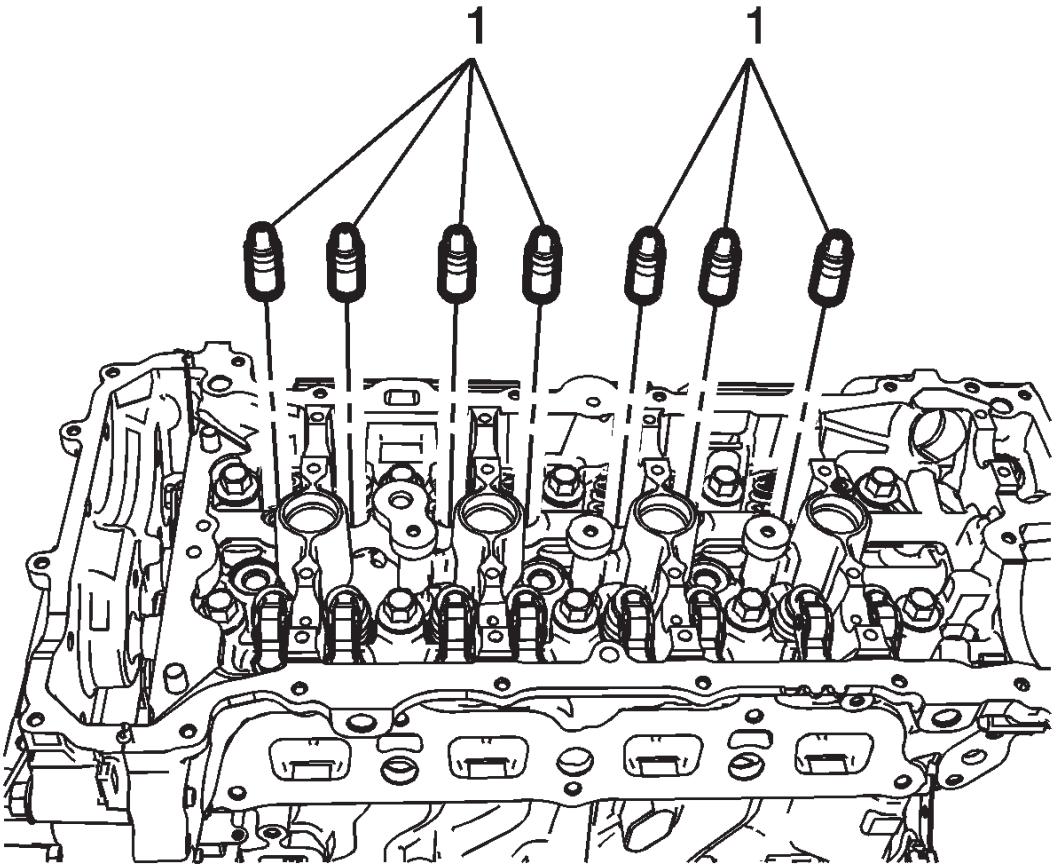

Fig. 137: Hydraulic Lash Adjusters - Intake
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.**

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers (LTG)** **Adhesives, Fluids, Lubricants, and Sealers (LCV)** .
2. Install the Intake valve rocker arm. Refer to **Valve Rocker Arm Replacement (Exhaust)** **Valve Rocker Arm Replacement (Intake)**.

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - INTAKE

Special Tools

- **EN-50656** Holding Tool
- **EN 50793** Locking Tool

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

Removal Procedure

NOTE: **Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.**

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
2. Remove the high pressure fuel pump. Refer to **Fuel Pump Replacement** .

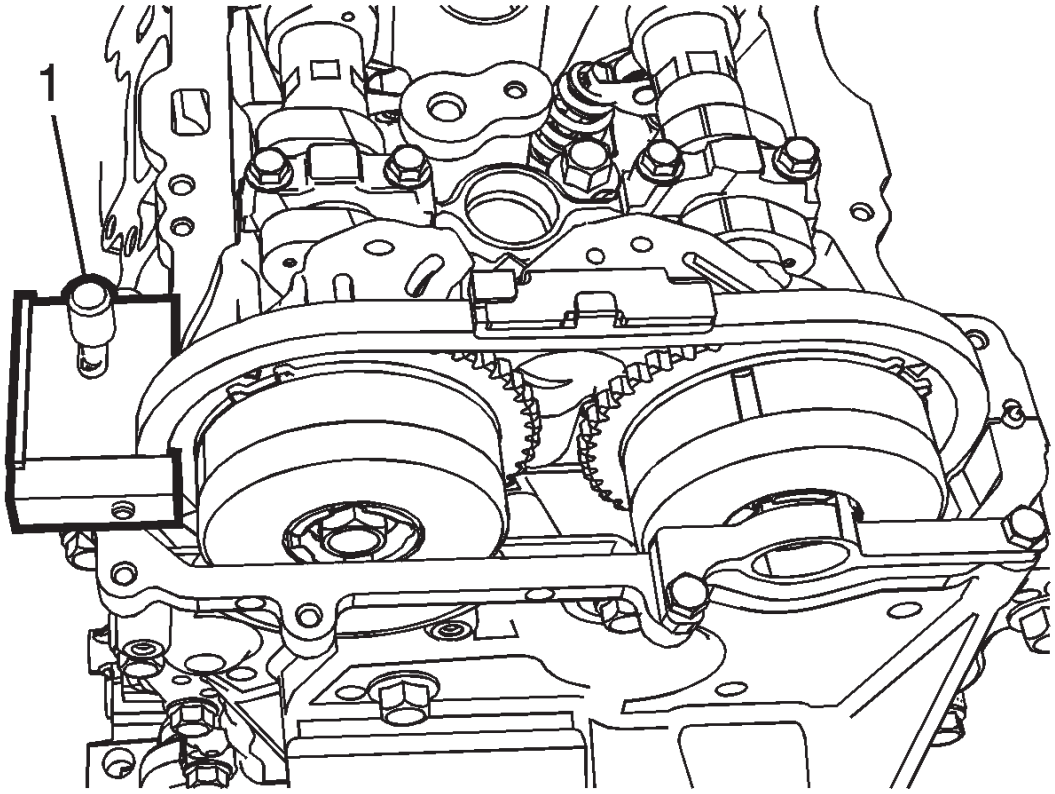

Fig. 138: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the EN-50656 holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.**

