

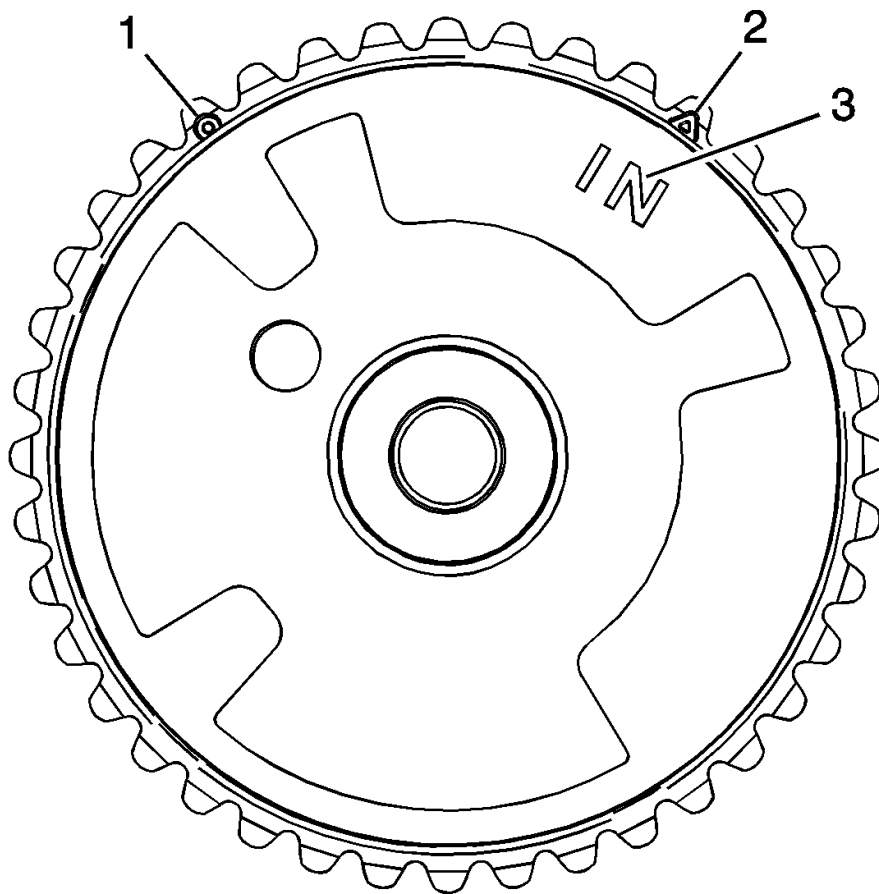
CAMSHAFT POSITION ACTUATOR INSTALLATION - RIGHT SIDE INTAKE

Fig. 557: View Of Camshaft Position Actuator Markings
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.

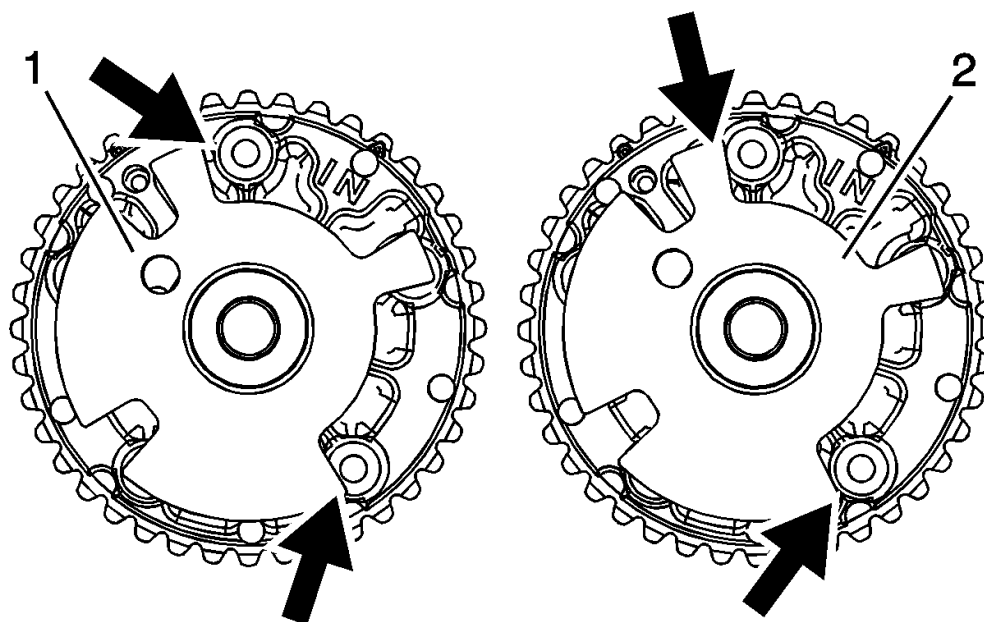


Fig. 558: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).

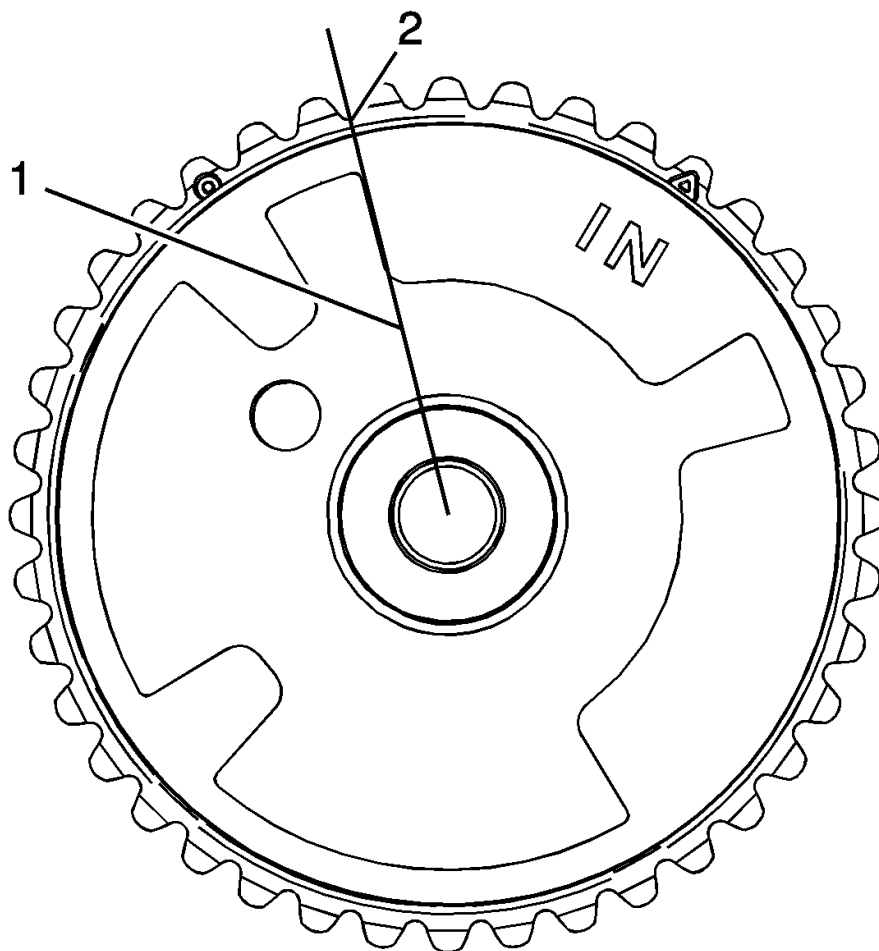


Fig. 559: View Of Reluctor Wheel & Valley
Courtesy of GENERAL MOTORS COMPANY

3. On the right intake camshaft actuator the edge of the reluctor wheel (1) lines up with the valley (2) of the sprocket tooth.

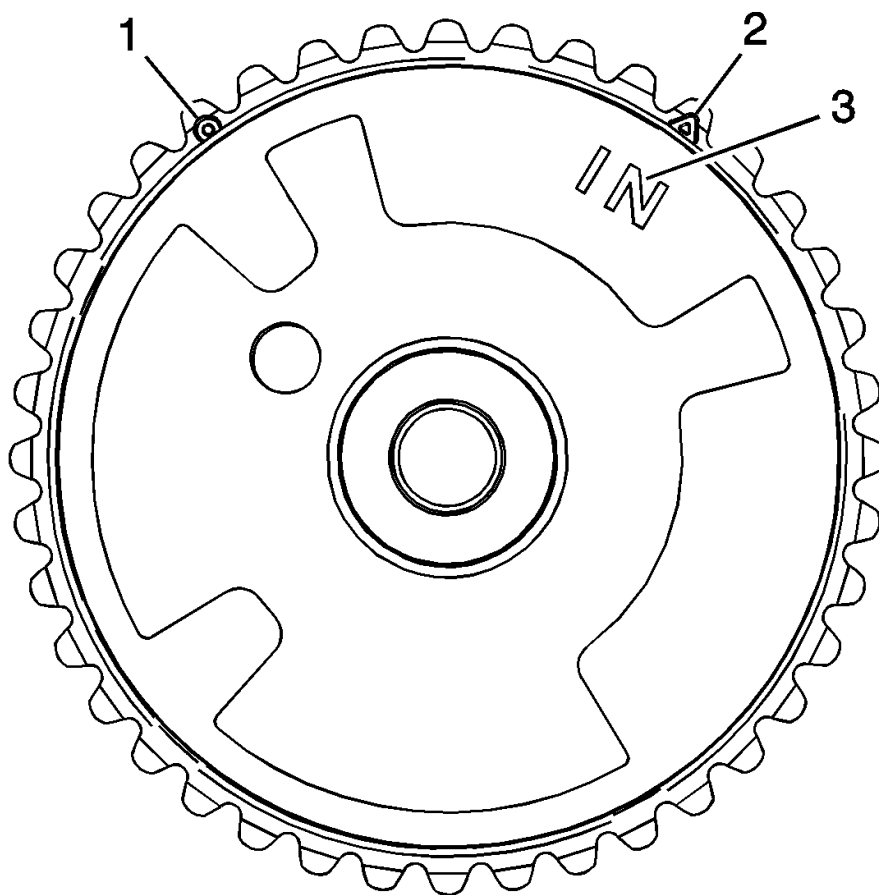


Fig. 560: View Of Camshaft Position Actuator Markings
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the triangle marking (2). The triangle marking is for alignment to the highlighted timing chain link on the right side of the engine.
5. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

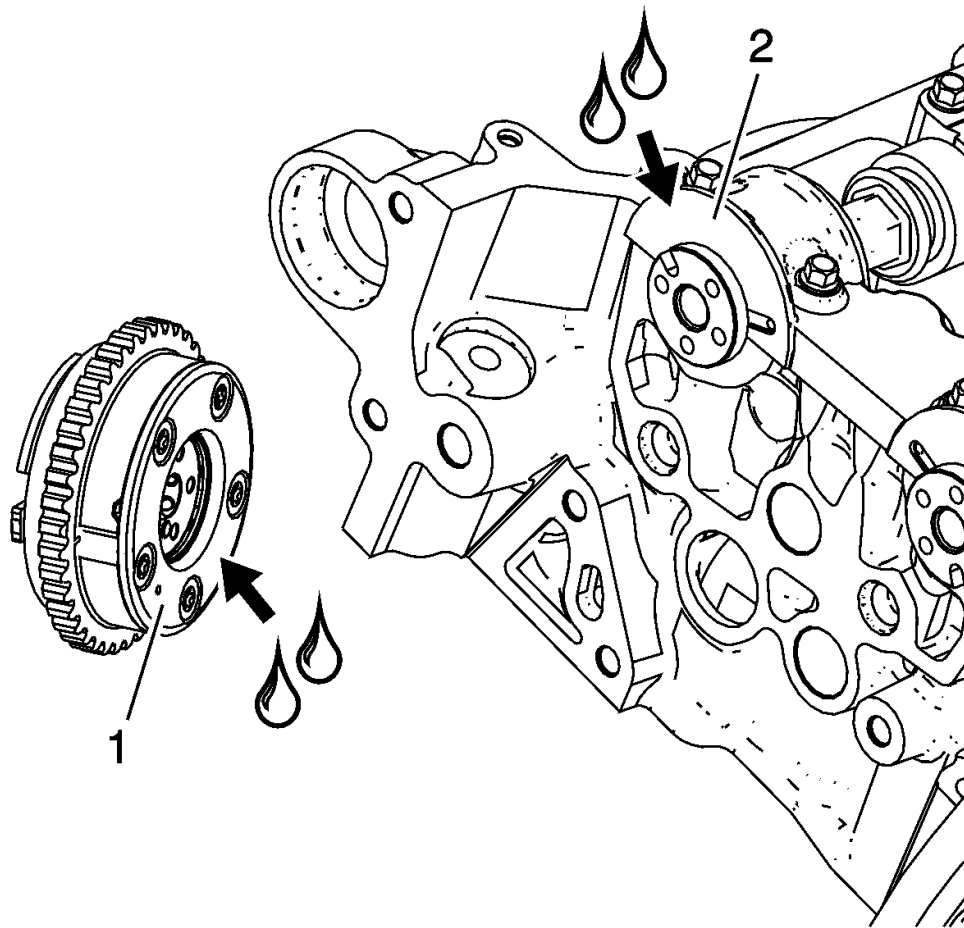


Fig. 561: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

6. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

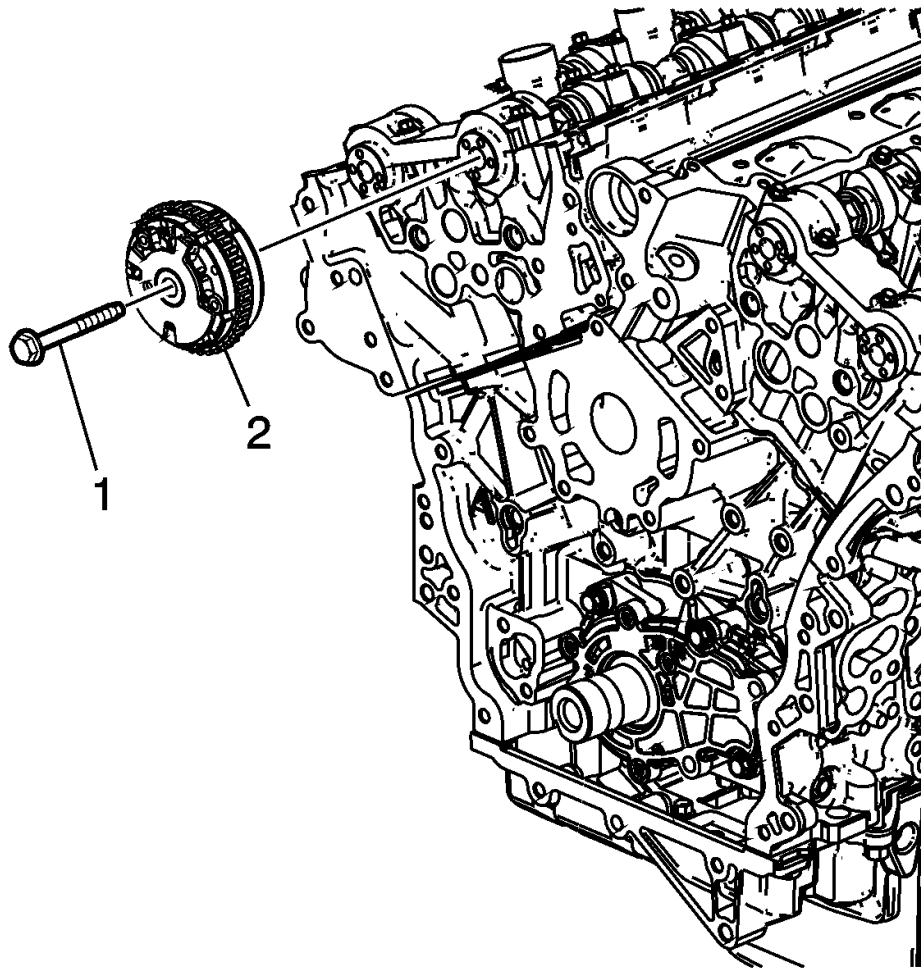


Fig. 562: Right Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

7. Install the right intake camshaft position actuator (2).
8. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAUTION: Refer to Fastener Caution .

CAMSHAFT POSITION ACTUATOR INSTALLATION - RIGHT SIDE EXHAUST

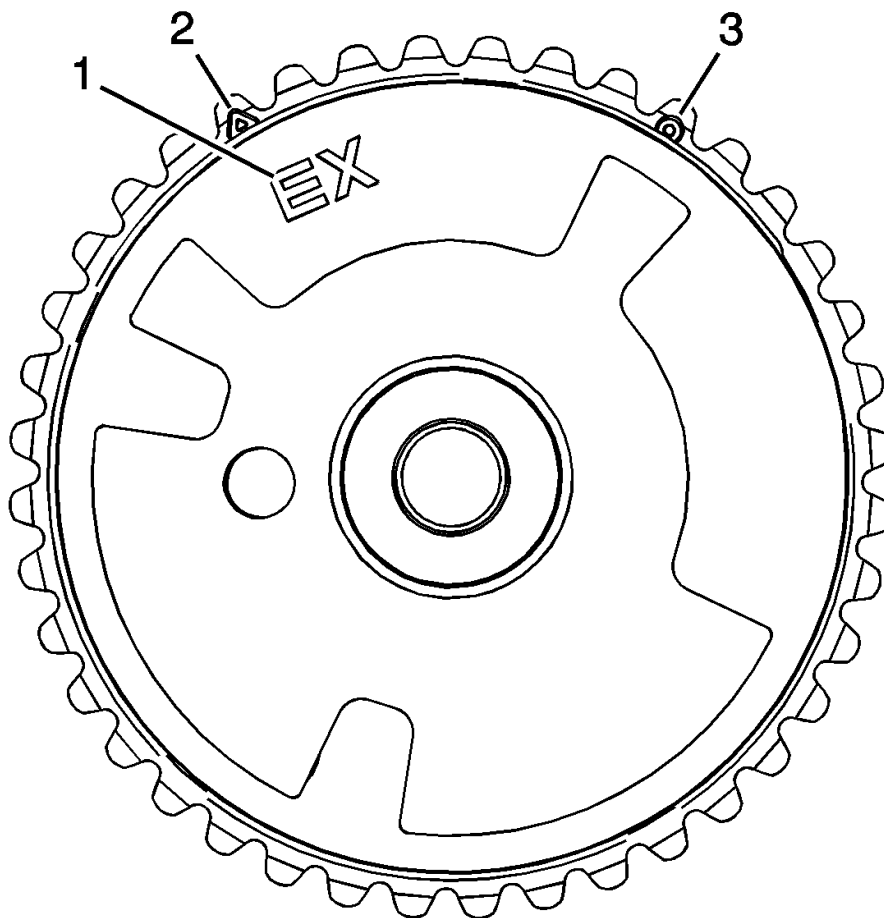


Fig. 563: View Of EX Marking, Triangle & Circle Marking
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the triangle marking (2). The marking is for alignment to the highlighted timing chain link on the right side of the engine.
3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

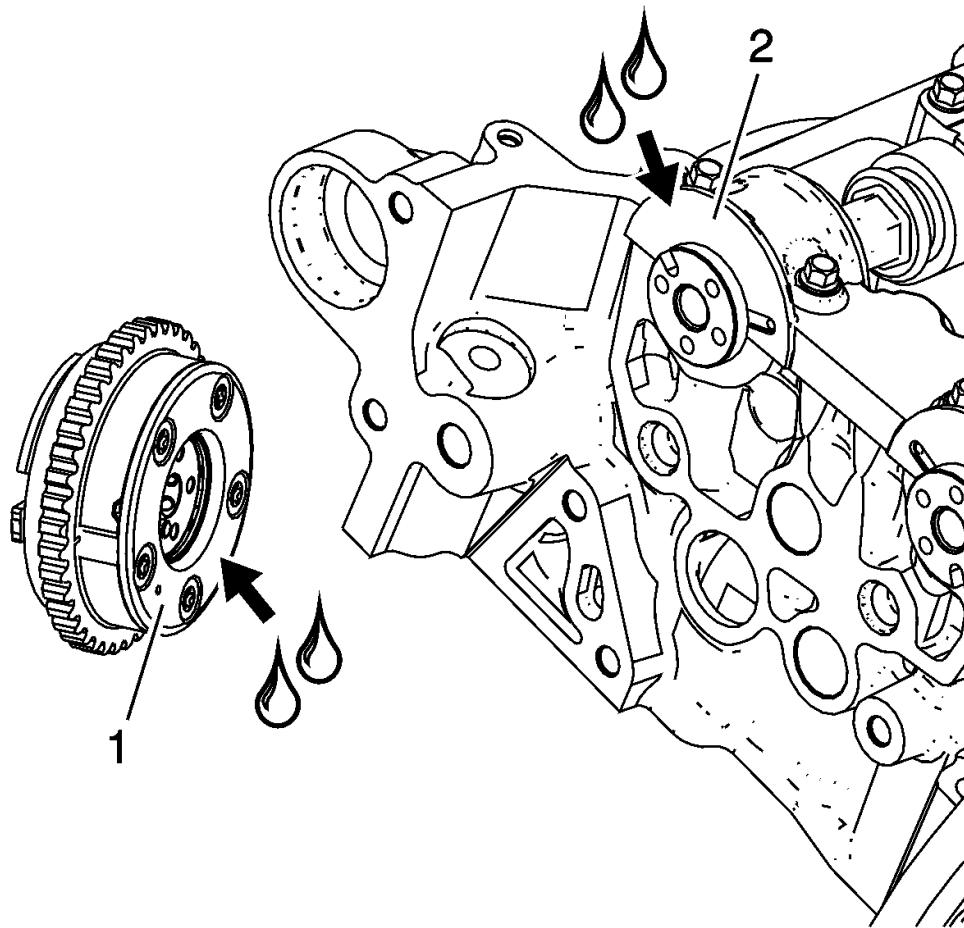


Fig. 564: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

4. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

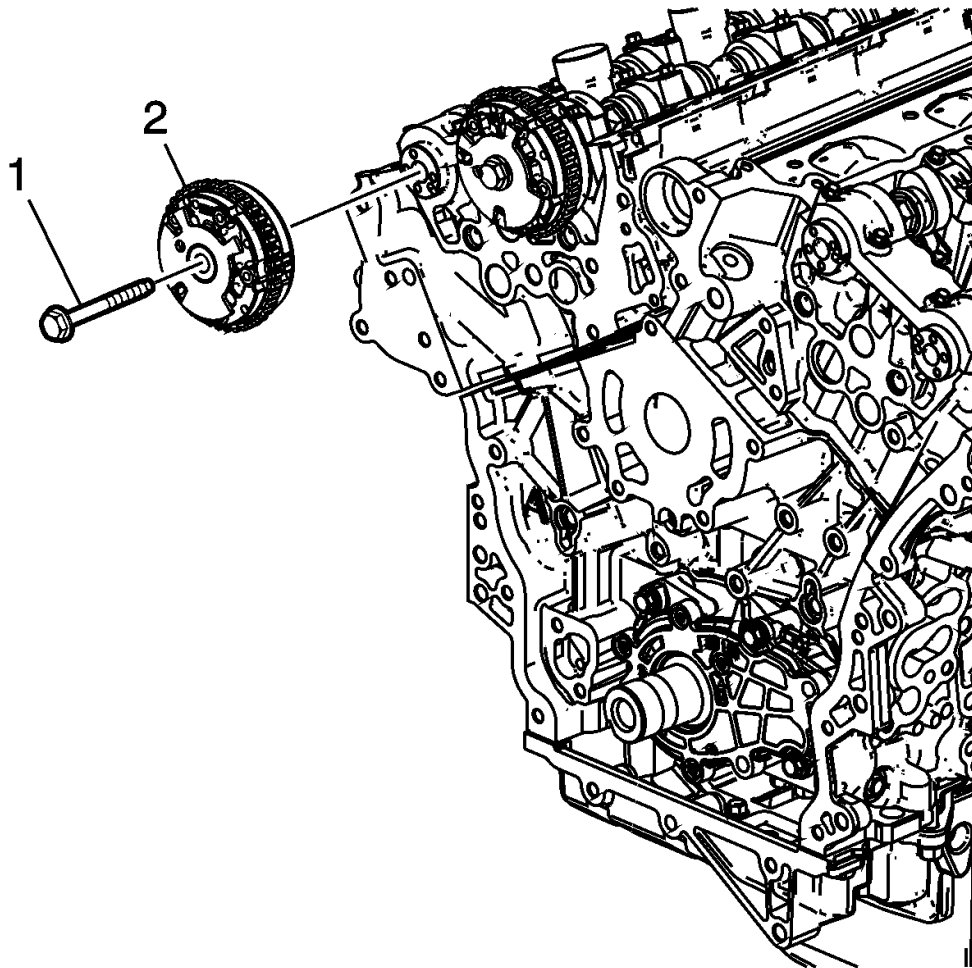


Fig. 565: Right Exhaust Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

5. Install the right exhaust camshaft position actuator (2).
6. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAUTION: Refer to Fastener Caution .

CAMSHAFT POSITION ACTUATOR INSTALLATION - LEFT SIDE INTAKE

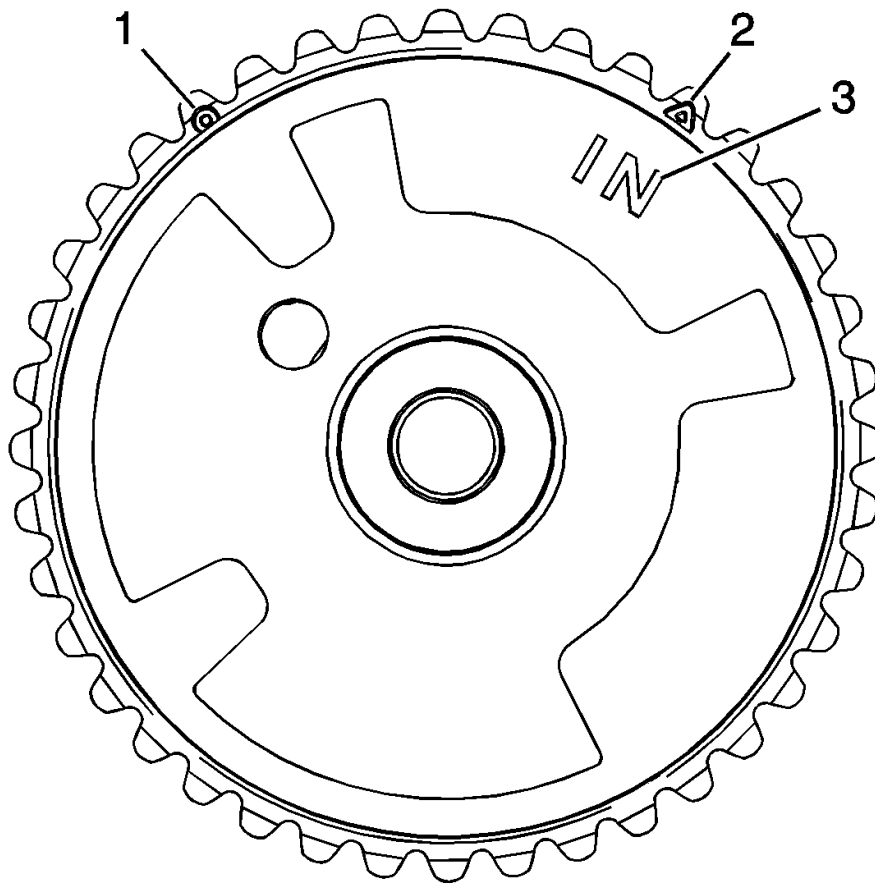


Fig. 566: Identifying Camshaft Position Actuator Marks
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.
2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).

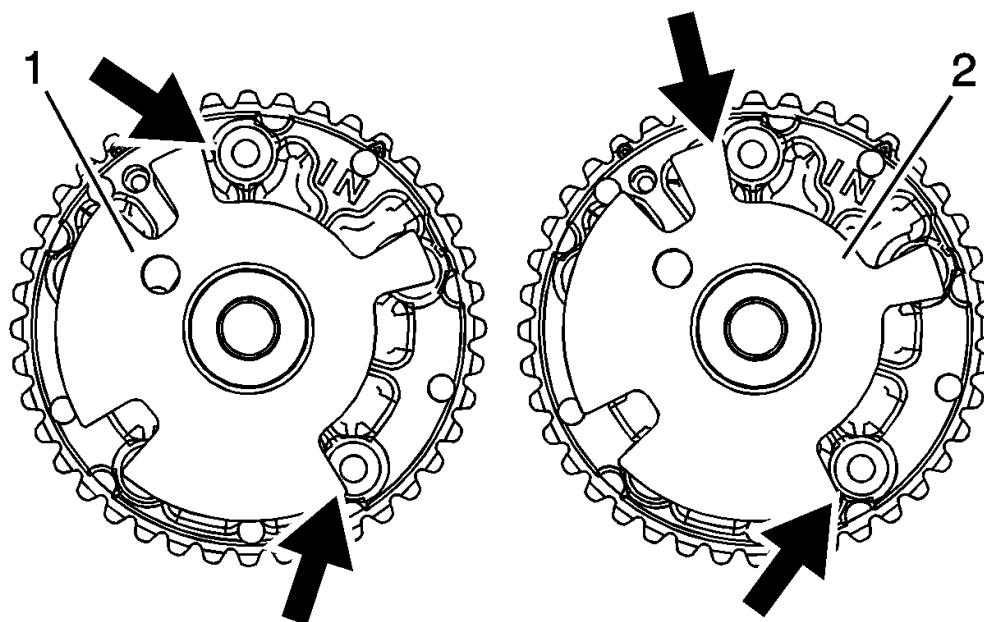


Fig. 567: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

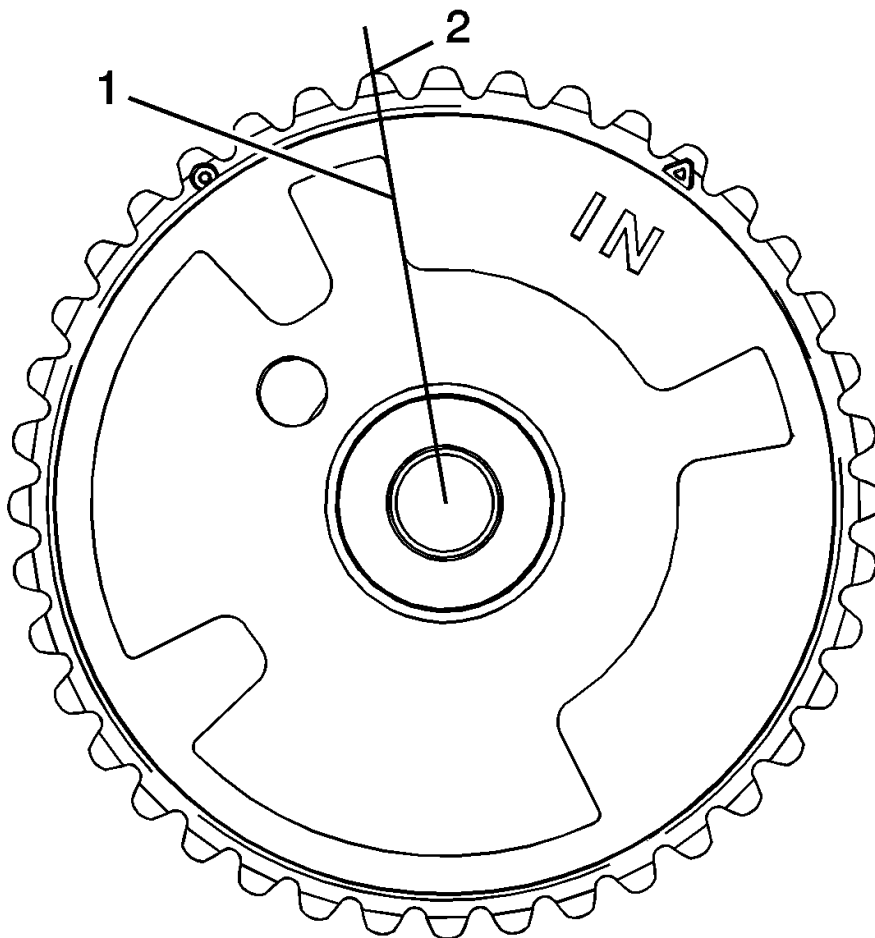


Fig. 568: View Of Reluctor Wheel Lines Up With Peak
Courtesy of GENERAL MOTORS COMPANY

3. On the left intake camshaft actuator the edge of the reluctor wheel (1) lines up with the peak (2) of the sprocket tooth.

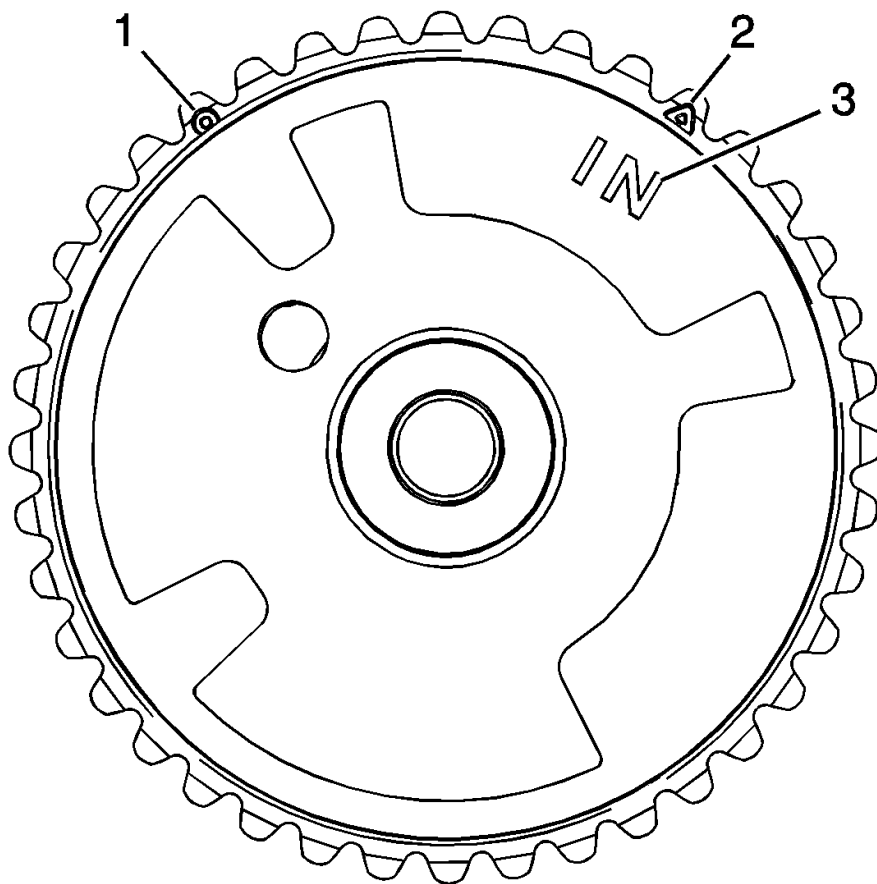


Fig. 569: Identifying Camshaft Position Actuator Marks
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the circle marking (1). The circle marking is for alignment to the highlighted timing chain link on the left side of the engine.
5. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

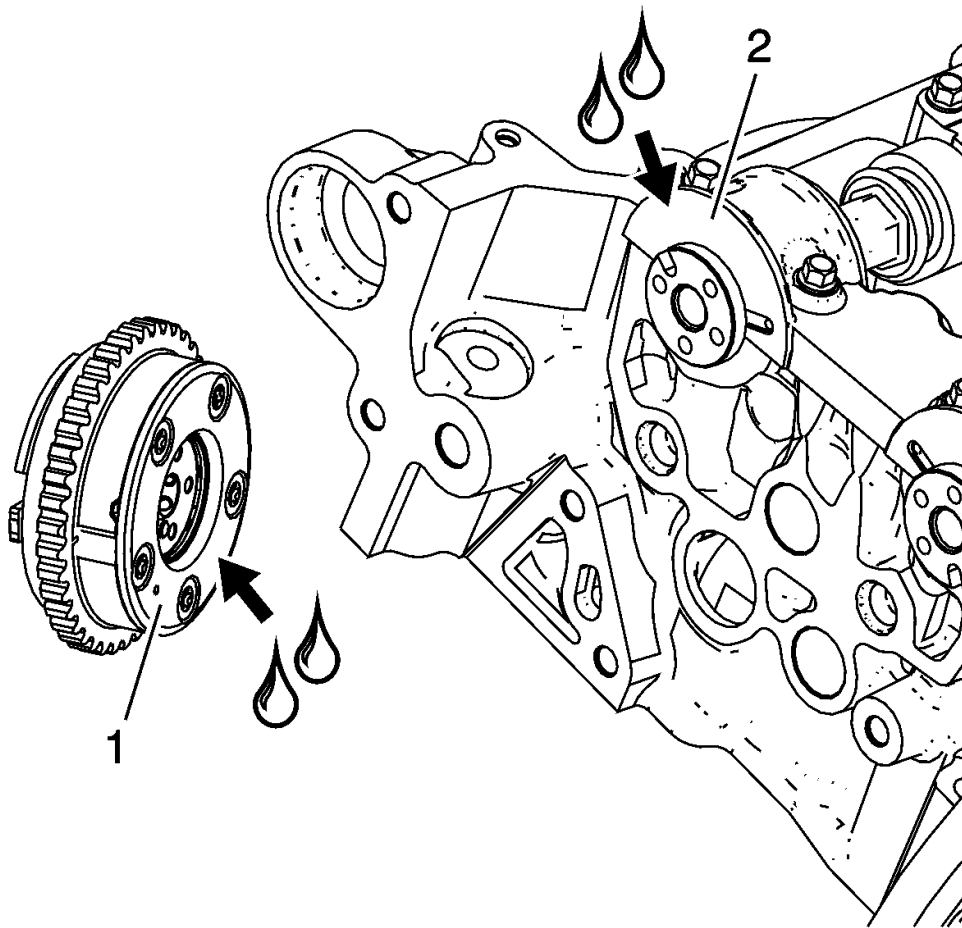


Fig. 570: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

6. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

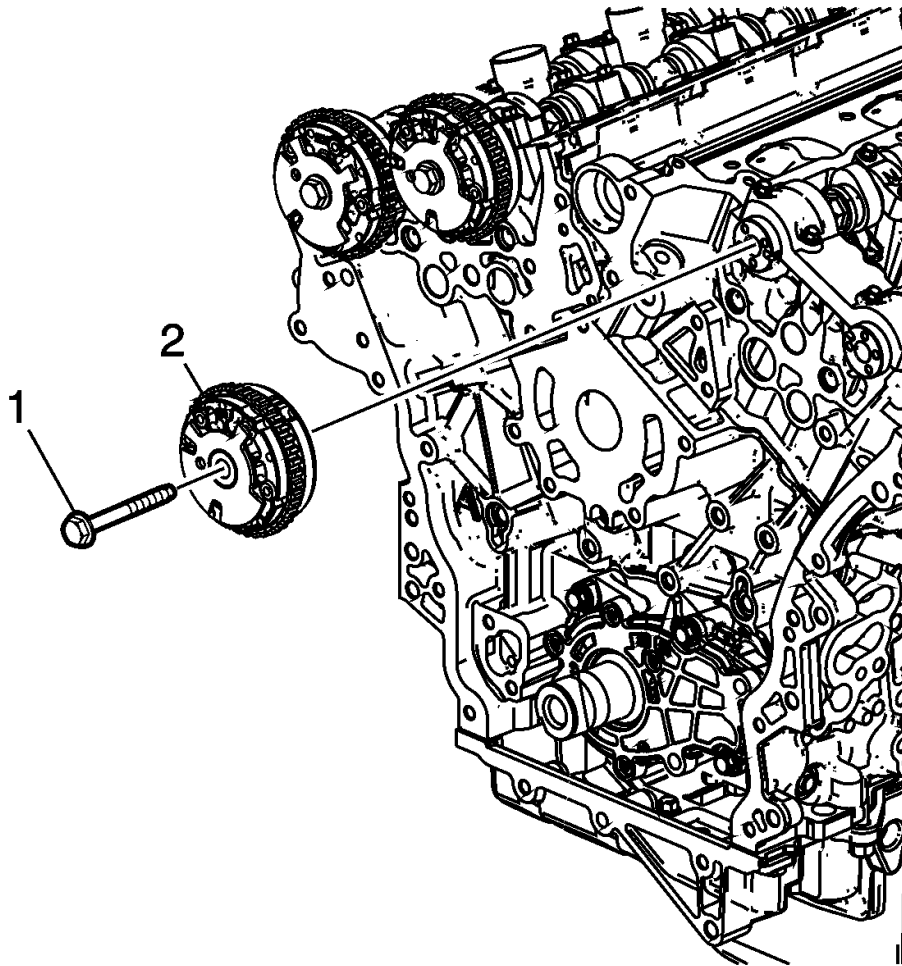


Fig. 571: Left Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

7. Install the left intake camshaft position actuator (2).
8. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAUTION: Refer to Fastener Caution .

CAMSHAFT POSITION ACTUATOR INSTALLATION - LEFT SIDE EXHAUST

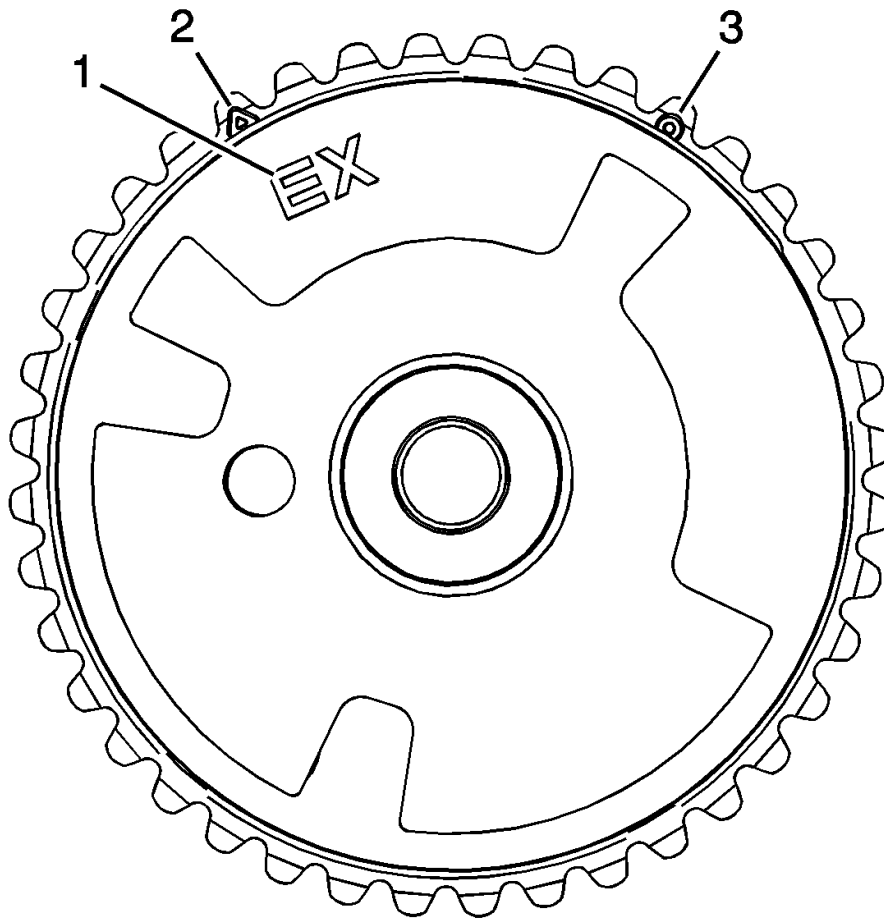


Fig. 572: View Of EX Marking, Triangle & Circle Marking
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the circle marking (3). The marking is for alignment to the highlighted timing chain link on the left side of the engine.
3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

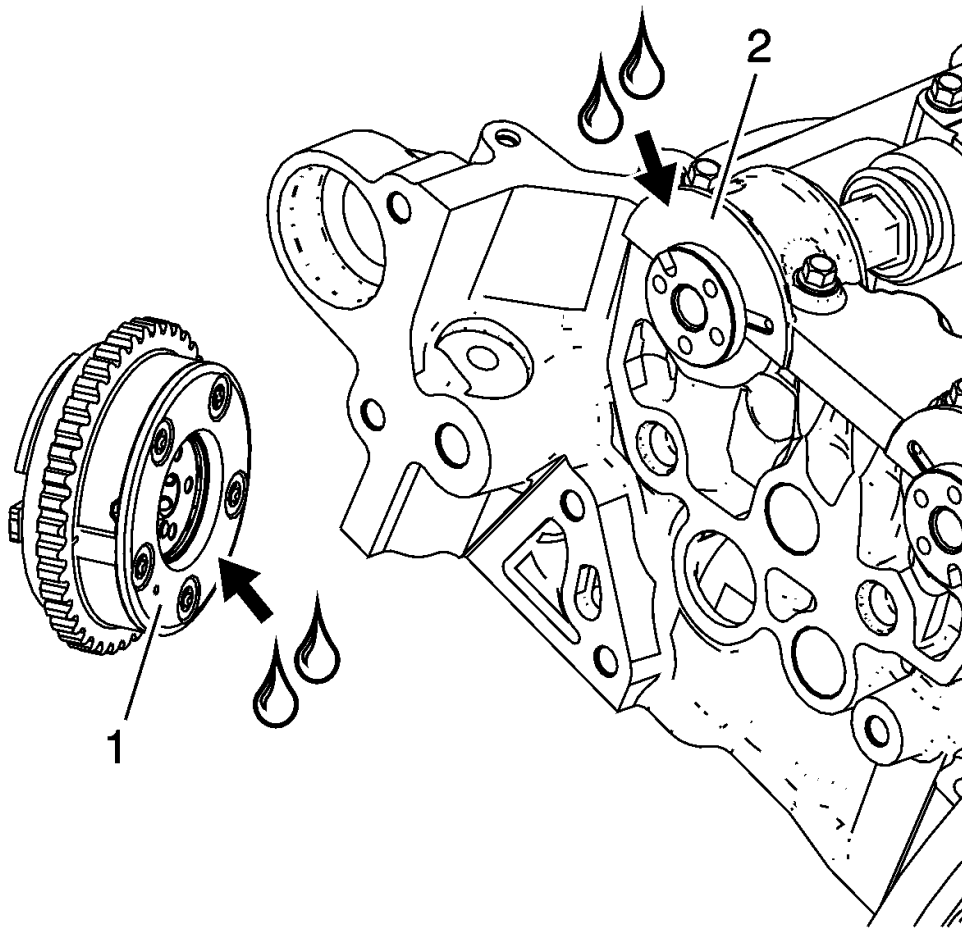


Fig. 573: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

4. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

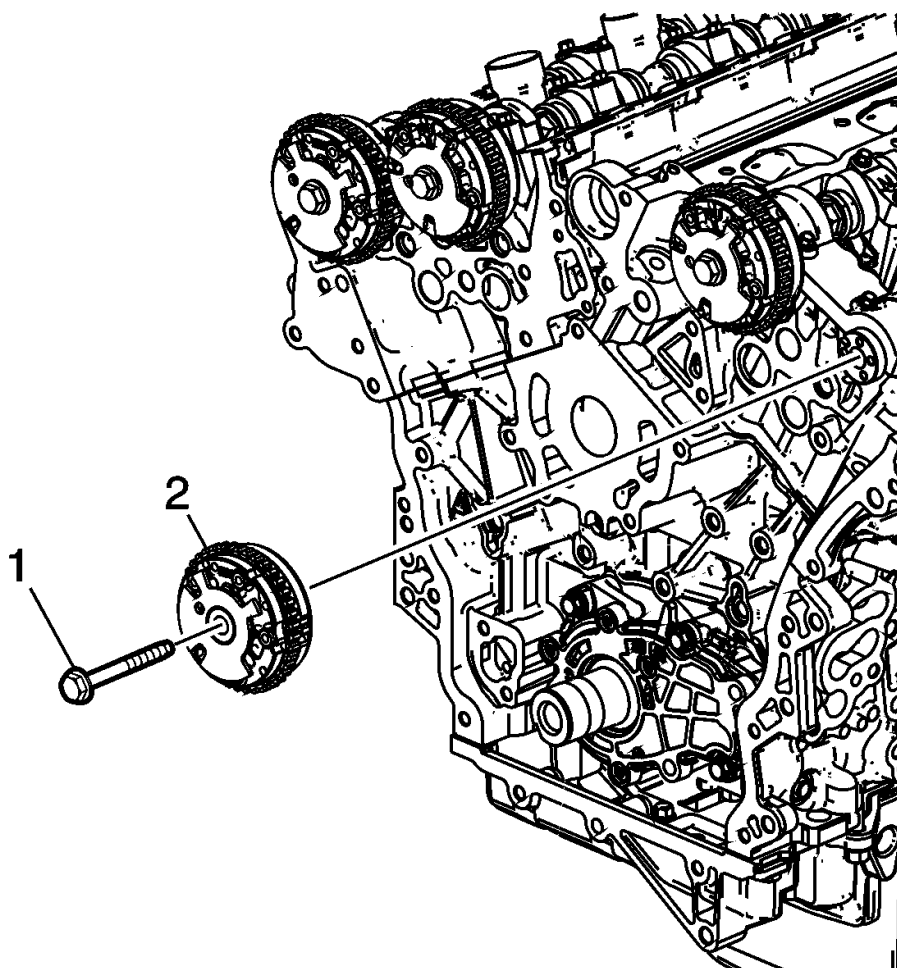


Fig. 574: Left Exhaust Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

5. Install the left exhaust camshaft position actuator (2).
6. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAUTION: Refer to Fastener Caution .

CRANKSHAFT SPROCKET INSTALLATION

Special Tools

EN-48589 Crankshaft Rotation Socket

For equivalent regional tools, refer to **Special Tools** .

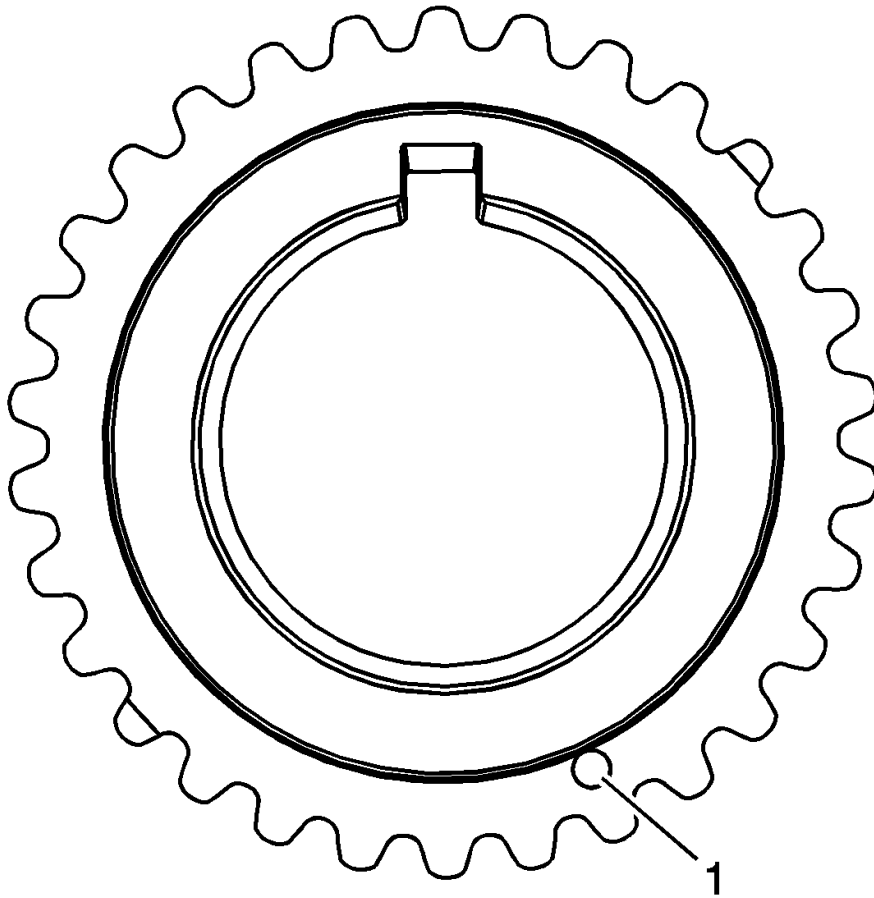


Fig. 575: Identifying Crankshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the crankshaft sprocket is installed with the timing mark (1) visible.

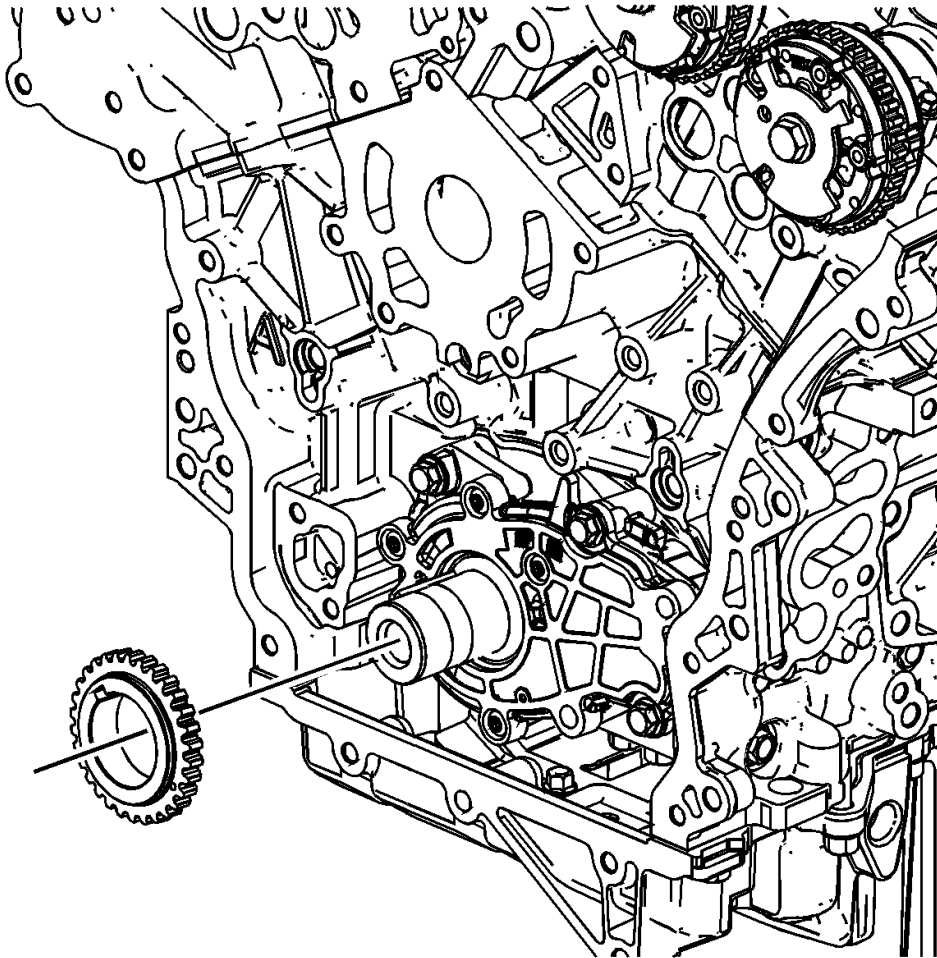


Fig. 576: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install the crankshaft sprocket onto the nose of the crankshaft.
3. Align the notch in the crankshaft sprocket with the pin in the crankshaft.
4. Slide the crankshaft sprocket on the crankshaft nose until the crankshaft sprocket contacts the step in the crankshaft.

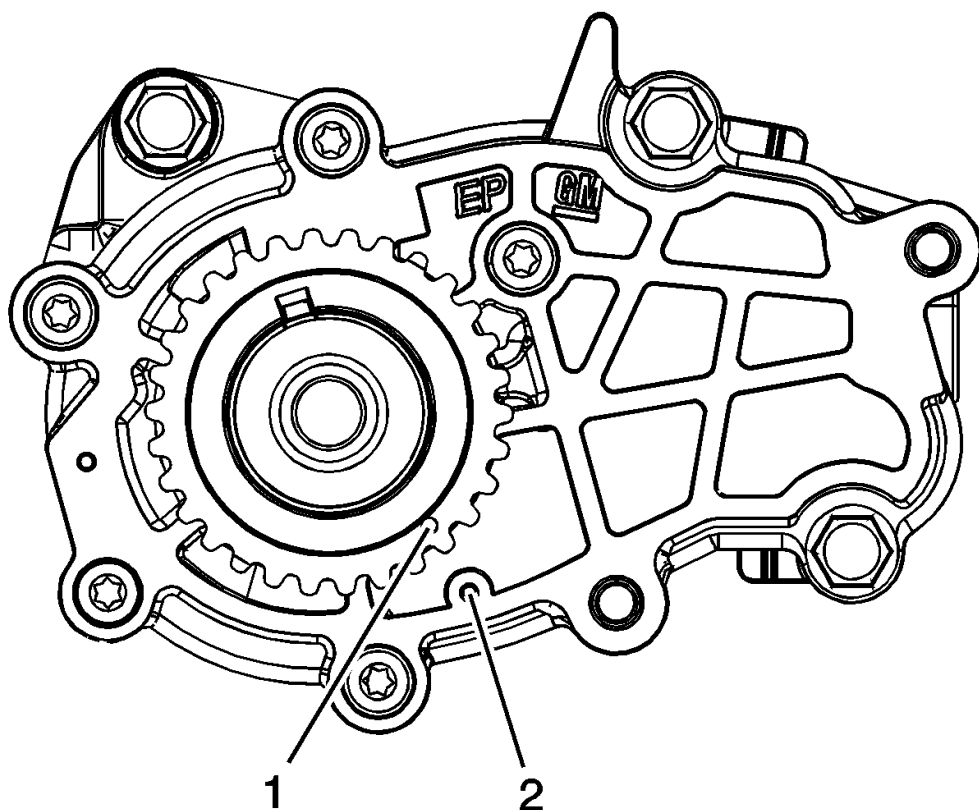


Fig. 577: View Of Stage One Timing Mark On Oil Pump Cover & Sprocket Timing Mark
 Courtesy of GENERAL MOTORS COMPANY

5. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN-48589** socket. Refer to **Timing Chain Alignment Diagram** .

TIMING CHAIN IDLER SPROCKET INSTALLATION - LEFT SIDE

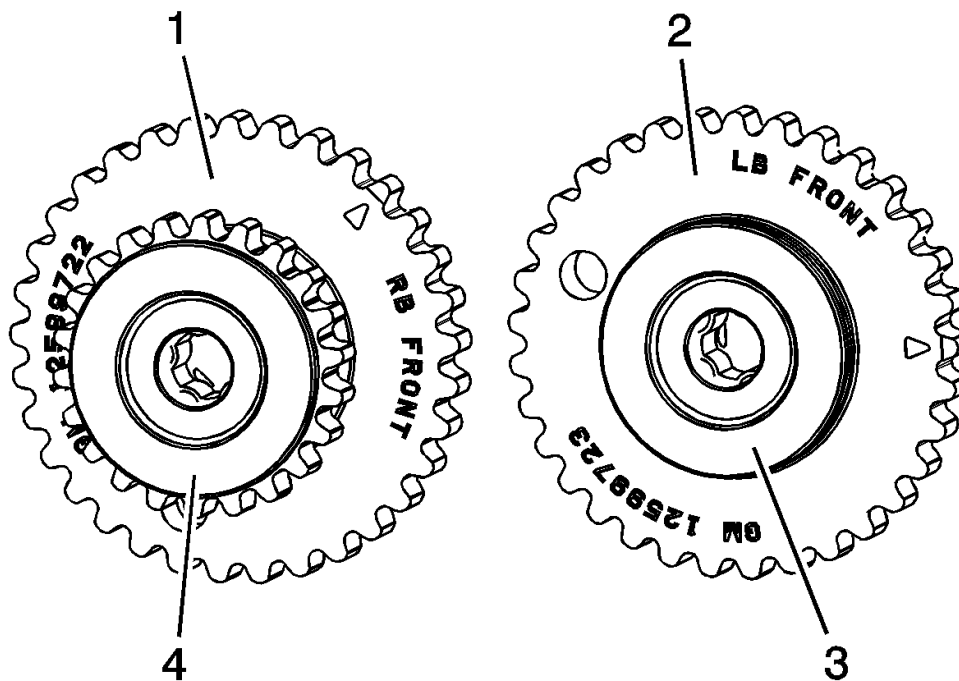


Fig. 578: View Of Camshaft Intermediate Drive Chain Idler - Left Side (Fourth Design)
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the left camshaft intermediate drive chain idler (2) is being installed. The recessed hub (3) and the larger sprocket of the left camshaft intermediate drive chain idler is installed outward. The raised hub and the smaller sprocket of the left camshaft intermediate drive chain idler is installed towards the block.

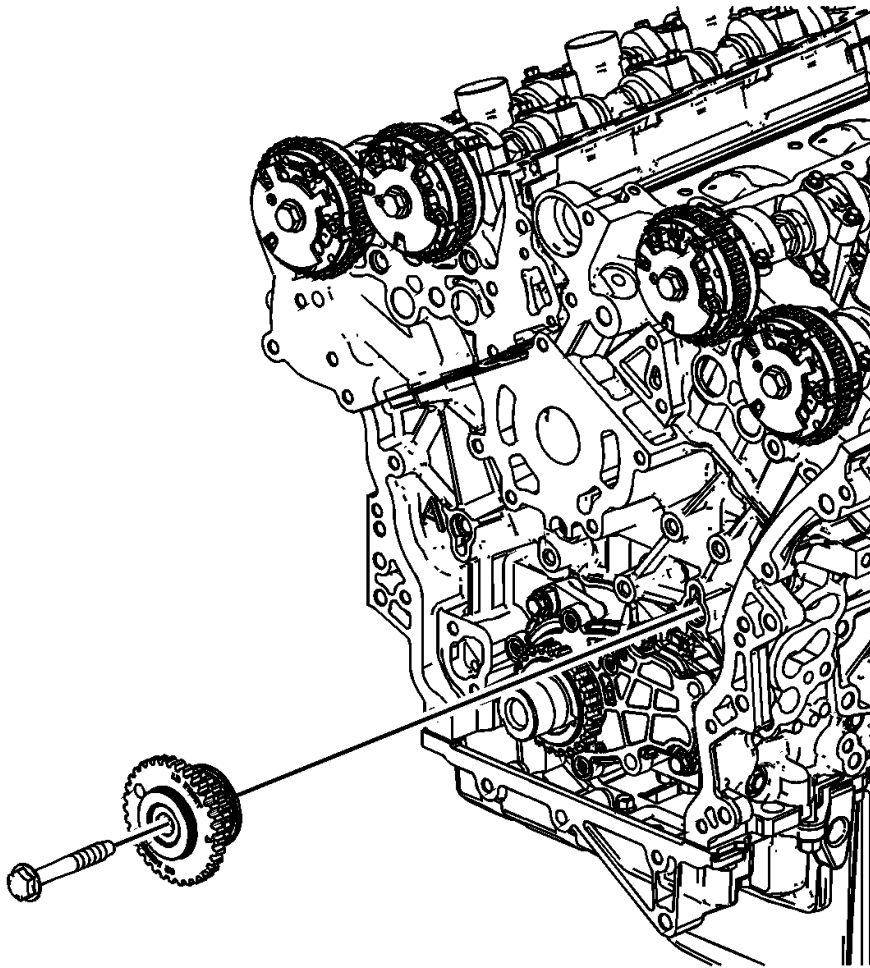


Fig. 579: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Place the left camshaft intermediate drive chain idler to the cylinder block.
3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 N.m (43 lb ft).

