PRODEMAND

YMMS: 2016 Cadillac ATS V
Engine: 3.6L Eng
VIN:

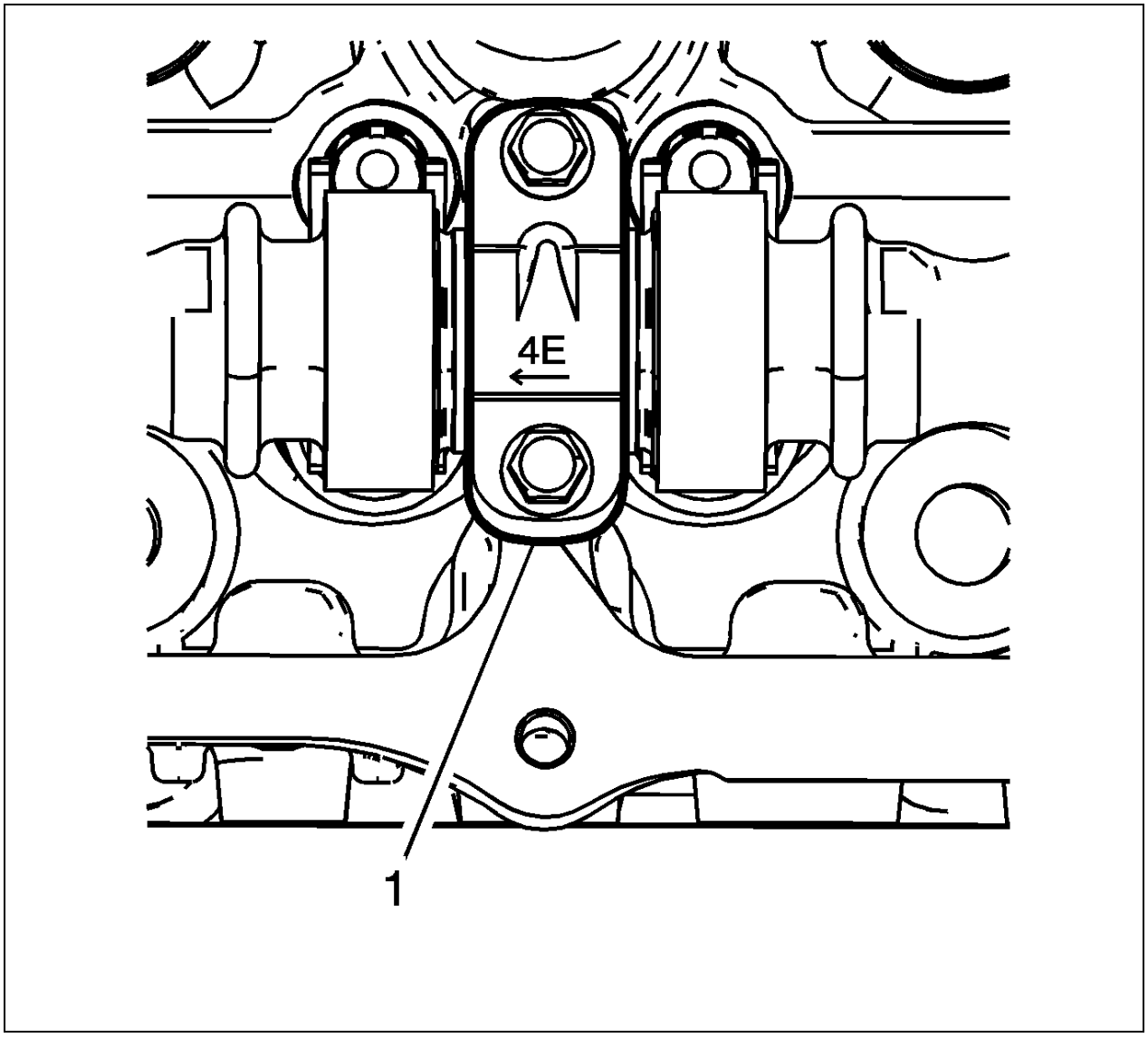
Apr 30, 2020
License:
Odometer:

Camshaft Replacement - Left Side (LF4)

Removal Procedure

1. Remove the fuel pump. Refer to Fuel Pump Replacement (LF4) .
2. Remove the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 2 (LF4).
3. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:

   Fig 1: Bearing Caps

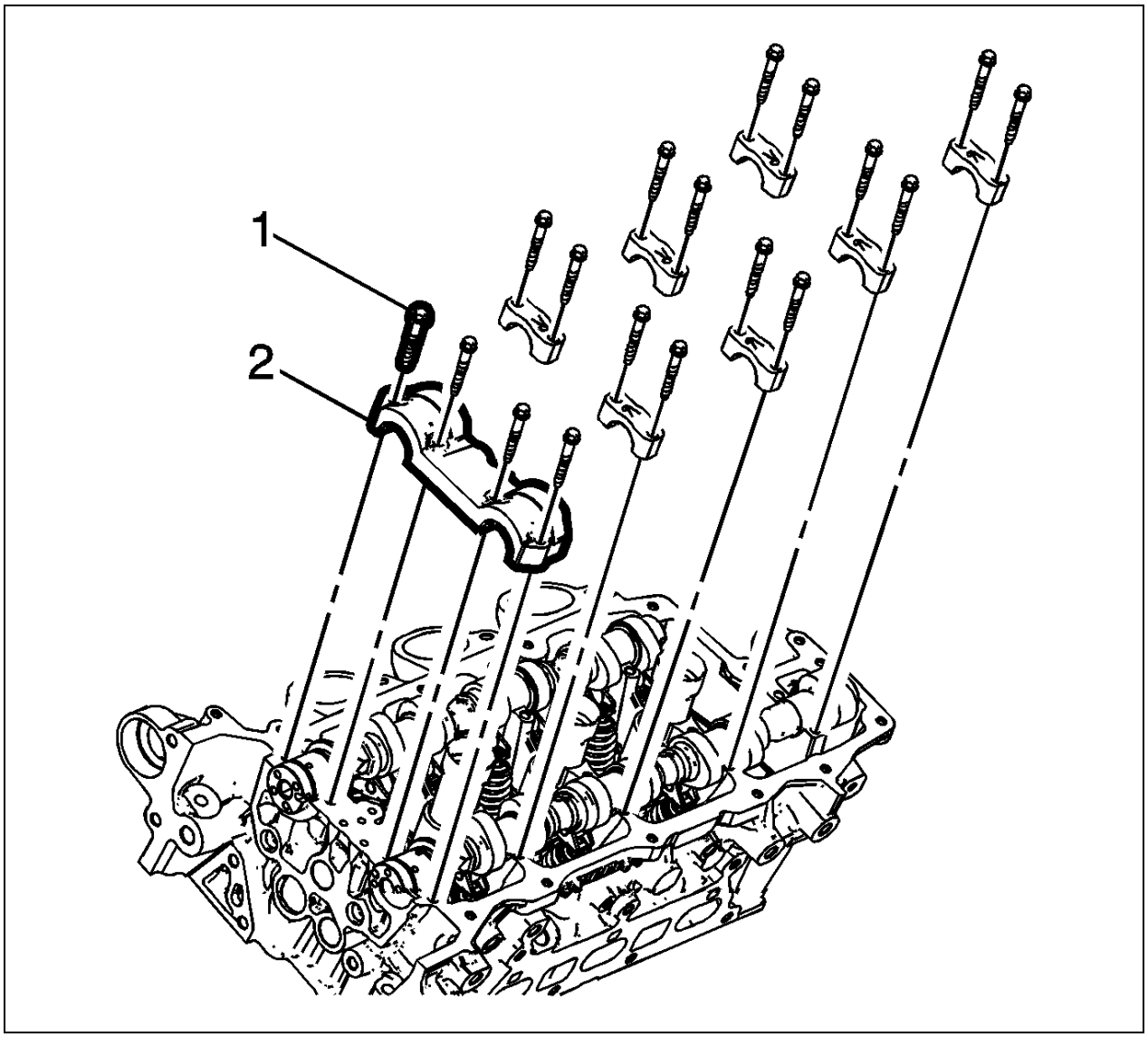


Courtesy of GENERAL MOTORS COMPANY

1. The raised feature must always be oriented toward the center of the cylinder head.
2. The I indicates the intake camshaft.
3. The E indicates the exhaust camshaft.
4. The number indicates the journal position from the front of the engine.

4. Remove the camshaft bearing cap bolts (1).

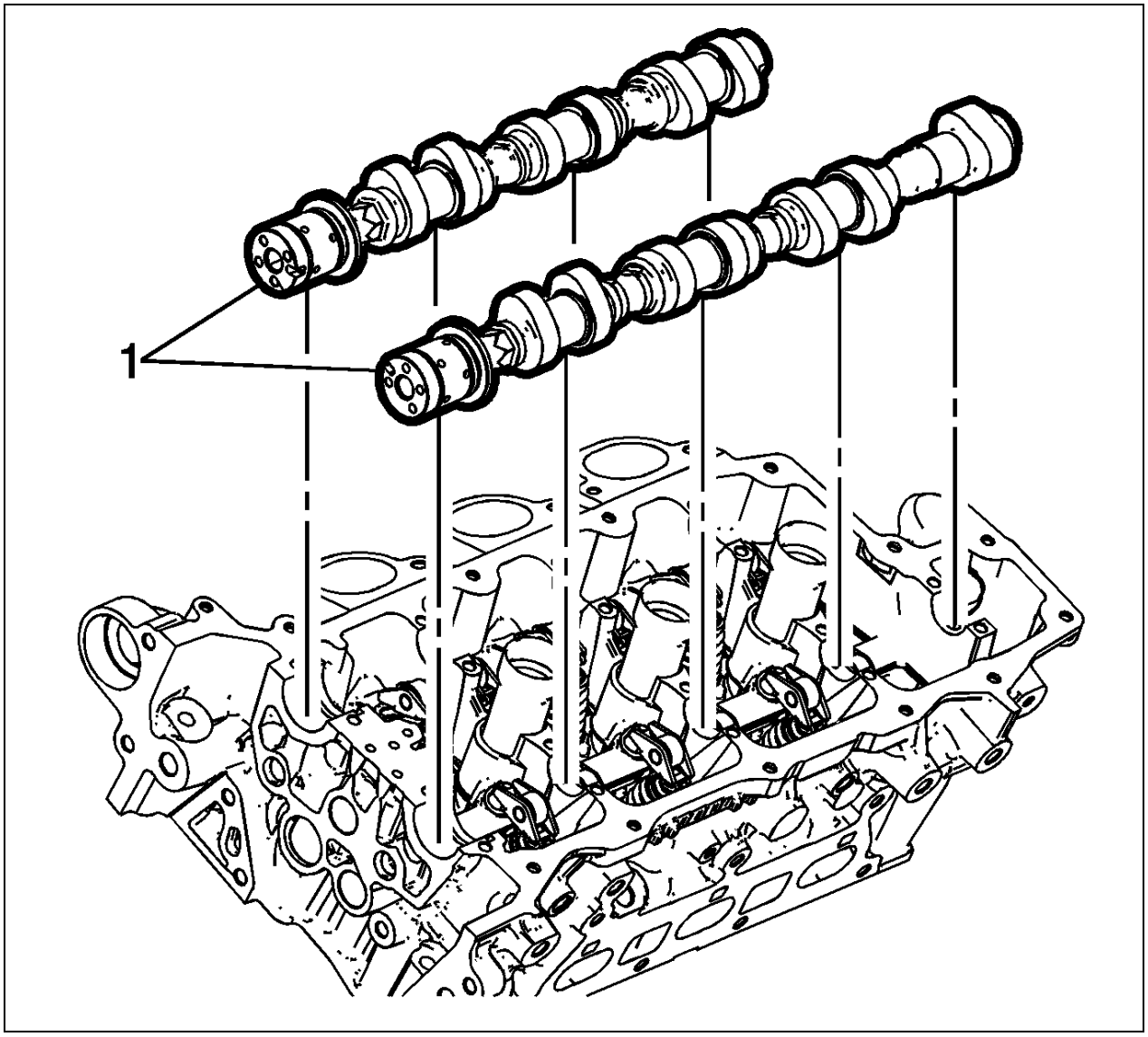
Fig 2: Bearing Cap Bolts



Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft bearing caps (2).
6. Remove the camshafts (1).

Fig 3: Camshafts



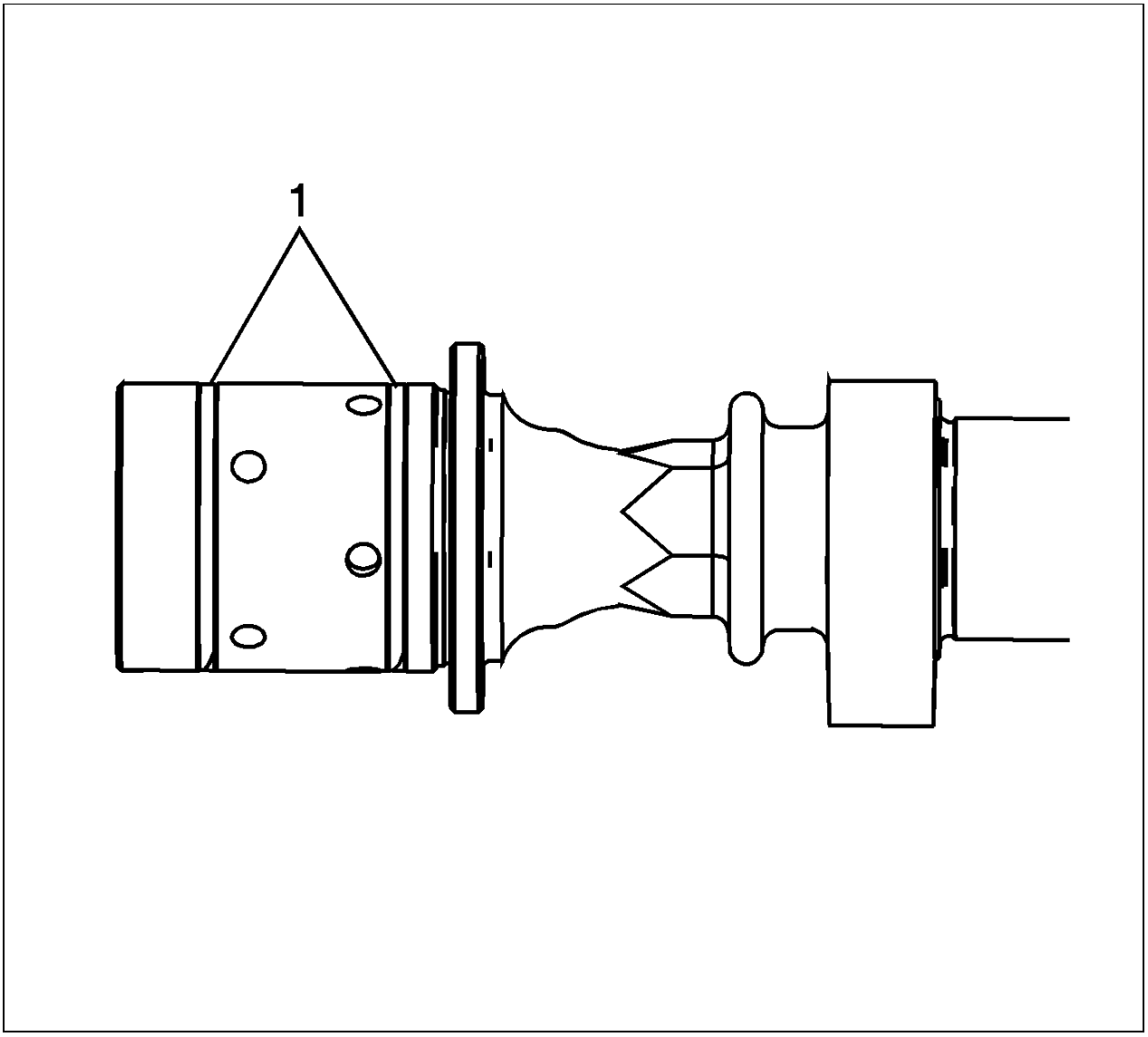
Courtesy of GENERAL MOTORS COMPANY

NOTE: *Mark the camshafts upon removal to ensure installation is in the correct position.*

Installation Procedure

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

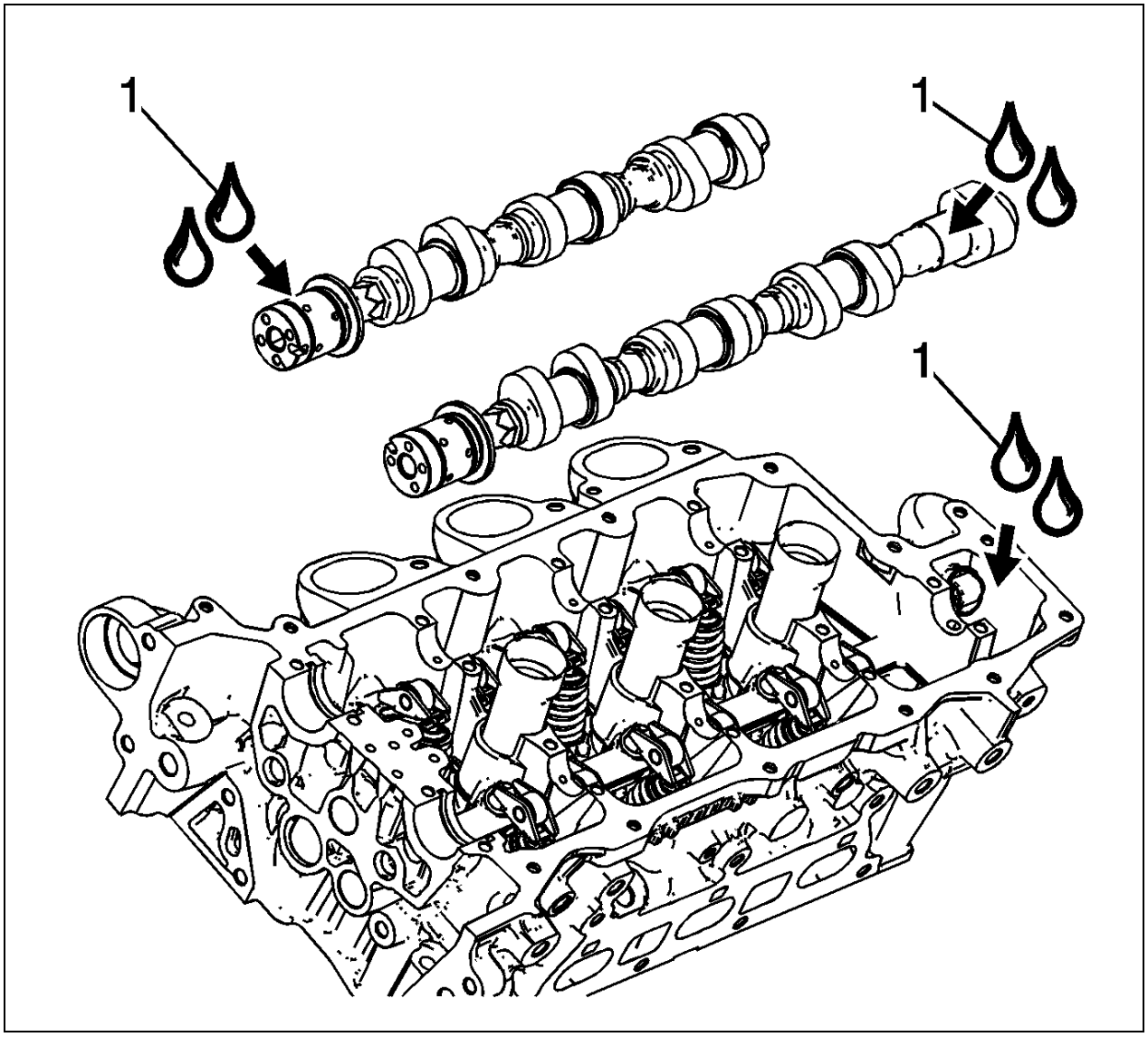
Fig 4: Locating Camshaft Sealing Rings In Camshaft Grooves



Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the left cylinder head camshaft carriers. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4) for recommended lubricant.

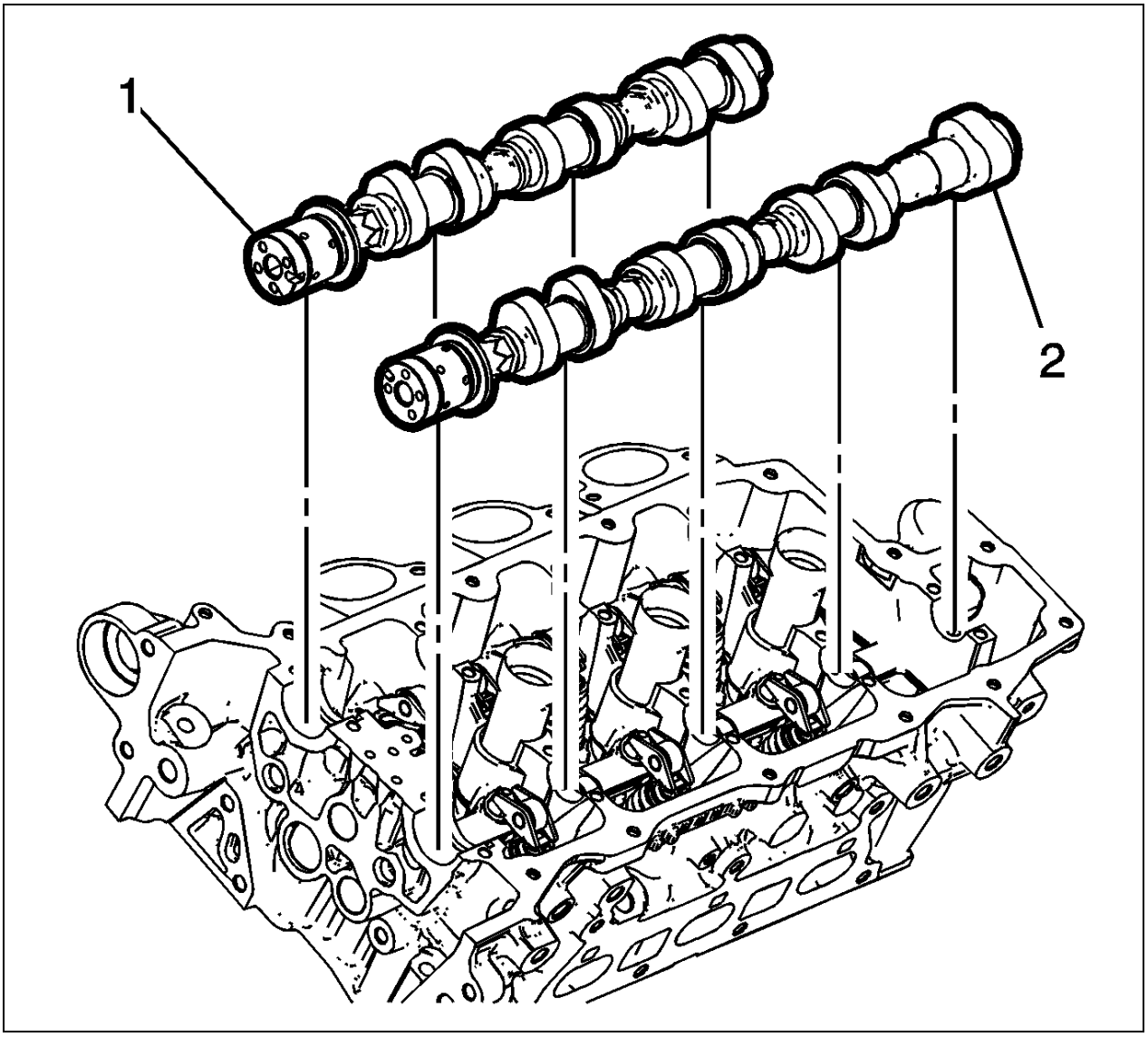
Fig 5: Camshaft Journal Lubrication Points



Courtesy of GENERAL MOTORS COMPANY

3. Place the left intake (1) and left exhaust (2) camshafts in position in the left cylinder head.

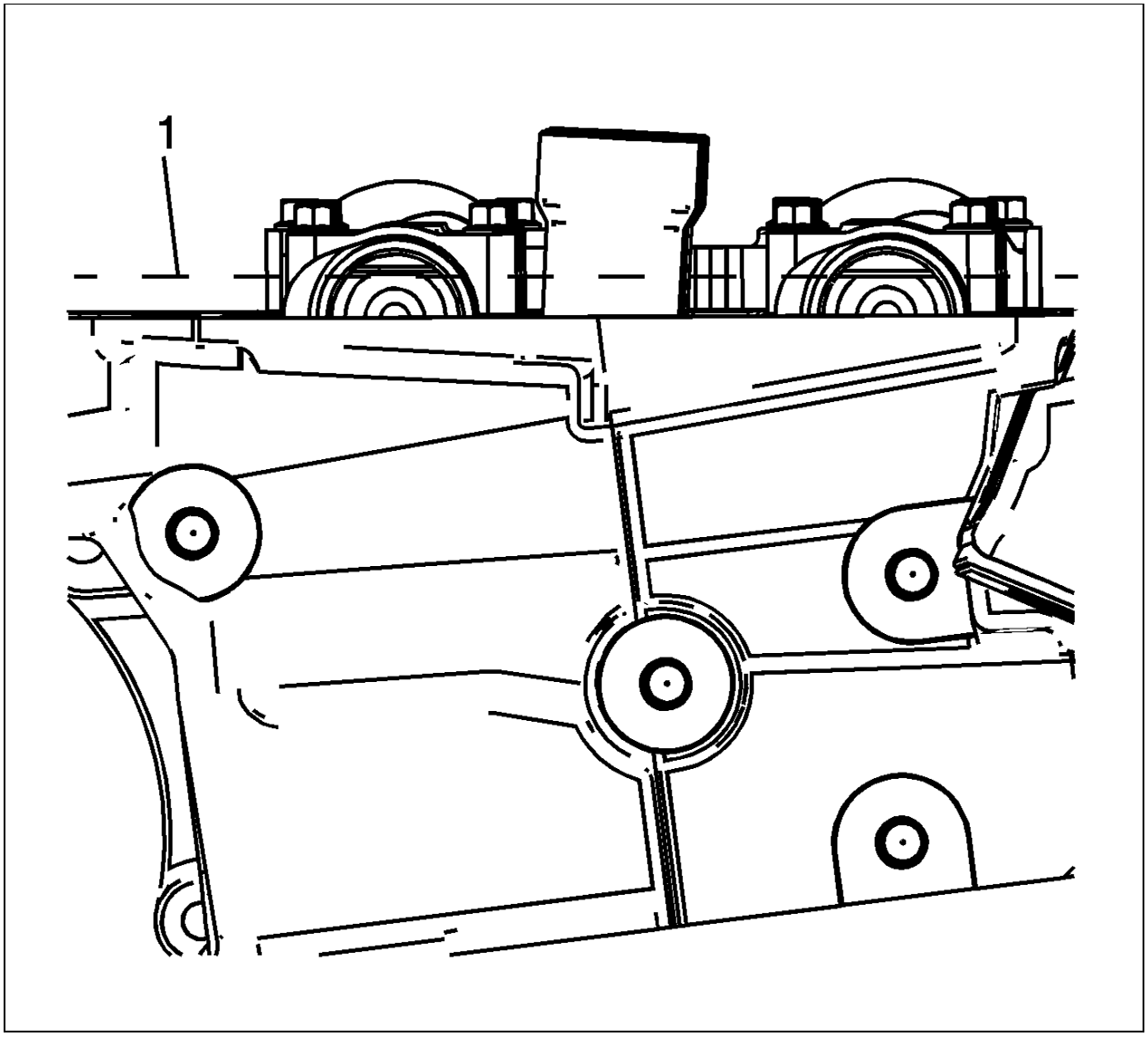
Fig 6: Camshaft Intake And Exhaust Positioning Points



Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

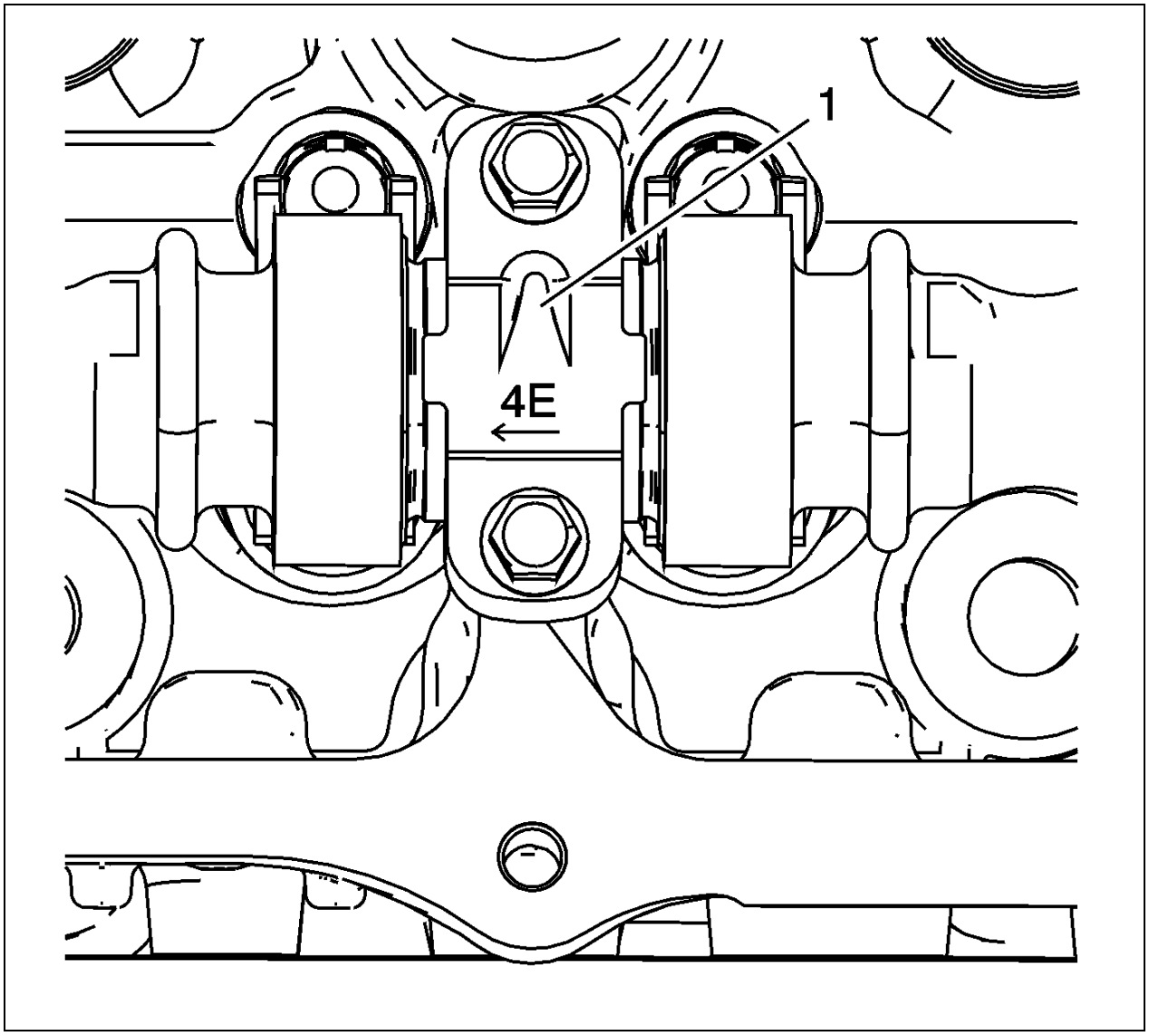
Fig 7: View Of Camshaft Flats Parallel With Camshaft Cover Rail



Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:

Fig 8: Left Cylinder Head Camshaft Bearing Cap Markings



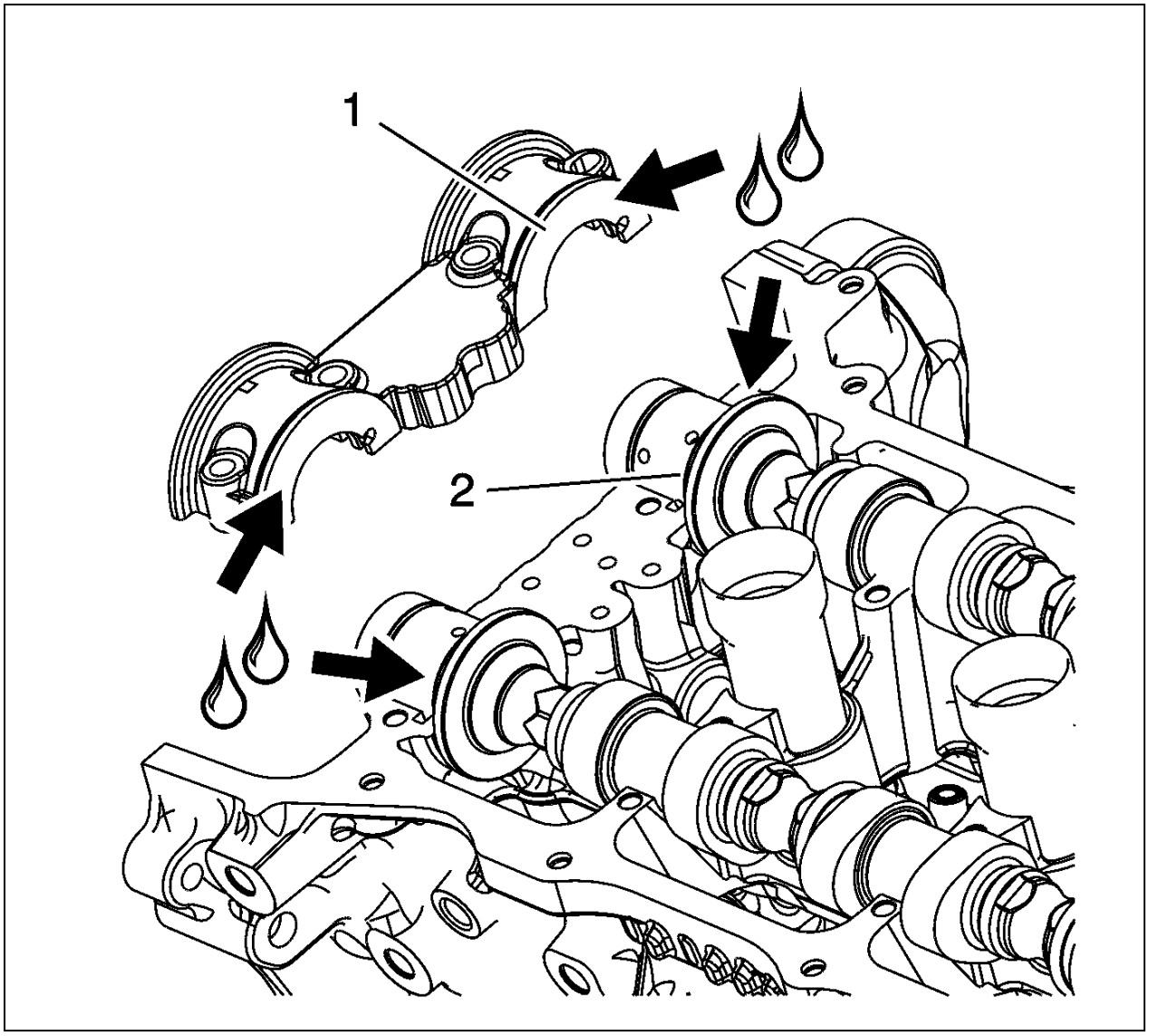
Courtesy of GENERAL MOTORS COMPANY

1. The raised feature (1) must always be oriented toward the center of the cylinder head.
2. The I indicates the intake camshaft.
3. The E indicates the exhaust camshaft.
4. The number 2, 4, 6 indicates the cylinder position from the front of the engine.

6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4) for recommended lubricant.

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4) for recommended lubricant.

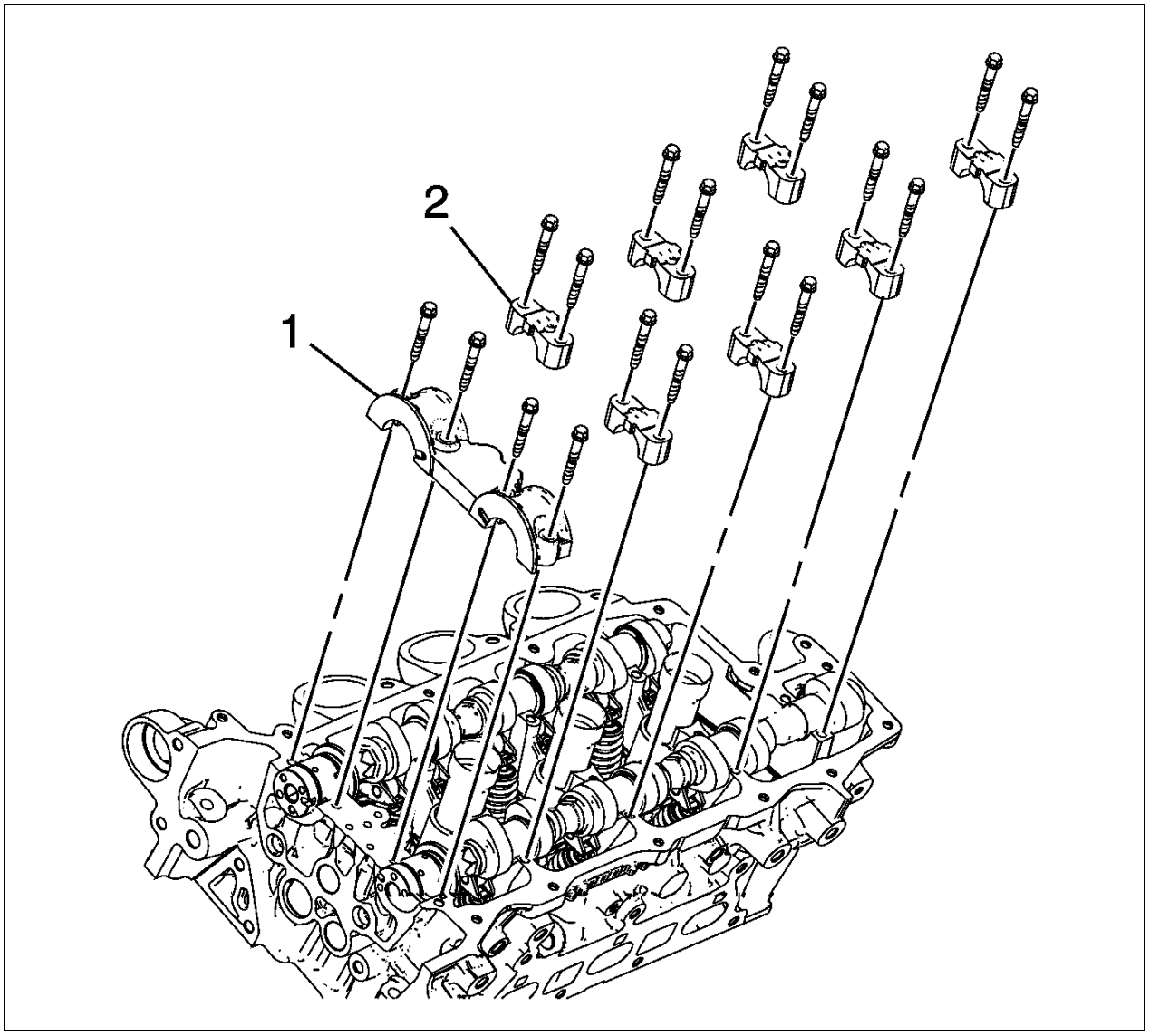
Fig 9: Camshaft Bearing Cap And Camshaft Thrust Surface



Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.

