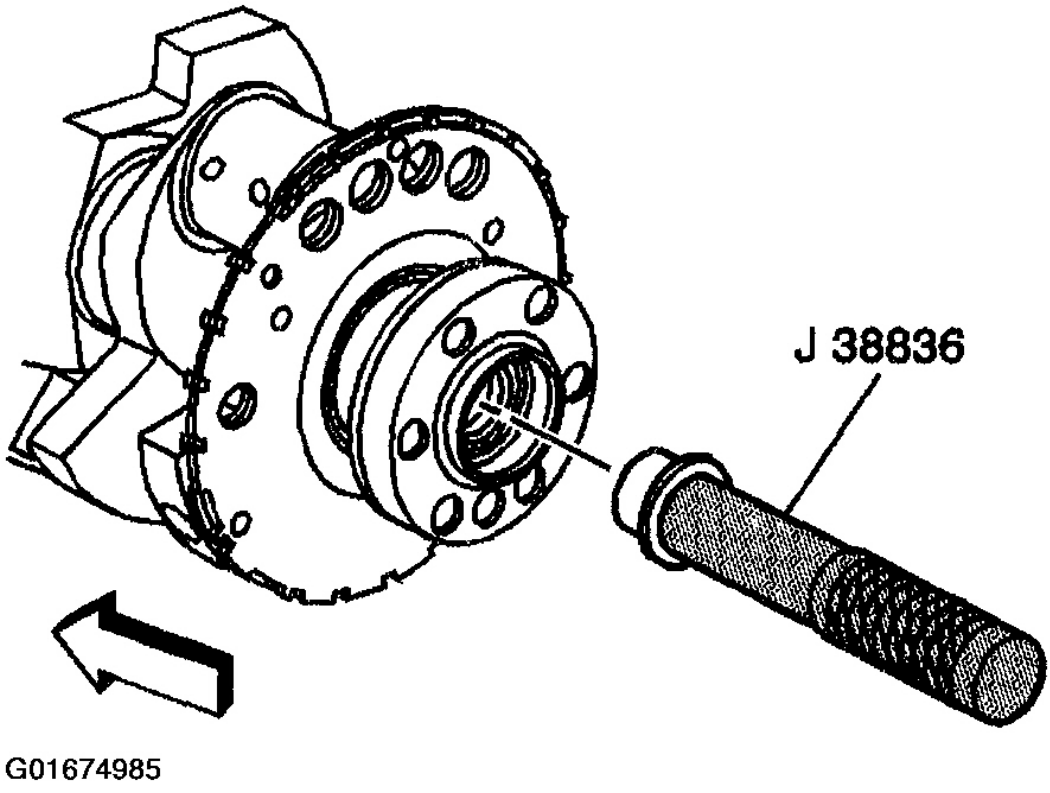


Fig. 455: Installing Pilot Bearing Using J 38836
Courtesy of GENERAL MOTORS CORP.

4. Inspect the clutch pilot bearing for proper installation.

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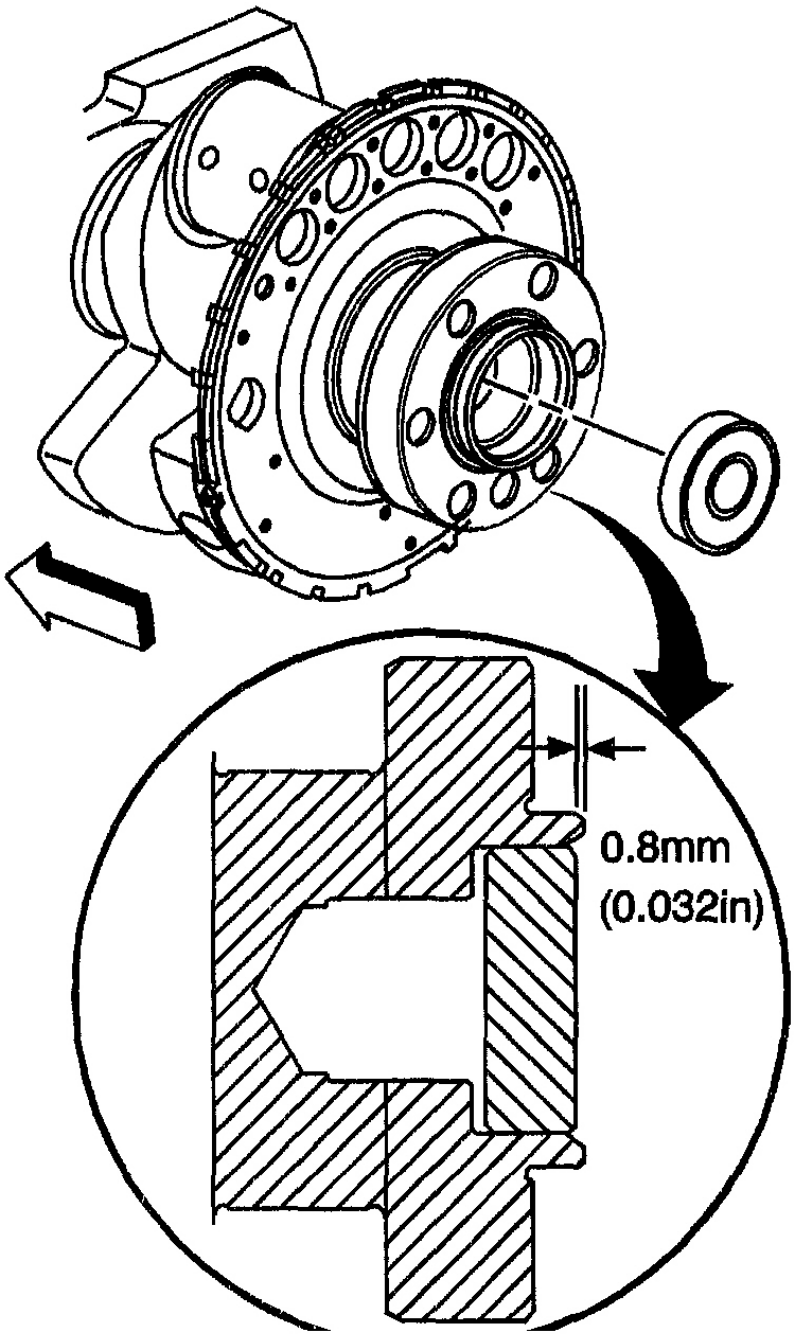


Fig. 456: Pilot Bearing Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

ENGINE FLYWHEEL INSTALLATION

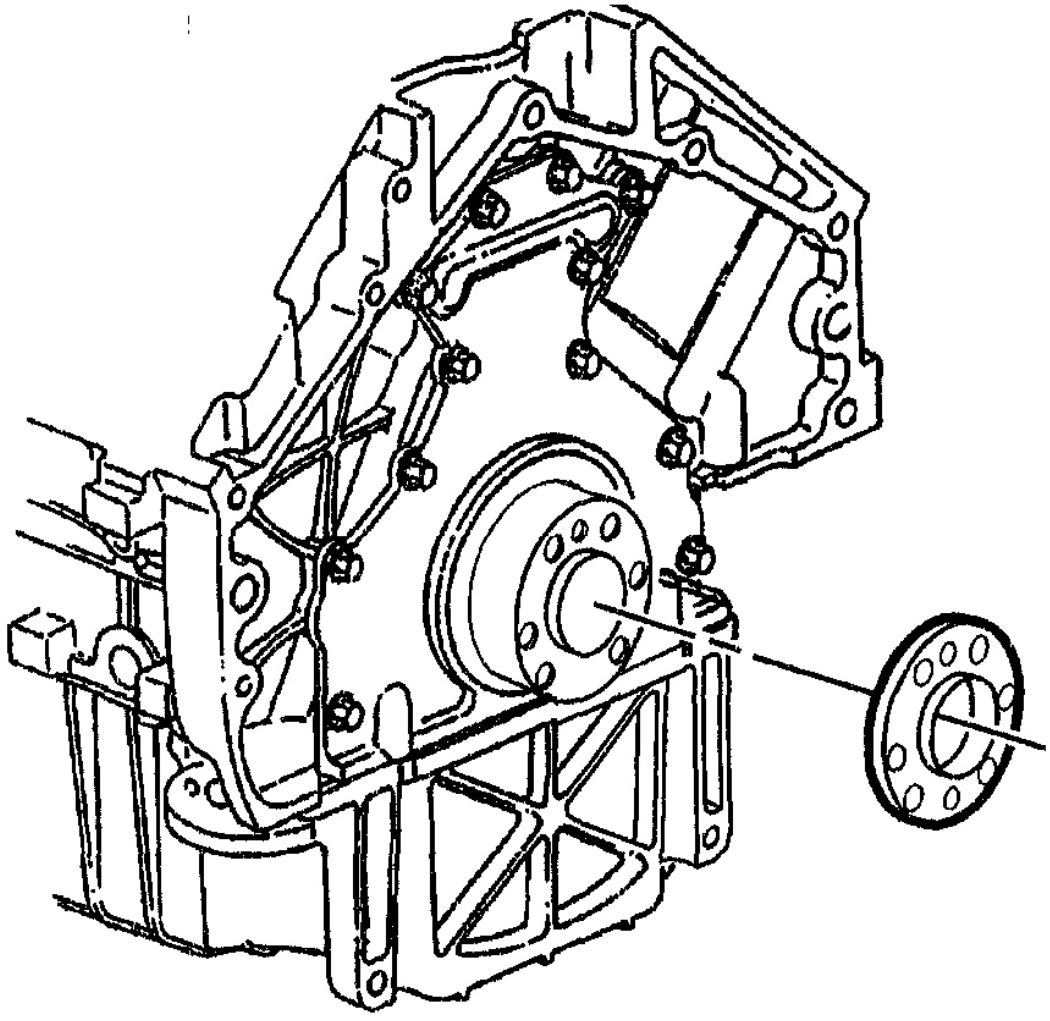
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Important:

- The flywheel does not use a locating pin for alignment, and will not initially seat against the crankshaft flange or spacer, if applicable, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a three stage tightening process.
- Certain applications, the 4.8 L manual transmission and all 6.0 L, require a spacer and longer bolts for proper flywheel position.