3. Install **EN-50656** timing chain holding tool (1) and tighten to 8 N.m (71 lb in).

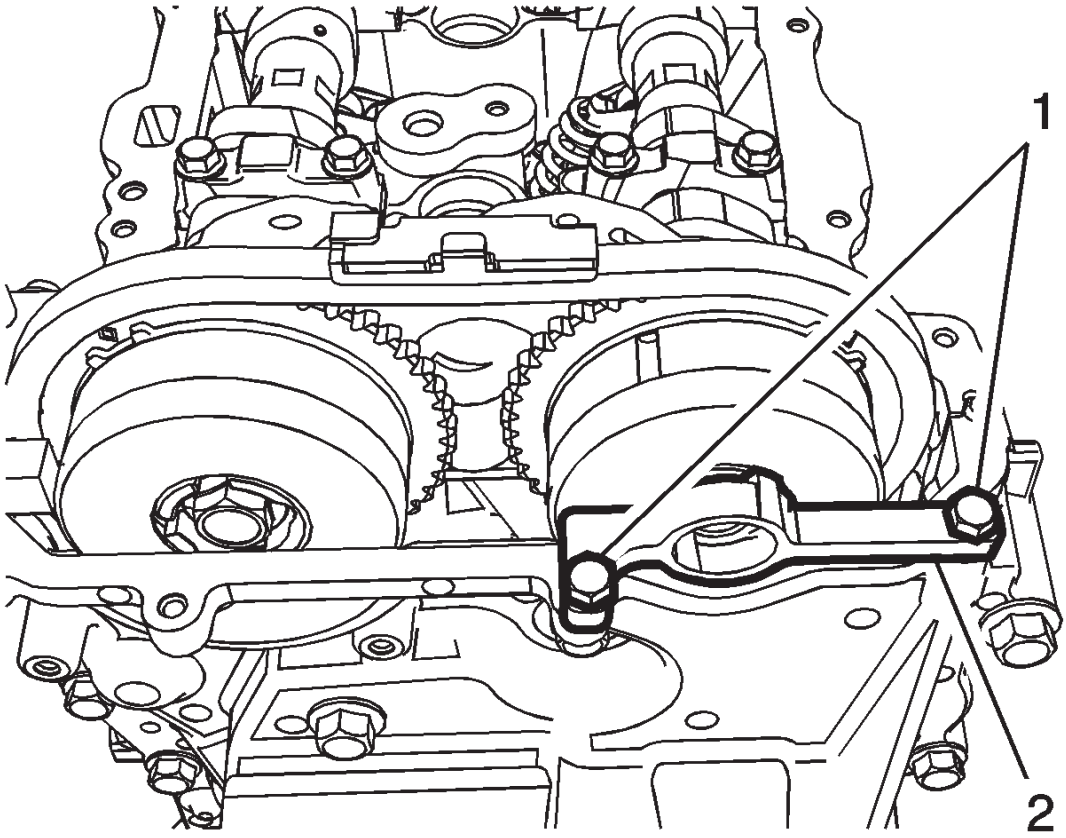

Fig. 139: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Ensure to mark actuator sprocket and chain before removal.**

4. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

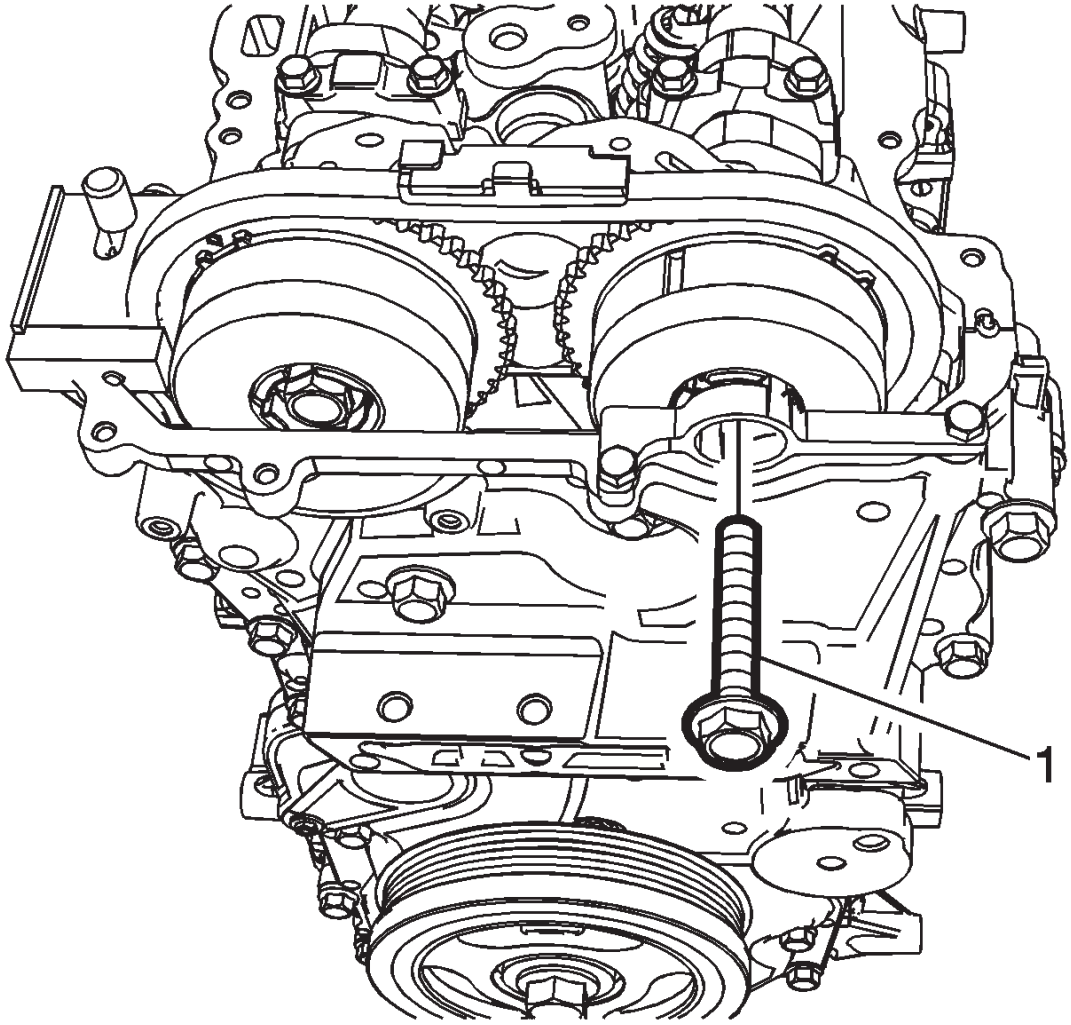

Fig. 140: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD the camshaft actuator bolt (1).