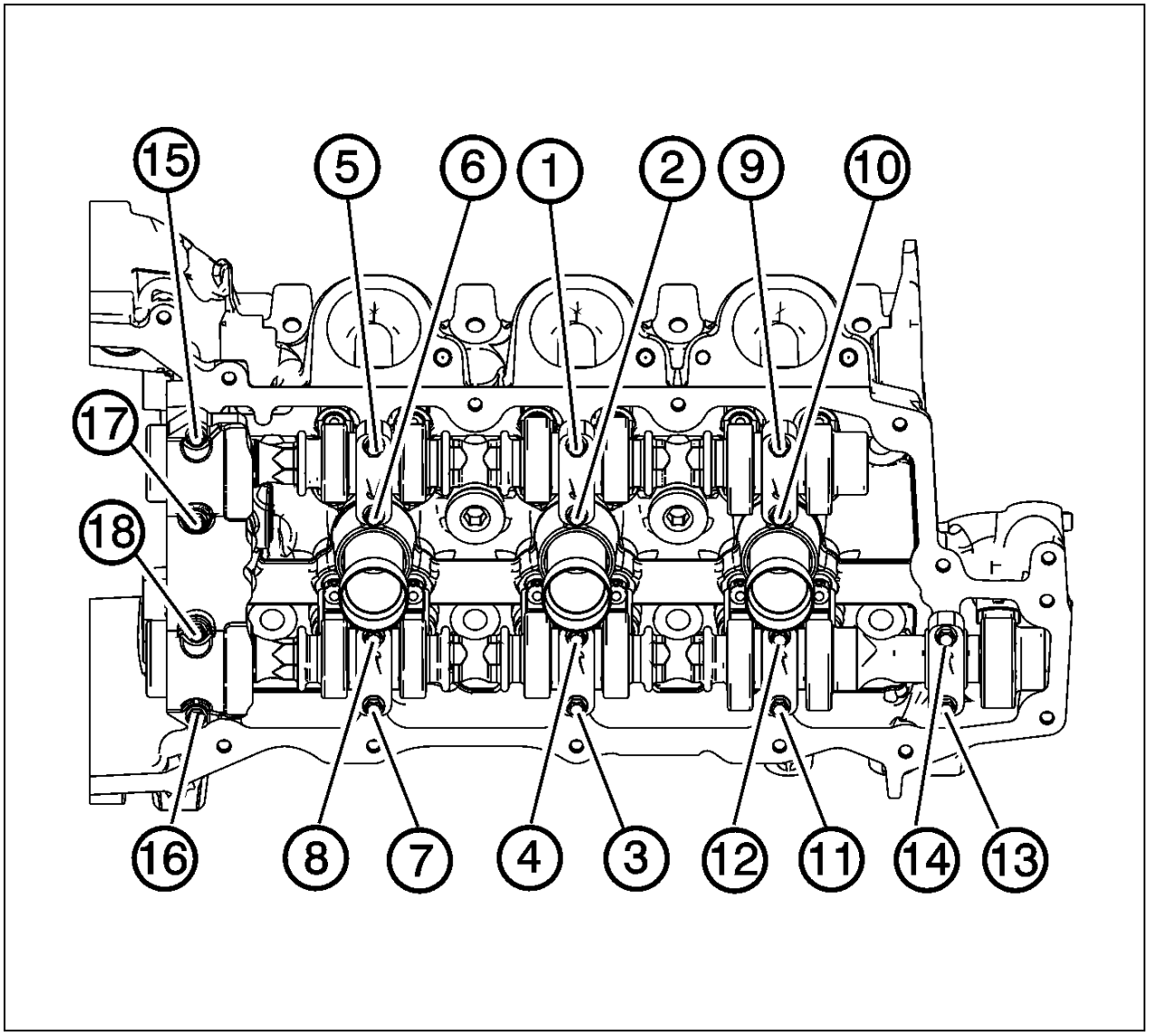
Fig 10: Camshaft Bearing Caps And Bolts



Courtesy of GENERAL MOTORS COMPANY

9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.
11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).

Fig 11: Identifying Camshaft Bearing Cap Bolt Tightening Sequence



Courtesy of GENERAL MOTORS COMPANY

CAUTION: *Refer to Fastener Caution .*

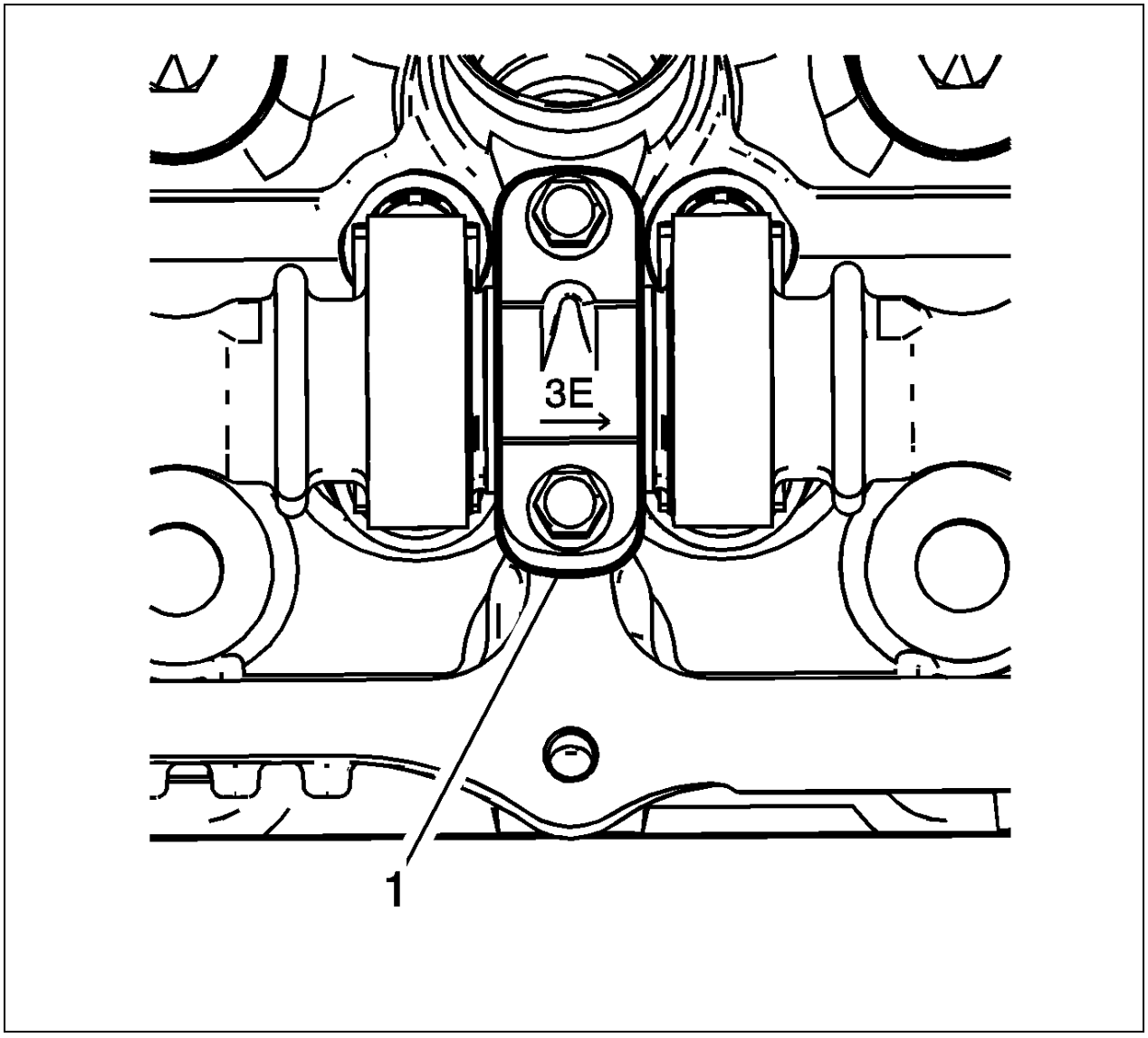
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 2 (LF4).
15. Install the fuel pump. Refer to Fuel Pump Replacement (LF4) .

Camshaft Replacement - Right Side (LF4)

Removal Procedure

1. Remove the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 (LF4) .
2. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:

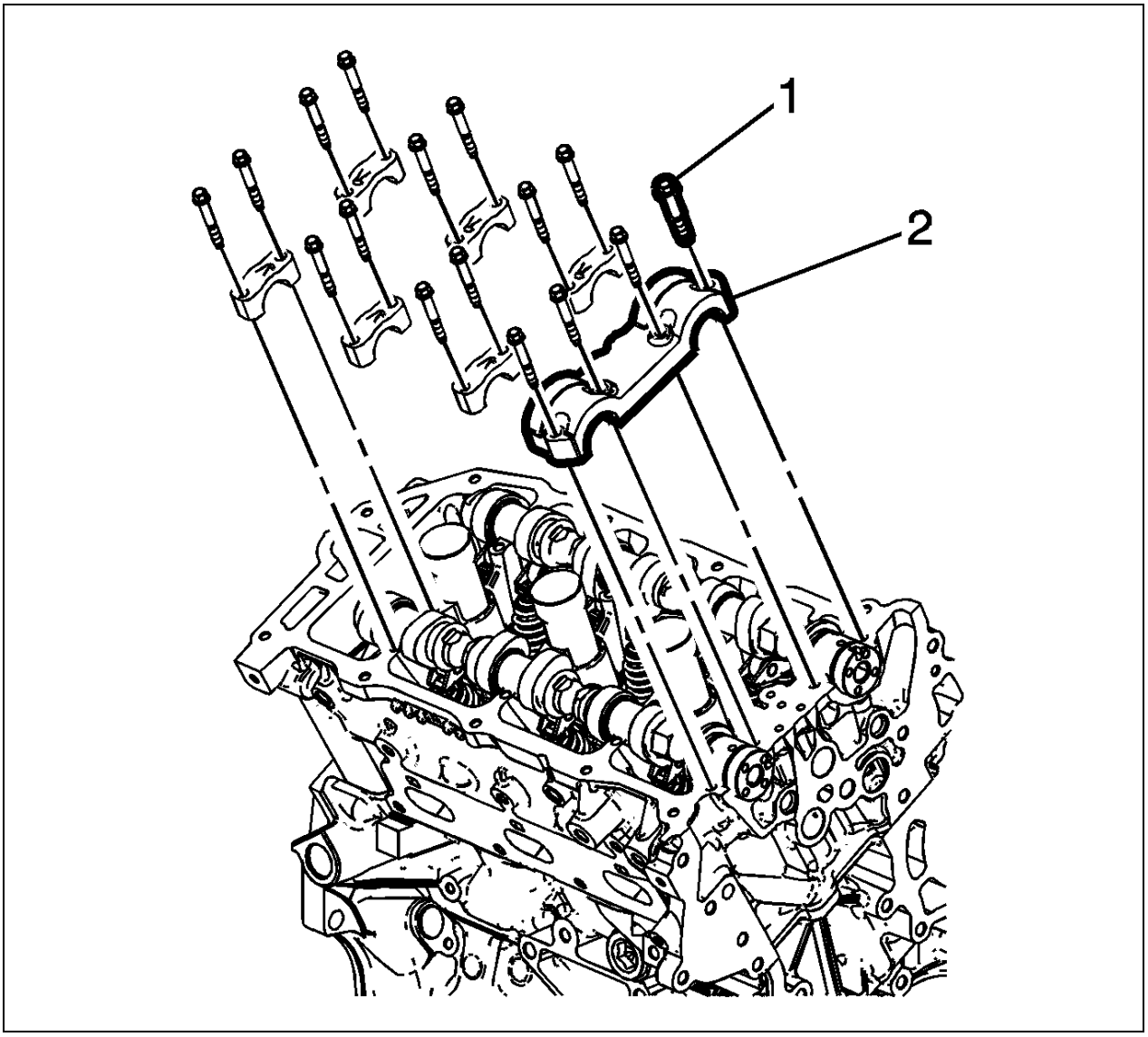
   Fig 12: Bearing Cap Markings



Courtesy of GENERAL MOTORS COMPANY

   1. The raised feature must always be oriented toward the center of the cylinder head.
   2. The I indicates the intake camshaft.
   3. The E indicates the exhaust camshaft.
   4. The number indicates the journal position from the front of the engine.
3. Remove the camshaft bearing cap bolts (1).

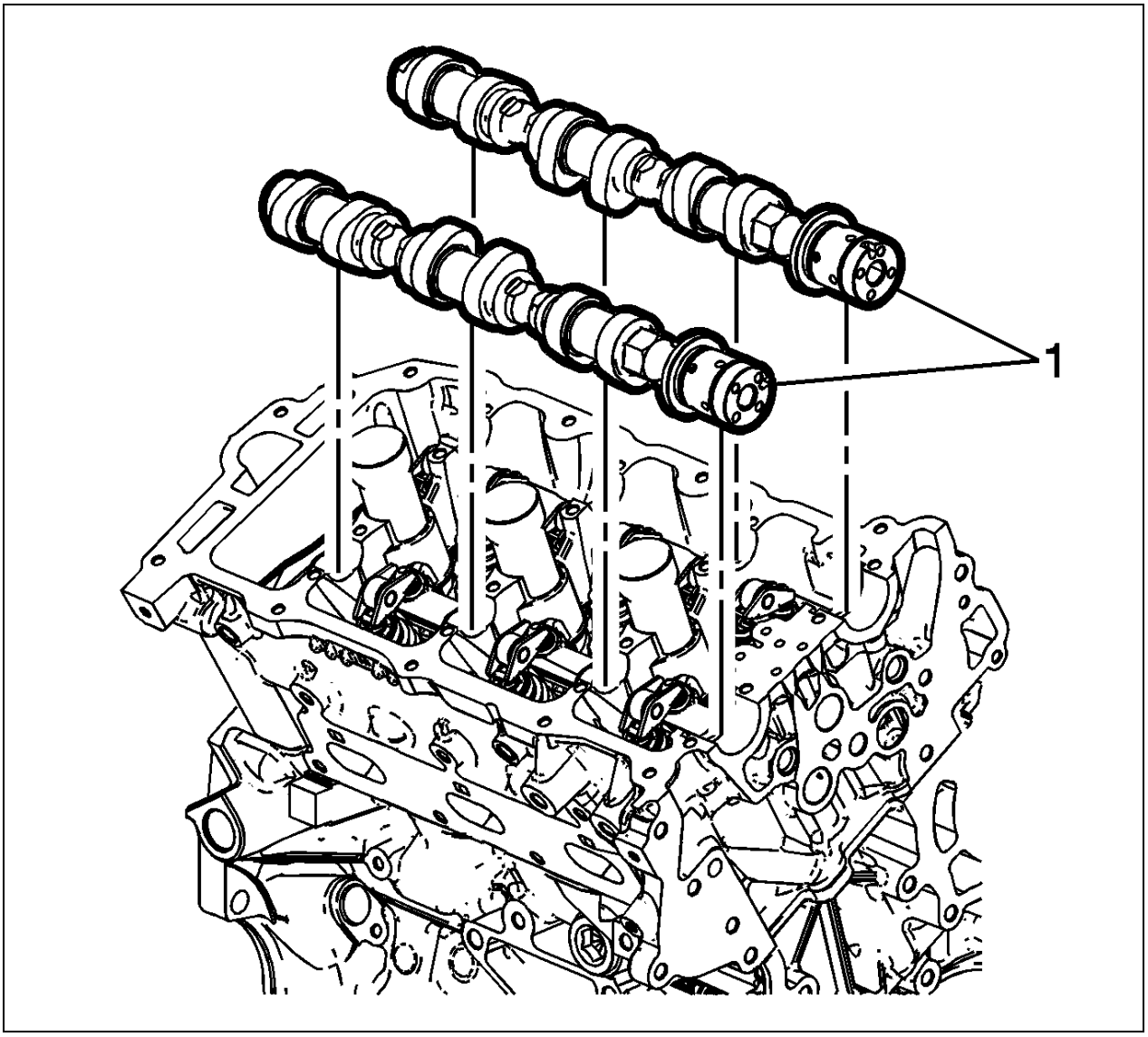
Fig 13: Camshaft Bearing Caps & Bolts



Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft bearing caps (2).
5. Remove the camshafts (1).

Fig 14: Camshafts



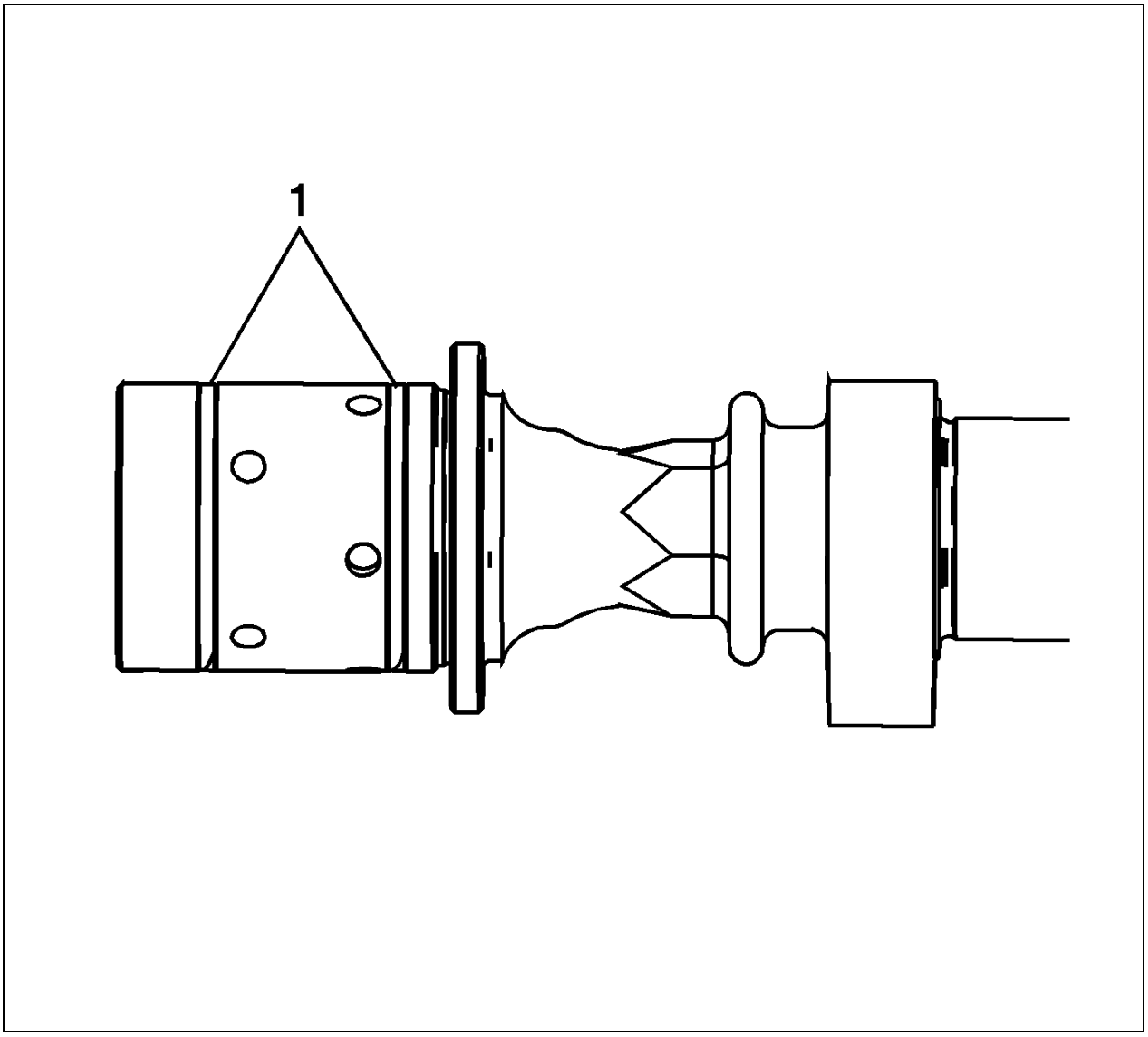
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: *Mark the camshafts upon removal to ensure installation is in the correct position.*

Installation Procedure

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

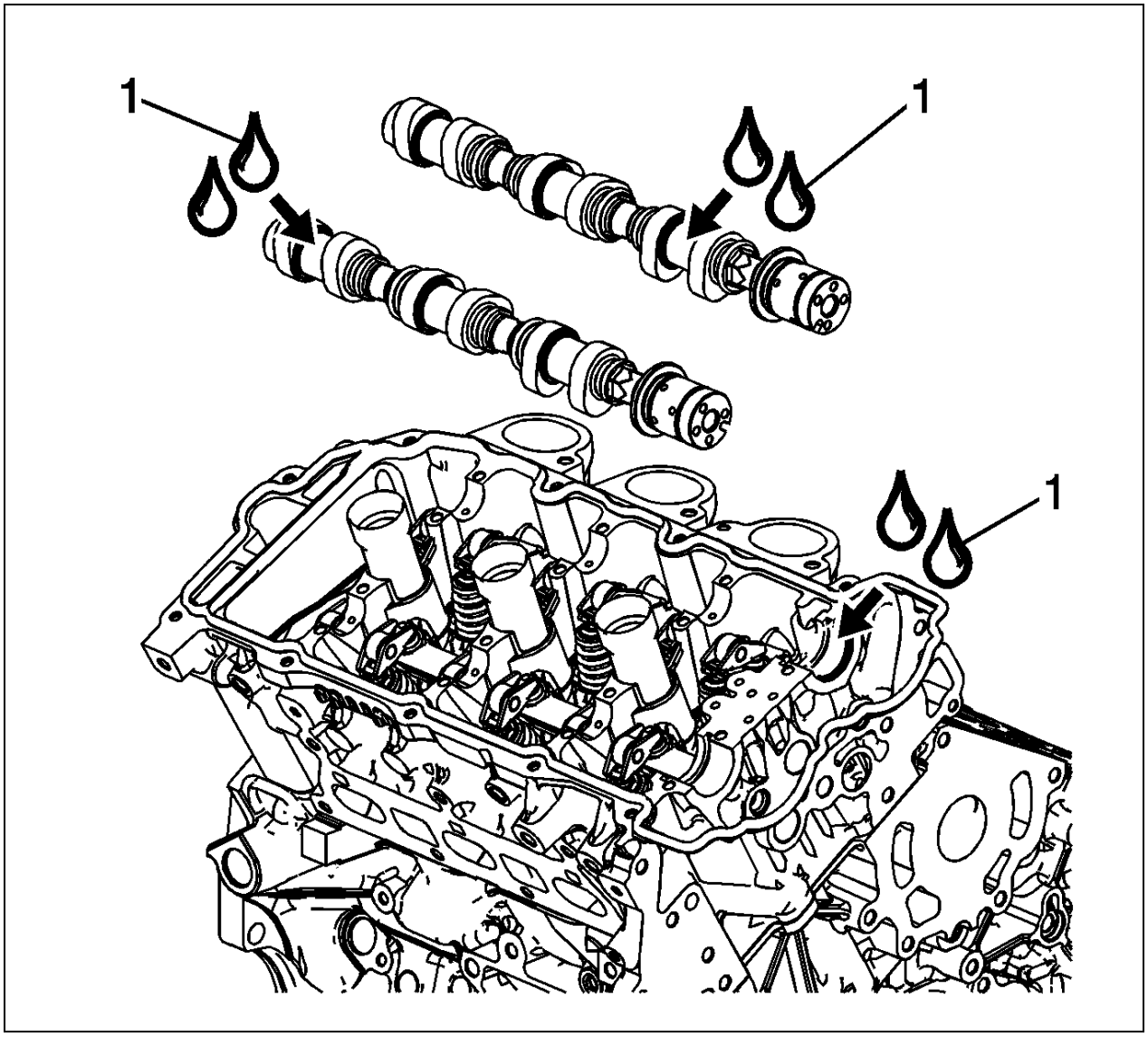
Fig 15: Locating Camshaft Sealing Rings In Camshaft Grooves



Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the right cylinder head camshaft carriers. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4) for recommended lubricant.

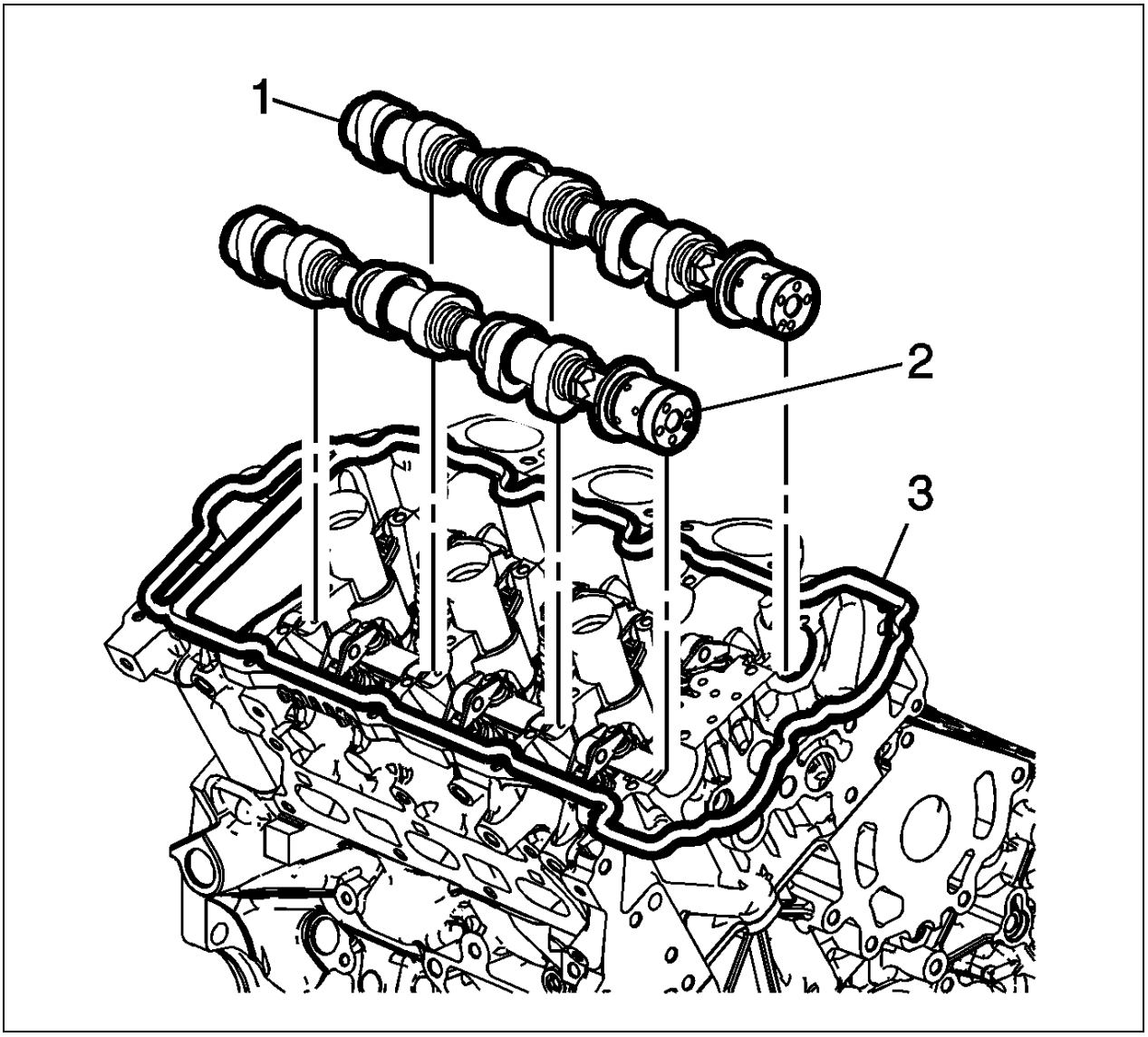
Fig 16: Right Cylinder Head Camshaft Lubrication Points



Courtesy of GENERAL MOTORS COMPANY

3. Place the right intake (1) and right exhaust (2) camshafts in position in the right cylinder head (3).

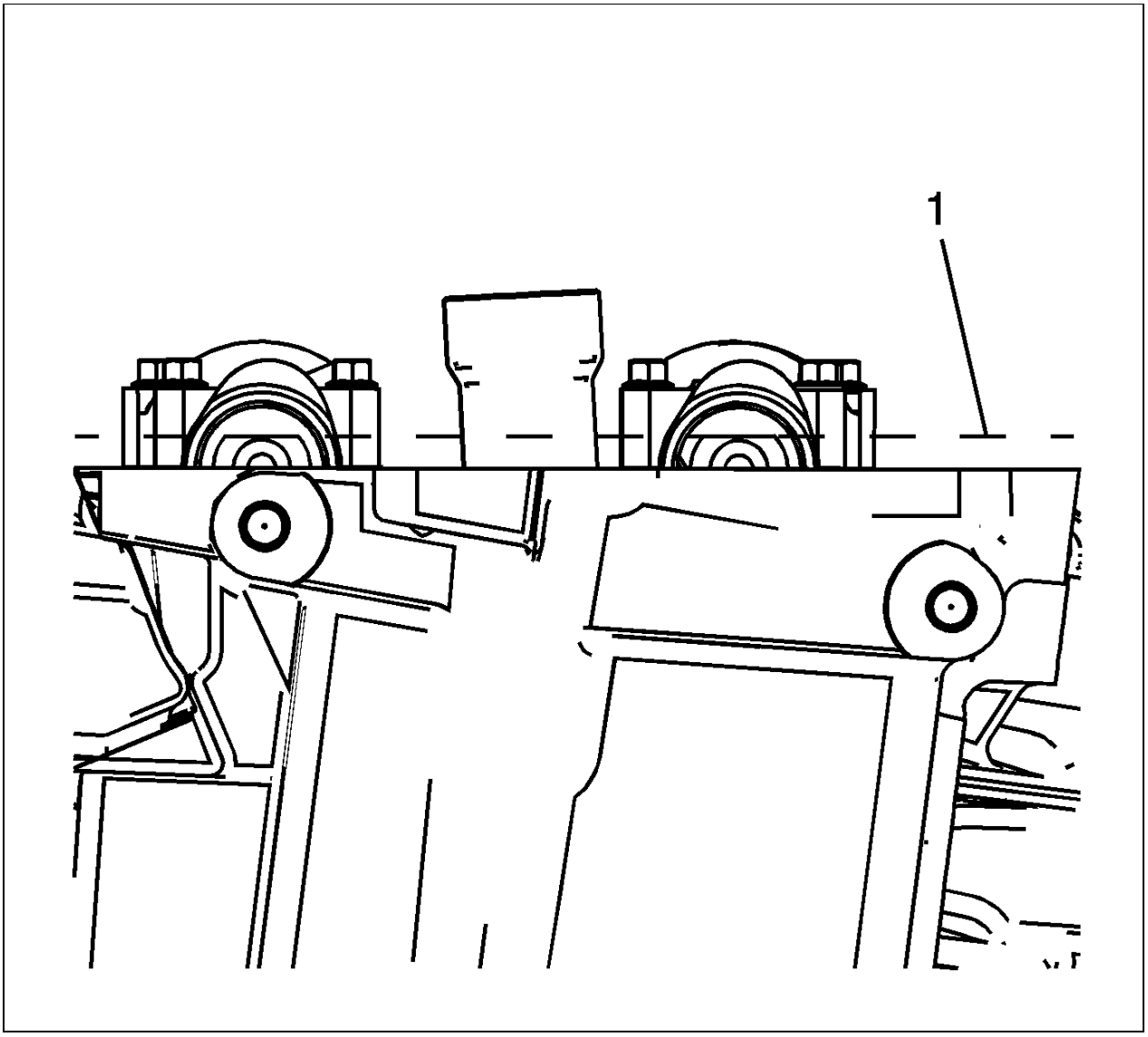
Fig 17: Right Cylinder Head Camshaft Intake & Exhaust Points



Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

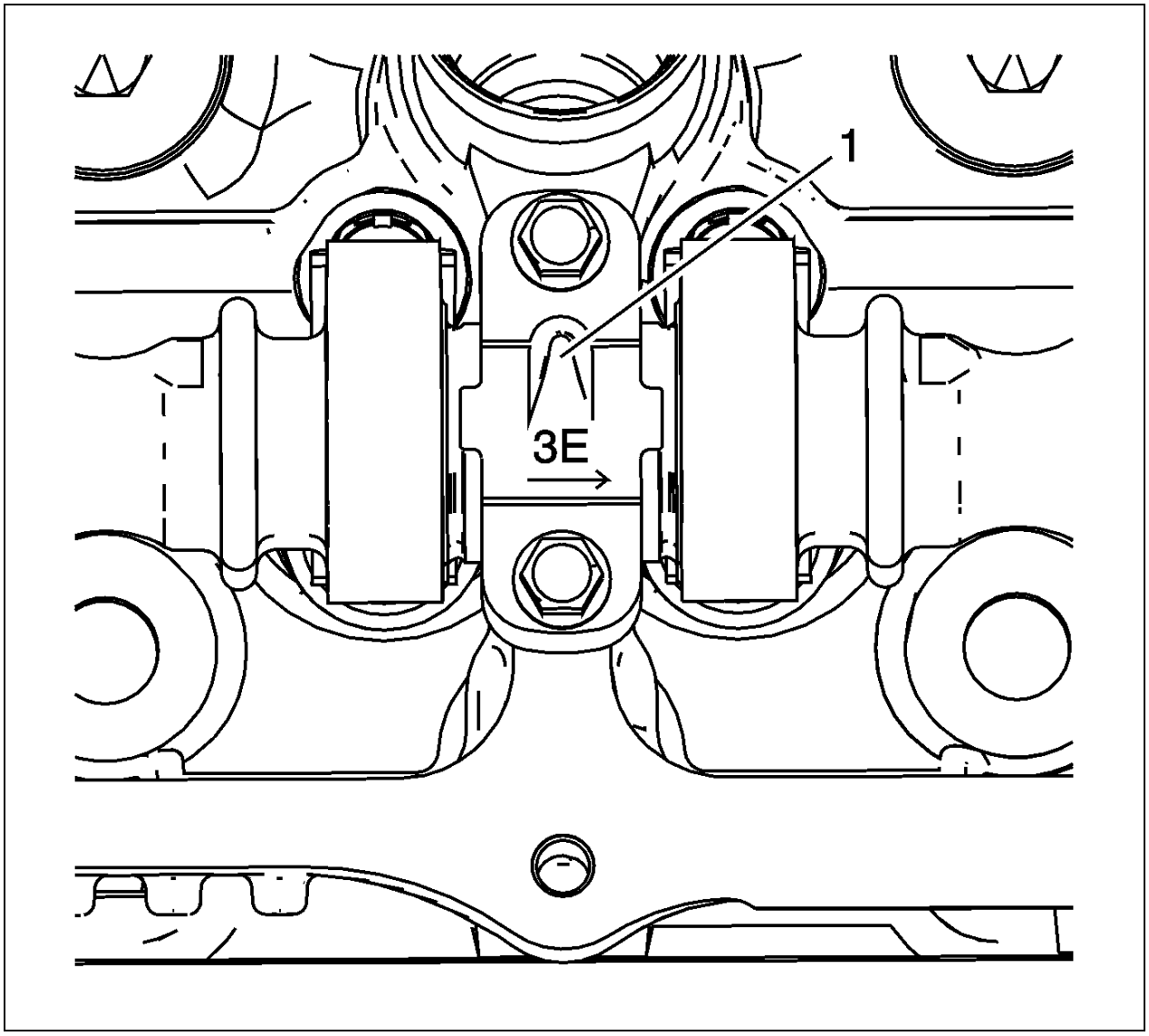
Fig 18: Identifying Camshaft Neutral (Low Tension) Position



Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:

Fig 19: Right Cylinder Head Camshaft Bearing Cap Markings



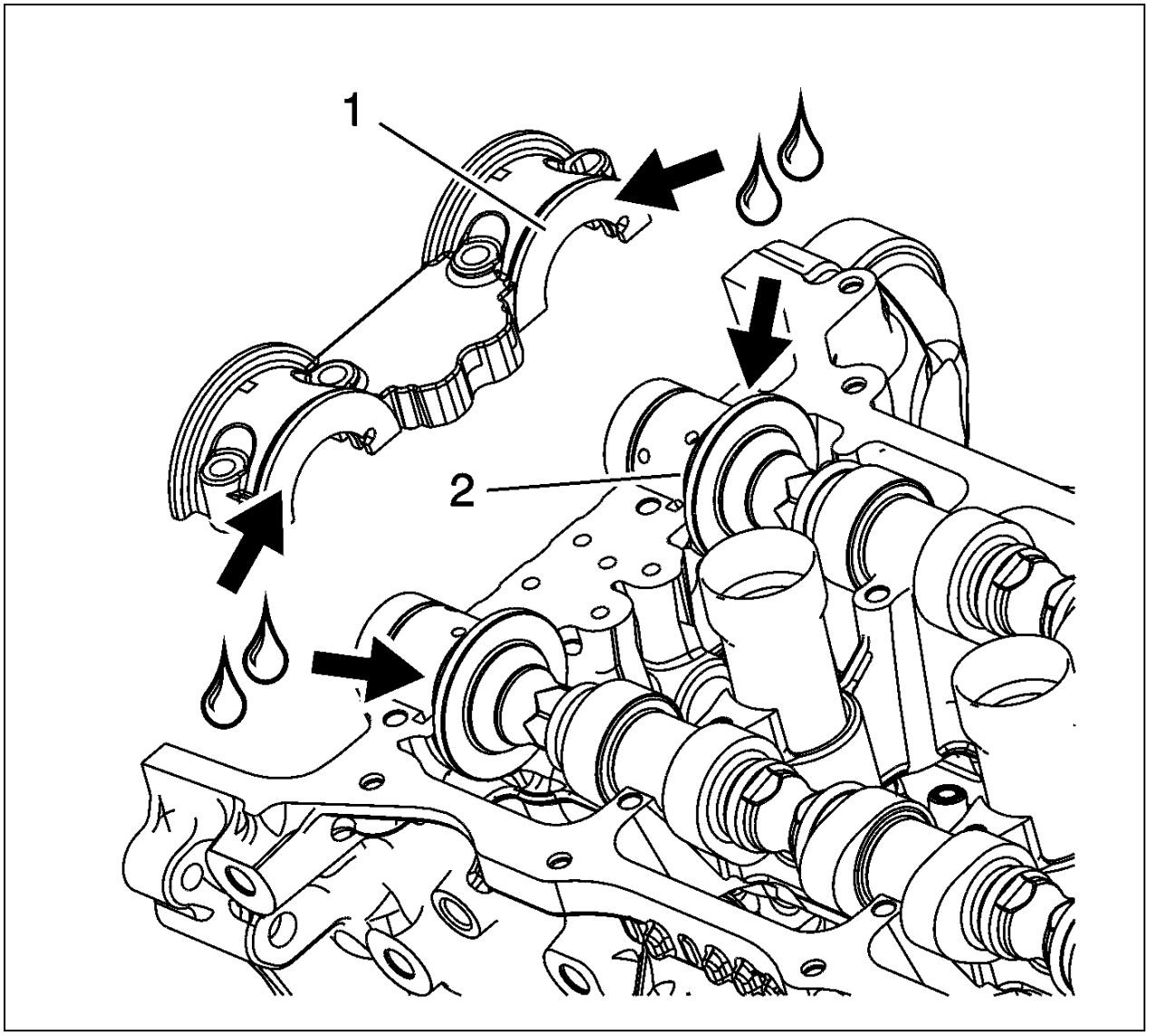
Courtesy of GENERAL MOTORS COMPANY

1. The raised feature (1) must always be oriented toward the center of the cylinder head.
2. The I indicates the intake camshaft.
3. The E indicates the exhaust camshaft.
4. The number 1, 3, 5 indicates the cylinder position from the front of the engine.

