Service Manual: ENGINE MECHANICAL - 6.2L (LT1)

SPECIFICATIONS > FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Accessory Drive Belt Tensioner Bolt - Lower	22 N.m	16 lb ft
Accessory Drive Belt Tensioner Pulley Bolt	58 N.m	43 lb ft
Supercharger Belt Idler Pulley Bolts - All	58 N.m	43 lb ft
Automatic Transmission Flex Plate Bolts (1)		
• First Pass	15 N.m	11 lb ft
• Second Pass	30 N.m	22 lb ft
• Final Pass	45 degrees	
Flywheel Bolts (1)		
• First Pass	15 N.m	11 lb ft
• Second Pass	30 N.m	22 lb ft
• Final Pass	45 degrees	
Camshaft Position (CMP) Actuator Magnet Bolts	10 N.m	89 lb in
Camshaft Position (CMP) Actuator Solenoid Valve (1)		
• First Pass	65 N.m	48 lb ft
• Final Pass	90 degrees	
Camshaft Position (CMP) Sensor Bolt	25 N.m	18 lb ft
Camshaft Position (CMP) Sensor Wire Harness Bolt	25 N.m	18 lb ft
Camshaft Retainer Bolts - TORX Head Bolts	15 N.m	11 lb ft
Connecting Rod Bolts (1)		

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• First Pass	20 N.m	15 lb ft
• Final Pass	85 degrees	
Coolant Temperature Sensor	20 N.m	15 lb ft
Crankshaft Balancer Bolt - Installation Pass with Used Bolt - to Ensure the Balancer is Completely Installed	330 N.m	243 lb ft
Crankshaft Balancer Bolt New Bolt with Flanged Head (1)		
• First Pass	150 N.m	111 lb ft
• Second Pass	Loosen 360 degrees	
• Third Pass	80 N.m	59 lb ft
• Final Step	125 degrees	
Crankshaft Balancer Bolt New Bolt with Retained Rotating Washer (1)		
• First Pass	150 N.m	111 lb ft
• Second Pass	Loosen 360 degrees	
• Third Pass	80 N.m	59 lb ft
• Final Step	200 degrees	
Crankshaft Bearing Cap Bolts (1)		
• Inner Bearing Cap Bolts - First Pass in Sequence (1)	20 N.m	15 lb ft
• Inner Bearing Cap Bolts - Final Pass in Sequence (1)	110 degrees	
• Outer Bearing Cap Bolts - First Pass in Sequence	20 N.m	15 lb ft
• Outer Bearing Cap Bolts - Final Pass in Sequence	80 degrees	

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SPECIFICATIONS > APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
6.2L (LT1)		
• Oil Capacity - with Filter	9.5 Liters	10.0 Quarts
• Oil Capacity - without Filter	9.0 liters	9.5 quarts

SPECIFICATIONS > ENGINE MECHANICAL SPECIFICATIONS (LT1)

Application	Specification	
	Metric	English
General		
• Engine Type	V8	
• Displacement	6.2L	376 CID
• RPO	LT1	
• VIN	7	
• Bore	103.0 mm	4.055 mm
• Stroke	92.0 mm	3.622 in
• Compression Ratio	11.5:1	
• Firing Order	1-8-7-2-6-5-4-3	

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• Spark Plug Gap	0.95-1.10 mm	0.037-0.043 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.869-69.891 mm	2.751-2.752 in
• Crankshaft Main Bearing Bore Out-of-Round	0.008 mm	0.00031 in
• Cylinder Bore Diameter	103.242-103.258 mm	4.0646-4.0653 in
• Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.575-234.825 mm	9.235-9.245 in
• Cylinder Head Deck Surface Flatness - Measured Within a 150.00 mm (5.9 in) Area	0.05 mm	0.002 in
• Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.1 mm	0.0039 in
• Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
• Valve Lifter Follower Bore Diameter	29.187-29.213 mm	1.149-1.150 in
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.990-55.015 mm	2.164-2.166 in

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• Camshaft Bearing Diameter	55.063-55.088 mm	2.1678-2.1688 in
• Camshaft Journal-to-Bearing Clearance	0.048-0.098 mm	0.0019-0.0038 in
• Camshaft Journal Out-of-Round	0.006 mm	0.0002 in
• Camshaft Lobe Lift - Exhaust Non AFM	7.360 mm	0.290 in
• Camshaft Lobe Lift - Exhaust AFM	7.490 mm	0.295 in
• Camshaft Lobe Lift - Intake Non AFM	7.760 mm	0.306 in
• Camshaft Lobe Lift - Intake AFM	7.890 mm	0.311 in
• Fuel Pump Lobe Lift	5.70 mm	0.224 in
• Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Camshaft Position Actuator		
• Range of Authority	62 degrees	
• Park Position	7 degrees Advanced	
Connecting Rod		
• Connecting Rod Bearing Clearance - Production	0.024-0.064 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.0029 in
• Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bore Out-of-Round - Bearing End - Production	0.006 mm	0.00023 in

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SPECIFICATIONS > ENGINE CONTENT SPECIFICATIONS

RPO	VIN	Displacement	Camshaft Position (CMP) Actuator Control System	Active Fuel Management Control System	E85 Capable	Block Material
LT1	7	6.2L	Yes	Yes	No	Aluminum
LT4	6	6.2L	Yes	Yes	No	Aluminum

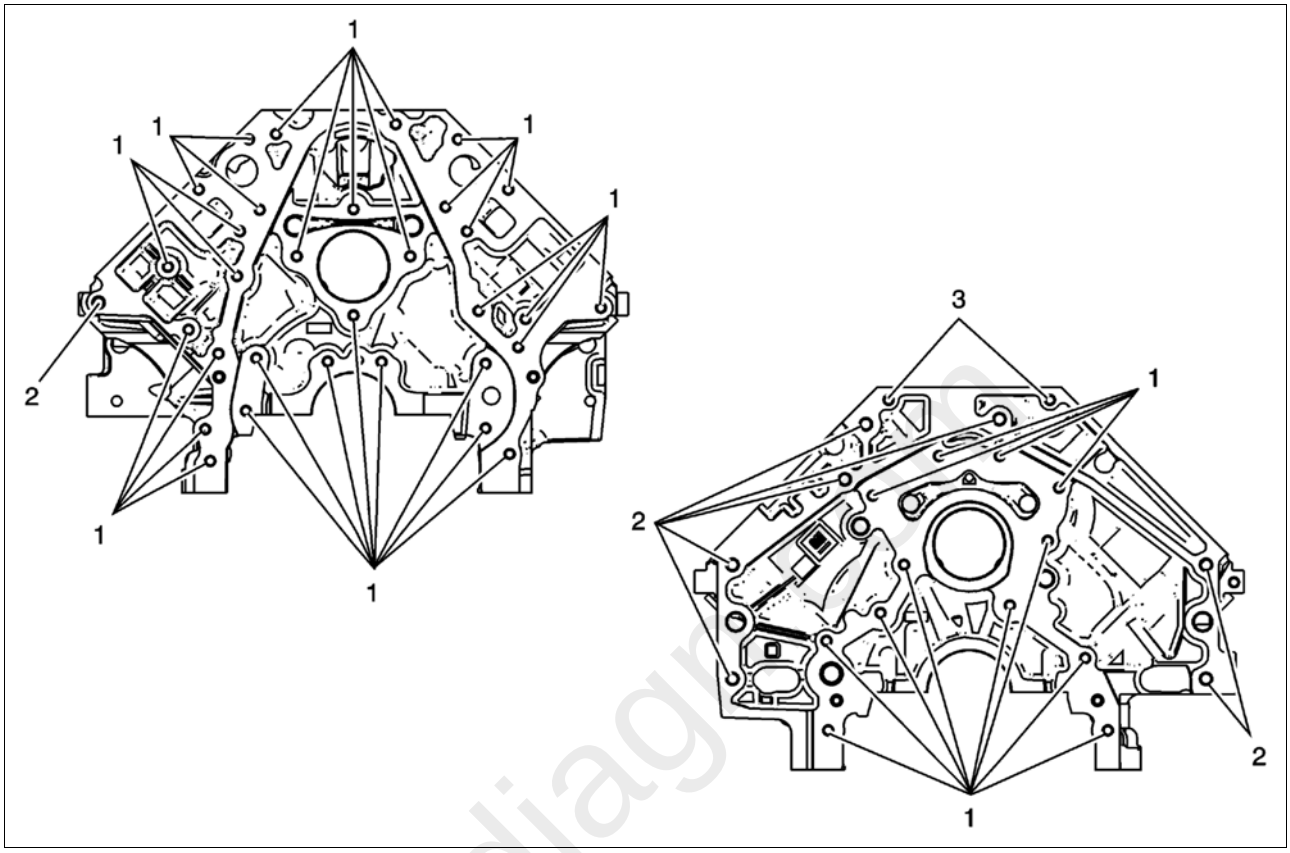
SPECIFICATIONS > ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Camshaft Retainer Bolts	Threadlocker	12345382	10953489
Engine Block to the Crankshaft Rear Oil Seal Housing *	Sealant	12378521	88901148
Engine Block to the Engine Front Cover *	Sealant	12378521	88901148
Engine Block to Oil Pan *	Sealant	12378521	88901148
Lower Oil Pan to Upper Oil Pan *	Sealant	12378521	88901148
Engine Block Coolant Drain Hole Plug	Sealant	12346004	10953480
Engine Block Oil Gallery Plug	Sealant	12346004	10953480
Engine Oil	5W-30	19293000	19386321
Engine Oil Pressure Sensor Threads	Sealant	12346004	10953480
Engine Coolant Temperature (ECT) Sensor	Sealant	12346004	10953480
Exhaust Manifold Bolts	Threadlocker	89021297	10953488
Engine Coolant Manifold Bolt	Threadlocker	12345382	10953489
Fuel Rail Bolts	Threadlocker	12345382	10953489
Intake Manifold Bolts	Threadlocker	12345382	10953489
Spark Plug Wires	Lubricant	19260901	19260902
Valve Lifter Oil Filter Plug	Sealant	12346004	10953480
* Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant			

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SPECIFICATIONS > THREAD REPAIR SPECIFICATIONS > ENGINE BLOCK-FRONT/REAR VIEWS

Fig 1: Engine Block - Front/Rear



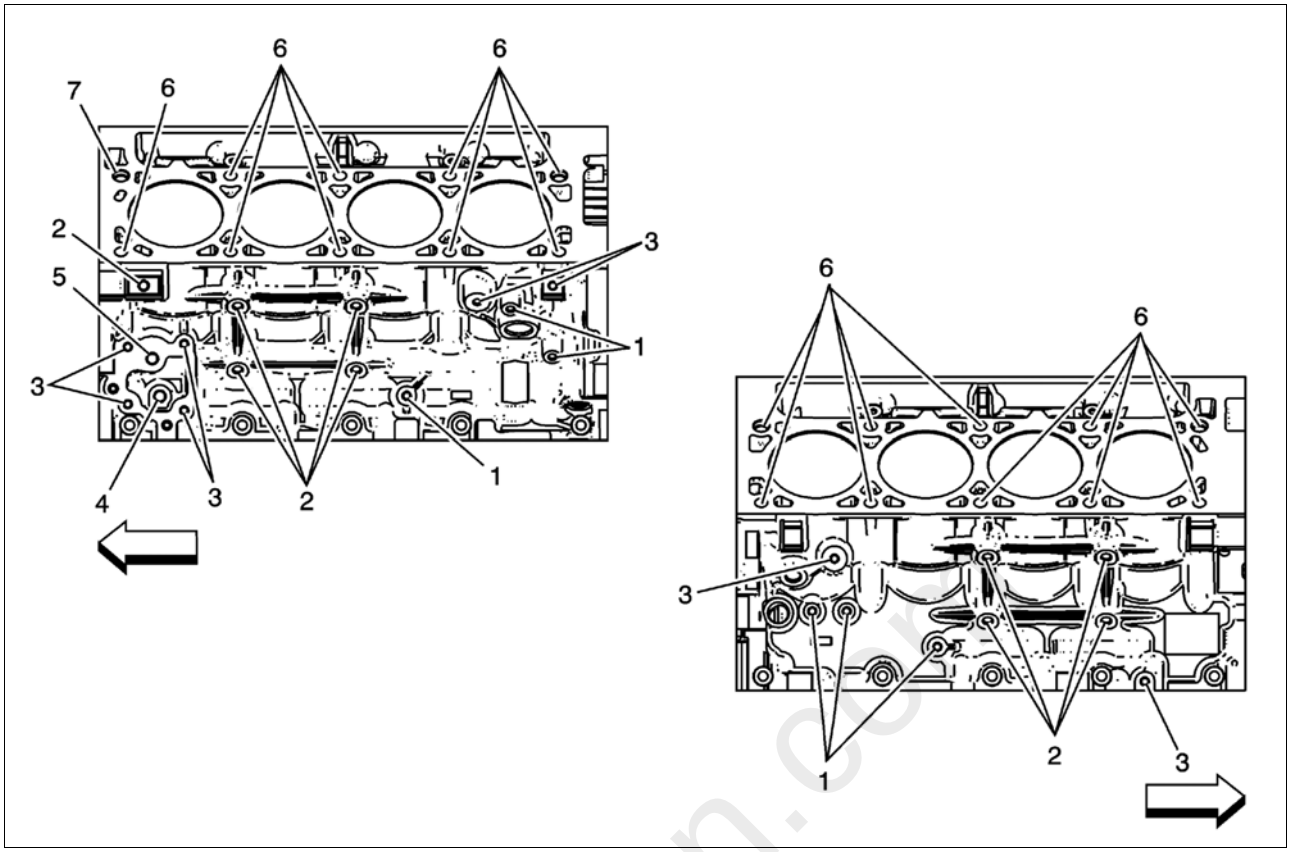
Courtesy of GENERAL MOTORS COMPANY

Engine Block- Front/Rear Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth-Maximum mm (in)	Tap Depth-Maximum mm (in)
J-42385-								
1	M8 x 1.25	210	206	207	208	209	23.0 (0.907)	23.0 (0.907)
2	M10 x 1.5	420	211	212	213	214	34.0 (1.35)	34.0 (1.35)
3	M8 x 1.25	61	206	207	208	209	29.0 (1.14)	29.0 (1.14)

SPECIFICATIONS > THREAD REPAIR SPECIFICATIONS > ENGINE BLOCK-LEFT/RIGHT SIDE VIEWS

Fig 1: Engine Block - Left/Right Side



Courtesy of GENERAL MOTORS COMPANY

Engine Block- Left/Right Side Views

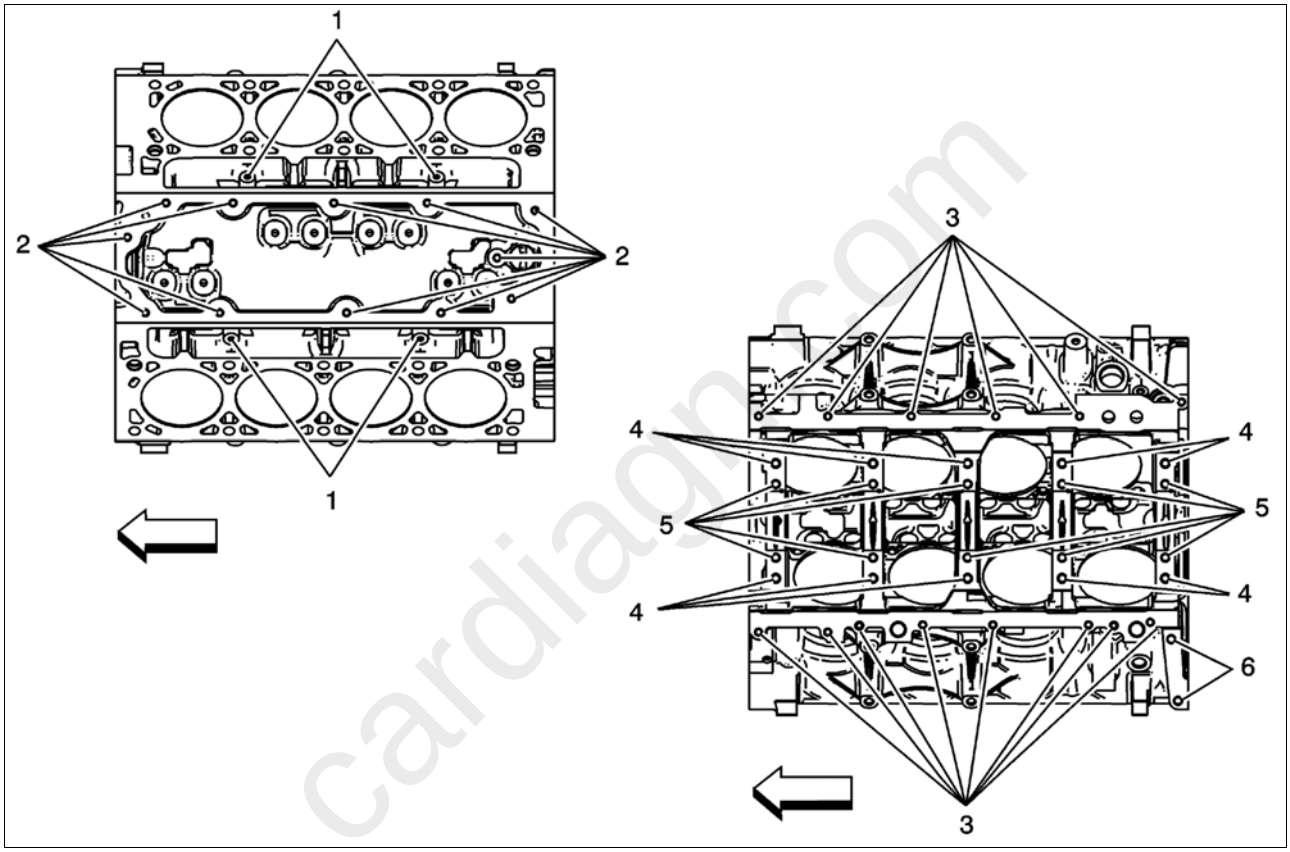
Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth-Maximum mm (in)	Tap Depth-Maximum mm (in)
Standard Bolts J-42385-								
1	M8 x 1.25	210	206	207	208	209	23.0 (0.907)	23.0 (0.907)
2	M10 x 1.25	420	211	212	213	214	34.0 (1.35)	34.0 (1.35)
3	M8 x 1.25	61	206	207	208	209	29.0 (1.14)	29.0 (1.14)
4	M12 x 1.75	865	856	857	858	859	16.0 (0.629)	16.0 (0.629)
Head Bolts EN-42385-								
5	M12 x 1.75	62	856	857	858	859	23.0 (0.907)	23.0 (0.907)
6	M12 x 1.75	58	51	N/A	52	53	58.0 (2.28)	58.0 (2.28)

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7	M12 x 1.75	58	51	57 (Stop Collar)	52	53	58.0 (2.28)	58.0 (2.28)
Cylinder head bolt hole (7) has a unique shallow depth. Use stop collar **EN-42385-57** . Stop tap and driver at first line. Refer to Thread Repair for head bolt thread repair hardware and procedure.								

SPECIFICATIONS > THREAD REPAIR SPECIFICATIONS > ENGINE BLOCK-TOP/BOTTOM VIEWS

Fig 1: Engine Block - Top/Bottom



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Courtesy of GENERAL MOTORS COMPANY

Engine Block- Top/Bottom Views

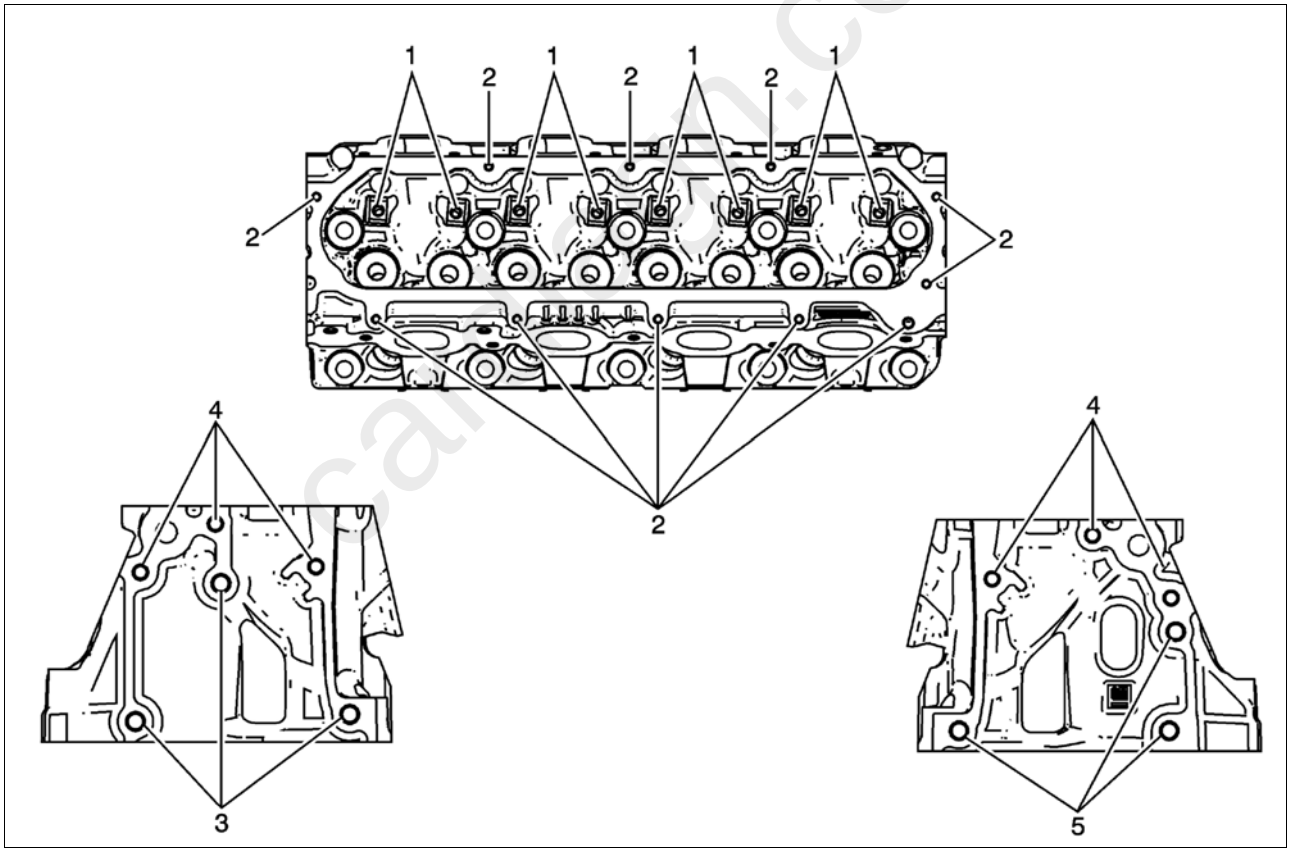
Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth-Maximum mm (in)	Tap Depth-Maximum mm (in)
				J-42385-				
1	M6 x 1.0	63	201	202	203	204	23.0 (0.907)	23.0 (0.907)
2	M8 x 1.25	61	206	207	208	209	29.0 (1.14)	29.0 (1.14)

3	M8 x 1.25	210	206	207	208	209	23.0 (0.907)	23.0 (0.907)
4	M10 x 2.0	104	101	N/A	102	103	30.0 (1.18)	30.0 (1.18)
5	M10 x 2.0	104	101	N/A	102	103	52.0 (2.05)	52.0 (2.05)
6	M10 x 1.5	N/A	N/A	N/A	N/A	N/A	34.0 (1.35)	34.0 (1.35)

- Bolt hole 4 has a 1.5 mm (0.059 in) counterbore included in the 30.0 mm (1.18 in) drill depth. Use sleeve **J-42385-316** with the drill tap. For the proper hardware and procedure, refer to Thread Repair .
- Bolt hole 5 has a 15.5 mm (0.807 in) counterbore included in the 52.0 mm (2.05 in) drill depth. For the proper hardware and procedure, refer to Thread Repair .

SPECIFICATIONS > THREAD REPAIR SPECIFICATIONS > CYLINDER HEAD- TOP/END VIEWS

Fig 1: Cylinder Head - Top/End



Courtesy of GENERAL MOTORS COMPANY

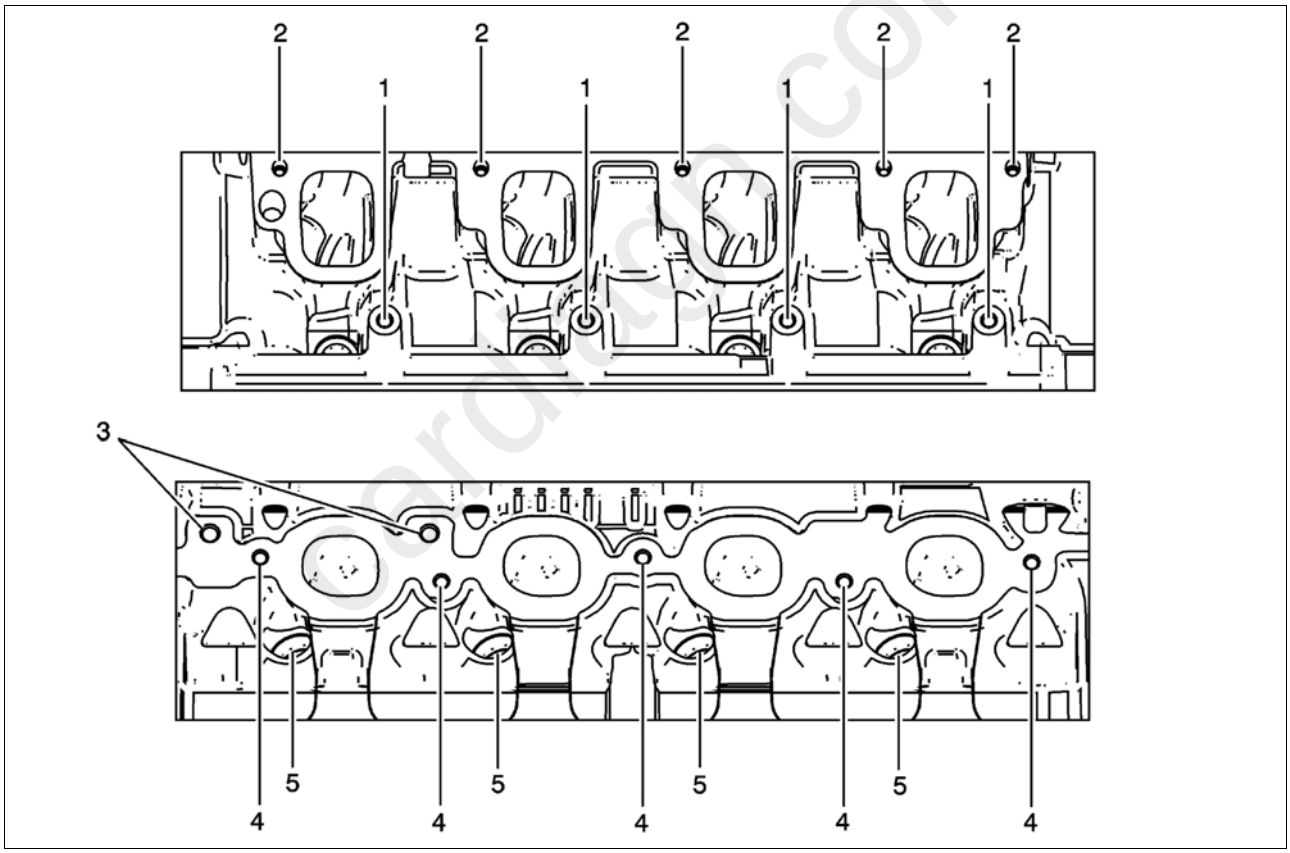
Cylinder Head- Top/End Views

Hole	Thread	Insert	Drill	Counterbore	Tap	Driver	Drill Depth-	Tap Depth-

	Size			Tool			Maximum mm (in)	Maximum mm (in)
				J 42385-				
1	M8 x 1.25	N/A	N/A	N/A	N/A	N/A	23.0 (0.907)	23.0 (0.907)
2	M6 x 1.0	205	201	202	203	204	23.0 (0.907)	23.0 (0.907)
3	M10 x 1.5	420	211	212	213	214	30.0 (1.18)	30.0 (1.18)
4	M8 x 1.25	210	206	207	208	209	23.0 (0.907)	23.0 (0.907)
Bolt Hole 1 (Rocker Arm Supports) are not serviceable.								

SPECIFICATIONS > THREAD REPAIR SPECIFICATIONS > CYLINDER HEAD-INTAKE/EXHAUST SIDE VIEWS

Fig 1: Cylinder Head - Intake/Exhaust Side



Courtesy of GENERAL MOTORS COMPANY

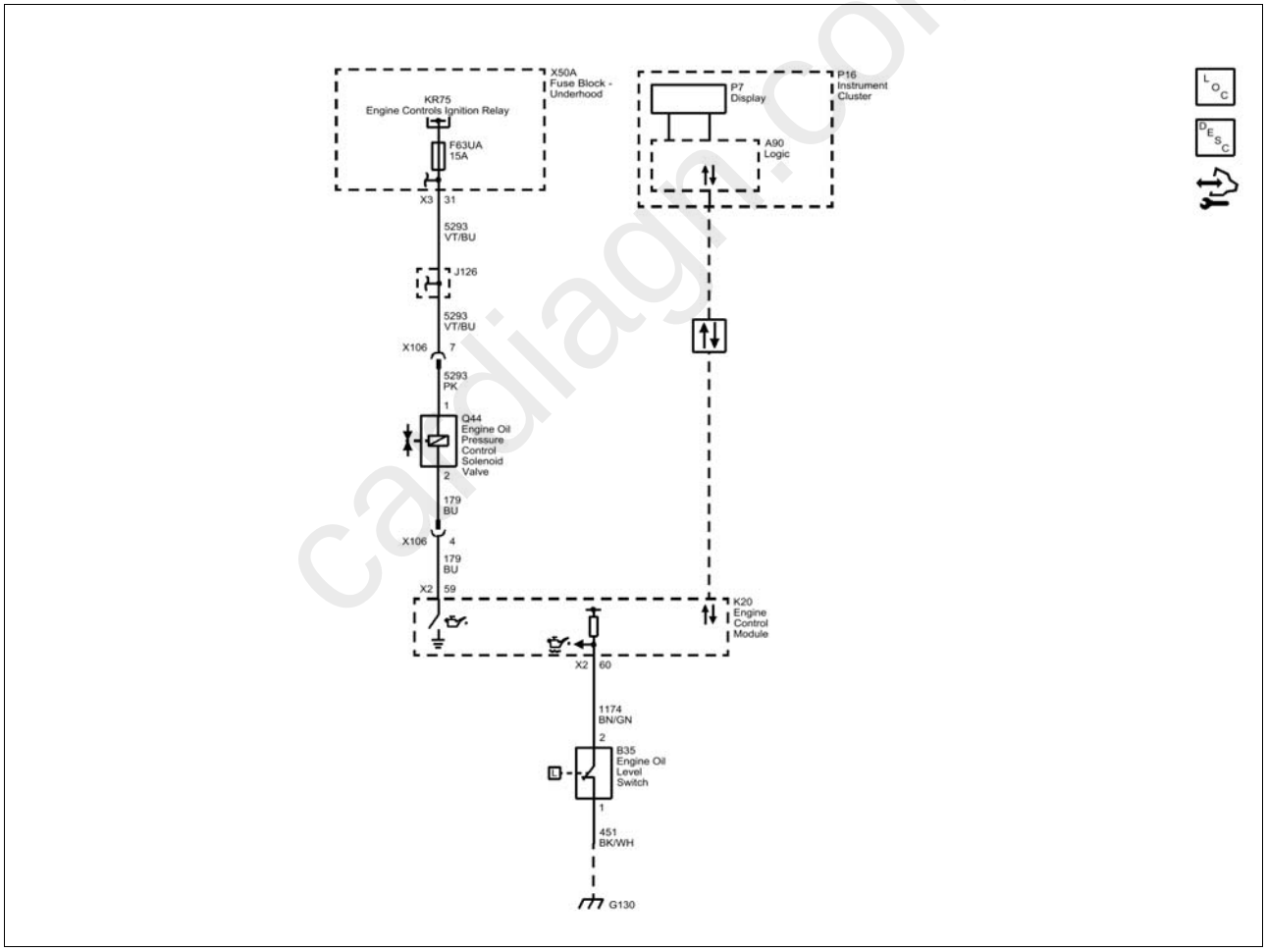
Cylinder Head- Intake/Exhaust Side Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth-Maximum mm (in)	Tap Depth-Maximum mm (in)

				J 42385-				
1	M8 x 1.25	210	206	207	208	209	23.0 (0.907)	23.0 (0.907)
2	M6 x 1.0	205	201	202	203	204	21.0 (0.825)	21.0 (0.825)
3	M10 x 1.5	420	211	212	213	214	34.0 (1.35)	34.0 (1.35)
4	M8 x 1.25	210	206	207	208	209	29.0 (1.14)	29.0 (1.14)
5	M14x 1.25	N/A	N/A	N/A	N/A	N/A	26.0 (1.023)	26.0 (1.023)
Bolt Hole 5 (Spark Plug Port) is not serviceable.								

SCHEMATIC WIRING DIAGRAMS > ENGINE MECHANICAL WIRING SCHEMATICS > ENGINE OIL LEVEL AND PRESSURE CONTROL

Fig 1: Engine Oil Level and Pressure Control

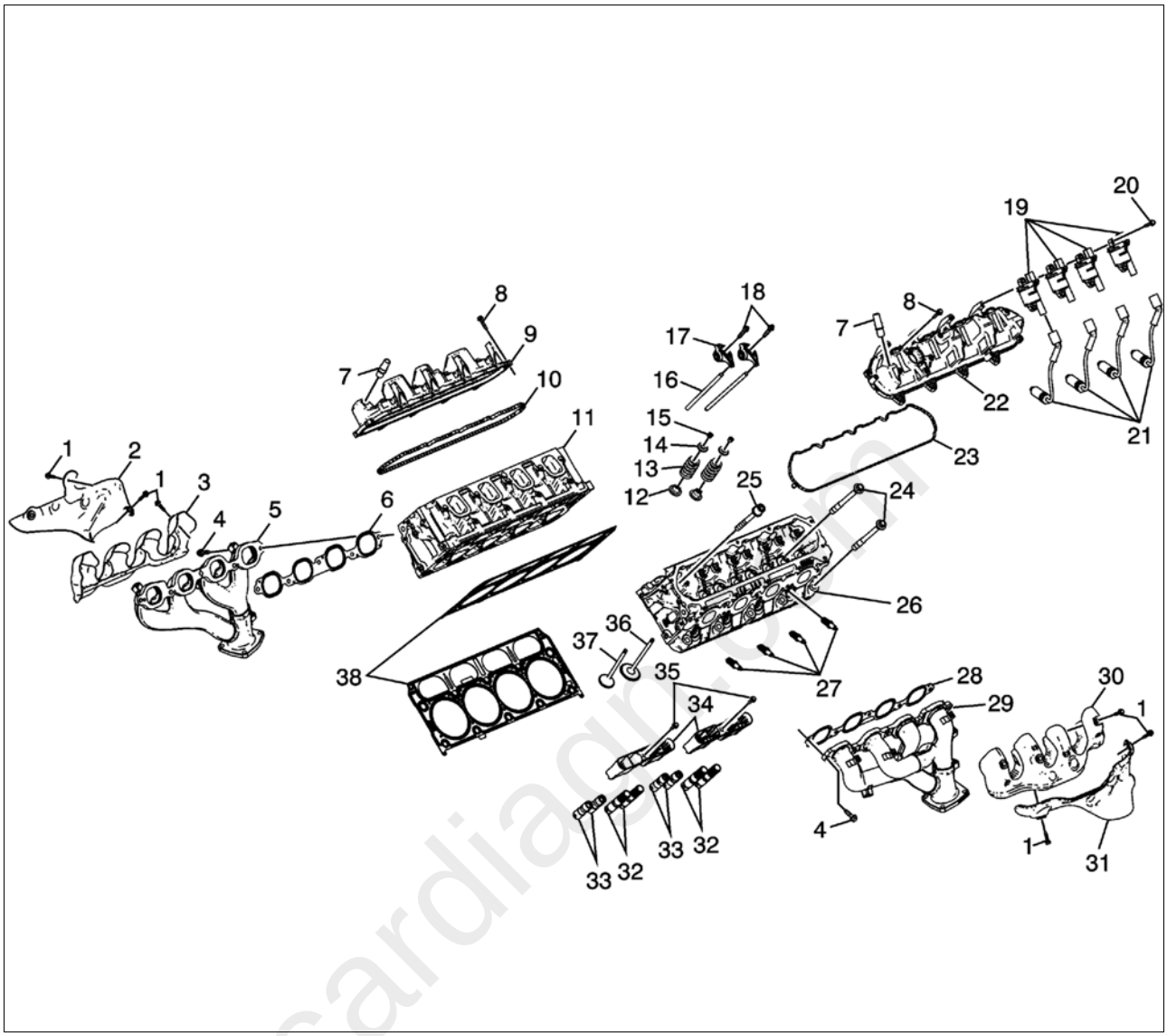


Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR > DISASSEMBLED VIEWS > CYLINDER HEAD/UPPER

ENGINE - WITH ACTIVE FUEL MANAGEMENT

Fig 1: Cylinder Head/Upper Engine - With Active Fuel Management



Courtesy of GENERAL MOTORS COMPANY

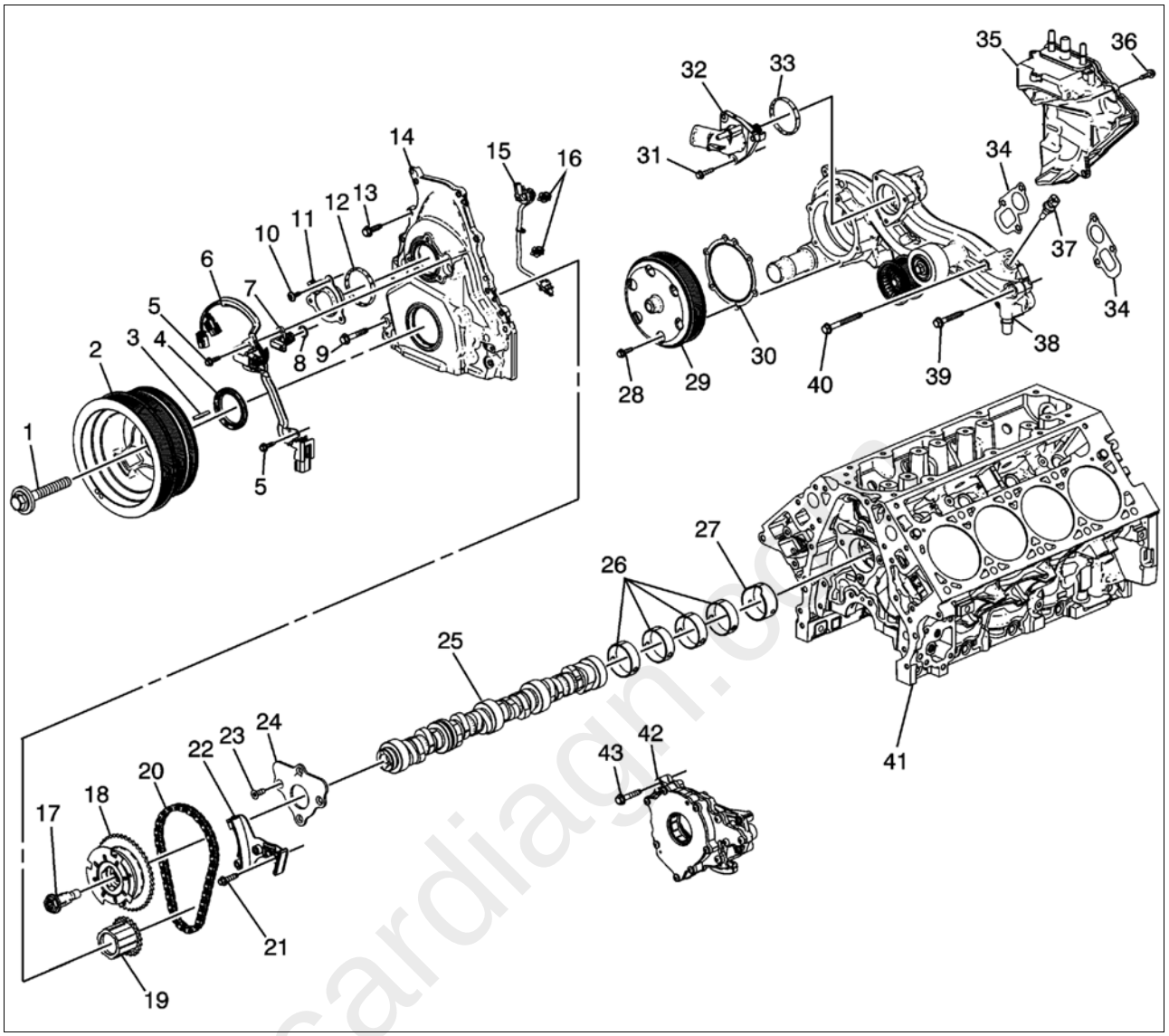
Callout	Component Name
1	Exhaust Manifold Heat Shield Bolt
2	Exhaust Manifold Heat Shield - Right (Upper)
3	Exhaust Manifold Heat Shield - Right (Lower)
4	Exhaust Manifold Bolt
5	Exhaust Manifold Assembly - Right
6	Exhaust Manifold Gasket
7	PCV Fitting

8	Valve Rocker Arm Cover Bolt
9	Valve Rocker Arm Cover - Right
10	Valve Rocker Arm Cover Gasket
11	Cylinder Head - Right
12	Valve Stem Oil Seal
13	Valve Spring
14	Valve Spring Cap
15	Valve Stem Key
16	Valve Push Rod Assembly
17	Valve Rocker Arm Assembly
18	Valve Rocker Arm Pivot Support Bolt
19	Ignition Coil Assembly
20	Ignition Coil Bolt
21	Spark Plug Wire Assembly
22	Valve Rocker Arm Cover - Left
23	Valve Rocker Arm Cover Gasket
24	Cylinder Head Bolt
25	Cylinder Head Bolt
26	Cylinder Head - Left
27	Spark Plug Assembly
28	Exhaust Manifold Gasket
29	Exhaust Manifold Assembly - Left
30	Exhaust Manifold Heat Shield - Left (Upper)
31	Exhaust Manifold Heat Shield - Left (Lower)
32	Valve Lifter
33	Valve Lifter - Non AFM
34	Valve Lifter Guide
35	Valve Lifter Guide Bolt
36	Exhaust Valve
37	Intake Valve
38	Cylinder Head Gasket

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COMPONENT LOCATOR > DISASSEMBLED VIEWS > FRONT OF ENGINE

Fig 1: Front of Engine



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Balancer Bolt
2	Crankshaft Balancer Assembly
3	Crankshaft Balancer Key
4	Crankshaft Front Oil Seal
5	Camshaft Position Sensor Wire Assembly Bracket Bolt
6	Camshaft Position Sensor Wire Assembly
7	Camshaft Position Sensor Assembly

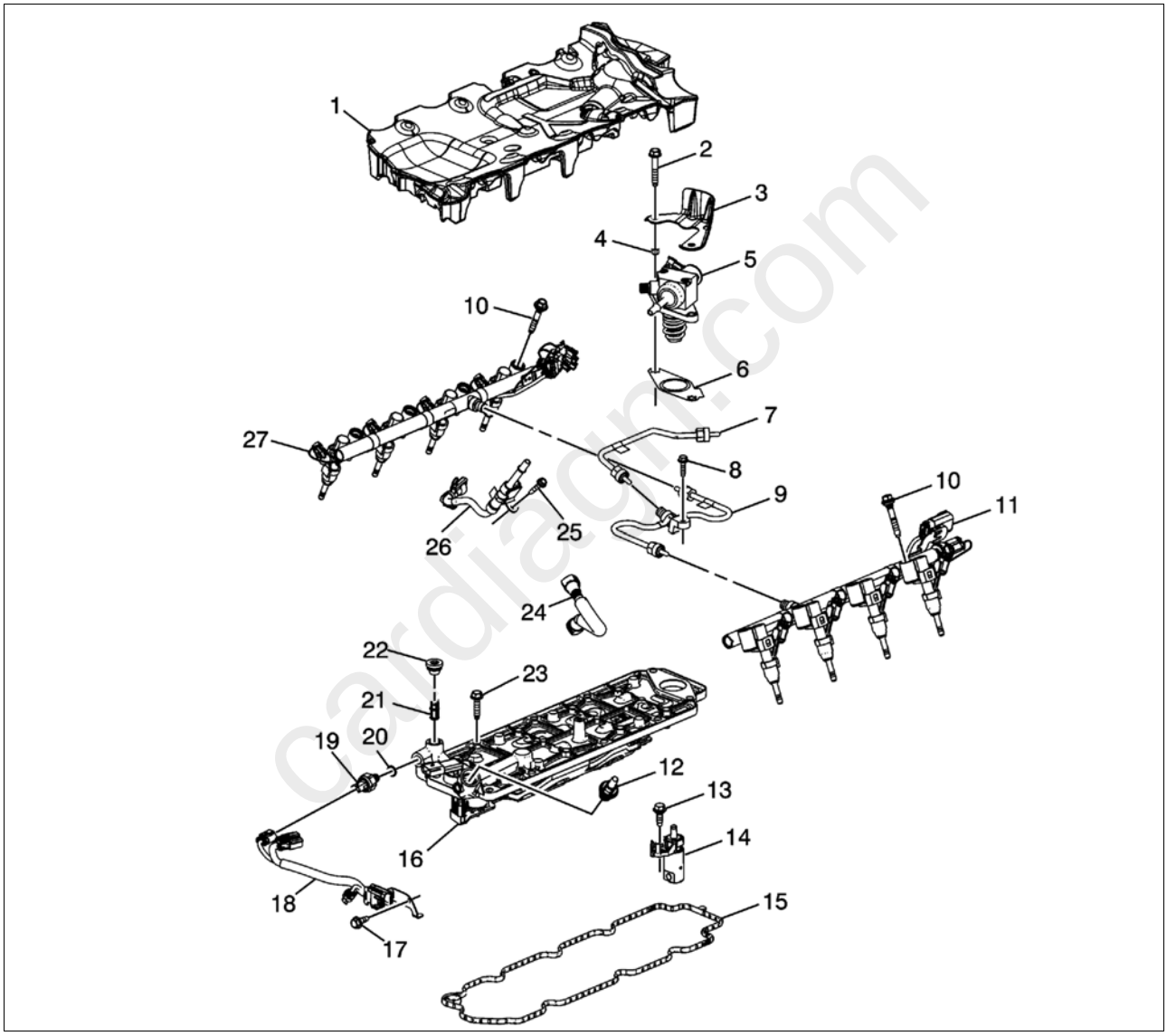
8	Camshaft Position Sensor Seal
9	Engine Front Cover Bolt
10	Camshaft Position Actuator Magnet Bolt
11	Camshaft Position Actuator Magnet
12	Camshaft Position Actuator Magnet Gasket
13	Engine Front Cover Bolt
14	Engine Front Cover Assembly
15	Oil Pump Flow Control Solenoid Valve Wire
16	Oil Pump Flow Control Solenoid Valve Wire Clip
17	Camshaft Position Actuator Solenoid Valve
18	Camshaft Position Actuator Assembly
19	Crankshaft Sprocket Assembly
20	Timing Chain Assembly
21	Timing Chain Tensioner Bolt
22	Timing Chain Tensioner Kit
23	Camshaft Retainer Bolt
24	Camshaft Retainer
25	Camshaft Assembly
26	Camshaft Bearings
27	Camshaft Bearing
28	Water Pump Bolt
29	Water Pump
30	Water Pump Gasket
31	Thermostat Housing Bolt
32	Thermostat Housing
33	Thermostat Housing Gasket
34	Water Pump Gasket
35	PCV Oil Separator Assembly
36	PCV Oil Separator Bolt
37	Engine Coolant Temperature Sensor
38	Engine Coolant Manifold
39	Engine Coolant Manifold Bolt
40	Engine Coolant Manifold Bolt

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41	Engine Block Assembly
42	Oil Pump Assembly
43	Oil Pump Bolt

COMPONENT LOCATOR > DISASSEMBLED VIEWS > FUEL DELIVERY SYSTEM AND COMPONENTS

Fig 1: Fuel Delivery System and Components



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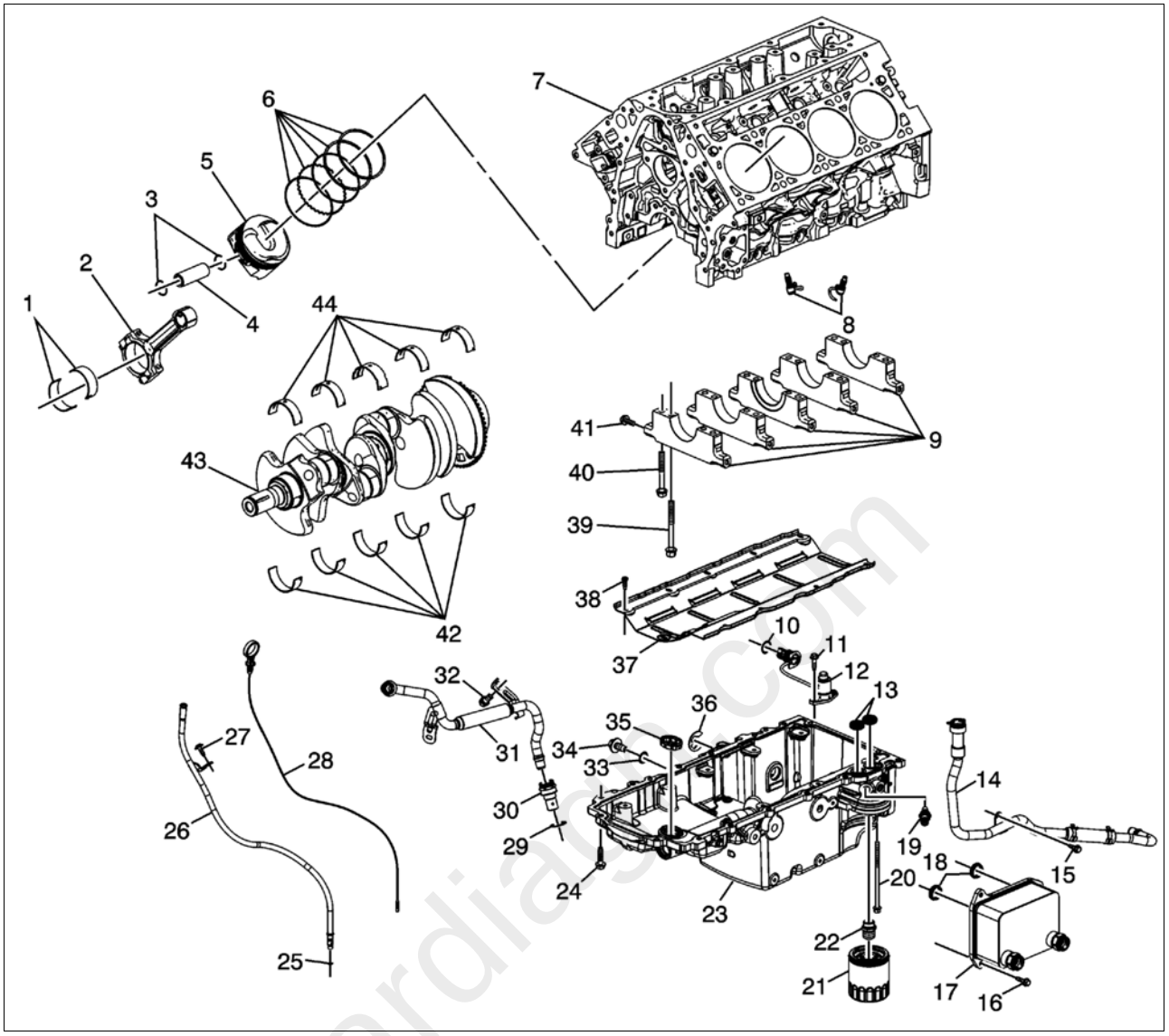
Callout	Component Name
1	Fuel Pump Insulator
2	Fuel Pump Bolt

3	Fuel Pump Cover
4	Fuel Pump Bolt Retainer
5	Fuel Pump Assembly
6	Fuel Pump Gasket
7	Fuel Feed Intermediate Pipe
8	Fuel Feed Intermediate Pipe Bolt
9	Fuel Feed Intermediate Pipe
10	Fuel Injection Fuel Rail Bolt
11	Direct Fuel Injection Fuel Rail Assembly - Left
12	PCV Assembly
13	Valve Lifter Follower Guide Assembly Bolt
14	Valve Lifter Follower Guide Assembly
15	Valve Lifter Oil Manifold Gasket
16	Valve Lifter Oil Manifold Assembly
17	Jumper
18	Jumper Bolt
19	Engine Oil Pressure Sensor Assembly
20	Engine Oil Pressure Sensor Assembly Seal
21	Valve Lifter Oil Filter
22	Valve Lifter Oil Manifold Plug
23	Valve Lifter Oil Manifold Bolt
24	PCV Tube Assembly
25	Fuel Feed Pipe Bolt
26	Fuel Feed Pipe Assembly
27	Direct Fuel Injection Fuel Rail Assembly - Right

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COMPONENT LOCATOR > DISASSEMBLED VIEWS > LOWER ENGINE AND COMPONENTS

Fig 1: Lower Engine and Components



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Connecting Rod Bushing
2	Connecting Rod Assembly
3	Piston Pin Retainer
4	Piston Pin
5	Piston
6	Piston Ring Set
7	Engine Block Assembly
8	Piston Oil Nozzle Assembly
9	Crankshaft Bearing Cap

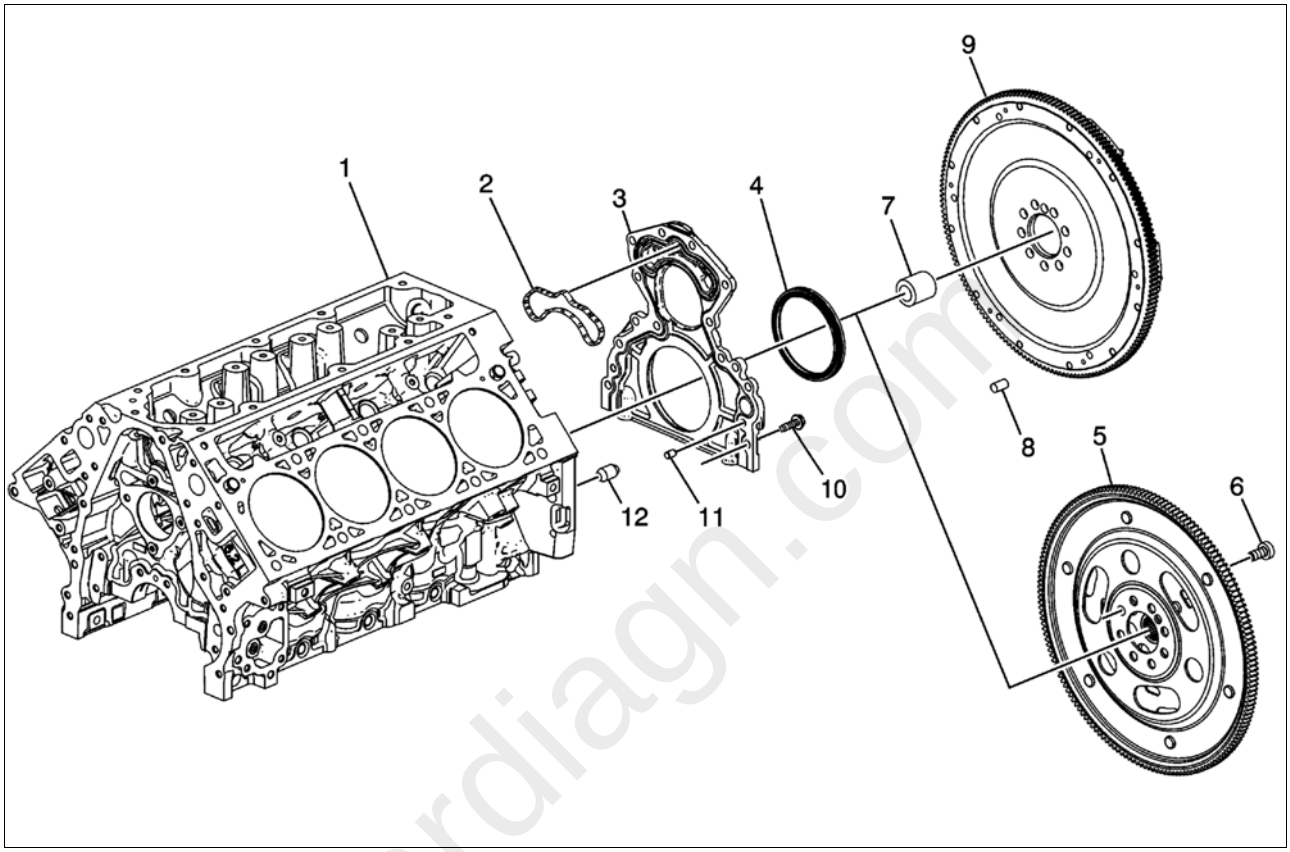
10	Engine Oil Level Indicator Switch O-Ring Seal
11	Engine Oil Level Indicator Switch Bolt
12	Engine Oil Level Indicator Switch
13	Oil Pan High Pressure Port Seal
14	Engine Oil Cooler Hose
15	Engine Oil Cooler Hose Bolt
16	Engine Oil Cooler Bolt
17	Engine Oil Cooler
18	Engine Oil Cooler Seal
19	Engine Coolant Temperature Sensor
20	Oil Pan Bolt
21	Oil Filter
22	Oil Filter Fitting
23	Oil Pan
24	Oil Pan Bolt
25	Oil Level Indicator Tube Seal
26	Oil Level Indicator Tube
27	Oil Level Indicator Tube Bolt
28	Oil Level Indicator
29	Turbocharger Coolant Feed and Return Pipe Gasket
30	Oil Flow Check Valve
31	Positive Crankcase Ventilation Oil Separator Drain Pipe
32	Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt
33	Oil Pan Drain Plug Seal
34	Oil Pan Drain Plug
35	Oil Pan Front Seal
36	Engine Oil Level Indicator Switch Connector Retainer
37	Crankshaft Oil Deflector
38	Crankshaft Oil Deflector Bolt
39	Crankshaft Bearing Cap Bolt - Inner
40	Crankshaft Bearing Cap Bolt - Outer
41	Crankshaft Bearing Cap Bolt - Side
42	Crankshaft Lower Bearing

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43	Crankshaft Assembly
44	Crankshaft Upper Bearing

COMPONENT LOCATOR > DISASSEMBLED VIEWS > REAR OF ENGINE

Fig 1: Rear of Engine



Courtesy of GENERAL MOTORS COMPANY

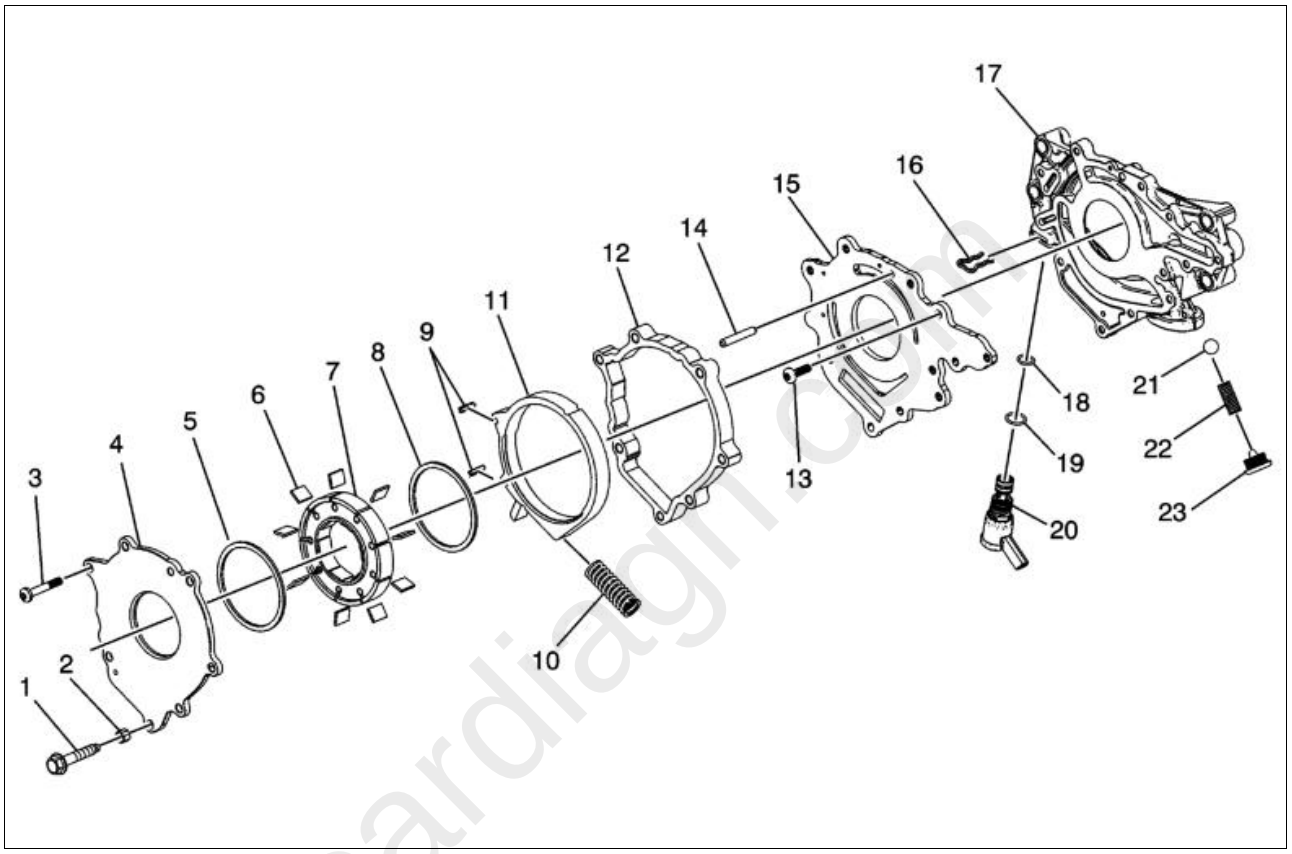
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Callout	Component Name
1	Engine Block
2	Crankshaft Rear Oil Seal Housing Gasket
3	Crankshaft Rear Oil Seal Housing
4	Crankshaft Rear Oil Seal
5	Automatic Transmission Flex Plate
6	Automatic Transmission Flex Plate Bolt
7	Transmission Pilot Bearing - Manual Transmission
8	Balance Weight - Flywheel - Manual Transmission
9	Flywheel - Manual Transmission

10	Crankshaft Rear Oil Seal Housing Bolt
11	Crankshaft Rear Oil Seal Housing Locating Pin
12	Transmission Locating Pin

COMPONENT LOCATOR > DISASSEMBLED VIEWS > OIL PUMP ASSEMBLY

Fig 1: Oil Pump Assembly



Courtesy of GENERAL MOTORS COMPANY

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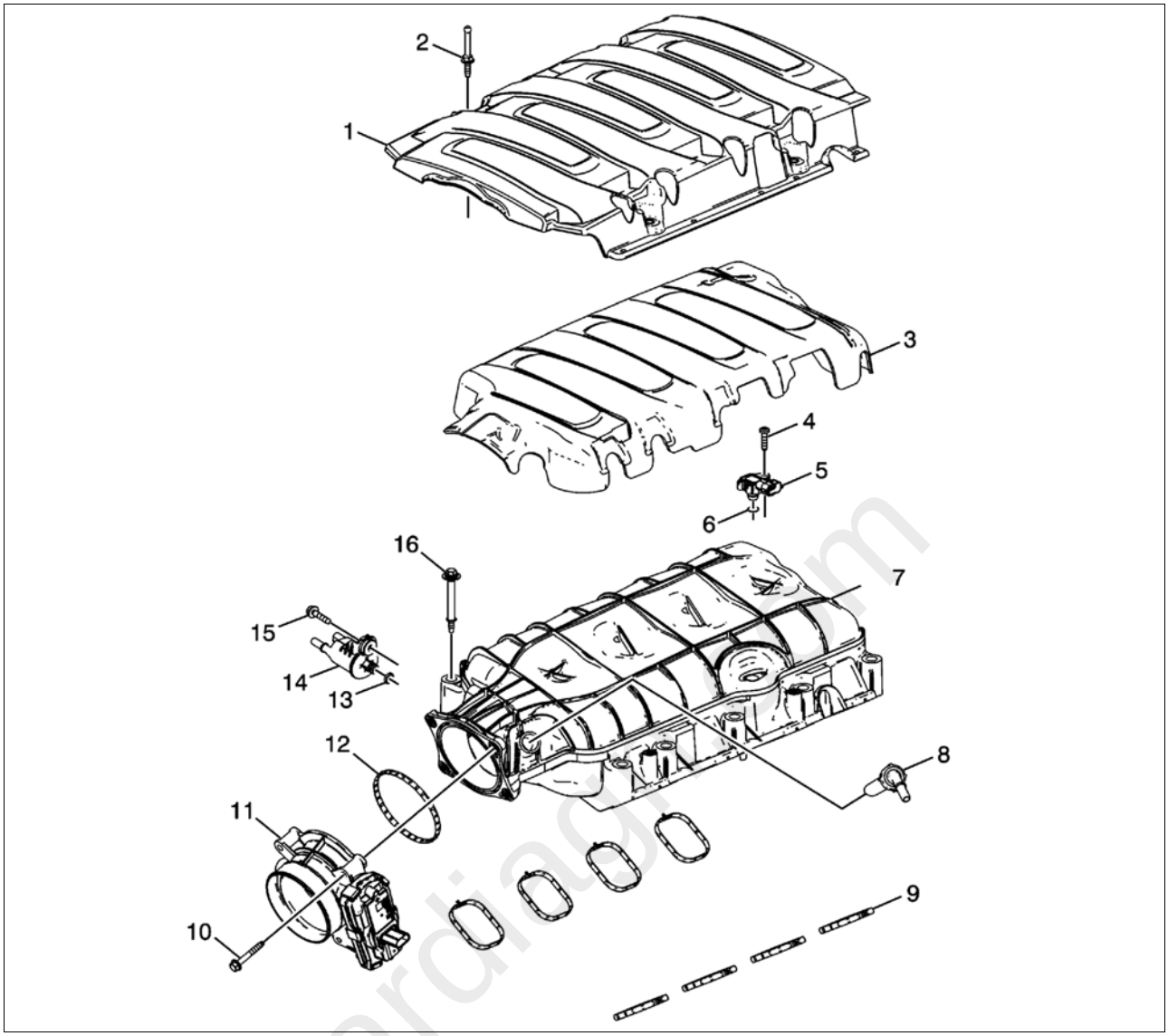
Callout	Component Name
1	Oil Pump Cover Bolt
2	Bolt Retainer
3	Oil Pump Cover Bolt
4	Oil Pump Cover
5	Oil Pump Vane Ring
6	Oil Pump Vane
7	Oil Pump Vane Rotor
8	Oil Pump Vane Ring

9	Oil Pump Slide Seal
10	Oil Pump Slide Spring
11	Oil Pump Slide
12	Oil Pump Intermediate Housing
13	Oil Pump Rear Cover Bolt
14	Oil Pump Slide Pivot Pin
15	Oil Pump Rear Cover
16	Oil Pump Flow Control Solenoid Retainer
17	Oil Pump Housing
18	Oil Pump Flow Control Solenoid O-ring
19	Oil Pump Flow Control Solenoid O-ring
20	Oil Pump Flow Control Solenoid
21	Oil Pressure Relief Valve
22	Oil Pressure Relief Valve Spring
23	Oil Pressure Relief Valve Bore Plug

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COMPONENT LOCATOR > DISASSEMBLED VIEWS > INTAKE MANIFOLD AND COMPONENTS

Fig 1: Intake Manifold and Components



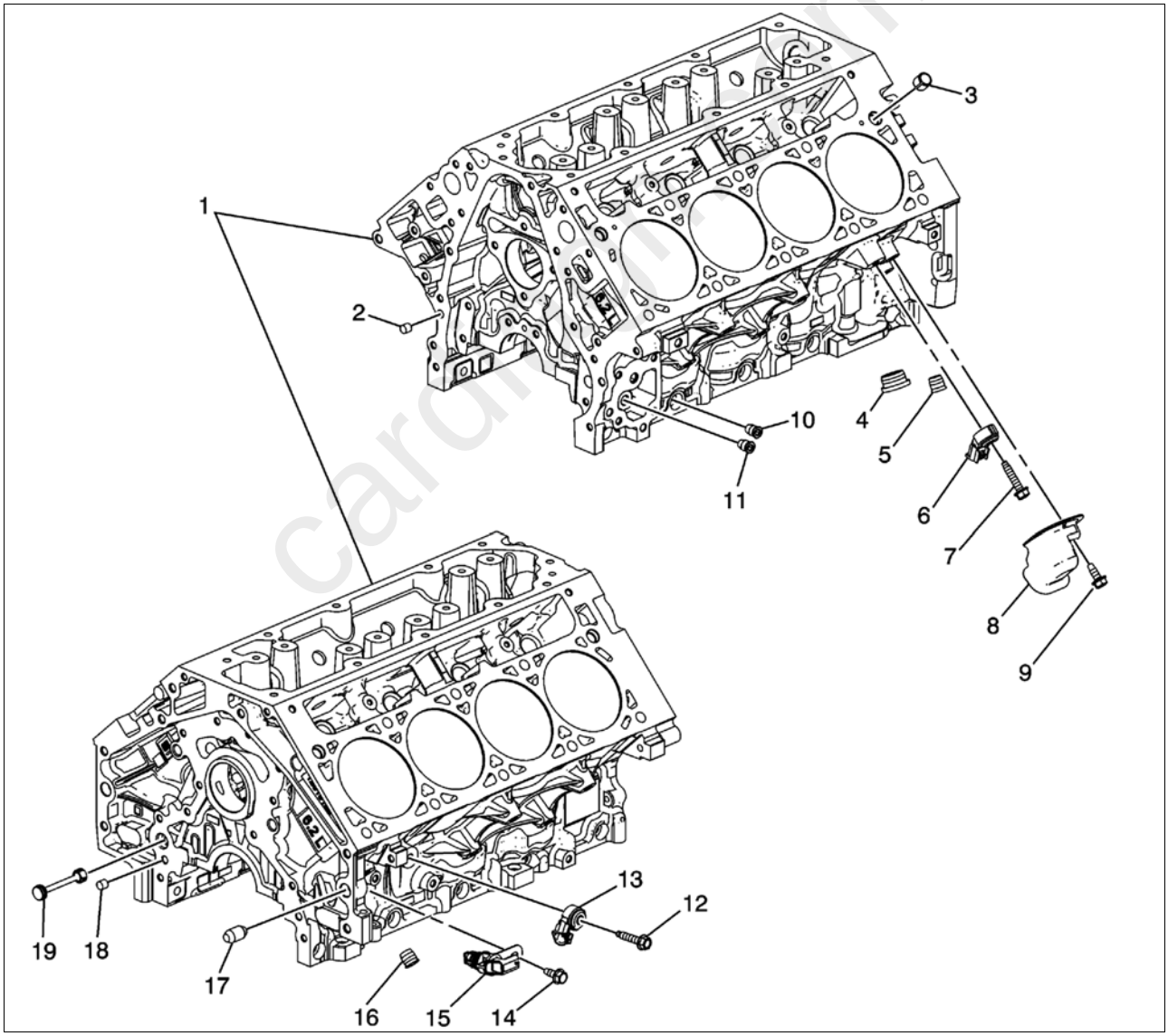
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Cover Assembly
2	Intake Manifold Cover Stud
3	Intake Manifold Cover Insulator
4	MAP Sensor Bolt
5	MAP Sensor
6	MAP Sensor Seal
7	Intake Manifold Assembly
8	PCV Fitting
9	Intake Manifold Gasket

10	Throttle Body Bolt
11	Throttle Body Assembly
12	Throttle Body Gasket
13	EVAP Emission Canister Purge Valve Seal
14	EVAP Emission Canister Purge Valve
15	EVAP Emission Canister Purge Valve Bolt
16	Intake Manifold Bolt

COMPONENT LOCATOR > DISASSEMBLED VIEWS > ENGINE BLOCK PLUGS/SENSORS

Fig 1: Engine Block Plugs/Sensors



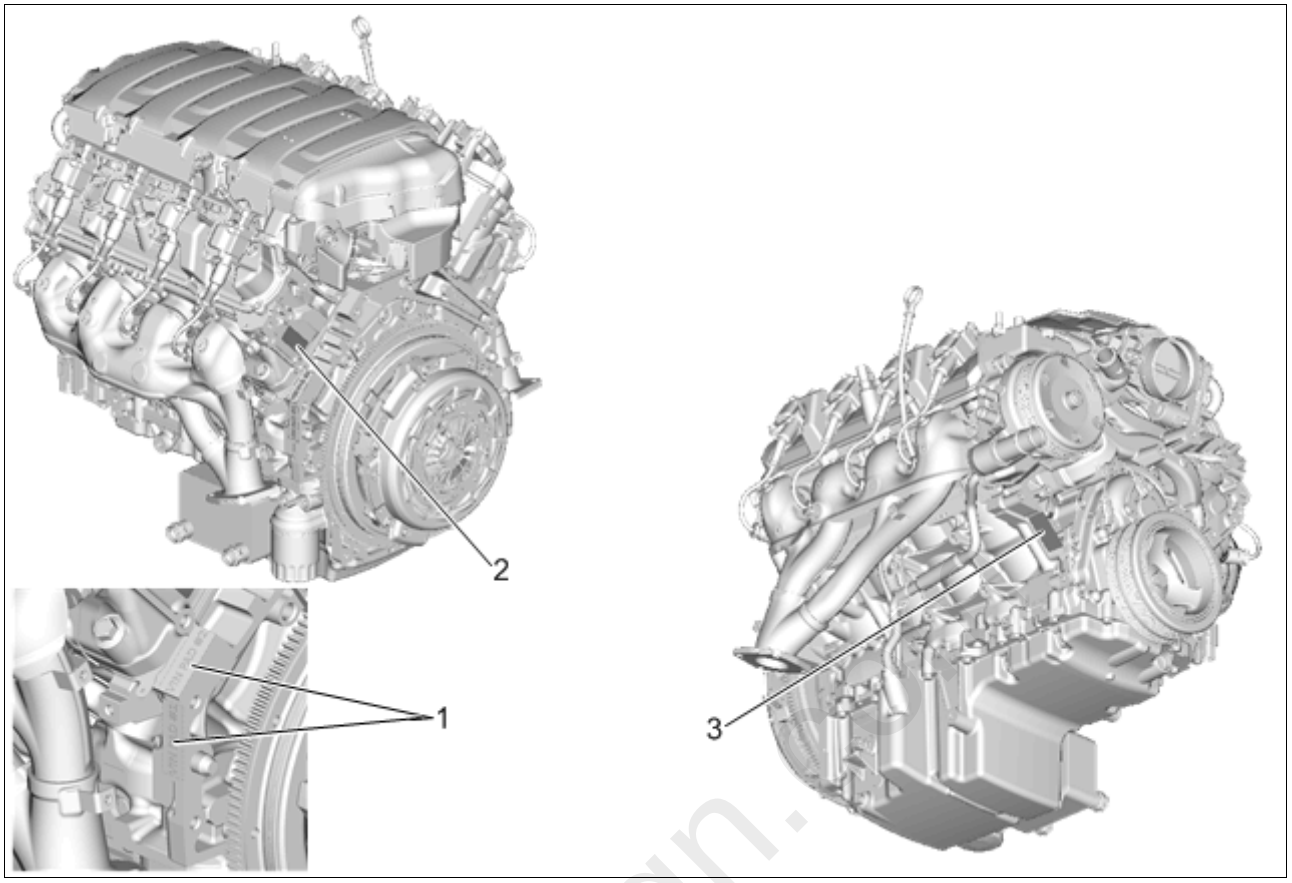
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Block
2	Engine Front Cover Locating Pin
3	Cylinder Head Locating Pin
4	Engine Block Plug
5	Engine Block Plug
6	Knock Sensor Assembly
7	Knock Sensor Bolt
8	Knock Sensor Shield
9	Knock Sensor Shield Bolt
10	Engine Block Oil Gallery Plug
10	Engine Block Oil Gallery Plug
12	Knock Sensor Bolt
13	Knock Sensor Assembly
14	Crankshaft Position Sensor Bolt
15	Crankshaft Position Sensor Assembly
16	Engine Block Plug
17	Transmission Locating Pin
18	Crankshaft Rear Oil Housing Locating Pin
19	Engine Block Oil Gallery Plug

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COMPONENT LOCATOR > ENGINE IDENTIFICATION

Fig 1: Vehicle Identification Number (VIN)



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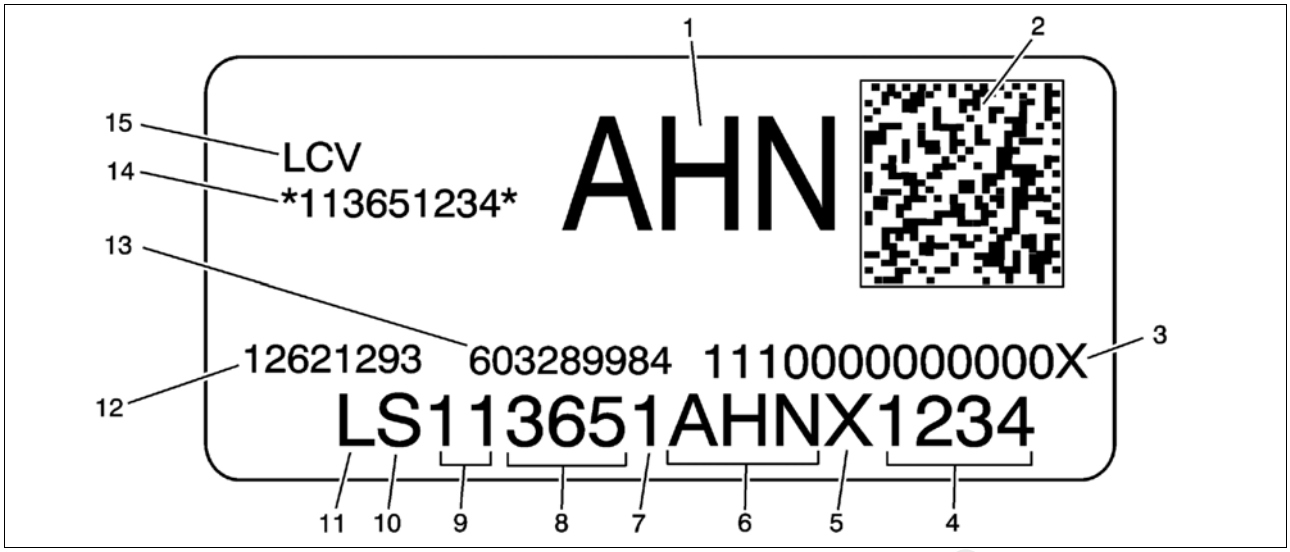
The vehicle identification number (VIN) is located on the left side rear of the engine block (1) and is typically a 9 digit number stamped or laser-etched onto the engine at the vehicle assembly plant.

- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last 6 digits of the VIN.

Engine identification can also be made through use of the Engine Traceability label (2) on the rear of the left cylinder head.

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Fig 2: Engine Traceability Label



Courtesy of GENERAL MOTORS COMPANY

1. Broadcast Code
2. Machine Readable 2D Matrix
3. VPPS Code
4. Part Sequence Number
5. Reserved use
6. Broadcast Code
7. Model year
8. Julian Date
9. Build Year
10. Shift ID
11. Plant ID
12. GM Part Number
13. Plant DUNS Number
14. Sequence Number
15. RPO/Engine Family Code

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DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > DTC DESCRIPTORS

DTC P06DA

Engine Oil Pressure Control Solenoid Valve Control Circuit

DTC P06DB

Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P06DC

Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open / High Resistance	Short to Voltage	Signal Performance
Ignition	P0030, P0031, P0050, P0051, P0135, P0155, P0300, P0443, P0458, P0506, P06DA, P3401, P3403, P3417, P3425, P3427, P3441, P3443, P3449, P3451	P06DA	P0690	-
Control	P06DB	P06DA	P06DC	P06DA

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > CIRCUIT/SYSTEM DESCRIPTION

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil

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pressure control solenoid with the following ECM input's.

- Engine Speed
- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate an electrical problem with the engine oil pressure control solenoid or wiring.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > CONDITIONS FOR RUNNING THE DTC

- The system voltage is greater than 11 V.
- DTC P06DA, P06DB or P06DC runs continuously when the above conditions are met.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > ACTION TAKEN WHEN THE DTC SETS

- DTC P06DA, P06DB and P06DC are Type B DTCs.
- ECM commands the engine oil pressure control solenoid valve OFF.
- ECM commands Reduced Engine Power.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > CONDITIONS FOR CLEARING THE MIL/DTC

- DTC P06DA, P06DB and P06DC are Type B DTC.

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DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > REFERENCE INFORMATION

Schematic Reference

Engine Mechanical Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve ON and OFF with a scan tool.
    1. Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
    2. Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status
    3. Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
    1. **If Malfunction is displayed**

        Refer to Circuit/System Testing.

    1. **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the

vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

4. Verify the DTC does not set.
    1. **If any DTC sets**

       Refer to Circuit/System Testing.

    1. **If the DTC does not set**

5. All OK.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the oil pressure control solenoid jumper harness X173. Refer to Master Electrical Component List .
2. Ignition ON.
3. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground, engine harness side.
    1. **If the test lamp does not illuminate and the circuit fuse is good**
        1. Ignition OFF, remove the test lamp.

           > *NOTE:*
           >
           > *An internal short in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.*

        2.
        3. Test for less than 2 Ω in the ignition circuit end to end.
            1. If 2 Ω or greater, repair the open/high resistance in the circuit.
            2. If less than 2 Ω verify the fuse is not open and there is voltage at the fuse.

    1. **If the test lamp does not illuminate and the circuit fuse is open**
        1. Ignition OFF, remove the test lamp.
        2. Test for infinite resistance between the ignition circuit and ground.
            1. If less than infinite resistance, repair the short to ground in the circuit.
            2. If infinite resistance, test all the components connected to fuse and replace as necessary.

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1. **If the test lamp illuminates**

4. Verify that a test lamp does not illuminate between the ignition circuit terminal 1 and the control circuit terminal 2.

    1. **If the test lamp illuminates**

        1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

        2. Test for infinite resistance between the control circuit and ground.

            1. If less than infinite resistance, repair the short to ground on the circuit.

            2. If infinite resistance, replace the K20 Engine Control Module.

    1. **If the test lamp does not illuminate**

5. Remove the test lamp, command the Q44 Engine Oil Pressure Control Solenoid Valve ON with a scan tool.

6. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status parameter displays OK.

    1. **If OK is not displayed**

        1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.

        2. Test for less than 1 V between the control circuit and ground.

            1. If 1 V or greater, repair the short to voltage on the circuit.

            2. If less than 1 V, replace the K20 Engine Control Module.

    1. **If OK is displayed**

7. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.

8. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Circuit High Voltage Test Status parameter is displaying Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve ON and OFF with a scan tool.

    1. **If Malfunction is not displayed**

        1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.

        2. Test for less than 2 Ω in the control circuit end to end.

            1. If 2 Ω or greater, repair the open/high resistance in the circuit.

            2. If less than 2 Ω replace the K20 Engine Control Module.

    1. **If Malfunction is displayed**

9. Test or replace the Q44 Engine Oil Pressure Control Solenoid Valve.

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DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > COMPONENT TESTING

Static Test

1. Ignition OFF, disconnect the harness connector at the Q44 Engine Oil Pressure Control Solenoid Valve.
2. Test for 10-30 Ω between the control terminal 2 and the ignition voltage terminal 1.
    1. **If not between 10.0-30.0 Ω**

       Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

    1. **If between 10.0-30.0 Ω**
3. Test for infinite resistance between each terminal and the Q44 Engine Oil Pressure Control Solenoid Valve housing.
    1. **If not OL**

       Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

    1. **If OL**
4. All OK.

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DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT > REPAIR INSTRUCTIONS

Perform the Diagnostic Repair Verification after completing the repair.

- Oil Pump Flow Control Solenoid Valve Replacement for Q44 Engine Oil Pressure Control Solenoid Valve Replacement
- Control Module References for ECM replacement, programming, and setup

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > DTC DESCRIPTORS

DTC P06DD

Engine Oil Pressure Control Solenoid Valve Stuck Off

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > CIRCUIT/SYSTEM DESCRIPTION

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil pressure control solenoid with the following ECM input's.

- Engine Speed
- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate either a stuck on or stuck off engine oil pressure control solenoid.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > CONDITIONS FOR RUNNING THE DTC

P06DD

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P111E, P2227, P2228, P2229 or P2230 is not set.
- Engine speed within range of 1, 200 RPM to 2, 500 RPM.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > CONDITIONS FOR SETTING THE DTC

P06DD

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Engine oil pressure is above or below a calibrated amount during the time the solenoid is changing from ON to OFF states.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > ACTION TAKEN WHEN THE DTC SETS

P06DD

DTC P06DD is a Type B DTC.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > CONDITIONS FOR CLEARING THE DTC

P06DD

DTC P06DD is a Type B DTC.

DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > REFERENCE INFORMATION

Schematic Reference

Engine Mechanical Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > CIRCUIT/SYSTEM VERIFICATION

1. Verify correct engine oil level and condition. Refer to Engine Mechanical Specifications (LT1) .
2. Engine Running, increase and maintain the engine speed at 1, 200 RPM.

> *NOTE:*
>
> *Selecting the scan tool line graph function may make it easier to identify Engine Oil Pressure changes.*

3. Verify the scan tool Engine Oil Pressure parameter changes greater than 30 kPa (4 PSI) when commanding the Engine Oil Pressure Control Solenoid On and Off.
    1. **If the parameter does not change**

       Replace the Q44 Engine Oil Pressure Control Solenoid.

    1. **If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
    1. **If the DTC sets**

       Refer to Oil Pressure Diagnosis and Testing .

    1. **If the DTC does not set**
6. All OK.

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DIAGNOSTIC INFORMATION AND PROCEDURES > DTC P06DD: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF > REPAIR INSTRUCTIONS

Perform the Diagnostic Repair Verification after completing the repair.

Oil Pump Flow Control Solenoid Valve Replacement Oil Pump Flow Control Solenoid Valve Replacement.

DIAGNOSTIC INFORMATION AND PROCEDURES > SYMPTOMS - ENGINE MECHANICAL > STRATEGY BASED DIAGNOSTICS

1. Perform the Diagnostic System Check - Vehicle before using the symptom tables.

2. Review the system operations in order to familiarize yourself with the system functions. Refer to Disassembled Views , Engine Content Specifications , Engine Component Description , Lubrication Description , Camshaft Position Actuator and Solenoid Valve Description , and Cylinder Deactivation (Active Fuel Management) System Description .

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

DIAGNOSTIC INFORMATION AND PROCEDURES > SYMPTOMS - ENGINE MECHANICAL > VISUAL/PHYSICAL INSPECTION

- Inspect for aftermarket devices which could affect the operation of the engine. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for the correct oil level, proper oil viscosity, and correct 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.

DIAGNOSTIC INFORMATION AND PROCEDURES > SYMPTOMS - ENGINE MECHANICAL > INTERMITTENT

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

DIAGNOSTIC INFORMATION AND PROCEDURES > SYMPTOMS - ENGINE MECHANICAL > 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

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- 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
- Coolant in Combustion Chamber
- Coolant in Engine Oil
- Cylinder Deactivation (Active Fuel Management) System Diagnosis
- Engine Compression Test
- Cylinder Deactivation (Active Fuel Management) System Test
- Cylinder Leakage Test
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing
- Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing
- Oil Leak Diagnosis
- Crankcase Ventilation System Inspection/Diagnosis
- Drive Belt Chirping, Squeal, and Whine Diagnosis
- Drive Belt Rumbling and Vibration Diagnosis
- Drive Belt Falls Off and Excessive Wear Diagnosis
- Drive Belt Tensioner Diagnosis

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DIAGNOSTIC INFORMATION AND PROCEDURES > BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
High oil pressure	• Verify oil pressure. Refer to Oil Pressure Diagnosis and Testing . • Repair or replace damaged components as required.

Worn, damaged, or improperly installed accessory drive belt - severe cracking, bumps or missing segments A misfire DTC may be present without an actual misfire condition.	• Inspect the accessory drive system components. • Repair or replace damaged components as required. Refer to Drive Belt Replacement - Accessory .
Worn, damaged, or improperly installed accessory drive system components A misfire DTC may be present without an actual misfire condition.	• Inspect the accessory drive system components. • Repair or replace damaged components as required.
Damaged, loose or improperly installed crankshaft balancer A misfire DTC may be present without an actual misfire condition.	• Inspect the crankshaft balancer. • Repair or replace damaged components as required. Refer to Crankshaft Balancer Replacement .
Worn, damaged, or improperly installed crankshaft reluctor wheel A worn or damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the wear or damage. • Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a DTC P0300 may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery. A DTC P0300 or P0336 may be set.	• Inspect the crankshaft position sensor. • Inspect the crankshaft reluctor wheel. • Inspect the crankshaft. • Repair or replace damaged components as required.
Damaged, improperly installed or restricted exhaust system, collapsed or dented pipes, plugged mufflers or malfunctioning catalytic converters A DTC may be present without an actual fault condition.	• Inspect the exhaust system components. • Repair or replace damaged components as required.

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Worn, damaged or improperly installed vacuum hoses	• Inspect the vacuum system components. • Repair or replace damaged components as required.
Damaged or improperly installed MAP sensor, sealing grommet nicked, torn or missing	• Inspect the MAP sensor. • Repair or replace damaged components as required.
Damaged or improperly installed throttle body	• Inspect the throttle body. • Repair or replace damaged components as required.
Damaged or improperly installed intake manifold	• Inspect the intake manifold. • Repair or replace damaged components as required.
Damaged or improperly installed cylinder head Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs. Refer to Spark Plug Inspection . • Verify engine compression. Refer to Engine Compression Test . • Inspect the cylinder heads. • Inspect the engine block. • Repair or replace damaged components as required.
Worn, damaged or loose valve rocker arm	• Inspect the valve rocker arms. • Repair or replace damaged components as required.
Worn, damaged or loose valve rotator	• Inspect the valve rotators. • Repair or replace damaged components as required.
Worn, damaged, loose or broken valve spring	• Inspect the valve springs. • Repair or replace damaged components as

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	required.
Worn, damaged or stuck valve, carbon on the valve stem or valve seat	• Inspect the valves. • Inspect the valve guides. • Repair or replace damaged components as required.
Worn or damaged valve guide	• Inspect the valve guides. • Inspect the valves. • Repair or replace damaged components as required.
Worn, damaged, loose or bent valve push rod	• Inspect the valve push rods. • Repair or replace damaged components as required.
Worn, damaged or dirty valve lifter	• Inspect the valve lifters. • Inspect the camshaft. • Repair or replace damaged components as required.
Worn or damaged camshaft lobe	• Inspect the camshaft. • Inspect the valve lifters. • Repair or replace damaged components as required.
Worn, damaged or loose timing chain and sprockets	• Inspect the timing chain and sprockets. • Repair or replace damaged components as required.
Worn, damaged or improperly installed piston 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. Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs. Refer to Spark Plug Inspection . • Verify engine compression. Refer to Engine Compression Test . • Inspect the cylinder bores.

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	• Inspect the pistons. • Inspect the piston pins. • Inspect the connecting rods. • Repair or replace damaged components as required.

DIAGNOSTIC INFORMATION AND PROCEDURES > BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

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

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

DIAGNOSTIC INFORMATION AND PROCEDURES > BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact within the rocker arm assembly.	Replace the valve rocker arms, as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace, as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets, as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Sticking lifters	Replace, as required.
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to Oil Pressure Diagnosis and Testing .
Improper operation of the active fuel management system	Repair, as required. Refer to Cylinder Deactivation (Active Fuel Management) System Diagnosis .
Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing .

DIAGNOSTIC INFORMATION AND PROCEDURES > BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine	1. Inspect for spark plugs saturated by

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block cooling system passages Coolant consumption may or may not cause the engine to overheat.	coolant. Refer to Spark Plug Inspection . 2. Perform a cylinder leak down test. Refer to Cylinder Leakage Test . 3. Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. Refer to Coolant in Combustion Chamber . 4. Repair or replace, as required.

DIAGNOSTIC INFORMATION AND PROCEDURES > BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

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

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DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

Cause	Correction
Fuel injector harness connectors are connected to the incorrect fuel injectors/cylinders	Relocate the fuel injector harness connectors, as necessary.
Abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or	Replace the drive belt. Refer to Drive Belt Replacement - Accessory .

components may cause engine RPM variations and lead to a misfire diagnostic trouble code (DTC). A misfire code may be present without an actual misfire condition.	
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout May lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components and repair or replace, as required.
Loose or improperly installed engine flex plate or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flex plate and/or balancer, as required. Refer to Automatic Transmission Flex Plate Replacement , or Crankshaft Balancer Replacement .
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace, as required.
Improperly installed or damaged vacuum hoses	Repair or replace, as required.
Improper sealing between the intake manifold and cylinder heads or throttle body	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body, as required.
Improperly installed or damaged manifold absolute pressure (MAP) sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor, as required.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms, as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace, as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets, as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing .

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loss of compression.	2. Repair or replace the oil pump, as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	1. Inspect for spark plugs saturated by coolant. Refer to Spark Plug Inspection . 2. Inspect the cylinder heads, engine block, and/or head gaskets. Refer to Coolant in Combustion Chamber . 3. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection . 2. Inspect the cylinders for a loss of compression. Refer to Engine Compression Test . 3. Perform cylinder leak down and compression testing to identify the cause. Refer to Cylinder Leakage Test . 4. Repair or replace, as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a P0300 DTC or P0336.	Replace the sensor and/or crankshaft, as required.
Improper operation of the active fuel management system	Repair, as required. Refer to Cylinder Deactivation (Active Fuel Management) System Diagnosis .

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Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing .

DIAGNOSTIC INFORMATION AND PROCEDURES > UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing . 2. Repair or replace, as required.
Loose and/or worn valve rocker arm attachments	1. Inspect the valve rocker arm, bolt, and pedestal. 2. Repair or replace, as required.
Worn or damaged valve rocker arm	1. Inspect the rocker arm for wear or missing needle bearings 2. Replace the valve rocker arms, as required.
Bent or damaged push rod	Inspect the following components and replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The valve lifter guide • The piston Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace, as required: • The valve rocker arm • The valve push rod

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	• The valve lifter • The oil filter bypass valve • The oil pump and pump screen • Improper operation of the active fuel management oil pressure relief valve • The engine block oil galleries
Broken valve spring	Replace the valve spring and spring shim.
Worn or dirty valve lifters	Replace the valve lifters, as required.
Active fuel management valve lifter with a broken spring	Replace the valve lifters, as required.
Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing .
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. Replace the camshaft and valve lifters, as required.
Worn valve guides or valve stems	Inspect the following components and repair, as required: • The valves • The valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components and repair, as required: • The valves • The valve guides
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to Oil Pressure Diagnosis and Testing .

DIAGNOSTIC INFORMATION AND PROCEDURES > LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction

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Low oil pressure	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing . 2. Repair or replace damaged components, as required.
Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	1. Inspect the accessory drive system. 2. Repair or replace, as required.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls system. Refer to Symptoms - Engine Mechanical .
Loose torque converter bolts	1. Inspect the torque converter bolts and flex plate. 2. Repair or replace, as required.
Loose or damaged flywheel or flex plate	Repair or replace the flywheel or flex plate.
Oil pump screen loose, damaged, or restricted	1. Inspect the oil pump screen. 2. Repair or replace, as required.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and cylinder bore. 2. Repair, as required.
Excessive piston pin-to-bore clearance	1. Inspect the piston, pin, and connecting rod. 2. Replace the piston and pin as an assembly, as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair, as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals

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DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE NOISE UNDER LOAD

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

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DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belts.

	2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing chain and/or gears	• Inspect timing chain and gears. • Repair as required.
Seized balance shaft	• Inspect balance shaft. • Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material	• Inspect cylinder for damaged components and/or foreign materials. • Repair or replace as required.
Seized crankshaft or connecting rod bearings	• Inspect crankshaft and connecting rod bearings. • Repair as required.
Bent or broken connecting rod	• Inspect connecting rods. • Repair as required.

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Broken crankshaft	• Inspect crankshaft. • Repair as required.

DIAGNOSTIC INFORMATION AND PROCEDURES > 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. *NOTE:* *While not always conclusive, use of hydrocarbon block test kits may reveal hydrocarbons indicating combustion chamber gases in cooling system. It is important to follow the kit instructions. This is not a substitute for service information. Combustion leak tests are available from a wide variety of aftermarket suppliers.* 1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to Engine Will Not Crank - Crankshaft Will Not Rotate . 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to Engine Compression Test .	
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 , and Cylinder Head Replacement - Left Side , or Cylinder Head Replacement - Right Side .
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.

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DIAGNOSTIC INFORMATION AND PROCEDURES > COOLANT IN ENGINE OIL

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

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DIAGNOSTIC INFORMATION AND PROCEDURES > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DIAGNOSIS

1. Measure the engine oil level. Fill, as required.
2. Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to Diagnostic System Check - Vehicle . Repair, as required.
3. Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to Oil Pressure Diagnosis and Testing .
4. Verify proper operation of the active fuel management system components. Refer to Cylinder Deactivation (Active Fuel Management) System Test .

5. Remove the valve lifter oil manifold. Refer to Valve Lifter Oil Manifold Replacement .
6. Verify proper operation of the valve lifter oil manifold. Refer to Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing .
7. Replace the active fuel management valve lifters, as required. Both intake and exhaust lifters should be replaced in pairs. Refer to Valve Lifter Replacement .

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE COMPRESSION TEST > REMOVAL PROCEDURE

1. Run the engine until it reaches normal operating temperature.
2. Ignition key in the OFF position.
3. Remove air cleaner resonator outlet duct. Refer to Air Cleaner Outlet Duct Replacement .
4. Remove the spark plug wires. Refer to Spark Plug Wire Replacement .
5. Remove the spark plugs. Refer to Spark Plug Replacement .

> *NOTE:*
>
> *In order to perform the compression test it will be necessary to use the scan tool in order to set up the compression test function.*

6. Put vehicle into compression test mode using the scan tool.
7. Without compression gauge attached crank the engine using the ignition key to remove any foreign substances from the cylinders.
8. Return the ignition key to the OFF position.
9. Install a compression gauge to the cylinder to be tested.
10. Start with the compression gauge at zero and crank the engine through 4 compression strokes, 4 puffs using the ignition key.
11. Return the ignition key to the OFF position.
12. Repeat starting at step 9 for all remaining cylinders. All cylinders must be tested to obtain valid test results. Record the readings.
13. The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. For example, if the highest pressure in any 1 cylinder is 862 kPa (125 psi), the lowest allowable pressure for any other cylinder would be 607 kPa (88 psi). (862 kPa x 70% = 607 kPa) (125 psi x 70% = 88 psi).
    1. Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
    2. Piston Rings Leaking - Compression is low on the first stroke. Compression builds up

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with the following strokes, but does not reach normal. Compression improves considerably when you add oil.

3. Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.

4. If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

14. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE COMPRESSION TEST > INSTALLATION PROCEDURE

1. Turn ignition key is in the OFF position.
2. Remove compression gauge.
3. Install the spark plugs. Refer to Spark Plug Replacement .
4. Install the spark plug wires. Refer Spark Plug Wire Replacement .
5. Install air cleaner resonator outlet duct. Refer to Air Cleaner Outlet Duct Replacement .
6. Using the scan tool, clear all diagnostic codes.

DIAGNOSTIC INFORMATION AND PROCEDURES > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM COMPRESSION TEST

The Cylinder Deactivation (Active Fuel Management) System Compression Test is a functional test of the valve lifter oil manifold and valve lifters. Using a compression gauge, the technician can monitor the specific cylinders ability to go into and out of active fuel management as commanded by the scan tool. The actual pressure values on the compression gauge are not as critical as is observing the on-off switching action of the solenoid and valve lifters.

1. Measure the engine oil level. Fill, as required.
2. Perform the Diagnostic System Check - Vehicle. Refer to Diagnostic System Check - Vehicle .
3. Disable the ignition system for the cylinder to be tested, by disconnecting the electrical wire harness to the ignition coil.
4. Disable the fuel injection system for the cylinder to be tested, by disconnecting the electrical wire harness to the fuel injector.
5. Remove the spark plug and wire for the cylinder to be tested.
6. Install a 0-1 378 kPa (0-200 psi) compression gauge.

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7. Start the engine.
8. Using the scan tool output controls, command the solenoid ON, for the cylinder to be deactivated.
9. Depress the Schrader valve on the compression gauge, in order to release the pressure and zero the gauge. With the engine running and the cylinder in active fuel management mode, the compression reading should be less than 172 kPa (25 psi).
10. Using the scan tool, de-energize the solenoid while observing the reading on the compression gauge. With the engine running and the cylinder NOT in active fuel management mode, the compression gauge reading should increase quickly to greater than 345 kPa (50 psi).

> *IMPORTANT:*
>
> *Only 1 cylinder can be tested at a time. When testing has been completed on a specific cylinder, the wire harness electrical connectors, spark plug, and spark plug wire must be installed prior to testing of each additional cylinder.*

11. Test each of the 4 active fuel management cylinders, 1 at a time. If the readings are not within specifications, remove, and test the valve lifter oil manifold, as required. Refer to Valve Lifter Oil Manifold Replacement , and Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing .
12. If the compression test has been performed and all active fuel management cylinders are operating within specifications, the active fuel management system is performing as designed and no repairs are required.
13. Clear the diagnostic trouble codes (DTCs) with a scan tool.

DIAGNOSTIC INFORMATION AND PROCEDURES > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM TEST

The Cylinder Deactivation (Active Fuel Management) System Test is a functional test of the valve lifter oil manifold and valve lifters. Using a scan tool, the technician can command the active fuel management solenoid for each cylinder on and off and monitor a specific cylinders ability to go into and out of active fuel management.

1. Measure the engine oil level. Fill, as required.
2. Perform the Diagnostic System Check - Vehicle. Refer to Diagnostic System Check - Vehicle .
3. Connect the scan tool.
4. Start the engine and idle.
5. Using the scan tool output controls, command the solenoid ON, for the cylinder to be deactivated. If the active fuel management system is working correctly, the engine should stumble and an engine RPM drop of at least 100 RPM should be observed.
6. Using the scan tool, de-energize the solenoid and perform step 5 for the remaining cylinders.

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7. Test each of the 4 active fuel management cylinders, 1 at a time. If the behavior described in step 5 is not observed, remove, and test the valve lifter oil manifold, as required. Refer to Valve Lifter Oil Manifold Replacement , and Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing .

8. If the system test has been performed and all active fuel management cylinders are operating normally, the active fuel management system is performing as designed and no repairs are required.

9. Clear the diagnostic trouble codes (DTCs) with a scan tool.

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE BALANCING

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

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

Crankshaft Balancer

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

Engine Flywheel

- The clutch discs and pressure plate are a balanced assembly and not available separately. The pressure plate mounts, or locates, onto the six flywheel dowel pins. If the pressure plate is not aligned properly onto the dowel pins and tightened down, the pins may bend and the plate may be incorrectly positioned, which will affect component balance.
- Existing flywheel, clutch, and pressure plate onto the existing engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft should be marked prior to removal because the bolt patterns on the flywheel and crankshaft are asymmetrical. Marking the flywheel will aid in installation of the flywheel on the extisting engine.
- Existing flywheel, clutch, and pressure plate onto a new engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft should be marked prior to removal because the bolt patterns on the flywheel and crankshaft are asymmetrical. Marking the flywheel will aid in installation of the flywheel on the new engine. Do not remove balance weights from flywheel, if applicable.
- New flywheel onto an existing engine: Install the same size balance weights into the new flywheel in the same location as the old flywheel.
- New flywheel, clutch, and pressure plate onto a new engine: Do not install balance weights.

DIAGNOSTIC INFORMATION AND PROCEDURES > CYLINDER LEAKAGE TEST

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Special Tools

J 35667-A Cylinder Head Leakdown Tester, or equivalent

For equivalent regional tools, refer to Special Tools .

NOTE:

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

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

WARNING:

Refer to Battery Disconnect Warning .

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to Spark Plug Replacement .
3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.
4. Install the **J 35667-A** tester, or equivalent.

NOTE:

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

5. Apply shop air pressure to the **J 35667-A** tester and adjust according to the manufacturers

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instructions.

6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
    1. Air leakage noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
    2. Air leakage noise at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
    3. Air leakage noise from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
    4. Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

DIAGNOSTIC INFORMATION AND PROCEDURES > OIL CONSUMPTION DIAGNOSIS

Checks	Causes
Excessive oil consumption, not due to leaks, is the use of 1 L (1 qt) or more of engine oil within 3 200 kilometers (2, 000 miles).	
Preliminary	The causes of excessive oil consumption may include the following conditions: • External oil leaks Refer to Oil Leak Diagnosis . • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time, 2-3 minutes, and measure for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components Refer to Crankcase Ventilation System Inspection/Diagnosis . • Worn valve guides and/or valve stems

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	• Worn or improperly installed valve stem oil seals Refer to Spark Plug Inspection . • Piston rings broken, worn, or not seated properly Allow adequate time for the rings to seat. Replace worn piston rings, as necessary. Refer to Cylinder Leakage Test . • Piston and rings improperly installed or not fitted to the cylinder bore Refer to Lower Engine Noise, Regardless of Engine Speed .

DIAGNOSTIC INFORMATION AND PROCEDURES > OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **EN-21867** Pressure Gauge
- **EN-21867-850** Active Fuel Management Oil Pressure Adapter

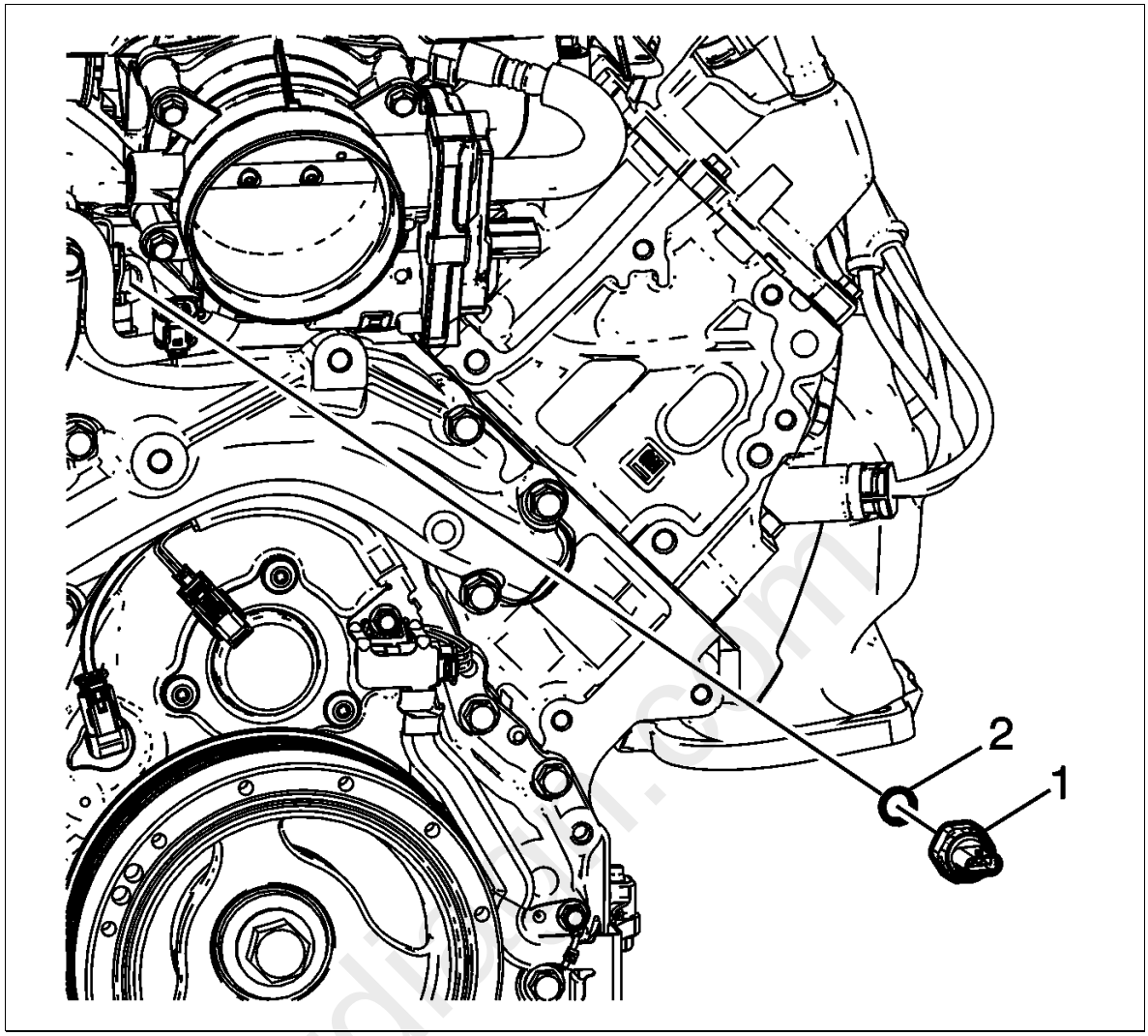
For equivalent regional tools, refer to Special Tools .

1. With the vehicle on a level surface, run the vehicle for a few minutes. Allow adequate drain down time, 2-3 minutes, and measure the oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10-15 seconds, and verify low or no oil pressure on the vehicle gauge or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following conditions:
    1. Oil diluted by water or glycol antifreeze

        Refer to Coolant in Engine Oil .
    2. Foamy oil, which may be caused by a cut or damaged oil pump screen O-ring seal

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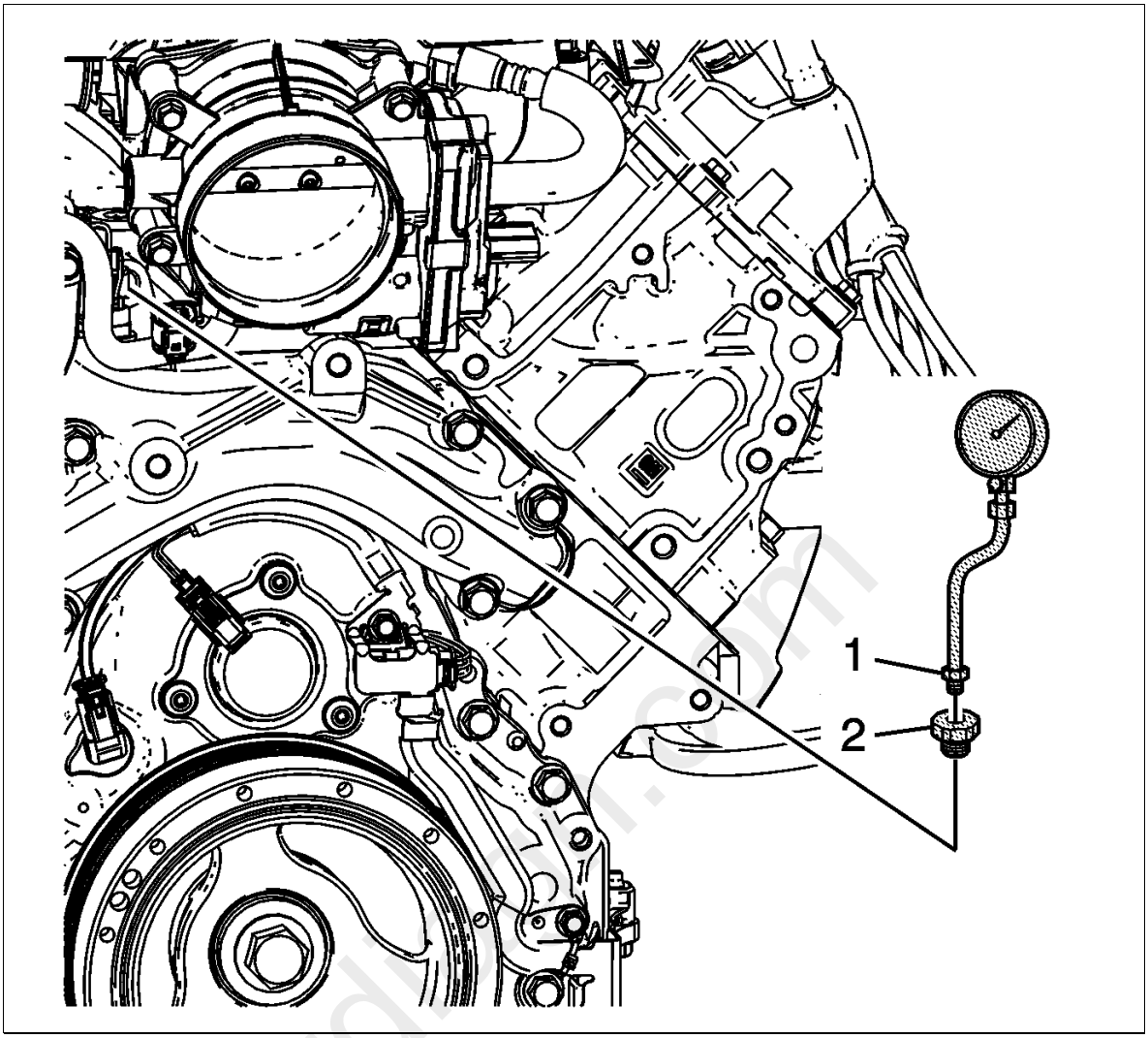
Fig 1: Oil Pressure Sensor And Seal



Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil pressure sensor (1) and seal (2).

Fig 2: Active Fuel Management Oil Pressure Adapter And Pressure Gauge



Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-21867-850** active fuel management oil pressure adapter (2) and **EN-21867** pressure gauge (1), or equivalent.
8. Run the engine until the engine reaches normal operating temperature and measure the engine oil pressure.
9. Compare the readings to Engine Mechanical Specifications (LT1) .
10. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
    1. Valve lifter oil manifold filter plugged or damaged. Refer to Valve Lifter Oil Manifold Cleaning and Inspection .
    2. Check if the engine oil cooler or oil cooler lines are plugged or damaged.
    3. Oil pump worn or dirty. Refer to Oil Pump Cleaning and Inspection .
    4. Oil pump-to-engine block bolts loose. Refer to Oil Pump Installation .

5. Oil pump screen loose, plugged, or damaged.
6. Oil pump screen O-ring seal missing or damaged.
7. Excessive debris in the oil pan and/or oil filter (possibly indicating internal engine damage).
8. Malfunctioning oil pump pressure relief valve. Refer to DTC P06DA-P06DC , or DTC P06DD .
9. Excessive bearing clearance and/or bearing damage. Refer to Crankshaft and Bearing Cleaning and Inspection , and Camshaft and Bearings Cleaning and Inspection .
10. Cracked, porous, or restricted oil galleries.
11. Oil gallery plugs missing or incorrectly installed. Refer to Engine Block Plug Installation .

DIAGNOSTIC INFORMATION AND PROCEDURES > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) VALVE LIFTER OIL MANIFOLD DIAGNOSIS AND TESTING

Special Tools

- **EN-46999** Active Fuel Management Tester
- **EN-46999-18** Active Fuel Management Tester Air Adapter
- **EN-46999-20** Active Fuel Management Tester Harness - Small Block V8

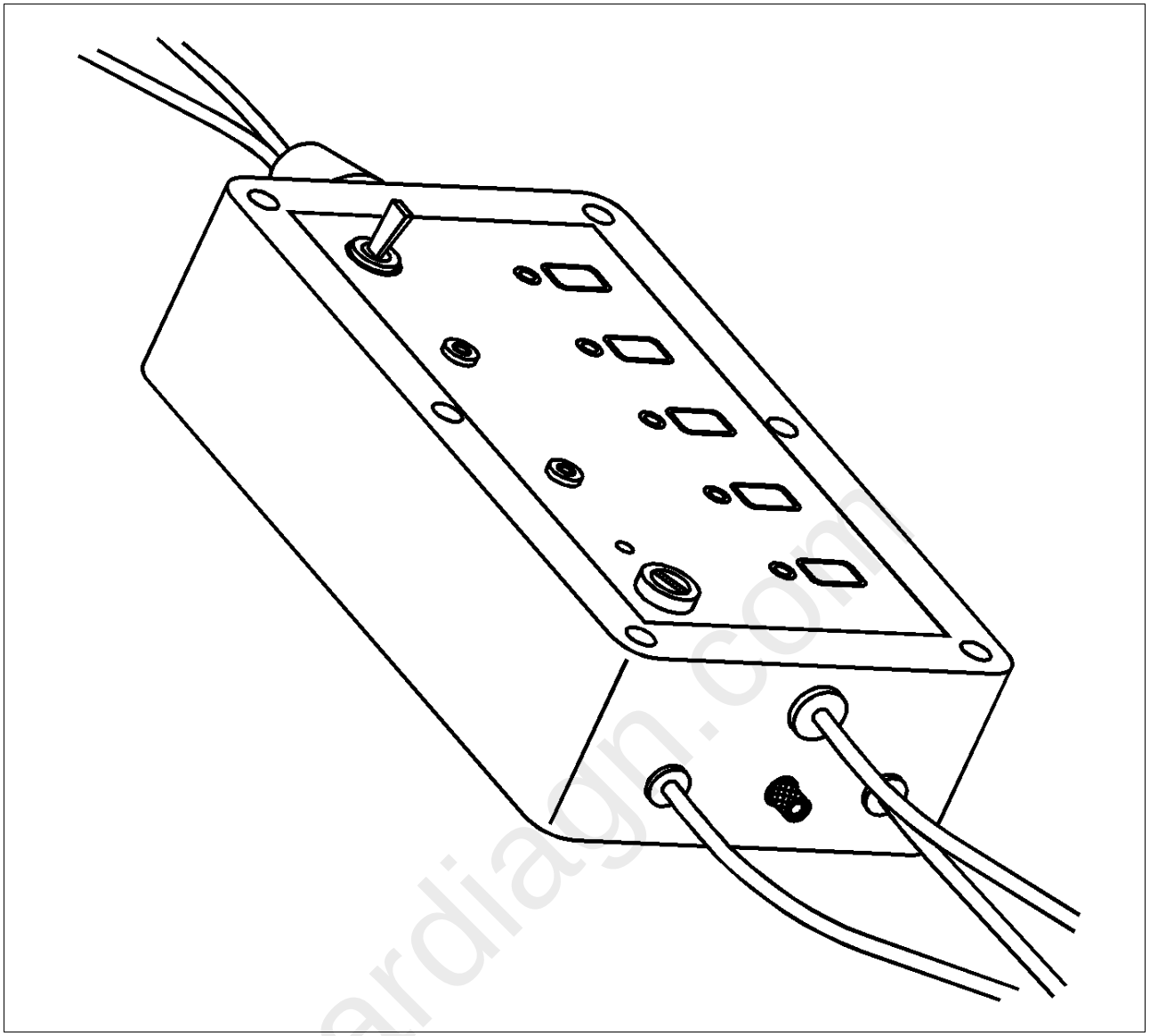
For equivalent regional tools, refer to Special Tools

NOTE:

- *A minimum shop air source of 206 kPa (30 psi) is required for manifold testing.*
- *A water bleed is located on the side of the **EN-46999** tester. Occasionally, depress the valve in order to remove excess water from the tool.*

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Fig 1: Displacement On-Demand Tester



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The manifold bench test provides a maximum 206 kPa (30 psi) of filtered shop air to the manifold and will test each solenoid/valve for the following conditions:

- Proper operation
- A stuck open condition - constant air flow
- A stuck closed condition - no air flow
- A flow restriction within the manifold

1. Individually depress each of the buttons 1-4 on the **EN-46999** tester in order to activate each of the solenoid/valves. When activating each solenoid/valve, a loud click should be heard from the solenoid and an increased amount of air will exit the outlet ports.

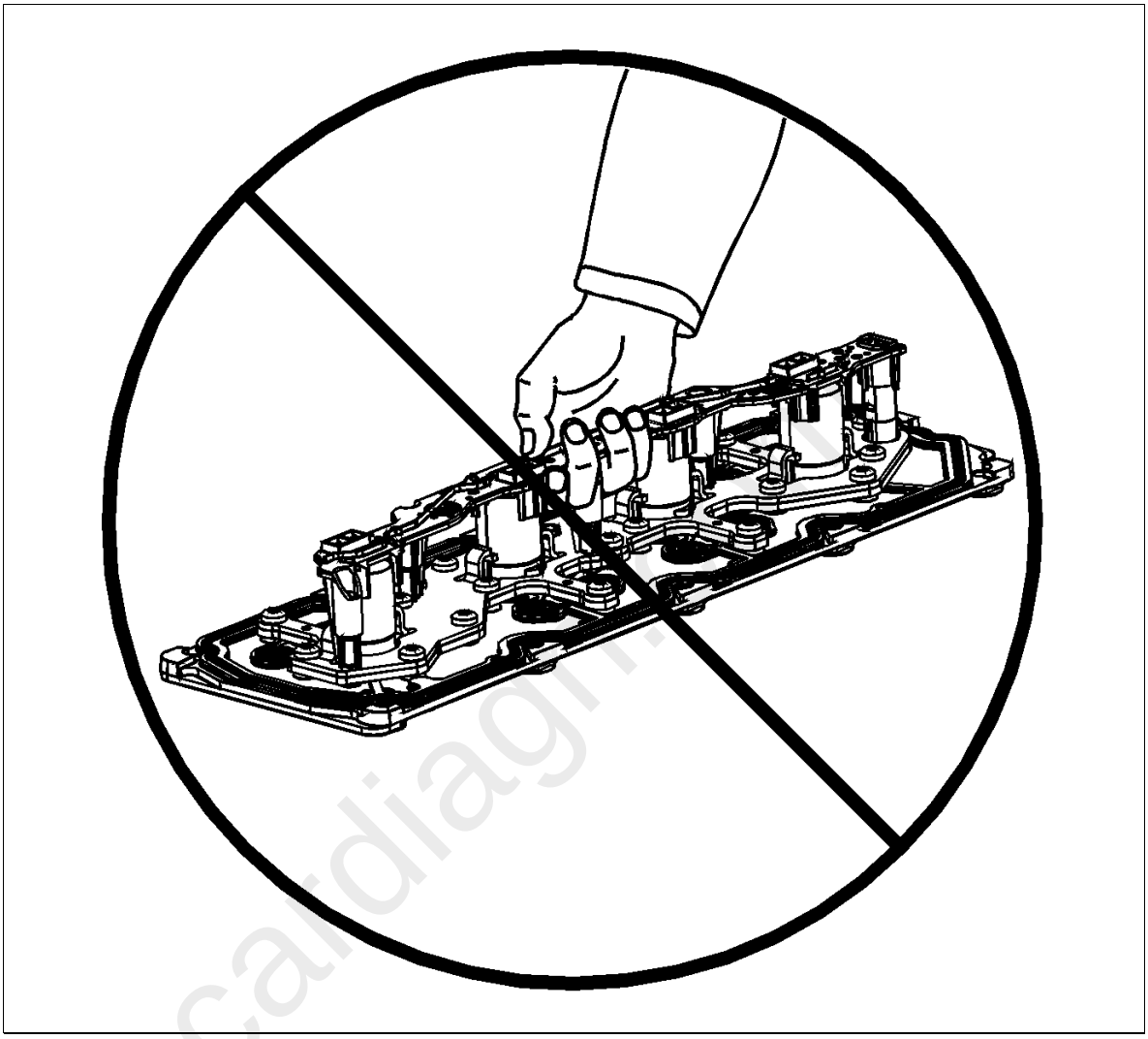
    1. Button 1 will energize the solenoid/valve 1 for engine cylinder number 1.

2. Button 2 will energize the solenoid/valve 2 for engine cylinder number 4.

3. Button 3 will energize the solenoid/valve 3 for engine cylinder number 6.

4. Button 4 will energize the solenoid/valve 4 for engine cylinder number 7.

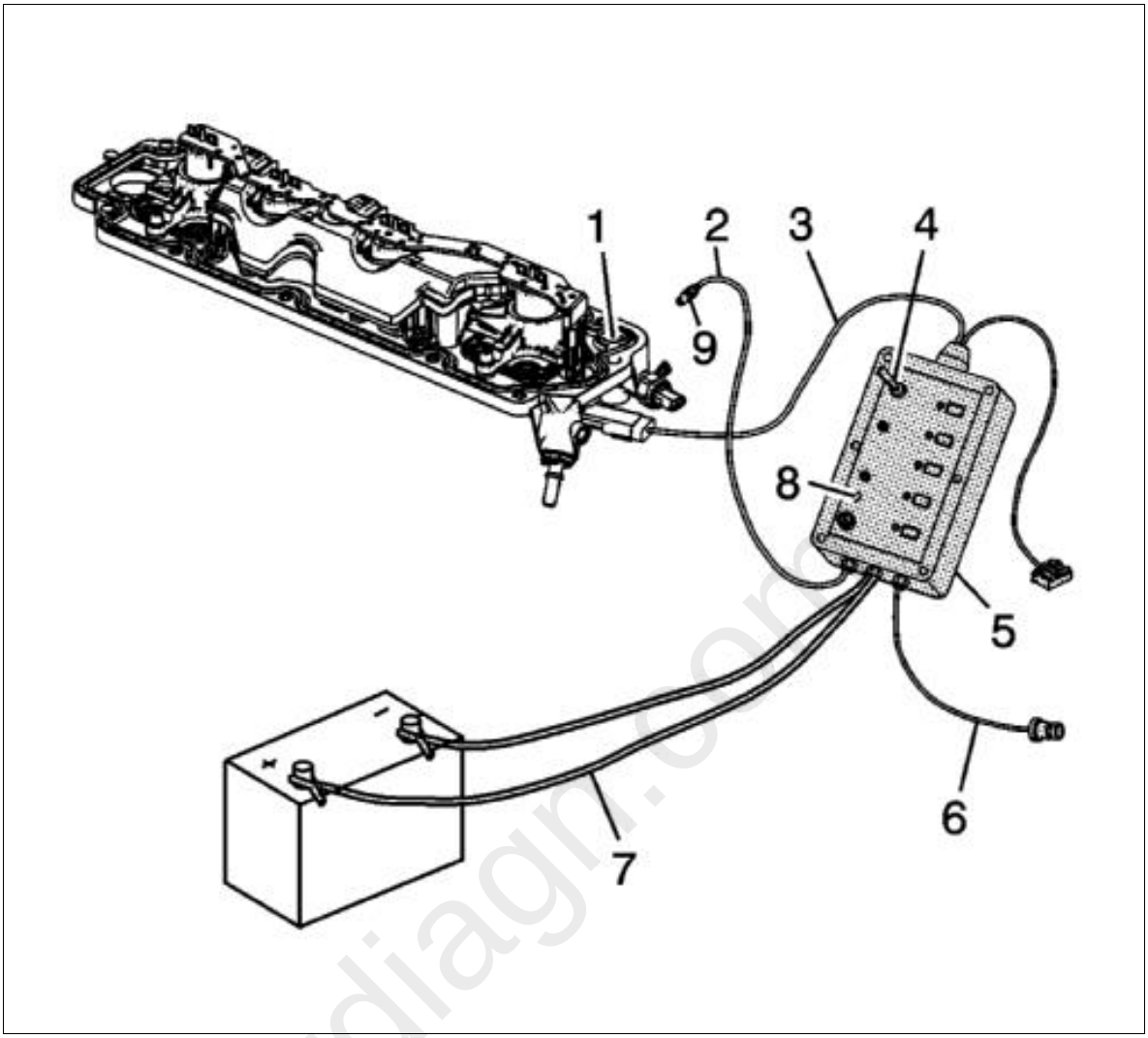
Fig 2: Valve Lifter Oil Manifold



Courtesy of GENERAL MOTORS COMPANY

2. Do not lift the manifold assembly by the electrical lead frame.

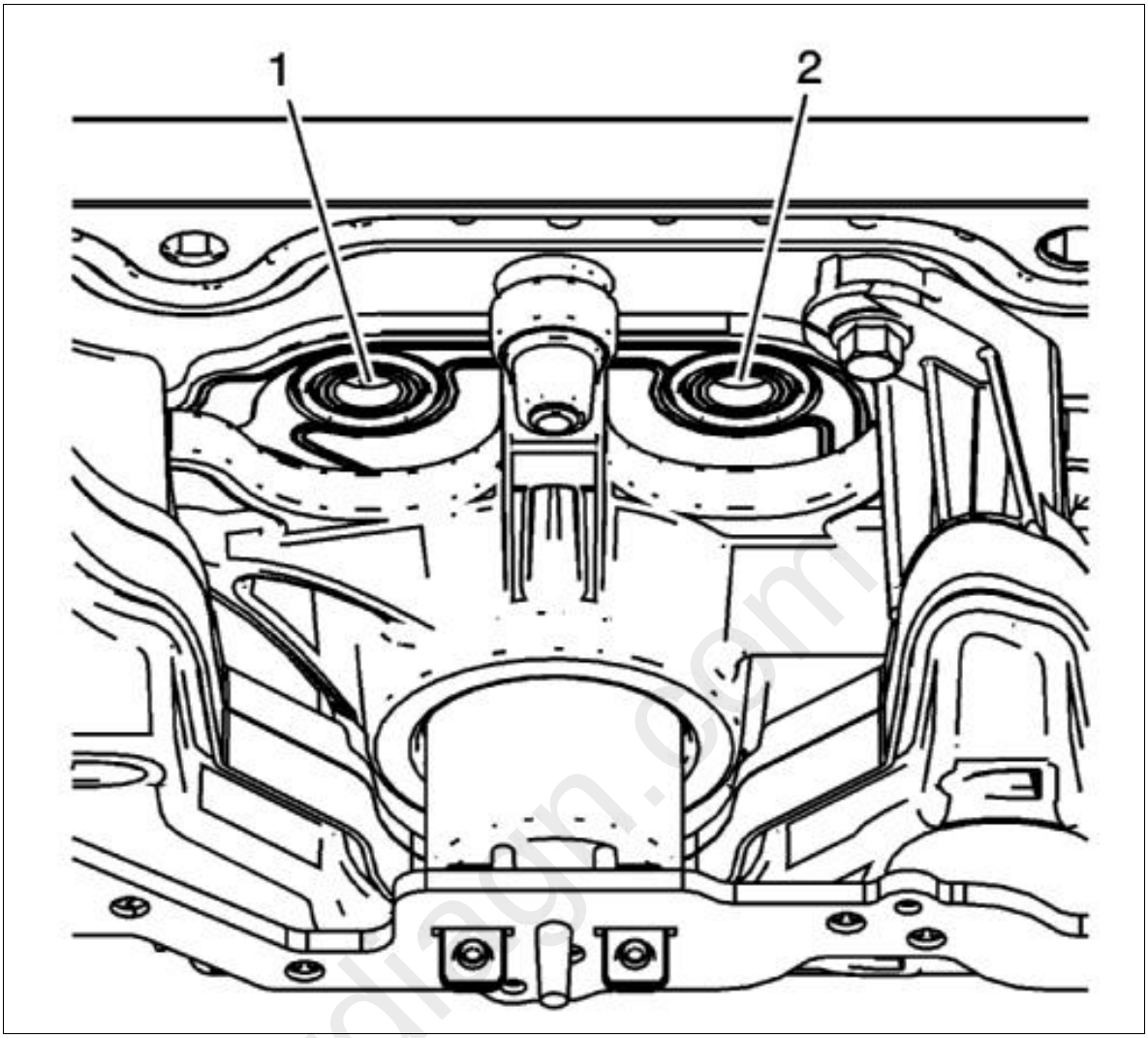
Fig 3: Active Fuel Management Tester Air Adapter, Air Out Hose And Air Supply Switch



Courtesy of GENERAL MOTORS COMPANY

3. Connect **EN-46999-18** active fuel management tester air adapter (9) to the air out hose (2) of the **EN-46999** tester (5). This will make it possible to connect an air nozzle fitted with a standard 1/4 in NPT female air fitting. Verify the air supply switch (4) is in the off position.
4. Connect the air out hose (6) of the **EN-46999** tester (5) to a shop air source.
5. Connect the 12 volt power supply connectors (7) of the **EN-46999** tester (5) to a 12 volt power supply. Verify the Power light (8) on the tool is illuminated. If the light on the tool is not illuminated when connected to a 12 volt power supply, test and/or replace the 3 amp fuse.
6. Connect the **EN-46999-20** active fuel management tester harness - small block V8 (3) to the tester. Connect **EN-46999-20** active fuel management tester harness - small block V8 to the electrical connector of the manifold.
7. Connect an air nozzle fitted with a tapered rubber tip to **EN-46999-18** active fuel management tester air adapter (9). Hold the tip of the air nozzle in the oil passage directly below the Valve Lifter Oil Manifold Oil Filter (1).

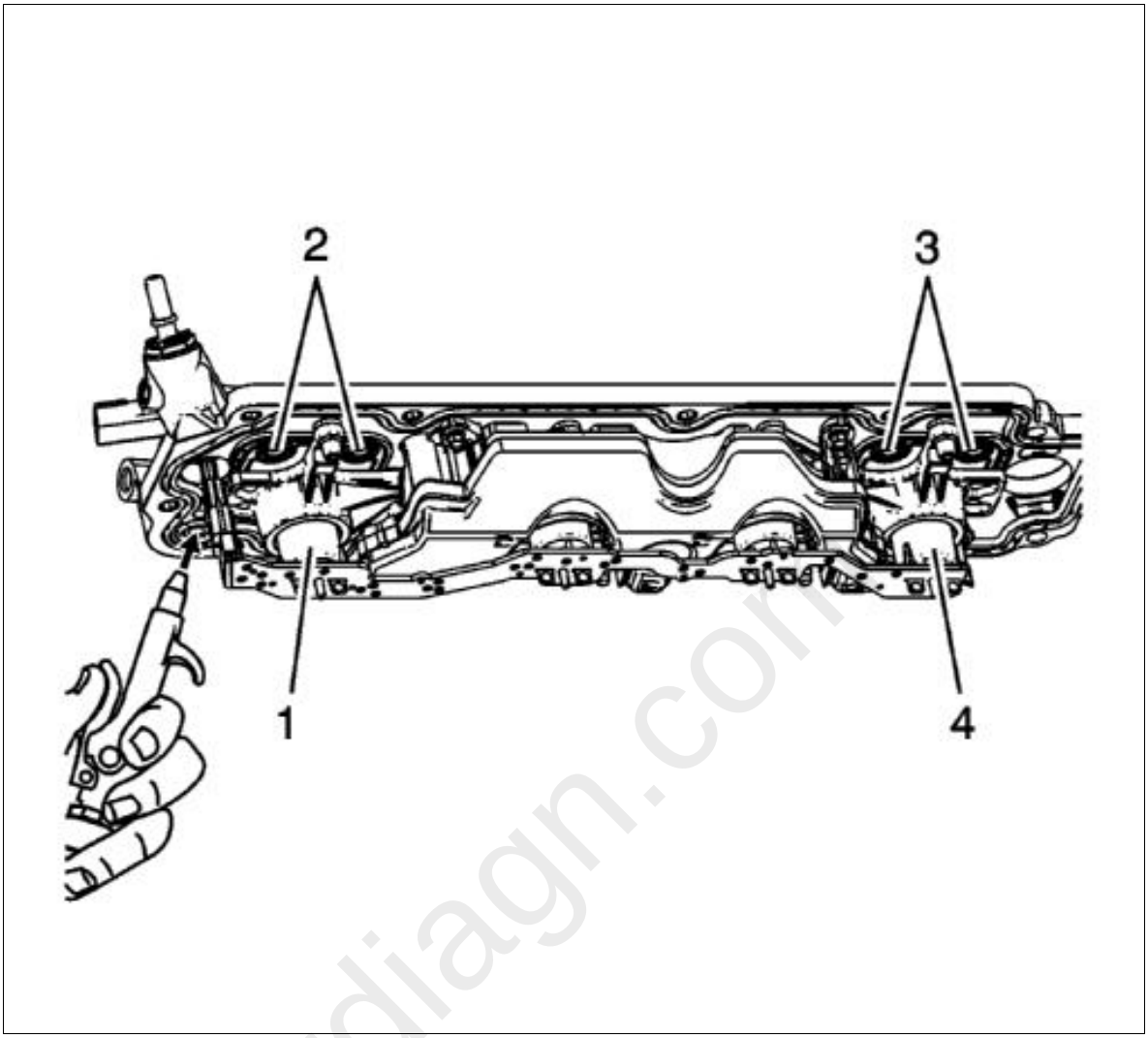
Fig 4: Air Supply Switch Position



Courtesy of GENERAL MOTORS COMPANY

8. Turn the air supply switch of the **EN-46999** tester to the ON position. With the air supply connected to the manifold assembly and the solenoid/valves in the closed position, a limited amount of air will exit from the outlet ports (1, 2) of the manifold.

Fig 5: Depressing Button Number 1 On Tool To Activate Solenoid/Valve 1



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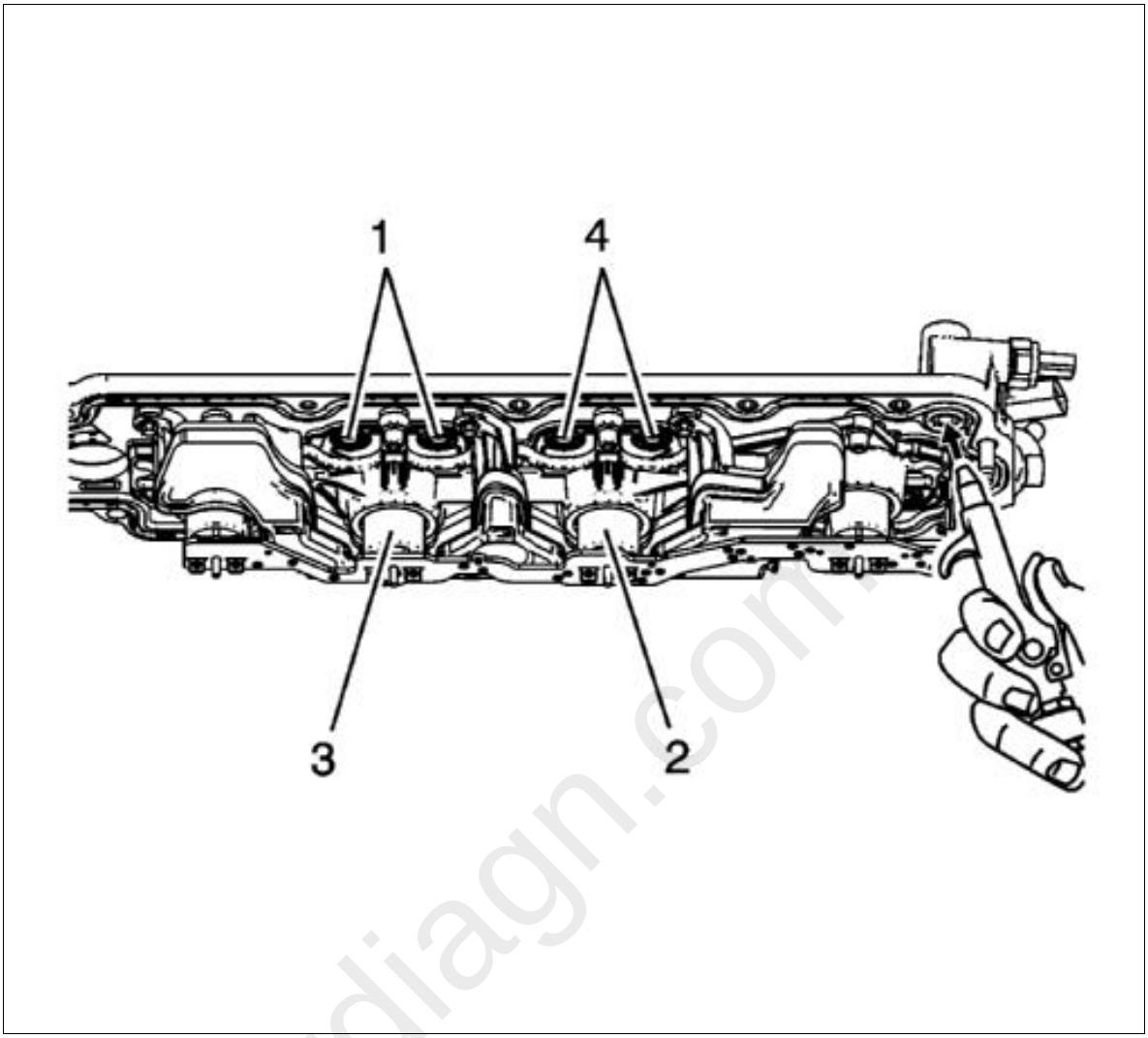
NOTE:

The manifold must be tested in the proper position to ensure the solenoid/valves operate as designed.

9. Position the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 1 and 4.
10. Depress button number 1 on the tool to activate solenoid/valve 1. With button 1 depressed, the solenoid/valve (1) should open, allowing an increased amount of air to exit the outlet ports (2) of the manifold.
11. Depress button number 4 on the tool to activate solenoid/valve 4. With button 4 depressed, the solenoid/valve (4) should open, allowing an increased amount of air to exit the outlet ports (3) of the manifold.

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Fig 6: Manifold Assembly Onto A Bench At A 45 Degree Angle



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12. Reposition the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 2 and 3.

13. Depress button number 2 on the tool to activate solenoid/valve 2. With button 2 depressed, the solenoid/valve (2) should open, allowing an increased amount of air to exit the outlet ports (4) of the manifold.

14. Depress button number 3 on the tool to activate solenoid/valve 3. With button 3 depressed, the solenoid/valve (3) should open, allowing an increased amount of air to exit the outlet ports (1) of the manifold.

15. When the test is completed, turn the air source switch on the **EN-46999** tester to the off position and disconnect the tool from the 12 volt power supply, and shop air source. Disconnect air nozzle.

16. If after testing, it has been determined that one or more of the solenoid/valves is not functioning properly, replace the manifold as an assembly.

17. If after testing, it has been determined that the solenoid/valves are functioning properly,

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replace the valve lifters as required. Both intake and exhaust lifters should be replaced in pairs.

DIAGNOSTIC INFORMATION AND PROCEDURES > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DIAGNOSIS AND TESTING

1. Measure the engine oil level. Fill, as required.
2. Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to Diagnostic System Check - Vehicle . Repair, as required.
3. Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to Oil Pressure Diagnosis and Testing .
4. Inspect the CMP actuator solenoid valve for proper operation. Refer to Camshaft Position Actuator Solenoid Valve Inspection .
    1. If valve inspection confirms proper movement of the spool, replace the CMP actuator and CMP valve.
    2. If valve inspection confirms improper movement of the spool, replace only the CMP valve.
5. Verify proper operation of the CMP actuator control system. Refer to Diagnostic System Check - Vehicle .

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Engine Oil Level Sensor Signal	2	1	-
Engine Oil Level Sensor Ground	-	1	-
1. DIC message Engine Oil Level Low always ON 2. DIC message Engine Oil Level Low always OFF			

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DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > TYPICAL SCAN TOOL DATA

Engine Oil Level Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK			
Engine Oil Level Sensor/Switch Signal	OK	Low	OK
Engine Oil Level Sensor/Switch Ground	-	Low	-

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > CIRCUIT/SYSTEM DESCRIPTION

The engine oil level sensor/switch is normally-closed with proper engine oil level. The switch opens when the engine oil level drops below a calibrated level. The engine control module (ECM) monitors the engine oil level signal circuit when the ignition is ON, and the engine is OFF. With the switch in the closed position, the ECM detects a low voltage on the signal circuit. With the switch in the open position, the ECM detects a high voltage on the signal circuit. When high voltage is detected on the signal circuit, the ECM will send a serial data message to the instrument panel cluster (IPC). The IPC will then display a message on the driver information center (DIC) or illuminate a low engine oil level lamp.

The following information determines the message sent from the ECM to the IPC:

- The Low Engine Oil Level message lamp is displayed only after the ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to greater than 50 minutes, depending on engine oil temperatures.
- The Low Engine Oil Level message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by an ignition ON event for less than 1 second.

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > REFERENCE INFORMATION

Schematic Reference

- Engine Mechanical Schematics
- Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information.

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > CIRCUIT/SYSTEM VERIFICATION

1. Verify proper engine oil level.
    1. **If not at proper level**

       Add oil as necessary.

    1. **If at proper level**
2. Ignition ON, verify the scan tool Engine Oil Level parameter reads OK.
    1. **If not OK**

       Refer to Circuit/System Testing.

    1. **If OK**
3. All OK.

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > CIRCUIT/SYSTEM TESTING

> *NOTE:*
>
> *Verify proper engine oil level before continuing with diagnosis.*

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B35 Engine Oil Level Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 1 and ground.

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1. **If 5 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the ground circuit end to end.
        1. If 2 Ω or greater, repair the open/high resistance in the circuit.
        2. If less than 2 Ω, repair the open/high resistance in the ground connection.
1. **If less than 5 Ω**

3. Ignition ON.
4. Verify the scan tool Engine Oil Level Switch parameter reads Low.
    1. **If the Engine Oil Level Switch parameter reads OK**
        1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
        2. Test for infinite resistance between the signal circuit terminal 2 and ground.
            1. If less than infinite resistance, repair the short to ground on the circuit.
            2. If infinite resistance, replace the K20 Engine Control Module.
    1. **If the Engine Oil Level Switch parameter reads Low**

> *NOTE:*
>
> *If a short to voltage is found on the signal circuit, the fuse in the 3A jumper wire will open.*

5. Install a 3A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 1.
6. Verify the scan tool Engine Oil Level Switch parameter reads OK.
    1. **If the Engine Oil Level Switch parameter reads Low**
        1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
        2. Test for less than 1 V between the signal circuit and ground.
            1. If 1 V or greater, repair the short to voltage on the circuit.
            2. If less than 1 V
        3. Test for less than 2 Ω in the signal circuit end to end.
            1. If 2 Ω or greater, repair the open/high resistance on the circuit.
            2. If less than 2 Ω, replace the K20 Engine Control Module.
    1. **If the Engine Oil Level Switch parameter reads OK**

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7. Test or replace the B35 Engine Oil Level Switch.

DIAGNOSTIC INFORMATION AND PROCEDURES > ENGINE OIL LEVEL SENSOR DIAGNOSIS > REPAIR INSTRUCTIONS

Perform the Diagnostic Repair Verification after completing the repair.

- Engine Oil Level Indicator Switch Replacement
- Control Module References for the ECM replacement, programming, and setup

DIAGNOSTIC INFORMATION AND PROCEDURES > OIL LEAK DIAGNOSIS

Step	Action	Yes	No
	IMPORTANT: *You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.*		
1	1. Operate the vehicle until it reaches normal operating temperature. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Inspect for drippings. Are drippings present?	Go to **Step 2**	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 3**
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: 1. Sealing surfaces 2. Fittings	Go to **Step 10**	Go to **Step 4**

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	3. Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?		
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 5**
5	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: 1. Sealing surfaces 2. Fittings 3. Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 6**
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area. 3. Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 7**

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7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: 1. Sealing surfaces 2. Fittings 3. Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 8**
8	Use the **J 28428-E** High-Intensity Black Light Kit in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 9**
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: 1. Sealing surfaces 2. Fittings 3. Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	System OK
10	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: 1. Higher than recommended fluid levels 2. Higher than recommended fluid pressures 3. Plugged or malfunctioning fluid filters or pressure bypass valves 4. Plugged or malfunctioning engine ventilation system 5. Improperly tightened or damaged fasteners 6. Cracked or porous components	Go to **Step 11**	System OK

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	7. Improper sealants or gaskets, where required 8. Improper sealant or gasket installation 9. Damaged or worn gaskets or seals 10. Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?		
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to **Step 1**	System OK

DIAGNOSTIC INFORMATION AND PROCEDURES > CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Symptom	Correction
External oil leak	Inspect for any of the following conditions: • Restricted or kinked PCV hose or engine vent hose • Damaged, incorrect, or incorrectly installed PCV hose • Excessive crankcase pressure • Restricted or blocked PCV valve
Rough Idle	Inspect for any of the following conditions: • Restricted or kinked PCV hose or engine vent hose • Leaking (damaged) PCV hose • Vacuum hoses worn or not properly installed • PCV valve leaking or stuck open
Stalling or slow idle speed	Inspect for any of the following conditions: • Restricted or kinked engine vent hose • Leaking (damaged) PCV hose • Restricted or blocked PCV valve
High idle speed	Inspect for the following conditions: • Inspect for a leaking (damaged) PCV hose

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	• PCV valve leaking or stuck open • PCV tube from PCV valve to intake manifold disconnected
Sludge in the engine	Inspect for restricted or kinked PCV hose or engine vent hose

DIAGNOSTIC INFORMATION AND PROCEDURES > DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS > DIAGNOSTIC AIDS

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

DIAGNOSTIC INFORMATION AND PROCEDURES > DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS > 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

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the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

10

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

12

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

14

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

15

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

16

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

17

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

19

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

Step	Action	Yes	No
	CAUTION: *Refer to Belt Dressing Caution .*		
DEFINITION: The following items are indications of chirping:			

- A high pitched noise that is heard once per revolution of the drive belt or a pulley.
- Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.

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

- A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs.
- The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.

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

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

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to Symptoms - Engine Mechanical
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to Symptoms - Engine Mechanical	Go to **Step 4**
4	• If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. • If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to **Step 5**	Go to **Step 6**
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to **Step 20**	Go to **Step 6**

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6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to **Step 7**	Go to **Step 8**
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to **Step 20**	Go to **Step 8**
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to **Step 9**	Go to **Step 10**
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to **Step 20**	Go to **Step 10**
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to **Step 11**	Go to **Step 12**
11	*CAUTION:* *Refer to Fastener Caution .* 1. Tighten any loose fasteners. Refer to Fastener Specifications . 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to **Step 20**	Go to **Step 12**
12	Inspect for a bent pulley. Did you find the condition?	Go to **Step 18**	Go to **Step 13**
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 14**
14	Test the drive belt tensioner for proper operation. Refer to Drive Belt Tensioner Diagnosis . Did you find and correct the condition?	Go to **Step 20**	Go to **Step 15**
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 16**
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 17**
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to **Step 20**	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to **Step 20**	Go to **Step 19**
19	Replace the drive belt. Refer to Drive Belt Replacement - Accessory . Did you complete the repair?	Go to **Step 20**	Go to Diagnostic Aids

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20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

DIAGNOSTIC INFORMATION AND PROCEDURES > DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS > DIAGNOSTIC AIDS

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

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

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

DIAGNOSTIC INFORMATION AND PROCEDURES > DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS > TEST DESCRIPTION

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

2

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

3

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

4

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

9

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

11

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

12

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

Step	Action	Yes	No
	CAUTION: *Refer to Belt Dressing Caution .* DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: ◦ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ◦ The separation of the drive belt ◦ A damaged drive belt DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.		
1	Did you review the 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 or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to **Step 3**	Go to Diagnostic Aids
3	*NOTE:*	Go to Symptoms - Engine Mechanical , or Vibration Analysis - Engine	Go to **Step 4**

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	If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 1. Remove the drive belt. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?		
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to **Step 7**	Go to **Step 5**
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to **Step 6**	Go to **Step 7**
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to Drive Belt Replacement - Accessory . Did you correct the condition?	Go to **Step 8**	Go to **Step 7**
7	Install a new drive belt. Refer to Drive Belt Replacement - Accessory . Did you complete the replacement?	Go to **Step 8**	Go to **Step 9**
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 9**
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to **Step 10**	Go to **Step 11**
10	*CAUTION:* *Refer to Fastener Caution .* 1. Tighten any loose fasteners. Refer to Fastener Specifications . 2. Replace improper or missing fasteners. Did you complete the repair?	Go to **Step 13**	Go to **Step 11**

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11	Inspect for a bent water pump shaft. Refer to Water Pump Replacement (LT1) . Did you find and correct the condition?	Go to **Step 13**	Go to **Step 12**
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to **Step 13**	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

DIAGNOSTIC INFORMATION AND PROCEDURES > DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS > DIAGNOSTIC AIDS

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

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

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

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

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

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

DIAGNOSTIC INFORMATION AND PROCEDURES > DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS > TEST DESCRIPTION

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

2

This inspection is to verify the condition of the drive belt. Damage may have occurred to the drive belt when the drive belt fell off. The drive belt may have 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

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

6

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

7

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

13

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

14

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

15

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

Step	Action	Yes	No
	CAUTION: *Refer to Belt Dressing Caution .*		
	DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.		
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to Symptoms - Engine Mechanical
2	• If diagnosing excessive wear, proceed to step 13. • If diagnosing a drive belt that falls off, inspect for a damaged drive belt.	Go to **Step 3**	Go to **Step 4**

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	Did you find the condition?		
3	Install a new drive belt. Refer to Drive Belt Replacement - Accessory . Does the drive belt continue to fall off?	Go to **Step 4**	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to **Step 12**	Go to **Step 5**
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to **Step 12**	Go to **Step 6**
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to **Step 12**	Go to **Step 7**
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to **Step 8**	Go to **Step 9**
8	*CAUTION:* *Refer to Fastener Caution .* 1. Tighten any loose fasteners. Refer to Fastener Specifications . 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to **Step 9**	System OK
9	Test the drive belt tensioner for operating correctly. Refer to Drive Belt Tensioner Diagnosis . Does the drive belt tensioner operate correctly?	Go to **Step 11**	Go to **Step 10**
10	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory . 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 13**
13	Inspect the drive belt for the proper installation. Refer to Drive Belt Tensioner Replacement - Accessory . Did you find this condition?	Go to **Step 16**	Go to **Step 14**
14	Inspect for the proper drive belt. Did you find this condition?	Go to **Step 16**	Go to **Step 15**
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to **Step 17**	Go to Diagnostic Aids

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16	Replace the drive belt. Refer to Drive Belt Replacement - Accessory . Did you complete the replacement?	Go to **Step 17**	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

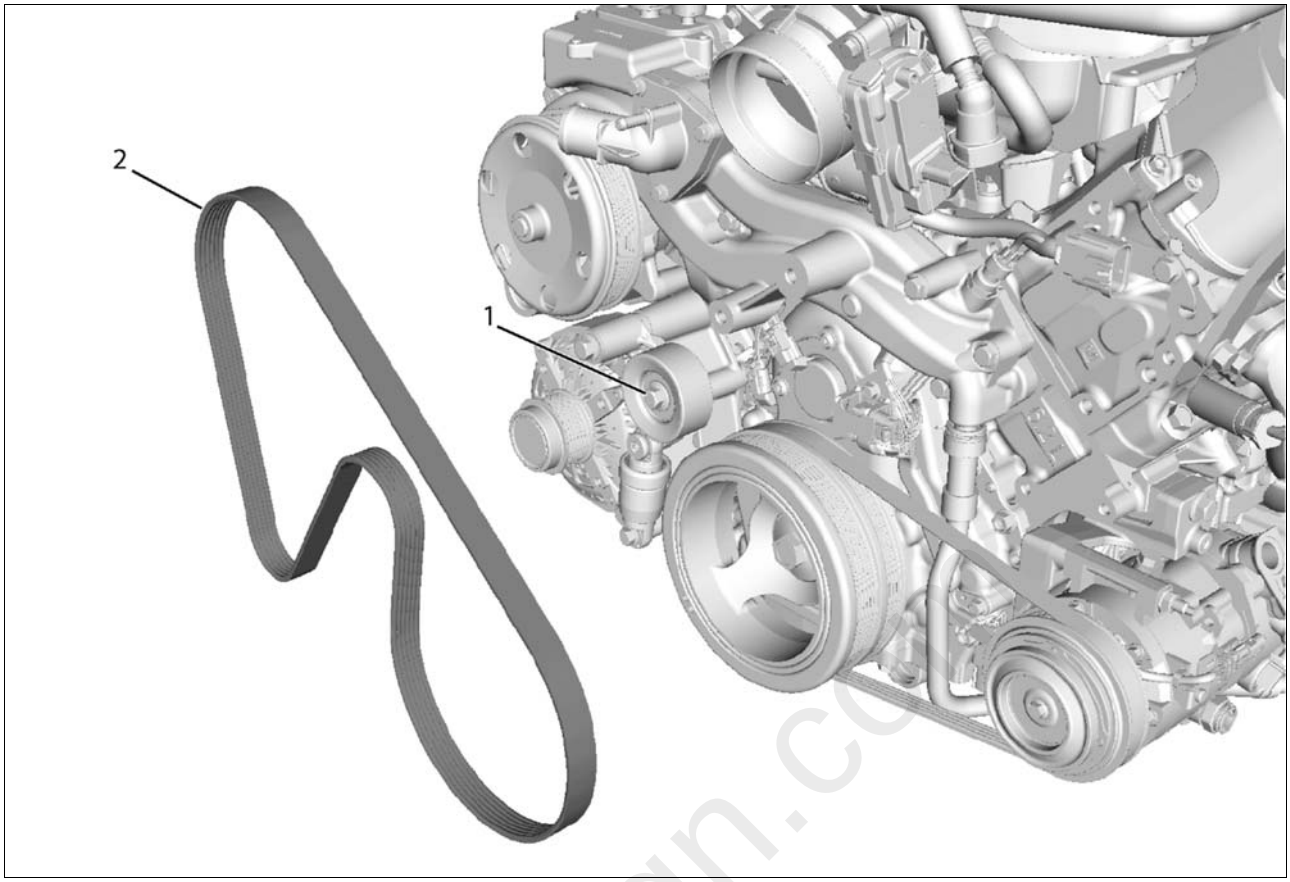
DIAGNOSTIC INFORMATION AND PROCEDURES > DRIVE BELT TENSIONER DIAGNOSIS

Step	Action	Yes	No
1	Remove the drive belt. Refer to Drive Belt Replacement - Accessory . 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 Drive Belt Tensioner Replacement - Accessory . Is the repair complete?	System OK	-

REPAIR INSTRUCTIONS - ON VEHICLE > DRIVE BELT REPLACEMENT - ACCESSORY

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Fig 1: Drive Belt Routing



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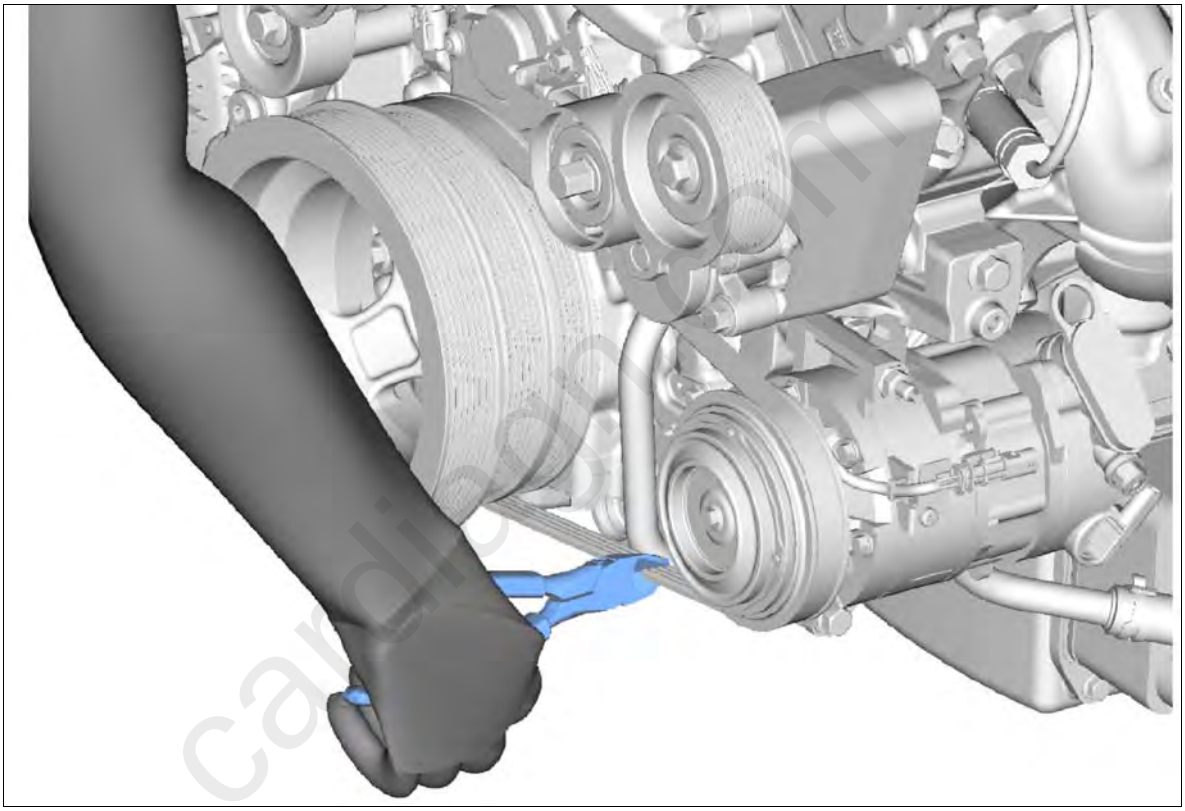
Callout	Component Name
Preliminary Procedure Air Cleaner Resonator Replacement (Air Cleaner Outlet Duct to Engine) Air Cleaner Resonator Replacement (Diagonal Brace to Air Cleaner Resonator) Air Cleaner Resonator Replacement (Dash to Diagonal Brace)	
1	Drive Belt Tensioner *CAUTION:* *Do not completely rotate the drive belt tensioner when removing the drive belt. Instead, rotate the drive belt tensioner slowly and only far enough to remove the belt from the tensioner pulley. If the tensioner dampener is compressed too far, or too quickly, the seal on the tensioner can be damaged.* **Procedure** Rotate the drive belt tensioner clockwise to release the drive belt tension.
2	Drive Belt

	Procedure 1. Slide the drive belt off of the belt generator pulley. 2. Slowly release the drive belt tensioner.

REPAIR INSTRUCTIONS - ON VEHICLE > AIR CONDITIONING COMPRESSOR BELT REPLACEMENT > REMOVAL PROCEDURE

1. Remove Drive Belt Replacement - Accessory

   Fig 1: Cut Belt

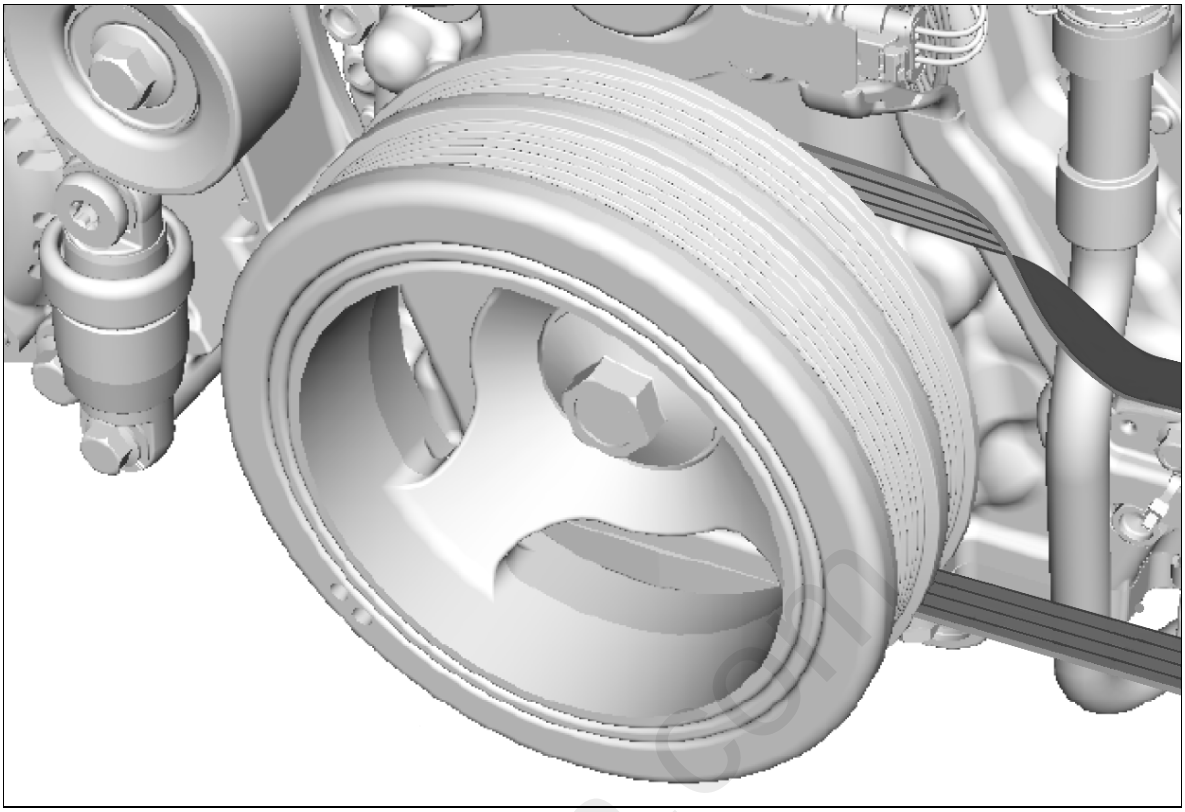


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2. Cut the belt (1) from the compressor and crankshaft pulleys.

REPAIR INSTRUCTIONS - ON VEHICLE > AIR CONDITIONING COMPRESSOR BELT REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Belt Behind Balancer Pulley

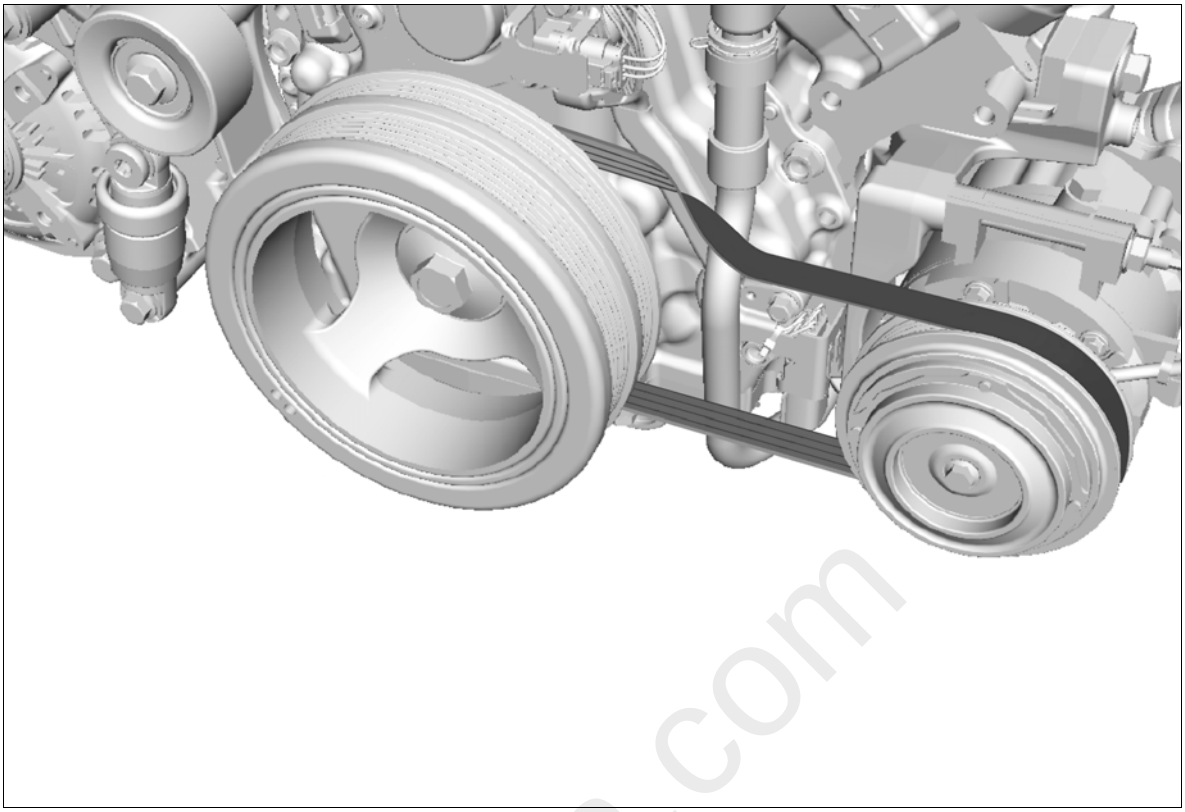


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1. Slide the belt behind the balancer pulley with belt ribs facing forward.

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Fig 2: Belt Behind Balancer Pulley With Belt Ribs Forward



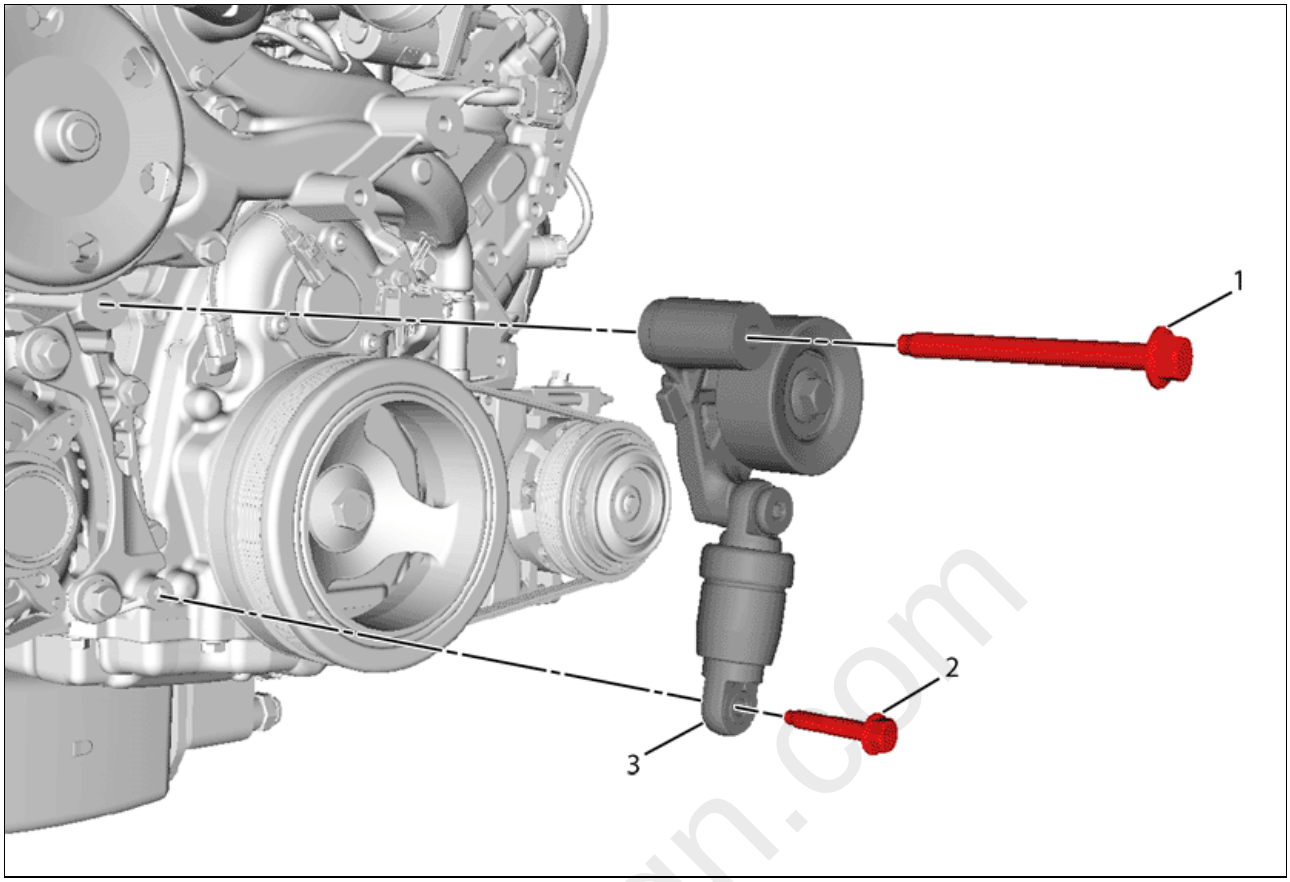
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2. Position the belt behind the balancer pulley with belt ribs forward and on the A/C pulley.
3. Position the belt in the grooves on the bottom side of the balancer pulley.
4. Slowly rotate the crankshaft pulley in a clockwise direction until the belt fully seats on both pulleys.
5. Inspect the belt for proper installation and alignment.
6. Rotate the balancer an additional 360 degrees to ensure proper belt installation.
7. Install Drive Belt Replacement - Accessory

REPAIR INSTRUCTIONS - ON VEHICLE > DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY

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Fig 1: Drive Belt Tensioner



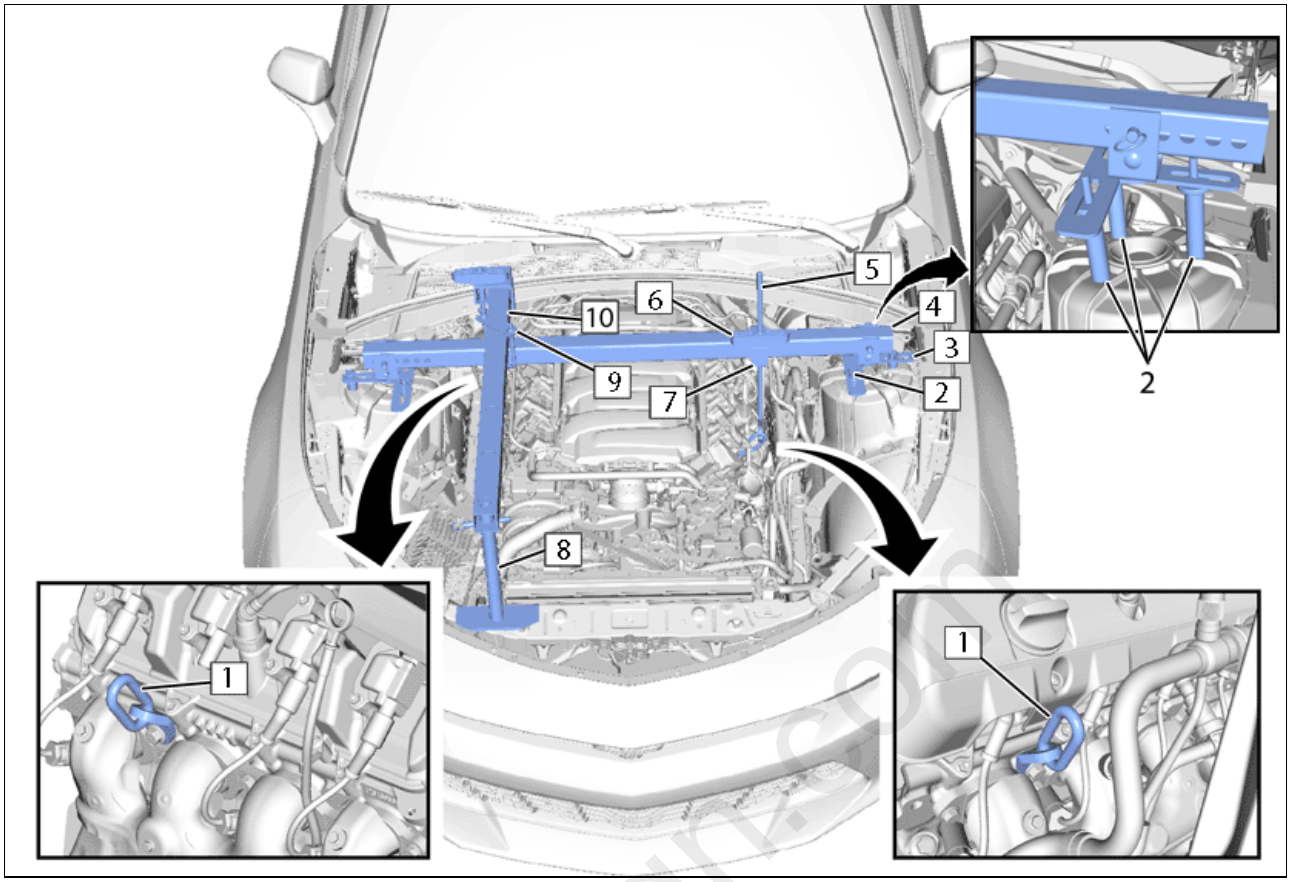
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the drive belt. Drive Belt Replacement - Accessory .	
1	*CAUTION:* *Refer to Fastener Caution .* Drive Belt Tensioner Bolt**Tighten** 58 N.m (43 lb ft)
2	Drive Belt Tensioner Bolt **Tighten** 22 N.m (16 lb ft)
3	Drive Belt Tensioner

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE SUPPORT FIXTURE

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Fig 1: Engine Support



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Callout	Component Name

Preliminary Procedures

1. Front Bumper Fascia Center Support Replacement
2. Valve Rocker Arm Cover Insulator Replacement - Left Side
3. Valve Rocker Arm Cover Insulator Replacement - Right Side
4. Radiator Surge Tank Replacement (LT1)

Special Tools

- **EN-36857** Engine Lift Bracket
- **EN-46114** Engine Lift Bracket
- **EN-28467-5A** Engine Support Beam Adapters
- **EN-28467-13** Strut Tower To Support Beam Adapters
- **EN-28467-B** Main Support Beam
- **EN-36462-1A** Radiator Tube Shelf Assembly

- **EN-28467-1A** Cross Bracket
- **EN-28467-4A** Front Support Assembly
- **EN-28467-6A** Bracket Assembly
- **EN-28467-8A** Hook Assembly
- **EN-28467-34** Lift Hook Wing Nut and Washer

For equivalent regional tools. Refer to Special Tools

1	**EN-36857** Engine Lift Bracket (Qty:2) **Procedure** *CAUTION:* *Refer to Fastener Caution .* Use a M10x1.5 - 35mm grade 10.9 bolt to install a **EN-36857** bracket to the right and left cylinder head in the location shown. Tighten the bolt to 65 N.m (48 lb ft).
2	**EN-28467-13** Strut Tower To Support Beam Adapters (Qty:6) **Procedure** Place the strut tower to support beam adapters over the strut fasteners.
3	**EN-28467-5A** Engine Support Beam Adapters (Qty:2) **Procedure** Place the engine support beam adapters over the strut towers to support beam adapters and secure using wing nuts.
4	**EN-28467-B** Main Support Beam **Procedure** Install main support beam through engine support beam adapters and pin in place.
5	**EN-28467-8A** Hook Assembly (Qty: 2)
6	**EN-28467-34** Lift Hook Wing Nut and Washer (Qty: 2)
7	**EN-28467-6A** Bracket Assembly (Qty: 2)
8	**EN-28467-4A** Front Support Assembly (Qty: 2) **Procedure** Place front support assembly through radiator tube shelf and pin at proper height.
9	**EN-28467-1A** Cross Bracket (Qty: 2) **Procedure** Loosely install cross bracket to retain radiator shelf tube to main support beam. Tighten cross bracket after front support assembly is in place.
10	**EN-36462-1A** Radiator Tube Shelf Assembly (Qty: 2) **Procedure** Place radiator shelf tubes on top of main support beam.

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REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE MOUNT INSPECTION

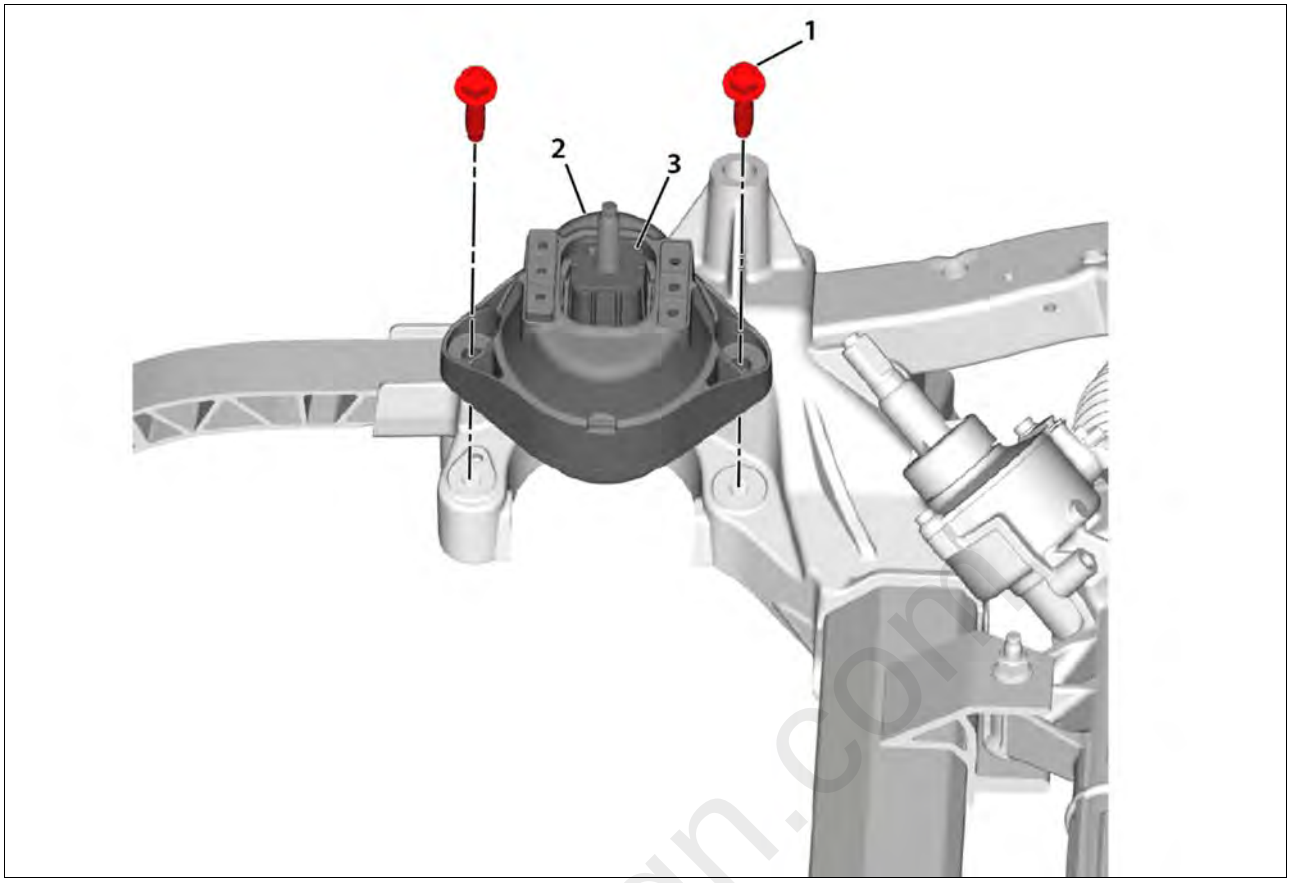
> *NOTE:*
>
> *Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.*

1. Install the engine support fixture. Refer to Engine Support Fixture .
2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
    1. The hard rubber is covered with heat check cracks.
    2. The rubber is separated from the metal plate of the engine mount.
    3. The rubber is split through the center of the engine mount.
    4. The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to Engine Mount Replacement - Right Side .

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE MOUNT REPLACEMENT - LEFT SIDE

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Fig 1: Engine Mount - Left Side



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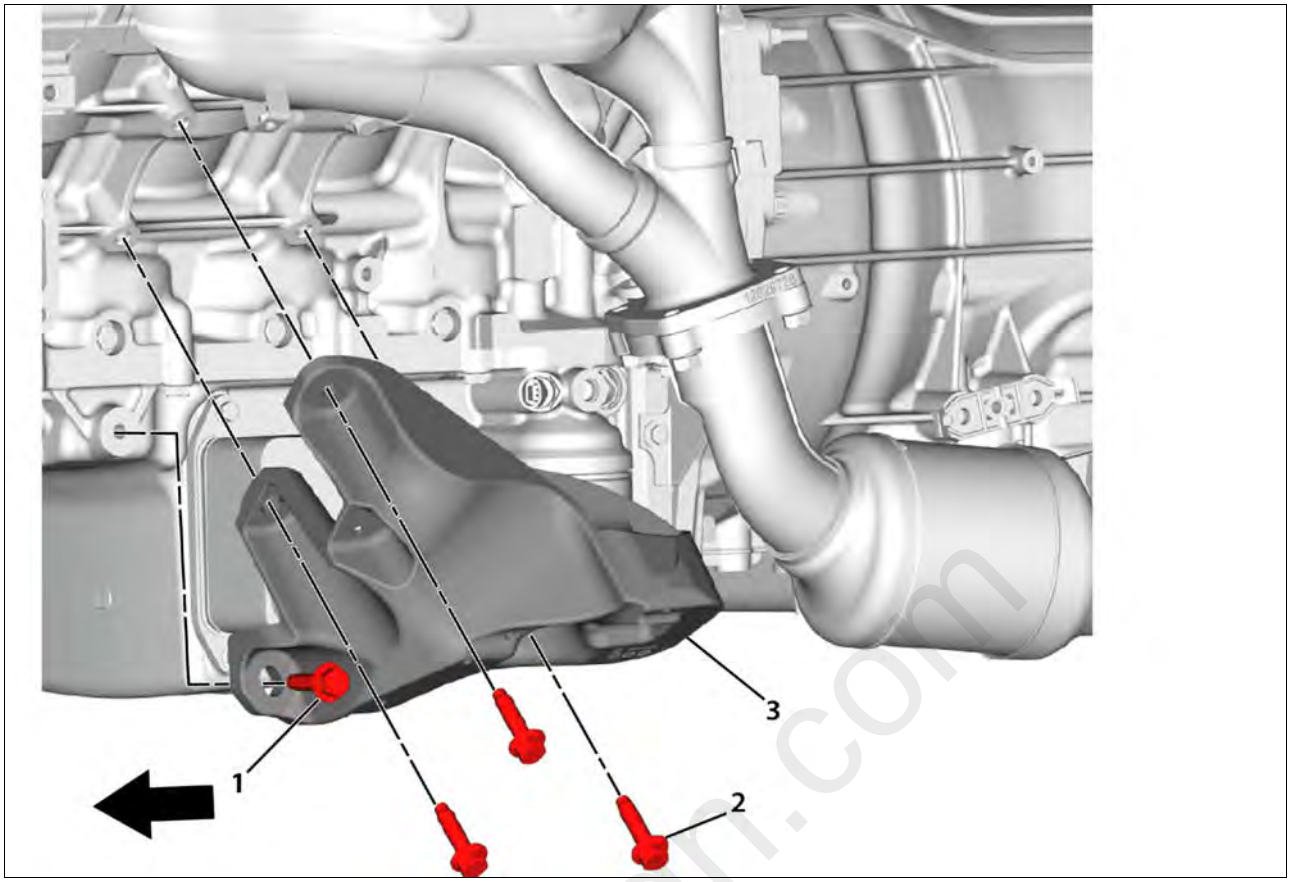
Callout	Component Name
Preliminary Procedure Drivetrain and Front Suspension Cradle Replacement (LT1)	
1	Engine Mount Fastener (Qty: 2) *CAUTION:* *Refer to Fastener Caution .* *CAUTION:* *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.* Procedure

	1. Remove and DISCARD the fasteners. 2. Install NEW fasteners. Tighten 1. First Pass: 58 N.m (43 lb ft) 2. Final Pass: plus 75 degrees
2	Engine Mount
3	Phenolic Spacer *CAUTION:* *Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket.* **Procedure** Inspect the engine mount to ensure the plastic spacer is in place and not damaged.

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

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Fig 1: Engine Mount Bracket - Left Side



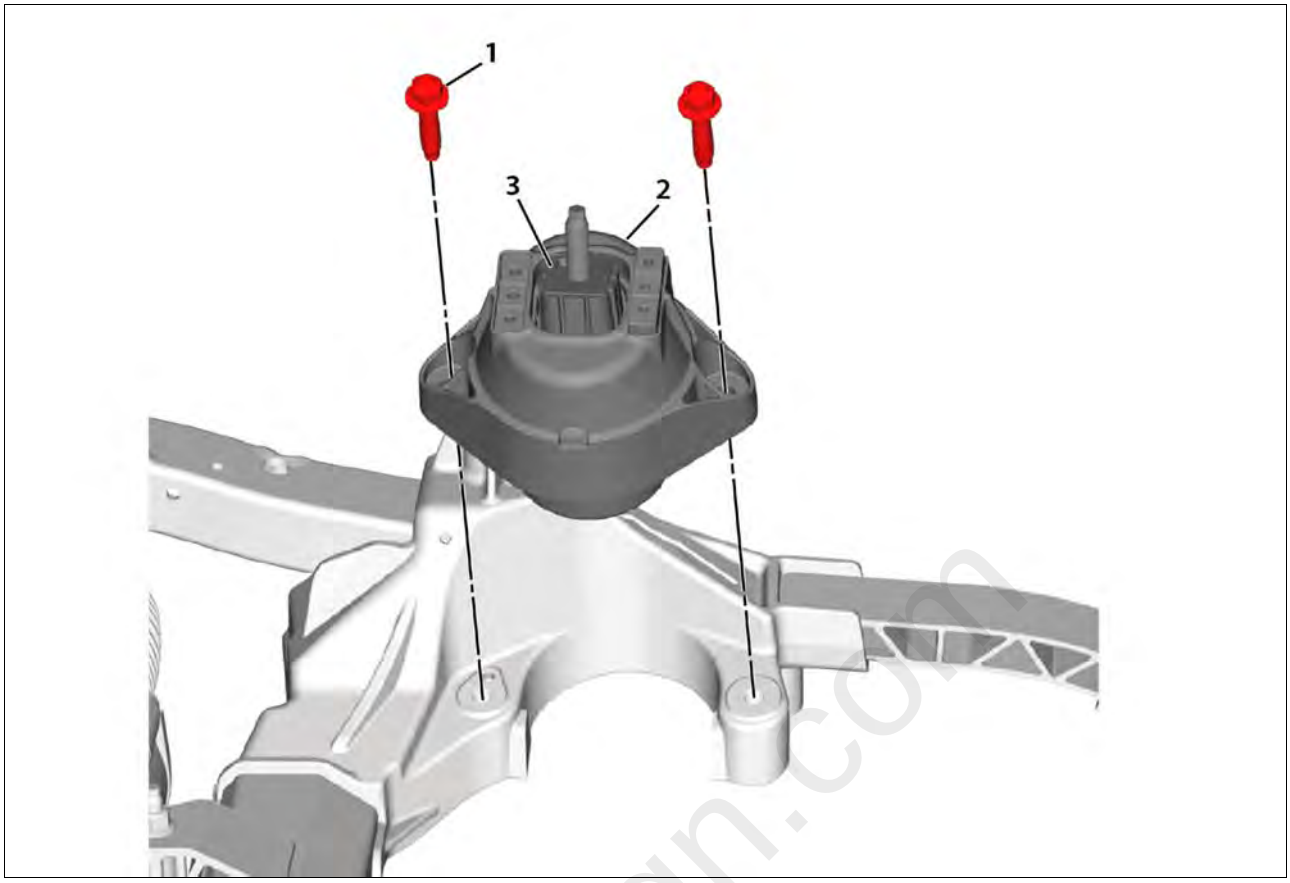
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Drivetrain and Front Suspension Cradle Replacement (LT1)	
1	*CAUTION:* *Refer to Fastener Caution .* Engine Mount Bracket Fastener**Tighten** 58 N.m (43 lb ft)
2	Engine Mount Bracket Fastener (Qty: 3) **Tighten** 58 N.m (43 lb ft)
3	Engine Mount Bracket

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE MOUNT REPLACEMENT - RIGHT SIDE

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Fig 1: Engine Mount - Right Side



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Callout	Component Name
Preliminary Procedure Drivetrain and Front Suspension Cradle Replacement (LT1)	
1	Engine Mount Fastener (Qty: 2) *CAUTION:* *Refer to Fastener Caution .* *CAUTION:* *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.* Procedure

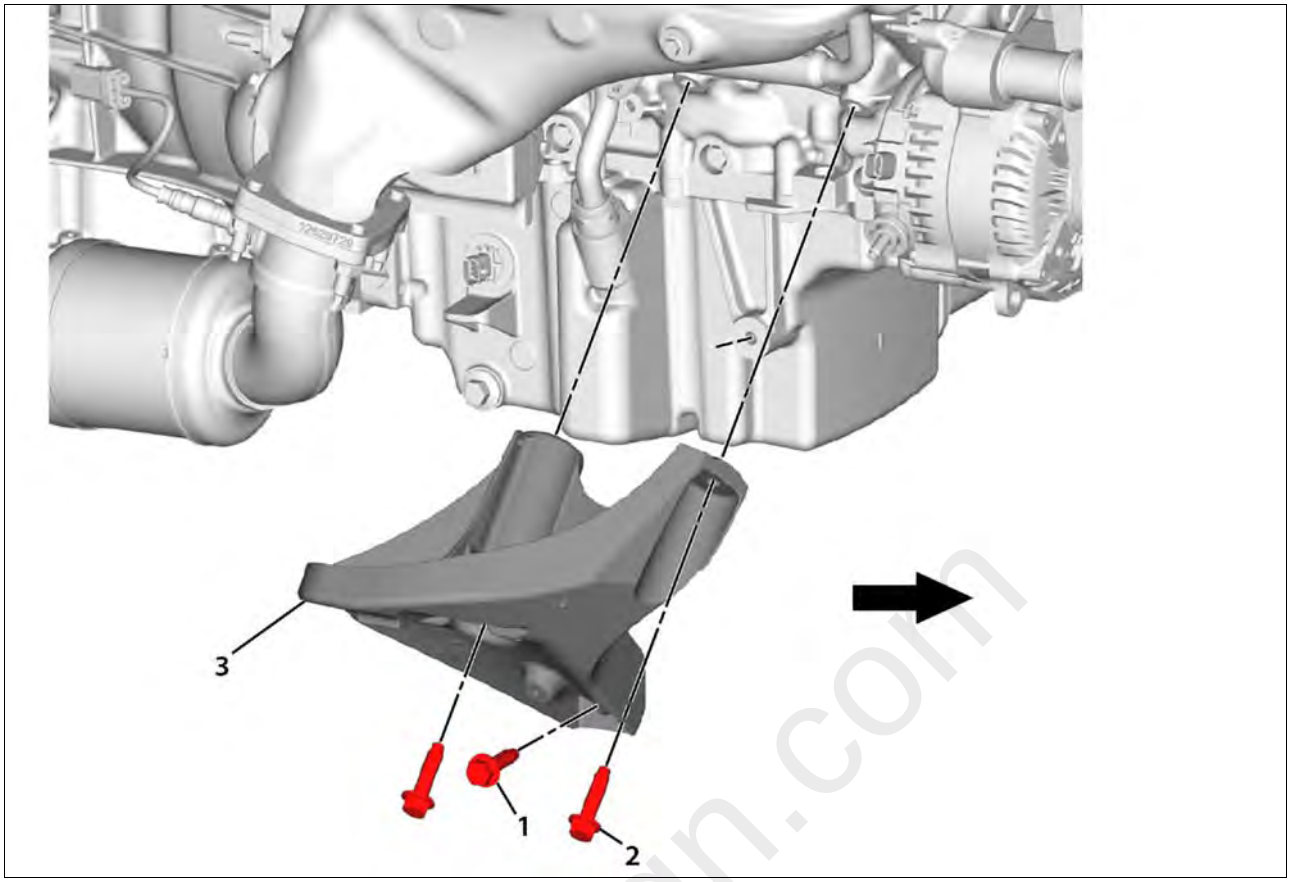
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	1. Remove and DISCARD the fasteners. 2. Install NEW fasteners. Tighten 1. First Pass: 58 N.m (43 lb ft) 2. Final Pass: plus 75 degrees
2	Engine Mount
3	Phenolic Spacer *CAUTION:* *Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket.* **Procedure** Inspect the engine mount to ensure the plastic spacer is in place and not damaged.

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

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Fig 1: Engine Mount Bracket - Right Side



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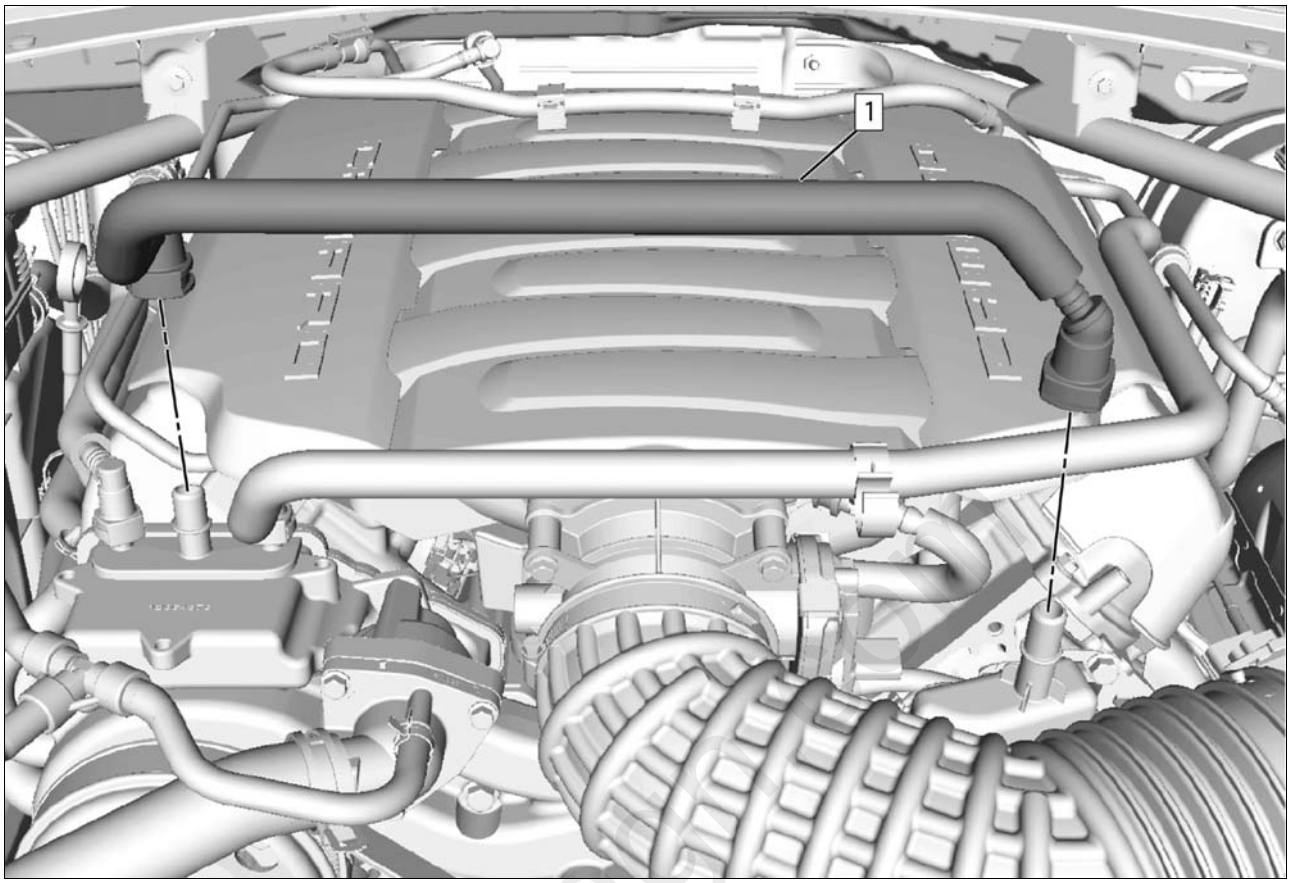
Callout	Component Name
Preliminary Procedure Drivetrain and Front Suspension Cradle Replacement (LT1)	
1	*CAUTION:* *Refer to Fastener Caution .* Engine Mount Bracket Fastener**Tighten** 58 N.m (43 lb ft)
2	Engine Mount Bracket Fastener (Qty: 2) **Tighten** 58 N.m (43 lb ft)
3	Engine Mount Bracket

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (OIL SEPARATOR TO AIR CLEANER OUTLET

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DUCT)

Fig 1: Positive Crankcase Ventilation Hose/Pipe/Tube (Oil Separator To Air Cleaner Outlet Duct)

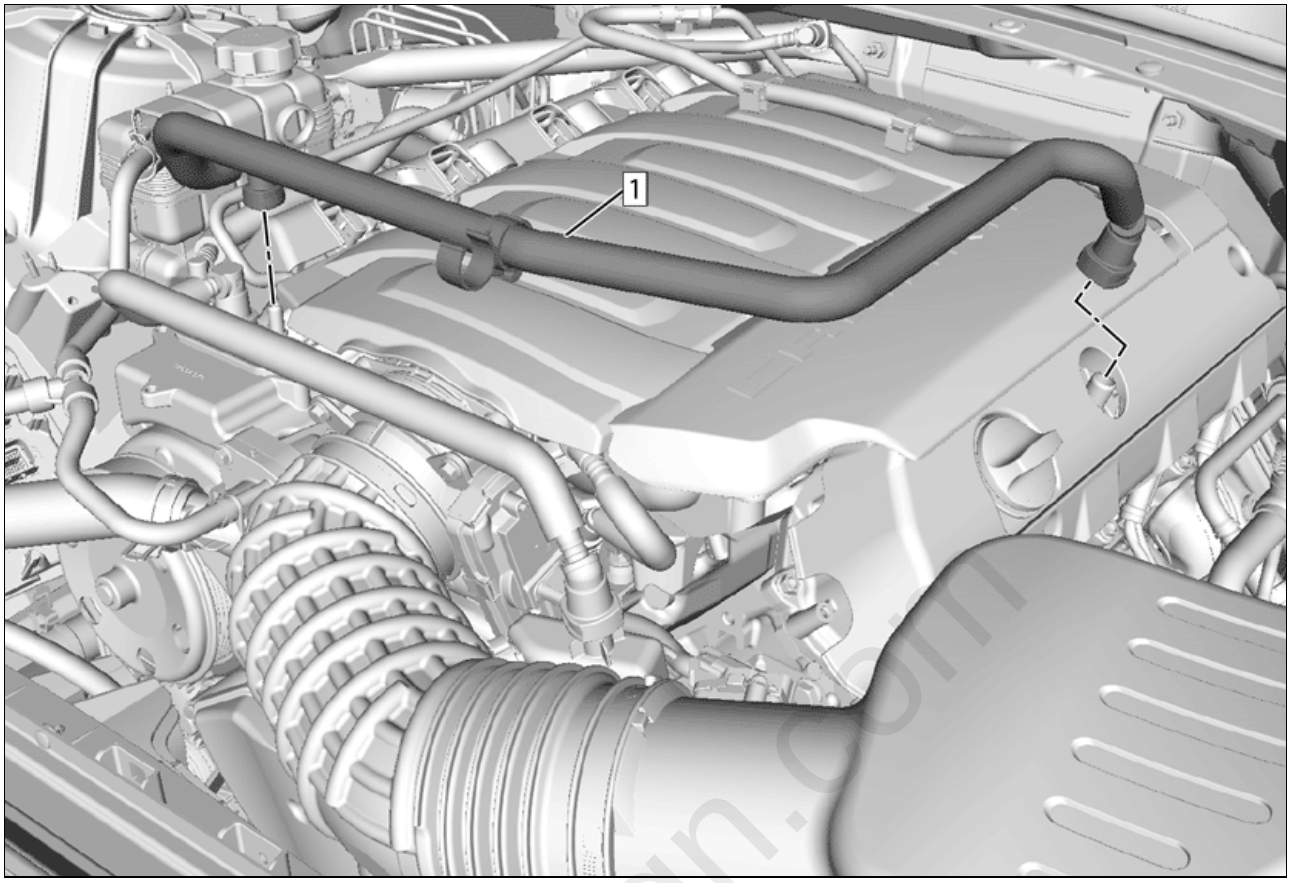


Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Hose **Procedure** Remove hose from the oil separator and the air cleaner outlet duct. Plastic Collar Quick Connect Fitting Service

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LEFT ROCKER ARM COVER TO OIL SEPARATOR)

Fig 1: Positive Crankcase Ventilation Hose/Pipe/Tube (Left Rocker Arm Cover To Oil Separator)



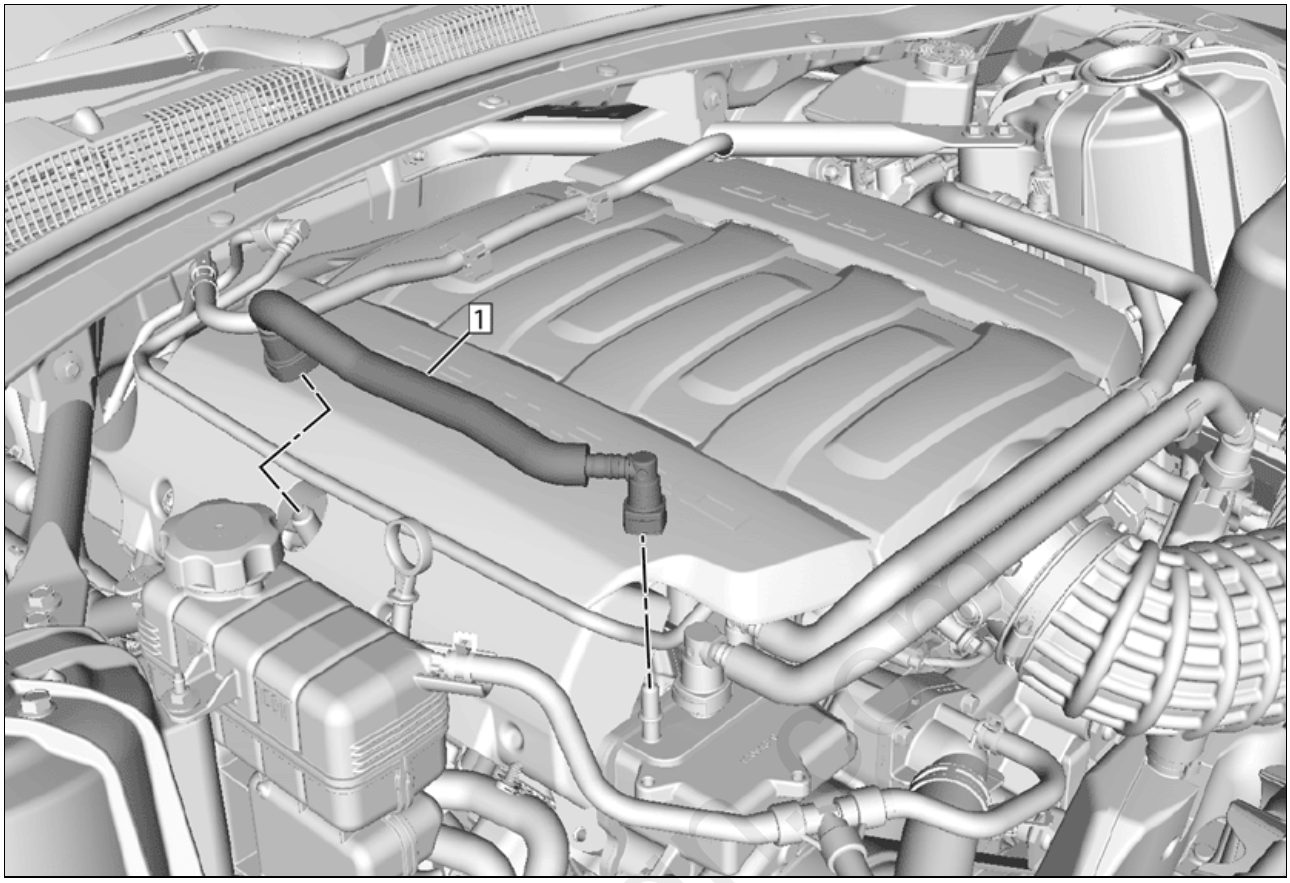
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the right side intake manifold cover. Intake Manifold Cover Replacement (Left) Intake Manifold Cover Replacement (Right) .	
1	Positive Crankcase Ventilation Hose **Procedure** Remove hose from the oil separator and the valve rocker arm cover. Plastic Collar Quick Connect Fitting Service

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (RIGHT ROCKER ARM COVER TO OIL SEPARATOR)

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Fig 1: Positive Crankcase Ventilation Hose/Pipe/Tube (Right Rocker Arm Cover To Oil Separator)

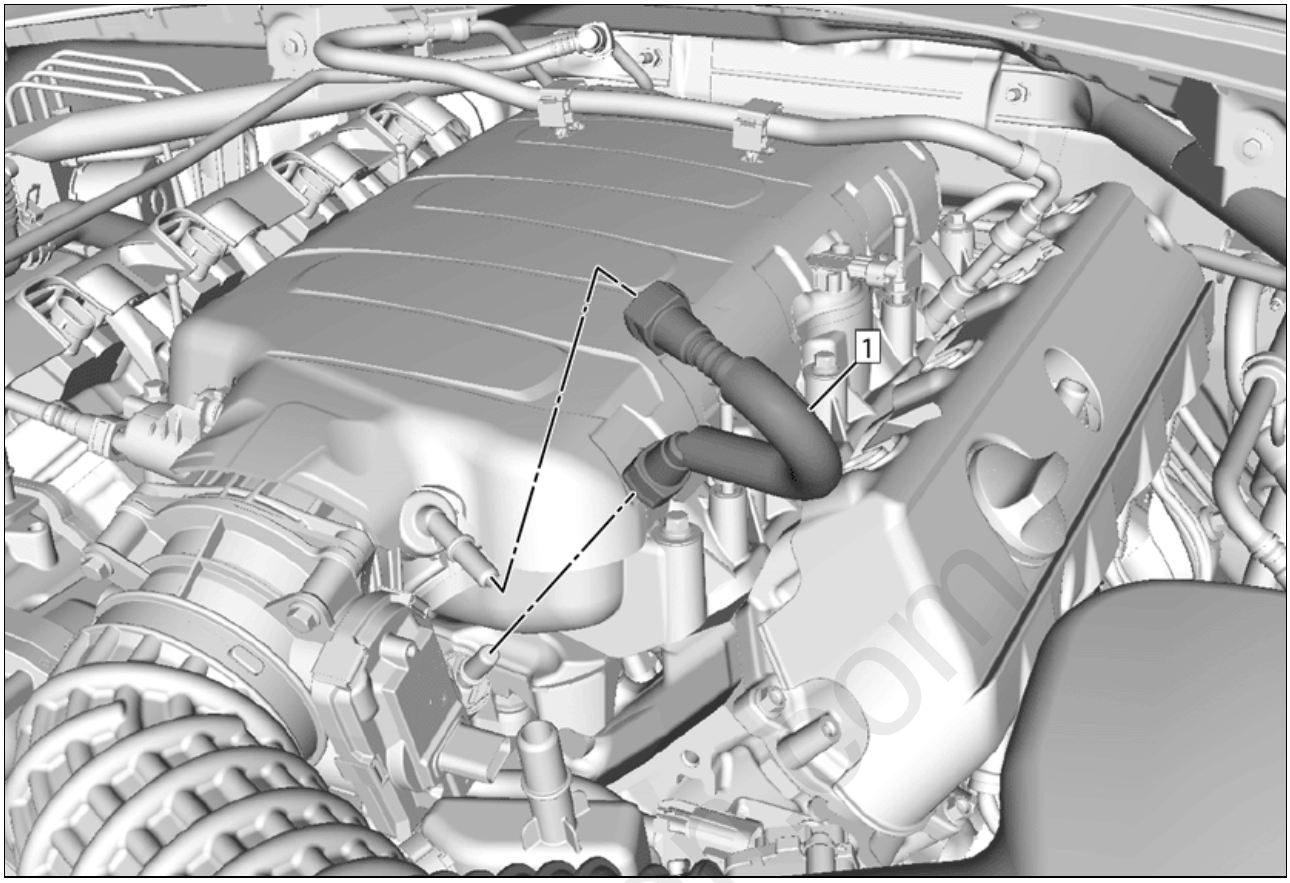


Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Hose **Procedure** Remove hose from the oil separator and the valve rocker arm cover Plastic Collar Quick Connect Fitting Service

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (INTAKE MANIFOLD TO PCV VALVE)

Fig 1: Positive Crankcase Ventilation Hose/Pipe/Tube (Intake Manifold To PCV Valve)

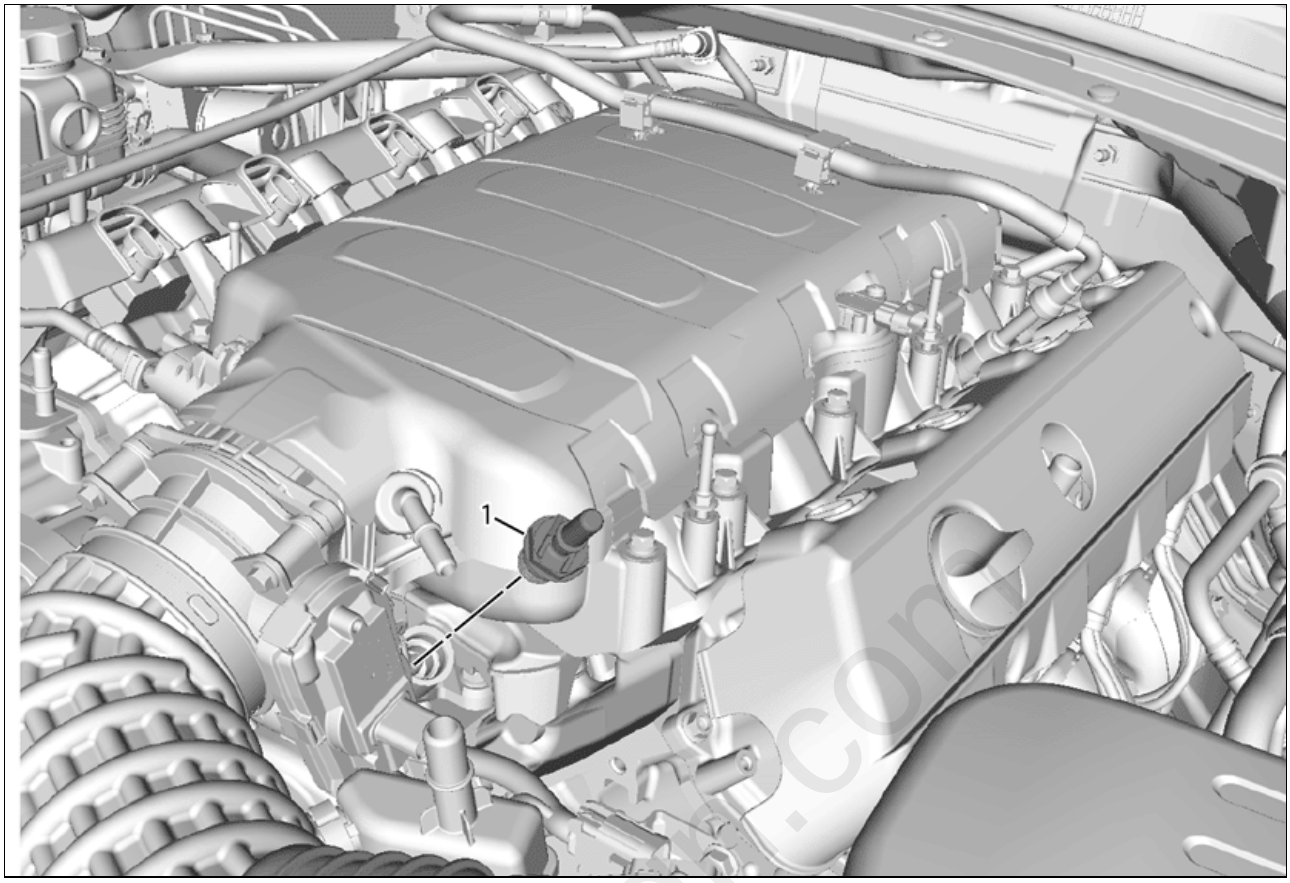


Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Upper Intake Manifold Cover Replacement .	
1	Positive Crankcase Ventilation Hose **Procedure** Remove hose from the intake manifold the PCV valve. Plastic Collar Quick Connect Fitting Service

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT

Fig 1: Positive Crankcase Ventilation Valve



Courtesy of GENERAL MOTORS COMPANY

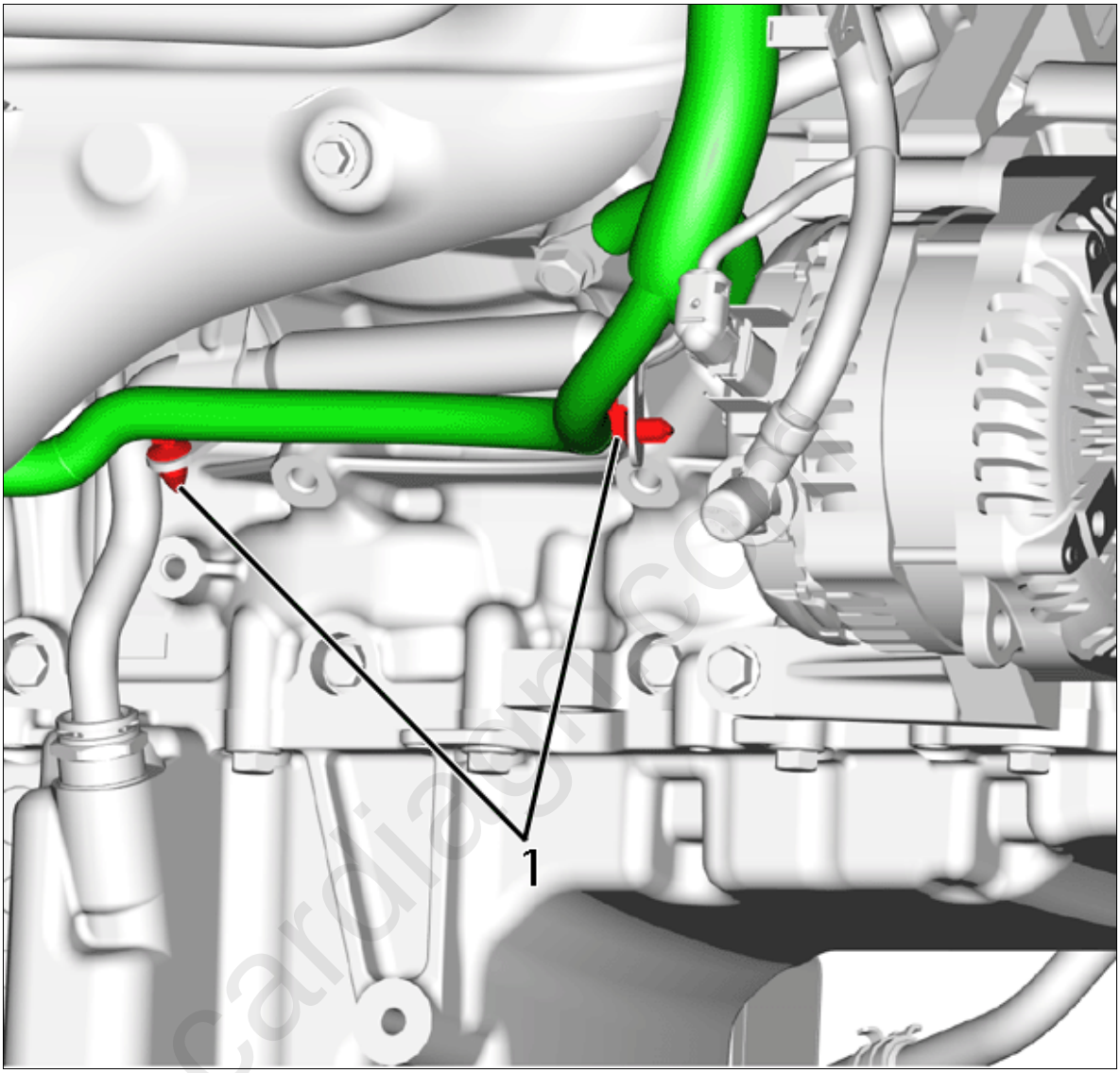
Callout	Component Name
Preliminary Procedure Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Oil Separator To Air Cleaner Outlet Duct) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Left Rocker Arm Cover To Oil Separator) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Right Rocker Arm Cover To Oil Separator) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Intake Manifold To PCV Valve)	
1	Positive Crankcase Ventilation Valve *CAUTION:* *Refer to Component Fastener Tightening Caution .* **Tighten** 6 N.m (53 lb in)

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION OIL

SEPARATOR DRAIN PIPE REPLACEMENT > REMOVAL PROCEDURE

1. Remove Engine Coolant Manifold Replacement (LT1)

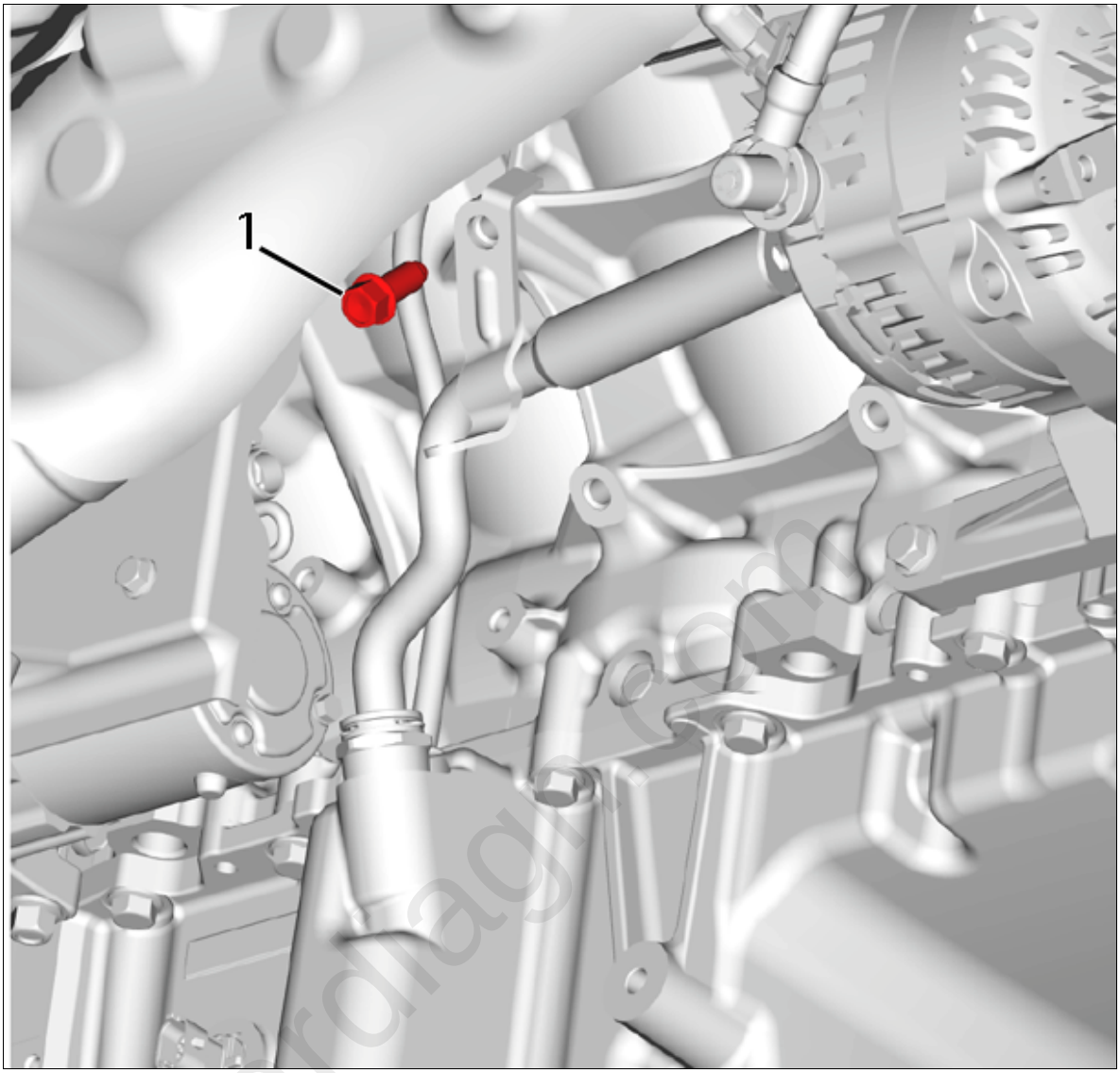
Fig 1: Wiring Harness Clip



Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Wiring Harness Clip (1) (Qty: 2)

Fig 2: Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt

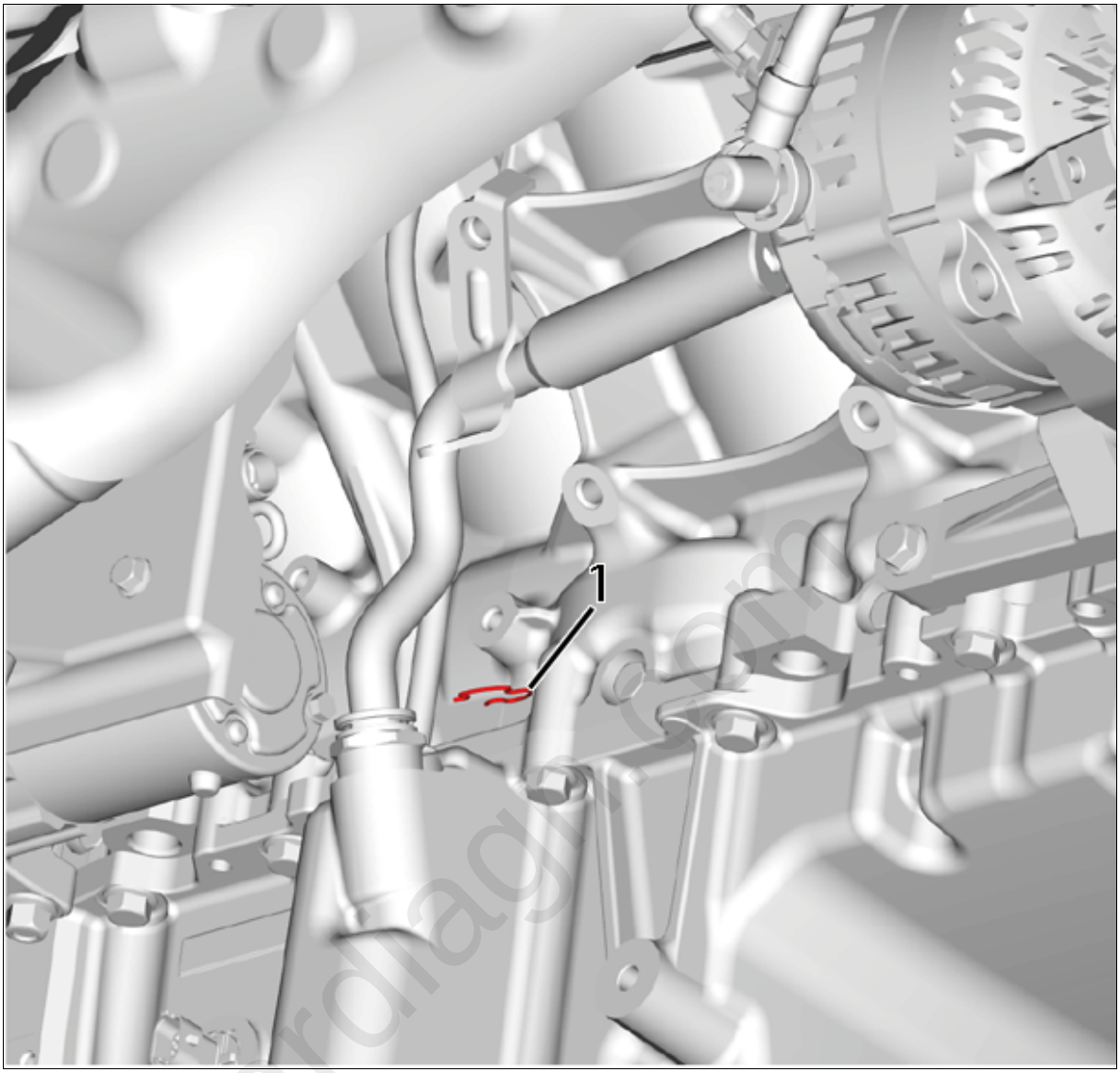


Courtesy of GENERAL MOTORS COMPANY

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3. Remove Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt (1)

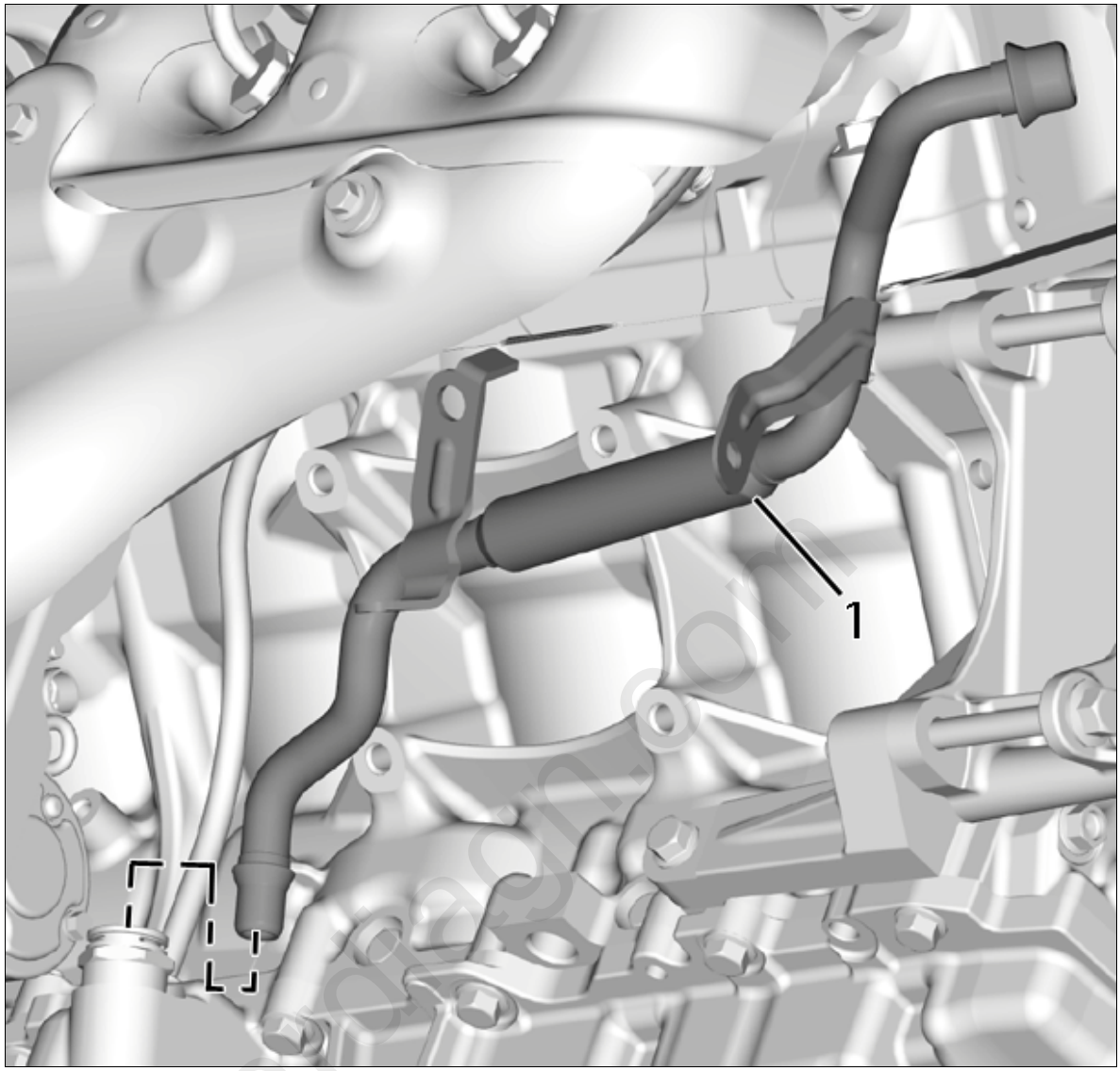
Fig 3: Positive Crankcase Ventilation Oil Separator Drain Pipe Clip



Courtesy of GENERAL MOTORS COMPANY

4. Remove Clip (1) at Positive Crankcase Ventilation Oil Separator Drain Pipe.

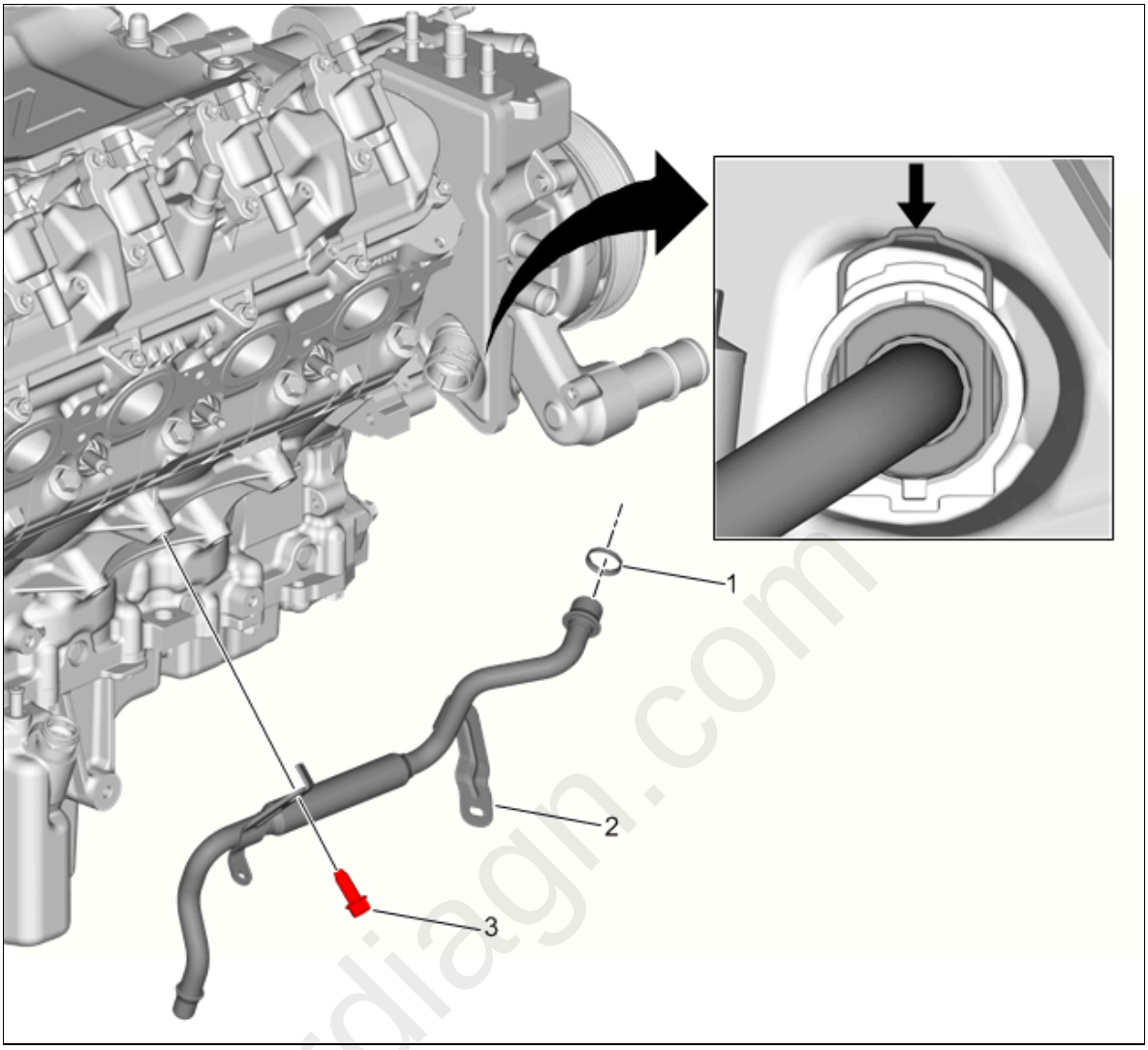
Fig 4: Positive Crankcase Ventilation Oil Separator Drain Pipe



Courtesy of GENERAL MOTORS COMPANY

5. Remove Positive Crankcase Ventilation Oil Separator Drain Pipe (1)

Fig 5: Positive Crankcase Ventilation Oil Separator Seal



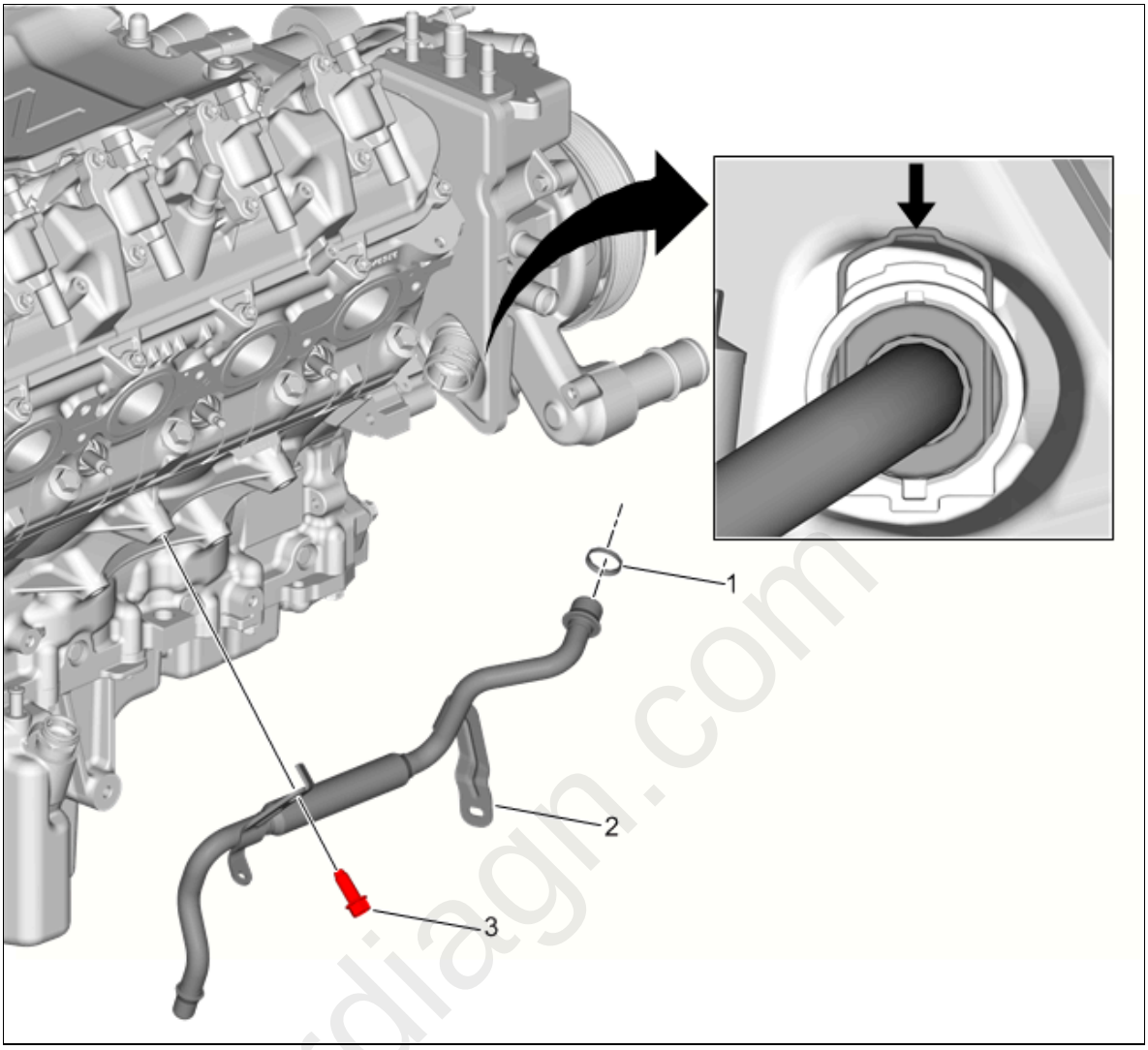
Courtesy of GENERAL MOTORS COMPANY

6. Remove Positive Crankcase Ventilation Oil Separator Seal (1) and DISCARD
7. Remove Oil Flow Check Valve and DISCARD-Oil Pan Disassemble

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION OIL SEPARATOR DRAIN PIPE REPLACEMENT > INSTALLATION PROCEDURE

1. Install Oil Flow Check Valve-Oil Pan Assemble

Fig 1: Positive Crankcase Ventilation Oil Separator Seal

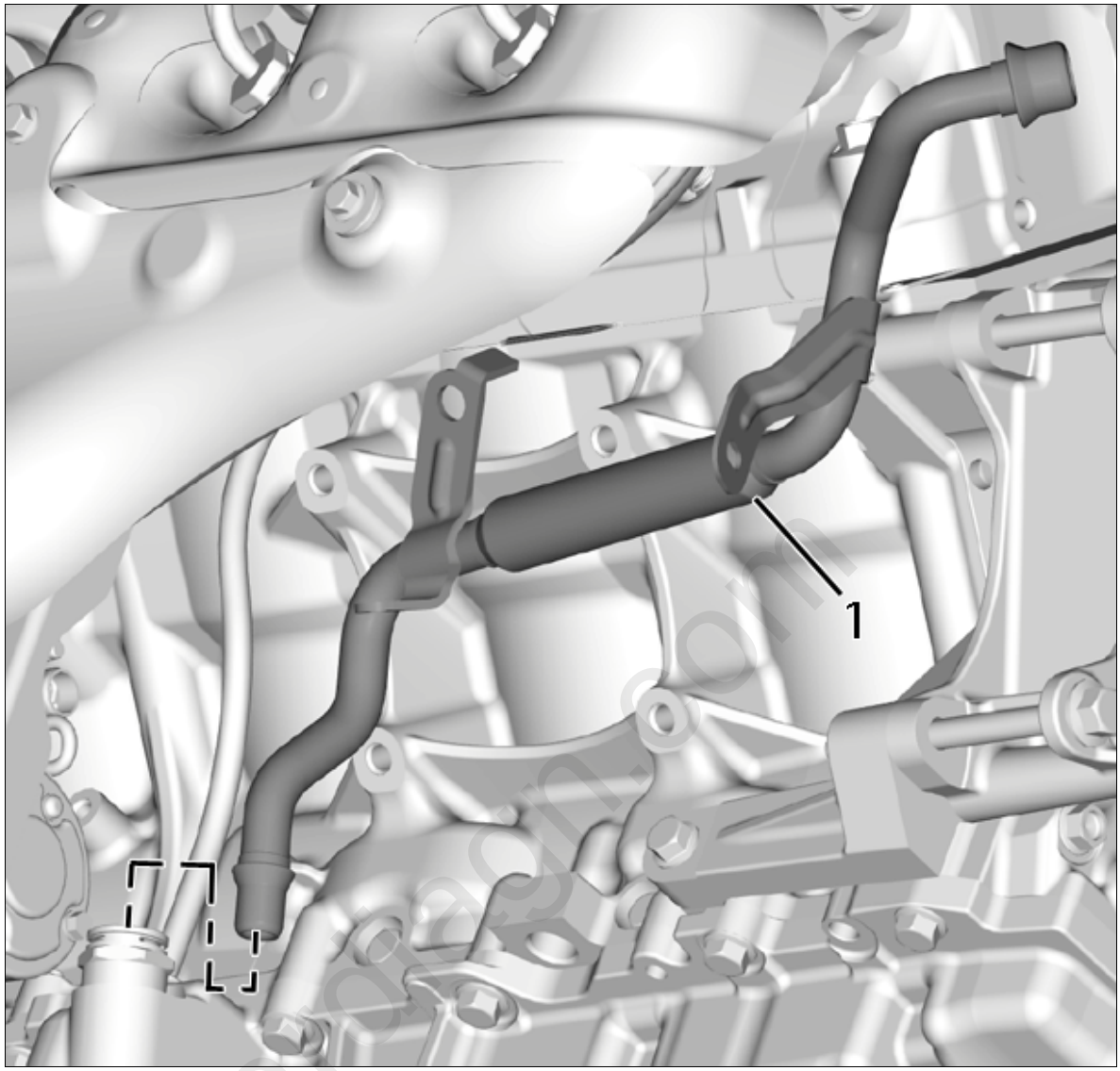


Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW Positive Crankcase Ventilation Oil Separator Seal (1)

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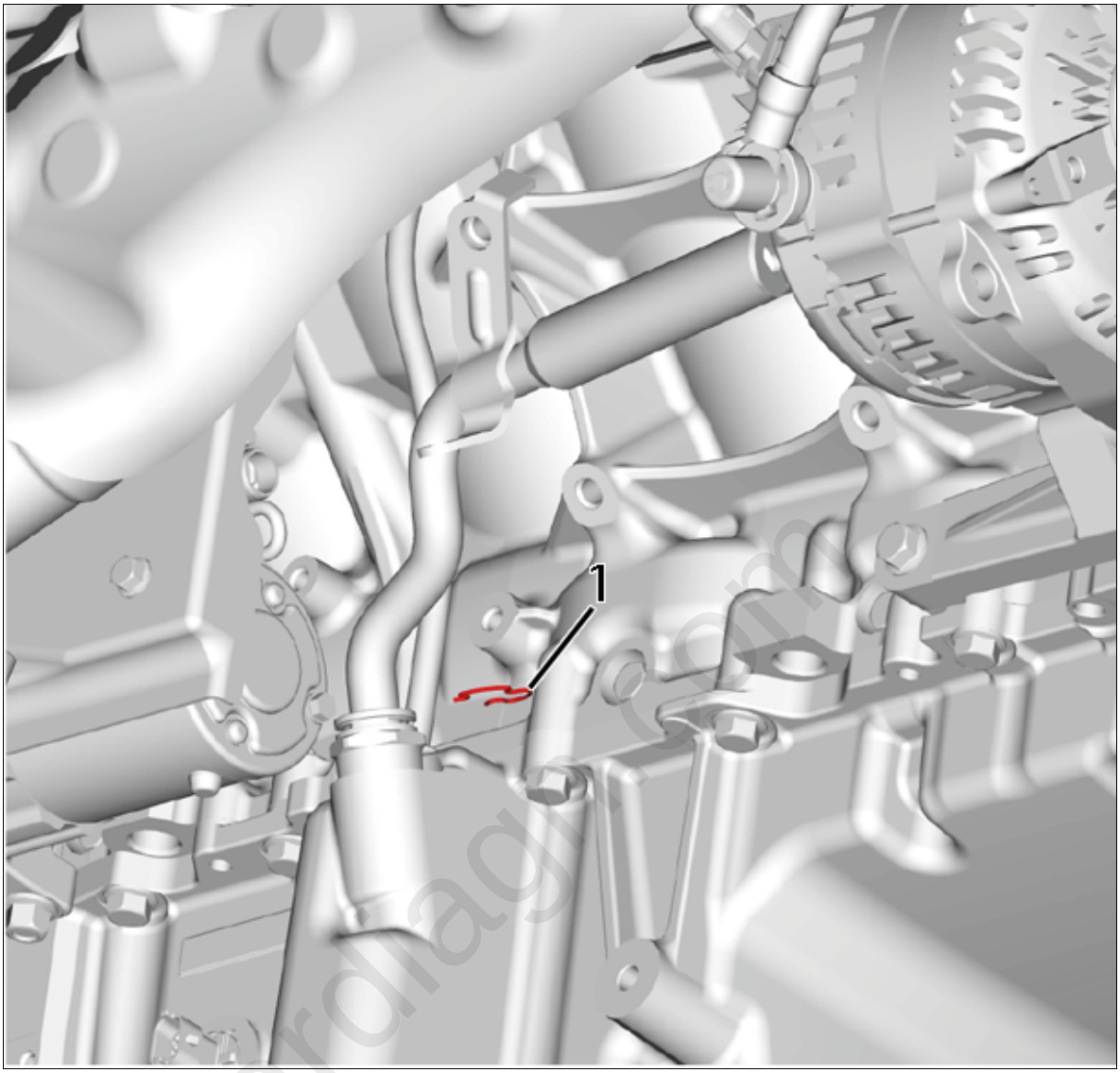
Fig 2: Positive Crankcase Ventilation Oil Separator Drain Pipe



Courtesy of GENERAL MOTORS COMPANY

3. Install Positive Crankcase Ventilation Oil Separator Drain Pipe (1)

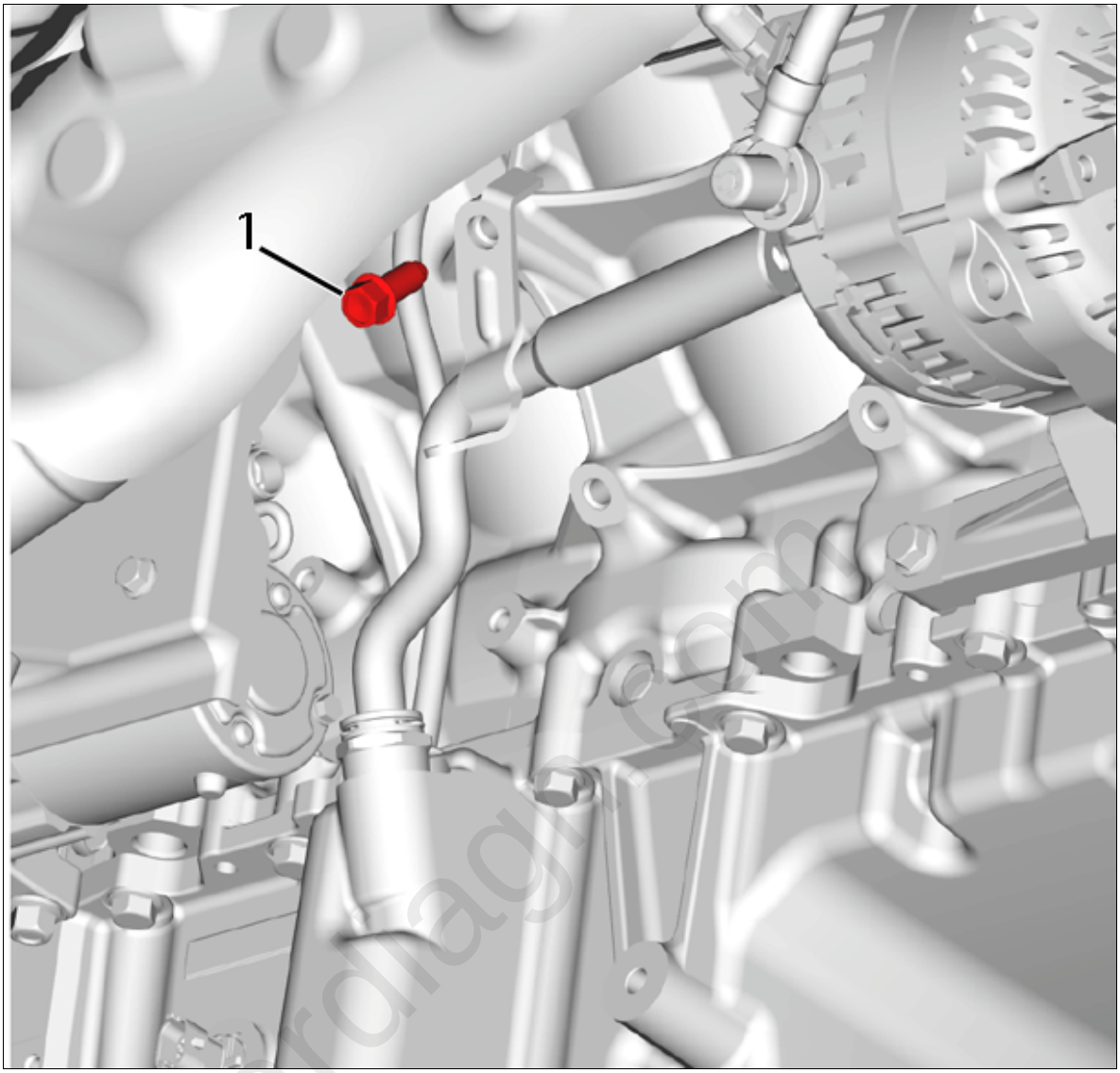
Fig 3: Positive Crankcase Ventilation Oil Separator Drain Pipe Clip



Courtesy of GENERAL MOTORS COMPANY

4. Install Clip (1) at Positive Crankcase Ventilation Oil Separator Drain Pipe.

Fig 4: Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt



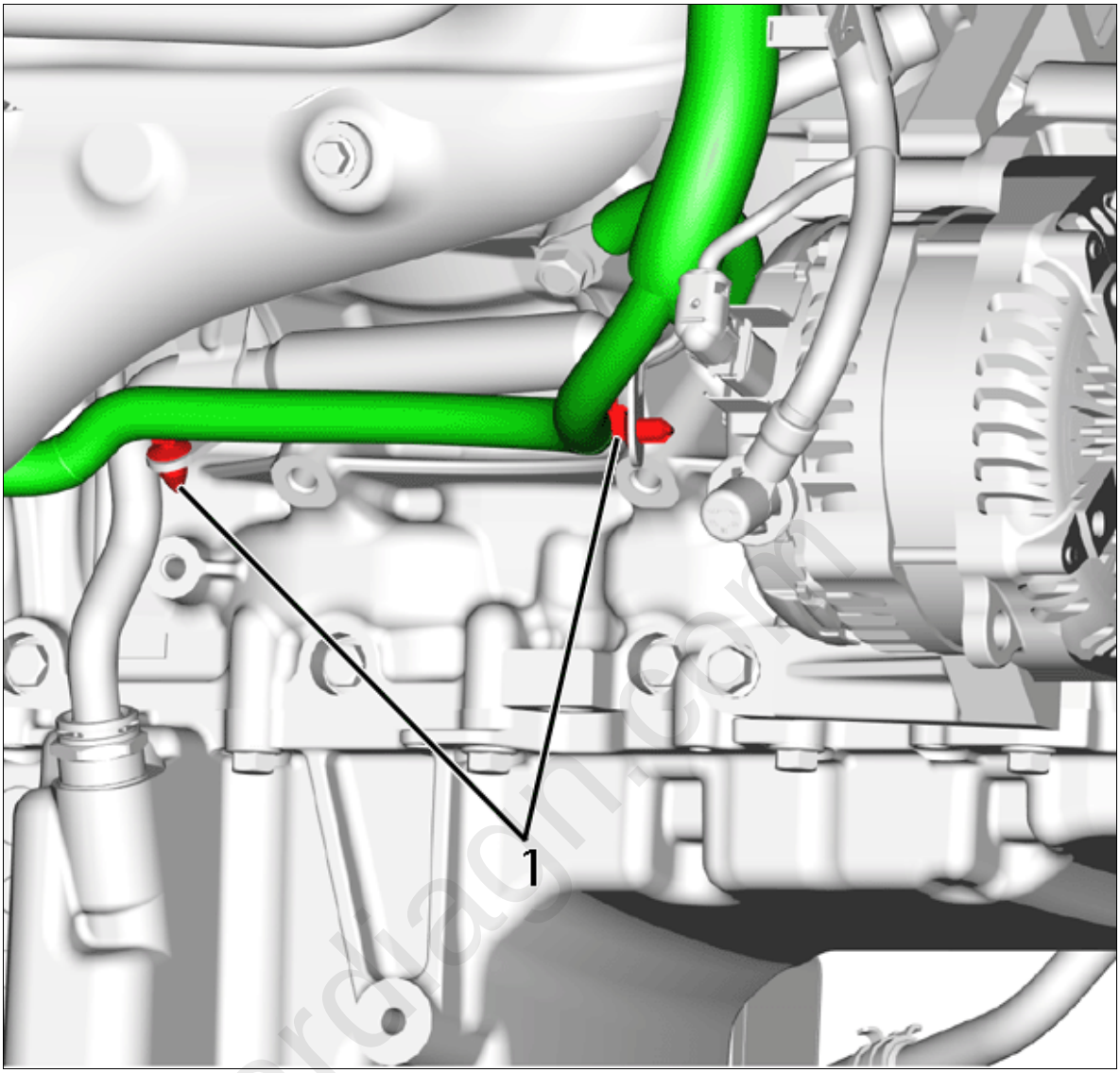
Courtesy of GENERAL MOTORS COMPANY

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> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

5. Install Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt (1)
6. Tighten Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt 25 N.m (18 lb ft)

Fig 5: Wiring Harness Clip

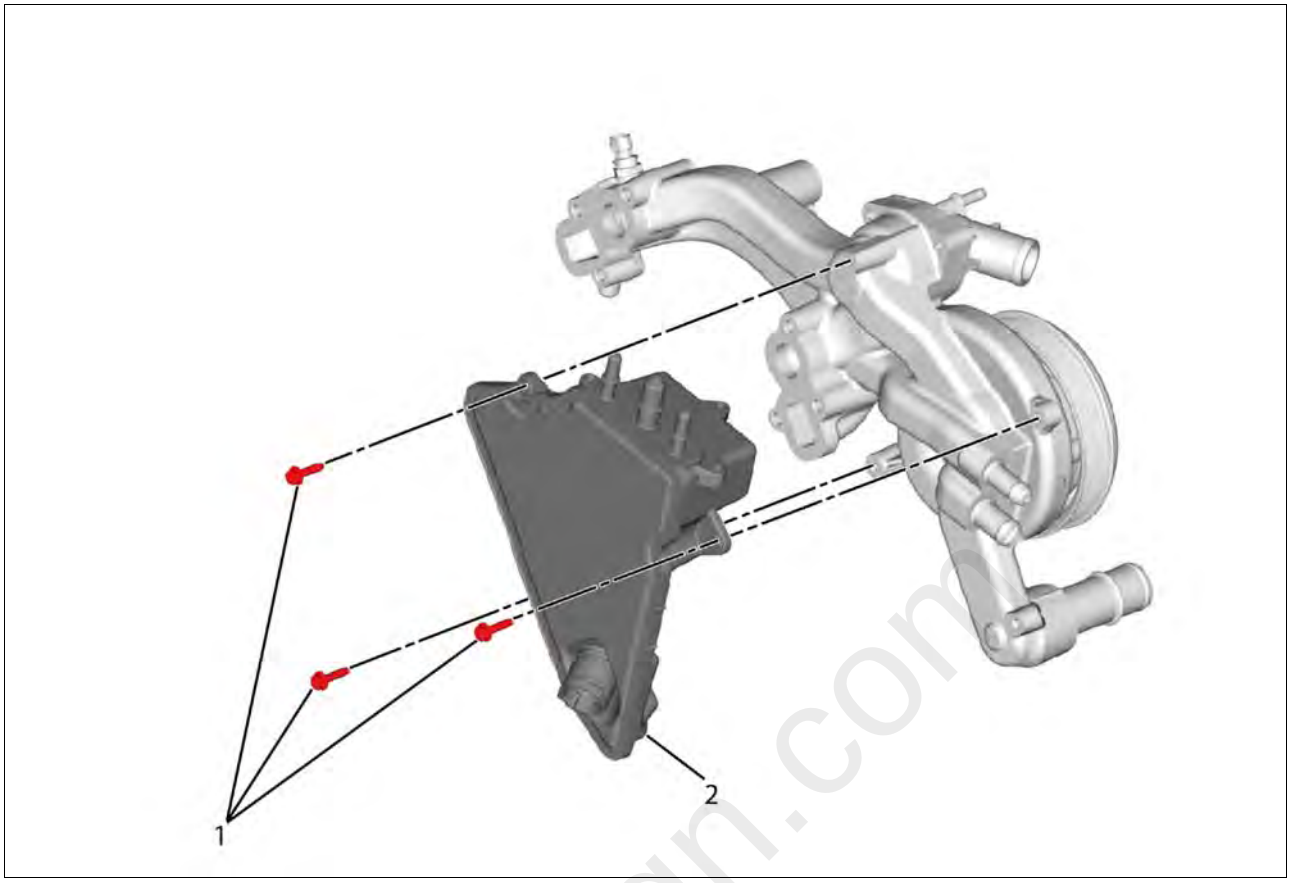


Courtesy of GENERAL MOTORS COMPANY

7. Connect Wiring Harness Clip (1) (Qty: 2)
8. Install Engine Coolant Manifold Replacement (LT1)

REPAIR INSTRUCTIONS - ON VEHICLE > POSITIVE CRANKCASE VENTILATION OIL SEPARATOR REPLACEMENT

Fig 1: Positive Crankcase Ventilation Oil Separator



Courtesy of GENERAL MOTORS COMPANY

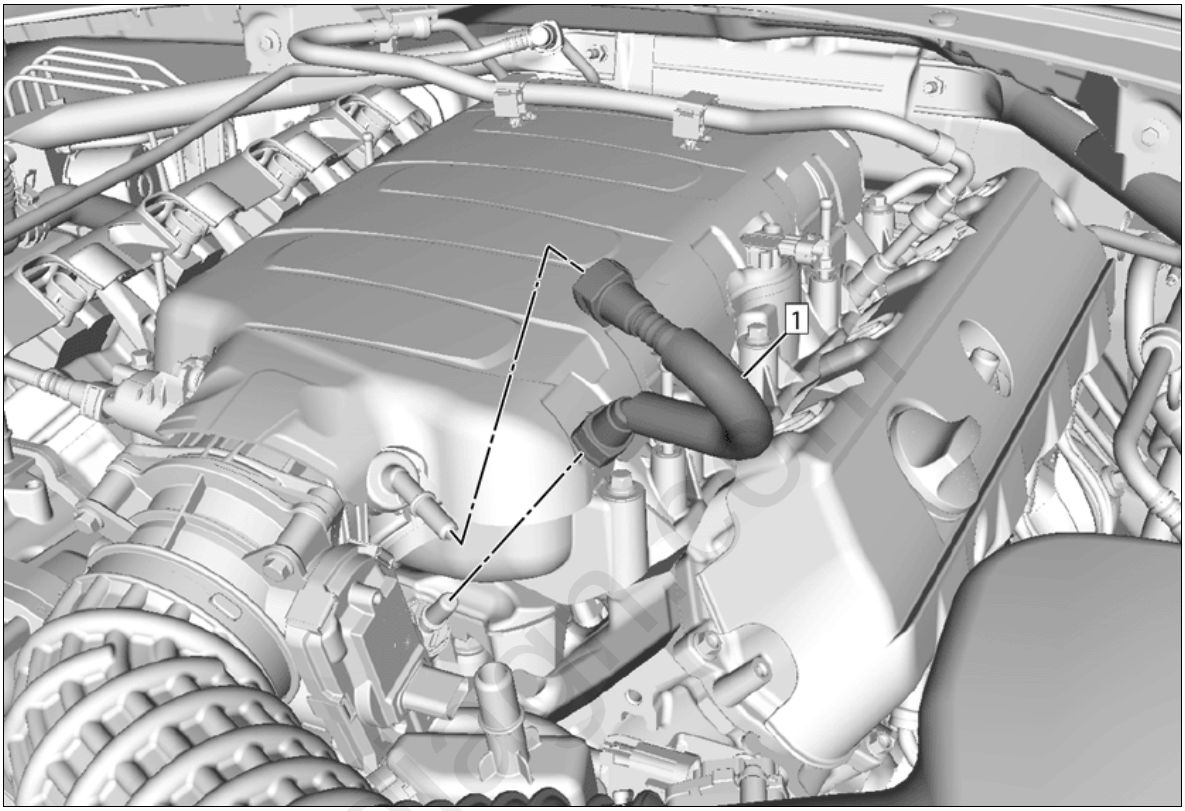
Callout	Component Name
Preliminary Procedure Engine Coolant Manifold Replacement (LT1) .	
1	Positive Crankcase Ventilation Oil Separator Bolt (Qty: 3) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 12 N.m (9 lb ft)
2	Positive Crankcase Ventilation Oil Separator

REPAIR INSTRUCTIONS - ON VEHICLE > INTAKE MANIFOLD REPLACEMENT > REMOVAL PROCEDURE

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1. Disconnect the battery ground cable. Battery Negative Cable Disconnection and Connection
2. Remove the fuel feed front hose. Fuel Feed Front Hose Replacement
3. Remove the upper intake manifold cover. Upper Intake Manifold Cover Replacement
4. Remove the air cleaner outlet duct. Air Cleaner Outlet Duct Replacement .

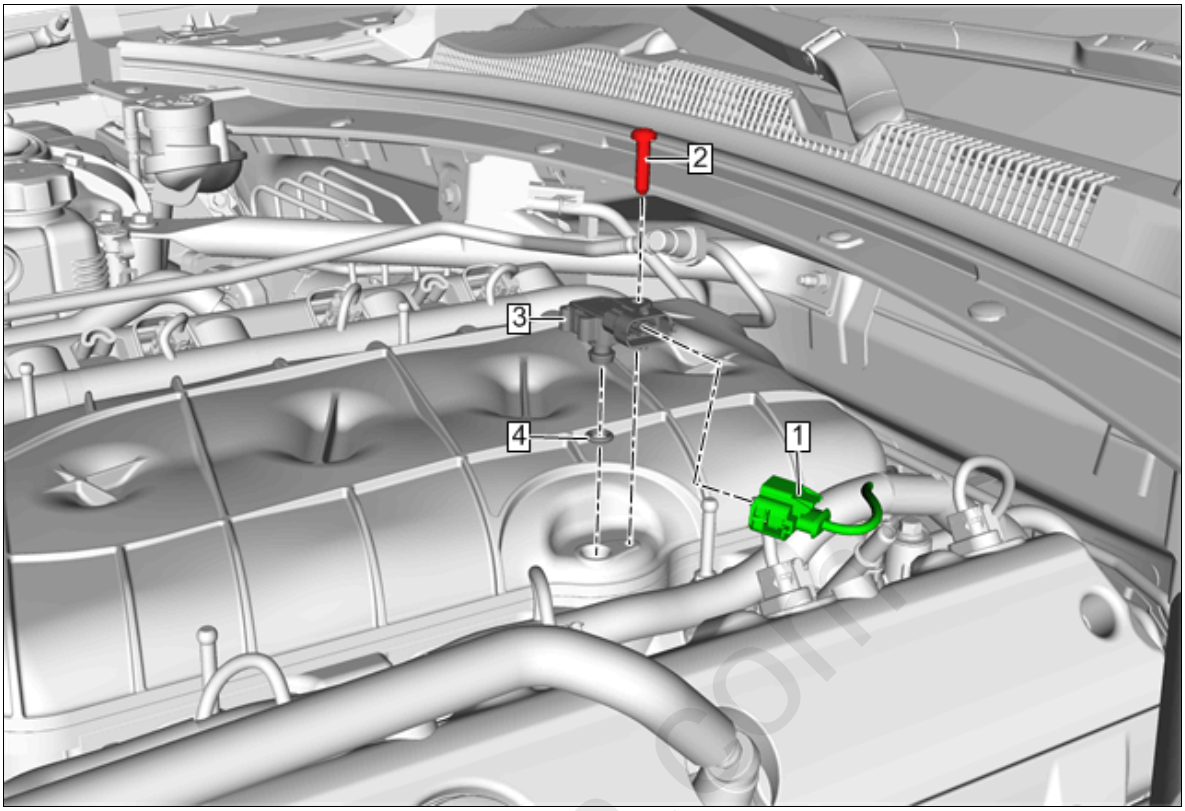
Fig 1: Positive Crankcase Ventilation (PCV) Hose



Courtesy of GENERAL MOTORS COMPANY

5. Remove the positive crankcase ventilation (PCV) hose (1)-Plastic Collar Quick Connect Fitting Service
6. Remove the power brake booster vacuum pipe. Power Brake Booster Vacuum Pipe Replacement

Fig 2: Manifold Absolute Pressure Sensor

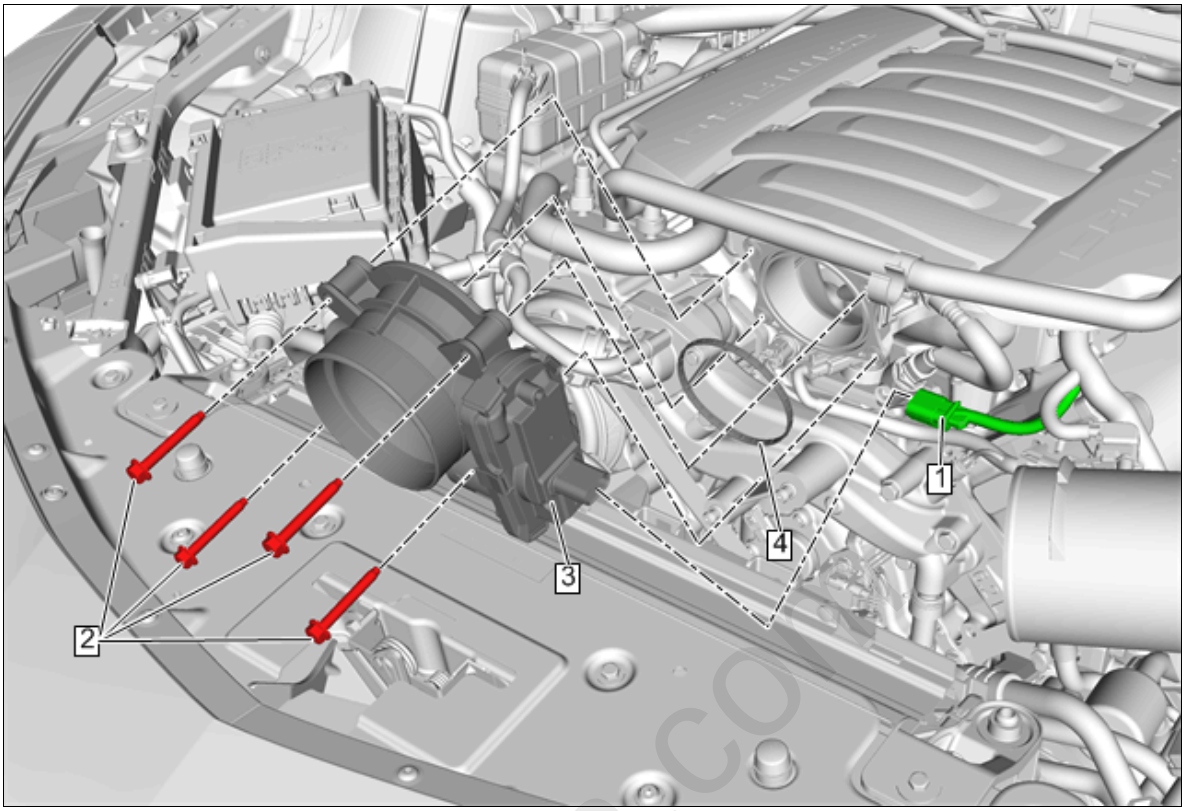


Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the engine wiring harness electrical connector (1) from the manifold absolute pressure (MAP) sensor.

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Fig 3: Throttle Body Assembly

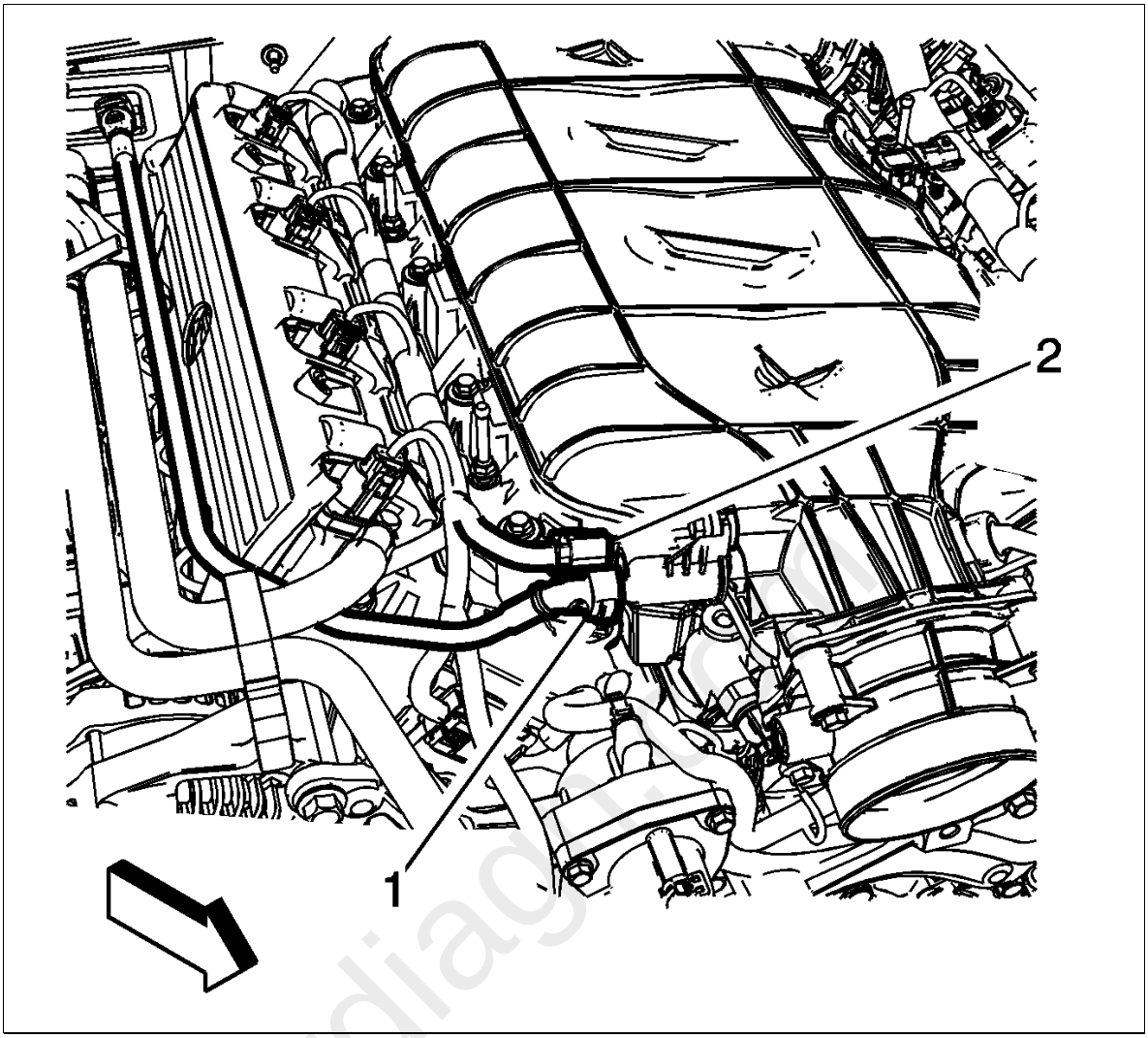


Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the engine harness electrical connector (1) from the throttle actuator.

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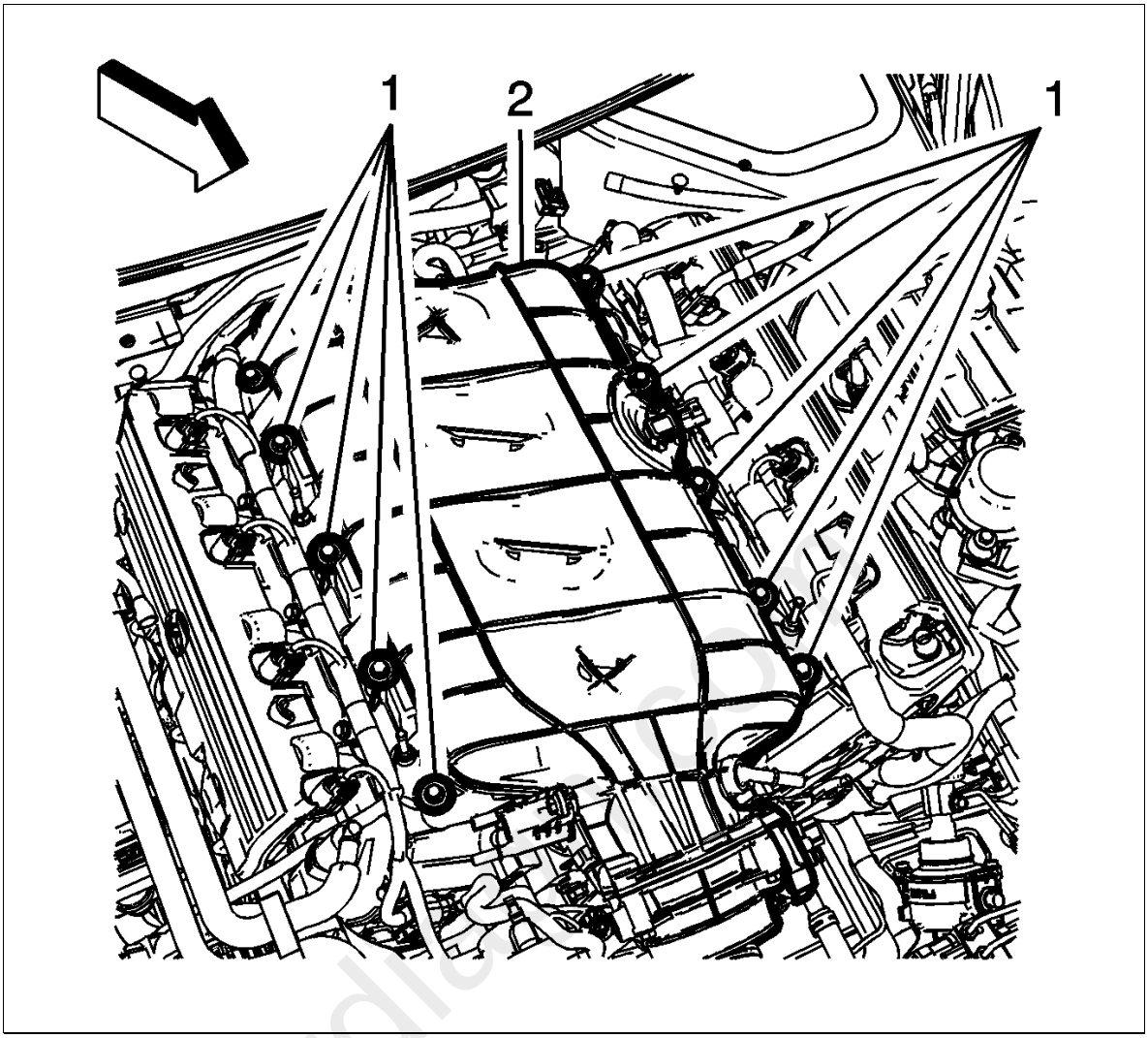
Fig 4: EVAP Canister Purge Tube



Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the EVAP canister purge tube (1) quick connect fitting from the EVAP canister purge solenoid valve. Plastic Collar Quick Connect Fitting Service .
10. Disconnect the engine harness electrical connector (2) from the evaporative emission (EVAP) canister purge solenoid valve.

Fig 5: Intake Manifold Bolts



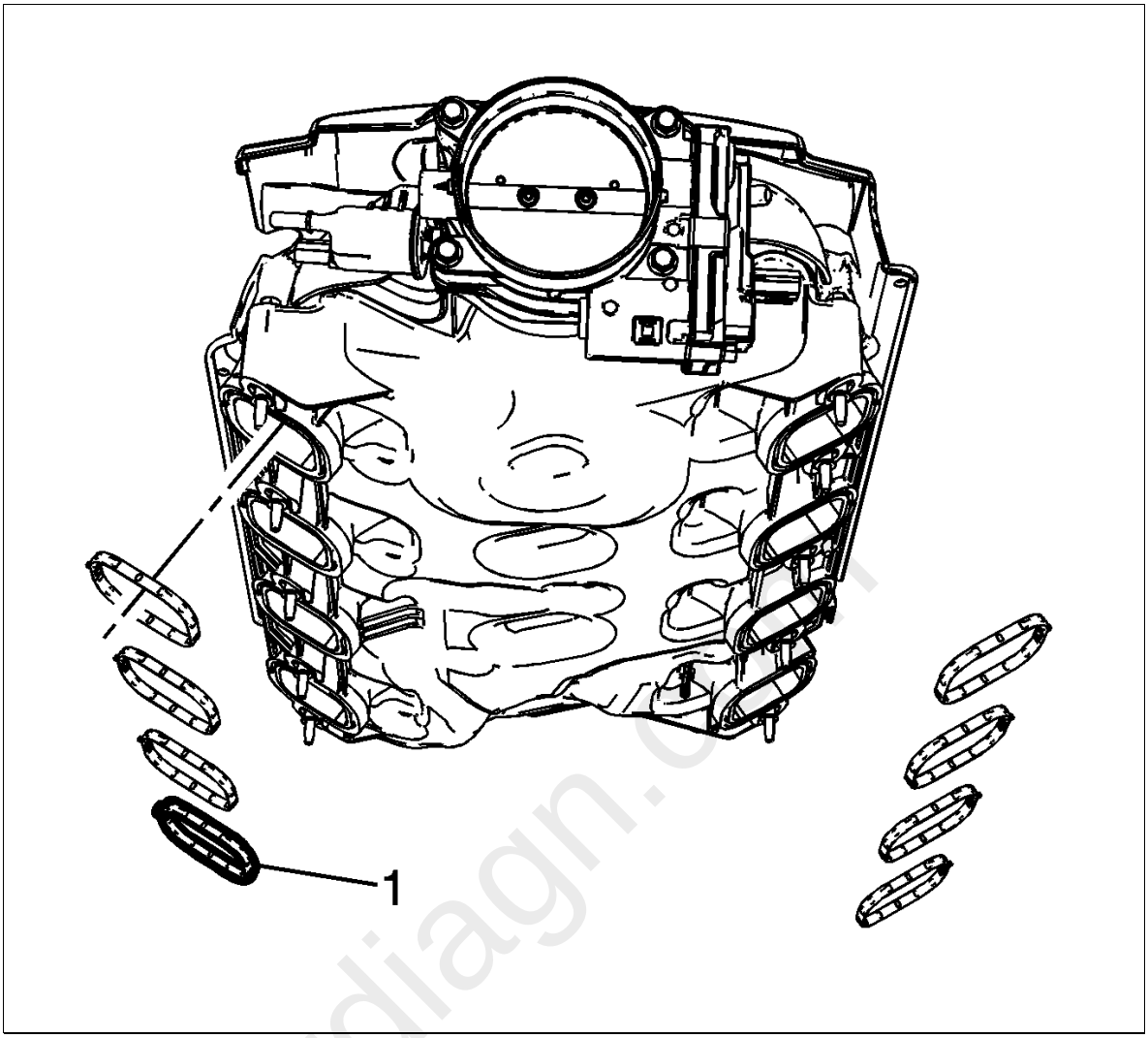
Courtesy of GENERAL MOTORS COMPANY

11. Loosen the 10 intake manifold bolts (1).

> *NOTE:*
>
> *The aid of an assistant may be helpful in holding the engine harness up out of the way so the upper intake manifold cover does not get caught against the engine harness.*

12. Remove the intake manifold (2).
13. Cover the cylinder head passages in order to prevent dirt or debris from entering the passages.

Fig 6: Intake Manifold Gaskets

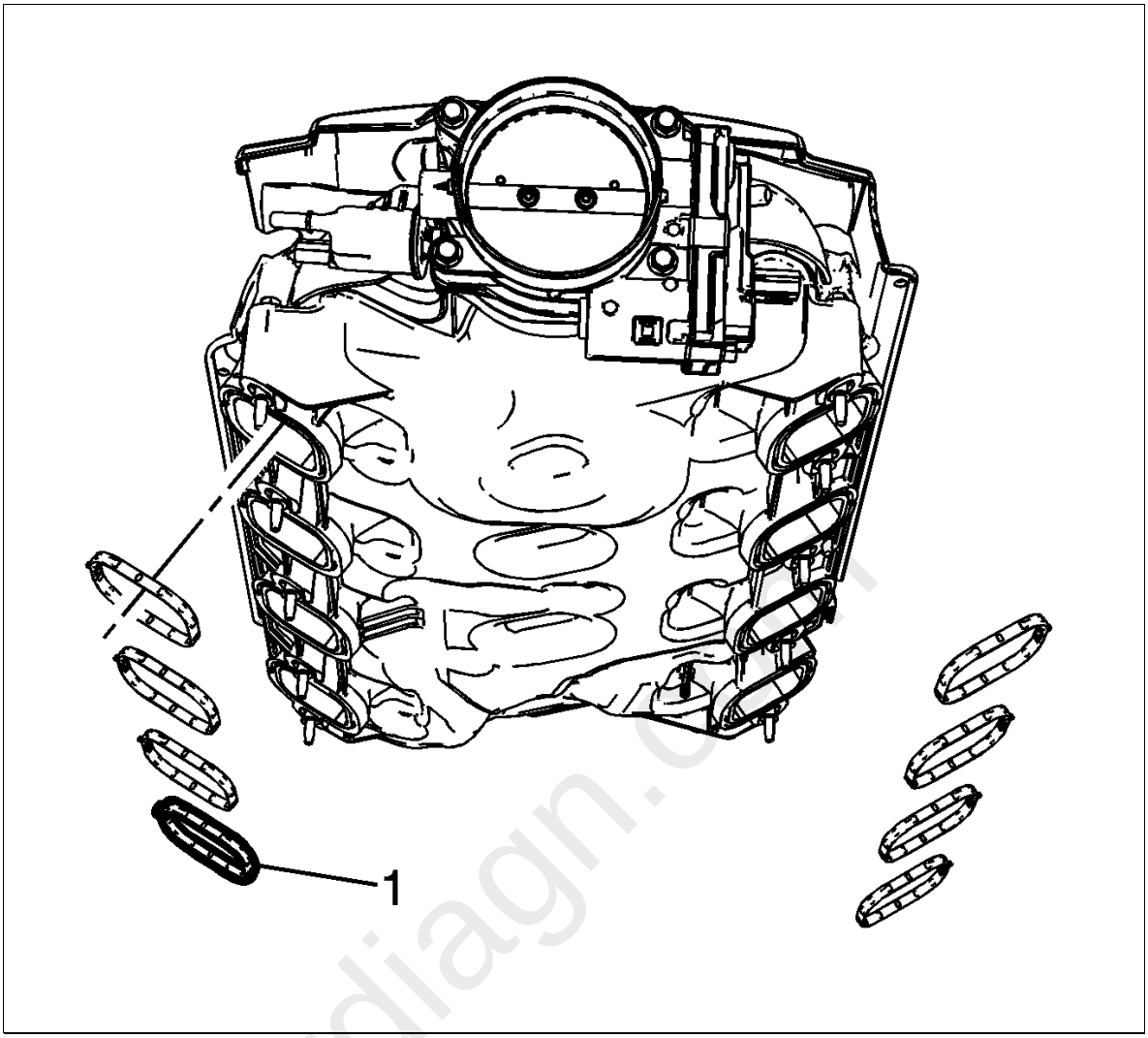


Courtesy of GENERAL MOTORS COMPANY

14. Remove and DISCARD the intake manifold gaskets (1).
15. Clean and inspect the intake manifold. Intake Manifold Cleaning and Inspection .
16. Transfer components as necessary.