1. Install the spacer, if applicable, onto the rear of the crankshaft.

   A longer flywheel bolt must be used on applications using a flywheel spacer.

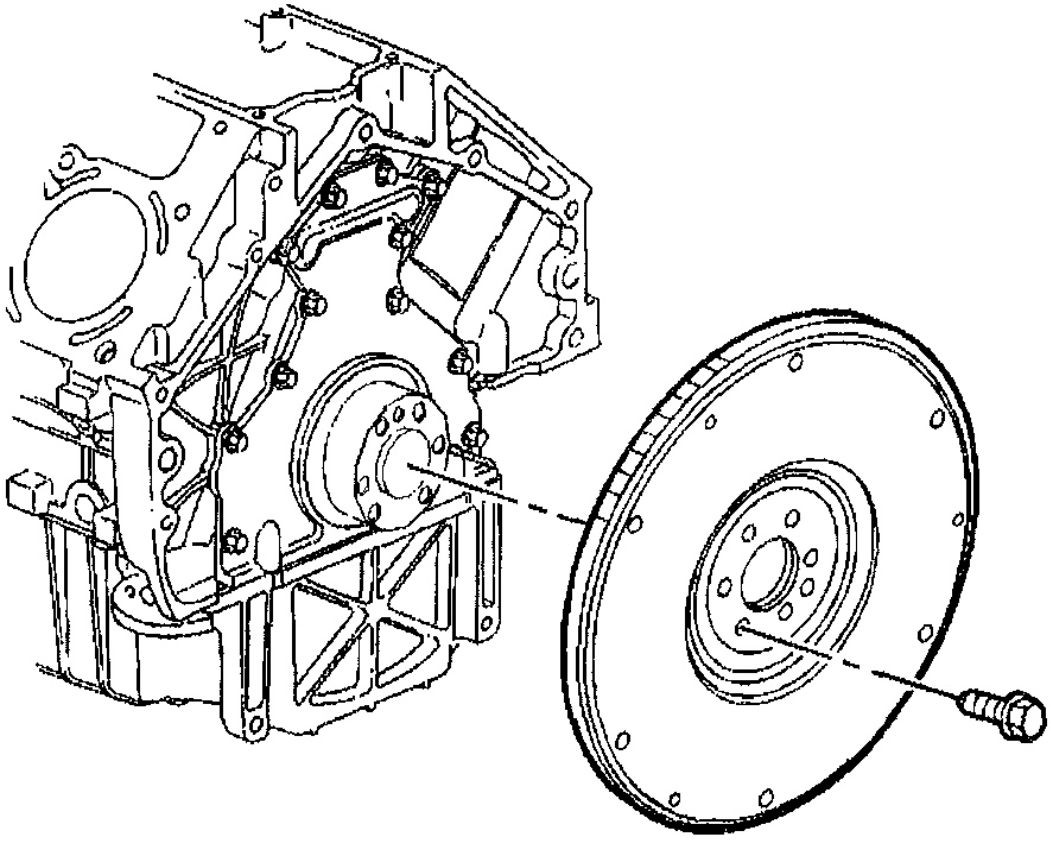


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Fig. 457: Flywheel Spacer
Courtesy of GENERAL MOTORS CORP.

2. Install the manual transmission engine flywheel to the crankshaft, if applicable.



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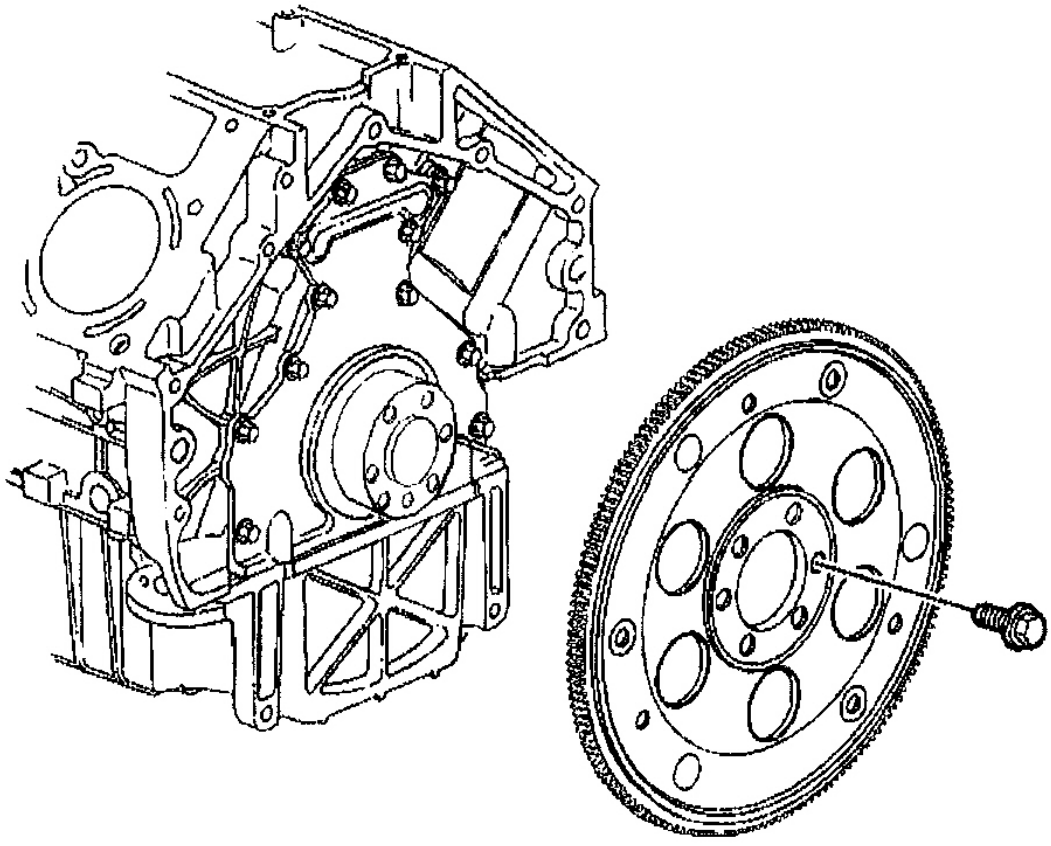
Fig. 458: Manual Transmission Engine Flywheel
Courtesy of GENERAL MOTORS CORP.

3. Install the automatic transmission engine flywheel to the crankshaft, if applicable.

IMPORTANT: A longer flywheel bolt must be used on applications using a flywheel spacer.

4. Apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the flywheel bolts.

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Fig. 459: Automatic Transmission Engine Flywheel
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

5. Install the engine flywheel bolts.

Tighten

5.1. Tighten the engine flywheel bolts first pass in sequence to 20 N.m (15 lb ft).
5.2. Tighten the engine flywheel bolts second pass in sequence to 50 N.m (37 lb ft).
5.3. Tighten the engine flywheel bolts final pass in sequence to 100 N.m (74 lb ft).

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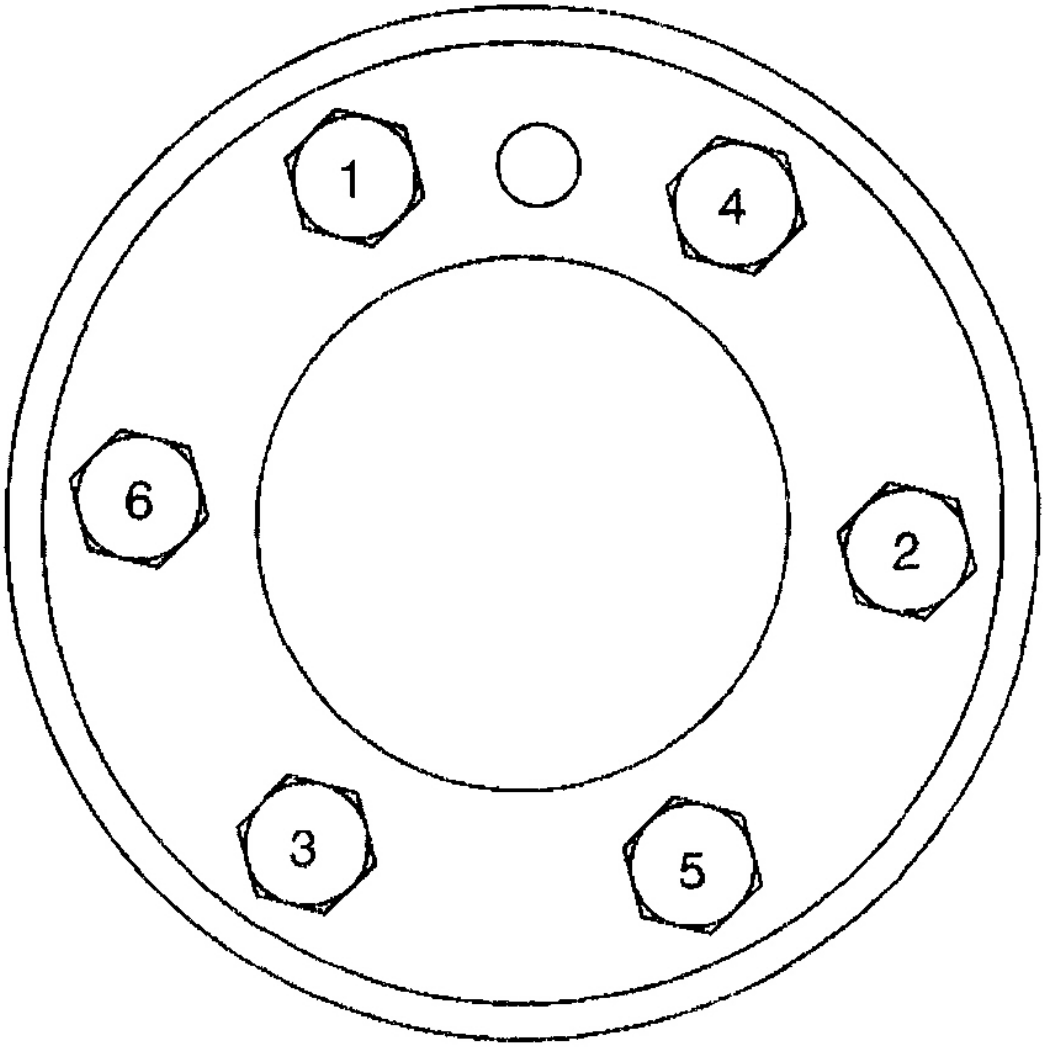