6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4) for recommended lubricant.

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4) for recommended lubricant.

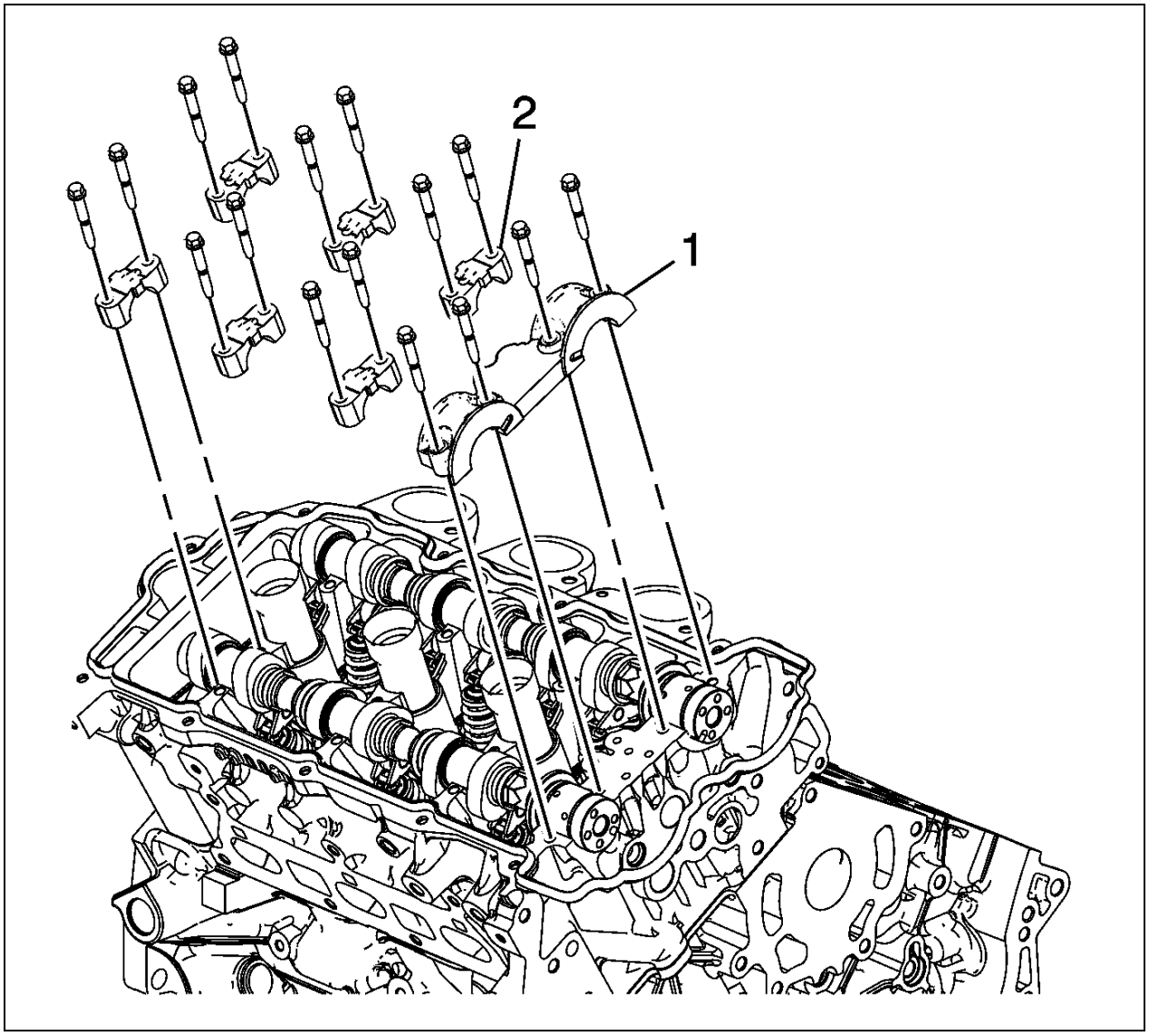
Fig 20: Camshaft Bearing Cap And Camshaft Thrust Surface



Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.

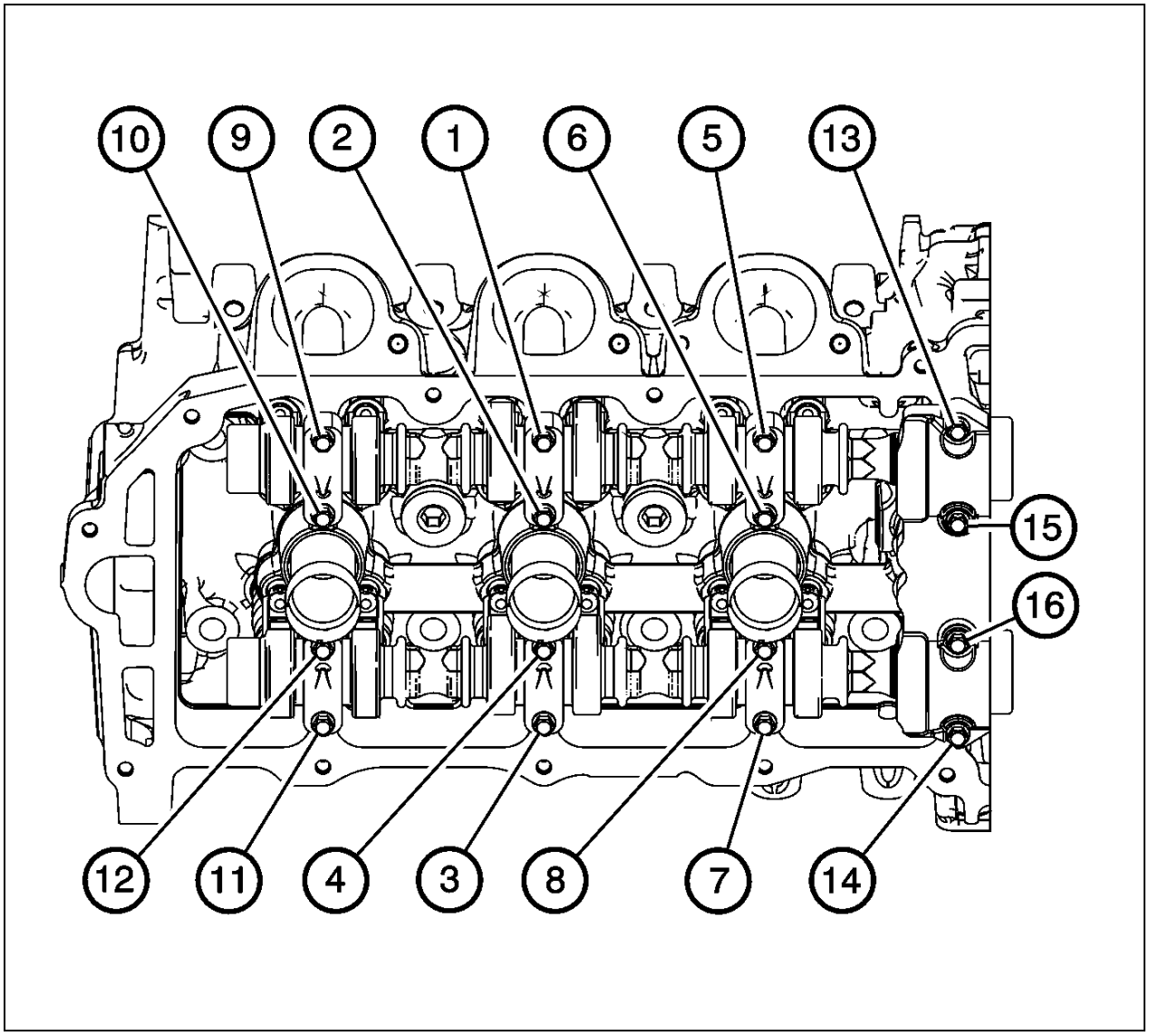
Fig 21: Camshaft Bearing Caps And Bolts



Courtesy of GENERAL MOTORS COMPANY

9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.
11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).

Fig 22: Camshaft Bearing Cap Bolts Tighten Sequence



Courtesy of GENERAL MOTORS COMPANY

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.*

12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).

13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

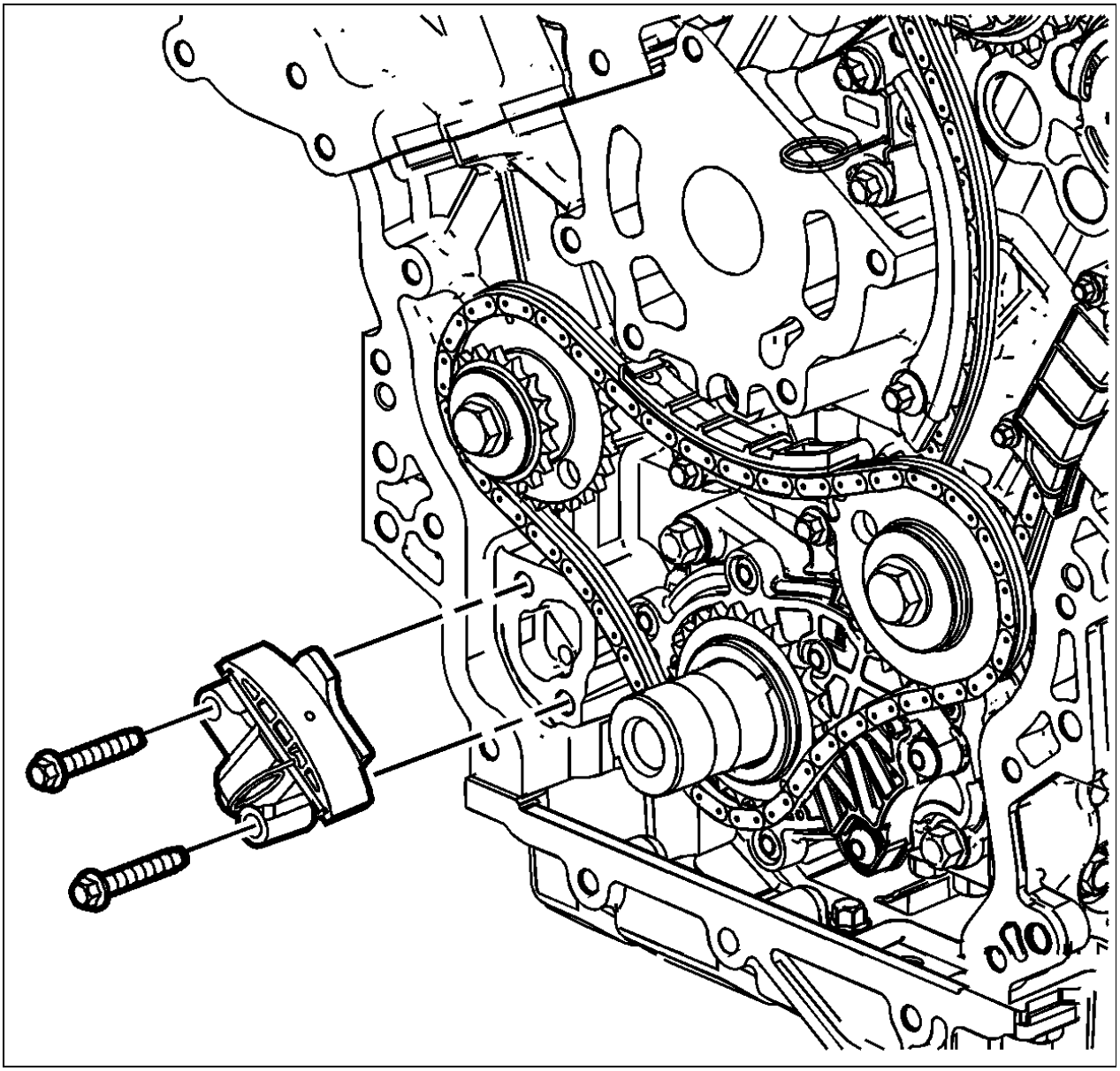
14. Install the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 (LF4) .

Primary Camshaft Intermediate Drive Chain Tensioner Replacement (LF4)

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement (LF4).

   Fig 23: View Of Primary Camshaft Drive Chain Tensioner



Courtesy of GENERAL MOTORS COMPANY

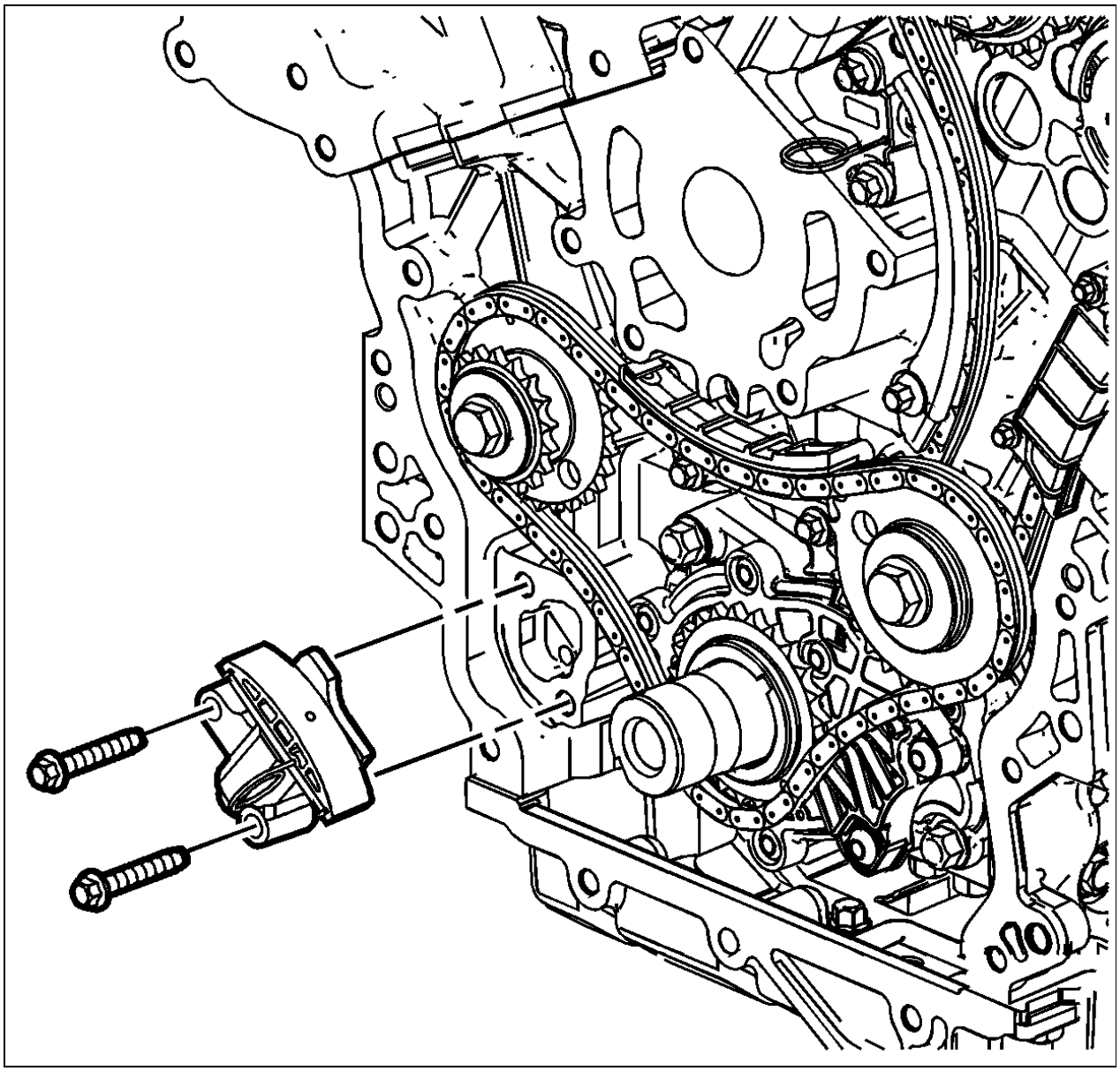
2. Remove the primary camshaft drive chain tensioner. Refer to Camshaft Timing Chain Components Removal (LF4) .

IMPORTANT: *If the entire camshaft timing system is not in Stage 2, Timing Chain Alignment Diagram (LF4) , mark the timing chain and sprockets in order to ensure proper reassembly.*

Installation Procedure

1. Install the primary camshaft drive chain tensioner. Refer to Camshaft Timing Chain Components Installation (LF4) .

   Fig 24: View Of Primary Camshaft Drive Chain Tensioner



Courtesy of GENERAL MOTORS COMPANY

2. Install the engine front cover. Refer to Engine Front Cover Replacement (LF4).

Secondary Camshaft Intermediate Drive Chain Replacement - Left Side (LF4)

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement (LF4).
2. Remove the camshaft timing chain components. Refer to Camshaft Timing Chain Components Removal (LF4) .
3. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive Components Cleaning and Inspection (LF4) . Replace components as necessary.

Installation Procedure

1. Install the camshaft timing chain components. Refer to Camshaft Timing Chain Components Installation (LF4) .
2. Install the engine front cover. Refer to Engine Front Cover Replacement (LF4).

Secondary Camshaft Intermediate Drive Chain Replacement - Right Side (LF4)

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement (LF4).
2. Remove the right side secondary camshaft drive chain components. Refer to Camshaft Timing Chain Components Removal (LF4) .
3. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive Components Cleaning and Inspection (LF4) . Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain components. Refer to Camshaft Timing Chain Components Installation (LF4) .
2. Install the engine front cover. Refer to Engine Front Cover Replacement (LF4).

Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Left Side (LF4)

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement (LF4).
2. Remove the left bank secondary camshaft drive chain tensioner. Refer to Camshaft Timing Chain Components Removal (LF4) .
3. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive Components Cleaning and Inspection (LF4) .

Installation Procedure

1. Install the left bank secondary camshaft drive chain tensioner. Refer to Camshaft Timing Chain Components Installation (LF4) .
2. Install the engine front cover. Refer to Engine Front Cover Replacement (LF4).

Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Right Side (LF4)

Removal Procedure

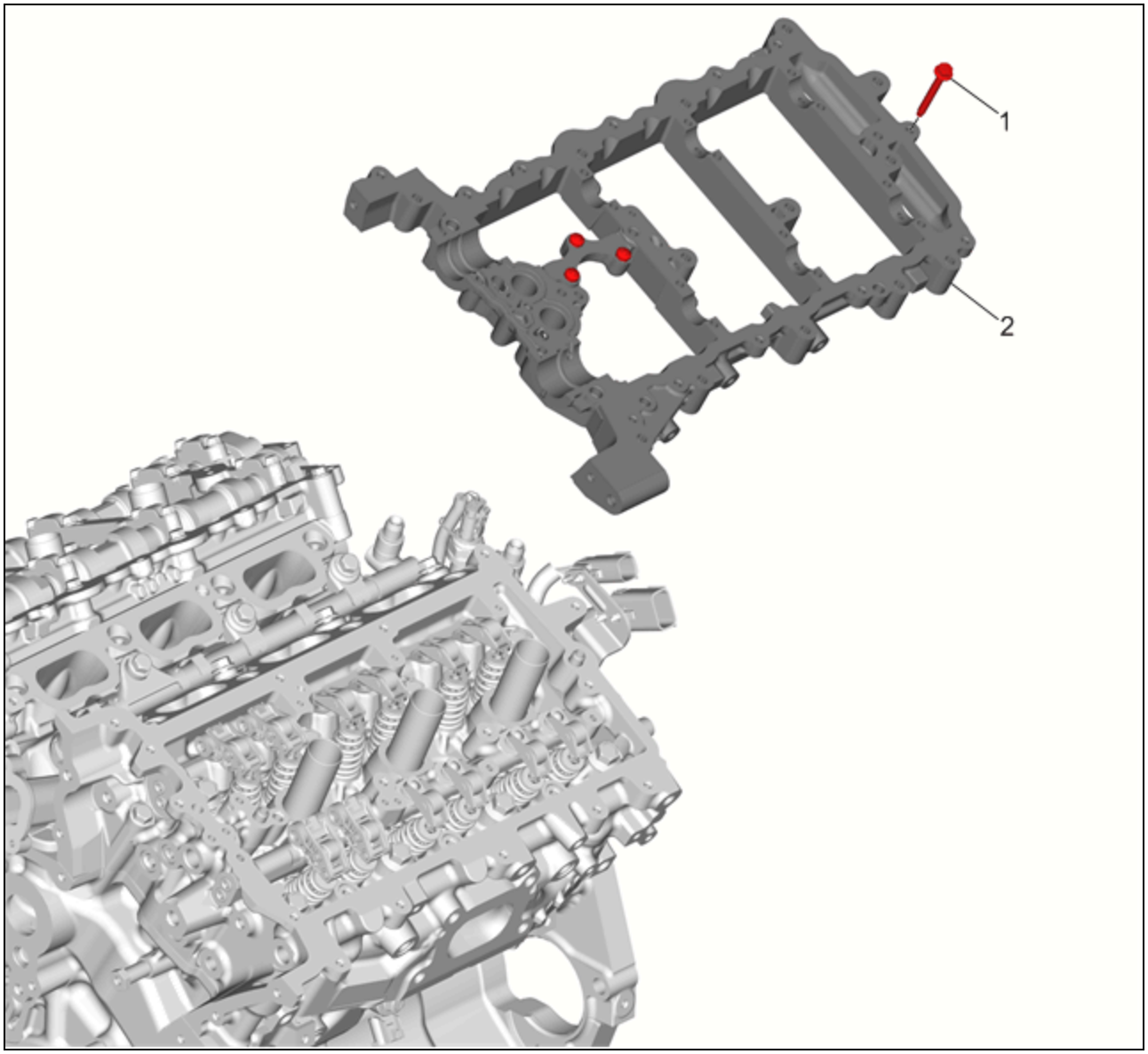
1. Remove the engine front cover. Refer to Engine Front Cover Replacement (LF4).
2. Remove the right side secondary camshaft drive chain tensioner. Refer to Camshaft Timing Chain Components Removal (LF4) .
3. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive Components Cleaning and Inspection (LF4) . Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain tensioner. Refer to Camshaft Timing Chain Components Installation (LF4) .
2. Install the engine front cover. Refer to Engine Front Cover Replacement (LF4).

Camshaft Carrier Removal - Left Side

Fig 25: Camshaft Carrier - Left Side

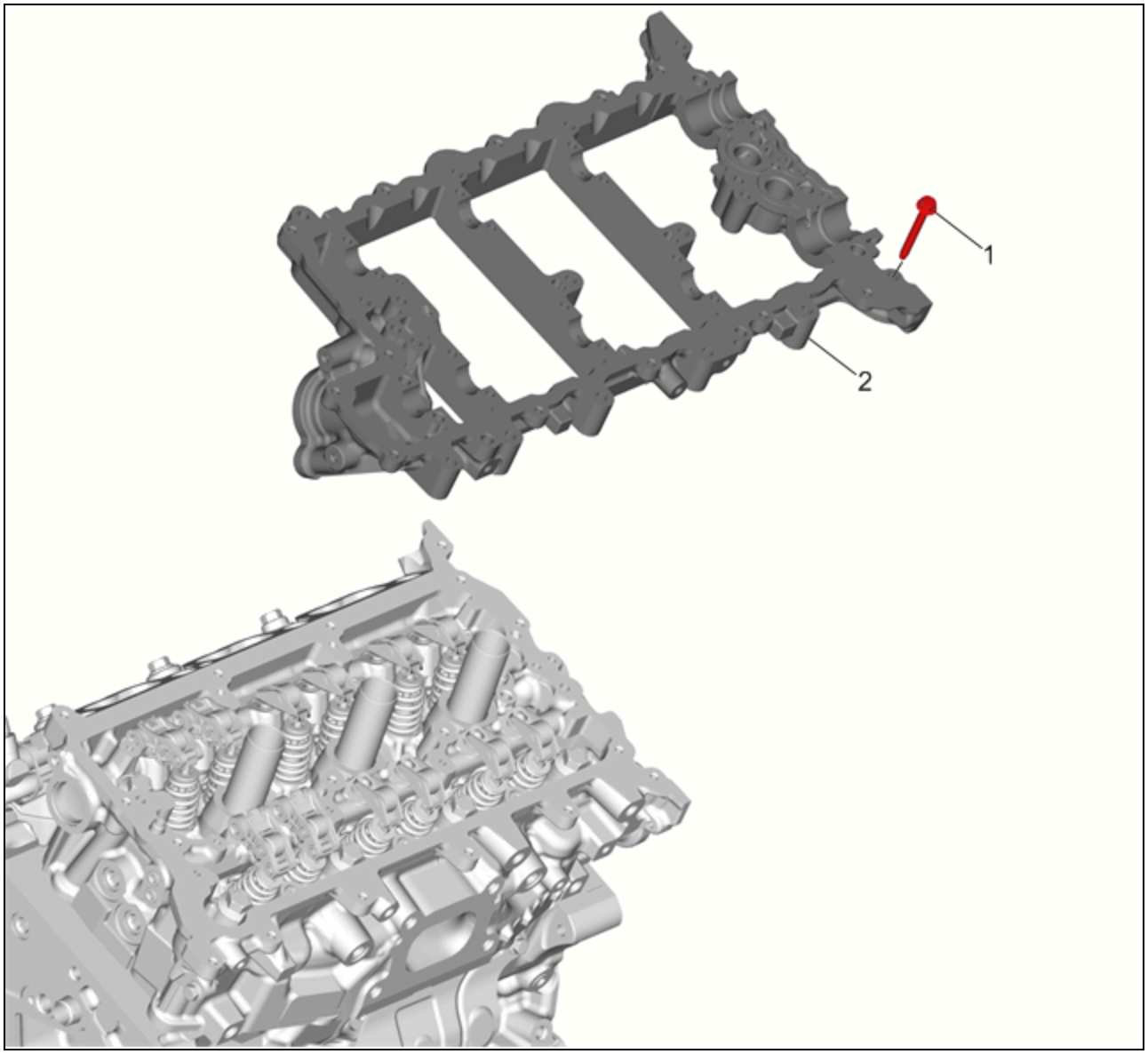


Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Carrier Bolt
2	Camshaft Carrier Left

Camshaft Carrier Removal - Right Side

Fig 26: Camshaft Carrier - Right Side



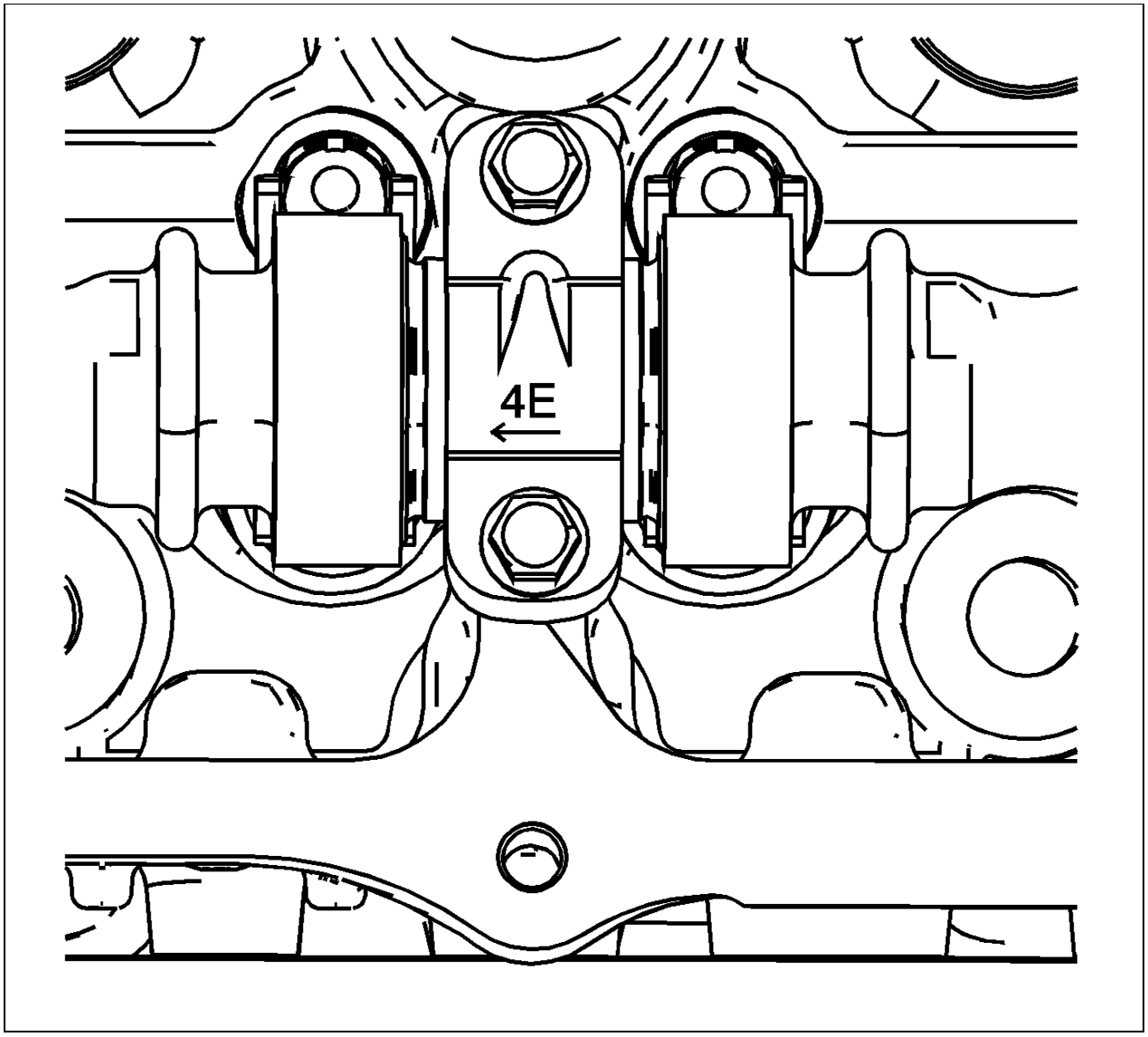
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Carrier Bolt
2	Camshaft Carrier Right

Camshaft Removal - Left Side (LF4)

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:

Fig 27: Identifying Markings On Bearing Caps

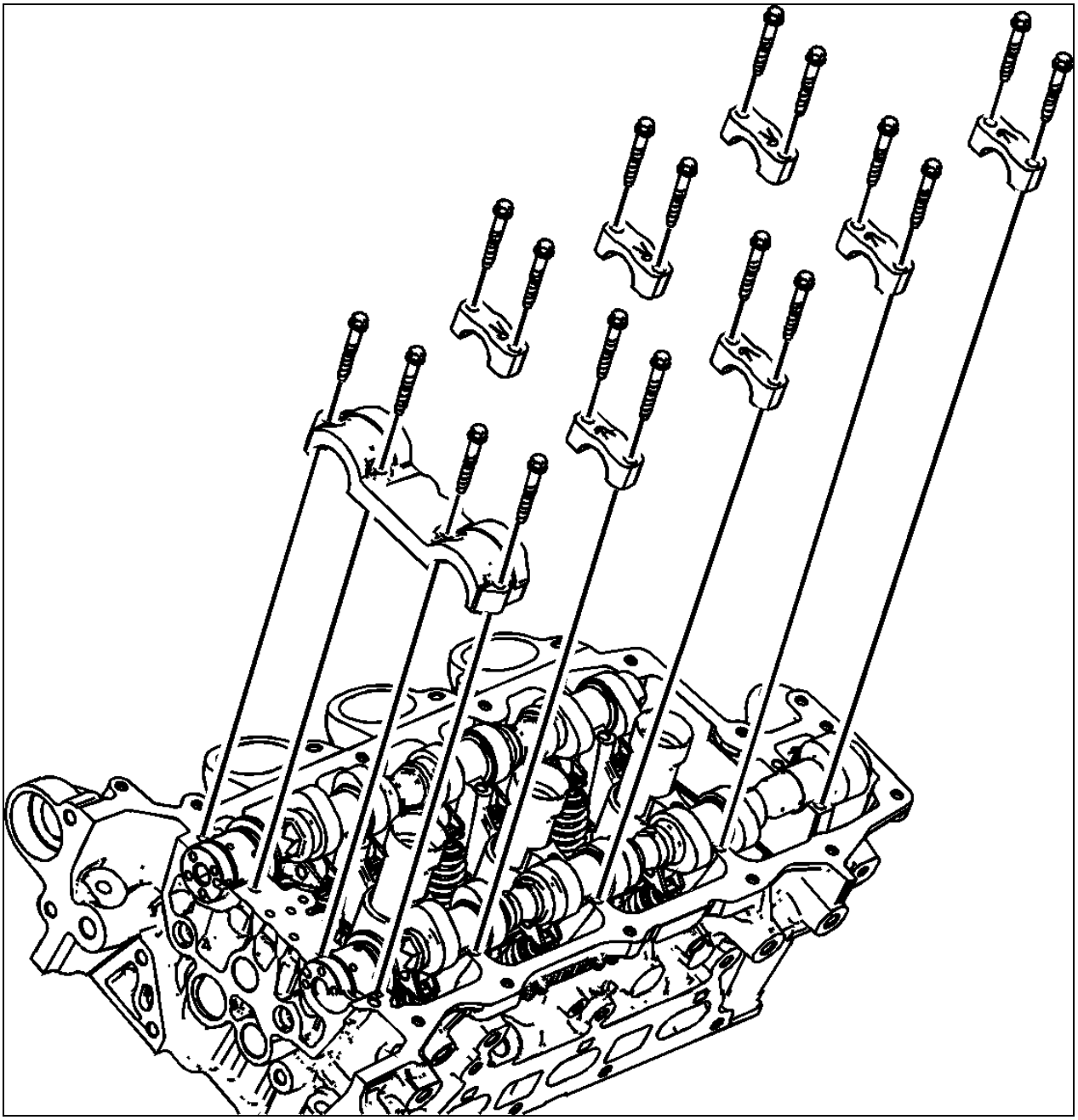


Courtesy of GENERAL MOTORS COMPANY

1. The raised feature must always be oriented toward the center of the cylinder head.
2. The I indicates the intake camshaft.
3. The E indicates the exhaust camshaft.
4. The number indicates the journal position from the front of the engine.