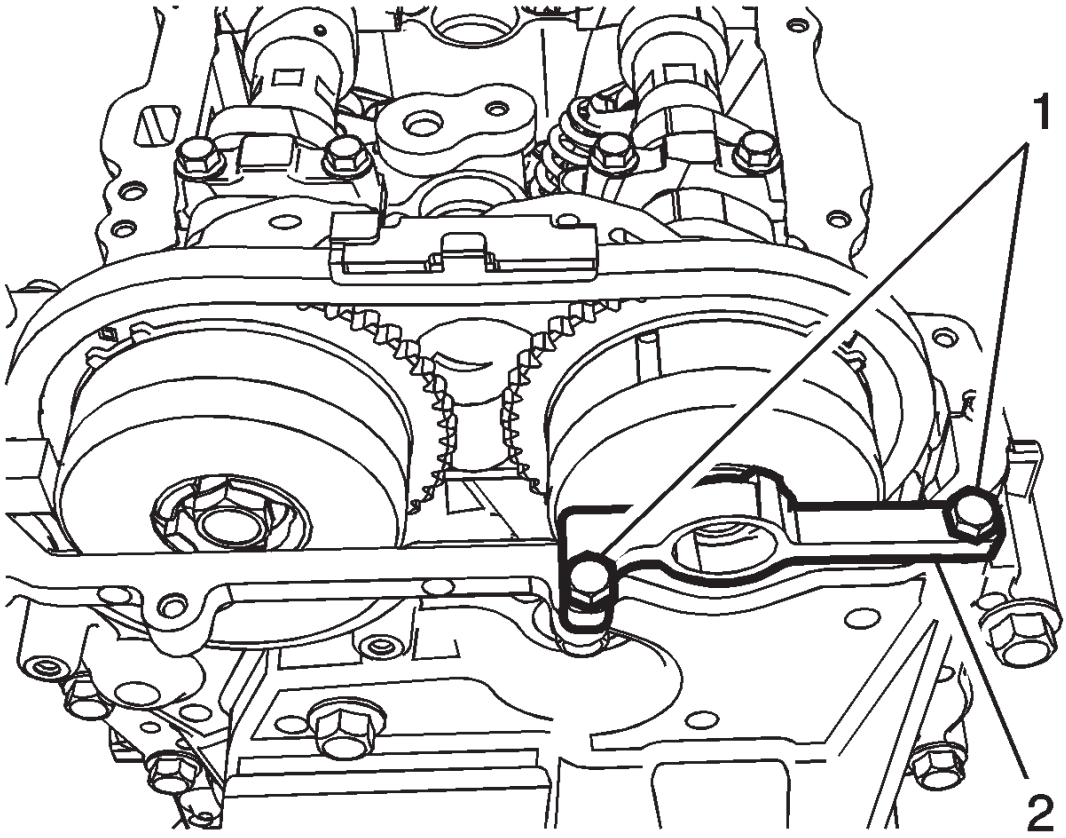

Fig. 141: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50793** holding tool (2).

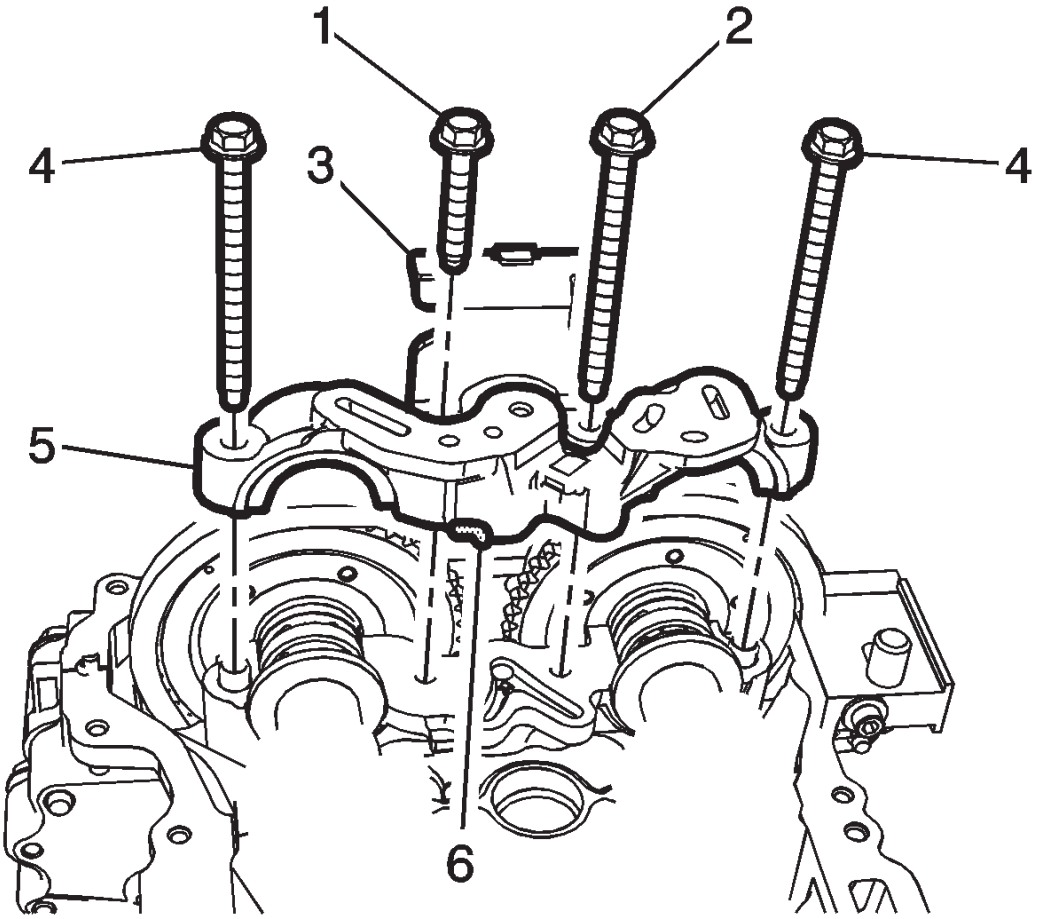

Fig. 142: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper timing chain guide bolts (1, 2).
8. Remove the upper timing chain guide (3).
9. Remove the camshaft front bearing cap bolts (4).