CAUTION: Refer to Fastener Caution .

CAMSHAFT TIMING CHAIN COMPONENTS INSTALLATION

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

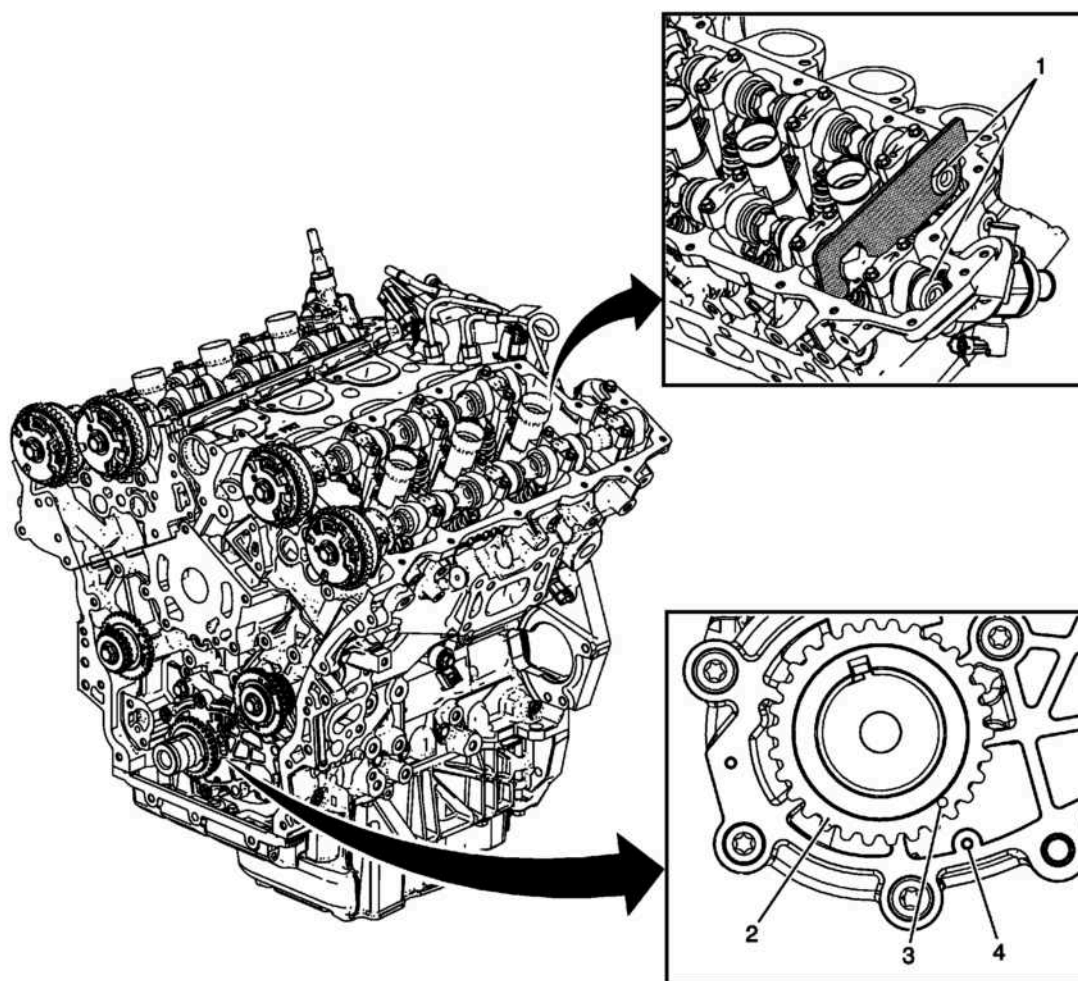


Fig. 580: Secondary Camshaft Intermediate Drive Chain Components - Left Side - Step 1
Courtesy of GENERAL MOTORS COMPANY

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

Callout	Component Name
1	Left Intake and Exhaust Camshaft Procedure 1. Install the EN-48383-1 retaining tool onto the rear of the left camshafts. 2. Ensure the EN-48383-1 retaining tool is fully seated onto the camshafts. NOTE: • 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. • All camshafts must be locked in place before installation of any camshaft drive chains.

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	Special Tools EN-48383 Camshaft Retaining Tools For equivalent regional tools, refer to Special Tools .
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 <u>Timing Chain Alignment Diagram</u> . Special Tools EN-48589 Crankshaft Rotation Socket For equivalent regional tools, refer to Special Tools .
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

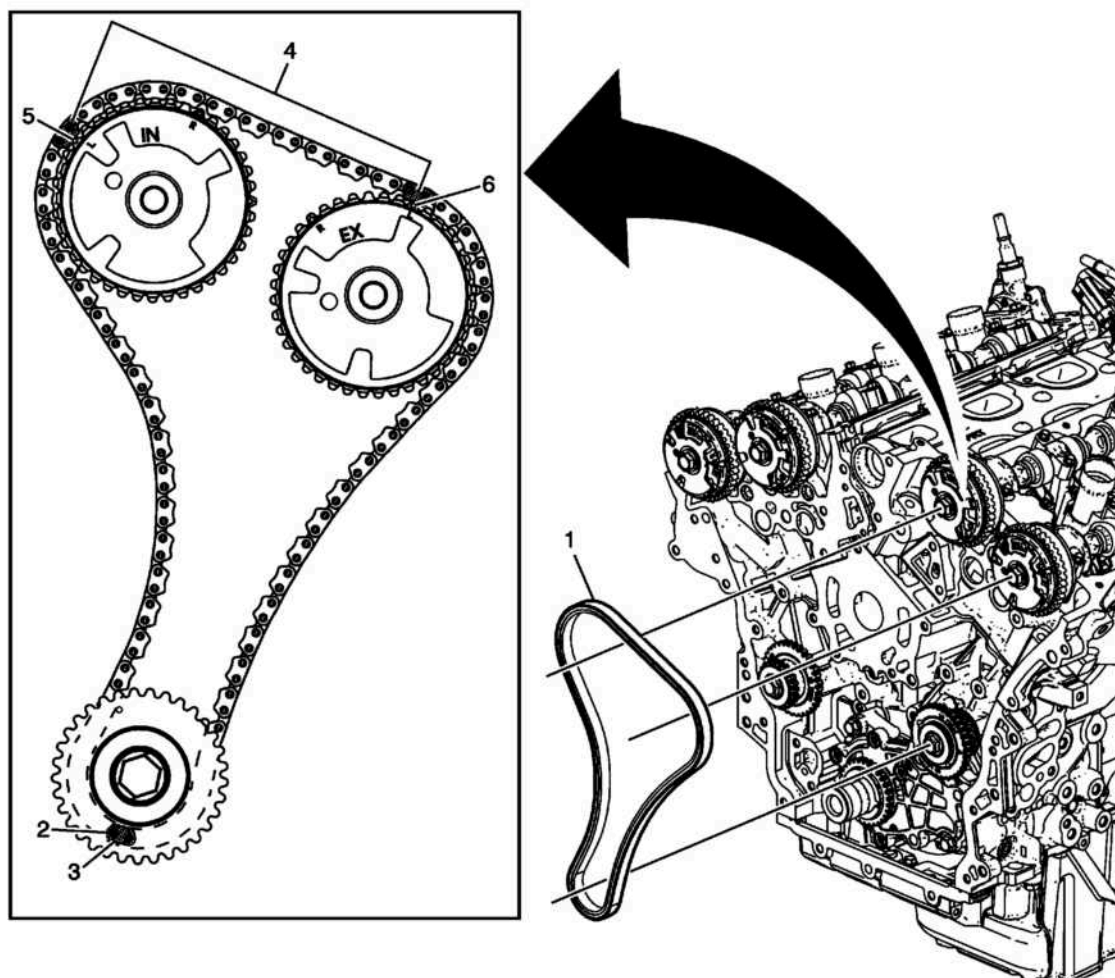


Fig. 581: Secondary Camshaft Intermediate Drive Chain Components - Left Side - Step 2
 Courtesy of GENERAL MOTORS COMPANY

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

Callout	Component Name
1	Left Secondary Camshaft 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 timing camshaft drive chain link (2) aligned to the alignment access hole (3) made in the left camshaft intermediate drive chain idler outer sprocket. 2. Wrap the secondary camshaft drive chain around both left actuator drive sprockets. 3. Ensure there are 10 links (4) between the timing camshaft drive chain links for the camshaft position actuator sprockets. 4. Align the left intake camshaft position actuator sprocket alignment circle mark (5) with the timing camshaft drive chain link.

	5. Align the left exhaust camshaft position actuator sprocket alignment circle mark (6) with the timing camshaft drive chain link.
2	Timing Camshaft Drive Chain
3	Alignment Access Hole
4	10 Links
5	Left Intake Camshaft Position Actuator Sprocket Alignment Circle Mark
6	Left Exhaust Camshaft Position Actuator Sprocket Alignment Circle Mark

Secondary Camshaft Drive Chain Guide and Shoe Installation - Left

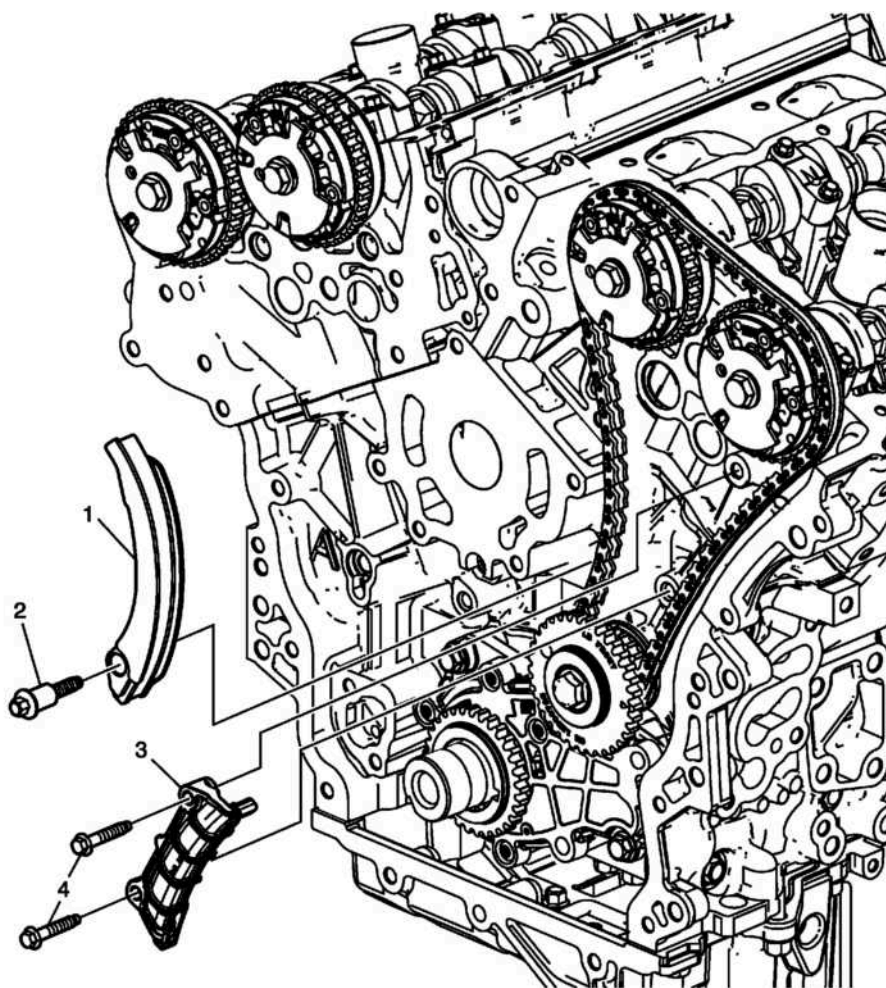


Fig. 582: Secondary Camshaft Drive Chain Guide and Shoe - Left
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Guide and Shoe Installation - Left

Callout	Component Name
1	Left Secondary Camshaft Drive Chain Guide
	Left Secondary Camshaft Drive Chain Guide Bolt

2	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
3	Left Secondary Camshaft Drive Chain Shoe
4	Left Secondary Camshaft Drive Chain Shoe Bolt Tighten 25 (18 lb ft)

Secondary Camshaft Drive Chain Tensioner Installation - Left Side

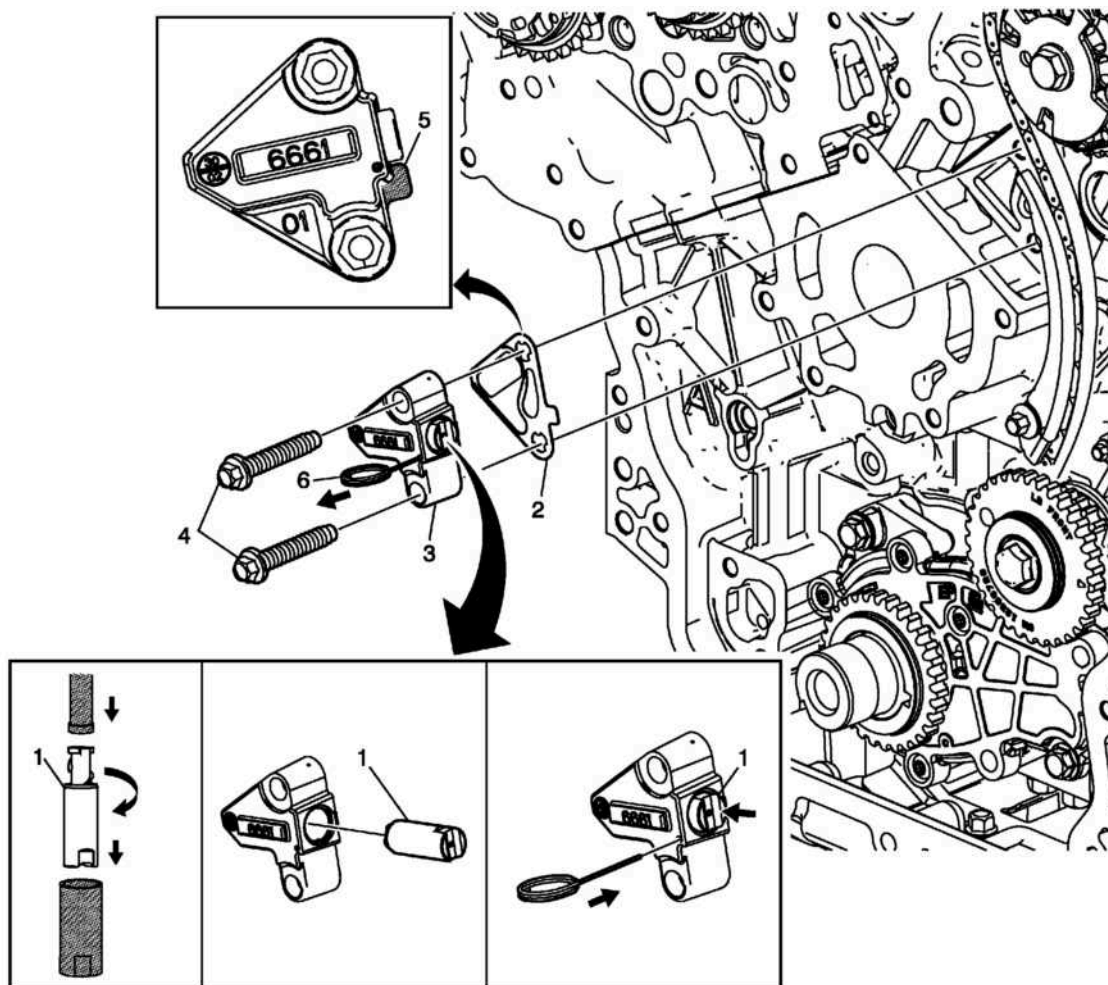


Fig. 583: Secondary Camshaft Drive Chain Tensioner And Components - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Tensioner Installation - Left Side

Callout	Component Name
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1	Left Secondary Camshaft Drive Chain Tensioner Plunger. Procedure 1. Reset the left secondary camshaft drive chain tensioner plunger using EN-45027 tensioner tool. 2. Install left secondary camshaft drive chain tensioner plunger into body. 3. Compress the plunger into the body and lock the left secondary camshaft drive chain tensioner by inserting the EN-46112 tensioner retraction pins into the access hole in the side of the left secondary camshaft drive chain tensioner body. 4. Slowly release pressure on the left secondary camshaft drive chain tensioner. The left secondary 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 .
2	Left Secondary Camshaft Drive Chain Tensioner Gasket NOTE: Ensure the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head does not have any burrs or defects that would degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.
3	Left Secondary Camshaft Drive Chain Tensioner
4	Left Secondary Camshaft Drive Chain Tensioner Bolt Procedure 1. Place the 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. Release the drive chain tensioner by pulling out the EN-46112 tensioner retraction pins pin (6) and unlocking the tensioner plunger. 5. Verify the left secondary camshaft drive chain timing mark alignments by referring to Timing Chain Alignment Diagram - Stage One. Tighten • First Pass 5 (44 lb in)

	• Second Pass 25 (18 lb ft)
5	Drive Chain Tensioner Gasket Tab
6	EN-46112 Pin

Primary Camshaft Intermediate Drive Chain Installation

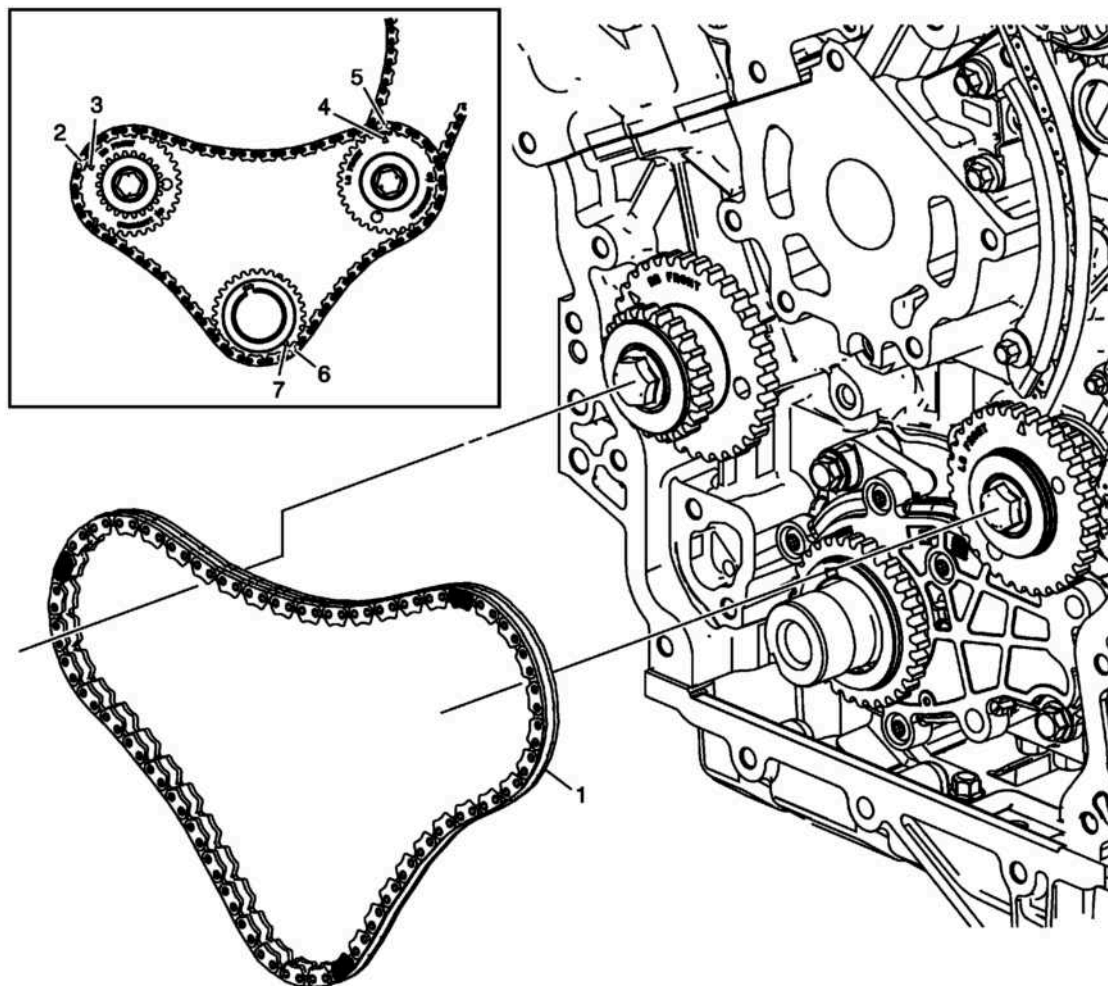


Fig. 584: Primary Camshaft Intermediate Drive Chain Components
Courtesy of GENERAL MOTORS COMPANY

Primary Camshaft Intermediate Drive Chain Installation

Callout	Component Name
1	Primary Camshaft Drive 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 a timing camshaft drive chain link (3).
3. The right camshaft intermediate drive chain idler timing mark (4) will align with a timing camshaft drive chain link (5).
4. The crankshaft sprocket timing mark (7) will align with a timing camshaft drive chain link (6).

2	Left Camshaft Intermediate Drive Chain Idler Timing Mark
3	Timing Camshaft Drive Chain Link
4	Right Camshaft Intermediate Drive Chain Idler Timing Mark
5	Timing Camshaft Drive Chain Link
6	Timing Camshaft Drive Chain Link
7	Crankshaft Sprocket Timing Mark

Primary Timing Chain Guide Installation - Lower and Upper

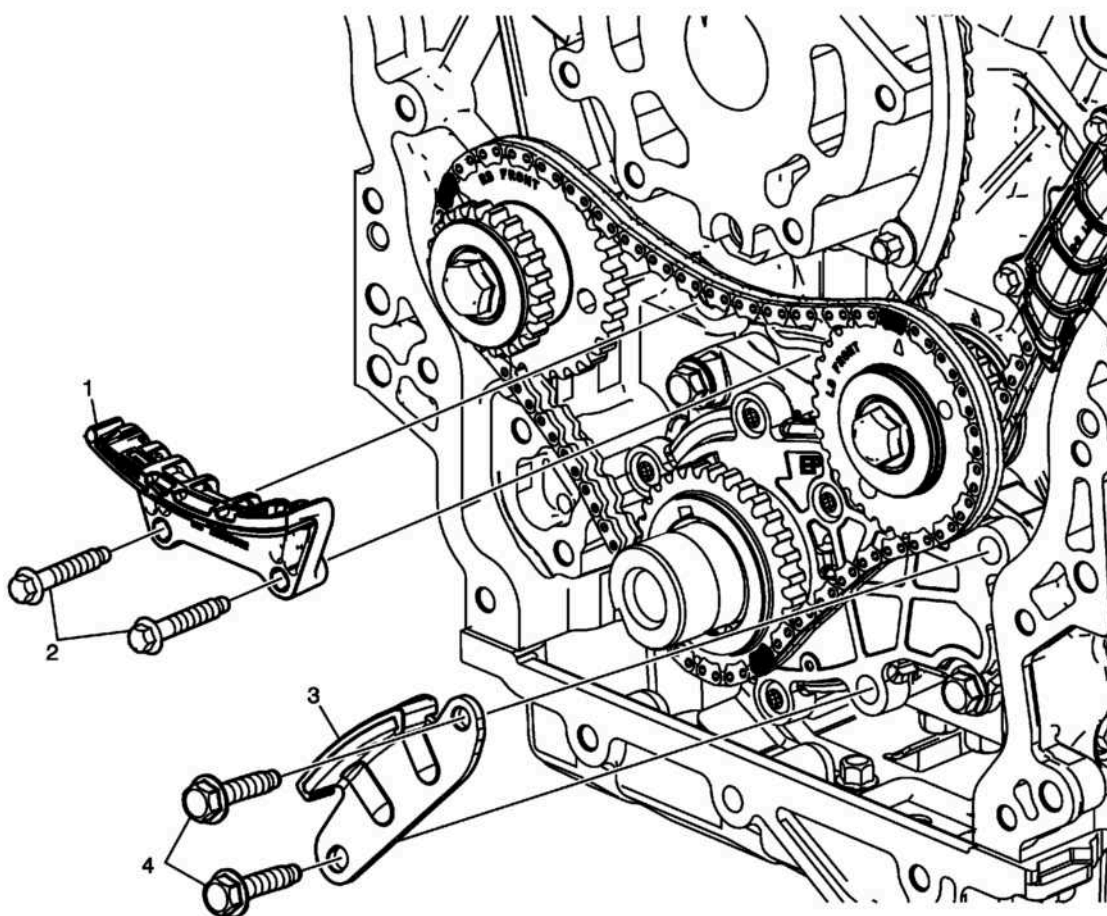


Fig. 585: Primary Timing Chain Guide And Bolts - Lower And Upper
 Courtesy of GENERAL MOTORS COMPANY

Primary Timing Chain Guide Installation - Lower and Upper

Callout	Component Name
1	Primary Camshaft Drive Chain Lower Guide
2	Primary Camshaft Drive Chain Lower Guide Bolt Tighten 25 (18 lb ft)
3	Upper Primary Camshaft Drive Chain Guide.
4	Upper Primary Camshaft Drive Chain Guide Bolt Tighten 25 (18 lb ft)

Primary Camshaft Intermediate Drive Chain Tensioner Installation

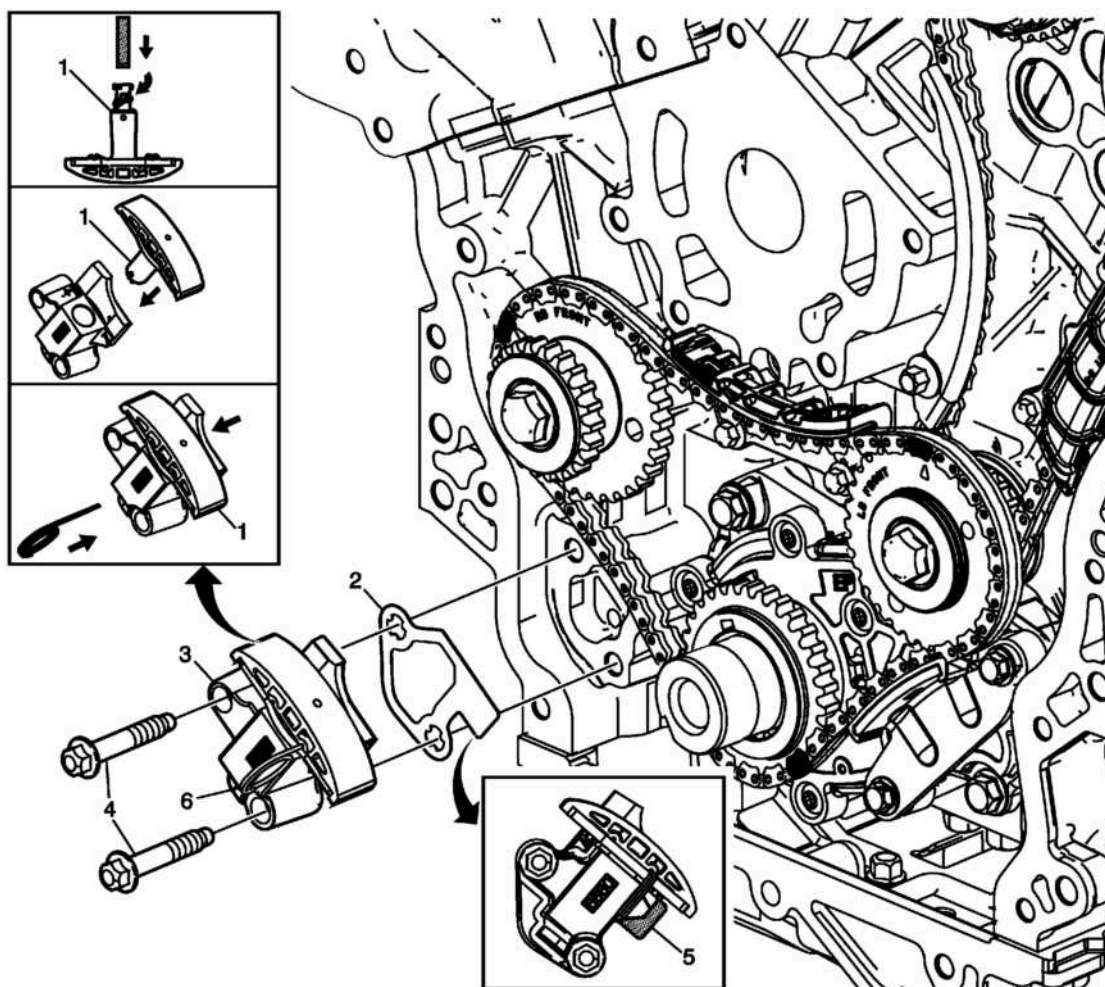


Fig. 586: Primary Camshaft Intermediate Drive Chain Tensioner & Components
Courtesy of GENERAL MOTORS COMPANY

Primary Camshaft Intermediate Drive Chain Tensioner Installation

Callout	Component Name

1	Primary Camshaft 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.
2	Primary Camshaft Drive Chain Tensioner 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	Primary Camshaft Drive Chain Tensioner
4	Primary Camshaft 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. Release the drive chain tensioner by pulling out the EN-46112 pin (6) and unlocking the tensioner plunger. 5. Verify the primary and left secondary camshaft drive chain timing mark alignments by referring to Timing Chain Alignment Diagram - Stage One. Tighten • First Pass 5 (44 lb in)

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	• Second Pass 25 (18 lb ft)
5	Drive Chain Tensioner Gasket Tab
6	EN-46112 Pin

Stage 1 Alignment Position to the Stage 2 Alignment Position

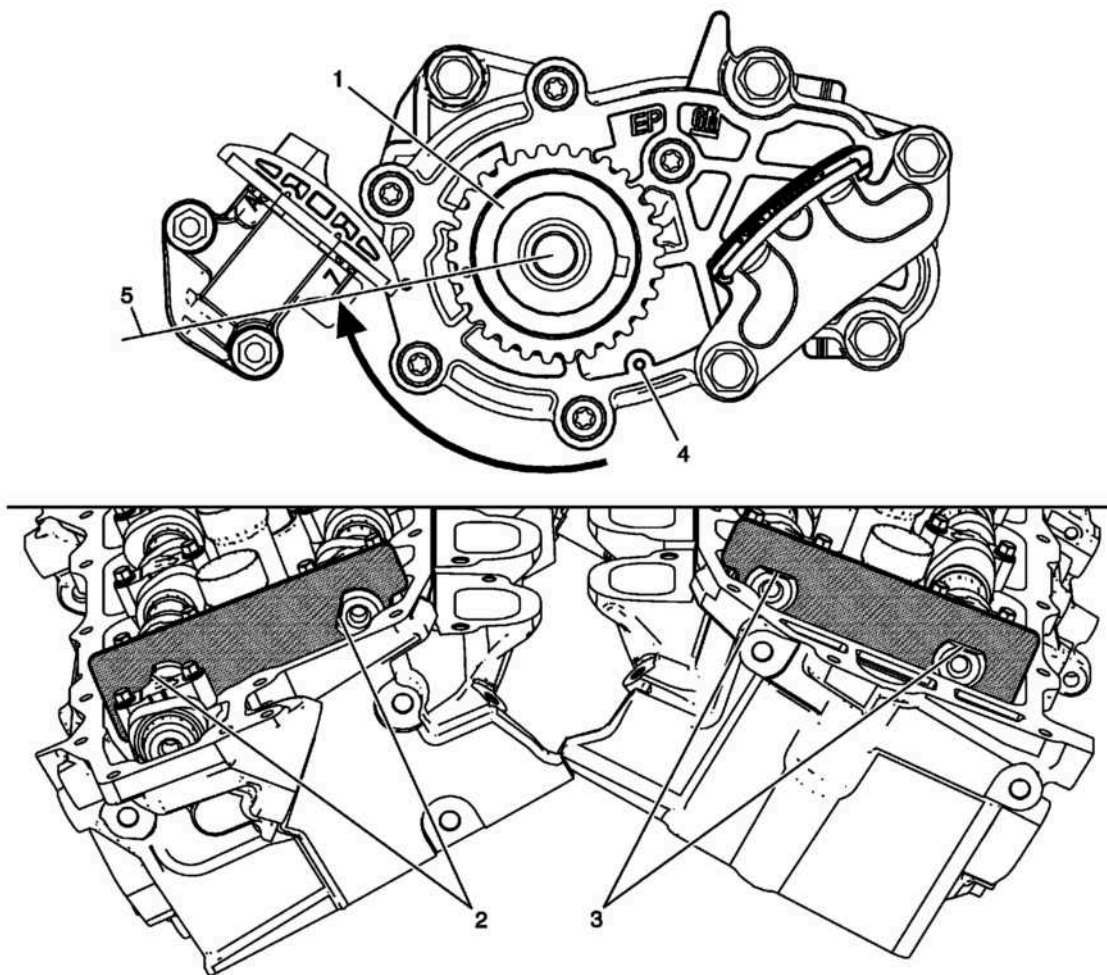


Fig. 587: Crankshaft Sprocket, Camshafts Stage 1 Alignment Position To Stage 2 Alignment Position
Courtesy of GENERAL MOTORS COMPANY

Stage 1 Alignment Position to the Stage 2 Alignment Position

Callout	Component Name
Preliminary Procedure	
Remove the EN 48383-1 from the rear of the left camshafts.	
1	Crankshaft Sprocket Procedure Using the EN-48589 crankshaft rotation socket, rotate the crankshaft and crankshaft sprocket from the stage one alignment position (4) to the stage two alignment position (5), 115 crankshaft degrees, in order to install the right secondary camshaft drive chain

	components. Special Tools EN-48589 Crankshaft Rotation Socket For equivalent regional tools, refer to Special Tools .
2	Left Intake and Exhaust Camshaft Procedure 1. Install the EN-48383-2 retainer onto the rear of the left camshafts. 2. Ensure the EN-48383-2 retainer is fully seated onto the camshafts. NOTE: • 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-48383-2 retainer. • All camshafts must be locked in place before installation of any camshaft drive chains. Special Tools EN-48383 Crankshaft Rotation Tools For equivalent regional tools, refer to Special Tools .
3	Right Intake and Exhaust Camshaft Procedure 1. Install the EN-48383-3 retainer onto the rear of the right camshafts. 2. Ensure the EN-48383-3 retainer is fully seated onto the camshafts. NOTE: • 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-48383-3 retainer. • All camshafts must be locked in place before installation of any camshaft drive chains. Special Tools EN-48383 Crankshaft Rotation Tools For equivalent regional tools, refer to Special Tools .
4	Stage One Alignment Position
5	Stage Two Alignment Position

Secondary Camshaft Intermediate Drive Chain Installation - Right Side

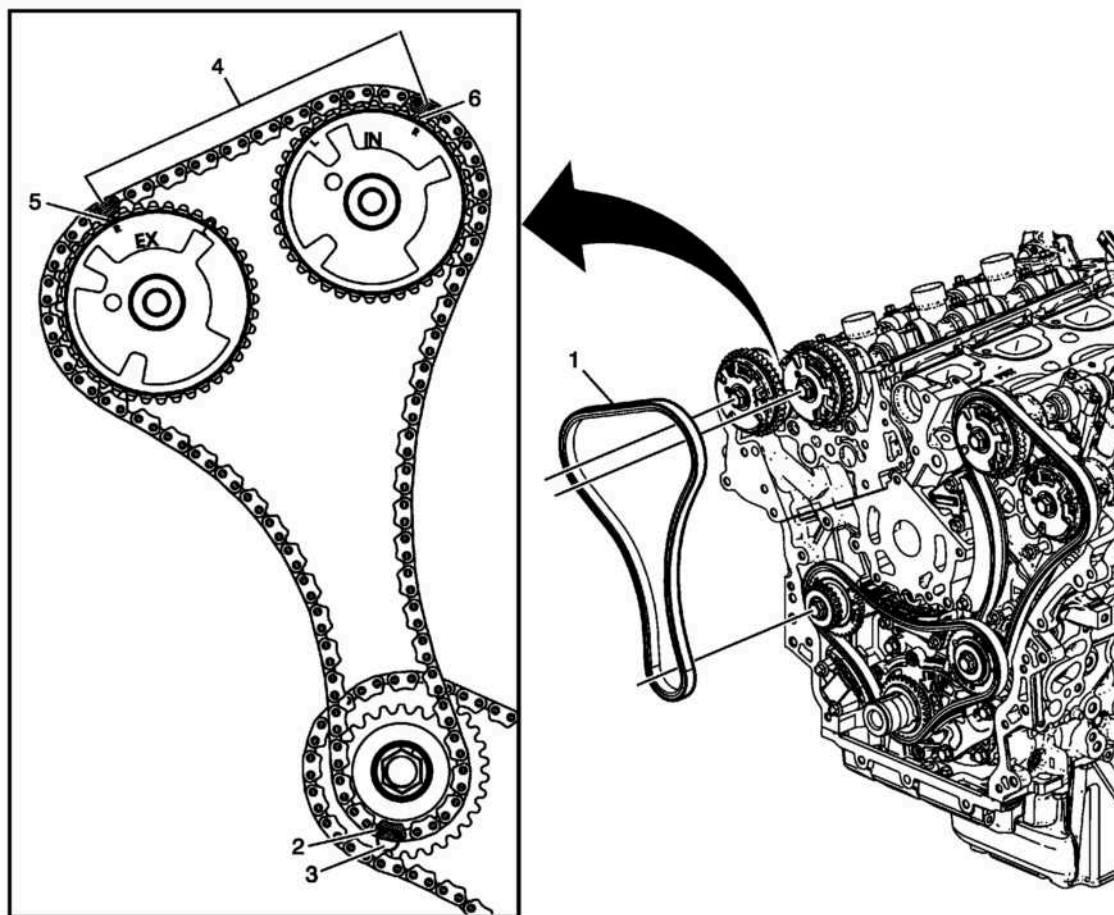


Fig. 588: Secondary Camshaft Intermediate Drive Chain - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Intermediate Drive Chain Installation - Right Side

Callout	Component Name
	Right 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 timing camshaft drive chain link (2) with the alignment access hole (3) made in the right camshaft intermediate drive chain idler inner sprocket. - Wrap the secondary camshaft intermediate drive chain around both right actuator drive sprockets.

3. Ensure there are 10 links (4) between the timing camshaft drive chain links for the camshaft position actuator sprockets.
4. Align the right intake camshaft position actuator sprocket alignment triangle mark (5) with the timing camshaft drive chain link.
5. Align the right exhaust camshaft position actuator sprocket alignment triangle mark (6) with the timing camshaft drive chain link.
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	Timing Camshaft Drive Chain Link
3	Alignment Access Hole
4	10 Links
5	Right Intake Camshaft Position Actuator Sprocket Alignment Triangle Mark
6	Right Exhaust Camshaft Position Actuator Sprocket Alignment Triangle Mark

Secondary Camshaft Drive Chain Guide and Shoe Installation - Right Side

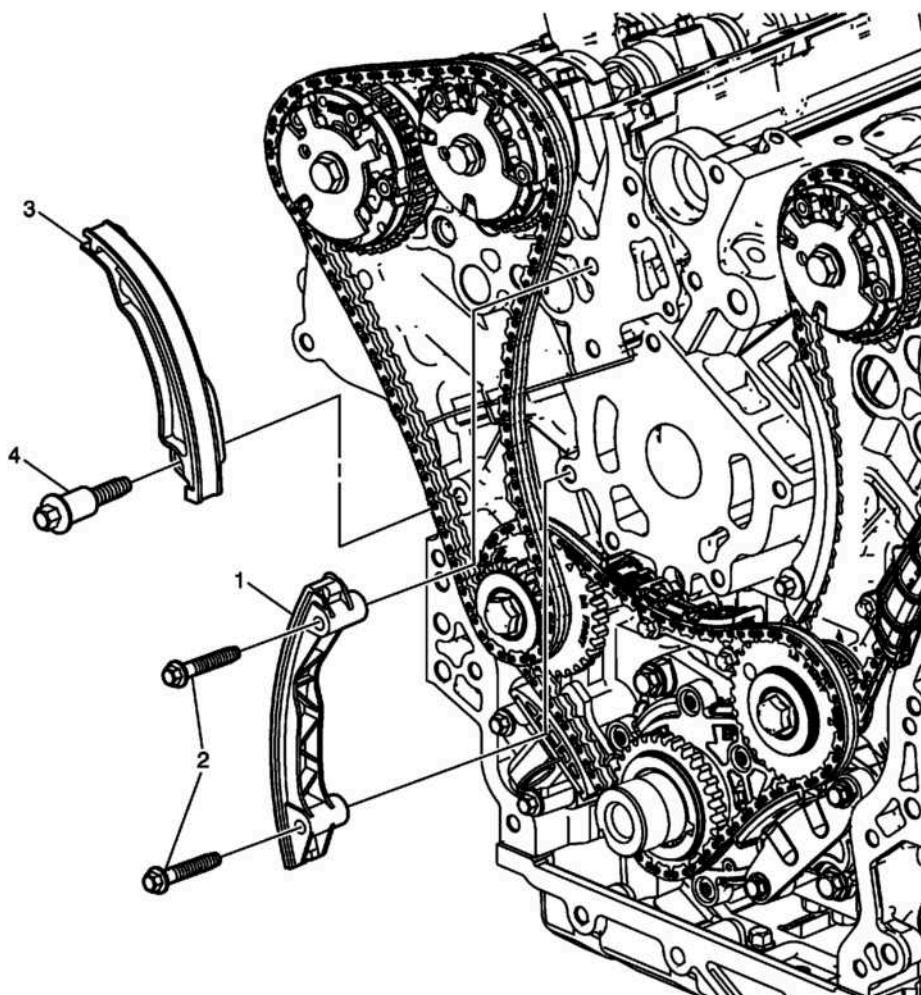


Fig. 589: Secondary Camshaft Drive Chain Guide And Shoe - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Guide and Shoe Installation - Right Side

Callout	Component Name
1	Right Secondary Camshaft Drive Chain Guide
2	Right Secondary Camshaft Drive Chain Guide Bolt Tighten 25 (18 lb ft)
3	Right Secondary Camshaft Drive Chain Shoe
4	Right Secondary Camshaft Drive Chain Shoe Bolt Tighten 25 (18 lb ft)

Secondary Camshaft Drive Chain Tensioner Installation - Right Side

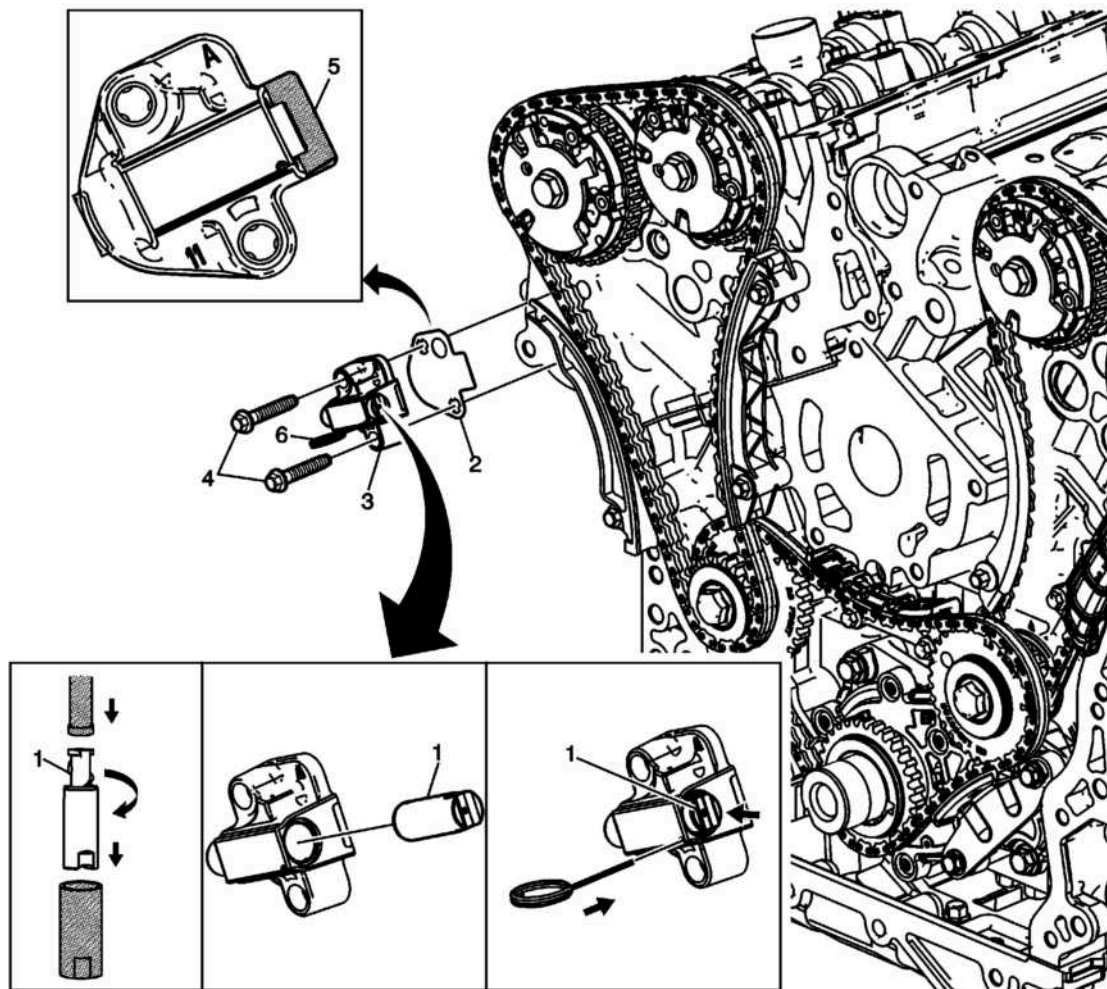


Fig. 590: Secondary Camshaft Drive Chain Tensioner - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Tensioner Installation - Right Side

Callout	Component Name
1	Right Secondary Camshaft Drive Chain Tensioner Plunger Procedure 1. Reset the right secondary camshaft drive chain tensioner plunger using EN-45027 tensioner tool. 2. Install right secondary camshaft drive chain tensioner plunger into body. 3. Compress the plunger into the body and lock the right secondary camshaft drive chain tensioner by inserting the EN-46112 tensioner retraction pins into the access hole in the side of the right secondary camshaft drive chain tensioner body. 4. Slowly release pressure on the right secondary camshaft drive chain tensioner. The right secondary 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.
2	Right Secondary Camshaft Drive Chain Tensioner Gasket NOTE: Ensure the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head does not have any burrs or defects that would degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.
3	Right Secondary Camshaft Drive Chain Tensioner
4	Right Secondary Camshaft Drive Chain Tensioner Bolt Procedure 1. Place the right secondary drive chain tensioner into position and loosely install the bolts to the block. 2. Verify the proper placement of the right secondary drive chain tensioner gasket tab (5). 3. Tighten the drive chain tensioner bolts in two passes. 4. Release the right secondary drive chain tensioner by pulling out the EN-46112 pin (6) and unlocking the tensioner plunger. 5. Verify all primary and secondary camshaft drive chain timing mark alignments by referring to Timing Chain Alignment Diagram - Stage One.

	Tighten • First Pass 5 (44 lb in) • Second Pass 25 (18 lb ft)
5	Right Secondary Drive Chain Tensioner Gasket Tab
6	EN-46112 Pin

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN INSTALLATION - LEFT SIDE

Special Tools

- **EN-48383** Camshaft Retaining Tools
- **EN-48589** Crankshaft Rotation Socket

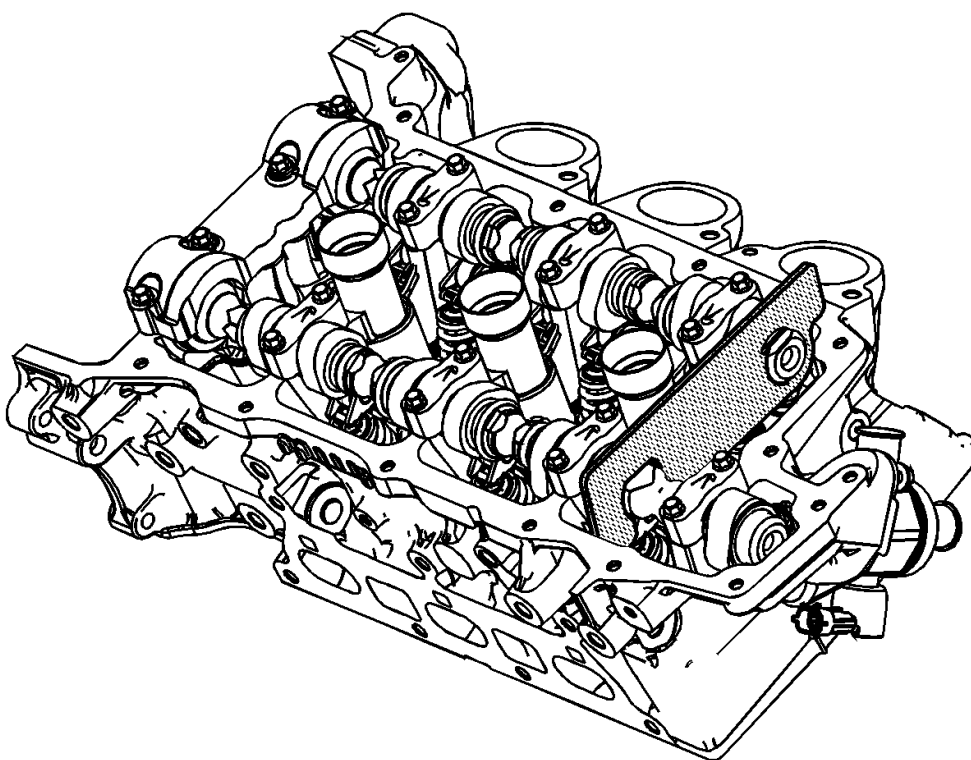


Fig. 591: View Of Camshafts & Special Tool EN 48383-1
 Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: There should be no need to rotate the camshaft more than 10°. Using the hex cast into the camshaft rotate the camshaft in order to install the EN-48383 camshaft retaining tools.

1. Install the EN 48383-1 onto the rear of the left camshafts.
2. Ensure that the EN 48383-1 is fully seated onto the camshafts.

IMPORTANT: All camshafts must be locked in place before installation of any camshaft drive chains.

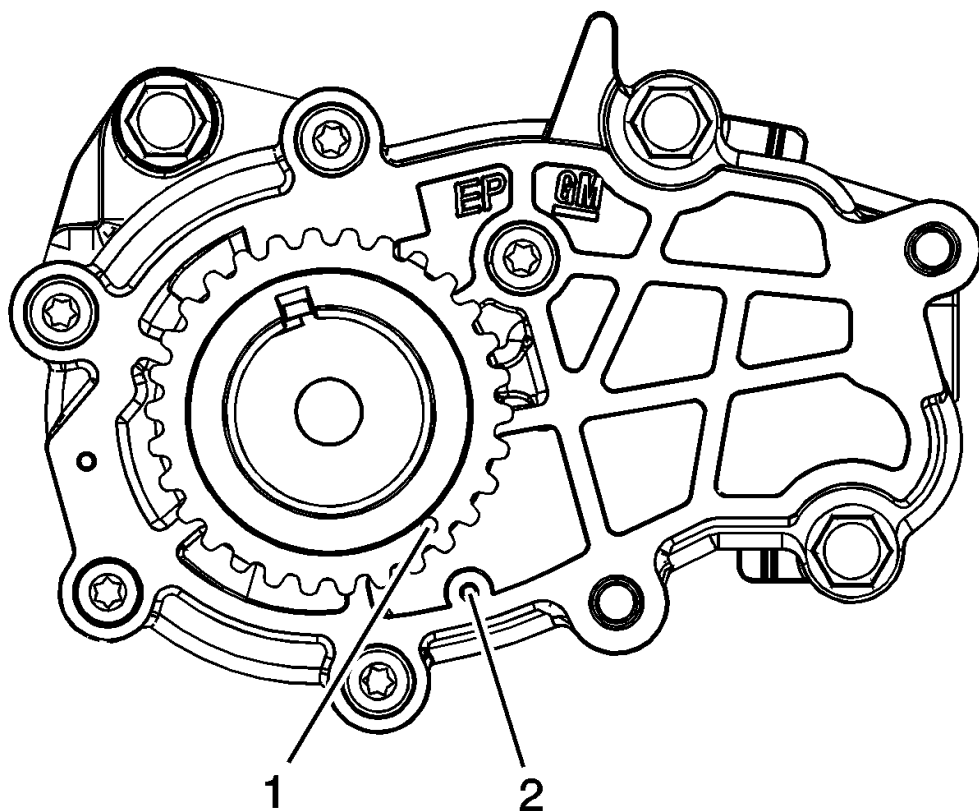


Fig. 592: View Of Crankshaft Sprocket Timing Mark & Oil Pump Cover
Courtesy of GENERAL MOTORS COMPANY

3. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN-48589** crankshaft rotation socket. Refer to **Timing Chain Alignment Diagram**.

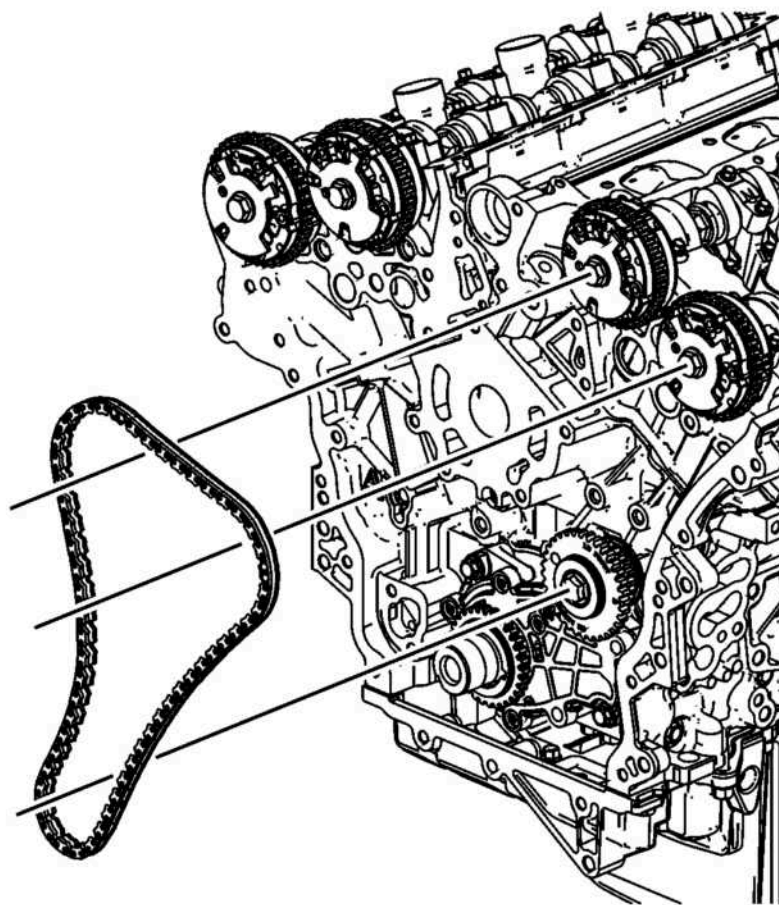


Fig. 593: Identifying Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

4. Install the left secondary camshaft drive chain.

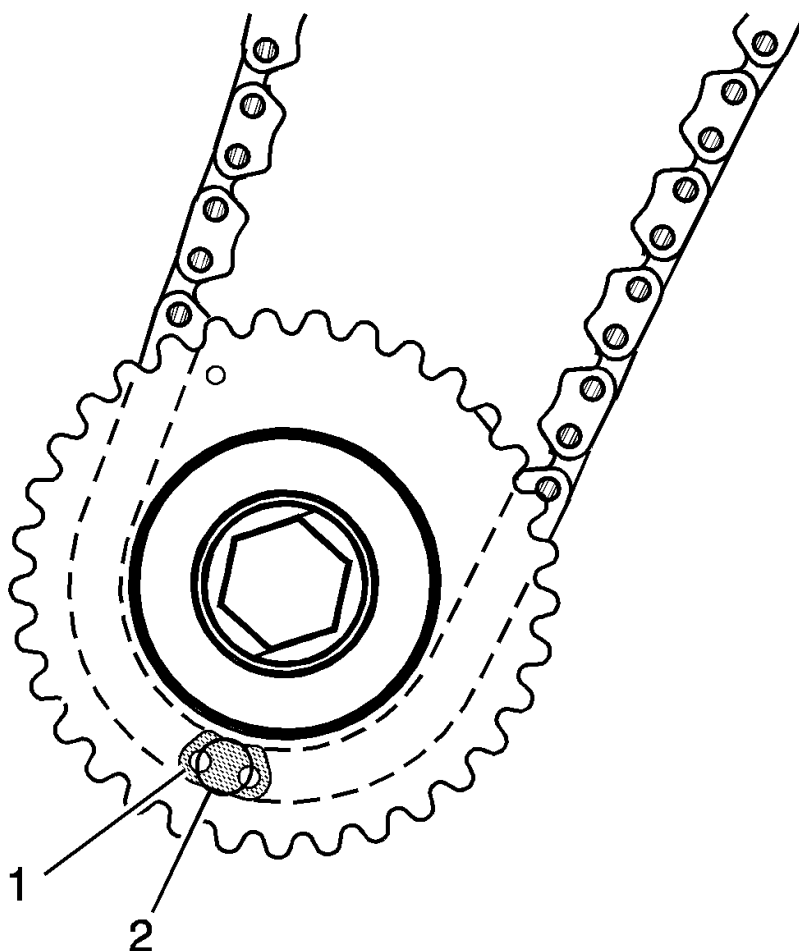


Fig. 594: Identifying Timing Camshaft Drive Chain Link & Alignment Access Hole
Courtesy of GENERAL MOTORS COMPANY

5. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the timing camshaft drive chain link (1) aligned to the alignment access hole (2) made in the left camshaft intermediate drive chain idler outer sprocket.

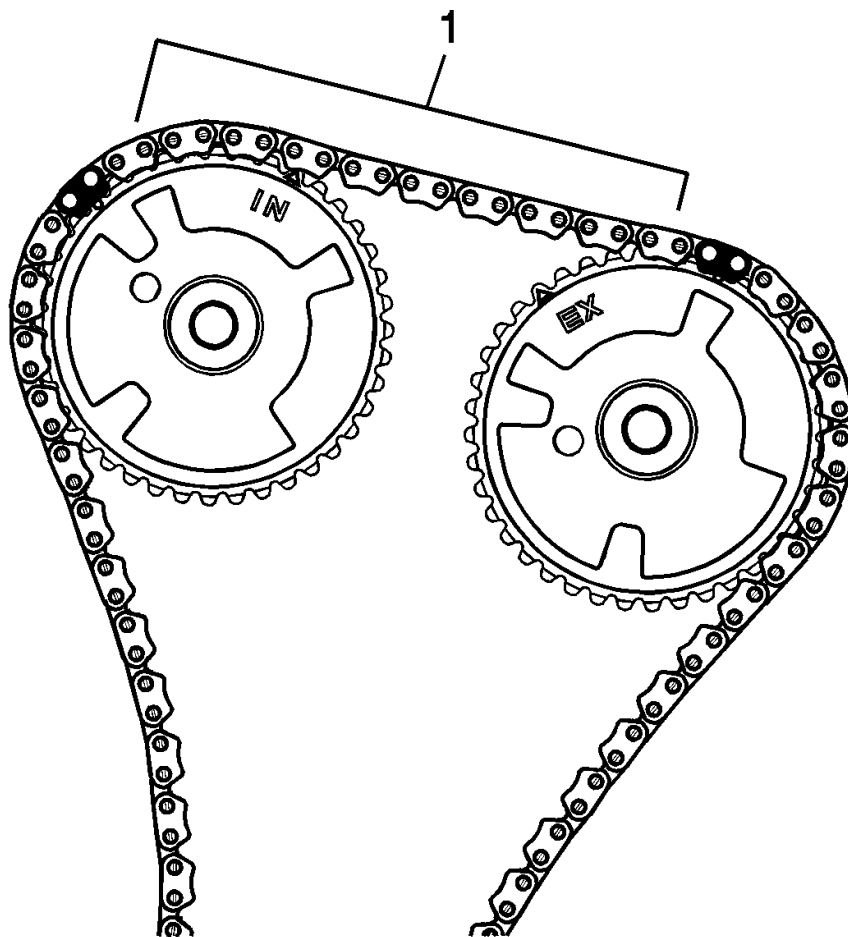


Fig. 595: View Of Camshaft Drive Chain Links
Courtesy of GENERAL MOTORS COMPANY

6. Wrap the secondary camshaft drive chain around both left actuator drive sprockets.
7. Ensure there are 10 links (1) between the timing camshaft drive chain links for the camshaft position actuator sprockets.