2. Remove the camshaft bearing cap bolts.

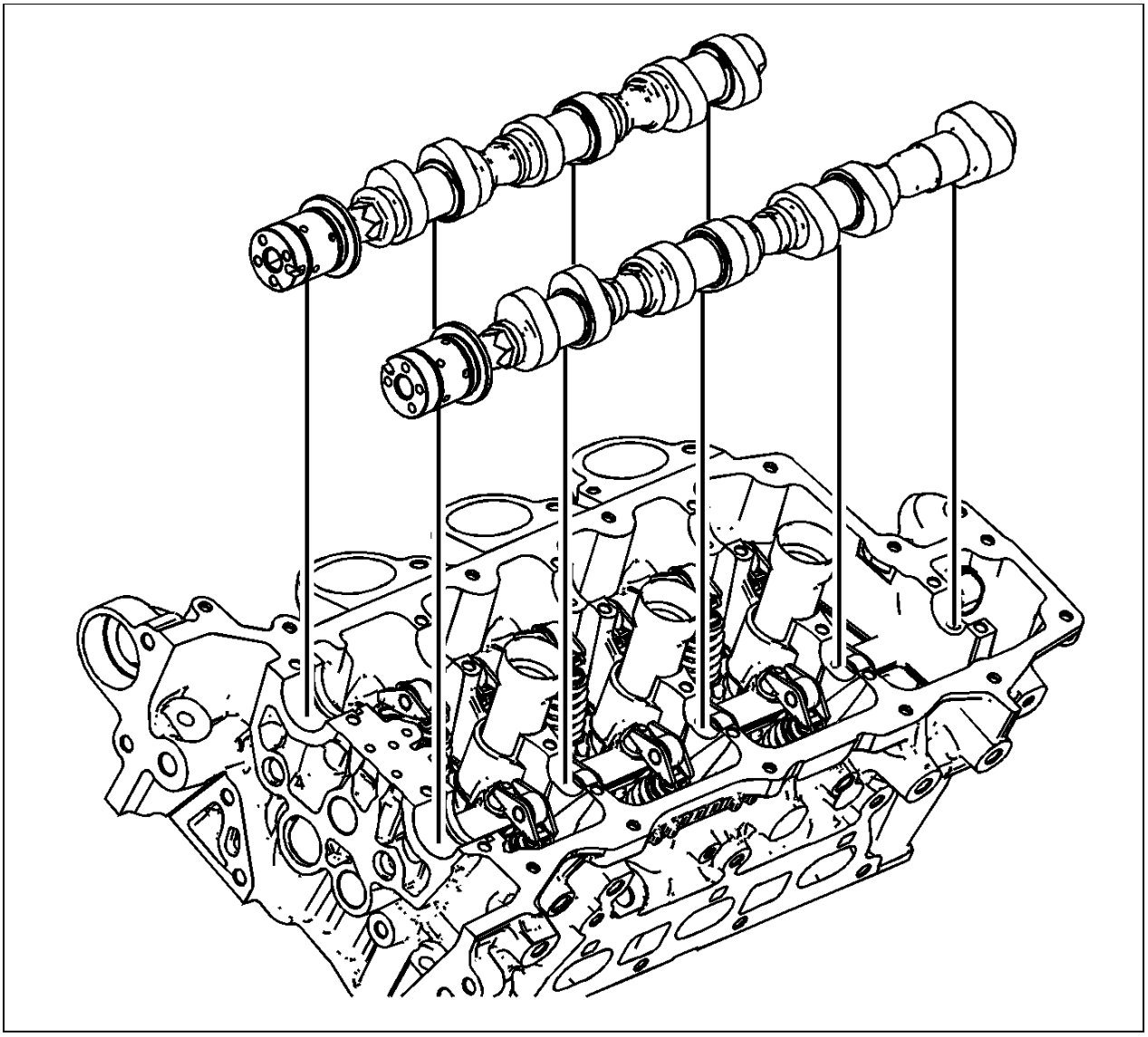
Fig 28: Removing/Installing Camshaft Bearing Thrust Caps



Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft bearing caps.
4. Remove the camshafts.

Fig 29: View of Camshafts and Cylinder Head



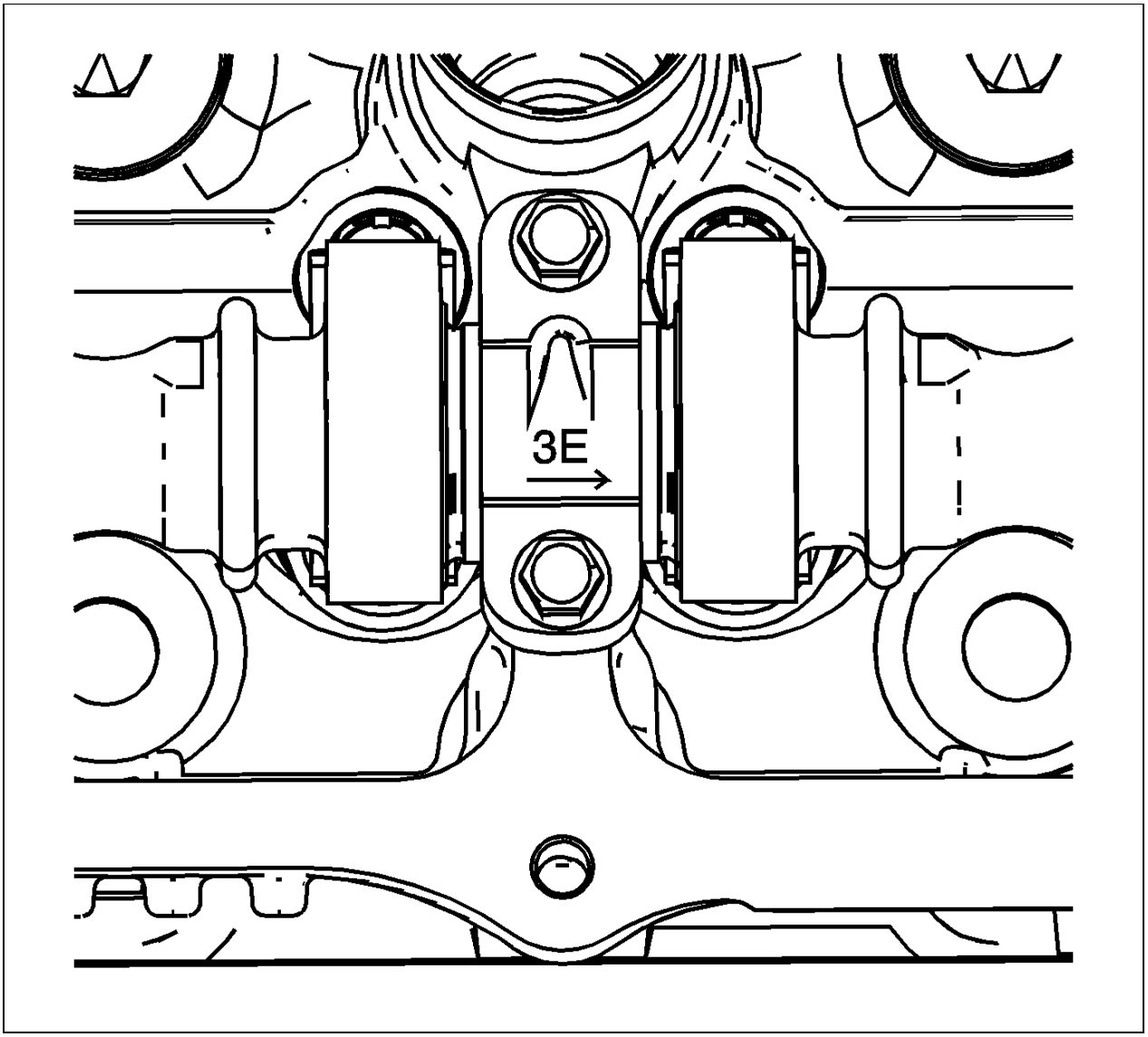
Courtesy of GENERAL MOTORS COMPANY

NOTE: *Mark the camshafts upon removal to ensure installation is in the correct position.*

Camshaft Removal - Right Side (LF4)

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:

Fig 30: Identifying Markings On Bearing Caps

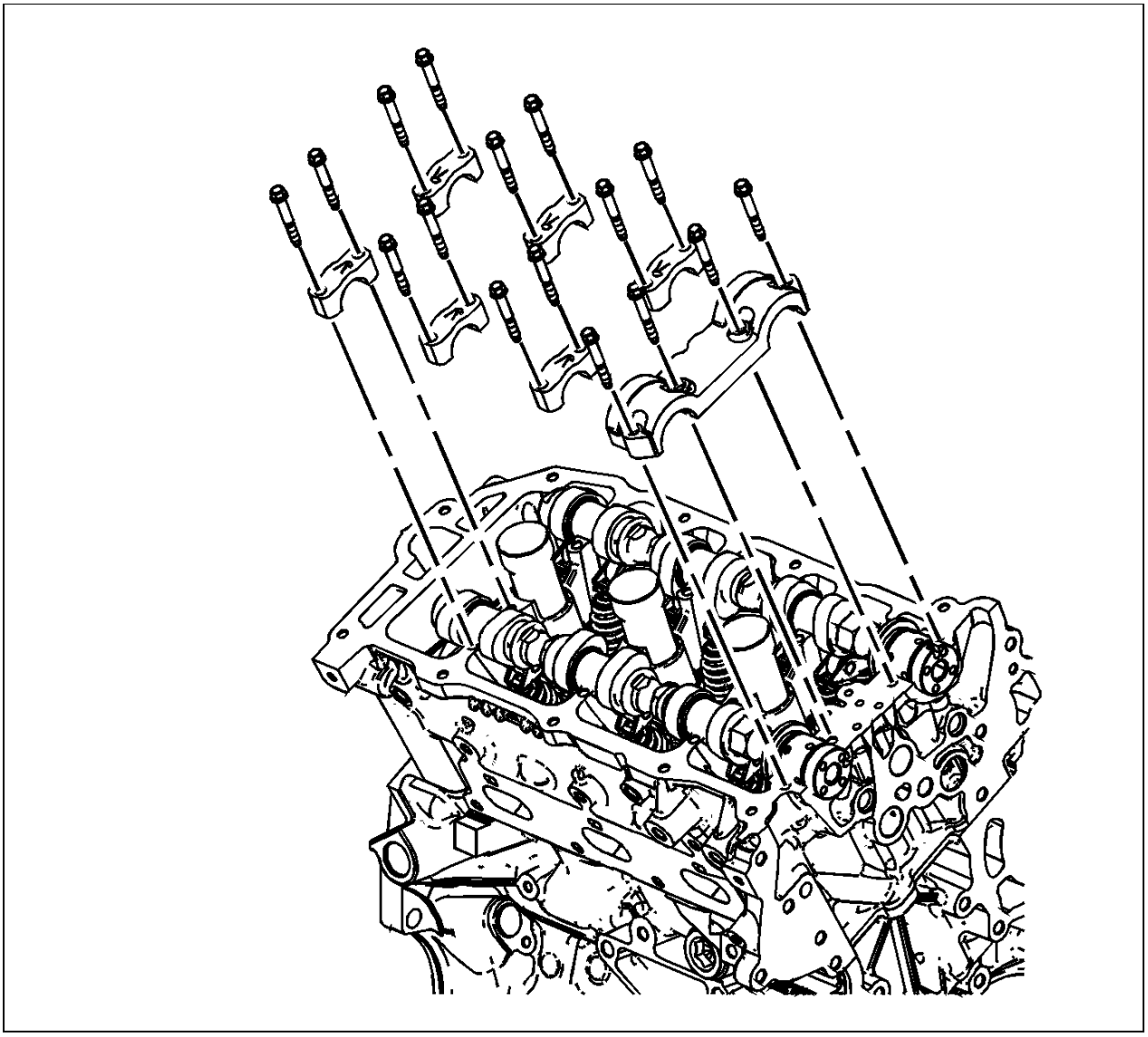


Courtesy of GENERAL MOTORS COMPANY

1. The raised feature must always be oriented toward the center of the cylinder head.
2. The I indicates the intake camshaft.
3. The E indicates the exhaust camshaft.
4. The number indicates the journal position from the front of the engine.

2. Remove the camshaft bearing cap bolts.

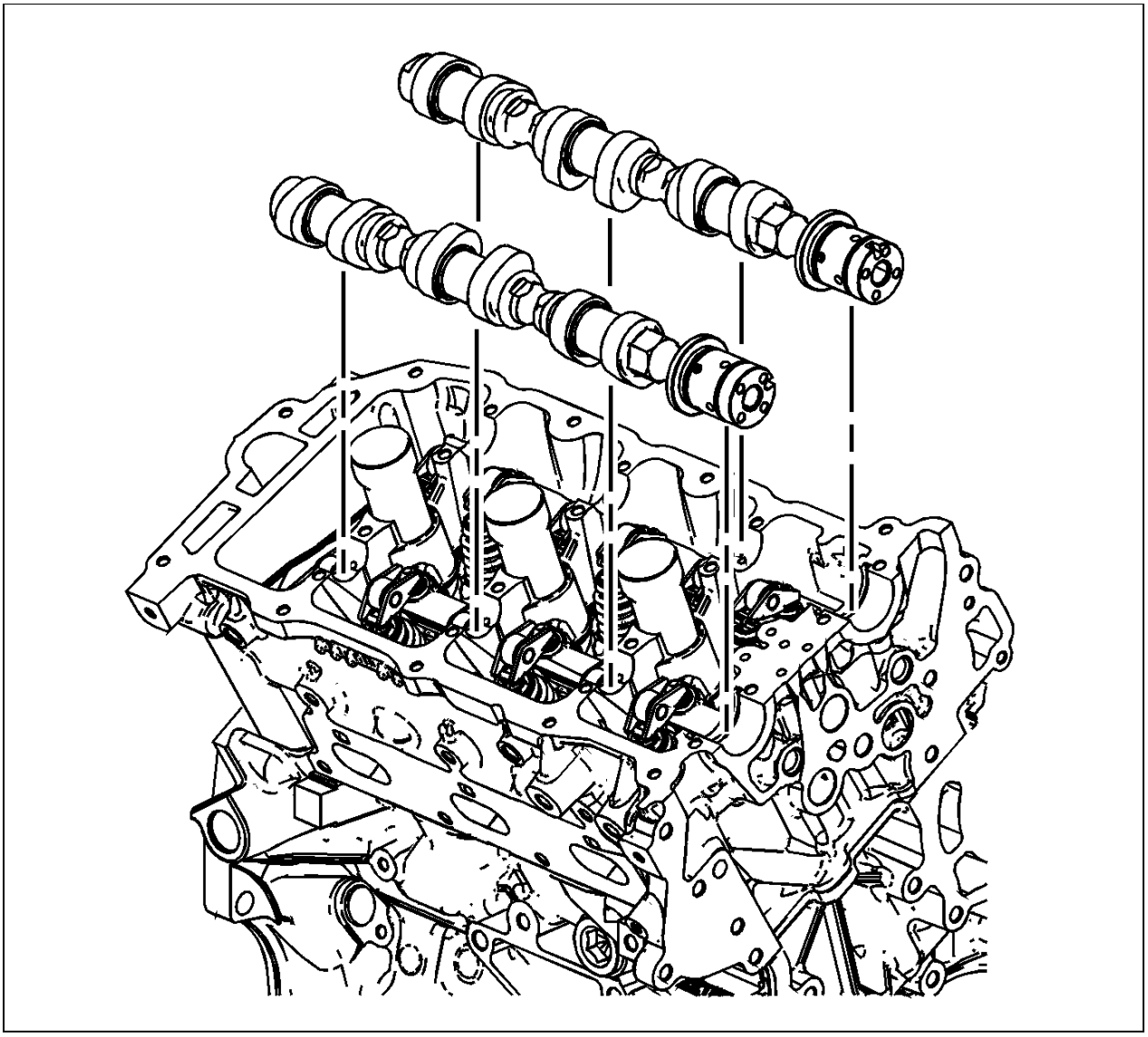
Fig 31: View Of Camshaft Bearing Caps & Bolts



Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft bearing caps.
4. Remove the camshafts.

Fig 32: Locating Camshafts



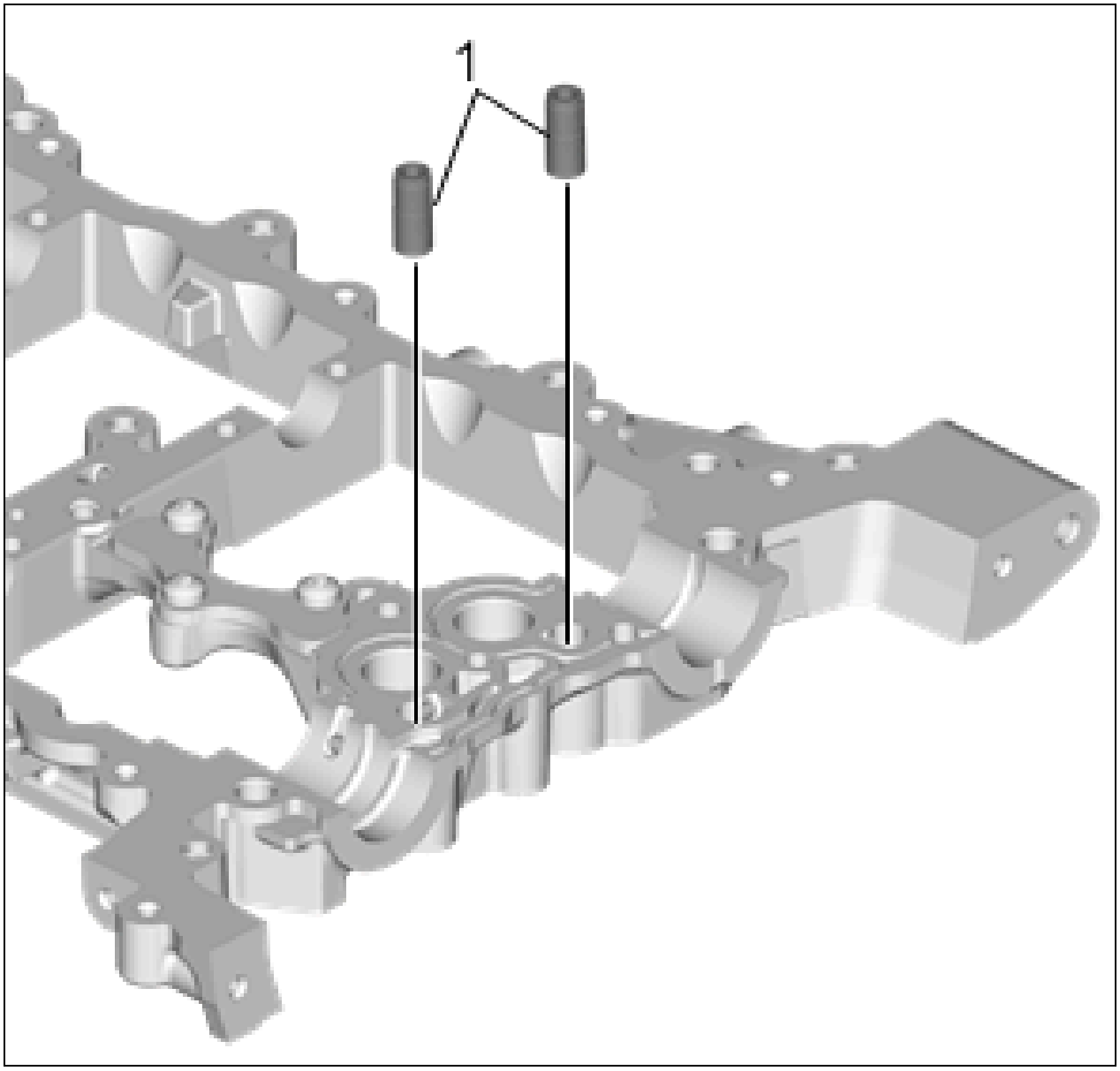
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: *Mark the camshafts upon removal to ensure installation is in the correct position.*

Camshaft Carrier Disassemble

1. Inspect the camshaft position actuator oil feed check valves (1). Damaged, restricted or clogged check valves must be replaced. If check valves require replacement, proceed to step 2.

Fig 33: camshaft position actuator oil feed check valves



Courtesy of GENERAL MOTORS COMPANY

2. Flip over and push out from the bottom side.
3. Clean check valve bore and related passages thoroughly to remove any debris.

Camshaft Carrier Cleaning And Inspection

Cleaning Procedure

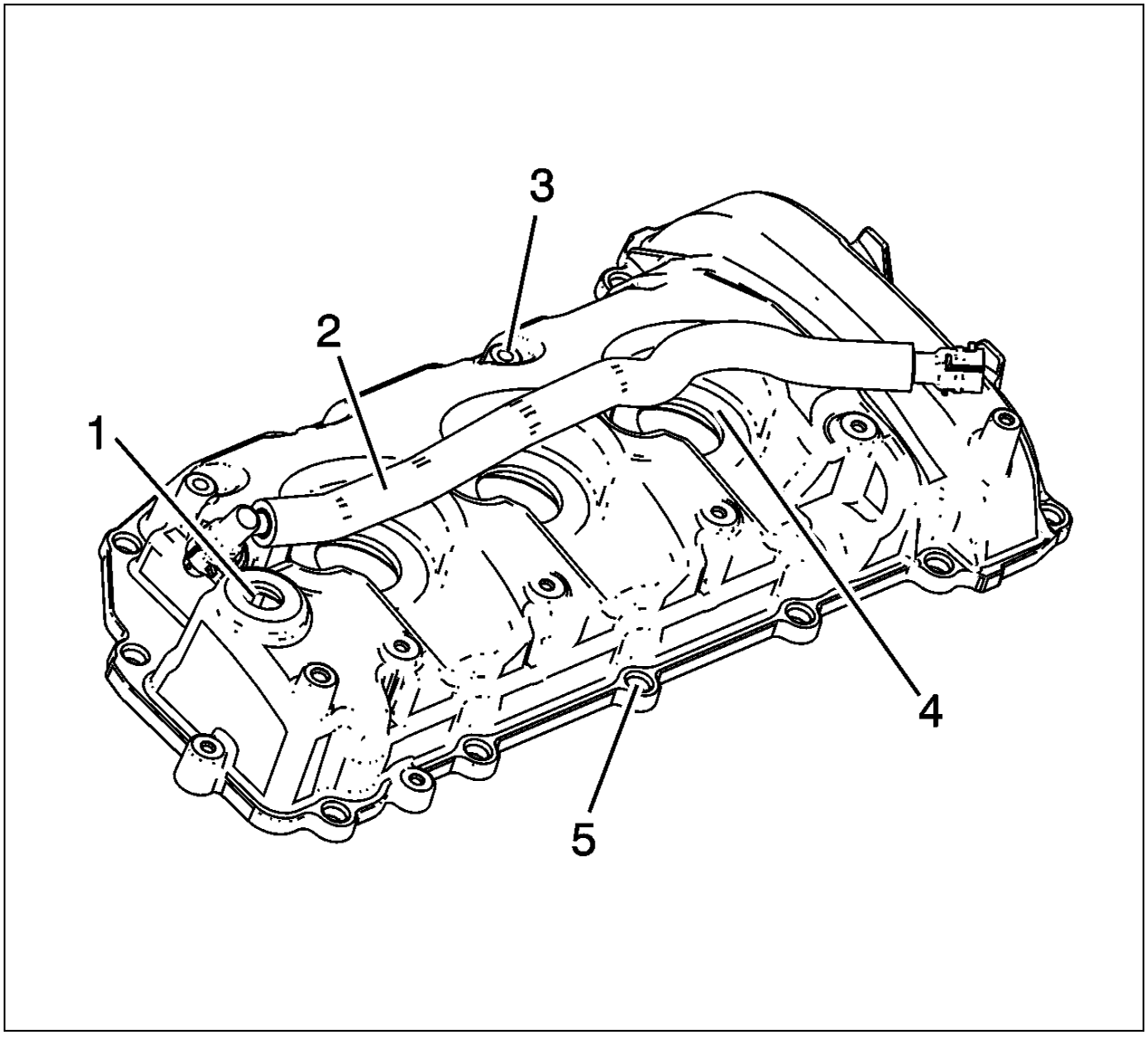
1. Clean the camshaft covers in solvent.
2. Dry the camshaft covers with compressed air.

WARNING: *Refer to Safety Glasses Warning .*

Inspection Procedure

1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
    1. Leak engine oil
    2. Affect crankcase ventilation
    3. Interfere with the camshafts
    4. Interfere with the ignition coil sealing
    5. Allow water or condensation to enter the engine
2. Inspect the exterior of the right camshaft cover for the following conditions:

Fig 34: Camshaft Cover Inspection Points

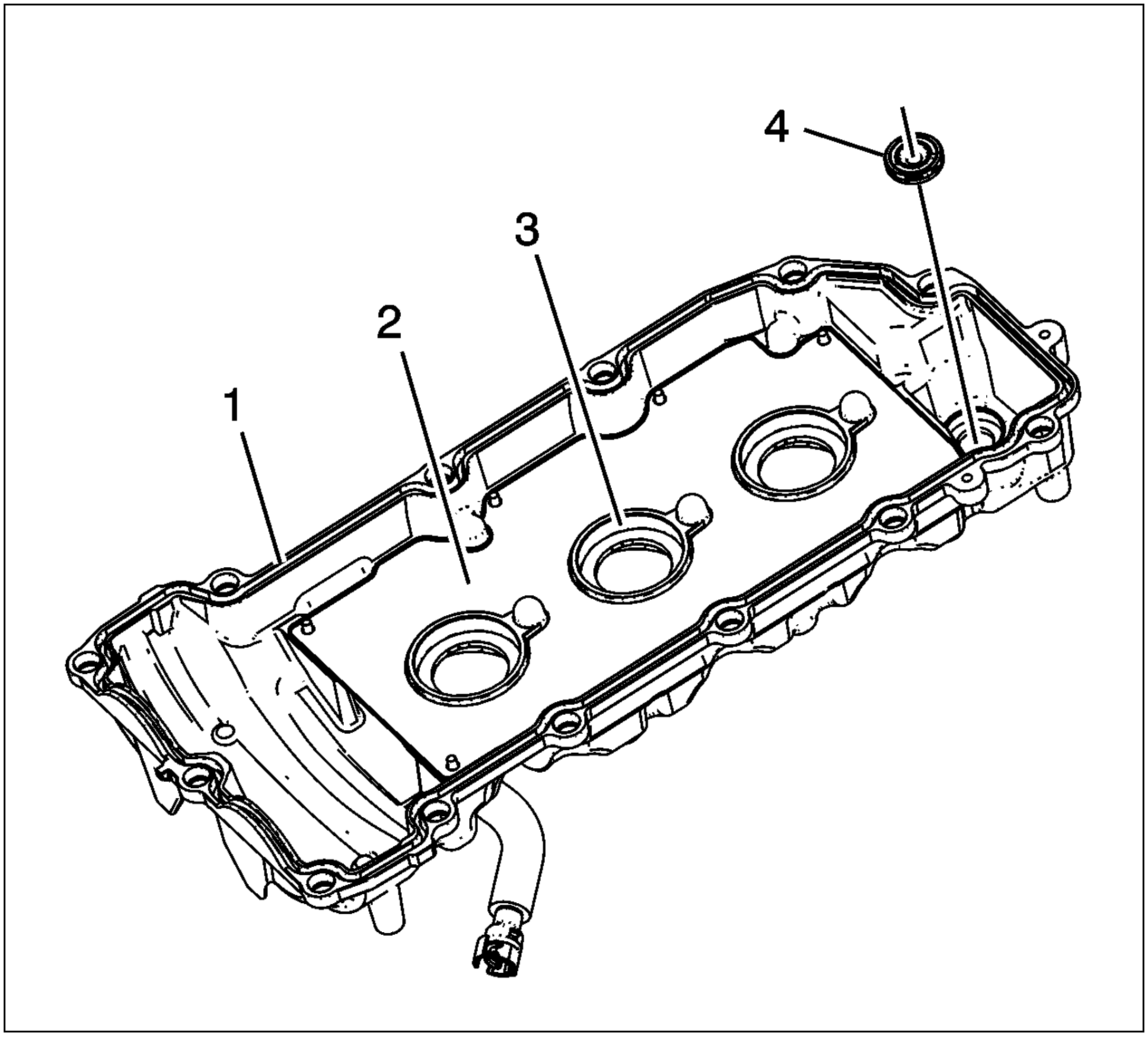


Courtesy of GENERAL MOTORS COMPANY

1. Damage to the vacuum pump hole (1)
2. Damage to the PCV orifice (2) A damaged tamperproof PCV hose or fitting cannot be replaced.
3. Damage to the mounting holes (3) for the ignition coil assembly and fuel injector sight shield ballstud.
4. Damage to the spark plug shield seal bore (4)
5. Damage to the camshaft cover bolt holes (5)

3. Inspect the interior of the right camshaft cover for the following conditions:

Fig 35: Camshaft Cover Inspection Points

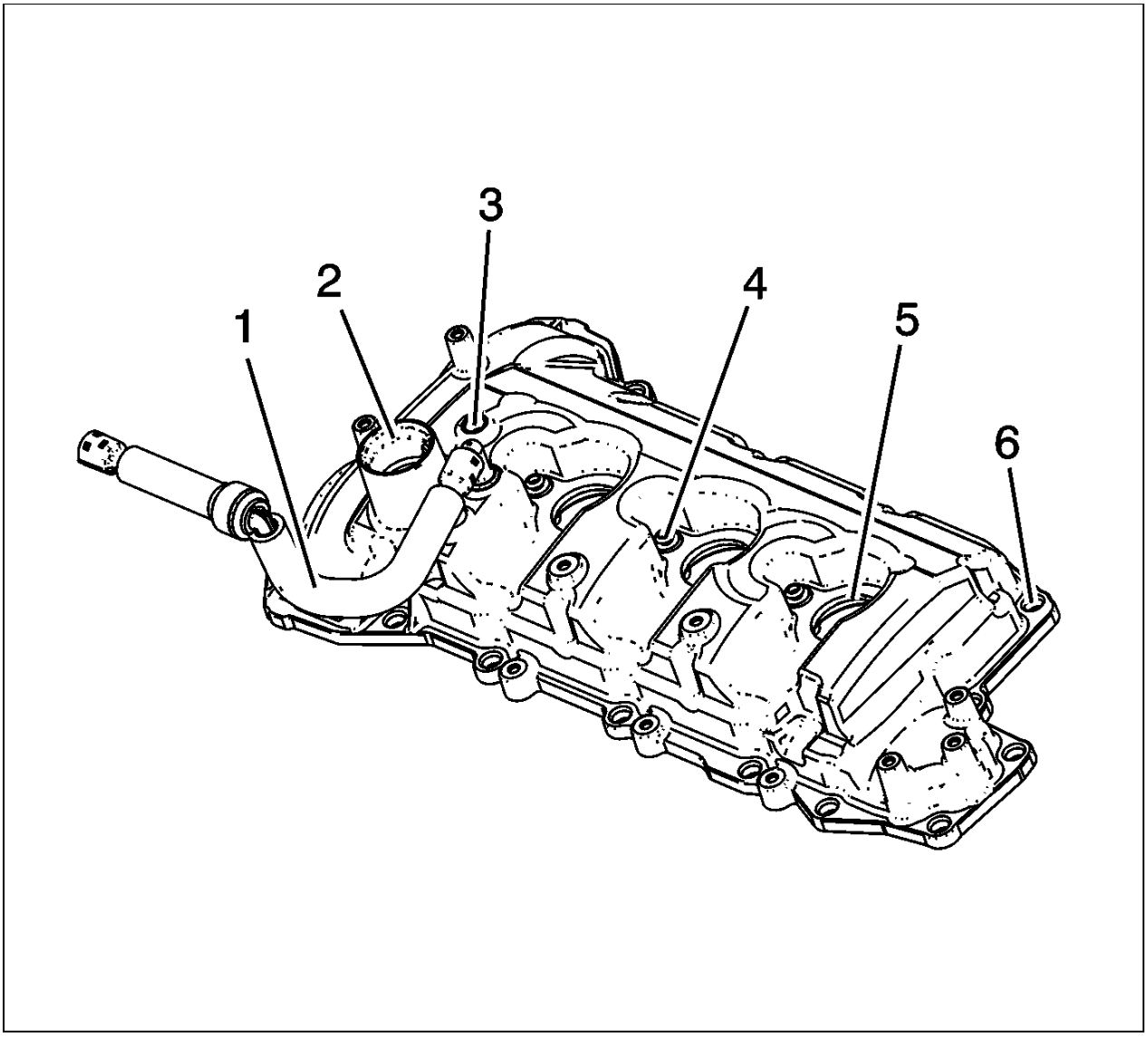


Courtesy of GENERAL MOTORS COMPANY

1. Gouges or damage to the camshaft cover sealing groove (1)
2. Damaged, loose or missing baffle fasteners (2)
3. Gouges or damage to the spark plug shield seal bore (3)
4. Install NEW vacuum pump seal (4)

4. Inspect the exterior of the left camshaft cover for the following conditions:

Fig 36: Camshaft Cover Left Exterior Inspection Points

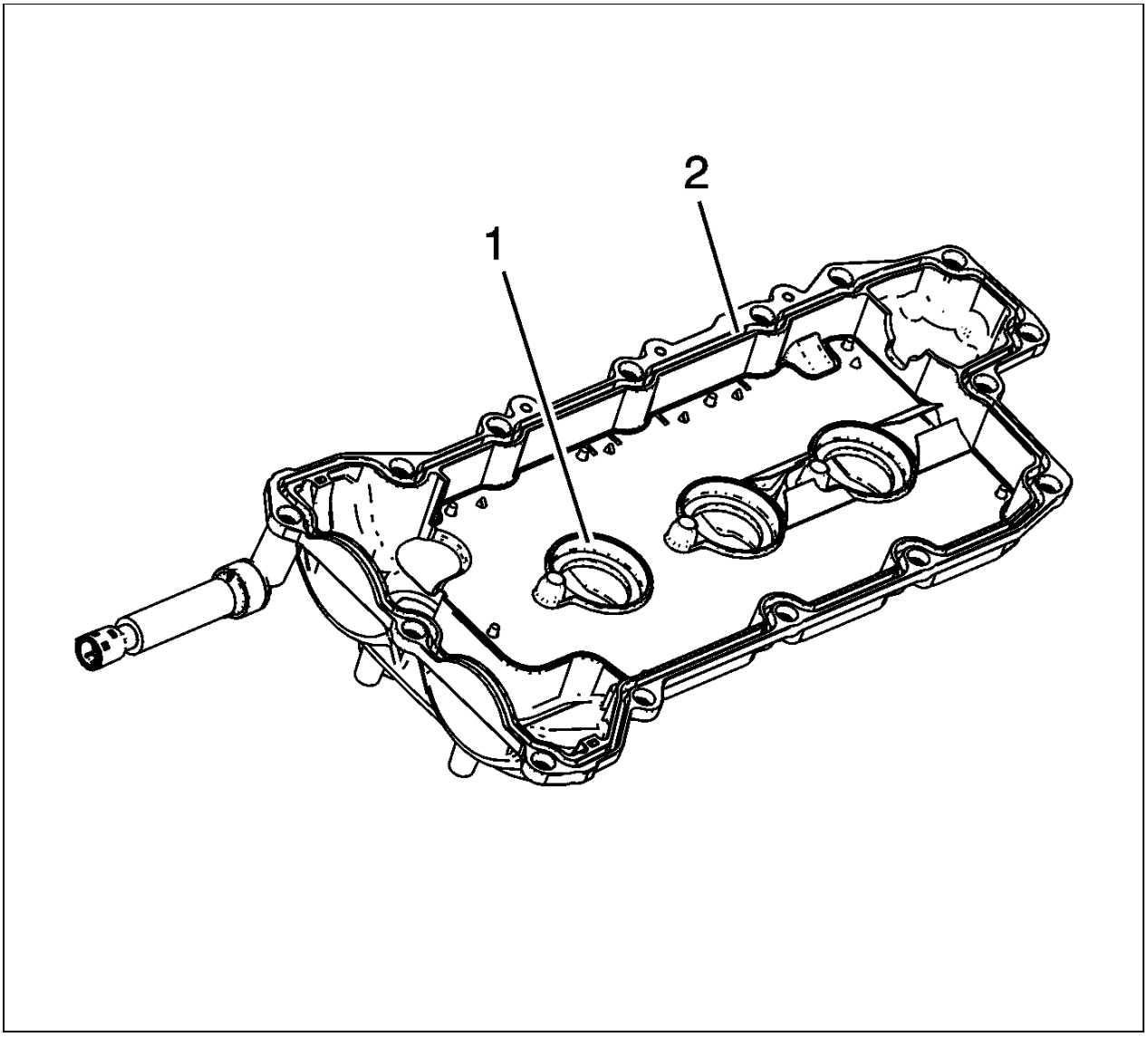


Courtesy of GENERAL MOTORS COMPANY

1. Damage to the PCV orifice (1) A damaged tamperproof PCV hose or fitting cannot be replaced.
2. Damage to the oil fill hole (2)
3. Damage to the PCV orifice (3) A damaged PCV orifice can be replaced.
4. Damage to the mounting holes (4) for the ignition coil assembly
5. Gouges or damage to the spark plug shield seal bore (5)
6. Damage to the camshaft cover bolt holes (6)

5. Inspect the interior of the left camshaft cover for the following conditions:

Fig 37: Camshaft Cover Left Interior Inspection Points



Courtesy of GENERAL MOTORS COMPANY

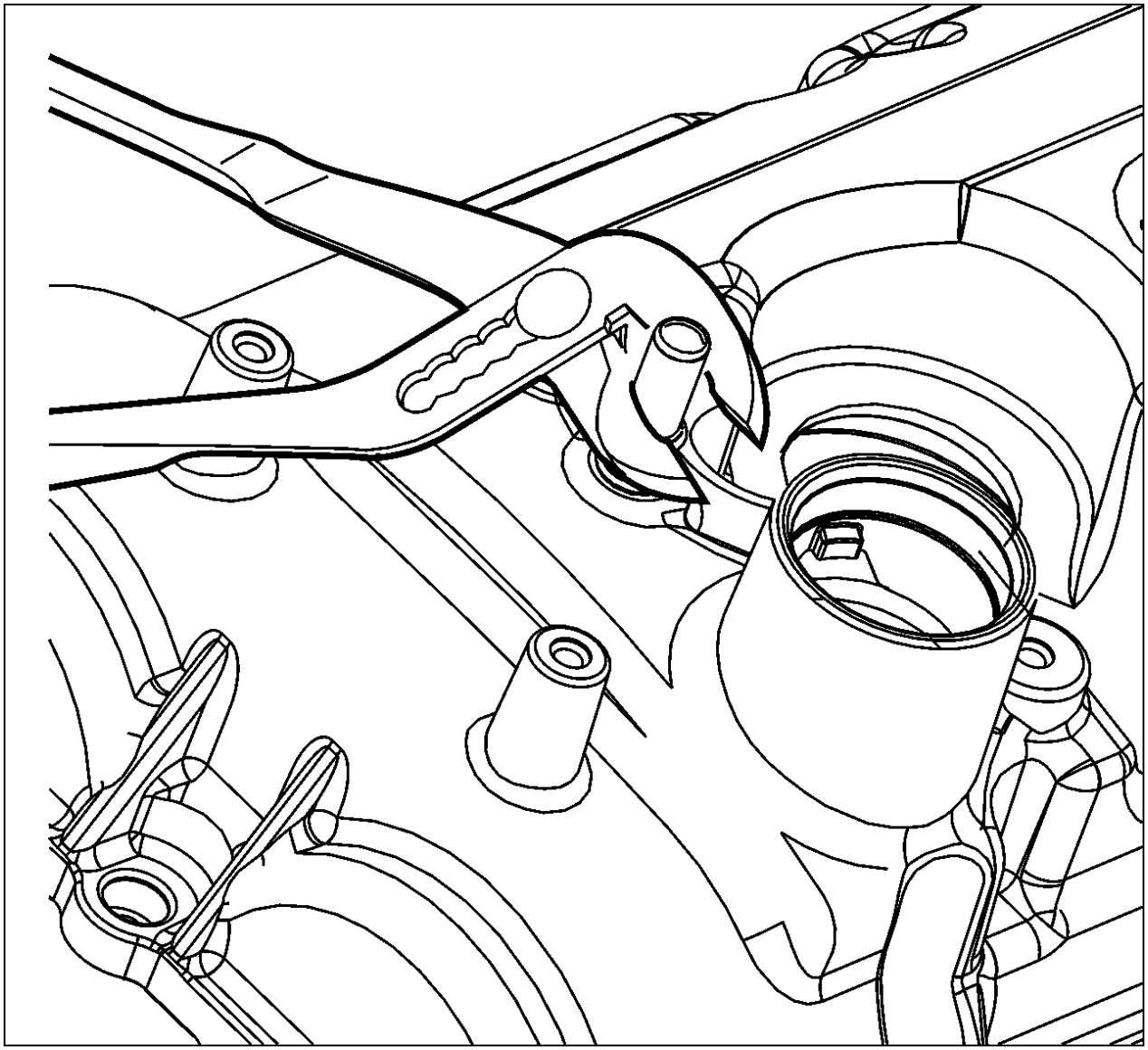
1. Gouges or damage to the spark plug shield seal bore (1)
2. Gouges or damage to the camshaft cover sealing groove (2)

6. Repair or replace the camshaft cover or covers as necessary.

PCV Orifice Replacement

1. Remove the old PCV orifice by gripping the neck of the orifice with pliers and twisting and pulling out of the left camshaft cover.