NOTE: **Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.**

10. Remove the camshaft front bearing cap (5).

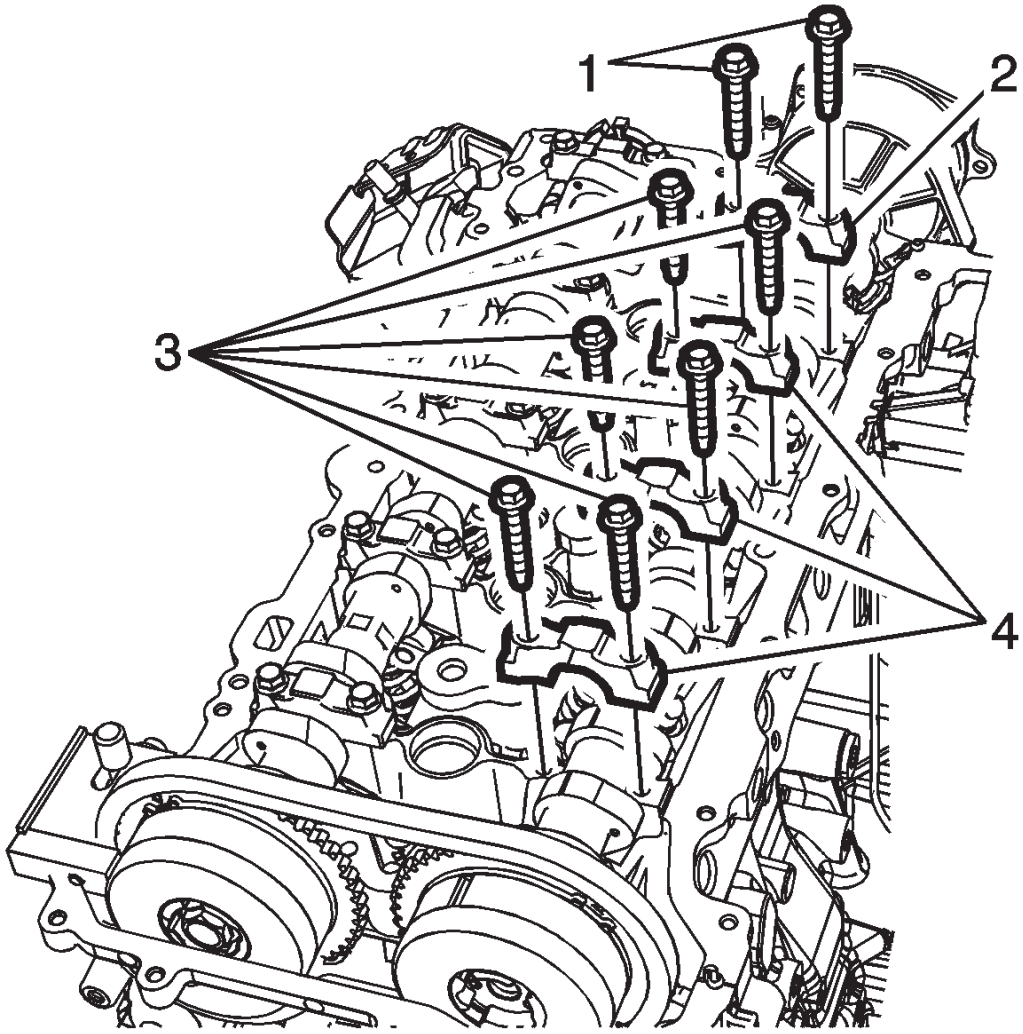

Fig. 143: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

11. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

12. Mark the camshaft caps (4) to ensure they are installed in the same position.
13. Remove the exhaust camshaft cap bolts (3).
14. Remove the camshaft caps (4).