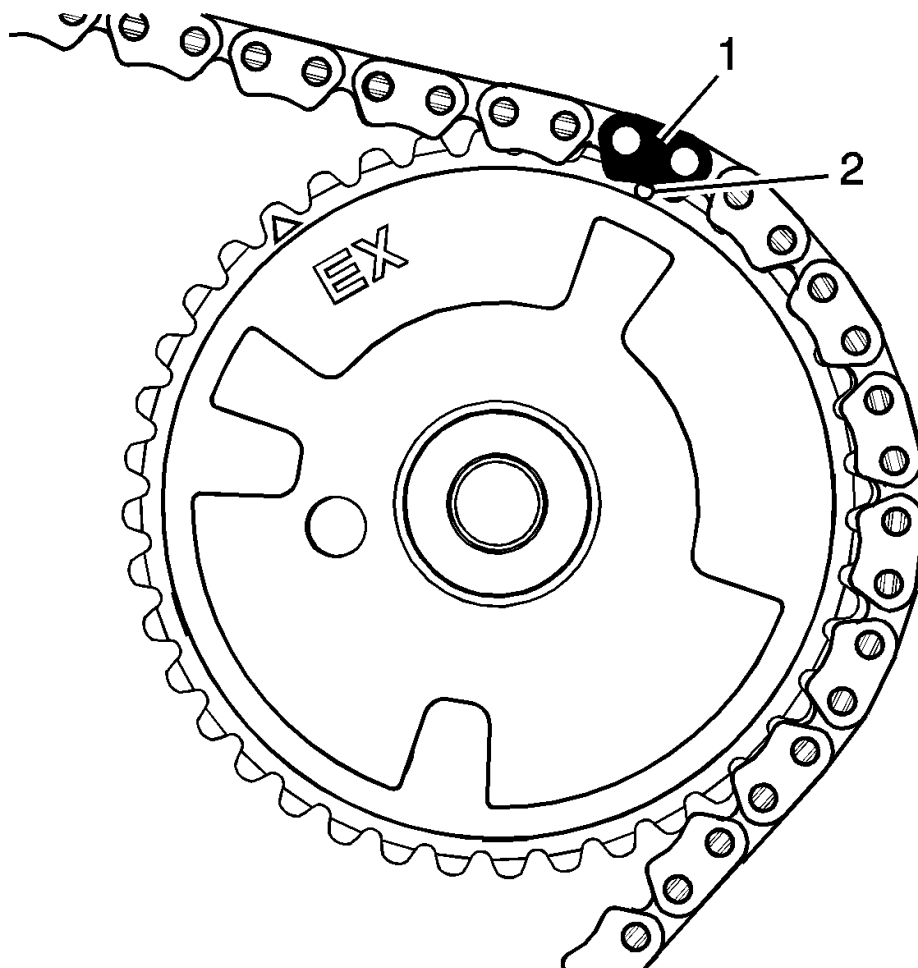


Fig. 596: View Of Exhaust Camshaft & Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

8. Align the left exhaust camshaft position actuator sprocket alignment circle mark (2) with the timing camshaft drive chain link (1).

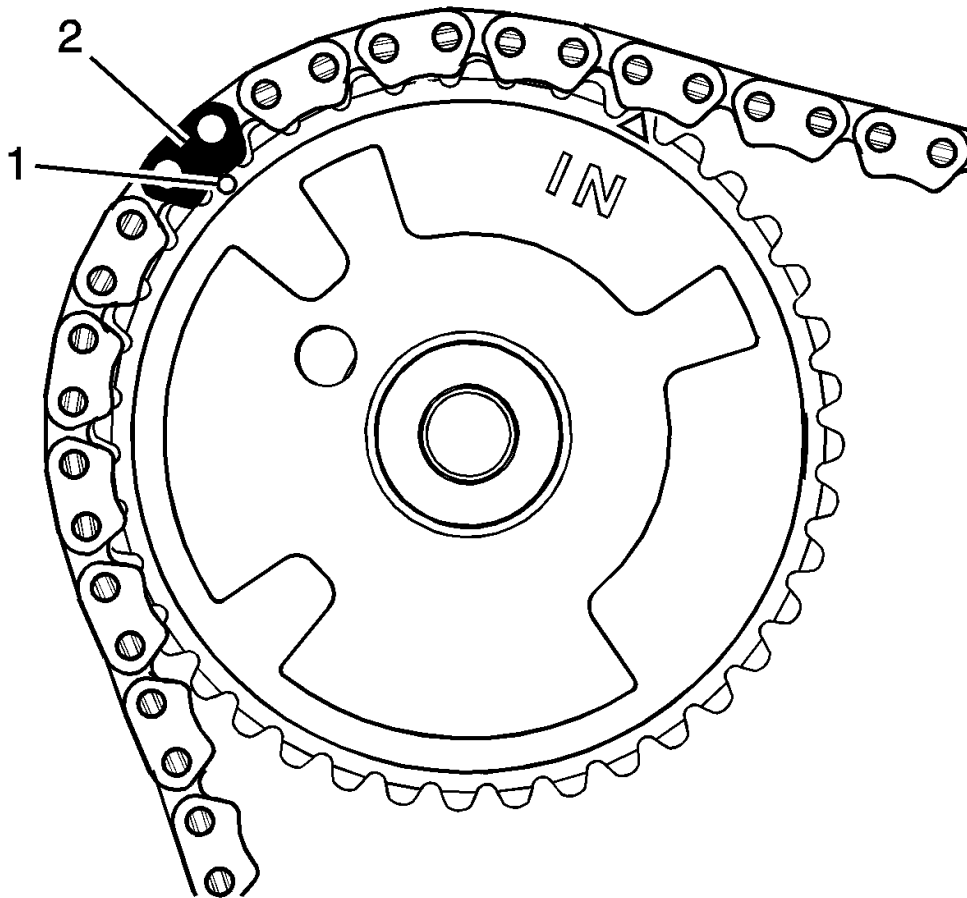


Fig. 597: View Of Intake Camshaft & Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

9. Align the left intake camshaft position actuator sprocket alignment circle mark (1) with the timing camshaft drive chain link (2).

SECONDARY TIMING CHAIN GUIDE INSTALLATION - LEFT SIDE

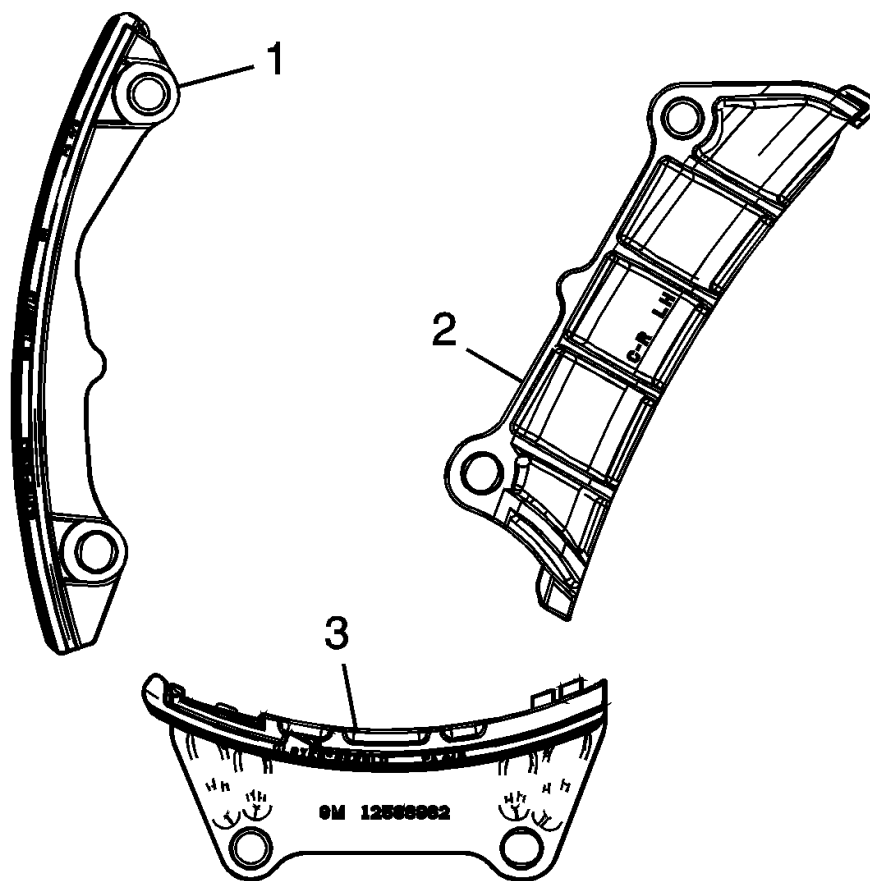


Fig. 598: View Of Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the left secondary camshaft drive chain guide (2) is being installed.

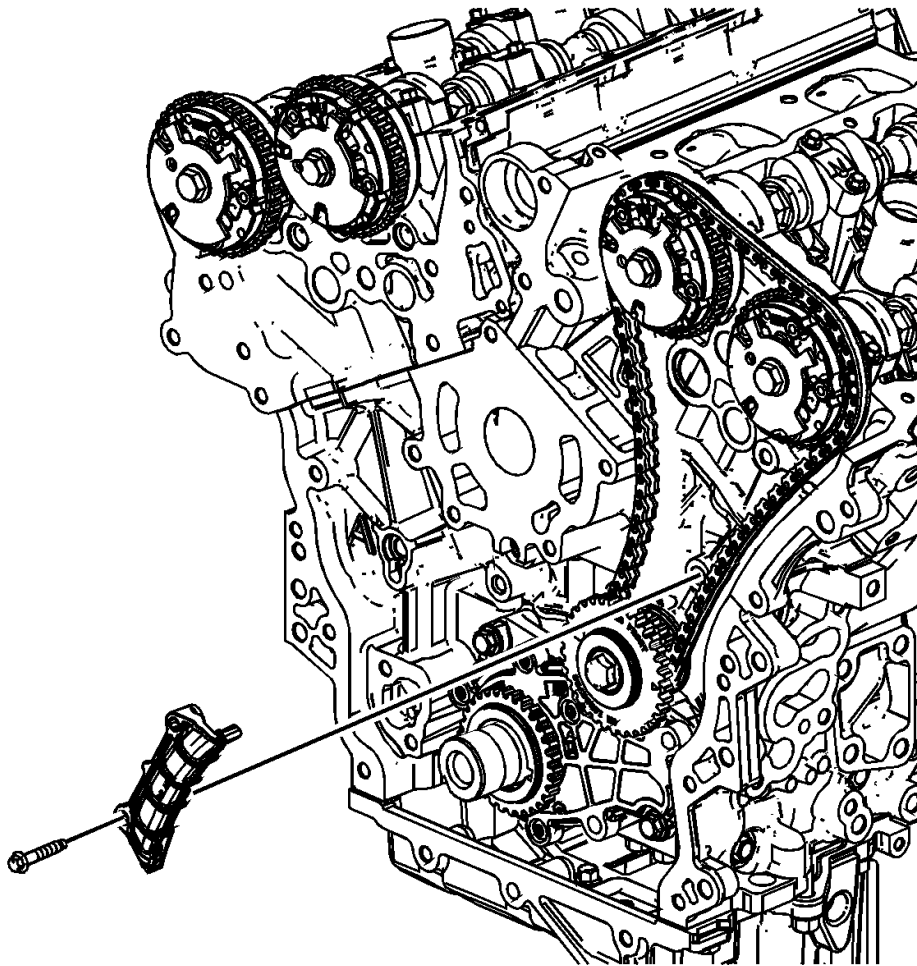


Fig. 599: View Of Secondary Camshaft Drive Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Position the left secondary camshaft drive chain guide.
3. Install the secondary camshaft drive chain guide bolts and tighten to 25 N.m (18 lb ft).

CAUTION: Refer to Fastener Caution .

SECONDARY CAMSHAFT DRIVE CHAIN SHOE INSTALLATION - LEFT SIDE

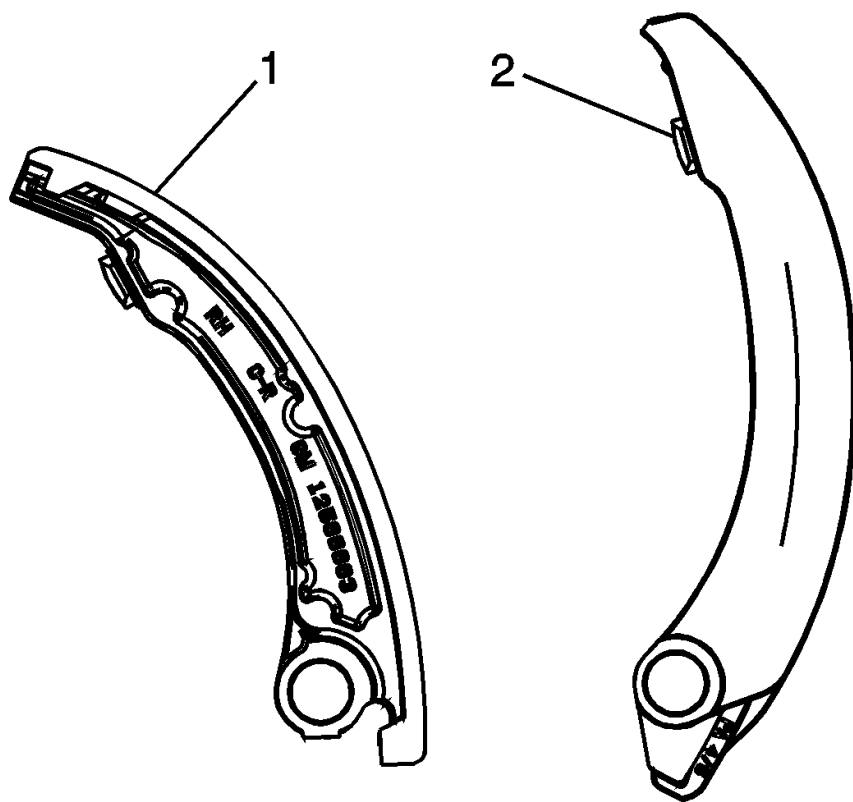


Fig. 600: Identifying Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the left secondary camshaft drive chain shoe (2) is being installed.

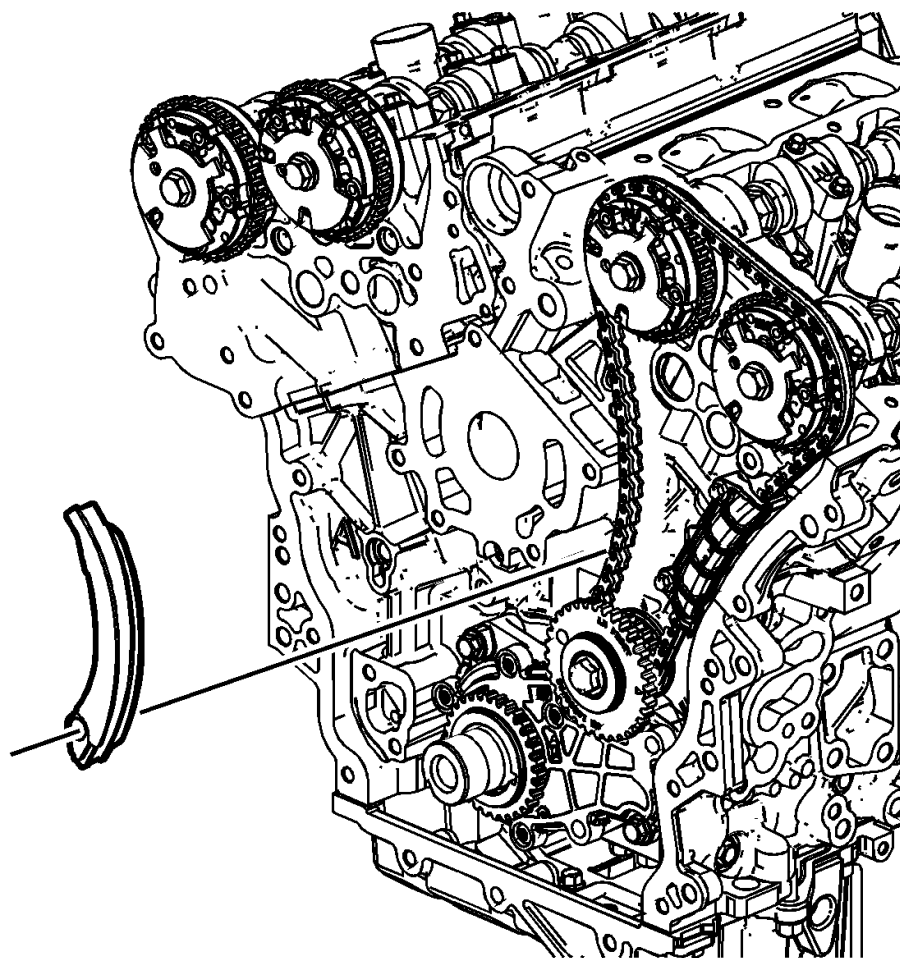


Fig. 601: View Of Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

2. Position the left secondary camshaft drive chain shoe.

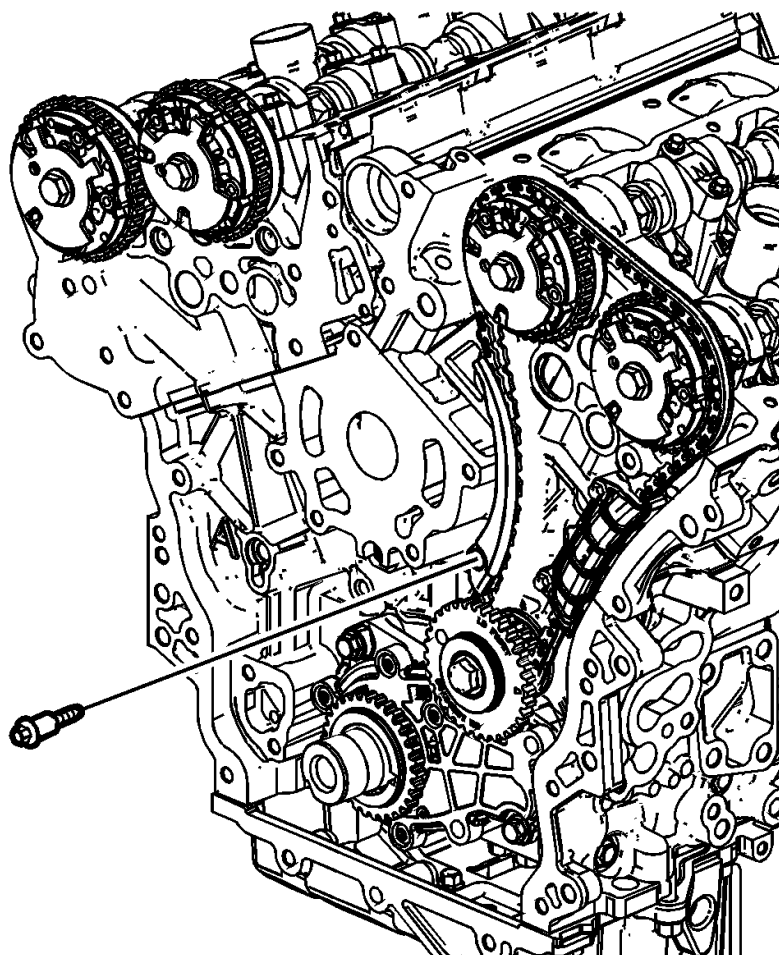


Fig. 602: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the secondary camshaft drive chain shoe bolt and tighten to 25 N.m (18 lb ft).

SECONDARY TIMING CHAIN TENSIONER INSTALLATION - LEFT SIDE

Special Tools

- EN 45027 Tensioner Tool
- EN 46112 Tensioner Retraction Pins

For equivalent regional tools, refer to Special Tools .

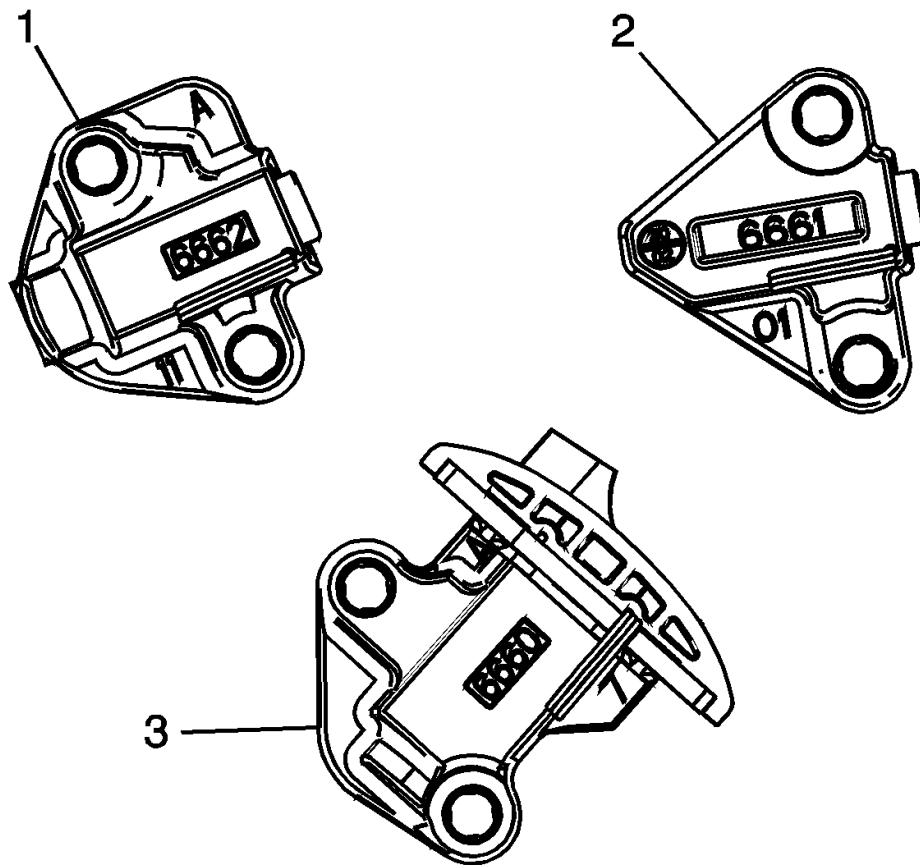


Fig. 603: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the left secondary camshaft drive chain tensioner (2) is being installed.

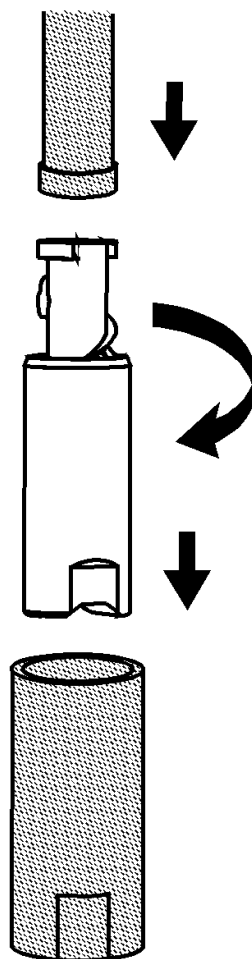


Fig. 604: Resetting Secondary Camshaft Drive Chain Tensioner Plunger
Courtesy of GENERAL MOTORS COMPANY

2. Using the **EN 45027** tool, reset the left secondary camshaft drive chain tensioner plunger.

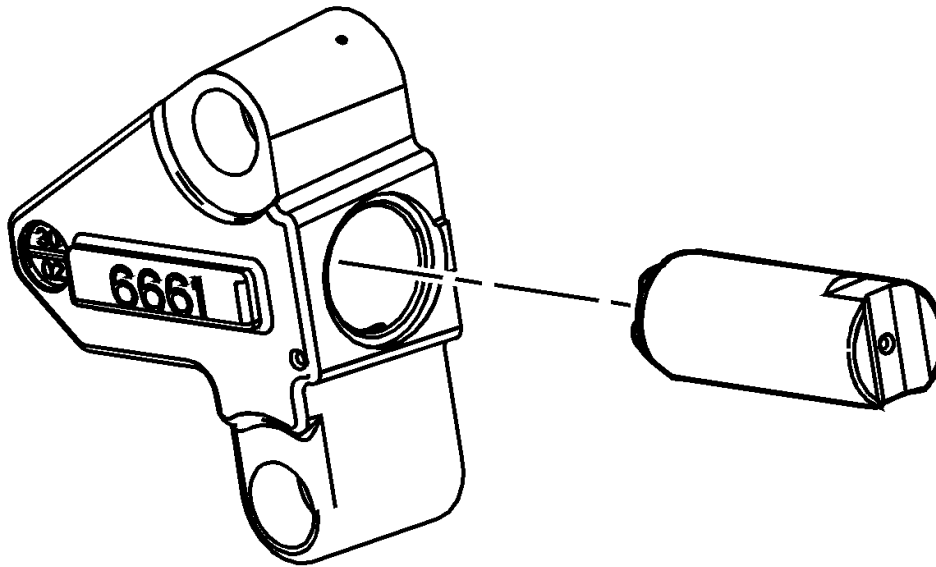


Fig. 605: View Of Plunger & Left Secondary Camshaft Drive Chain Tensioner Body
Courtesy of GENERAL MOTORS COMPANY

3. Install the plunger into the left secondary camshaft drive chain tensioner body.

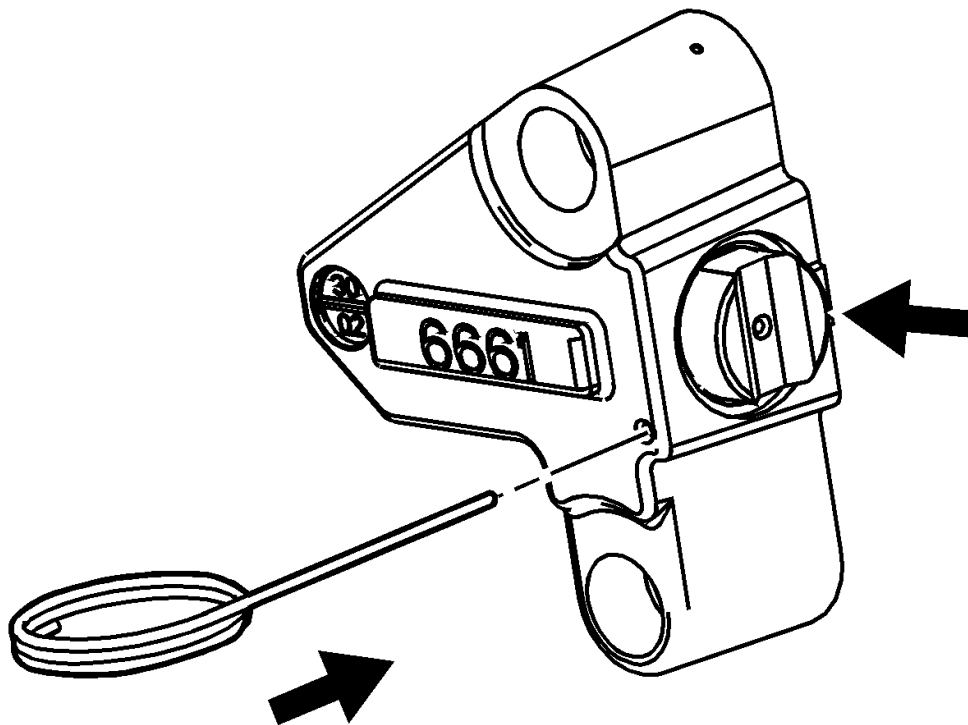


Fig. 606: Inserting EN 46112 Into Access Hole In Side Of Left Secondary Camshaft Drive Chain Tensioner Body

Courtesy of GENERAL MOTORS COMPANY

4. Compress the plunger into the body and lock the left secondary camshaft drive chain tensioner by inserting the **EN-46112** pins into the access hole in the side of the left secondary camshaft drive chain tensioner body.
5. Slowly release pressure on the left secondary camshaft drive chain tensioner. The left secondary camshaft drive chain tensioner should remain compressed.

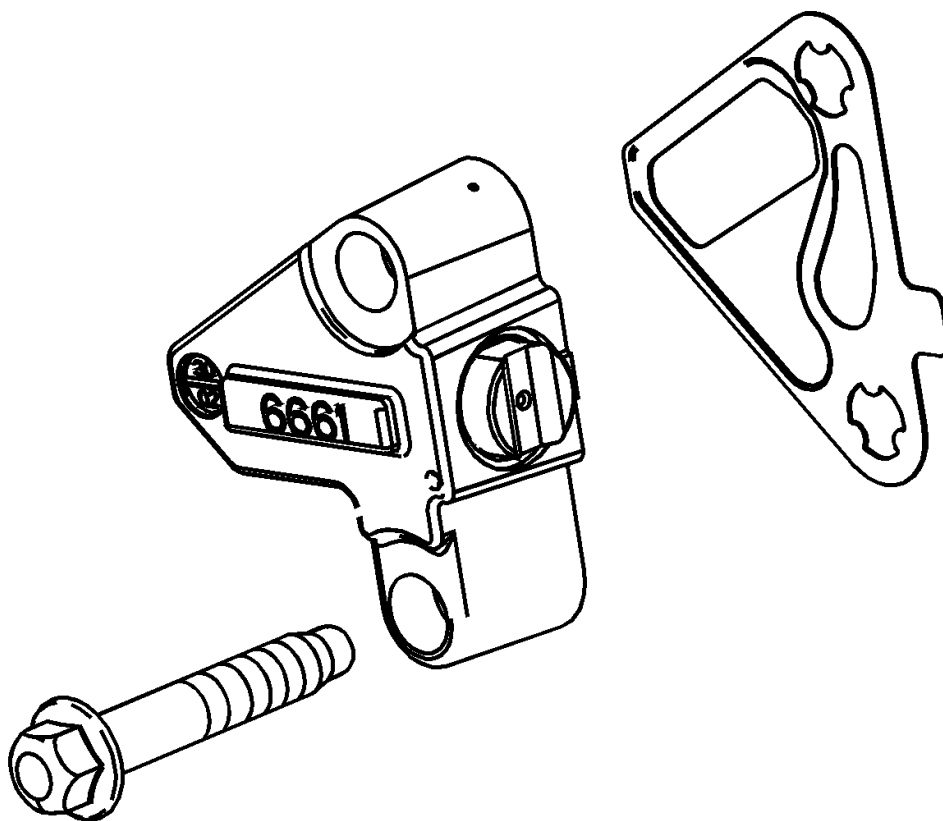


Fig. 607: Identifying Left Secondary Camshaft Drive Chain Tensioner & Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW left secondary camshaft drive chain tensioner gasket to the left secondary camshaft drive chain tensioner.
7. Install the left secondary camshaft drive chain tensioner bolts through the left secondary camshaft drive chain tensioner and gasket.
8. Ensure the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head does not have any burrs or defects that would degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.

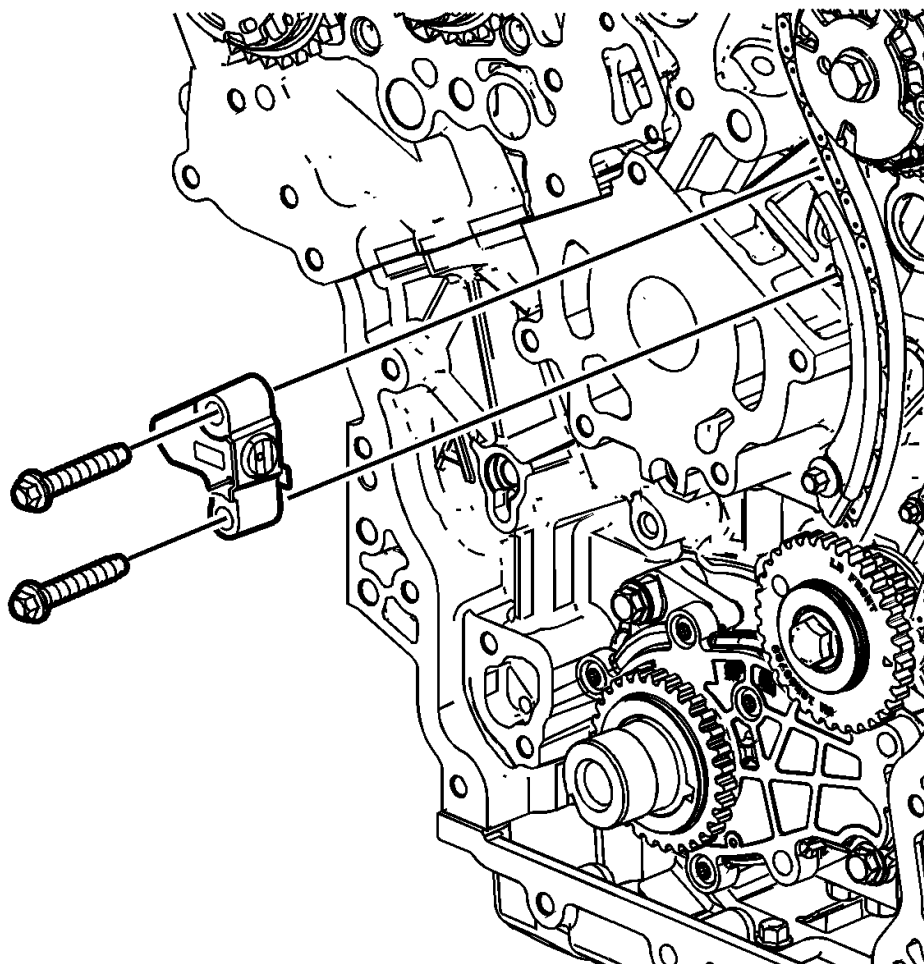


Fig. 608: View Of Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Place the left secondary camshaft drive chain tensioner into position and loosely install the bolts to the block.

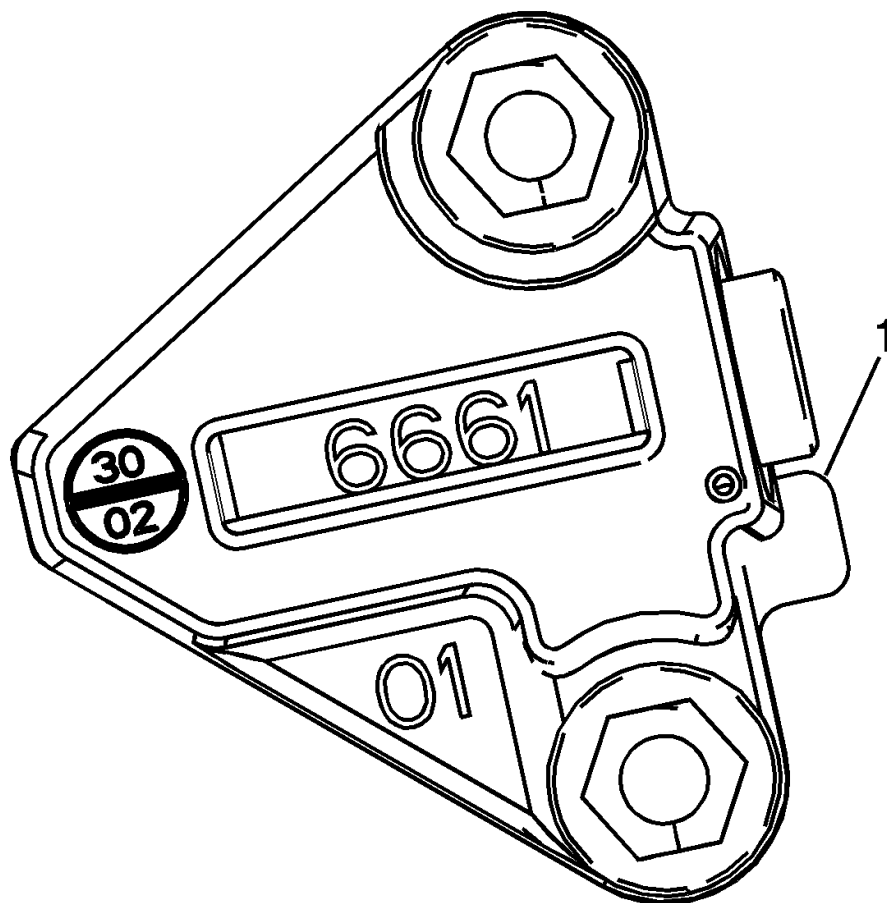


Fig. 609: Locating Left Secondary Camshaft Drive Chain Tensioner Gasket Tab
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Verify the proper placement of the left secondary camshaft drive chain tensioner gasket tab (1).

1. First Pass

Tighten the left secondary camshaft drive chain tensioner bolts to 5 N.m (44 lb in).

2. Final Pass

Tighten the left secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

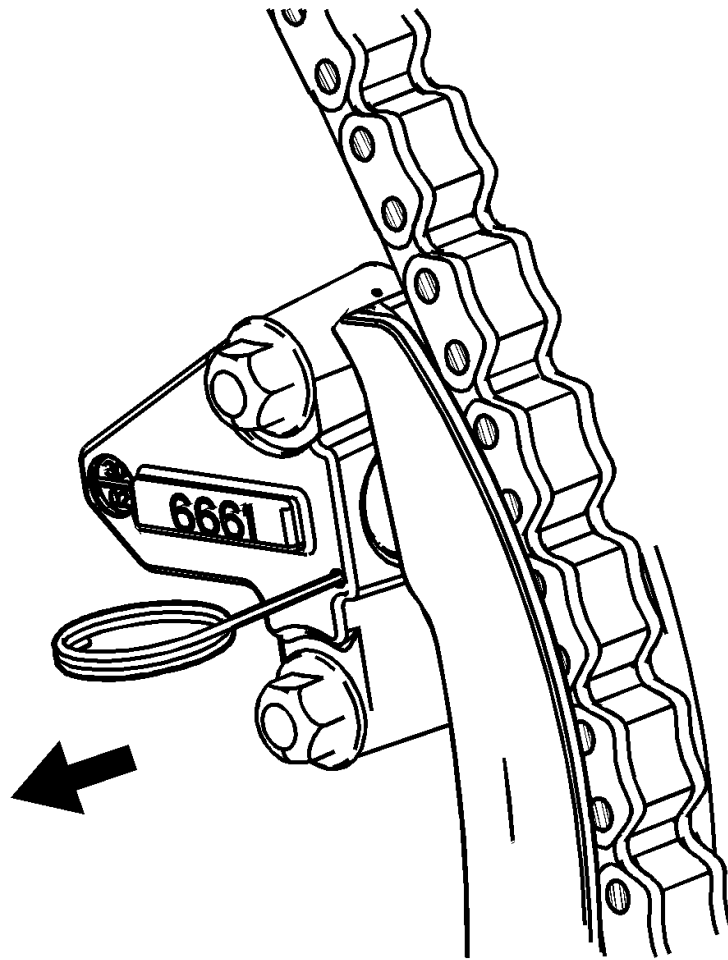


Fig. 610: View Of Left Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Release the left secondary camshaft drive chain tensioner by pulling out the **EN 46112** pins and unlocking the tensioner plunger.
12. Verify the left secondary camshaft drive chain timing mark alignments by referring to **Timing Chain Alignment Diagram** - Stage One.

TIMING CHAIN IDLER SPROCKET INSTALLATION - RIGHT SIDE

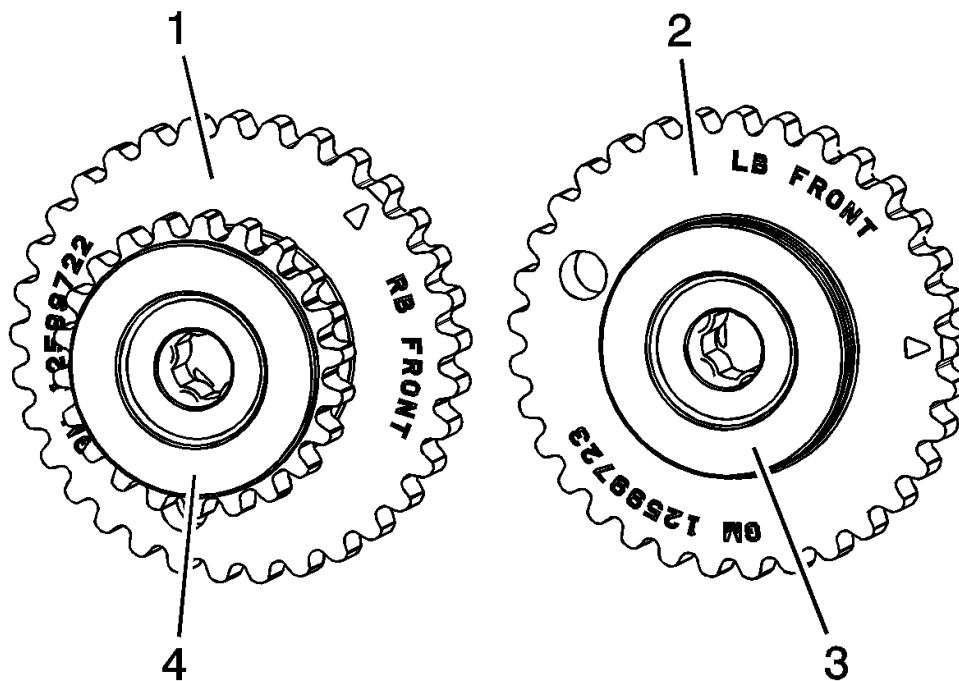


Fig. 611: View Of Camshaft Intermediate Drive Chain Idler - Left Side (Fourth Design)
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the right camshaft intermediate drive chain idler (1) is being installed. The recessed hub (4) and the smaller sprocket of the right camshaft intermediate drive chain idler is installed outward. The raised hub and the larger sprocket of the right camshaft intermediate drive chain idler is installed towards the block.

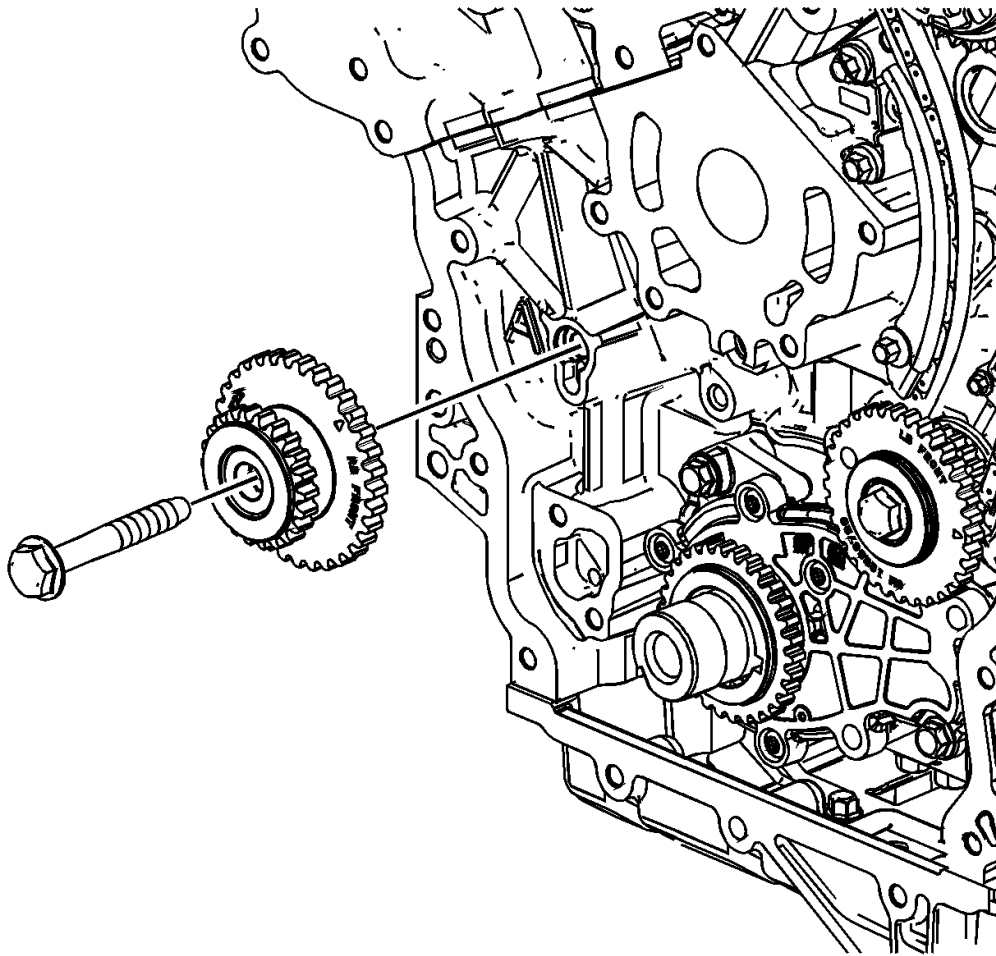


Fig. 612: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the right camshaft intermediate drive chain idler.
3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 N.m (43 lb ft).

CAUTION: Refer to Fastener Caution .

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN INSTALLATION

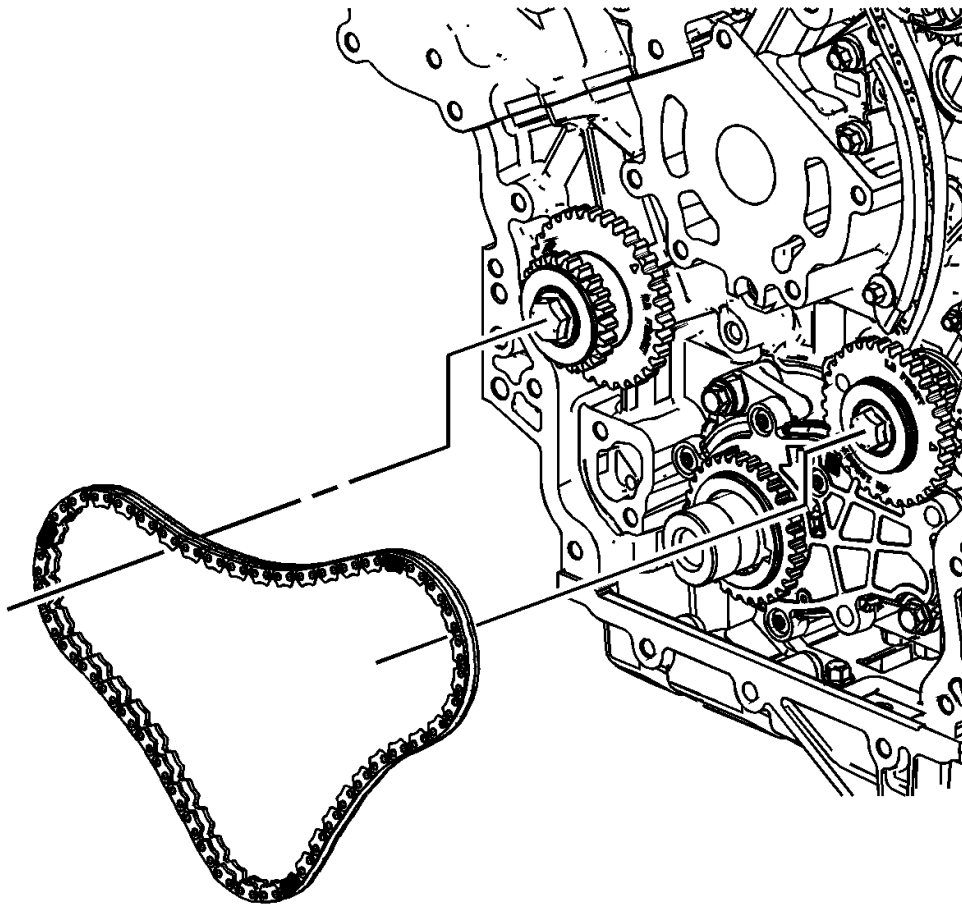


Fig. 613: Identifying Primary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the crankshaft is in the stage one timing drive assembly position.

1. Install the primary camshaft drive chain.

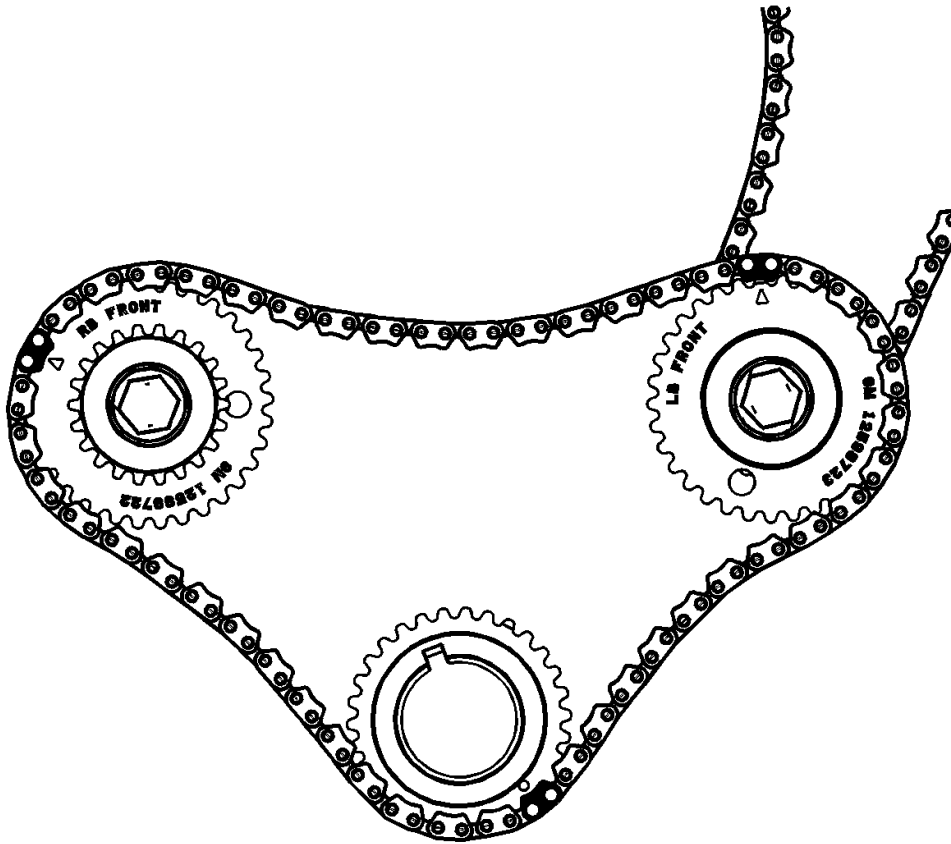


Fig. 614: View Of Primary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

2. Wrap the primary camshaft drive chain around the large sprockets of each camshaft intermediate drive chain idler and the crankshaft sprocket.

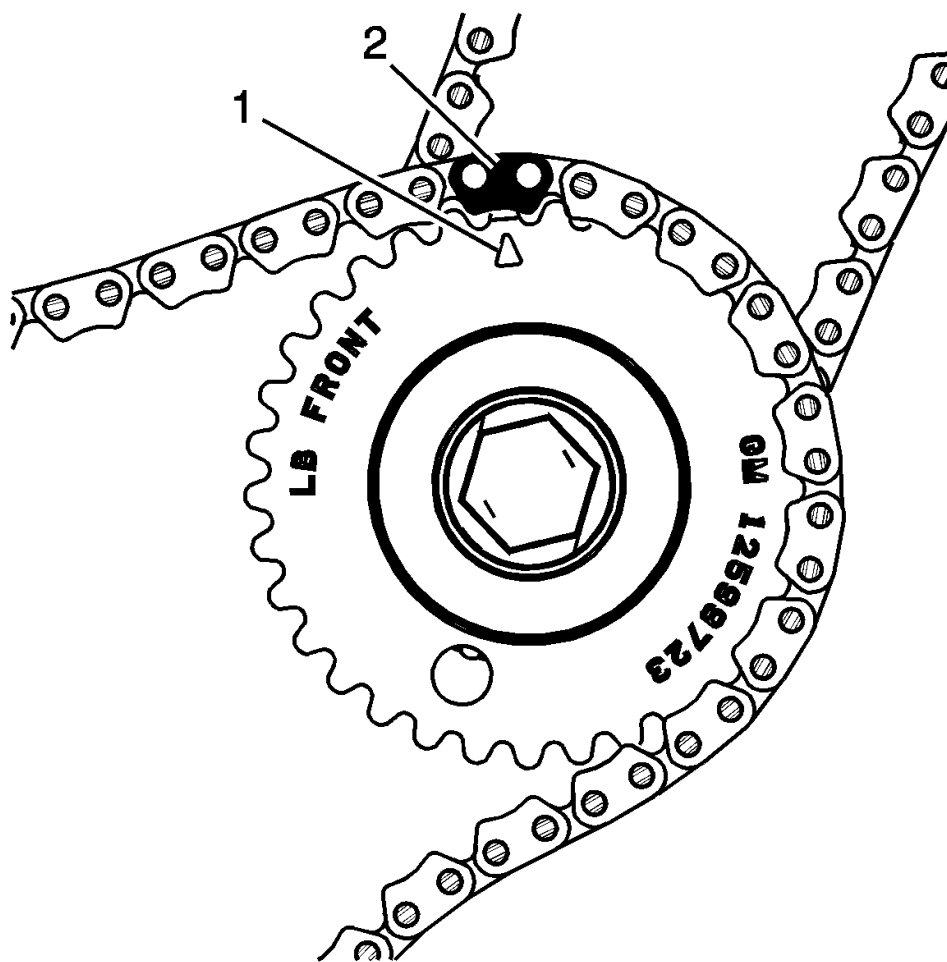


Fig. 615: View Of Camshaft Timing Marks
Courtesy of GENERAL MOTORS COMPANY

3. The left camshaft intermediate drive chain idler timing mark (1) will align with a timing camshaft drive chain link (2).

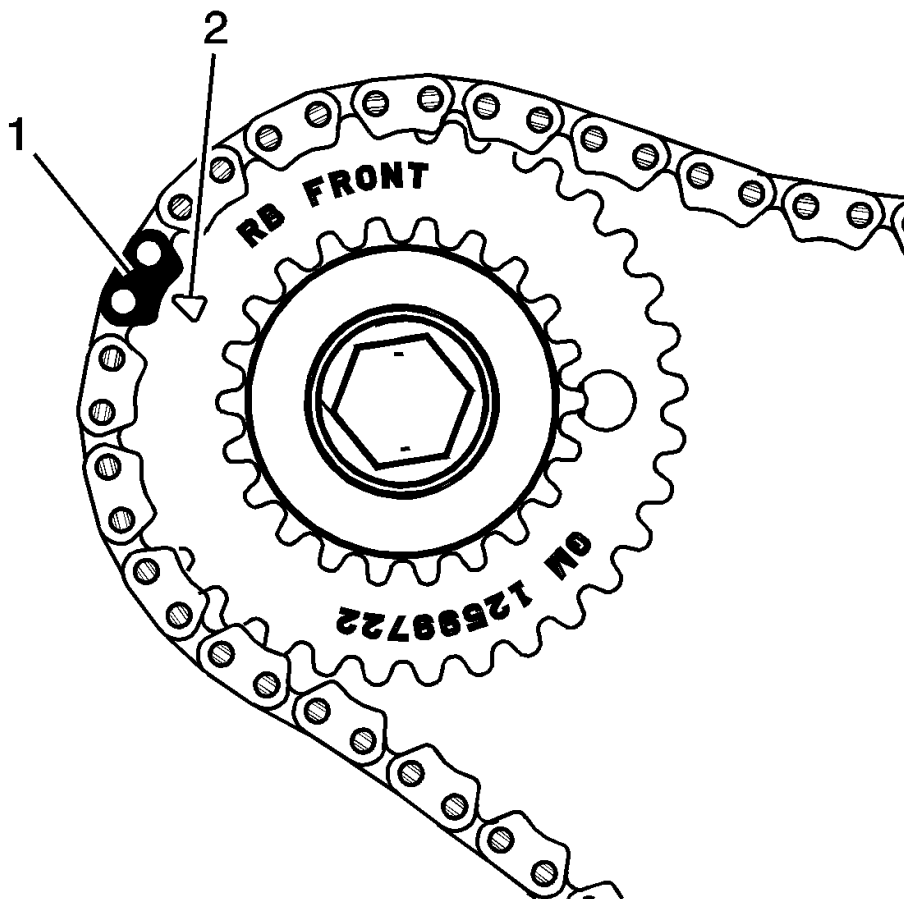


Fig. 616: View Of Right Camshaft Timing Marks
 Courtesy of GENERAL MOTORS COMPANY

4. The right camshaft intermediate drive chain idler timing mark (2) will align with a timing camshaft drive chain link (1).

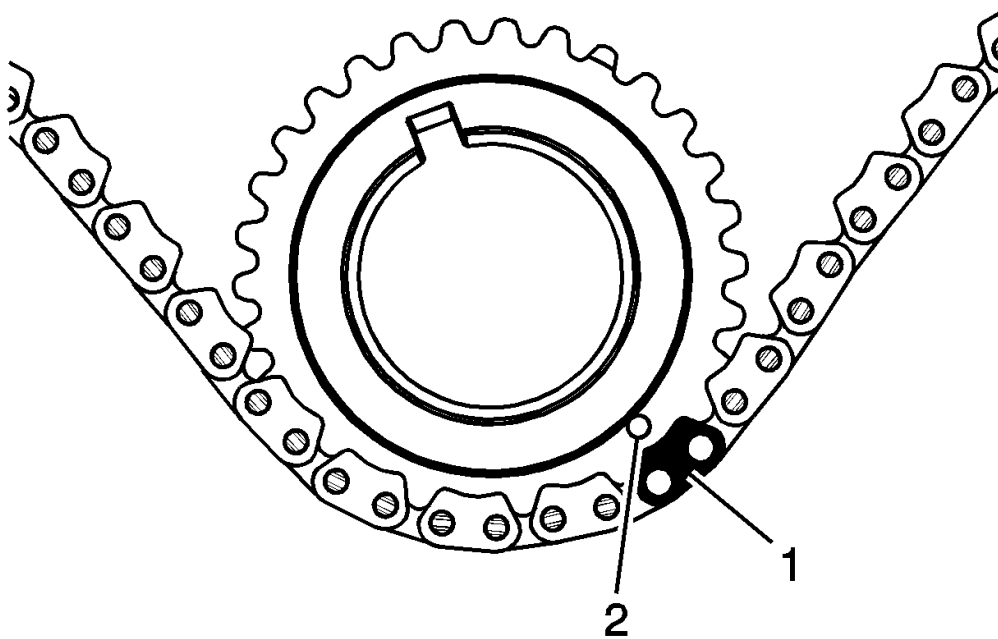


Fig. 617: View Of Crankshaft Sprocket Timing Mark & Timing Camshaft Drive Chain Link
Courtesy of GENERAL MOTORS COMPANY

5. The crankshaft sprocket timing mark (2) will align with a timing camshaft drive chain link (1).

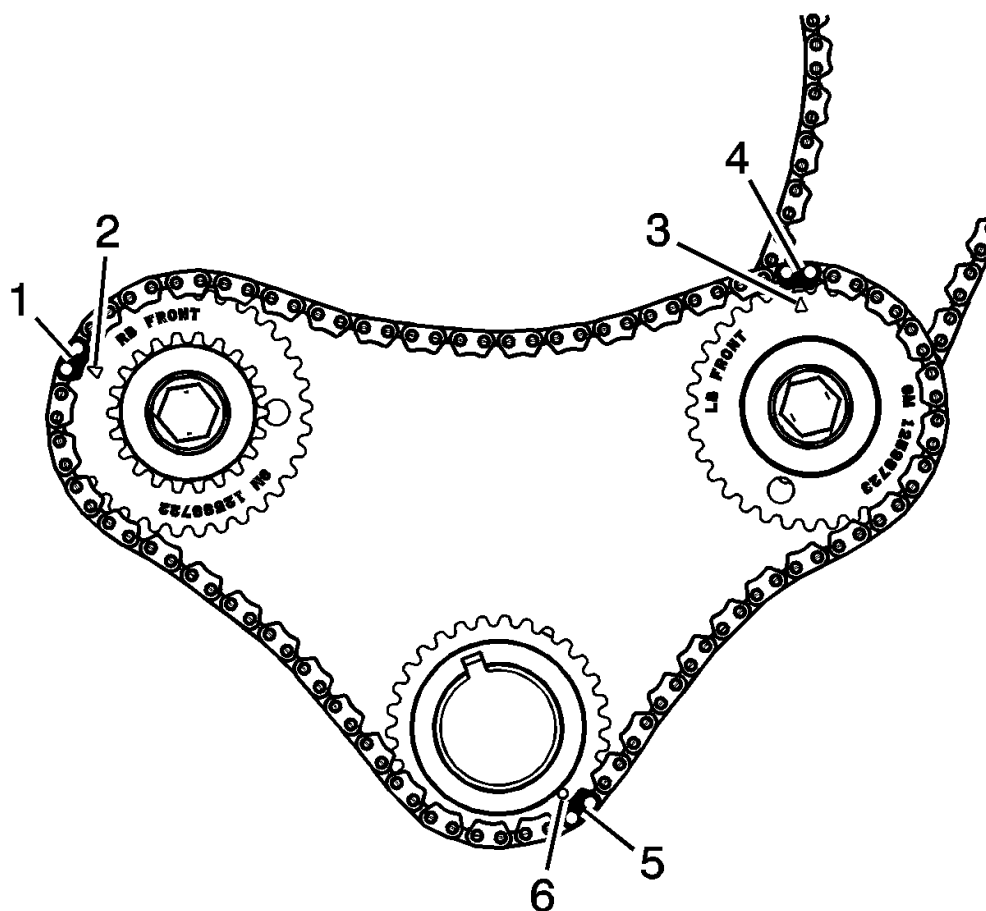


Fig. 618: View Of Timing Marks And Drive Chain Links
 Courtesy of GENERAL MOTORS COMPANY

6. Ensure all the timing marks (2, 3, 6) are properly aligned with the timing camshaft drive chain links (1, 4, 5).

PRIMARY TIMING CHAIN GUIDE INSTALLATION - LOWER

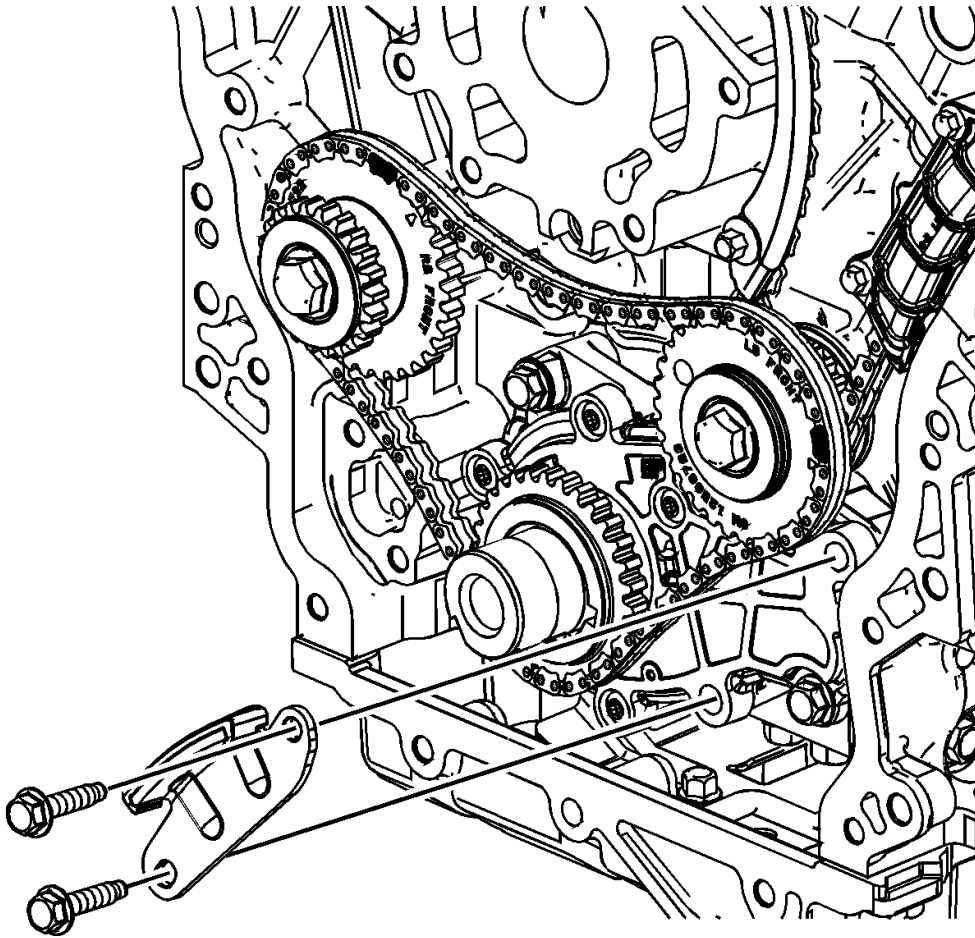


Fig. 619: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the primary camshaft drive chain lower guide to the oil pump.
2. Install the primary camshaft drive chain lower guide bolts and tighten to 25 N.m (18 lb ft).