REPAIR INSTRUCTIONS - ON VEHICLE > INTAKE MANIFOLD REPLACEMENT > INSTALLATION PROCEDURE

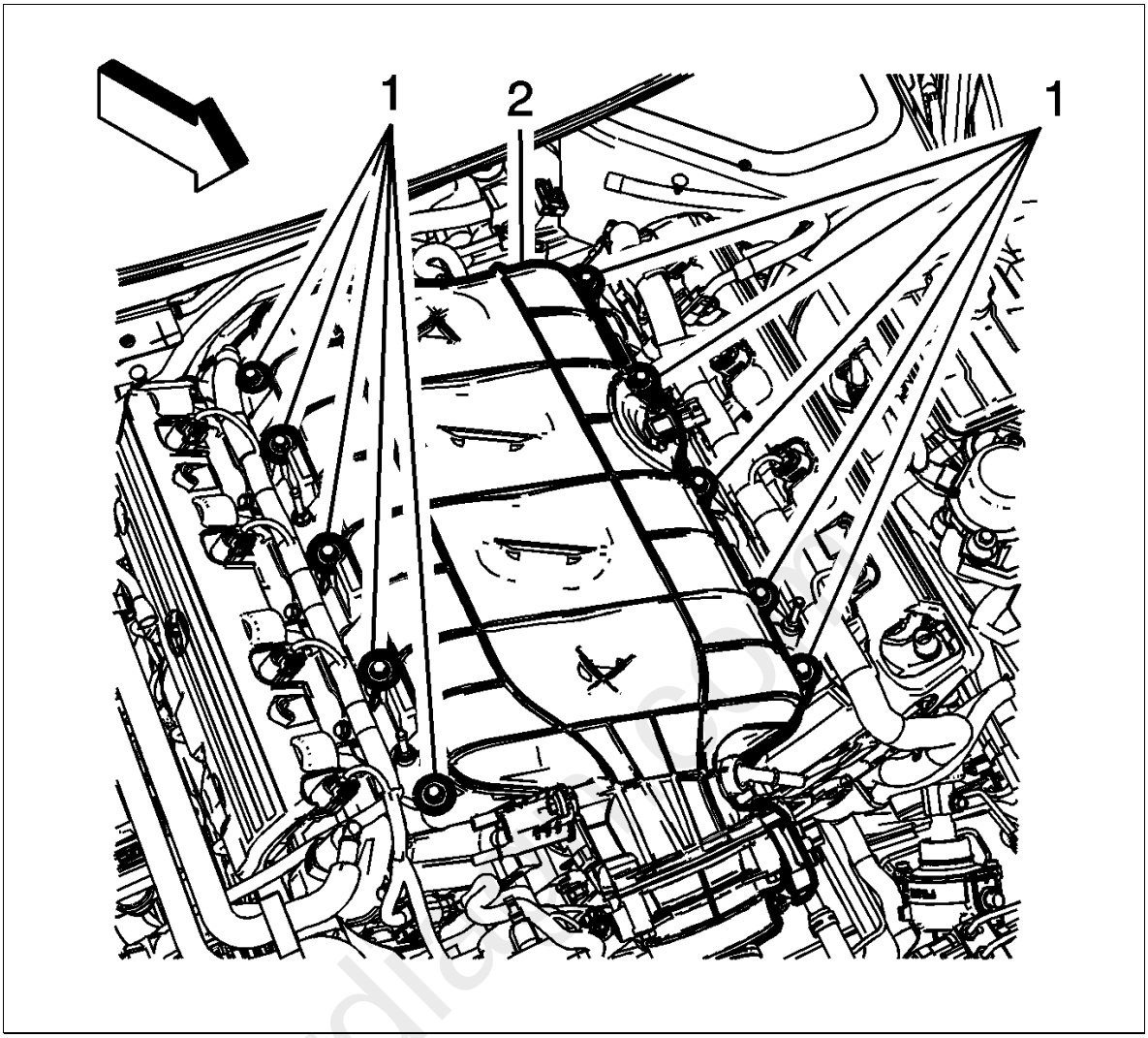
Fig 1: Intake Manifold Gaskets



Courtesy of GENERAL MOTORS COMPANY

1. Install NEW intake manifold gaskets (1) to the intake manifold.
2. Apply a 5 mm (0.20 in) band of threadlock to the threads of the intake manifold bolts. Adhesives, Fluids, Lubricants, and Sealers .
3. Remove the covers from the cylinder head passages.

Fig 2: Intake Manifold Bolts



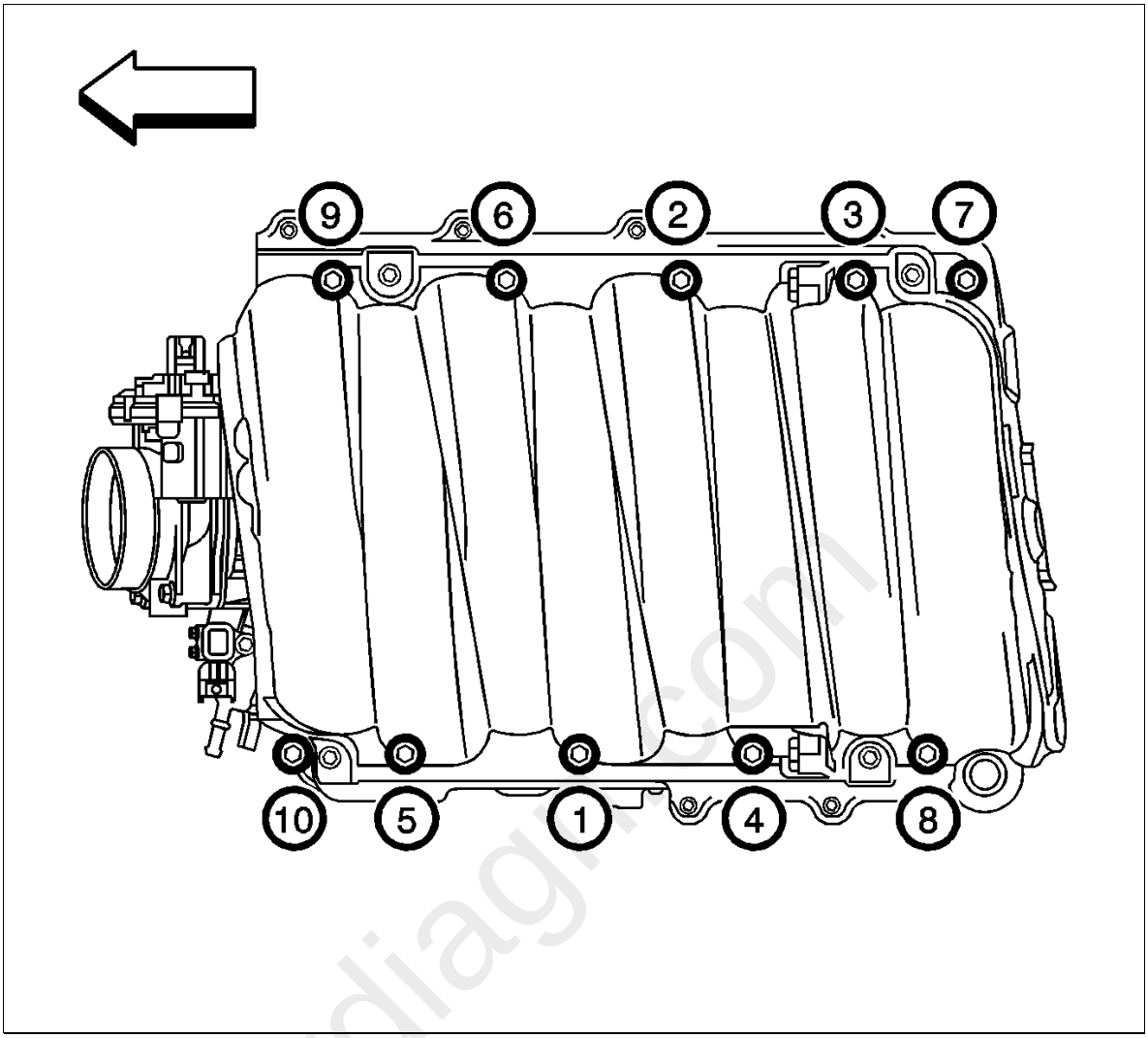
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake manifold (2).

> *NOTE:*
>
> *The aid of an assistant may be helpful in holding the engine harness up out of the way so the upper intake manifold cover does not get caught against the engine harness.*

5. Install the intake manifold bolts (1) finger tight.

Fig 3: Intake Manifold Bolts Tightening Sequence



Courtesy of GENERAL MOTORS COMPANY

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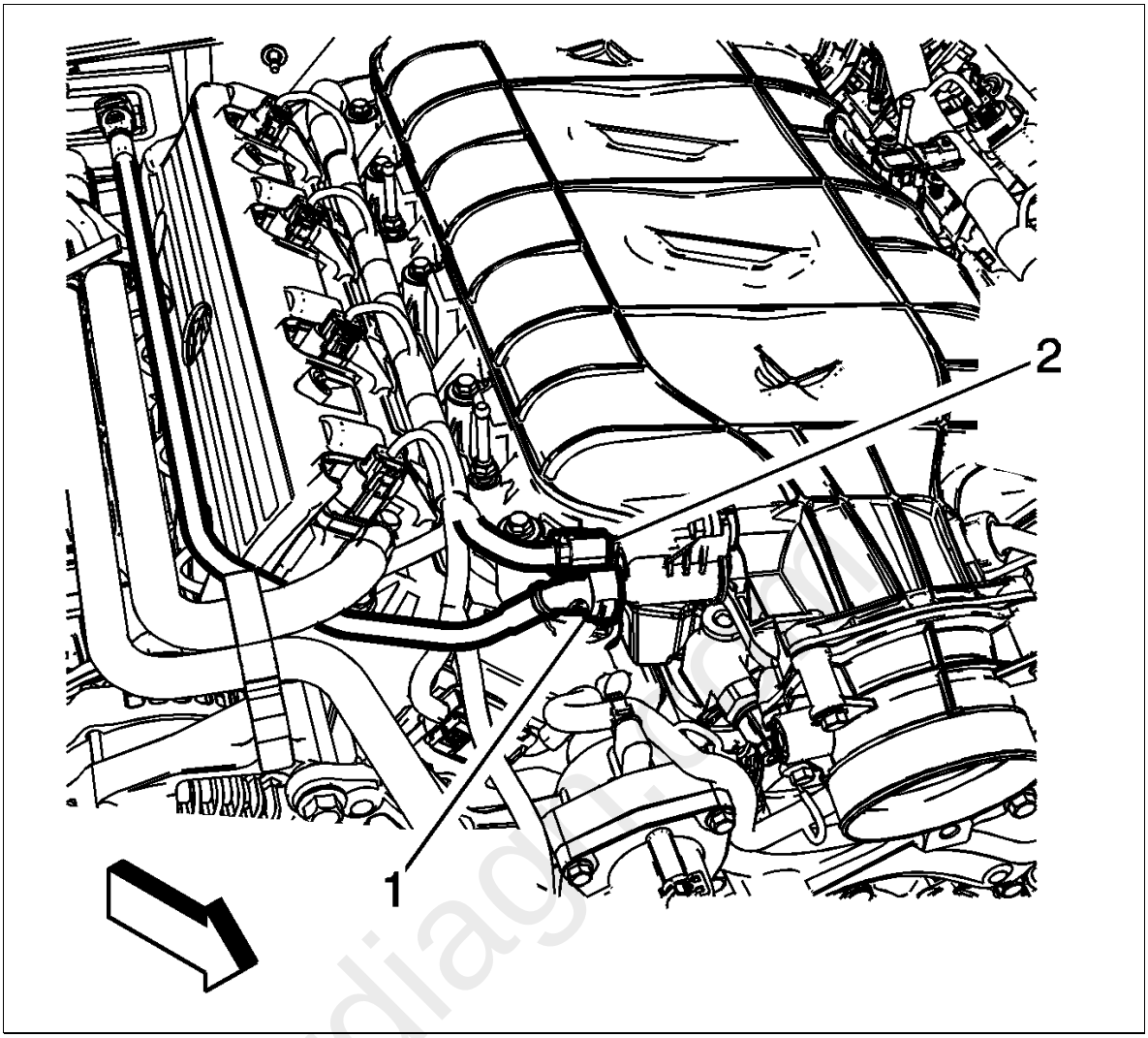
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

6. Tighten the intake manifold bolts to specifications.

Tighten

1. Tighten the bolts a first pass in the sequence shown to 5 N.m (44 lb in).
2. Tighten the bolts a final pass in the sequence shown to 10 N.m (89 lb in).

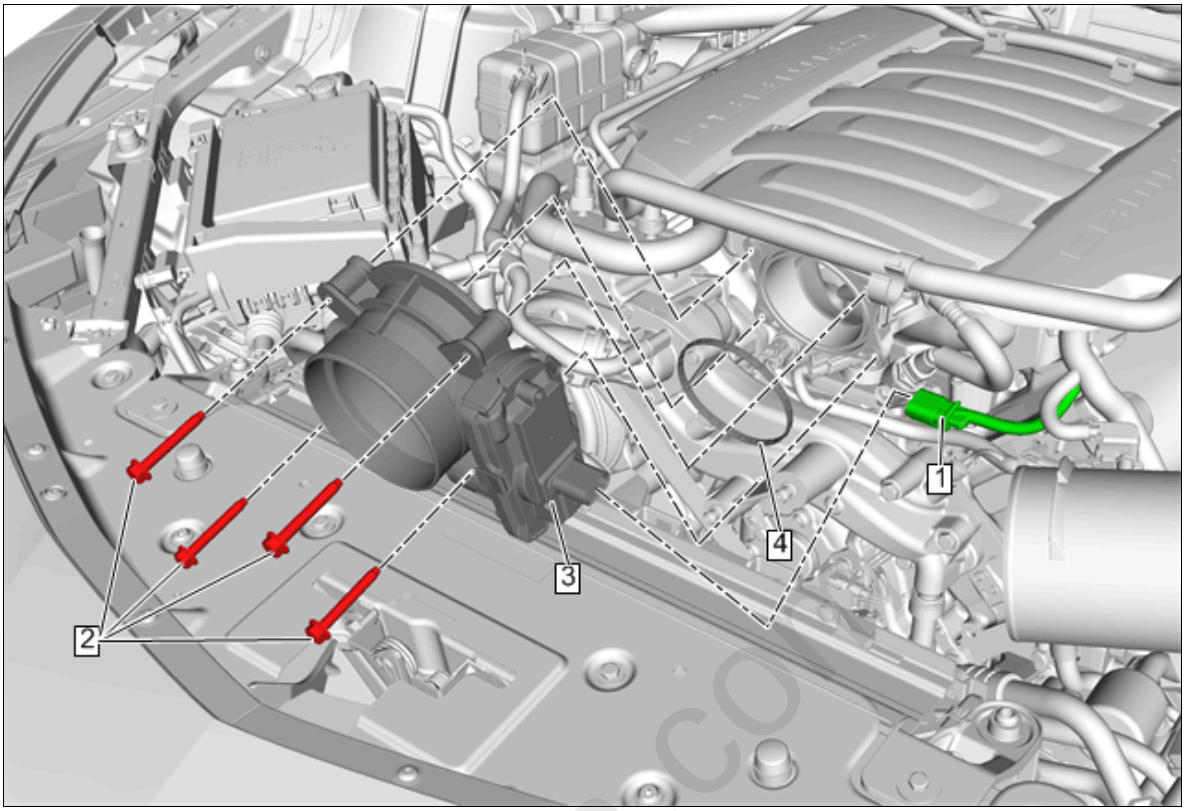
Fig 4: EVAP Canister Purge Tube



Courtesy of GENERAL MOTORS COMPANY

7. Connect the engine harness electrical connector (2) to the evaporative emission (EVAP) canister purge solenoid valve.
8. Connect the EVAP canister purge tube (1) quick connect fitting to the EVAP canister purge solenoid valve.

Fig 5: Throttle Body Assembly

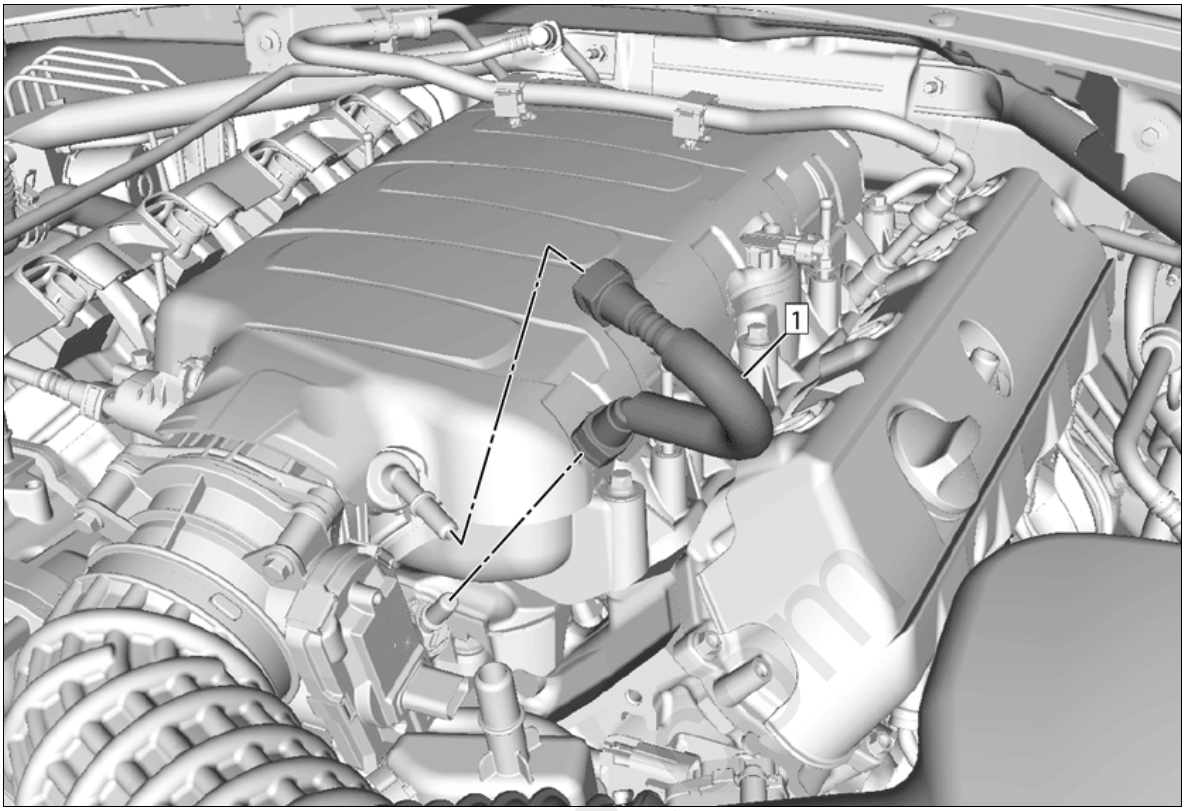


Courtesy of GENERAL MOTORS COMPANY

9. Connect the engine harness electrical connector (1) to the throttle actuator.

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Fig 6: Positive Crankcase Ventilation (PCV) Hose

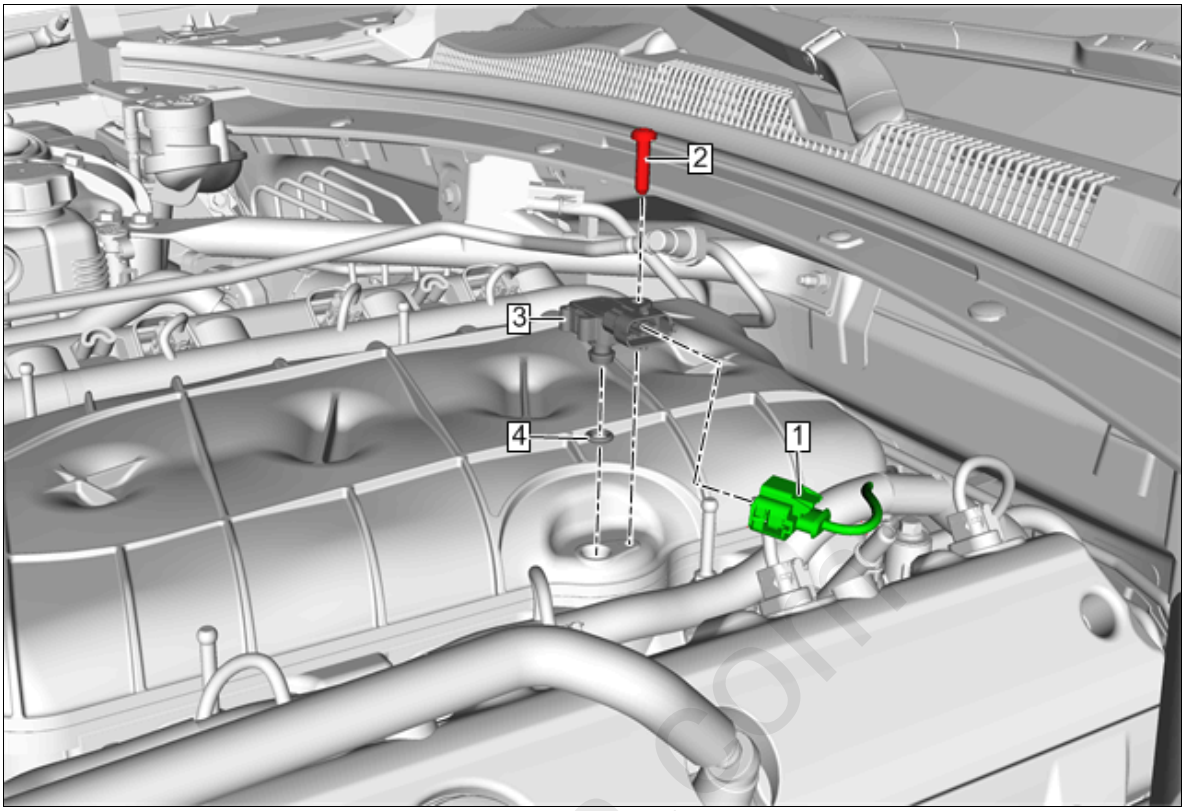


Courtesy of GENERAL MOTORS COMPANY

10. Install the positive crankcase ventilation (PCV) hose (1). Plastic Collar Quick Connect Fitting Service .
11. Install the power brake booster vacuum pipe. Power Brake Booster Vacuum Pipe Replacement .

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Fig 7: Manifold Absolute Pressure Sensor



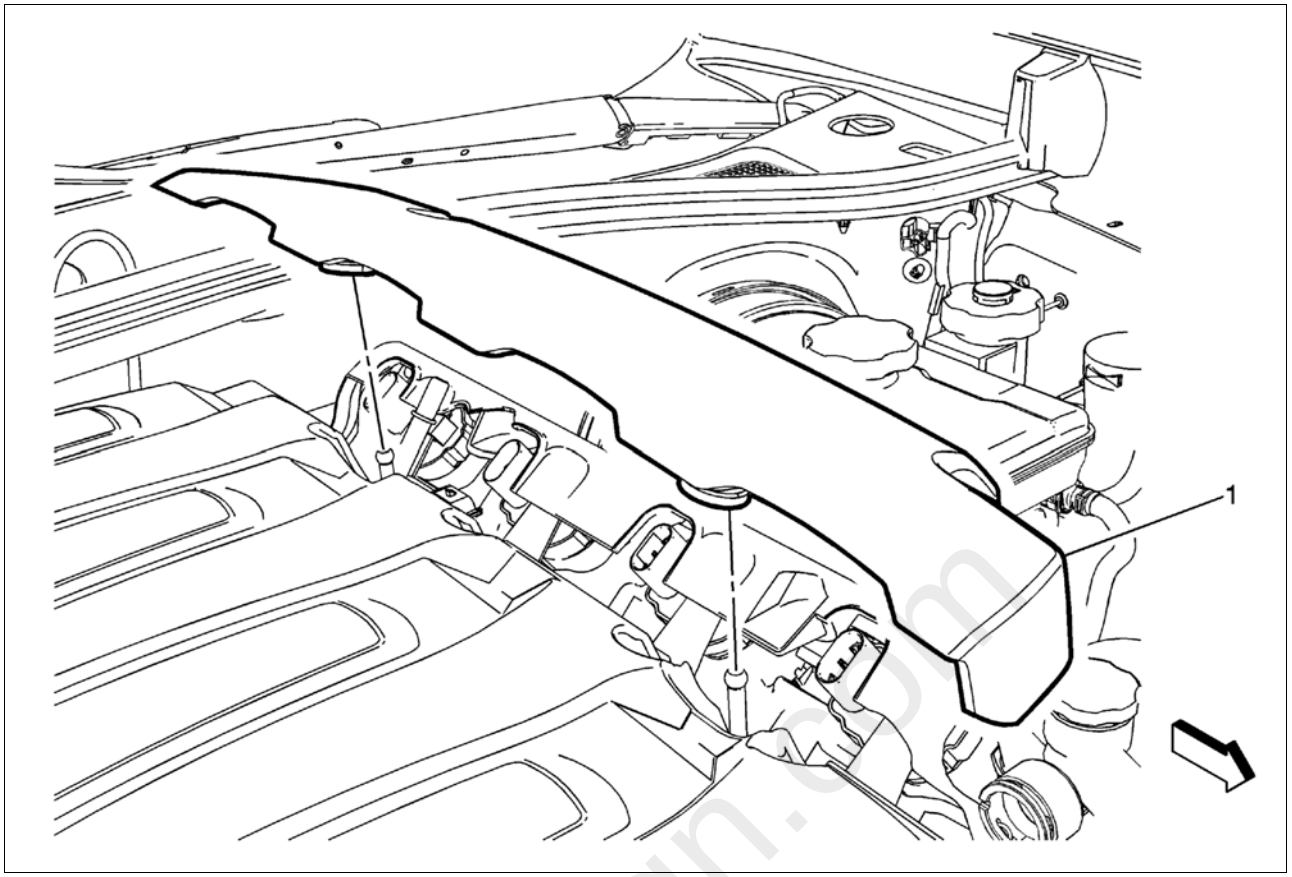
Courtesy of GENERAL MOTORS COMPANY

12. Connect the engine wiring harness electrical connector (1) to the manifold absolute pressure (MAP) sensor.
13. Install the air cleaner outlet duct. Air Cleaner Outlet Duct Replacement .
14. Install the upper intake manifold cover. Upper Intake Manifold Cover Replacement .
15. Connect the battery ground cable. Battery Negative Cable Disconnection and Connection .

REPAIR INSTRUCTIONS - ON VEHICLE > INTAKE MANIFOLD COVER REPLACEMENT (LEFT)

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Fig 1: Intake Manifold Cover (Left)



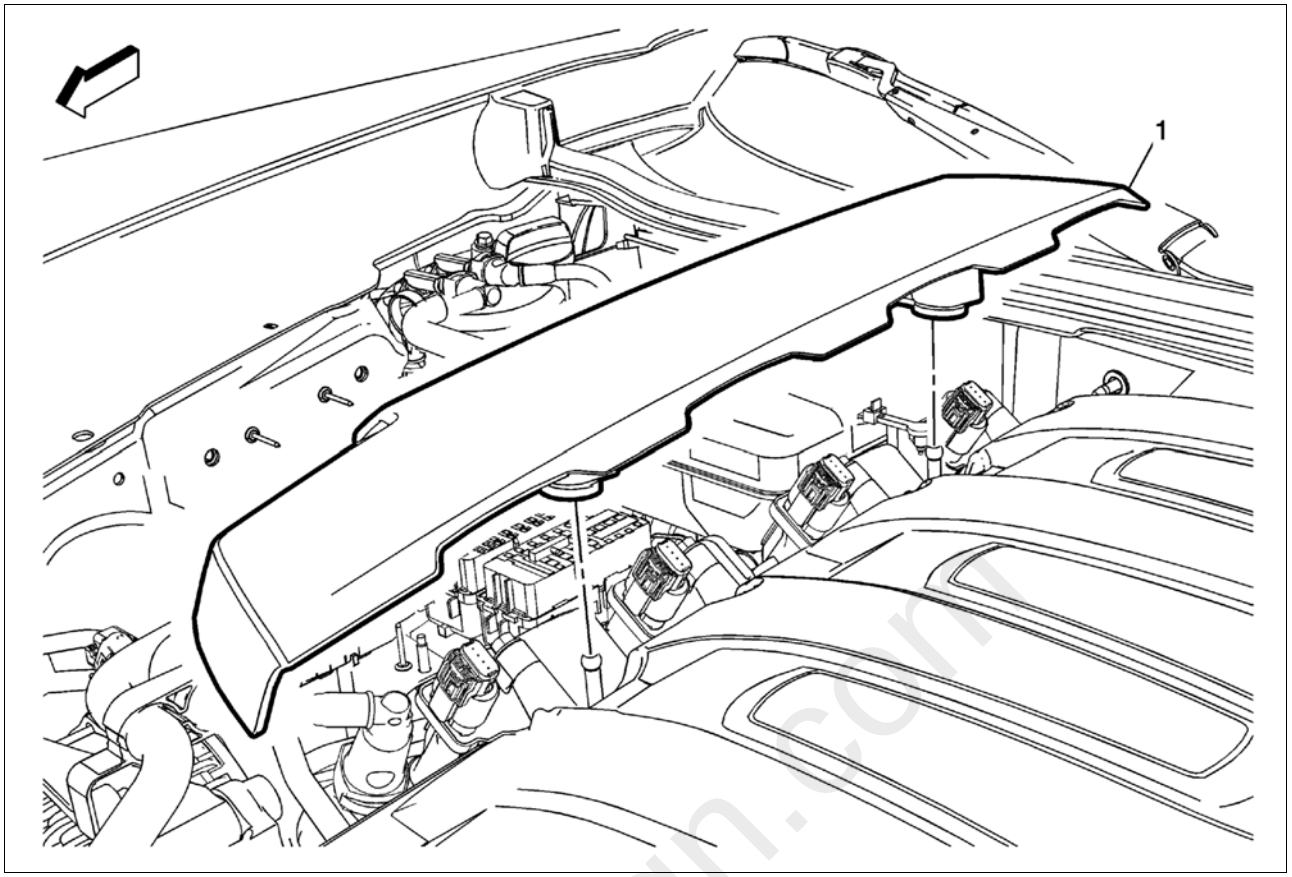
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Cover **Procedure** Grasp the intake manifold cover and lift up disengaging the grommets from the studs.

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REPAIR INSTRUCTIONS - ON VEHICLE > INTAKE MANIFOLD COVER REPLACEMENT (RIGHT)

Fig 1: Intake Manifold Cover (Right)



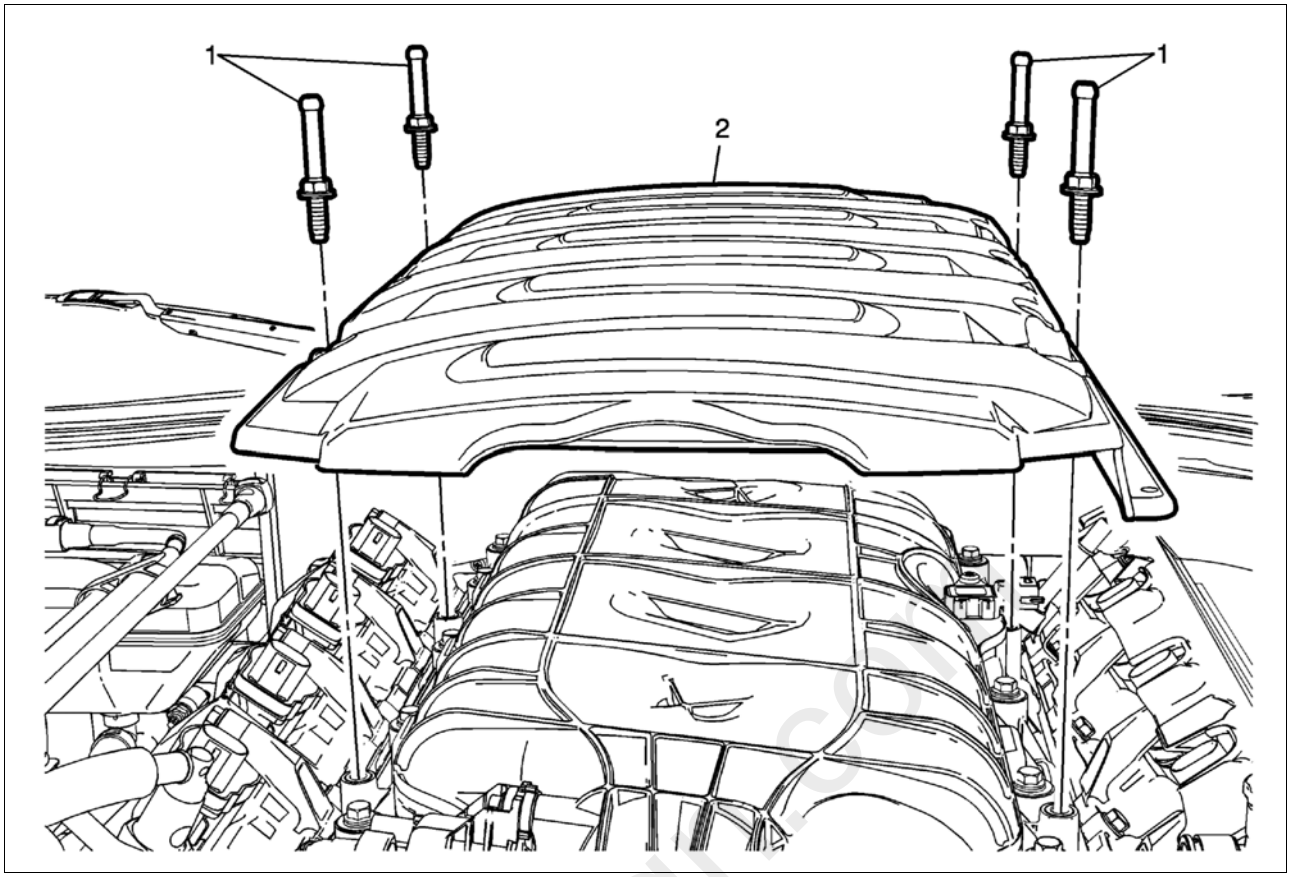
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Cover **Procedure** Grasp the intake manifold cover and lift up disengaging the grommets from the studs.

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REPAIR INSTRUCTIONS - ON VEHICLE > UPPER INTAKE MANIFOLD COVER REPLACEMENT

Fig 1: Upper Intake Manifold Cover



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the left and right side intake manifold covers. Intake Manifold Cover Replacement (Left) Intake Manifold Cover Replacement (Right) . 2. Disconnect Fuel Feed Front Hose at Upper Intake Manifold Cover-Fuel Feed Front Hose Replacement	
1	Upper Intake Manifold Cover Fasteners *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (89 lb in)

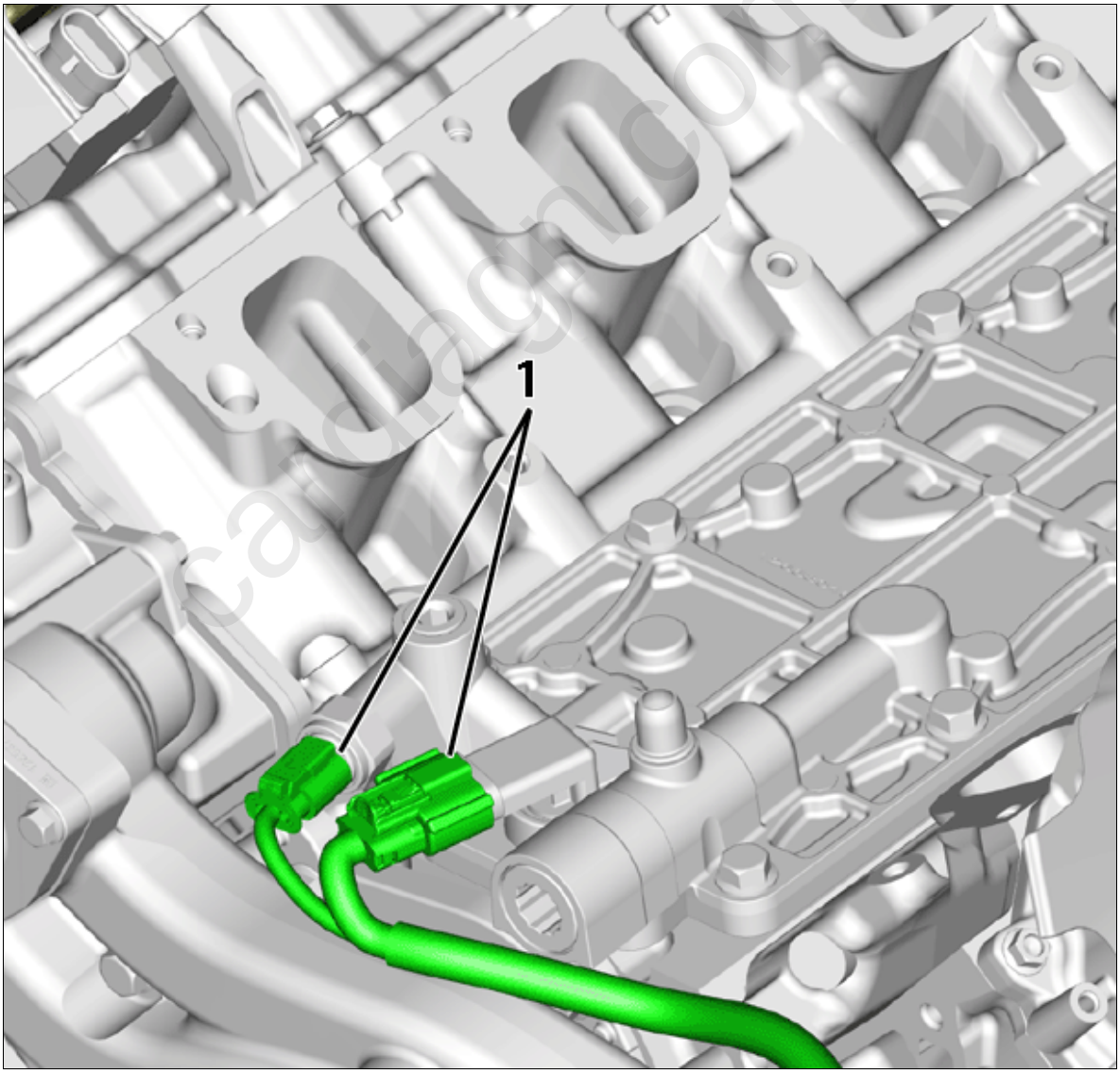
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2	Upper Intake Manifold Cover **Procedure** 1. Disconnect the manifold absolute pressure sensor electrical connector. 2. Detach the engine wiring harness from the upper intake manifold cover.

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER OIL MANIFOLD REPLACEMENT > REMOVAL PROCEDURE

1. Remove the fuel pump. Fuel Pump Replacement .
2. Remove the fuel injection fuel rail assemblies. Fuel Injection Fuel Rail Assembly Replacement - Bank 1 , and Fuel Injection Fuel Rail Assembly Replacement - Bank 2 .

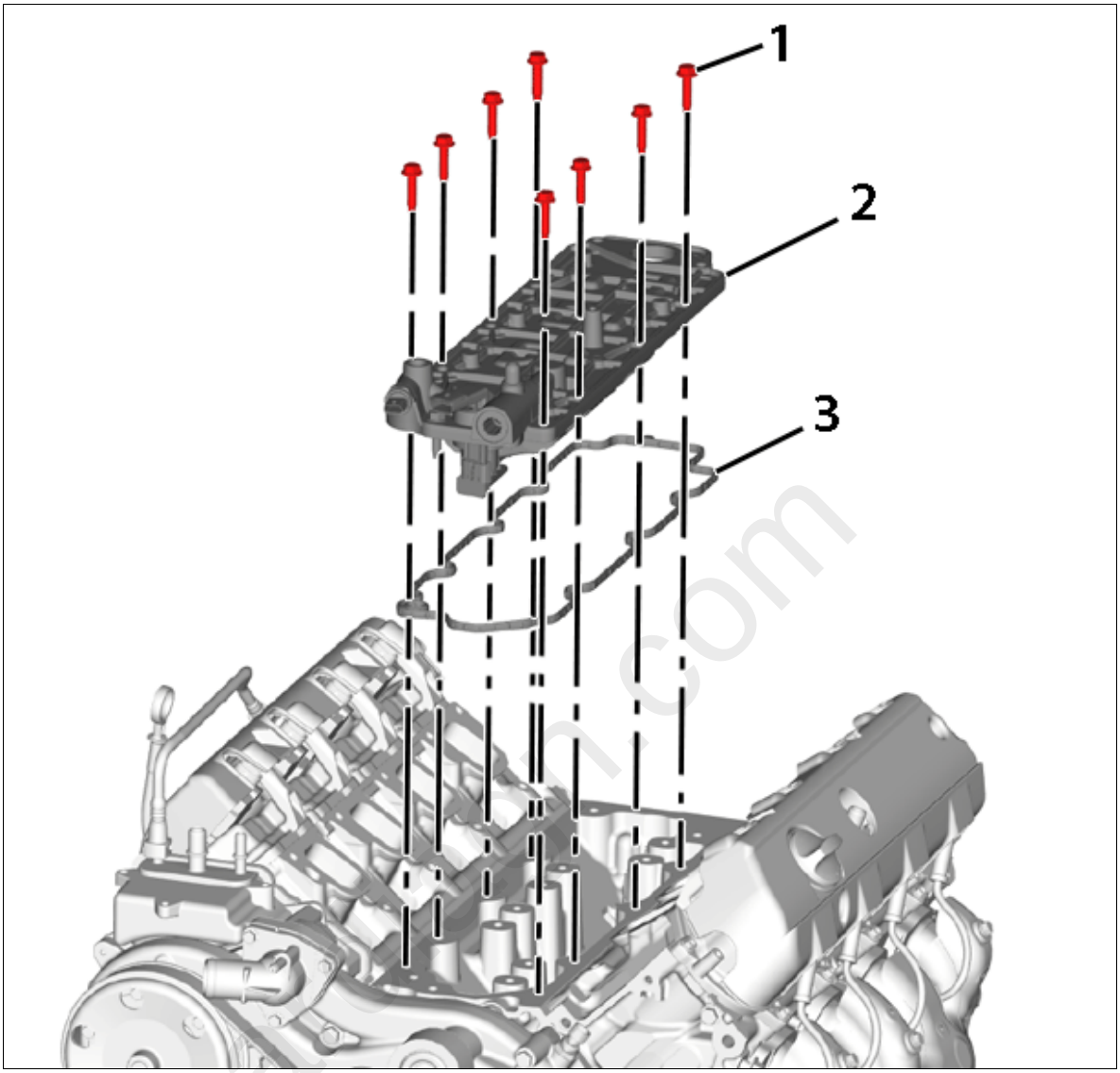
Fig 1: Two Electrical Connectors



Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the two electrical connectors (1).

Fig 2: Valve Lifter Oil Manifold Bolts



Courtesy of GENERAL MOTORS COMPANY

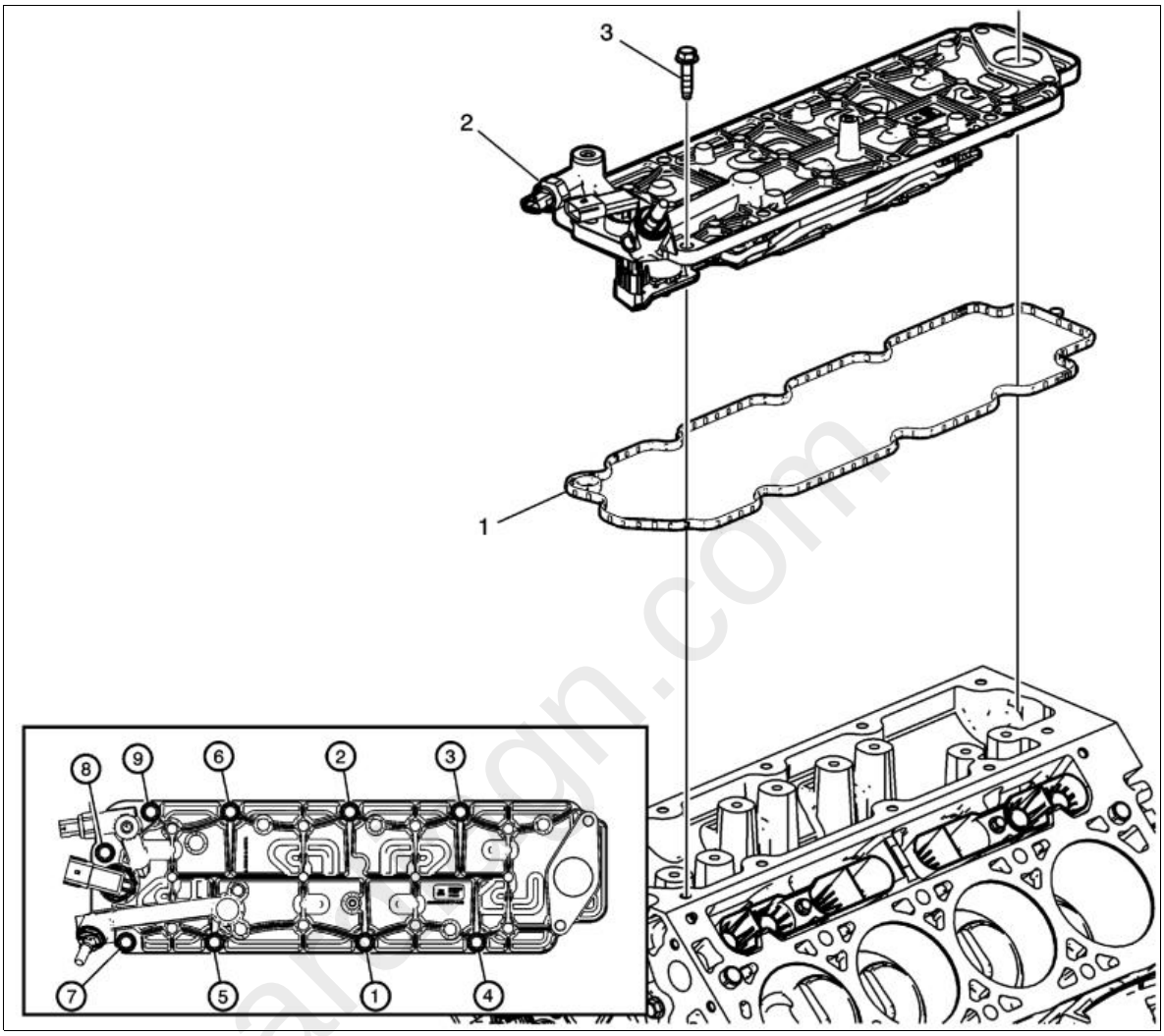
4. Remove the valve lifter oil manifold bolts (1).
5. Remove the valve lifter oil manifold (2).
6. Remove the gasket (3) from the valve lifter oil manifold and DISCARD.
7. Transfer parts as necessary.

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER OIL MANIFOLD REPLACEMENT > INSTALLATION PROCEDURE

NOTE:

All gasket surfaces should be free of oil or other foreign material during assembly.

Fig 1: Valve Lifter Oil Manifold



Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket (1) on the valve lifter oil manifold.
2. Set the valve lifter oil manifold (2) onto the engine.

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

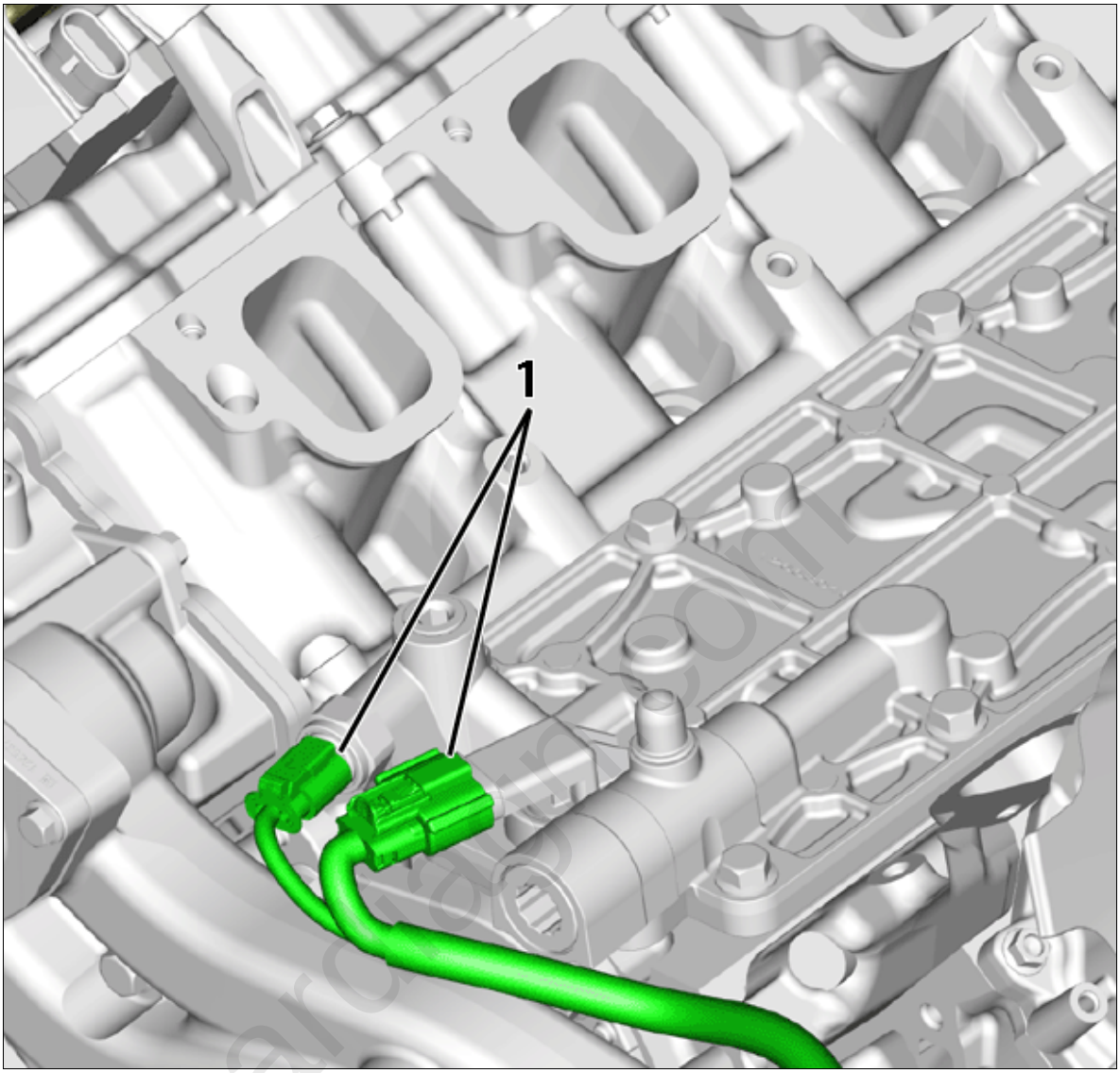
3. Install the valve lifter oil manifold bolts (3).

   Tighten

   1. First pass in sequence 15 N.m (11 lb ft).

2. Final pass in sequence 30 N.m (22 lb ft).

Fig 2: Two Electrical Connectors



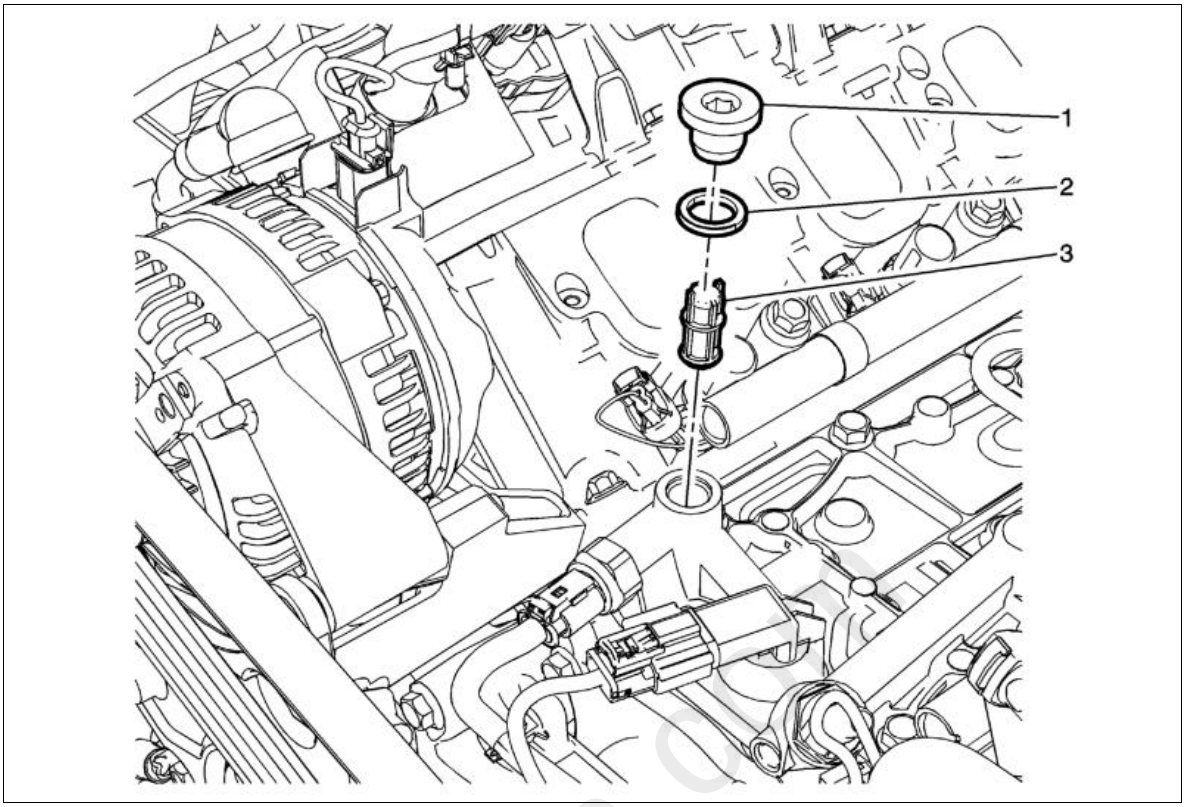
Courtesy of GENERAL MOTORS COMPANY

4. Connect the two electrical connectors (1).
5. Install the fuel injection fuel rail assemblies. Fuel Injection Fuel Rail Assembly Replacement - Bank 1 , and Fuel Injection Fuel Rail Assembly Replacement - Bank 2 .
6. Install the fuel pump. Fuel Pump Replacement .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER OIL FILTER REPLACEMENT > REMOVAL PROCEDURE

1. Remove the intake manifold. Intake Manifold Replacement .

Fig 1: Drive Motor Oil Filler Hole Plug And Washer



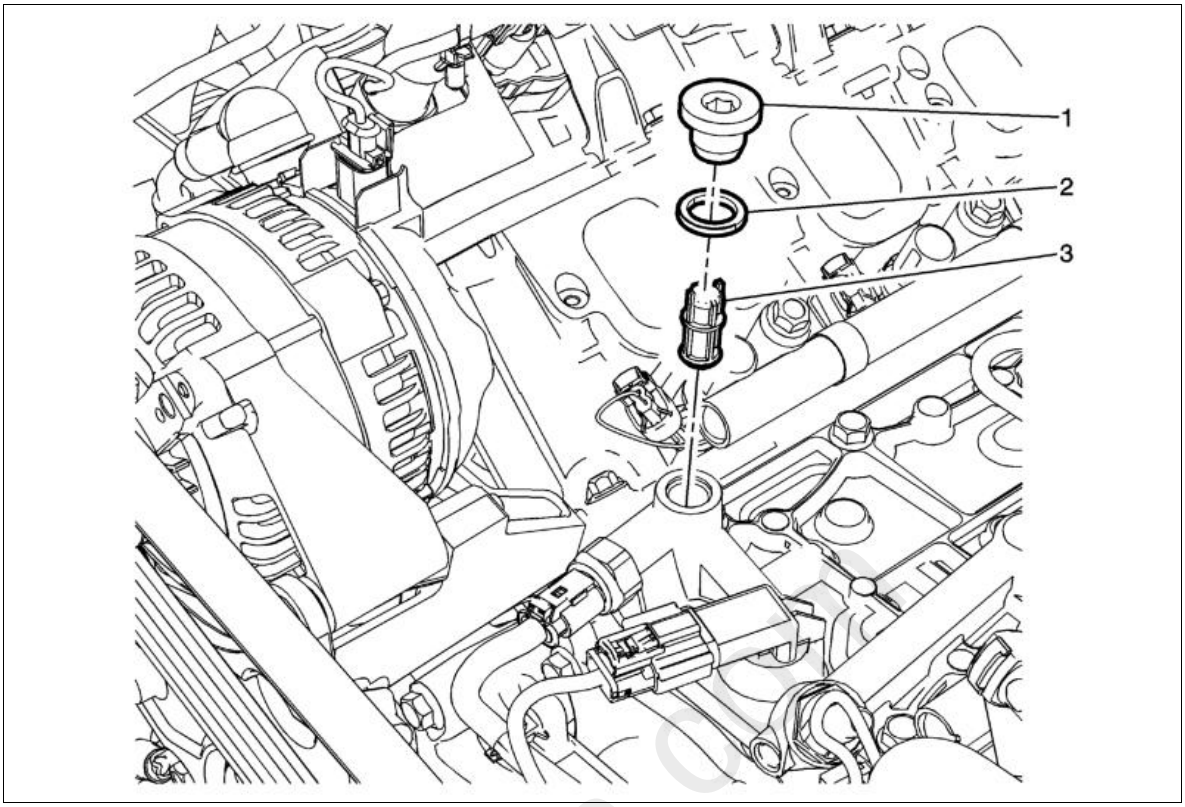
Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive motor oil filler hole plug (1) and washer (2).
3. Remove and DISCARD the valve lifter oil filter (3).

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER OIL FILTER REPLACEMENT > INSTALLATION PROCEDURE

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Fig 1: Drive Motor Oil Filler Hole Plug And Washer



Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW valve lifter oil filter (3).
2. Apply approved GM sealant or equivalent to the threads of the drive motor oil filler hole plug. Adhesives, Fluids, Lubricants, and Sealers .

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

3. Install the drive motor oil filler hole plug washer (2) and plug (1).

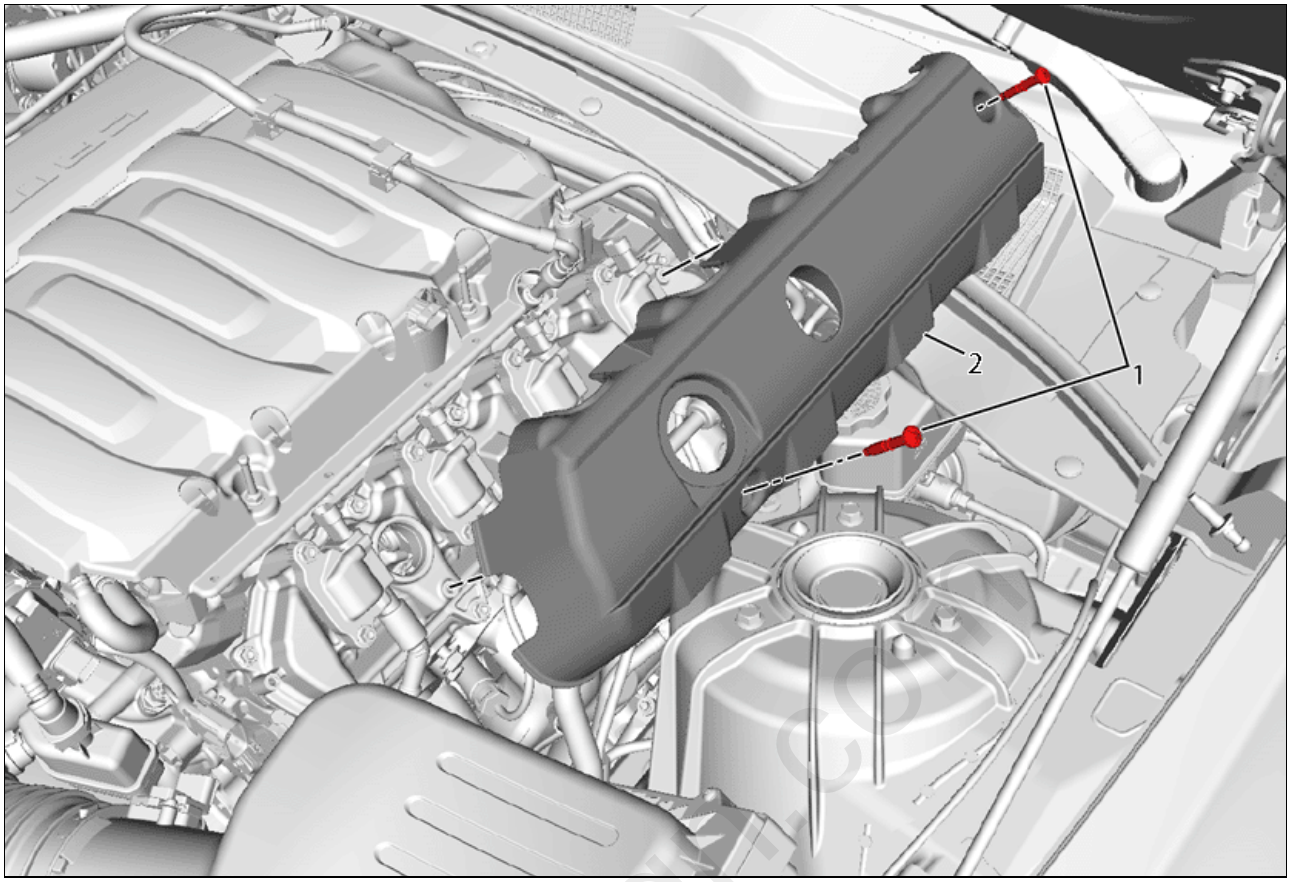
   Tighten

   Tighten the plug to 30 N.m (22 lb ft).

4. Install the intake manifold. Intake Manifold Replacement .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM COVER INSULATOR REPLACEMENT - LEFT SIDE

Fig 1: Valve Rocker Arm Cover Insulator - Left Side



Courtesy of GENERAL MOTORS COMPANY

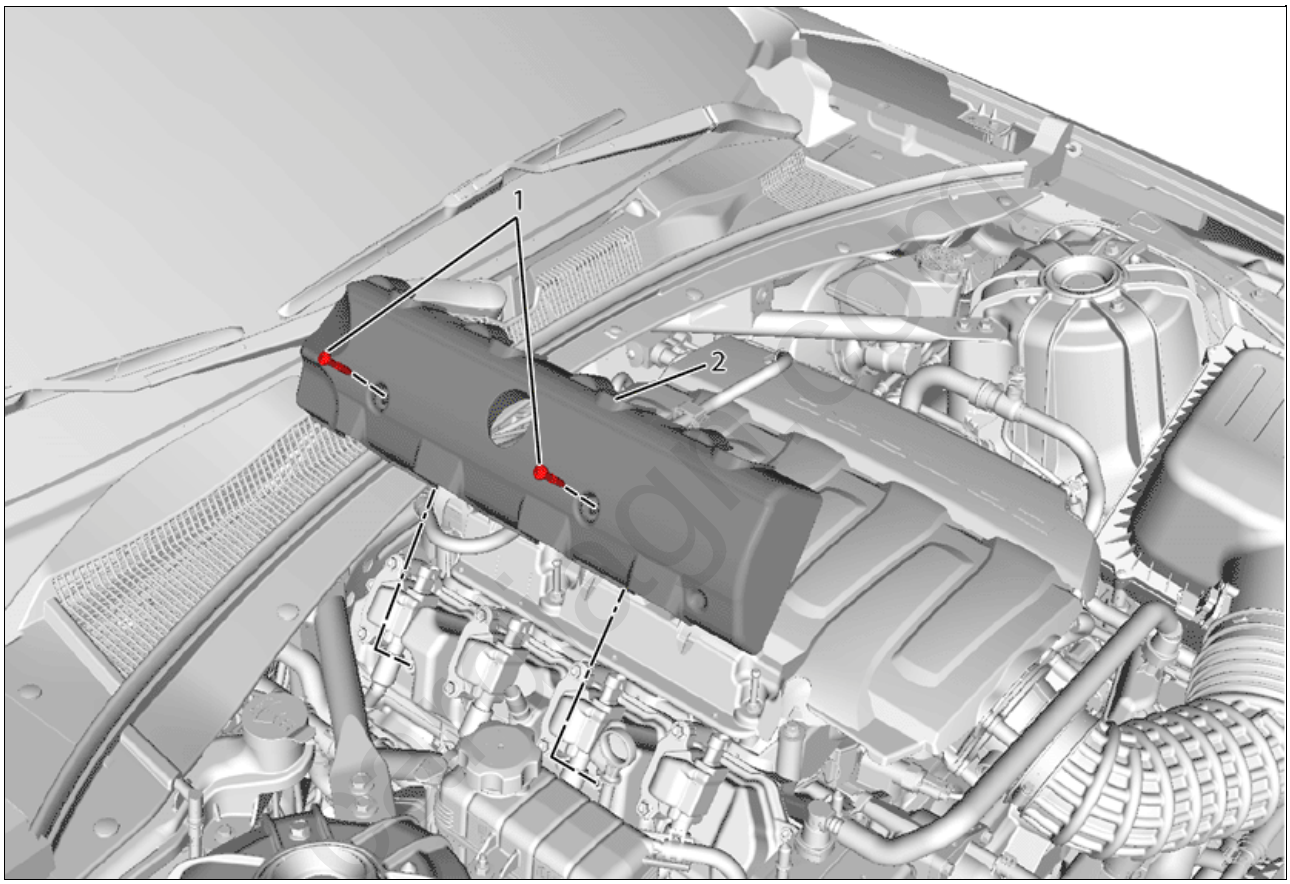
Callout	Component Name
Preliminary Procedures 1. Intake Manifold Cover Replacement (Left) Intake Manifold Cover Replacement (Right) 2. Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Oil Separator To Air Cleaner Outlet Duct) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Left Rocker Arm Cover To Oil Separator) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Right Rocker Arm Cover To Oil Separator) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Intake Manifold To PCV Valve)	
1	Valve Rocker Arm Cover Insulator Fasteners (Qty: 2) *CAUTION:* *Refer to Fastener Caution .* **Tighten**

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	9 N.m (80 lb in)
2	Valve Rocker Arm Cover Insulator **Procedure** Remove the oil filler cap

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM COVER INSULATOR REPLACEMENT - RIGHT SIDE

Fig 1: Valve Rocker Arm Cover Insulator - Right Side



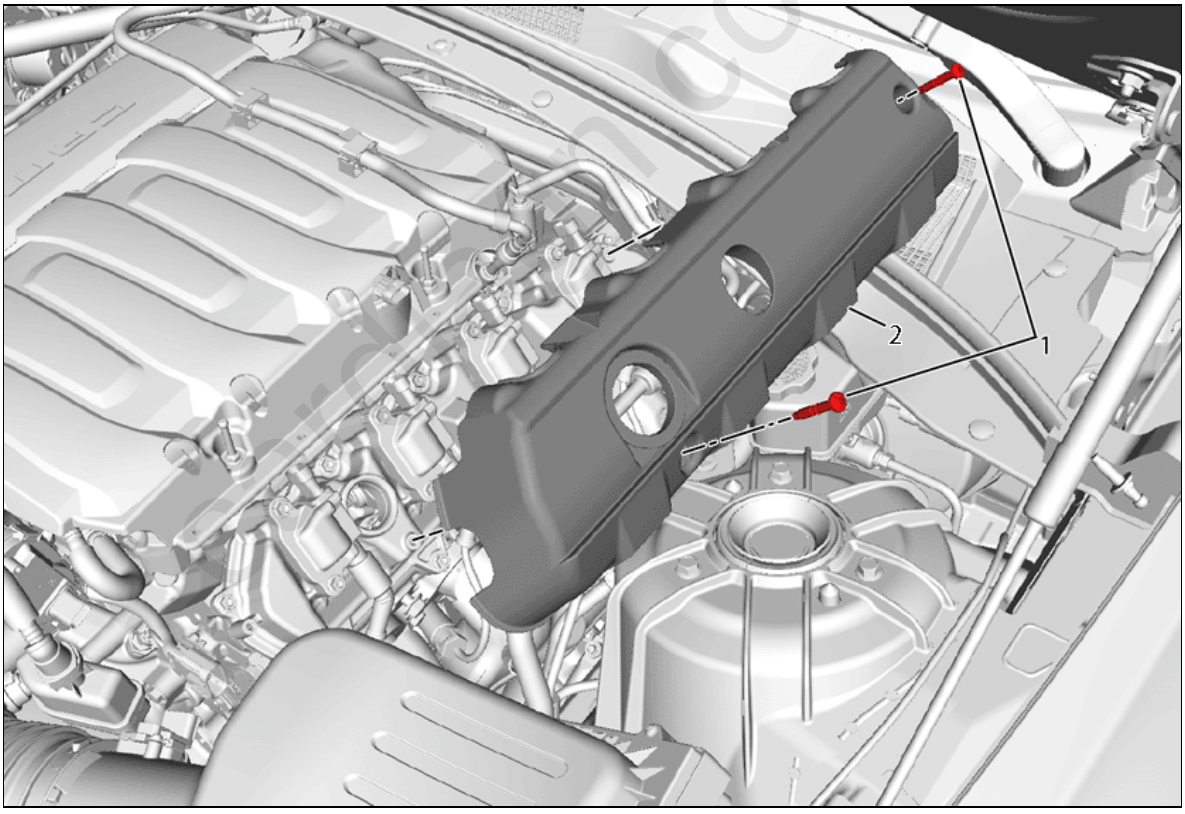
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Intake Manifold Cover Replacement (Left) Intake Manifold Cover Replacement (Right) 2. Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Oil Separator To Air Cleaner Outlet Duct) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Left Rocker Arm Cover To Oil Separator) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Right Rocker Arm Cover To Oil Separator) Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Intake Manifold To PCV Valve)	

1	Valve Rocker Arm Cover Insulator Fasteners (Qty: 2) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 9 N.m (80 lb in)
2	Valve Rocker Arm Cover Insulator

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE > REMOVAL PROCEDURE

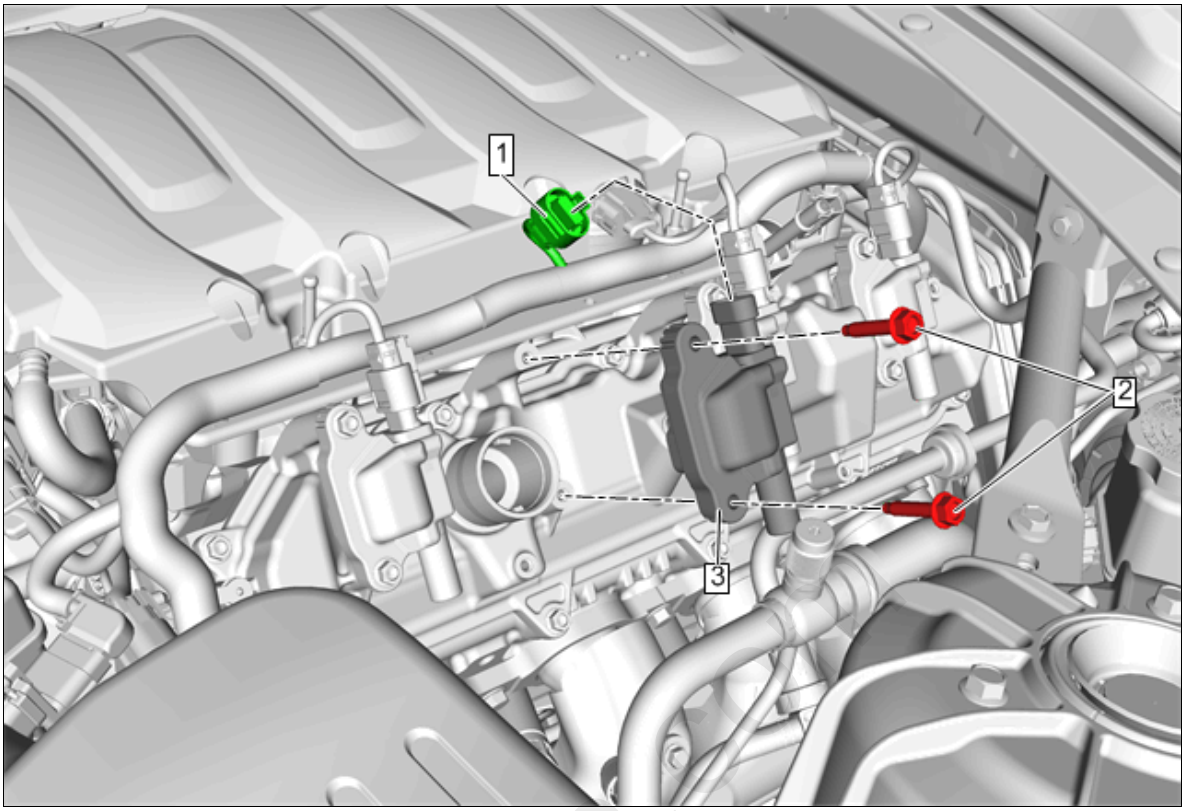
Fig 1: Left Rocker Arm Cover Insulator



Courtesy of GENERAL MOTORS COMPANY

1. Remove the left rocker arm cover insulator. Valve Rocker Arm Cover Insulator Replacement - Left Side

Fig 2: Ignition Coil (Bank 1)

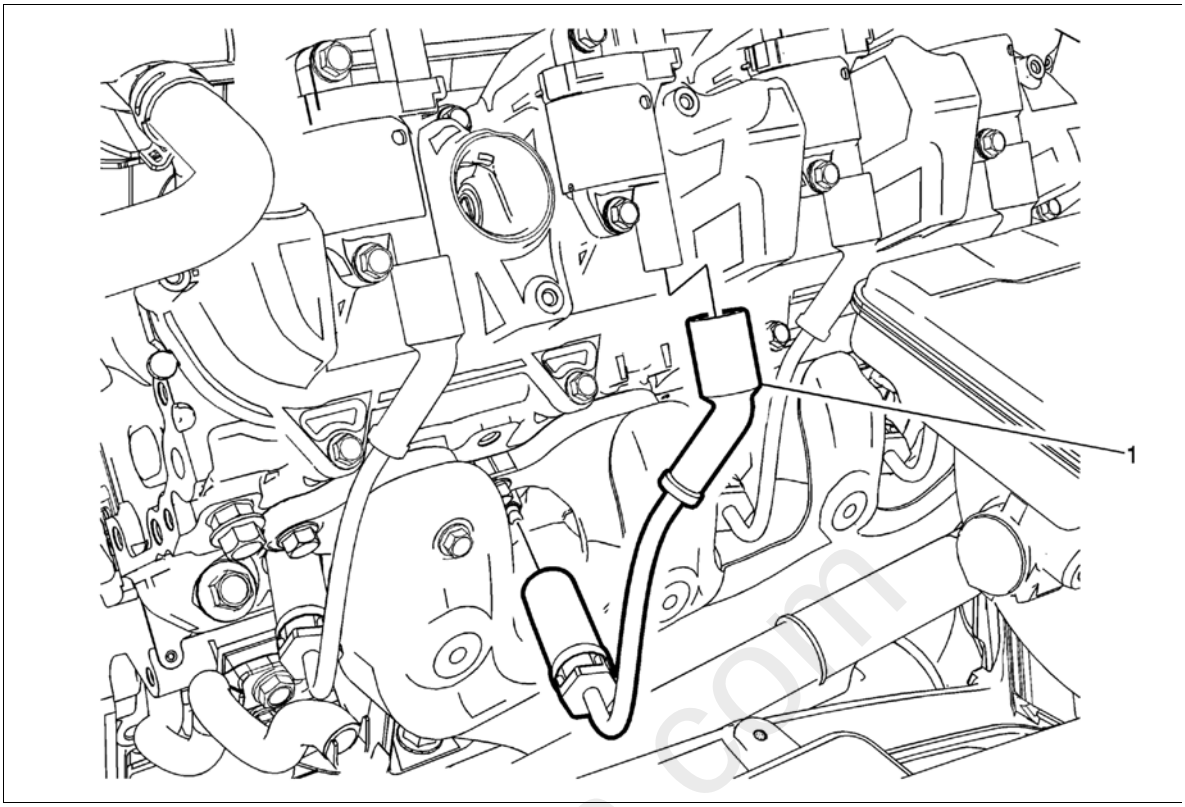


Courtesy of GENERAL MOTORS COMPANY

2. Disconnect bank 1 ignition coil electrical connectors (1)

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Fig 3: Spark Plug Wire

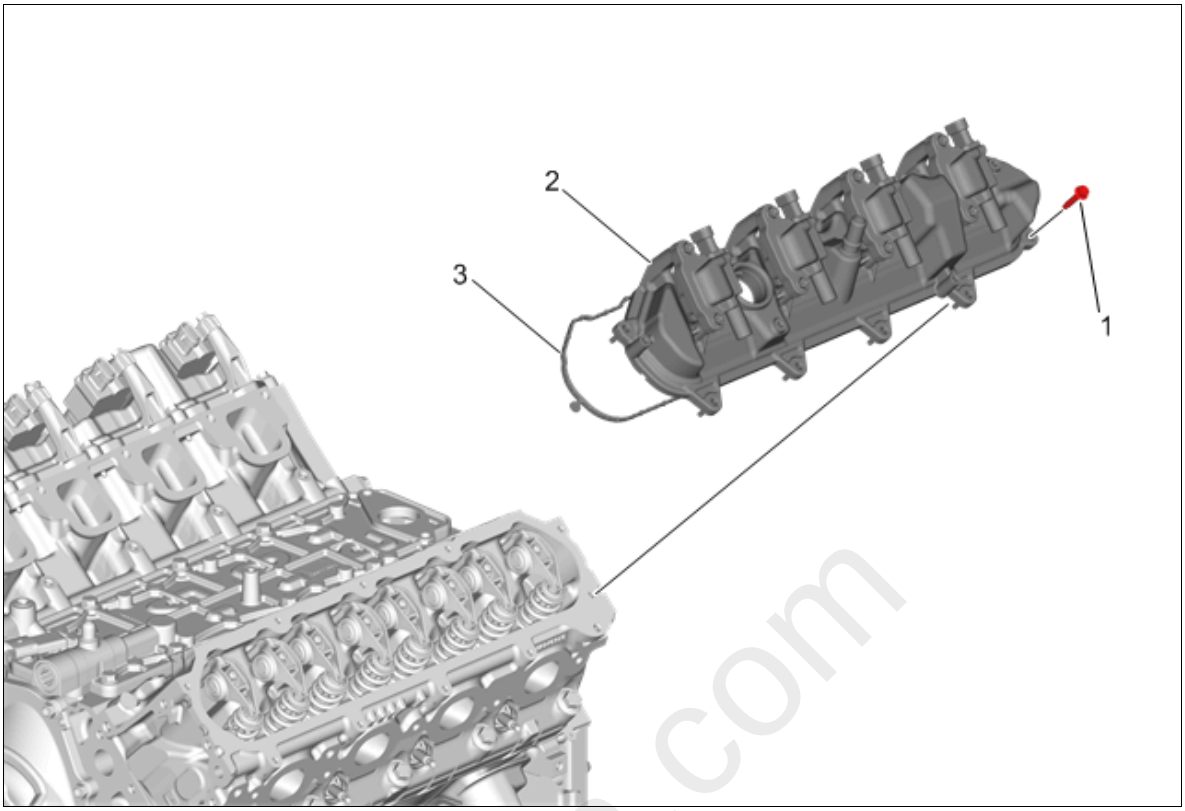


Courtesy of GENERAL MOTORS COMPANY

3. Disconnect spark wires at bank 1 ignition coils.

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Fig 4: Valve Rocker Arm Cover Bolts



Courtesy of GENERAL MOTORS COMPANY

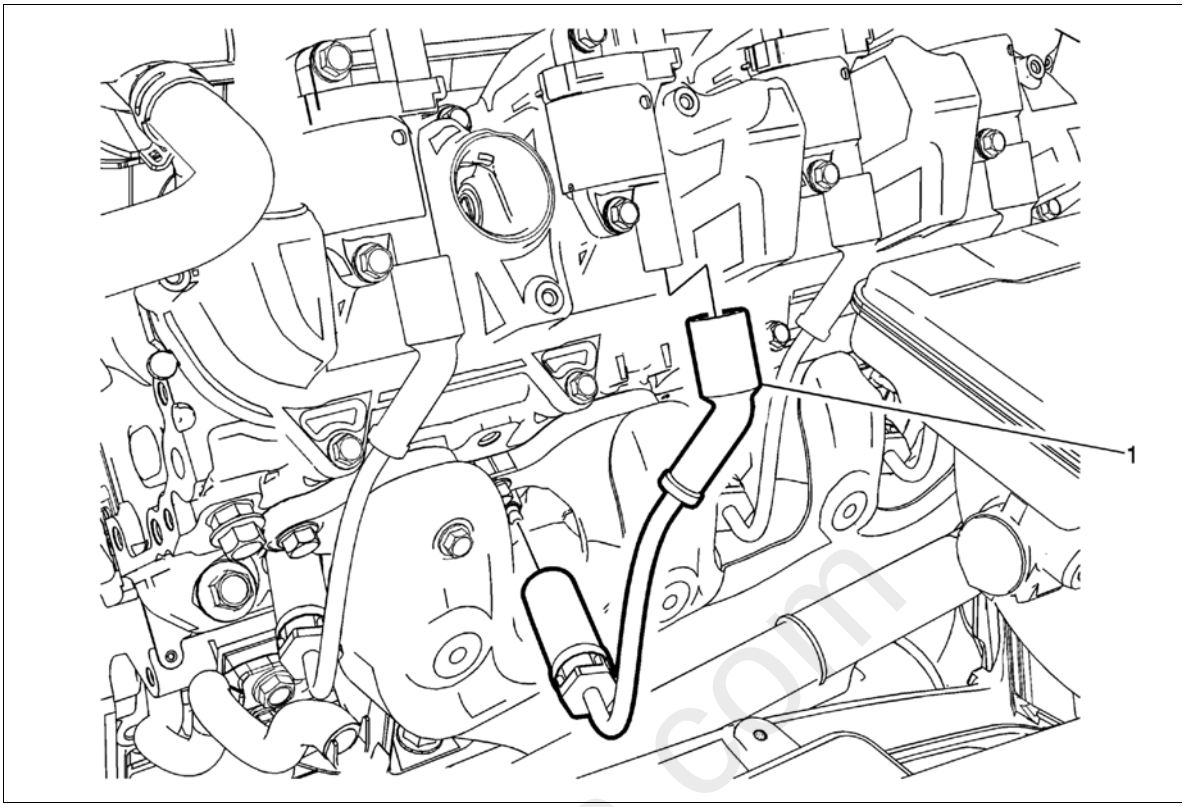
4. Remove the valve rocker arm cover bolts (1) (Qty: 10)
5. Remove the valve rocker arm cover (2)
6. Remove and discard the valve rocker arm cover gasket (3)
7. Clean and inspect the valve rocker arm cover. Valve Rocker Arm Cover Cleaning and Inspection .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE > INSTALLATION PROCEDURE

1. Install the valve rocker arm cover. Valve Rocker Arm Cover Installation - Left Side

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Fig 1: Spark Plug Wire

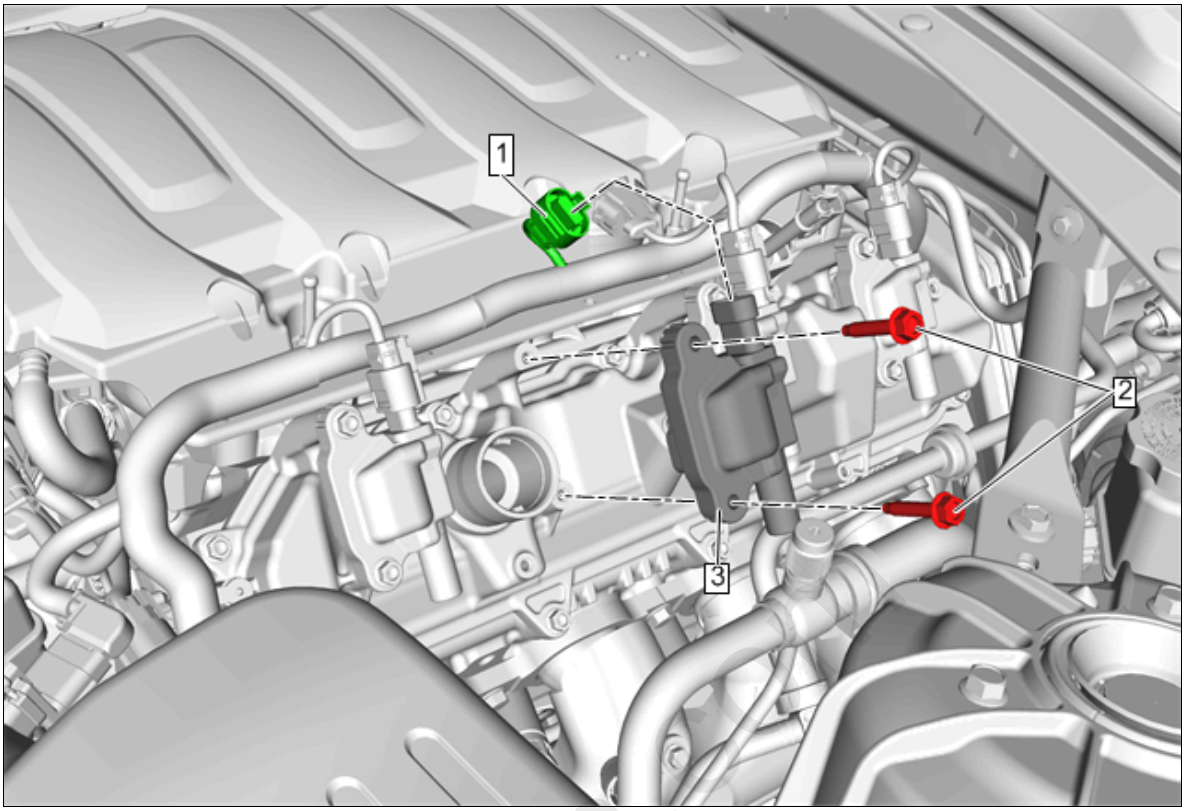


Courtesy of GENERAL MOTORS COMPANY

2. Connect spark wires at bank 2 ignition coils.

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Fig 2: Ignition Coil (Bank 1)

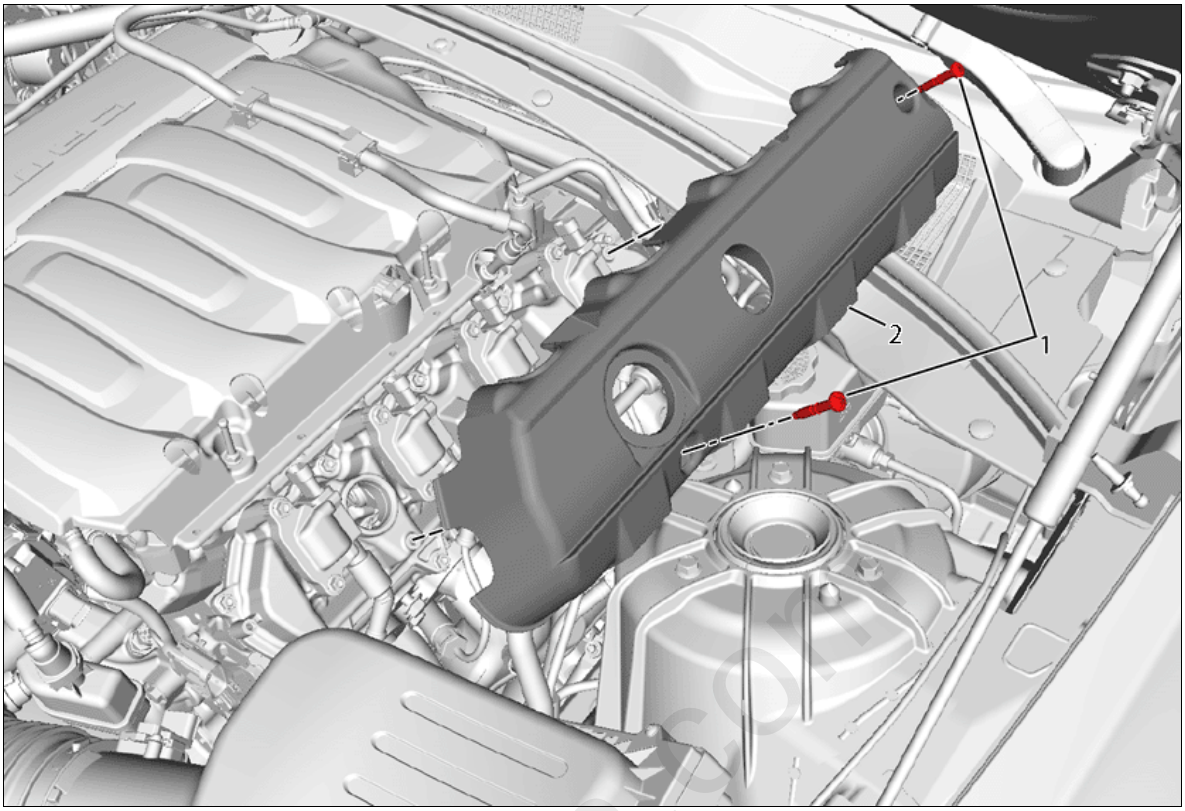


Courtesy of GENERAL MOTORS COMPANY

3. Connect bank 2 ignition coil electrical connectors (1)

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Fig 3: Left Rocker Arm Cover Insulator



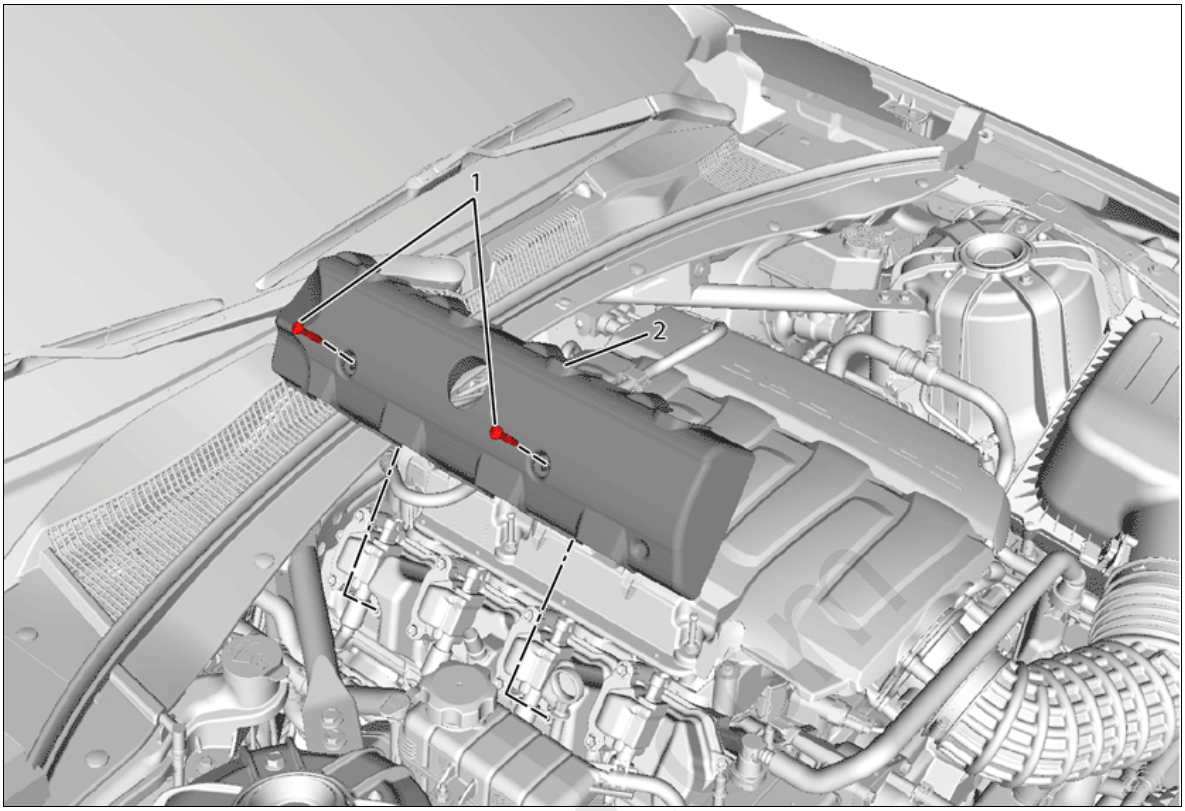
Courtesy of GENERAL MOTORS COMPANY

4. Install the left rocker arm cover insulator. Valve Rocker Arm Cover Insulator Replacement - Left Side

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE > REMOVAL PROCEDURE

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Fig 1: Right Rocker Arm Cover Insulator

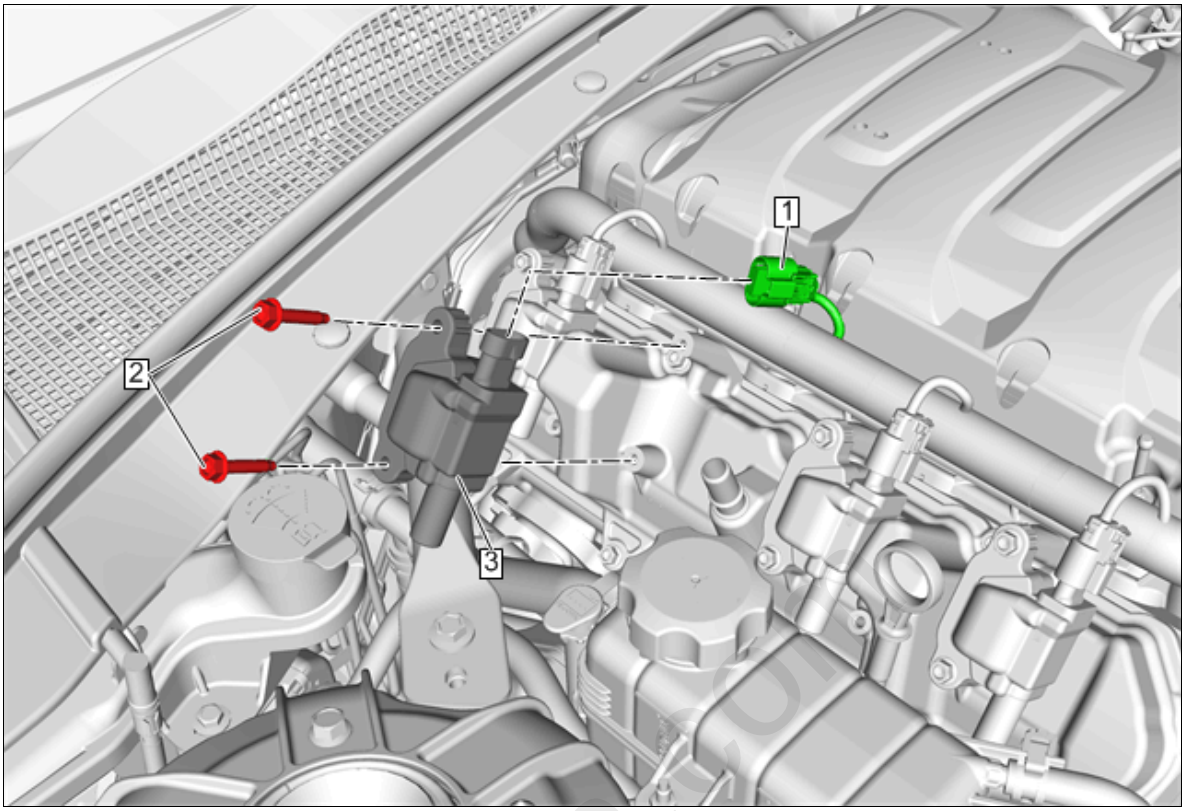


Courtesy of GENERAL MOTORS COMPANY

1. Remove the right rocker arm cover insulator. Valve Rocker Arm Cover Insulator Replacement - Right Side
2. Remove the oil level indicator tube bracket bolt. Oil Level Indicator Tube Replacement

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Fig 2: Ignition Coil (Bank 2)

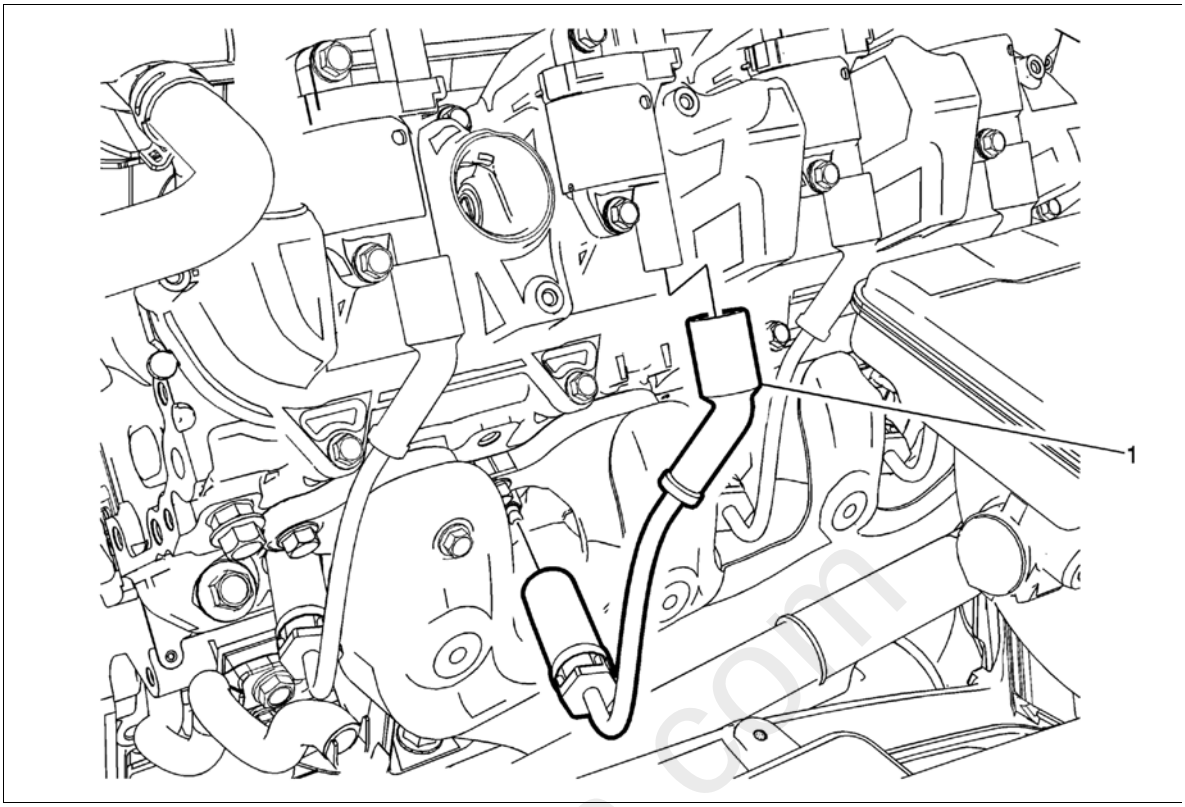


Courtesy of GENERAL MOTORS COMPANY

3. Disconnect bank 2 ignition coil electrical connectors (1)

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Fig 3: Spark Plug Wire

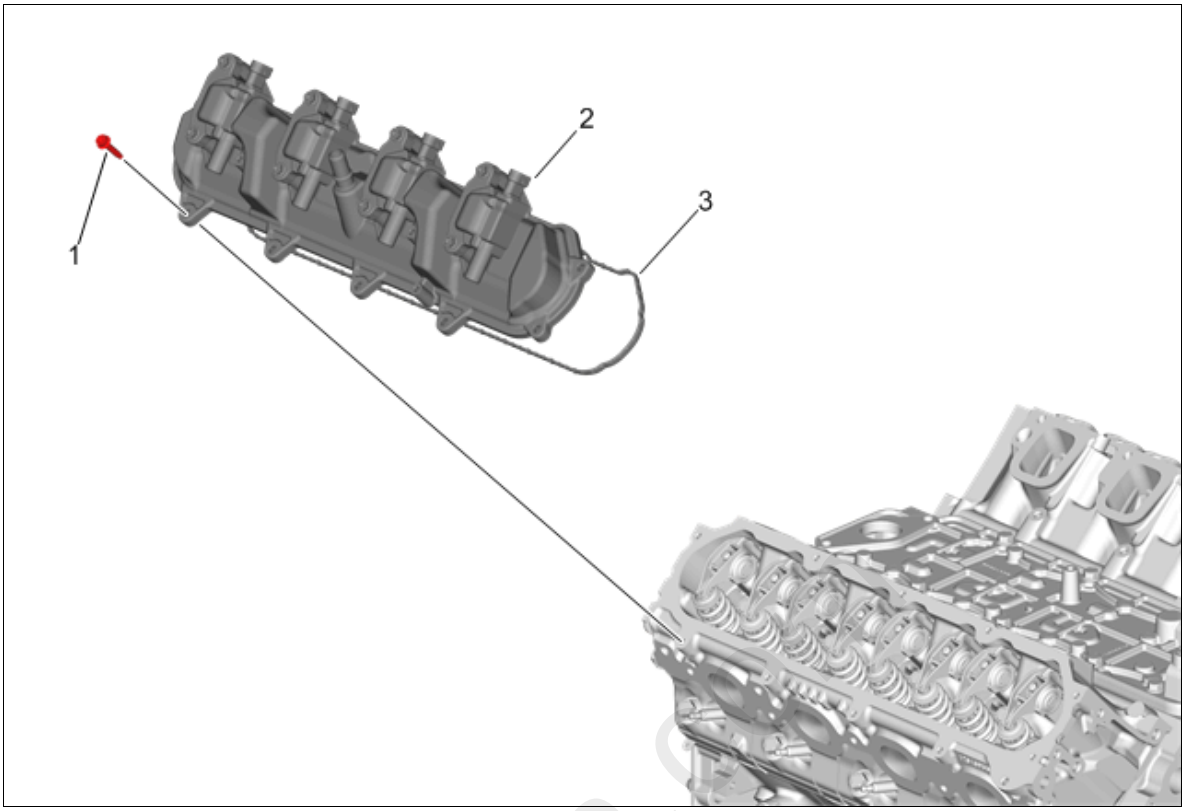


Courtesy of GENERAL MOTORS COMPANY

4. Disconnect spark wires at bank 2 ignition coils.

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Fig 4: Valve Rocker Arm Cover Bolts



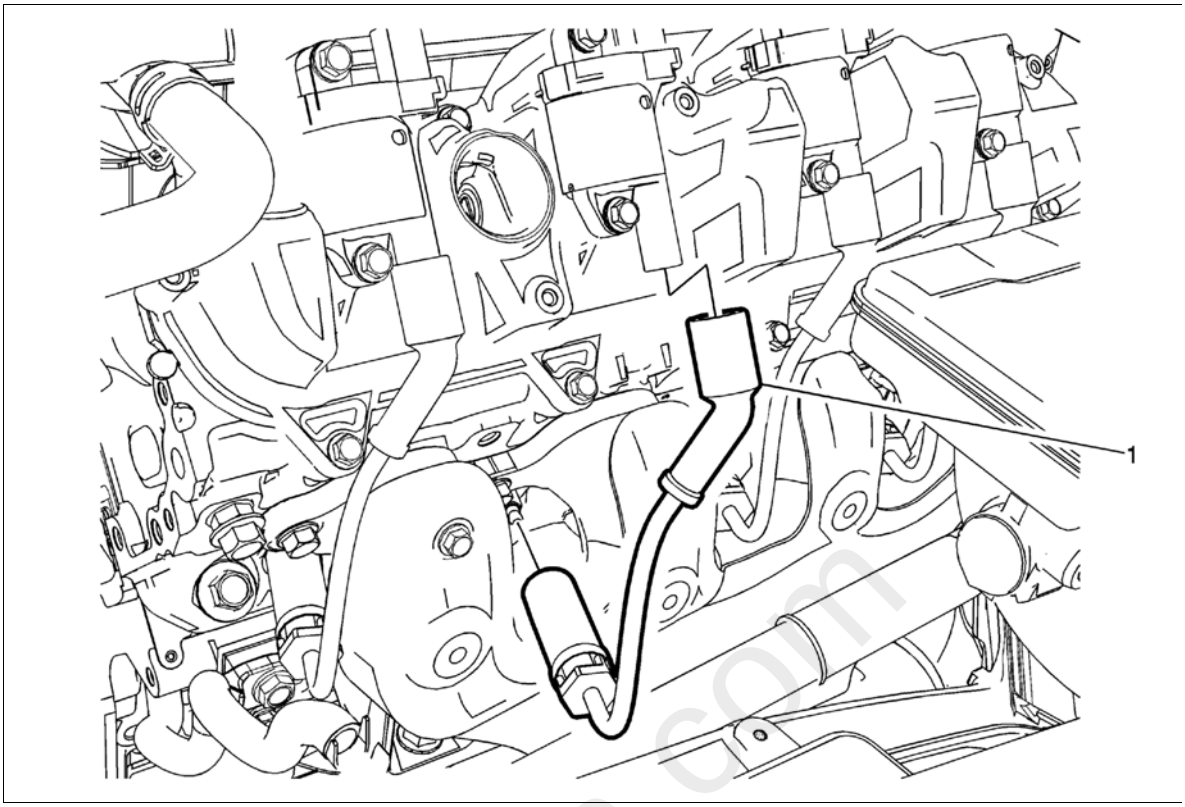
Courtesy of GENERAL MOTORS COMPANY

5. Remove the valve rocker arm cover bolts (1) (Qty: 10)
6. Remove the valve rocker arm cover (2)
7. Remove and discard the valve rocker arm cover gasket (3)
8. Clean and inspect the valve rocker arm cover. Valve Rocker Arm Cover Cleaning and Inspection .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE > INSTALLATION PROCEDURE

1. Install the valve rocker arm cover. Valve Rocker Arm Cover Installation - Right Side

Fig 1: Spark Plug Wire

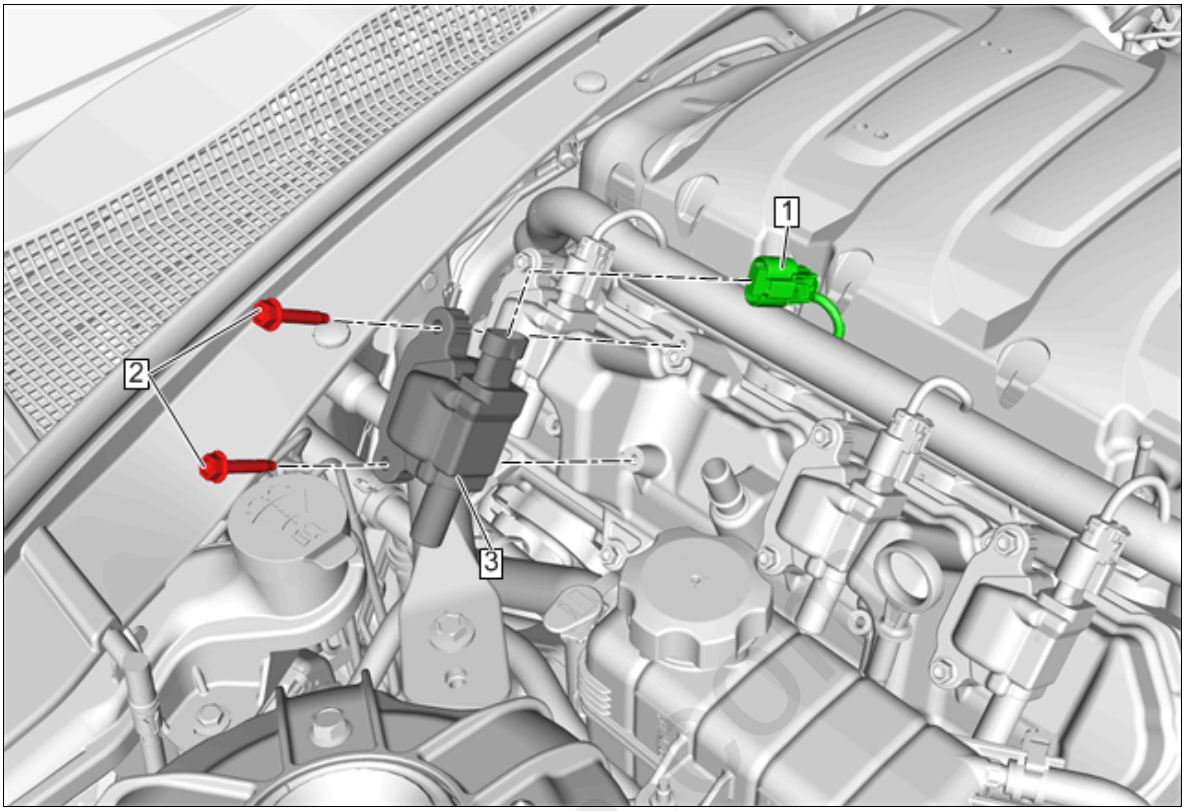


Courtesy of GENERAL MOTORS COMPANY

2. Connect spark wires at bank 2 ignition coils.

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Fig 2: Ignition Coil (Bank 2)

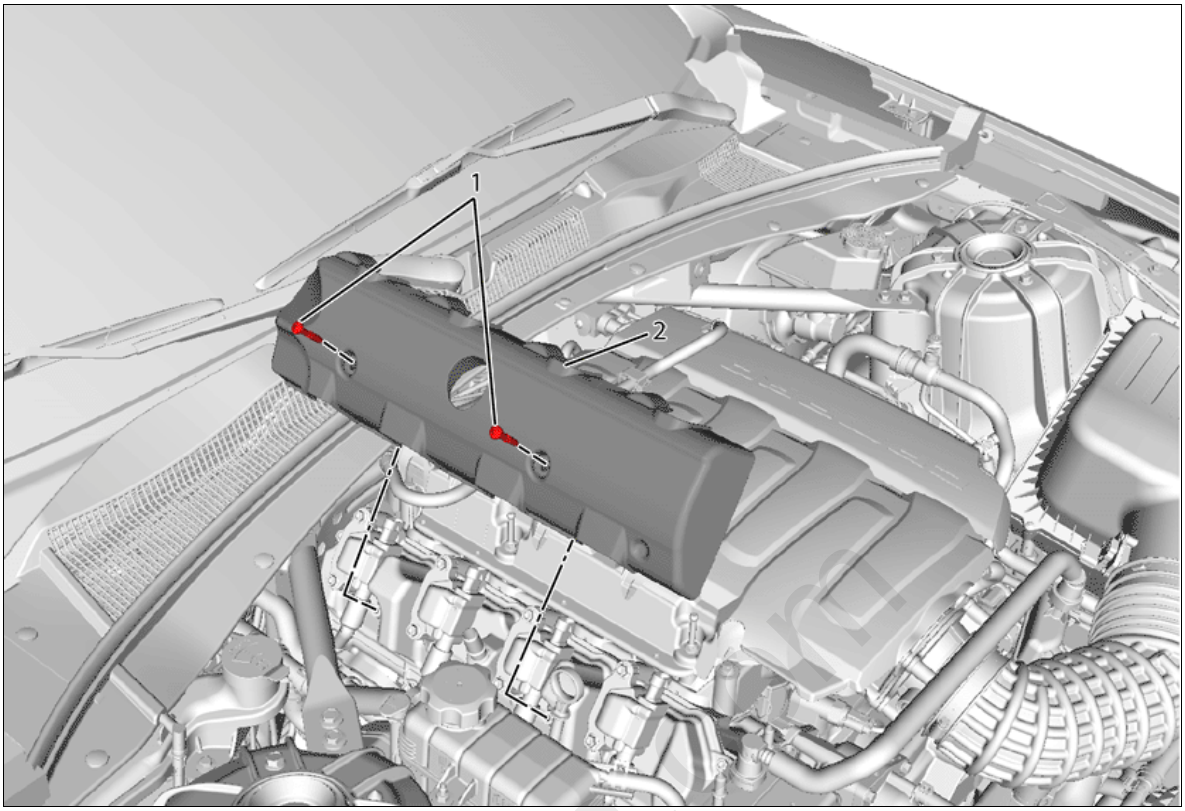


Courtesy of GENERAL MOTORS COMPANY

3. Connect bank 2 ignition coil electrical connectors (1)
4. Install the oil level indicator tube bracket bolt. Oil Level Indicator Tube Replacement

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Fig 3: Right Rocker Arm Cover Insulator



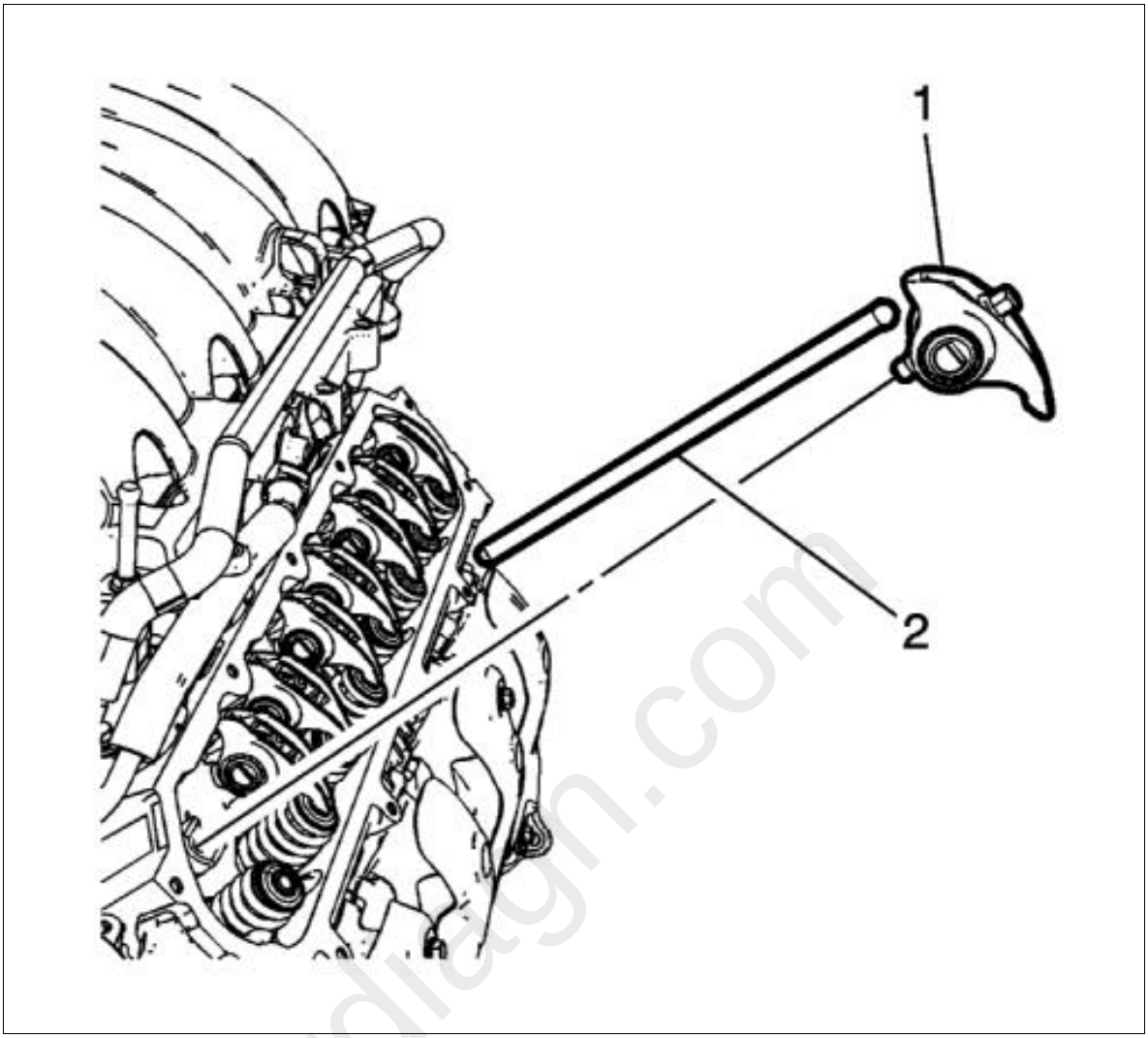
Courtesy of GENERAL MOTORS COMPANY

5. Install the right rocker arm cover insulator. Valve Rocker Arm Cover Insulator Replacement - Right Side

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM AND PUSH ROD REPLACEMENT > REMOVAL PROCEDURE

1. Remove the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side , or Valve Rocker Arm Cover Replacement - Right Side .

Fig 1: Valve Rocker Arm And Bolt Assembly And Pushrod



Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

2. Remove the valve rocker arm and bolt assembly (1).
3. Remove the pushrod (2).
4. Clean and inspect the rocker arms and/or pushrods, if necessary. Refer to Valve Rocker Arm and Push Rod Cleaning and Inspection .

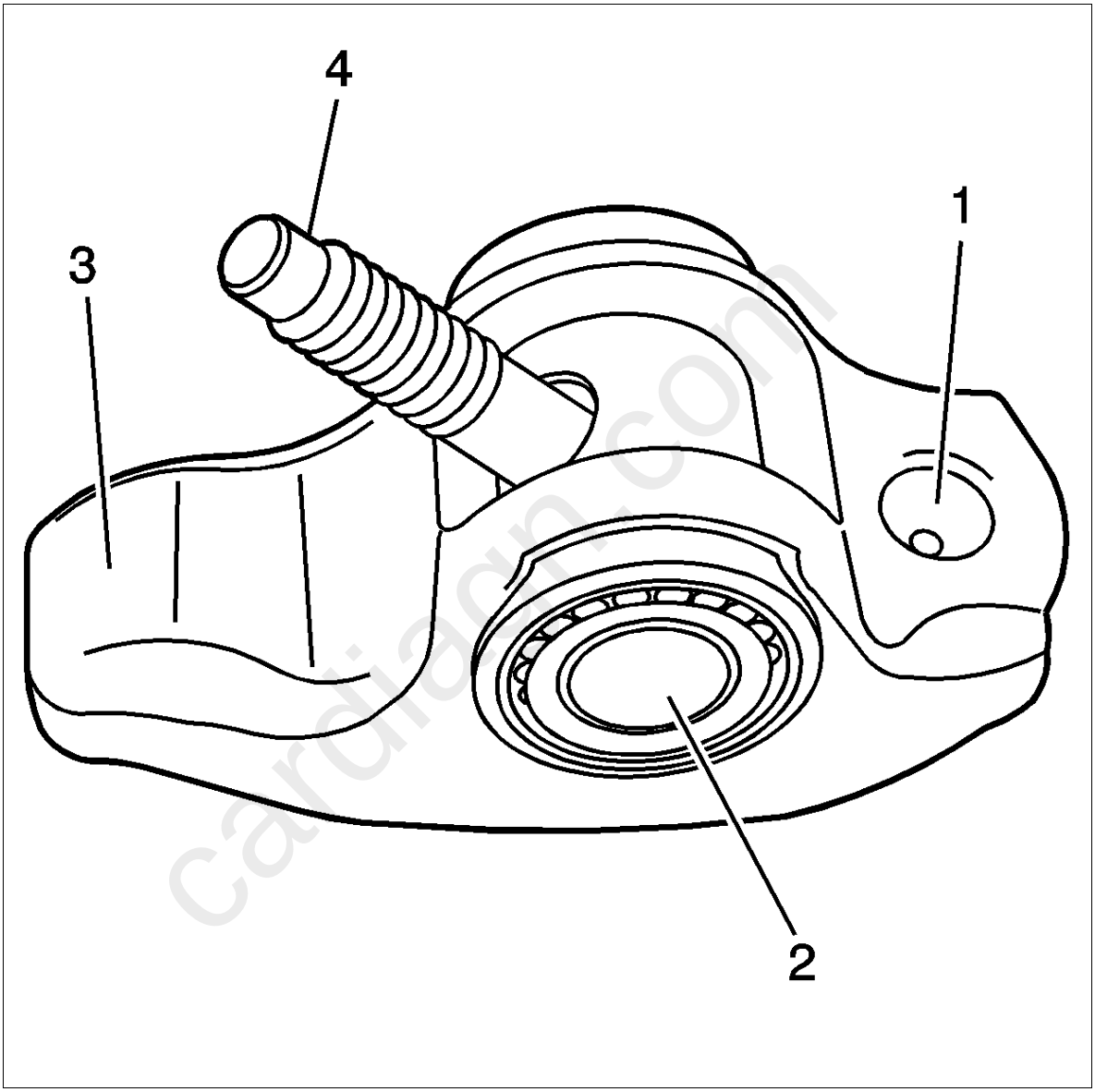
REPAIR INSTRUCTIONS - ON VEHICLE > VALVE ROCKER ARM AND PUSH ROD REPLACEMENT > INSTALLATION PROCEDURE

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NOTE:

Be sure to keep parts in order. Parts must be reinstalled into the original location and position.

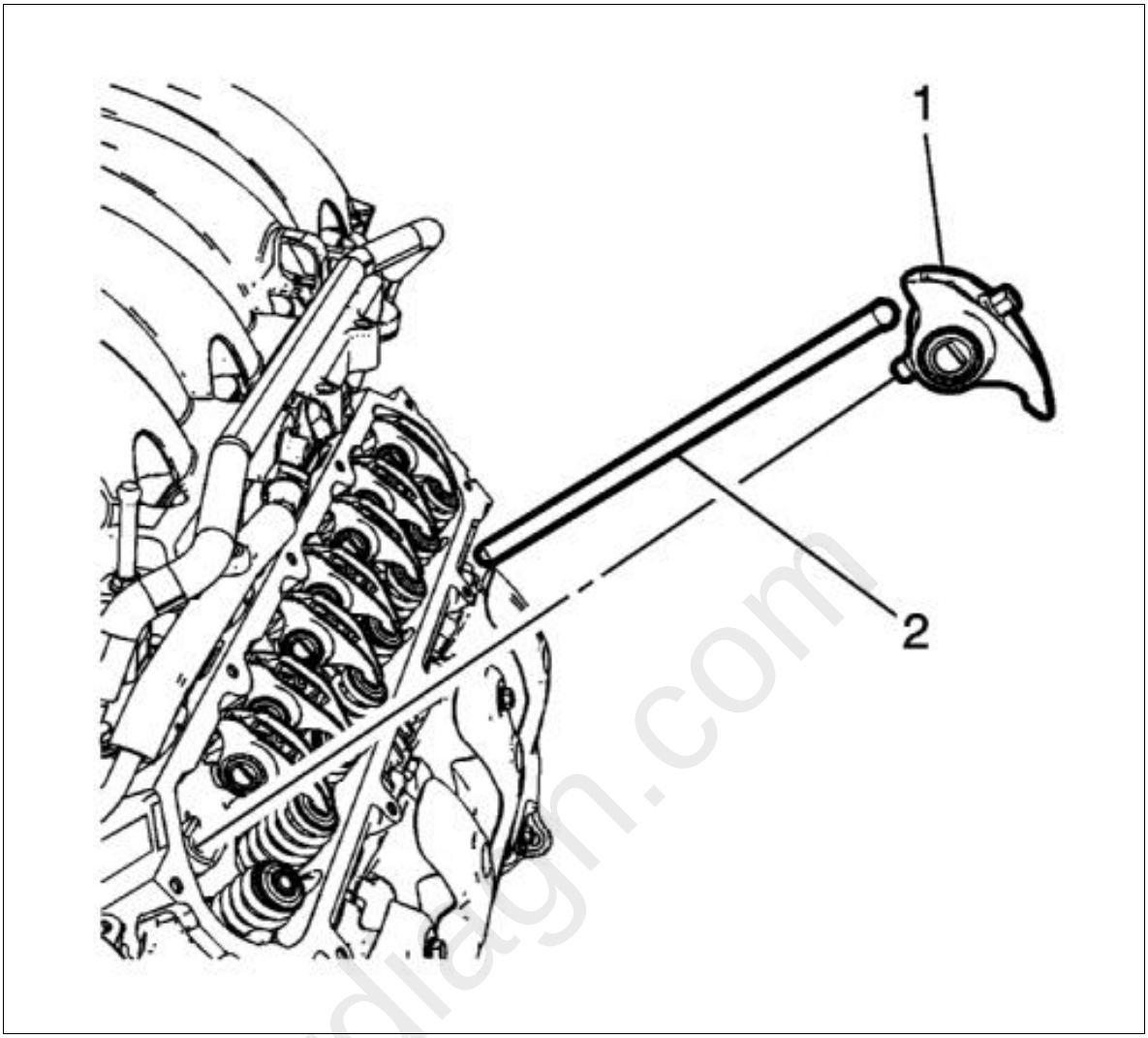
Fig 1: Pushrod Socket, Roller Pivot & Valve Stem Tip



Courtesy of GENERAL MOTORS COMPANY

1. Apply lubricant to the following rocker arm contact surfaces:
    1. Pushrod socket (1)
    2. Roller pivot (2)
    3. Valve stem tip (3)

Fig 2: Valve Rocker Arm And Bolt Assembly And Pushrod

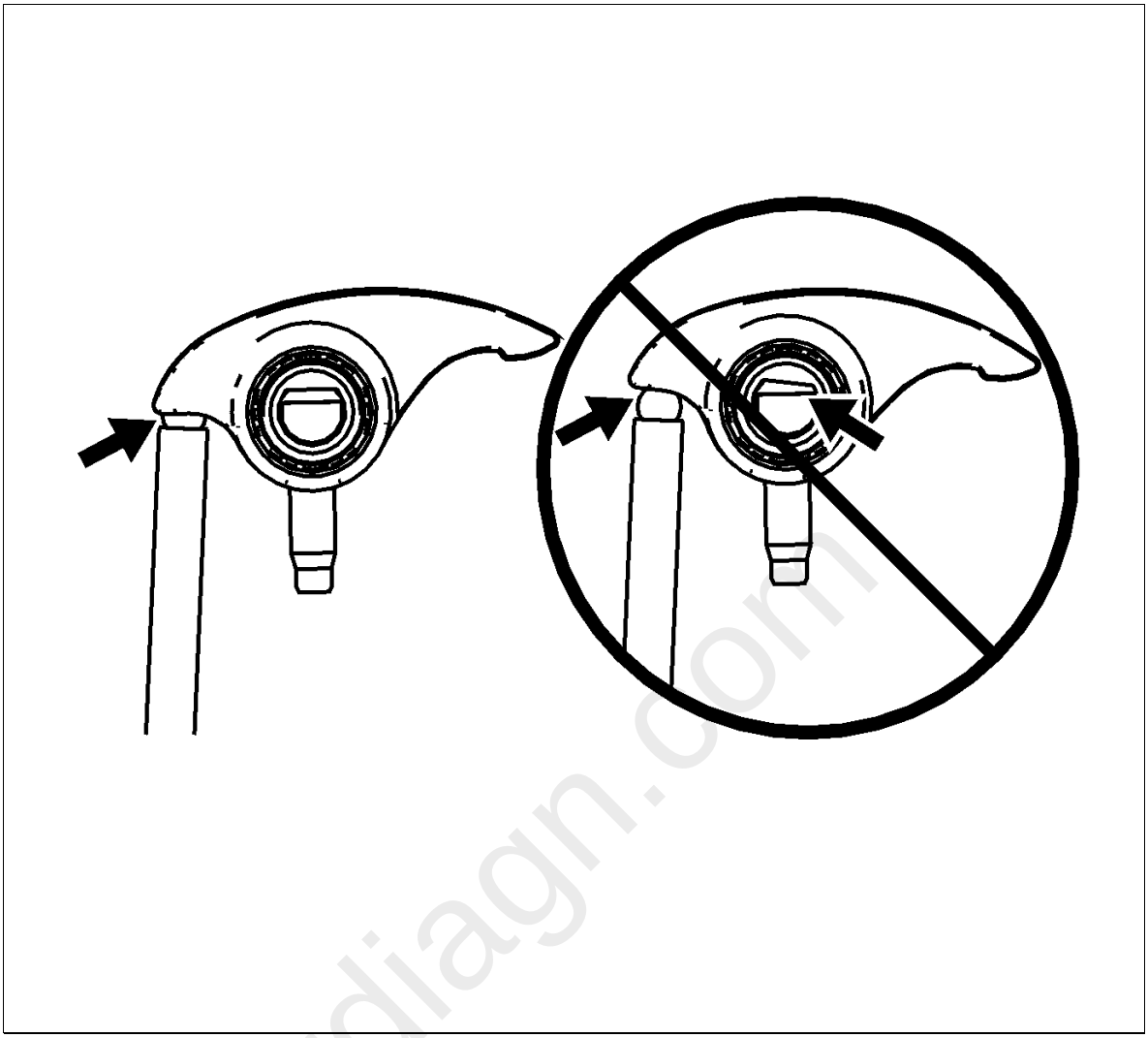


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2. Install the pushrod (2).

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Fig 3: Proper Seating Of Push Rod



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CAUTION:

Refer to Fastener Caution .

NOTE:

1. *When using the valve train components again, always install the components to the original location and position.*
2. *Valve lash is net build. No valve adjustment is required.*
3. *Lubricate the flange of the valve rocker arm bolts with clean engine oil.*
4. *Lubricate the valve rocker arms and pushrods with clean engine oil.*
5. *Ensure the pushrods seat properly to the valve lifter sockets.*

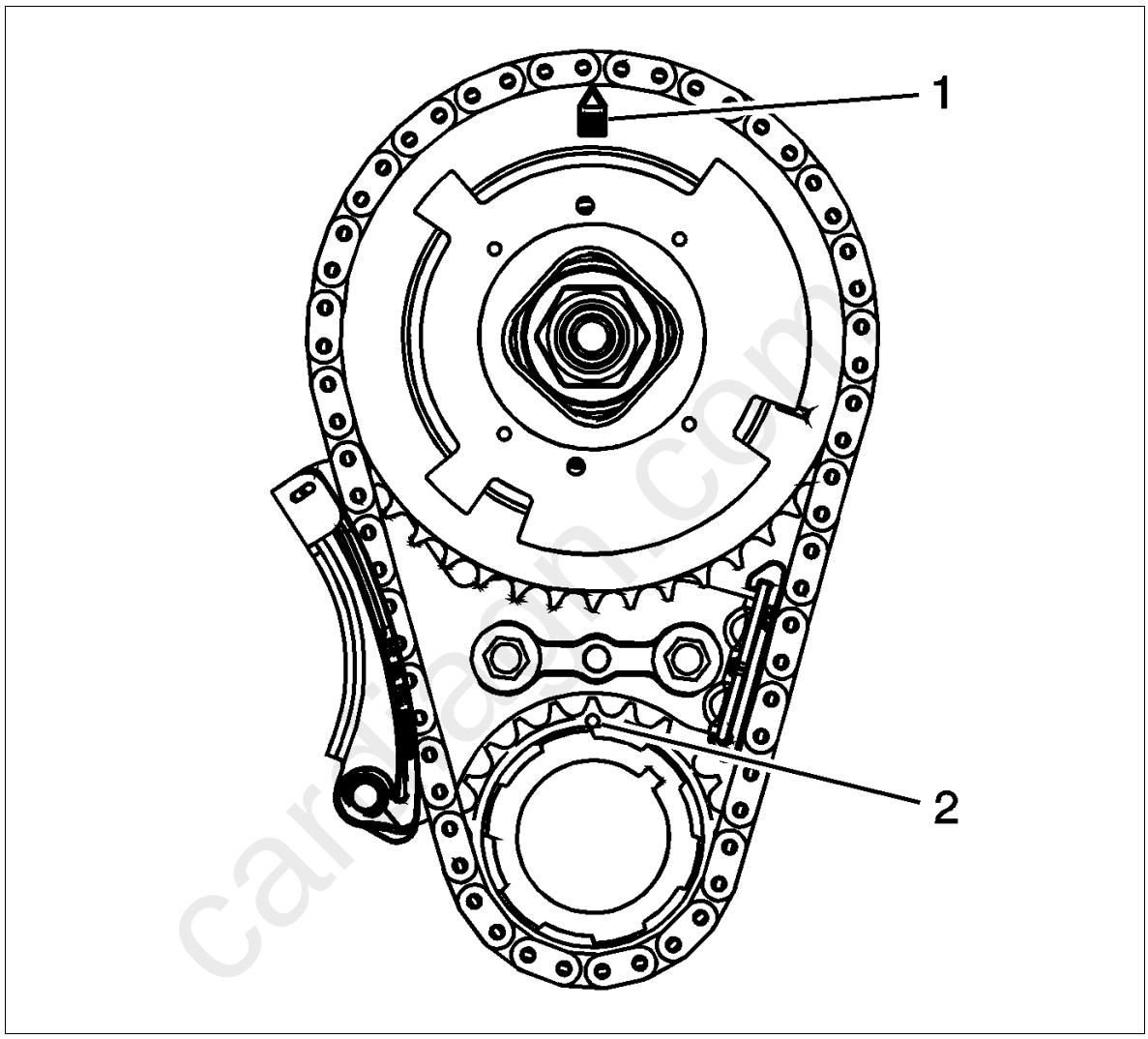
6. The rocker arm bolts are not serviced separately.

7. Ensure the pushrods seat properly to the ends of the rocker arms.

8. DO NOT tighten the rocker arm bolts at this time.

3. Install the rocker arm and bolt assembly.

Fig 4: Camshaft & Crankshaft Sprocket Alignment Marks



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4. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

Cylinders 1, 3, 5, and 7 are left bank.

Cylinders 2, 4, 6, and 8 are right bank.

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution*

5. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft).
    2. Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft).
6. Rotate the crankshaft 360 degrees.
7. Tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft).
    2. Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft).
8. Install the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side , or Valve Rocker Arm Cover Replacement - Right Side .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **J-22794** Spark Plug Port Adapter
- **J-38606** Valve Spring Compressor

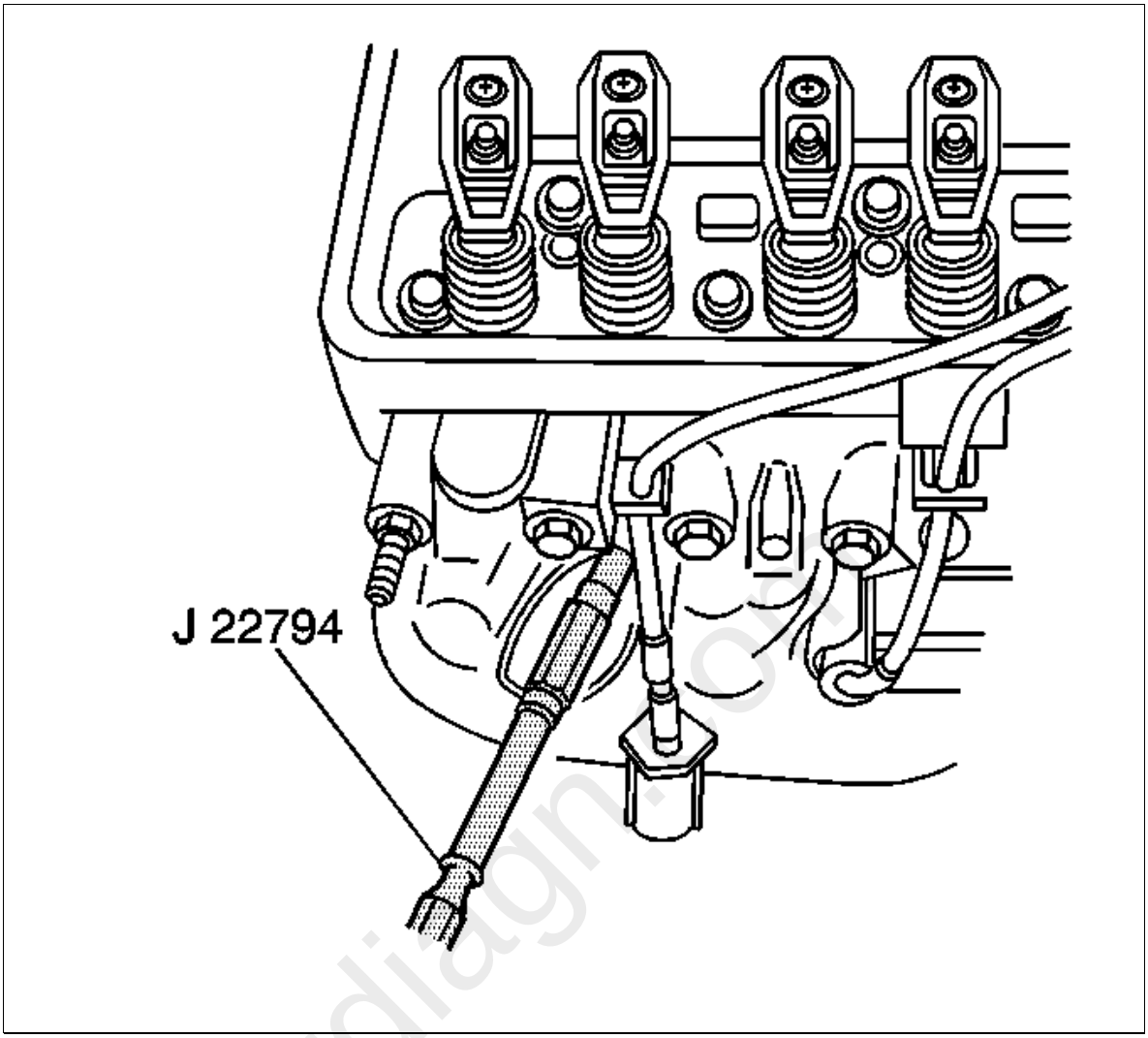
For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT > REMOVAL PROCEDURE

1. Remove the valve rocker arms as needed. Refer to Valve Rocker Arm and Push Rod Replacement .
2. Remove the spark plugs as needed. Refer to Spark Plug Replacement .

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Fig 1: Compressed Air Adapter Hose

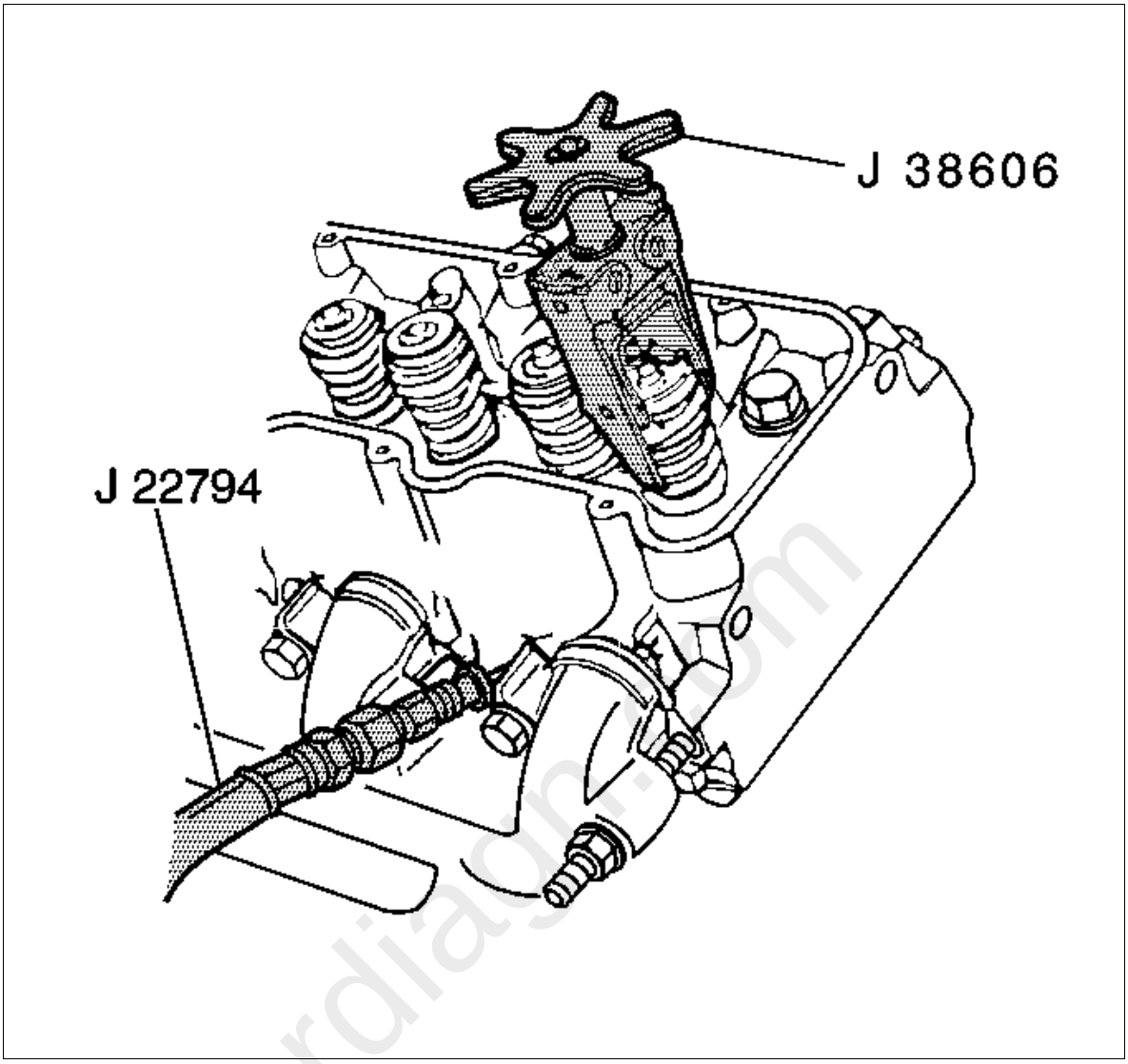


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3. Install the **J- 22794** adapter into the spark plug hole.
4. Connect a shop air supply hose and apply compressed air in order to hold the valves in place.

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Fig 2: Compressing Valve Spring (Cylinder Head Installed) Using Special Tools



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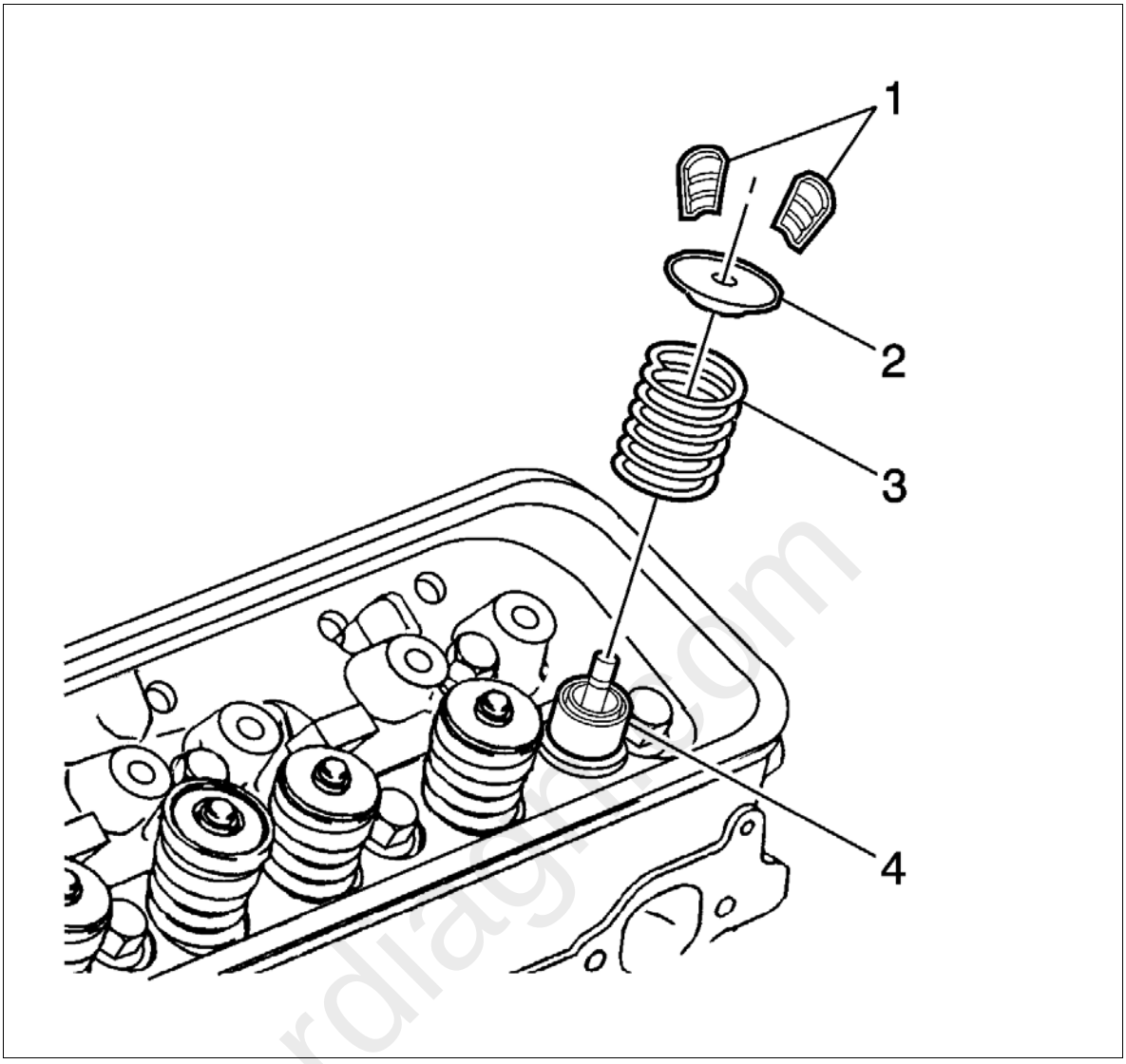
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⚠ *CAUTION:*

Completely engage the J 38606 jaws on the valve spring. The J 38606 may slip off and scratch the valve spring. Replace the valve spring if the valve spring becomes scratched.

5. Use **J 38606** compressor.
6. Apply steady pressure on the valve spring cap until the valve keys are accessible.

Fig 3: Valve Components

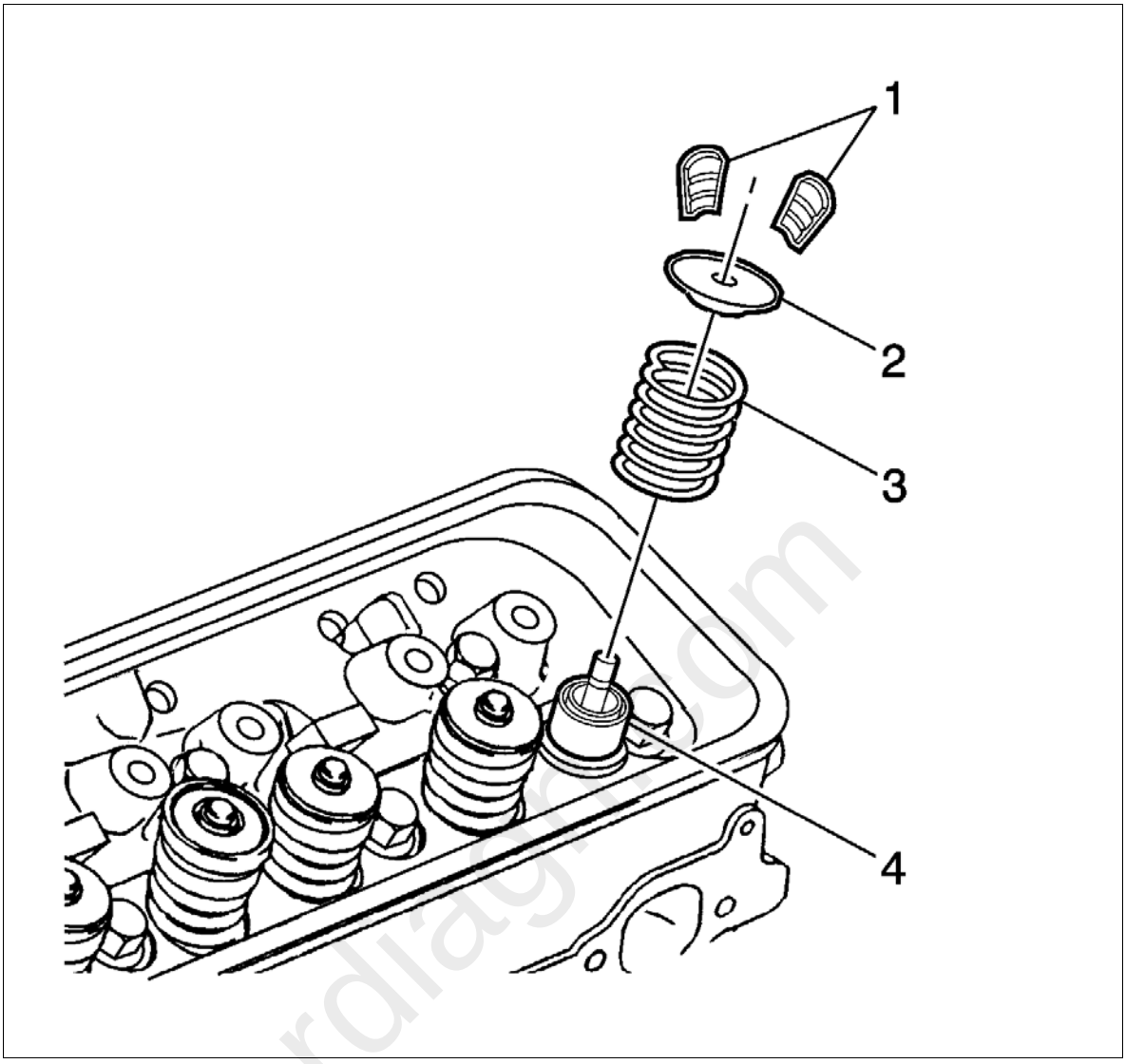


Courtesy of GENERAL MOTORS COMPANY

7. Remove the valve keys (1).
8. Carefully release the valve spring tension.
9. Remove the **J-38606** compressor.
10. Remove the valve spring cap (2) and valve spring (3).
11. Remove the valve stem oil seal (4).

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT > INSTALLATION PROCEDURE

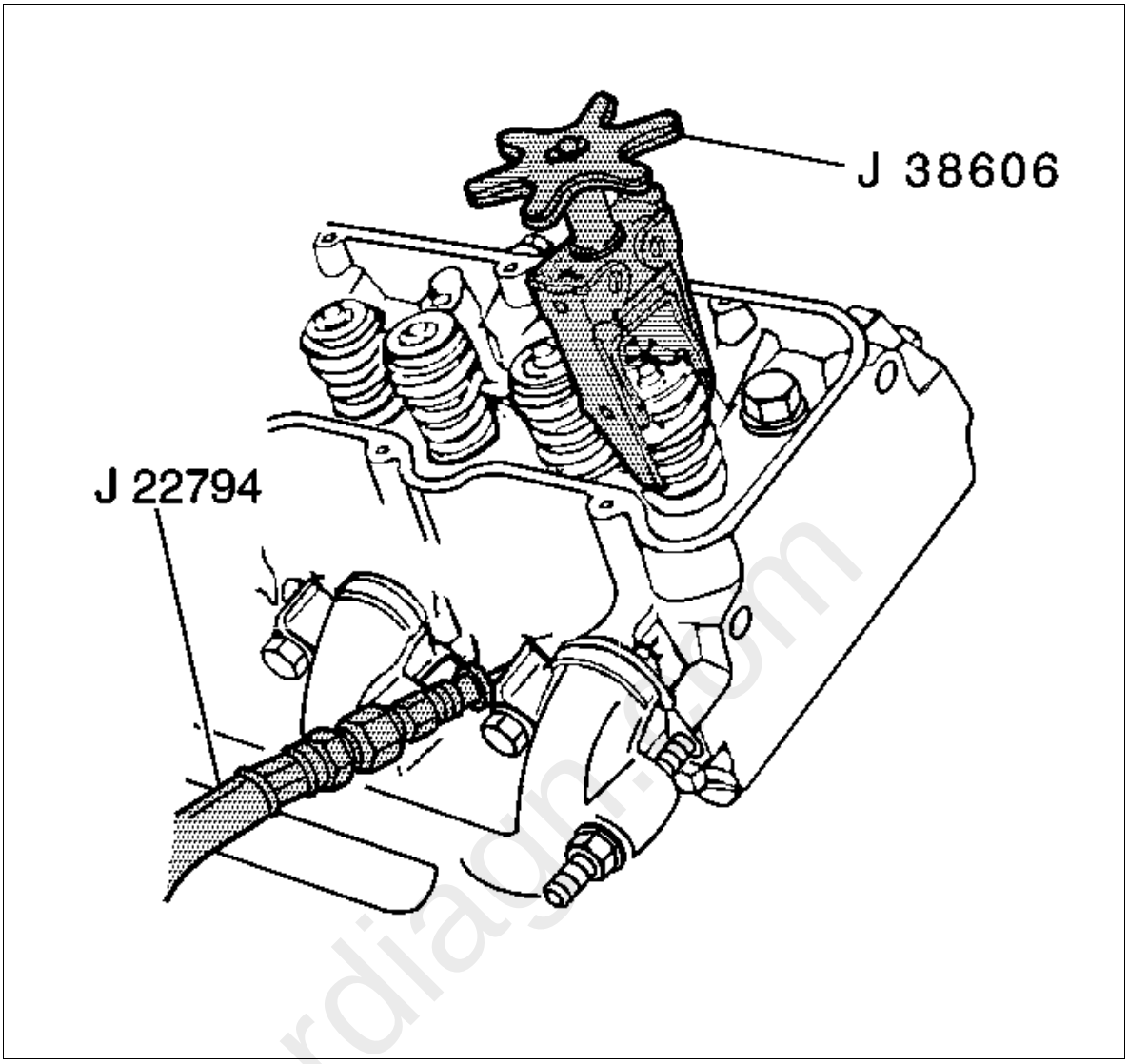
Fig 1: Valve Components



Courtesy of GENERAL MOTORS COMPANY

1. Install the valve stem oil seal (4).
2. Install the valve spring (3).
3. Install the valve spring cap (2) onto the valve spring (3), over the valve stem.

Fig 2: Compressing Valve Spring (Cylinder Head Installed) Using Special Tools



Courtesy of GENERAL MOTORS COMPANY

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> ⚠ *CAUTION:*
>
> *Completely engage the J 38606 jaws on the valve spring. The J 38606 may slip off and scratch the valve spring. Replace the valve spring if the valve spring becomes scratched.*

4. Use the **J-38606** compressor.
5. Apply steady pressure on the valve spring cap until the valve key groves are accessible.

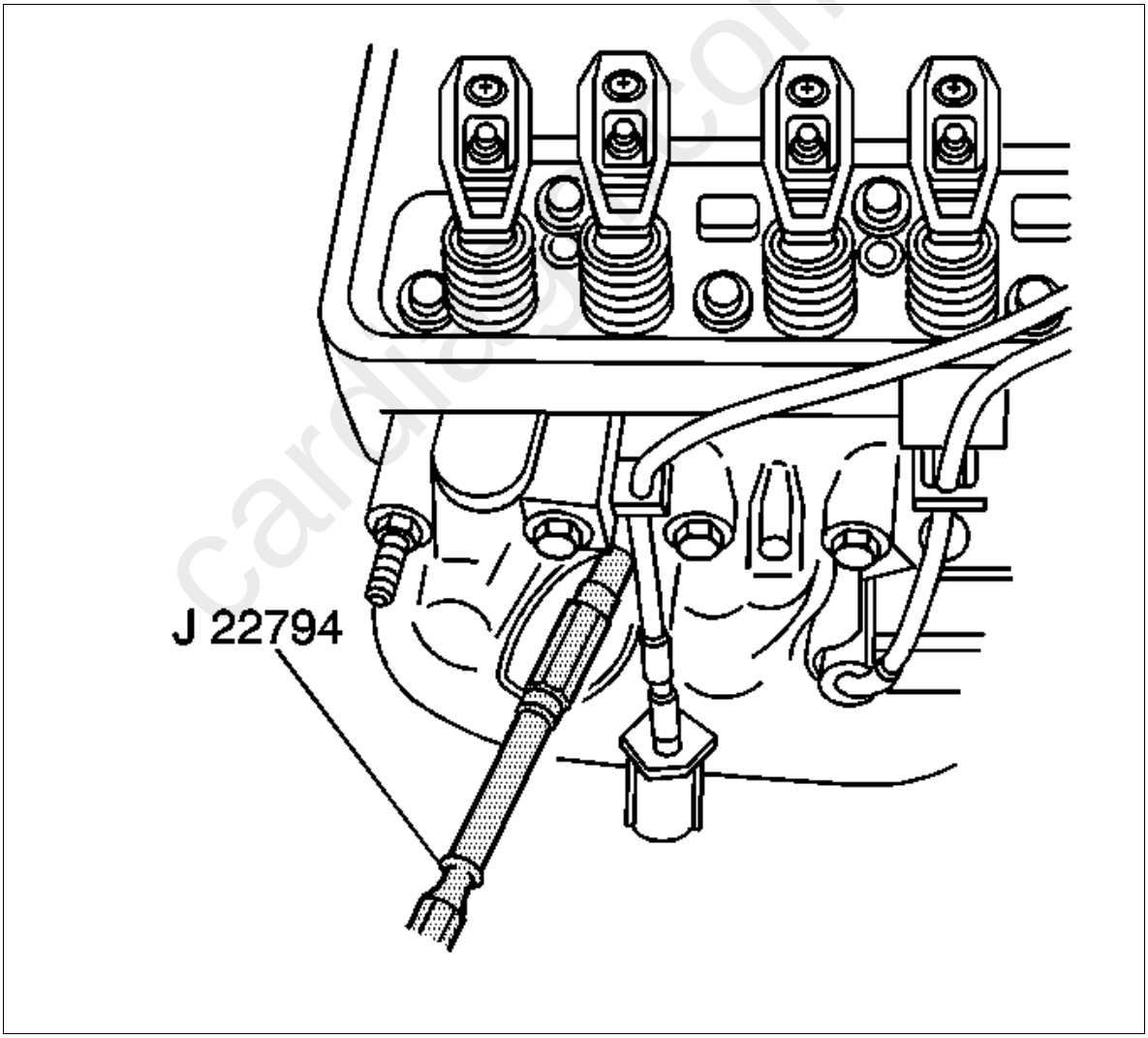
> *NOTE:*
>
> *Use grease in order to hold the valve stem keys in place.*

6. Install the valve stem keys.
7. Carefully release the valve spring pressure, making sure the valve stem keys stay in place.

> ⚠ *CAUTION:*
>
> *The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.*

8. Remove the **J-38606** compressor.
    1. Look to ensure that the valve stem keys seat properly in the upper groove of the valve stem.
    2. Tap the end of the valve stem with a plastic faced hammer in order to seat the valve stem keys, if necessary.

Fig 3: Compressed Air Adapter Hose



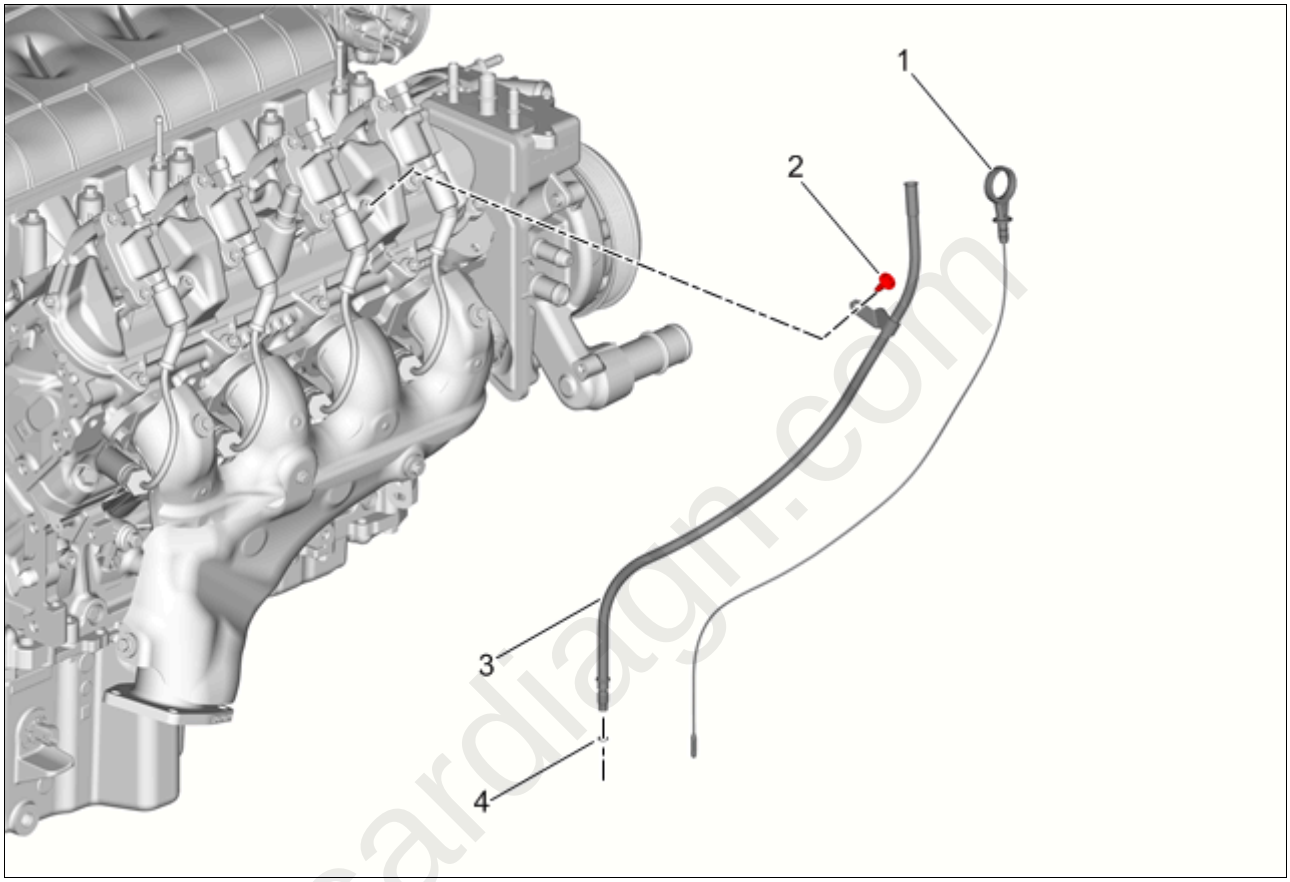
Courtesy of GENERAL MOTORS COMPANY

9. Remove the **J-22794** adapter.

10. Install the spark plugs. Refer to Spark Plug Replacement .
11. Install the valve rocker arms. Refer to Valve Rocker Arm and Push Rod Replacement .

REPAIR INSTRUCTIONS - ON VEHICLE > OIL LEVEL INDICATOR TUBE REPLACEMENT

Fig 1: Oil Level Indicator Tube



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Callout	Component Name
Preliminary Procedures 1. Valve Rocker Arm Cover Insulator Replacement - Right Side 2. Exhaust Manifold Replacement - Right Side (LT1)	
1	Oil Level Indicator
2	Oil Level Indicator Tube Bracket Bolt *CAUTION:*

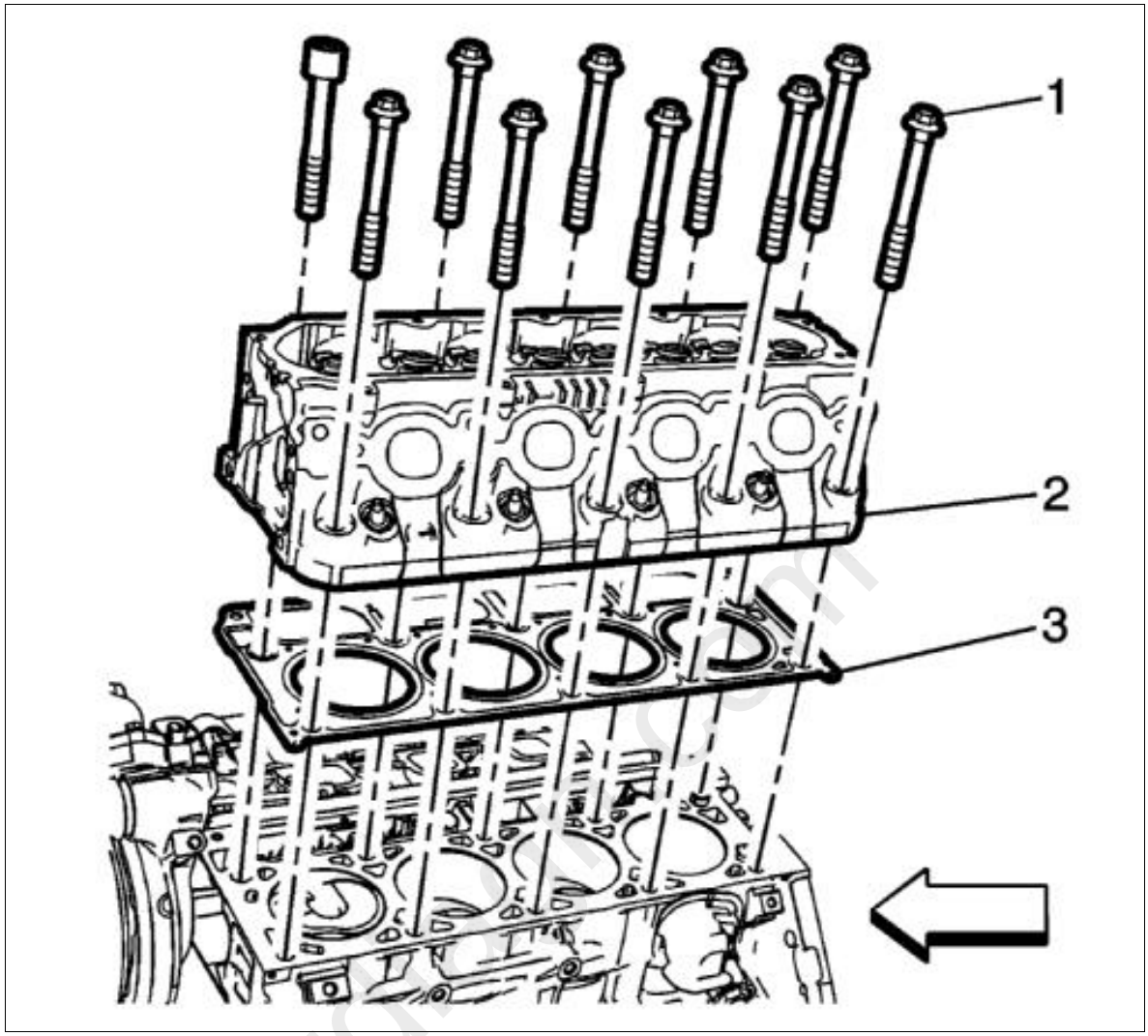
	Refer to Fastener Caution . **Tighten** 10 N.m (88 lb in)
3	Oil Level Indicator Tube
4	Oil Level Indicator Tube O-Ring **Procedure** Use a NEW oil level indicator tube seal when installing the tube.

REPAIR INSTRUCTIONS - ON VEHICLE > CYLINDER HEAD REPLACEMENT - LEFT SIDE > REMOVAL PROCEDURE

1. Drain the coolant system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static Fill) .
2. Remove the fuel injector rail. Fuel Injection Fuel Rail Assembly Replacement - Bank 1 .
3. Remove the exhaust manifold. Exhaust Manifold Replacement - Left Side (LT1) .
4. Remove the ground wire bolt from the rear of the cylinder head and position the ground wire away.
5. Remove the valve rocker arms and push rods. Valve Rocker Arm and Push Rod Replacement .

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Fig 1: Cylinder Head Bolts



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Ensure to DISCARD all cylinder head bolts.

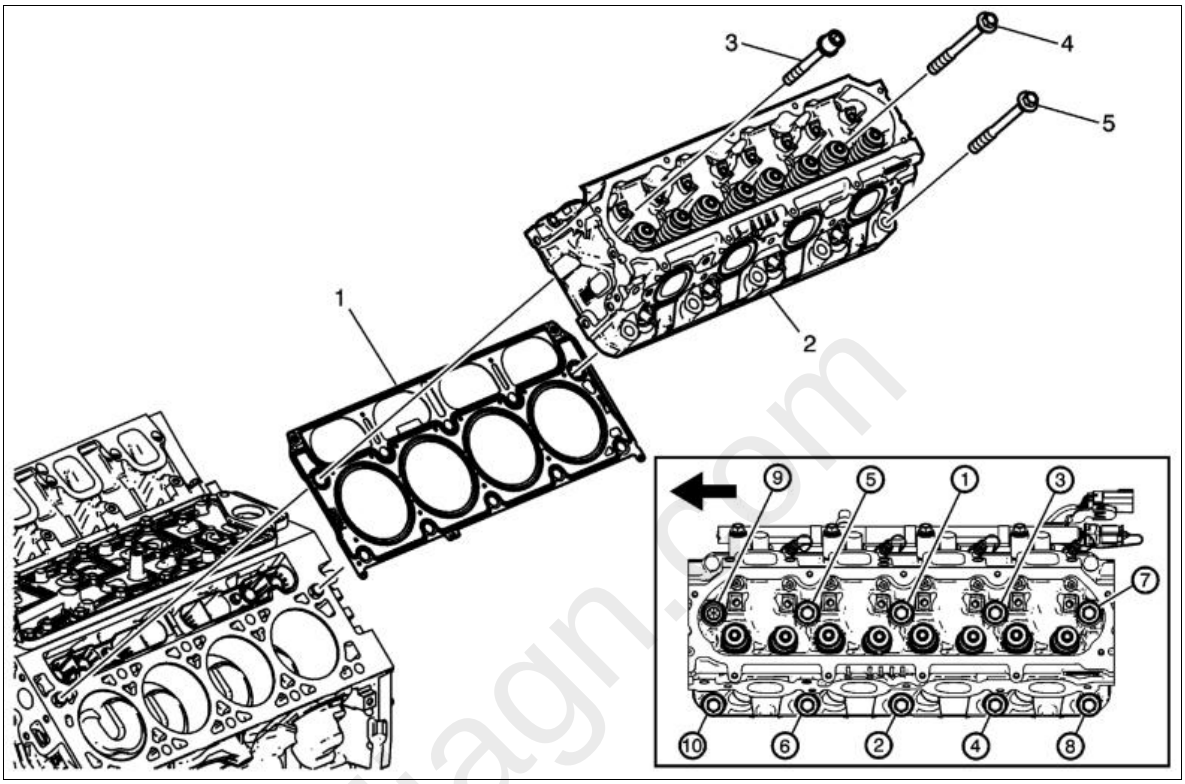
6. Remove the cylinder head bolts (1).
7. Remove cylinder head (2).
8. Remove and DISCARD cylinder head gasket (3). Replacing Engine Gaskets .
9. Clean and inspect the cylinder head. Cylinder Head Cleaning and Inspection .
10. Disassemble the cylinder as necessary. Cylinder Head Disassemble .

REPAIR INSTRUCTIONS - ON VEHICLE > CYLINDER HEAD REPLACEMENT - LEFT

SIDE > INSTALLATION PROCEDURE

1. Assemble the cylinder head as necessary. Cylinder Head Assemble .
2. Clean any debris or residual fastener thread sealant from the engine block cylinder head bolt holes to ensure proper torque or clamp load.

   Fig 1: NEW Cylinder Head Gasket



Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW cylinder head gasket (1).
4. Install cylinder head (2).

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

5. Hand start NEW cylinder head bolts (3 and 4).

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

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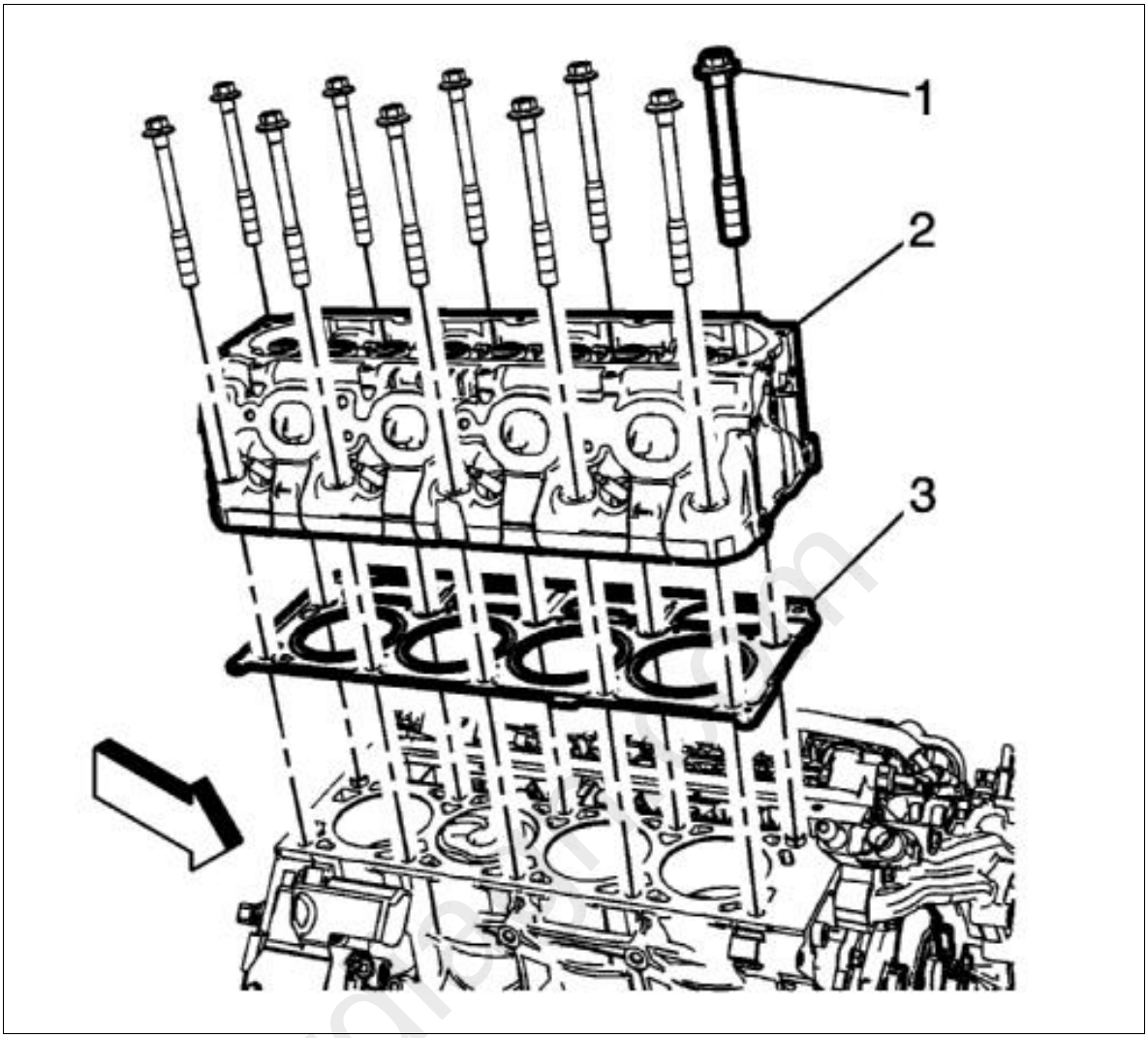
6. Tighten the cylinder head bolt (3) in sequence.
    1. First Pass: 80 N.m (59 lb ft)
    2. Second Pass: 90°
    3. Final Pass: 40°
7. Tighten the cylinder head bolt (4) in sequence.
    1. First Pass: 80 N.m (59 lb ft)
    2. Second Pass:> 90°
    3. Final Pass: 60°
8. Install the valve rocker arms and push rods. Valve Rocker Arm and Push Rod Replacement .
9. Install the ground wire and bolt at the rear of the cylinder head. Tighten the bolt to 15 N.m (11 lb ft)
10. Install the exhaust manifold. Exhaust Manifold Replacement - Left Side (LT1) .
11. Install the fuel injector rail. Fuel Injection Fuel Rail Assembly Replacement - Bank 1 .
12. Refill the coolant system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static Fill) .

REPAIR INSTRUCTIONS - ON VEHICLE > CYLINDER HEAD REPLACEMENT - RIGHT SIDE > REMOVAL PROCEDURE

1. Remove the engine coolant manifold. Engine Coolant Manifold Replacement (LT1) .
2. Remove the fuel injector rail. Fuel Injection Fuel Rail Assembly Replacement - Bank 2 .
3. Remove the exhaust manifold. Exhaust Manifold Replacement - Right Side (LT1) .
4. Remove the ground wire bolt from the rear of the cylinder head and position the ground wire away.
5. Remove the valve rocker arms and push rods. Valve Rocker Arm and Push Rod Replacement .

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Fig 1: Cylinder Head Bolts And Cylinder Head Gasket



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Ensure to DISCARD all cylinder head bolts.

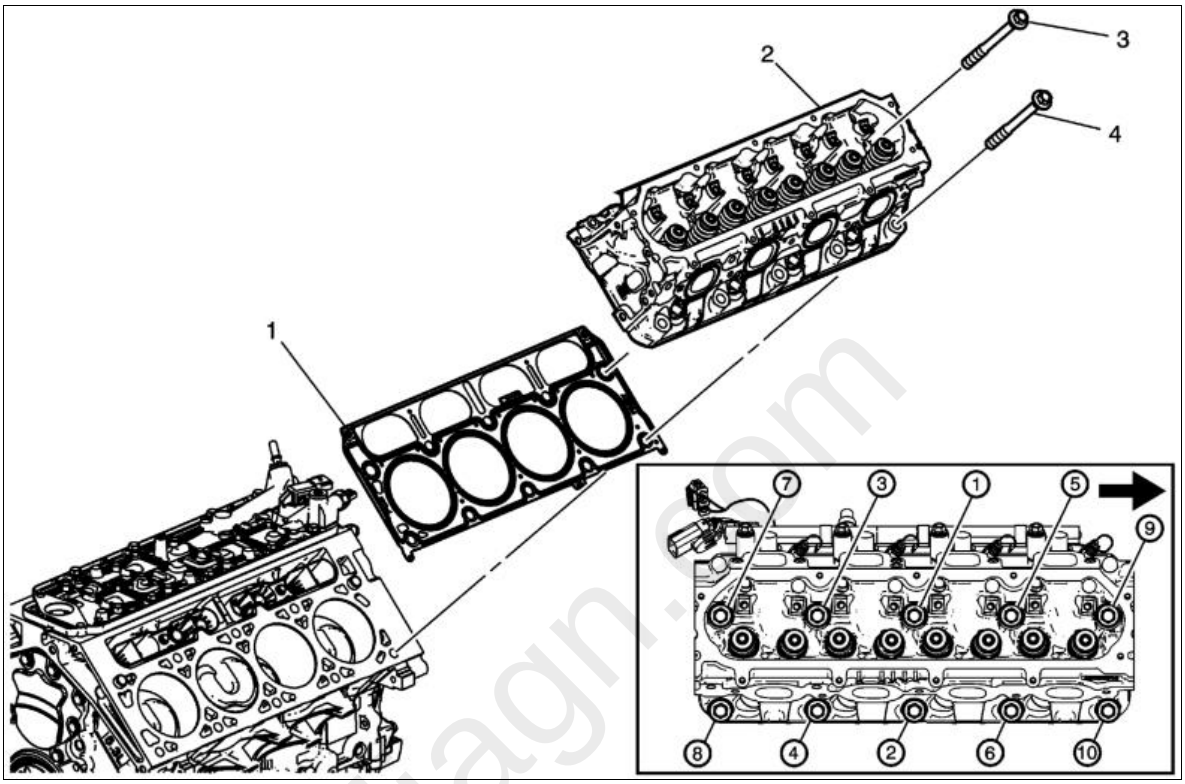
6. Remove and DISCARD the cylinder head bolts (1).
7. Remove cylinder head (2).
8. Remove and DISCARD cylinder head gasket (3). Replacing Engine Gaskets .
9. Clean and inspect the cylinder head. Cylinder Head Cleaning and Inspection .
10. Disassemble the cylinder head as necessary. Cylinder Head Disassemble .

REPAIR INSTRUCTIONS - ON VEHICLE > CYLINDER HEAD REPLACEMENT - RIGHT

SIDE > INSTALLATION PROCEDURE

1. Assemble the cylinder head as necessary. Cylinder Head Assemble .
2. Clean any debris or residual fastener thread sealant from the engine block cylinder head bolt holes to ensure proper torque or clamp load.

   Fig 1: NEW Cylinder Head Gasket And Cylinder Head



Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW cylinder head gasket (1).
4. Install cylinder head (2).

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

5. Hand start NEW cylinder head bolts (3).

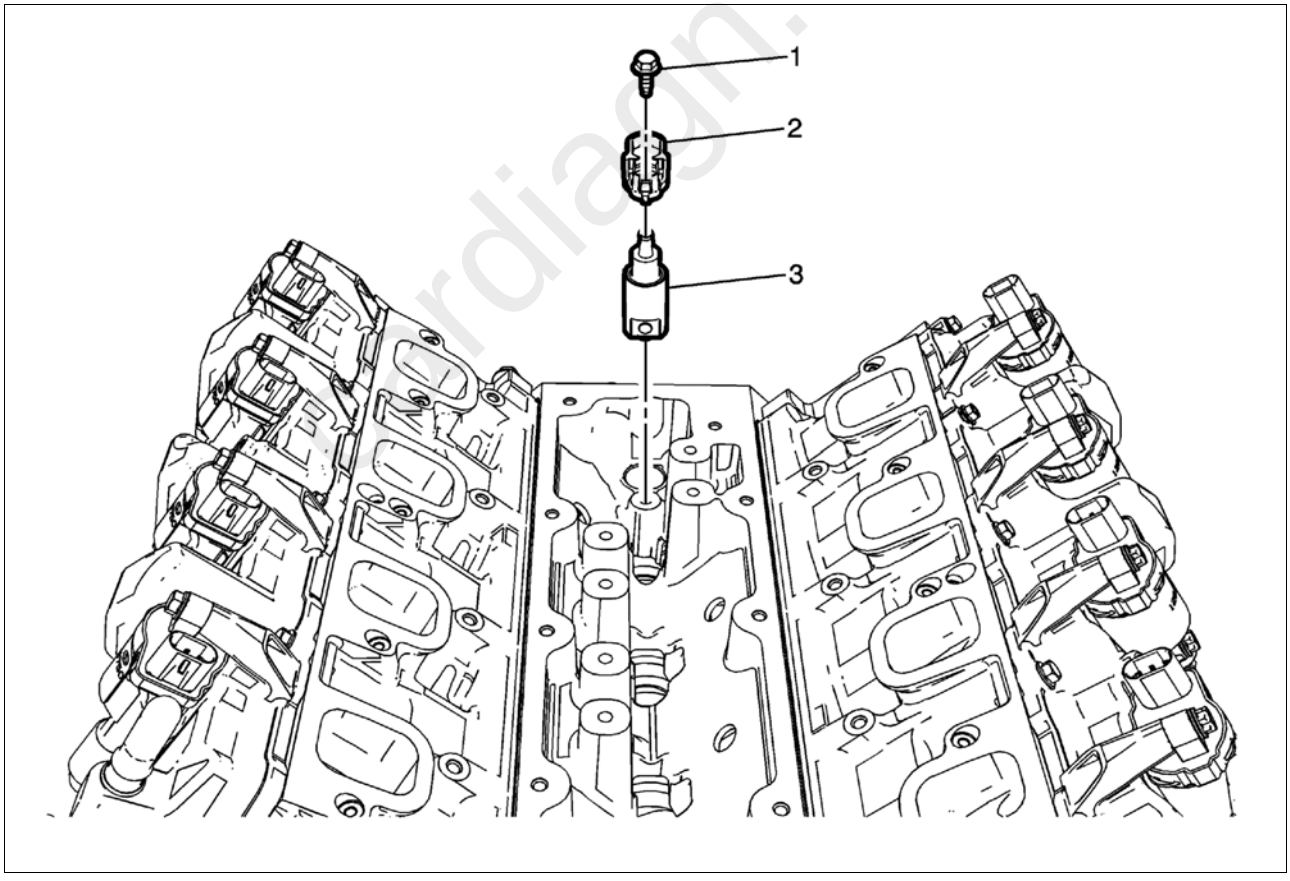
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

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6. Tighten the cylinder head bolts (3) in sequence.
    1. First Pass: 80 N.m (59 lb ft)
    2. Second Pass: 90°
    3. Final Pass: 60°
7. Install the valve rocker arms and push rods. Valve Rocker Arm and Push Rod Replacement .
8. Install the ground wire and bolt at the rear of the cylinder head. Tighten the bolt to 15 N.m (11 lb ft)
9. Install the exhaust manifold. Exhaust Manifold Replacement - Right Side (LT1) .
10. Install the fuel injector rail. Fuel Injection Fuel Rail Assembly Replacement - Bank 2 .
11. Install the engine coolant manifold. Engine Coolant Manifold Replacement (LT1) .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER FOLLOWER GUIDE ASSEMBLY REPLACEMENT

Fig 1: Valve Lifter Follower Guide Assembly

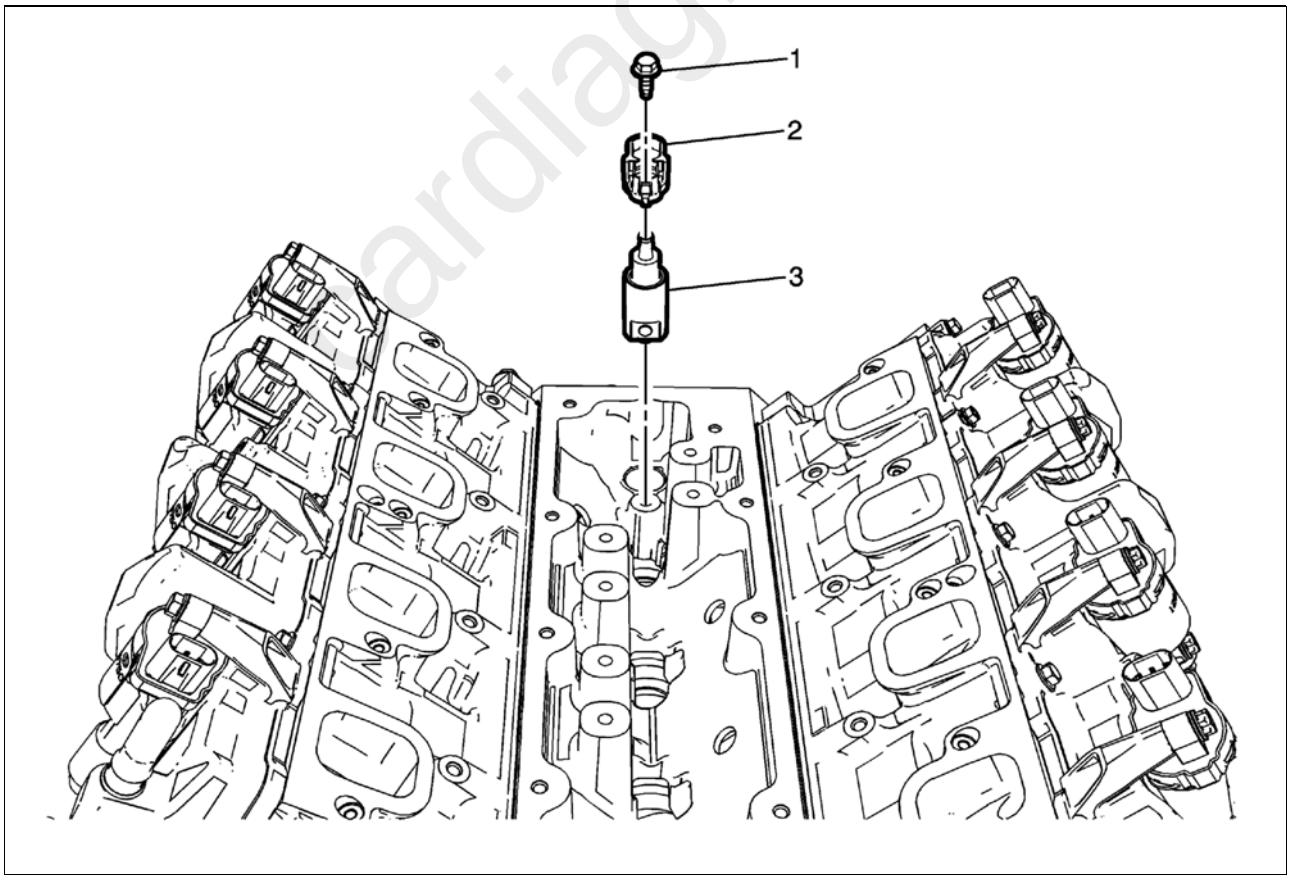


Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the valve lifter oil manifold. Refer to Valve Lifter Oil Manifold Replacement .	
1	Valve Lifter Follower Guide Fastener *CAUTION:* *Refer to Fastener Caution .* **Tighten** 12 N.m (106 lb in)
2	Valve Lifter Follower Guide
3	Valve Lifter Follower

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER FOLLOWER GUIDE REPLACEMENT

Fig 1: Valve Lifter Follower Guide Assembly



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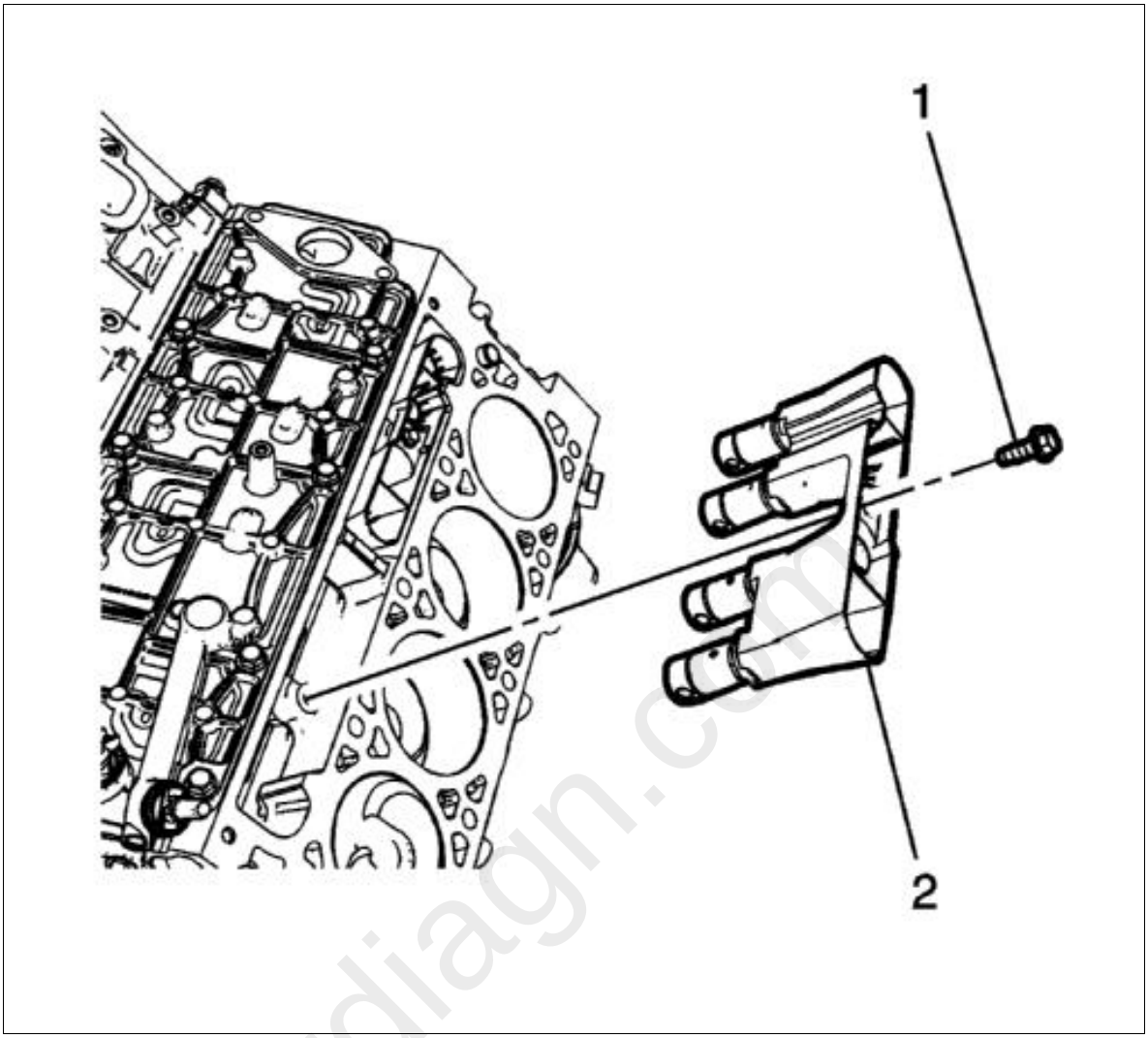
Callout	Component Name
Preliminary Procedure Remove the valve lifter oil manifold. Refer to Valve Lifter Oil Manifold Replacement .	
1	Valve Lifter Follower Guide Fastener *CAUTION:* *Refer to Fastener Caution .* **Tighten** 12 N.m (106 lb in)
2	Valve Lifter Follower Guide
3	Valve Lifter Follower

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER REPLACEMENT > REMOVAL PROCEDURE

1. Remove the cylinder head and gasket. Refer to Cylinder Head Replacement - Left Side , or Cylinder Head Replacement - Right Side .

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Fig 1: Valve Lifter Guide Bolt

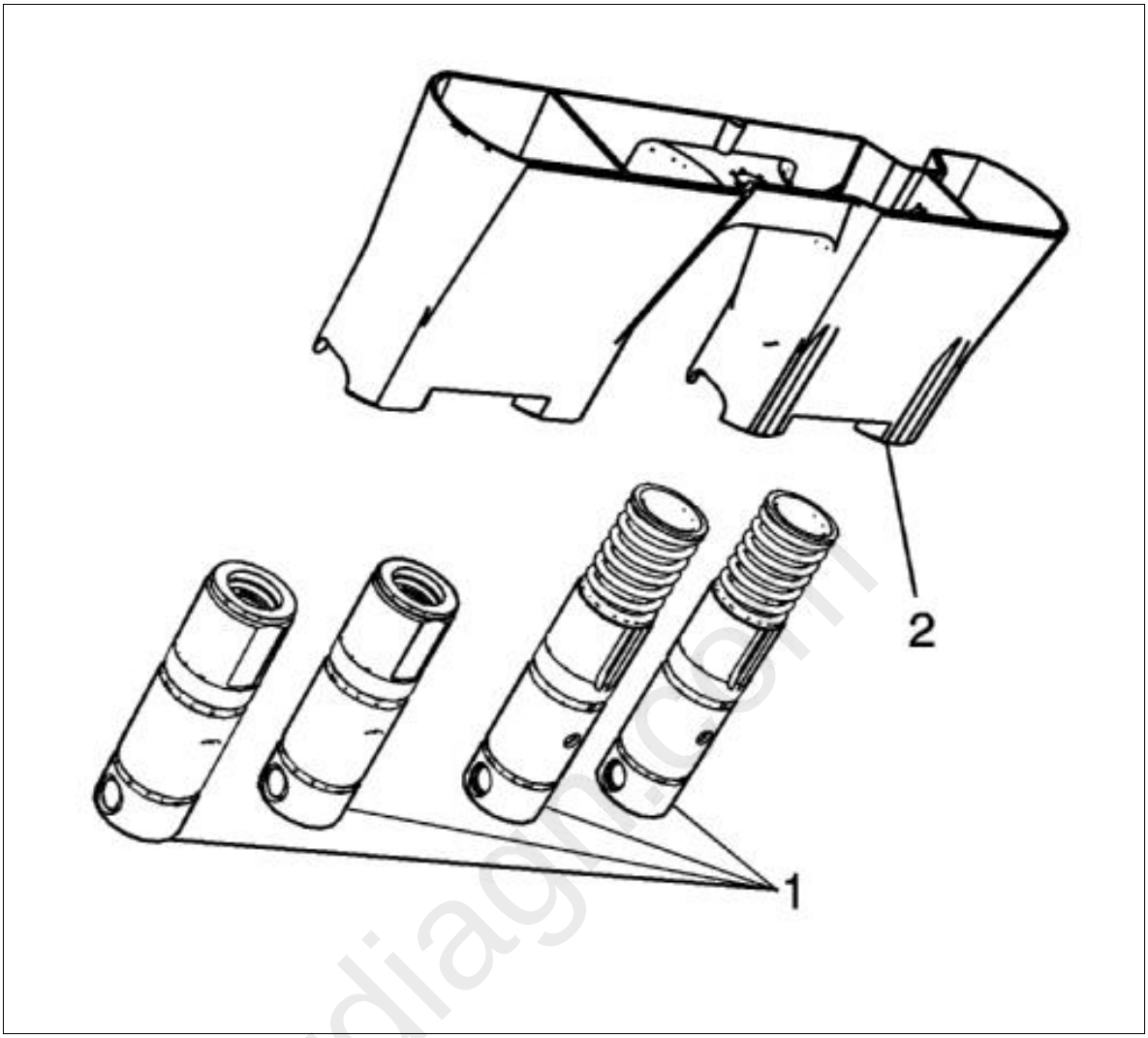


Courtesy of GENERAL MOTORS COMPANY

2. Remove the valve lifter guide bolt (1).
3. Remove the valve lifter guides (2) with the lifters. Note the installed position of the guides. The notched area of the guides is to align with the locating tab on the engine block.

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Fig 2: Valve Lifters And Quide

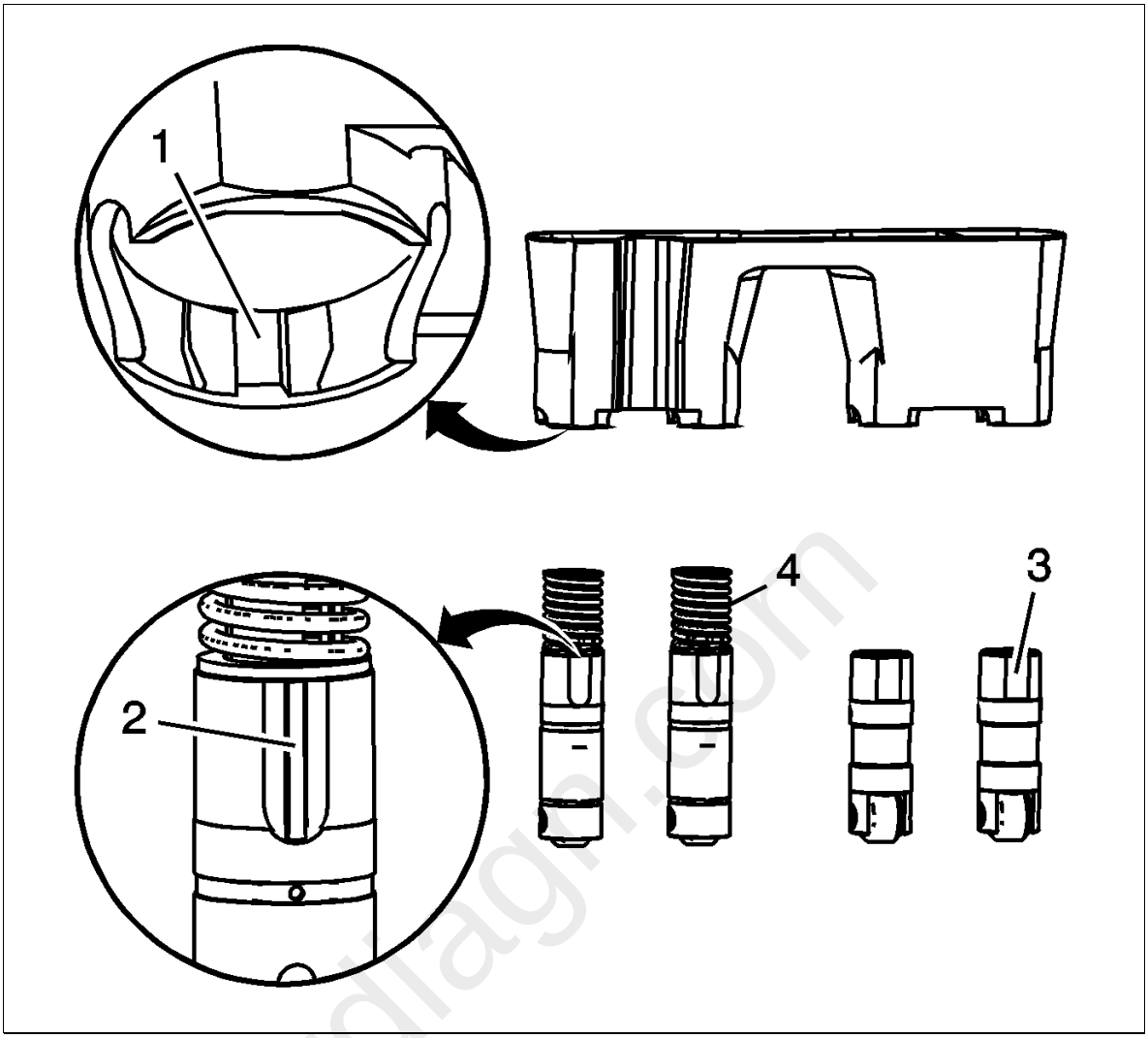


Courtesy of GENERAL MOTORS COMPANY

4. Remove the valve lifters (1) from the guide (2).

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Fig 3: Valve Lifters Into Lifter Guides



Courtesy of GENERAL MOTORS COMPANY

NOTE:

The active fuel management lifters are installed into the guide by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2).

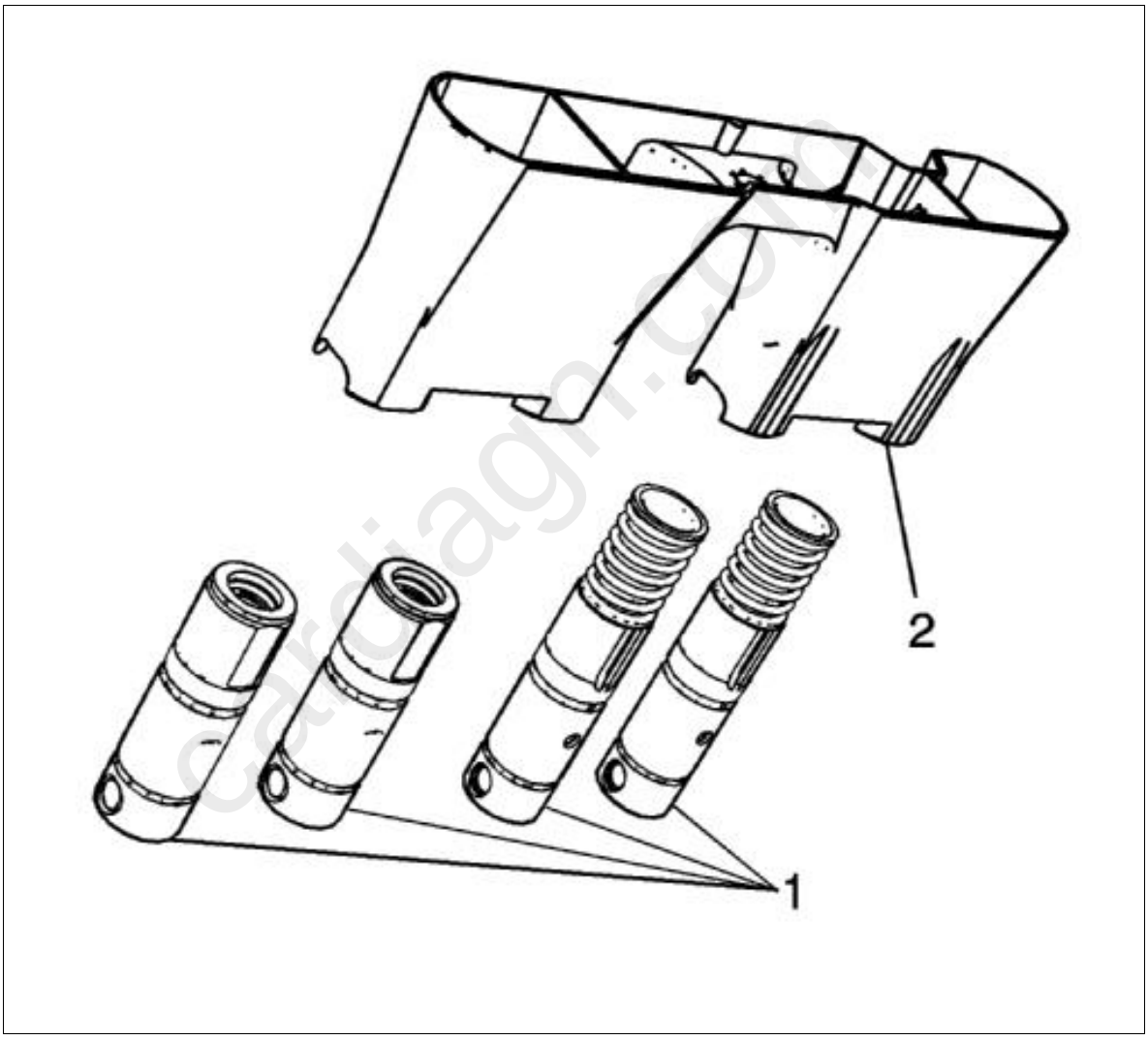
5. Organize or mark the components so that they can be installed in the same location from which they were removed, if required.
6. Clean and inspect the valve lifters, if required. Refer to Valve Lifter and Guide Cleaning and Inspection .

REPAIR INSTRUCTIONS - ON VEHICLE > VALVE LIFTER REPLACEMENT > INSTALLATION PROCEDURE

IMPORTANT:

- *When reusing valve lifters, install the lifters to their original locations.*
- *Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non active fuel management valve lifters.*
- *With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter bores will each contain 2 active fuel management valve lifters.*

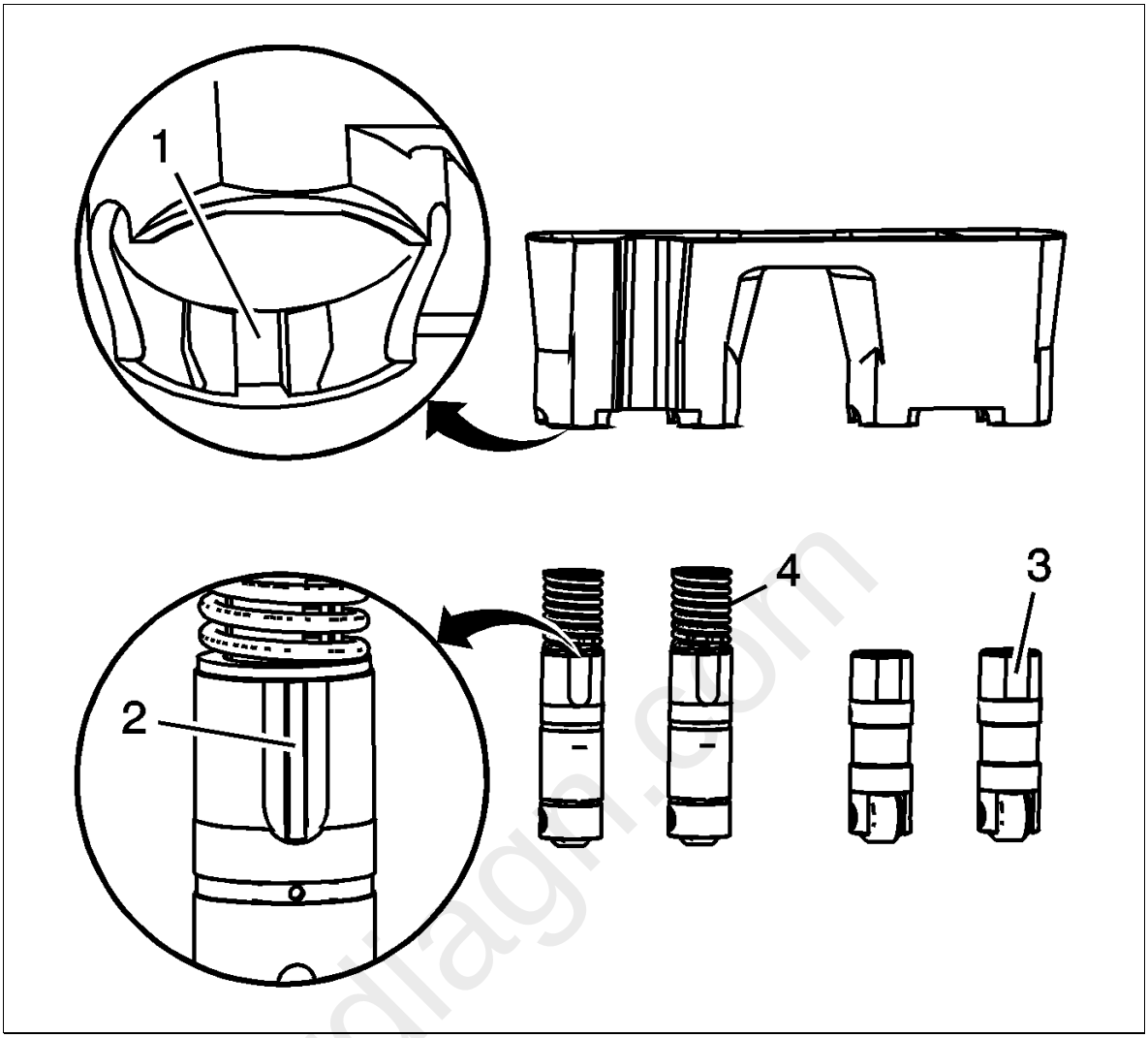
Fig 1: Valve Lifters And Quide



Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve lifters (1) and engine block valve lifter bores with clean engine oil.

Fig 2: Valve Lifters Into Lifter Guides

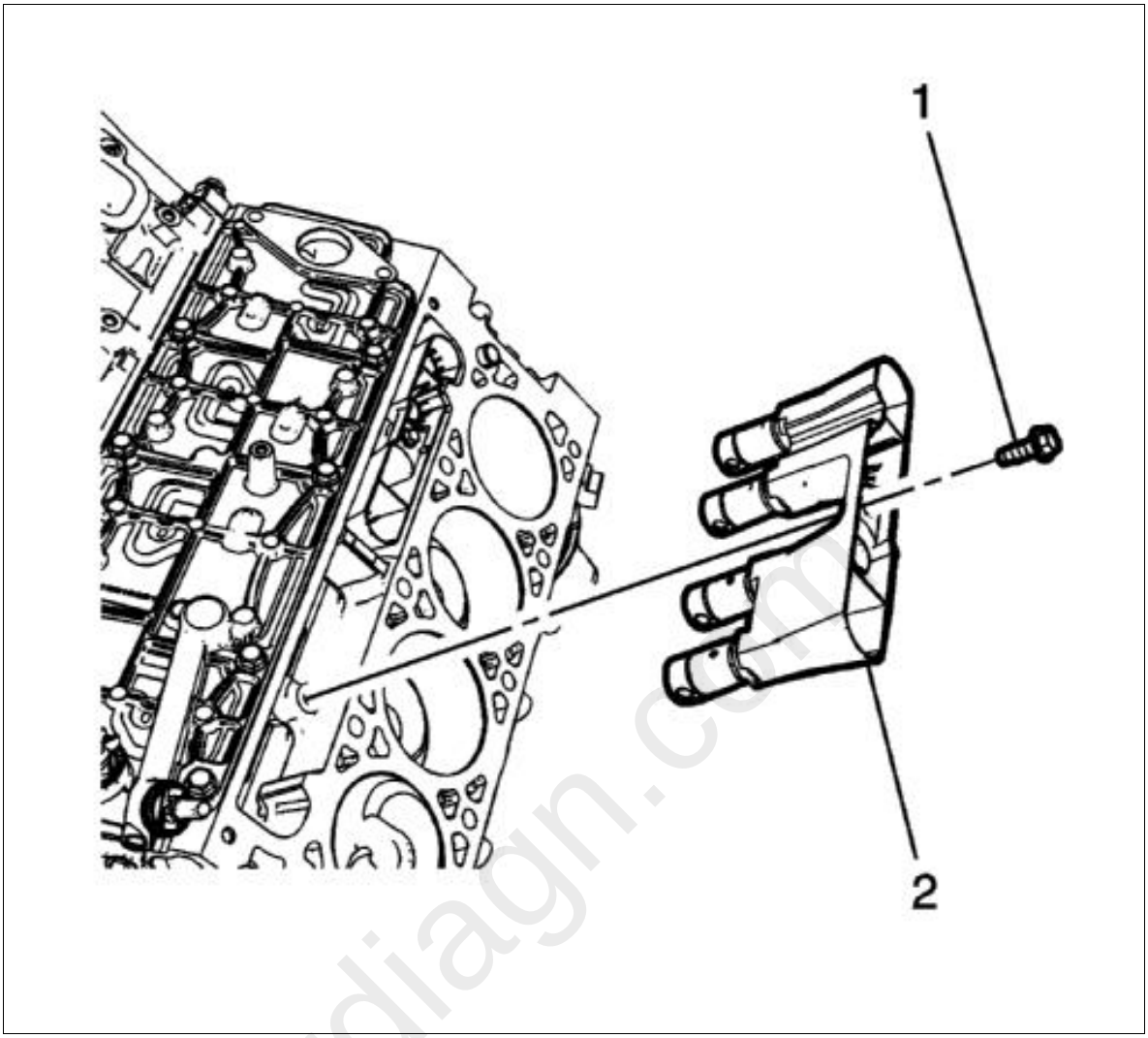


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2. Insert the valve lifters into the lifter guides.
    1. Align the flat area (3) on the top of the non active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
    2. The active fuel management lifters are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.

Fig 3: Valve Lifter Guide Bolt



Courtesy of GENERAL MOTORS COMPANY

3. Install the valve lifters and guide (2) to the engine block.

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

4. Install the valve lifter guide bolts (1).

   Tighten

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

5. Install the cylinder head and gasket. Refer to Cylinder Head Replacement - Left Side , or Cylinder Head Replacement - Right Side .

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REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **J 41478** Crankshaft Front Oil Seal Installer
- **J 41665** Crankshaft Balancer and Sprocket Installer
- **J 41816** Crankshaft Balancer Remover
- **J 41816-2** Crankshaft End Protector
- **J 42386-A** Flywheel Holding Tool
- **J 45059** Angle Meter

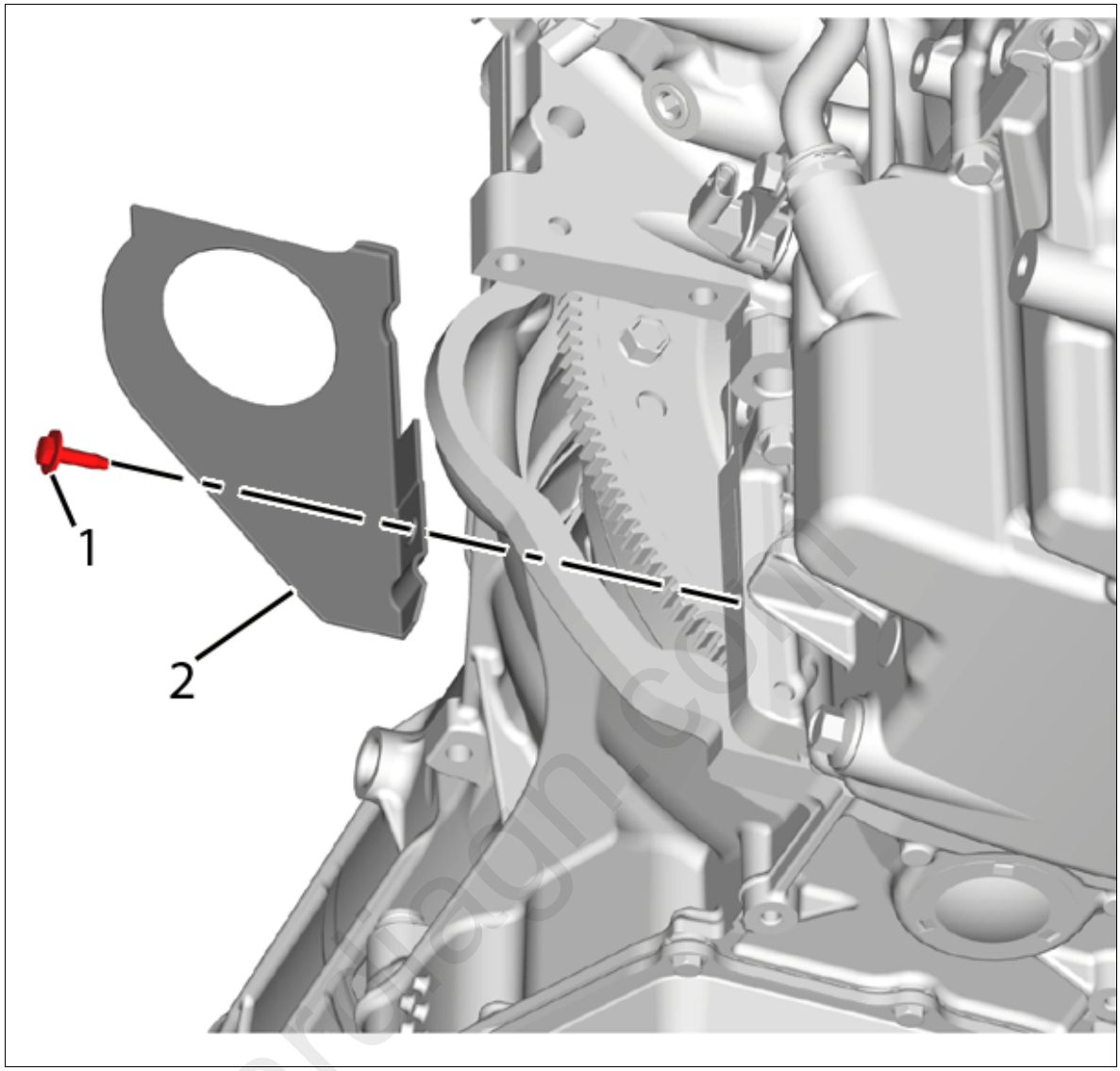
For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT BALANCER REPLACEMENT > REMOVAL PROCEDURE

1. Air Conditioning Compressor Belt»Remove — Air Conditioning Compressor Belt Replacement
2. Radiator Assembly»Remove — Radiator Replacement (LT1)
3. Radiator Outlet Hose»Remove — Radiator Outlet Hose Replacement (LT1 V18 V03)
4. Remove the starter motor. Starter Replacement (LT1)

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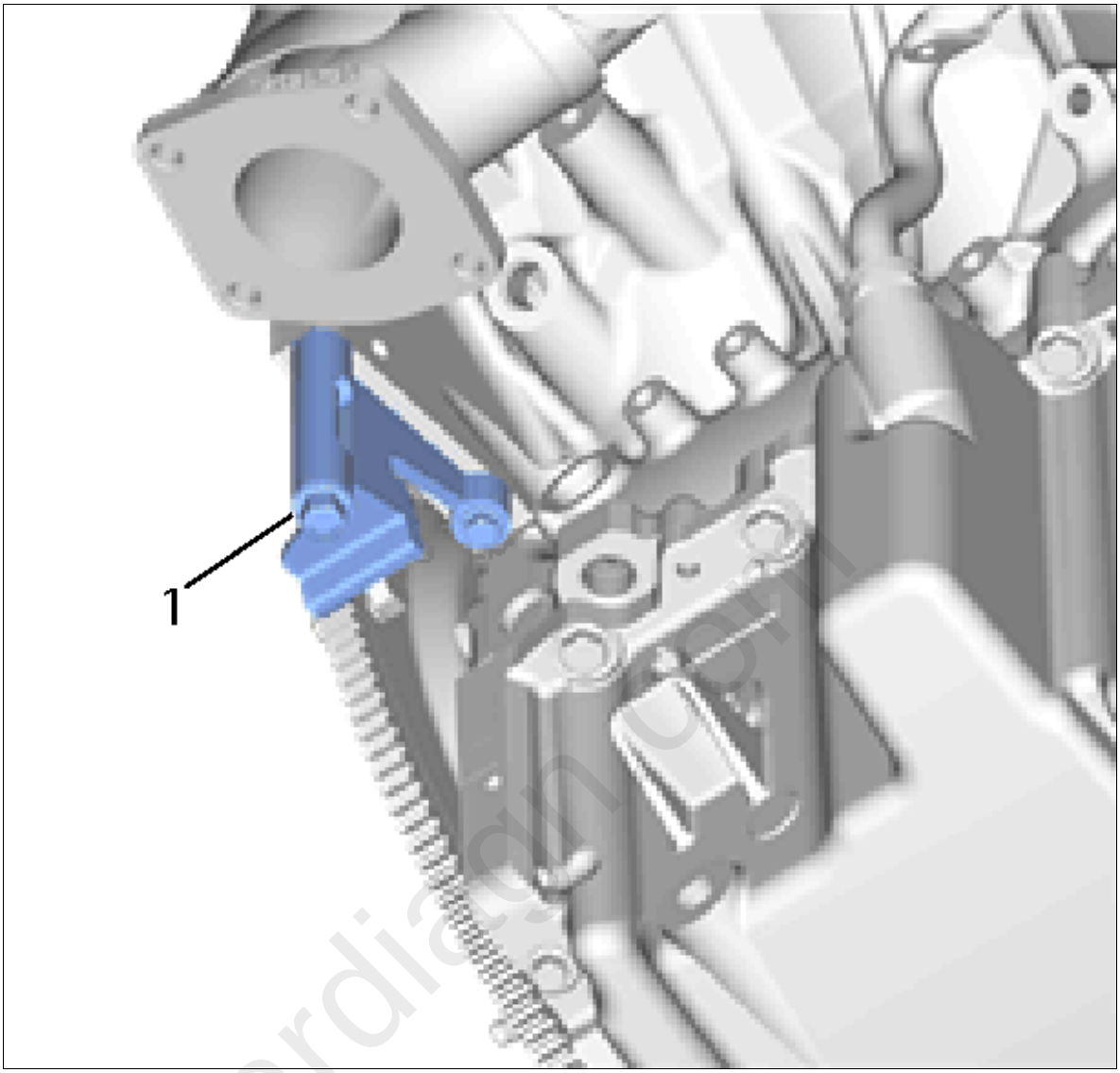
Fig 1: Right Transmission Bolt



Courtesy of GENERAL MOTORS COMPANY

5. Remove the right transmission bolt (1) and cover (2).

Fig 2: Flywheel Holding Tool And Bolts



Courtesy of GENERAL MOTORS COMPANY

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> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

> *NOTE:*
>
> 1. *Note the position of the crankshaft balancer before removal. The balancer does not use a key or keyway for positioning. Mark or scribe the end of the crankshaft and the balancer before component removal. The crankshaft balancer must be installed to the original position. If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be*

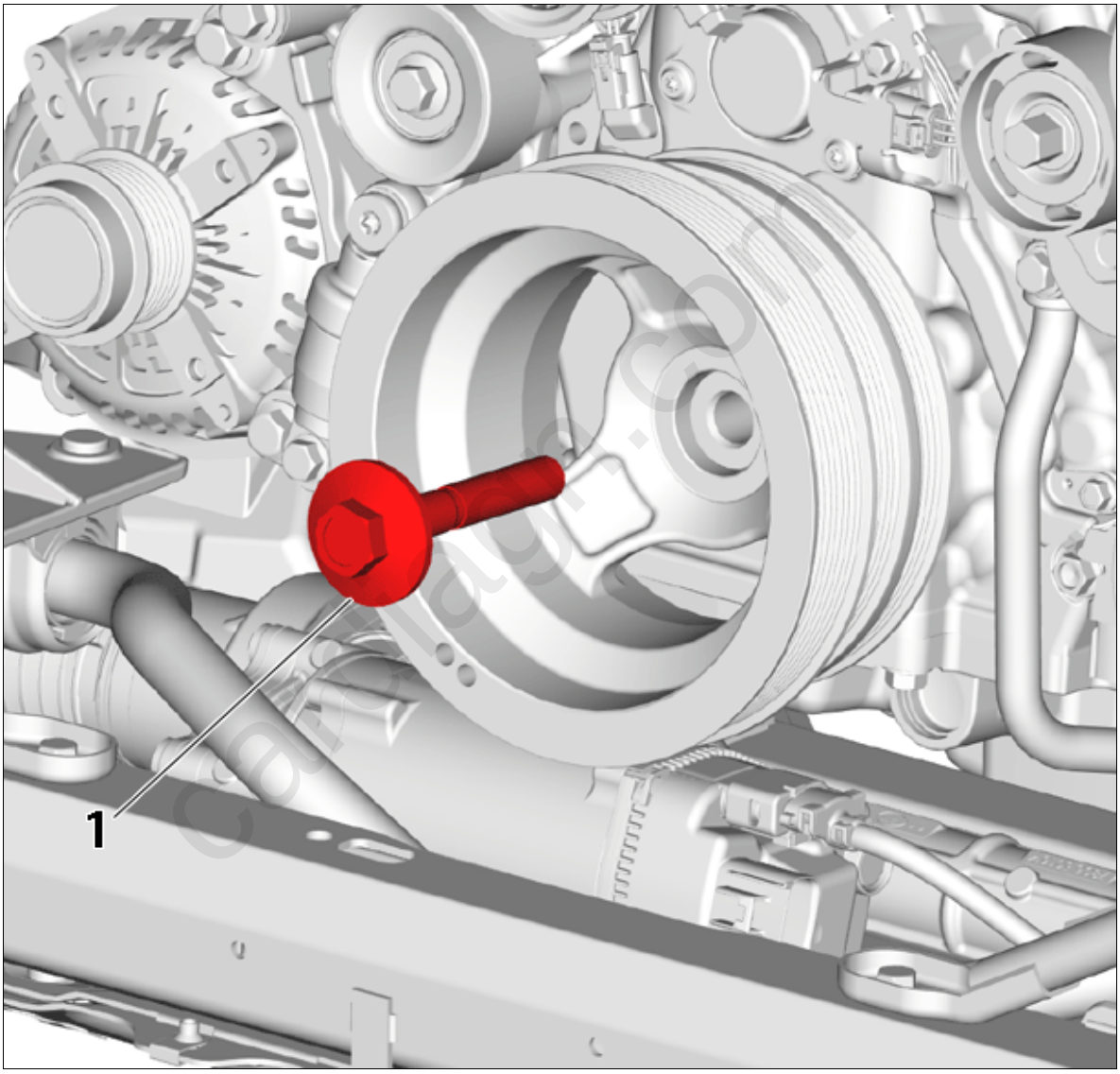
either flush or below flush with the face of the balancer.

2. *Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.*

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

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

   Fig 3: Crankshaft Balancer Bolt

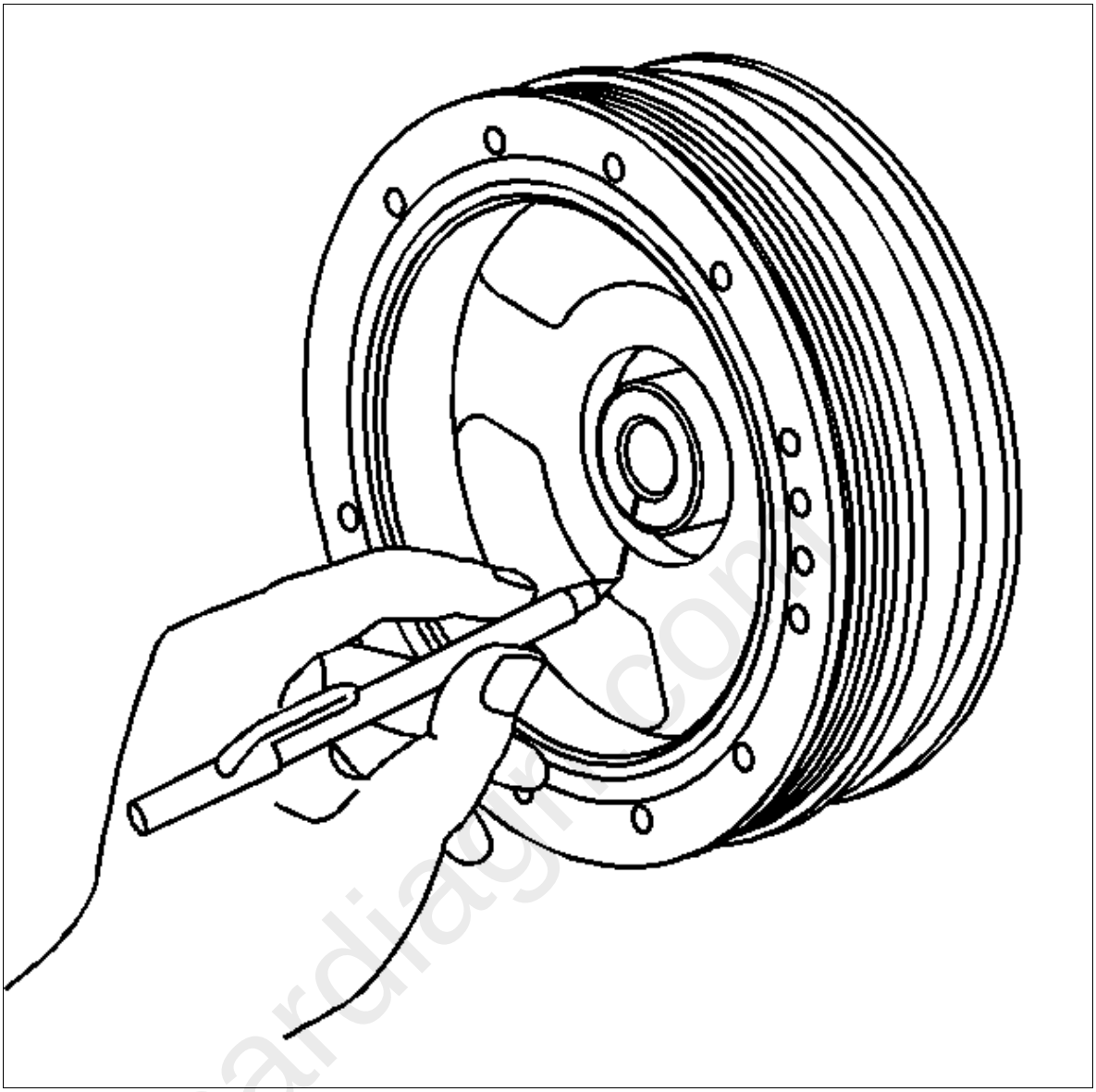


Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft balancer bolt (1).

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

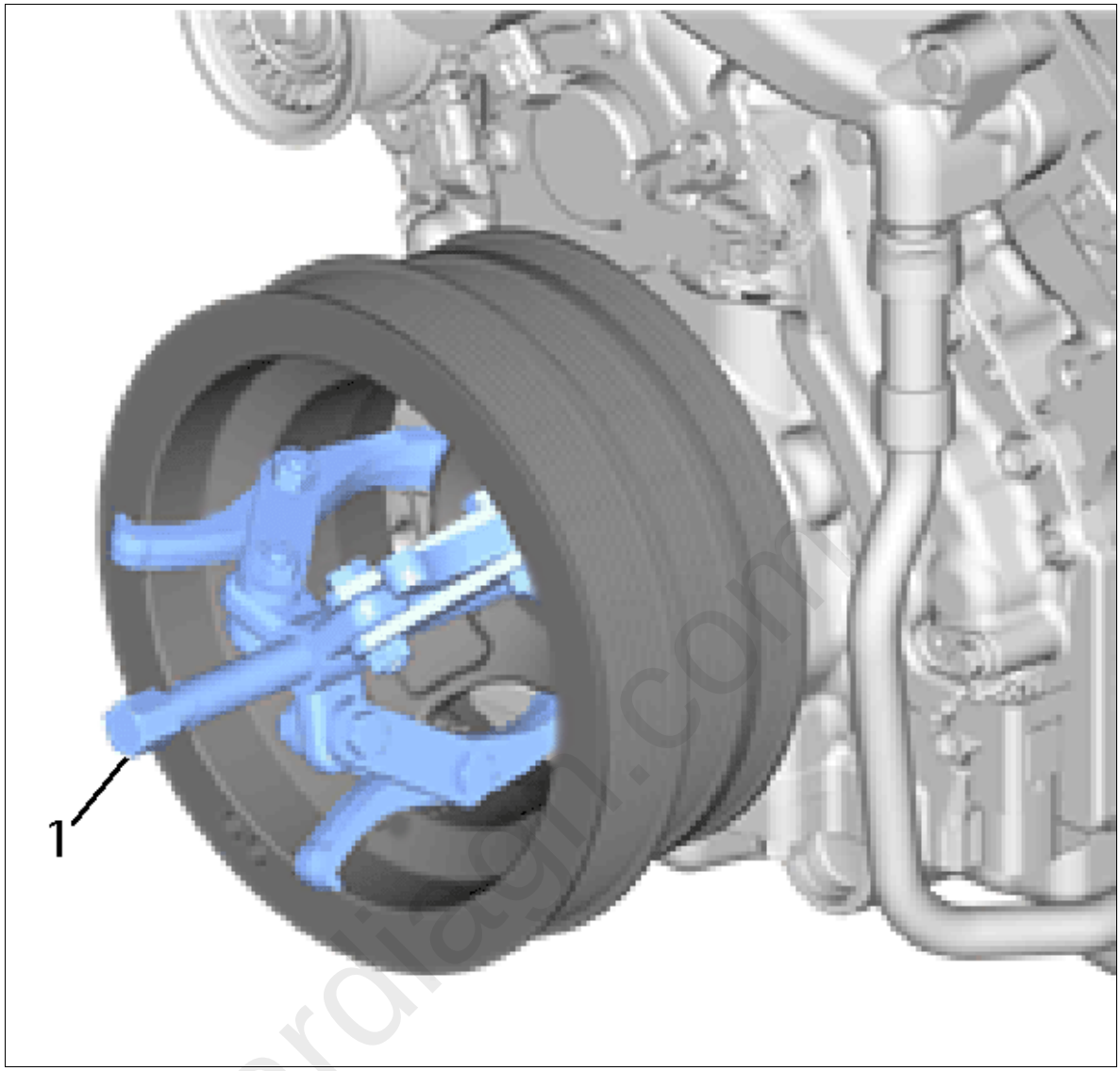
Fig 4: Marking Crankshaft Balancer & End Of Crankshaft



Courtesy of GENERAL MOTORS COMPANY

8. Mark or scribe the crankshaft balancer and the end of the crankshaft.

Fig 5: Crankshaft Balancer Remover

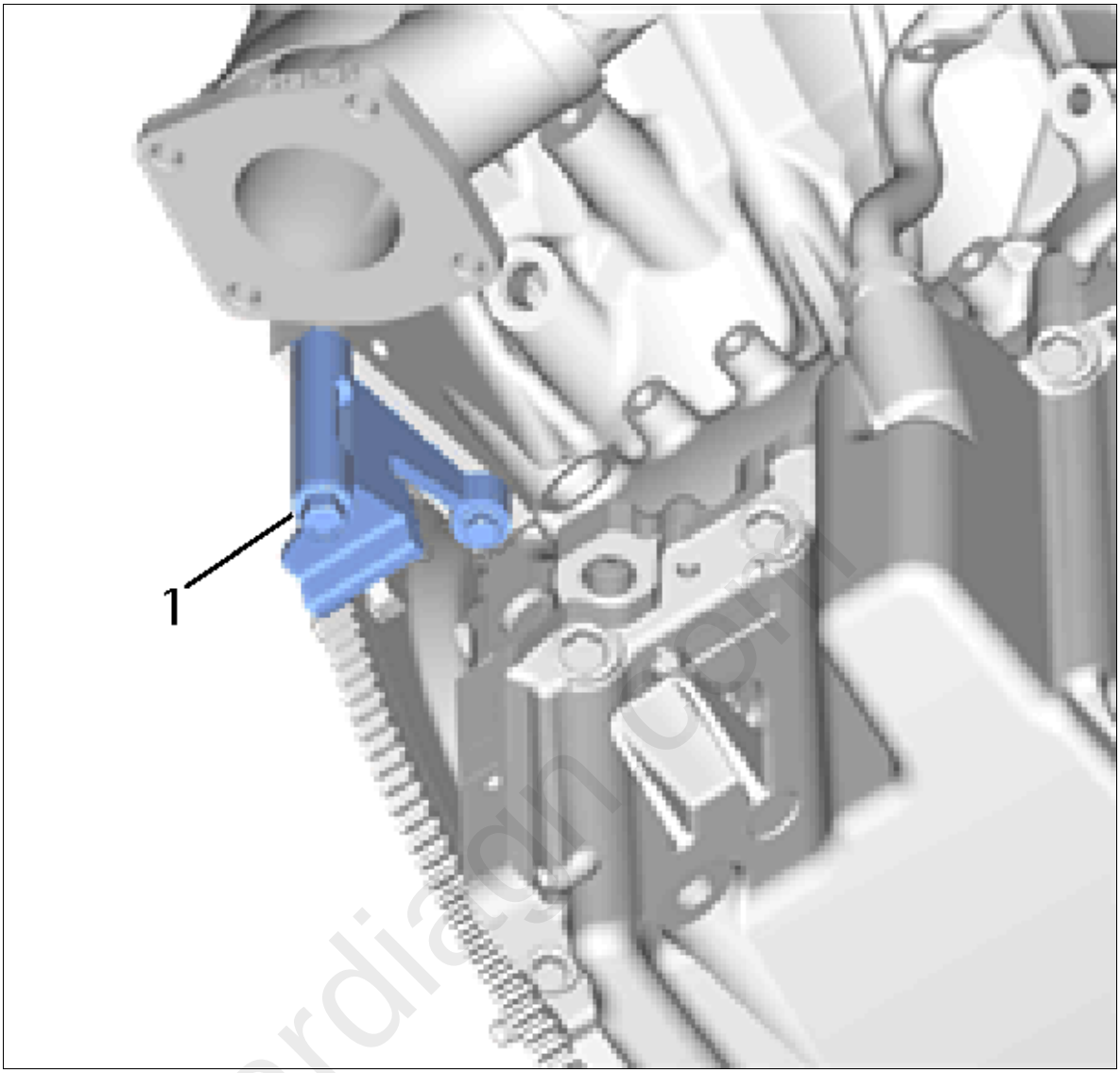


Courtesy of GENERAL MOTORS COMPANY

9. Use the **J 41816** crankshaft balancer remover (1) and the **J 41816-2** crankshaft end protector (2) in order to remove the crankshaft balancer.
10. Clean and inspect the crankshaft balancer. Crankshaft Balancer Cleaning and Inspection

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT BALANCER REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Flywheel Holding Tool And Bolts



Courtesy of GENERAL MOTORS COMPANY

NOTE:

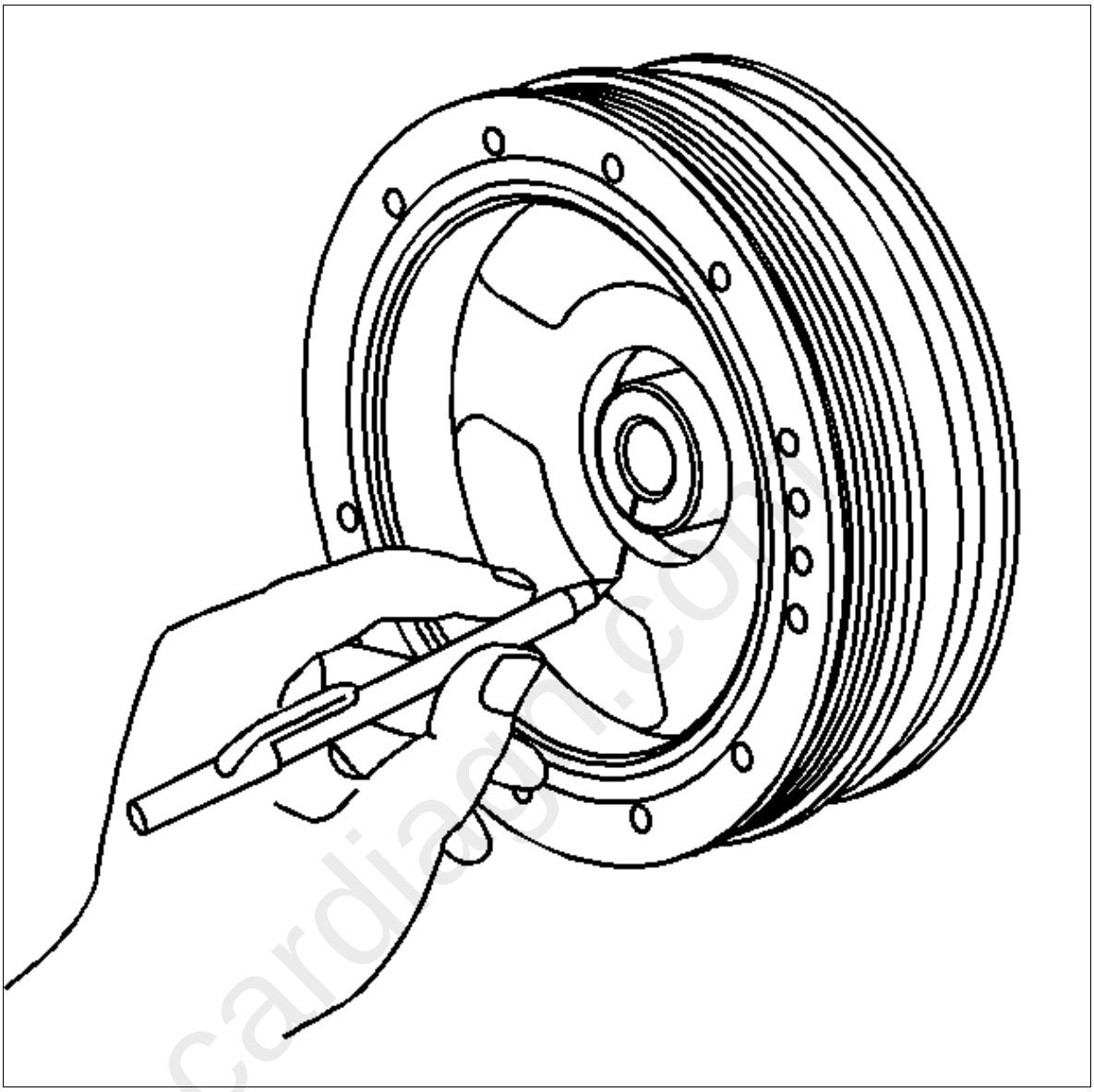
1. *The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the NEW bolt to the proper torque.*
2. *The used crankshaft balancer bolt is used only during the first pass of the balancer installation procedure. Install a NEW crankshaft balancer bolt and tighten as described in the second, third and fourth passes of the balancer bolt tightening procedure.*

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

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

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

Fig 2: Marking Crankshaft Balancer & End Of Crankshaft



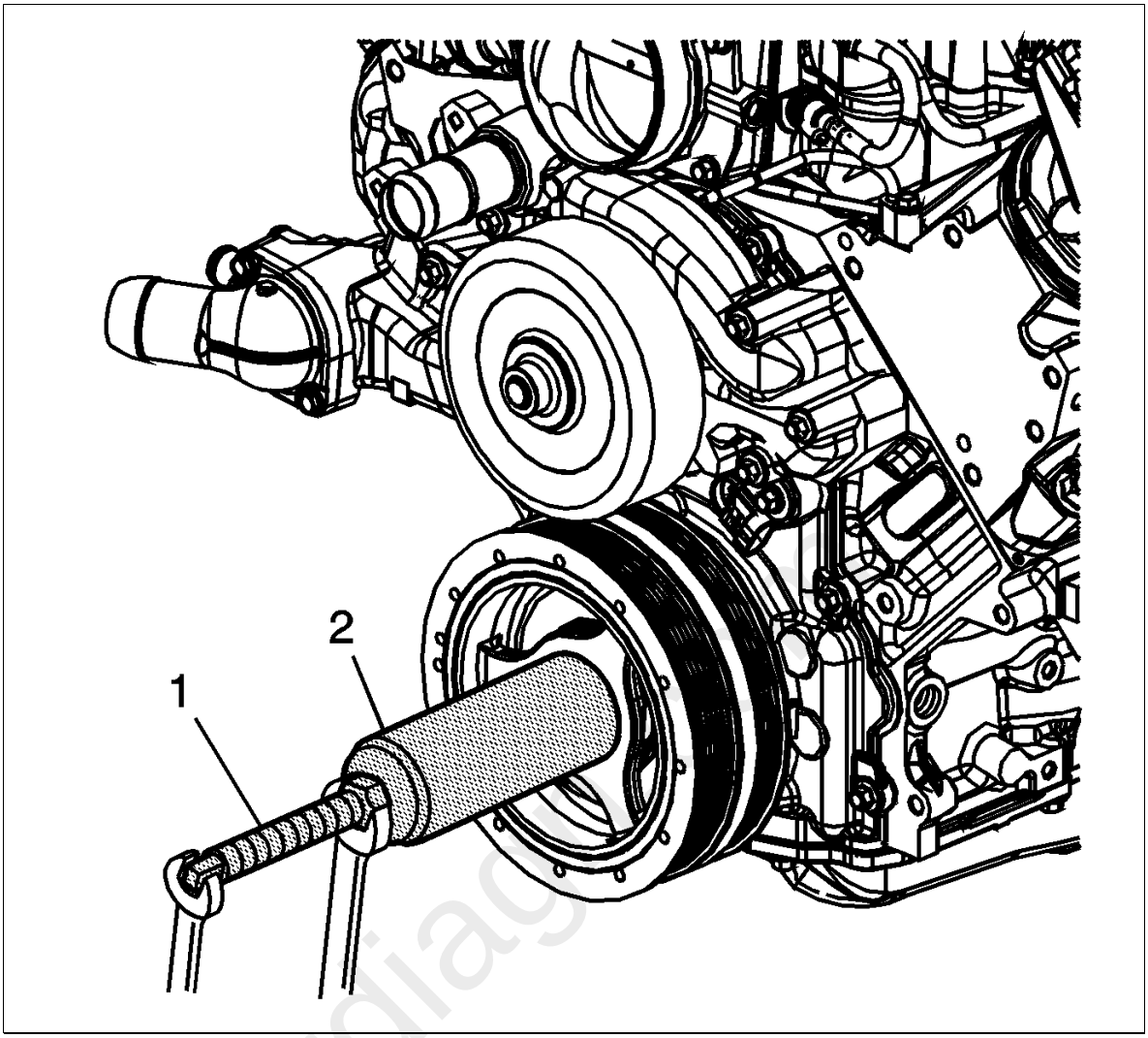
Courtesy of GENERAL MOTORS COMPANY

2. Using the old balancer as a reference, mark or scribe the new balancer in the same location, if applicable.

> *NOTE:*
>
> *The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.*

3. Position the balancer onto the end of the crankshaft.

Fig 3: Crankshaft Balancer Installation Tools



Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 41665** crankshaft balancer and sprocket installer (2) and the **J 41478** crankshaft front oil seal installer (1) in order to install the balancer.

    1. Assemble the **J 41478** crankshaft front oil seal installer (1), nut, washer and the **J 41665** crankshaft balancer and sprocket installer (2).

       Insert the smaller end of the **J 41665** crankshaft balancer and sprocket installer into the front of the balancer.

    2. Use a wrench and hold the hex end of the **J 41478** crankshaft front oil seal installer.

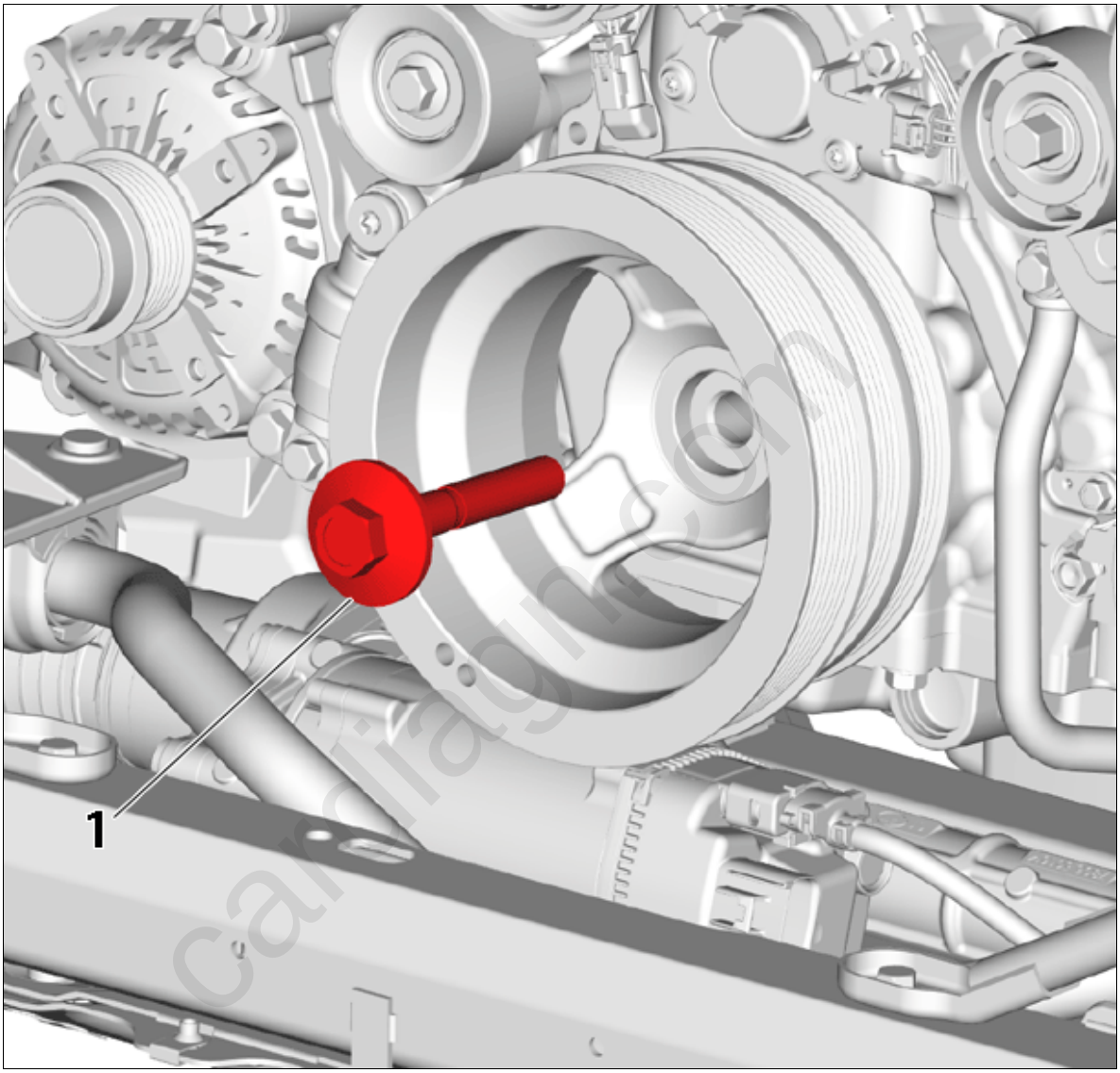
    3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.

    4. Remove the **J 41665** crankshaft balancer and sprocket installer and reverse the installation tool.

       Position the larger end of the **J 41665** crankshaft balancer and sprocket installer against the front of the balancer.

5. Use a wrench and hold the end of the **J 41478** crankshaft front oil seal installer.
6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
7. Remove the balancer installation tool.

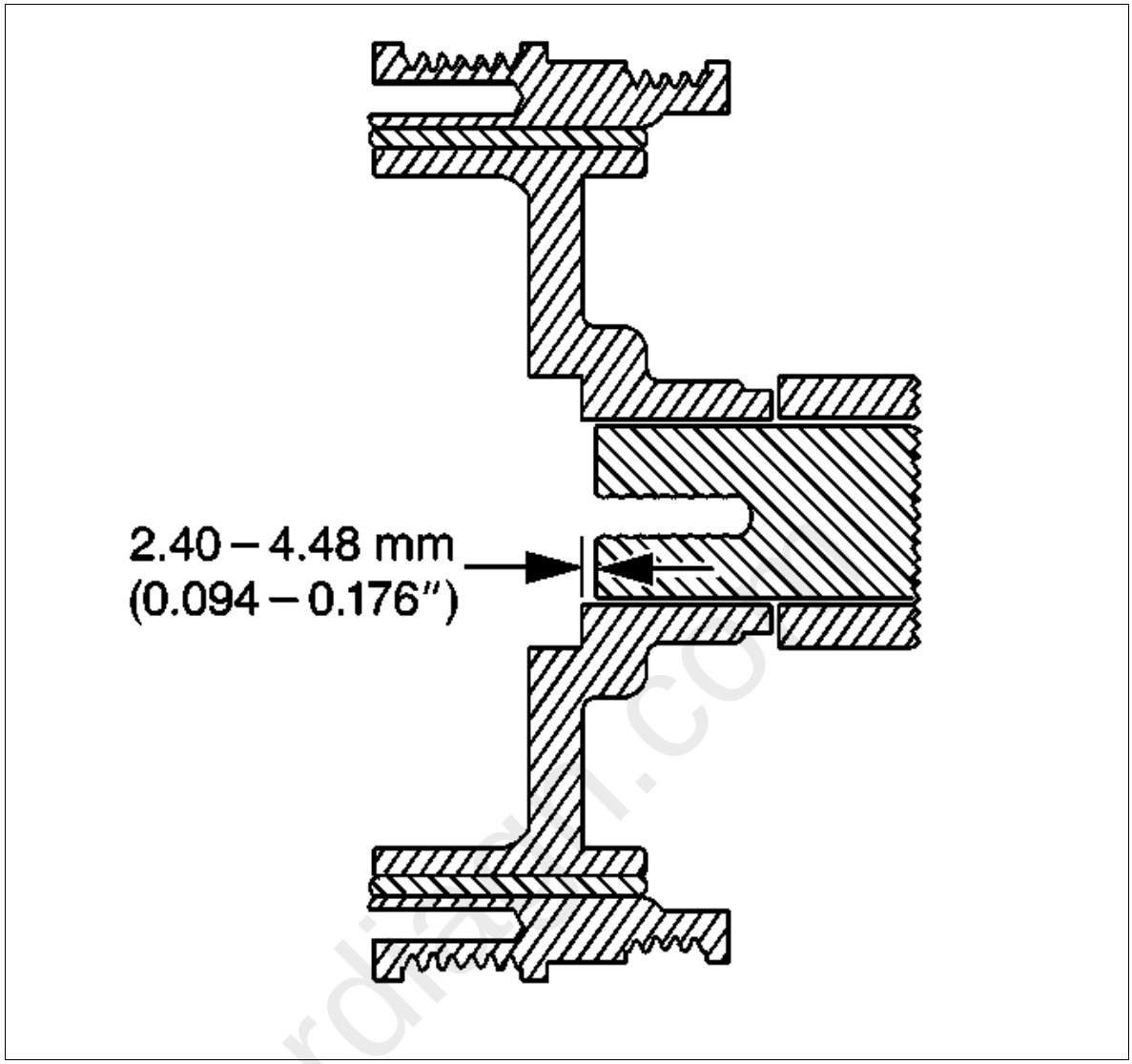
Fig 4: Crankshaft Balancer Bolt



Courtesy of GENERAL MOTORS COMPANY

5. Install the used crankshaft balancer bolt (1) and tighten to 330 N.m (240 lb ft).
6. Remove the used crankshaft balancer bolt.

Fig 5: Hub To Crankshaft Distance



Courtesy of GENERAL MOTORS COMPANY

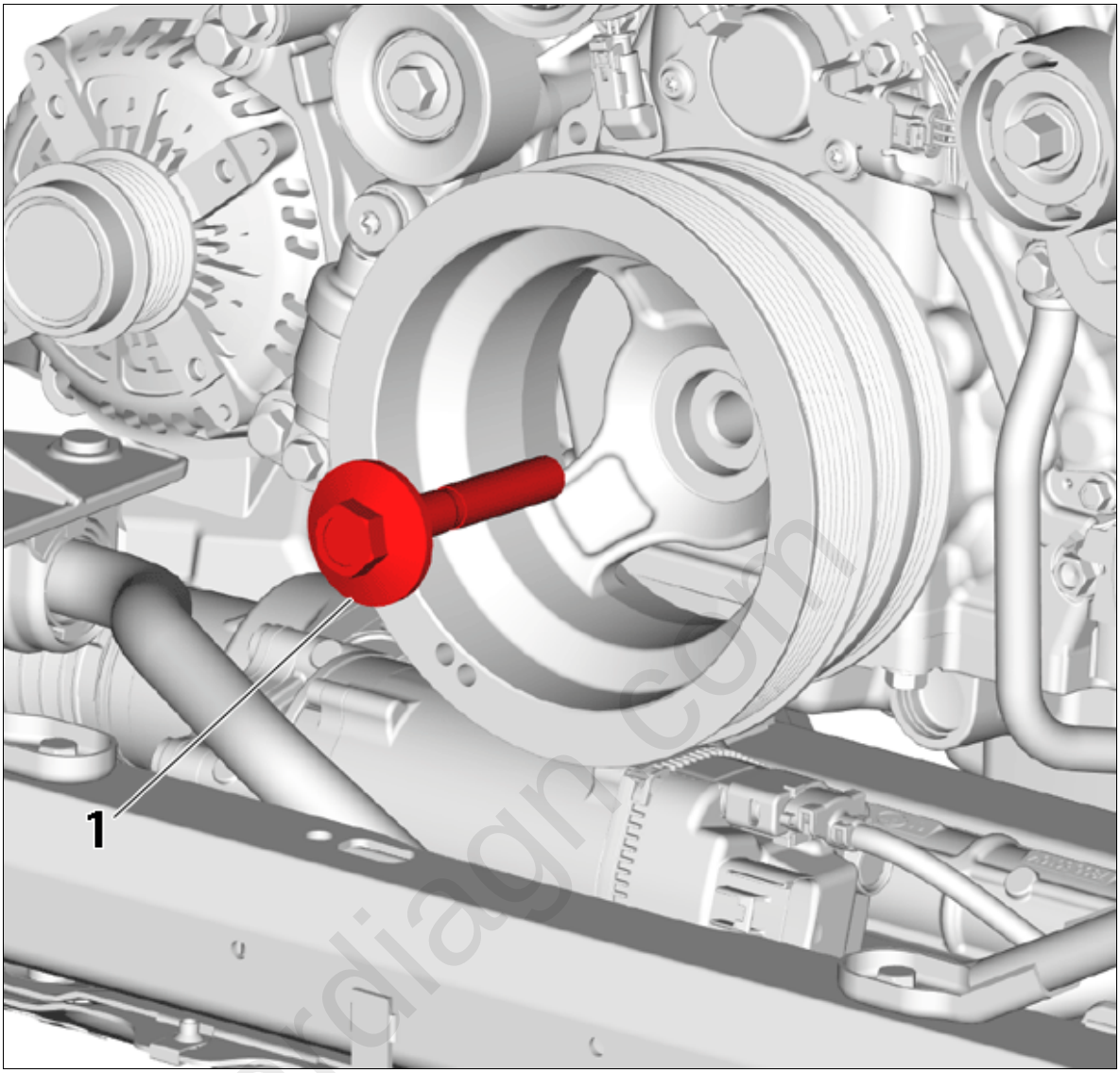
NOTE:

The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

7. Measure for a correctly installed balancer.

   If the balancer is not installed to the proper dimensions, install the **J 41665** crankshaft balancer and sprocket installer and repeat the installation procedure.

Fig 6: Crankshaft Balancer Bolt



Courtesy of GENERAL MOTORS COMPANY

8. Install the NEW crankshaft balancer bolt (1).
    1. Tighten the crankshaft balancer bolt to 120 N.m (89 lb ft).
    2. Loosen the crankshaft balancer bolt 360 degrees.
    3. Tighten the crankshaft balancer bolt to 80 N.m (59 lb ft).
    4. Balancer bolt with a flanged head tighten the crankshaft balancer bolt a final pass to 125 degrees using the **J 45059** angle meter.
    5. Balancer bolt with a retained rotating washer tighten the crankshaft balancer bolt a final pass to 200 degrees using the **J 45059** angle meter.
9. Remove the **J 42386-A** flywheel holding tool.
10. Install the starter motor. Starter Replacement (LT1)

11. Radiator Outlet Hose»Install — Radiator Outlet Hose Replacement (LT1 V18 V03)
12. Radiator Assembly»Install — Radiator Replacement (LT1)
13. Air Conditioning Compressor Belt»Install — Air Conditioning Compressor Belt Replacement

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

- **J-41478-A** Crankshaft Front Oil Seal Installer
- **EN-51091** Crankshaft Front Oil Seal Installer
- **EN-51096** Crankshaft Rear Seal Remover
- **GE-23907-1** Slide Hammer

For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT FRONT OIL SEAL REPLACEMENT > REMOVAL PROCEDURE

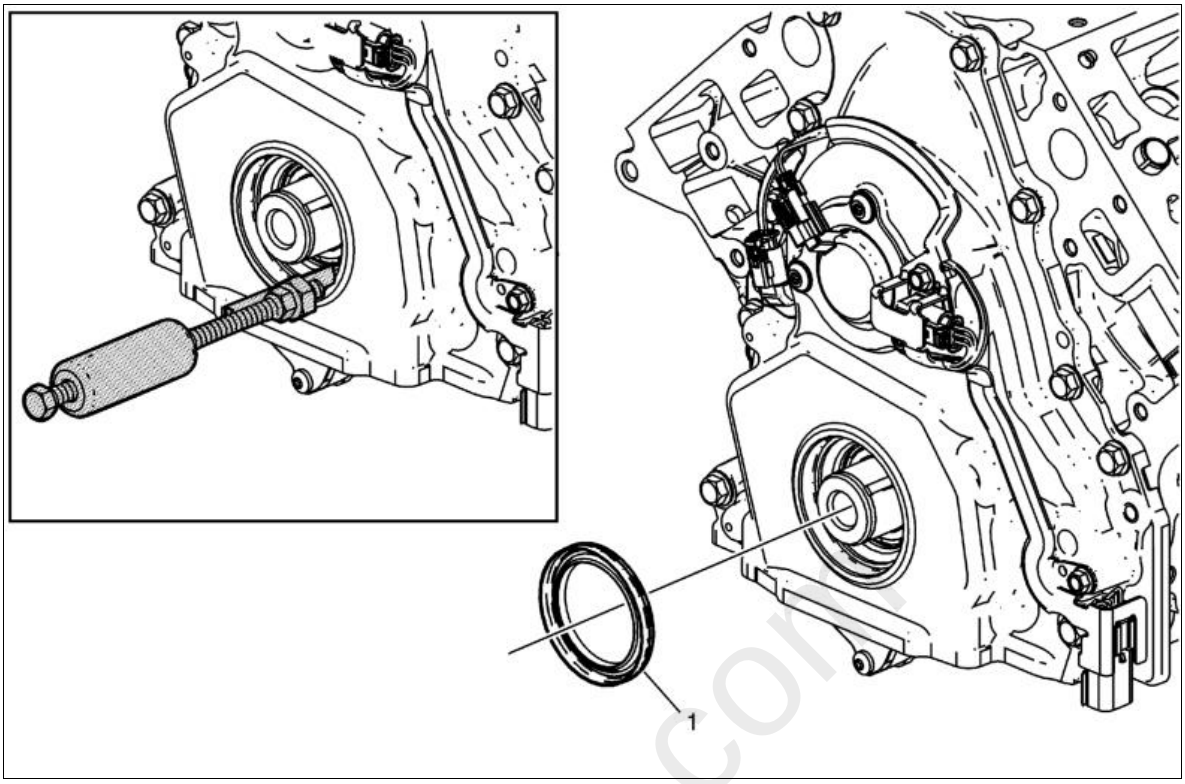
1. Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement .

> *NOTE:*
>
> ***EN-51096*** *crankshaft rear seal remover has two ends. The end with the small bend will be used to remove the seal.*

2. Install **EN-51096** crankshaft rear seal remover onto **GE-23907-1** slide hammer.

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Fig 1: Crankshaft Front Oil Seal

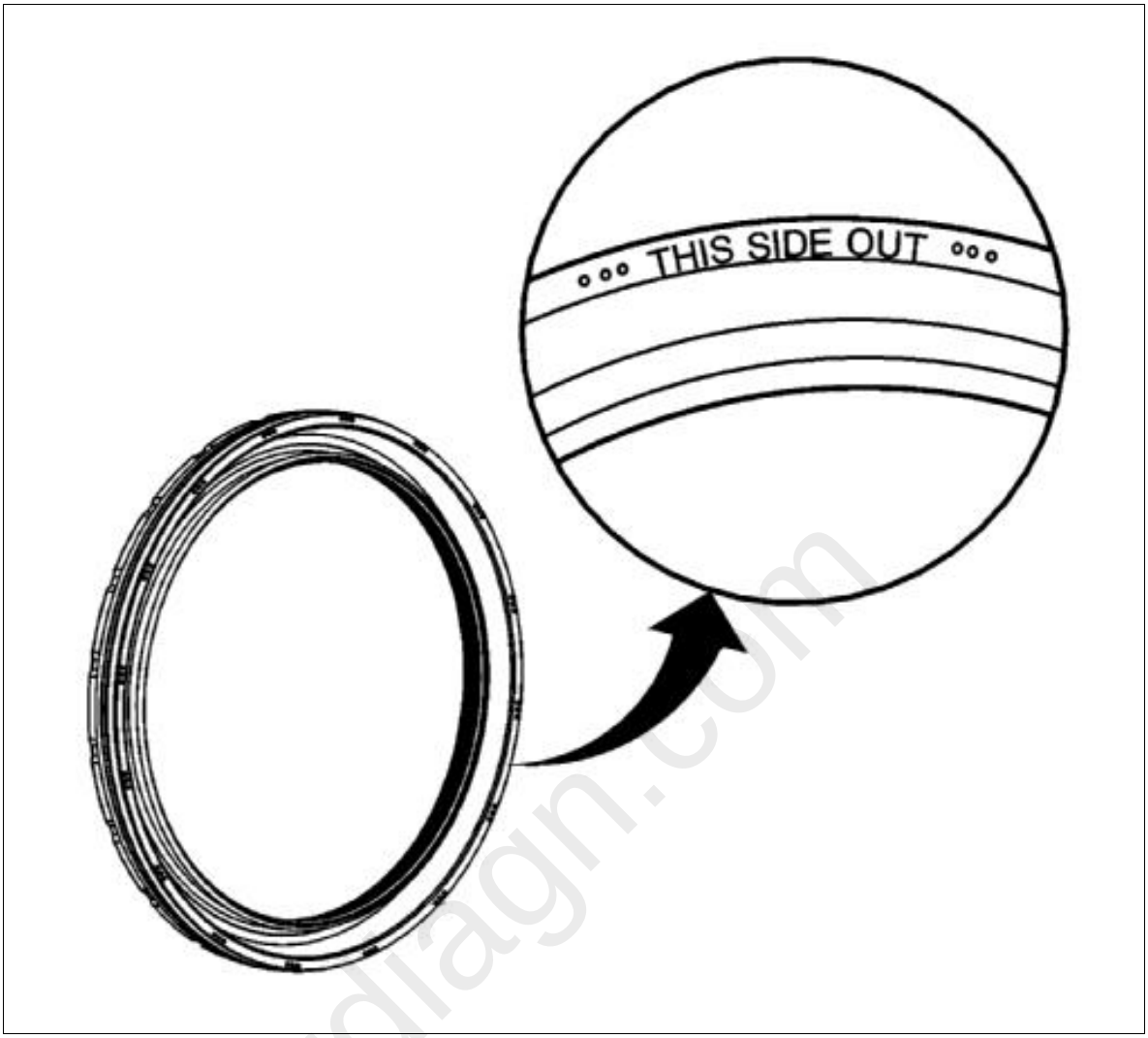


Courtesy of GENERAL MOTORS COMPANY

3. Slide the small bend of **EN-51096** crankshaft rear seal remover between the lip of the front seal and crankshaft. Ensure that the small bend of **EN-51096** crankshaft rear seal remover engages the rear side of the front seal (1). While rotating **EN-51096** crankshaft rear seal remover and **GE-23907-1** slide hammer around the seal, use the slide hammer to remove the seal.

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT FRONT OIL SEAL REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Inspecting Seal For Proper Orientation



Courtesy of GENERAL MOTORS COMPANY

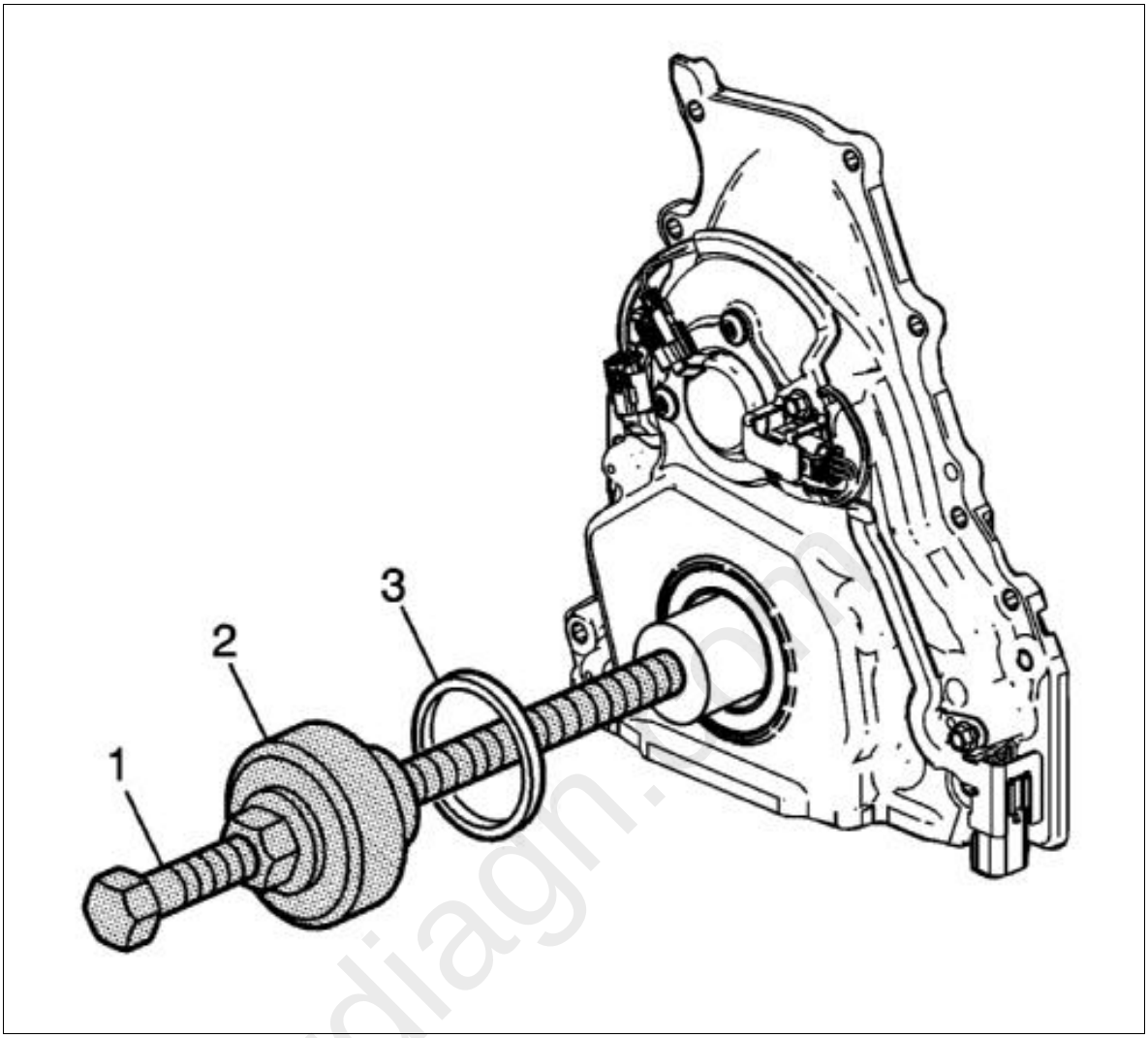
IMPORTANT:

For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. Install with "THIS SIDE OUT" displayed as shown.

1. Inspect the seal for proper orientation.

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Fig 2: Crankshaft Front Oil Seal



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NOTE:

1. Do not lubricate the oil seal sealing surface.

2. Do not use the crankshaft front oil seal again.

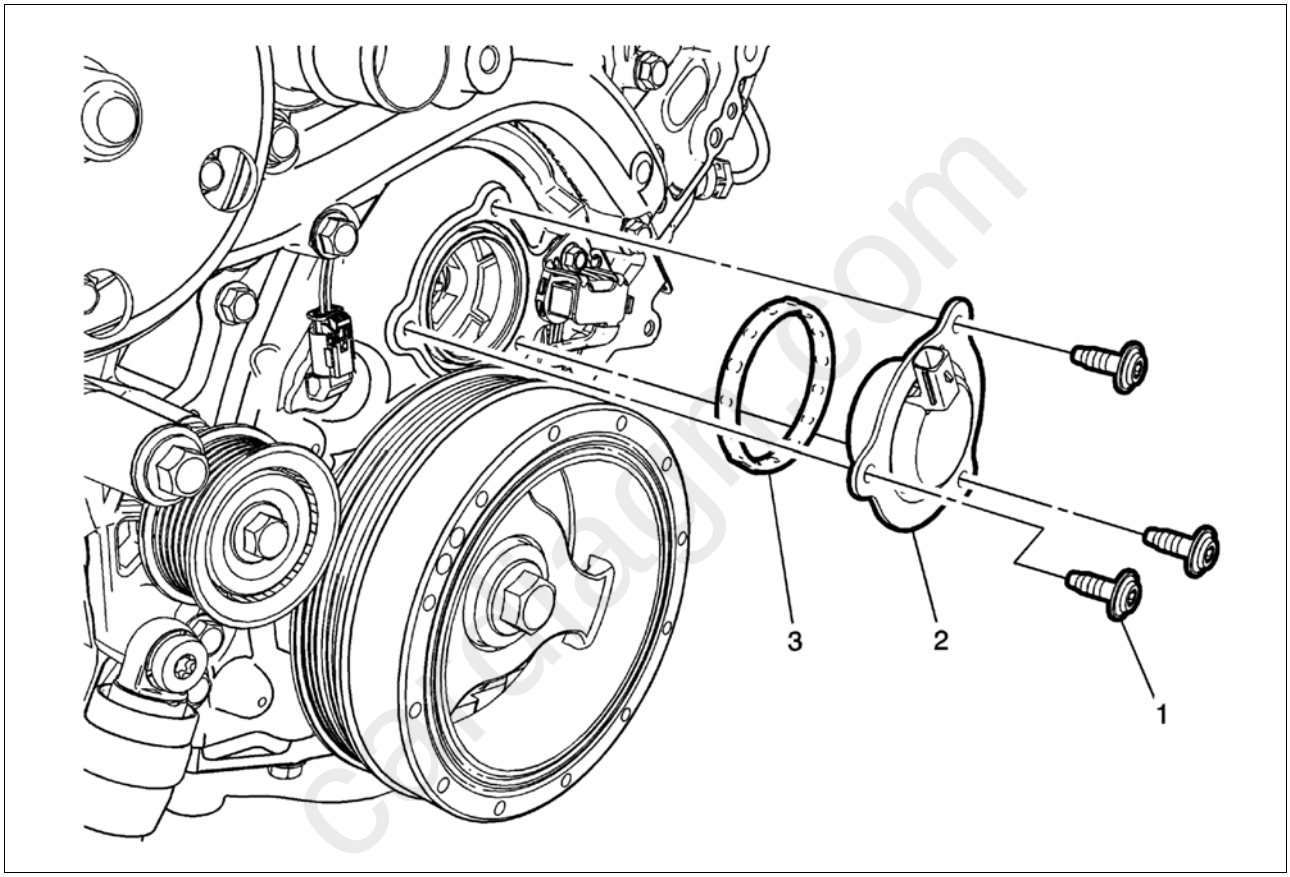
2. Install the crankshaft front oil seal (3) onto the threaded rod, nut and washer from **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal installer (2).
3. Install the **J-41478-A** crankshaft front oil seal installer threaded rod, nut and washer (1) and **EN-51091** crankshaft front oil seal installer (2) and oil seal (3), into the end of the crankshaft.
4. Use the **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal installer (2) in order to install the oil seal (3) into the cover bore.
    1. Use a wrench and hold the hex on the installer bolt.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in

the cover bore.

3. Remove the tool.
4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

REPAIR INSTRUCTIONS - ON VEHICLE > CAMSHAFT POSITION ACTUATOR MAGNET REPLACEMENT

Fig 1: Camshaft Position Actuator



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Drive Belt Replacement - Accessory	

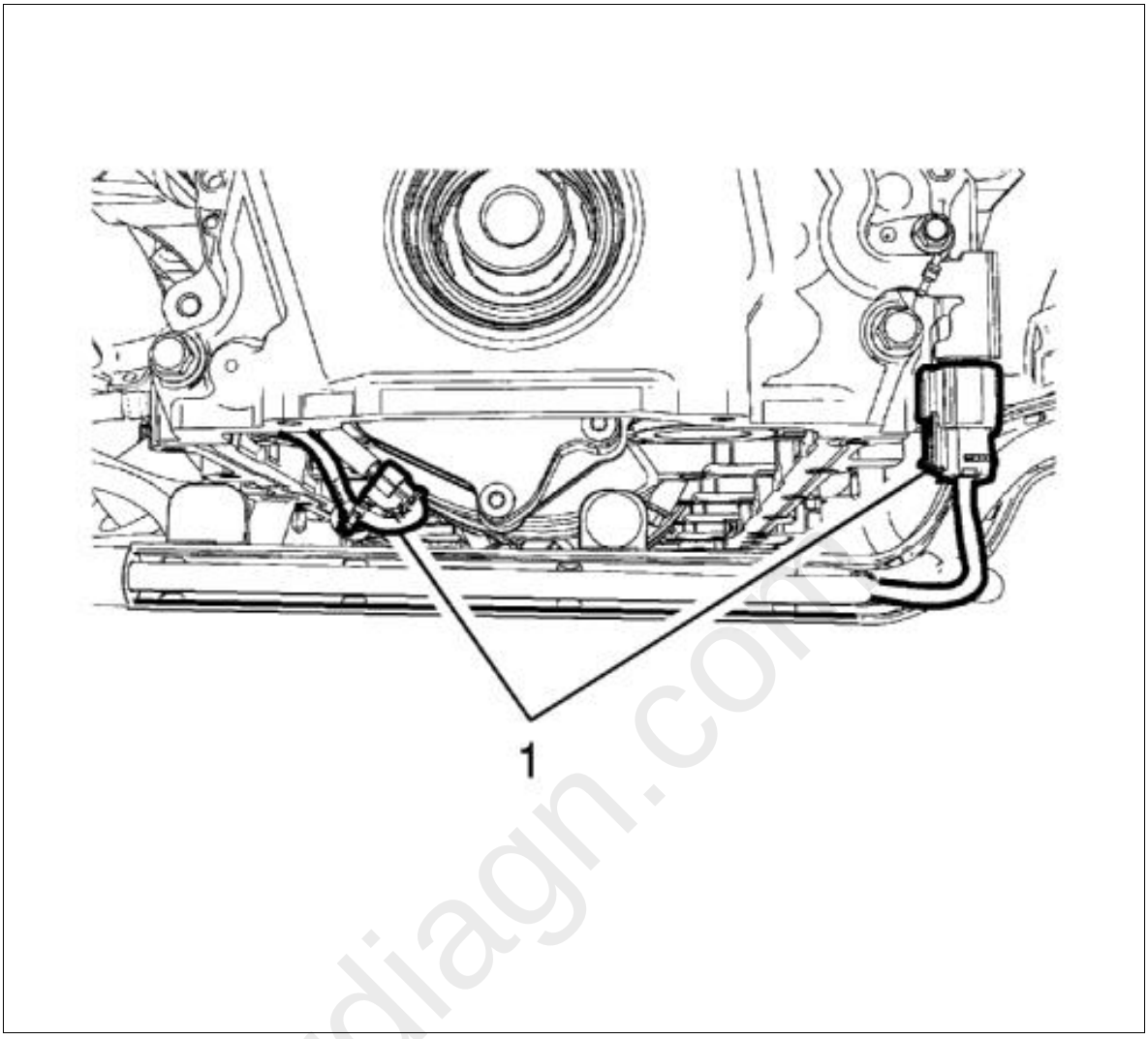
1	Camshaft Position Actuator Fasteners (Qty: 3) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Magnet **Procedure** Unplug the camshaft position actuator magnet electrical connector.
3	Camshaft Position Actuator Seal *NOTE:* *Replace with NEW seal.*

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE FRONT COVER REPLACEMENT > REMOVAL PROCEDURE

1. Remove the oil pan. Refer to Oil Pan Replacement .
2. Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement .
3. Remove the engine coolant manifold. Refer to Engine Coolant Manifold Replacement (LT1) .
4. Remove the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory .

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Fig 1: Electrical Connectors

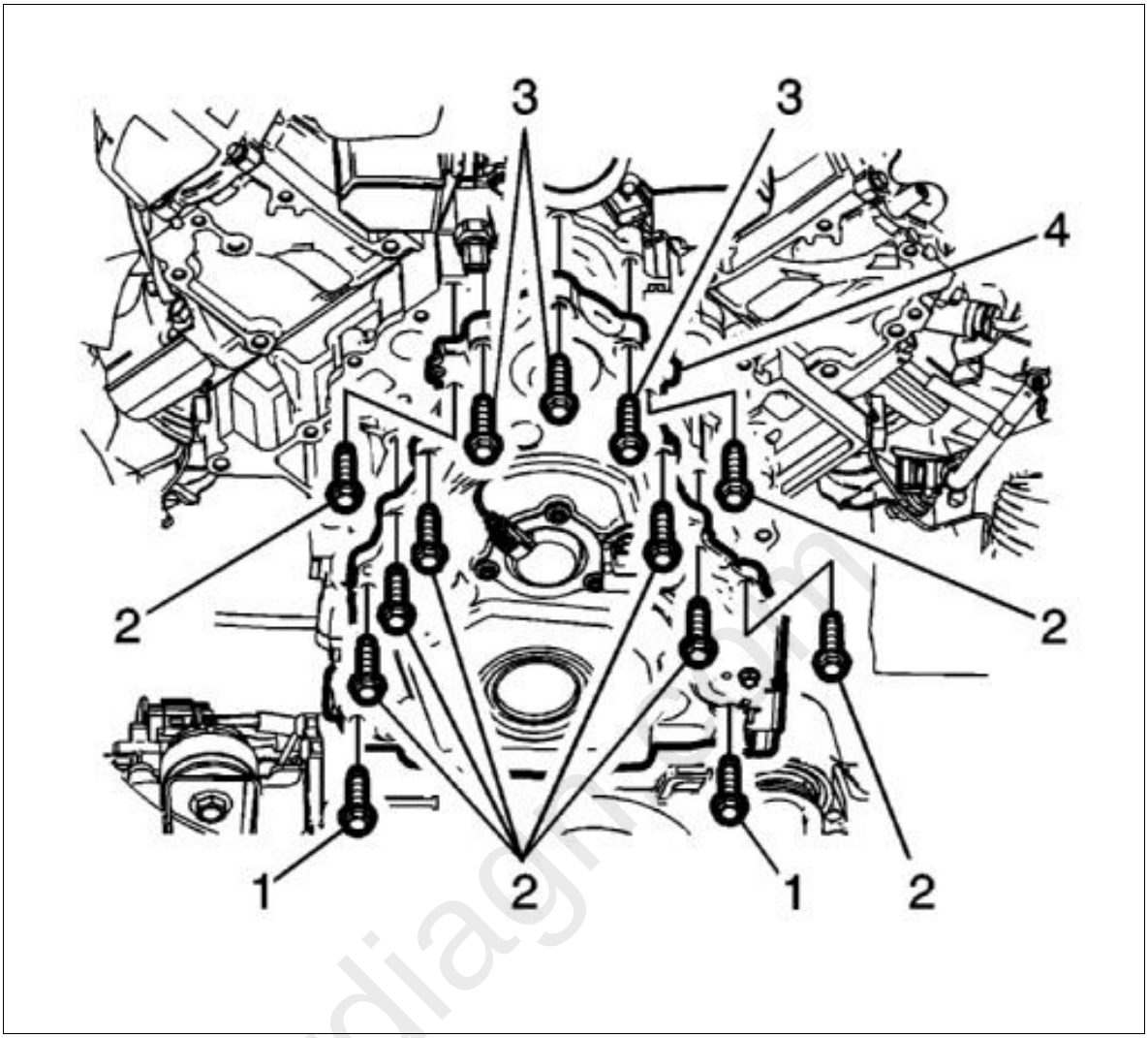


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5. Disconnect the electrical connectors (1).

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Fig 2: Front Cover Bolts

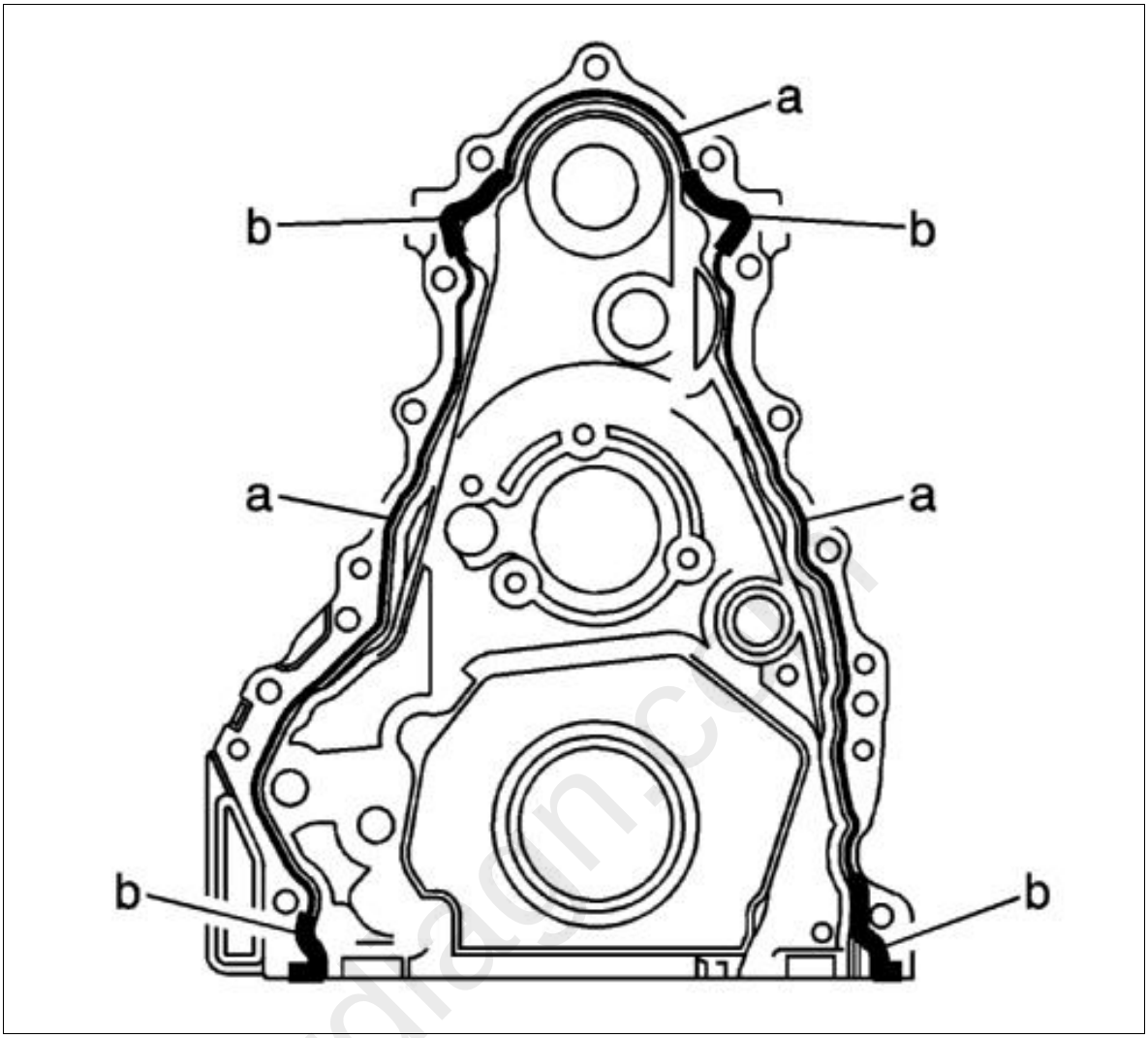


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6. Remove the front cover bolts (1-3).
7. Remove front cover (4).
8. Ensure to clean and inspect the engine front cover. Refer to Engine Front Cover Cleaning and Inspection .