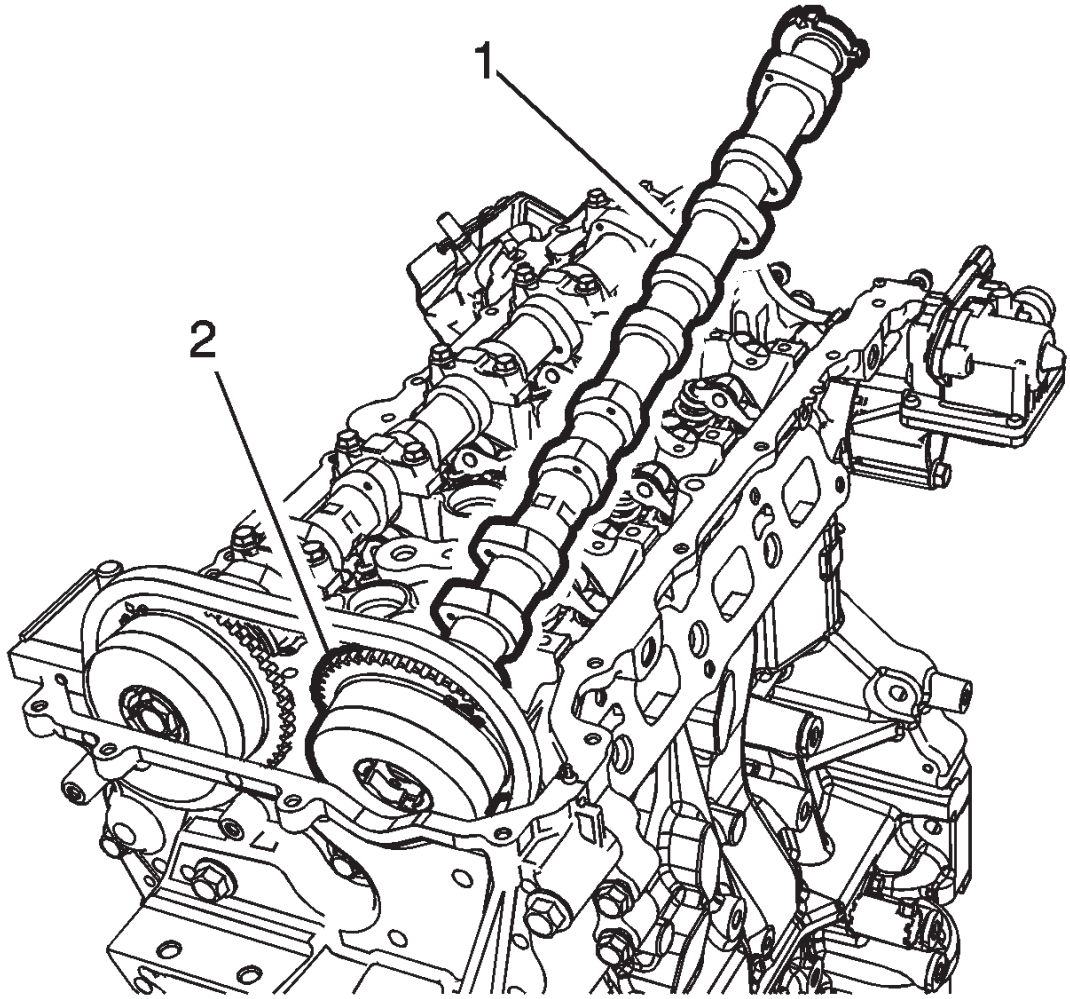

Fig. 144: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

15. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

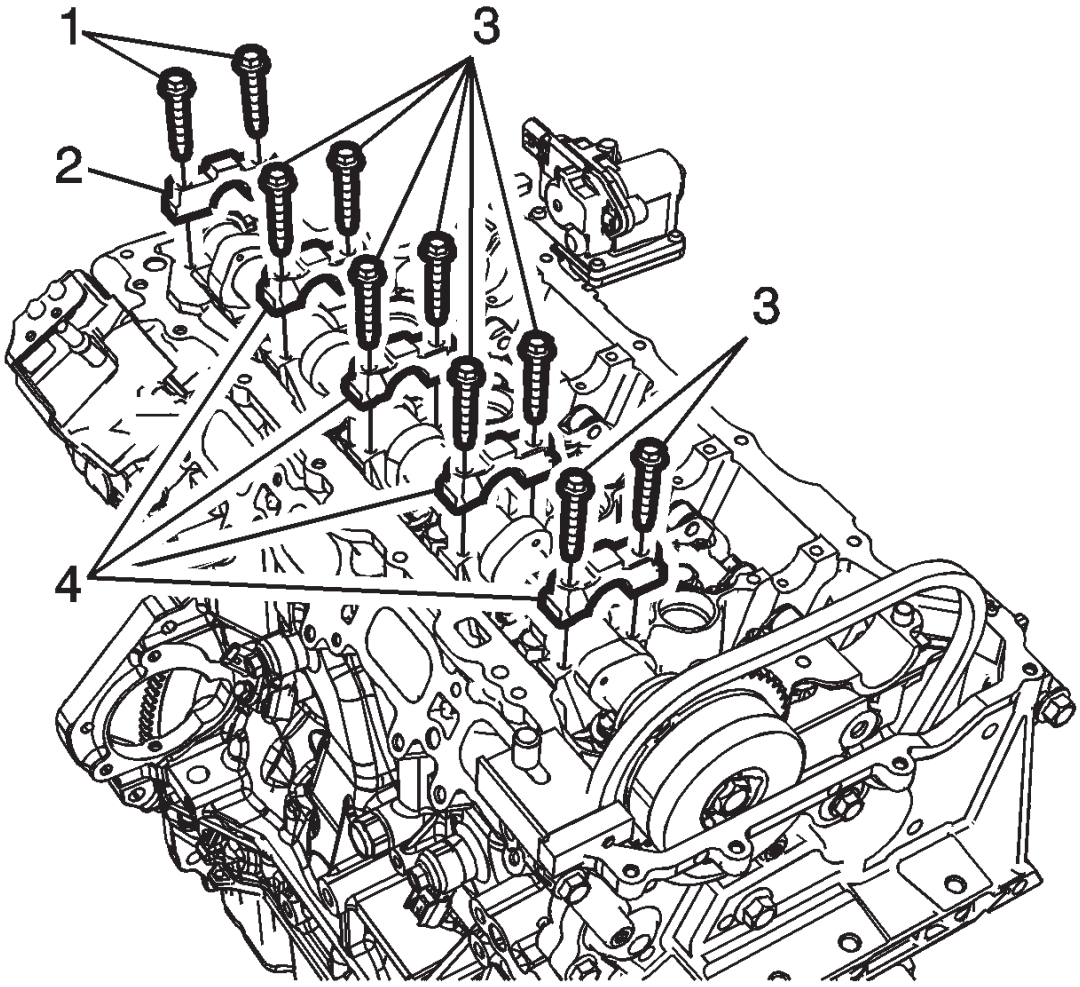

Fig. 145: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

16. Mark the intake camshaft rear cap to ensure it is installed in the same position. Remove the intake camshaft bearing rear cap bolts (1) and cap (2).

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

17. Mark the camshaft caps (4) to ensure they are installed in the same position.
18. Remove the intake camshaft cap bolts (3).
19. Remove the camshaft caps (4).
20. Lift and roll intake camshaft assembly from original position over into exhaust camshaft position within engine head assembly.