CAUTION: Refer to Fastener Caution .

PRIMARY TIMING CHAIN GUIDE INSTALLATION - UPPER

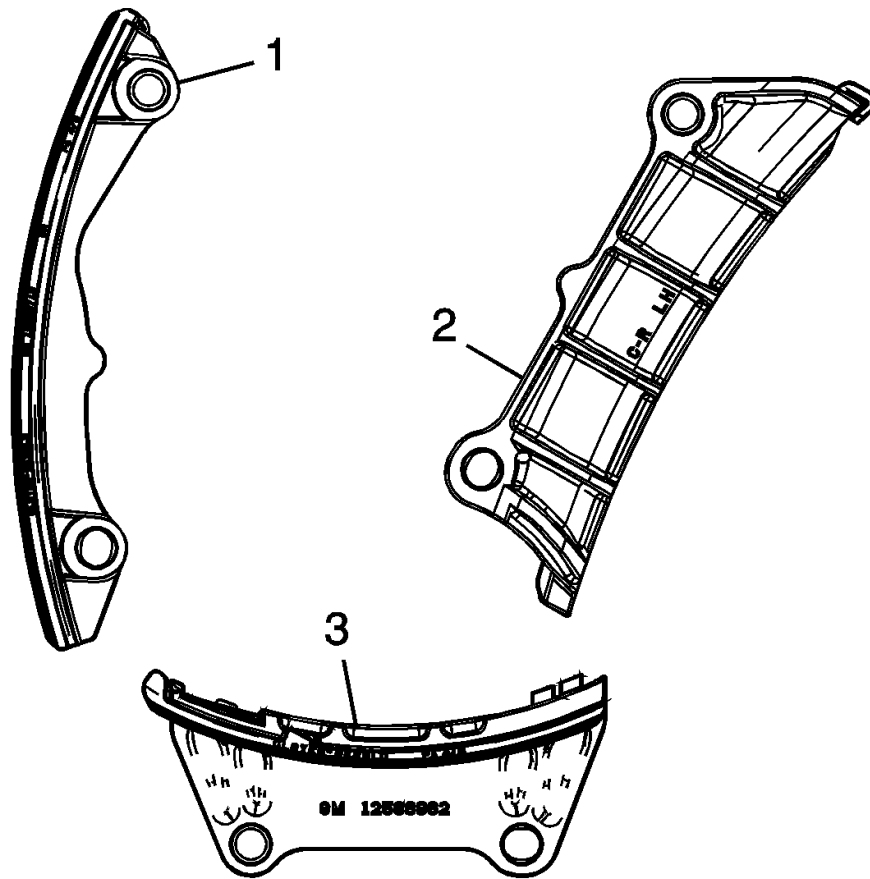


Fig. 620: View Of Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the upper primary camshaft drive chain guide (3) is being installed.

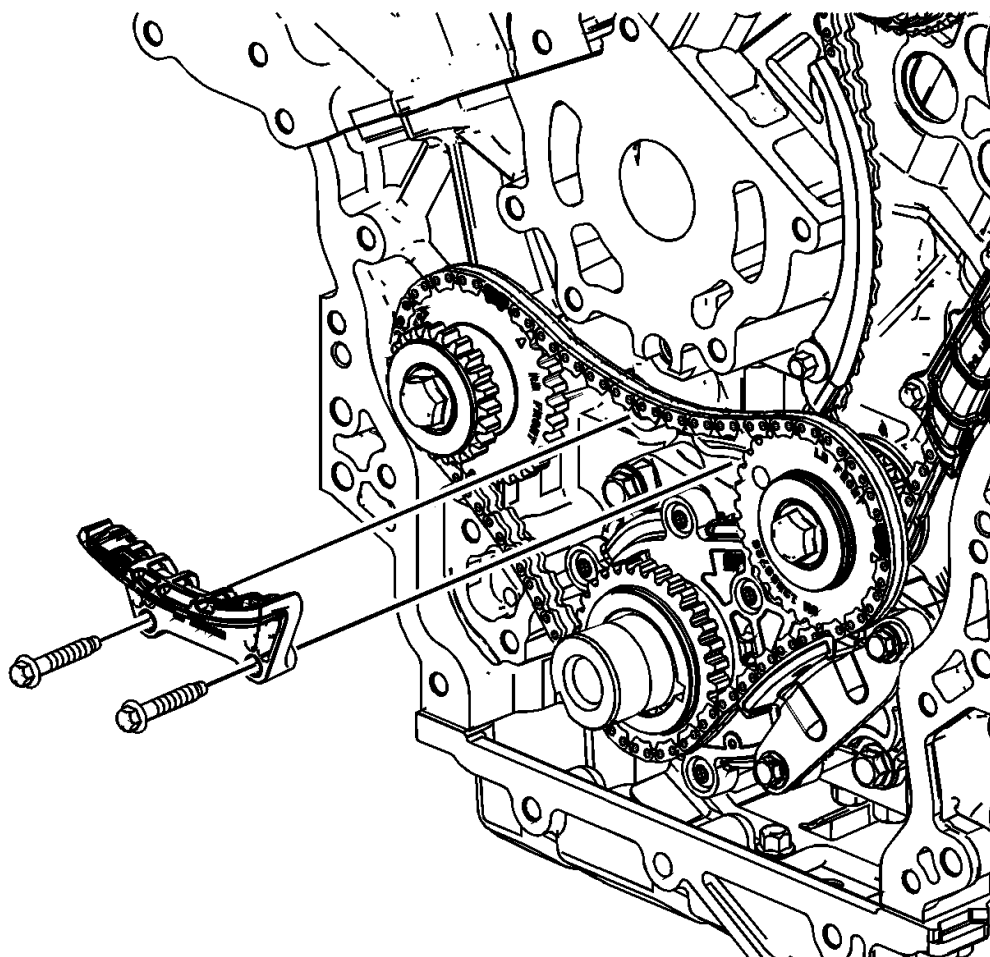


Fig. 621: Identifying Primary Camshaft Drive Chain Upper Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the upper primary camshaft drive chain guides.
3. Install the upper primary camshaft drive chain guide bolts and tighten to 25 N.m (18 lb ft).

CAUTION: Refer to Fastener Caution .

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER INSTALLATION

Special Tools

- **EN-45027** Tensioner Tool
- **EN-46112** Tensioner Retraction Pins
- **EN-48383** Camshaft Retaining Tools
- **EN-48589** Crankshaft Rotation Socket

For equivalent regional tools, refer to **Special Tools** .

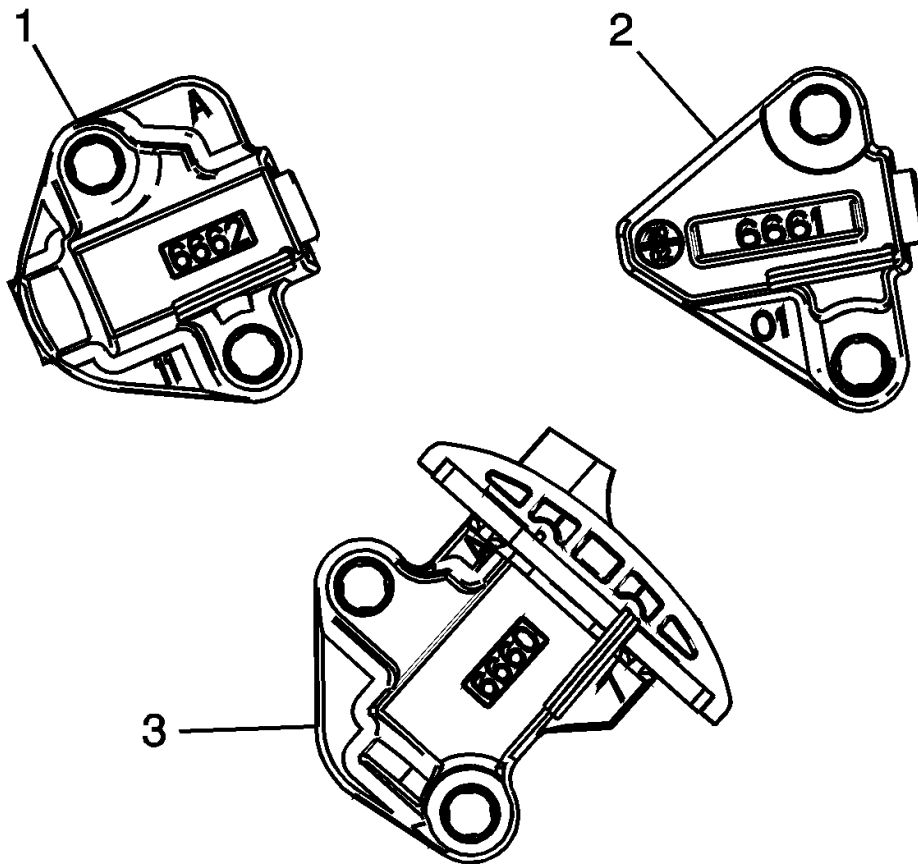


Fig. 622: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the primary camshaft drive chain tensioner (3) is being installed.

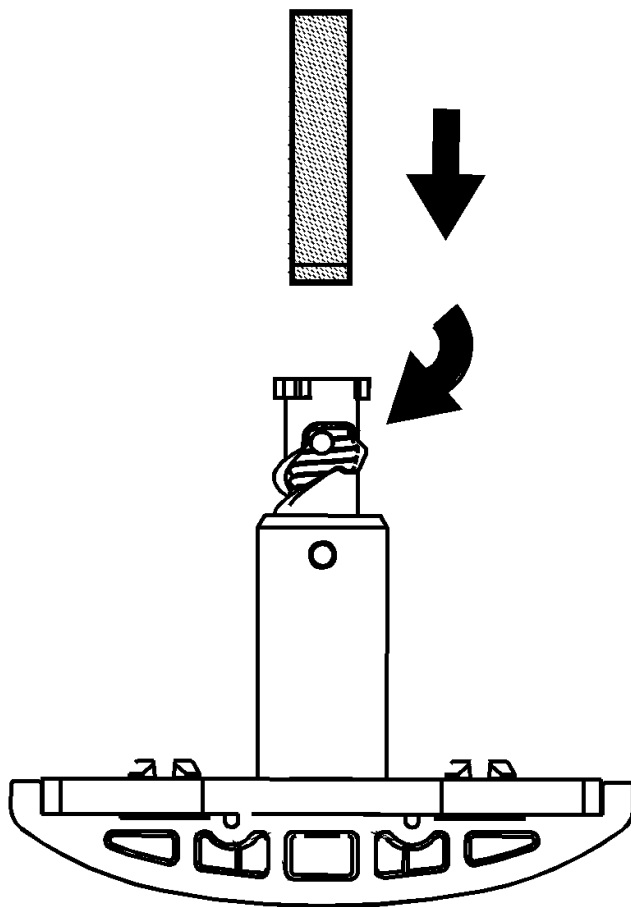


Fig. 623: View Of Primary Camshaft Drive Chain Tensioner Plunger & J 45027
Courtesy of GENERAL MOTORS COMPANY

2. Using the **EN-45027** tool, reset the primary camshaft drive chain tensioner plunger.

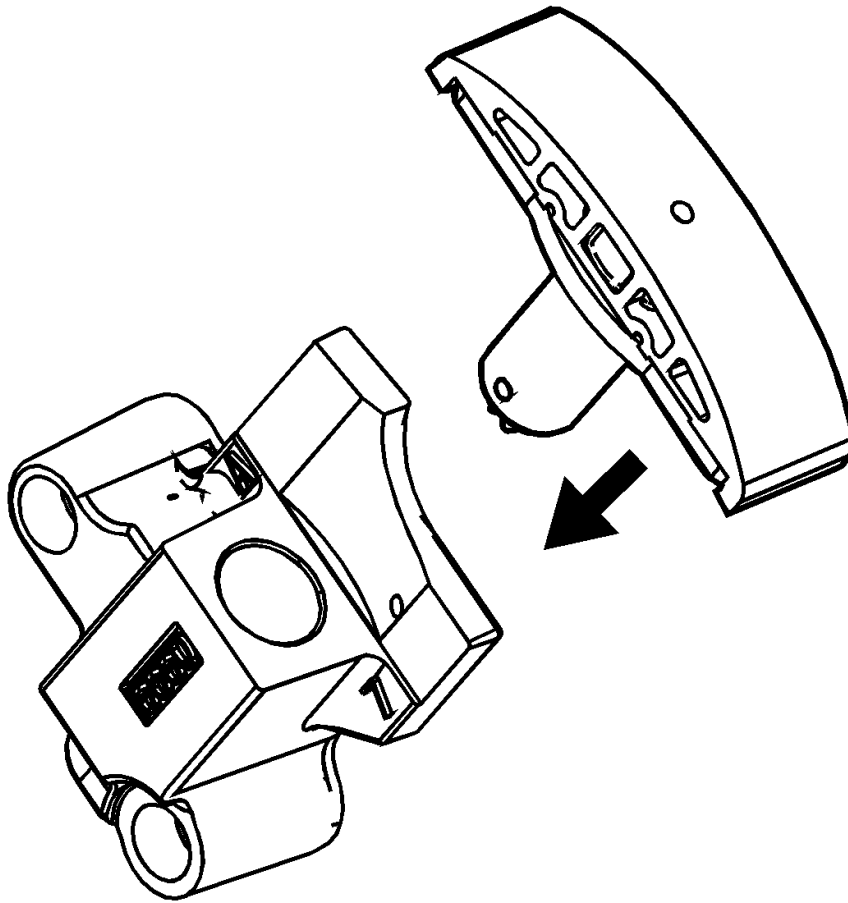


Fig. 624: View Of Plunger & Primary Camshaft Drive Chain Tensioner Body
Courtesy of GENERAL MOTORS COMPANY

3. Install the plunger into the primary camshaft drive chain tensioner body.

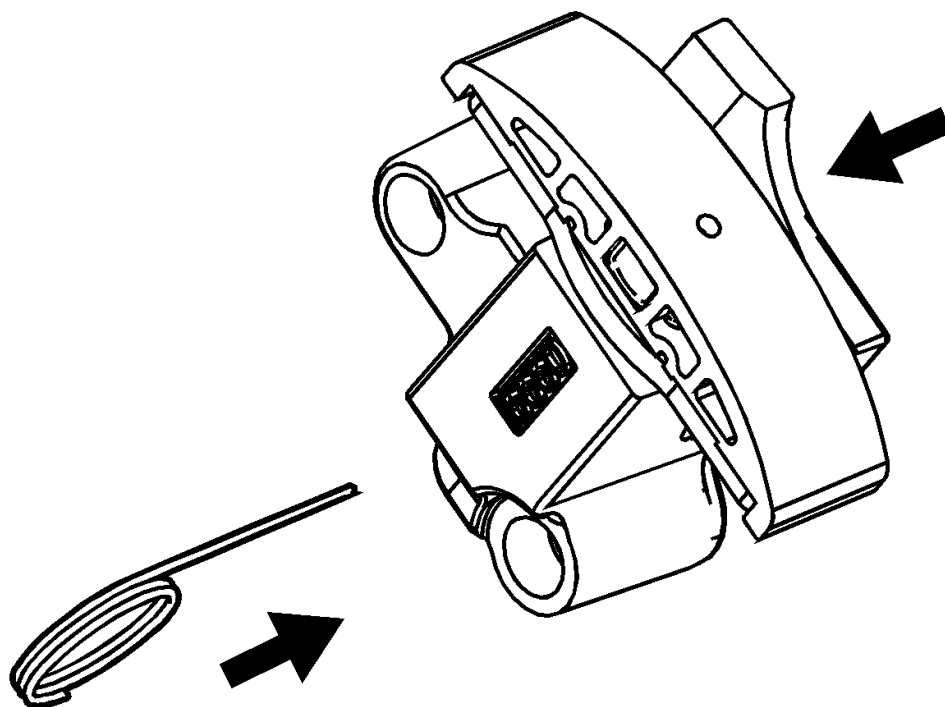


Fig. 625: Identifying Special Tools - EN 46112
Courtesy of GENERAL MOTORS COMPANY

4. Compress the plunger into the body and lock the primary camshaft drive chain tensioner by inserting the **EN-46112** pins into the access hole in the side of the primary camshaft drive chain tensioner body.
5. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed.

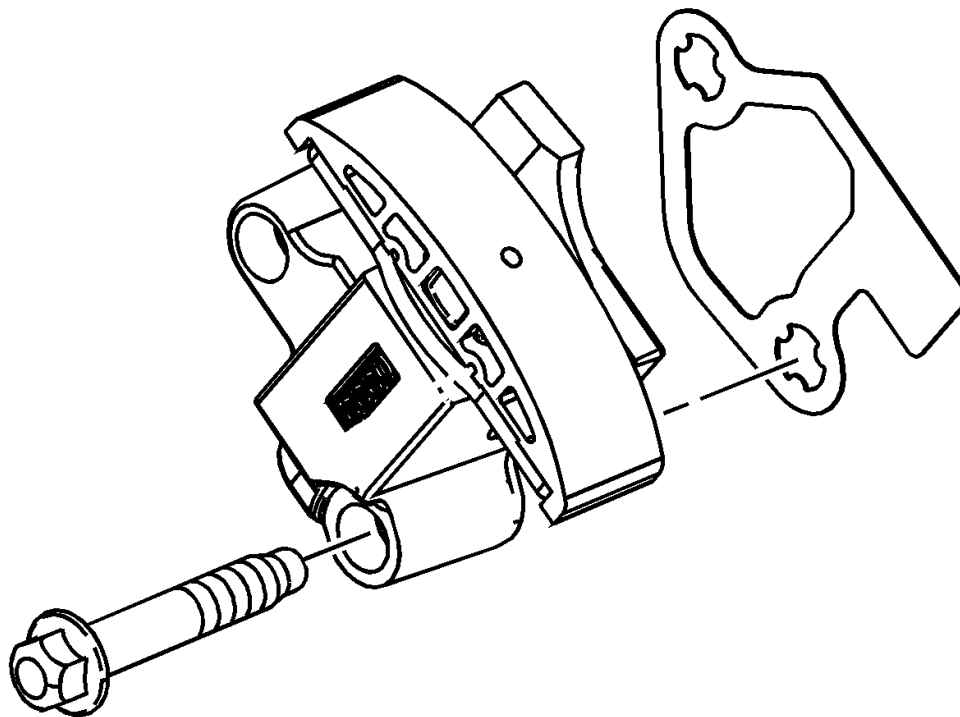


Fig. 626: Identifying Primary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW primary camshaft drive chain tensioner gasket to the primary camshaft drive chain tensioner.
7. Install the primary camshaft drive chain tensioner bolts through the primary camshaft drive chain tensioner and gasket.
8. 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.

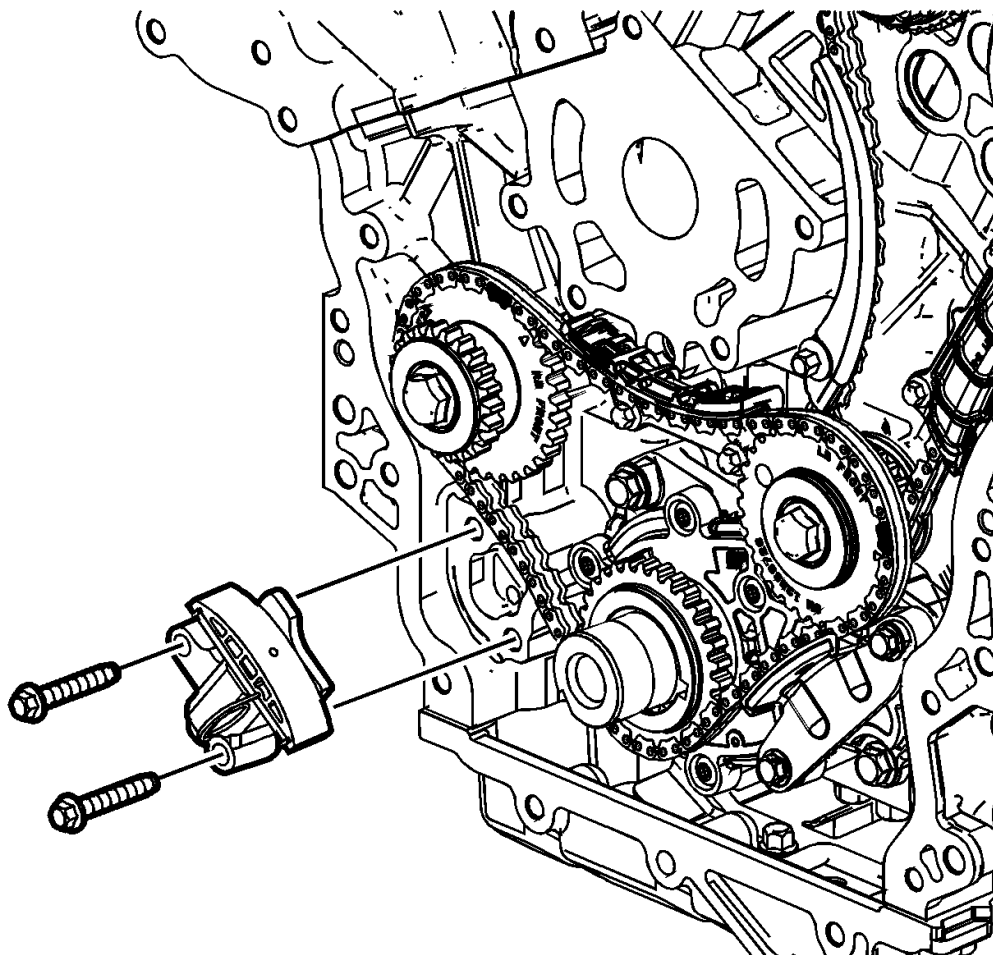


Fig. 627: View Of Primary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Place the primary camshaft drive chain tensioner into position and loosely install the bolts to the block.

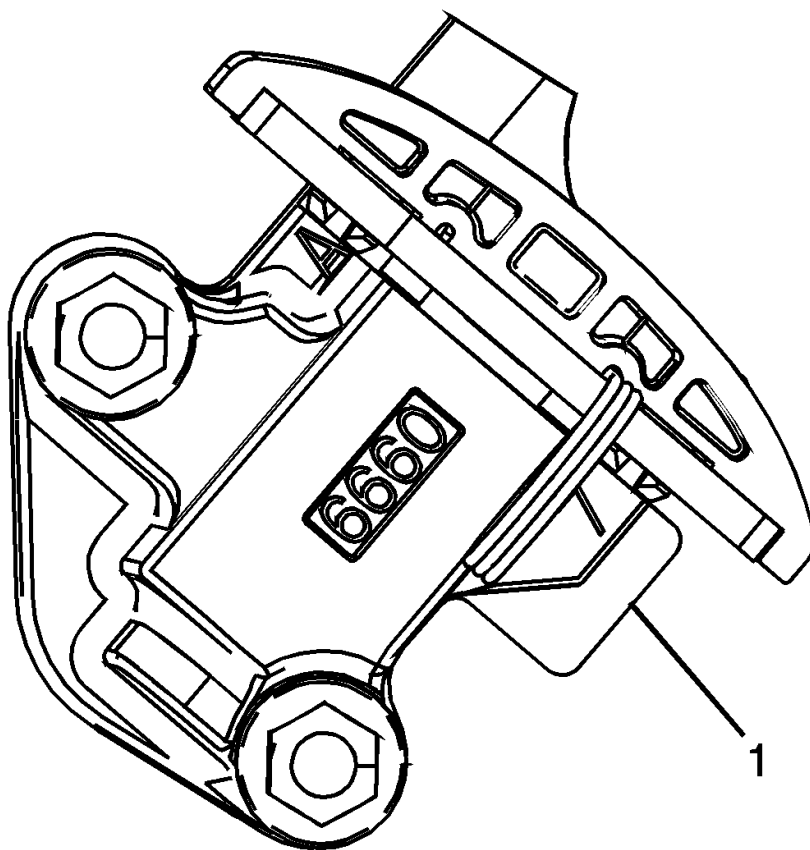


Fig. 628: Locating Primary Camshaft Drive Chain Tensioner Gasket Tab
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Verify the proper placement of the primary camshaft drive chain tensioner gasket tab (1).

1. First Pass

Tighten the primary camshaft drive chain tensioner bolts to 5 N.m (44 lb in).

2. Final Pass

Tighten the primary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

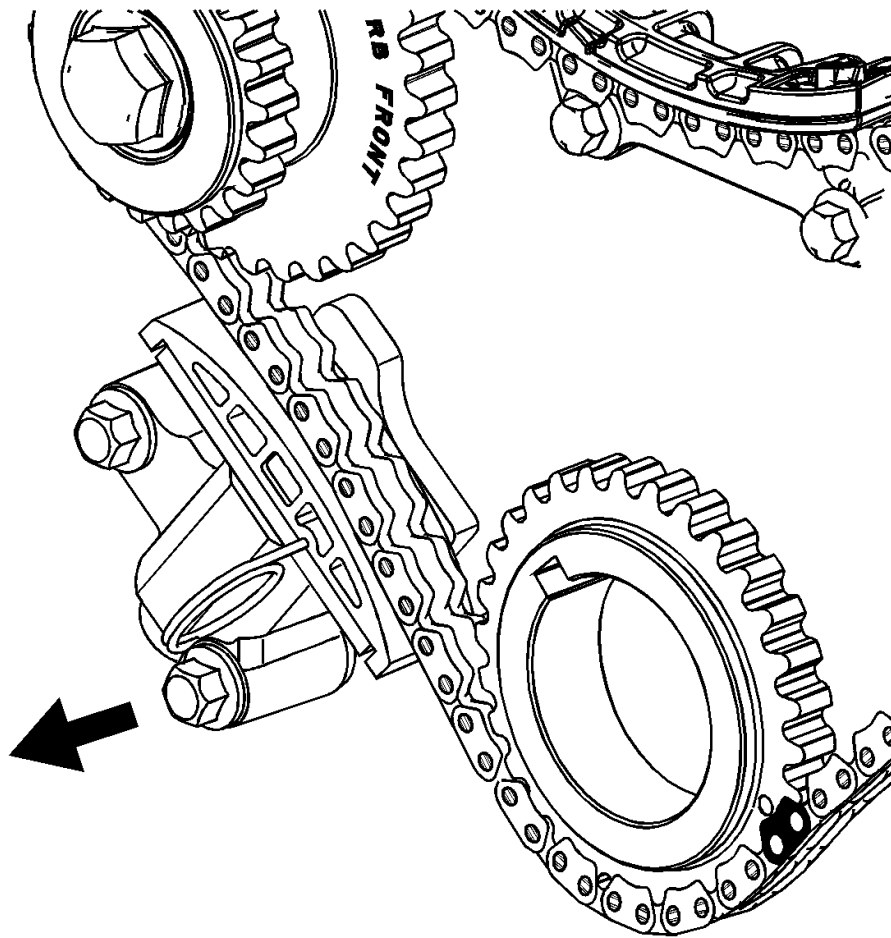


Fig. 629: View Of Primary Camshaft Drive Chain Tensioner
 Courtesy of GENERAL MOTORS COMPANY

11. Release the primary camshaft drive chain tensioner by pulling out the **EN-46112** pins and unlocking the tensioner plunger.
12. Verify the primary and left secondary camshaft drive chain timing mark alignments. Refer to **Timing Chain Alignment Diagram** - Stage One.

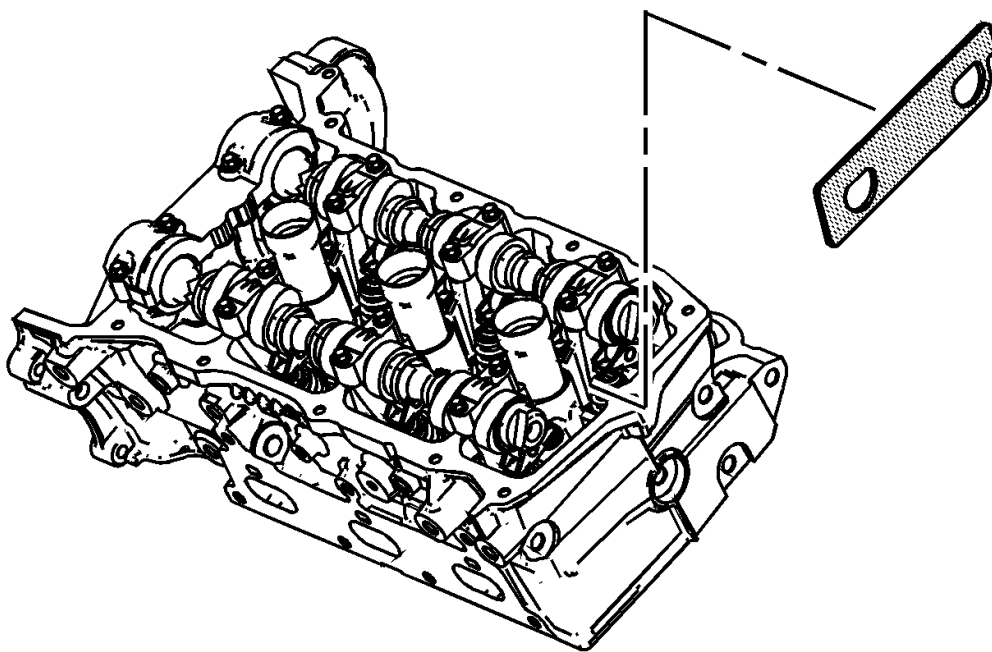


Fig. 630: Identifying Special Tools - EN 46105-1
Courtesy of GENERAL MOTORS COMPANY

13. Remove the EN 48383-1 from the rear of the left camshafts.

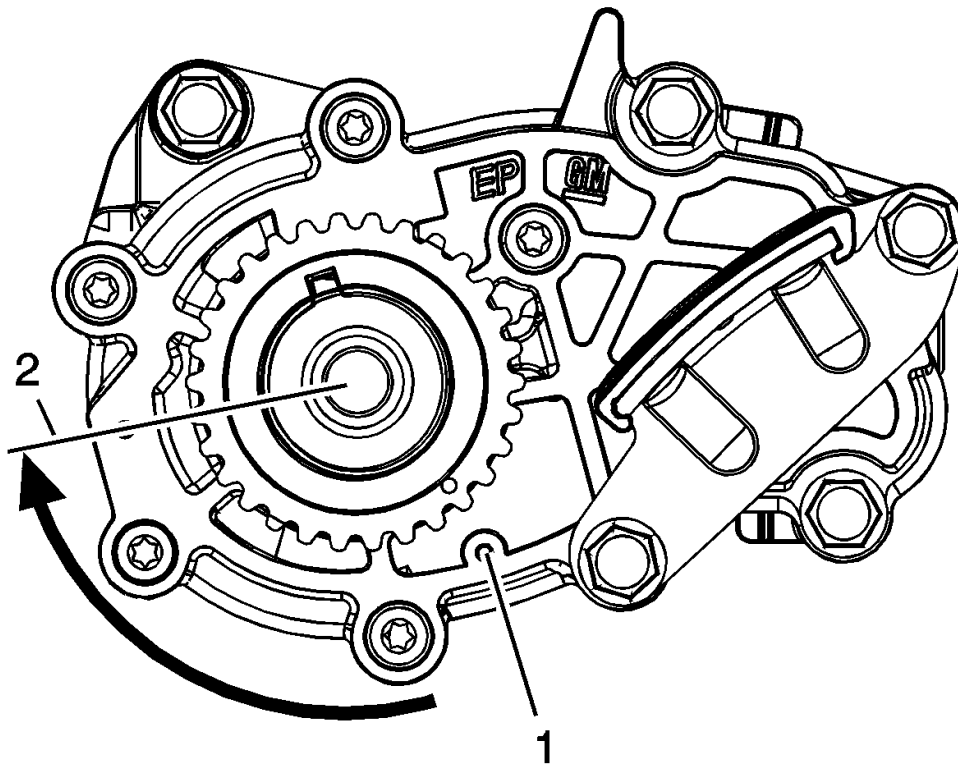


Fig. 631: View Of Stage 1 & Stage 2 Alignment Positions
Courtesy of GENERAL MOTORS COMPANY

14. Using the **EN-48589** socket, rotate the crankshaft and crankshaft sprocket from the stage 1 alignment position (1) to the stage 2 alignment position (2), 115 crankshaft degrees, in order to install the right secondary camshaft drive chain components.

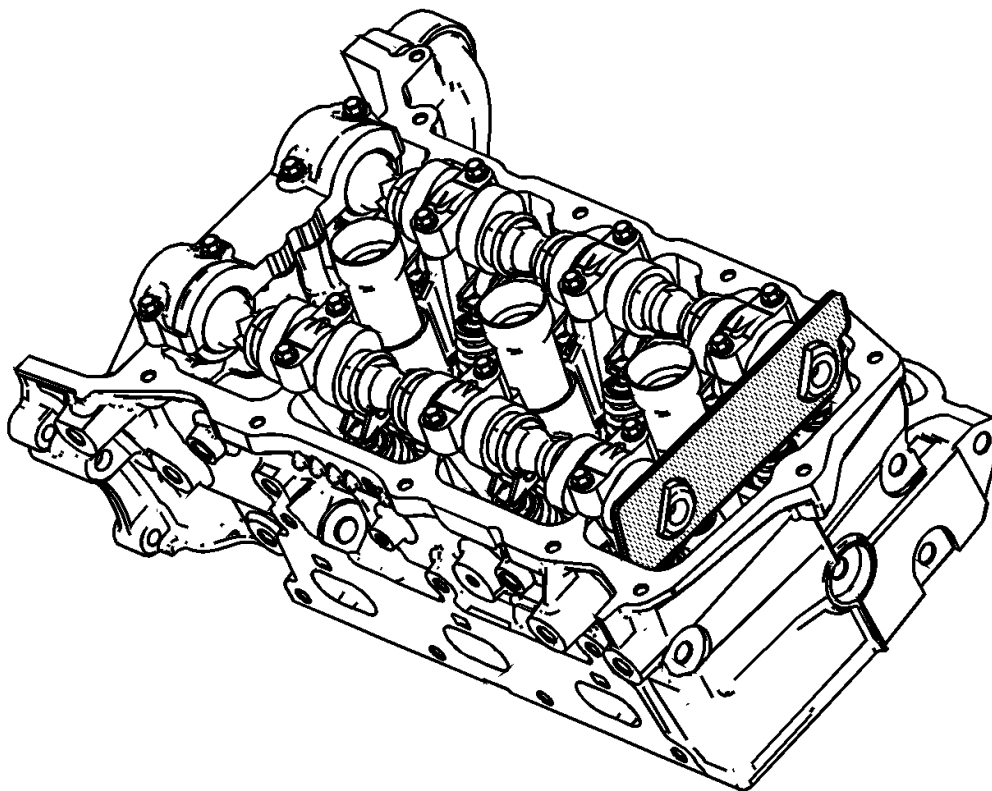


Fig. 632: Camshaft Holding Tool

Courtesy of GENERAL MOTORS COMPANY

15. Install the EN 48383-2 onto the rear of the left camshafts.

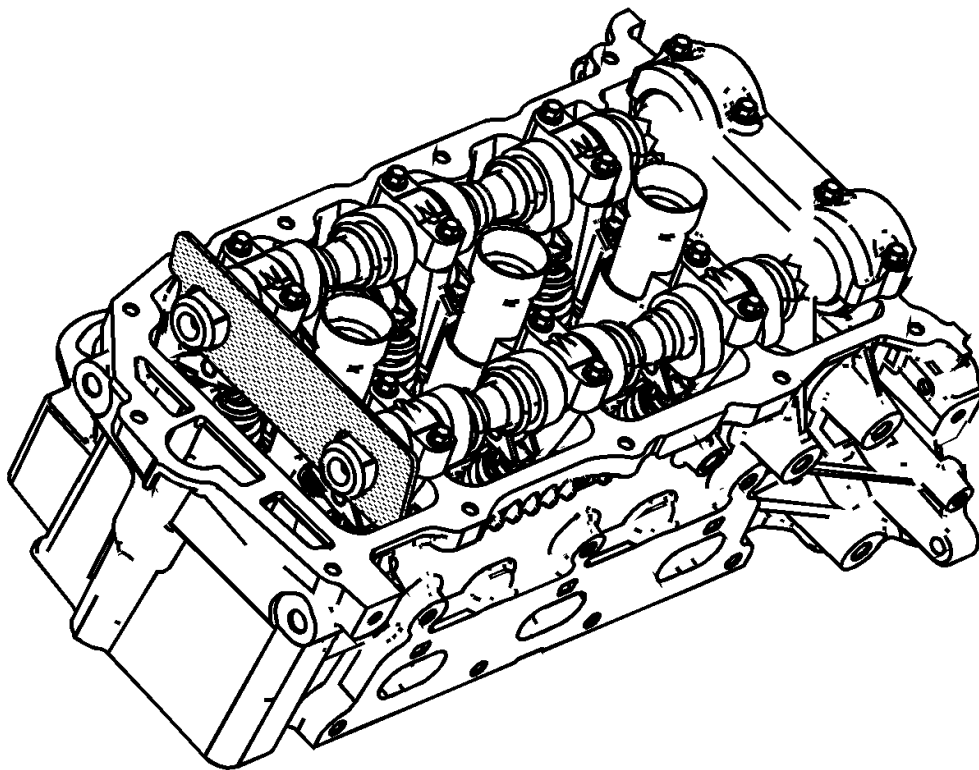


Fig. 633: View Of EN 46105-1 On Right Camshafts
Courtesy of GENERAL MOTORS COMPANY

16. Install the EN 48383-3 onto the rear of the right camshafts.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN INSTALLATION - RIGHT SIDE

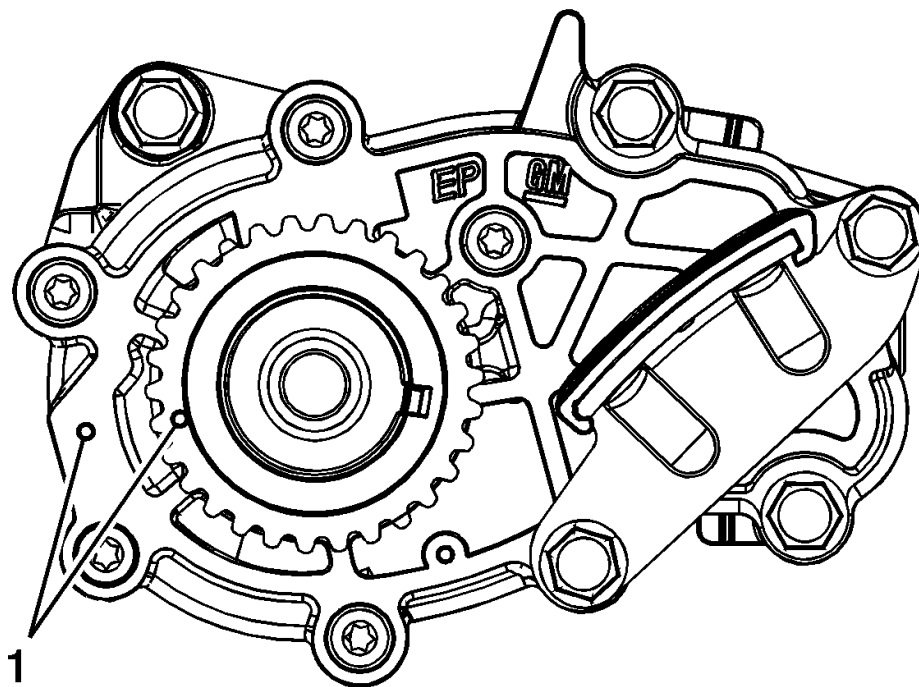


Fig. 634: View Of Crankshaft In Stage 2 Timing Drive Assembly Position
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the crankshaft is in the stage 2 timing drive assembly position (1).

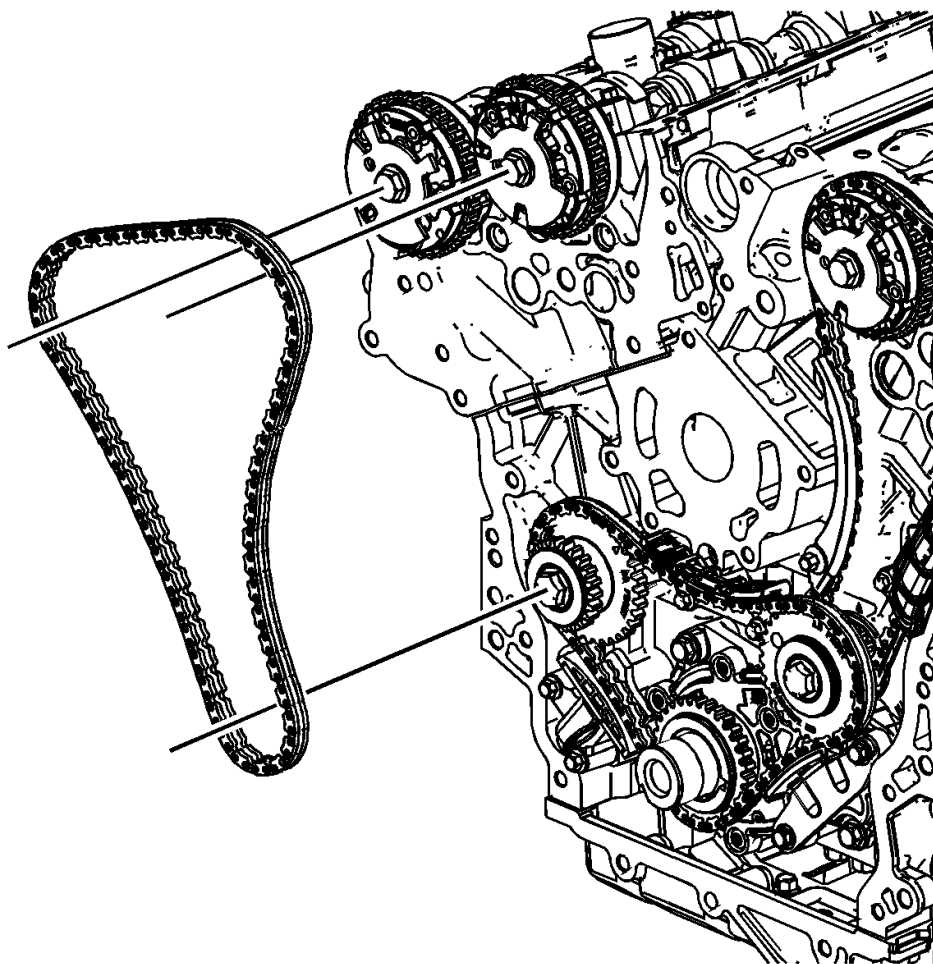


Fig. 635: View Of Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

2. Install the right secondary camshaft drive chain.

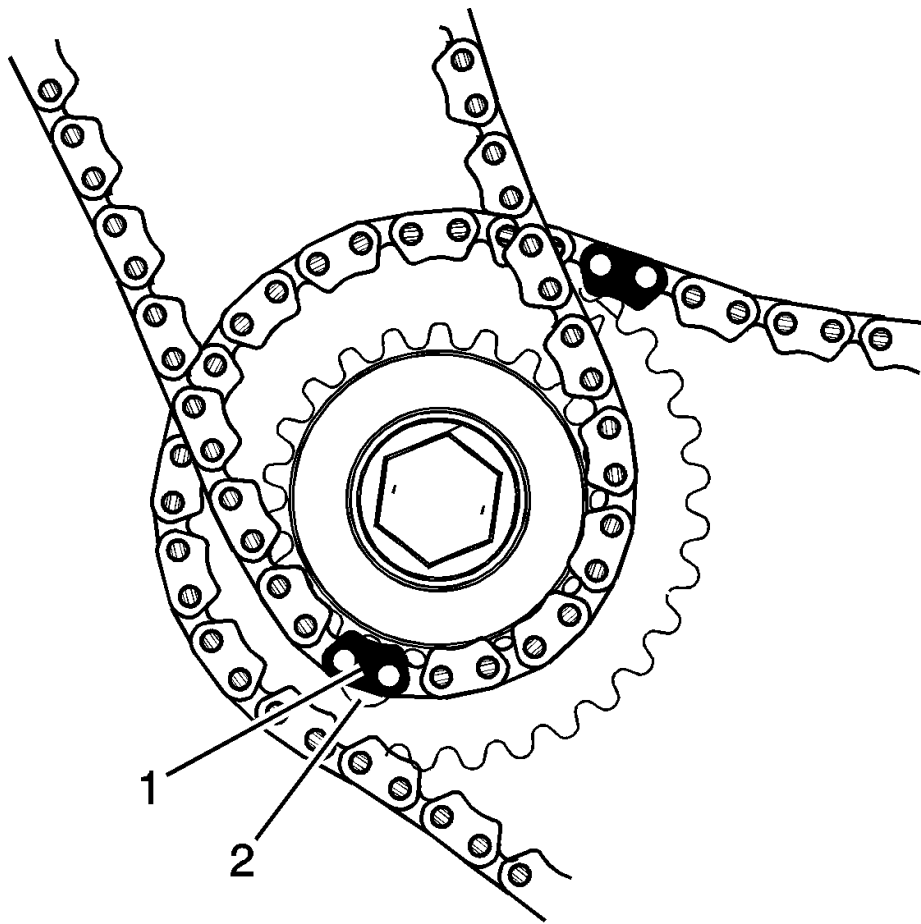


Fig. 636: View Of Timing Camshaft Drive Chain Link & Alignment Access Hole
Courtesy of GENERAL MOTORS COMPANY

3. Place the secondary camshaft drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the timing camshaft drive chain link (1) with the alignment access hole (2) made in the right camshaft intermediate drive chain idler inner sprocket.

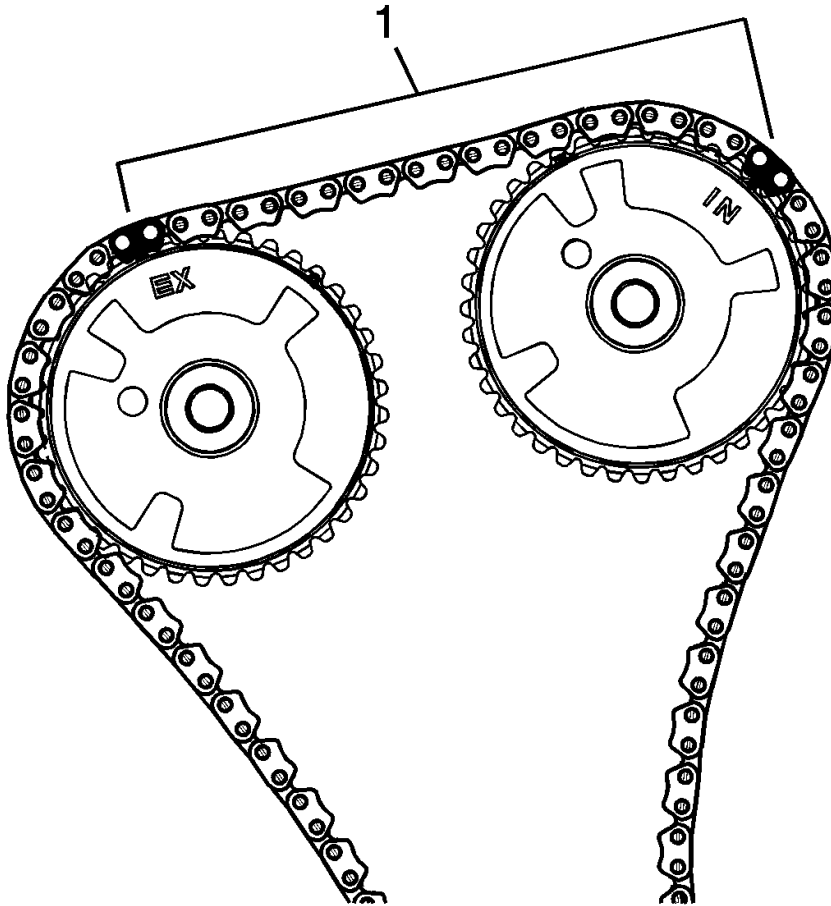


Fig. 637: Identifying Correct Number Of Links
Courtesy of GENERAL MOTORS COMPANY

4. Wrap the secondary camshaft drive chain around both right actuator drive sprockets.
5. Ensure there are 10 links (1) between the timing camshaft drive chain links for the camshaft position actuator sprockets.

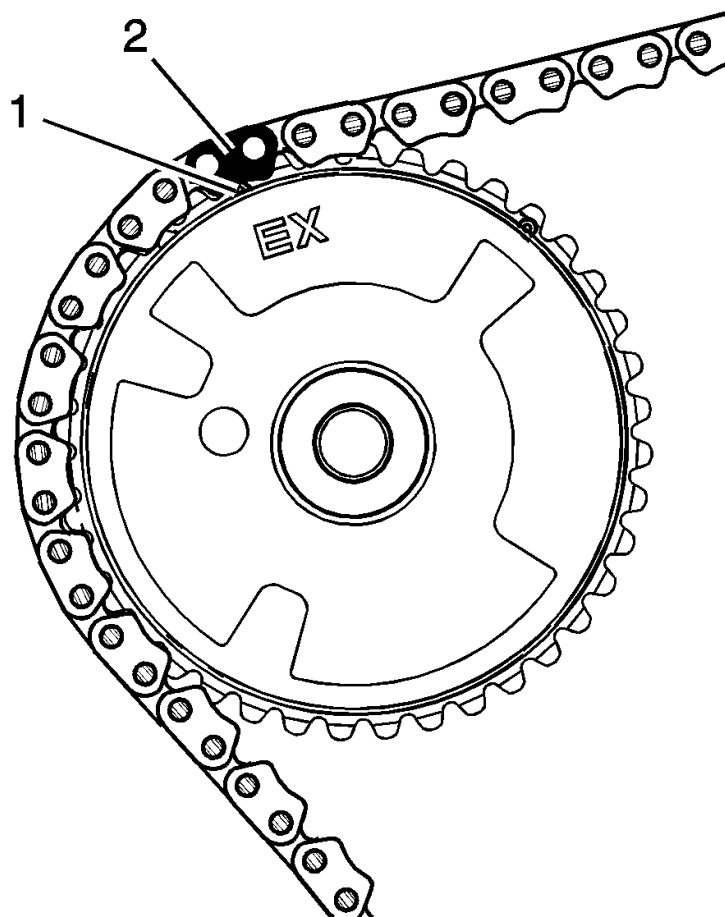


Fig. 638: View Of Right Exhaust Camshaft & Drive Chain Marks
Courtesy of GENERAL MOTORS COMPANY

6. Align the right exhaust camshaft position actuator sprocket alignment triangle mark (1) with the timing camshaft drive chain link (2).

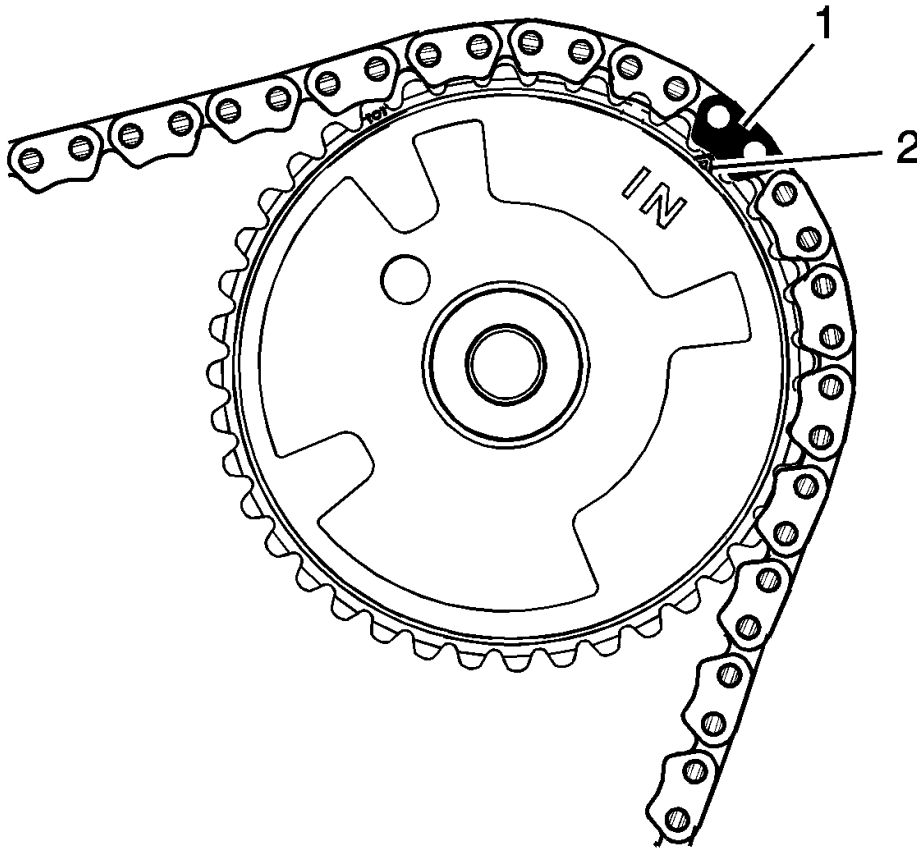


Fig. 639: View Of Right Intake Camshaft Position Actuator Sprocket Alignment Triangle Mark
Courtesy of GENERAL MOTORS COMPANY

7. Align the right intake camshaft position actuator sprocket alignment triangle mark (2) with the timing camshaft drive chain link (1).

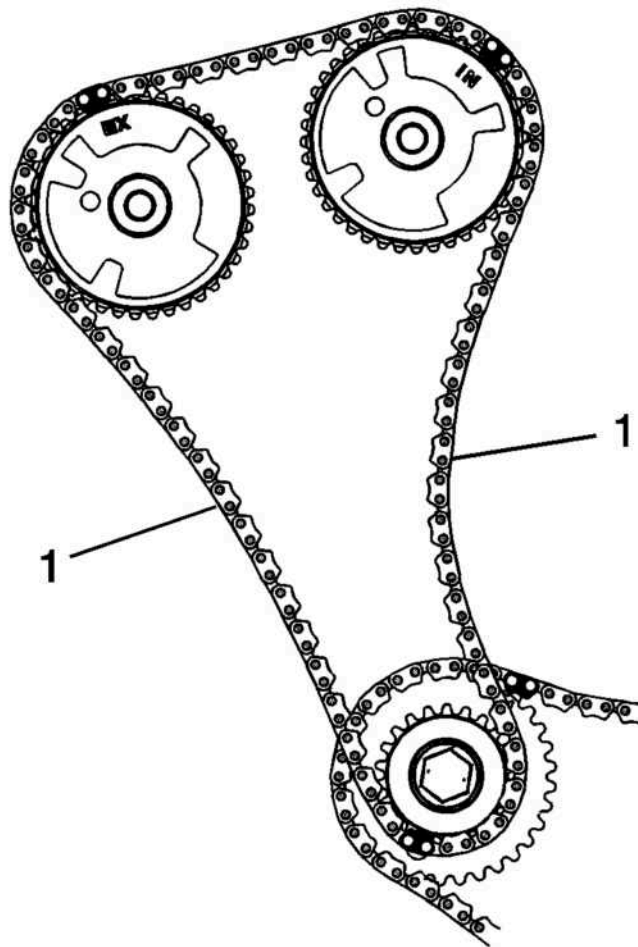


Fig. 640: Identifying Correct Number Of Links Between Points
 Courtesy of GENERAL MOTORS COMPANY

8. There will be 22 links (1) 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.

SECONDARY TIMING CHAIN GUIDE INSTALLATION - RIGHT SIDE

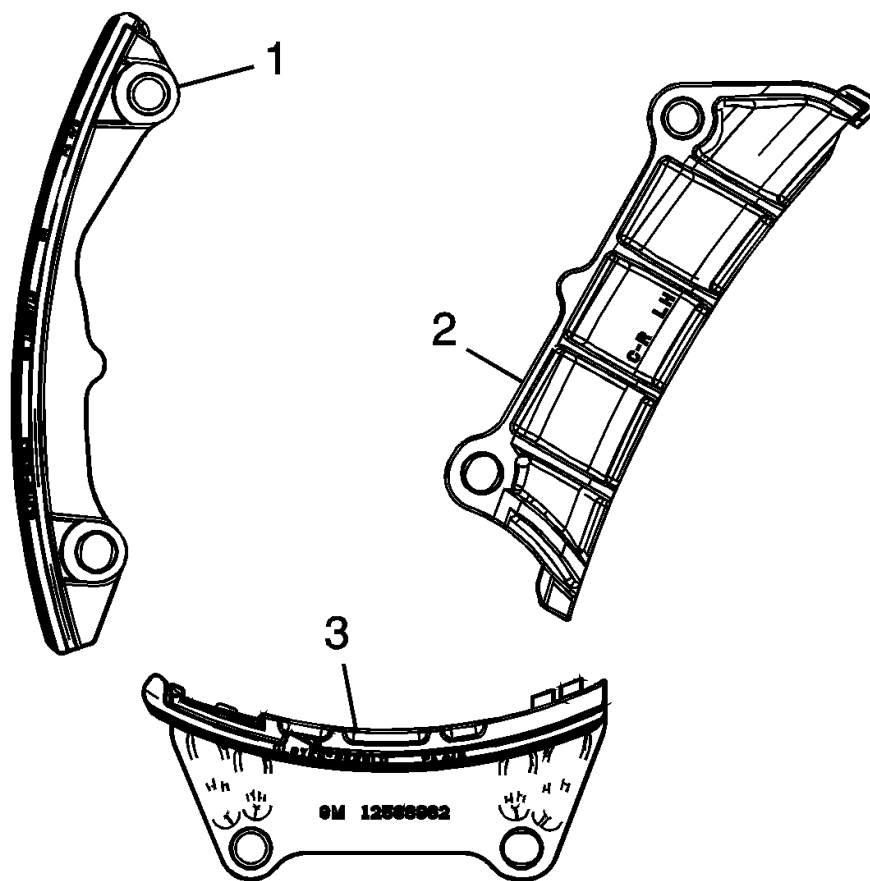


Fig. 641: View Of Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the right secondary camshaft drive chain guide (1) is being installed.

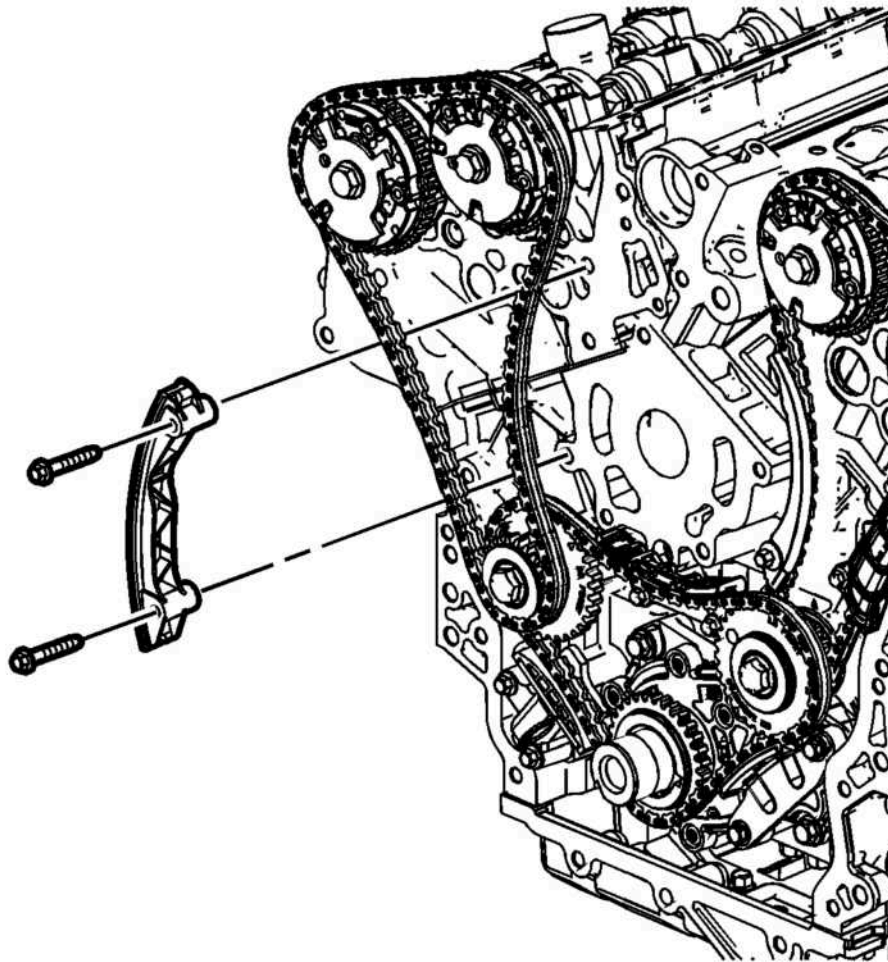


Fig. 642: Identifying Secondary Camshaft Drive Chain Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Position the right secondary camshaft drive chain guide.
3. Install the secondary camshaft drive chain guide bolts and tighten to 25 N.m (18 lb ft).

CAUTION: Refer to Fastener Caution .