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE FRONT COVER REPLACEMENT > INSTALLATION PROCEDURE

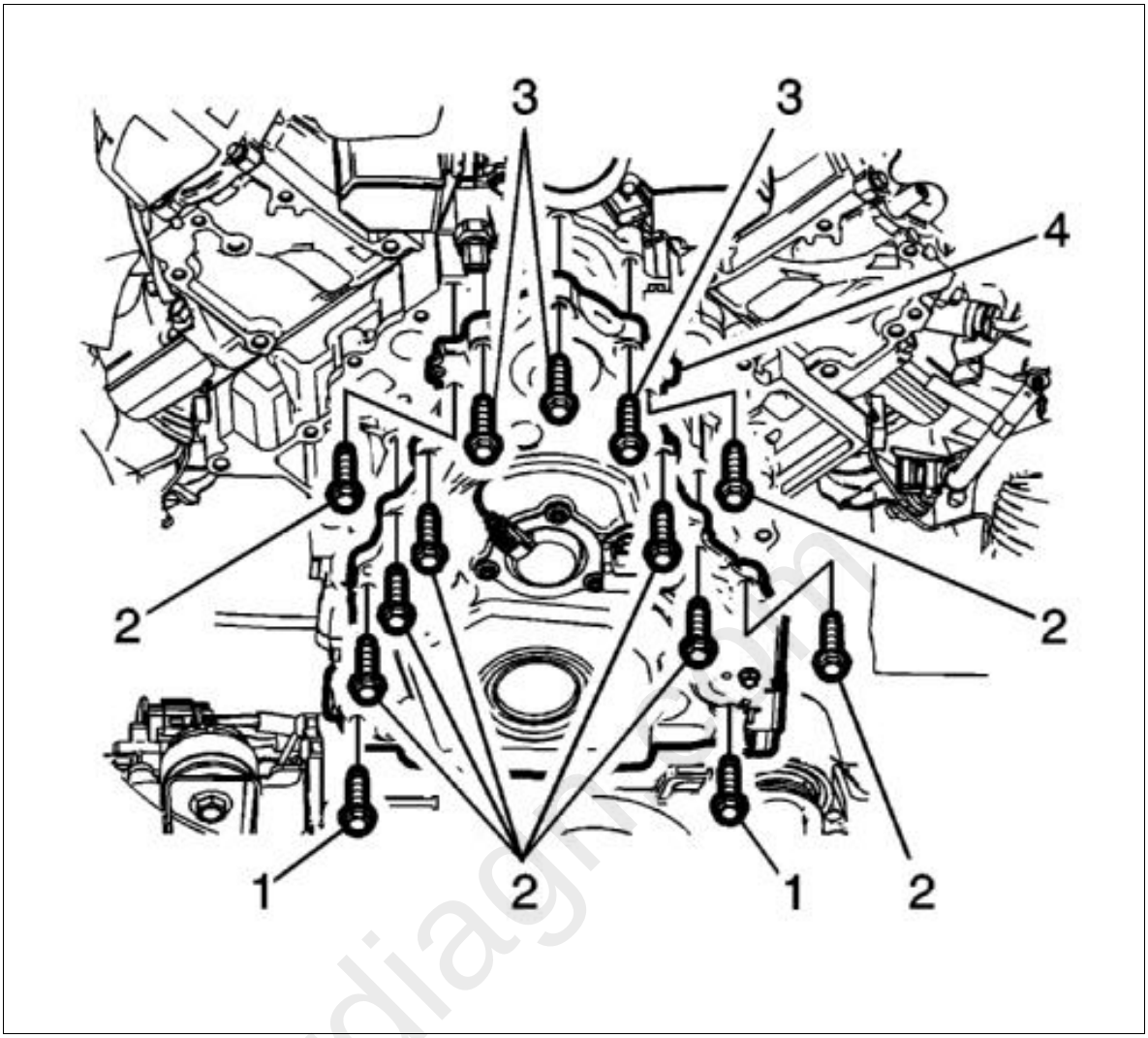
Fig 1: Applying 3mm (0.118 in) Bead Of RTV Sealant On Engine Front Cover



Courtesy of GENERAL MOTORS COMPANY

1. Apply a 3 mm (0.118 in)bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in)bead of RTV sealant on the engine front cover as shown (b). Refer to Adhesives, Fluids, Lubricants, and Sealers .

Fig 2: Front Cover Bolts



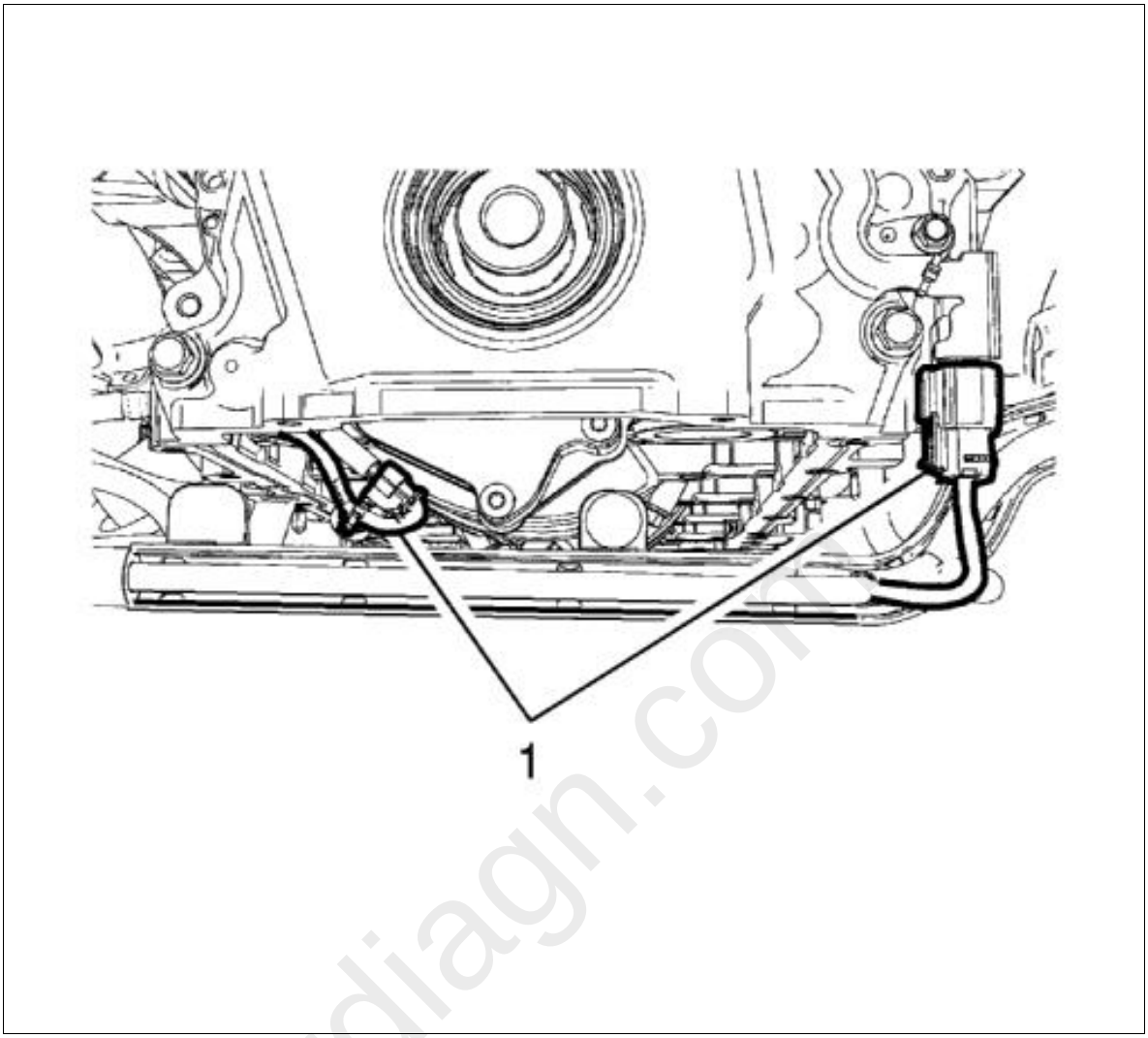
Courtesy of GENERAL MOTORS COMPANY

2. Install the front cover (4).

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

3. Install the front cover bolts (1-3) and tighten to 25 N.m (18 lb ft).

Fig 3: Electrical Connectors



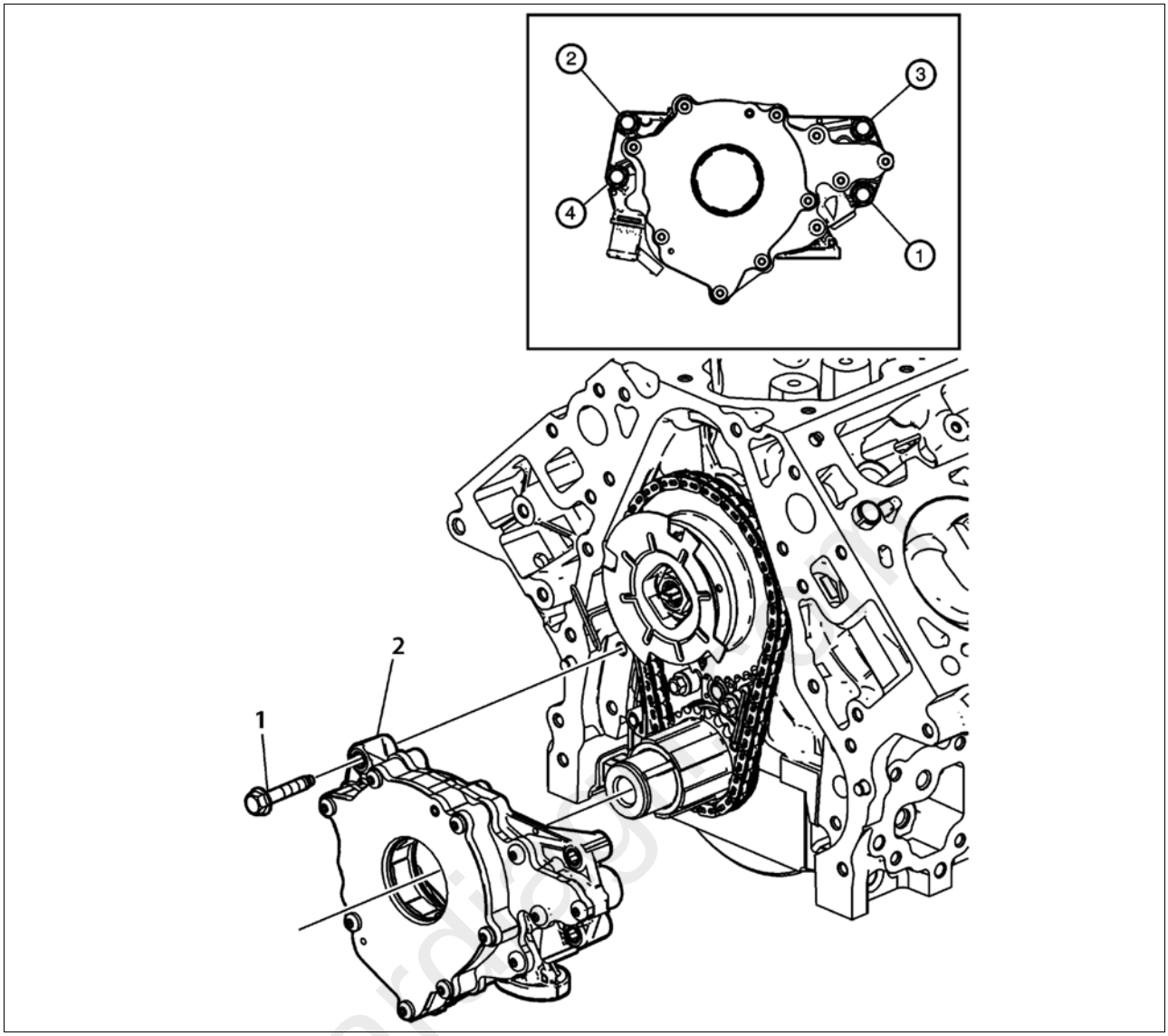
Courtesy of GENERAL MOTORS COMPANY

4. Connect the electrical connectors (1).
5. Install the engine coolant manifold. Refer to Engine Coolant Manifold Replacement (LT1) .
6. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement .
7. Install the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory .
8. Install the oil pan. Refer to Oil Pan Replacement .

REPAIR INSTRUCTIONS - ON VEHICLE > OIL PUMP REPLACEMENT

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Fig 1: Oil Pump



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Preliminary Procedure

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

NOTE:

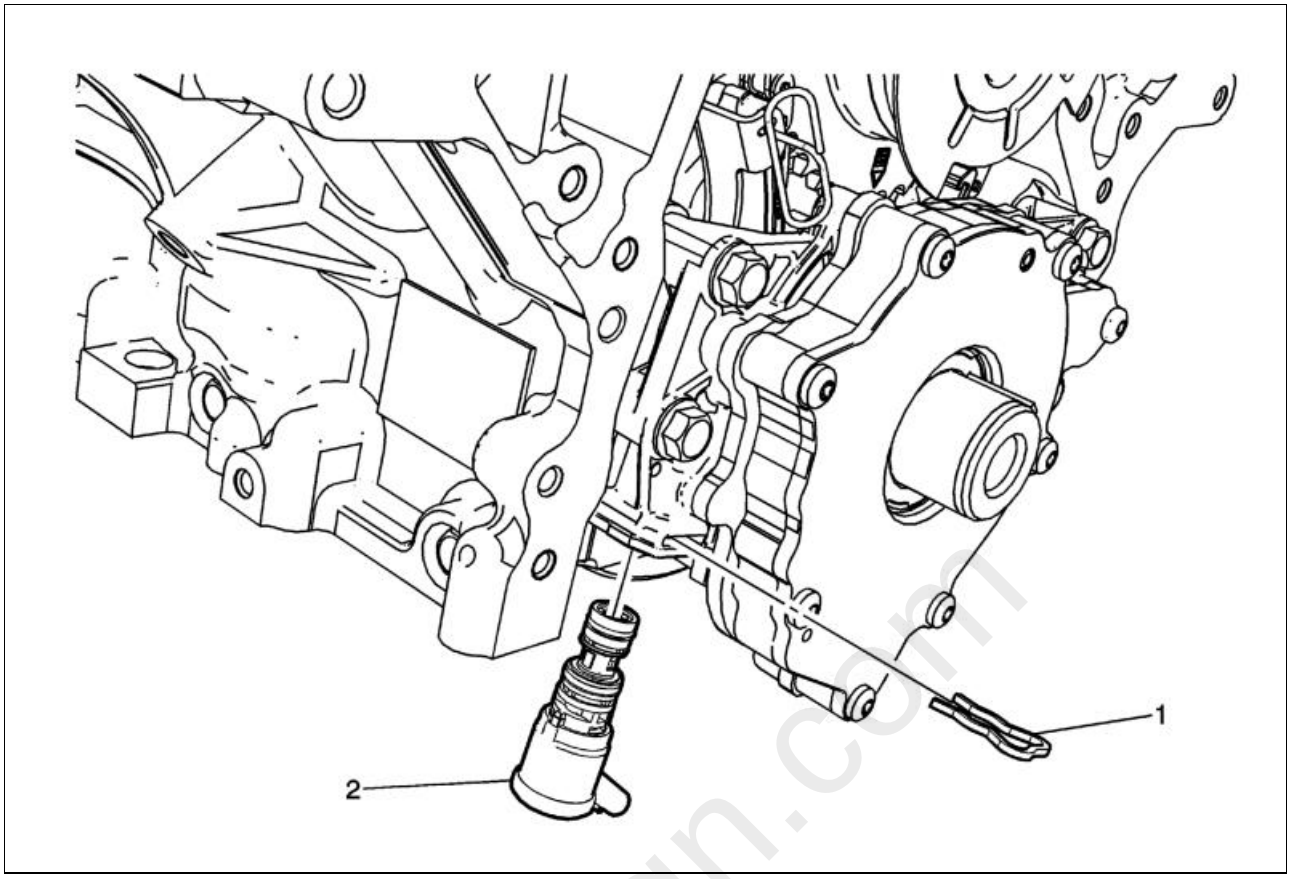
If the oil pump is removed to perform a different repair and is going to be REUSED, the ***EN-51267*** *oil pump alignment tool must be installed on the engine block BEFORE the oil pump is removed and left in place until the installation of the original oil pump. If the* ***EN-51267*** *oil pump alignment tool IS NOT installed prior to oil pump housing removal, AND left in place while other repairs are performed, a NEW oil pump MUST be installed.*

1	Oil Pump Fastener (Qty: 4) *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten oil pump bolts in sequence shown. *NOTE:* *Upward pressure must be applied to the oil pump while tightening the fasteners. Contact between the oil pump housing and the oil pump alignment tool must be maintained while oil pump bolts are tightened. Prior to removing the oil pump alignment tool, ensure that there is no gap between the oil pump housing and the tool. If there is a gap, the oil pump bolts need to be loosened and the installation procedure repeated.* **Tighten** 25 N.m (18 lb ft)
2	Oil Pump *NOTE:* *Prior to installing the oil pump, ensure that oil pump housing gasket is fully installed in the timing chain tensioner assembly and is not damaged. If the gasket is missing or damaged, replace the tensioner assembly.* **Procedure** For oil pump cleaning and inspection. Refer to Oil Pump Cleaning and Inspection . **Special Tools** **EN-51267** Oil Pump Alignment Tool For equivalent regional tools, refer to Special Tools .

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REPAIR INSTRUCTIONS - ON VEHICLE > OIL PUMP FLOW CONTROL SOLENOID VALVE REPLACEMENT

Fig 1: Oil Pump Flow Control Solenoid Valve



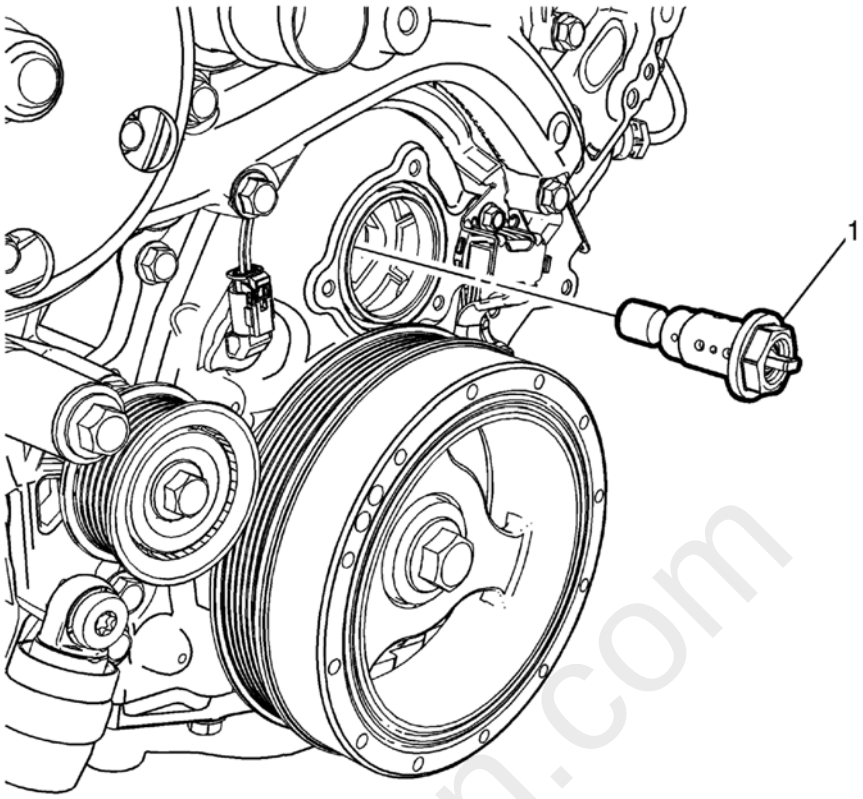
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminarily Procedure Remove the engine front cover. Refer to Engine Front Cover Replacement .	
1	Oil Pump Flow Control Solenoid Valve Clip
2	Oil Pump Flow Control Solenoid Valve

REPAIR INSTRUCTIONS - ON VEHICLE > CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT

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Fig 1: Camshaft Position Actuator Solenoid Valve



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Callout	Component Name
Preliminary Procedure Remove the camshaft position actuator magnet. Refer to Camshaft Position Actuator Magnet Replacement .	
1	Camshaft Position Actuator Solenoid Valve *WARNING:* *Refer to Camshaft Position Actuator Removal and Installation Warning .* *CAUTION:* *Refer to Component Fastener Tightening Caution .* *CAUTION:* *The camshaft position actuator solenoid valves must be kept parallel to the*

engine front cover during removal and installation. The camshaft position actuator solenoid valves can be damaged if they become wedged or stuck during this process.

NOTE:

The CPA solenoid valve must be Discarded and replaced with a NEW valve.

Tighten

1. First pass 65 N.m (48 lb ft).
2. Final pass 90 degrees.

Special tools
J 45059 Angle Meter
For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

J-41479 Crankshaft Rear Oil Seal Installer

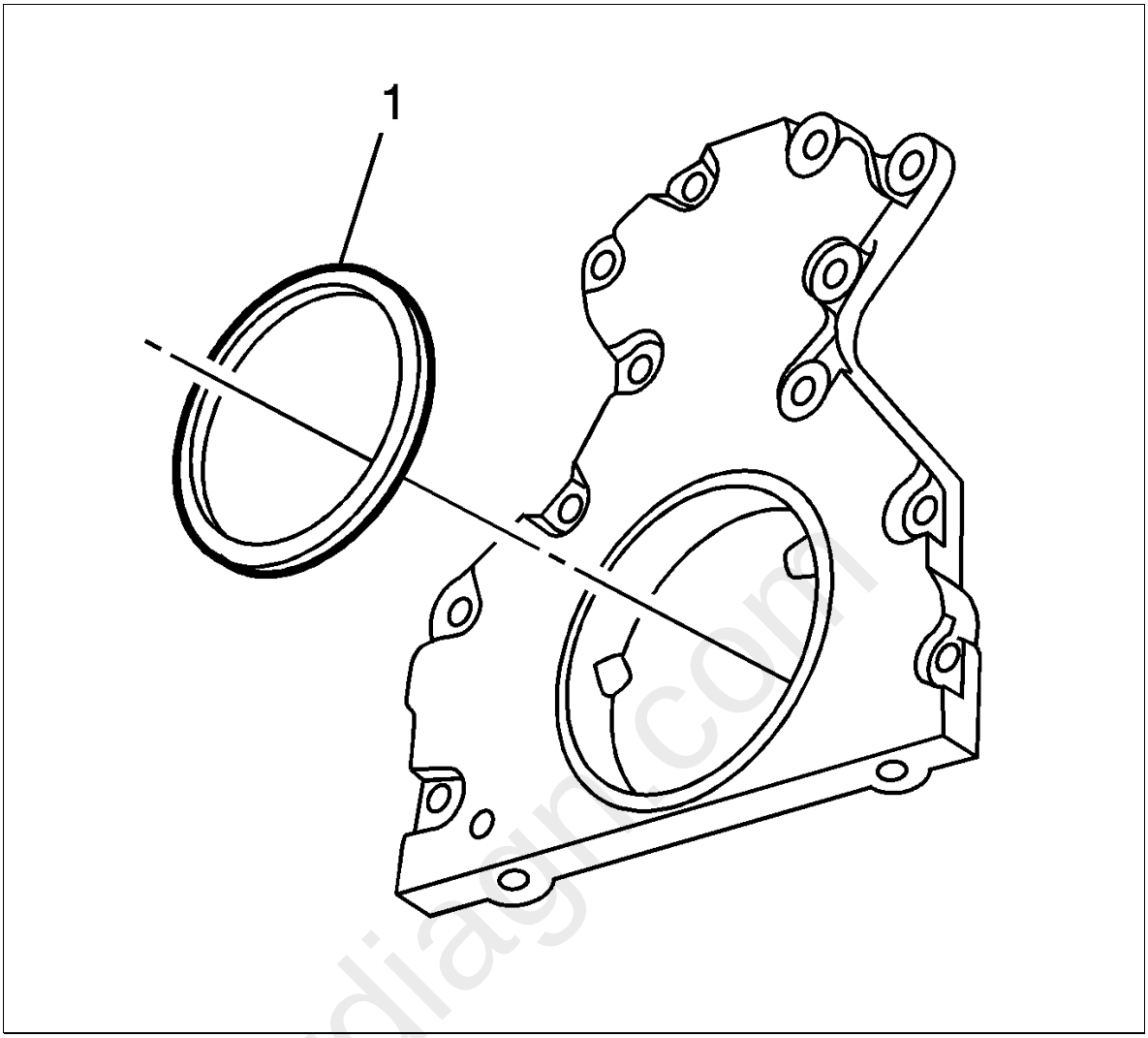
For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT REAR OIL SEAL REPLACEMENT > REMOVAL PROCEDURE

1. If equipped with a manual transmission, remove the engine flywheel. Refer to Engine Flywheel Replacement .
2. If equipped with a automatic transmission, remove the automatic transmission flex plate. Refer to Automatic Transmission Flex Plate Replacement .

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Fig 1: Crankshaft Rear Oil Seal

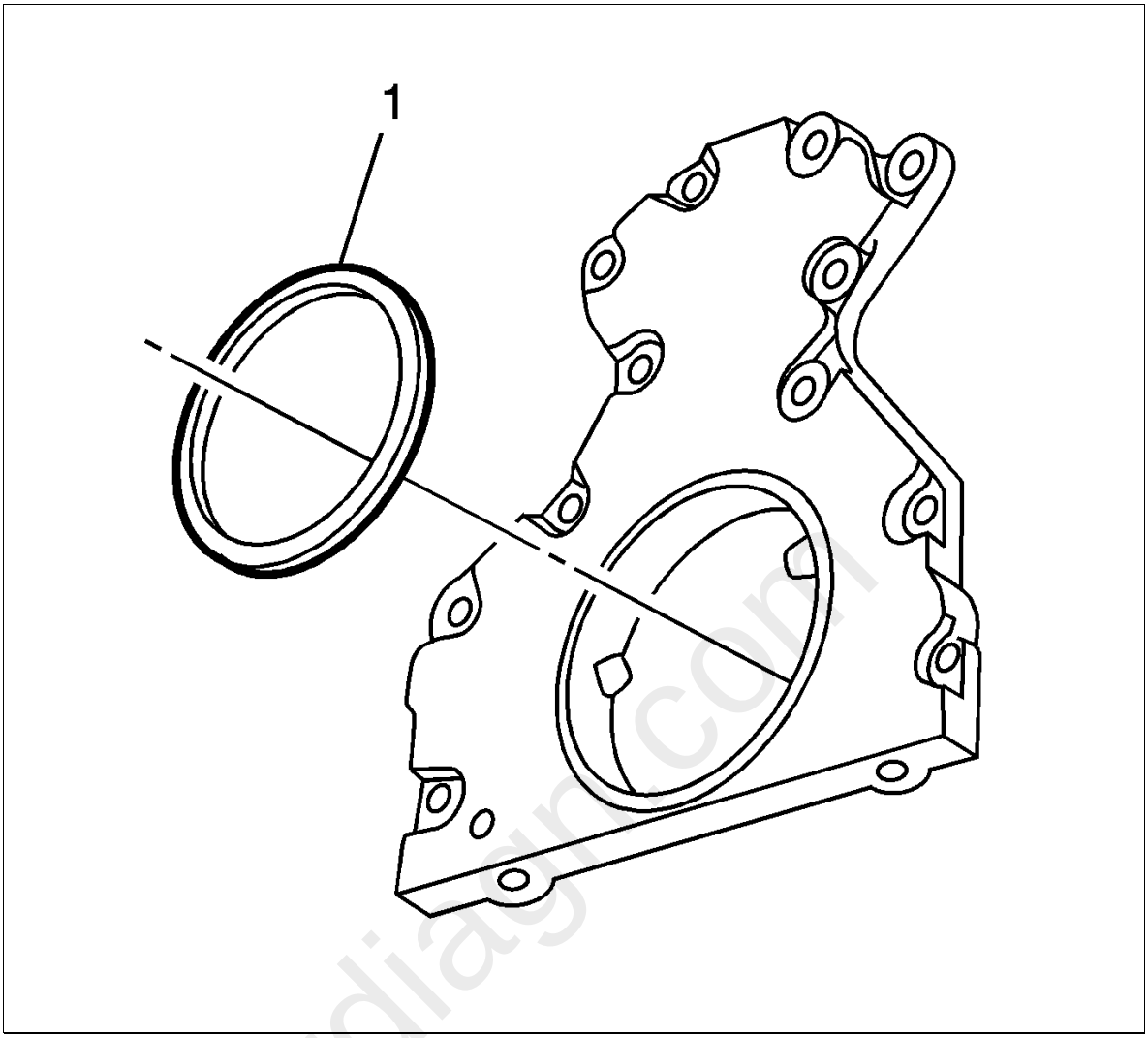


Courtesy of GENERAL MOTORS COMPANY

3. Remove the crankshaft rear oil seal (1) from the rear cover. Refer to Crankshaft Rear Oil Seal Removal

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT REAR OIL SEAL REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Crankshaft Rear Oil Seal



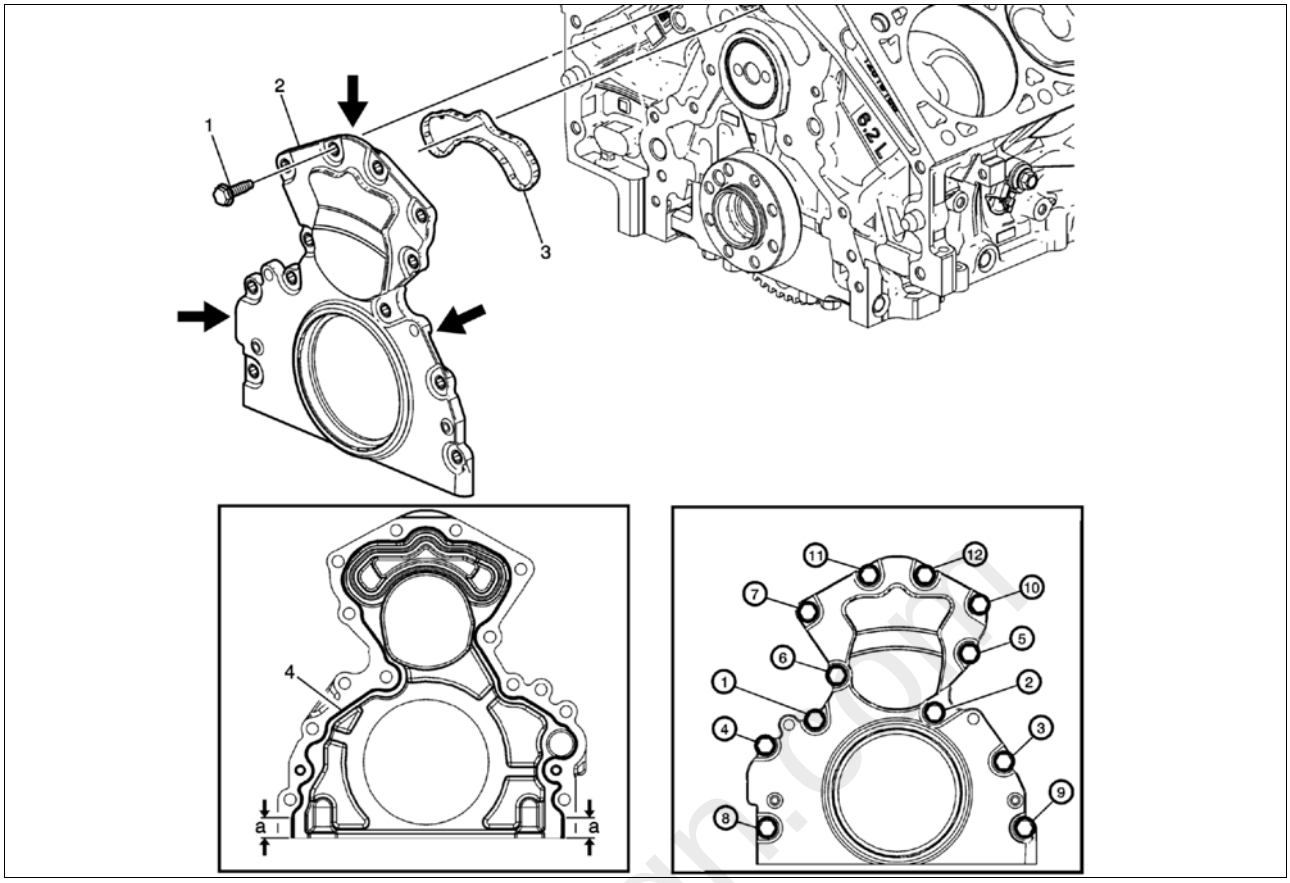
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1. Install the crankshaft rear oil seal (1) on the rear cover. Refer to Crankshaft Rear Oil Seal Installation
2. If equipped with a automatic transmission, Install the automatic transmission flex plate. Refer to Automatic Transmission Flex Plate Replacement .
3. If equipped with a manual transmission, install the engine flywheel. Refer to Engine Flywheel Replacement .

REPAIR INSTRUCTIONS - ON VEHICLE > CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

Fig 1: Crankshaft Rear Oil Seal Housing



Courtesy of GENERAL MOTORS COMPANY

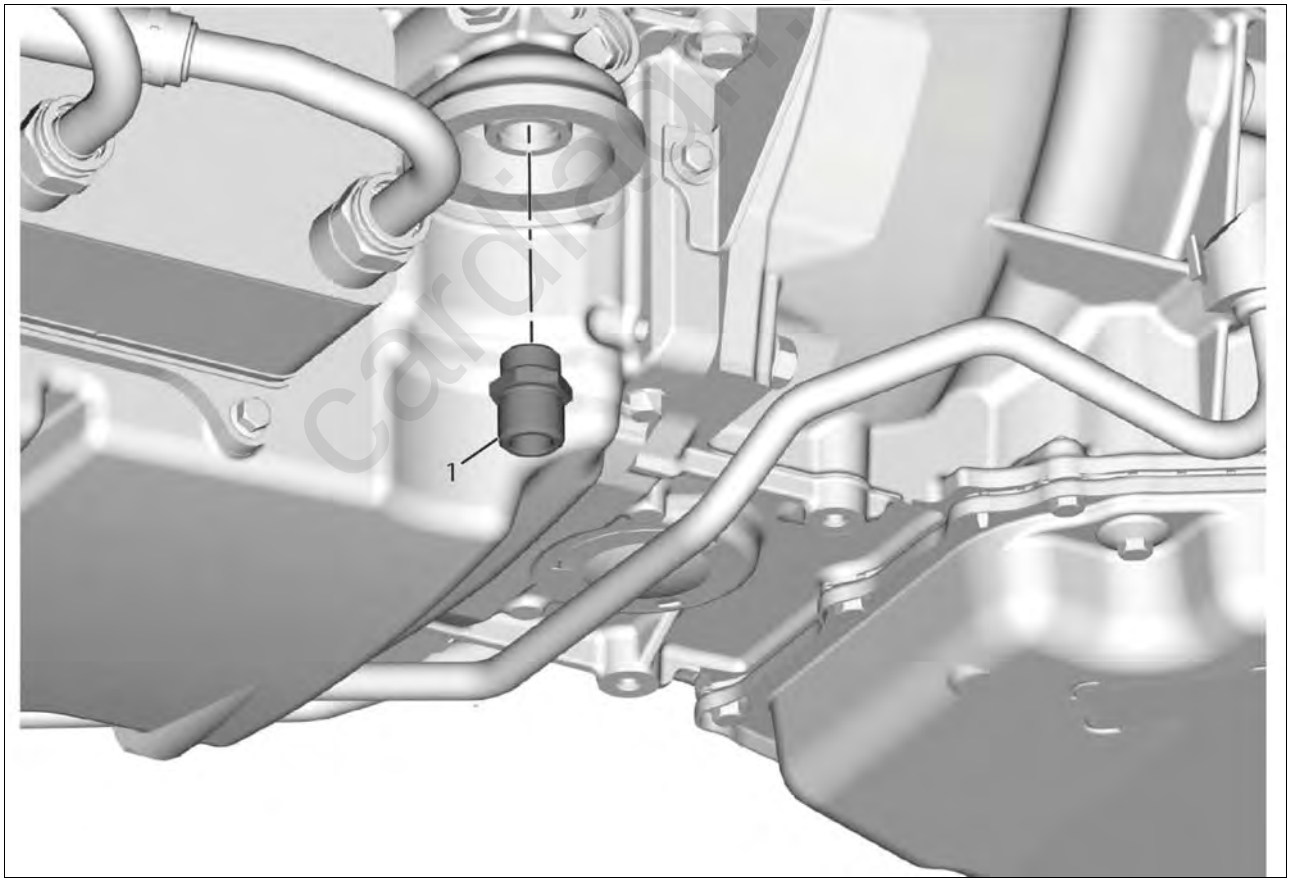
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Callout	Component Name
Preliminary Procedure 1. Automatic Transmission Flex Plate Replacement 2. Engine Flywheel Replacement	
1	Crankshaft Rear Oil Seal Housing Fastener (Qty: 12) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 25 N.m (18 lb ft)
2	Crankshaft Rear Oil Seal Housing Procedure

	1. To separate the rear housing from the engine, pry at the points that are shown by the arrows. Refer to Replacing Engine Gaskets 2. For cleaning and inspection refer to Crankshaft Rear Oil Seal Housing Cleaning and Inspection
3	Crankshaft Rear Oil Seal Housing Gasket Procedure 1. A NEW gasket must be used when installing the rear housing.
4	**Procedure** Apply a 3 mm (0.118 in) bead of RTV sealant on the engine rear cover as shown. Apply a 5 mm (0.197 in) bead of RTV sealant on the engine rear cover as shown. The 5 mm (0.197 in) bead must be applied only 10 mm (0.393 in) up from the bottom of the rear cover as shown (a). Refer to Adhesives, Fluids, Lubricants, and Sealers .

REPAIR INSTRUCTIONS - ON VEHICLE > OIL FILTER ADAPTER REPLACEMENT

Fig 1: Oil Filter Adapter



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the oil filter. Engine Oil and Oil Filter Replacement	
1	*CAUTION:* *Refer to Component Fastener Tightening Caution .* Oil Filter Adapter**Tighten** 30 N.m (22 lb ft)

REPAIR INSTRUCTIONS - ON VEHICLE > OIL PAN REPLACEMENT > REMOVAL PROCEDURE

1. Remove Oil Level Indicator Tube Replacement
2. Disconnect Positive Crankcase Ventilation Oil Separator Drain Pipe at Oil Pan-Positive Crankcase Ventilation Oil Separator Drain Pipe Replacement

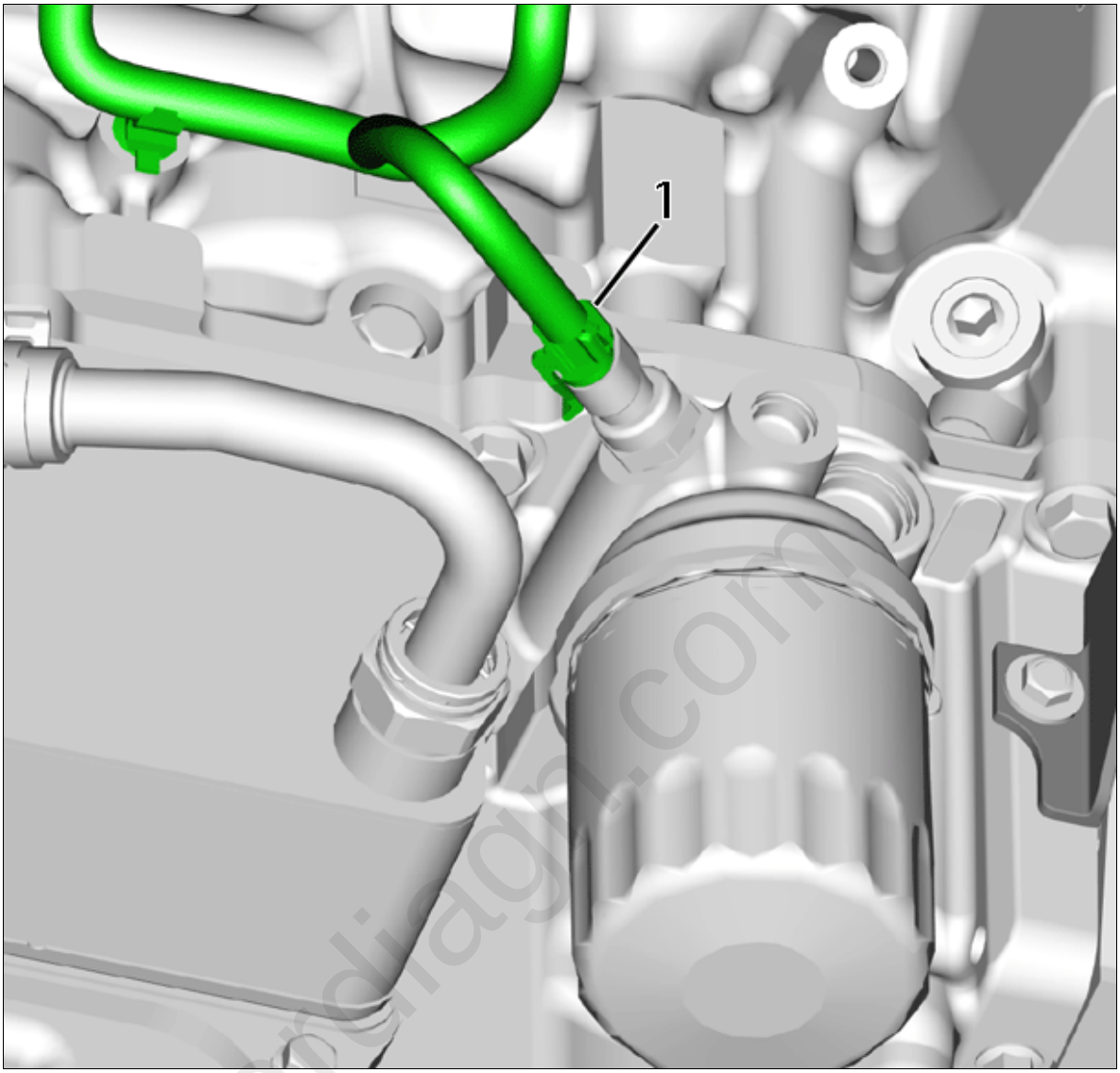
> *NOTE:*
>
> *It is not necessary to remove the transverse spring or steering gear intermediate shaft from the cradle.*

> *NOTE:*
>
> *It is not necessary to remove the stabilizer shaft, only to disconnect the links.*

3. Remove Drivetrain and Front Suspension Cradle Replacement (LT1)
4. Remove Engine Mount Bracket-Engine Mount Bracket Replacement - Right Side
5. Remove Engine Mount Bracket-Engine Mount Bracket Replacement - Left Side

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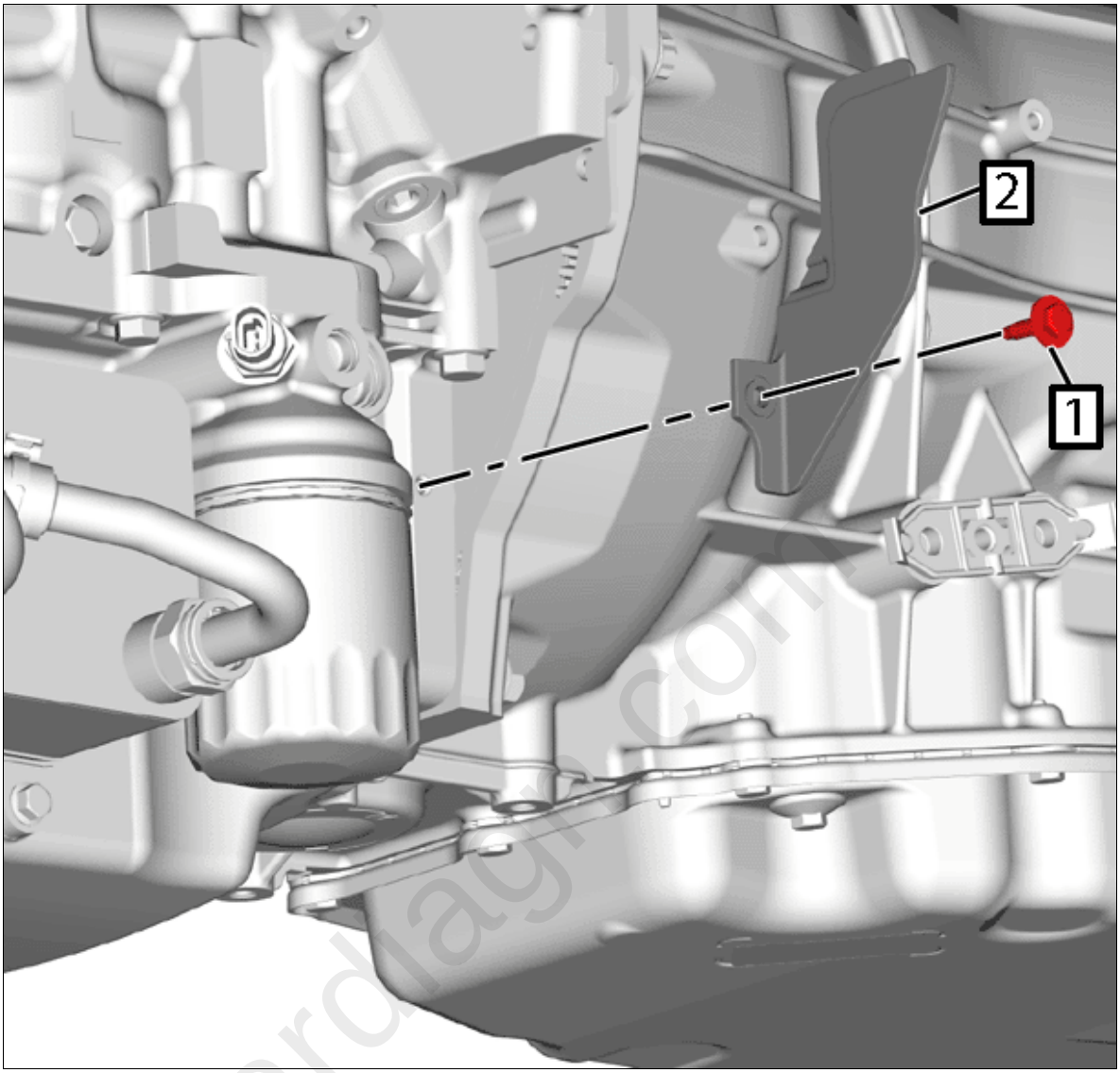
Fig 1: Engine Coolant Temperature Sensor



Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the Engine Coolant Temperature Sensor (1)
7. Remove Oil Filter-Engine Oil and Oil Filter Replacement

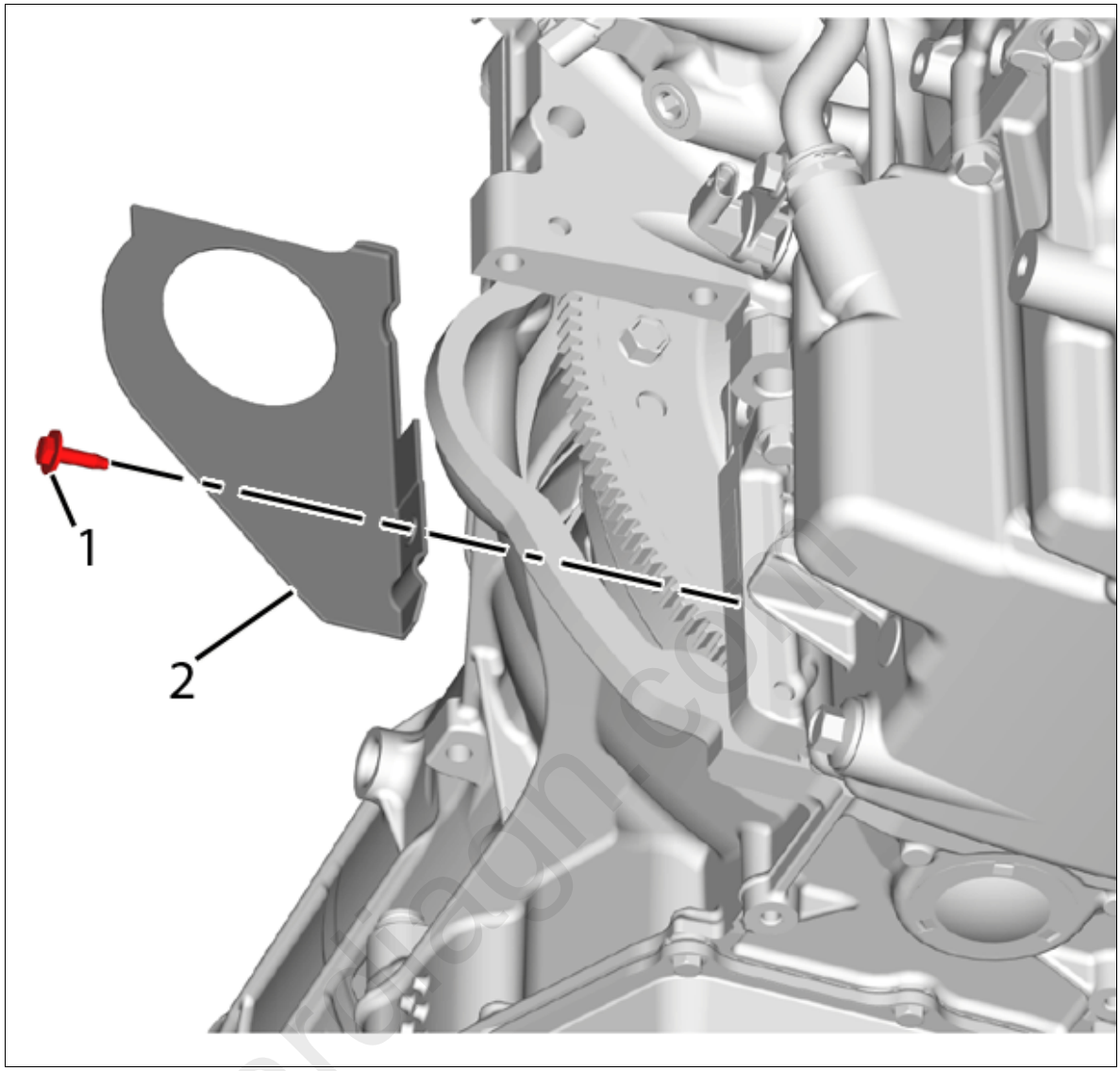
Fig 2: Left Rear Transmission Cover



Courtesy of GENERAL MOTORS COMPANY

8. Remove the bolt (1) and the left rear transmission cover (2).
9. Remove Starter Replacement (LT1)
10. Remove Engine Oil Cooler Replacement (LT1)

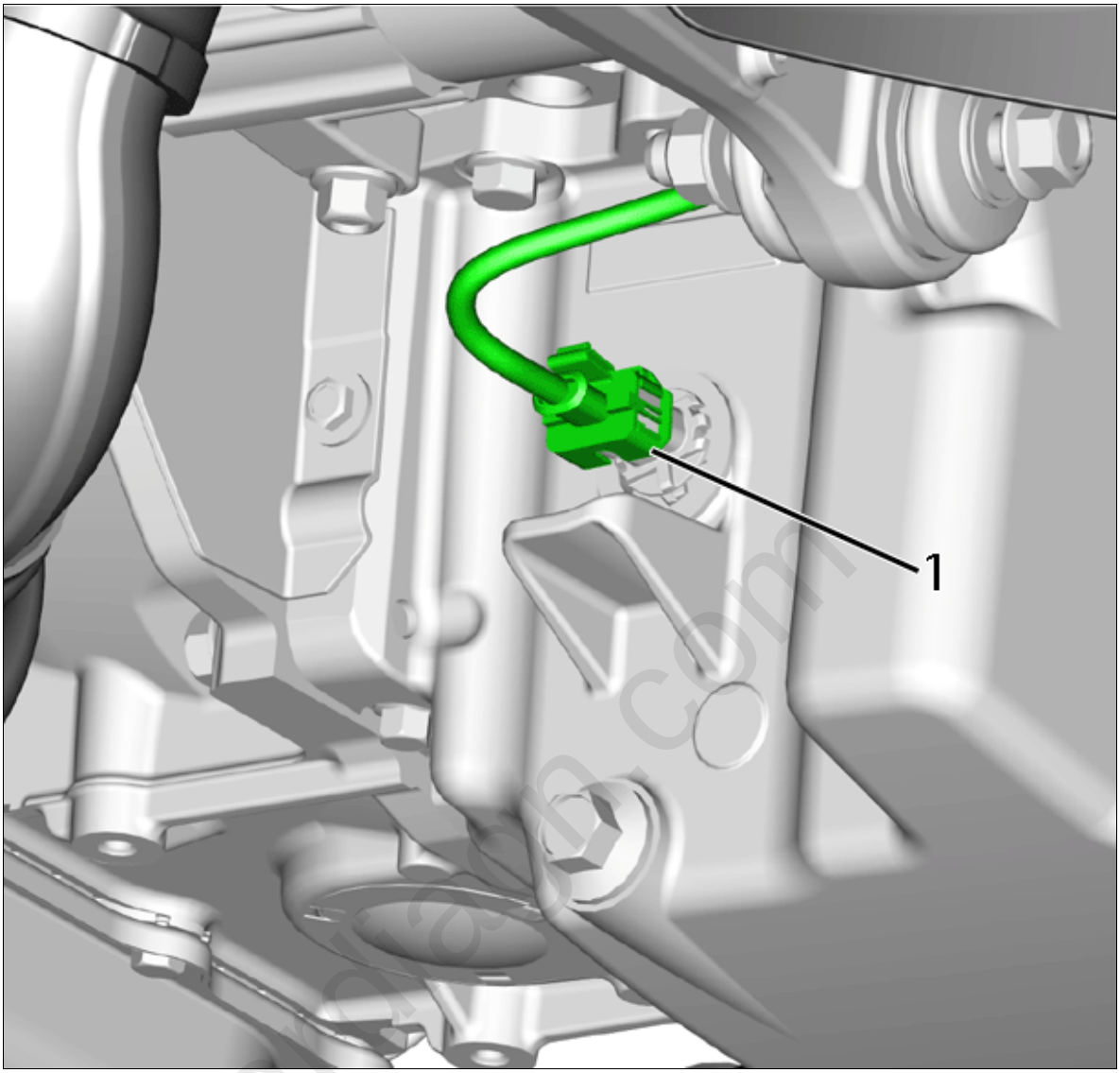
Fig 3: Right Transmission Cover



Courtesy of GENERAL MOTORS COMPANY

11. Remove the bolt (1) and right transmission cover (2).

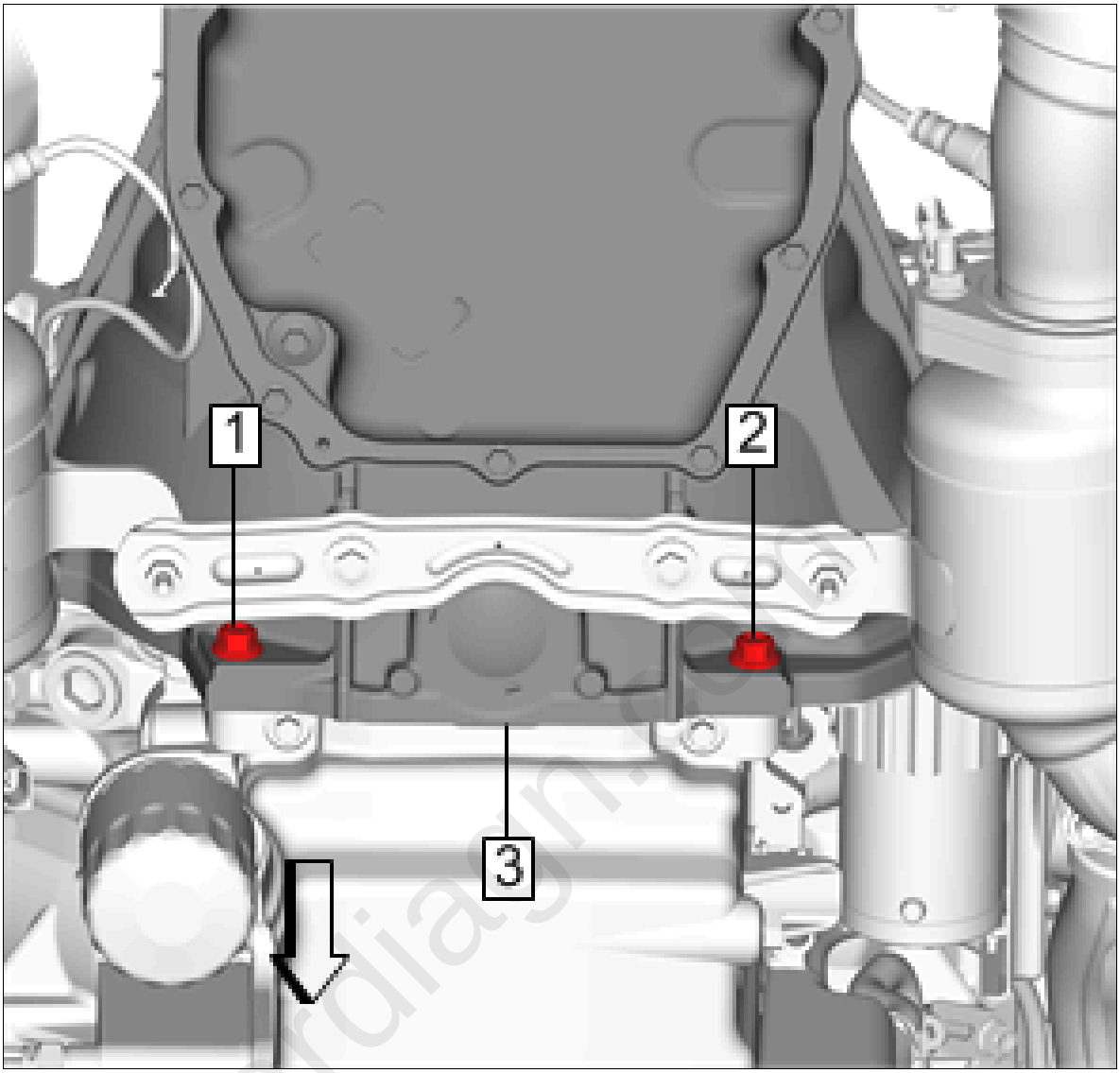
Fig 4: Engine Oil Level Sensor



Courtesy of GENERAL MOTORS COMPANY

12. Disconnect Engine Oil Level Sensor (1)

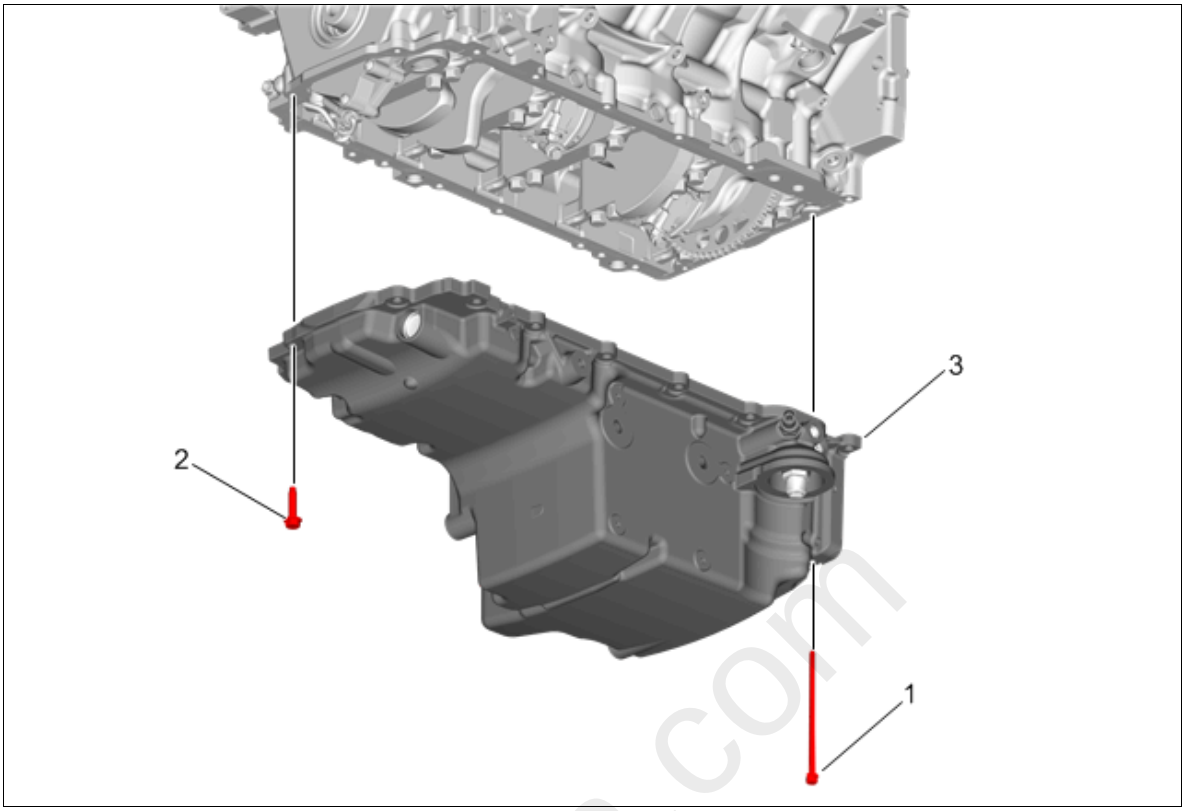
Fig 5: Lower Transmission To Engine Bolts



Courtesy of GENERAL MOTORS COMPANY

13. Remove the bolts from the bell housing to the oil pan (1 and 2).

Fig 6: Oil Pan Bolts



Courtesy of GENERAL MOTORS COMPANY

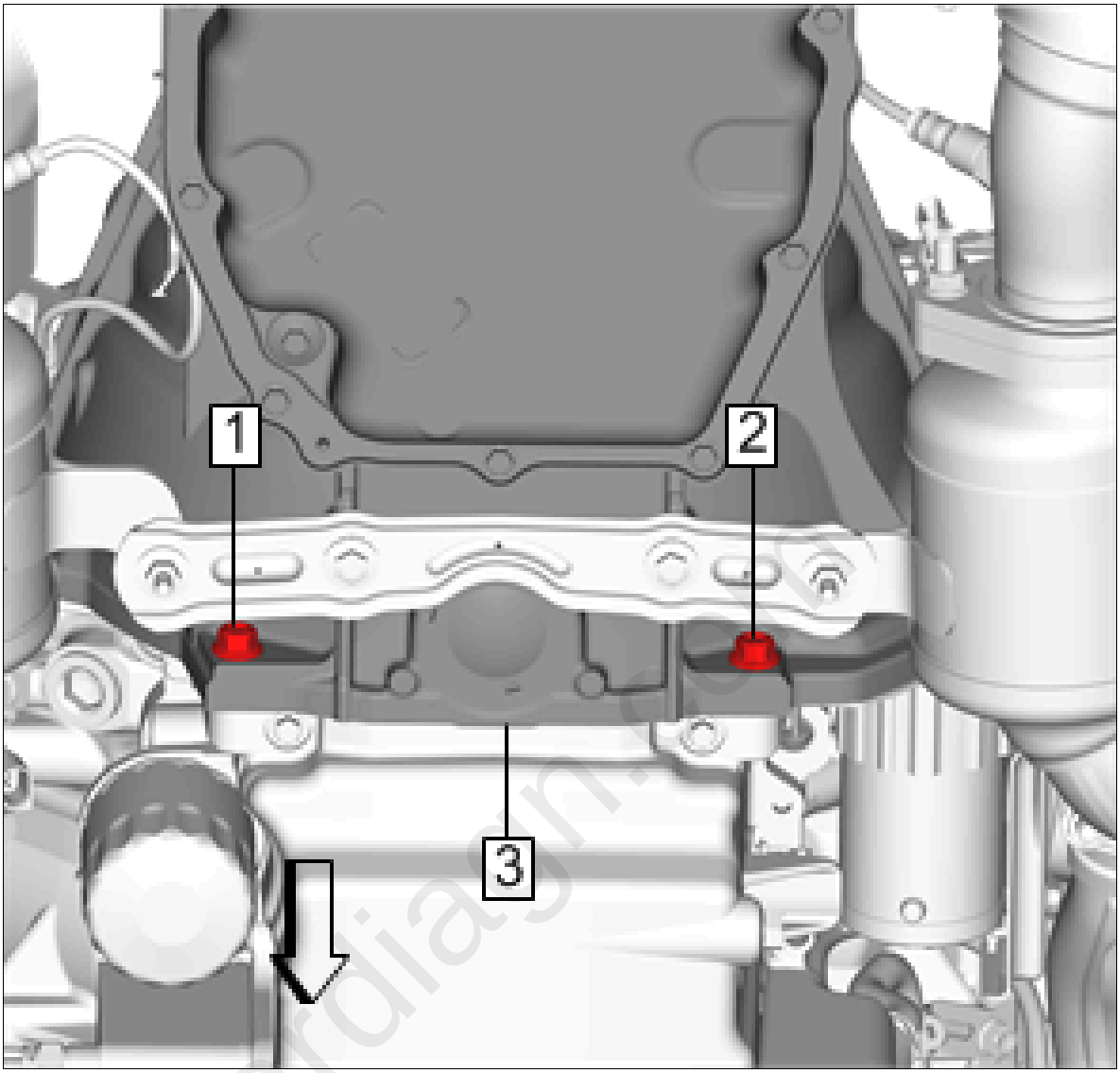
14. Remove Oil pan bolts (1) (Qty: 2)
15. Oil Pan Bolt (2) (Qty: 14)
16. Remove the oil pan (3) from the engine block.
17. Disassemble the oil pan as necessary. Oil Pan Disassemble .
18. Oil Pan Cleaning and Inspection .

REPAIR INSTRUCTIONS - ON VEHICLE > OIL PAN REPLACEMENT > INSTALLATION PROCEDURE

1. Assemble the oil pan as necessary. Oil Pan Assemble .
2. Install Oil Pan Installation

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Fig 1: Lower Transmission To Engine Bolts

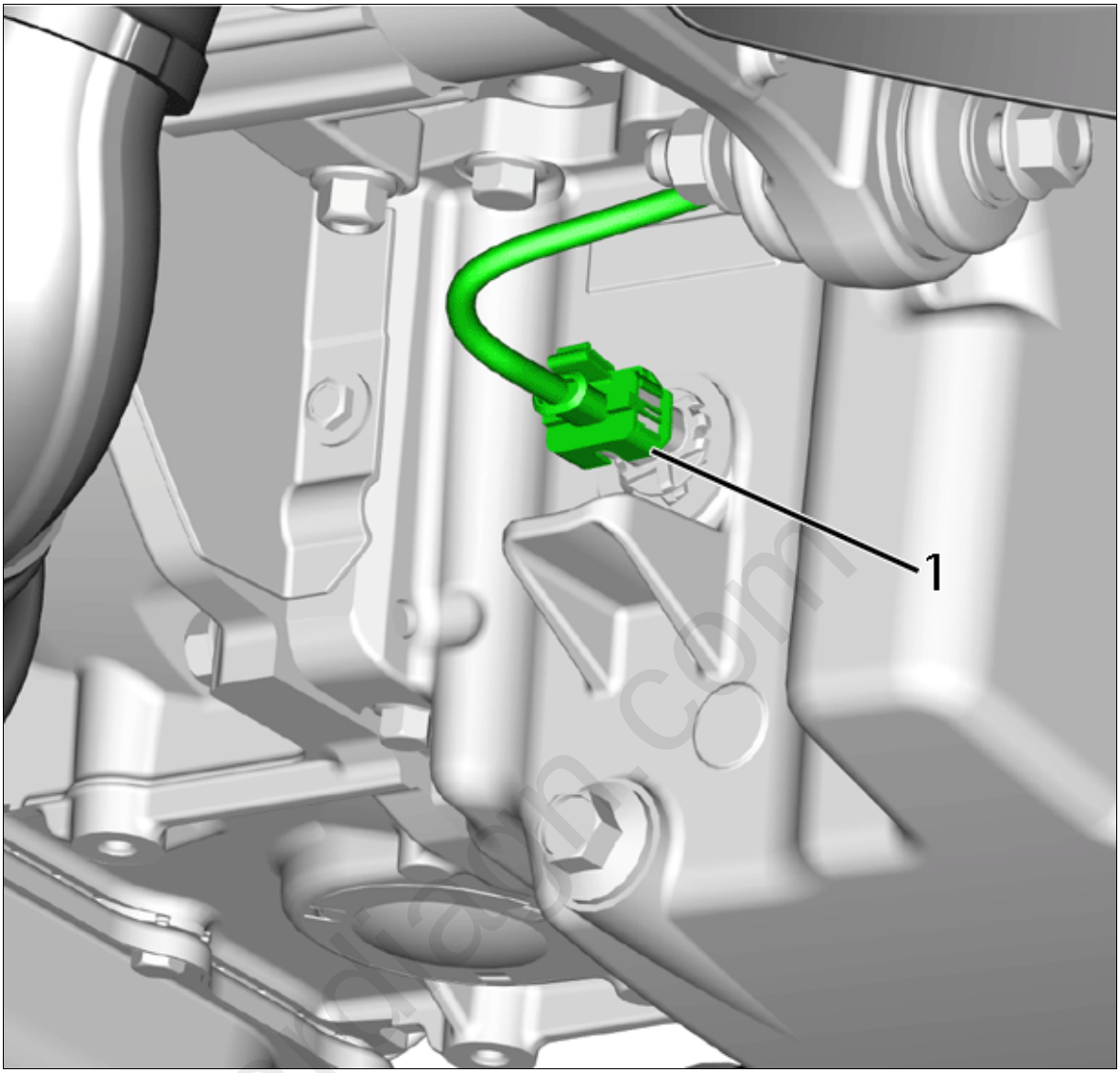


Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

3. Install the bell housing to oil pan bolts (1 and 2). Tighten the bolts to 50 N.m (37 lb ft).

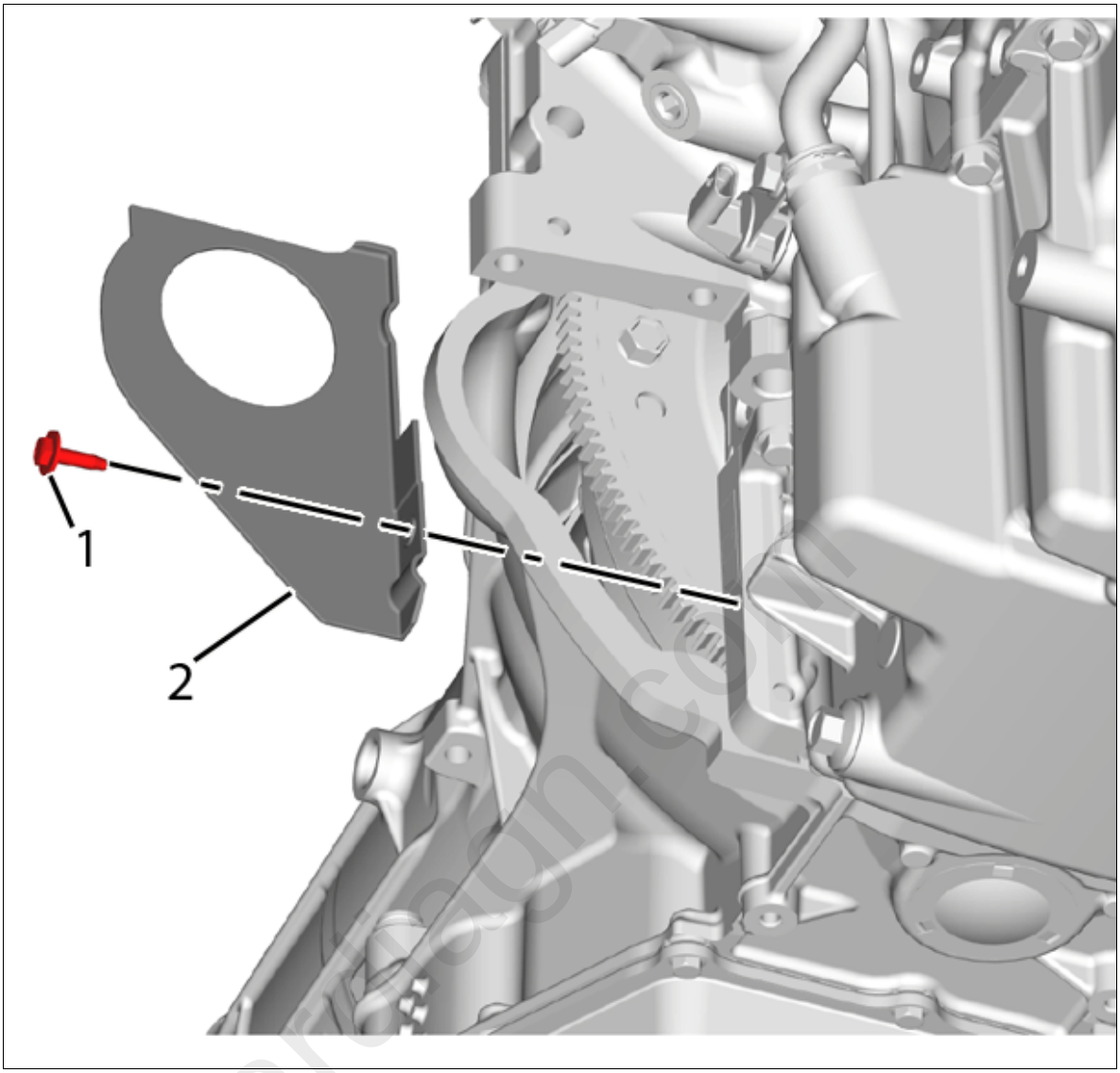
Fig 2: Engine Oil Level Sensor



Courtesy of GENERAL MOTORS COMPANY

4. Connect Engine Oil Level Sensor (1)

Fig 3: Right Transmission Cover



Courtesy of GENERAL MOTORS COMPANY

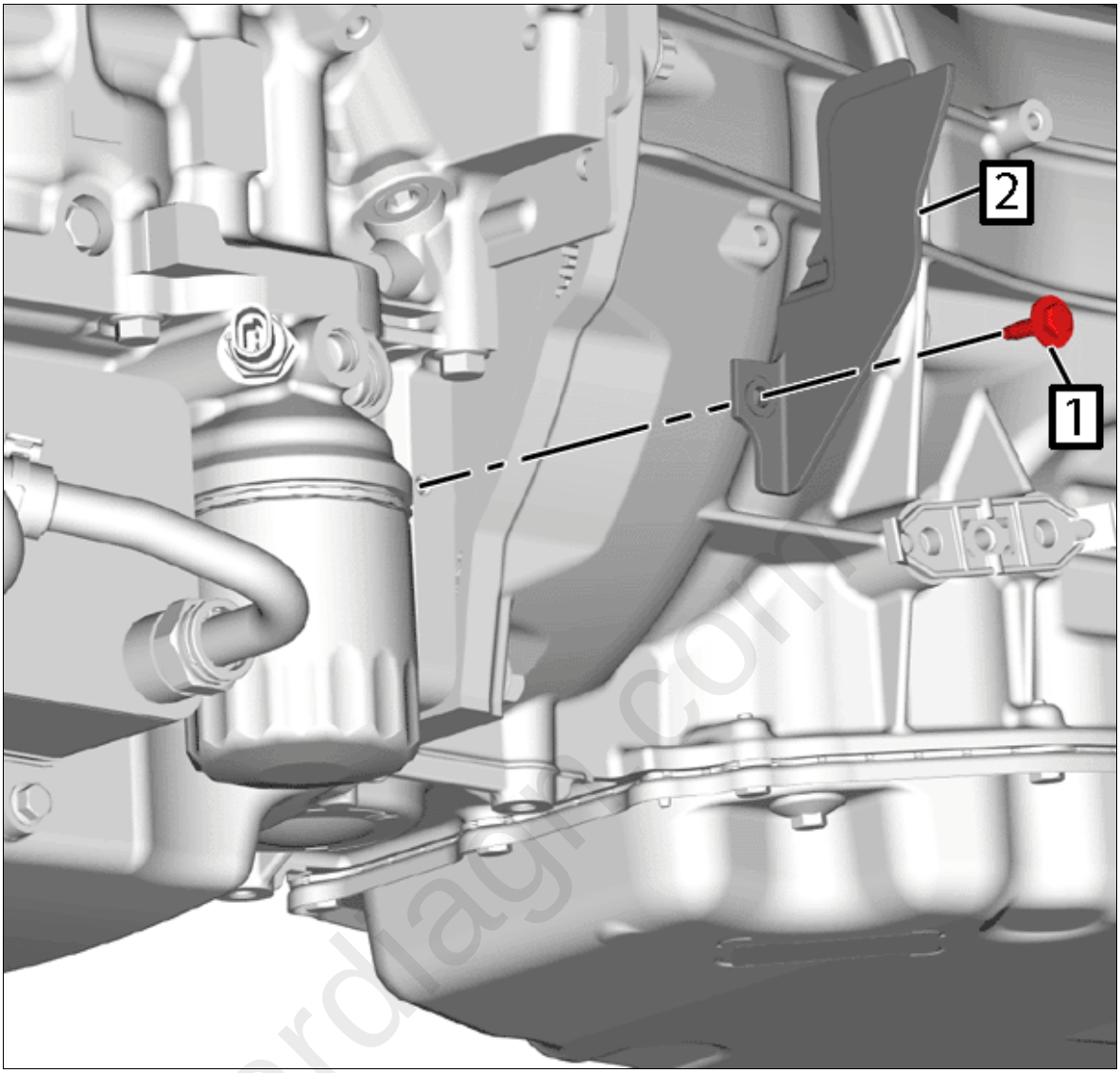
5. Install the right transmission cover (2) and bolt (1).

   Tighten

   Tighten the transmission cover bolt to 12 N.m (106 lb in).

6. Install Engine Oil Cooler Replacement (LT1)
7. Install Starter Replacement (LT1)

Fig 4: Left Rear Transmission Cover



Courtesy of GENERAL MOTORS COMPANY

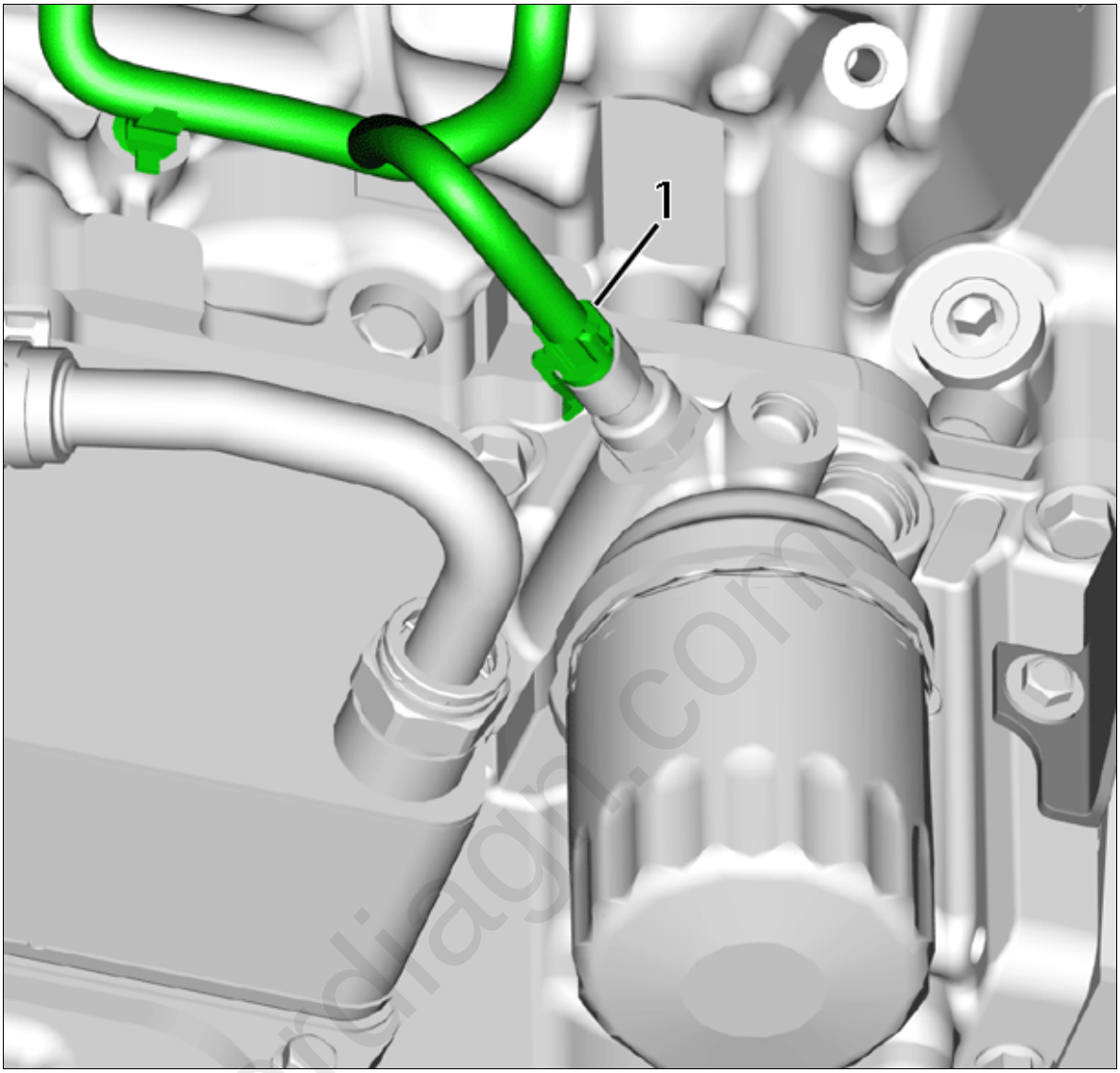
8. Install the left rear transmission cover (2) and the bolt (1).

   Tighten

   Tighten the transmission cover bolt to 12 N.m (106 lb in).

9. Install Oil Filter-Engine Oil and Oil Filter Replacement

Fig 5: Engine Coolant Temperature Sensor



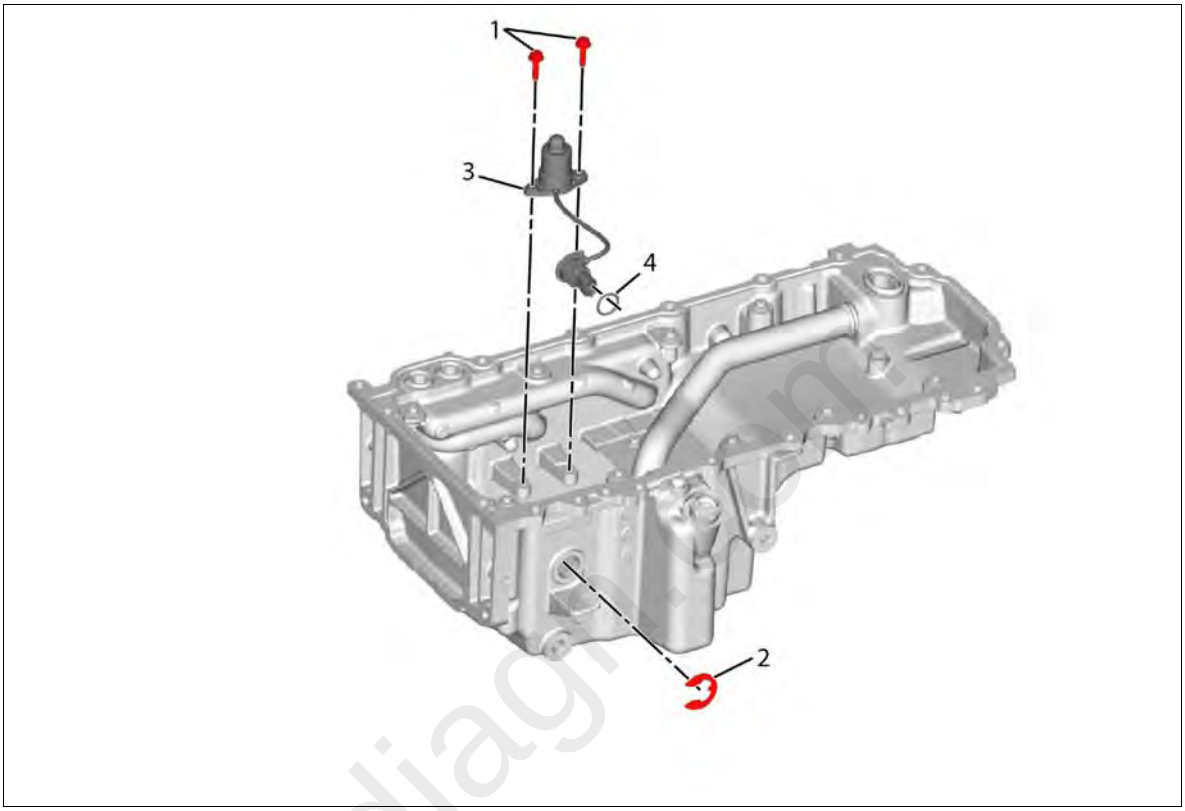
Courtesy of GENERAL MOTORS COMPANY

10. Connect the Engine Coolant Temperature Sensor (1)
11. Install Engine Mount Bracket-Engine Mount Bracket Replacement - Left Side
12. Install Engine Mount Bracket-Engine Mount Bracket Replacement - Right Side
13. Install Drivetrain and Front Suspension Cradle Replacement (LT1)
14. Connect Positive Crankcase Ventilation Oil Separator Drain Pipe at Oil Pan-Positive Crankcase Ventilation Oil Separator Drain Pipe Replacement
15. Install Oil Level Indicator Tube Replacement
16. Fill the engine oil to the proper level. Approximate Fluid Capacities , and Adhesives, Fluids, Lubricants, and Sealers

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT > REMOVAL PROCEDURE

1. Remove the oil pan. Oil Pan Replacement .
2. Remove the crankshaft oil deflector. Oil Pan Disassemble .

   Fig 1: Engine Oil Level Indicator Switch

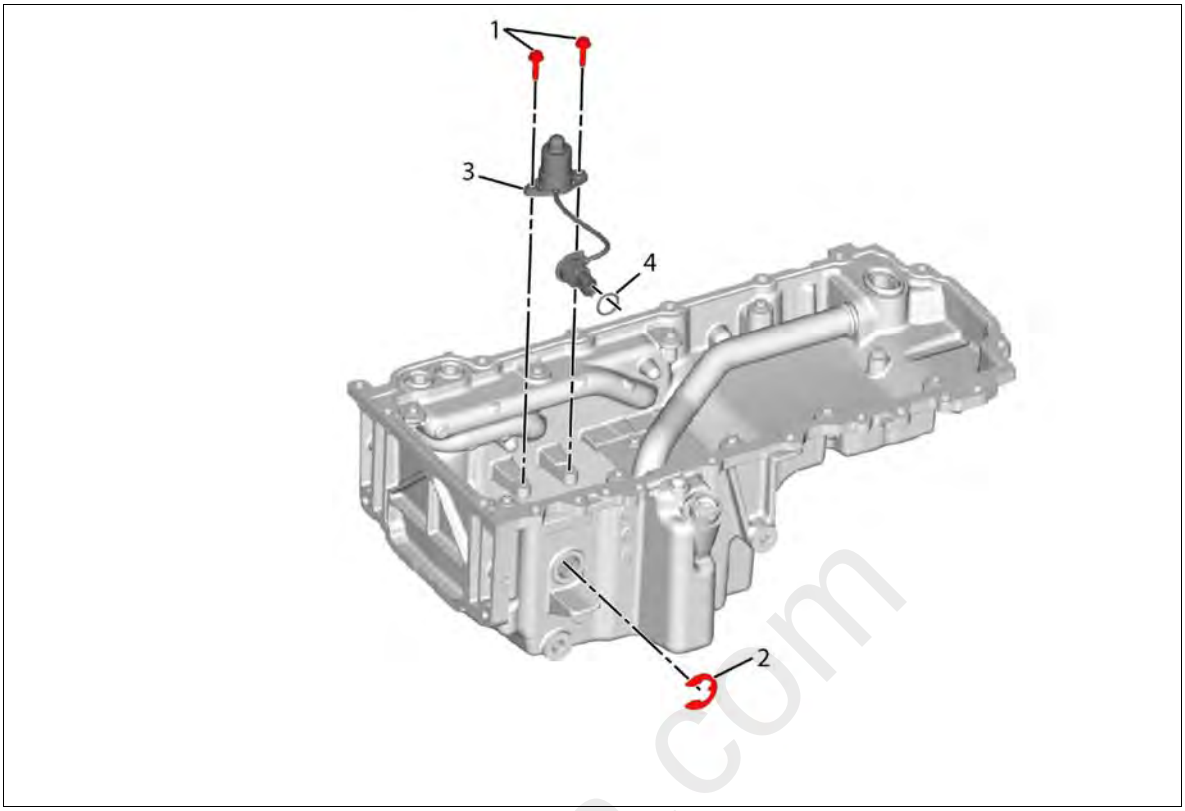


Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil level indicator switch bolts (1), retaining clip (2) and switch (3). DISCARD seal (4).
4. Oil Pan Cleaning and Inspection .

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Engine Oil Level Indicator Switch



Courtesy of GENERAL MOTORS COMPANY

1. Install NEW seal (4).
2. Install the engine oil level indicator switch (3), retaining clip (2), and bolts (1). Oil Pan Assemble .
3. Install the crankshaft oil deflector. Oil Pan Assemble .
4. Install the oil pan. Oil Pan Replacement .

REPAIR INSTRUCTIONS - ON VEHICLE > TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REPLACEMENT

Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin
- **EN-42386-A** Flywheel Holding Tool
- **EN-45059** Angle Meter

For equivalent regional tools, refer to Special Tools .

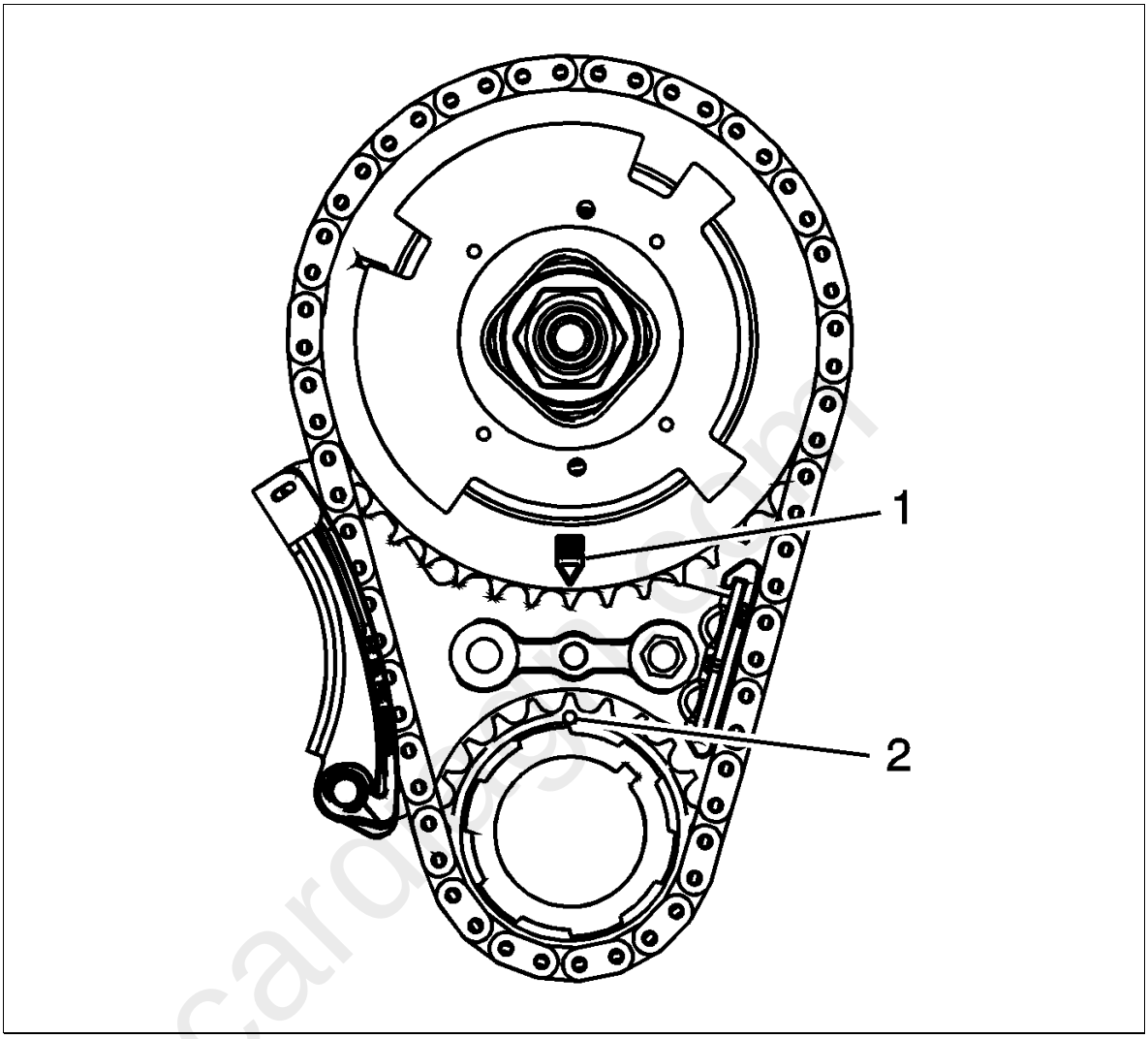
REPAIR INSTRUCTIONS - ON VEHICLE > TIMING CHAIN, CRANKSHAFT SPROCKET,

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CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REPLACEMENT > REMOVAL PROCEDURE

1. Remove oil pump. Refer to Oil Pump Replacement .

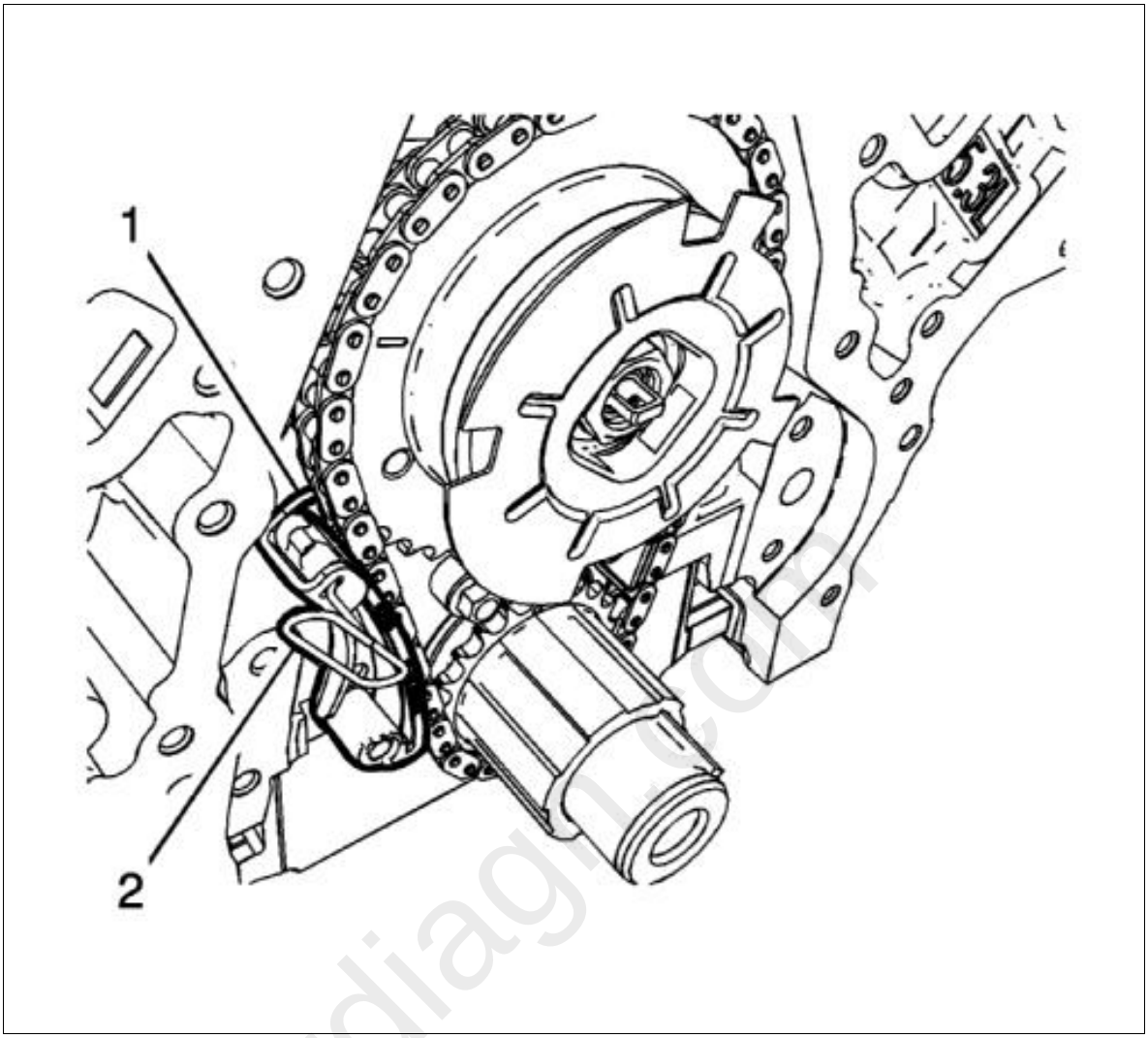
   Fig 1: CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark



Courtesy of GENERAL MOTORS COMPANY

2. Rotate the crankshaft sprocket until the camshaft sprocket alignment mark (1) and the crankshaft sprocket alignment mark (2) are aligned.

Fig 2: Back Timing Chain Tensioner

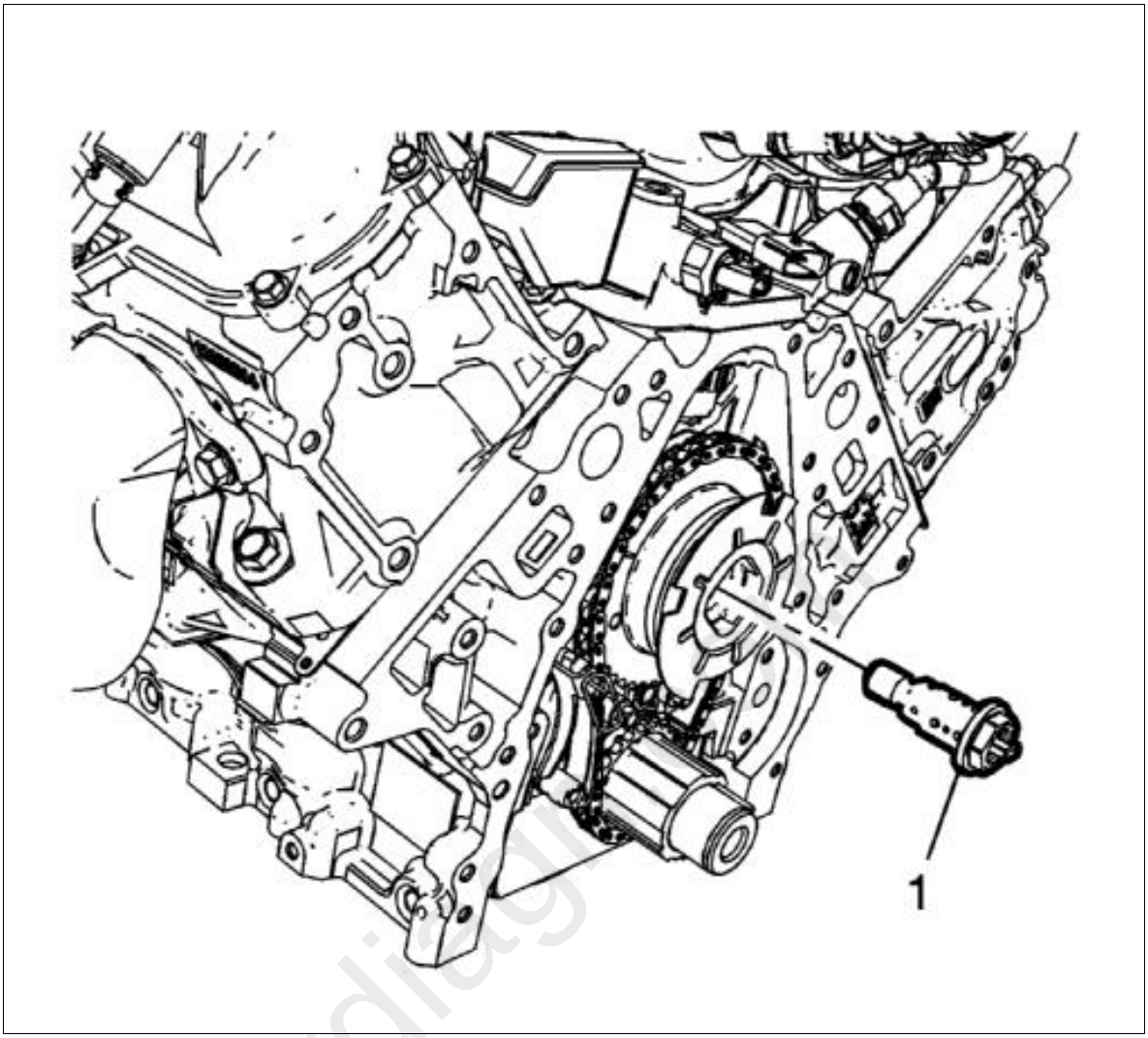


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3. Push back the timing chain tensioner (1) and install **EN-46330** tension pin (2).

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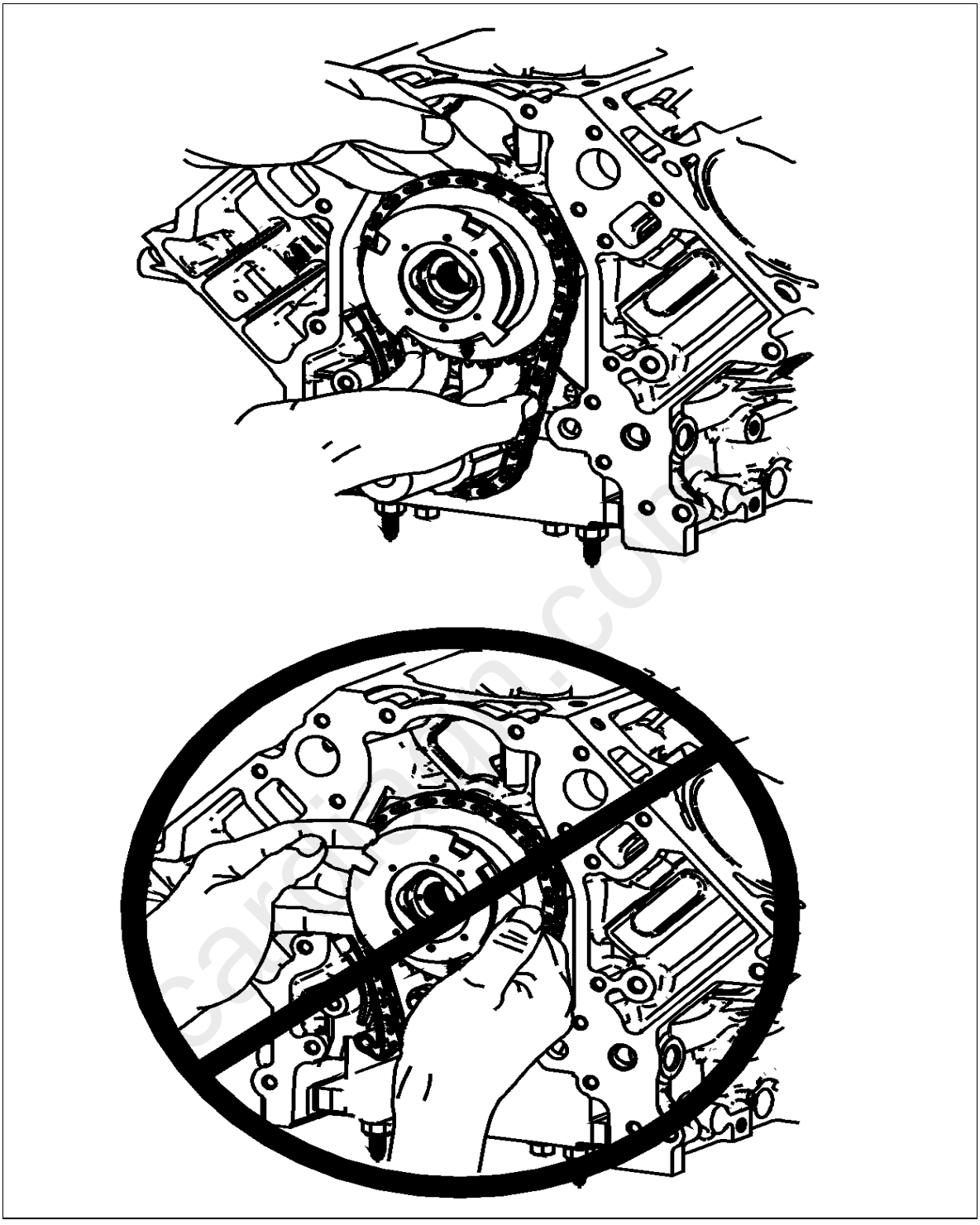
Fig 3: CMP Actuator Solenoid Valve



Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the CMP actuator solenoid valve (1). Refer to Camshaft Position Actuator Solenoid Valve Replacement

Fig 4: Proper CMP Actuator Removal



Courtesy of GENERAL MOTORS COMPANY

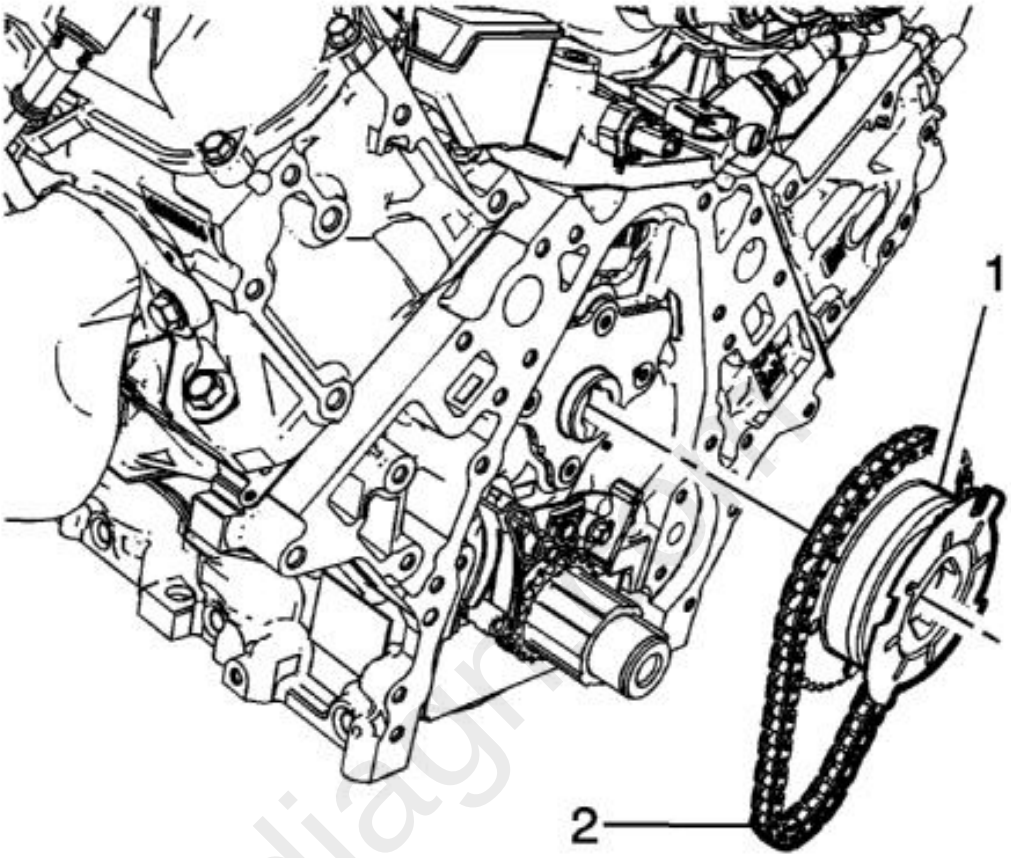
WARNING:

Refer to Camshaft Position Actuator Removal and Installation Warning .

5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position fingers

behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

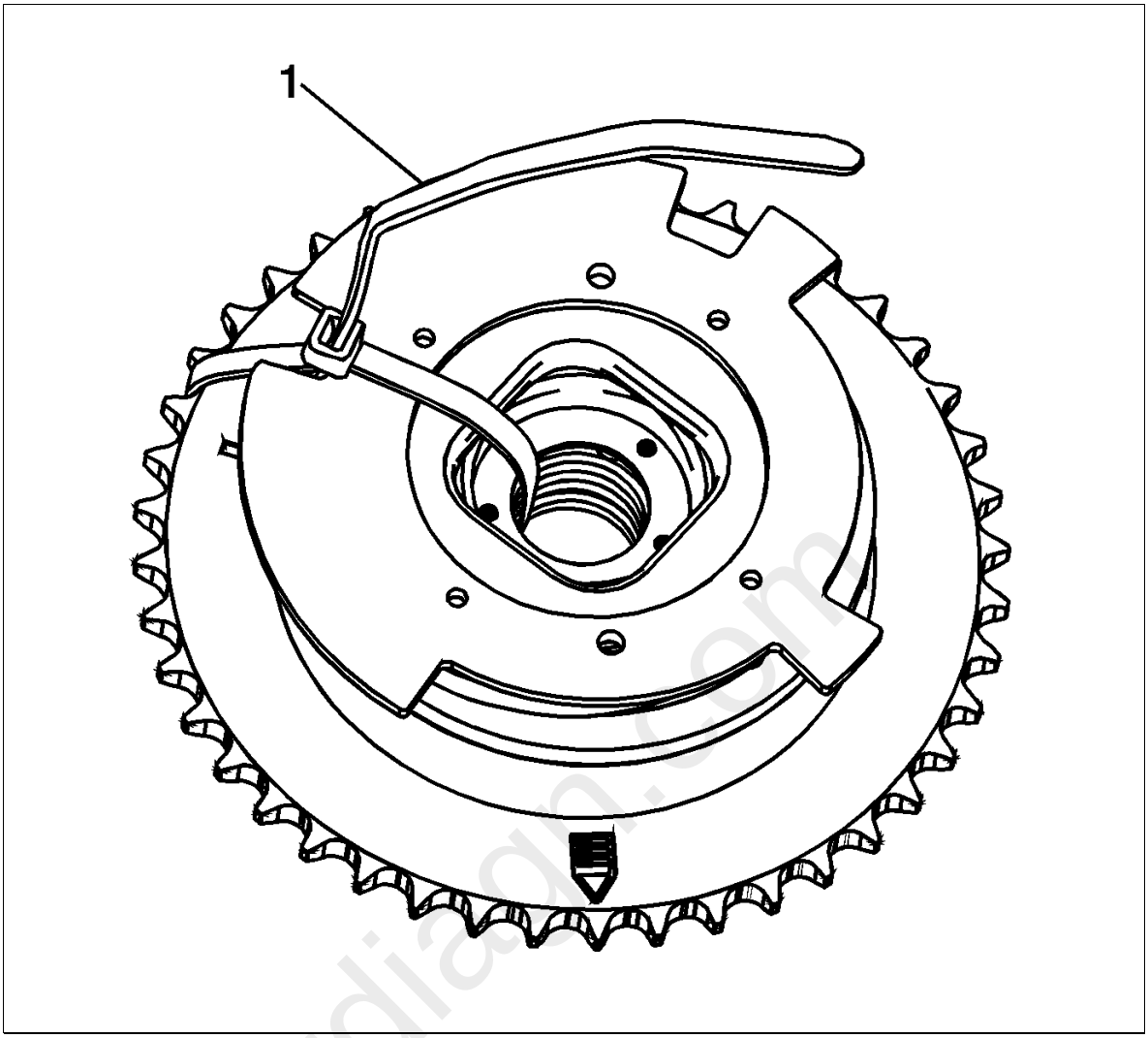
Fig 5: CMP Actuator And Timing Chain



Courtesy of GENERAL MOTORS COMPANY

6. Remove the CMP actuator (1) and timing chain (2).

Fig 6: Tie Strap Through Center Of Actuator

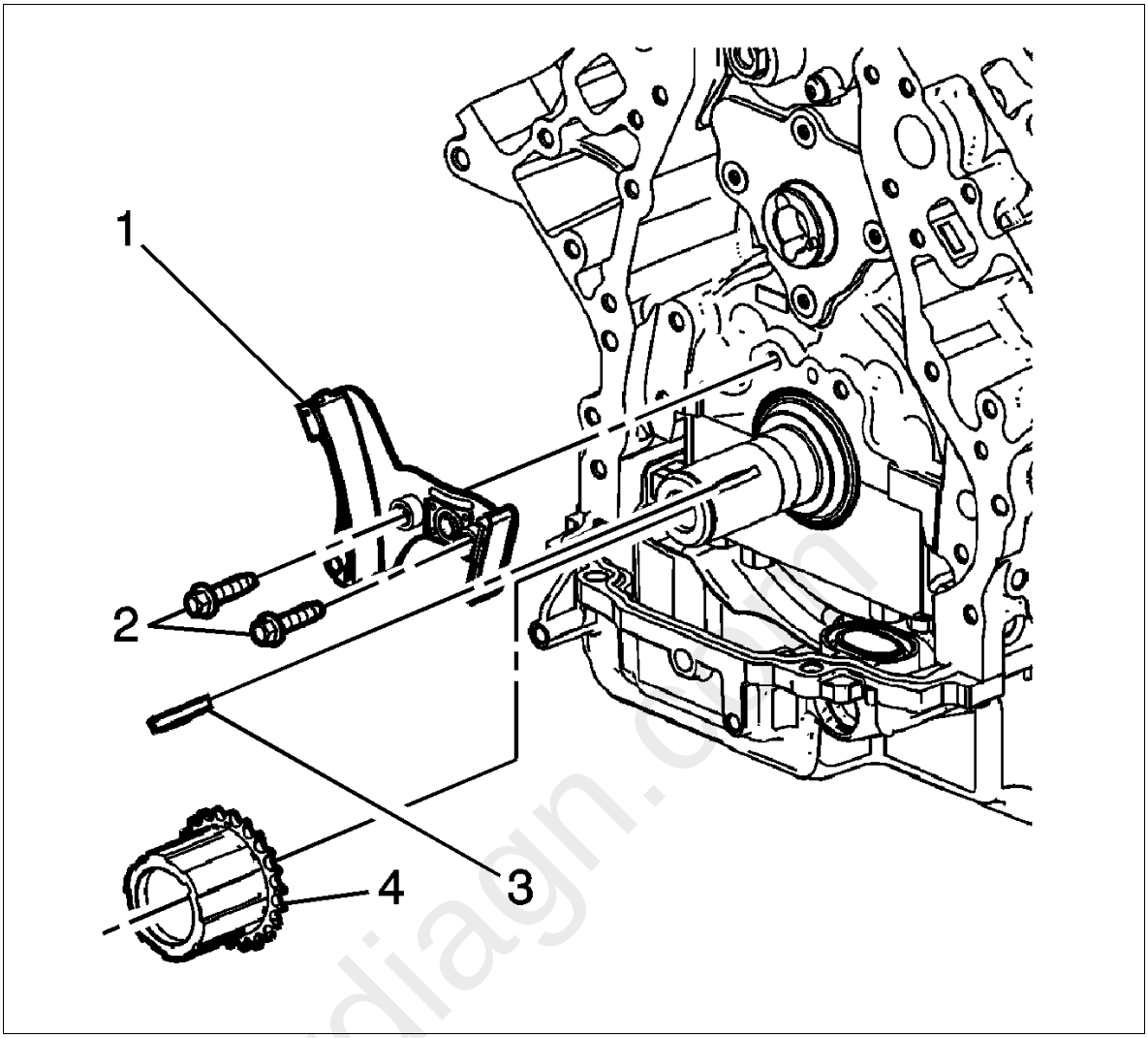


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7. Insert a tie strap (1) through the center of the actuator and over the reluctor wheel.

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Fig 7: Crankshaft Sprocket And Key

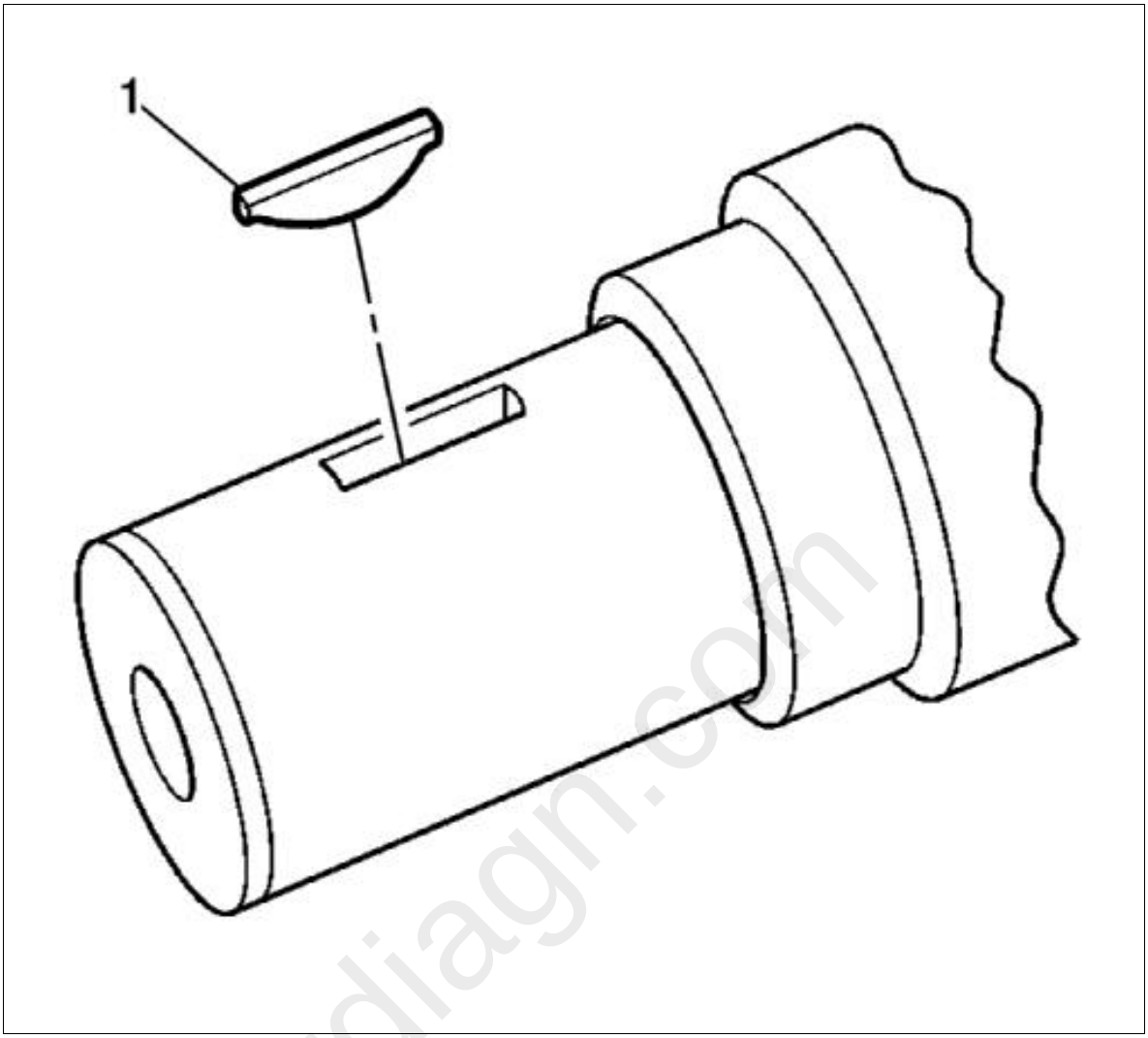


Courtesy of GENERAL MOTORS COMPANY

8. Remove the crankshaft sprocket (4), and key (3).
9. Remove the timing chain tensioner bolts (2) and the timing chain tensioner (1).

REPAIR INSTRUCTIONS - ON VEHICLE > TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Key Into Crankshaft Keyway

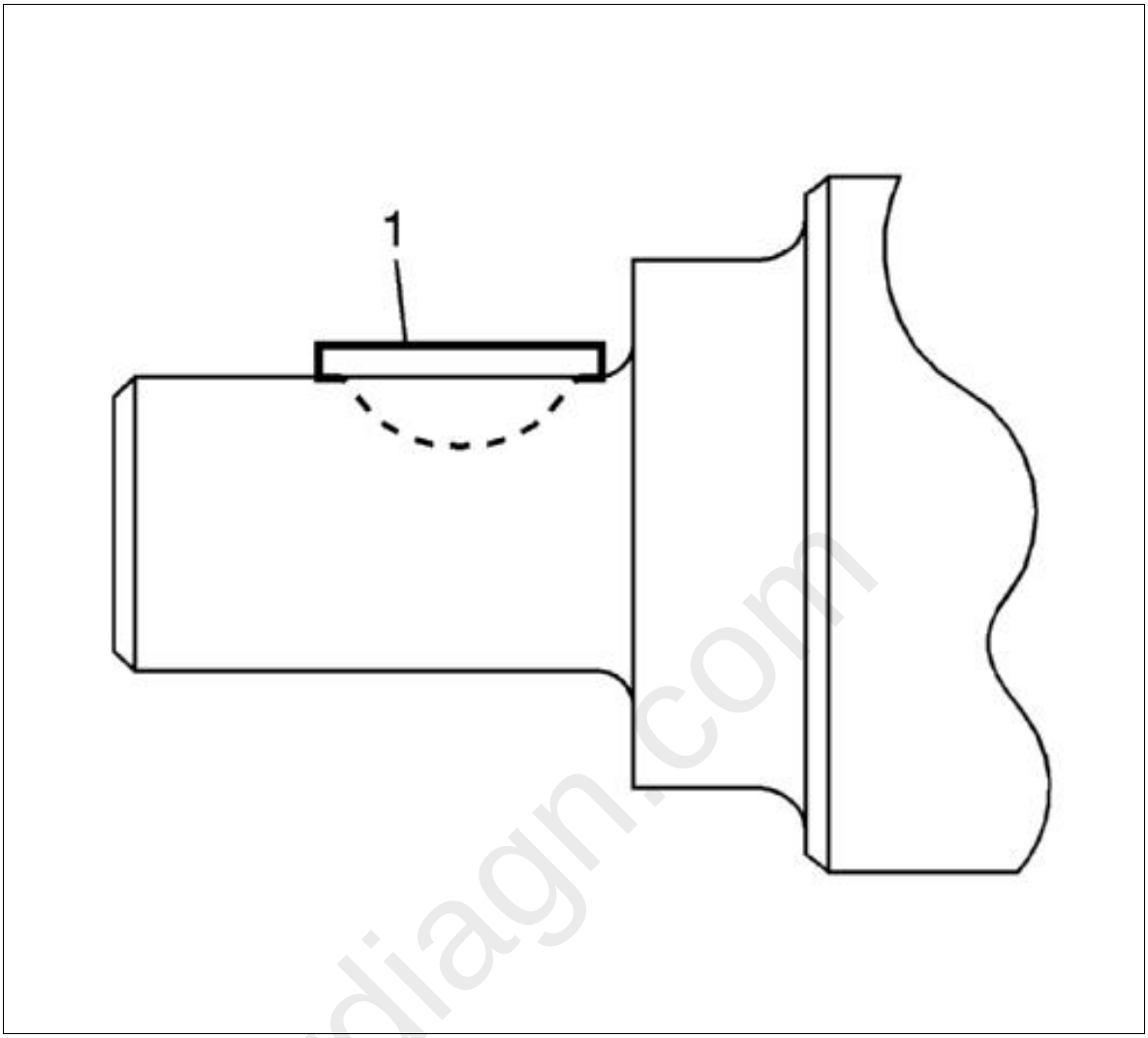


Courtesy of GENERAL MOTORS COMPANY

1. Install the key into the crankshaft keyway (1).

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Fig 2: Key Into Keyway

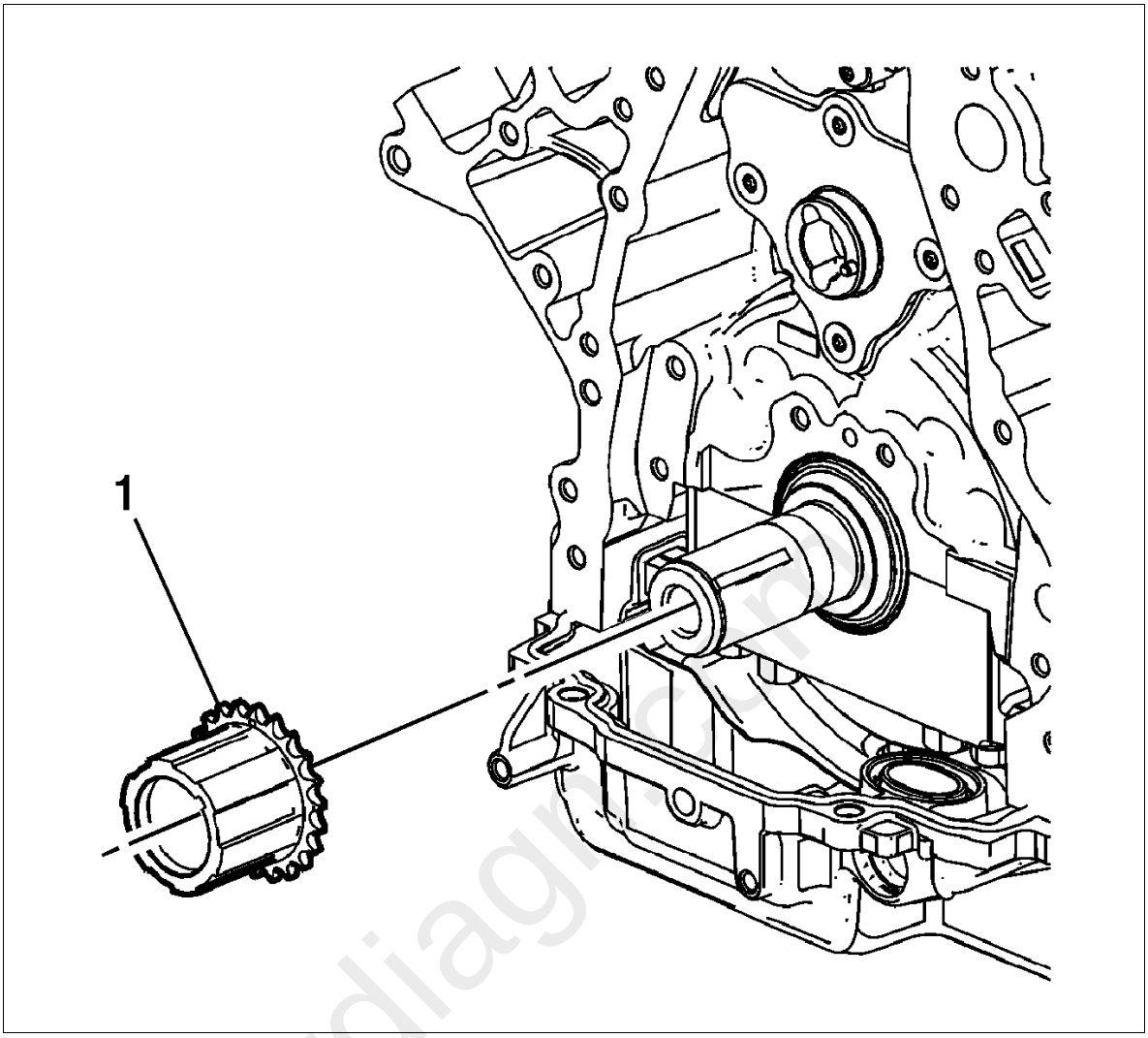


Courtesy of GENERAL MOTORS COMPANY

2. Tap the key (1) into the keyway until both ends of the key bottom onto the crankshaft.

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Fig 3: Crankshaft Sprocket

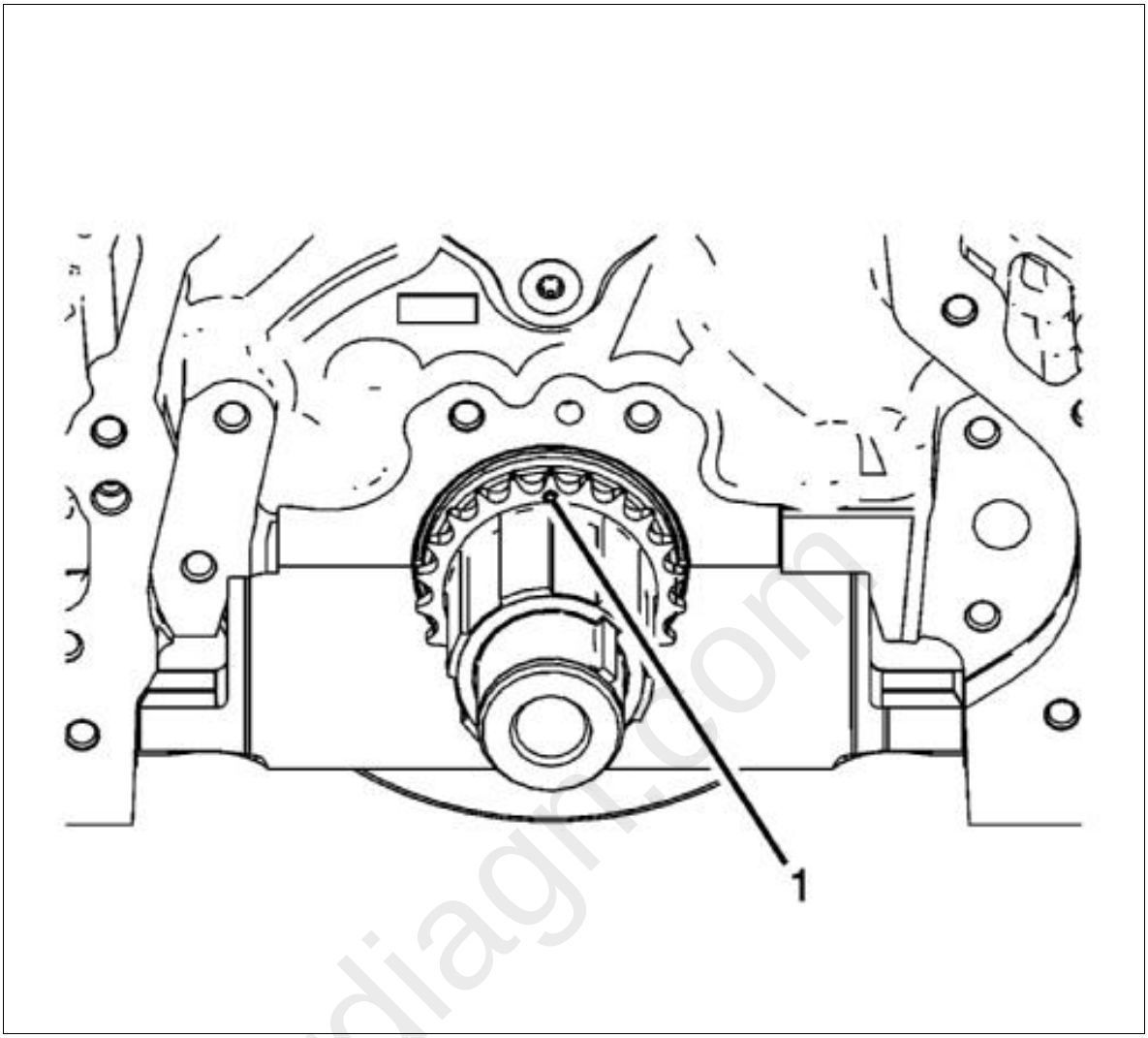


Courtesy of GENERAL MOTORS COMPANY

3. Install the crankshaft sprocket (1). Align the crankshaft key with the crankshaft sprocket keyway.

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Fig 4: Rotating Crankshaft Until Sprocket Alignment Mark

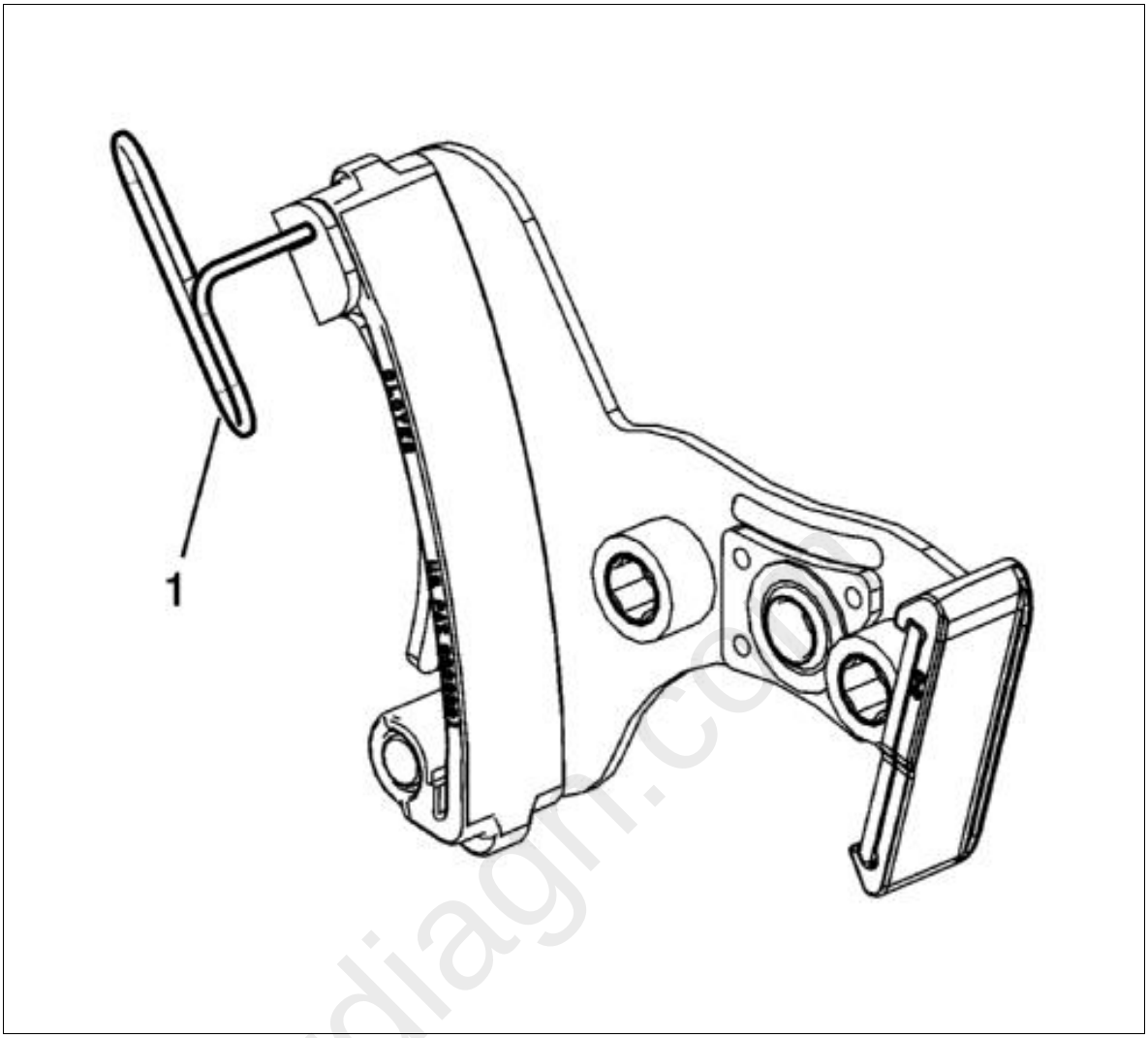


Courtesy of GENERAL MOTORS COMPANY

4. Rotate the crankshaft until the sprocket alignment mark (1) is in the 12 o'clock position.

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Fig 5: Timing Chain Tensioner Guide And Pin

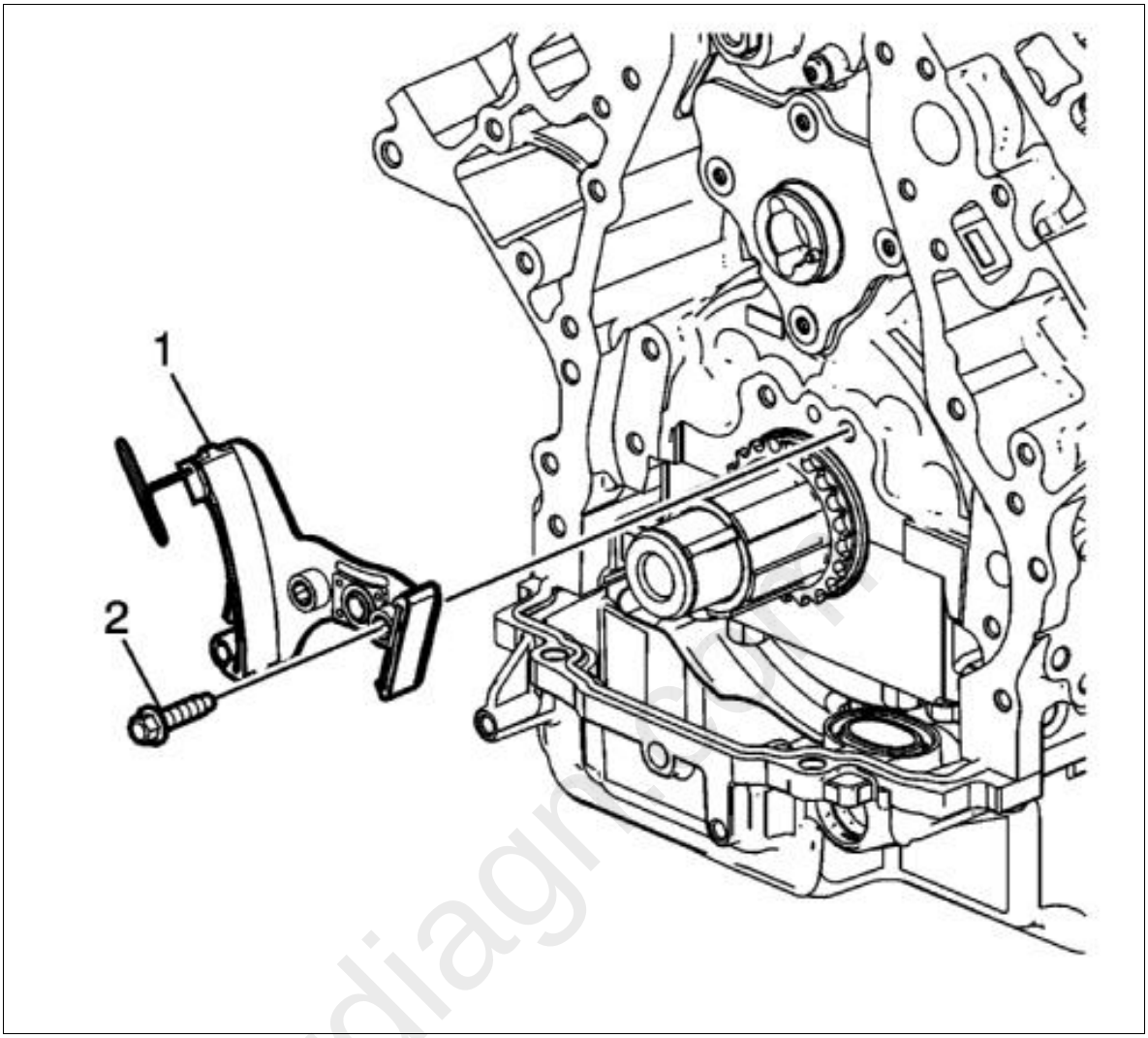


Courtesy of GENERAL MOTORS COMPANY

5. Compress the timing chain tensioner guide and install the **EN-46330** tension pin (1).

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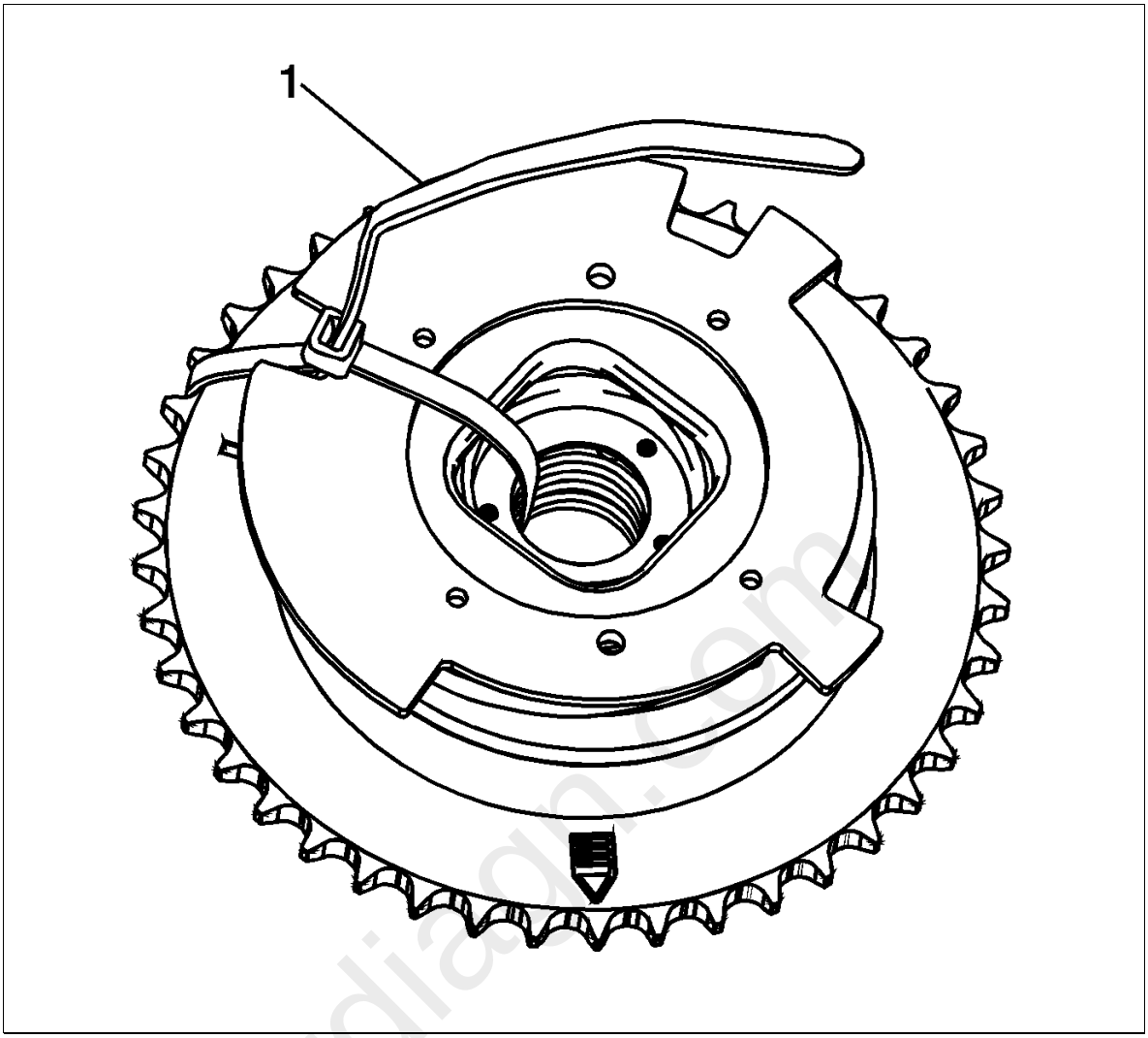
Fig 6: Timing Chain Tensioner And Left Side Bolt



Courtesy of GENERAL MOTORS COMPANY

6. Install the timing chain tensioner and left side bolt (2) hand tight. Do not install the right side bolt at this time. The right side bolt will be installed after the camshaft position (CMP) actuator and chain have been installed onto the engine.

Fig 7: Tie Strap Through Center Of Actuator



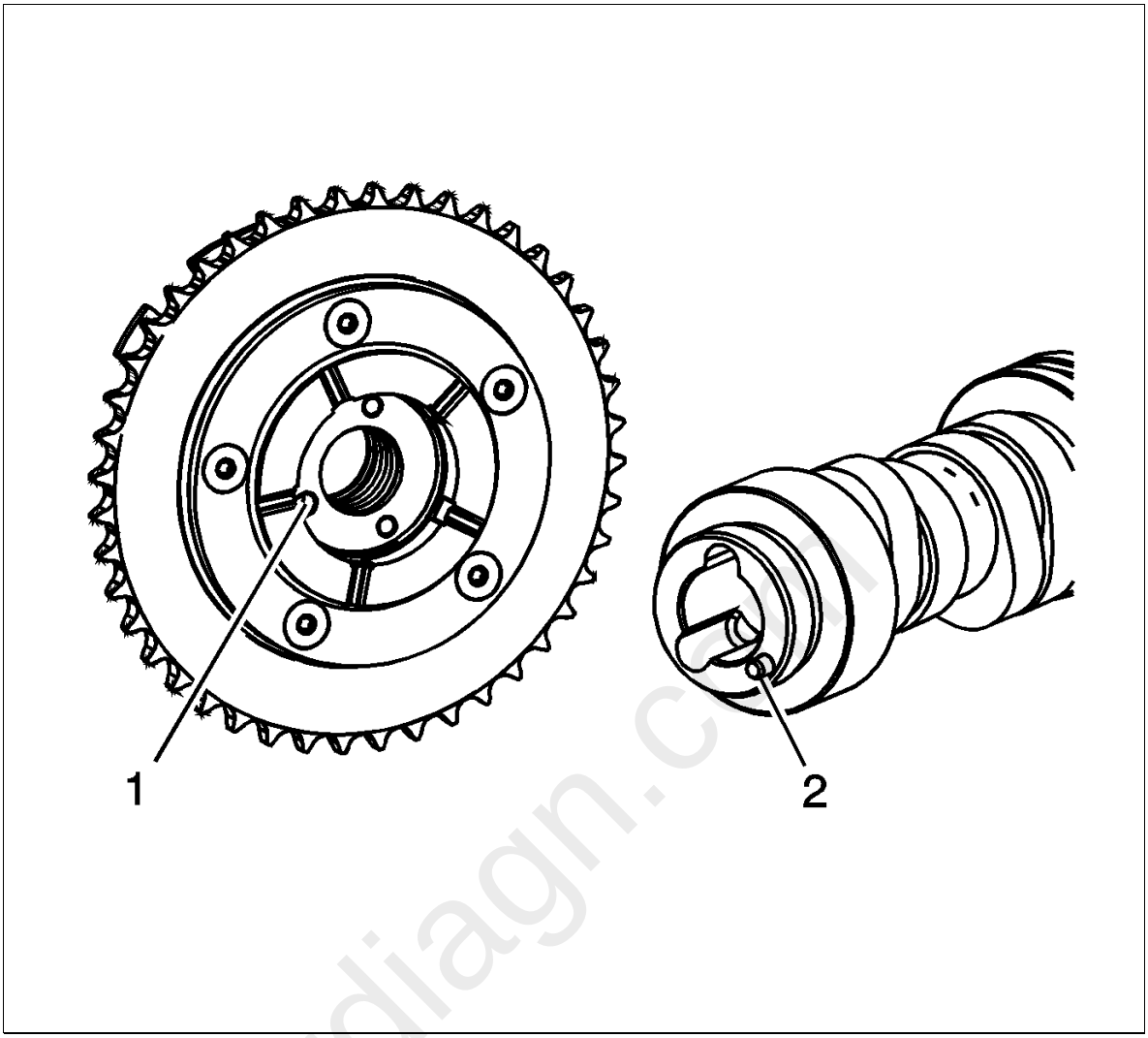
Courtesy of GENERAL MOTORS COMPANY

WARNING:

Refer to Camshaft Position Actuator Removal and Installation Warning .

7. Remove the tie strap (1) from the actuator.

Fig 8: Alignment Hole & Locating Pin



Courtesy of GENERAL MOTORS COMPANY

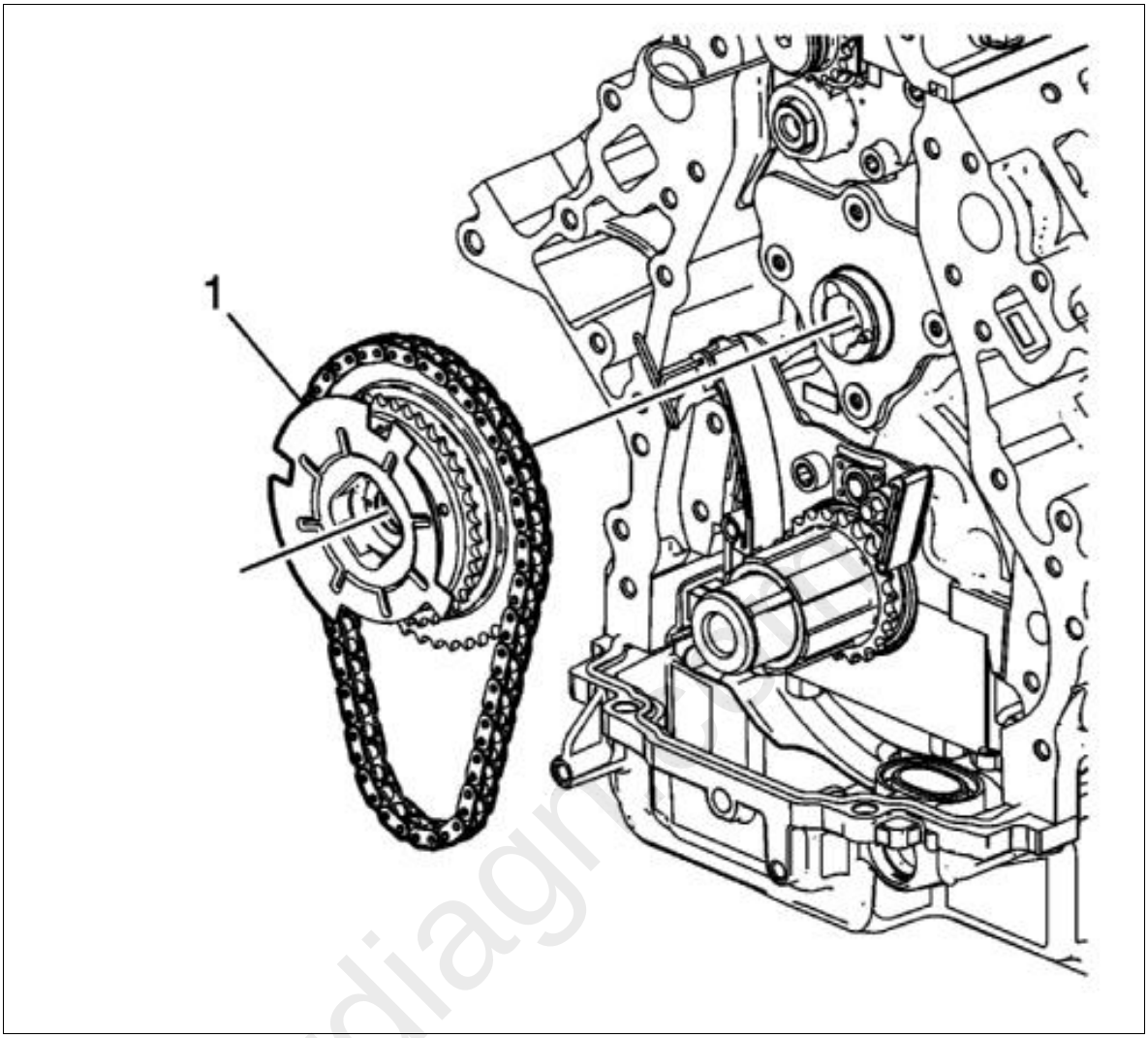
NOTE:

1. *Properly locate the CMP actuator onto the locating pin of the camshaft.*
2. *The sprocket teeth and timing chain must mesh*
3. *The camshaft and the sprocket alignment marks MUST be aligned properly.*
4. *Do not use the CMP solenoid valve again. Install a NEW valve during assembly.*

8. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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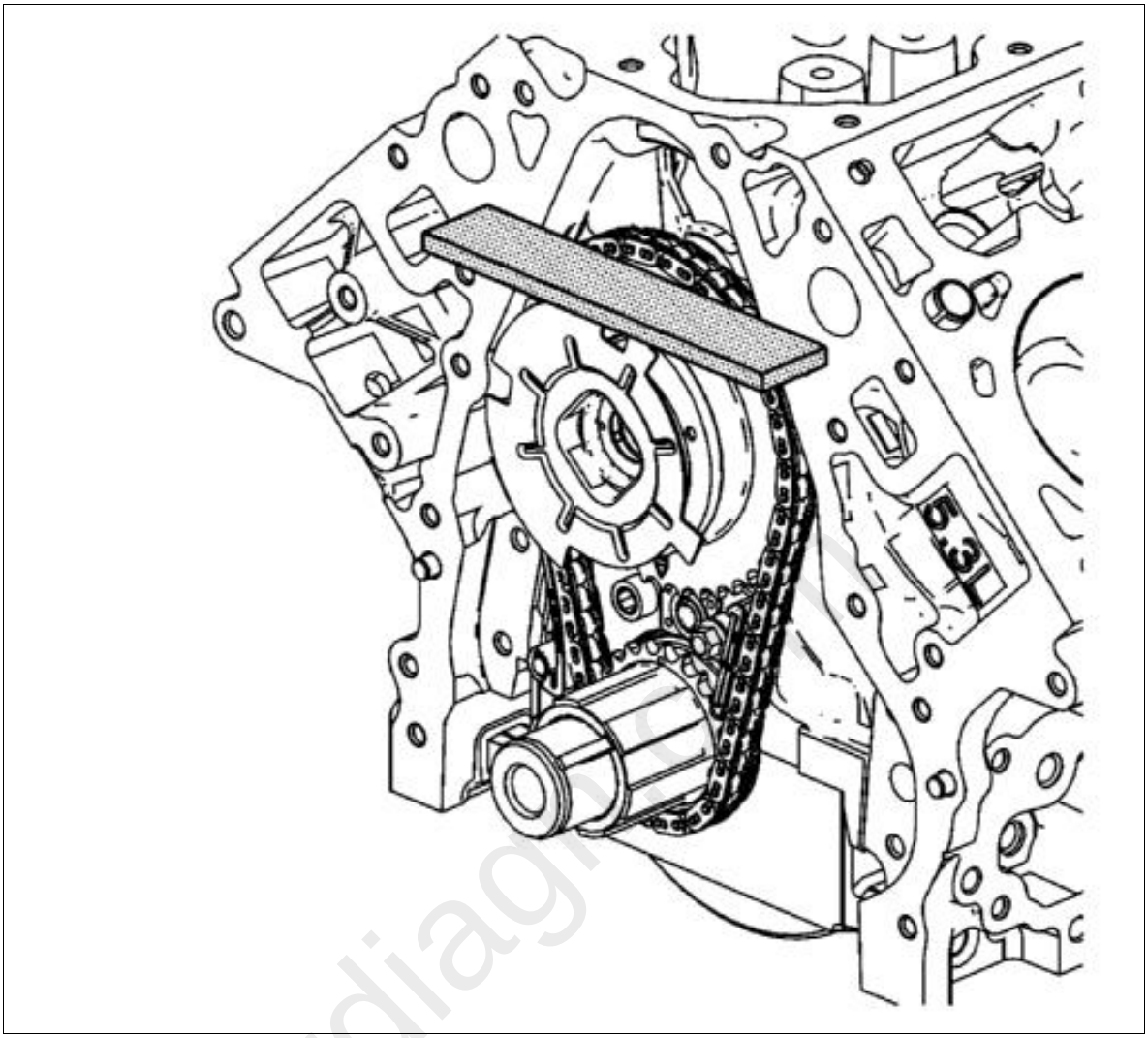
Fig 9: CMP Actuator And Timing Chain



Courtesy of GENERAL MOTORS COMPANY

9. Install the CMP actuator and timing chain (1). Use care to install the actuator completely onto the front of the camshaft. Position fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

Fig 10: Inspecting For Proper Installation Of CMP Actuator And Timing Chain



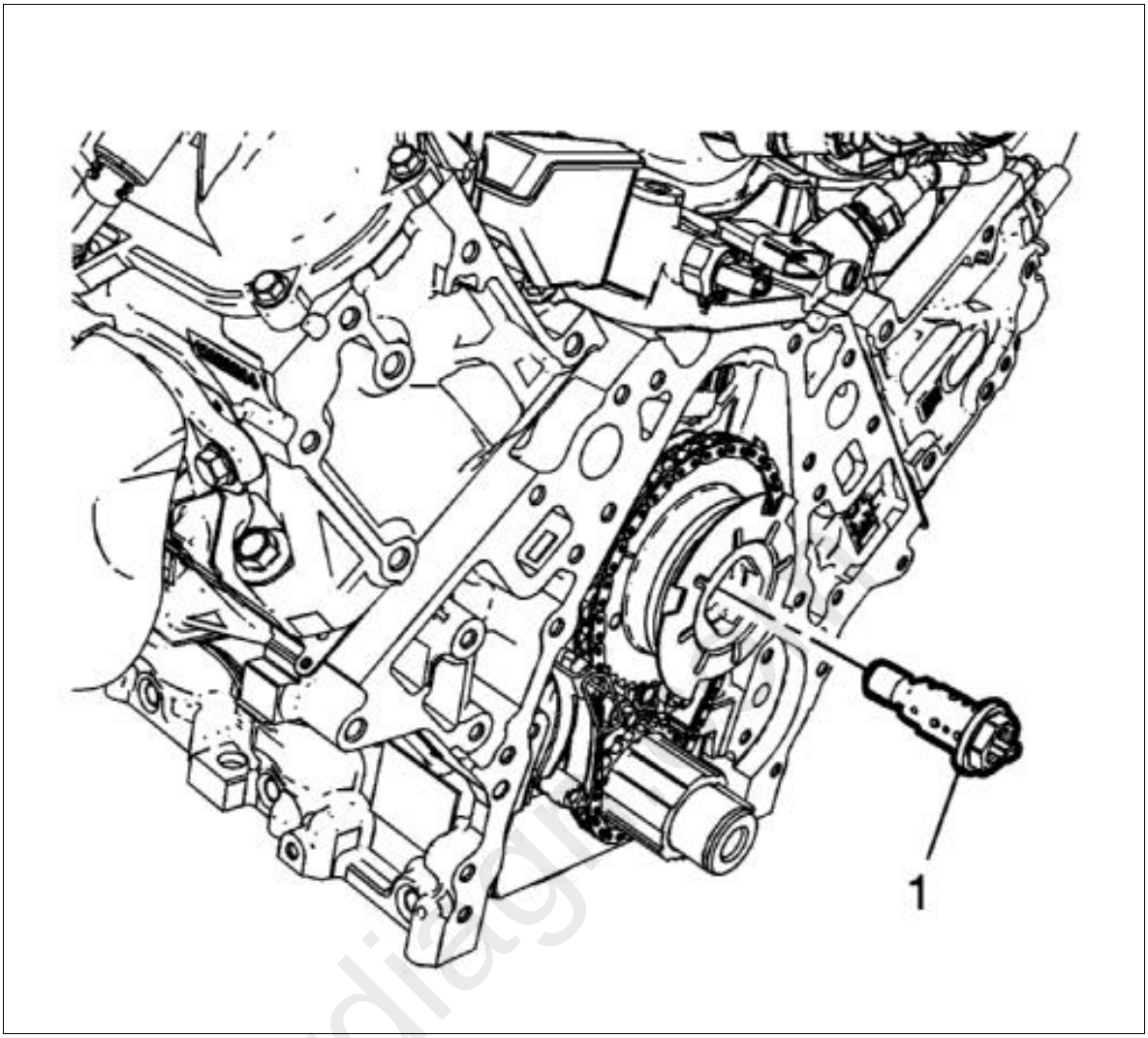
Courtesy of GENERAL MOTORS COMPANY

NOTE:

It is possible to push the camshaft rearward when installing the CMP actuator. Verify that the camshaft lobes are centered in the valve lifter bores after the CMP actuator is installed.

10. Locate a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of camshaft, the timing chain will not protrude beyond the front face of engine block.

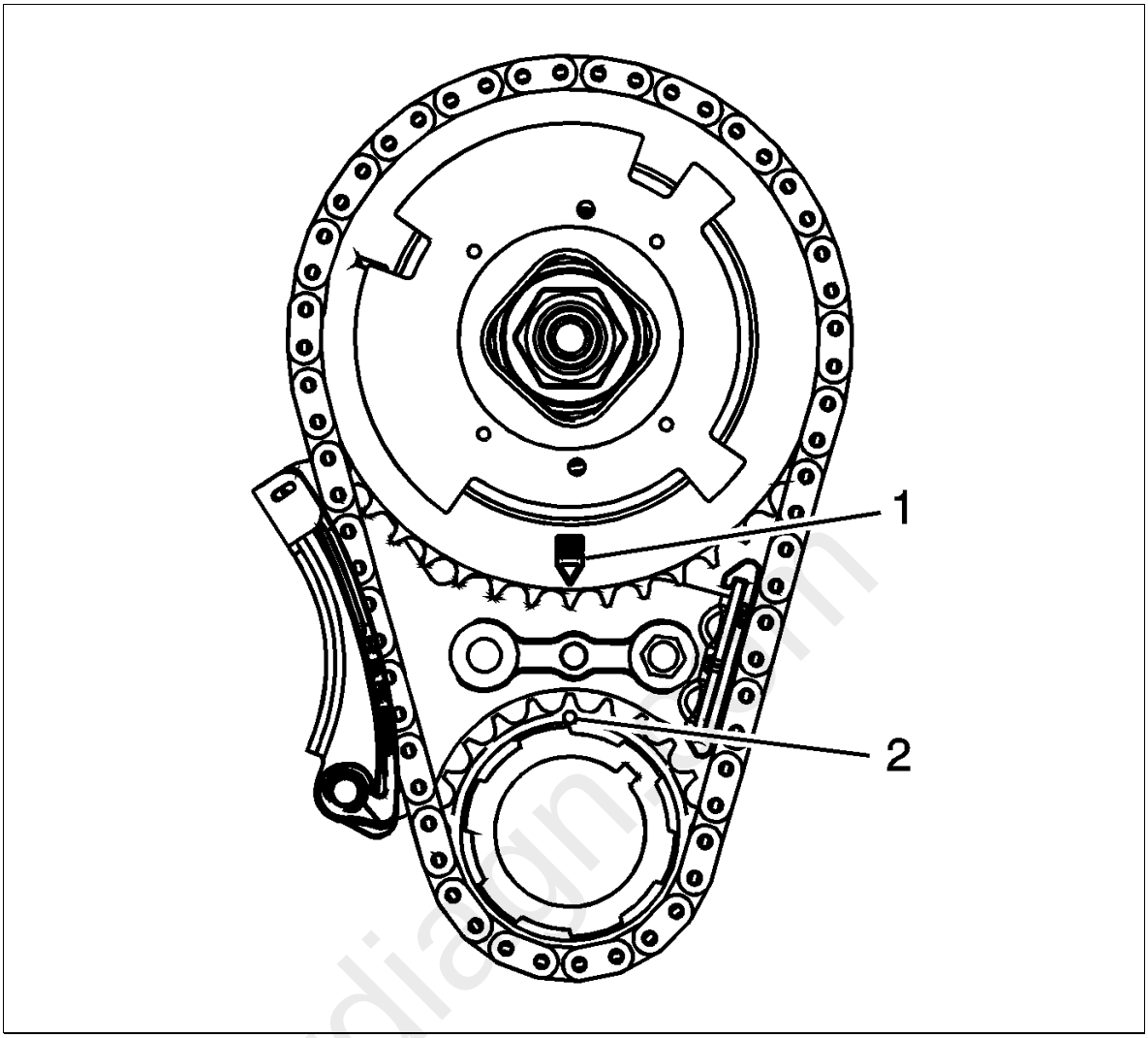
Fig 11: CMP Actuator Solenoid Valve



Courtesy of GENERAL MOTORS COMPANY

11. Install the NEW CMP actuator solenoid valve (1). Refer to Camshaft Position Actuator Solenoid Valve Replacement

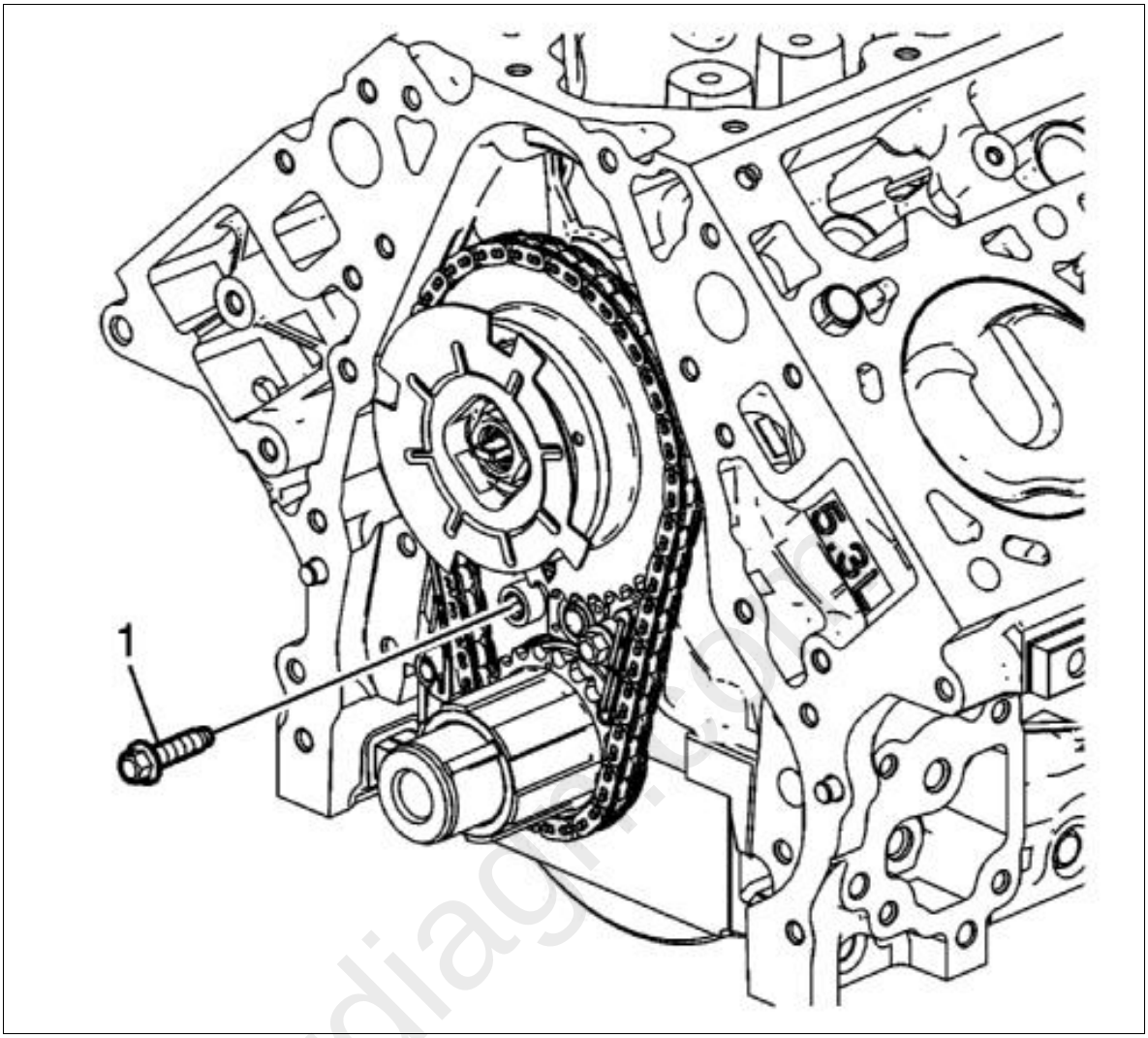
Fig 12: CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark



Courtesy of GENERAL MOTORS COMPANY

12. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

Fig 13: Timing Chain Tensioner

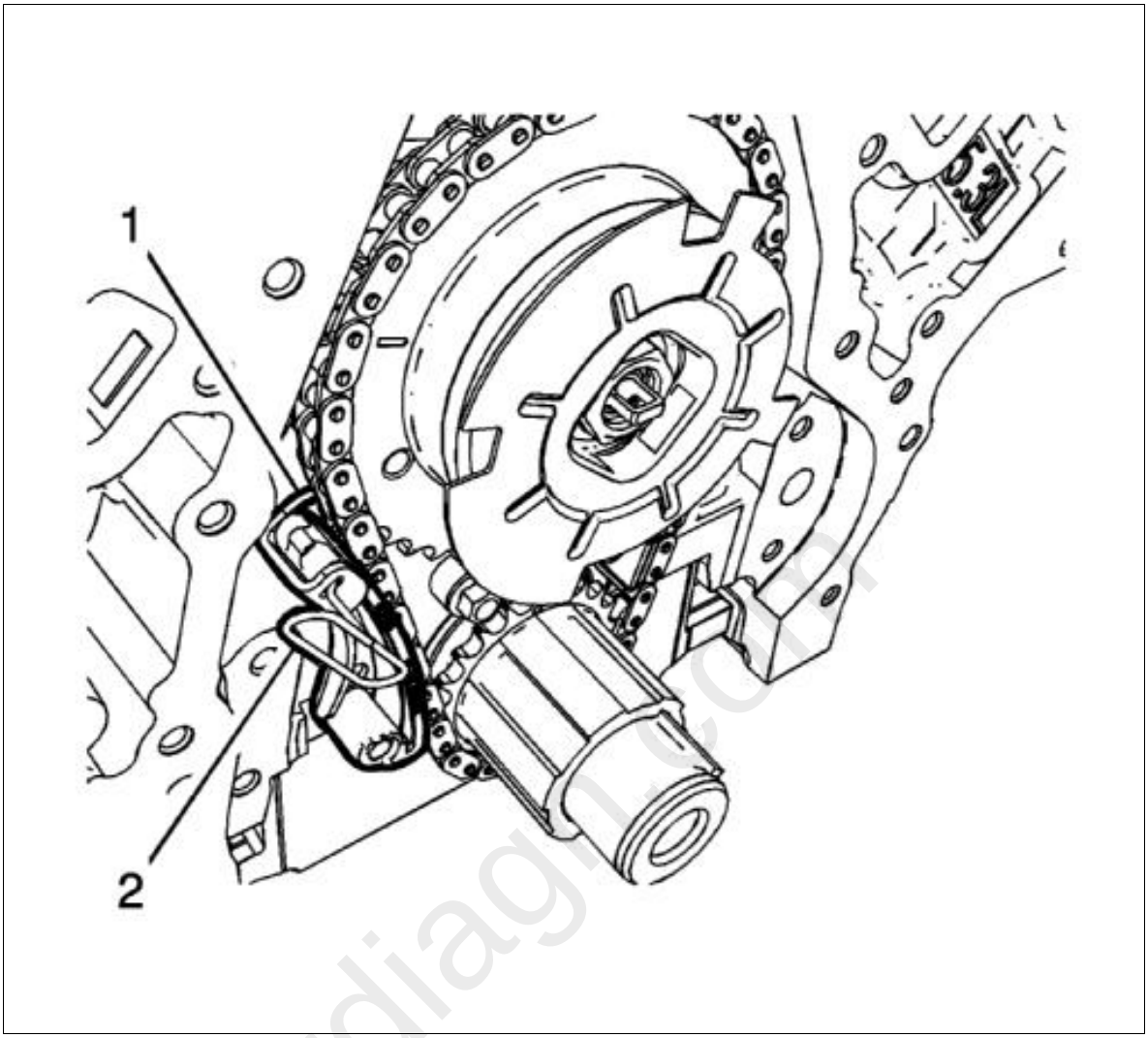


Courtesy of GENERAL MOTORS COMPANY

13. Install the right side bolt (1) into the timing chain tensioner and tighten both bolts to 30 N.m (22 lb ft).

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Fig 14: Back Timing Chain Tensioner



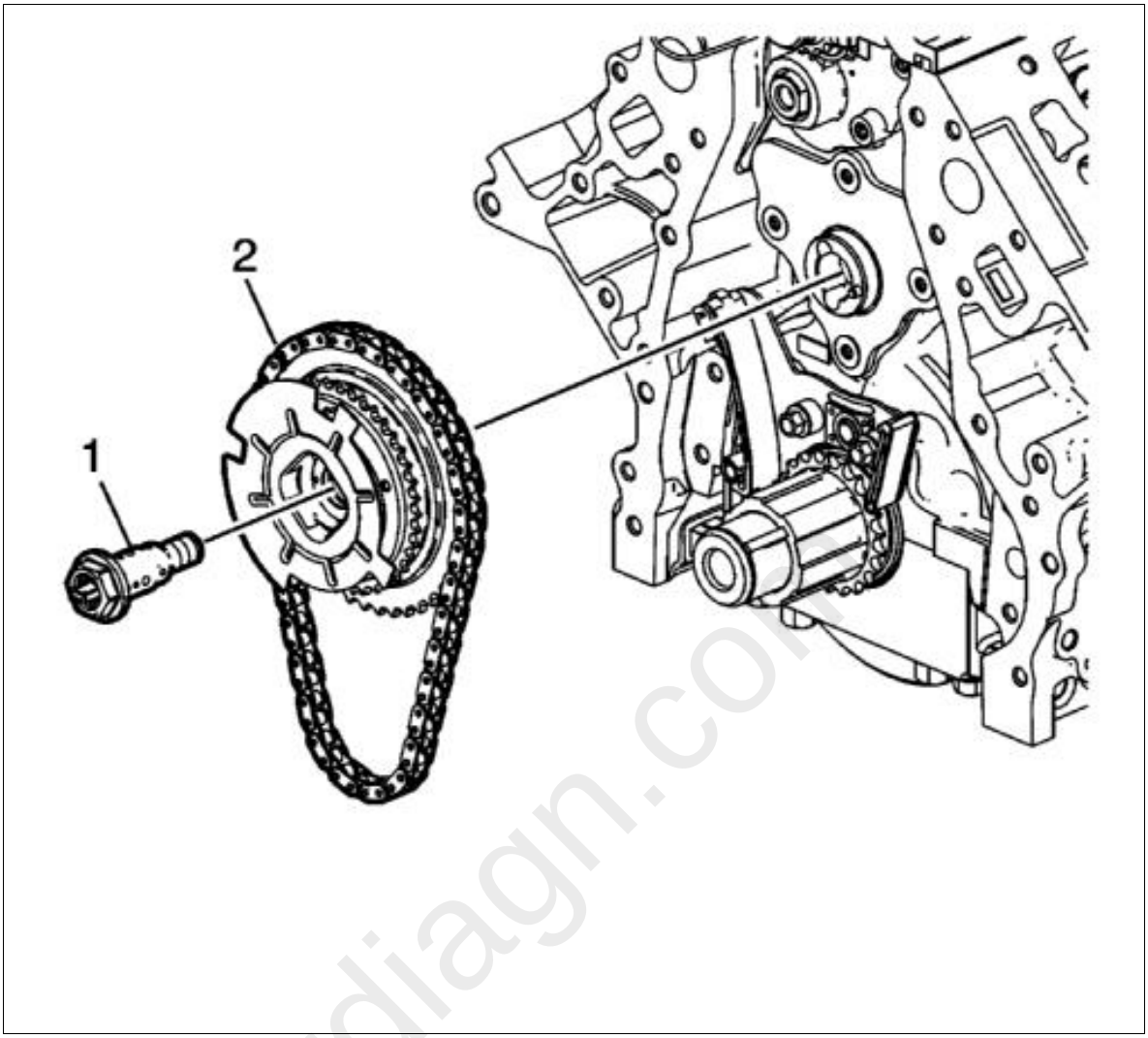
Courtesy of GENERAL MOTORS COMPANY

14. Remove the **EN-46330** tension pin (2) from the timing chain tensioner guide (1).
15. Install oil pump. Refer to Oil Pump Replacement .

REPAIR INSTRUCTIONS - ON VEHICLE > CAMSHAFT REPLACEMENT > REMOVAL PROCEDURE

1. Remove the engine. Refer to Engine Replacement (Automatic Transmission) .
2. Remove the valve lifter follower guide. Refer to Valve Lifter Follower Guide Replacement .
3. Remove the valve lifters. Refer to Valve Lifter Replacement .

Fig 1: Actuator And Timing Chain

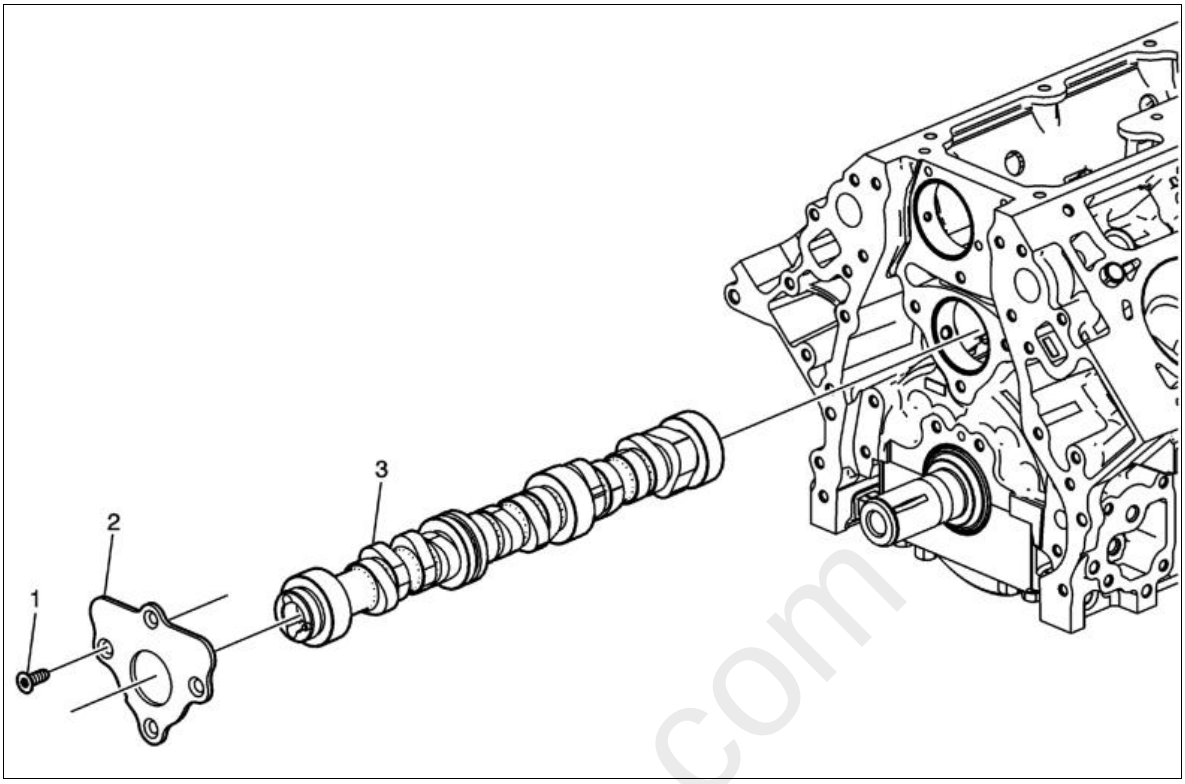


Courtesy of GENERAL MOTORS COMPANY

4. Remove the CMP actuator (1) and timing chain (2). Refer to Timing Chain, Crankshaft Sprocket, Camshaft Position Actuator, and Solenoid Valve Replacement . Discard the CMP actuator.

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Fig 2: Camshaft Retainer Bolts



Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 camshaft retainer bolts (1).
6. Remove the camshaft retainer (2).
7. Remove the camshaft (3).
8. For camshaft cleaning and inspection, refer to Camshaft and Bearings Cleaning and Inspection .

REPAIR INSTRUCTIONS - ON VEHICLE > CAMSHAFT REPLACEMENT > INSTALLATION PROCEDURE

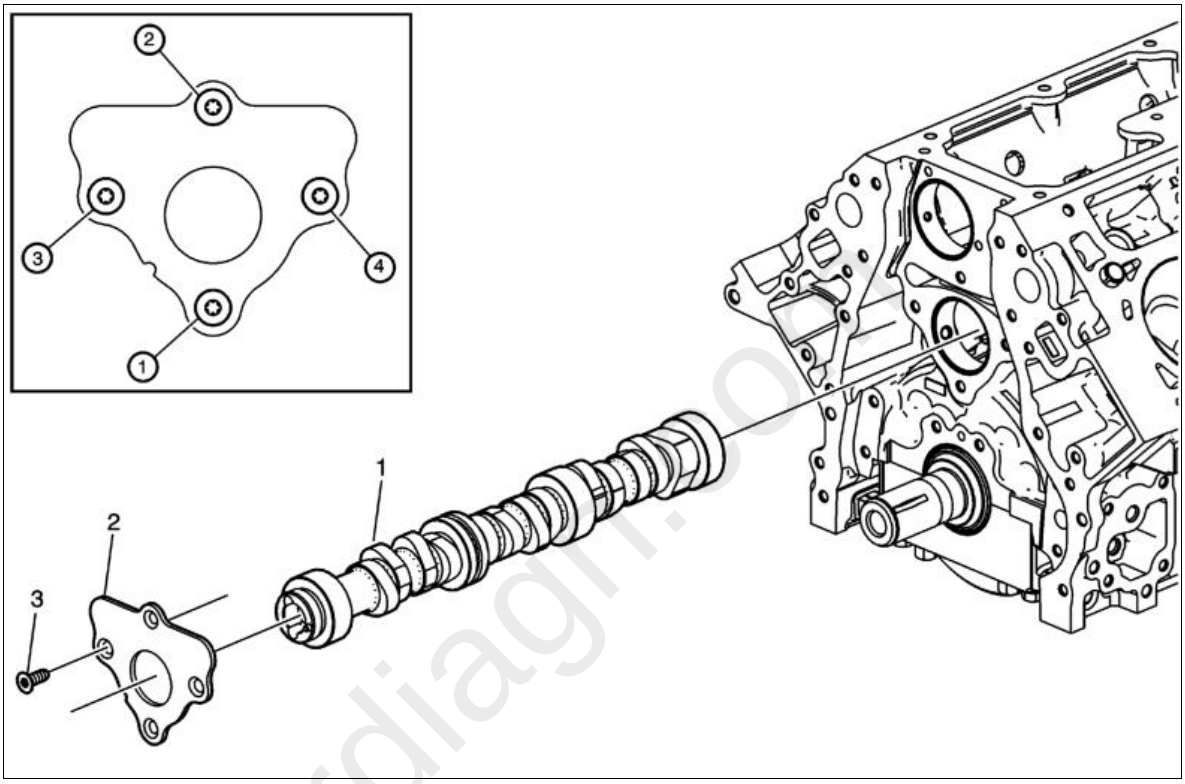
> *NOTE:*
>
> *The threads of the camshaft retainer bolts and threaded holes of the engine block must be free of residue and debris prior to the application of threadlocker to ensure proper adhesion and fastener retention.*

1. Prepare the camshaft retainer bolts and engine block threaded holes for assembly:
    1. Thoroughly clean the residue from the bolt threads with denatured alcohol and allow to dry.

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2. Thoroughly clean the residue from the threaded holes of the engine block with denatured alcohol and allow to dry.
3. Apply threadlocker to 2/3 of the threaded length of the camshaft retainer bolts. Refer to Adhesives, Fluids, Lubricants, and Sealers .
4. Ensure there are no gaps in the threadlocker along the filled area of the bolts.
5. Allow the threadlocker to cure approximately 10 minutes before installation.

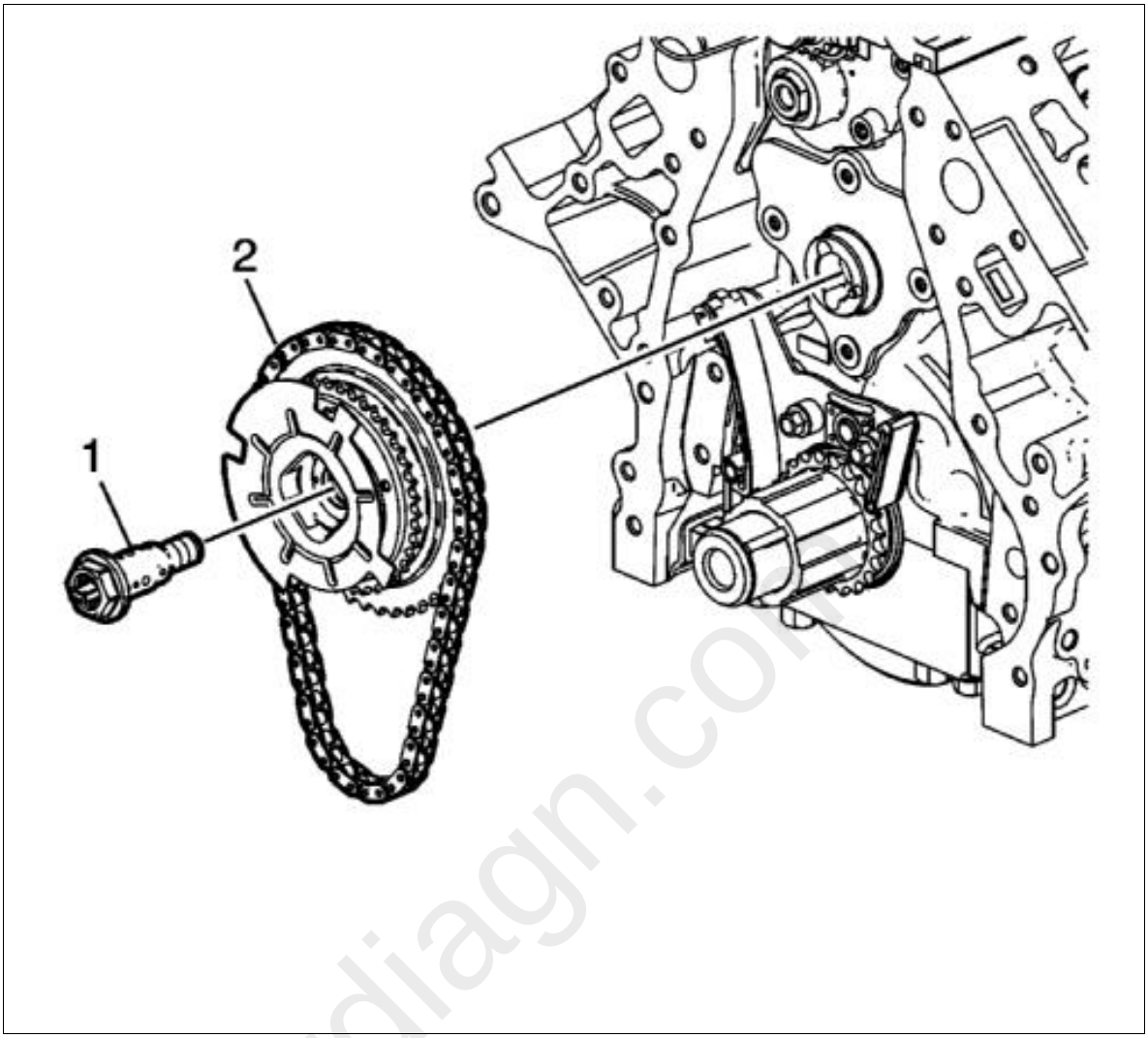
Fig 1: Camshaft Retainer And Bolts



Courtesy of GENERAL MOTORS COMPANY

2. Install the camshaft (1), camshaft retainer (2), and camshaft retainer bolts (3). Refer to Camshaft Installation .

Fig 2: Actuator And Timing Chain



Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW CMP actuator (1) and timing chain (2). Refer to Timing Chain, Crankshaft Sprocket, Camshaft Position Actuator, and Solenoid Valve Replacement .
4. Install the valve lifter follower guide. Refer to Valve Lifter Follower Guide Replacement .
5. Install the valve lifters. Refer to Valve Lifter Replacement .
6. Install the engine. Refer to Engine Replacement (Automatic Transmission) .

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE FLYWHEEL REPLACEMENT

Special Tools

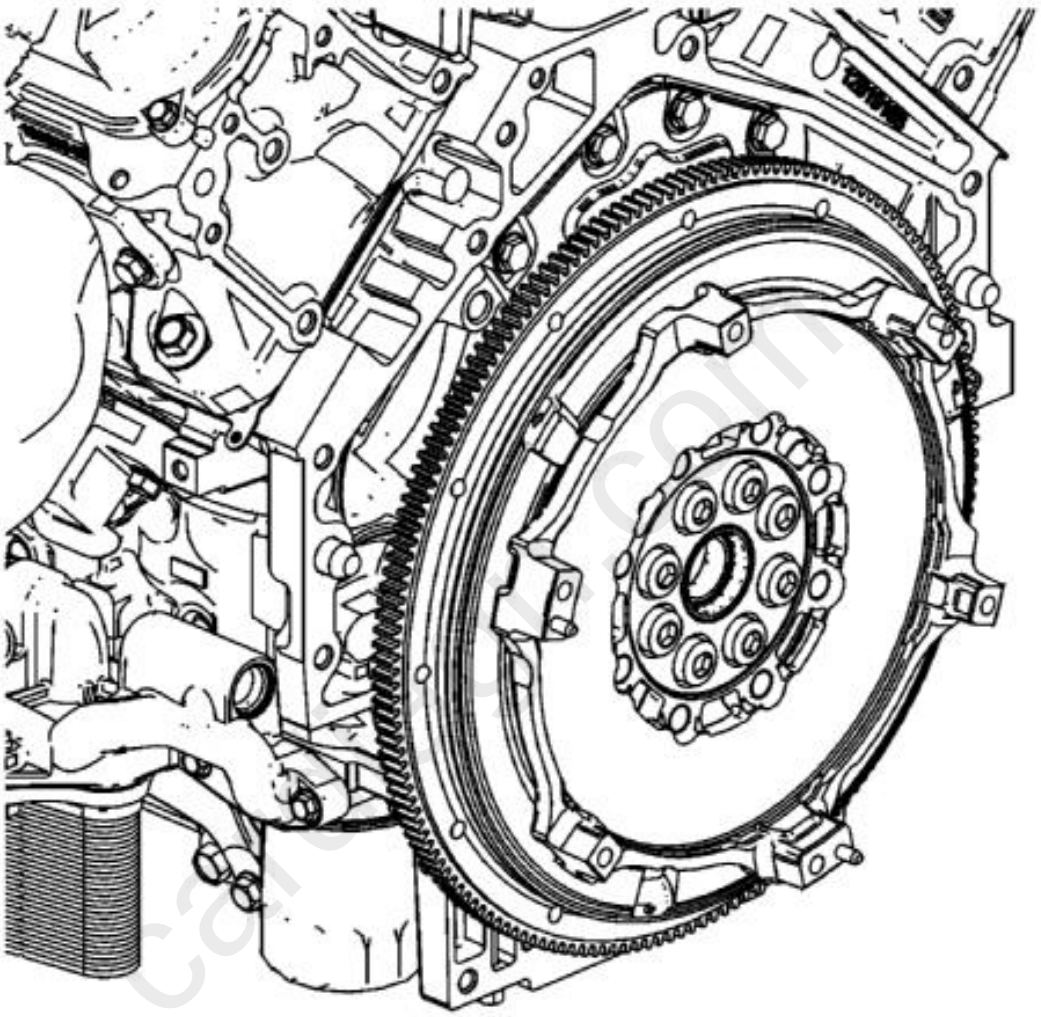
- **J-42386-A** Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE FLYWHEEL REPLACEMENT > REMOVAL PROCEDURE

1. Remove the clutch assembly. Refer to Clutch Assembly Replacement (M13 Transmission)Clutch Assembly Replacement (MM6 Transmission) .

   Fig 1: Mark Or Scribe End Of Crankshaft And Manual Transmission Flywheel

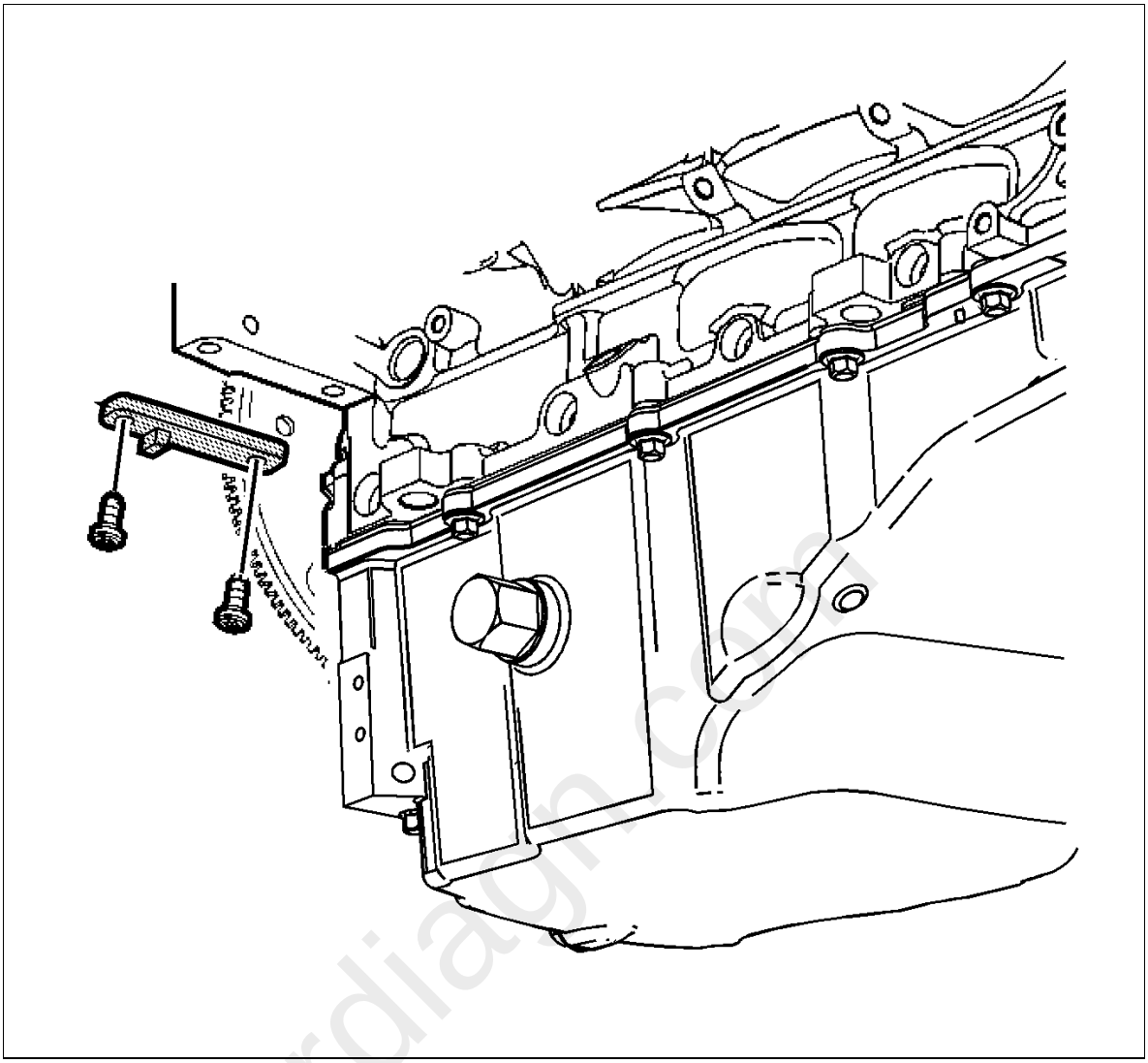


Courtesy of GENERAL MOTORS COMPANY

> *NOTE:*
>
> *Note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction.*

2. Mark or scribe the end of the crankshaft and the manual transmission flywheel.

Fig 2: Flywheel Holder



Courtesy of GENERAL MOTORS COMPANY

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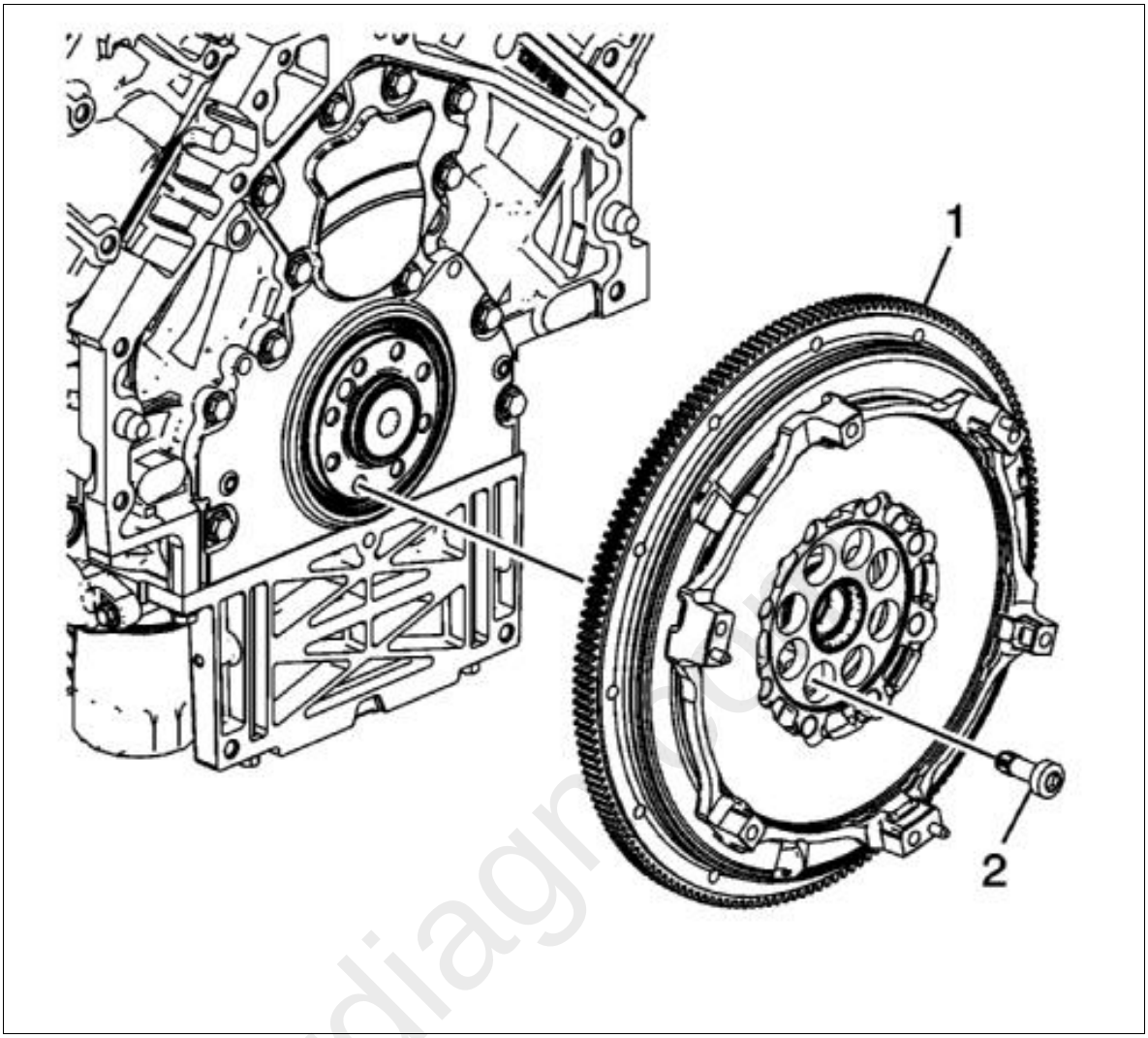
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

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

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

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

Fig 3: Manual Transmission Flywheel



Courtesy of GENERAL MOTORS COMPANY

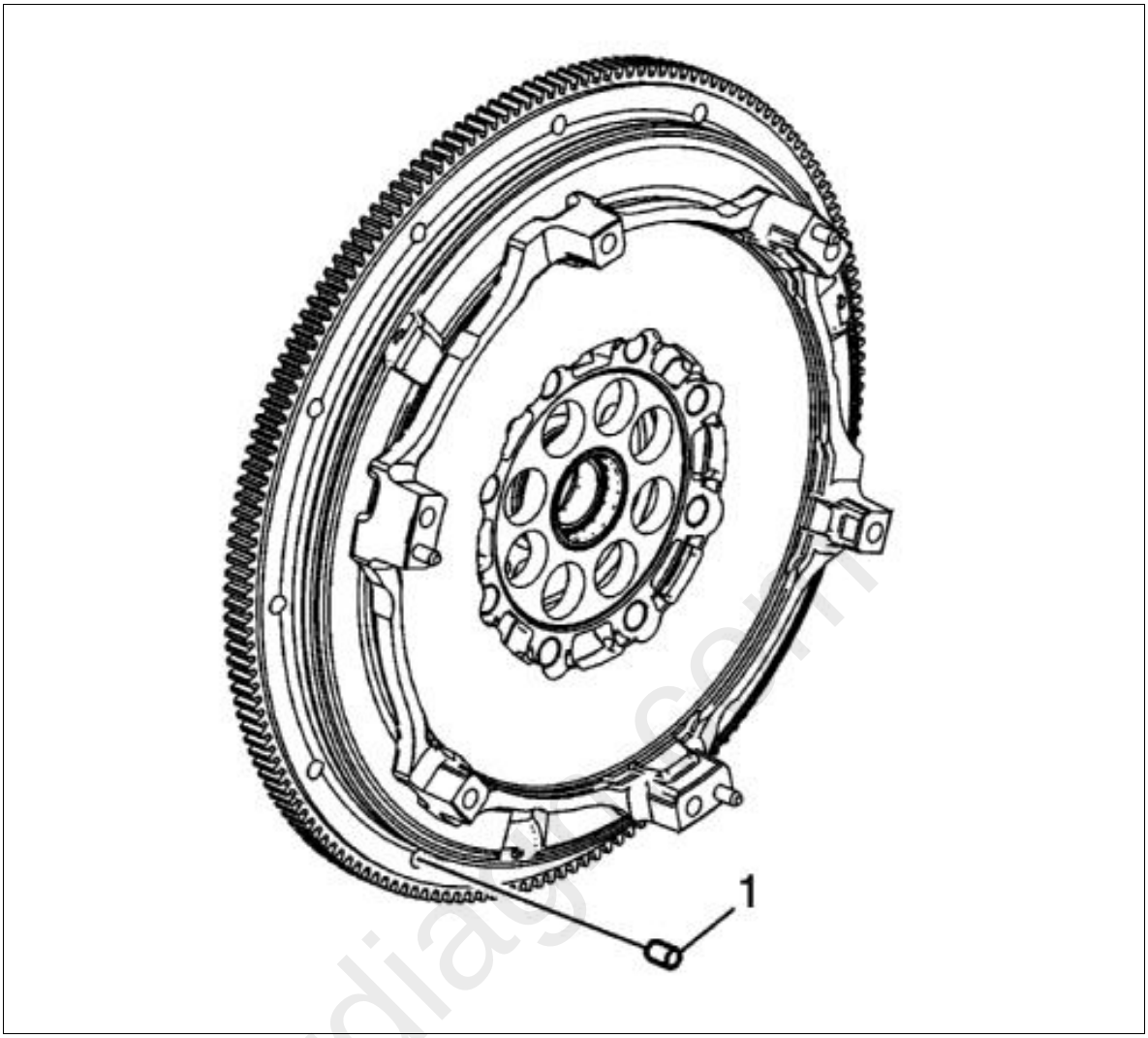
NOTE:

Do NOT reuse the flywheel bolts.

4. Remove and discard the flywheel bolts (2).
5. Remove the manual transmission flywheel (1).

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Fig 4: Manual Transmission Flywheel Balance Weights

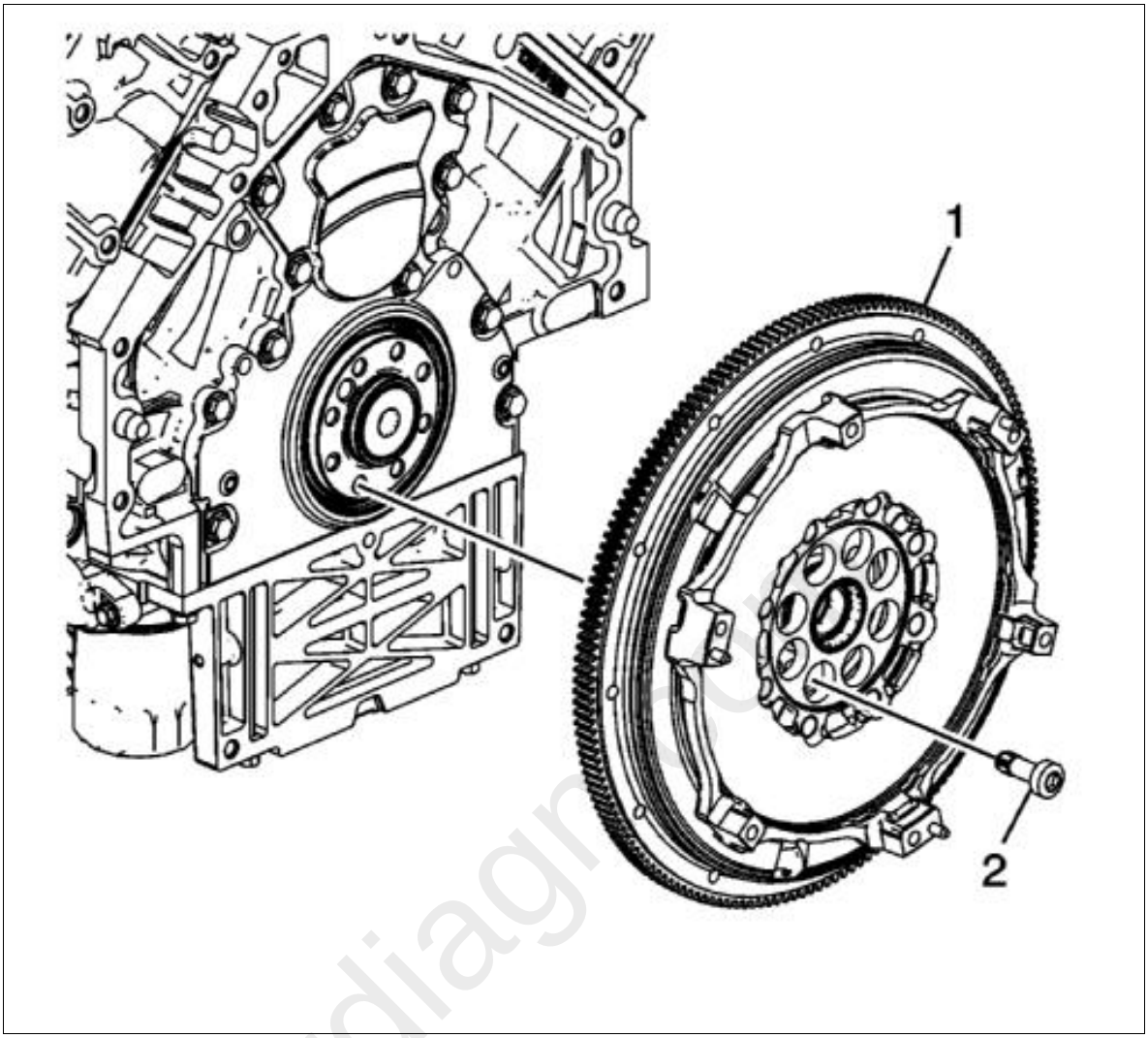


Courtesy of GENERAL MOTORS COMPANY

6. Note the location of the manual transmission flywheel balance weights (1), if applicable.
7. Remove the **J-42386-A** flywheel holding tool

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE FLYWHEEL REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Manual Transmission Flywheel



Courtesy of GENERAL MOTORS COMPANY

NOTE:

The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts.

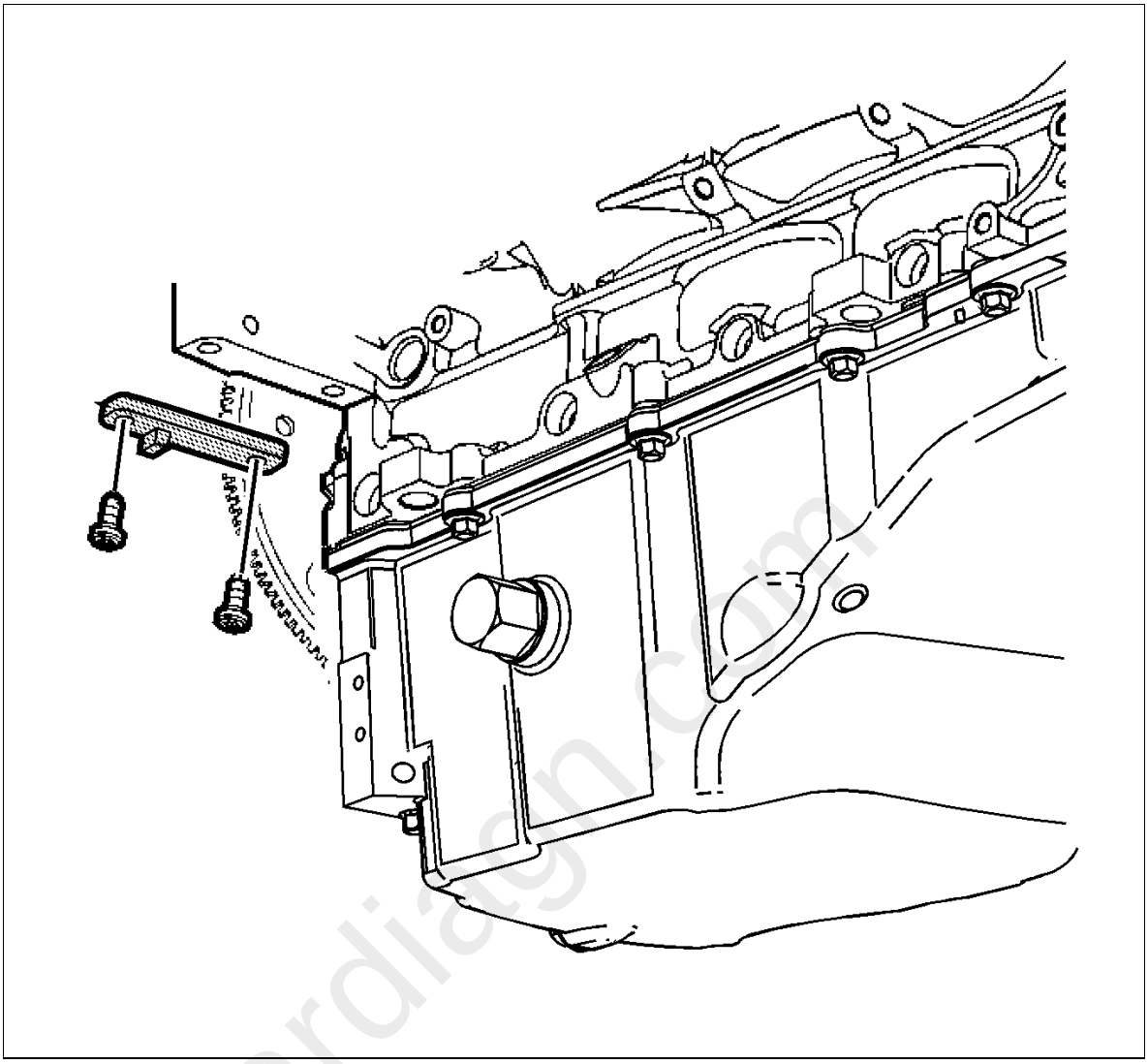
1. Install the flywheel (1) to the crankshaft.

CAUTION:

This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

2. Install and hand tighten the NEW flywheel bolts (2).

Fig 2: Flywheel Holder



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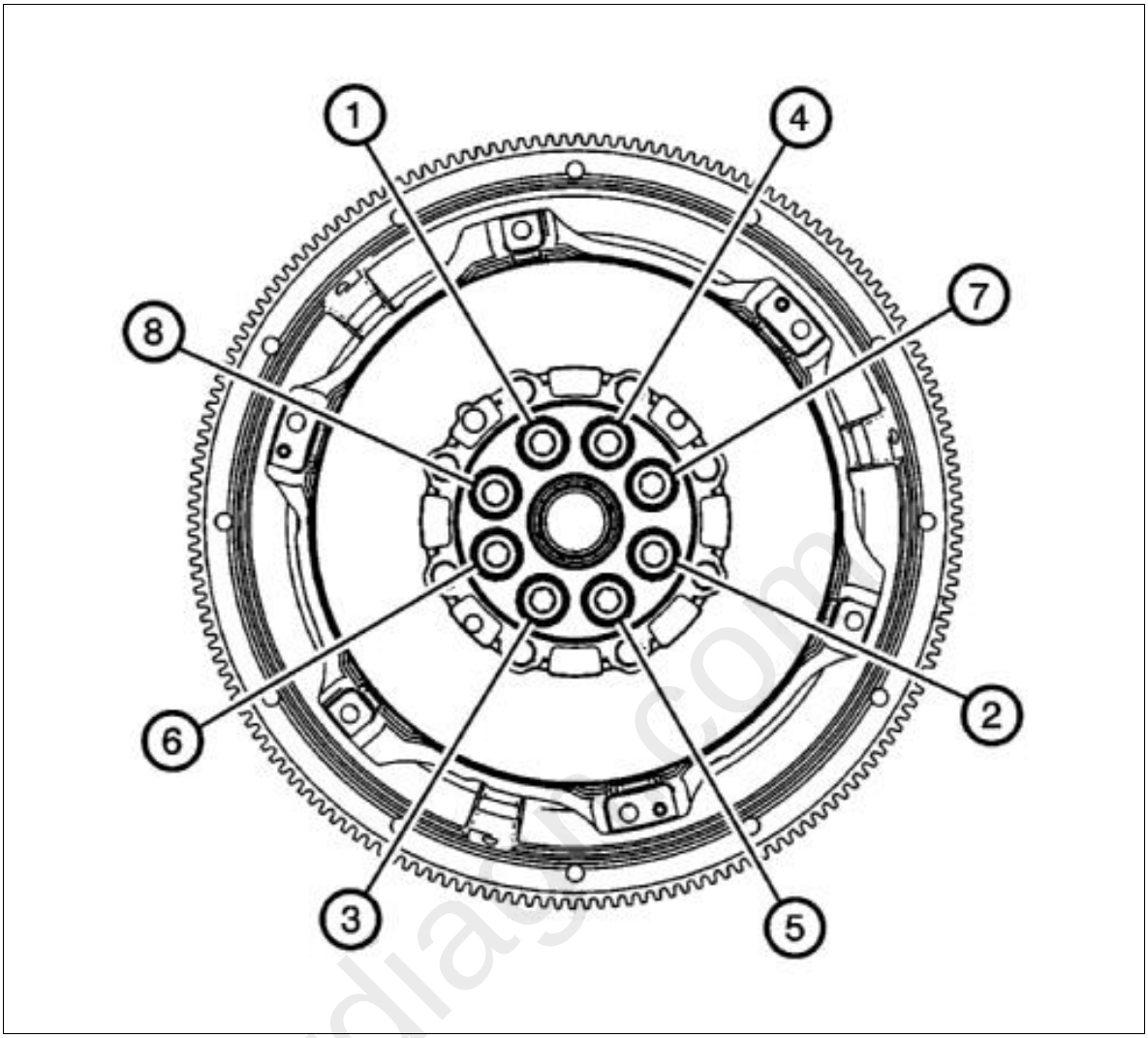
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

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

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

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

Fig 3: Tightening Flywheel Bolts In Sequence



Courtesy of GENERAL MOTORS COMPANY

4. Tighten the flywheel bolts (1).
    1. Tighten the bolts (1-8) a first pass in sequence to 15 N.m (11 lb ft).
    2. Tighten the bolts (1-8) a second pass in sequence to 30 N.m (22 lb ft).
    3. Tighten the bolts (1-8) a final pass in sequence an additional 45 degrees using **EN-45059** angle meter.
5. Remove the **J-42386-A** flywheel holding tool
6. Install the clutch assembly. Refer to Clutch Assembly Replacement (M13 Transmission)Clutch Assembly Replacement (MM6 Transmission) .

REPAIR INSTRUCTIONS - ON VEHICLE > AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Special Tools

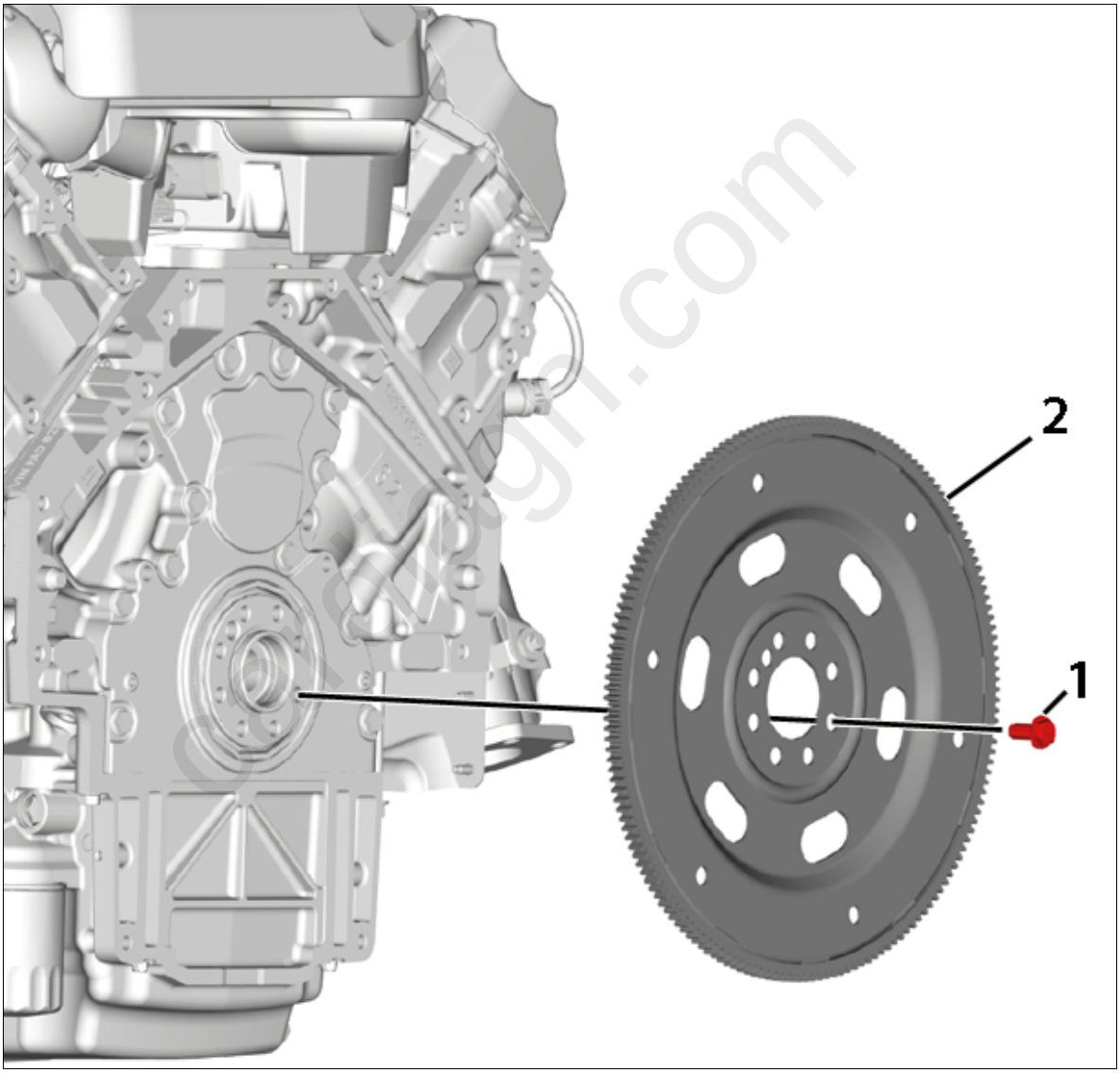
- **EN-45059** Angle Meter

For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT > REMOVAL PROCEDURE

1. Remove the automatic transmission. Transmission Replacement (M5U with LT1 Engine) .

Fig 1: Flex Plate



Courtesy of GENERAL MOTORS COMPANY

NOTE:

The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine

flex plate bolts. This procedure requires a 3 stage tightening process.

2. Remove and DISCARD the flex plate bolts (1).

NOTE:

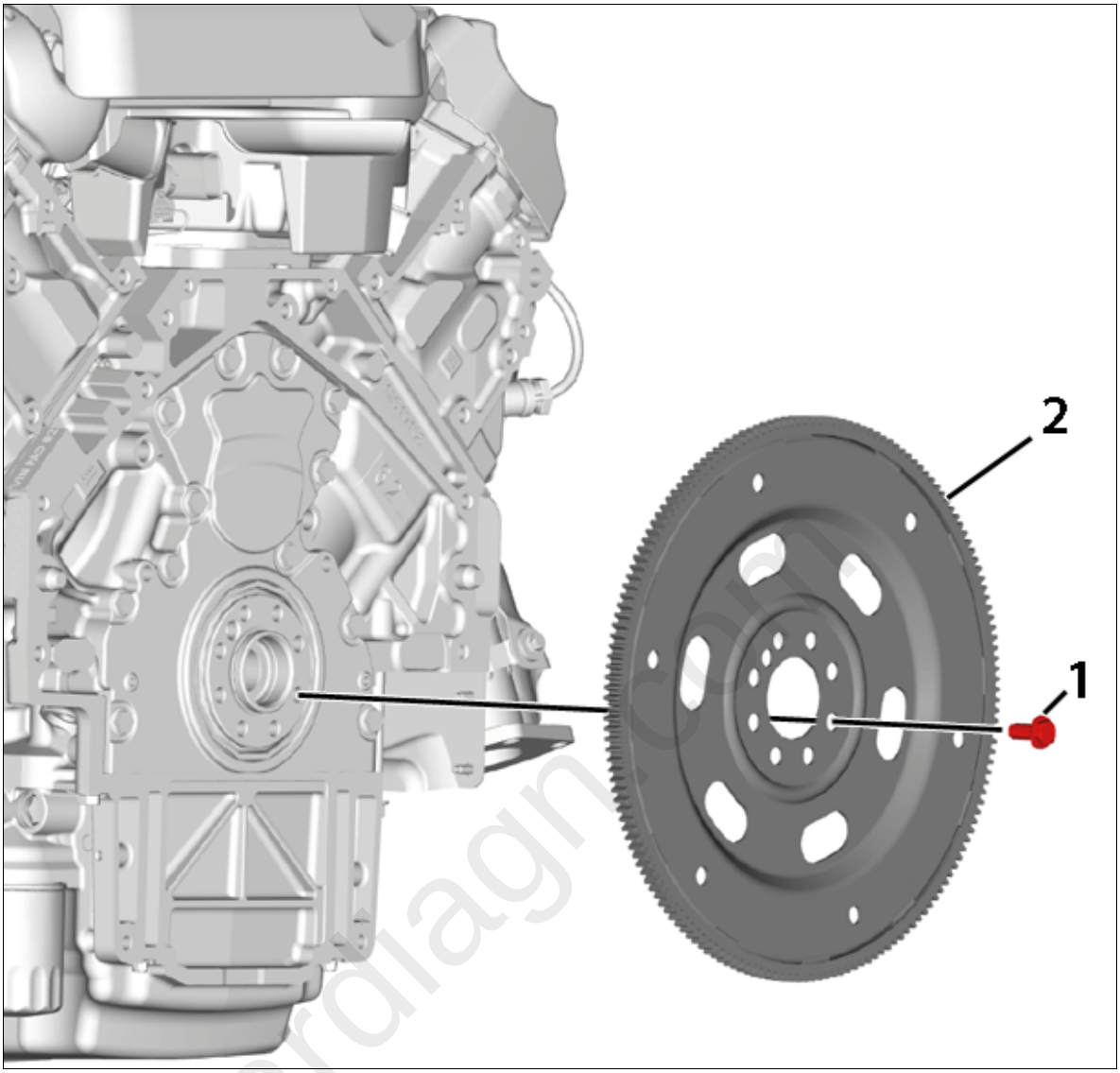
Mark the flex plate and crankshaft before removal.

3. Remove the flex plate (2).

REPAIR INSTRUCTIONS - ON VEHICLE > AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT > INSTALLATION PROCEDURE

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Fig 1: Flex Plate



Courtesy of GENERAL MOTORS COMPANY

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⚠ *CAUTION:*

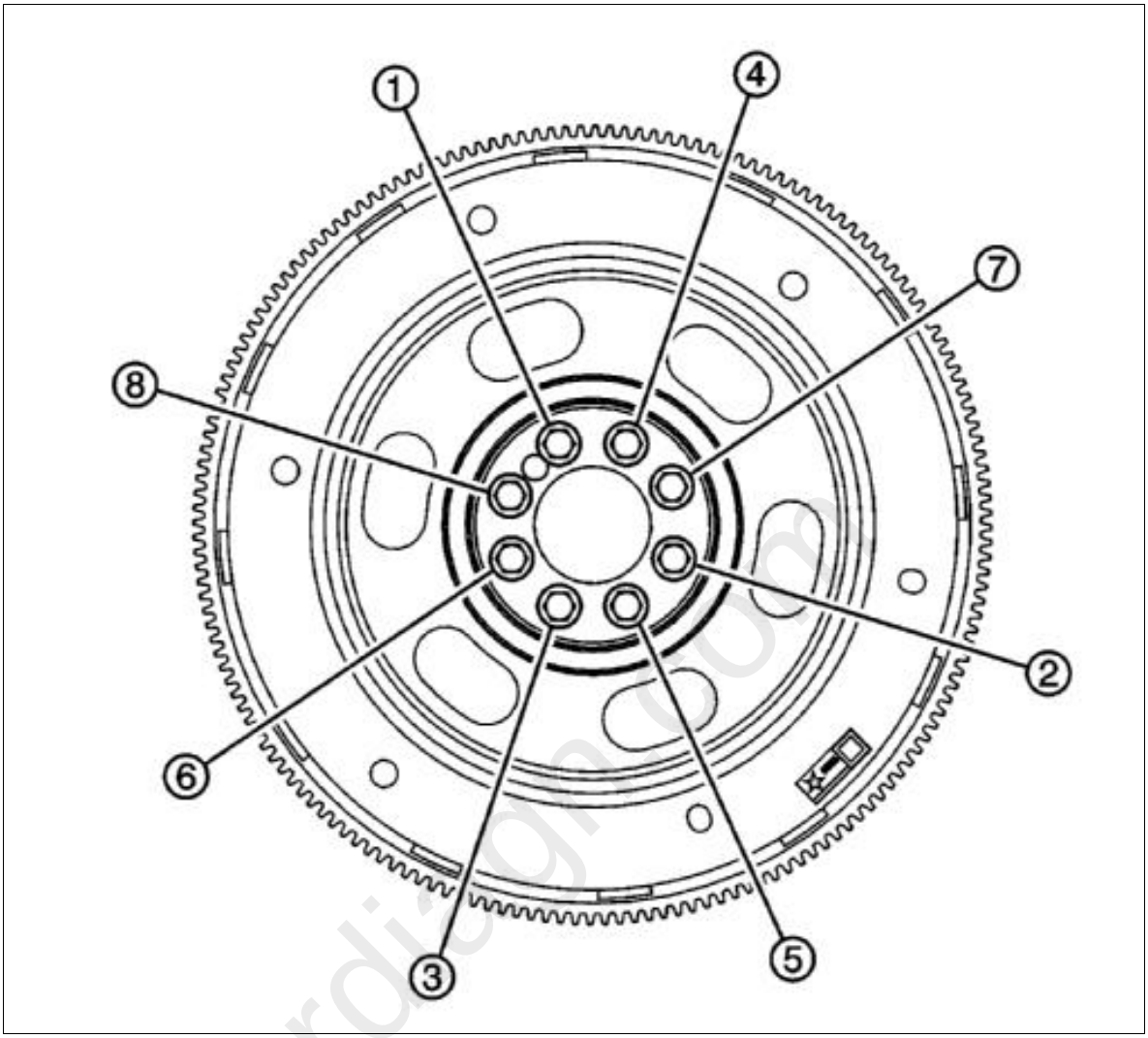
This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE:

The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.

1. Install the flex plate (2) to the crankshaft.

Fig 2: NEW Engine Flex Plate Bolts



Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

2. Install NEW flex plate bolts (1).
    1. Tighten the flex plate bolts (1-8) a first pass in sequence to 15 N.m (11 lb ft).
    2. Tighten the flex plate bolts (1-8) a second pass in sequence to 30 N.m (22 lb ft).
    3. Tighten the flex plate bolts (1-8) a final pass in sequence an additional 45 degrees using **EN-45059** angle meter.
3. Install the automatic transmission. Transmission Replacement (M5U with LT1 Engine) .

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REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE REPLACEMENT (AUTOMATIC TRANSMISSION)

Special Tools

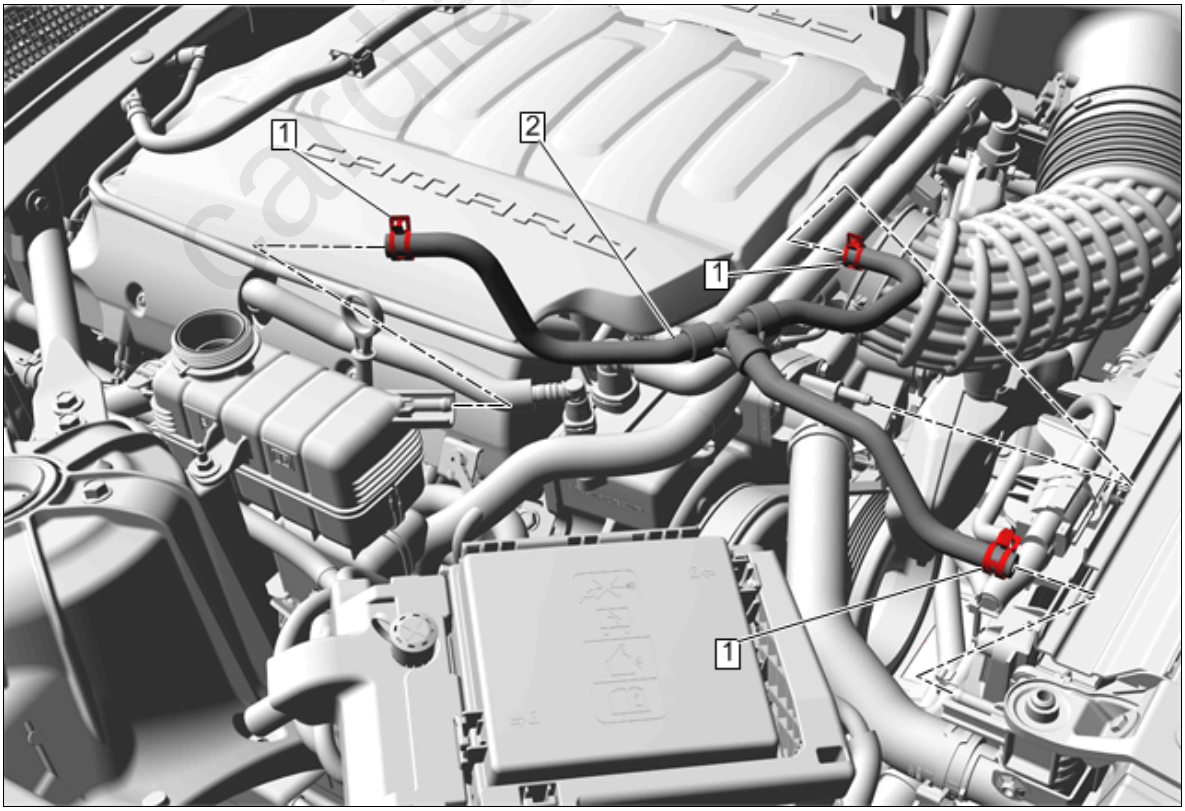
- **J 36660-A** Torque Angle Meter
- **J 39580** Engine Support Table
- **J 39580-500** Engine Support Table Top
- **J-41803-9** Engine Lift Hook

For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE REPLACEMENT (AUTOMATIC TRANSMISSION) > REMOVAL PROCEDURE

1. Disconnect Battery Negative Cable.
2. Recover the refrigerant. Refrigerant Recovery and Recharging (R-134a)Refrigerant Recovery and Recharging (R-1234yf)
3. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static Fill)

   Fig 1: Radiator Surge Tank Inlet Hose

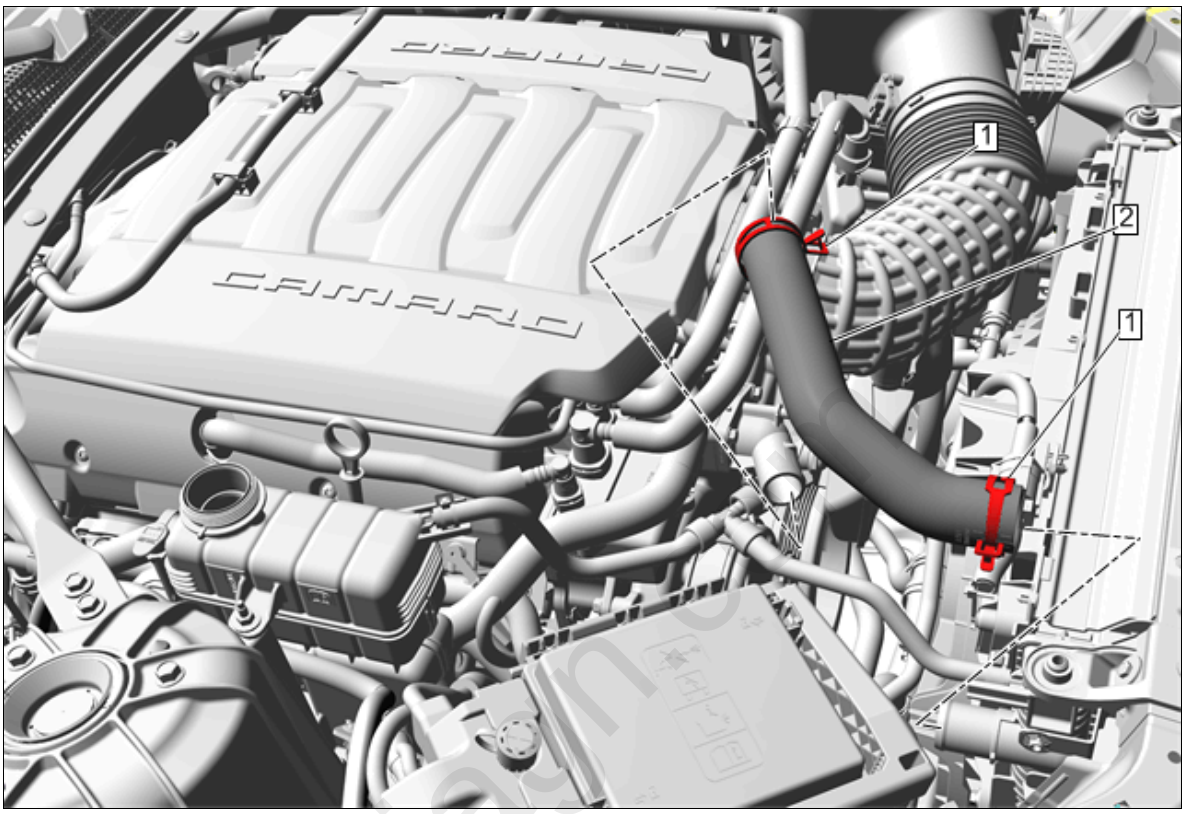


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4. Disconnect Radiator Surge Tank Inlet Hose (2) at Engine Coolant Thermostat Housing.
5. Disconnect Heater Inlet Hose at Heater Core-Heater Inlet Hose Replacement (LT1)
6. Disconnect Heater Outlet Hose at Heater Core-Heater Outlet Hose Replacement (LT1)

Fig 2: Radiator Inlet Hose

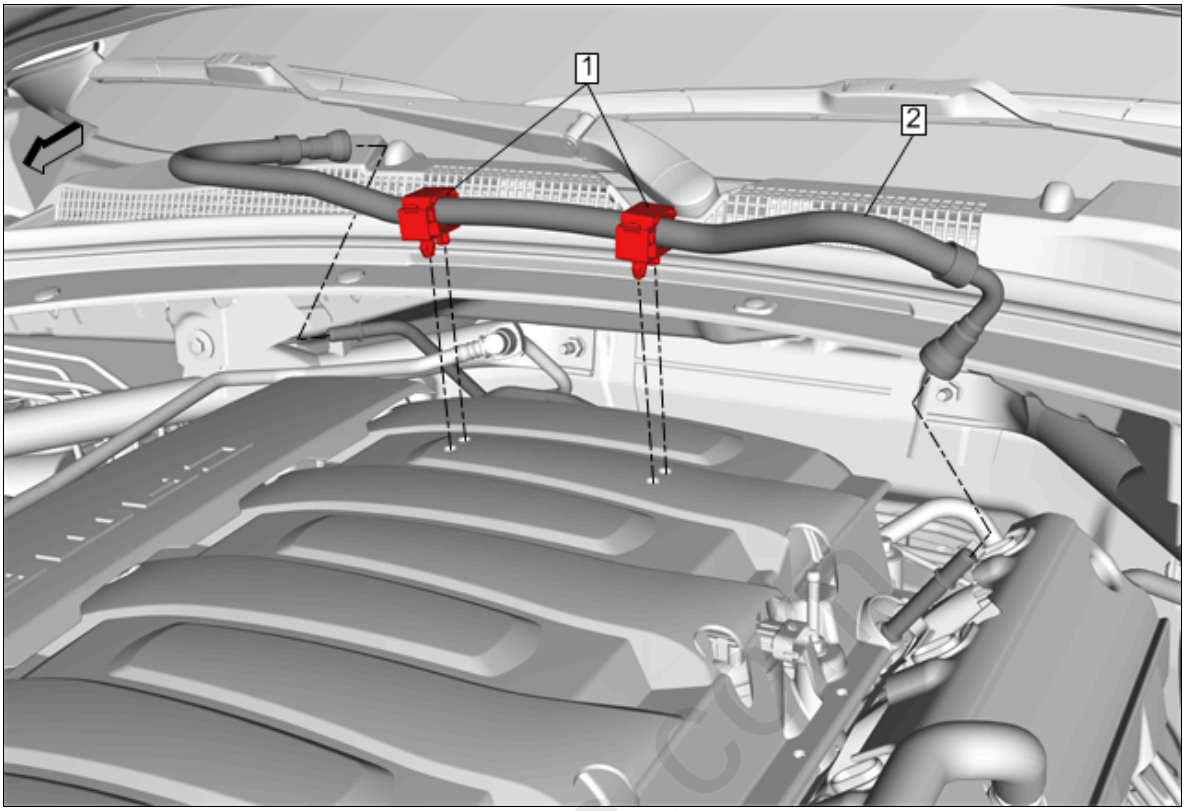


Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Radiator Inlet Hose (2) at Engine Coolant Thermostat Housing.
8. Remove Radiator Outlet Hose-Radiator Outlet Hose Replacement (LT1 V18 V03)

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Fig 3: Fuel Feed Front Hose

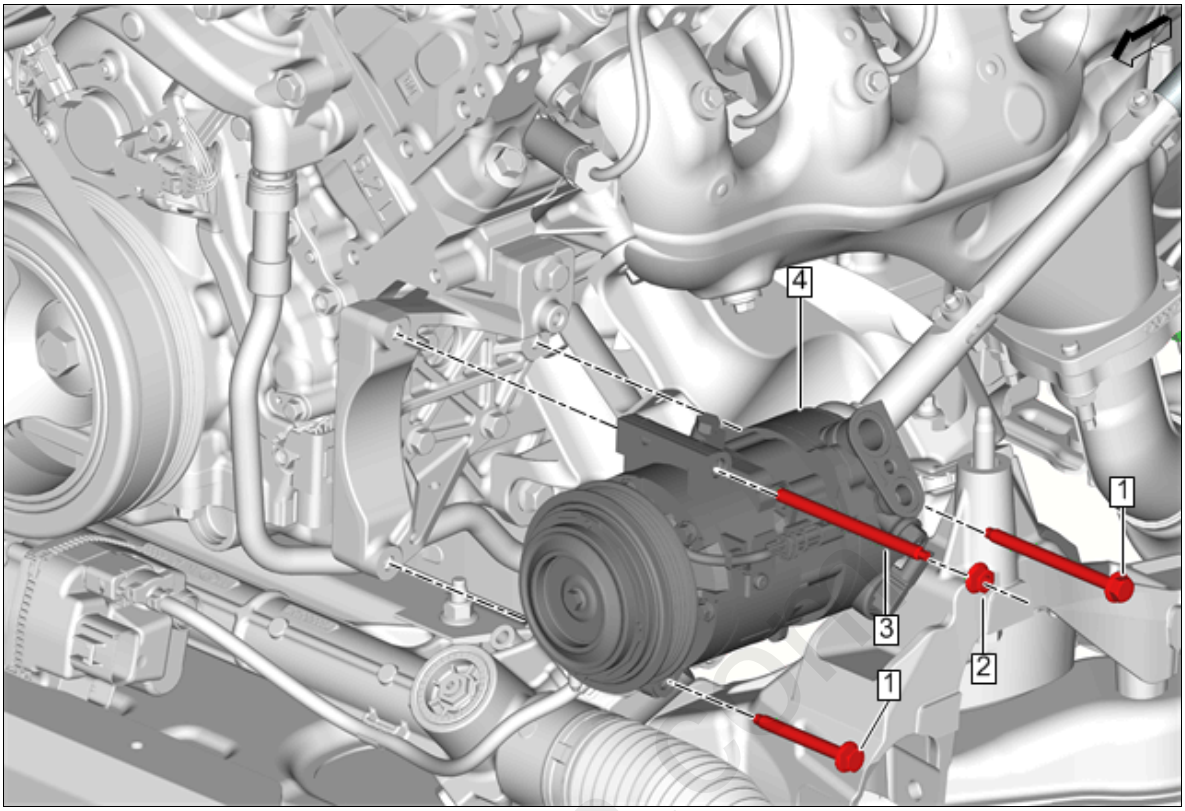


Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Fuel Feed Hose (2) at Fuel Feed Pipe-Fuel Feed Front Hose Replacement

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Fig 4: Air Conditioning Compressor

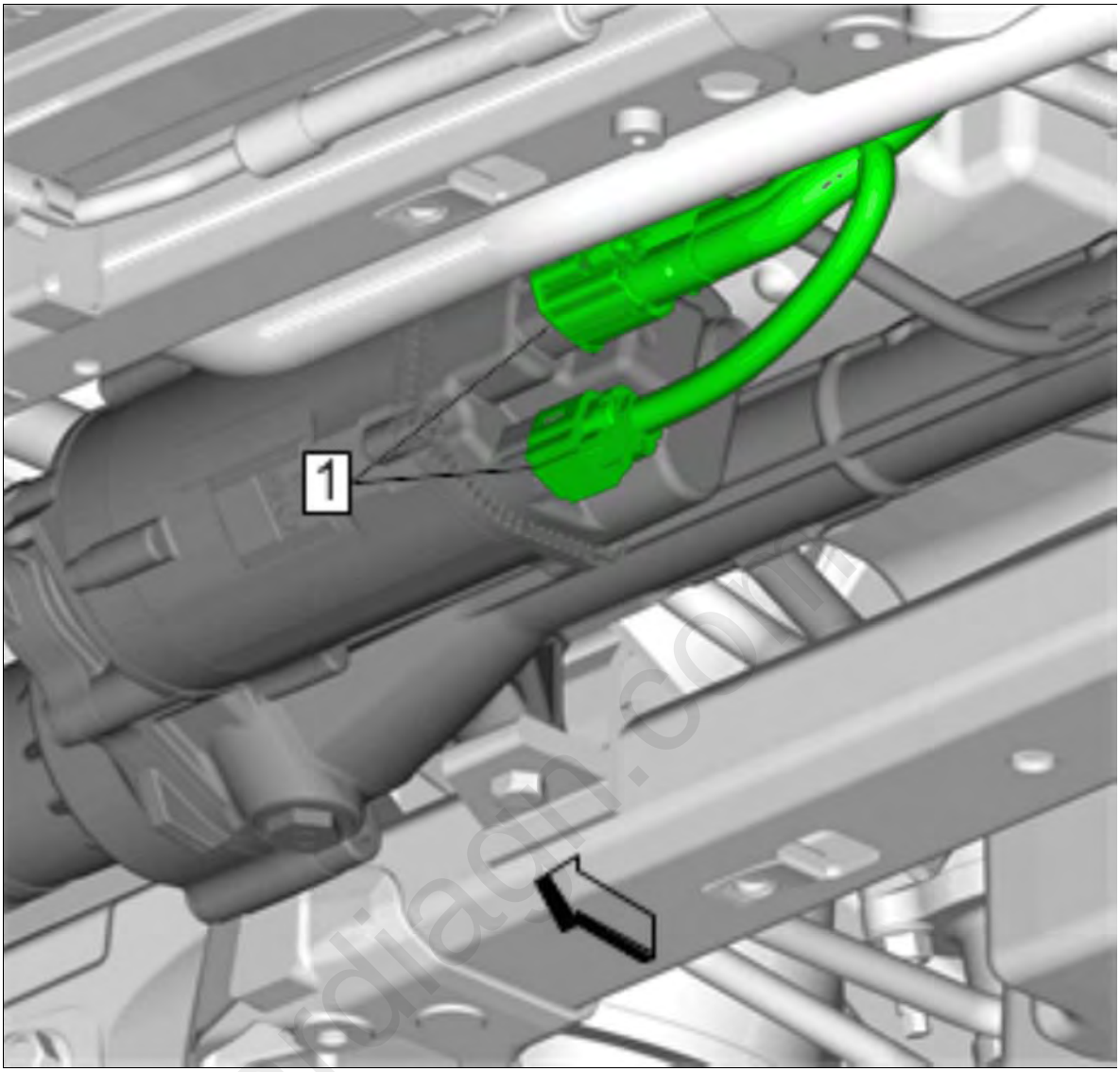


Courtesy of GENERAL MOTORS COMPANY

10. Remove Air Conditioning Compressor (4)-Air Conditioning Compressor Replacement (LT1)
11. Remove the front tires and wheels. Tire and Wheel Removal and Installation
12. Drain the engine oil into a suitable container. Engine Oil and Oil Filter Replacement
13. Remove Front Cradle Shear Plate-Front Cradle Shear Plate Replacement
14. Disconnect the intermediate steering shaft from the steering gear. Intermediate Steering Shaft Replacement

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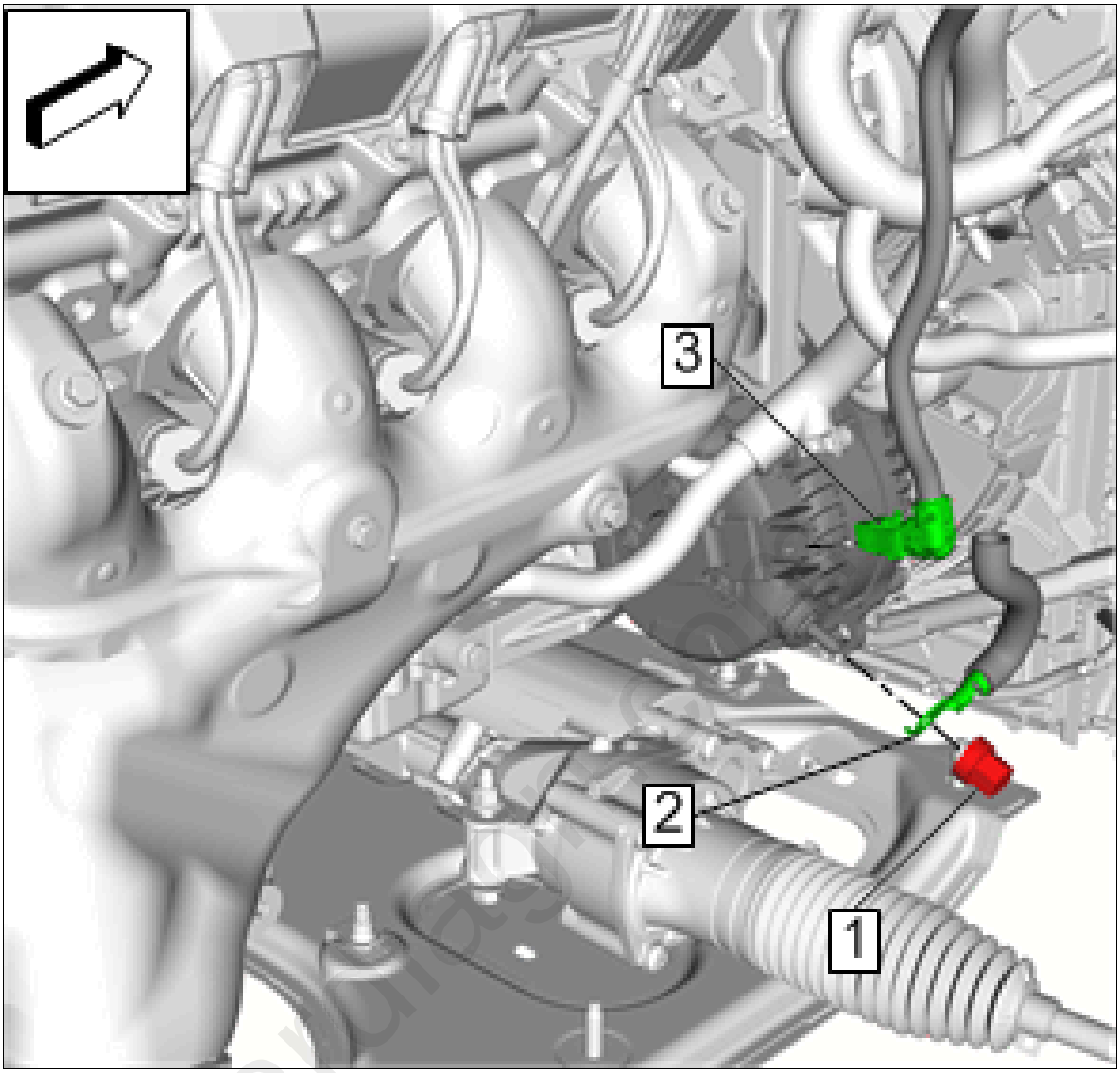
Fig 5: Steering Gear Electrical Connectors



Courtesy of GENERAL MOTORS COMPANY

15. Disconnect Electrical Connector (1) at Steering Gear.
16. Remove Exhaust Muffler-Exhaust Muffler Replacement (LT1, Coupe)Exhaust Muffler Replacement (LT1, Convertible)
17. Remove Transmission-Transmission Replacement (M5U with LT1 Engine)

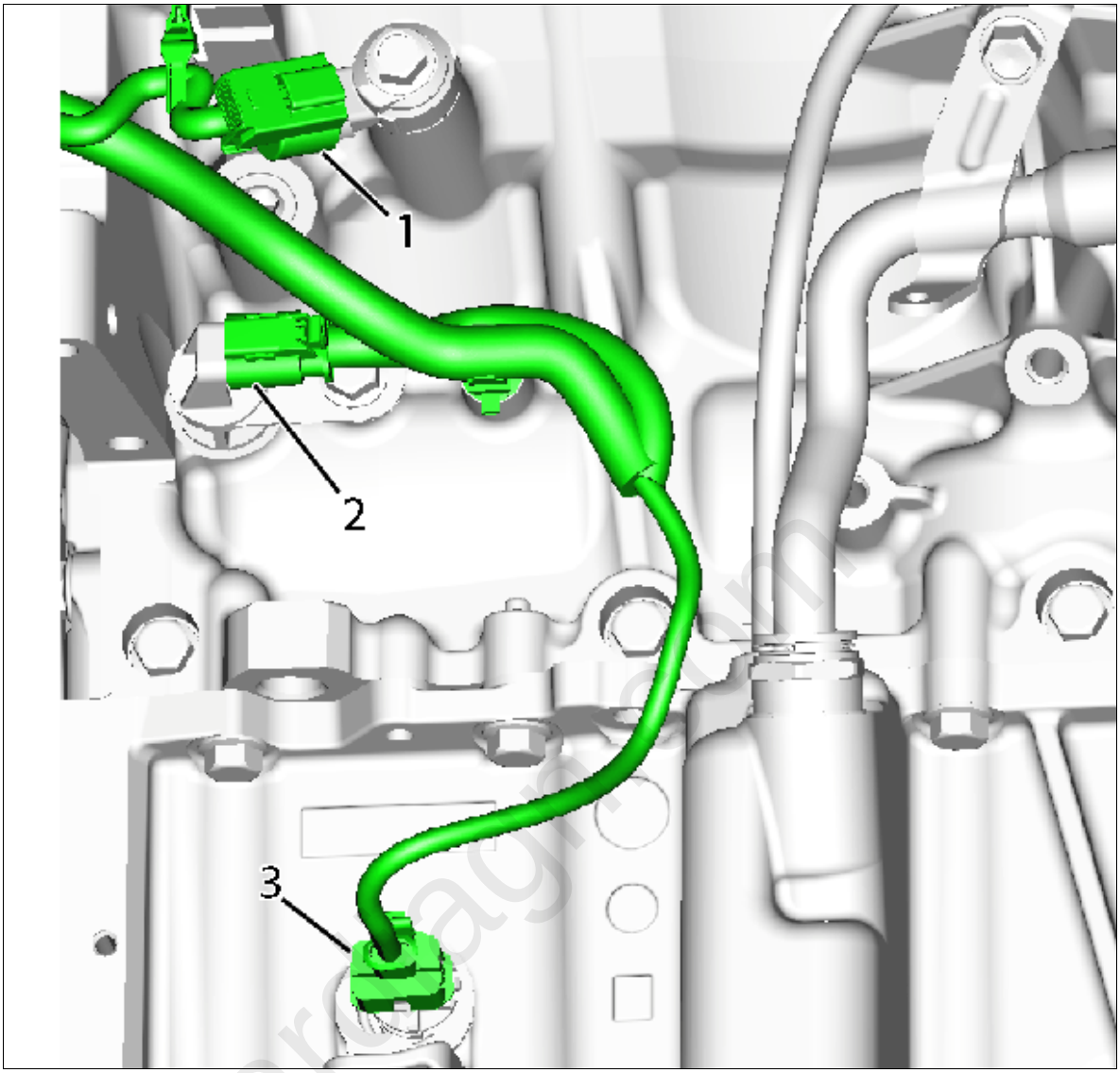
Fig 6: Starter Solenoid Cable



Courtesy of GENERAL MOTORS COMPANY

18. Remove Generator Fastener (1)
19. Remove Starter Solenoid Cable (2)
20. Remove Electrical Connector (3)

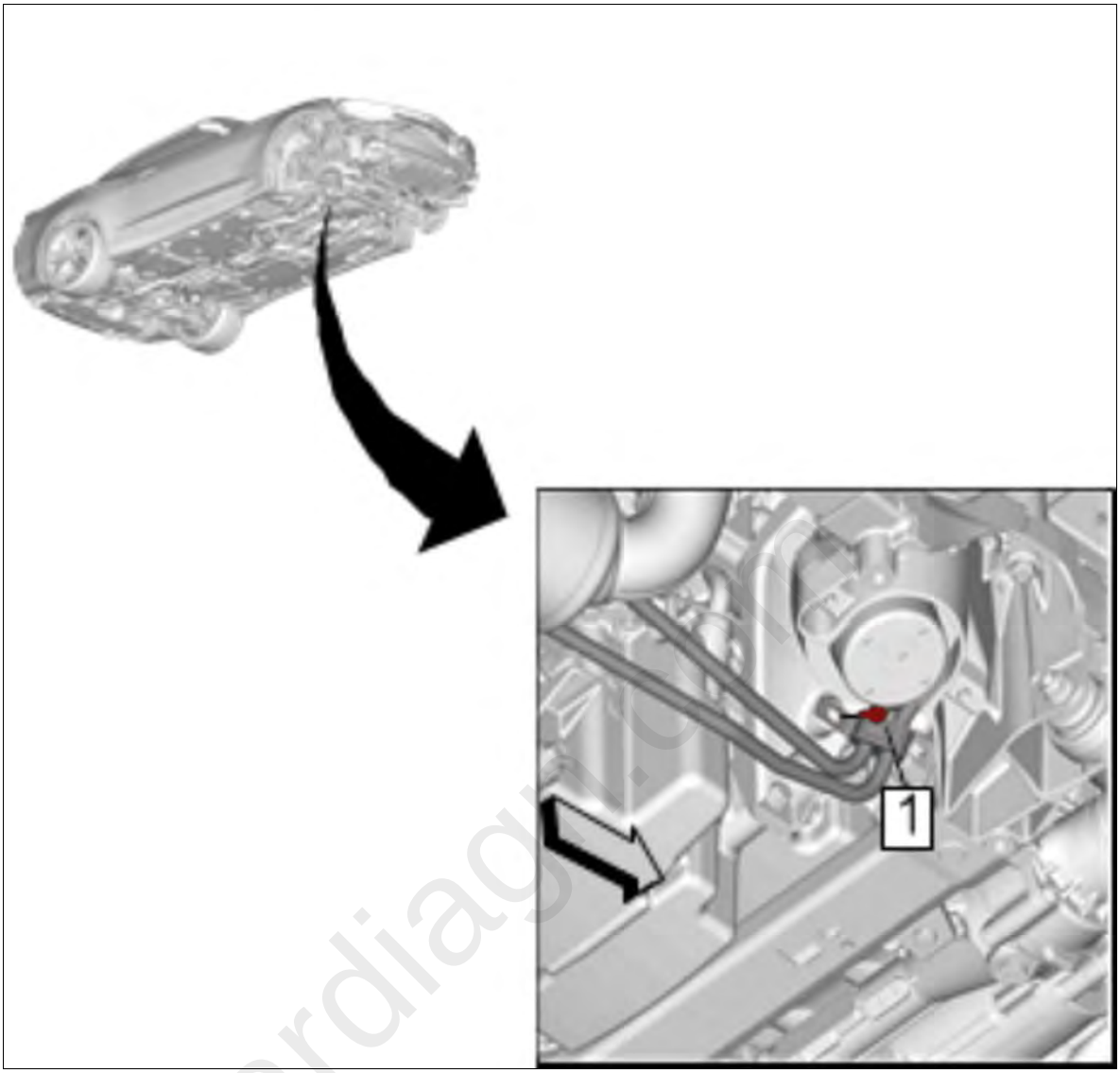
Fig 7: Knock Sensor



Courtesy of GENERAL MOTORS COMPANY

21. Disconnect Knock Sensor (1)
22. Disconnect Crankshaft Position Sensor (2)
23. Disconnect Oil Level Sensor (3)
24. Disconnect Stabilizer Shaft Link at Lower Control Arm-Stabilizer Shaft Link Replacement (LT1)
25. Disconnect Steering Linkage Outer Tie Rod at Steering Knuckle (Qty: 2)-Steering Linkage Outer Tie Rod Replacement
26. Separate the steering knuckle from the lower ball joint (Qty: 2)-Front Lower Control Front Link Replacement (LT1, Without V18)Front Lower Control Front Link Replacement (LT1, With V18)

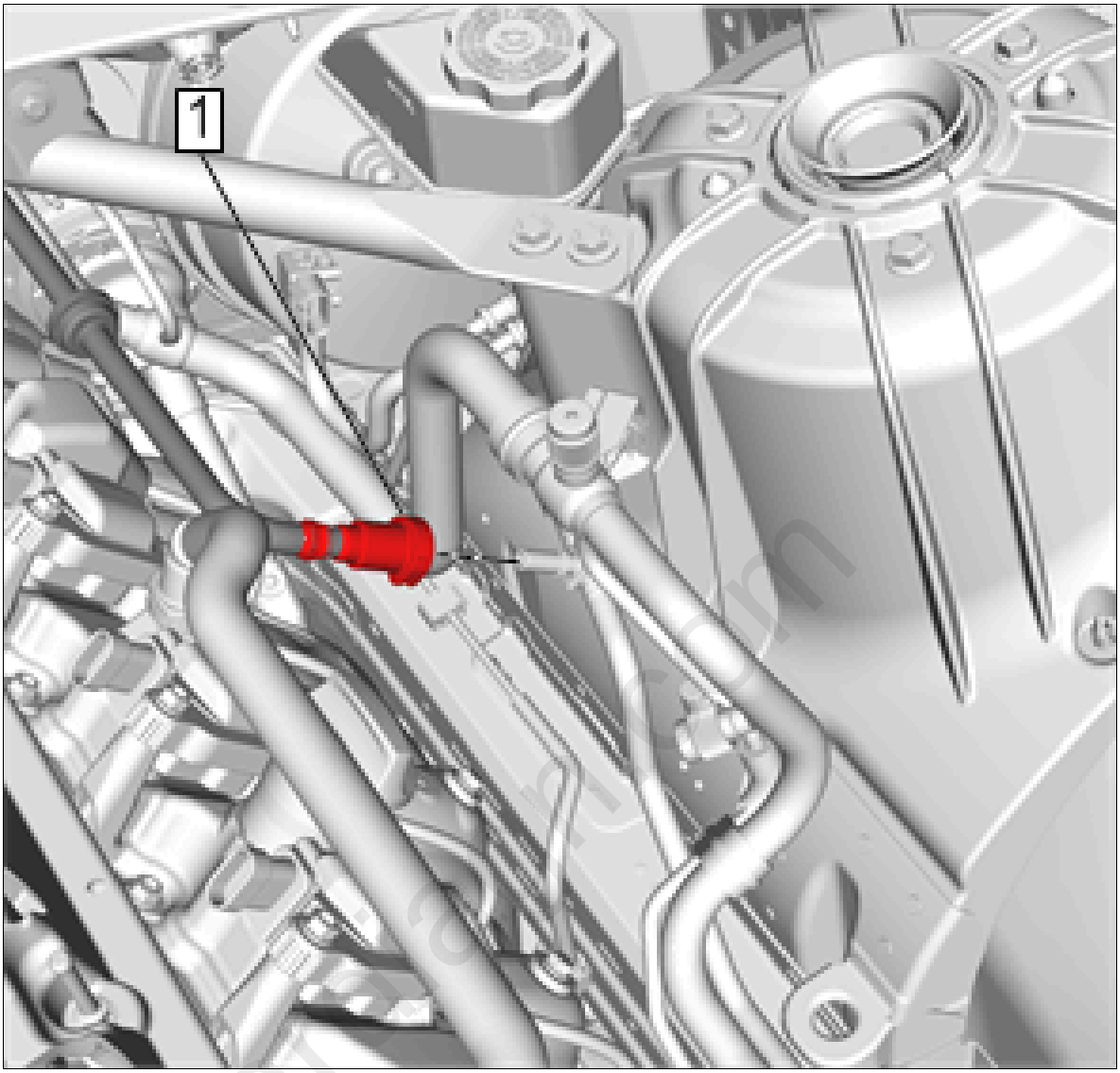
Fig 8: Transmission Fluid Cooler Pipe Clip Bolt At Engine Mount - Right Side



Courtesy of GENERAL MOTORS COMPANY

27. Remove Transmission Fluid Cooler Pipe Clip Bolt (1) at Engine Mount - Right Side

Fig 9: Power Brake Booster Inlet Pipe Quick Connect At Vacuum Pipe



Courtesy of GENERAL MOTORS COMPANY

28. Disconnect Power Brake Booster Inlet Pipe Quick Connect (1) at Vacuum Pipe.
29. Disconnect electrical connectors and detach harness retainers as necessary.
30. Position harness as needed
31. Remove the ground strap bolts at the rear of the cylinder heads.
32. Remove the ground straps from the rear cylinder heads.
33. Support the engine on the **J 39580** engine support table and the **J 39580-500** engine support table top.
34. Remove the front and rear cradle fasteners. Drivetrain and Front Suspension Cradle Replacement (LT1)
35. Disconnect the electrical connector for the knock sensor, left side.

36. Remove the engine harness retaining fasteners at the rear of the engine.

> *NOTE:*
>
> *Visually inspect the wiring harness clearances while raising the vehicle.*

37. Raise the vehicle completely off of the engine and cradle.
38. Install the **J-41803-9** engine lift hooks to the engine.
39. Remove the engine mount nuts.
40. Using a engine hoist and the **J-41803-9** engine lift hooks slowly raise the engine.
41. Remove the engine from the cradle.
42. Install the engine onto an engine stand and prepare for disassembly.
43. Remove the engine hoist.
44. Remove the **J-41803-9** engine lift hooks from the engine.

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE REPLACEMENT (AUTOMATIC TRANSMISSION) > INSTALLATION PROCEDURE

1. Prepare the engine for installation.
2. If replacing the engine, transfer components as necessary.
3. Install the **J-41803-9** engine lift hooks to the engine.
4. Using an engine hoist and the **J-41803-9** engine lift hooks raise the engine slightly.
5. Remove the engine from the engine stand.
6. Using an engine hoist and the **J-41803-9** engine lift hooks lower the engine onto the cradle.

> *CAUTION:*
>
> *Refer to Fastener Caution .*

7. Install the engine mount nuts and tighten to 65 N.m (48 lb ft).
8. Remove the **J 41798** engine lifting brackets from the engine.
9. Position the engine and cradle beneath the vehicle.
10. Partially lower the vehicle onto the engine and cradle.
11. Route the ground harness and install retaining fasteners at the left and right rear cylinder

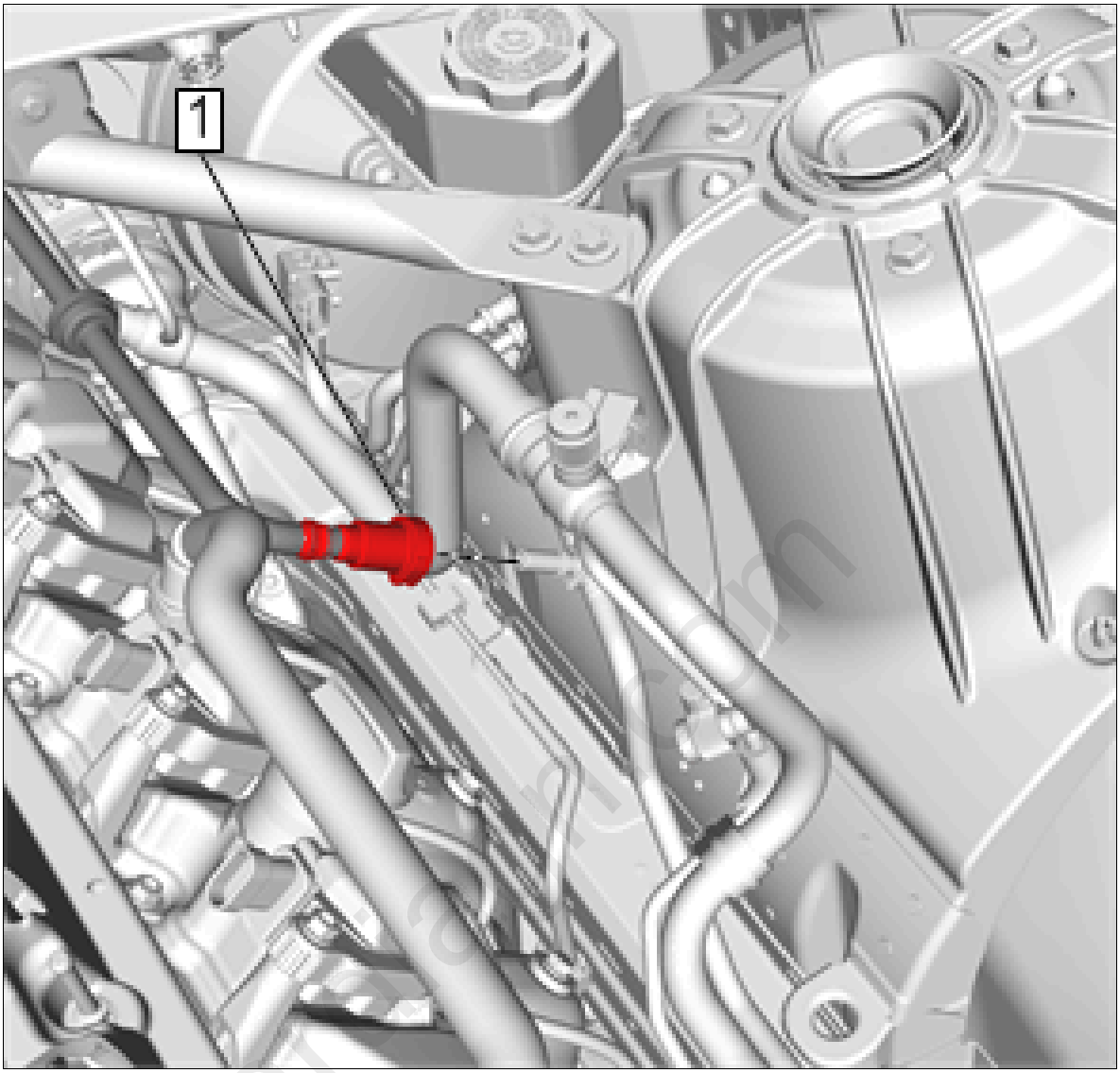
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heads. Tighten the fasteners to 10 N.m (89 lb in).

12. Route the engine harness and install retaining fasteners at the rear of the engine. Tighten the fasteners to 10 N.m (89 lb in).
13. Install the ground straps and ground strap bolts to the rear of cylinder heads. Tighten the ground strap bolts to 32 N.m (24 lb ft).
14. Reconnect the electrical connector for the knock sensor, left side.
15. Reconnect the electrical connector for the knock sensor, right side.
16. Lower the vehicle onto the cradle and align the dowels.
17. Install the front and rear cradle fasteners. Drivetrain and Front Suspension Cradle Replacement (LT1)
18. Remove the **J 39580** engine support table and the **J 39580-500** engine support table top.
19. Position harness as needed
20. Attach harness retainers and connect electrical connectors as necessary.

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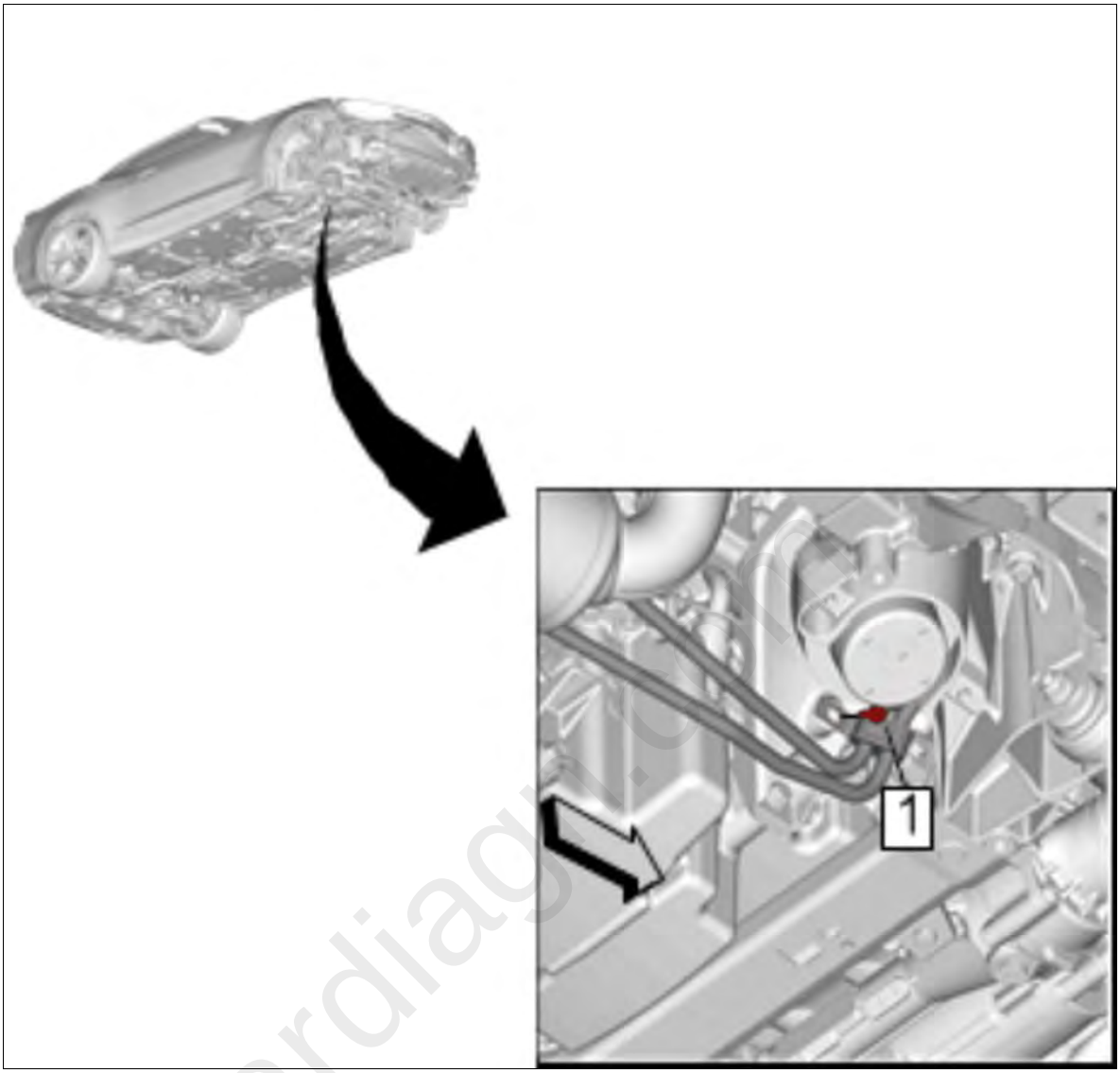
Fig 1: Power Brake Booster Inlet Pipe Quick Connect At Vacuum Pipe



Courtesy of GENERAL MOTORS COMPANY

21. Connect Power Brake Booster Inlet Pipe Quick Connect (1) at Vacuum Pipe.

Fig 2: Transmission Fluid Cooler Pipe Clip Bolt At Engine Mount - Right Side



Courtesy of GENERAL MOTORS COMPANY

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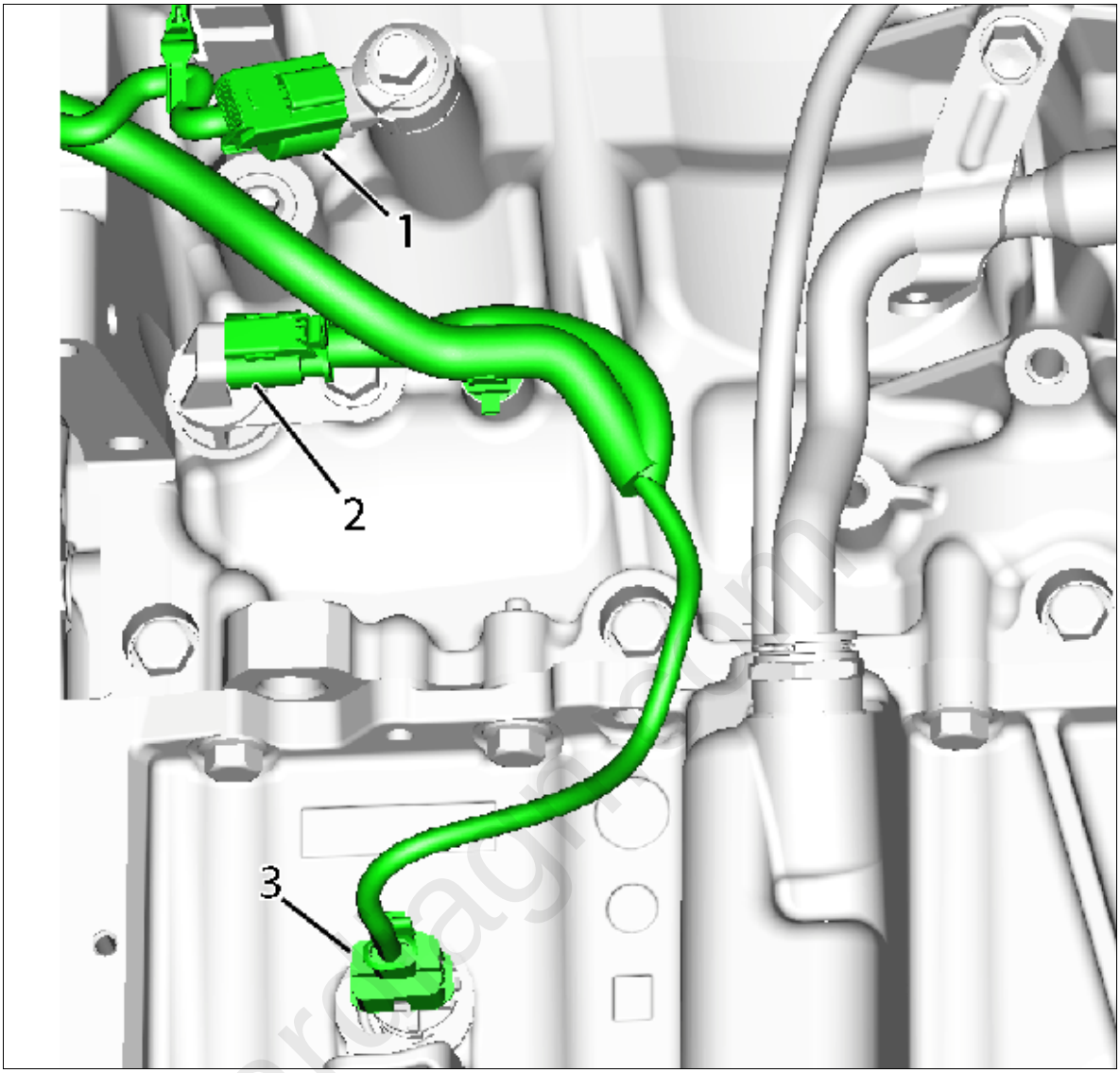
22. Install Transmission Fluid Cooler Pipe Clip Bolt (1) at Engine Mount - Right Side and tighten-Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LT1 With MM6, With KNR)Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LT1 With M5U, With KNR)Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LT1 With M5U, Without KNR)Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LT1 With MM6, Without KNR)

23. Install the lower ball joint in the steering knuckle (Qty: 2)-Front Lower Control Front Link Replacement (LT1, Without V18)Front Lower Control Front Link Replacement (LT1, With V18)

24. Connect Steering Linkage Outer Tie Rod at Steering Knuckle (Qty: 2)-Steering Linkage Outer Tie Rod Replacement

25. Connect Stabilizer Shaft Link at Lower Control Arm-Stabilizer Shaft Link Replacement (LT1)

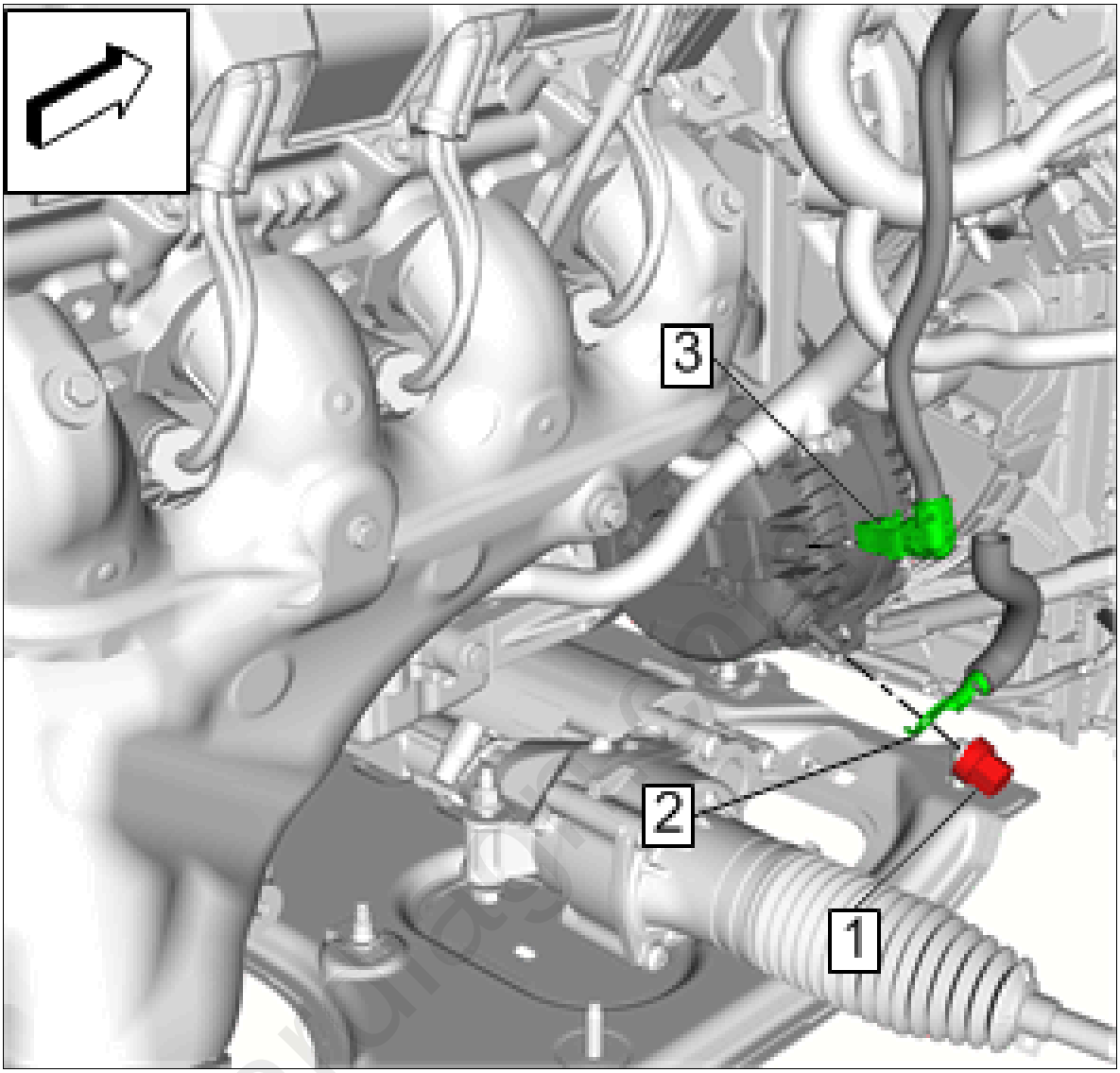
Fig 3: Knock Sensor



Courtesy of GENERAL MOTORS COMPANY

26. Connect Oil Level Sensor (3)
27. Connect Crankshaft Position Sensor (2)
28. Connect Knock Sensor (1)

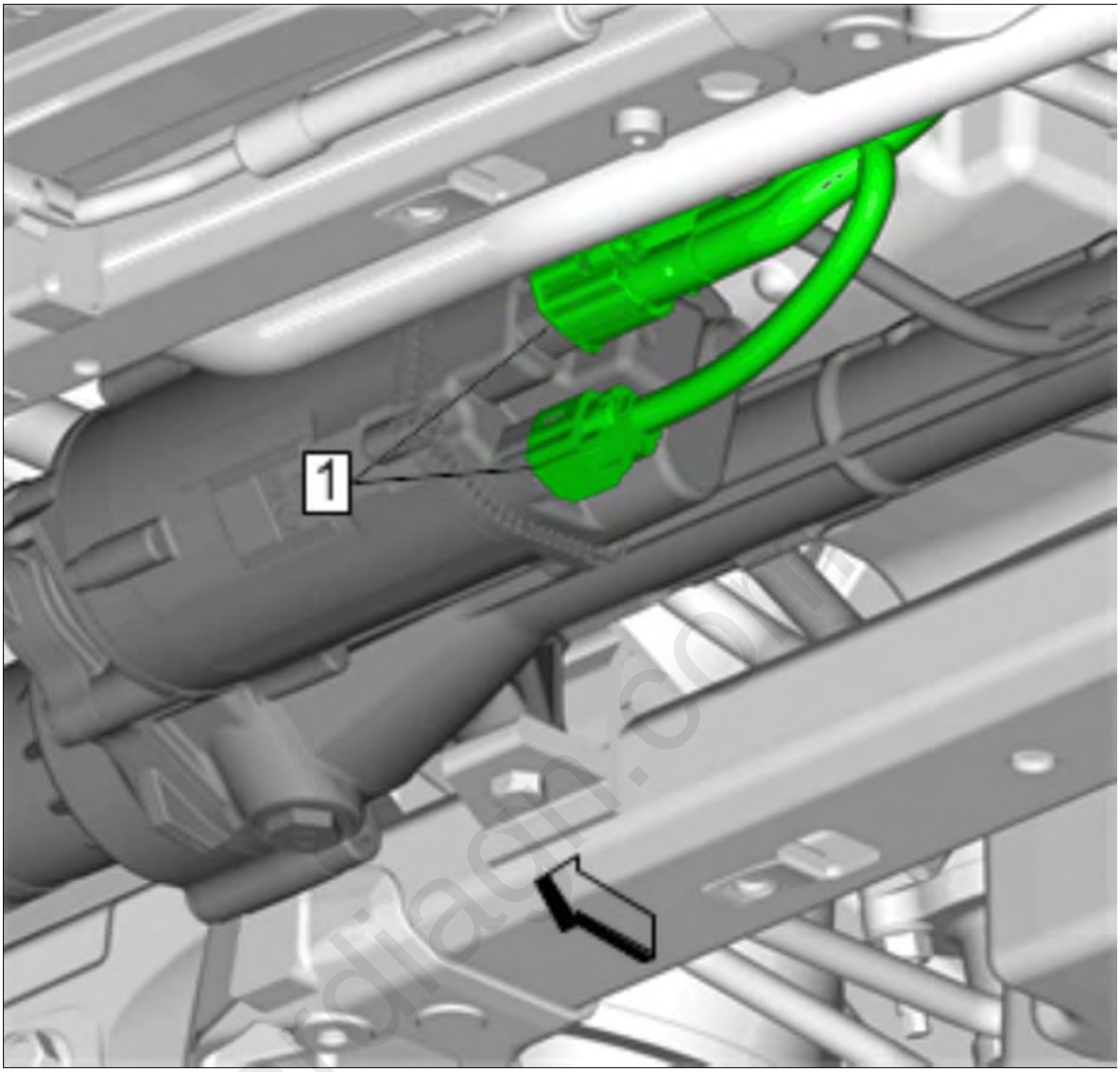
Fig 4: Starter Solenoid Cable



Courtesy of GENERAL MOTORS COMPANY

29. Install Starter Solenoid Cable (2)
30. Install Generator Fastener (1) and tighten-Generator Replacement (LT1)
31. Install Electrical Connector (3)
32. Install Transmission-Transmission Replacement (M5U with LT1 Engine)
33. Install Exhaust Muffler-Exhaust Muffler Replacement (LT1, Coupe)Exhaust Muffler Replacement (LT1, Convertible)

Fig 5: Steering Gear Electrical Connectors

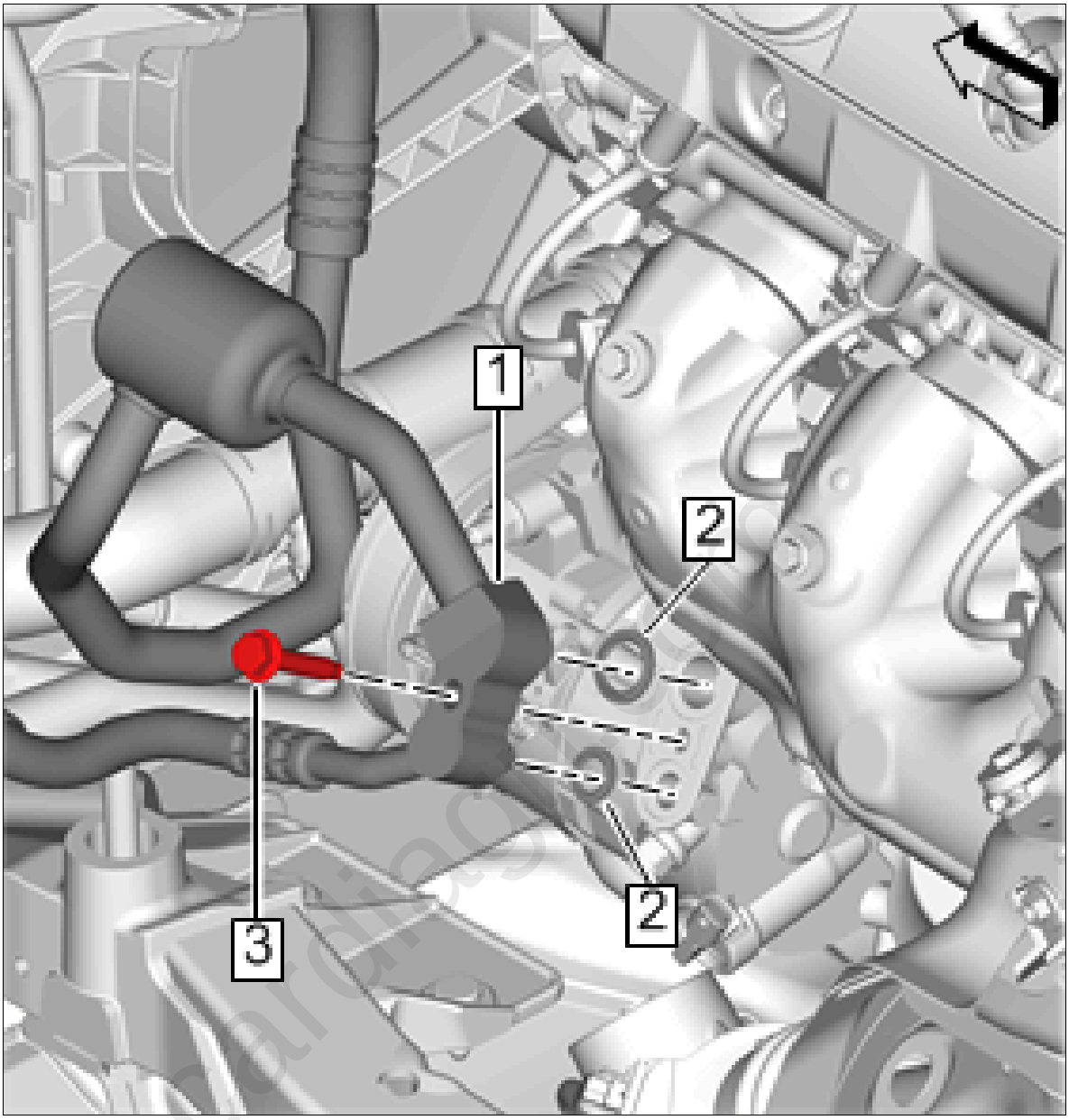


Courtesy of GENERAL MOTORS COMPANY

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34. Connect Electrical Connector at Steering Gear (Qty: 2)
35. Connect the intermediate steering shaft to the steering gear. Intermediate Steering Shaft Replacement
36. Install the front tires and wheels. Tire and Wheel Removal and Installation
37. Install Front Cradle Shear Plate-Front Cradle Shear Plate Replacement
38. Lower the vehicle.