Fig. 460: Engine Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CRANKSHAFT BALANCER INSTALLATION

Tools Required

- **J 41665** Crankshaft Balancer and Sprocket Installer
- **J 36660-A** Torque Angle Meter
- **J 42386-A** Flywheel Holding Tool

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Important:

- The crankshaft balancer is balanced as an individual component. It is not necessary to mark the balancer prior to removal.
- The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the new bolt to the proper torque.
- The used crankshaft balancer bolt will be used only during the first pass of the balancer installation procedure. Install a NEW crankshaft balancer bolt and tighten as described in the second, third and fourth passes of the balancer bolt tightening procedure.

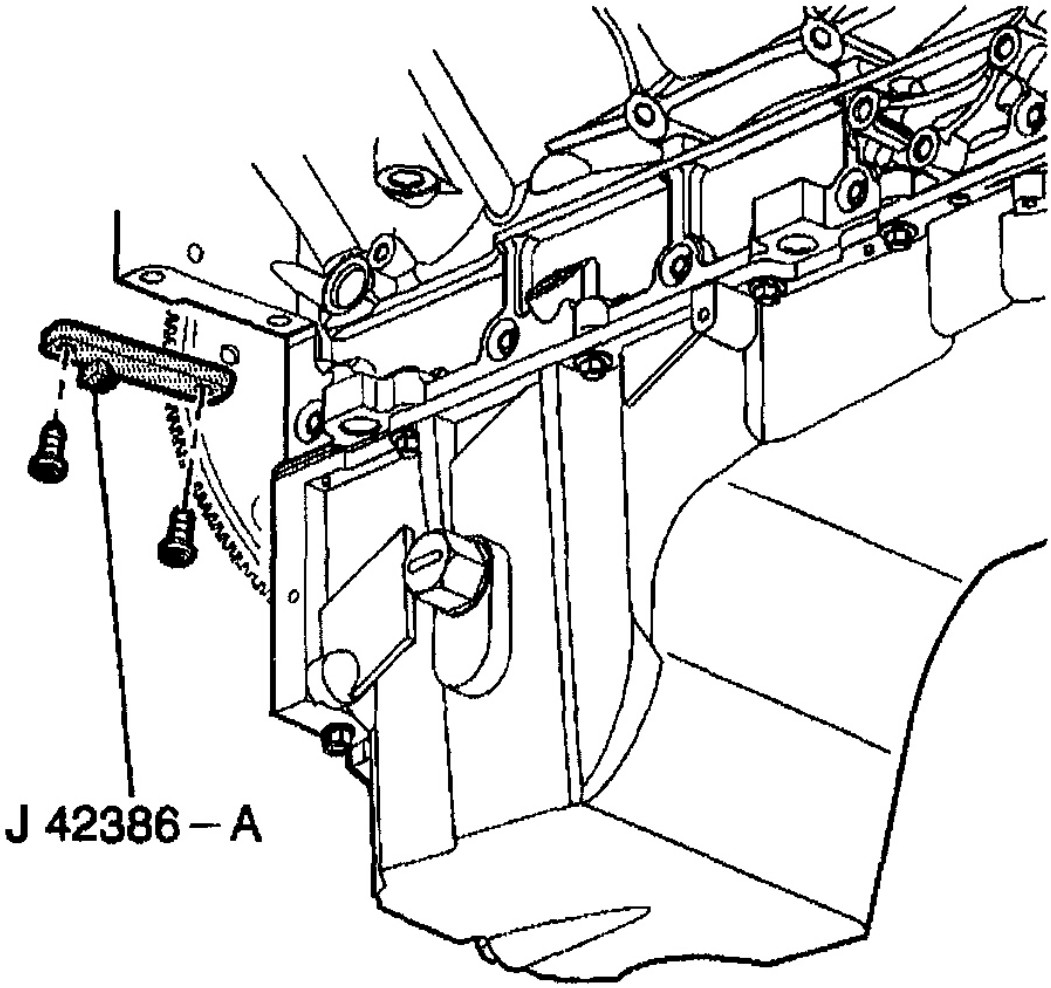


Fig. 461: J 42386-A
Courtesy of GENERAL MOTORS CORP.

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- Make sure the teeth of the tool engage the engine flywheel teeth.

NOTE: Refer to FASTENER NOTICE in Cautions and Notices.

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

   Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation.

   Tighten

   Tighten the **J 42386-A** bolts to 50 N.m (37 lb ft).

   IMPORTANT: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

2. Install the balancer onto the end of the crankshaft.

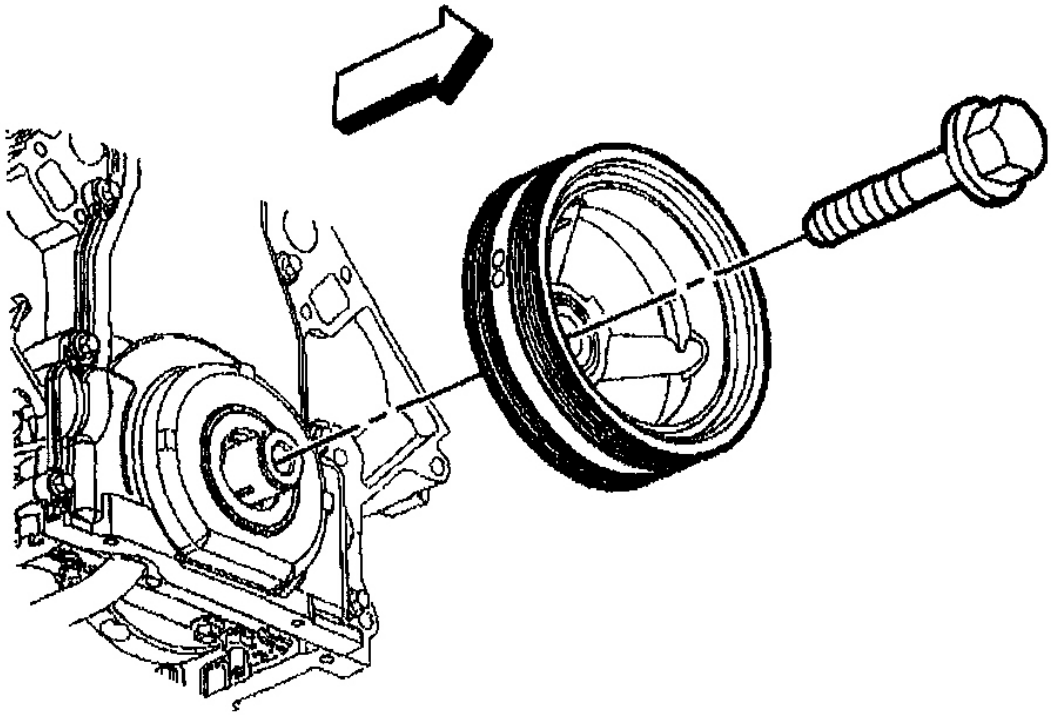


Fig. 462: Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

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3. Use the **J 41665** in order to install the balancer.

   3.1. Assemble the threaded rod, nut, washer and installer.

   Insert the smaller end of the installer into the front of the balancer.

   3.2. Use a wrench and hold the hex end of the threaded rod.

   3.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto crankshaft.

   3.4. Remove the tool and reverse the installation tool.

   Position the larger end of the installer against the front of the balancer.

   3.5. Use a wrench and hold the hex end of the threaded rod.

   3.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.