SECONDARY CAMSHAFT DRIVE CHAIN SHOE INSTALLATION - RIGHT SIDE

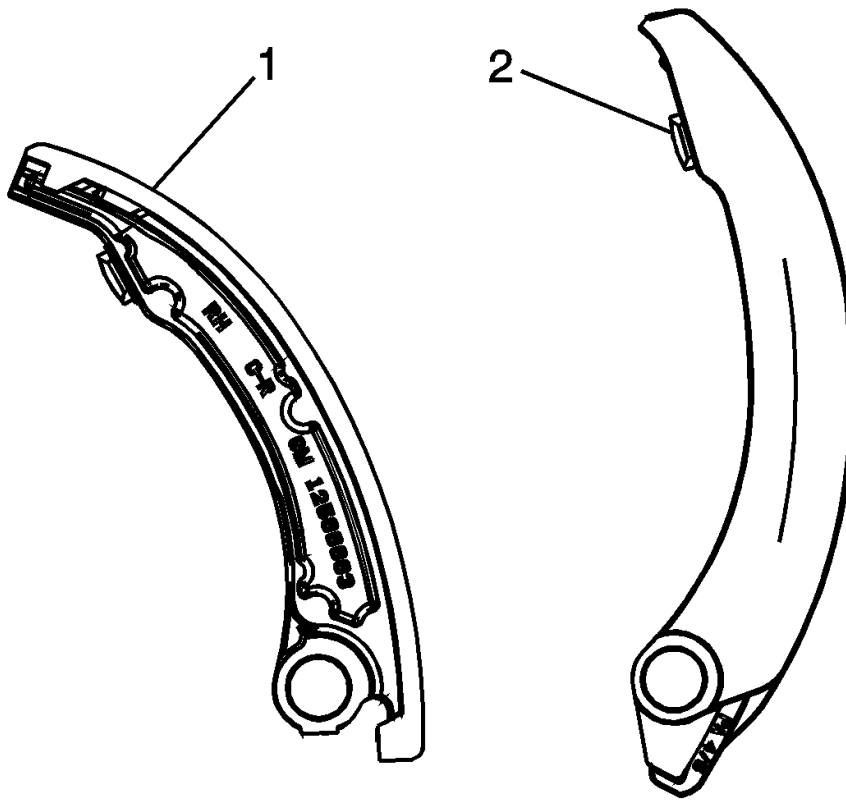


Fig. 643: Identifying Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the right secondary camshaft drive chain shoe (1) is being installed.

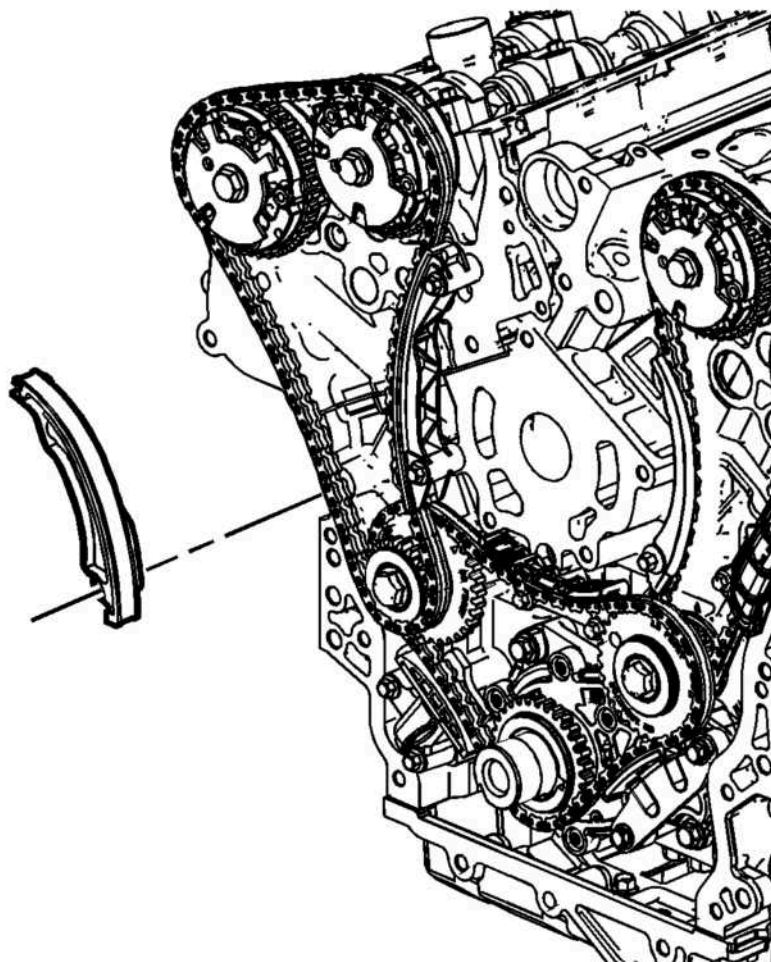


Fig. 644: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

2. Position the right secondary camshaft drive chain shoe.

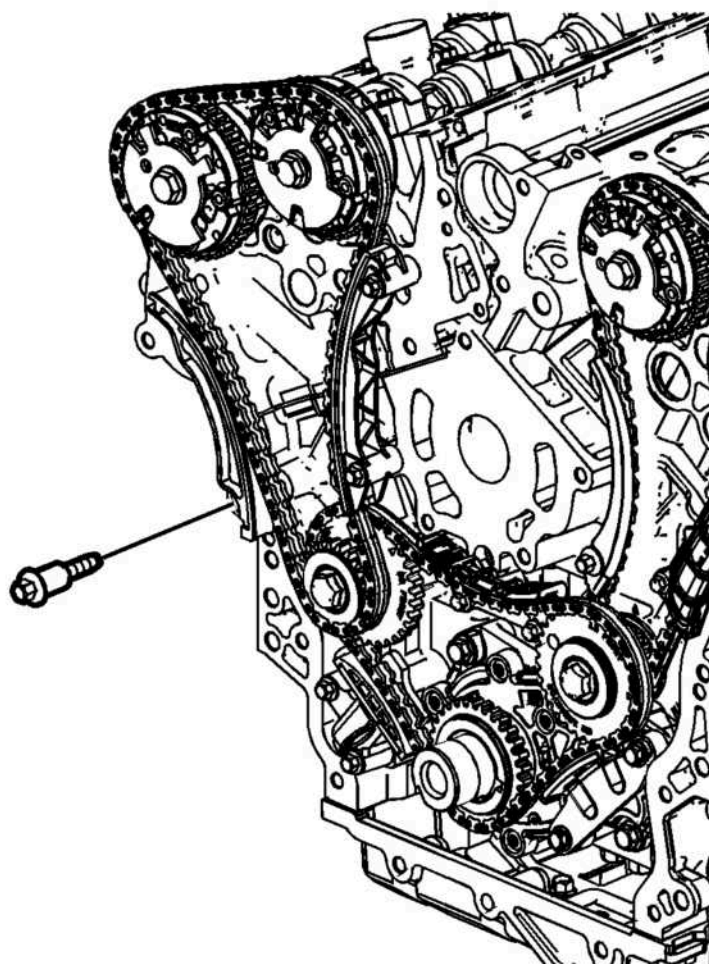


Fig. 645: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the secondary camshaft drive chain shoe bolt and tighten to 25 N.m (18 lb ft).

SECONDARY TIMING CHAIN TENSIONER INSTALLATION - RIGHT SIDE

Special Tools

- **EN 45027** Tensioner Tool
- **EN 46112** Tensioner Retraction Pins

For equivalent regional tools, refer to Special Tools .

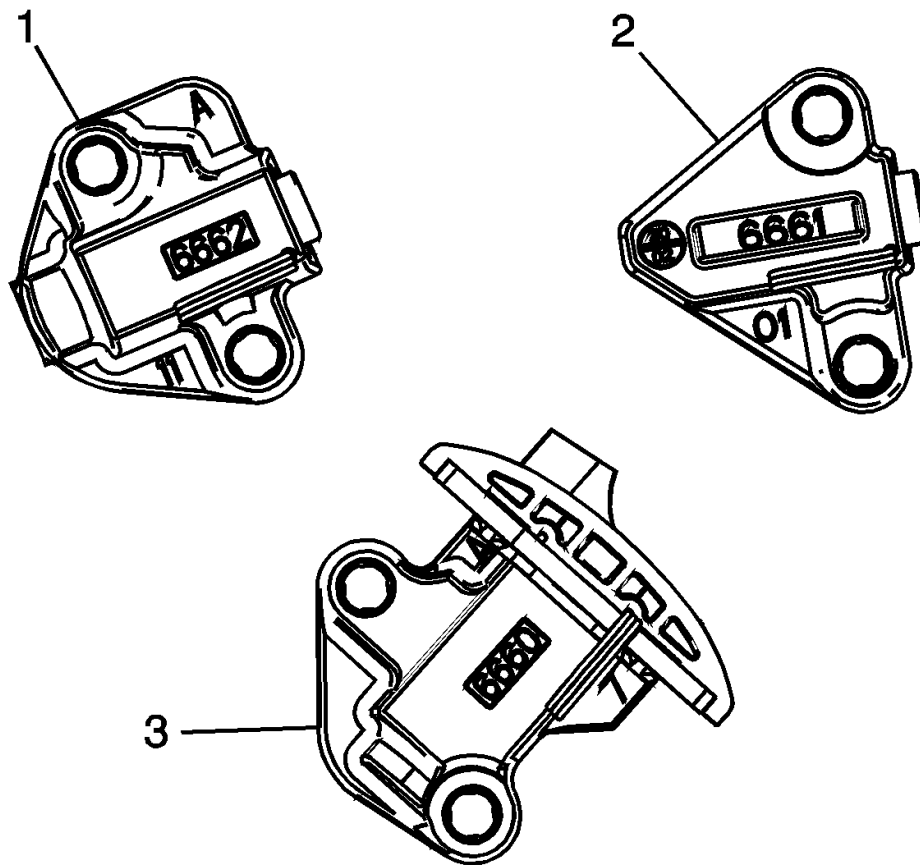


Fig. 646: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the right secondary camshaft drive chain tensioner (1) is being installed.

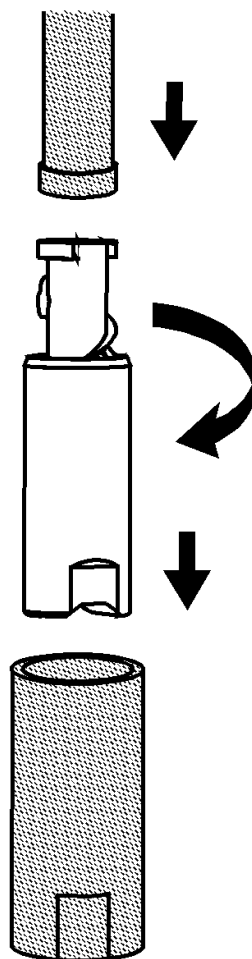


Fig. 647: Resetting Secondary Camshaft Drive Chain Tensioner Plunger
Courtesy of GENERAL MOTORS COMPANY

2. Using the **EN 45027** tool, reset the right secondary camshaft drive chain tensioner plunger.

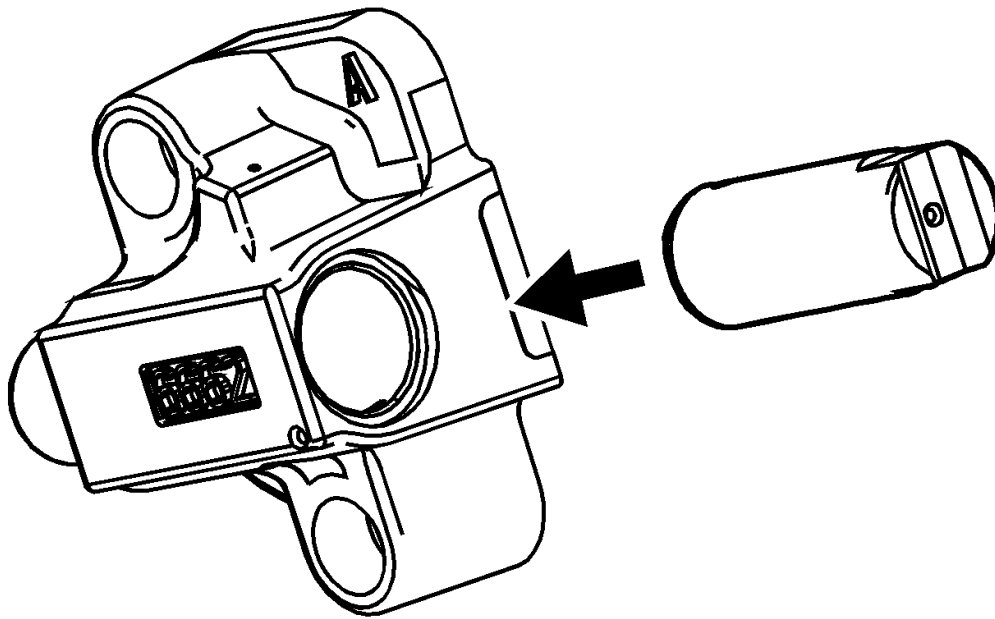


Fig. 648: View Of Plunger & Right Secondary Camshaft Drive Chain Tensioner Body
Courtesy of GENERAL MOTORS COMPANY

3. Install the plunger into the right secondary camshaft drive chain tensioner body.

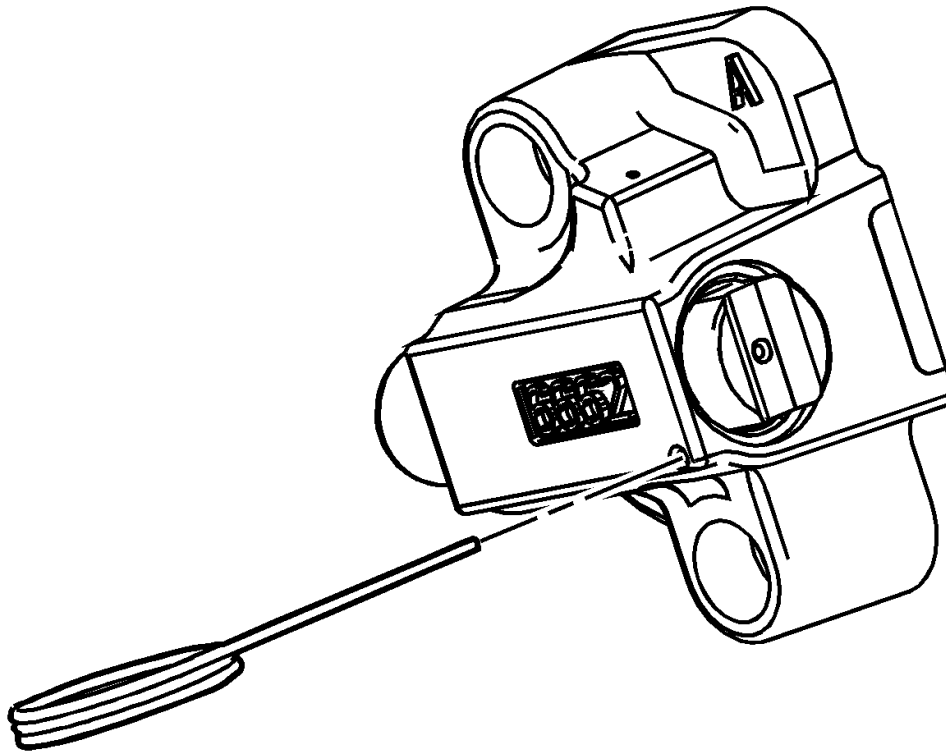


Fig. 649: Identifying Special Tool - EN 46112
Courtesy of GENERAL MOTORS COMPANY

4. Compress the plunger into the body and lock the right secondary camshaft drive chain tensioner by inserting the **EN 46112** pins into the access hole in the side of the right secondary camshaft drive chain tensioner body.
5. Slowly release pressure on the right secondary camshaft drive chain tensioner. The right secondary camshaft drive chain tensioner should remain compressed.

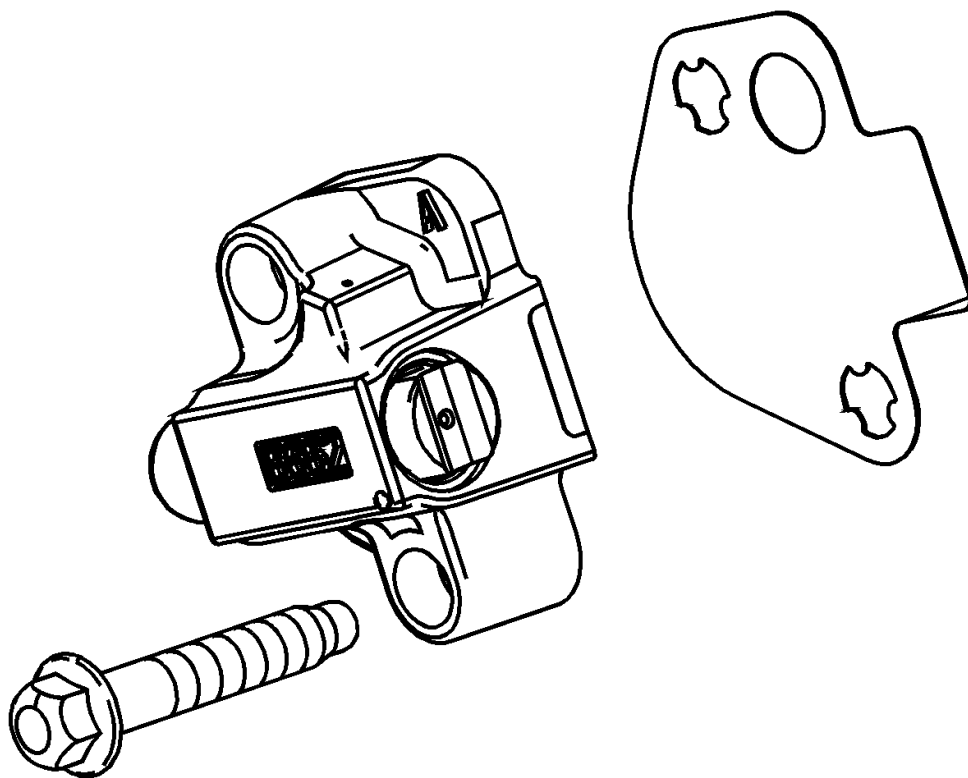


Fig. 650: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW right secondary camshaft drive chain tensioner gasket to the right secondary camshaft drive chain tensioner.
7. Install the right secondary camshaft drive chain tensioner bolts through the right secondary camshaft drive chain tensioner and gasket.
8. Ensure the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head does not have any burrs or defects that would degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.

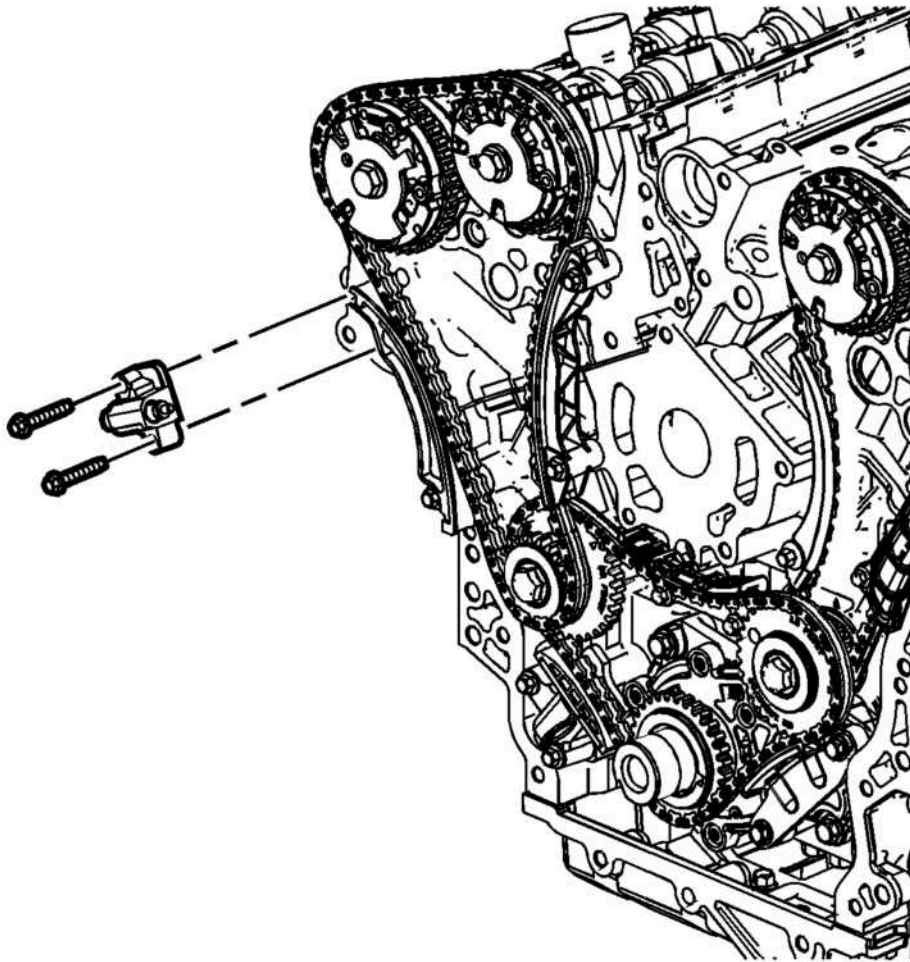


Fig. 651: View Of Secondary Camshaft Drive Chain Tensioner And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Place the right secondary camshaft drive chain tensioner into position and loosely install the bolts to the block.

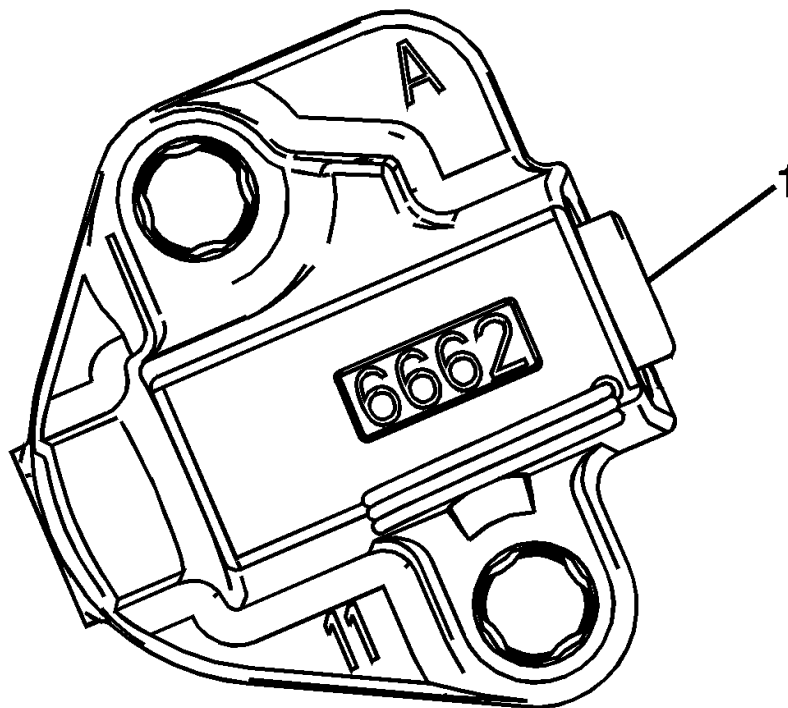


Fig. 652: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket Tab
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Verify the proper placement of the right secondary camshaft drive chain tensioner gasket tab (1).

1. First Pass

Tighten the right secondary camshaft drive chain tensioner bolts to 5 N.m (44 lb in).

2. Final Pass

Tighten the right secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

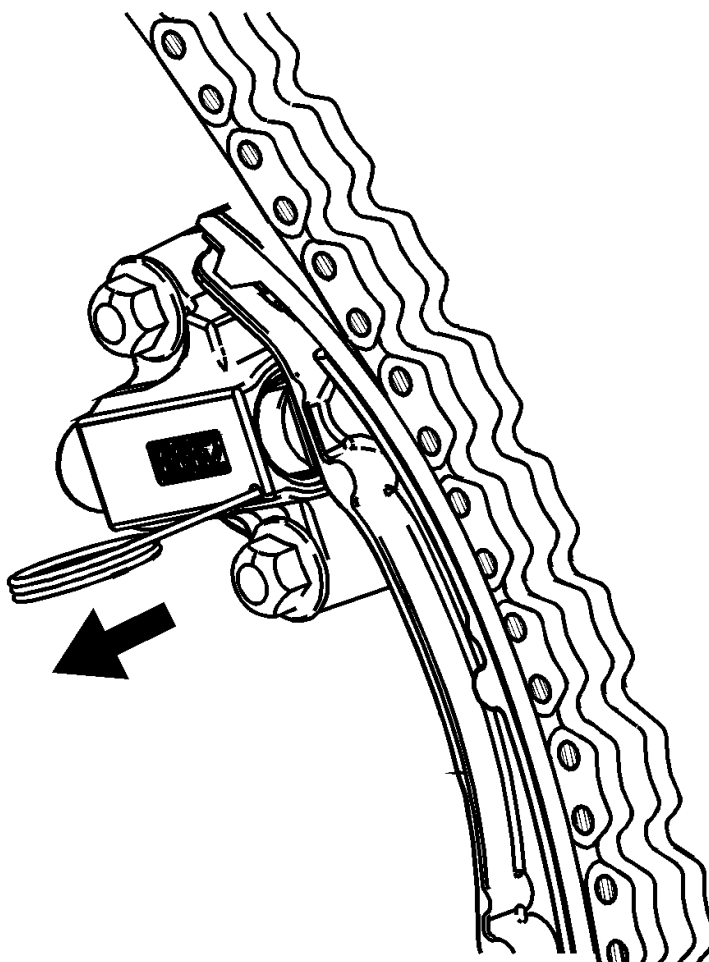


Fig. 653: Identifying Right Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Release the right camshaft drive chain tensioner by pulling out the **EN 46112** pins and unlocking the tensioner plunger.
12. Verify all primary and secondary camshaft drive chain timing mark alignments. Refer to **Timing Chain Alignment Diagram** - Stage Two.

CAUTION: Ensure that all timing chain tensioners are completely released. A timing chain tensioner that is not properly released can lead to serious engine damage.

ENGINE FRONT COVER INSTALLATION

Special Tools

EN-46109 Guide Pins

For equivalent regional tools, refer to **Special Tools** .

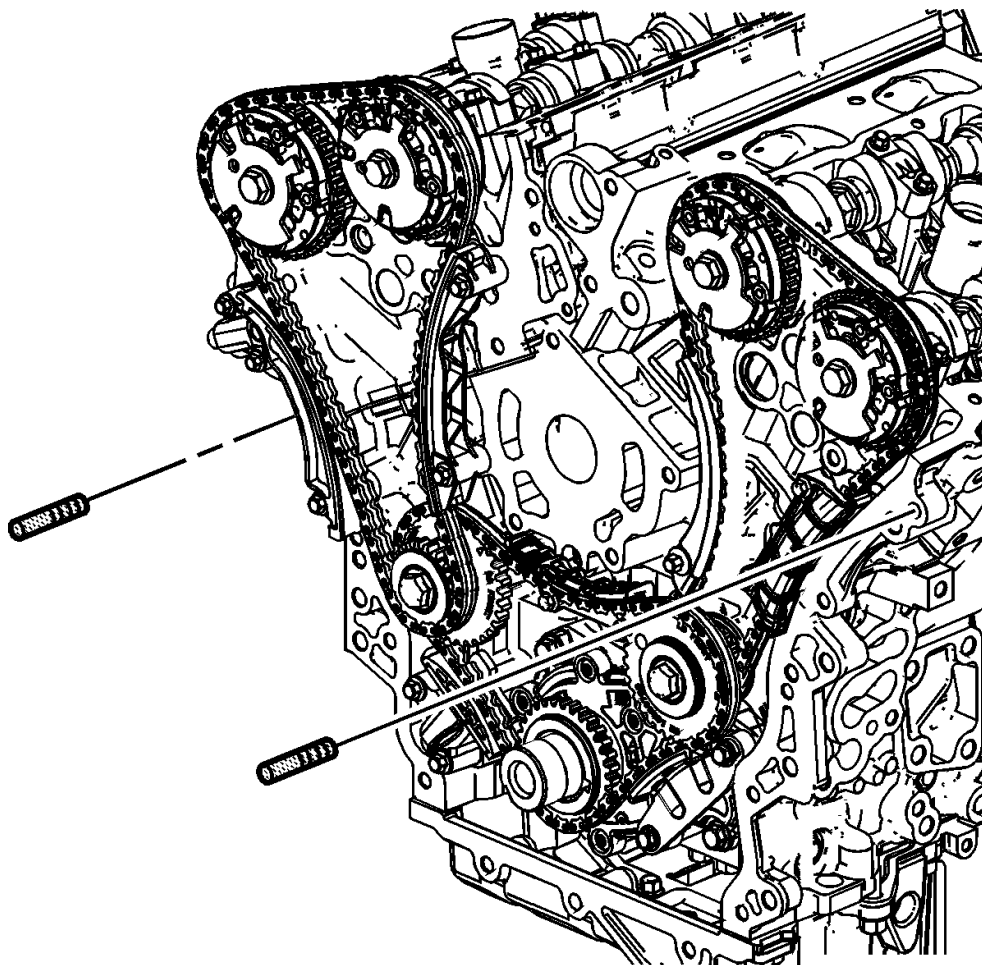


Fig. 654: Identifying Cylinder Block Guide Studs
Courtesy of GENERAL MOTORS COMPANY

1. Install the 8 mm (0.315 in) guide from the **EN-46109** pins into the cylinder block positions as shown.

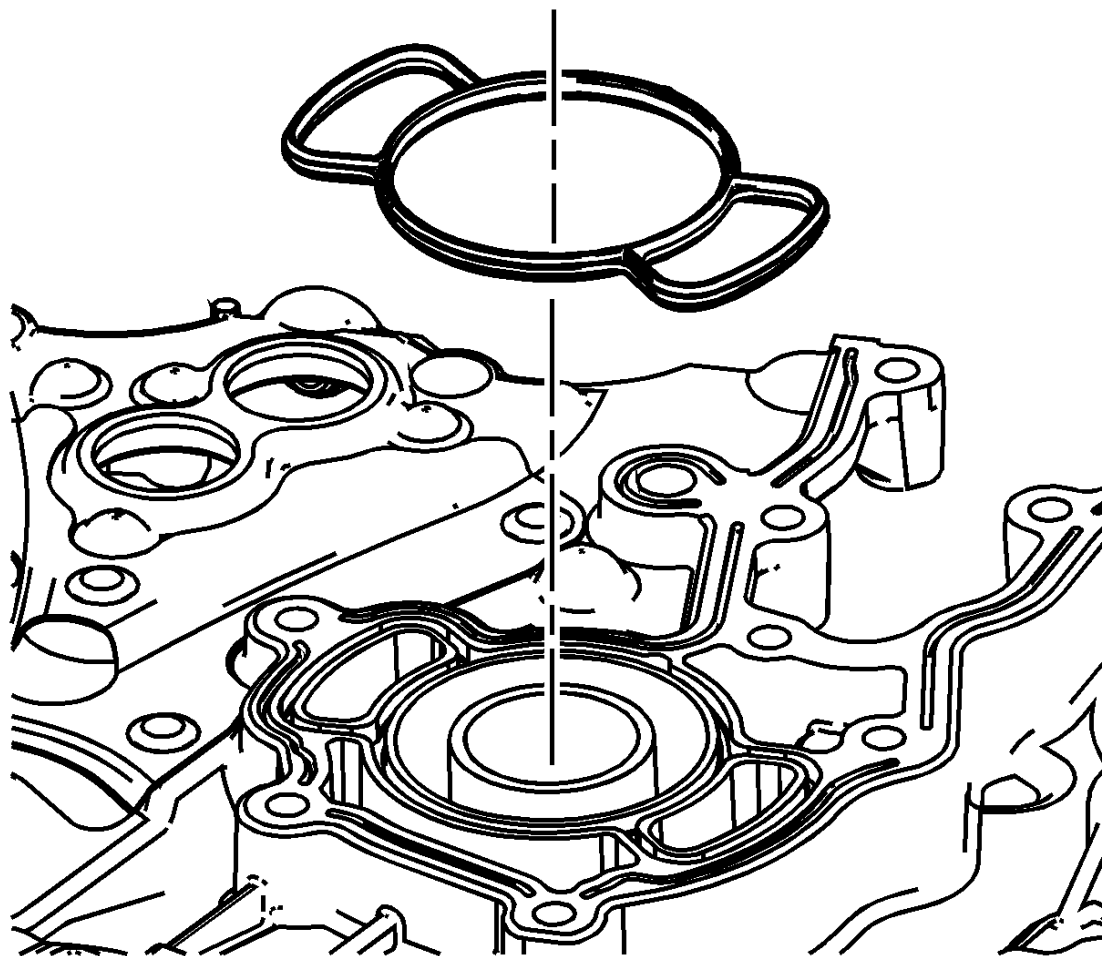


Fig. 655: Identifying Water Pump Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW engine front cover to cylinder block seal.

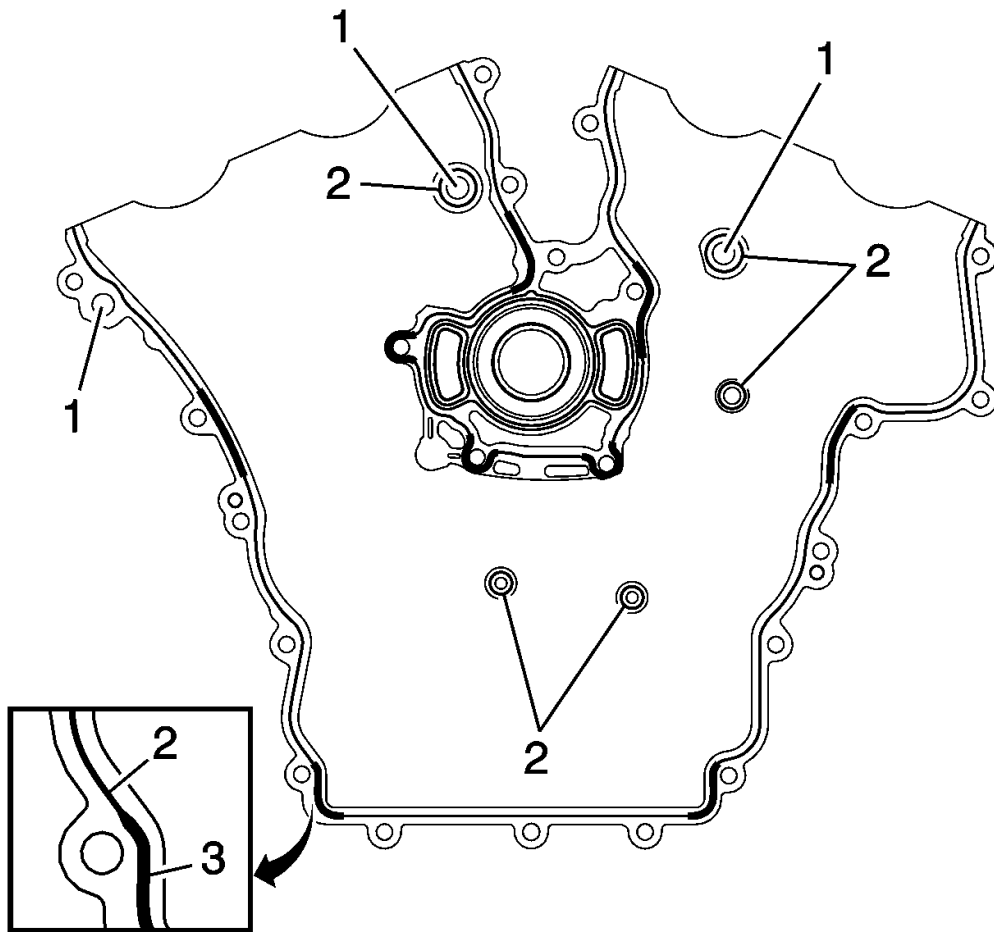


Fig. 656: Applying Sealant

Courtesy of GENERAL MOTORS COMPANY

NOTE: No RTV sealant should be visible in the M12 bolt holes (1) upon final assembly of front cover to engine.

3. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (2). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (3). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

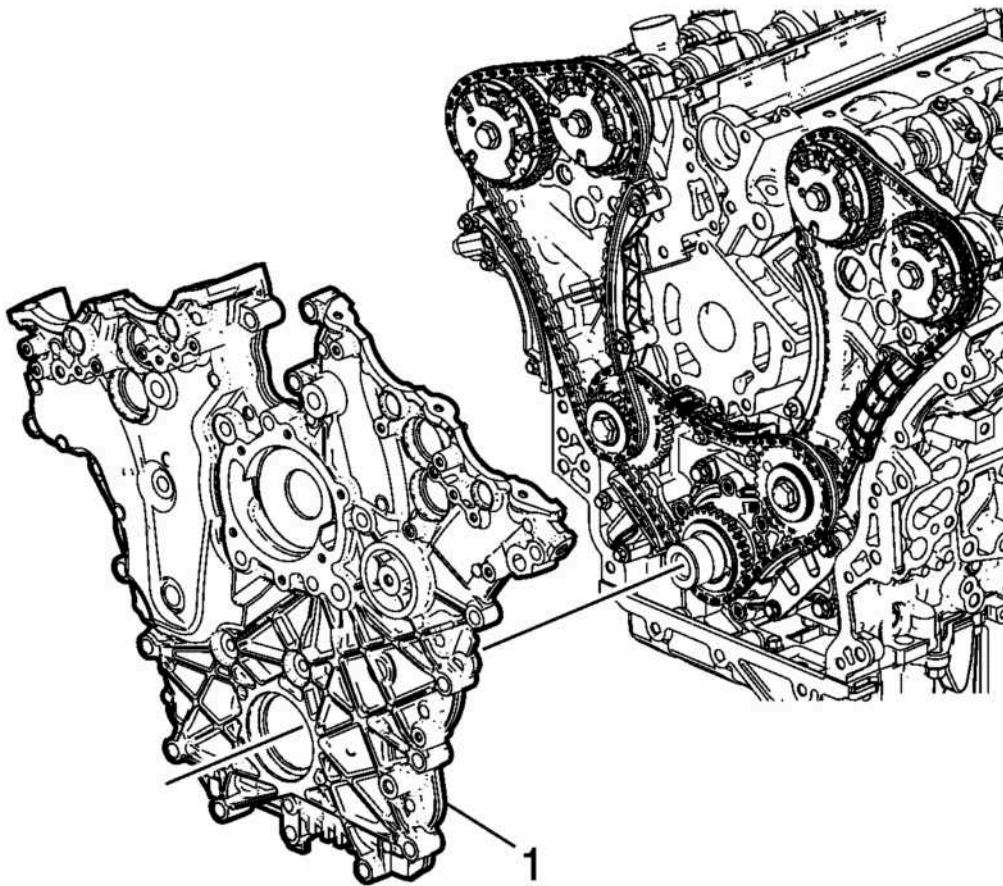


Fig. 657: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

4. Place the engine front cover (1) onto the **EN-46109** pins and slide into position.
5. Remove the **EN-46109** pins from the cylinder block.
6. Hand start all the engine front cover bolts.

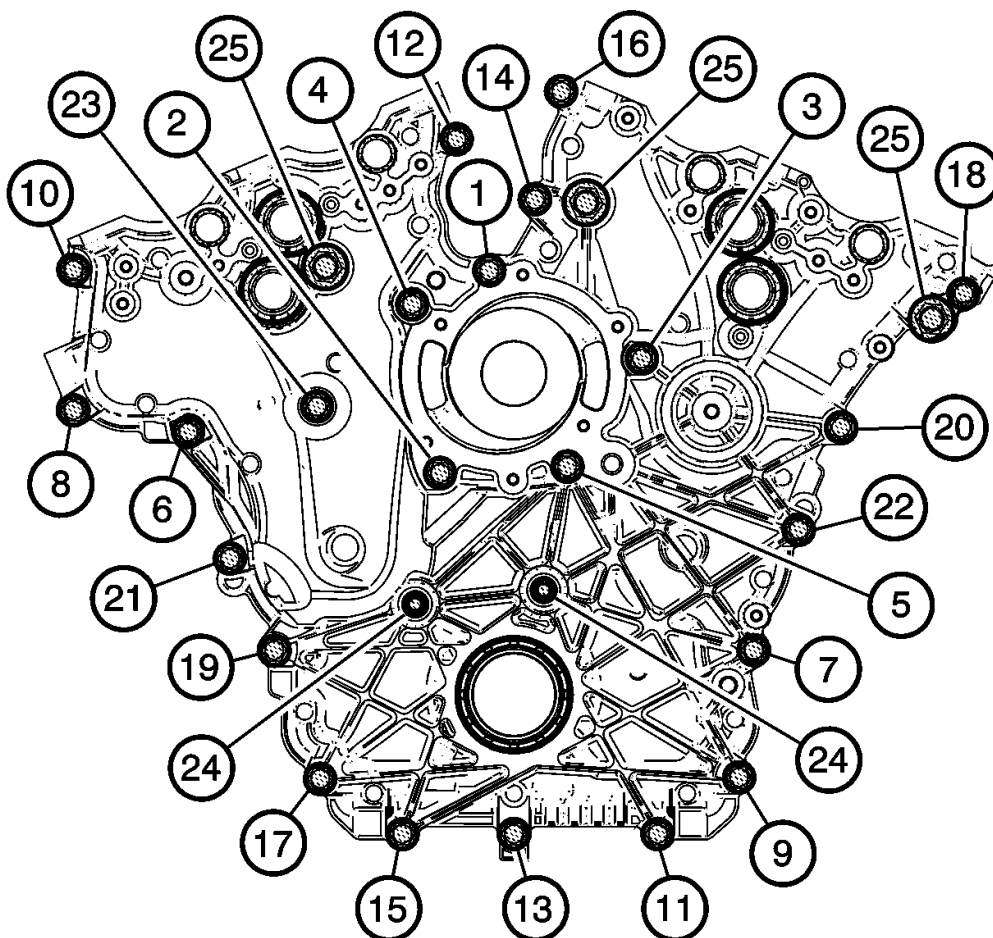


Fig. 658: Identifying Engine Front Cover Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Engine front cover bolts in the number (25) location are model dependent and may not apply.

7. Tighten the engine front cover bolts (1-23) in the sequence shown to 20 N.m (15 lb ft).
 1. Tighten the engine front cover bolts (1-23) a second pass in sequence to 20 N.m (15 lb ft).
 2. Tighten the engine front cover bolts (1-23) a third pass in sequence an additional 60°.
 3. Tighten the engine front cover bolts (24) to 15 N.m (11 lb ft).
 4. Tighten the engine front cover bolts (25) to 65 N.m (48 lb ft).

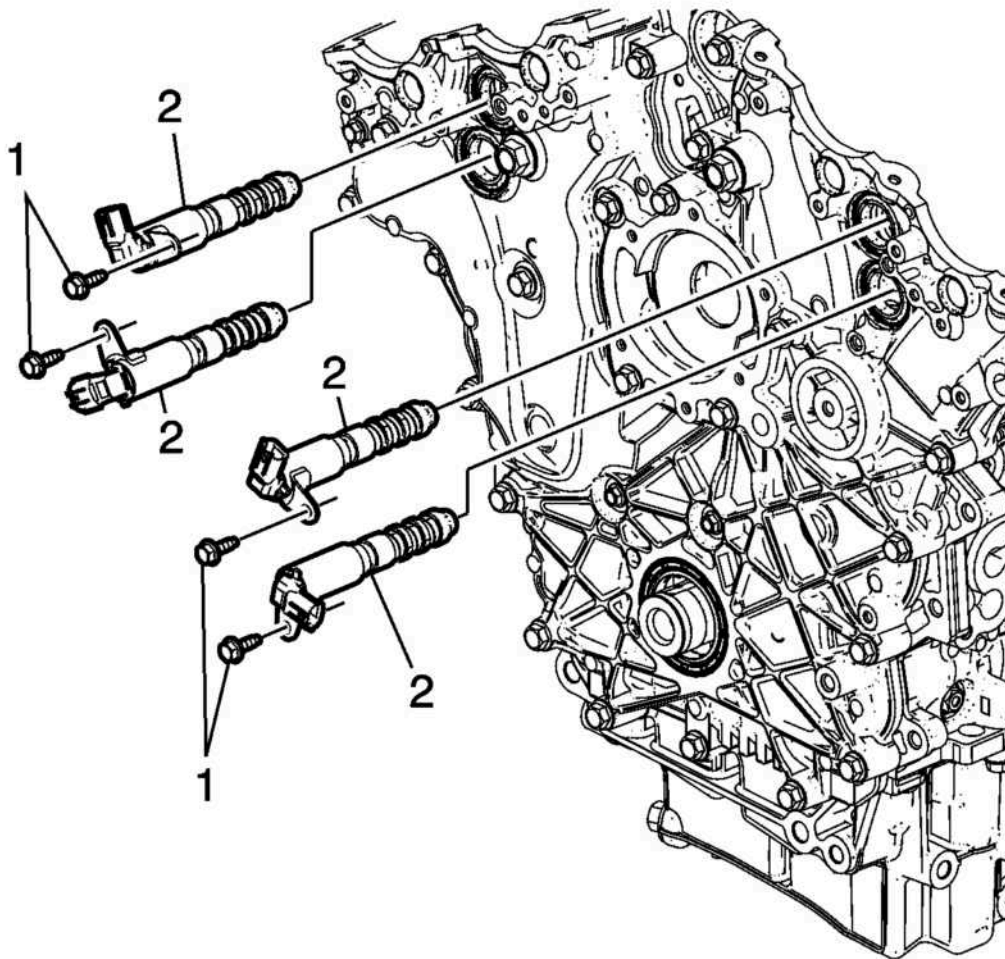


Fig. 659: Placing Camshaft Position Actuator Valves
Courtesy of GENERAL MOTORS COMPANY

8. Place the camshaft position actuator valves (2) in position on the front cover.
9. Install the camshaft position actuator valve bolts (1) and tighten to 10 N.m (89 lb in).

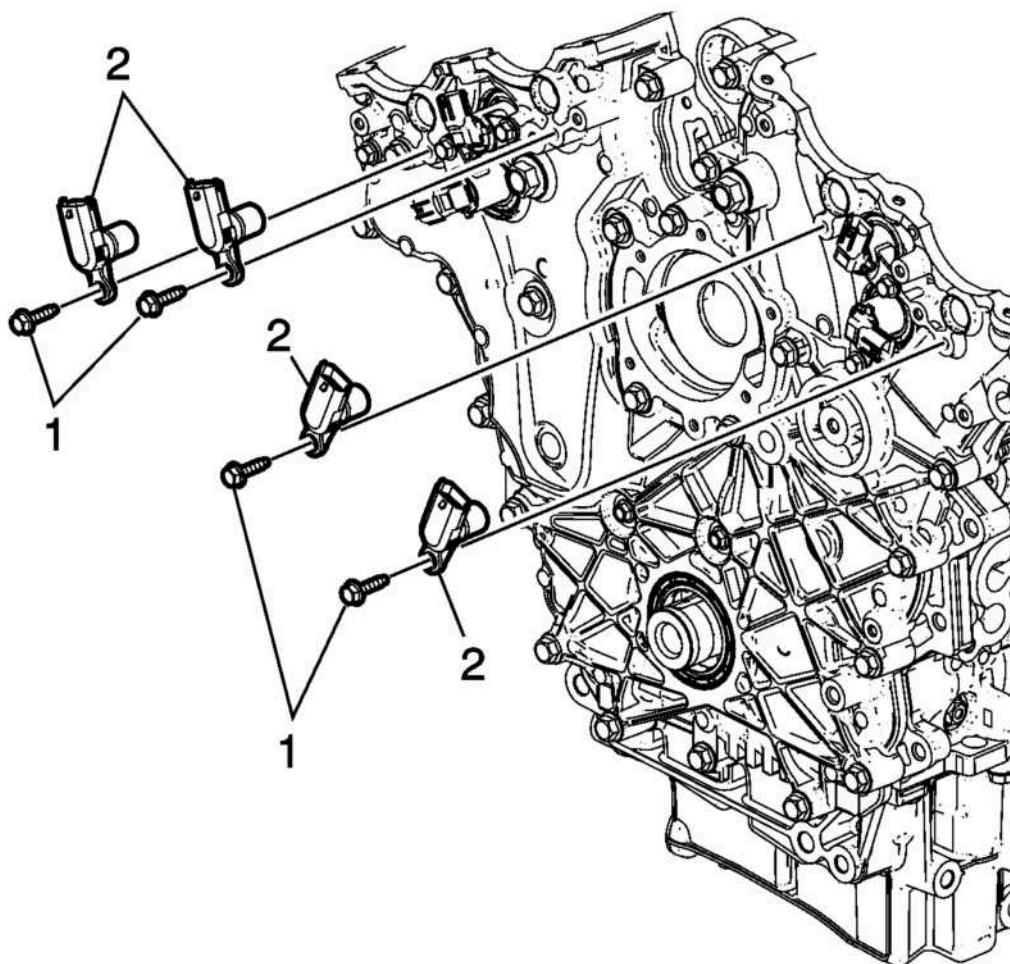


Fig. 660: Placing Camshaft Position Sensors
 Courtesy of GENERAL MOTORS COMPANY

NOTE: **Inspect the camshaft position sensor O-ring seals. If the seals are damaged, the entire camshaft position sensor must be replaced.**

10. Place the camshaft position sensors (2) in position on the front cover.
11. Install the camshaft position sensor bolts (1) and tighten to 10 N.m (89 lb in).

WATER PUMP INSTALLATION

Special Tools

EN-46104 Water Pump Pulley Holding Tool

For equivalent regional tools, refer to **Special Tools** .

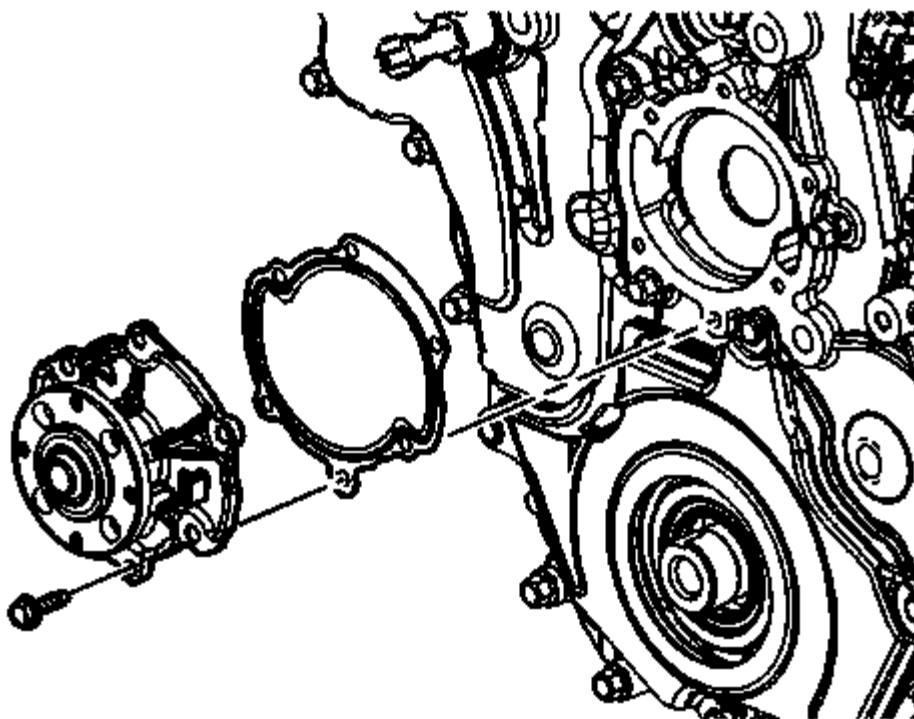


Fig. 661: View Of Water Pump, Gasket & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the engine front cover and water pump are clear of old gasket material.
2. Ensure that the water pump mounting bolt holes in the front cover are completely clean and dry.
3. Place a NEW water pump gasket on the water pump.
4. Place the water pump in position on the front cover.
5. Install the NEW water pump bolts finger tight.

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.

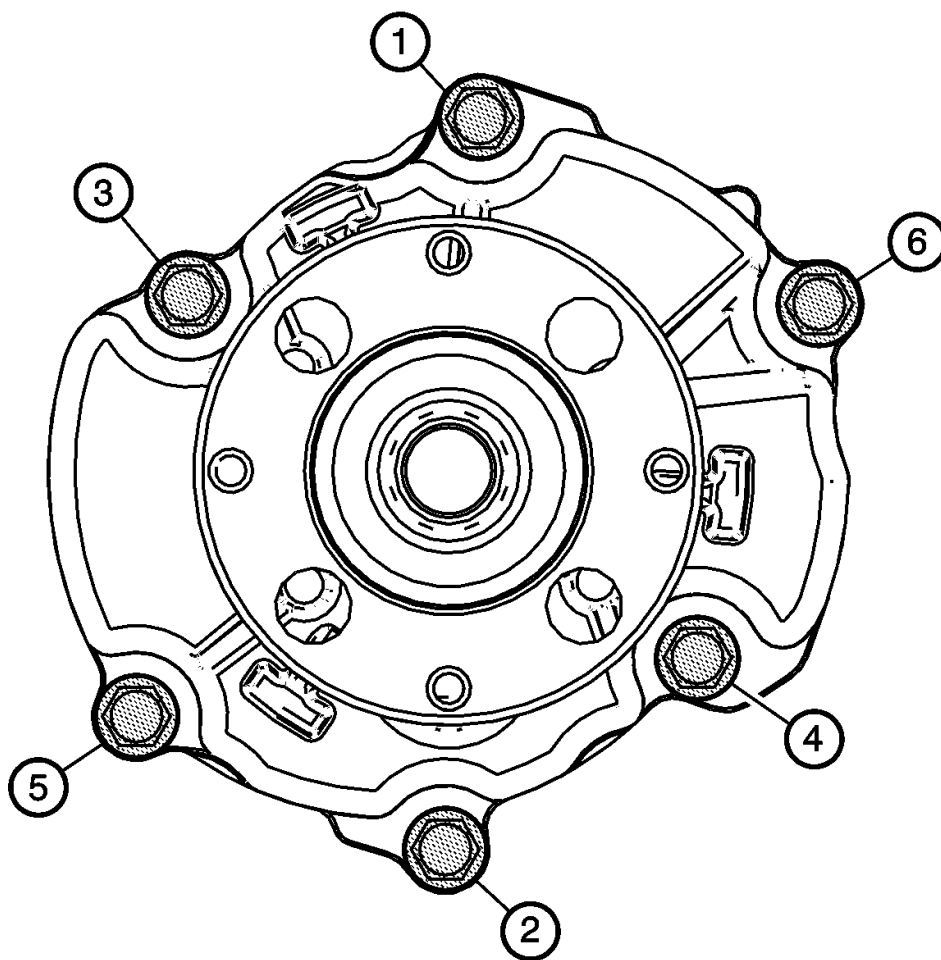


Fig. 662: Water Pump Bolts And Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the NEW water pump bolts.
 1. Tighten the bolts a first pass in the sequence shown to 10 N.m (89 lb in).
 2. Tighten the bolts a second pass in the sequence shown to 10 N.m (89 lb in).
 3. Tighten the bolts a final pass in the sequence shown an additional 45°.

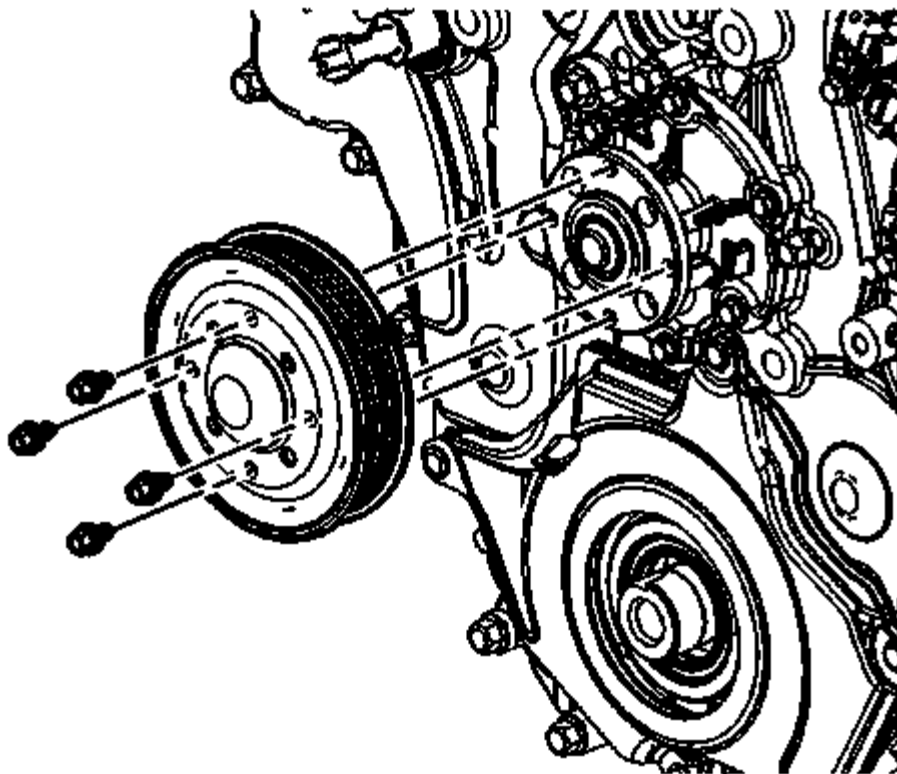


Fig. 663: View Of Water Pump Pulley & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the water pump pulley.
8. Loosely install the water pump pulley bolts.

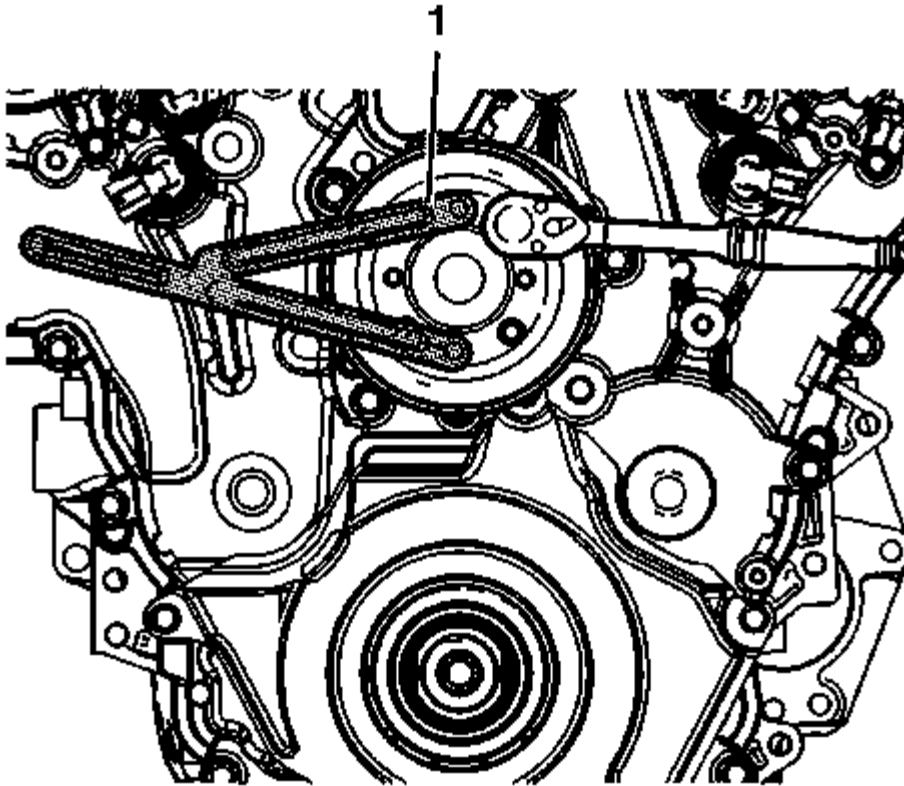


Fig. 664: Identifying Special Tool - EN 46104
 Courtesy of GENERAL MOTORS COMPANY

9. Install the **EN-46104** tool (1) onto the water pump pulley and tighten to 10 N.m (89 lb in).

CAMSHAFT COVER INSTALLATION - LEFT SIDE

Special Tools

- **EN 46101** Spark Plug Tube Seal Guide
- **EN-48383** Camshaft Retaining Tools

For equivalent regional tools, refer to **Special Tools** .

