

2004 Cadillac SRX

2004 ENGINE Engine Mechanical (Introduction) - 4.6L (LH2) - SRX

2004 ENGINE**Engine Mechanical (Introduction) - 4.6L (LH2) - SRX****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS****Fastener Tightening Specifications**

Application	Specification	
	Metric	English
A/C Compressor Bolt	50 N.m	37 lb ft
A/C Compressor and Power Steering Bracket Bolt	50 N.m	37 lb ft
A/C Drive Belt Tensioner Bolt	25 N.m	18 lb ft
Block Coolant Drain Hole Plug	20 N.m	15 lb ft
Camshaft Bearing Cap Bolt	12 N.m	106 lb in
Camshaft Cover Bolt	10 N.m	89 lb in
Camshaft Cover Ground Strap	25 N.m	18 lb ft
• Camshaft Cover Bolt	10 N.m	89 lb in
• Cylinder Head Bolt	25 N.m	18 lb ft
Camshaft Intermediate Drive Shaft		
• Bolt	10 N.m	89 lb in
• Sprocket Bolt	60 N.m	44 lb ft
Camshaft Position Actuator Bolt	120 N.m	89 lb ft
Camshaft Position Actuator Housing Bolt	10 N.m	89 lb in
Camshaft Position Actuator Magnet Bolt	8 N.m	71 lb in
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Connecting Rod Bolt		
• First Pass	30 N.m	22 lb ft
• Second Pass	Back off to zero	
• Third Pass	25 N.m	18 lb ft
• Final Pass	100 degrees	
Crankshaft Balancer Bolt		
• First Pass	50 N.m	37 lb ft
	150 degrees	

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• Final Pass		
Crankshaft Position Sensor and Knock Sensor Wiring Harness Bracket Bolt	10 N.m	89 lb in
Crankshaft Position Sensor Bolt	10 N.m	89 lb in
Cylinder Head Bolt		
• M11		
• First Pass - In Sequence	30 N.m	22 lb ft
• Second Pass - In Sequence	60 degrees	
• Third Pass - In Sequence	60 degrees	
• Final Pass - In Sequence	60 degrees, total 180 degrees	
• M6	12 N.m	106 lb in
Cylinder Head Coolant Plug	80 N.m	60 lb ft
Cylinder Head Oil Gallery Plug	60 N.m	44 lb ft
Drive Belt		
• Idler Bolt	50 N.m	37 lb ft
• Idler Nut	50 N.m	37 lb ft
• Tensioner Bolt	50 N.m	37 lb ft
ECT Sensor	20 N.m	15 lb ft
Engine Flywheel Bolt		
• First Pass	15 N.m	11 lb ft
• Final Pass	50 degrees	
Engine Front Cover Bolt	15 N.m	11 lb ft
Engine Mount Bracket Bolt	58 N.m	43 lb ft
Engine Mount Nut	58 N.m	43 lb ft
Engine Wiring Harness		
• Front Clip Nut to Left Side Engine Mount Bracket Stud	35 N.m	26 lb ft
• Rear Clip Bolt to Left Side of Block	30 N.m	22 lb ft
• Bolt to Right Side of Block	35 N.m	26 lb ft
• Left Side Ground Bolt	12 N.m	106 lb in
• Right Side Ground to Intake Manifold Nut	8 N.m	71 lb in
EVAP Emission Canister Purge Valve Bolt	10 N.m	89 lb in

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Exhaust Manifold

• Bolt	25 N.m	18 lb ft
• Nut	25 N.m	18 lb ft
• Pipe Hanger Bolt	50 N.m	37 lb ft
Exhaust Manifold Heat Shield Bolt	10 N.m	89 lb in
Exhaust Manifold Stud	6 N.m	53 lb in
Fuel Rail Bolt	10 N.m	89 lb in
Generator Bolt	50 N.m	37 lb ft
Generator Rear Brace Bolt	50 N.m	37 lb ft
Generator Stud	12 N.m	106 lb in
Ignition Coil Assembly Bolt	10 N.m	89 lb in

Intake Manifold

• Mounting Bolt	10 N.m	89 lb in
• Brake Booster Hose Fitting	2 N.m	18 lb in
Knock Sensor Bolt	25 N.m	18 lb ft

Lower Crankcase

• Bearing Bolt		
• M10 x 1.5 First Pass - In Sequence	20 N.m	15 lb ft
• M10 x 1.5 Final Pass - In Sequence	65 degrees	
• Perimeter Bolt		
• M8 x 1.25 - In Sequence	30 N.m	22 lb ft
Oil Filter	30 N.m	22 lb ft

Oil Filter Adapter

• Oil Filter Bypass Hole Plug	30 N.m	22 lb ft
• Oil Filter Fitting	29 N.m	21 lb ft
• Mounting Bolt	25 N.m	18 lb ft
Oil Level Indicator Tube Bolt	50 N.m	37 lb ft
Oil Level Sensor	20 N.m	15 lb ft
Oil Manifold Plate Bolt	10 N.m	89 lb in
Oil Outlet Tube Bolt	10 N.m	89 lb in
Oil Pan Bolt	25 N.m	18 lb ft
Oil Pan Baffle Bolt	12 N.m	106 lb in

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Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pressure Switch	20 N.m	15 lb ft
Oil Pump		
• Cover Bolt	12 N.m	106 lb in
• Mounting Bolt		
• First Pass	10 N.m	89 lb in
• Final Pass	35 degrees	
Oil Suction Tube		
• Bolt	10 N.m	89 lb in
• Nut	24 N.m	18 lb ft
Oxygen Sensor	42 N.m	31 lb ft
Plenum Duct Clamp	2.25 N.m	20 lb in
Power Steering Pump Bolt	25 N.m	18 lb ft
Power Steering Pump Reservoir Bracket Nut	10 N.m	89 lb in
Primary Camshaft Drive Chain		
• Guide Bolt	25 N.m	18 lb ft
• Tensioner Bolt	25 N.m	18 lb ft
Secondary Camshaft Drive Chain		
• Guide Bolt	25 N.m	18 lb ft
• Shoe Bolt	25 N.m	18 lb ft
• Tensioner Bolt	25 N.m	18 lb ft
Sight Shield		
• Bracket Nut	10 N.m	89 lb in
• Retainer	7 N.m	62 lb in
Spark Plug	15 N.m	11 lb ft
Starter Motor Bolt	30 N.m	22 lb ft
Starter Motor Wiring Harness		
• Generator Nut	20 N.m	15 lb ft
• Starter Nut - Large	10 N.m	89 lb in
• Starter Nut - Small	4 N.m	35 lb in
Thermostat Housing Bolt	10 N.m	89 lb in
Throttle Body Bolt	10 N.m	89 lb in

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Water Outlet Housing Bolt	25 N.m	18 lb ft
Water Pump Bolt	10 N.m	89 lb in
Water Pump Pulley Bolt	10 N.m	89 lb in

ENGINE MECHANICAL SPECIFICATIONS**Engine Mechanical Specifications**

Application	Specification	
	Metric	English
General		
• Engine Type	V-8	
• Displacement	4.6 Liter	279 cu in
• RPO	LH2	
• VIN	A	
• Bore	93 mm	3.661 in
• Stroke	84 mm	3.3071 in
• Compression Ratio	10.5:1	
• Engine Compression Test	965-1172 kPa	140-170 psi
• Firing Order	1-2-7-3-4-5-6-8	
• Spark Plug Gap	1.270 mm	0.0500 in
Block		
• Crankshaft Main Bearing Bore Diameter	72.430-72.442 mm	2.8516-2.8521 in
• Crankshaft Main Bearing Bore Out-of-Round	0.010 mm	0.0004 in
• Crankshaft Main Rear Oil Seal		
• Bore	115.962-116.038 mm	4.5654-4.5684 in
• Runout	0.250 mm	0.0098 in
• Cylinder Bore Diameter @ 41 mm (1.610 in) Below Deck Face	92.992-93.008 mm	3.6611-3.6617 in
• Cylinder Bore Out-of-Round		
• Production	0.010 mm	0.0004 in
• Service	0.100 mm	0.0039 in

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• Cylinder Bore Taper		
• Production	0.010 mm	0.0004 in
• Service	0.100 mm	0.0039 in
• Cylinder Head Deck Height	224.55 mm	8.8406 in
• Cylinder Head Deck Surface Flatness	0.100 mm	0.0039 in
Camshaft		
• Camshaft End Play	0.120-0.220 mm	0.0050-0.0087 in
• Camshaft Journal Diameter	26.948-26.972 mm	1.0610-1.0619 in
• Camshaft Journal Out-of-Round	0.006 mm	0.0002 mm
• Camshaft Journal to Bore Clearance		
• Production	0.051-0.076 mm	0.0020-0.0030 in
• Service	0.040-0.090 mm	0.0016-0.0035 in
• Camshaft Lobe Duration @ 0.150 mm (0.006 in) Lift - Exhaust	246 degrees	
• Camshaft Lobe Duration @ 0.150 mm (0.006 in) Lift - Intake	251 degrees	
• Camshaft Lobe Lift - Exhaust	5.94 mm	0.2339 in
• Camshaft Lobe Lift - Intake	6.15 mm	0.2421 in
• Camshaft Lobe Overlap @ 0.150 mm (0.006 in) Lift	0.0 degrees	
• Camshaft Runout	0.050 mm	0.0020 in
• Camshaft Thrust Surface		
• Runout	0.037 mm	0.0015 in
• Width	22.990-23.090 mm	0.9051-0.9091 in
• Camshaft Timing @ 0.150 mm (0.006 in) Lift		
• Intake Opens	11.0 degrees ATDC	
• Intake Centerline	133.0 degrees ATDC	
• Intake Closes	255.7 degrees ATDC	
• Exhaust Opens	243.2 degrees BTDC	
• Exhaust Centerline	107.0 degrees BTDC	

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• Exhaust Closes	11.3 degrees ATDC	
Camshaft Position Actuator		
• Exhaust Authority	50 crankshaft degrees/25 camshaft degrees	
• Intake Authority	40 crankshaft degrees/20 camshaft degrees	
Cooling System		
• Thermostat Full Open Temperature	85°C	185°F
Connecting Rod		
• Connecting Rod Bearing Clearance		
• Production and Service	0.0250-0.0760 mm	0.0010-0.0030 in
• Connecting Rod Bore Diameter - Bearing End	57.136-57.152 mm	2.2495-2.2501 in
• Connecting Rod Bore Diameter - Pin End	23.002-23.014 mm	0.9056-0.9061 in
• Connecting Rod Bore Out-of-Round - Bearing End	0.006 mm	0.0002 in
• Connecting Rod Bore Out-of-Round - Pin End	0.005 mm	0.0002 in
• Connecting Rod Length Center to Center	151.00 mm	5.9449 in
• Connecting Rod Side Clearance	0.200-0.500 mm	0.0079-0.0197 in
• Connecting Rod Straightness	0.050 mm	0.0020 in
Crankshaft		
• Connecting Rod Journal Diameter	53.947-53.963 mm	2.1239-2.1245 in
• Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
• Connecting Rod Journal Taper	0.005 mm	0.0002 in
• Connecting Rod Journal Width	43.840-43.960 mm	1.7260-1.7307 in
• Crankshaft Balancer		
• Surface Diameter	50.730-50.870 mm	1.9972-2.0028 in
• Hub Inside Diameter	34.847-34.864 mm	1.3719-1.3726 in
• Crankshaft End Play	0.050-0.500 mm	0.0020-0.0197 in
• Crankshaft Main Bearing Clearance		
• Production	0.0150-0.0550 mm	0.0006-0.0022 in
• Service	0.0150-0.0635 mm	0.0006-0.0025 in

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• Crankshaft Main Journal Diameter	64.350-64.366 mm	2.5335-2.5341 in
• Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
• Crankshaft Main Journal Taper	0.005 mm	0.0002 in
• Crankshaft Main Journal Thrust Wall Runout	0.040 mm	0.0016 in
• Crankshaft Main Journal Thrust Wall Square	0.010 mm	0.0004 in
• Crankshaft Main Journal Width, #1, #2, #4, #5	24.540-24.660 mm	0.9661-0.9709 in
• Crankshaft Main Journal Width, Thrust #3	25.150-25.250 mm	0.9902-0.9941 in
• Crankshaft Nose Diameter		
• From Front Face 0.00-21.00 mm (0.0000-0.8268 in)	34.500-34.750 mm	1.3583-1.3681 in
• From Front Face 21.00-53.00 mm (0.8268-2.0866 in)	34.892-34.912 mm	1.3737-1.3745 in
• From Front Face 53.00 to Rolled Fillet (2.0866-Rolled Fillet)	33.450-33.550 mm	1.3169-1.3209 in
• From Front Face 89.94-110.54 mm (3.5409-4.3520 in)	44.950-45.000 mm	1.7697-1.7717 in
• Crankshaft Nose Runout		
• From Front Face 0.00-21.00 mm (0.0000-0.8268 in)	0.100 mm	0.0039 in
• From Front Face 21.00-53.00 mm (0.8268-2.8066 in)	0.030 mm	0.0012 in
• From Front Face 53.00 to Rolled Fillet (2.0866-Rolled Fillet)	0.100 mm	0.0039 in
• From Front Face 89.94-110.54 mm (3.5409-4.3520 in)	0.025 mm	0.0010 in
• Crankshaft Rear Flange		
• Diameter	95.880-95.980 mm	3.7748-3.7787 in
• Runout	0.025 mm	0.0010 in
• Crankshaft Rear Flange Face to Engine Flywheel Runout	0.025 mm	0.0010 in
• Crankshaft Runout		

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• Main Journals #1, #5	0.022 mm	0.0009 in
• Main Journals #2, #4, #6	0.025 mm	0.0010 in
Cylinder Head		
• Camshaft Bearing Bore Diameter	27.013-27.033 mm	1.0635-1.0642 in
• Camshaft Bearing Bore Out-of-Round	0.010 mm	0.0004 in
• Combustion Chamber Depth - at Measurement Point	10.470-10.710 mm	0.4122-0.4217 in
• Cylinder Head Height - Deck to Camshaft Centerline Bore	136.00 mm	5.3543 in
• Surface Flatness - Block Deck	0.050 mm	0.0020 in
• Surface Flatness - Exhaust Manifold Deck	0.220 mm	0.0087 in
• Surface Flatness - Intake Manifold Deck	0.220 mm	0.0087 in
• Valve Guide Bore - Exhaust	5.969-5.989 mm	0.2350-0.2359 in
• Valve Guide Bore - Intake	5.969-5.989 mm	0.2350-0.2359 in
• Valve Guide Installed Height - Exhaust	14.300 mm	0.5630 in
• Valve Guide Installed Height - Intake	14.720 mm	0.5795 in
• Valve Lifter Bore Diameter	12.013-12.037 mm	0.4730-0.4739 in
Flywheel		
• Runout	0.300 mm	0.0118 in
Intake Manifold		
• Surface Flatness	0.500 mm	0.0200 in
Lubrication System		
• Oil Capacity - with New Dry Oil Filter	7.6 Liters	8.0 Quarts
• Oil Capacity - without Oil Filter Change	7.1 Liters	7.5 Quarts
• Oil Pressure - Minimum @ Idle	35 kPa	5 psi
• Oil Pressure - Minimum @ 2,000 RPM	250 kPa	35 psi
Piston Rings		
• Piston Ring End Gap		
• First Compression Ring	0.250-0.400 mm	0.0098-0.0157 in
• Second Compression Ring	0.350-0.050 mm	0.0138-0.0020 in

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• Oil Control Ring	0.250-0.760 mm	0.0098-0.0299 in
• Piston Ring to Groove Clearance		
• First Compression Ring	0.040-0.095 mm	0.0016-0.0037 in
• Second Compression Ring	0.040-0.095 mm	0.0016-0.0037 in
• Oil Control Ring	None - Side Sealing	
• Piston Ring Thickness		
• First Compression Ring	1.199-1.203 mm	0.0472-0.0474 in
• Second Compression Ring	1.499-1.504 mm	0.0590-0.0592 in
• Oil Control Ring	2.530-2.555 mm	0.0996-0.1006 in
Pistons and Pins		
• Piston		
• Piston Diameter @ 42 mm (1.6353 in) Below Crown	92.957-92.972 mm	3.6597-3.6603 in
• Piston Pin Bore Diameter	23.002-23.007 mm	0.9056-0.9058 in
• Piston Ring Groove Inside Diameter		
• First Compression Ring	84.750-85.000 mm	3.3366-3.3464 in
• Second Compression Ring	83.400-83.650 mm	3.2835-3.2933 in
• Oil Control Ring	85.670-85.920 mm	3.3728-3.3827 in
• Piston Ring Groove Width		
• First Compression Ring	1.230-1.255 mm	0.0484-0.0494 in
• Second Compression Ring	1.530-1.555 mm	0.0602-0.0612 in
• Oil Control Ring	2.530-2.555 mm	0.0996-0.1006 in
• Piston to Bore Clearance	0.020-0.051 mm	0.0008-0.0020 in
• Pin		
• Piston Pin Clearance to Connecting Rod Bore	0.002-0.014 mm	0.0001-0.0006 in
• Piston Pin Clearance to Piston Pin Bore	0.002-0.012 mm	0.0001-0.0005 in
• Piston Pin Diameter	22.995-23.000 mm	0.9053-0.9055 in
• Piston Pin End Play		
• Piston Pin Length	61.500-62.000 mm	2.4213-2.4409 in

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Valve System

● Valves		
● Valve Face Angle	45 degrees	
● Valve Face Runout	0.038 mm	0.0015 in
● Valve Face Width		
● Exhaust	1.500 mm	0.0591 in
● Intake	1.000 mm	0.0394 in
● Valve Head Diameter		
● Exhaust	28.880-29.140 mm	1.1370-1.1472 in
● Intake	36.090-36.350 mm	1.4209-1.4311 in
● Valve Length		
● Exhaust	91.730-91.990 mm	3.6114-3.6217 in
● Intake	110.600-110.860 mm	4.3543-4.3646 in
● Valve Seat Angle	45.75 degrees	
● Valve Seat Relief Angle	20 degrees	
● Valve Seat Relief Width		
● Exhaust	0.160-0.360 mm	0.0063-0.0142 in
● Intake	0.110-0.310 mm	0.0043-0.0118 in
● Valve Seat Runout	0.050 mm	0.0020 in
● Valve Seat Undercut Angle		
● Exhaust	65 degrees	
● Intake	60 degrees	
● Valve Seat Width		
● Exhaust	1.300-1.700 mm	0.0512-0.0669 in
● Intake	0.420-0.820 mm	0.0165-0.0323 in
● Valve Stem Diameter	5.920-5.940 mm	0.2331-0.2339 in
● Valve Stem Out-of-Round	0.008 mm	0.0003 in
● Valve Stem Straightness	0.013 mm	0.0005 in

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• Valve Stem-to-Guide Clearance		
• Exhaust		
• Production	0.050-0.100 mm	0.0020-0.0039 in
• Service	0.050-0.120 mm	0.0020-0.0047 in
• Intake		
• Production	0.028-0.068 mm	0.0011-0.0027 in
• Service	0.028-0.110 mm	0.0011-0.0043 in
• Valve Lifters		
• Valve Lifter Diameter	11.986-12.000 mm	0.4719-0.4724 in
• Valve Lifter-to-Bore Clearance	0.037-0.041 mm	0.0015-0.0016 in
• Rocker Arms		
• Valve Rocker Arm Ratio	1.68 to 1	
• Valve Rocker Arm Roller Diameter	17.740-17.800 mm	0.6984-0.7008 in
• Valve Springs		
• Valve Spring Coil Thickness	4.110 x 3.280 mm	0.1618 x 0.1291 in
• Valve Spring Diameter		
• Inside	17.750-18.250 mm	0.6988-0.7185 in
• Outside	26.23 mm	1.0327 in
• Valve Spring Free Length	40.790-43.690 mm	1.6059-1.7201 in
• Valve Spring Height		
• Closed	35.000 mm	1.3780 in
• Open	24.500 mm	0.9646 in
• Valve Spring Load		
• Closed	211.4-233.4 mm	47.5-52.4 lb
• Open	579.0-631.0 mm	130.2-141.9 lb
• Valve Spring Total Number of Coils	6.90-7.10	

SEALERS, ADHESIVES, AND LUBRICANTS

Sealers, Adhesives, and Lubricants

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Application	Type of Material	GM Part Number	
		United States	Canada
Camshaft Position Actuator Magnets	Sealant	12378521	N/A
Camshaft Prelube	Lubricant	12345501	992704
Crankshaft Prelube	Lubricant	1052367	992869
Cylinder Block	Sealant	12345739	10953541
Fuel Injector Bores	Lubricant	12345610	993193
Oxygen Sensor	Lubricant	12377953	N/A
Split Lines Between Components for Camshaft Covers, Crankshaft Rear Oil Seal, Engine Front Cover Gasket	Sealant	12378521	88901148
Upper-to-Lower Crankcase	Sealant - 6 ML	1052942	10953466
Upper-to-Lower Crankcase	Sealant - 50 ML	1052943	10953491
Valve Lifter	Lubricant	12345616	993182
Water Pump, Flywheel Bolts	Sealant	12346004	10953480

THREAD REPAIR SPECIFICATIONS

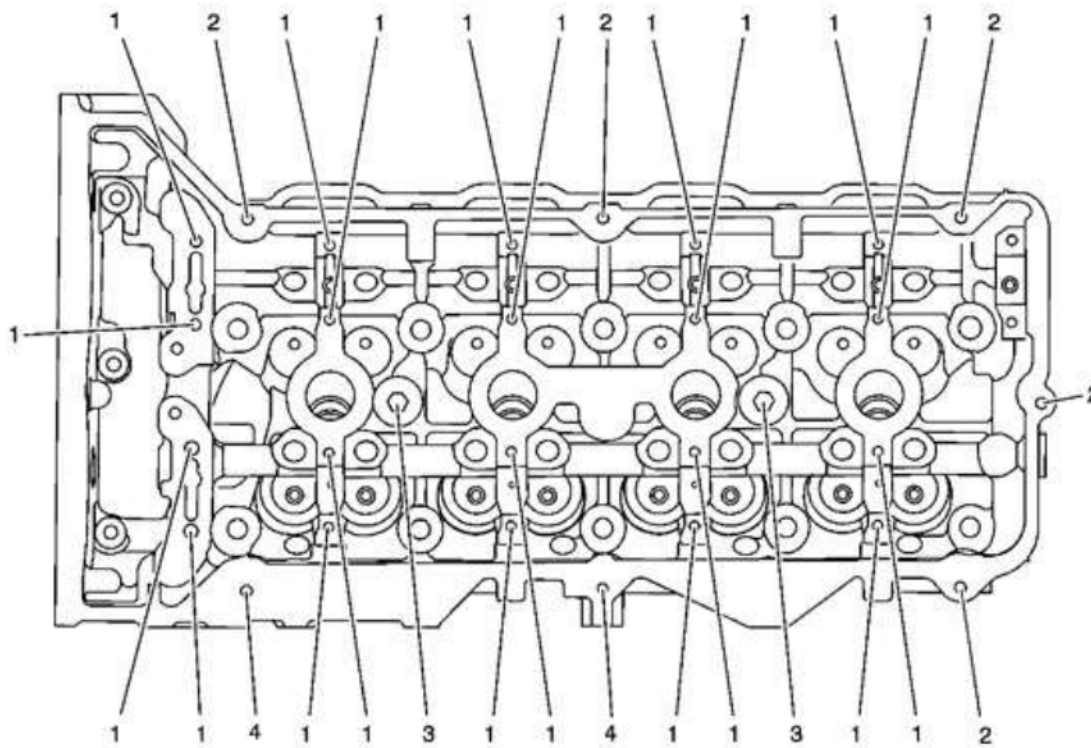


Fig. 1: Left Cylinder Head Camshaft Cover Face Thread Repair Locations

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Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	608	N/A	N/A	203	204	205	26.0	1.0236	22.0	0.8661
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
3	M20 x 1.5	715	716	N/A	717	718	719	32.0	1.2598	21.0	0.8268
4	M6 x 1.0	201	202	N/A	203	204	205	22.0	0.8661	18.0	0.7087

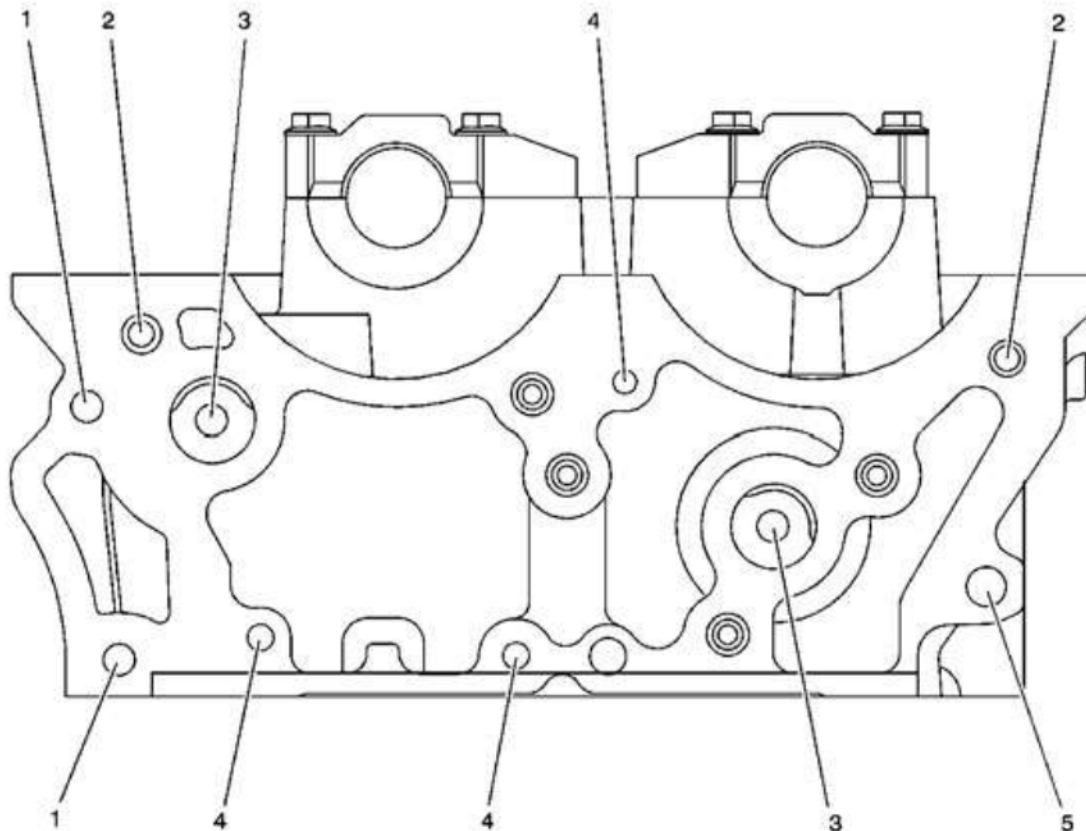


Fig. 2: Left Cylinder Head Front Face Thread Repair Locations

Courtesy of GENERAL MOTORS CORP.