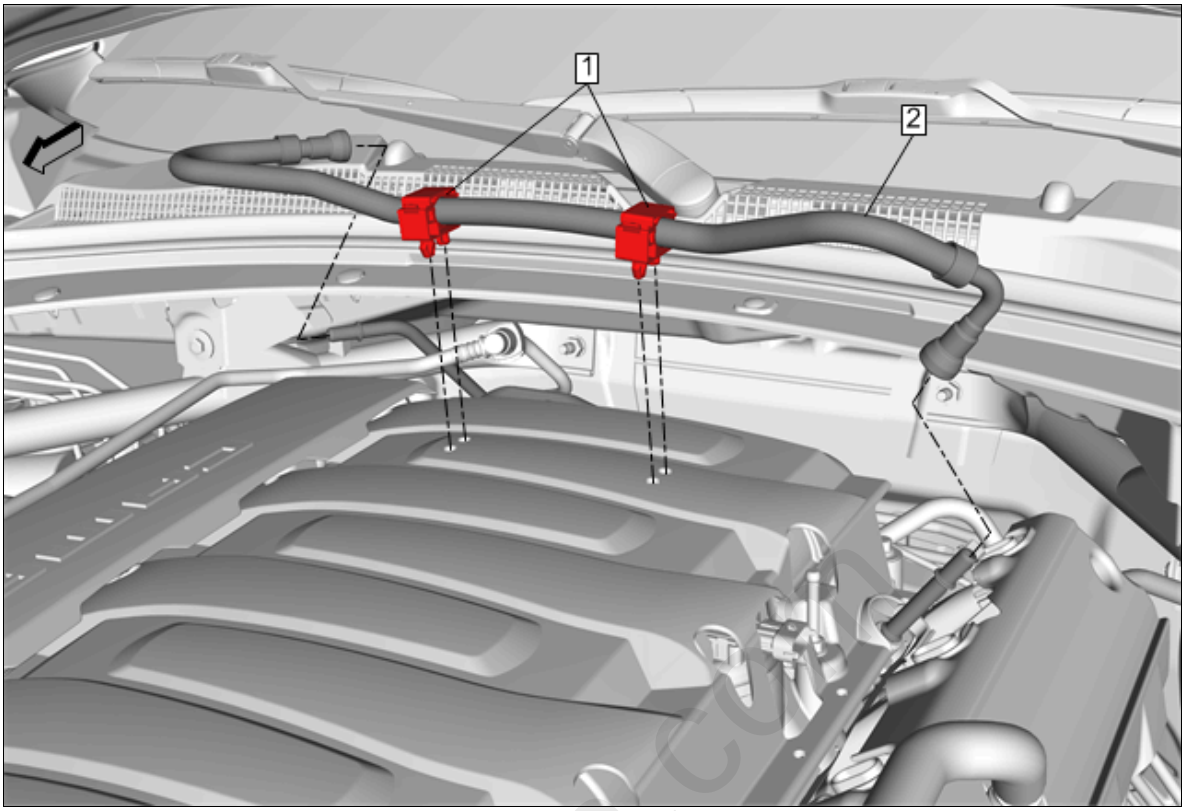
Fig 6: Air Conditioning Compressor Hose Bolt



Courtesy of GENERAL MOTORS COMPANY

39. Connect Air Conditioning Compressor Hose-Air Conditioning Compressor Replacement (LT1)

Fig 7: Fuel Feed Front Hose

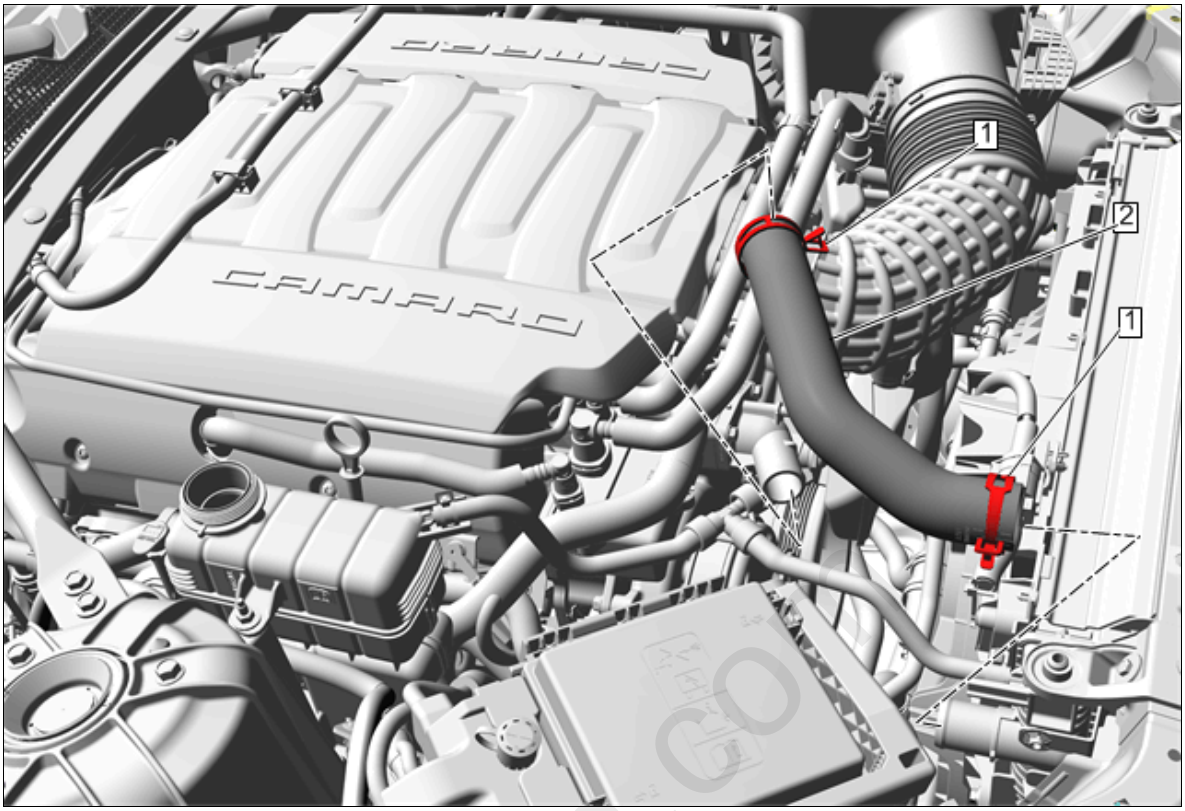


Courtesy of GENERAL MOTORS COMPANY

40. Connect Fuel Feed Hose (2) at Fuel Feed Pipe-Fuel Feed Front Hose Replacement
41. Install Radiator Outlet Hose-Radiator Outlet Hose Replacement (LT1 V18 V03)

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Fig 8: Radiator Inlet Hose

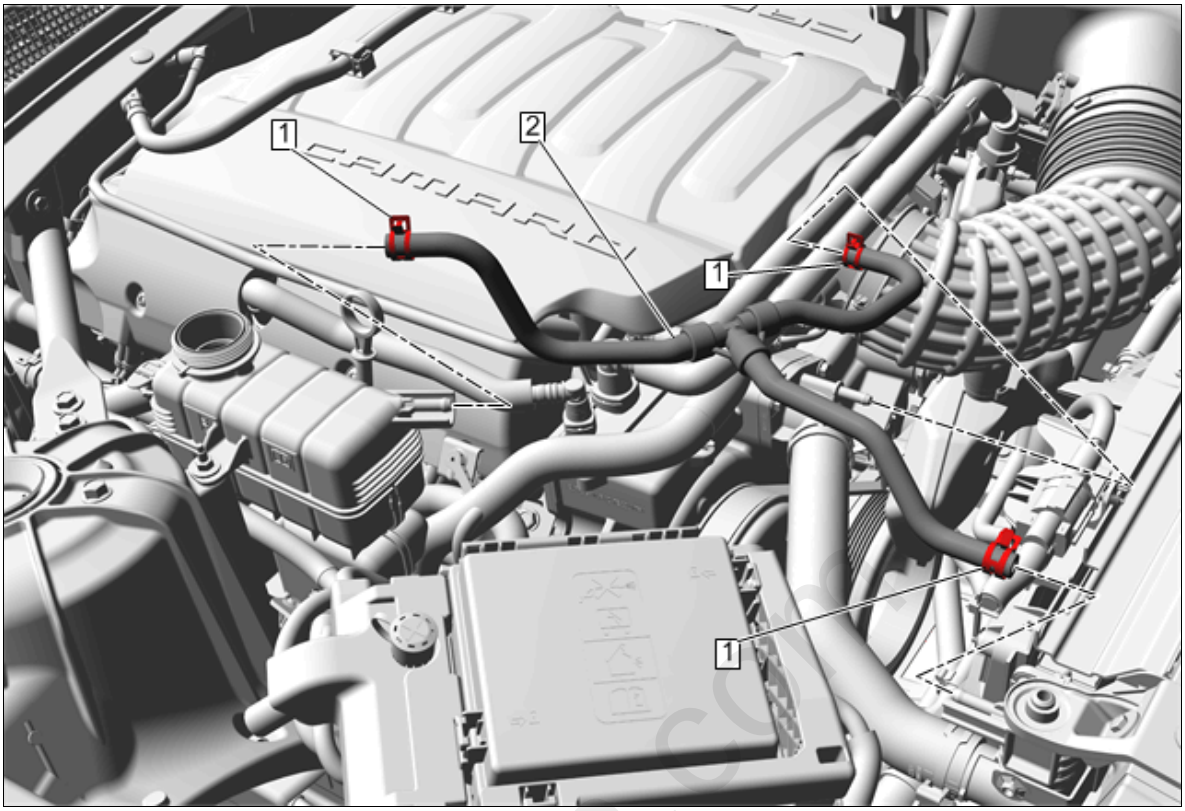


Courtesy of GENERAL MOTORS COMPANY

42. Connect Radiator Inlet Hose (2) at Engine Coolant Thermostat Housing.

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Fig 9: Radiator Surge Tank Inlet Hose



Courtesy of GENERAL MOTORS COMPANY

43. Connect Radiator Surge Tank Inlet Hose (2) at Engine Coolant Thermostat Housing.
44. Recharge the A/C system. Refrigerant Recovery and Recharging (R-134a)Refrigerant Recovery and Recharging (R-1234yf)

> *NOTE:*
>
> *Prelube is necessary if the engine is replaced or overhauled.*

45. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Engine Prelubing
46. Fill the crankcase with the proper quantity and grade of engine oil. Approximate Fluid Capacities , and Fluid and Lubricant Recommendations
47. Disable the ignition system.
48. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
49. Enable the ignition system.
50. Start the engine and listen for unusual noises.
51. Check the vehicle oil pressure gauge and confirm that the engine has acceptable oil pressure.

If necessary, install an oil pressure gauge and measure the engine oil pressure.

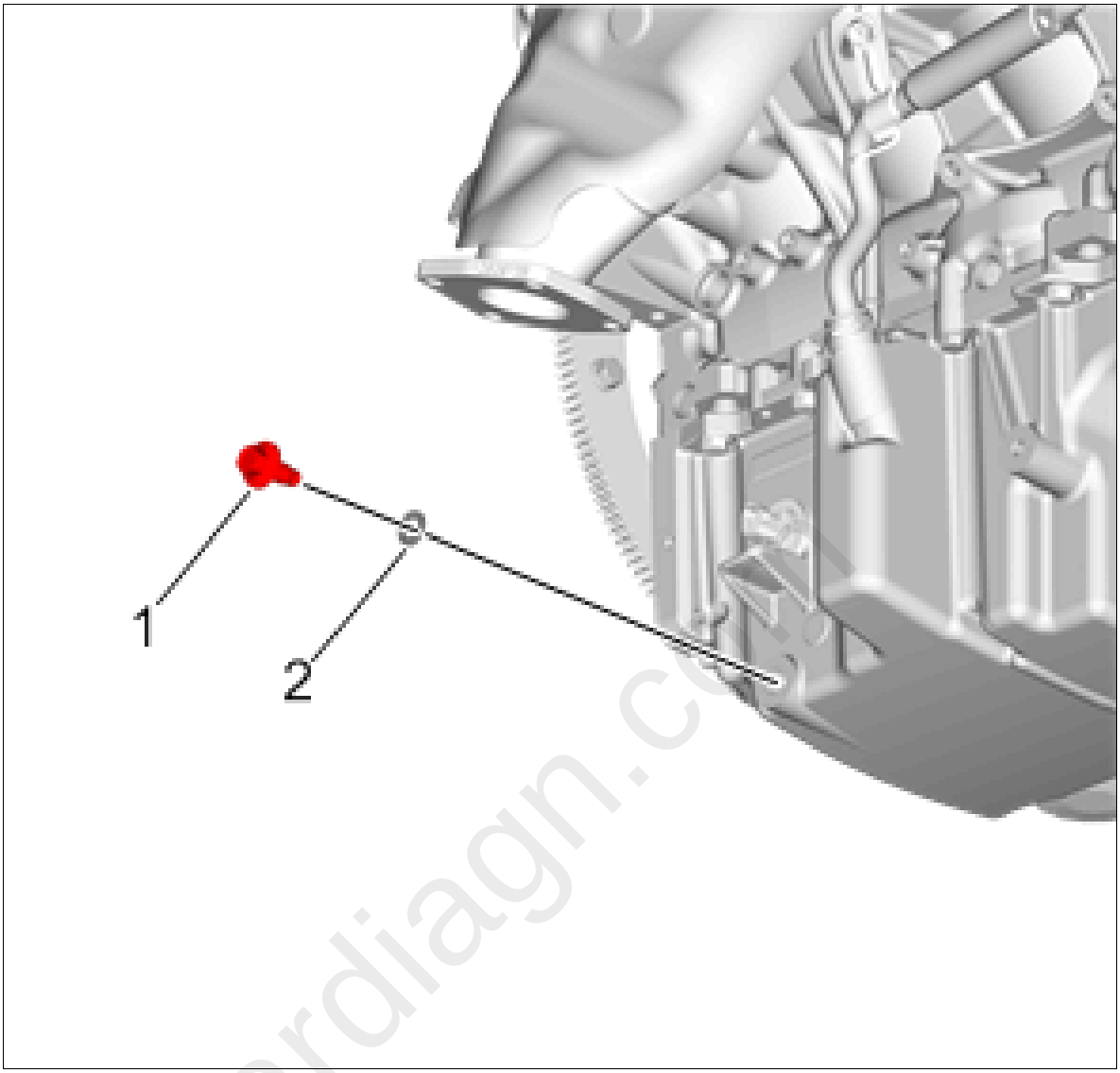
52. Start the engine and run the engine speed at about 1, 000 RPM until the engine has reached normal operating temperature.
53. Listen for sticking lifters and other unusual noises.
54. Inspect for fuel, oil, and/or other coolant leaks while the engine is running.
55. Perform a final inspection for the proper engine oil and coolant levels.
56. Align the vehicle. Wheel Alignment Measurement

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE OIL AND OIL FILTER REPLACEMENT > REMOVAL PROCEDURE

1. Open the hood.
2. Remove the oil fill cap.
3. Raise and support the vehicle. Lifting and Jacking the Vehicle (Base)Lifting and Jacking the Vehicle (HP) .

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Fig 1: Oil Pan Drain Plug

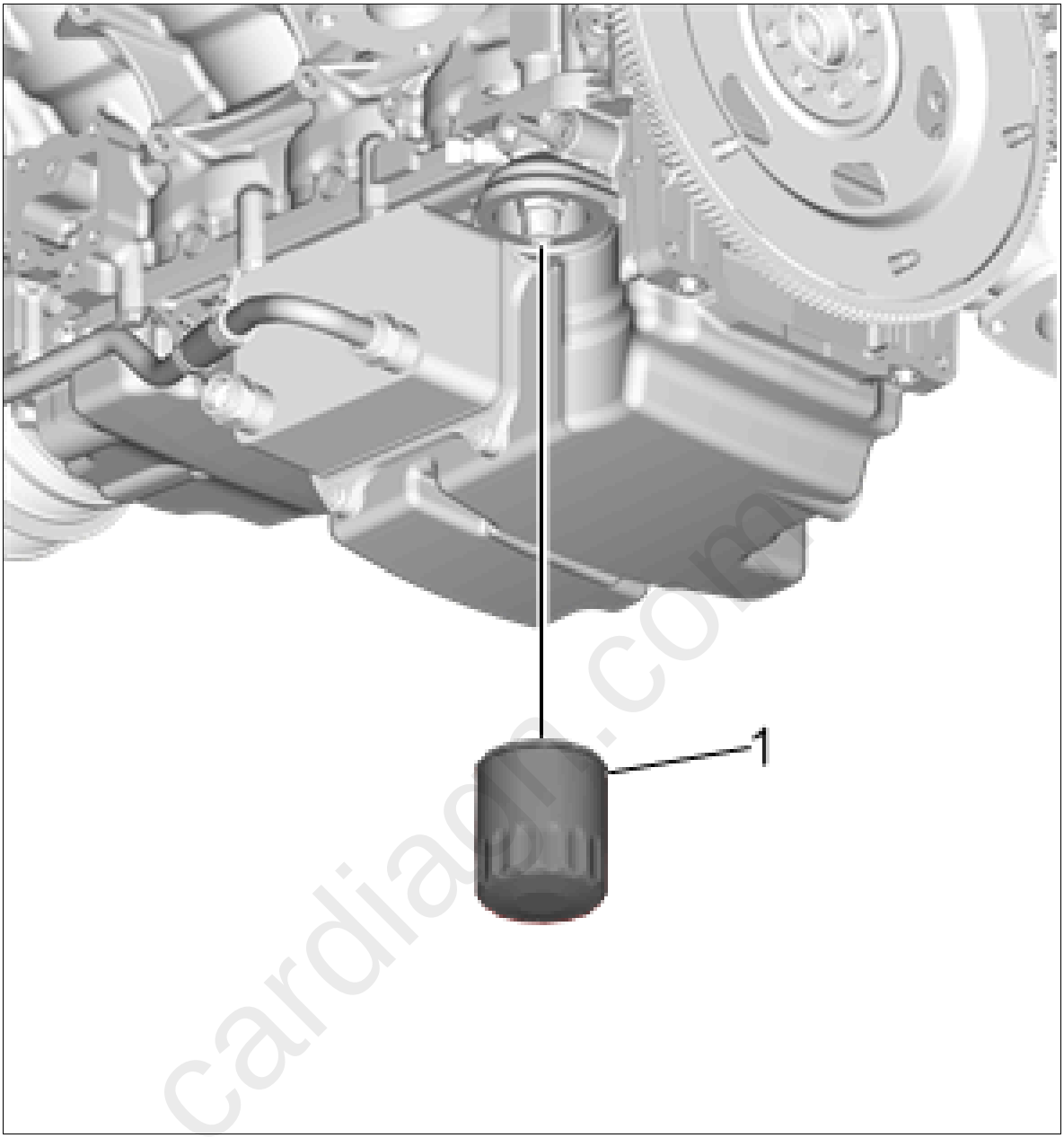


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4. Remove the oil pan drain plug (1) with O-ring (2).
5. Drain the engine oil into an appropriate container.

Fig 2: Engine Oil Filter

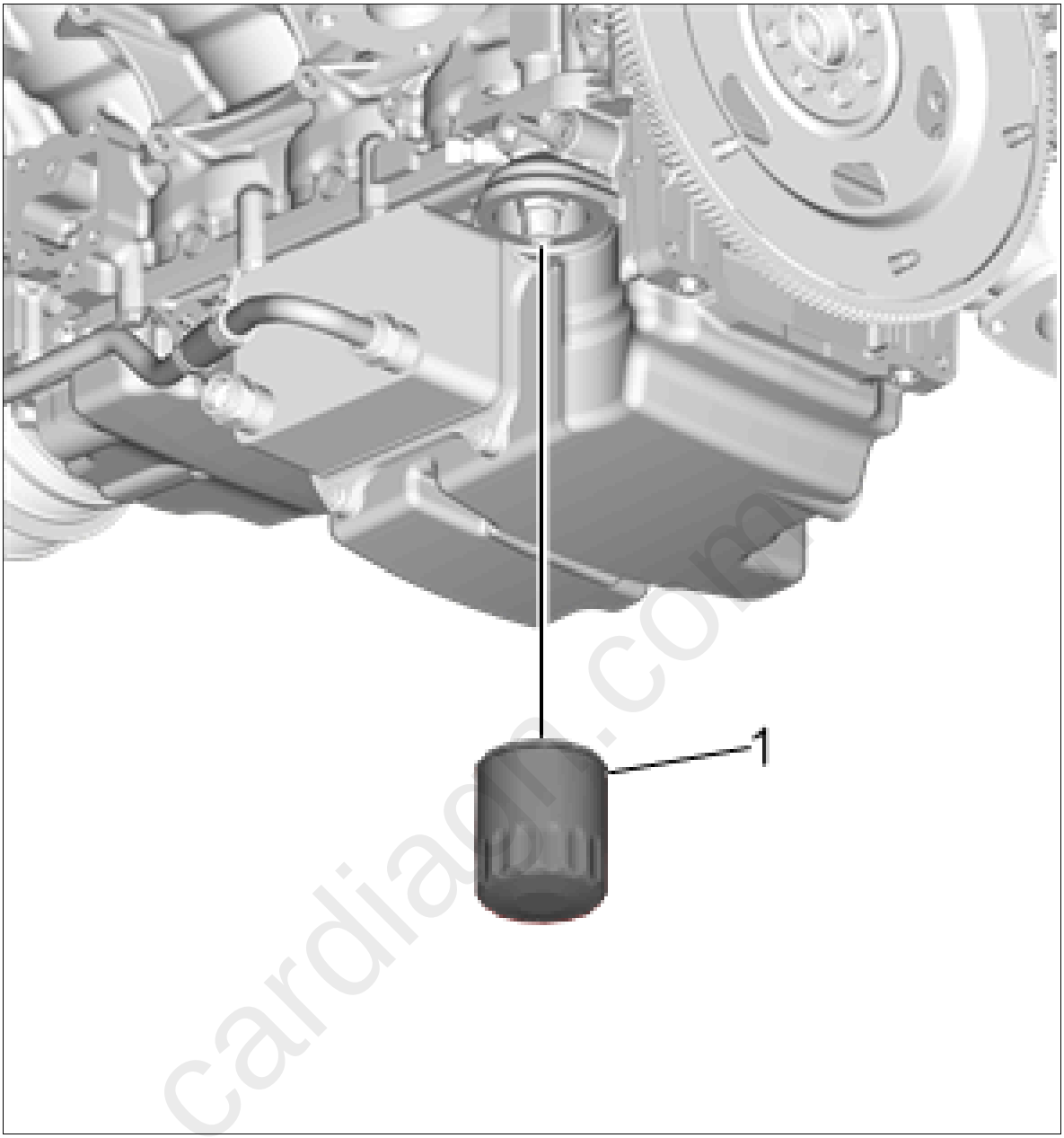


Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine oil filter (1) from the engine block.

REPAIR INSTRUCTIONS - ON VEHICLE > ENGINE OIL AND OIL FILTER REPLACEMENT > INSTALLATION PROCEDURE

Fig 1: Engine Oil Filter



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Before installing the new oil filter, ensure that the old oil filter seal has been removed. If not, remove the old seal.

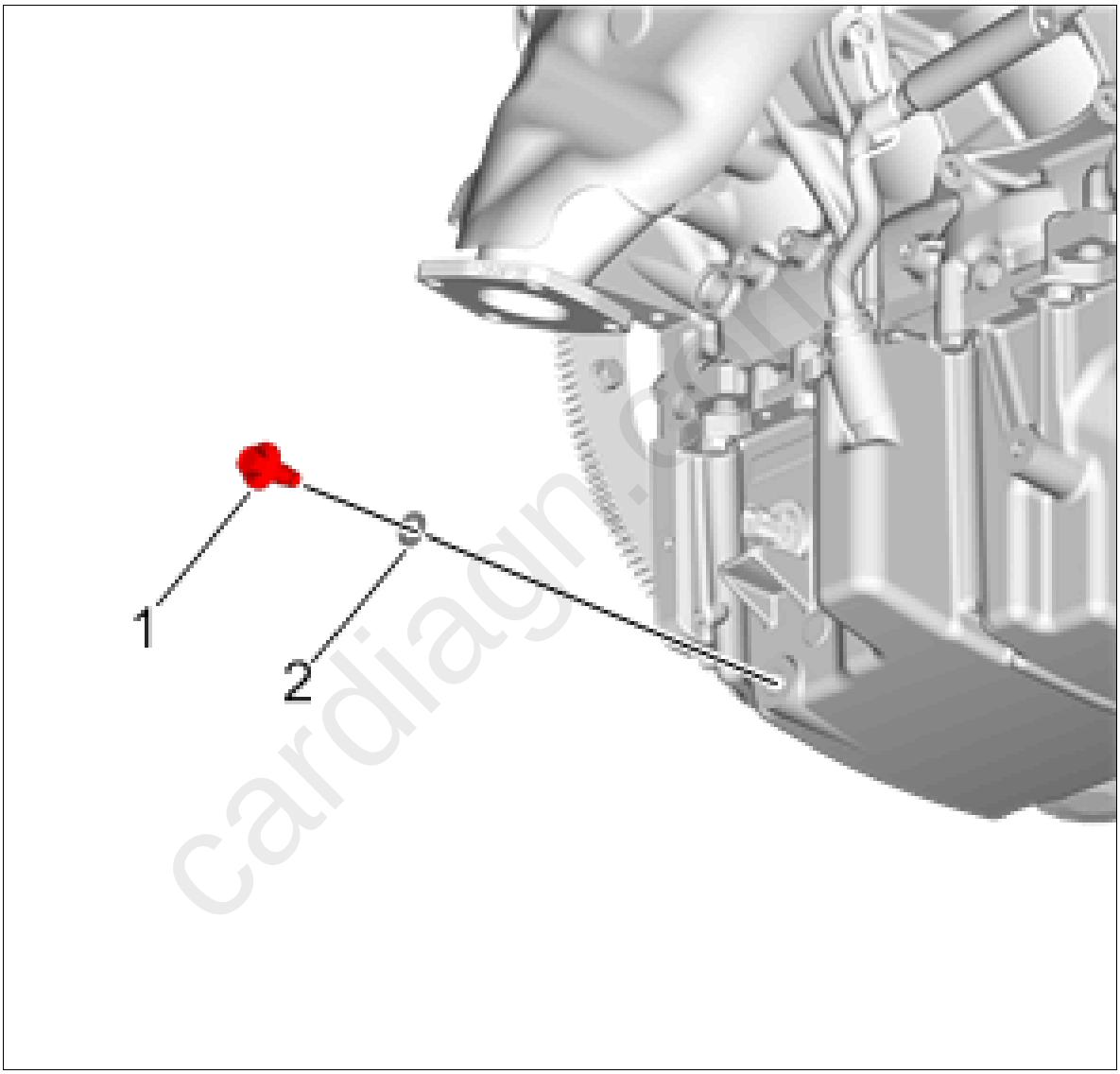
1. Lubricate the oil filter seal with clean engine oil.

CAUTION:

Refer to Component Fastener Tightening Caution .

2. Install the oil filter (1) to the engine block and tighten the engine oil filter to 3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange.

Fig 2: Oil Pan Drain Plug



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Clean and inspect the oil pan drain plug seal (2), replace parts as necessary.

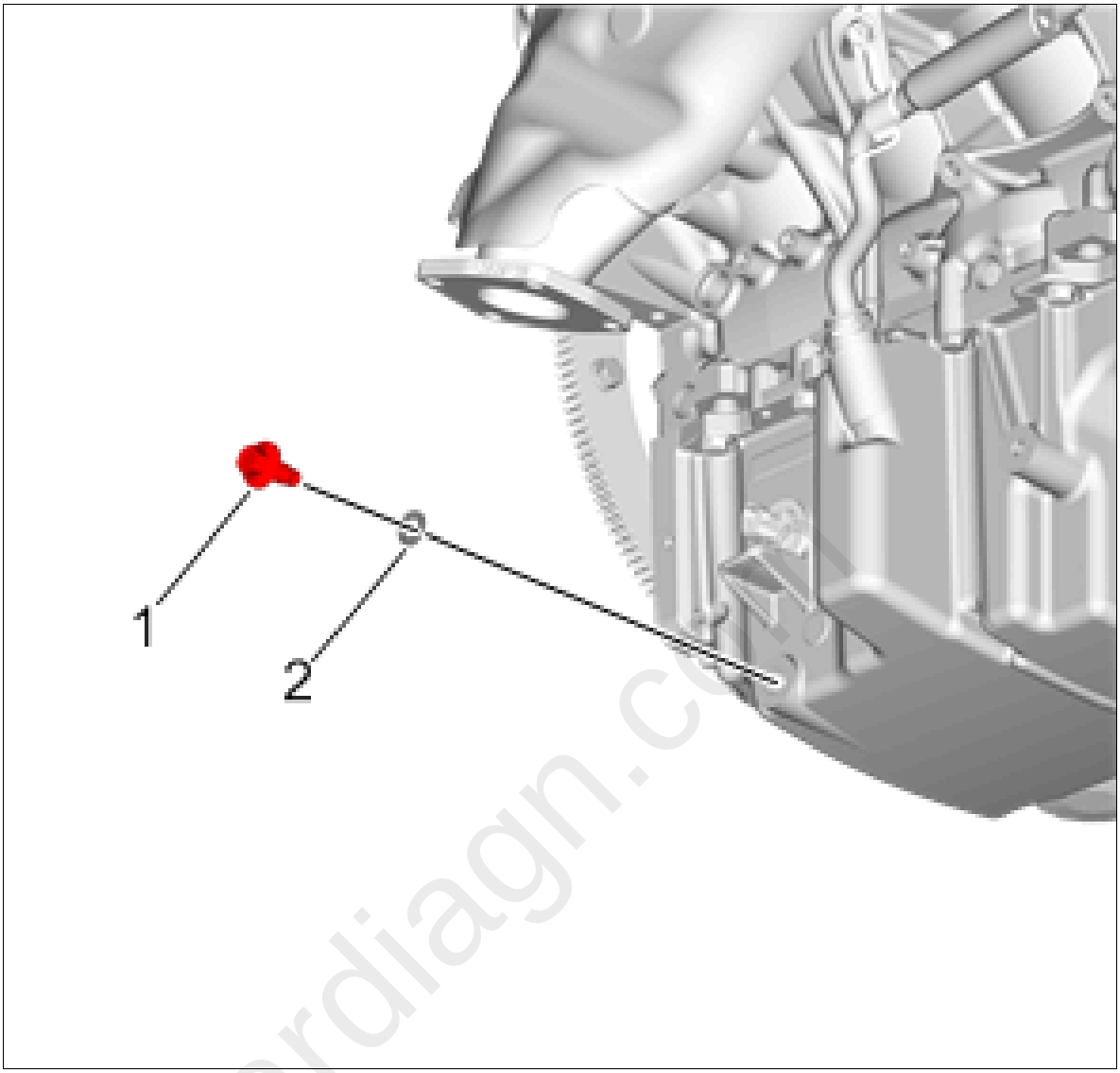
3. Install the oil pan drain plug (1) and tighten to 25 N.m (18 lb ft).

4. Lower the vehicle.
5. Fill the engine with the appropriate amount and type of engine oil. Approximate Fluid Capacities , and Adhesives, Fluids, Lubricants, and Sealers .
6. Start the engine, check for leaks and correct.
7. Shut the engine off and check the oil level.
8. Install the oil fill cap.
9. Close the hood.
10. Reset the engine oil life monitor. GM Oil Life System Resetting .

REPAIR INSTRUCTIONS - OFF VEHICLE > DRAINING FLUIDS AND OIL FILTER REMOVAL

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Fig 1: Oil Pan Drain Plugs

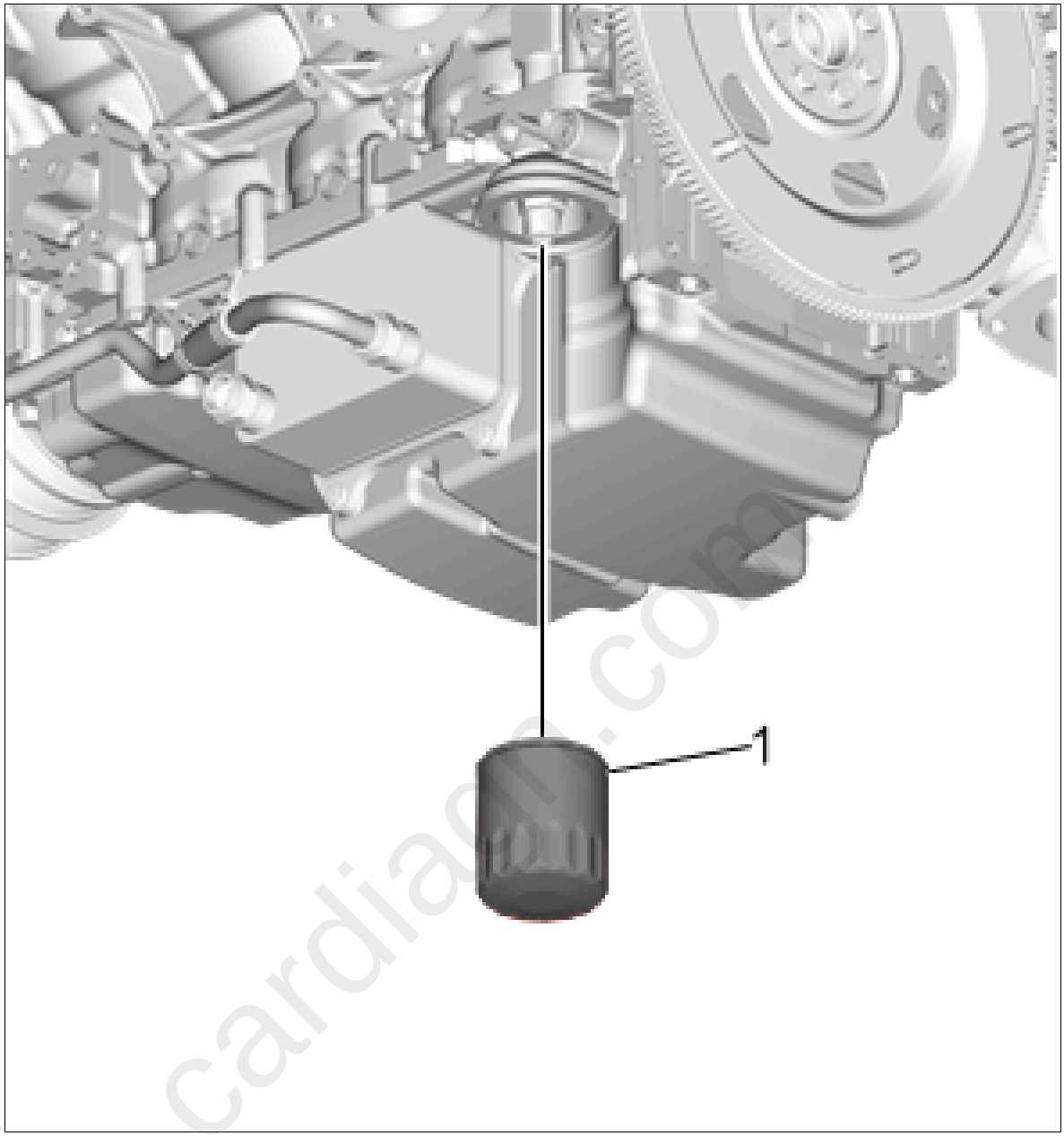


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1. Remove the oil pan drain plugs (1) with O-ring (2)

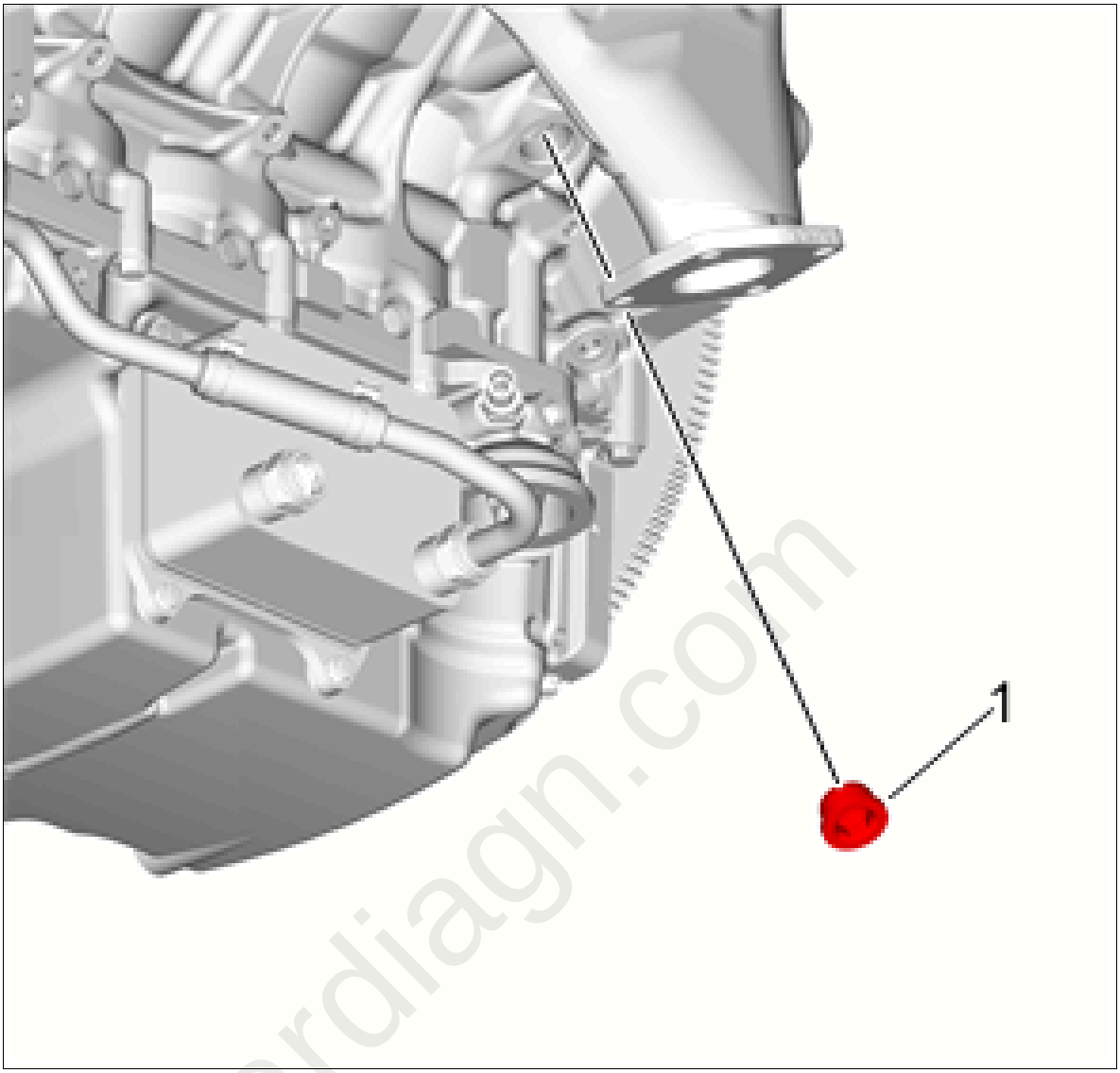
Fig 2: Engine Oil Filter



Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil filter (1).

Fig 3: Left Side Rear Engine Block Coolant Drain Hole Plug

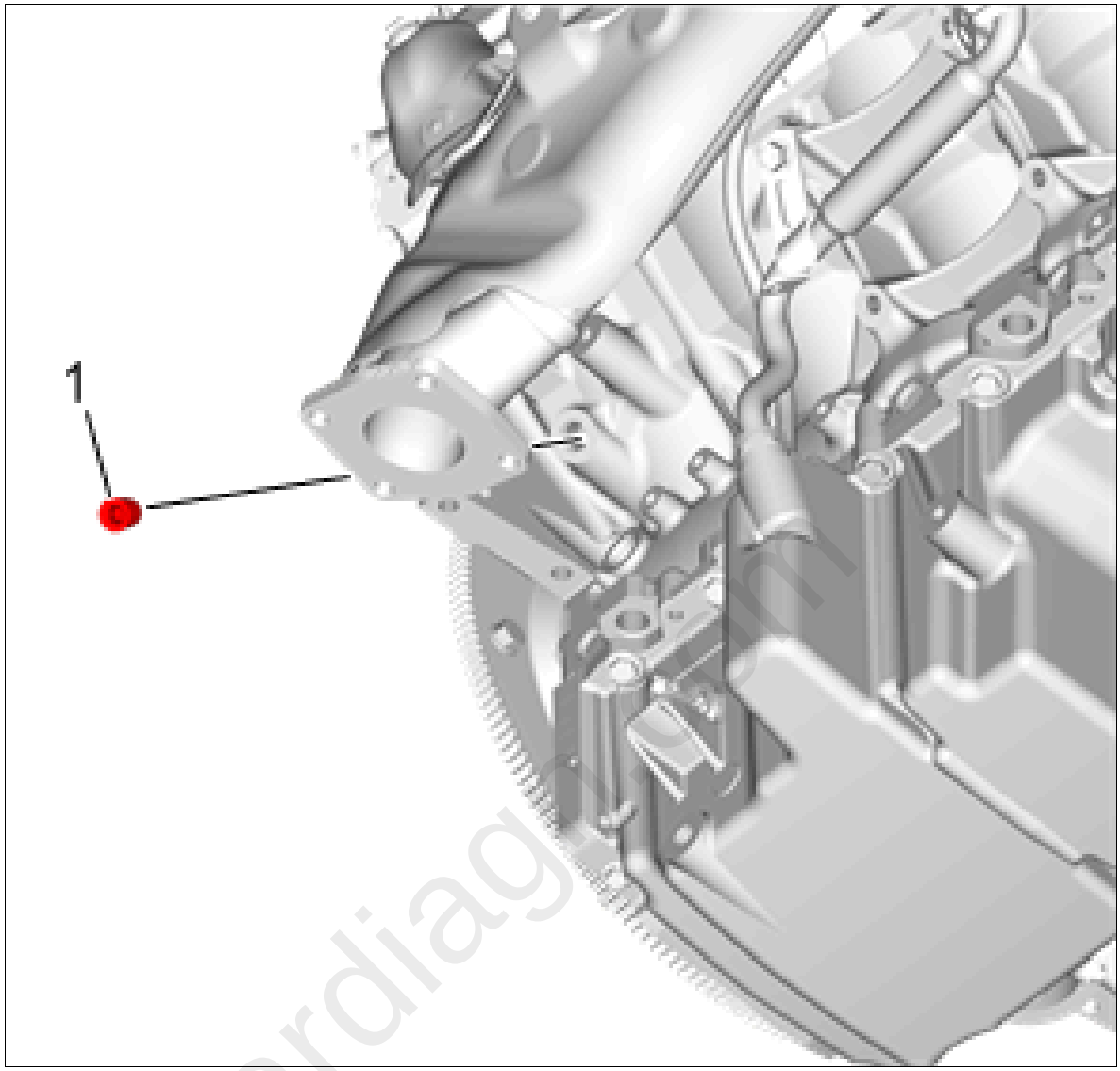


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3. Remove the left side rear engine block coolant drain hole plug (1).

Fig 4: Right Side Rear Engine Block Coolant Drain Hole Plug

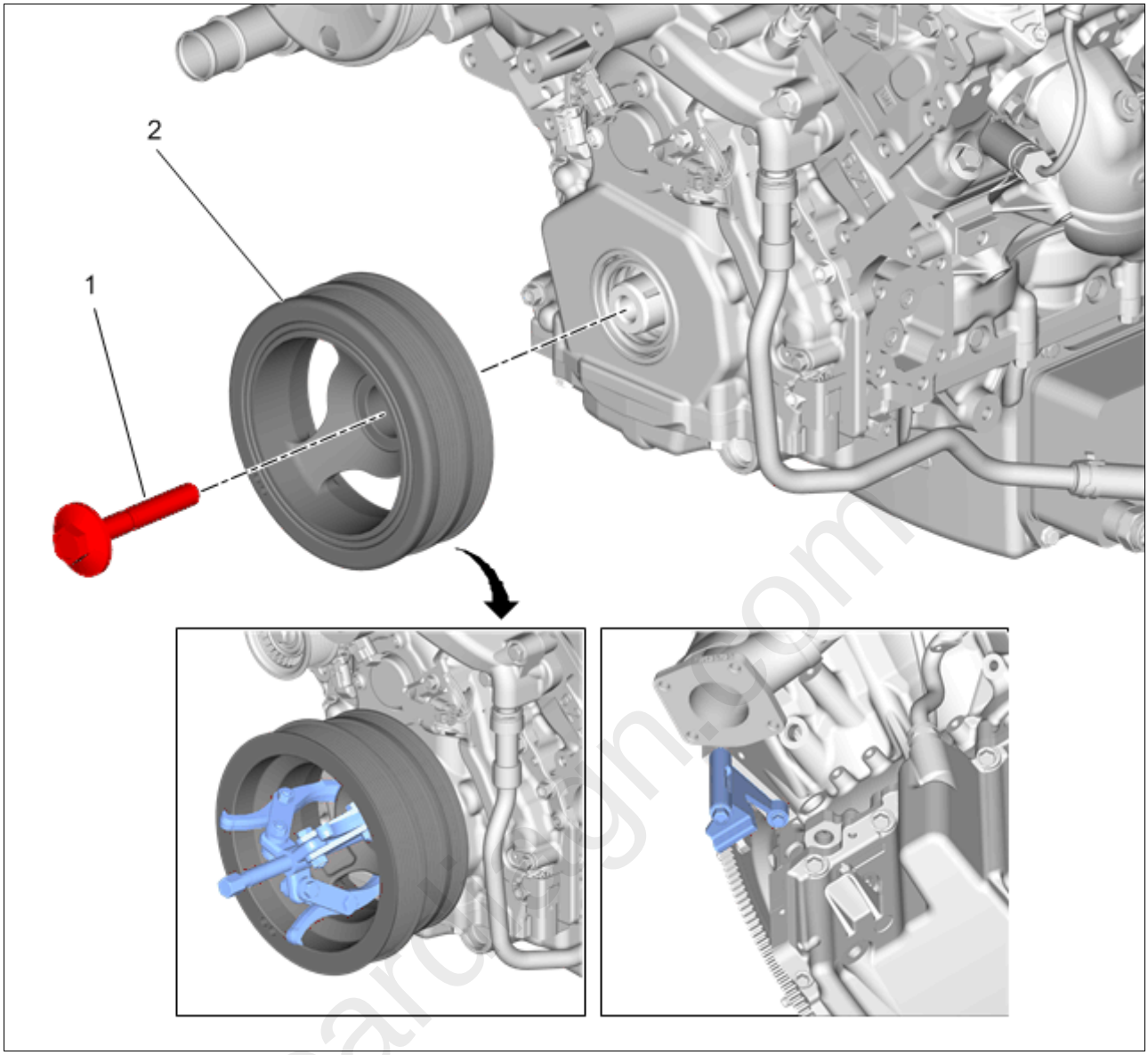


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4. Remove the right side rear engine block coolant drain hole plug (1).

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT BALANCER REMOVAL

Fig 1: Crankshaft Balancer



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Balancer Bolt *NOTE:* *Do not discard balancer bolt, it will be used later for installation.* **Procedure** Install the **J-42386-A** flywheel holding tool. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation and tighten bolts to 50 N.m (37 lb ft).

	Special Tools **J-42386-A** Flywheel Holding Tool For equivalent regional tools, refer to Special Tools .
2	Crankshaft Balancer Assembly Procedure 1. Install the **EN-41816-2** crankshaft end protector. 2. Install the **EN-41816** crankshaft balancer remover. 3. Using both tools remove the crankshaft balancer. Special Tools • **EN-41816** Crankshaft Balancer Remover • **EN-41816-2** Crankshaft End Protector For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FLYWHEEL REMOVAL

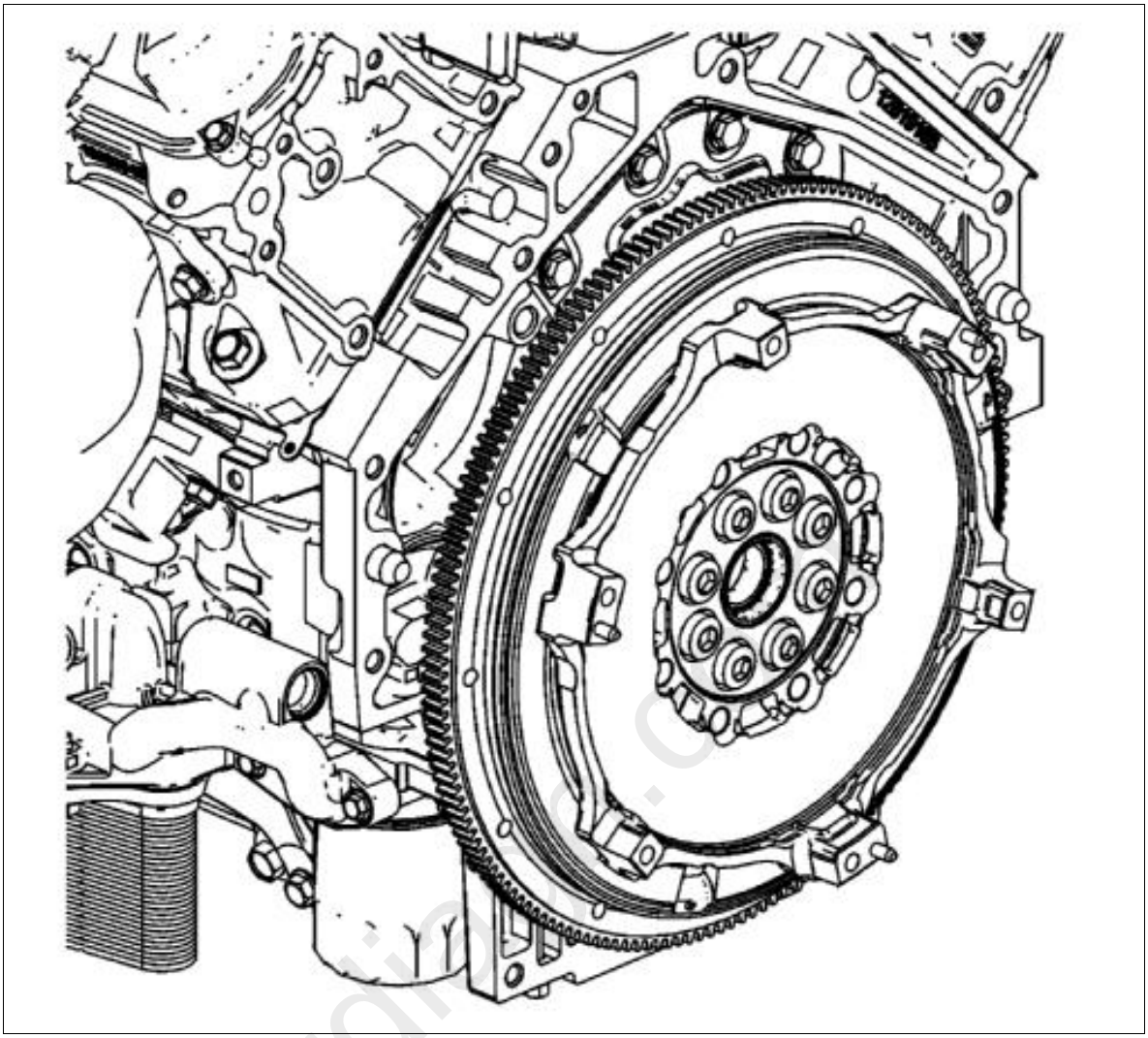
Special Tools

J-42386-A Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools .

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Fig 1: Mark Or Scribe End Of Crankshaft And Manual Transmission Flywheel



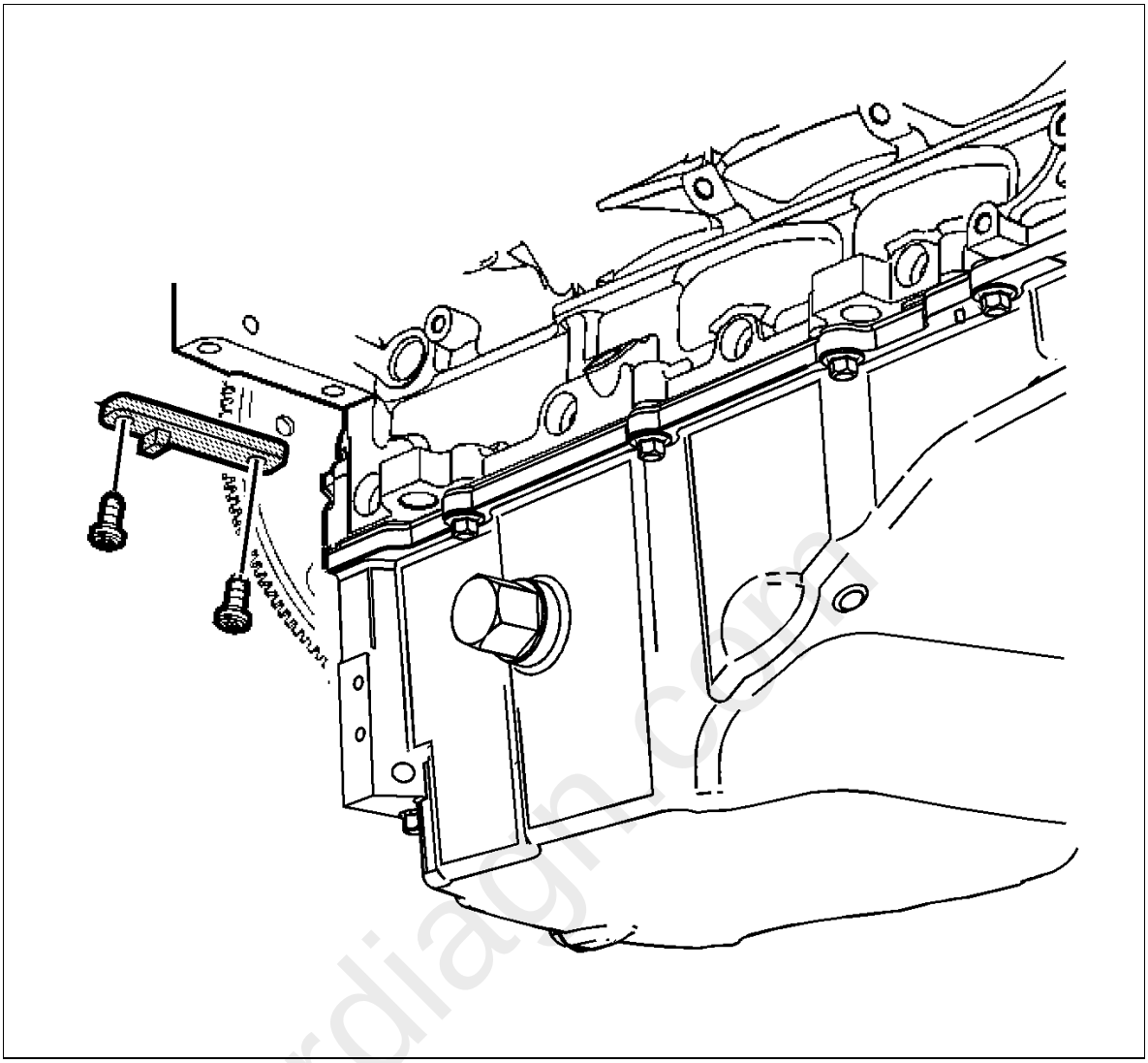
Courtesy of GENERAL MOTORS COMPANY

NOTE:

Note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction.

1. Mark or scribe the end of the crankshaft and the manual transmission flywheel. Refer to Engine Balancing .

Fig 2: Flywheel Holder



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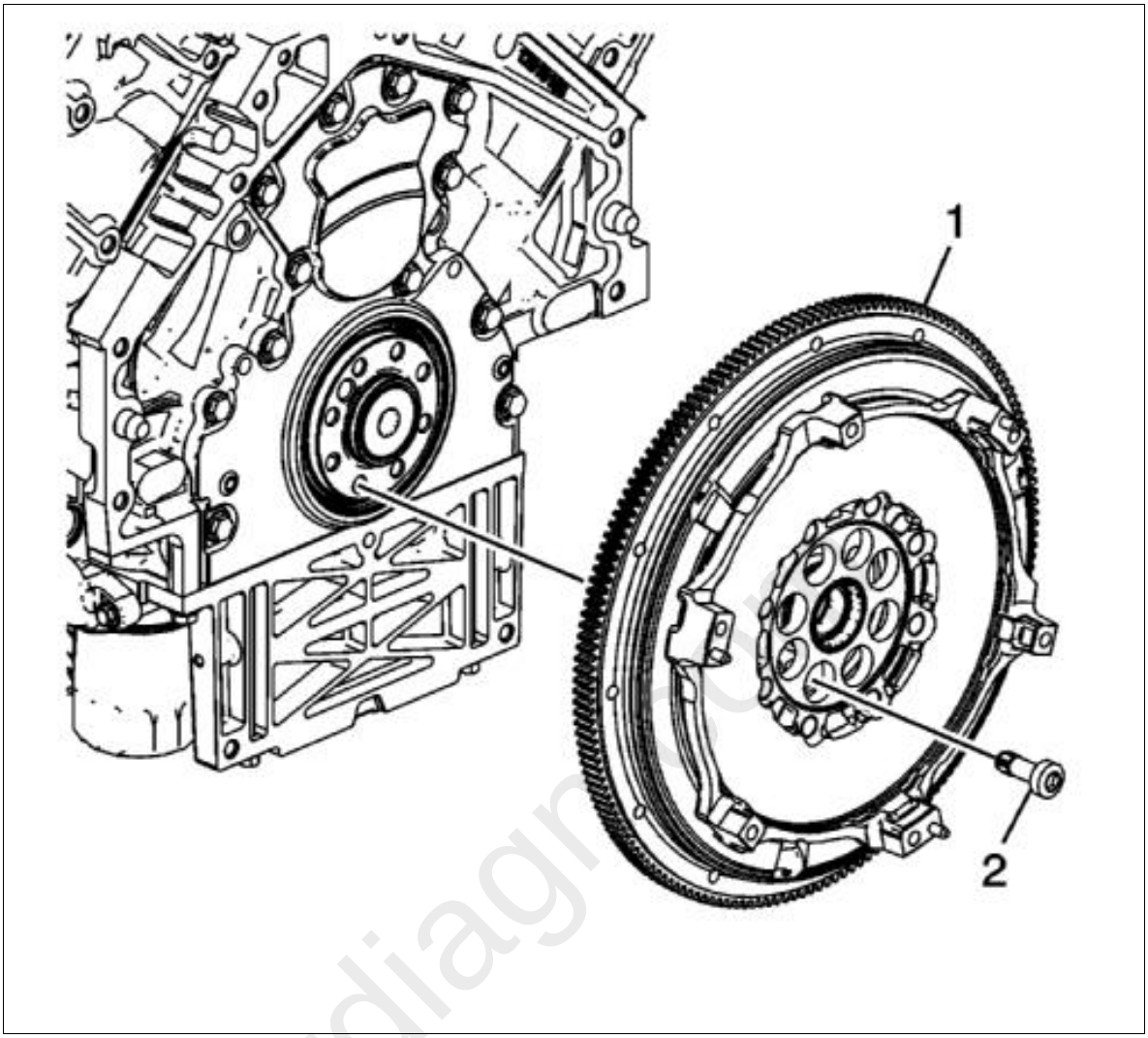
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

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

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

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

Fig 3: Manual Transmission Flywheel



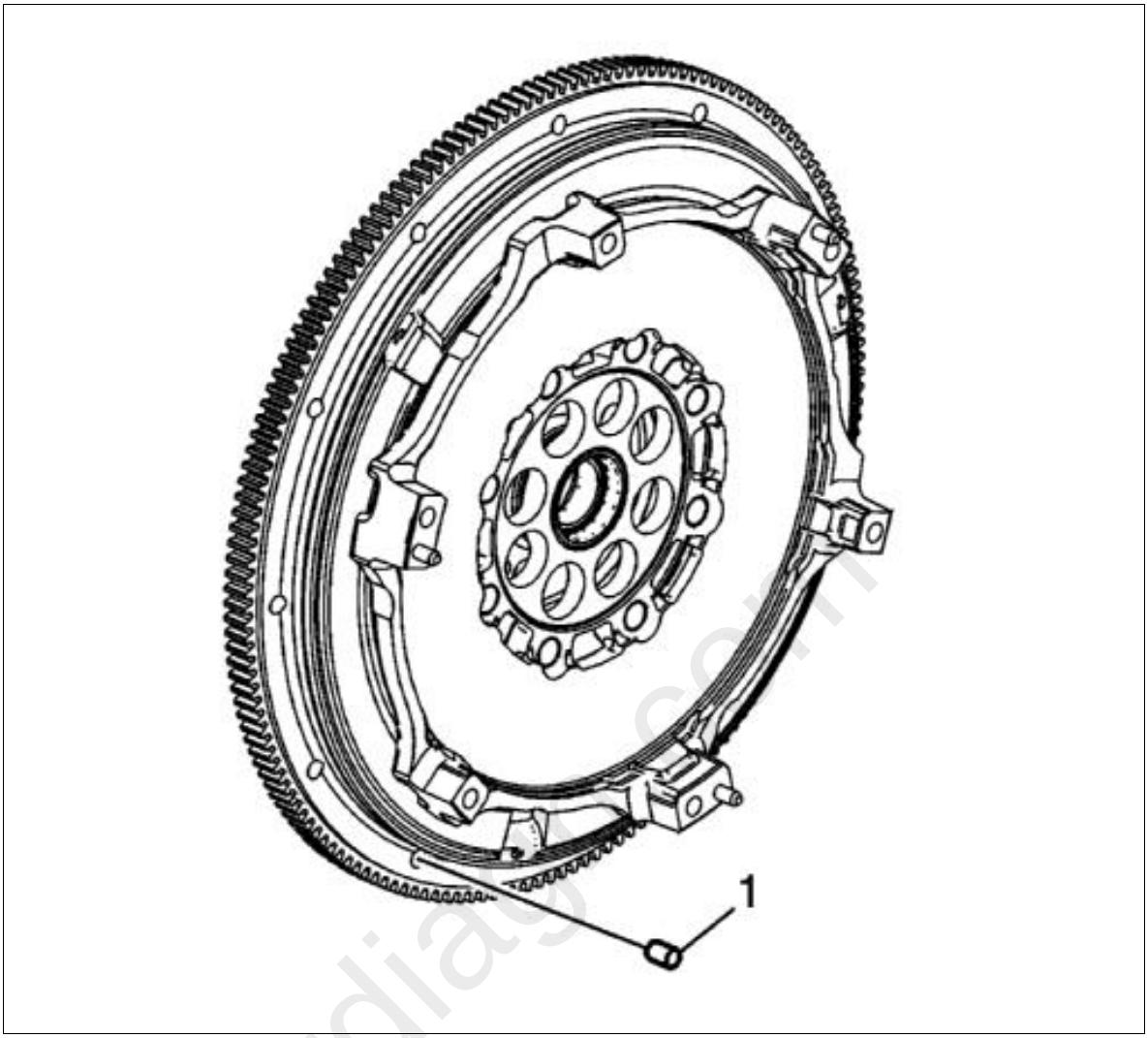
Courtesy of GENERAL MOTORS COMPANY

NOTE:

Do NOT reuse the flywheel bolts.

3. Remove and discard the flywheel bolts (2).
4. Remove the manual transmission flywheel (1).

Fig 4: Manual Transmission Flywheel Balance Weights

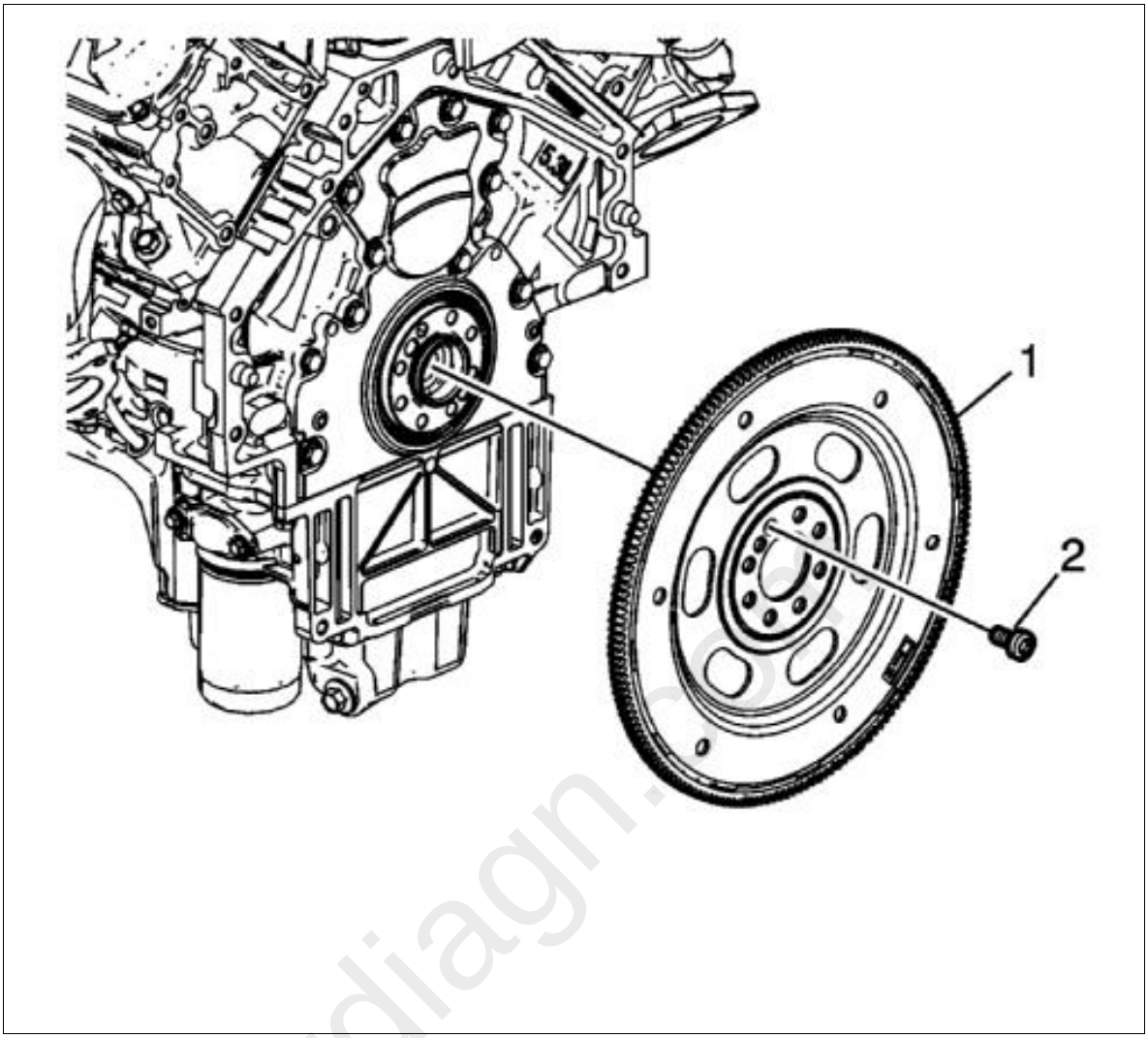


Courtesy of GENERAL MOTORS COMPANY

5. Note the location of the manual transmission flywheel balance weights (1), if applicable. Refer to Engine Balancing .
6. Remove the **J-42386-A** flywheel holding tool

REPAIR INSTRUCTIONS - OFF VEHICLE > AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Fig 1: Automatic Transmission Flex Plate



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NOTE:

The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.

1. Mark or scribe the end of the crankshaft and the flex plate before removal.
2. Remove the engine flex plate bolts (2).
3. Remove the flex plate (1).

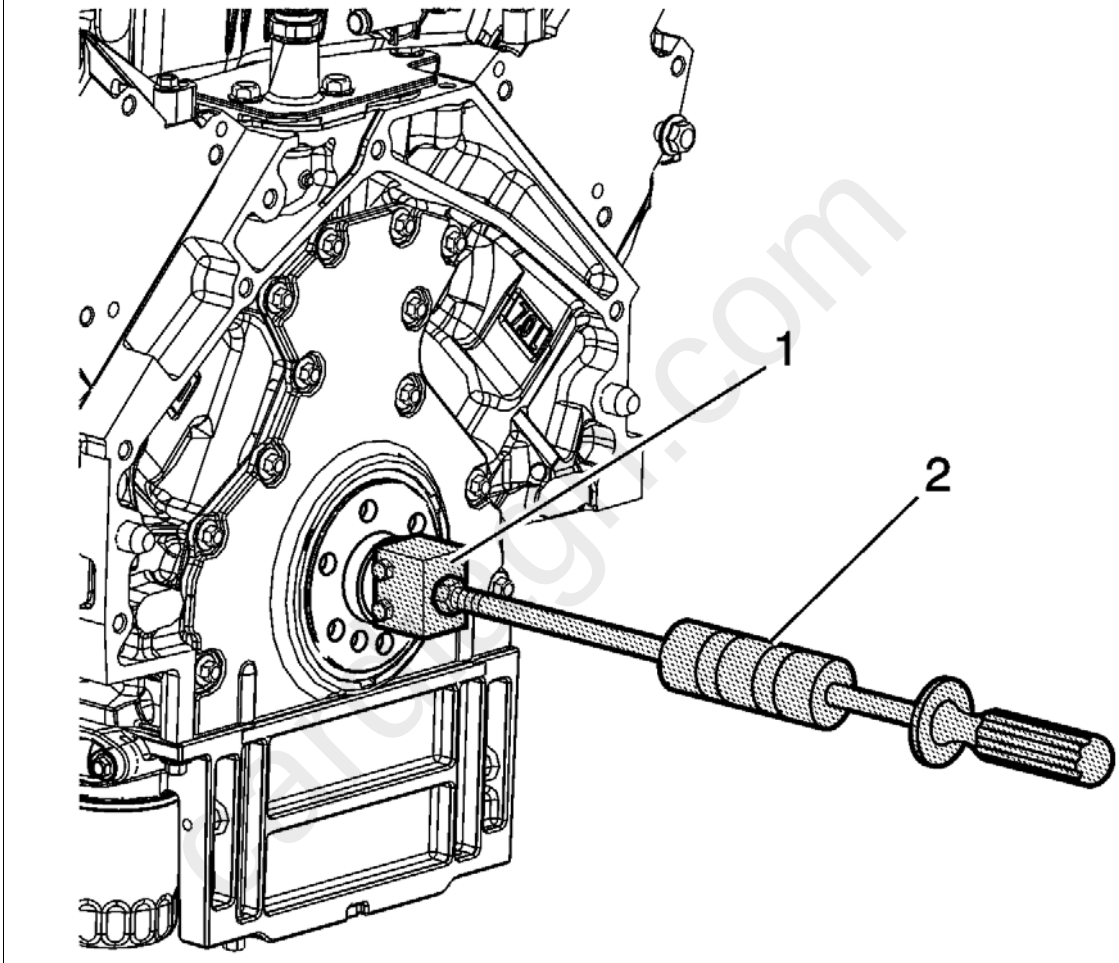
REPAIR INSTRUCTIONS - OFF VEHICLE > CLUTCH PILOT BEARING REMOVAL

Special Tools

- **GE-2619-01** Slide Hammer
- **GE-23907** Slide Hammer with Bearing Adapter
- **GE-23907-1** Slide Hammer

For equivalent regional tools, refer to Special Tools .

Fig 1: Clutch Pilot Bearing Slide Hammer & Adapter



Courtesy of GENERAL MOTORS COMPANY

NOTE:

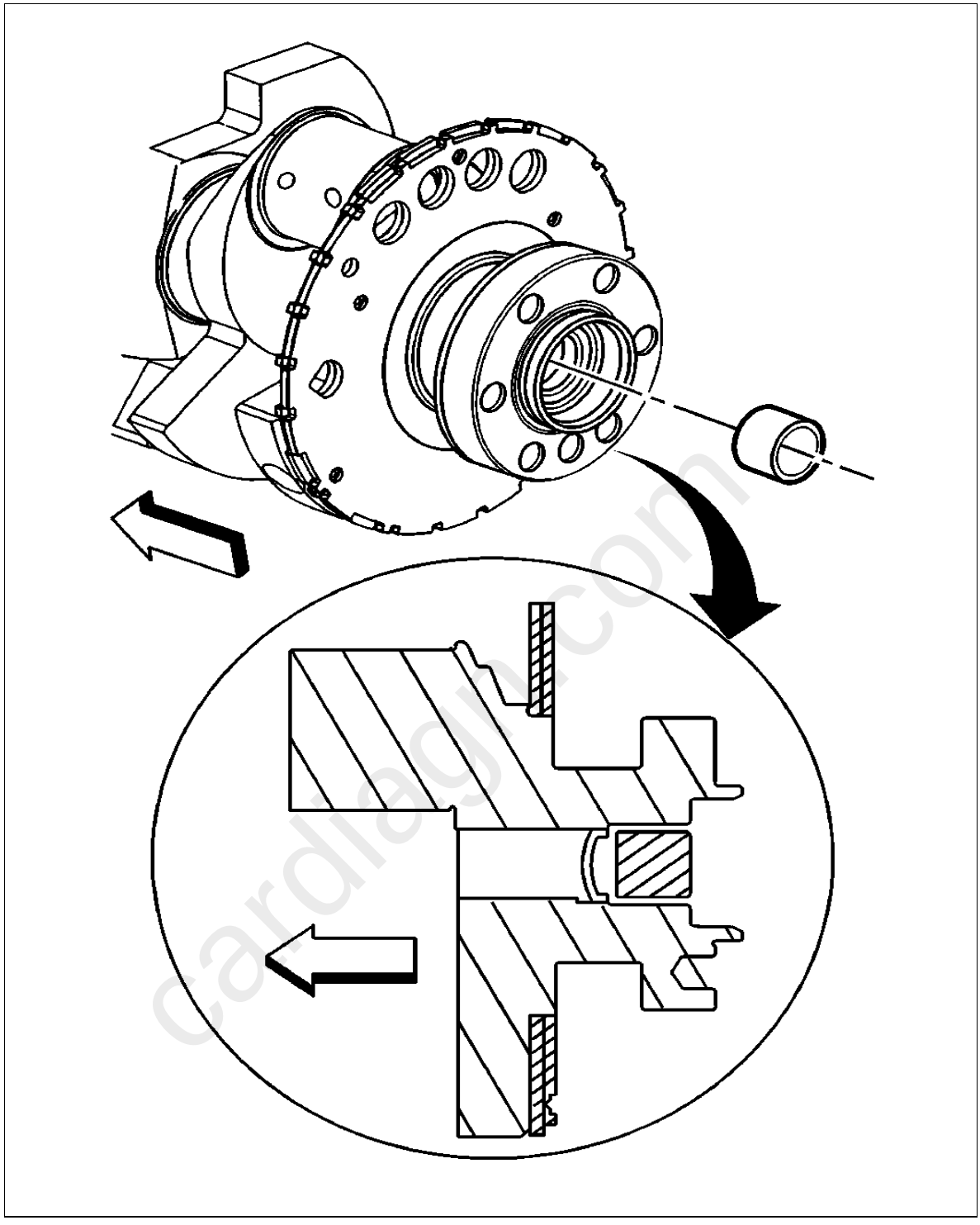
GE-23907-1 *slide hammer was part of the* ***GE-23907*** *slide hammer with bearing adapter set. The adapter is still available as* ***GE-23907*** *adapter.*

1. Remove the clutch pilot bearing using the **GE-23907** adapter (1) and **GE-23907-1** slide hammer (2).

1. Install the legs of the **GE-23907** adapter (1) into the clutch pilot bearing.
2. Rotate the shaft of the tool until the legs of the tool are snug and contacting the I.D. surface of the bearing.
3. Install the **GE-23907-1** slide hammer (2) to the **GE-23907** adapter (1).
4. Remove the bearing from the rear of the crankshaft.
5. Remove the special tools from the bearing.

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Fig 2: Locating Clutch Pilot Bearing

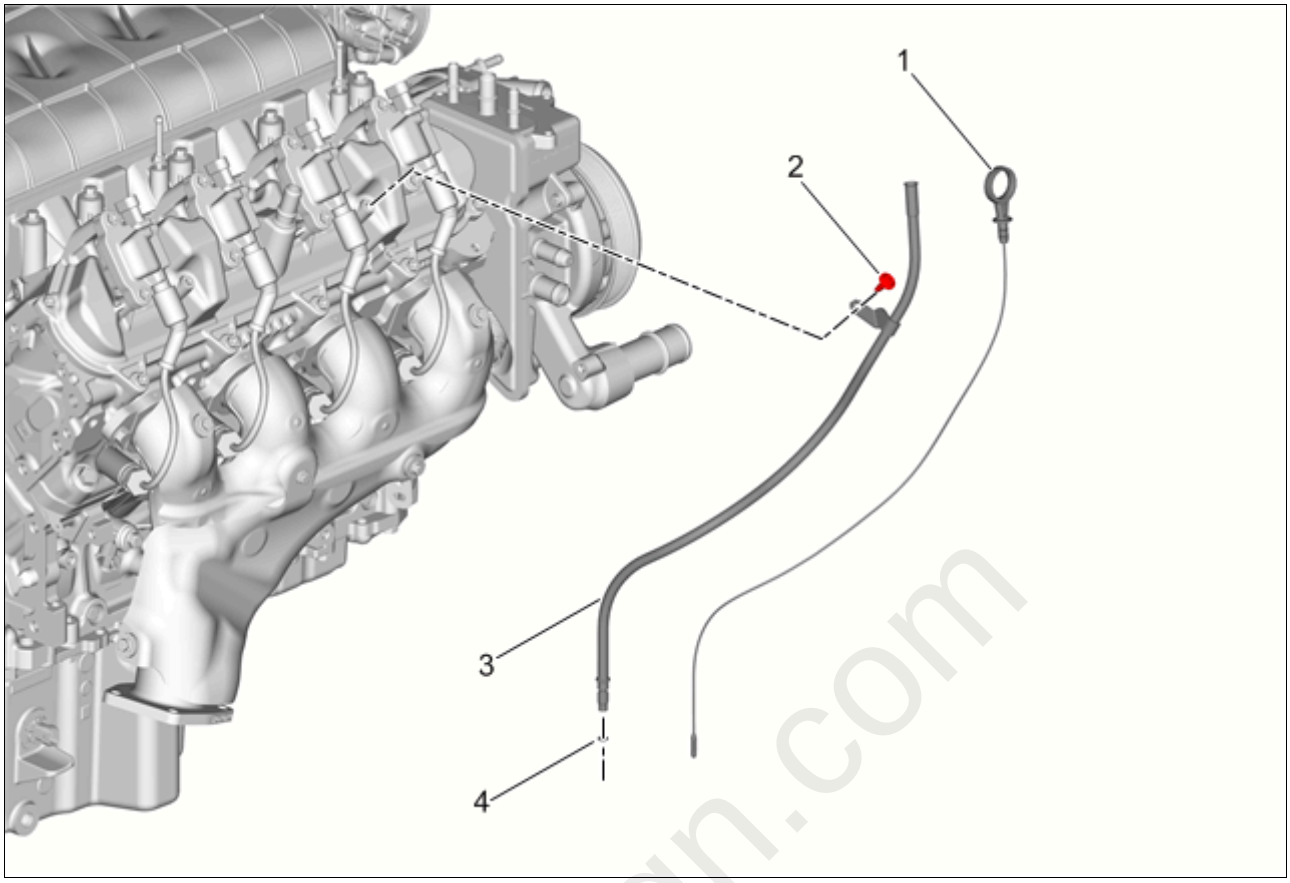


Courtesy of GENERAL MOTORS COMPANY

2. Discard the bearing.

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL LEVEL INDICATOR AND TUBE REMOVAL

Fig 1: Oil Level Indicator Tube



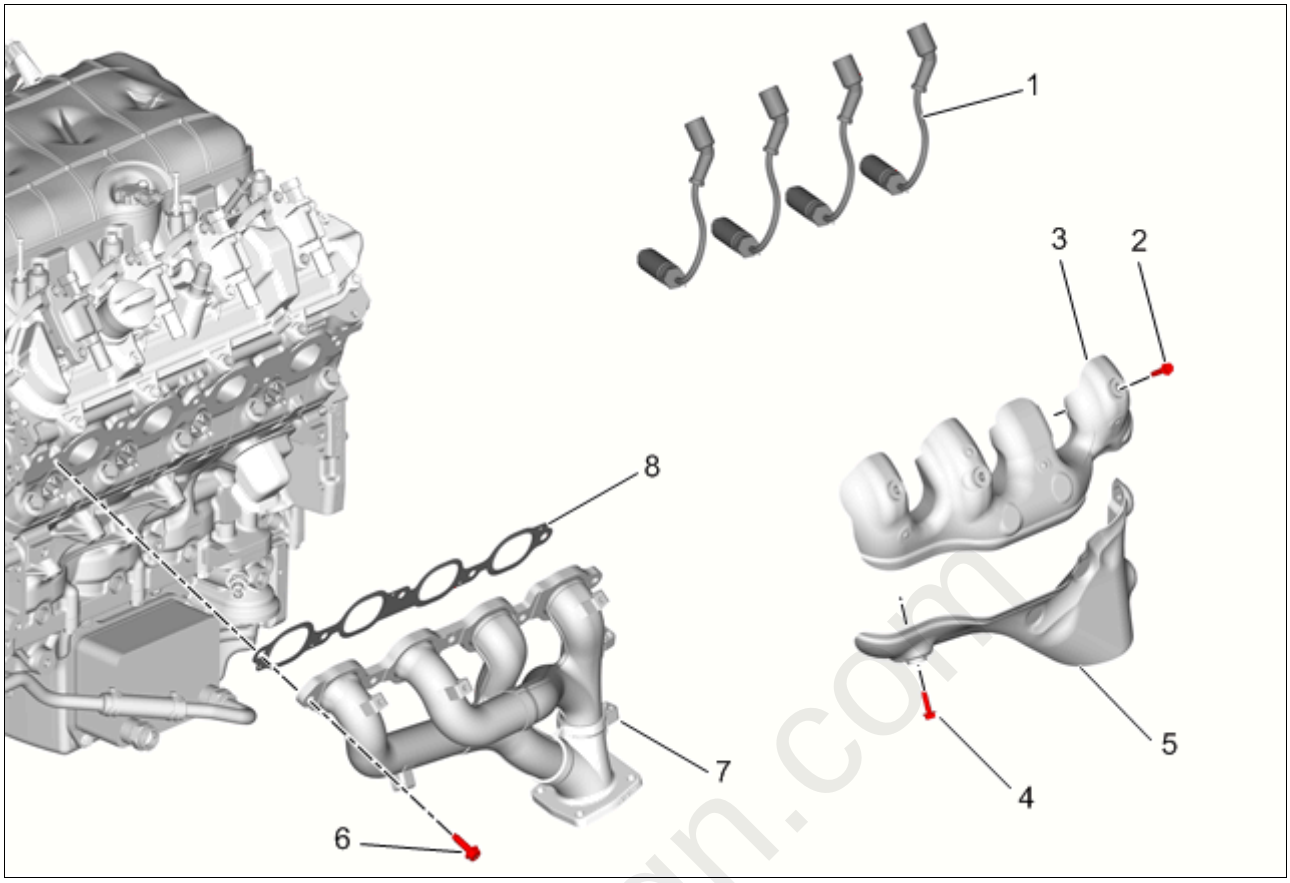
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Level Indicator
2	Oil Level Indicator Tube Bracket Bolt
3	Oil Level Indicator Tube
4	Oil Level Indicator Tube O-Ring

REPAIR INSTRUCTIONS - OFF VEHICLE > EXHAUST MANIFOLD REMOVAL - LEFT SIDE

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Fig 1: Exhaust Manifold - Left Side



Courtesy of GENERAL MOTORS COMPANY

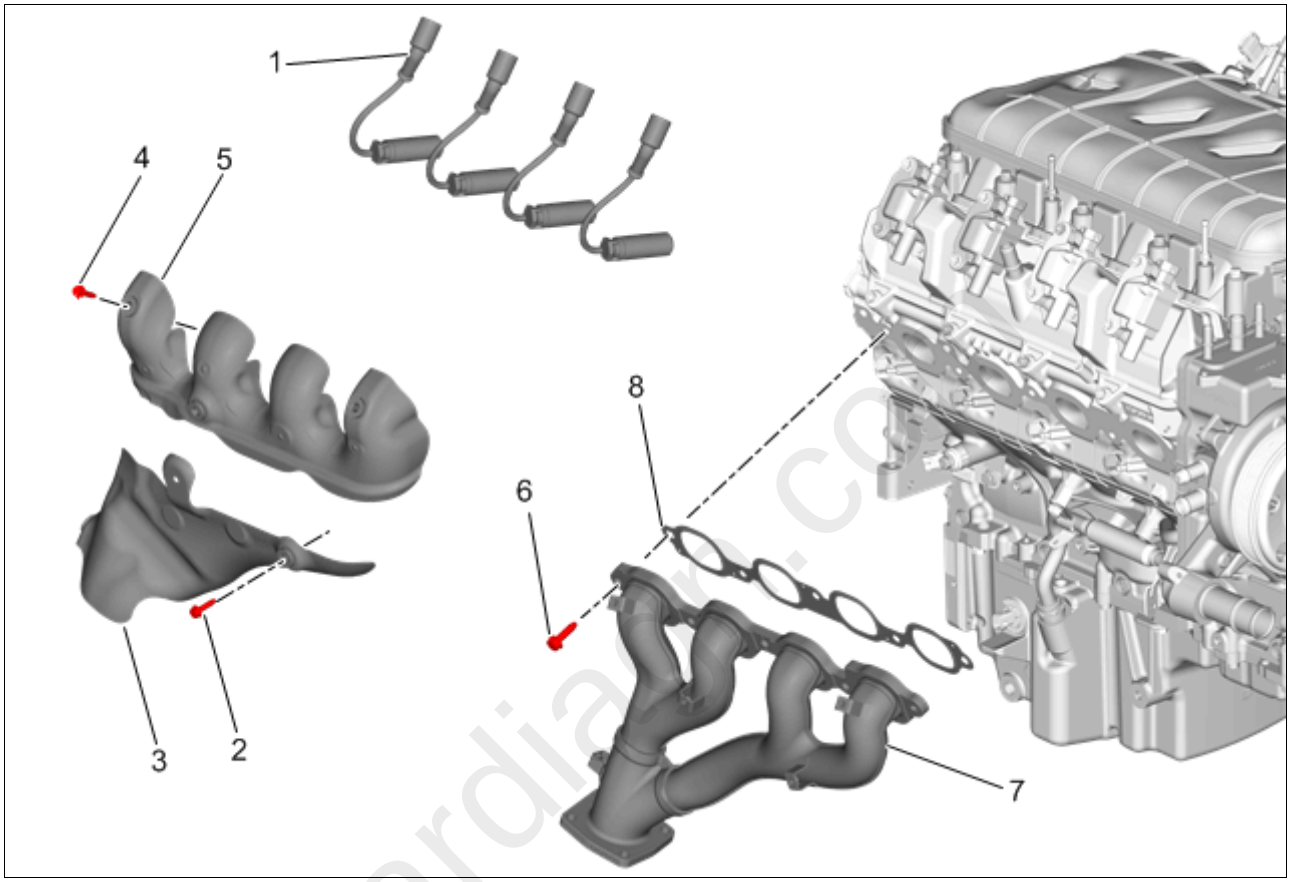
Callout	Component Name
1	Spark Plug Wire
2	Heat Shield Bolt (Qty: 3)
3	Heat Shield
4	Heat Shield Bolt (Qty: 3)
5	Heat Shield
6	Exhaust Manifold Bolt
7	Exhaust Manifold
8	Exhaust Manifold Gasket *NOTE:* *Discard gasket, it is not reusable.*

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	Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > EXHAUST MANIFOLD REMOVAL - RIGHT SIDE

Fig 1: Exhaust Manifold - Right Side



Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
1	Spark Plug Wire
2	Exhaust Manifold Heat Shield Bolt (Qty: 3)
3	Exhaust Manifold Heat Shield
4	Exhaust Manifold Heat Shield Bolt (Qty: 3)
5	Exhaust Manifold Heat Shield
6	Exhaust Manifold Bolt
7	Exhaust Manifold
8	Exhaust Manifold Gasket

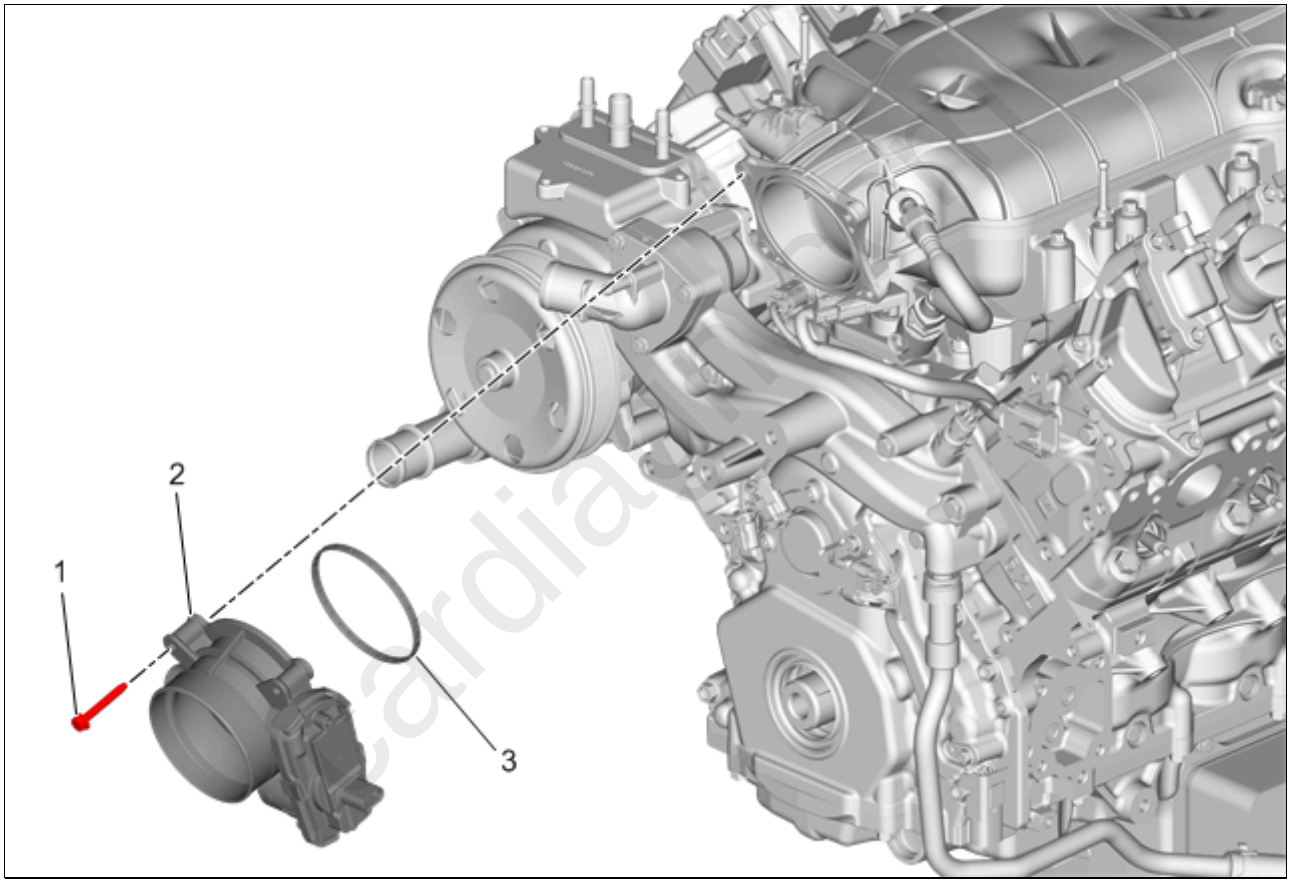
NOTE:

Discard gasket, it is not reusable.

Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > THROTTLE BODY ASSEMBLY REMOVAL

Fig 1: Throttle Body Assembly



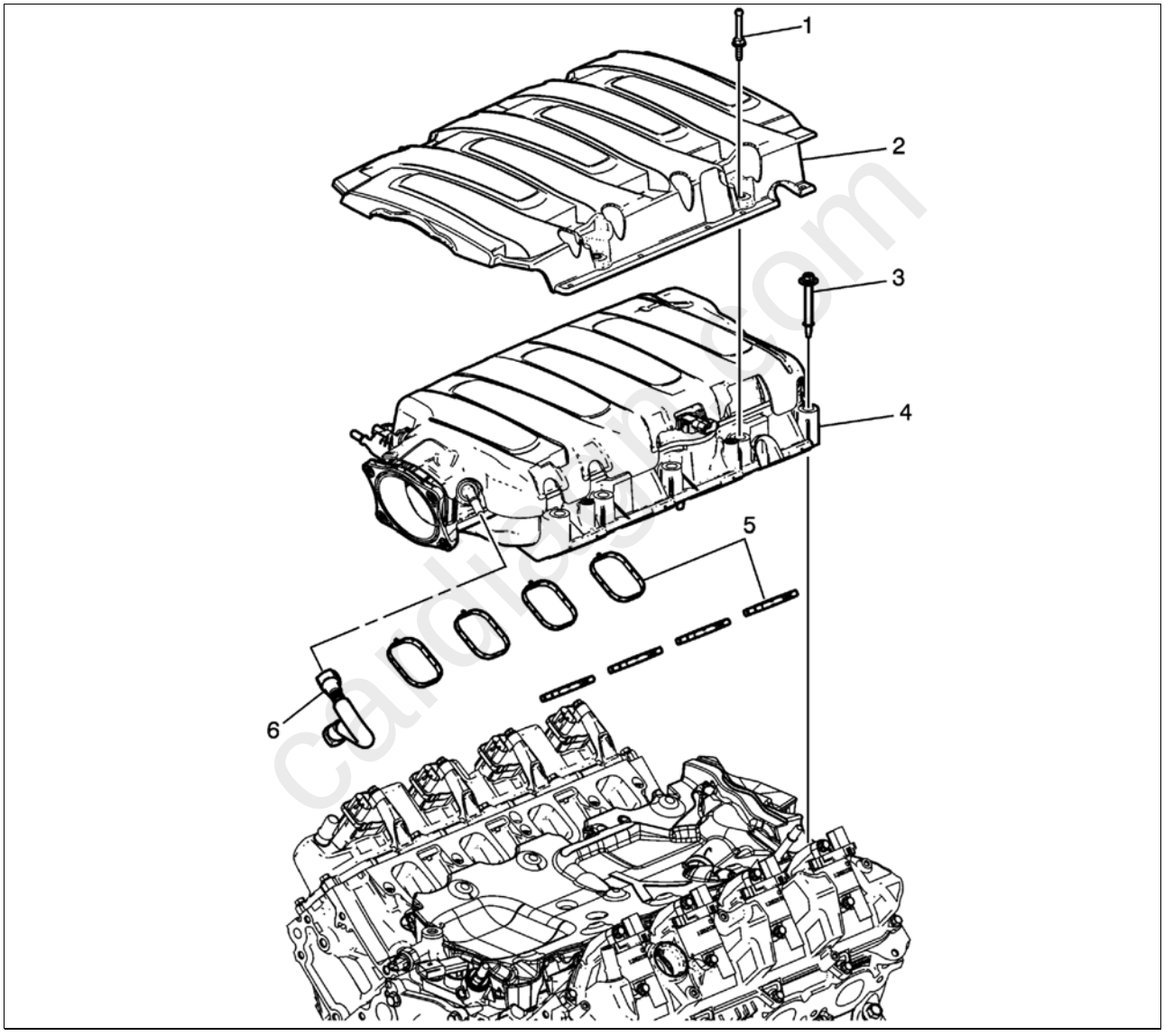
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Throttle Body Bolt
2	Throttle Body Assembly
3	Throttle Body Gasket *NOTE:*

	Discard gasket, it is not reusable. Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > INTAKE MANIFOLD REMOVAL

Fig 1: Intake Manifold



Courtesy of GENERAL MOTORS COMPANY

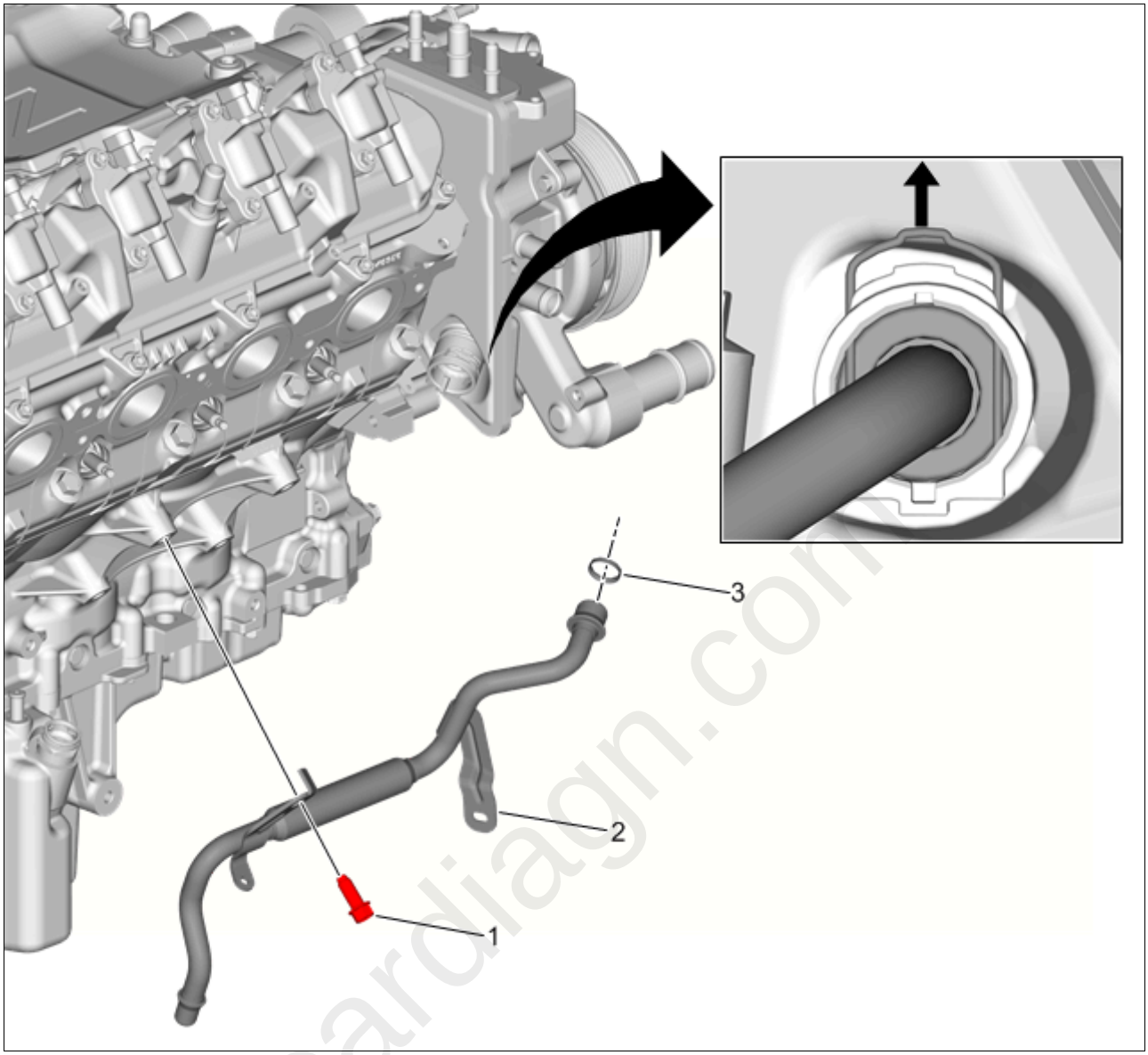
Callout	Component Name
1	Intake Manifold Cover Stud
2	Intake Manifold Cover Assembly

3	Intake Manifold Bolt
4	Intake Manifold Assembly
5	Intake Manifold Gasket *NOTE:* *Discard gasket it is not reusable.* Refer to Replacing Engine Gaskets .
6	PCV Tube Procedure 1. The PCV tube is connected to the intake manifold and the engine via a plastic collar quick connect fitting. 2. To remove the PCV tube, refer to Plastic Collar Quick Connect Fitting Service .

REPAIR INSTRUCTIONS - OFF VEHICLE > POSITIVE CRANKCASE VENTILATION OIL SEPARATOR DRAIN PIPE REMOVAL

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Fig 1: Positive Crankcase Ventilation Oil Separator Drain Pipe



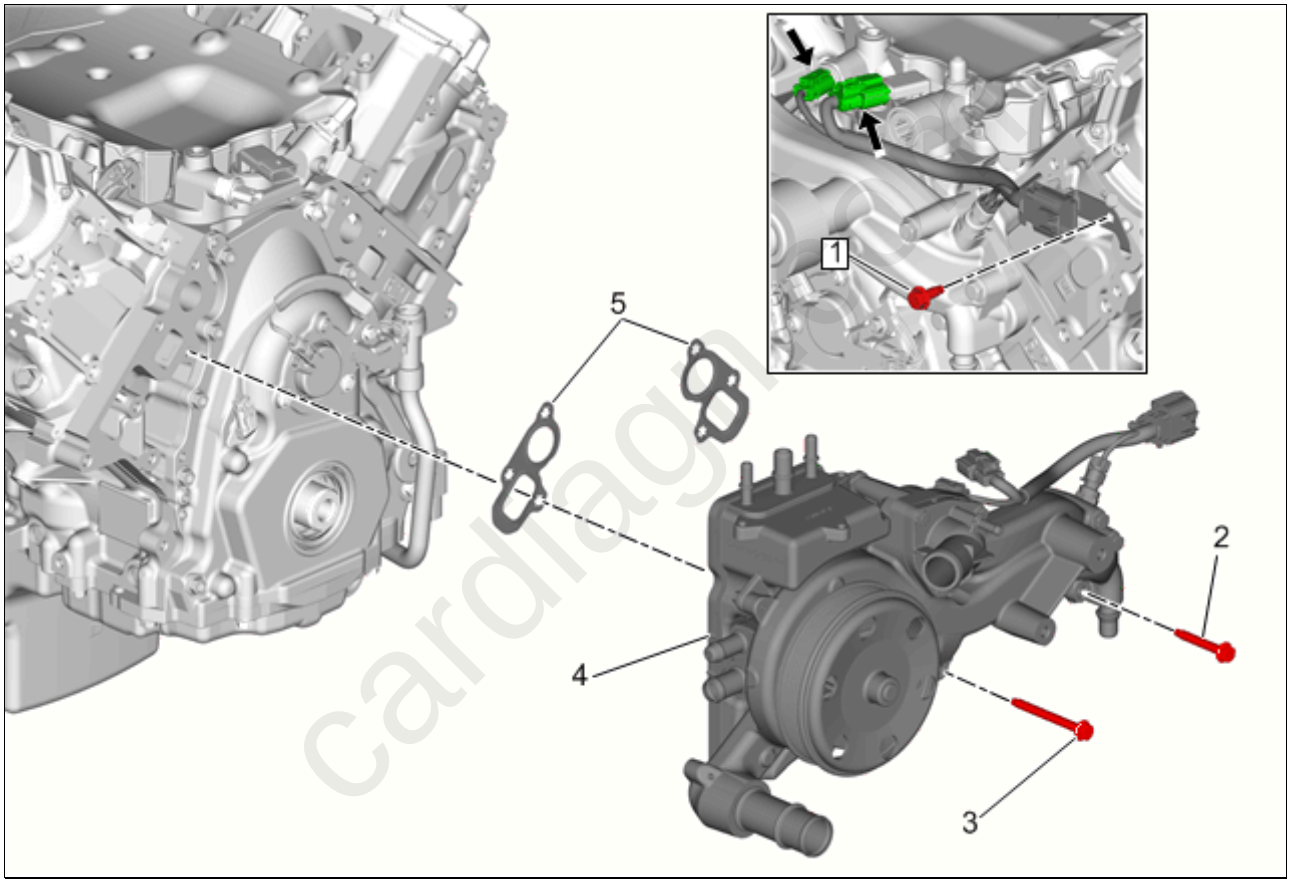
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Oil Separator Drain Tube Bolt
2	Positive Crankcase Ventilation Oil Separator Drain Tube *NOTE:* *Check valve must be replaced if tube is removed.* **Procedure** Pull retainer up on fitting to release tube.

3	Positive Crankcase Ventilation Oil Separator Drain Tube O-ring *NOTE:* *Discard O-ring, replace with new.*

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE COOLANT MANIFOLD REMOVAL

Fig 1: Engine Coolant Manifold



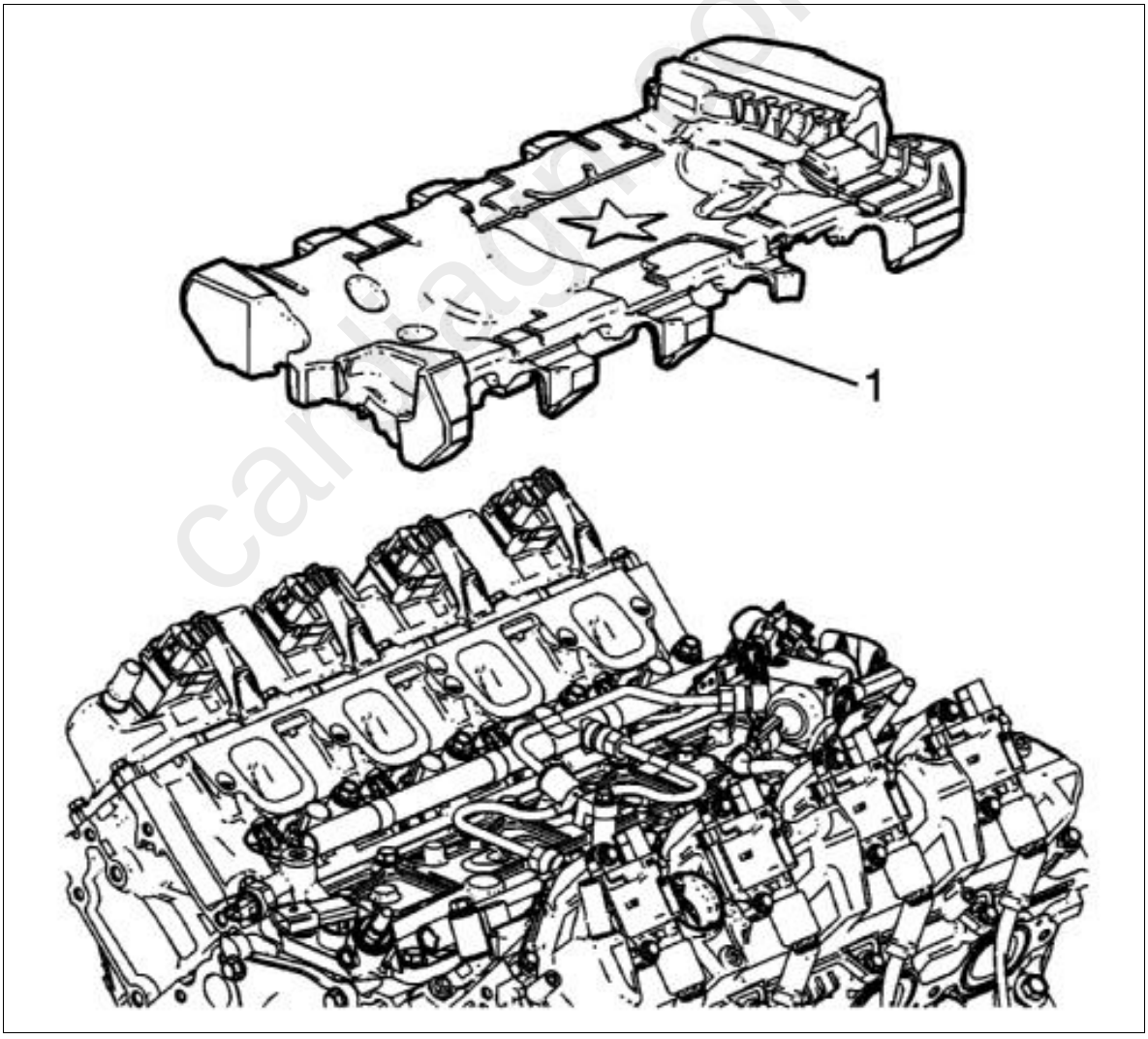
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure The oil pressure sensor and valve lifter oil manifold connectors must be disconnected before the engine coolant manifold can be removed.	
1	Jumper Harness Bolt
2	Engine Coolant Manifold Bolt
3	Engine Coolant Manifold Bolt

4	Engine Coolant Manifold Assembly
5	Engine Coolant Manifold Gaskets *NOTE:* *Discard gasket, it is not reusable.* Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > FUEL PUMP INSULATOR AND FUEL FEED PIPES REMOVAL

Fig 1: Fuel Pump Insulator



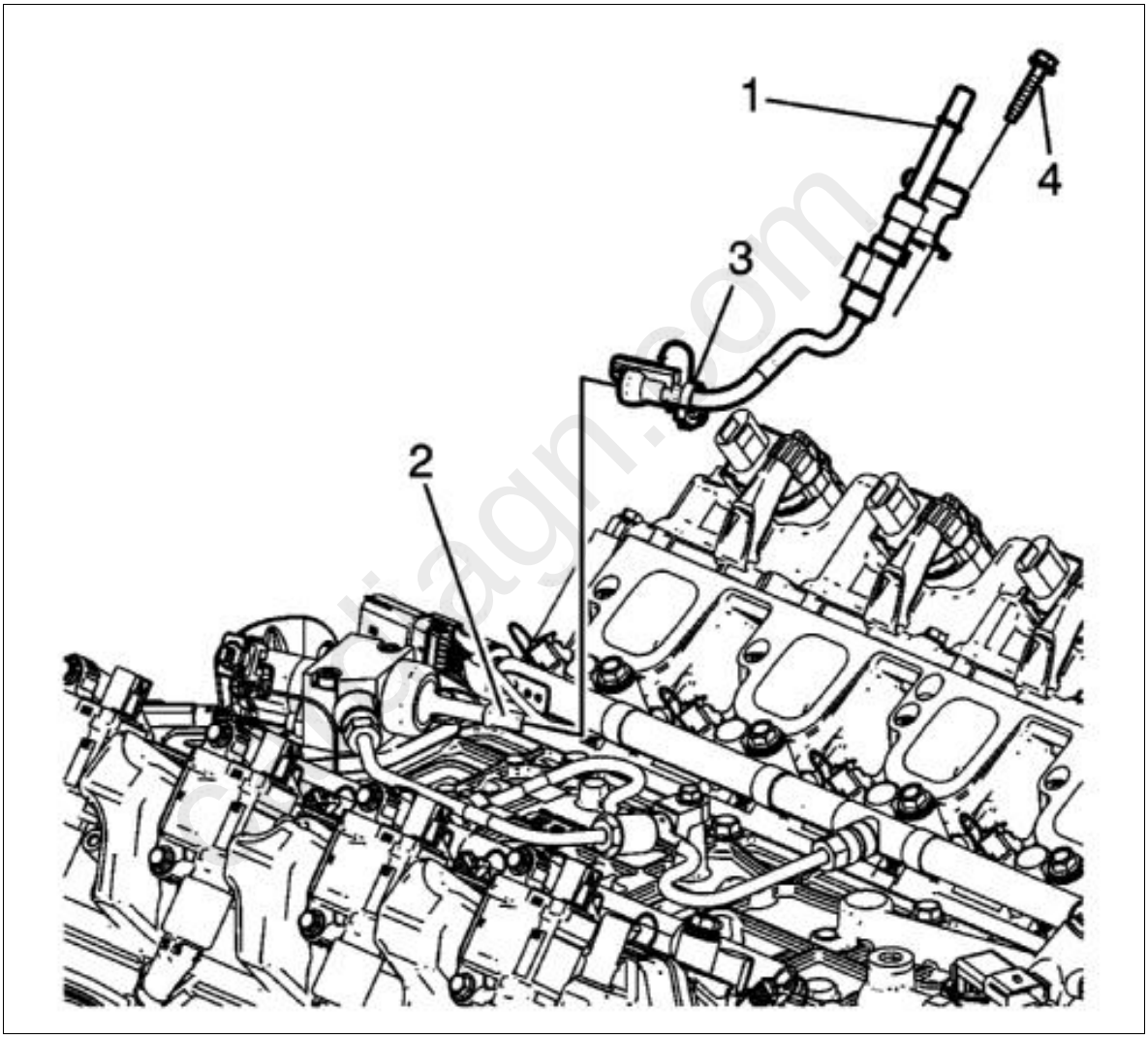
Courtesy of GENERAL MOTORS COMPANY

WARNING:

The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

1. Remove the fuel pump insulator (1).

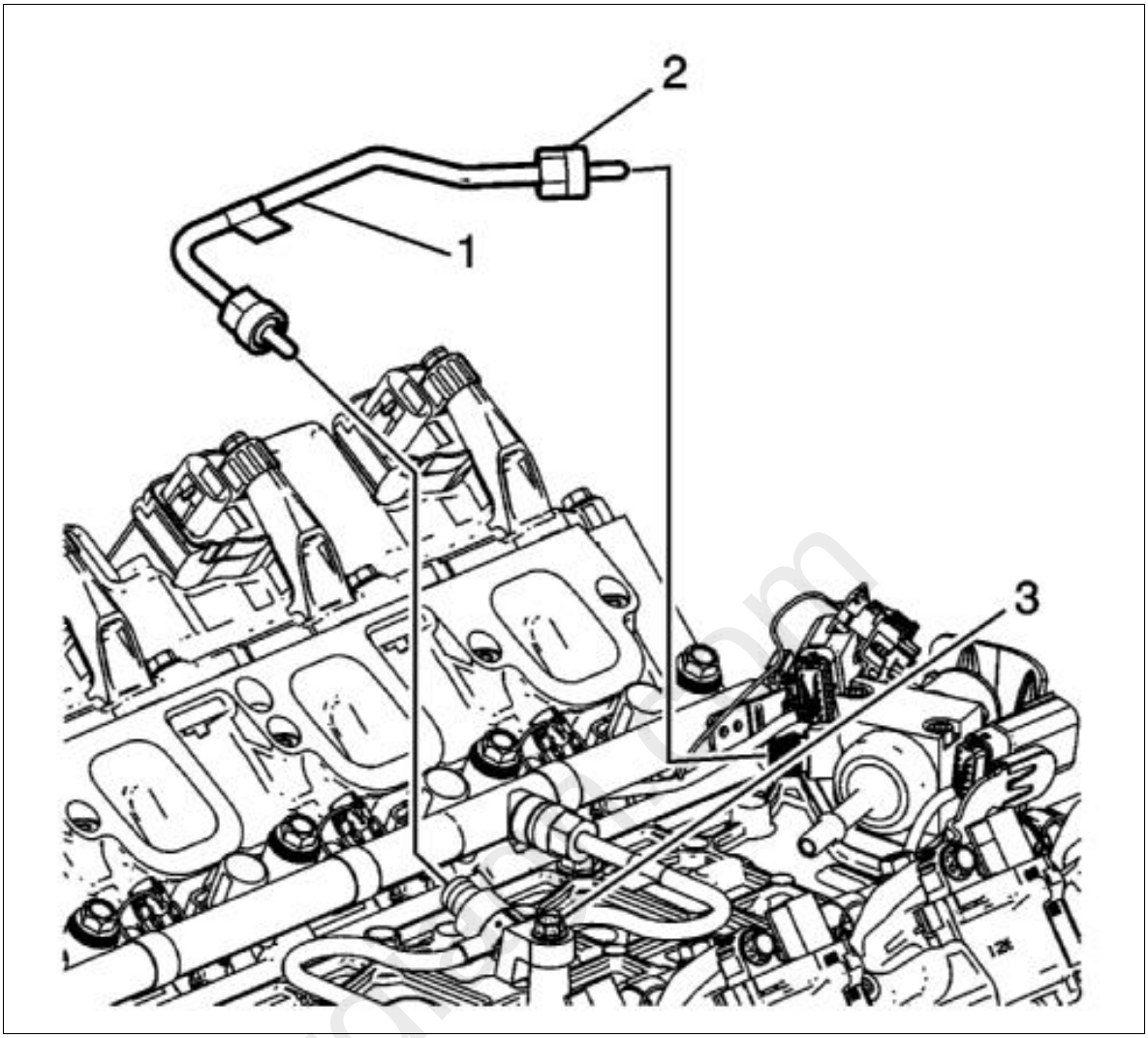
Fig 2: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt



Courtesy of GENERAL MOTORS COMPANY

2. Remove the low pressure fuel feed pipe to LH rocker cover bolt (4).
3. Remove the redundant clip (3). Remove low pressure fuel feed pipe (1) from the fuel pump (2).

Fig 3: Crossover Pipe And Fuel Feed Pipe Fittings

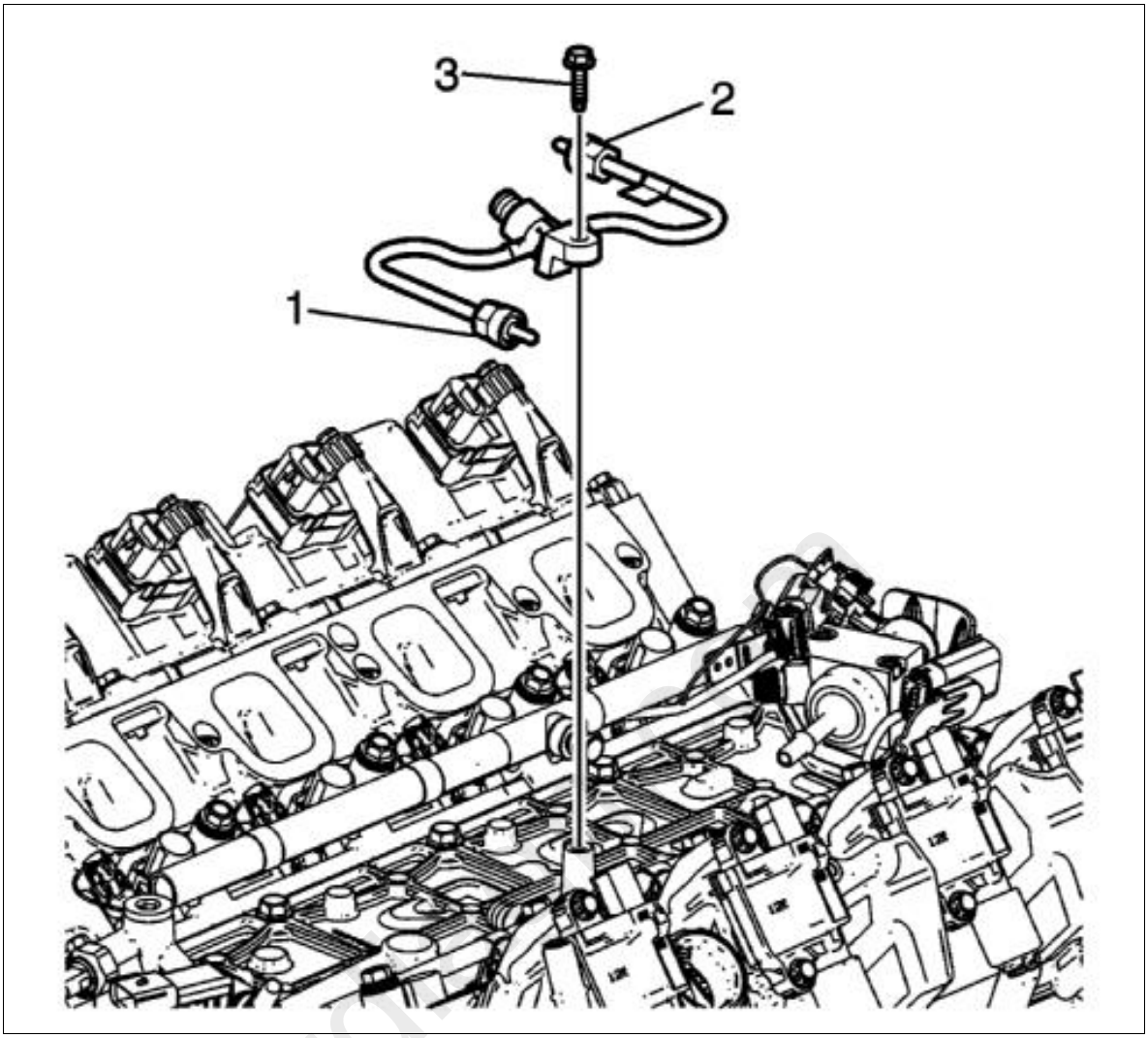


Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

4. Remove the high pressure fuel feed pipe that connects the fuel pump to the crossover pipe (1) by loosening the fuel feed pipe fittings (2).

Fig 4: RH Fuel Rail Crossover Pipe Bolt



Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

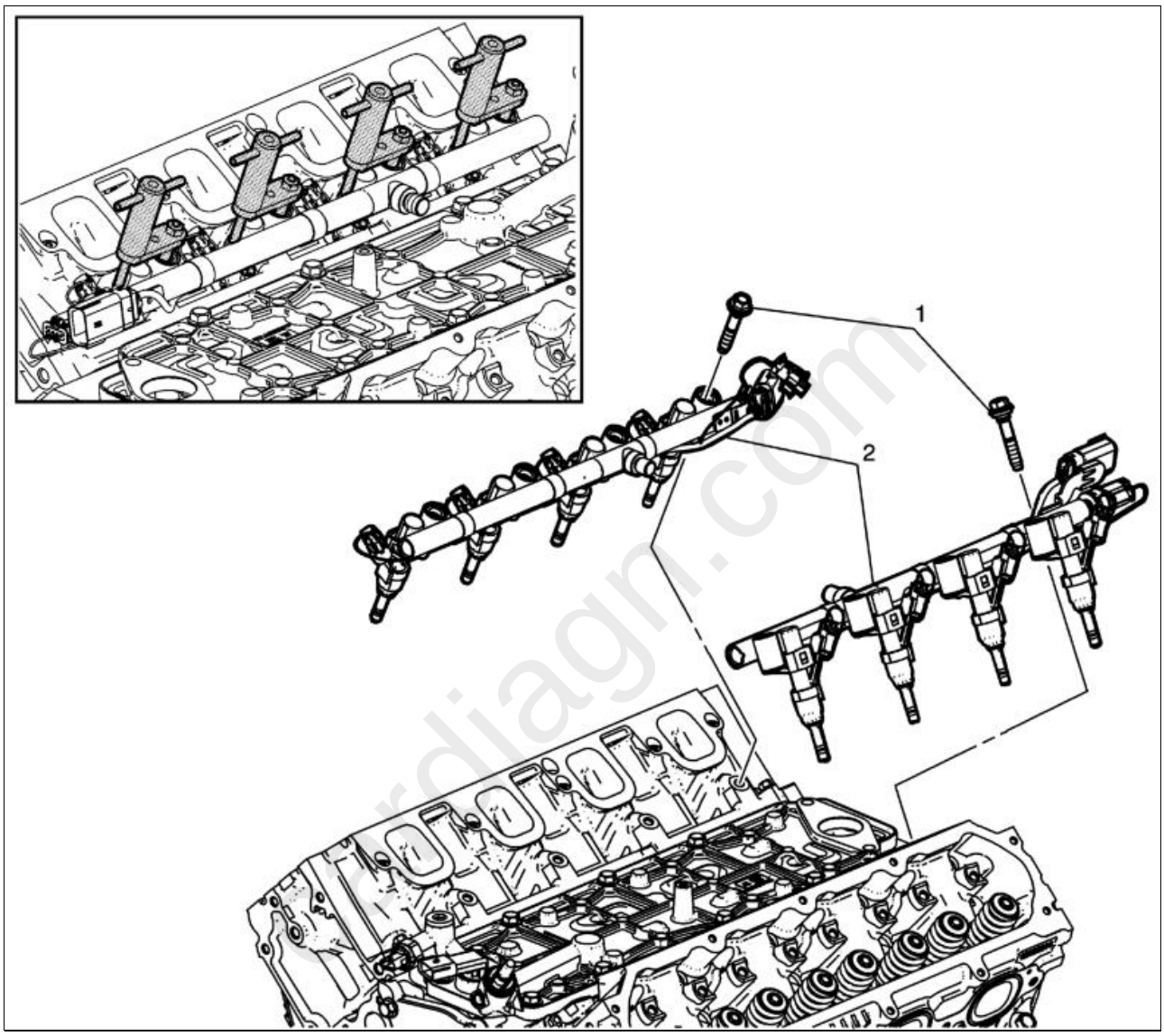
> *NOTE:*
>
> 1. *DO NOT reuse the high pressure fuel rail crossover pipe.*
> 2. *The tightening order and torque are critical to proper fuel system fit and function. Be sure to follow installation and tightening steps exactly.*

5. Remove the high pressure LH to RH fuel rail crossover pipe bolt (3).

6. Remove the fuel rail crossover pipe by loosening the pipe fittings (1 and 2).

REPAIR INSTRUCTIONS - OFF VEHICLE > FUEL RAIL AND INJECTORS REMOVAL

Fig 1: Fuel Rail and Injectors



Courtesy of GENERAL MOTORS COMPANY

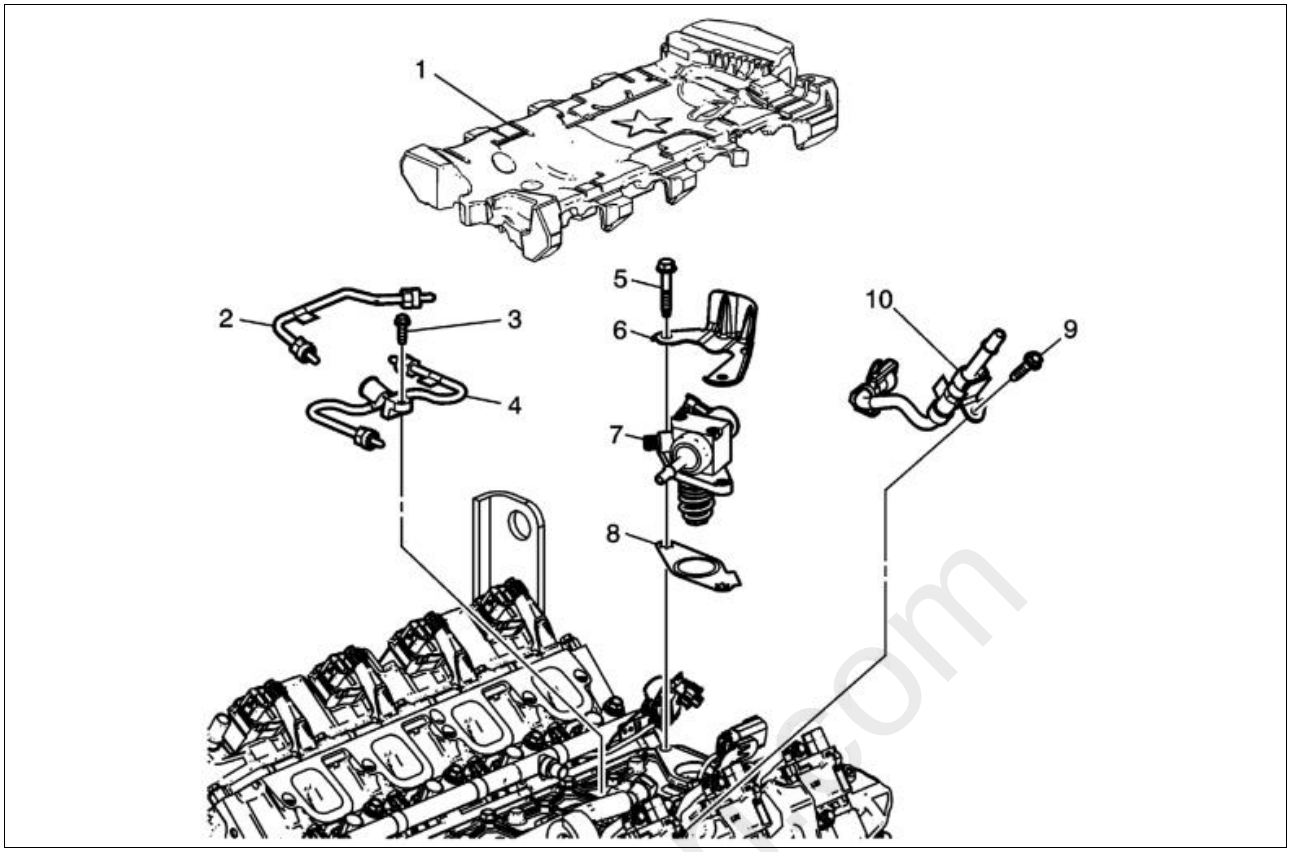
Callout	Component Name
1	Fuel Injection Fuel Rail Bolt
2	Direct Fuel Injection Fuel Rail Assembly Procedure *NOTE:*

	1. *In some cases, the fuel injectors may be difficult to remove because of heavy carbon build-up or other factors. Excessive force with the removal tool can damage the fuel rail, injectors or both. If injectors are difficult to remove, apply solvent to the base of the injector bores, and allow adequate soaking time, to loosen the fuel injectors.* 2. *Pull the fuel rail and injectors as an assembly.* 3. *To prevent material from entering the combustions chambers make sure the area around each injector is clean and free of debris before the injectors are removed from the injector bores.* 1. Install two sets of **EN-49248** remover. 2. Install one remover in each of the fuel rail fastener bores. 3. Remove by turning each section of the remover an equal amount to pull the fuel rail and injectors out evenly. **Special Tools** **EN-49248** Injector Rail Assembly Remover For equivalent regional tools, refer to Special Tools .
3	Fuel Rail Insulator

REPAIR INSTRUCTIONS - OFF VEHICLE > FUEL PUMP REMOVAL

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Fig 1: Fuel Pump



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	*CAUTION:* *Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage* Fuel Pump Bolt
2	Fuel Pump Cover
3	Bolt Retainer
4	Fuel Pump Assembly
5	Fuel Pump Gasket

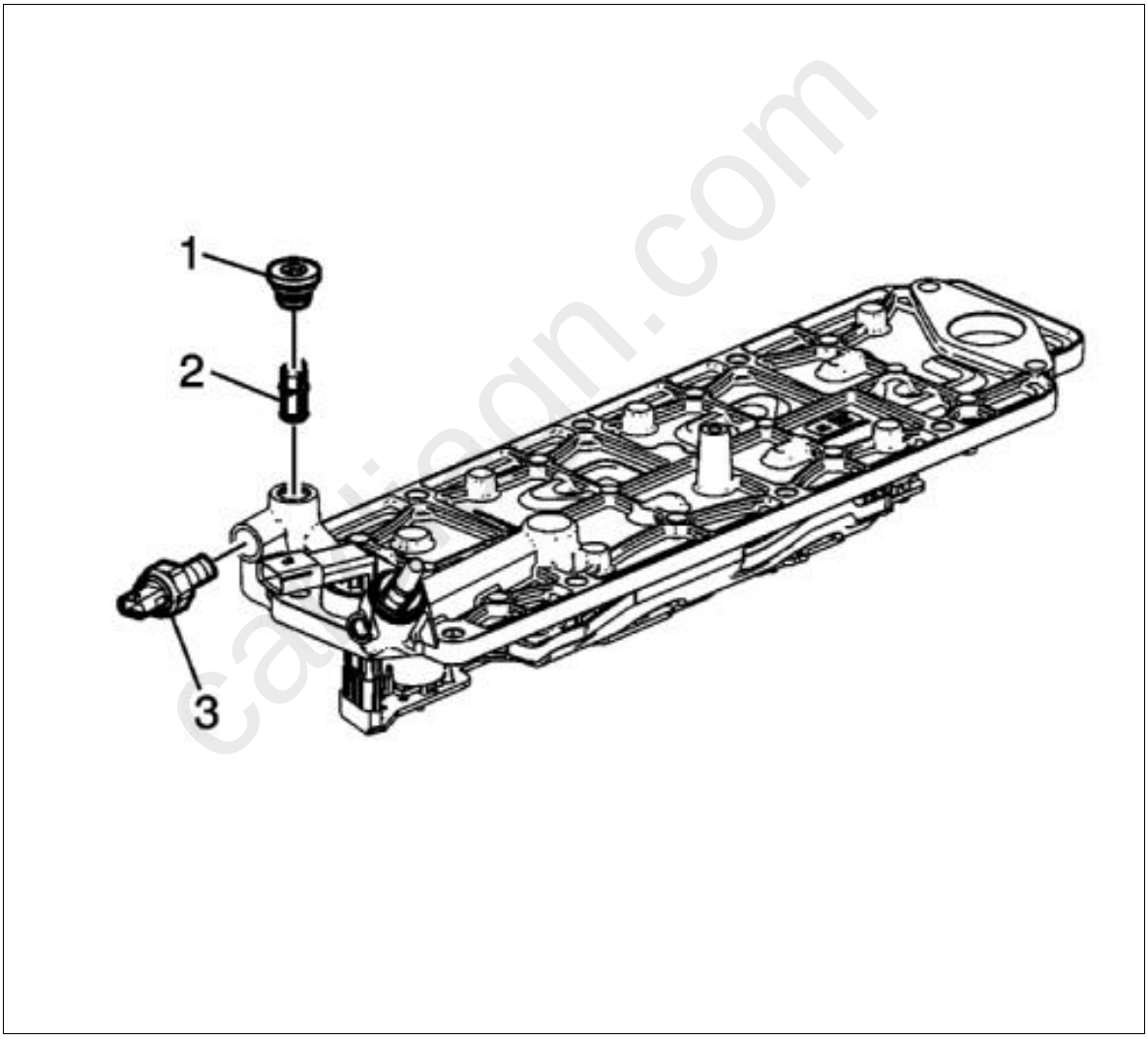
NOTE:

Discard gasket, it is not reusable.

Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER OIL FILTER REMOVAL

Fig 1: Valve Lifter Oil Filter



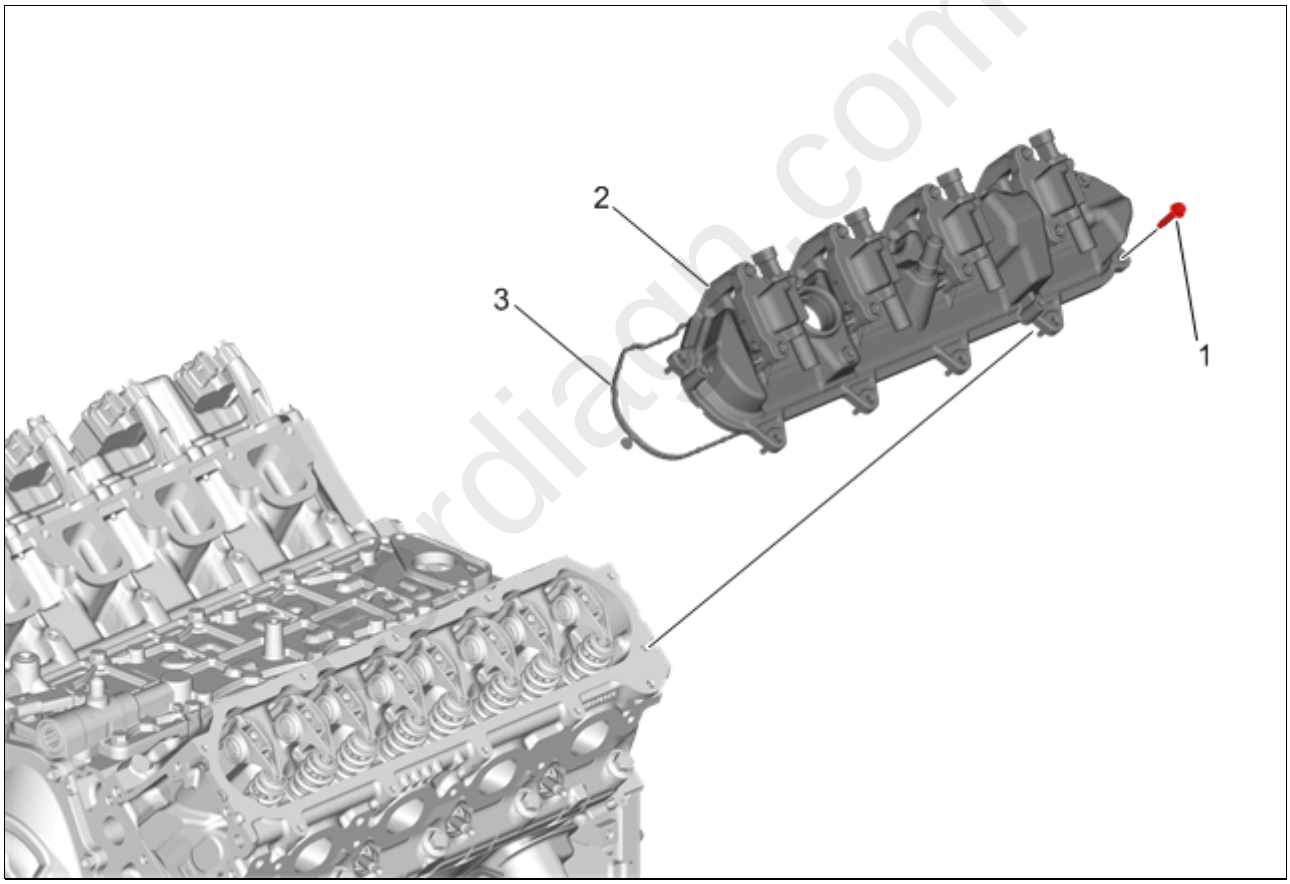
Courtesy of GENERAL MOTORS COMPANY

> *NOTE:*
>
> *Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.*

1. Remove the oil pressure sensor (3).
2. Remove the valve lifter oil manifold plug (1) and oil filter (2).

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE > VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE

Fig 1: Valve Rocker Arm Cover - Left Side



Courtesy of GENERAL MOTORS COMPANY

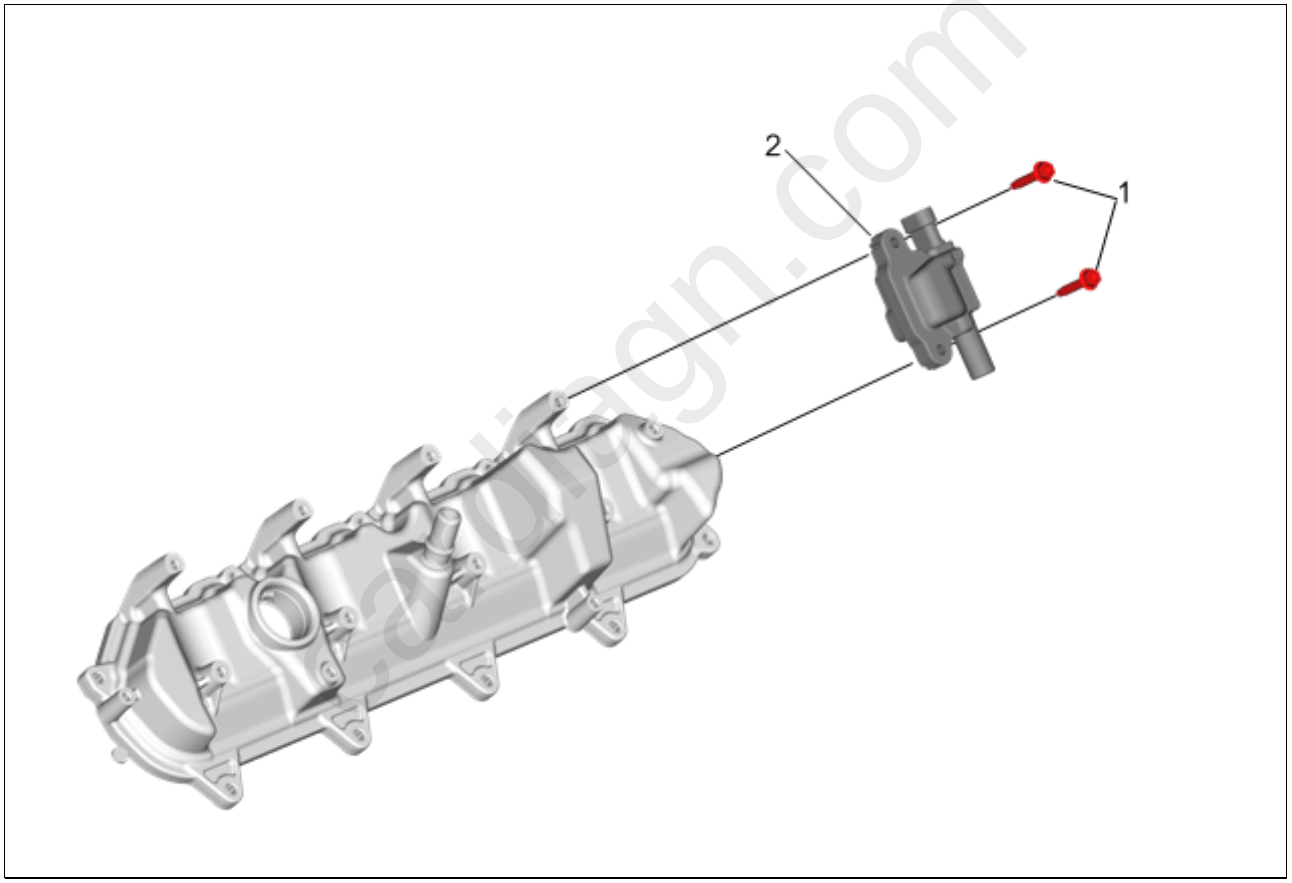
Valve Rocker Arm Cover Removal - Left Side

Callout	Component Name
1	Valve Rocker Arm Cover Bolt (Qty: 10)
2	Valve Rocker Arm Cover - Left Side

3	Valve Rocker Arm Cover Gasket Refer to Replacing Engine Gaskets . *NOTE:* *Discard gasket, it is not reusable.*

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE > VALVE ROCKER ARM COVER DISASSEMBLE - LEFT SIDE

Fig 1: Valve Rocker Arm Cover - Left Side



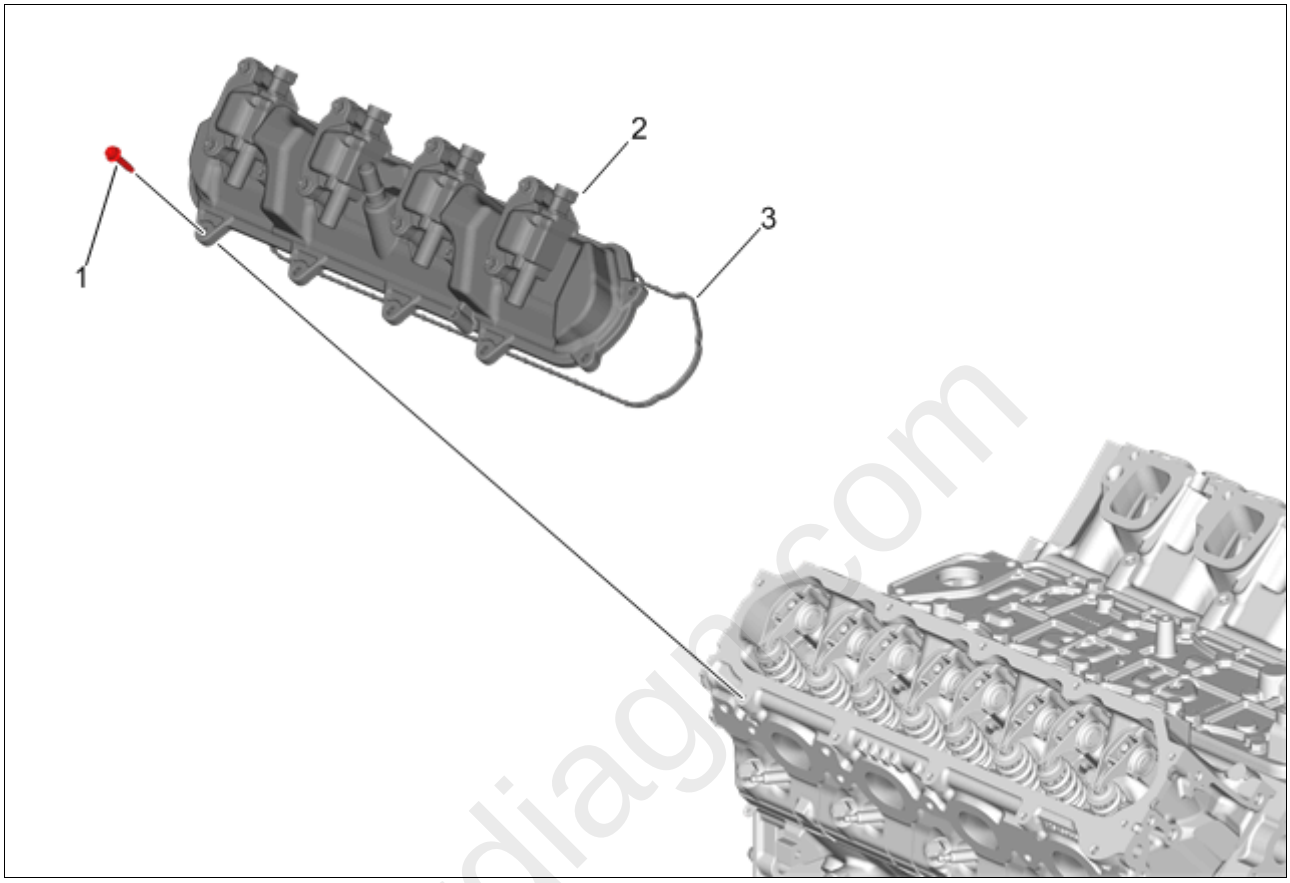
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Disassemble - Left Side

Callout	Component Name
1	Ignition Coil Bolt (Qty: 8)
2	Ignition Coil (Qty: 4)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE > VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE

Fig 1: Valve Rocker Arm Cover - Right Side



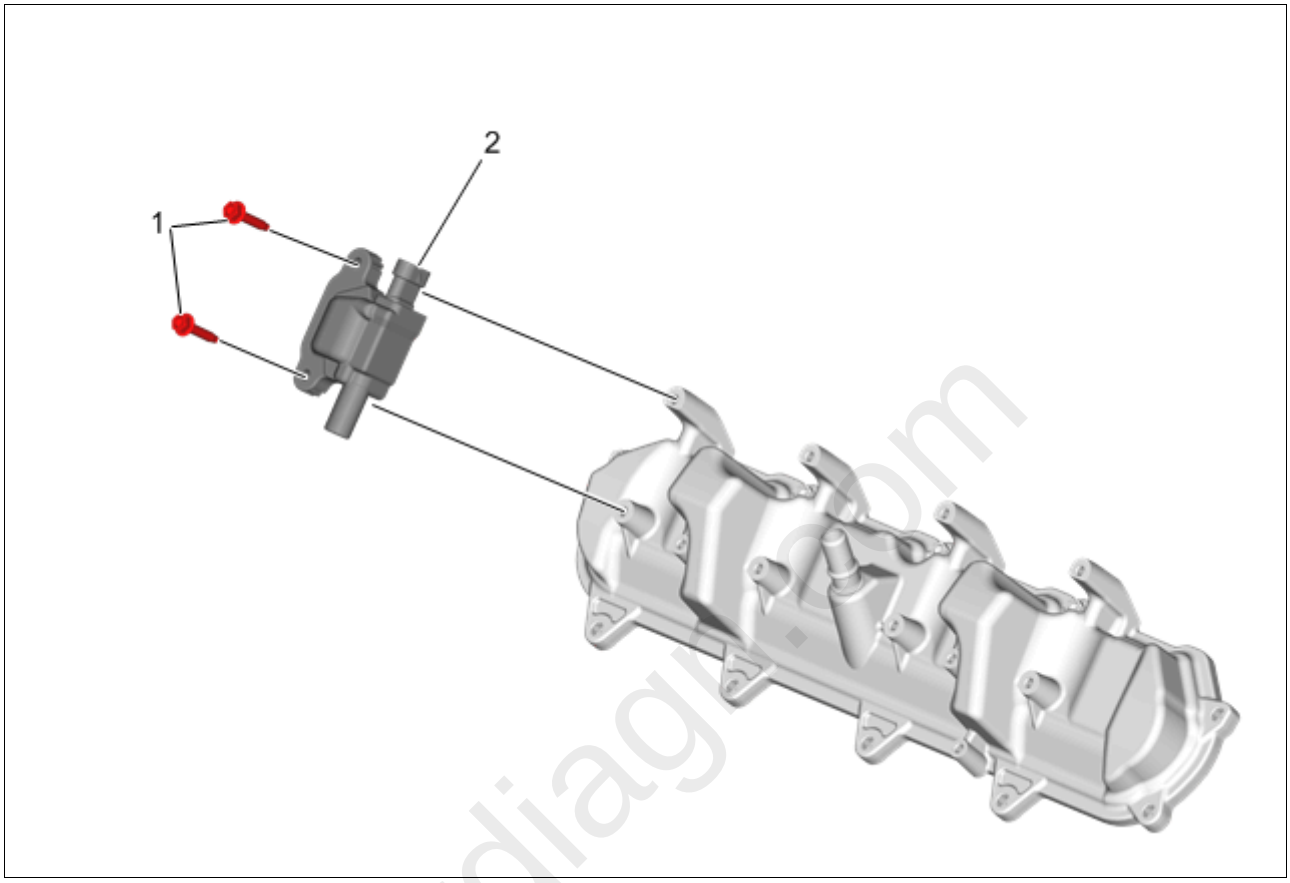
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Removal - Right Side

Callout	Component Name
1	Valve Rocker Arm Cover Bolt (Qty: 10)
2	Valve Rocker Arm Cover - Right Side
3	Valve Rocker Arm Cover Gasket Refer to Replacing Engine Gaskets . *NOTE:* *Discard gasket, it is not reusable.*

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE > VALVE ROCKER ARM COVER DISASSEMBLE - RIGHT SIDE

Fig 1: Valve Rocker Arm Cover - Right Side



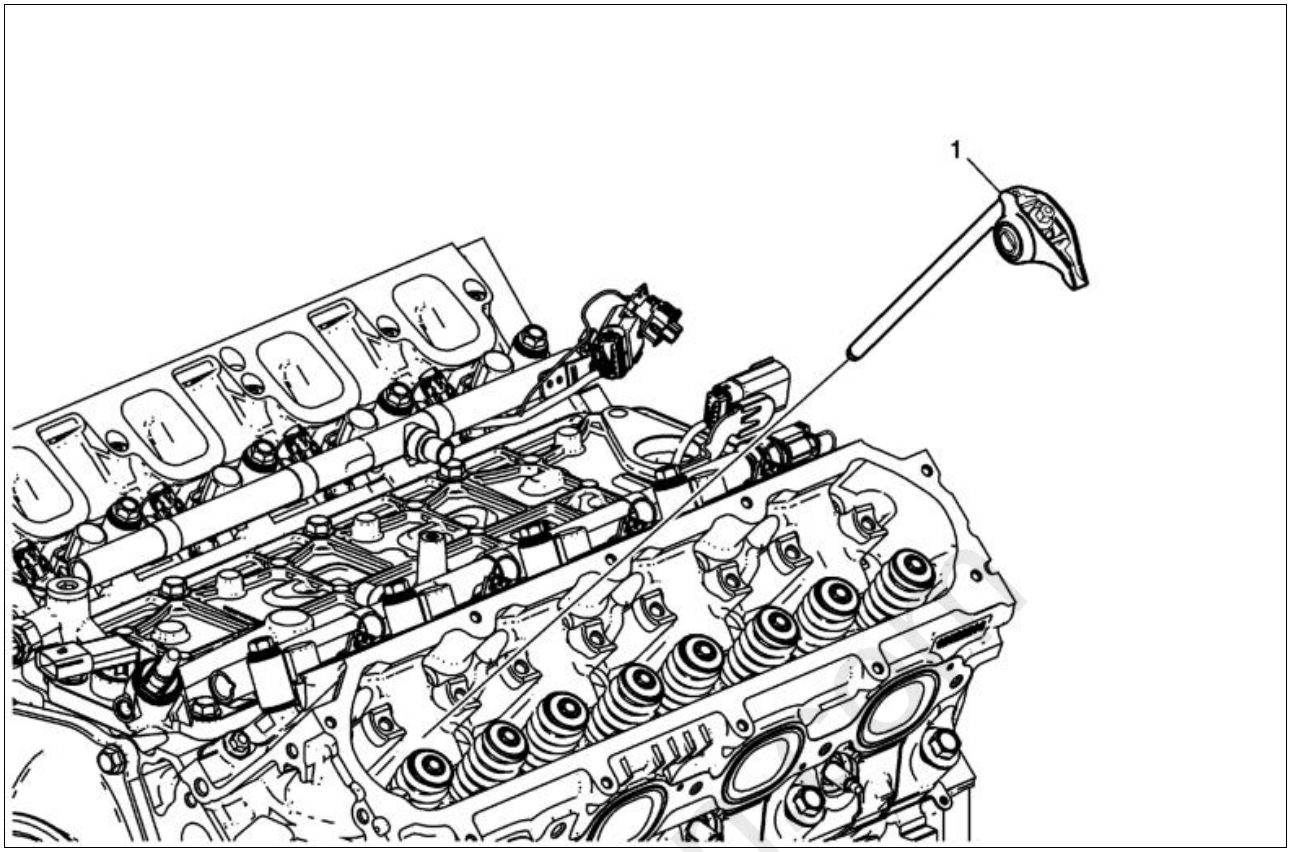
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Disassemble - Right Side

Callout	Component Name
1	Ignition Coil Bolt (Qty: 8)
2	Ignition Coil (Qty: 4)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM AND PUSH ROD REMOVAL

Fig 1: Valve Rocker Arm and Push Rod



Courtesy of GENERAL MOTORS COMPANY

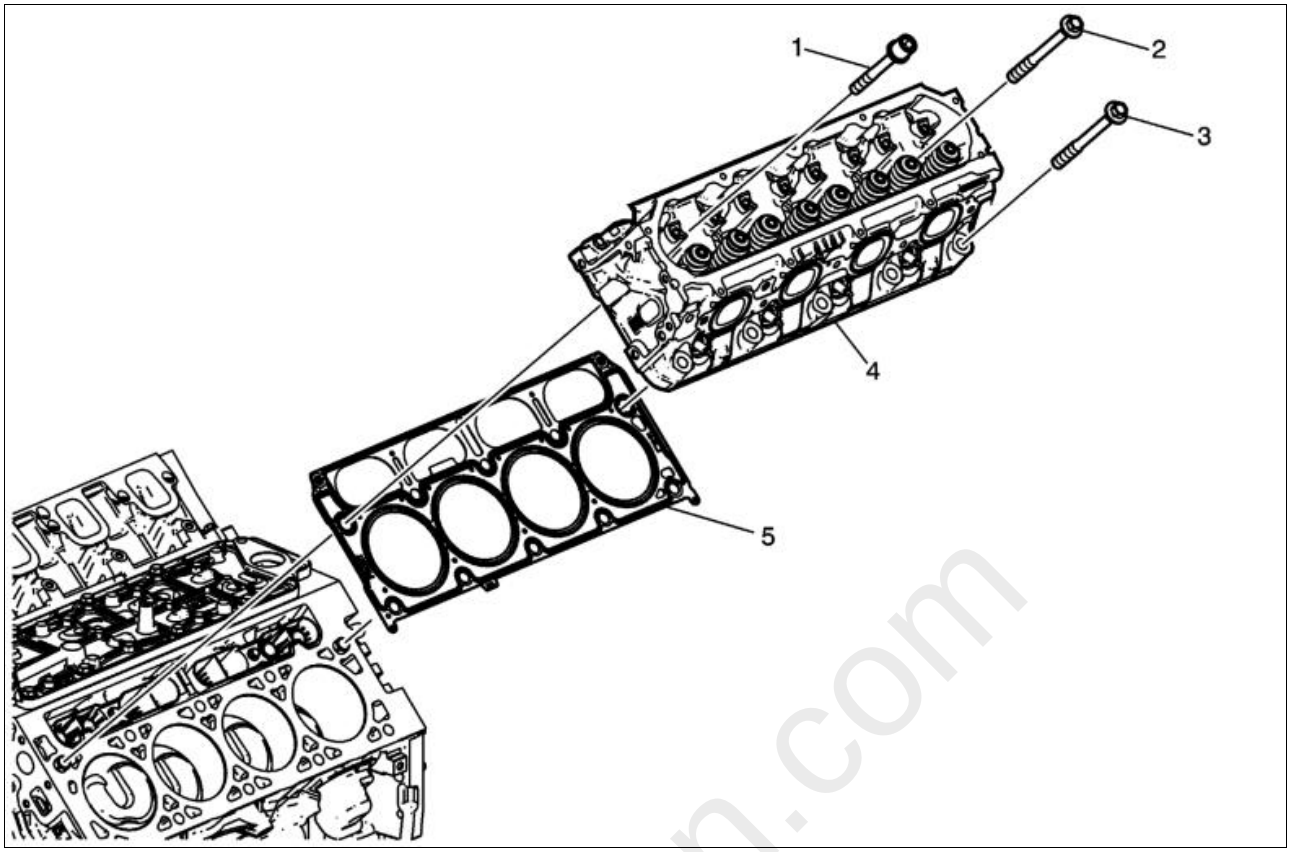
NOTE:

Place the valve rocker arms and valve pushrods in a rack so they can be installed in the same location from which they were removed.

Callout	Component Name
1	Valve Rocker Arm and Push Rod Assembly *NOTE:* *The rocker arm bolts are not serviced separately.*

REPAIR INSTRUCTIONS - OFF VEHICLE > CYLINDER HEAD REMOVAL - LEFT SIDE

Fig 1: Cylinder Head Removal - Left Side



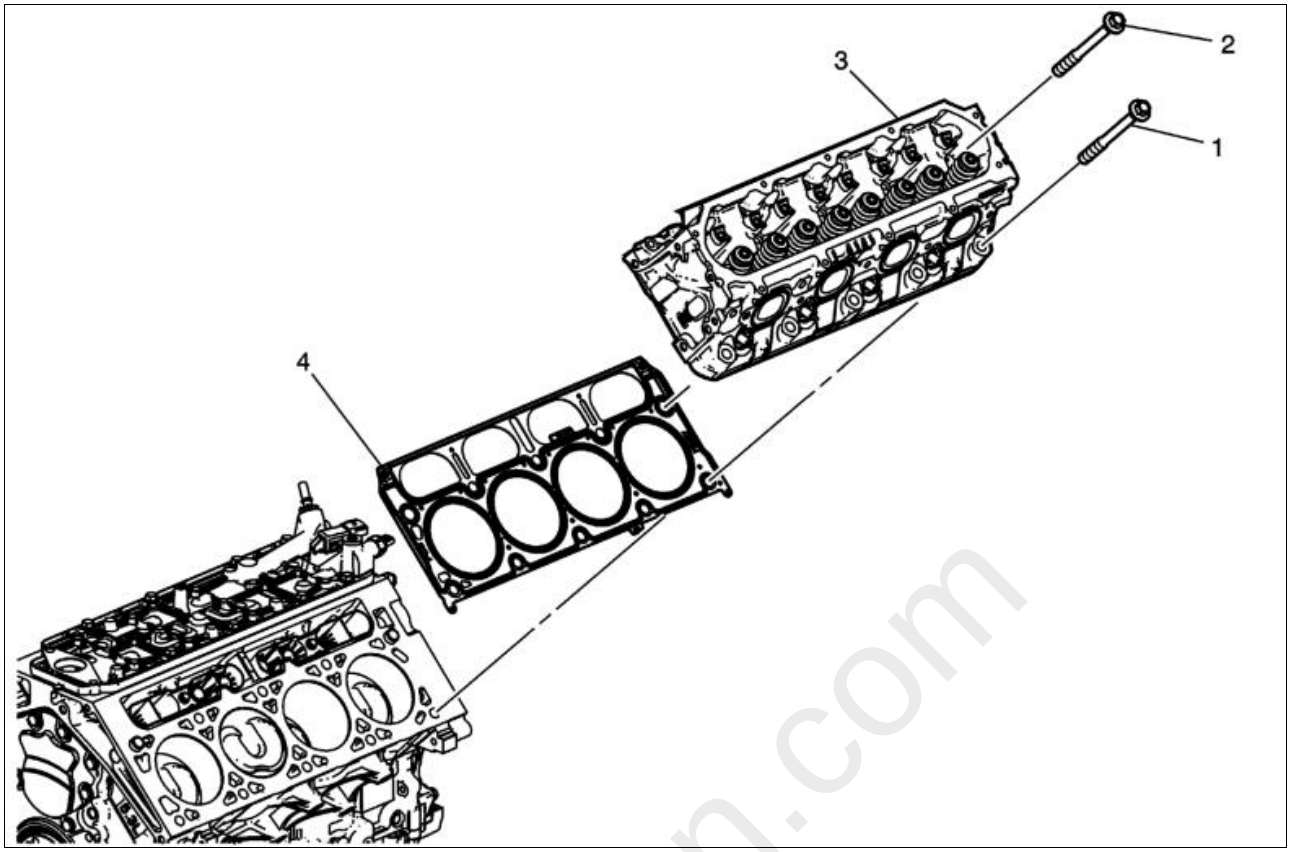
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure If camshaft lobe lift measurement is required, perform measurement prior to removal of the cylinder heads. Refer to Camshaft and Bearings Cleaning and Inspection .	
1	Cylinder Head Bolt
2	Cylinder Head Bolt
3	Cylinder Head Bolt
4	Cylinder Head Assembly
5	Cylinder Head Gasket Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > CYLINDER HEAD REMOVAL - RIGHT SIDE

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Fig 1: Cylinder Head Removal - Right Side



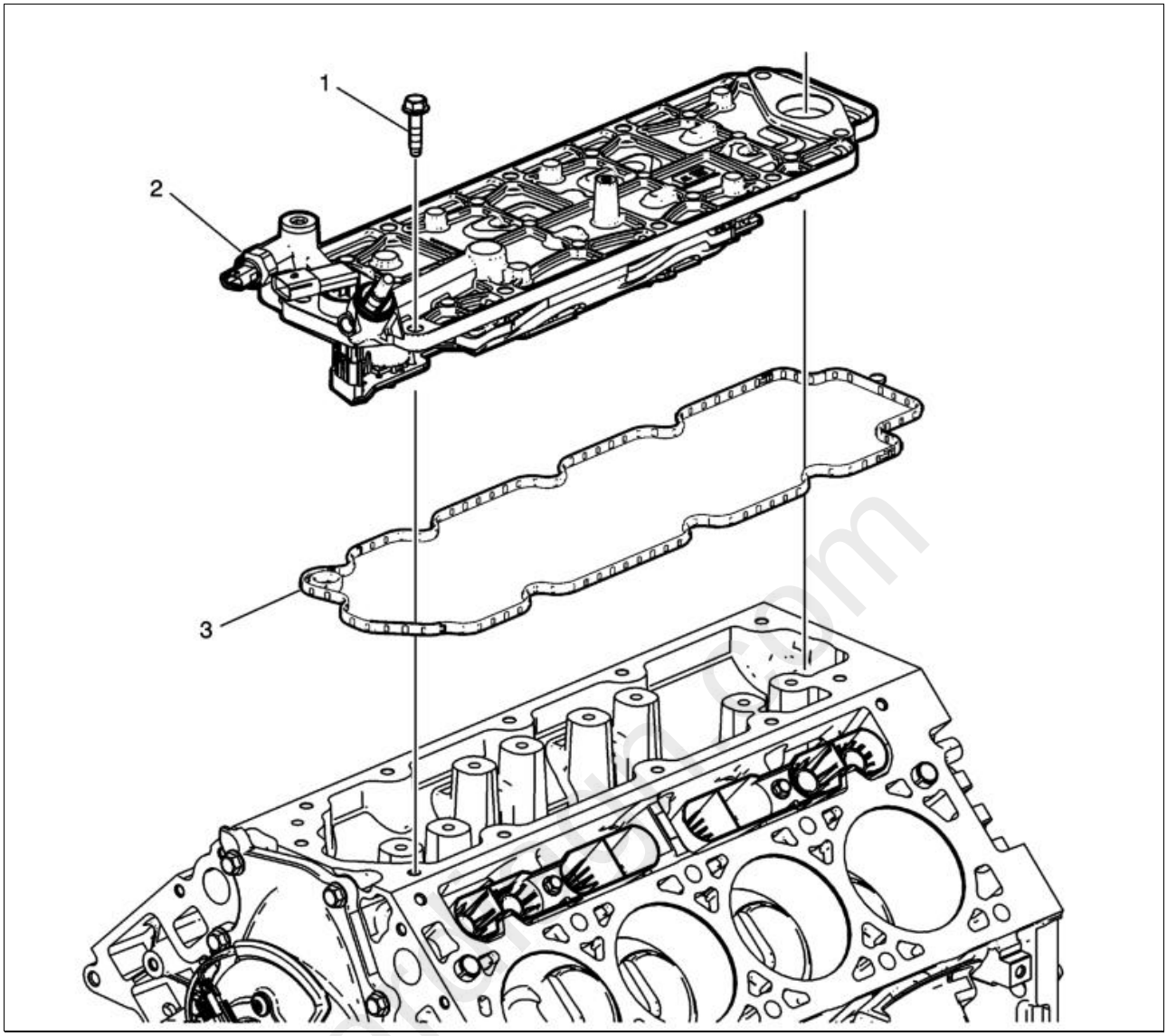
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure If camshaft lobe lift measurement is required, perform measurement prior to removal of the cylinder heads. Refer to Camshaft and Bearings Cleaning and Inspection .	
1	Cylinder Head Bolt
2	Cylinder Head Bolt
3	Cylinder Head Assembly
4	Cylinder Head Gasket Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER OIL MANIFOLD REMOVAL > VALVE LIFTER OIL MANIFOLD REMOVAL

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Fig 1: Valve Lifter Oil Manifold



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Valve Lifter Oil Manifold Removal

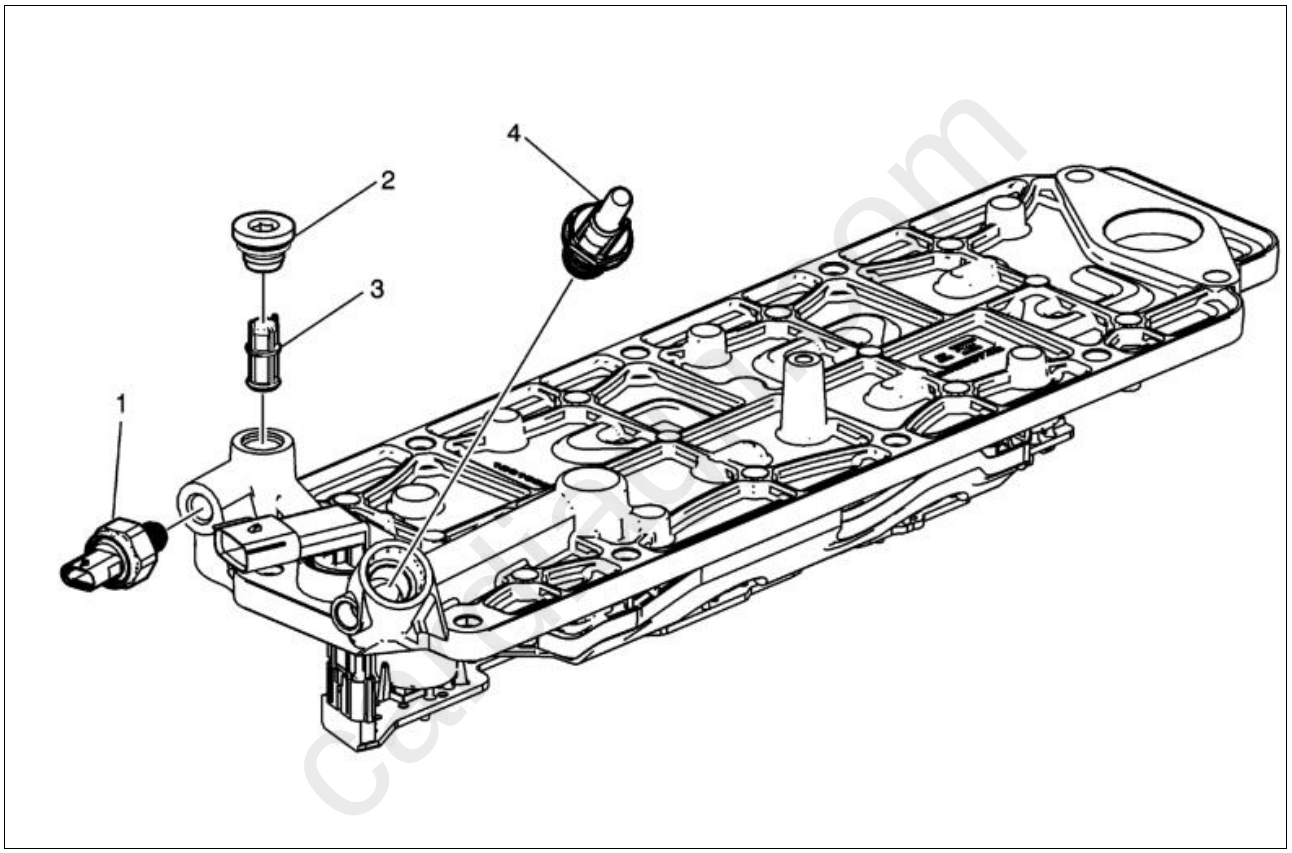
Callout	Component Name
1	Valve Lifter Oil Manifold Bolt
2	Valve Lifter Oil Manifold Assembly
3	Valve Lifter Oil Manifold Gasket Refer to Replacing Engine Gaskets .

NOTE:

Discard gasket, it is not reusable.

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER OIL MANIFOLD REMOVAL > VALVE LIFTER OIL MANIFOLD DISASSEMBLE

Fig 1: Valve Lifter Oil Manifold Disassemble



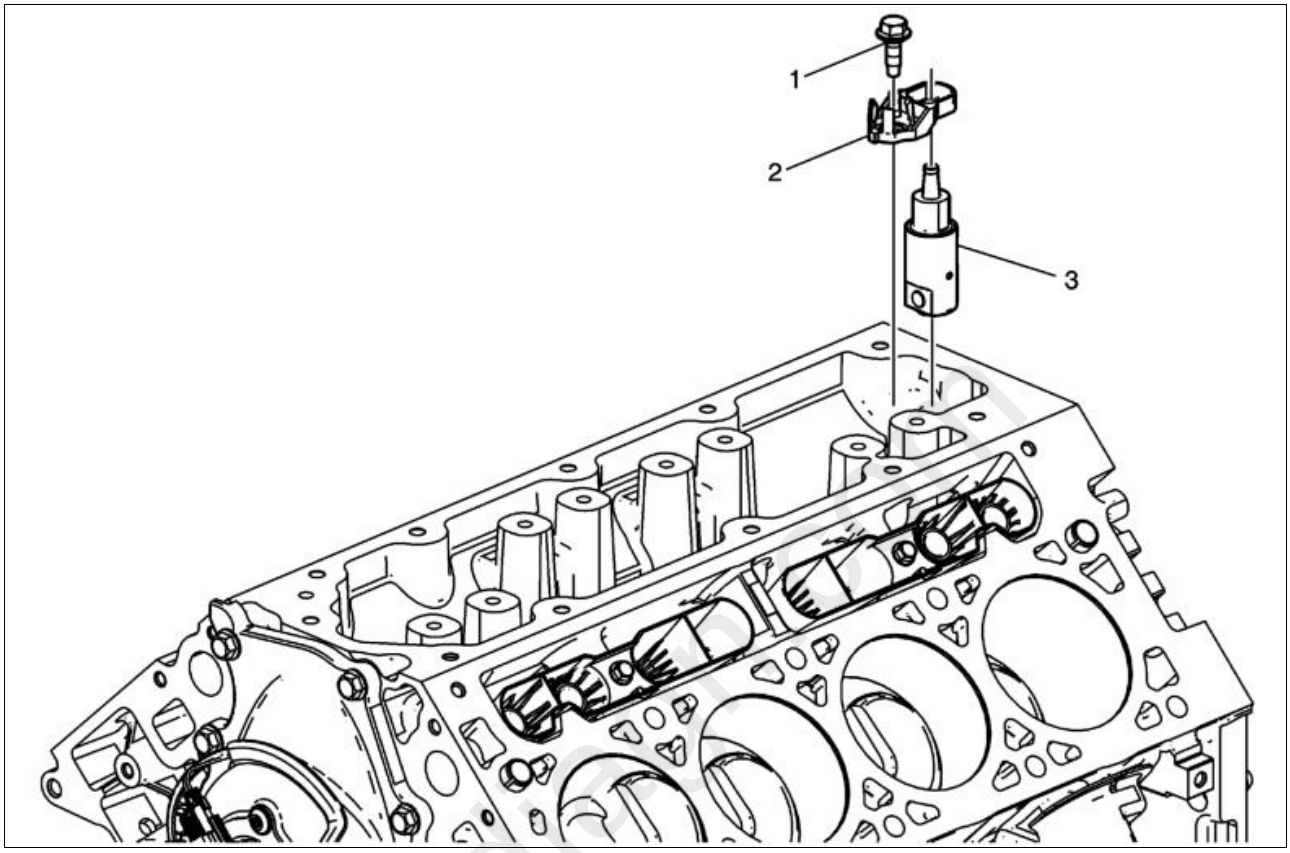
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Oil Manifold Disassemble

Callout	Component Name
1	Oil Pressure Sensor
2	Valve Lifter Oil Manifold Plug
3	Valve Lifter Oil Filter
4	PCV Valve

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER FOLLOWER GUIDE REMOVAL

Fig 1: Valve Lifter Follower Guide

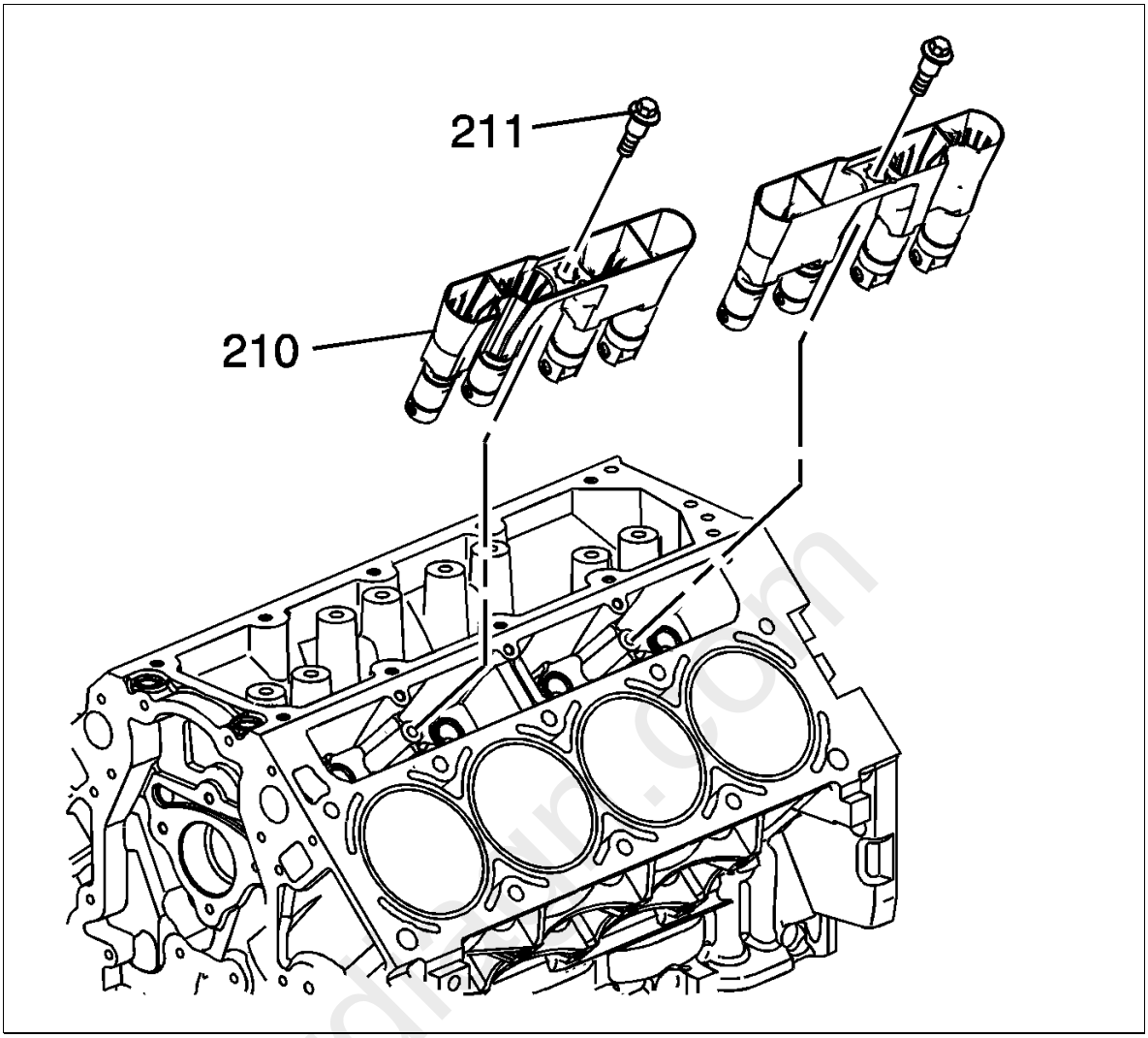


Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Valve Lifter Follower Guide Bolt
2	Valve Lifter Follower Guide
3	Valve Lifter Follower

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER REMOVAL

Fig 1: Lifter Guides & Lifters

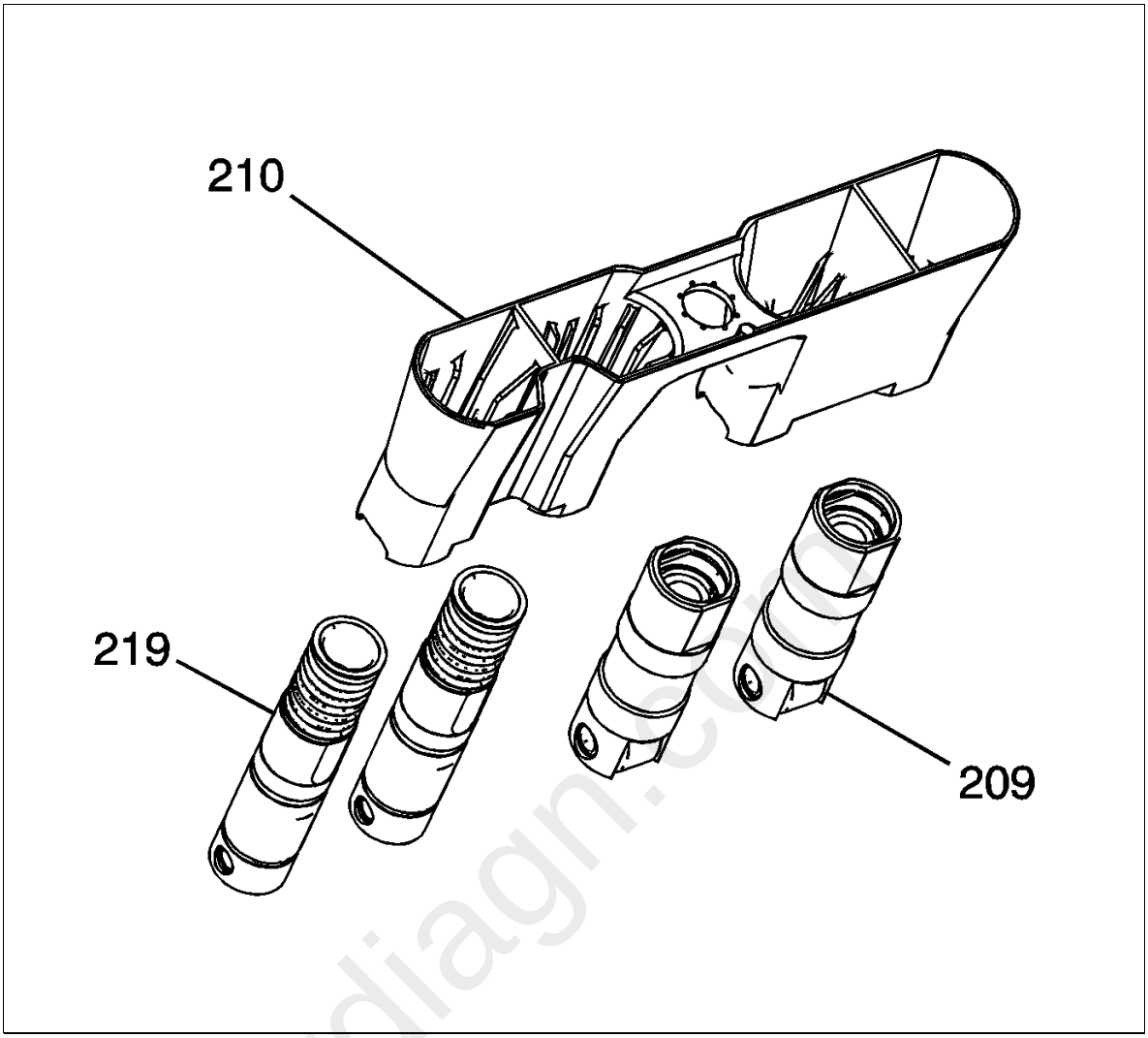


Courtesy of GENERAL MOTORS COMPANY

1. Remove the bolts (211).
2. Remove the guides (210) with lifters.

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

Fig 2: Lifter Guides & Lifters

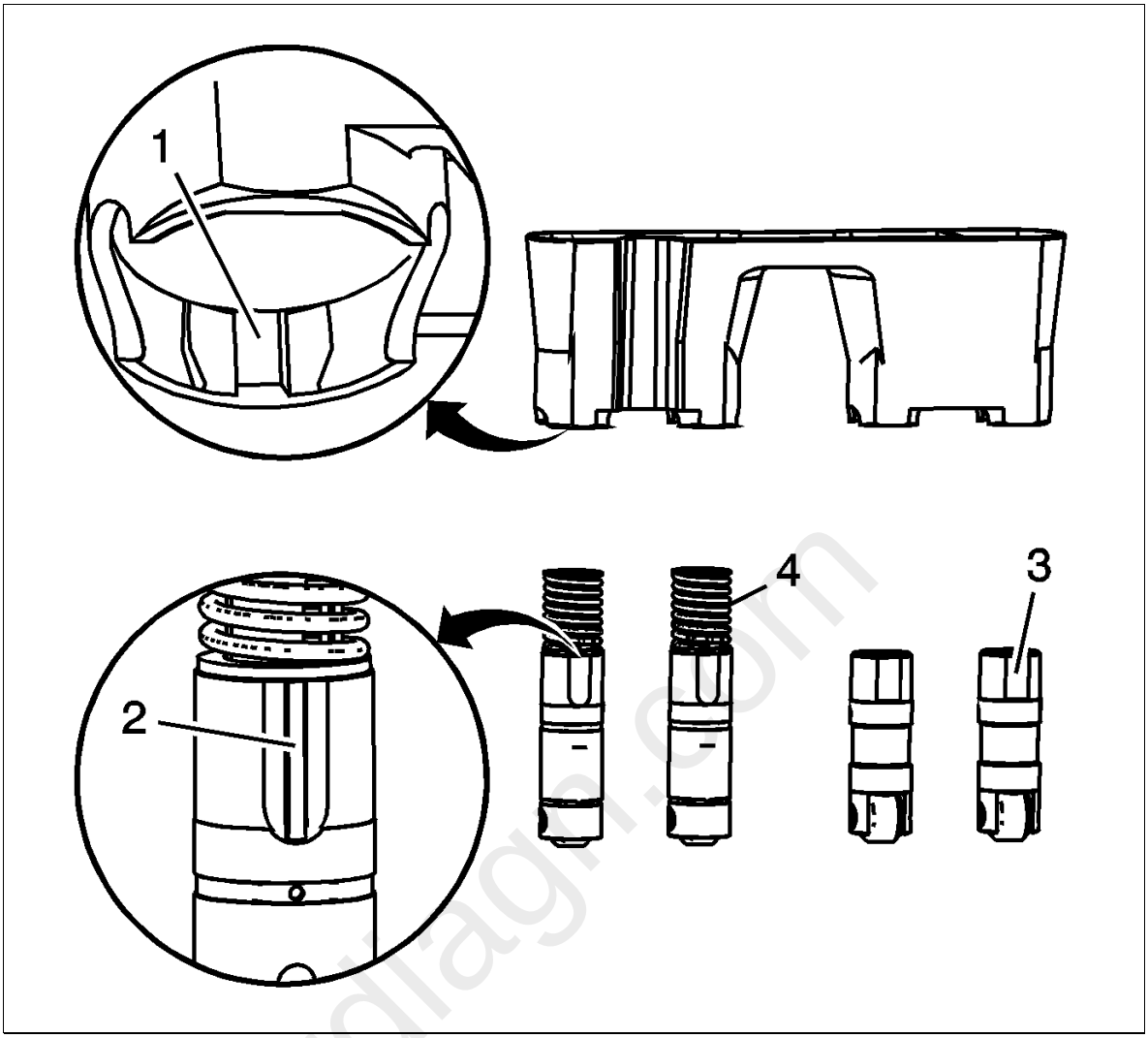


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3. Remove the valve lifters (209, 219) from the guide (210).

Fig 3: Inserting Valve Lifters Into Lifter Guides

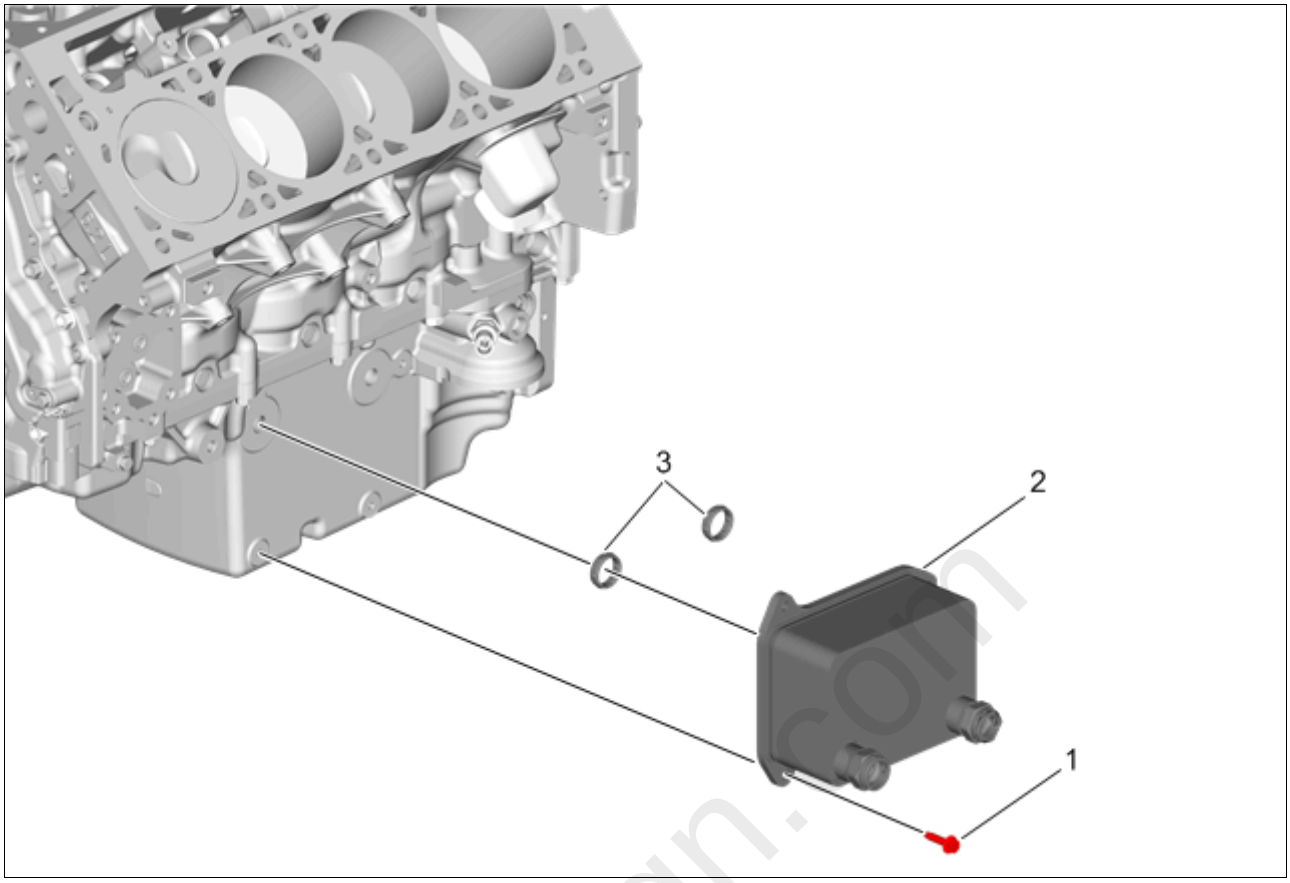


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4. Organize or mark the components so they can be installed in the same location from which they were removed. The active fuel management lifters (4) are installed into the guide by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2). Refer to Separating Parts .

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE OIL COOLER REMOVAL

Fig 1: Engine Oil Cooler



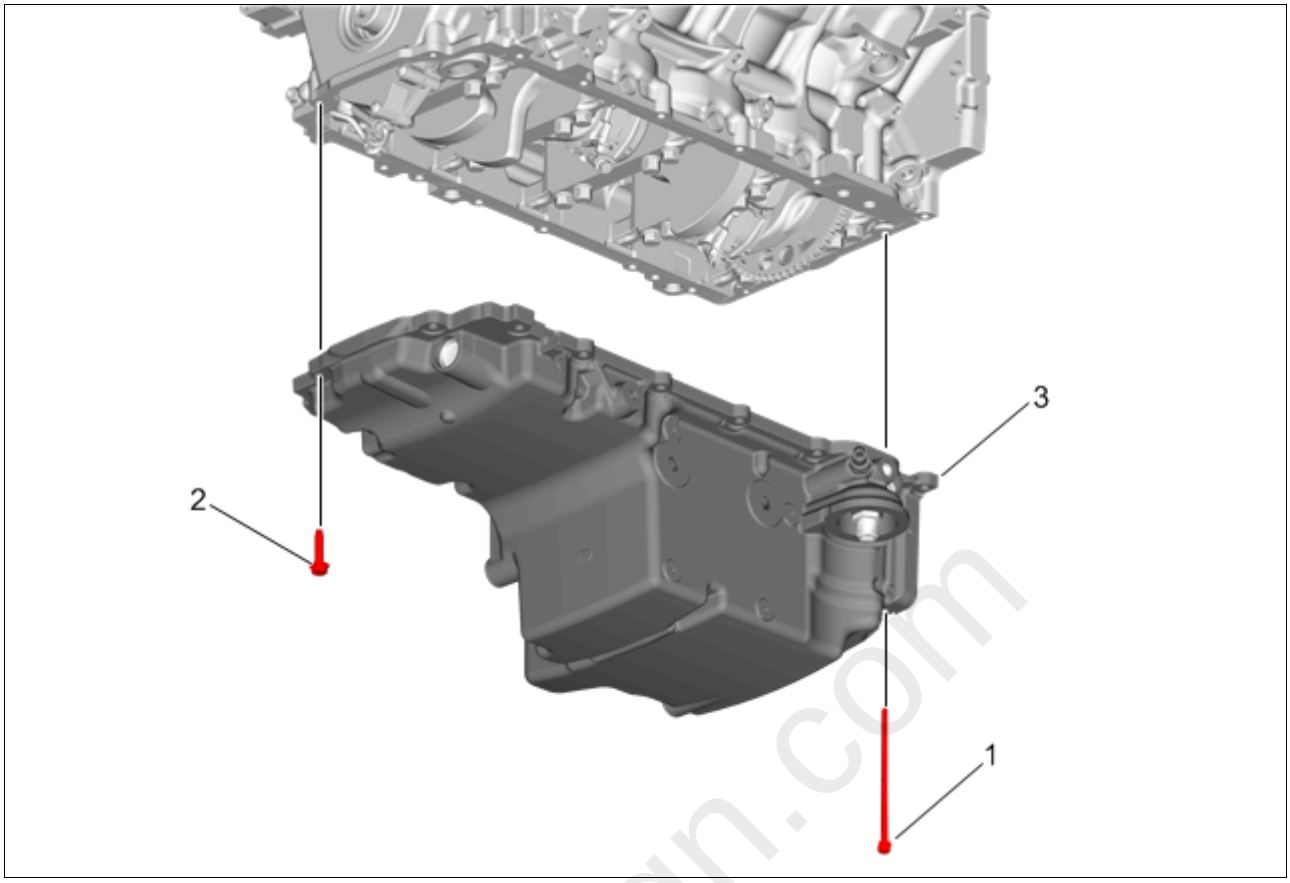
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Oil Cooler Bolt (Qty: 4)
2	Engine Oil Cooler
3	Engine Oil Cooler Gasket (Qty: 2) *NOTE:* *Discard gasket, it is not reusable.* Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PAN REMOVAL

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Fig 1: Oil Pan



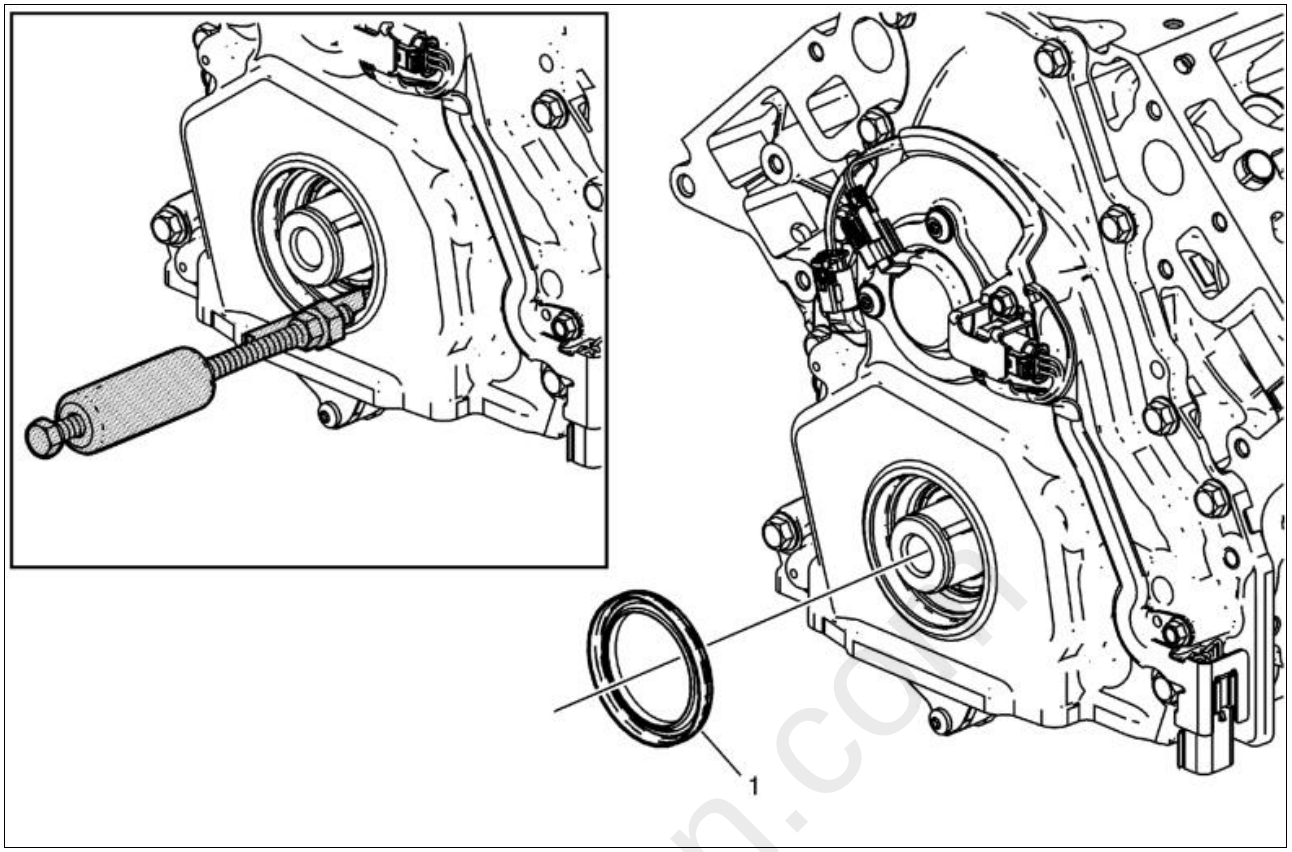
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pan Bolt (Qyt. 2)
2	Oil Pan Bolt (Qty: 14)
3	Oil Pan Assembly

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REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT FRONT OIL SEAL REMOVAL

Fig 1: Crankshaft Front Oil Seal



Courtesy of GENERAL MOTORS COMPANY

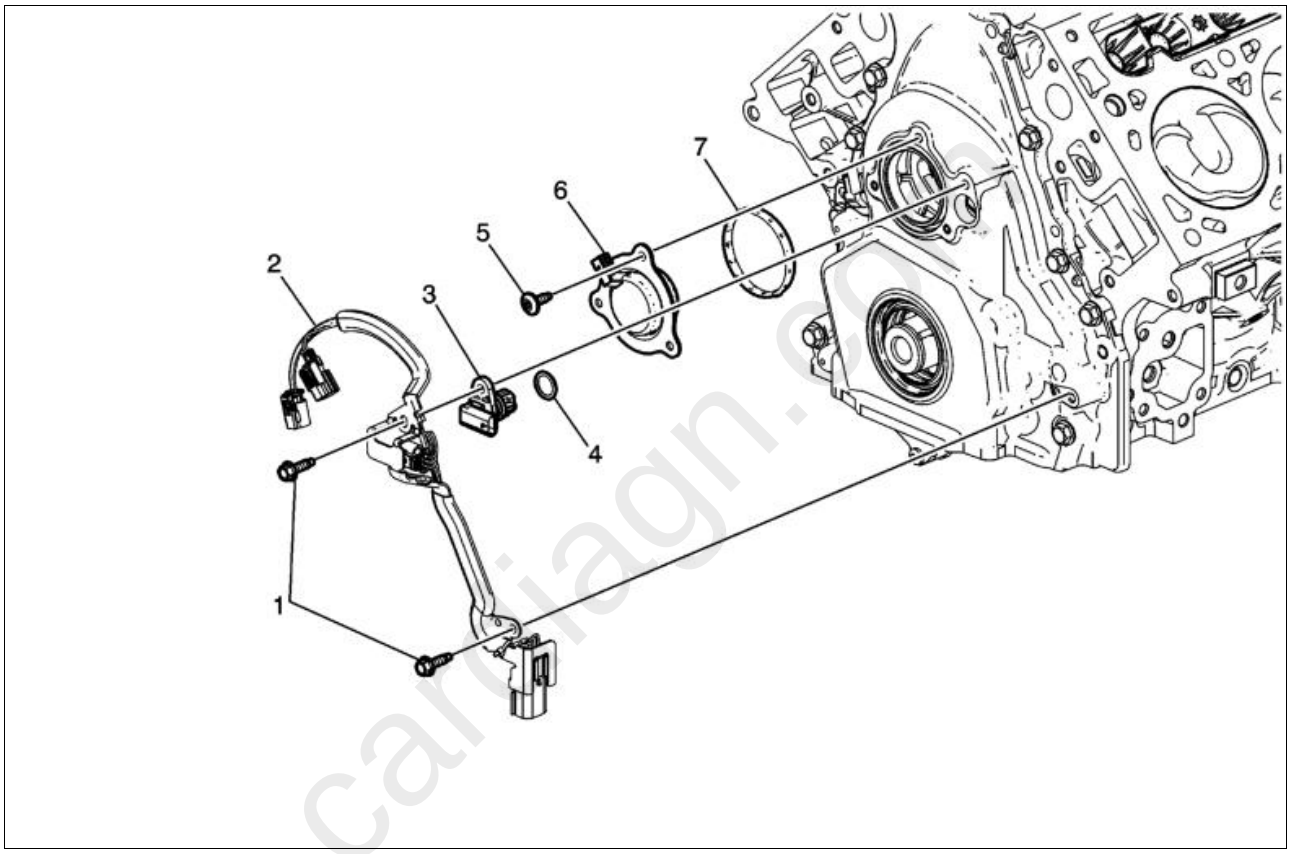
Callout	Component Name
1	Crankshaft Front Oil Seal Procedure 1. Install **EN-51096** crankshaft rear seal remover onto **GE-23907-1** slide hammer. *NOTE:* ***EN-51096*** *crankshaft rear seal remover has two ends. The end with the small bend will be used to remove the seal.* 2. Slide the small bend of **EN-51096** crankshaft rear seal remover between the lip of the front seal and crankshaft. Ensure that the small bend of **EN-51096** crankshaft rear seal remover engages the rear side of the front seal (1). While rotating **EN-51096** crankshaft rear seal remover and **GE-23907-1** slide hammer around the seal, use the slide hammer to remove the seal. Special Tools • **EN-51096** Crankshaft Rear Seal Remover

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	• **GE-23907-1** Slide Hammer For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FRONT COVER REMOVAL > CAMSHAFT POSITION SENSOR HARNESS, CAMSHAFT POSITION SENSOR AND CAMSHAFT ACTUATOR MAGNET REMOVAL

Fig 1: Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet



Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Removal

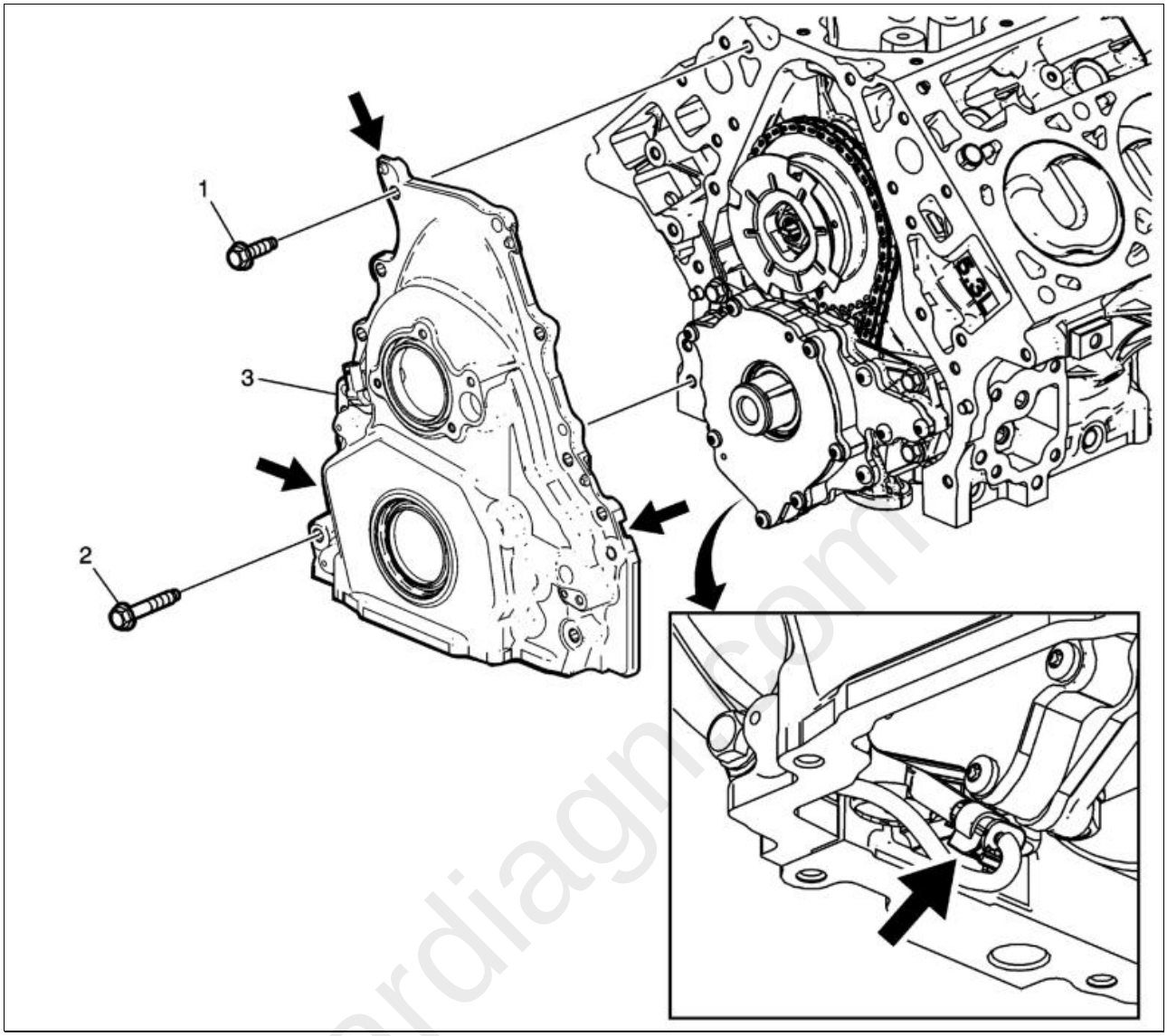
Callout	Component Name
1	Camshaft Position Sensor Harness Bolts
2	Camshaft Position Sensor Harness
3	Camshaft Position Sensor
4	Camshaft Position Sensor Seal

	NOTE: *Discard seal, it is not reusable.* Refer to Replacing Engine Gaskets .
5	Camshaft Actuator Magnet Bolts
6	Camshaft Actuator Magnet
7	Camshaft Actuator Magnet Gasket *NOTE:* *Discard gasket, it is not reusable.*

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FRONT COVER REMOVAL > FRONT COVER REMOVAL

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Fig 1: Front Cover



Courtesy of GENERAL MOTORS COMPANY

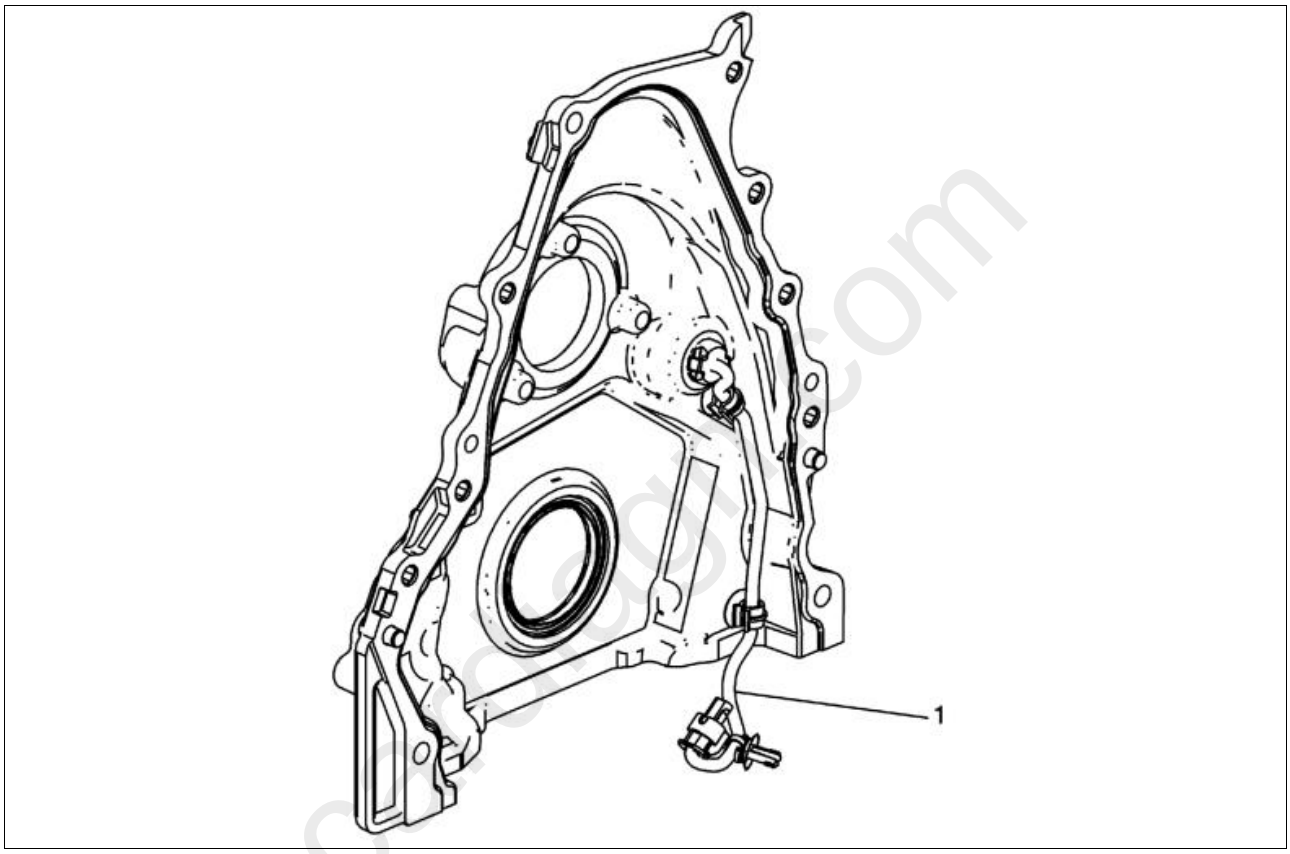
Front Cover Removal

Callout	Component Name
Preliminary Procedure The oil pump flow control valve harness must be removed before the front cover can be removed.	
1	Engine Front Cover Bolt
2	Engine Front Cover Bolt
3	Engine Front Cover *NOTE:*

To separate the front cover from the engine, pry at the points that are shown by the arrows.

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FRONT COVER REMOVAL > OIL PUMP FLOW CONTROL VALVE HARNESS REMOVAL

Fig 1: Oil Pump Flow Control Valve Harness



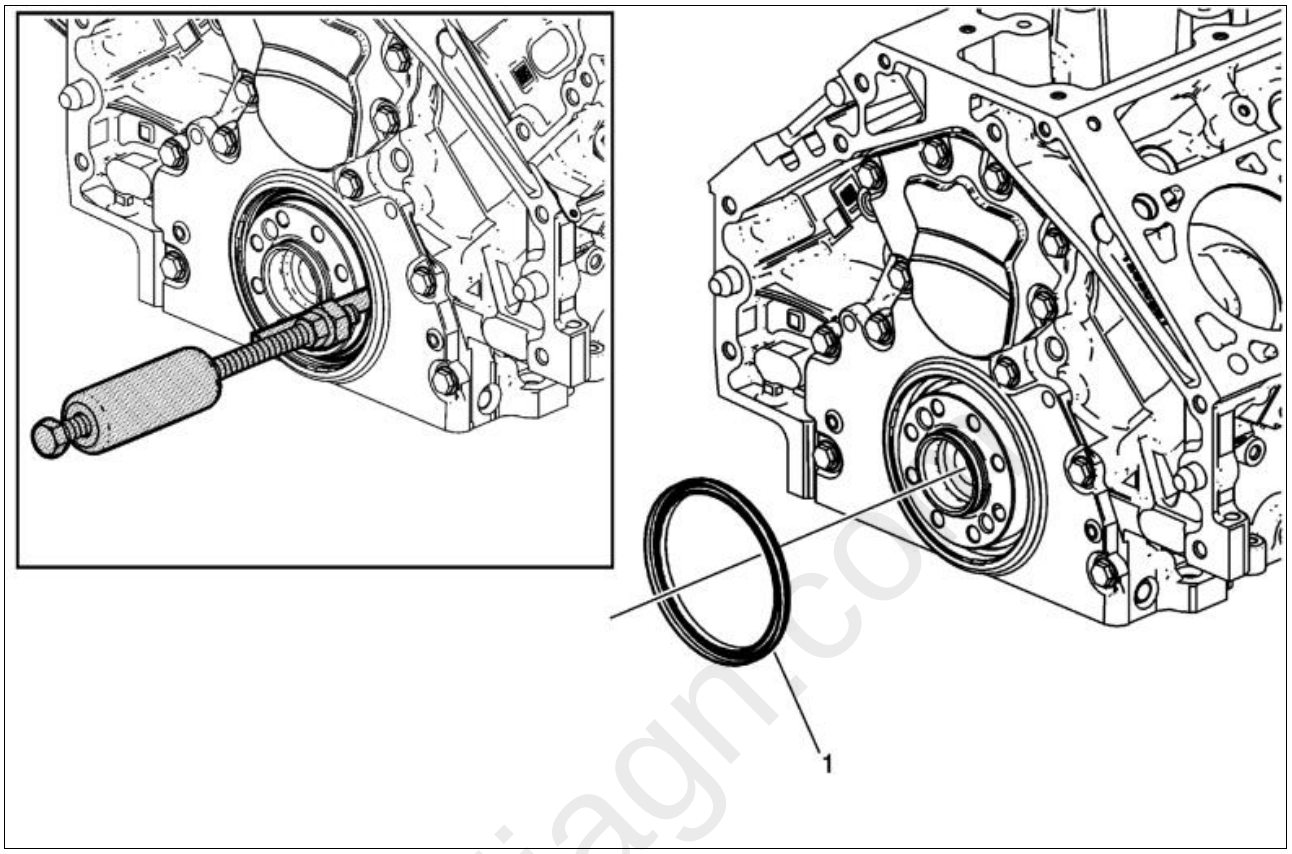
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Harness Removal

Callout	Component Name
1	Oil Pump Flow Control Valve Harness Procedure 1. Remove the wire from the 2 retainer clips. 2. Push the tabs in and pull the harness and connector through the front of the engine front cover

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT REAR OIL SEAL REMOVAL

Fig 1: Crankshaft Rear Oil Seal



Courtesy of GENERAL MOTORS COMPANY

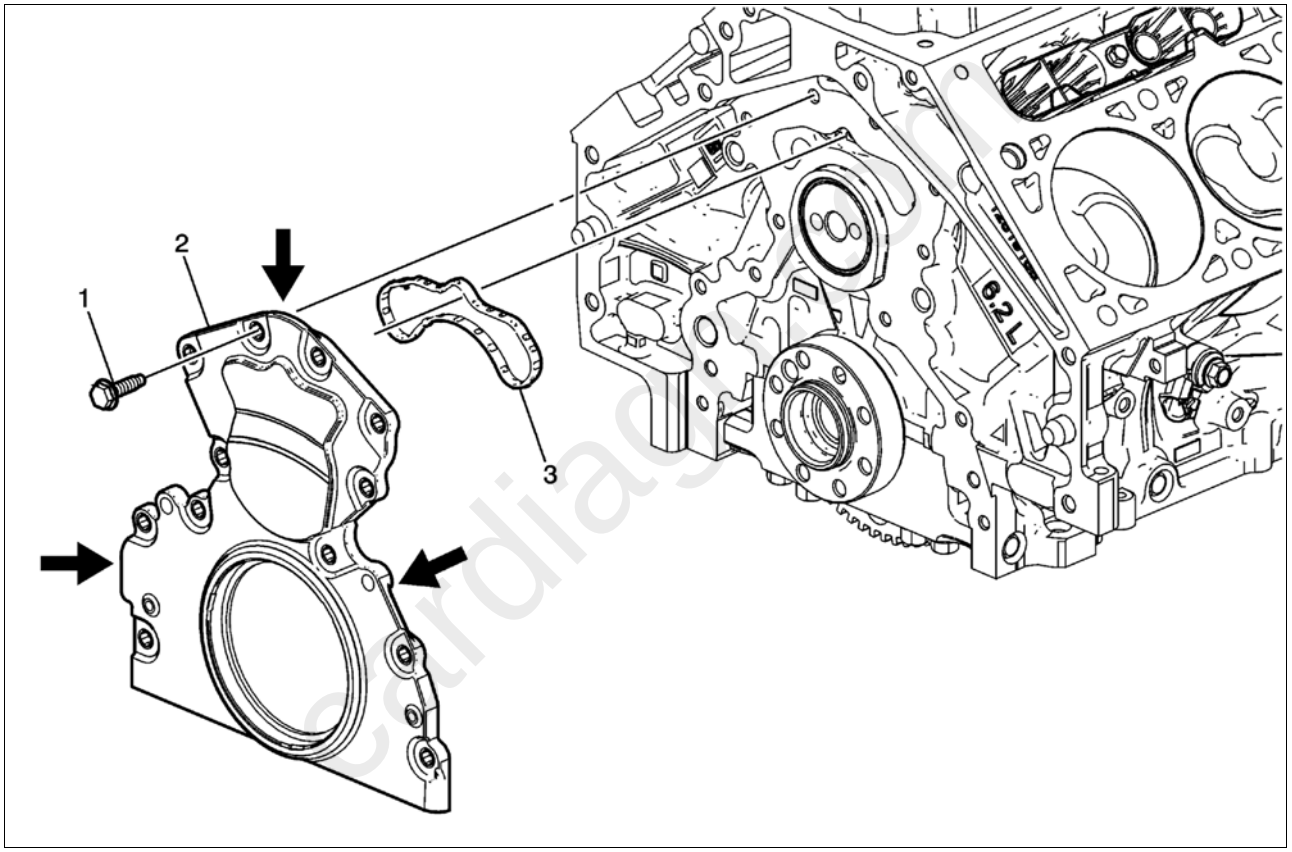
Callout	Component Name
1	Crankshaft Rear Oil Seal Procedure 1. Install **EN-51096** crankshaft rear seal remover onto **GE-23907-1** slide hammer. *NOTE:* ***EN-51096*** *crankshaft rear seal remover has two ends. The end with the small bend will be used to remove the seal.* 2. Slide the small bend of **EN-51096** crankshaft rear seal remover between the lip of the rear seal and crankshaft. Ensure that the small bend of **EN-51096** crankshaft rear seal remover engages the rear side of the rear seal (1). While rotating **EN-51096** crankshaft rear seal remover and **GE-23907-1** slide hammer around the seal and use the slide hammer to remove the seal.

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	Special Tools • **EN-51096** Crankshaft Rear Seal Remover • **GE-23907-1** Slide Hammer For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT REAR OIL SEAL HOUSING REMOVAL

Fig 1: Crankshaft Rear Oil Seal Housing



Courtesy of GENERAL MOTORS COMPANY

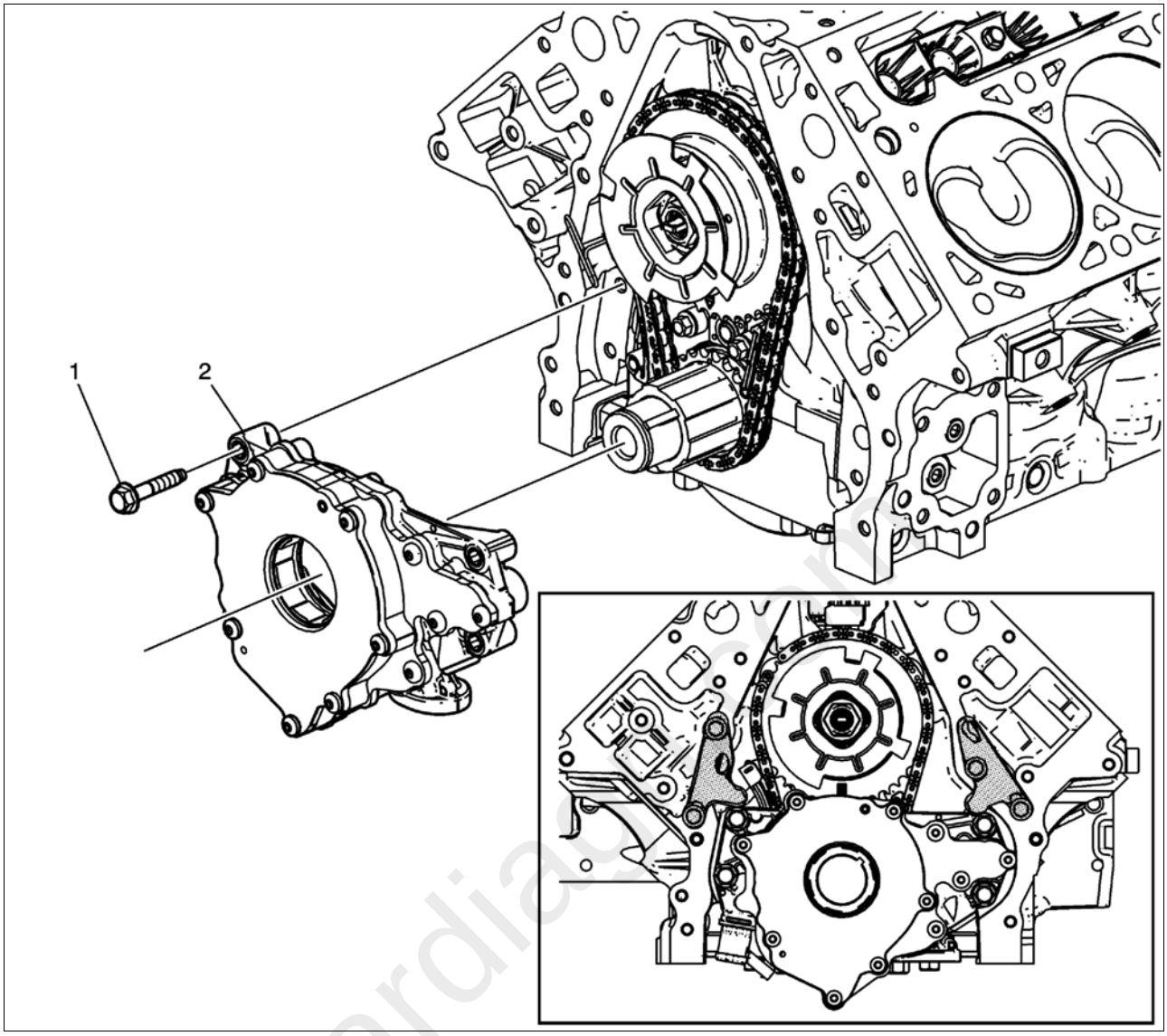
Callout	Component Name
1	Crankshaft Rear Oil Seal Housing Bolt
2	Crankshaft Rear Oil Seal Housing

	NOTE: *To separate the rear housing from the engine, pry at the points that are shown by the arrows.*
3	Crankshaft Rear Oil Seal Housing Gasket *NOTE:* *Discard gasket, it is not reusable.* Refer to Replacing Engine Gaskets .

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PUMP REMOVAL

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Fig 1: Oil Pump



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Callout	Component Name
Preliminary Procedure If oil pump is being removed to perform a different repair and is going to be reused, then **EN-51267** oil pump alignment tool MUST be installed on the engine block before the oil pump is removed and left in place until the oil pump is reinstalled. Failure to do so before the oil pump is removed will result in the original oil pump having to be replaced with a new oil pump.	
1	Oil Pump Bolt

	NOTE: *If the Oil Pump is going to be reused, then prior to removing oil Pump Bolts, install the oil pump alignment tool. If the oil pump is going to be replaced, then just remove the bolts and proceed to step 2.* Procedure 1. Hand Tighten the supplied bolts in the positions shown. 2. Hold the alignment tools tight to the oil pump housing and then torque the alignment tool bolts to 10 N.m (86 lb in). **Special Tools** **EN-51267** Oil Pump Alignment Tool For equivalent regional tools, refer to Special Tools .
2	Oil Pump Assembly

REPAIR INSTRUCTIONS - OFF VEHICLE > TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REMOVAL

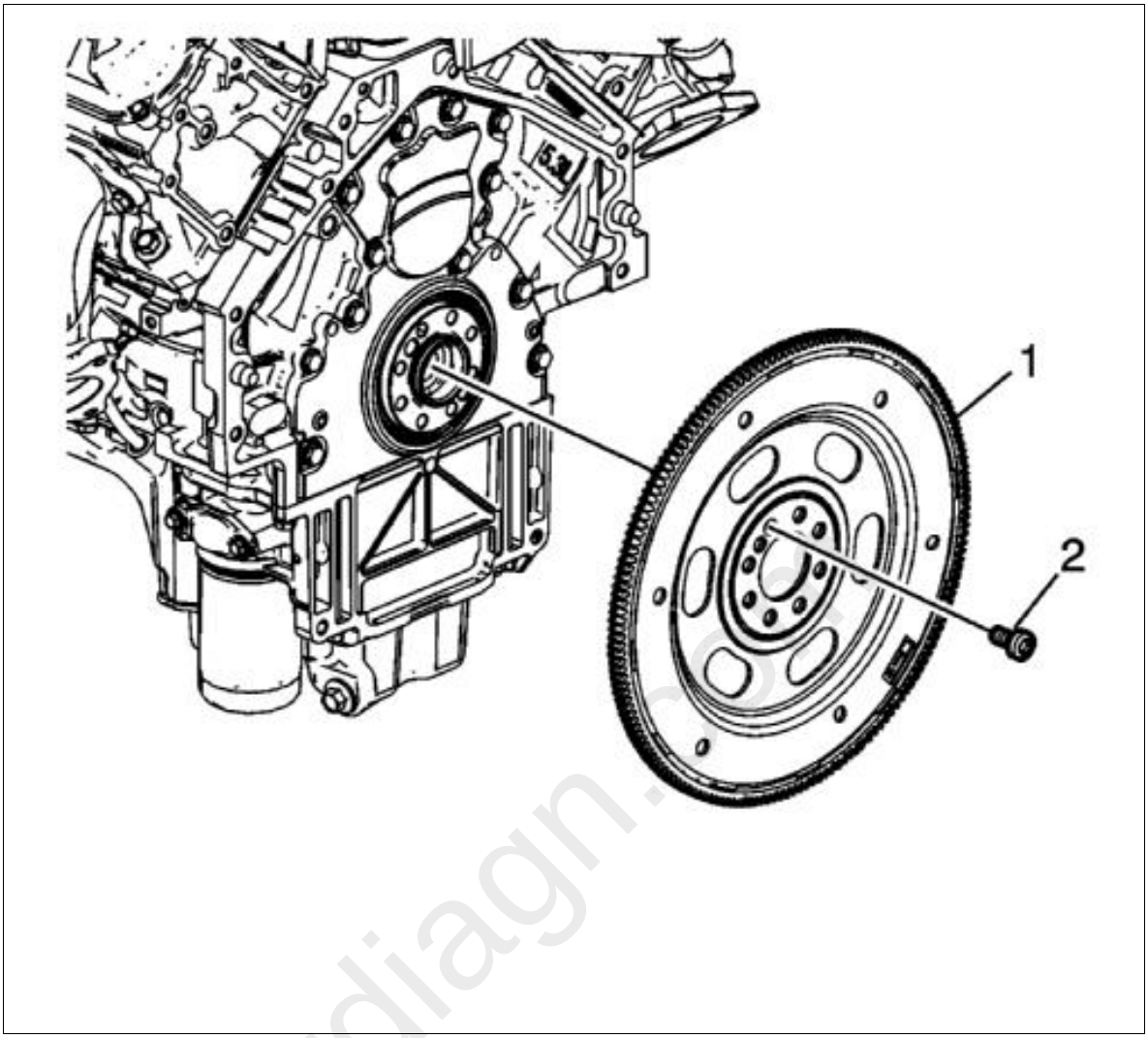
Special Tools

EN-42386-A Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools

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Fig 1: Automatic Transmission Flex Plate



Courtesy of GENERAL MOTORS COMPANY

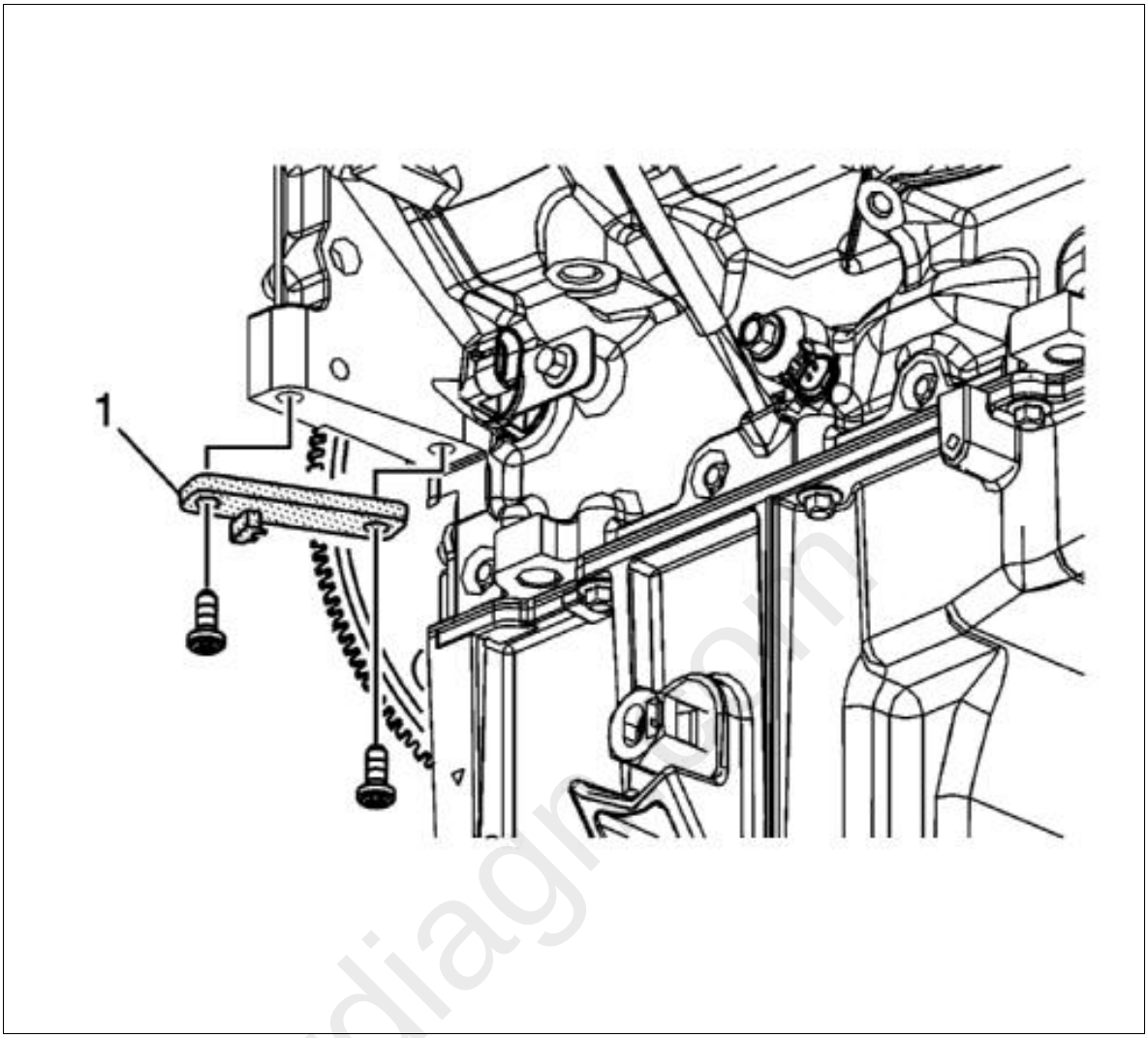
NOTE:

1. *Do not use the camshaft position (CMP) actuator solenoid valve again. Upon installation of the CMP actuator and timing chain, install a NEW valve.*
2. *Do not apply threadlock to the flex plate bolts at this time.*

1. Temporarily install the automatic transmission flex plate (1) and bolts (2). Refer to Automatic Transmission Flex Plate Installation .

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Fig 2: Automatic Transmission Flex Plate And Bolts



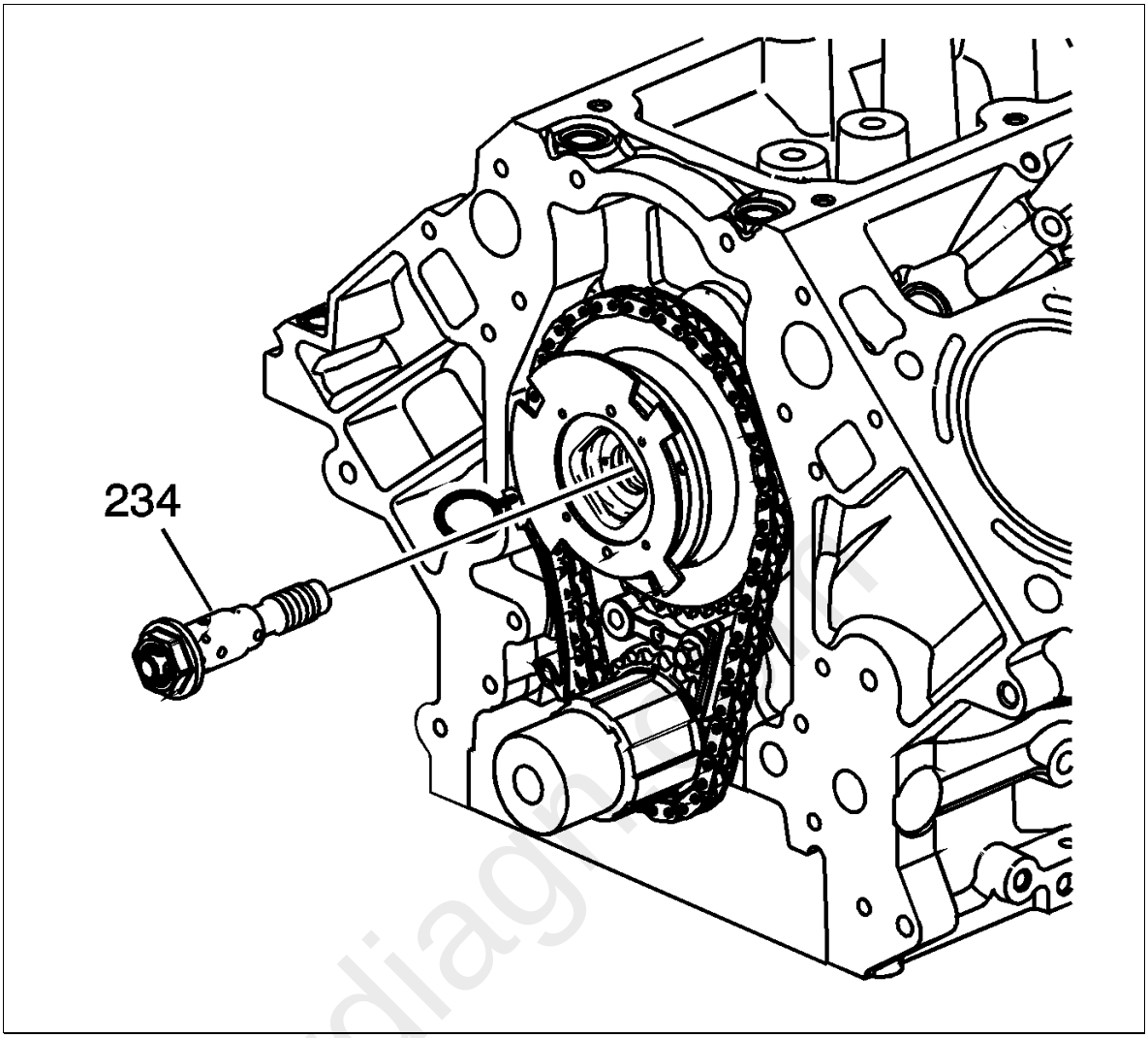
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> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

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

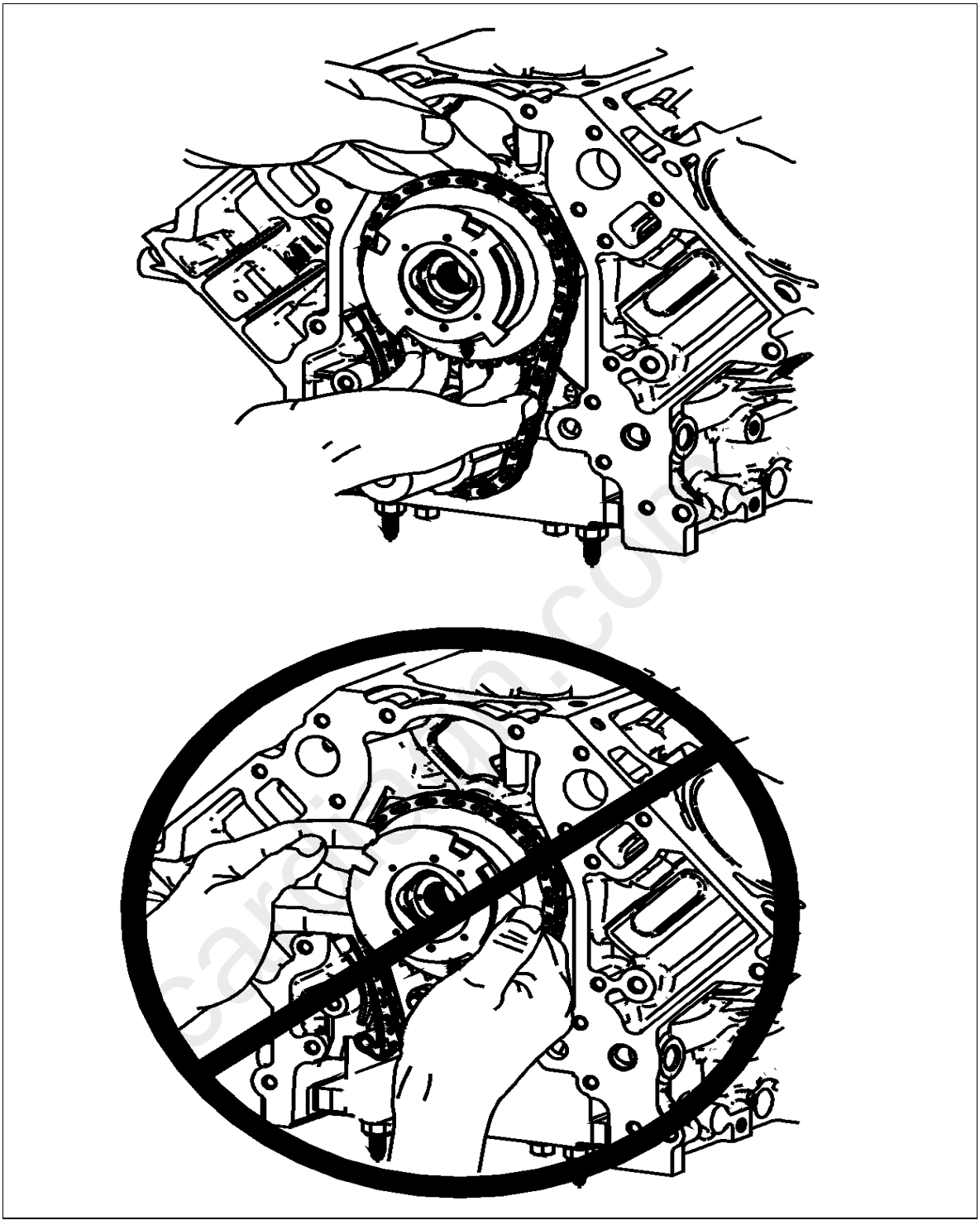
Fig 3: CMP Actuator Solenoid Valve



Courtesy of GENERAL MOTORS COMPANY

3. Remove the CMP actuator solenoid valve (234).
4. Discard the solenoid valve.

Fig 4: Proper CMP Actuator Removal



Courtesy of GENERAL MOTORS COMPANY

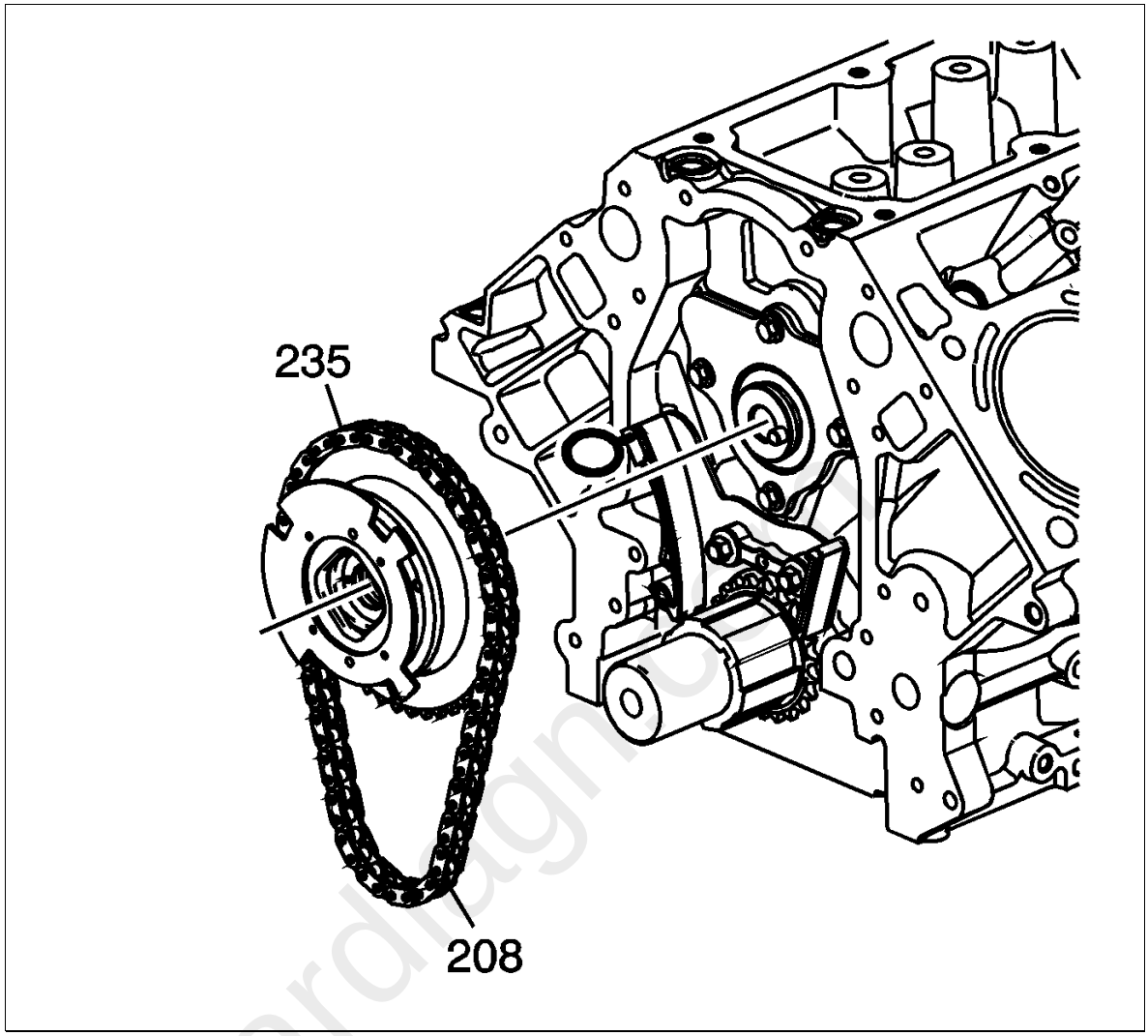
WARNING:

Refer to Camshaft Position Actuator Removal and Installation Warning .

5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position fingers

behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

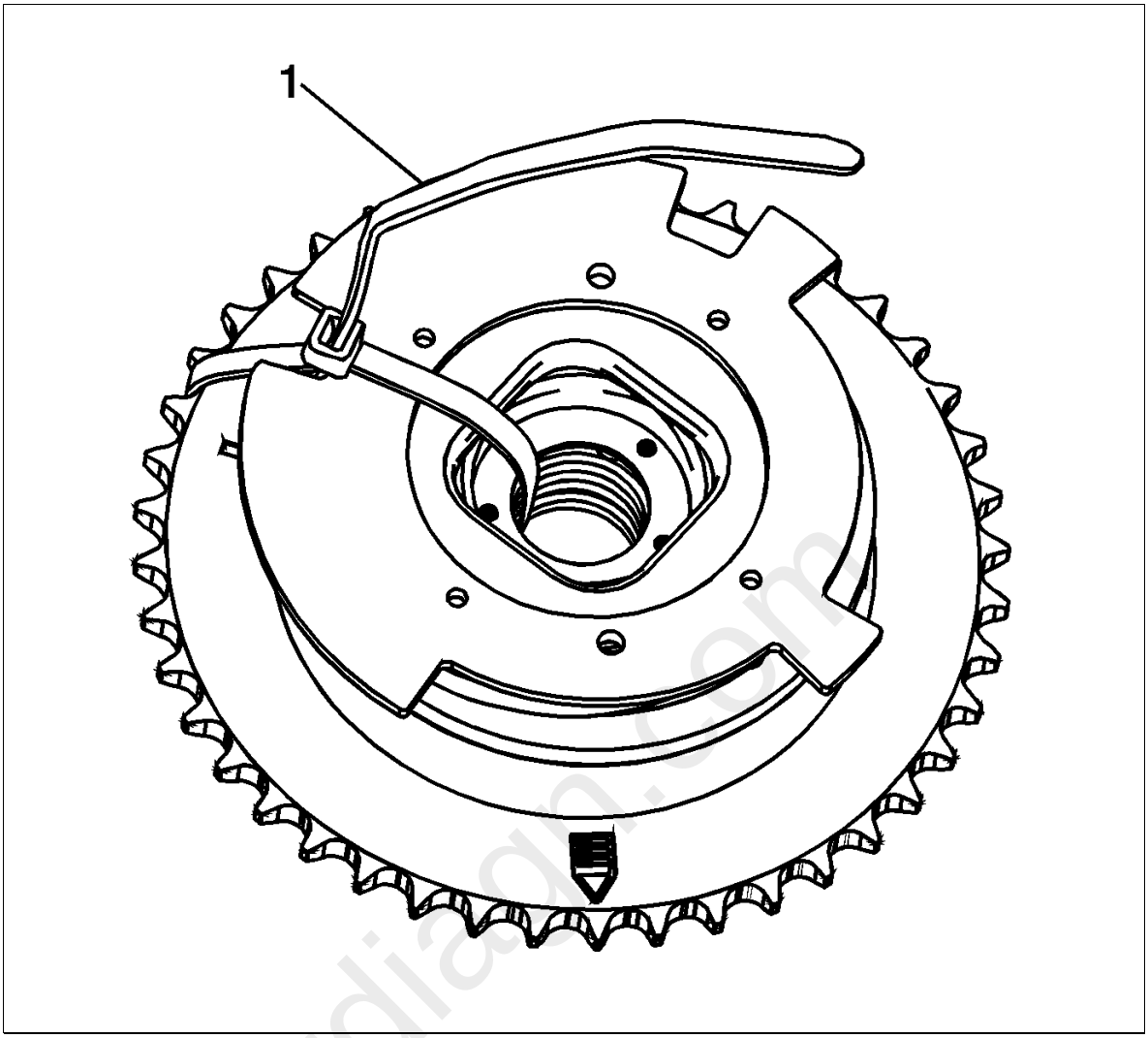
Fig 5: CMP Actuator & Timing Chain



Courtesy of GENERAL MOTORS COMPANY

6. Remove the CMP actuator (235) and timing chain (208).

Fig 6: Tie Strap Through Center Of Actuator

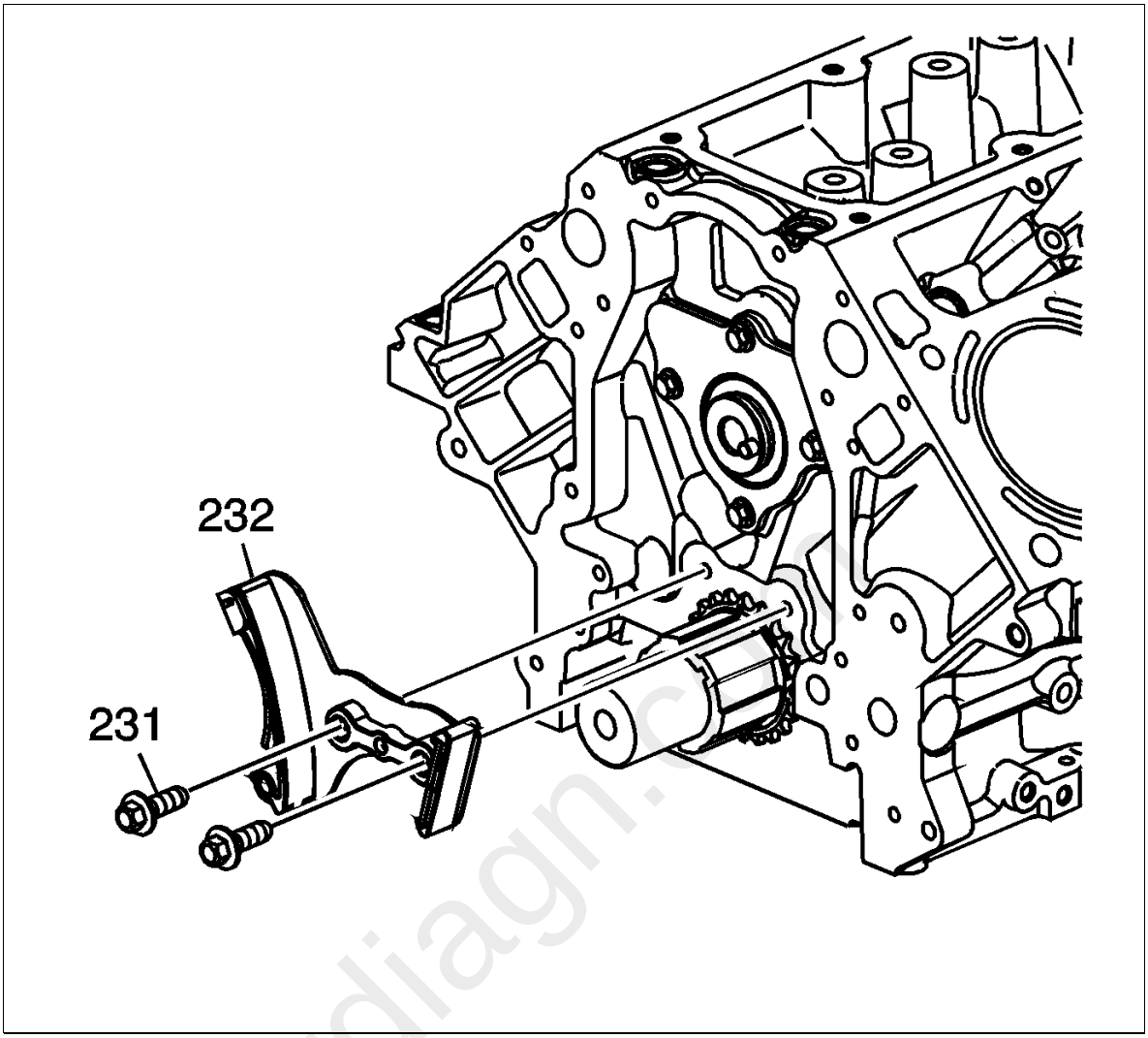


Courtesy of GENERAL MOTORS COMPANY

7. Insert a tie strap (1) through the center of the actuator and over the reluctor wheel.

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Fig 7: Timing Chain Tensioner & Bolts

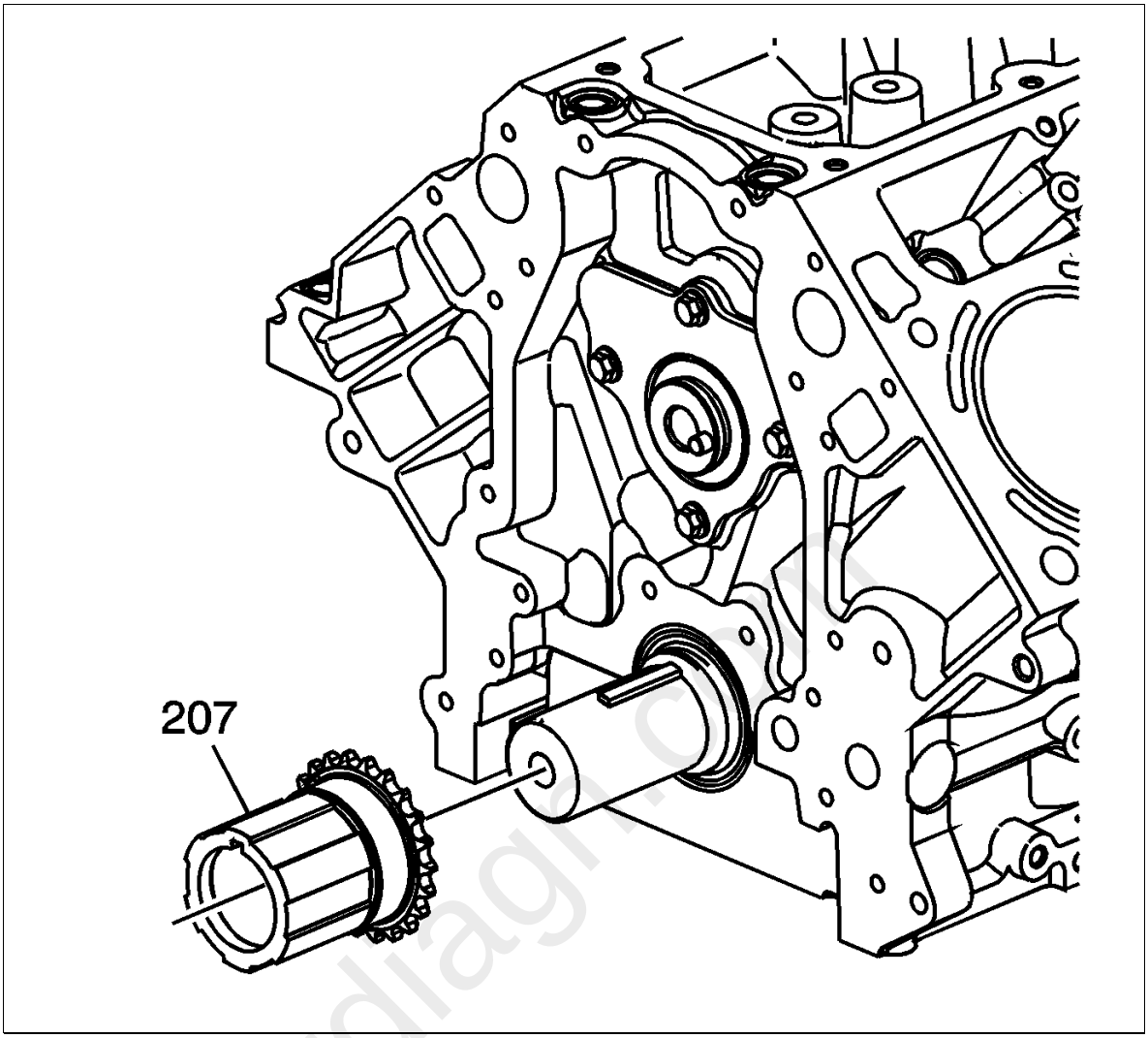


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8. Remove the bolts (231) and timing chain tensioner (232).

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Fig 8: Crankshaft Sprocket

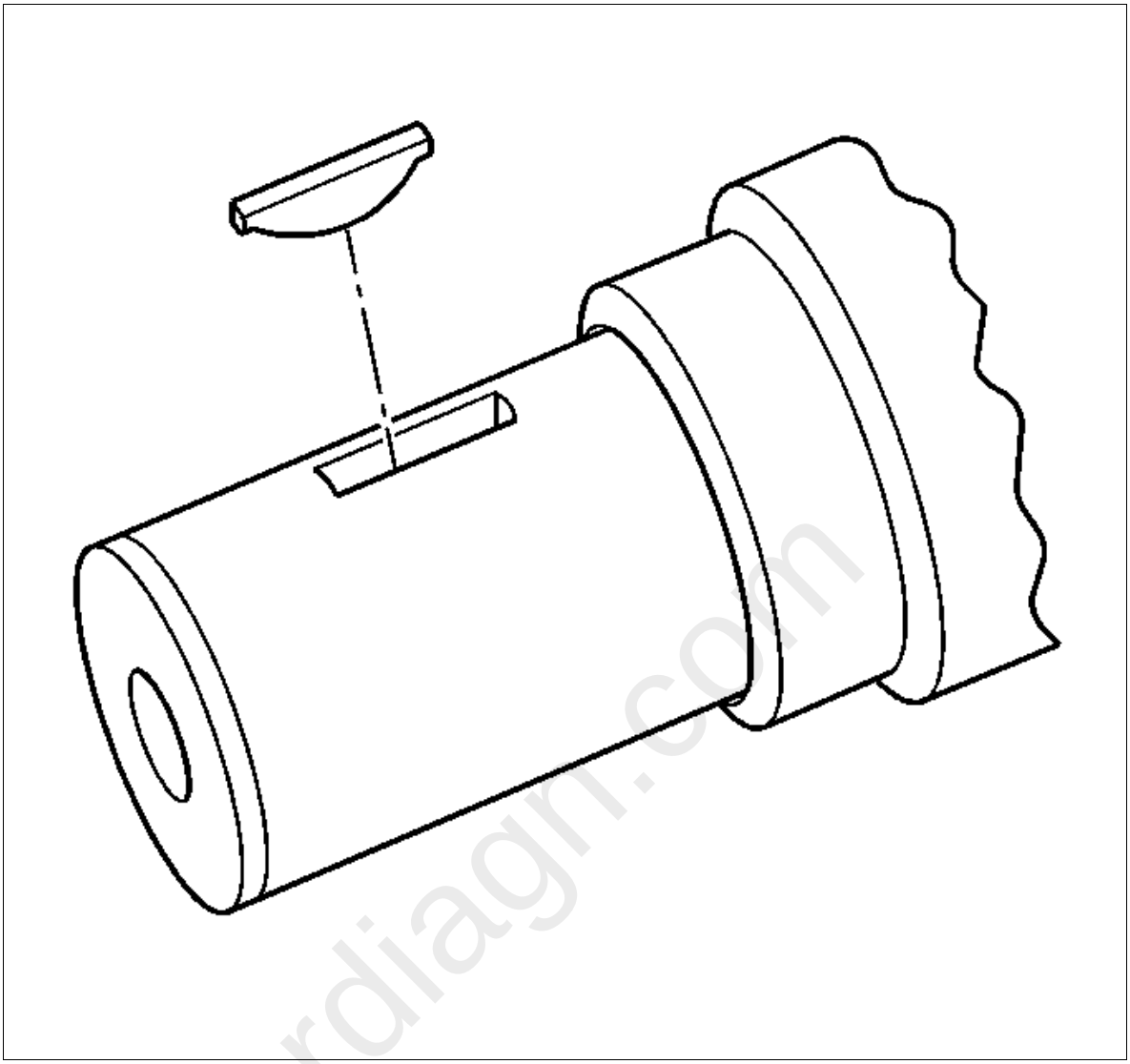


Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft sprocket (207).

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Fig 9: Crankshaft Key & Keyway



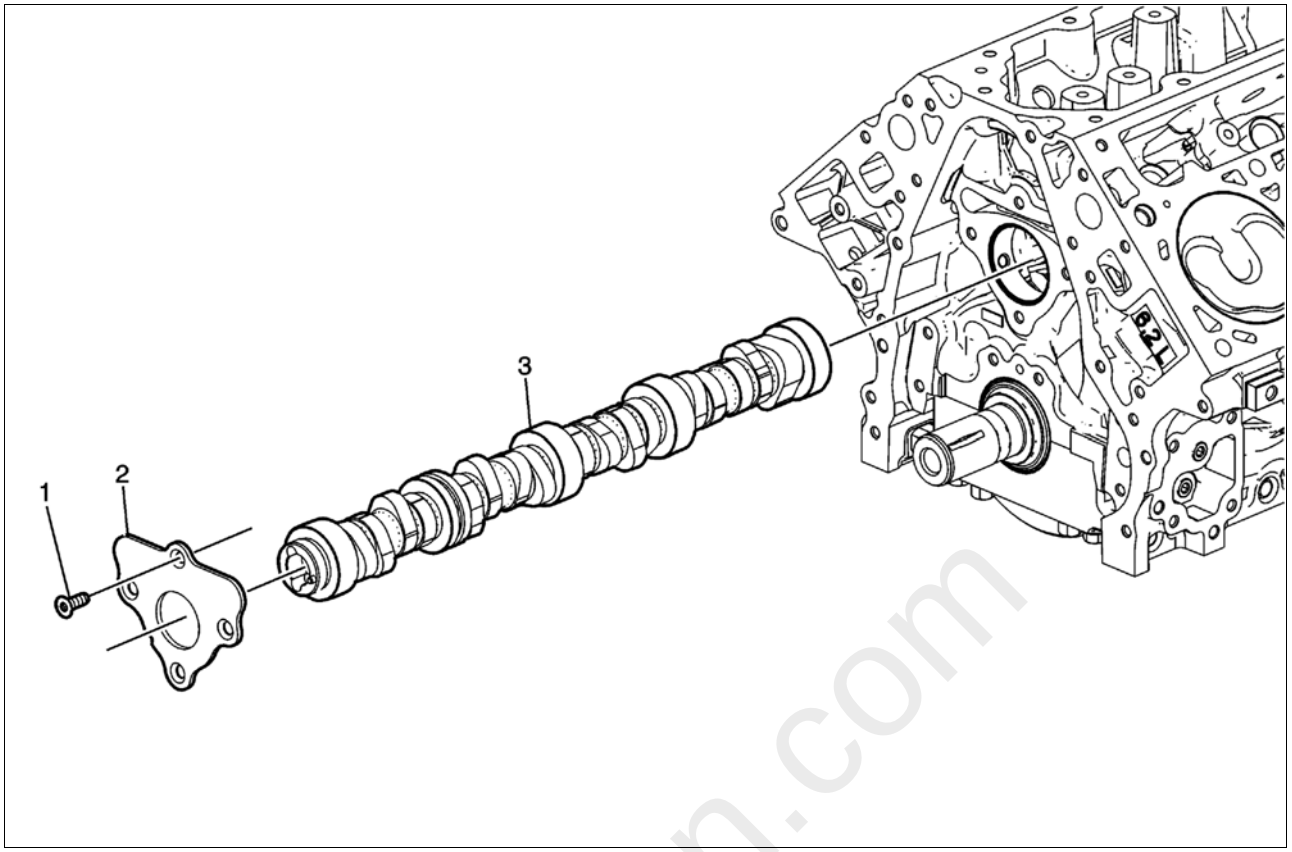
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10. Remove the crankshaft sprocket key, as required.
11. Remove the flex plate and bolts. Refer to Automatic Transmission Flex Plate Removal .
12. Remove the **EN-42386-A** tool and bolts.

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT REMOVAL

Fig 1: Camshaft



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Retainer Bolt
2	Camshaft Retainer
3	Camshaft Assembly

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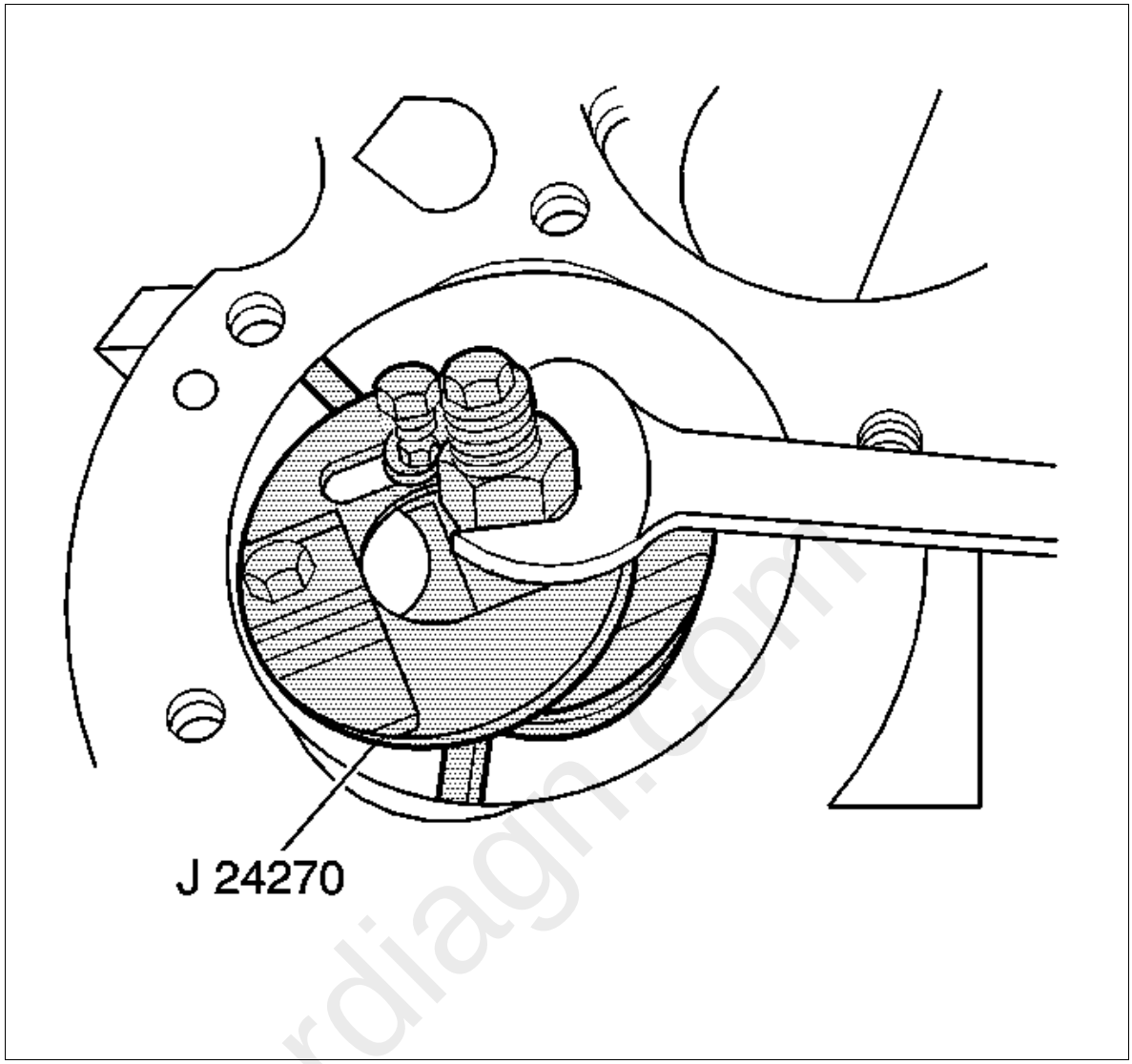
REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON, CONNECTING ROD, AND BEARING REMOVAL

Special Tools

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

For equivalent regional tools, refer to Special Tools .

Fig 1: Removing Cylinder Bore Ring Ridge

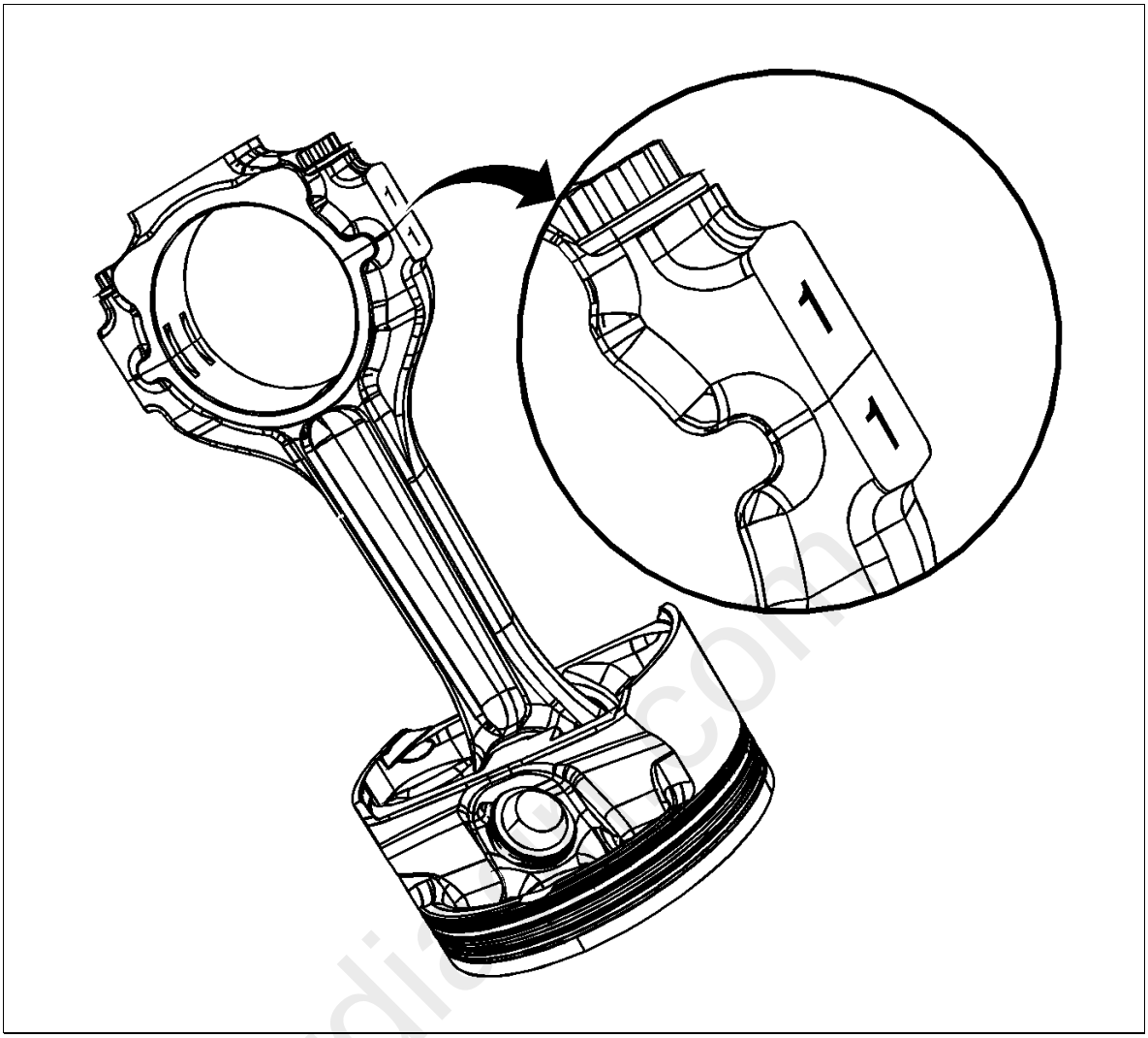


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1. Use the **EN-24270** cylinder bore ridge reamer in order to remove the cylinder bore ring ridge, if required.
    1. Turn the crankshaft until the piston is at the bottom of the stroke.
    2. Place a cloth on top of the piston.
    3. Use the **EN-24270** cylinder bore ridge reamer, or equivalent, in order to remove a cylinder ring ridge.
    4. Turn the crankshaft so the piston is at the top of the stroke.
    5. Remove the cloth.
    6. Remove the cutting debris from the cylinder and piston.

Fig 2: Matchmarks On Connecting Rods & Caps



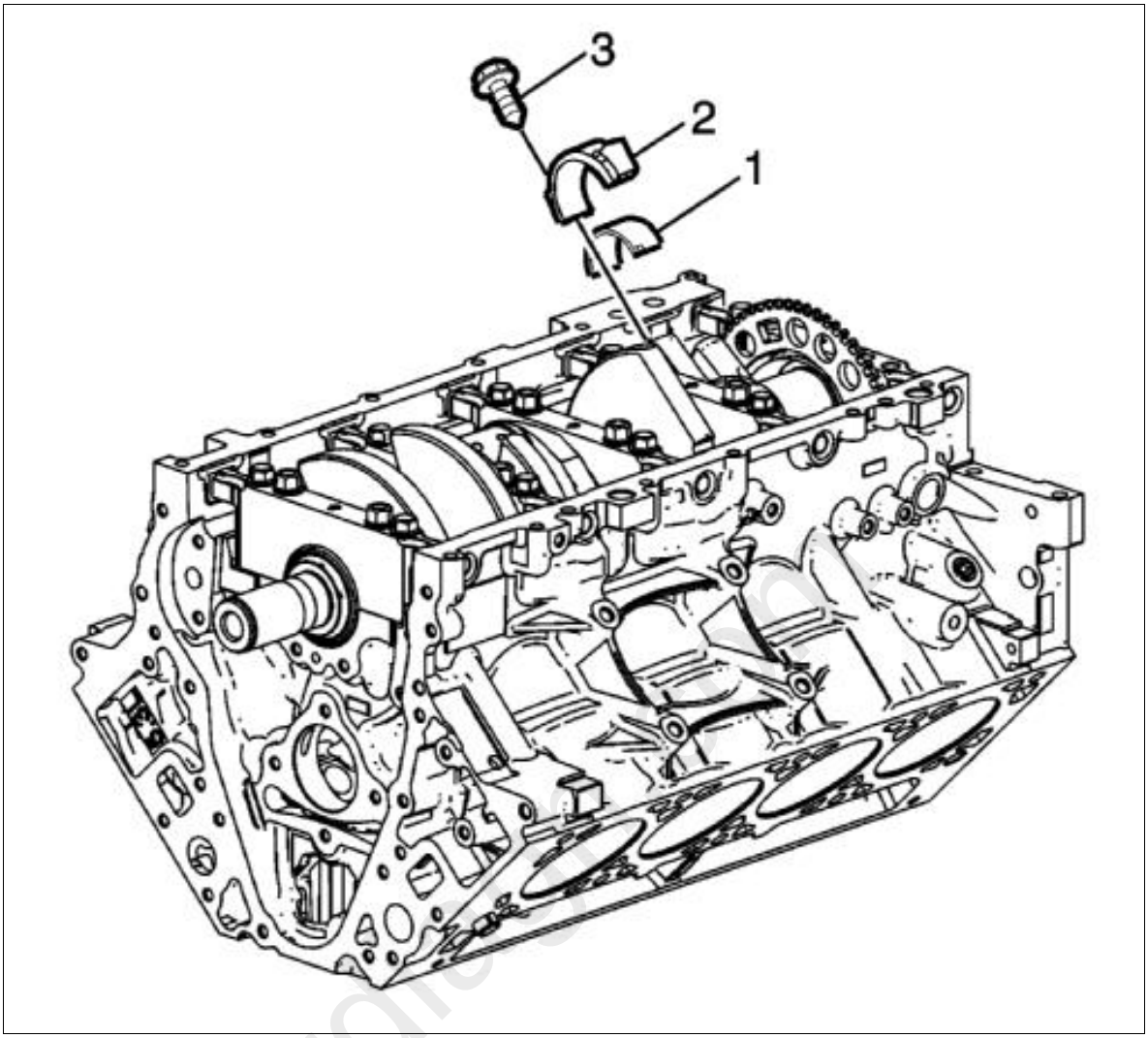
Courtesy of GENERAL MOTORS COMPANY

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

    1. A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.

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

Fig 3: Connecting Rod Bolts, Cap And Bearing



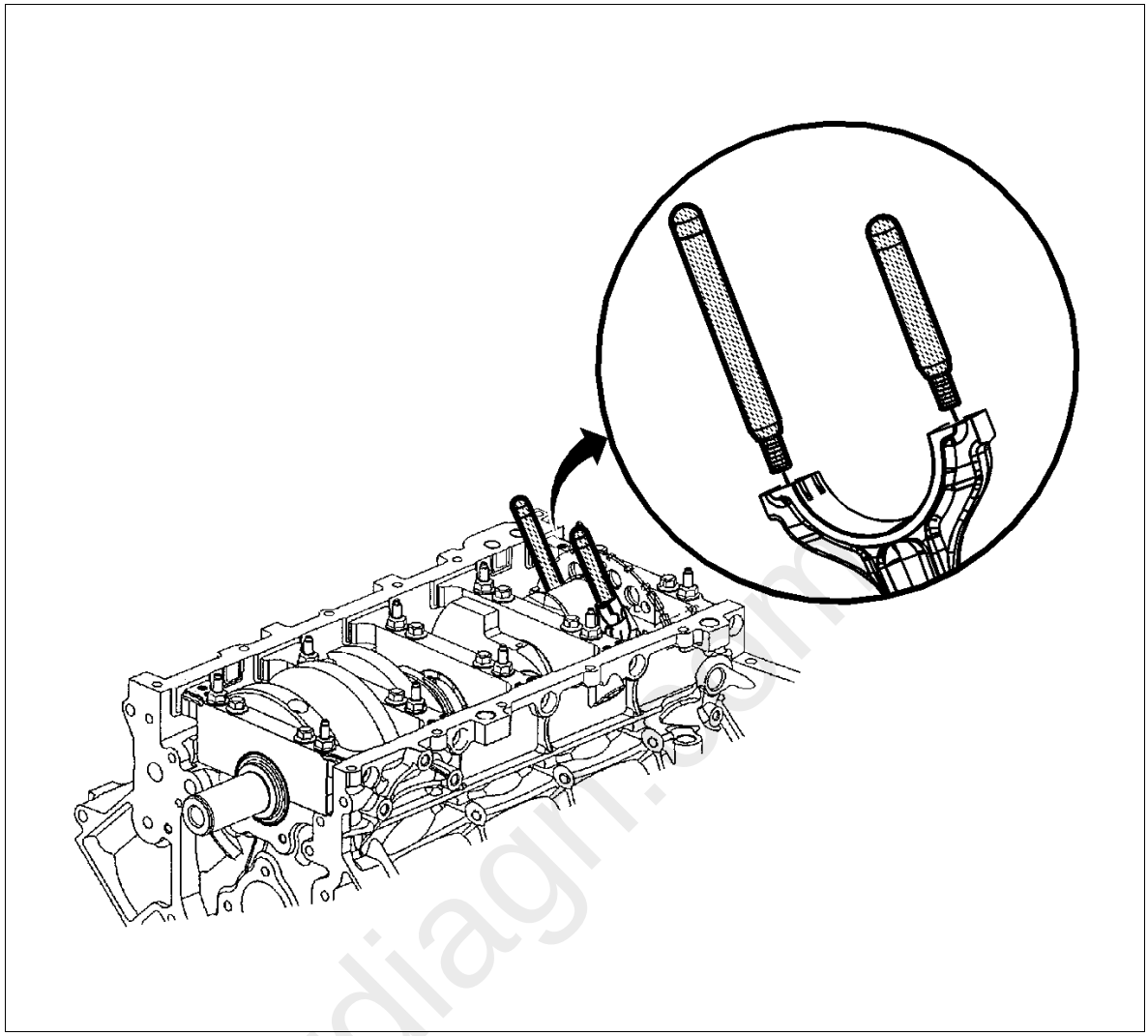
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT:

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

3. Remove the connecting rod bolts (3), cap (2) and bearing (1).

Fig 4: Crankshaft Protector Pins Installed in Connecting Rod Bolt Holes

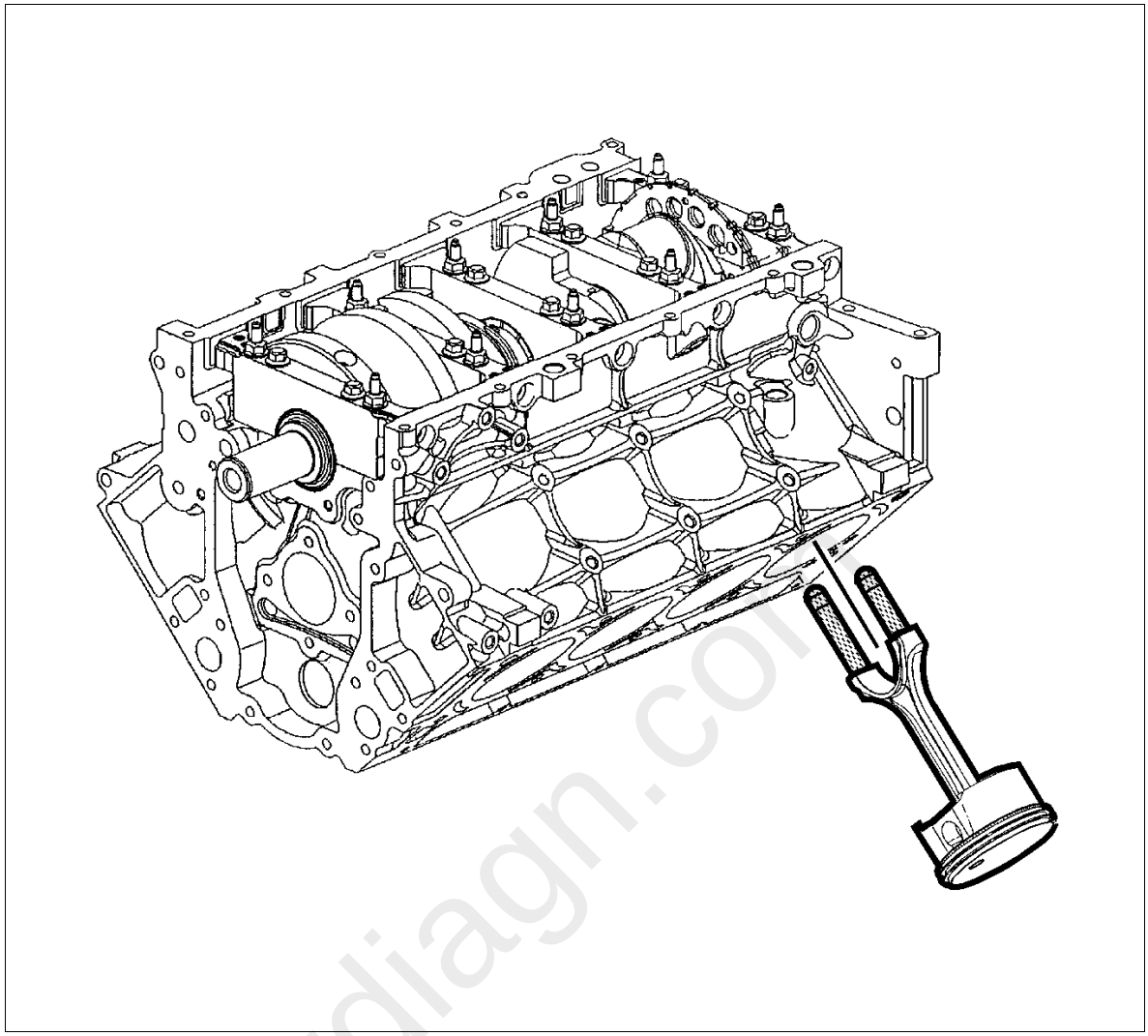


Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-41556** connecting rod guide to the connecting rod.