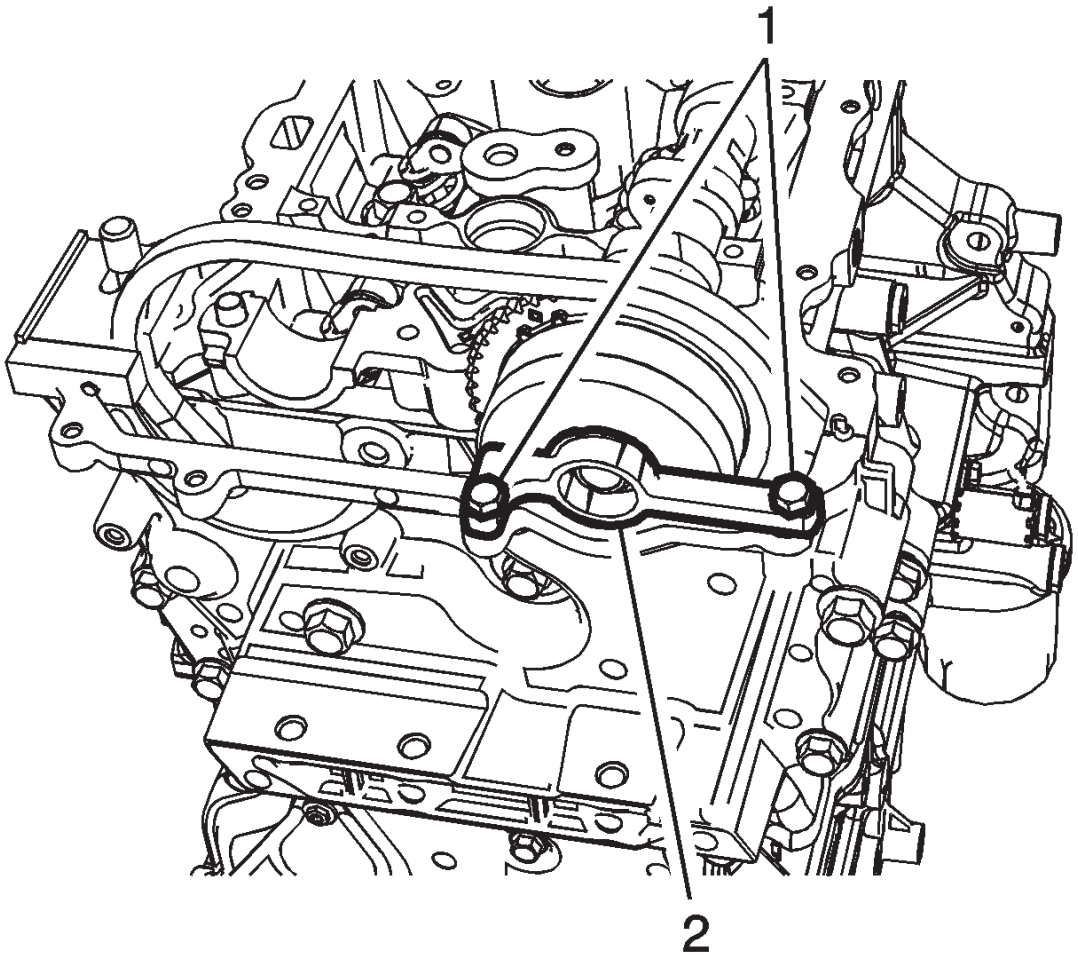

Fig. 146: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

21. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

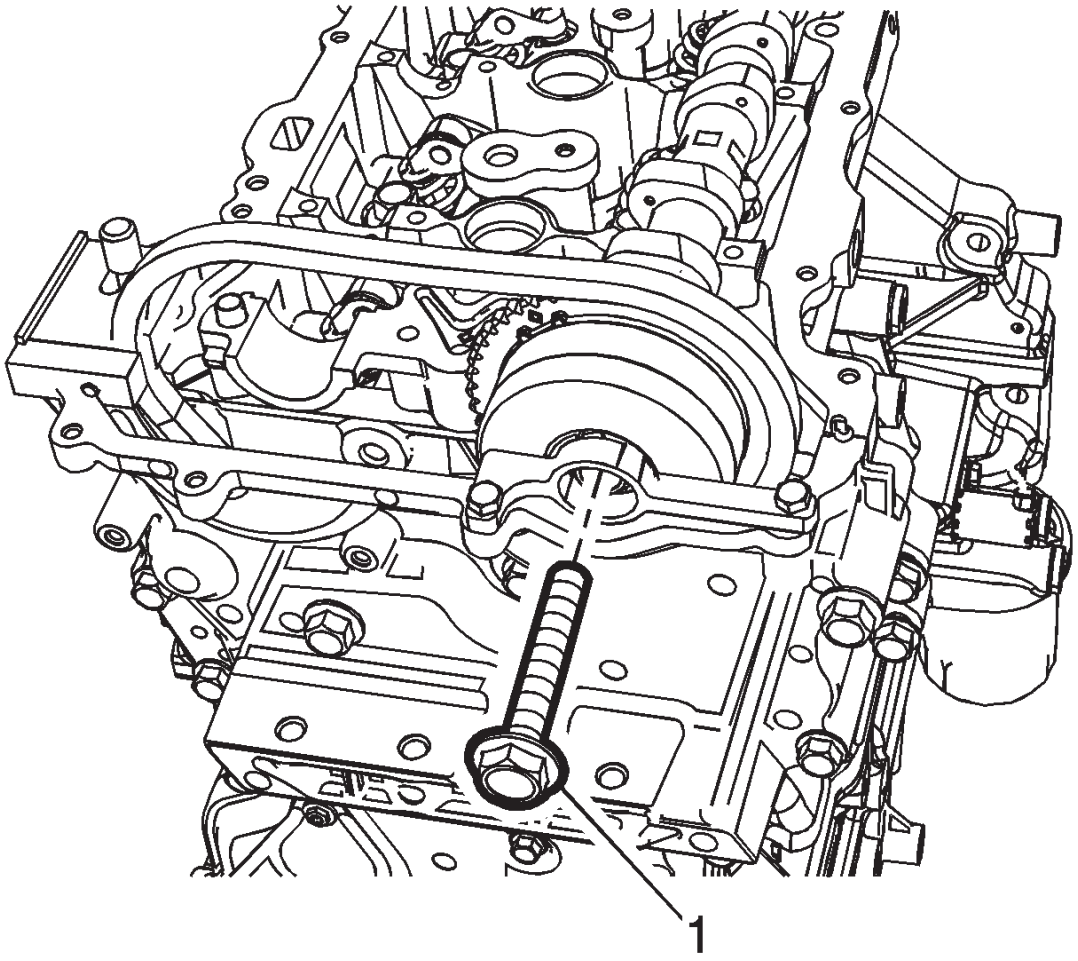

Fig. 147: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove the camshaft actuator bolt (1).