   3.7. Remove the balancer installation tool.

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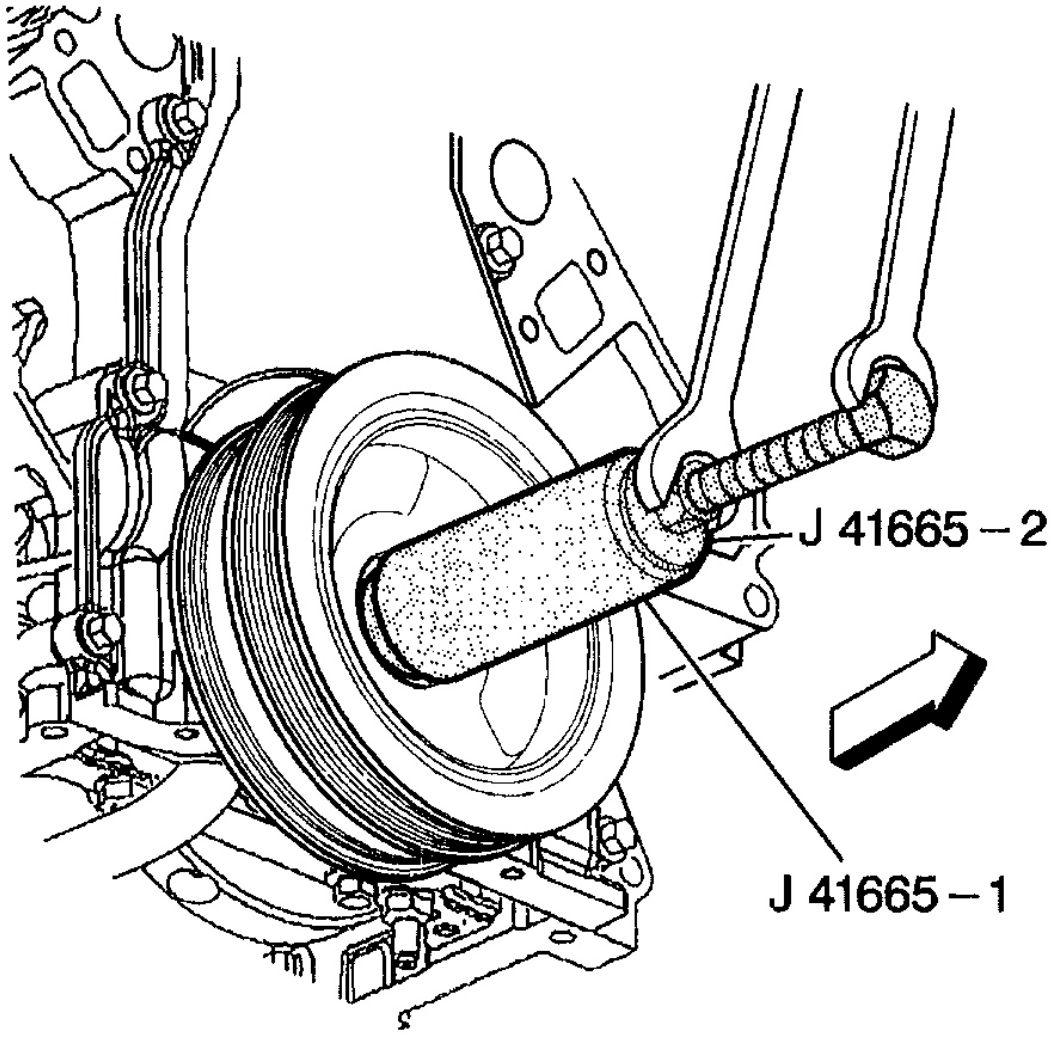


Fig. 463: Installing Crankshaft Balancer Using J 41665
Courtesy of GENERAL MOTORS CORP.

4. Install the used crankshaft balancer bolt.

   Tighten

   Tighten the crankshaft balancer bolt to 330 N.m (240 lb ft).

5. Remove the used crankshaft balancer bolt.

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IMPORTANT: The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

6. Measure for a correctly installed balancer.

   If the balancer is not installed to the proper dimensions, install the **J 41665** and repeat the installation procedure.

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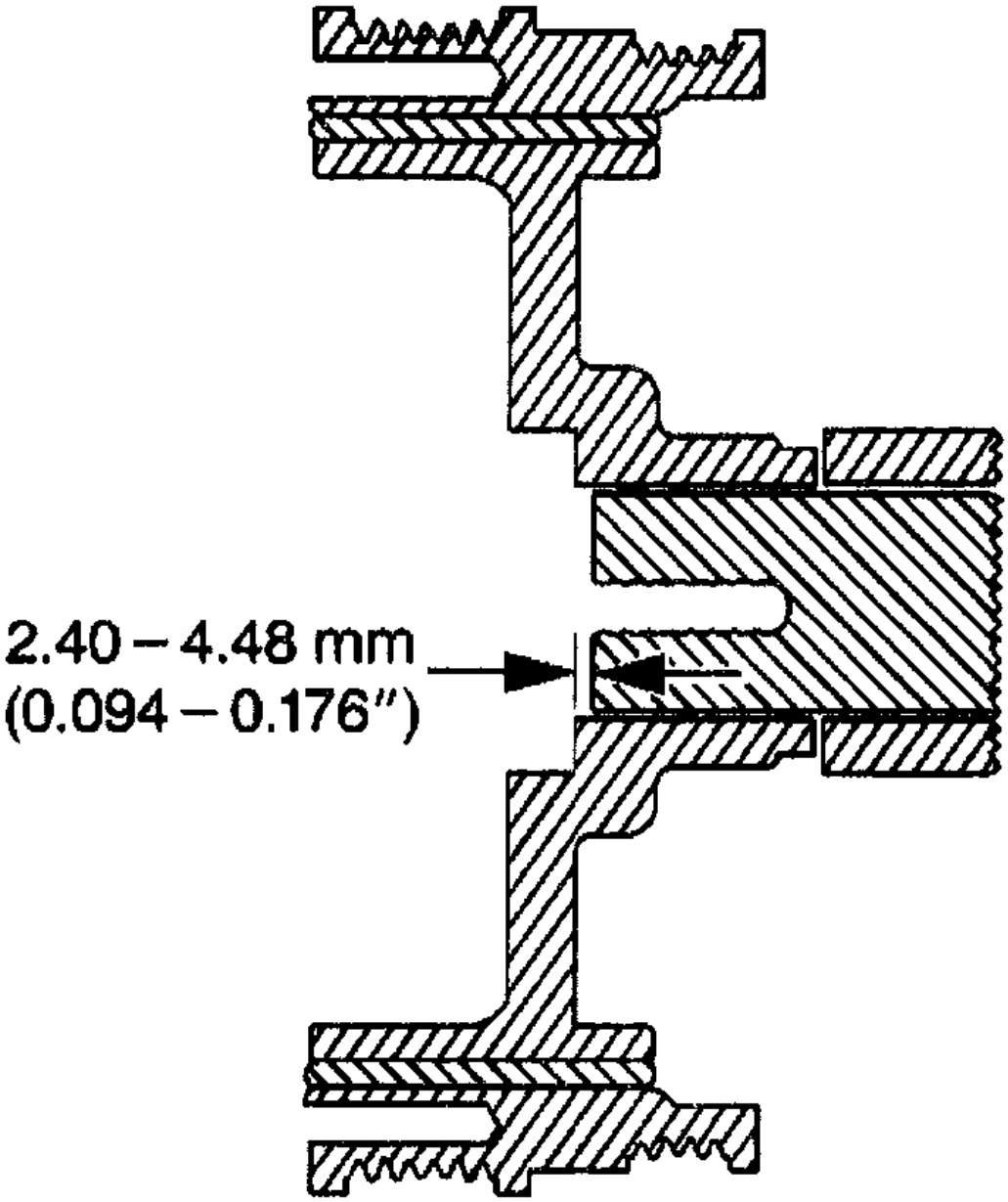


Fig. 464: Crankshaft Balancer Installation Position
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW crankshaft balancer bolt.