Fig 38: PCV Orifice

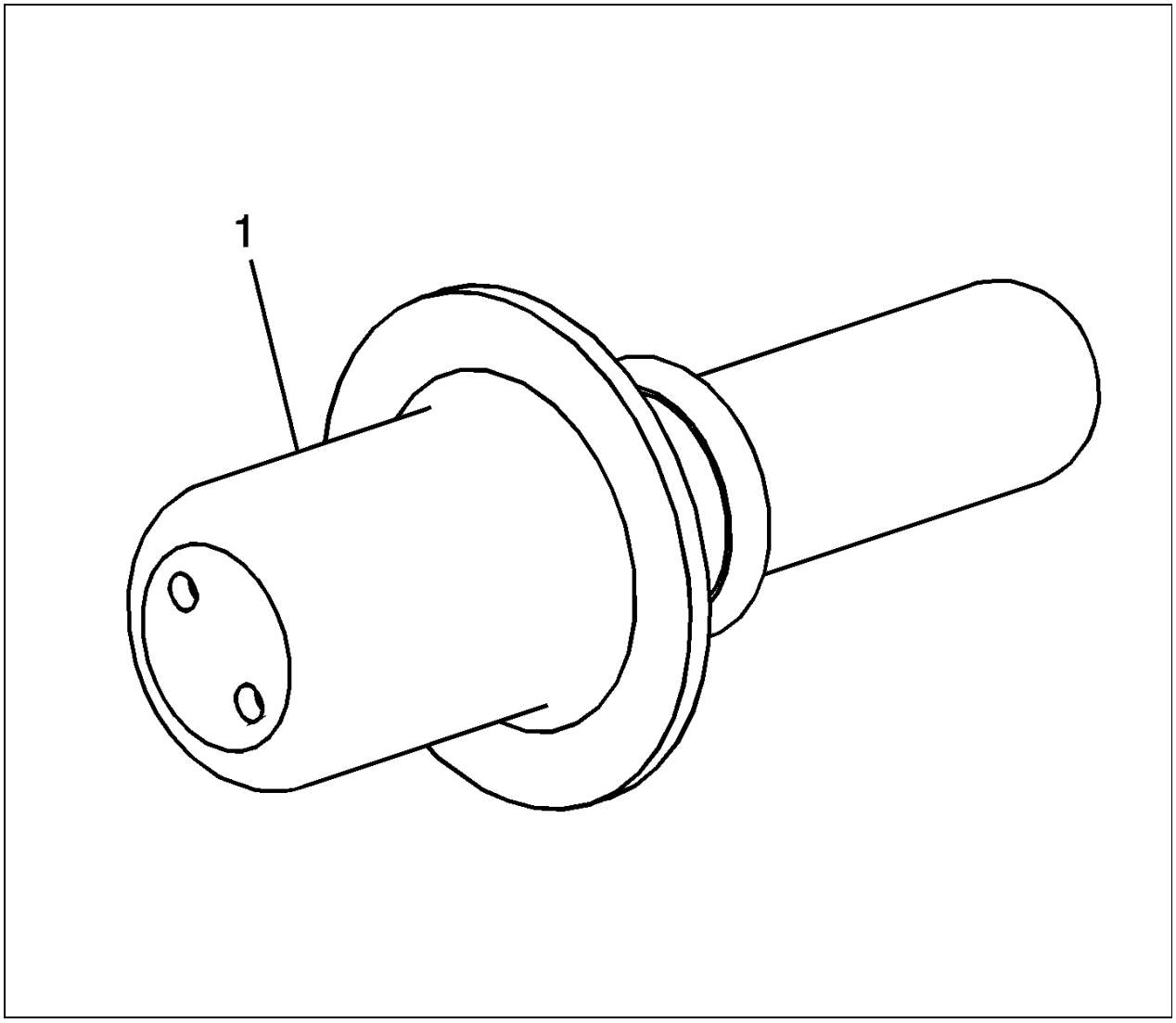


Courtesy of GENERAL MOTORS COMPANY

NOTE: *If the PCV orifice is damaged or plugged and cannot be cleaned out, the PCV orifice can be replaced.*

2. Apply sealant to the NEW PCV orifice (1). Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended sealant.

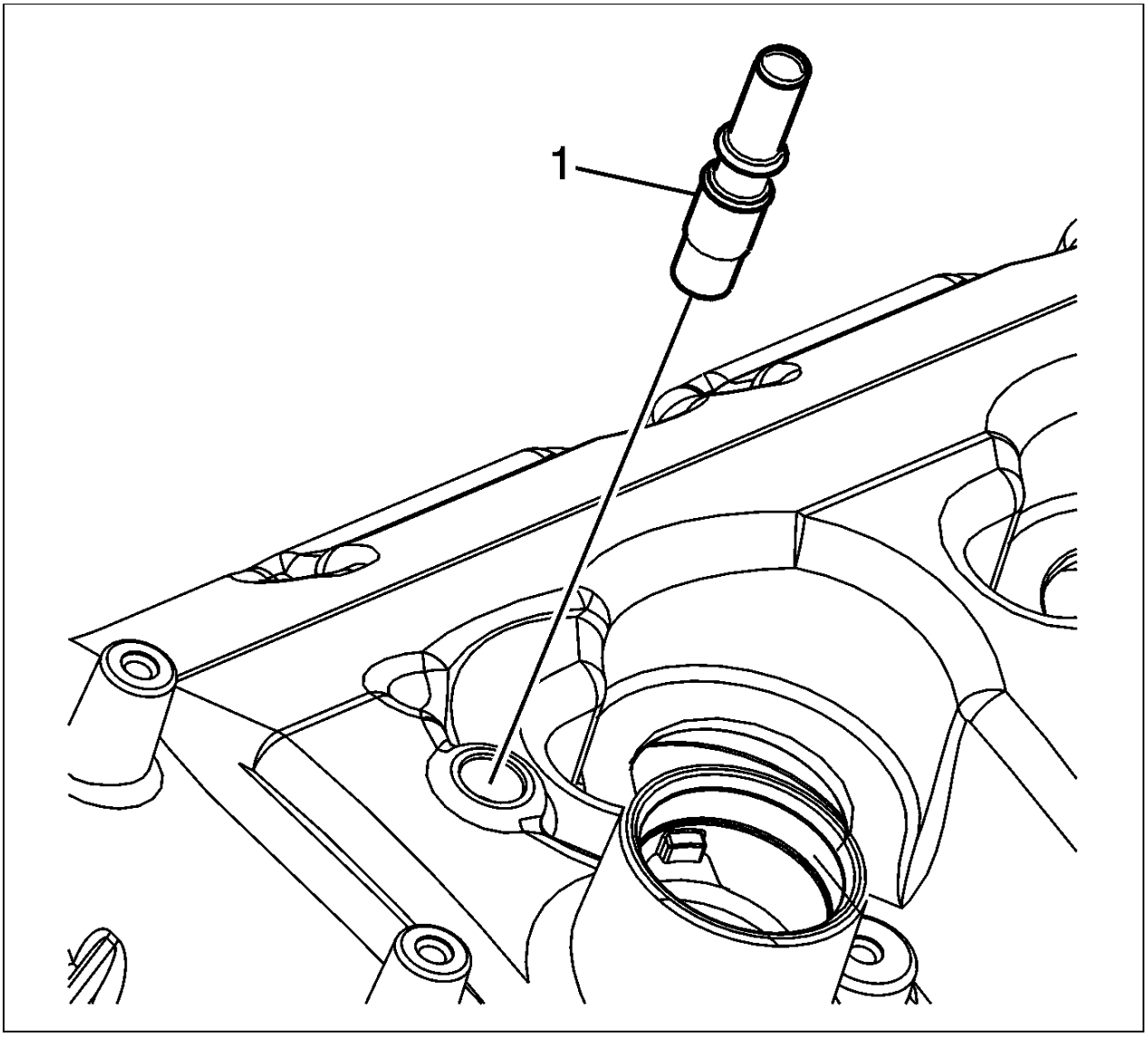
Fig 39: Identifying Sealant Area On PCV Orifice



Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW PCV orifice (1) into the left camshaft cover. After insertion, twist the PCV orifice in order to eliminate any vertical leak paths in the sealant.

Fig 40: PCV Orifice



Courtesy of GENERAL MOTORS COMPANY

Camshaft Cleaning And Inspection

Special Tools
GE 7872 Magnetic Base Dial Indicator
For equivalent regional tools, refer to Special Tools (LGX)Special Tools (LF4) .

Cleaning Procedure

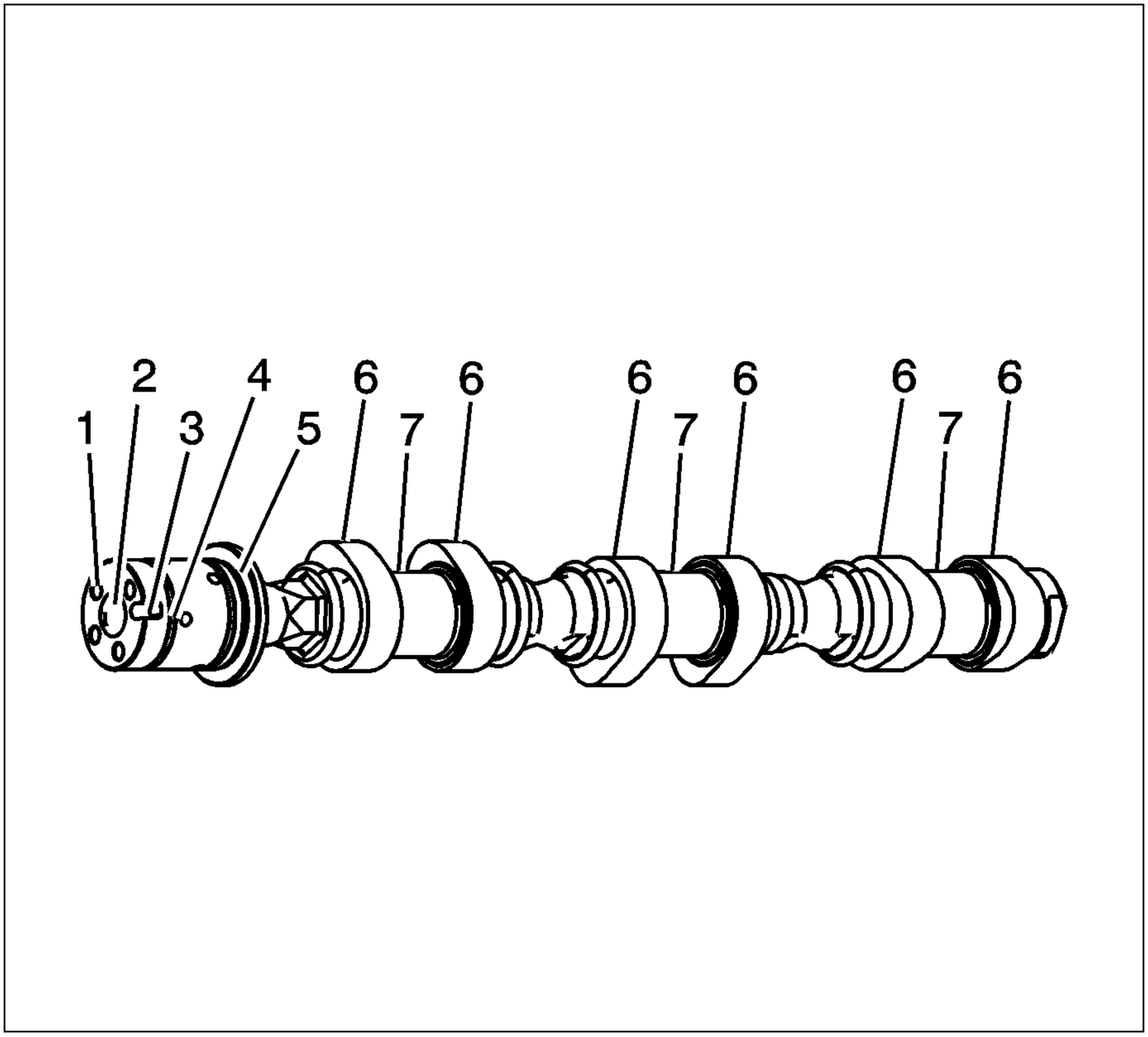
1. Clean the camshaft in solvent.
2. Dry the camshaft with compressed air.

> **WARNING:** *Refer to Safety Glasses Warning .*

Visual Inspection

1. Inspect the camshaft oil feed holes (1) to the camshaft position actuator for dirt, debris or blockage.

Fig 41: Identifying Camshaft Inspection Areas



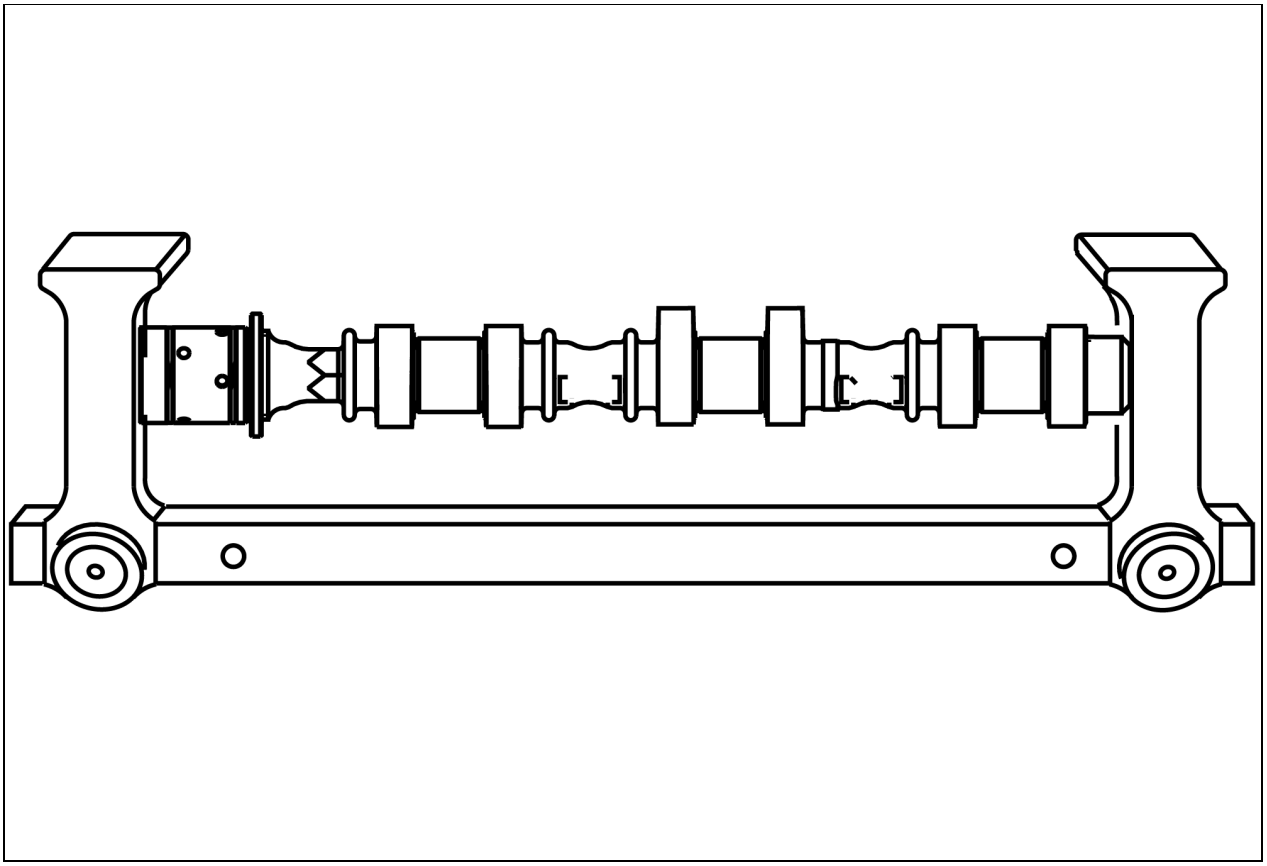
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the threaded hole (2) for damage.
3. Inspect the camshaft position actuator locating notch (3) for damage or wear.
4. Inspect the camshaft sealing grooves (4) for damage.
5. Inspect the camshaft thrust surface (5) for damage.
6. Inspect the camshaft lobes (6) and journals (7) for the following conditions:
    1. Excessive scoring or pitting
    2. Discoloration from overheating
    3. Deformation from excessive wear, especially the camshaft lobes
7. If any of the above conditions exist on the camshaft, replace the camshaft.

Camshaft Measurement

1. With the camshaft in a suitable fixture, measure the camshaft for wear.

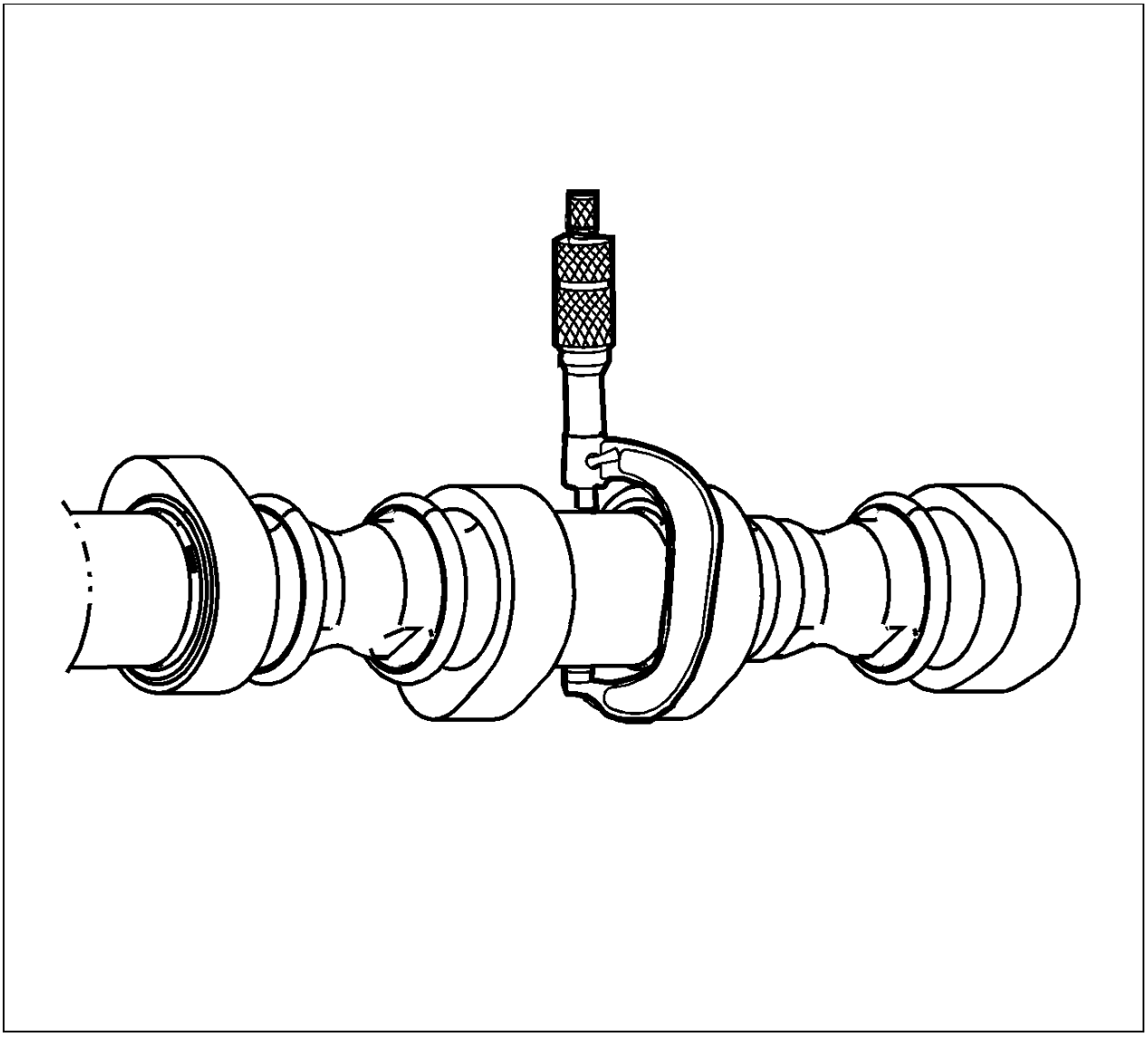
   Fig 42: Supporting Camshaft In Fixture



Courtesy of GENERAL MOTORS COMPANY

2. Measure the camshaft journals for diameter and out-of-round using an outside micrometer. Refer to Engine Mechanical Specifications (LF4)Engine Mechanical Specifications (LGX) .

Fig 43: Measuring Camshaft Journals

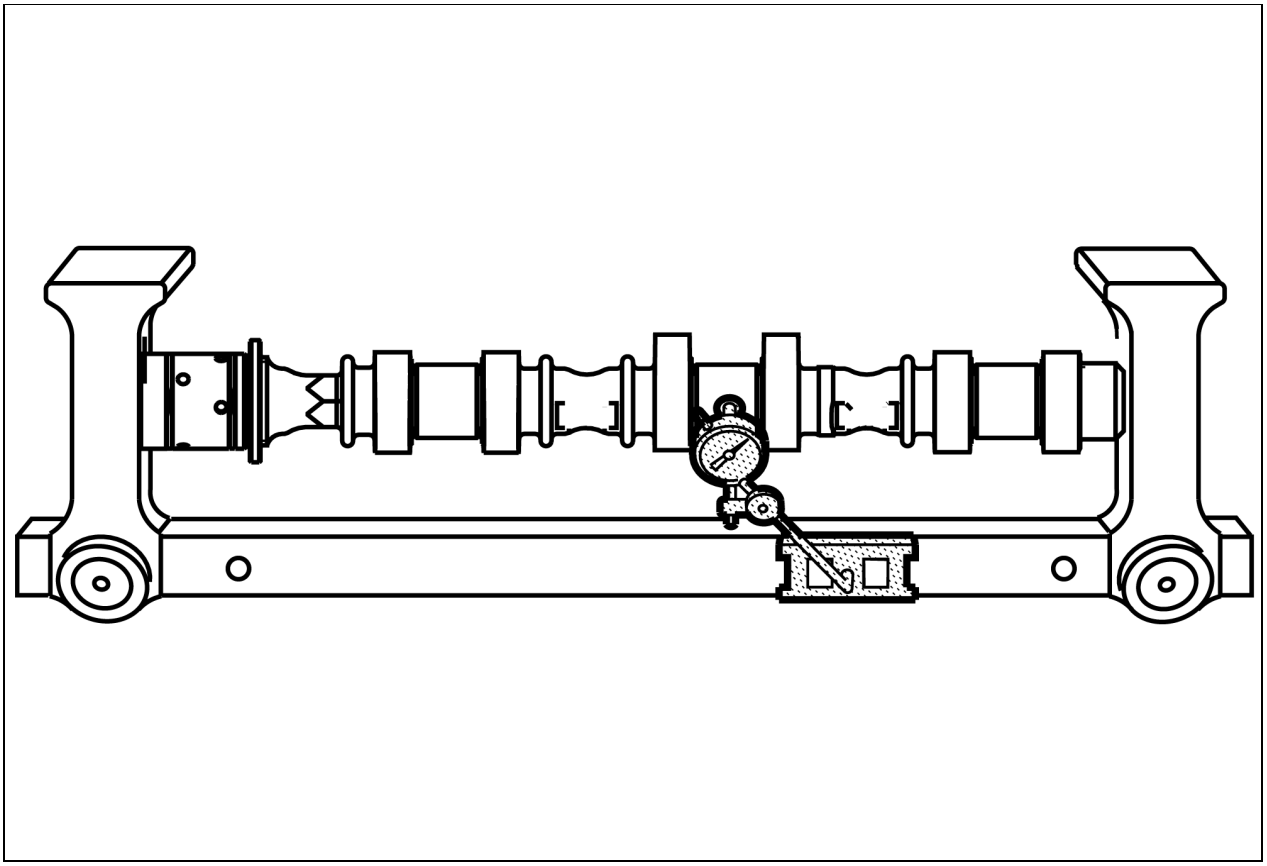


Courtesy of GENERAL MOTORS COMPANY

1. If the diameter is smaller than specifications, replace the camshaft.
2. If the out-of-round exceeds specifications, replace the camshaft.

3. Measure the camshaft runout using the **GE 7872** indicator. Refer to Engine Mechanical Specifications (LF4)Engine Mechanical Specifications (LGX) .

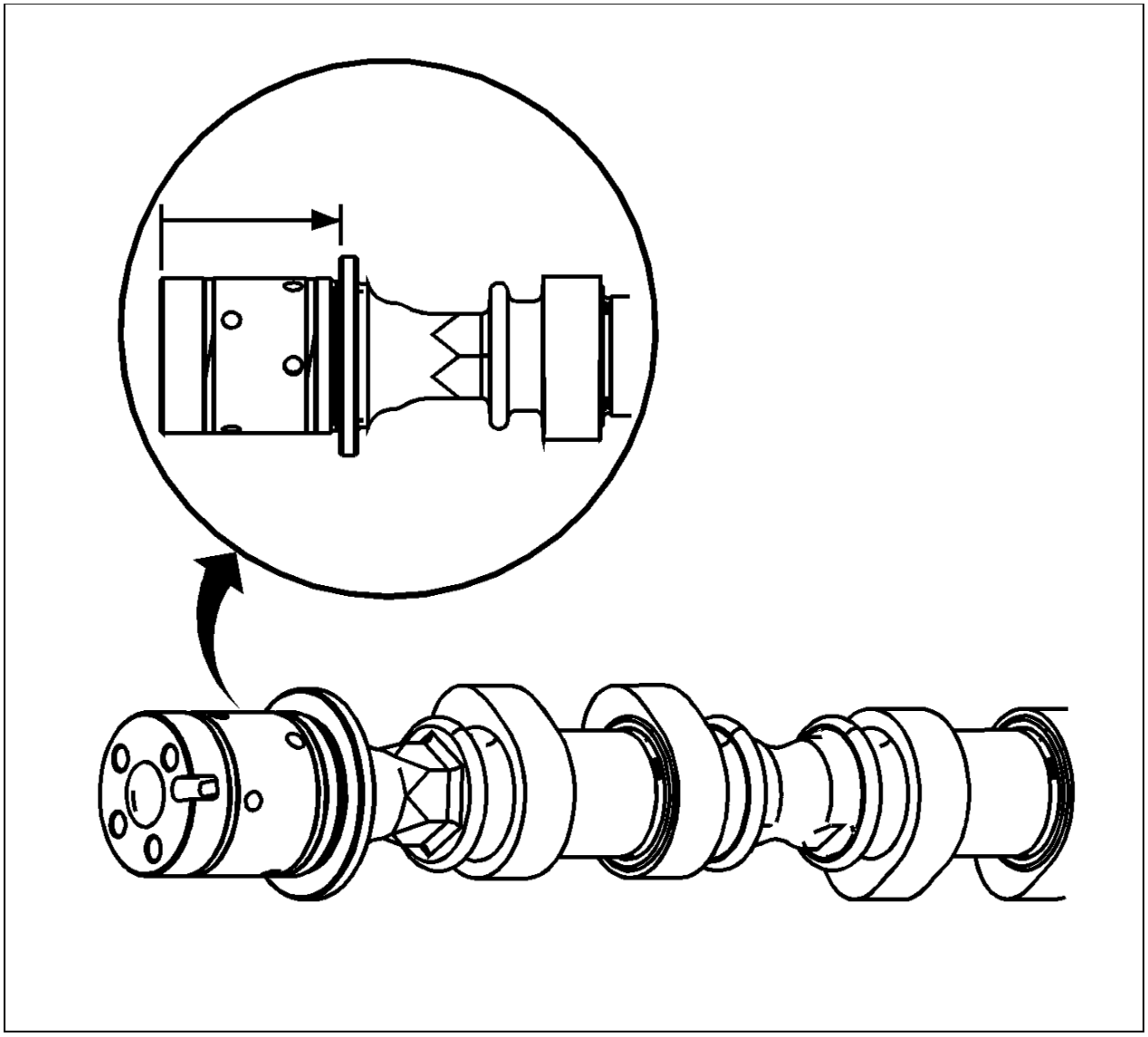
Fig 44: Checking Camshaft Runout



Courtesy of GENERAL MOTORS COMPANY

4. Measure the camshaft thrust width for wear using a depth micrometer. Refer to Engine Mechanical Specifications (LF4)Engine Mechanical Specifications (LGX) .

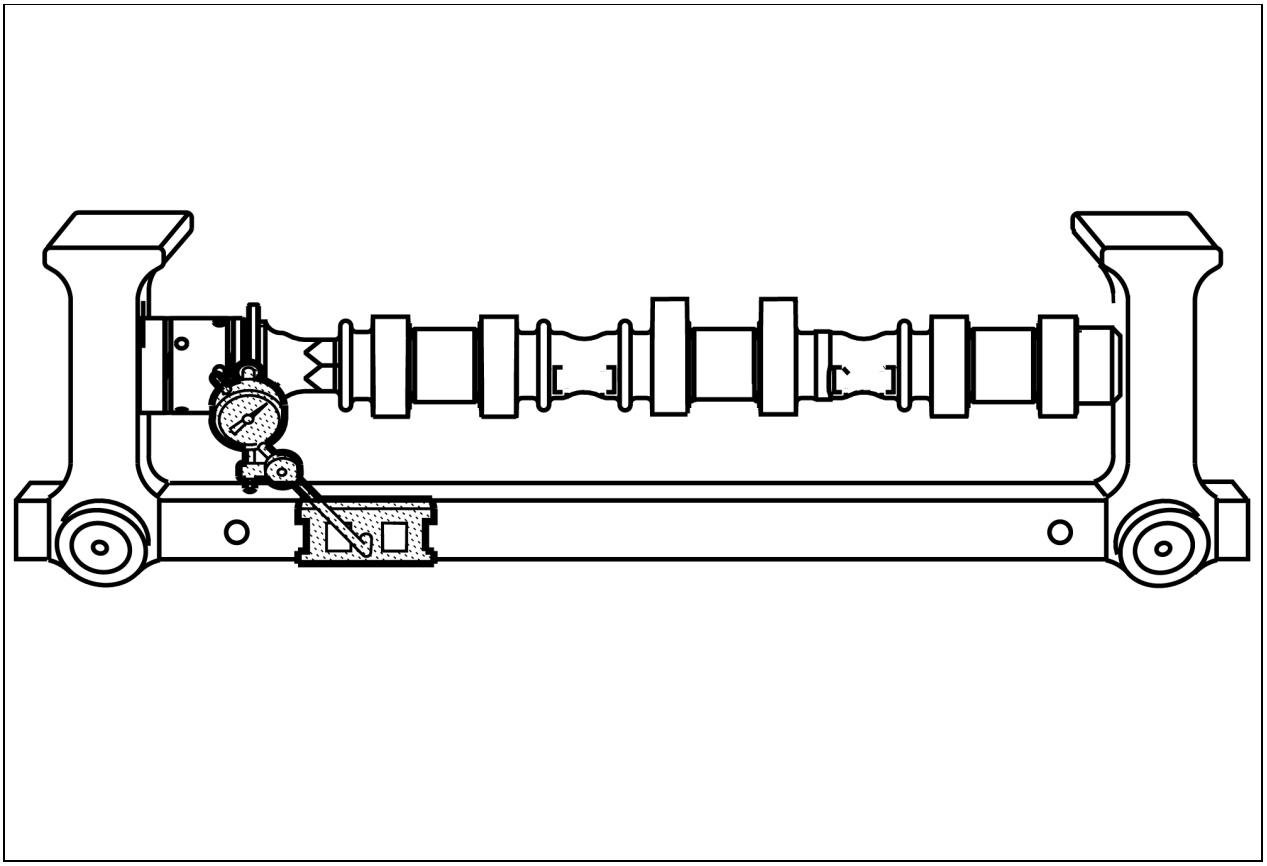
Fig 45: Measuring Camshaft Thrust Width



Courtesy of GENERAL MOTORS COMPANY

5. Measure the camshaft thrust wall surface for runout using **GE 7872** indicator. Refer to Engine Mechanical Specifications (LF4)Engine Mechanical Specifications (LGX) .

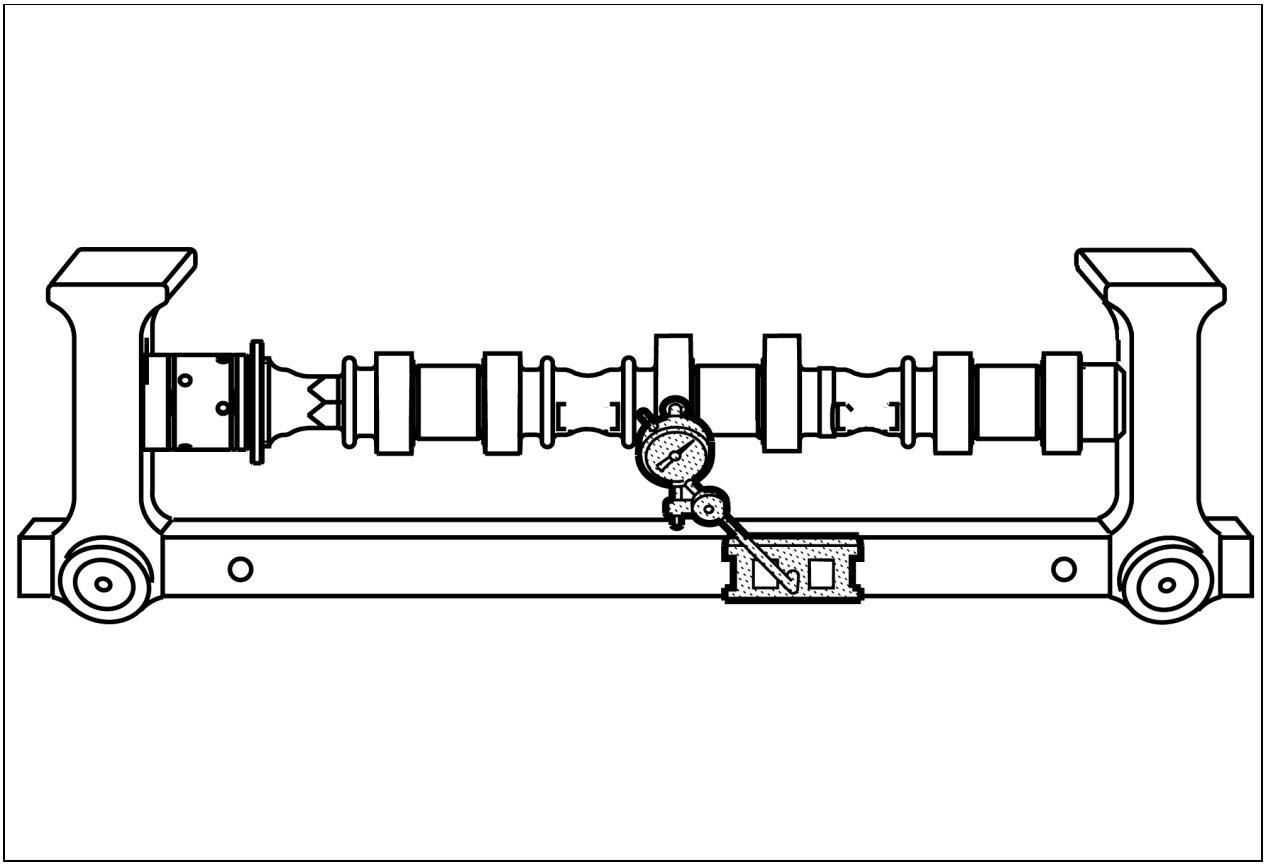
Fig 46: Measuring Camshaft



Courtesy of GENERAL MOTORS COMPANY

6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.
7. Measure the camshaft lobes for wear using the **GE 7872** indicator.