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Left Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	27.0	1.0630	22.0	0.8661
2	M6 x 1.0	201	202	N/A	203	204	205	30.0	1.1811	26.0	1.0236
3	M8 x 1.25	610	N/A	619	208	209	620	27.0	1.0630	22.0	0.8661
4	M6 x 1.0	201	202	N/A	203	204	205	22.0	0.8661	18.0	0.7087
5	M10 x 1.5	211	212	N/A	213	214	215	32.0	1.2599	26.0	1.0236

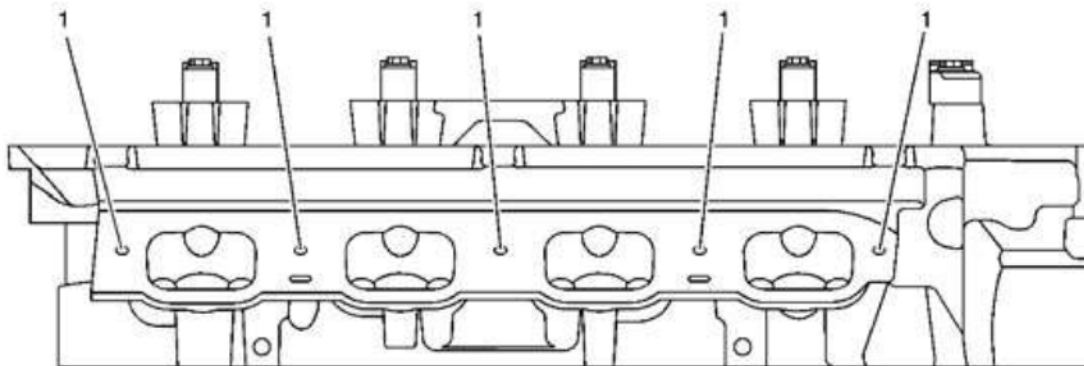


Fig. 3: Left Cylinder Head Intake Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Intake Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	25.0	0.9843	21.25	0.8366

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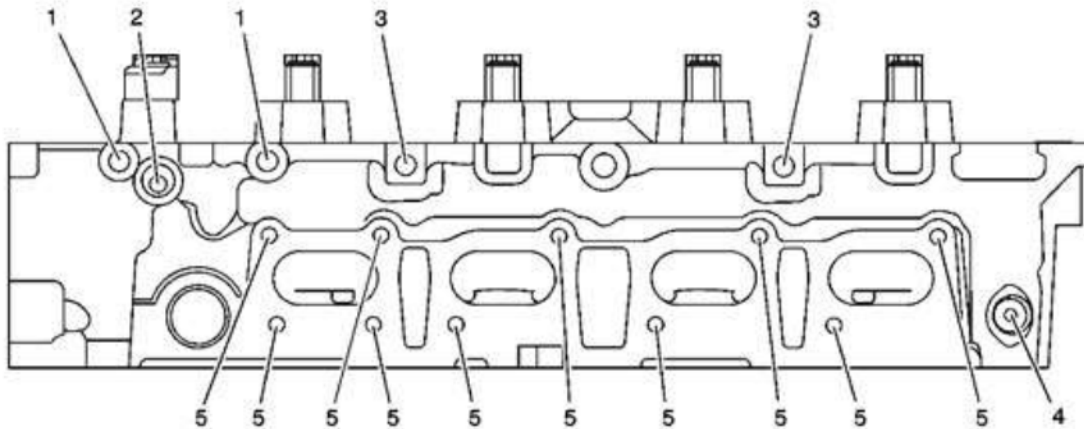


Fig. 4: Left Cylinder Head Exhaust Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Exhaust Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	32.0	1.2599	27.5	1.0827
2	M16 x 1.5	861	862	N/A	863	864	860	20.0	0.7874	16.0	0.6299
3	M10 x 1.5	211	212	N/A	213	214	215	32.0	1.2599	26.0	1.0236
4	M6 x 1.0	201	202	N/A	203	204	205	22.0	0.8661	18.0	0.7087
5	M8 x 1.25	206	207	N/A	208	209	210	25.0	0.9843	20.0	0.7874

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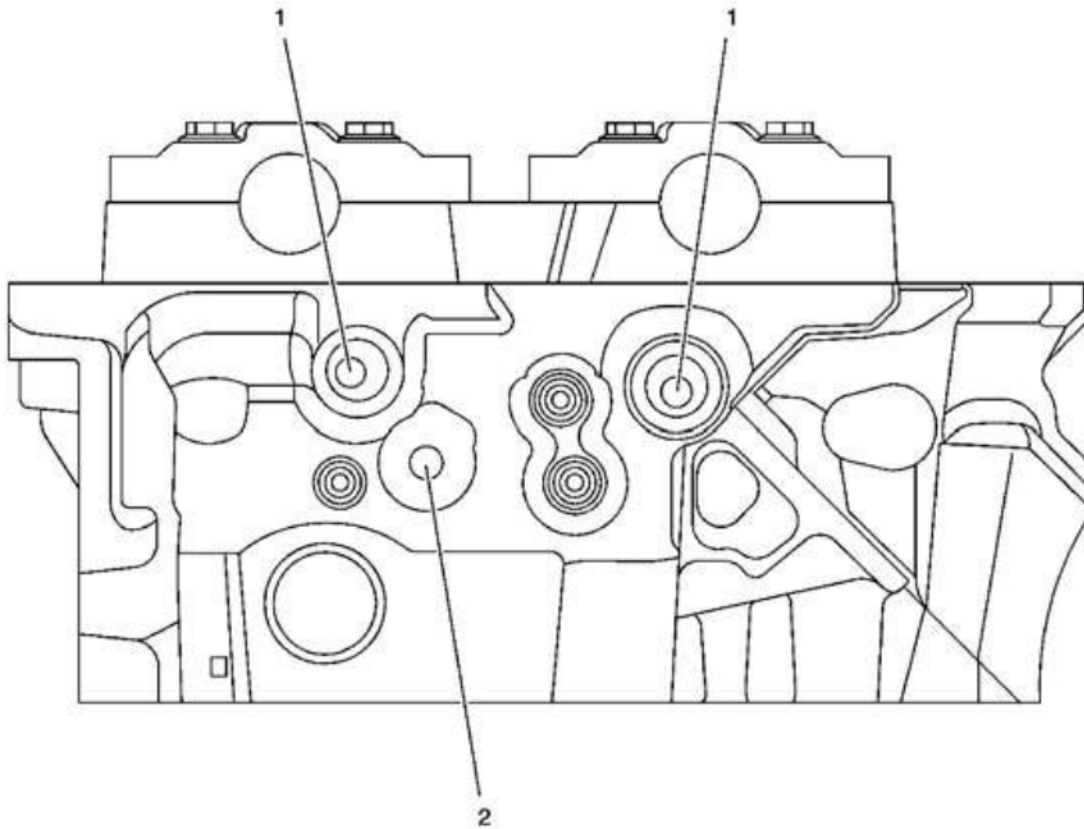


Fig. 5: Left Cylinder Head Rear Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Rear Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M16 x 1.5	861	862	N/A	863	864	860	20.0	0.7874	16.0	0.6299
2	M8 x 1.25	206	207	N/A	208	209	210	27.0	1.0630	22.0	0.8661

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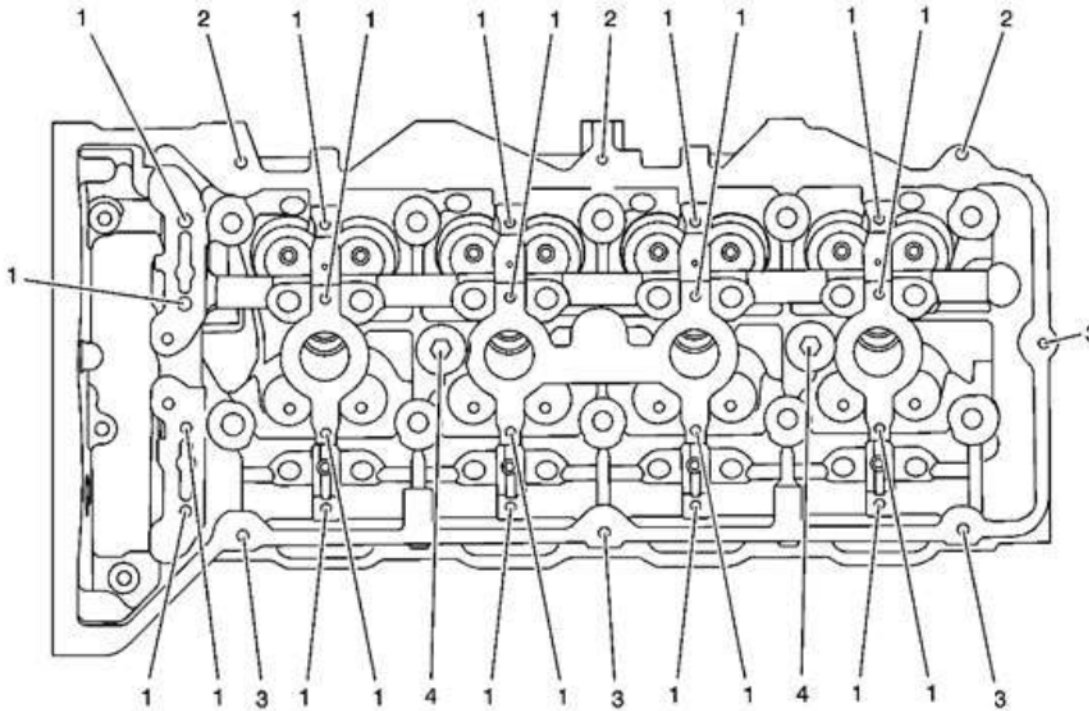


Fig. 6: Right Cylinder Head Camshaft Cover Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	608	N/A	N/A	203	204	205	26.0	1.0240	22.0	0.8660
2	M6 x 1.0	201	202	N/A	203	204	205	22.0	0.8660	18.0	0.7090
3	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
4	M20 x 1.5	715	716	N/A	717	718	719	32.0	1.2598	21.0	0.8268

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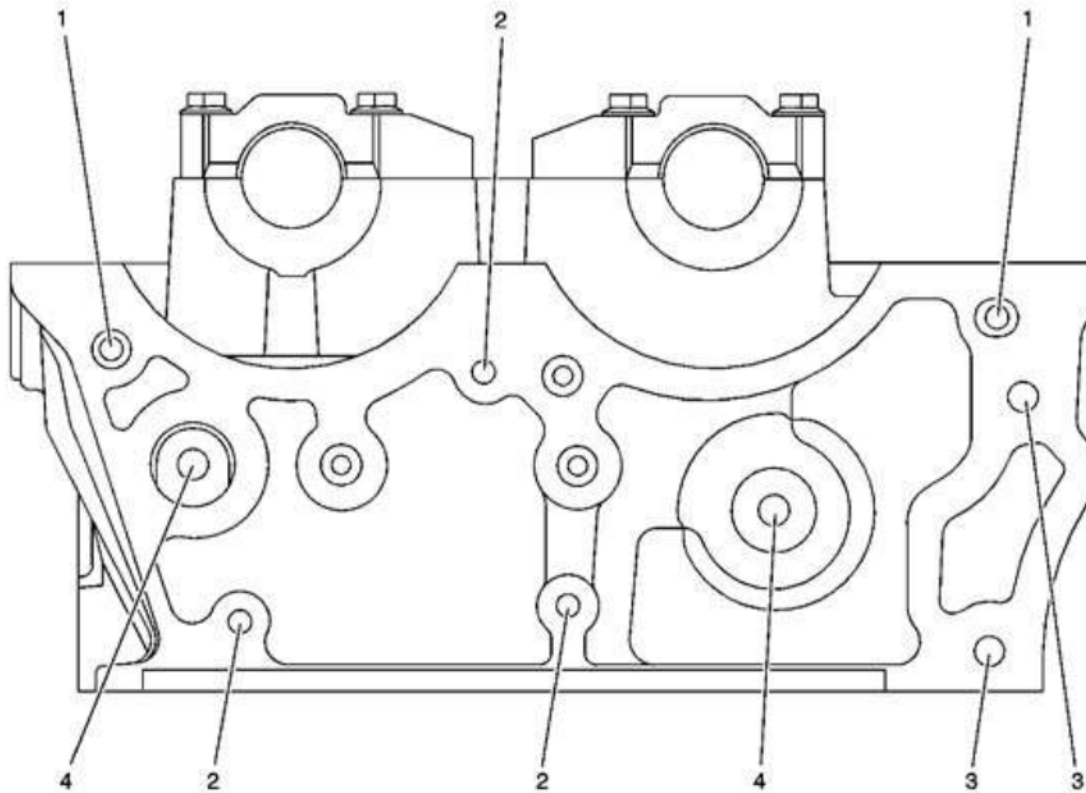


Fig. 7: Right Cylinder Head Front Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	30.0	1.1811	26.0	1.0236
2	M6 x 1.0	201	202	N/A	203	204	205	22.0	0.8661	18.0	0.7087
3	M8 x 1.25	206	207	N/A	208	209	210	27.0	1.0630	22.0	0.8661
4	M8 x 1.25	610	N/A	619	208	209	620	27.0	1.0630	22.0	0.8661

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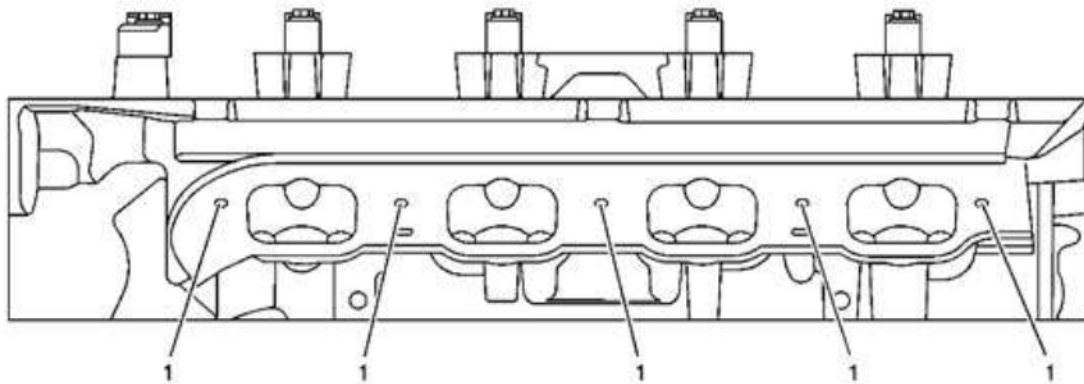


Fig. 8: Right Cylinder Head Intake Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Intake Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	25.0	0.9843	21.25	0.8366

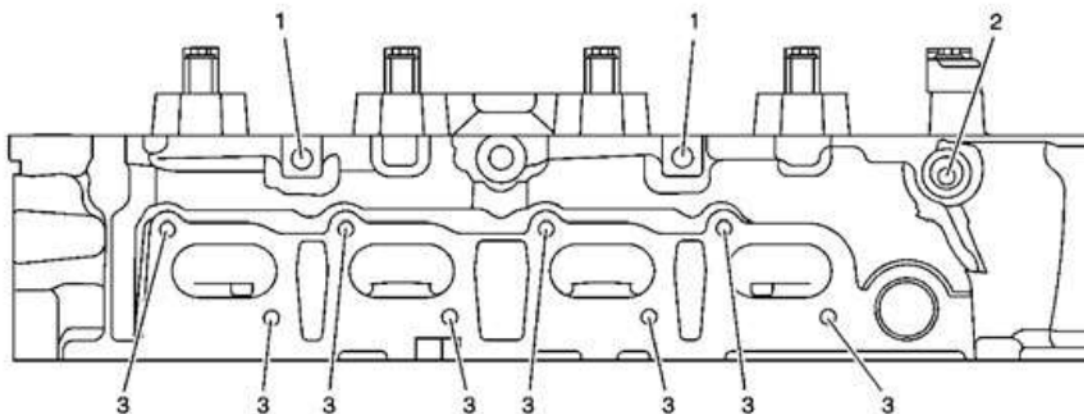


Fig. 9: Right Cylinder Head Exhaust Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Exhaust Face

Hole	Thread	Drill	Counter Bore	Stop	Tap	Driver	Insert	Drill Depth		Tap Depth	
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Location	Size	Drill	Tool	Collar	Tap	Driver	Insert	(Maximum)		(Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	32.0	1.2599	27.5	1.0827
2	M16 x 1.5	861	862	N/A	863	864	860	20.0	0.7874	16.0	0.6299
3	M8 x 1.25	206	207	N/A	208	209	210	25.0	0.9843	20.0	0.7874

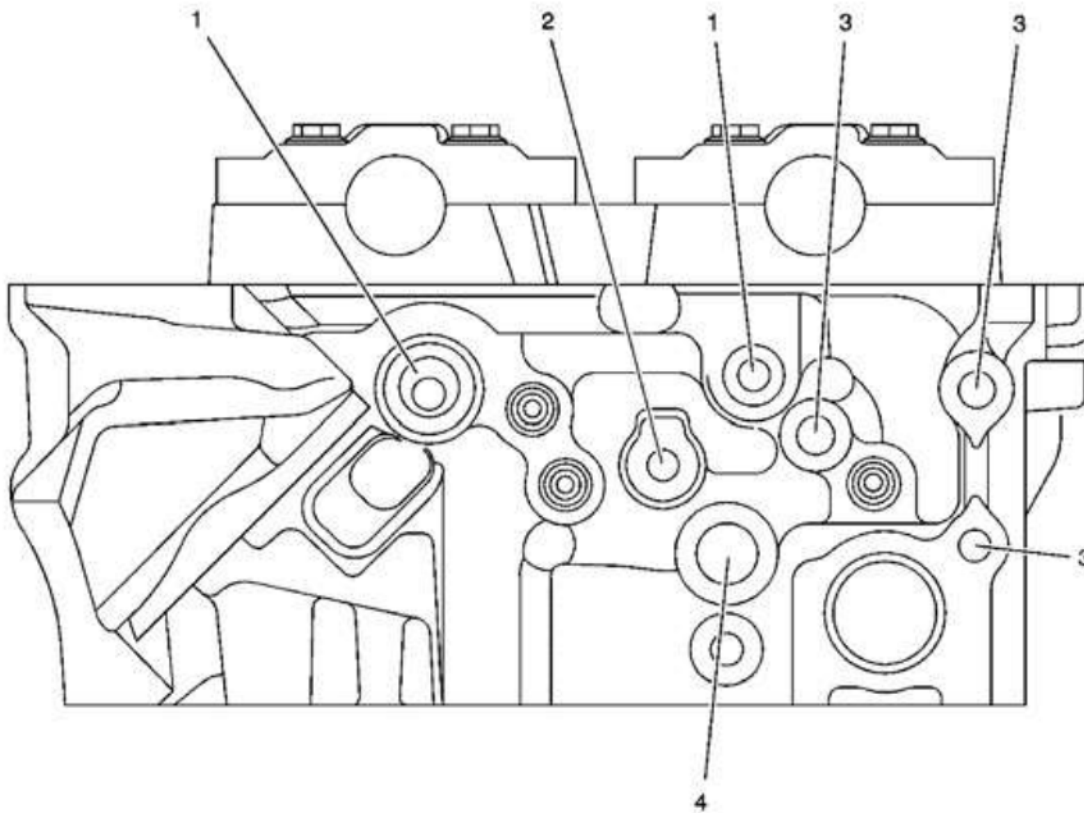


Fig. 10: Right Cylinder Head Rear Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Rear Face

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1	1.5	861	862	N/A	863	864	860	20.0	0.7874	16.0	0.6299
2	M8 x 1.25	206	207	N/A	208	209	210	27.0	1.0630	22.0	0.8661
3	M10 x 1.5	211	212	N/A	213	214	215	32.0	1.2598	26.0	1.0240
4	3/8 - 18 NPSF	2013	N/A	N/A	2014	2015	2016	THRU		THRU	

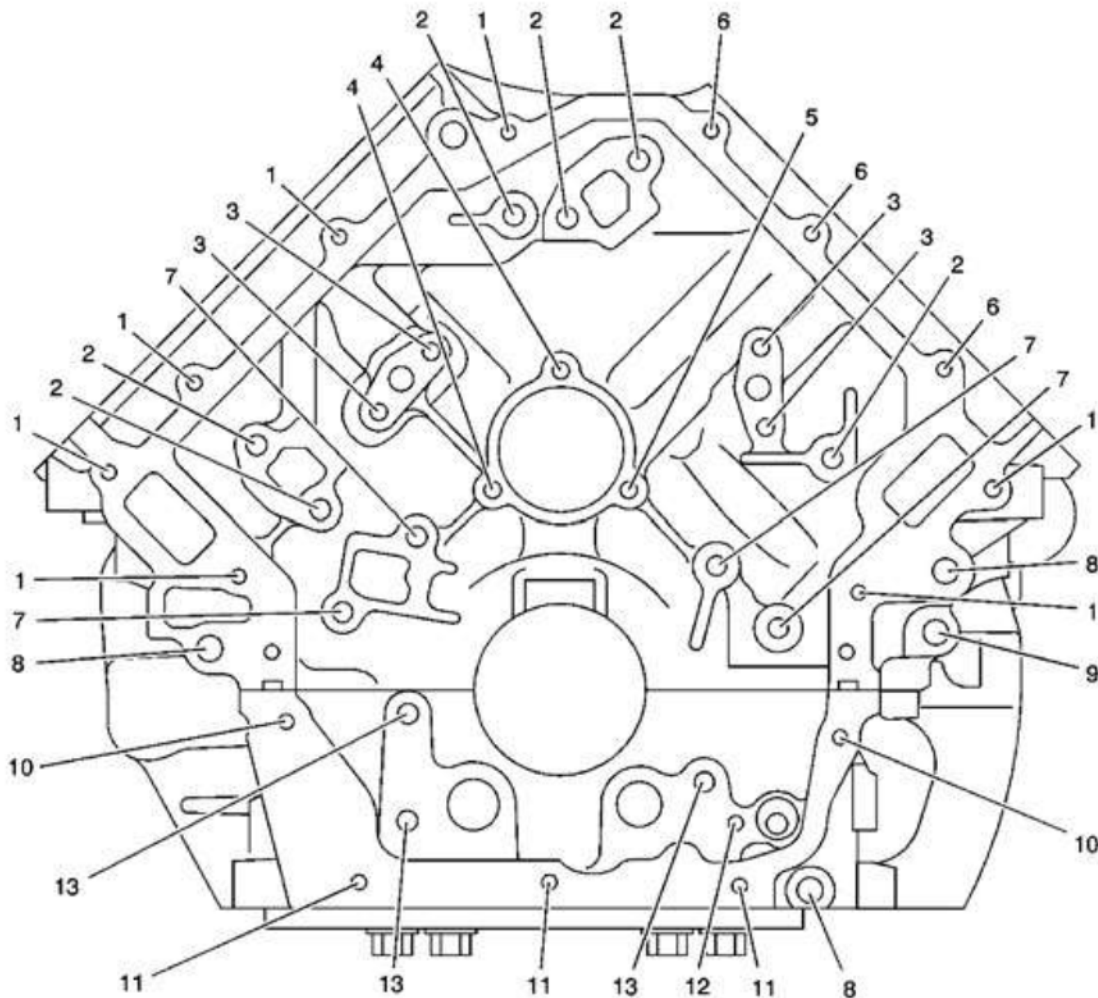


Fig. 11: Engine Block Front Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Engine Block Front

Hole	Thread		Counter Bore	Stop				Drill Depth	Tap Depth
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Location	Size	Drill	Tool	Collar	Tap	Driver	Insert	(Maximum)		(Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	19.5	0.7677	15.5	0.6102
2	M8 x 1.25	206	207	N/A	208	209	210	27.0	1.0630	22.0	0.8661
3	M6 x 1.0	201	202	N/A	203	204	205	23.0	0.9055	19.0	0.7480
4	M6 x 1.0	201	202	N/A	203	204	205	THRU		17.0	0.6693
5	M6 x 1.0	201	202	N/A	203	204	205	24.0	0.9449	17.0	0.6693
6	M6 x 1.0	201	202	N/A	203	204	205	THRU		15.5	0.6102
7	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
8	M10 x 1.5	211	212	N/A	213	214	420	30.0	1.1811	24.0	0.9449
9	M10 x 1.5	211	212	N/A	213	214	420	THRU		THRU	
10	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
11	M6 x 1.0	201	202	N/A	203	204	205	20.25	0.7972	16.25	0.6398
12	M6 x 1.0	201	202	N/A	203	204	205	23.75	0.9350	19.75	0.7776
13	M8 x 1.75	2001	2002	N/A	2003	2004	2005	26.75	1.0532	21.75	0.8563

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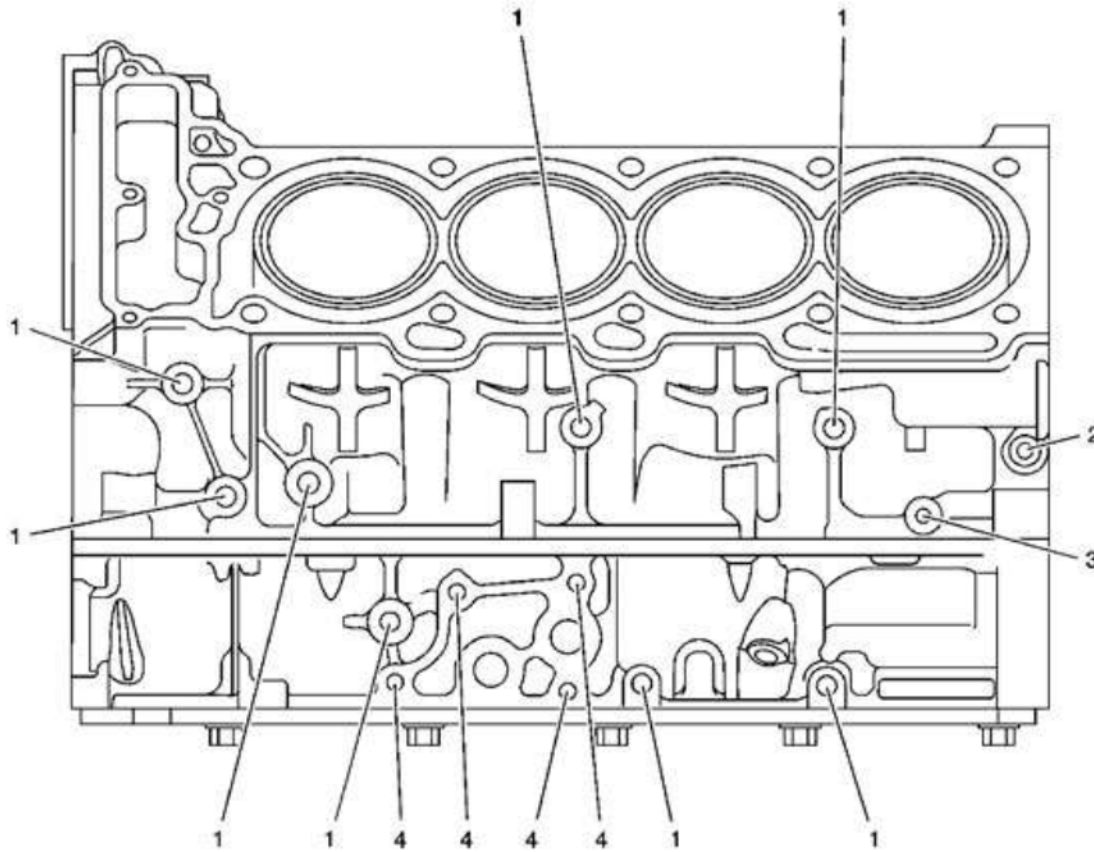


Fig. 12: Engine Block Left Side Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Engine Block Left Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	30.0	1.1811	24.0	0.0827
2	M6 x 1.0	201	202	N/A	203	204	205	25.0	0.9843	21.0	0.8268
3	M8 x 1.25	610	N/A	N/A	208	209	620	30.0	1.1811	25.0	0.9843
4	M8 x 1.25	206	207	N/A	208	209	210	20.0	0.7874	16.0	0.6299

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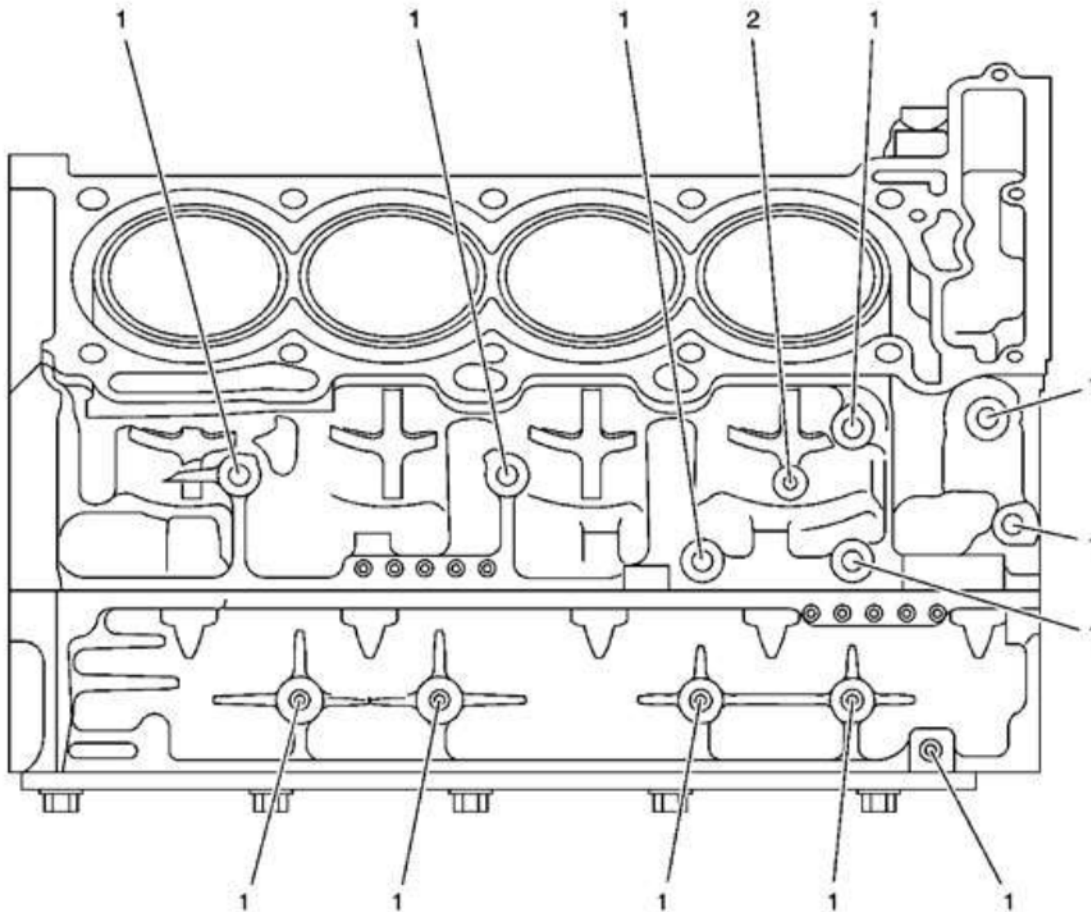