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Tighten

7.1. Tighten the crankshaft balancer bolt a first pass to 50 N.m (37 lb ft).

7.2. Tighten the crankshaft balancer bolt a second pass to 140 degrees using the **J 36660-A** .

8. Remove the **J 42386-A** .

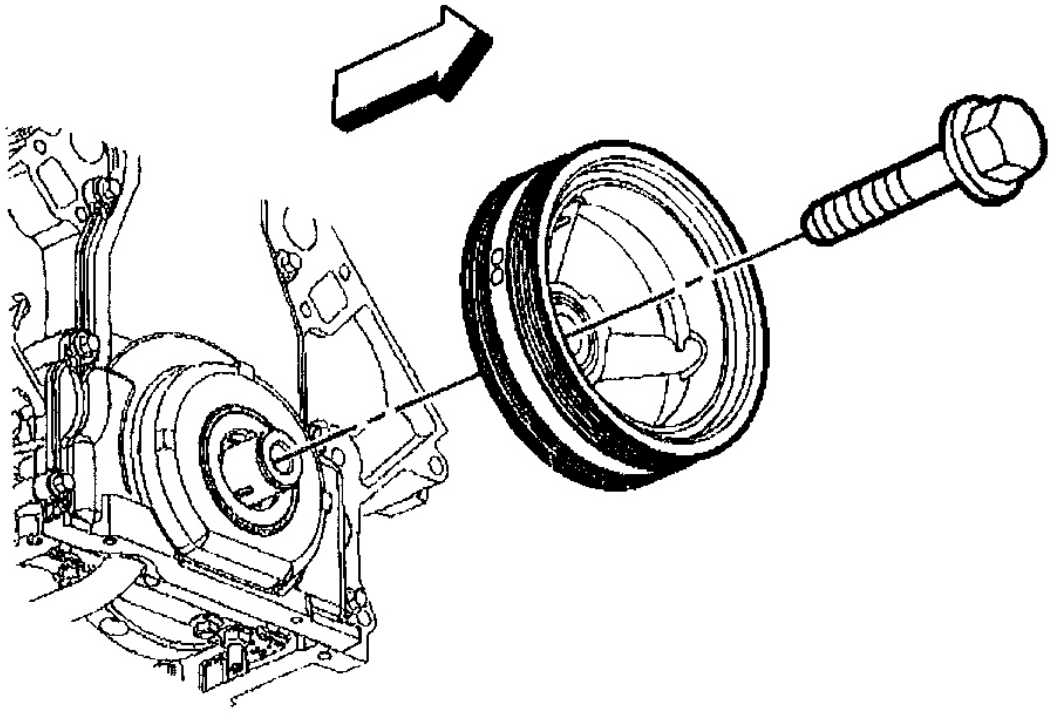


Fig. 465: Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

DESCRIPTION AND OPERATION

ENGINE COMPONENT DESCRIPTION

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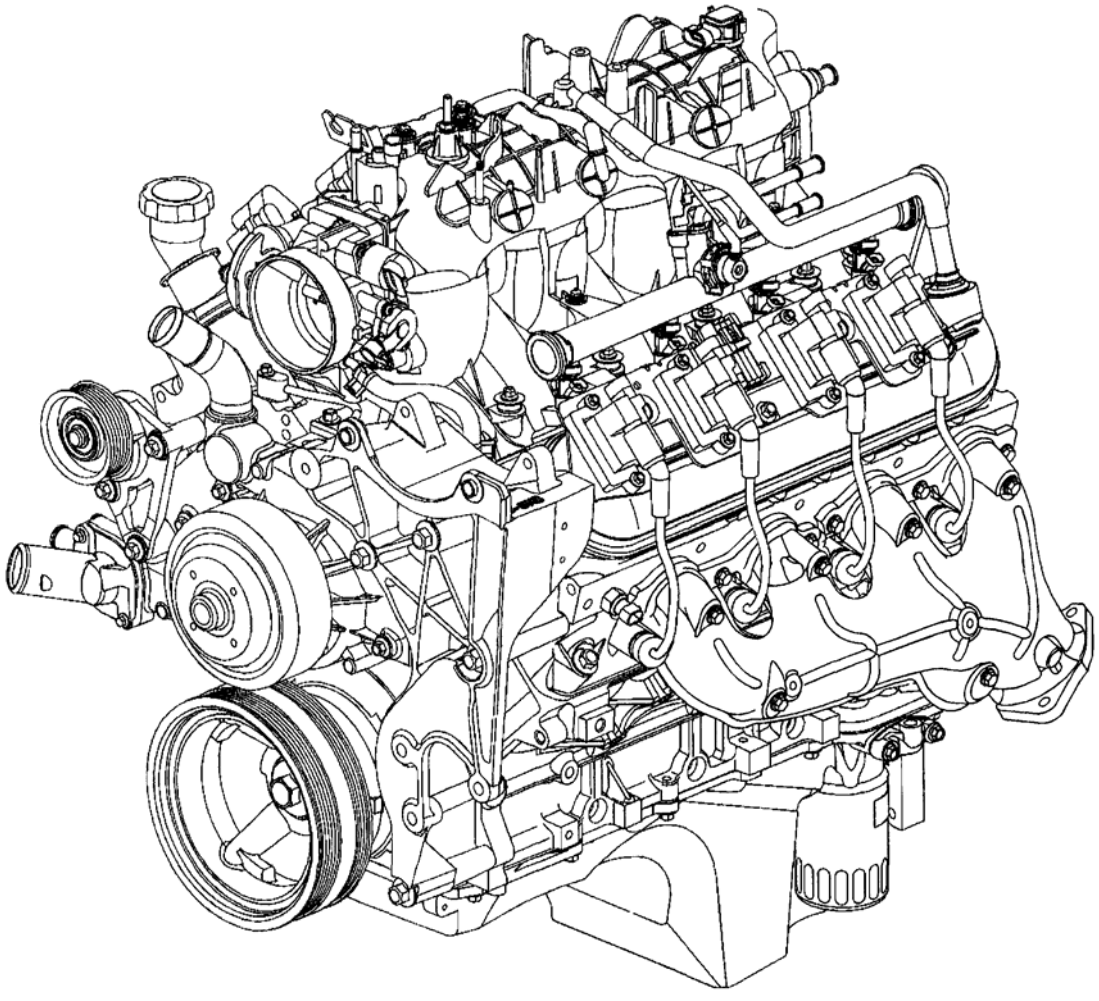


Fig. 466: The 4.8/5.3/6.0 Liter V-8 Engines
Courtesy of GENERAL MOTORS CORP.

The 4.8/5.3/6.0 Liter V-8 engines are identified as RPO-LR4 VIN-V (4.8), RPO-LM7 VIN-T (5.3), RPO-L59 VIN-Z (5.3), RPO-LQ4 VIN-U (6.0), and RPO-LQ9 VIN-N (6.0).

Camshaft and Drive System

A billet steel one piece camshaft is supported by five bearings pressed into the engine block. The camshaft has a machined camshaft sensor reluctor ring incorporated between the fourth and fifth bearing journals. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain.

The splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket splines drive the oil pump driven gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

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Crankshaft

The crankshaft is cast nodular iron. The crankshaft is supported by five crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position reluctor ring is press fit mounted at the rear of the crankshaft.

The reluctor ring is not serviceable separately. All crankshafts will have a short rear flange (at the crankshaft rear oil seal area). The 4.8 L manual transmission and all 6.0 L applications require a spacer between the rear of the crankshaft and the flywheel for proper flywheel positioning. Longer bolts are required in applications using the spacer.

Cylinder Heads

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder head by four center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with five crankshaft bearing caps. The engine block is cast iron. The five crankshaft bearing caps each have four vertical M10 and two horizontal M8 mounting bolts. The camshaft is supported by five camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are a one piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. On certain applications, the right manifold has an outlet for the Exhaust Gas Recirculation (EGR) system. Exhaust system gasses are directed from the right exhaust manifold through the EGR pipe assembly and valve to the intake manifold. The EGR pipe assembly is retained to the exhaust manifold by two bolts and sealed at the exhaust manifold flange with a gasket. The EGR pipe assembly is retained to the intake manifold by one bolt and sealed by an O-ring seal. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a one piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle cable bracket, throttle body, Evaporative Emission (EVAP) solenoid, wire harness stud, Exhaust Gas Recirculation (EGR) pipe, engine sight shield and sight shield bracket. Each side of the intake manifold is sealed to the cylinder head by a nonreusable silicone sealing gasket and nylon carrier assembly. The cable or electronically actuated throttle body (if applicable) bolts to the front of the intake manifold. The throttle body is sealed by a one piece push in place silicone gasket. The fuel rail assembly with eight separate fuel injectors is retained to the intake by four bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear of the left cylinder head by a mounting bolt. The Manifold Absolute Pressure (MAP) sensor is installed and retained to the top rear of the intake manifold and sealed by an O-ring seal. The EVAP solenoid is mounted to the top front of the intake manifold and retained by one bolt. On certain applications, an externally mounted EGR pipe assembly installs into the front right of the intake manifold. The EGR pipe assembly is sealed to the intake manifold by an O-ring

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seal and is retained by one bolt. There are no coolant passages within the intake manifold.

Oil Pan

The structural oil pan is cast aluminum. Incorporated into the design are the oil filter mounting boss, drain plug opening, oil level sensor mounting bore, and oil pan baffle. The oil pan transfer cover and oil level sensor mount to the sides of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission bell housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use two compression rings and one oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel, have floating fit in the piston, and are retained by a press fit in the connecting rod. 6.0 L LQ9 applications will have full-floating pistons/pins retained by internal clips. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the covers are the oil fill tube, the Positive Crankcase Ventilation (PCV) system passages, and the engine fresh air passages.

Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals (pivot supports). Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build.

NEW PRODUCT INFORMATION

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

Changes may include one or more of the following items:

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

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Torque Values and/or Fastener Tightening Strategies

- All fasteners and threaded holes on the 4.8/5.3/6.0 liter engines utilize metric threads.
- Cylinder head, connecting rod, crankshaft balancer, and main bearing cap bolts now apply a torque angle strategy.
- Certain fasteners should not be reused. Bolts, studs, or other fasteners that must be replaced will be called out in the specific service procedure.
- Refer to **Fastener Tightening Specifications** and **Thread Repair Specifications** .

New Sealants and/or Adhesives

Canadian SPO Part Numbers have been added.

Changed Engine Specifications

LQ9 6.0 L applications have a higher compression ratio. Refer to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)** .

Disassembly and Assembly Procedure Revisions

- For certain applications, a spacer plate has been added between the flywheel and rear of the crankshaft. It is necessary to remove the spacer plate prior to removal and installation of the crankshaft rear oil seal and clutch pilot bearing.
- An Exhaust Gas Recirculation (EGR) system is used on limited applications.

Engine Mechanical Diagnostic Procedure Revisions

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system problem. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **STRATEGY BASED DIAGNOSIS** in General Information or **DIAGNOSTIC STARTING POINT -- ENGINE MECHANICAL** in Engine Mechanical.

New Special Tools Required

- A variety of new tools have been developed to assist in engine disassembly, assembly, and on-vehicle service.
- **J 42078** is not required for installation of the second design valve stem oil seal and shim assembly. Refer to **Special Tools and Equipment** .

A Component Comparison from the Previous Year

- A new 5.3 L engine has been developed and is identified as RPO L59-VIN Z.
- A new 6.0 L engine has been developed and is identified as RPO LQ9-VIN N.
- All applications will use a two-point engine coolant air bleed pipe design.

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- The Air Injection Reaction (AIR) system had been deleted from all applications.
- A second design valve stem oil seal and shim assembly will be used on all engines.
- Certain applications use a multi-layer steel design cylinder head gasket.
- 6.0 L LQ9 engines will use a full-floating piston and pin design. In those applications, the pin is retained in the piston by retaining clips.