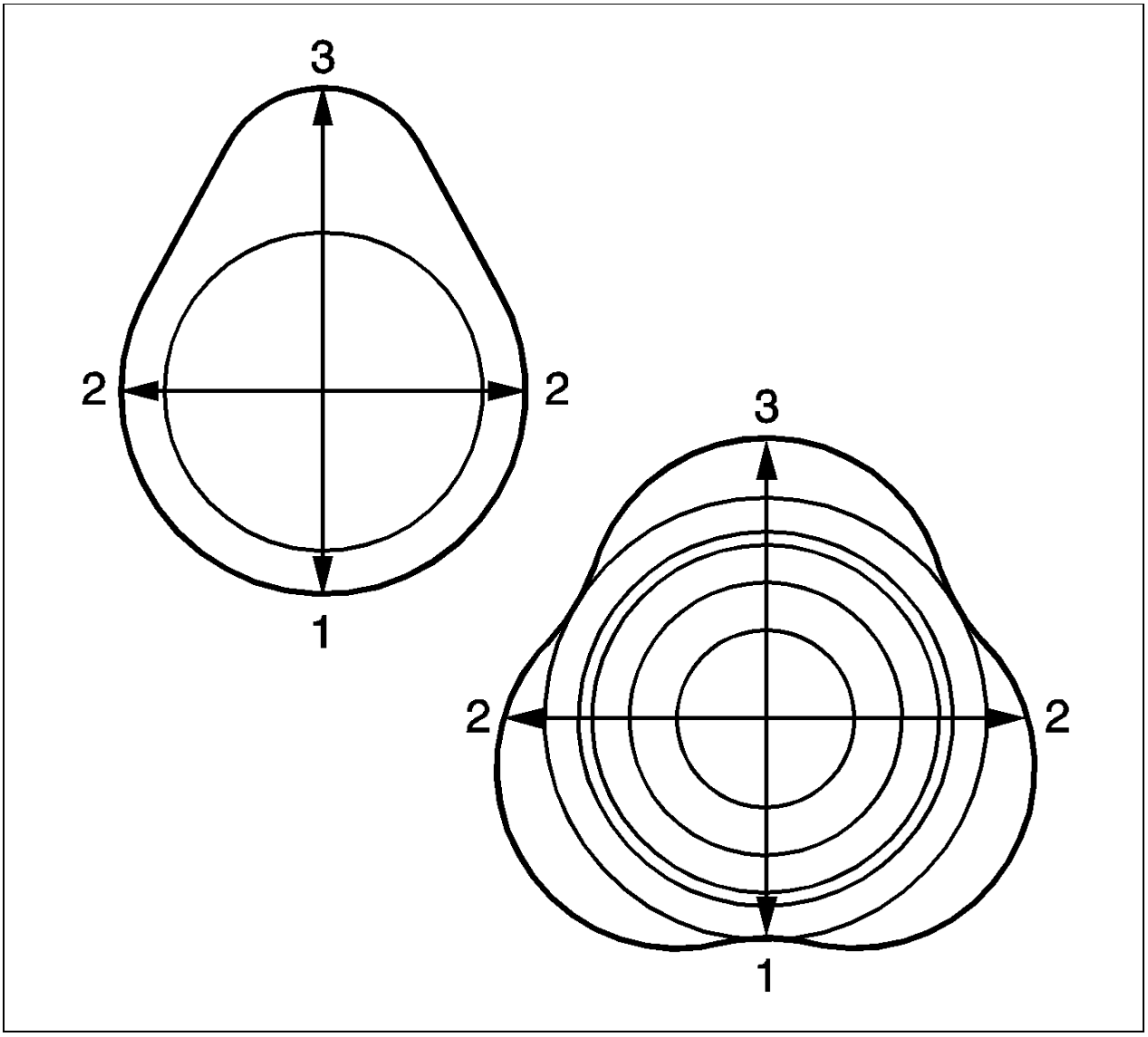
Fig 47: Measuring Camshaft Lobes For Wear



Courtesy of GENERAL MOTORS COMPANY

8. Place the **GE 7872** indicator with the indicator tip on the base circle (1) of the camshaft lobe.

Fig 48: View of Lobe Diagram



Courtesy of GENERAL MOTORS COMPANY

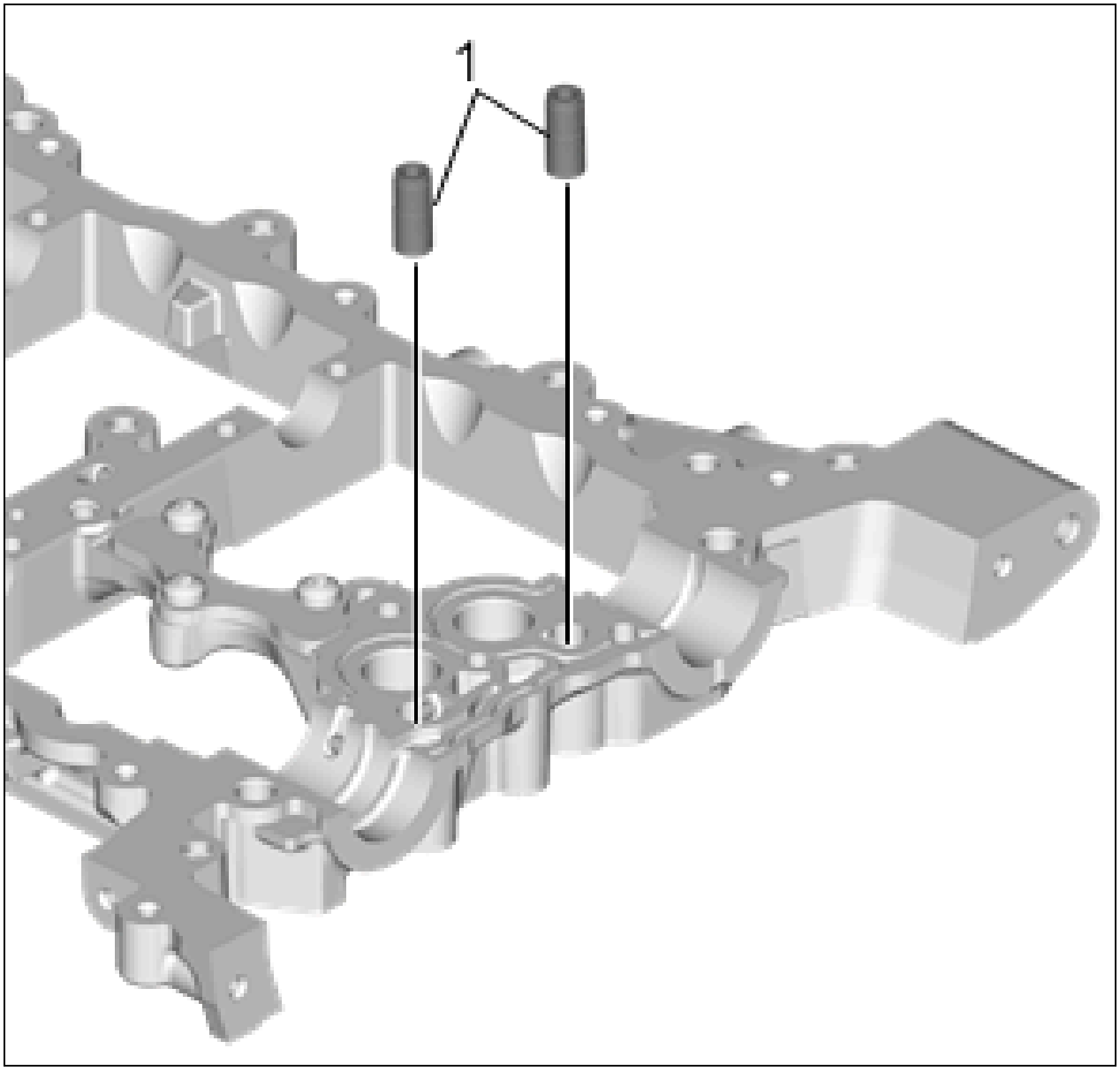
1. Place the **GE 7872** indicator at zero.
2. Rotate the camshaft until the indicator tip is at the highest point (3) on the lobe. This reading is the lift of the camshaft lobe. Refer to Engine Mechanical Specifications (LF4)Engine Mechanical Specifications (LGX) .
3. If the indicated measurement is significantly lower than these specifications, replace the camshaft or engine performance will be reduced.

Camshaft Carrier Assemble

Special Tools
EN-46122 Camshaft Position Actuator Check-Ball Valve Remover/Installer
For equivalent regional tools, refer to Special Tools (LGX)Special Tools (LF4) .

1. Use lubricant included with **EN-46122** remover/installer to lubricate outside of new check valve (1).

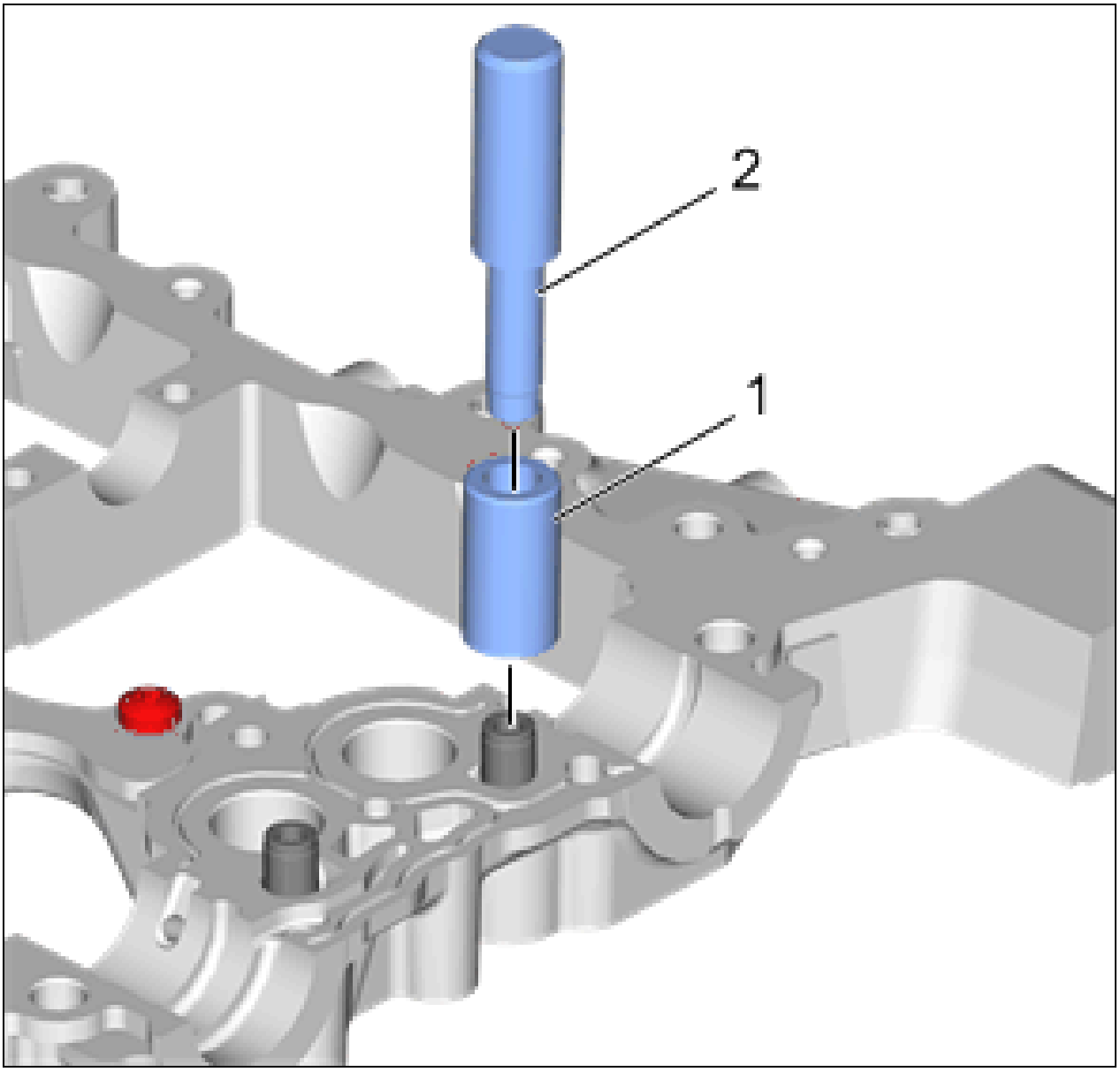
Fig 49: Camshaft Carrier Check Valves



Courtesy of GENERAL MOTORS COMPANY

2. With the check ball end of the check valve facing UP, away from the head, insert the NEW check valve into the check valve bore in the cylinder head.
3. Place collar **EN-46122-2** (1) over the new check valve with the slightly-larger inside diameter of the collar DOWN toward the cylinder head.

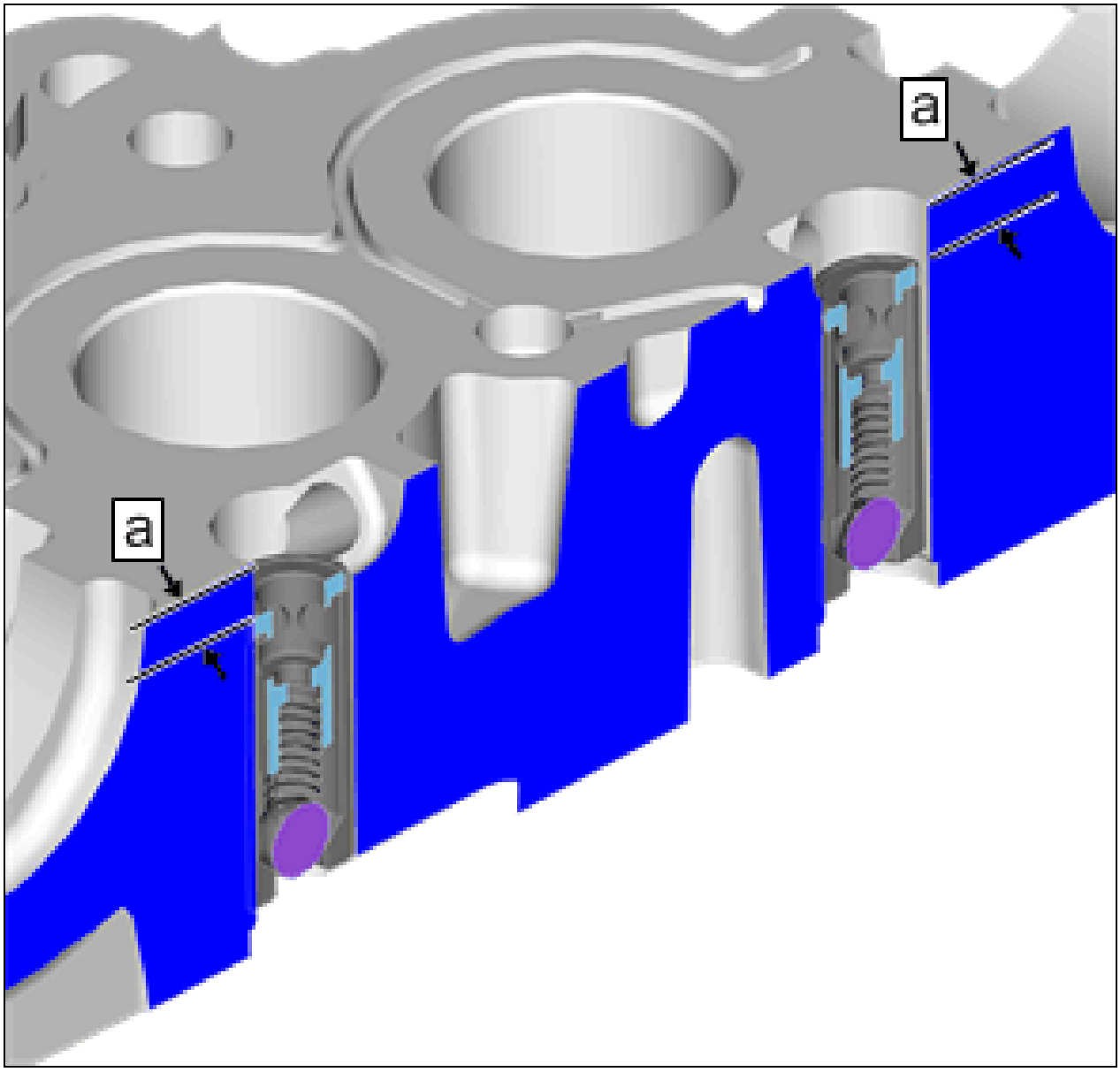
Fig 50: Installing Camshaft Carrier Check Valves



Courtesy of GENERAL MOTORS COMPANY

4. Using the driver **EN-46122-1** (2), lightly tap the new check valve into place until the driver stops against the top of the collar.
5. Inspect the camshaft position actuator oil feed check valves in order to ensure they are properly installed in the cylinder head. The camshaft position actuator oil feed check valve should be flush to .75 mm (0.0295 in) below the cylinder head deck surface (a).

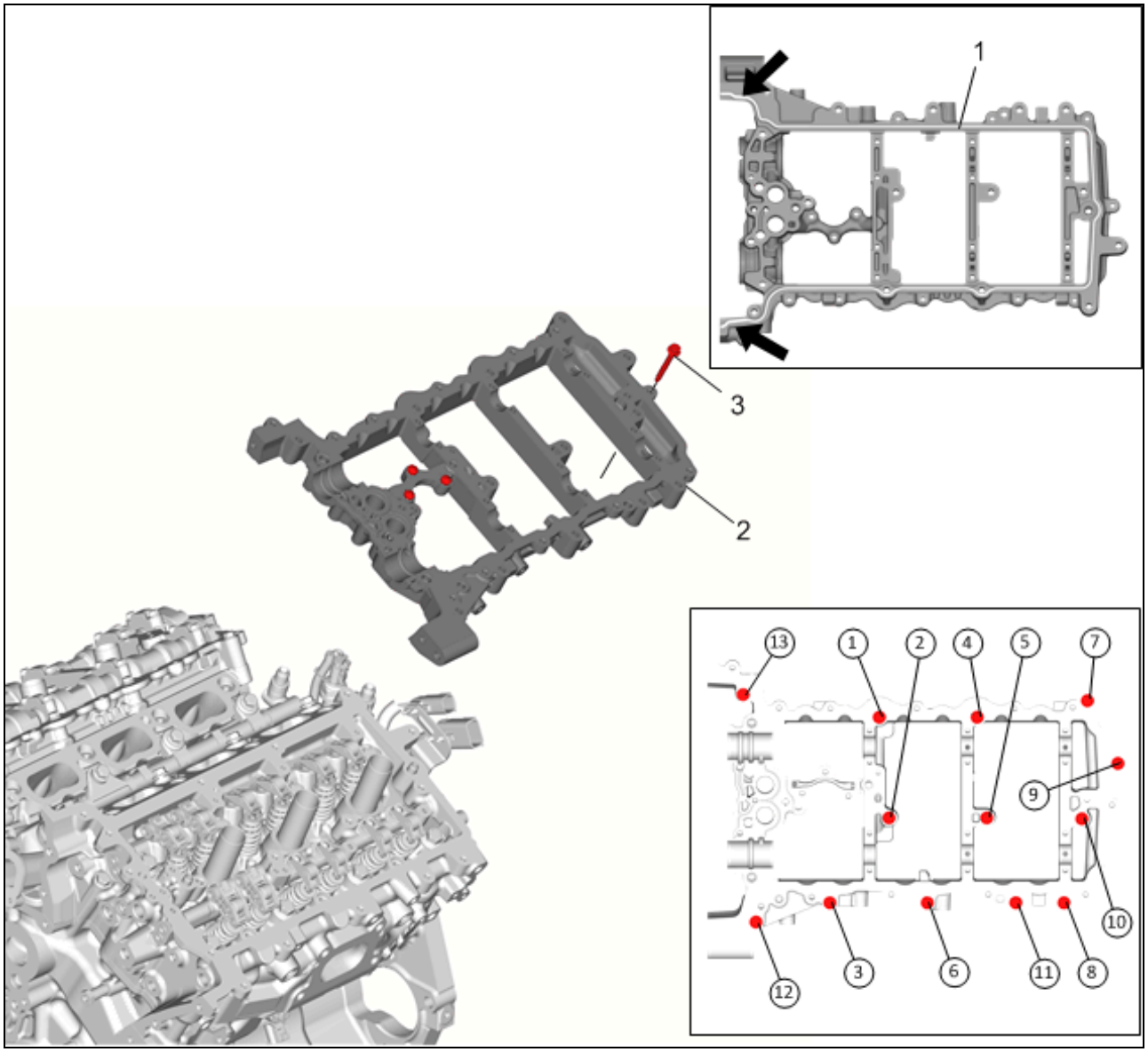
Fig 51: Camshaft Position Actuator Oil Feed Check Valve Installed Depth



Courtesy of GENERAL MOTORS COMPANY

Camshaft Carrier Installation - Left Side

Fig 52: Camshaft Carrier - Left Side



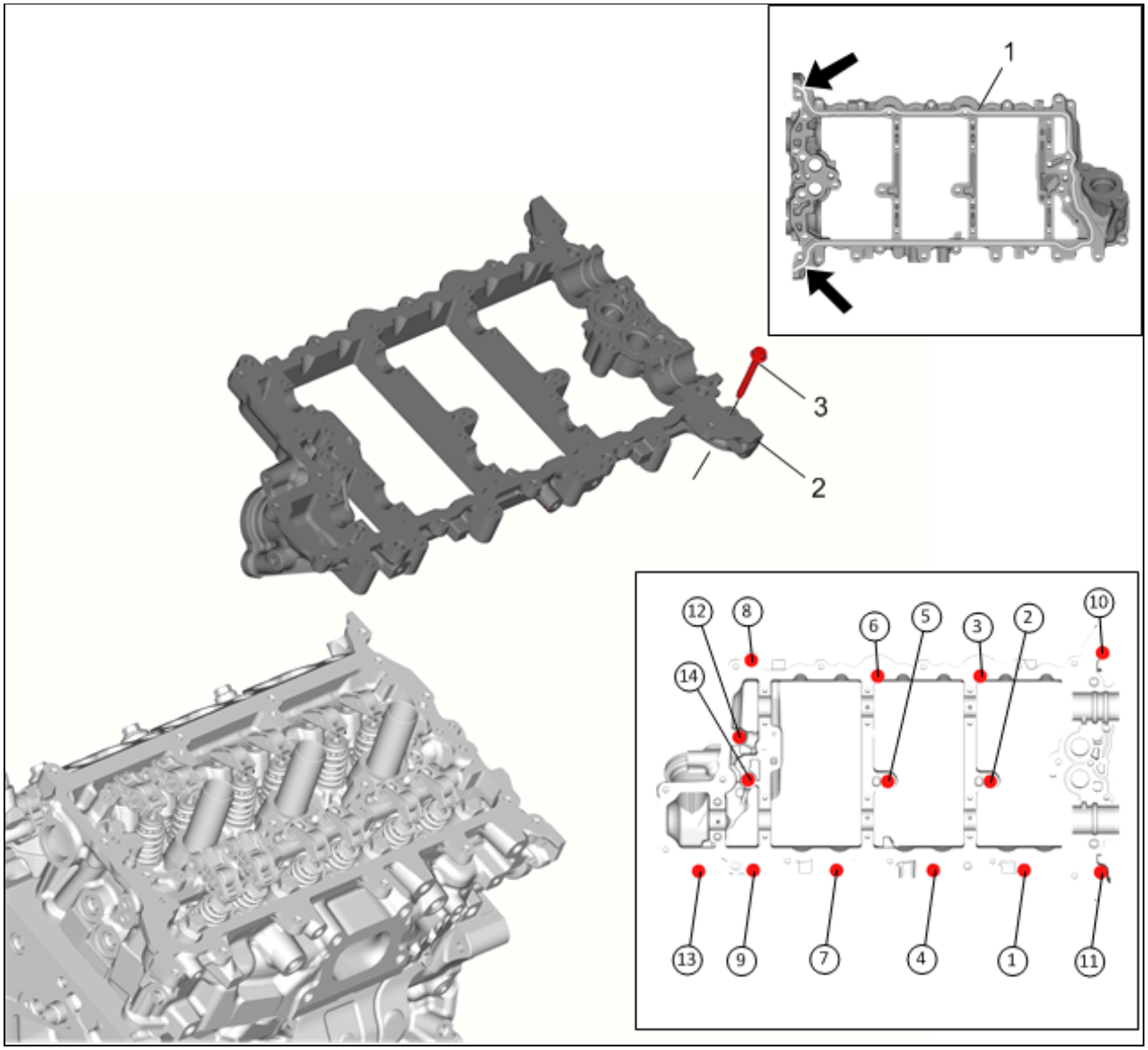
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Sealant **CAUTION:** *Do not apply more room temperature vulcanization (RTV) silicone than specified. Excess RTV silicone could plug up oil passage holes in the camshaft carrier and lead to engine damage.* Procedure

	1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant 2. Place a 3 mm (0.118 in) bead of RTV sealant on the bottom of the camshaft carrier, following the specific bead path. 3. Place a 5 mm (0.197 in) bead of RTV sealant on the bottom of the camshaft carrier as arrows show. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended sealant. **NOTE:** *Camshaft carrier surfaces should be free and clean of oil and foreign substances.*
2	Camshaft Carrier Left
3	Camshaft Bearing Cap Bolt **CAUTION:** *Refer to Fastener Caution .* **Tighten in sequence** 13 N.m (115 lb in)

Camshaft Carrier Installation - Right Side

Fig 53: Camshaft Carrier - Right Side



Courtesy of GENERAL MOTORS COMPANY

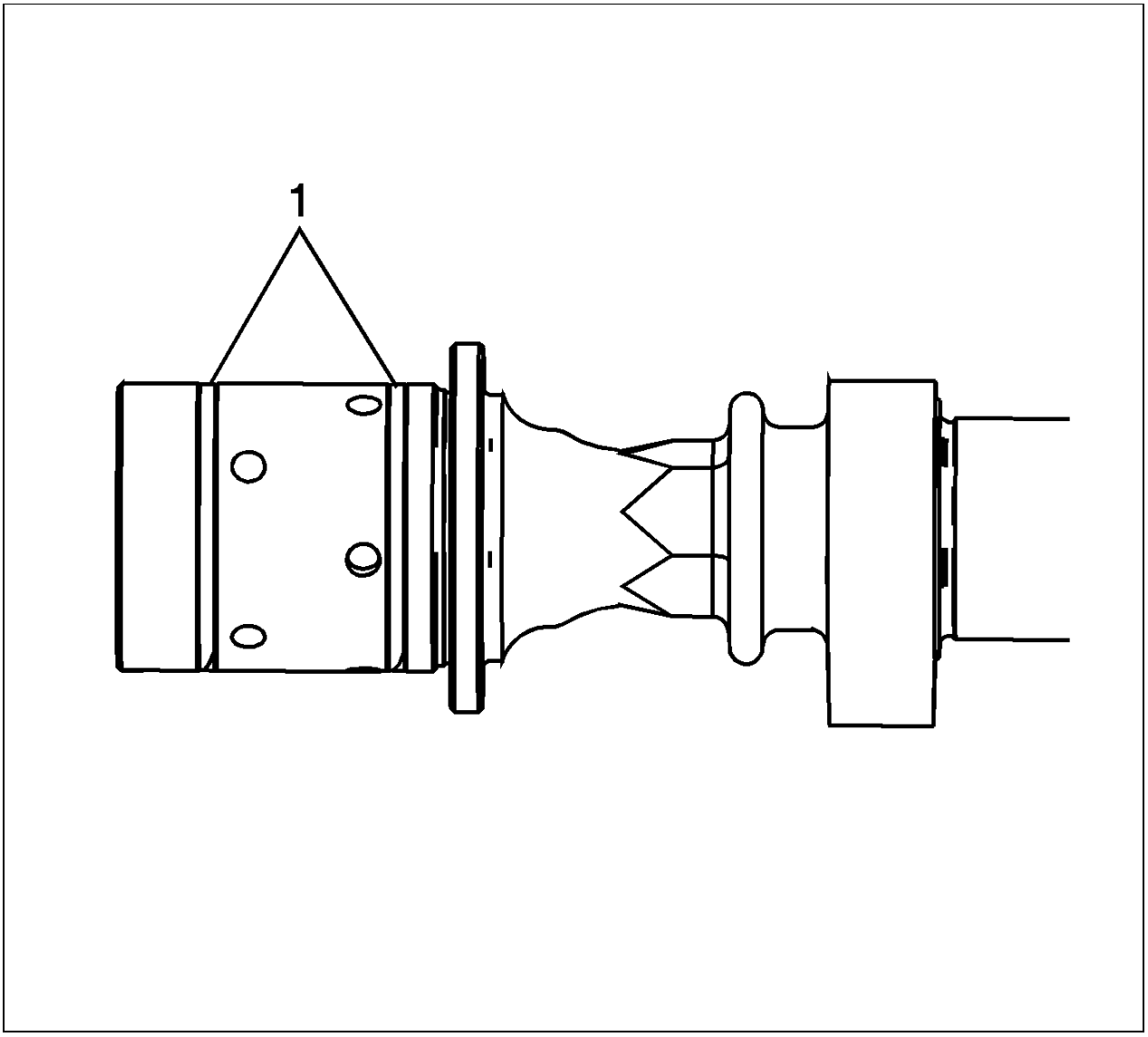
Callout	Component Name
1	Sealant **CAUTION:** *Do not apply more room temperature vulcanization (RTV) silicone than specified. Excess RTV silicone could plug up oil passage holes in the camshaft carrier and lead to engine damage.* Procedure

	1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant 2. Place a 3 mm (0.118 in) bead of RTV sealant on the bottom of the camshaft carrier, following the specific bead path. 3. Place a 5 mm (0.197 in) bead of RTV sealant on the bottom of the camshaft carrier as arrows show. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended sealant. **NOTE:** *Camshaft carrier surfaces should be free and clean of oil and foreign substances.*
2	Camshaft Carrier Right
3	Camshaft Carrier Bolt **CAUTION:** *Refer to Fastener Caution .* **Tighten in sequence** 13 N.m (115 lb in)

Camshaft Installation - Left Side (LF4)

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

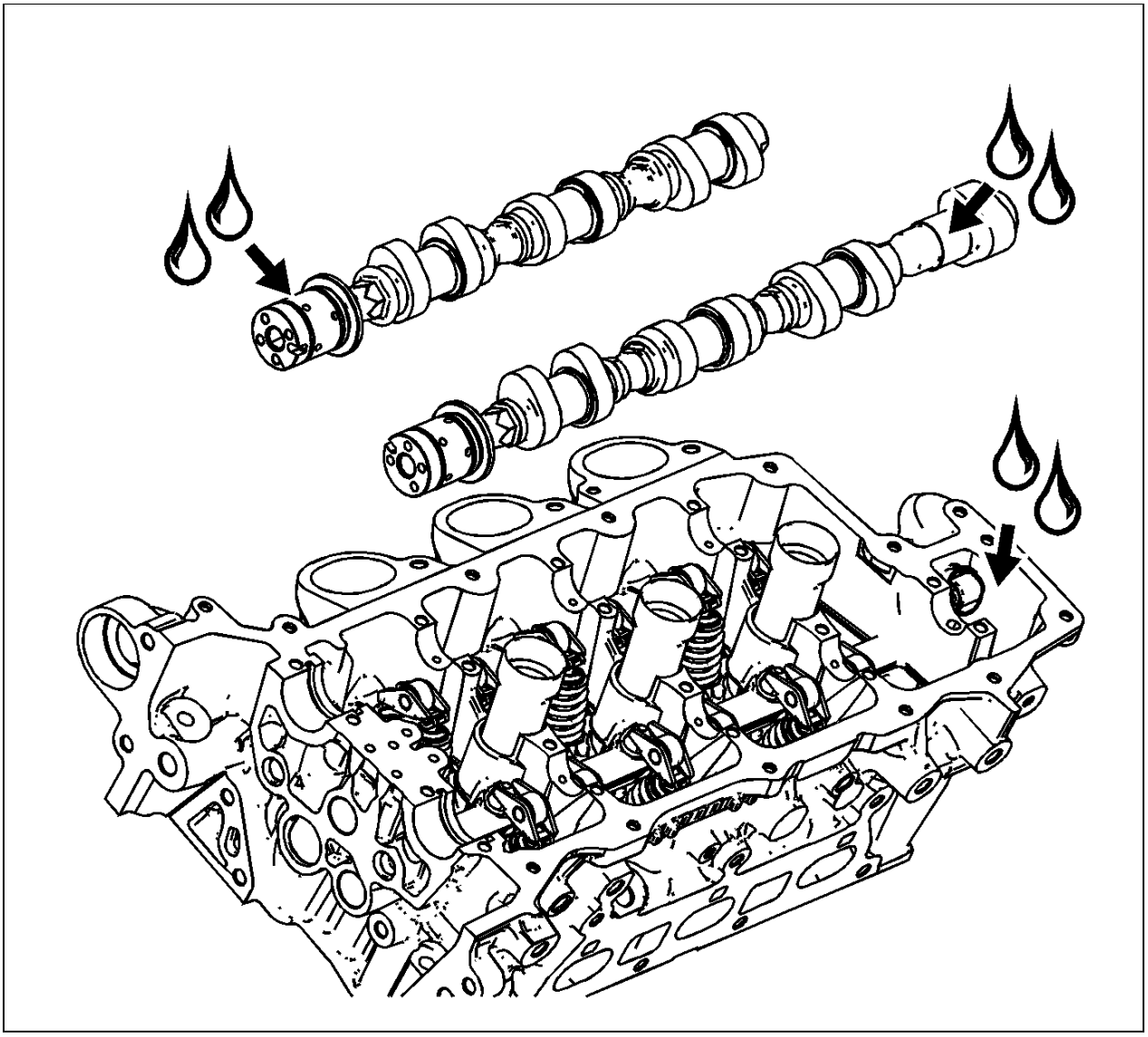
Fig 54: Locating Camshaft Sealing Rings In Camshaft Grooves



Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant to the camshaft journals and the left cylinder head camshaft carriers. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended lubricant.