Fig. 13: Engine Block Right Side Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Engine Block Right Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	30.0	1.1811	24.0	1.0827
2	M8 x 1.25	206	207	N/A	208	209	210	24.5	0.9646	15.0	0.5906

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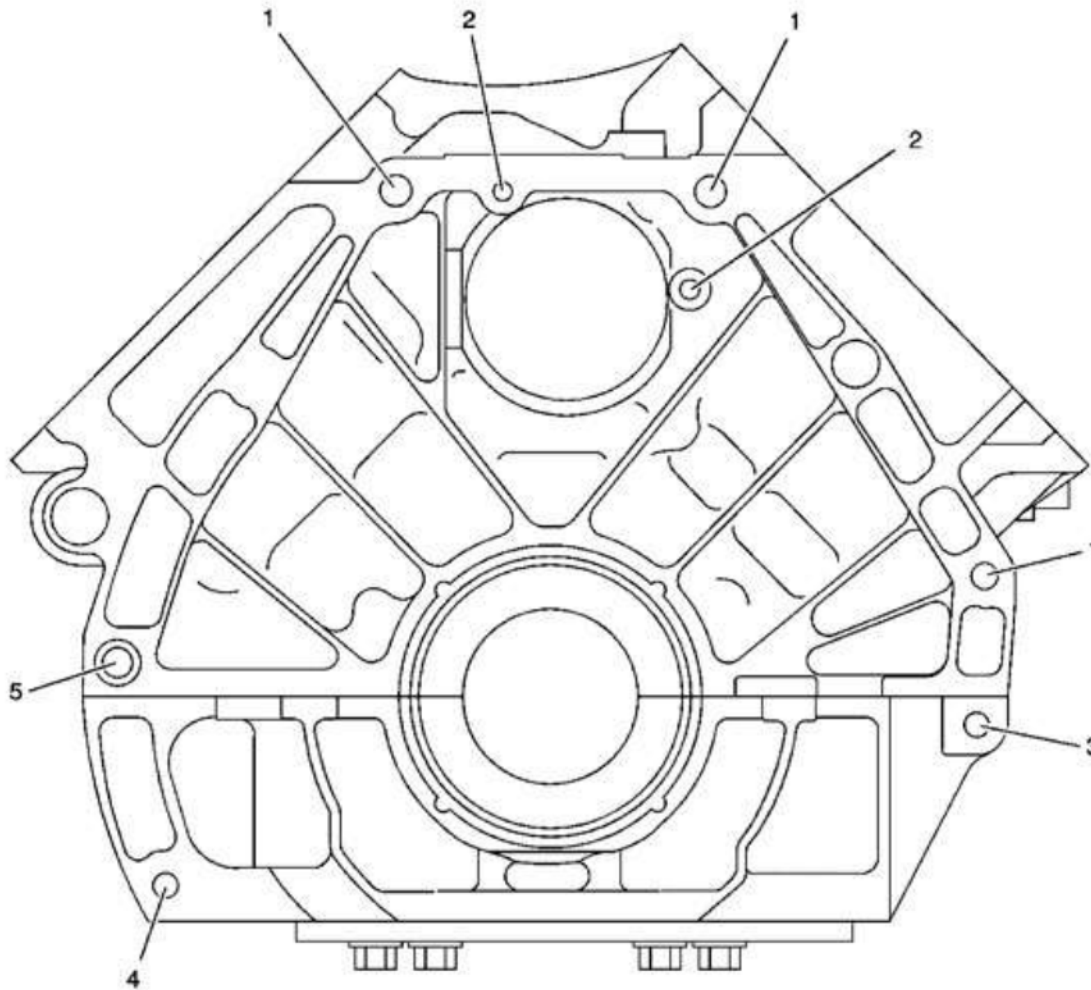


Fig. 14: Engine Block Rear Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Engine Block Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	THRU		THRU	
2	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
3	M10 x 1.5	211	212	N/A	213	214	420	39.75	1.5650	33.75	1.0827

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4	M10 x 1.5	211	212	N/A	213	214	420	THRU		THRU	
5	M10 x 1.5	211	212	N/A	213	214	420	39.0	1.5354	33.0	1.2992

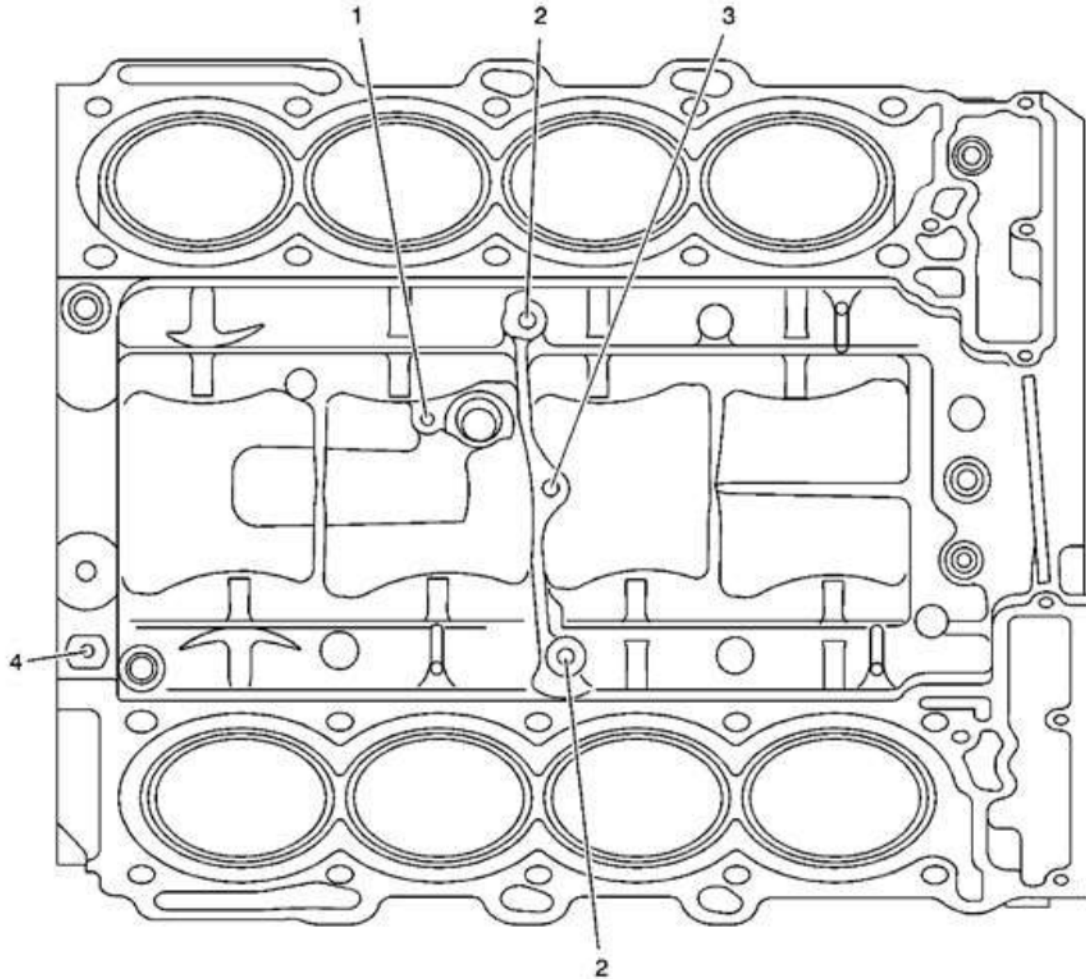


Fig. 15: Engine Block Top Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Engine Block Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x	201	202	N/A	203	204	205	20.0	0.7874	16.0	0.6299

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	1.0										
2	M8 x 1.25	206	207	N/A	208	209	210	23.5	0.9252	18.5	0.7283
3	M8 x 1.25	206	207	N/A	208	209	210	23.0	0.9055	19.0	0.7480
4	M6 x 1.0	201	202	N/A	203	204	205	23.0	0.9055	19.0	0.7480

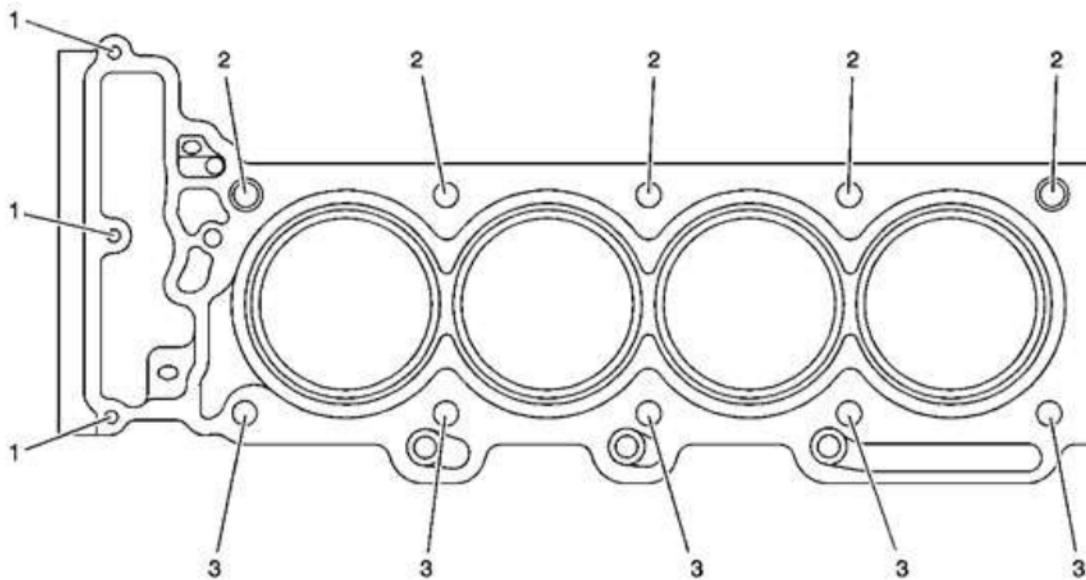


Fig. 16: Engine Block Left Deck Face Thread Repair Locations

Courtesy of GENERAL MOTORS CORP.

Engine Block Left Deck Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	608	N/A	N/A	203	204	205	30.0	1.1811	25.0	0.9843
2	M11 x 2.0	2031	N/A	N/A	2032	2033	108	73.0	2.8740	67.0	2.6378
3	M11 x 2.0	2031	N/A	N/A	2032	2033	108	89.5	3.5236	83.5	3.2874

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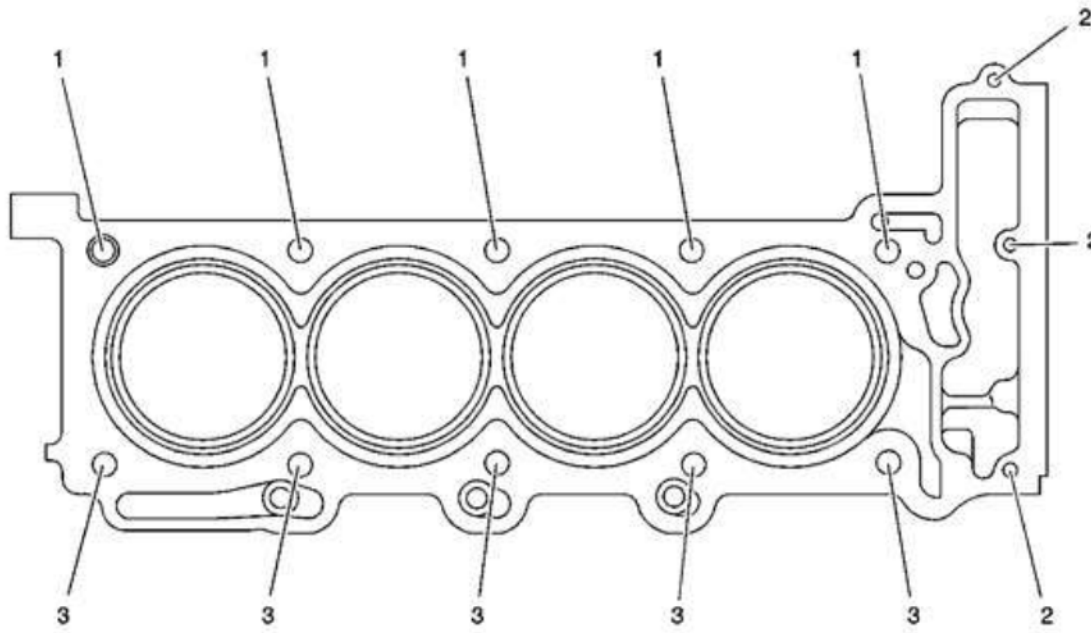


Fig. 17: Engine Block Right Deck Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Engine Block Right Deck Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M11 x 2.0	2031	N/A	N/A	2032	2033	108	73.0	2.8740	67.0	2.6378
2	M6 x 1.0	608	N/A	N/A	203	204	205	30.0	1.1811	25.0	0.9843
3	M11 x 2.0	2031	N/A	N/A	2032	2033	108	89.5	3.5236	83.5	3.2874

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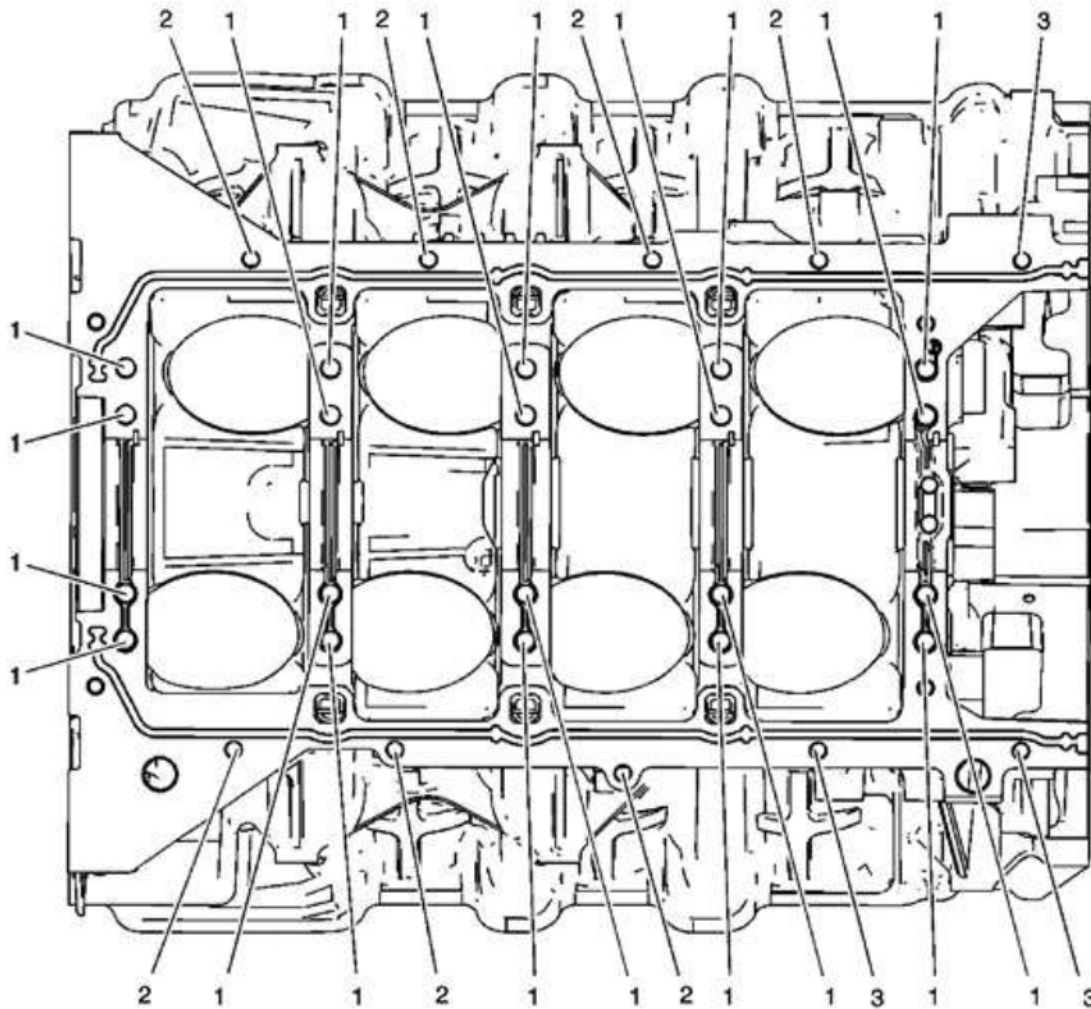


Fig. 18: Engine Block Lower Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Engine Block Lower Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	511	N/A	N/A	512	513	514	32.0	1.2598	26.5	1.0433
2	M8 x 1.25	610	N/A	N/A	208	209	620	THRU		THRU	
3	M8 x 1.25	610	N/A	N/A	208	209	620	37.0	1.4567	32.0	1.2598

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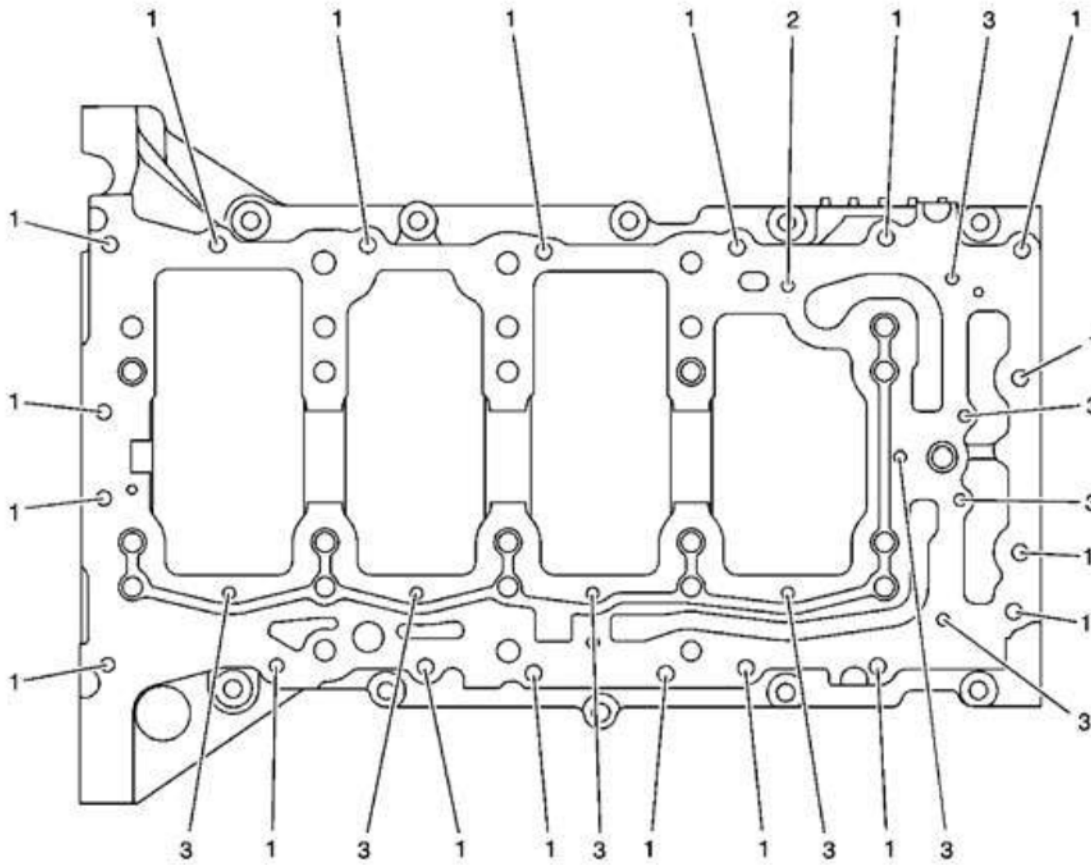
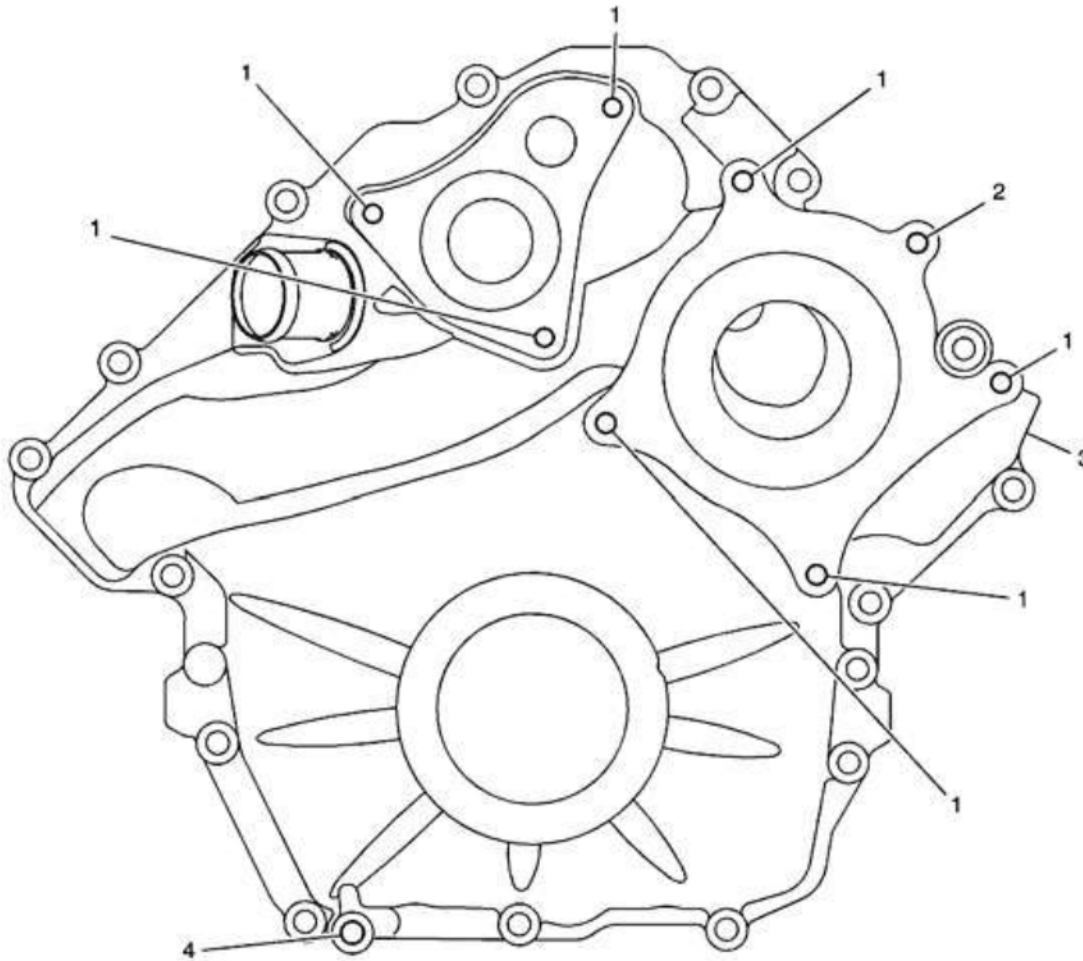


Fig. 19: Lower Crankcase Pan Face Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Lower Crankcase Pan Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	25.0	0.9843	20.0	0.7874
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
3	M6 x 1.0	201	202	N/A	203	204	205	22.0	0.8661	18.0	0.7087



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Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.5	0.7283
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		18.5	0.7283
3	M18 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	11.7	0.4606	9.0	0.3543

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.5	0.7283
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		18.5	0.7283
3	M18 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	11.7	0.4606	9.0	0.3543

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4	M8 x 1.25	206	207	N/A	208	209	210	THRU	18.5	0.7283
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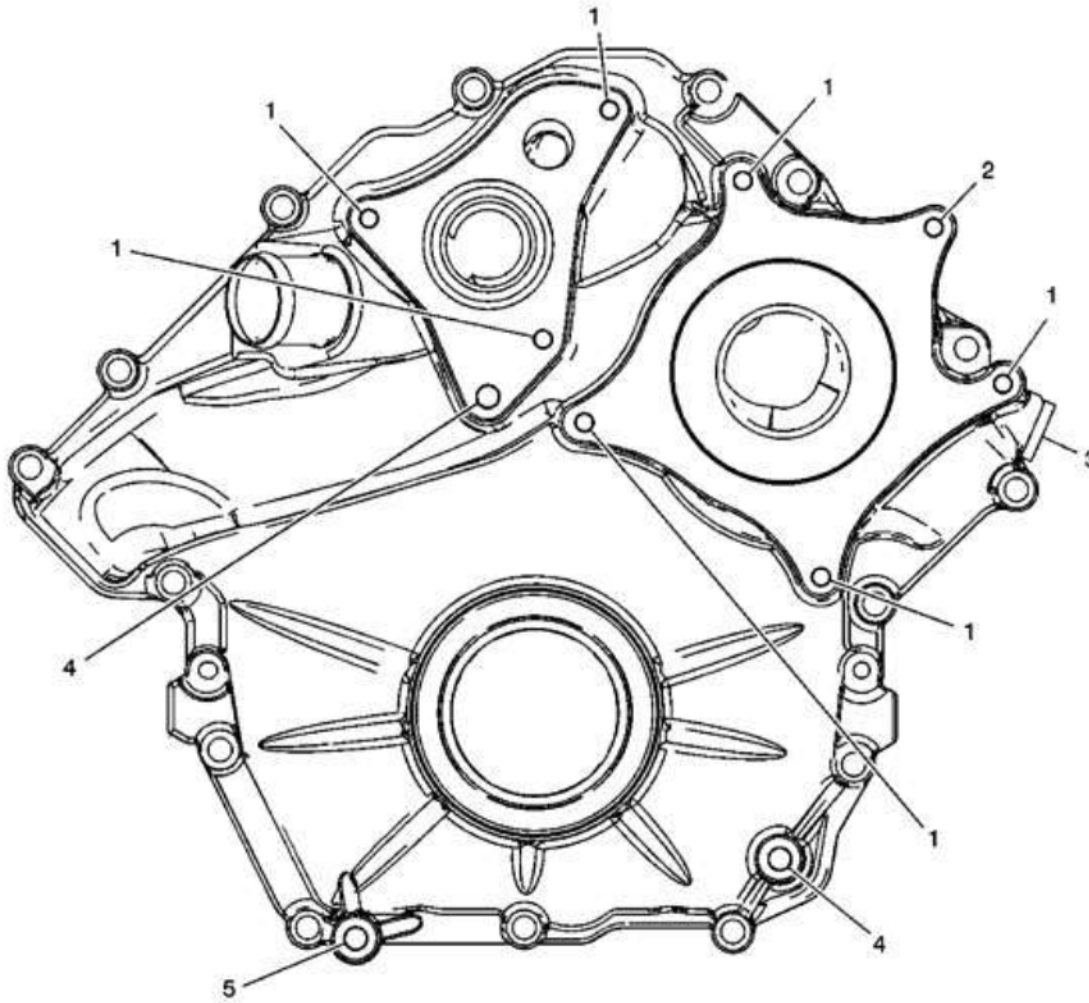


Fig. 21: Engine Front Cover Thread Repair Locations - Second Design
Courtesy of GENERAL MOTORS CORP.