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Fig 5: Piston, Connecting Rod & Cylinder Bore

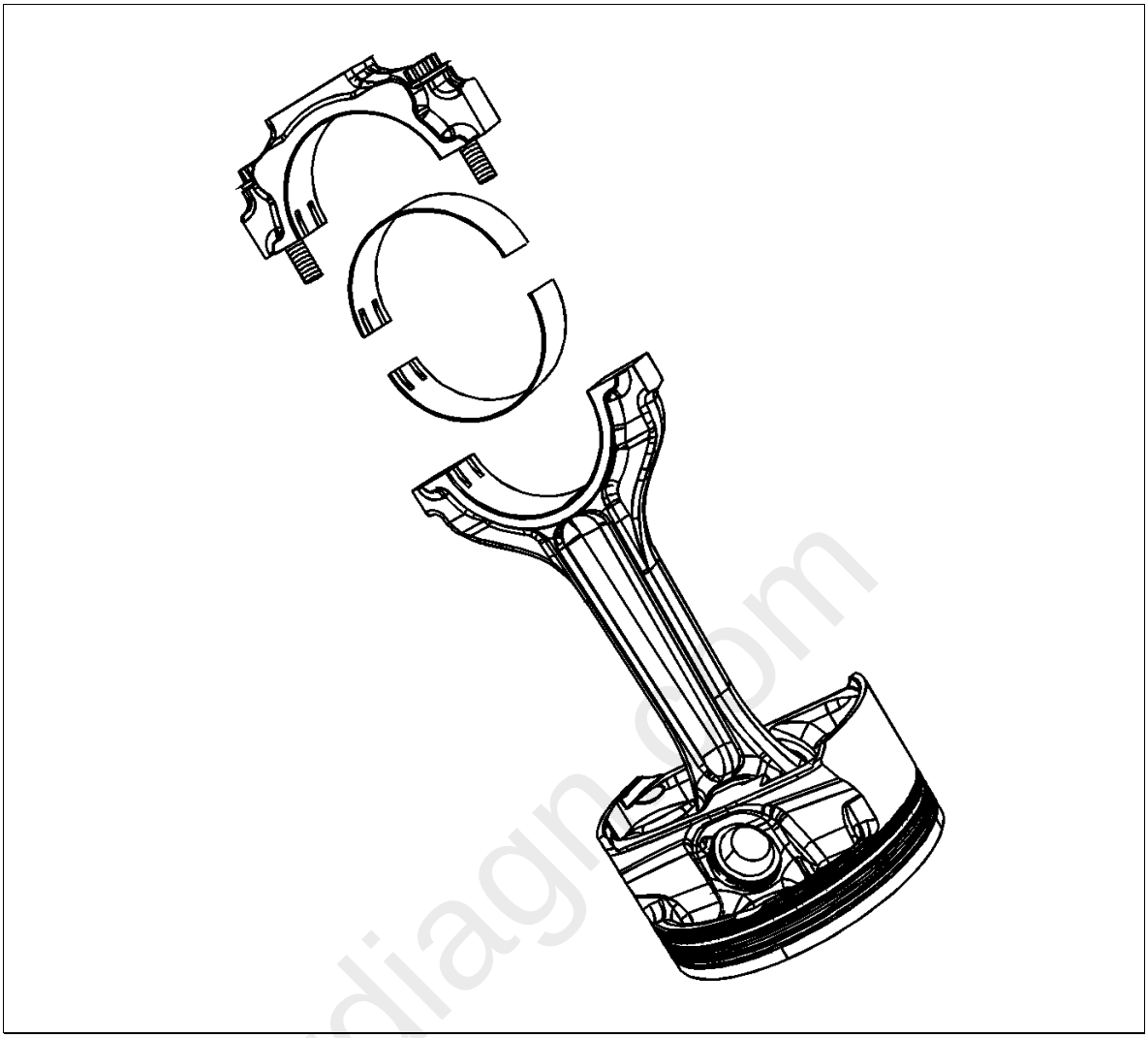


Courtesy of GENERAL MOTORS COMPANY

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

Fig 6: Piston, Connecting Rod & Bearing Assembly



Courtesy of GENERAL MOTORS COMPANY

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

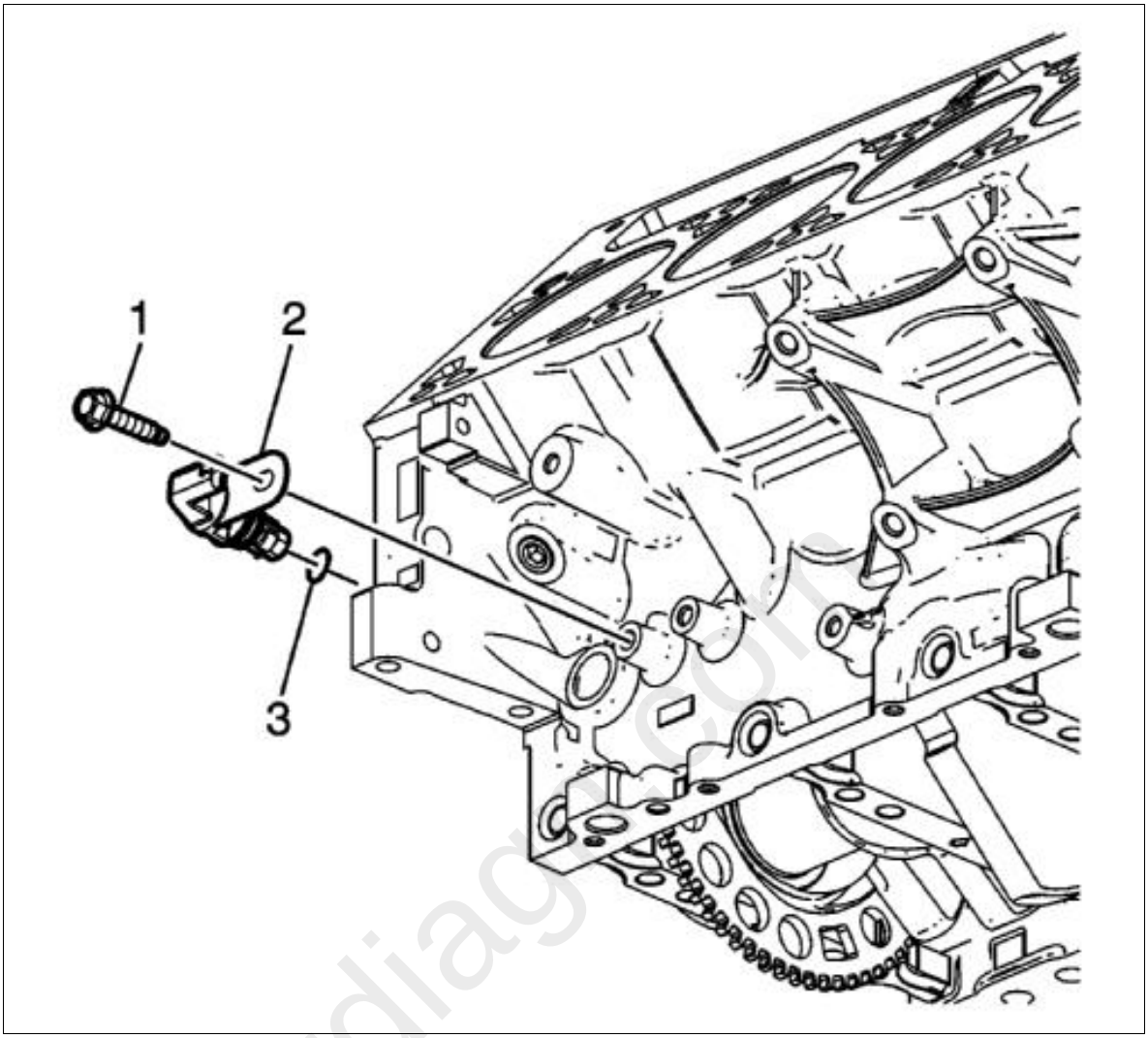
REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING REMOVAL

Special Tools

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

For equivalent regional tools, refer to Special Tools

Fig 1: Crankshaft Position (CKP) Sensor Bolt And CKP Sensor



Courtesy of GENERAL MOTORS COMPANY

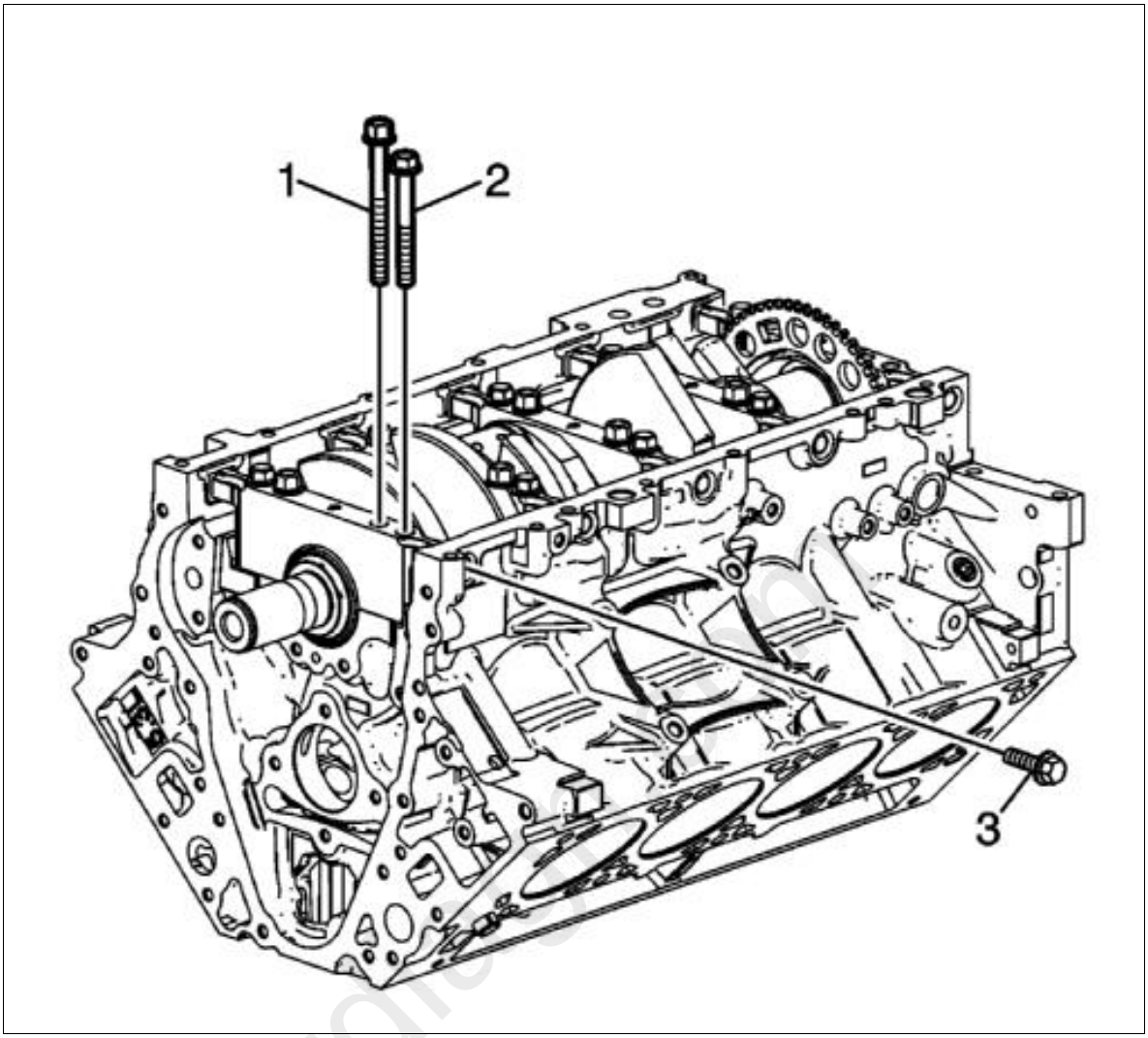
NOTE:

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

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

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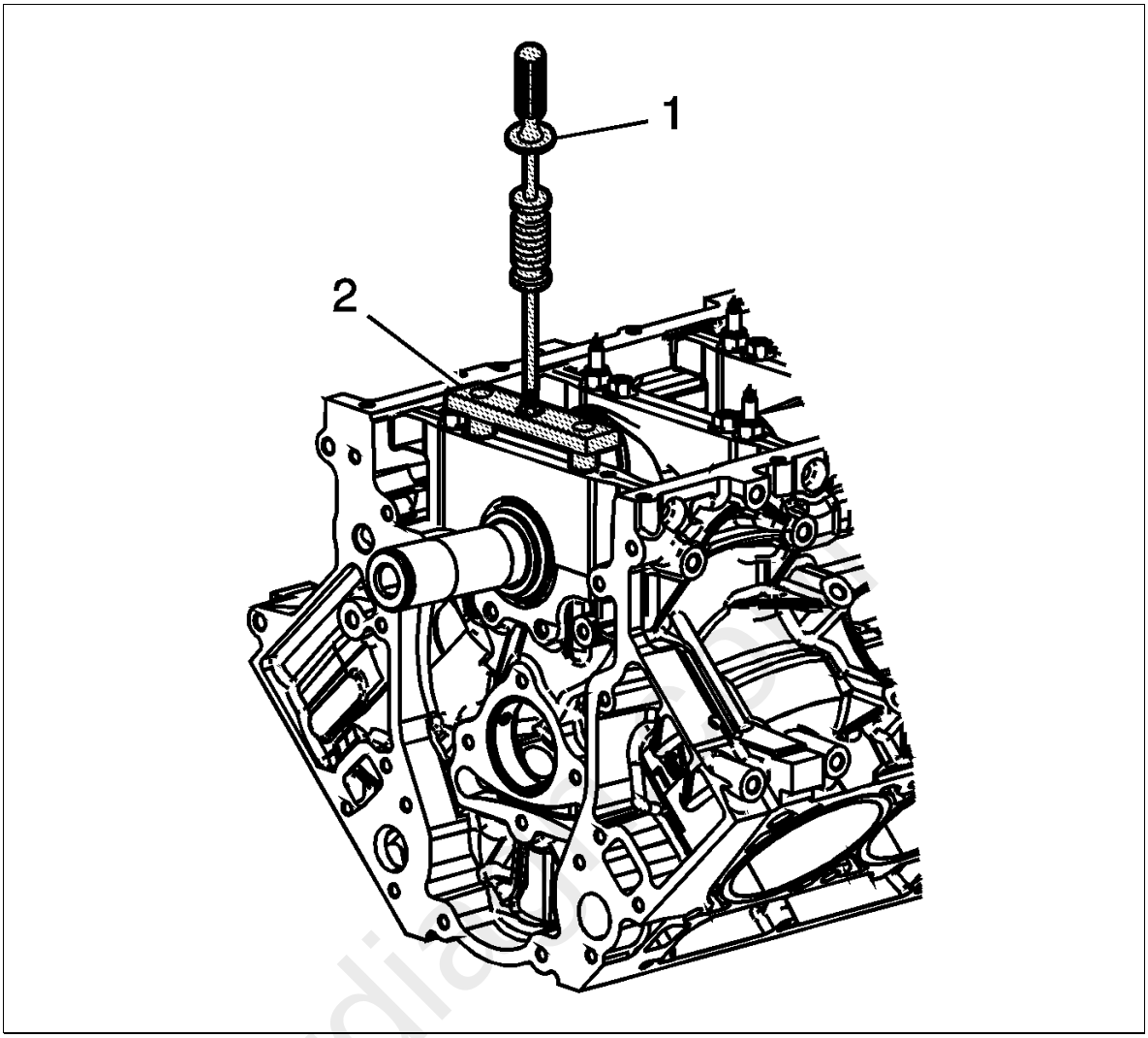
Fig 2: Crankshaft Inner Bearing Cap Bolts And Outer Bearing Cap Bolts



Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the crankshaft inner bearing cap bolts (1) and outer bearing cap bolts (2).
5. Remove and discard the bearing cap side bolts (3).

Fig 3: Crankshaft Bearing Cap Bolts (M10)

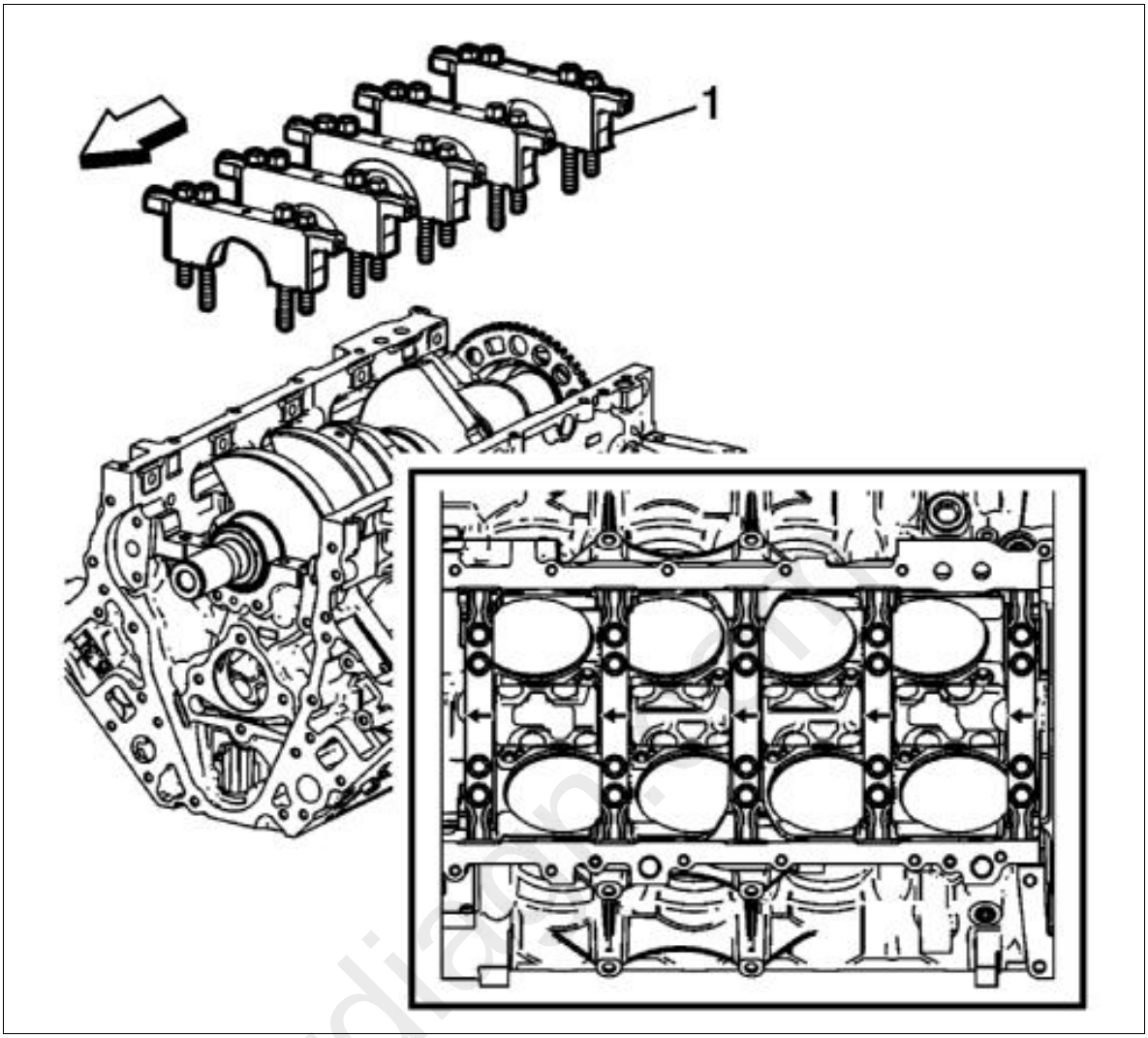


Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

6. Install the **J-41818** remover (2) and tighten to 11 N.m (100 lb in).
7. Install the **J-6125-1B** hammer (1) to the **J 41818** remover (2) in order to remove the crankshaft bearing caps.

Fig 4: Crankshaft Bearing Caps



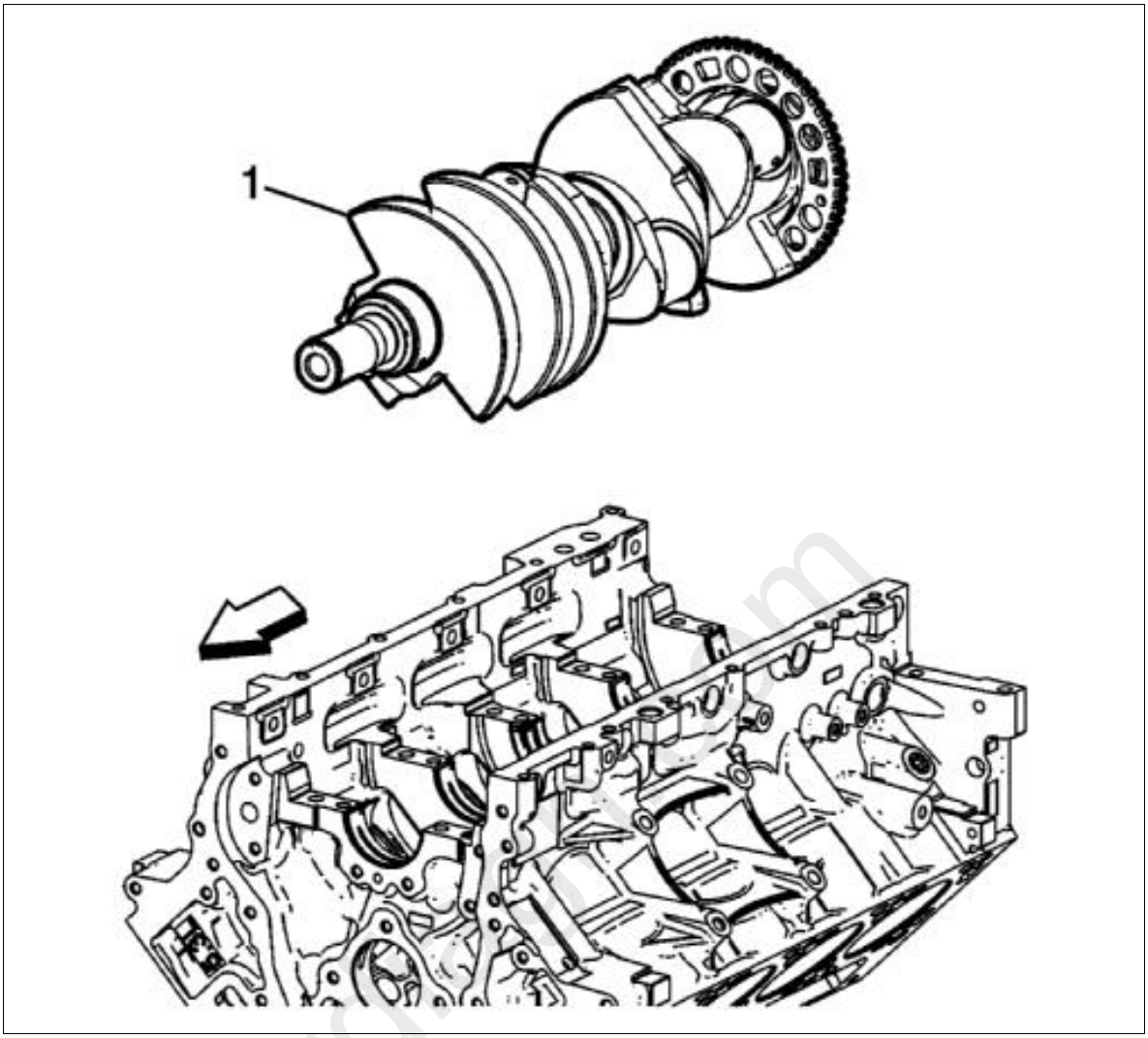
Courtesy of GENERAL MOTORS COMPANY

NOTE:

Before removal note the direction of the bearing caps arrows and location.

8. Remove the bearing caps (1).

Fig 5: Crankshaft



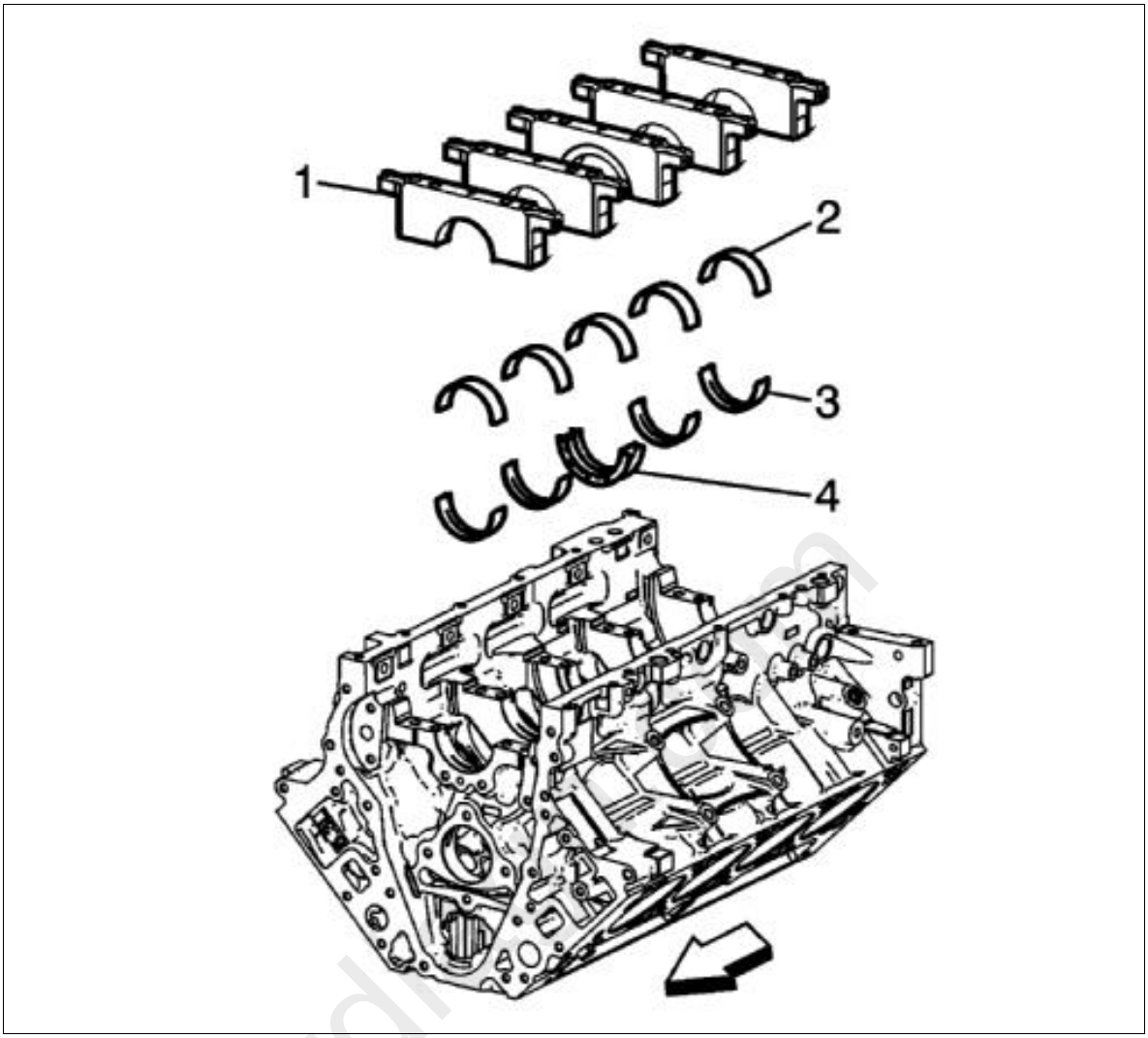
Courtesy of GENERAL MOTORS COMPANY

NOTE:

Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may affect on-board diagnostics (OBD) II system performance.

9. Remove the crankshaft (1).
10. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.

Fig 6: Crankshaft Bearings And Bearing Caps

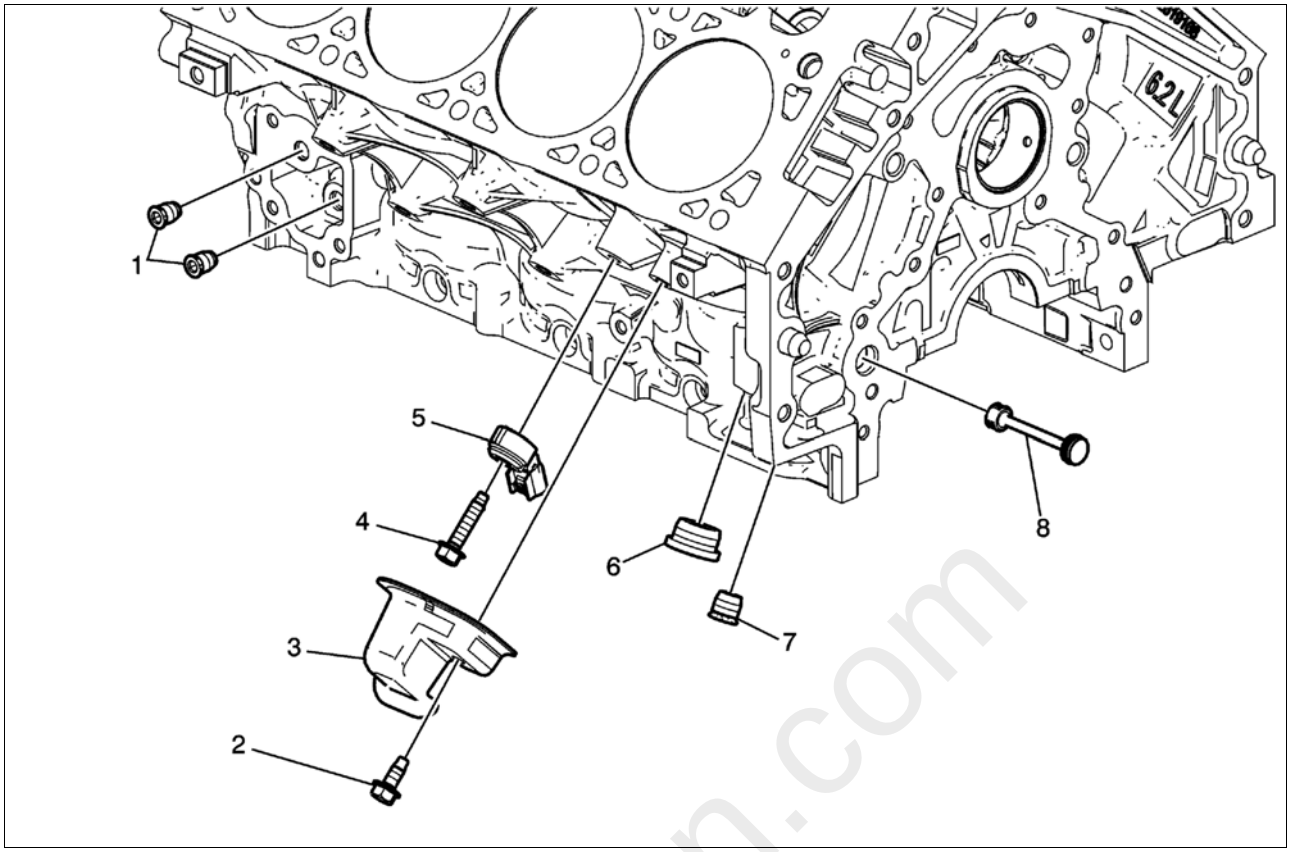


Courtesy of GENERAL MOTORS COMPANY

11. Remove the crankshaft bearings (2, 3, and 4) from the bearing caps (1) and the engine block.
12. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to Separating Parts .

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK PLUG REMOVAL > KNOCK SENSOR SHIELD, KNOCK SENSOR, AND ENGINE BLOCK OIL GALLERY PLUG REMOVAL

Fig 1: Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug



Courtesy of GENERAL MOTORS COMPANY

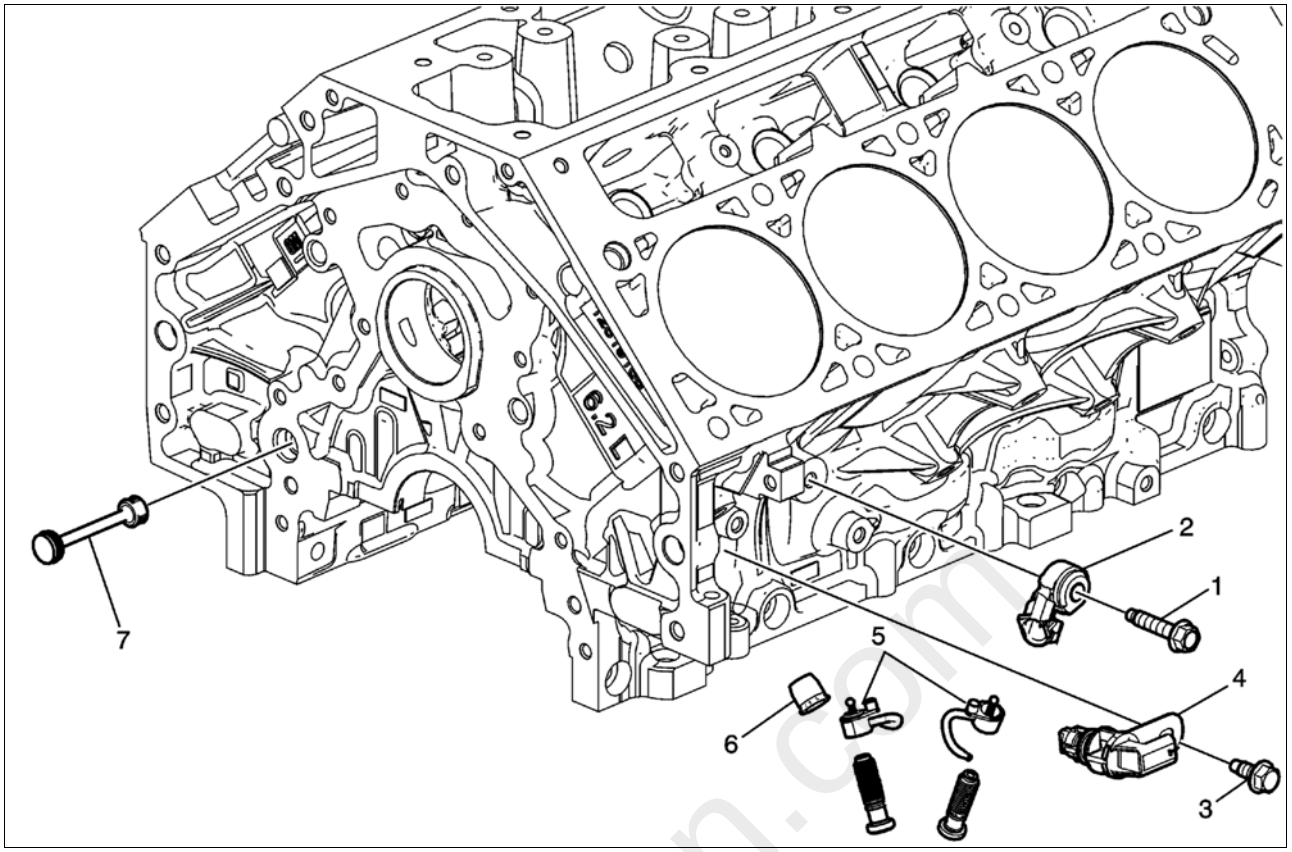
Knock Sensor Shield, Knock Sensor, and Engine Block Oil Gallery Plug Removal

Callout	Component Name
1	Engine Block Oil Gallery Plug
2	Knock Sensor Shield Bolt
3	Knock Sensor Shield
4	Knock Sensor Bolt
5	Knock Sensor Assembly
6	Engine Block Plug
7	Engine Block Plug
8	Engine Block Plug

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK PLUG REMOVAL > CRANKSHAFT POSITION SENSOR, ENGINE BLOCK PLUG, KNOCK SENSOR, AND PISTON OIL NOZZLE REMOVAL

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Fig 1: Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle



Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor, Engine Block Plug, Knock Sensor, and Piston Oil Nozzle Removal

Callout	Component Name
1	Knock Sensor Bolt
2	Knock Sensor Assembly
3	Crankshaft Position Sensor Bolt
4	Crankshaft Position Sensor
5	Piston Oil Nozzle Assembly
6	Engine Block Plug
7	Engine Block Plug

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

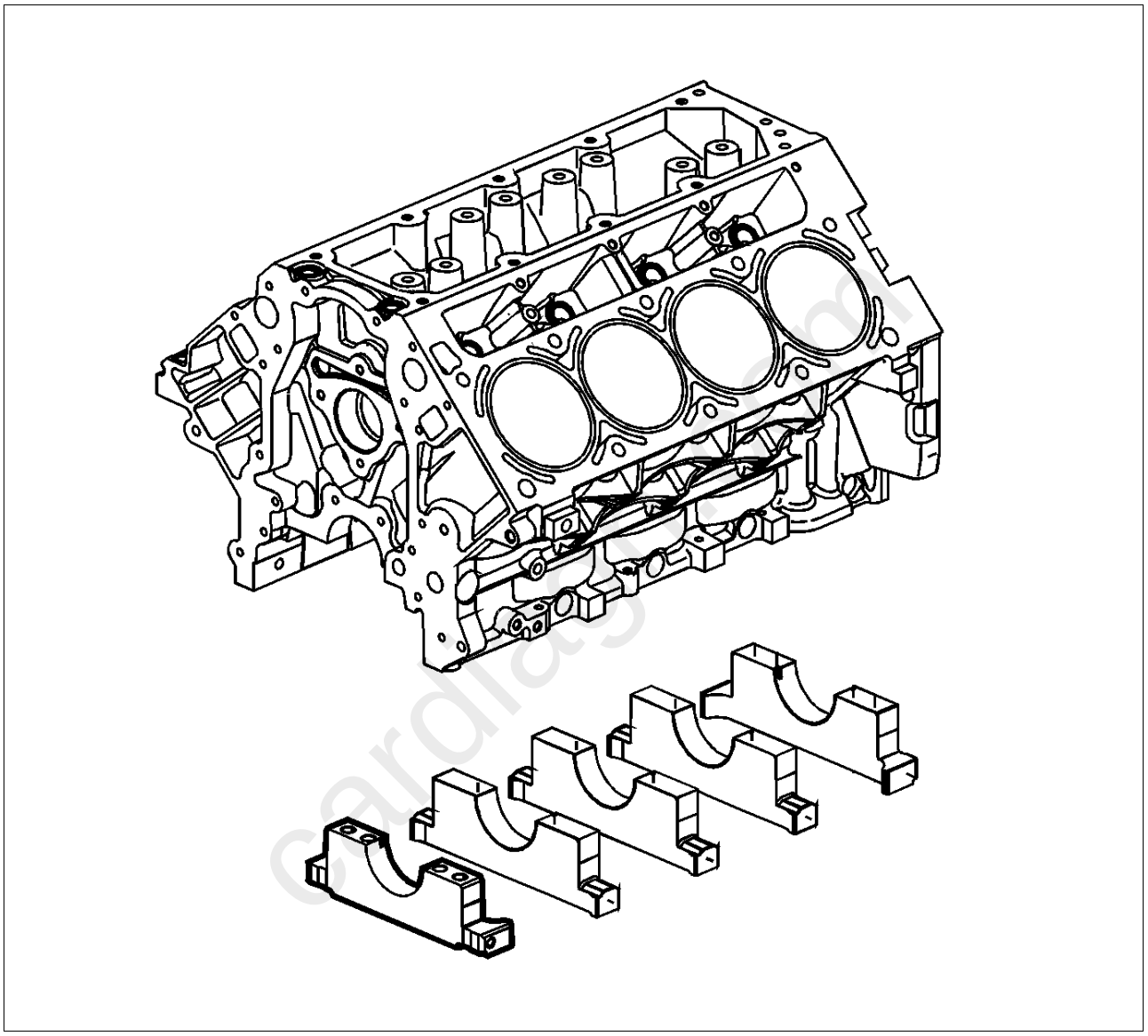
J 8087 Cylinder Bore Gauge

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For equivalent regional tools, refer to Special Tools

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK CLEANING AND INSPECTION > CLEANING PROCEDURE

Fig 1: Main Bearing Caps



Courtesy of GENERAL MOTORS COMPANY

⚠ *CAUTION:*

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

NOTE:

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

Clean the following components:

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

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

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK CLEANING AND INSPECTION > INSPECTION PROCEDURE

1. Inspect the following components:

   NOTE:

   Check the cylinder condition. Some light vertical marks may be visible on the cylinder wall. In these areas, check that the honing marks are still visible in this marked area. If they are, the cylinder surface has not been compromised and the engine block can be used.

   1. Cylinder walls for excessive scratches, gouging, or ring ridge
   2. Cylinder bores for excessive ring ridge at the top of the cylinder
   3. Coolant jacket for cracks
   4. Valve lifter bores for excessive scoring or wear
   5. Crankshaft bearing webs for cracks
   6. Gasket sealing surfaces for excessive scratches or gouging

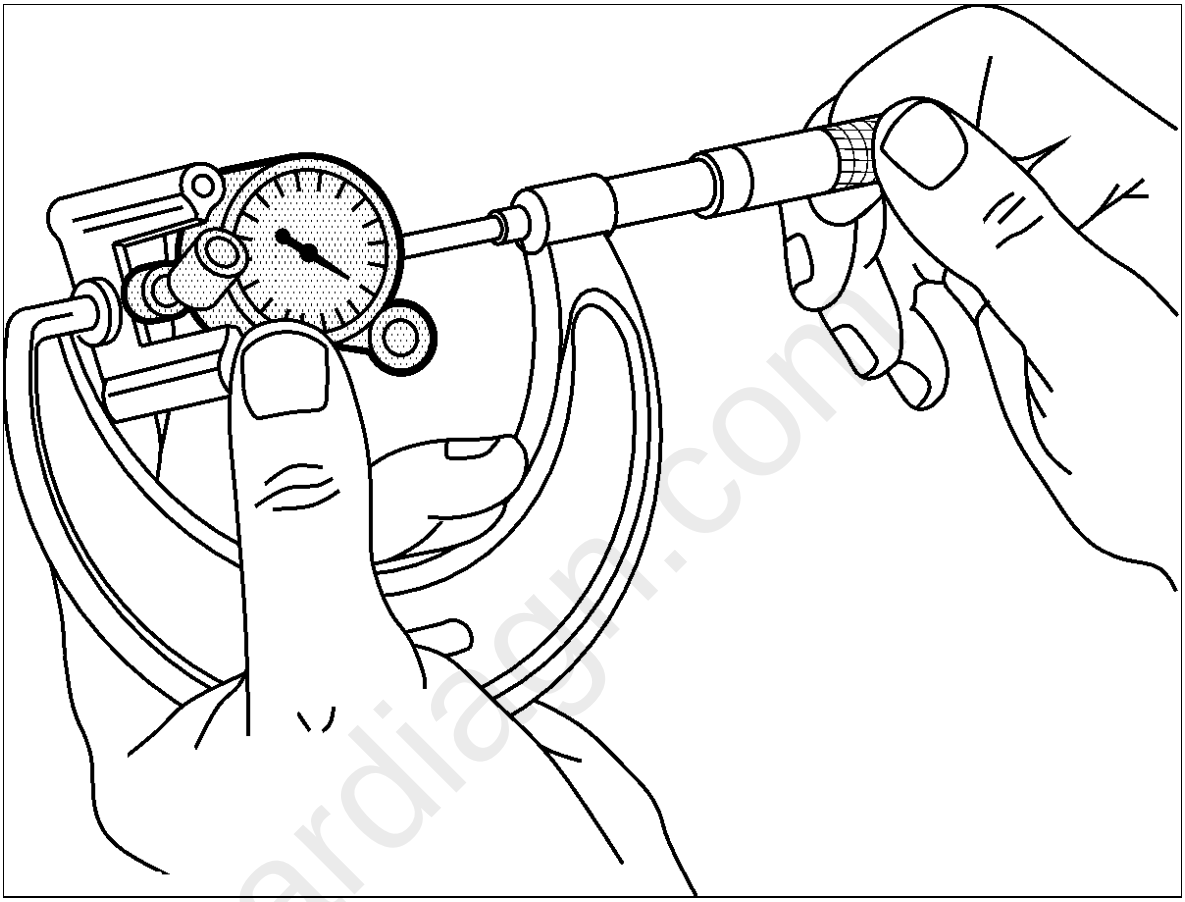
      Refer to Replacing Engine Gaskets .
   7. Oil galleries for restrictions
   8. Threaded bolt holes for damaged threads
   9. Cylinder bores for excessive ring ridge at the top of the cylinder

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2. Measure the cylinder bores for an oversize condition:

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK CLEANING AND INSPECTION > MEASURING THE CYLINDER FOR OVERSIZE

Fig 1: Bore Gauge With Micrometer

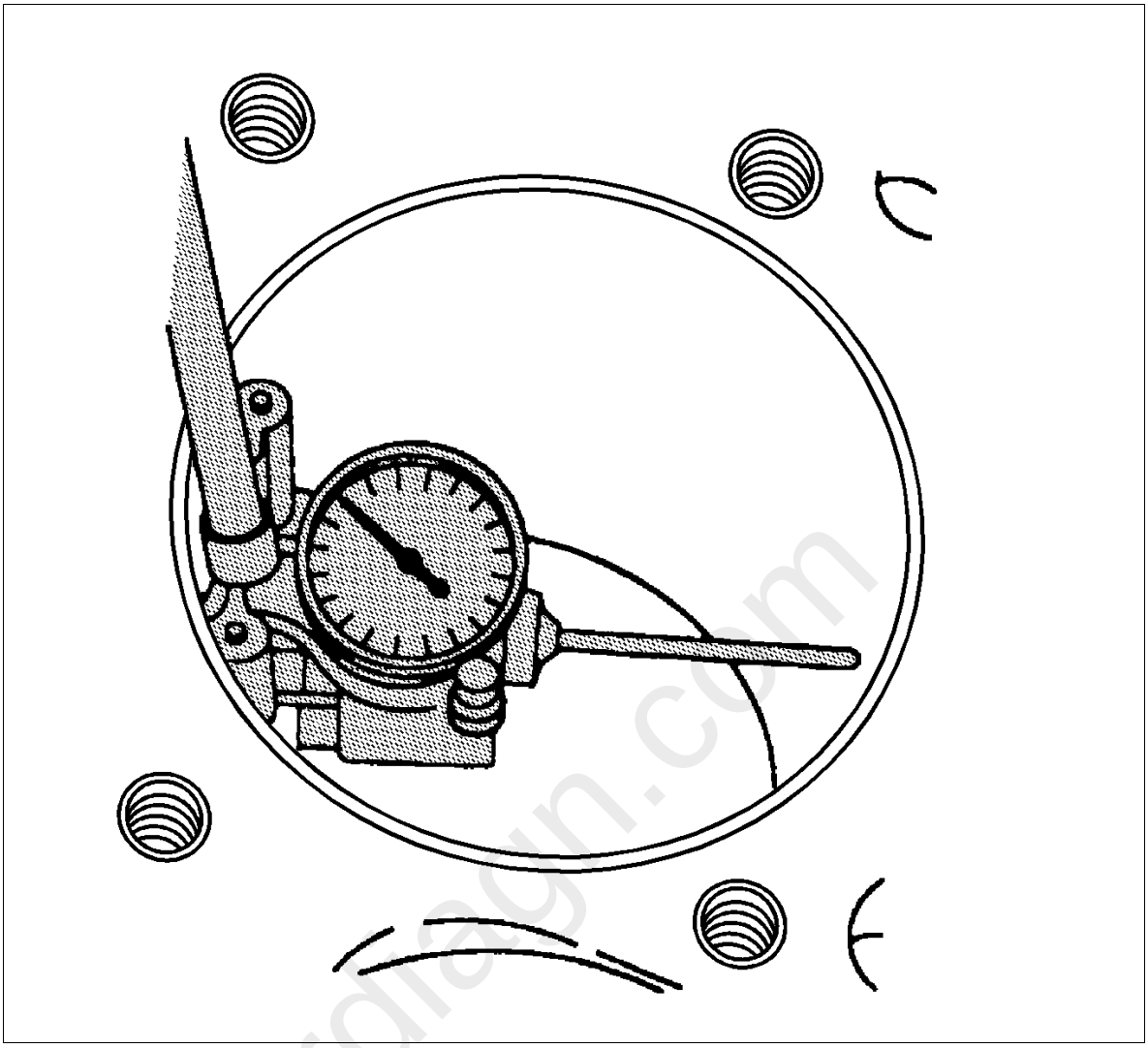


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1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to Engine Mechanical Specifications (LT1) .
2. Insert the **J 8087** gauge into the micrometer and zero the bore gauge dial.

Fig 2: Cylinder Bore



Courtesy of GENERAL MOTORS COMPANY

3. Use the **J 8087** gauge and measure the cylinder bore for oversize.

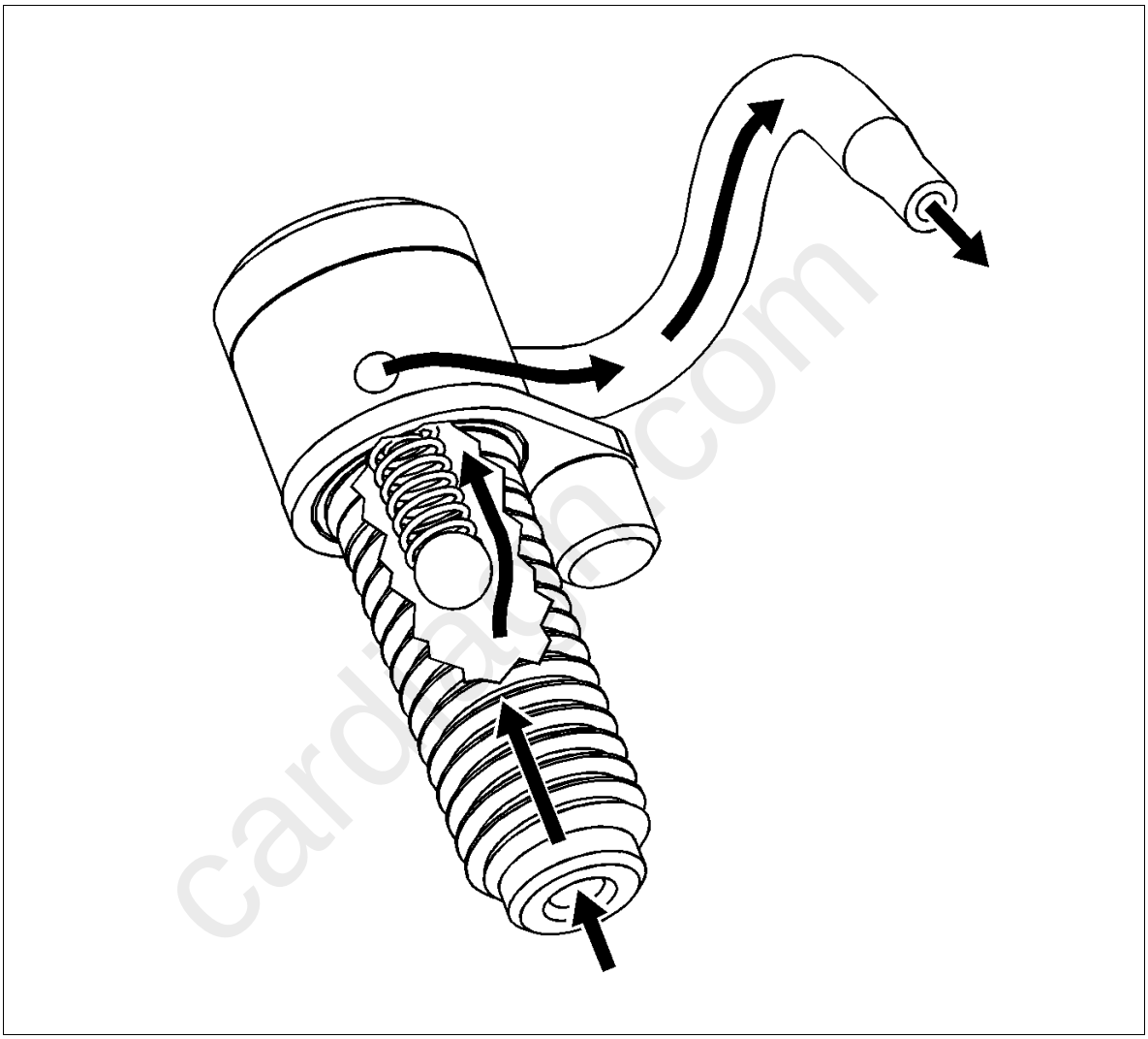
   Slide the bore gauge up and down throughout the length of the cylinder bore. Measure the bore, both parallel and perpendicular to the centerline of the crankshaft, at the top, center, and bottom of the bore. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON OIL NOZZLE CLEANING AND INSPECTION

NOTE:

The piston oil nozzle assembly is designed to provide oil to the bottom side of the piston for cooling purposes. The internal check ball is held in the normally closed position by the spring until system oil pressure exceeds 300 kPa (43.5 psi).

Fig 1: Piston Oil Nozzle Assembly



Courtesy of GENERAL MOTORS COMPANY

1. Clean the nozzle assembly in solution.
2. Inspect the nozzle assembly for the following:
    1. damaged bolt threads
    2. damaged or cut O-ring seal
    3. bent nozzle
    4. A restricted or stuck-open nozzle assembly

3. With no oil pressure, the check ball should be seated and not permit flow through the nozzle tube. Using a blow gun, apply air pressure to the inlet portion of the bolt. Air pressure should unseat the check ball and permit flow through and out of the nozzle tube.

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

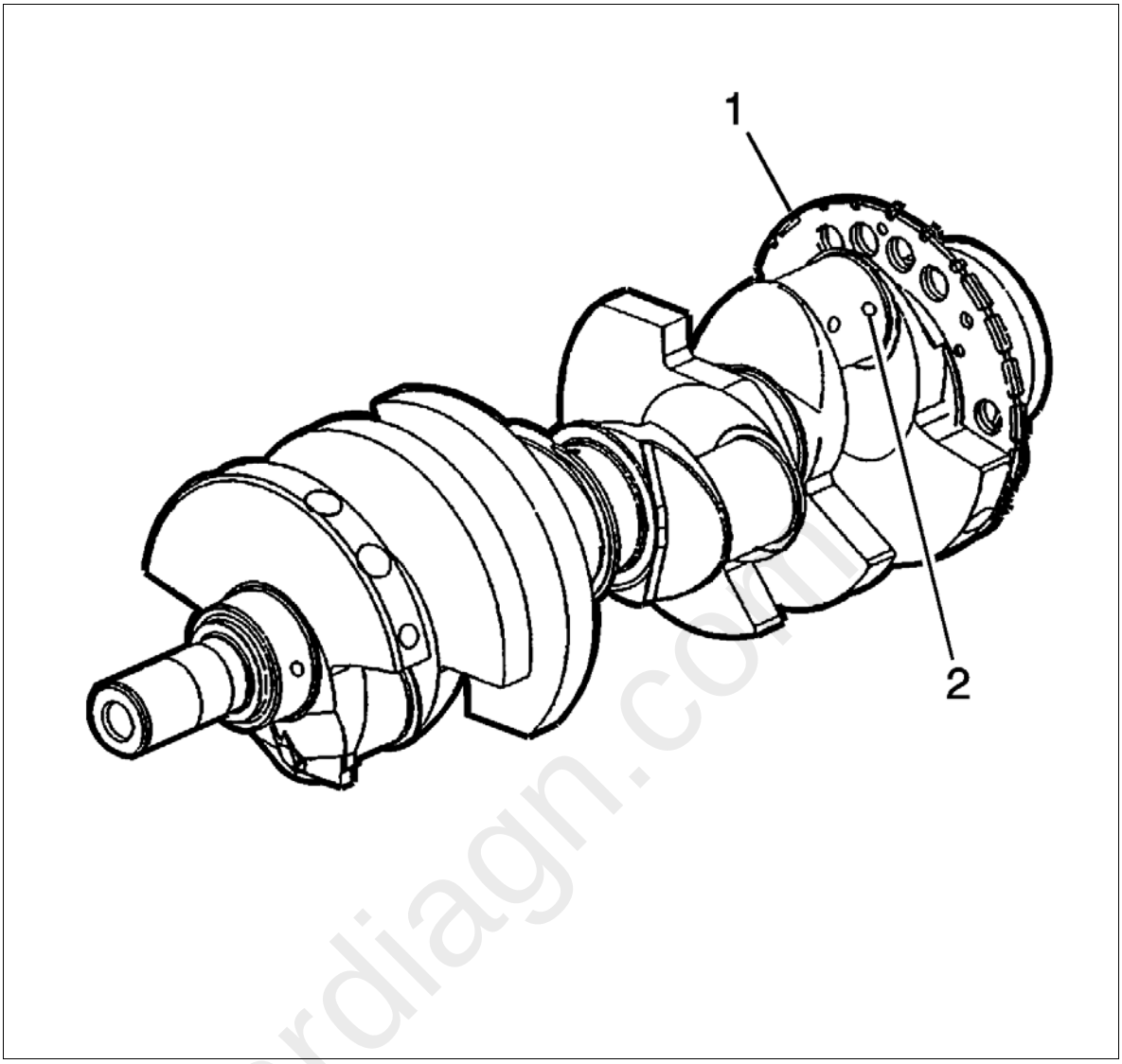
- **J 7872** Magnetic Base Dial Indicator Set
- **J 43690** Rod Bearing Checking Tool
- **J 43690-100** Rod Bearing Checking Tool - Adapter Kit

For equivalent regional tools, refer to Special Tools

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING CLEANING AND INSPECTION > CLEANING PROCEDURE

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Fig 1: Oil Passages & CKP Reluctor Ring Teeth



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.

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

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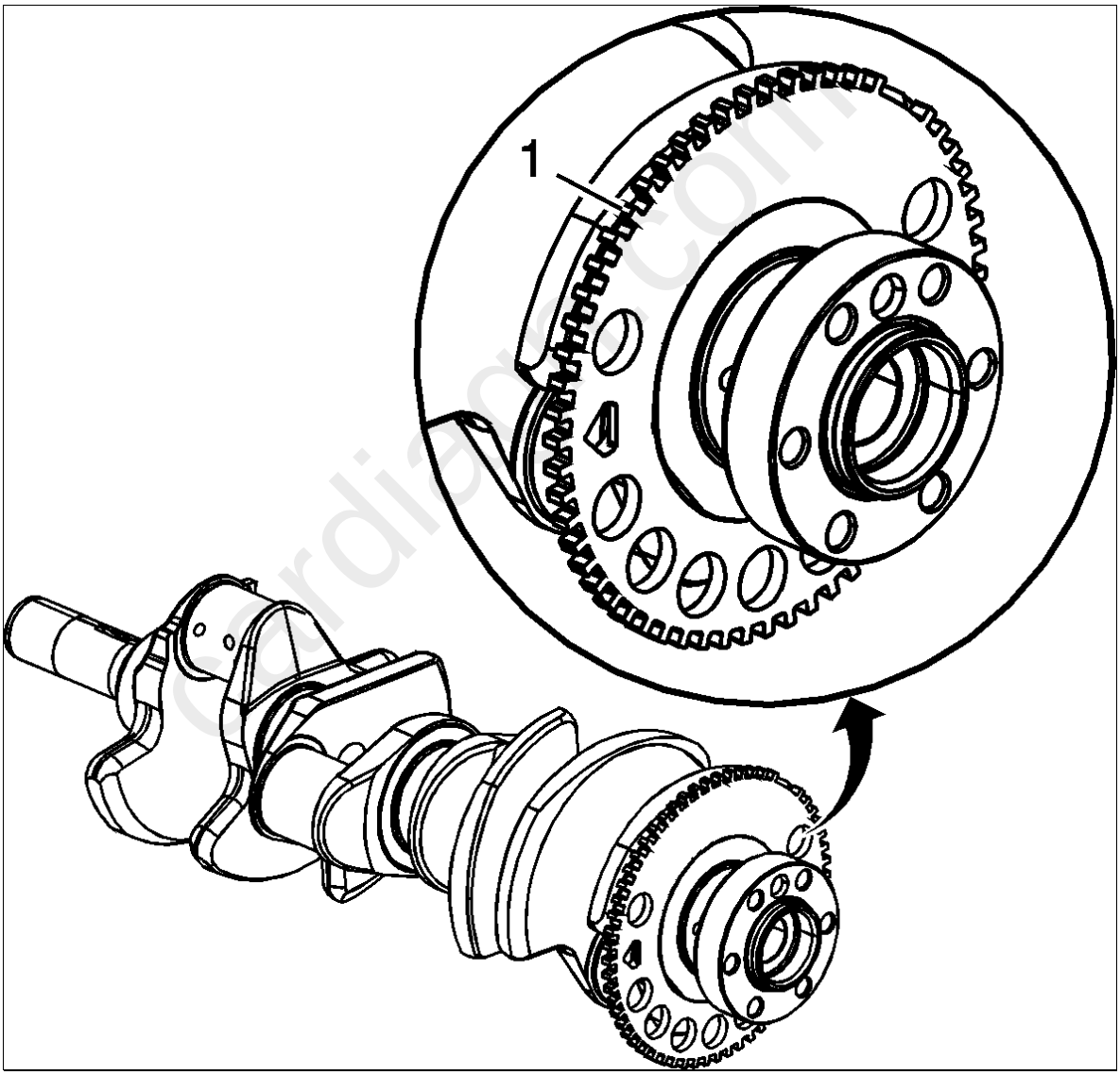
WARNING:

Refer to Safety Glasses Warning .

3. Dry the crankshaft with compressed air.

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING CLEANING AND INSPECTION > INSPECTION PROCEDURE

Fig 1: Reluctor Ring Teeth



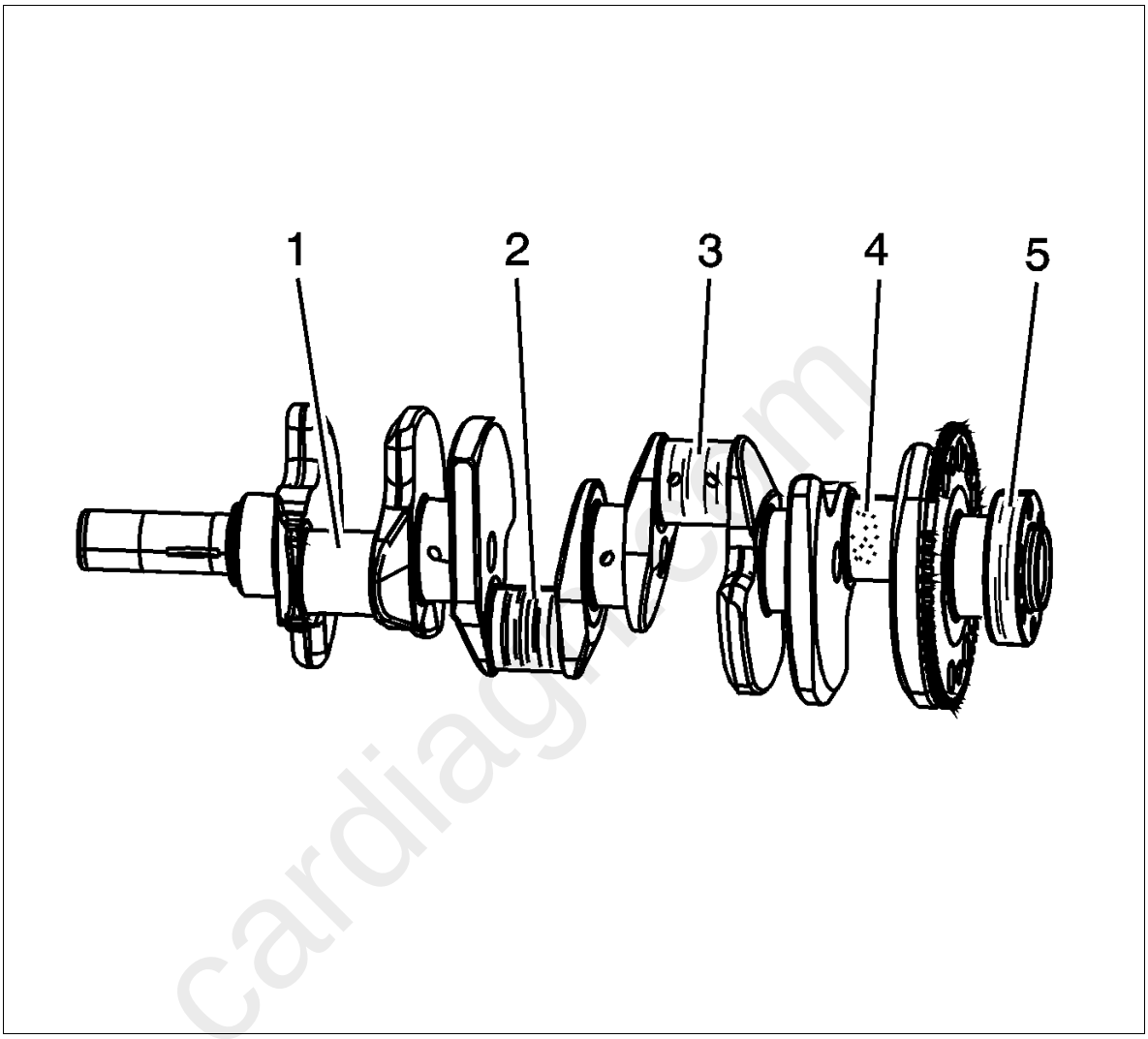
Courtesy of GENERAL MOTORS COMPANY

NOTE:

The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may affect OBD II system performance.

1. Inspect the CKP reluctor ring teeth (1) for damage.

Fig 2: Crankshaft Journals



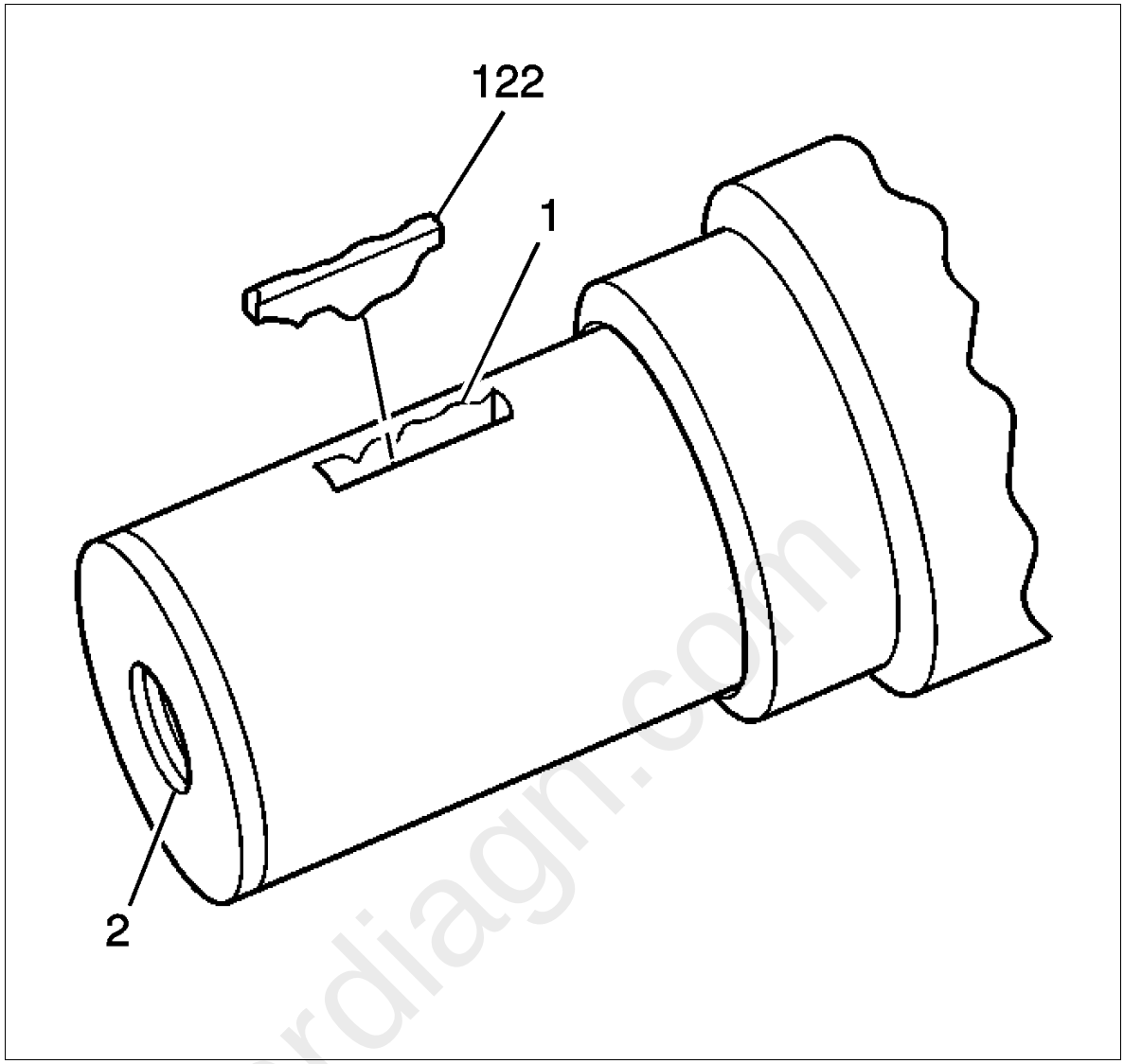
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the crankshaft journals for wear.

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

3. Inspect the crankshaft journals for grooves or scoring (2).
4. Inspect the crankshaft journals for scratches or wear (3).
5. Inspect the crankshaft journals for pitting or imbedded bearing material (4).
6. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.

Fig 3: Crankshaft Key, Keyway & Threaded Hole

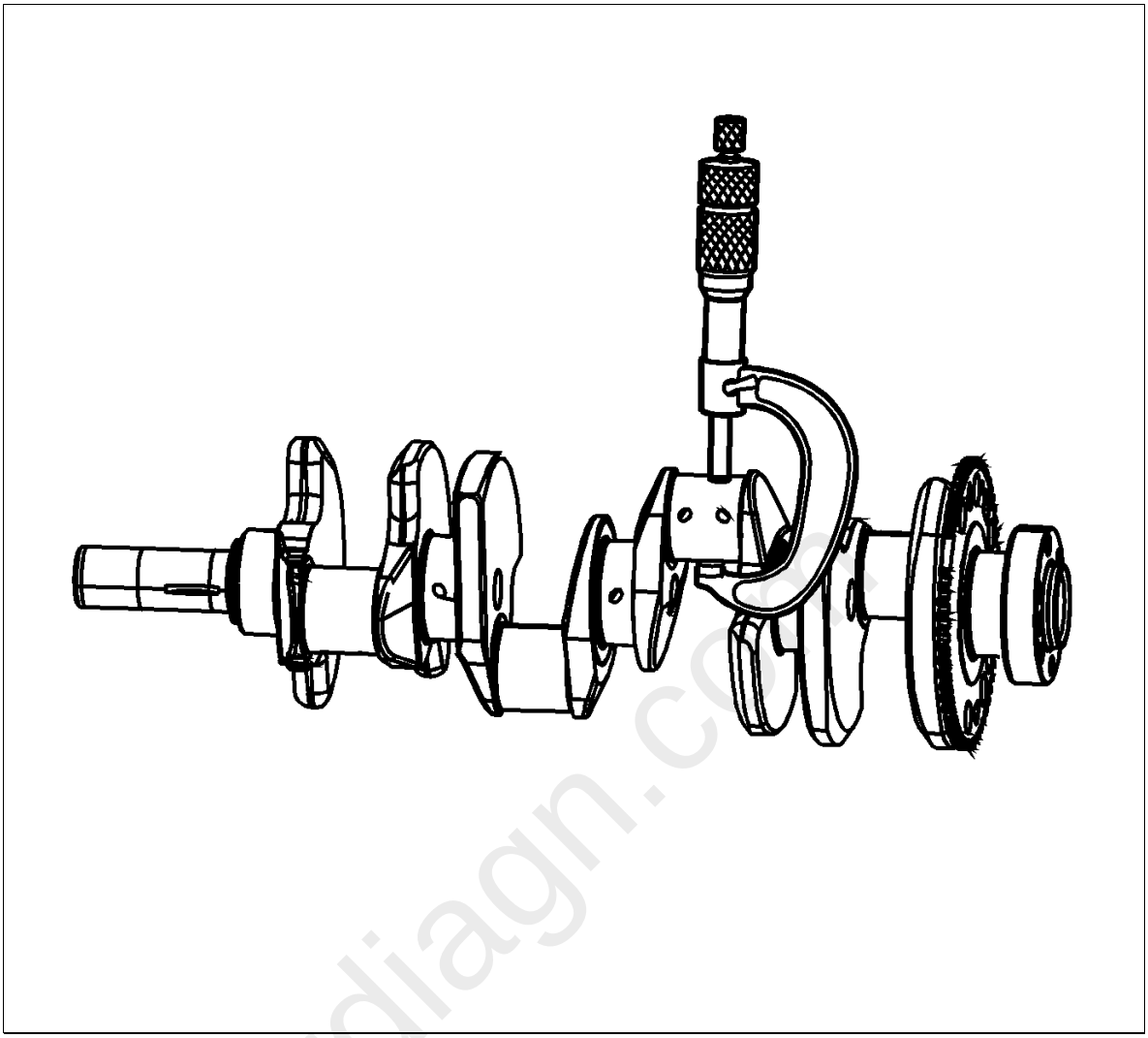


Courtesy of GENERAL MOTORS COMPANY

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

Fig 4: Connecting Rod Journals For Out-Of-Round And Taper

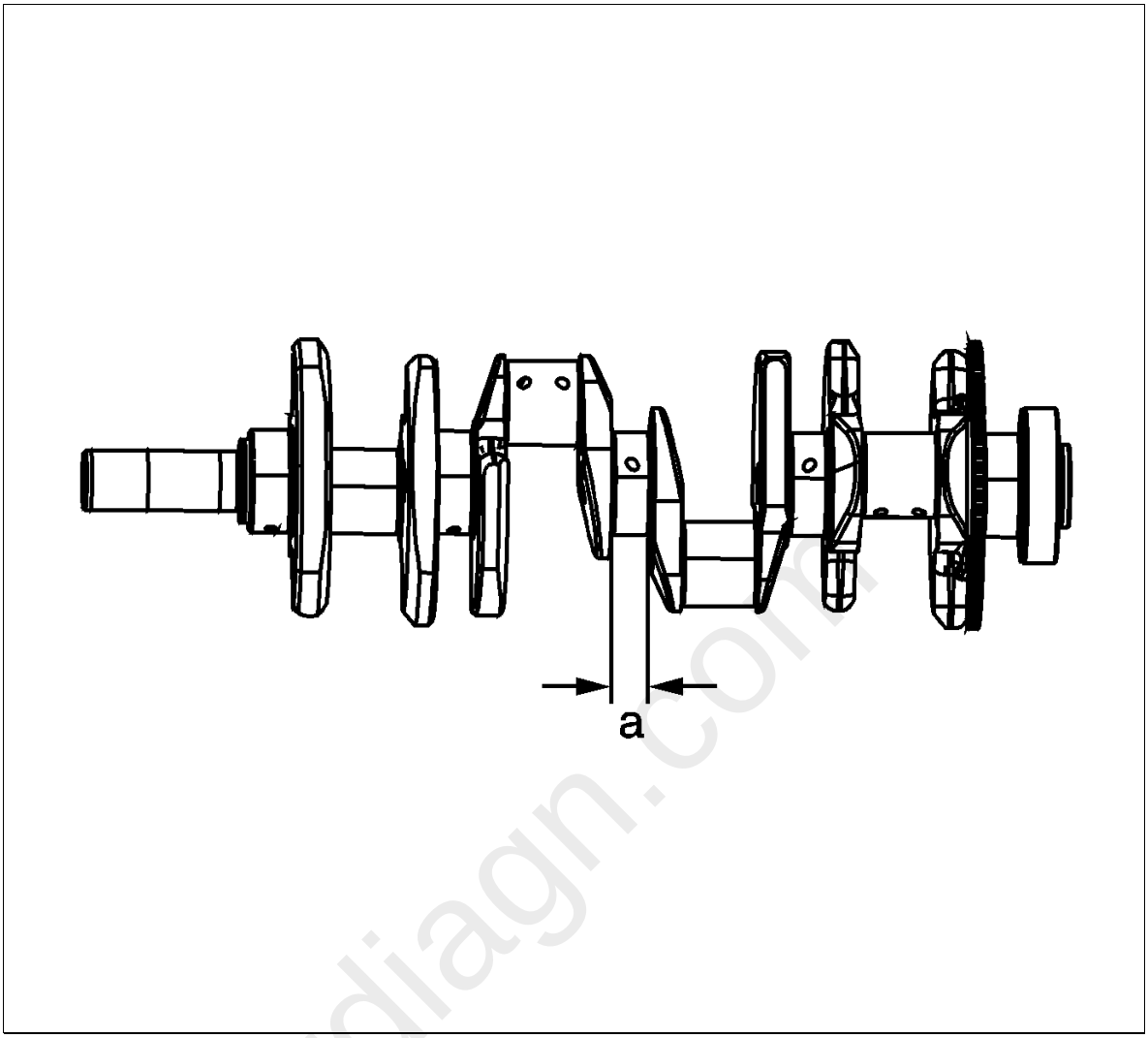


Courtesy of GENERAL MOTORS COMPANY

8. Measure the connecting rod journals for out-of-round and taper.

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Fig 5: Crankshaft Thrust Wall Width



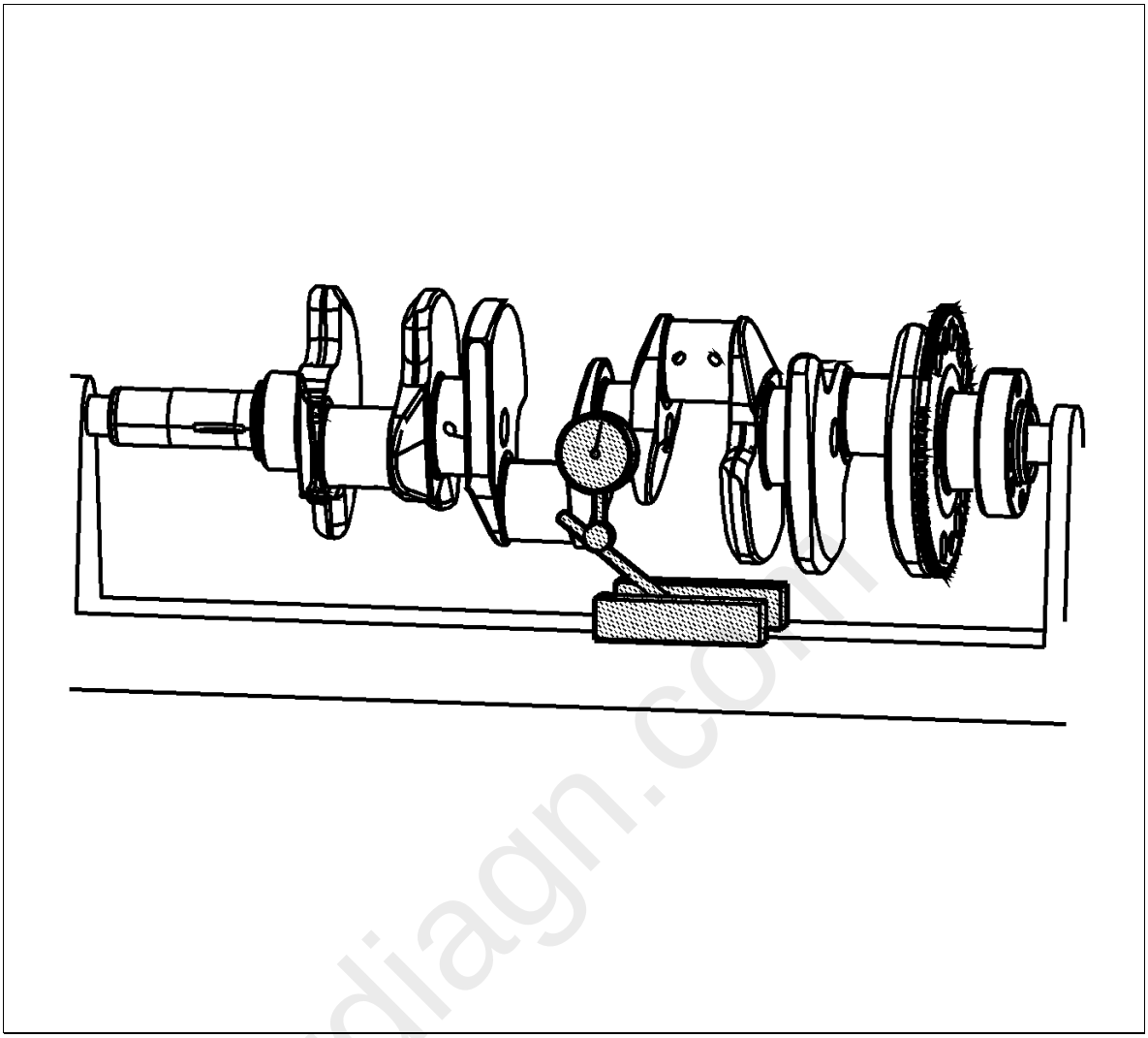
Courtesy of GENERAL MOTORS COMPANY

9. Measure the crankshaft thrust wall width.

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

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Fig 6: Crankshaft Runout



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10. Measure the crankshaft runout.

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

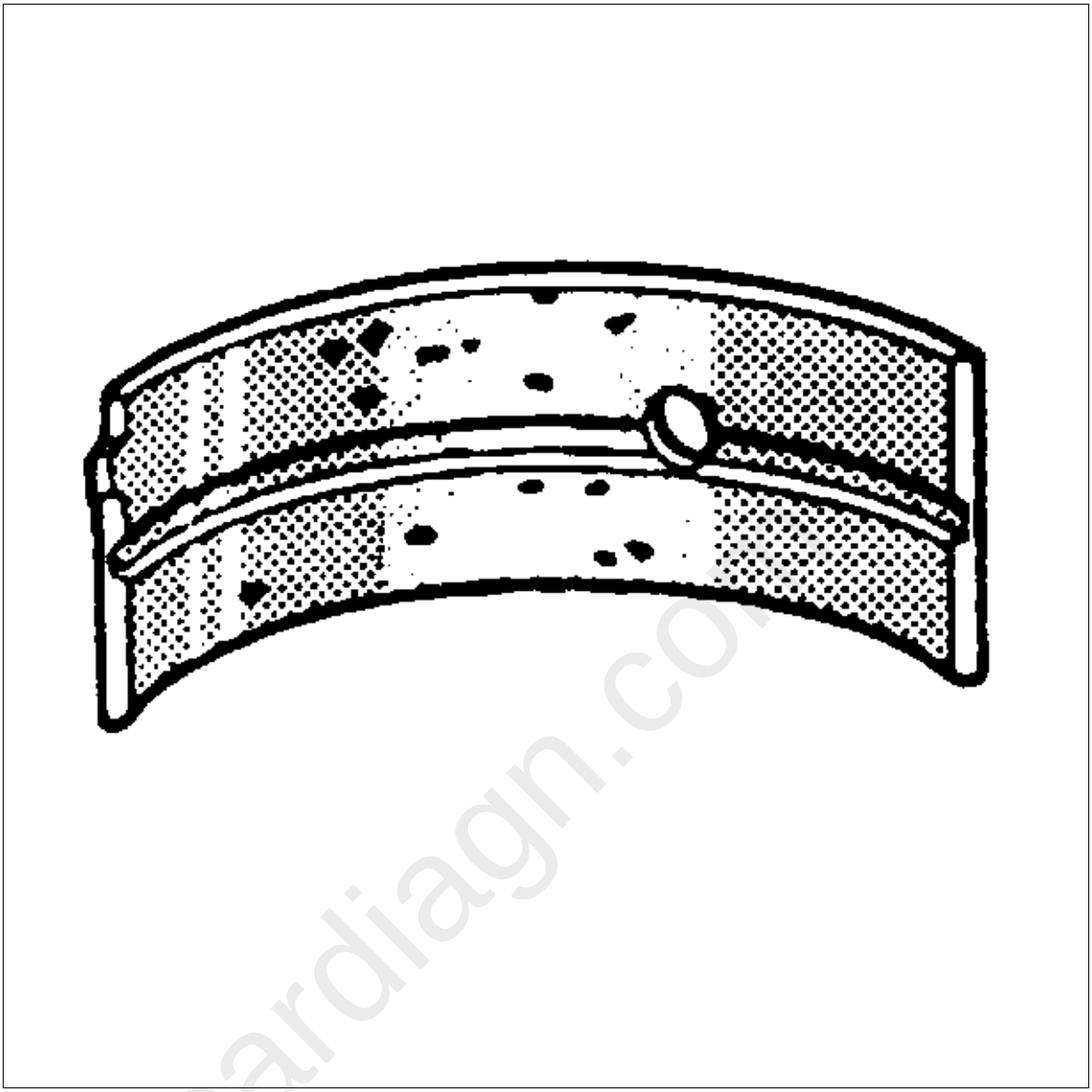
11. Use the **J 7872** set in order to measure the crankshaft runout at the front and rear intermediate journals.

12. Use the **J 7872** set in order to measure the runout of the crankshaft rear flange.

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

    If the front and rear intermediate journals, crankshaft rear flange, or reluctor ring runout exceeds specification, replace the crankshaft. Refer to Engine Mechanical Specifications (LT1) .

Fig 7: Crankshaft Bearing Craters Or Pockets

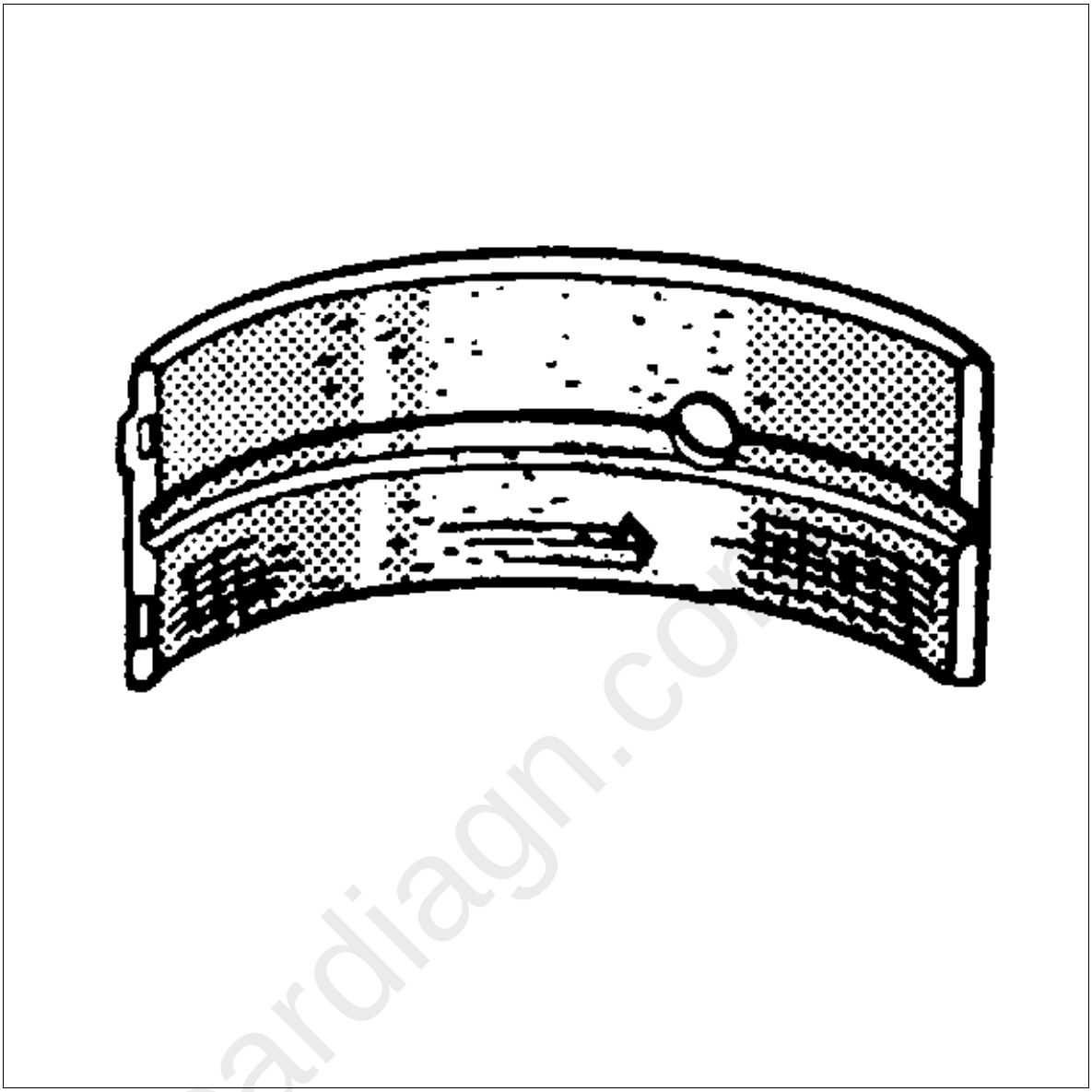


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14. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

Fig 8: Connecting Rod Bearing Scoring Or Discoloration

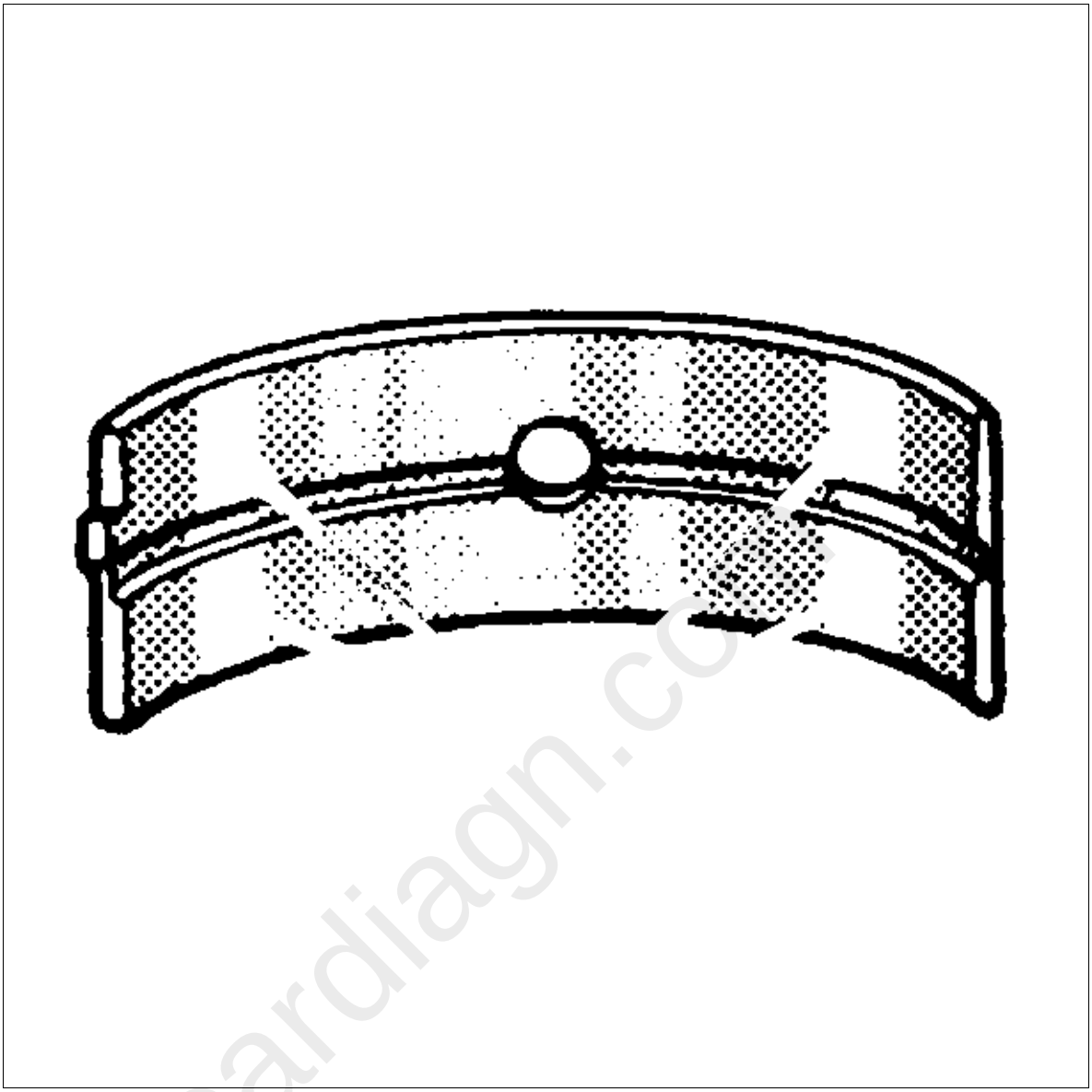


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15. Inspect the crankshaft bearings for excessive scoring or discoloration.
16. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

Fig 9: Crankshaft Bearing Improper Seating



Courtesy of GENERAL MOTORS COMPANY

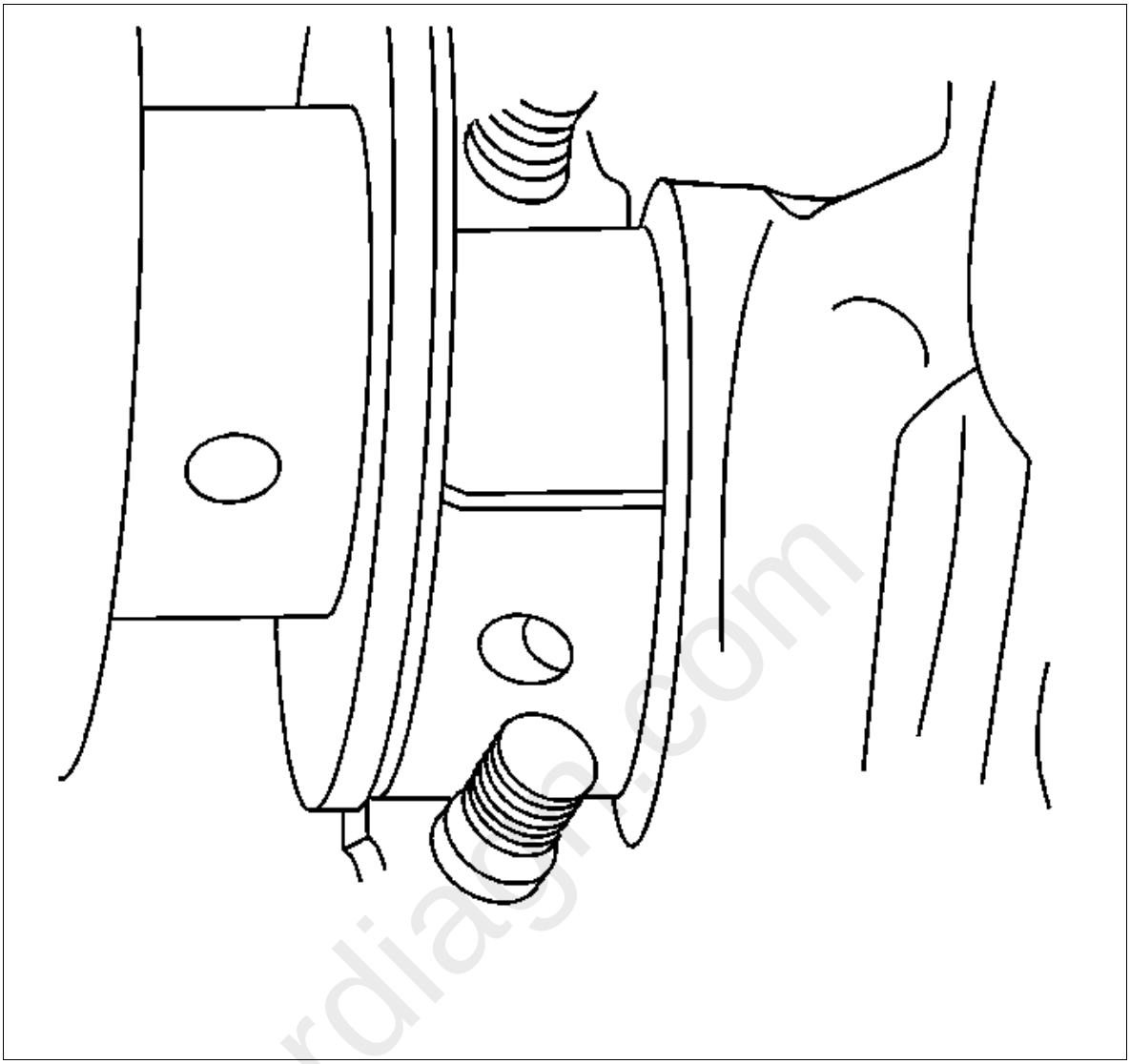
17. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

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

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

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING CLEANING AND INSPECTION > MEASURING MAIN BEARING CLEARANCE - GAGING PLASTIC METHOD

Fig 1: Gaging Plastic Installed On Crankshaft Journal



Courtesy of GENERAL MOTORS COMPANY

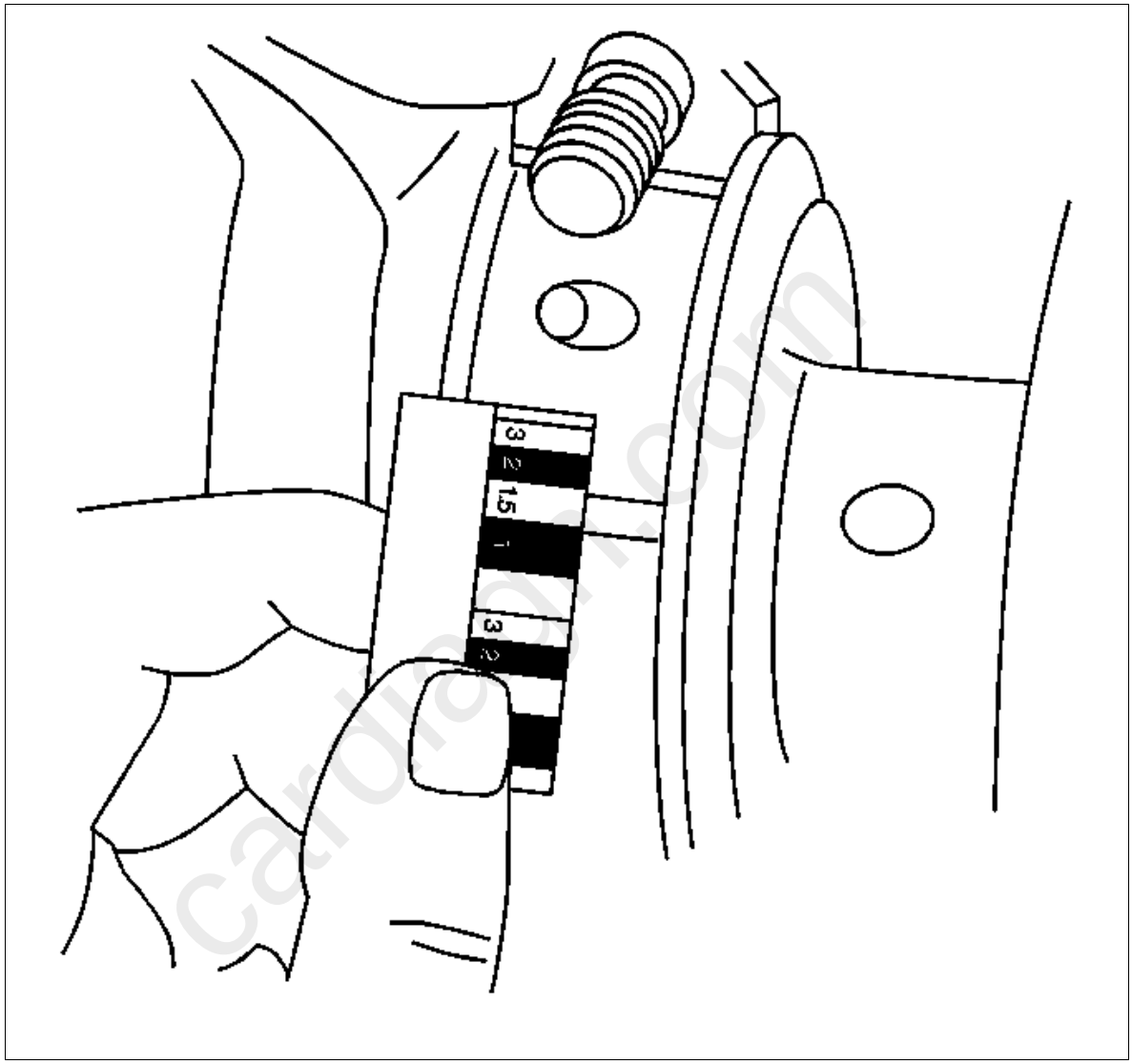
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NOTE:

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

1. Remove the bearing caps, bearing half, and bolts. Refer to Crankshaft and Bearing Removal .
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half, and bolts. Refer to Crankshaft and Bearing Installation .
4. Remove the bearing caps, bearing half, and bolts. Refer to Crankshaft and Bearing Removal .

Fig 2: Gaging Plastic

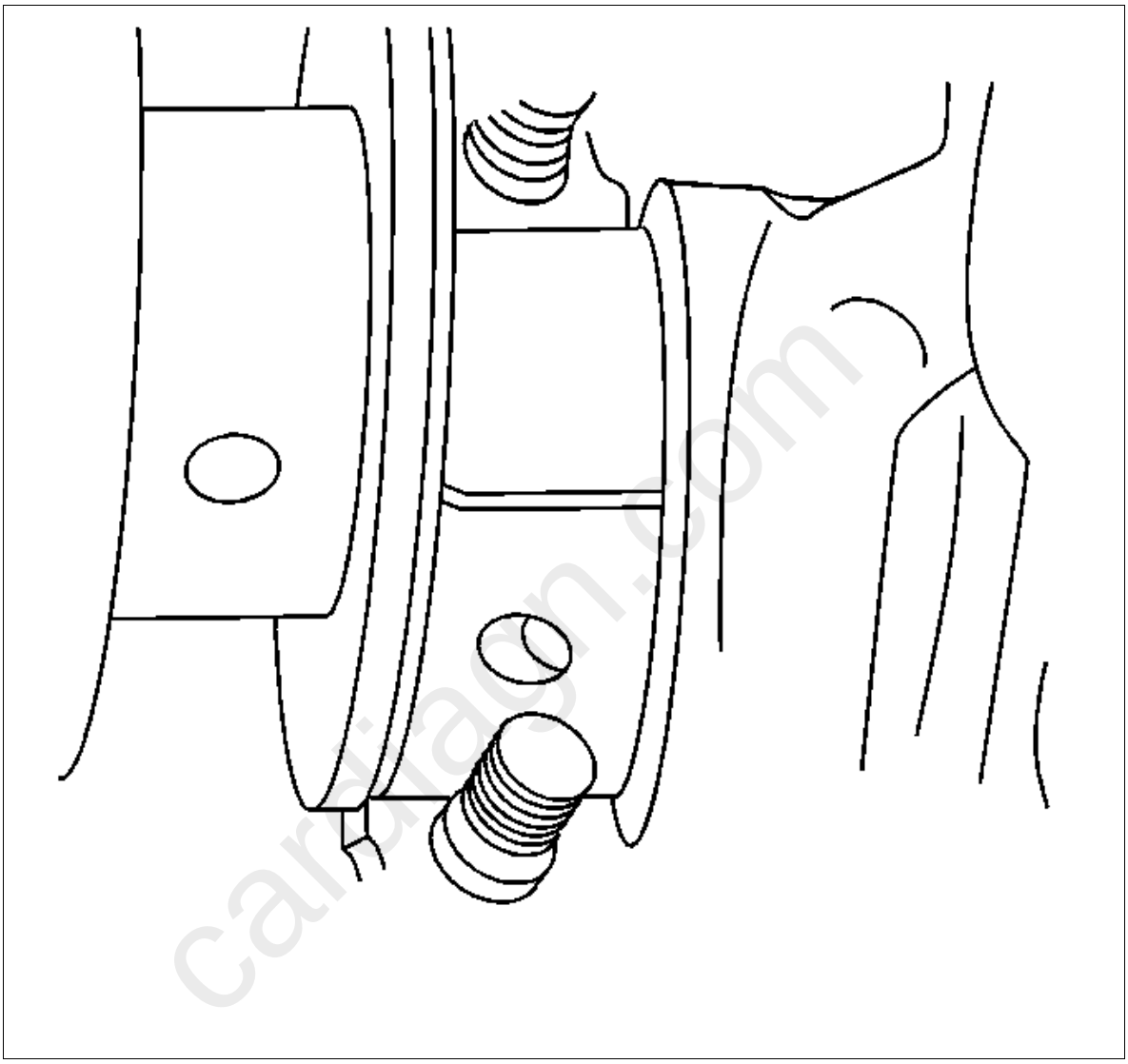


Courtesy of GENERAL MOTORS COMPANY

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.
    1. If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
    2. If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING CLEANING AND INSPECTION > MEASURING CONNECTING ROD BEARING CLEARANCE - GAGING PLASTIC METHOD

Fig 1: Gaging Plastic Installed On Crankshaft Journal



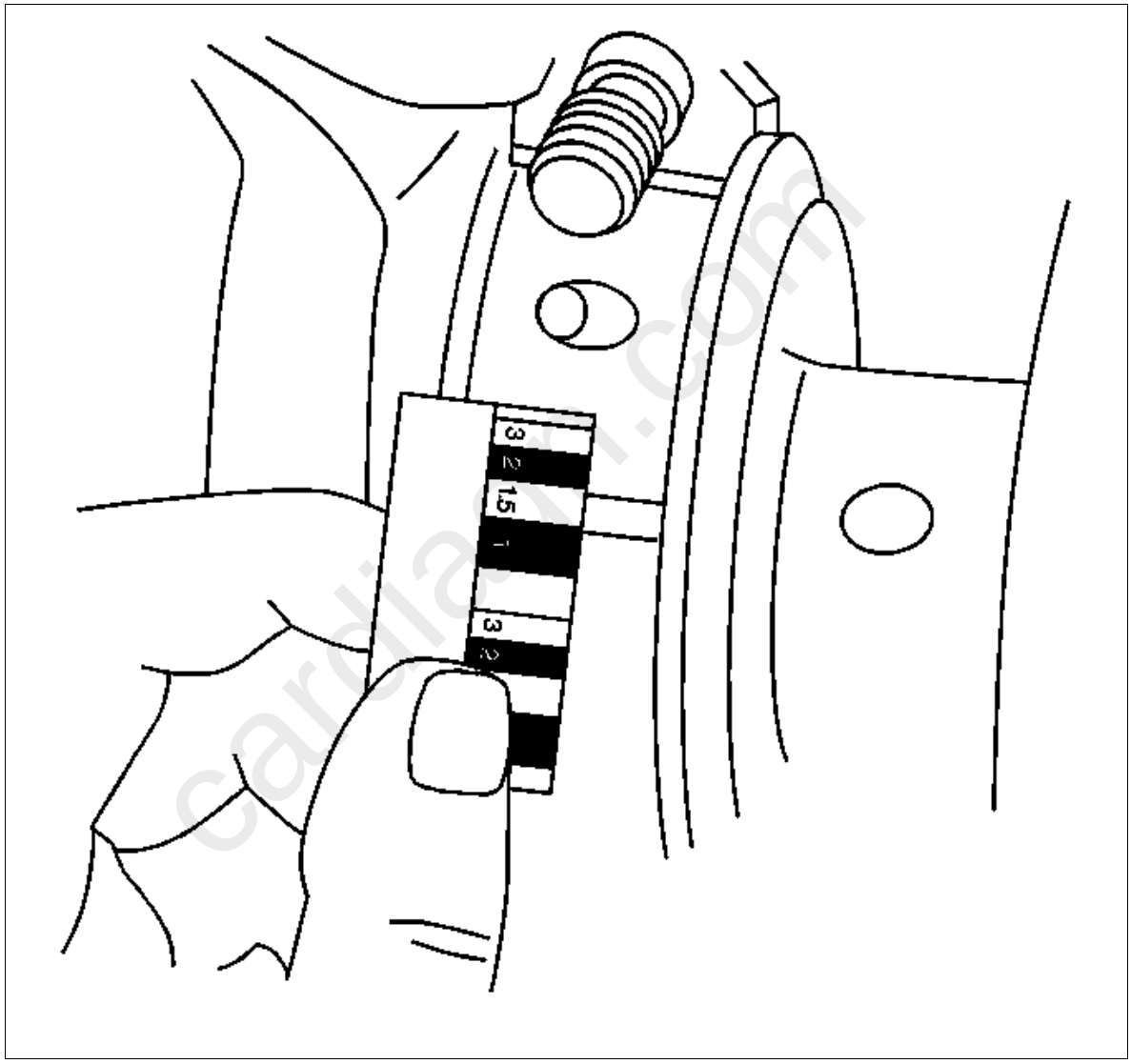
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

   Fig 2: Gaging Plastic



Courtesy of GENERAL MOTORS COMPANY

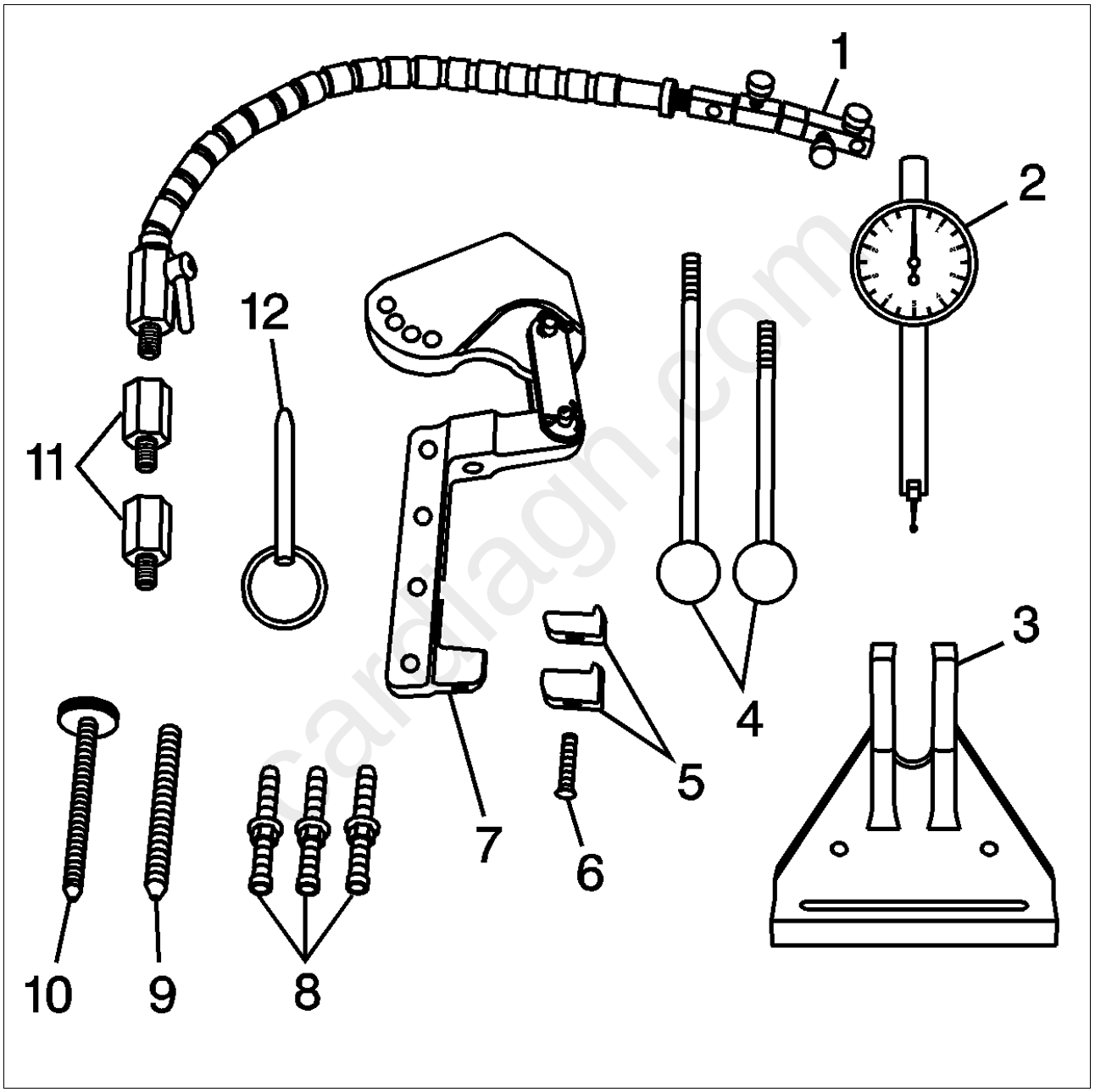
5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING CLEANING

AND INSPECTION > MEASURING CONNECTING ROD BEARING CLEARANCE - USING J 43690/J 43690-100

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

Fig 1: Rod Bearing Clearance Checking Tool



Courtesy of GENERAL MOTORS COMPANY

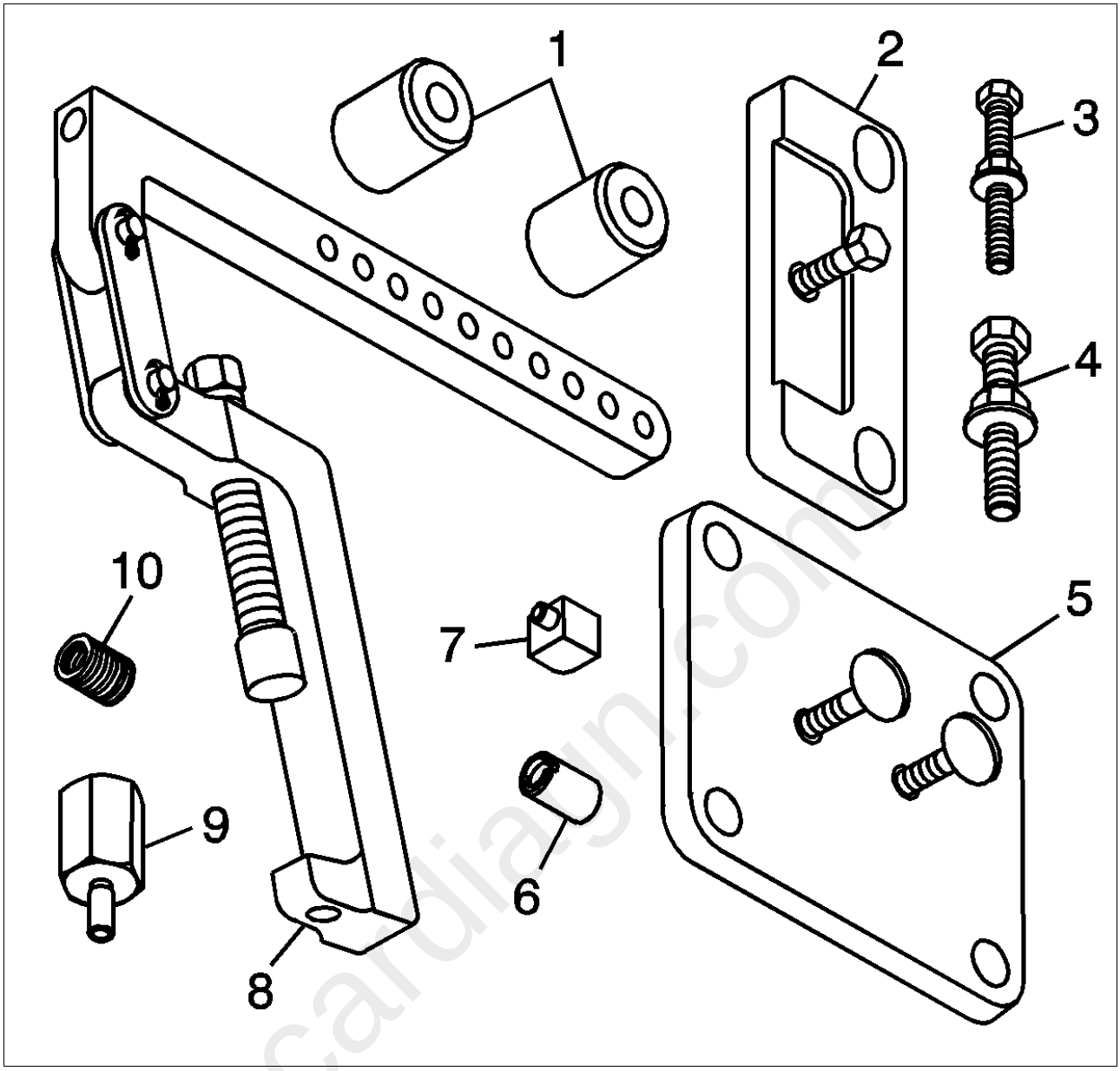
J 43690 tool

- J 43690-20 Swivel Base (1)

- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, J 43690-18 Adapter (11)
- 280310 Pin (12)

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Fig 2: Rod Bearing Clearance Tool - Adapter Kit



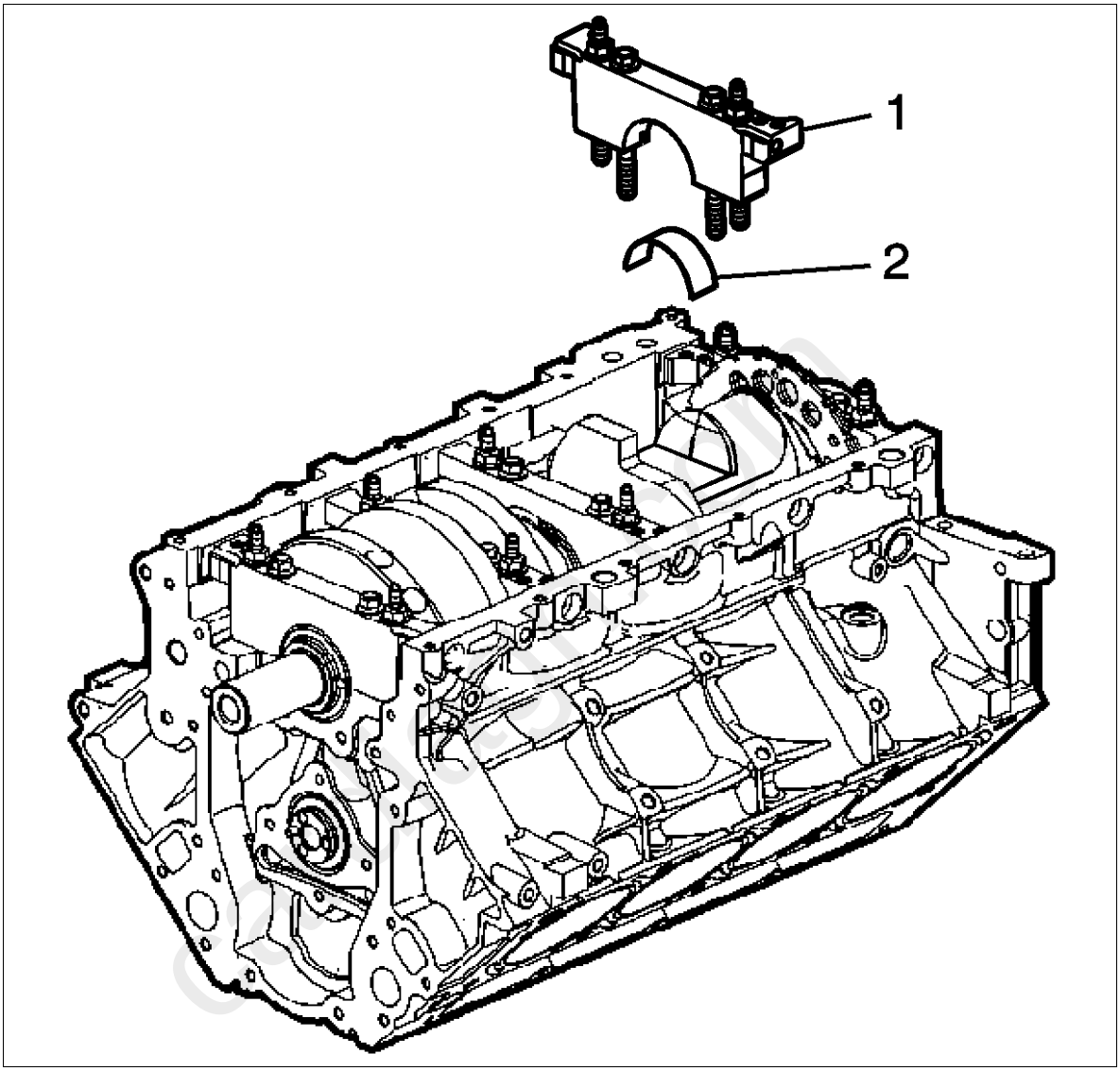
Courtesy of GENERAL MOTORS COMPANY

J 43690 Rod Bearing Checking Tool

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)

- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)

Fig 3: Bearing Cap, Bolt & Bearing Half



Courtesy of GENERAL MOTORS COMPANY

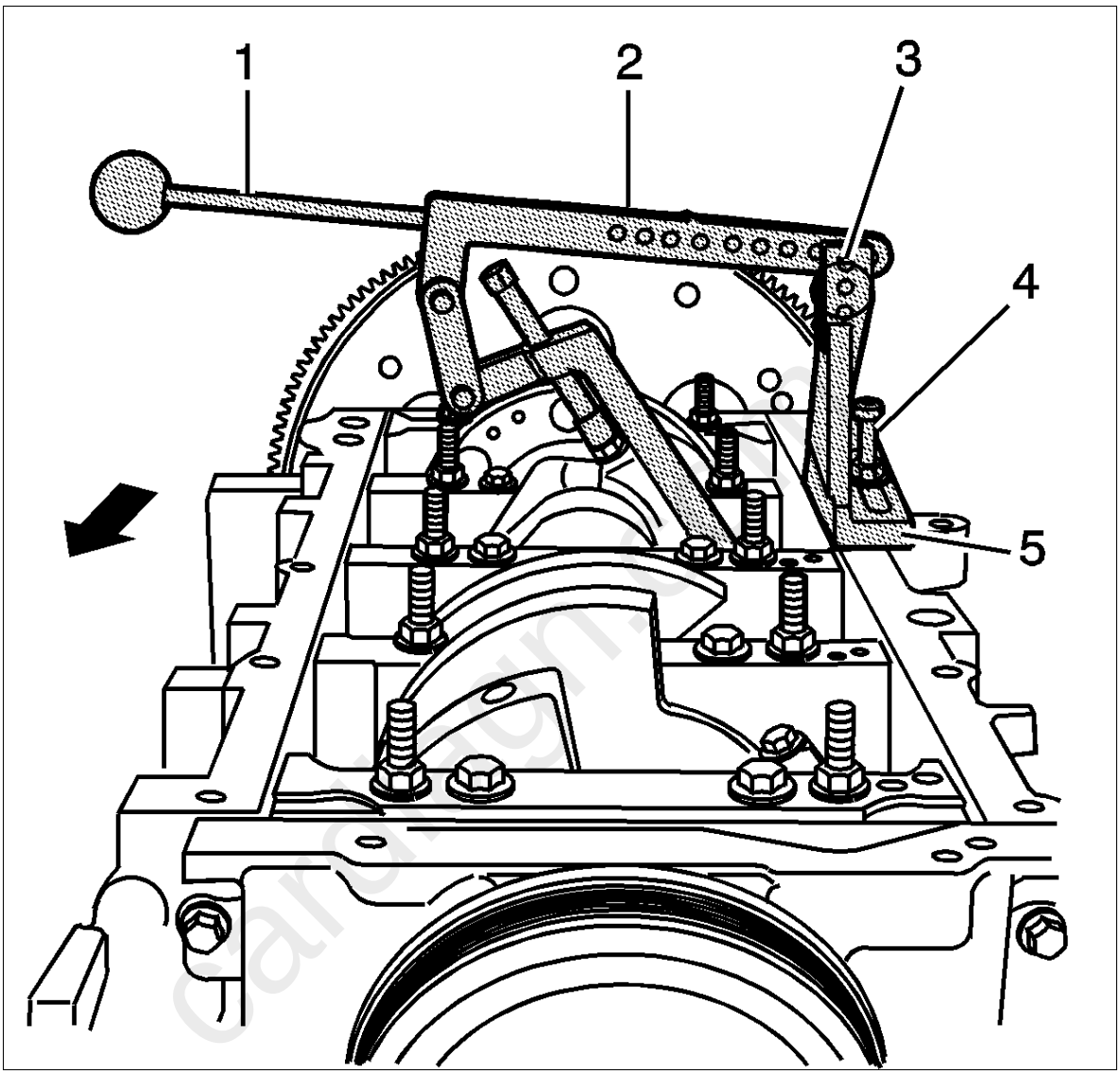
NOTE:

The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.

1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.
2. Remove a bearing cap and bolts (1).

3. Remove the bearing half (2).
4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to Fastener Specifications .

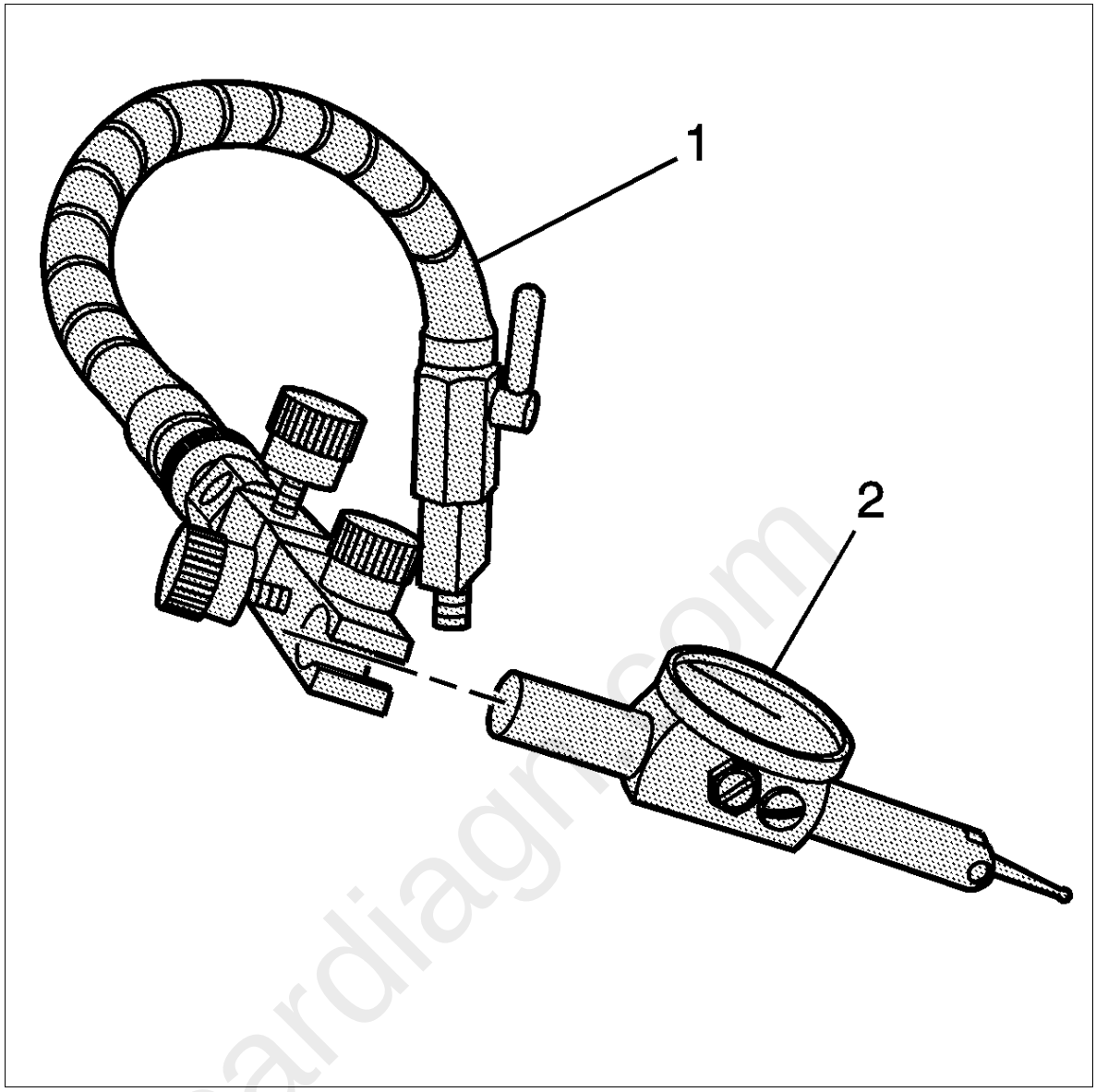
Fig 4: Special Tool Installed On Engine Block



Courtesy of GENERAL MOTORS COMPANY

6. Install the following:
    1. J 43690-2 (5)
    2. J 43690-3 (4)
    3. J 43690-101 (2)
    4. 280310 (3)
    5. J 43690-5 (1)

Fig 5: Swivel Base & Dial Indicator



Courtesy of GENERAL MOTORS COMPANY

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

   A connecting rod with a clearance in excess of 0.076 mm (0.003 in) is considered excessive. Service components, as required.

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT BALANCER CLEANING AND INSPECTION

Fig 1: Crankshaft Balancer



Courtesy of GENERAL MOTORS COMPANY

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

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

    2. Worn, grooved, or damaged hub seal surface

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

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

> *NOTE:*
>
> *In order for the belt to track properly, the belt grooves should be free of all dirt and debris.*

3. Dirty or damaged belt grooves

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

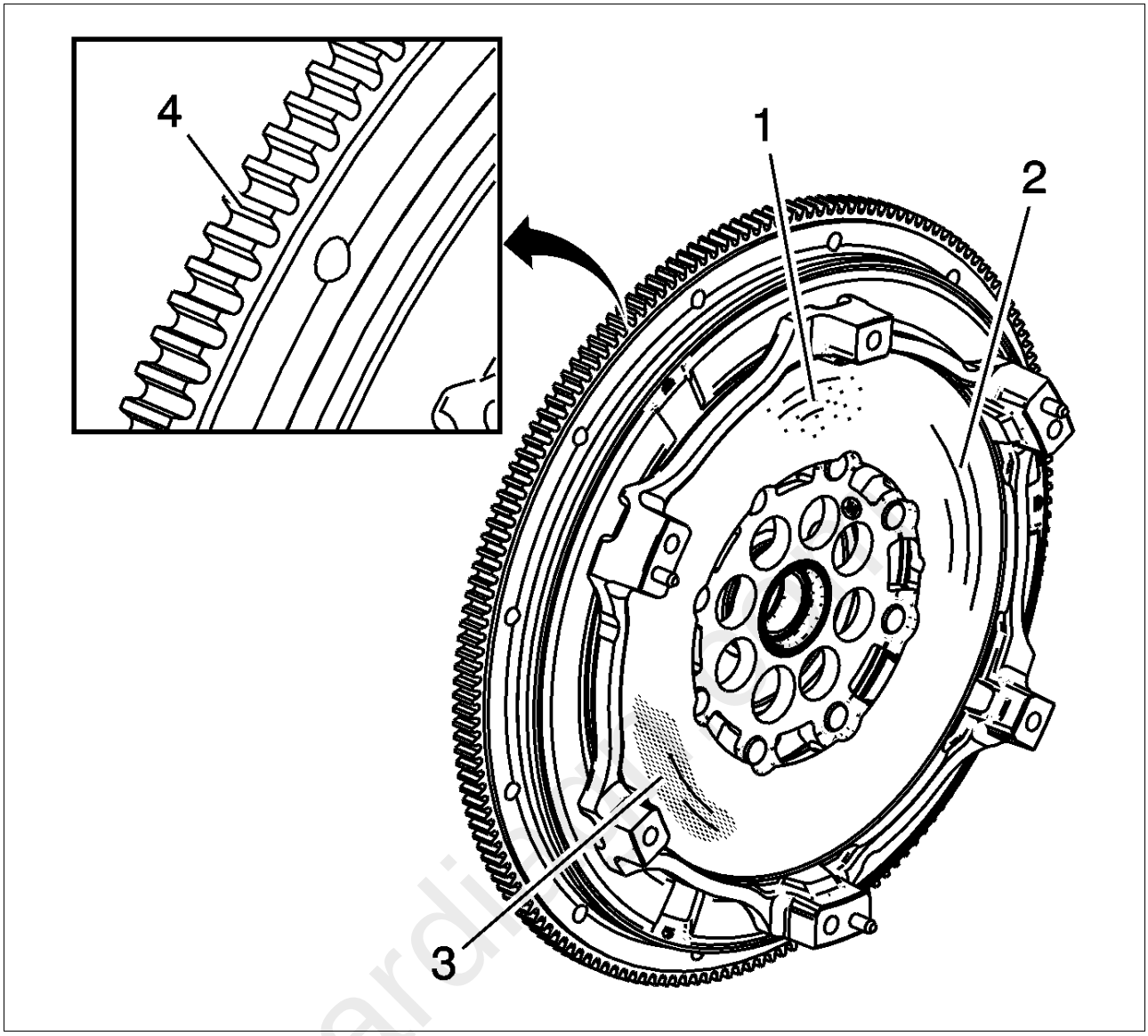
   Minor imperfections may be removed with a fine file.

4. Worn, chunking or deteriorated rubber between the hub and pulley

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FLYWHEEL CLEANING AND INSPECTION

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Fig 1: Flywheel Surfaces



Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

- Pitted surface (1)
- Grooved or scored surface (2)
- Rusted surface (3)
- Damaged ring gear teeth (4)

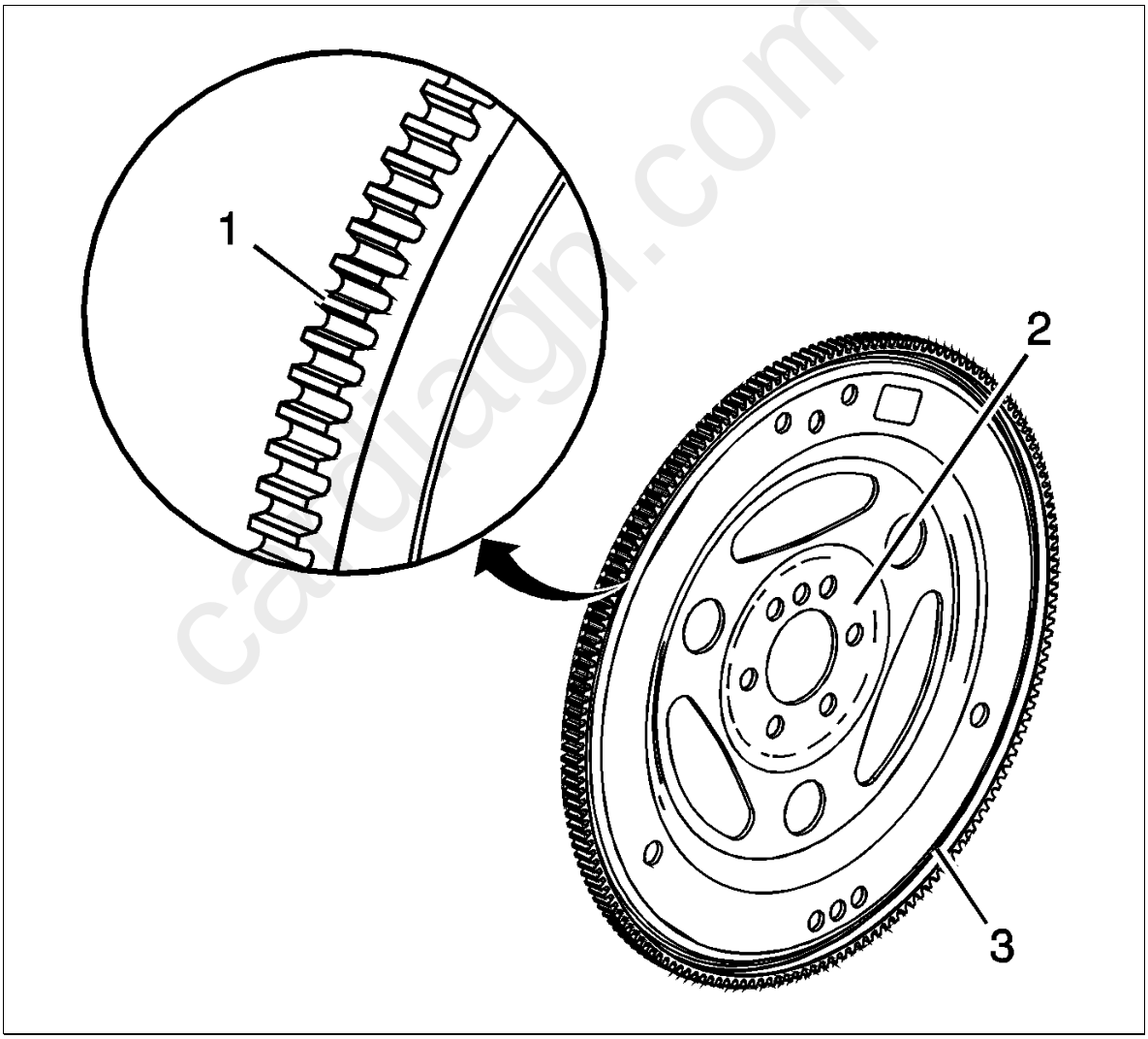
- Loose or improperly positioned ring gear

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

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

REPAIR INSTRUCTIONS - OFF VEHICLE > AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

Fig 1: Ring Gear Teeth



Courtesy of GENERAL MOTORS COMPANY

1. Clean the flex plate in solvent.

> *WARNING:*
>
> *Refer to Safety Glasses and Compressed Air Warning .*

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

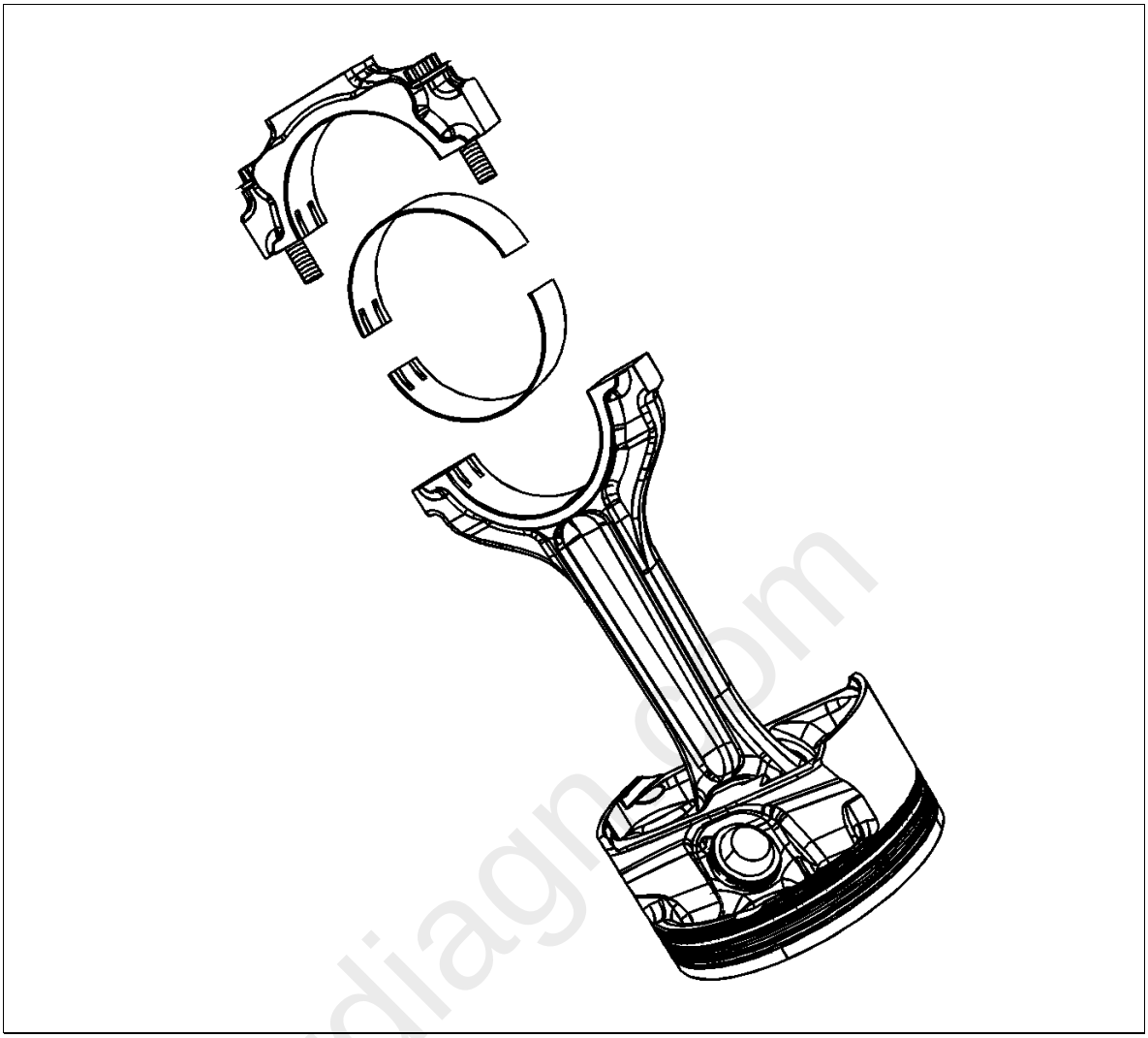
> *NOTE:*
>
> *Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate.*

    3. Welded areas (3) that retain the ring gear onto the flex plate for cracking

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON AND CONNECTING ROD DISASSEMBLE

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Fig 1: Piston, Connecting Rod & Bearing Assembly

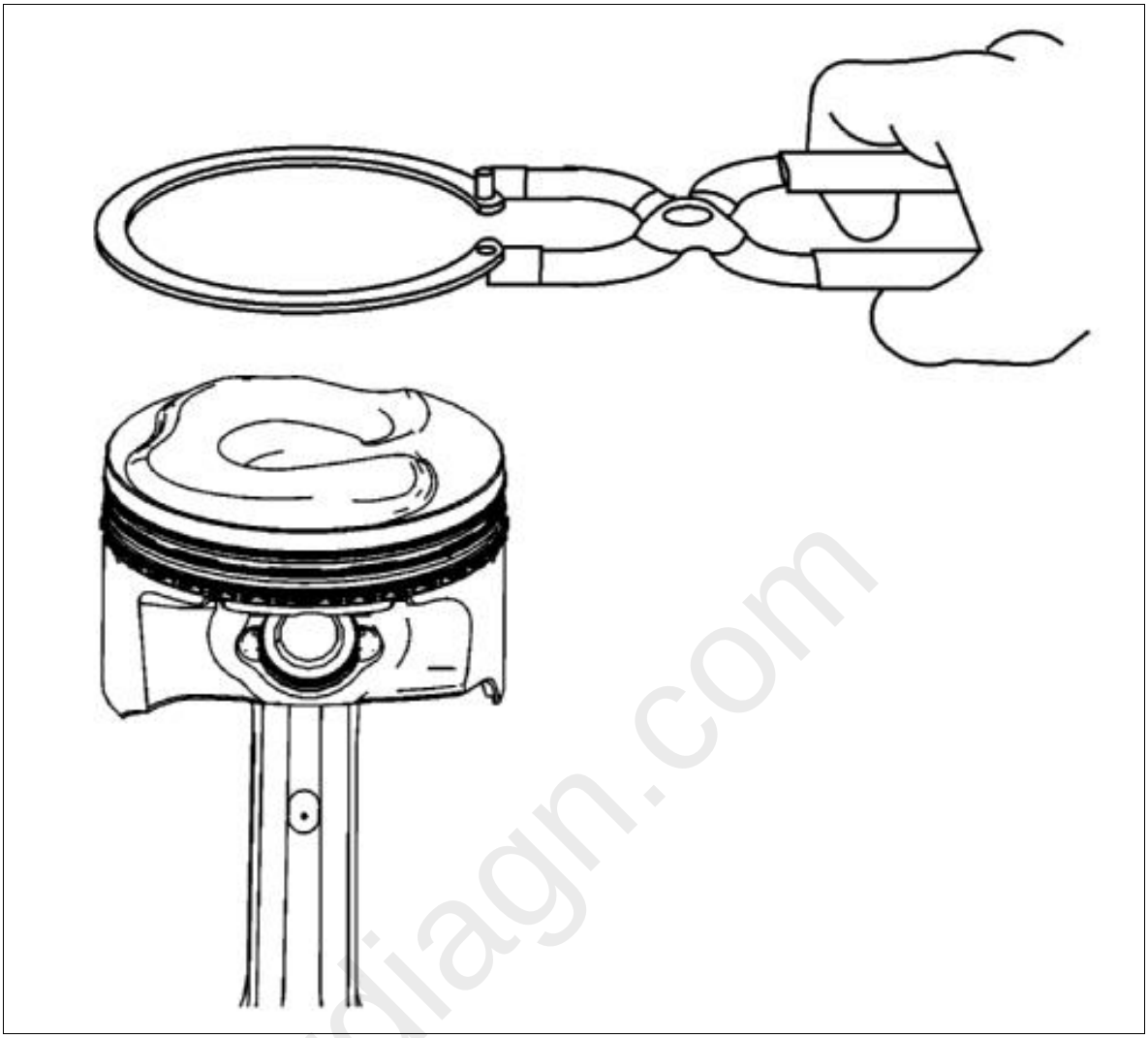


Courtesy of GENERAL MOTORS COMPANY

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

Fig 2: Removing Piston Rings From Piston Using Piston Ring Pliers

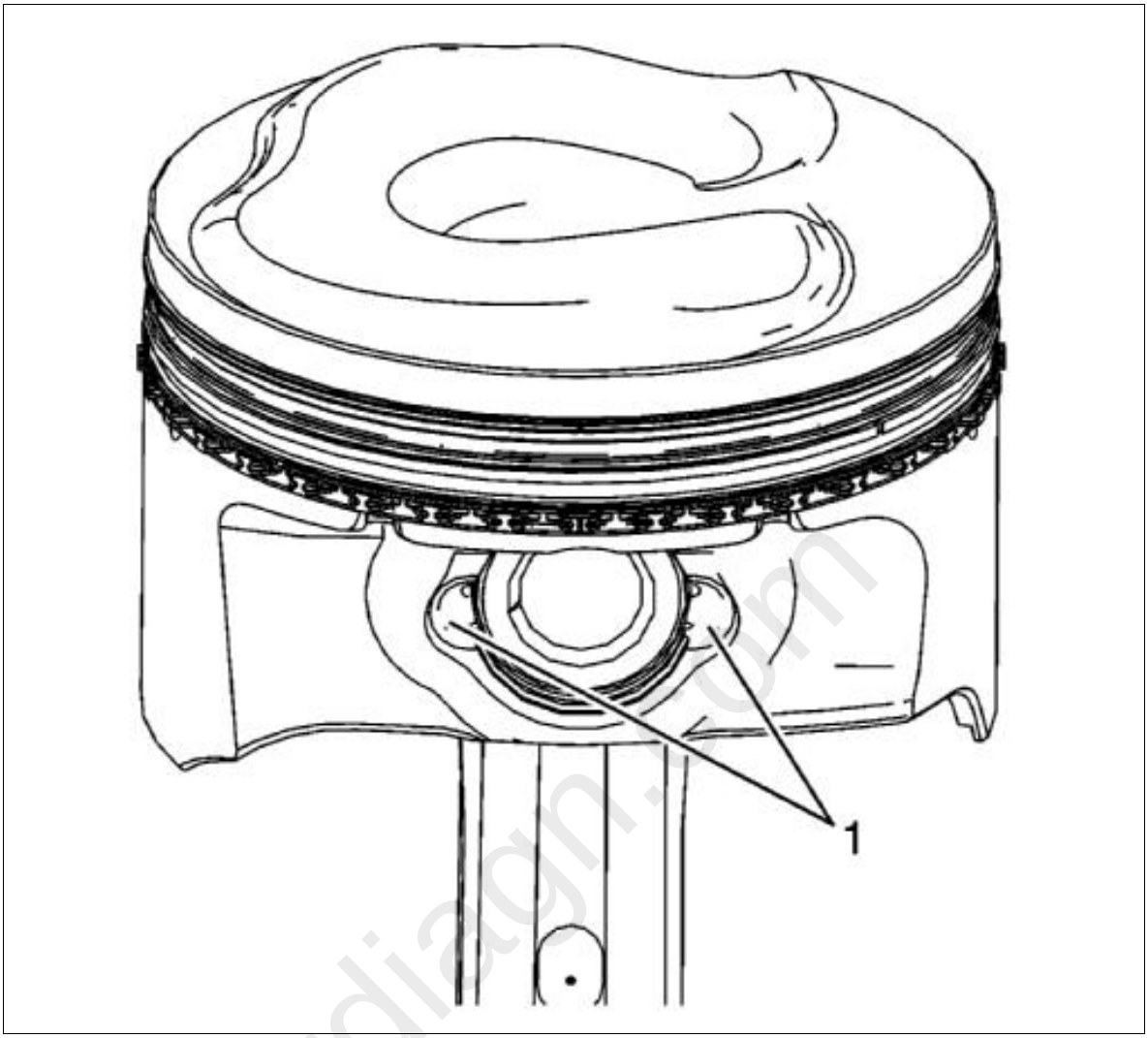


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2. Using piston ring pliers, remove the piston rings from the piston.

Fig 3: Rotating Piston Pin Retainers Until Ring End Gaps Are Positioned In Cutout Area

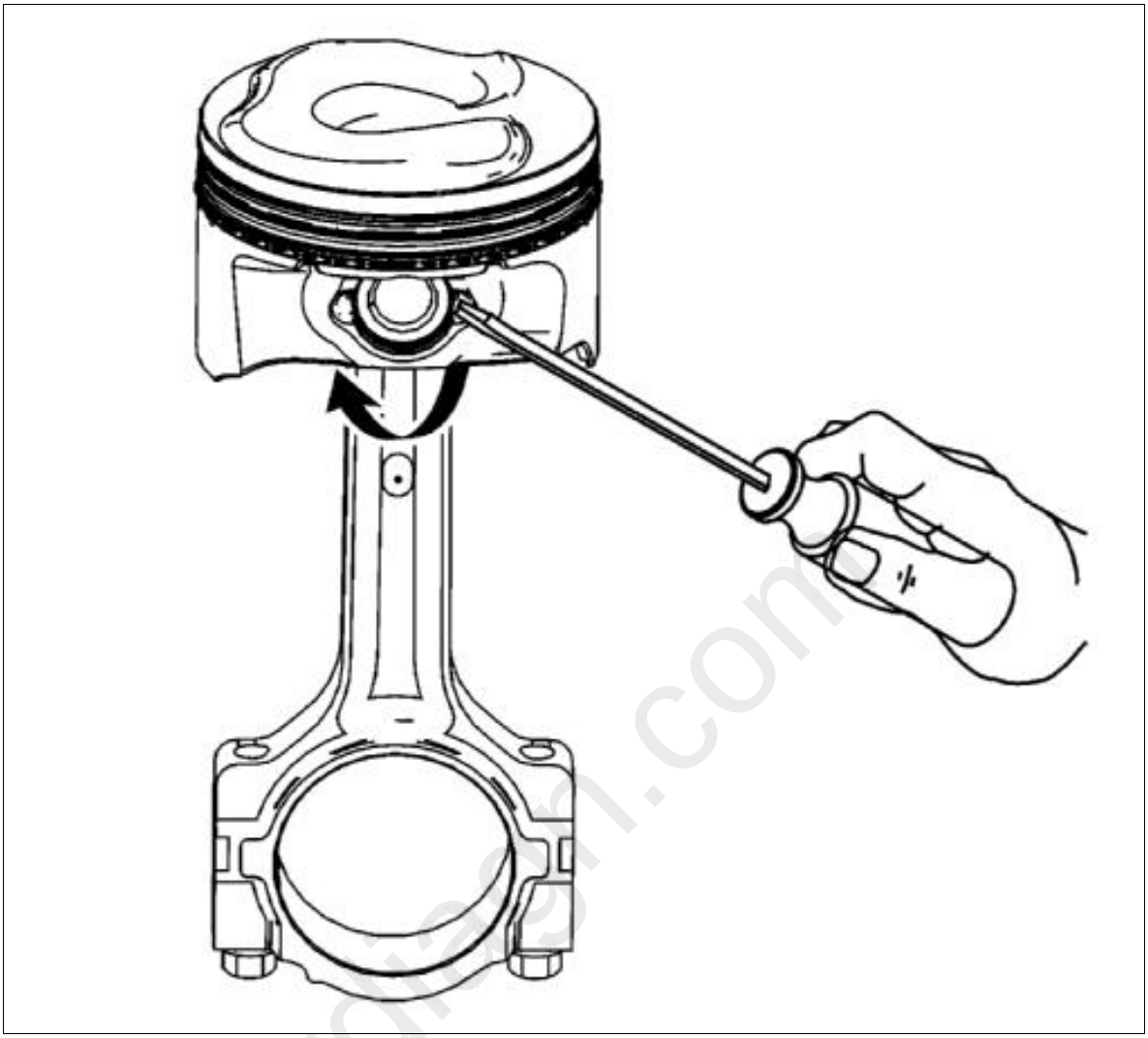


Courtesy of GENERAL MOTORS COMPANY

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

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Fig 4: Retainers Starting In Cutout Area Of Pin Bore

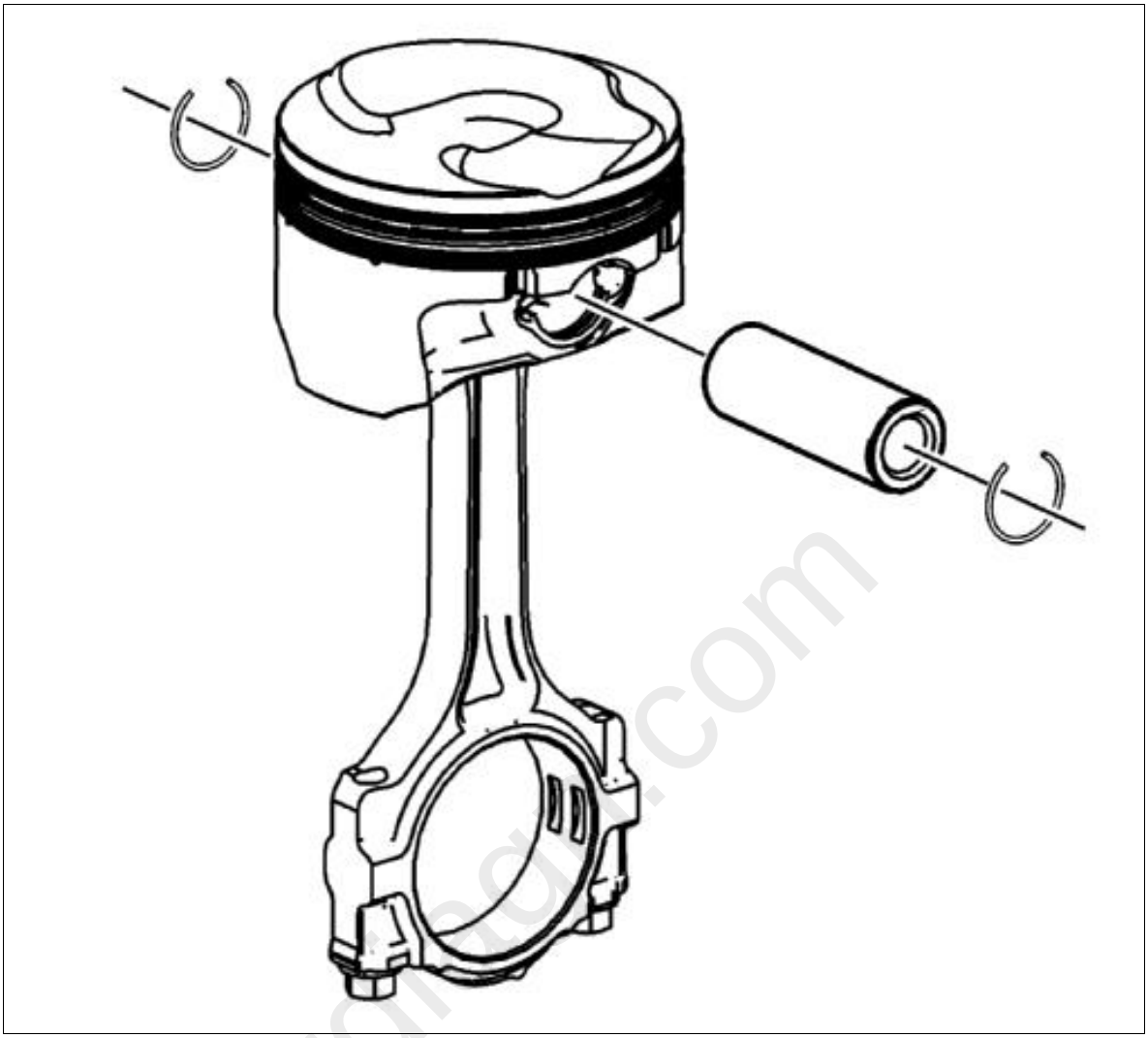


Courtesy of GENERAL MOTORS COMPANY

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

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Fig 5: Removing Pin From Piston And Connecting Rod



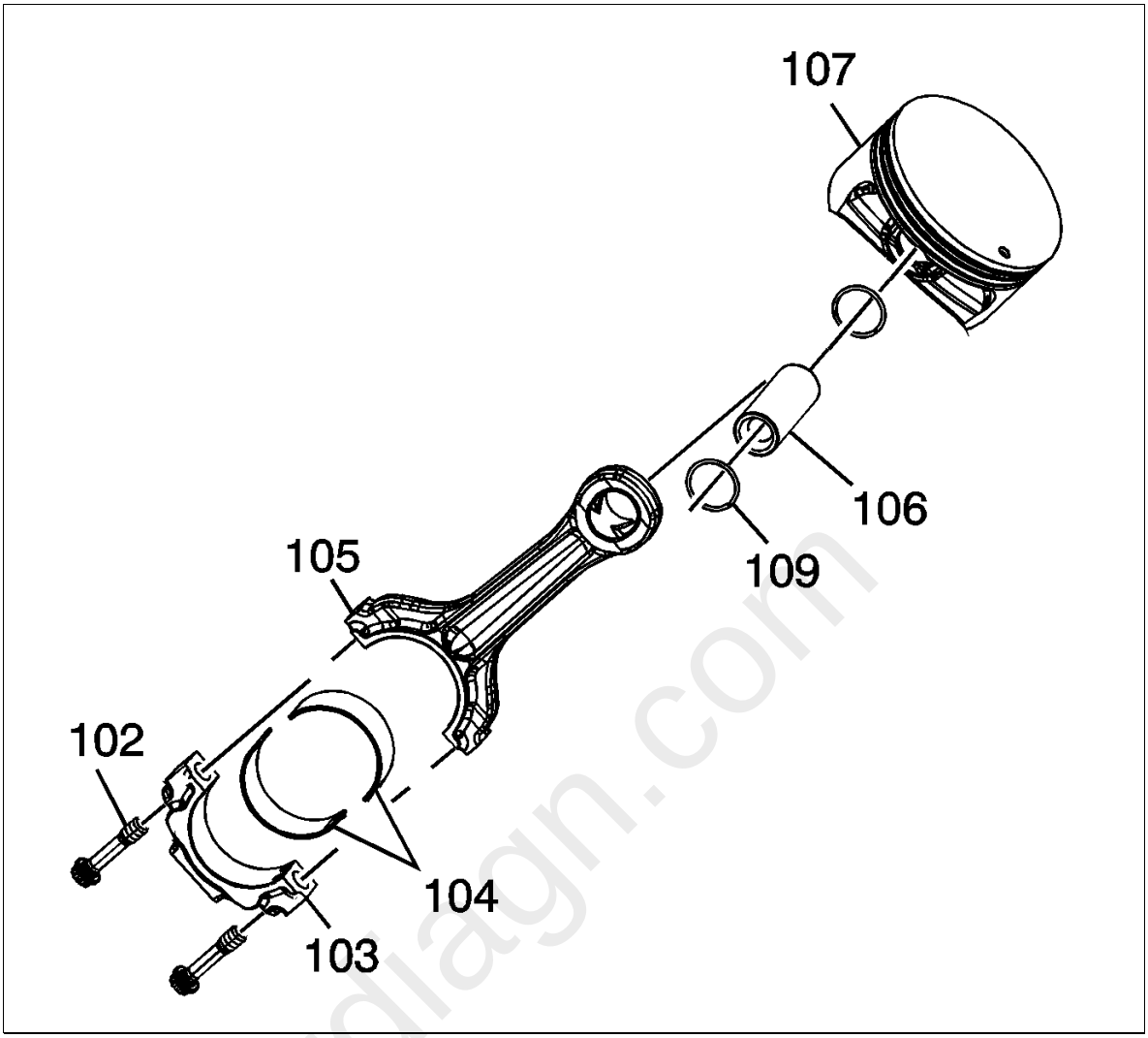
Courtesy of GENERAL MOTORS COMPANY

5. Remove the pin from the piston and connecting rod.
6. The piston and pin are a matched set and are not to be serviced separately.

   Mark, sort, or organize the piston and the matching piston pin.

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION > PISTON, PIN, AND PISTON RINGS

Fig 1: Piston, Pin & Piston Rings



Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

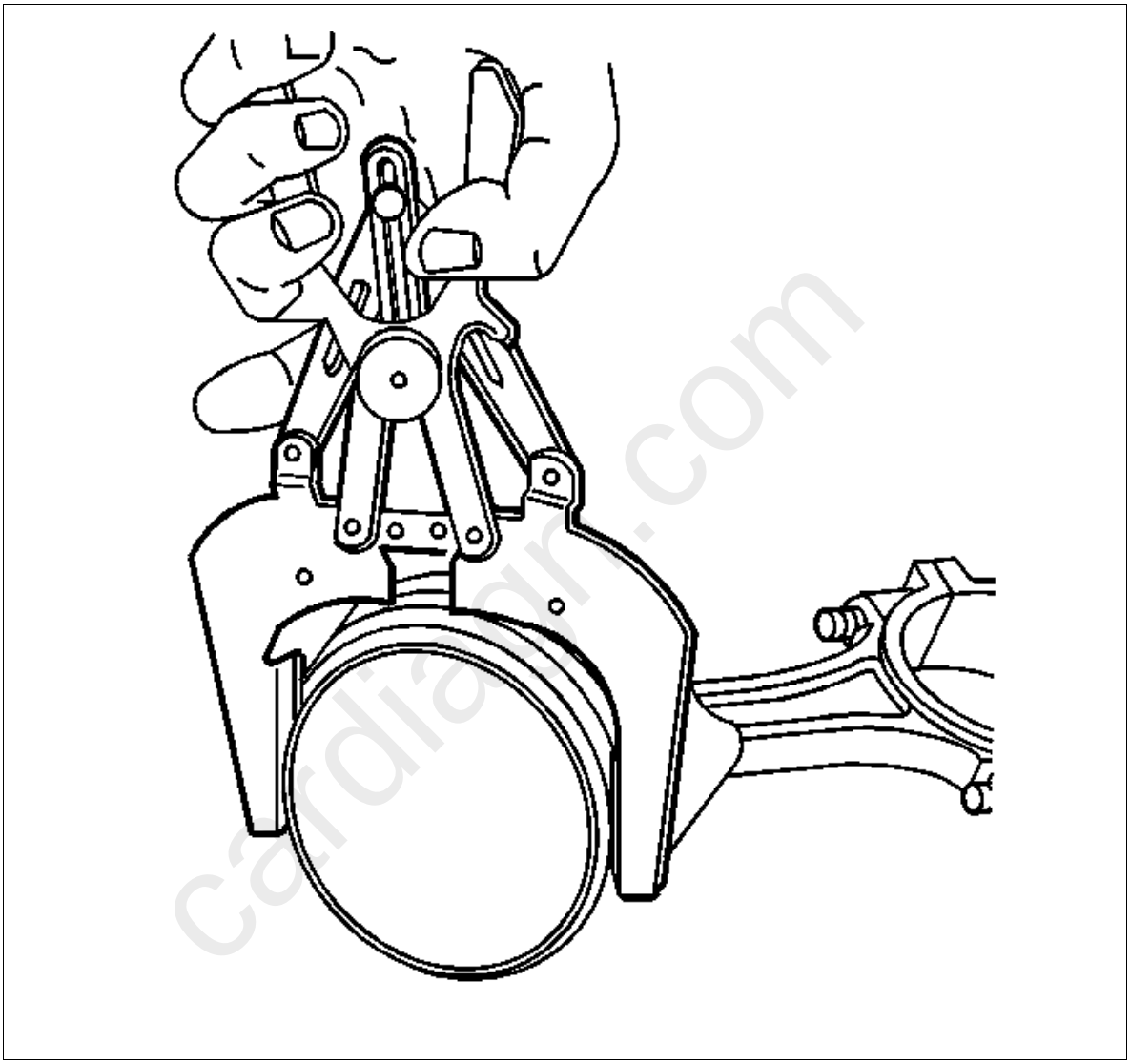
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WARNING:

Refer to Safety Glasses Warning .

2. Dry the components with compressed air.

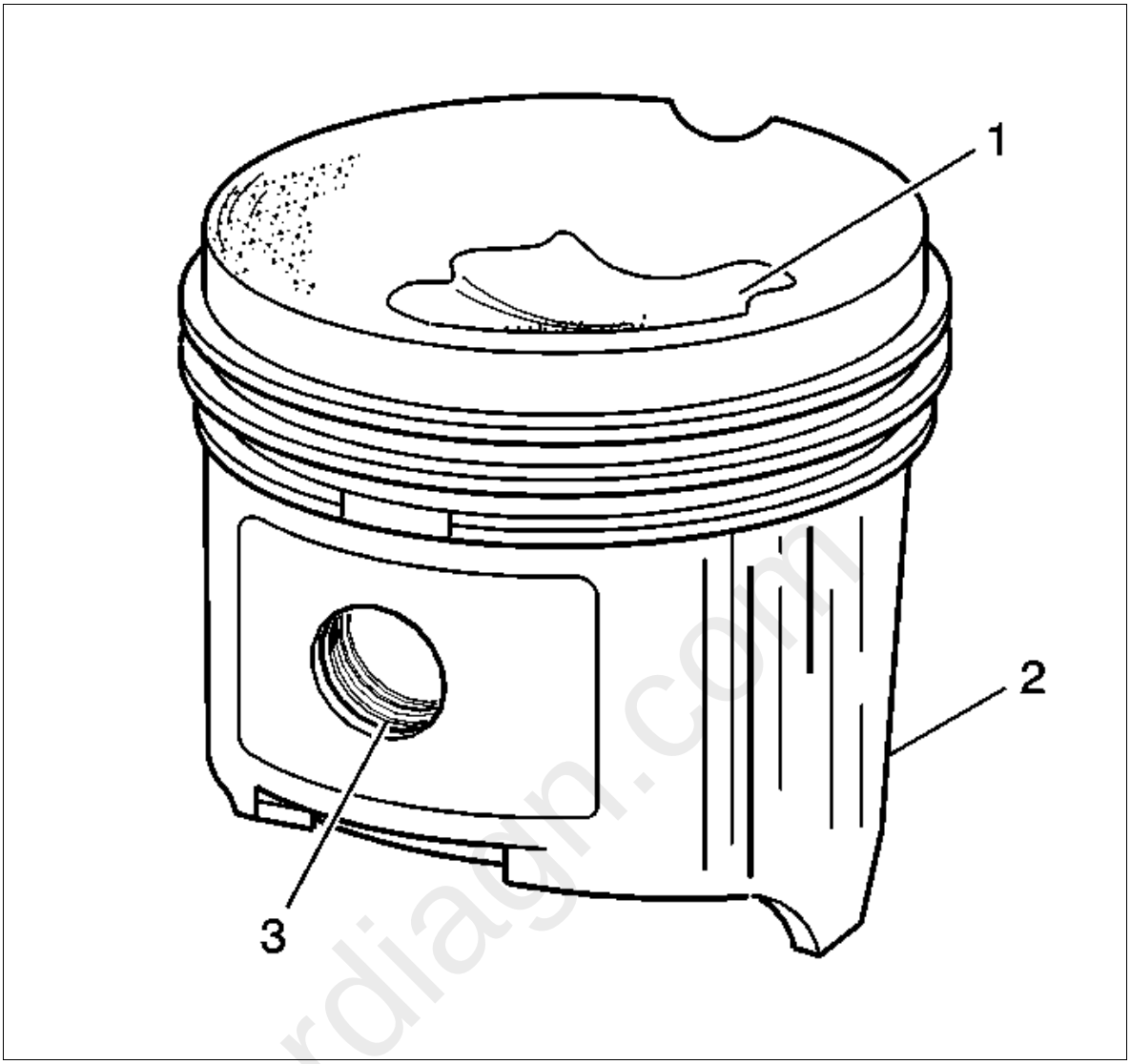
Fig 2: Cleaning Piston Ring Grooves



Courtesy of GENERAL MOTORS COMPANY

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

Fig 3: Piston Damage Inspection Areas



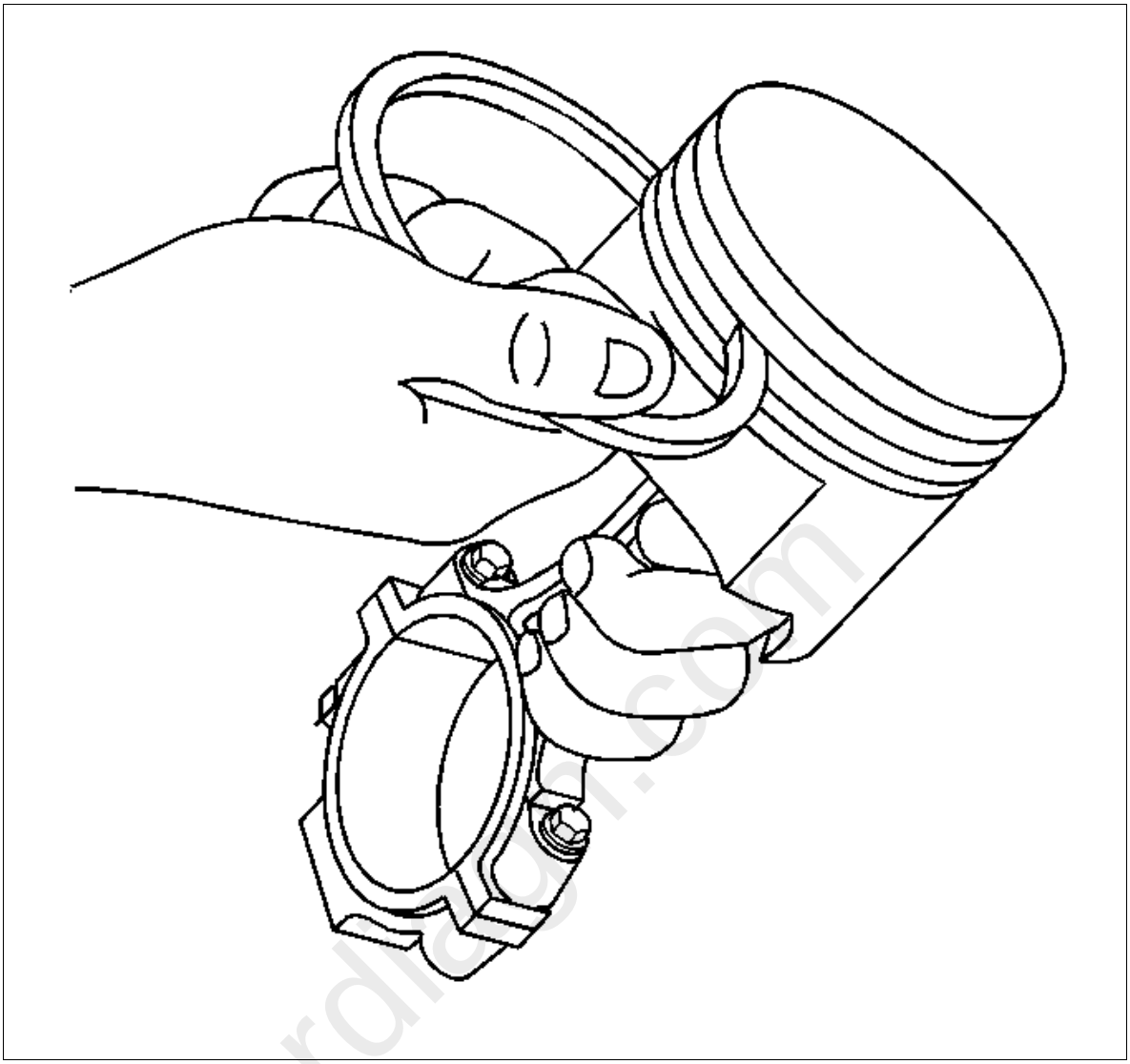
Courtesy of GENERAL MOTORS COMPANY

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

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

Fig 4: Inserting Piston Ring Into Ring Groove

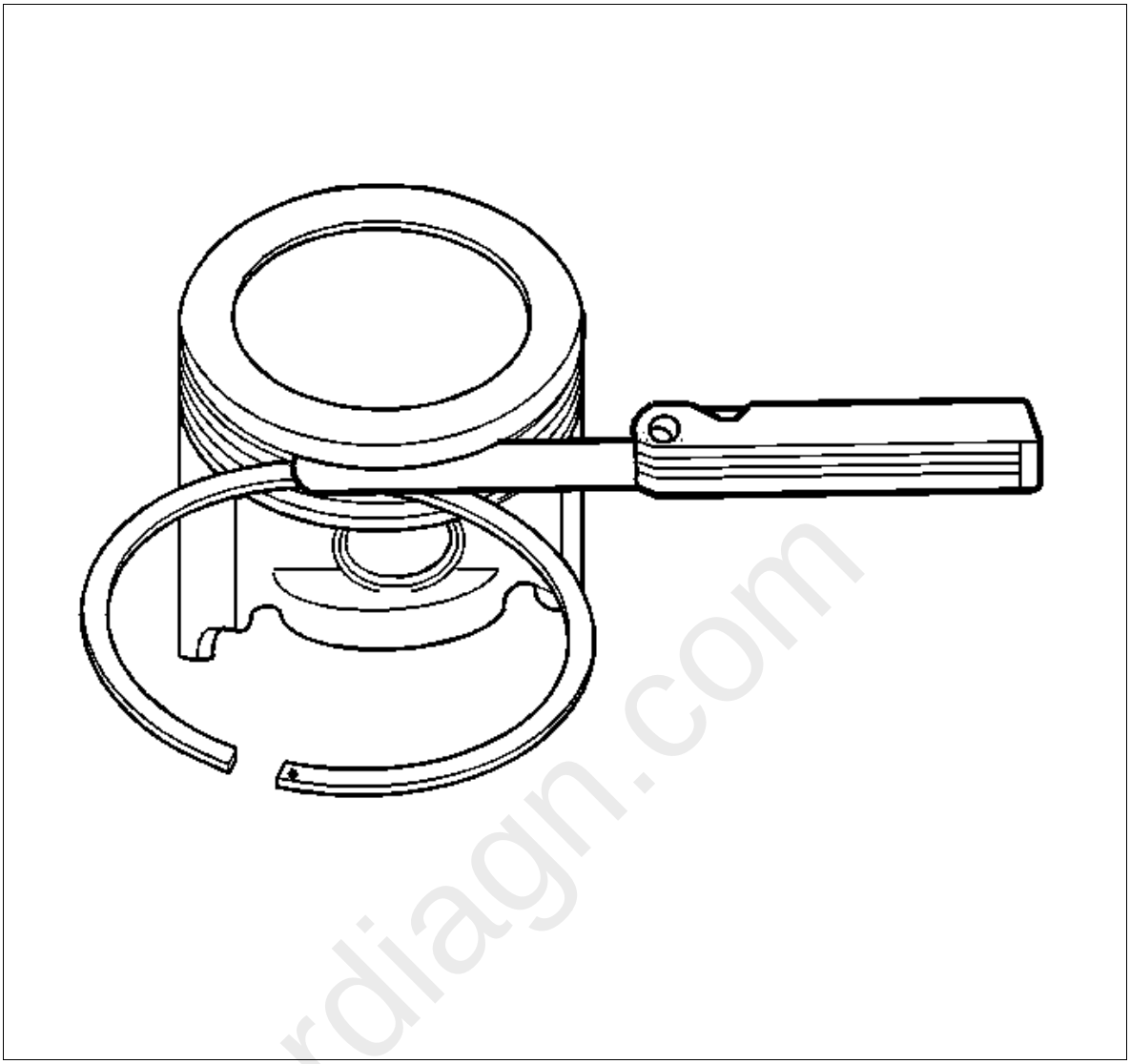


Courtesy of GENERAL MOTORS COMPANY

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

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

Fig 5: Piston Ring Side Clearance

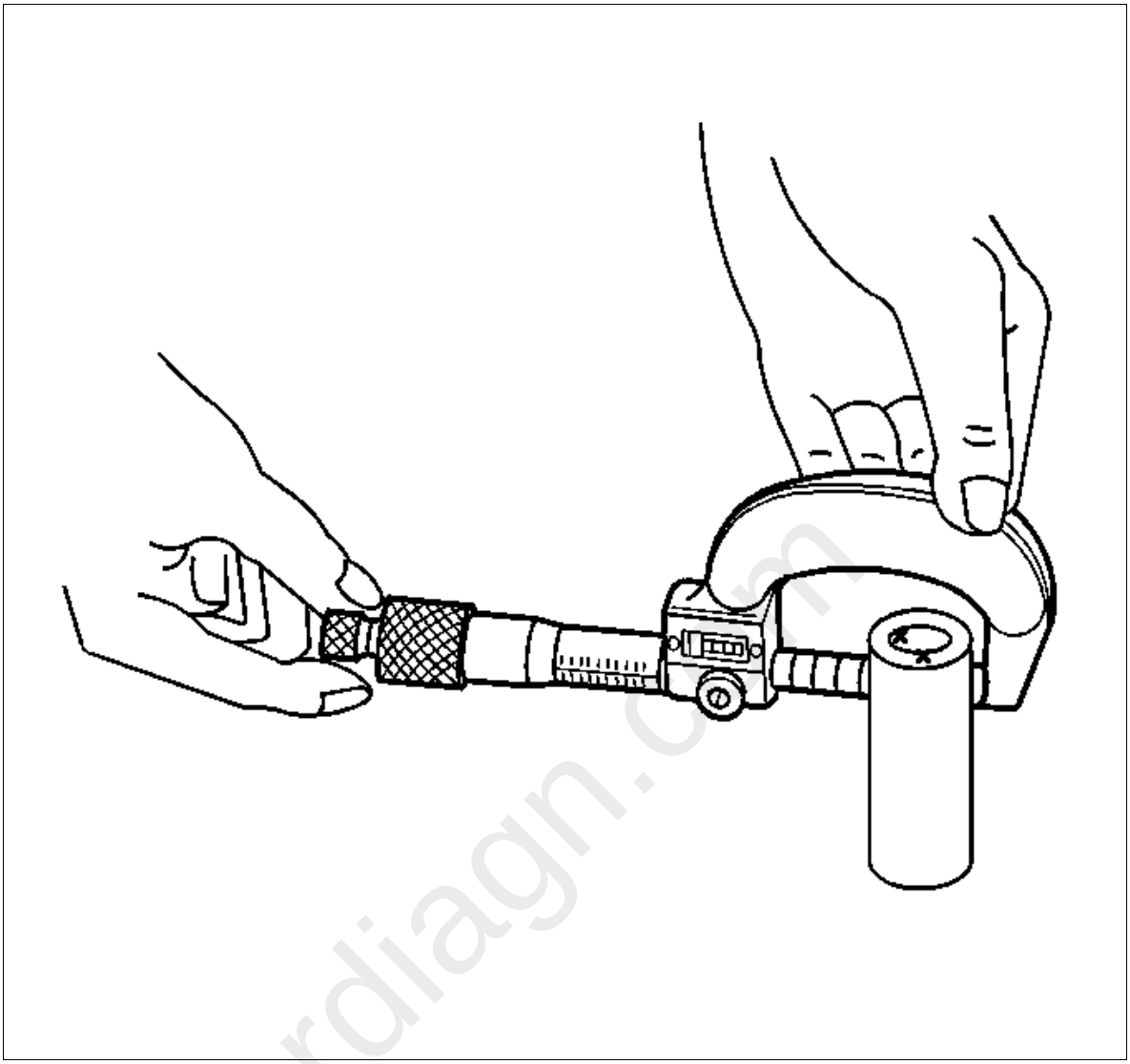


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7. Measure the piston ring side clearance with a feeler gauge. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to Engine Mechanical Specifications (LT1) .

Fig 6: Piston Pin Diameter

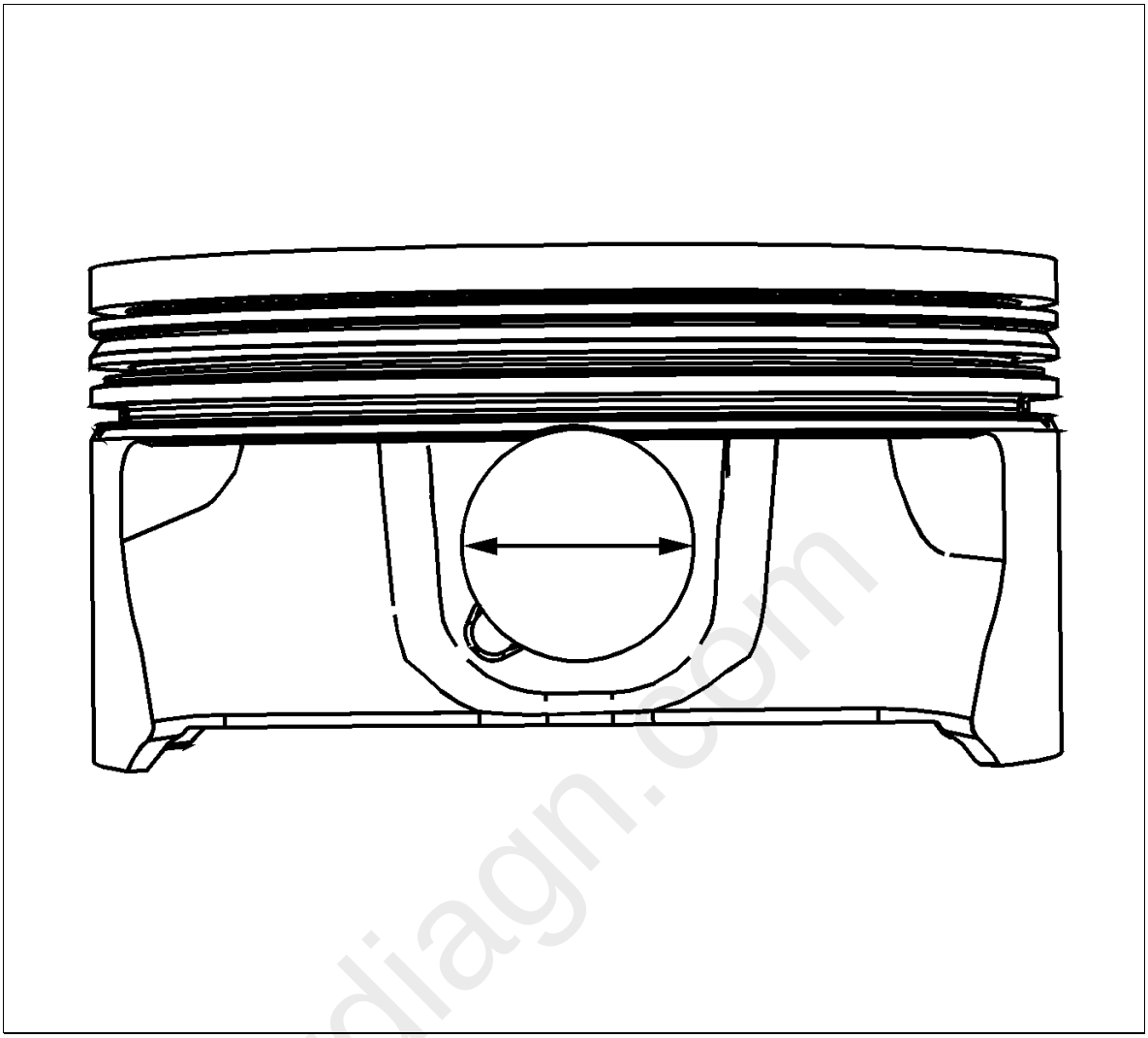


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8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).

Fig 7: Piston Pin-To-Bore Clearance



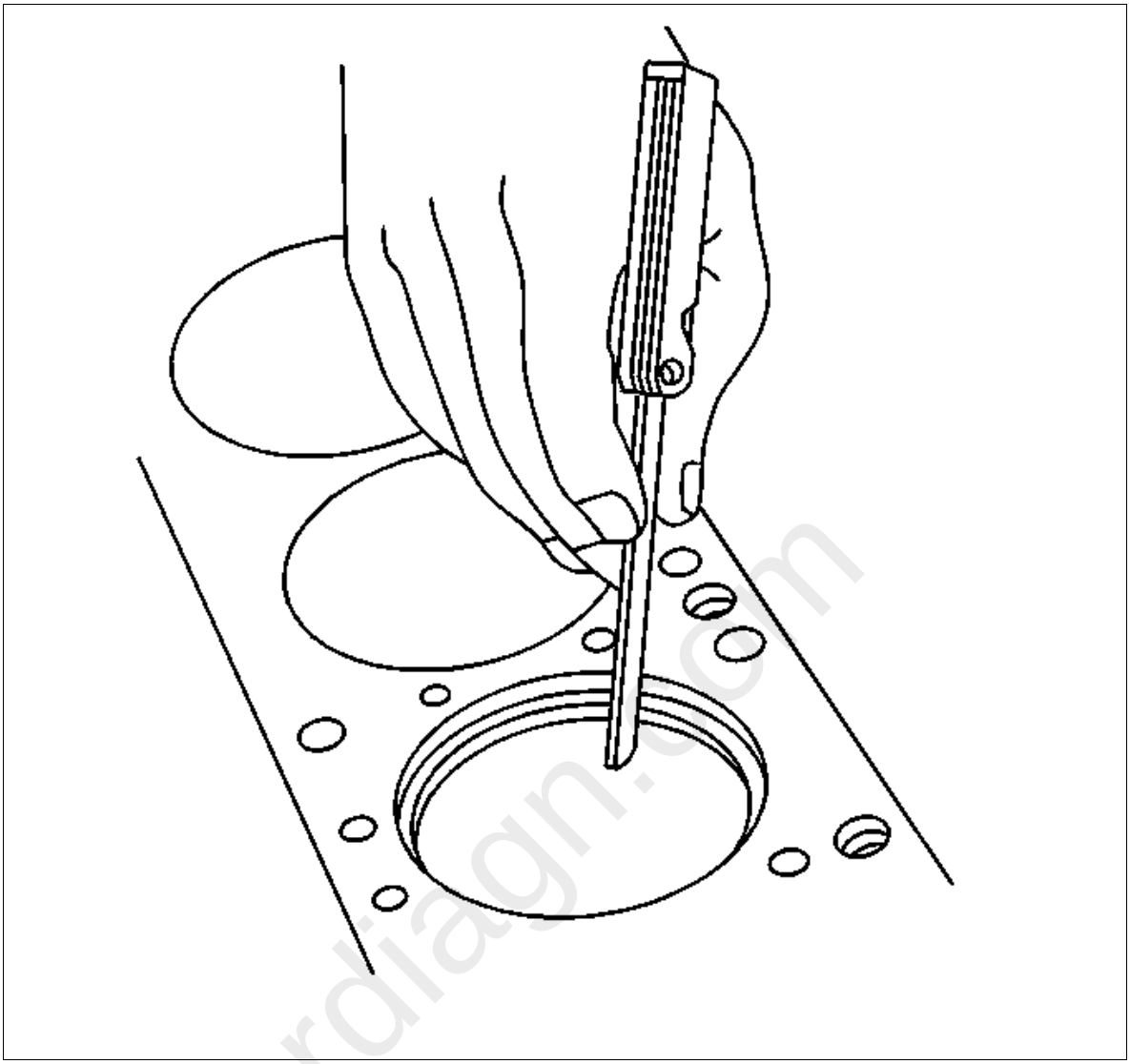
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9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION > MEASURING PISTON RING END GAP

Fig 1: Piston Ring End Gap



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NOTE:

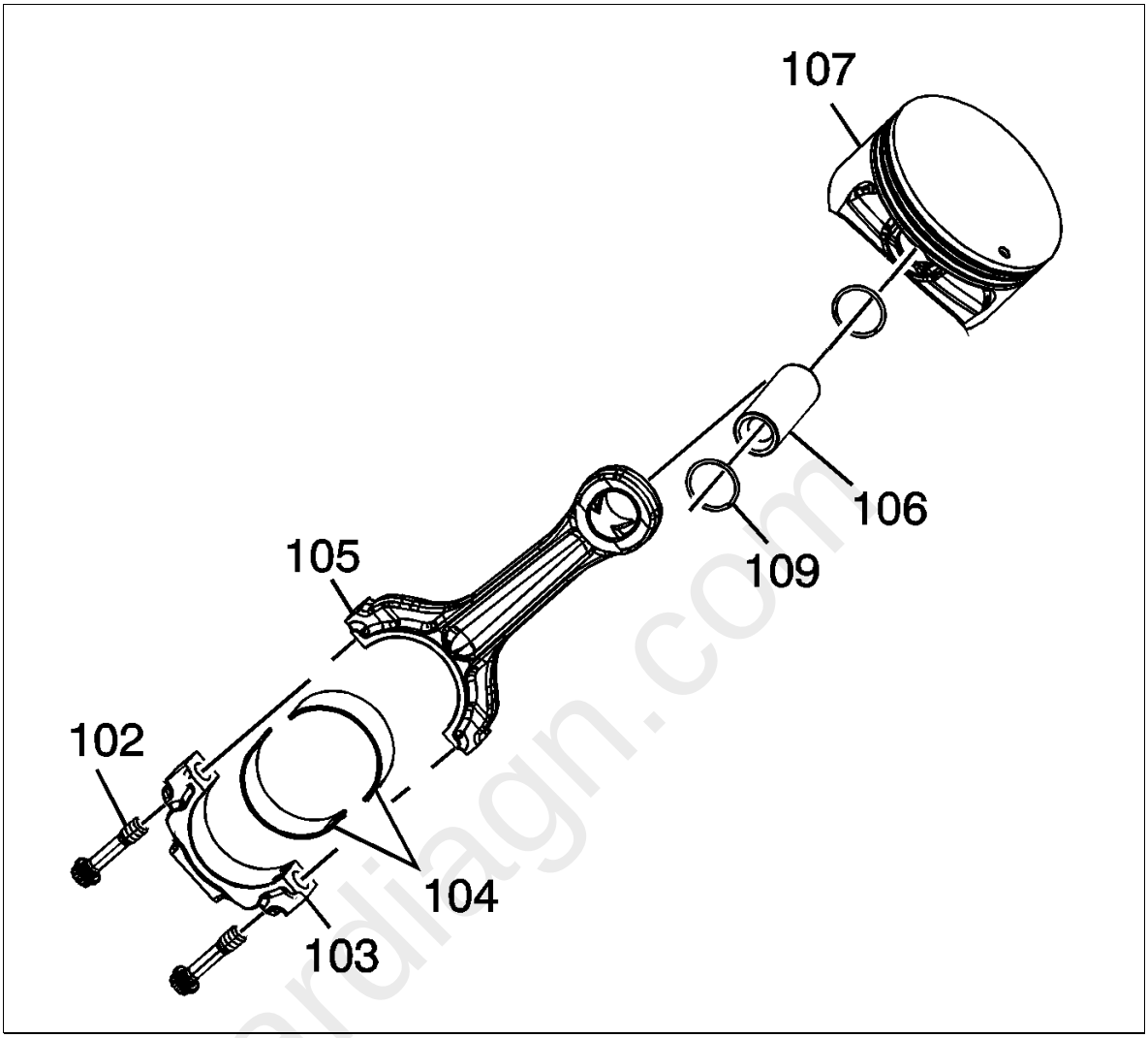
1. *Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.*
2. *Measure the piston ring in the cylinder in which it will be used.*

1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
2. Insert a feeler gauge and measure the piston ring end gap. Refer to Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON, CONNECTING ROD, AND

BEARING CLEANING AND INSPECTION > CONNECTING ROD AND BEARINGS

Fig 1: Piston, Pin & Piston Rings



Courtesy of GENERAL MOTORS COMPANY

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NOTE:

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

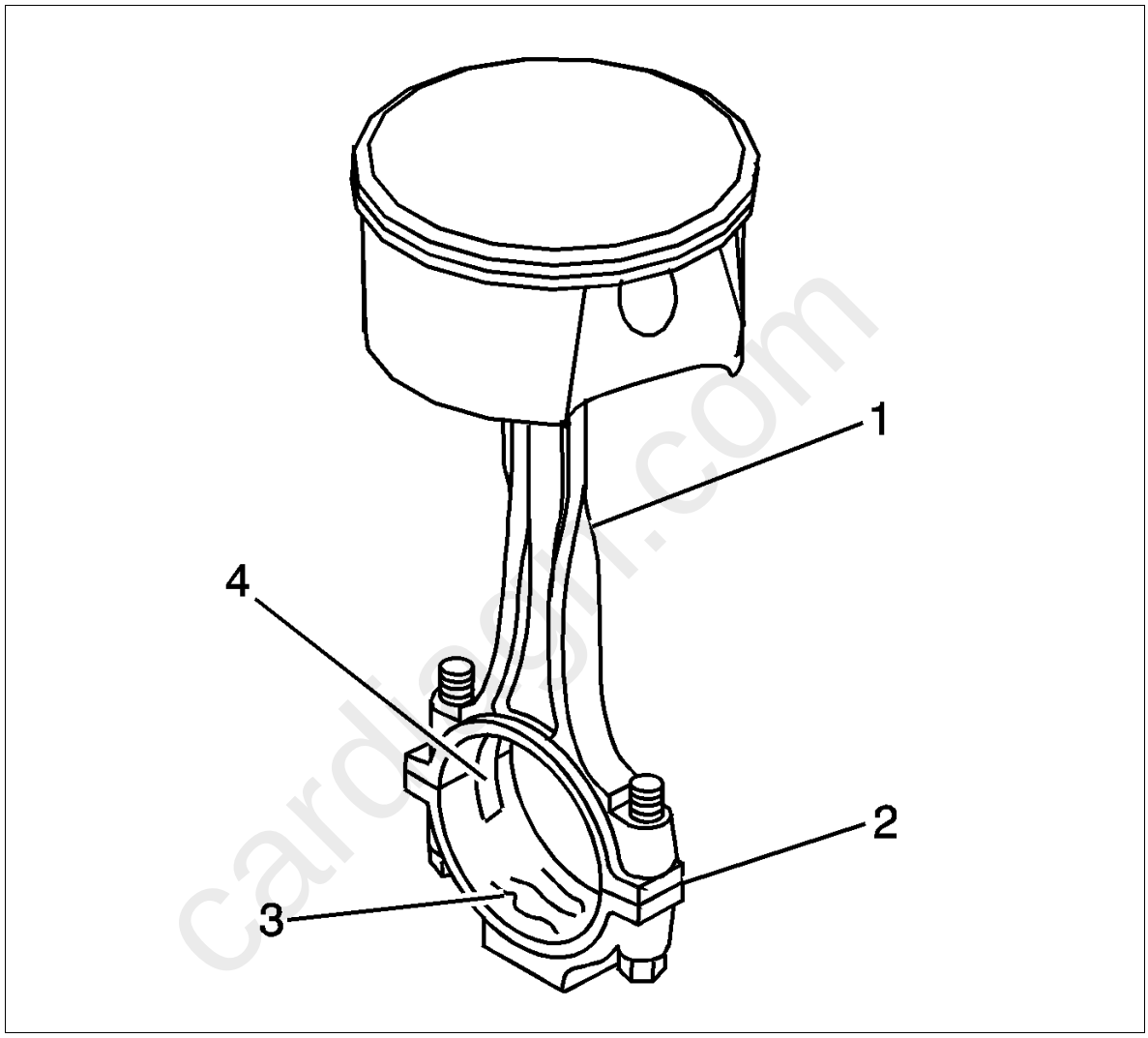
1. Clean the connecting rod (105) and cap (103) in solvent.

WARNING:

Refer to Safety Glasses Warning .

2. Dry the components with compressed air.

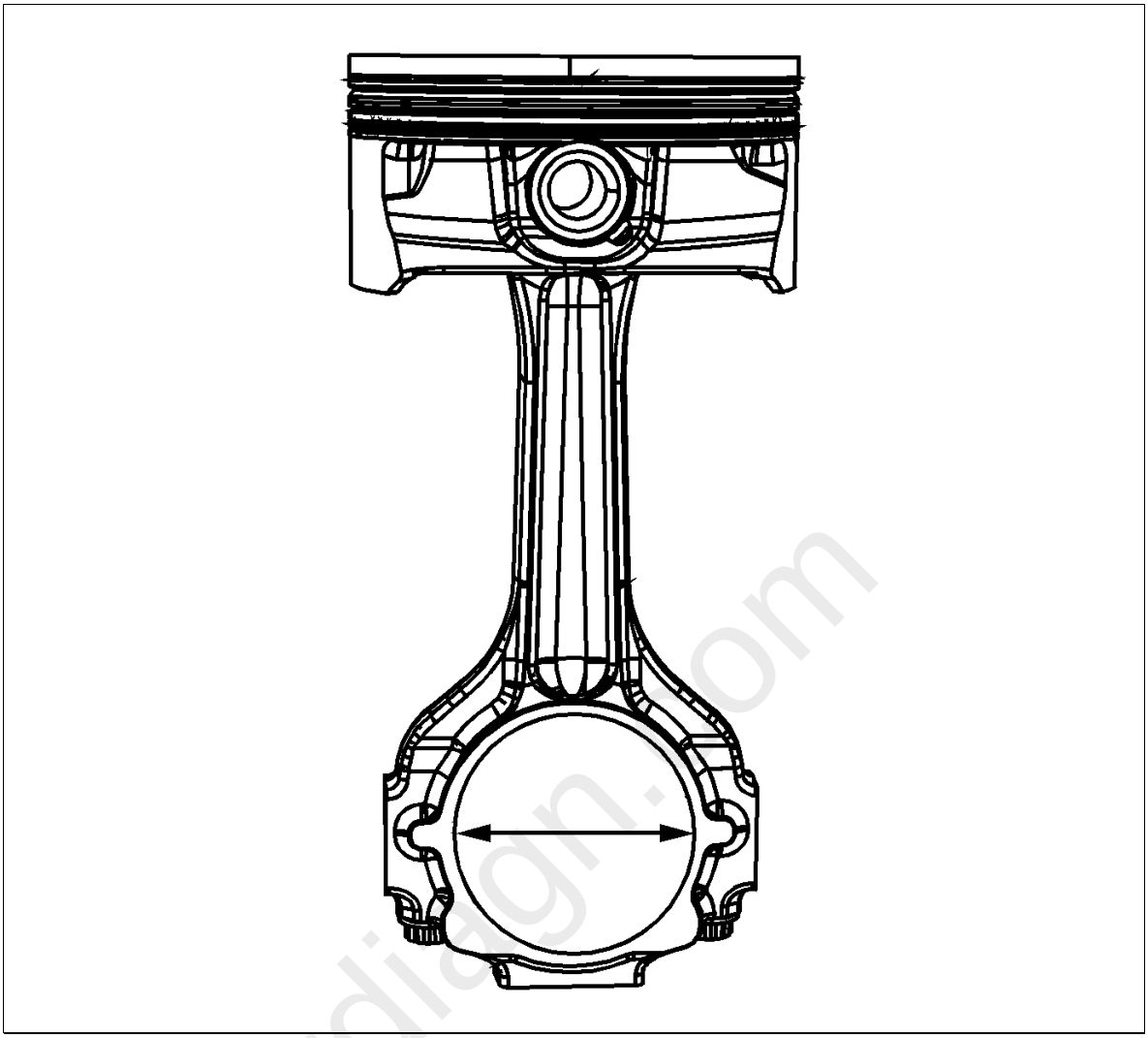
Fig 2: Connecting Rod Inspection Areas



Courtesy of GENERAL MOTORS COMPANY

3. Inspect the connecting rod for the following conditions:
    1. Twisting (1)
    2. Proper fit of the connecting rod and cap mating surfaces (2)
    3. Nicks or gouges in the bearing bore (3)
    4. Damage to the bearing locating slots (4)

Fig 3: Connecting Rod Bearing Bore

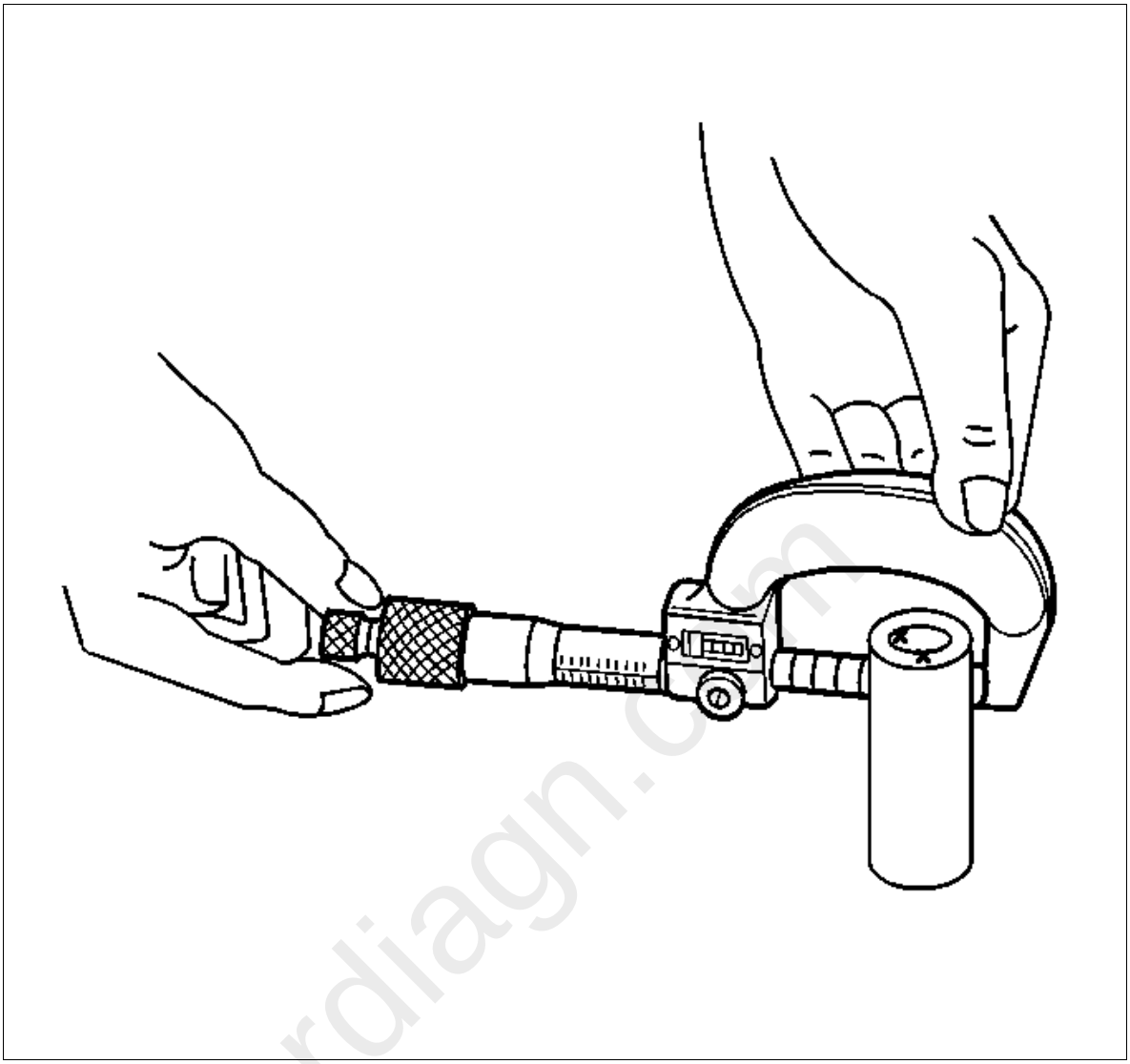


Courtesy of GENERAL MOTORS COMPANY

4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to Engine Mechanical Specifications (LT1) .

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Fig 4: Piston Pin Diameter

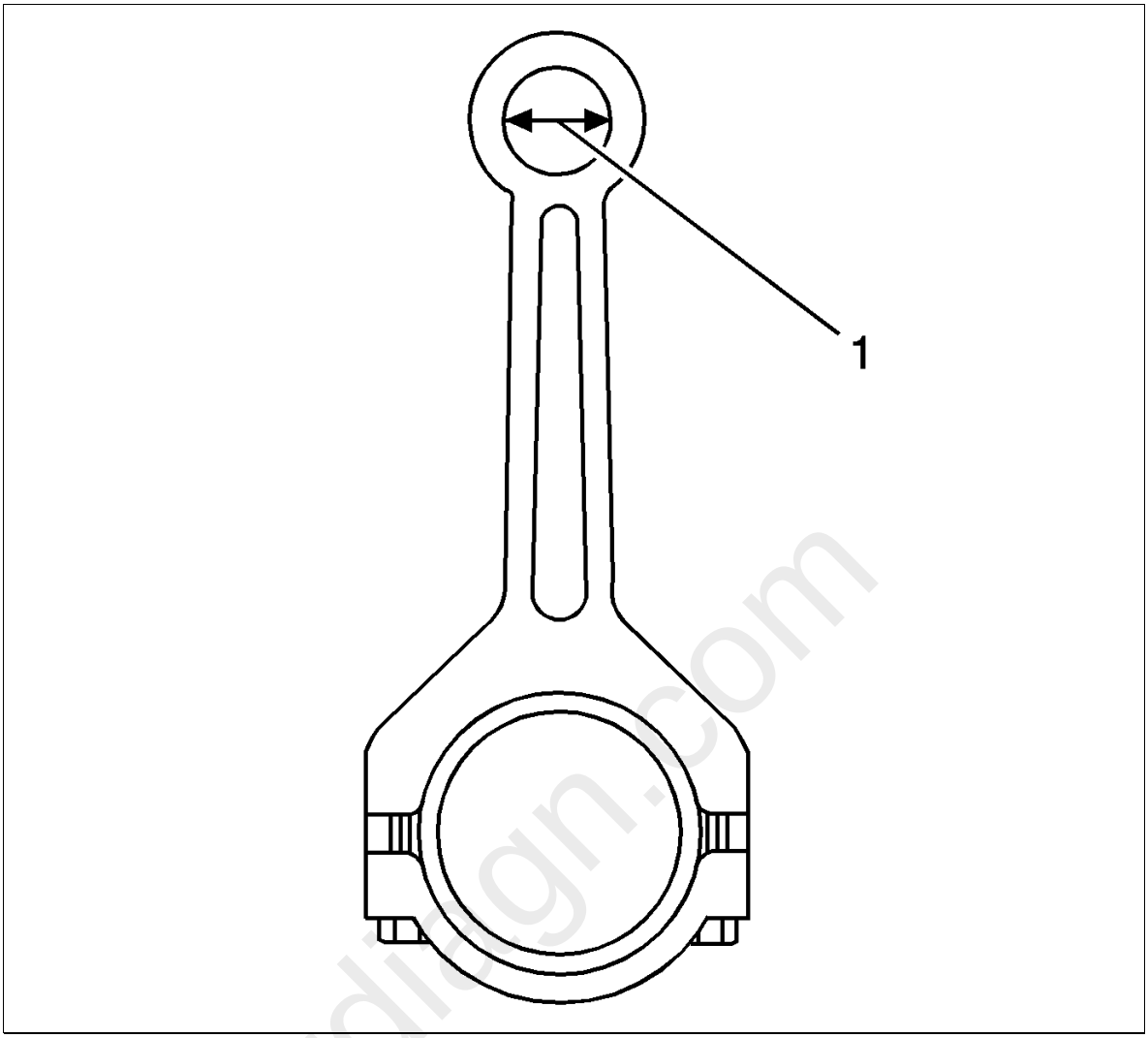


Courtesy of GENERAL MOTORS COMPANY

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

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Fig 5: Connecting Rod Pin Bore Inside Diameter

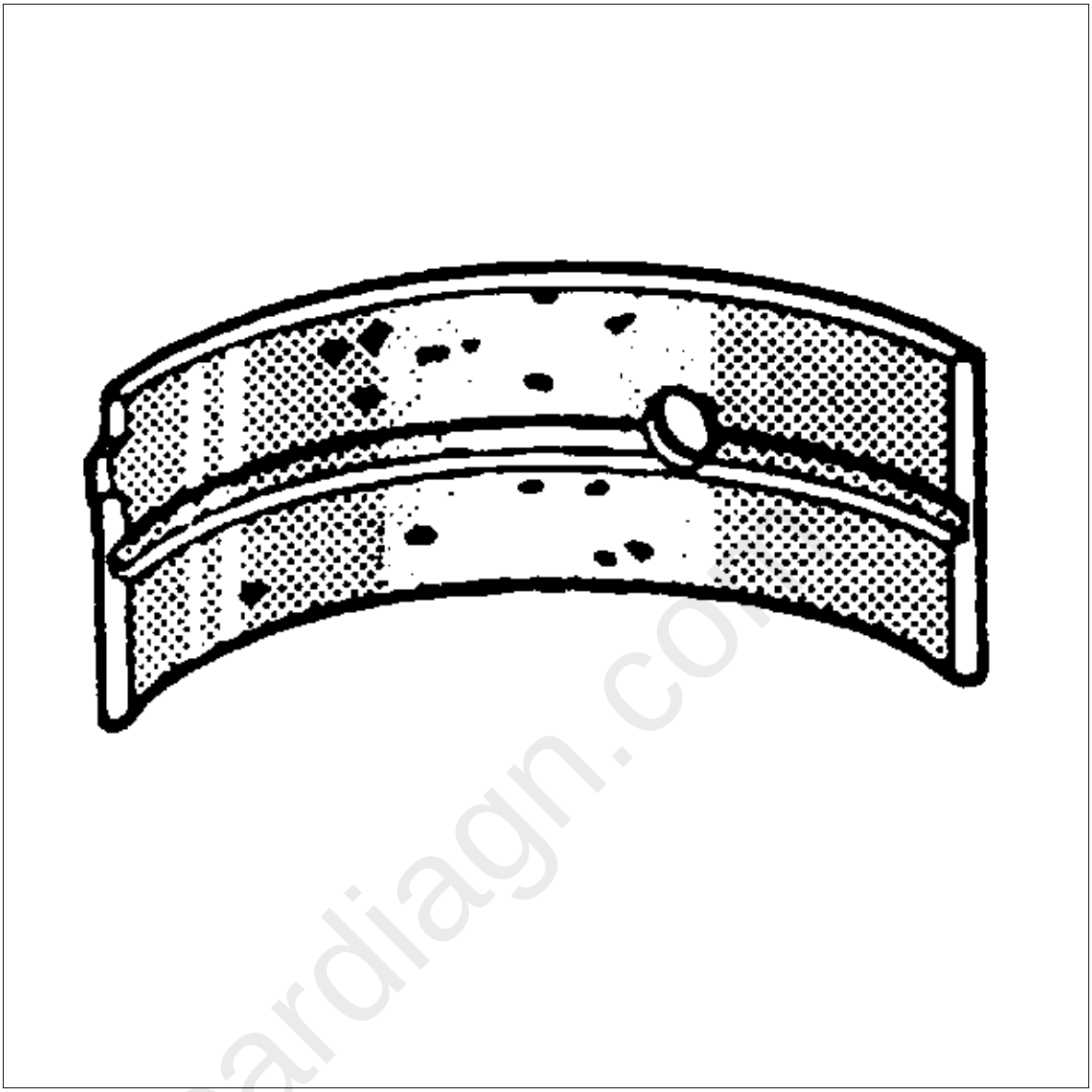


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6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine pin-to-bore clearance. Refer to Engine Mechanical Specifications (LT1) .

Fig 6: Crankshaft Bearing Craters Or Pockets

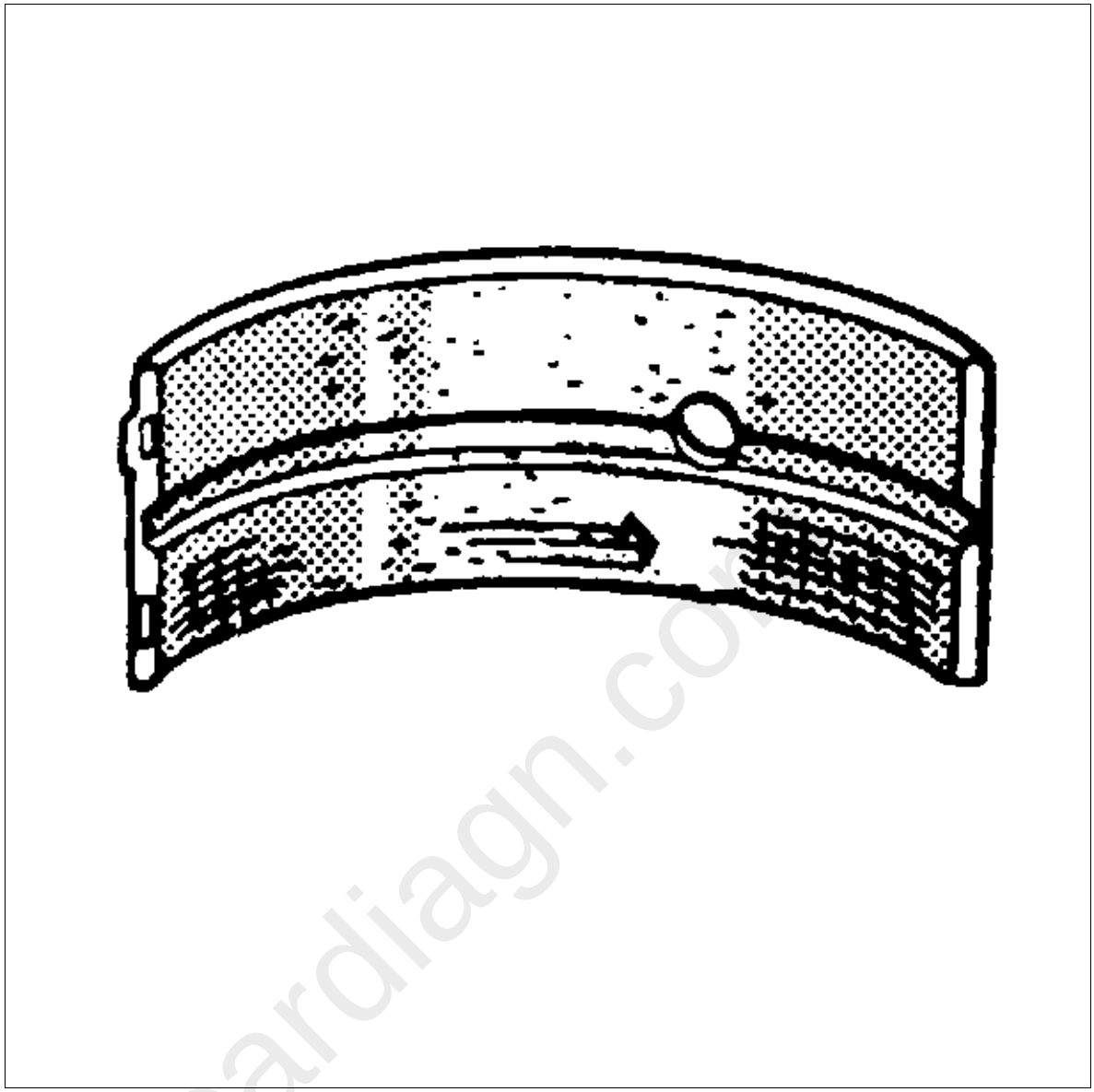


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8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.

Fig 7: Connecting Rod Bearing Scoring Or Discoloration

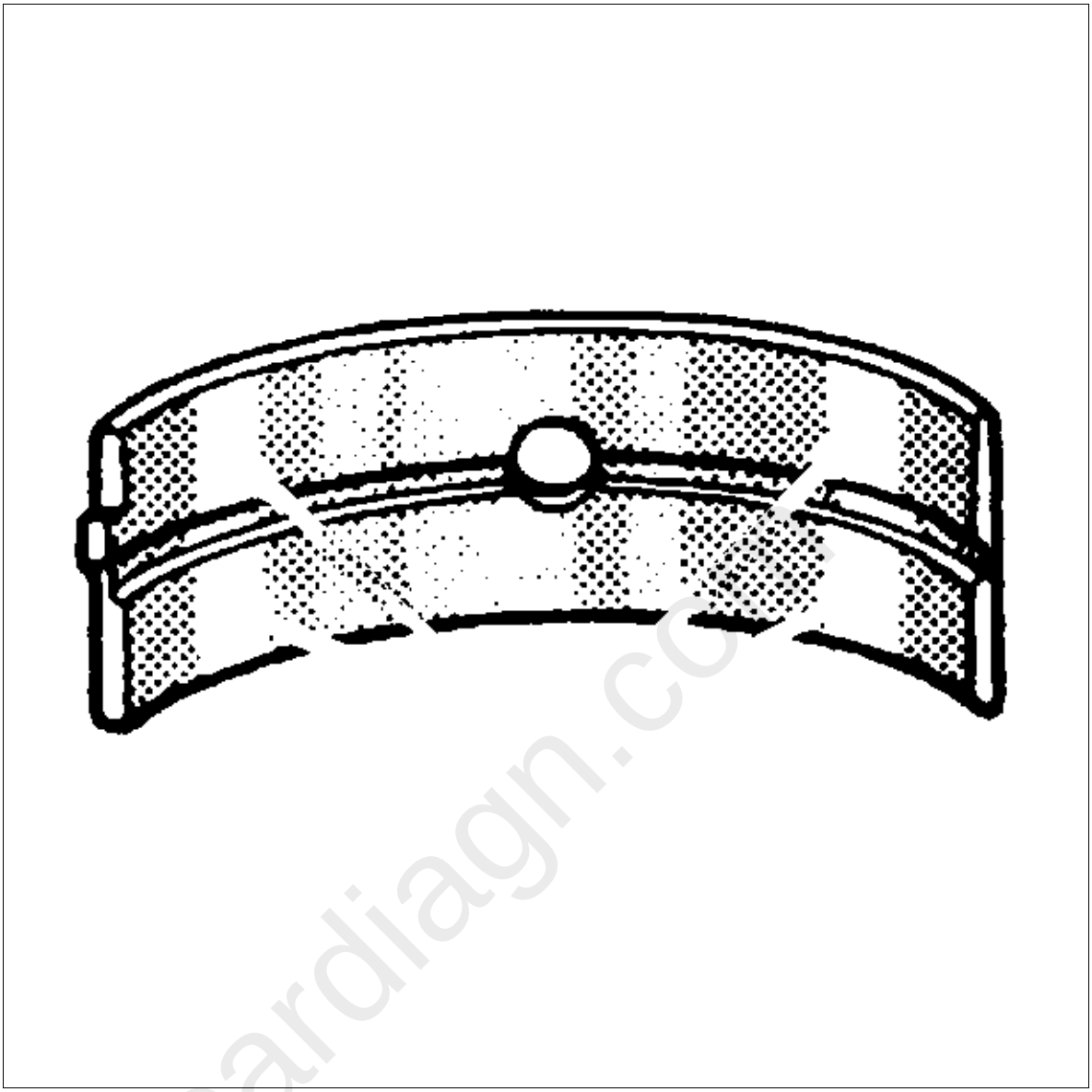


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9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.

Fig 8: Crankshaft Bearing Improper Seating



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11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.
12. Measure the connecting rod bearings for excessive connecting rod bearing-to-crankshaft journal clearance. Refer to Crankshaft and Bearing Cleaning and Inspection .

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON AND CONNECTING ROD ASSEMBLE

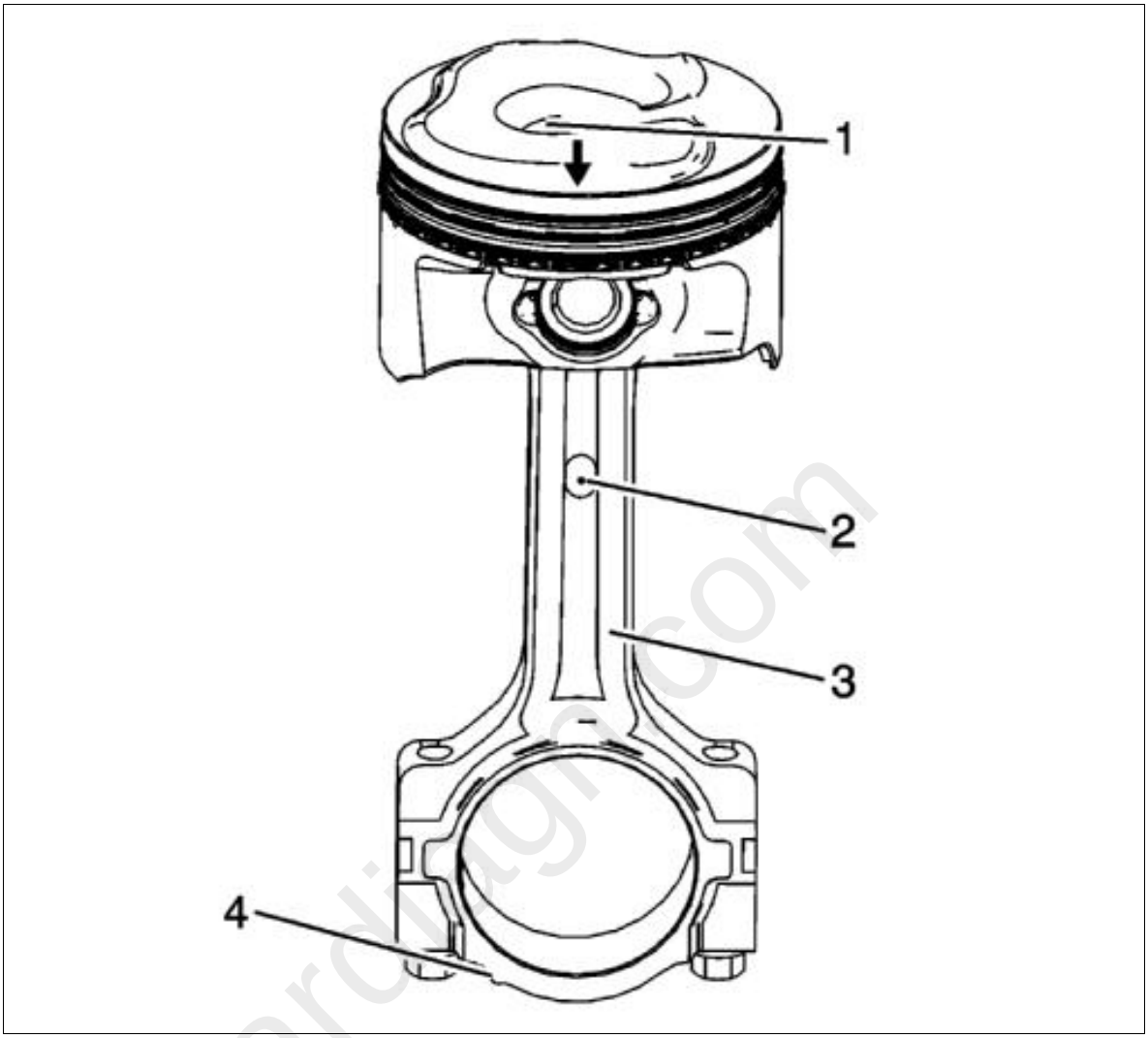
Special Tools

EN-46745 Piston Pin Clip Remover/Installer

For equivalent regional tools, refer to Special Tools .

1. Lubricate the piston pin bores in the piston, the piston pin, and the connecting rod pin bore with clean engine oil.

   Fig 1: Top Of Piston And Dimple On Rod

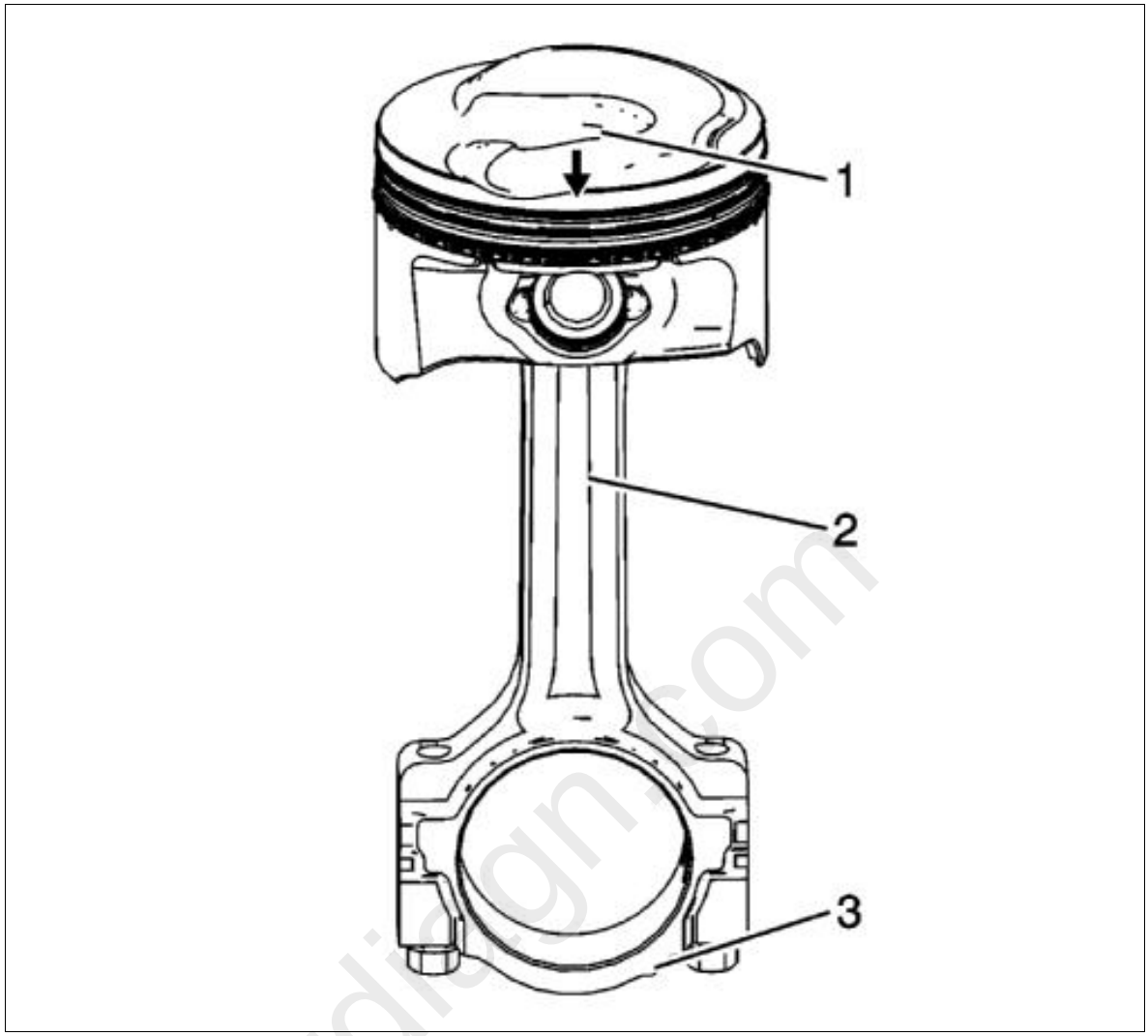


Courtesy of GENERAL MOTORS COMPANY

> *NOTE:*
>
> *The left side and right side piston and rod assemblies are assembled differently.*

2. Ensure that on the right side piston and rod assemblies, the arrow on the top of the piston (1) and the dimple on the rod (2) are facing the same direction.

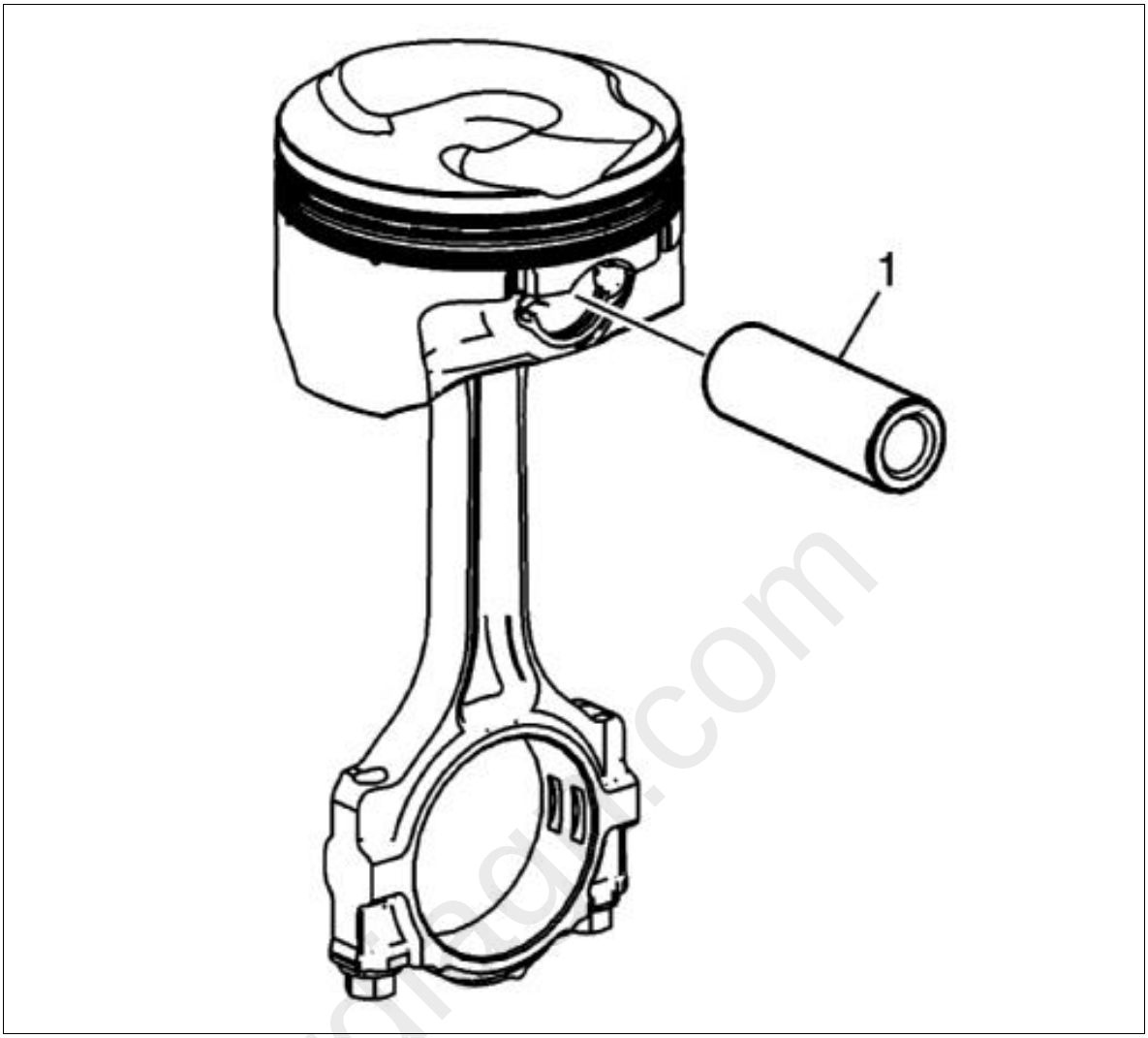
Fig 2: Top Of Piston And Dimple On Rod



Courtesy of GENERAL MOTORS COMPANY

3. Ensure that on the left side piston and rod assemblies, the arrow on the top of the piston (1) and the dimple on the rod (2) are facing the opposite direction.

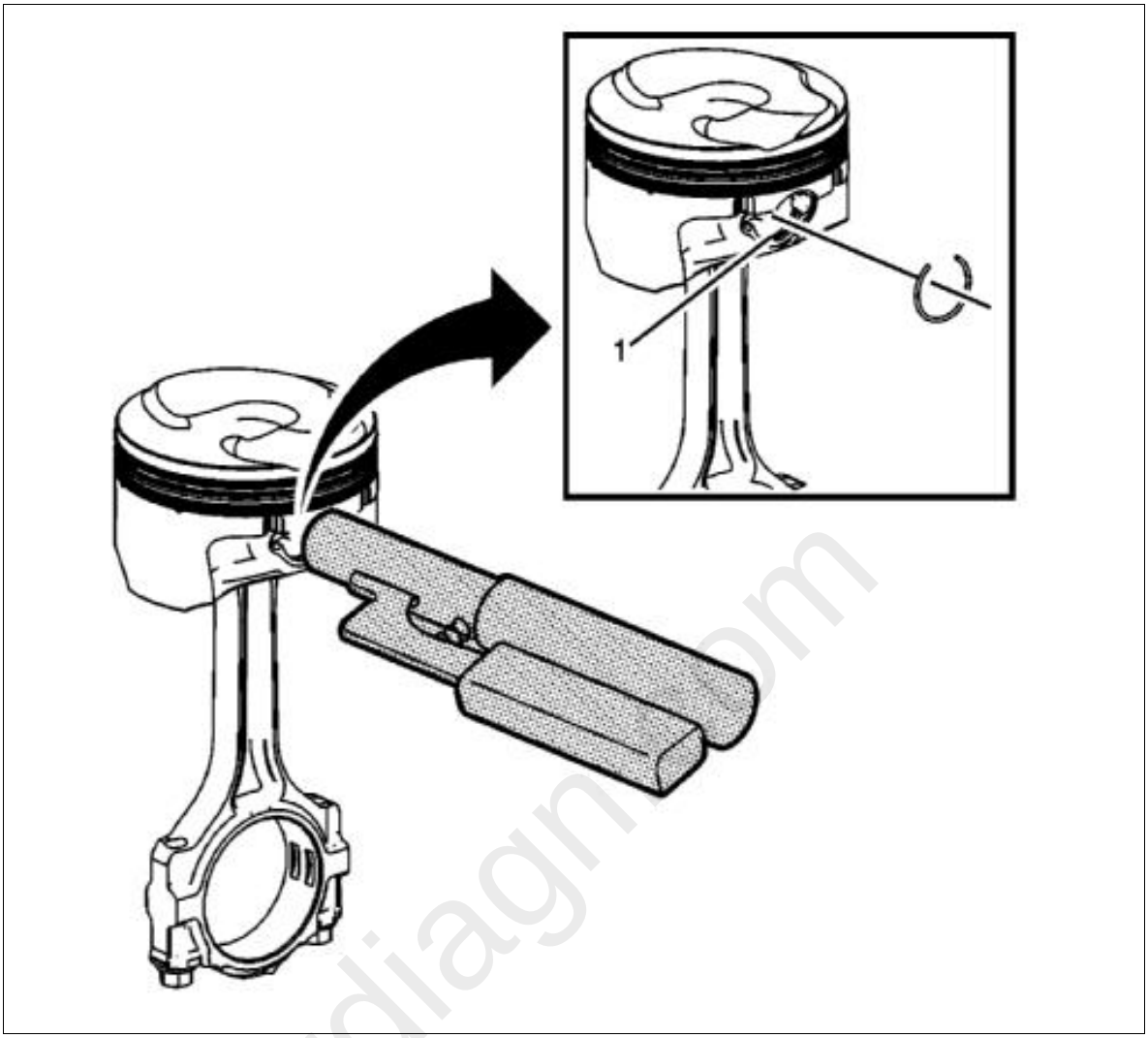
Fig 3: Piston Pin



Courtesy of GENERAL MOTORS COMPANY

4. Install the piston pin (1) to the piston and connecting rod.

Fig 4: NEW Piston Pin Retainers Using EN-46745 Remover/Installer



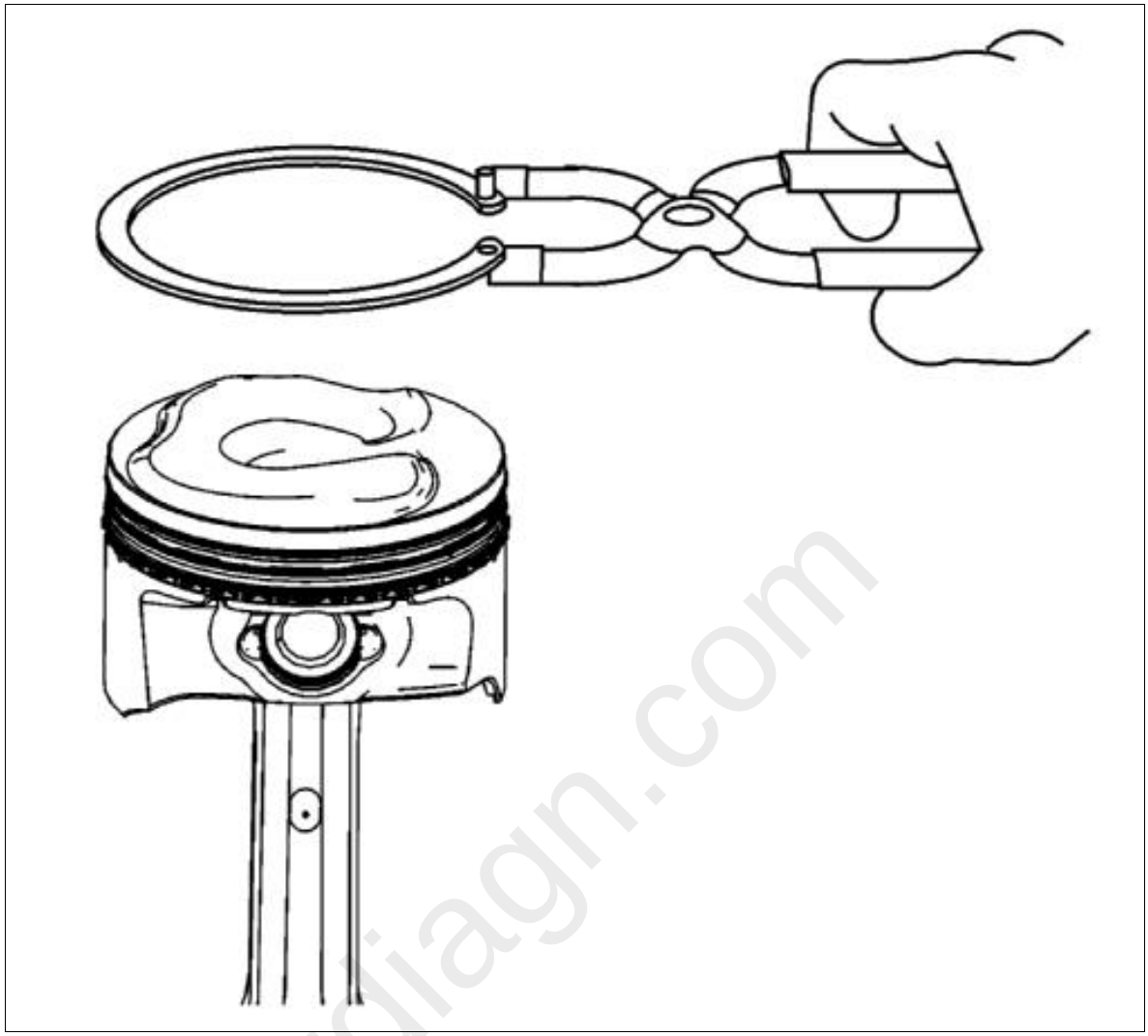
Courtesy of GENERAL MOTORS COMPANY

NOTE:

NEW piston pin retainers must be used. Never reuse the piston pin retainers.

5. Install NEW piston pin retainers using the **EN-46745** remover/installer. Align the **EN-46745** remover/installer to one of the notches (1) in the piston.

Fig 5: Removing Piston Rings From Piston Using Piston Ring Pliers



Courtesy of GENERAL MOTORS COMPANY

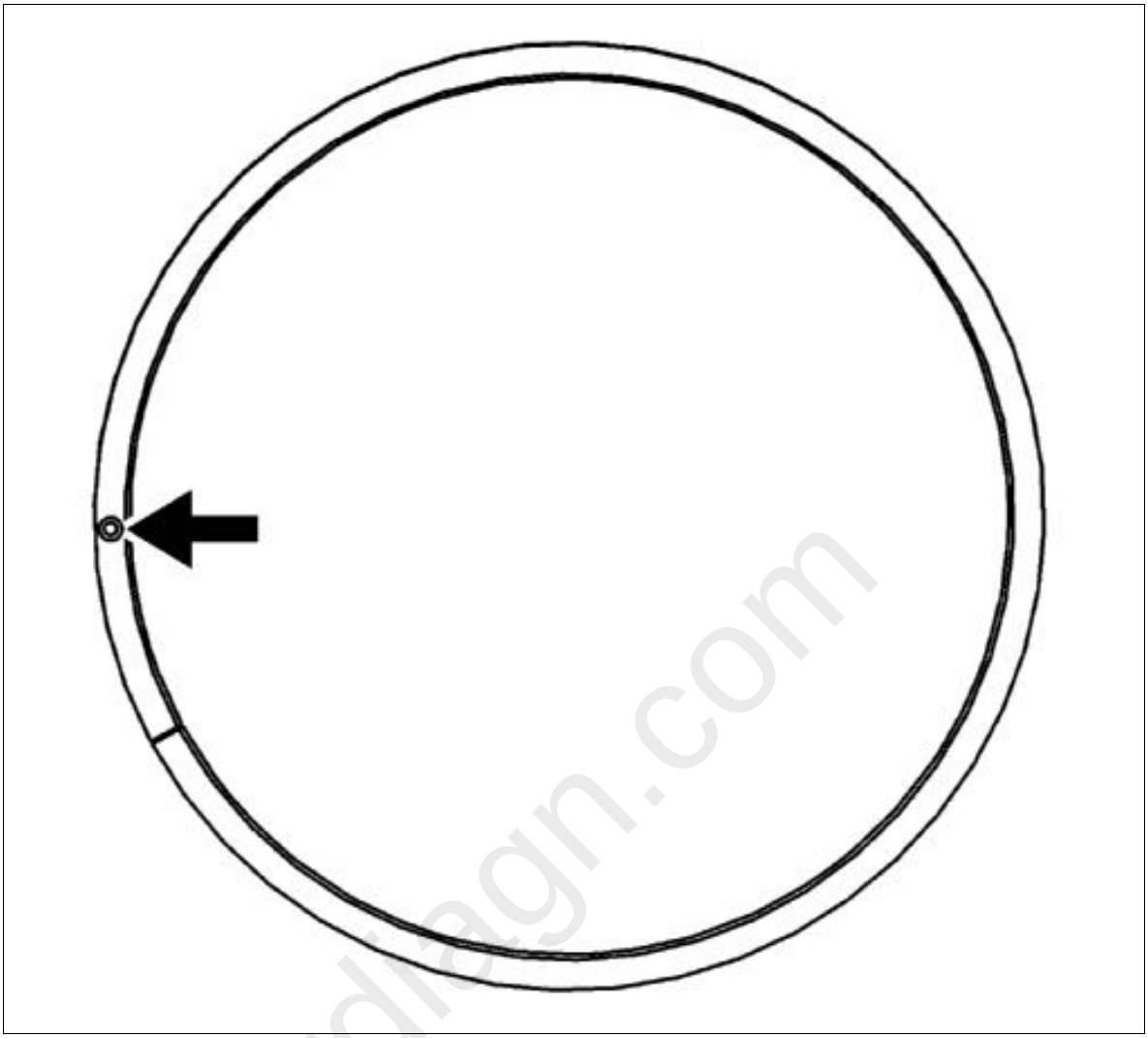
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NOTE:

When installing piston rings, use a ring expander plier type tool. Do not roll the rings into the grooves of the piston. Use caution and care to expand the rings only slightly larger than the outside diameter (OD) of the piston.

6. Using piston ring pliers, install the piston rings onto the piston.
7. Position the oil control ring end gaps 180 degrees opposite each other.

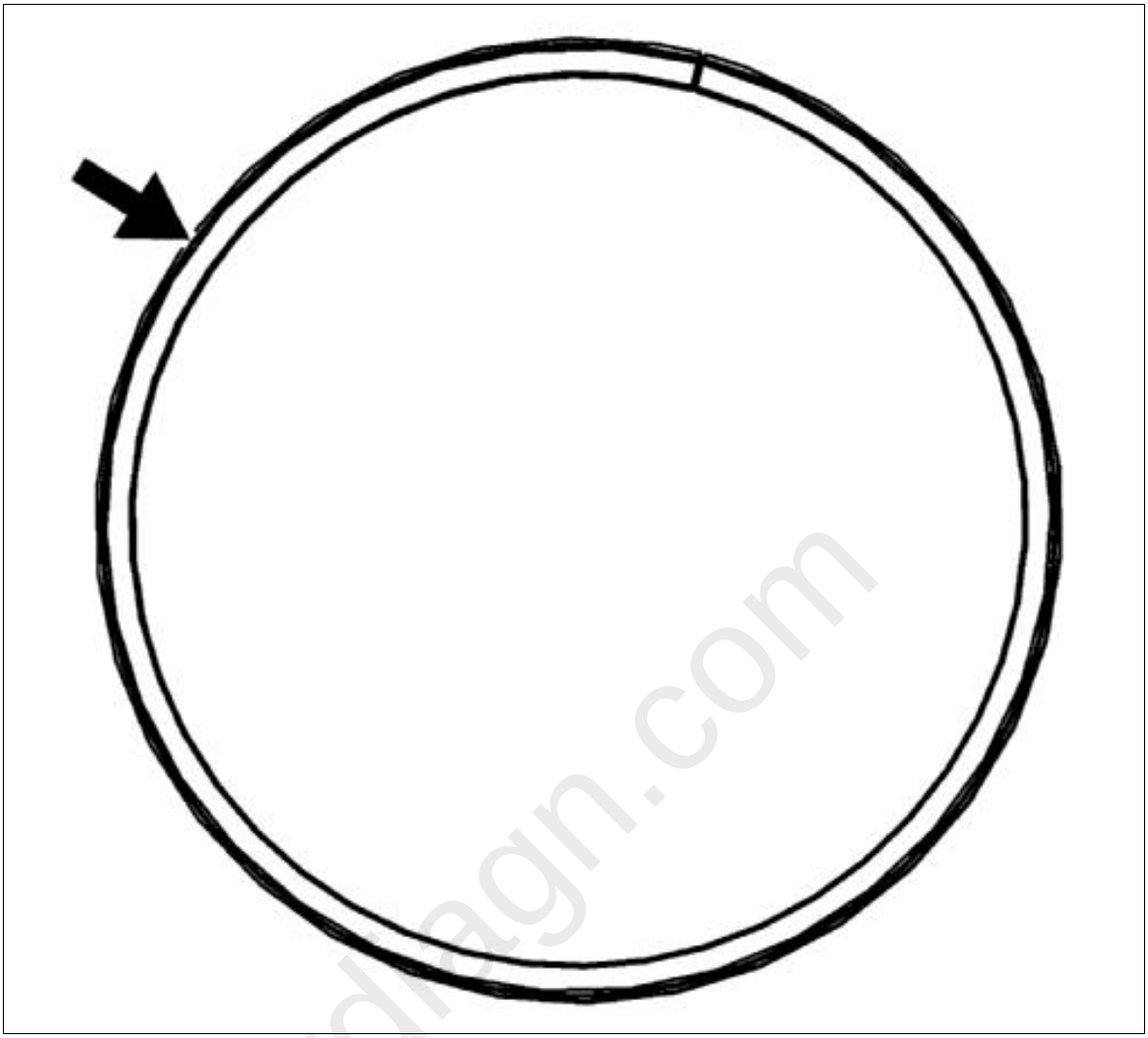
Fig 6: Positioning Compression Ring End Gaps 180 Degrees Opposite Each Other



Courtesy of GENERAL MOTORS COMPANY

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Fig 7: Positioning Compression Ring End Gaps 180 Degrees Opposite Each Other



Courtesy of GENERAL MOTORS COMPANY

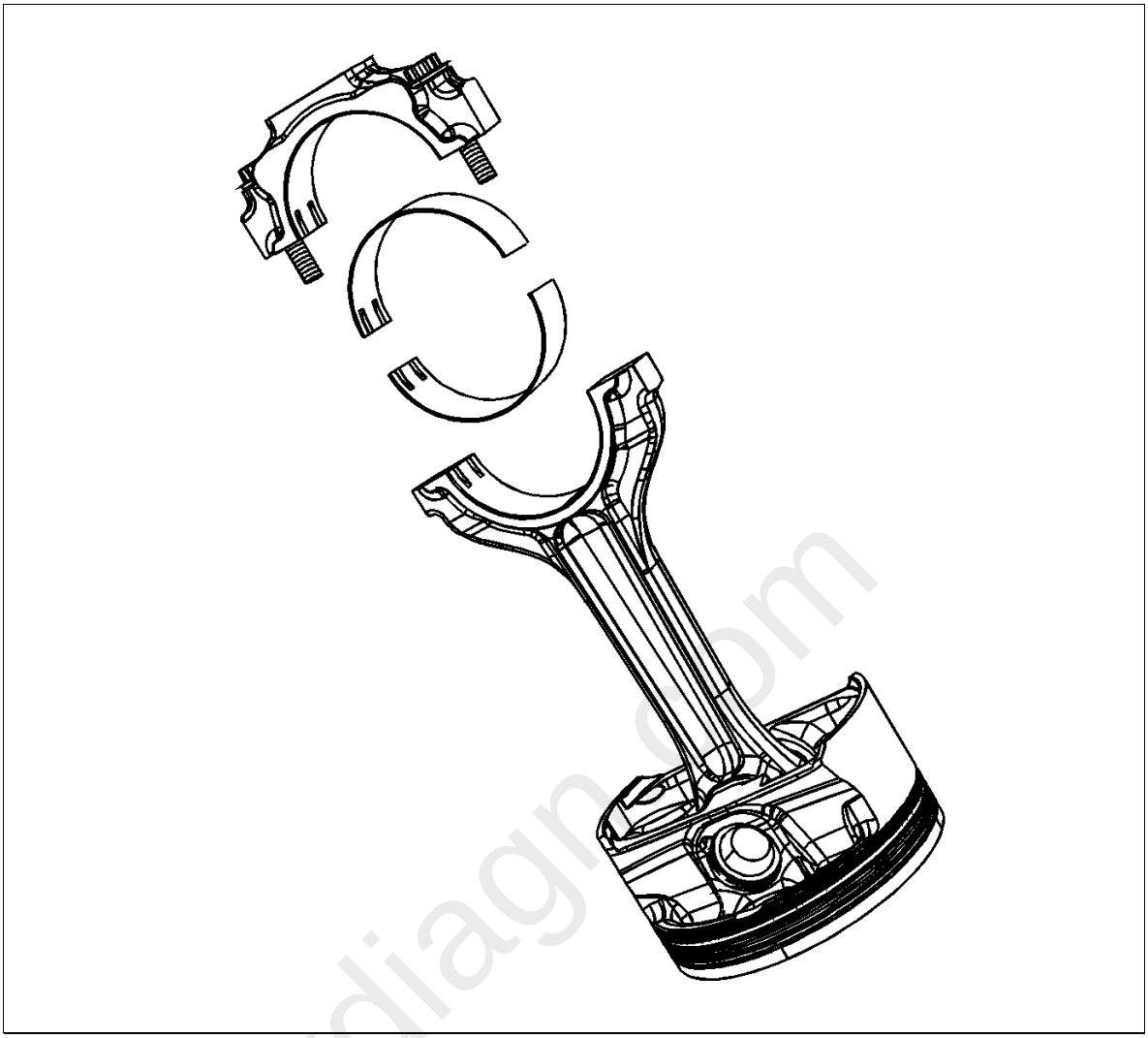
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NOTE:

1. *The upper compression ring has a dimple on the top of the ring. The dimple on upper compression ring should face the top of the piston.*
2. *The lower compression ring has a groove on the bottom of the ring. The groove on the lower compression ring should face the bottom of the piston.*

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

Fig 8: Piston, Connecting Rod & Bearing Assembly



Courtesy of GENERAL MOTORS COMPANY

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

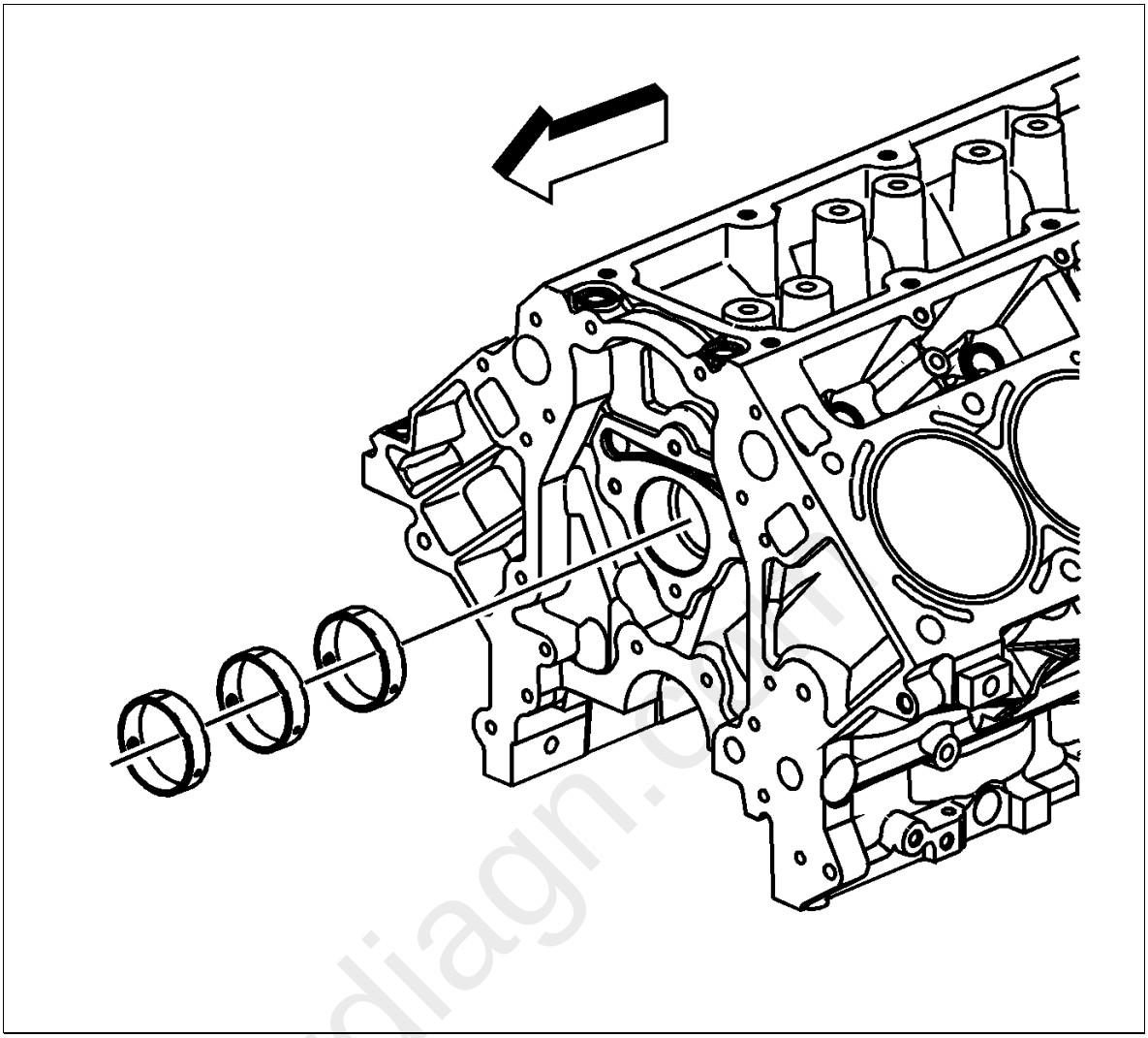
REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT BEARING REMOVAL

Special Tools

J 33049 Camshaft Bearing Service Set

For equivalent regional tools, refer to Special Tools .

Fig 1: Camshaft Bearings



Courtesy of GENERAL MOTORS COMPANY

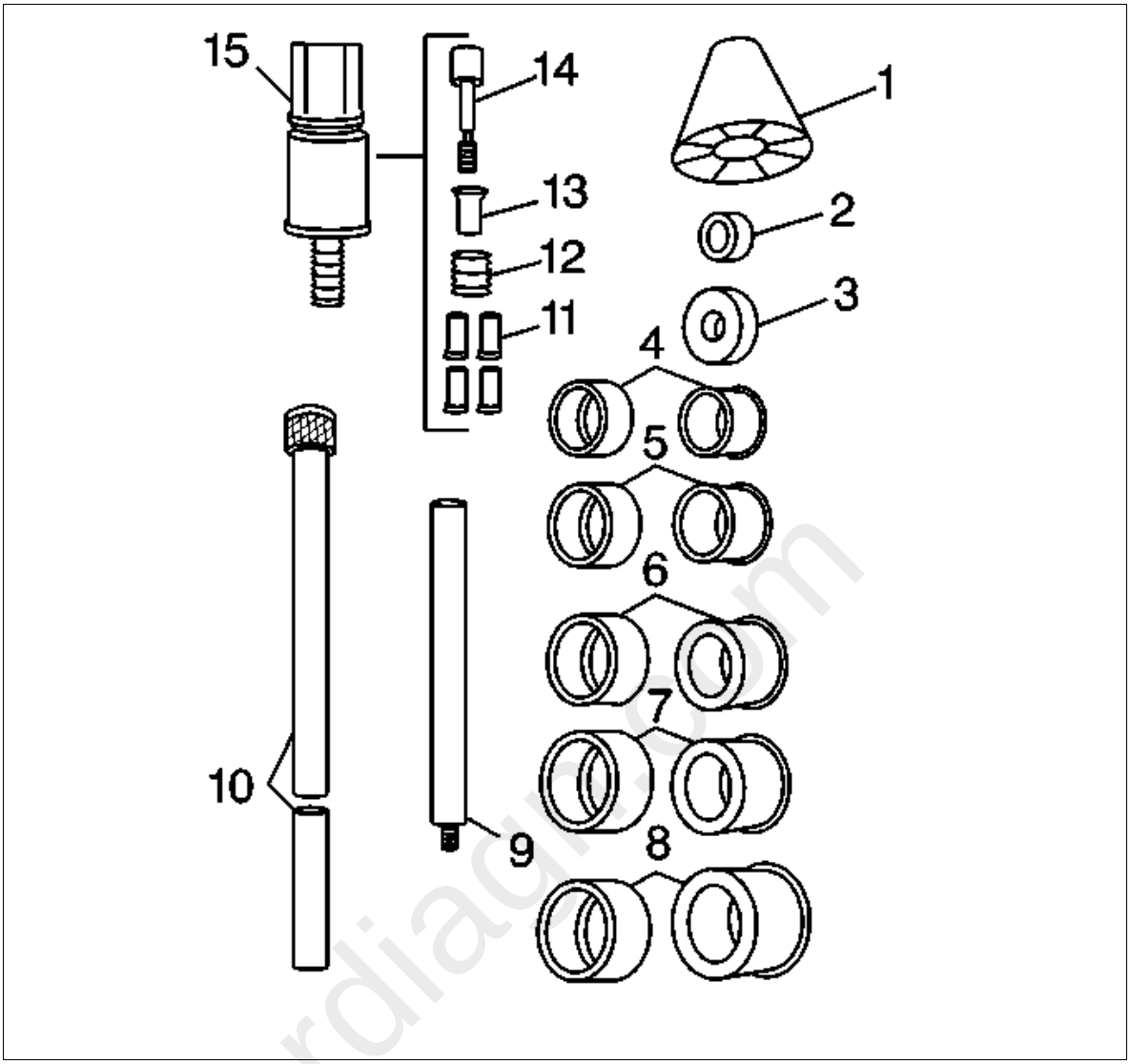
IMPORTANT:

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

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

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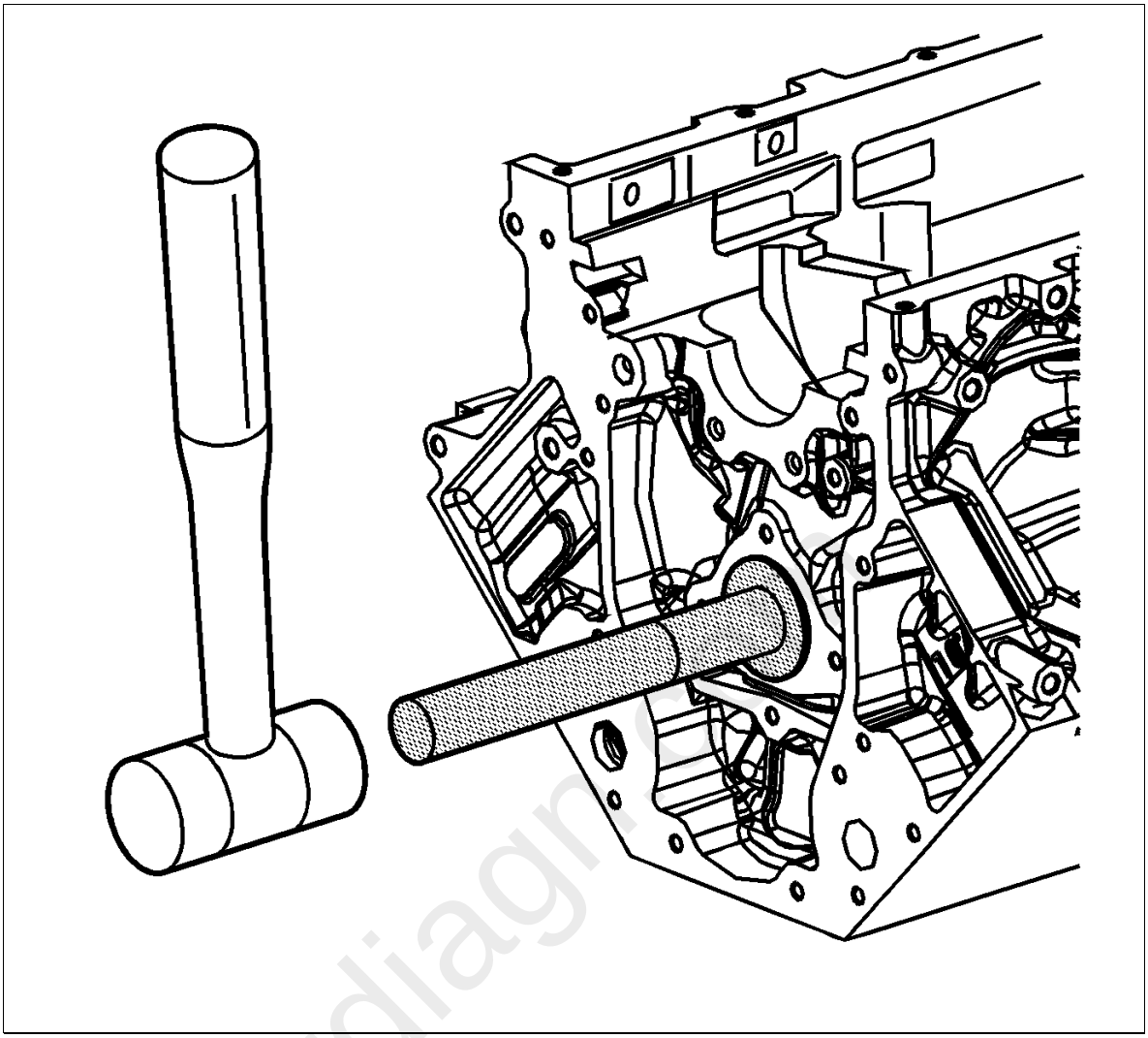
Fig 2: Camshaft Bearing Service Kit Components



Courtesy of GENERAL MOTORS COMPANY

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

Fig 3: Driving Bearing Out Of Or Into Engine Block



Courtesy of GENERAL MOTORS COMPANY

8. Drive the bearing from the block bore.

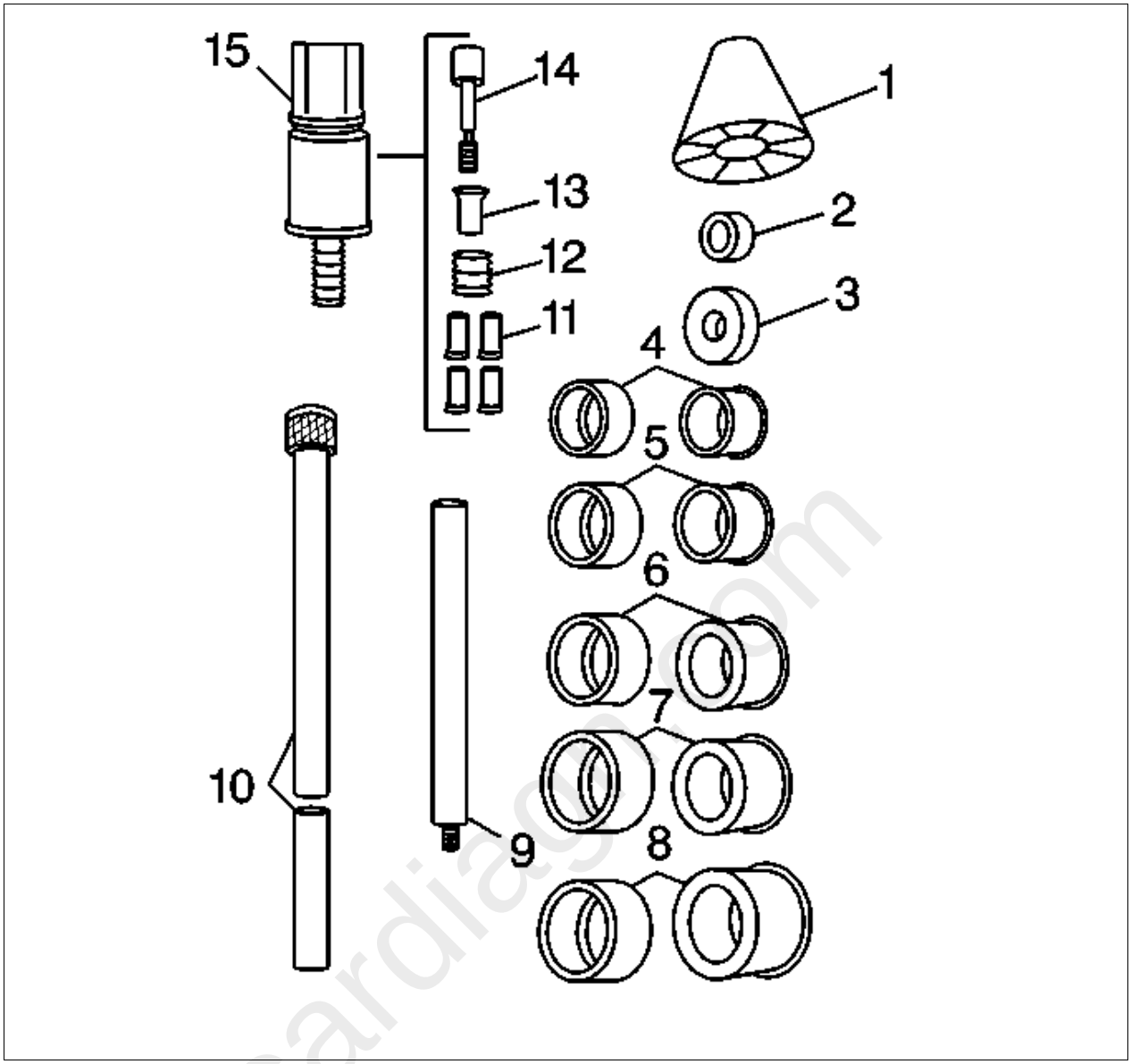
> *IMPORTANT:*
>
> *In order to remove the inner camshaft bearings, operate the tool from either end of the block, using the driver bar extension and the guide cone in the front or rear camshaft bearing bore.*

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

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT BEARING REMOVAL > TOOL USAGE INFORMATION

Bearing, Expander, and Expander Driver Information

Fig 1: Camshaft Bearing Service Kit Components



Courtesy of GENERAL MOTORS COMPANY

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

> *NOTE:*
>
> *The expander bearing drivers (4-8) in the **J 33049** service set are stamped with a number (1-5) to assist in identifying the appropriate diameter driver.*

- Expander assembly (15) is used as a driver for the bearing when inside diameter is 28.575-37.465 mm (1.125-1.475 in) and is used with the small washer.
- Expander bearing driver number 1 inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used

with the expander assembly (15) and the small washer.

- Expander bearing driver number 2 inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 3 inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 4 inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with expander assembly (15) and the large washer.
- Expander bearing driver number 5 inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with expander assembly (15) and the large washer.

Tool Assembly and Operation

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

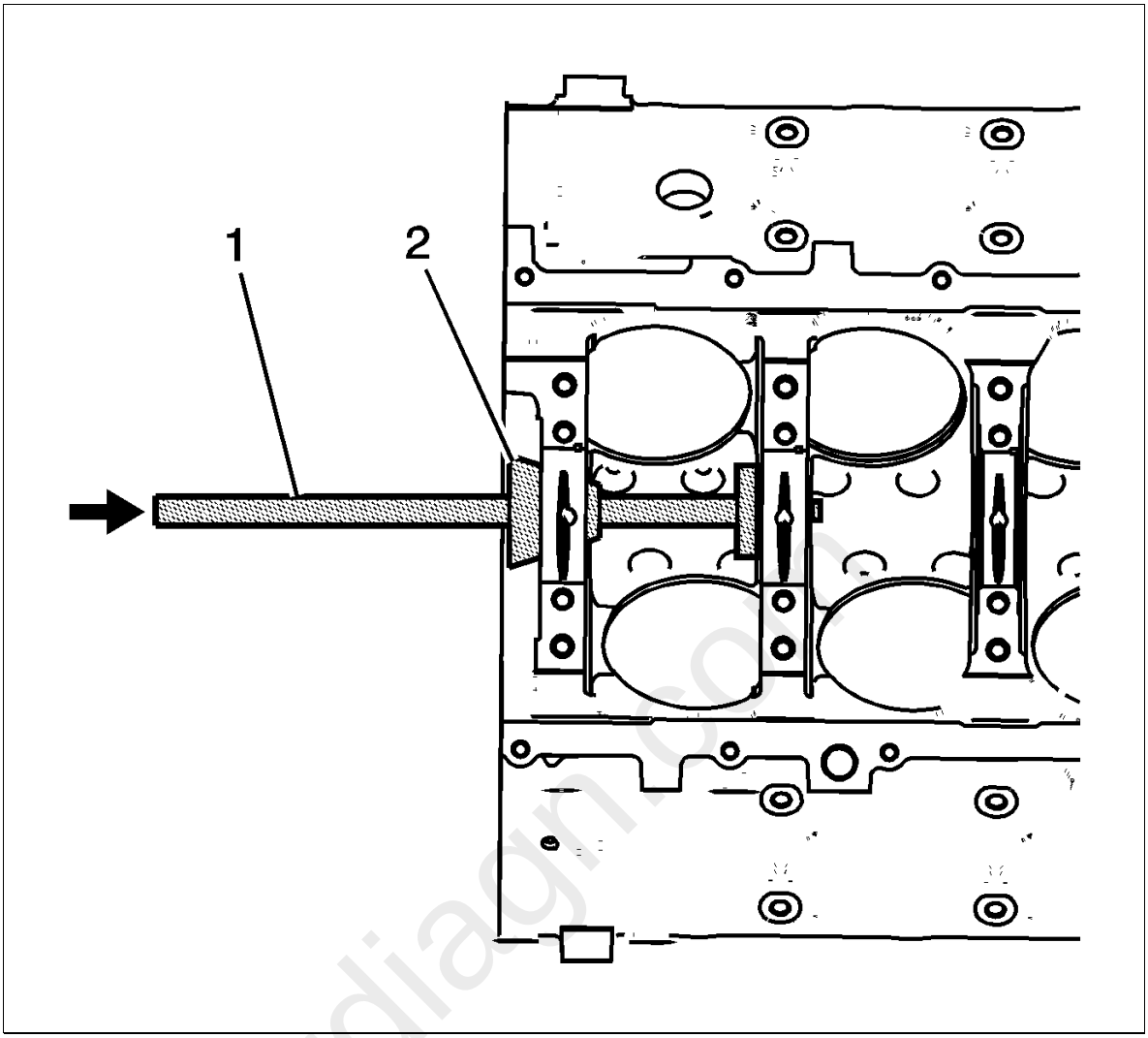
   > *IMPORTANT:*
   >
   > *To install or remove the expanding driver, always push on or pull from the ends.*
   >
   > *Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.*

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

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

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Fig 2: Driving Bearing Out Of Or Into Engine Block



Courtesy of GENERAL MOTORS COMPANY

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

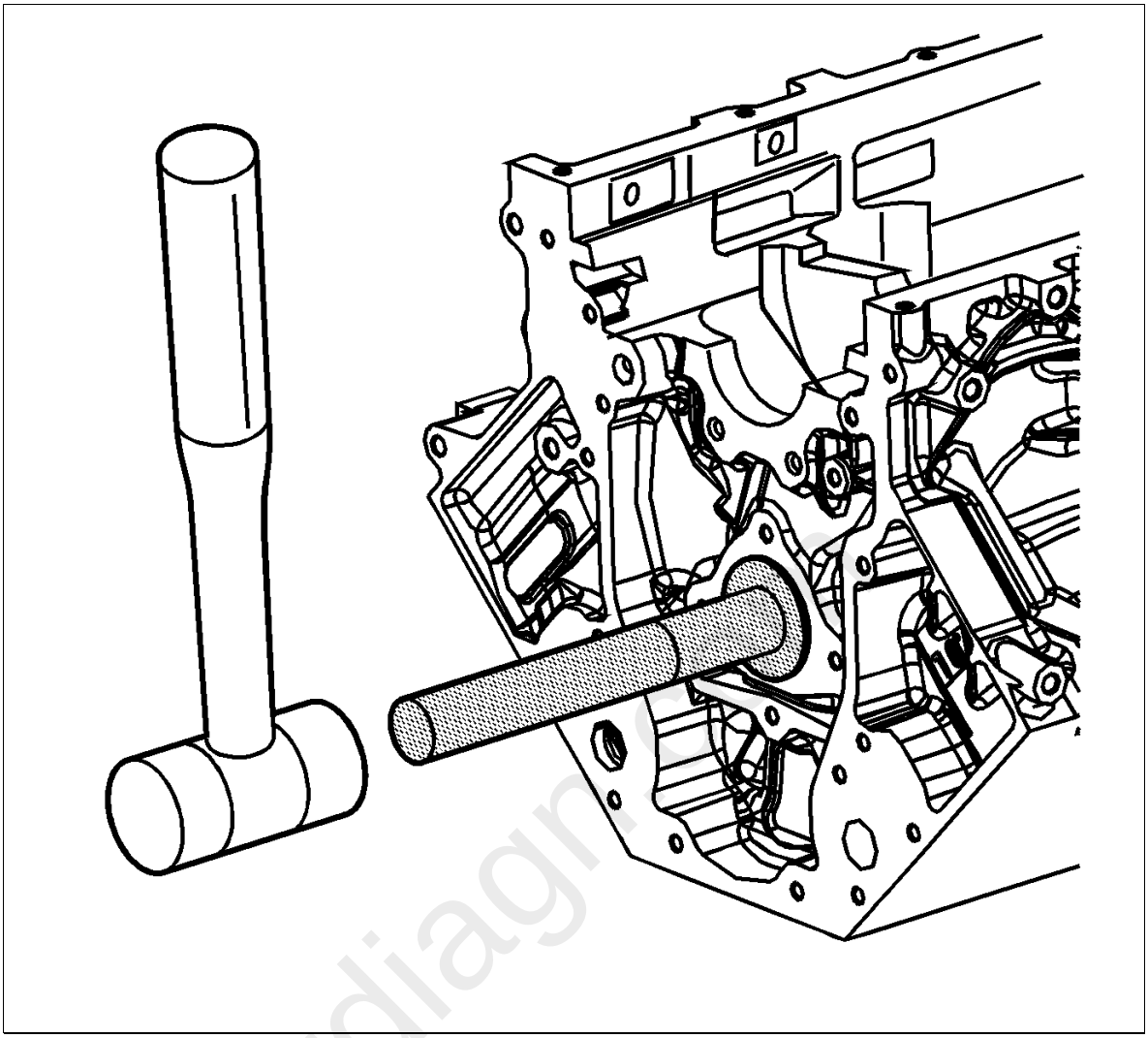
   Operate the tool from the front or rear of the engine block.

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

8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.

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Fig 3: Driving Bearing Out Of Or Into Engine Block



Courtesy of GENERAL MOTORS COMPANY

11. For the end bearings, front, position number 1, and the rear, position number 5, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT AND BEARINGS CLEANING AND INSPECTION

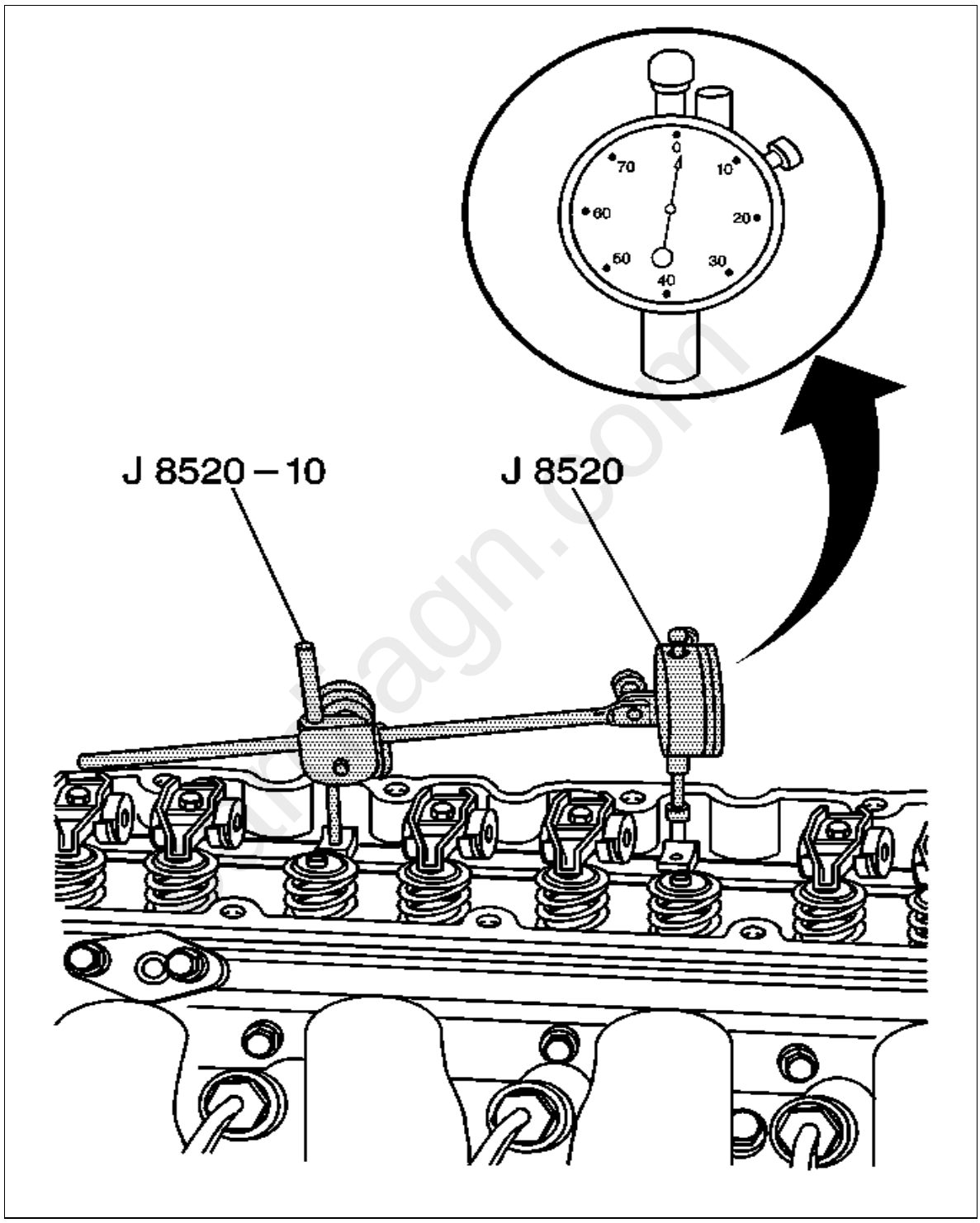
Special Tools

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

For equivalent regional tools, refer to Special Tools

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT AND BEARINGS CLEANING AND INSPECTION > MEASURING CAMSHAFT LOBE LIFT

Fig 1: Camshaft Lobe Lift



Courtesy of GENERAL MOTORS COMPANY

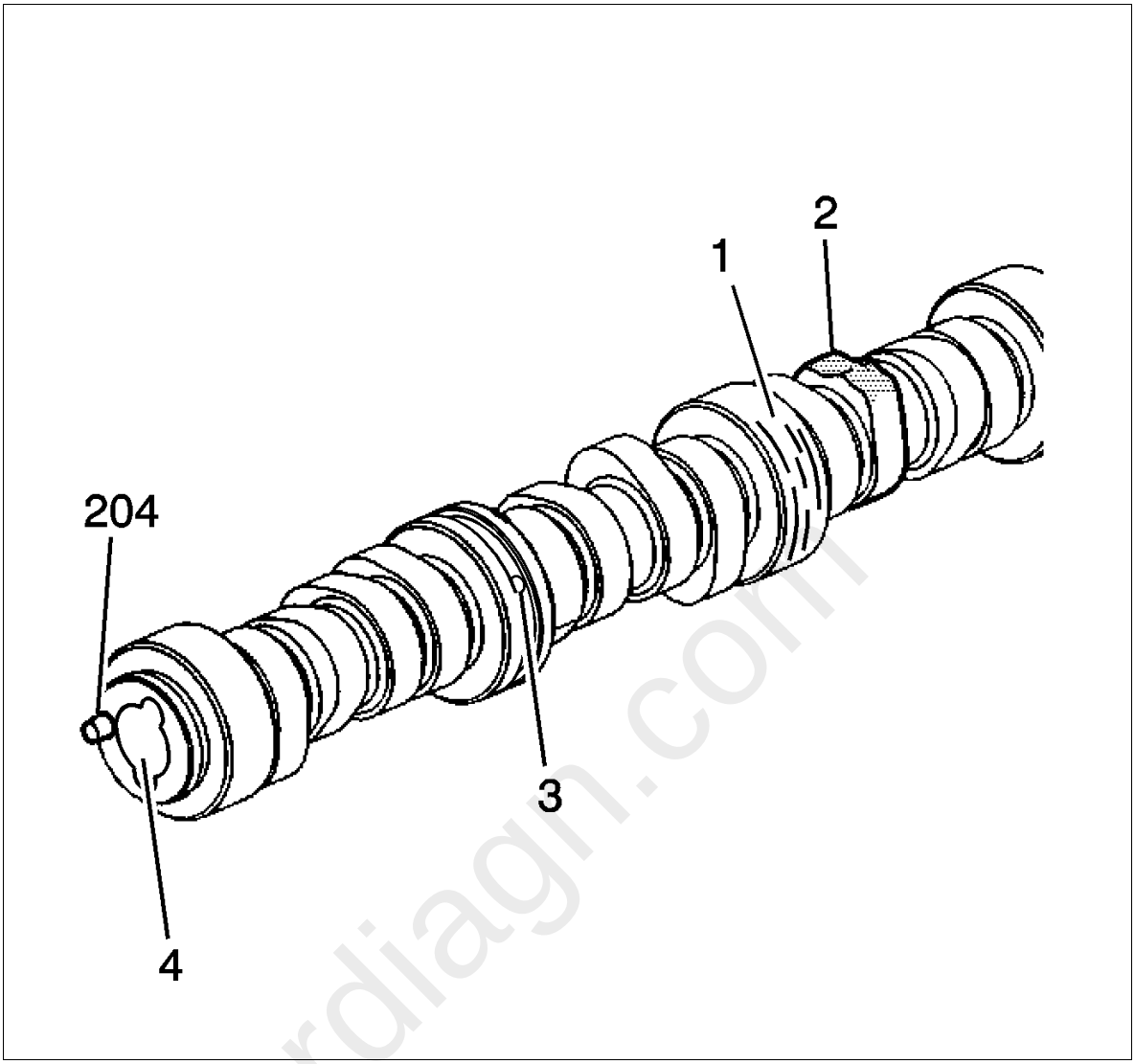
NOTE:

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

1. Using the **J 8520** indicator, measure camshaft lobe lift.
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520** indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to Engine Mechanical Specifications (LT1) . The total lobe lift is the difference between the highest and lowest reading.

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Fig 2: Camshaft Inspection Points



Courtesy of GENERAL MOTORS COMPANY

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1. Clean the components in solvent.

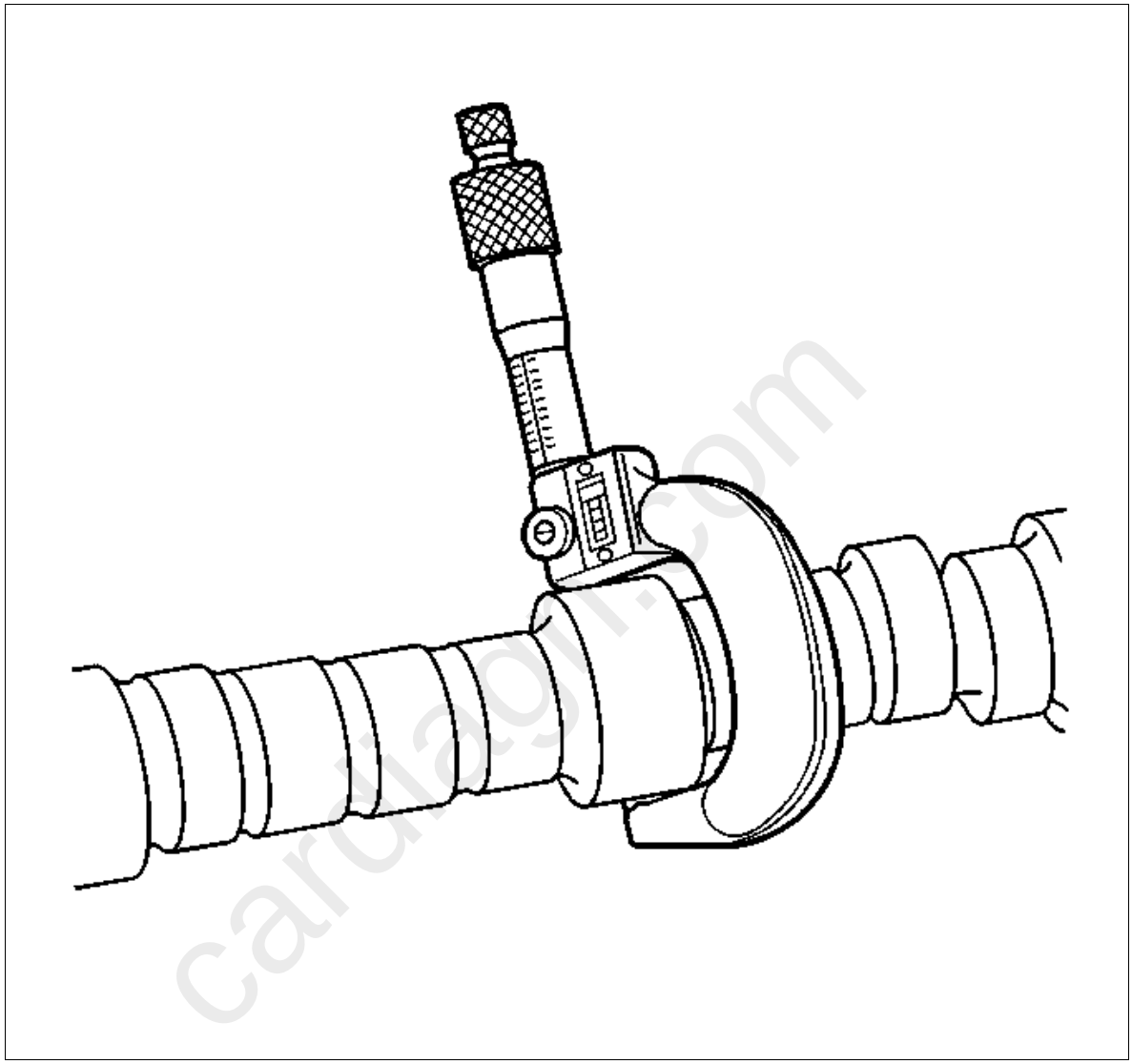
> *WARNING:*
>
> *Refer to Safety Glasses and Compressed Air Warning*

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the camshaft position (CMP) actuator oil passages (3) for restrictions.
6. Inspect the threaded bolt hole (4) in the front of the camshaft for damaged threads or debris.

7. Inspect the camshaft sprocket pin (204) for damage.
8. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

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

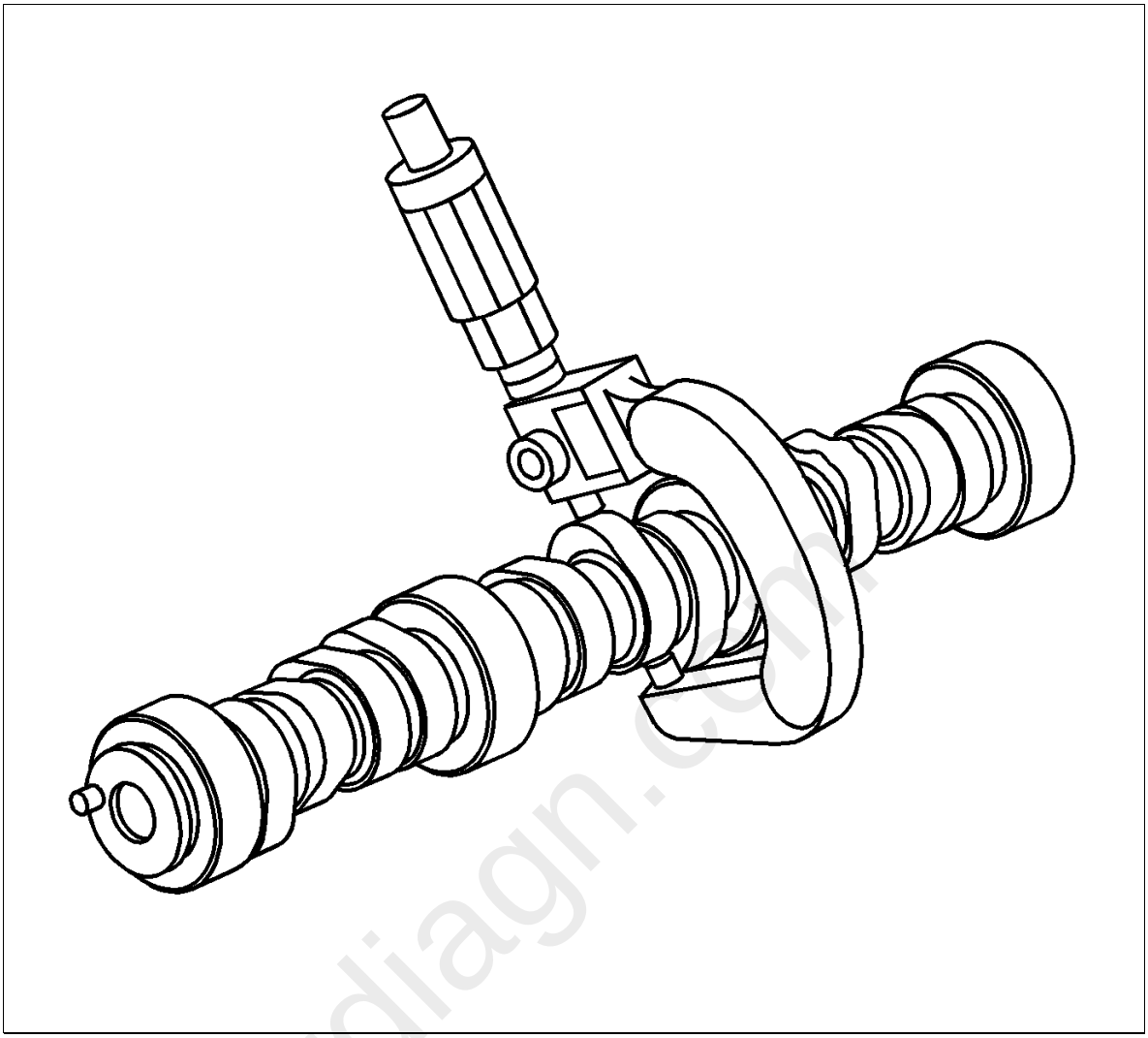
   Fig 3: Measure Camshaft Journals With Micrometer



Courtesy of GENERAL MOTORS COMPANY

9. Using a micrometer, measure the camshaft journals for wear and out-of-round. Refer to Engine Mechanical Specifications (LT1) .
   1. If the camshaft bearing journals are out-of-round, replace the camshaft.
   2. If the camshaft bearing journal diameter is not within specification, replace the camshaft.