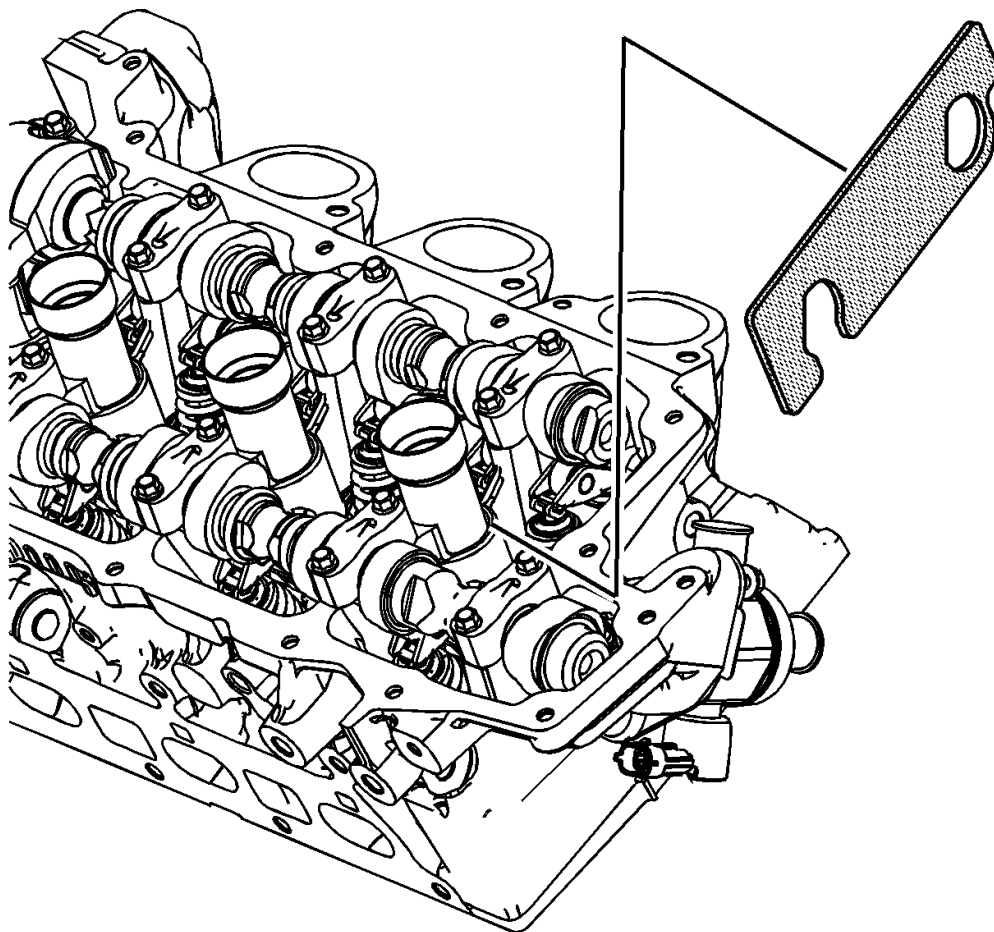


Fig. 665: View Of Special Tool EN 48383-2 & Camshaft
Courtesy of GENERAL MOTORS COMPANY

1. Remove the EN 48383-2 from the rear of the left camshafts.

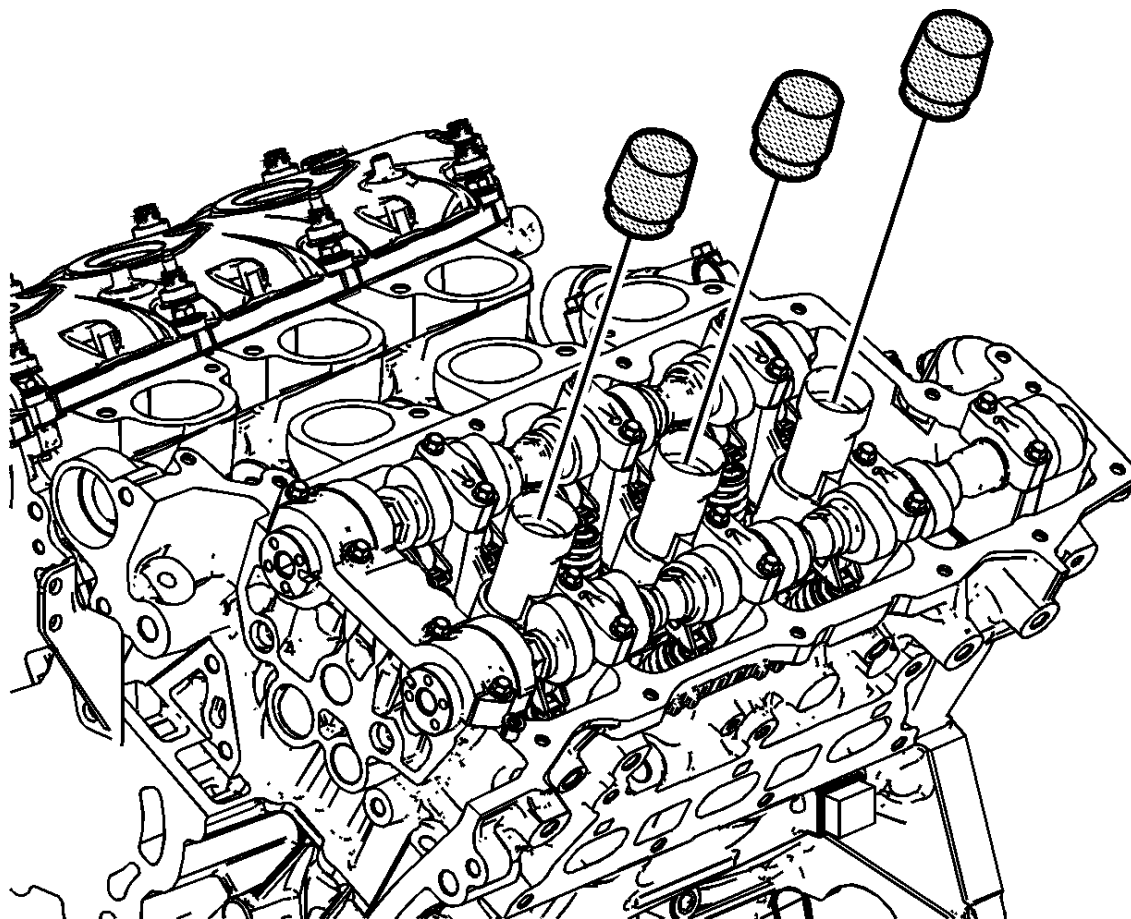


Fig. 666: View Of Spark Plug Tubes & Left Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN 46101** guide onto the spark plug tubes of the left cylinder head.

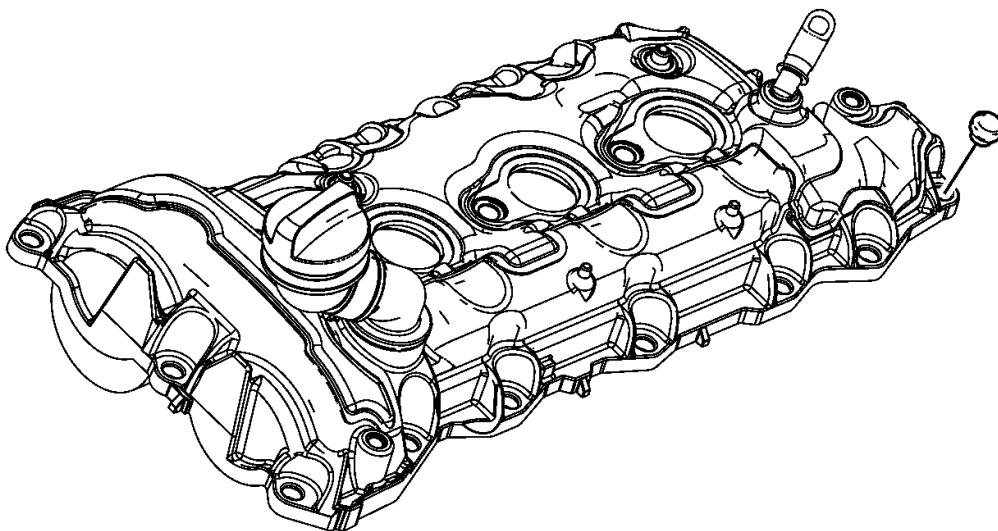


Fig. 667: View of Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.

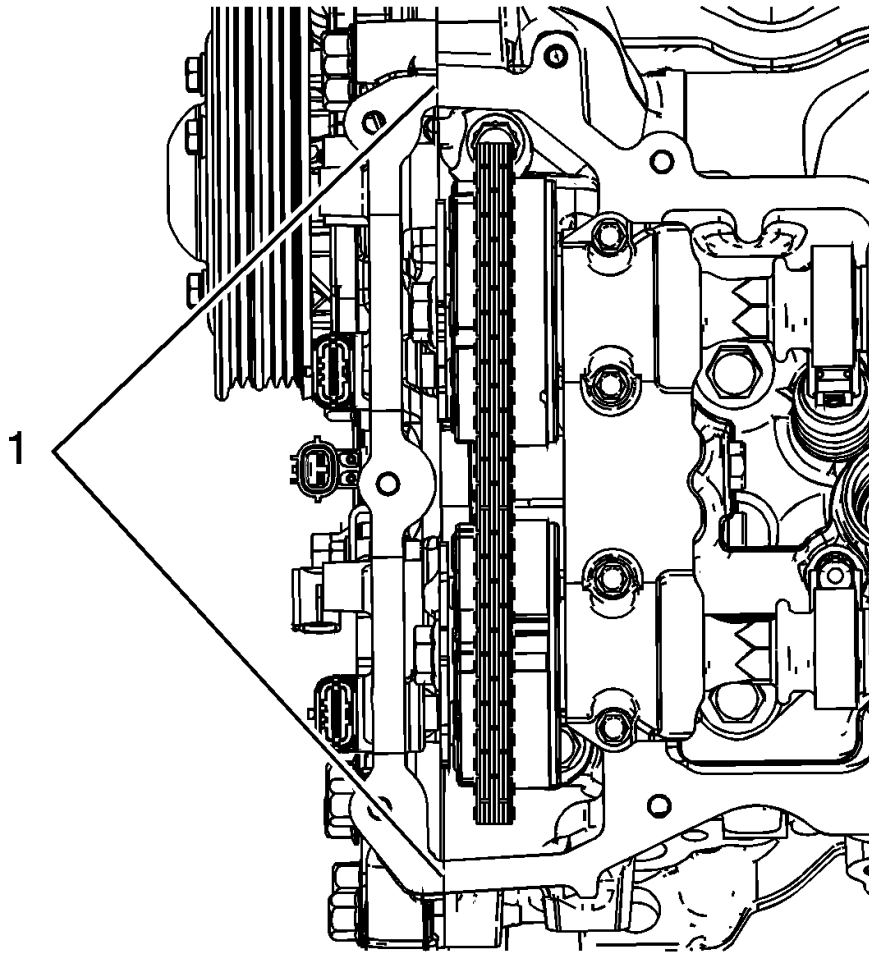


Fig. 668: Locating Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).

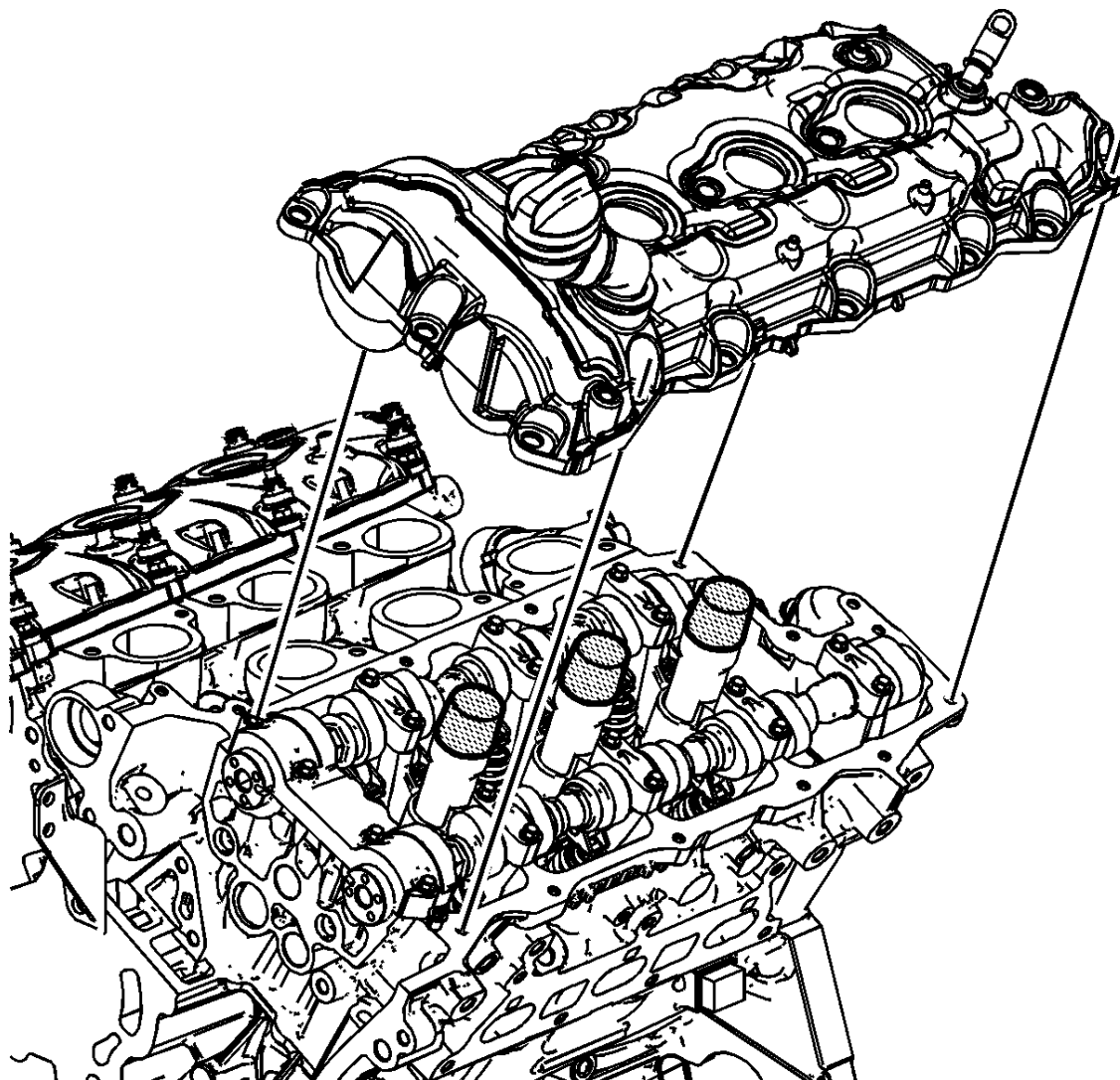


Fig. 669: View of Camshaft Cover & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

6. Place the left camshaft cover into position onto the left cylinder head.

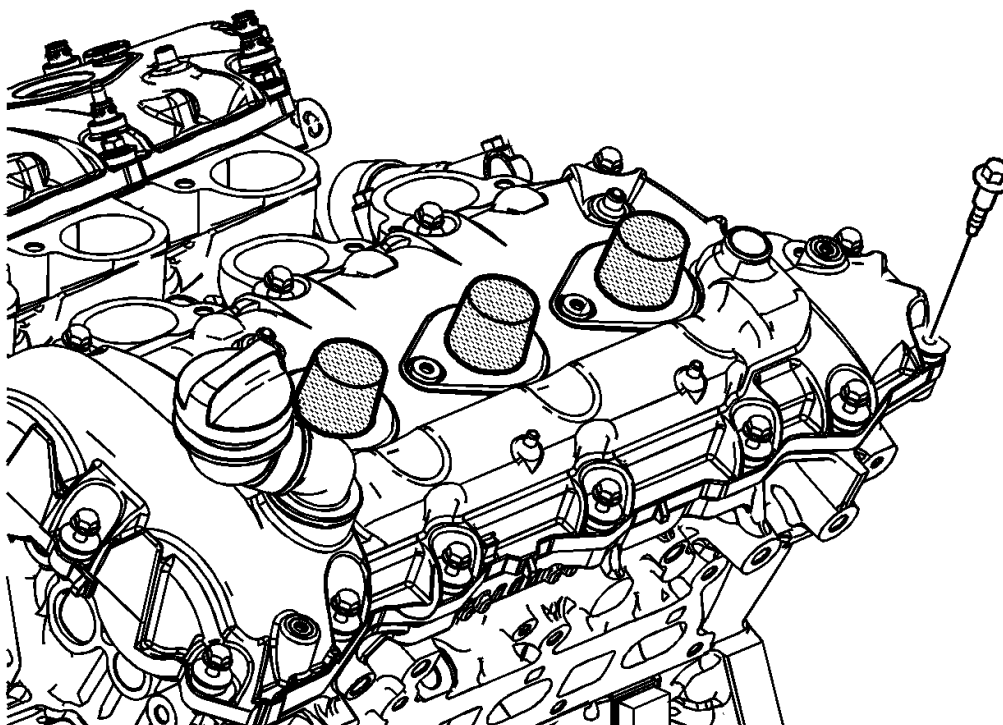


Fig. 670: View of Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosely install the left camshaft cover bolts.

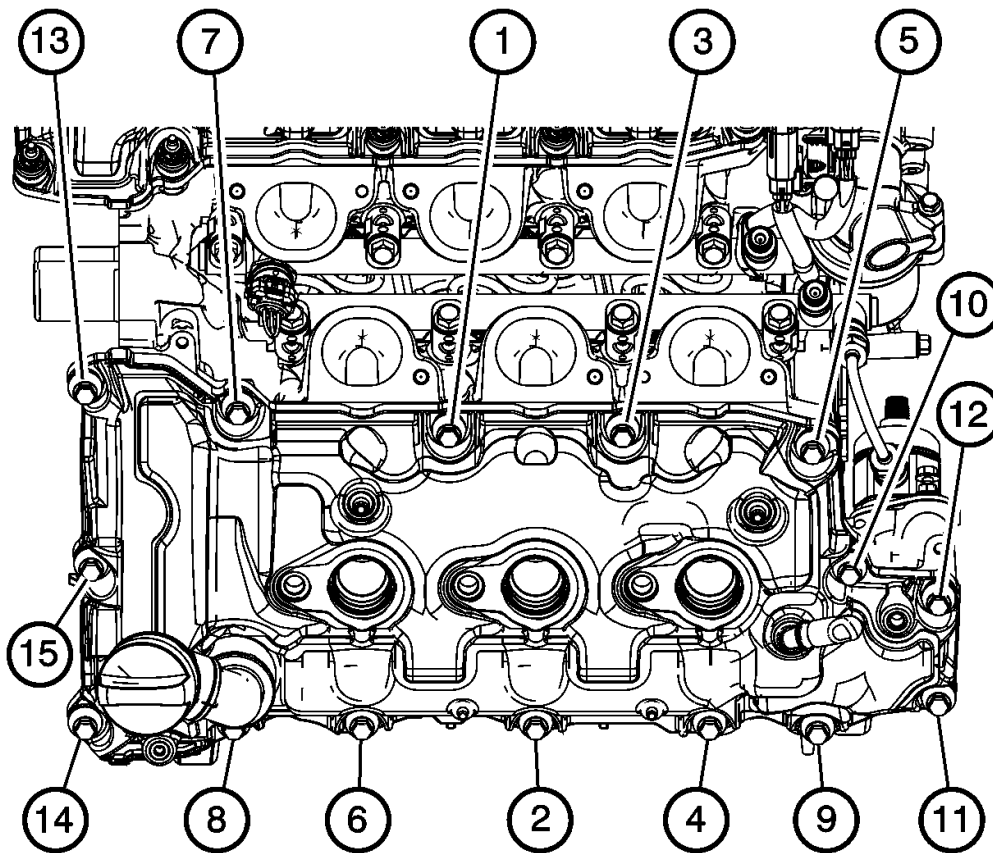


Fig. 671: Identifying Left Camshaft Cover Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the left camshaft cover bolts in the sequence shown.
 1. Tighten the left camshaft cover bolts in the sequence to 10 N.m (89 lb in).
 2. Tighten the left camshaft cover bolts a second pass in the sequence to 10 N.m (89 lb in).

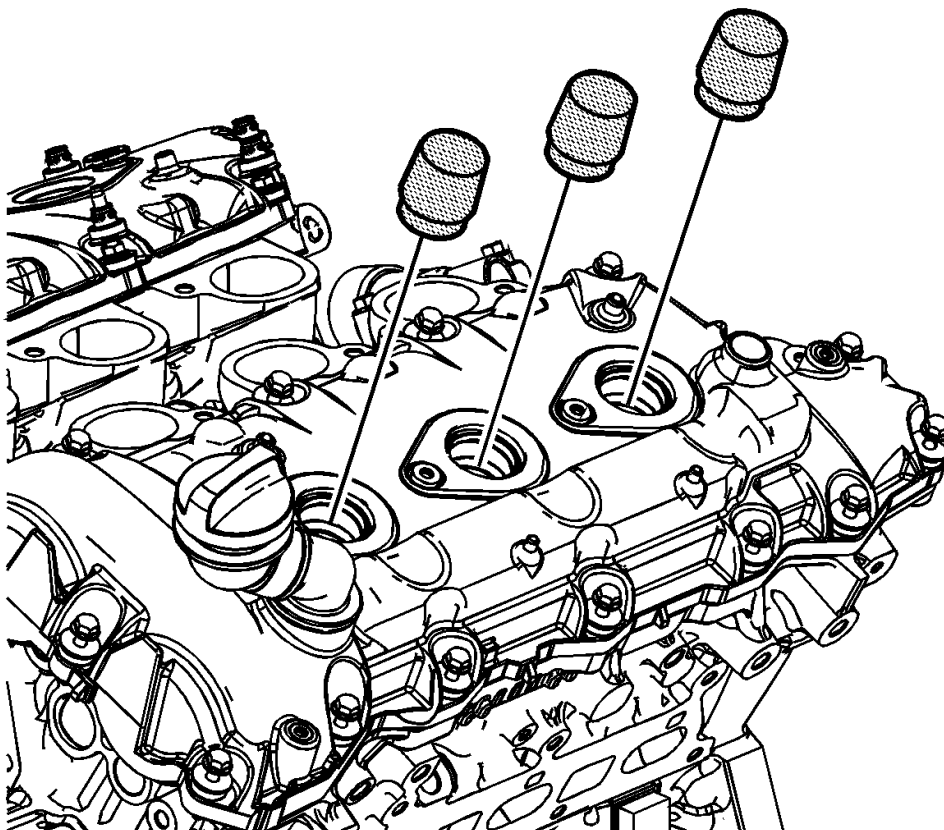


Fig. 672: View of Spark Plug Tubes & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN 46101** guide from the spark plug tubes of the left cylinder head.

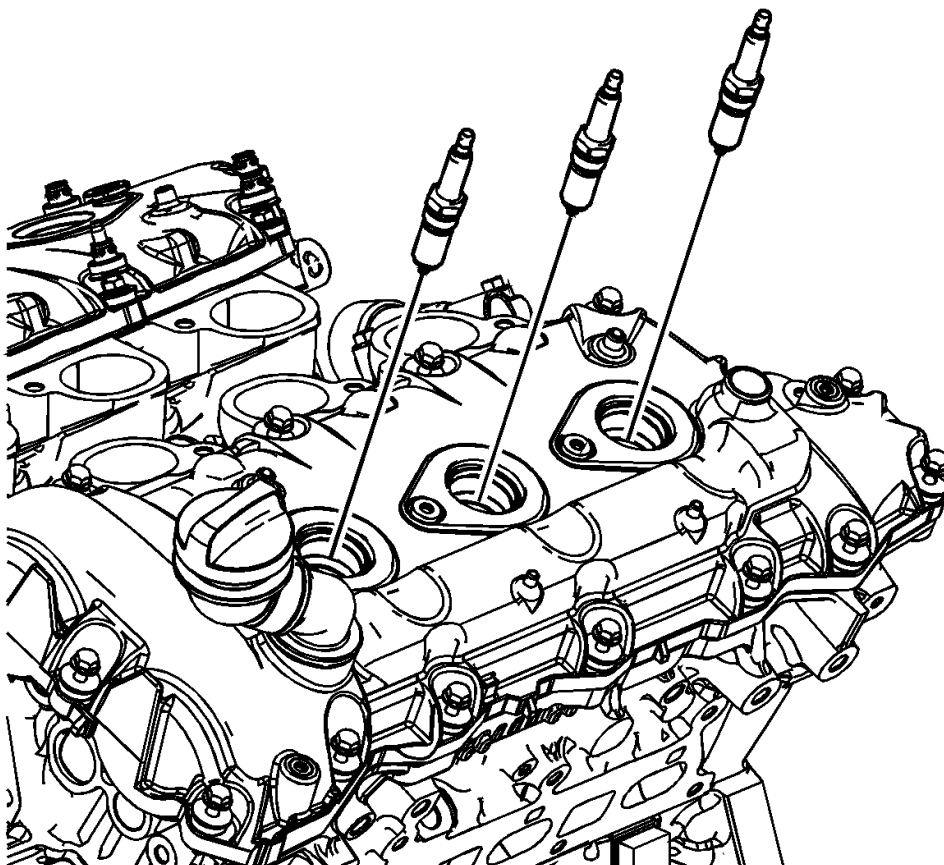


Fig. 673: Identifying Spark Plugs & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

10. Install the NEW spark plugs into the left cylinder head and tighten to 18 N.m (13 lb ft).

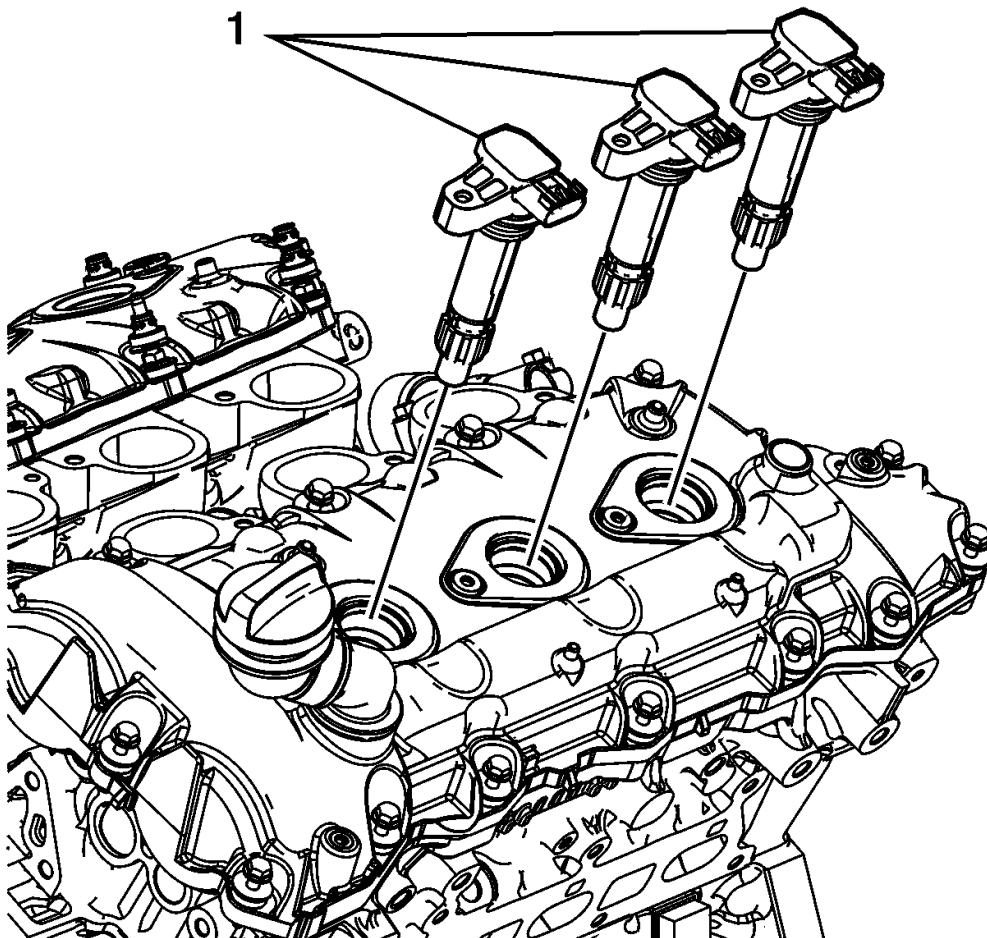


Fig. 674: View of Ignition Coils and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the inside of the ignition coil rubber 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 ignition coil rubber 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.
12. Install the ignition coils.

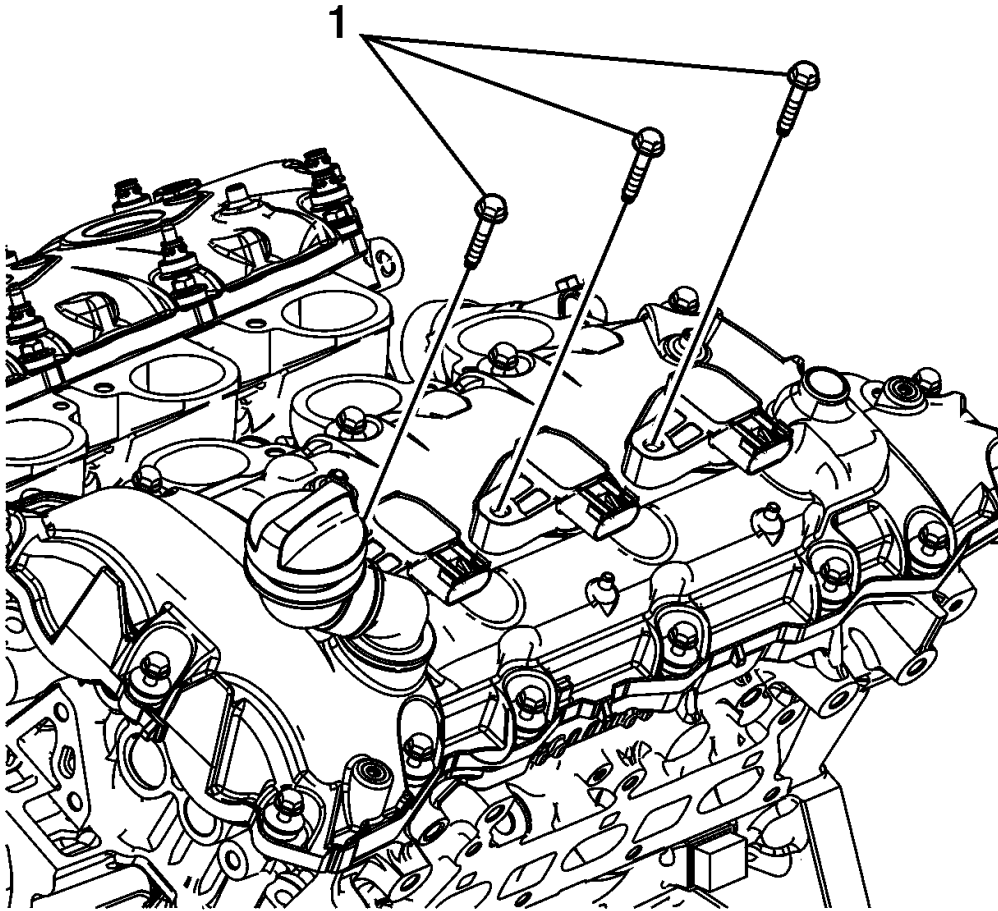


Fig. 675: View of Ignition Coil Bolts and Cylinder Heads
 Courtesy of GENERAL MOTORS COMPANY

13. Install the ignition coil bolts and tighten to 10 N.m (89 lb in).

CAMSHAFT COVER INSTALLATION - RIGHT SIDE

Special Tools

- EN 46101 Spark Plug Tube Seal Guide
- EN-48383 Camshaft Retaining Tools

For equivalent regional tools, refer to **Special Tools** .

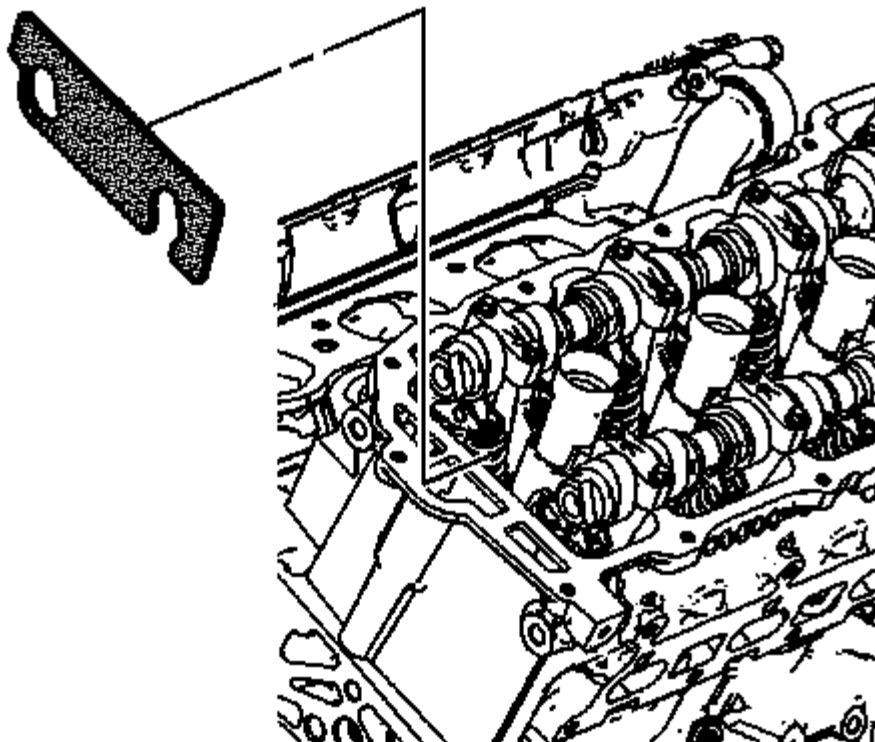


Fig. 676: Identifying Special Tool EN 48383-3
Courtesy of GENERAL MOTORS COMPANY

1. Remove the EN 48383-3 from the rear of the right camshafts.

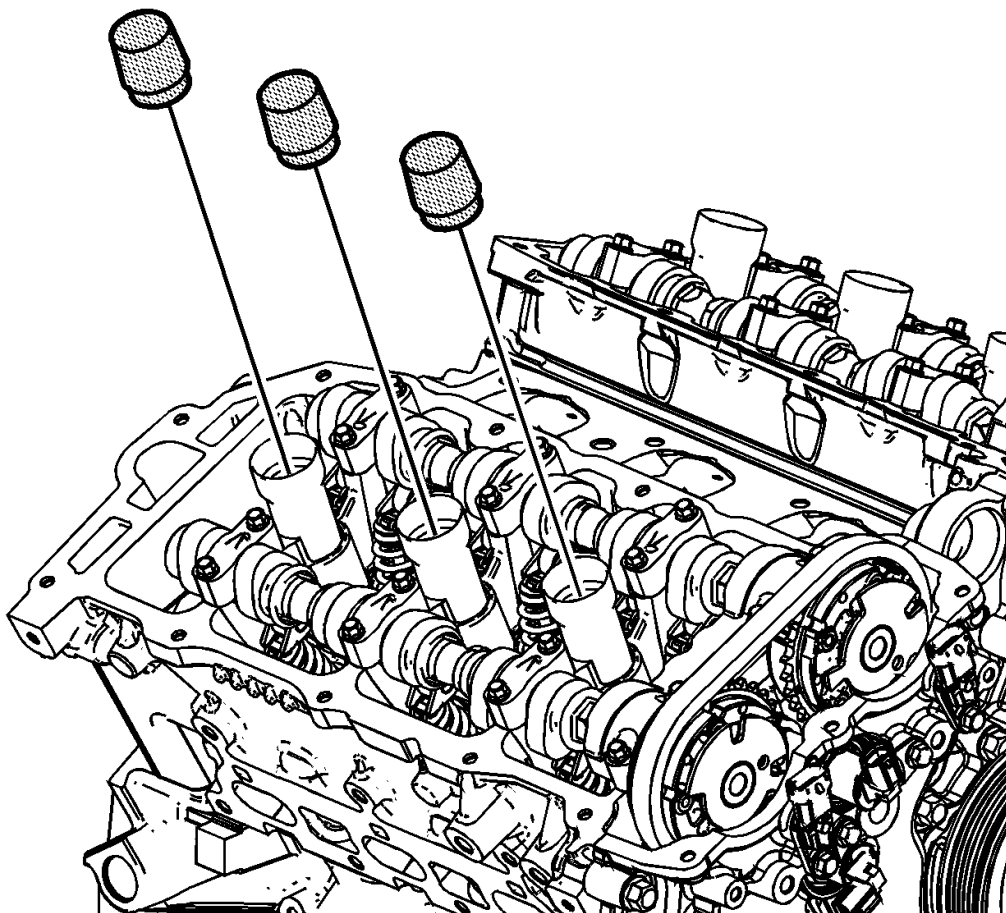


Fig. 677: Identifying Spark Plug Tubes
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN 46101** guide onto the spark plug tubes of the right cylinder head.

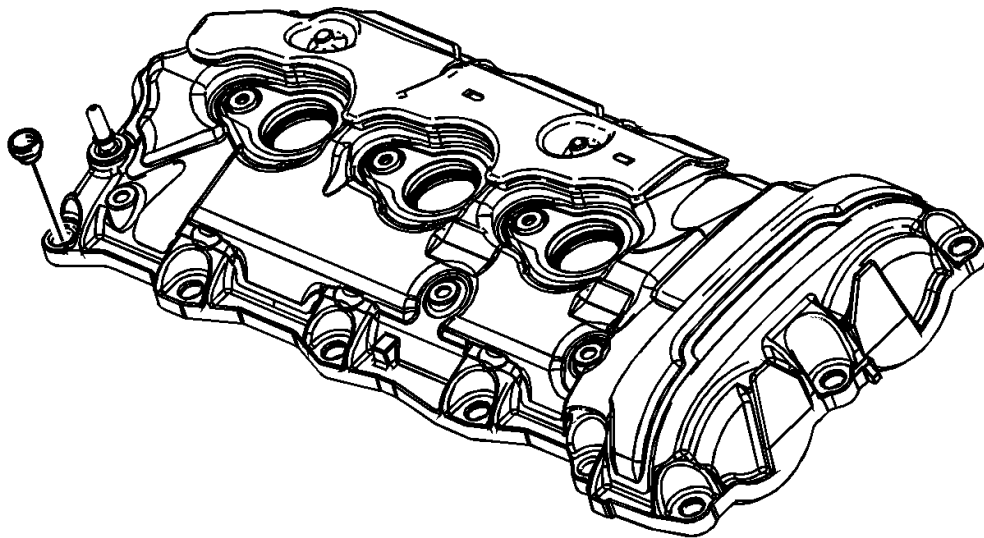


Fig. 678: View Of Right Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the right cylinder head with a clean, lint-free cloth.

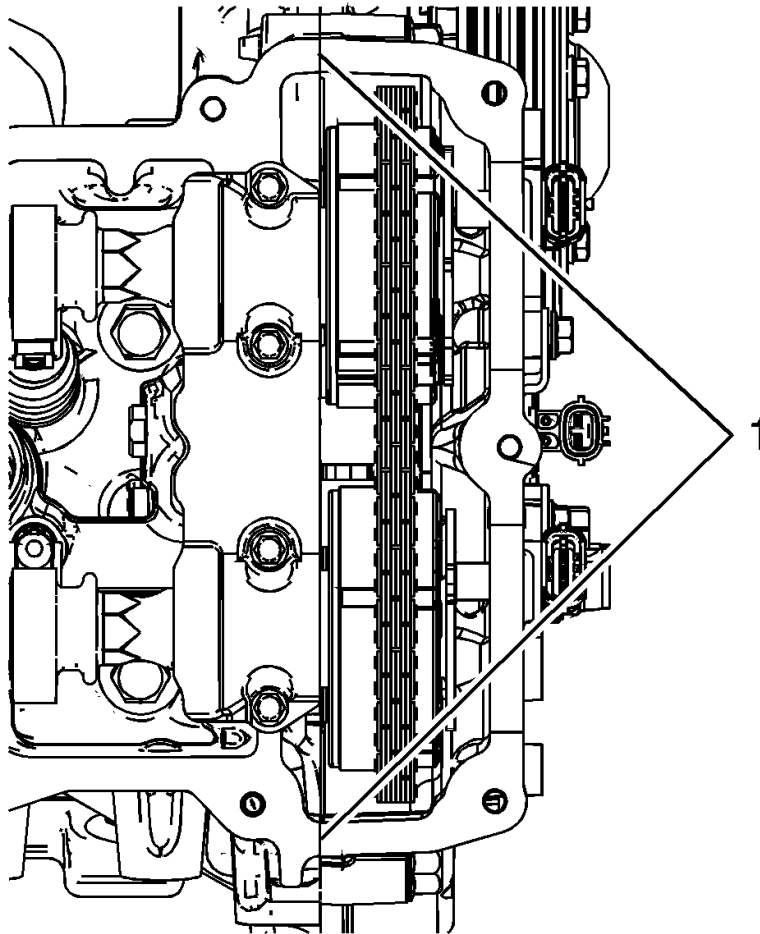


Fig. 679: Identifying Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).

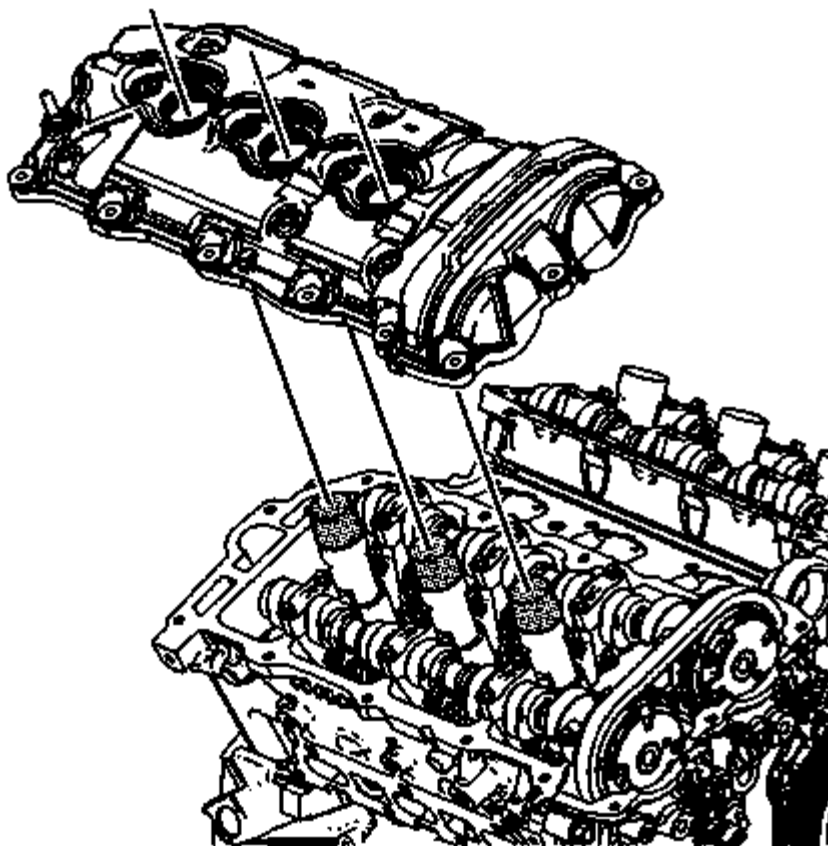


Fig. 680: Identifying Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

6. Place the right camshaft cover into position onto the right cylinder head.

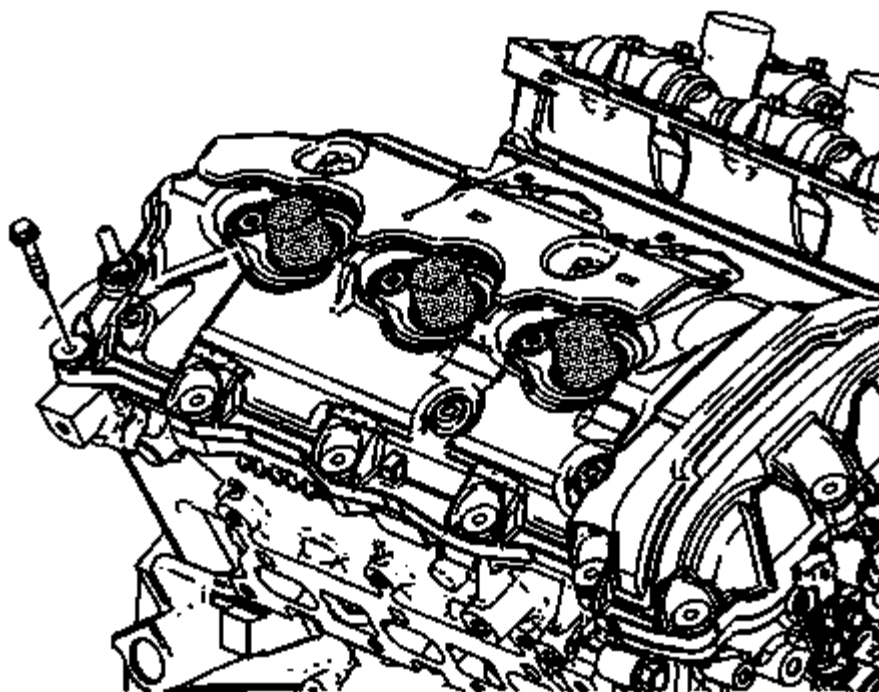


Fig. 681: View Of Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosely install the right camshaft cover bolts.

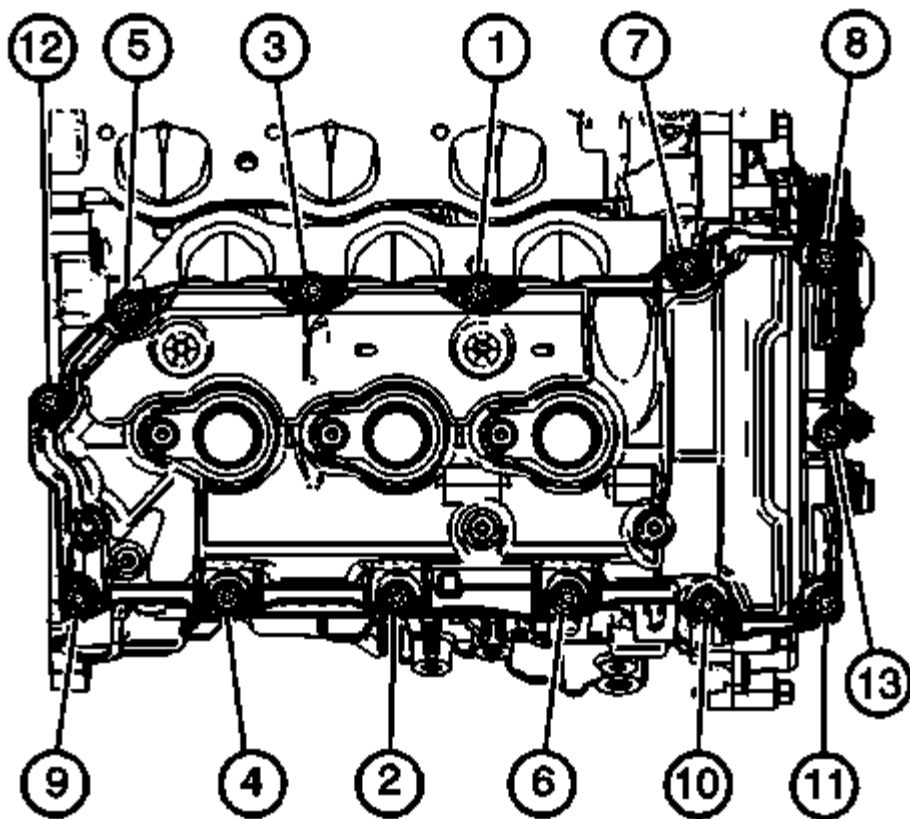


Fig. 682: Identifying Right Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the right camshaft cover bolts in the sequence shown.
 1. Tighten the right camshaft cover bolts in sequence to 10 N.m (89 lb in).
 2. Tighten the right camshaft cover bolts a second pass in sequence to 10 N.m (89 lb in).

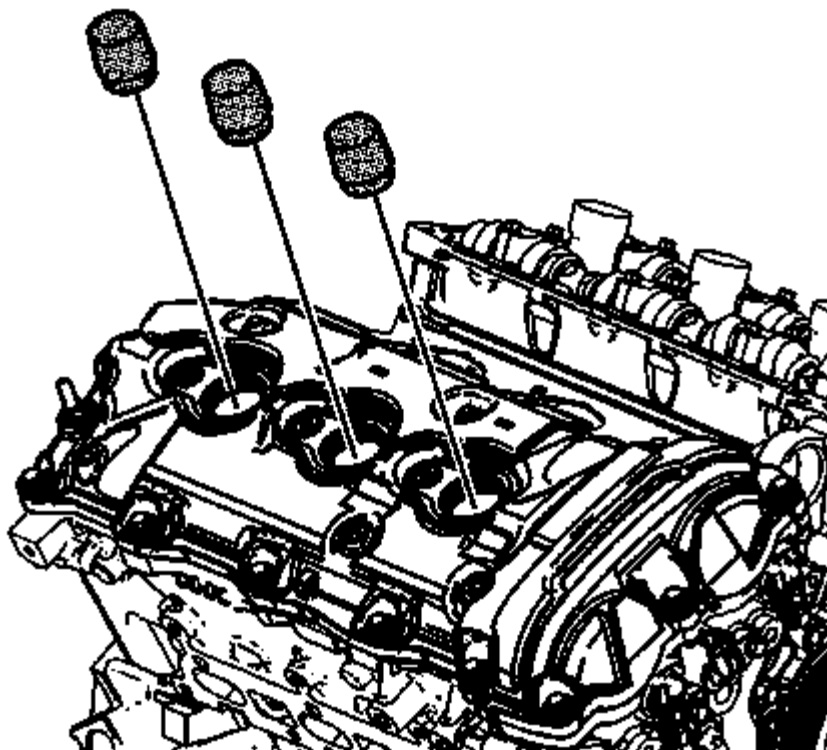


Fig. 683: View Of Spark Plug Tubes On Right Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN 46101** guide from the spark plug tubes of the right cylinder head.

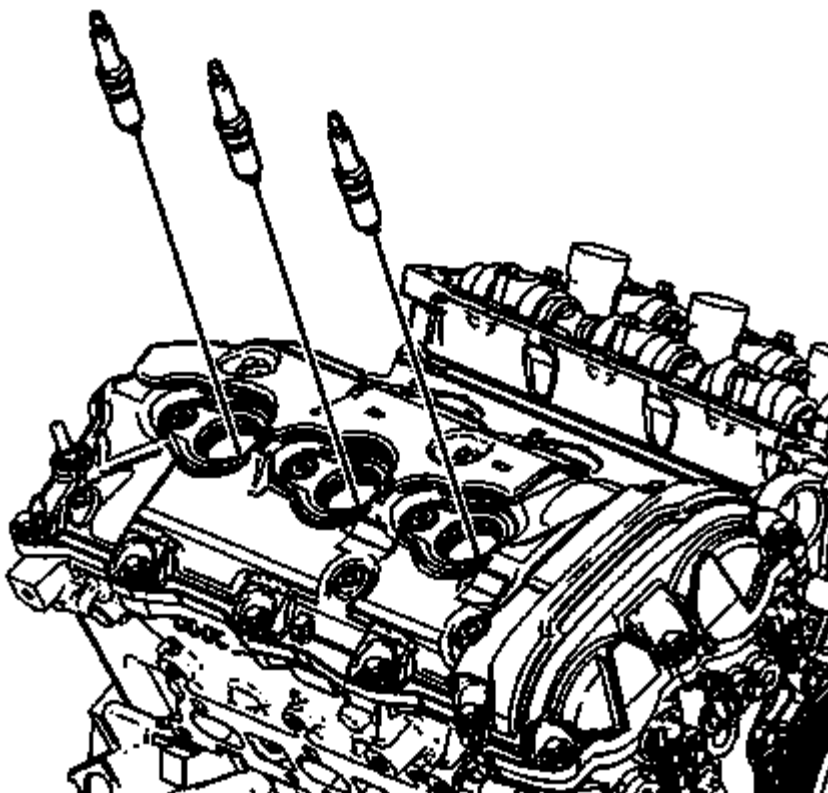


Fig. 684: View Of Spark Plugs In Right Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

10. Install the NEW spark plugs into the right cylinder head and tighten to 18 N.m (13 lb ft).

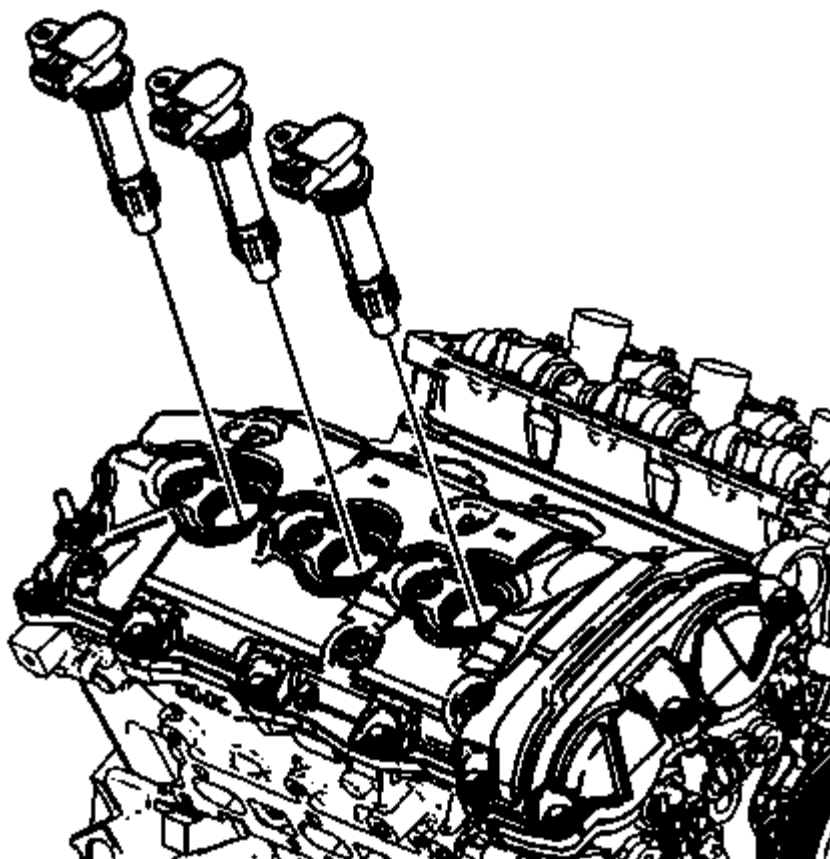


Fig. 685: View Of Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

11. Inspect the inside of the ignition coil rubber 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 ignition coil rubber 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.
12. Install the ignition coils.

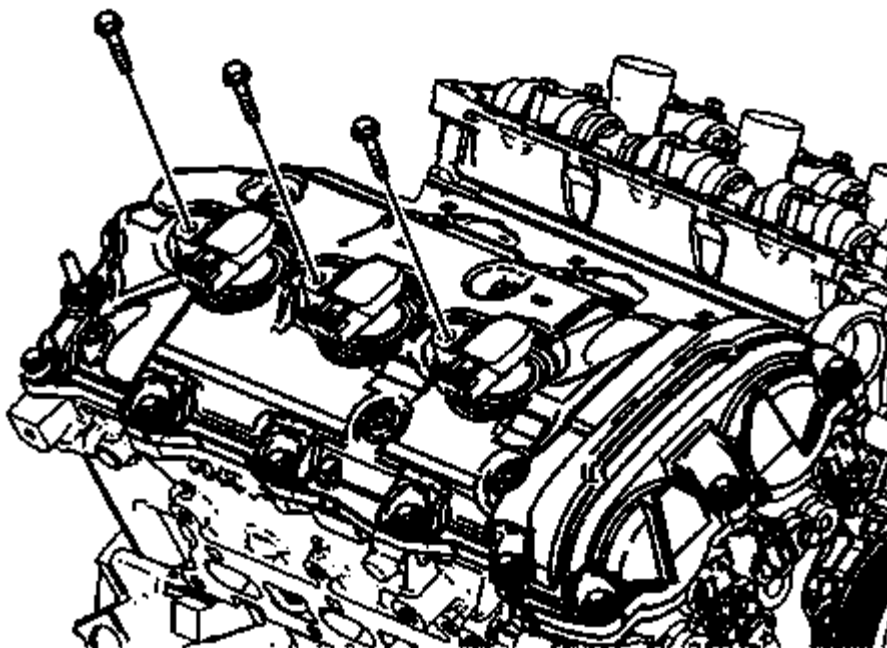


Fig. 686: View Of Ignition Coil Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the ignition coil bolts and tighten to 10 N.m (89 lb in).

INTAKE MANIFOLD INSTALLATION

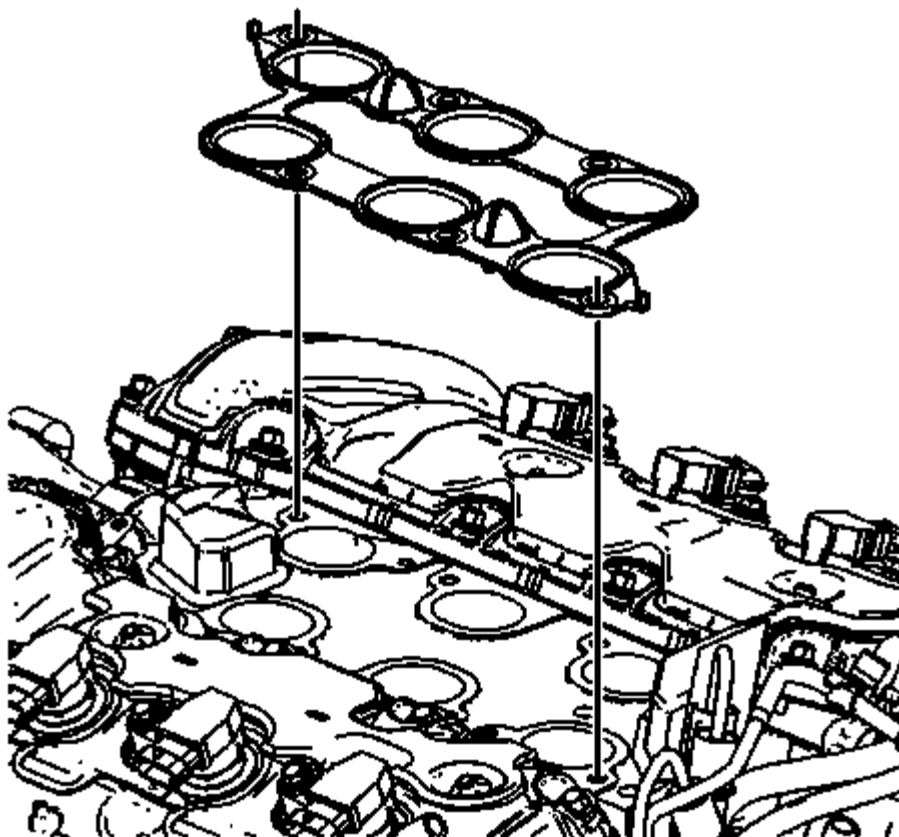


Fig. 687: View Of Lower Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW intake manifold gasket.

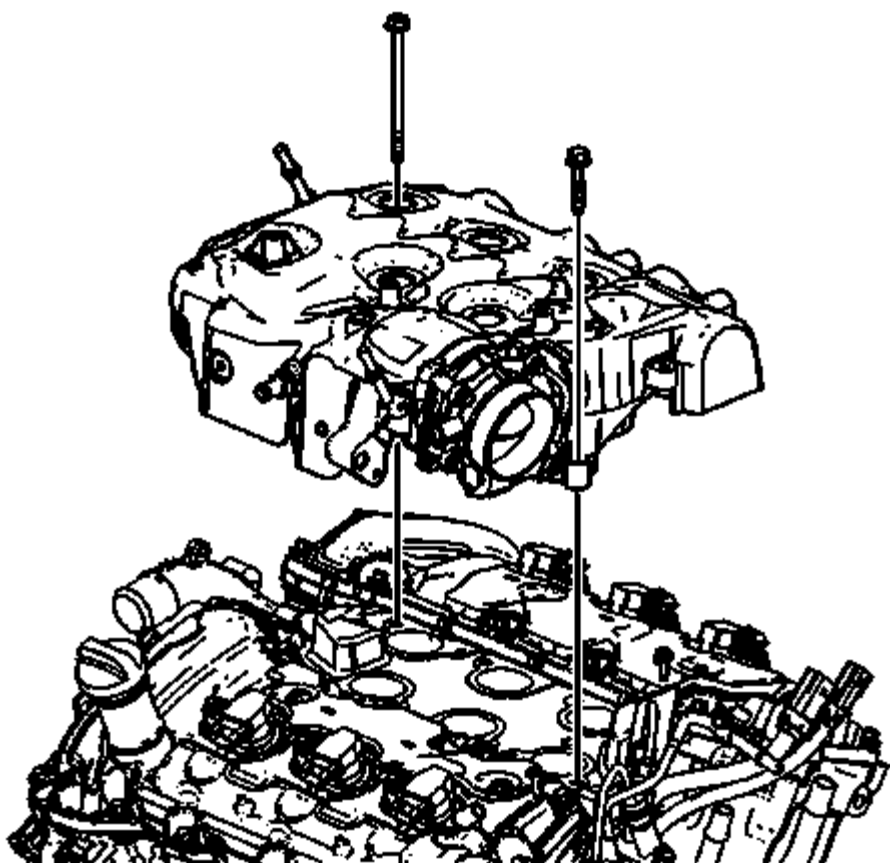


Fig. 688: View Of Intake Manifold & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold assembly.
3. Install the intake manifold bolts.

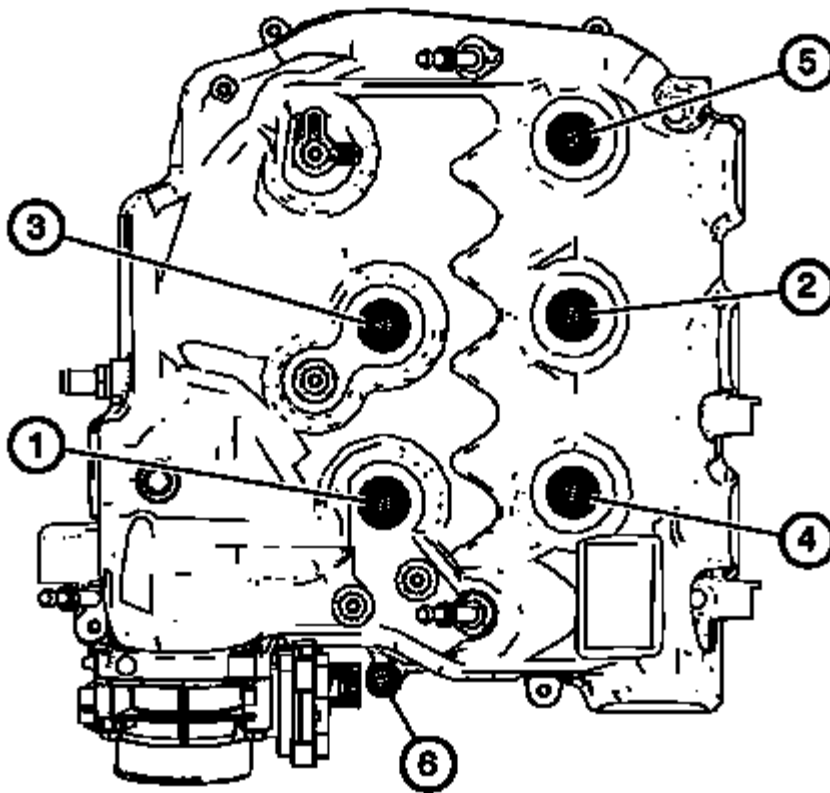


Fig. 689: Identifying Intake Manifold Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the intake manifold bolts in the sequence shown.
5. Tighten the intake manifold bolts in sequence to 25 N.m (18 lb ft).
6. Tighten the intake manifold bolts a second pass in sequence to 25 N.m (18 lb ft).