LUBRICATION DESCRIPTION

Lubrication Flow Schematic

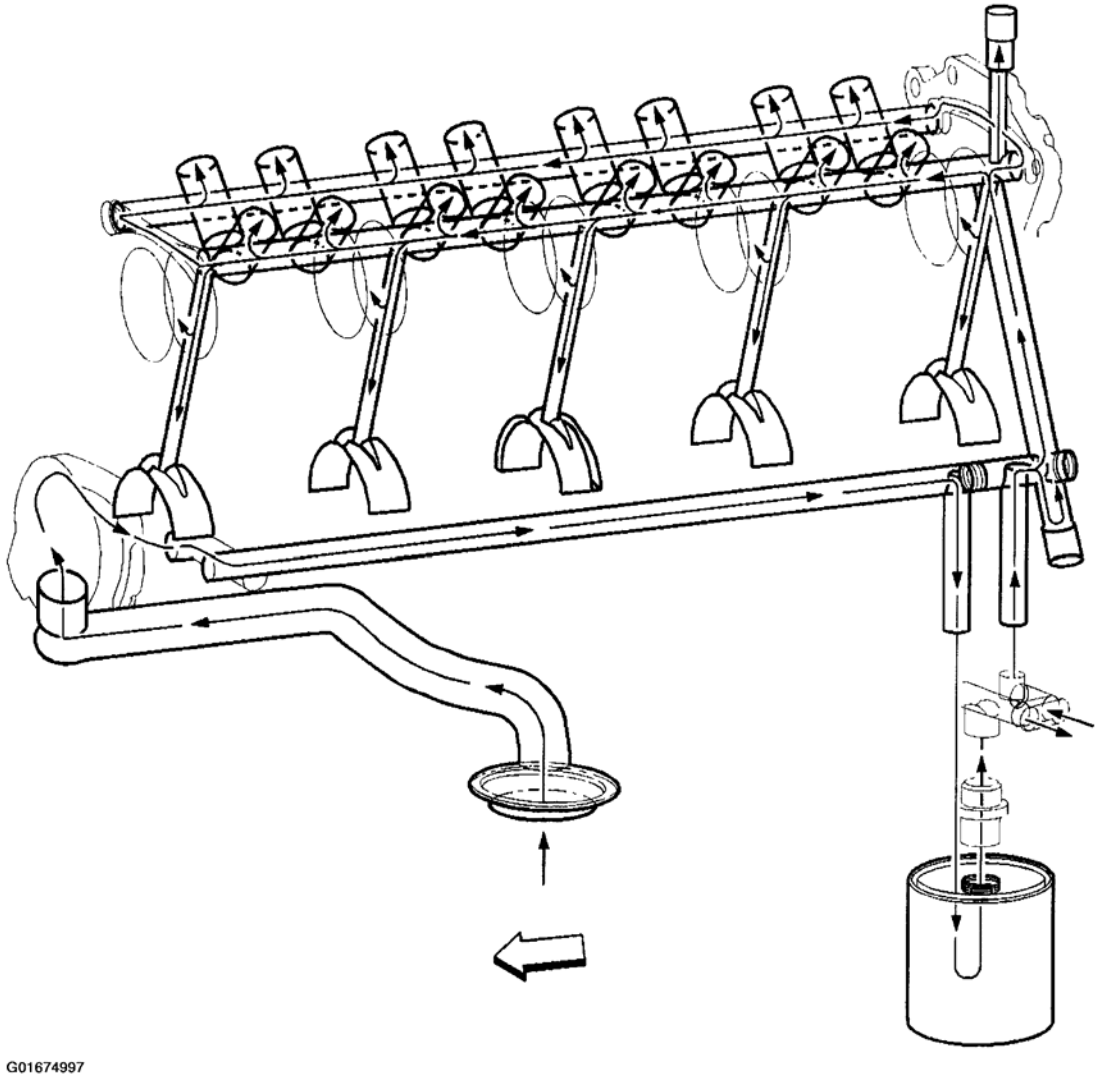


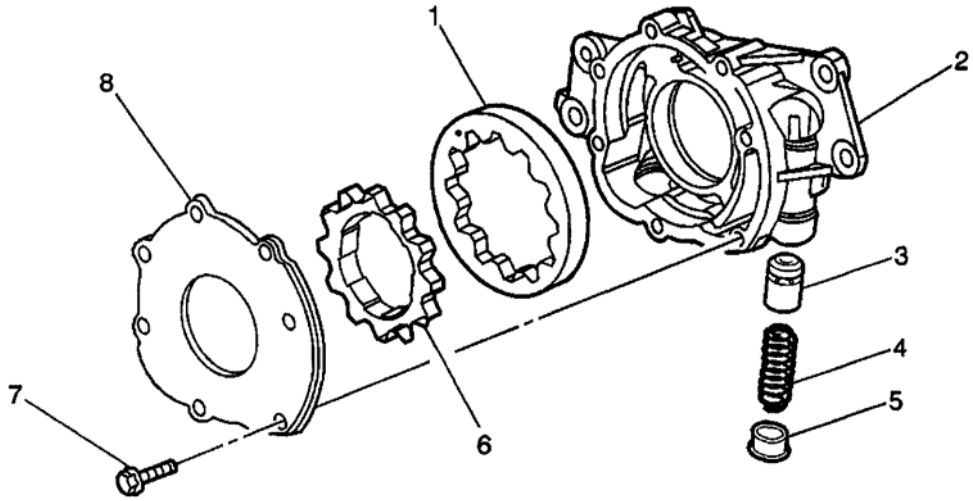
Fig. 467: Lubrication Flow Schematic
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The pump is mounted on the front of the

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engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block oil galleries. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range. Pressurized oil is directed through the lower gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil pan (at the oil filter boss) which will permit oil flow in the event the filter becomes restricted. At the rear of the block, oil is then directed to the upper main oil galleries which are drilled just above the camshaft assembly. From there oil is then directed to the crankshaft and camshaft bearings. Oil that has entered the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. Oil pressure and crankcase level are each monitored by individual sensors.

A external oil cooler is available on certain applications (all 6.0 L). Oil is directed from the oil pump, through the lower main oil gallery to the full flow oil filter. Oil is then directed through the oil pan outlet oil gallery (located in the left rear of the oil pan) and to the external oil cooler via a hose assembly. Oil flows through the oil cooler and returns to the engine at the oil pan inlet oil gallery (located in the left rear of the oil pan). Oil is then directed to the upper main oil galleries and the remainder of the engine assembly.



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

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Fig. 468: Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

CLEANLINESS AND CARE

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not

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specifically stated.

- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for reassembly.

  Refer to **Separating Parts** .

- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

Replacing Engine Gaskets

Tools Required

J 28410 Gasket Remover

Gasket Reuse and Applying Sealants

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

Separating Components

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

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the **J 28410** or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
  - These methods of cleaning can cause damage to the component sealing surfaces.
  - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
  - This grit is abrasive and has been known to cause internal engine damage.

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Assembling Components

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
- Tighten bolts to specifications. Do not overtighten.

USE OF RTV AND ANAEROBIC SEALER

Pipe Joint Compound

IMPORTANT: Three types of sealer are commonly used in engines. These are RTV sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

- Pipe joint compound is a pliable sealer that does not completely harden. This type sealer is used where two non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets** .

NOTE: Refer to SEALANT NOTICE in Cautions and Notices.

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

RTV Sealer

- Room Temperature Vulcanizing (RTV) sealant hardens when exposed to air. This type sealer is used where two non-rigid parts, such as the intake manifold and the engine block, are assembled together.
- Do not use Room Temperature Vulcanizing (RTV) sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator

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is specified.

- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets** .

NOTE: Refer to SEALANT NOTICE in Cautions and Notices.

- Apply RTV to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes.
- Assemble components while RTV is still wet, within 3 minutes. Do not wait for RTV to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- Anaerobic gasket eliminator hardens in the absence of air. This type sealer is used where two rigid parts, such as castings, are assembled together. When two rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets** .

- Apply a continuous bead of gasket eliminator to one flange. Surfaces to be resealed must be clean and dry.

NOTE: Refer to SEALANT NOTICE in Cautions and Notices.

- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.

IMPORTANT: Anaerobic sealed joints that are partially torqued and allowed to cure more than five minutes may result in incorrect shimming and sealing of the joint.

- Tighten bolts to specifications. Do not overtighten.
- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

SEPARATING PARTS

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

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

Separate, mark, or organize the following components:

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- 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, lifter guides, pushrods and rocker arm assemblies
- 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

TOOLS AND EQUIPMENT

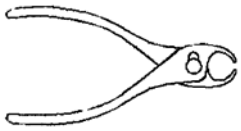
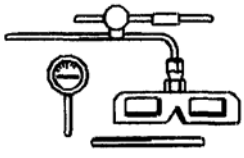
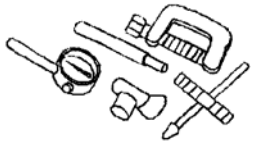
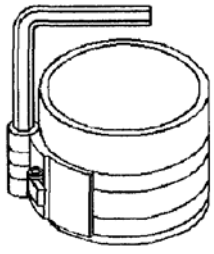
Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize 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

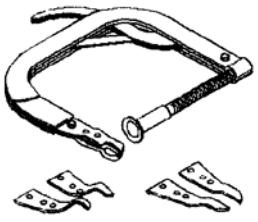
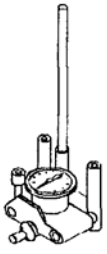
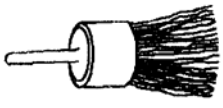
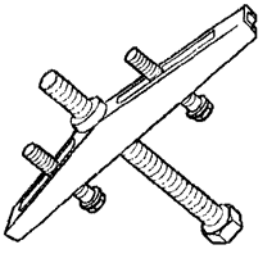
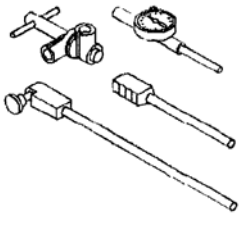
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Illustration	Tool Number/ Description
	J 3049-A Valve Lifter Remover
	J 6125-1B Slide Hammer
	J 7872 Magnetic Base Dial Indicator Set
	J 8001 Dial Indicator Set
	J 8037 Piston Ring Compressor

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Fig. 469: Special Tools & Equipment (1 Of 9)
Courtesy of GENERAL MOTORS CORP.