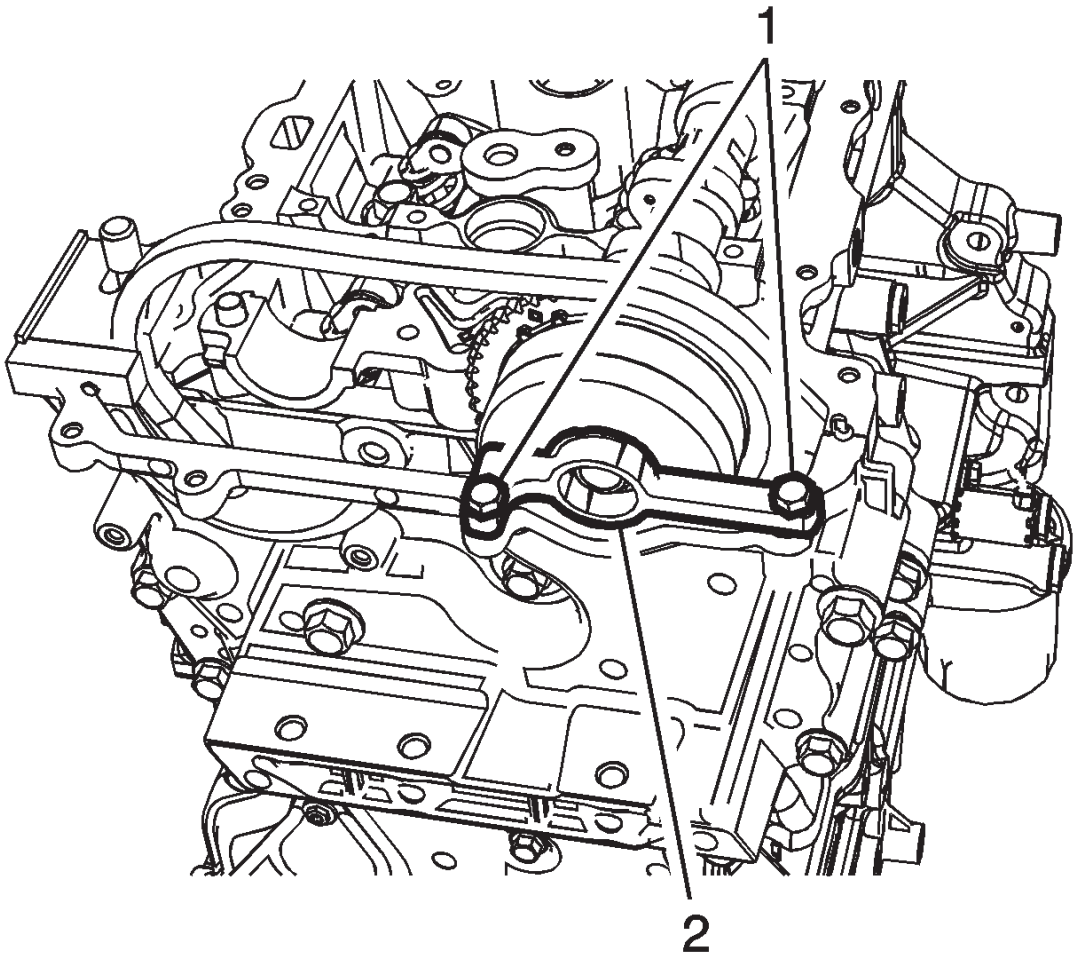

Fig. 148: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

23. Remove the **EN-50793** holding tool (2).

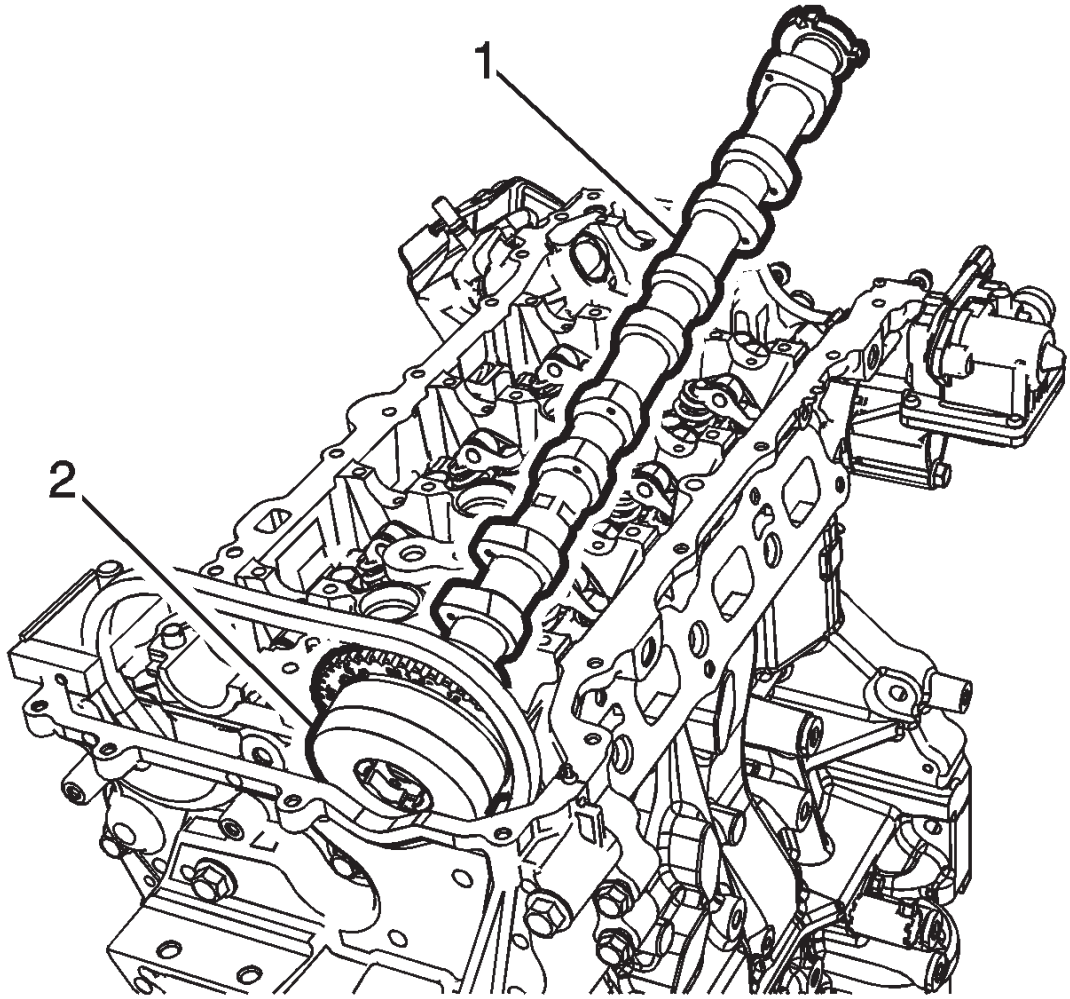

Fig. 149: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

24. Pull intake camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of intake camshaft assembly to a tilt and pull free from intake camshaft actuator assembly (2).