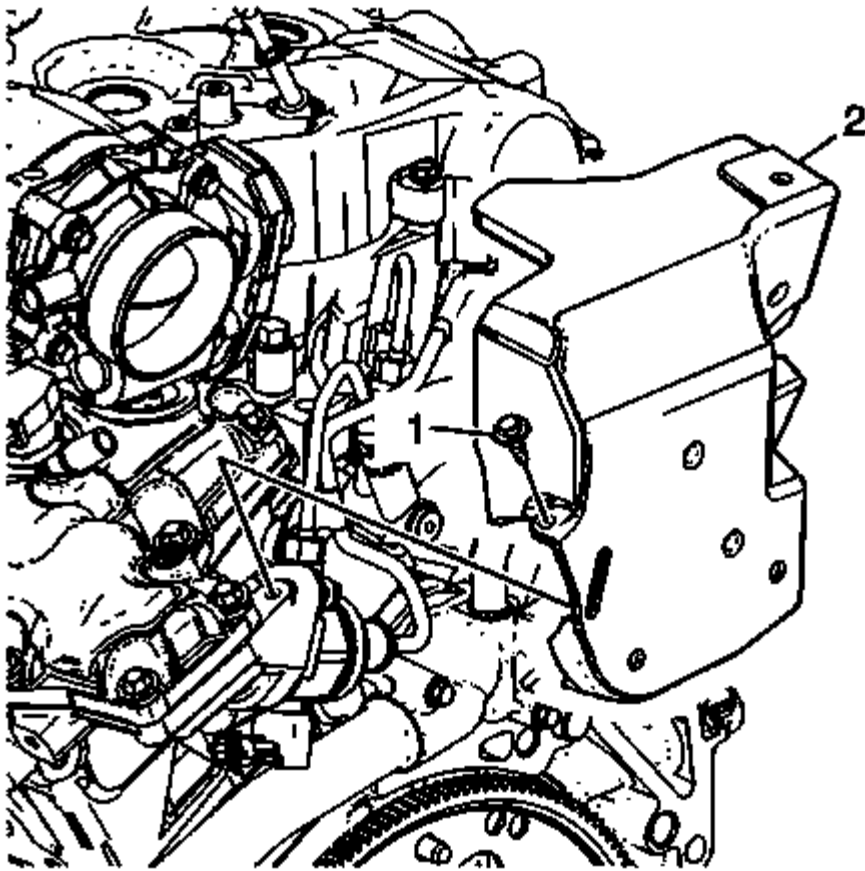


Fig. 690: Identifying Fuel Pump Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the fuel pump cover (2).
8. Install the fuel pump cover bolt (1) and tighten to 10 N.m (89 lb in).

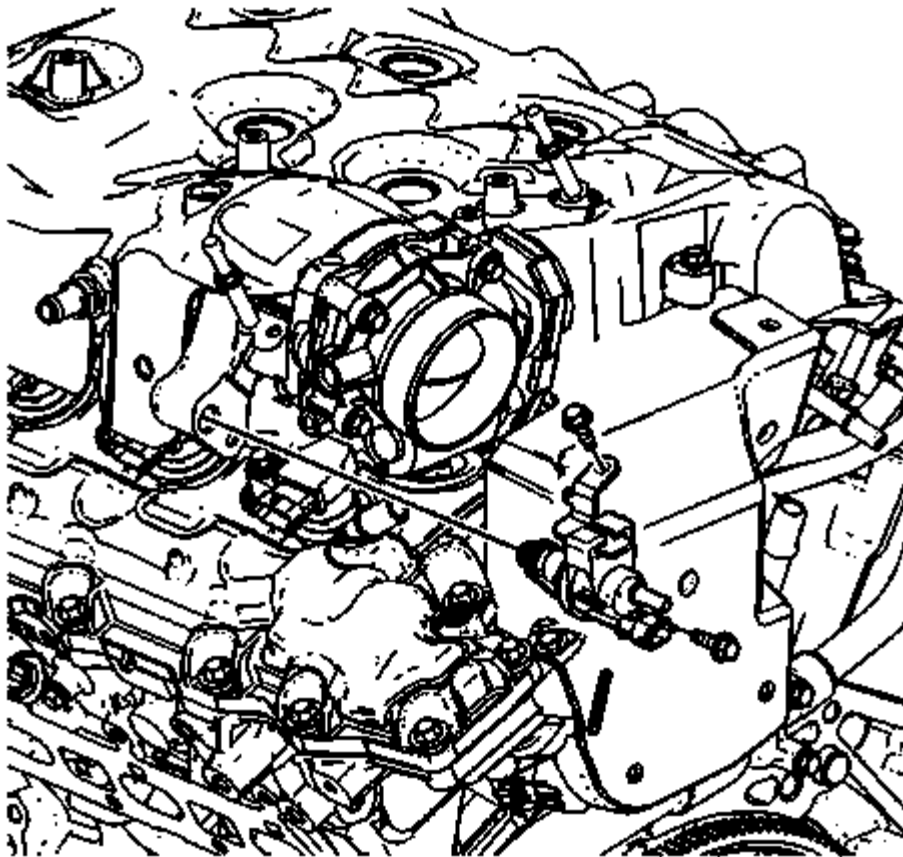


Fig. 691: Identifying EVAP Solenoid & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the evaporative (EVAP) solenoid.
10. Install the EVAP solenoid bolts and tighten to 10 N.m (89 lb in).

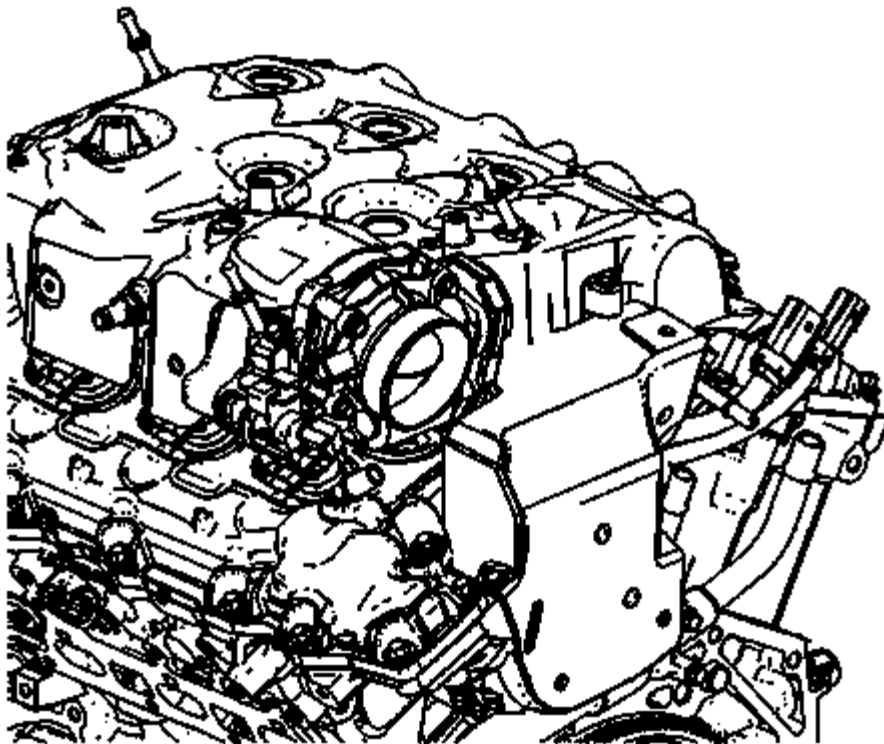


Fig. 692: View Of Evaporative (EVAP) Hose
Courtesy of GENERAL MOTORS COMPANY

11. Connect the EVAP hose to the upper intake manifold and EVAP solenoid.

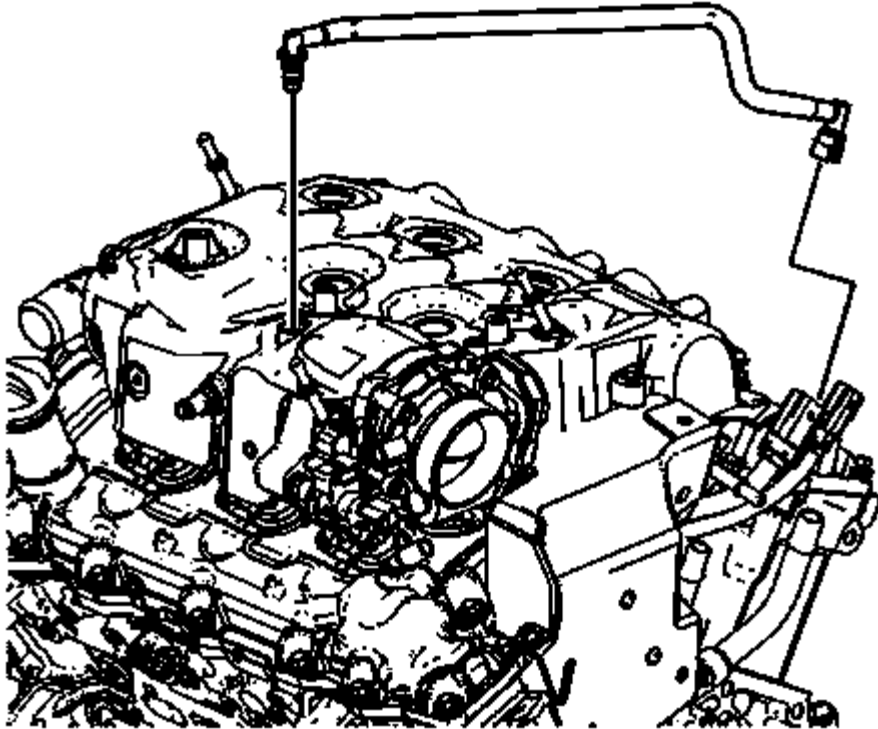


Fig. 693: View Of Positive Crankcase Ventilation (PCV) Tube
Courtesy of GENERAL MOTORS COMPANY

12. Connect the positive crankcase ventilation (PCV) tube assembly to the upper intake manifold and the right camshaft cover.

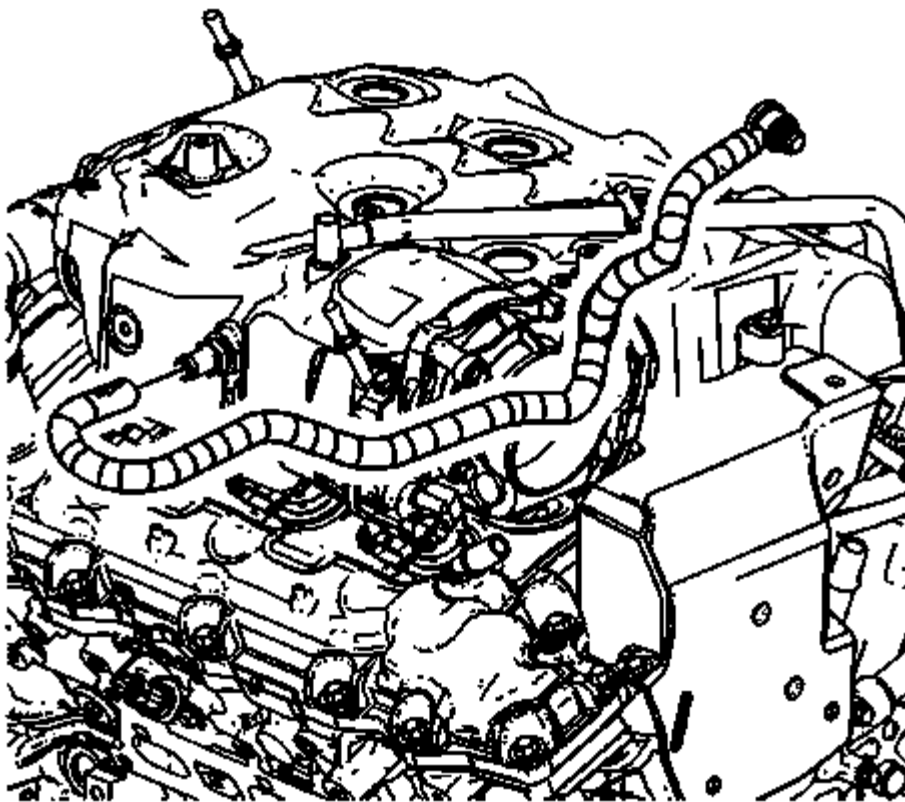


Fig. 694: View Of Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

13. Install the brake booster hose to the upper intake manifold.

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

- **EN 45059** Angle Meter
- **EN 46106** Engine Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

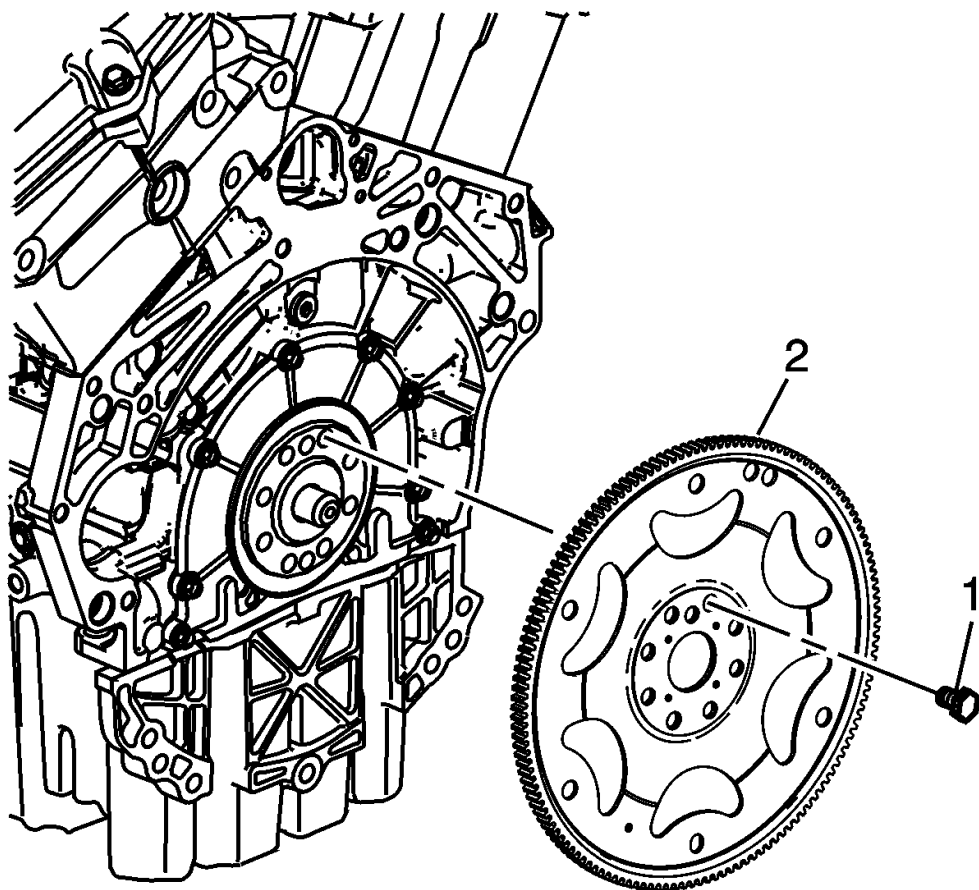


Fig. 695: View Of Engine Flywheel Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Place the flex plate (2) in position on the crankshaft.
2. Install 2 NEW bolts (1) in location at the top and bottom of the flex plate bolt pattern allowing the flex plate (2) to hang in position.

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.

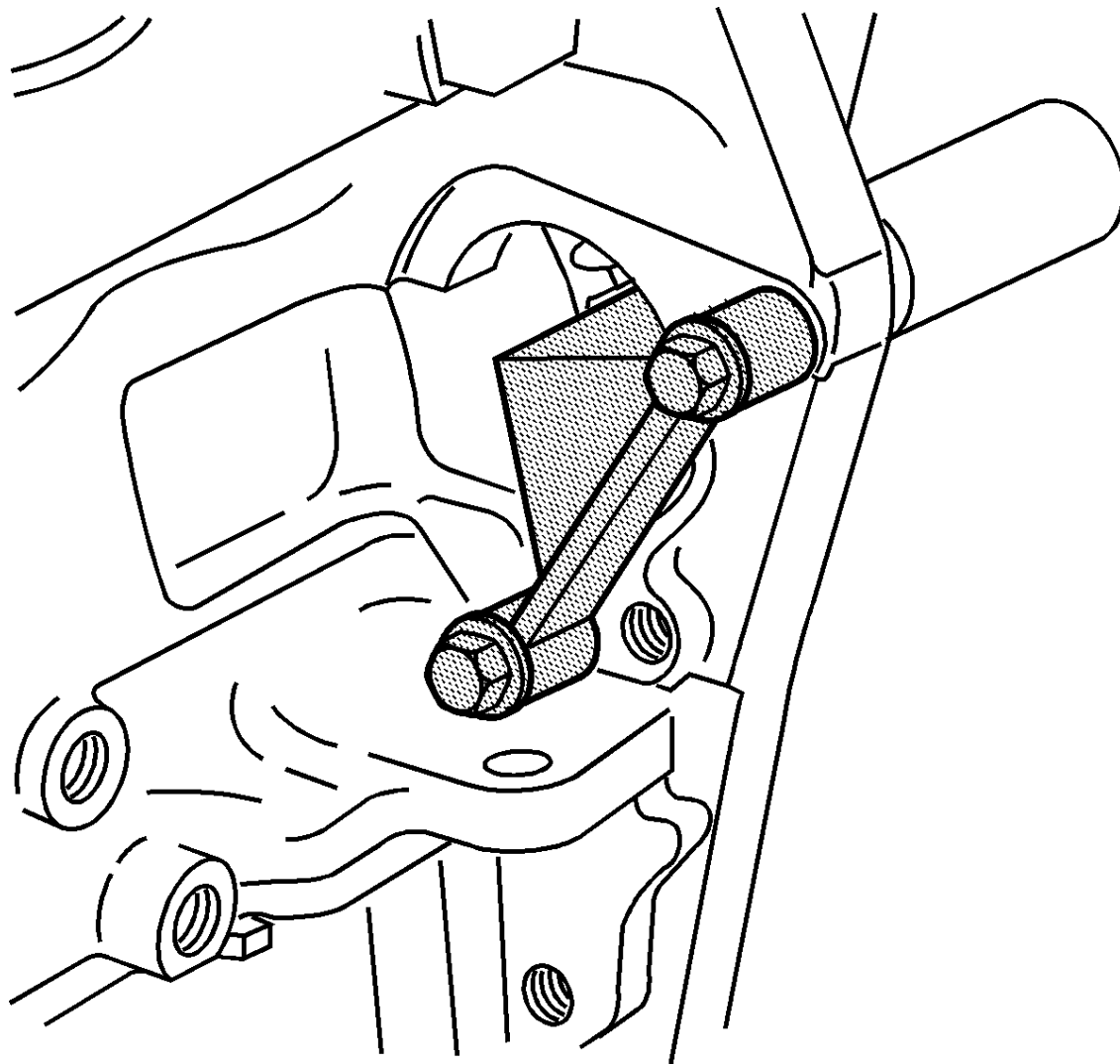


Fig. 696: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN 46106** tool.

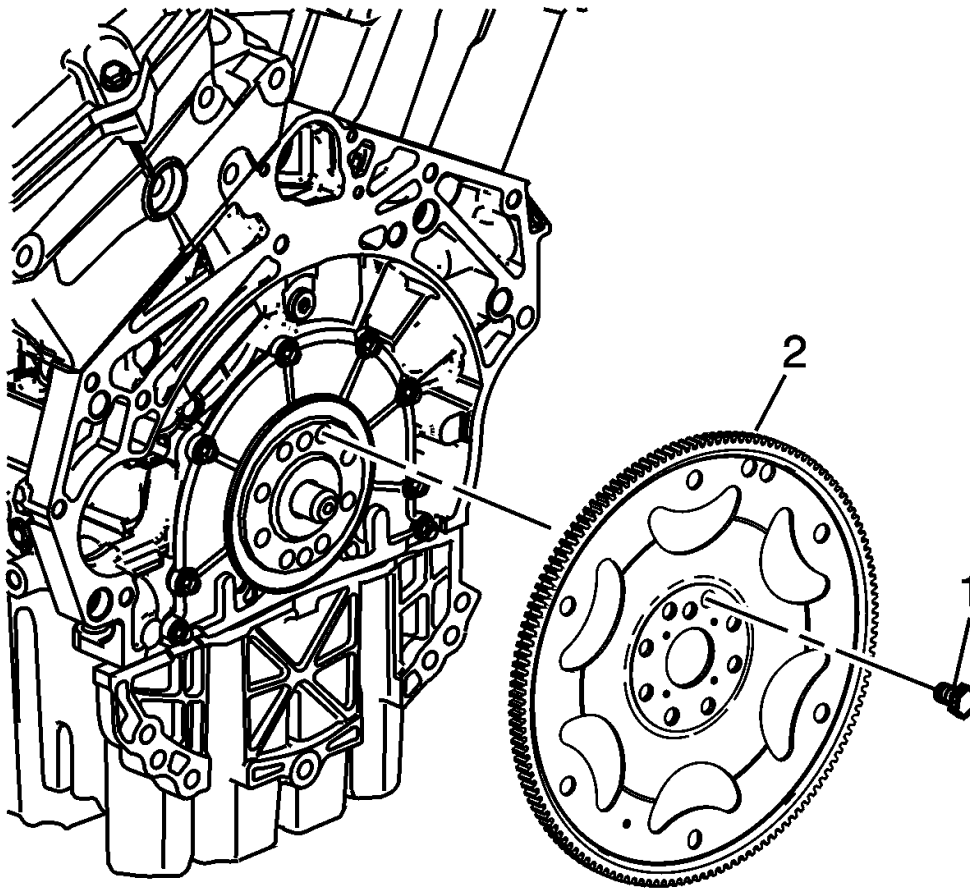


Fig. 697: View Of Engine Flywheel Bolts
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the remaining NEW flex plate bolts (1).
 1. Tighten the NEW flex plate bolts (1) to 30 N.m (22 lb ft).
 2. Tighten the NEW flex plate bolts (1) an additional 75° using the **EN 45059** meter.

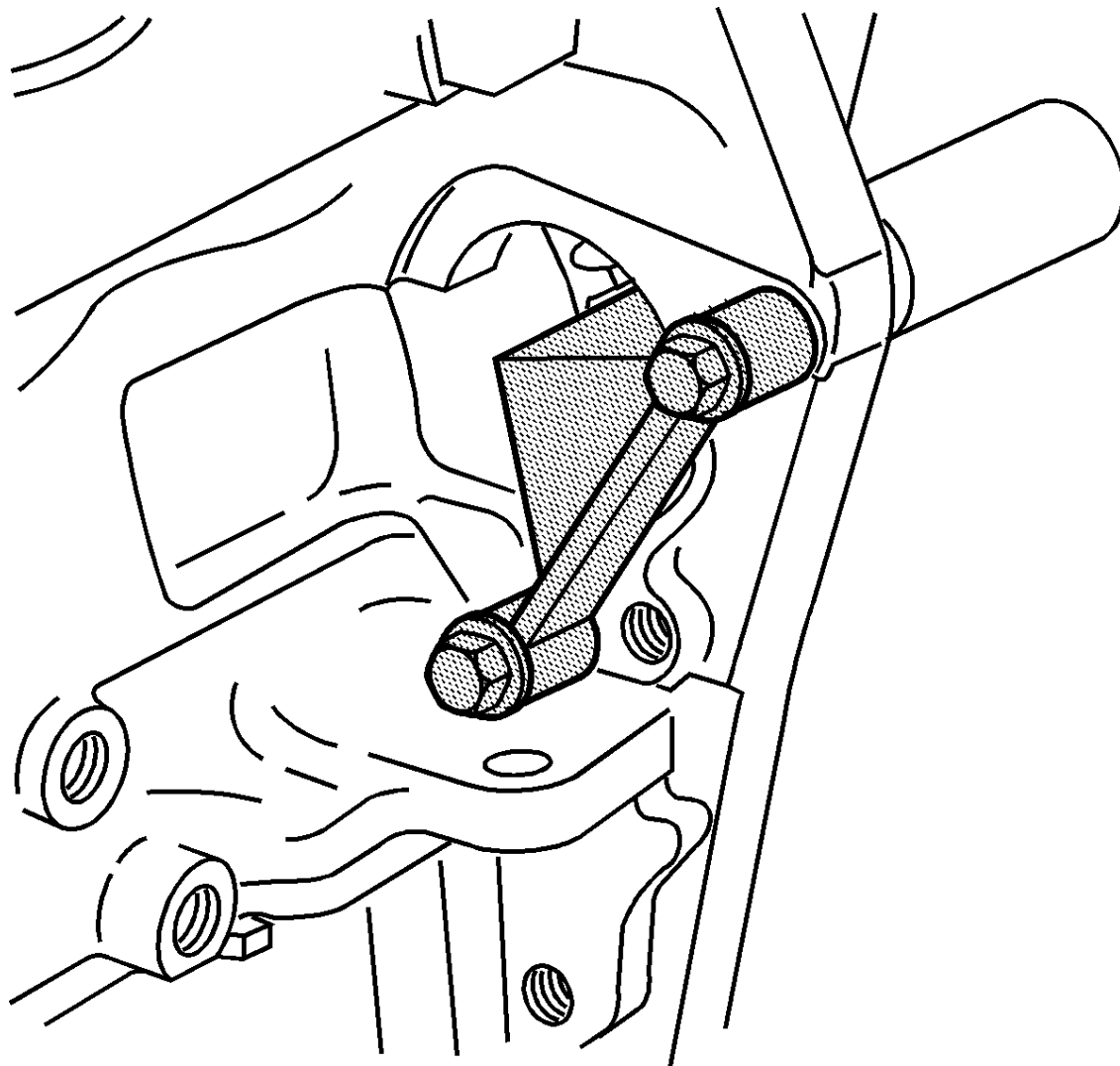


Fig. 698: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN 46106** tool.

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **EN-46106** Engine Flywheel Holding Tool
- **J-41998-B** Crankshaft Balancer Installer
- **J-45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

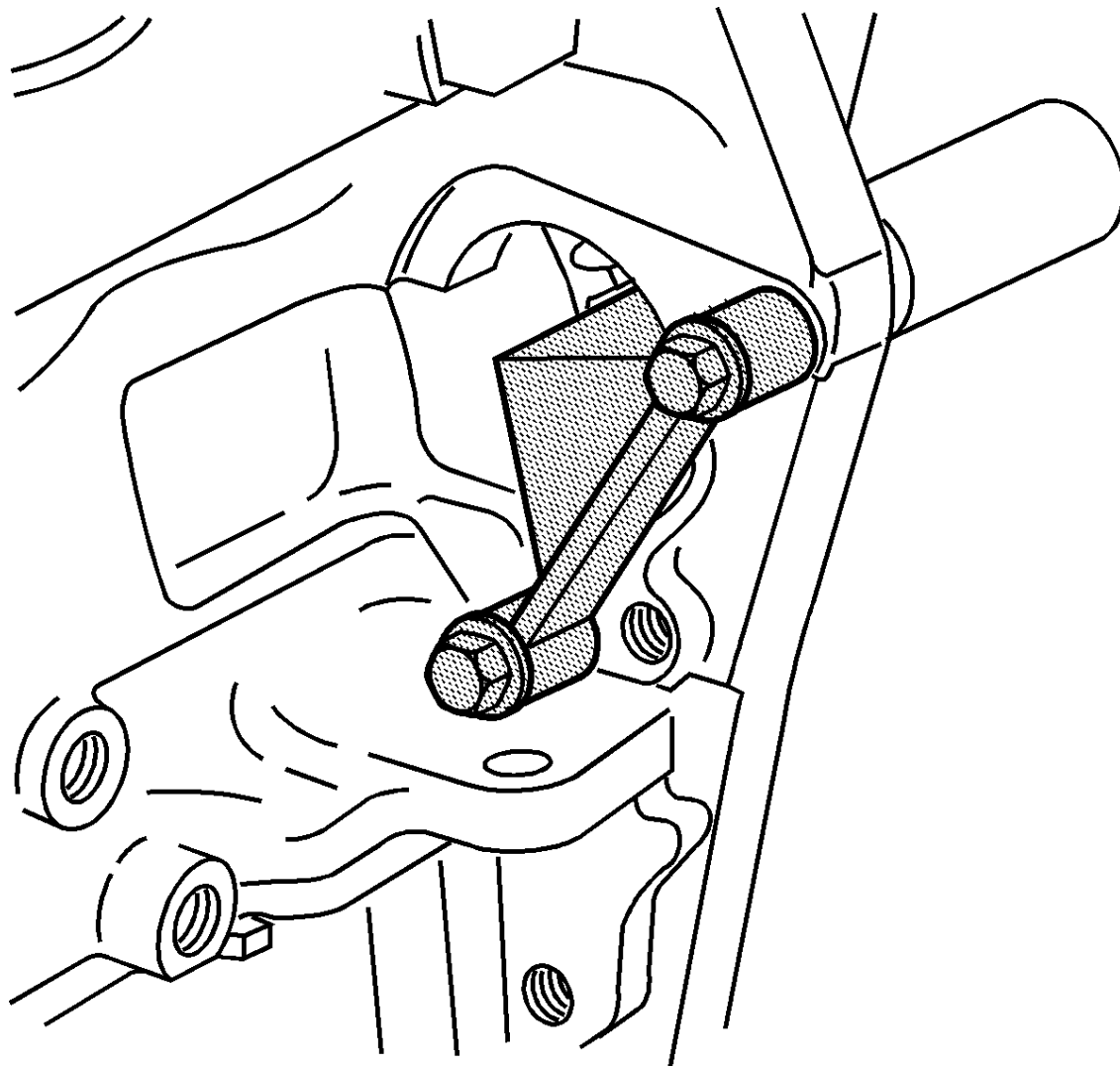


Fig. 699: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

1. The **EN-46106** tool must be installed onto the flywheel.
2. Use the **J-41998-B** installer, nut, bearing and washer to install the crankshaft balancer.

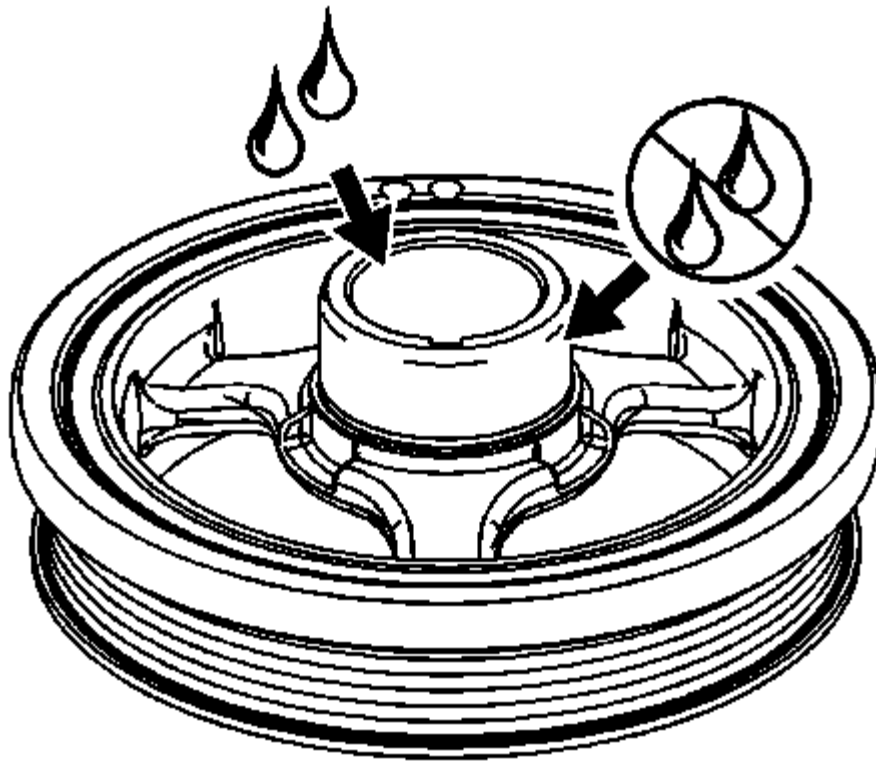


Fig. 700: Lubricating Inside Of Crankshaft Balancer Hub Bore
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

3. Apply lubricant to the inside of the crankshaft balancer hub bore.

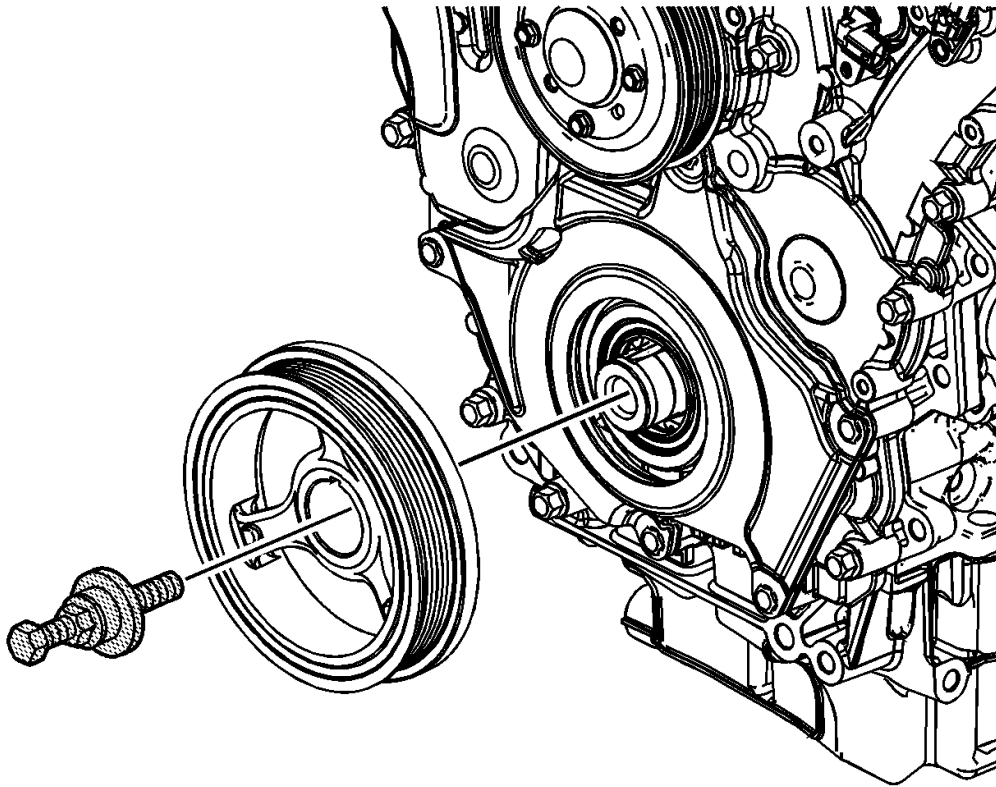


Fig. 701: View Of Crankshaft Balancer & Bolt
 Courtesy of GENERAL MOTORS COMPANY

4. Place the crankshaft balancer in position on the crankshaft.
5. Thread the **J-41998-B** installer in the crankshaft. Ensure you engage at least 10 threads of the **J-41998-B** installer before pressing the crankshaft balancer in place.
6. Push the crankshaft balancer into position by tightening the nut on the **J-41998-B** installer until the large washer bottoms out on the crankshaft end.
7. Remove the **J-41998-B** installer.

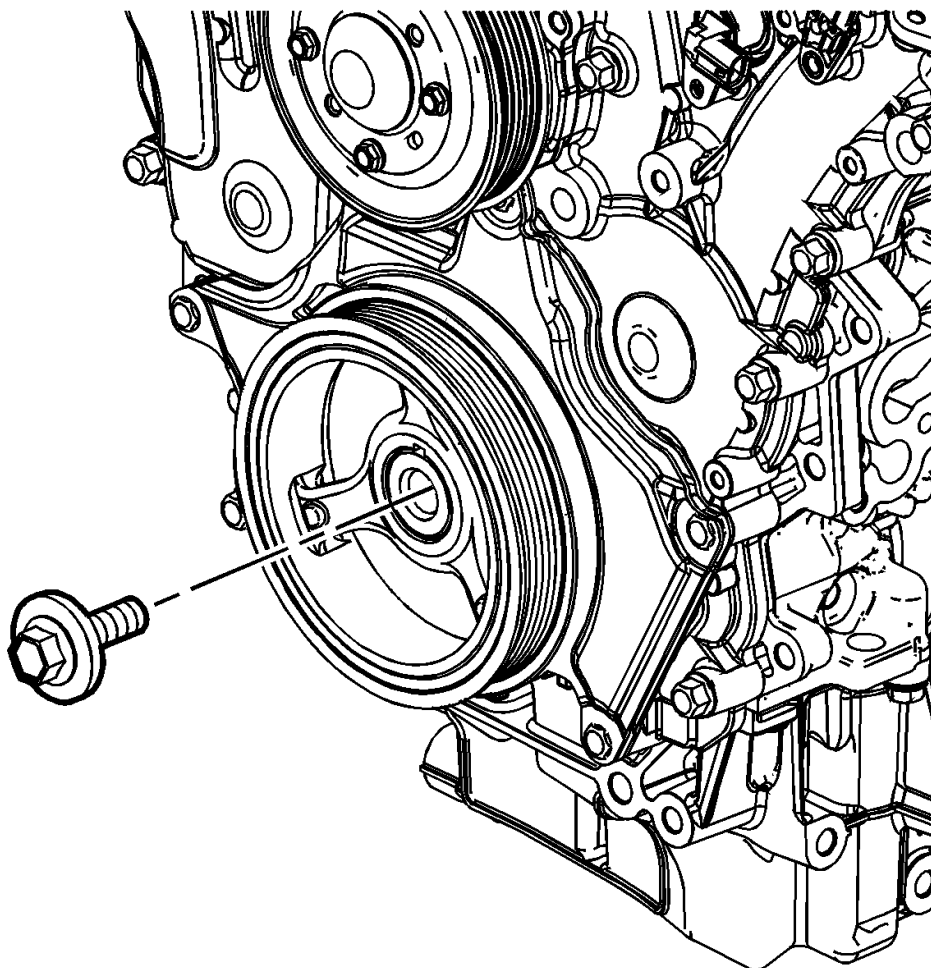


Fig. 702: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the NEW crankshaft balancer bolt.
9. Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft) and an additional 150 degrees using the **J-45059** meter.

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.

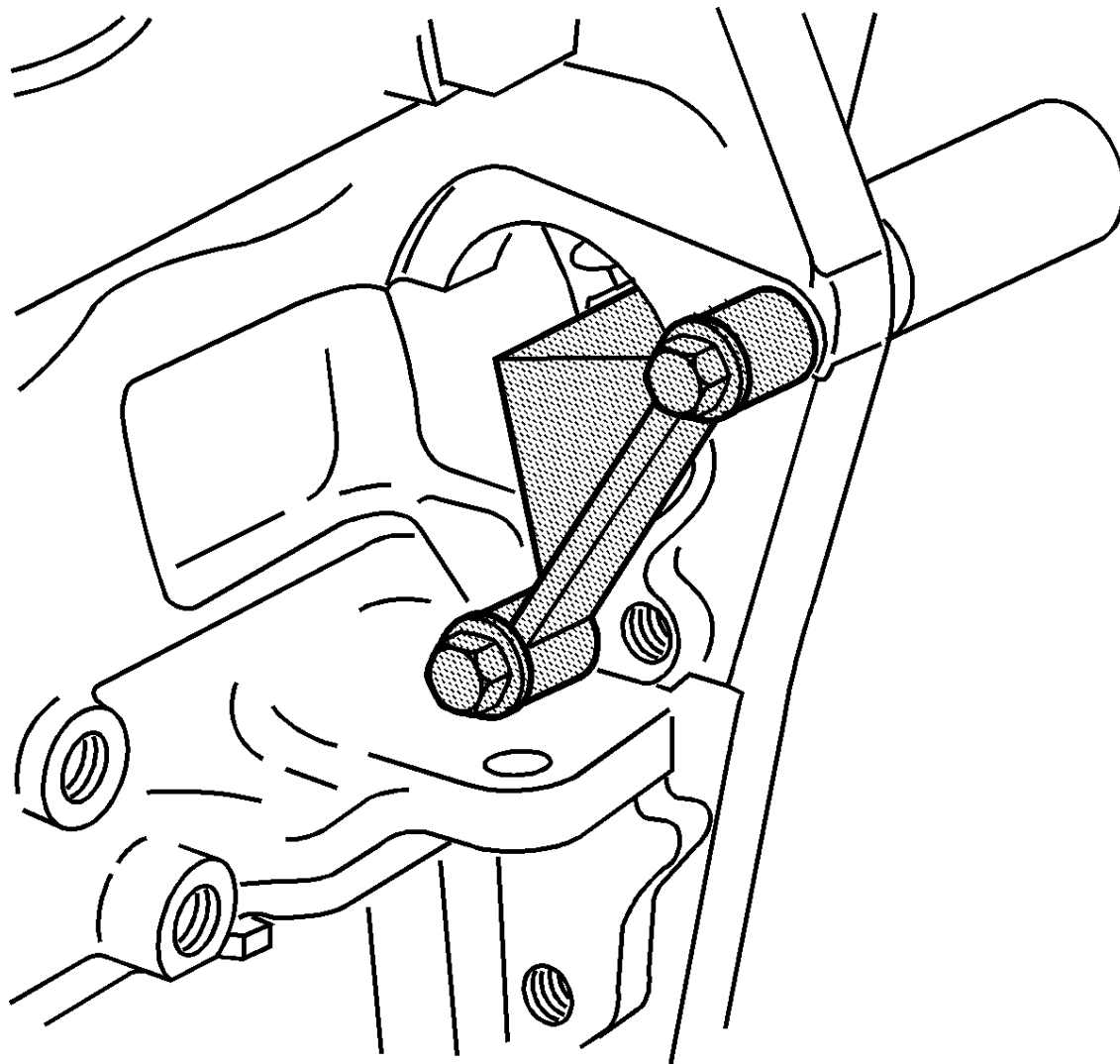


Fig. 703: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN-46106** tool.

OIL FILTER ADAPTER INSTALLATION

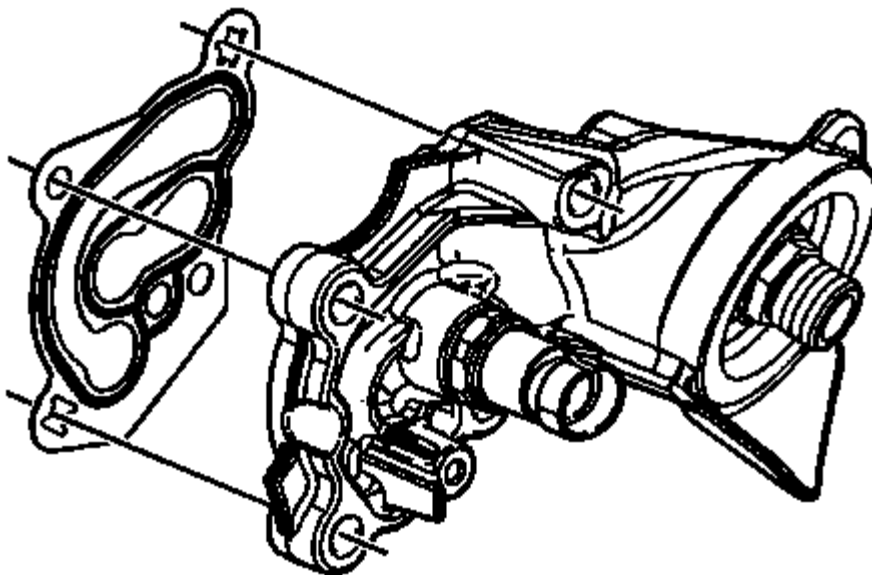


Fig. 704: Identifying Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Position a NEW oil filter adapter gasket onto the oil filter adapter.

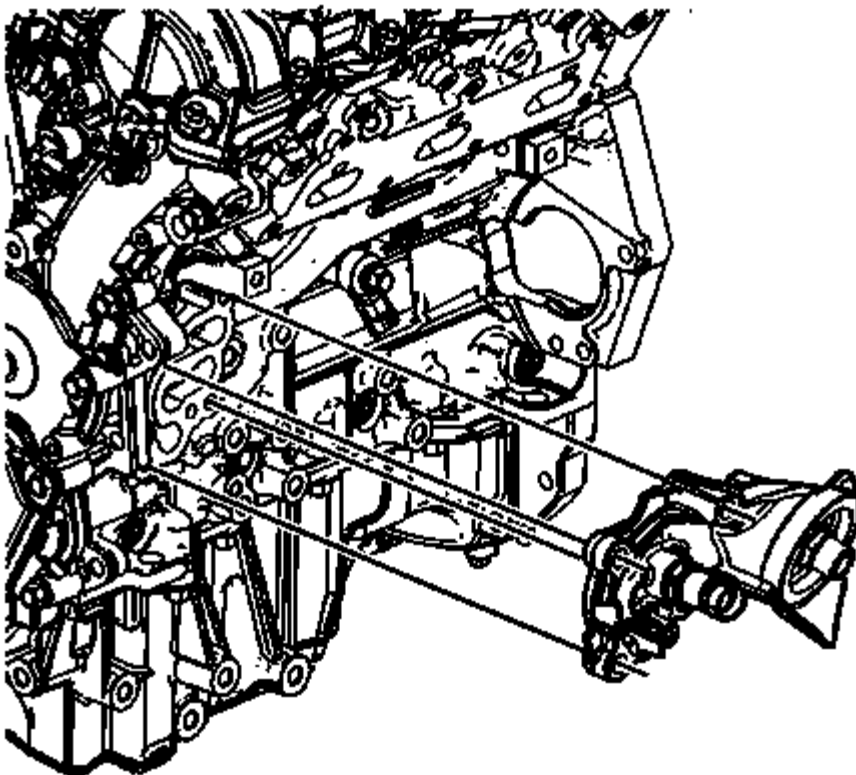


Fig. 705: Removing/Installing Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

2. Place the oil filter adapter into position.

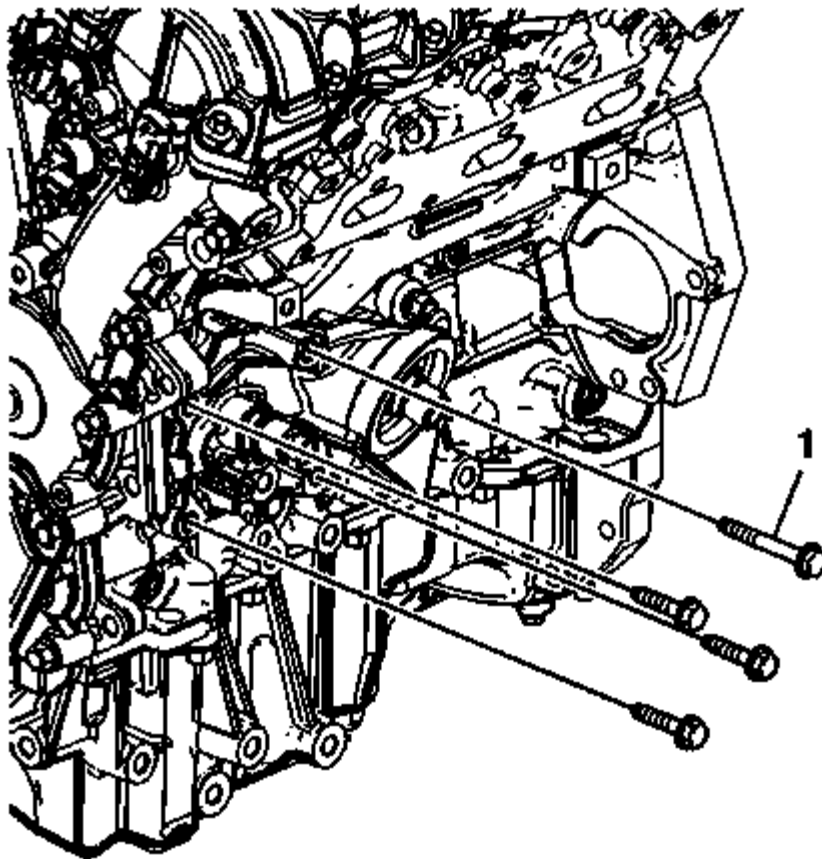


Fig. 706: Identifying Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the oil filter adapter bolts. Ensure the longer bolts (1) is installed in the upper rear position and tighten the oil filter adapter bolts to 25 N.m (18 lb ft).

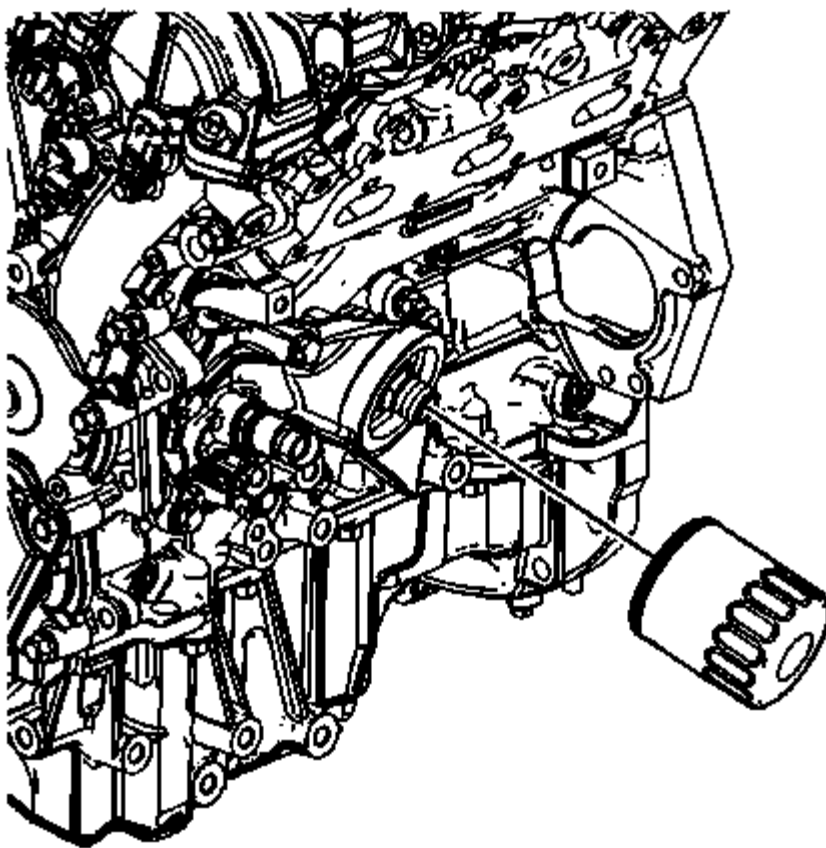


Fig. 707: Removing/Installing Oil Filter
Courtesy of GENERAL MOTORS COMPANY

4. Install a NEW oil filter.

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

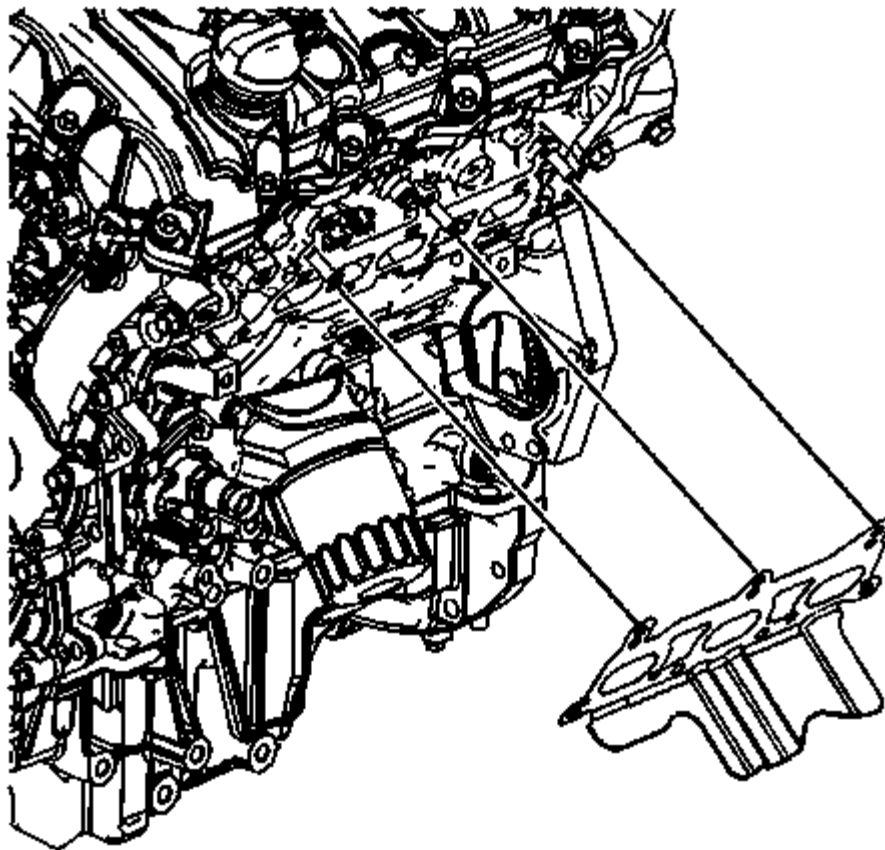


Fig. 708: View Of Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW left exhaust manifold gasket.

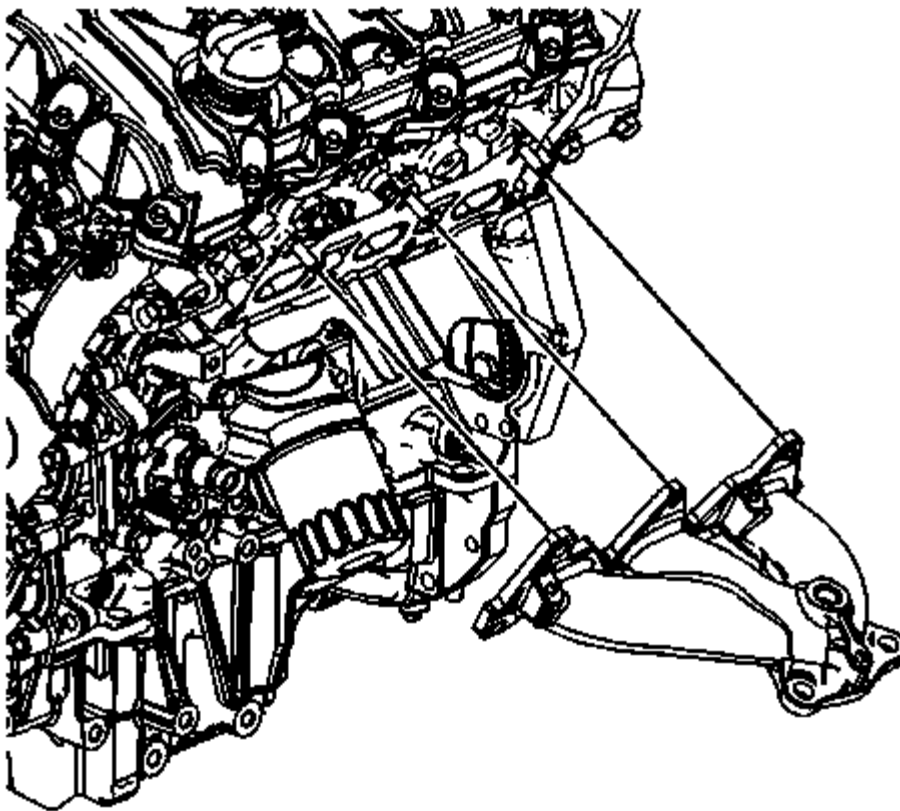


Fig. 709: Removing/Installing Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the left exhaust manifold.

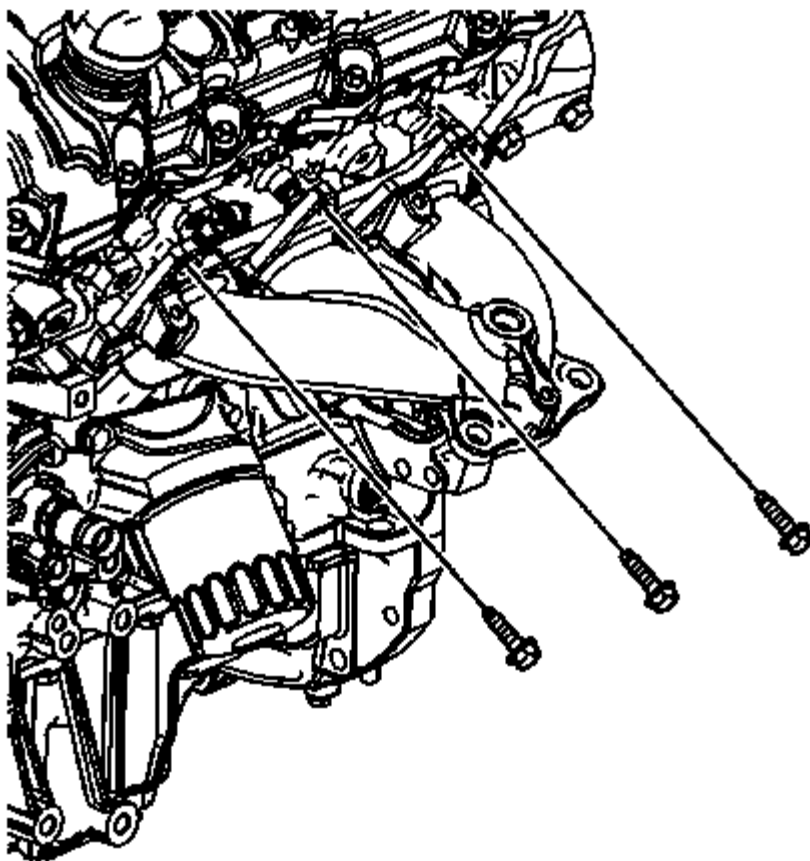


Fig. 710: Identifying Exhaust Manifold Upper Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Loosely install the left exhaust manifold upper bolts into the left cylinder head.

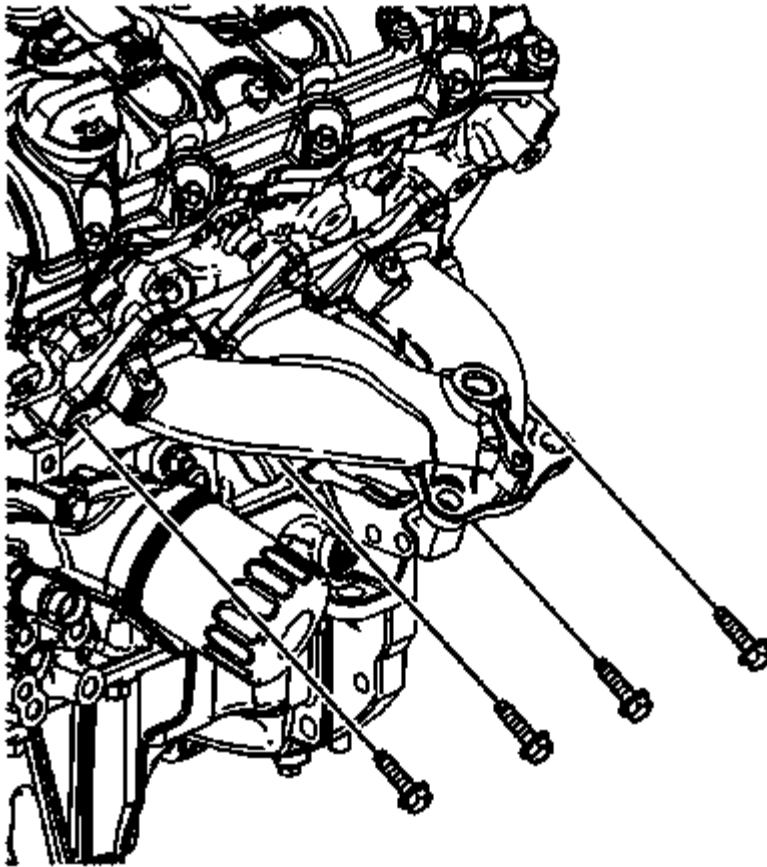


Fig. 711: Identifying Exhaust Manifold Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Loosely install the left exhaust manifold lower bolts into the left cylinder head.
5. Tighten the left exhaust manifold bolts to 25 N.m (18 lb ft).

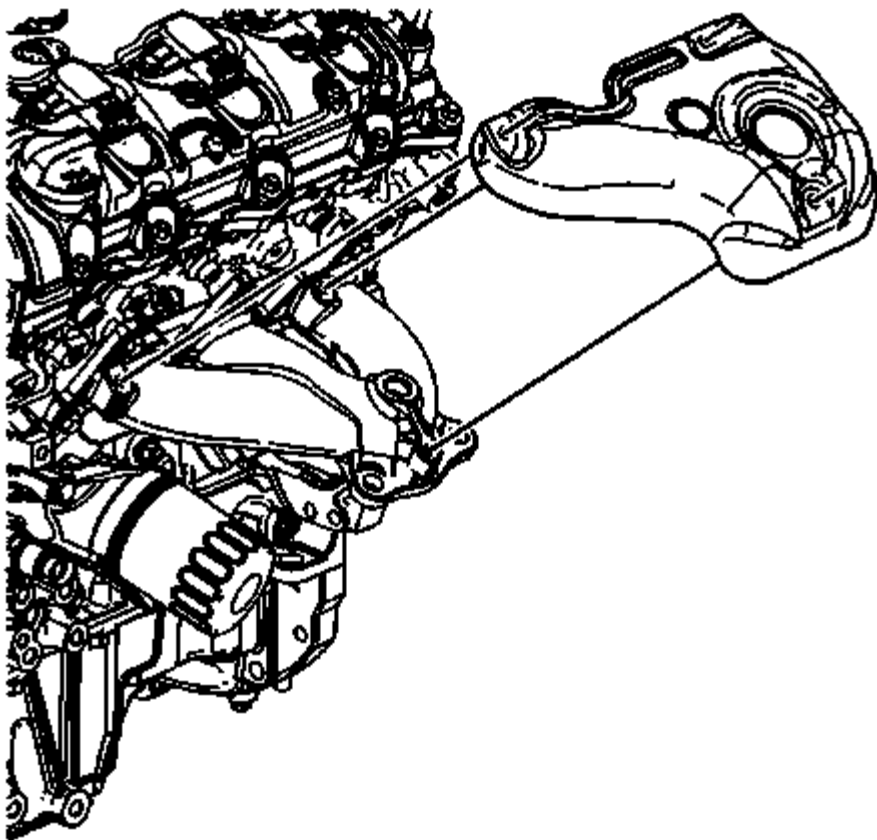


Fig. 712: Removing/Installing Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

6. Place the left exhaust manifold heat shield in position.

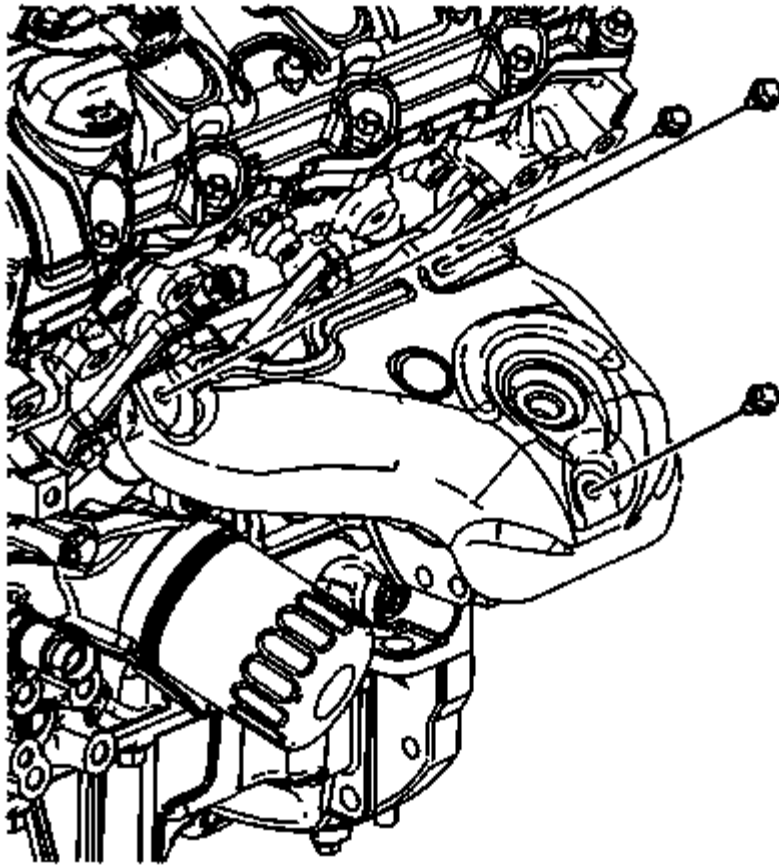


Fig. 713: Locating Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the exhaust manifold heat shield bolts and tighten to 10 N.m (89 lb in).