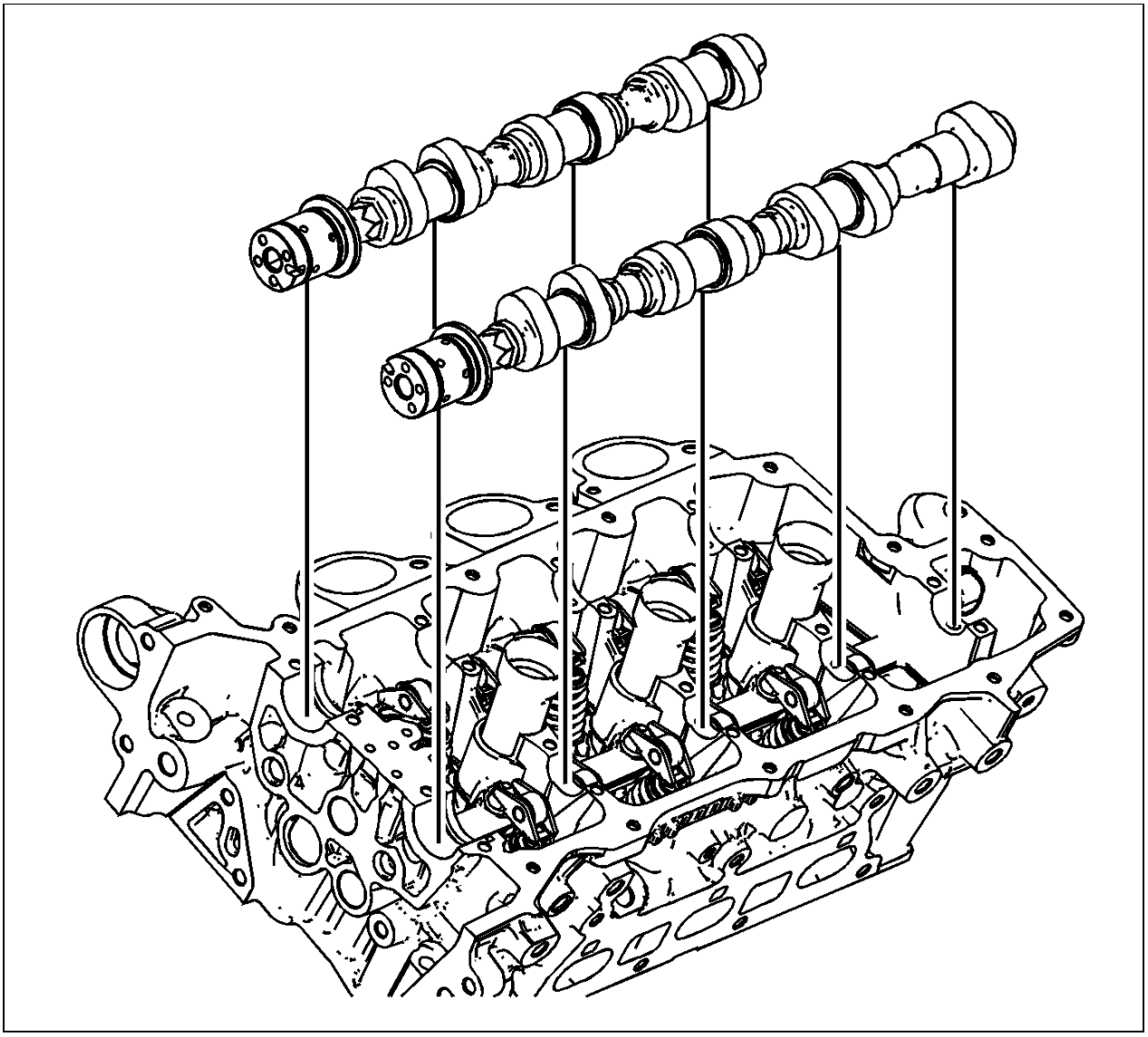
Fig 55: Lubricating Camshaft Journals



Courtesy of GENERAL MOTORS COMPANY

3. Place the left intake and left exhaust camshafts in position in the left cylinder head.

Fig 56: View of Camshafts and Cylinder Head

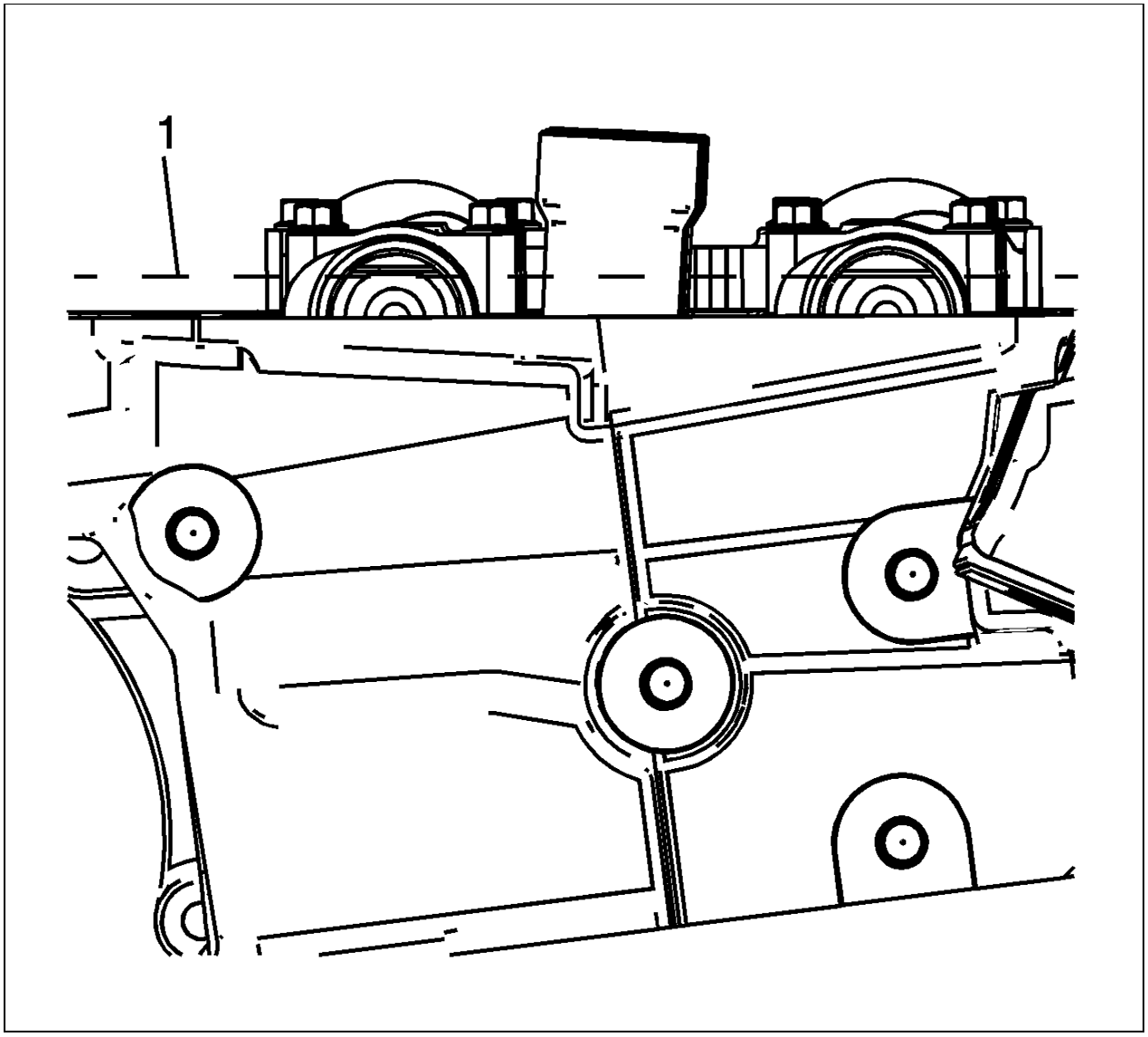


Courtesy of GENERAL MOTORS COMPANY

NOTE: *The left intake camshaft has a laser inscription marking on the rear of the shaft to identify it as left bank intake (LI).*

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

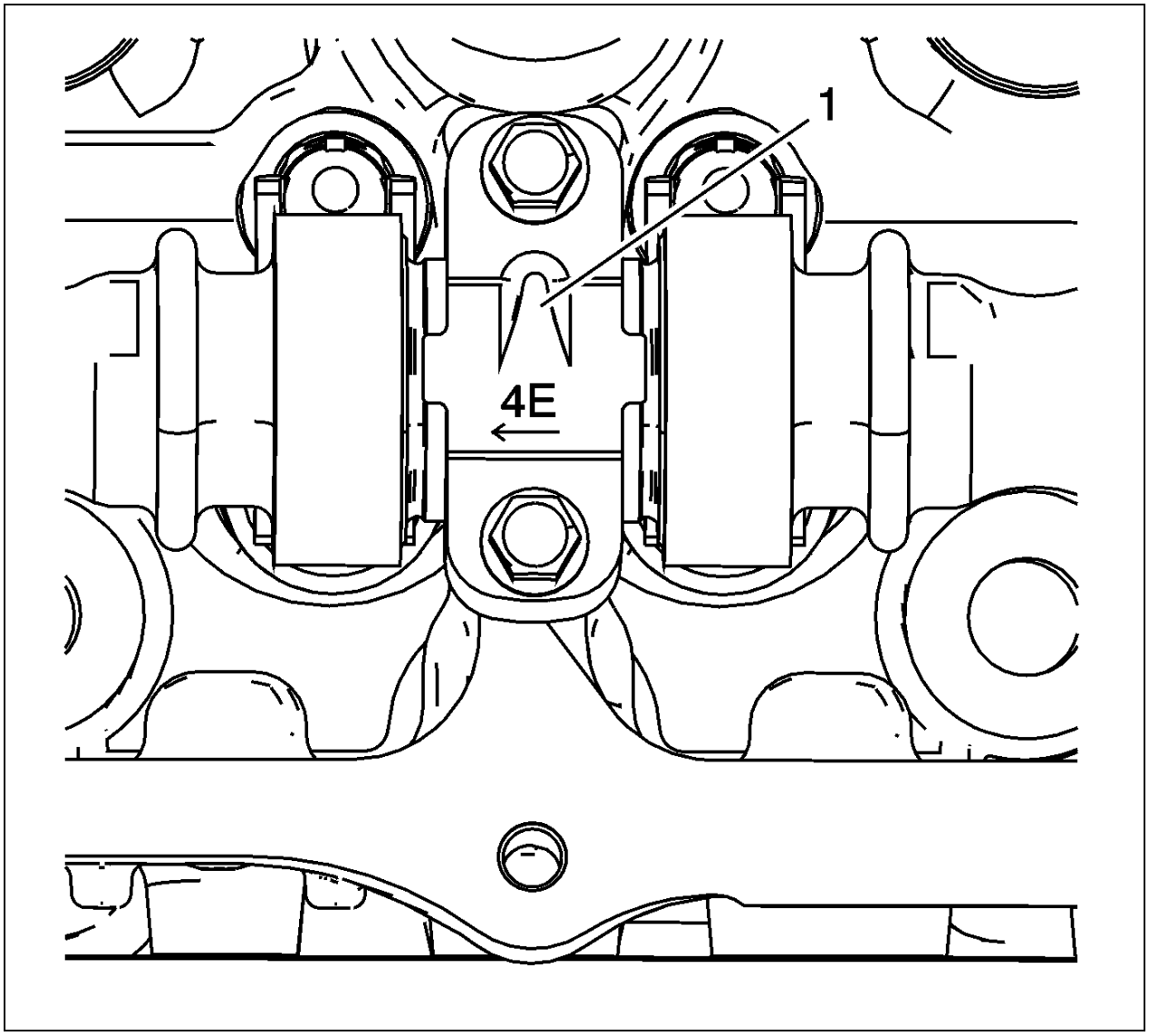
Fig 57: View Of Camshaft Flats Parallel With Camshaft Cover Rail



Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:

Fig 58: Left Cylinder Head Camshaft Bearing Cap Markings



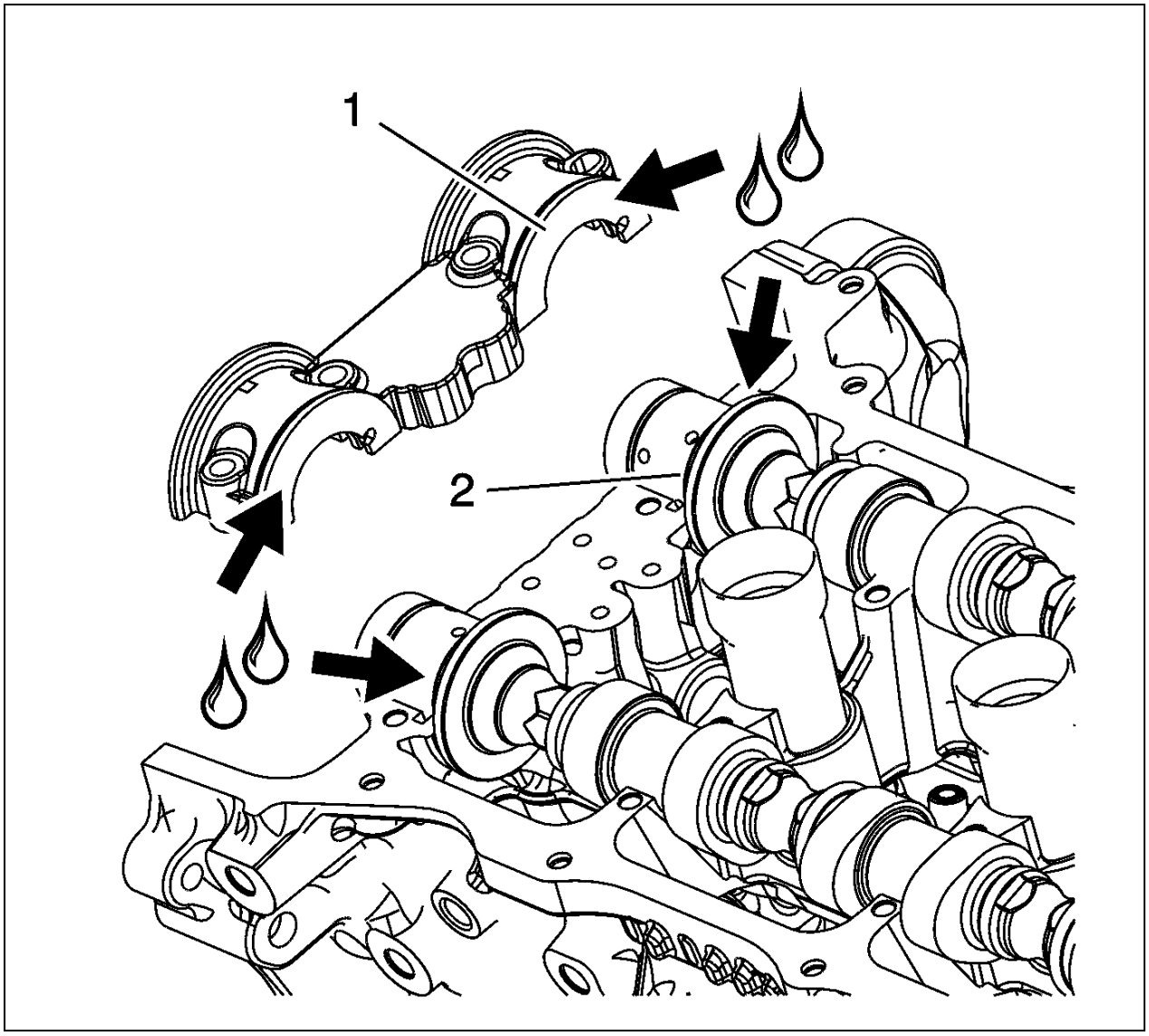
Courtesy of GENERAL MOTORS COMPANY

1. The raised feature (1) must always be oriented toward the center of the cylinder head.
2. The I indicates the intake camshaft.
3. The E indicates the exhaust camshaft.
4. The number 2, 4, 6 indicates the cylinder position from the front of the engine.

6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended lubricant.

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended lubricant.

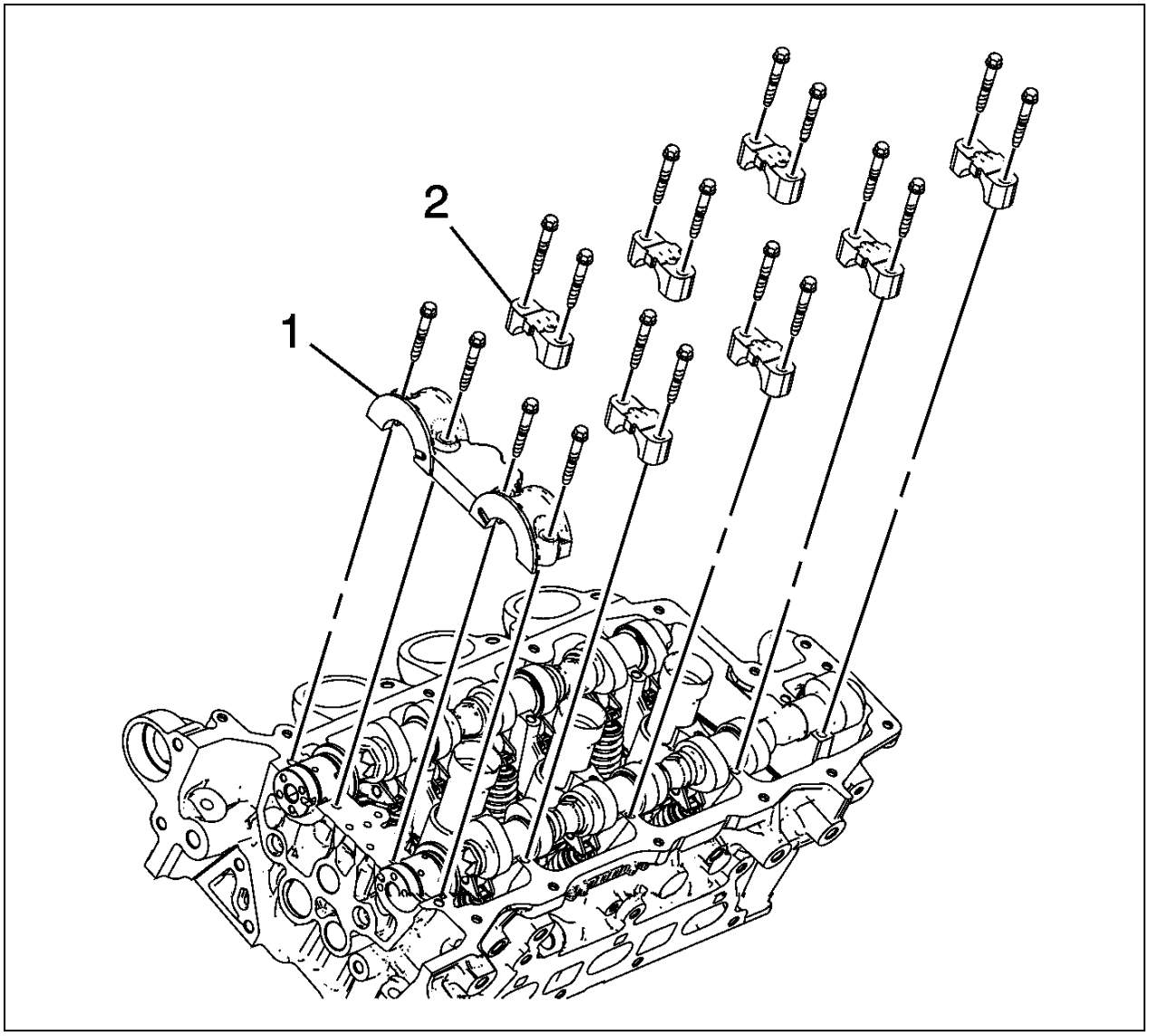
Fig 59: Camshaft Bearing Cap And Camshaft Thrust Surface



Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.

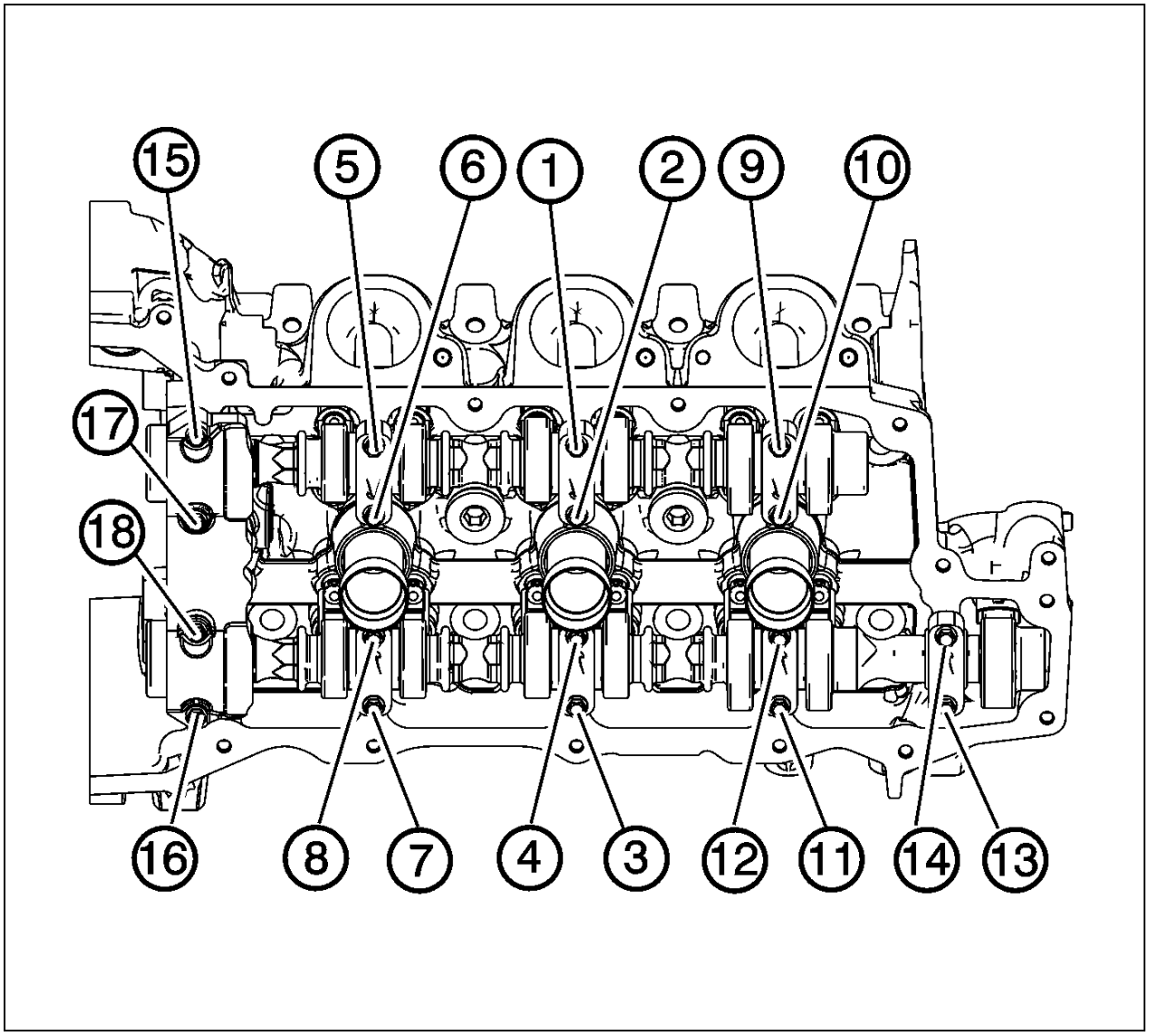
Fig 60: Camshaft Bearing Caps And Bolts



Courtesy of GENERAL MOTORS COMPANY

9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.
11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).

Fig 61: Identifying Camshaft Bearing Cap Bolt Tightening Sequence



Courtesy of GENERAL MOTORS COMPANY

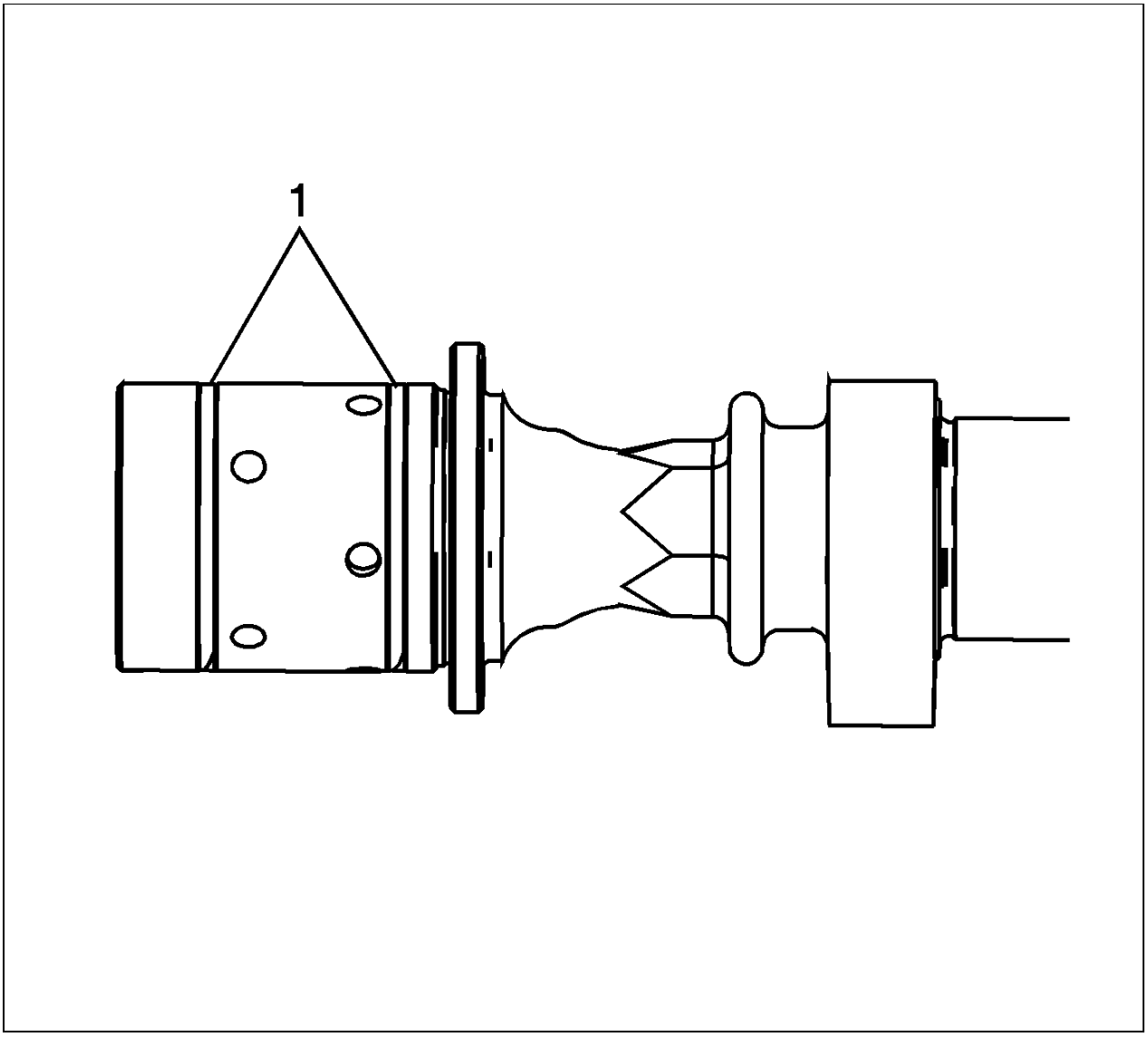
CAUTION: *Refer to Fastener Caution .*

12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

Camshaft Installation - Right Side (LF4)

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

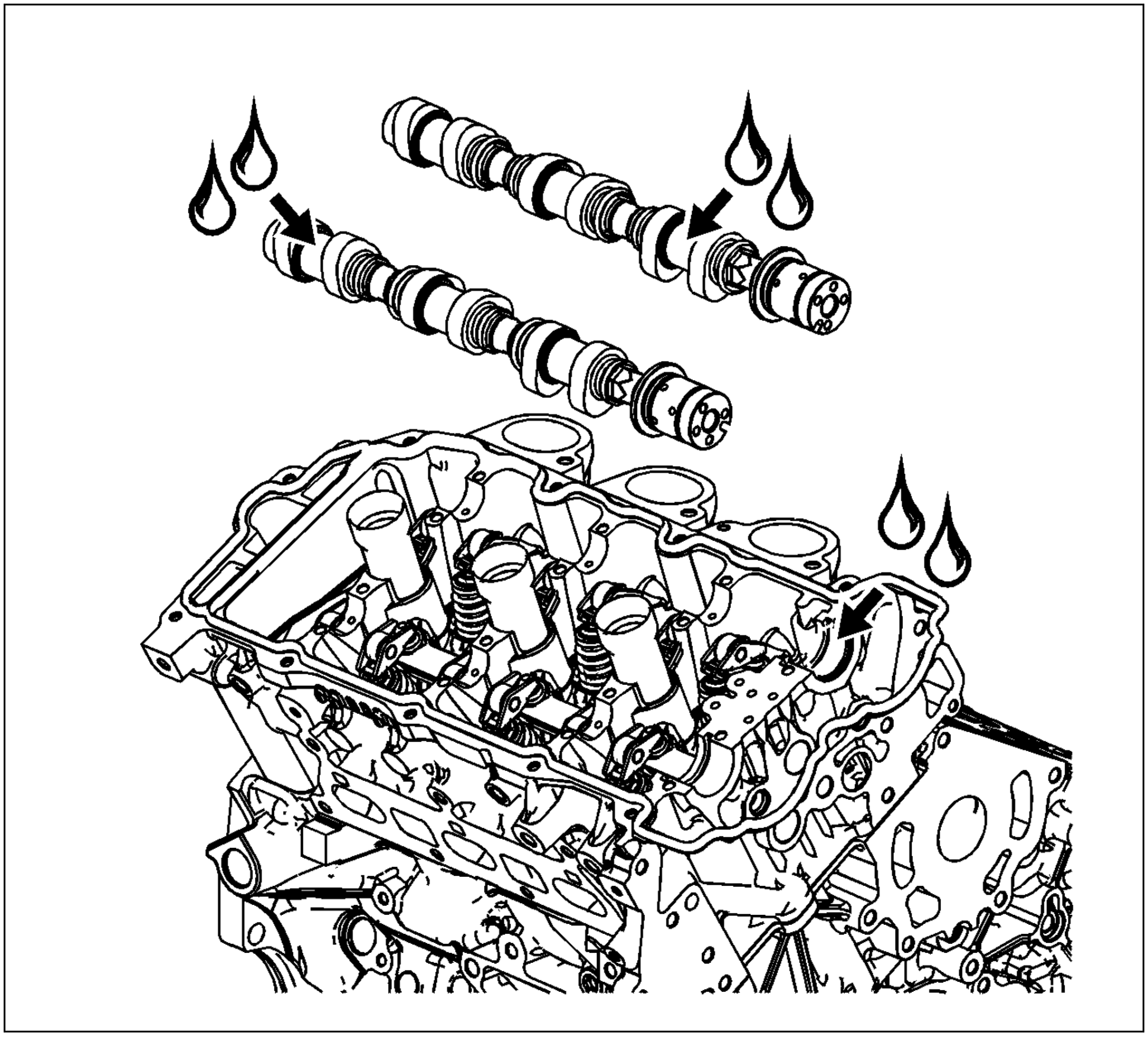
Fig 62: Locating Camshaft Sealing Rings In Camshaft Grooves



Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant to the camshaft journals and the right cylinder head camshaft carriers. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended lubricant.

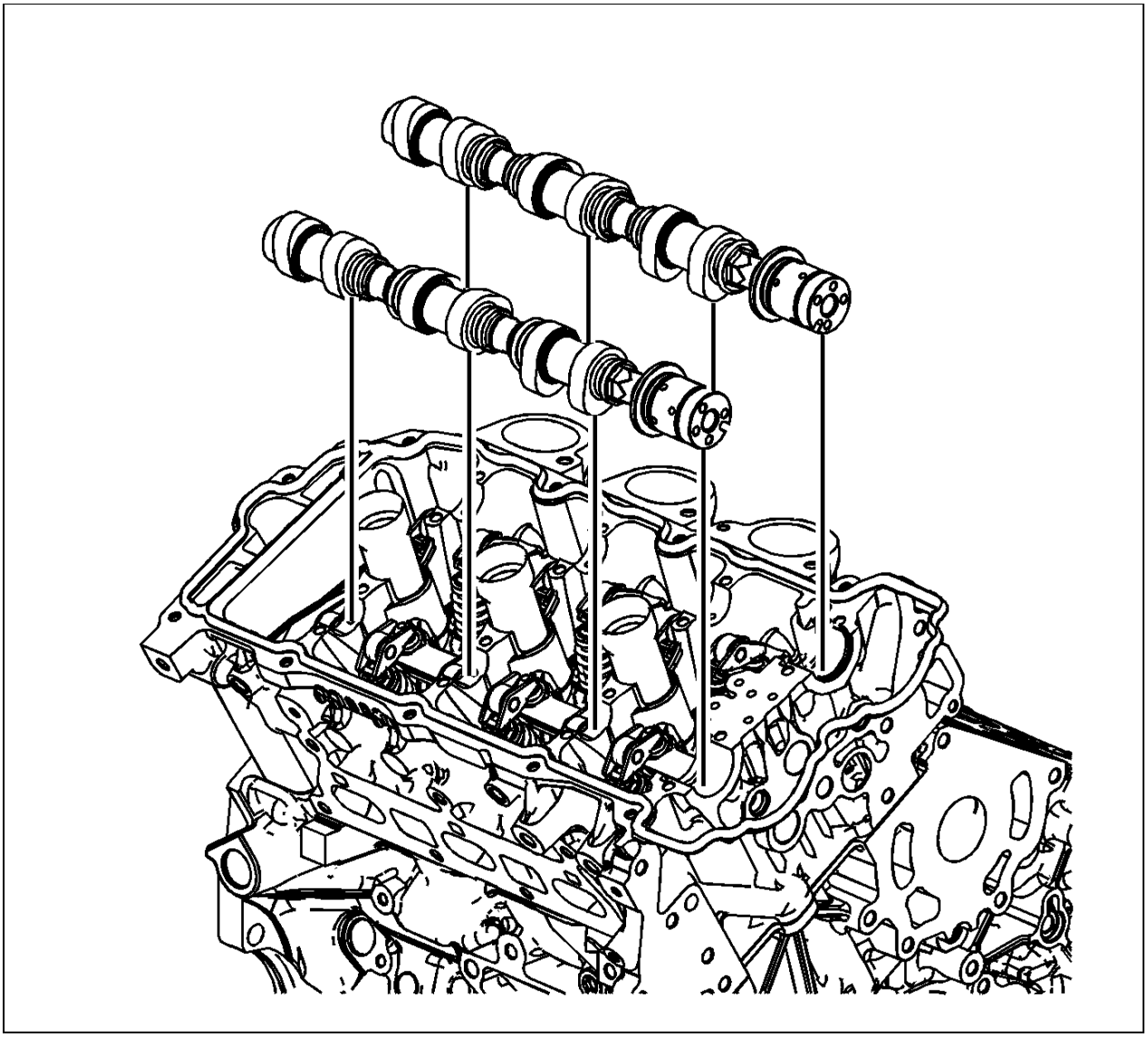
Fig 63: Applying Liberal Amount Of Lubricant Or Equivalent To Camshaft Journals & Right Cylinder Head Camshaft Carriers



Courtesy of GENERAL MOTORS COMPANY

3. Place the right intake and right exhaust camshafts in position in the right cylinder head.

Fig 64: Positioning Right Intake & Right Exhaust Camshafts In Right Cylinder Head

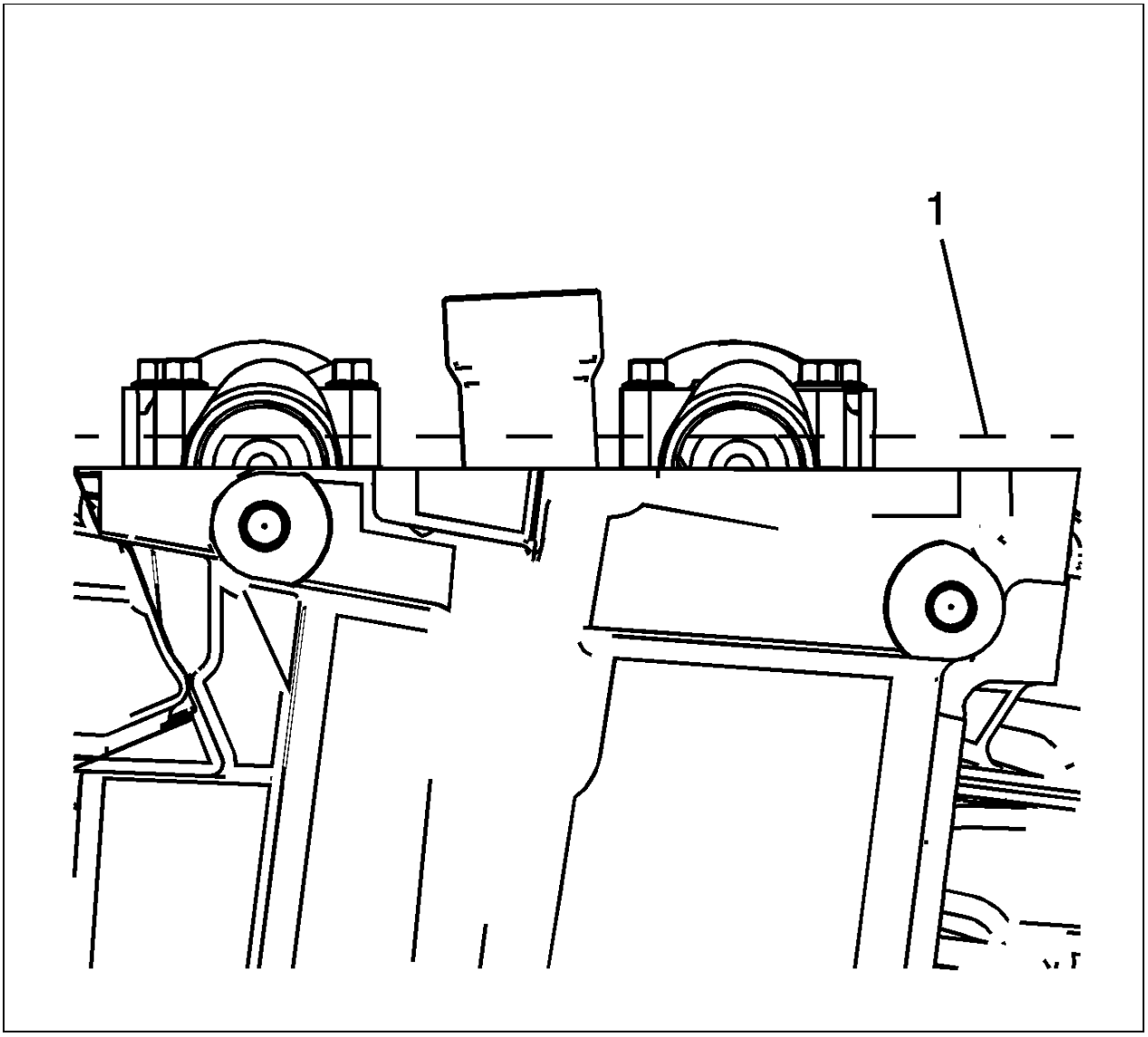


Courtesy of GENERAL MOTORS COMPANY

NOTE: *The right intake camshaft has a laser inscription marking on the rear of the shaft to identify it as right bank intake (RI).*

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

Fig 65: Identifying Camshaft Neutral (Low Tension) Position



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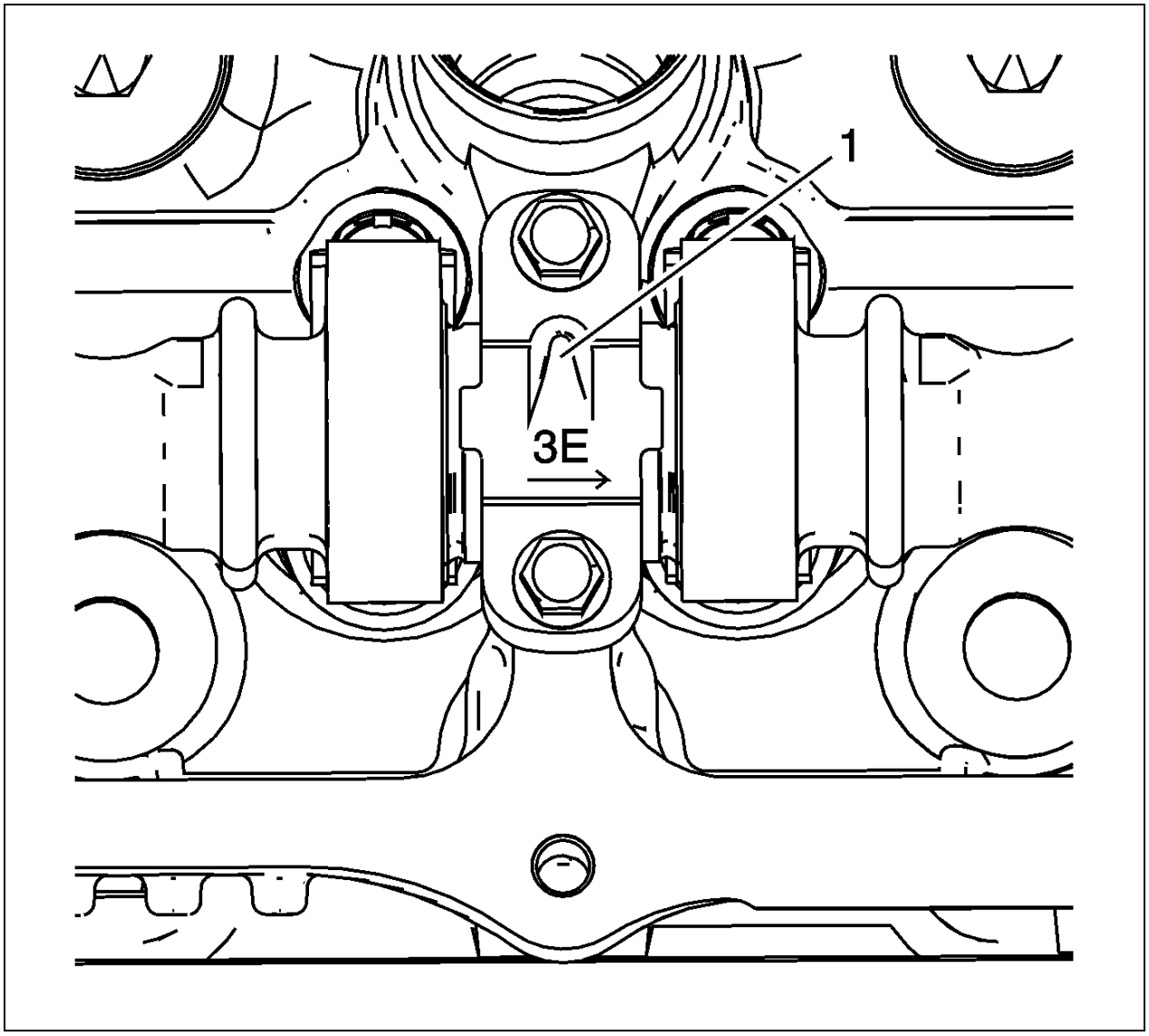
5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:

Fig 66: Right Cylinder Head Camshaft Bearing Cap Markings



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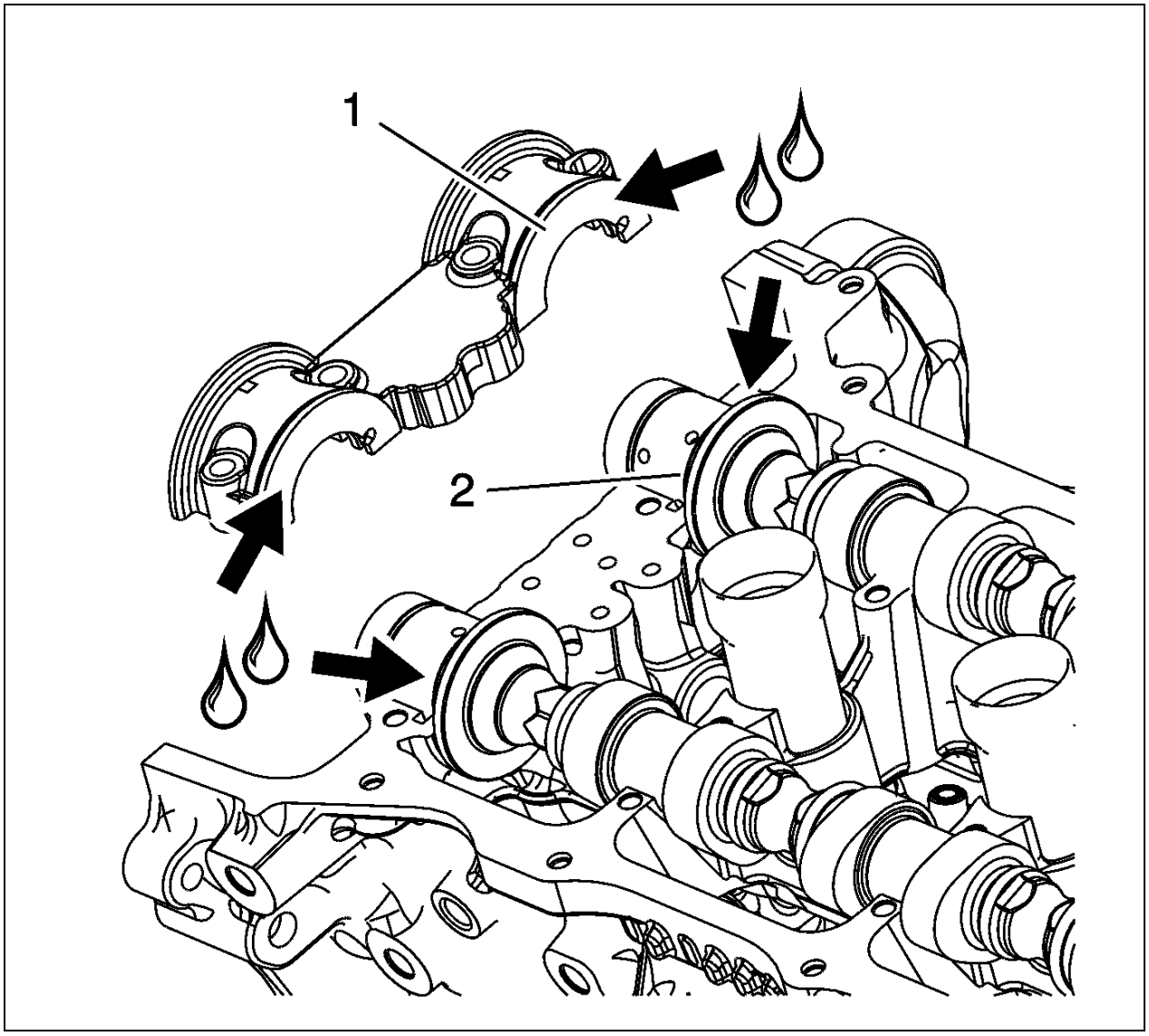
1. The raised feature (1) must always be oriented toward the center of the cylinder head.
2. The I indicates the intake camshaft.
3. The E indicates the exhaust camshaft.
4. The number 1, 3, 5 indicates the cylinder position from the front of the engine.