Engine Front Cover - Second Design

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2	1.0	201	202	N/A	203	204	205	THRU		18.5	0.7283
3	M18 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	11.7	0.4606	9.0	0.3543
4	M8 x 1.25	206	207	N/A	208	209	210	26.0	1.0236	21.5	0.8465
5	M8 x 1.25	206	207	N/A	208	209	210	THRU		18.5	0.7283

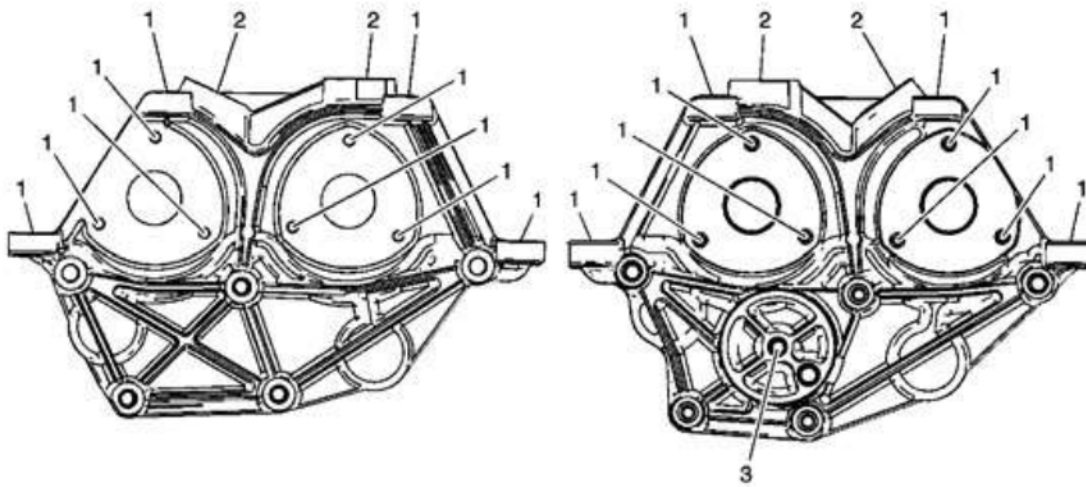


Fig. 22: Camshaft Position Actuator Housing Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Camshaft Position Actuator Housing

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M6 x 1.0	201	202	N/A	203	204	205	18.0	0.7087	14.0	0.5512
3	M10 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	THRU		THRU	

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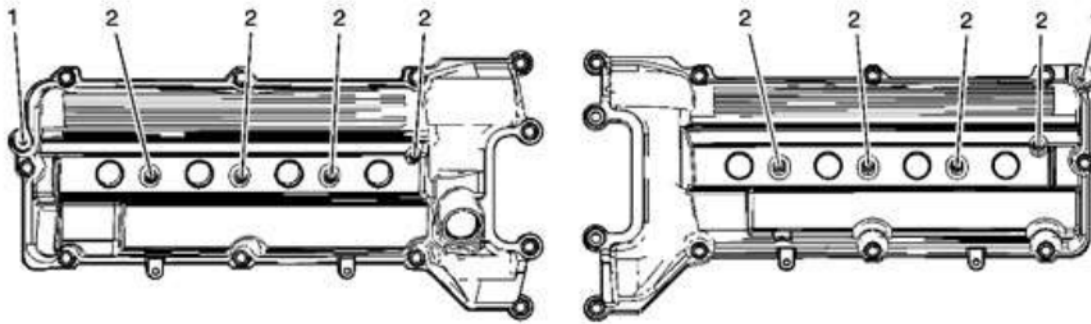


Fig. 23: Camshaft Cover Thread Repair Locations
Courtesy of GENERAL MOTORS CORP.

Camshaft Covers

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	-	-	-	-	-	-	-	THRU		THRU	
2	M6 x 1.0	201	202	N/A	203	204	205	23.0	0.9055	19.0	0.7480

#1 Threads are created initially when coil ground strap bolt is installed.

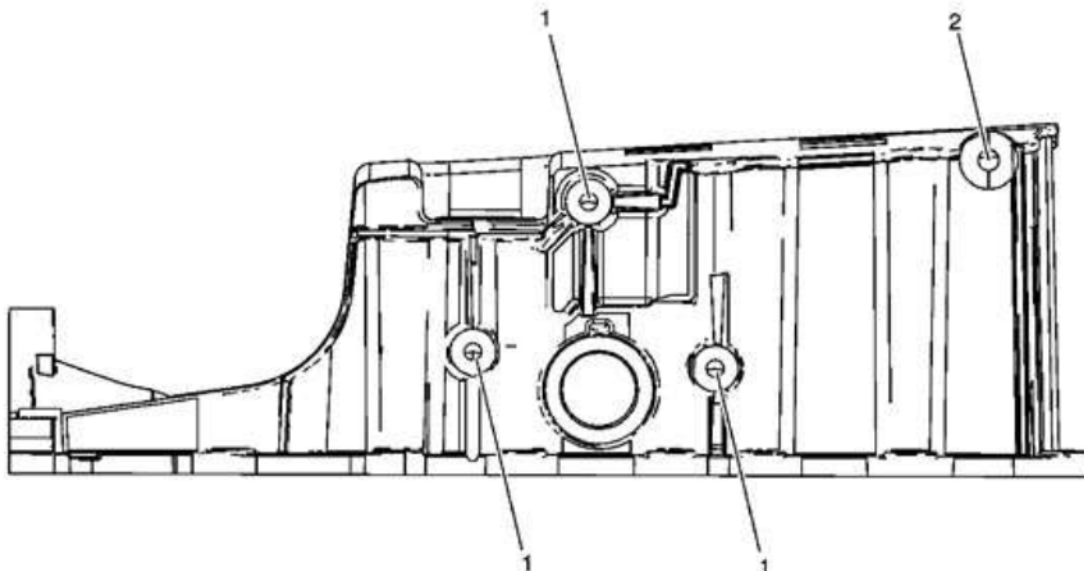


Fig. 24: Oil Pan Thread Repair Locations - Left

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Courtesy of GENERAL MOTORS CORP.

Oil Pan - Left

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
2	M12 x 1.75	856	857	N/A	858	859	865	THRU		THRU	

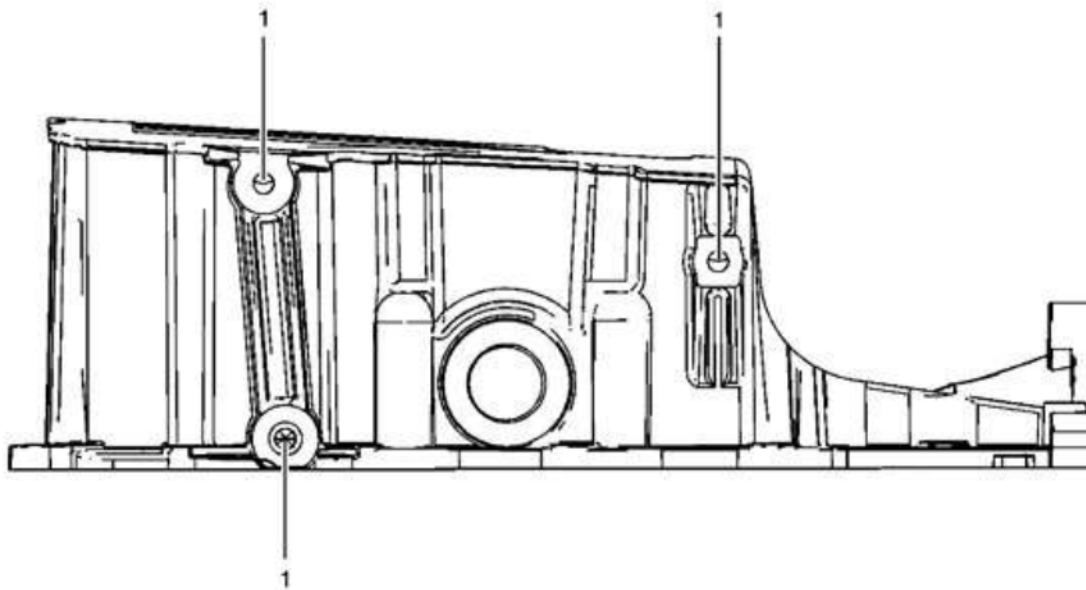


Fig. 25: Oil Pan Thread Repair Locations - Right
Courtesy of GENERAL MOTORS CORP.

Oil Pan - Right

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M12 x 1.75	856	857	N/A	858	859	855	39.5	1.5551	32.0	1.2598

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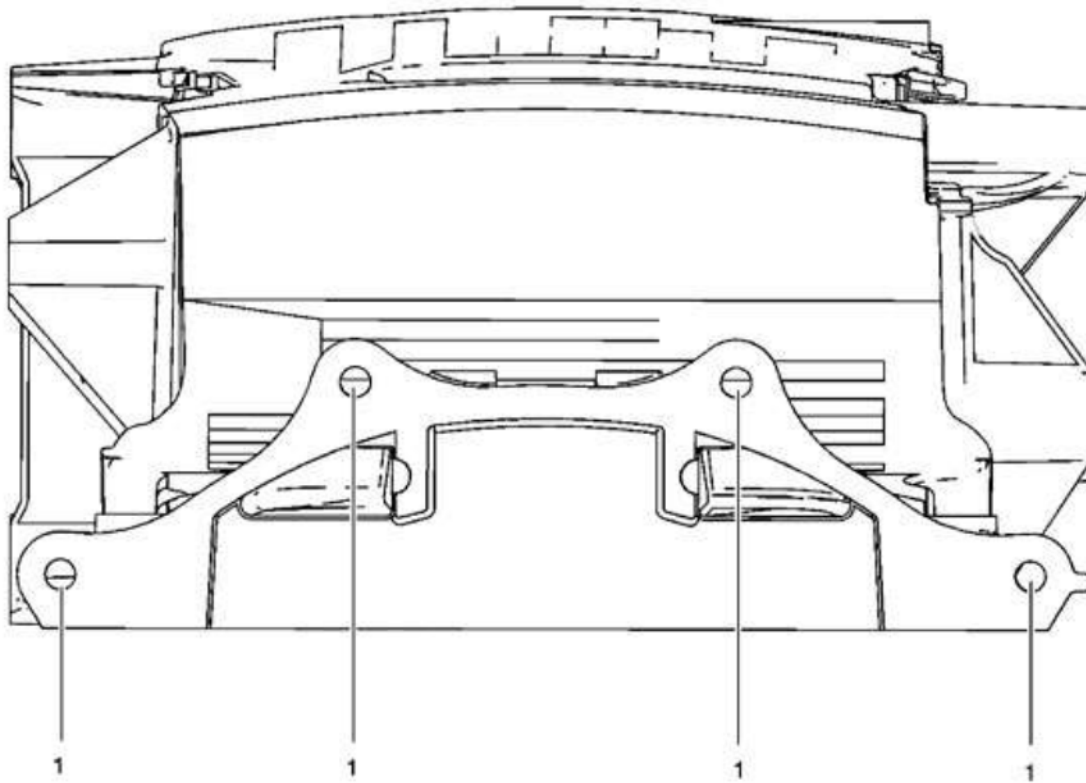


Fig. 26: Oil Pan Thread Repair Locations - Rear
 Courtesy of GENERAL MOTORS CORP.

Oil Pan - Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	THRU		21.5	0.8465

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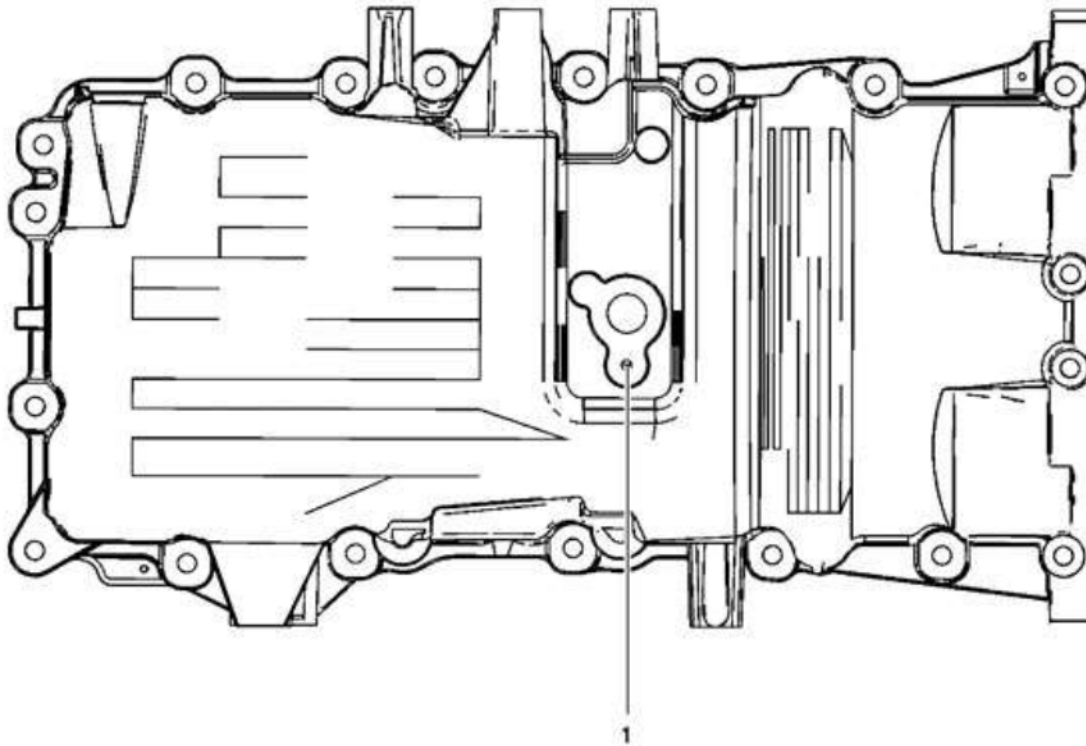


Fig. 27: Oil Pan Thread Repair Locations - Bottom
Courtesy of GENERAL MOTORS CORP.

Oil Pan - Bottom

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	28.0	1.1024	23.5	0.9252

COMPONENT LOCATOR

DISASSEMBLED VIEWS

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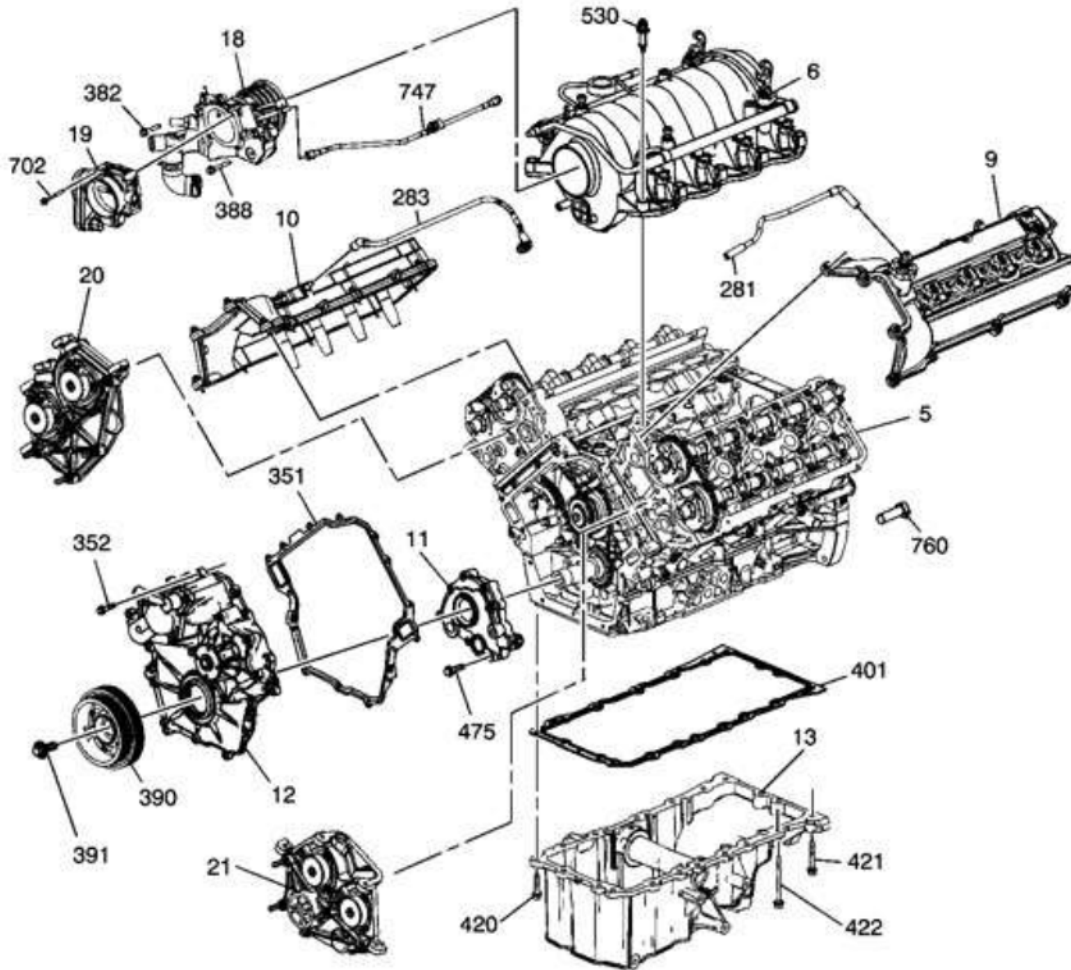


Fig. 28: Disassembled View Of Engine Covers & Component Assemblies (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 28

Callout	Component Name
5	Engine Long Block Assembly
6	Intake Manifold Assembly
9	Left Camshaft Cover Assembly
10	Right Camshaft Cover Assembly
11	Oil Pump Assembly
12	Engine Front Cover Assembly
13	Oil Pan Assembly
18	Water Outlet Assembly

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19	Throttle Body Assembly
20	Right Camshaft Position Actuator Housing Assembly
21	Left Camshaft Position Actuator Housing Assembly
281	PCV Fresh Air Tube
283	PCV Dirty Air Tube
351	Engine Front Cover Gasket
352	Engine Front Cover Bolt
382	Water Outlet Bolt - Short
388	Water Outlet Bolt - Long
390	Crankshaft Balancer
391	Crankshaft Balancer Bolt
401	Oil Pan Gasket
420	Oil Pan Bolt - Short
421	Oil Pan Bolt - Medium
422	Oil Pan Bolt - Long
475	Oil Pump Bolt
530	Intake Manifold Bolt
702	Throttle Body Bolt
747	EVAP Tube
760	Block Heater - 110 Volt

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Fig. 29: Disassembled View Of Engine Covers & Component Assemblies (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 29

Callout	Component Name
5	Engine Long Block Assembly
14	Oil Filter Adapter Assembly
16	Oil Level Indicator Assembly
405	Oil Pump Suction Pipe
406	Oil Pump Suction Pipe Gasket
407	Oil Pump Suction Pipe Bolt
408	Oil Pump Suction Pipe Nut
441	Oil Filter Adapter Gasket
442	Oil Filter Adapter Bolt

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449	Oil Filter
480	Oil Pump Outlet Tube
481	Oil Pump Outlet Tube O-Ring
482	Oil Pump Outlet Tube Bolt
600	Left Exhaust Manifold and Converter
601	Left Exhaust Manifold Gasket
610	Left Exhaust Manifold Heat Shield
611	Left Exhaust Manifold Heat Shield Bolt
620	Right Exhaust Manifold and Converter
621	Right Exhaust Manifold Gasket
623	Cylinder Head Exhaust Manifold Nut
624	Cylinder Head Exhaust Manifold Bolt
630	Right Exhaust Manifold Heat Shield
631	Right Exhaust Manifold Heat Shield Bolt
720	Crankshaft Position Sensor
721	Crankshaft Position Sensor O-Ring
722	Crankshaft Position Sensor Bolt
723	Knock Sensor
723	Knock Sensor
724	Knock Sensor Bolt
724	Knock Sensor Bolt
790	Starter Motor
791	Starter Motor Bolt
792	Starter Motor Solenoid Cable Nut - Larger
793	Starter Motor Solenoid Cable Nut - Small
794	Battery Positive and Negative Starter Cable
795	Bracket Bolt
796	Crankshaft Position Sensor and Knock Sensor Wiring Harness
797	Bracket

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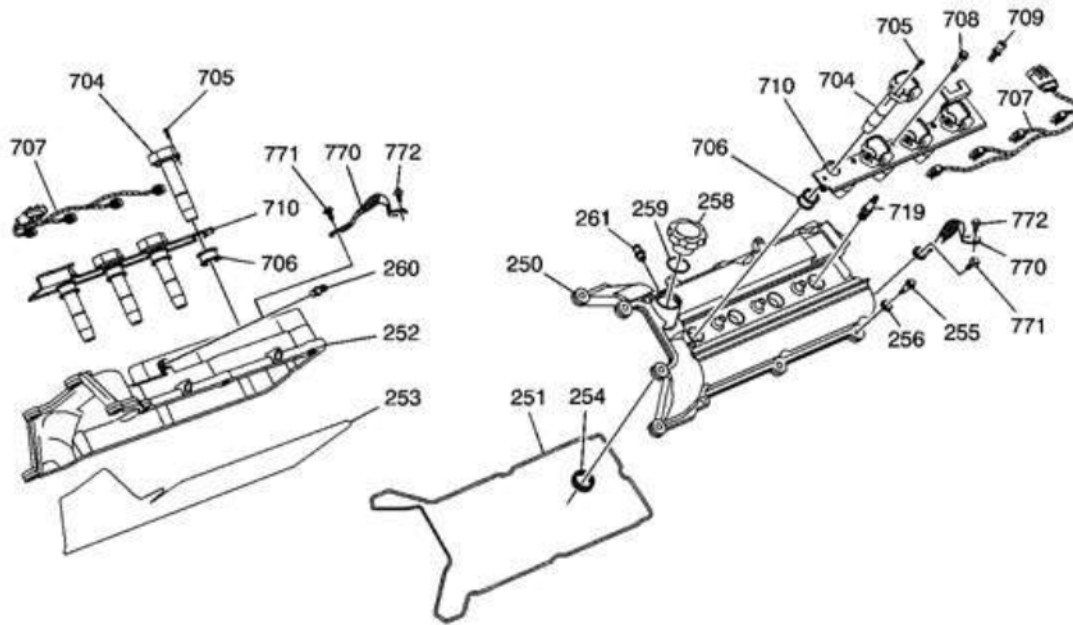


Fig. 30: Disassembled View Of Camshaft Cover Assembly Component View
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 30

Callout	Component Name
250	Left Camshaft Cover
251	Left Camshaft Cover Gasket
252	Right Camshaft Cover
253	Right Camshaft Cover Gasket
254	Camshaft Cover Spark Plug Port Seal
255	Camshaft Cover Bolt
256	Camshaft Cover Bolt Insulator
258	Oil Fill Cap
259	Oil Fill Cap O-Ring
260	Left Camshaft Cover PCV Fitting
261	Right Camshaft Cover PCV Fitting Orifice
704	Ignition Coil
704	Ignition Coil
705	Ignition Coil Bolt
705	Ignition Coil Bolt

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706	Ignition Coil Seal
706	Ignition Coil Seal
707	Ignition Coil Assembly Wiring Harness
707	Ignition Coil Assembly Wiring Harness
708	Ignition Coil Assembly Bolt
709	Ignition Coil Assembly Ball Stud
710	Ignition Coil Assembly Bracket
710	Ignition Coil Assembly Bracket
719	Spark Plug
770	Camshaft Cover to Cylinder Head Ground Strap
770	Camshaft Cover to Cylinder Head Ground Strap
771	Ground Strap to Camshaft Cover Bolt
771	Ground Strap to Camshaft Cover Bolt
772	Ground Strap to Cylinder Head Bolt
772	Ground Strap to Cylinder Head Bolt

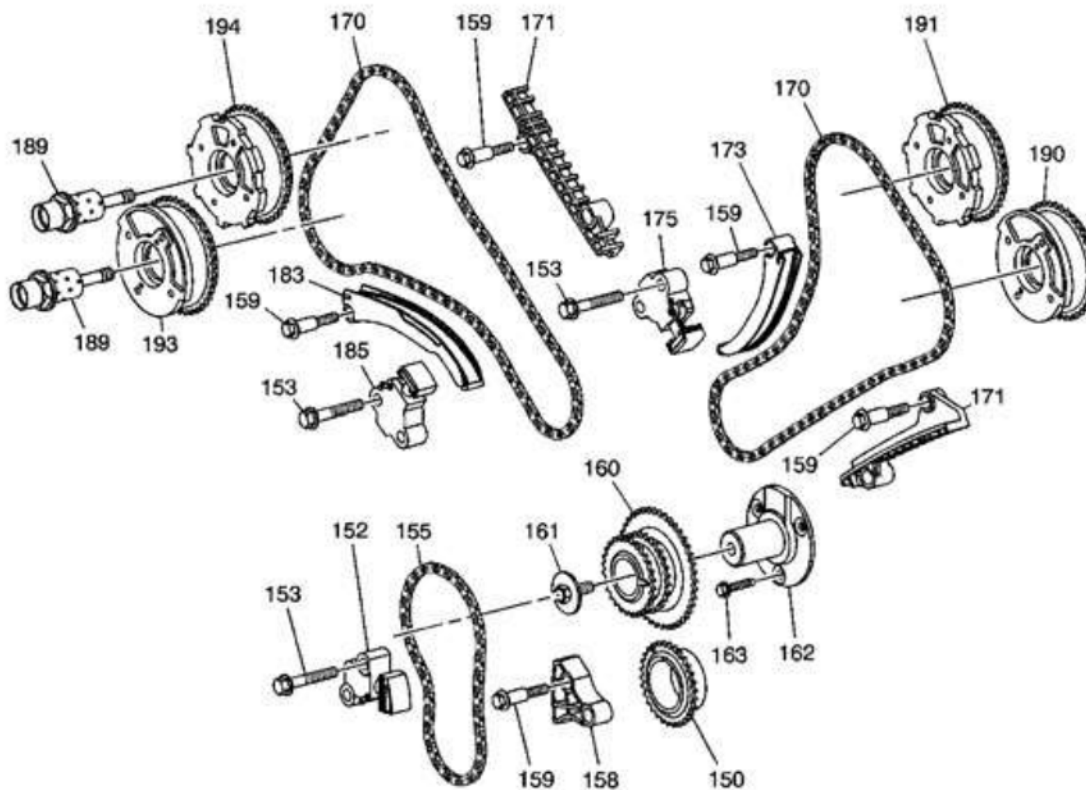


Fig. 31: Disassembled View Of Camshaft Timing Components

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Courtesy of GENERAL MOTORS CORP.**Callouts For Fig. 31**

Callout	Component Name
150	Crankshaft Sprocket
152	Primary Timing Chain Tensioner
153	Primary Timing Chain Tensioner Bolt
155	Primary Timing Chain
158	Primary Timing Chain Guide
159	Primary Timing Chain Guide Bolt
160	Camshaft Intermediate Drive Shaft Sprocket
161	Camshaft Intermediate Drive Shaft Sprocket Bolt
162	Camshaft Intermediate Drive Shaft
163	Camshaft Intermediate Drive Shaft Bolt
170	Left Secondary Timing Chain
171	Left Secondary Timing Chain Guide
172	Left Secondary Timing Chain Guide Bolt
173	Left Secondary Timing Chain Shoe
174	Left Secondary Timing Chain Shoe Bolt
175	Left Secondary Timing Chain Tensioner
176	Left Secondary Timing Chain Tensioner Bolt
180	Right Secondary Timing Chain
181	Right Secondary Timing Chain Guide
182	Right Secondary Timing Chain Guide Bolt
183	Right Secondary Timing Chain Shoe
184	Right Secondary Timing Chain Shoe Bolt
185	Right Secondary Timing Chain Tensioner
186	Right Secondary Timing Chain Tensioner Bolt
189	Camshaft Position Actuator Oil Control Valve
189	Camshaft Position Actuator Oil Control Valve
190	Left Exhaust Camshaft Position Actuator
191	Left Intake Camshaft Position Actuator
193	Right Exhaust Camshaft Position Actuator
194	Right Intake Camshaft Position Actuator

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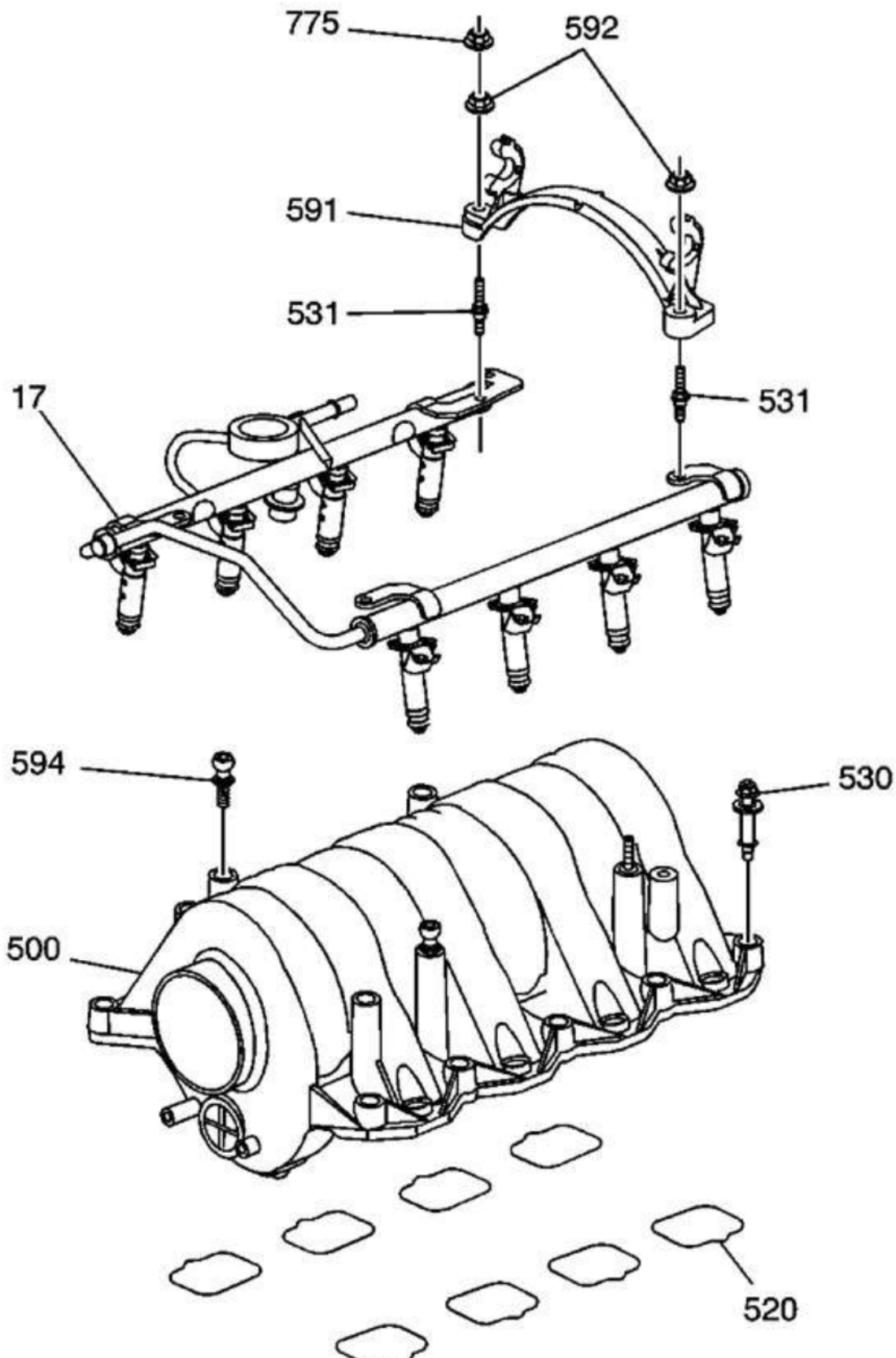