Fig 4: Camshaft Lobes

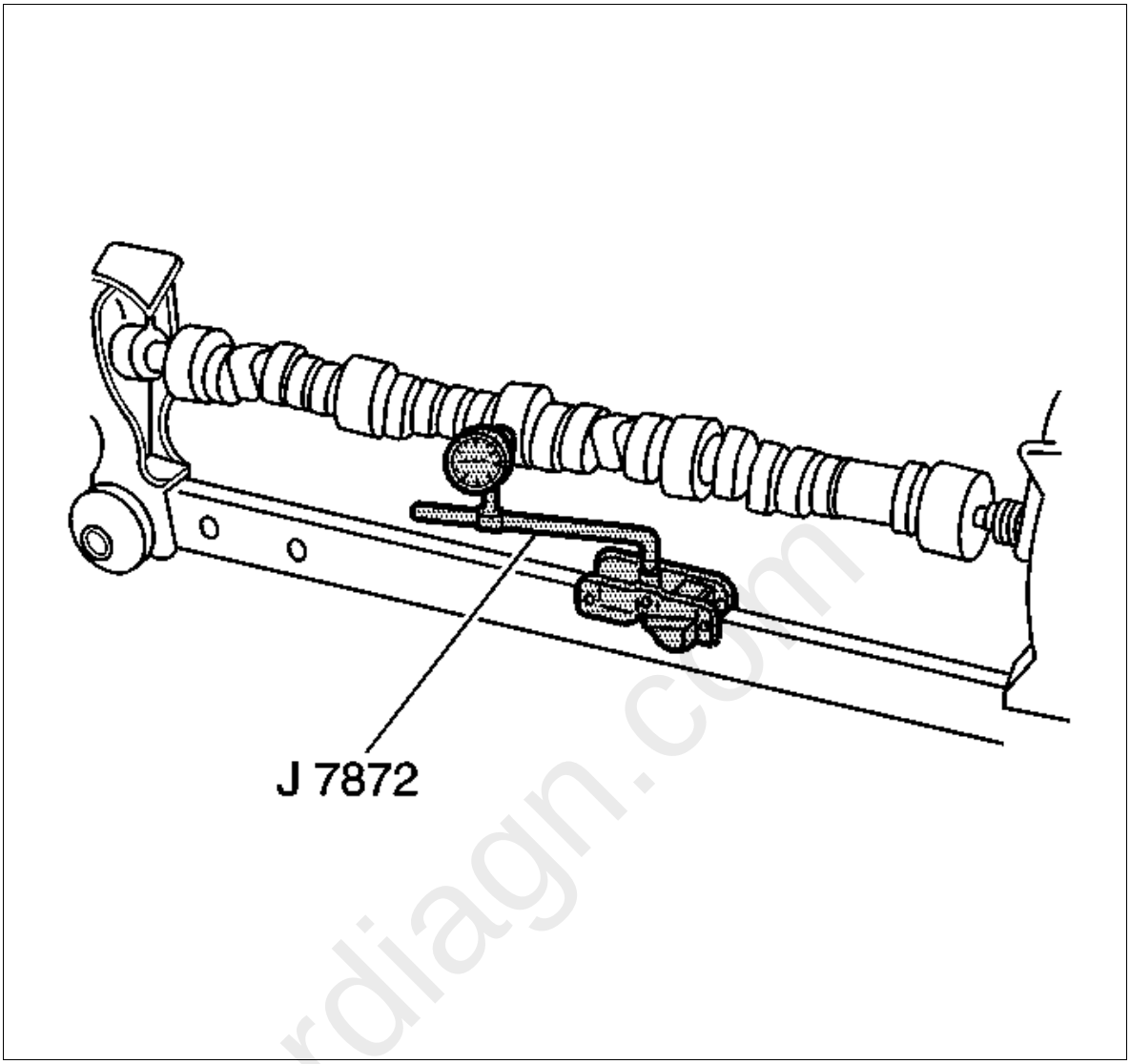


Courtesy of GENERAL MOTORS COMPANY

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10. Using a micrometer, measure the camshaft lobes for wear. Refer to Engine Mechanical Specifications (LT1) .

Fig 5: Camshaft Runout

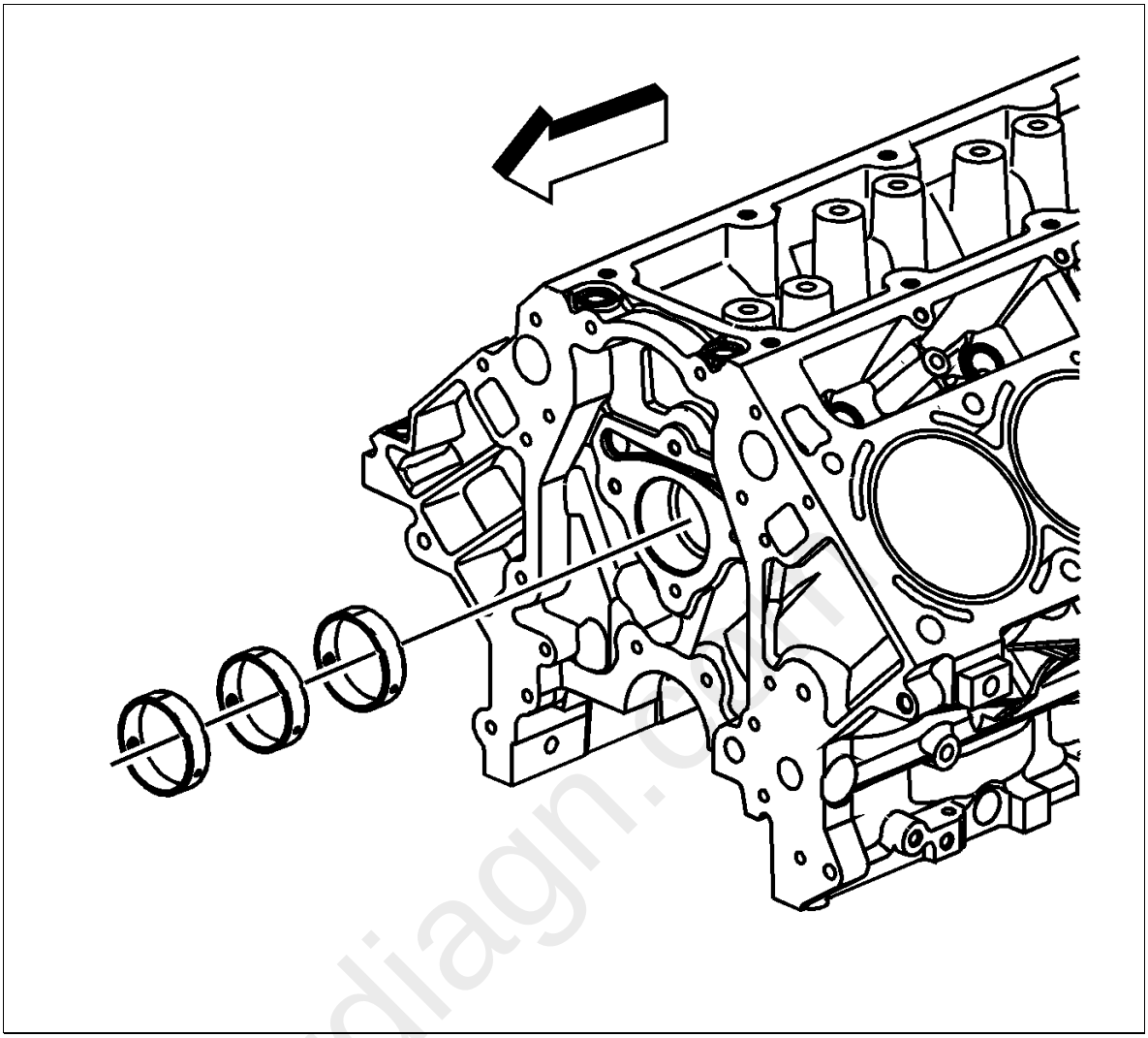


Courtesy of GENERAL MOTORS COMPANY

11. Measure the camshaft runout.
    1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    2. Using the **J 7872** set, measure the runout of the intermediate camshaft bearing journals.
    3. If camshaft runout is not within specification, the camshaft is bent and should be replaced. Refer to Engine Mechanical Specifications (LT1) .

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Fig 6: Camshaft Bearings



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12. Inspect the camshaft bearings for the following:

    1. Excessive wear, evidence of galling, pitting, scoring, or embedded debris. The appearance of the bearing material being different shades of gray are considered normal, and are not guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to Engine Mechanical Specifications (LT1) .

    2. Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.

    3. The oil lubrication feed hole in the bearing must be in alignment with the drilled out passage in the block.

    4. The oil lubrication feed hole is not plugged by debris.

    5. Bearings with excessive wear or scoring must be replaced.

    6. Bearings with excessive wear, galling, pitting, scoring, or embedded debris must be replaced.

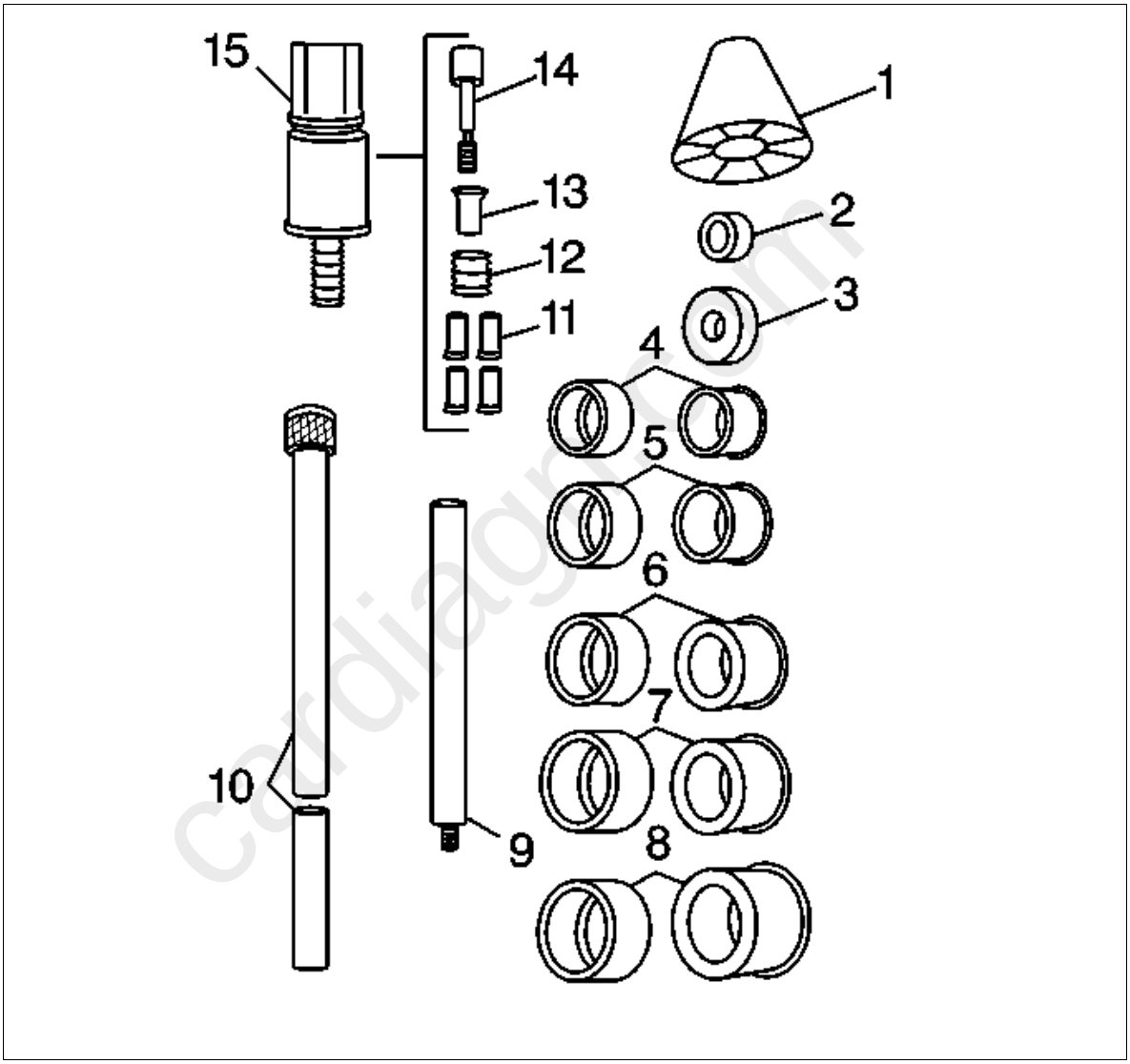
REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT BEARING INSTALLATION

Special Tools

J 33049 Camshaft Bearing Service Set

For equivalent regional tools, refer to Special Tools

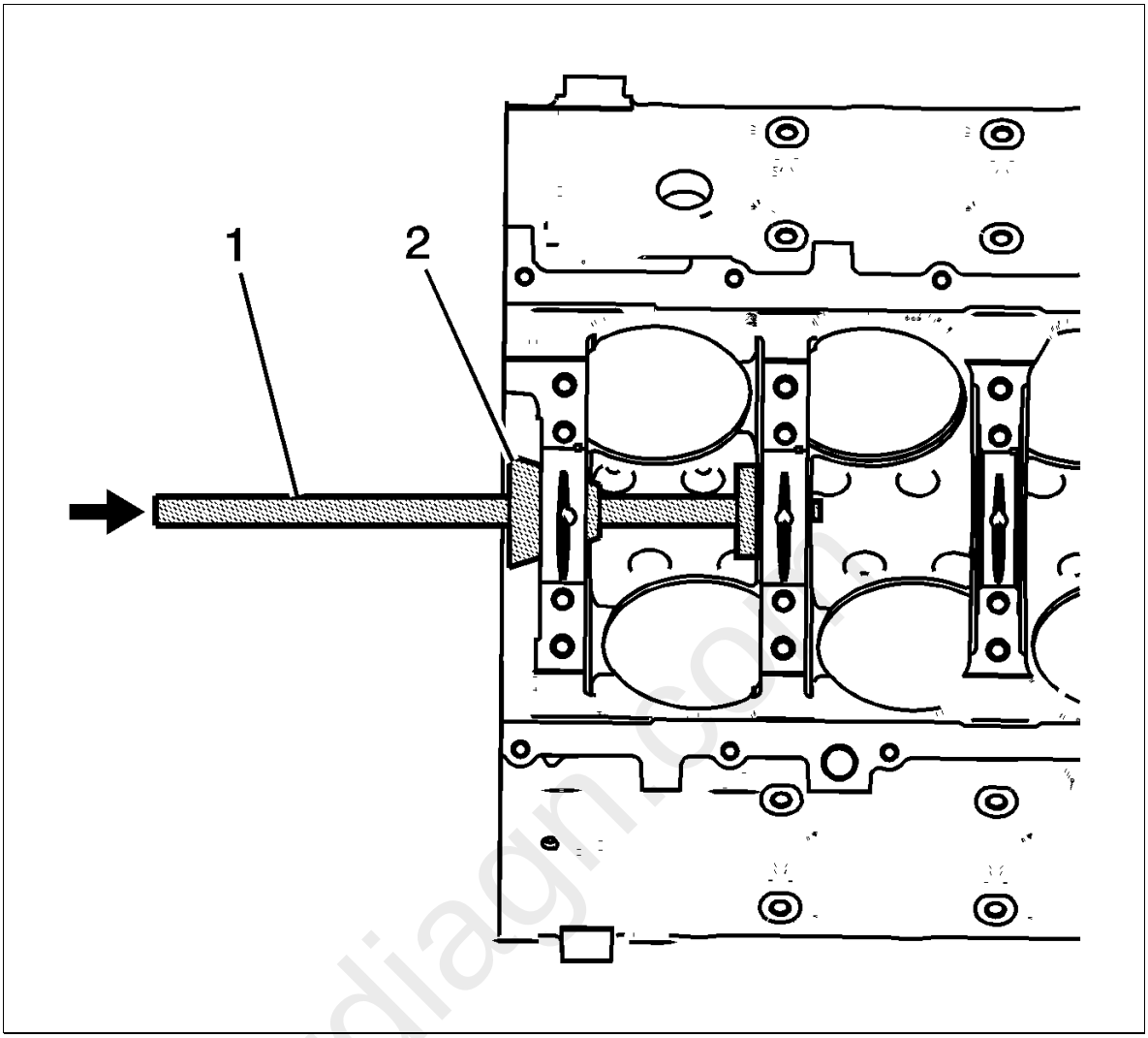
Fig 1: Camshaft Bearing Service Kit Components



Courtesy of GENERAL MOTORS COMPANY

1. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049** set. Refer to Camshaft Bearing Removal .
2. Assemble the tool.

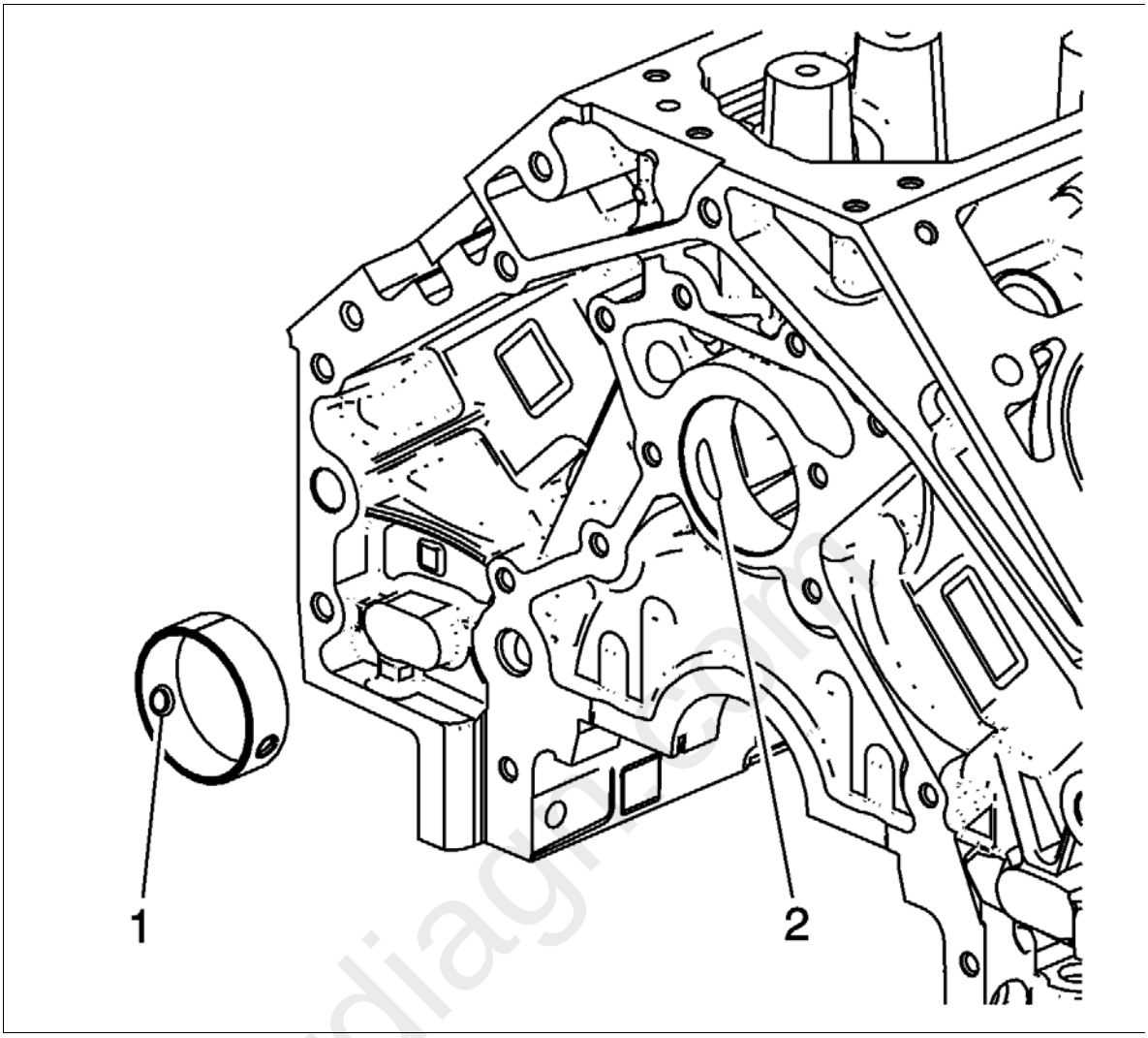
Fig 2: Driving Bearing Out Of Or Into Engine Block



Courtesy of GENERAL MOTORS COMPANY

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

Fig 3: Positioning Camshaft Bearing With Oil Feed Hole



Courtesy of GENERAL MOTORS COMPANY

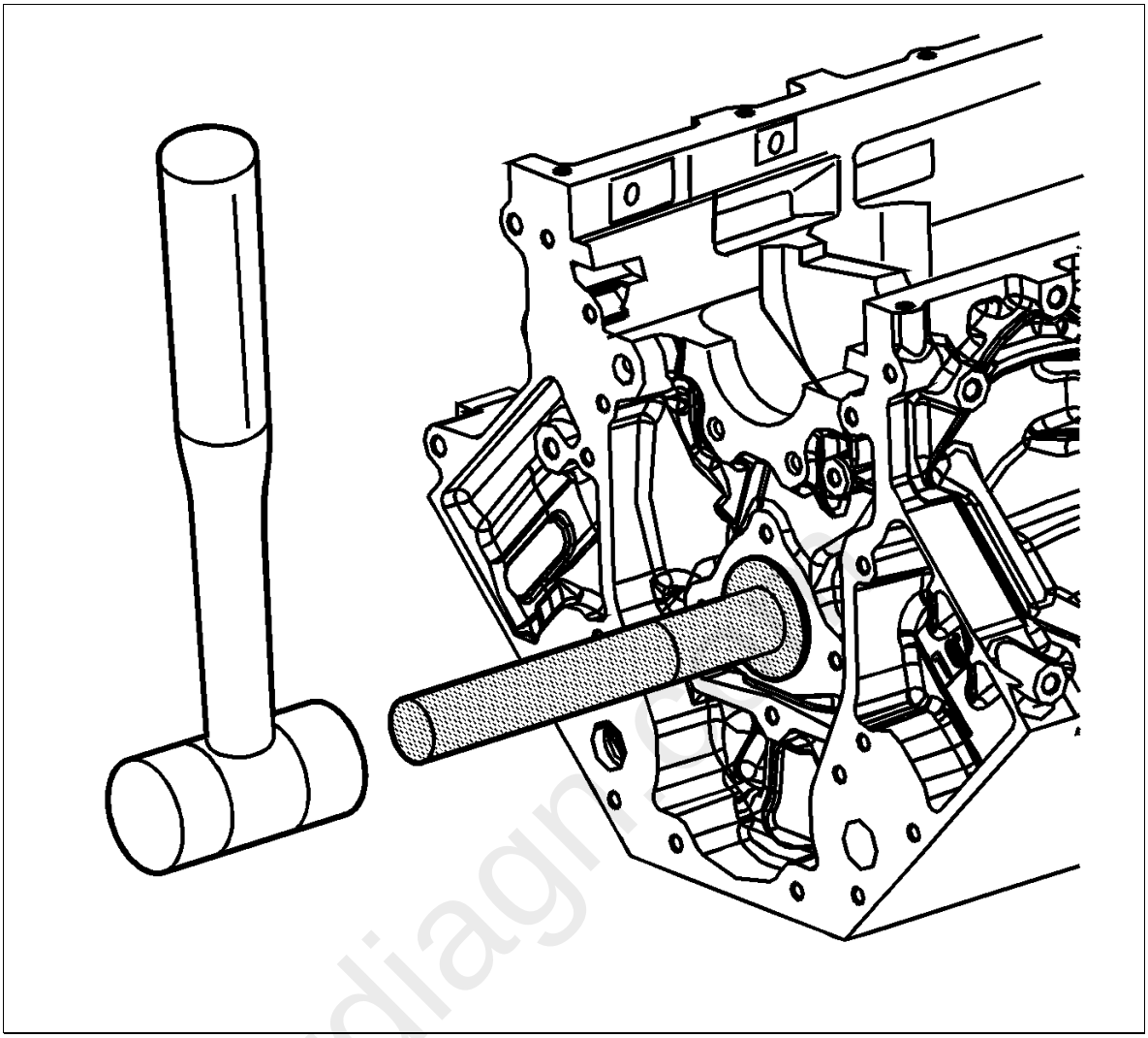
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⚠ *CAUTION:*

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

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

Fig 4: Driving Bearing Out Of Or Into Engine Block

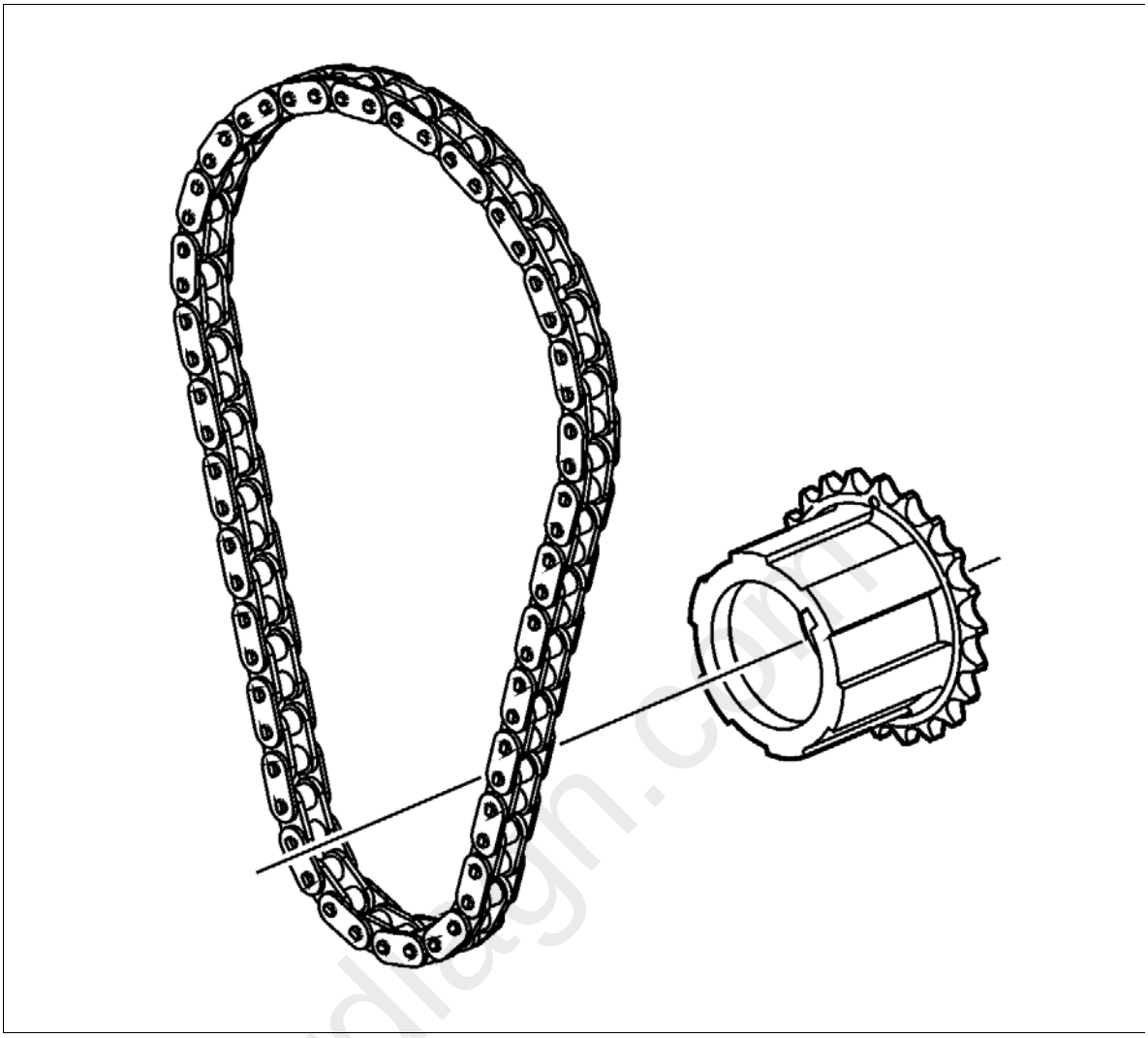


Courtesy of GENERAL MOTORS COMPANY

7. Drive the bearing into the block bore. During installation, ensure the bearing is installed straight.
8. Remove **J 33049** service set, inspect bearing to confirm the oil hole in the bearing is in alignment with the drilled oil passage in the block bore.
9. Repeat procedure to install the remaining bearings into the block.

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION

Fig 1: Camshaft Timing Chain And Crankshaft Sprocket



Courtesy of GENERAL MOTORS COMPANY

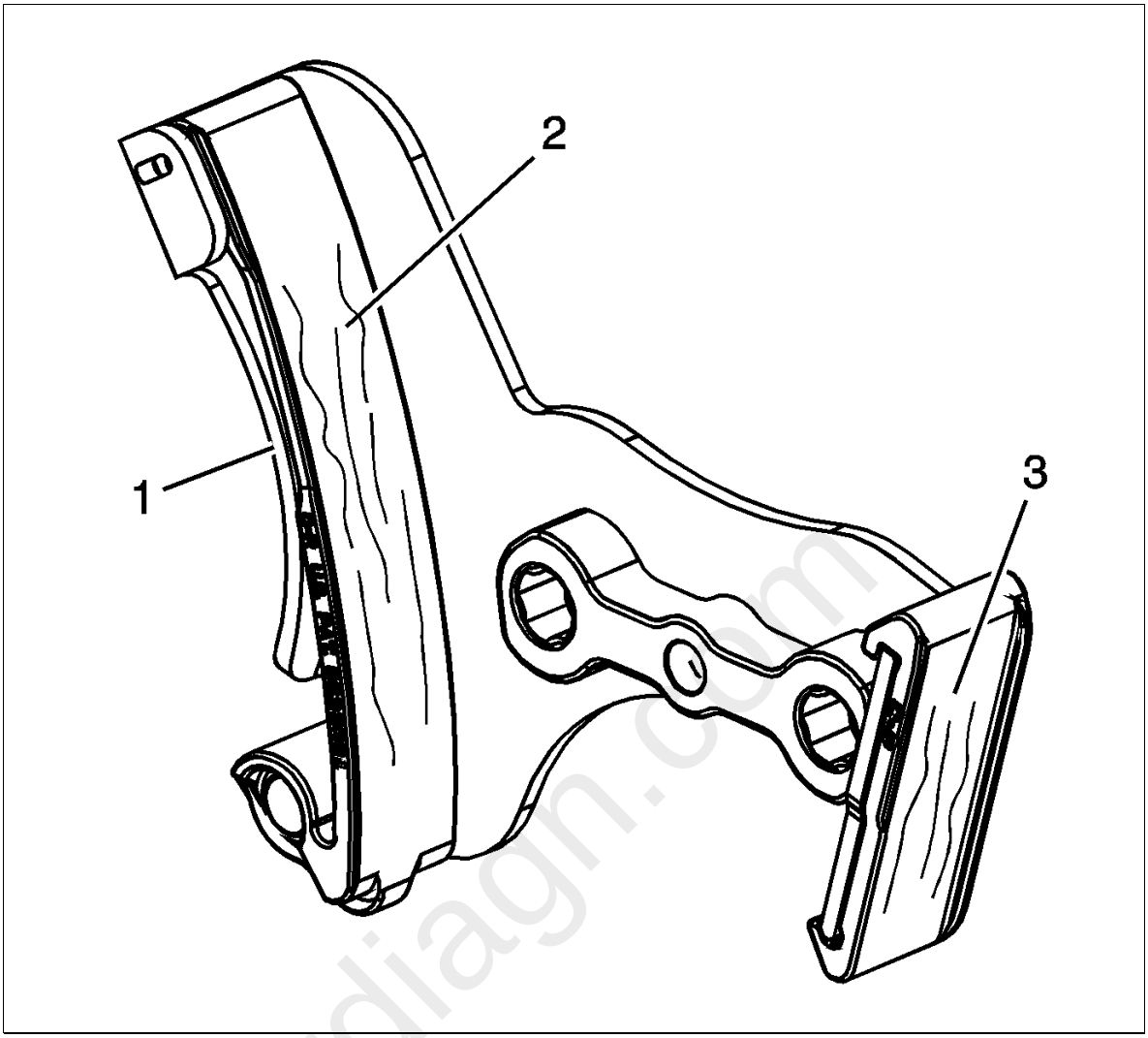
1. Clean the components with cleaning solvent.

> *WARNING:*
>
> *Refer to Safety Glasses and Compressed Air Warning .*

2. Dry the components with compressed air.
3. Inspect the timing chain for binding or wear.
4. Inspect the crankshaft sprocket for worn, damaged, or chipped teeth.
5. Inspect for a damaged keyway.
6. Inspect for worn oil pump drive splines.

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Fig 2: Timing Chain Tensioner Inspection Points



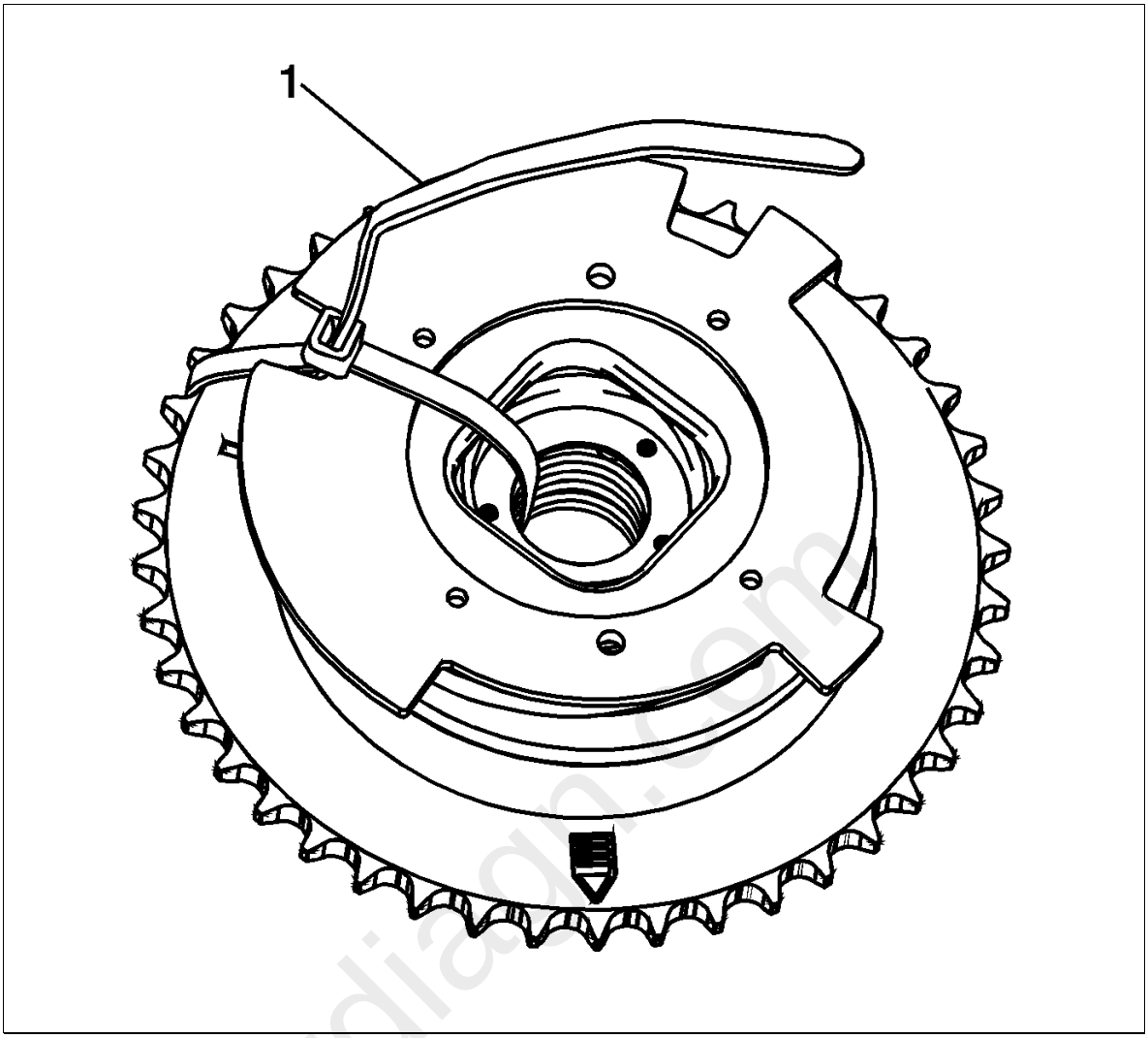
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7. Inspect the timing chain tensioner for the following conditions:
    1. Damaged or broken tension spring (1)
    2. Excessive wear or scoring on the chain guide surfaces (2, 3)

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT POSITION ACTUATOR CLEANING AND INSPECTION

Fig 1: Tie Strap Through Center Of Actuator



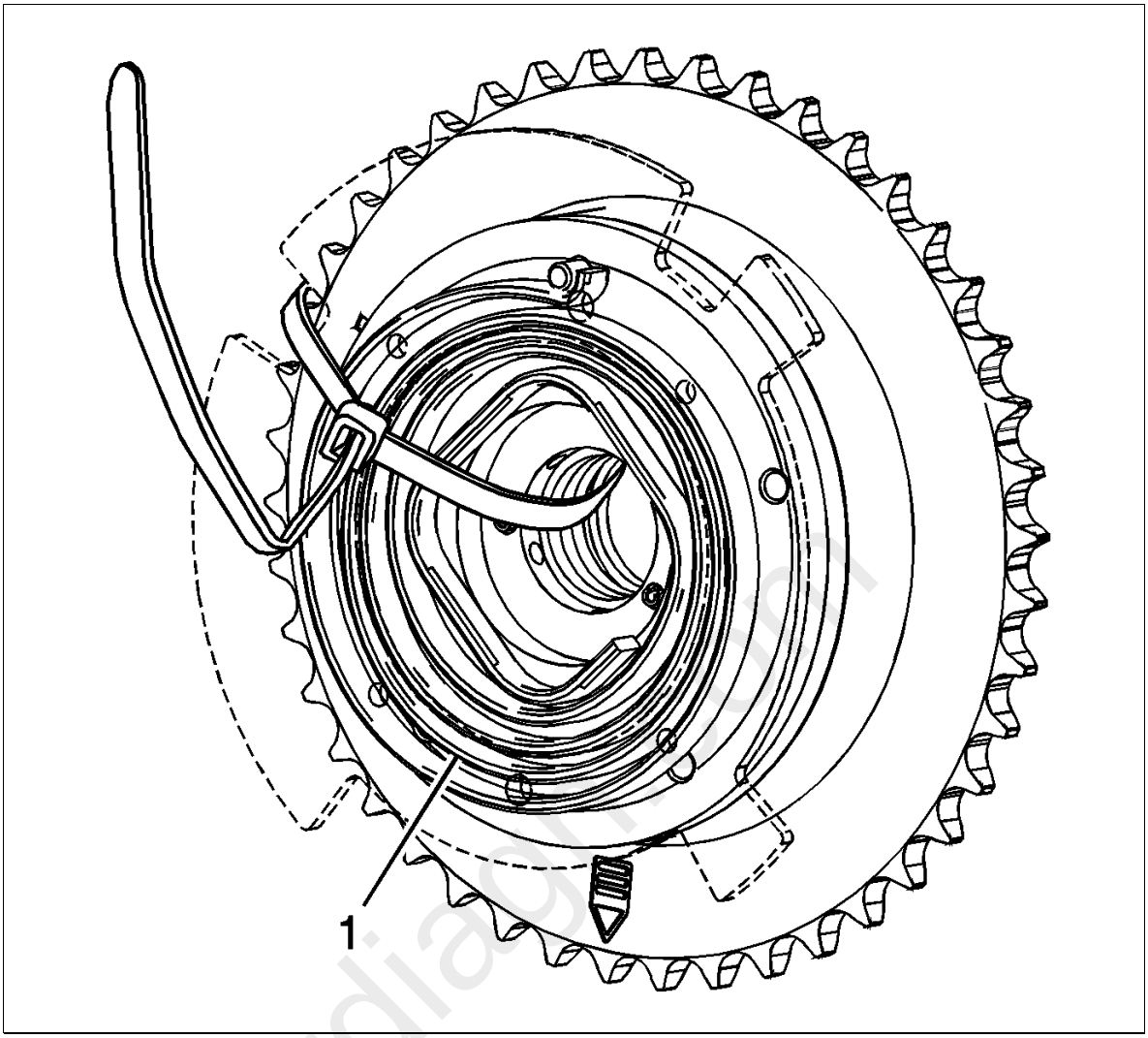
Courtesy of GENERAL MOTORS COMPANY

WARNING:

Refer to Camshaft Position Actuator Removal and Installation Warning .

1. Insert a tie strap (1) through the center of the camshaft position (CMP) actuator and over the reluctor wheel.

Fig 2: Inspecting CMP Actuator For Broken Spring



Courtesy of GENERAL MOTORS COMPANY

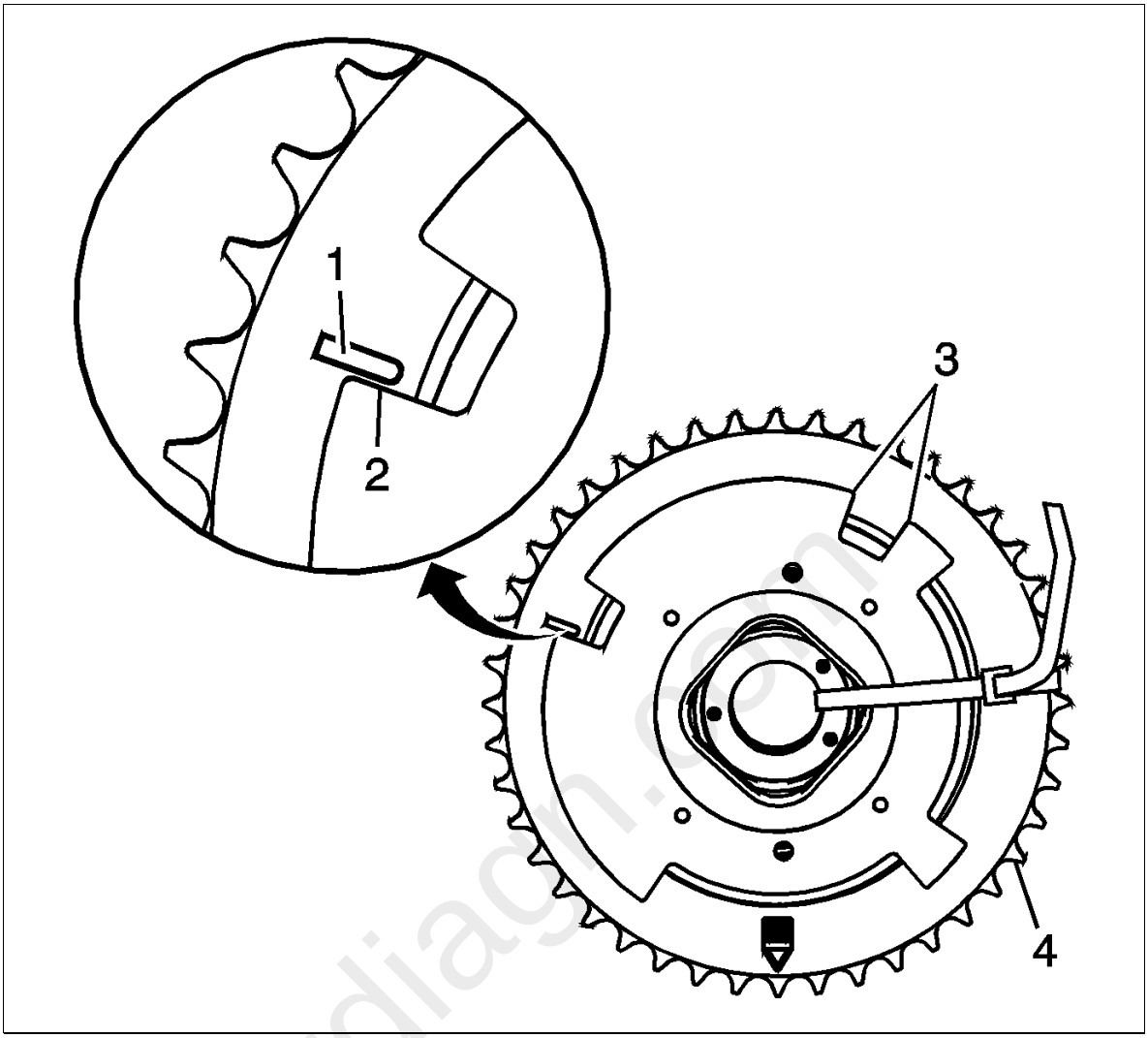
2. Clean the CMP actuator with cleaning solvent.

> *WARNING:*
>
> *Refer to Safety Glasses and Compressed Air Warning .*

3. Dry the components with compressed air.

4. Inspect the CMP actuator for a broken spring (1).

Fig 3: CMP Actuator Inspection Points

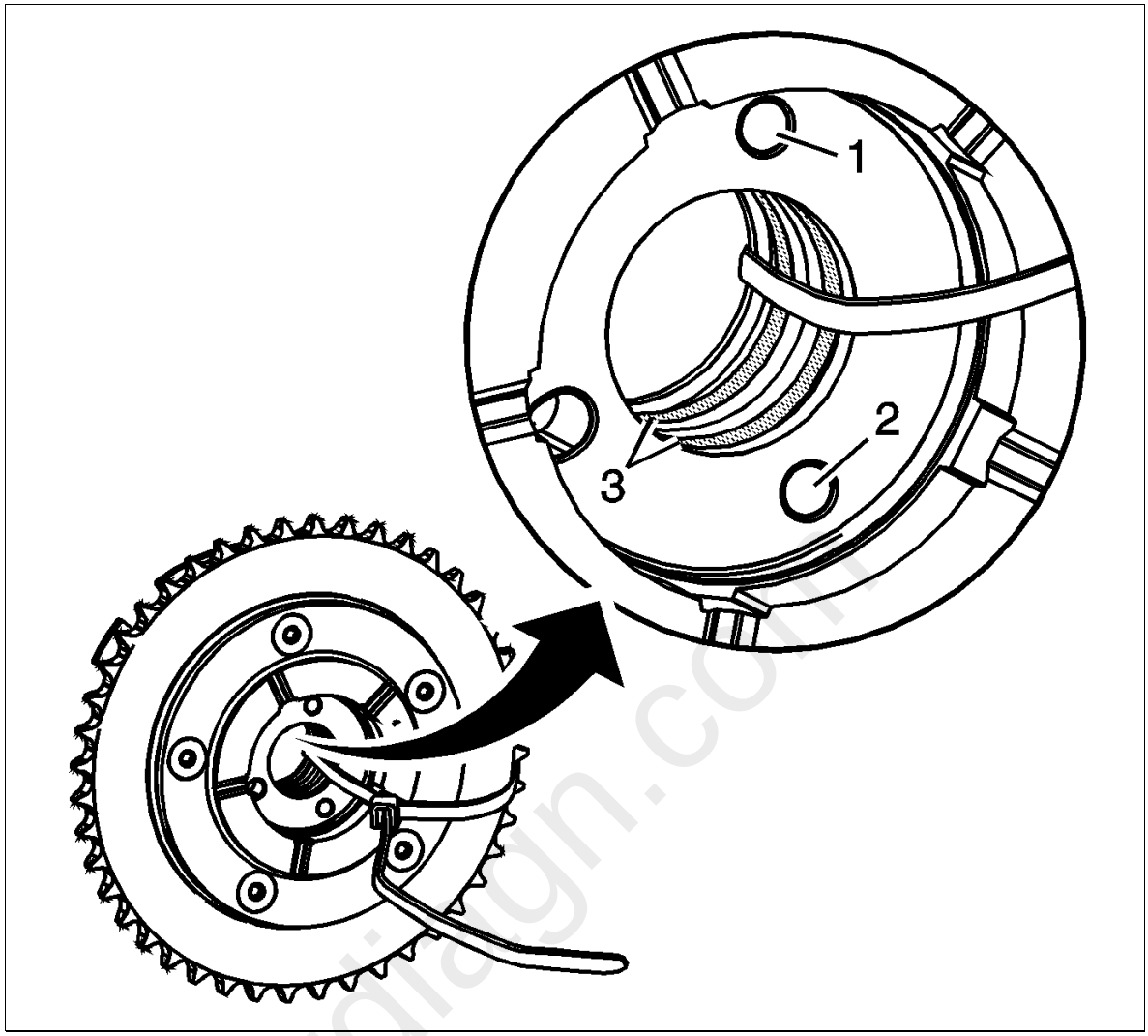


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5. Inspect the CMP actuator for the following conditions:
    1. Improper positioning of the CMP reluctor wheel. The actuator return spring should reposition the reluctor wheel to the PARK position. Inspect for proper alignment of the mark on the face of the sprocket (1) with the flat edge of the reluctor wheel (2). If the reluctor wheel is not properly positioned, the internal components of the actuator are sticking or the return spring is broken and the actuator should be replaced as an assembly.
    2. Nicked or damaged edges (3) on the CMP reluctor wheel
    3. Damaged timing sprocket teeth (4)

Fig 4: Oil Passages

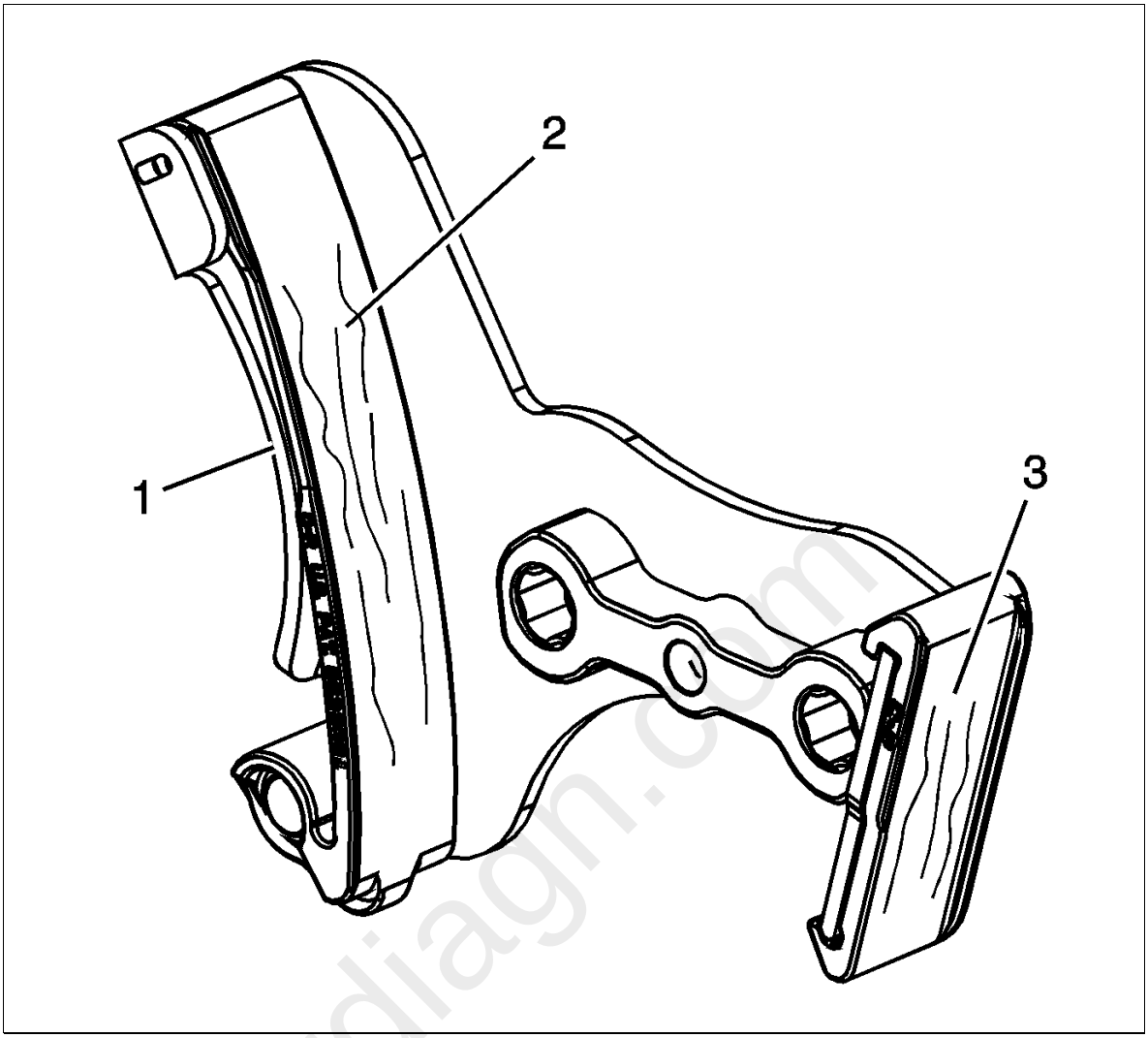


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6. Inspect the CMP actuator for dirt, debris, or restrictions within the oil passages (1, 2, 3).

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Fig 5: Timing Chain Tensioner Inspection Points



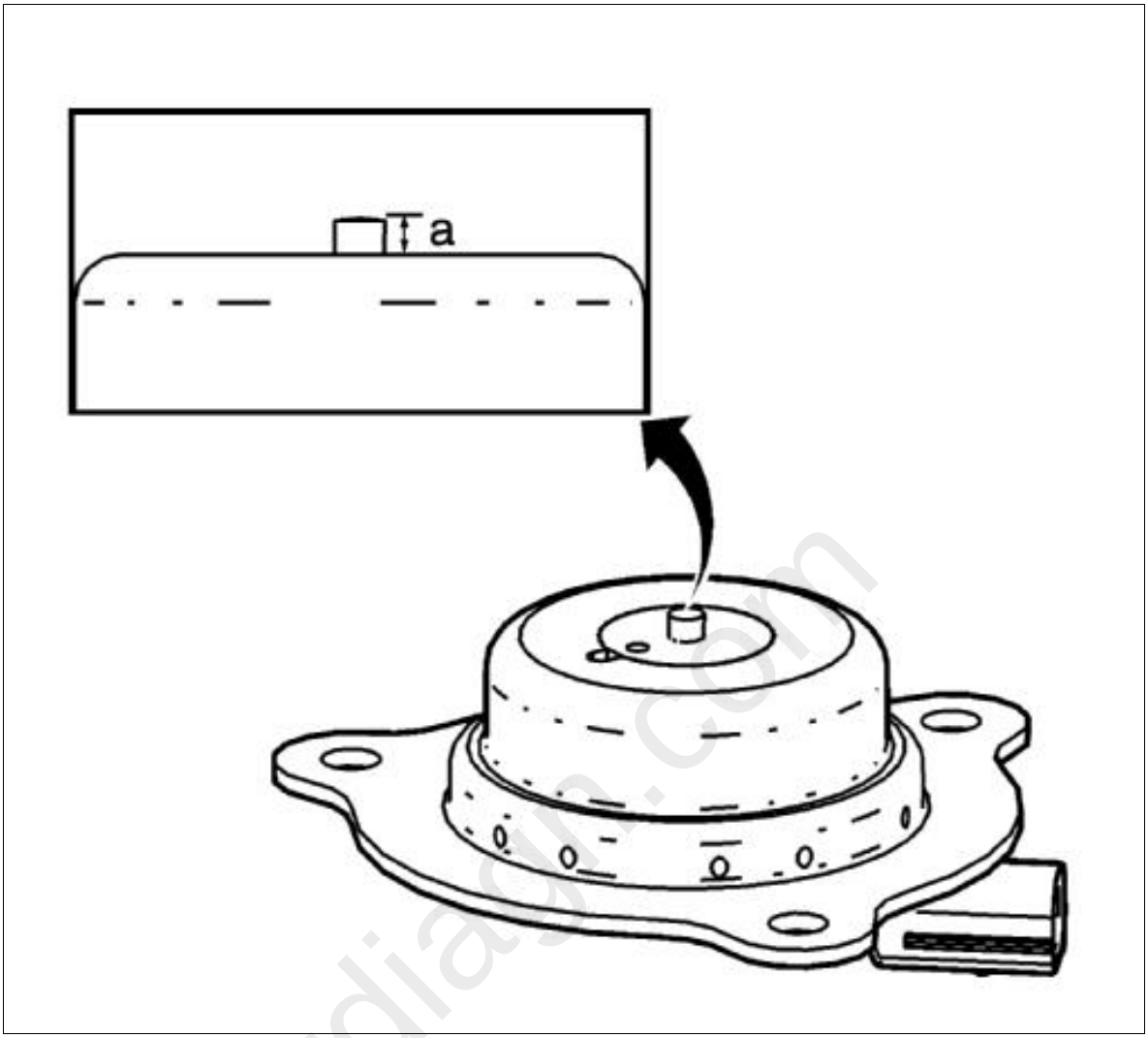
Courtesy of GENERAL MOTORS COMPANY

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7. Inspect the timing chain tensioner for the following conditions:
    1. Damaged or broken tension spring (1)
    2. Excessive wear or scoring on the chain guide surfaces (2, 3)

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT POSITION ACTUATOR MAGNET CLEANING AND INSPECTION

Fig 1: Camshaft Position Actuator Magnet



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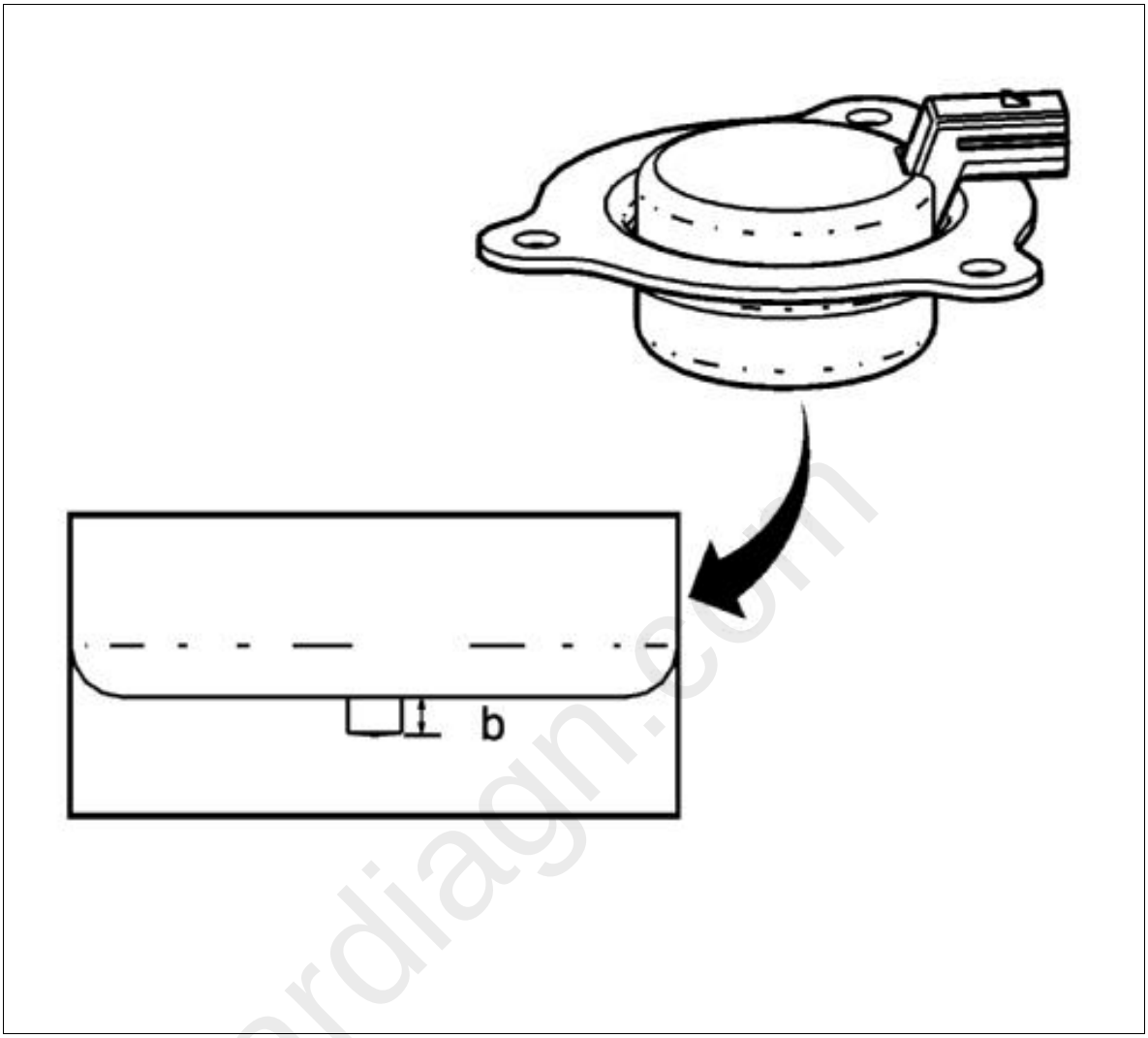
IMPORTANT:

If checking the operating range of the CMP magnet pintle, DO NOT energize the magnet with a 12V power supply. Use steps 2 thru 5 below to check pintle operating range. To dynamically test the magnet pintle with a power supply, refer to the dynamic test instructions listed under the component testing portion of DTC P0011. Refer to DTC P0011 .

1. Inspect the CMP magnet for the following conditions:
    1. A damaged electrical connector
    2. An accumulation of dirt or debris in the recessed area around the pintle
    3. A build-up of burnt engine oil on the shaft of the pintle which may cause the pintle to stick and not move freely within the proper range of travel

2. Holding the CMP magnet with the pintle facing upward, measure the pintle retracted position (a). Record the dimension.

Fig 2: Pintle Extended Position



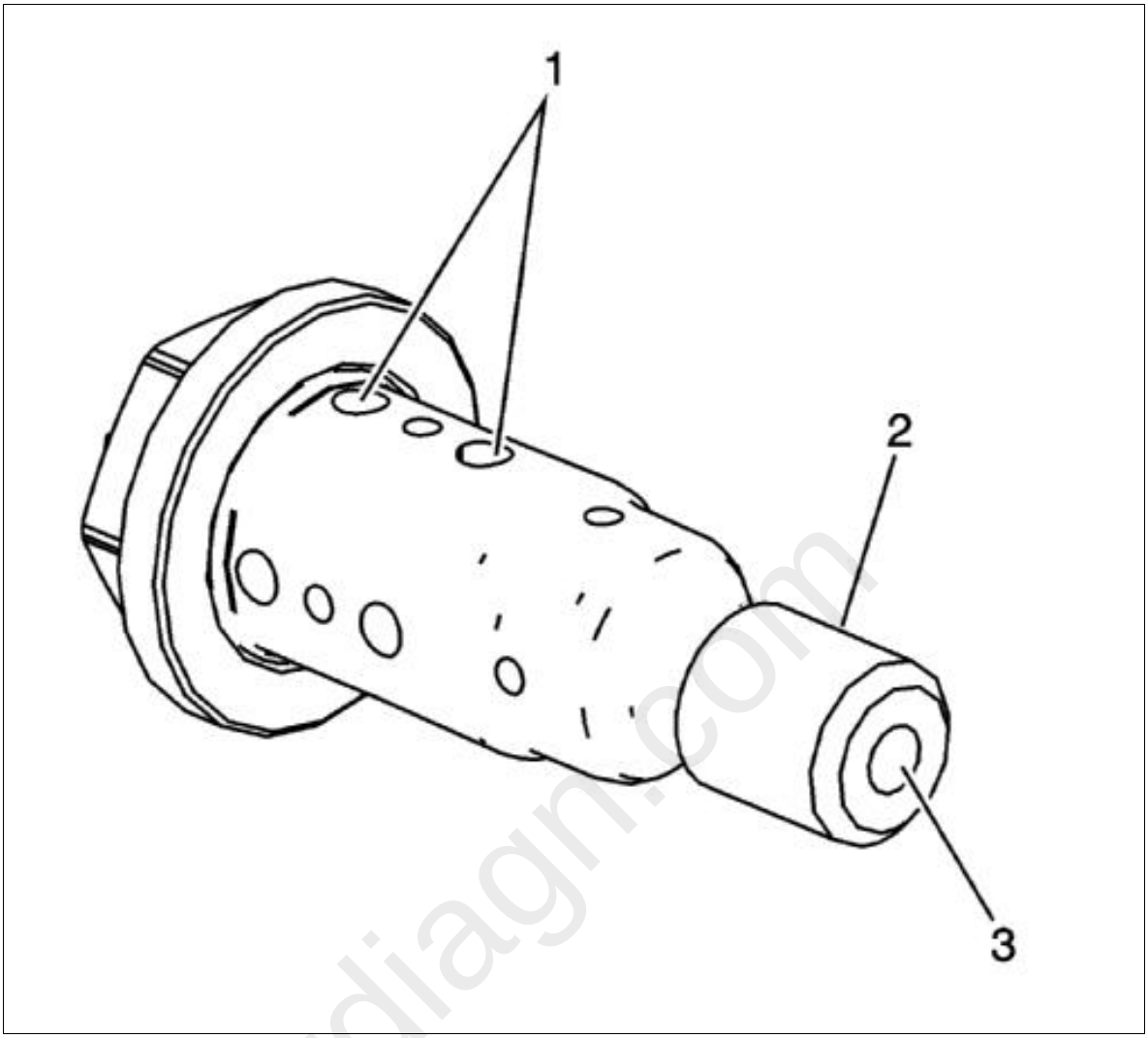
Courtesy of GENERAL MOTORS COMPANY

3. Holding the CMP magnet with the pintle facing downward, measure the pintle extended position (b). Record the dimension.
4. Subtract the retracted dimension (a) from the extended dimension (b) to determine pintle travel. A properly moving pintle will travel 3.0-5.5 mm (0.12-0.22 in).
5. If the pintle of the CMP magnet is binding or does not move within the proper range of travel, replace the CMP magnet as an assembly.

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSPECTION

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Fig 1: Camshaft Position Actuator Solenoid Valve Inspection



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IMPORTANT:

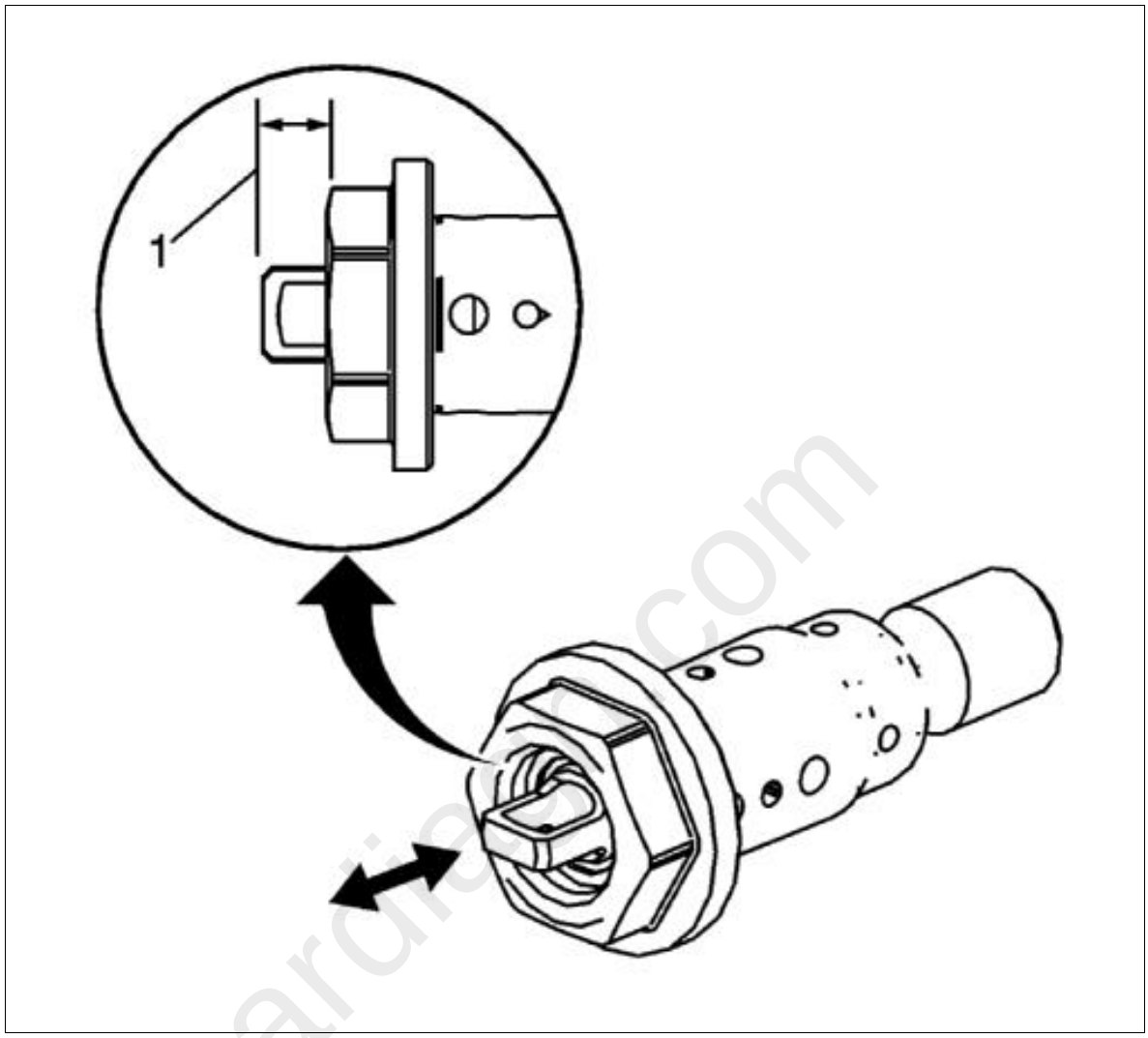
Do not use the camshaft position (CMP) actuator solenoid valve again. Install a NEW valve during assembly. The inspection procedure below is provided for off-vehicle diagnostic purposes only.

1. Inspect the CMP valve for the following conditions:
    1. Dirt, debris, or restrictions within the oil passages (1)
    2. Damaged threads (2)

        If the threads of the valve are damaged, also inspect the threads in the front of the camshaft for damage.
    3. Dirt, debris, or restrictions within the oil inlet (3)

If debris is detected, the engine assembly should be inspected to determine the source of contamination.

Fig 2: Camshaft Position Actuator Solenoid Valve Inspection

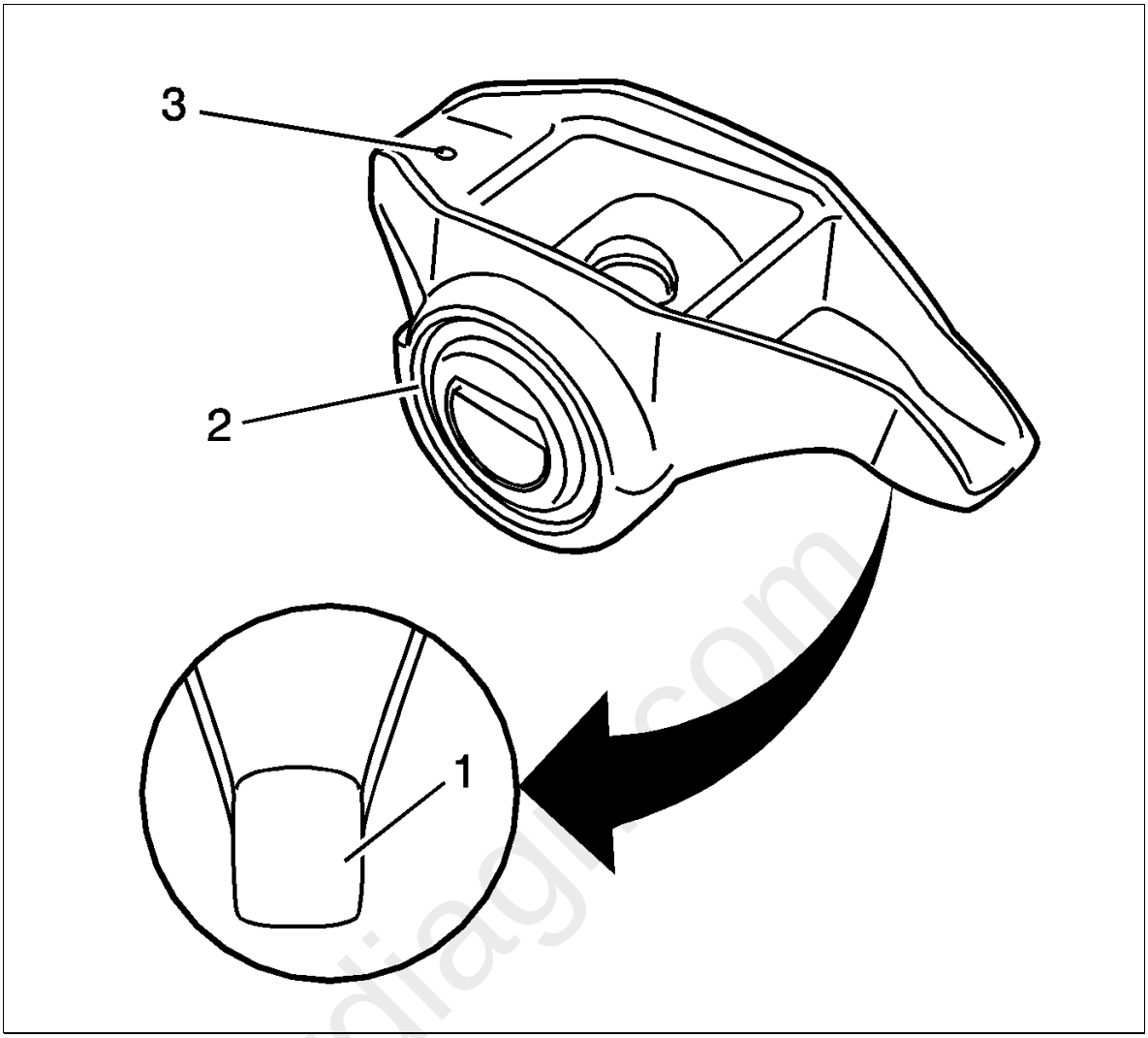


Courtesy of GENERAL MOTORS COMPANY

2. Inspect for a sticking valve spool or broken valve spool spring.
3. Depress the valve spool into the housing. The valve should move freely with no binding or sticking and minimal resistance inward. When released, the valve spring should return the spool to the proper extended position (1) of 6.52-6.92 mm (0.257-0.272 in).

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM AND PUSH ROD CLEANING AND INSPECTION

Fig 1: Valve Rocker Arm Components



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Parts that are to be used again must be marked, sorted or organized for assembly.

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

WARNING:

Refer to Safety Glasses and Compressed Air Warning .

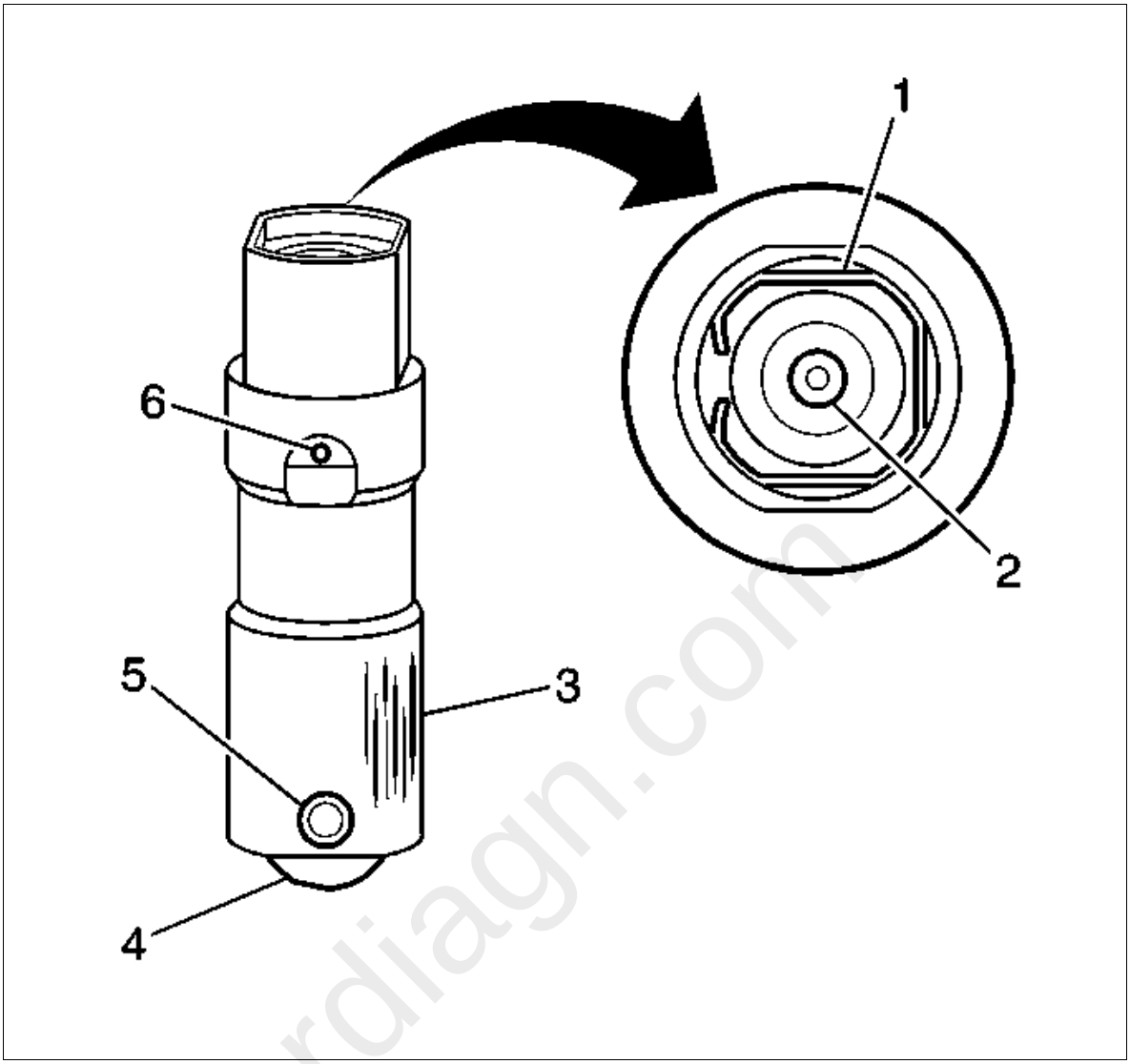
3. Dry the components with compressed air.

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

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER AND GUIDE CLEANING AND INSPECTION > NON ACTIVE FUEL MANAGEMENT VALVE LIFTERS

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Fig 1: Valve Lifter Inspection Areas



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NOTE:

Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

WARNING:

Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.

3. Inspect the valve lifters for the following conditions:
    1. Bent or broken clip (1)
    2. Worn pushrod socket (2)
    3. Scuffed or worn sides (3)

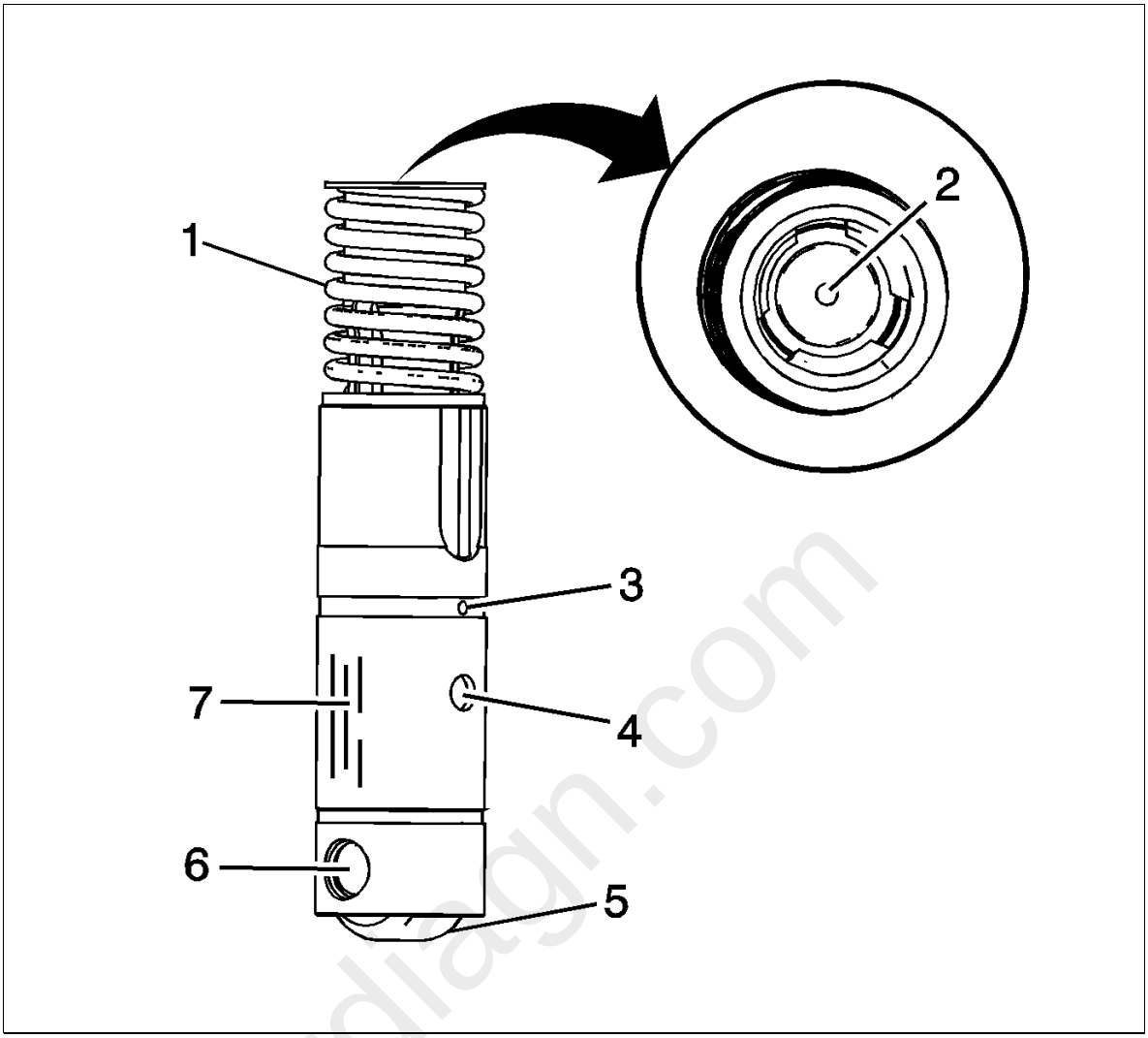
       If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.
    4. Flat spots on the roller (4)
    5. Loose or damaged pin (5)
    6. Plugged oil hole (6)
    7. Worn or damaged roller bearing

       The roller should rotate freely with no binding or roughness.

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER AND GUIDE CLEANING AND INSPECTION > ACTIVE FUEL MANAGEMENT VALVE LIFTERS

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Fig 1: Displacement On Demand Valve Lifters Assembly



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NOTE:

Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

WARNING:

Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:

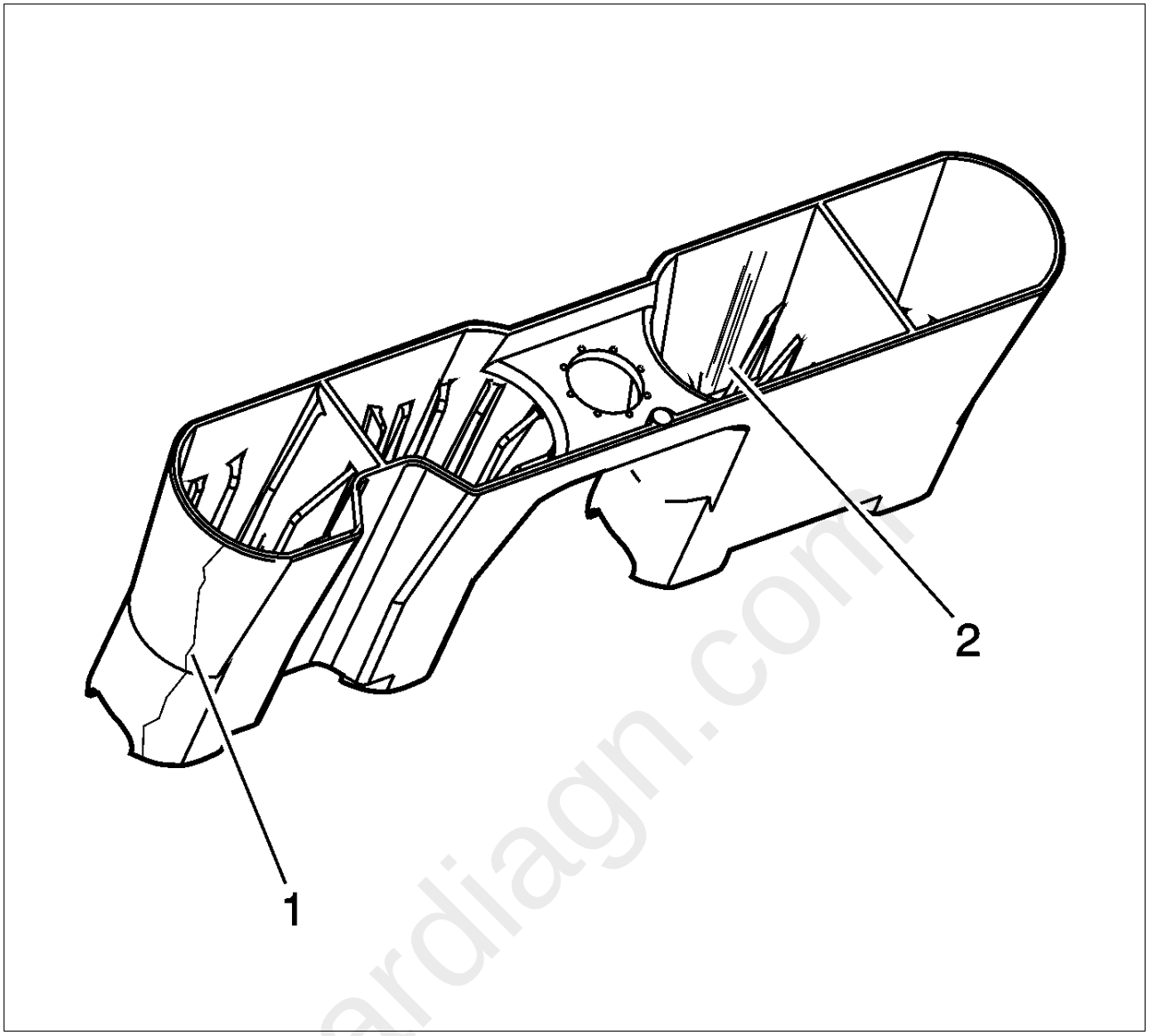
1. Broken or collapsed spring (1)
2. Worn pushrod socket (2)
3. Plugged lubrication hole (3)
4. Plugged lifter oil-switching hole (4)
5. Flat spots on the roller (5)
6. Worn or damaged roller bearing (6)

   The roller should rotate freely with no binding or roughness.
7. Scuffed or worn sides (7)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER AND GUIDE CLEANING AND INSPECTION > VALVE GUIDES

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Fig 1: Inspecting Valve Lifter Guides



Courtesy of GENERAL MOTORS COMPANY

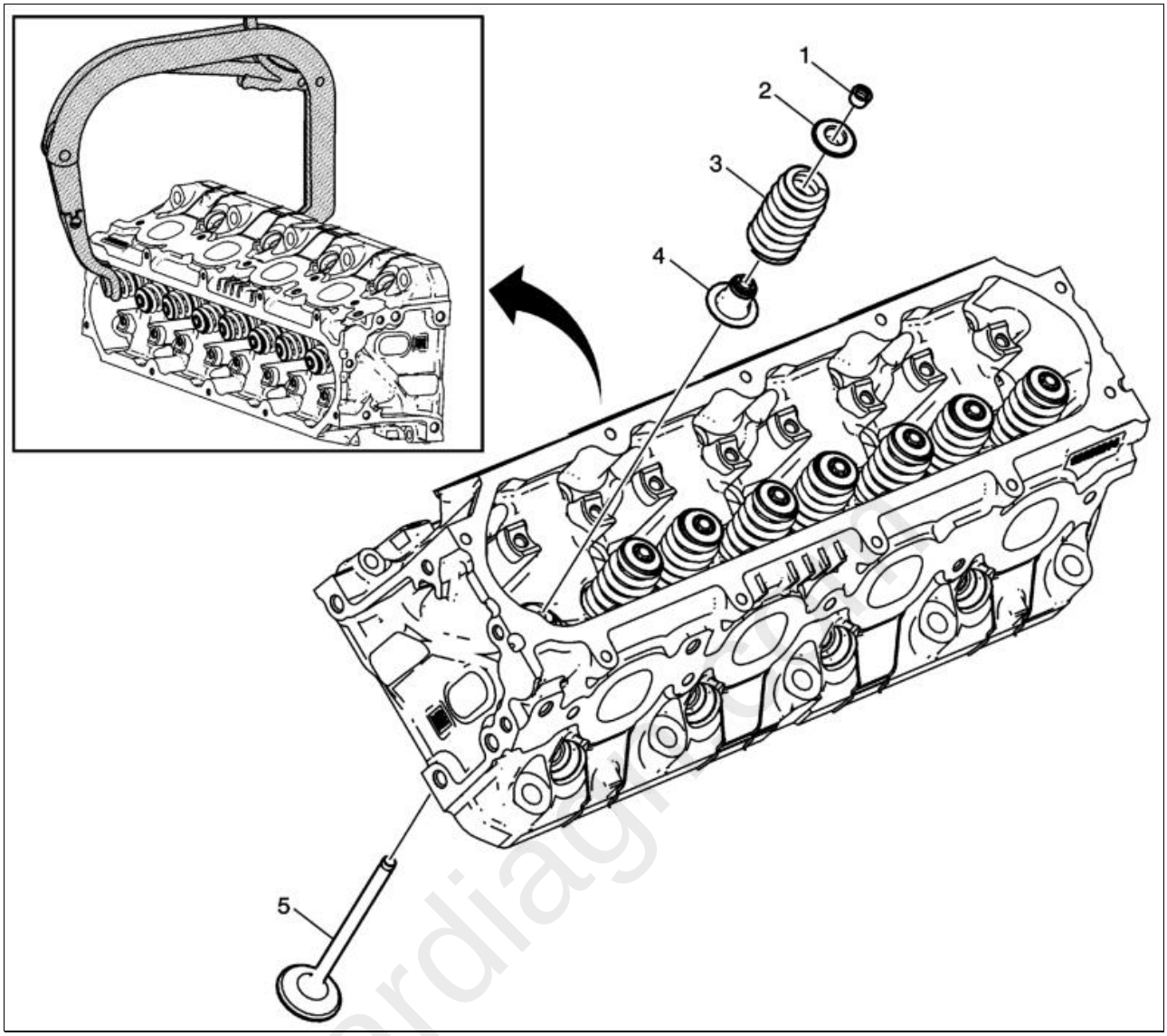
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Inspect the valve lifter guides for the following conditions:

- Cracks or damage (1)
- Excessive wear in the lifter mounting bores (2)

REPAIR INSTRUCTIONS - OFF VEHICLE > CYLINDER HEAD DISASSEMBLE

Fig 1: Cylinder Head Disassemble



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Valve Stem Key Procedure 1. Install the **J-8062** compressor (3) onto the head. 2. Remove the valve stem keys. **Special Tools** **J-8062** Valve Spring Compressor For equivalent regional tools, refer to Special Tools .
2	Valve Stem Spring Cap

3	Valve Spring
4	Valve Stem Oil Seal *NOTE:* *NEVER reuse a valve stem oil seal.*
5	Valve

REPAIR INSTRUCTIONS - OFF VEHICLE > CYLINDER HEAD CLEANING AND INSPECTION

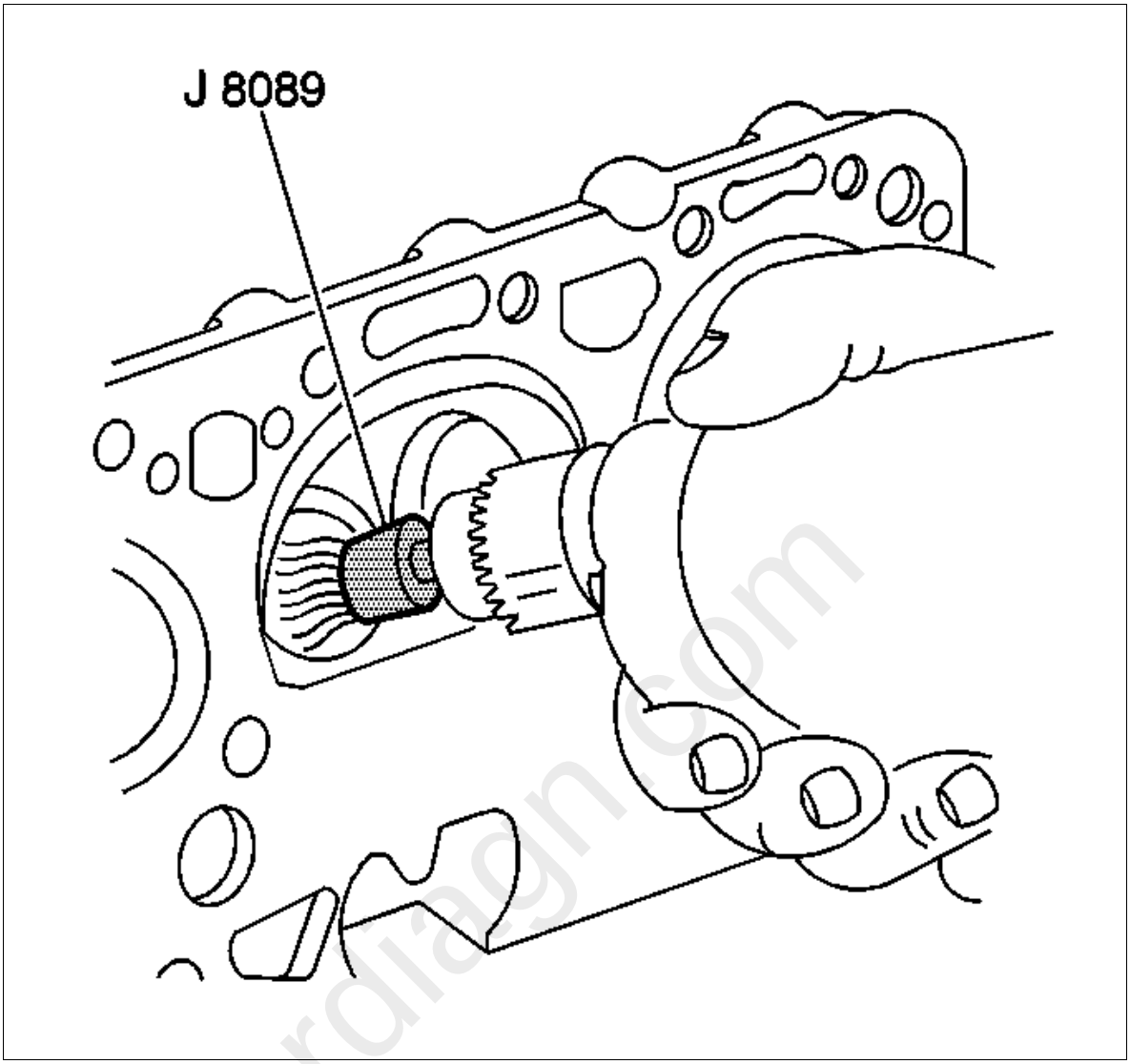
Special Tools

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

For equivalent regional tools, refer to Special Tools .

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Fig 1: Cleaning Carbon



Courtesy of GENERAL MOTORS COMPANY

WARNING:

Refer to Safety Glasses Warning .

NOTE:

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

1. Clean the following components:
    1. Use the **J 8089** brush in order to remove the carbon from the combustion chambers.

2. Gasket surfaces

   Refer to Replacing Engine Gaskets .

3. Valve stems and heads on a buffing wheel
4. Bolt hole threads

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

2. Inspect the cylinder head for the following conditions:
    1. Cracks in the exhaust ports and combustion chambers
    2. External cracks in the water chambers
    3. Gasket surfaces for excessive scratches or gouging

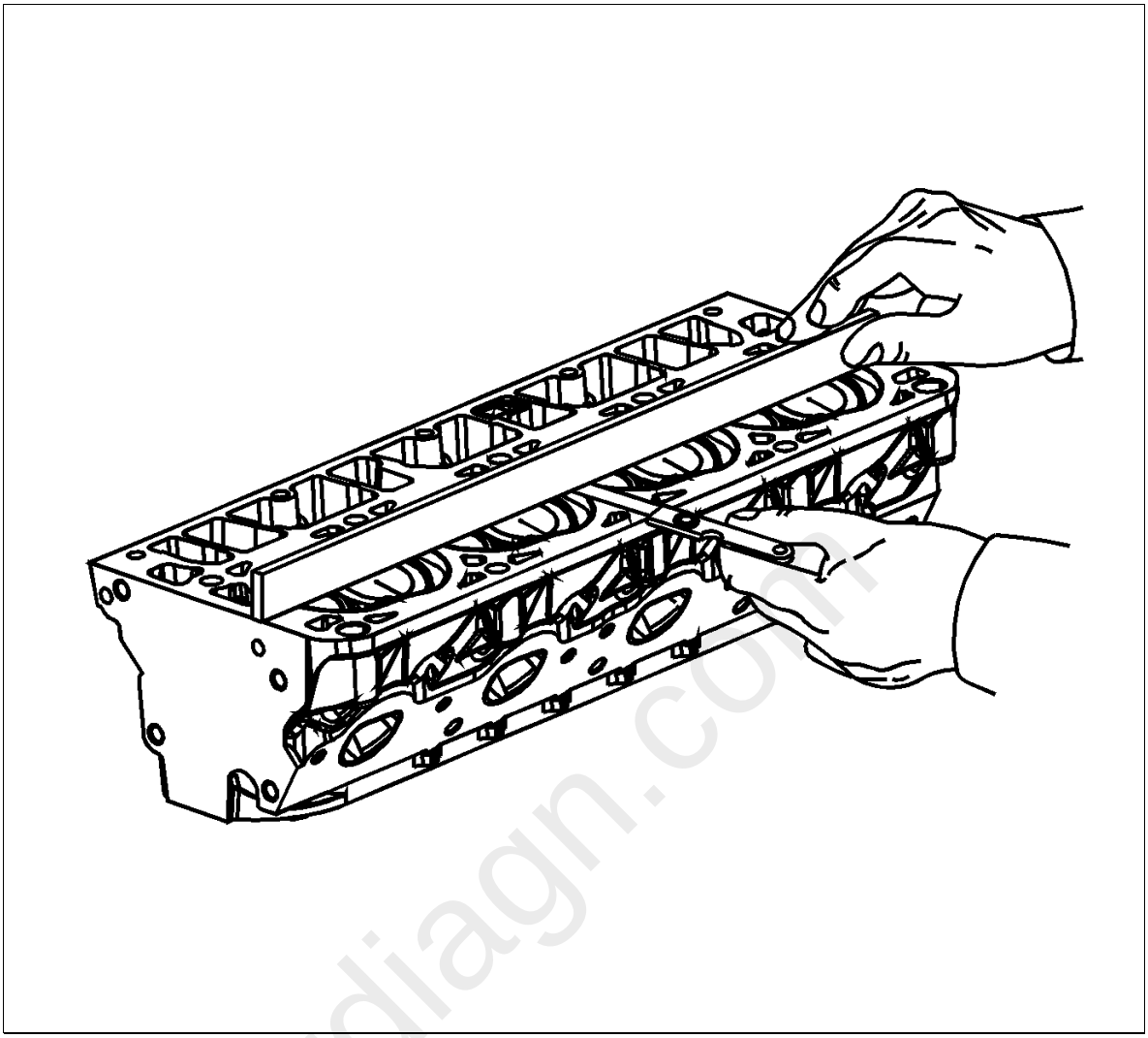
       Refer to Replacing Engine Gaskets .

    4. Bolt hole threads for debris or damaged threads

       Refer to Thread Repair , or Thread Repair Specifications .

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Fig 2: Inspecting Cylinder Head For Warpage

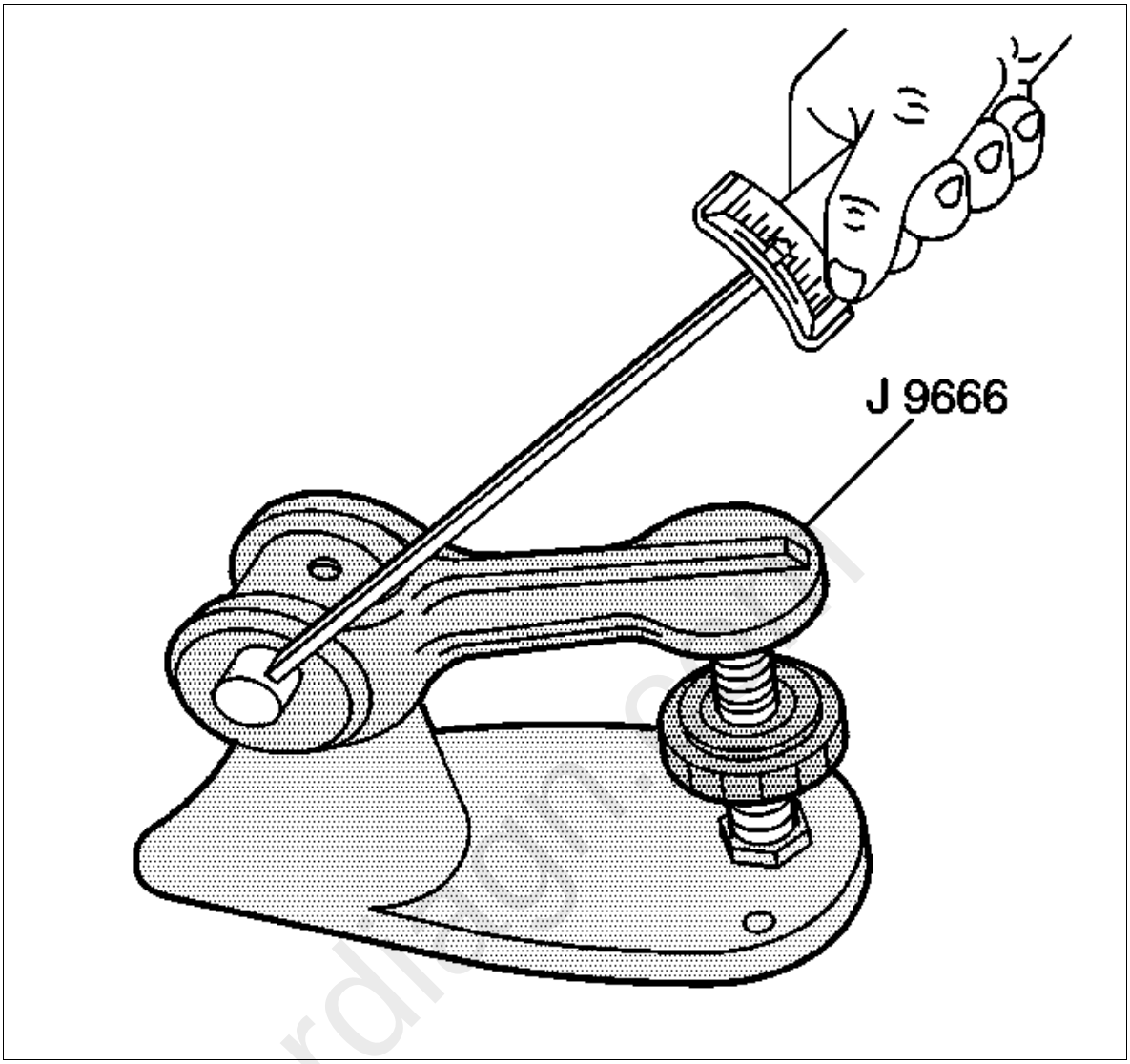


Courtesy of GENERAL MOTORS COMPANY

3. Inspect the cylinder head for warpage. Refer to Engine Mechanical Specifications (LT1) .

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Fig 3: Valve Spring Tension

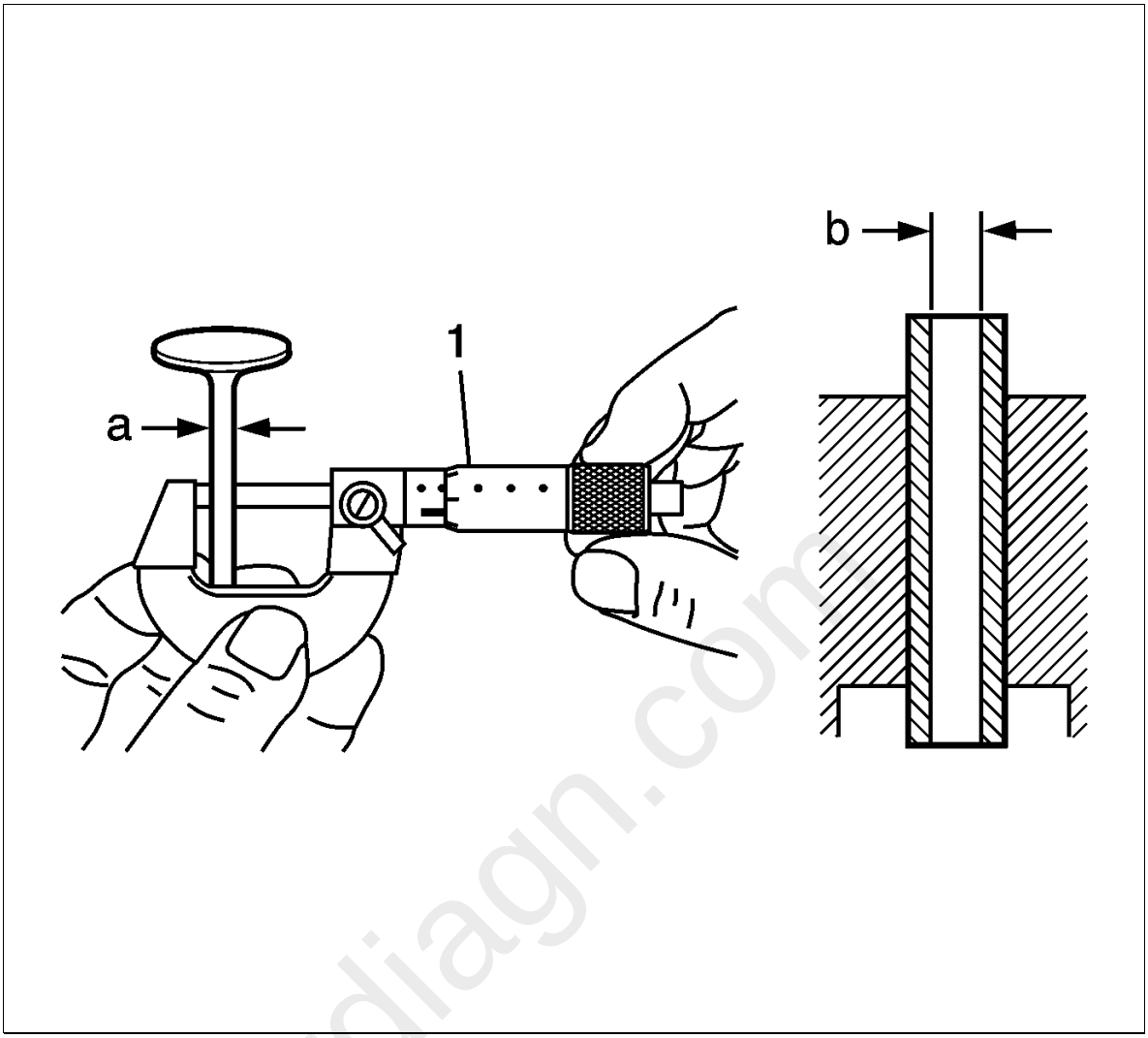


Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 9666** tester in order to measure the valve spring tension. Refer to Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE GUIDE REAMING, AND VALVE AND SEAT GRINDING > VALVE GUIDE REAMING

Fig 1: Valve Guide Reaming, and Valve and Seat Grinding



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⚠ *CAUTION:*

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

⚠ *CAUTION:*

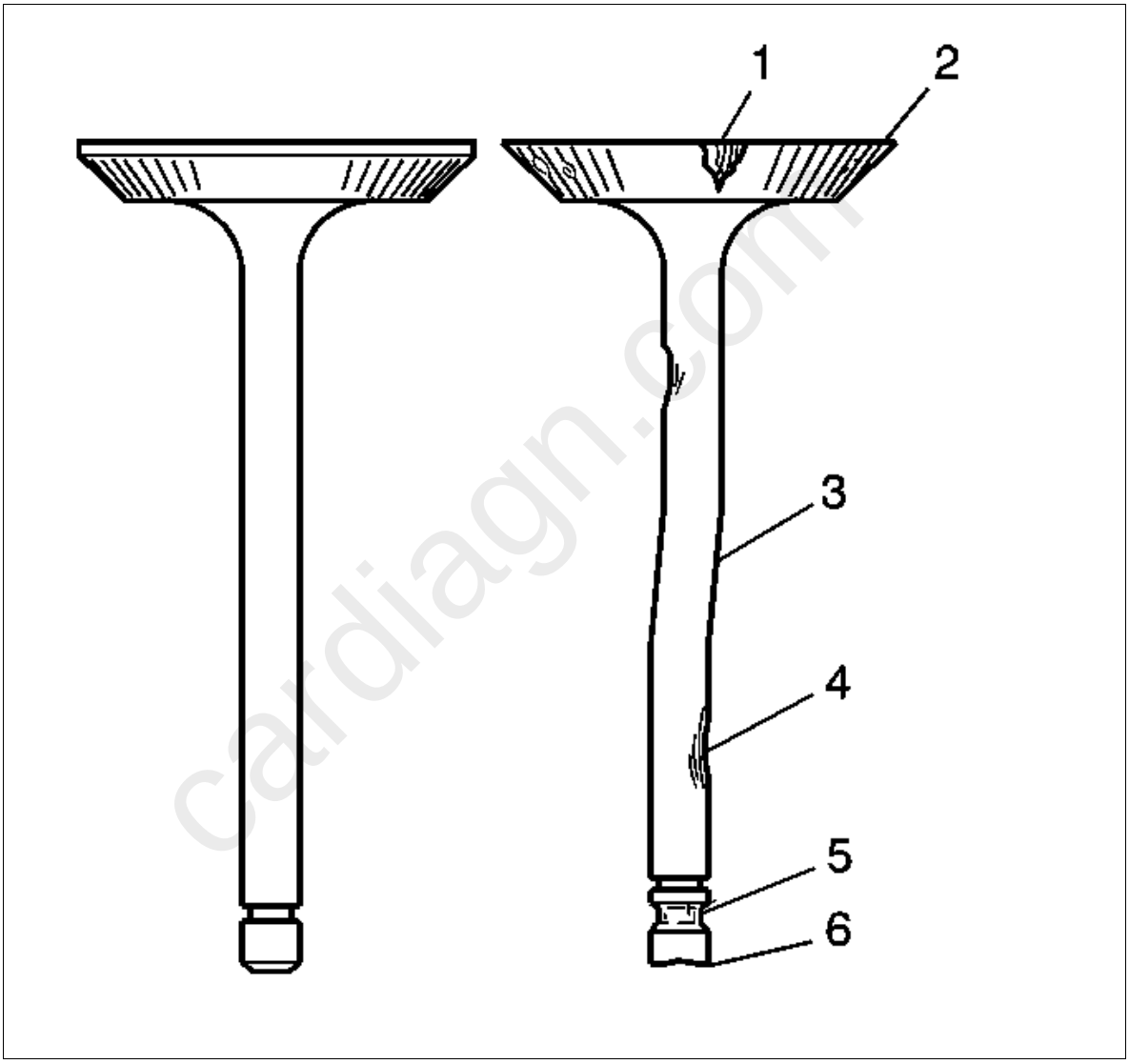
Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Measure the valve stem to guide clearance.

1. Using a micrometer (1) measure the diameter of the valve stem (a).
2. Using a ball style measuring gauge, measure the inner diameter (b) of the valve guide at the specified depth. Refer to Engine Mechanical Specifications (LT1) .
3. Subtract the valve stem diameter (a) from the valve guide inner diameter (b) to obtain the valve stem to guide clearance.

2. If the clearance measurement between the valve stem and guide is not within specification, the valve and/or the cylinder head must be replaced. Refer to Engine Mechanical Specifications (LT1) .

Fig 2: Inspection Points For Valves Damage



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Courtesy of GENERAL MOTORS COMPANY

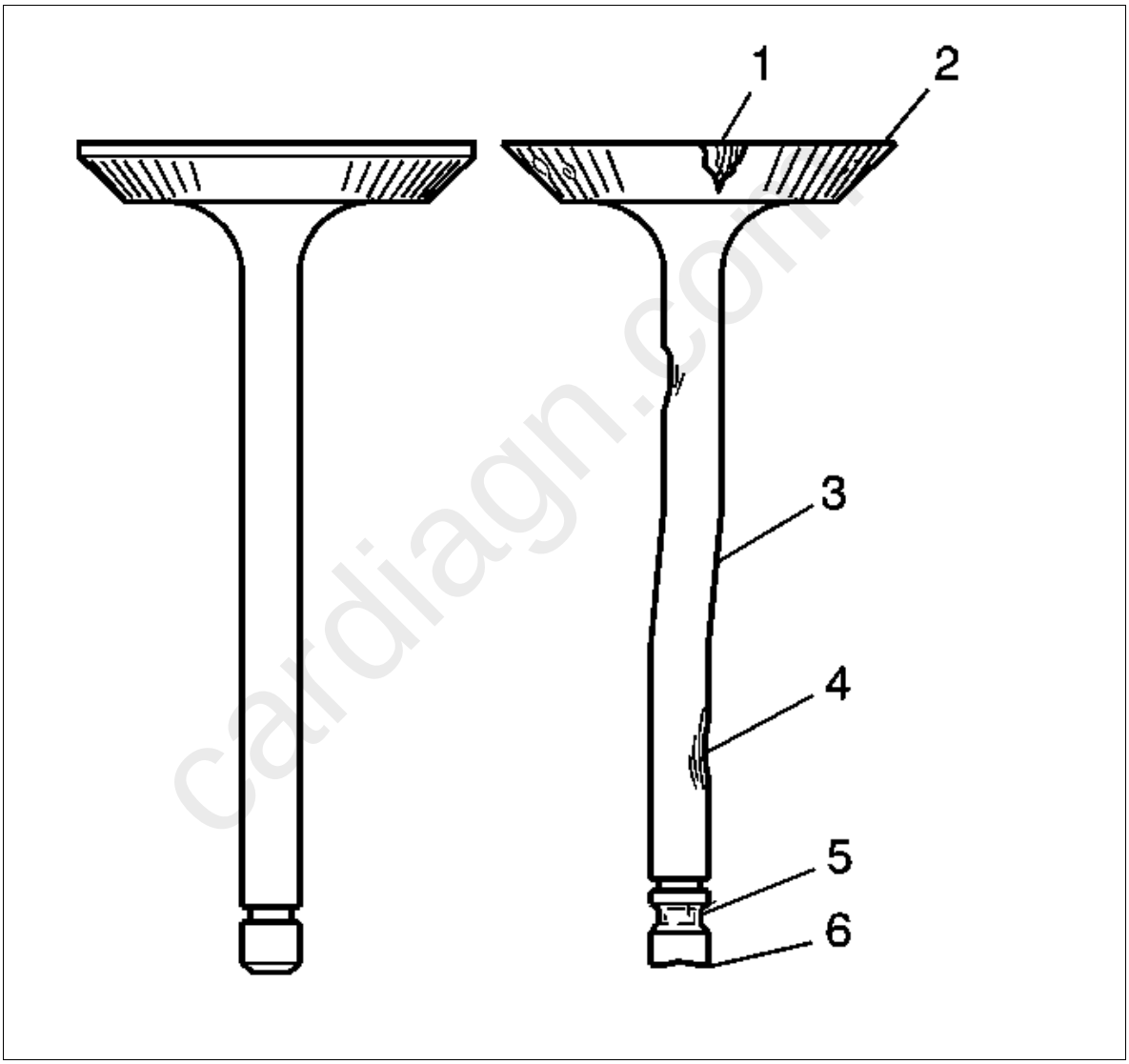
3. Inspect the valve stems for excessive scoring, wear, or warpage.
    1. A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
    2. If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.

4. Measure the valve stem diameter. If the valve stem diameter is not within specification, the valve must be replaced. Refer to Engine Mechanical Specifications (LT1) .

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

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE GUIDE REAMING, AND VALVE AND SEAT GRINDING > VALVE AND SEAT GRINDING

Fig 1: Inspection Points For Valves Damage



Courtesy of GENERAL MOTORS COMPANY

NOTE:

1. *Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.*

2. *Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.*

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

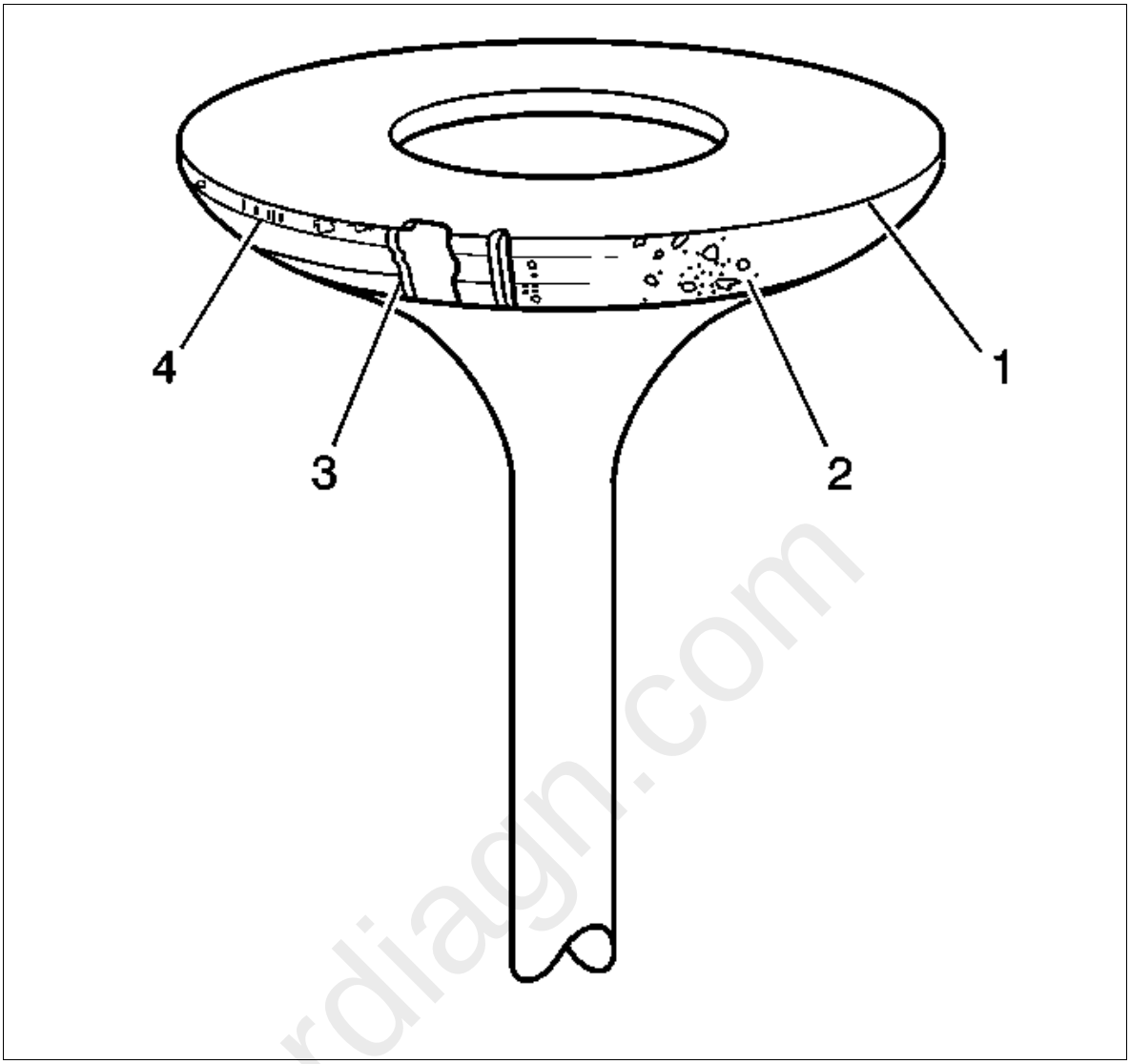
4. *Valves that are pitted or have stems that stems that show excessive wear, or valves that are warped excessively must be replaced.*

5. *DO NOT reface valves. Valves with excessive wear or damage MUST be replaced.*

1. Inspect the valve for the following conditions:
    1. Burnt or eroded areas (1)
    2. A worn margin (2)
    3. A bent stem (3)
    4. A worn or scored stem (4)
    5. A worn key groove (5)
    6. A worn stem tip (6)

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Fig 2: Inspecting Valve Face For Burning, Pitting & Cracking

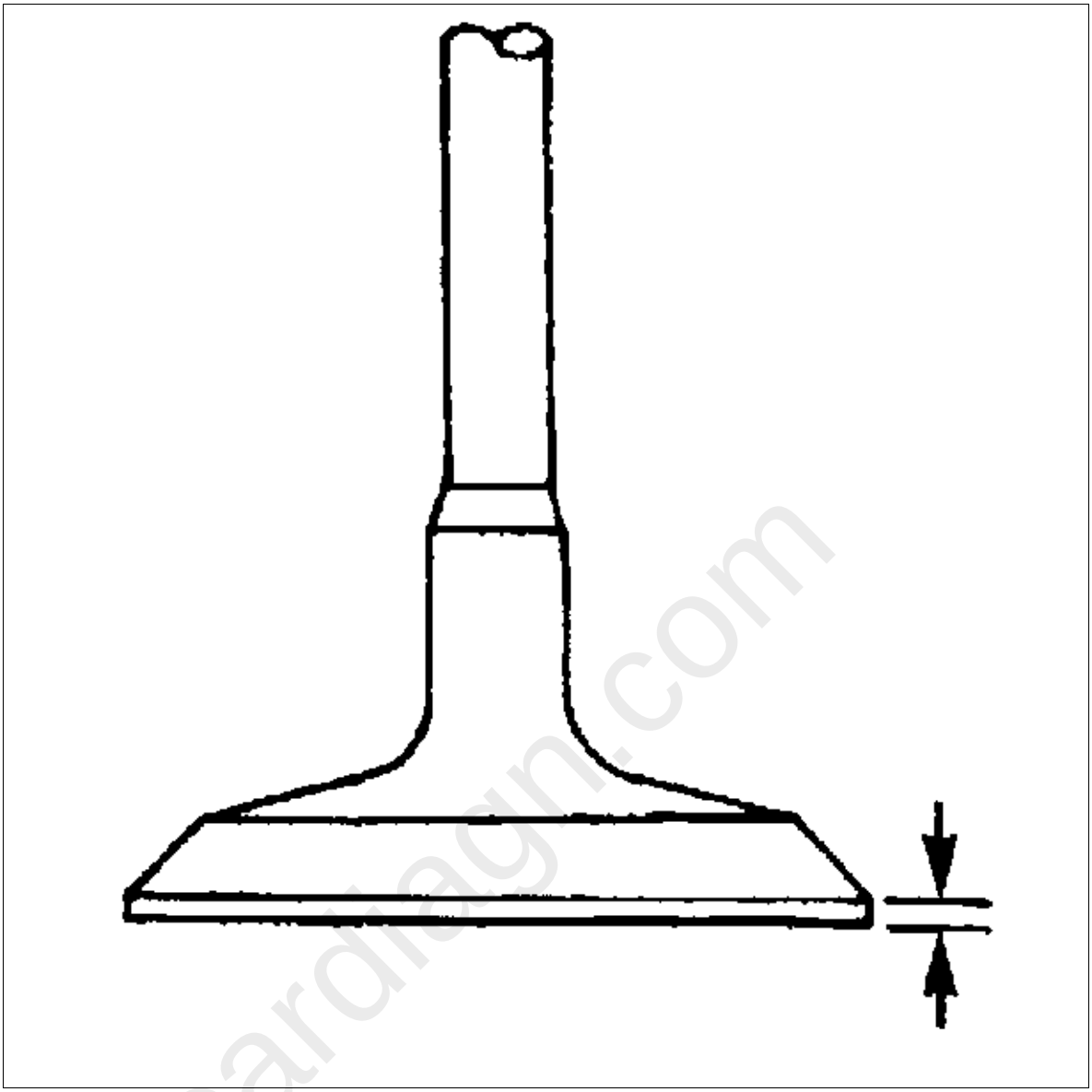


Courtesy of GENERAL MOTORS COMPANY

2. Inspect the valve face for the following conditions:
    1. Worn or no margin (1 or 4)
    2. Pitted surfaces (2)
    3. Burnt or eroded areas (3)

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Fig 3: Inspecting Valve Margin



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3. Inspect the valve margin.

   If the margin has worn away, it can lead to breakage, burning or pre-ignition due to heat localizing on this edge. If the vertical edge of the valve head, margin, is not visible and only a sharp edge remains, replace the valve.

4. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.

5. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

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

6. Grind the valve seat.

   The recommendations of the equipment manufacturer should be followed carefully to obtain the

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

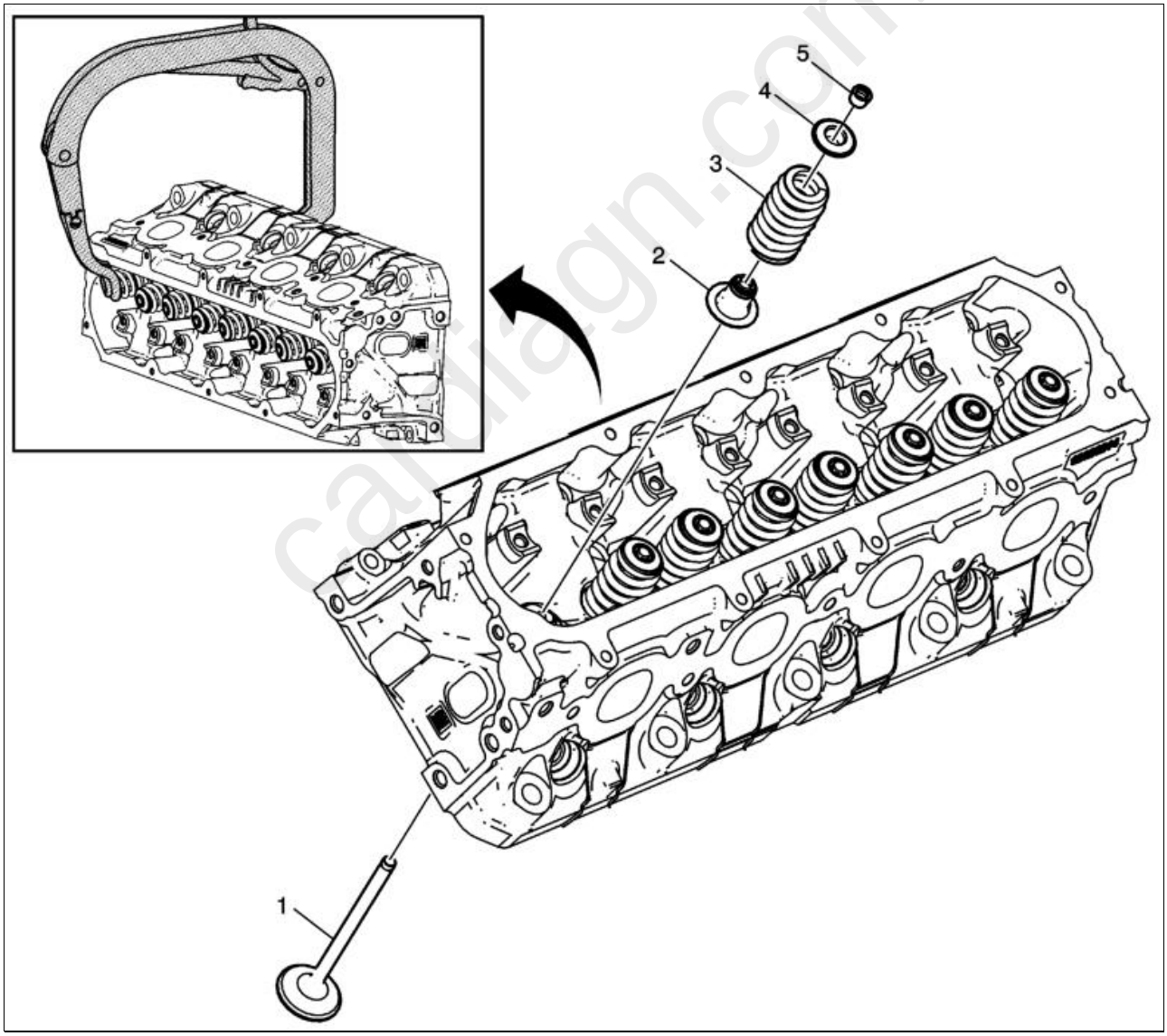
7. Inspect the valve seats.

    1. The valve seats should be concentric to the centerline of the guide, measure valve seat runout. The total indicator runout reading must be within specification. Refer to Engine Mechanical Specifications (LT1) .

    2. If the valve seat has been ground, measure the valve stem height after reassembly of the cylinder head. The cylinder head, and/or valve must be replaced if the valve stem height is not within specification after seat grinding. Refer Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > CYLINDER HEAD ASSEMBLE

Fig 1: Cylinder Head Assemble



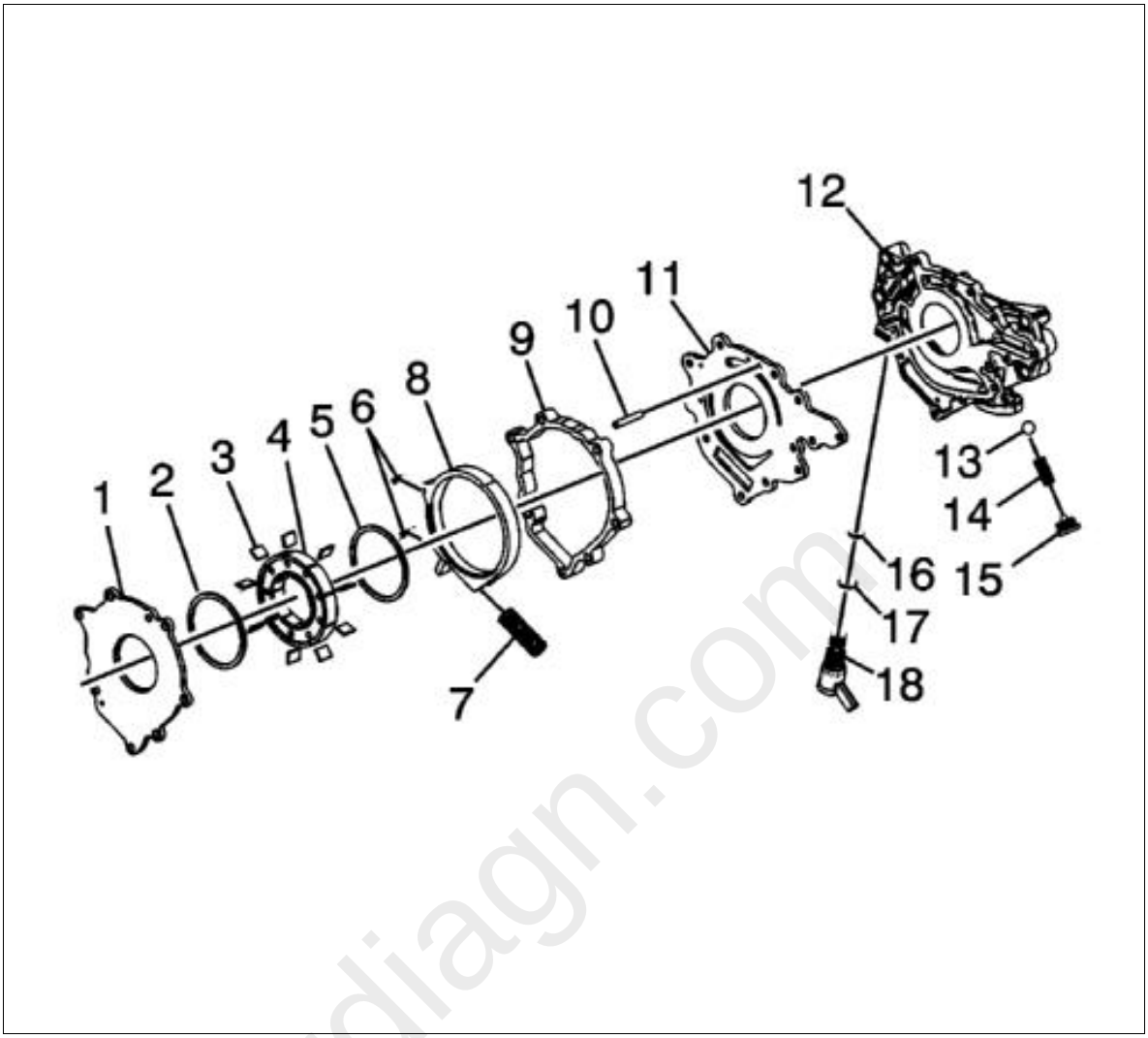
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Valve
2	Valve Stem Oil Seal *NOTE:* *NEVER reuse a valve stem oil seal.*
3	Valve Spring
4	Valve Stem Spring Cap
5	Valve Stem Key Procedure 1. Install the **J-8062** compressor (3) onto the head. 2. Install the valve stem keys. **Special Tools** **J-8062** Valve Spring Compressor For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PUMP CLEANING AND INSPECTION

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Fig 1: Oil Pump Components



Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

1. Clean the components in solvent.

WARNING:

Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.

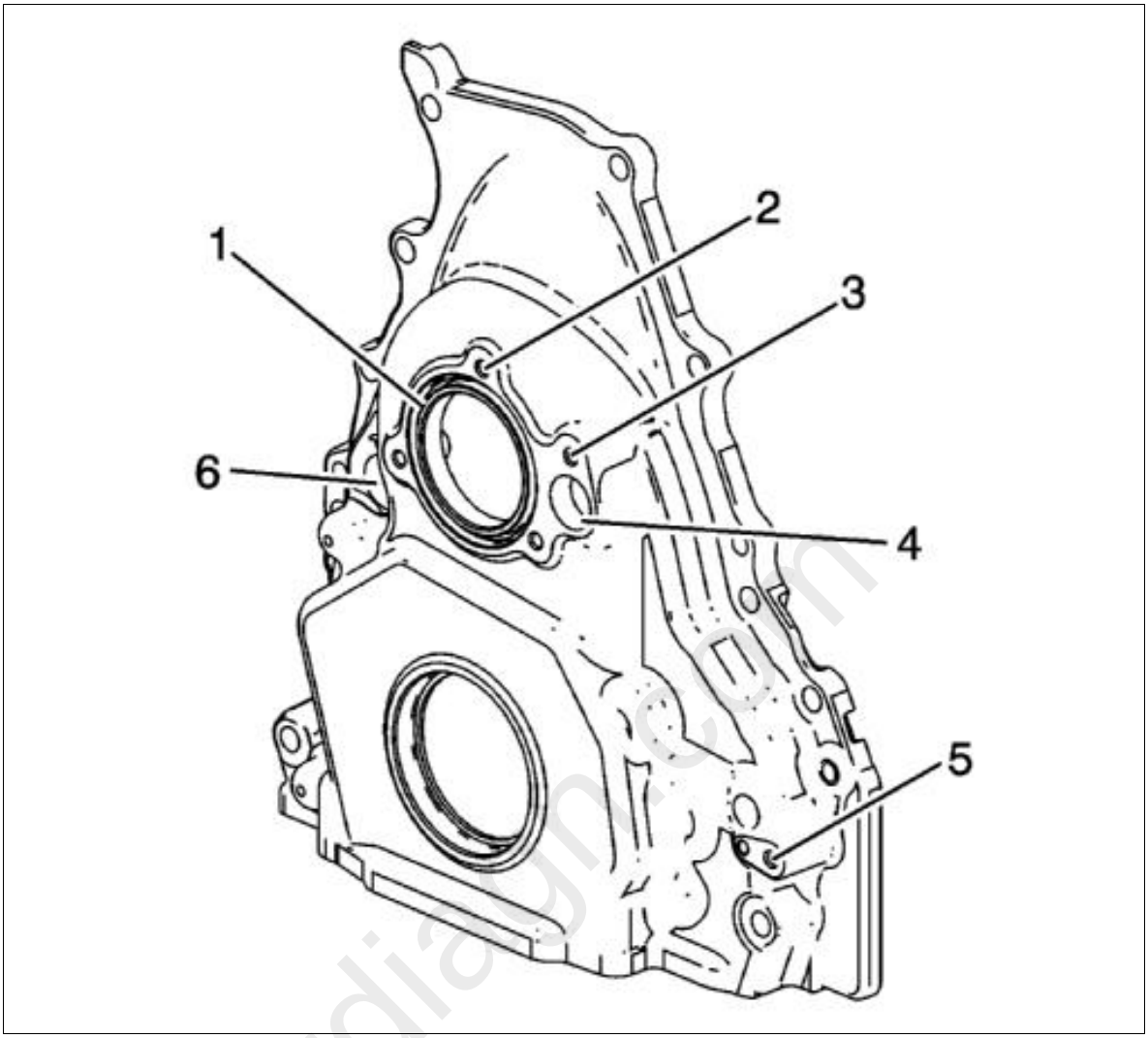
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3. Inspect the oil pump housing (12), intermediate cover (11), intermediate housing (9), and the housing cover (1) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-oil pan sealing surface for scratches or gouging.
5. Inspect the oil pump base-to-engine block oil gallery surfaces for scratches or gouging.
6. Inspect the oil pump base for damaged bolt hole threads.
7. Inspect the pump slide (8) for excessive wear, scoring, or gouges.
8. Inspect the oil pump internal oil passages for restrictions.
9. Inspect the oil pump rotor (4) and vanes (3) for cracks, wear, or damage.
10. Inspect the oil pump slide spring (7) for breakage.
11. Inspect the oil pump slide (8) and slide seals (6) for cuts or damage.
12. Inspect the Oil Pressure Relief Valve Plug (15) for leaks or damage.
13. Inspect the Oil Flow Control Solenoid O-rings (16, 17) cracks or damage.

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FRONT COVER CLEANING AND INSPECTION

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Fig 1: Engine Front Cover Components



Courtesy of GENERAL MOTORS COMPANY

NOTE:

1. *Do not use the crankshaft front oil seal again. Install a NEW crankshaft front oil seal during assembly.*
2. *Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.*
3. *Do not use the camshaft position (CMP) actuator magnet gasket again. Install a NEW gasket during assembly.*

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Replacing Engine Gaskets

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WARNING:

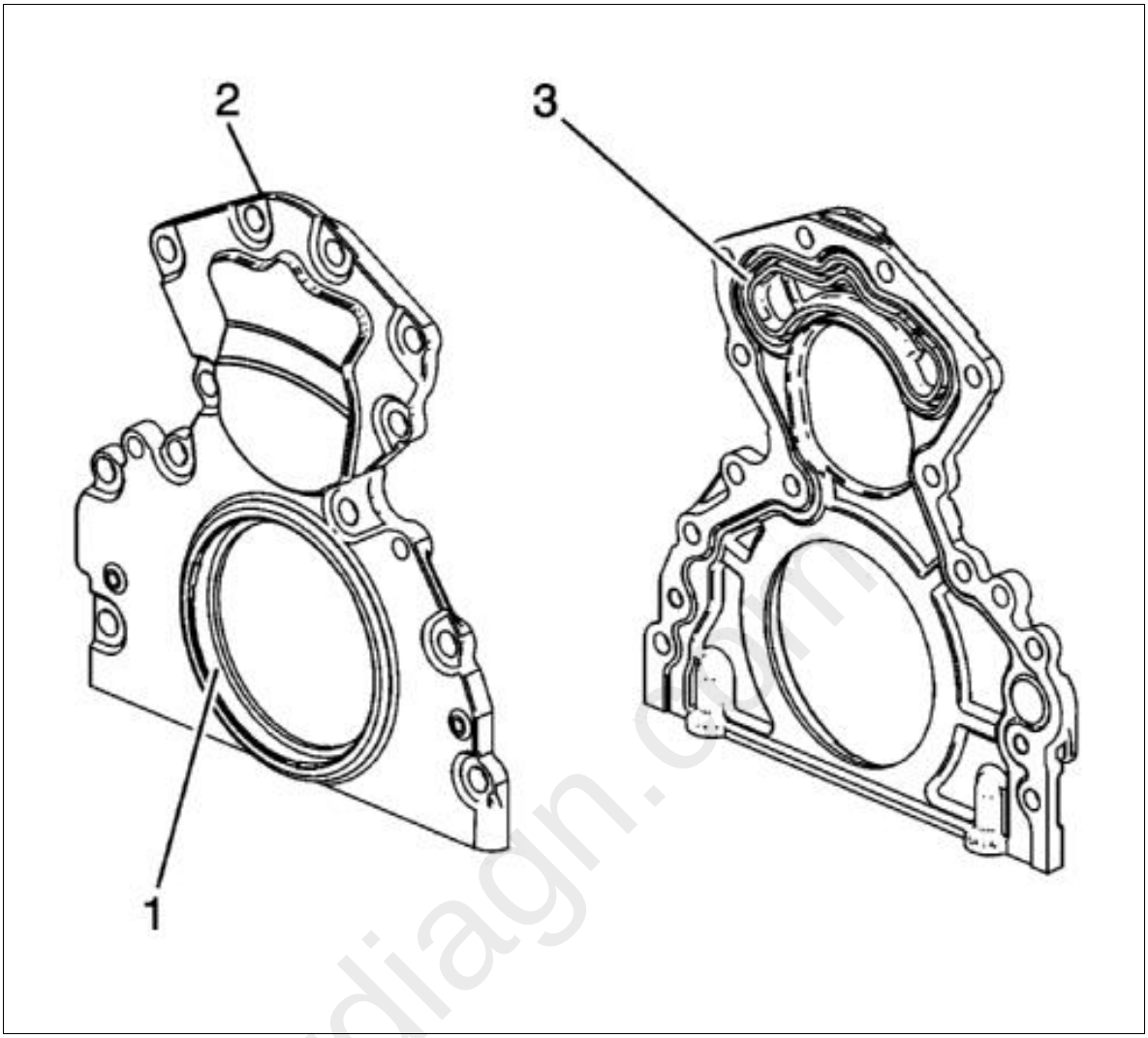
Refer to Safety Glasses and Compressed Air Warning .

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces (1) for excessive scratches or gouging.
5. Inspect the threaded bolt holes (2, 3, and 5) for damaged threads or debris.
6. Inspect the camshaft position sensor pass-thru hole and sealing surface (4) for excessive scratches or gouging.
7. Inspect the oil flow control valve connector pass-thru hole and sealing surface (6) for excessive scratches or gouging.

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT REAR OIL SEAL HOUSING CLEANING AND INSPECTION

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Fig 1: Crankshaft Rear Oil Seal Housing



Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant
2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Replacing Engine Gaskets

WARNING:

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Refer to Safety Glasses Warning .

3. Dry the housing with compressed air.
4. Inspect the gasket sealing surfaces (3) for excessive scratches or gouging.
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage (1).

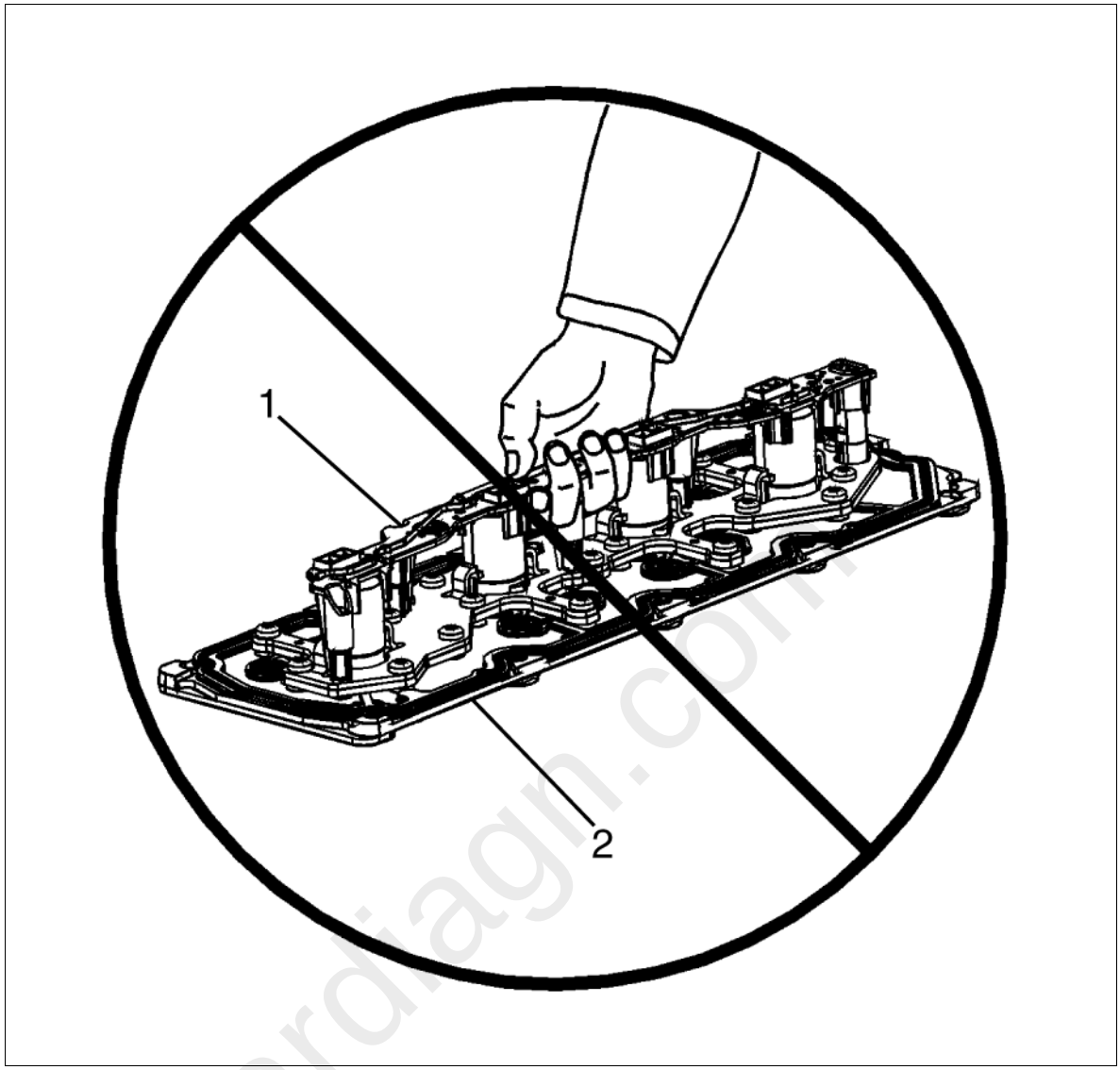
REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER OIL MANIFOLD CLEANING AND INSPECTION

NOTE:

- *DO NOT allow dirt or debris to enter the oil passages of the Valve Lifter Oil Manifold (VLOM). Plug, as required.*
- *DO NOT disassemble the electrical components from the VLOM.*
- *DO NOT submerge the electrical components in cleaning solvent.*
- *DO NOT use the VLOM outer gasket again. Remove the VLOM outer gasket and install a NEW VLOM outer gasket during assembly.*

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Fig 1: Improper Lifting Of VLOM

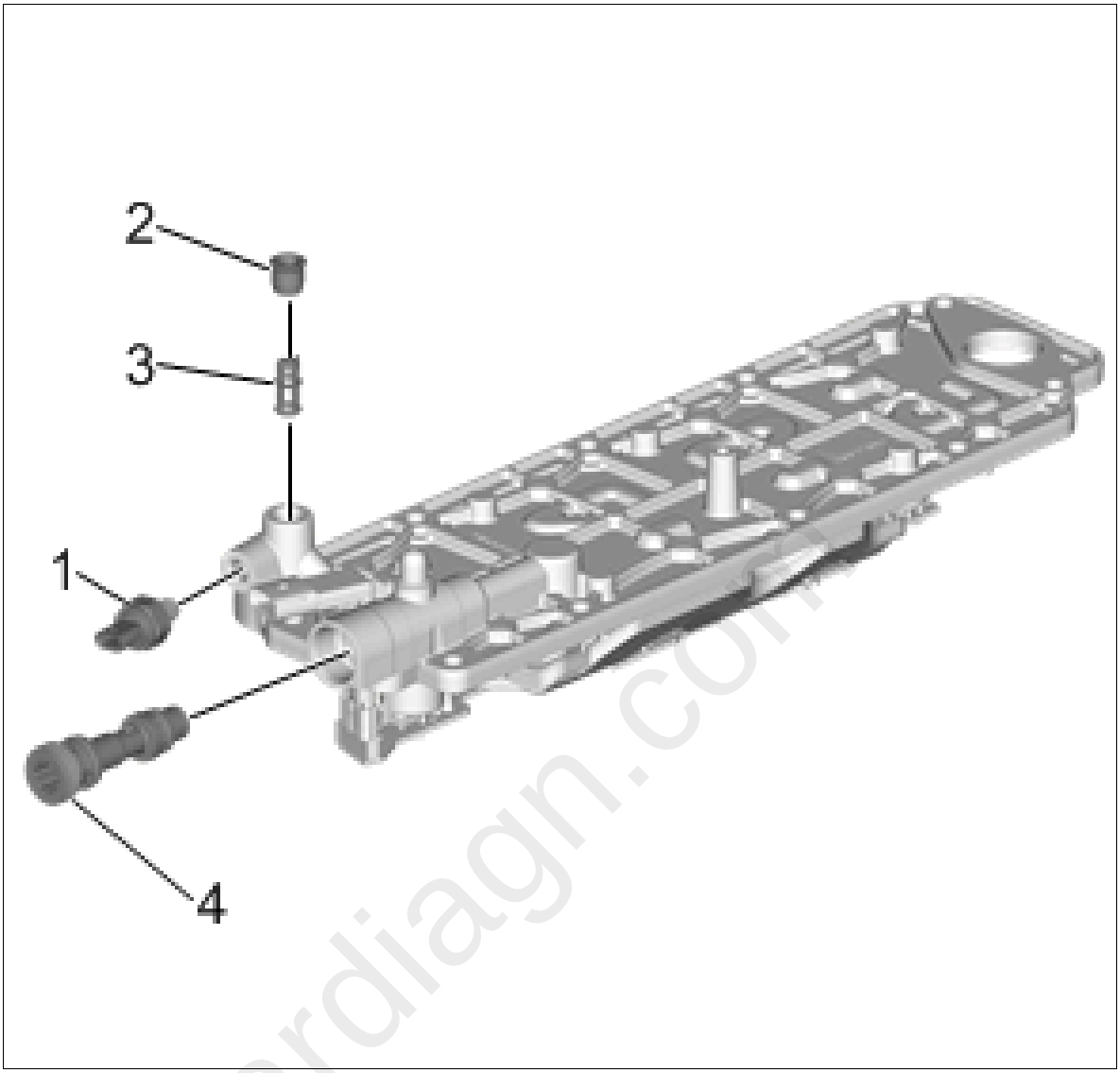


Courtesy of GENERAL MOTORS COMPANY

1. DO NOT lift the VLOM (2) by the electrical lead frame (1).

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Fig 2: Oil Pressure Sensor And VLOM (LT4)



Courtesy of GENERAL MOTORS COMPANY

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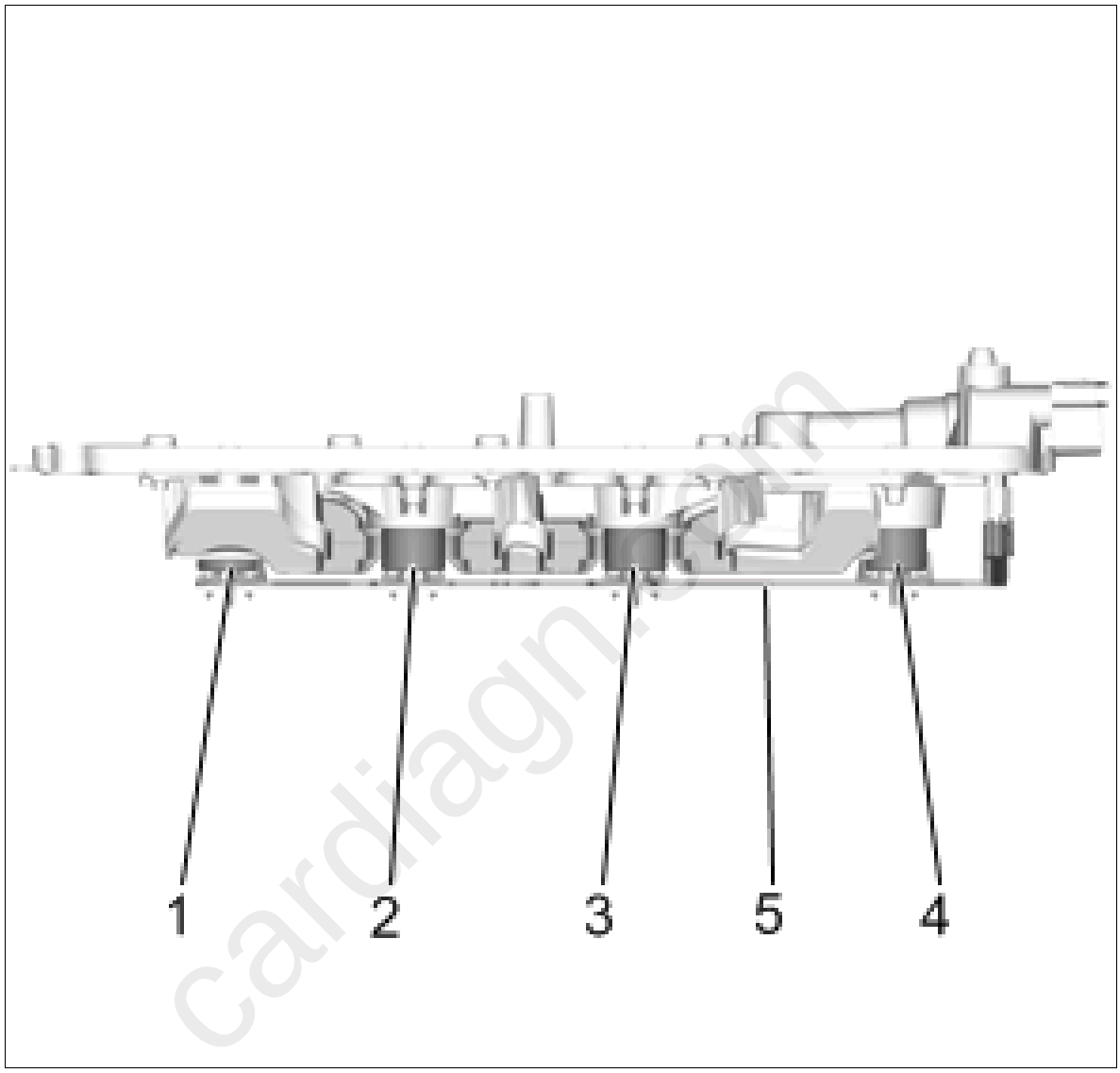
2. Remove the oil pressure sensor (1) from the VLOM.
3. Remove the VLOM plug (2).
4. Remove the VLOM filter (3).
5. Remove the PCV valve assembly (4).
6. Inspect the PCV valve seals for cuts, tears or damage.
7. Inspect the oil pressure sensor and oil pressure sensor boss threads for damage.
8. Inspect the VLOM plug and VLOM plug boss threads for damage.
9. Inspect the VLOM filter for cuts, tears, damage or foreign material.

WARNING:

Refer to Safety Glasses and Compressed Air Warning .

10. Clean the VLOM with compressed air.

Fig 3: Electrical Lead Frame And Electrical Solenoids

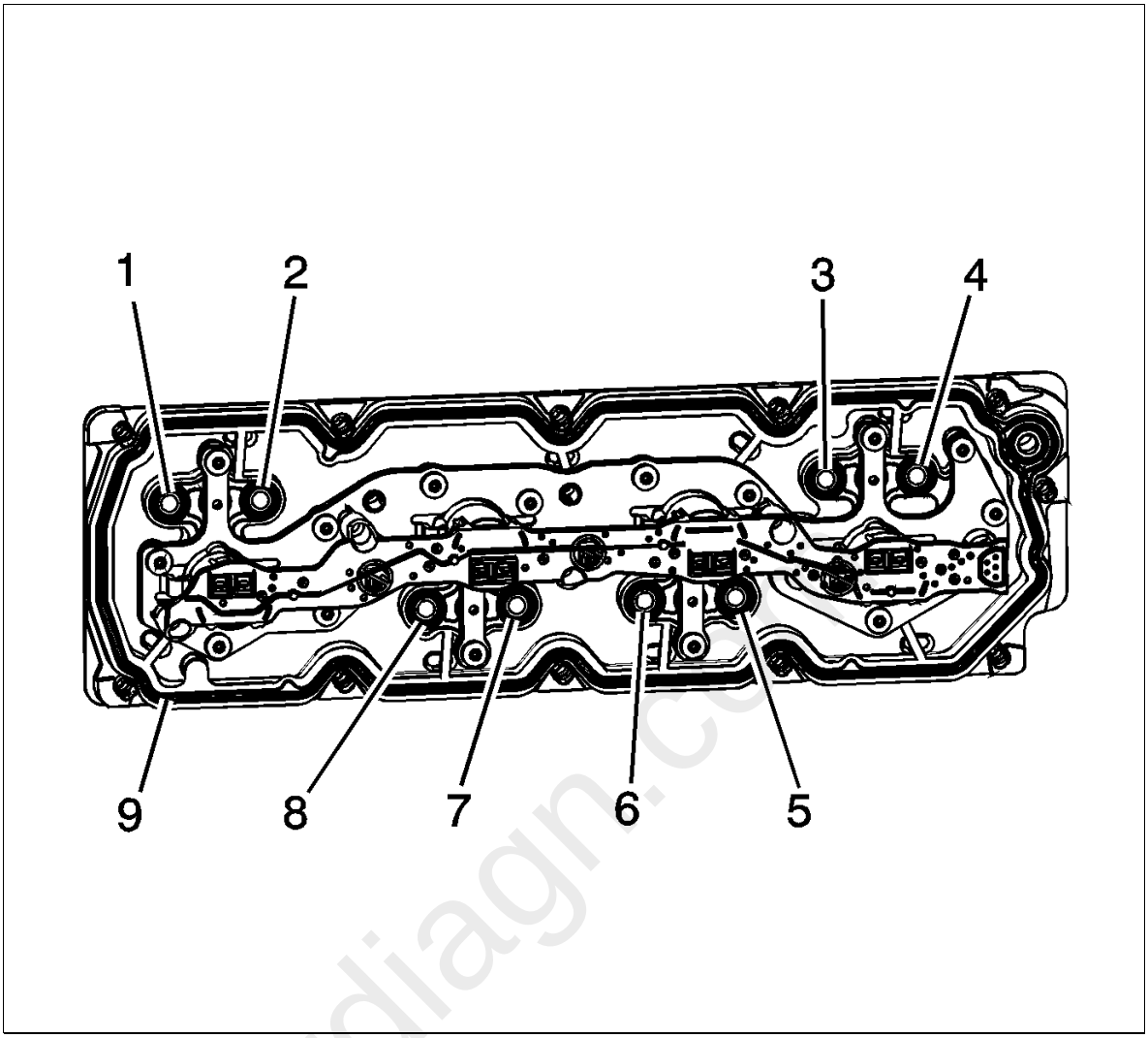


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11. Inspect for loose electrical solenoids (1-4) or loose or missing bolts.
12. Inspect for damage to the electrical lead frame (5).
13. Inspect for a damaged electrical connector, for bent or corroded pins.

Fig 4: Sealing Gaskets

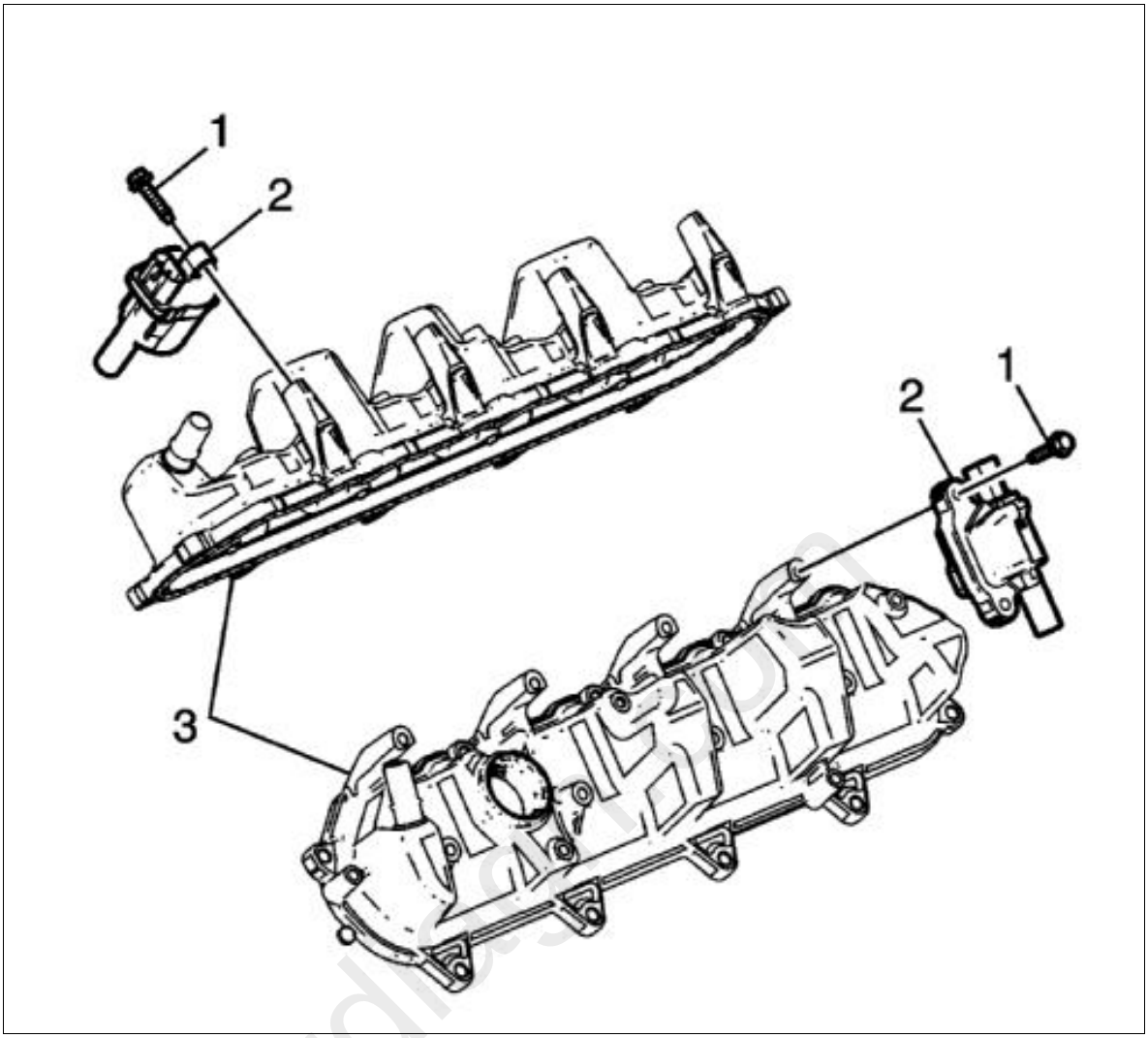


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14. Inspect for damaged VLOM inner gaskets (1-8). If the VLOM inner gaskets are damaged, the VLOM must be replaced as an assembly.
15. Inspect for a damaged VLOM outer gasket (9) or scored gasket surfaces.
16. Inspect for debris or restrictions within the oil passages of the VLOM. Refer to Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing .

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER CLEANING AND INSPECTION

Fig 1: Valve Rocker Arm Cover Components



Courtesy of GENERAL MOTORS COMPANY

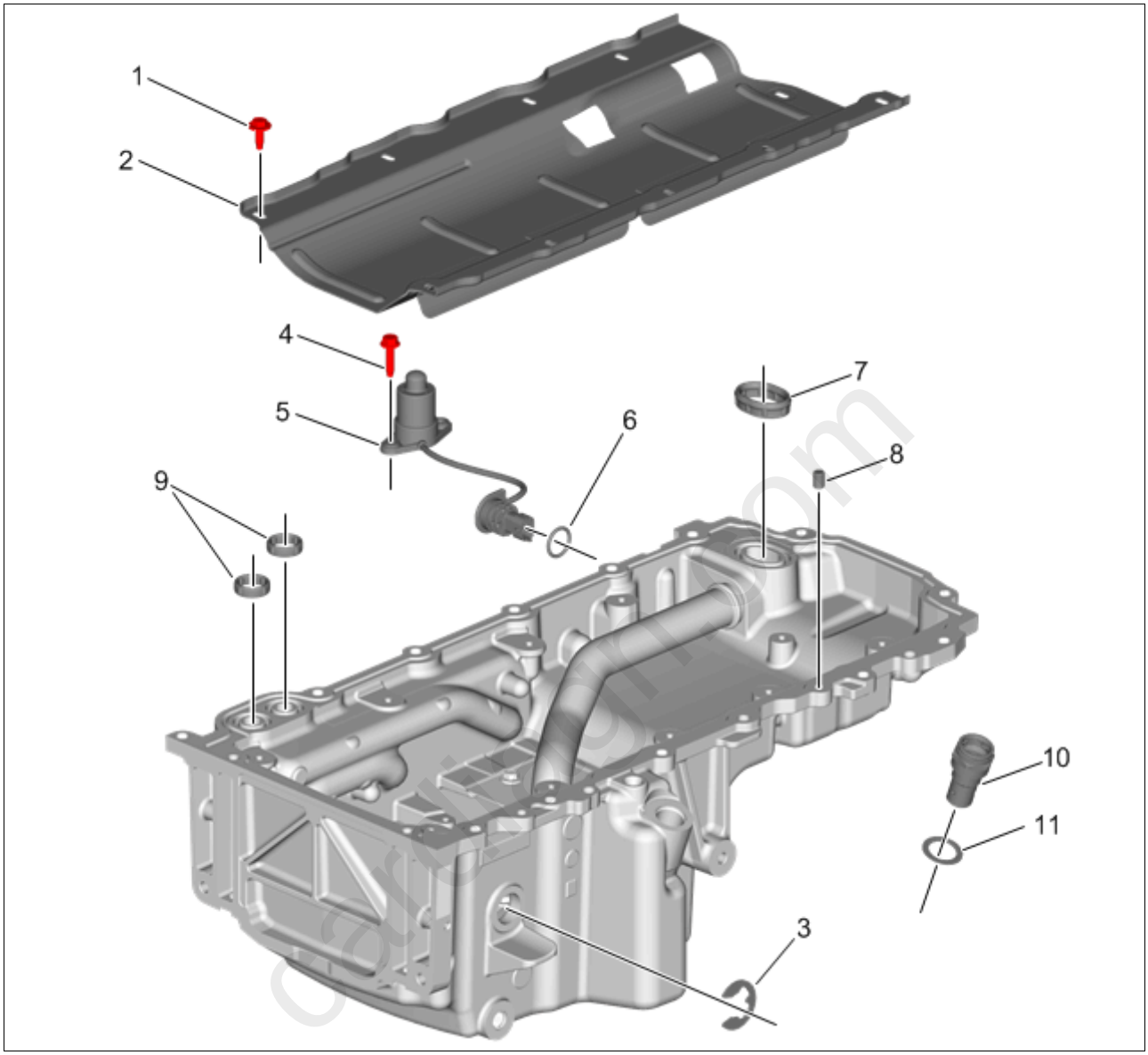
IMPORTANT:

1. *Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.*
2. *Remove the ignition bolts (1) and coils (2) before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.*

1. Inspect the covers (3) for the following conditions:
    1. Scoring or damage to the gasket surfaces
    2. Ventilation system passages for restrictions
    3. Threaded bolt holes for damage or debris

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PAN DISASSEMBLE > CRANKSHAFT OIL DEFLECTOR, HIGH PRESSURE PORT SEAL, AND FRONT SEAL REMOVAL

Fig 1: Crankshaft Oil Deflector, High Pressure Port Seal, and Front Seal



Courtesy of GENERAL MOTORS COMPANY

Crankshaft Oil Deflector, High Pressure Port Seal, and Front Seal Removal

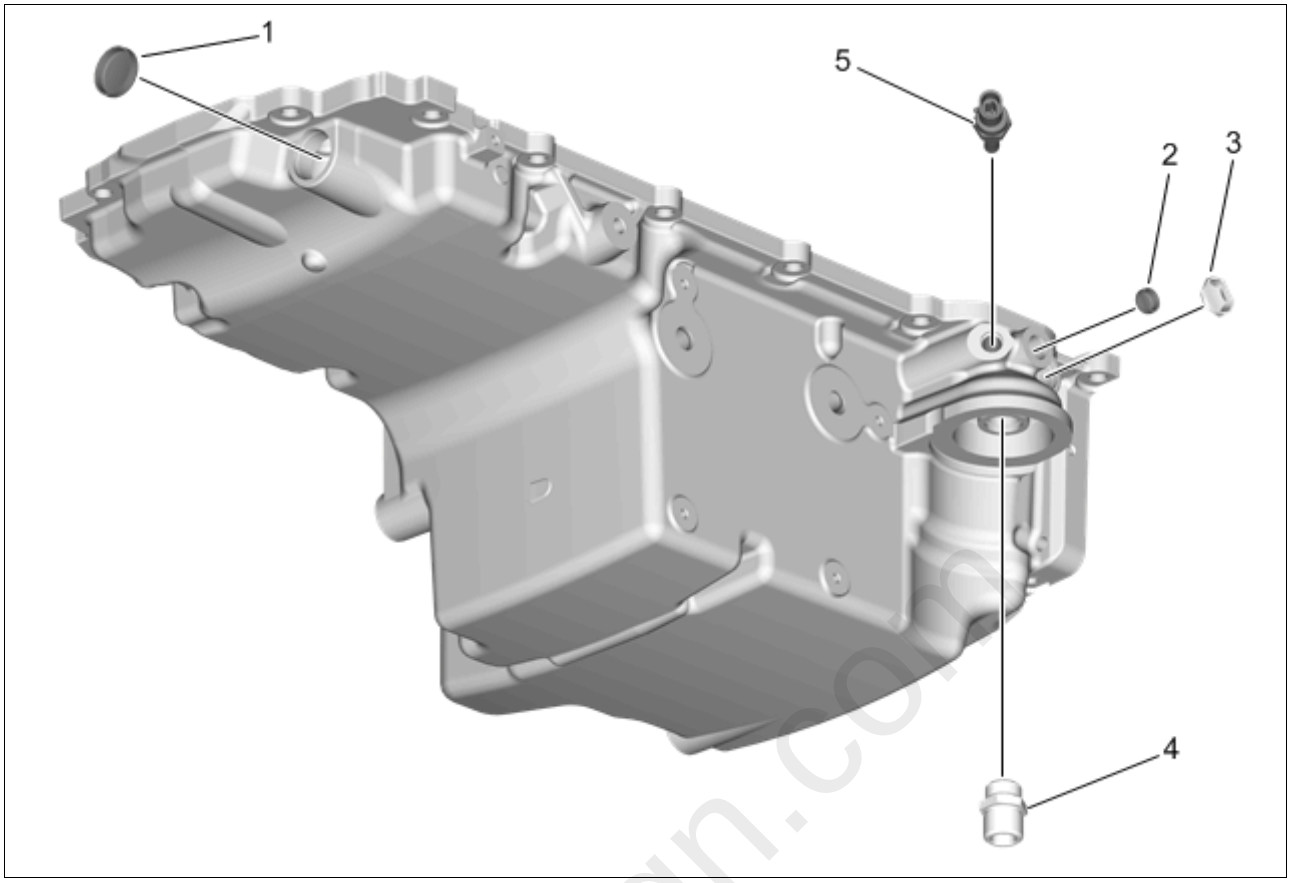
Callout	Component Name
1	Crankshaft Oil Deflector Bolt
2	Crankshaft Oil Deflector
3	Engine Oil Level Sensor Lead Clip
4	Engine Oil Level Indicator Switch Bolt

5	Engine Oil Level Indicator Switch
6	Engine Oil Level Indicator Switch O-Ring Seal *NOTE:* *Discard seal it is not reusable.*
7	Oil Pan Front Seal *NOTE:* *Discard seal it is not reusable.*
8	Oil Pan Locating Pin
9	Oil Pan High Pressure Port Seal *NOTE:* *Discard seal it is not reusable.*
10	Oil Flow Check Valve *NOTE:* *DISCARD the valve.*
11	Turbocharger Coolant Feed and Return Pipe Gasket

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REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PAN DISASSEMBLE > OIL FILTER FITTING AND CUP PLUG REMOVAL

Fig 1: Oil Filter Fitting and Cup Plug



Courtesy of GENERAL MOTORS COMPANY

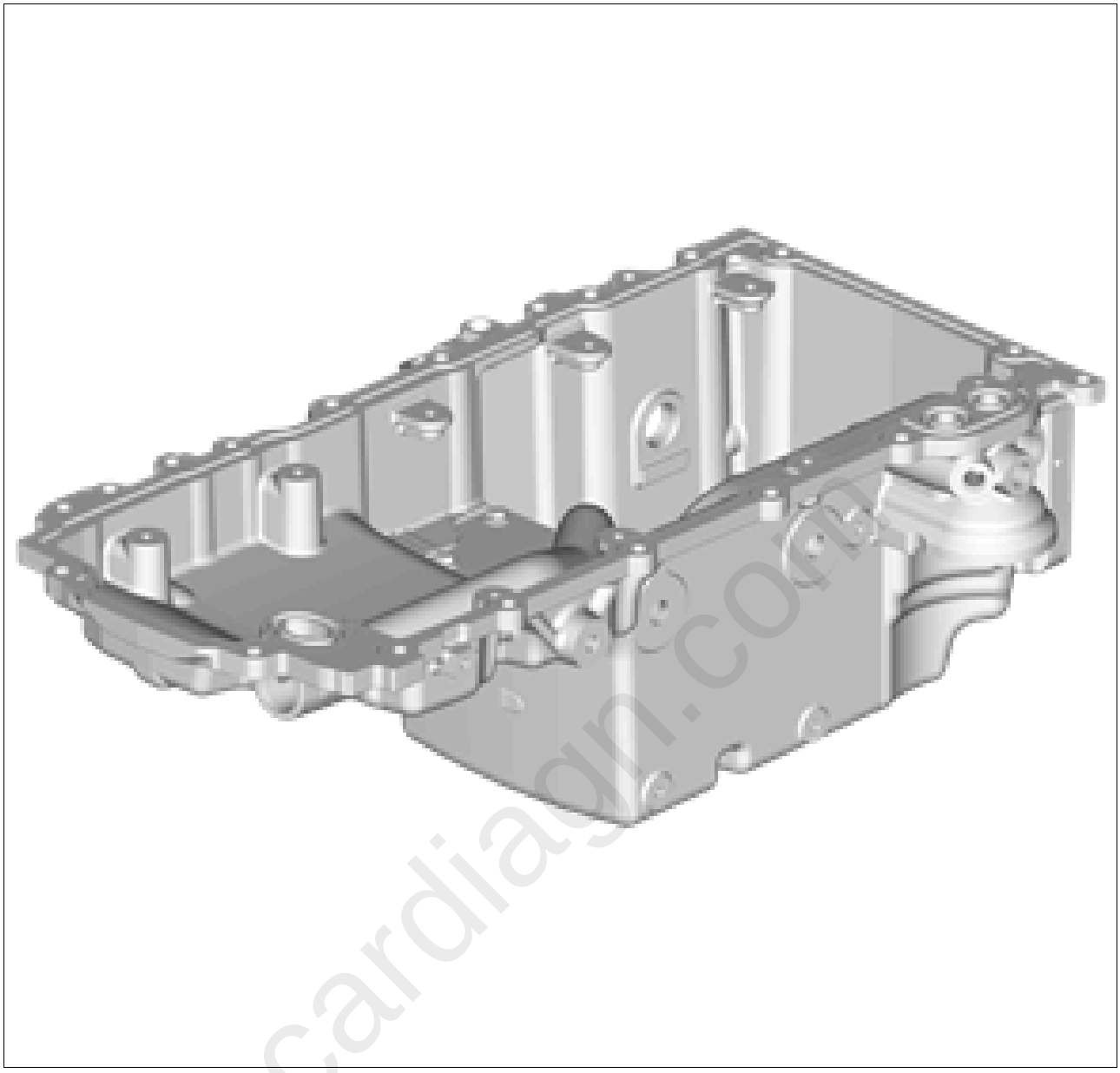
Oil Filter Fitting and Cup Plug Removal

Callout	Component Name
1	Oil Pan Cup Plug
2	Oil Pan Cup Plug
3	Oil Pan Cup Plug
4	Oil Filter Fitting
5	Engine Coolant Temperature Sensor

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PAN CLEANING AND INSPECTION

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Fig 1: Oil Pan



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Courtesy of GENERAL MOTORS COMPANY

NOTE:

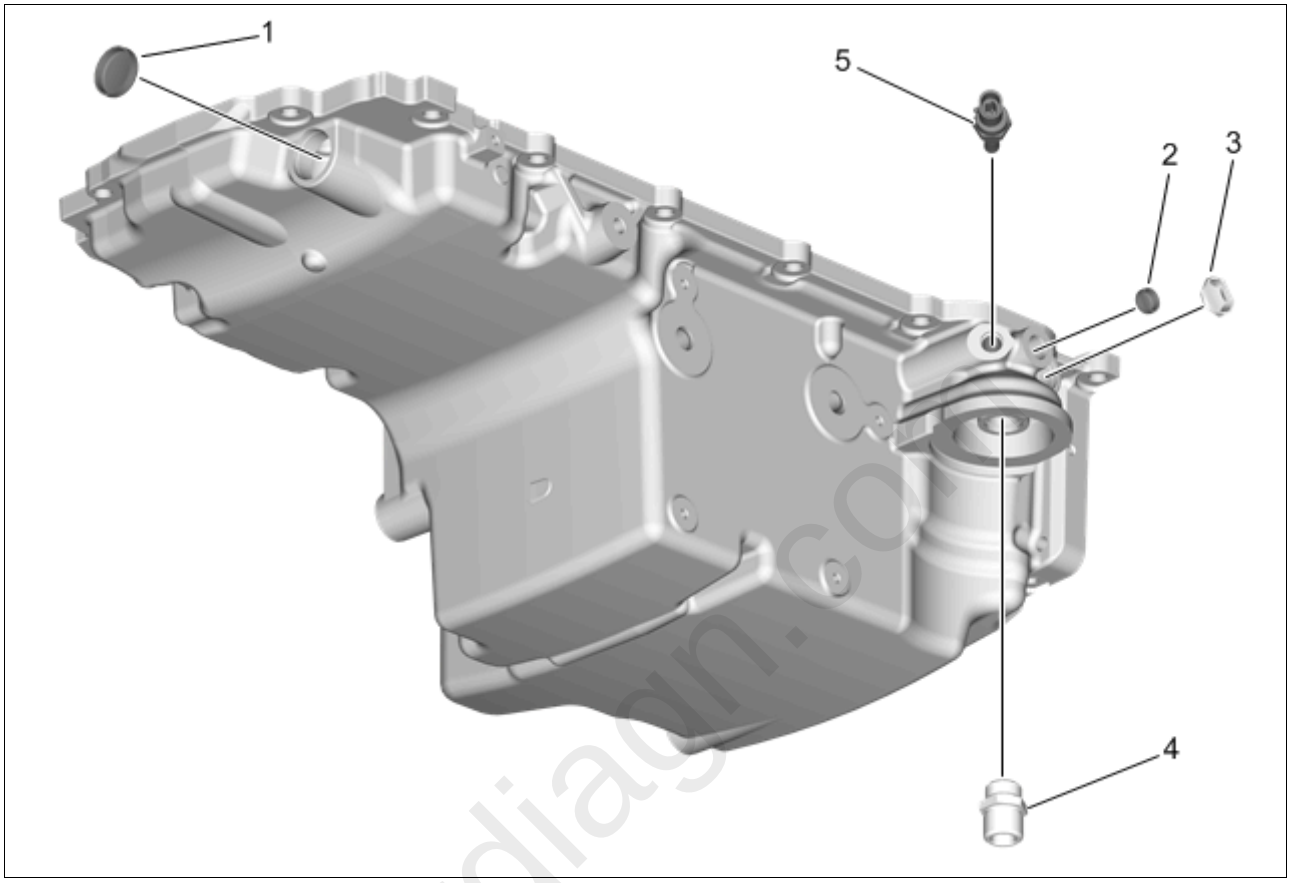
Do not remove the pickup tube.

Inspect the oil pan for the following conditions:

- Damaged gasket surfaces
- Restrictions within the oil passages of the pan
- Damaged oil filter seal surface

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PAN ASSEMBLE > OIL FILTER FITTING AND CUP PLUG INSTALLATION

Fig 1: Oil Filter Fitting and Cup Plug



Courtesy of GENERAL MOTORS COMPANY

Oil Filter Fitting and Cup Plug Installation

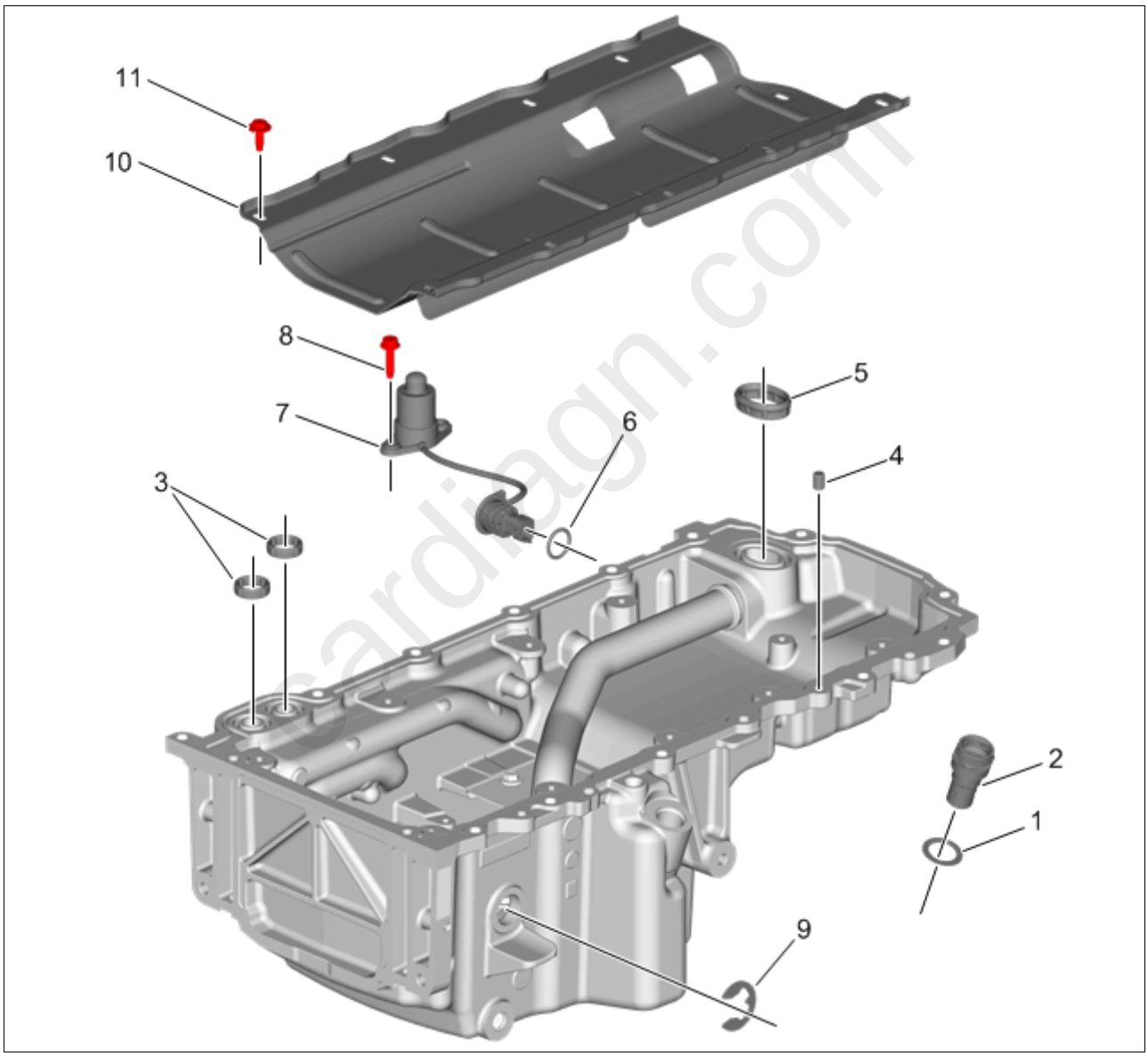
Callout	Component Name
1	Oil Pan Cup Plug
2	Oil Pan Cup Plug
3	Oil Pan Cup Plug
4	Oil Filter Fitting *CAUTION:* *Refer to Fastener Caution .*

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	Tighten 55 N.m (40 lb ft)
5	Engine Coolant Temperature Sensor **Tighten** 22 N.m (16 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PAN ASSEMBLE > CRANKSHAFT OIL DEFLECTOR, HIGH PRESSURE PORT SEAL, AND FRONT SEAL INSTALLATION

Fig 1: Crankshaft Oil Deflector, High Pressure Port Seal, and Front Seal



Courtesy of GENERAL MOTORS COMPANY

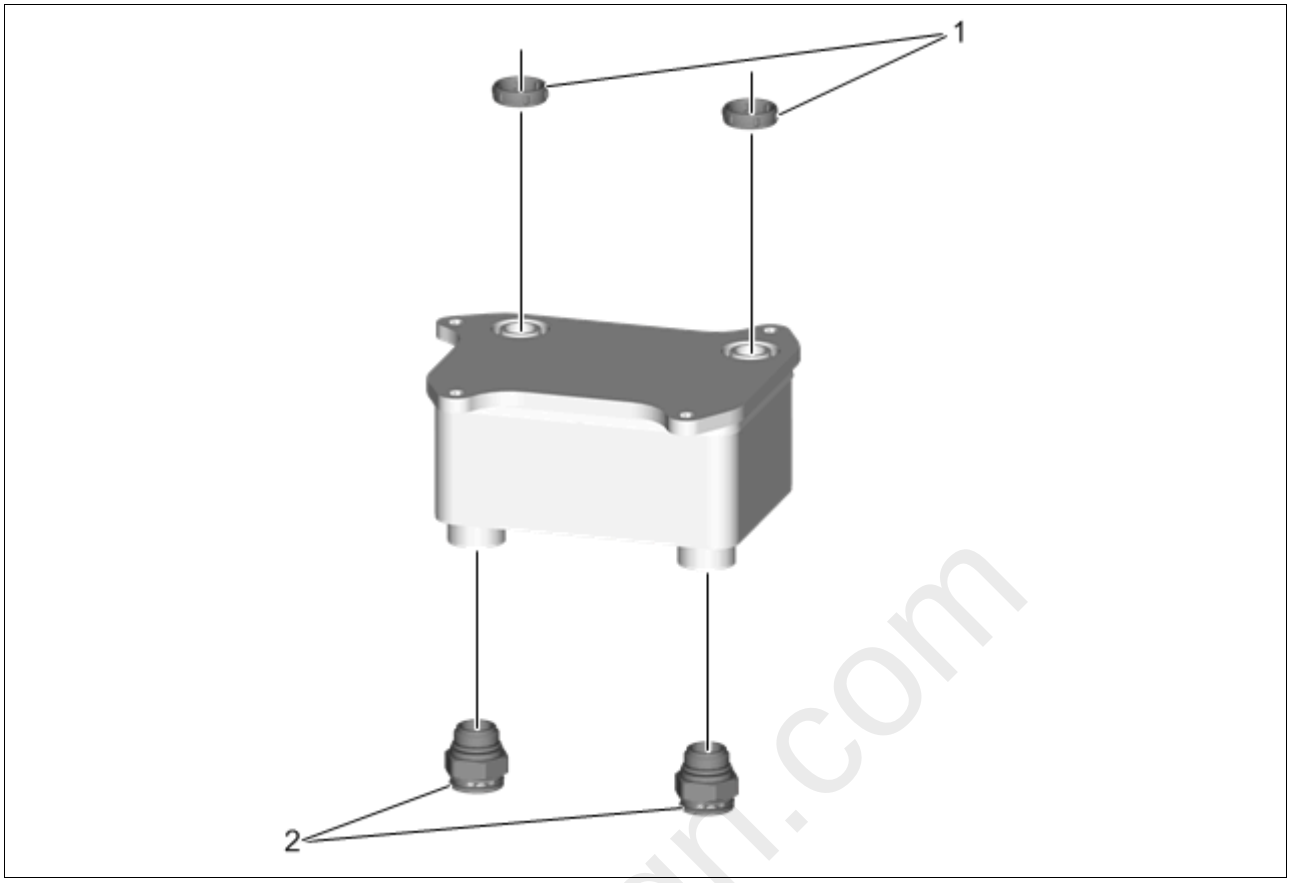
Crankshaft Oil Deflector, High Pressure Port Seal, and Front Seal Installation

Callout	Component Name
1	Turbocharger Coolant Feed and Return Pipe Gasket *NOTE:* *Use a NEW gasket.*
2	Oil Flow Check Valve
3	Oil Pan High Pressure Port Seal *NOTE:* *Use a NEW seal.*
4	Oil Pan Locating Pin
5	Oil Pan Front Seal *NOTE:* *Use a NEW seal.*
6	Engine Oil Level Indicator Switch O-Ring Seal
7	Engine Oil Level Indicator Switch
8	Engine Oil Level Indicator Switch Bolt **Tighten** 10 N.m (88 lb in)
9	Engine Oil Level Sensor Lead Clip
10	Crankshaft Oil Deflector
11	Crankshaft Oil Deflector Bolt **Tighten** 10 N.m (88 lb in)

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REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE OIL COOLER DISASSEMBLE

Fig 1: Engine Oil Cooler



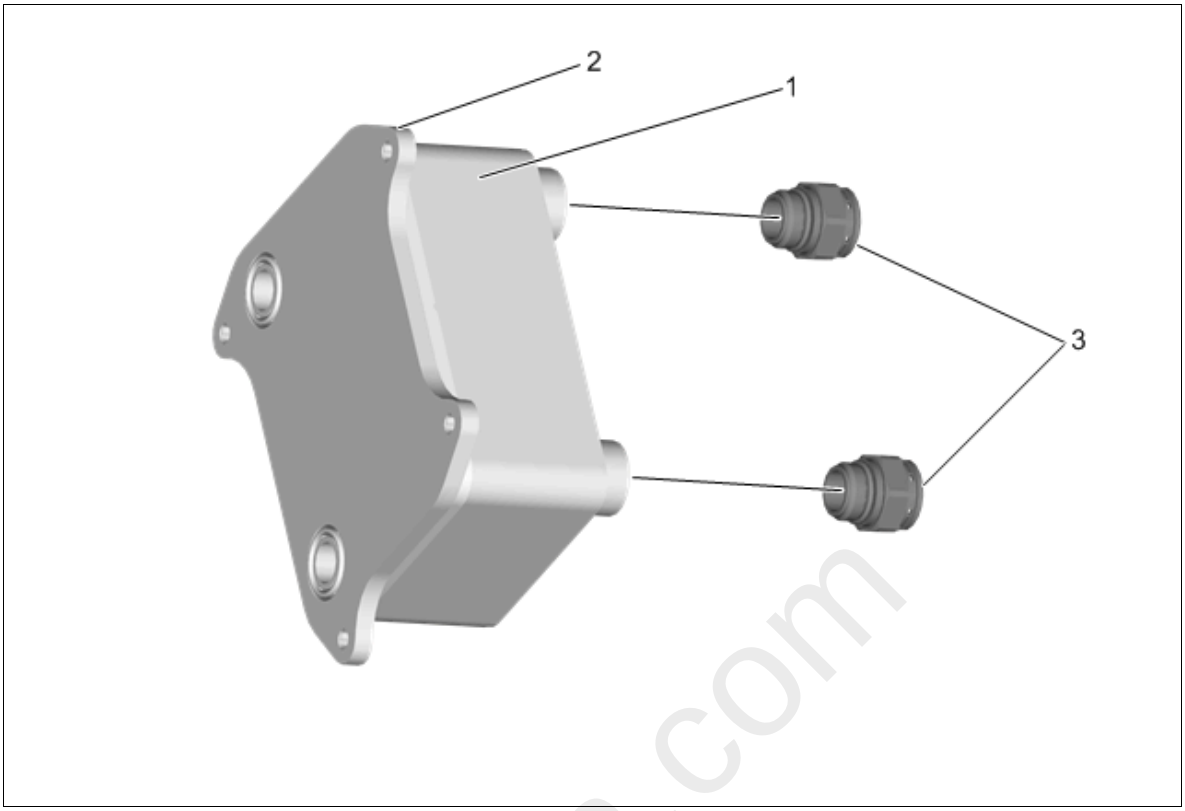
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Oil Cooler Core Seal
2	Engine Oil Cooler Hose Connector *NOTE:* *DISCARD the connector.*

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE OIL COOLER CLEANING AND INSPECTION

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Fig 1: Engine Oil Cooler



Courtesy of GENERAL MOTORS COMPANY

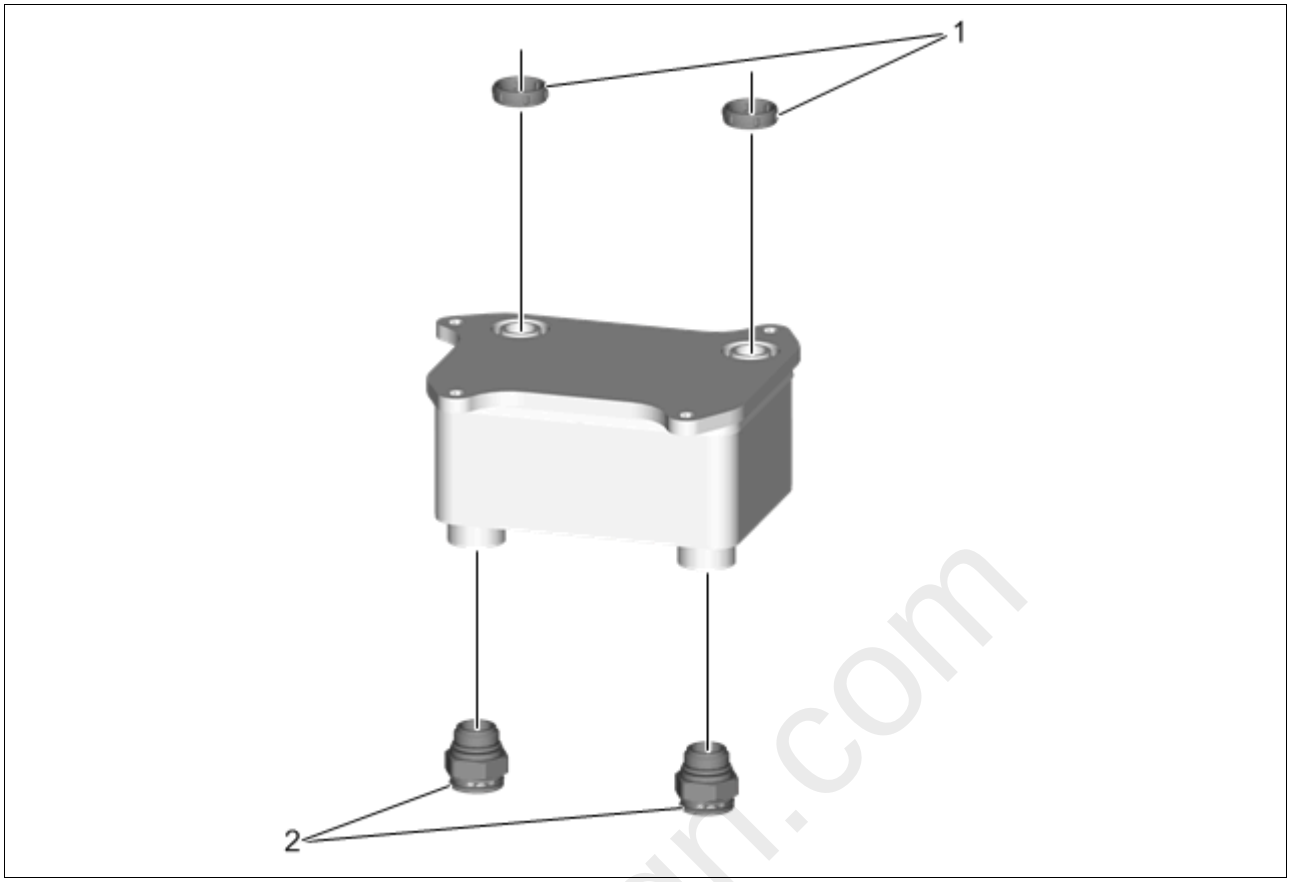
> ⚠ *CAUTION:*
>
> *Refer to Engine Oil Cooler Debris Caution .*

1. Inspect the oil cooler core (1) and the oil cooler housing (2) for cracks or casting imperfections.
2. Inspect the oil cooler housing for damaged bolt hole threads.
3. Inspect the oil cooler housing and core for damaged seal surfaces.
4. Inspect the oil cooler core for damaged or broken cooling fins.
5. Inspect for restrictions within the coolant passages of the core or housing.
6. Inspect for restrictions within the oil passages of the core or housing.
7. Inspect for a leaking coolant hose fitting (3).

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE OIL COOLER ASSEMBLE

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Fig 1: Engine Oil Cooler



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Callout	Component Name
1	Engine Oil Cooler Core Seal *NOTE:* *Use a NEW seal.*
2	Engine Oil Cooler Hose Connector *CAUTION:* *Refer to Fastener Caution .*

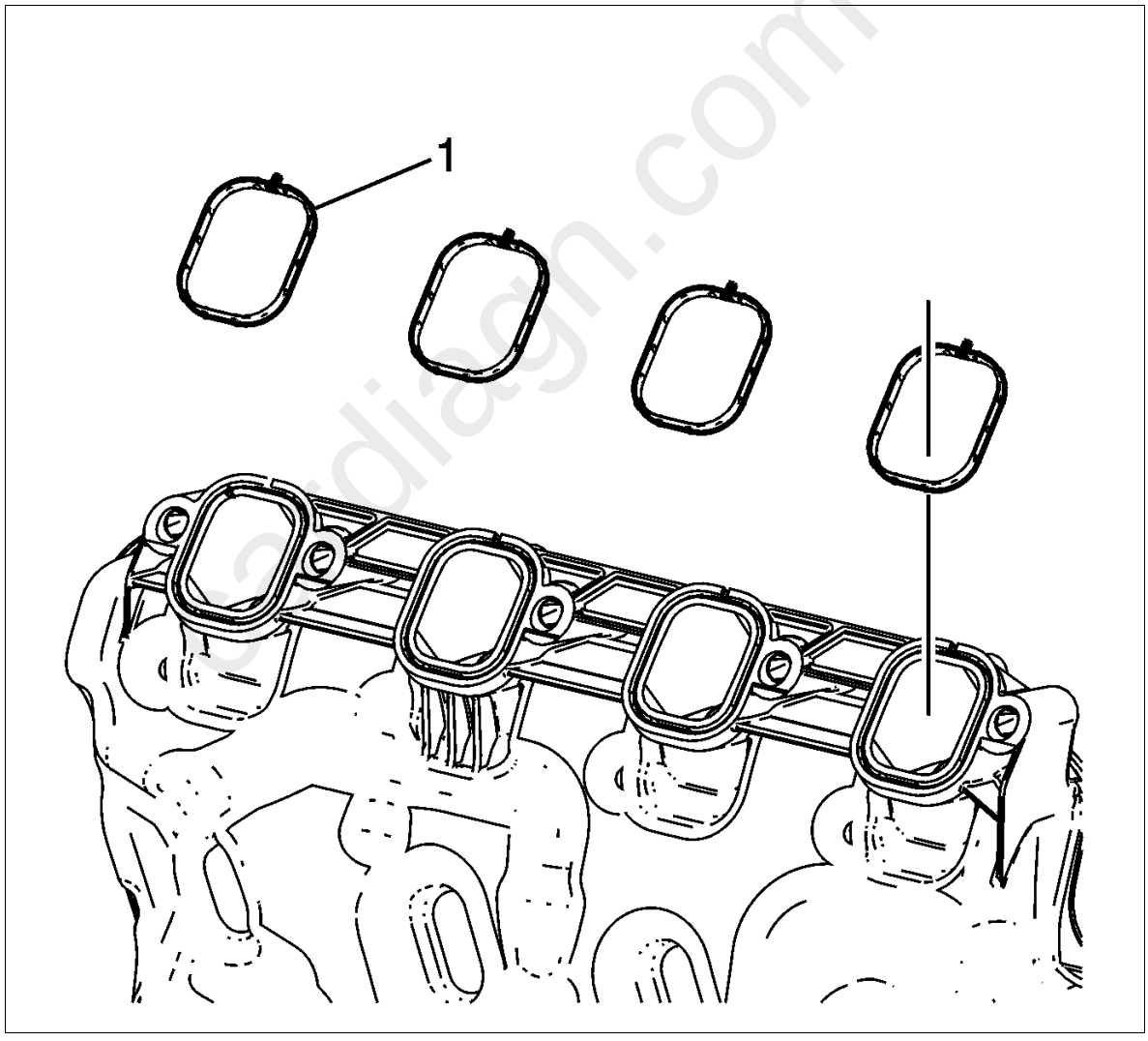
NOTE:

Use a NEW connector.

Tighten
35 N.m (26 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > INTAKE MANIFOLD CLEANING AND INSPECTION > CLEANING PROCEDURE

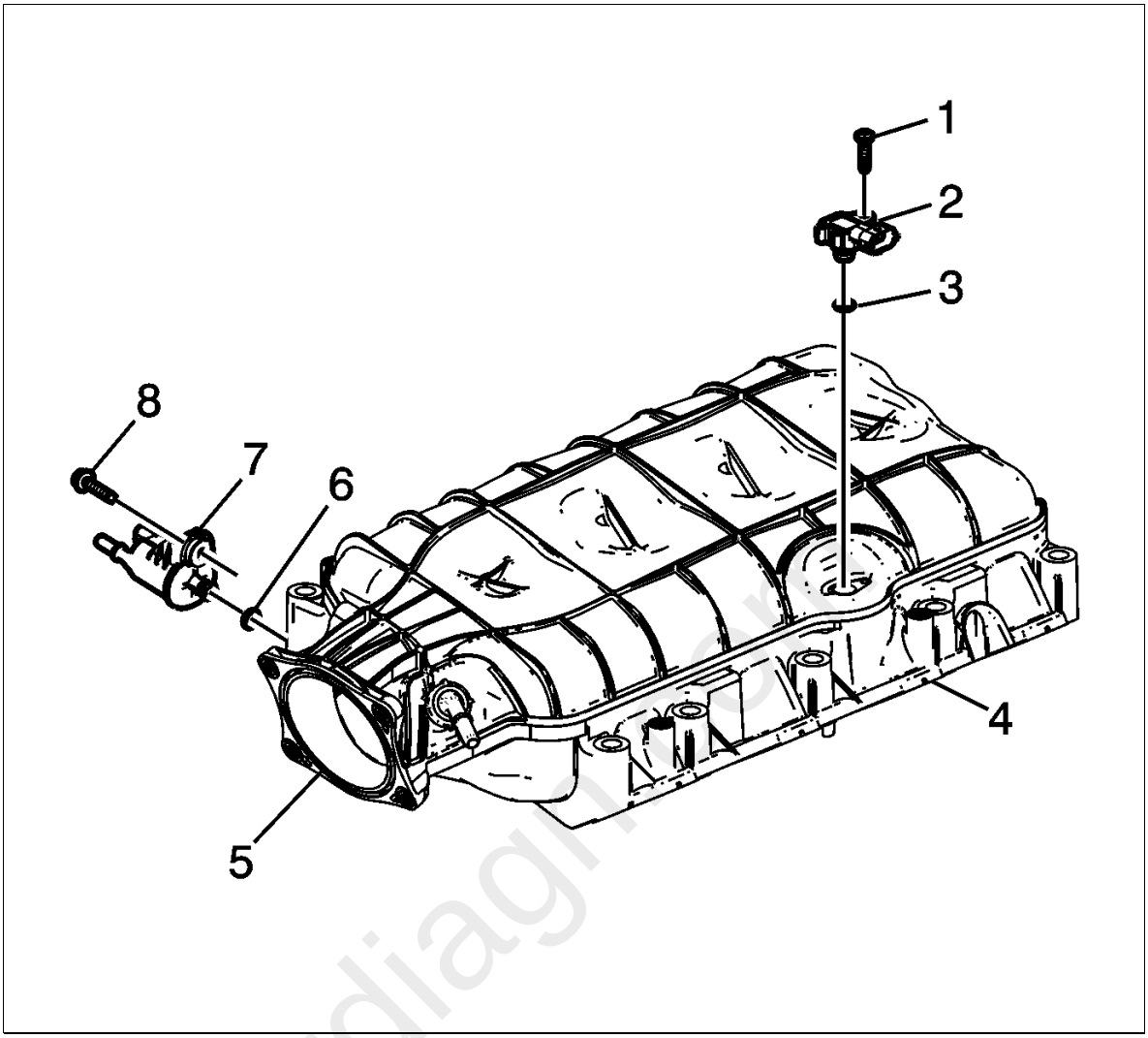
Fig 1: Intake Manifold-To-Cylinder Head Gaskets



Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the intake manifold-to-cylinder head gaskets (1).

Fig 2: Manifold Absolute Pressure (MAP) Sensor Bolt, MAP Sensor And Seal



Courtesy of GENERAL MOTORS COMPANY

2. Remove the manifold absolute pressure (MAP) sensor bolt (1), MAP sensor (2), and seal (3).
3. Remove the evaporative emission (EVAP) canister purge solenoid valve bolt (8), EVAP canister purge solenoid valve (7), and seal (6).
4. Clean the intake manifold in solvent.

> *WARNING:*
>
> *Refer to Safety Glasses and Compressed Air Warning .*

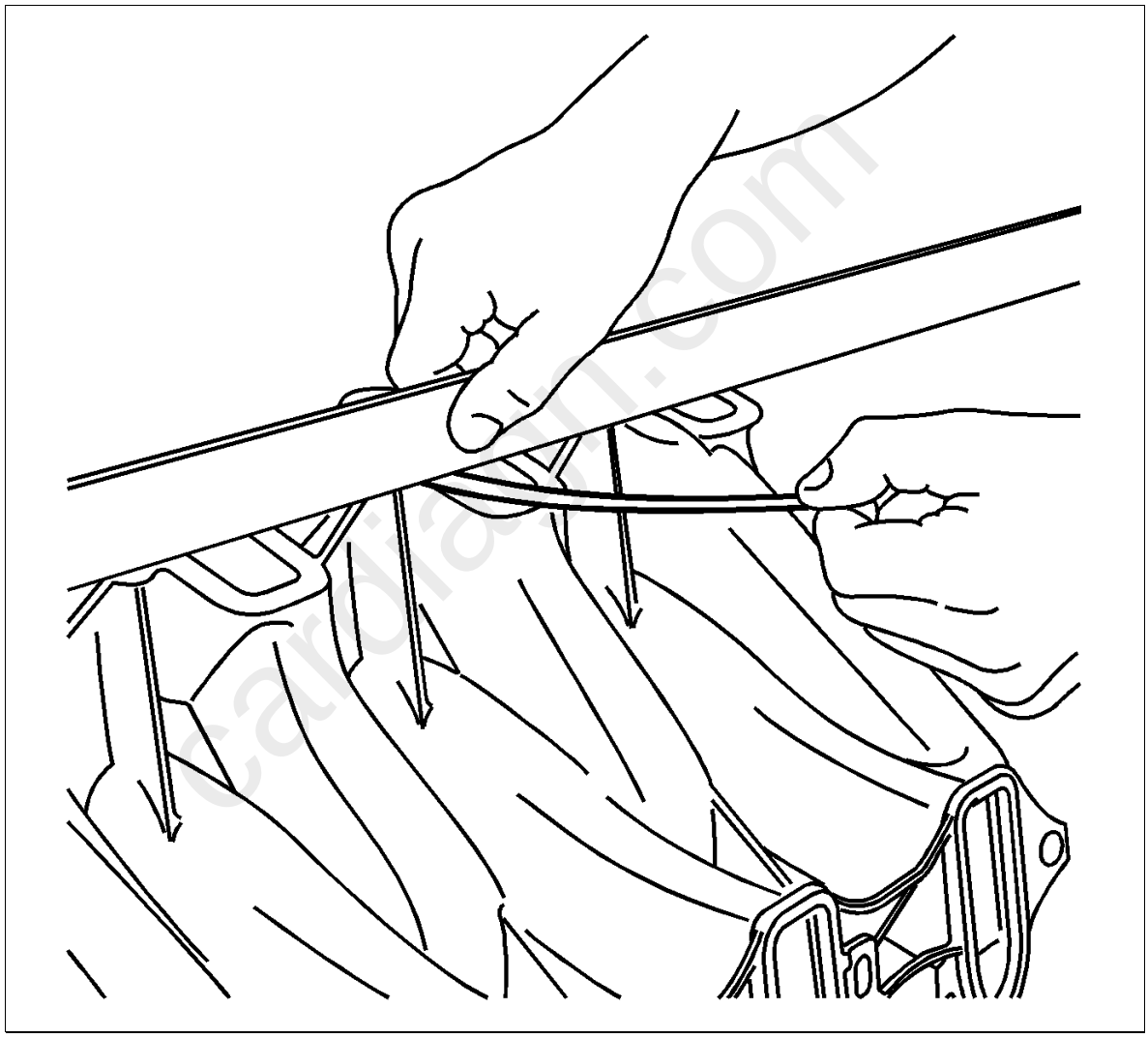
5. Dry the intake manifold with compressed air.

REPAIR INSTRUCTIONS - OFF VEHICLE > INTAKE MANIFOLD CLEANING AND

INSPECTION > INSPECTION PROCEDURE

1. Inspect the manifold for the following conditions:
    1. Damaged gasket or sealing surfaces
    2. Loose threaded inserts or studs
    3. Debris or restrictions within the passages of the manifold
    4. Damaged or broken vacuum fittings
    5. Inspect the composite intake manifold assembly for cracks or other damage.

Fig 1: Inspecting Intake Manifold Cylinder Head Deck For Warpage



Courtesy of GENERAL MOTORS COMPANY

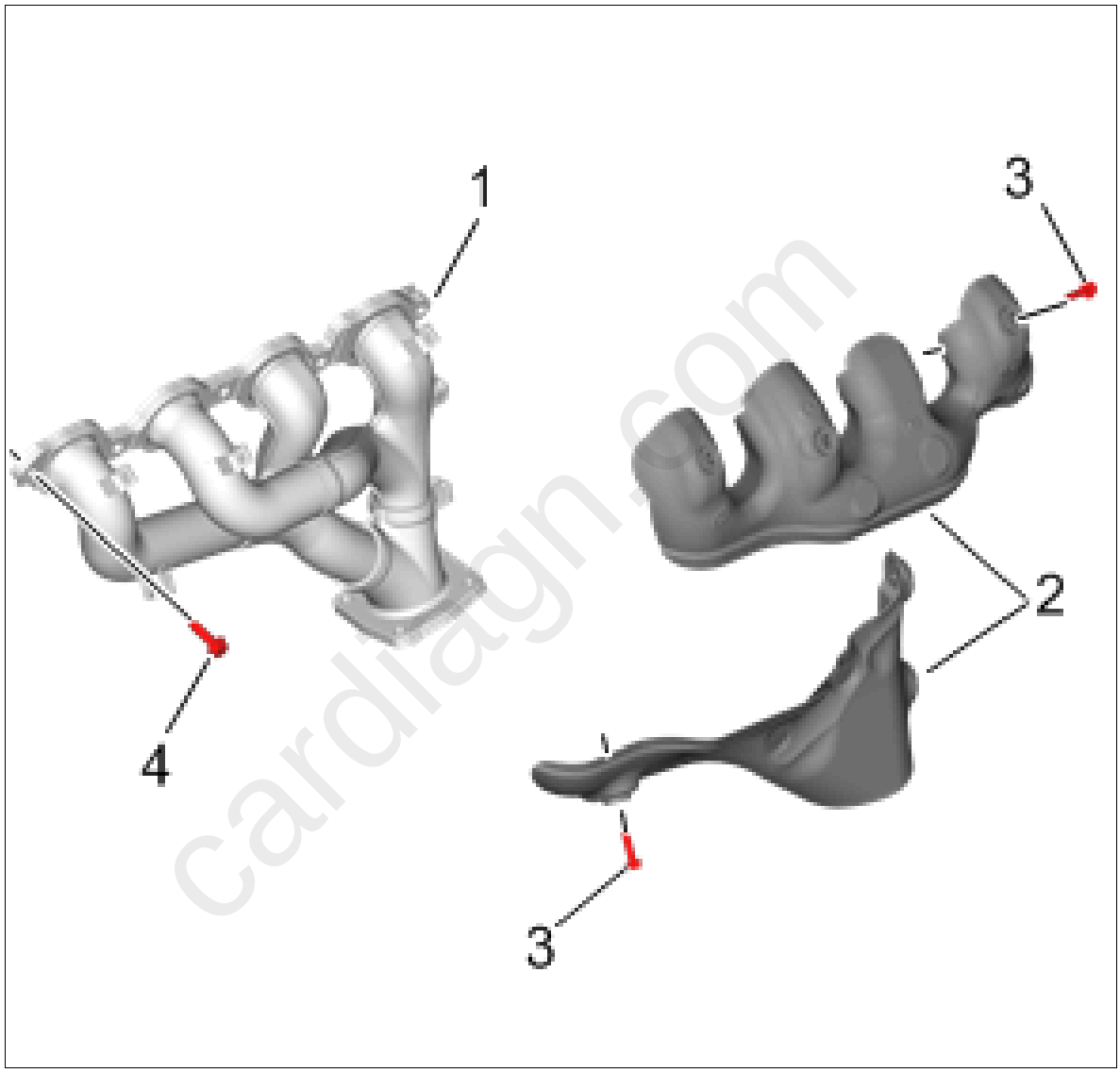
2. Inspect the intake manifold cylinder head deck for warpage.
    1. Locate a straight edge across the intake manifold cylinder head deck surface.

       Position the straight edge across a minimum of two runner port openings.
    2. Insert a feeler gauge between the intake manifold and the straight edge.

An intake manifold with warpage in excess of 3 mm (0.118 in) over a 200 mm (7.87 in) area is warped and should be replaced.

REPAIR INSTRUCTIONS - OFF VEHICLE > EXHAUST MANIFOLD CLEANING AND INSPECTION

Fig 1: Exhaust Manifold



Courtesy of GENERAL MOTORS COMPANY

NOTE:

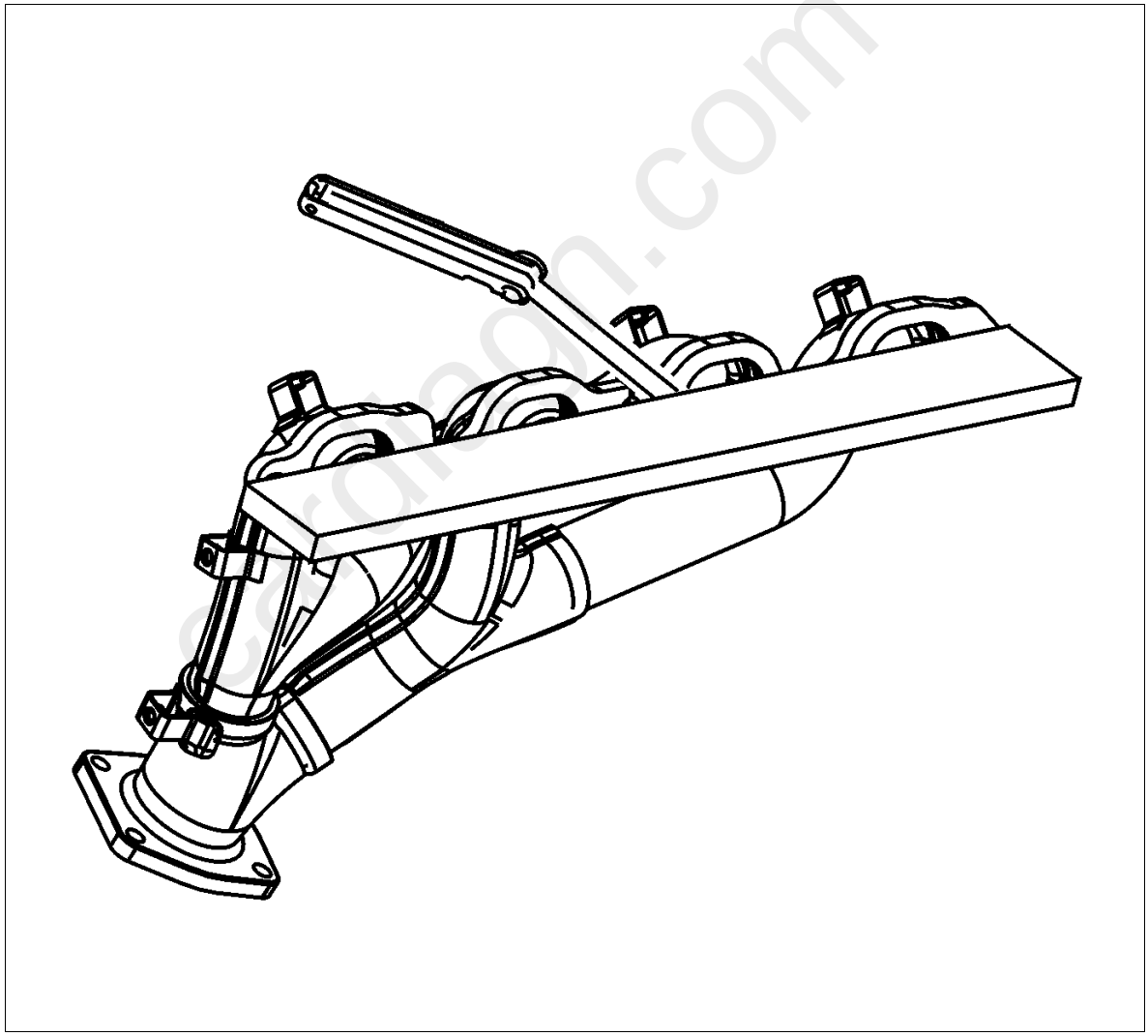
Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may affect on-board diagnostics (OBD) II system performance.

1. Clean the exhaust manifold (1) and heat shields (2) in solvent.

> *WARNING:*
>
> *Refer to Safety Glasses Warning .*

2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shields (2).
5. Inspect the bolts (3 and 4) for damaged threads.

Fig 2: Measure Exhaust Manifold Cylinder Head Deck For Warpage



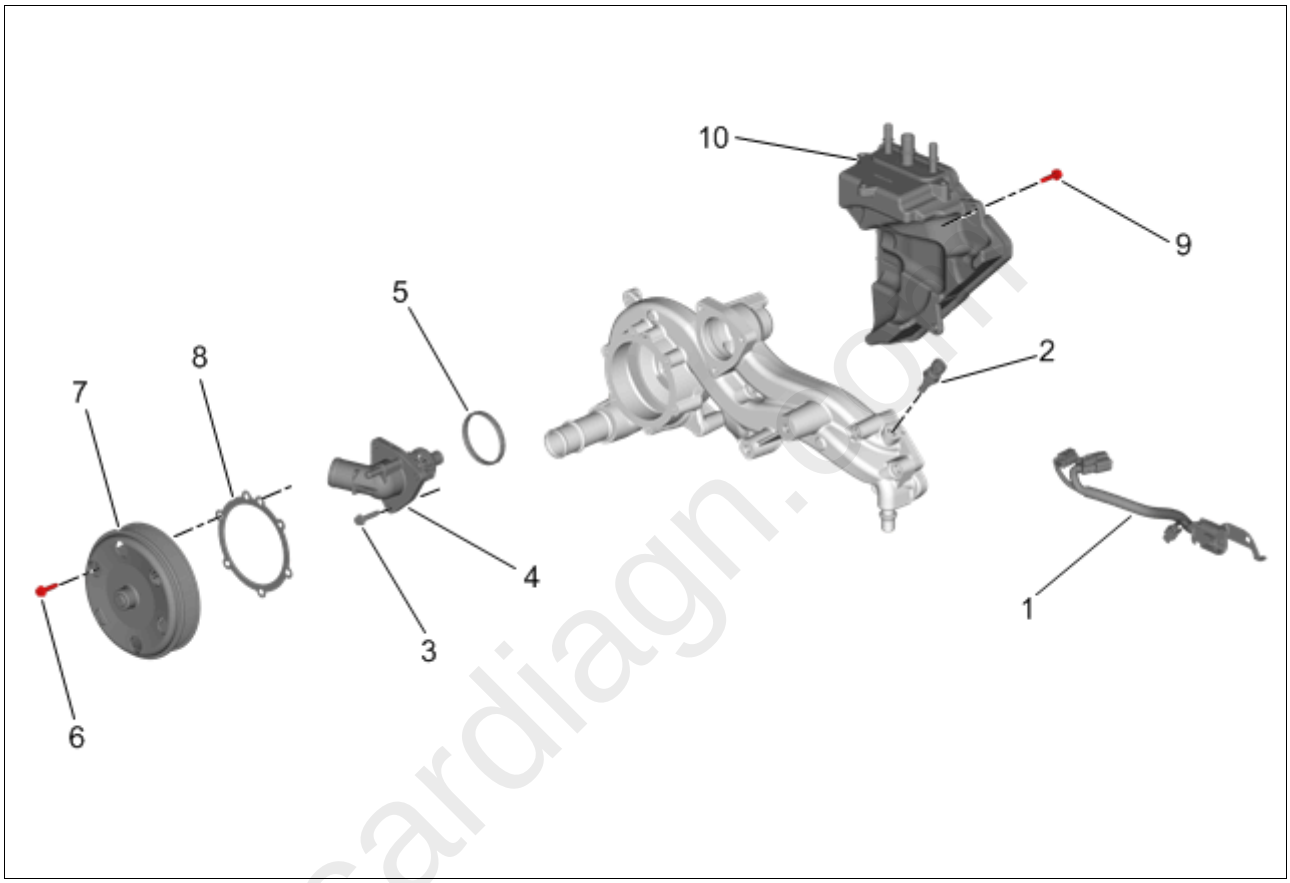
Courtesy of GENERAL MOTORS COMPANY

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

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

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE COOLANT MANIFOLD DISASSEMBLE

Fig 1: Engine Coolant Manifold



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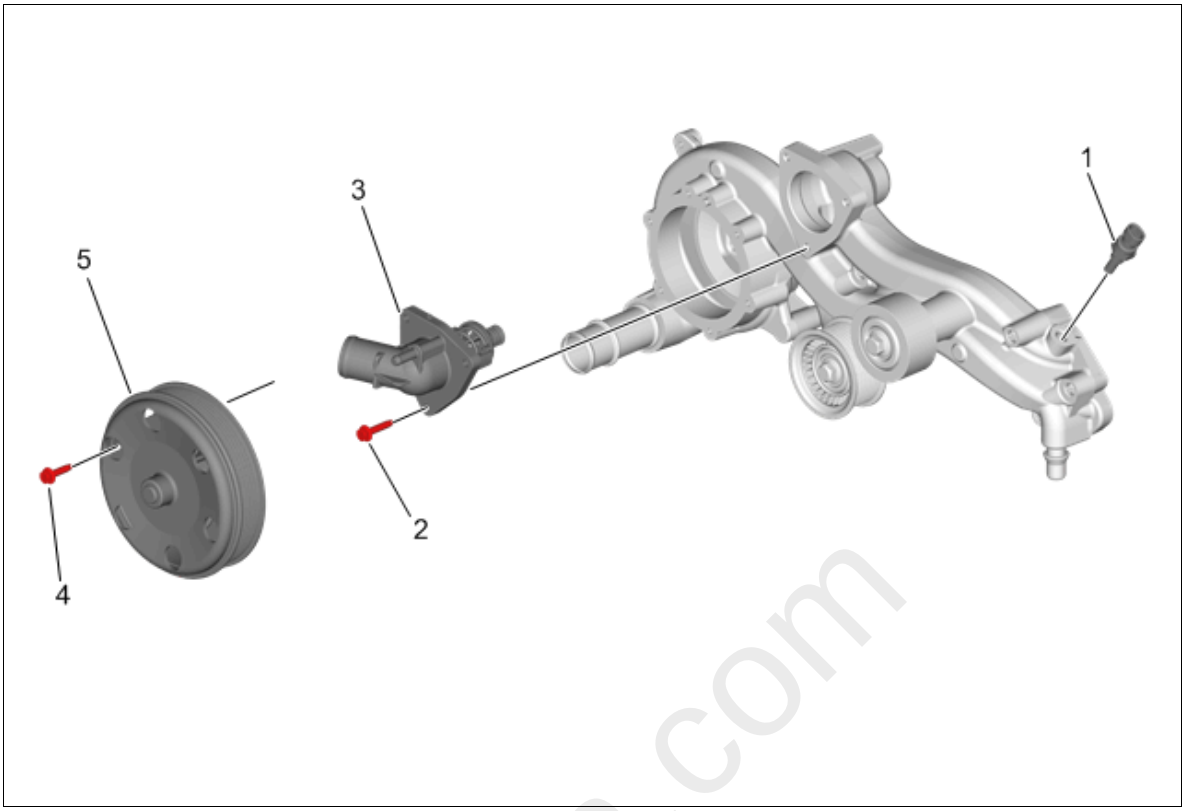
Callout	Component Name
1	Jumper Harness
2	Engine Coolant Temperature Sensor
3	Water Pump Outlet Bolts (Qty: 3)
4	Water Pump Outlet Assembly (with Thermostat)
5	Water Pump Outlet Gasket

	NOTE: *Discard gasket, it is not reusable.*
6	Water Pump Assembly Bolts (Qty: 6)
7	Water Pump Assembly
8	Water Pump Assembly Gasket *NOTE:* *Discard gasket, it is not reusable.*
9	Positive Crankcase Ventilation Oil Separator Bolt (Qty: 3)
10	Positive Crankcase Ventilation Oil Separator

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE COOLANT MANIFOLD CLEANING AND INSPECTION

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Fig 1: Engine Coolant Manifold



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Inspect for leakage between the water output flange and the thermostat housing.

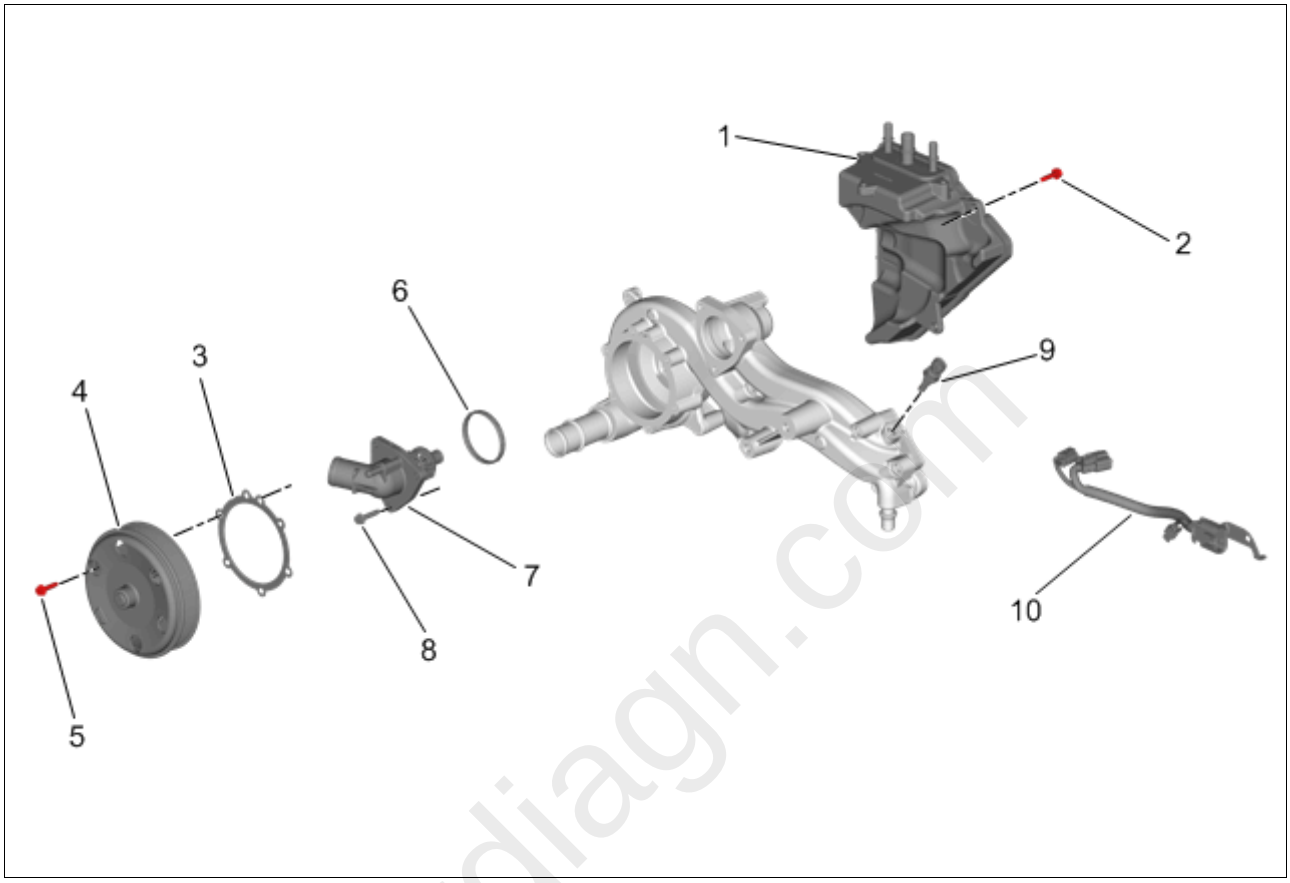
1. Clean all excess dirt and debris from the engine coolant manifold housing.
2. Inspect the engine coolant manifold for the following conditions:
    1. Gasket and hose sealing surfaces for excessive scratches or gouging
    2. Restrictions within the internal coolant passages
    3. Excessive side-to-side play in the pulley shaft
    4. Leakage at the water inlet housing or rear cover
    5. Leakage at the water outlet housing or water pump outlet assembly
    6. Leakage at the Engine Coolant Manifold vent hole

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

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REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE COOLANT MANIFOLD ASSEMBLE

Fig 1: Engine Coolant Manifold



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Oil Separator
2	Positive Crankcase Ventilation Oil Separator Bolt (Qty: 3) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (88 lb in)
3	Water Pump Assembly Gasket

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	NOTE: *Install a NEW Gasket.*
4	Water Pump Assembly
5	Water Pump Assembly Bolts **Tighten** 10 N.m (88 lb in)
6	Water Pump Outlet Gasket *NOTE:* *Install a NEW Gasket.*
7	Water Pump Outlet Assembly (with Thermostat)
8	Water Pump Outlet Bolts Procedure 1. Install and hand tighten all three bolts. 2. Tighten bolts to final torque. **Tighten** 10 N.m (88 lb in)
9	Engine Coolant Temperature Sensor **Tighten** 20 N.m (15 lb ft)
10	Jumper Harness

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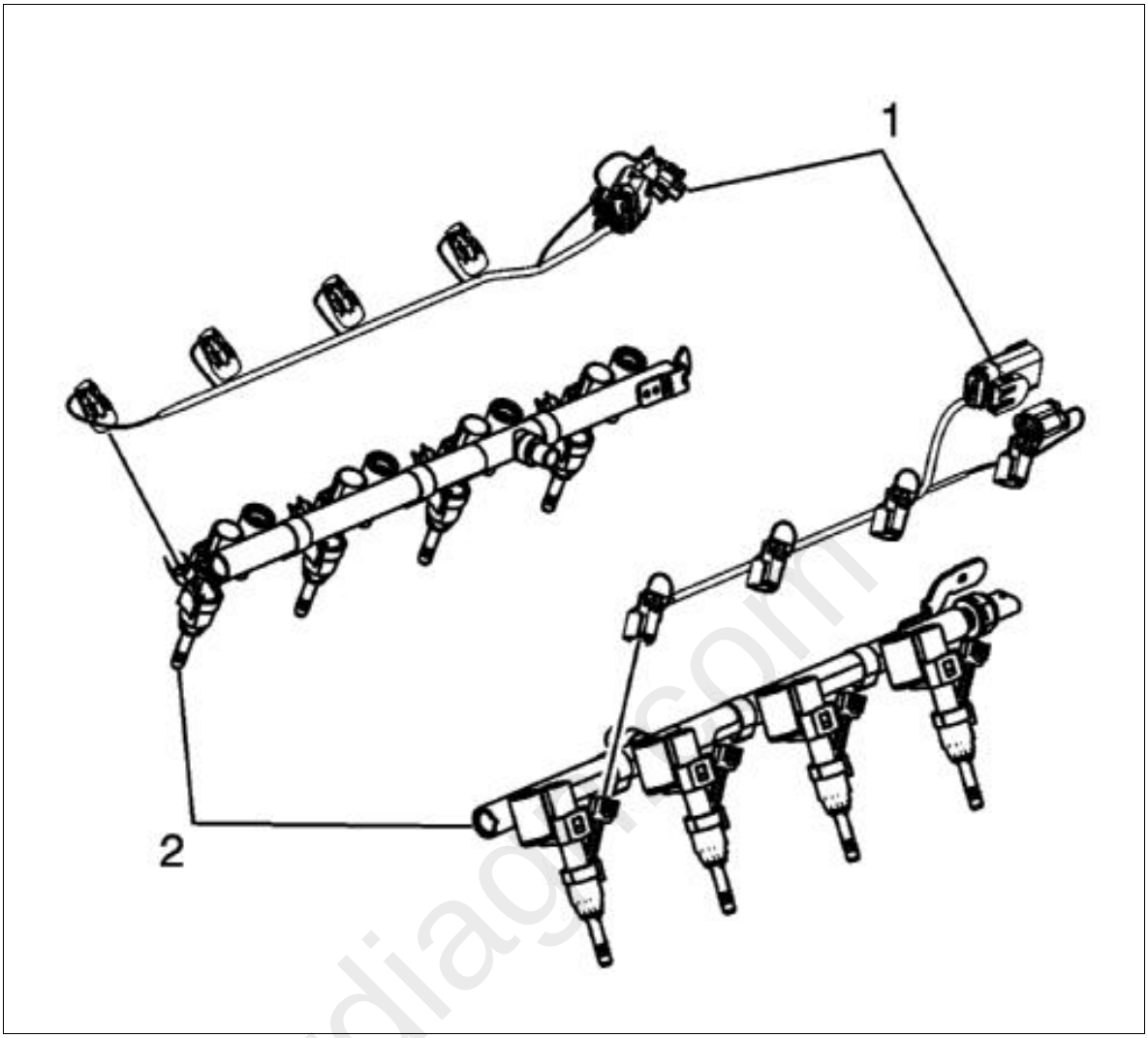
REPAIR INSTRUCTIONS - OFF VEHICLE > FUEL RAIL AND INJECTORS CLEANING AND INSPECTION

Special Tools

- **EN-49245** Injector Seal Installer Kit
- **EN-51097** Injector Retaining Clip Installer and Sizer
- **EN-51105** Injector Seal Installer and Sizer

For equivalent regional tools, refer to Special Tools .

Fig 1: Fuel Rail Wiring Harnesses

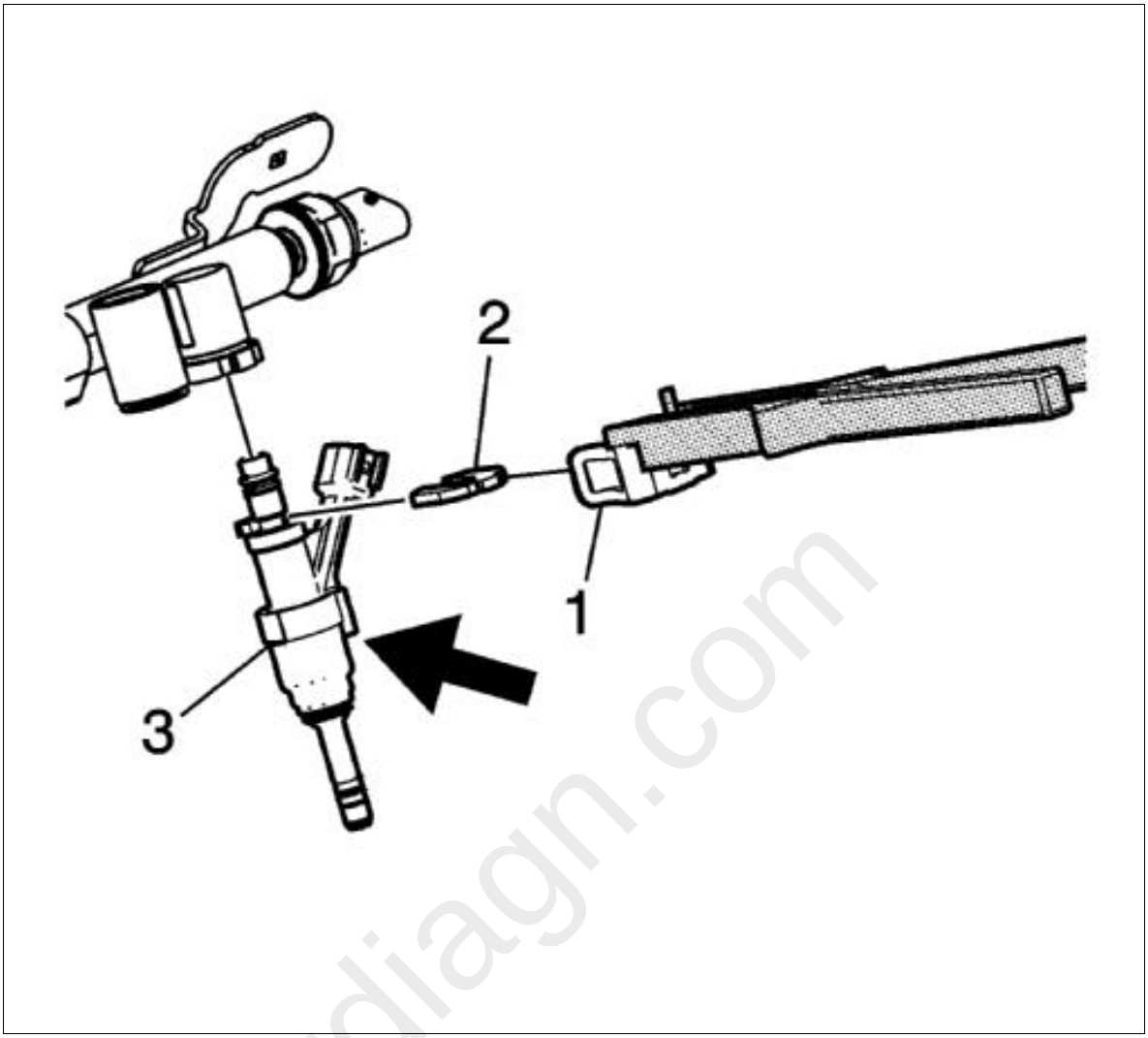


Courtesy of GENERAL MOTORS COMPANY

1. Disconnect and remove the fuel rail wiring harnesses (1).

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Fig 2: Fuel Injector Retainer Clips

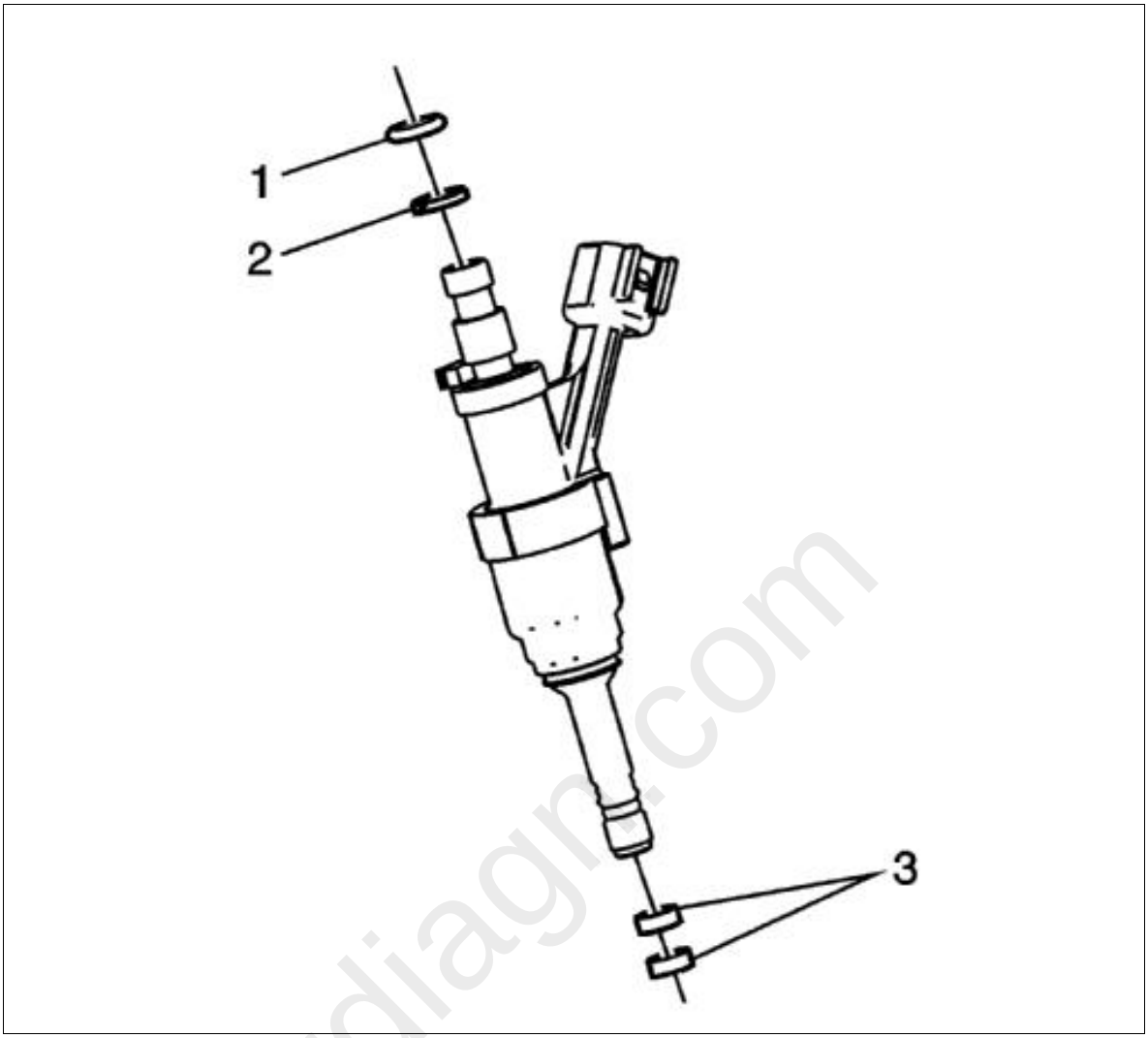


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2. Remove and discard the fuel injector retainer clips (1) by installing **EN-51097** injector retaining clip installer and spreading both sides of the clip evenly.
3. Remove the fuel injector collars (2).

Fig 3: Fuel Injector O-Ring And Plastic Spacer



Courtesy of GENERAL MOTORS COMPANY

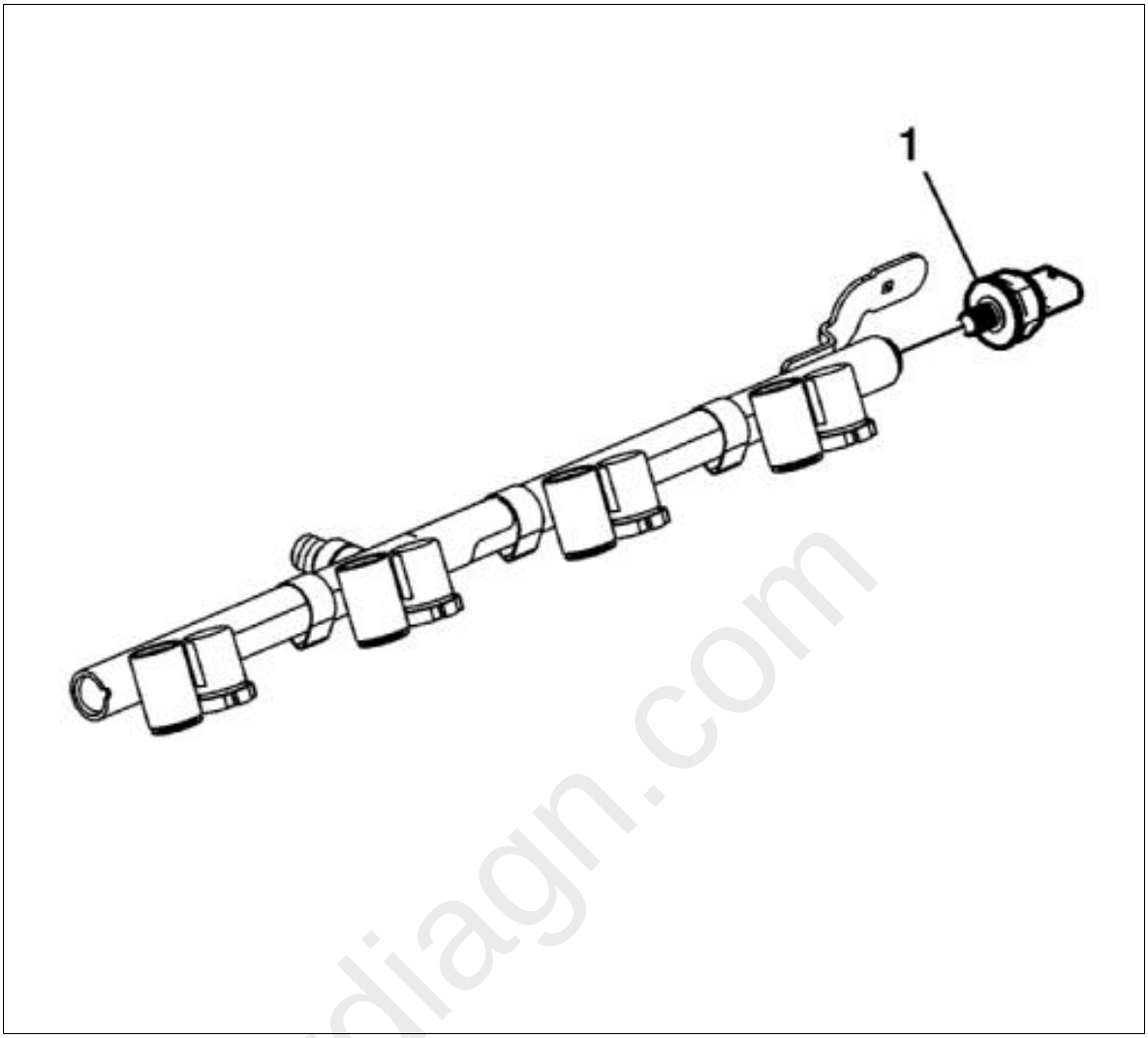
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⚠ *CAUTION:*

Do not use a metal tool to remove O-rings, spacers or injector seals. Care must be taken not to scratch or damage the tubes of the injector.

4. Remove and discard the fuel injector O-ring (1) and plastic spacer (2).
5. Remove and discard the fuel injector seals (3).

Fig 4: Fuel Pressure Sensor And LH Fuel Rail



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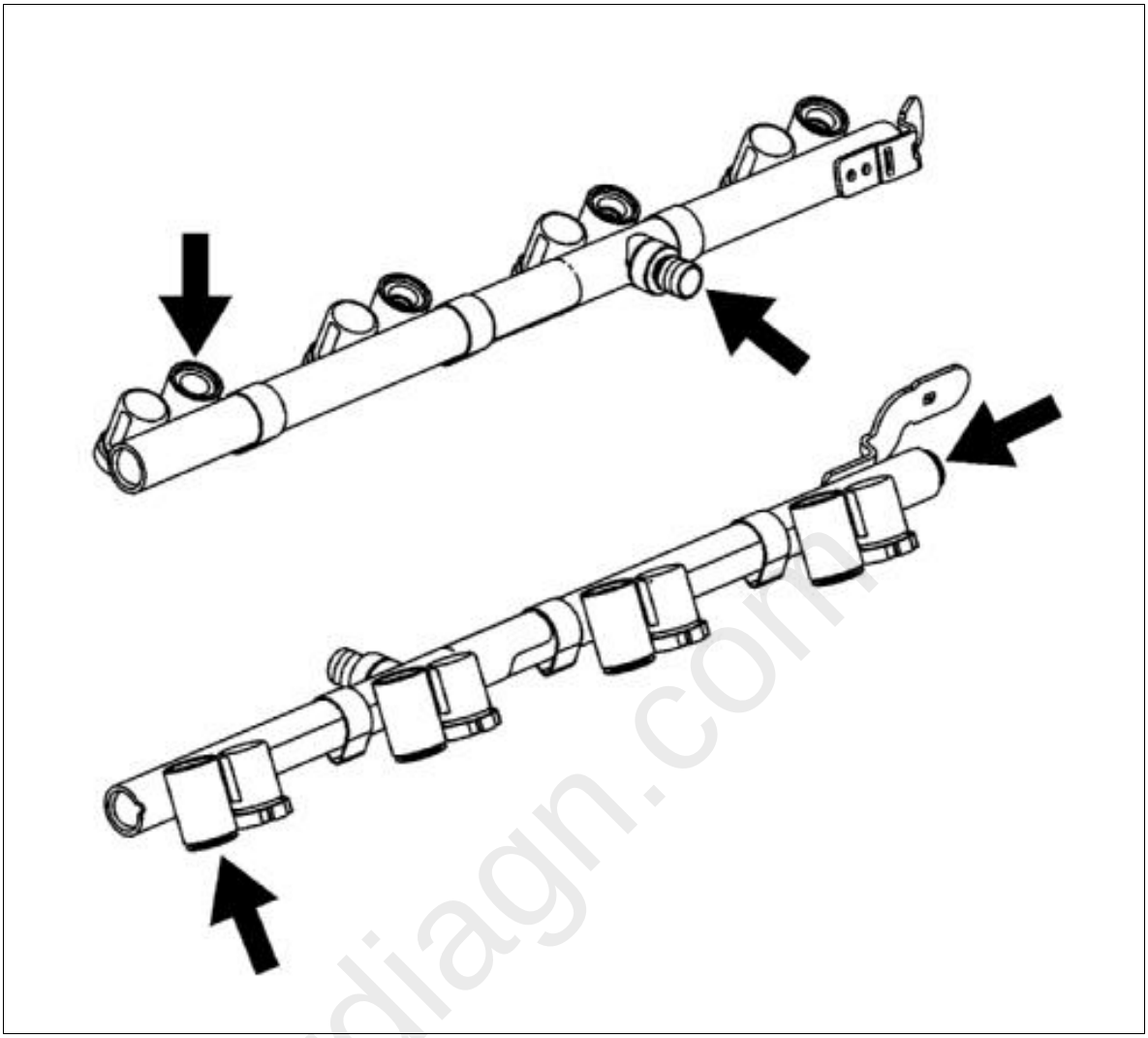
> *NOTE:*
>
> *Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.*

6. Remove the fuel pressure sensor (1) from the LH fuel rail.

> *NOTE:*
>
> *Do not soak or submerge the fuel rail or injectors in solvent.*

7. Clean the exterior of the fuel rail and injectors with solvent.

Fig 5: Inspecting Fuel Rail And Components

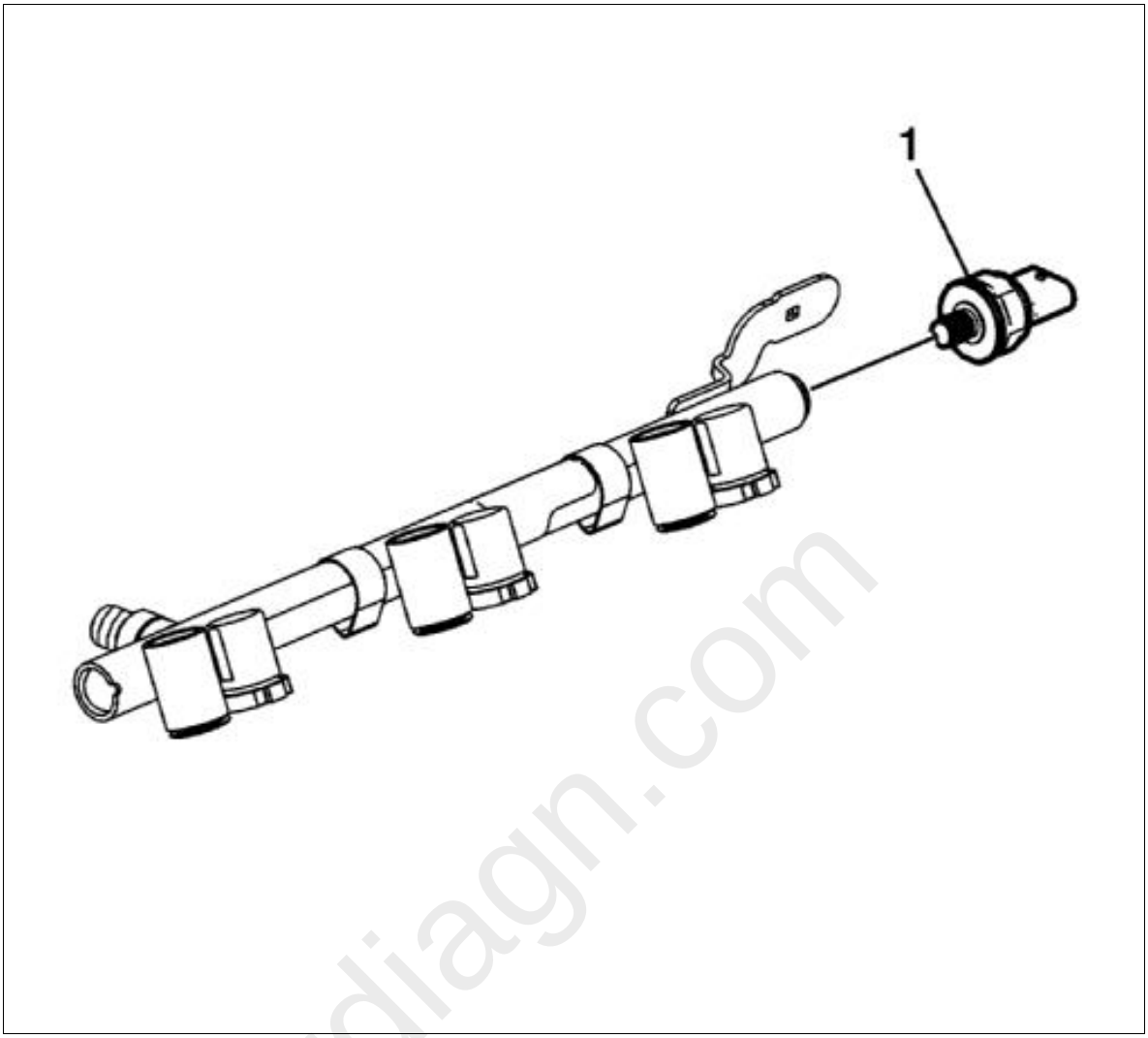


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8. Inspect the fuel rail and components for the following conditions:
    1. Damage, debris or restrictions to the fuel rail
    2. Damage, debris or restrictions to the fuel ports in the fuel rail
    3. Damage to the mounting area for the fuel rail
    4. Damage to the fuel rail mounting bolts or mounting bolt grommets/isolators
    5. Damage to the threads on the fuel rail feed fitting
    6. Damage to the threads in the fuel pressure sensor bore
    7. Damage to the fuel pressure sensor connector, threads, or sealing face

Fig 6: Fuel Pressure Sensor



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> *NOTE:*
>
> *Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.*

9. Install the fuel pressure sensor (1).

> *NOTE:*
>
> *Ensure that the fuel rail threads have been cleaned of any excess fuel or the fuel pressure sensor will NOT seal properly.*

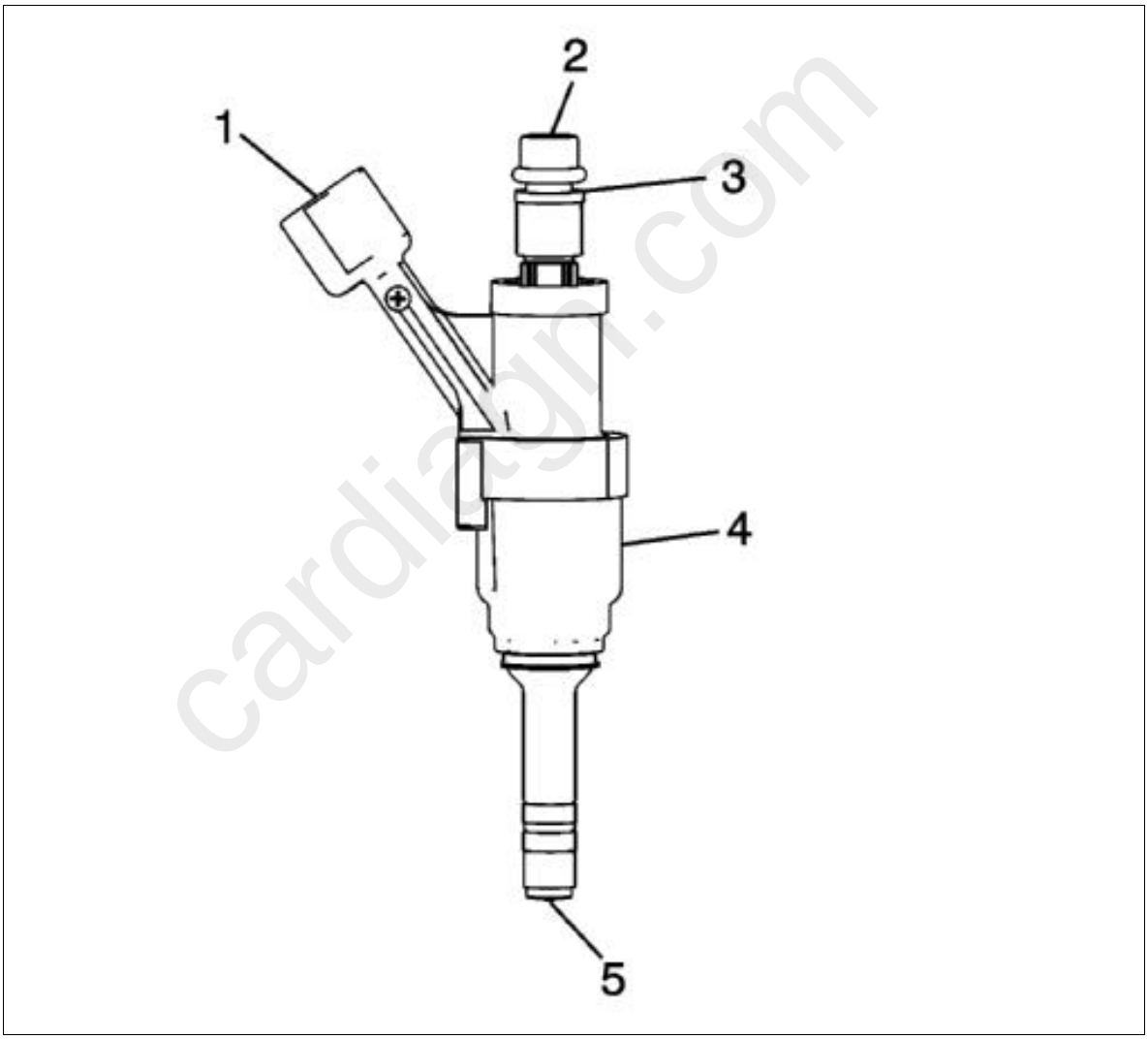
10. Lubricate the threads and the sealing area in the fuel rail with silicon free engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended lubricant.

11. Lubricate the threads and the sealing area on the fuel pressure sensor with silicon free engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended lubricant.
12. Install the fuel pressure sensor hand tight.
13. Remove the fuel pressure sensor and re-lubricate.

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

14. Install the fuel pressure sensor and tighten to 33 N.m (24 lb ft)

Fig 7: Fuel Injector Connector Components



Courtesy of GENERAL MOTORS COMPANY

15. Inspect the fuel injectors for the following conditions:
    1. Damage to the fuel injector connector (1)
    2. Damage to the fuel inlet cone (2)

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3. Damage to the O-ring (cracking, splitting, tearing) and the O-ring sealing surface (3)

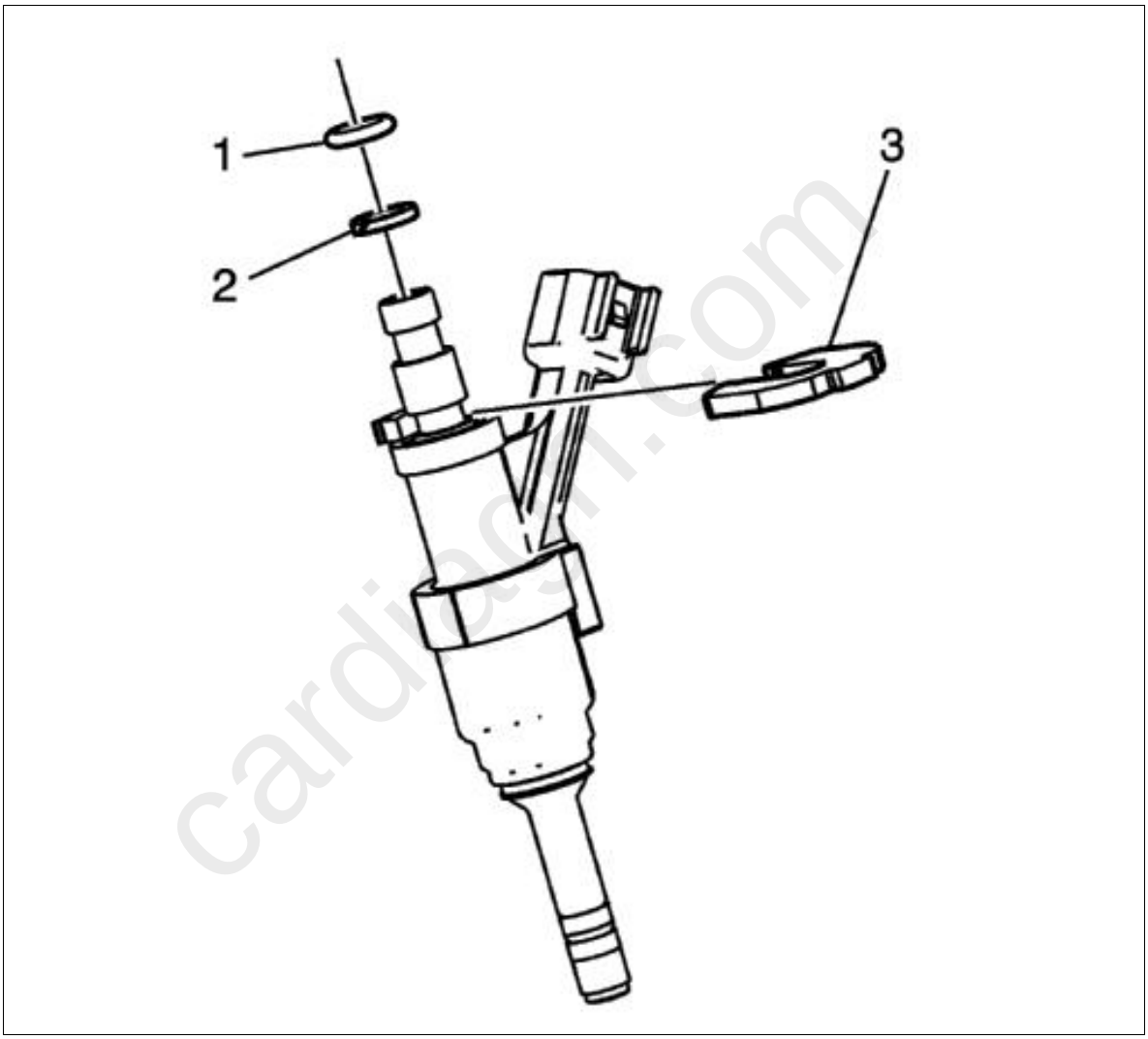
   Damaged O-rings can result in fuel odor, fuel leaks, and other symptoms. Refer to Symptoms - Engine Controls .

4. Damage to the fuel injector body (4)

5. Damage to the fuel injector tip (5)

16. Replace the fuel rail or injector if any damage is found. Do not attempt to repair a fuel rail or injector.

    Fig 8: Installing NEW Spacer On Fuel Injector



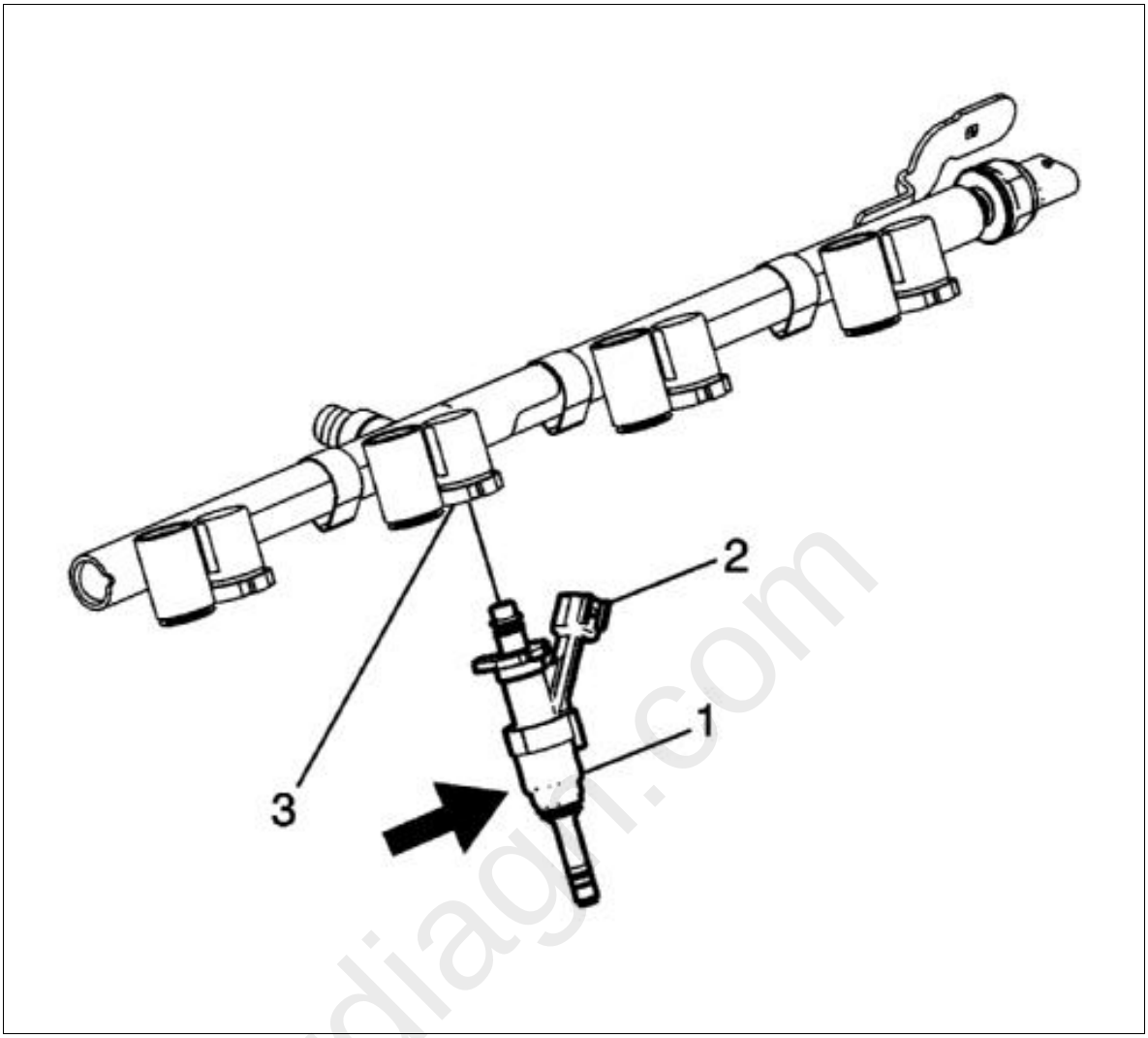
Courtesy of GENERAL MOTORS COMPANY

17. Install a NEW spacer (2) on the fuel injector.

18. Lubricate the NEW O-ring (1) with a drop of clean engine oil and install on injector.

19. Install injector collar (3) on fuel injector.

Fig 9: Injector Assembly And Fuel Rail



Courtesy of GENERAL MOTORS COMPANY

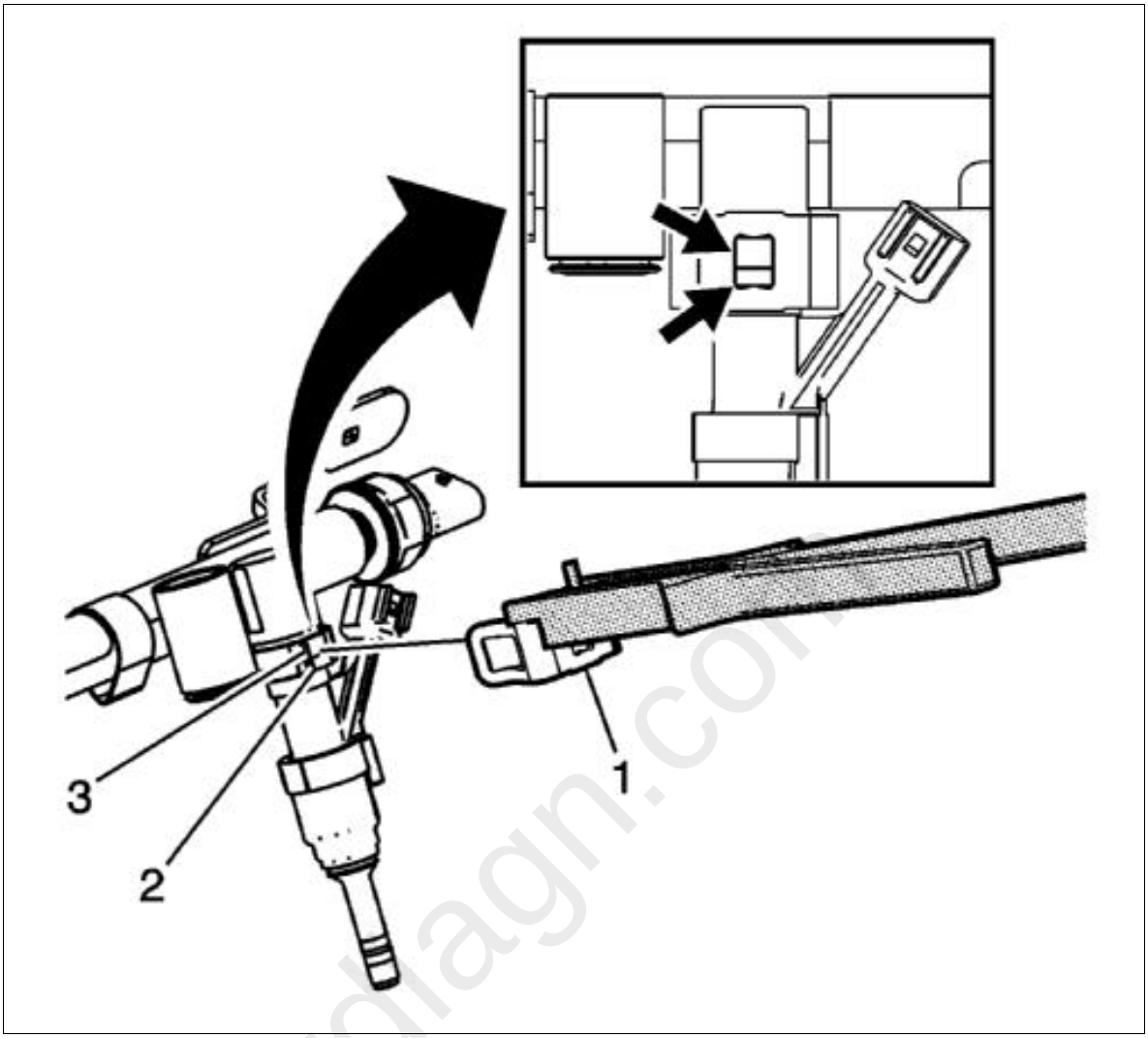
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NOTE:

Do NOT install the injector tip/bore seals until AFTER the injectors are installed on the fuel rail.

20. Lubricate the socket (3) of the fuel rail with clean engine oil. Holding the largest diamenter/body of the injector only, indicated by arrow in graphic, insert the injector assembly (1) into the fuel rail. Ensure correct orientation of the electrical connector (2). LH Rail: Electrical connectors face the front of the engine. RH Rail: Electrical connectors face the rear of the engine.

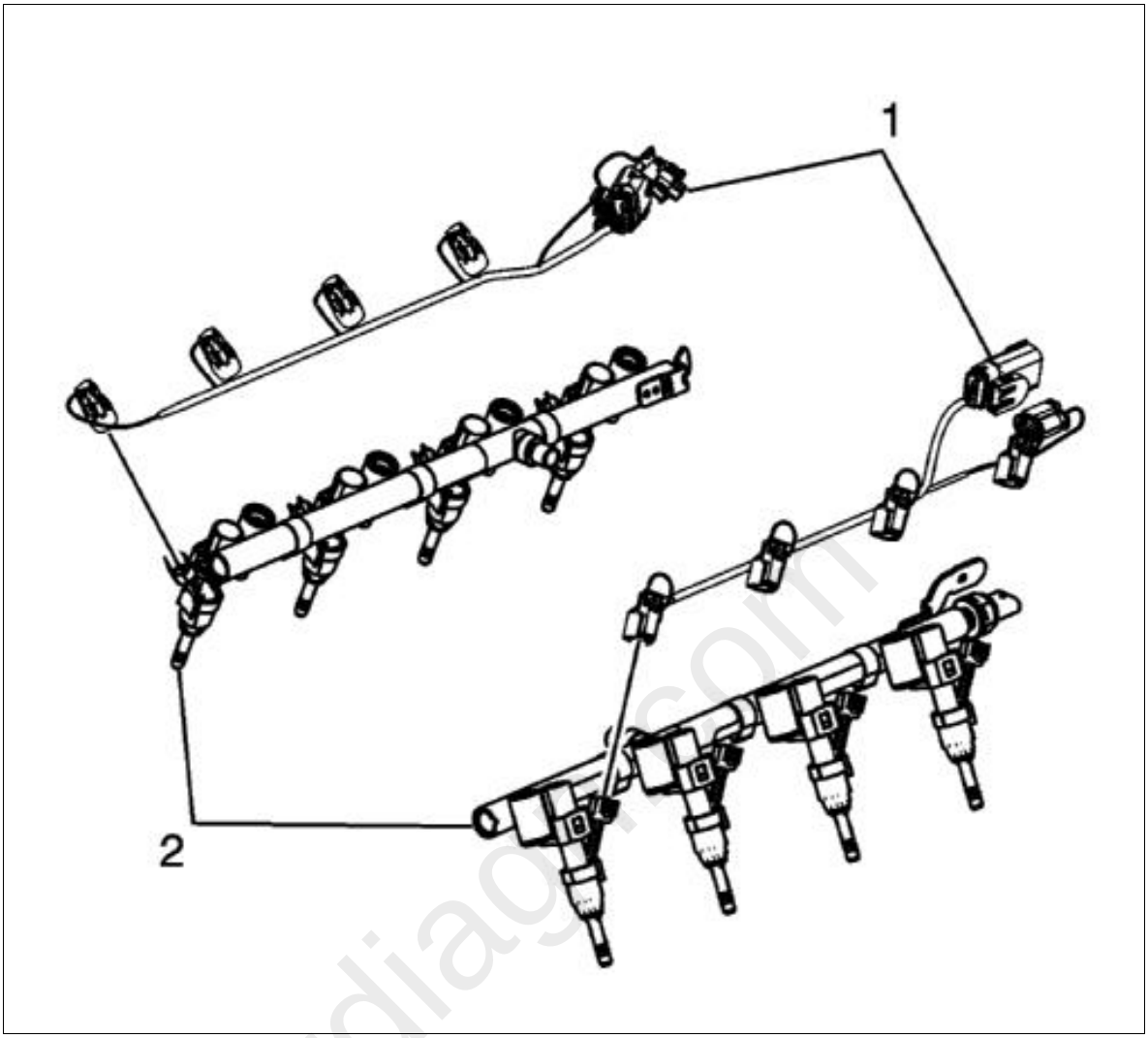
Fig 10: Installing Fuel Injector Clip Onto EN-51097 Injector Retaining Clip Installer



Courtesy of GENERAL MOTORS COMPANY

21. Install the fuel injector clip onto the **EN-51097** injector retaining clip installer.
22. Using **EN-51097** injector retaining clip installer spread the retainer clip (1) and install onto the fuel rail. Inspect the front and side windows of the retainer clip to ensure that the flange on the rail (3) and the tab on the injector collar (2) are completely captured and firmly seated in the retainer clip (1) as shown.
23. Repeat for remaining injectors until all are installed and retained in fuel rail.

Fig 11: Fuel Rail Wiring Harnesses

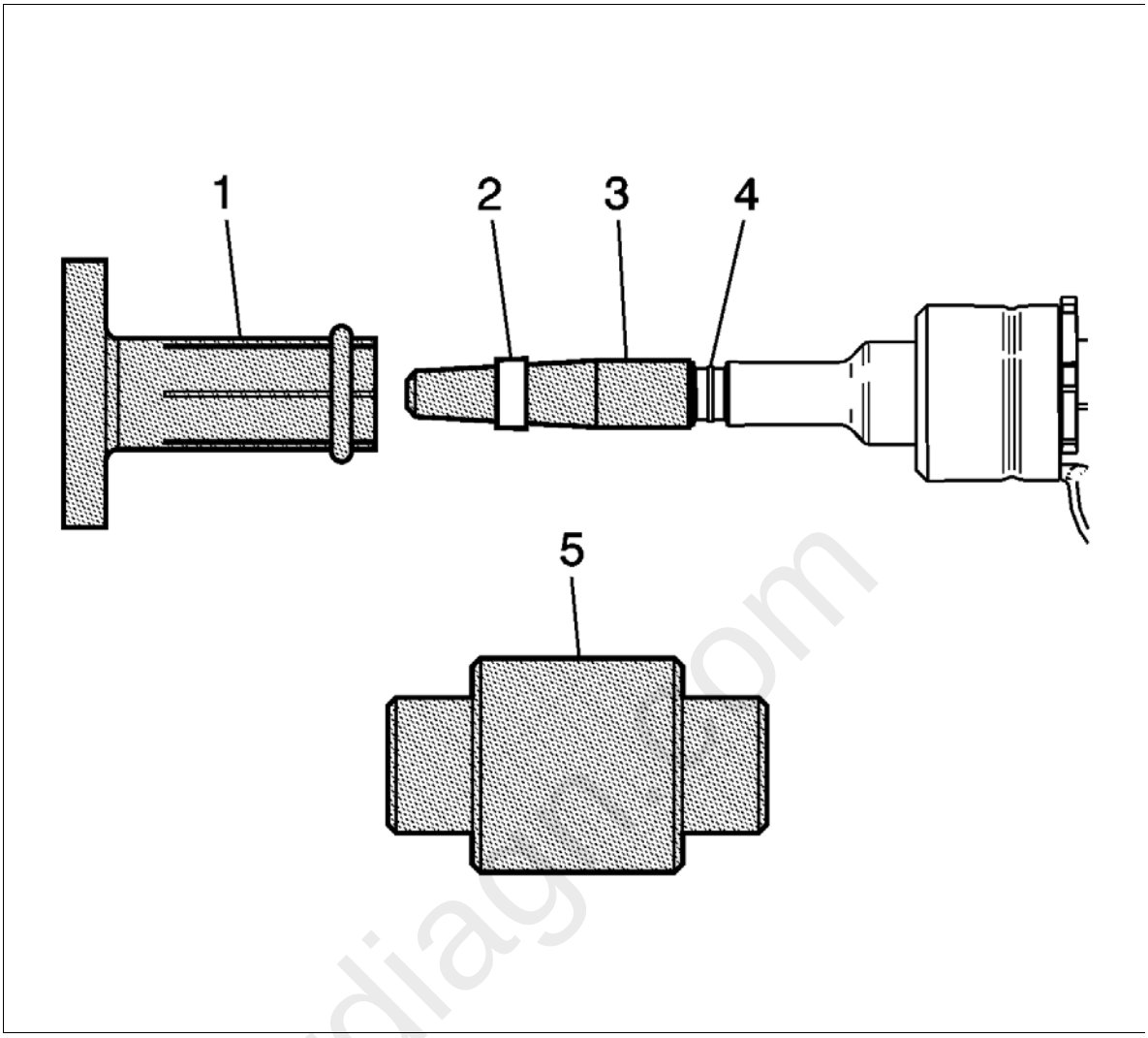


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24. Install the fuel rail wiring harnesses (1).

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Fig 12: Fuel Injector Tip & Seals



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NOTE:

Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector.

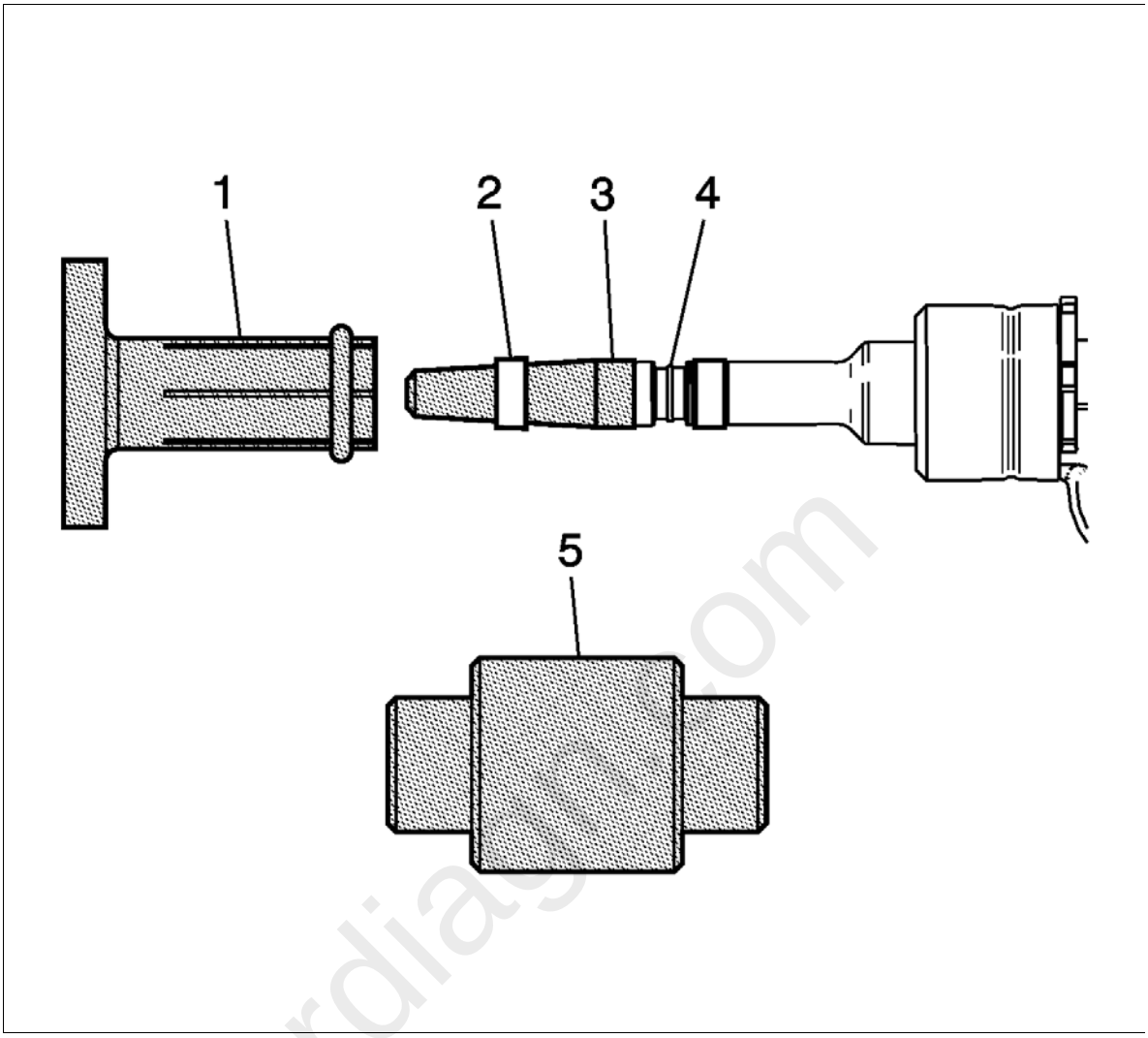
25. Install **EN-51105-1** long protector (3) onto the fuel injector tip, covering the first recessed area closest to the tip. Place a new seal (2) on **EN-51105-1** long protector.
26. Using **EN-49245-3** pusher (1), install the seal into the second recessed area (4) of the fuel injector.

NOTE:

*The **EN-49245-4** sizer is two sided, and either direction will size the seal correctly.*

27. Compress the seal with your fingers, then resize the seal if using the **EN-49245-4** sizer (5).

Fig 13: Fuel Injector Tip & Seals



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector.

28. Install **EN-51105-2** short protector (3) onto the fuel injector tip. Place a NEW seal (2) on **EN-51105-2** short protector.