6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended lubricant.

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to Adhesives, Fluids, Lubricants, and Sealers (LF4)Adhesives, Fluids, Lubricants, and Sealers (LGX) for recommended lubricant.

Fig 67: Camshaft Bearing Cap And Camshaft Thrust Surface



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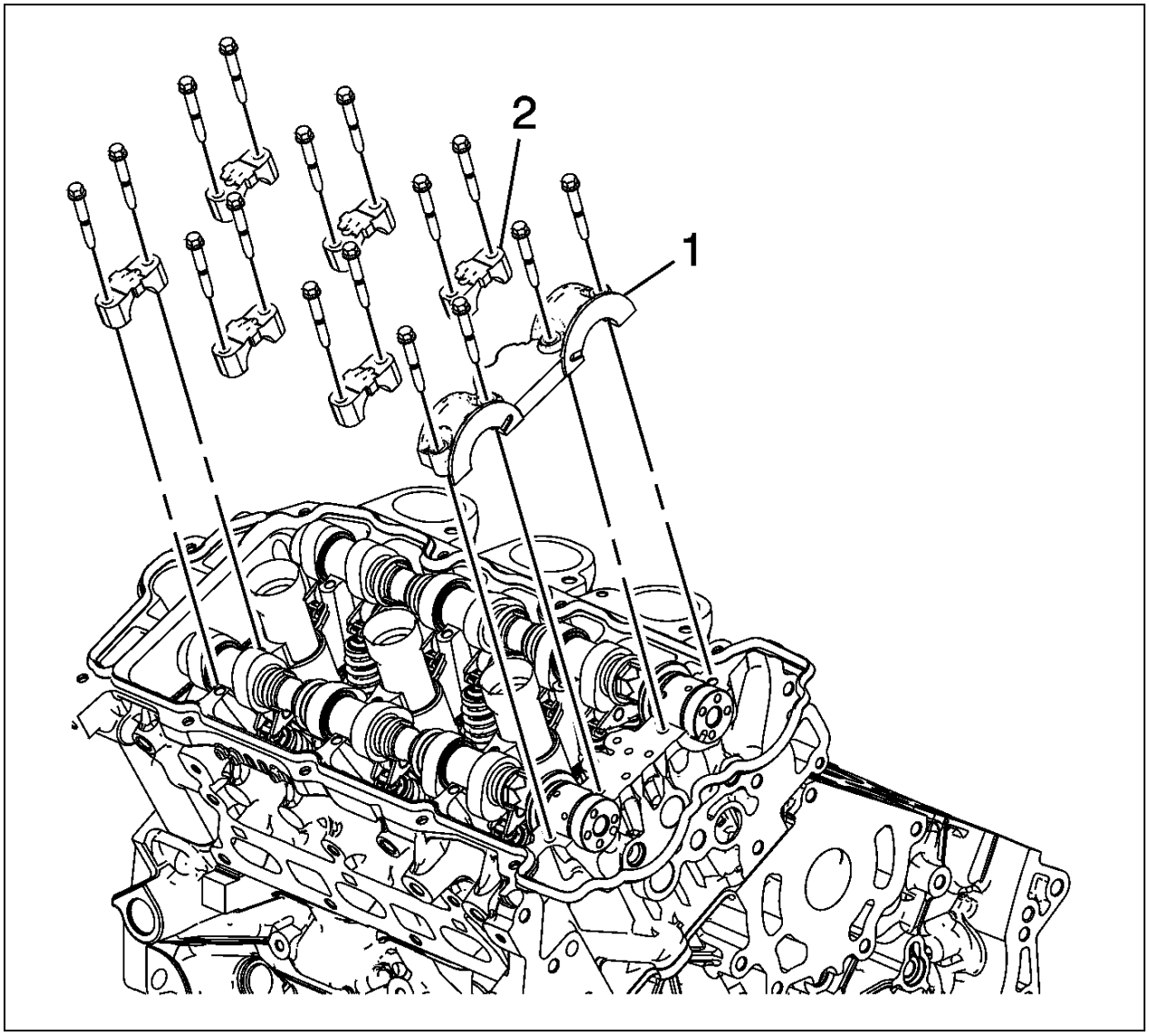
8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.

Fig 68: Camshaft Bearing Caps And Bolts



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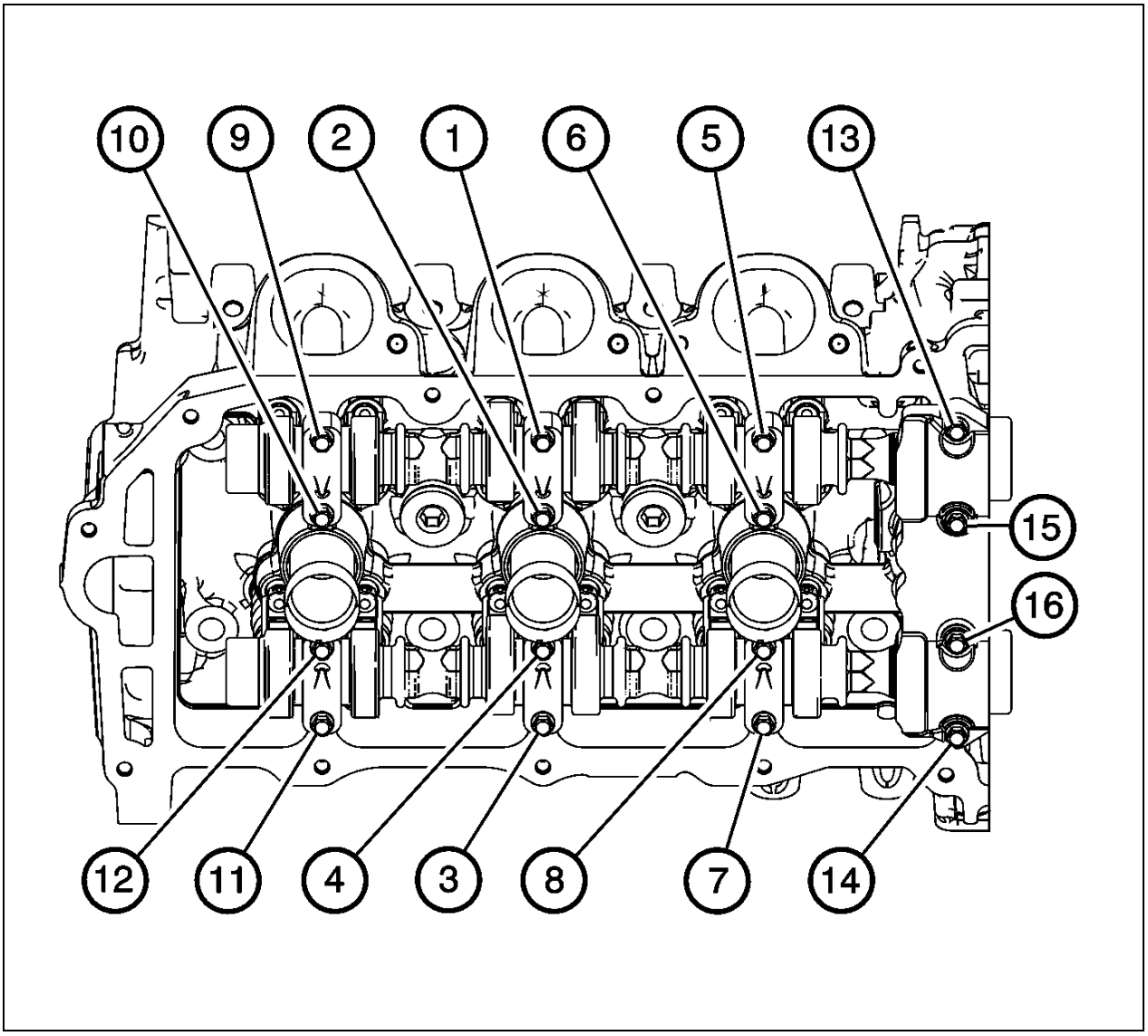
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.
11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).

Fig 69: Camshaft Bearing Cap Bolts Tighten Sequence



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CAUTION: *Refer to Fastener Caution .*

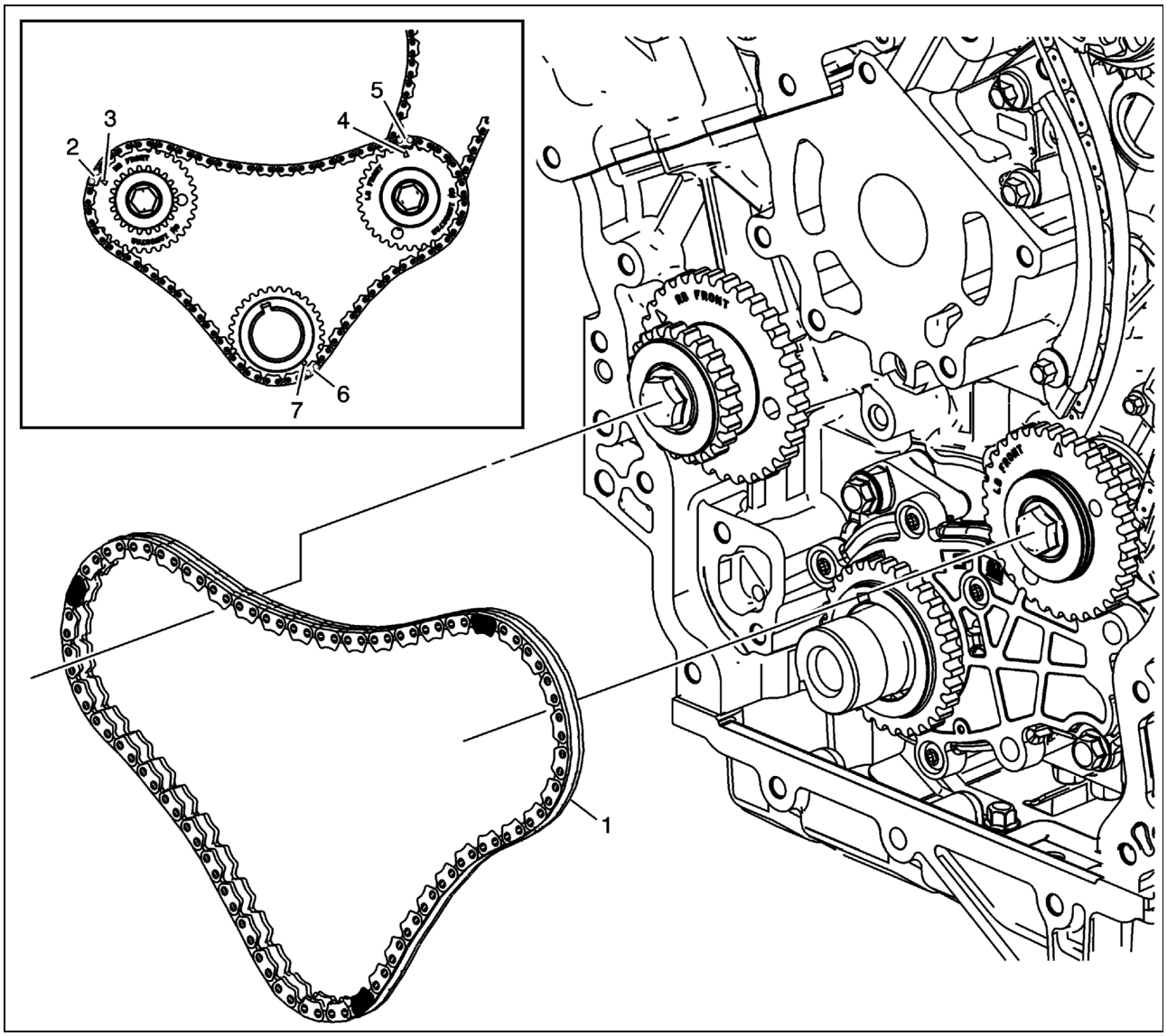
CAUTION: *This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.*

12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).

13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

Primary Camshaft Intermediate Drive Chain Installation

Fig 70: Primary Camshaft Intermediate Drive Chain Components



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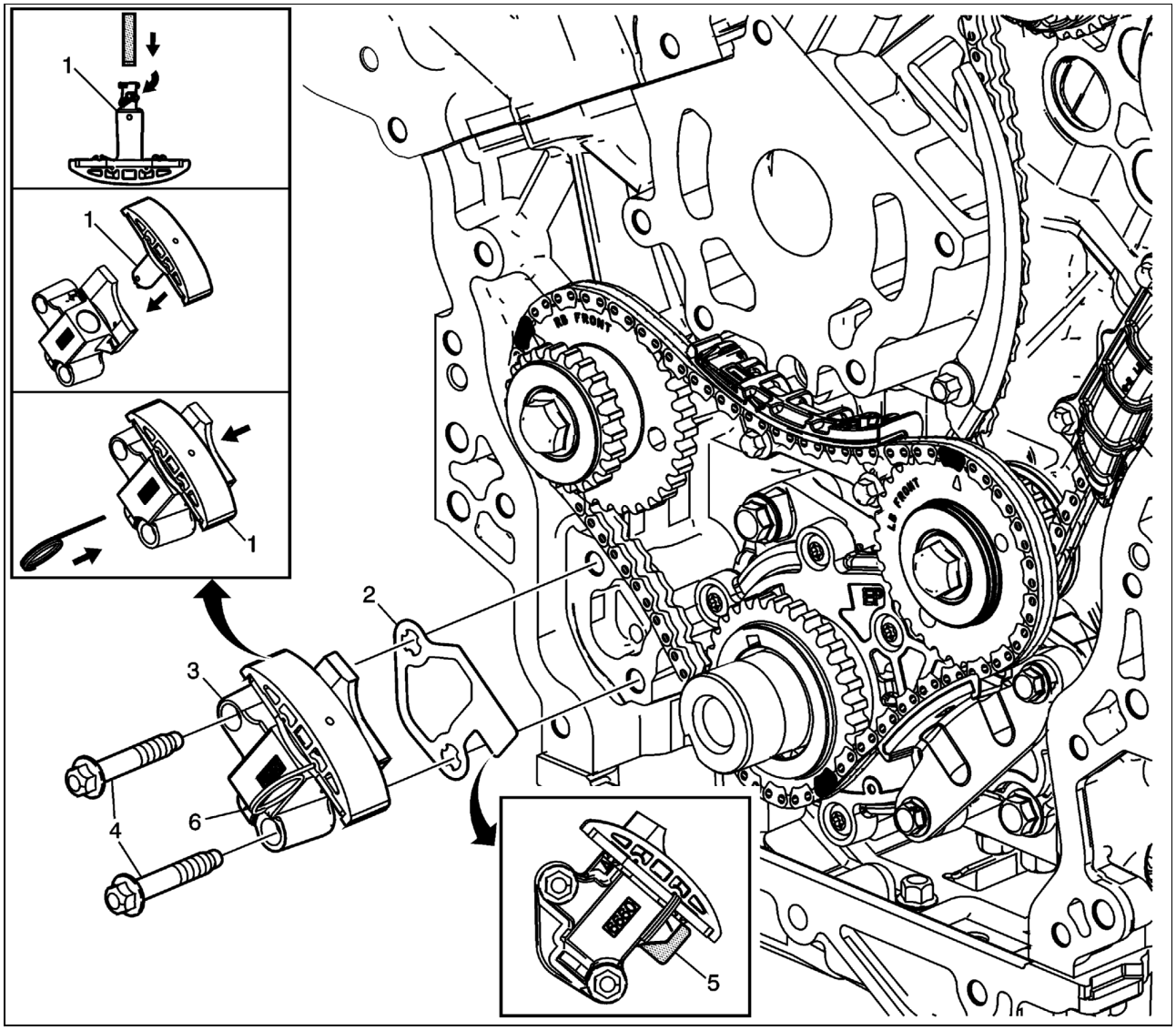
Primary Camshaft Intermediate Drive Chain Installation

Callout	Component Name
1	Primary Camshaft Drive Intermediate Chain Procedure 1. Wrap the primary camshaft drive chain around the large sprockets of each camshaft intermediate drive chain idler and the crankshaft sprocket.

	2. The left camshaft intermediate drive chain idler timing mark (2) will align with camshaft drive chain timing link (3). 3. The right camshaft intermediate drive chain idler timing mark (4) will align with camshaft drive chain timing link (5). 4. The crankshaft sprocket timing mark (7) will align with camshaft drive chain timing link (6).
2	Left Camshaft Intermediate Drive Chain Idler Timing Mark
3	Camshaft Drive Chain Timing Link
4	Right Camshaft Intermediate Drive Chain Idler Timing Mark
5	Camshaft Drive Chain Timing Link
6	Camshaft Drive Chain Timing Link
7	Crankshaft Sprocket Timing Mark

Primary Camshaft Intermediate Drive Chain Tensioner Installation

Fig 71: Primary Camshaft Intermediate Drive Chain Tensioner & Components



Courtesy of GENERAL MOTORS COMPANY

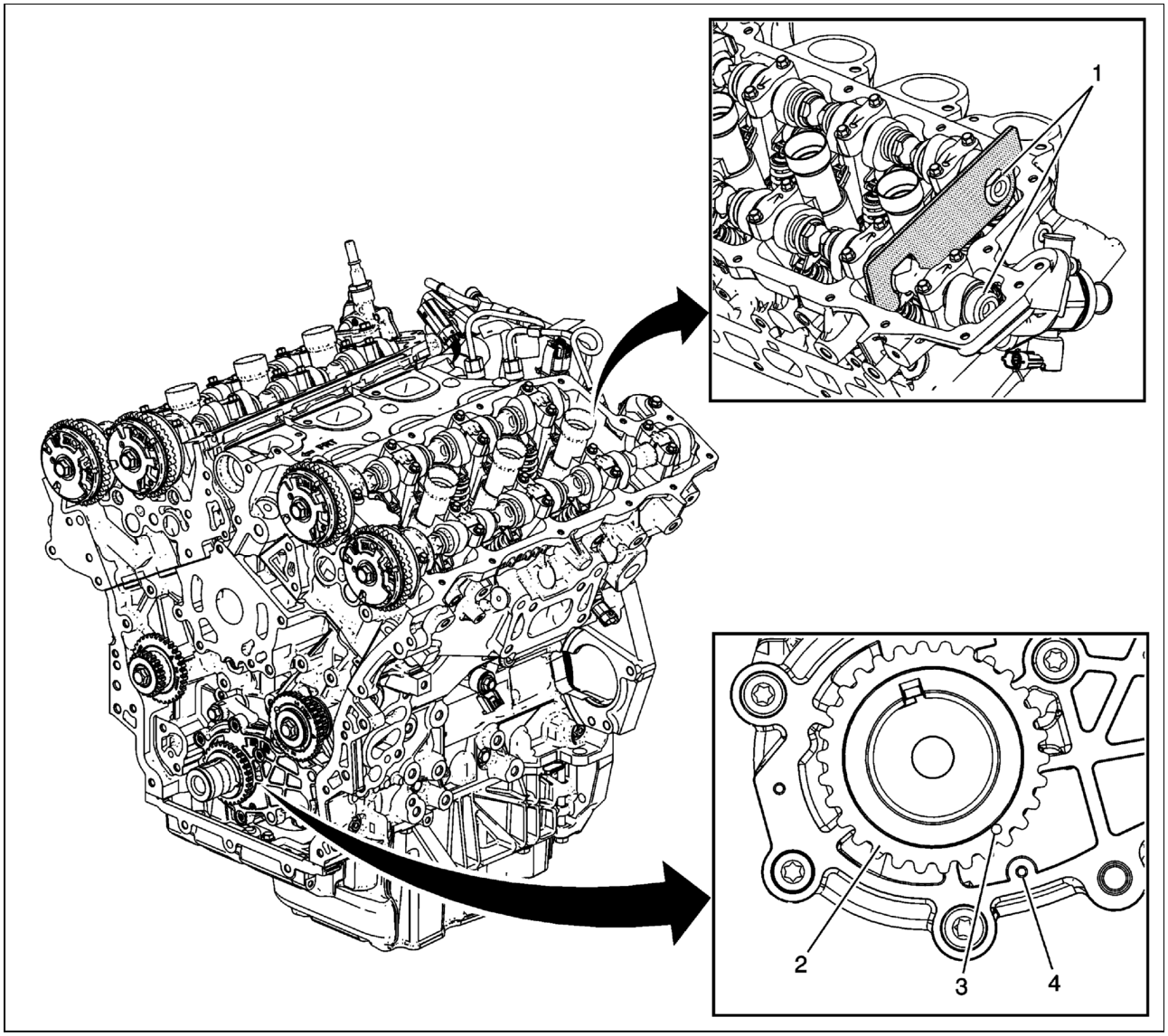
Primary Camshaft Intermediate Drive Chain Tensioner Installation

Callout	Component Name
1	Camshaft Intermediate Drive Chain Tensioner Plunger. Procedure 1. Reset the primary camshaft drive chain tensioner plunger using **EN-45027** tensioner tool. 2. Install primary camshaft drive chain tensioner plunger into body. 3. Compress the plunger into the body and lock the primary camshaft drive chain tensioner by inserting the **EN-46112** tensioner retraction pins into the access hole in the side of the primary camshaft drive chain tensioner body. 4. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed.

	Special Tools • **EN-45027** Tensioner Tool • **EN-46112** Tensioner Retraction Pins For equivalent regional tools, refer to Special Tools (LGX)Special Tools (LF4) .
2	Timing Chain Housing Gasket **NOTE:** *Ensure the primary camshaft drive chain tensioner mounting surface on the engine block does not have any burrs or defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.*
3	Camshaft Intermediate Drive Chain Tensioner
4	Camshaft Intermediate Drive Chain Tensioner Bolt Procedure 1. Place the drive chain tensioner into position and loosely install the bolts to the block. 2. Verify the proper placement of the drive chain tensioner gasket tab (5). 3. Tighten the drive chain tensioner bolts in two passes. 4. Verify the timing marks are in the correct position before releasing the drive chain tensioner. 5. Release the drive chain tensioner by pulling out the **EN-46112** pin (6) and unlocking the tensioner plunger. 6. Verify the primary and left secondary camshaft drive chain timing mark alignments by referring to Timing Chain Alignment Diagram (LF4)Timing Chain Alignment Diagram (LGX) - Stage One. **Tighten** • First Pass 5 N.m (44 lb in) • Second Pass 25 N.m (18 lb ft)
5	Timing Chain Housing Gasket Tab
6	**EN-46112** Pin

Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 1

Fig 72: Secondary Camshaft Intermediate Drive Chain Components - Left Side - Step 1



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Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 1

Callout	Component Name

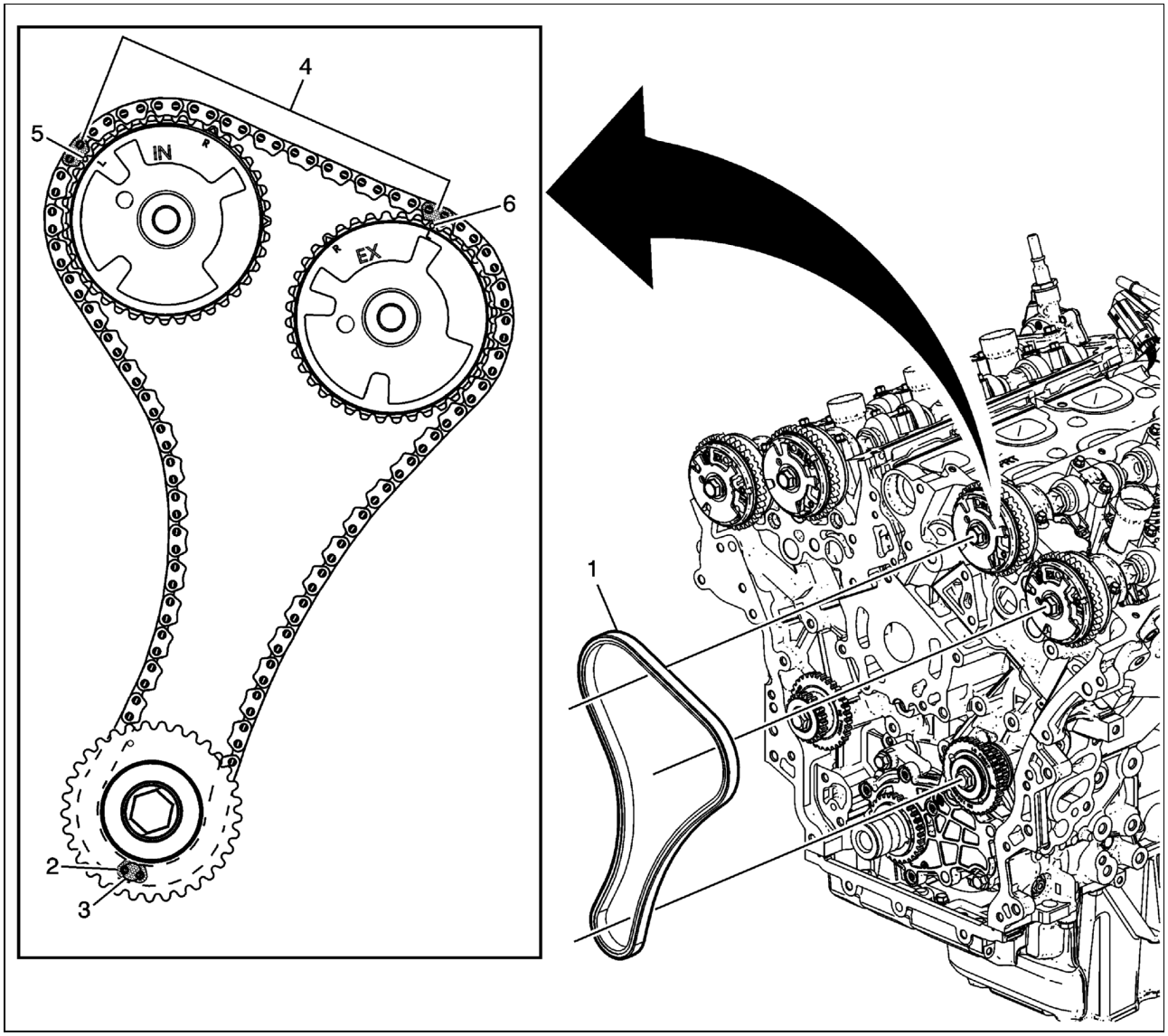
NOTE: *If you are performing this procedure for the first time, it is recommended that you view video 56510.12V from the common training website before beginning (U.S. Dealers Only). To search for the video number, click on the catalog icon on the home page. Canadian dealers should view Tech Assist video 16038.01W on the LMS website and a related video on GM Global Connect (Library-Service>Technician Review>TAC*

Talk Video Help). See https://www.centerlearning.com/HomePage/Portal.asp for more information.

1	Left Intake and Exhaust Camshaft Procedure 1. Install the **EN-48383-1** retaining tool onto the rear of the left camshafts. **NOTE:** *1. There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the **EN-48383** retaining tools .* *2. All camshafts must be locked in place before installation of any camshaft drive chains.* 2. Ensure the **EN-48383-1** retaining tool is fully seated onto the camshafts. **Special Tools** **EN-48383** Camshaft Retaining Tools For equivalent regional tools, refer to Special Tools (LGX)Special Tools (LF4) .
2	Crankshaft Sprocket **NOTE:** *Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (3) aligned to the stage one timing mark on the oil pump cover (4) using the **EN-48589** socket. Refer to Timing Chain Alignment Diagram (LF4)Timing Chain Alignment Diagram (LGX) .* **Special Tools** **EN-48589** Crankshaft Rotation Socket For equivalent regional tools, refer to Special Tools (LGX)Special Tools (LF4) .
3	Crankshaft Sprocket Timing Mark
4	Stage One Timing Mark On The Oil Pump Cover

Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 2

Fig 73: Secondary Camshaft Intermediate Drive Chain Components - Left Side - Step 2



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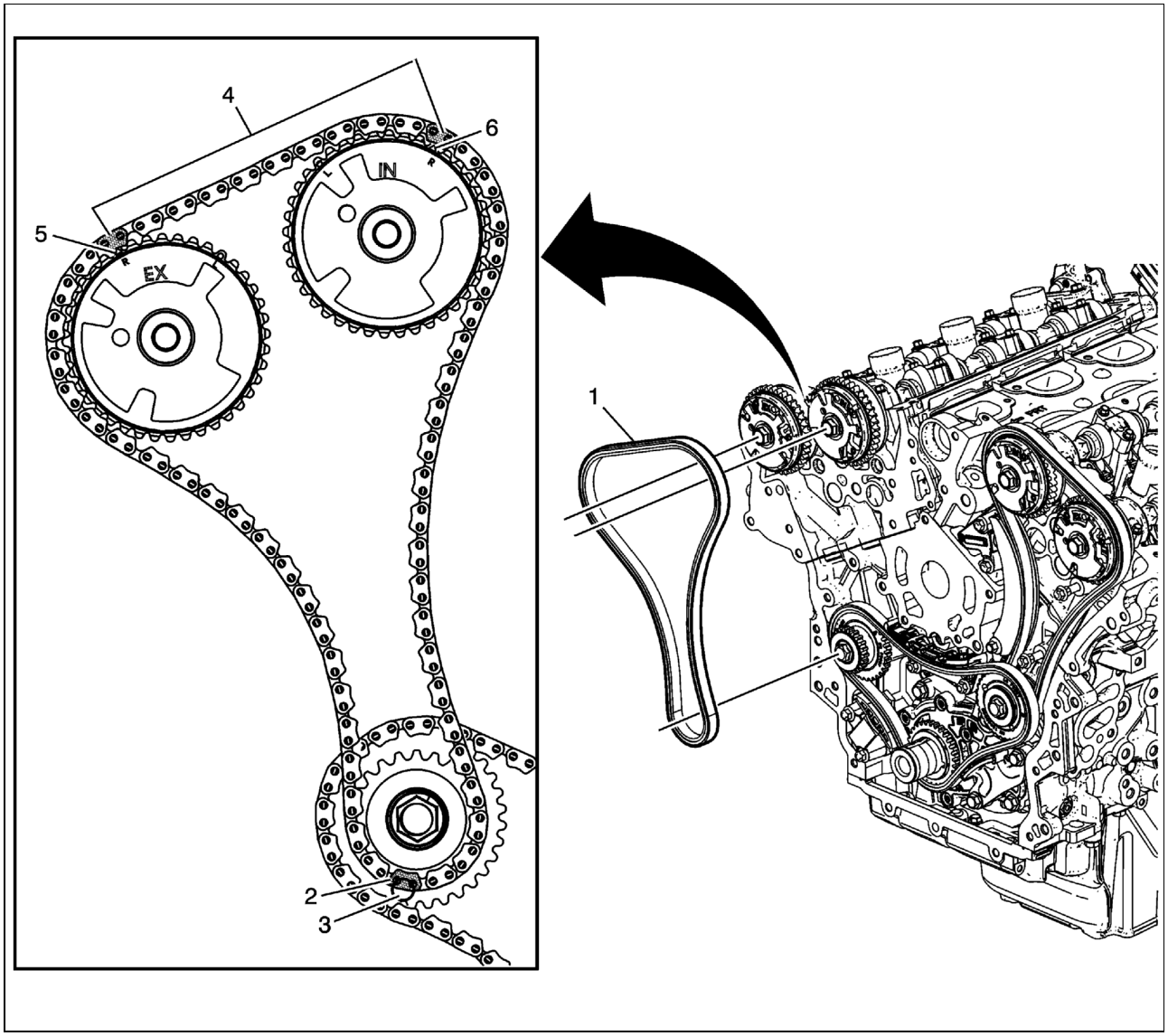
Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 2

Callout	Component Name
	NOTE: *Ensure that the left (L) camshaft position actuator sprocket alignment circle marks are used during this step.*
1	Secondary Camshaft Intermediate Drive Chain Procedure 1. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the camshaft drive chain timing link (2) aligned

	to the alignment access hole (3) in the left camshaft intermediate drive chain idler outer sprocket. **NOTE:** *Once the lower timing link is aligned, it may be helpful to hold the drive chain in position using a small flat blade screwdriver through the idler sprocket alignment access hole.* 2. Wrap the secondary camshaft drive chain around both left (L) actuator drive sprockets. 3. Align the left (L) intake camshaft position actuator sprocket alignment circle mark (5) with the camshaft drive chain timing link. 4. Align the left (L) exhaust camshaft position actuator sprocket alignment circle mark (6) with the camshaft drive chain timing link. 5. Once aligned, ensure there are 10 chain links (4) between timing marks for the left (L) camshaft position actuator sprockets.
2	Timing Camshaft Drive Chain
3	Alignment Access Hole
4	10 Chain Links Between Timing Marks for the Left (L) Camshaft Position Actuator Sprockets
5	Left (L) Intake Camshaft Position Actuator Sprocket Alignment Circle Mark
6	Left (L) Exhaust Camshaft Position Actuator Sprocket Alignment Circle Mark

Secondary Camshaft Intermediate Drive Chain Installation - Right Side

Fig 74: Secondary Camshaft Intermediate Drive Chain - Right Side



Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Intermediate Drive Chain Installation - Right Side

Callout	Component Name
	NOTE: *Ensure that the right (R) camshaft position actuator sprocket alignment triangle marks are used during this step.*
1	Secondary Camshaft Intermediate Drive Chain

	NOTE: *Ensure that the crankshaft is in the stage 2 timing drive assembly position.* Procedure 1. Place the secondary camshaft intermediate drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the camshaft drive chain timing link (2) with the alignment access hole (3) in the right camshaft intermediate drive chain idler inner sprocket. 2. Wrap the secondary camshaft intermediate drive chain around both right (R) actuator drive sprockets. 3. Align the right (R) intake camshaft position actuator sprocket alignment triangle mark (5) with the camshaft drive chain timing link. 4. Align the right (R) exhaust camshaft position actuator sprocket alignment triangle mark (6) with the camshaft drive chain timing link. 5. Once aligned, ensure there are 10 chain links (4) between timing marks for the right (R) camshaft position actuator sprockets. 6. There will be 22 links between the right camshaft intermediate drive chain idler timing camshaft drive chain link and each right camshaft position actuator sprocket timing camshaft drive chain link.
2	Camshaft Drive Chain Timing Link
3	Alignment Access Hole
4	10 Chain Links Between Timing Marks for the Right (R) Camshaft Position Actuator Sprockets
5	Right (R) Intake Camshaft Position Actuator Sprocket Alignment Triangle Mark
6	Right (R) Exhaust Camshaft Position Actuator Sprocket Alignment Triangle Mark