Fig. 32: Disassembled View Of Intake Manifold Components
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 32

Callout	Component Name
17	Fuel Rail Assembly
500	Intake Manifold
520	Intake Manifold Seal
530	Intake Manifold Bolt
531	Fuel Rail Stud
531	Fuel Rail Stud
591	Fuel Injector Sight Shield Cover Bracket
592	Fuel Injector Sight Shield Cover Bracket Nut
594	Fuel Injector Sight Shield Cover Ball Stud
775	Engine Wiring Harness Ground Nut

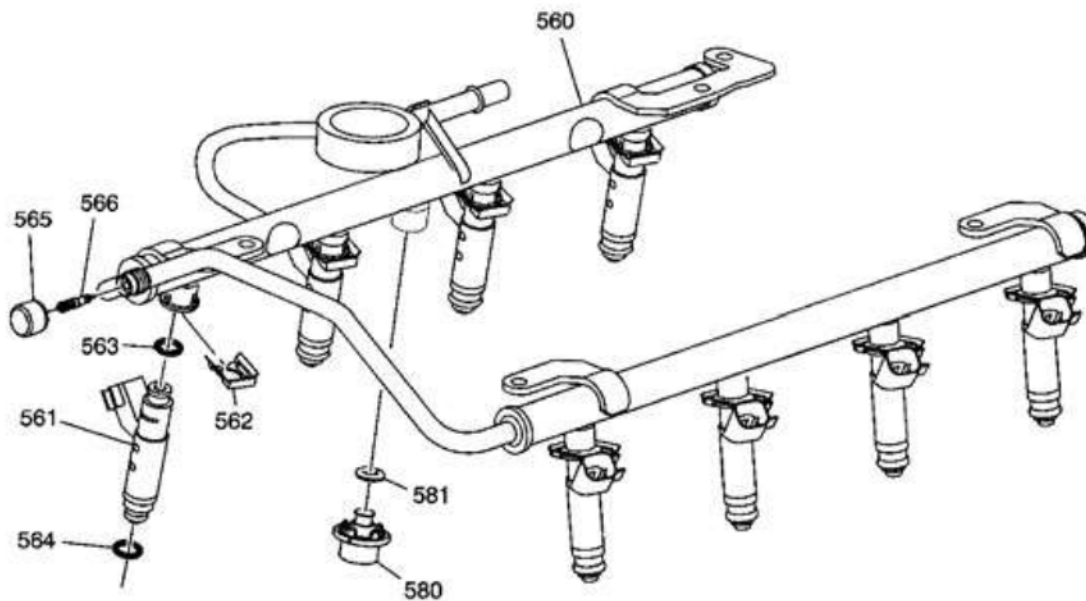


Fig. 33: Disassembled View Of Fuel Rail Components
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 33

Callout	Component Name
560	Fuel Rail

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561	Fuel Injector
562	Fuel Injector Retainer
563	Fuel Injector Upper Seal
564	Fuel Injector Lower Seal
565	Fuel Pressure Service Valve Cap
566	Fuel Pressure Service Valve
580	Fuel Pulse Dampener
581	Fuel Pulse Dampener O-ring

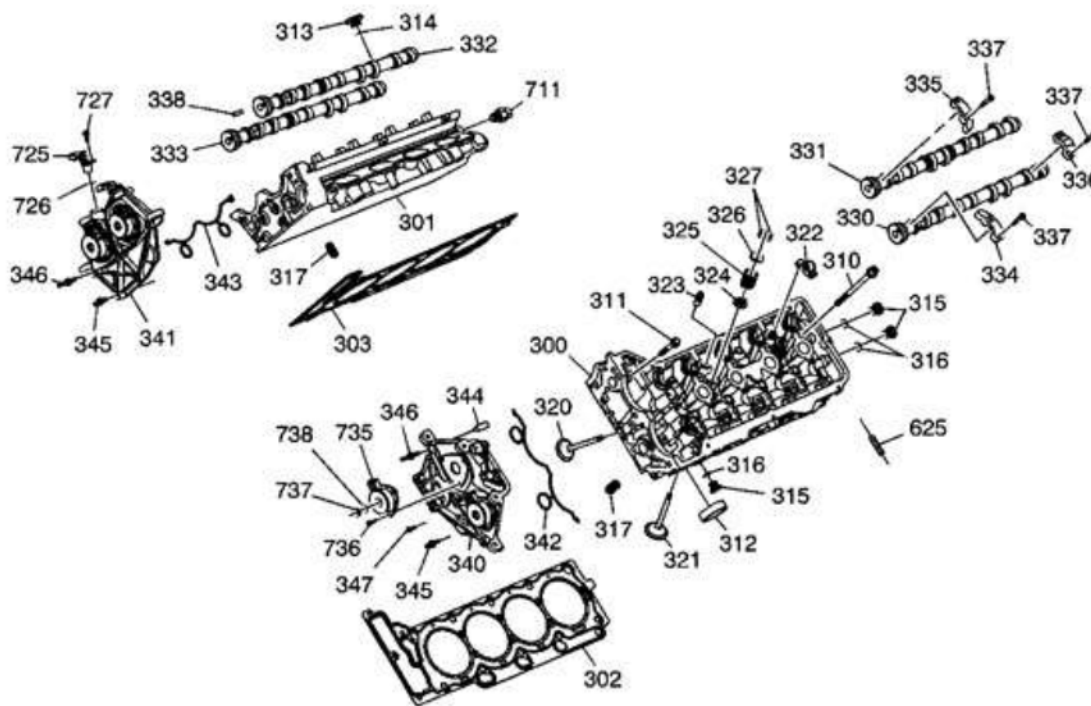


Fig. 34: Disassembled View Of Cylinder Head Assemblies Components
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 34

Callout	Component Name
300	Left Cylinder Head
301	Right Cylinder Head
302	Left Cylinder Head Gasket
303	Right Cylinder Head Gasket
310	Cylinder Head Bolt - M11

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311	Cylinder Head Front Bolt - M6
312	Cylinder Head Coolant Hole Expansion Plug
313	Cylinder Head Coolant Hole Plug
314	Cylinder Head Coolant Hole Plug Seal Ring
315	Cylinder Head Oil Gallery Plug
315	Cylinder Head Oil Gallery Plug
316	Cylinder Head Oil Gallery Plug Ring
316	Cylinder Head Oil Gallery Plug Ring
317	Engine Oil Gallery Restrictor
317	Engine Oil Gallery Restrictor
320	Exhaust Valve
321	Intake Valve
322	Valve Rocker Arm Assembly
323	Hydraulic Valve Lash Adjuster Assembly
324	Valve Stem Oil Seal
325	Valve Spring
326	Valve Spring Cap
327	Valve Stem Key
330	Left Exhaust Camshaft
331	Left Intake Camshaft
332	Right Intake Camshaft
333	Right Exhaust Camshaft
334	Cylinder Head Front Camshaft Cap
335	Cylinder Head Front Camshaft Cap
336	Cylinder Head Camshaft Cap
337	Cylinder Head Camshaft Cap Bolt
337	Cylinder Head Camshaft Cap Bolt
337	Cylinder Head Camshaft Cap Bolt
338	Camshaft Sprocket Locating Pin
340	Left Camshaft Position Actuator Housing
341	Right Camshaft Position Actuator Housing
342	Left Camshaft Position Actuator Housing Gasket
343	Right Camshaft Position Actuator Housing Gasket
344	Camshaft Position Actuator Housing Pin
345	Camshaft Position Actuator Housing Stud - Short

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	Camshaft Position Actuator Housing Stud - Short
346	Camshaft Position Actuator Housing Stud - Long
346	Camshaft Position Actuator Housing Stud - Long
347	Camshaft Position Actuator Housing Bolt
625	Cylinder Head Exhaust Manifold Stud
711	Engine Coolant Temperature Sensor
725	Camshaft Position Sensor
726	Camshaft Position Sensor O-Ring
727	Camshaft Position Sensor Bolt
735	Camshaft Position Actuator Magnet
736	Camshaft Position Actuator Magnet Bolt
737	Camshaft Position Actuator Magnet Plug
738	Camshaft Position Actuator Magnet Plug O-Ring

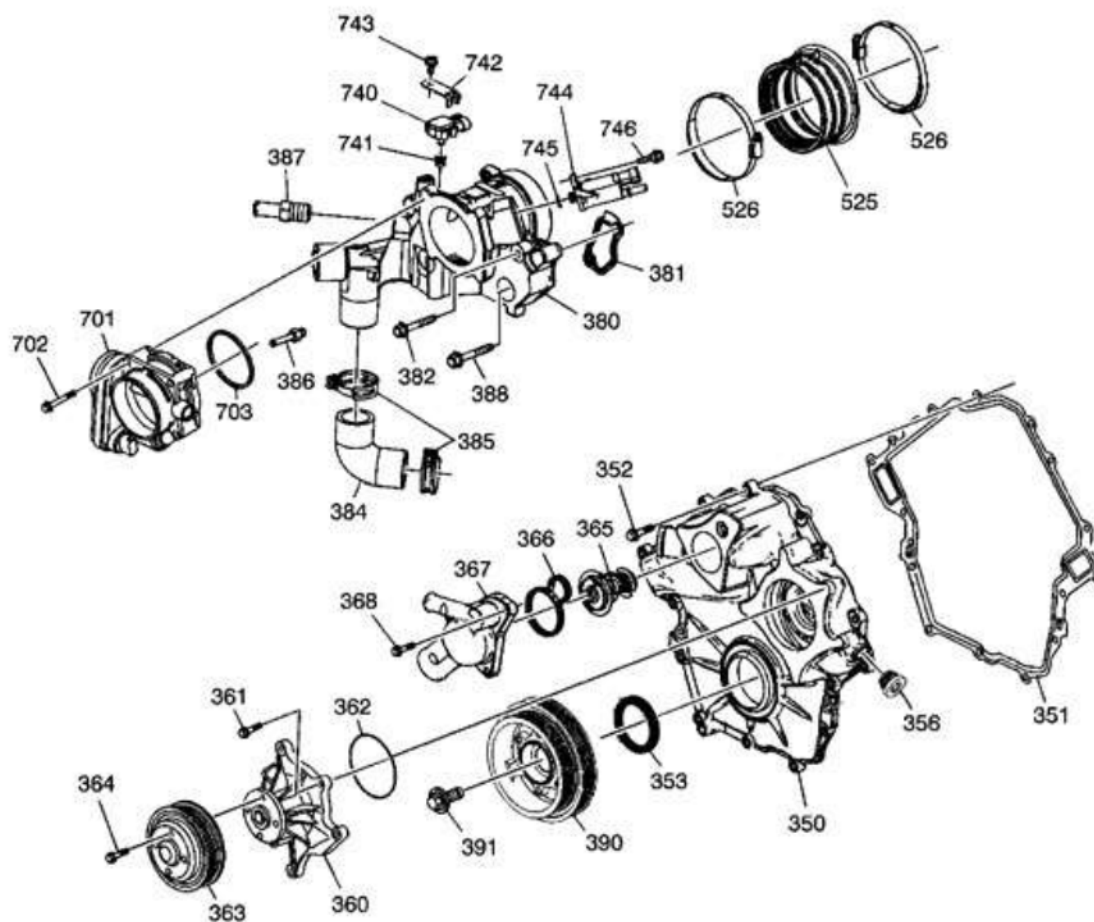


Fig. 35: Disassembled View Of Engine Front Cover, Water Crossover & Throttle Body

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Assembly Components

Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 35

Callout	Component Name
350	Engine Front Cover
351	Engine Front Cover Gasket
352	Engine Front Cover Bolt
353	Engine Front Cover Seal
356	Engine Front Cover Fitting
360	Water Pump Assembly
361	Water Pump Bolt
362	Water Pump Gasket
363	Water Pump Pulley
364	Water Pump Pulley Bolt
365	Engine Cooling Thermostat
366	Engine Cooling Thermostat Gasket
367	Engine Cooling Thermostat Housing
368	Engine Cooling Thermostat Housing Bolt
380	Water Outlet
381	Water Outlet Gasket
382	Water Outlet Bolt - Short
384	Water Bypass Hose
385	Water Bypass Hose Clamp
386	Engine Coolant Air Bleed Hose Fitting
387	Heater Inlet Hose Fitting
388	Water Outlet Bolt - Long
390	Crankshaft Balancer
391	Crankshaft Balancer Bolt
525	Intake Manifold Plenum Duct
526	Intake Manifold Plenum Duct Clamp
526	Intake Manifold Plenum Duct Clamp
701	Throttle Body
702	Throttle Body Bolt
703	Throttle Body Gasket

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740	MAP Sensor
741	MAP Sensor O-Ring
742	MAP Sensor Bracket
743	MAP Sensor Stud
744	EVAP Purge Solenoid
745	EVAP Purge Solenoid O-Ring
746	EVAP Purge Solenoid Bolt

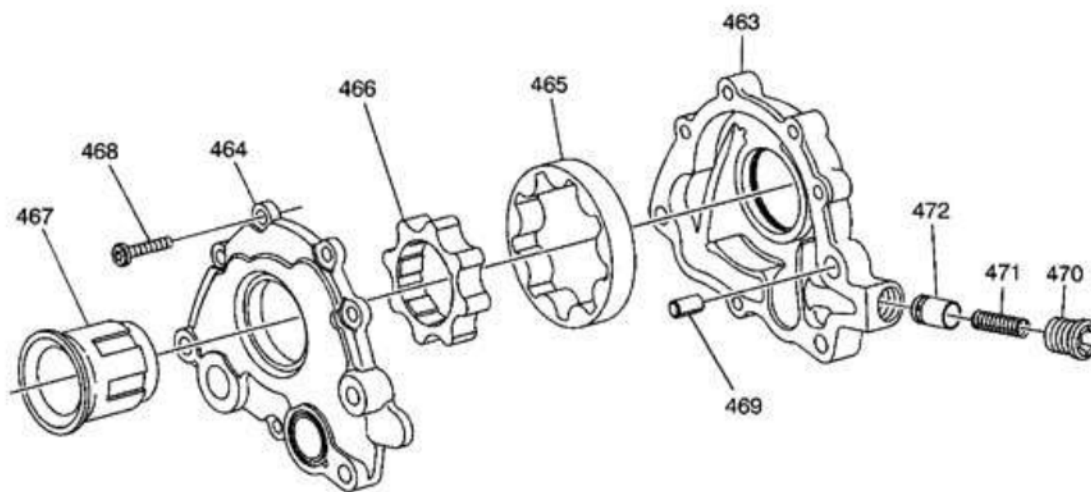


Fig. 36: Disassembled View Of Oil Pump Components
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 36

Callout	Component Name
463	Oil Pump Housing
464	Oil Pump Cover
465	Oil Pump Driven Gear
466	Oil Pump Drive Gear
467	Oil Pump Driven Gear Spacer
468	Oil Pump Cover Bolt
469	Oil Pump Cover Locating Pin
470	Oil Pump Pressure Relief Valve Bore Plug
471	Oil Pump Pressure Relief Valve Spring
472	Oil Pressure Relief Valve

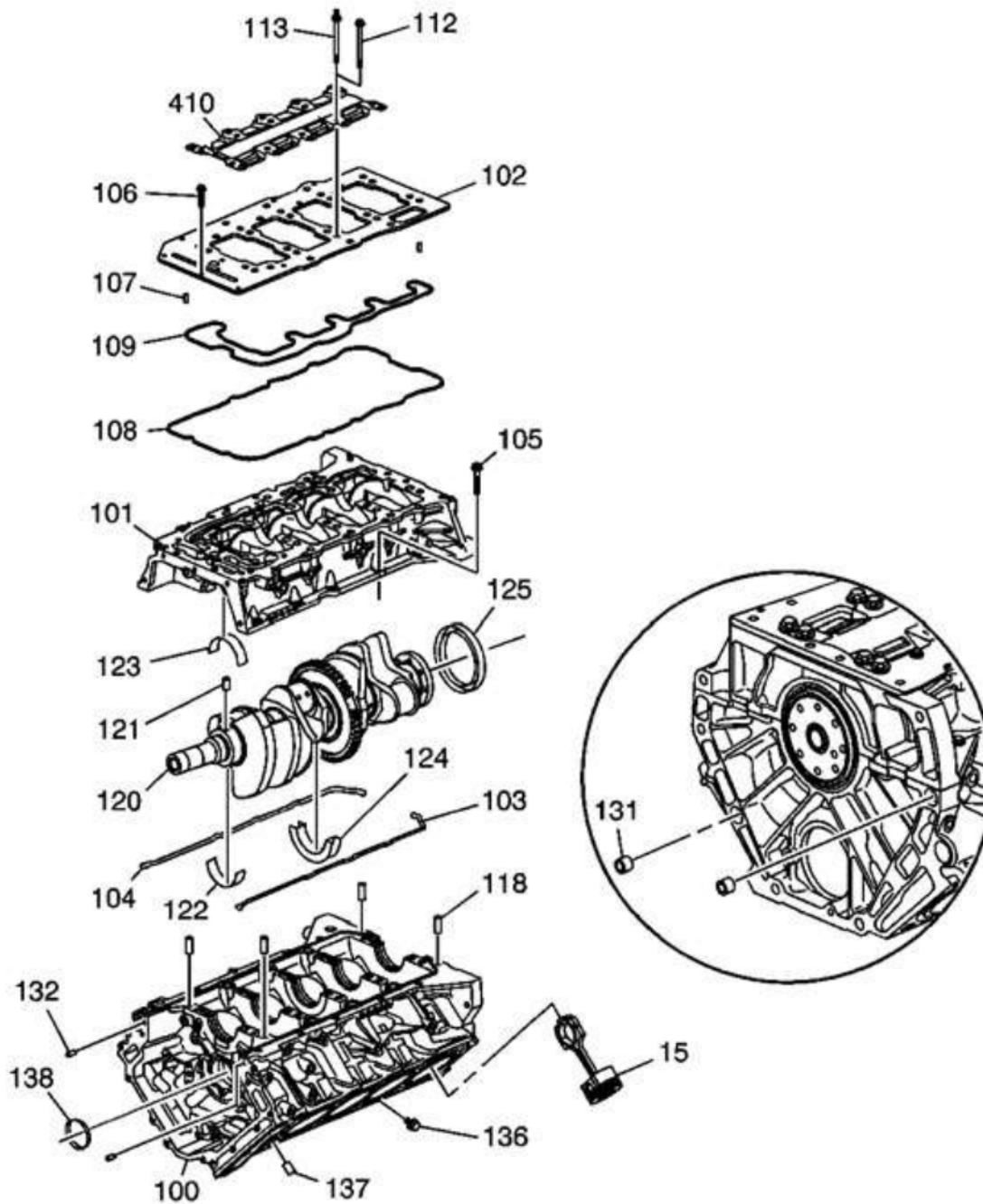


Fig. 37: Disassembled View Of Engine Block Assembly Components
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 37

Callout	Component Name
15	Piston and Connecting Rod Assembly

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100	Engine Block
101	Lower Crankcase
102	Engine Oil Distribution Plate
103	Right Lower Crankcase Seal
104	Left Lower Crankcase Seal
105	Lower Crankcase Bolt
106	Engine Oil Distribution Plate Bolt
107	Oil Pan Locating Pin
108	Engine Oil Distribution Plate Outer Seal
109	Engine Oil Distribution Plate Inner Seal
112	Lower Crankcase Main Bolt
113	Lower Crankcase Main Stud
118	Lower Crankcase Locating Pin
120	Crankshaft
121	Crankshaft Sprocket Locating Pin
122	Crankshaft Upper Bearing
123	Crankshaft Lower Bearing
124	Crankshaft Upper Thrust Bearing #3
125	Piston, Rings and Connecting Rod Assembly
131	Transaxle Locating Pin
132	Engine Front Cover Locating Pin
136	Engine Block Coolant Drain Plug
137	Cylinder Head Locating Pin
138	Camshaft Intermediate Drive Shaft Plug
410	Oil Pan Baffle Scraper

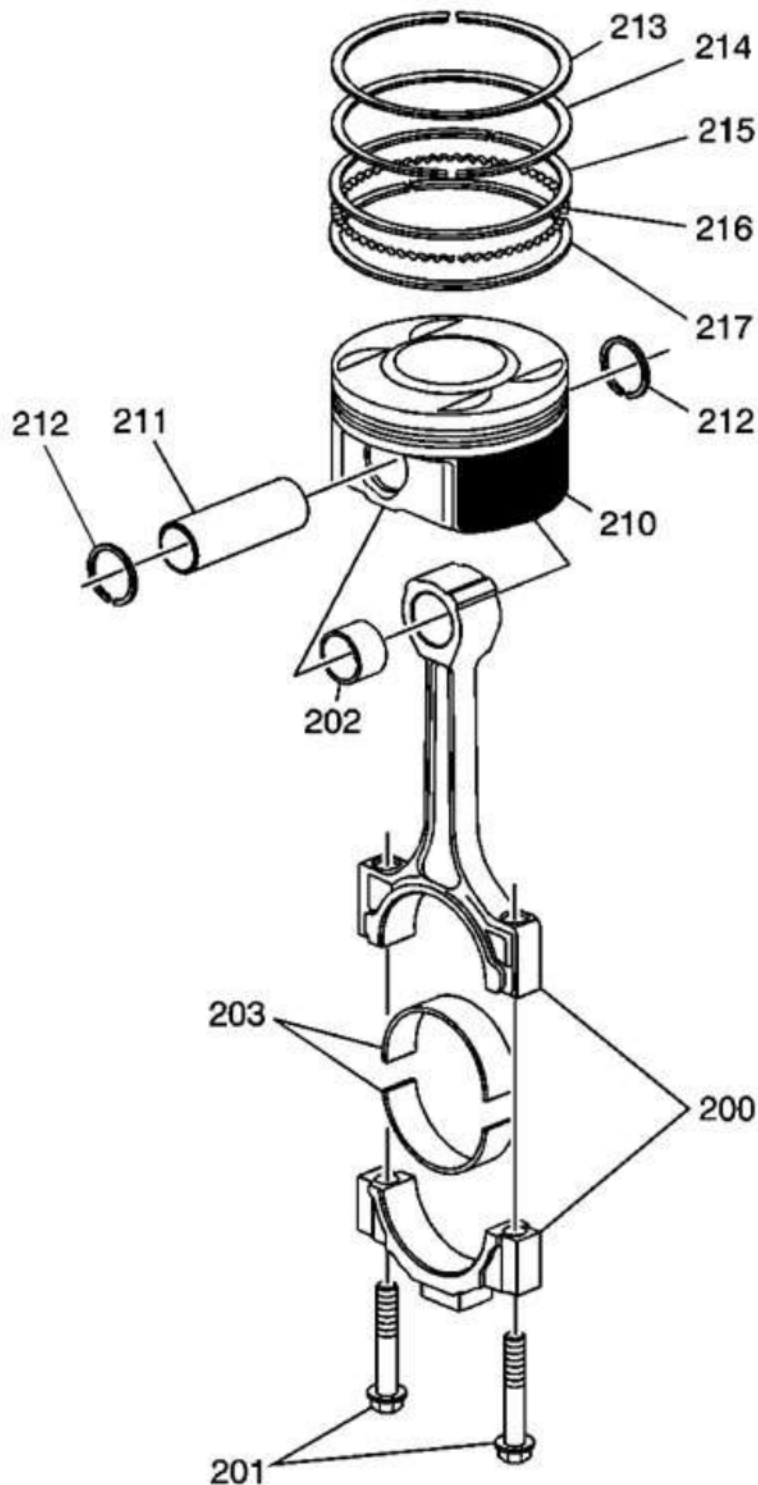


Fig. 38: Disassembled View Of Piston, Rings, Bearing & Connecting Rod Components
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 38

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Callout	Component Name
200	Connecting Rod
201	Connecting Rod Bolt
202	Connecting Rod Bushing
203	Upper Connecting Rod Bearing
204	Lower Connecting Rod Bearing
210	Piston
211	Piston Pin
212	Piston Pin Retainer
212	Piston Pin Retainer
213	Piston Upper Compression Ring
214	Piston Lower Compression Ring
215	Piston Oil Control Rail Ring
215	Piston Oil Control Rail Ring
216	Piston Oil Control Ring Spacer

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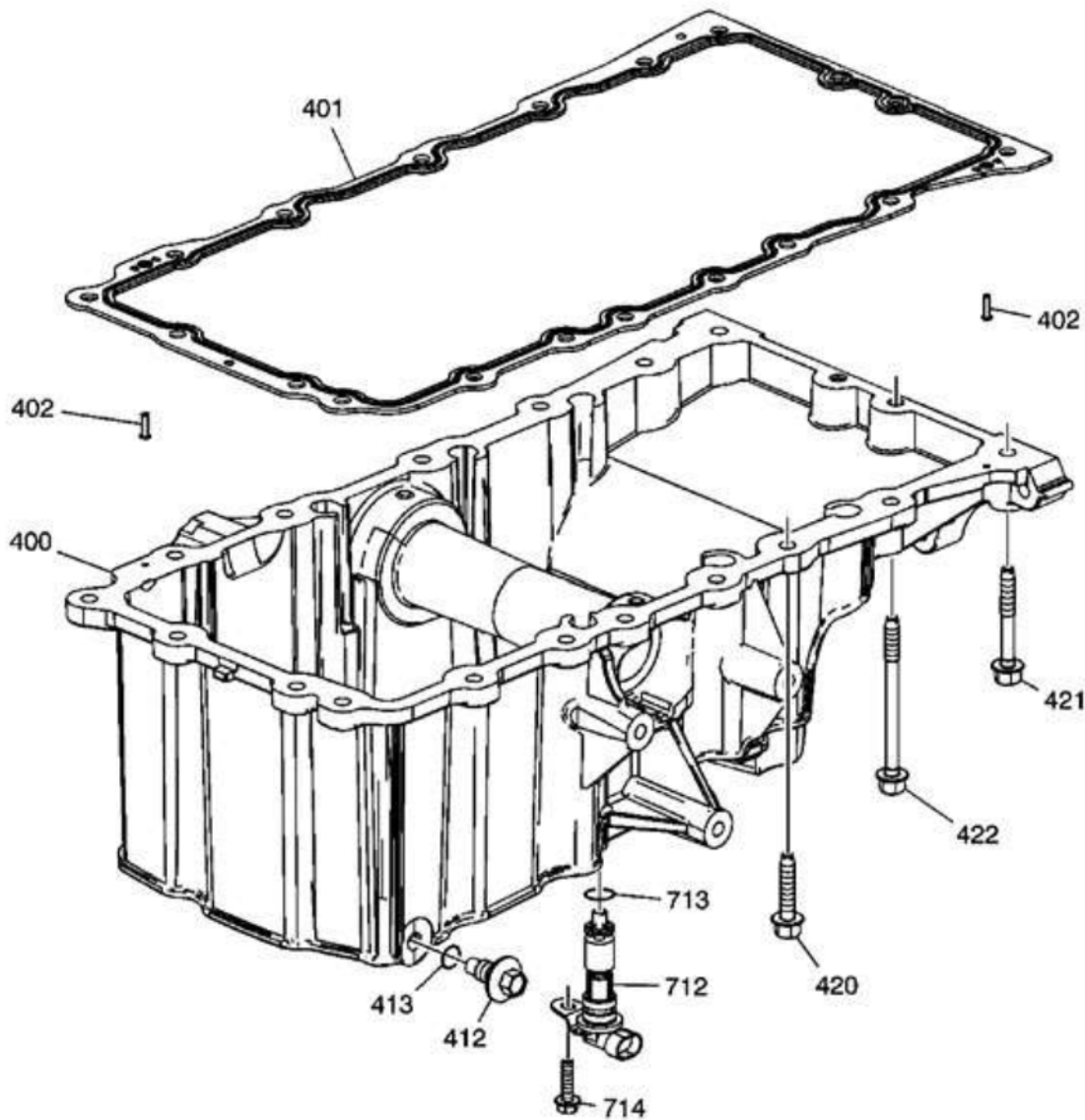


Fig. 39: Disassembled View Of Oil Pan Assembly Components
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 39

Callout	Component Name
400	Oil Pan
401	Oil Pan Gasket
402	Oil Pan Gasket Rivet
402	Oil Pan Gasket Rivet
412	Oil Pan Drain Plug

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413	Oil Pan Drain Plug O-ring
420	Oil Pan Bolt - Short
421	Oil Pan Bolt - Medium
422	Oil Pan Bolt - Long
712	Engine Oil Level Sensor
713	Engine Oil Level Sensor O-ring
714	Engine Oil Level Sensor Bolt

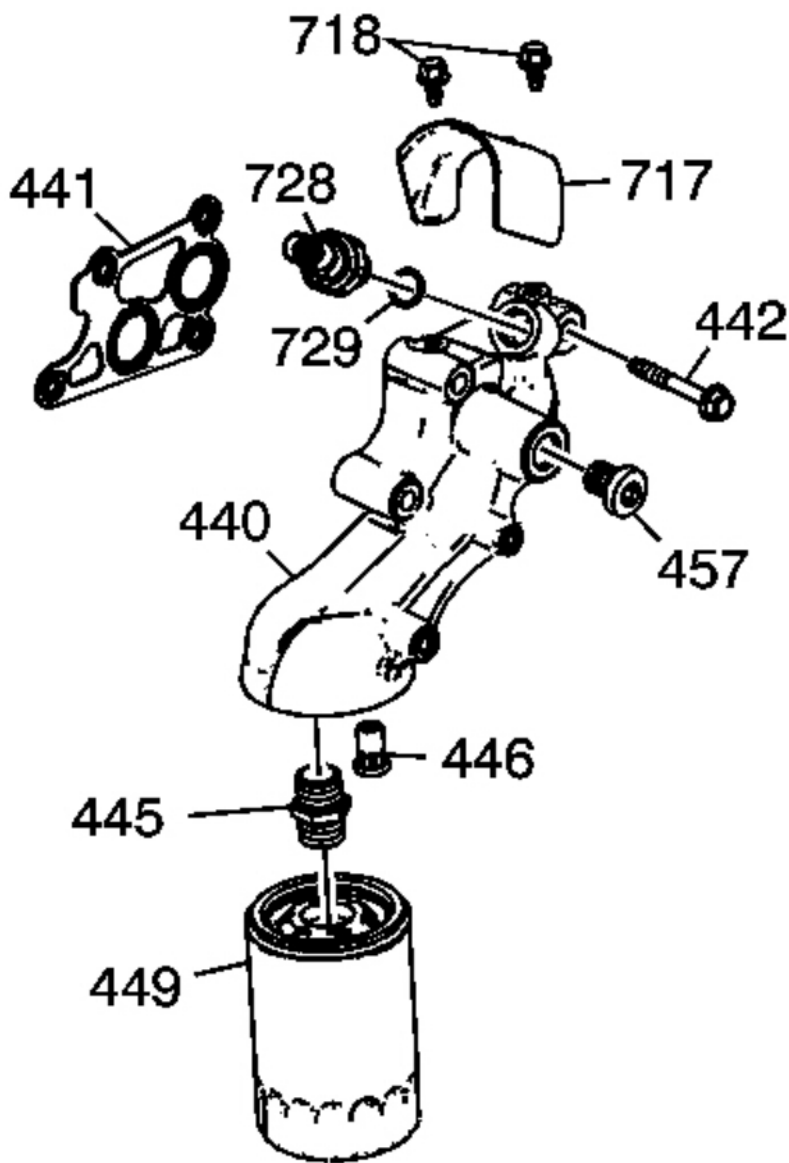


Fig. 40: Disassembled View Of Oil Filter Adapter Components
Courtesy of GENERAL MOTORS CORP.