29. Using **EN-49245-3** pusher (1), install the seal into the first recessed area (4) of the fuel injector.

NOTE:

*The **EN-49245-4** sizer is two sided, and either direction will size the seal correctly.*

30. Compress the seal with your fingers, then resize the seal using the **EN-49245-4** sizer (5).

REPAIR INSTRUCTIONS - OFF VEHICLE > THREAD REPAIR

Special Tools

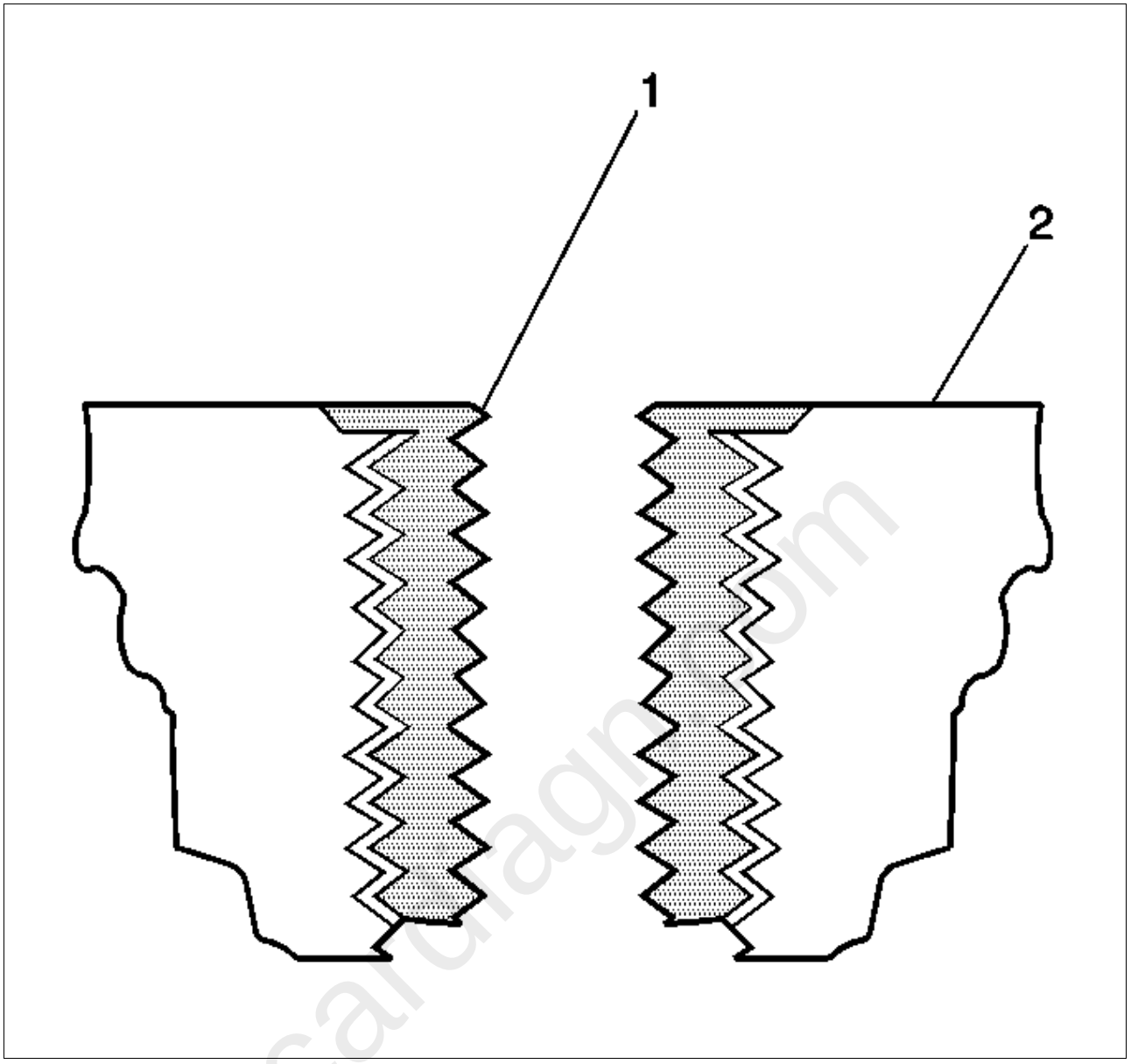
- **EN-42385-50** Head/Main Bolt Thread Repair Kit
- **J 42385-200** Fixtures and Hardware Kit
- **J 42385-300** Fixtures and Hardware Kit

For equivalent regional tools, refer to Special Tools

REPAIR INSTRUCTIONS - OFF VEHICLE > THREAD REPAIR > GENERAL THREAD REPAIR

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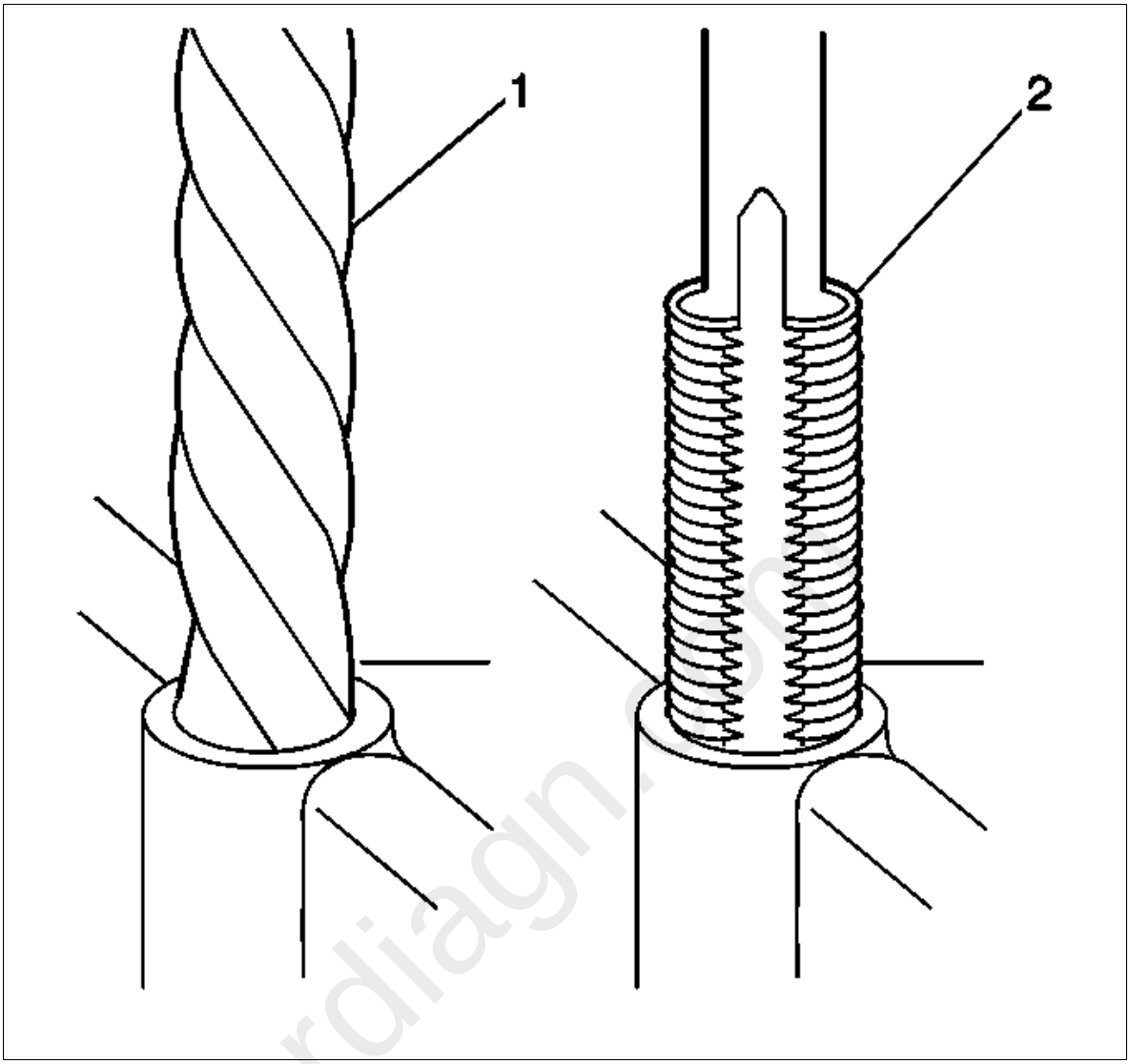
Fig 1: Bushing Type Insert & Base Material



Courtesy of GENERAL MOTORS COMPANY

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

Fig 2: Drilling & Tapping Threads



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WARNING:

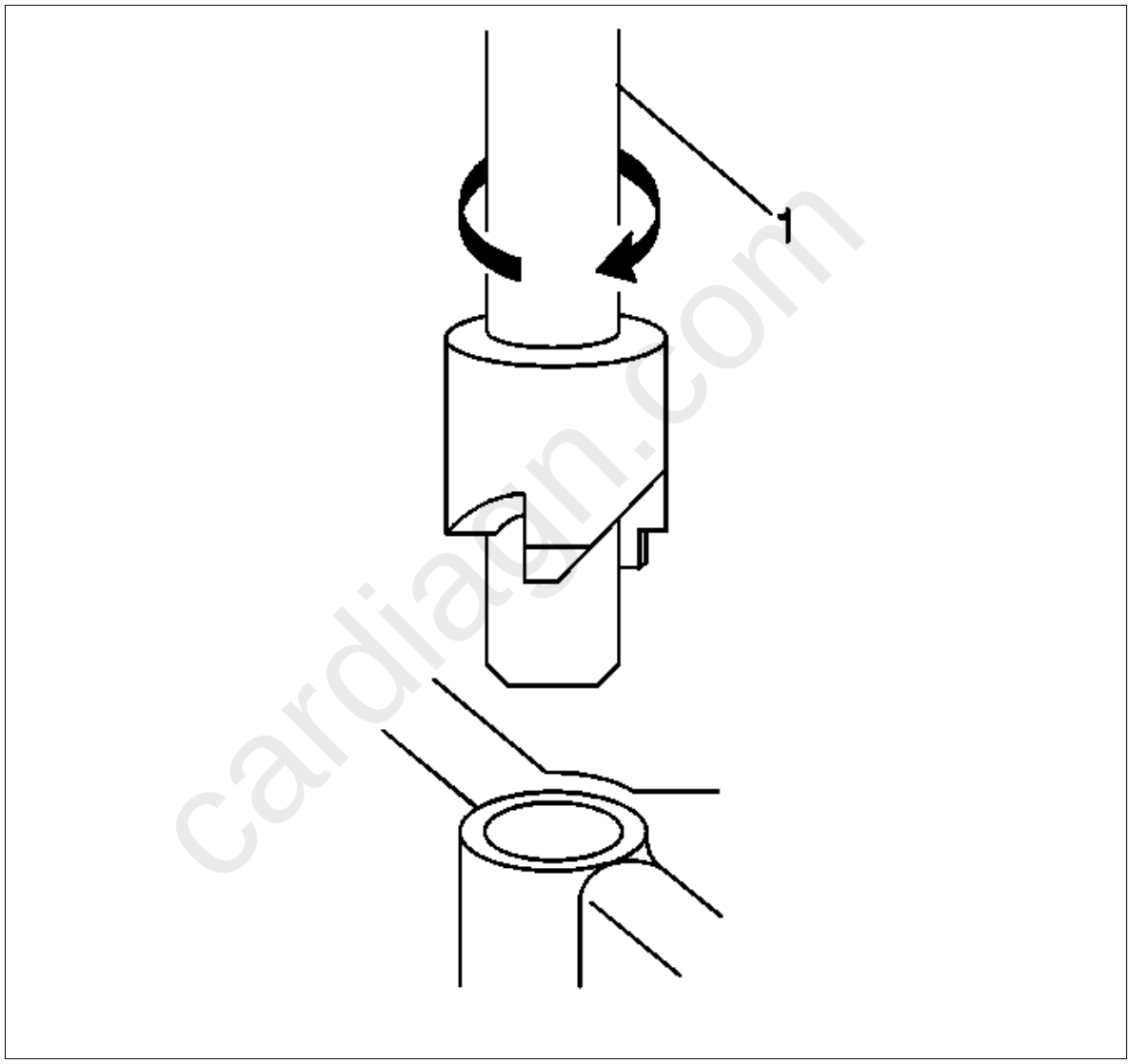
Refer to Safety Glasses Warning .

NOTE:

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

1. Drill out the threads of the damaged hole (1).
    1. M6 inserts require a minimum drill depth of 15 mm (0.59 in).
    2. M8 inserts require a minimum drill depth of 20 mm (0.79 in).
    3. M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).
2. Using compressed air, clean out any chips.

Fig 3: Tool Used To Counterbore The Hole

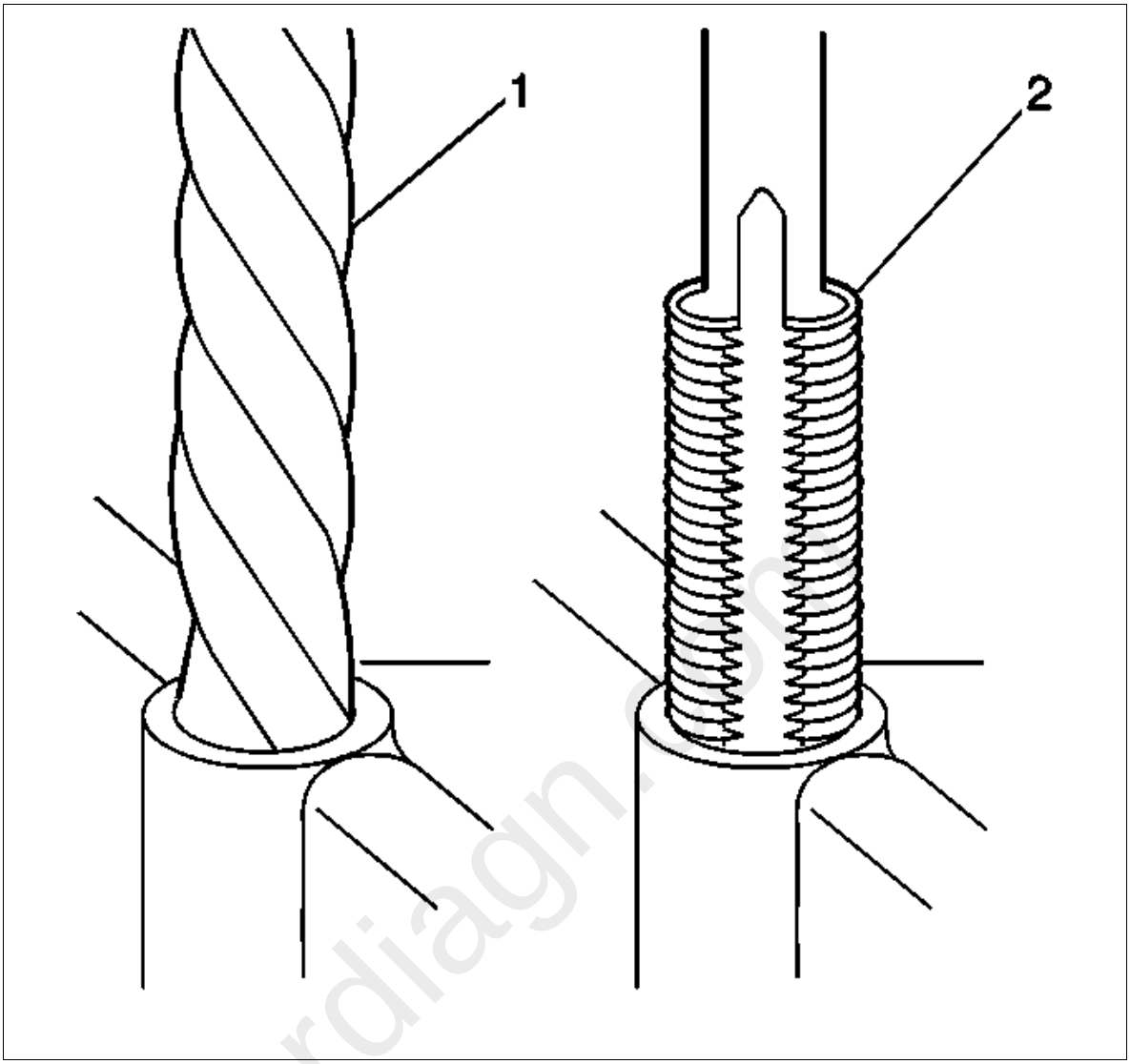


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3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

Fig 4: Drilling & Tapping Threads

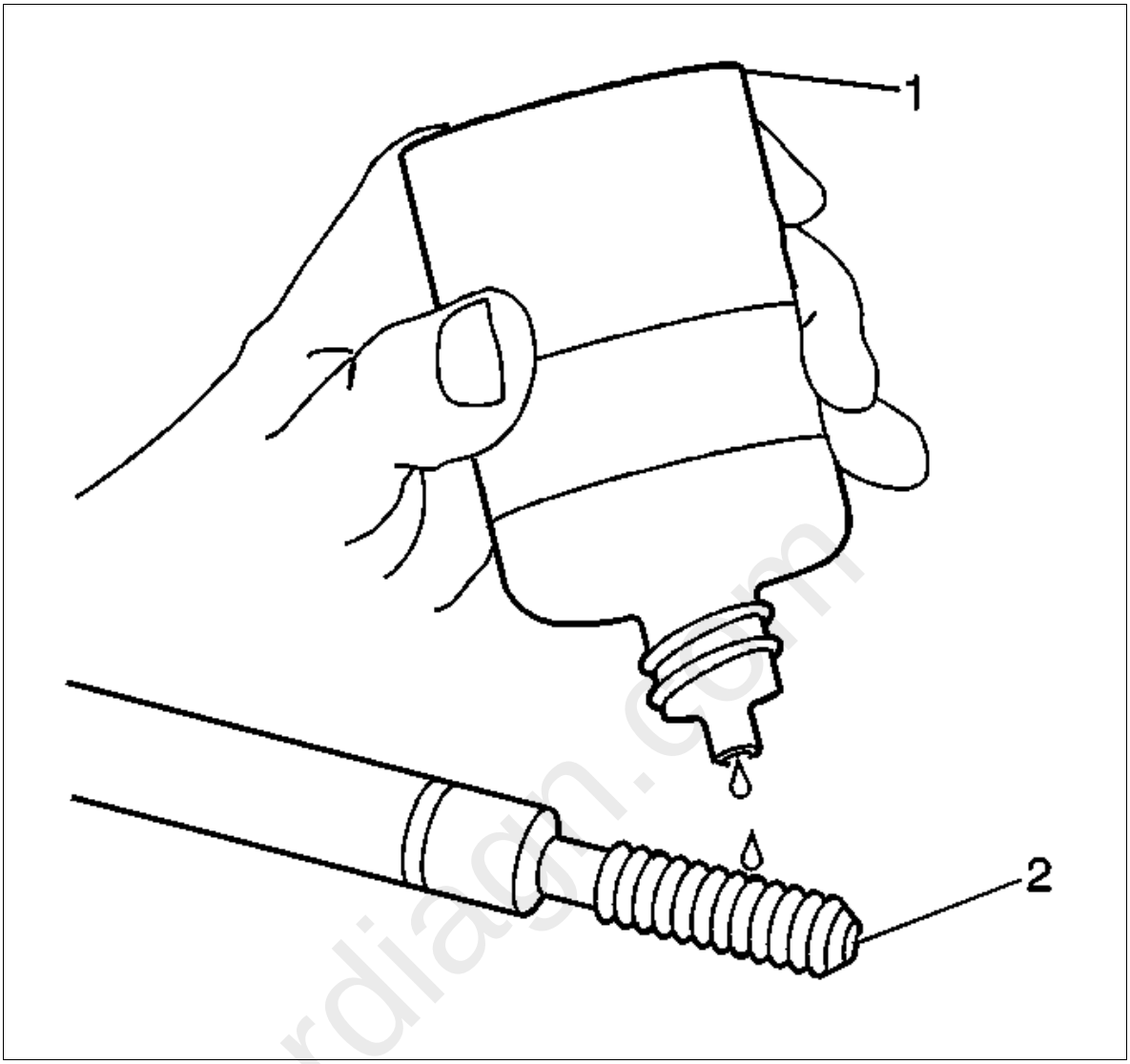


Courtesy of GENERAL MOTORS COMPANY

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

Fig 5: Lubricating Installer Tool Using Driver Oil



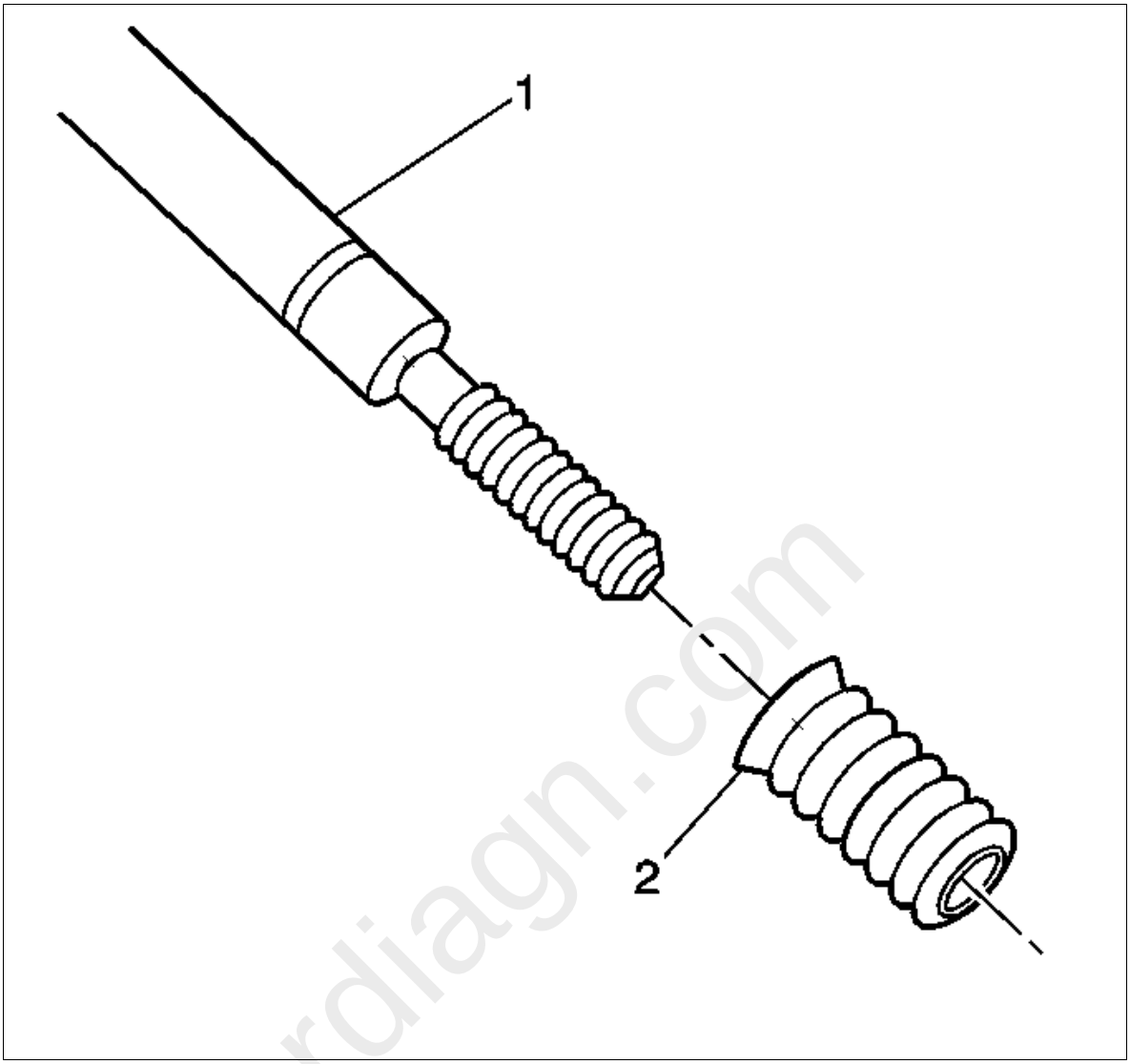
Courtesy of GENERAL MOTORS COMPANY

NOTE:

Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

Fig 6: Bushing Type Insert

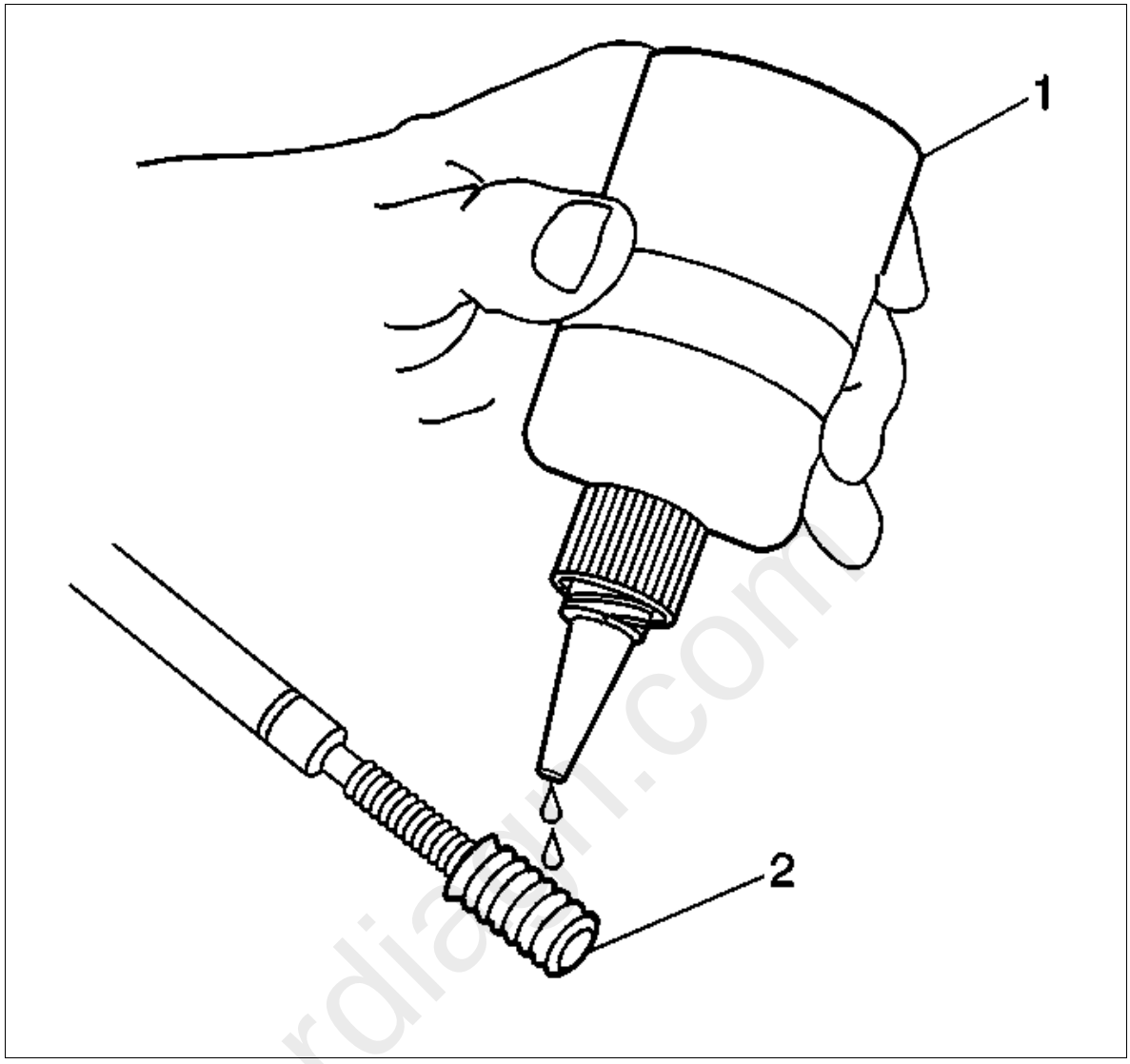


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10. Install the insert (2) onto the driver tool (1).

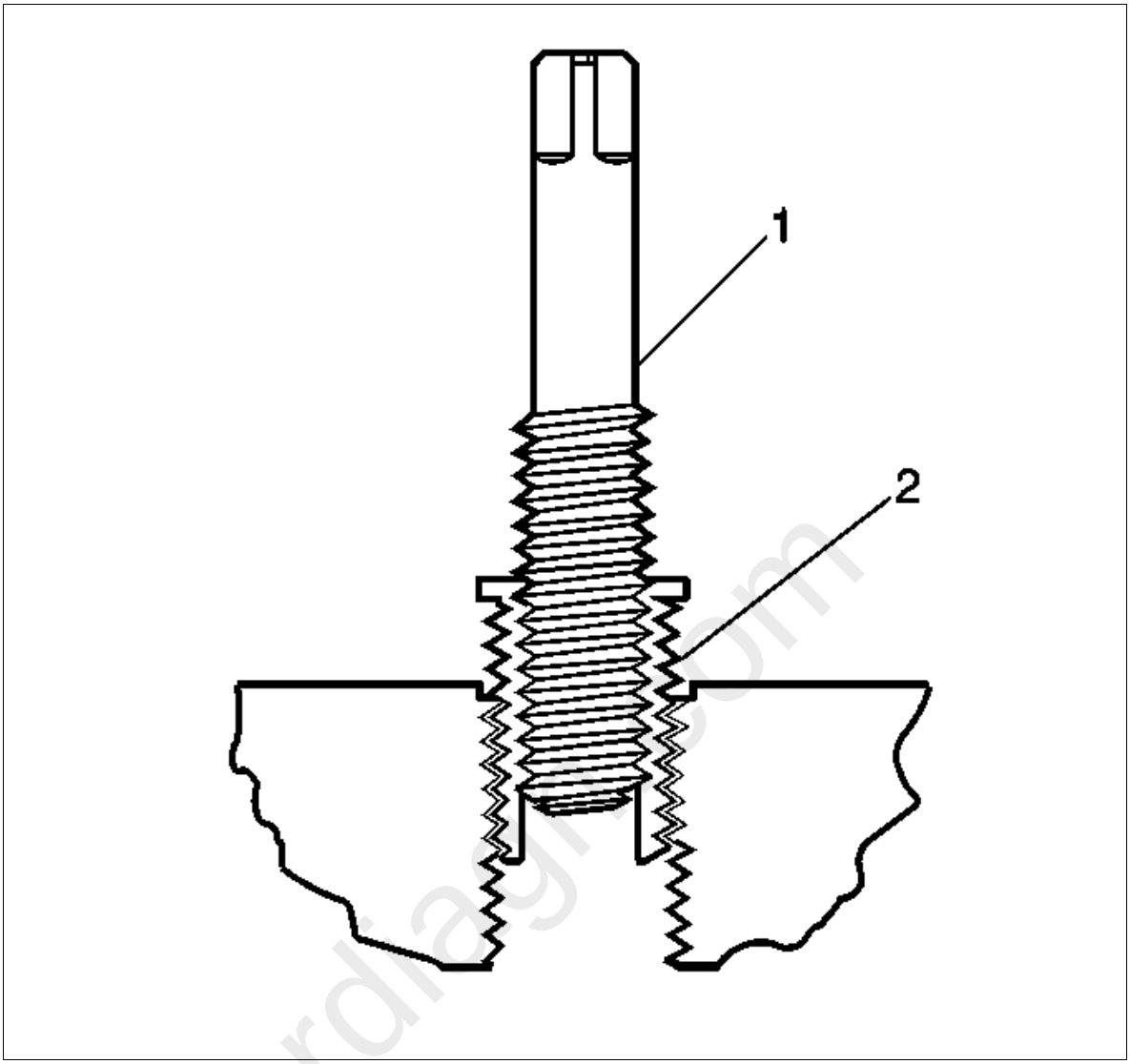
Fig 7: Threadlock To Insert



Courtesy of GENERAL MOTORS COMPANY

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

Fig 8: Insert In Tapped Bolt Hole



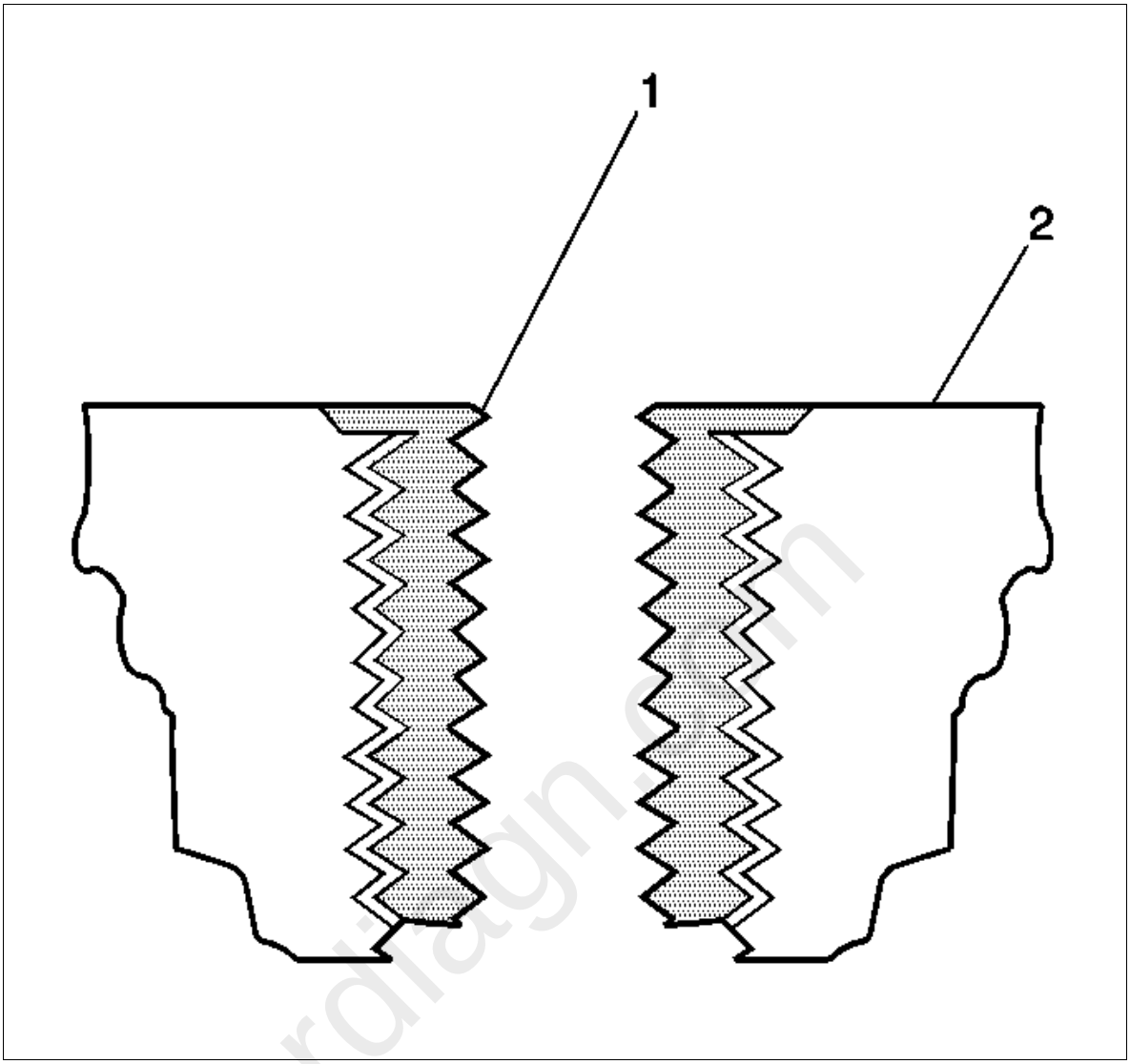
Courtesy of GENERAL MOTORS COMPANY

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

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

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

Fig 9: Bushing Type Insert & Base Material



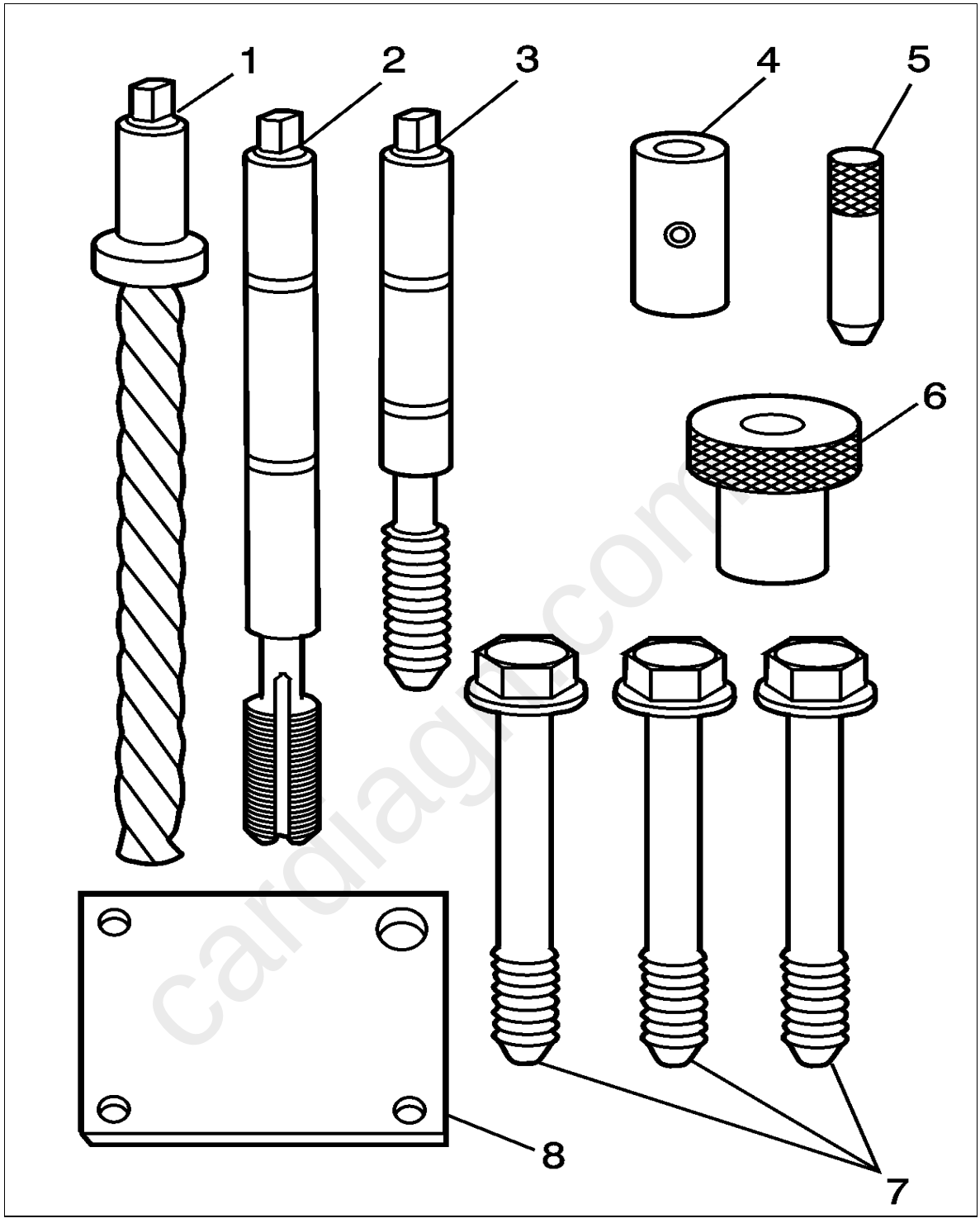
Courtesy of GENERAL MOTORS COMPANY

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

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

REPAIR INSTRUCTIONS - OFF VEHICLE > THREAD REPAIR > CYLINDER HEAD BOLT HOLE THREAD REPAIR

Fig 1: Cylinder Head Bolt Hole Thread Repair Kit

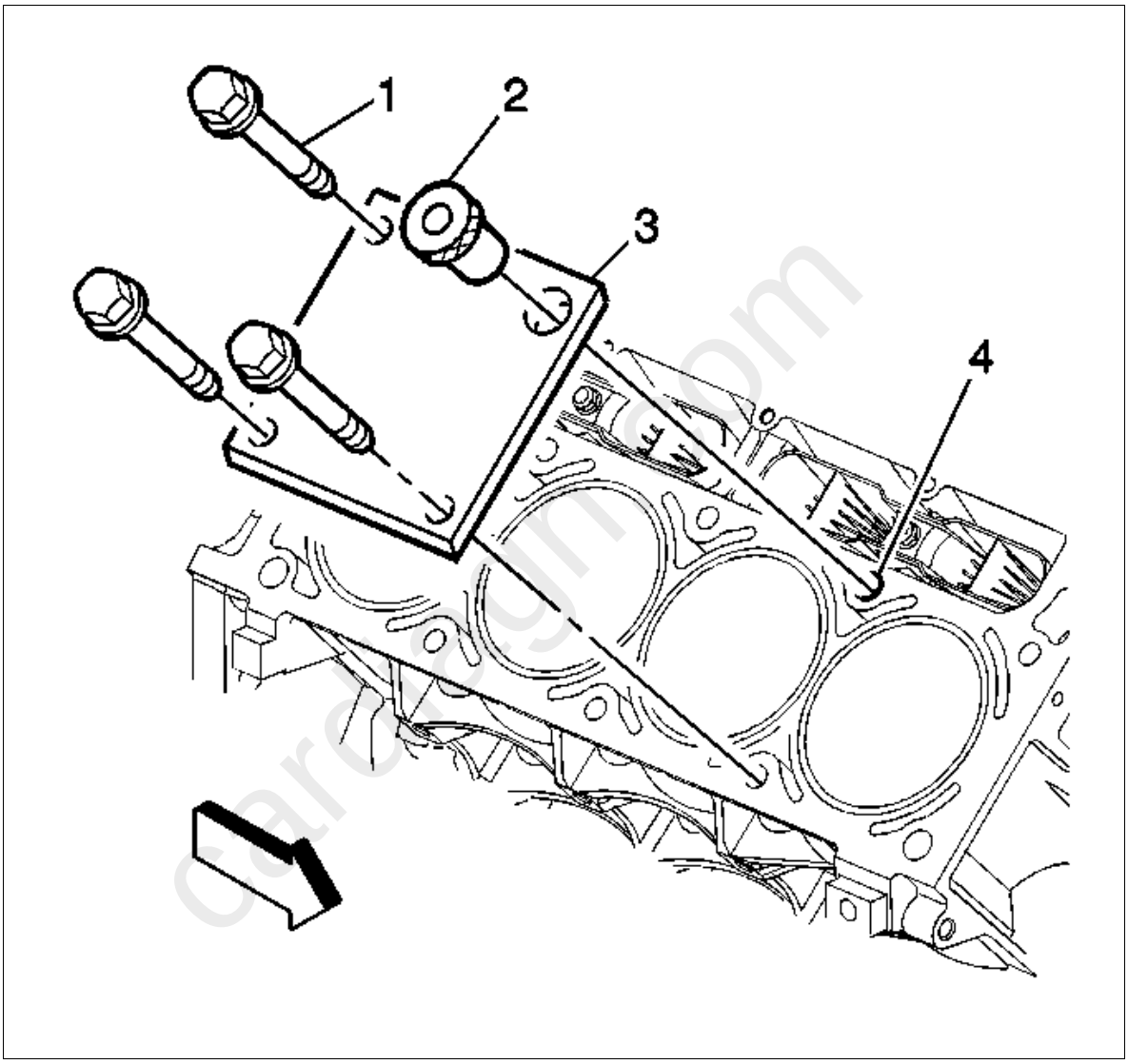


Courtesy of GENERAL MOTORS COMPANY

1. The cylinder head bolt hole thread repair kit consists of the following items:
    1. **EN-42385-51** The drill (1)
    2. **EN-42385-52** The tap (2)
    3. **EN-42385-53** The installer (3)

4. **EN-42385-57** The sleeve (4)
5. **EN-42385-55** The alignment pin (5)
6. **EN-42385-54** The bushing (6)
7. **EN-42385-56** The bolts (7)
8. **J-42385-301** The fixture plate (8) (Part of **J-42385-300** Fixtures and Hardware Kit

Fig 2: Fixture Plate, Bolts, Bushing & Cylinder Hole



Courtesy of GENERAL MOTORS COMPANY

WARNING:

Refer to Safety Glasses Warning .

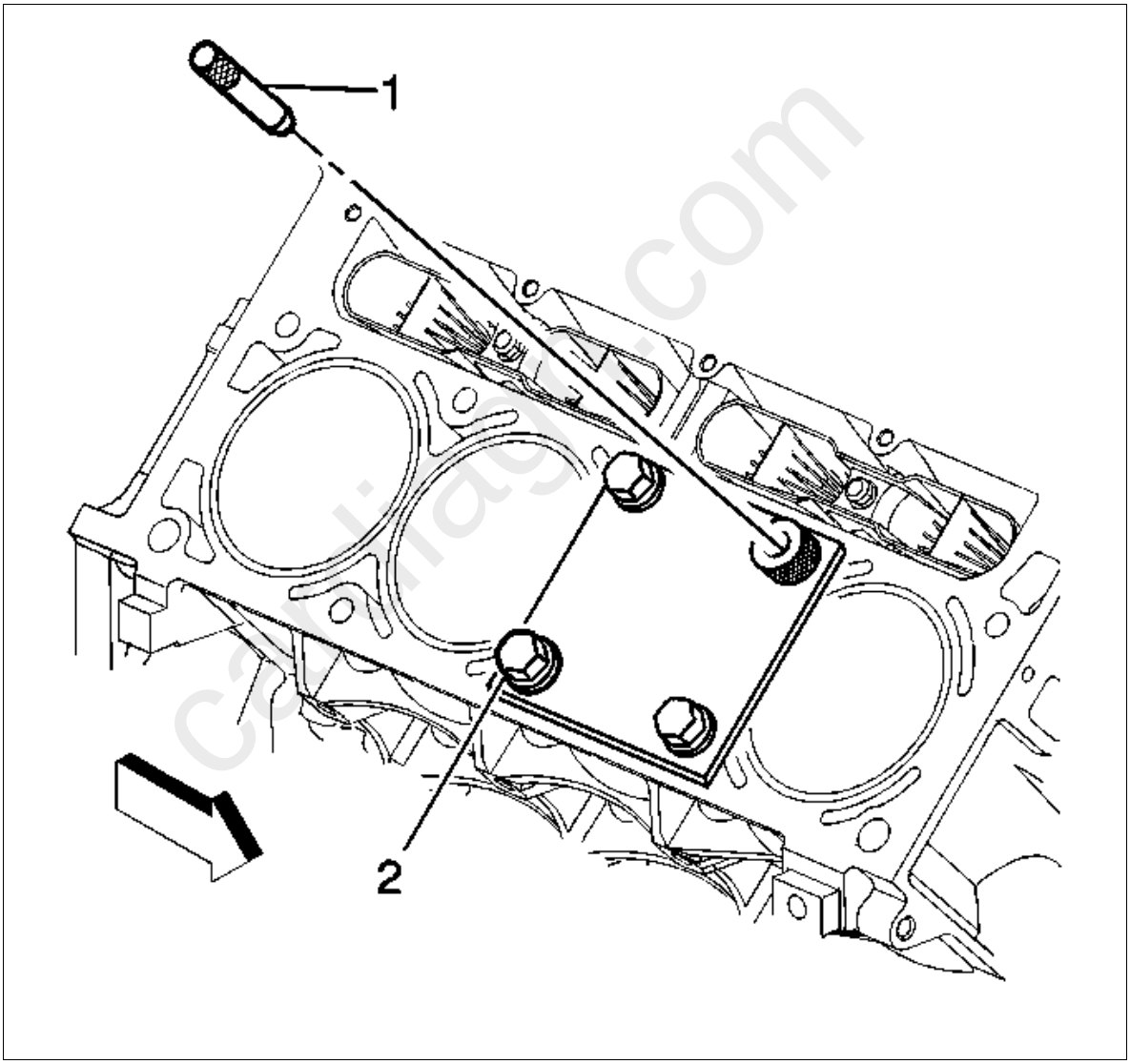
NOTE:

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

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

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

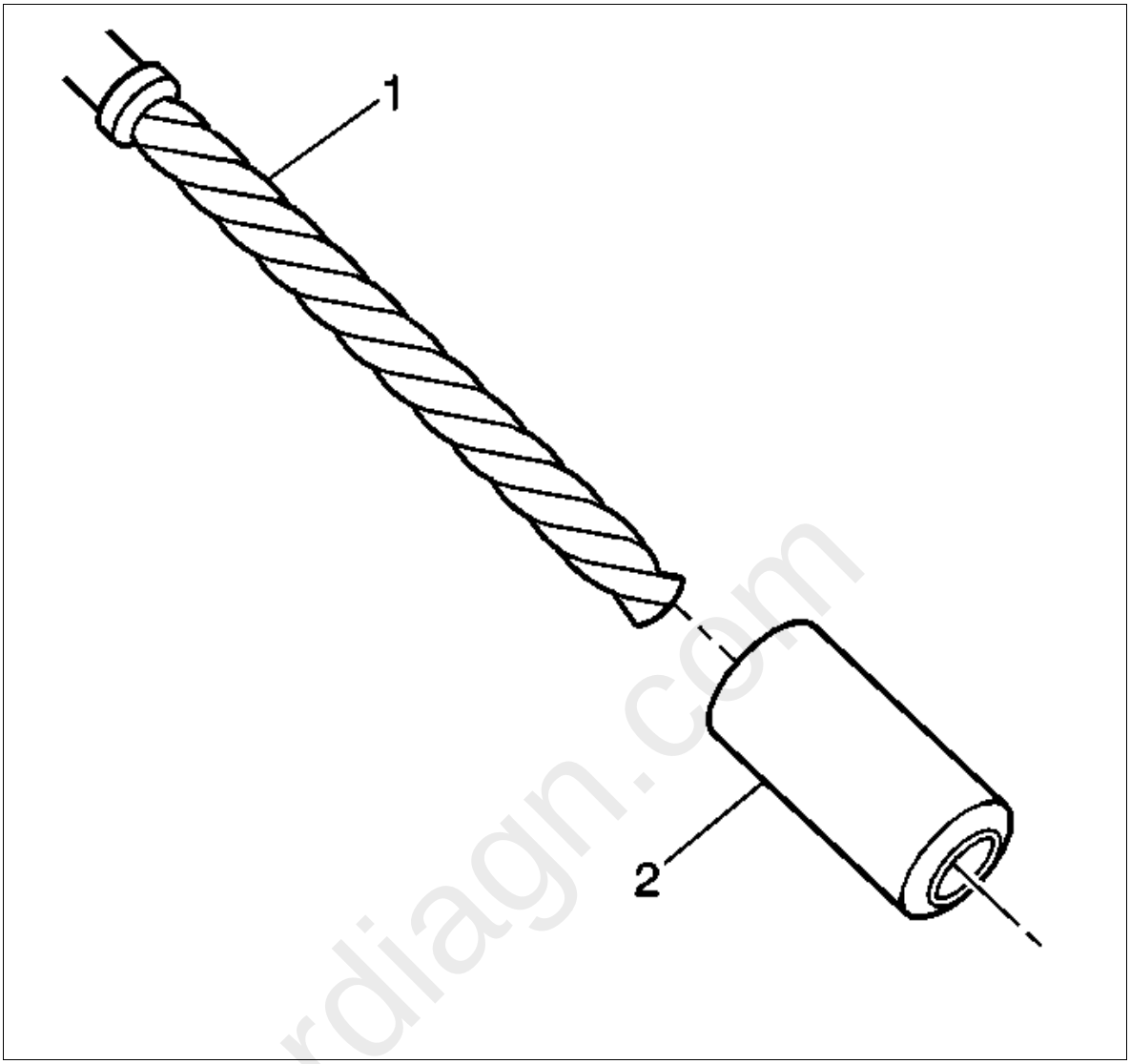
   Fig 3: Alignment Pin & Fixture Retaining Bolts



Courtesy of GENERAL MOTORS COMPANY

3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.

Fig 4: Stop Collar & Counterbore Drill



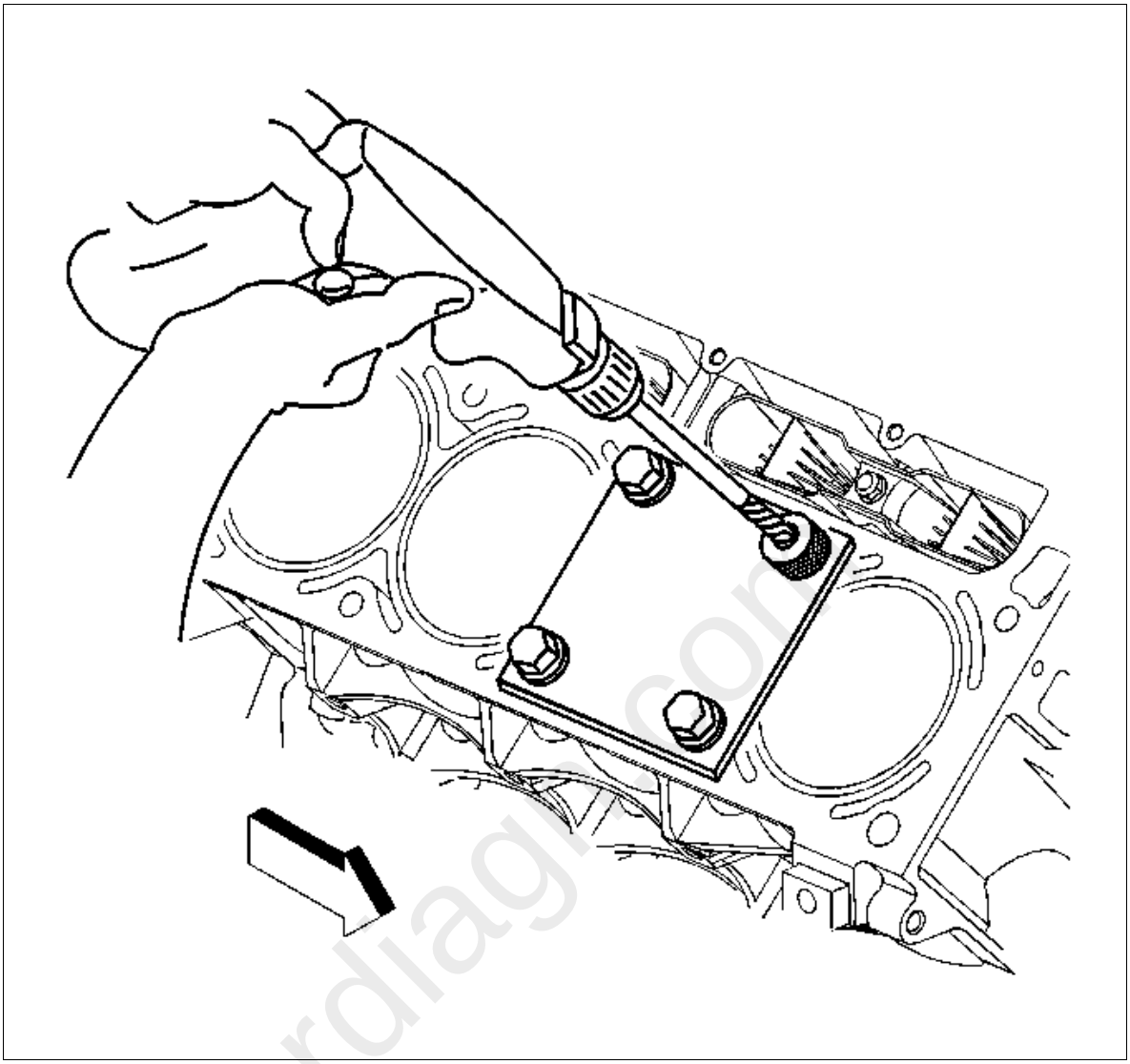
Courtesy of GENERAL MOTORS COMPANY

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> ⚠ *CAUTION:*
>
> *For the hole on the upper front corner of cylinder #1 (Left Cylinder Bank), install EN-42385-57 sleeve onto the drill. The depth of this hole is shallower than the others. If the sleeve is not used, damage to the engine block will occur.*

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

Fig 5: Drilling Cylinder Head Bolt Hole



Courtesy of GENERAL MOTORS COMPANY

NOTE:

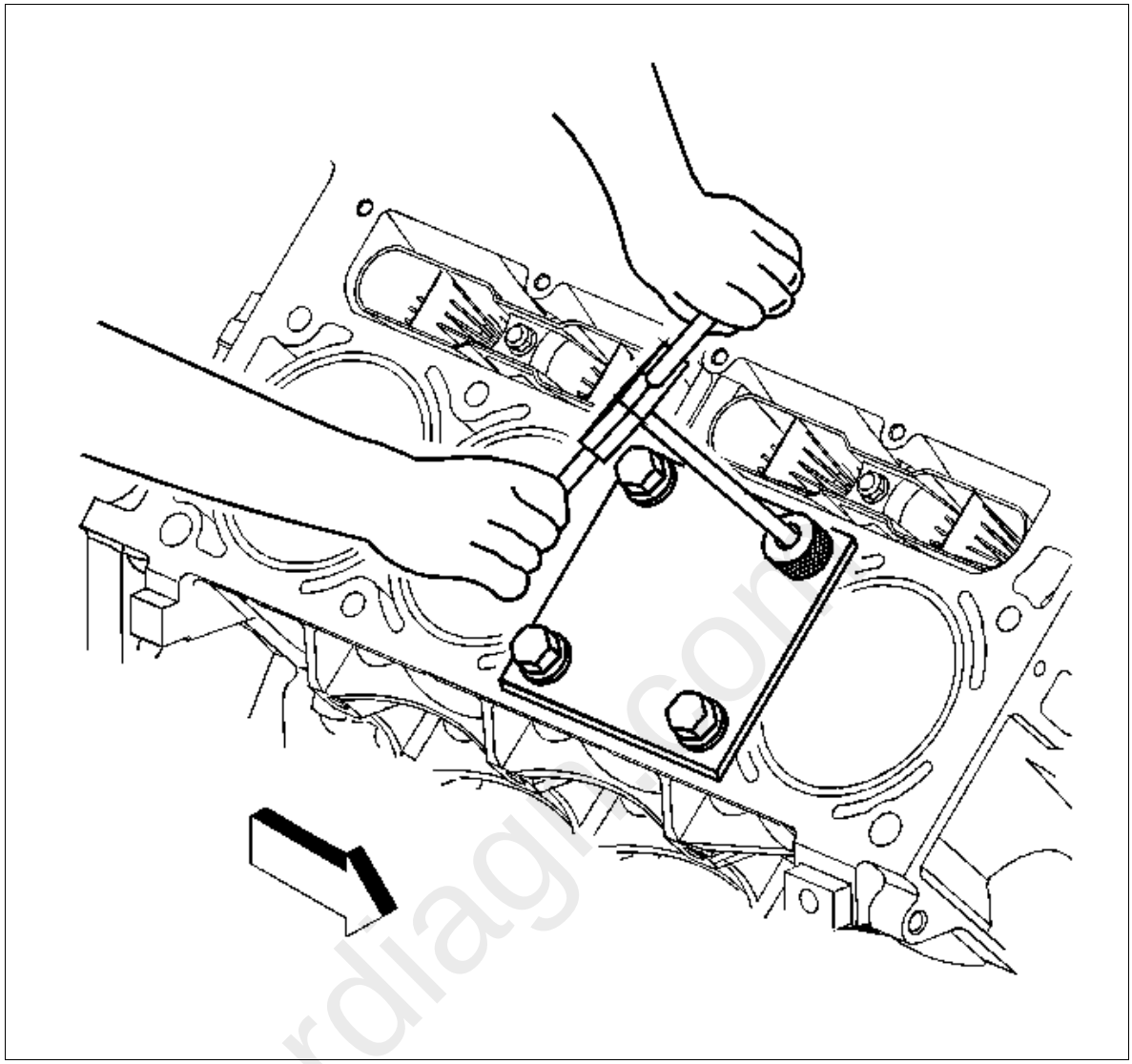
During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

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

8. Using compressed air, clean out any chips.

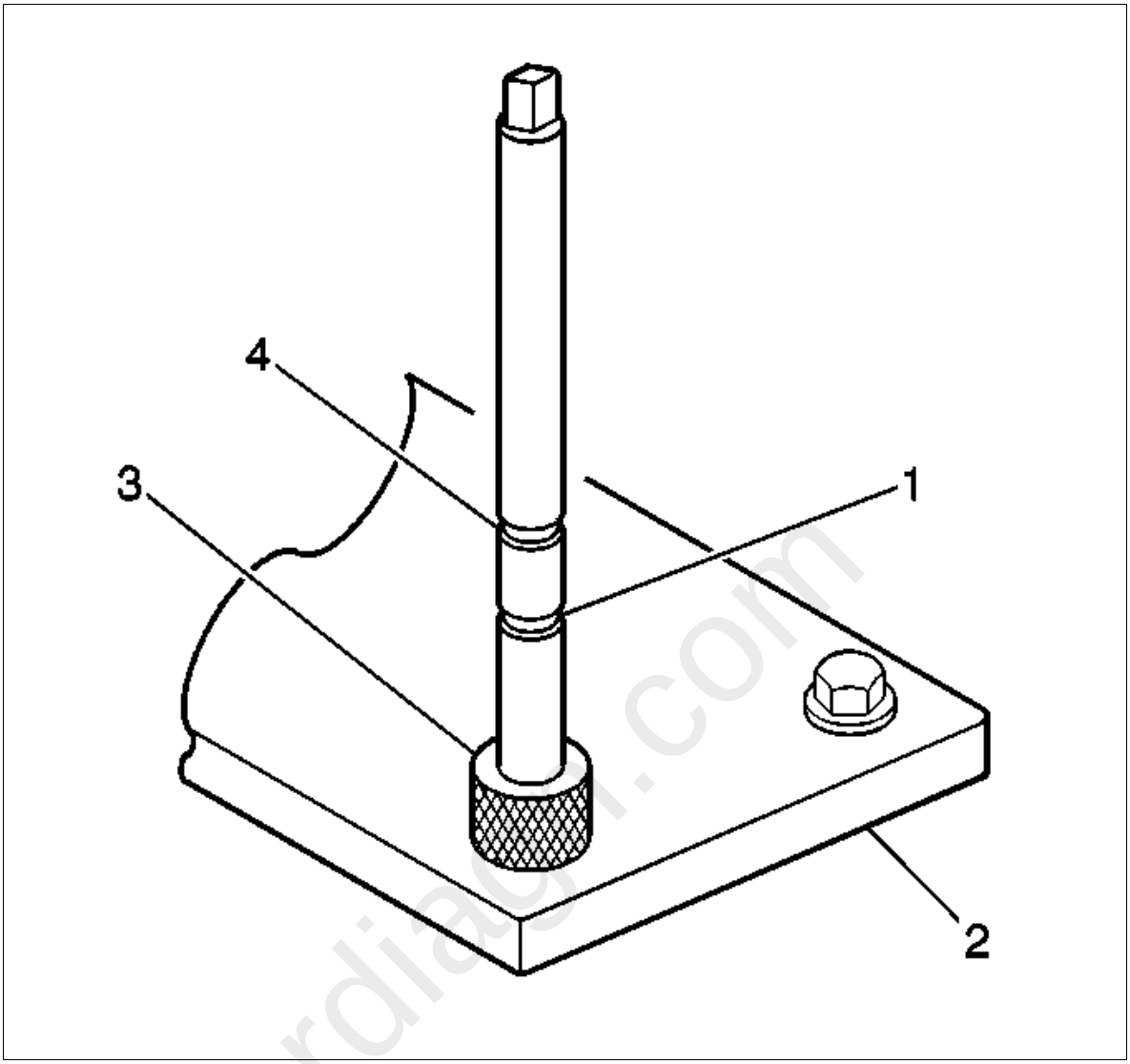
Fig 6: Tapping Threads Of Drilled Hole Using Tapping Wrench



Courtesy of GENERAL MOTORS COMPANY

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

Fig 7: Tap Upper & Lower Marks, Fixture Plate & Bushing



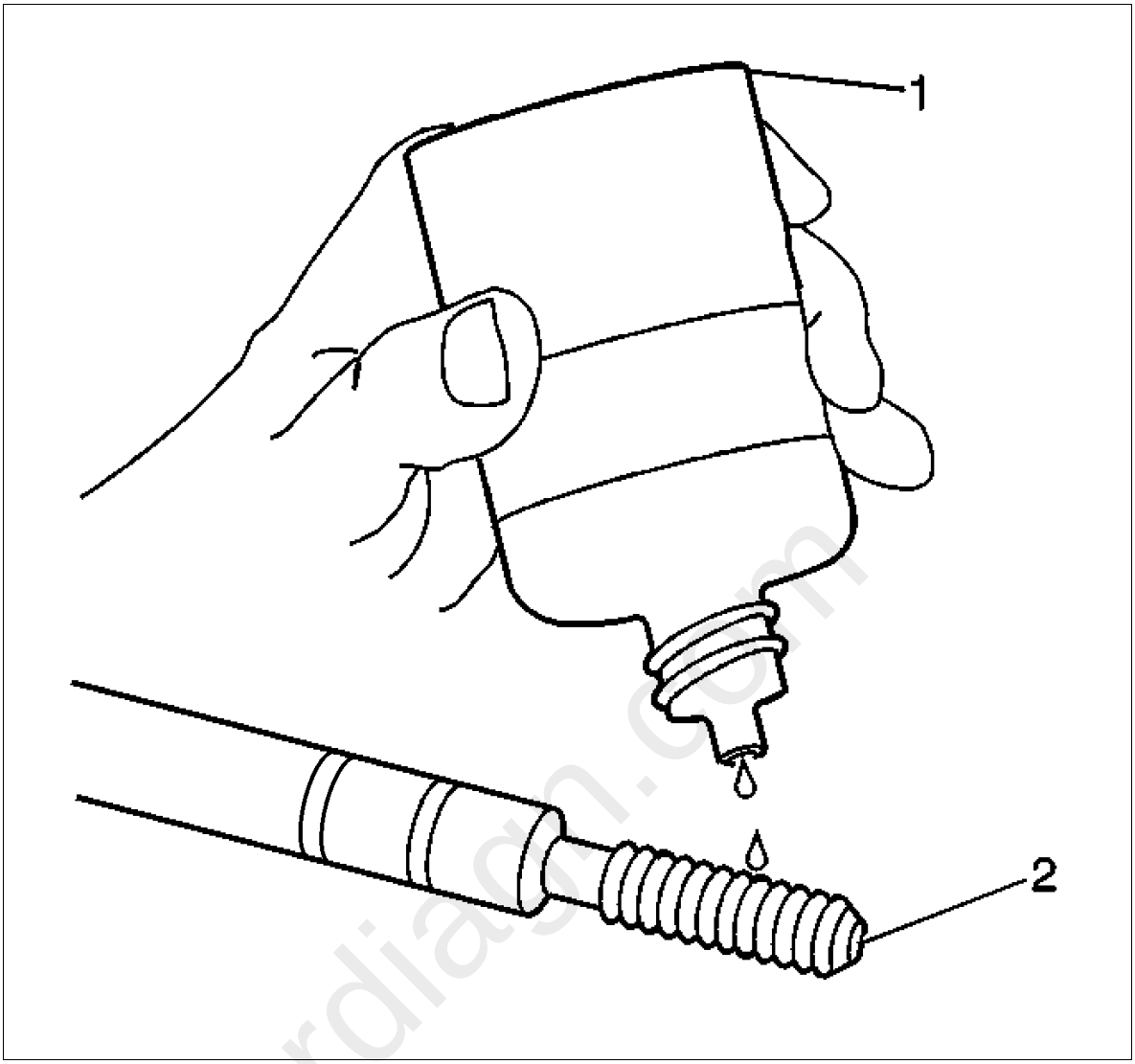
Courtesy of GENERAL MOTORS COMPANY

10. For the hole on the upper front corner of cylinder #1 (Left Cylinder Bank) only, rotate the tap into the hole until the first mark (1) on the tap aligns with the top of the drill bushing (3).

    For all other cylinder head bolt holes, rotate the tap into the hole until the second mark (4) on the tap aligns with the top of the drill bushing (3).

11. Remove the fixture plate (2), bushing (3), and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
14. Using compressed air, clean any cutting oil and chips out of the hole.

Fig 8: Installer Tool



Courtesy of GENERAL MOTORS COMPANY

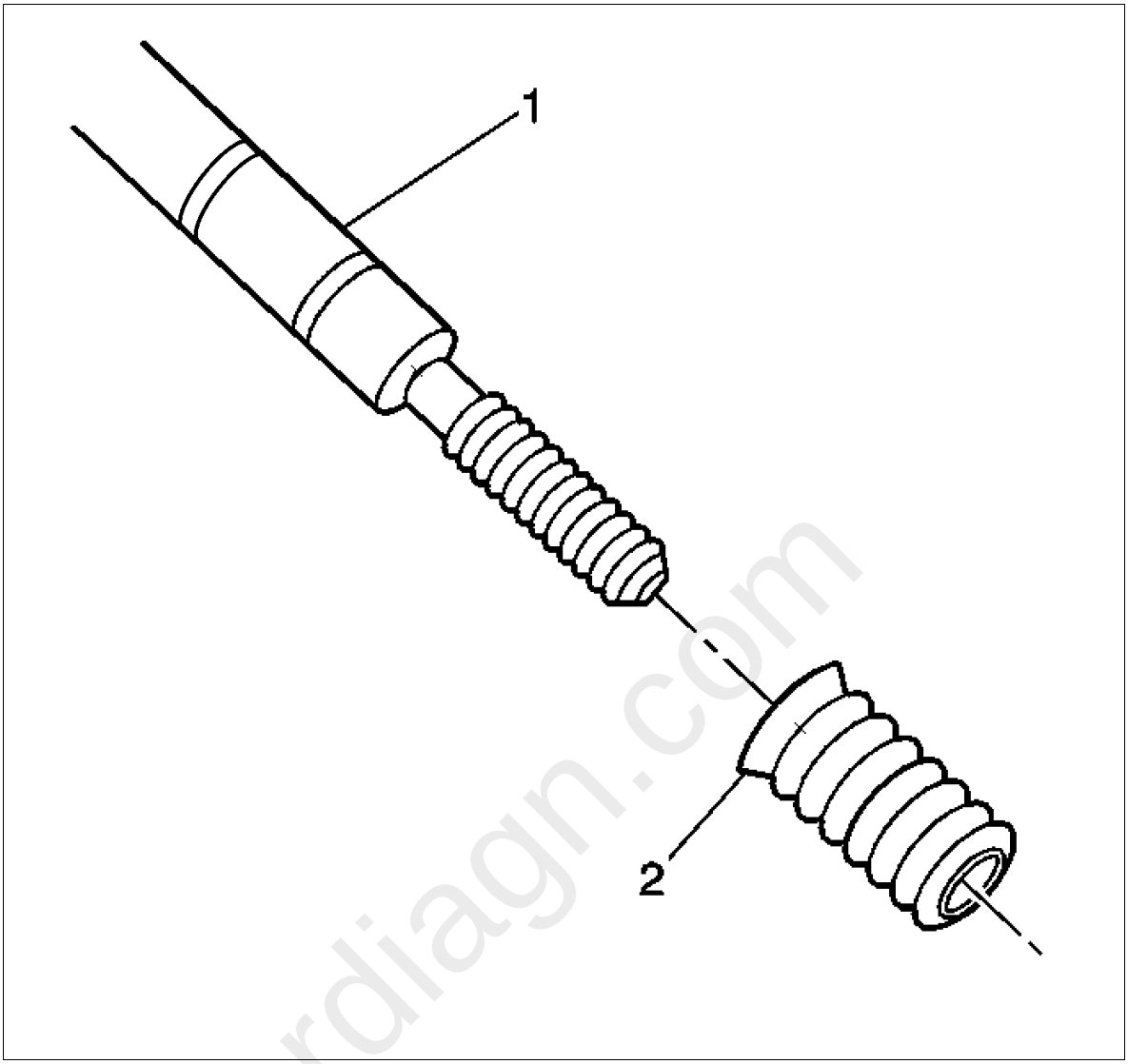
NOTE:

Do not allow oil or foreign material to contact the OD of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

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Fig 9: Insert And Driver Tool

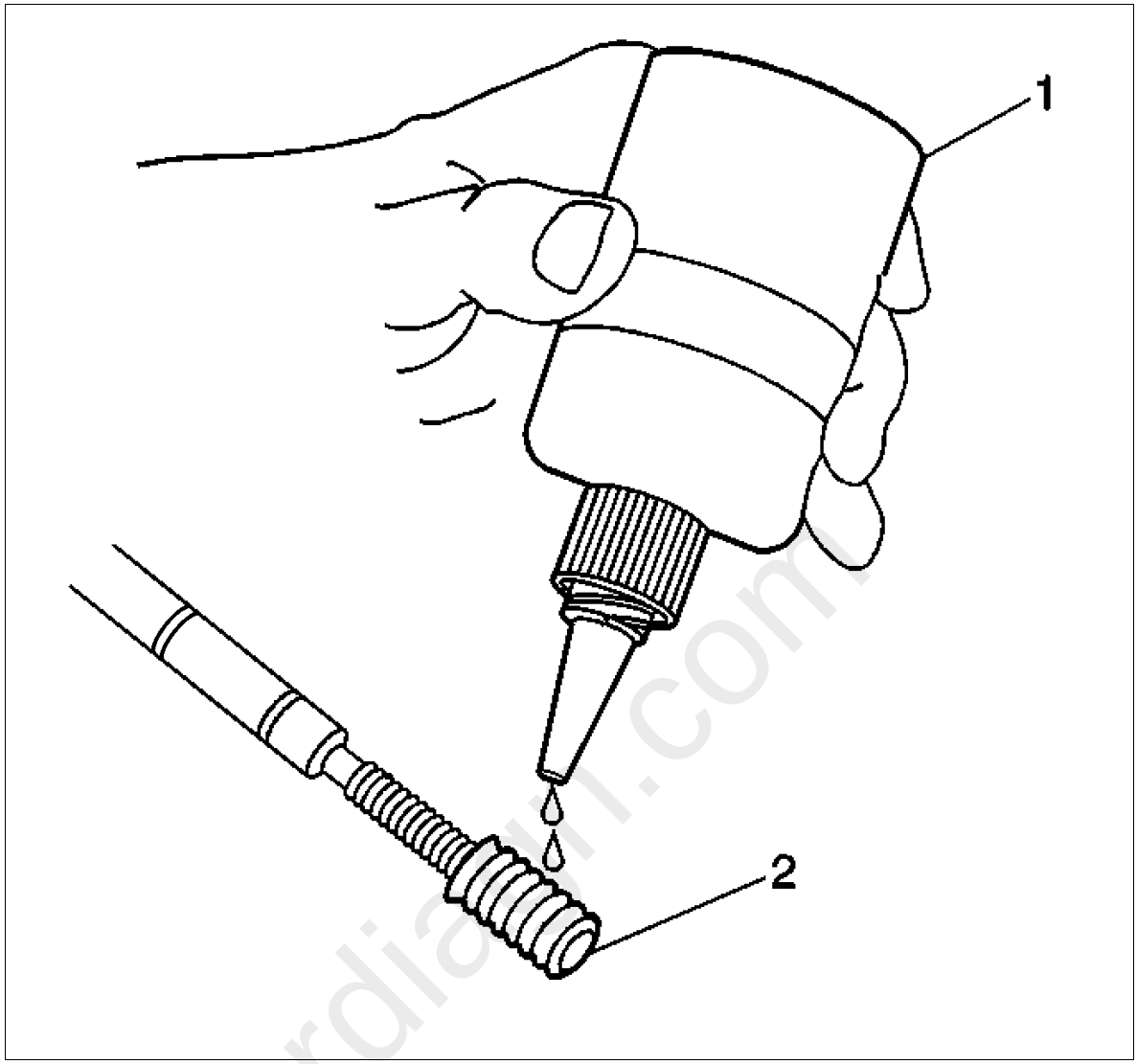


Courtesy of GENERAL MOTORS COMPANY

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

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Fig 10: Threadlock

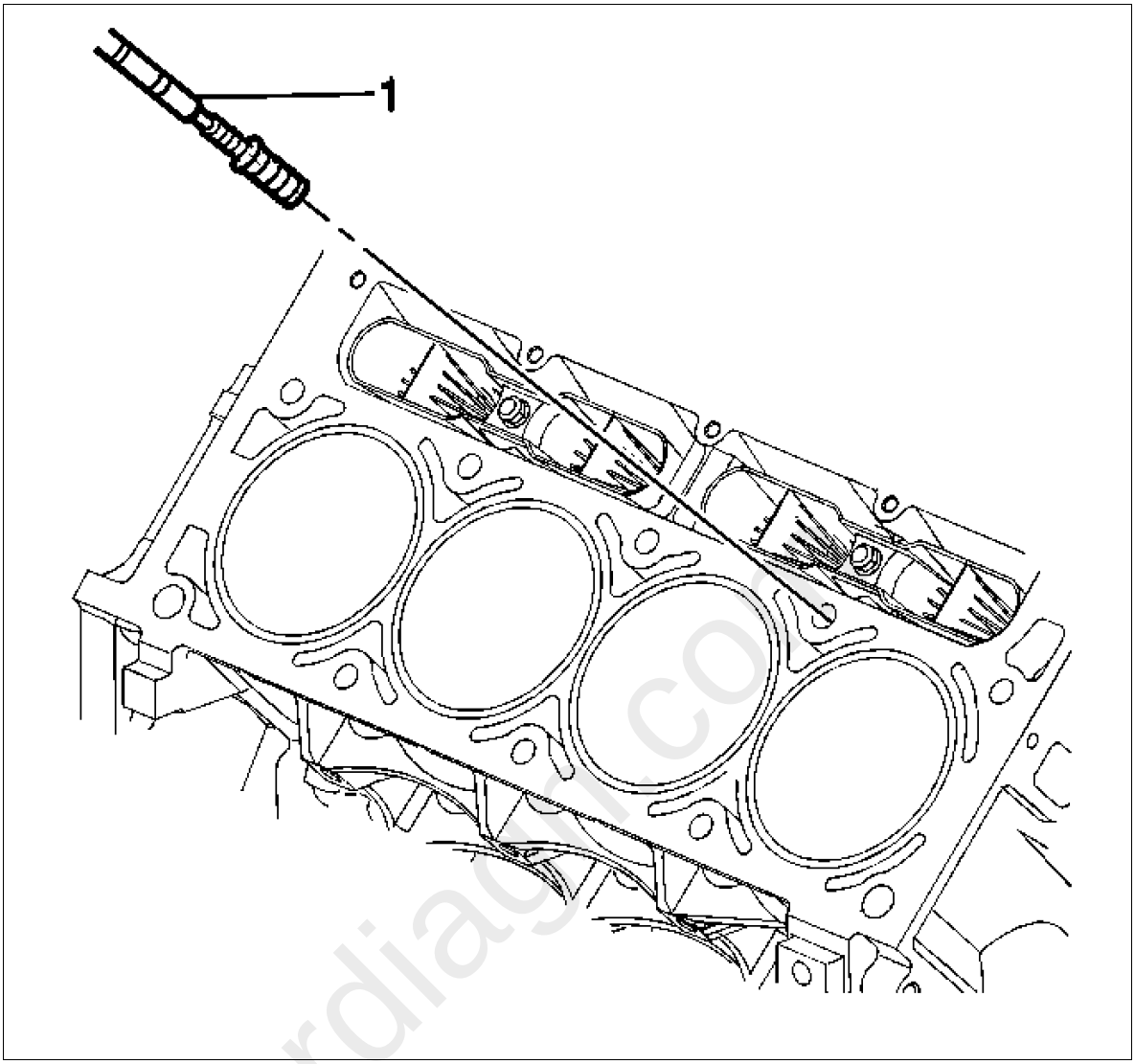


Courtesy of GENERAL MOTORS COMPANY

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

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Fig 11: Insert And Driver



Courtesy of GENERAL MOTORS COMPANY

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

    For the hole on the upper front corner of cylinder #1 (Left Cylinder Bank) only, rotate the driver tool until the lower mark on the driver tool aligns with the deck surface of the engine block.

    For all other cylinder head bolt holes, rotate the driver tool until the upper mark on the driver tool aligns with the deck surface of the engine block.

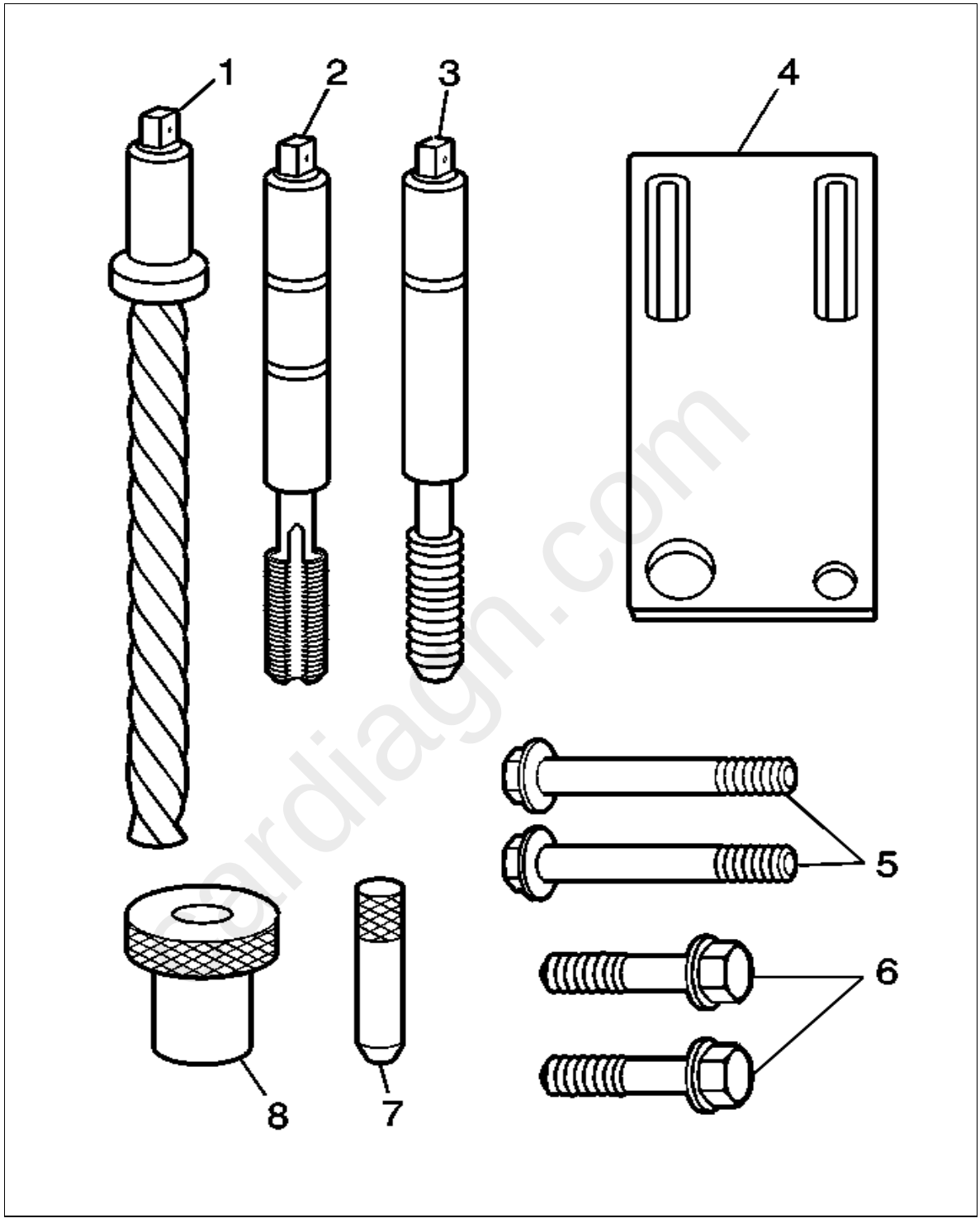
    1. Rotate the driver tool until the upper mark on the driver tool aligns with the deck surface of the engine block.

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

REPAIR INSTRUCTIONS - OFF VEHICLE > THREAD REPAIR > MAIN CAP BOLT HOLE

THREAD REPAIR

Fig 1: Thread Repair Kit Components

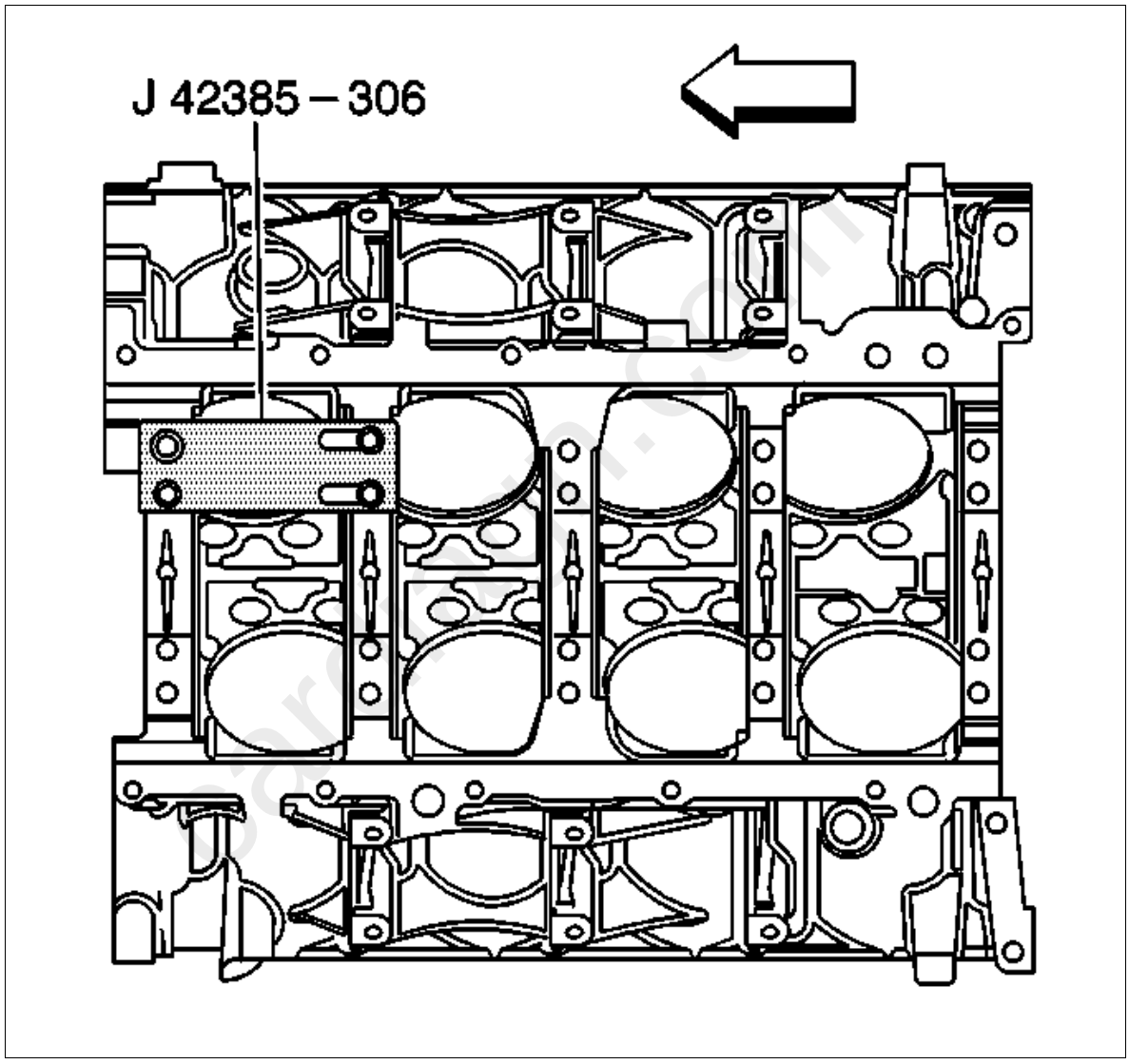


Courtesy of GENERAL MOTORS COMPANY

1. The main cap bolt hole thread repair kit consists of the following items:
    1. The drill (1)
    2. The tap (2)

3. The installer (3)
4. The fixture plate (4)
5. The long bolts (5)
6. The short bolts (6)
7. The alignment pin (7)
8. The bushing (8)

Fig 2: Fixture Plate, Bolt & Bushing



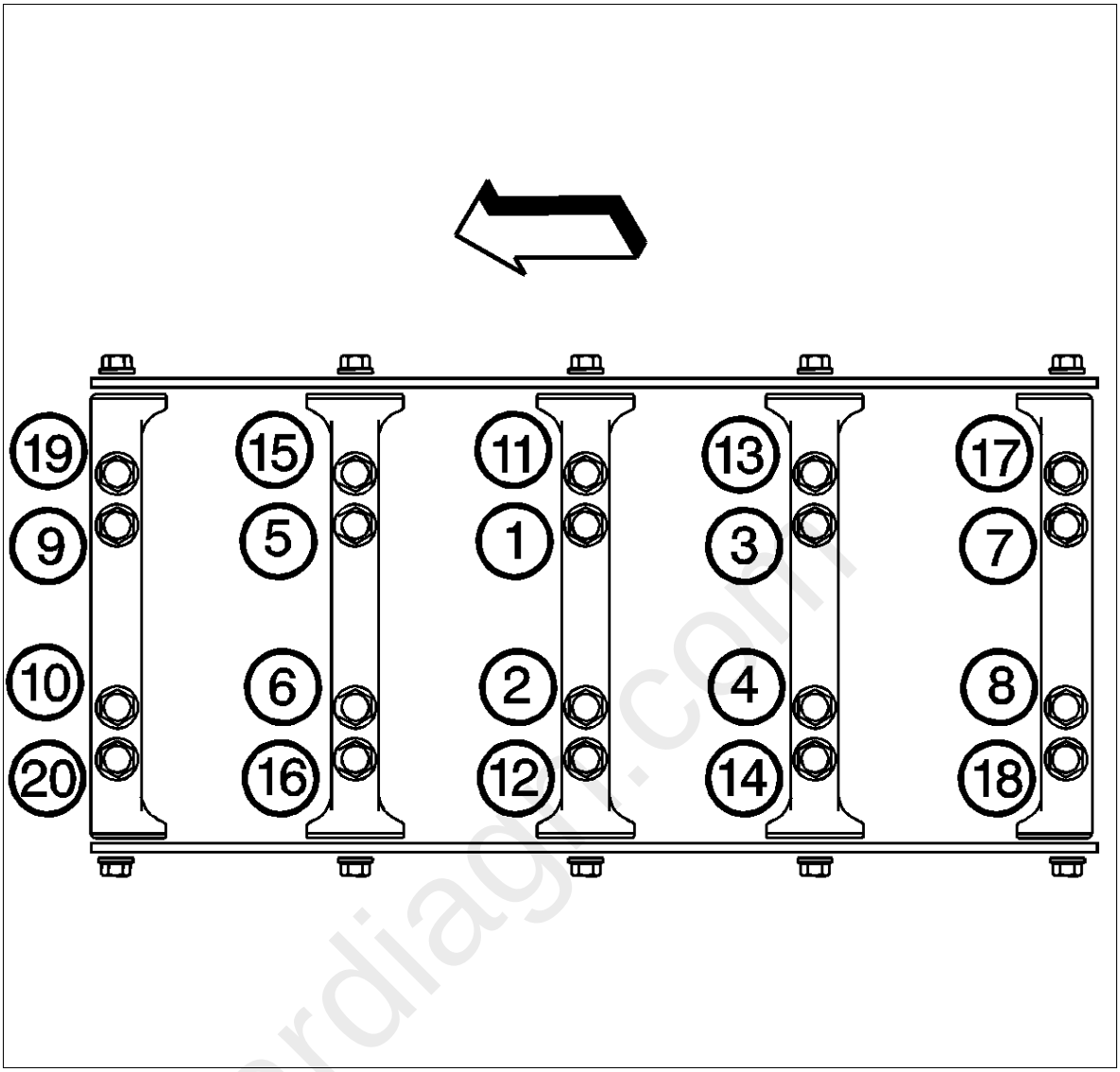
Courtesy of GENERAL MOTORS COMPANY

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

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

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

Fig 3: Crankshaft Main Bearing Cap Bolt Tightening Sequence



Courtesy of GENERAL MOTORS COMPANY

4. Drill out the damaged hole.

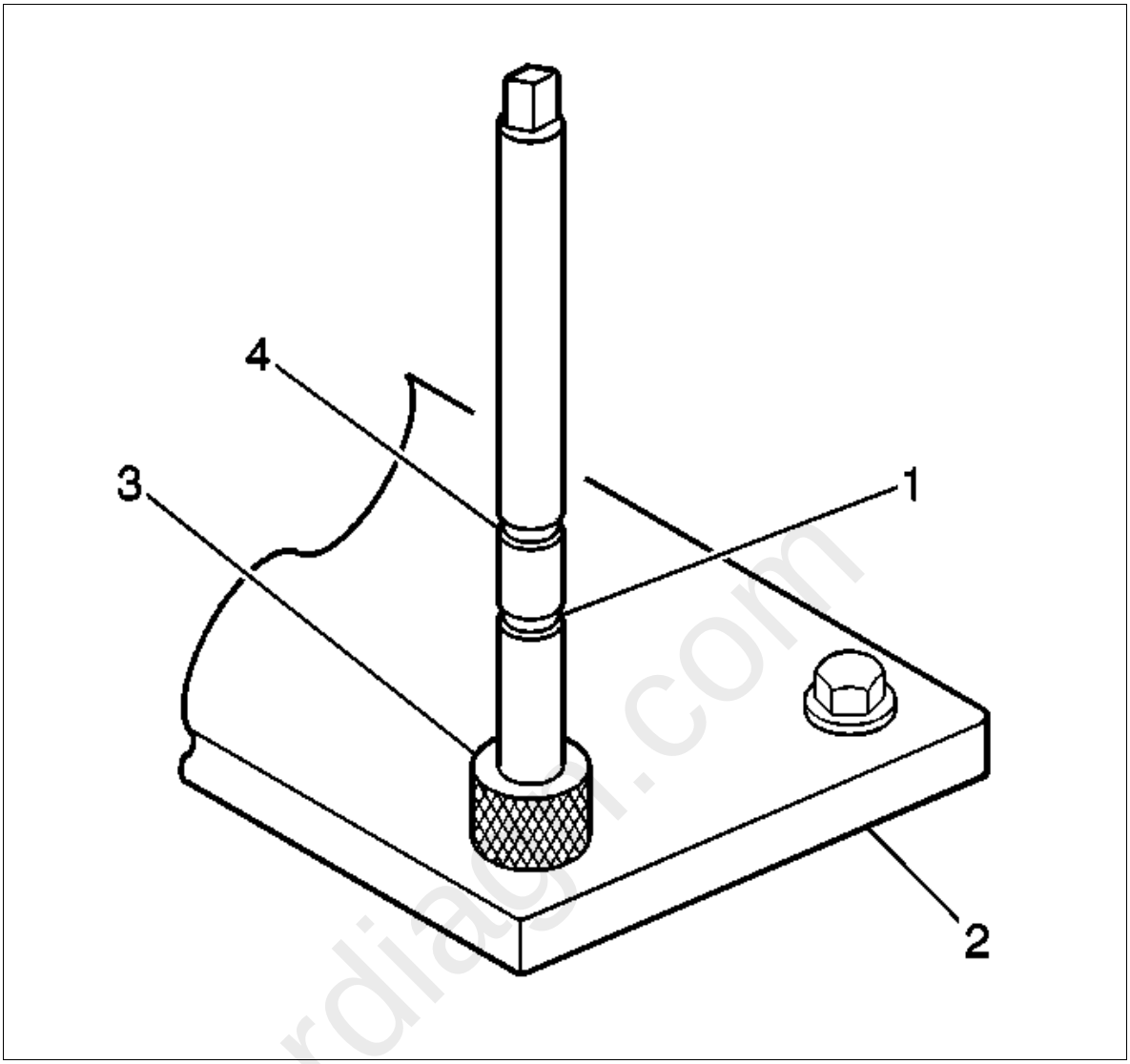
   The outer bolt hole locations 11-20 have the shallower counterbores. Use sleeve J 42385-316 with the drill.

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

5. Using compressed air, clean out any chips.

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Fig 4: Tap Upper & Lower Marks, Fixture Plate & Bushing



Courtesy of GENERAL MOTORS COMPANY

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

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

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

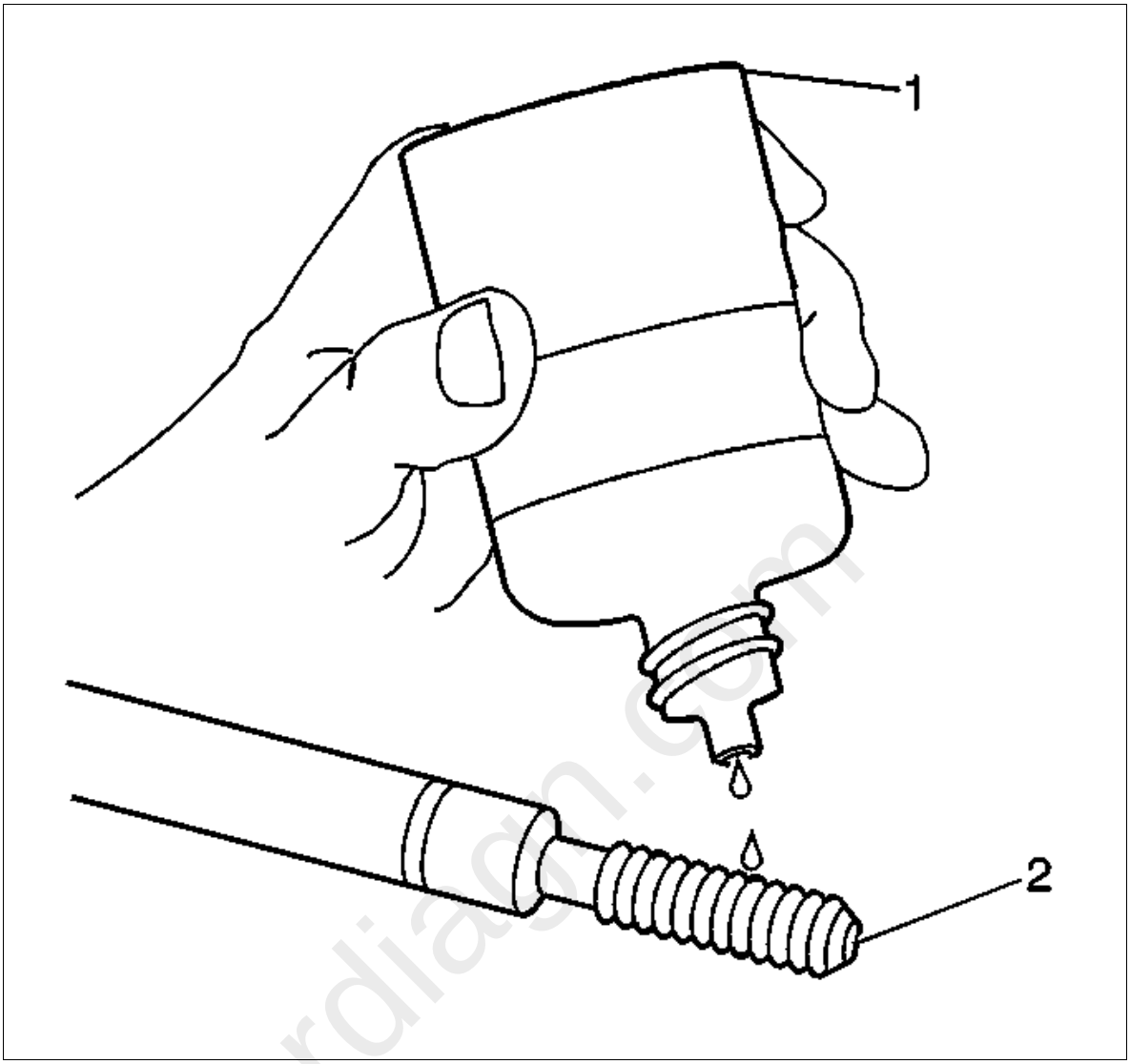
   For the shallower main cap holes 11-20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

7. Using compressed air, clean out any chips.

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

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

Fig 5: Lubricating Installer Tool Using Driver Oil



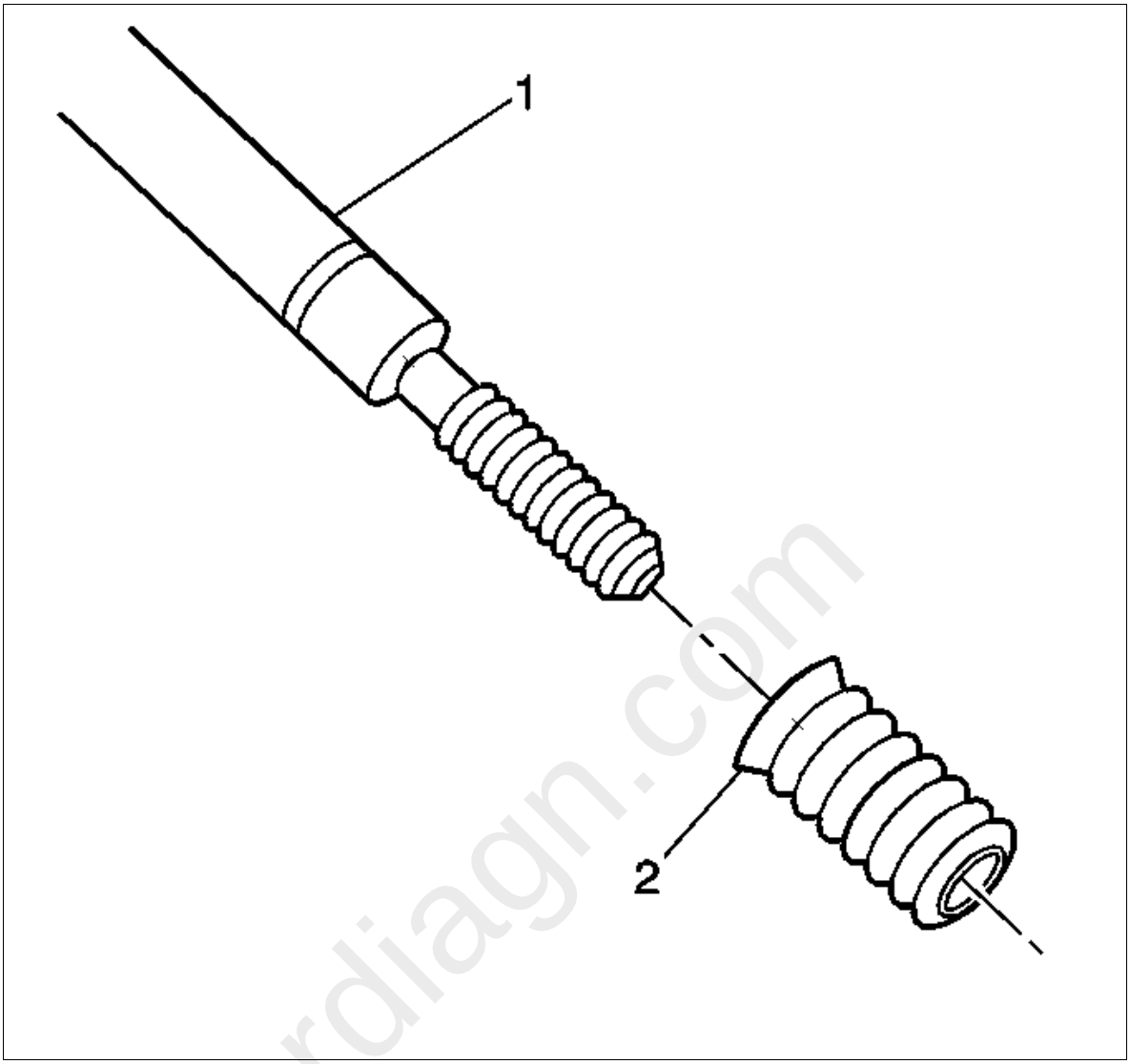
Courtesy of GENERAL MOTORS COMPANY

NOTE:

Do not allow oil or foreign material to contact the OD of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).

Fig 6: Bushing Type Insert

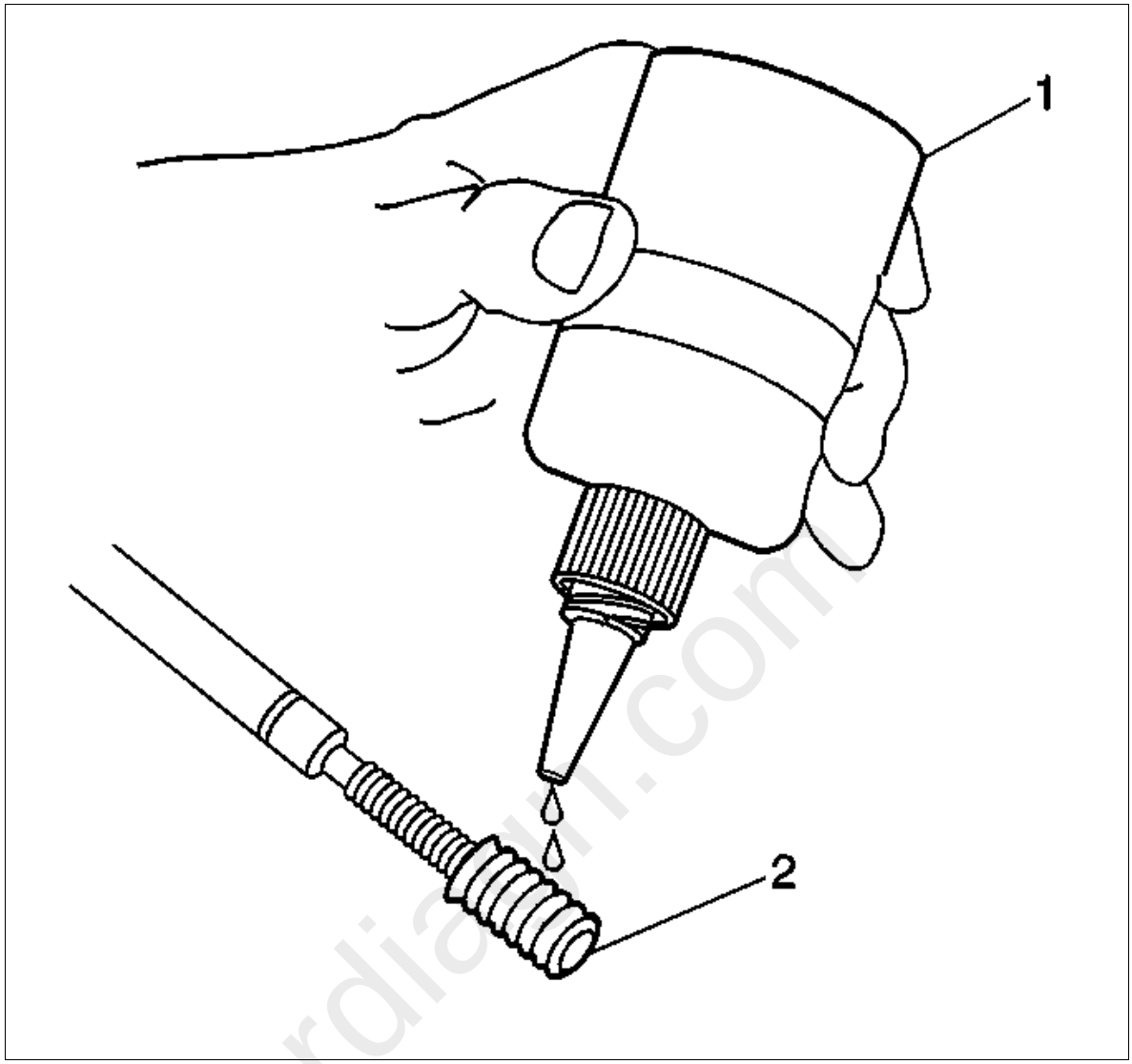


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Courtesy of GENERAL MOTORS COMPANY

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

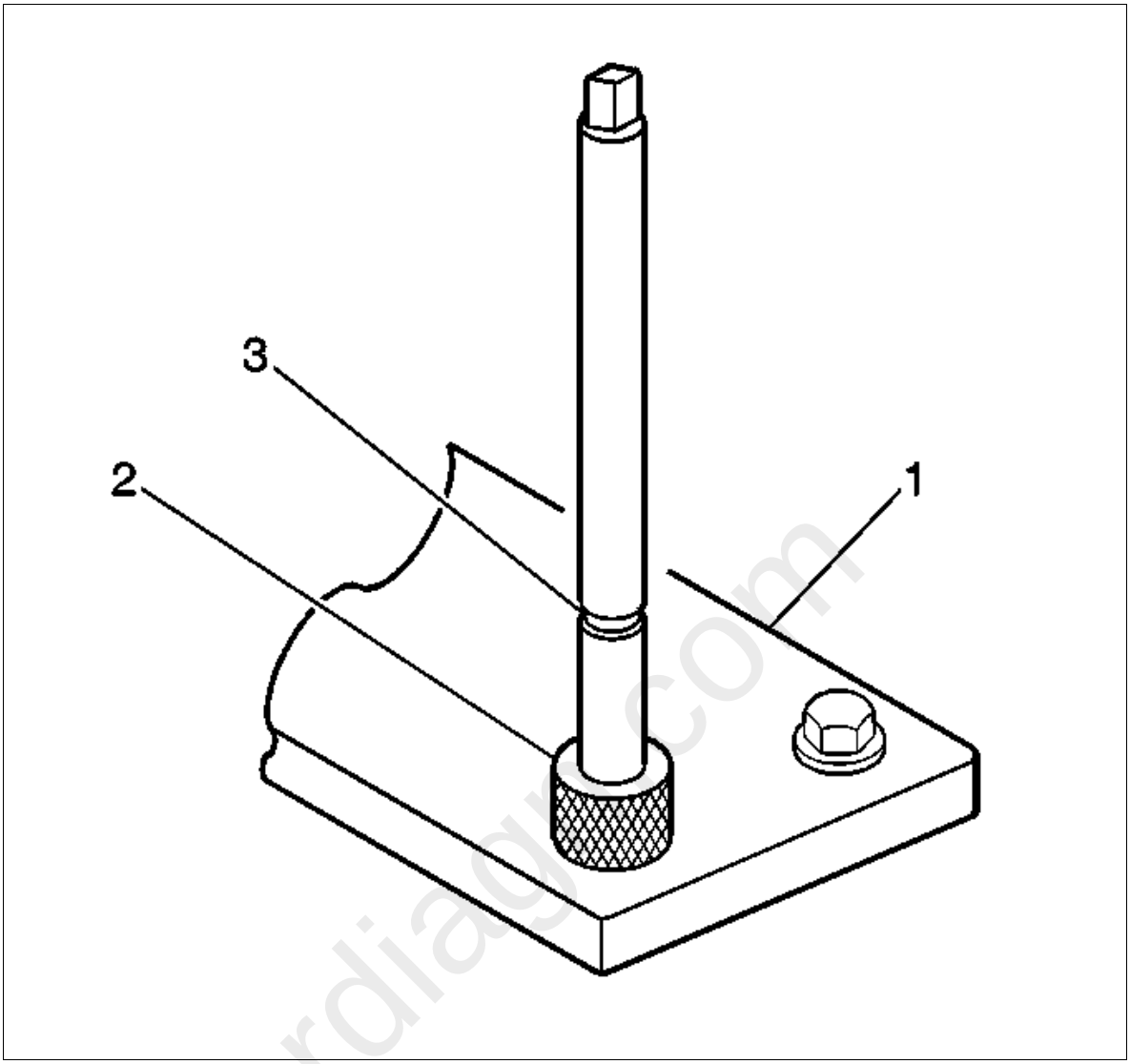
Fig 7: Threadlock To Insert



Courtesy of GENERAL MOTORS COMPANY

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

Fig 8: Fixture Plate, Drill Bushing & Tool Marking



Courtesy of GENERAL MOTORS COMPANY

NOTE:

The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

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

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

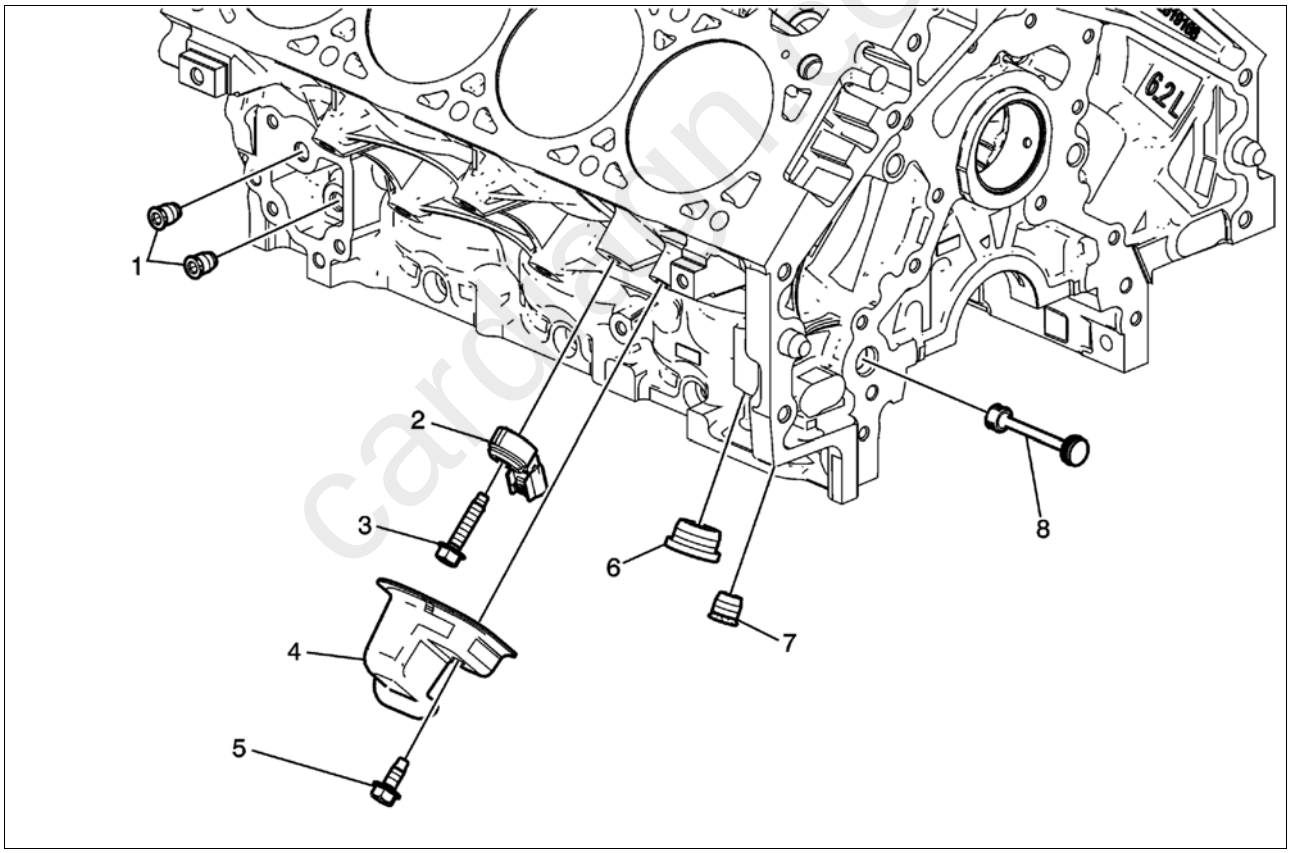
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REPAIR INSTRUCTIONS - OFF VEHICLE > SERVICE PRIOR TO ASSEMBLY

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

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK PLUG INSTALLATION > KNOCK SENSOR SHIELD, KNOCK SENSOR, AND ENGINE BLOCK OIL GALLERY PLUG INSTALLATION

Fig 1: Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug



Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Shield, Knock Sensor, and Engine Block Oil Gallery Plug Installation

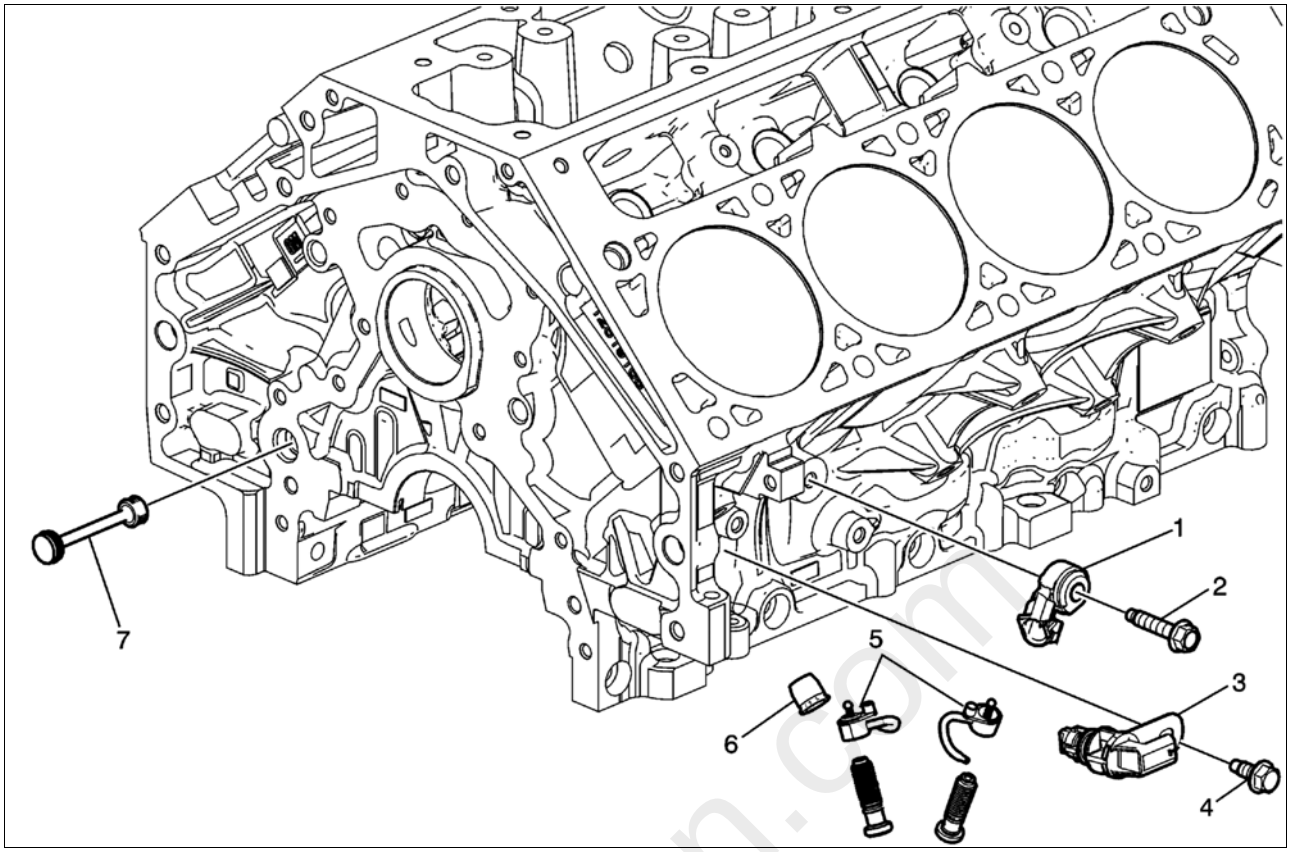
Callout	Component Name

1	Engine Block Oil Gallery Plug *CAUTION:* *Refer to Fastener Caution .* **Tighten** 25 N.m (18 lb ft)
2	Knock Sensor Assembly
3	Knock Sensor Bolt **Tighten** 25 N.m (18 lb ft)
4	Knock Sensor Shield
5	Knock Sensor Shield Bolt **Tighten** 25 N.m (18 lb ft)
6	Engine Block Plug **Tighten** 60 N.m (44 lb ft)
7	Engine Block Plug **Tighten** 30 N.m (22 lb ft)
8	Engine Block Plug

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REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE BLOCK PLUG INSTALLATION > CRANKSHAFT POSITION SENSOR, ENGINE BLOCK PLUG, KNOCK SENSOR, AND PISTON OIL NOZZLE INSTALLATION

Fig 1: Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle



Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor, Engine Block Plug, Knock Sensor, and Piston Oil Nozzle Installation

Callout	Component Name
1	Knock Sensor Assembly
2	Knock Sensor Bolt **Tighten** 25 N.m (18 lb ft)
3	Crankshaft Position Sensor
4	Crankshaft Position Sensor Bolt **Tighten** 25 N.m (18 lb ft)
5	Piston Oil Nozzle Assembly **Tighten** 20 N.m (15 lb ft)
6	Engine Block Plug **Tighten** 30 N.m (22 lb ft)
7	Engine Block Plug

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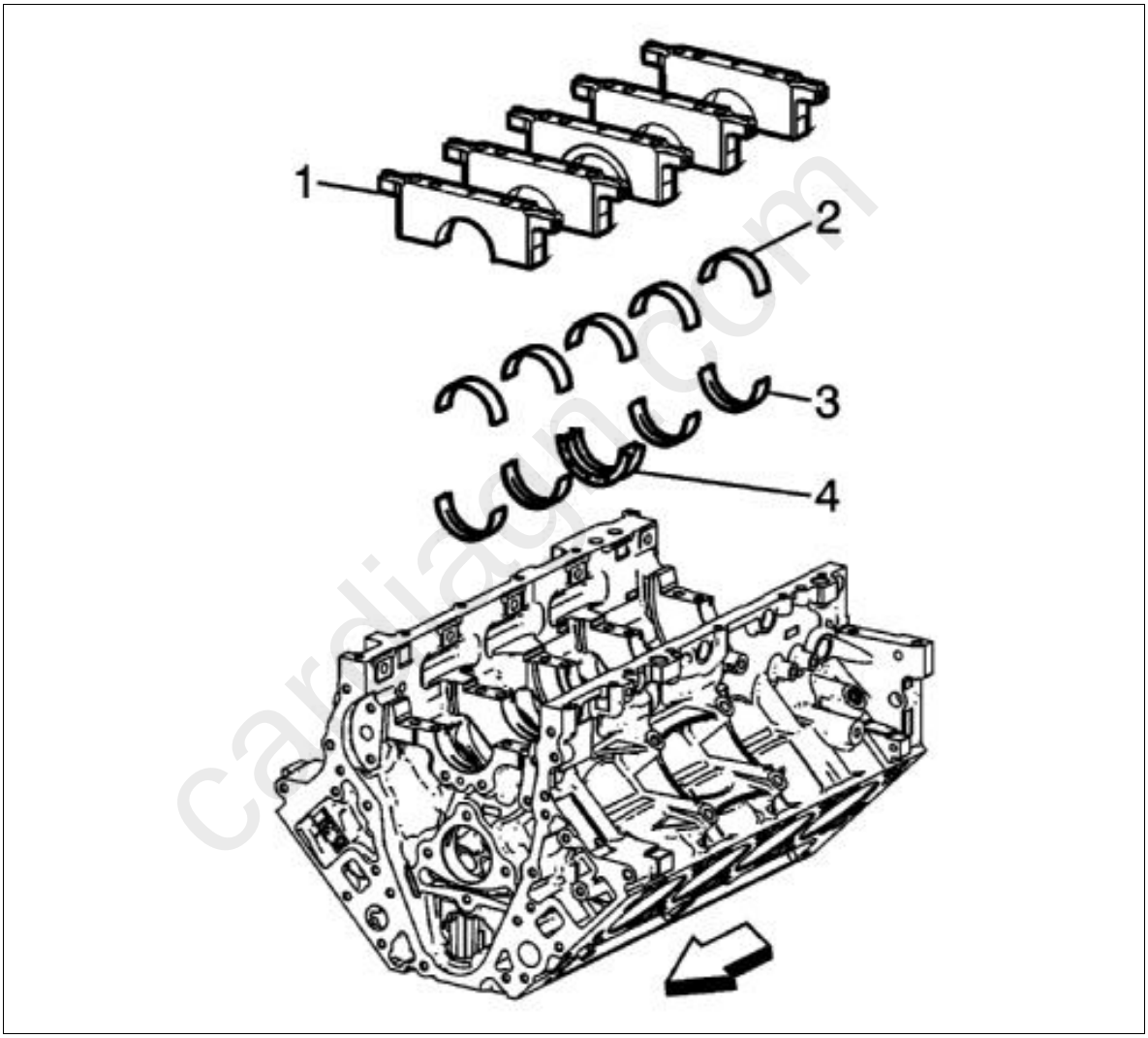
REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT AND BEARING INSTALLATION

Special Tools

J-45059 Angle Meter

For equivalent regional tools, refer to Special Tools

Fig 1: Crankshaft Bearings And Bearing Caps



Courtesy of GENERAL MOTORS COMPANY

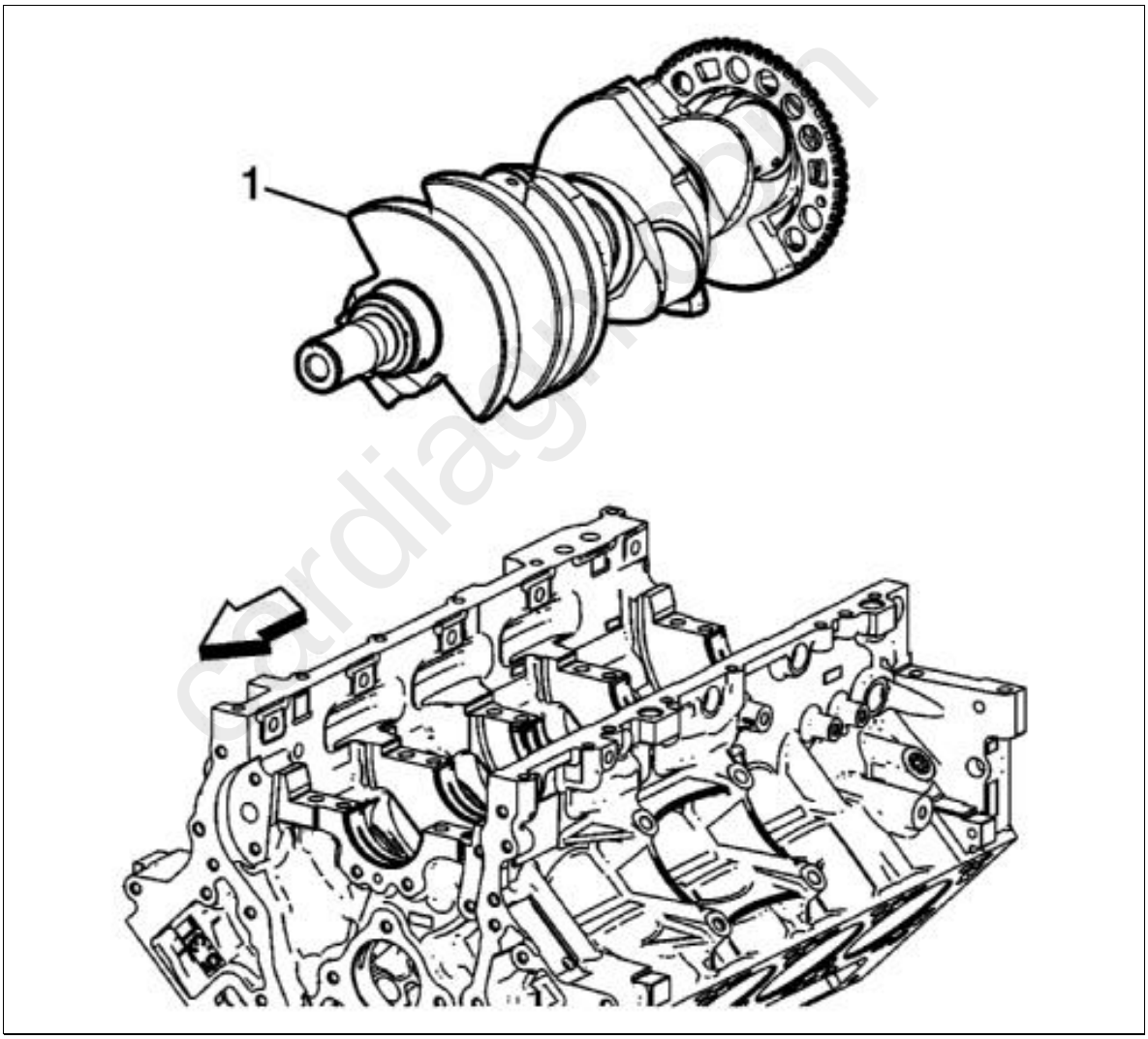
NOTE:

1. *Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.*
2. *Crankshaft bearing caps must be installed to the proper location and direction.*

3. *When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.*
4. *Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.*
5. *In order to prevent engine block oil leakage, install NEW crankshaft bearing cap side bolts.*

1. Install the crankshaft bearings (2 and 3) to the engine block and bearing caps (1). The thrust bearings (4) are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

Fig 2: Crankshaft



Courtesy of GENERAL MOTORS COMPANY

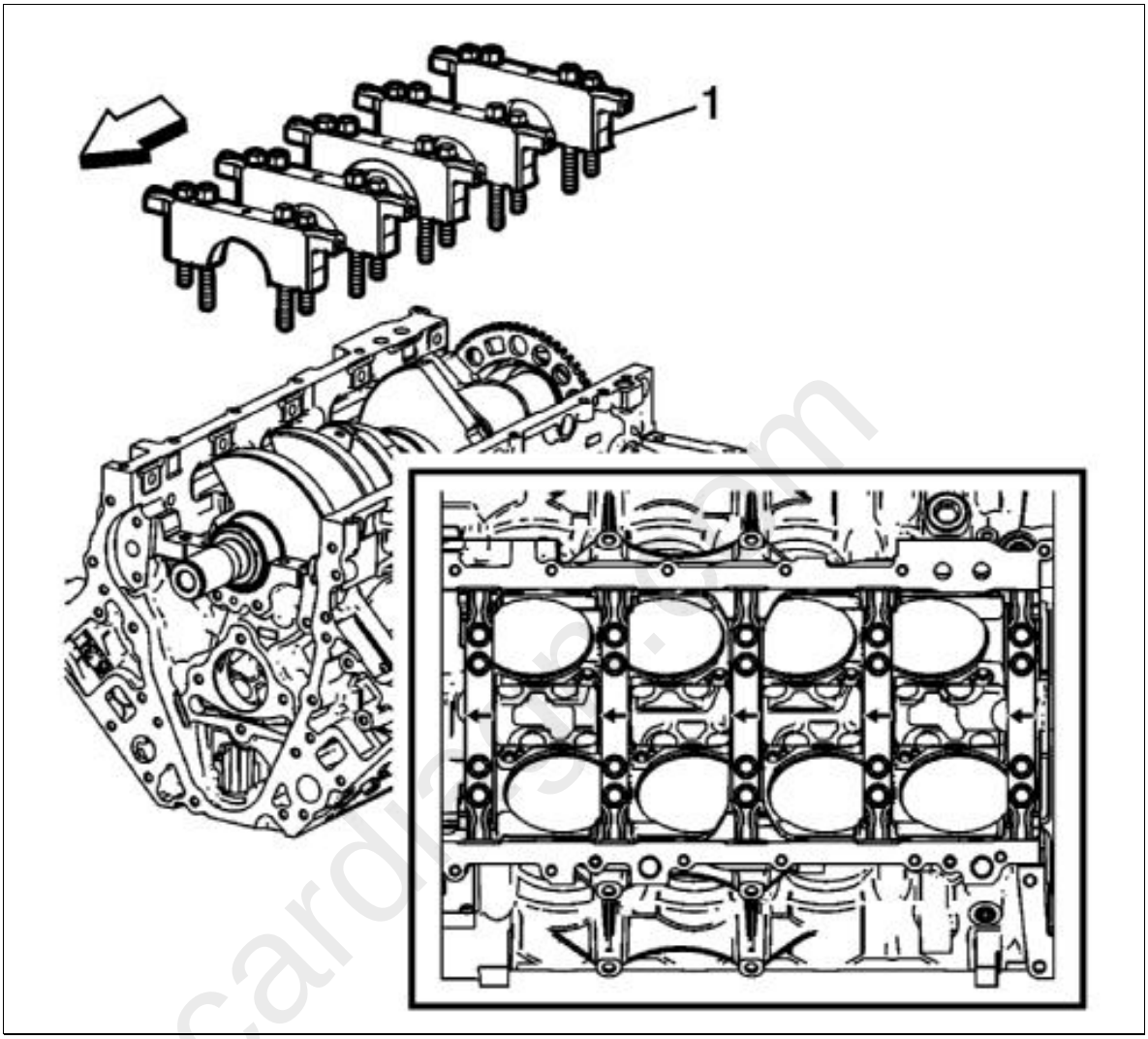
⚠ *CAUTION:*

To maintain proper crankshaft end play, use extreme care during crankshaft

installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft (1).

Fig 3: Crankshaft Bearing Caps



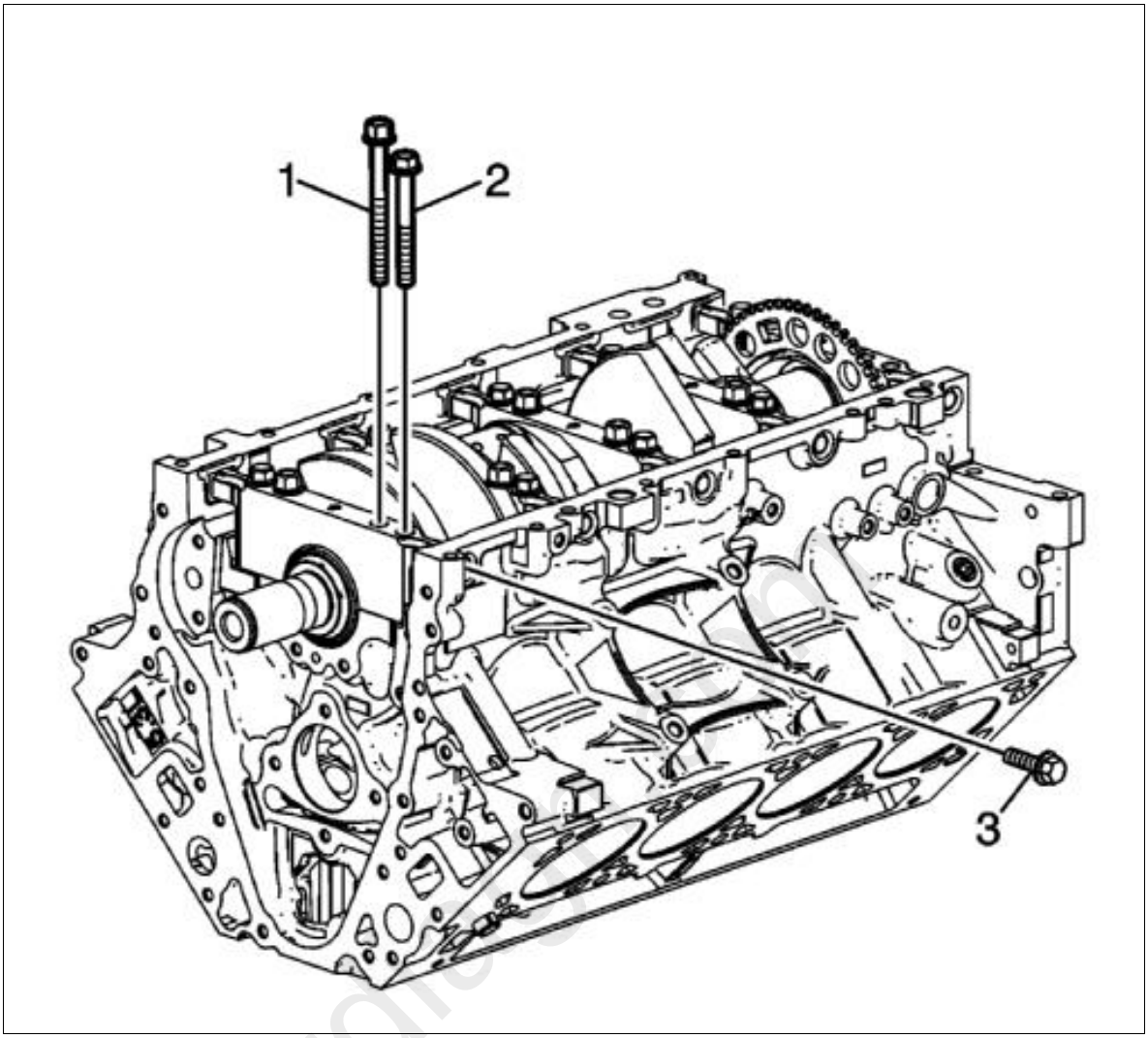
Courtesy of GENERAL MOTORS COMPANY

NOTE:

The bearing caps (1) must be installed in the proper location and direction. The arrows on the bearing caps must point toward front of engine.

4. Install the crankshaft bearing caps (1), with bearings, into the engine block.

Fig 4: Crankshaft Inner Bearing Cap Bolts And Outer Bearing Cap Bolts



Courtesy of GENERAL MOTORS COMPANY

CAUTION:

This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

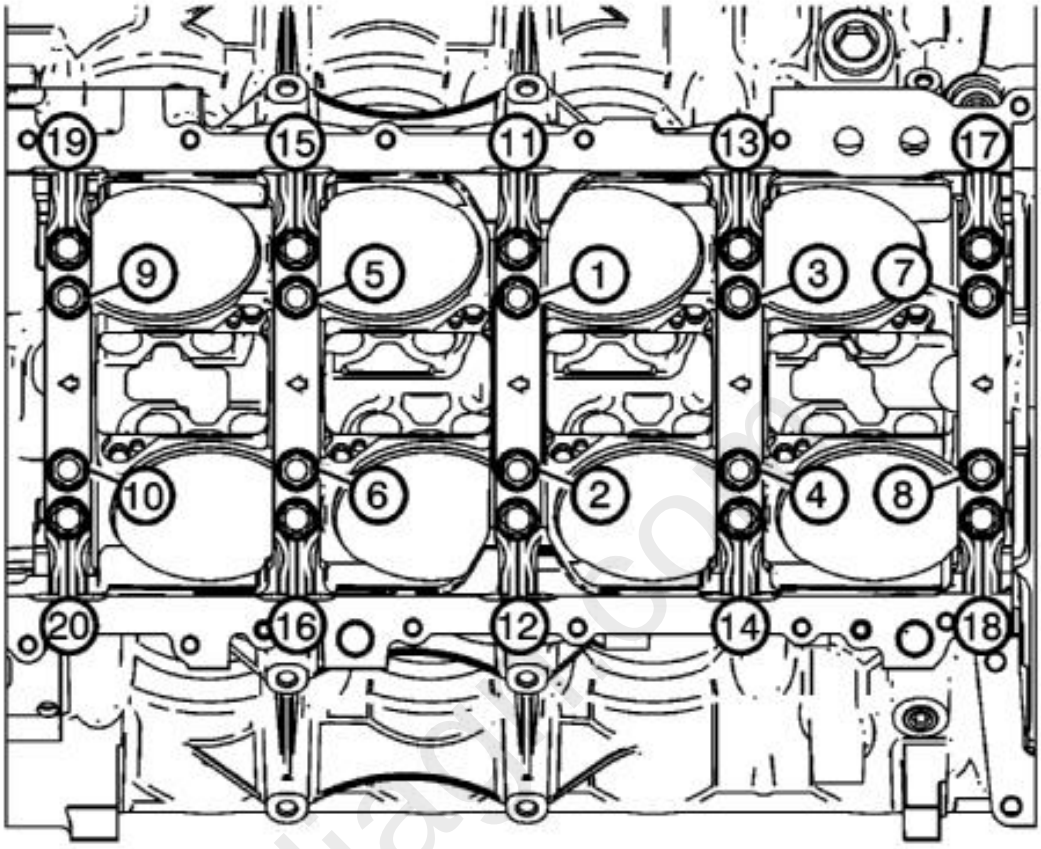
NOTE:

The inner bearing cap bolts are longer than the outer bearing cap bolts.

5. Install NEW inner bearing cap bolts (1) and NEW outer bearing cap bolts (2)
6. Using a plastic-face hammer, tap the bearing caps into place.

7. Install the NEW bearing cap side bolts (3).

Fig 5: Inner Bearing Cap Bolts Tightening Sequence



Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

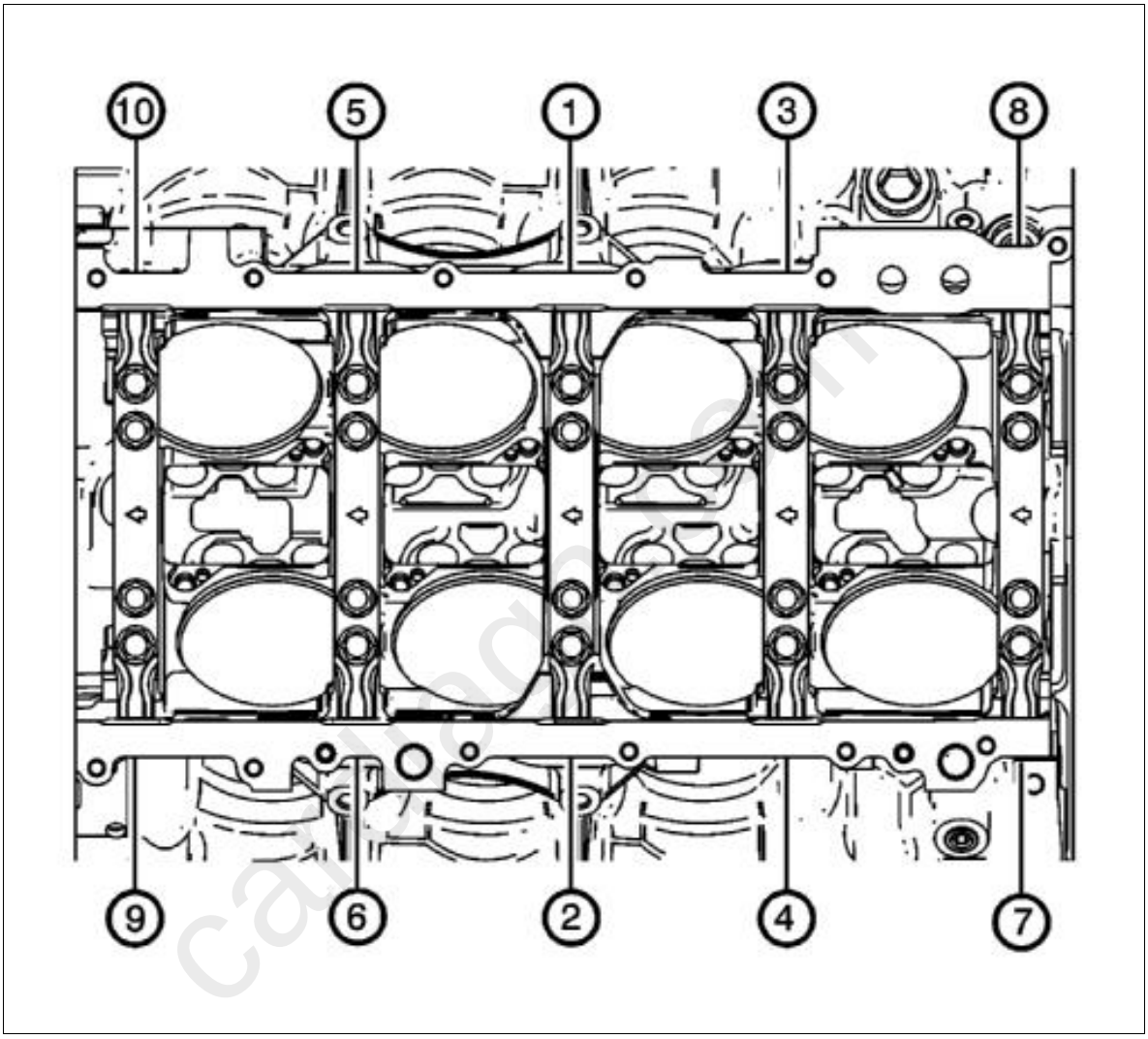
8. Tighten the inner bearing cap bolts (1-10) a first pass in sequence to 20 N.m (22 lb ft).

> *NOTE:*
>
> *To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.*

9. Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.

1. Tighten the inner bearing cap bolts (1-10) a final pass in sequence 110 degrees using the **J-45059** meter.
2. Tighten the outer bearing cap bolts (11-20) a first pass in sequence to 20 N.m (15 lb ft).
3. Tighten the outer bearing cap bolts (11-20) a final pass in sequence 80 degrees using the **J 45059** meter.

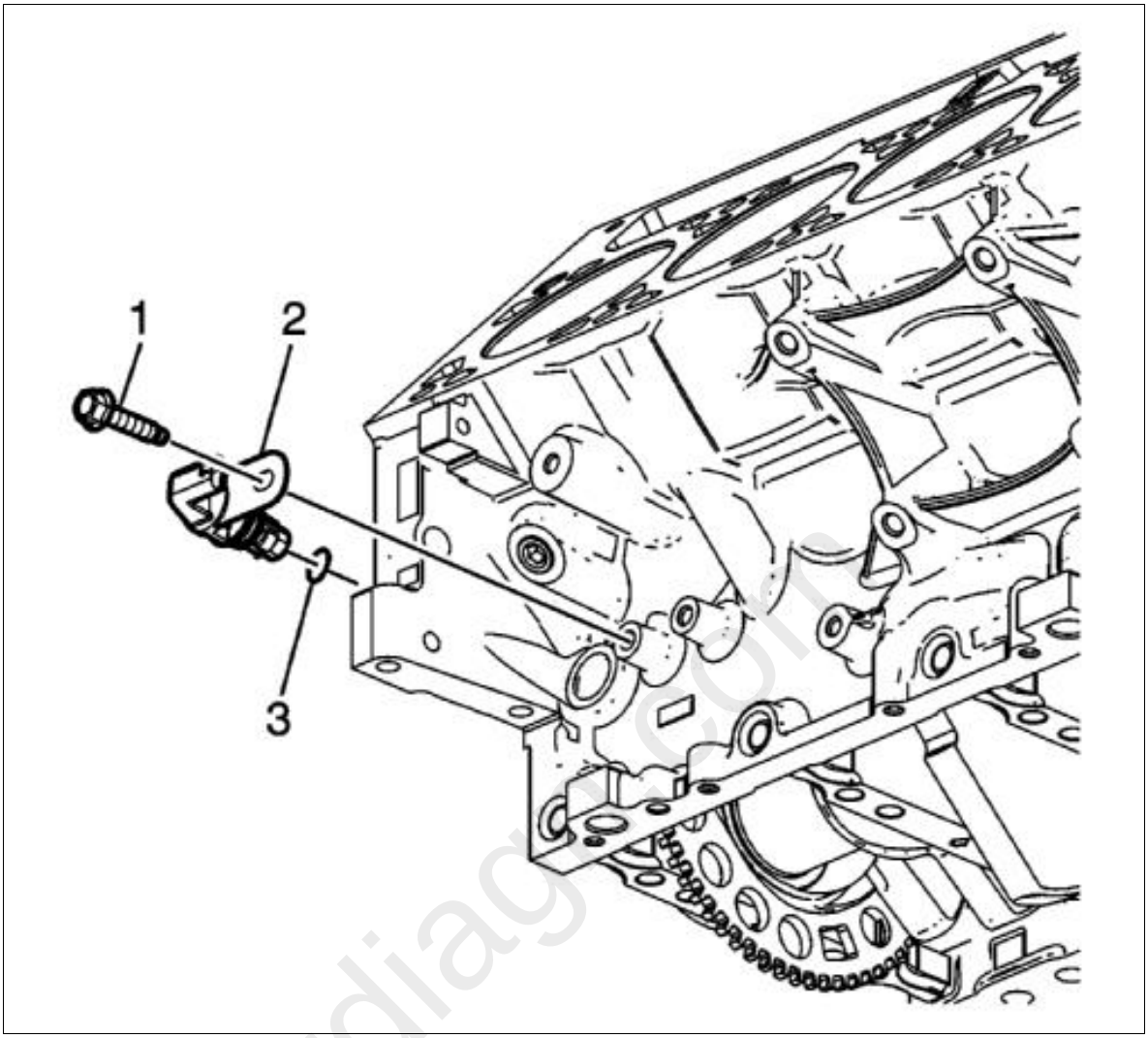
Fig 6: Crankshaft Main Bearing Cap Bolt Tightening Sequence



Courtesy of GENERAL MOTORS COMPANY

10. Tighten the main bearing cap side bolts (1-10).
    1. Tighten the bearing cap side bolts (1-10) a first pass in sequence to 25 N.m (18 lb ft).
    2. Tighten the bearing cap side bolts (1-10) a final pass in sequence to 60 degrees using the **J 45059** meter.

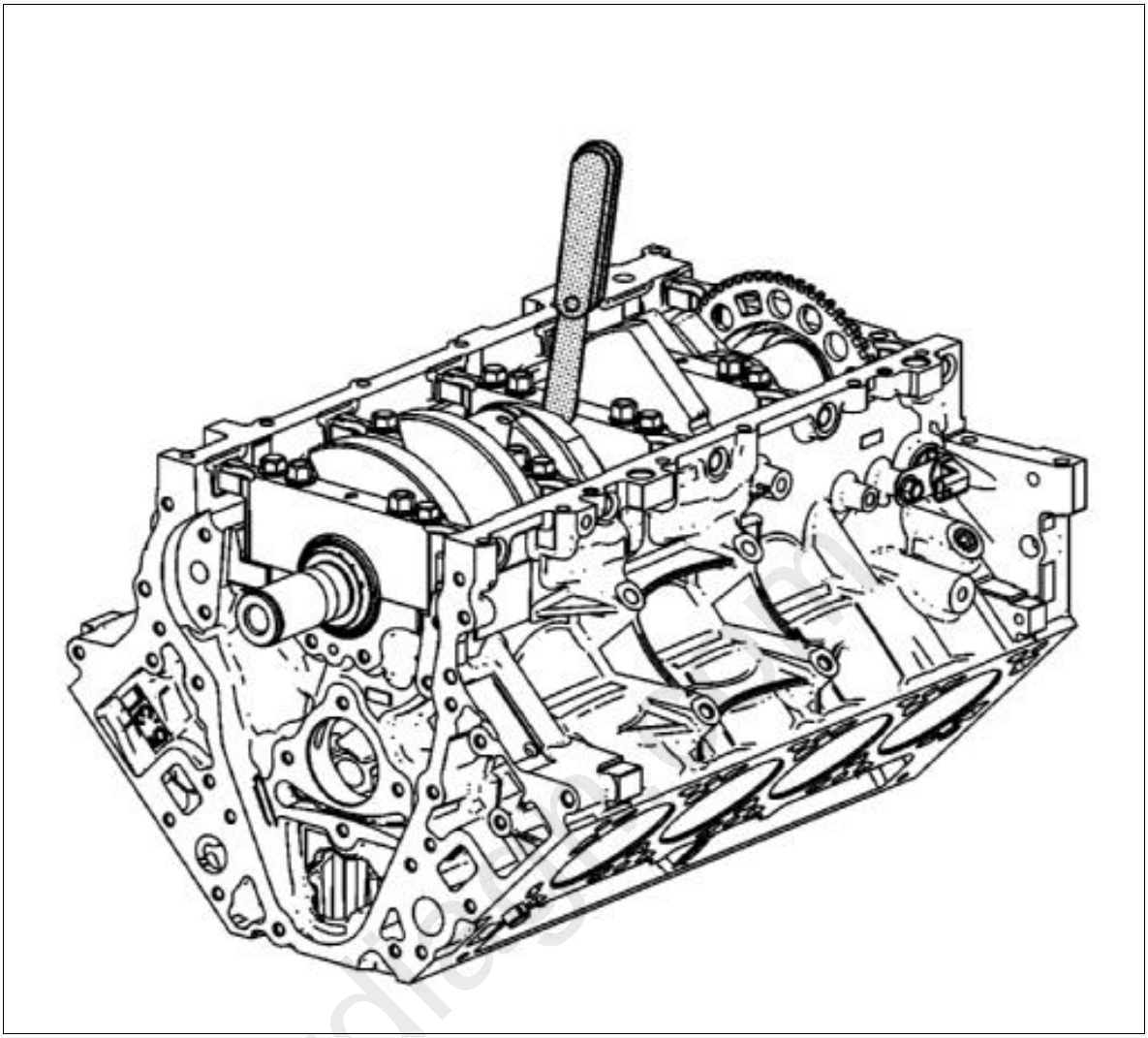
Fig 7: Crankshaft Position (CKP) Sensor Bolt And CKP Sensor



Courtesy of GENERAL MOTORS COMPANY

11. Install the CKP sensor (2).
    1. Inspect the CKP sensor O-ring seal (3). If the O-ring seal is not cut or damaged, it may be used again.
    2. Coat the O-ring seal (3) with clean engine oil.
    3. Install the O-ring seal (3) onto the sensor.
    4. Install the sensor (2). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
    5. Install the sensor bolt (1) and tighten to 25 N.m (18 lb ft).

Fig 8: Crankshaft End Play



Courtesy of GENERAL MOTORS COMPANY

12. Measure the crankshaft end play.
    1. Thrust the crankshaft forward or rearward.
    2. Insert a feeler gauge between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

       The proper crankshaft end play clearance is 0.04-0.2 mm (0.0015-0.0078 in).
    3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON, CONNECTING ROD, AND BEARING INSTALLATION

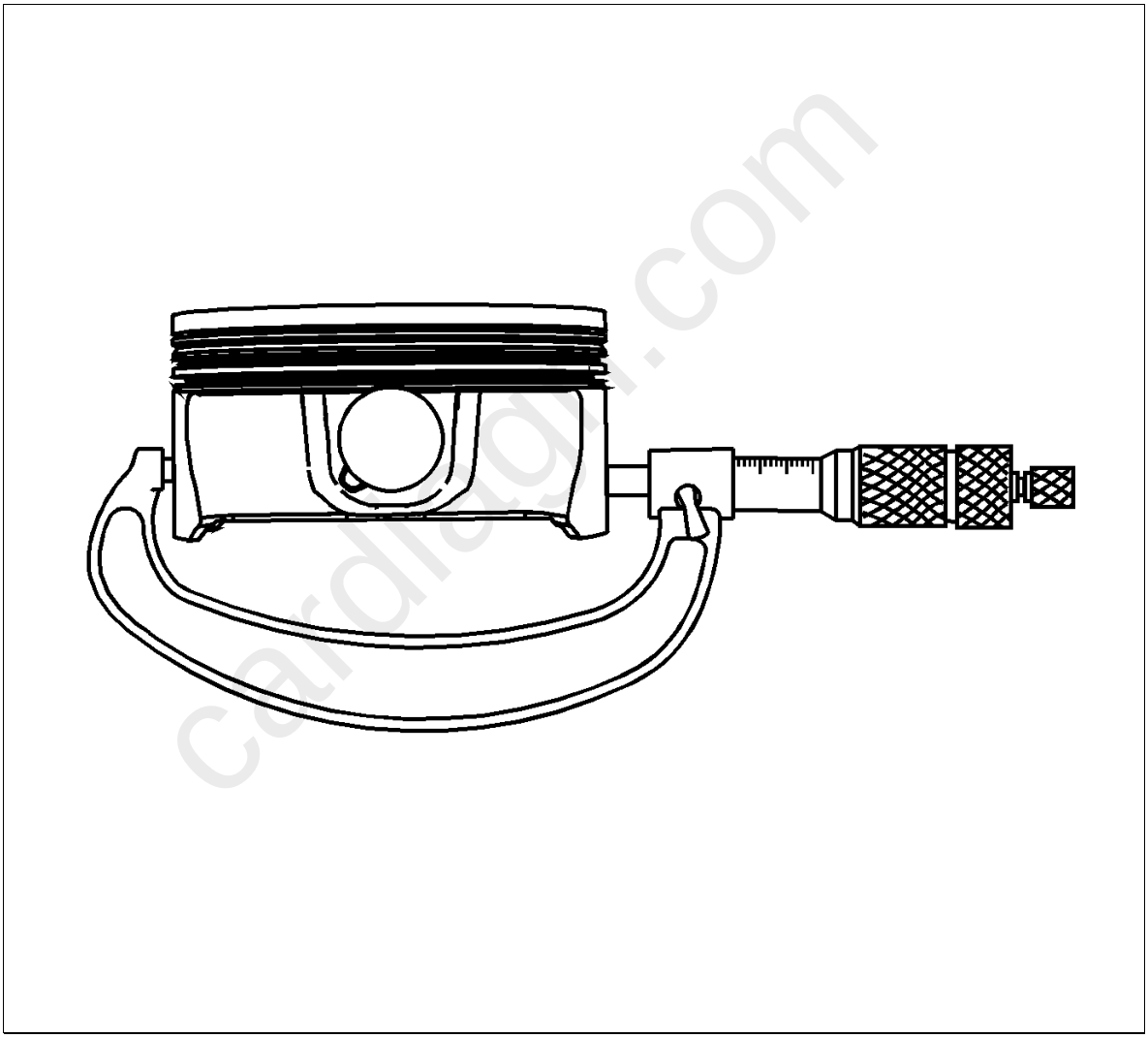
Special Tools

- **EN-8087** Cylinder Bore Gauge
- **EN-41556** Connecting Rod Guide
- **EN-45059** Angle Meter

For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON, CONNECTING ROD, AND BEARING INSTALLATION > PISTON SELECTION

Fig 1: Piston Outside Diameter



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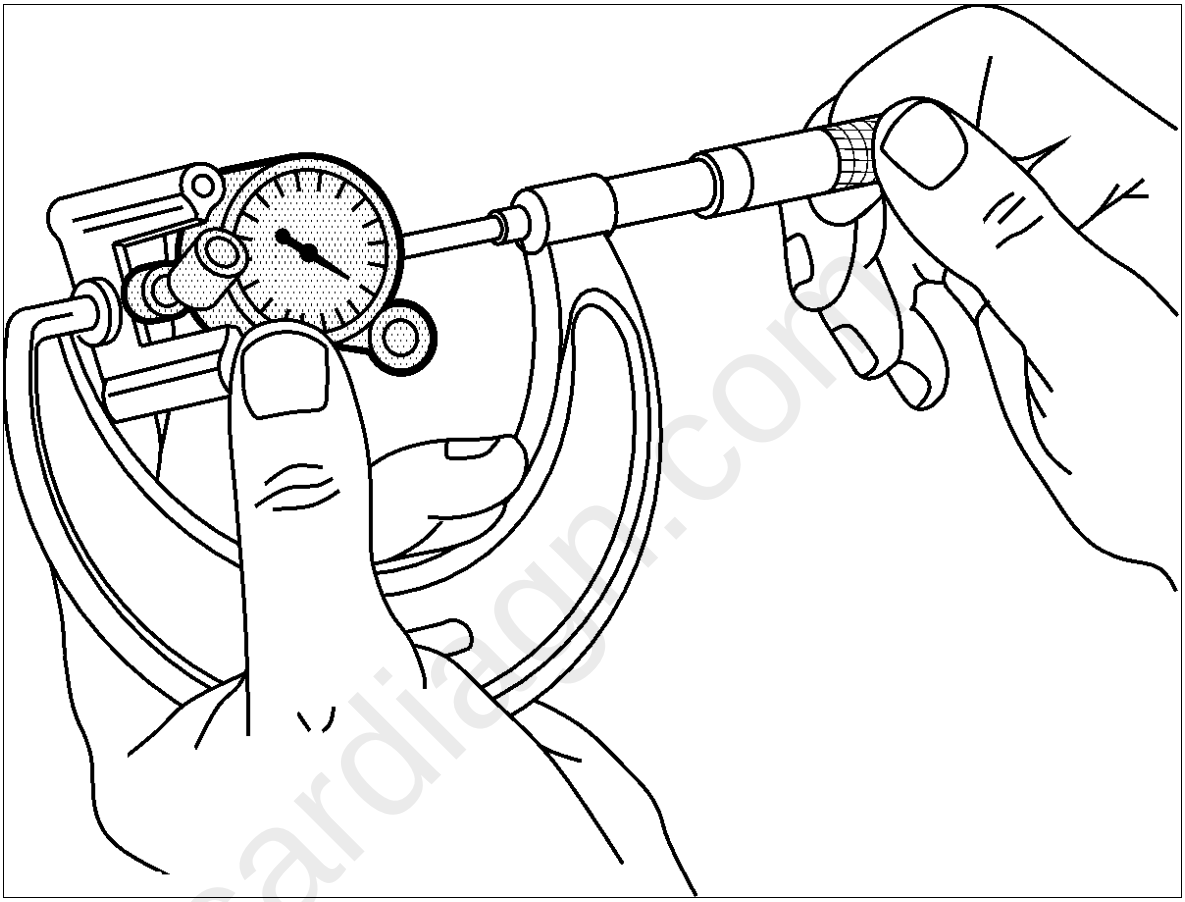
NOTE:

Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly

may be installed if, after inspection is within specifications.

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to Engine Mechanical Specifications (LT1) .
2. Record the piston OD.

Fig 2: Bore Gauge With Micrometer

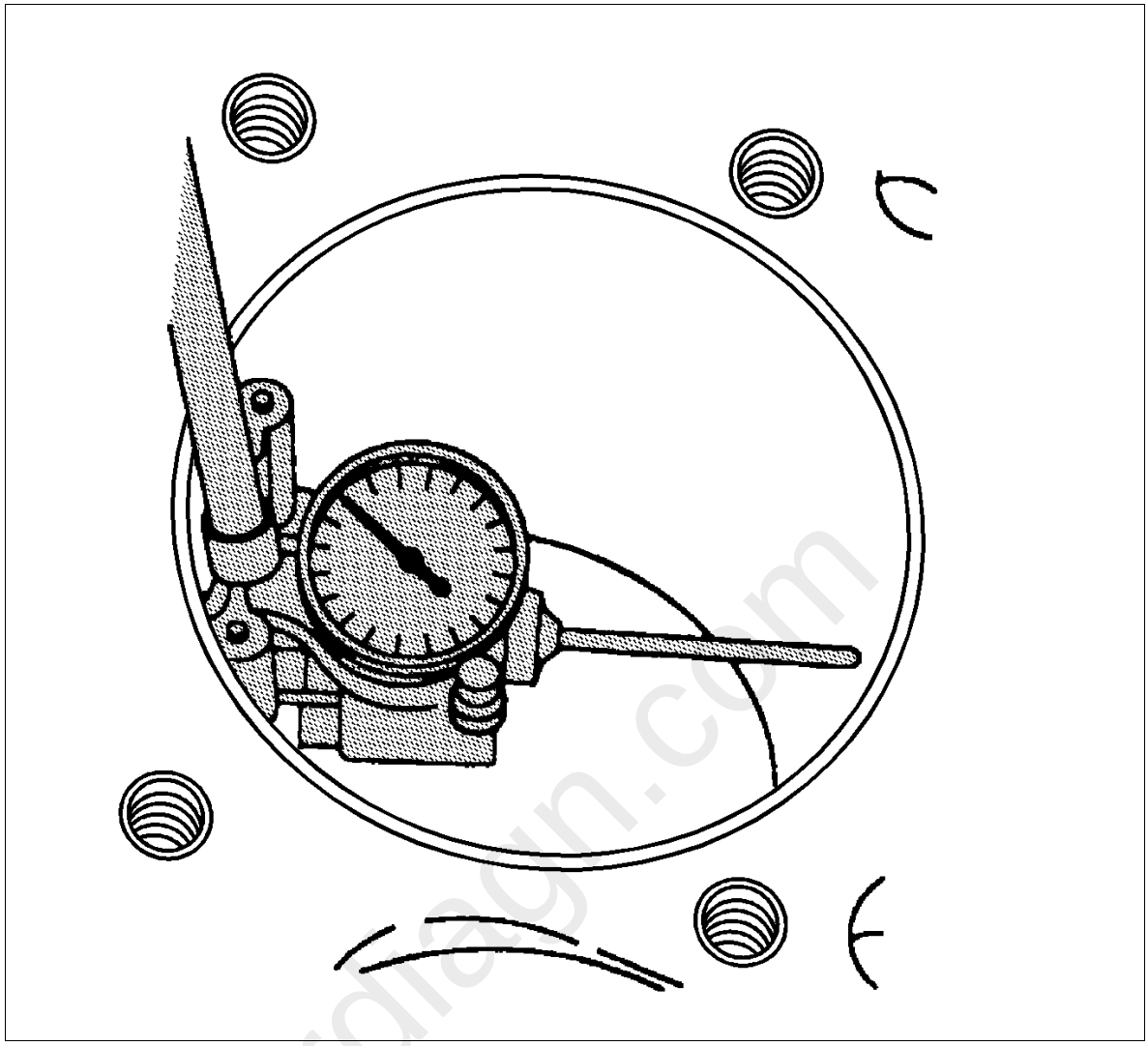


Courtesy of GENERAL MOTORS COMPANY

3. Adjust the micrometer to the recorded piston OD.
4. Insert the **EN-8087** bore gauge into the micrometer and zero the gauge dial.

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Fig 3: Cylinder Bore

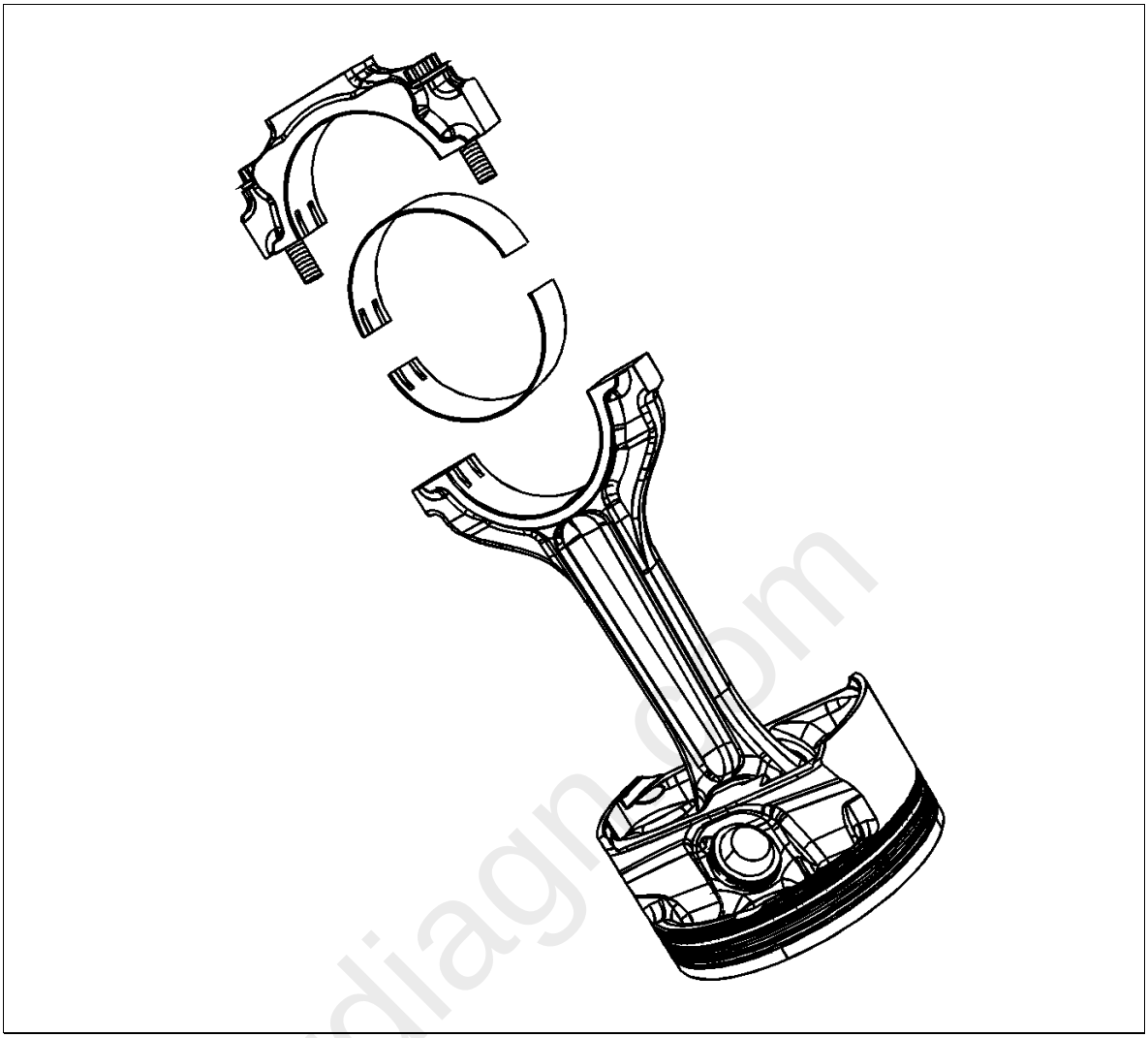


Courtesy of GENERAL MOTORS COMPANY

5. Using the **EN-8087** bore gauge, measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to Engine Mechanical Specifications (LT1) .
8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

REPAIR INSTRUCTIONS - OFF VEHICLE > PISTON, CONNECTING ROD, AND BEARING INSTALLATION > PISTON, PIN, AND CONNECTING ROD INSTALLATION

Fig 1: Piston, Connecting Rod & Bearing Assembly

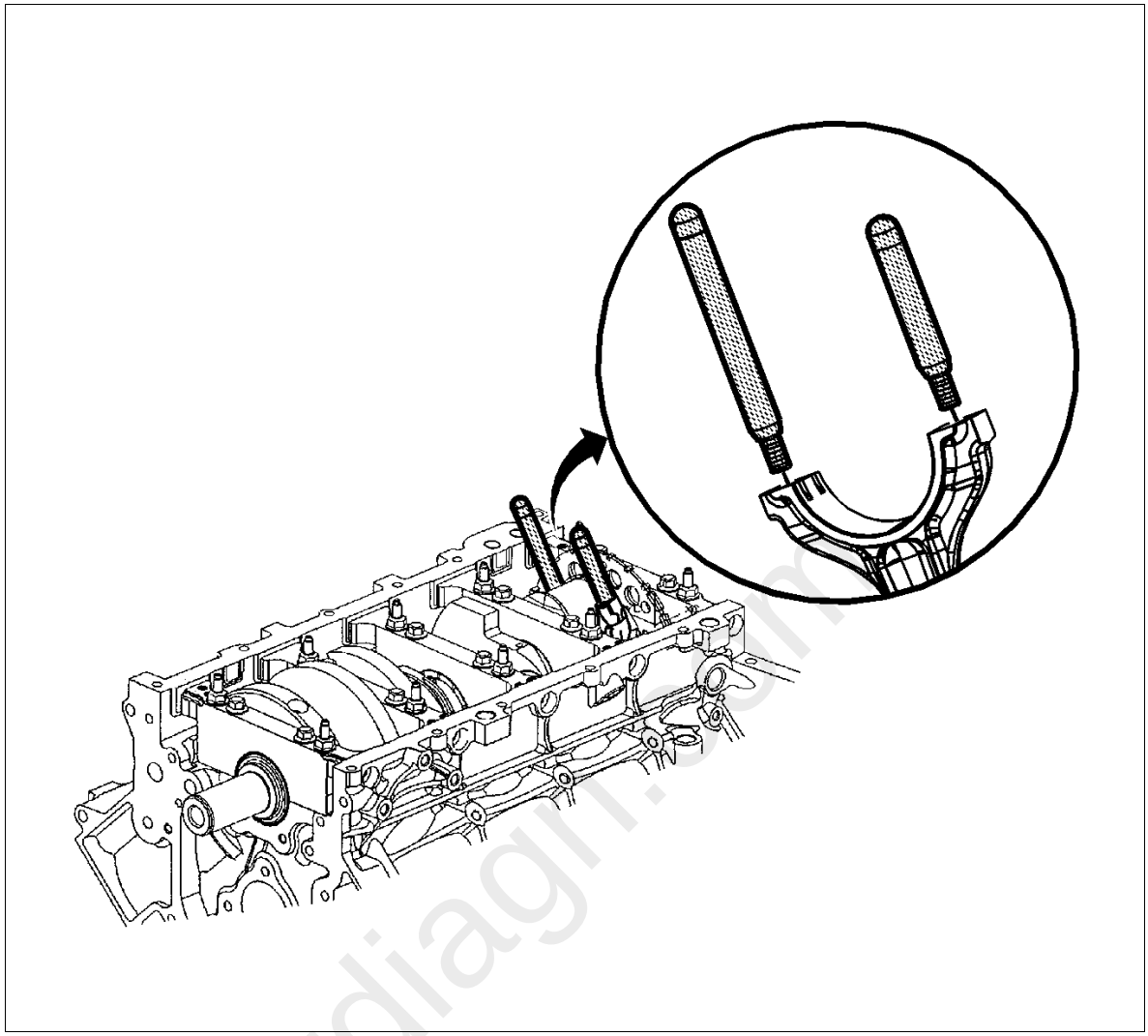


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1. Lubricate the following components with clean engine oil:
    1. Piston
    2. Piston rings
    3. Cylinder bore
    4. Bearings and bearing surfaces
2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.

Fig 2: Crankshaft Protector Pins Installed in Connecting Rod Bolt Holes

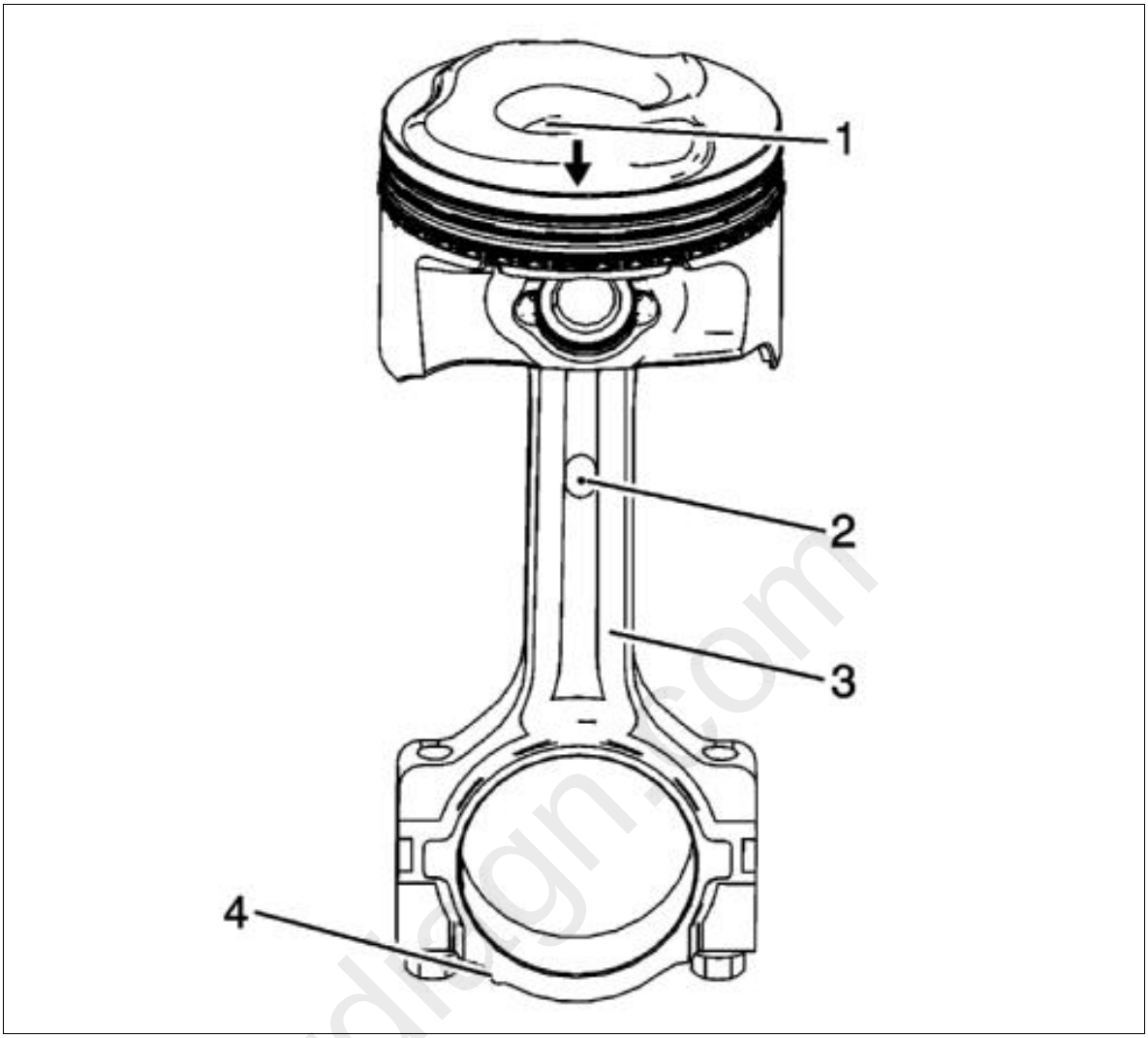


Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-41556** rod guide to the connecting rod.

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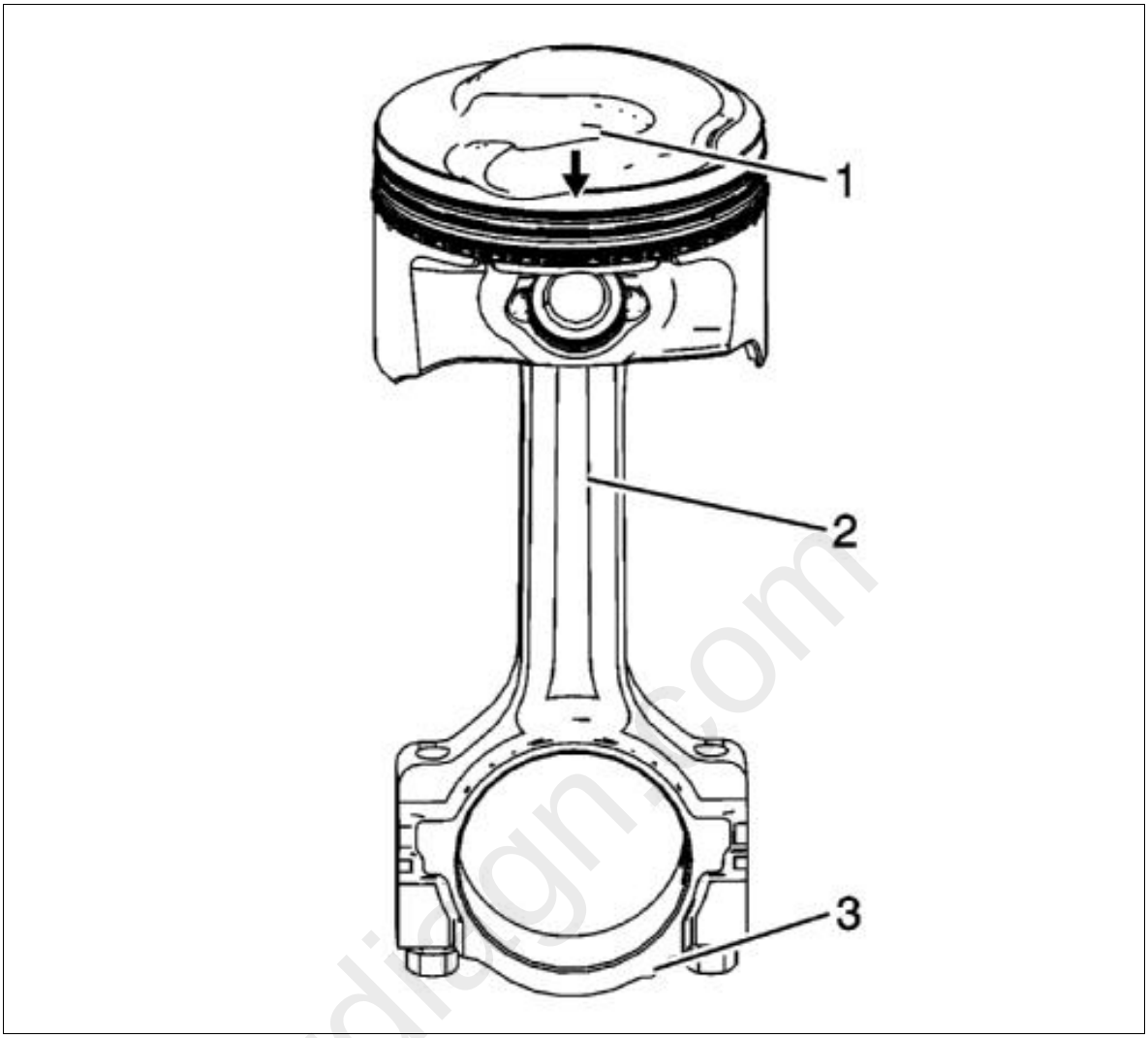
Fig 3: Top Of Piston And Dimple On Rod



Courtesy of GENERAL MOTORS COMPANY

6. Identify the proper installation direction of the piston and connecting rod assembly. The right and left side are assembled differently. Right Side: The arrow on top of the piston and the dimple (2) on the rod face the same direction. When installing the right side piston and rod (3) assemblies, the arrow on top of the piston and the dimple (2) on the rod face the front of the engine. the raised bump (4) on bottom of rod (3) will be closest to the outside of the engine.

Fig 4: Top Of Piston And Dimple On Rod



Courtesy of GENERAL MOTORS COMPANY

7. Left Side: the arrow on top of the piston and the dimple on the rod face the opposite direction. When installing the left side piston and rod (2) assemblies, the arrow on top of the piston faces the front of the engine and the dimple on the rod faces the rear of the engine. The raised bump (3) on the bottom of rod will be closest to the outside of engine.

NOTE:

When installing a piston into a cylinder, use a ring compressor sleeve or equivalent for best results. The following features should be looked for when selecting a ring compressor sleeve.

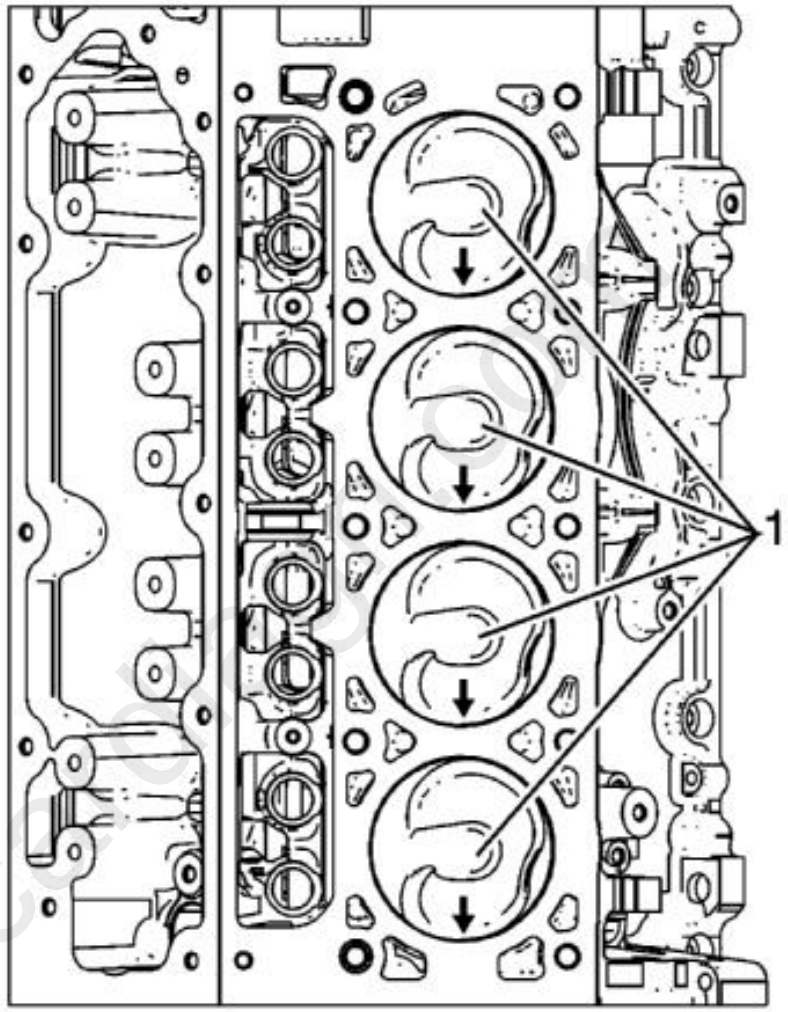
1. *Hard anodized and Teflon coated for low friction and prolonged wear resistance.*
2. *Smooth radius that tapers down to the specific bore size.*
3. *Sleeve should compress the piston rings smoothly and evenly.*

4. *Using a ring compressor sleeve greatly reduces the difficulty with installing thin high-performance oil rings.*

If a ring compressor sleeve is unavailable, a universal ring compressor will work, but is more difficult to use.

8. Compress the piston rings using a ring compressor sleeve or equivalent.

Fig 5: Fuel Bowls



Courtesy of GENERAL MOTORS COMPANY

NOTE:

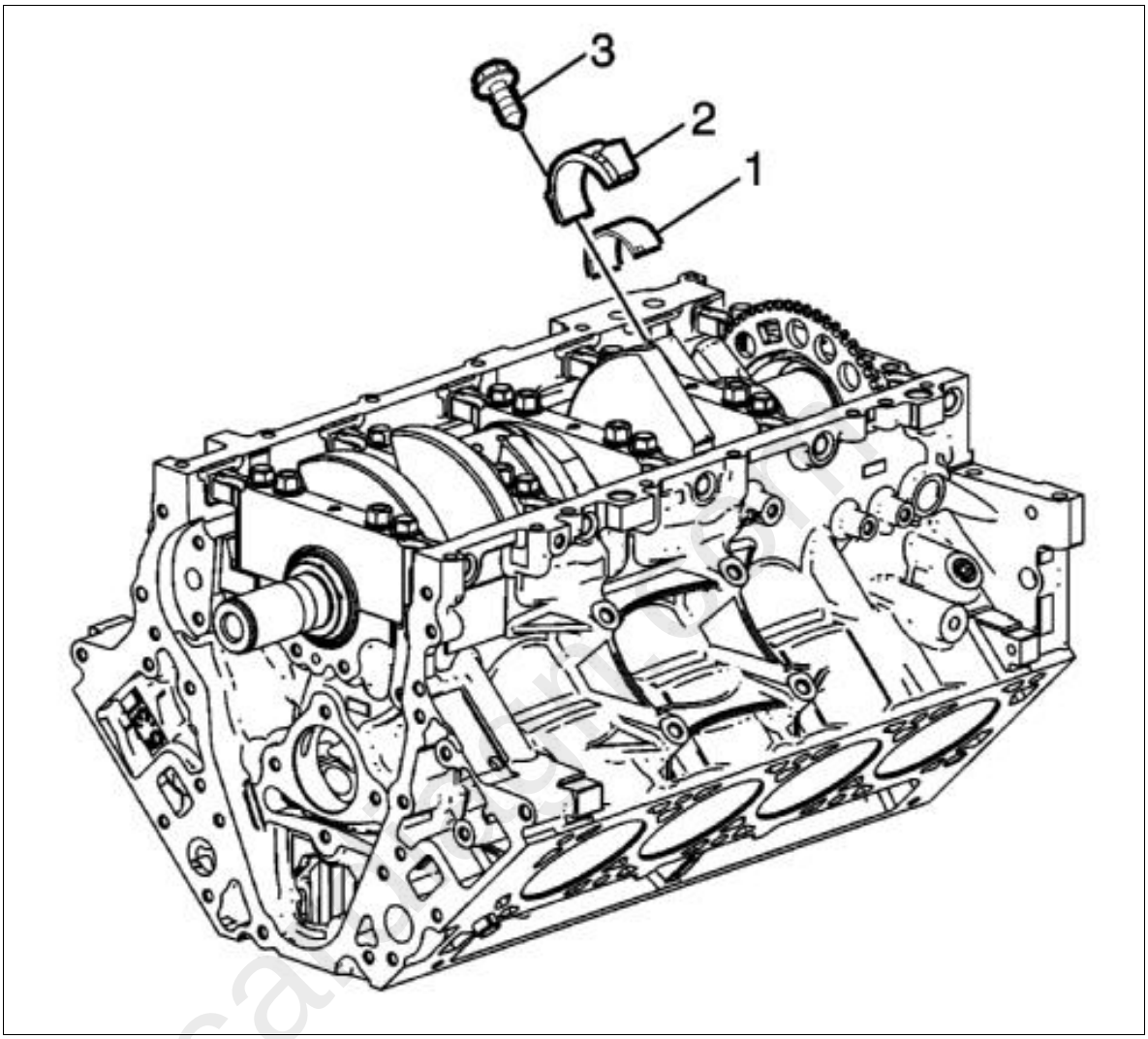
The arrow on the top of the piston MUST face the front of the engine block. The deepest portion of the fuel bowls (1) must be toward the outside of the engine.

9. Install the piston, pin, and connecting rod assembly into the cylinder bore. Tap the piston into the bore with a wooden hammer handle. Guide the connecting rod to the crankshaft journal using the **J-41556** rod guide while gently tapping the piston into place. Hold the ring

compressor sleeve or equivalent against the engine block until all rings have entered the cylinder bore.

10. Remove the **EN-41556** rod guide from the connecting rod.

Fig 6: Connecting Rod Bolts, Cap And Bearing



Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

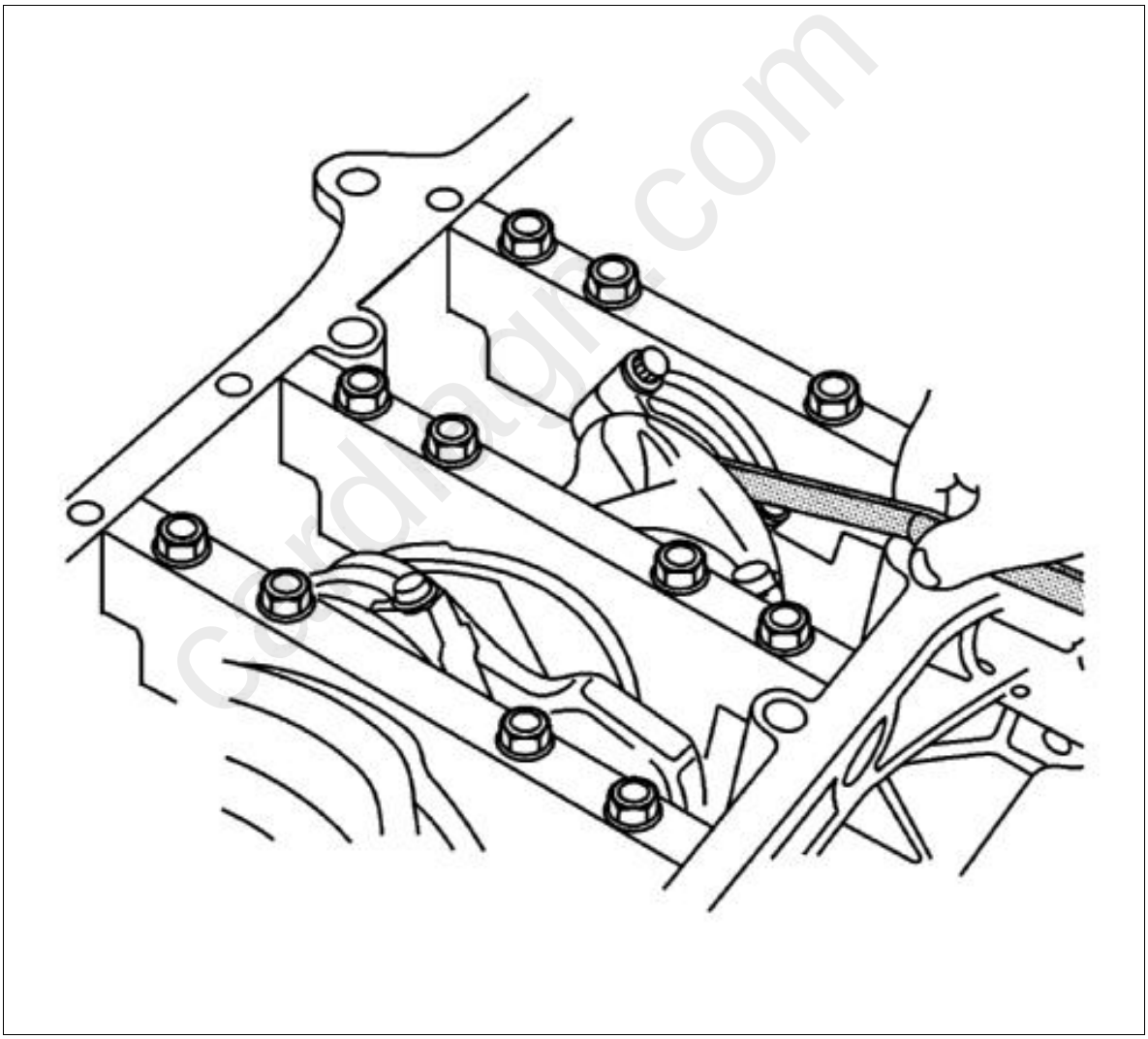
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

NOTE:

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

11. Install the bearing (1), bearing cap (2), and bolts (3).
    1. Tighten the bolts a first pass to 20 N.m (15 lb ft).
    2. Tighten the bolts a final pass to 85 degrees using the **EN-45059** angle meter.

Fig 7: Connecting Rods For Proper Side Clearance

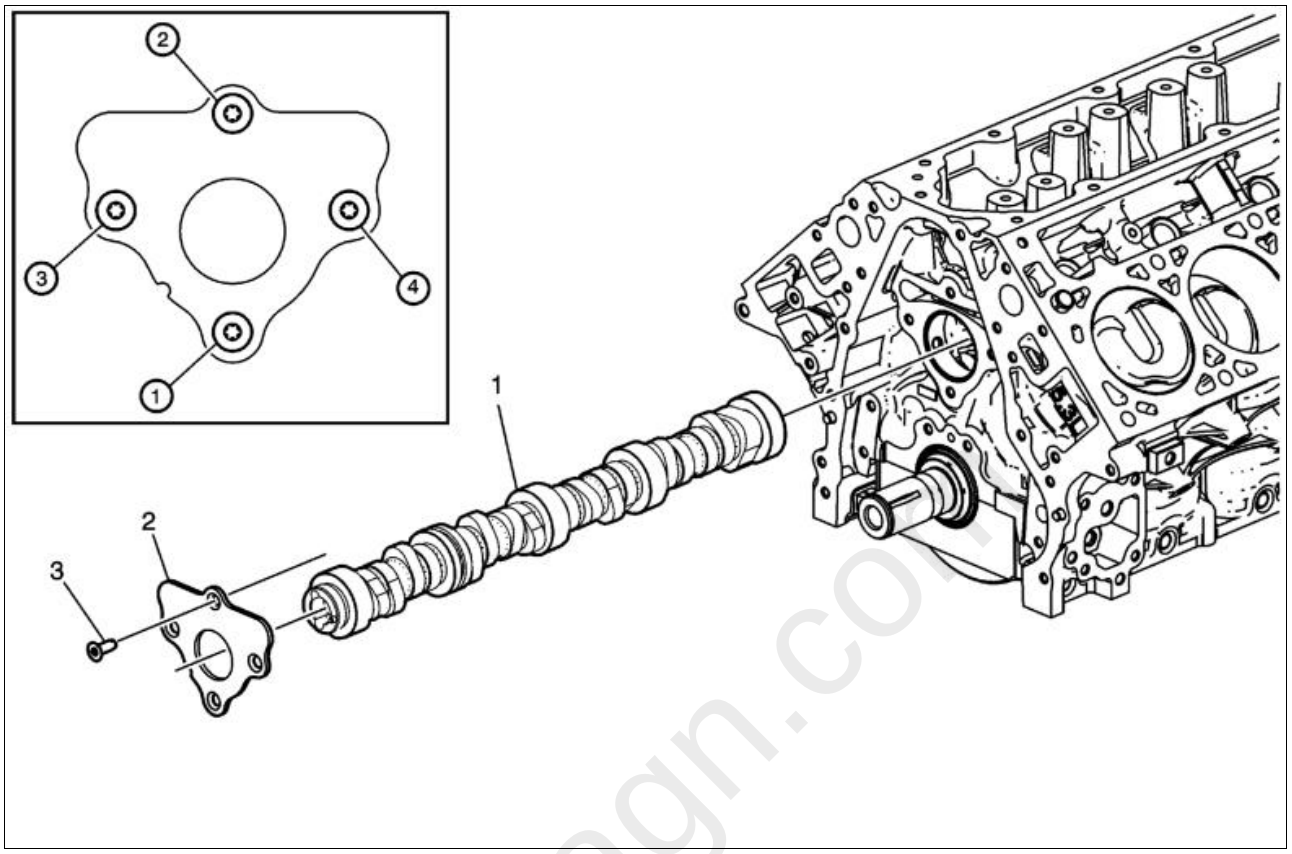


Courtesy of GENERAL MOTORS COMPANY

12. Measure the connecting rods for the proper side clearance. Refer to Engine Mechanical Specifications (LT1) .

REPAIR INSTRUCTIONS - OFF VEHICLE > CAMSHAFT INSTALLATION

Fig 1: Camshaft



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Assembly
2	Camshaft Retainer
3	Camshaft Retainer Bolt (Qty: 4) *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the retainer bolts in the sequence shown.

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NOTE:

Clean the threads of the cam retainer bolts and apply a sealant.

Tighten
15 N.m (11 lb ft)
Refer to Adhesives, Fluids, Lubricants, and Sealers .

REPAIR INSTRUCTIONS - OFF VEHICLE > TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE INSTALLATION

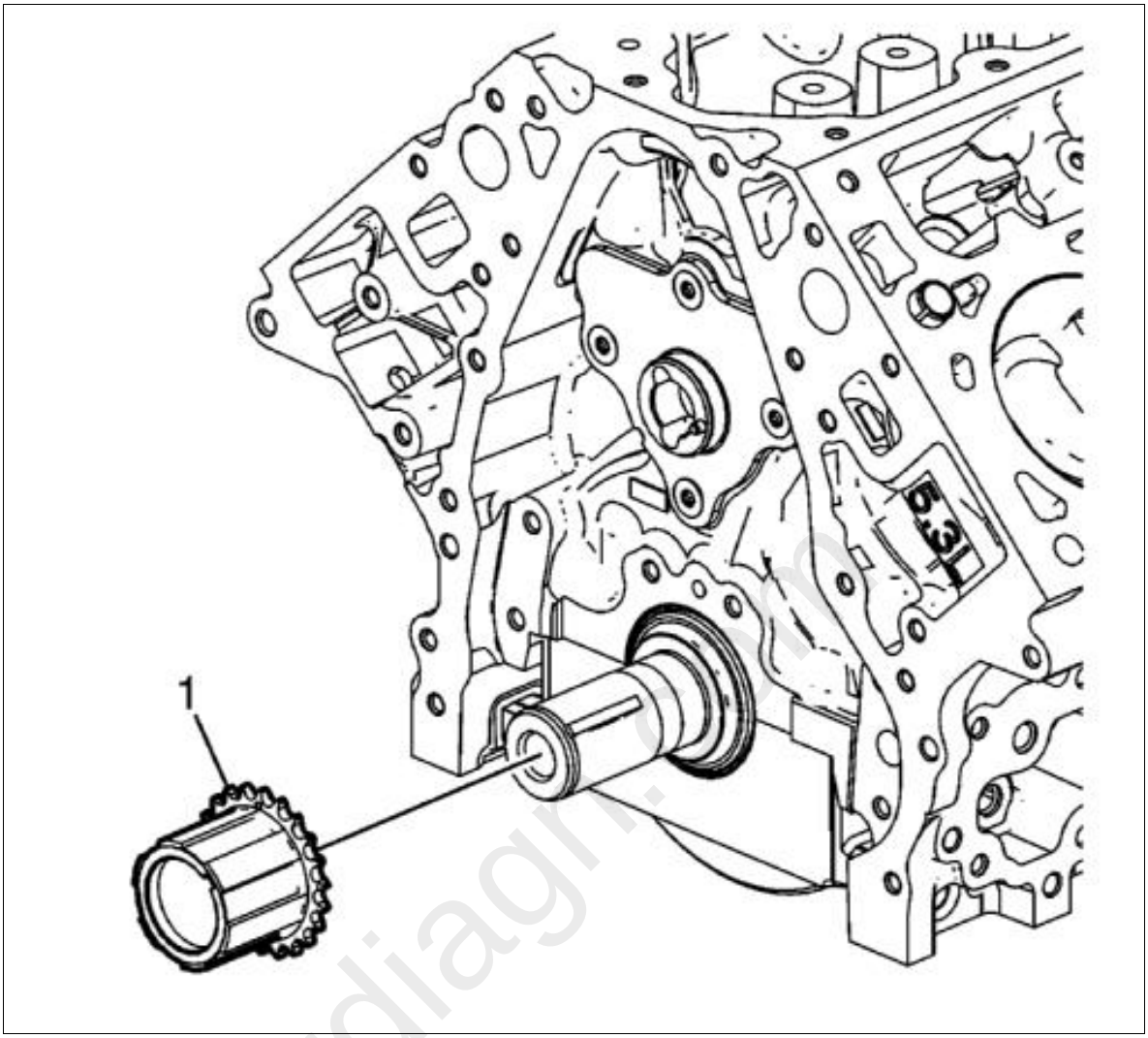
Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin
- **EN-42386-A** Flywheel Holding Tool
- **EN-45059** Angle Meter

For equivalent regional tools, refer to Special Tools .

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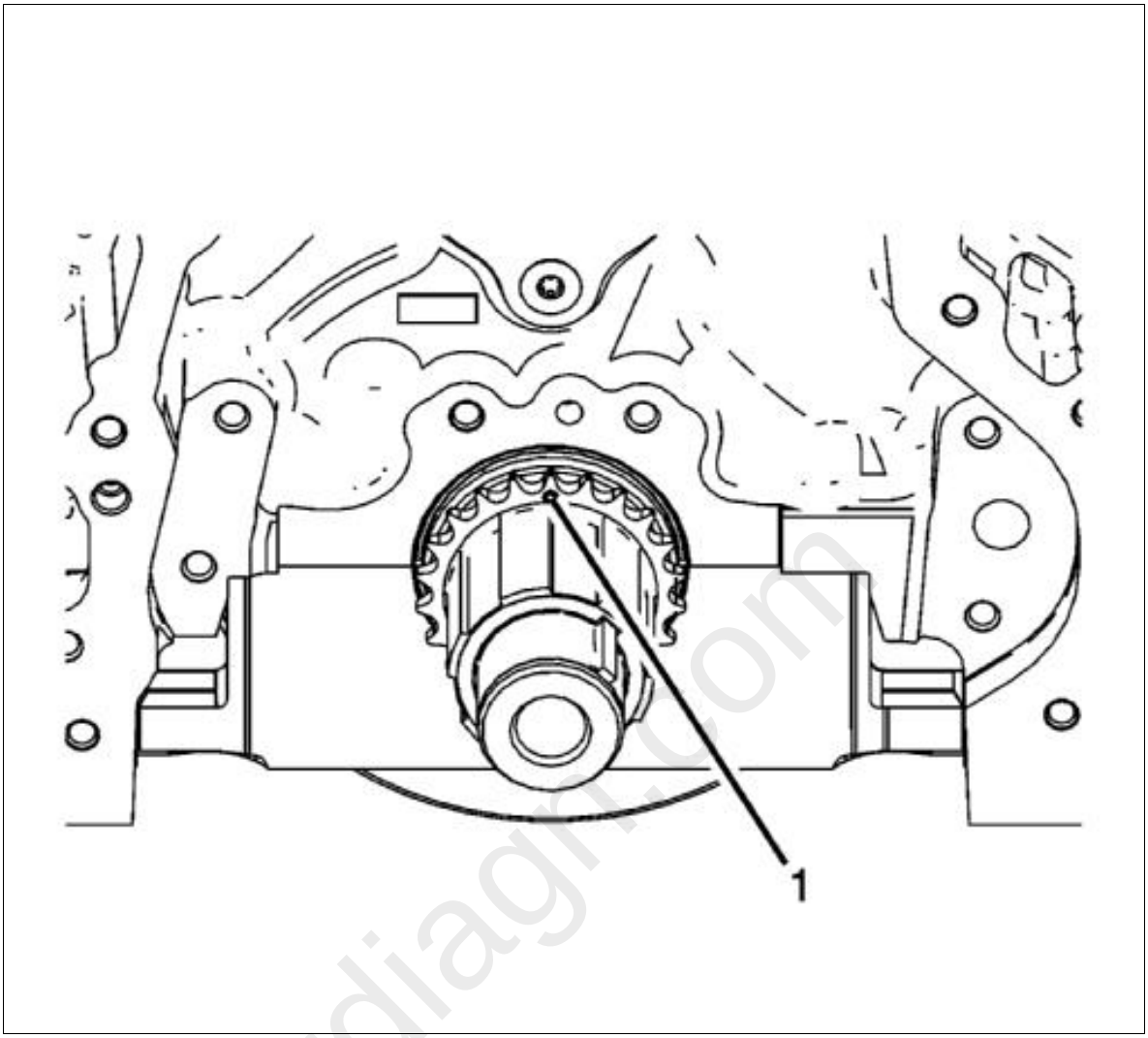
Fig 1: Crankshaft Sprocket



Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft sprocket (1) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

Fig 2: Rotating Crankshaft Until Sprocket Alignment Mark

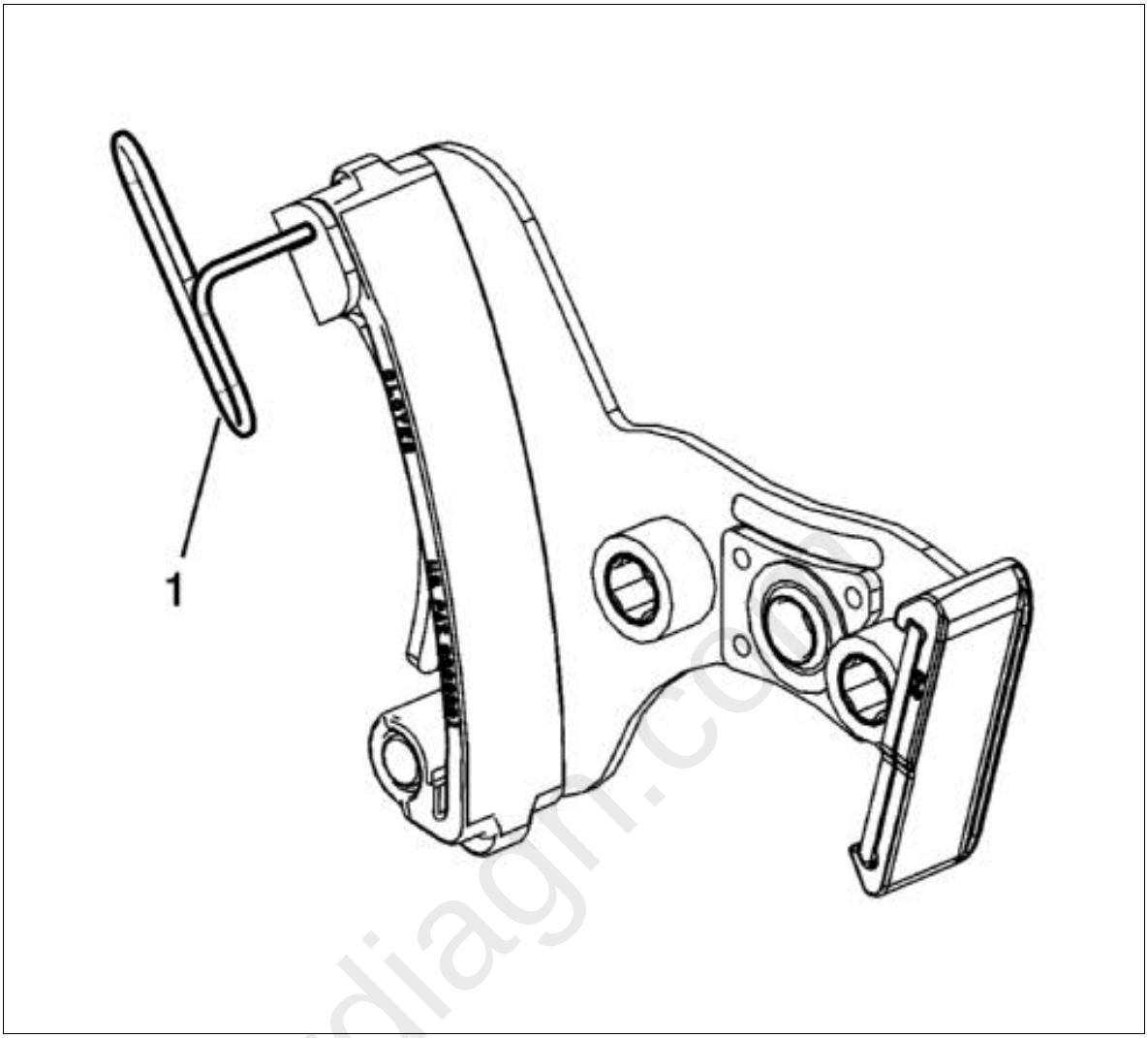


Courtesy of GENERAL MOTORS COMPANY

2. Rotate the crankshaft sprocket until the sprocket alignment mark (1) is in the 12 o'clock position.

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Fig 3: Timing Chain Tensioner Guide And Pin

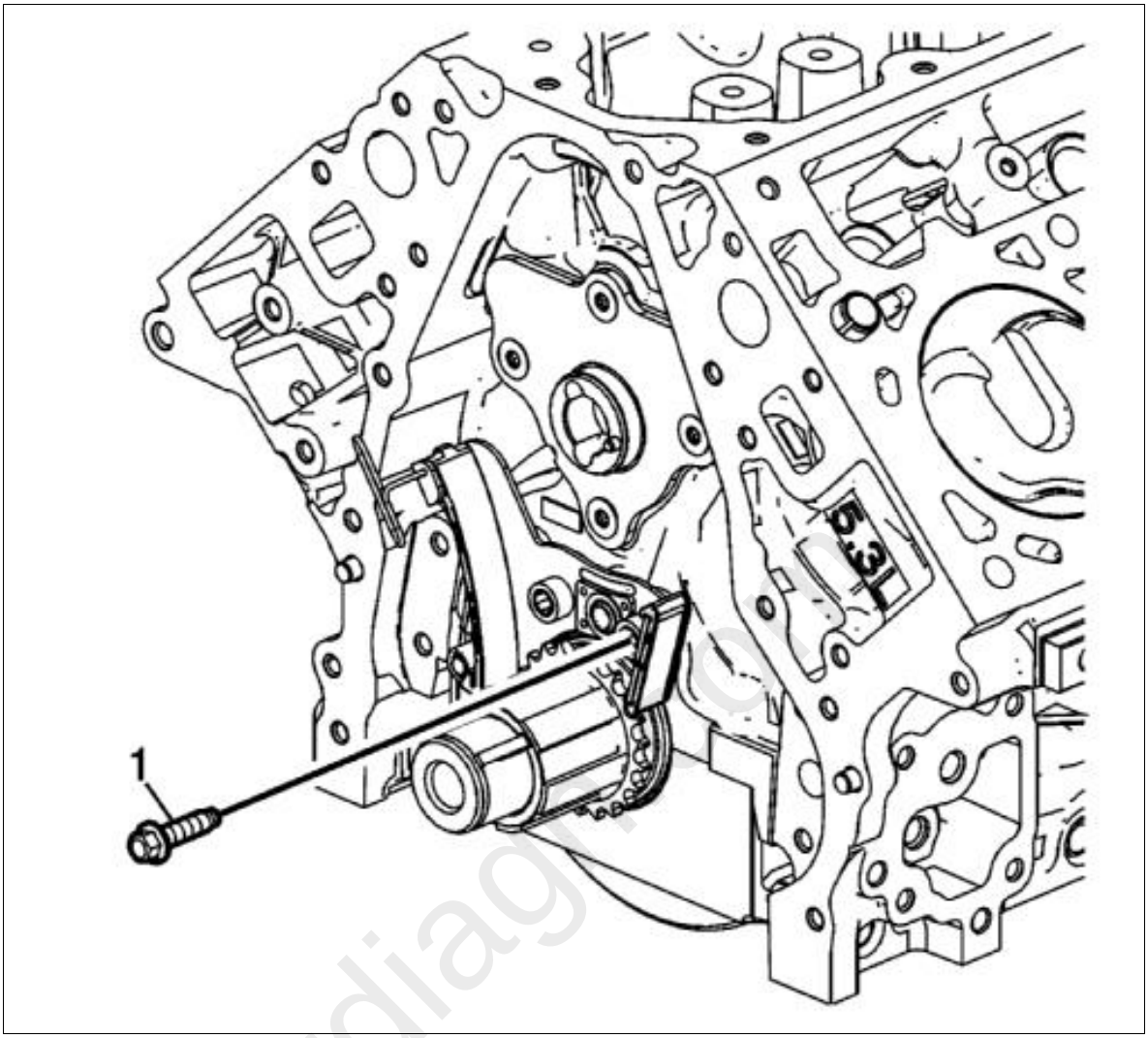


Courtesy of GENERAL MOTORS COMPANY

3. Compress the timing chain tensioner guide and install the **EN 46330** pin (1).

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Fig 4: Timing Chain Tensioner And Left Side Bolt

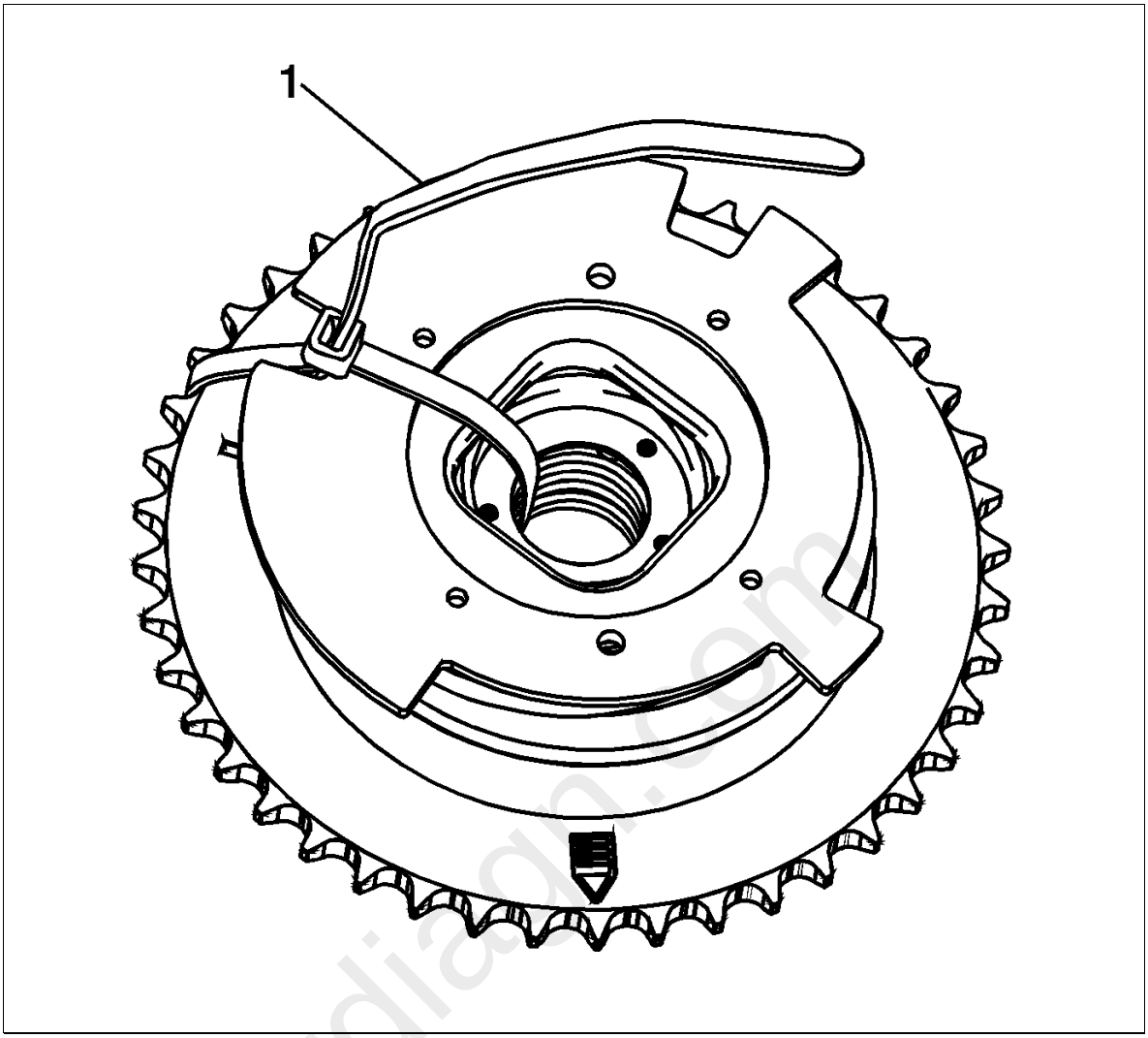


Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

4. Install the timing chain tensioner and left side bolt (1). Do not install the right side bolt at this time. The right side bolt will be installed after the camshaft position (CMP) actuator and chain have been installed onto the engine.

Fig 5: Tie Strap Through Center Of Actuator



Courtesy of GENERAL MOTORS COMPANY

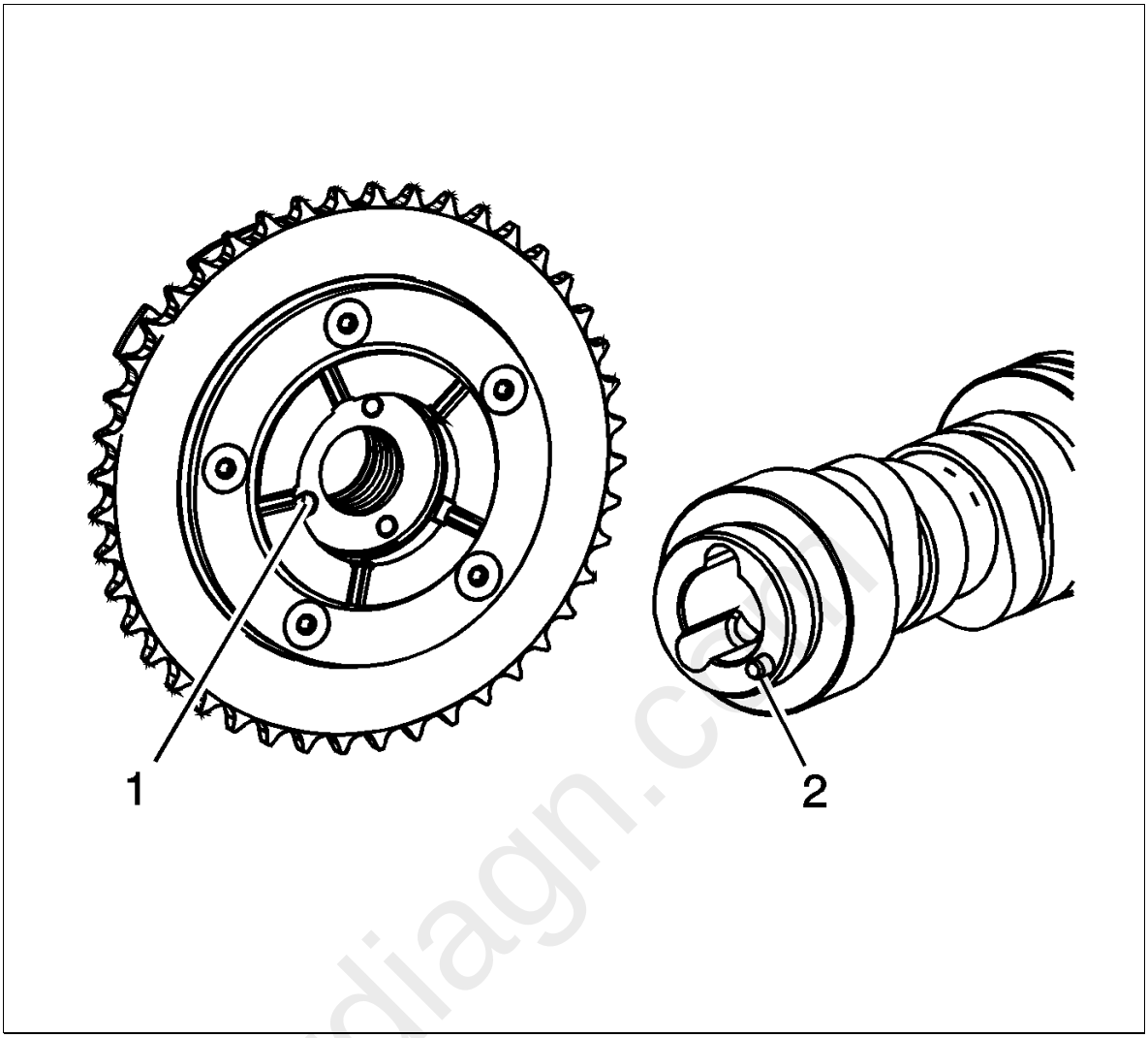
WARNING:

Refer to Camshaft Position Actuator Removal and Installation Warning .

5. Remove the tie strap (1) from the actuator.

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Fig 6: Alignment Hole & Locating Pin



Courtesy of GENERAL MOTORS COMPANY

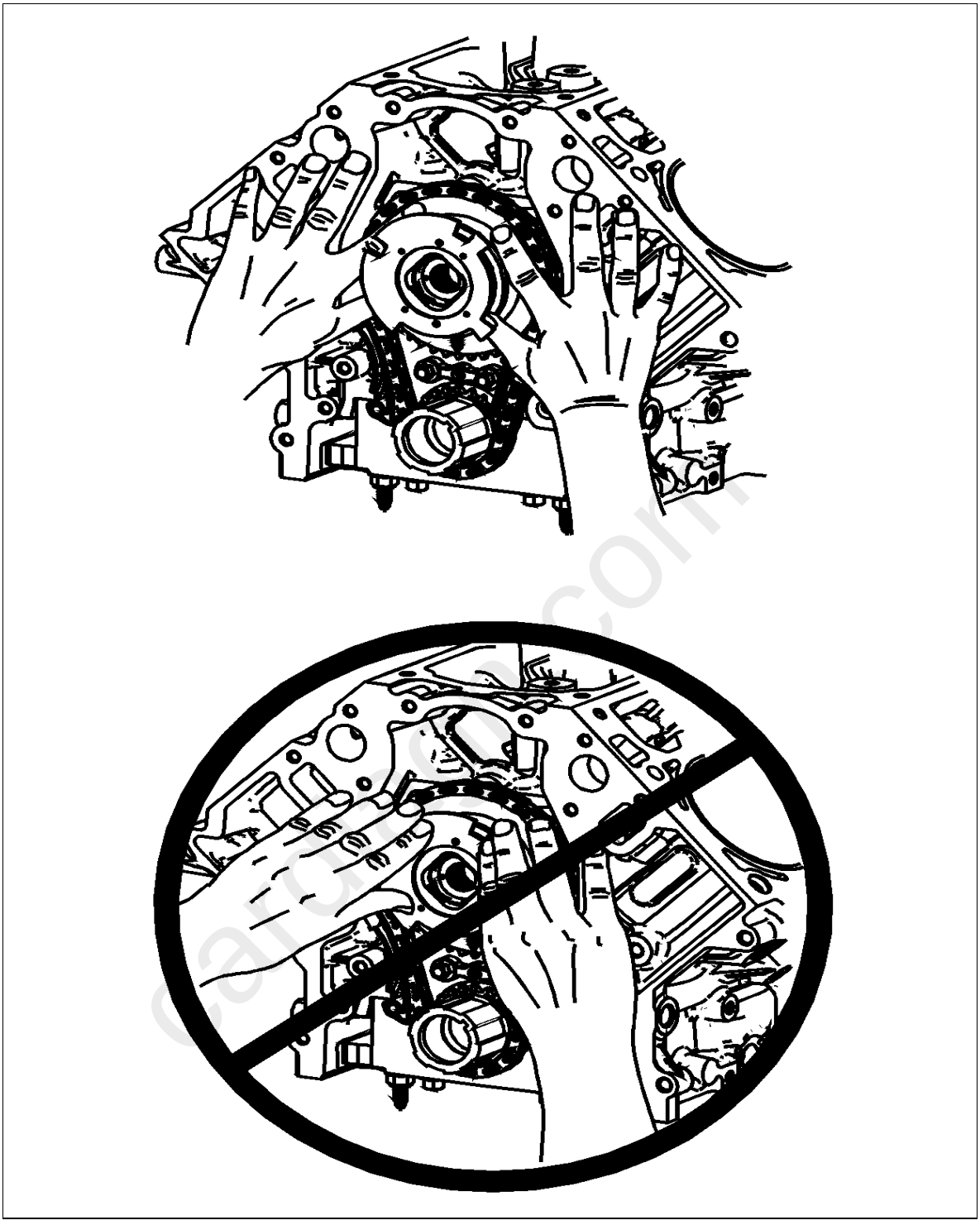
NOTE:

1. *Properly locate the CMP actuator onto the locating pin of the camshaft.*
2. *The sprocket teeth and timing chain must mesh.*
3. *The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.*
4. *Do not use the CMP solenoid valve again. Install a NEW valve during assembly.*

6. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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Fig 7: Proper Installation Of CMP Actuator



Courtesy of GENERAL MOTORS COMPANY

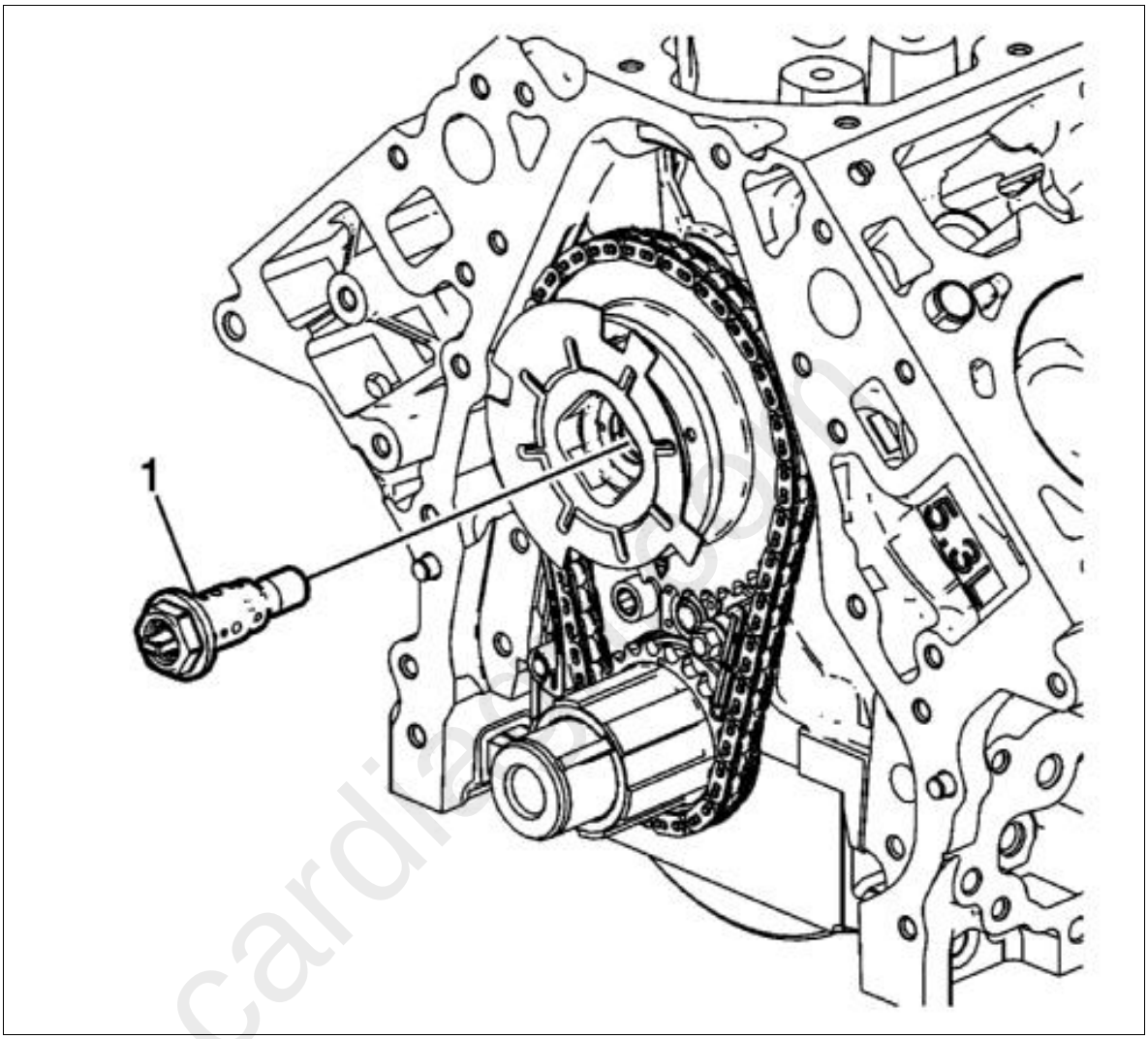
WARNING:

Refer to Camshaft Position Actuator Removal and Installation Warning .

7. Install the CMP actuator and timing chain. Align the hole in the rear face of the CMP actuator

with the locating pin on the front face of the camshaft. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks. Use care to install the actuator completely onto the front of the camshaft. Position fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

Fig 8: NEW CMP Actuator Solenoid Valve



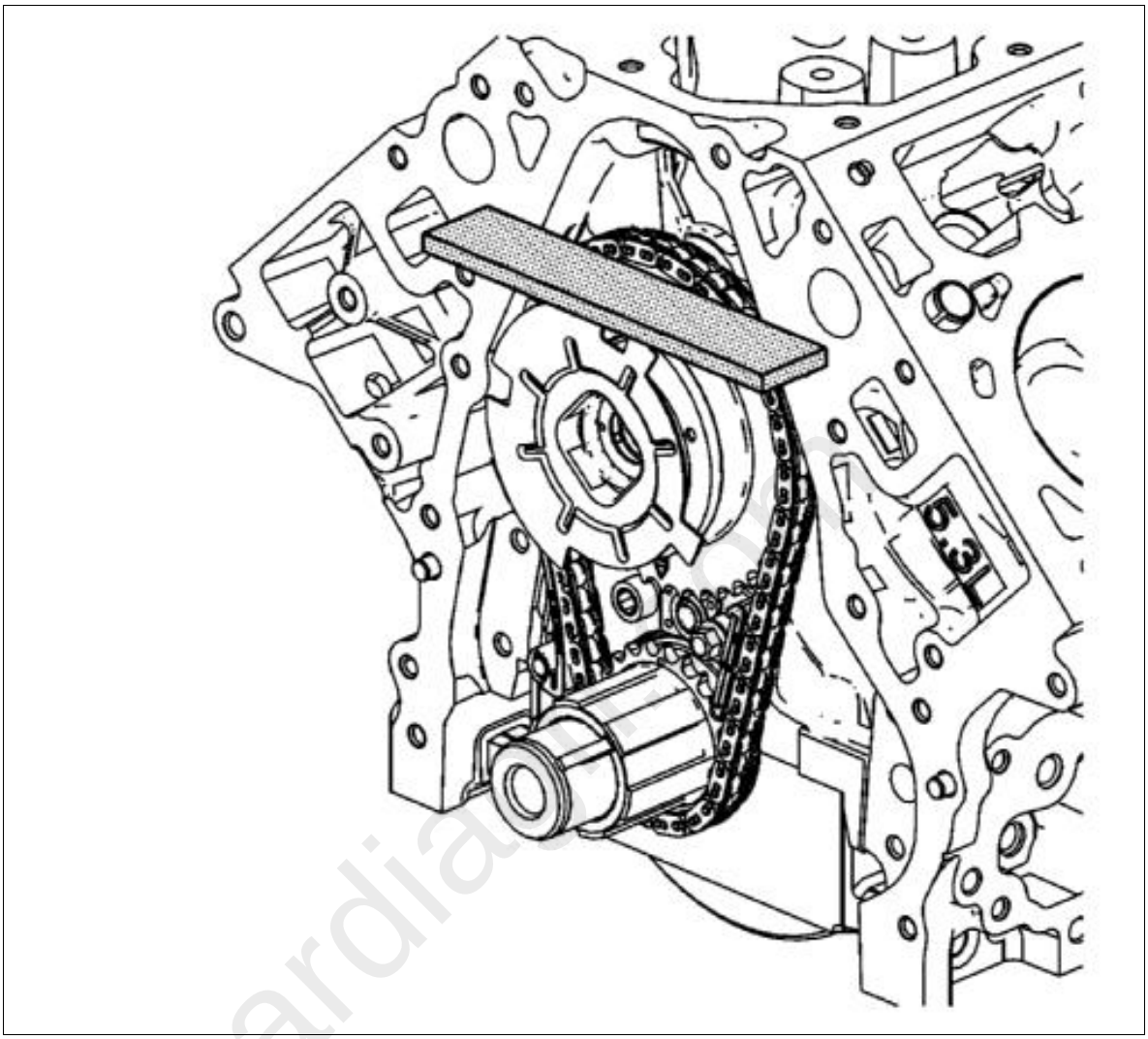
Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

8. Install a NEW CMP actuator solenoid valve (1). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

1. Tighten a first pass to 65 N.m (48 lb ft).
2. Tighten a final pass an additional 90 degrees using **EN-45059** angle meter.

Fig 9: Inspecting For Proper Installation Of CMP Actuator And Timing Chain



Courtesy of GENERAL MOTORS COMPANY

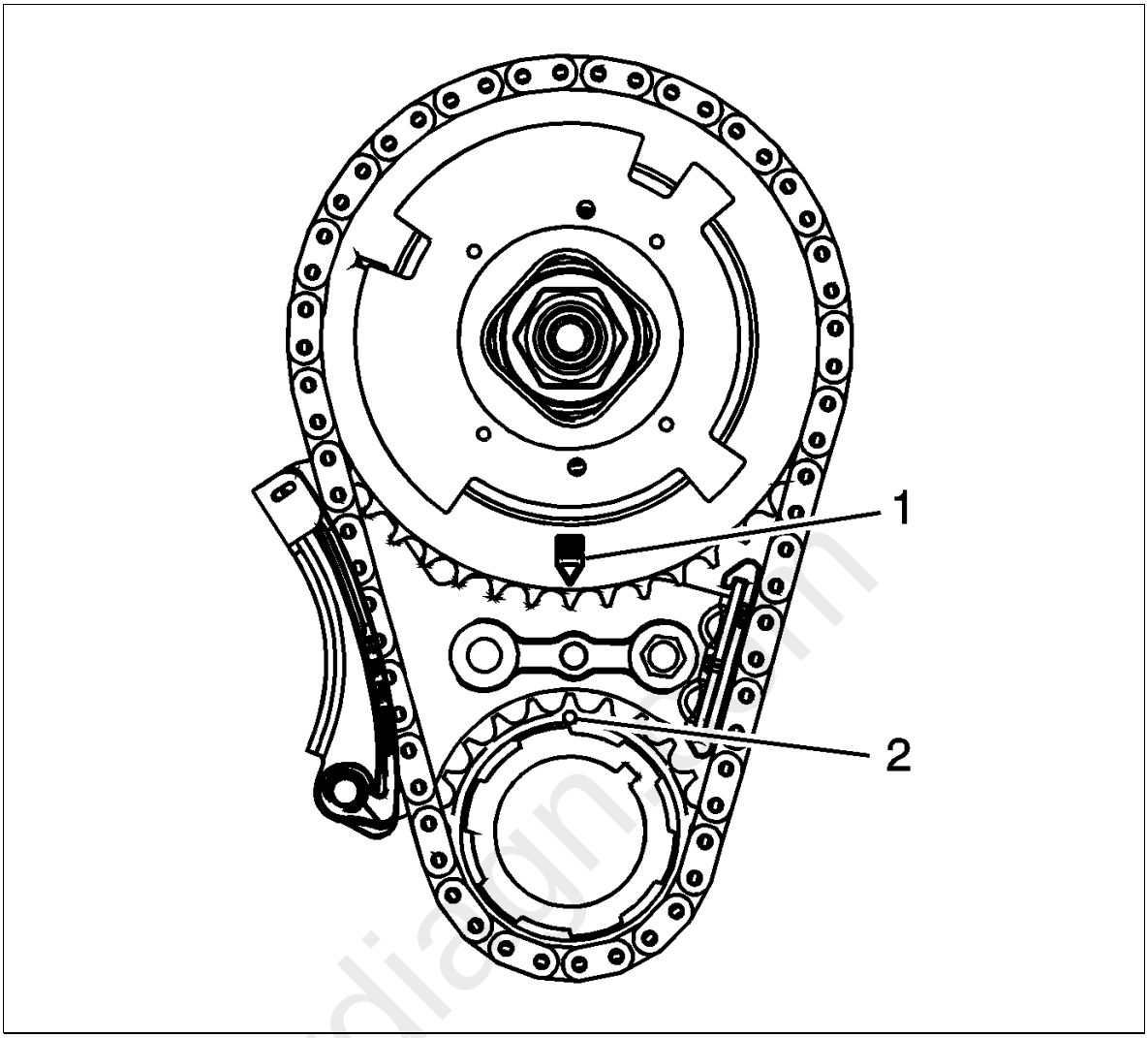
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NOTE:

It is possible to push the camshaft rearward when installing the CMP valve. Verify that the camshaft lobes are centered in the valve lifter bores after the CMP actuator is installed.

9. Locate a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of camshaft, the timing chain will not protrude beyond the front face of engine block.

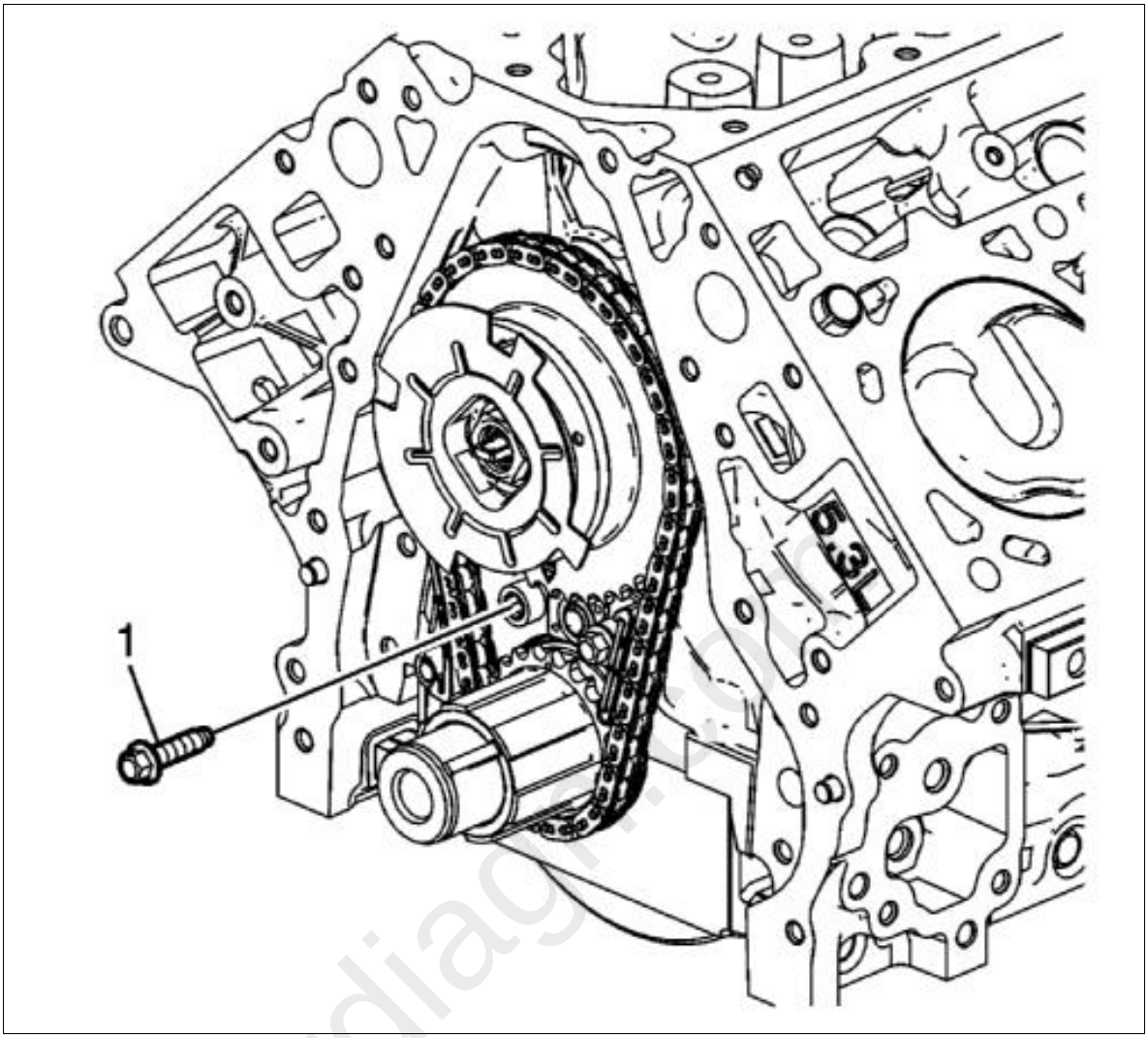
Fig 10: CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark



Courtesy of GENERAL MOTORS COMPANY

10. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

Fig 11: Timing Chain Tensioner

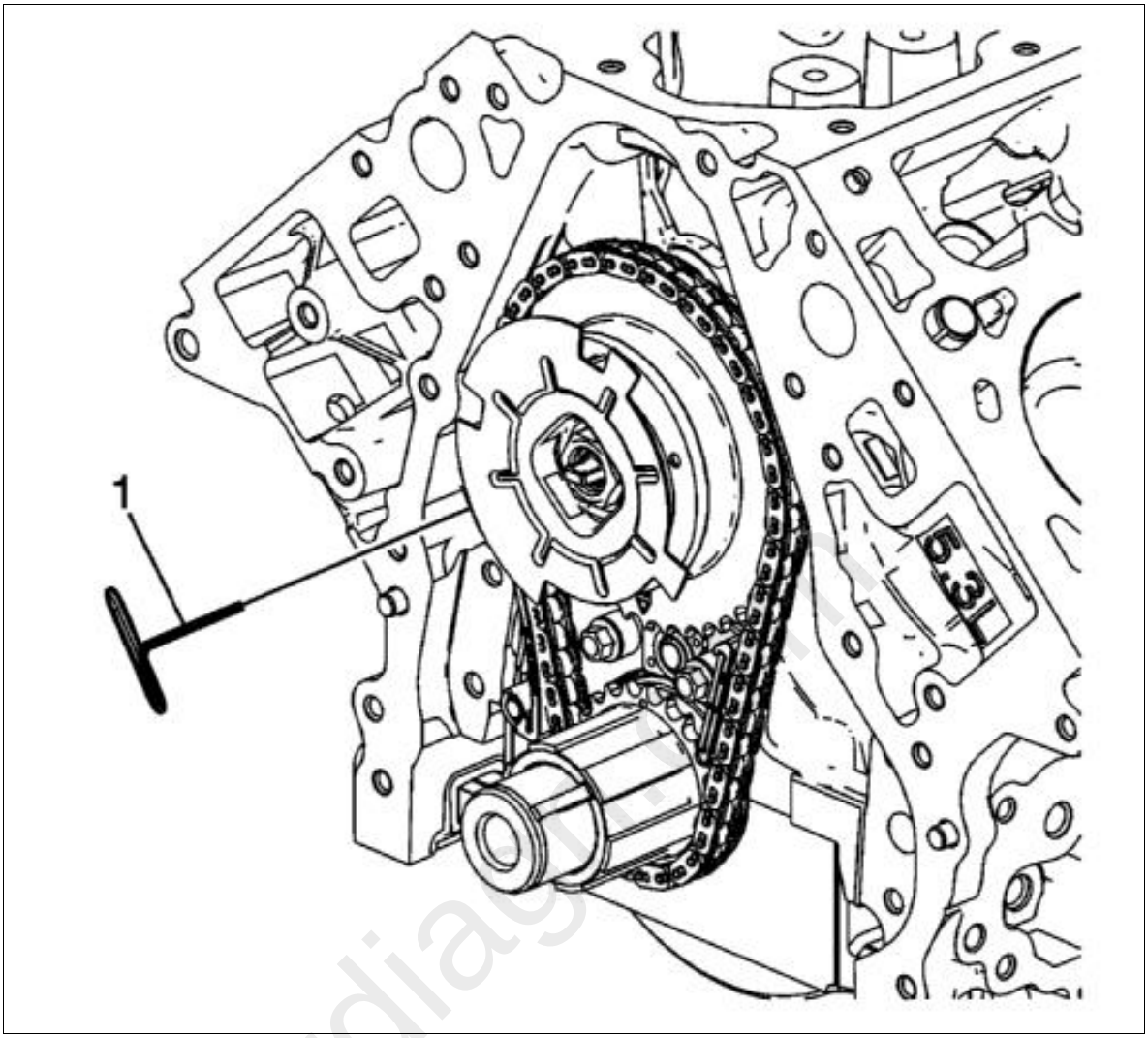


Courtesy of GENERAL MOTORS COMPANY

11. Install the right side bolt (1) into the timing chain tensioner and tighten both bolts to 25 N.m (18 lb ft).

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Fig 12: Pin

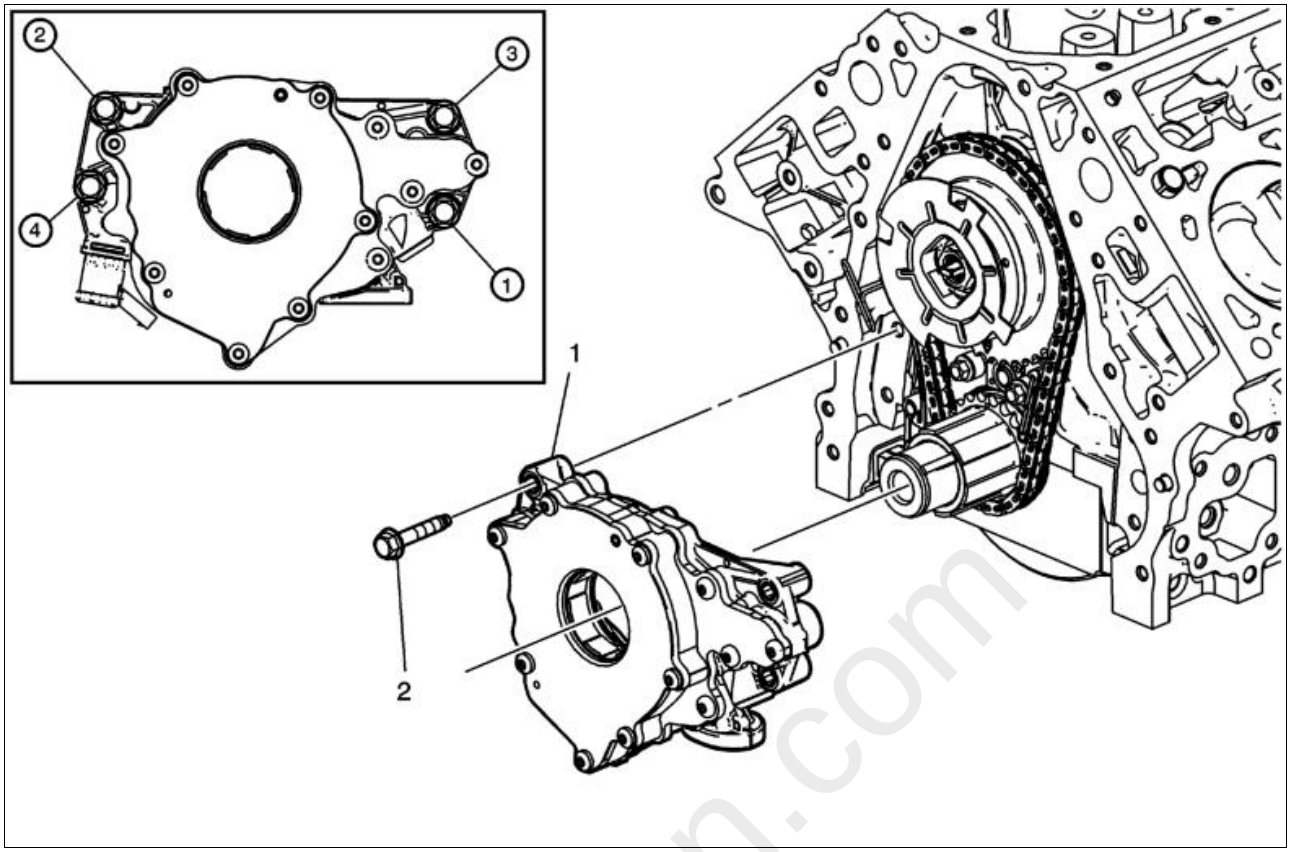


Courtesy of GENERAL MOTORS COMPANY

12. Remove the **EN 46330** pin.

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PUMP INSTALLATION

Fig 1: Oil Pump



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure If oil pump is removed to perform a different repair and is going to be REUSED, the alignment tool **EN-51267** oil pump alignment tool MUST be installed on the engine block BEFORE the oil pump is removed and left in place until the installation of the original oil pump. If **EN-51267** oil pump alignment tool IS NOT installed prior the oil pump being removed AND left in place while other repairs are performed, a NEW oil pump MUST be installed.	
1	Oil Pump Assembly *NOTE:* *Prior to installing the oil pump, ensure that oil pump housing gasket is fully installed in the timing chain tensioner assembly and is not damaged. If the gasket is missing or damaged, replace the tensioner assembly.*
2	Oil Pump Bolt *CAUTION:*

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Refer to Fastener Caution .

NOTE:

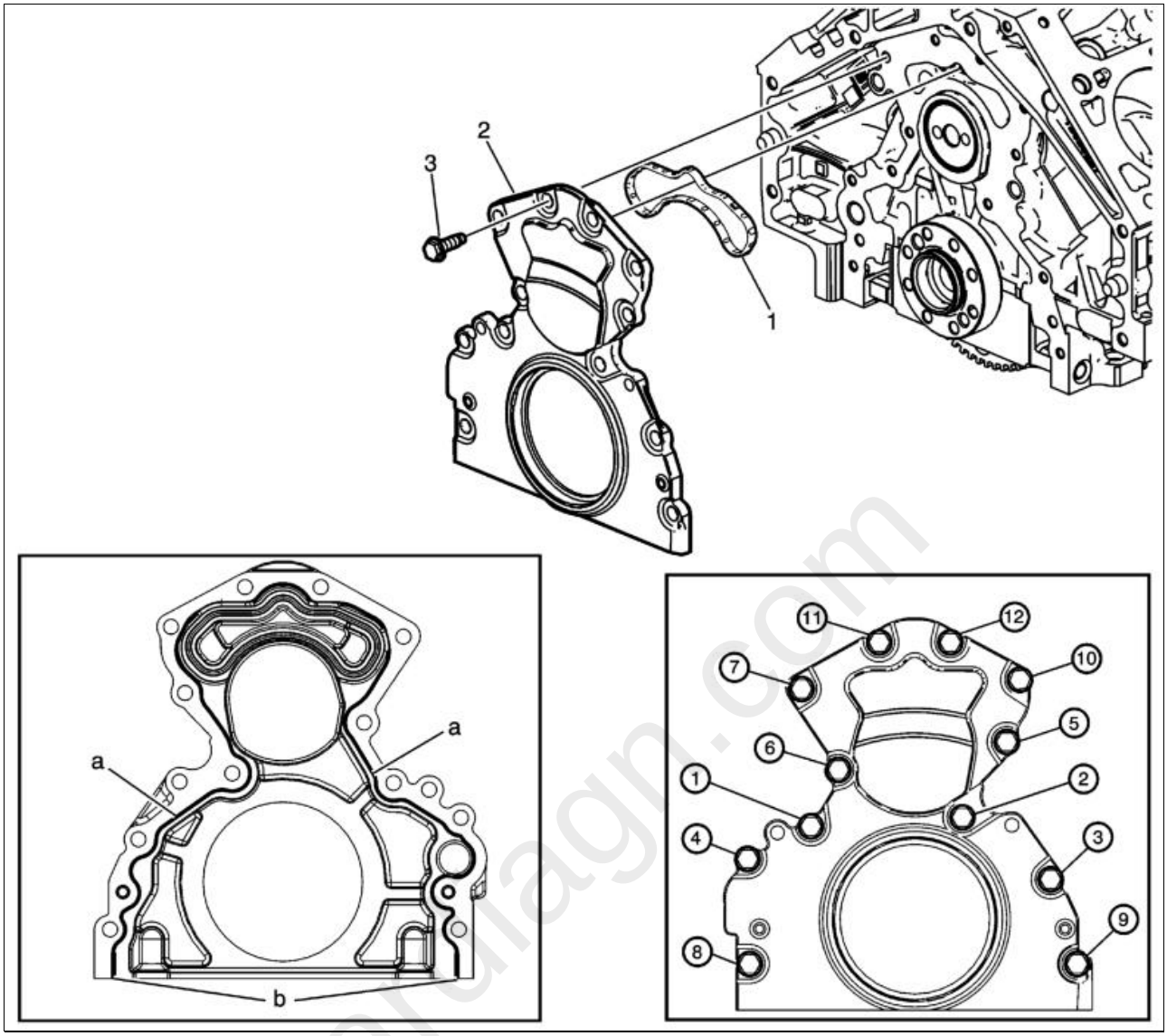
Upward pressure must be applied to the oil pump while tightening the fasteners. Contact between the oil pump housing and the oil pump alignment tool must be maintained while oil pump bolts are tightened. Prior to removing the oil pump alignment tool, ensure that there is no gap between the oil pump housing and the tool. If there is a gap, the oil pump bolts need to be loosened and the installation procedure repeated.

Procedure
Tighten the oil pump bolts in the sequence shown.
Tighten
25 N.m (18 lb ft)
Special Tools
EN-51267 Oil Pump Alignment Tool
For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT REAR OIL SEAL HOUSING INSTALLATION

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Fig 1: Crankshaft Rear Oil Seal Housing Installation



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Rear Oil Seal Housing Gasket *NOTE:* *Must use a NEW gasket when installing the rear housing.*
2	Crankshaft Rear Oil Seal Housing Procedure 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room

	Temperature Vulcanizing (RTV) and Anaerobic Sealant 2. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended sealant.
3	Crankshaft Rear Oil Seal Housing Bolt *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the rear oil seal housing bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT REAR OIL SEAL INSTALLATION

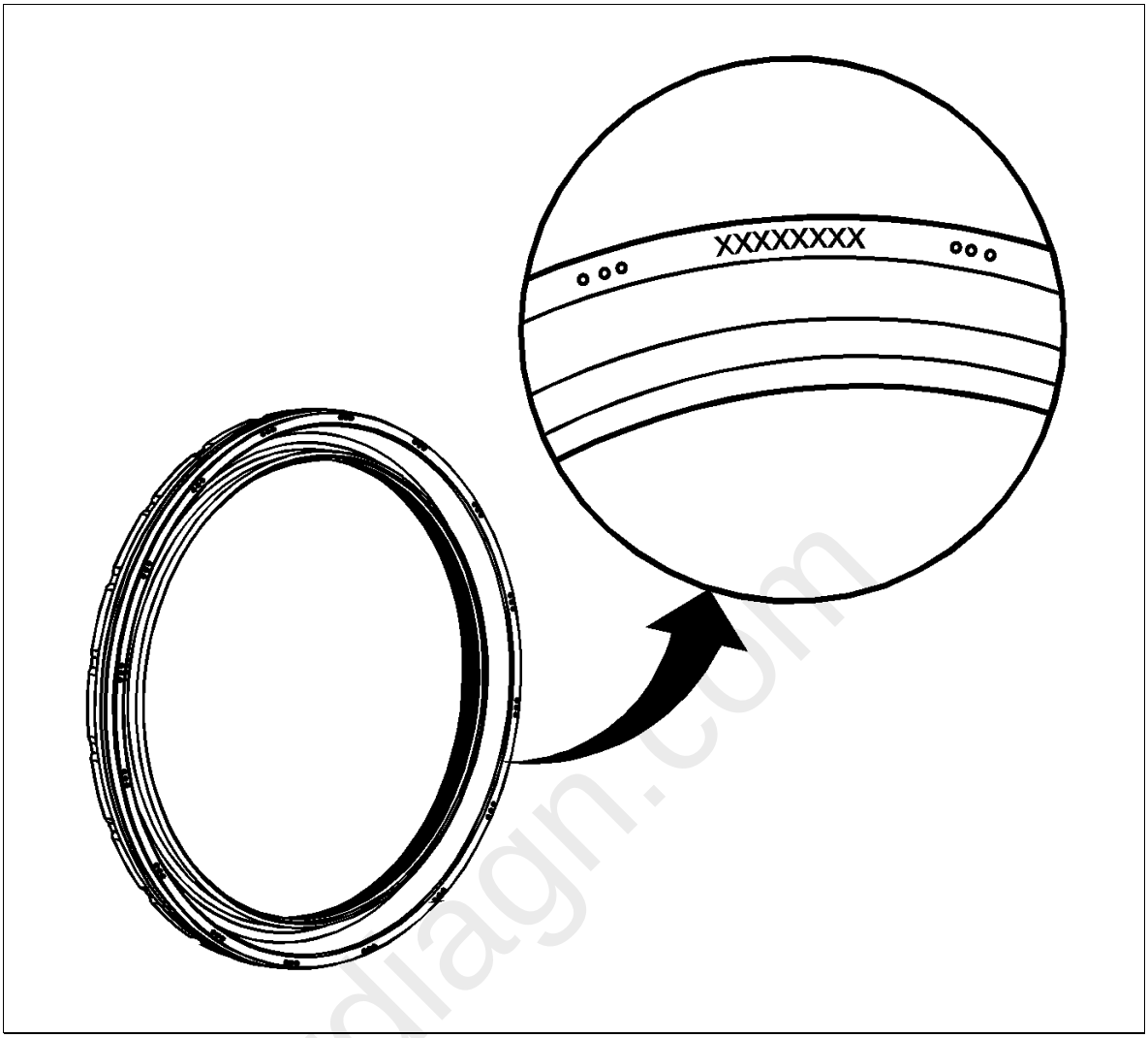
Special Tools

- **J 41479** Crankshaft Rear Oil Seal Installer
- **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide

For equivalent regional tools, refer to Special Tools .

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Fig 1: Oil Seal



Courtesy of GENERAL MOTORS COMPANY

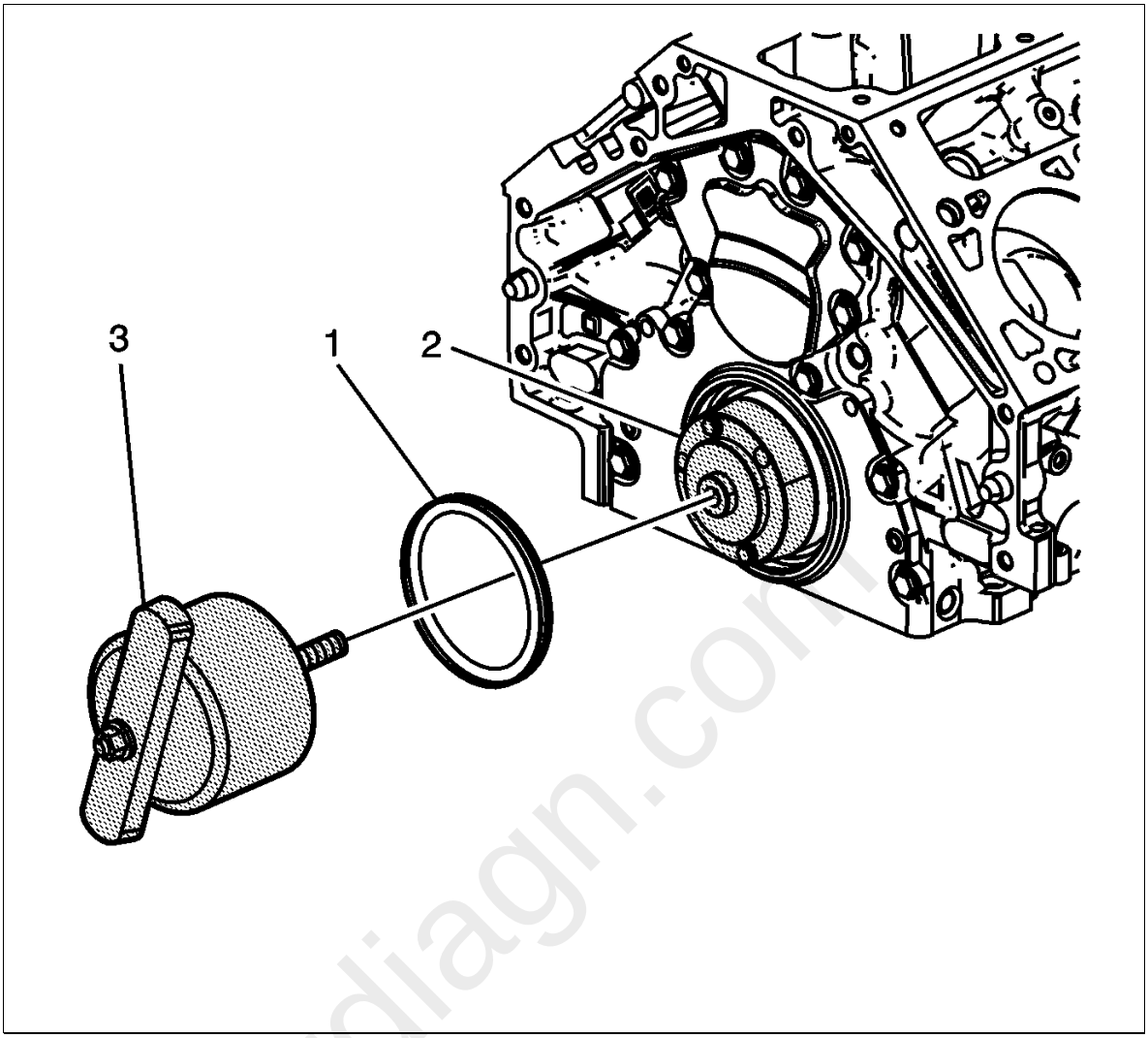
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IMPORTANT:

For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

Fig 2: J 14179 Crankshaft Rear Oil Seal Installer



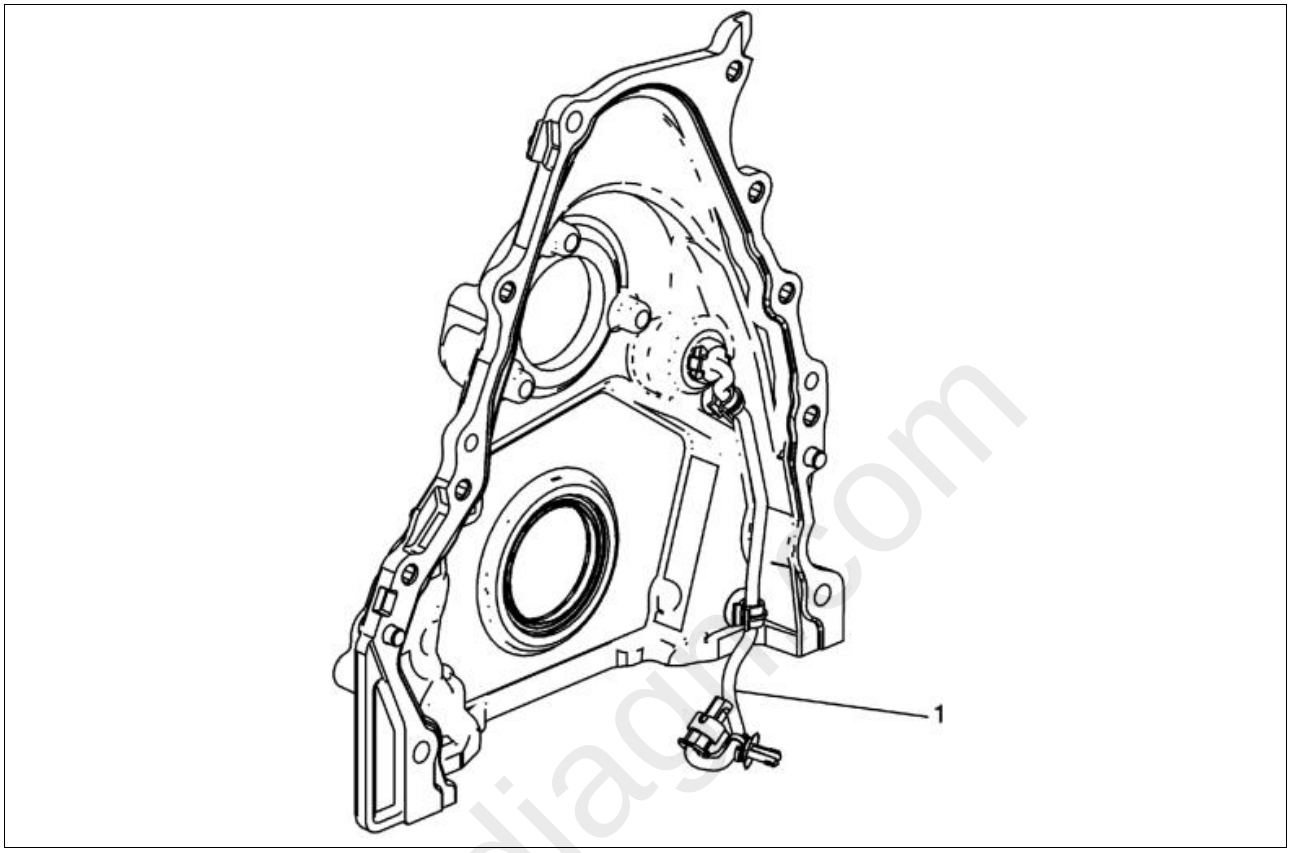
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2. Install the **J 41479** Crankshaft Rear Oil Seal Installer (3) or the **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide cone (2) and bolts onto the rear of the crankshaft. The **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide may be required for manual transmission applications.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal (1) onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the **J 41479** Crankshaft Rear Oil Seal Installer threaded rod into the tapered cone until the tool (3) contacts the oil seal.
6. Align the oil seal onto the tool (3).
7. Rotate the handle of the tool (3) clockwise until the seal enters the rear housing and bottoms into the seal bore.
8. Remove the tool.

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FRONT COVER INSTALLATION > OIL PUMP FLOW CONTROL VALVE HARNESS INSTALLATION

Fig 1: Oil Pump Flow Control Valve Harness



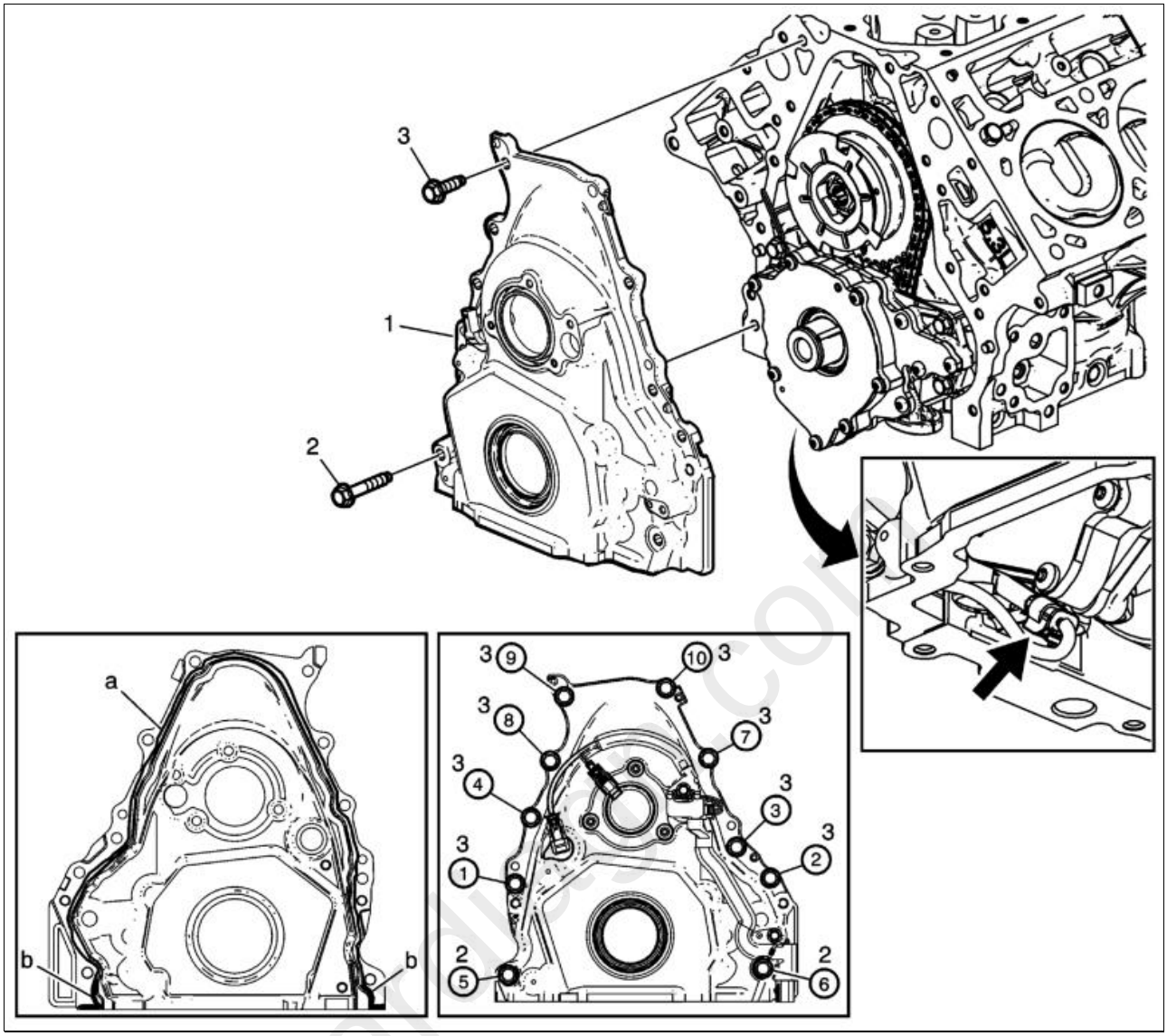
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Harness Installation

Callout	Component Name
1	Oil Pump Flow Control Valve Harness Procedure 1. Install the harness through the front of the engine front cover and push connector into engine front cover until it clicks. 2. Install the wire into the 2 retainer clips.

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FRONT COVER INSTALLATION > FRONT COVER INSTALLATION

Fig 1: Engine Front Cover



Courtesy of GENERAL MOTORS COMPANY

Front Cover Installation

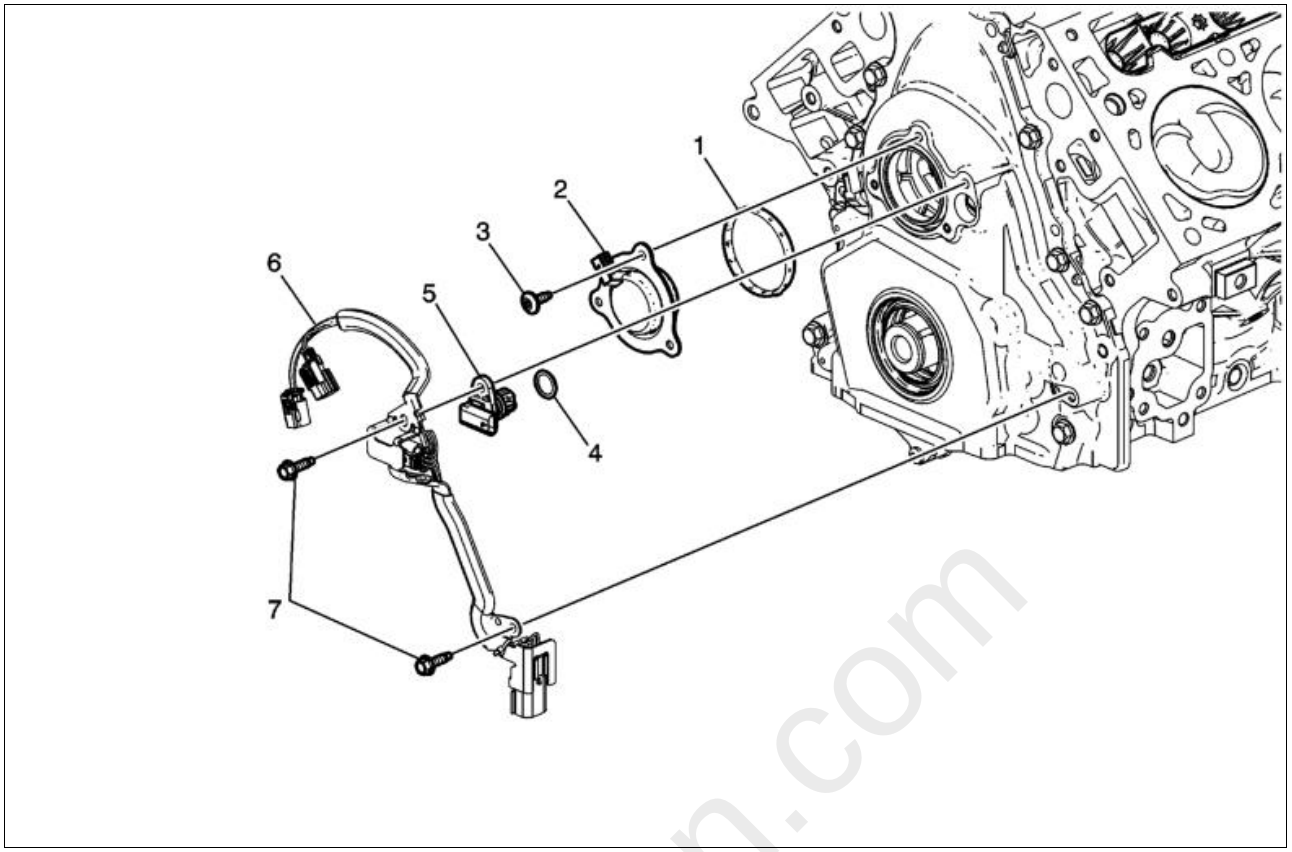
Callout	Component Name
1	Engine Front Cover *NOTE:* *Install and align the front cover within 10 minutes of applying the sealer.* Procedure 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room

	Temperature Vulcanizing (RTV) and Anaerobic Sealant 2. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to Adhesives, Fluids, Lubricants, and Sealers . 3. Connect the oil pump flow control valve harness connector after installing the engine front cover.
2	Engine Front Cover Bolt *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the engine front cover bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)
3	Engine Front Cover Bolt **Procedure** Tighten the engine front cover bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)

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REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FRONT COVER INSTALLATION > CAMSHAFT POSITION SENSOR HARNESS, CAMSHAFT POSITION SENSOR AND CAMSHAFT ACTUATOR MAGNET INSTALLATION

Fig 1: Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet



Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Installation

Callout	Component Name
1	Camshaft Actuator Magnet Gasket *NOTE:* *Must use a NEW gasket.*
2	Camshaft Actuator Magnet
3	Camshaft Actuator Magnet Bolts **Tighten** 10 N.m (88 lb in)
4	Camshaft Position Sensor Seal *NOTE:*

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	Must use a NEW seal.
5	Camshaft Position Sensor
6	Camshaft Position Sensor Harness
7	Camshaft Position Sensor Harness Bolts **Tighten** 25 N.m (18 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT FRONT OIL SEAL INSTALLATION

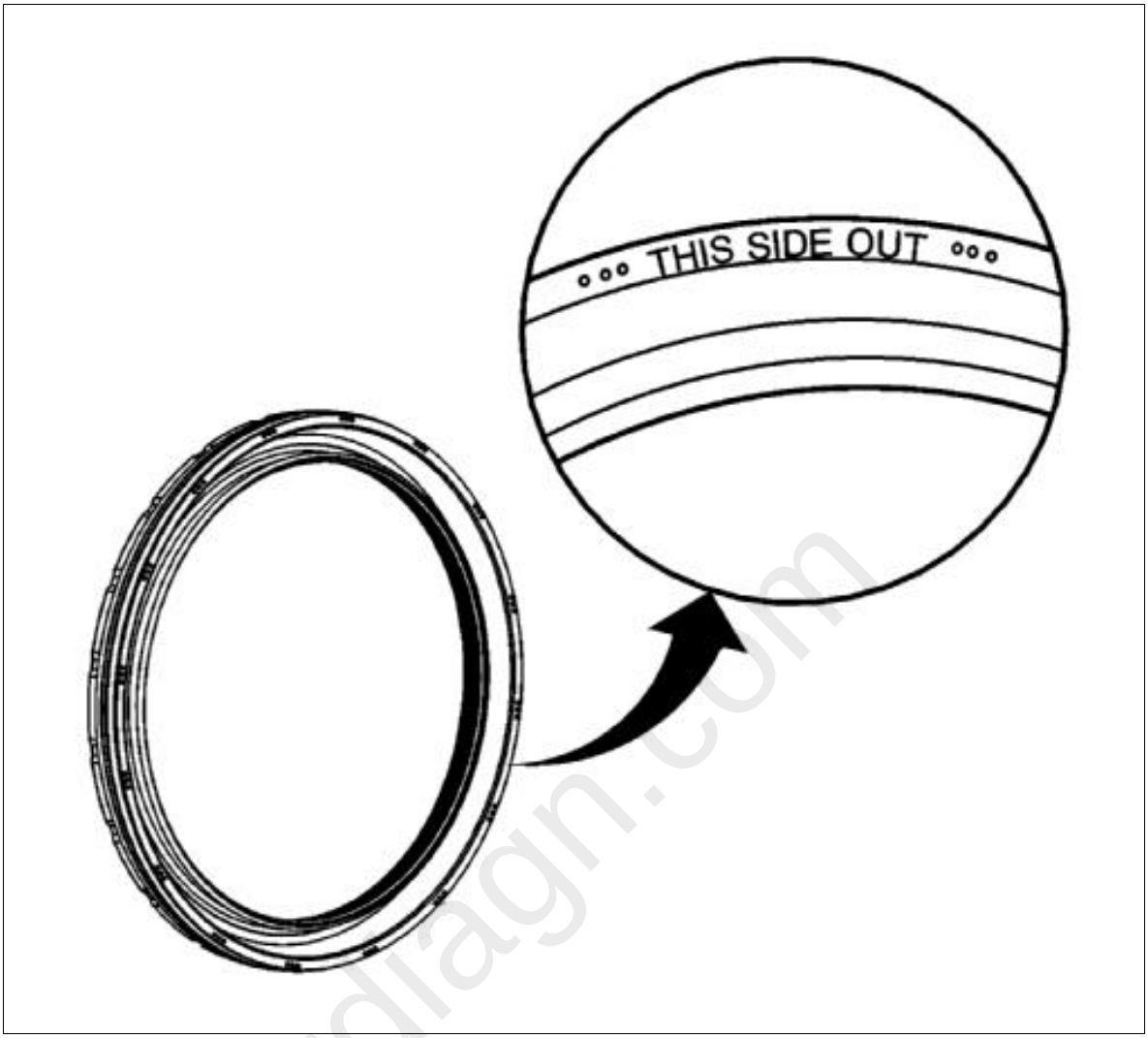
Special Tools

- **J-41478-A** Crankshaft Front Oil Seal Installer
- **EN-51091** Crankshaft Front Oil Seal Installer

For equivalent regional tools, refer to Special Tools

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Fig 1: Inspecting Seal For Proper Orientation



Courtesy of GENERAL MOTORS COMPANY

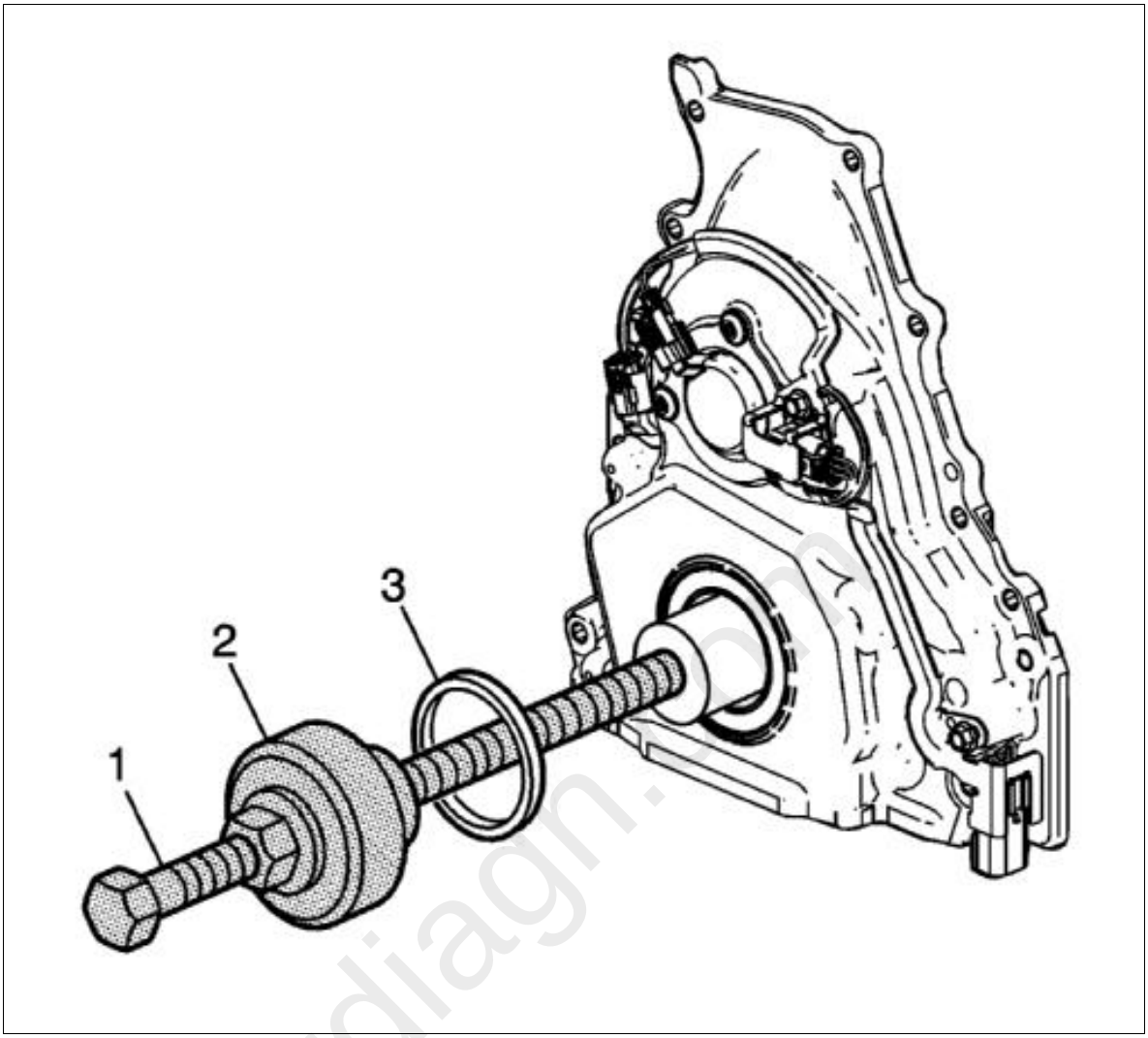
IMPORTANT:

For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. Install with "THIS SIDE OUT" displayed as shown.

1. Inspect the seal for proper orientation.

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Fig 2: Crankshaft Front Oil Seal



Courtesy of GENERAL MOTORS COMPANY

NOTE:

1. Do not lubricate the oil seal sealing surface.

2. Do not use the crankshaft front oil seal again.

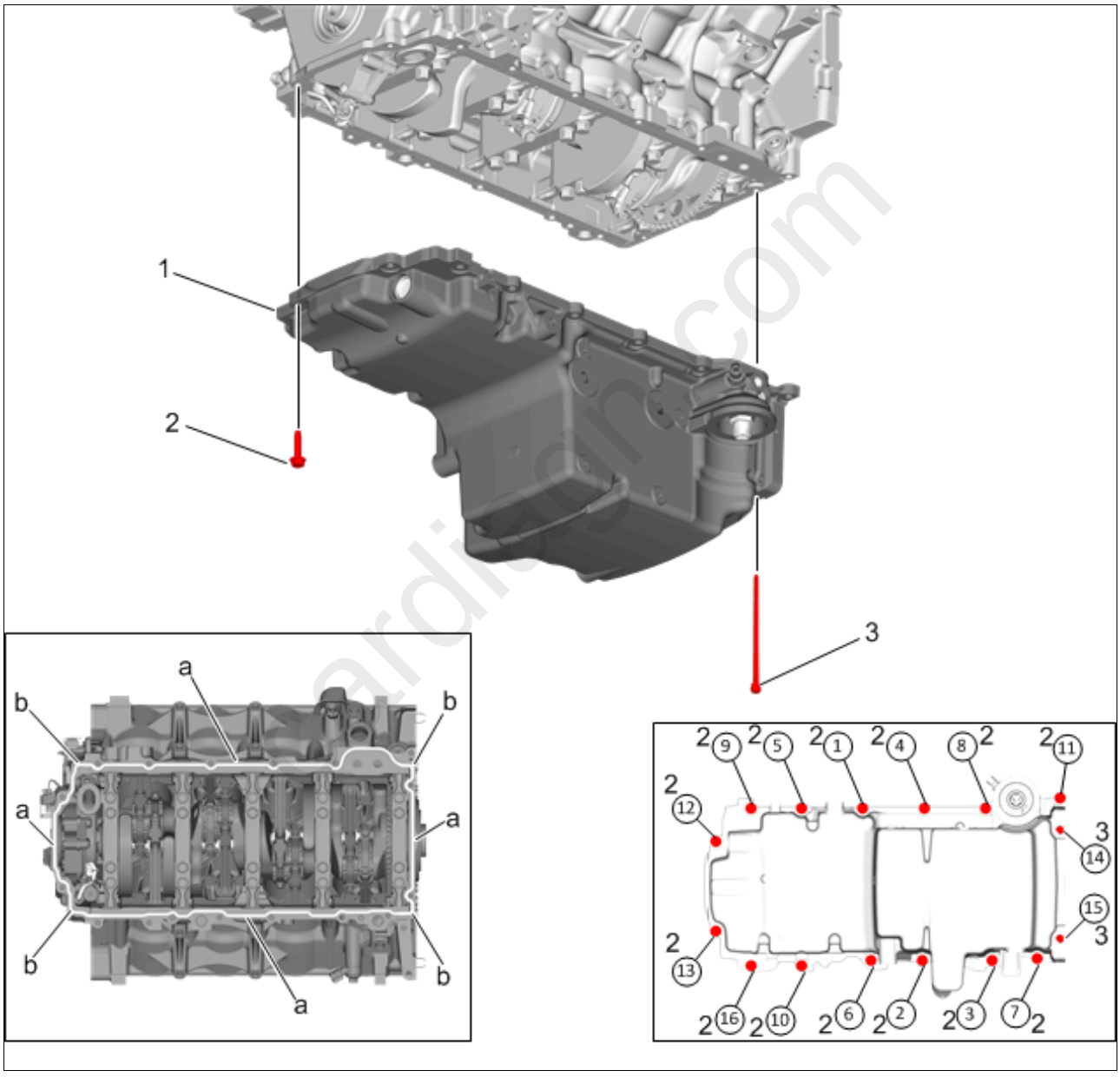
2. Install the crankshaft front oil seal (3) onto the threaded rod, nut and washer from **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal installer (2).
3. Install the **J-41478-A** crankshaft front oil seal installer threaded rod, nut and washer (1) and **EN-51091** crankshaft front oil seal installer (2) and oil seal (3), into the end of the crankshaft.
4. Use the **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal installer (2) in order to install the oil seal (3) into the cover bore.
    1. Use a wrench and hold the hex on the installer bolt.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in

the cover bore.