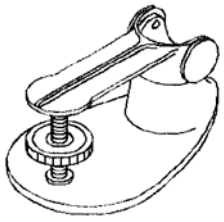
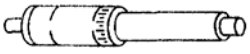
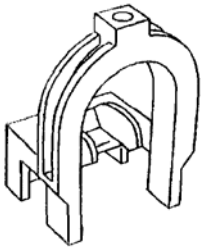
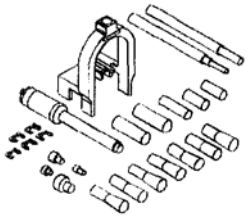
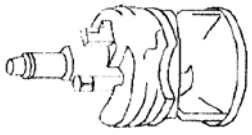
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Illustration	Tool Number/ Description
 3414	J 8062 Valve Spring Compressor – head off-vehicle
	J 8087 Cylinder Bore Checking Gage
	J 8089 Carbon Removal Brush
	J 8433-1 Pulley Puller
	J 8520 Camshaft Lobe Lift Dial Indicator Set

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Fig. 470: Special Tools & Equipment (2 Of 9)
Courtesy of GENERAL MOTORS CORP.

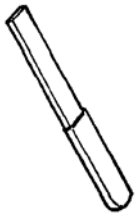
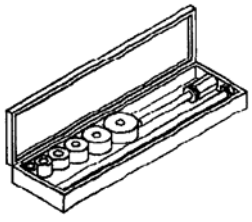
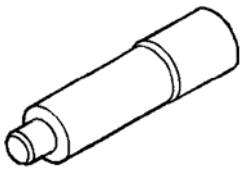
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Illustration	Tool Number/ Description
	J 9666 Valve Spring Tester
	J 24086-9 Adjustable Installer
	J 24086-10 Piston Pin Remover Installer Base
	J 24086-C Piston Pin Remover/Installer
	J 24270 Cylinder Ridge Remover

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Fig. 471: Special Tools & Equipment (3 Of 9)
Courtesy of GENERAL MOTORS CORP.

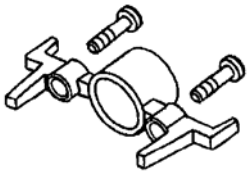
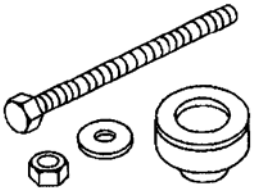
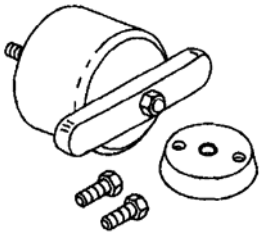
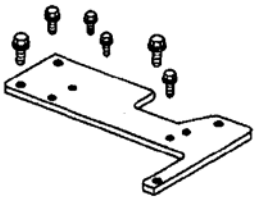
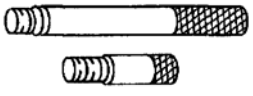
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Illustration	Tool Number/ Description
	J 28410 Gasket Remover
	J 33049 Camshaft Bearing Remover/Installer
	J 36660-A Torque Angle Meter
	J 37378-1 Valve Guide Reamer
	J 38836 Pilot Bushing Installer/Clutch

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Fig. 472: Special Tools & Equipment (4 Of 9)
Courtesy of GENERAL MOTORS CORP.

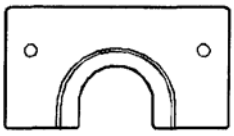
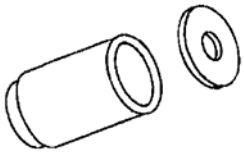
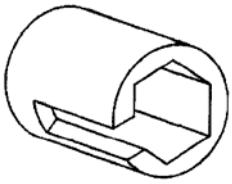
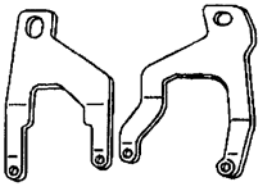
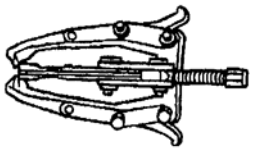
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Illustration	Tool Number/ Description
	J 41476 Front and Rear Cover Alignment – at crankshaft seal area
	J 41478 Crankshaft Front Oil Seal Installer
	J 41479 Crankshaft Rear Oil Seal Installer
	J 41480 Front and Rear Cover Alignment – at oil pan surface
	J 41556 Connecting Rod Guide

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Fig. 473: Special Tools & Equipment (5 Of 9)
Courtesy of GENERAL MOTORS CORP.

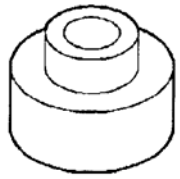
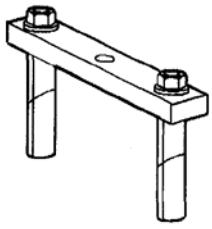
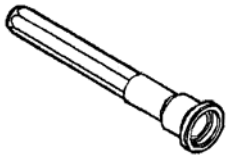
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Illustration	Tool Number/ Description
	J 41558 Crankshaft Sprocket Remover
	J 41665 Crankshaft Balancer and Sprocket Installer
	J 41712 Oil Pressure Sensor Socket
	J 41798 Engine Lifting Brackets
	J 41816 Crankshaft Balancer Remover

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Fig. 474: Special Tools & Equipment (6 Of 9)
Courtesy of GENERAL MOTORS CORP.

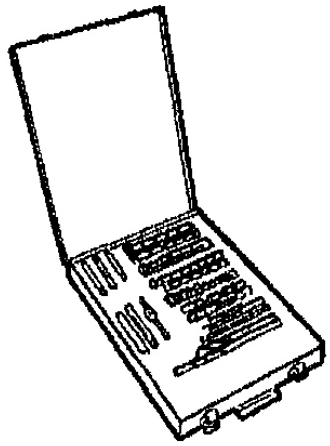
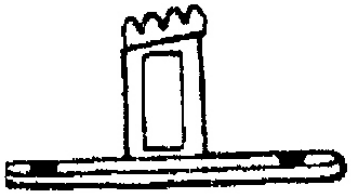
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Illustration	Tool Number/ Description
	J 41816-2 Crankshaft End Protector
	J 41818 Crankshaft Bearing Cap Remover
	J 42078 Valve Stem Oil Seal Installer
	J 42385-100 Thread Repair Kit – Cylinder Head/Main Bearing Bolt
	J 42385-200 Thread Repair Kit – General Threads

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Fig. 475: Special Tools & Equipment (7 Of 9)
Courtesy of GENERAL MOTORS CORP.

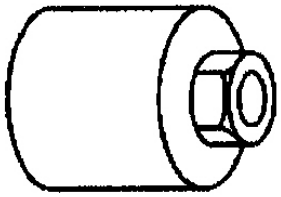
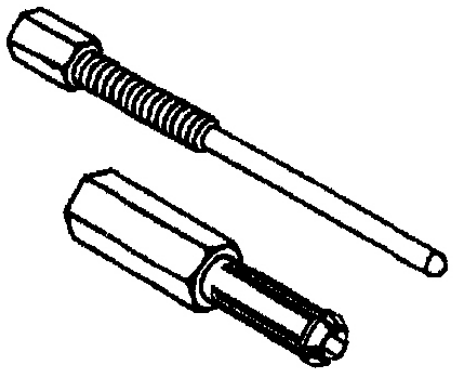
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Illustration	Tool Number/ Description
	J 42385-300 Thread Repair Kit – Fixtures and Hardware
	J 42386-A Flywheel Holding Tool

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Fig. 476: Special Tools & Equipment (8 Of 9)
Courtesy of GENERAL MOTORS CORP.

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Illustration	Tool Number/ Description
	J 42907 Oil Pressure Testing Tool
	J 43276 Clutch Pilot Bearing Remover

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Fig. 477: Special Tools & Equipment (9 Of 9)
Courtesy of GENERAL MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs (N.m)
Accessory Drive Belt Tensioner Bolt	37 (50)
Air Conditioning Belt Tensioner Bolt	37 (50)

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Automatic Transmission Oil Level Indicator Tube Nut	13 (18)
Camshaft Retainer Bolt	18 (25)
Camshaft Sensor Bolt	18 (25)
Camshaft Sprocket Bolt	26 (35)
Clutch Pressure Plate Bolt	52 (70)
Crankshaft Balancer Bolt	
Installation Tightening Pass: To Ensure Balancer Is Completely Installed	240 (330)
First Tightening Pass: Install A NEW Bolt After Installation Pass & Tighten As Described In First & Final Passes	37 (50)
Final Tightening Pass	140 Degrees
Crankshaft Oil Deflector Nut	18 (25)
Crossbar Bolt	74 (100)
Cylinder Head Bolt (1)	
First Tightening Pass (All M11 Bolts)	22 (30)
Second Tightening Pass (All M11 Bolts)	90 Degrees
Final Tightening Pass (All M11 Bolts Excluding Medium Length Bolts At Front & Rear Of Each Cylinder Head)	90 Degrees
Final Tightening Pass (M11 Medium Length Bolts At Front & Rear Of Each Cylinder Head)	50 Degrees
M8 Inner Bolts In Sequence	22 (30)
Drive Belt Idler Pulley Bolt	37 (50)
Engine Flywheel Bolt (2)	
First Tightening Pass	15 (20)
Second Tightening Pass	37 (50)
Final Tightening Pass	74 (100)
Engine Front Cover Bolt	18 (25)
Engine Mount Bolt	37 (50)
Engine Mount Bracket Bolt	55 (75)
Engine Mount-To-Engine Mount Bracket Bolt	37 (50)
Engine Rear Cover Bolt	18 (25)
Engine Service Lift Bracket	
M10 Bolt	37 (50)
M8 Bolt	18 (25)
Engine Shield Bolt	15 (20)
Engine Valley Cover Bolt	18 (25)
EGR Valve Pipe-To-Cylinder Head Bolt	37 (50)
EGR Valve Pipe-To-Exhaust Manifold Bolt	22 (30)
Generator Bracket Bolt	37 (50)
Harness Ground Bolt	18 (25)
Harness Ground Bolt (Rear Of Block)	12 (16)
Hood Hinge Bolt	18 (25)