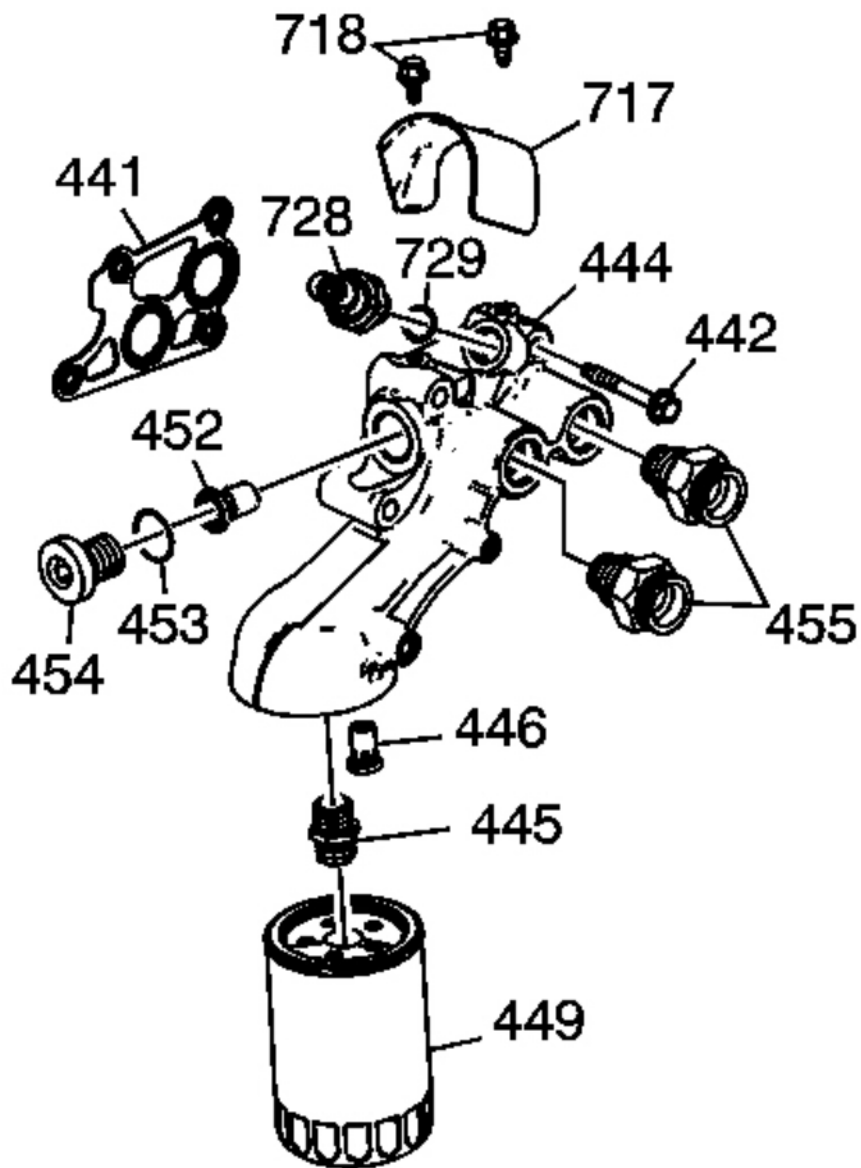
Callouts For Fig. 40

Callout	Component Name

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440	Oil Filter Adapter
441	Oil Filter Adapter Gasket
442	Oil Filter Adapter Bolt
445	Oil Filter Fitting
446	Oil Filter Bypass Valve
449	Oil Filter
457	Oil Filter Bypass Valve Hole Plug
717	Engine Oil Pressure Sensor Heat Shield
718	Engine Oil Pressure Sensor Heat Shield Bolt
728	Engine Oil Pressure Sensor
729	Engine Oil Pressure Sensor O-ring



Callouts For Fig. 41

Callout	Component Name

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441	Oil Filter Adapter Gasket
442	Oil Filter Adapter Bolt
444	Oil Filter Adapter with Oil Cooler
445	Oil Filter Fitting
446	Oil Filter Bypass Valve
449	Oil Filter
452	Oil Cooler Bypass Valve
453	Oil Cooler Bypass Valve Hole Plug O-ring
454	Oil Cooler Bypass Valve Hole Plug
455	Oil Filter Adapter Oil Cooler Pipe Fitting
717	Engine Oil Pressure Sensor Heat Shield
718	Engine Oil Pressure Sensor Heat Shield Bolt
728	Engine Oil Pressure Sensor
729	Engine Oil Pressure Sensor O-ring

ENGINE IDENTIFICATION

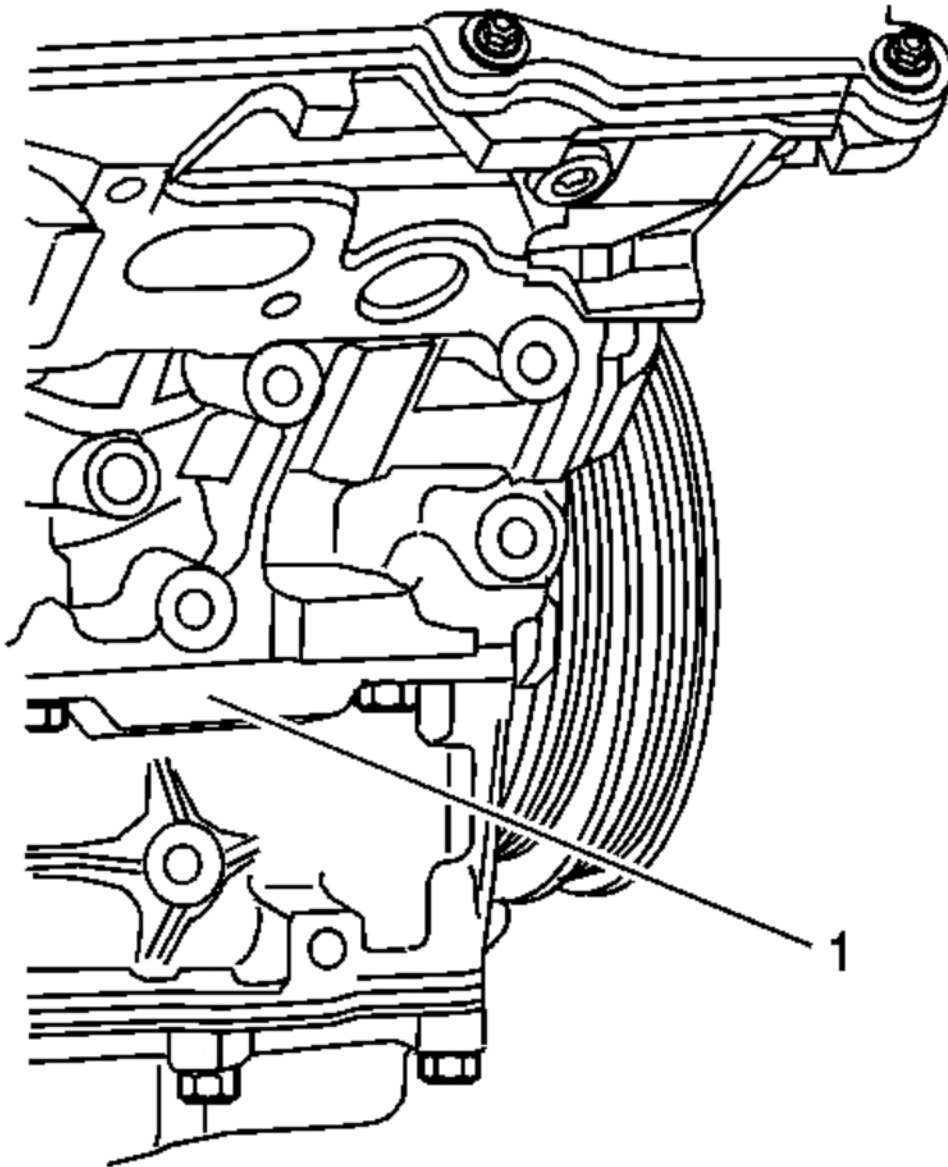


Fig. 42: Locating VIN Derivative On Engine Block
Courtesy of GENERAL MOTORS CORP.

The Vehicle Identification Number (VIN) Derivative is located on the right front side of the engine block (1) and is a nine digit number stamped or laser etched onto the engine at the vehicle

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assembly plant. If reading the identification number the following information can be obtained:

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

Engine Verification

The engine verification label is placed in two locations on the right side of the engine.

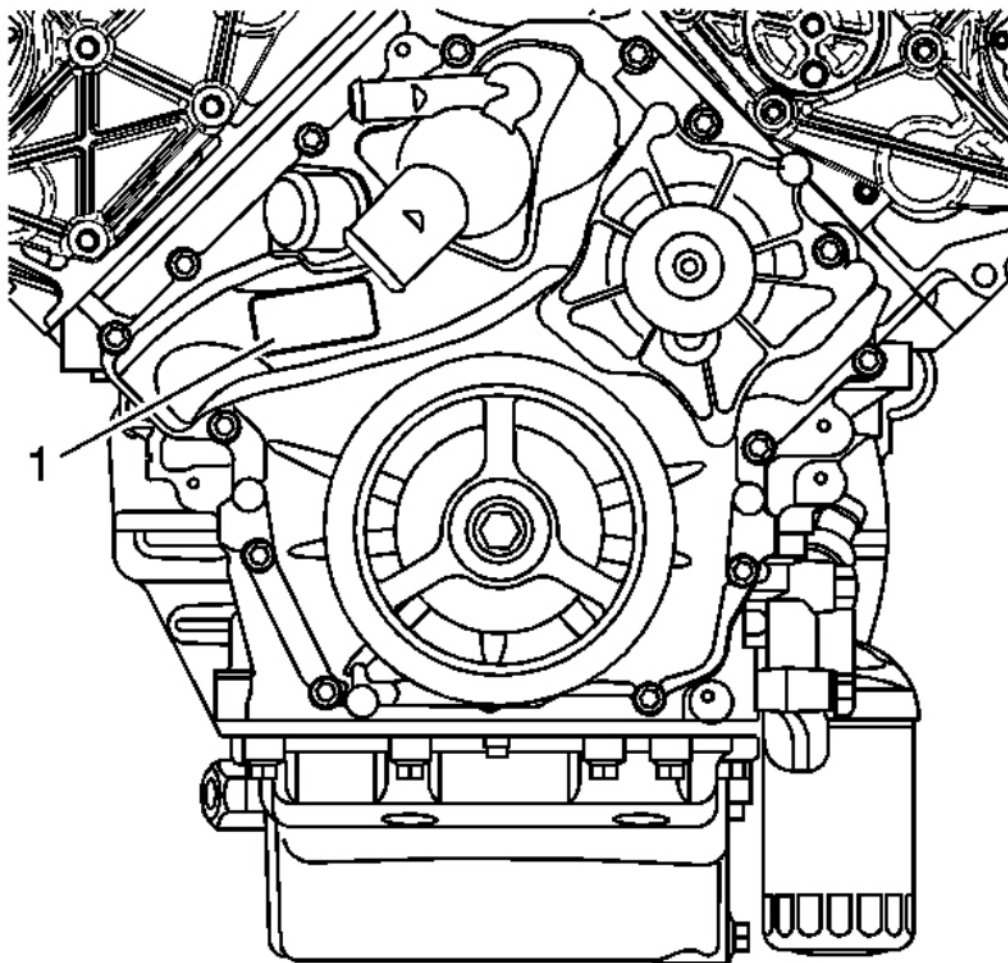


Fig. 43: Locating Engine Verification Label On Engine Block
Courtesy of GENERAL MOTORS CORP.

The engine front cover has an engine verification label (1).

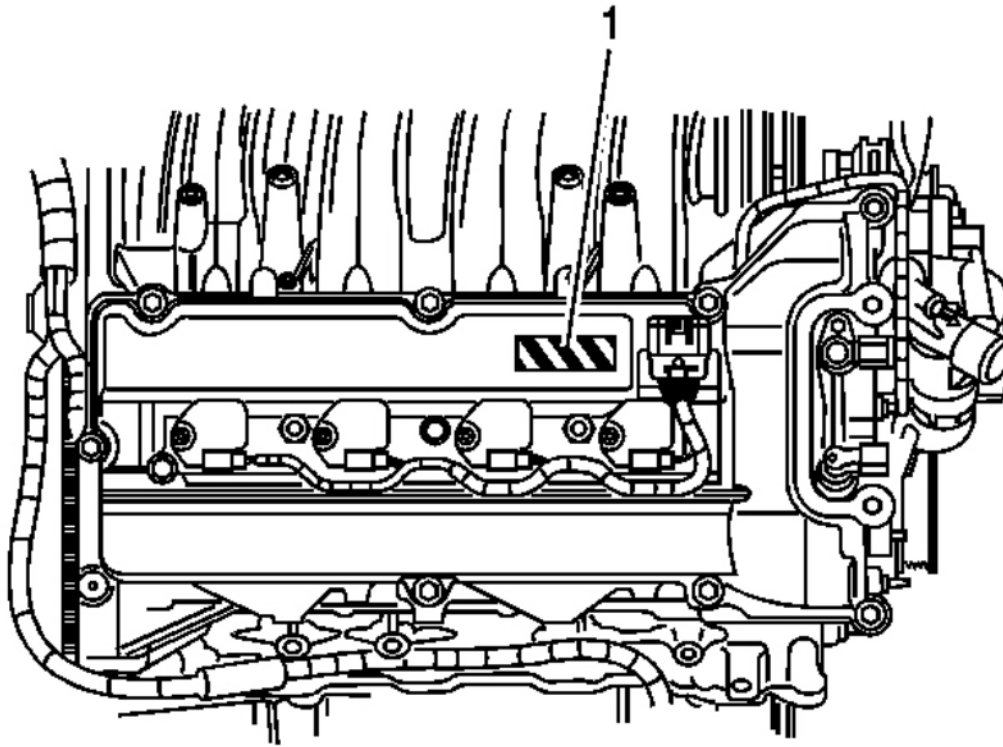


Fig. 44: Locating Traceability Label On Engine Block
Courtesy of GENERAL MOTORS CORP.

The front of the right camshaft cover has a traceability label (1).

SCHEMATIC AND ROUTING DIAGRAMS

CAMSHAFT TIMING DRIVE CHAIN ALIGNMENT DIAGRAM

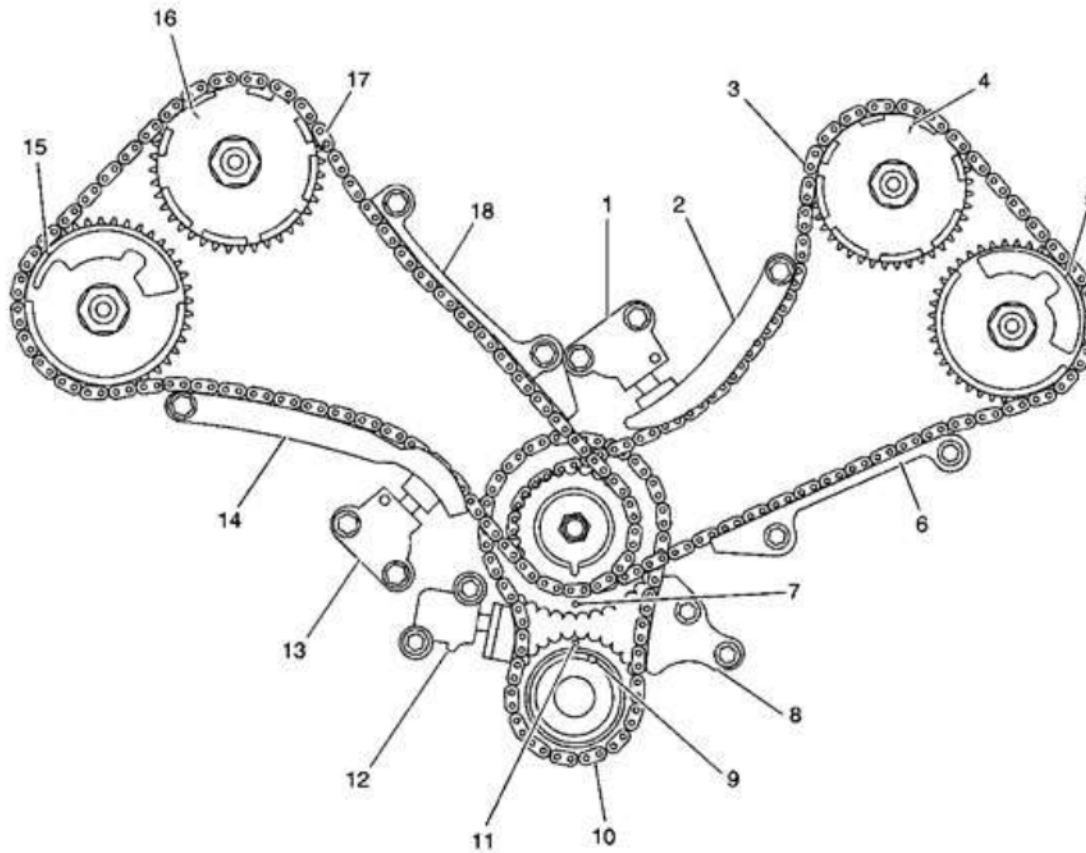


Fig. 45: Camshaft Drive System Set At Base Engine Timing
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 45

Callout	Component Name
1	Left Secondary Timing Chain Tensioner
2	Left Secondary Timing Chain Shoe
3	Left Secondary Timing Chain
4	Left Intake Camshaft Position Actuator Timing Mark
5	Left Exhaust Camshaft Position Actuator Timing Mark
6	Left Secondary Timing Chain Guide
7	Intermediate Position Actuator Timing Mark
8	Primary Timing Chain Guide
9	Crankshaft Position Actuator Pin Alignment Slot
10	Primary Timing Chain
11	Crankshaft Position Actuator Timing Mark

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12	Primary Timing Chain Tensioner
13	Right Secondary Timing Chain Tensioner
14	Right Secondary Timing Chain Shoe
15	Right Exhaust Camshaft Position Actuator Timing Mark
16	Right Intake Camshaft Position Actuator Timing Mark
17	Right Secondary Timing Chain
18	Right Secondary Timing Chain Guide

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

Begin the system diagnosis by reviewing the **Disassembled Views** , **Engine Component Description** , **Drive Belt System Description** , **Lubrication Description** and **New Product Information** . Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Engine Mechanical** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

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

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.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine. Refer to **Checking Aftermarket Accessories** in Wiring Systems.
- Inspect the easily accessible or visible system components for obvious damage or conditions

which could cause the symptom.

- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

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

Symptom List

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

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

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Base Engine Misfire without Internal Engine Noises

Cause	Correction

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Abnormalities, severe cracking, bumps, or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout and may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to <u>Engine Flywheel Replacement</u> or <u>Crankshaft Balancer Replacement</u> .
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads, intake manifold and plenum duct, plenum duct and water crossover, water crossover and throttle body and/or pressure relief valve and intake manifold.	Replace the intake manifold, plenum duct, gaskets, cylinder heads, throttle body and/or pressure relief valve as required.
Improperly installed or damaged MAP sensor and/or seal The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Improperly installed or damaged EVAP purge solenoid and/or O-ring seal	Repair or replace the EVAP purge solenoid as required.
Worn or loose followers, valve rocker arms The follower, valve rocker arm, roller	Replace the followers, valve rocker arms, as required.

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bearing should be intact and in the proper position	
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain or chains	Replace the timing chain or chains and sprockets as required.
Worn camshaft lobes	Replace the camshaft or camshafts and SHLAs, valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u> . • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <u>Diagnostic Starting Point - Engine Cooling</u> in Engine Cooling. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to <u>Spark Plug Inspection</u> in Engine Controls. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn Piston Rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> in Engine Controls. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u> . • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with SEVERE reluctor ring damage may exhibit periodic loss of	Replace the crankshaft as required.

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crankshaft position, stop delivering a signal, and then re-sync the crankshaft position.

- Systems with SLIGHT reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the engine flywheel and/or crankshaft balancer as required. Refer to <u>Engine Flywheel Replacement</u> or <u>Crankshaft Balancer Replacement</u> .
Worn or Broken Piston Rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> in Engine Controls. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u> . • Perform cylinder leak down and compression testing to determine the cause.

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	• Repair or replace as required.
Worn Crankshaft Thrust Bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose followers, valve rocker arms The follower, valve rocker arm, roller bearing should be intact and in the proper position.	Replace the followers, valve rocker arms, as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chains or components	Replace the primary timing chain, secondary timing chains, intermediate sprocket, camshaft position actuators and/or related timing components as required.
Worn camshaft lobes	Replace the camshaft or camshafts and SHLAs, valve lifters.
Sticking SHLAs, lifters	Replace the SHLAs as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Base Engine Misfire with Coolant Consumption

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <u>Diagnostic Starting Point - Engine Cooling</u> in Engine Cooling. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to <u>Spark Plug Inspection</u> in Engine Controls. • Perform a cylinder leak down test. • Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket.

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- Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	• Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> in Engine Controls. • Repair or replace as required.
Worn Piston Rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> in Engine Controls. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u> . • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.

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

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

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	Drain the engine oil and replace with the correct viscosity oil.
High SHLA, valve lifter, leak down rate	Replace the SHLAs, valve lifters, as required.
Worn crankshaft thrust bearing	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Damaged or faulty oil filter by-pass valve	• Inspect the oil filter by-pass valve for proper operation. • Repair or replace as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED**Upper Engine Noise, Regardless of Engine Speed**

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace as required.
Loose and/or worn follower, valve rocker arm	• Inspect the follower, valve rocker arm. • Repair or replace as required.
Improper lubrication to the followers, valve rocker arms	Inspect the following components, and repair or replace as required: • The follower, valve rocker arm • The SHLA, valve lifter • The oil filter bypass valve • The oil pump and pump screen • The cylinder head oil galleries • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty SHLAs, valve lifters	Replace the SHLAs, valve lifters.
Stretched or broken timing chain or chains and/or damaged camshaft position actuator sprocket teeth	Replace the primary timing chain, secondary timing chains, intermediate sprocket, camshaft position actuators and/or related timing components as required.
Worn timing chain tensioner or tensioners	Replace the timing chain tensioner or tensioners as required.
Worn timing chain shoe or shoes	Replace the timing chain shoe or shoes as required.
Worn timing chain guide or guides	Replace the timing chain guide or guides as required.
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft or camshafts and SHLAs, valve lifters, as required.
Worn valve guides or valve stems	Inspect the following components, and repair as required:

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	• The valves • The valve guides
Stuck Valves Carbon on the valve stem or valve seat may cause the valve to stay open	Inspect the following components, and repair as required: • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	• Inspect the accessory drive system. • Repair or replace as required.
Loose or damaged crankshaft balancer	• Inspect the crankshaft balancer. • Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to <u>Electronic Ignition (EI) System Diagnosis</u> in Engine Controls.
Loose torque converter bolts	• Inspect the torque converter bolts and engine flywheel. • Repair or replace as required.
Loose or damaged engine flywheel	Repair or replace the engine flywheel.
Damaged oil pan, contacting the oil pump screen An oil pan that has been damaged may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	• Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace as required.
Oil pump screen loose, damaged or restricted	• Inspect the oil pump screen. • Repair or replace as required.

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Excessive piston-to-cylinder bore clearance	• Inspect the piston and cylinder bore. • Repair as required.
Excessive piston pin-to-bore clearance	• Inspect the piston, piston pin, and the connecting rod. • Repair or replace as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin and connecting rod installation Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	• Verify the pistons, piston pins and connecting rods are installed correctly. • Repair as required.

ENGINE NOISE UNDER LOAD

Engine Noise Under Load

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to <u>Electronic Ignition (EI) System Diagnosis</u> in Engine Controls.
Loose torque converter bolts	• Inspect the torque converter bolts and engine flywheel.