3. Remove the tool.
4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL PAN INSTALLATION

Fig 1: Oil Pan Assembly



Courtesy of GENERAL MOTORS COMPANY

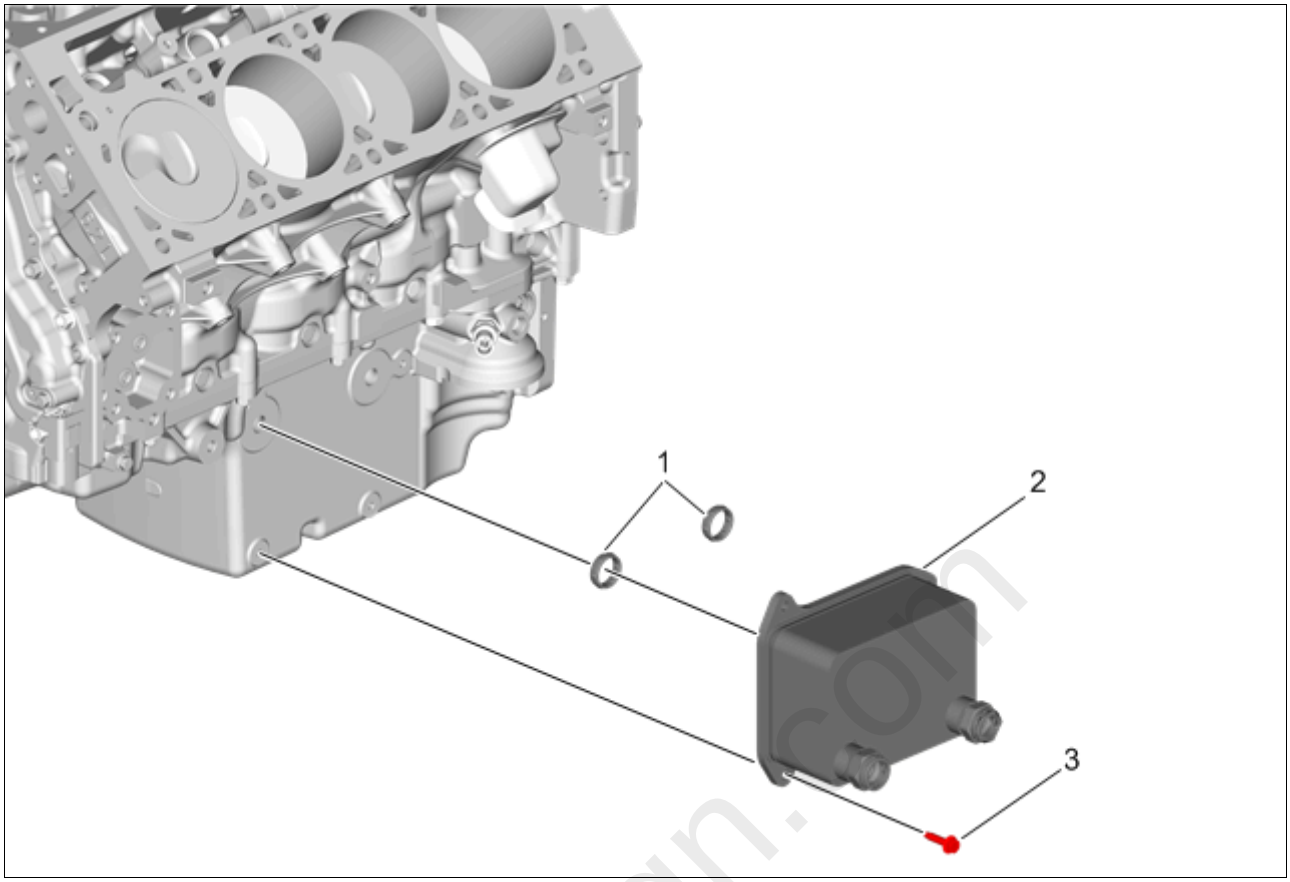
Callout	Component Name
1	Oil Pan Assembly

	NOTE: *Install and align the oil pan within 10 minutes of applying the sealer.* 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant 2. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to Adhesives, Fluids, Lubricants, and Sealers .
2	Oil Pan Bolt *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the oil pan bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)
3	Oil Pan Bolt **Procedure** Tighten the oil pan bolts in the sequence shown. **Tighten** 12 N.m (106 lb in)

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REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE OIL COOLER INSTALLATION

Fig 1: Engine Oil Cooler



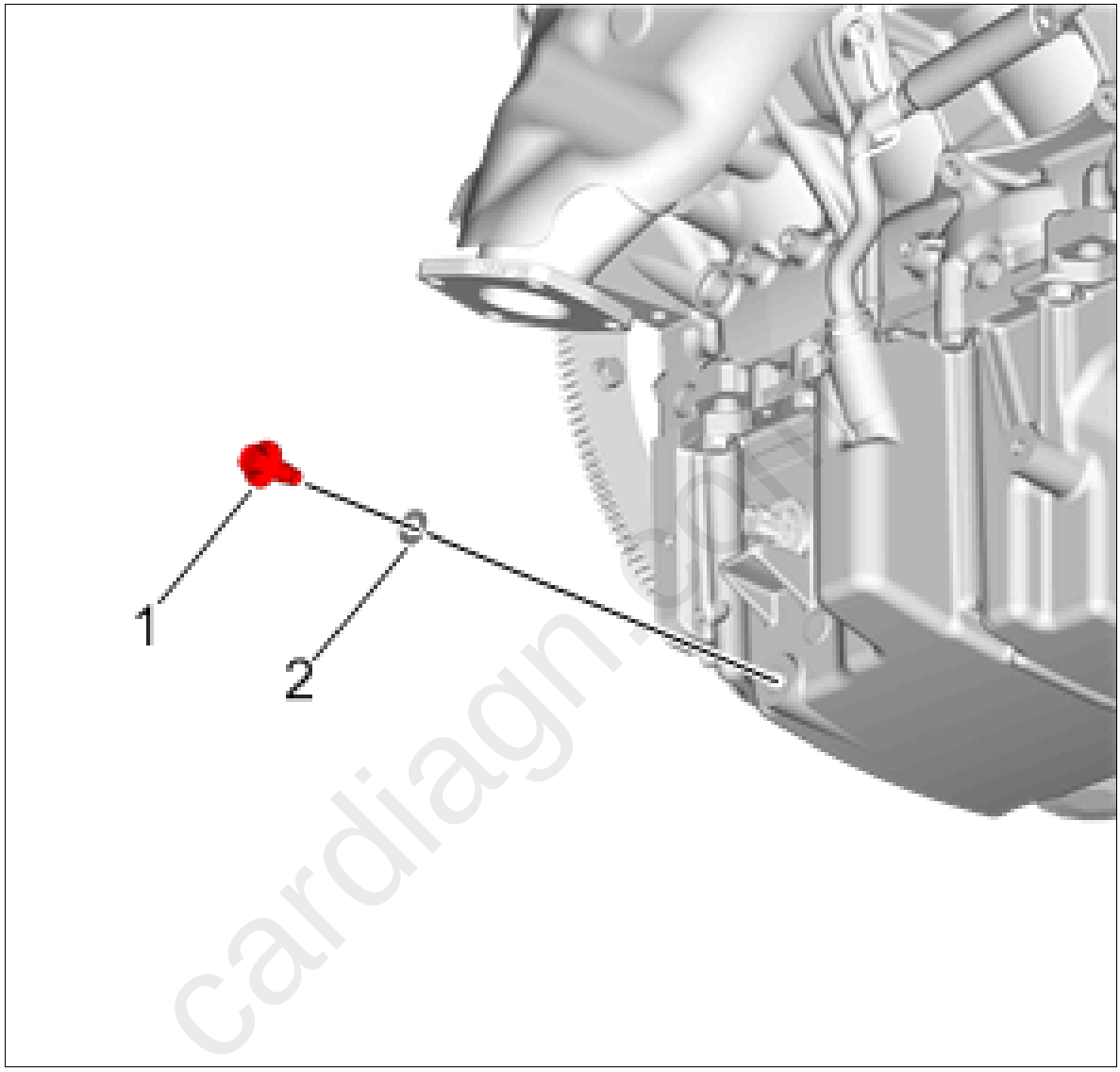
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Callout	Component Name
1	Engine Oil Cooler Gasket (Qty: 2) *NOTE:* *Must use a NEW gasket.*
2	Engine Oil Cooler
3	Engine Oil Cooler Bolt (Qty: 4) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (89 lb in)

REPAIR INSTRUCTIONS - OFF VEHICLE > OIL FILTER INSTALLATION

Fig 1: Oil Pan Drain Plug

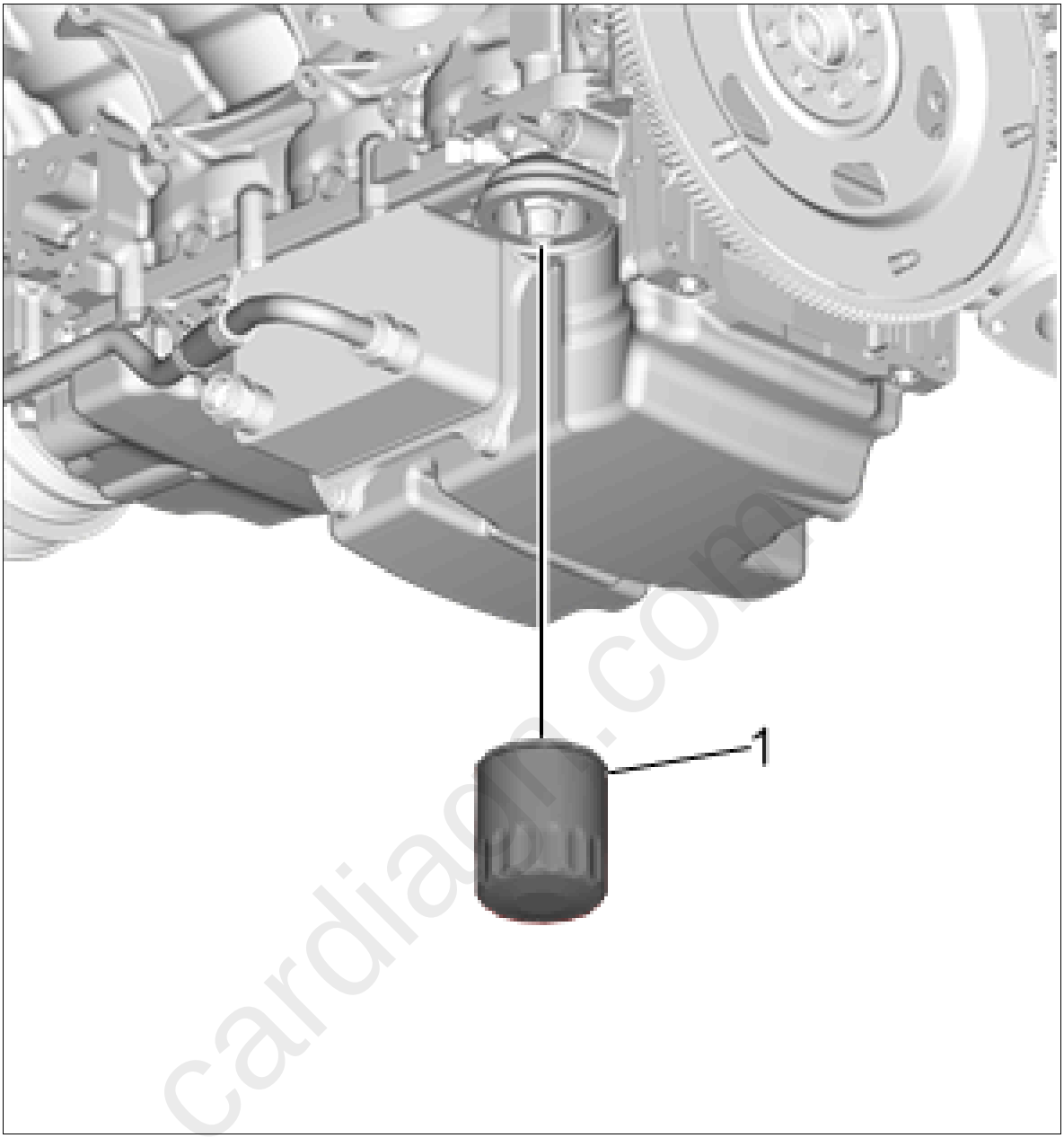


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1. Install the oil pan drain plug (1) with seal (2). Tighten to 25 N.m (18 lb ft)

Fig 2: Engine Oil Filter

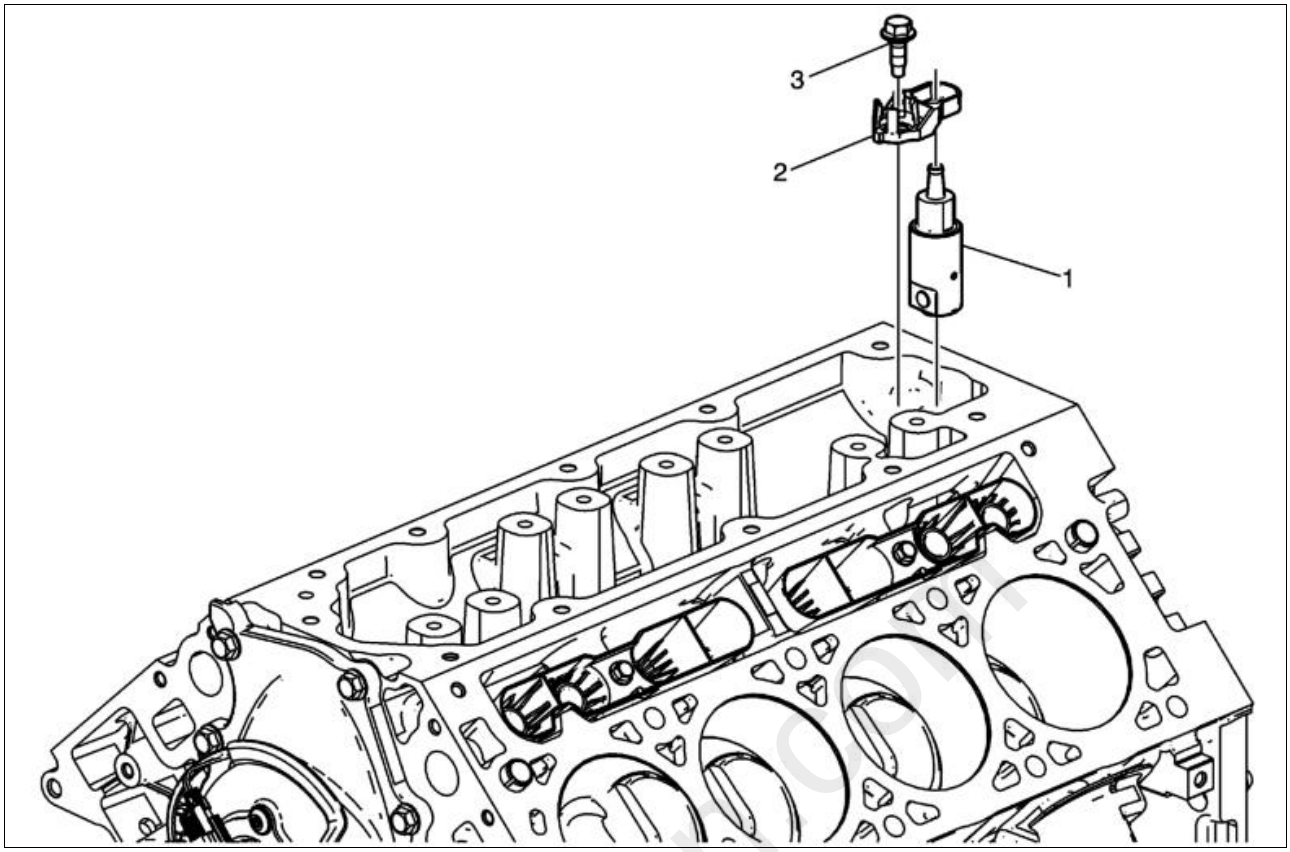


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2. Install the engine oil filter (1). Tighten the filter 3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange.

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER FOLLOWER GUIDE INSTALLATION

Fig 1: Valve Lifter Follower Guide

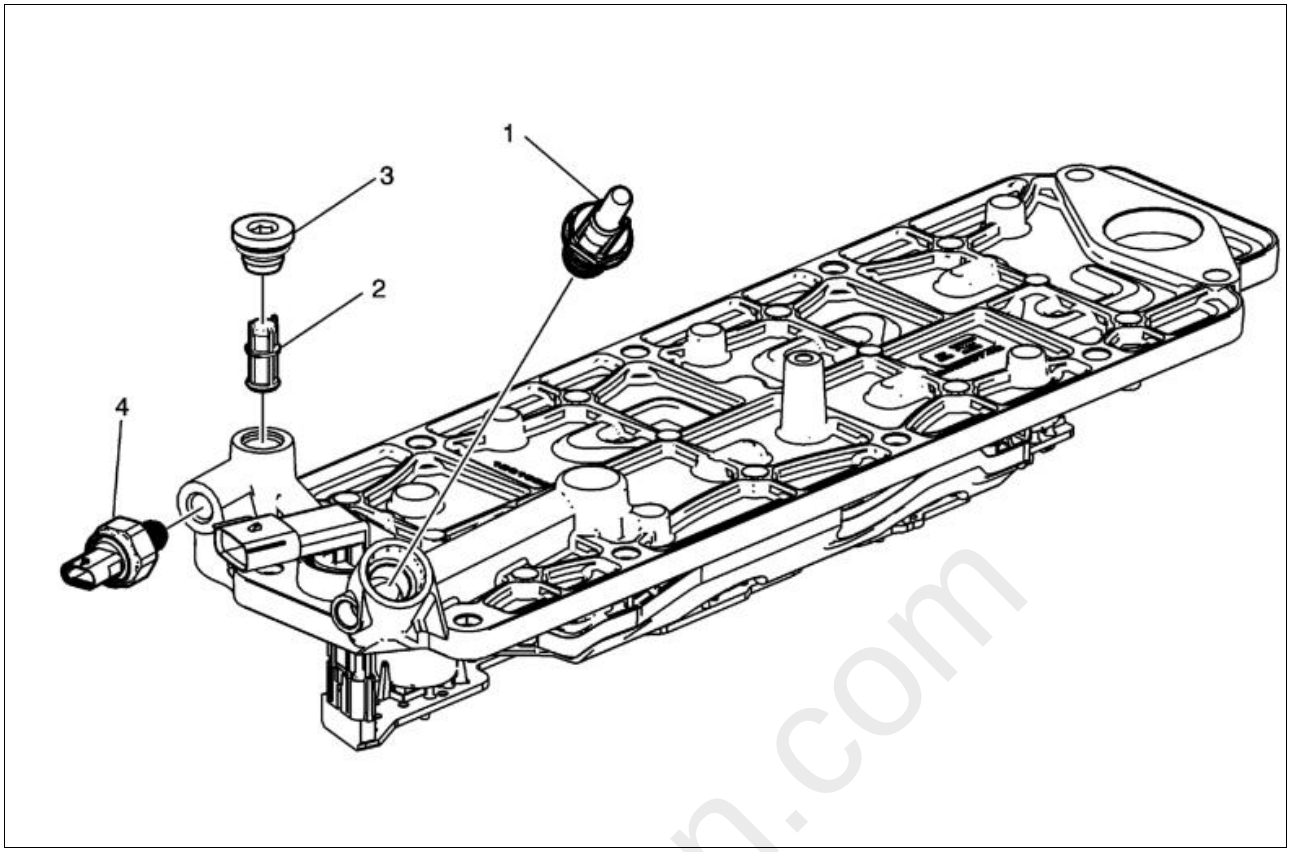


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Callout	Component Name
1	Valve Lifter Follower
2	Valve Lifter Follower Guide
3	Valve Lifter Follower Guide Bolt *CAUTION:* *Refer to Fastener Caution .* **Tighten** 12 N.m (106 lb in)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER OIL MANIFOLD INSTALLATION > VALVE LIFTER OIL MANIFOLD ASSEMBLE

Fig 1: Valve Lifter Oil Manifold



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Valve Lifter Oil Manifold Assemble

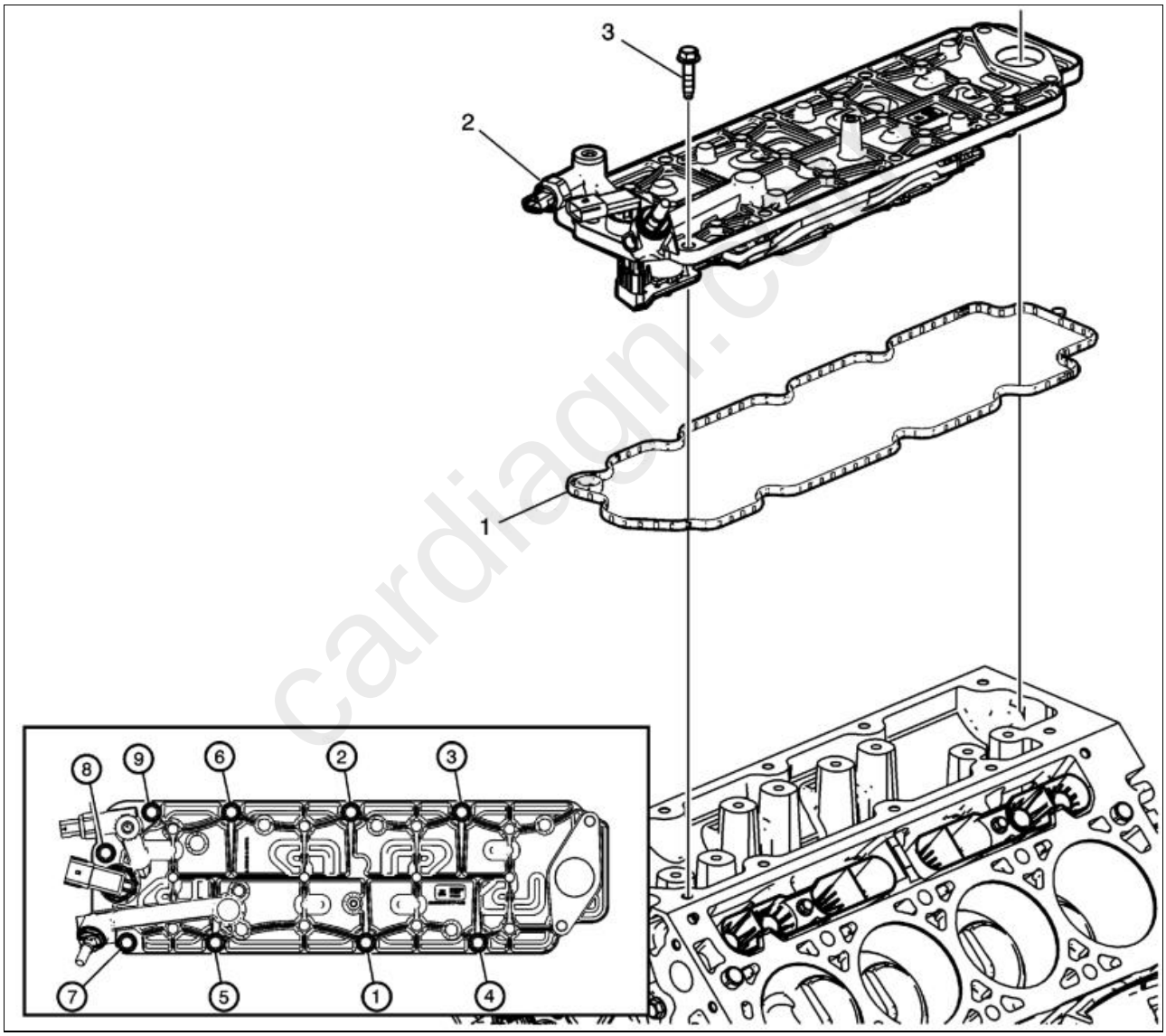
Callout	Component Name
1	PCV Valve *CAUTION:* *Refer to Fastener Caution .* **Tighten** 6 N.m (53 lb in)
2	Valve LIfter Oil Filter
3	Valve Lifter Oil Manifold Plug **Procedure** Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor. Refer to Adhesives, Fluids, Lubricants, and Sealers . **Tighten** 30 N.m (22 lb ft)

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4	Oil Pressure Sensor **Procedure** Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor. Refer to Adhesives, Fluids, Lubricants, and Sealers . **Tighten** 35 N.m (26 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER OIL MANIFOLD INSTALLATION > VALVE LIFTER OIL MANIFOLD INSTALLATION

Fig 1: Valve Lifter Oil Manifold



Courtesy of GENERAL MOTORS COMPANY

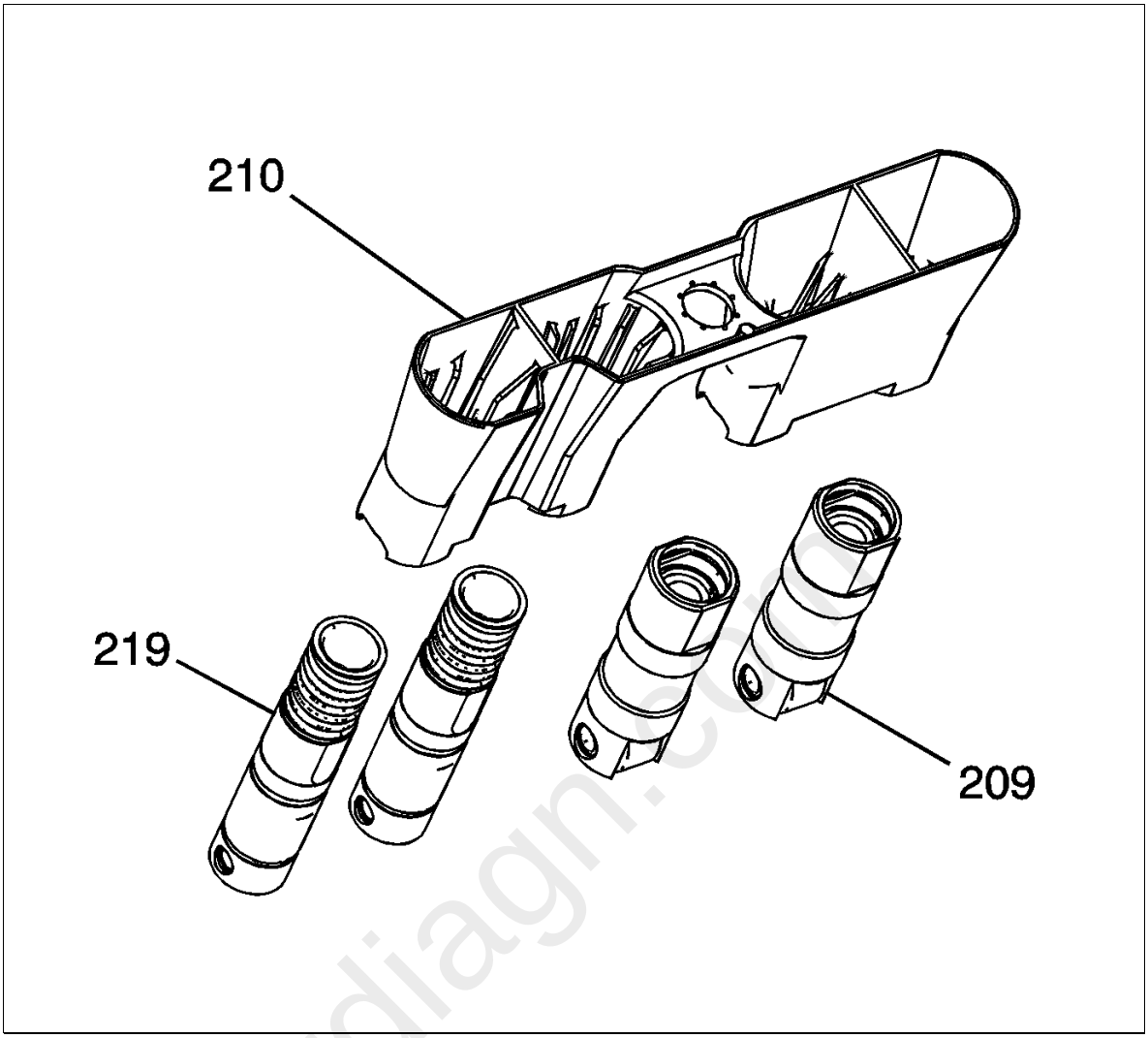
Valve Lifter Oil Manifold Installation

Callout	Component Name
1	Valve Lifter Oil Manifold Gasket *NOTE:* *Must use a NEW gasket.*
2	Valve Lifter Oil Manifold Assembly
3	Valve Lifter Oil Manifold Bolt **Tighten** 1. Tighten the bolts a first pass in sequence to 15 N.m (11 lb ft). 2. Tighten the bolts a final pass in sequence to 30 N.m (22 lb ft).

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER INSTALLATION

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Fig 1: Lifter Guides & Lifters



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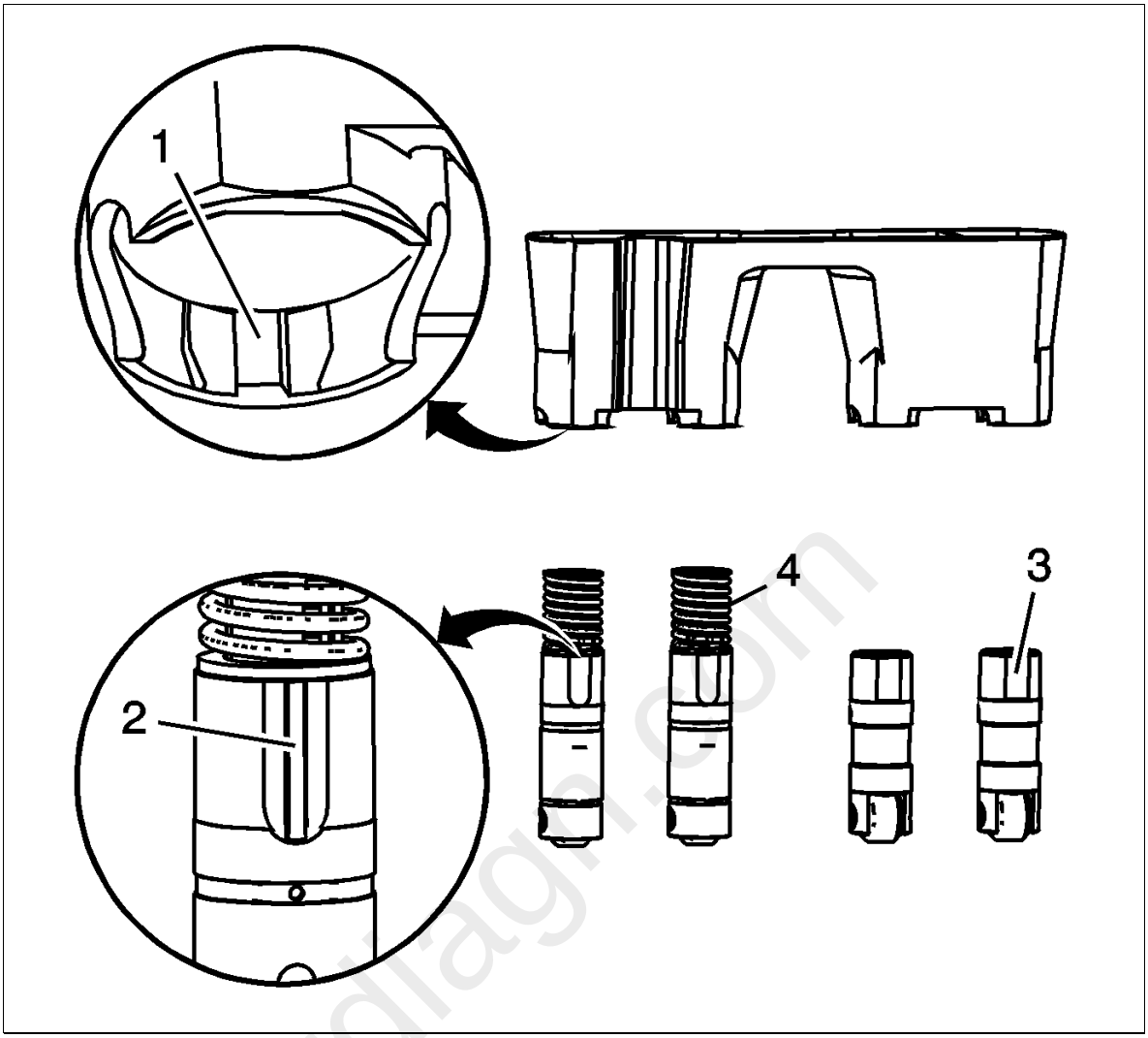
NOTE:

1. *When using the valve lifters again, install the lifters to their original locations.*
2. *If camshaft replacement is required, the valve lifters must also be replaced.*
3. *Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non-active fuel management valve lifters.*
4. *With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter bores will each contain 2 active fuel management valve lifters.*

1. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.

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Fig 2: Inserting Valve Lifters Into Lifter Guides

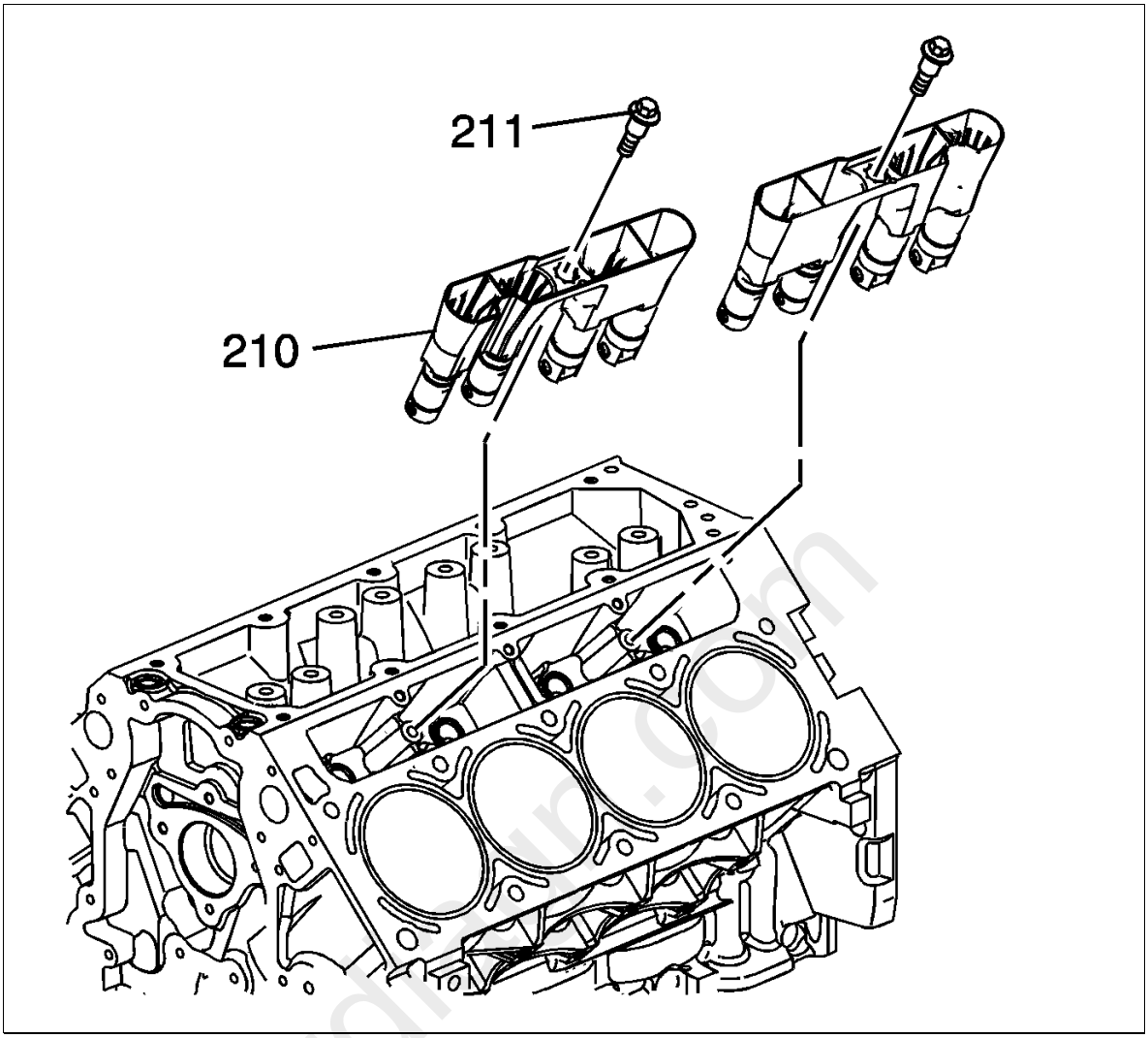


Courtesy of GENERAL MOTORS COMPANY

2. Insert the valve lifters into the lifter guides.
    1. Align the flat area (3) on the top of the non-active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
    2. The active fuel management lifters (4) are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.

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Fig 3: Lifter Guides & Lifters



Courtesy of GENERAL MOTORS COMPANY

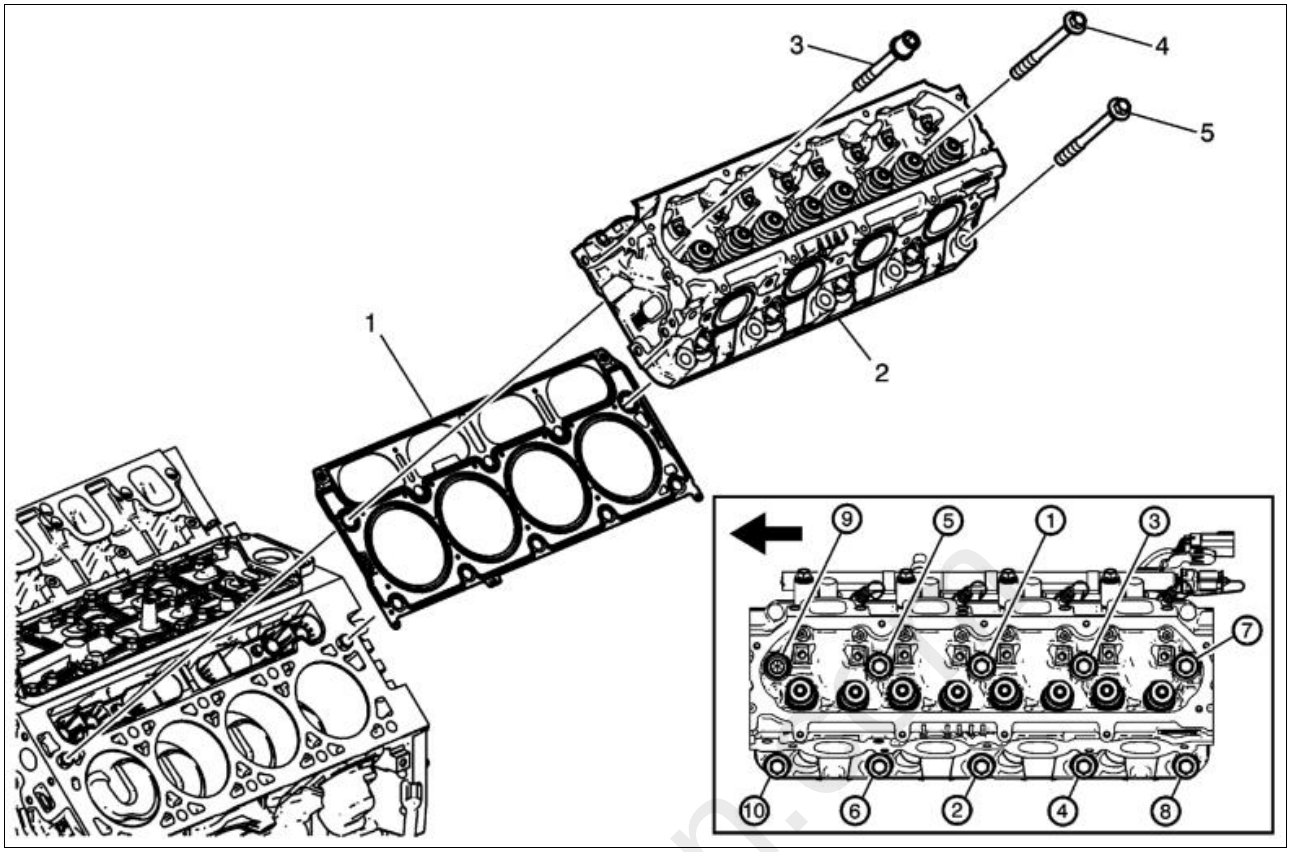
3. Install the valve lifters and guide assembly (210) to the engine block.

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

4. Install the valve lifter guide bolts (211) and tighten to 12 N.m (106 lb in).

REPAIR INSTRUCTIONS - OFF VEHICLE > CYLINDER HEAD INSTALLATION - LEFT SIDE

Fig 1: NEW Cylinder Head Gasket



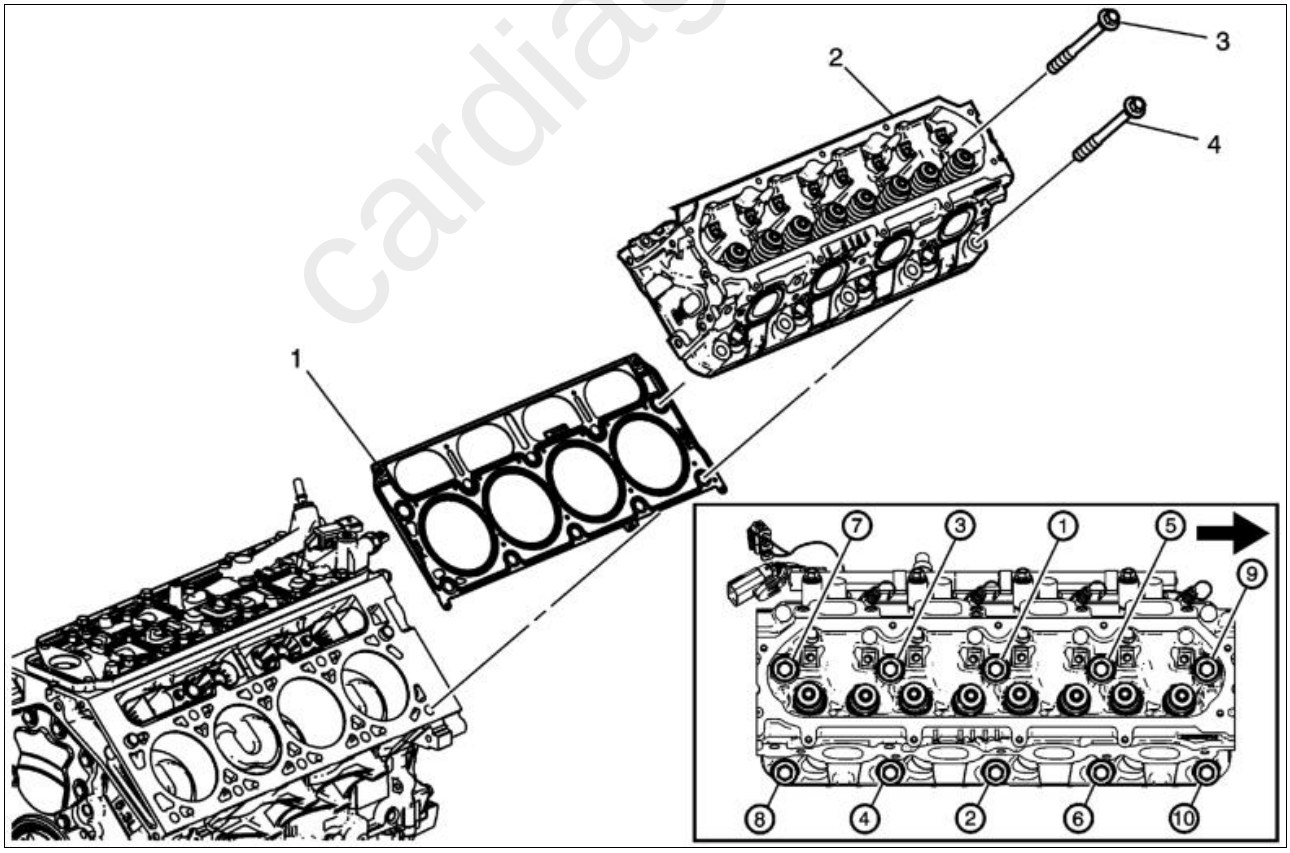
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Clean the holes in the block of any debris or residual fastener thread sealant. Failing to do so can cause the bolts not to reach proper torque and/or clamp load.	
1	Cylinder Head Gasket *NOTE:* *Must use NEW gasket.*
2	Cylinder Head Assembly
3	Cylinder Head Bolt *CAUTION:* *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause*

	damage to the vehicle or component. *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the cylinder head bolts each pass in the sequence shown. **Tighten** 80 N.m (59 lb ft) + 90° + 40°
4	Cylinder Head Bolt **Procedure** Tighten the cylinder head bolts each pass in the sequence shown. **Tighten** 80 N.m (59 lb ft) + 90° + 60°

REPAIR INSTRUCTIONS - OFF VEHICLE > CYLINDER HEAD INSTALLATION - RIGHT SIDE

Fig 1: NEW Cylinder Head Gasket And Cylinder Head



Courtesy of GENERAL MOTORS COMPANY

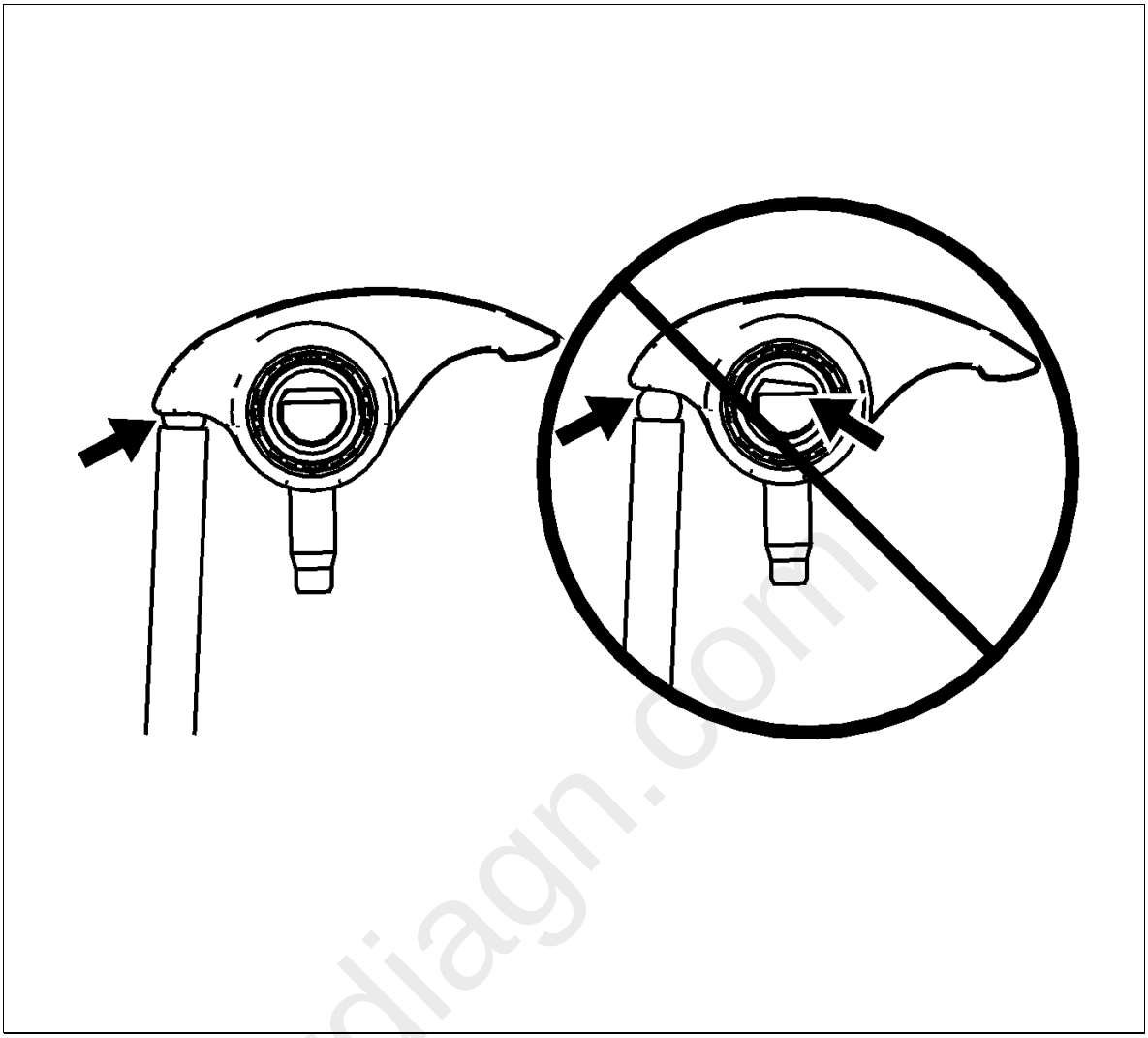
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Callout	Component Name
Preliminary Procedure Clean the holes in the block of any debris or residual fastener thread sealant. Failing to do so can cause the bolts not to reach proper torque and/or clamp load.	
1	Cylinder Head Gasket *NOTE:* *Must use NEW gasket.*
2	Cylinder Head Assembly
3	Cylinder Head Bolt *CAUTION:* *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.* *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the cylinder head bolts each pass in the sequence shown. **Tighten** 80 N.m (59 lb ft) + 90° + 60°

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REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM AND PUSH ROD INSTALLATION

Fig 1: Proper Seating Of Push Rod



Courtesy of GENERAL MOTORS COMPANY

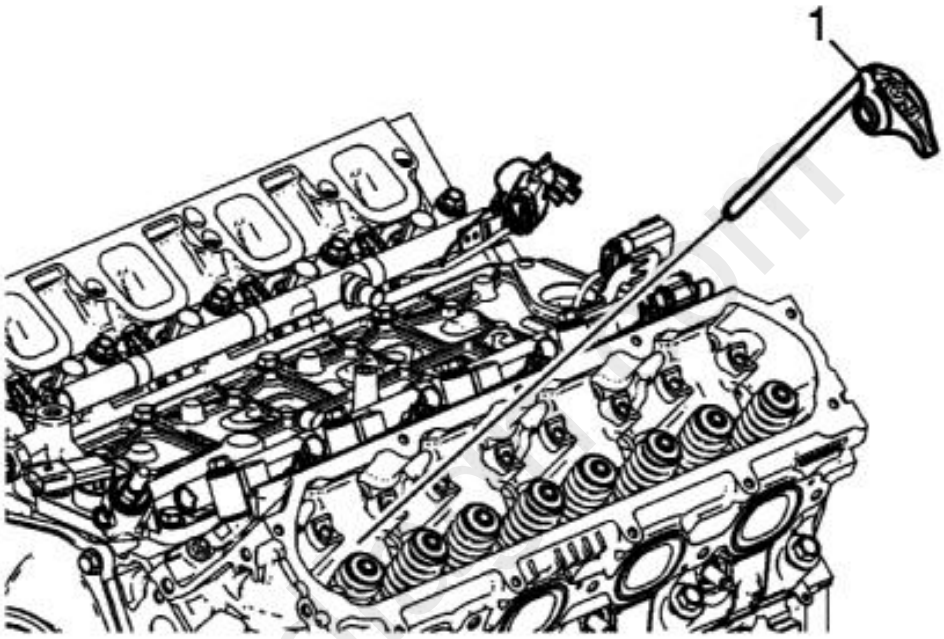
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NOTE:

Ensure the pushrods seat properly to the ends of the rocker arms.

1. Inspect the rocker arm and pushrod assemblies before installation.

Fig 2: Valve Rocker Arm And Push Rod



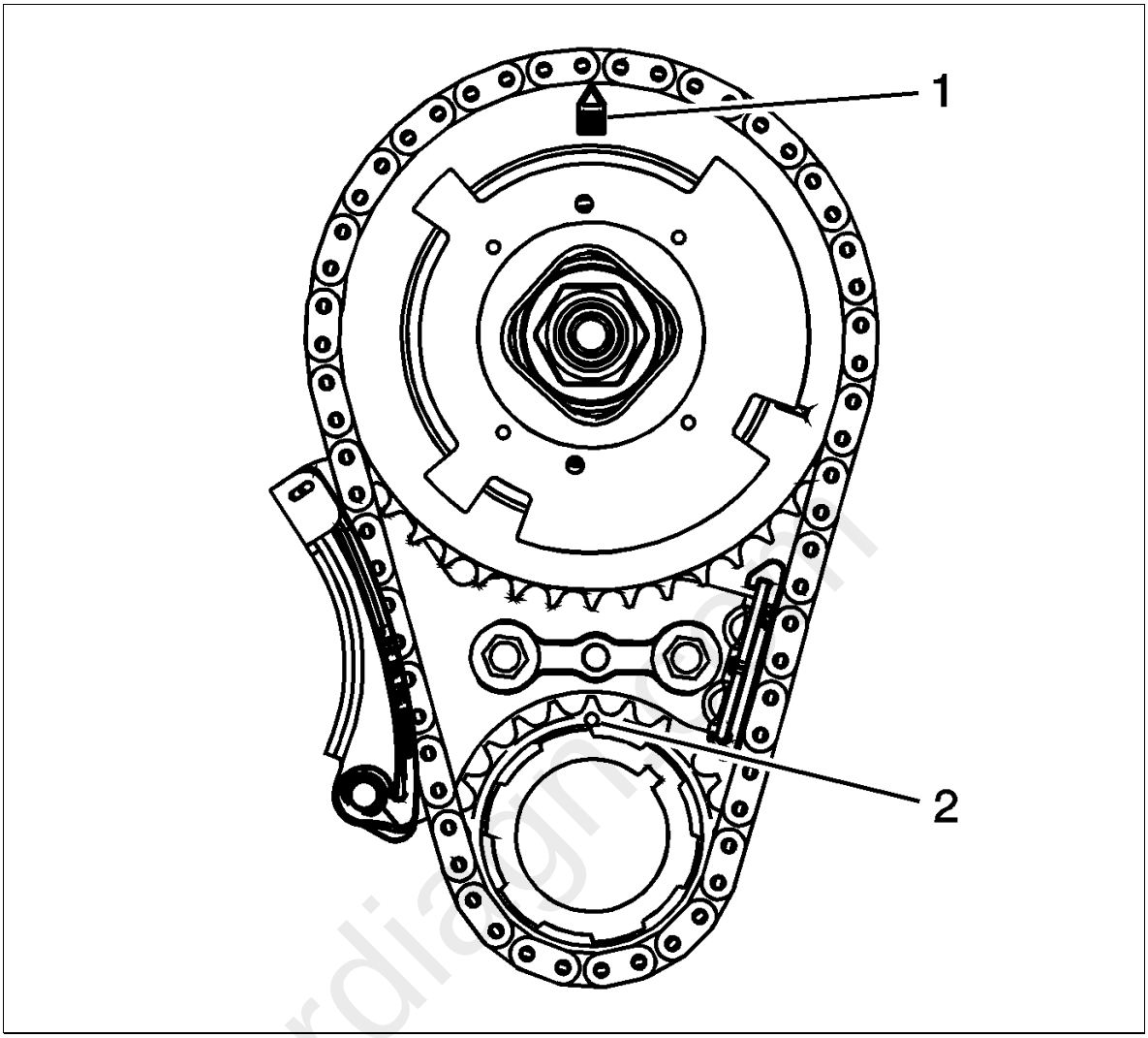
Courtesy of GENERAL MOTORS COMPANY

NOTE:

1. *When using the valve train components again, always install the components to the original location and position.*
2. *Valve lash is net build. No valve adjustment is required.*
3. *Lubricate the flange of the valve rocker arm bolts with clean engine oil.*
4. *Lubricate the valve rocker arms and pushrods with clean engine oil.*
5. *Ensure the pushrods seat properly to the valve lifter sockets.*
6. *The rocker arm bolts are not serviced separately.*
7. *Ensure the pushrods seat properly to the ends of the rocker arms.*
8. *DO NOT tighten the rocker arm bolts at this time.*

2. Install the valve rocker arm and pushrod assemblies (1).

Fig 3: Camshaft & Crankshaft Sprocket Alignment Marks



Courtesy of GENERAL MOTORS COMPANY

3. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

   In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

   The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

   Cylinders 1, 3, 5, and 7 are left bank.

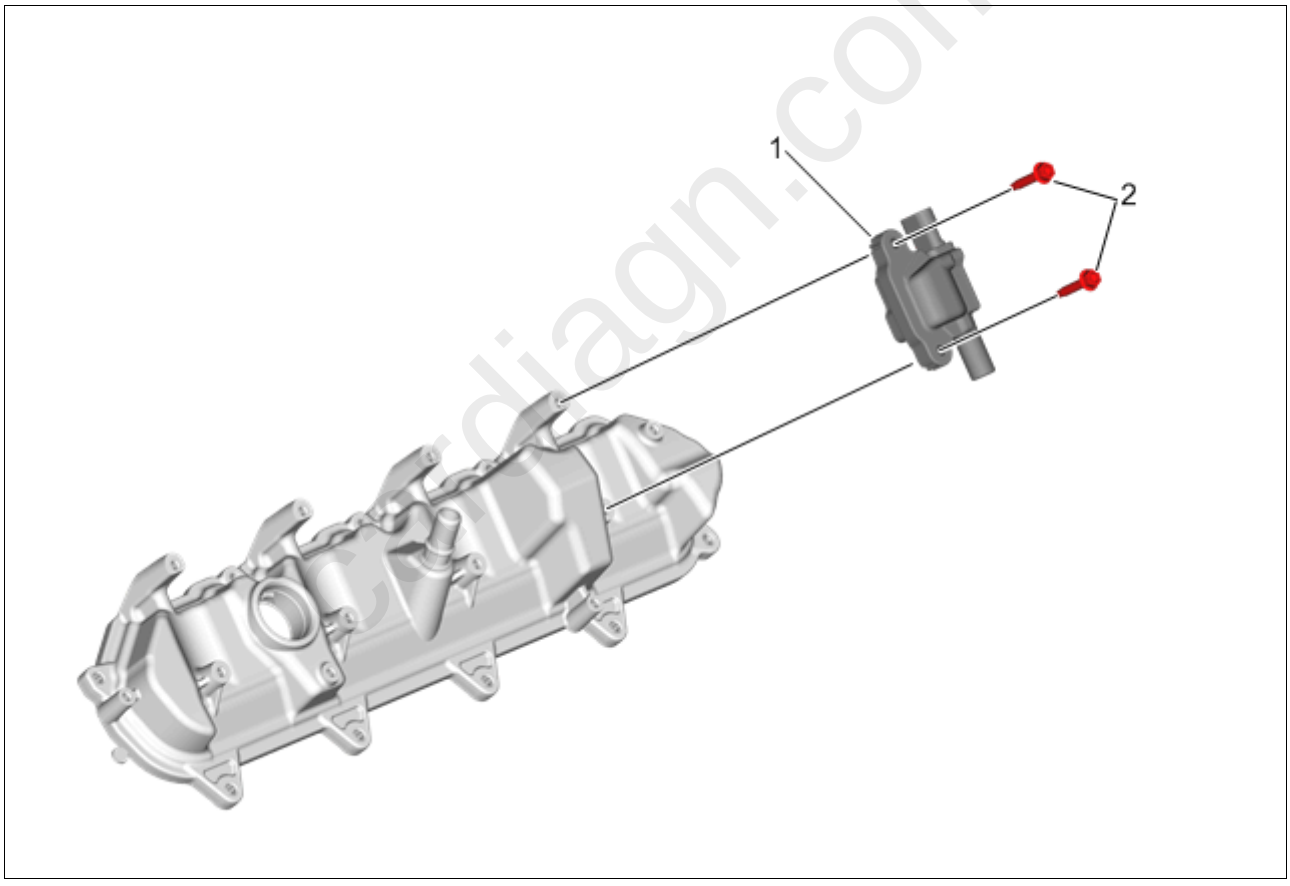
   Cylinders 2, 4, 6, and 8 are right bank.

> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution*

4. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft).
    2. Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft).
5. Rotate the crankshaft 360 degrees.
6. Tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft).
    2. Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft).

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE > VALVE ROCKER ARM COVER ASSEMBLE - LEFT SIDE

Fig 1: Valve Rocker Arm Cover - Left Side



Courtesy of GENERAL MOTORS COMPANY

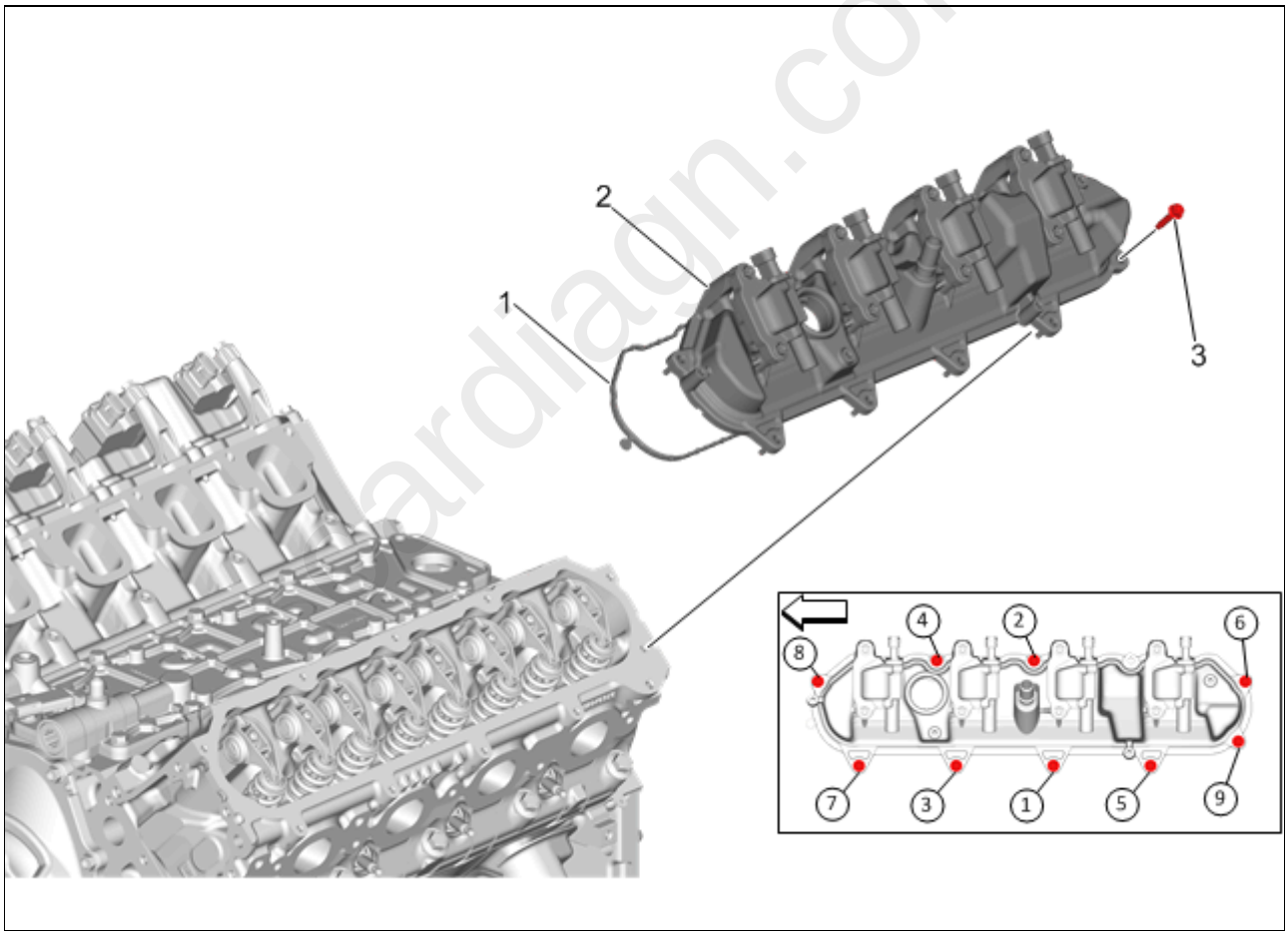
Valve Rocker Arm Cover Assemble - Left Side

Callout	Component Name
1	Ignition Coil (Qty: 4)

2	Ignition Coil Bolt (Qty: 8) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (89 lb in)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE > VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE

Fig 1: Valve Rocker Arm Cover - Left Side



Courtesy of GENERAL MOTORS COMPANY

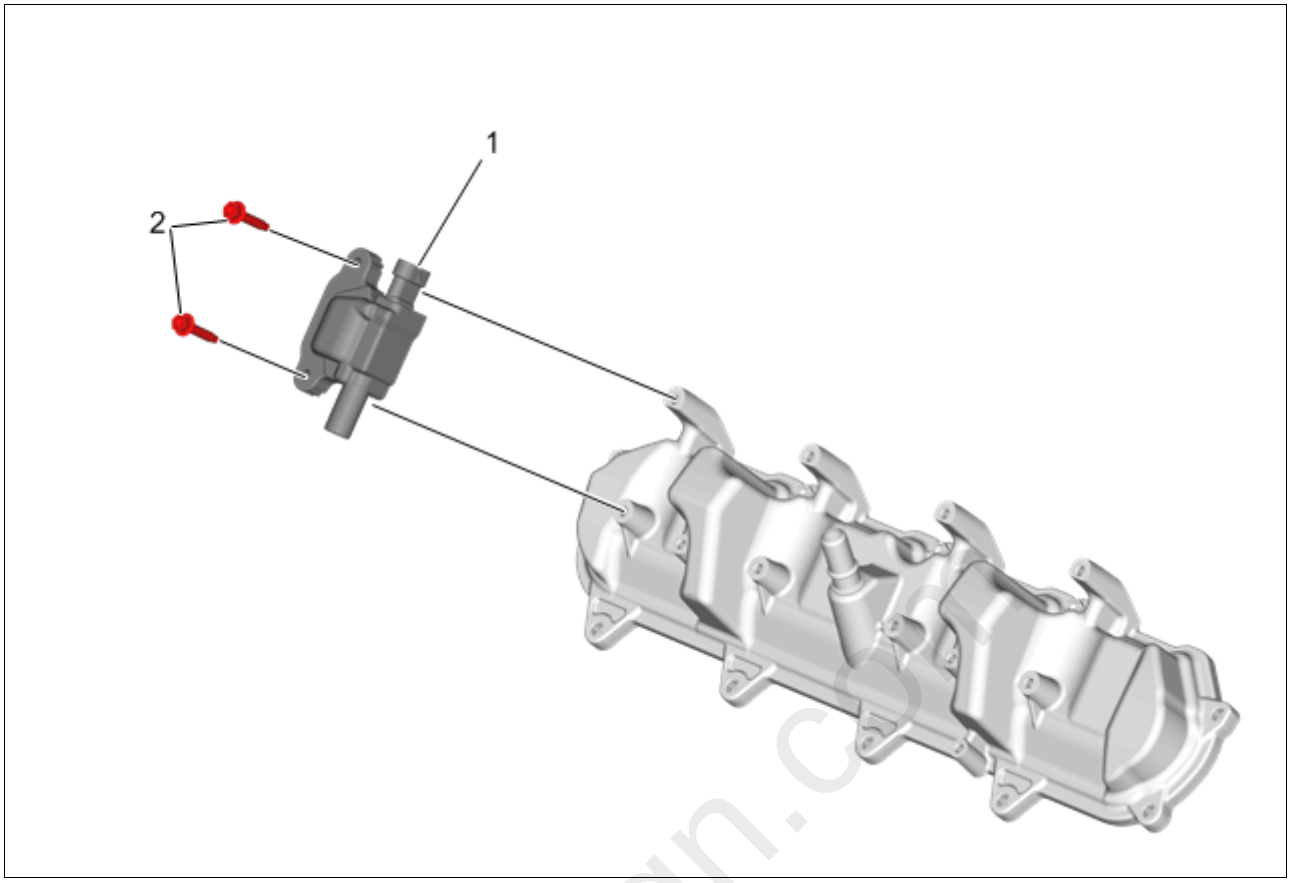
Valve Rocker Arm Cover Installation - Left Side

Callout	Component Name
1	Valve Rocker Arm Cover Gasket *NOTE:* *Must use a NEW gasket.*
2	Valve Rocker Arm Cover - Left Side
3	Valve Rocker Arm Cover Bolt (Qty: 10) *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the valve rocker arm cover bolts in the sequence shown. **Tighten** 10 N.m (89 lb in)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE > VALVE ROCKER ARM COVER ASSEMBLE - RIGHT SIDE

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Fig 1: Valve Rocker Arm Cover - Right Side



Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Assemble - Right Side

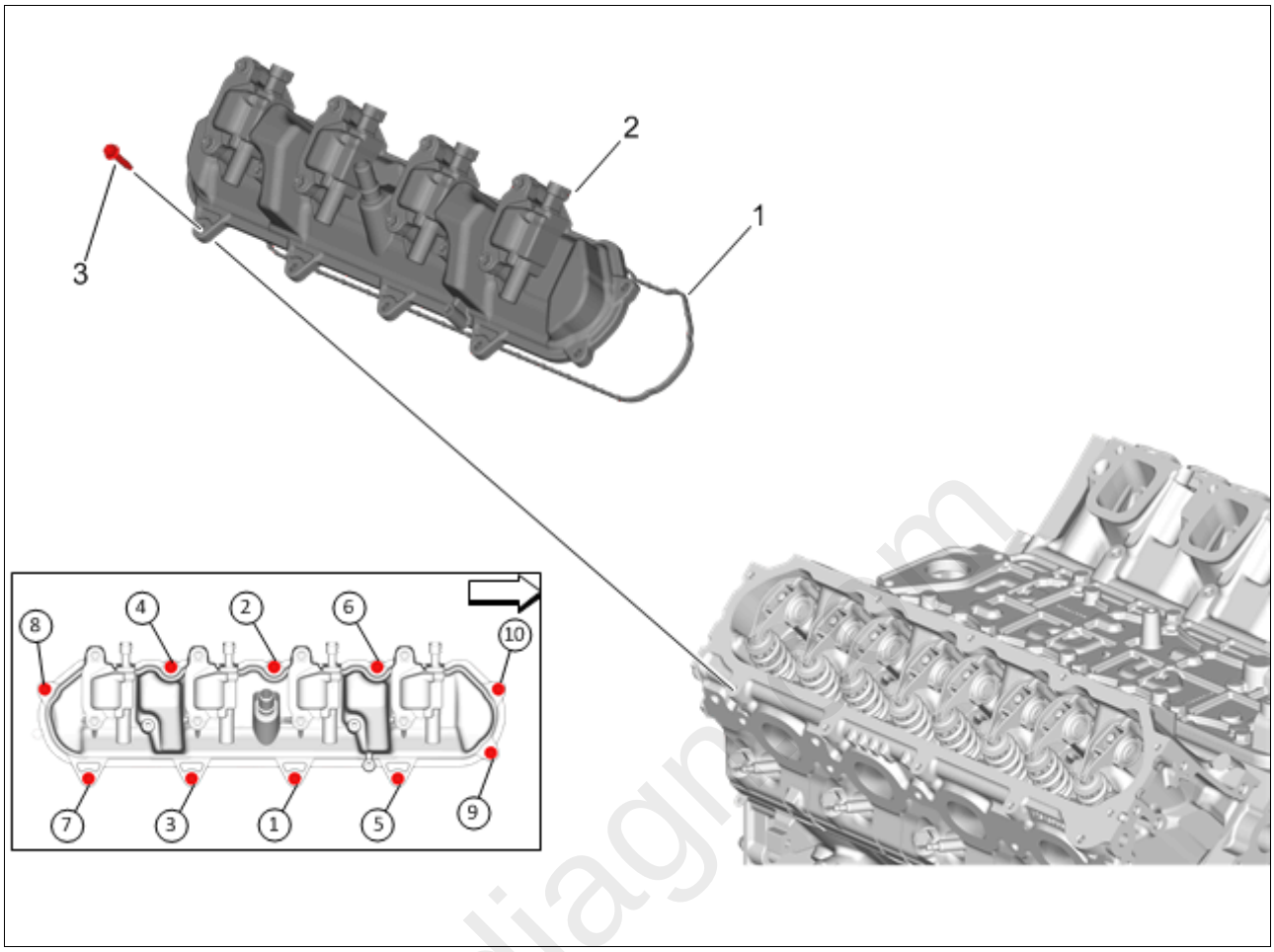
Callout	Component Name
1	Ignition Coil (Qty: 4)
2	Ignition Coil Bolt (Qty: 8) *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (88 lb in)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE > VALVE ROCKER ARM COVER INSTALLATION -

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RIGHT SIDE

Fig 1: Valve Rocker Arm Cover - Right Side



Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Installation - Right Side

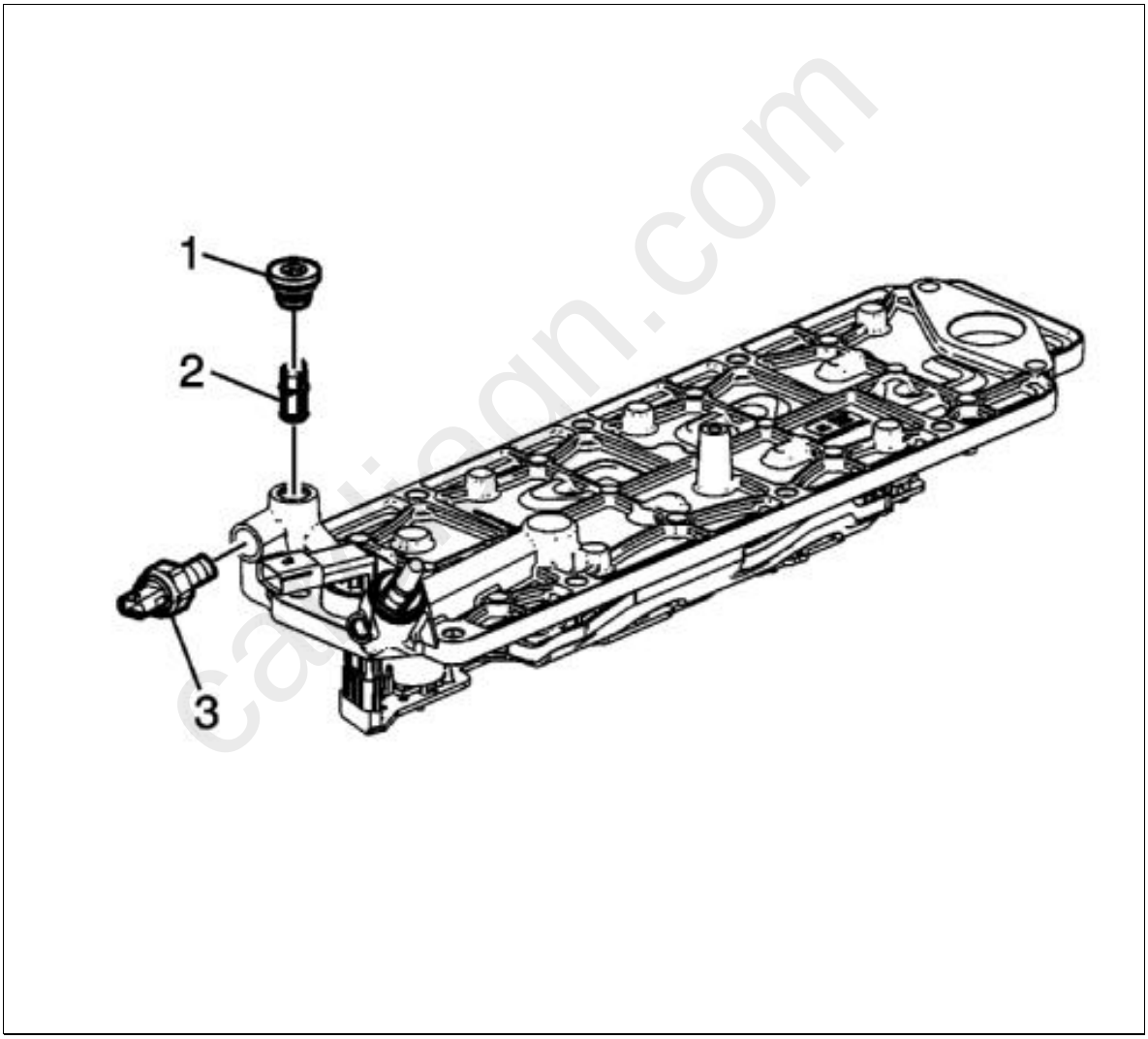
Callout	Component Name
1	Valve Rocker Arm Cover Gasket *NOTE:* *Must use a NEW gasket.*
2	Valve Rocker Arm Cover - Right Side
3	Valve Rocker Arm Cover Bolt (Qty: 10) *CAUTION:*

Refer to Fastener Caution .

Procedure
Tighten the valve rocker arm cover bolts in the sequence shown.
Tighten
10 N.m (88 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > VALVE LIFTER OIL FILTER INSTALLATION

Fig 1: Valve Lifter Oil Filter



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Install a NEW oil filter (2).
2. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the plug. Refer to Adhesives, Fluids, Lubricants, and Sealers .

CAUTION:

Refer to Fastener Caution .

3. Install the valve lifter oil manifold plug (1). Tighten to 30 N.m (22 lb ft).
4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor. Install the oil pressure sensor (3).
5. Tighten the oil pressure sensor to 35 N.m (26 lb ft).

REPAIR INSTRUCTIONS - OFF VEHICLE > FUEL PUMP INSTALLATION

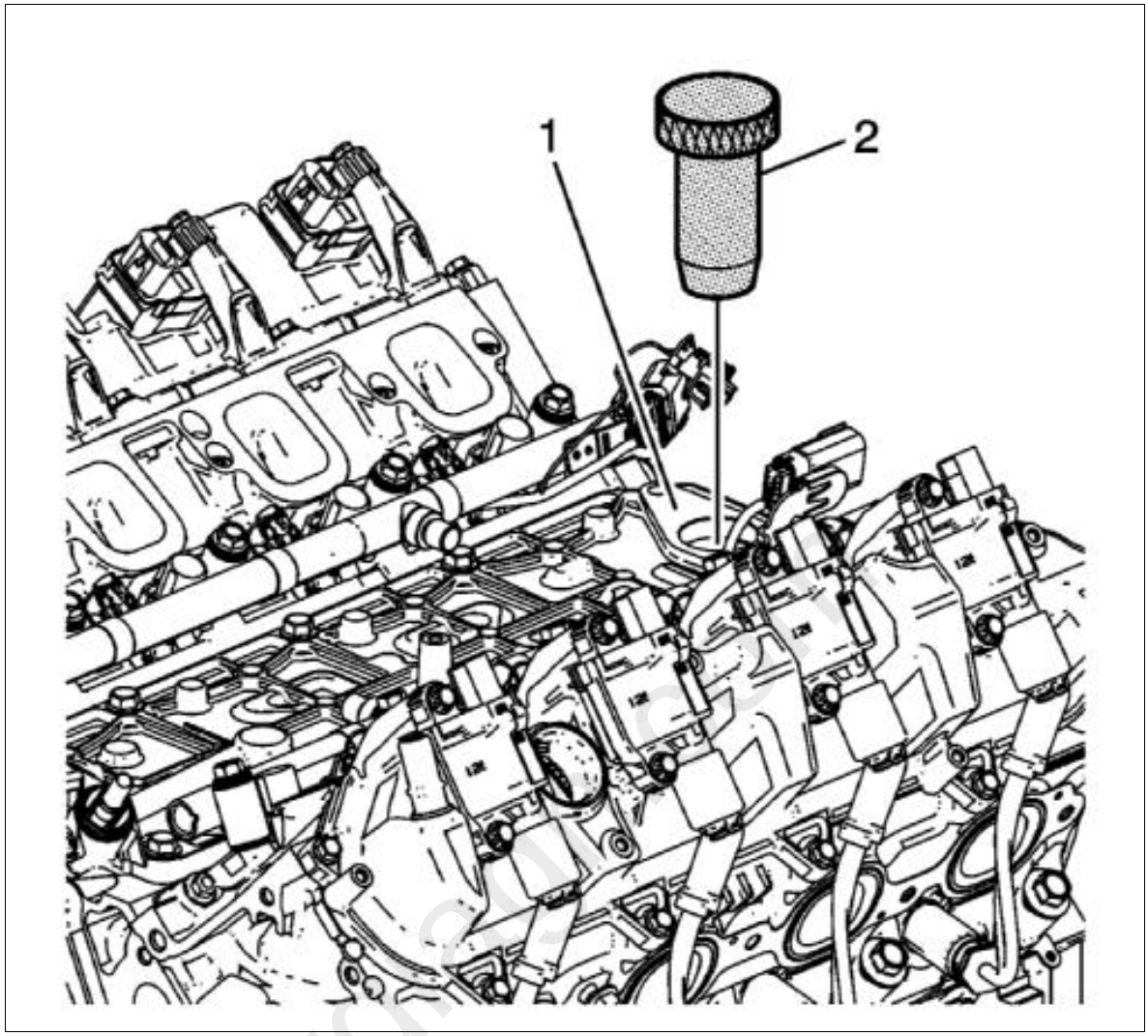
Special Tools

EN-51092 Fuel Pump Installation Gauge

For equivalent regional tools, refer to Special Tools .

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Fig 1: Lifter Oil Manifold Assembly



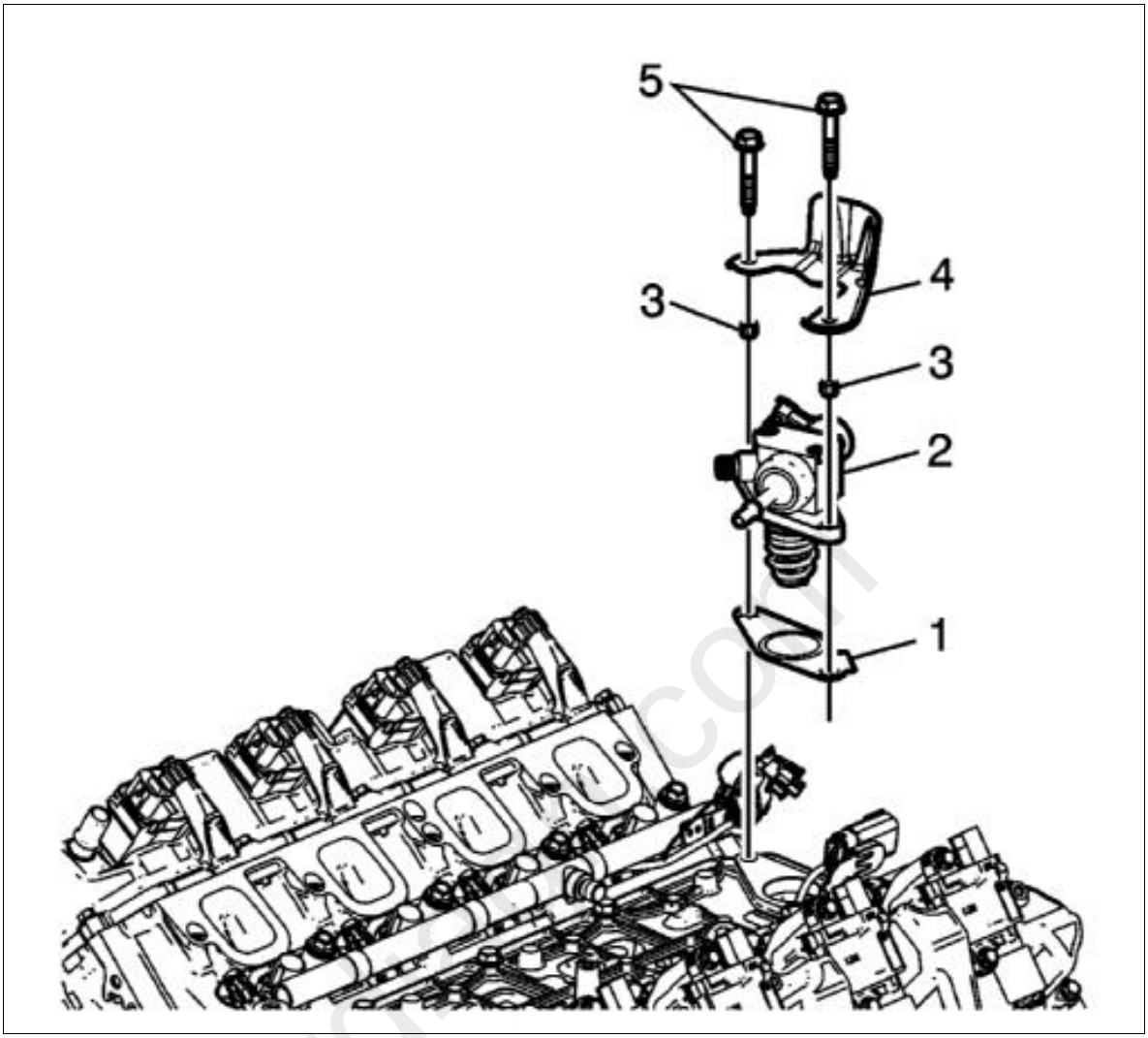
Courtesy of GENERAL MOTORS COMPANY

NOTE:

The camshaft must be in the base circle position before the high pressure fuel pump is installed.

1. Use the **EN-51092** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the top surface of the Lifter Oil Manifold Assembly (1).

Fig 2: NEW High Pressure Fuel Pump Gasket



Courtesy of GENERAL MOTORS COMPANY

NOTE:

Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke.

NOTE:

Ensure the plastic bolt retainers (3) are installed in the high pressure fuel pump mounting holes before installing.

2. Install a NEW high pressure fuel pump gasket (1).
3. Install the high pressure fuel pump (2) and high pressure fuel pump cover (4).

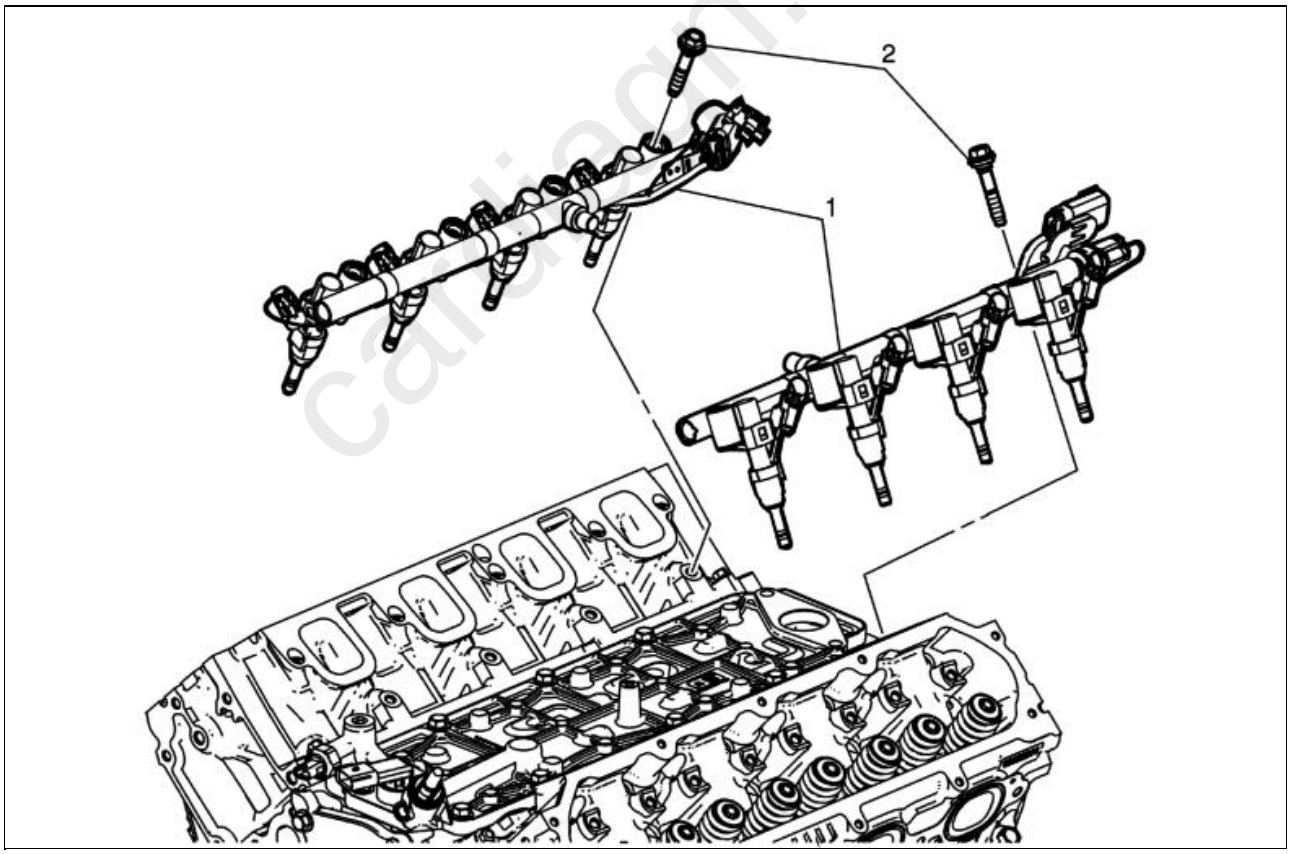
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

> ⚠ *CAUTION:*
>
> *Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.*

4. Start and hand-tighten the high pressure fuel pump bolts (5) evenly and tighten the high pressure fuel pump bolts to 25 N.m (18 lb ft).

REPAIR INSTRUCTIONS - OFF VEHICLE > FUEL RAIL AND INJECTORS INSTALLATION

Fig 1: Fuel Rail and Injectors



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

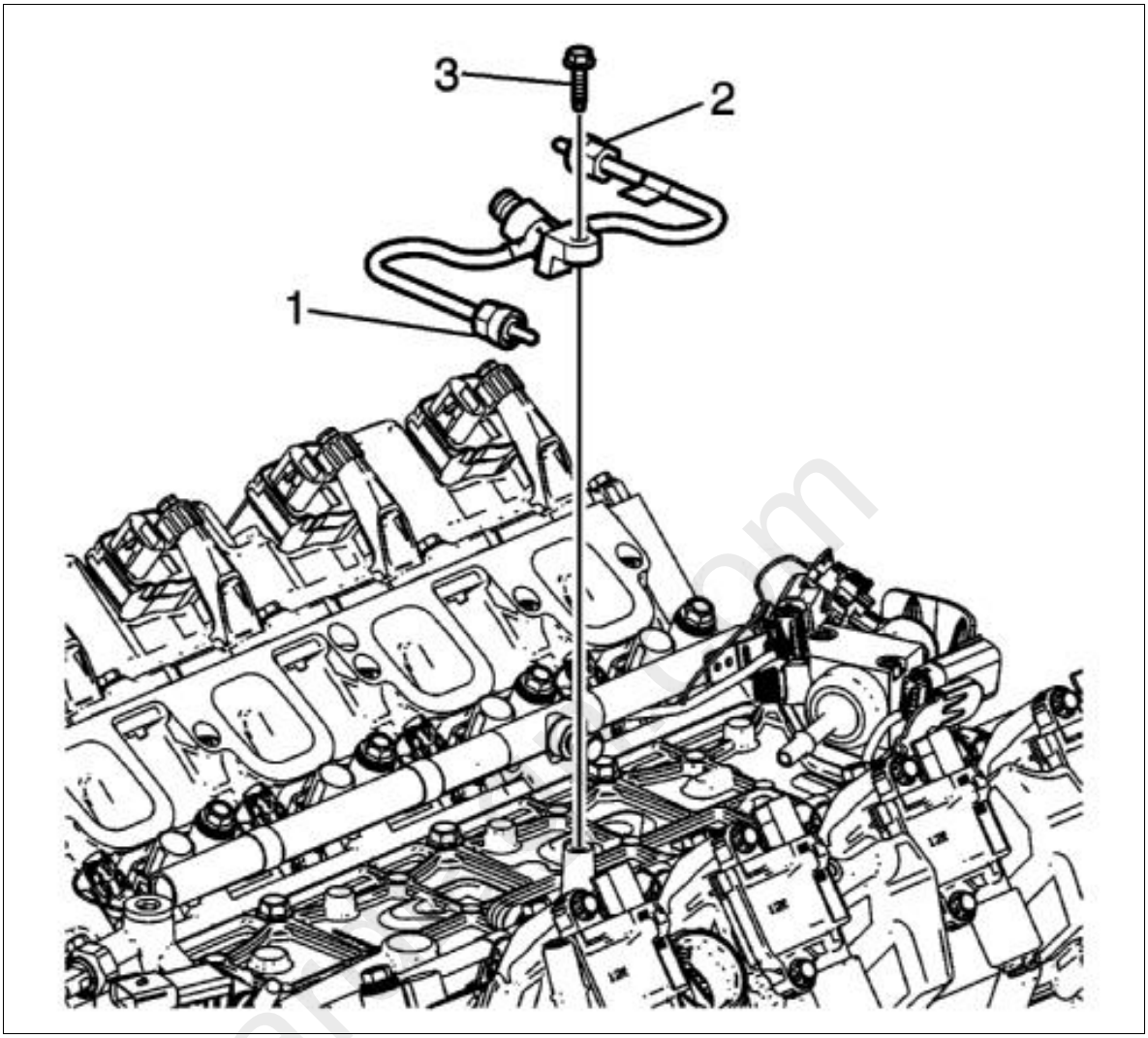
1	Fuel Rail Insulator
2	Direct Fuel Injection Fuel Rail Assembly *CAUTION:* *Make sure the fuel injectors are free from debris and lubricant. Lubricant can burn and ruin the fuel injector seals.* • *CAUTION:* *The fuel rail assemblies must be drawn down evenly before final torque. Failure to draw down the fuel rail assemblies evenly may result in scoring of the lifter bores.* • *NOTE:* • *If re-using injectors be sure to replace lower compression seals.* • *Do not lubricate the combustion seals when replacing.* • *Clean the holes in the cylinder head of any debris or residual fastener thread sealant. Failing to do so can cause the bolts not to reach proper torque and/or clamp load.* Refer to Fuel Rail and Injectors Cleaning and Inspection .
3	Fuel Injection Fuel Rail Bolt *NOTE:* *Clean the threads and apply a threadlocker.* Refer to Adhesives, Fluids, Lubricants, and Sealers . **Tighten** 25 N.m (18 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > FUEL PUMP INSULATOR AND FUEL FEED

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PIPES INSTALLATION

Fig 1: RH Fuel Rail Crossover Pipe Bolt



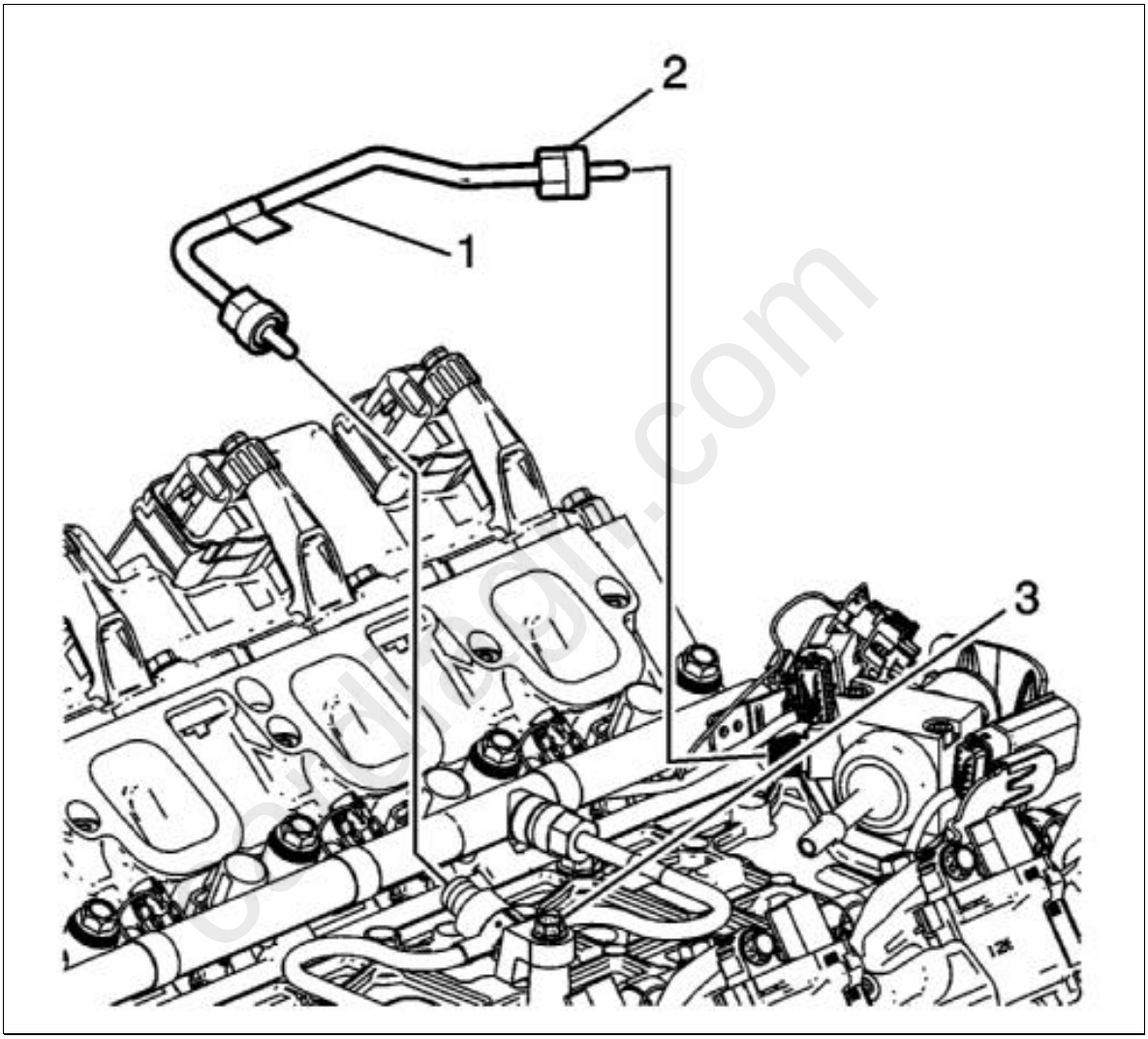
Courtesy of GENERAL MOTORS COMPANY

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

> *NOTE:*
>
> 1. *DO NOT reuse the high pressure fuel rail crossover pipe.*
> 2. *The tightening order and torque are critical to proper fuel system fit and function. Be sure to follow installation and tightening steps exactly.*

1. Install the NEW high pressure LH to RH fuel rail crossover pipe by starting both fuel crossover pipe fitting nuts (1 and 2) to finger-tight only.
2. Install the high pressure LH to RH fuel rail crossover pipe bolt (3) and hand tighten only.
3. Tighten the fuel rail crossover pipe fittings to 28 N.m (21 lb ft) in the following order: Left Fuel Rail (1) then Right Fuel Rail (2).

   Fig 2: Crossover Pipe And Fuel Feed Pipe Fittings



Courtesy of GENERAL MOTORS COMPANY

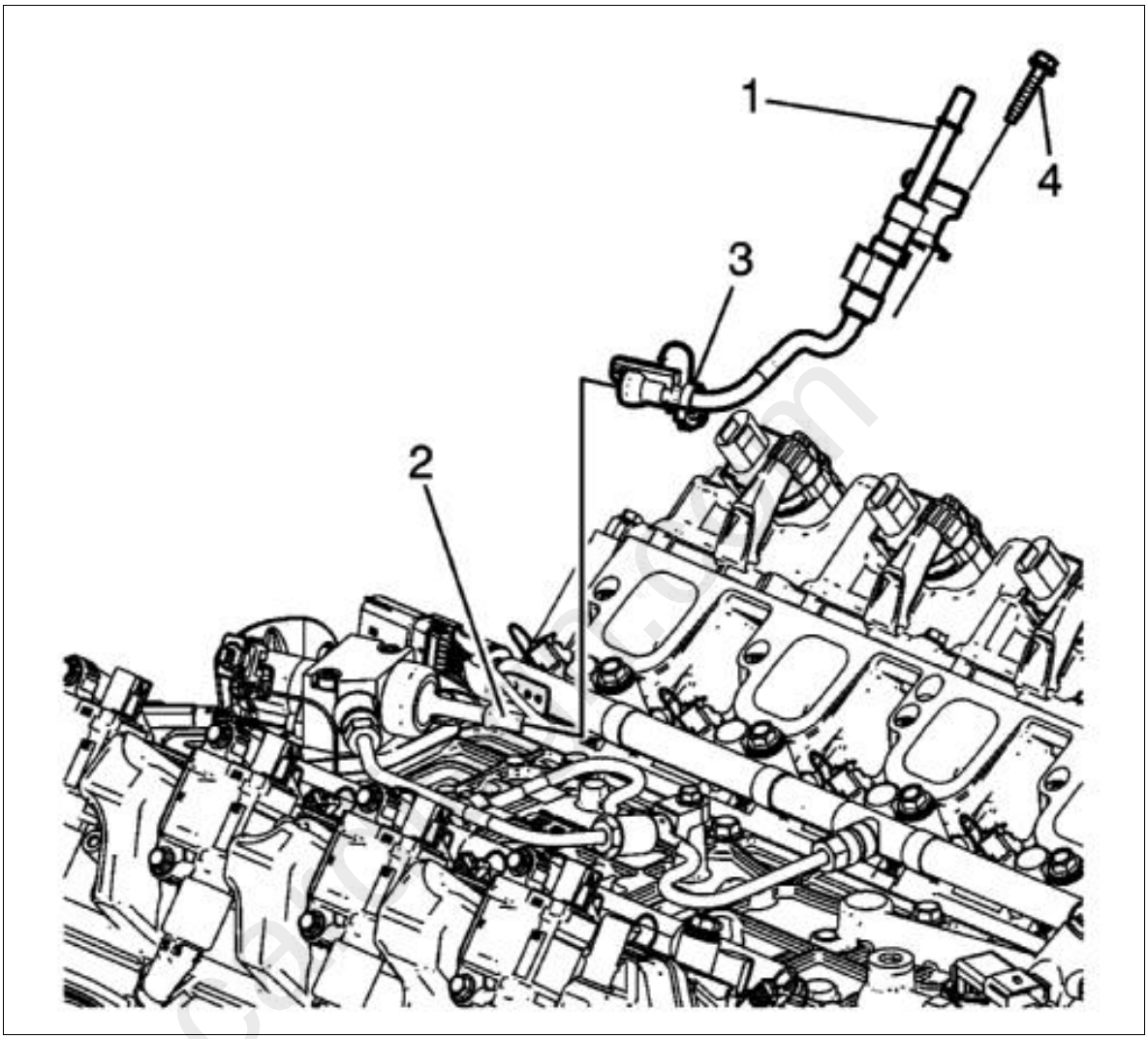
> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

4. Tighten the crossover pipe bolt (3) to 10 N.m (89 lb in).

5. Install the NEW high pressure fuel feed pipe that connects the fuel pump to the crossover pipe (1). Finger-tighten both fuel pipe fitting nuts (2).

6. Tighten the high pressure fuel feed pipe fittings to 28 N.m (21 lb ft) in the following order: at the fuel pump (1) then at the crossover (2).

Fig 3: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt

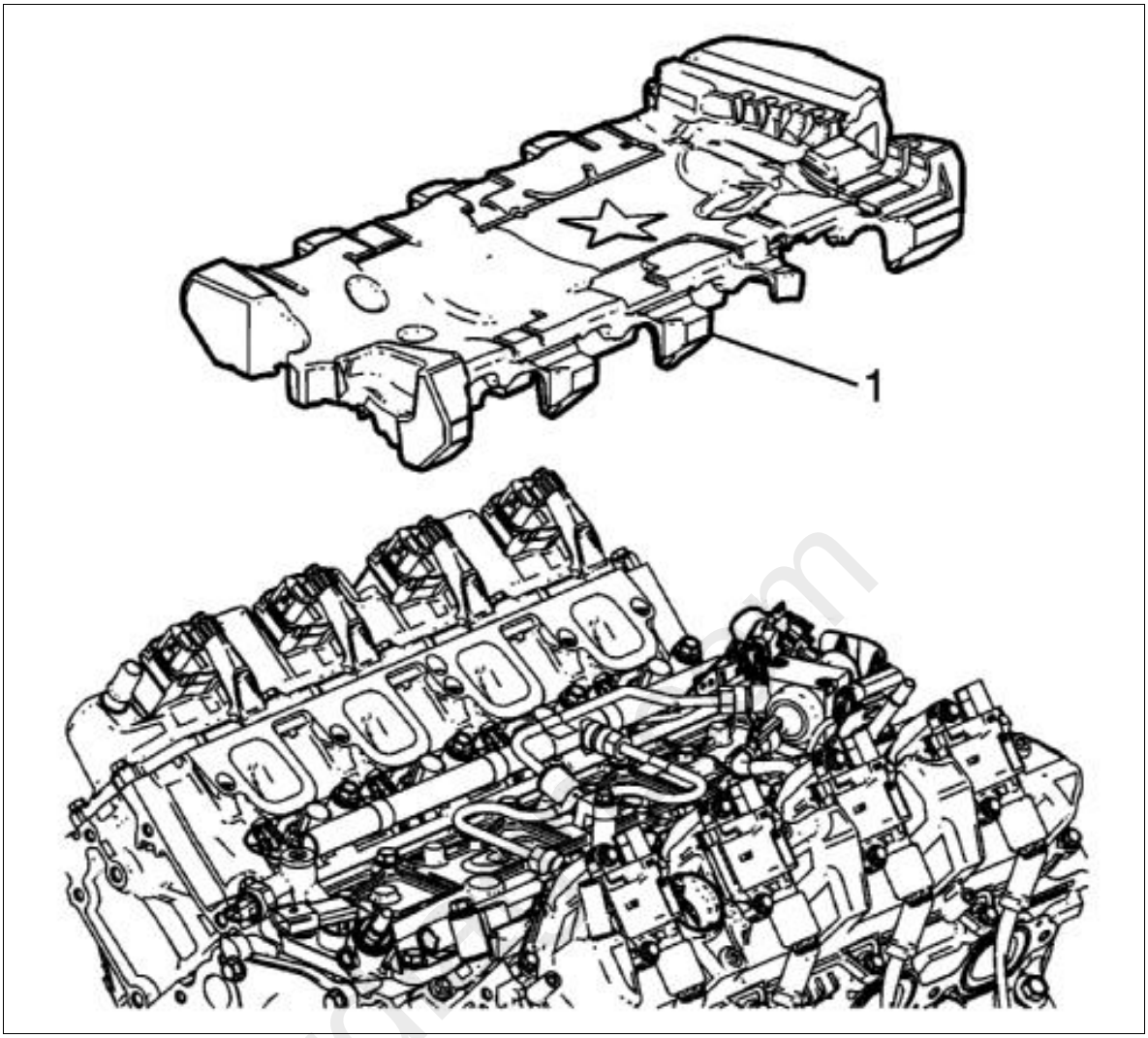


Courtesy of GENERAL MOTORS COMPANY

7. Install low pressure fuel feed pipe (1) to the fuel pump (2). Press fuel pipe until an audible click is heard. Install redundant clip (3).

8. Install low pressure fuel feed pipe to LH rocker cover. Tighten fuel fee bolt (4) to 10 N.m (89 lb in).

Fig 4: Fuel Pump Insulator



Courtesy of GENERAL MOTORS COMPANY

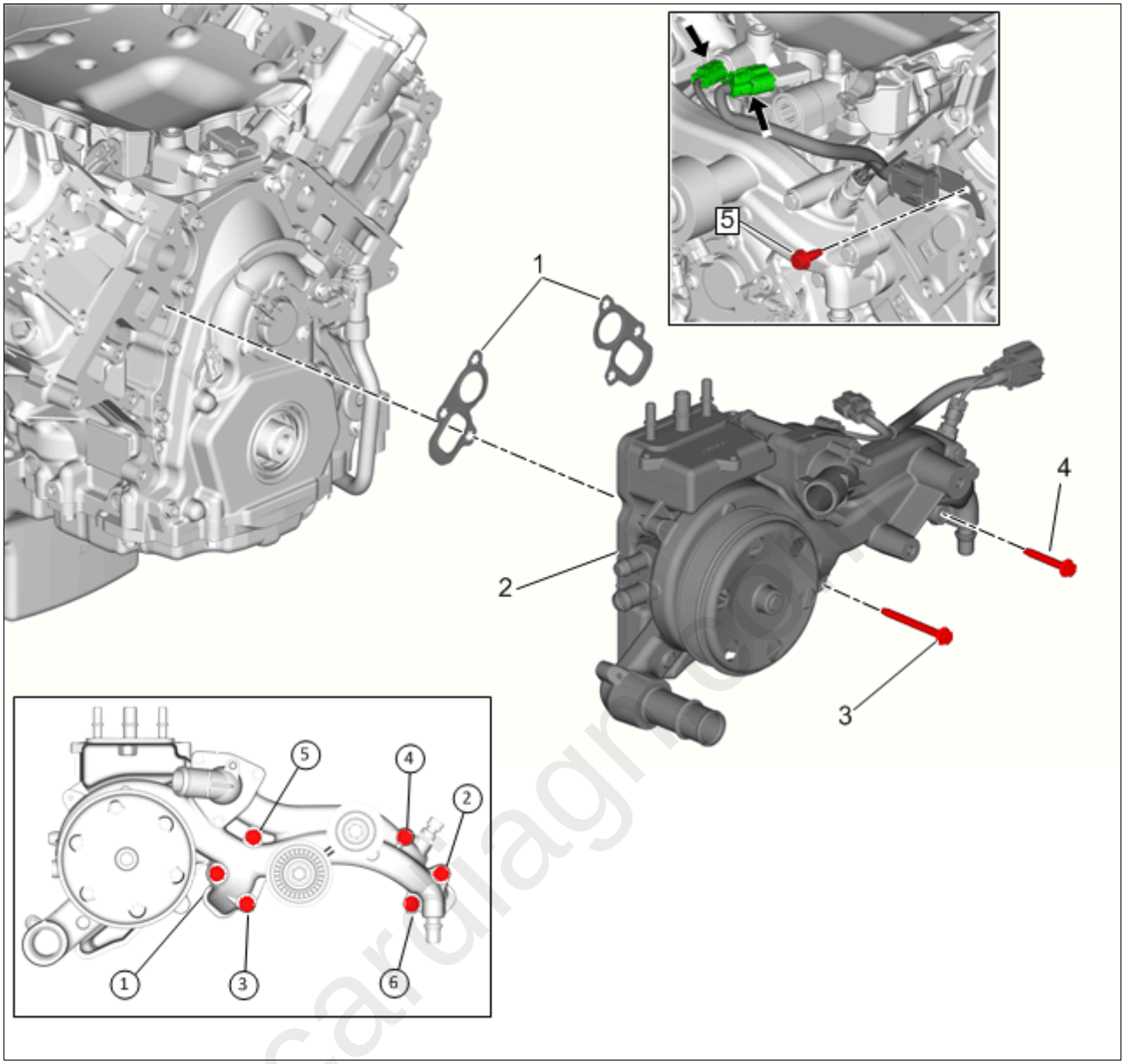
WARNING:

The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

9. Install the fuel pump insulator (1).

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE COOLANT MANIFOLD INSTALLATION

Fig 1: Engine Coolant Manifold



Courtesy of GENERAL MOTORS COMPANY

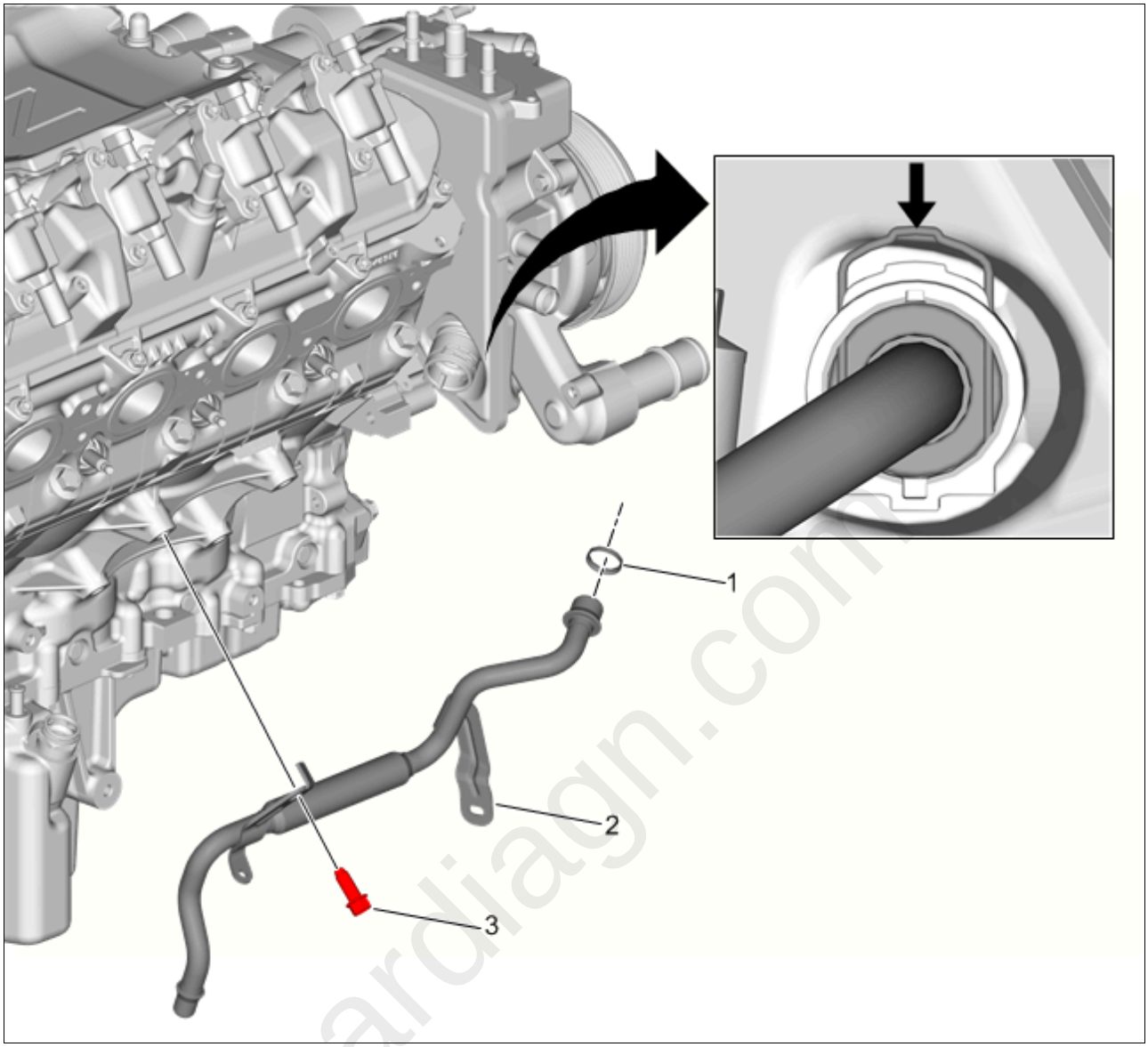
Callout	Component Name
1	Engine Coolant Manifold Gaskets *NOTE:* *Must use NEW gaskets when installing engine coolant manifold.*
2	Engine Coolant Manifold Assembly **Procedure** Connect the oil pressure sensor and valve lifter oil manifold connectors after installing the

	engine coolant manifold assembly.
3	Engine Coolant Manifold Bolt *CAUTION:* *Refer to Fastener Caution .* **Procedure** Tighten the engine coolant manifold bolts in the sequence shown. *NOTE:* *Clean the threads and apply a threadlocker.* **Tighten** 25 N.m (18 lb ft) Refer to Adhesives, Fluids, Lubricants, and Sealers .
4	Engine Coolant Manifold Bolt **Procedure** Tighten the engine coolant manifold bolts in the sequence shown. *NOTE:* *Clean the threads and apply a threadlocker.* **Tighten** 25 N.m (18 lb ft) Refer to Adhesives, Fluids, Lubricants, and Sealers .
5	Jumper Harness Bolt **Tighten** 25 N.m (18 lb ft)

REPAIR INSTRUCTIONS - OFF VEHICLE > POSITIVE CRANKCASE VENTILATION OIL SEPARATOR DRAIN PIPE INSTALLATION

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Fig 1: Positive Crankcase Ventilation Oil Separator Drain Pipe



Courtesy of GENERAL MOTORS COMPANY

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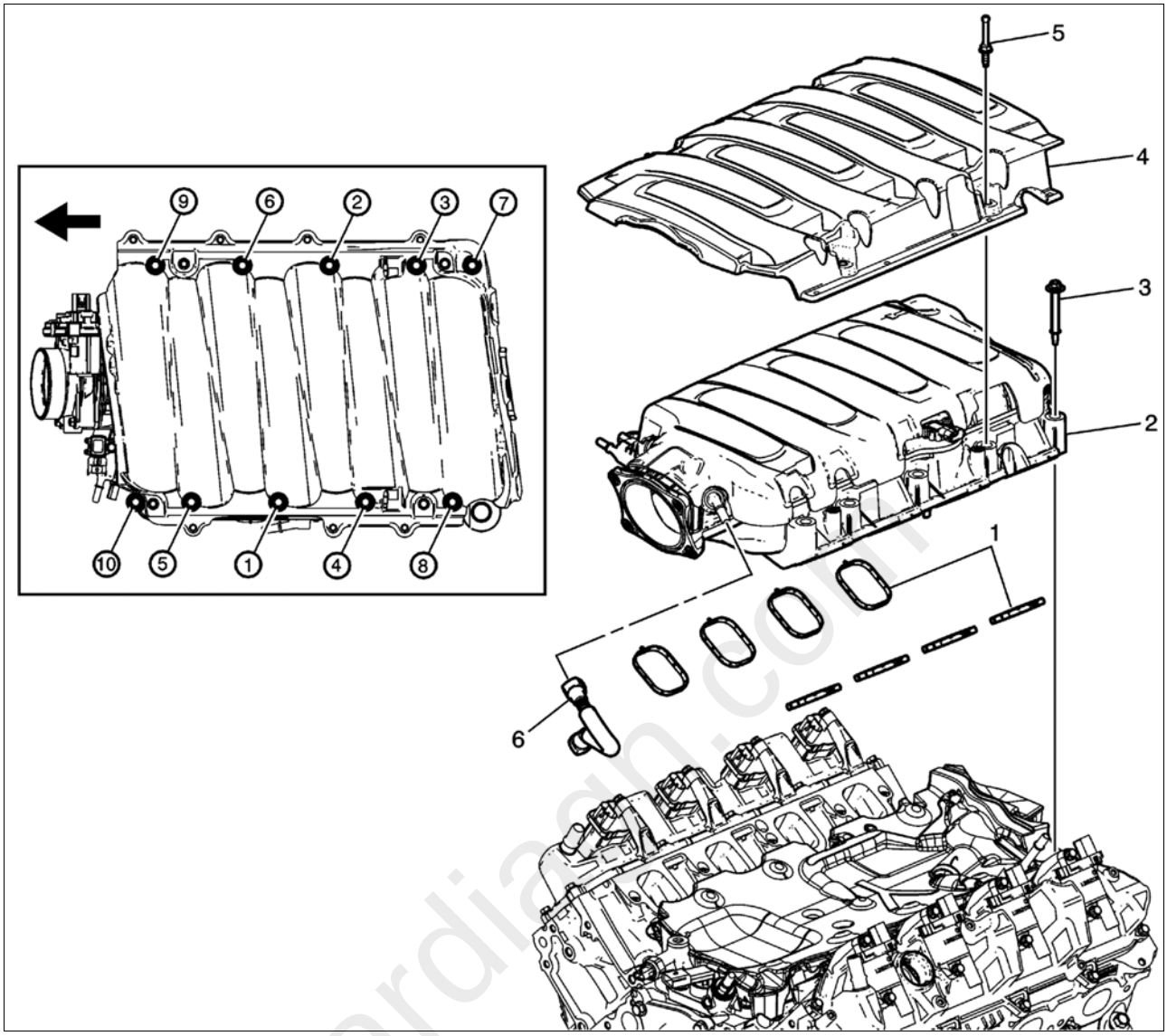
Callout	Component Name
1	Positive Crankcase Ventilation Oil Separator Drain Tube O-ring *NOTE:* *Use a NEW O-ring.*
2	Positive Crankcase Ventilation Oil Separator Drain Tube *NOTE:*

	Check valve must be replaced if tube is removed. **Procedure** Push retainer down on fitting to secure tube.
3	Positive Crankcase Ventilation Oil Separator Drain Tube Bolt *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (89 lb in)

REPAIR INSTRUCTIONS - OFF VEHICLE > INTAKE MANIFOLD INSTALLATION

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Fig 1: Intake Manifold



Courtesy of GENERAL MOTORS COMPANY

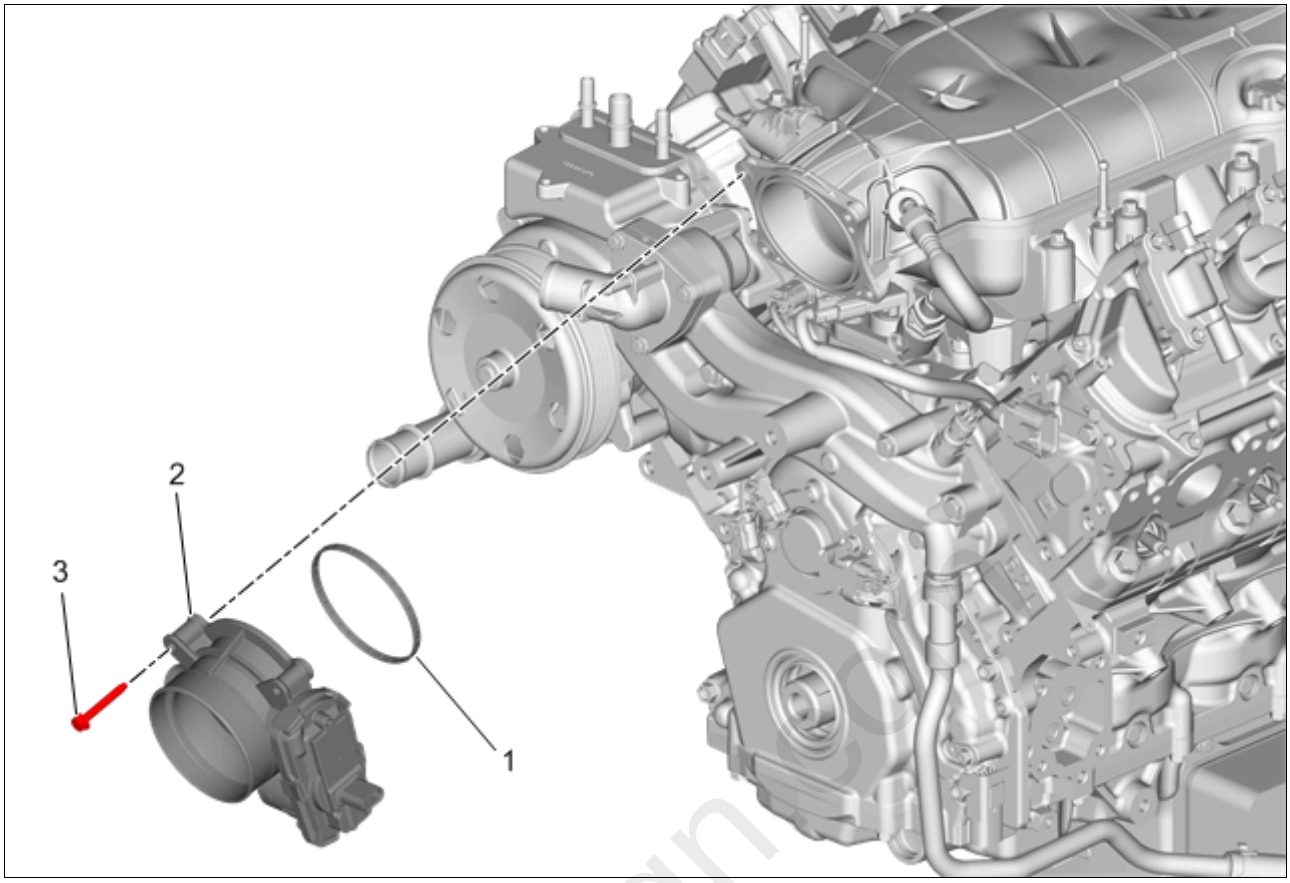
Callout	Component Name
1	Intake Manifold Gasket *NOTE:* *A NEW gasket must be used when installing the intake manifold assembly.*
2	Intake Manifold Assembly
3	Intake Manifold Bolt *CAUTION:*

	Refer to Fastener Caution . **Tighten:** • Tighten the bolts a first pass in the sequence shown to 5 N.m (44 lb in). • Tighten the bolts a final pass in the sequence shown to 10 N.m (89 lb in).
4	Intake Manifold Cover Assembly
5	Intake Manifold Cover Stud **Tighten** 4.5 N.m (40 lb in)
6	PCV Tube Procedure 1. The PCV tube is connected to the intake manifold and the engine via a plastic collar quick connect fitting. 2. To install the PCV tube, refer to Plastic Collar Quick Connect Fitting Service .

REPAIR INSTRUCTIONS - OFF VEHICLE > THROTTLE BODY ASSEMBLY INSTALLATION

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Fig 1: Throttle Body Assembly



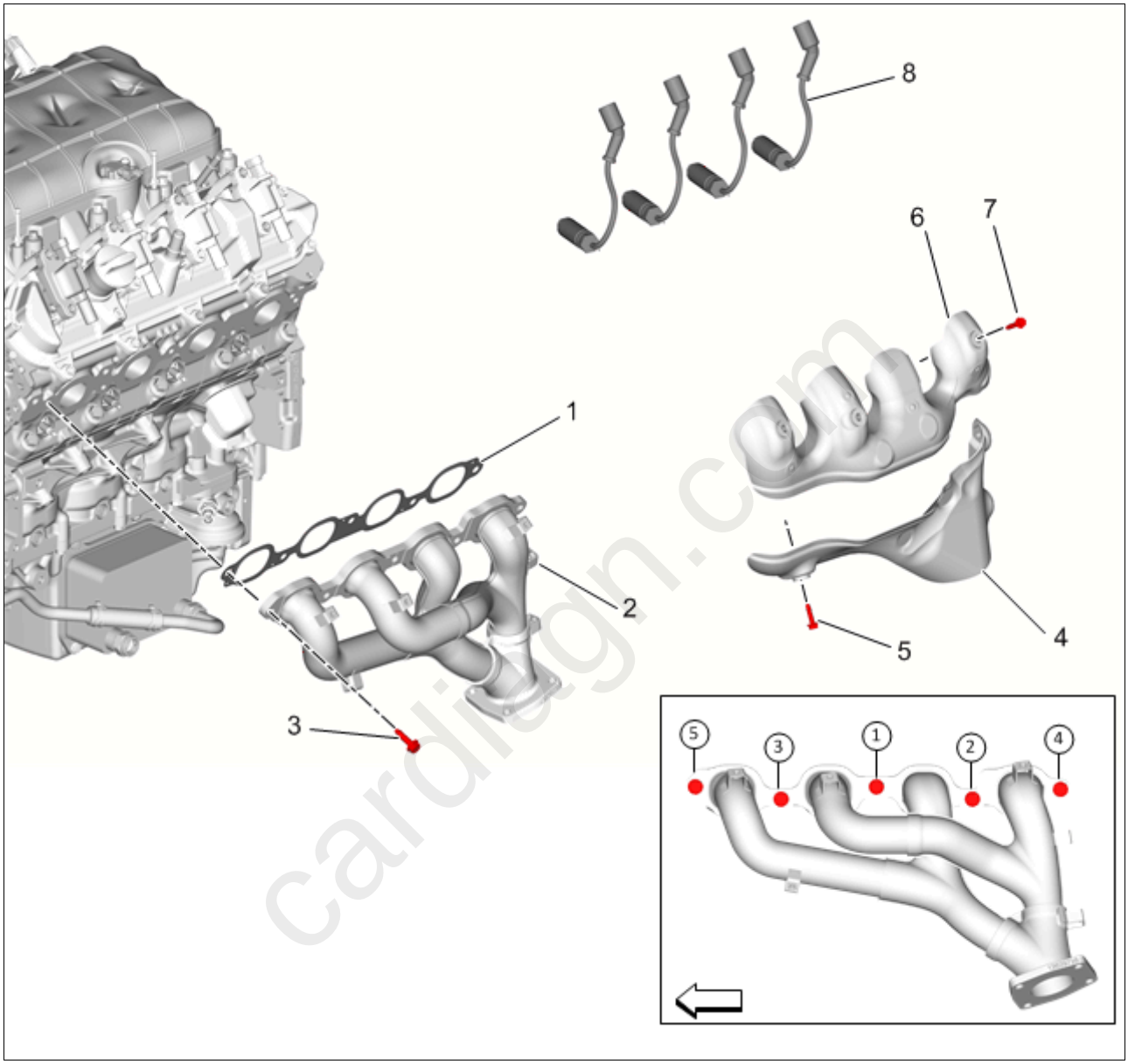
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Throttle Body Gasket *NOTE:* *Must use a NEW gasket.*
2	Throttle Body Assembly
3	Throttle Body Bolt *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (88 lb in)

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REPAIR INSTRUCTIONS - OFF VEHICLE > EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

Fig 1: Exhaust Manifold - Left Side



Courtesy of GENERAL MOTORS COMPANY

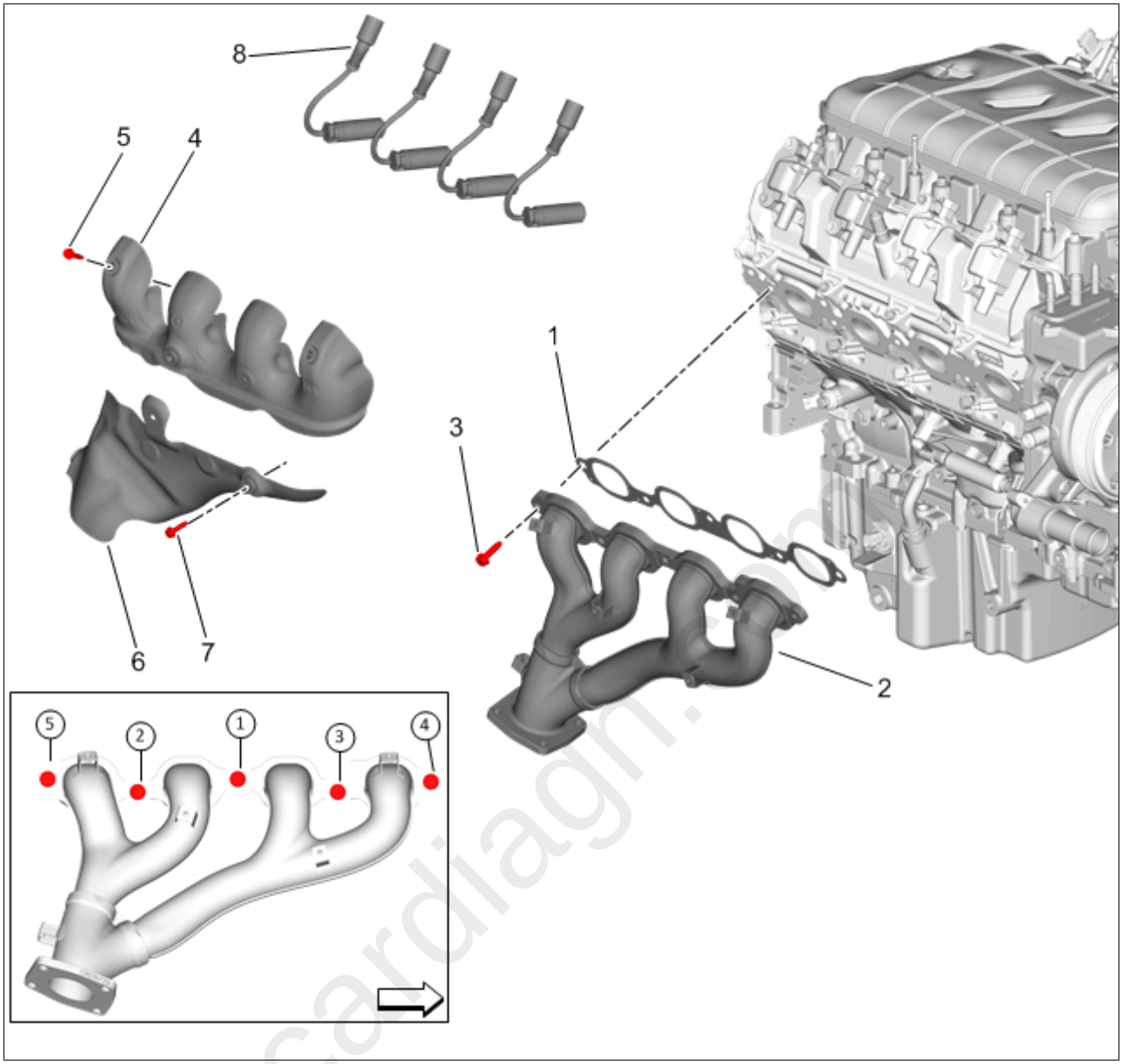
Callout	Component Name
1	Exhaust Manifold Gasket
2	Exhaust Manifold
3	Exhaust Manifold Bolt *CAUTION:*

	Refer to Fastener Caution . **Procedure** Tighten the exhaust manifold bolts in the sequence shown. 1. If installing on existing cylinder head - Tighten the bolts to 23 N.m (17 lb ft). 2. If installing on NEW cylinder head - Tighten bolts to 27 N.m (20 lb ft)
4	Heat Shield
5	Heat Shield Bolts (Qty: 3) **Tighten** 10 N.m (89 lb in)
6	Heat Shield
7	Heat Shield Bolts (Qty: 3) **Tighten** 10 N.m (89 lb in)
8	Spark Plug Wires *NOTE:* *Only apply dielectric grease to the spark plug side of the spark plug wire boot.* **Procedure** 1. Inspect the inside of the spark plug wire boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure: 1. Apply a thin coating of dielectric grease evenly to the inside of the spark plug wire boot, up to a depth of 15 mm from the end of the boot. Refer to Adhesives, Fluids, Lubricants, and Sealers . 2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.

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REPAIR INSTRUCTIONS - OFF VEHICLE > EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE

Fig 1: Exhaust Manifold - Right Side



Courtesy of GENERAL MOTORS COMPANY

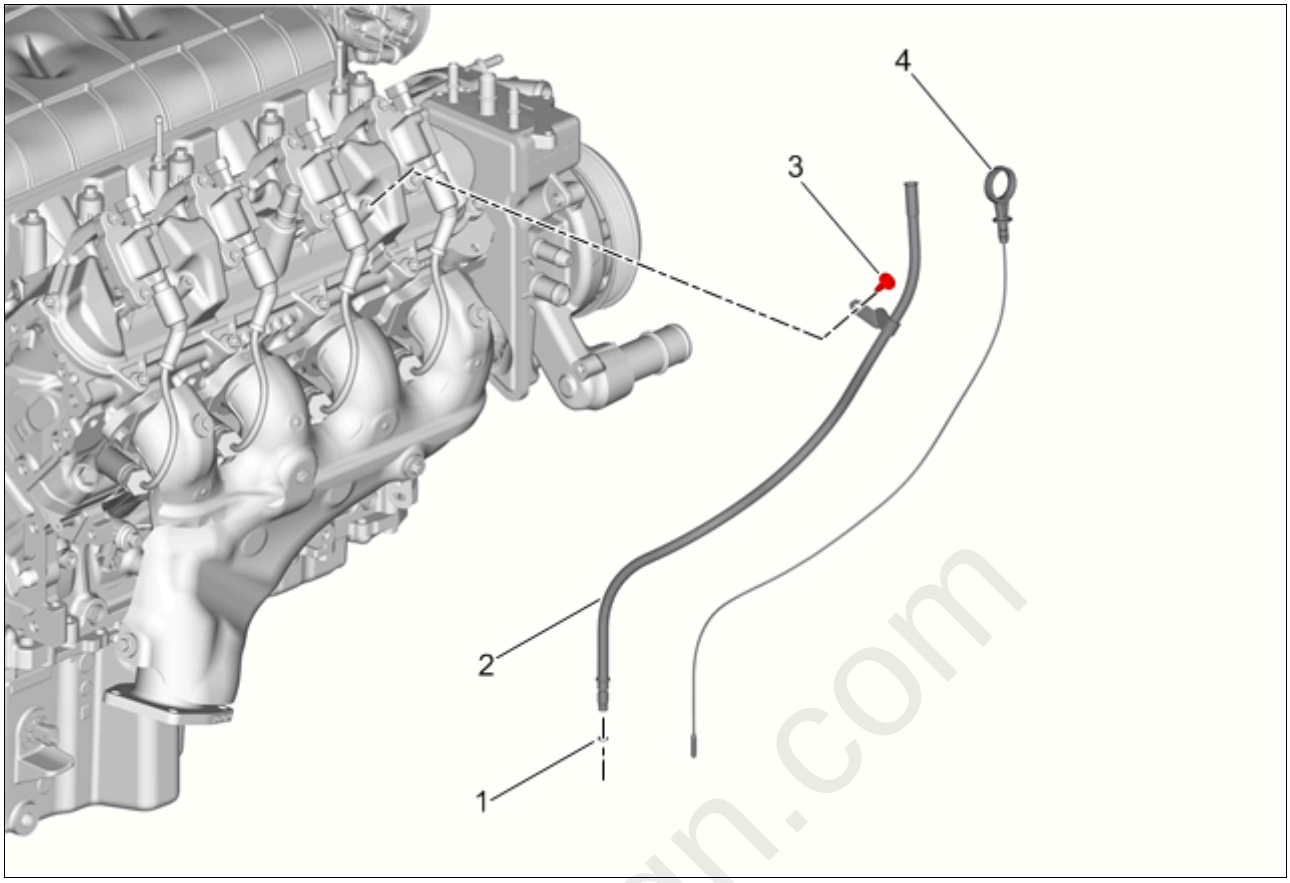
Callout	Component Name
1	Exhaust Manifold Gasket
2	Exhaust Manifold
3	Exhaust Manifold Bolt *CAUTION:* *Refer to Fastener Caution .*

	Procedure Tighten the exhaust manifold bolts in the sequence shown. 1. If installing on existing cylinder head - Tighten the bolts to 23 N.m (17 lb ft). 2. If installing on NEW cylinder head - Tighten bolts to 27 N.m (20 lb ft)
4	Heat Shield
5	Heat Shield Bolt (Qty: 3) **Tighten** 10 N.m (89 lb in)
6	Heat Shield
7	Heat Shield Bolt (Qty: 3) **Tighten** 10 N.m (89 lb in)
8	Spark Plug Wires *NOTE:* *Only apply dielectric grease to the spark plug side of the spark plug wire boot.* **Procedure** Inspect the inside of the spark plug wire boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure: 1. Apply a thin coating of dielectric grease evenly to the inside of the spark plug wire boot, up to a depth of 15 mm from the end of the boot. Refer to Adhesives, Fluids, Lubricants, and Sealers . 2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.

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REPAIR INSTRUCTIONS - OFF VEHICLE > OIL LEVEL INDICATOR AND TUBE INSTALLATION

Fig 1: Oil Level Indicator and Tube



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Level Indicator Tube O-Ring
2	Oil Level Indicator Tube
3	Oil Level Indicator Tube Bracket Bolt *CAUTION:* *Refer to Fastener Caution .* **Tighten** 10 N.m (88 lb in)
4	Oil Level Indicator

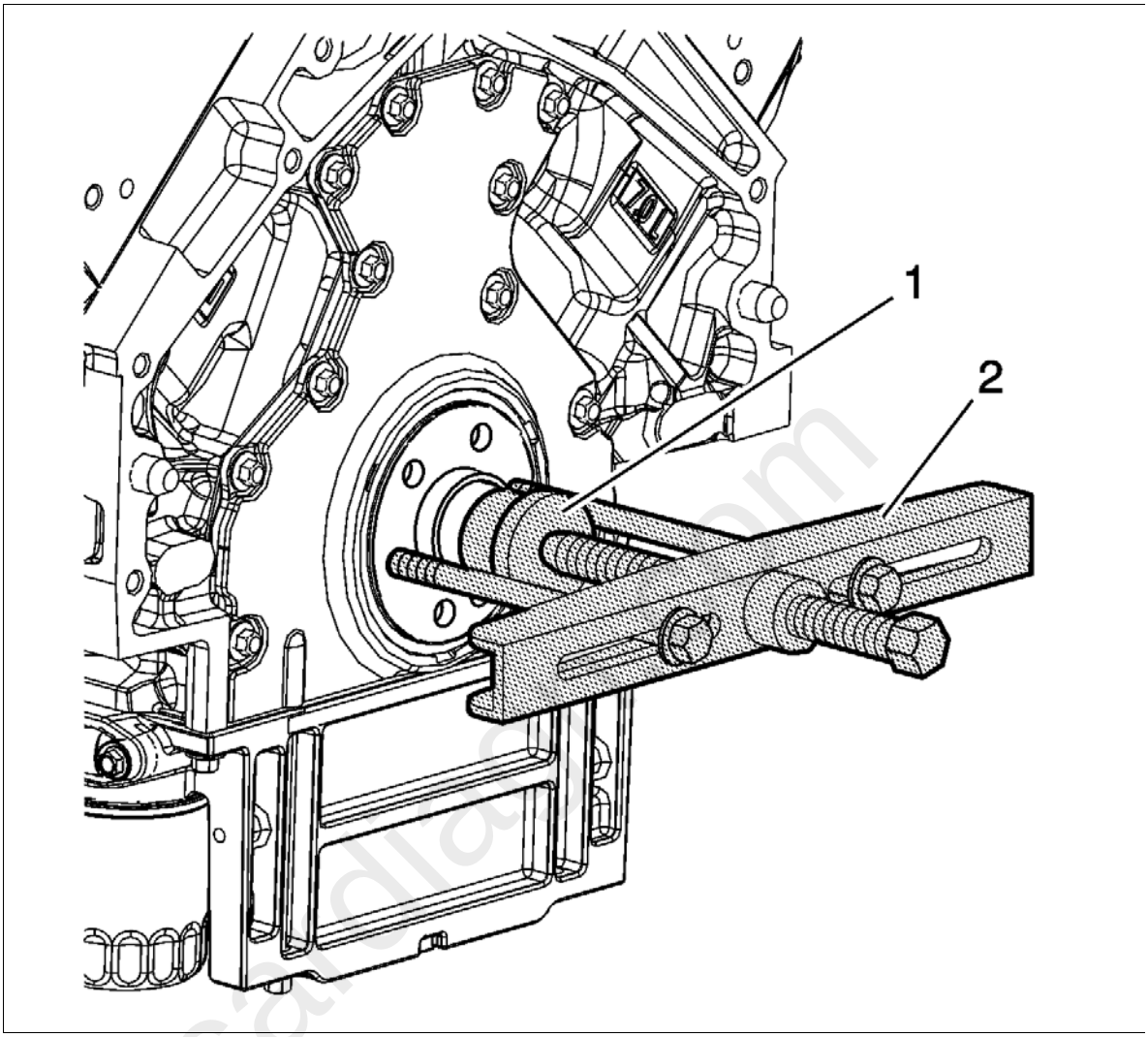
REPAIR INSTRUCTIONS - OFF VEHICLE > CLUTCH PILOT BEARING INSTALLATION

Special Tools

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- **GE-8433** Two Jaw Puller
- **EN-45949** Pilot Bearing and Flywheel Locator Installer

Fig 1: Special Tools

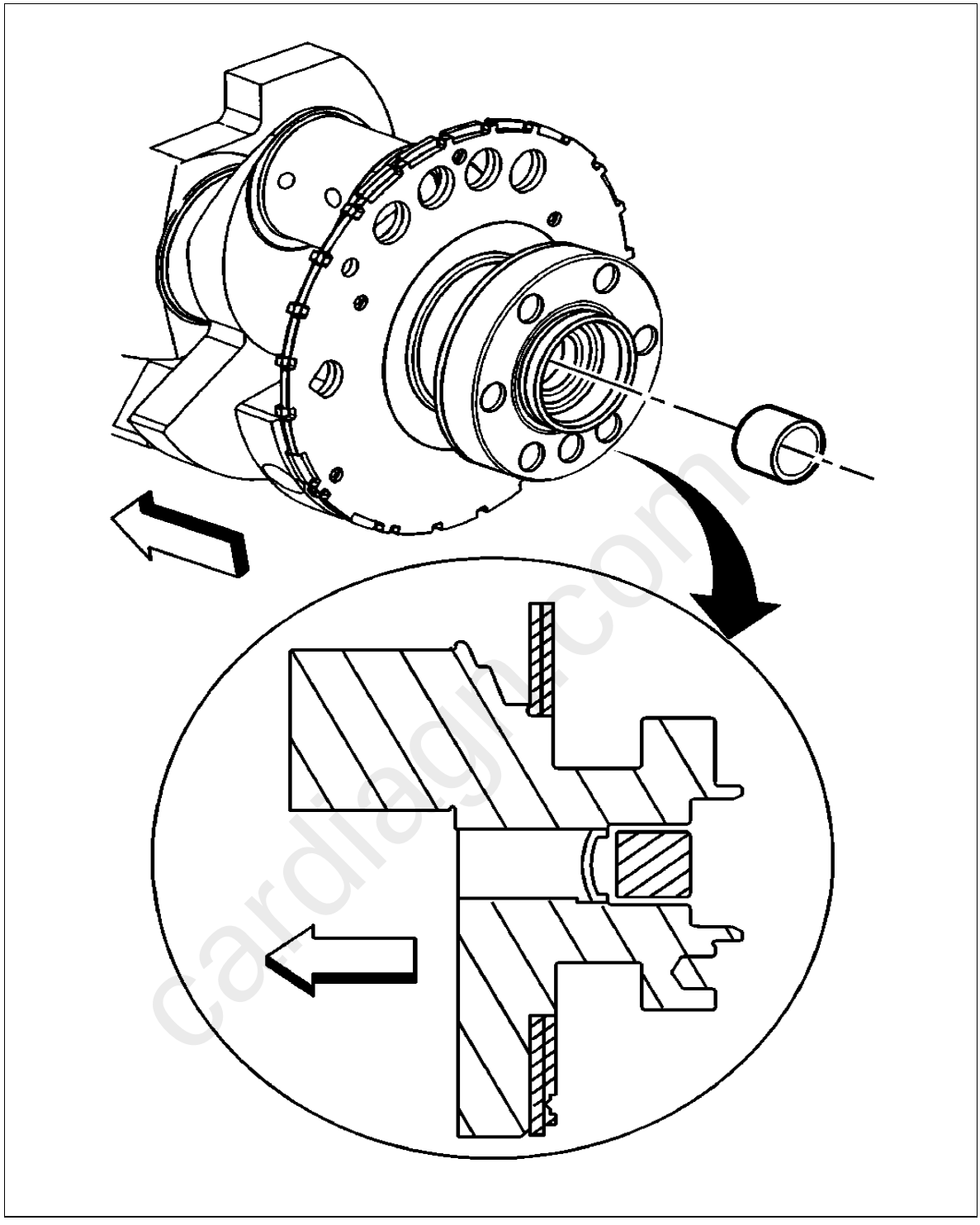


Courtesy of GENERAL MOTORS COMPANY

1. Position the bearing to the rear of the crankshaft.
2. Assemble the **GE-8433** two jaw puller (2), the **EN-45949** pilot bearing and flywheel locator installer (1) and bolts to the rear of the crankshaft.

   Tighten the bolts until snug.
3. Rotate the bolt of the **GE-8433** two jaw puller (2) until the bearing is seated in the bore of the crankshaft.
4. Remove the tools.

Fig 2: Locating Clutch Pilot Bearing



Courtesy of GENERAL MOTORS COMPANY

5. Inspect the clutch pilot bearing for proper installation.

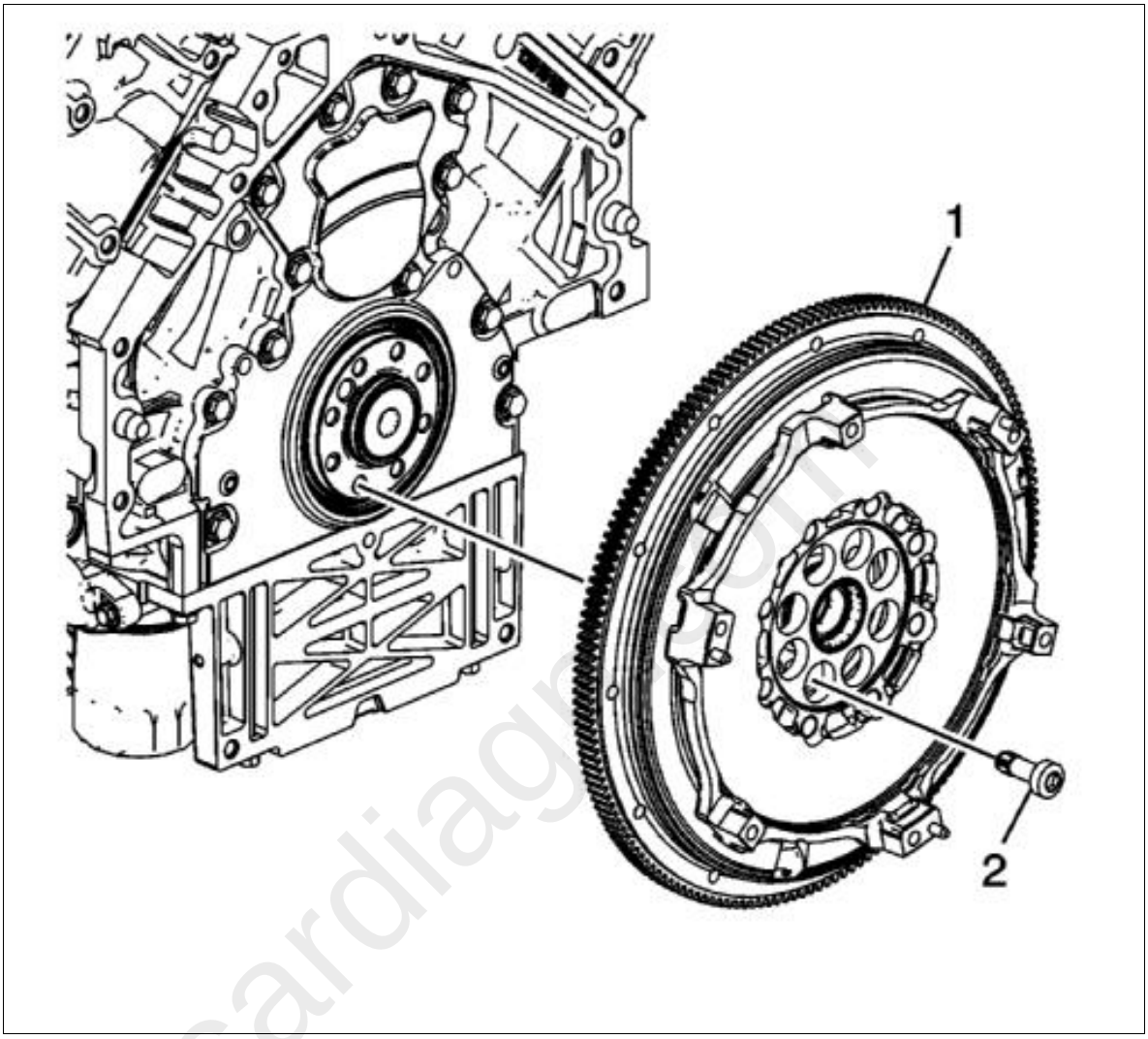
REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE FLYWHEEL INSTALLATION

Special Tools

J-42386-A Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools .

Fig 1: Manual Transmission Flywheel



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> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

> *NOTE:*
>
> *The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine*

flywheel bolts.

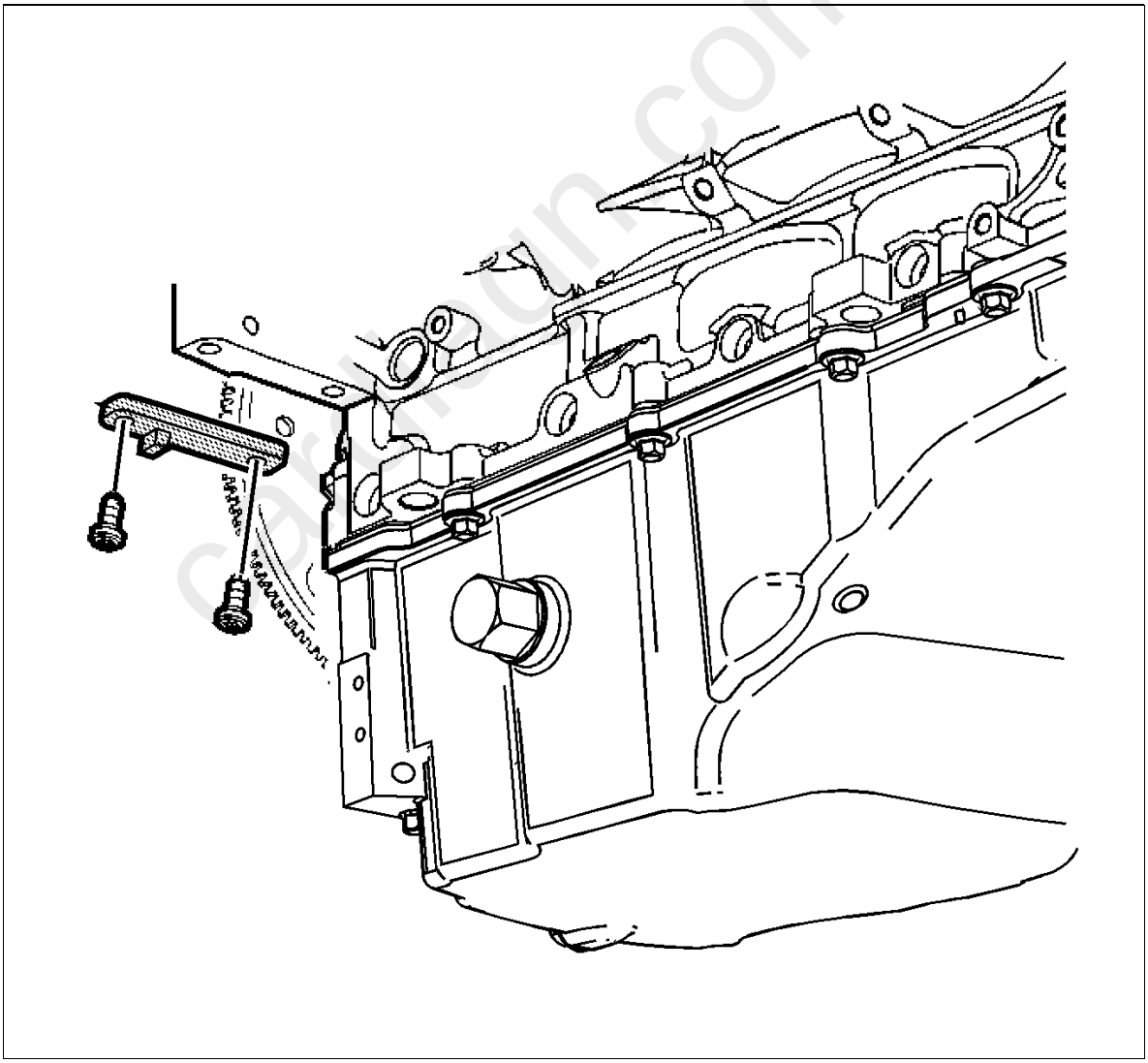
1. Install the flywheel (1) to the crankshaft.

> ⚠ *CAUTION:*
>
> *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

2.

3. Install and hand tighten the NEW flywheel bolts (2).

Fig 2: Flywheel Holder



Courtesy of GENERAL MOTORS COMPANY

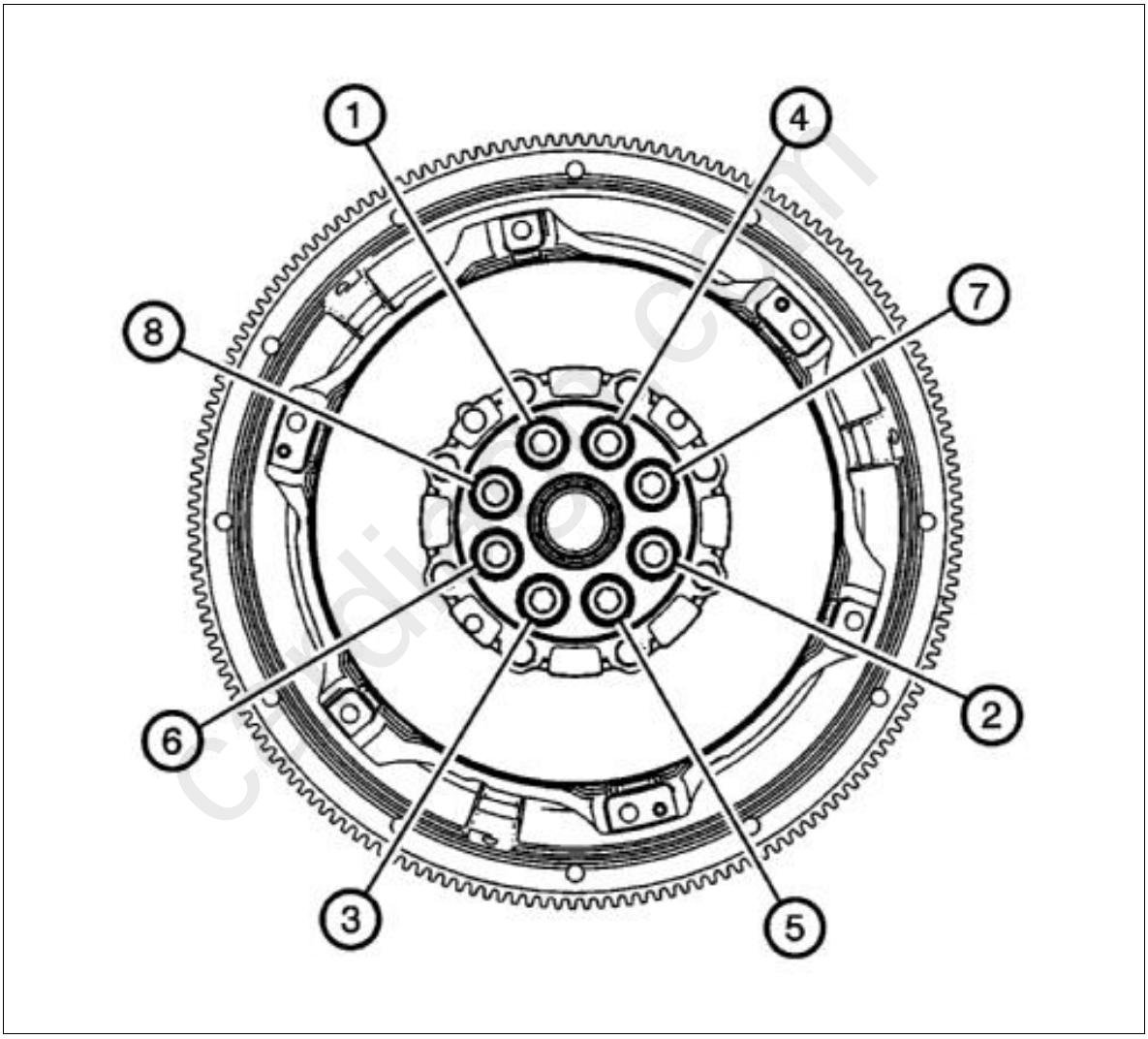
> ⚠ *CAUTION:*
>
> *Refer to Fastener Caution .*

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

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

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

   Fig 3: Tightening Flywheel Bolts In Sequence



Courtesy of GENERAL MOTORS COMPANY

5. Tighten the flywheel bolts (1).

   1. Tighten the bolts (1-8) a first pass in sequence to 15 N.m (11 lb ft).
   2. Tighten the bolts (1-8) a second pass in sequence to 30 N.m (22 lb ft).
   3. Tighten the bolts (1-8) a final pass in sequence an additional 45 degrees using

EN-45059 angle meter.

6. Remove the **J-42386-A** flywheel holding tool

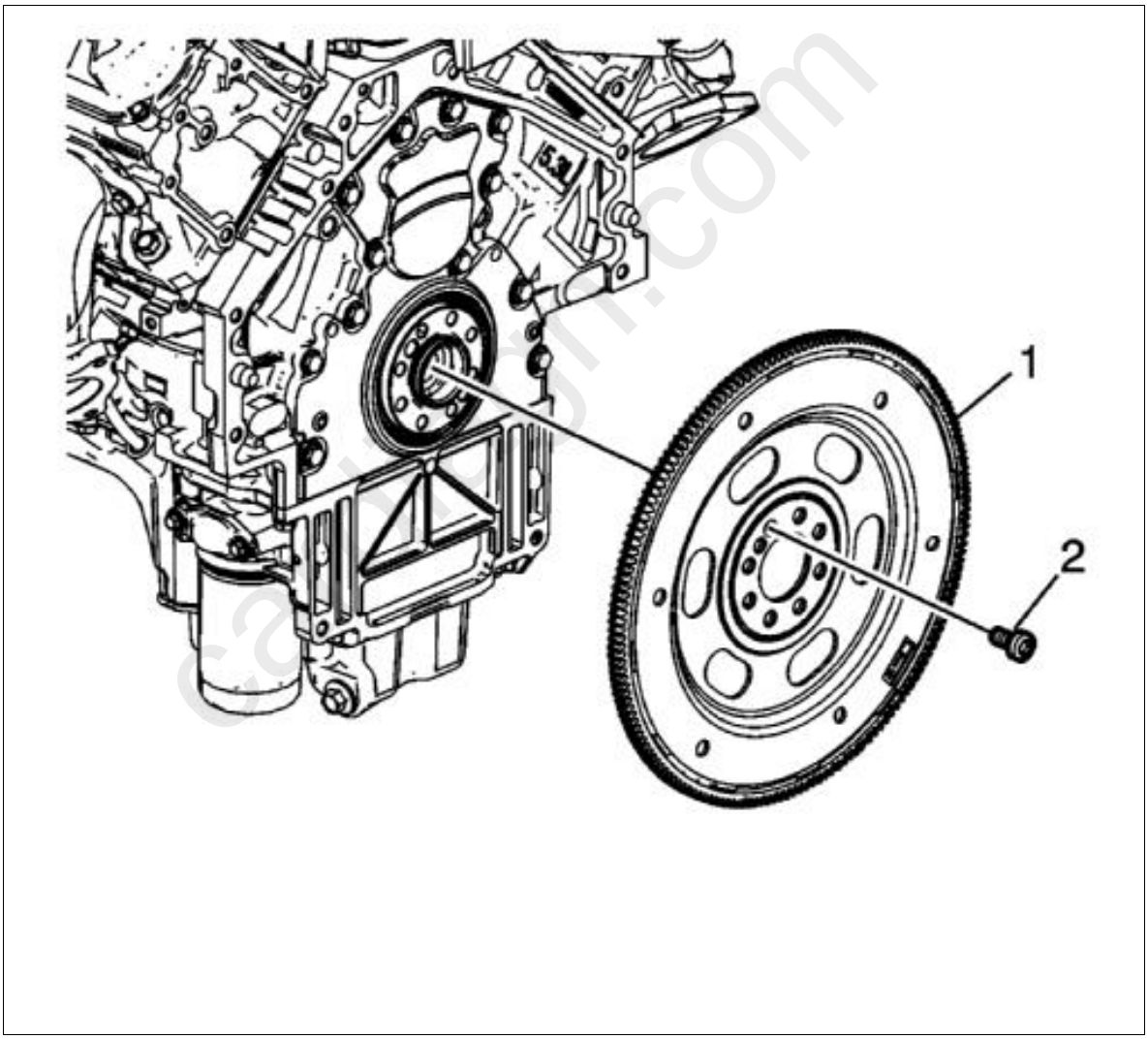
REPAIR INSTRUCTIONS - OFF VEHICLE > AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

EN-45059 Angle Meter

For equivalent regional tools, refer to Special Tools .

Fig 1: Automatic Transmission Flex Plate



Courtesy of GENERAL MOTORS COMPANY

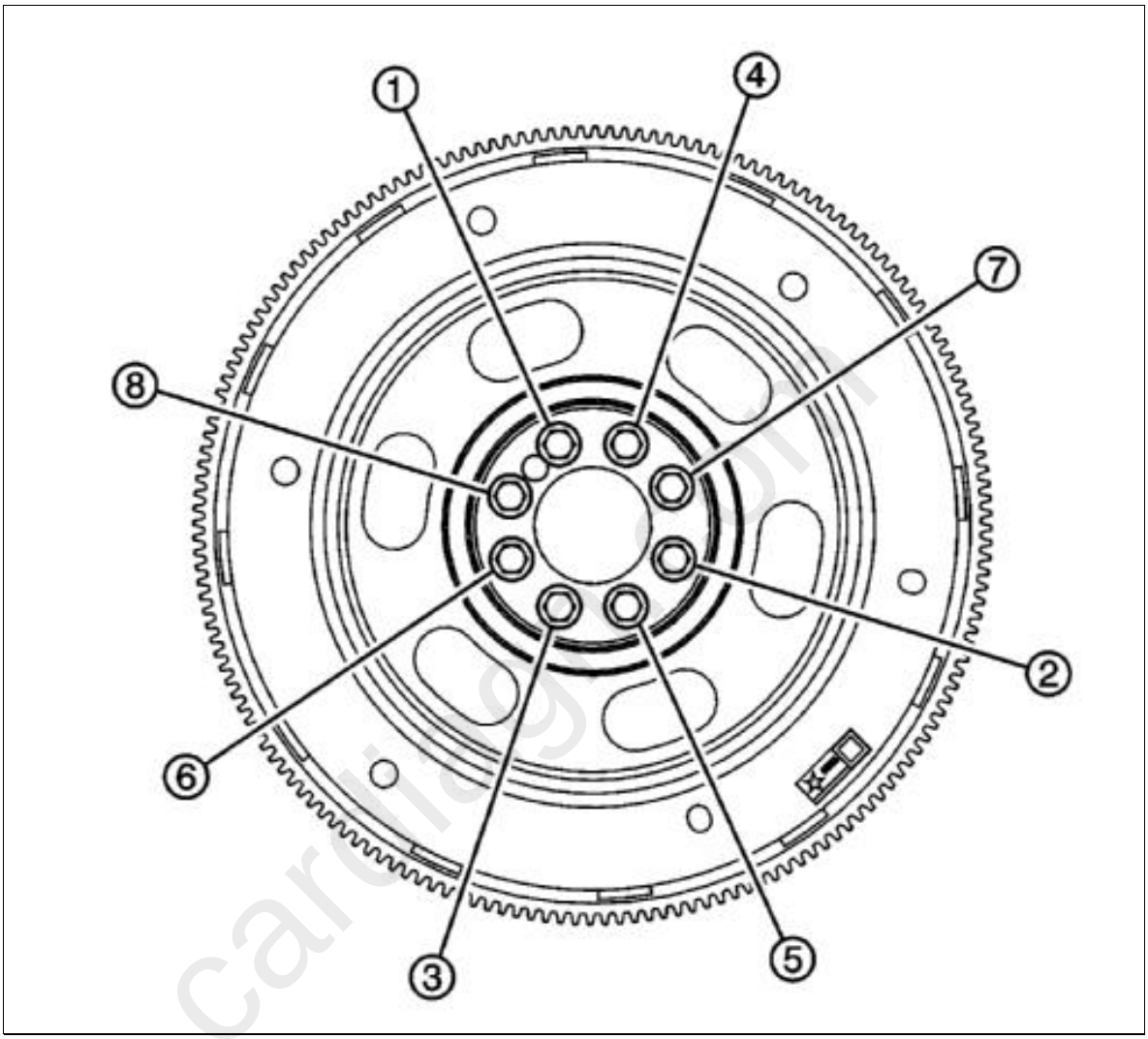
NOTE:

The flex plate does not use a locating pin for alignment and will not initially seat

against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.

1. Install the flex plate (1) to the crankshaft.

Fig 2: NEW Engine Flex Plate Bolts



Courtesy of GENERAL MOTORS COMPANY

⚠ *CAUTION:*

This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

> *CAUTION:*
>
> *Refer to Fastener Caution .*

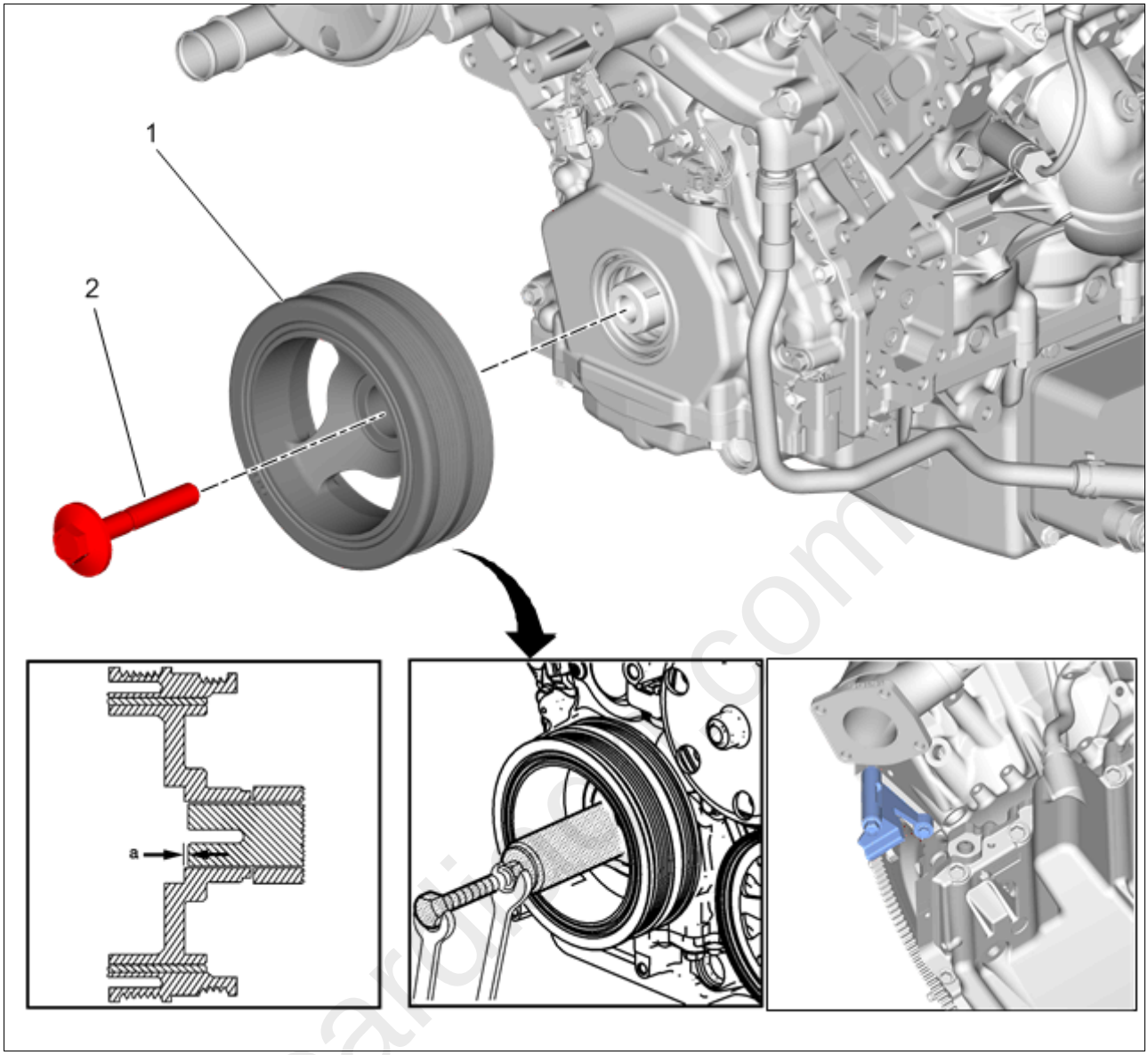
> *NOTE:*
>
> *Must use NEW bolts.*

2. Install the NEW engine flex plate bolts (2).
    1. Tighten the engine flex plate bolts (1-8) a first pass in sequence to 15 N.m (11 lb ft).
    2. Tighten the engine flex plate bolts (1-8) a second pass in sequence to 30 N.m (22 lb ft).
    3. Tighten the engine flex plate bolts (1-8) a final pass in sequence an additional 45 degrees using **EN-45059** angle meter.

REPAIR INSTRUCTIONS - OFF VEHICLE > CRANKSHAFT BALANCER INSTALLATION

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Fig 1: Crankshaft Balancer



Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Balancer Assembly *CAUTION:* *Refer to Fastener Caution .* *NOTE:* • *Ensure the teeth of the tool engage the engine flywheel teeth.*

- *The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.*

Procedure

1. Install the **EN-42386-A** flywheel holding tool. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation and tighten bolts to 50 N.m (37 lb ft).
2. Assemble the **EN-41478** installer threaded rod, nut, washer and the **EN-41665** installer.
3. Insert the smaller end of the installer into the front of the balancer. Use a wrench and hold the hex end of the threaded rod. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
4. Remove the tool and reverse the installation tool. Position the larger end of the installer against the front of the balancer. Use wrench and hold the hex end of the threaded rod. Use a second wrench and rotate the nut clockwise until the balancer is installed onto the crankshaft.
5. Remove the balancer installation tools.

Special Tools

- **EN-41478** Crankshaft Front Oil Seal Installer
- **EN-41665** Crankshaft Balancer and Sprocket Installer
- **EN-42386-A** Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools .

2

Crankshaft Balancer Bolt

NOTE:

The nose of the crankshaft (a) should be recessed 2.40-4.48 mm (0.094-0.176 in) into the balancer bore.

Procedure

1. Install the used crankshaft balancer bolt and tighten to 330 N.m (240 lb ft) to fully seat the balancer.
2. Remove the used crankshaft balancer bolt.
3. Measure for correctly installed balancer. If the balancer is not installed to proper dimensions, install the **EN-41665** installer and repeat the installation procedure.

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4. Install the NEW crankshaft balancer bolt:
    1. Tighten the crankshaft balancer bolt to 120 N.m (110 lb ft).
    2. Loosen the crankshaft balancer bolt 360 degrees.
    3. Tighten the crankshaft balance bolt to 80 N.m (59 lb ft).
    4. Tighten the crankshaft balancer bolt a final pass to:
        1. Balancer bolt with flanged head tighten to 125 degrees using the **EN-45059** angle meter.
        2. Balancer bolt with retained rotating washer tighten to 200 degrees using the **EN-45059** angle meter.
5. Remove the **EN-42386-A** flywheel holding tool.

Special Tools

- **EN-41665** Crankshaft Balancer and Sprocket Installer
- **EN-42386-A** Flywheel Holding Tool
- **EN-45059** Angle Meter

For equivalent regional tools, refer to Special Tools .

REPAIR INSTRUCTIONS - OFF VEHICLE > ENGINE PRELUBING

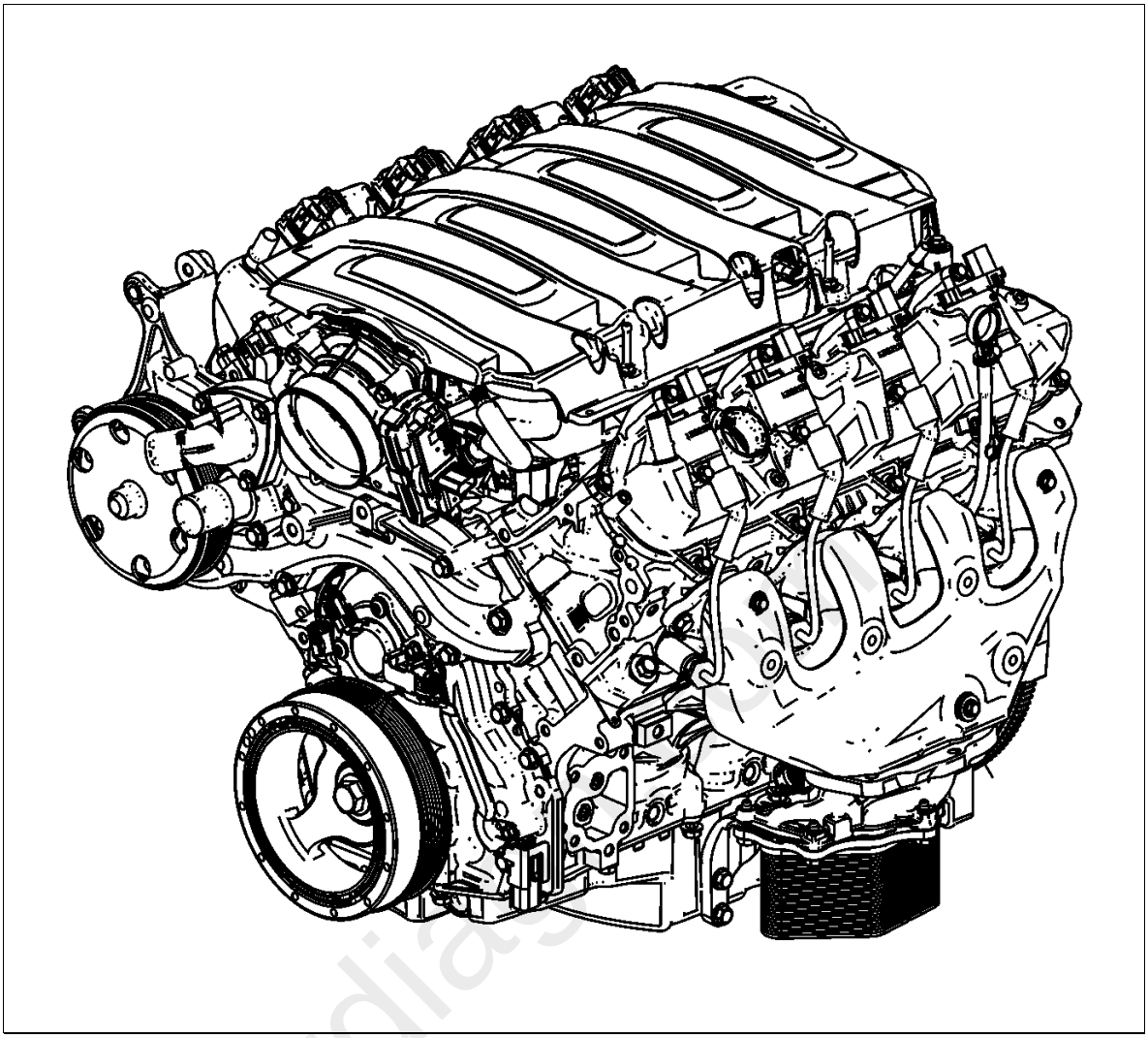
Special Tools

J 45299 Engine Preluber

For equivalent regional tools, refer to Special Tools

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Fig 1: Engine Oil Filter



Courtesy of GENERAL MOTORS COMPANY

NOTE:

A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Use an approved engine oil as specified in the owners manual.

1. Remove the engine oil filter and fill with clean engine oil.

CAUTION:

Refer to Fastener Caution .

2. Install the oil filter and tighten to 30 N.m (22 lb ft).
3. Ensure that the oil drain plug(s) are installed and tightened to 25 N.m (18 lb ft)

4. Locate the engine block left rear oil gallery plug.
5. Install the M16 x 1.5 adapter P/N 509375.

Fig 2: Preluber Flexible Hose



Courtesy of GENERAL MOTORS COMPANY

6. Install the flexible hose to the adapter and open the valve.
7. Pump the handle on the **J 45299** preluber in order to flow a minimum of 1-1.9 liters (1-2 quarts) engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
8. Close the valve and remove the flexible hose and adapter from the engine.
9. Install the gallery plug to the engine and tighten to 30 N.m (44 lb ft).
10. Top-off the engine oil to the proper level.

DESCRIPTION AND OPERATION > CRANKCASE VENTILATION SYSTEM

DESCRIPTION

A positive crankcase ventilation system is used in order to provide a more complete scavenging of crankcase vapors. Filtered air from the air induction system duct is supplied to the crankcase, mixed with blow-by vapors, and passes through a crankcase ventilation metering device before entering the intake manifold. The primary component in the positive crankcase ventilation (PCV) system is the PCV flow metering device (valve or orifice). Vacuum changes within the intake manifold assembly result in flow variations of the blow-by vapors. If abnormal operating conditions occur, the design of the PCV system permits excessive amounts of blow-by vapors to back flow through the crankcase vent tube and into the engine induction system to be consumed during normal combustion. This engine ventilation system design minimizes oil consumption and significantly reduces the potential for oil ingestion during vehicle limit handling maneuvers.

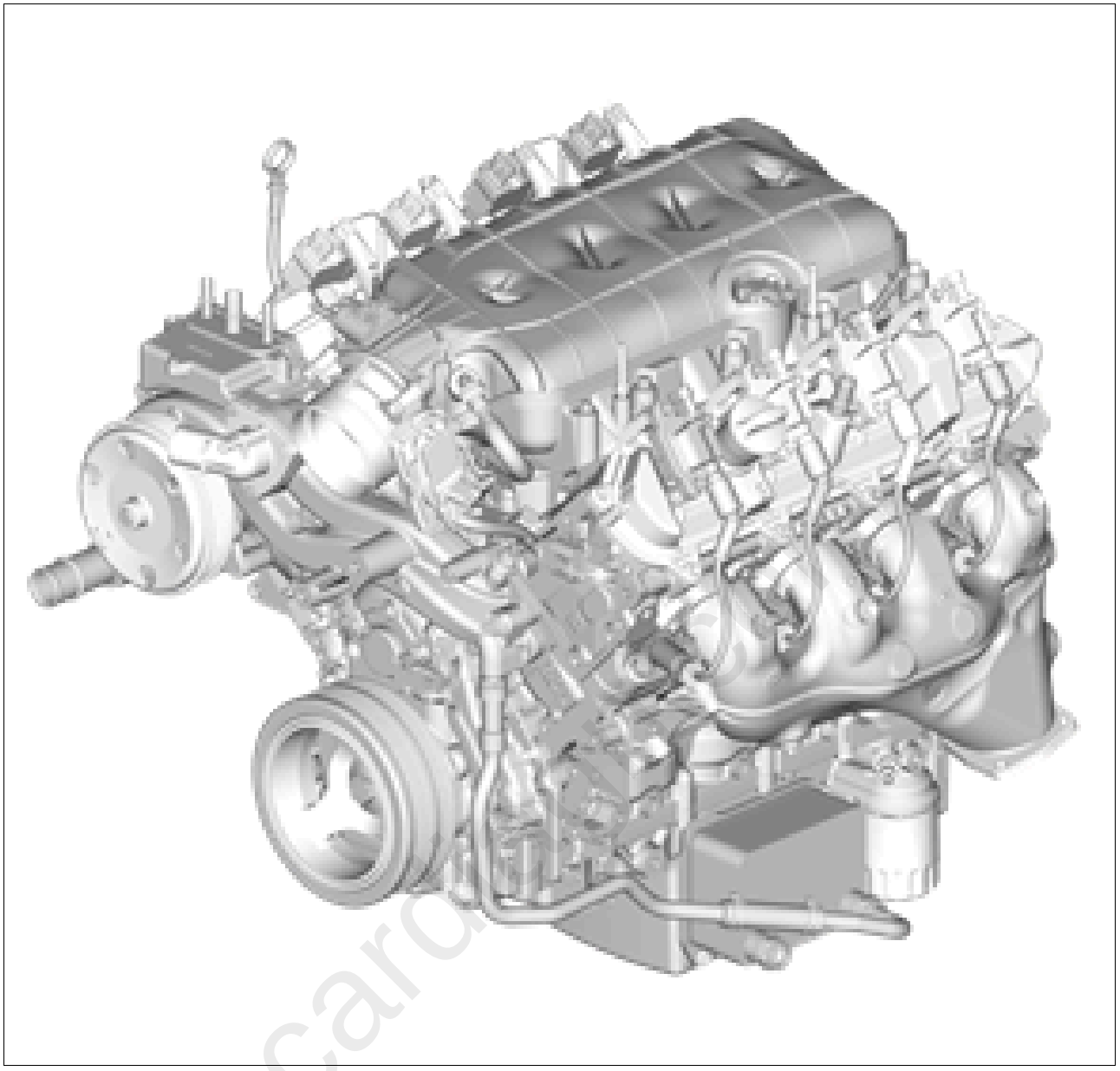
LT1 Engine

The LT1 engine utilizes an integral positive crankcase ventilation (PCV) system which is located in the Valve Lifter Oil Manifold Assembly beneath the Intake Manifold Assembly. The Valve Lifter Oil Manifold Assembly contains composite oil separating baffles and PCV plumbing. Filtered fresh air is routed from upstream of the throttle plate to the external PCV oil separator tank. From there it is passed to both engine rocker arm covers. The rocker arm covers' design shields rocker arm oil spray, thereby reducing the potential for oil being drawn back into the tank during backflow of the ventilation system. If oil is drawn back into the tank it will drain down to the oil pan, which further reduces oil consumption. Blow-by vapors are routed from the valve lifter oil manifold assembly through a fixed orifice (7.5 mm) within a steel PCV tube, then into the Intake Manifold Assembly.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > THE 6.2 LITER V8 LT1 ENGINE

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Fig 1: 6.2 Liter V8 LT1 Engine



Courtesy of GENERAL MOTORS COMPANY

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > CAMSHAFT AND DRIVE SYSTEM

A billet steel 1-piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft has a tri-lobe forward of the rear journal for actuating the direct injection fuel pump. The CMP actuator is mounted to the front of the camshaft and retained by the CMP solenoid valve. The CMP actuator is driven by the crankshaft sprocket through the camshaft timing chain. The CMP sensor wheel is incorporated into the front face of the CMP actuator with the CMP sensor and CMP actuator magnet mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining

plate mounted to the front of the engine block maintains camshaft location. Refer to Camshaft Position Actuator and Solenoid Valve Description .

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > CRANKSHAFT

The crankshaft is made of hardened forged steel. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A CKP reluctor ring is press-fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > CYLINDER HEADS

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. The valve rocker arm covers are retained to the cylinder head by 10 perimeter mounted rocker arm cover bolts. Cylinder heads are a high-flow design with offset intake valve rocker arms.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > ENGINE BLOCK

The engine block is a cam-in-block deep skirt 90 degree V-configuration with 5 crankshaft bearing caps. The engine block is cast aluminum. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block. The left bank of cylinders are number 1-3-5-7 (#1 is front left) and the right bank of cylinders are 2-4-6-8 (#2 is front right) viewed from the flywheel end of the engine. The engine firing order is 1-8-7-2-6-5-4-3.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > EXHAUST MANIFOLDS

The exhaust manifolds are a 1-piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > INTAKE MANIFOLD

The intake manifold is a 1-piece composite design that incorporates brass threaded inserts for mounting the throttle body, and wire harness studs. Each side of the intake manifold is sealed to the cylinder head by 8 silicone push in place gaskets. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1-piece push in place silicone gasket. The intake

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manifold covers the direct injected fuel rail assembly, fuel pipes and fuel pump. The manifold absolute pressure (MAP) sensor is installed and retained to the top left of the intake manifold midway back under the left engine cover. The evaporative (EVAP) emission canister purge solenoid valve is mounted right front of the intake aft of the throttle body assembly

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > FUEL SYSTEM

The fuel system consists of 8 separate direct injection fuel injectors, two high pressure fuel rails, a high pressure cross-over fuel pipe (connects the two fuel rails), a high pressure fuel feed pipe (connects the cross-over pipe to the high pressure fuel pump), a high pressure fuel pump and a low pressure fuel feed pipe. The injectors are each seated into their individual bores in the cylinder heads with two combustion seals to provide sealing. The high pressure fuel pump mounts to the rear of the Valve Lifter Oil Manifold in the engine valley. Motion is transmitted to the pump from a tri-lobe on the rear of the camshaft through a hydraulic roller lifter.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > OIL PAN

The structural rear-sump oil pan is cast aluminum. Incorporated into the design is the oil filter mounting boss, drain plug opening, baffle, oil deflector, oil pump screen, and oil level sensor (wet sump system only). The oil filter bypass valve is in the oil filter assembly. An external oil cooler assembly is mounted directly to the left side of the oil pan. The oil pan is sealed to the oil pump with a silicone push in place gasket and to the engine block with RTV sealant. Dowels are pressed into the pan for aid in alignment to the engine block during assembly.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > PISTON AND CONNECTING ROD ASSEMBLY

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > VALVE ROCKER ARM COVER ASSEMBLIES

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil assemblies. Incorporated into the left and right valve rocker arm covers are the positive crankcase ventilation (PCV) fresh air passages. Incorporated into the left cover is the oil fill tube (wet sump system only).

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DESCRIPTION AND OPERATION > ENGINE COMPONENT DESCRIPTION > VALVE TRAIN

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms are mounted on individual pedestals or pivot supports that are incorporated into the cylinder heads. Each rocker arm is retained by a bolt. Valve lash is net build. Cylinders 1, 4, 6, and 7 are active fuel management. Refer to Cylinder Deactivation (Active Fuel Management) System Description .

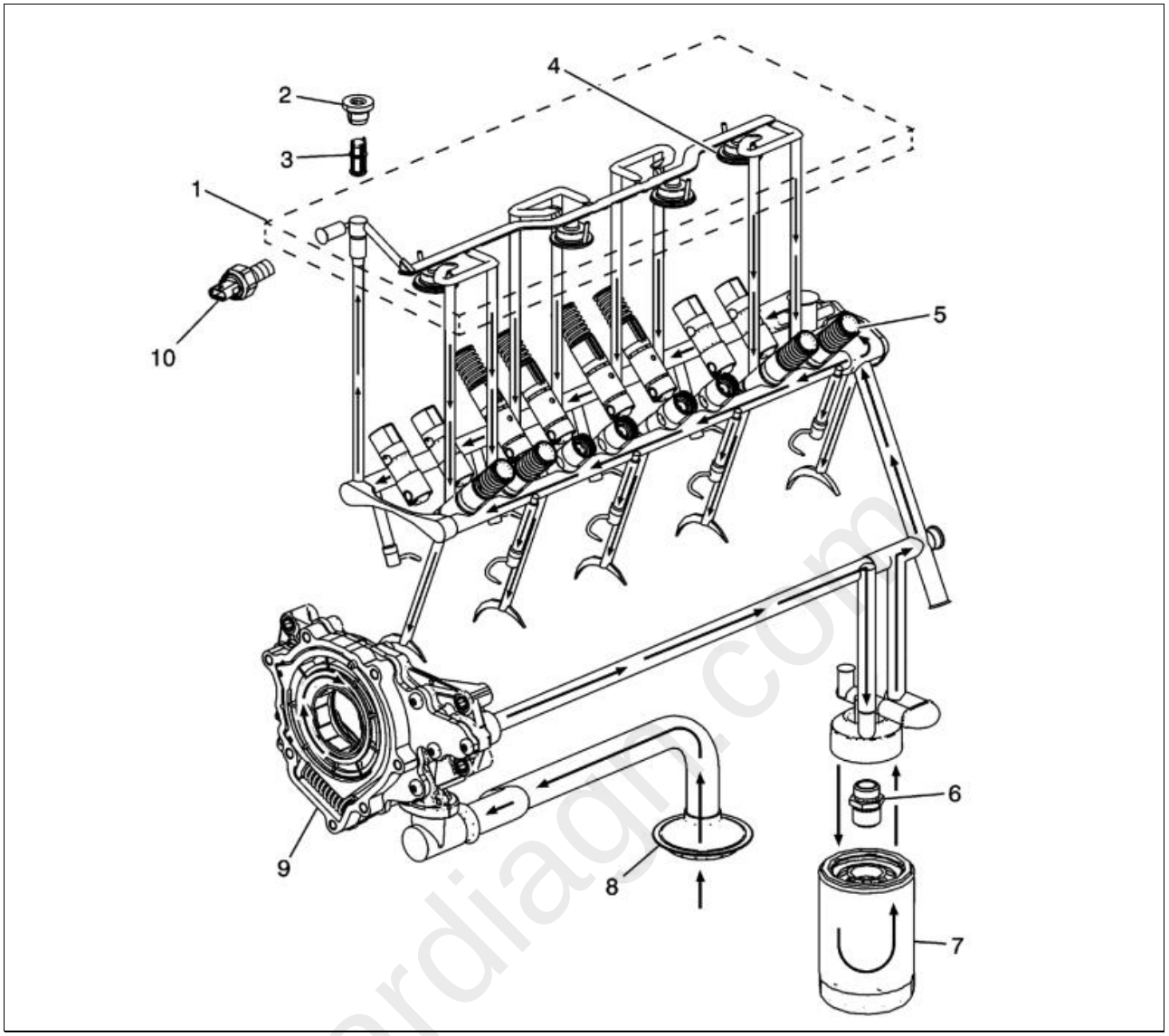
DESCRIPTION AND OPERATION > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION > SYSTEM OPERATION

General Motors Active Fuel Management engine control system has the ability, under certain light load driving conditions, to provide maximum fuel economy by deactivating 4 of the engines 8 cylinders. The engine will normally operate on 8 cylinders in V8 mode during starting, idling, and medium or heavy throttle conditions. When commanded ON, the engine control module (ECM) will direct the active fuel management system and deactivate cylinders 1 and 7 on the left bank and cylinders 4 and 6 on the right bank, forcing V4 mode. Refer to Lubrication Description , and Cylinder Deactivation (Active Fuel Management) System Description .

DESCRIPTION AND OPERATION > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION > VALVE LIFTER OIL MANIFOLD ASSEMBLY

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Fig 1: Valve Lifter Oil Manifold Assembly



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The valve lifter oil manifold assembly (1) is bolted to the top of the engine block beneath the intake manifold assembly. The oil manifold consists of 4 electrically operated and normally-closed solenoids (4). Each solenoid directs the flow of pressurized engine oil to the active fuel management intake and exhaust valve lifters (5).

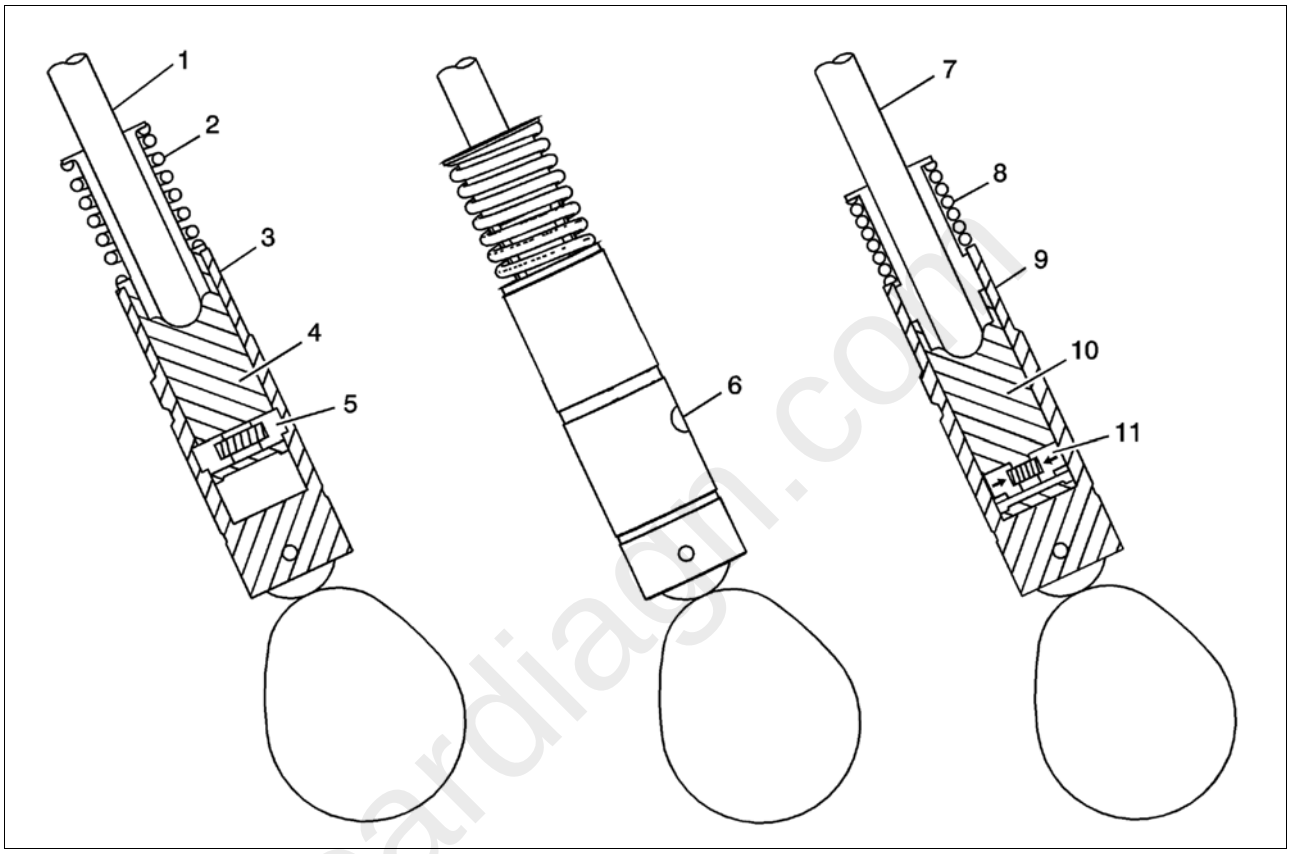
When enabling conditions are met for active fuel management operation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the solenoid windings. With the windings energized, the solenoid valves open and direct pressurized engine oil through the valve lifter oil manifold into 8 vertical passages in the engine block lifter valley. The 8 vertical passages, 2 per AFM cylinder, direct pressurized oil to the valve lifter bores of the cylinders to be deactivated. When vehicle operating conditions require a return to V8 mode, the ECM will turn OFF the ground circuit for the solenoids, allowing the solenoid valves to close. When the solenoid valves are closed, remaining oil pressure is exhausted through the bleed passages of the valve lifter oil manifold into the engine block lifter valley. The housing of the oil manifold incorporates a vent orifice that continuously purges trapped air from the manifold

To help control contamination within the active fuel management hydraulic system, a small replaceable oil

filter (3) is located in the valve lifter oil manifold oil inlet passage. The oil pressure sensor (10) monitors engine oil pressure and provides information to the ECM.

DESCRIPTION AND OPERATION > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION > ACTIVE FUEL MANAGEMENT VALVE LIFTERS

Fig 1: Displacement On Demand Valve Lifters



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When operating in V8 mode, the active fuel management valve lifters function similar to the non-active fuel management valve lifters. The active fuel management oil manifold solenoids are in the closed position, with no pressurized oil directed to the valve lifters. The pushrod (1) travels upward and downward to actuate the rocker arm and valve. The spring loaded locking pins (5) of the lifter are extended outward and mechanically lock the pin housing (4) to the outer body of the valve lifter (3).

When the active fuel management system is commanded ON, the ECM will direct the solenoids of the oil manifold to open and direct pressurized oil to the valve lifters. Oil travels through the valve lifter oil manifold and engine block oil galleries and enters the inlet port (6) of the valve lifter.

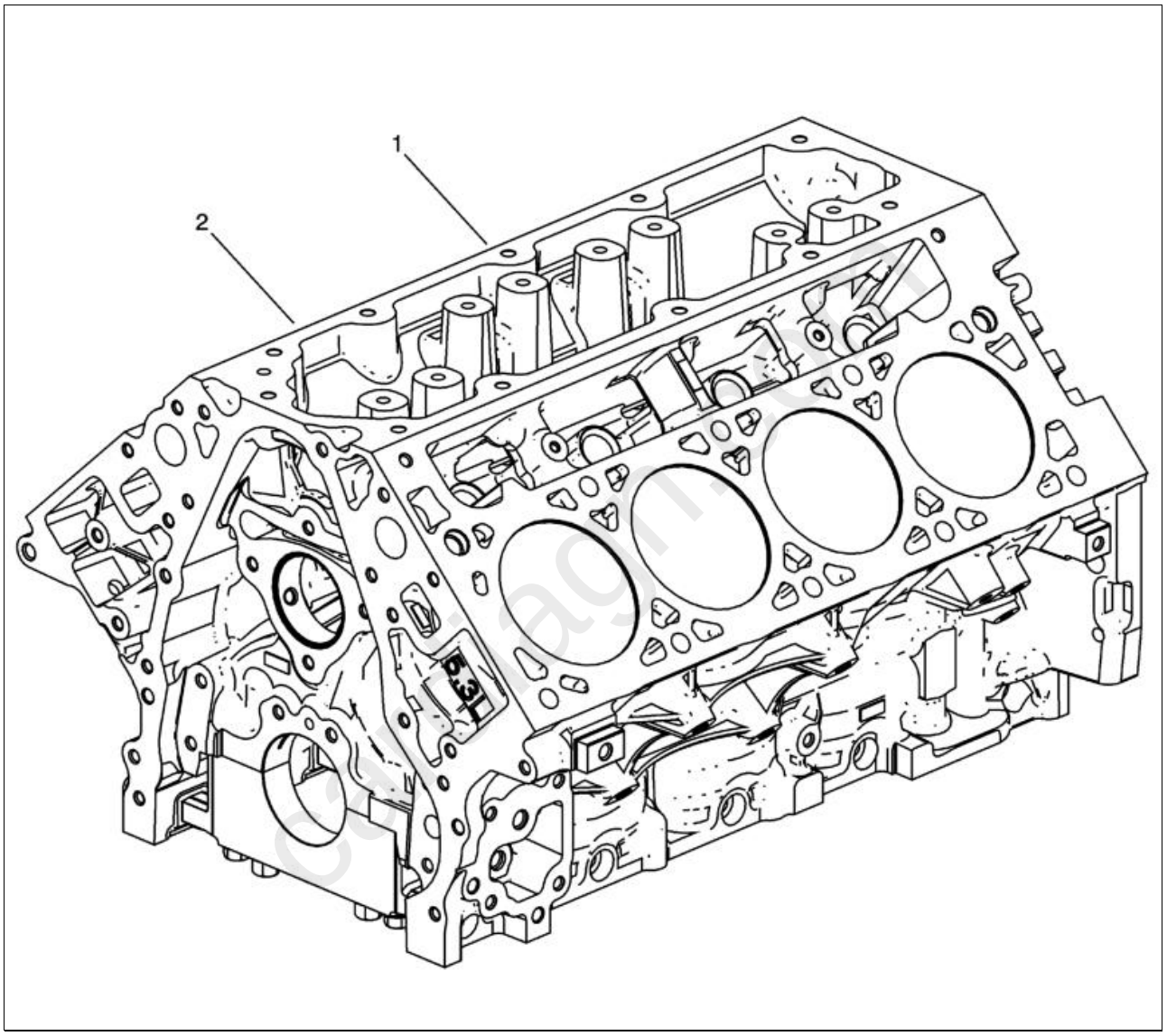
When operating in V4 mode, pressurized oil forces the locking pins (11) inward. The pushrod (7) remains in a constant position and does not travel upward and downward. The outer body of the lifter (9) moves upward and downward independently from the pin housing (10). The valve lifter spring (8) retains tension on the valve train components to eliminate valve train noise.

When the active fuel management system is commanded OFF, the ECM directs the solenoids of the oil

manifold to close, stopping the flow of pressurized oil to the valve lifters. The oil pressure within the lifter will decrease and the locking pins will move outward to mechanically lock the pin housing and outer body.

DESCRIPTION AND OPERATION > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION > ENGINE BLOCK

Fig 1: Engine Block



Courtesy of GENERAL MOTORS COMPANY

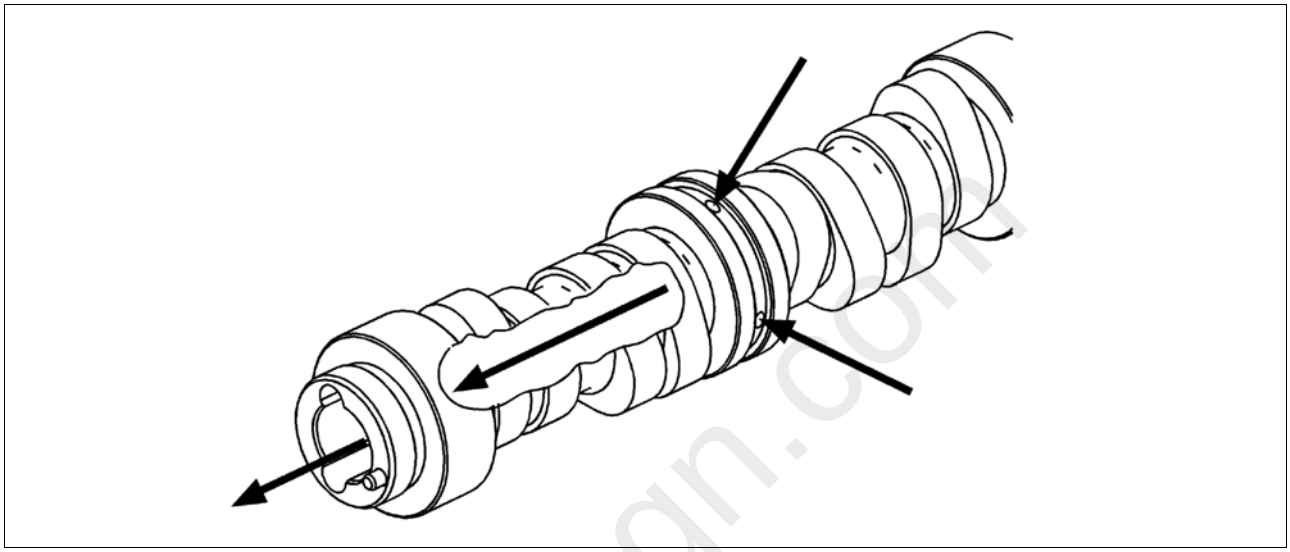
The active fuel management engine block incorporates additional features to support active fuel management system operation. Engine oil pressure is routed to the valve lifter oil manifold assembly from an oil gallery (2) in the front of the cylinder block. Cylinders 1, 4, 6, and 7 each have 2 vertical, cast-in-block oil passages (1). The vertical oil passages permit oil flow from the manifold assembly to the valve lifter bores.

DESCRIPTION AND OPERATION > CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION > ENGINE CONTROL MODULE (ECM)

Refer to Cylinder Deactivation (Active Fuel Management) System Description .

DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CAMSHAFT

Fig 1: Camshaft Lubrication Path



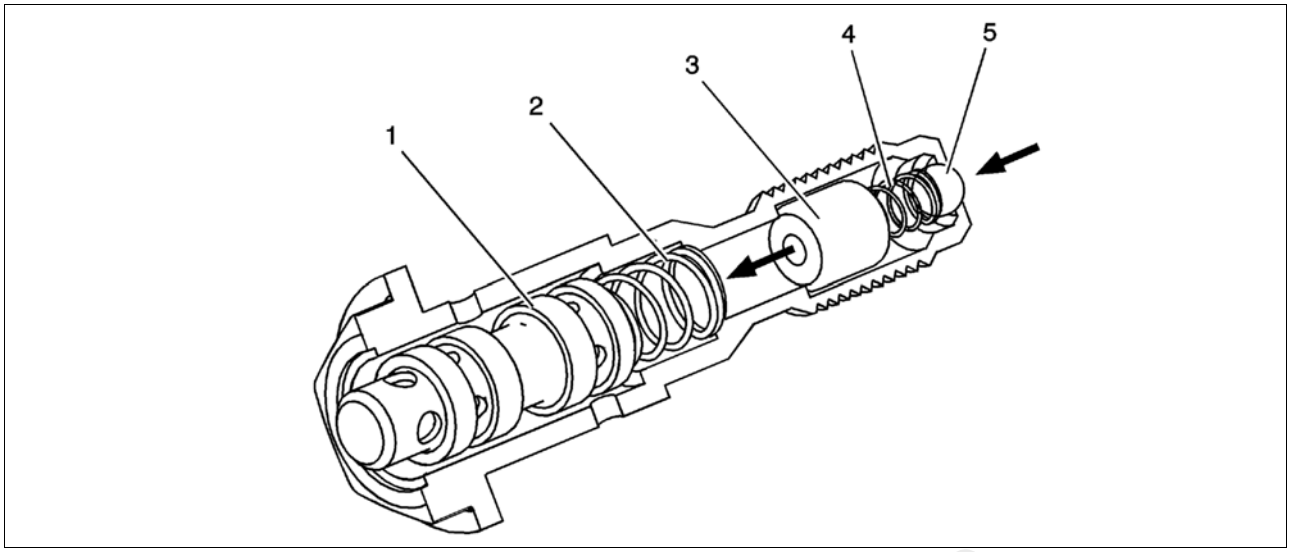
Courtesy of GENERAL MOTORS COMPANY

The camshaft is designed to provide a lubrication path for pressurized engine oil to flow to the camshaft position (CMP) actuator. Pressurized engine oil enters the camshaft at bearing journal location number 2. Oil travels through the camshaft, out the front, and into the CMP actuator solenoid valve.

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DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CMP ACTUATOR SOLENOID VALVE

Fig 1: CMP Actuator Solenoid Valve Components



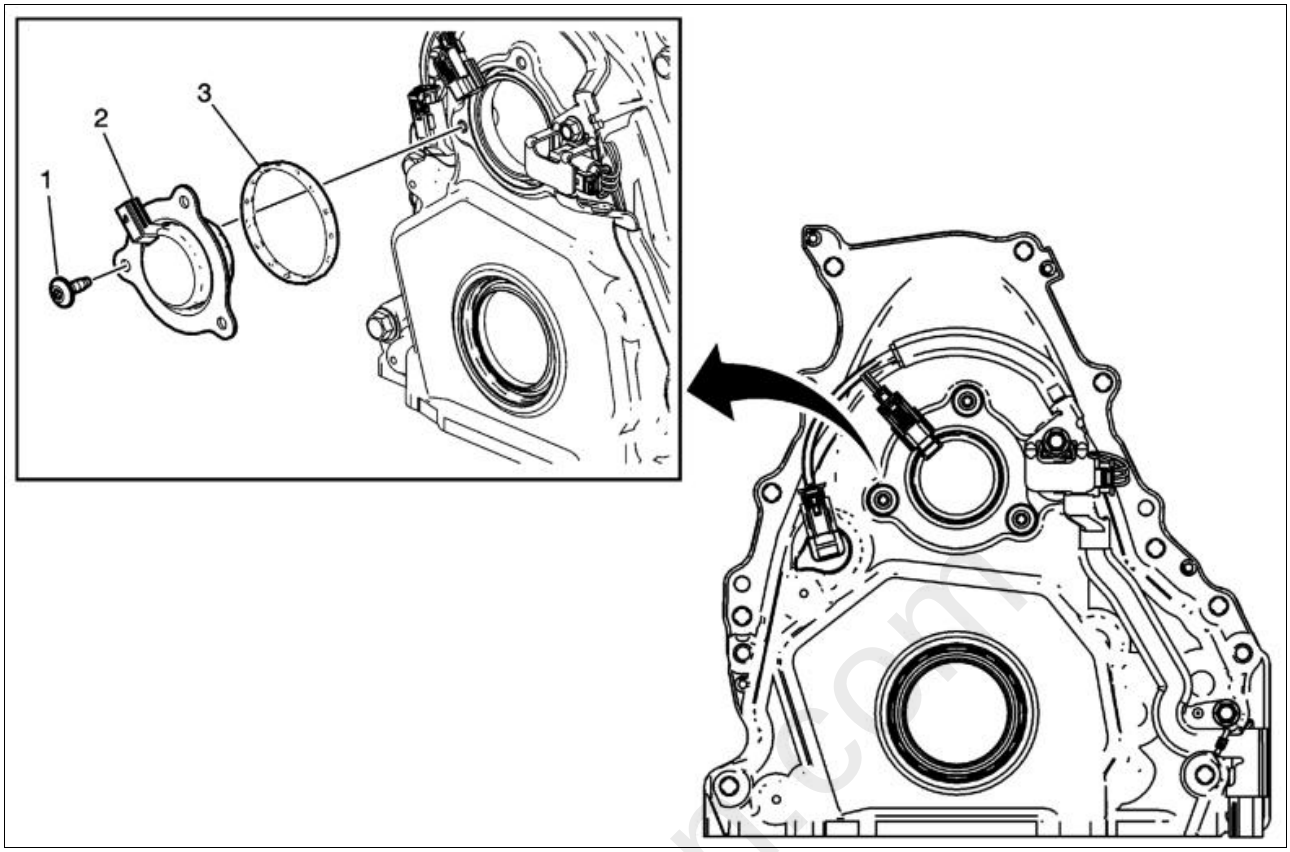
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The CMP actuator solenoid valve consists of a housing, spool valve (1), spool return spring (2), oil filter (3), inlet check ball return spring (4), and inlet check ball (5). Pressurized engine oil enters the valve and travels through the filter to the spool. Spool position is controlled by the CMP magnet and engine control module (ECM). When the spool is moved to the proper position, oil flow is directed through the valve and into the CMP actuator assembly. The CMP solenoid valve is a torque-to-yield design and should be replaced each time it is removed.

DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CMP ACTUATOR MAGNET

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Fig 1: CMP Actuator Magnet

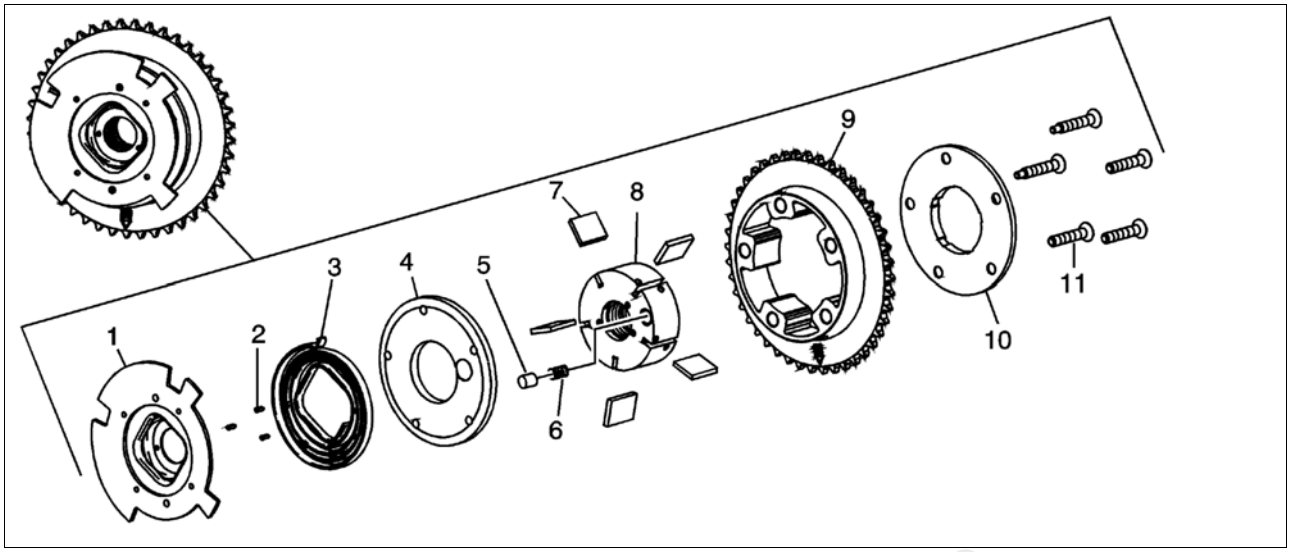


Courtesy of GENERAL MOTORS COMPANY

The CMP actuator magnet (2) is located in the engine front cover and is sealed by a press in place gasket (3). The CMP actuator magnet is controlled by a 12-volt 150 Hz pulse width 0-100 percent duty cycle signal from the ECM. When energized, the solenoid uses electromagnetic force on the magnet pintle to position the spool valve of the CMP solenoid valve.

DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CMP ACTUATOR

Fig 1: CMP Actuator Components



Courtesy of GENERAL MOTORS COMPANY

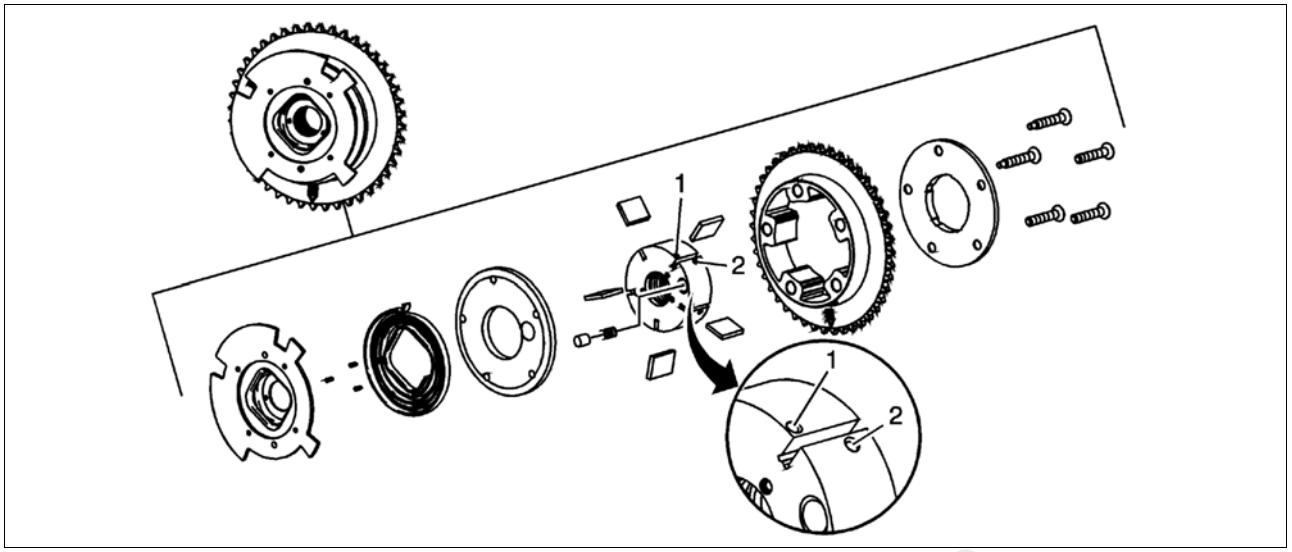
The CMP actuator is a vane type design that hydraulically changes angle or timing of the camshaft relative to crankshaft position. The CMP actuator allows earlier or later intake and exhaust valve opening during the 4-stroke engine cycle. The CMP actuator cannot vary the duration of valve opening or valve lift. The CMP actuator is to be serviced as an assembly. For system operation, refer to Camshaft Actuator System Description .

The CMP actuator consists of the CMP reluctor wheel (1), wheel retaining pins (2), return spring (3), front cover (4), park position pin (5), park position pin spring (6), vanes and vane springs (7), rotor (8), housing with chain sprocket (9), sealing cover/thrust plate (10), and bolts (11).

DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CMP SYSTEM OPERATION

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Fig 1: CMP Actuator



Courtesy of GENERAL MOTORS COMPANY

A CMP actuator dynamically changes valve timing events relative to piston timing by controlling camshaft position. This is sometimes referred to as variable valve timing or camshaft phasing. Variable valve timing or camshaft phasing does not change duration or lift.

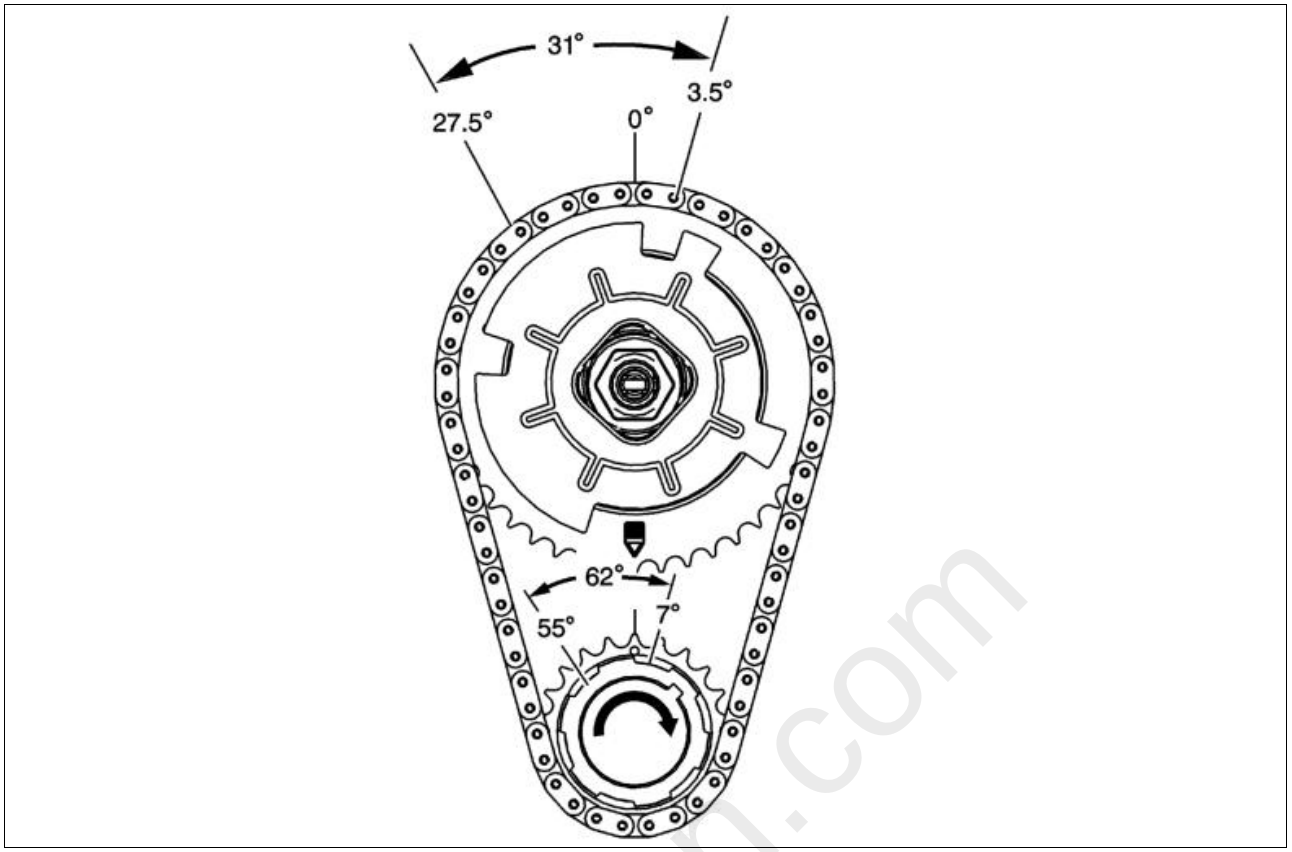
- By advancing camshaft timing, an improvement in low end torque can be achieved.
- By retarding camshaft timing slightly, an improvement in high end power can be achieved.
- By retarding camshaft timing significantly, an improvement in light load fuel economy can be achieved.

There are 5 cavities divided by vanes within the CMP actuator.

- When oil is directed to the advance cavities (1), the camshaft timing is advanced.
- When oil is directed to the retard cavities (2), the camshaft timing is retarded.
- When oil is directed to both cavities, the camshaft is held stationary.

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Fig 2: Degree Range Of Authority At Crankshaft



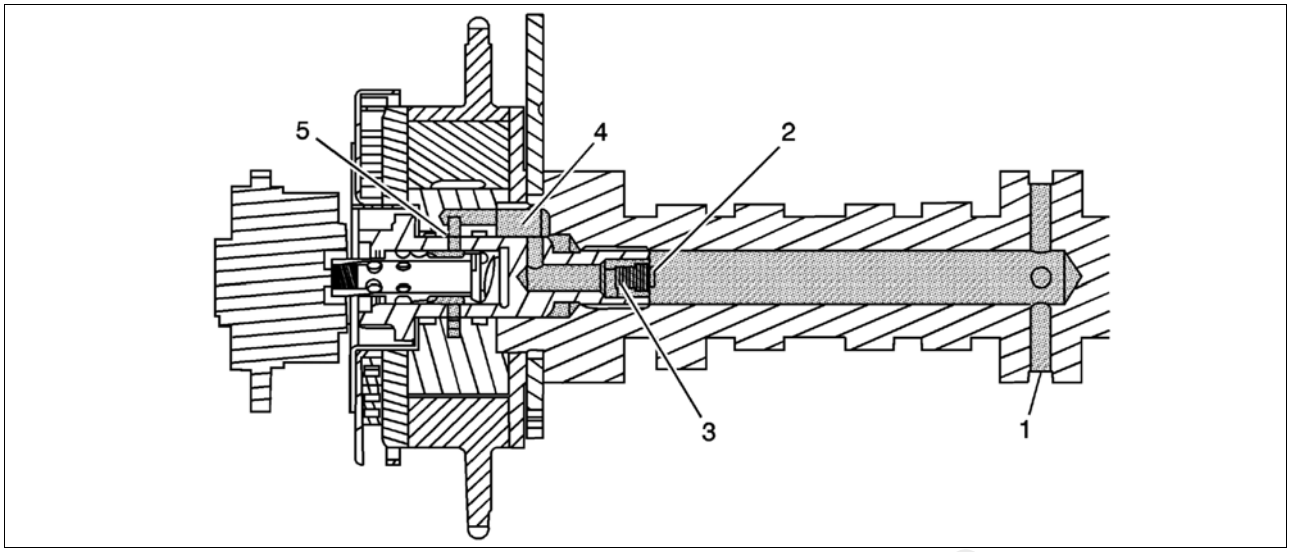
Courtesy of GENERAL MOTORS COMPANY

The CMP actuator has a 62 degree range of authority at the crankshaft (31 degrees at the camshaft). With the engine not running and no engine oil pressure to the CMP actuator, the high tension spring positions camshaft timing at the 7 degree advanced park position at the crankshaft (3.5 degrees at the camshaft). During normal engine operation, and based on performance requirements, the ECM may adjust camshaft timing, as required, within a range from 7 degrees advanced at the crankshaft (3.5 degrees at the camshaft) to 55 degrees retard at the crankshaft (27.5 degrees at the camshaft).

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DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CMP SYSTEM LUBRICATION FLOW AND ACTUATOR OPERATION

Fig 1: Cutaway View Of Actuator

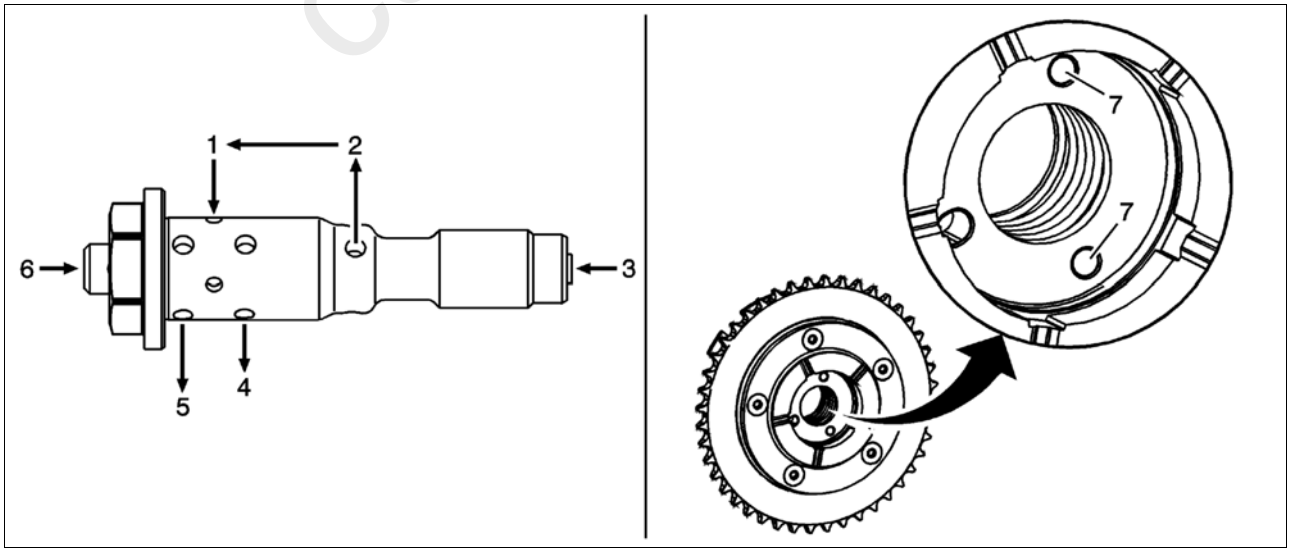


Courtesy of GENERAL MOTORS COMPANY

1. Oil enters the camshaft at the second main bearing journal (1).
2. Oil travels through the camshaft into the CMP actuator valve check ball (2) and filter (3).
3. Oil exits the valve and travels through the internal passages of the camshaft (4).
4. Oil exits the camshaft and enters the actuator oil entry ports.
5. Oil travels through the actuator and is directed back into the valve (5).
6. Valve spool position directs oil to the advance or retard passages of the actuator.

The valve may also, under certain conditions, be positioned in a neutral position with alternating low, balanced oil flow between the advance and retard passages of the actuator.

Fig 2: Actuator Passages



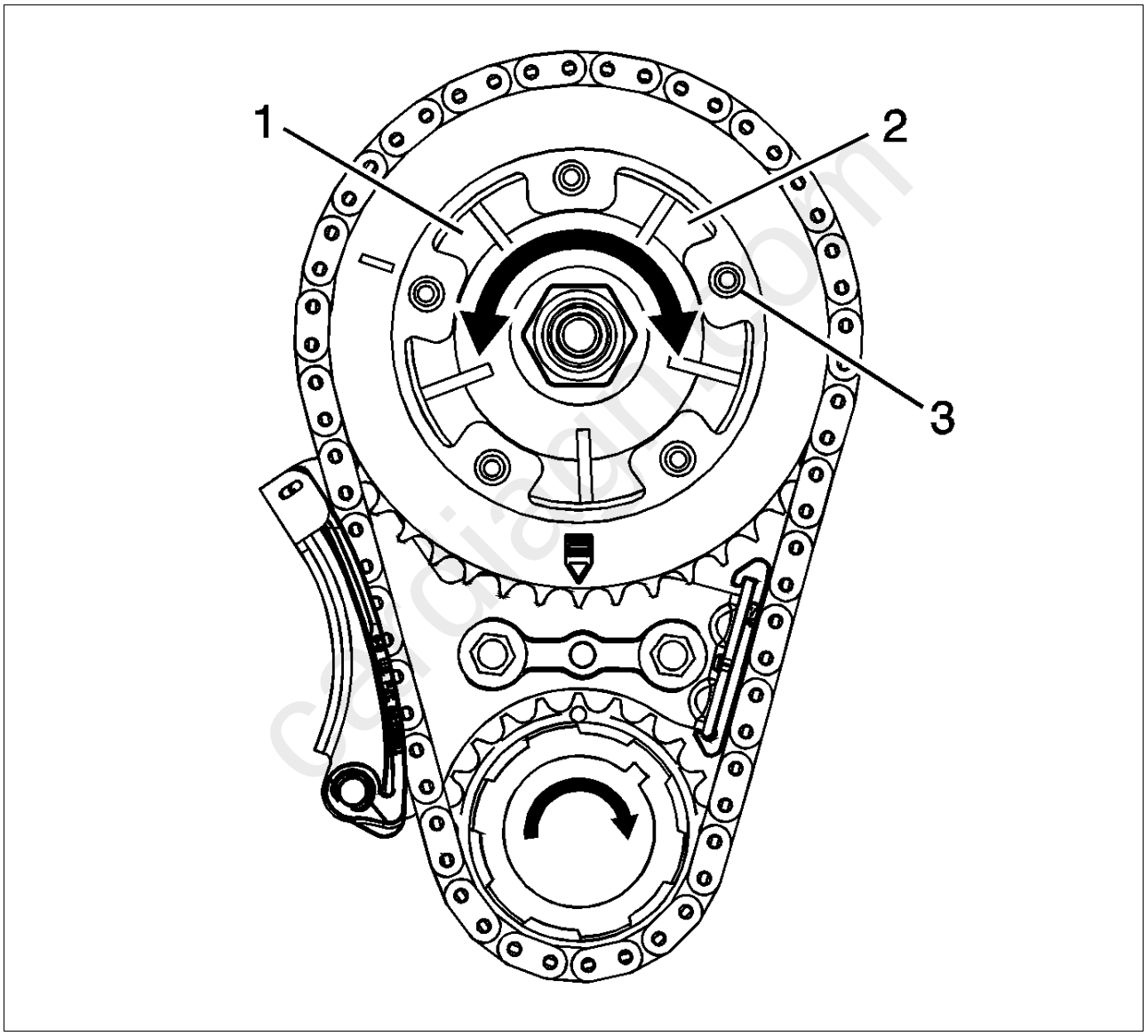
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1. Oil flows from the camshaft into the valve inlet (3) through the internal check ball and filter.
2. Oil exits the valve (2) and travels within the internal passages of the camshaft into the entry ports (7) of the actuator.
3. The center oil groove of the actuator is pressurized and oil reenters the valve (1).
4. Valve spool position directs oil out of the valve advance (5) or retard (4) ports to the actuator.

The valve may also, under certain conditions, be positioned in a neutral position with alternating low, balanced oil flow between the advance and retard passages of the actuator.

Fig 3: Advance And Retard Cavities



Courtesy of GENERAL MOTORS COMPANY

1. Pressurized oil enters the retard cavities (2) of the actuator and moves the park pin (3) from the locked position.
2. As pressure increases within the retard cavities (2), the rotor and camshaft rotate counter clockwise retarding valve timing.

3. As the duty cycle decreases, the spool is repositioned and oil is sent to the advance cavities (1), rotating the rotor and camshaft clockwise, advancing valve timing.

    1. With a 0 percent duty cycle signal to the magnet, the spool is positioned in the fully extended position and there is full flow to the advance cavities of the actuator. As duty cycle increases to near 50 percent, flow to the advance cavities is decreased.

    2. With a 50 percent duty cycle, the spool is positioned neutral, with no flow to either the advance and retard cavities.

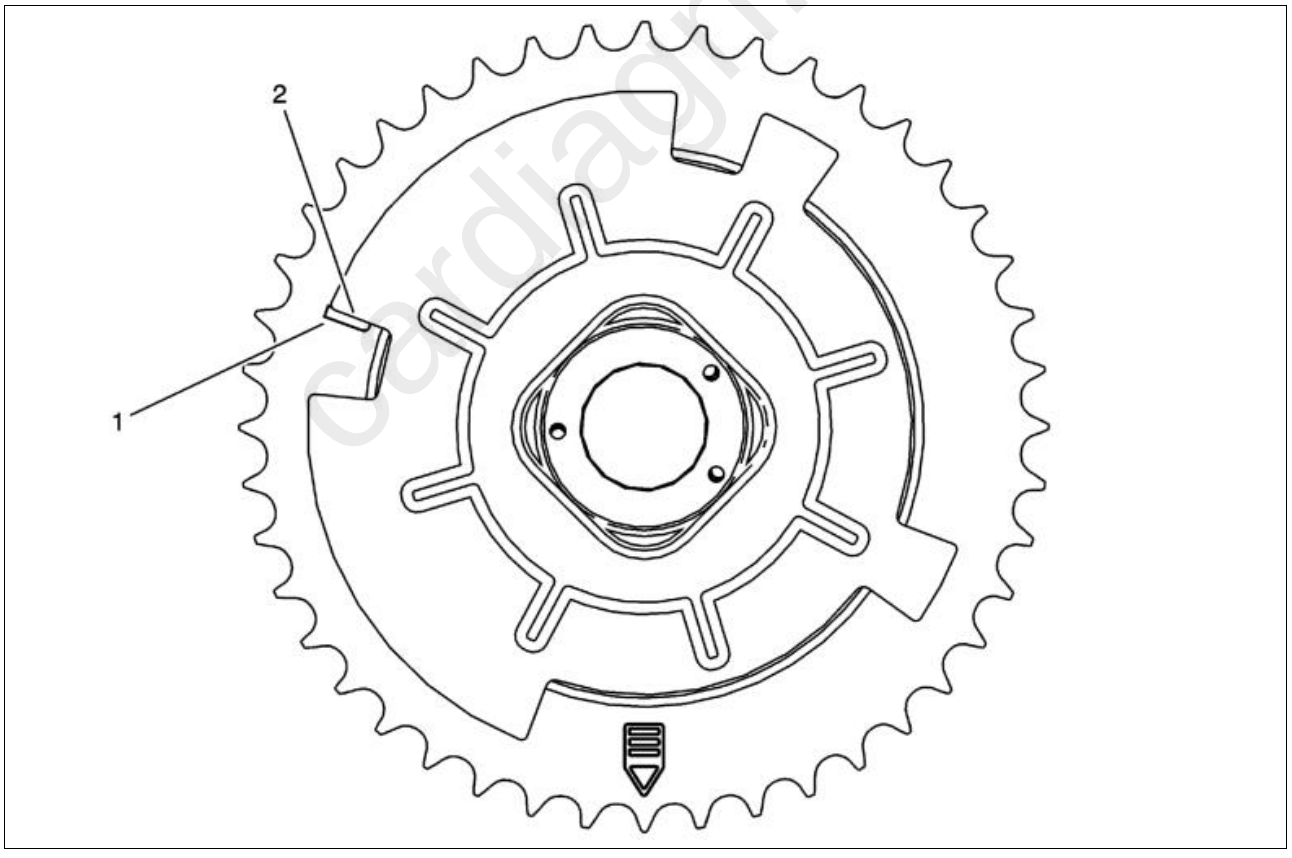
    3. With a 51-100 percent duty cycle, the spool is positioned to provide oil flow to retard cavities. As the duty cycle increases, the flow to retard cavities increases.

    4. With a 100 percent duty cycle, there is full flow to the retard cavities of the actuator.

    5. The above duty cycle percentage values are only a guideline, as the actual duty cycle values may vary based on engine oil temperature, solenoid magnet coil temperature, magnet coil resistance, and other specifics.

DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CMP ACTUATOR PARK POSITION VERIFICATION

Fig 1: CMP Actuator Park Position



Courtesy of GENERAL MOTORS COMPANY

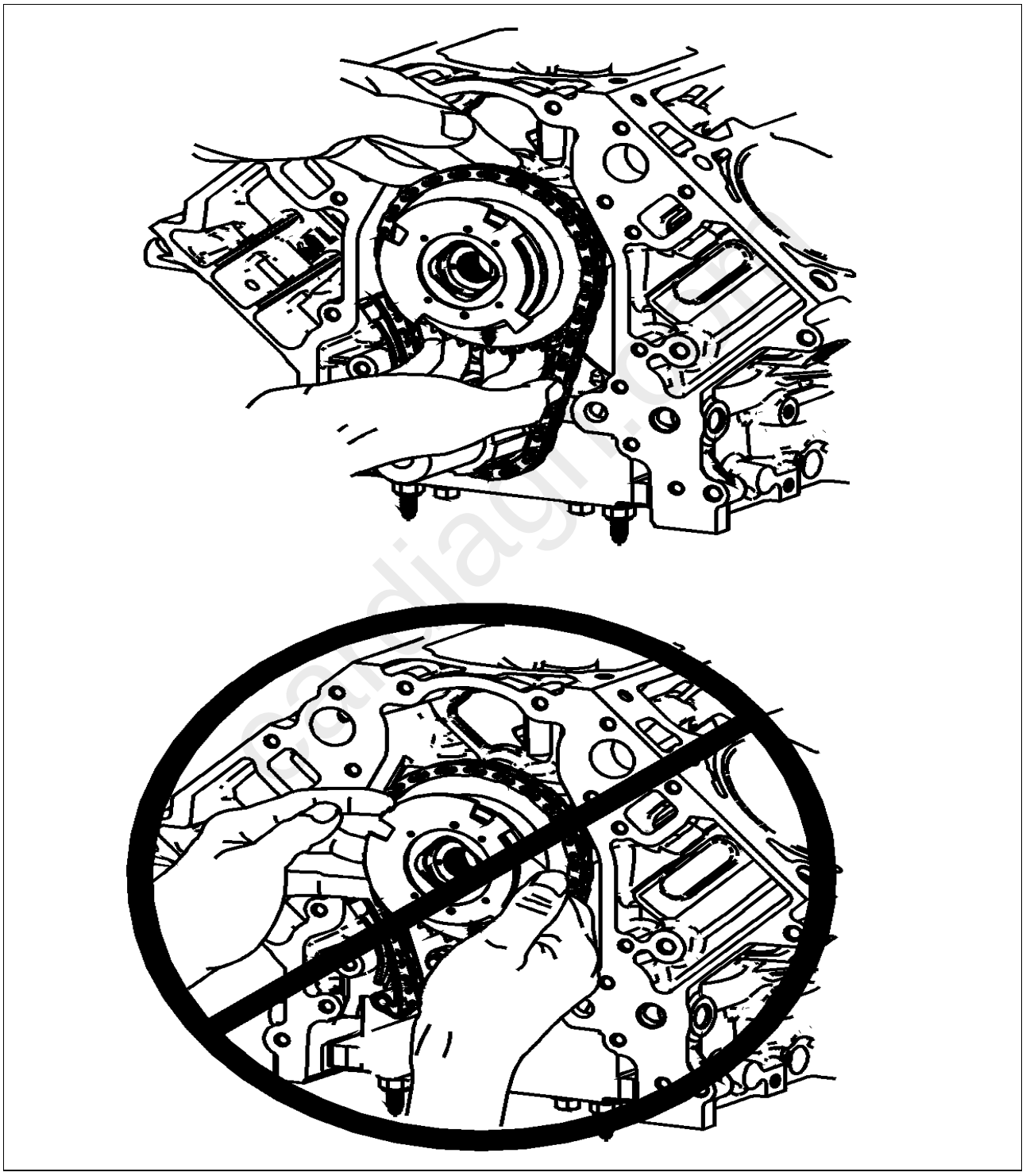
The CMP actuator can be visually inspected to determine if the tension spring has returned the reluctor wheel and rotor to the park position.

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With the reluctor wheel returned to the proper parked position, the edge of the notched area of the wheel (2) aligns with the marking (1) on the camshaft sprocket.

DESCRIPTION AND OPERATION > CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION > CMP ACTUATOR HANDLING SAFETY

Fig 1: Proper CMP Actuator Removal

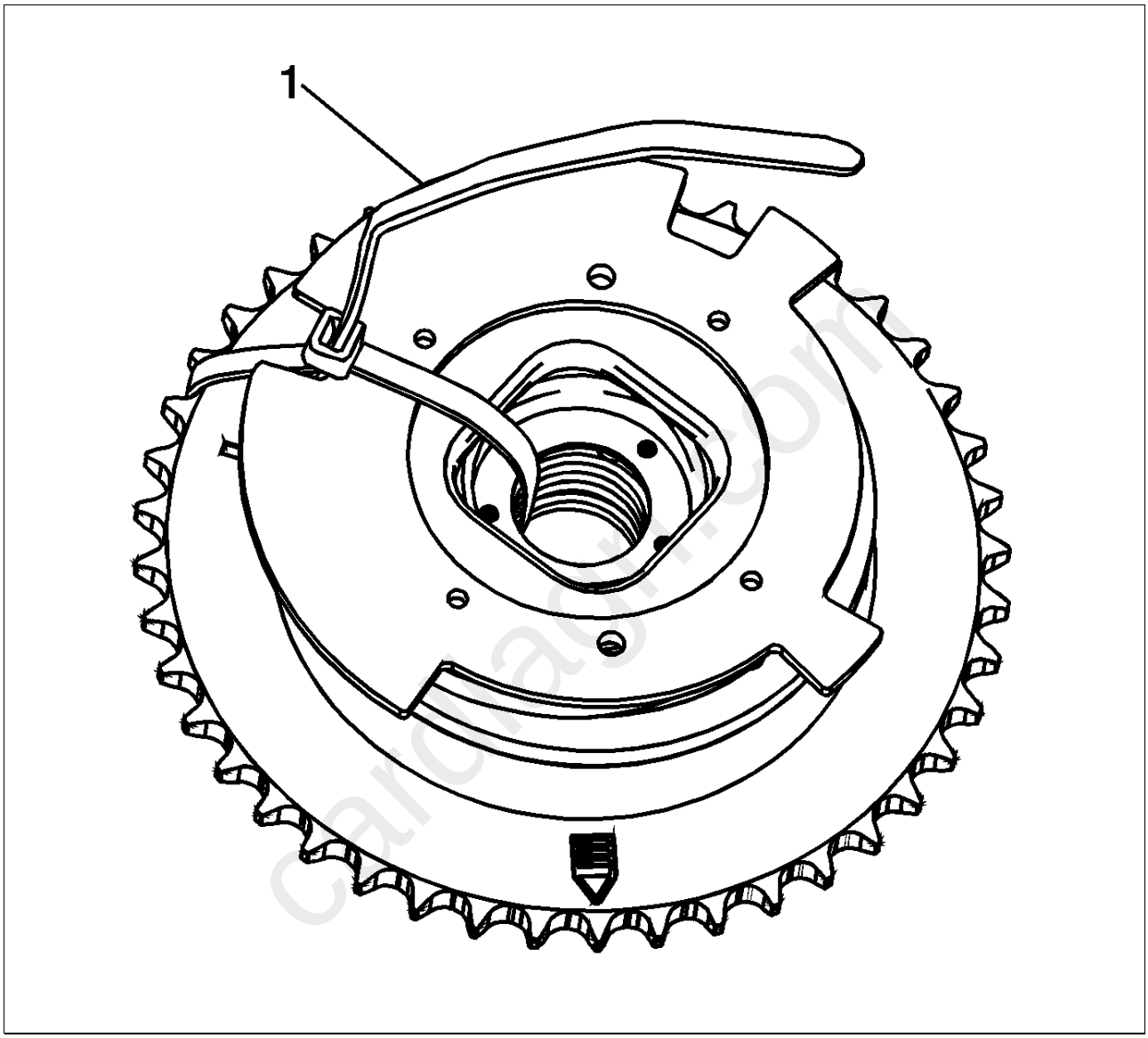


Courtesy of GENERAL MOTORS COMPANY

WARNING:

Refer to Camshaft Position Actuator Removal and Installation Warning .

Fig 2: Tie Strap Through Center Of Actuator



Courtesy of GENERAL MOTORS COMPANY

Install tie wrap (1) to retain the reluctor wheel to the sprocket. The reluctor wheel is mounted to the actuator body with 3 roll pins.

DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION

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

Changes may include 1 or more of the following items:

- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required
- A component comparison from the previous year

DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION > CHANGED ENGINE SPECIFICATIONS

A variety of specifications have been revised based on the new design of the LT1 engine. Refer to Engine Mechanical Specifications (LT1) .

DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION > TORQUE VALUES AND/OR FASTENER TIGHTENING STRATEGIES

- All fasteners and threaded holes on the LT1 engine utilize metric threads.
- Cylinder head, connecting rod, crankshaft balancer, camshaft sprocket, and main bearing cap bolts still apply a torque and angle tightening strategy.
- Certain fasteners should not be used again. Bolts, studs, or other fasteners that must be replaced, will be called out in the specific service procedure.

DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION > NEW SEALANTS AND/OR ADHESIVES

Sealers and adhesives, as required, are identified within the specific service procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers .

DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION > DISASSEMBLY AND ASSEMBLY PROCEDURE REVISIONS

A variety of procedures have been revised based on the new design LT1 engine.

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DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION > ENGINE MECHANICAL DIAGNOSTIC PROCEDURE REVISIONS

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

DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION > NEW SPECIAL TOOLS REQUIRED

A variety of new special tools are required for the new design LT1 engine. Refer to Special Tools .

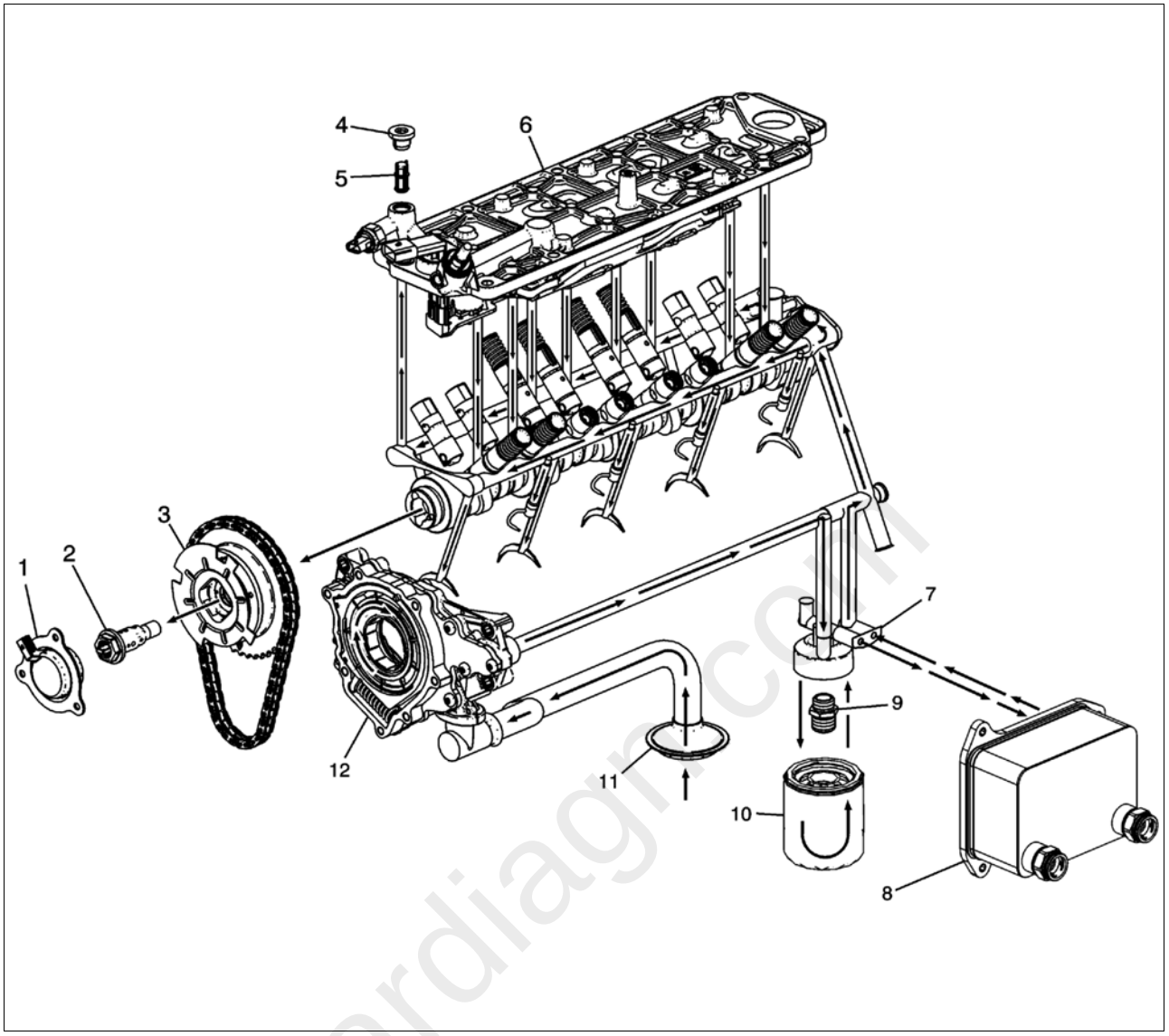
DESCRIPTION AND OPERATION > NEW PRODUCT INFORMATION > A COMPONENT COMPARISON FROM THE PREVIOUS YEAR

The 6.2L LS3 VIN W and the 6.2L L99 VIN J Gen engines are replaced by the 6.2L LT1 VIN 7 Gen 5 engine. Refer to Engine Component Description. Engine Component Description .

DESCRIPTION AND OPERATION > LUBRICATION DESCRIPTION

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Fig 1: Lubrication System



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Engine lubrication is supplied by a variable displacement two-stage vane-type oil pump assembly (12). An oil control solenoid valve, controlled by the engine control module (ECM), mounted to the oil pump provides two stage functionality. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump rotor and vanes rotate and draw oil from the oil pan sump through a pick-up screen and pipe (11). The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (10) where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted.

Oil exits the oil filter and is then directed to the external oil cooler (8). The external oil cooler is a liquid-to- liquid (engine coolant to oil) oil cooler and consists of an oil pan mounted core and coolant lines that connect the oil cooler to the engine cooling circuit. A bypass valve (7) is incorporated into the oil cooler assembly in the event oil flow within the cooler is restricted. Then the oil moves to the upper main oil galleries and the valve lifter manifold assembly (6). Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes

the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top front of the engine.

An oil passage at camshaft bearing location 2 permits oil flow into the center of the camshaft. Oil enters the camshaft exiting at the front and into the camshaft position (CMP) actuator solenoid valve (2). The CMP valve spool position is controlled by the engine control module (ECM) and CMP magnet (1). When commanded by the ECM, the CMP magnet repositions the CMP actuator solenoid valve spool directing pressurized oil into the CMP actuator to control valve timing. Refer to Camshaft Position Actuator and Solenoid Valve Description .

With active fuel management activated, the ECM commands the 4 solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7.

DESCRIPTION AND OPERATION > CLEANLINESS AND CARE

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice, even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for assembly. Refer to Separating Parts .
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

DESCRIPTION AND OPERATION > SEPARATING PARTS

IMPORTANT:

- *Many internal engine components will develop specific wear patterns on their friction surfaces.*
- *When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.*

Separate, mark, or organize the following components:

- Piston and the piston pin

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- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod location and orientation to the crankshaft journal
- Connecting rod to the bearing cap

  A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.
- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, lifter guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

DESCRIPTION AND OPERATION > REPLACING ENGINE GASKETS

Special Tools

J 28410 Gasket Remover

For equivalent regional tools, refer to Special Tools .

DESCRIPTION AND OPERATION > REPLACING ENGINE GASKETS > GASKET USE AND APPLYING SEALANTS

- Do not use any gasket again unless specified.
- Gaskets that can be used again will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

DESCRIPTION AND OPERATION > REPLACING ENGINE GASKETS > SEPARATING COMPONENTS

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

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DESCRIPTION AND OPERATION > REPLACING ENGINE GASKETS > CLEANING GASKET SURFACES

- Remove all gasket and sealing material from the part using the **J 28410** remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
    - These methods of cleaning can cause damage to the component sealing surfaces.
    - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
    - This grit is abrasive and has been known to cause internal engine damage.

DESCRIPTION AND OPERATION > REPLACING ENGINE GASKETS > ASSEMBLING COMPONENTS

> ⚠ *CAUTION:*
>
> *Refer to Sealant Caution .*

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Tighten bolts to specifications. Do not overtighten.

DESCRIPTION AND OPERATION > USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT > CLEANING MATING PART SURFACES FOR RTV JOINTS

RTV sealant depends greatly on adhesion to the mating parts in order to form and maintain a robust sealed joint. As with any adhesion system, proper surface preparation of the bonded parts is extremely important to ensure good adhesion over the life of the product.

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⚠ *CAUTION:*

When cleaning the sealing surfaces of engine components, DO NOT use bristle discs, abrasive pads, wire wheels or surface conditioning discs. These types of devices should not be used because they produce a very fine grit that is abrasive and known to cause internal engine damage. The bristle discs and pads are embedded with abrasive material and wear down as they clean, continually exposing fresh abrasive to the surface of the component.

Abrasive pads, wire wheels and bristle discs can remove enough metal to affect the engine front cover, cylinder head, engine block, oil pan rail, and intake manifold runner surface flatness, which can then result in engine coolant leaks, engine oil leaks and air leaks. It takes about 15 seconds to remove 0.203 mm (0.008 in) of metal with an abrasive pad.

Abrasive pads, wire wheels and bristle discs used with high speed grinders produce airborne debris that can travel throughout the shop contaminating other work being performed outside of the immediate work area.

When cleaning engine gasket sealing surfaces and/or cleaning parts from an engine that are to be reused, surface conditioning discs, typically constructed of woven fiber or molded bristles that contain abrasives, such as a high amount of aluminum oxide, should NOT be used. The use of such surface conditioning discs dislodges aluminum oxide from the disk and metal component particles, which can lead to premature engine bearing failure. The presence of aluminum oxide in engine oil has been shown to cause premature engine bearing failure. In some cases, this failure occurs in as little as 1, 600 km (1, 000 mi) or less after the repair has been made.

Surface conditioning discs may grind the component material and embed it into the disc. This can result when more aggressive grinding of the gasket surface takes place.

General Motors strongly recommends using a plastic razor blade, plastic gasket scraper, a wood scraper or a non-metallic scraper to remove all sealer/gasket material on the surface of engine components that are to be reused. Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not gouge or scratch any engine sealing surface during the cleaning process.
- It is not necessary to remove every speck of the old sealer.

To remove the old RTV sealant from the sealing surface, spray GM Low VOC Cleaner or an equivalent, on the mating surfaces and allow it to soak to loosen the old gasket material. Use care to avoid getting GM Low VOC Cleaner in any area other than the mating surface to be cleaned.

Use a plastic razor blade, that mounts in a scraper device or a hand held plastic razor blade, to remove old RTV sealant from a sealing surface. Use a new blade for each corresponding engine component surface. Hold the blade as parallel to the flat surface as possible.

To properly clean the sealing surfaces prior to reassembly, spray GM Low VOC Cleaner on a folded lint free shop cloth. Wipe the mating surfaces on the engine and front cover and rotate the shop cloth until there are no more visible signs of contamination on the cloth.

After the final cleaning of the parts, allow up to 5 minutes for the components to dry before applying new RTV sealant.

NOTE:

After the final cleaning with GM Low VOC Cleaner and before reassembly, DO NOT touch the cleaned surfaces with your hand. Oils from your skin WILL CONTAMINATE the surface and prevent proper bonding of the new RTV sealant.

DESCRIPTION AND OPERATION > USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT > TYPICAL APPLICATIONS

This procedure is intended for use in the following operations:

- Building of engines in a manual low volume build process where the use of assembly lubricants and other typical conditions exist which may contaminate the component sealing surfaces in an RTV joint.
- Cleaning of surfaces contaminated with oil or other substance during the assembly operation as a special case event.

In the typical situation, both the part being assembled, and the assembly to which it is to be sealed will be cleaned. An example is an oil pan assembled to a block/front cover/rear cover assembly using an RTV seal applied to the pan or the block. Both the pan and the block assembly should be cleaned prior to RTV application.

Any loose gaskets that are part of the RTV joint should not be cleaned unless it is known that they have been contaminated during the build process. Examples of loose gaskets are intake side and end seals which contact RTV used to seal a T-joint.

Assemblies supplied to GM with gaskets in place should not be cleaned unless they are known to be contaminated during the build process. Examples are rocker/cam covers with press in place gaskets using RTV at corners or T-joints.

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DESCRIPTION AND OPERATION > USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT > MATERIALS NEEDED

Use clean dry lint free cloths to wipe surface with approved solvent based cleaner. Examples are:

- GM Good Wrench Service Low VOC Brake Parts Cleaner
- AC Delco Non-Chlorinated Brake Parts Cleaner
- Loctite ODC -Free Cleaner & Degreaser

Procedure:

1. Identify the surfaces to which the RTV will come into contact in the assembled joint.
2. Using an approved solvent based cleaner, thoroughly soak an appropriate portion of a clean, dry cloth. Immediately wipe the surfaces with the cloth to remove any residue of oil, soap, etc.

3. Repeat step 2 using a clean portion of the cloth as many times as required until the cleanliness of the cloth after wiping the surface becomes constant in appearance. There is typically some discoloration of the cloth after wiping however a clean surface should produce the same level of discoloration with successive wiping with a clean cloth and solvent.
4. If crevices exist in the joint such that wiping the surface would not be sufficient to clean the crevice, the approved solvent based cleaner should be directly sprayed on the joint to ensure wetting of the surfaces and removal of the contaminant. DO NOT spray rubber components directly. Care must be used to avoid getting solvent in areas other than necessary to clean the joint. Then continue with step 3.
5. Allow the surfaces to dry for a minimum of 1 minute or longer if necessary for the solvent to evaporate from the surface.
6. Do not touch the cleaned surface with anything prior to RTV application.
7. The surface is now prepared for RTV application.

DESCRIPTION AND OPERATION > USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT > SEALANT TYPES

NOTE:

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 two major types of sealant are commonly used in engines:

- Room Temperature Vulcanizing (RTV)
- Anaerobic sealant, which include the following:
    - Gasket Eliminator
    - Pipe Sealant
    - Threadlock

Room Temperature Vulcanizing (RTV) Sealer

This type of sealant is used where two 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

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    - Any other surfaces where a different type of sealant is specified in the service procedure

- Do not use RTV sealant unless the ambient air temperature is at least 18°C (65°F) degrees or higher.
- 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.

> ⚠ *CAUTION:*
>
> *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.*

> 📌 *NOTE:*
>
> *The bead size is critical and is easier to maintain consistency and application with a RTV dispensing tool. This also helps to eliminate waste.*

- 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.

> 📌 *NOTE:*
>
> *Do not wait for the RTV sealant to skin over.*

- Assemble the components while the RTV sealant is still wet to the touch, within 10 minutes.

> 📌 *NOTE:*
>
> *Do not overtighten the fasteners.*

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

Anaerobic Type Gasket Eliminator Sealant

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

> ⚠ *CAUTION:*
>
> *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.*

- Do not allow the gasket eliminator sealed joint to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.
- 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 two 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.

> *NOTE:*
>
> - *Do not allow the threadlock sealant to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.*

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- *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 two 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.

> ⚠ *CAUTION:*
>
> *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.

> *NOTE:*
>
> *Do not overtighten the fasteners.*

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

DESCRIPTION AND OPERATION > TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of

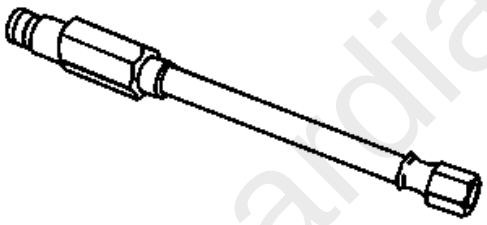
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various fasteners.

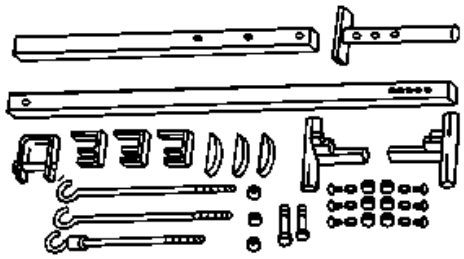
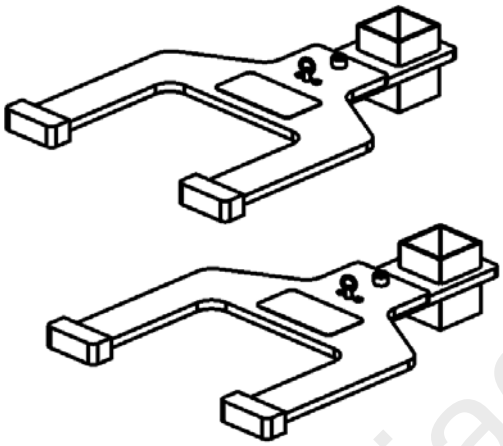
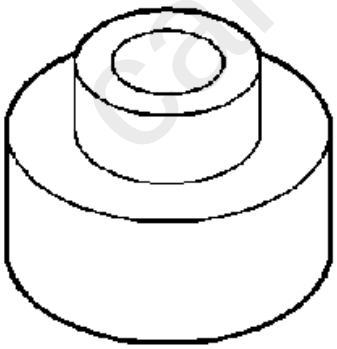
To properly service the engine assembly, the following items should be readily available:

- 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

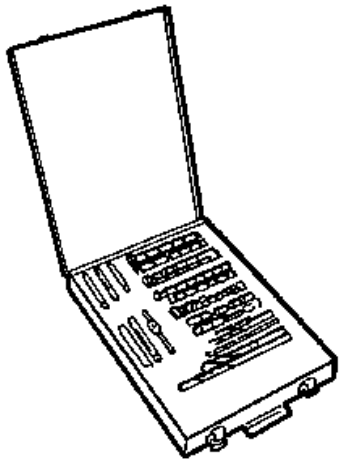
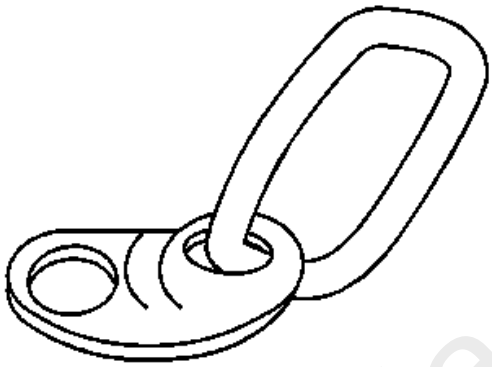
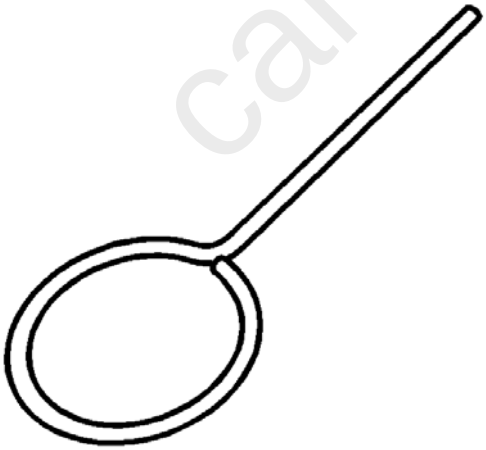
SPECIAL TOOLS AND EQUIPMENT > SPECIAL TOOLS

Illustration	Tool Number/Description
	EN-22794 J-22794 Spark Plug Port Adapter

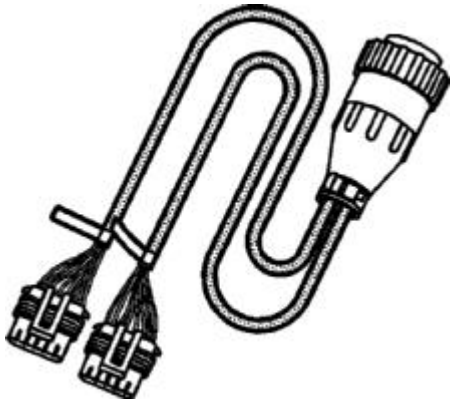
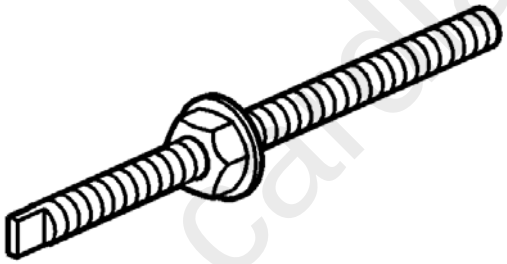
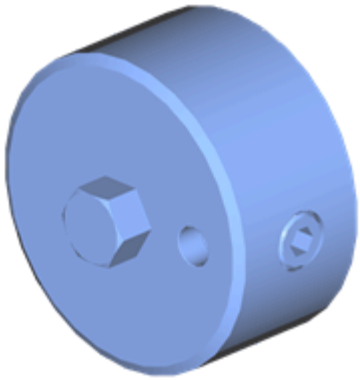
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	EN-28467-B J-28467-B Universal Engine Support Fixture
	EN-28467-40 J-28467-40 Engine Support Fixture Feet
	EN-41816-2 J-41816-2 Crankshaft End Protector

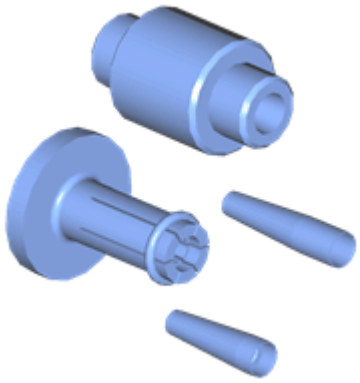
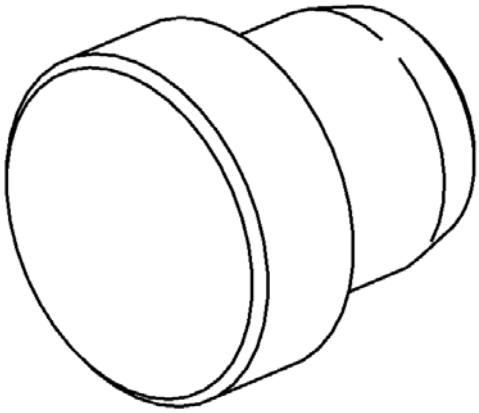
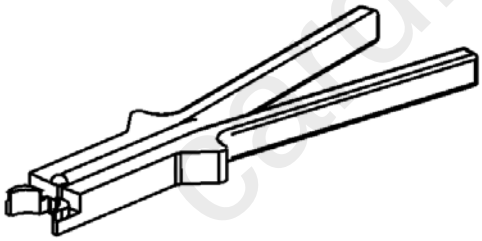
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	EN-42385-50 Head/Main Bolt Thread Repair Kit
	EN-42451-1 J-42451-1 Engine Support Adapter
	EN-46330 Timing Belt Tensioner Retaining Pin

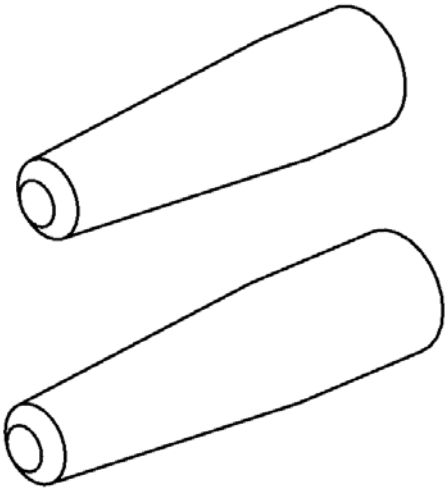
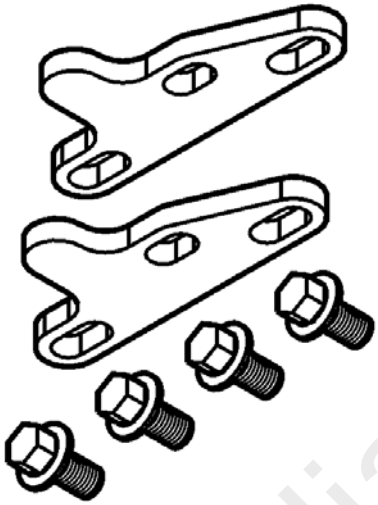
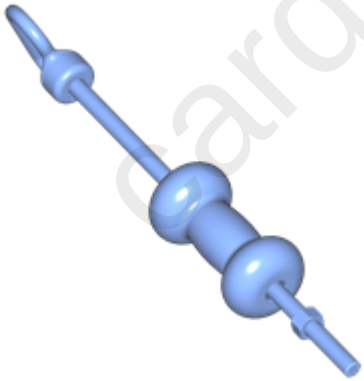
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	EN-46999-18 Active Fuel Management Tester Air Adapter
	EN-46999-20 Active Fuel Management Tester Harness - Small Block V8
	EN-47812 Installer Bolt
	EN-47971 Oil Pressure Gauge Adapter

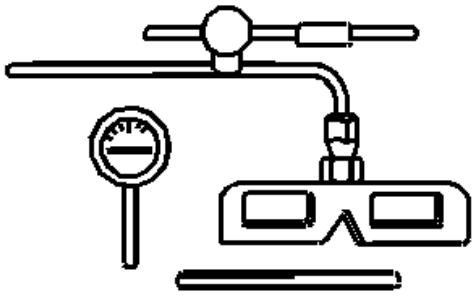
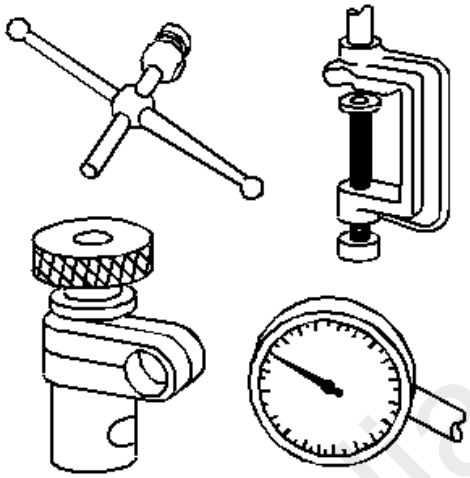
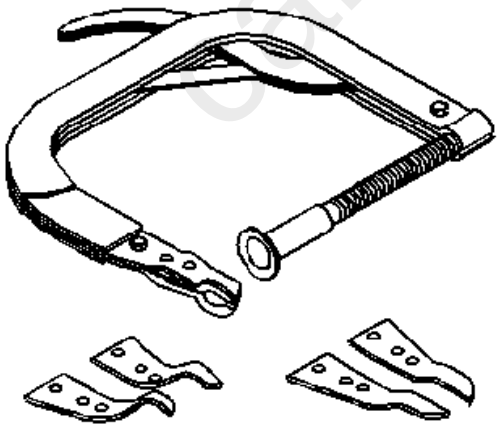
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	EN-49245 Fuel Injection Seal Installer Sizer
	EN-51092 Fuel Pump Installation Guage
	EN-51097 Injector Retaining Clip Installer

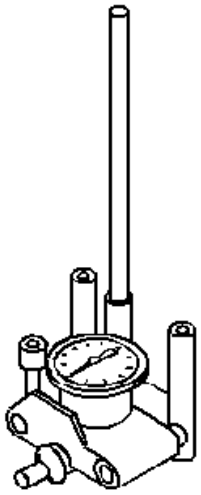
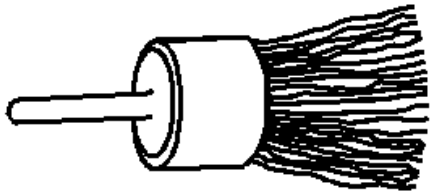
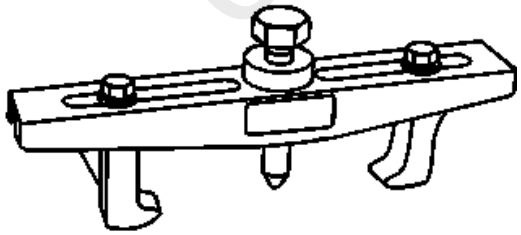
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	EN-51105 Injector Seal Installer and Sizer
	EN-51267 Oil Pump Alignment Tool
	GE-02619-A J-02619-A Slide Hammer
	GE-6125-1B J-6125-1B Slide Hammer with Adapter

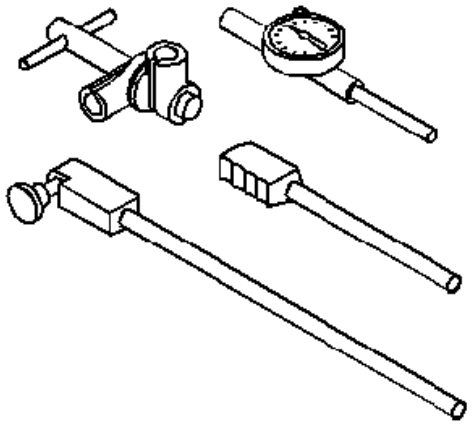
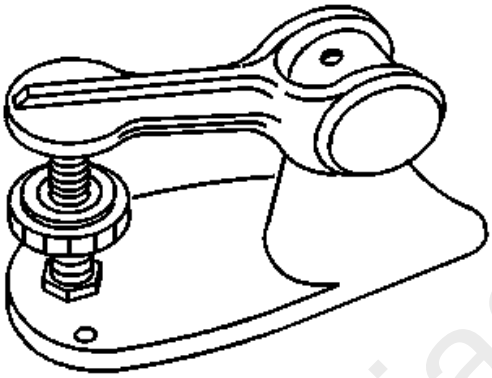
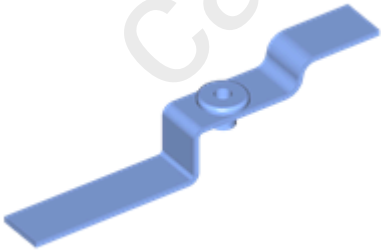
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	GE-7872 J-7872 Magnetic Base Dial Indicator Set
	GE-8001 J-8001 Dial Indicator Set
	EN-8062 J-8062 Valve Spring Compressor- Head Off

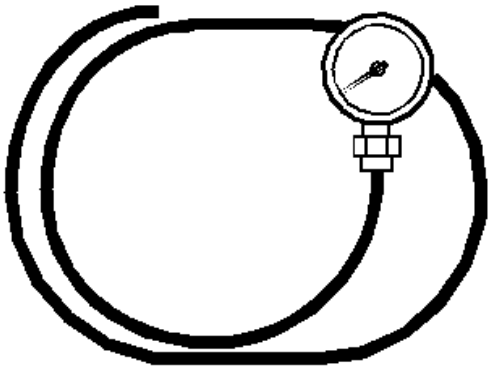
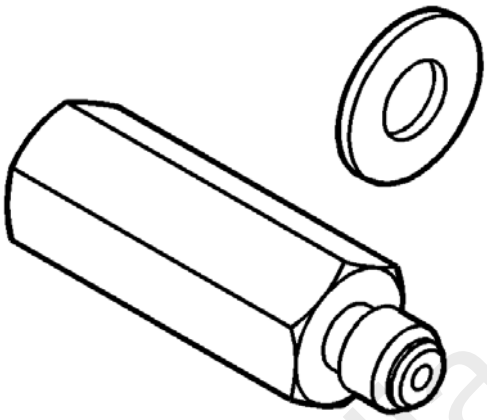
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	EN-8087 J-8087 Cylinder Bore Gauge
	EN-8089 J-8089 Carbon Removal Brush
	GE-8433 J-8433 Two Jaw Puller

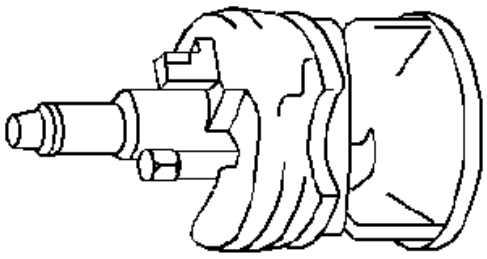
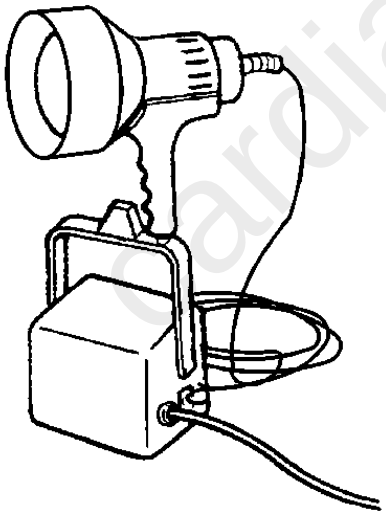
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	EN-8520 J-8520 Cam Lobe Lift Indicator
	EN-22738-B J-9666 Valve Spring Tester
	DT-21366 J-21366 Converter Holding Strap

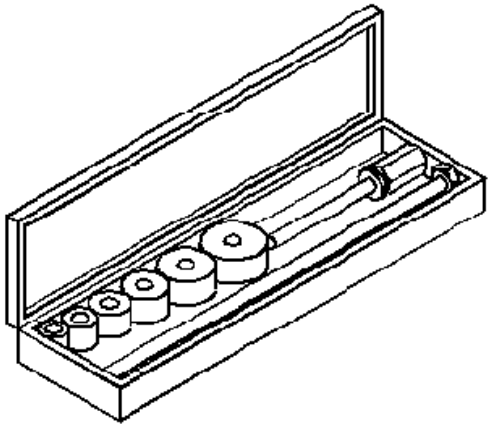
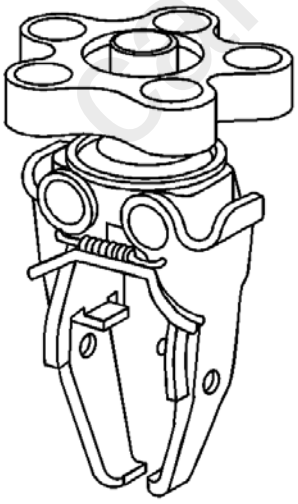
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	GE-21867-A J-21867-A Pressure Gauge
	J-21867-850 Oil Pressure Adapter
	GE-2307-1 J-23907-1 Slide Hammer with Bearing Adapter

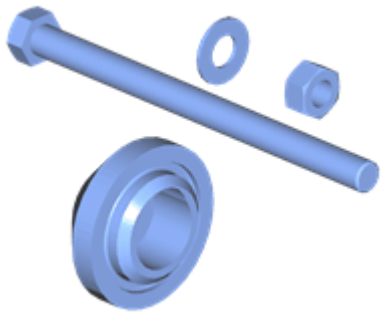
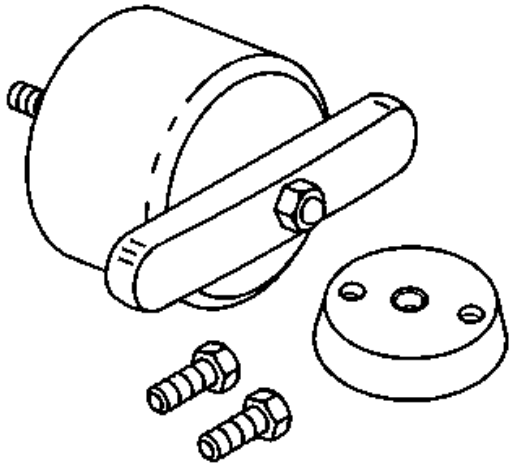
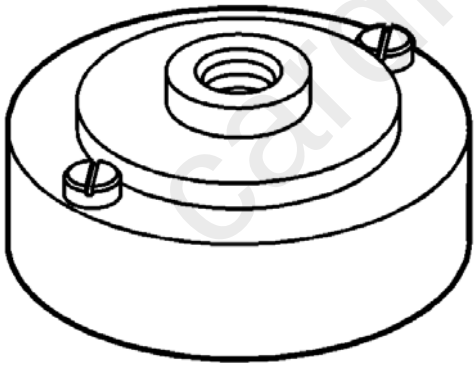
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	EN-24270 J-24270 Cylinder Bore Ridge Reamer
	EN-28410 J-28410 Gasket Remover
	GE-42220 J-28428-E High-Intensity Black Light Kit

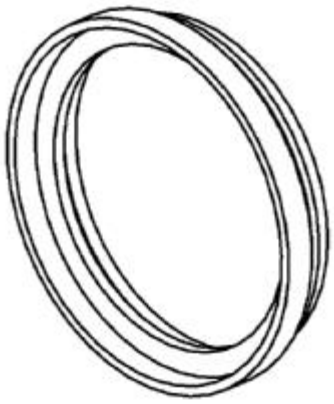
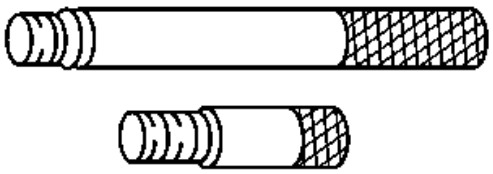
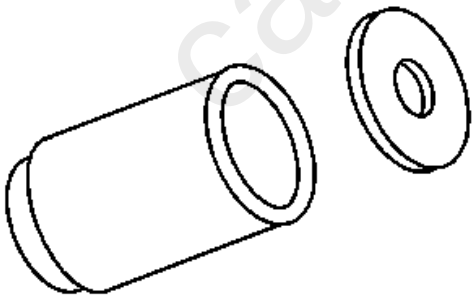
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	EN-33049 J-33049 Camshaft Bearing Service Set
	EN-35667-A J-35667-A Cylinder Head Leakdown Tester
	EN-38606 J-38606 Valve Spring Compressor

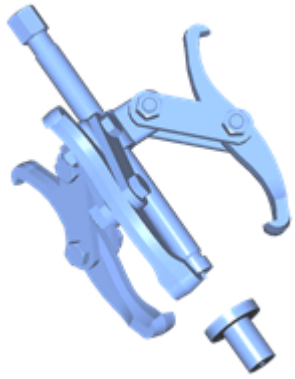
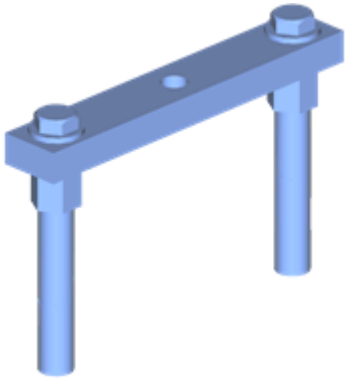
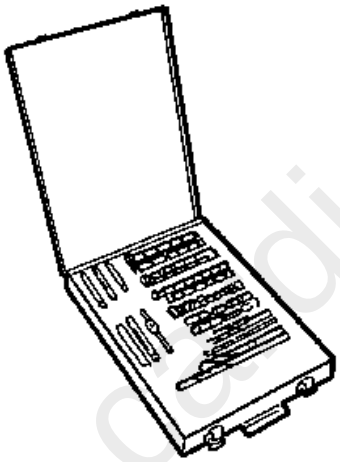
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	EN-41478-A Crankshaft Front Oil Seal Installer
	EN-41479-B J-41479-B Crankshaft Rear Oil Seal Installer
	EN-41479-2A J-41479-2A Crankshaft Rear Oil Seal Installation Guide

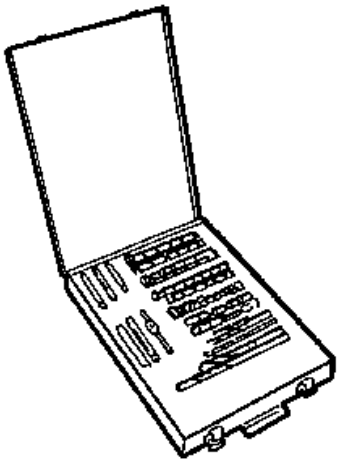
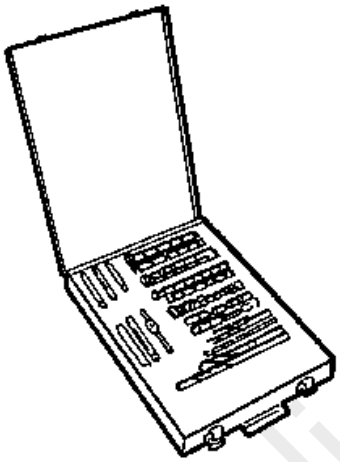
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	EN-41479-10 J-41479-10 Crankshaft Rear Oil Seal Installer Adapter
	EN-41556 J-41556 Connecting Rod Guide
	EN-41665-A J-41665-A J-41665 Crankshaft Balancer and Sprocket Installer

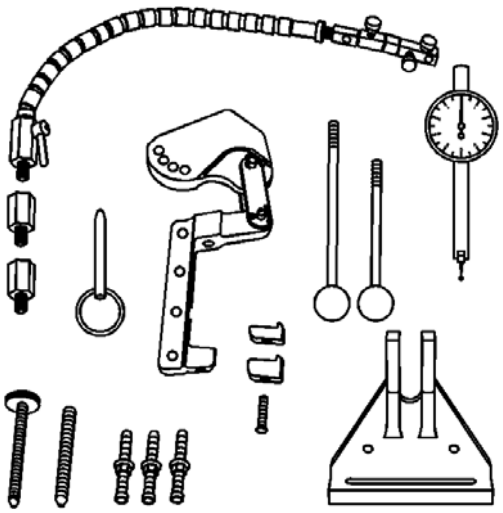
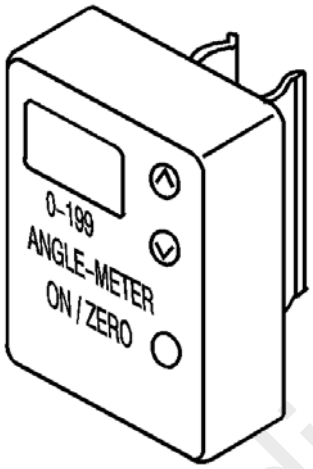
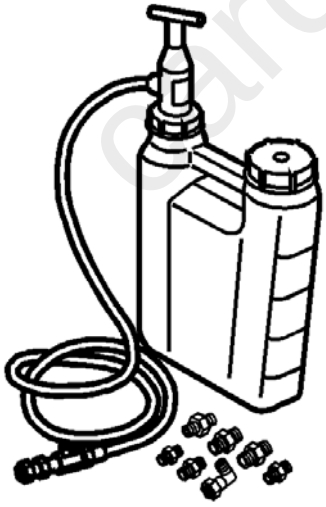
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	EN-41816 J-41816 Crankshaft Balancer Remover
	EN-49102 J-41818 Crankshaft Bearing Cap Remover
	EN-42385-100 J-42385-100 Head/Main Bolt Thread Repair Kit

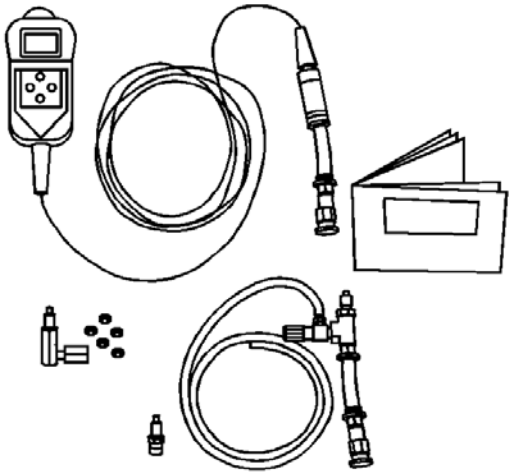
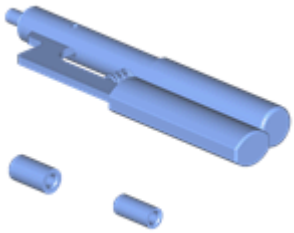
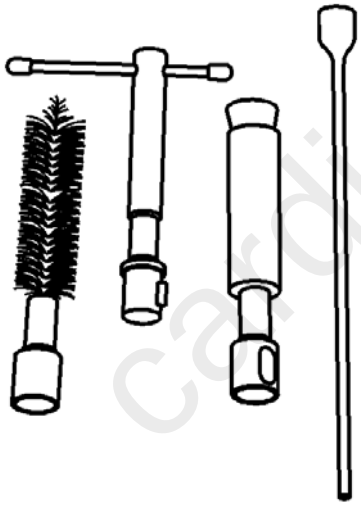
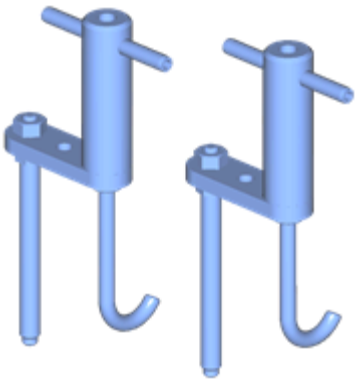
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	EN-42385-200 J-42385-200 Common Thread Repair Kit
	EN-42385-300 J-42385-300 Fixtures and Hardware Kit
	EN-42386-A J-42386-A Flywheel Holding Tool

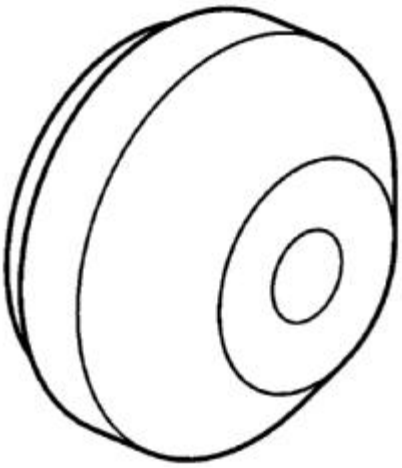
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	EN-43690-A J-43690-A Rod Bearing Clearance Checking Tool
	EN-45059 J-45059 Angle Meter
	EN-45299 J-45299 Engine Preluber

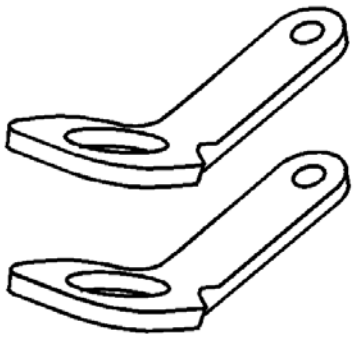
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	CH-48027 Digital Pressure Gauge
	EN-46745 J-46354 Piston Pin Clip Remover/Installer
	EN-47909 Injector Bore and Sleeve Cleaning Kit
	EN-49248 Injector Rail Assembly Remover

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	EN-51091 Crankshaft Front Oil Seal Installer
	EN-51096 Rear Main Seal Remover
	EN-36857 J-36857 Engine Lift Bracket

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	J-41803-9 Engine Lift Hooks

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