OIL LEVEL INDICATOR AND TUBE INSTALLATION

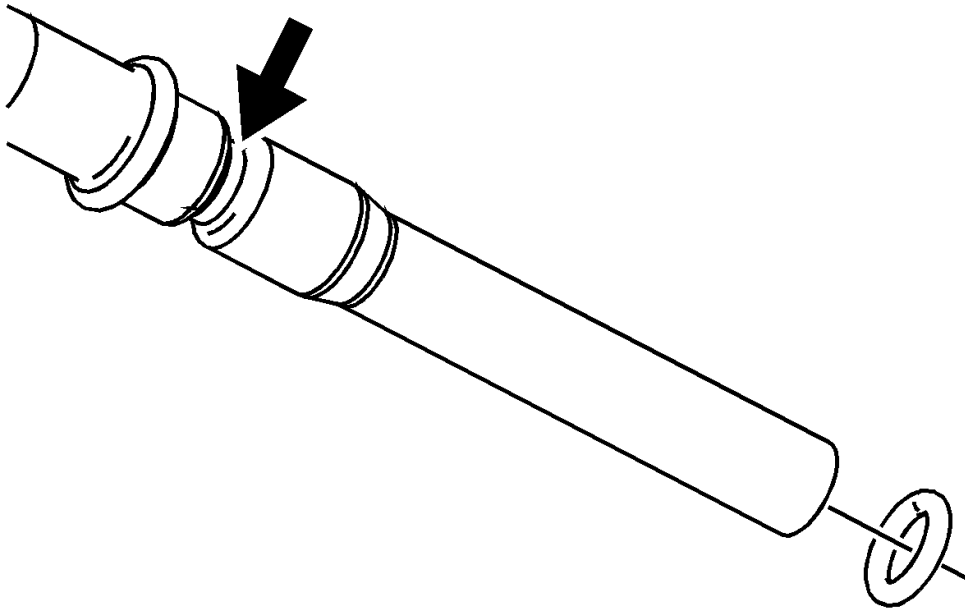


Fig. 714: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW O-ring on the oil level indicator tube.

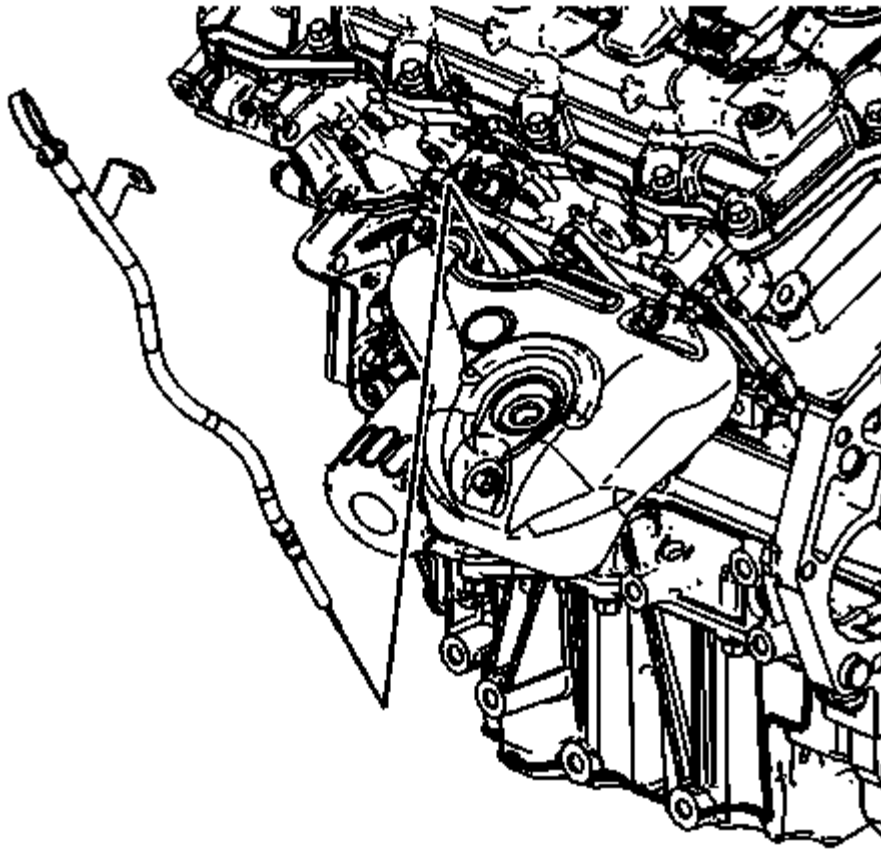


Fig. 715: Identifying Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil level indicator and tube by sliding the tube down through the lower crankcase hole.

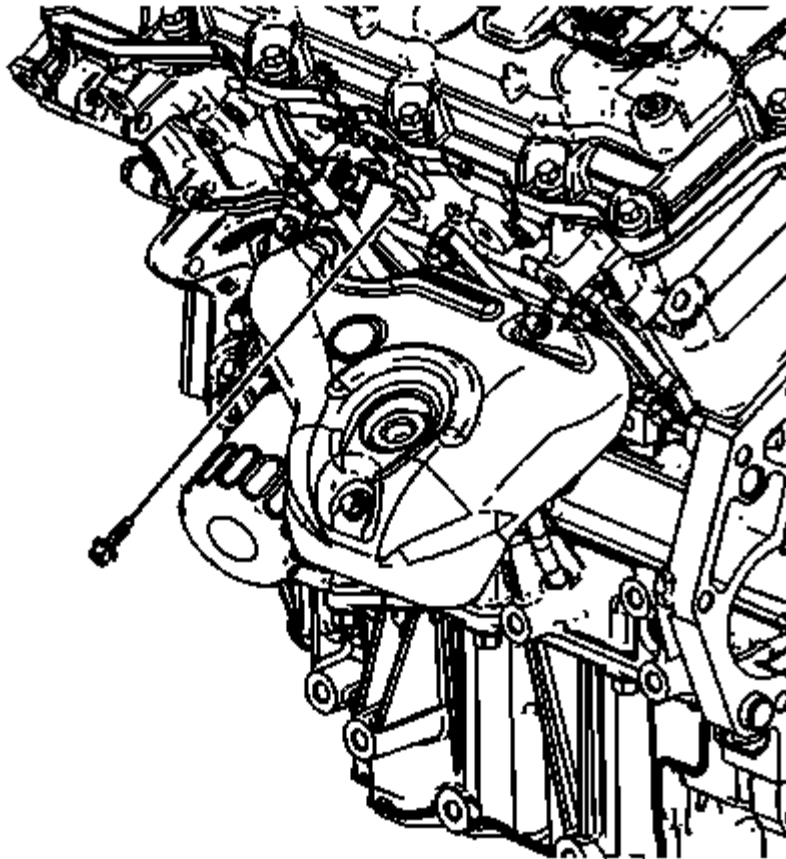


Fig. 716: View Of Oil Level Indicator Tube Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the oil level indicator tube bracket bolt and tighten to 10 N.m (89 lb in).

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE

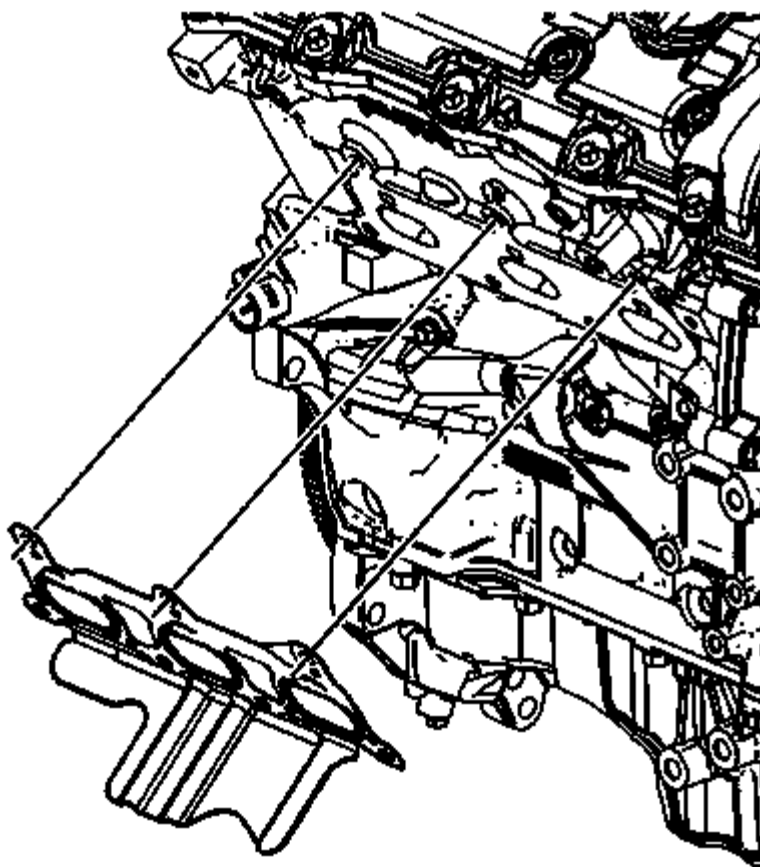


Fig. 717: Identifying Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW right exhaust manifold gasket.

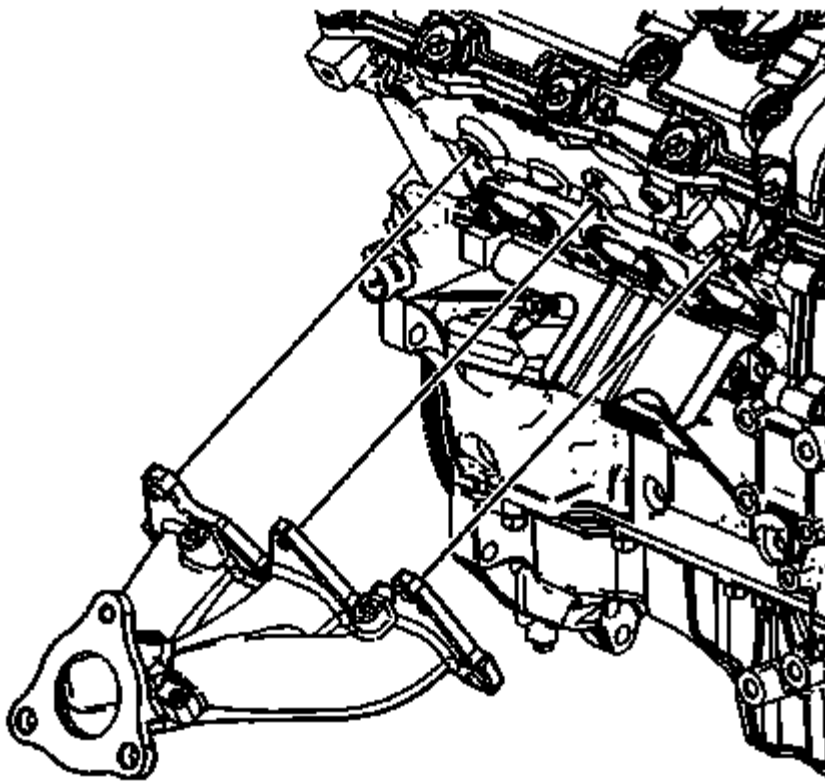


Fig. 718: Removing/Installing Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the right exhaust manifold.

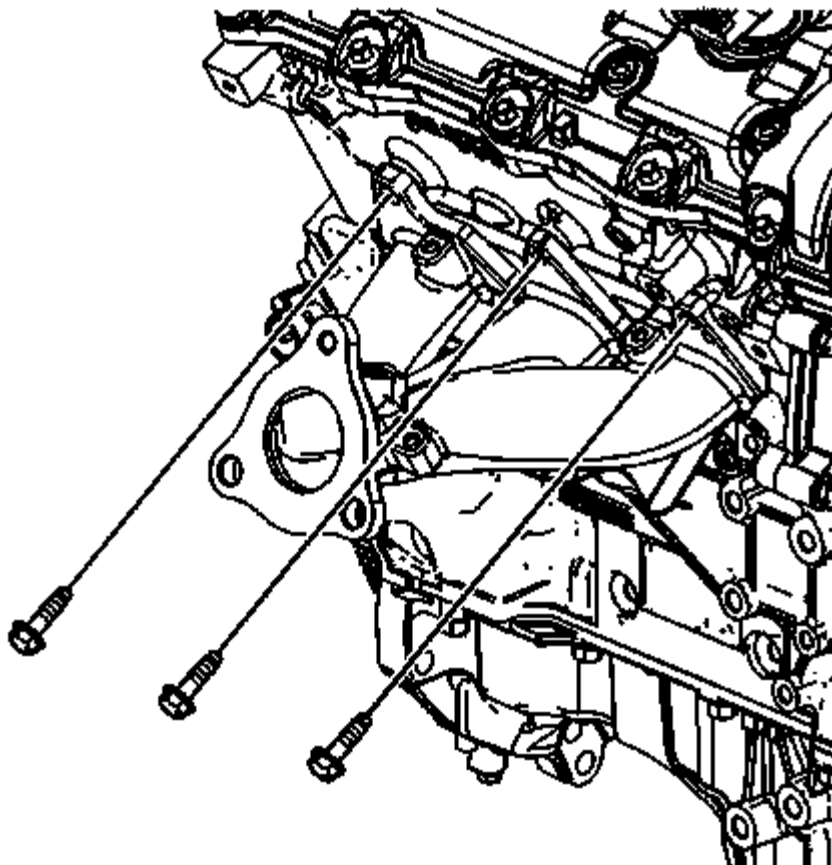


Fig. 719: Locating Exhaust Manifold Upper Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Loosely install the right exhaust manifold upper bolts into the right cylinder head.

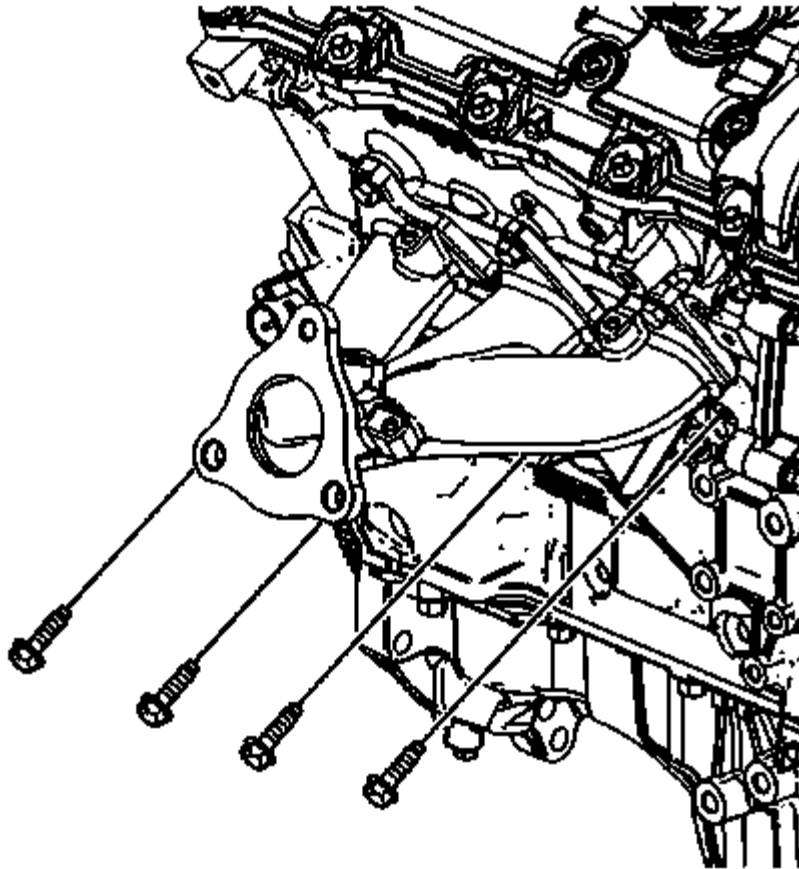


Fig. 720: Locating Exhaust Manifold Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Loosely install the right exhaust manifold lower bolts into the right cylinder head.
5. Tighten the right exhaust manifold bolts and tighten to 25 N.m (18 lb ft).

CAUTION: Refer to Fastener Caution .

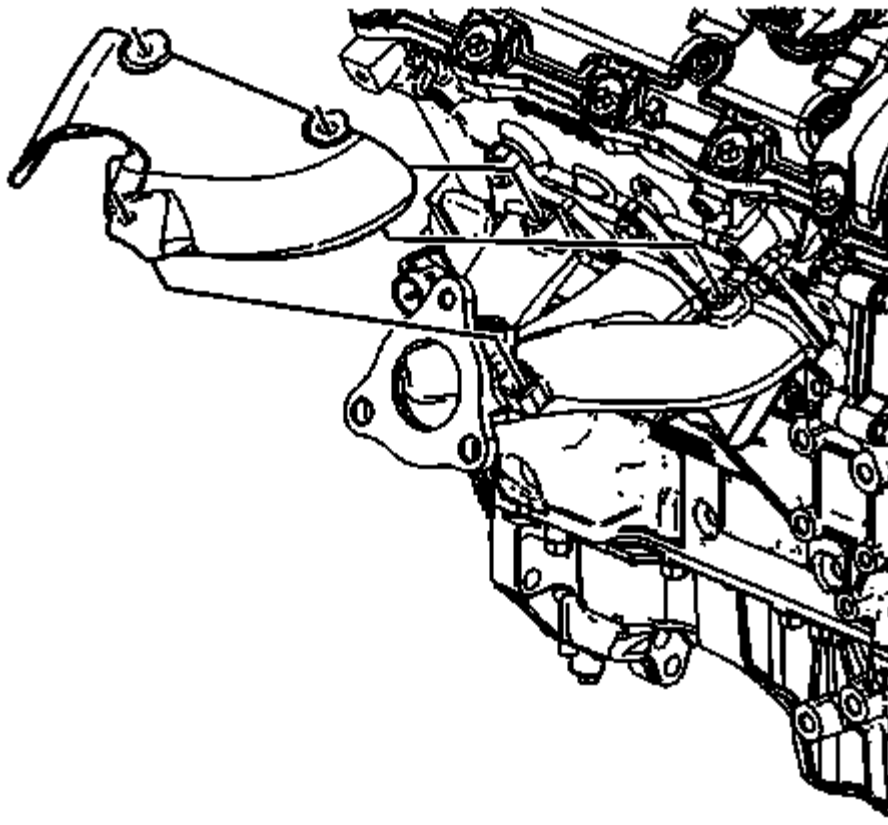


Fig. 721: Identifying Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

6. Place the right exhaust manifold heat shield in position.

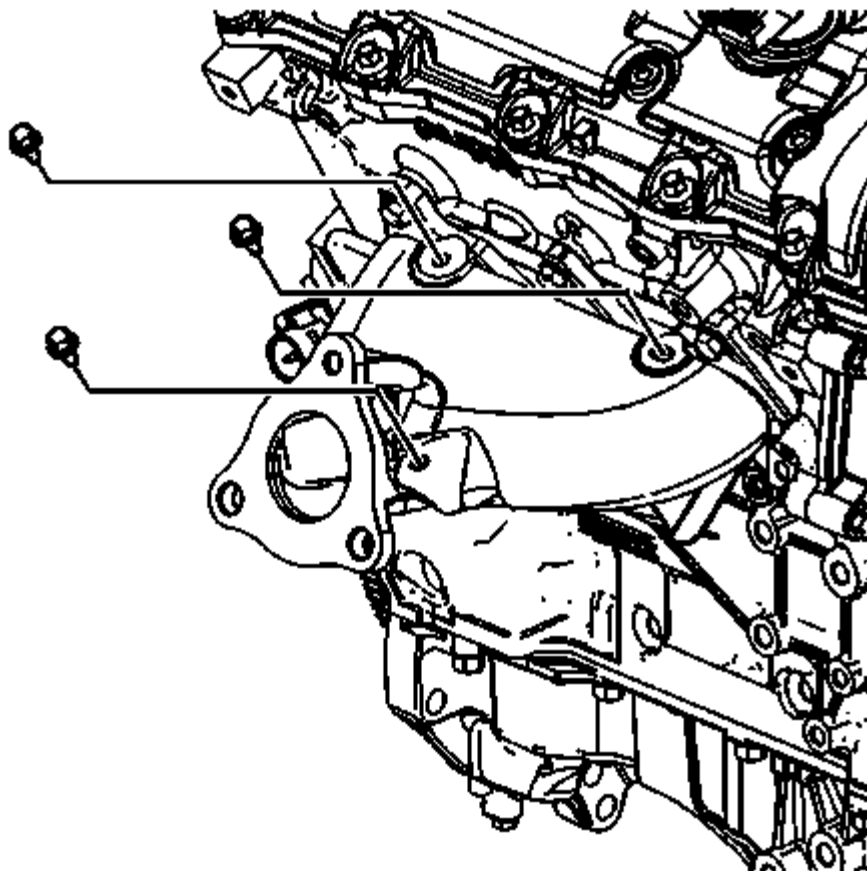


Fig. 722: View Of Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the exhaust manifold heat shield bolts and tighten to 10 N.m (89 lb in).

ENGINE COOLANT THERMOSTAT HOUSING INSTALLATION

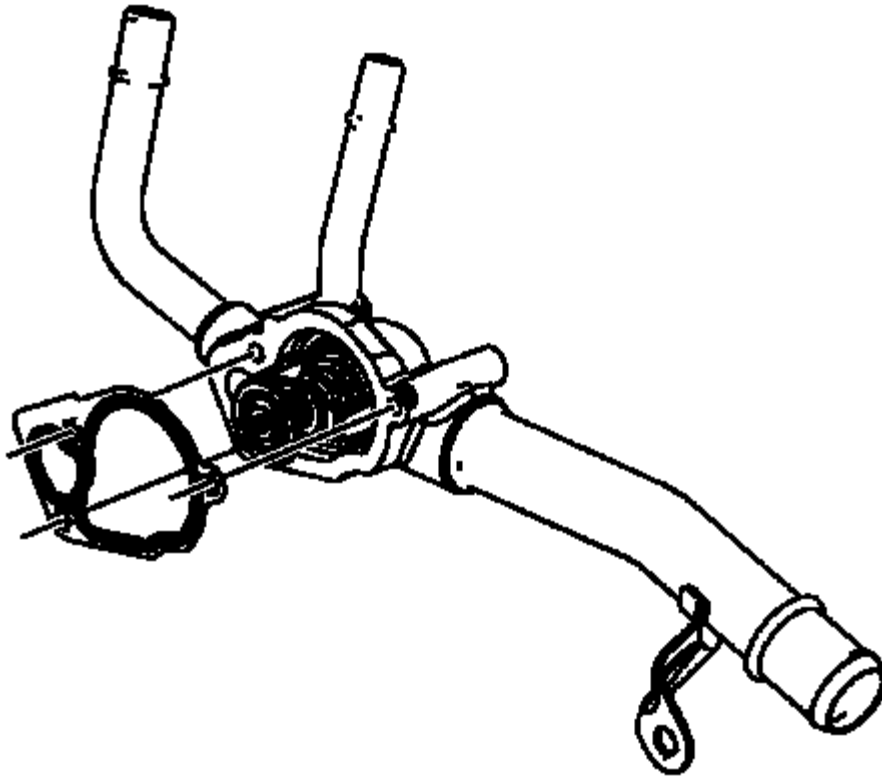


Fig. 723: Identifying Thermostat Housing Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket onto the thermostat housing.

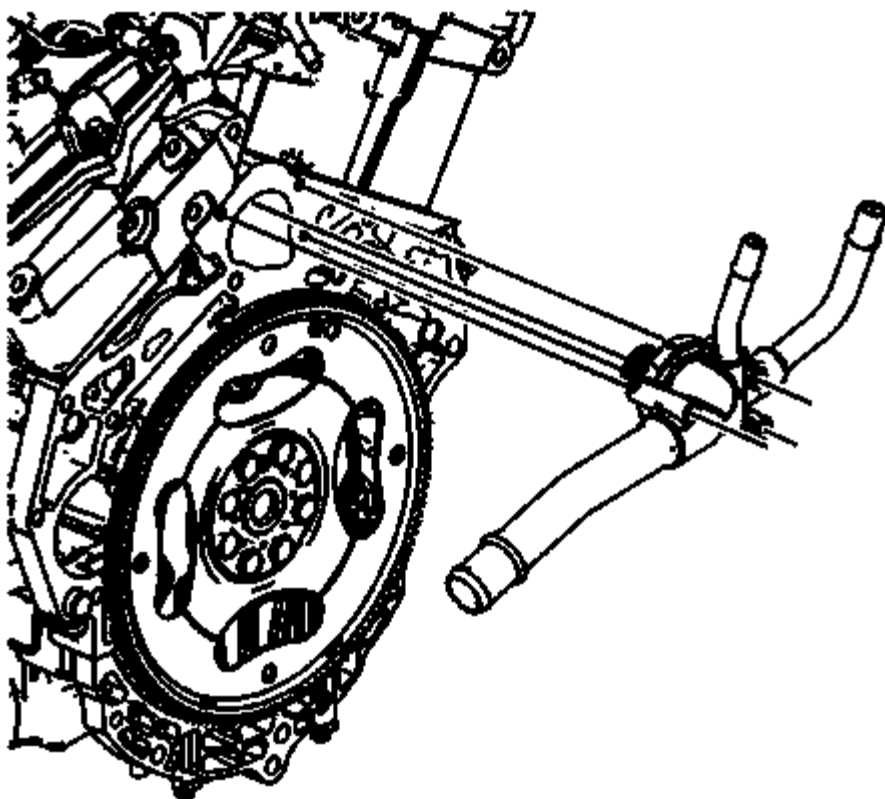


Fig. 724: Removing/Installing Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

2. Install the thermostat housing.

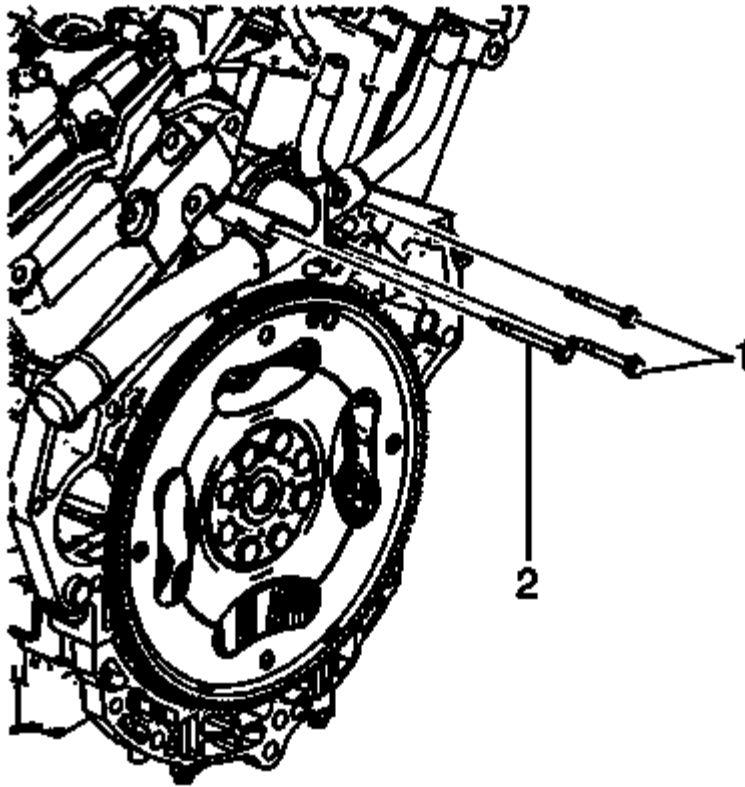


Fig. 725: View Of Thermostat Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the thermostat housing bolts. Ensure to install the short bolts (1) and the long bolt (2) in the proper position and tighten the thermostat housing bolts to 10 N.m (89 lb in).

WATER OUTLET INSTALLATION

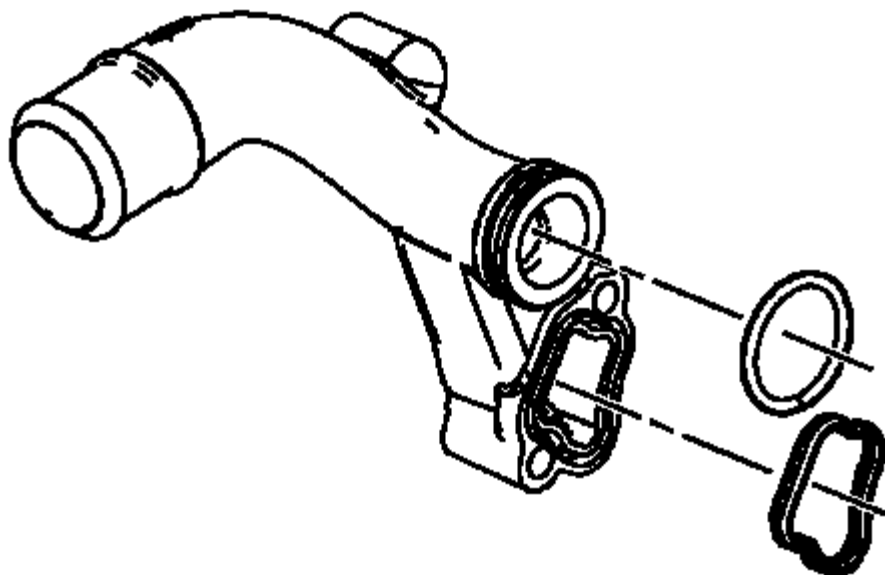


Fig. 726: Identifying Water Outlet Gasket & O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket and O-ring onto the water outlet.

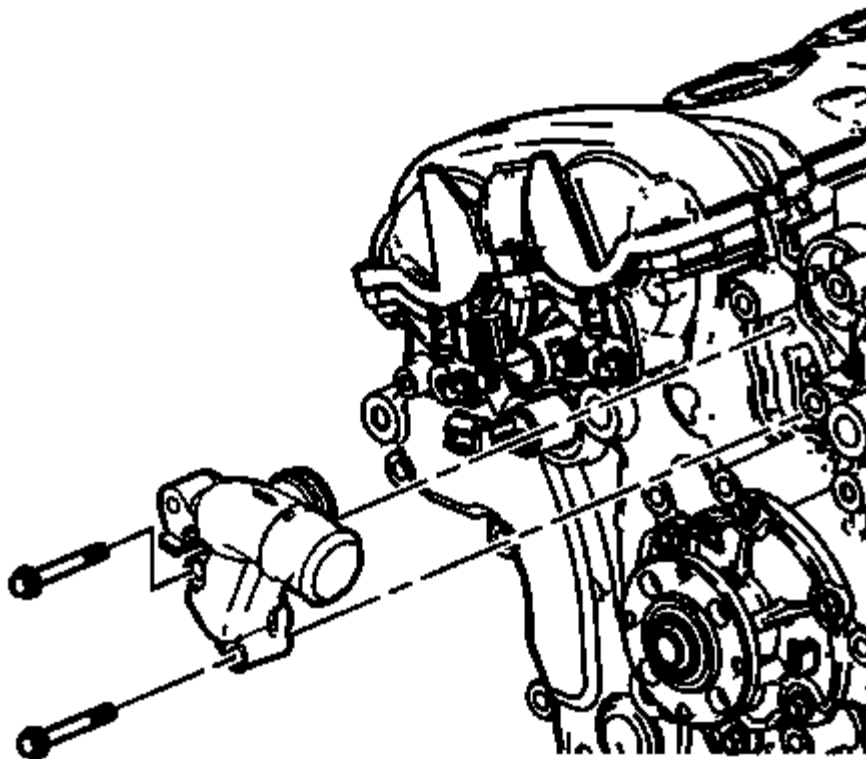


Fig. 727: Locating Water Outlet Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the water outlet.
3. Install the water outlet bolts and tighten to 10 N.m (89 lb in).

CAUTION: Refer to Fastener Caution .

DRIVE BELT IDLER PULLEY INSTALLATION

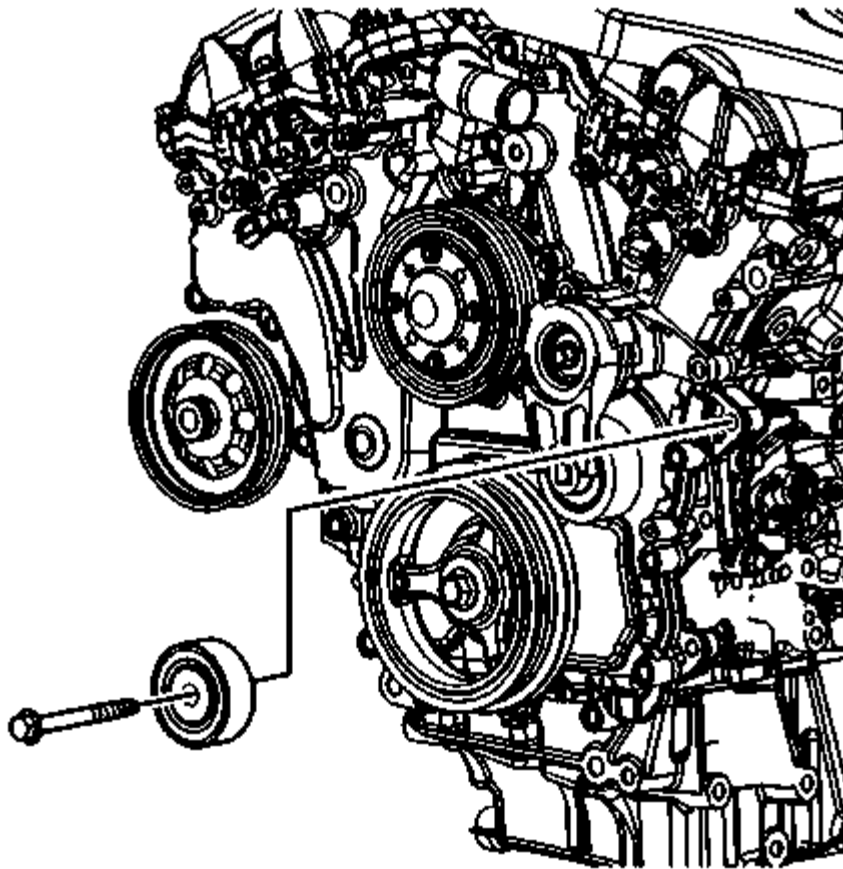


Fig. 728: Identifying Drive Belt Idler Pulley & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Place the drive belt idler pulley and bolt in position through the generator mounting hole and into the engine front cover.
2. Install the drive belt idler pulley bolt and tighten to 58 N.m (43 lb ft).

CAUTION: Refer to Fastener Caution .

3. Tighten the generator bolts to 50 N.m (37 lb ft).

DRIVE BELT TENSIONER INSTALLATION

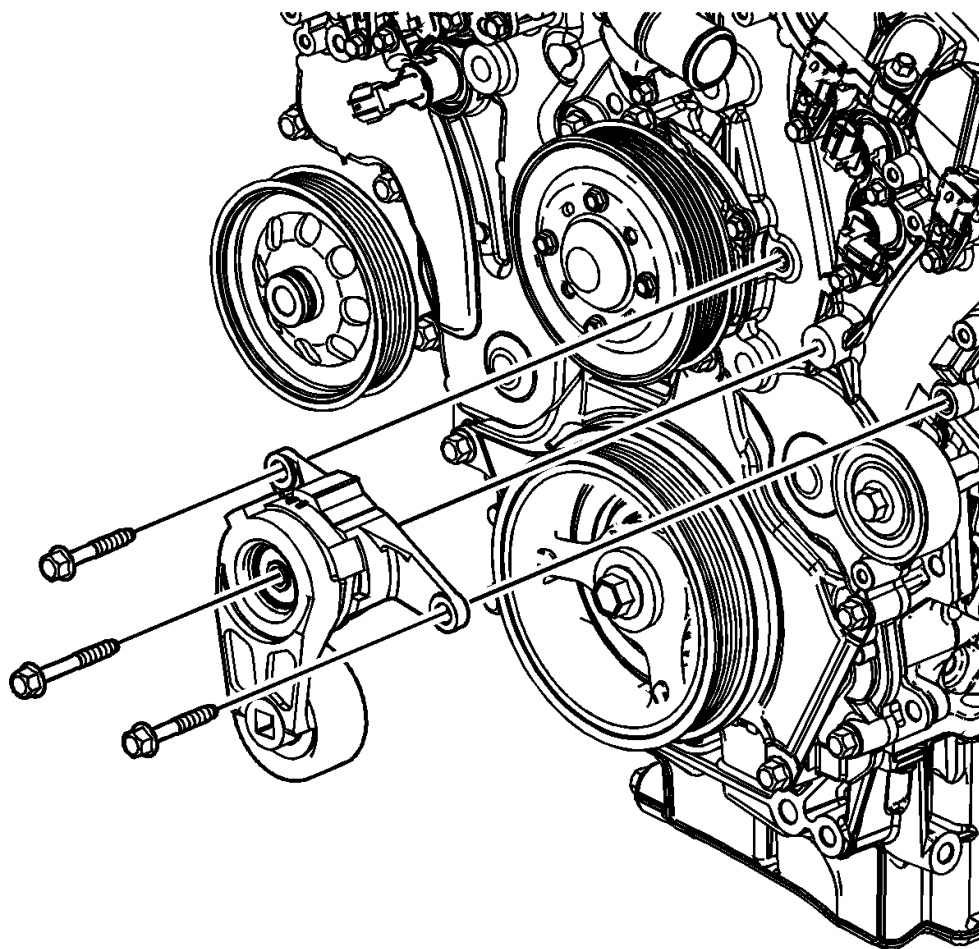


Fig. 729: Locating Drive Belt Tensioner Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Place the left drive belt tensioner assembly in position to the engine front cover.
2. Install the left drive belt tensioner bracket bolts and tighten to 25 N.m (18 lb ft).

CAUTION: Refer to Fastener Caution .

ENGINE PRELUBING

Special Tools

- EN-47971 Oil Pressure Gauge Adapter
- J 45299 Engine Preluber

For equivalent regional tools, refer to **Special Tools** .

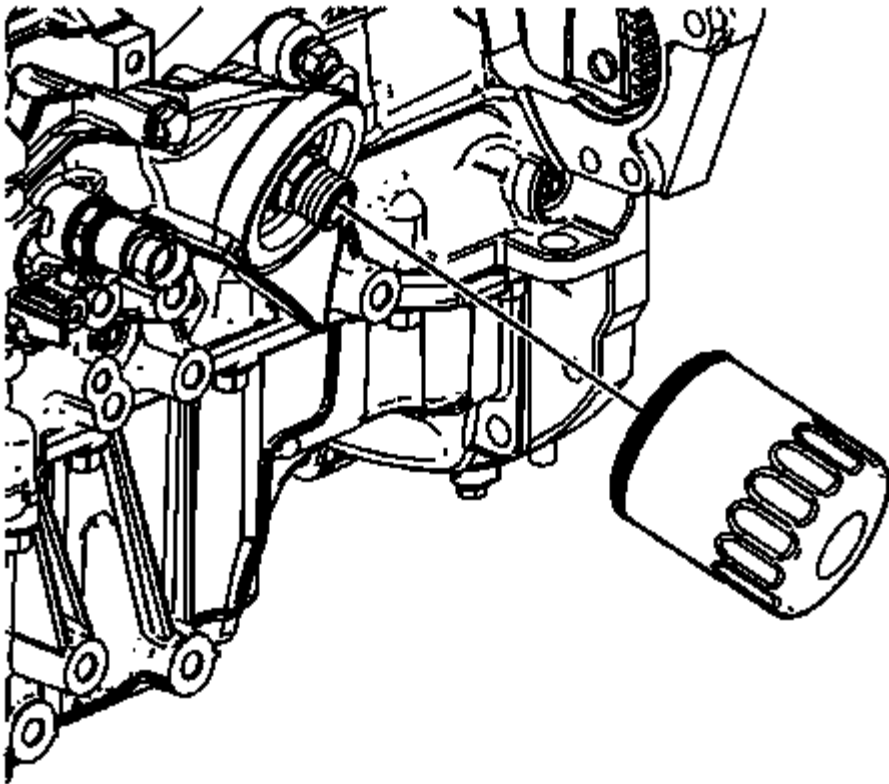


Fig. 730: Identifying Oil Filter

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the oil cooler lines are disconnected and the oil filter adapter oil cooler line ports are blocked in order to direct the oil from the engine preluber into the engine.

1. Remove the engine oil filter.

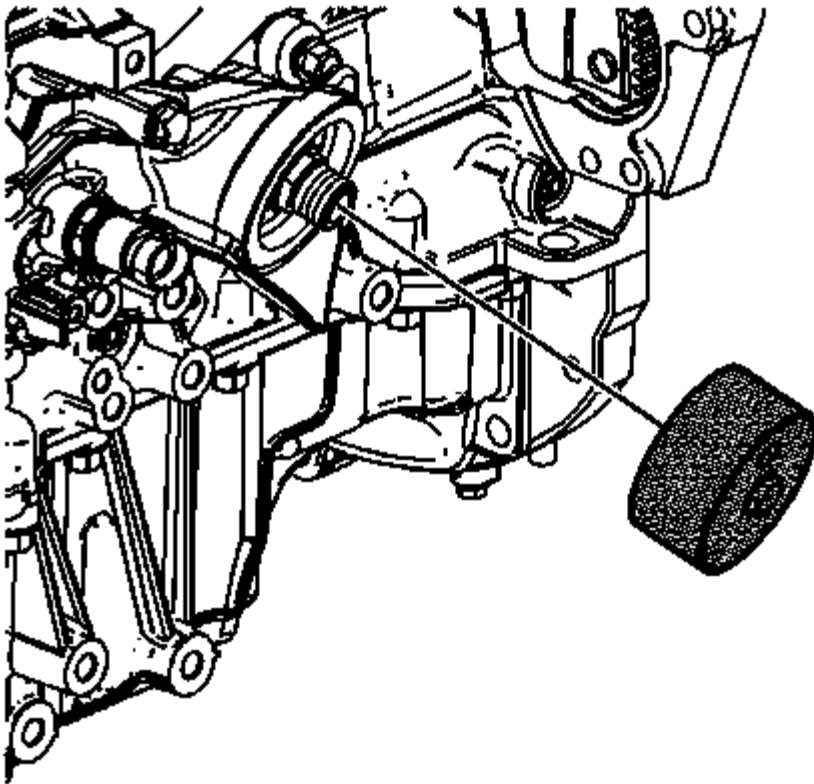


Fig. 731: Identifying Special Tool - EN-47971
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Special new tool EN 47971 must be used. Due to the special size and thread pitch of the oil filter adapter fitting ensure the proper tool is used or component damage will result.

2. Install the **EN-47971** adapter onto the oil filter adapter.

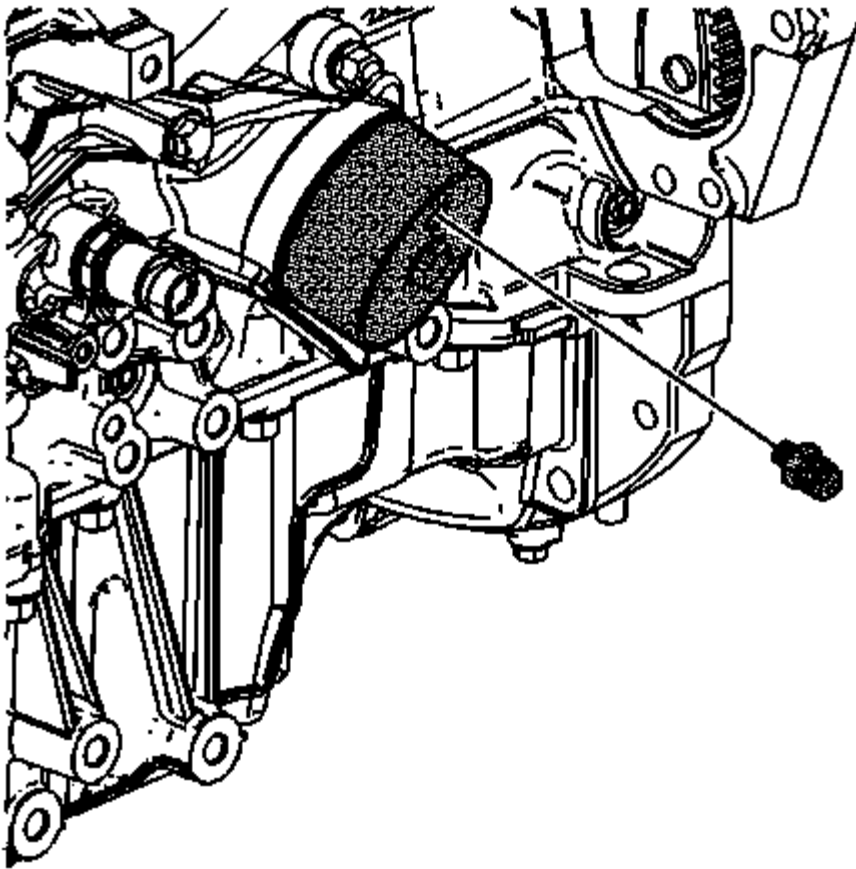


Fig. 732: Identifying Special Tool - 1/8 NPT Fitting From J 45299
Courtesy of GENERAL MOTORS COMPANY

3. Install the 1/8 NPT fitting from the **J 45299** preluber into the port on the **EN-47971** adapter.

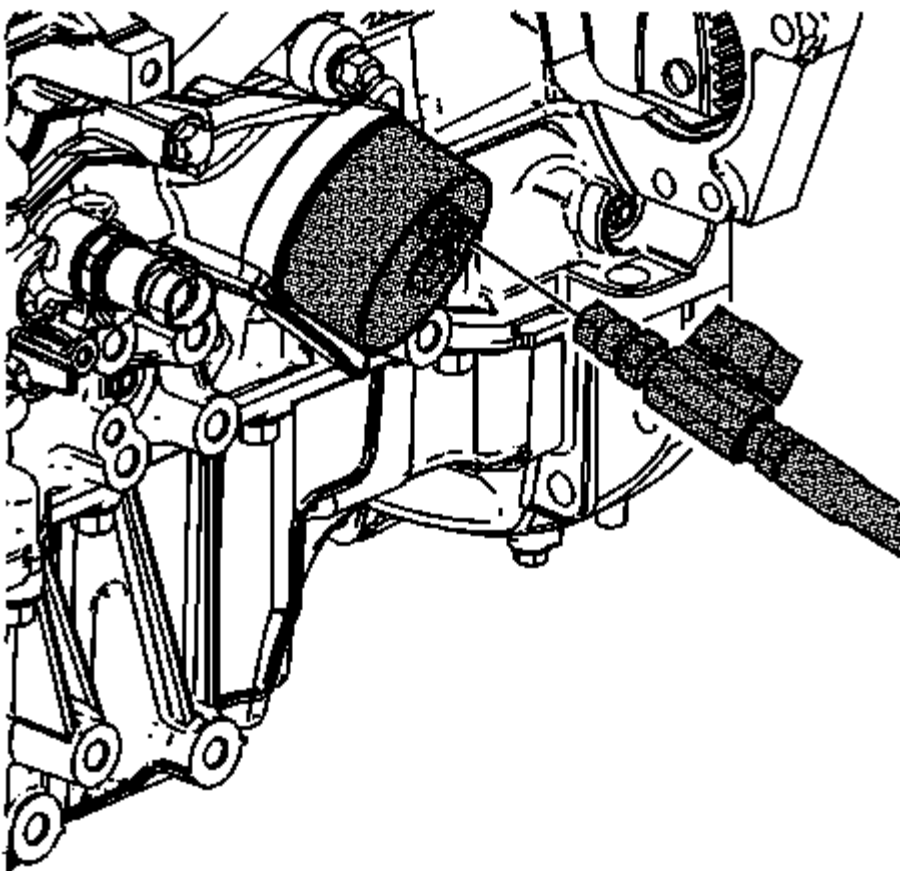


Fig. 733: Identifying Special Tool - J 45299
Courtesy of GENERAL MOTORS COMPANY

4. Install the **J 45299** preluber flexible hose to the fitting.

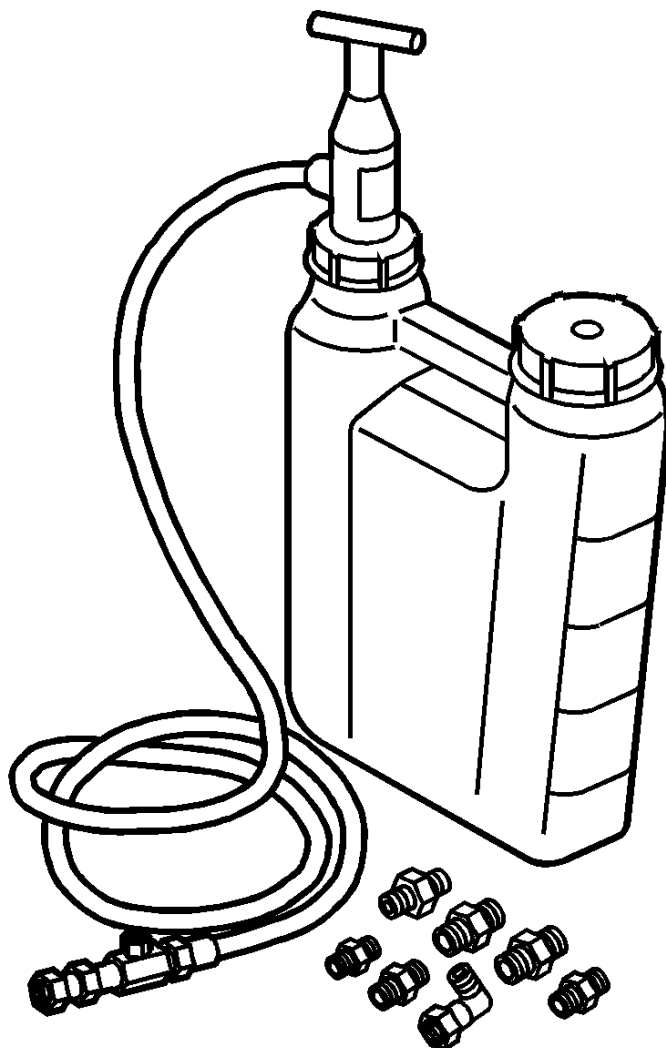


Fig. 734: View Of Engine Preluber
Courtesy of GENERAL MOTORS COMPANY

5. Open the valve of the **J 45299** preluber.
6. Pump the handle of the **J 45299** preluber in order to flow a minimum of 1-1.9 liters (1-2 quarts) of fresh clean engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.

NOTE: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Use the approved engine oil as specified in the owner's manual.

7. Close the valve of the **J 45299** preluber.

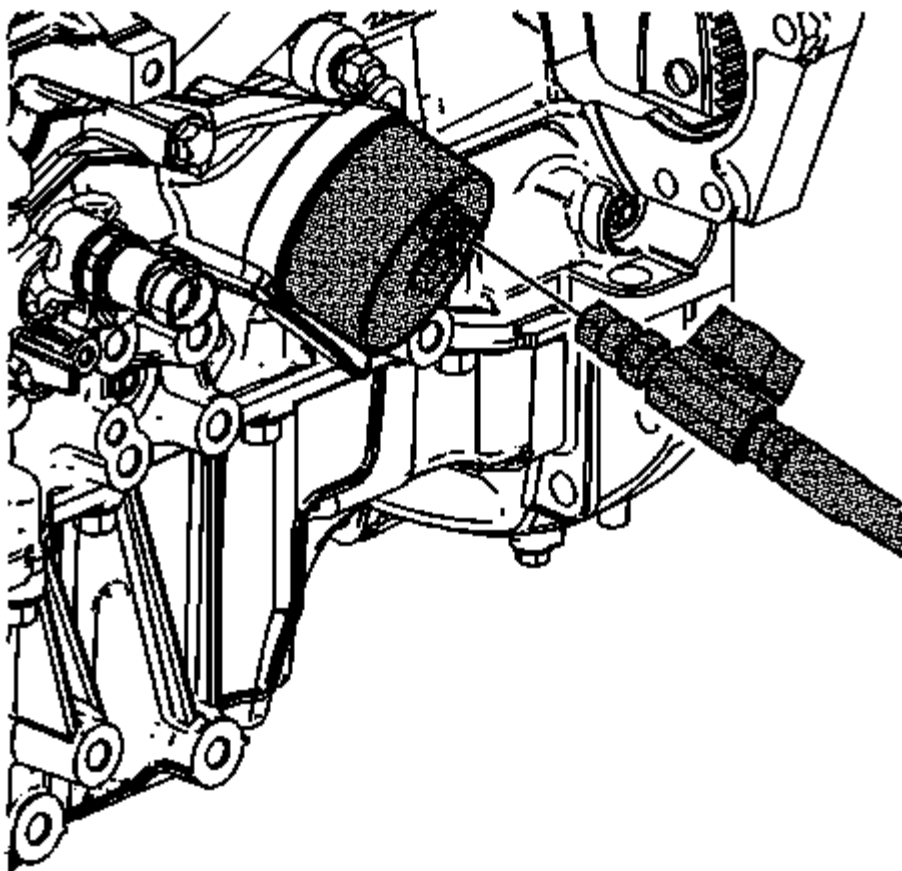


Fig. 735: Identifying Special Tool - J 45299
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **J 45299** preluber flexible hose.

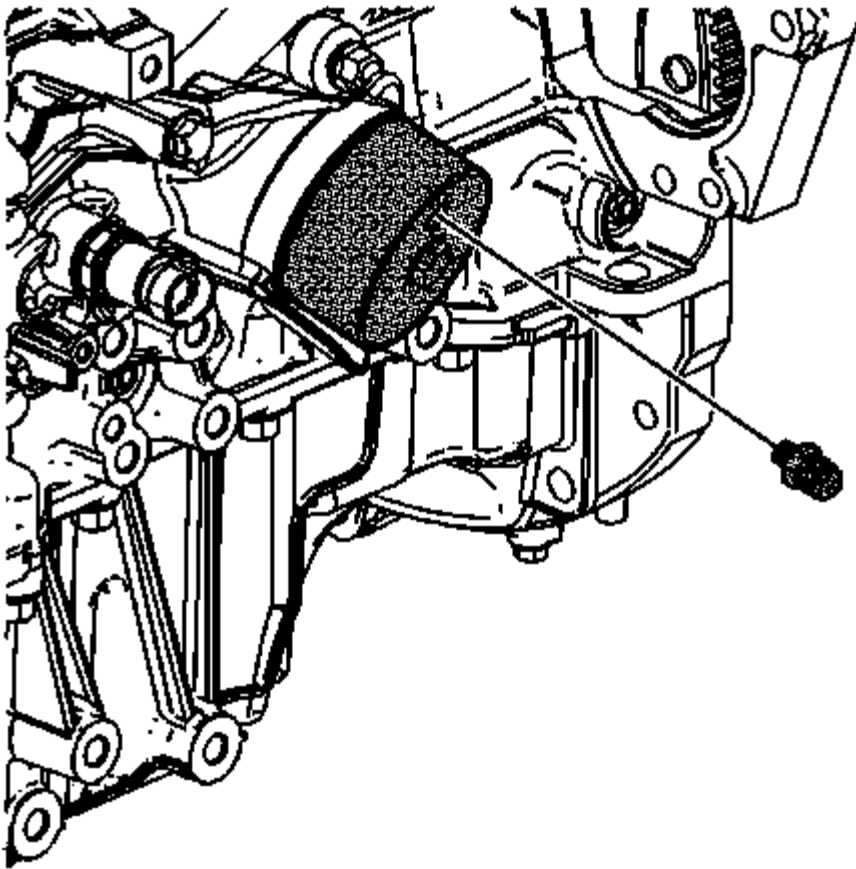


Fig. 736: Identifying Special Tool - 1/8 NPT Fitting From J 45299
Courtesy of GENERAL MOTORS COMPANY

9. Remove the fitting from the EN-47971 adapter.

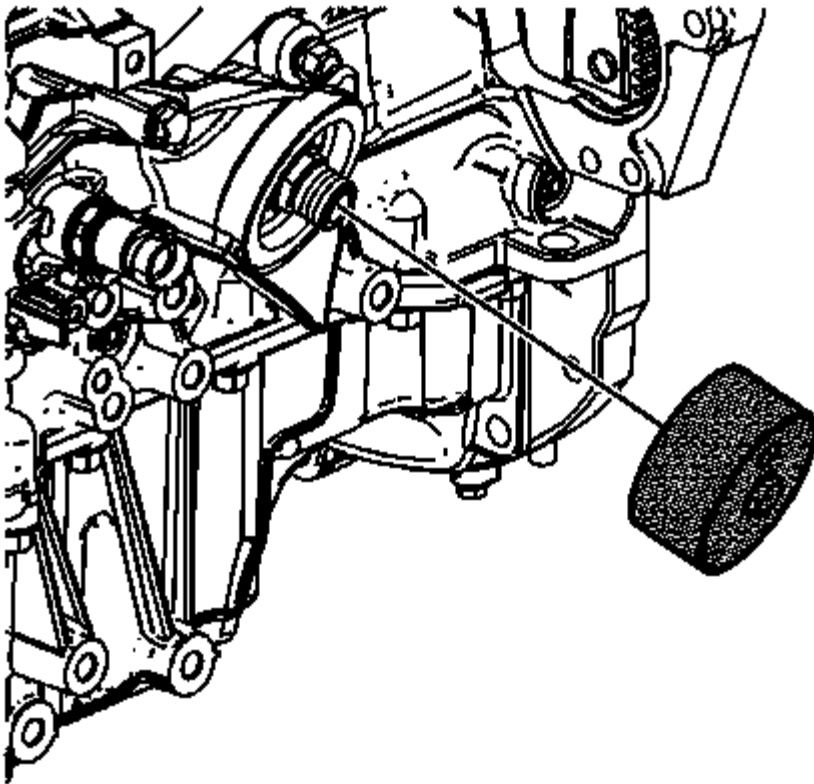


Fig. 737: Identifying Special Tool - EN-47971
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN-47971** adapter from the oil filter adapter.
11. Ensure the **NEW** oil filter is filled with clean fresh engine oil.

CAUTION: This engine uses a special high performance oil filter. Use of any other filter may lead to filter failure and/or severe engine damage.

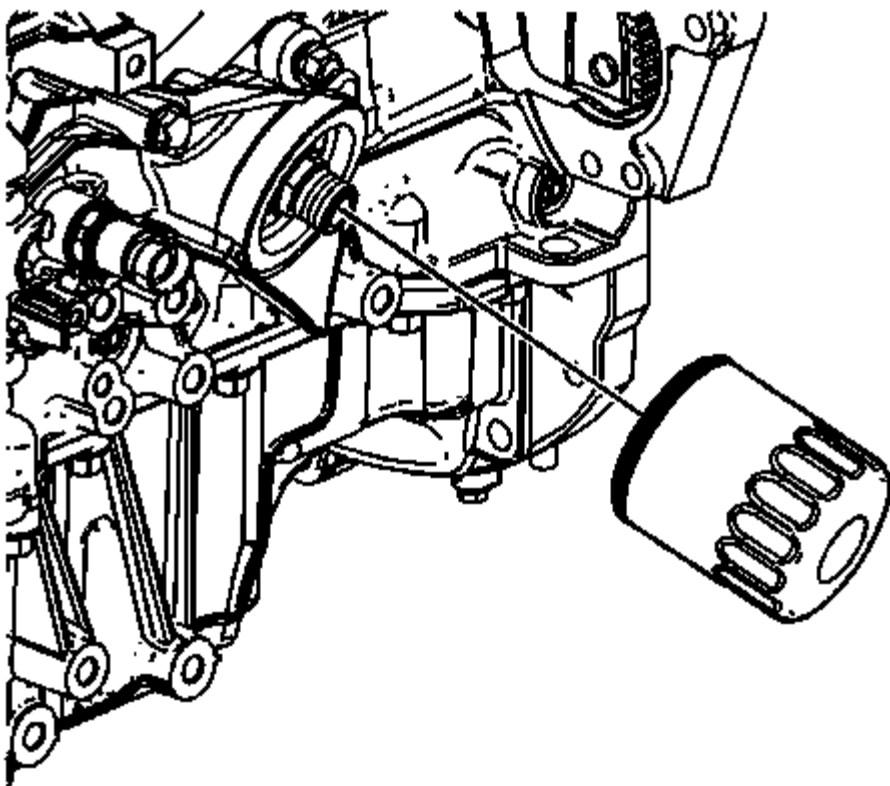


Fig. 738: Identifying Oil Filter

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

12. Install the NEW oil filter and tighten to 30 N.m (22 lb ft).