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	• Repair as required.
Cracked engine flywheel	• Inspect the engine flywheel and bolts. • Repair as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized Accessory Drive System Component	1. Remove the accessory drive belt or belts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. 3. Repair or replace as required.
Hydraulically Locked Cylinder • Coolant/Antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove the spark plugs and check for fluid. 2. Inspect for broken head gasket or gaskets. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace as required.
Seized Automatic Transmission Torque	

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Converter	1. Remove the torque converter bolts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. 3. Repair or replace as required.
Material in Cylinder • Broken valve • Piston material • Foreign material	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized Crankshaft or Connecting Rod Bearings	1. Inspect the crankshaft and the connecting rod bearings. 2. Repair as required.
Bent or Broken Connecting Rod	1. Inspect the connecting rods. 2. Repair as required.
Broken Crankshaft	1. Inspect the crankshaft. 2. Repair as required.
Seized or Broken Camshaft	1. Inspect the camshaft or camshafts. 2. Inspect the cylinder head camshaft journals for damage. 3. Repair as required.
Seized or Broken Intermediate Sprocket	1. Inspect the intermediate sprocket. 2. Inspect the intermediate shaft. 3. Inspect the oil feed to the intermediate shaft. 4. Repair as required.
Seized or Broken Camshaft Timing Components	1. Inspect the following sprockets: • The crankshaft sprocket • The intermediate sprocket • The exhaust camshaft position actuator sprockets • The intake camshaft position actuator sprockets

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	2. Inspect the following chains: • The primary camshaft drive chain • The secondary camshaft drive chains 3. Inspect the following guides: • The primary camshaft drive chain guide • The secondary camshaft drive chain guides 4. Inspect the secondary camshaft drive chain shoes. 5. Inspect the following tensioners: • The primary camshaft drive chain tensioner • The secondary camshaft drive chain tensioners 6. Repair as required.
Seized or Broken Valve Train Components	1. Inspect the followers, rocker arms. 2. Inspect the lifters 3. Inspect the valves 4. Inspect the valve springs 5. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Coolant in Combustion Chamber

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage.	
1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> . 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore.	

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3. Inspect by performing a **Cylinder Leakage Test** . During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component.
4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to **Engine Compression Test** .

Cracked intake manifold or failed gasket	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to Cylinder Head Cleaning and Inspection .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head or engine block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Coolant in Engine Oil

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.	
1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to Lower Engine Noise, Regardless of Engine Speed . 2. Inspect by performing a Cylinder Leakage Test . During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket. Refer to Engine Compression Test .	
Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as

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	required. Refer to <u>Cylinder Head Cleaning and Inspection</u> .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.

ENGINE COMPRESSION TEST

Tools Required:

J 39313 Spark Plug Port Adapter

A compression pressure test of the engine cylinders determines the condition of the rings, the valves and the head gasket.

1. Run the engine until it reaches normal operating temperature. The battery must be at or near full charge.
2. Turn the engine OFF.

IMPORTANT: Remove the Powertrain Control Module (PCM) and the ignition fuse from the IP fuse block.

3. Disable the ignition.
4. Disable the fuel systems.
5. Remove the spark plugs from all cylinders.
6. Remove the air duct from the throttle body.
7. Block the throttle plate in open position.
8. Measure the engine compression, using the following procedure:
 1. Thread the **J 39313** into the spark plug hole.
 2. Thread the compression gage into the **J 39313** .
 3. Have an assistant crank the engine through, at least four compression strokes, in the testing cylinder.
 4. Check and record the readings on the gage at each stroke.

5. Remove the compression gage from the **J 39313**.
6. Remove the **J 39313** from the spark plug hole.
7. Repeat the compression test for each cylinder.
9. Record the compression readings from all of the cylinders.
 - The lowest reading should not be less than 70 percent of the highest reading.
 - No cylinder reading should be less than 965 kPa (140 psi).
10. The following are examples of measurement problems:
 - When the compression measurement is normal, the compression builds up quickly and evenly to specified compression on each cylinder
 - When low compression is caused by the piston rings, compression is low on the first stroke and tends to build up on the following strokes, but does not reach normal. Compression improves considerably with the addition of oil. Use approximately three squirts of oil from a plunger-type oiler.
 - When low compression is caused by the valves, the measurement is low on the first stroke and does not build up even with the addition of oil.
 - Leaking head gaskets will provide the same results as worn valves but engine coolant may be identified in the crankcase. In addition, a leaking head gasket will give low readings on paired cylinders.
11. Remove the block from the throttle plate.
12. Install the air duct to the throttle body.
13. Install the spark plugs.
14. Install the Powertrain Control Module (PCM).
15. Install the ignition fuses to the IP fuse block.

CYLINDER LEAKAGE TEST

Tools Required

- **EN 46326** Flywheel Holding Tool. See **Special Tools and Equipment**.
- **J 35667-A** Cylinder Head Leakdown Tester
- **J 39313** Spark Plug Port Adapter

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

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

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

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** in Engine Controls.
3. Rotate the crankshaft to place the piston in the cylinder being tested at Top Dead Center (TDC) of the compression stroke.
4. Install the **J 39313**.
5. Install the **J 35667-A** or equivalent.

IMPORTANT: In order to prevent the engine from turning, it may be necessary to install the EN 46326 . See Special Tools and Equipment .

6. Apply shop air pressure to the **J 35667-A** and adjust according to the manufacturers instructions.
7. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
 - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
 - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
 - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may

indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.

- Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.

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

OIL CONSUMPTION DIAGNOSIS

Oil Consumption Diagnosis

Checks	Causes
DEFINITION: Excessive oil consumption (not due to leaks) is the use of 1.9 L (2 qts) or more of engine oil within 3 200 km (2,000 mi). The causes of excessive oil consumption may include the following conditions:	
Preliminary	• External oil leaks Refer to <u>Oil Leak Diagnosis</u> . • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time (2-3 minutes) and check for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components • Worn valve guides and/or valve stems • Worn, missing or improperly installed valve stem oil seals • Piston rings broken, worn, not seated properly Allow adequate time for the rings to seat.

Replace worn piston rings as necessary.

- Piston and rings improperly installed or miss-fitted to the cylinder bore

OIL PRESSURE DIAGNOSIS AND TESTING

Tools Required:

J 21867 Pressure Gage and Hose Assembly

1. With the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time, 2-3 minutes, and measure for a low oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10-15 seconds, and verify low or no oil pressure on the vehicle gage or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following:
 - Foamy oil
 - Slow idle speed
 - Plugged oil filter
 - Oil diluted by the following:
 - Water
 - Engine coolant
 - Unburned fuel mixtures
 - Malfunctioning oil filter bypass valve
 - Incorrect or faulty oil pressure gage
 - Incorrect or faulty oil pressure gage sensor
 - Improper engine oil viscosity for the expected temperature

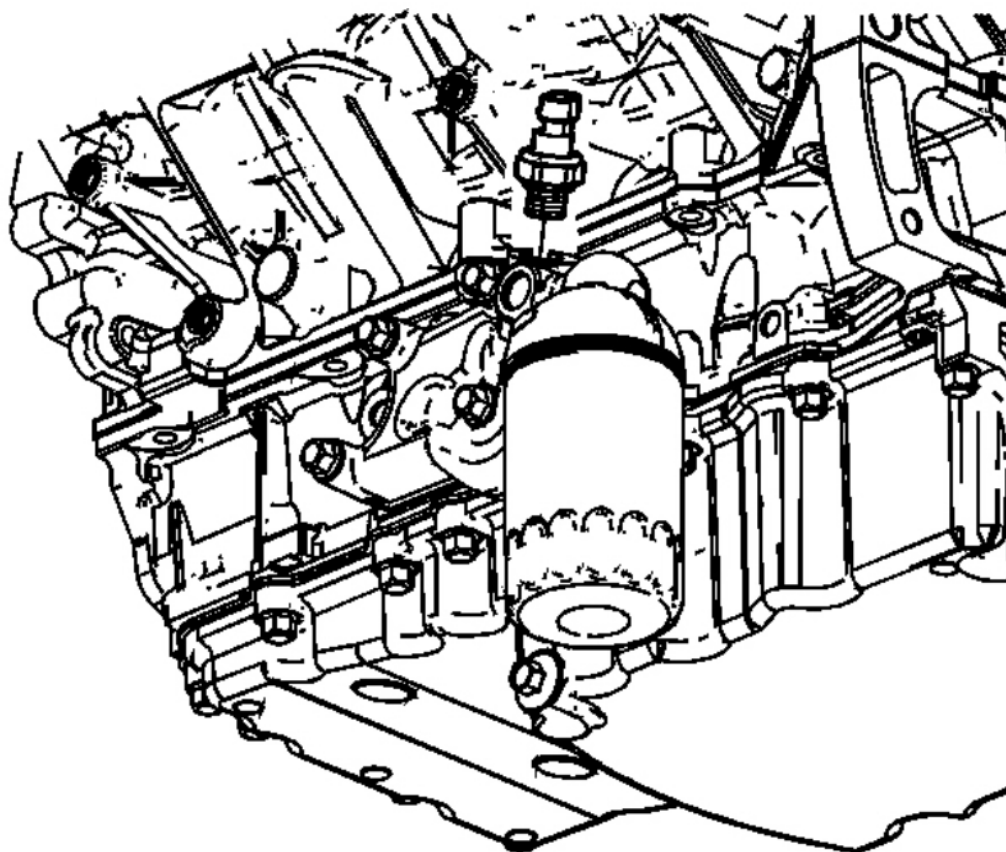


Fig. 46: View Of Oil Pressure Gage Sensor
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil pressure gage sensor.
7. Install the **J 21867** .
8. Start the engine and then allow the engine to reach normal operation temperature.
9. Measure the engine oil pressure.
10. Compare the readings to the **Engine Mechanical Specifications** .
11. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
 - Loose oil filter adapter bolts
 - Missing or damaged oil filter adapter O-ring seal or seals

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- Worn or dirty oil pump
- Loose oil pump-to-engine block bolts
- Loose, plugged or damaged oil pump screen
- Missing or damaged oil pump screen O-ring seal
- Damage or leak in the oil pump screen suction tube
- Malfunctioning oil pump pressure regulator valve
- Missing or incorrectly installed oil gallery plugs
- Loose camshaft intermediate drive shaft bolts
- Excessive bearing clearance for the following:
 - Connecting rod or rods
 - Crankshaft
 - Camshaft or camshafts
 - Camshaft intermediate drive shaft sprocket
- Cracked, porous or restricted oil galleries
- Broken valve lifters

12. Repair or replace components as necessary.

OIL LEAK DIAGNOSIS

Oil Leak Diagnosis

Checks	Action
NOTE: It is important to correctly identify the source of an oil leak. A power steering fluid leak or spillage can travel across the valley area of the engine and run out the weep hole, which is located at the back of the block. Failure to correctly identify the source of an oil leak can lead to the incorrect or unnecessary replacement of components. You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.	
Locating and identifying the leak	To determine if the leaking fluid is engine oil, transmission fluid, power steering fluid, brake fluid, or some other fluid, use the visual inspection method.
Visual Inspection Method	1. Bring the vehicle to normal operating temperature. 2. Park the vehicle over a large sheet of paper, or other clean surface.

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	3. Wait several minutes, then check for drippings. 4. Identify the type of fluid, and the approximate location of the leak. 5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 6. Check for leaks at sealing surfaces, fittings, or from cracked or damaged components. 7. If you cannot locate the leak, do the following: 1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operation temperature and at varying speeds. 3. Park the vehicle over a large sheet of paper, or other clean surface. 4. Wait several minutes, then check for drippings. 5. Identify the type of fluid, and the approximate location of the leak. 6. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 7. See possible causes for leaks. 8. If you still cannot locate the leak, use the powder method or the black light and dye method.
Powder Method	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder (baby powder, foot powder, etc.) to the suspected area. 3. Operate the vehicle for several miles at normal operation temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. 5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 6. See possible causes for leaks.
Black Light and Dye	1. A dye and light kit is available for finding leaks. Use the

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Method	J 28428-E High-Intensity Black Light Kit or equivalent. Refer to the manufacturer's instructions when using the tool. 2. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 3. See possible causes for leaks.
Possible Causes for Leaks	Check for the following conditions: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Crankcase Ventilation (CV) System Inspection

- Test for vacuum at the vacuum hose where it connects to the crankcase ventilation housing. There should be manifold vacuum present at the hose. If there is no vacuum, inspect for a plugged hose, leaking hose or a plugged vent adapter.
- Plug the end of the vacuum hose while the engine is running. Inspect the hose for any areas that collapse when the end of the hose is blocked. Replace the hose if it collapses when blocked.
- If oil has accumulated in the intake air duct, inspect for the following conditions:
 - Plugged vacuum orifice in the crankcase ventilation housing
 - Plugged or restricted crankcase ventilation housing
 - Excessive crankcase pressure or blow-by, refer to **Oil Consumption Diagnosis** .
- Additional items to inspect:
 - Plugged or leaking fresh air vent hose assembly or vent adapter

- Plugged or restricted passages in the throttle body
- Missing or damaged O-ring seals on the vent adapter
- Inspect the cam covers, the oil pan gasket, and other sealing areas for leaks

Results of Incorrect Operation

- A plugged crankcase ventilation housing or hose may contribute to the following conditions:
 - A rough idle
 - Stalling or a slow idle speed
 - Oil leaks
 - Oil accumulation in the intake air duct
 - Sludge in the engine
- A leaking housing or hose may contribute to the following conditions:
 - A rough idle
 - Stalling
 - Unstable idle speed

DRIVE BELT CHIRPING DIAGNOSIS**Diagnostic Aids**

The symptom may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.

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

Test Description

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

- 2:** The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.
- 3:** The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

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

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

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

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

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

Drive Belt Chirping Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>Belt Dressing Notice</u> in Cautions and Notices.			
DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to Step 3	Go to Diagnostic Aids
	1. Remove one of the drive belts. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> .		

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3	2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt. Does the chirping noise still exist?	Go to <u>Symptoms - Engine Mechanical</u>	Go to Step 4
4	Inspect for severe pilling exceeding 1/3 of the belt groove depth. Does the belt grooves have pilling?	Go to Step 5	Go to Step 6
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to Step 15	Go to Step 6
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to Step 7	Go to Step 8
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to Step 15	Go to Step 8
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to Step 9	Go to Step 10
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to Step 15	Go to Step 10
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12
11	NOTE: Refer to <u>Fastener Notice</u> in Cautions and Notices. 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to Step 15	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 13	Go to Step 14
13	Replace the bent pulley. Did you complete the repair?	Go to Step 15	Go to Step 14

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14	Replace the drive belt. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . Did you complete the repair?	Go to Step 15	Go to Diagnostic Aids
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT SQUEAL DIAGNOSIS

Diagnostic Aids

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

If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.

Test Description

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

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

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

4: This test is to verify that an accessory drive component does not have a seized bearing. With the belt removed, test the bearings in the accessory drive components to verify that they are turning smoothly. Also test the accessory drive components with the engine operating by varying the load on the components to verify that the components operate properly.

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

6: This test is to verify that the drive belt is not too long, which would prevent the drive belt

tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

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

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

Drive Belt Squeal Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>Belt Dressing Notice</u> in Cautions and Notices.			
DEFINITION: The following items are indications of drive belt squeal: • A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a squeal noise. Does the engine make the squeal noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove one of the drive belts. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this step if necessary by removing the remaining belt.	Go to Symptoms -	

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	Does the noise still exist?	<u>Engine Mechanical</u>	Go to Step 4
4	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to Step 9	Go to Step 5
5	Test the drive belt tensioner for proper operation. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Inspect for the correct drive belt length. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 9	Go to Step 8
8	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 9	Go to Diagnostic Aids
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT WHINE DIAGNOSIS**Diagnostic Aids**

The drive belts will not cause the whine noise.

If the whine noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. Such items but not limited to may be an A/C system overcharged, the power steering system restricted or the wrong fluid, or the generator failing.

Test Description

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

3: This test is to verify that the noise is being caused by the drive belts or the accessory

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drive components. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4: The inspection should include checking the drive belt tensioners and the drive belt idler pulley bearings. The drive belts may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the proper inspection and replacement procedure.

Drive Belt Whine Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>Belt Dressing Notice</u> in Cautions and Notices.			
DEFINITION: A high pitched continuous noise that may be caused by an accessory drive component failed bearing.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a whine noise. Does the engine make the whine noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove one of the drive belts. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt. Does the whine noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	Inspect for a failed accessory drive component bearing. Did you find and repair the condition?	Go to Step 5	Go to Diagnostic Aids
5	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT RUMBLING DIAGNOSIS

Diagnostic Aids

Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise.

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

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

Test Description

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

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

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

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

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

Drive Belt Rumbling Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>Belt Dressing Notice</u> in Cautions and Notices.			
DEFINITION:			

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- A low pitch tapping, knocking, or thumping noise heard at or just above idle.
- Heard once per revolution of the drive belt or a pulley.
- Rumbling may be caused from:
 - Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove
 - The separation of the drive belt
 - A damaged drive belt

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove one of the drive belts. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this step if necessary by removing the remaining belt. Does the rumbling noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	Inspect the drive belts for damage, separation, or sections of missing ribs. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> .		

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	Did you complete the repair?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> .		
	Did you complete the replacement?	Go to Step 8	-
8	Operate the system in order to verify the repair.		Go to Diagnostic Aids
	Did you correct the condition?	System OK	

DRIVE BELT VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Such as but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

Test Description

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

- 2:** This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom such as the exhaust system, or the drivetrain.
- 3:** This test is to verify that the drive belt(s) or accessory drive components may be causing the vibration. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belt removed.
- 4:** The drive belt may cause a vibration. While the drive belt is removed this is the best time to inspect the condition of the belt.
- 6:** Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.
- 8:** This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.
- 9:** Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

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Drive Belt Vibration Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>Belt Dressing Notice</u> in Cautions and Notices.			
DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove one of the drive belts. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt. Does the engine still make the vibration?	Go to <u>Vibration Analysis - Engine</u> in Vibration Diagnosis and Correction	Go to Step 4
4	Inspect the drive belt for wear, damage, debris build-up and missing drive belt ribs. Did you find any of these conditions?	Go to Step 5	Go to Step 6
5	Install a new drive belt. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . Did you complete the replacement?	Go to Step 10	-
6	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 7	Go to Step 8
	NOTE: Refer to <u>Fastener Notice</u> in Cautions and		

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	Notices.		
7	1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace improper or missing fasteners.		
	Did you complete the repair?	Go to Step 10	-
8	Inspect for a bent water pump shaft. Refer to <u>Water Pump Replacement (LH2)</u> or <u>Water Pump Replacement (LY7)</u> in Engine Cooling. Did you find and correct the condition?	Go to Step 10	Go to Step 9
9	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 10	Go to Diagnostic Aids
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT FALLS OFF DIAGNOSIS

Diagnostic Aids

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

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

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

Test Description

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

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

4: Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the

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

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

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

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

Drive Belt Falls Off Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>Belt Dressing Notice</u> in Cautions and Notices.			
DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
	Inspect for improper, loose or missing		

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7	fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	NOTE: Refer to <u>Fastener Notice</u> in Cautions and Notices. 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement - Generator</u> or <u>Drive Belt Tensioner Replacement - Air Conditioning, Power Steering and Water Pump</u> . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

DRIVE BELT EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

- Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.
- Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.
- Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

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Test Description

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

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

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

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

Drive Belt Excessive Wear Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>Belt Dressing Notice</u> in Cautions and Notices.			
DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Inspect the drive belt for the proper installation. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . Did you find this condition?	Go to Step 5	Go to Step 3
3	Inspect for the proper drive belt. Did you find this condition?	Go to Step 5	Go to Step 4
4	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 6	Go to Diagnostic Aids
5	Replace the drive belt. Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> .		

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	Did you complete the replacement?	Go to Step 6	-
6	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	Remove the drive belt Refer to <u>Drive Belt Replacement - Generator</u> or <u>Drive Belt Replacement - Air Conditioning, Power Steering and Water Pump</u> . Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to Step 4	Go to Step 2
2	Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?	Go to Step 3	Go to Step 4
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10% of the second torque reading?	System OK	Go to Step 4
4	Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement - Generator</u> or <u>Drive Belt Tensioner Replacement - Air Conditioning, Power Steering and Water Pump</u> . Is the repair complete?	System OK	-

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

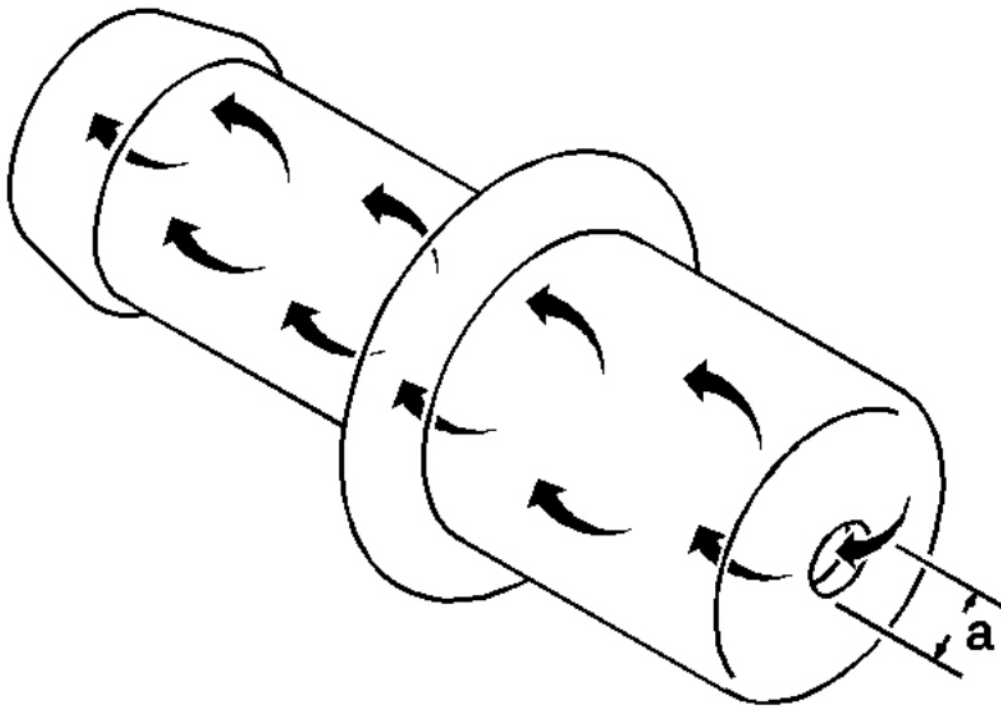


Fig. 47: Crankcase Ventilation System
Courtesy of GENERAL MOTORS CORP.

A crankcase ventilation system is used to consume crankcase vapors created during the combustion process instead of venting them to the atmosphere.

Fresh air is supplied through a filter to the crankcase, the crankcase mixes the fresh air with the blow-by gases and then passed through a positive crankcase ventilation (PCV) orificed tube into the intake manifold.

The PCV orificed tube restricts the flow rate of the blow-by gases using a 3 mm (0.118 in) (a) orifice located at the end of the tube. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the throttle body in order to be consumed by normal combustion.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
 - The power steering pump, if belt driven
 - The generator
 - The A/C compressor, if equipped
 - The engine cooling fan, if belt driven
 - The water pump, if belt driven
 - The vacuum pump, if equipped
 - The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. There also may be a V-belt style belt used to drive certain accessory drive components. The drive belts are made of different types of rubbers - chloroprene or EPDM - and have different layers or plies containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

ENGINE COMPONENT DESCRIPTION

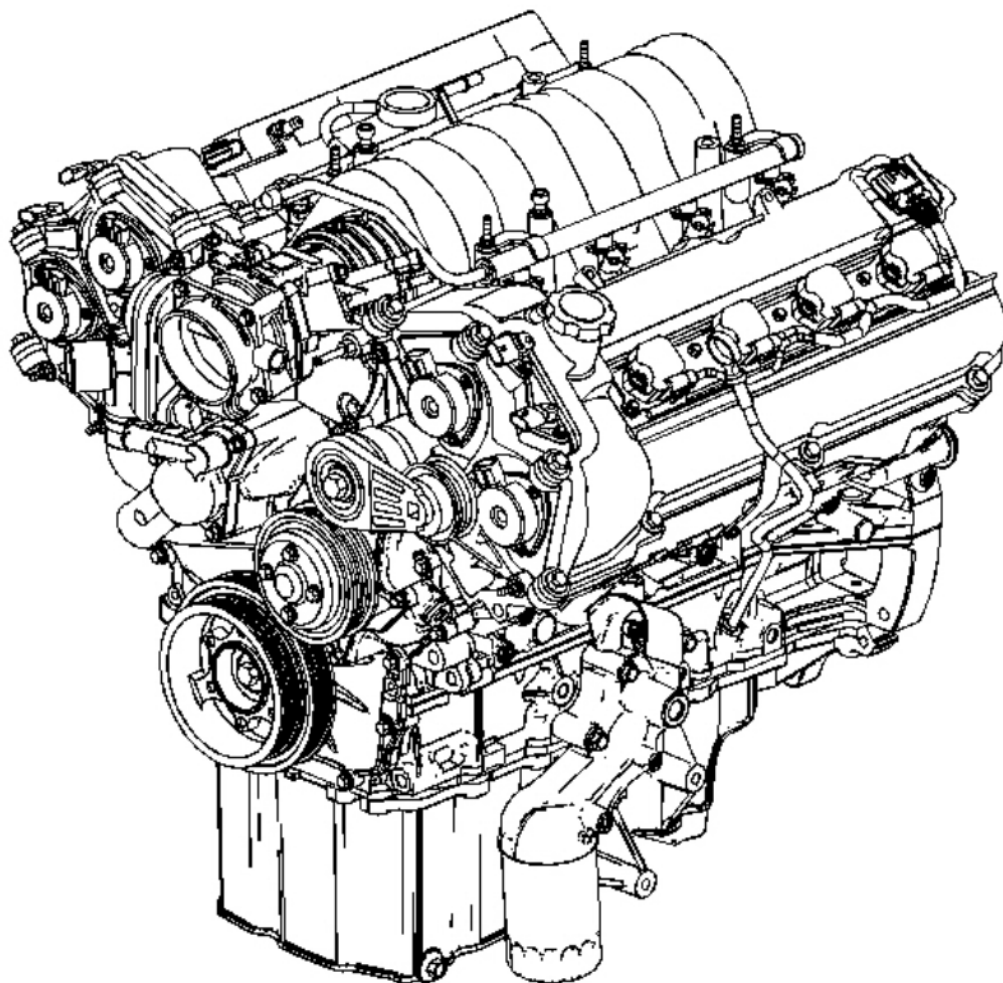


Fig. 48: View Of 4.6L Engine
Courtesy of GENERAL MOTORS CORP.

The Northstar V8 VIN Code A is a 4.6L (279 cu in) engine incorporating two intake and two exhaust valves per cylinder with individual cylinder head mounted camshafts with camshaft position actuators for intake and exhaust functions (DOHC). The cylinder bore diameter is 93 mm (3.43 in) and the piston stroke is 84 mm (3.31 in). The cylinders are arranged in two banks of four with a 90 degree included angle. The left, front, bank of cylinders are number 2-4-6-8 and the right, rear, bank cylinders are 1-3-5-7. Engine firing order is 1-2-7-3-4-5-6-8.

The cylinder block is constructed of aluminum alloy by the die casting method and is constructed of two sections, an upper and a lower crankcase, split at the crankshaft center line. The grey cast iron cylinder liners are cast with the upper crankcase. The upper and lower crankcase sections are held in alignment by four dowel pins. Once machined, the sections must be kept together as a set. Sealing between the crankcase halves consists of a silicone rubber seal and a bead of anaerobic sealant along each side. Since the lower crankcase contains the lower main bearings, this casting adds to the structural rigidity of the engine assembly. Both upper and lower crankcases incorporate oil drain back passages isolated from the crankcase. These passages provide a direct path from the cylinder heads to the oil pan in order to prevent the needless aeration of the oil through contact with the rotating components.

Crankshaft

The crankshaft is a forged steel design with five main bearings. Crankshaft thrust is taken by the number three main bearing. The position sensor, also known as the reluctor wheel, is integral with the crankshaft. The crankshaft is internally balanced and incorporates a one piece rear seal. A rolled fillet radius is incorporated on all bearing journals to improve fatigue strength.

Connecting Rods and Pistons

The connecting rods are forged steel and have full floating piston pins. These pins are slip fit in the bronze bushed rods and are retained in the piston by round wire retainers. The cast aluminum pistons use two low tension compression rings and one multi-piece oil ring. The top compression ring is nitrided steel. The second compression ring is coated cast iron. The oil ring is a three piece side seal type ring which incorporates a steel expander and two chrome plated steel rails. To provide a non-scuffing surface when the engine is new, the pistons are tin plated. The piston skirts are coated with a coating to provide reduced friction.

Camshaft Drive System

The four overhead camshafts are driven by three separate fine pitch chains. The primary drive chain connects the crankshaft with the intermediate shaft and sprocket located directly above the crankshaft behind the engine front cover. Each camshaft drive chain connects the intermediate sprocket with the camshaft position actuators on each intake and exhaust camshafts on the cylinder heads. Two camshaft drive chains are used; one for each cylinder head. Each of the chains incorporates a hydraulic tensioner to minimize chain noise and provide accurate valve action by keeping slack out of the chain and continuously adjusting for chain wear. This is accomplished by providing engine oil pressure to each tensioner forcing a nylon pad into mesh with the slack side of the chain. As the chain stretches from wear, a ratchet mechanism inside the tensioner prevents the nylon pad from retracting when the engine is turned off and engine oil pressure ceases.

Camshaft Position Actuator System

The camshaft position actuator system is an electronically controlled and hydraulically actuated system. The camshaft position actuator system enables the engine control module (ECM) to change camshaft timing of all four camshafts hydraulically while the engine is operating.