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Knock Sensor	15 (20)
Oil Filter	22 (30)
Oil Filter Adapter	40 (55)
Oil Level Indicator Tube Bolt	18 (25)
Oil Pan Drain Plug	18 (25)
Oil Pan-To-Front Cover Bolt	18 (25)
Oil Pan Skid Plate Bolt	15 (20)
Oil Pressure Sensor	15 (20)
Oil Pump Bolt	18 (25)
Oil Pump Screen Nut	18 (25)
Power Steering Pump Rear Bolt	37 (50)
Spark Plug	11 (15)
Torque Converter Bolt	
4L60E Transmission	47 (63)
4L80E Transmission	44 (60)
Transmission Bolt/Stud	37 (50)
Valve Rocker Arm Bolt	22 (30)
	INCH Lbs. (N.m)
Accelerator Control Cable Bracket Bolt	89 (10)
Battery Cable Channel Bolt	106 (12)
Engine Wiring Harness Bracket Nut	44 (5)
EGR Valve Pipe-To-Intake Manifold Bolt	89 (10)
Evaporative Emission Purge Solenoid Bolt	89 (10)
Fuel Rail Cover Bolt	80 (9)
Generator Output Terminal Nut	80 (9)
Ignition Coil Bracket Stud	106 (12)
Intake Manifold Bolt (3)	
First Tightening Pass	44 (5)
Final Tightening Pass	89 (10)
Oil Level Sensor	115 (13)
Oil Pan-To-Rear Cover Bolt	106 (12)
Oil Pump Screen Bolt	106 (12)
Positive Battery Cable Clip Bolt	80 (9)
Transmission Cover Bolt	106 (12)
Intake Manifold Sight Shield Bolt (RPO LQ9 - 6.0L Engine)	80 (9)
Intake Manifold Sight Shield Bolt (4.8L, 5.3L, and RPO LQ4 - 6.0L Engines)	89 (10)
Intake Manifold Sight Shield Retainer Bolt	44 (5)
Valve Lifter Guide Bolt	106 (12)
Valve Rocker Arm Cover Bolt	106 (12)

(1) Tighten bolts in sequence shown, see **Fig. 478** .

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(2) Tighten bolts in sequence shown, see **Fig. 479** .

(3) Tighten bolts in sequence shown, see **Fig. 480** .

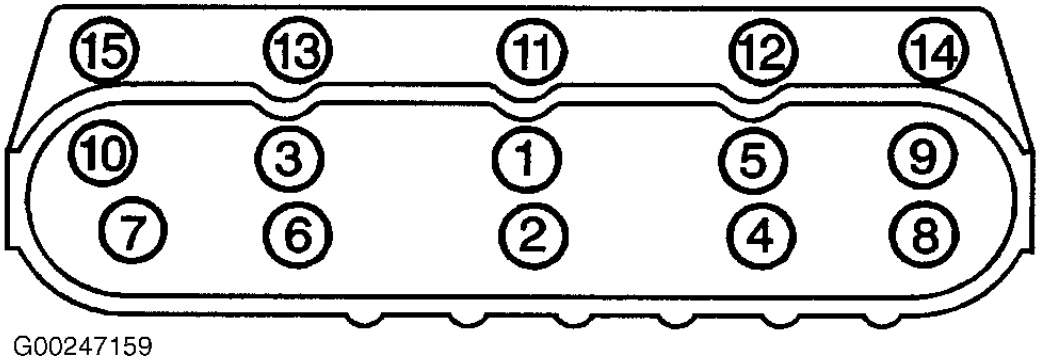


Fig. 478: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

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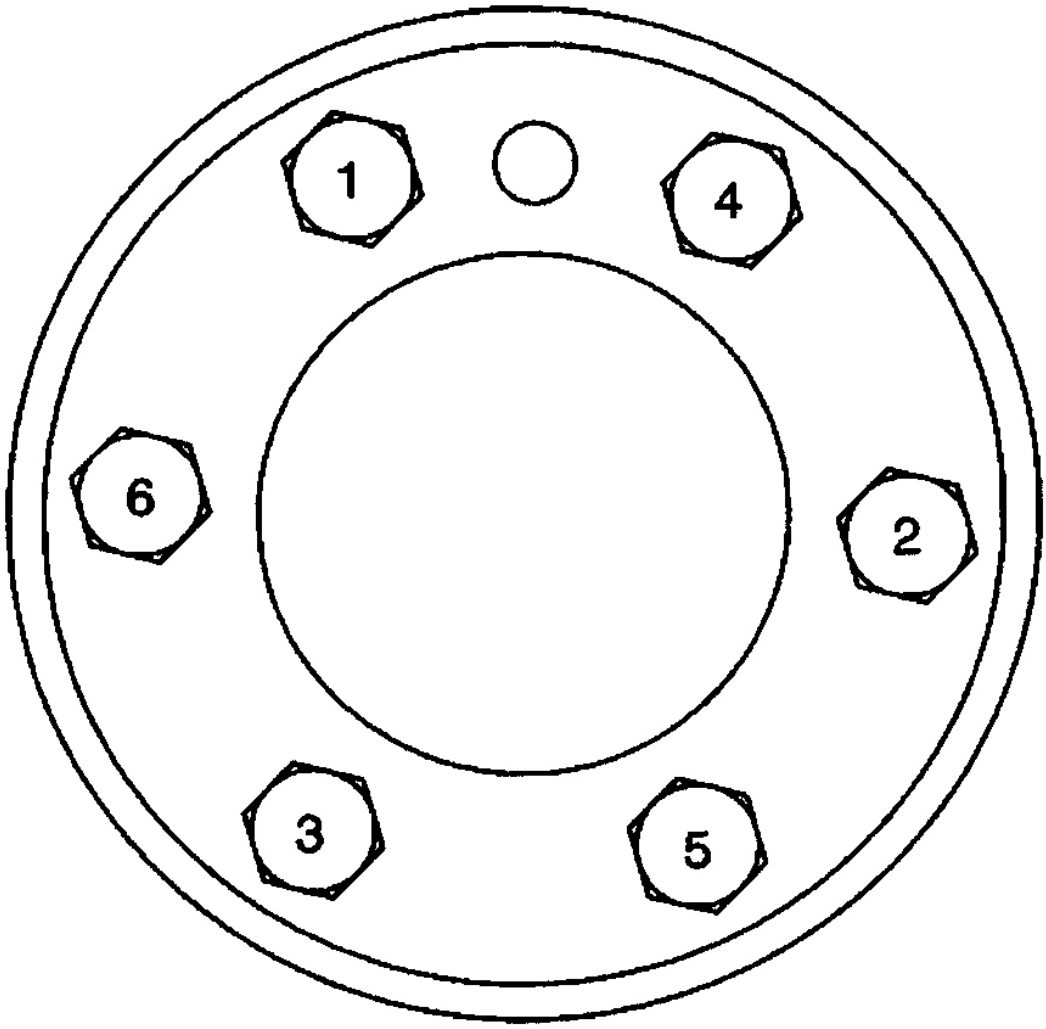
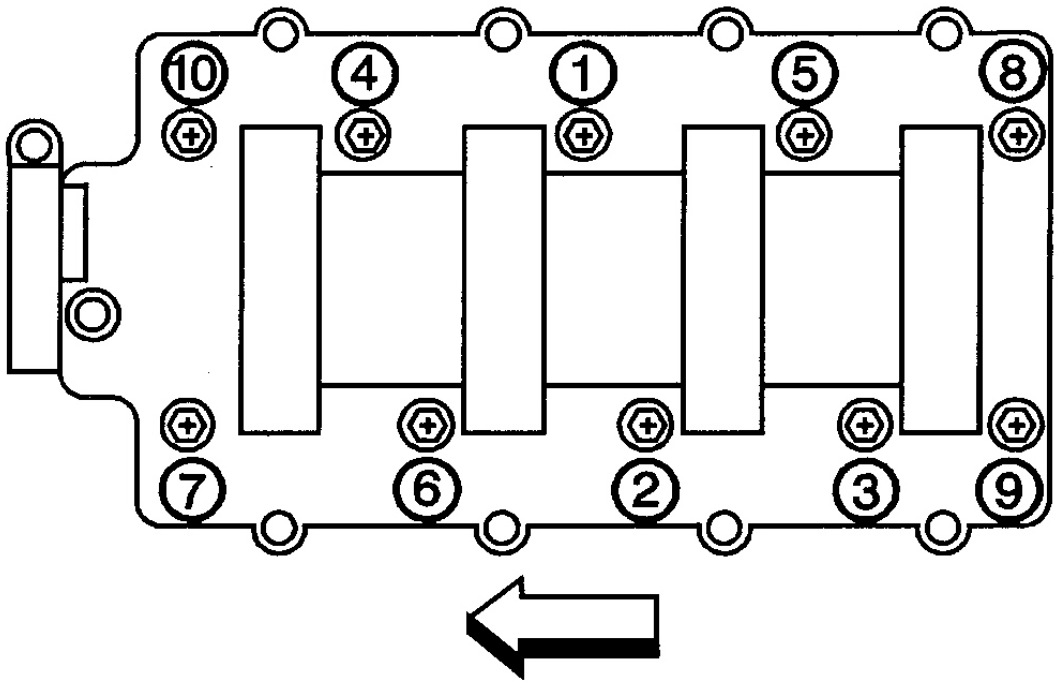


Fig. 479: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

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Fig. 480: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

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