Two camshaft position actuator magnets, one for each camshaft position actuator oil control valve, are mounted to a camshaft position actuator housing on the front of each cylinder head. The ECM energizes the camshaft position actuator magnet in order to create a magnetic field. The magnetic field created by the camshaft position actuator magnet pulls, from the home position, the spring loaded spool valve in the center of the camshaft position actuator oil control valve. The camshaft position actuator oil control valve is incorporated into the fastener that bolts the camshaft position actuator to the camshaft. Alignment between the camshaft position actuator magnet and the camshaft position actuator oil control valve is crucial. An air gap must be maintained between both components.

Oil under pressure is supplied to the front camshaft bearing cap and flows through passages into the camshaft front journal. The camshaft front journal passages supply oil to the camshaft position actuator oil control valve. The camshaft position actuator oil control valve supplies oil to the camshaft position actuator. The camshaft position actuator oil control valve incorporates a return spring in order to return the internal spool valve to the home position.

The camshaft position actuator contains an inner rotor with vanes bolted to the camshaft and an outer housing incorporating the timing drive chain sprocket and camshaft position sensor trigger wheel. Internally the camshaft position actuator contains a spring loaded locking pin that prevents movement between the inner rotor and outer housing and keeps the camshaft position actuator in the home position. The locking pin releases when proper oil pressure reaches the camshaft position actuator. The exhaust camshaft position actuators also incorporate return springs in order to return the exhaust camshaft position actuators to the home position when the engine is turned off. Due to rotation direction of the intake camshaft position actuators return springs are not necessary.

Oil directed by the camshaft position actuator oil control valve's position is used to vary the advance or return of the camshaft position actuator's vanes from the home position.

Cylinder Heads

The cylinder heads are semi permanent mold cast aluminum with powdered metal valve seat inserts and valve guides. Two 36.2 mm (1.425 in) intake valves and two 29 mm (1.142 in) exhaust valves are actuated by roller finger followers pivoting on a stationary hydraulic lash adjuster (SHLA). Separate intake and exhaust camshafts are supported by five bearings machined

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into the cylinder head with camshaft thrust taken by the first bearing. The combustion chamber is roughly in the shape of a clover leaf with a nominal volume of 48.6 cc (2.965 cubic inch) and a centrally located spark plug.

Engine Cooling System

The coolant pump assembly is located on the engine front cover. The water outlet housing distributes coolant to the cylinder block and collects it from the cylinder head for delivery to the radiator.

Induction System

The induction manifold is a plastic, lost core casting with a removable plastic sight shield cover.

Right and Left Bank Designation

Right hand (RH) and Left hand (LH) designations through the engine mechanical On-Vehicle Service section are viewed from the rear of the engine.

NEW PRODUCT INFORMATION

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

The Northstar V8 4.6 Liter VIN Code A (RPO LH2) is new for 2004.

A Component Comparison from the Previous Year

The thread pitch on the M11 cylinder head bolts and the engine block cylinder head bolt holes has been revised for MY2004. Determine the pitch of the threads by using a thread pitch gage or measure the length of the threads of the cylinder head bolt.

*Some early MY2004 cylinder head bolts have a pitch of 1.5 mm and the length of the threads are about 48 mm (1.890 in) long.

*For most MY2004 the cylinder head bolts have a pitch of 2.0 mm and the length of the threads are about 67 mm (2.638 in) long.

LUBRICATION DESCRIPTION

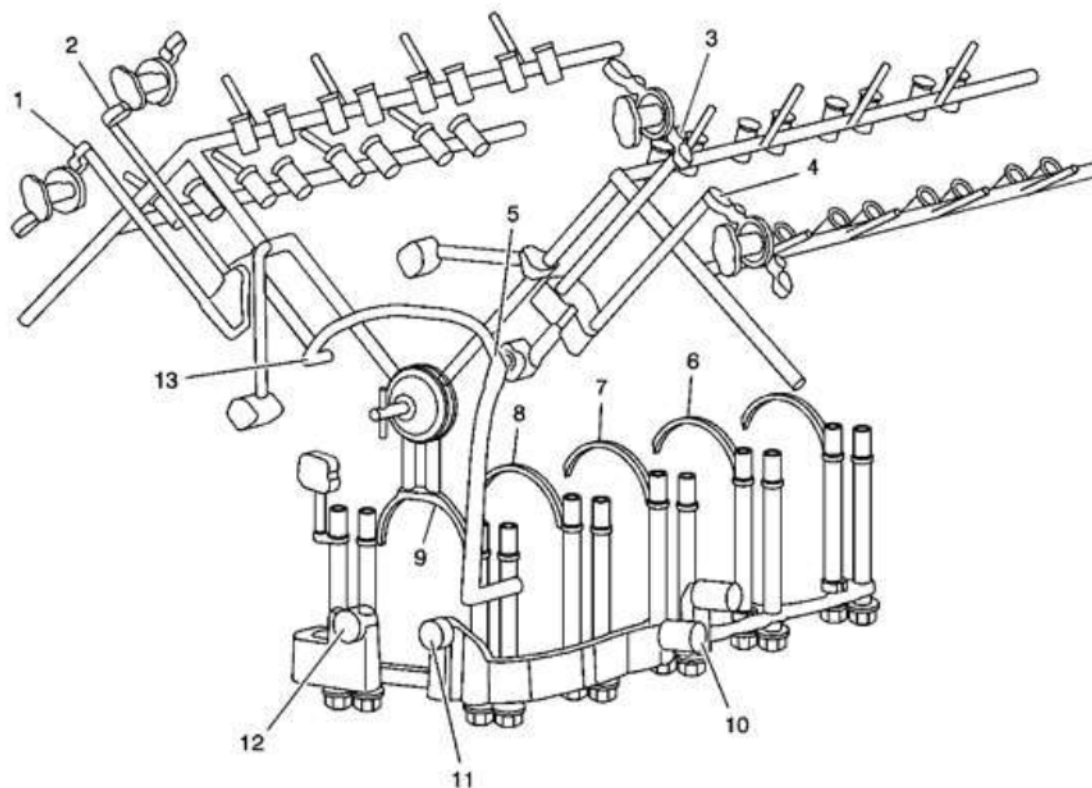


Fig. 49: View Of 4.6L Engine Lubrication System
Courtesy of GENERAL MOTORS CORP.

The cast aluminum oil pan is used as a structural member of the powertrain by connecting the oil pan and the engine to the flywheel housing. The oil pan incorporates an oil baffle plate and seals to the lower crankcase with a gasket. The oil pan also provides mounting for an oil level sensor.

The oil sump pickup is fastened to the lower crankcase and oil manifold by a bolt and nut to one stud-headed main bearing bolt. A gasket seals this joint on the suction side of the oil system. The engine oil pump is a gerotor design mounted to the lower crankcase behind the engine front cover by 3 mounting bolts. Drive for the gerotor elements is provided by the clamp load of the harmonic dampener and bolt. As the pump rotates, oil is drawn from the sump through the sump pickup to a channel cast into the lower crankcase. The oil is then directed to the pump inlet cavity (12) on the lower crankcase front face. Oil compressed by the pump re-enters the lower crankcase distribution channel through the pump outlet cavity (11) opposite the inlet. A portion of the pump output is diverted via an internal passage to the oil pump inlet to provide a pressure seal at the crankcase interface.

The oil pump outlet channel in the lower crankcase routes the oil to the oil outlet tube for the camshaft position actuator system and the oil filter circuit connections on the, front/left, side of

the lower crankcase.

The cast aluminum oil filter adapter is fastened to the crankcase with 3 bolts. The inlet and return (10) passages are sealed with a gasket. The adapter contains the oil pressure switch and a non-serviceable bypass valve. The oil filter bypass valve routes oil directly from the filter inlet to the filter outlet if the filter becomes plugged.

Filtered oil re-enters the crankcase distribution channels and is first directed to the main bearings (6-9). Cross drilled passages in the crankshaft in turn provide oil for the connecting rod bearings and provide splash oiling for the cylinder walls. The lower crankcase distribution channel also connects with passages in the upper crankcase to provide oil to the overhead camshafts and valve lifters. This passage (9), beside the number one bearing, also provides oil for the 3 hydraulic chain tensioners as well as lubrication for the camshaft drive intermediate shaft ultimately lubricating the camshaft chains via oil splash.

Designed into the upper crankcase behind the camshaft drive intermediate shaft is a chamber that feeds 2 passages in the upper crankcase. Each passage directs oil flow up to the cylinder block deck through the cylinder head gasket and into each cylinder head. The oil passage in each cylinder head that feeds the valve train system has a pressed-in restrictor. The orifice within the restrictor is 3 mm (0.1181 in). The restrictor ensures proper oil flow to the valve train and thereby ensures suitable oil flow from the oil pump to the camshaft position actuator system. After passing through the restrictor the oil enters a cross drilled passage that feeds the 2 valve train oil passages that run the length of the cylinder head. Each valve train passages delivers oil to each set of exhaust and intake camshaft bearings along with the corresponding stationary hydraulic lifters (SHLAs).

Oil returns to the sump either through the camshaft chain area or by way of cast oil drain back passages on the outside walls of the cylinder heads, upper and lower crankcases and oil pan. The lubrication system also includes a baffle, attached by the main bearing bolts, and channels oil thrown from the crankshaft back into the oil sump.

Oil to operate the camshaft position actuator system is supplied by the oil outlet tube located under the timing chain drive system. The oil outlet tube is sealed to the front of the engine block next to the oil pump with an O-ring. Oil travels up through the tube and is filtered by an integral screen. Oil is distributed by the oil outlet tube to both sides of the engine block just below the engine block deck (5, 13). A chamber within the block directs oil up 2 passages through the engine block deck and into 2 passages in each cylinder head. Oil supplied to the front camshaft bearing cap groove (1-4) supplies oil to passages drilled into the front camshaft journal. Oil passes through the center of the camshaft and into the camshaft position actuator oil control valve. The spool valve within the camshaft position actuator oil control valve directs the oil in and out of the camshaft position actuator. The spool valve is actuated by a magnetic field created by the

camshaft position actuator magnet. The camshaft position actuator magnet is mounted to the camshaft position actuator housing bolted onto the front of each cylinder head. Oil pressure applied to either side of the internal vanes of the camshaft position actuator allows the ECM to vary the valve timing between the exhaust and intake camshafts.

CLEANLINESS AND CARE

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

- Machined
- Honed
- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, practice proper cleaning and protection procedures to the machined surfaces and to the friction areas.

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

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

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

Disconnect the negative battery cables before you perform any major work on the engine. For more information on the disconnection of the battery, refer to Engine Electrical.

SEPARATING PARTS

In addition to the room temperature vulcanizing (RTV) sealant's sealing capabilities, the RTV sealants may form an adhesive bond between the components. This may make the components difficult to remove or to separate. If possible, bump the components sideways rather than using prying tools in order to remove the components. This technique prevents damage when the bonding strength of the RTV sealant is stronger than the component itself. Perform bumping at the

bends or at the reinforced areas in order to prevent part distortion.

REPLACING ENGINE GASKETS

Gasket Reuse and Applying Sealant

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

Separating Components

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

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.

Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.

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

Assembling Components

- Assemble components using only the sealant (or equivalent) that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.

- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- Do not allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener from clamping properly or cause component damage when tightened.

IMPORTANT: Do not overtighten the fasteners.

- Tighten the fasteners to the proper specifications.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALER

Sealant Types

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

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

- Anaerobic sealant room temperature vulcanizing (RTV)
- Anaerobic sealant, which include the following:
 - Gasket eliminator
 - Pipe
 - Threadlock

Anaerobic Type Room Temperature Vulcanizing (RTV) Sealant

Anaerobic type room temperature vulcanizing (RTV) sealant cures when exposed to air. This type of sealant is used where 2 components, such as the intake manifold and the engine block, are assembled together.

Use the following information when using RTV sealant:

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

- Any other surfaces where a different type of sealant is specified in the service procedure
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

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

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

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

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

IMPORTANT: Do not overtighten the fasteners.

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

Anaerobic Type Gasket Eliminator Sealant

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

Use the following information when using gasket eliminator sealant:

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

The surfaces to be sealed must be clean and dry.

NOTE: Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.

- IMPORTANT:**
- Gasket eliminator sealed joint fasteners that are partially torqued and the gasket eliminator sealant allowed to cure more than 5 minutes, may result in incorrect shimming and sealing of the joint.
 - Do not overtighten the fasteners.
 - Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.
 - Tighten the fasteners in sequence, if specified, and to the proper torque specifications.
 - After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

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

Use the following information when using threadlock sealant:

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

IMPORTANT:

- **Fasteners that are partially torqued and then the threadlock sealant allowed to cure more than 5 minutes, may result in incorrect clamp load of assembled components.**
- **Do not overtighten the fasteners.**
- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Pipe Sealant

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

Use the following information when using pipe sealant:

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

NOTE:

Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.

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

IMPORTANT: Do not overtighten the fasteners.

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

TOOLS AND EQUIPMENT

- Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.
- To properly service the engine assembly, the following items should be readily available:
 - Approved eye protection and safety gloves
 - A clean, well-lit, work area
 - A suitable parts cleaning tank
 - A compressed air supply
 - Trays or storage containers to keep parts and fasteners organized
 - An adequate set of hand tools
 - Approved engine repair stand
 - An approved engine lifting device that will adequately support the weight of the components

SPECIAL TOOLS AND EQUIPMENT

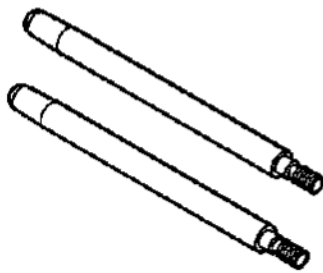
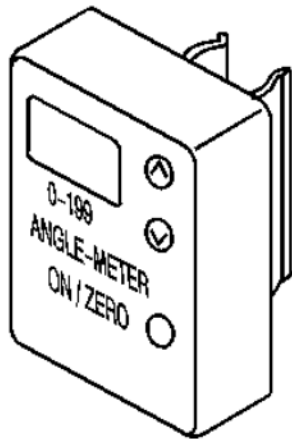
SPECIAL TOOLS

Special Tools

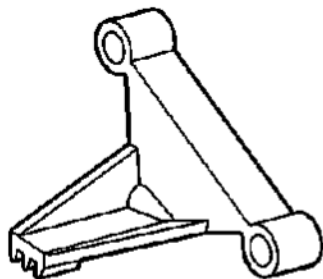
Illustration	Tool Number/Description
	EN 46109 Guide Pins

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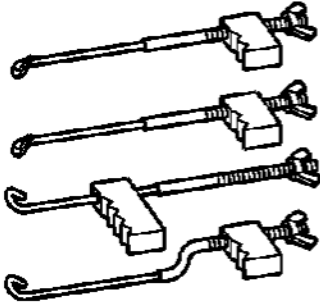
EN 46121
Connecting Rod Guide Pin Set



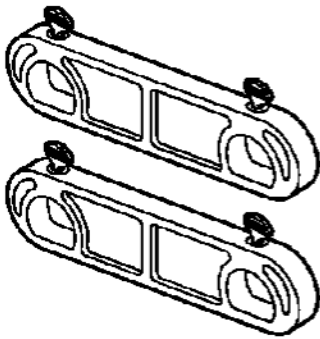
EN 46326
Flywheel Holding Tool

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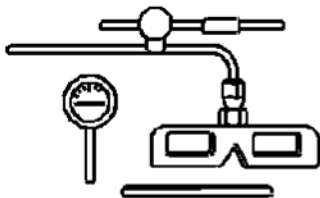
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EN 46327
Timing Chain Retention Tool



EN 46328
Camshaft Holding Tool

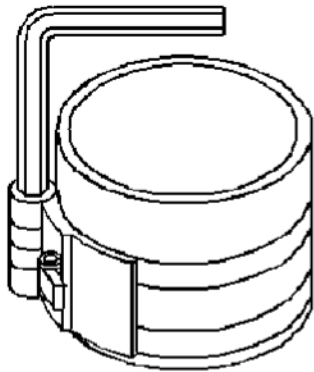
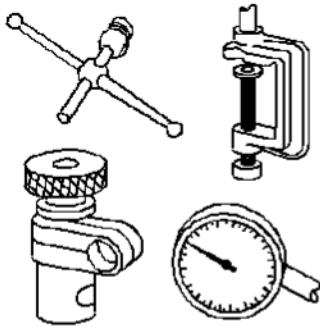


J 7872
Magnetic Base Dial Indicator

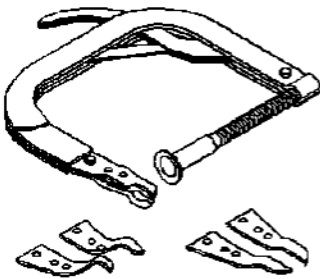
J 8001
Dial Indicator Set

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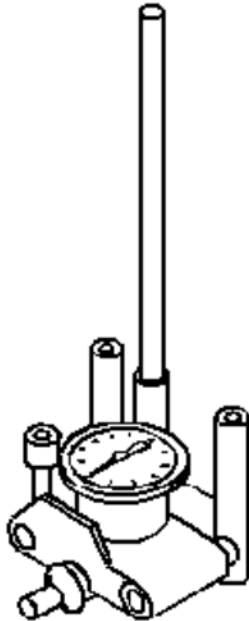
J 8037
Piston Ring Compressor



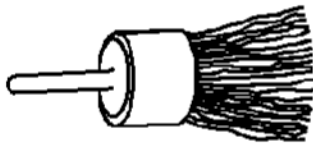
J 8062
Valve Spring Compressor - Head Off

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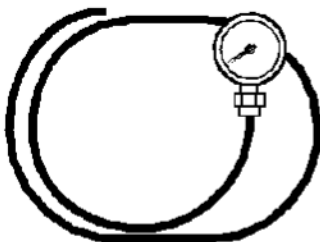
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J 8087
Cylinder Bore Gage



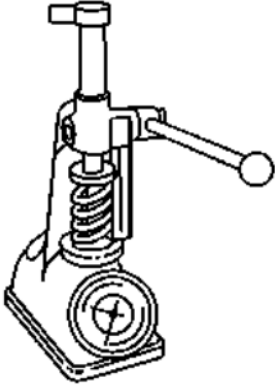
J 8358
Carbon Removal Brush



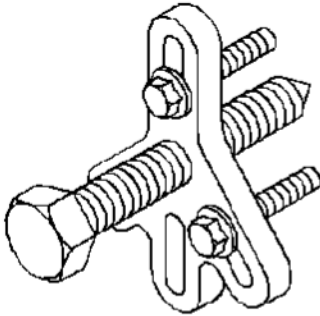
J 21867
Pressure Gage

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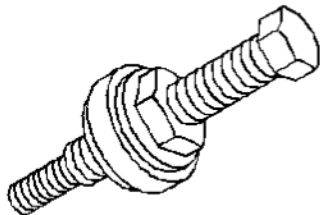
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J 22738-B
Valve Spring Tester



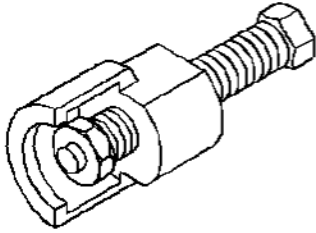
J 24420-C
Crankshaft Balancer Puller



J 25033-C
Pulley Installer

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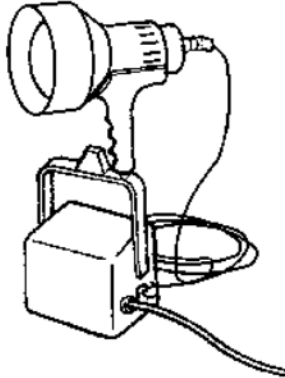
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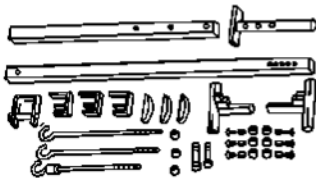
J 25034-C
Pulley Remover



J 28410
Gasket Remover



J 28428-E
High Intensity Black Light Kit



J 28467-B
Universal Engine Support Fixture

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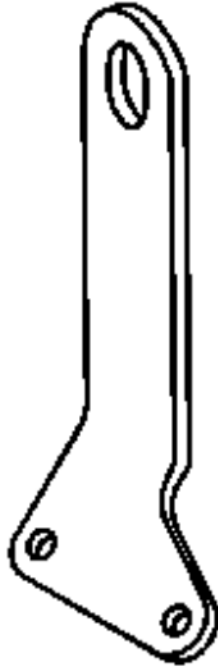
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J 28467-15
Engine Support Adapter

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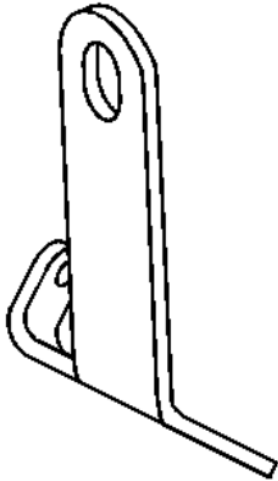


J 28467-86
Engine Lift Bracket

J 28467-87
Engine Lift Bracket

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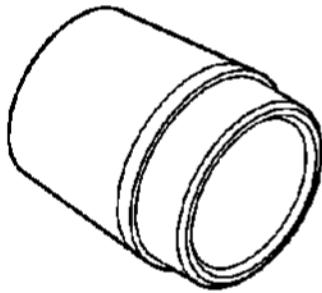
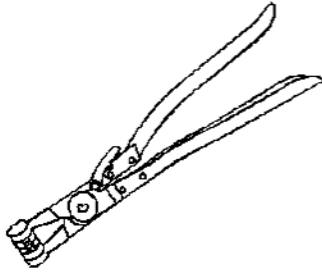


J 35667-A
Cylinder Head Leakdown Tester

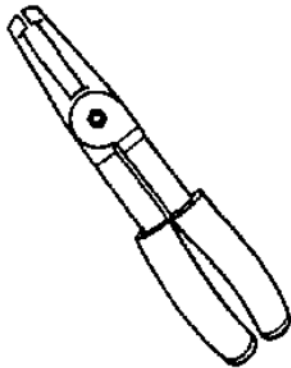
J 38185
Hose Clamp Pliers

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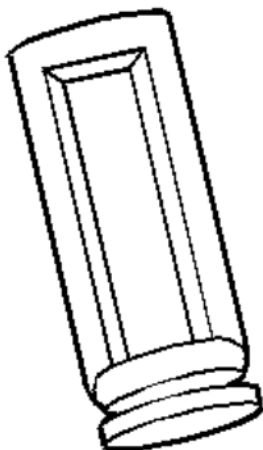
J 38416-2
Crankshaft Button



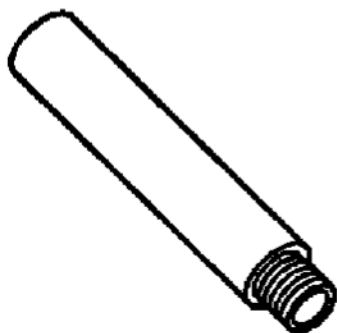
J 38820
Valve Stem Seal Installer

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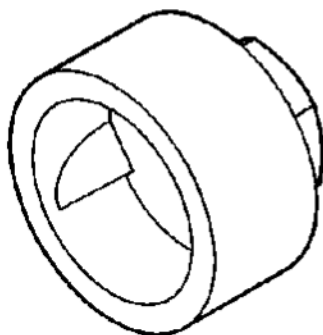
2004 ENGINE Engine Mechanical (Introduction) - 4.6L (LH2) - SRX



J 38821
Valve Spring Compressor Adapter



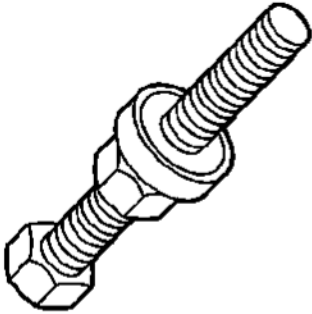
J 39313
Spark Plug Port Adapter



J 39946
Crankshaft Socket - 4.0L and 4.6L

2004 Cadillac SRX

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J 41998-B
Crankshaft Balancer Installer

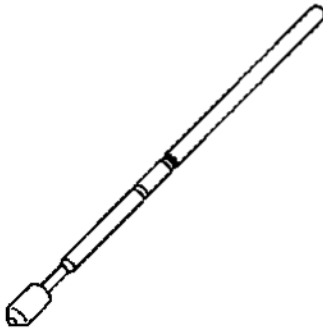


J 42385-2000
Thread Insert Kit

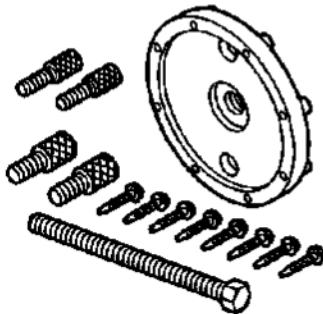
J 42385-2030
M11 x 2.0 Cylinder Head Bolt -
Northstar/Premium V8 Thread Repair Kit

2004 Cadillac SRX

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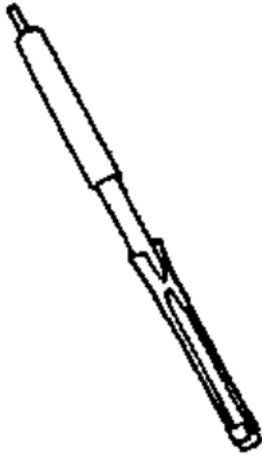
J 42640
Steering Column Anti-Rotation Pin



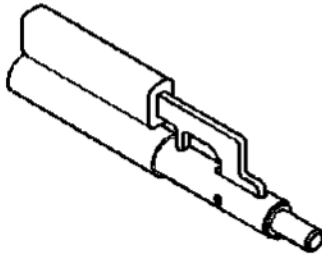
J 42841-A
Rear Oil Seal Remover

2004 Cadillac SRX

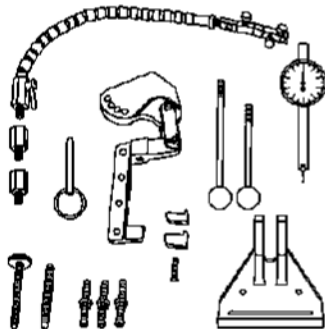
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J 43059
Valve Retainer Remover/Installer



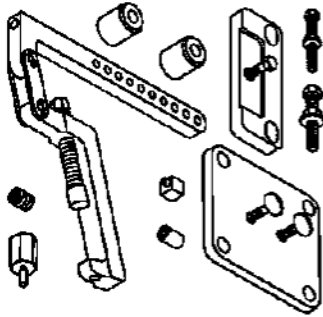
J 43654
Piston Pin Clip Remover and Installer



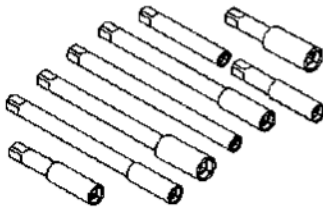
J 43690
Rod Bearing Clearance Checking Tool

2004 Cadillac SRX

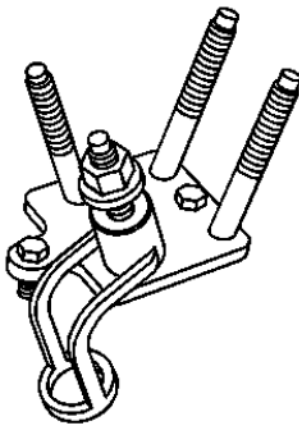
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J 43690-100
Rod Bearing Clearance Checking Tool -
Adapter Kit



J 43965
Thread Repair Extension Kit

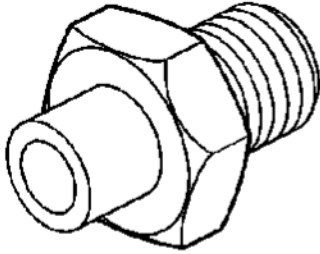


J 44211
On-Vehicle Valve Spring Compressor

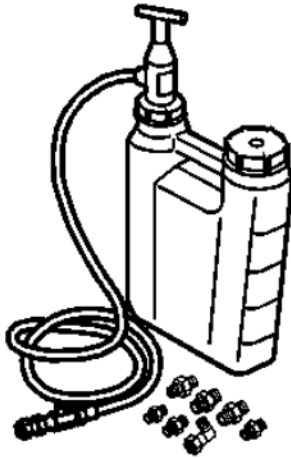
J 45059

2004 Cadillac SRX

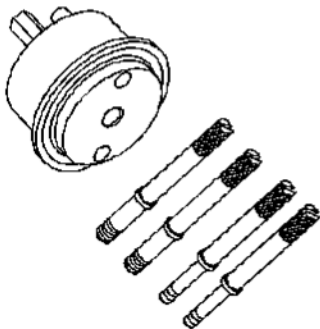
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Angle Meter



J 45299
Engine Preluber



J 45930-A
Crankshaft Rear Oil Seal Installer