NOTE: **If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.**

25. Replace the camshaft if necessary.

Installation Procedure

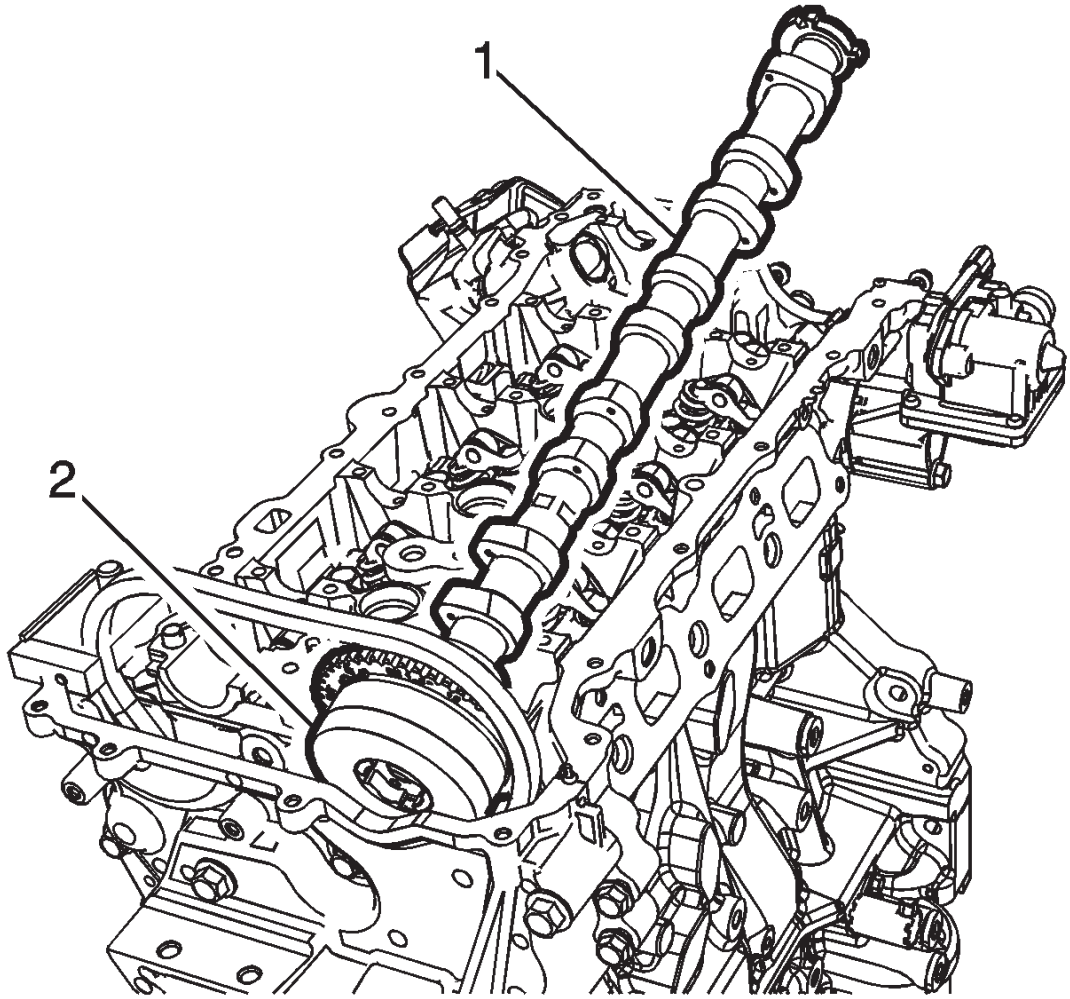

Fig. 150: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake camshaft (1) and camshaft actuator (2).

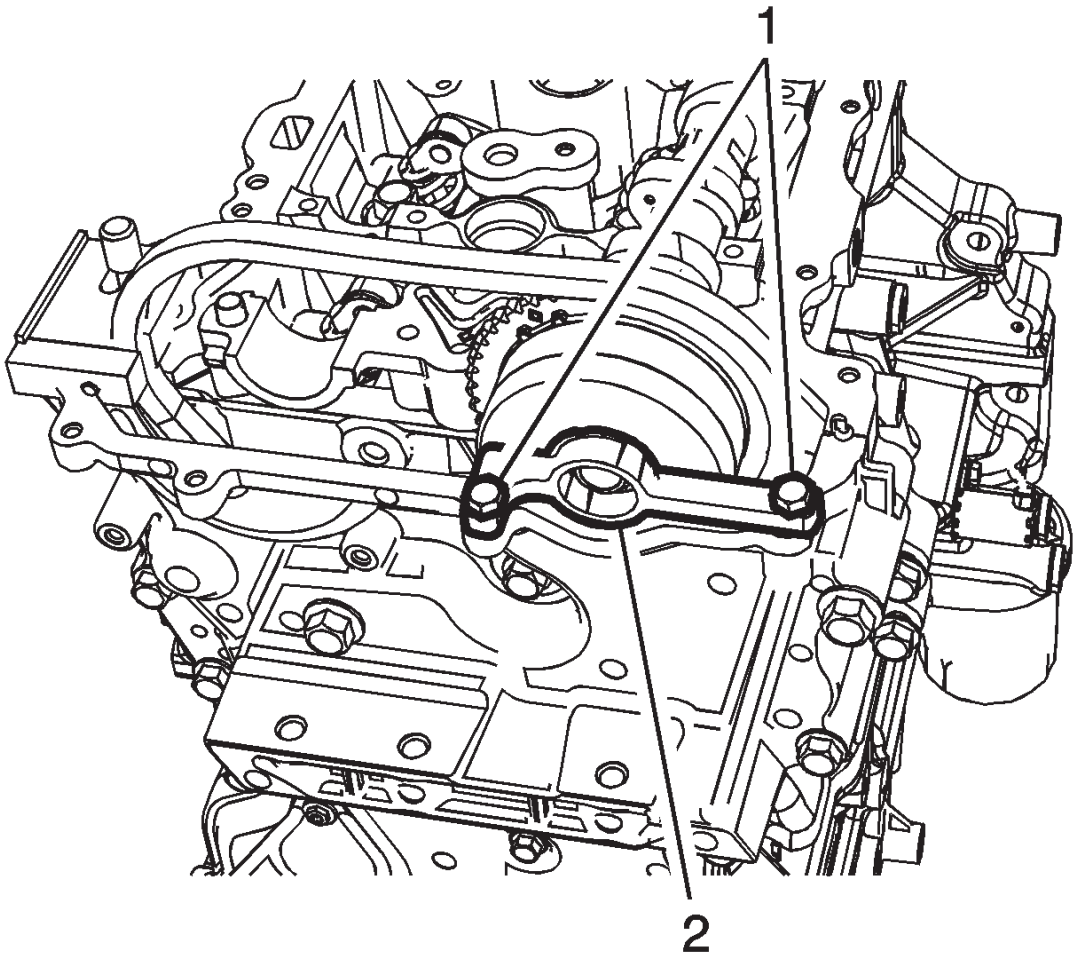

Fig. 151: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

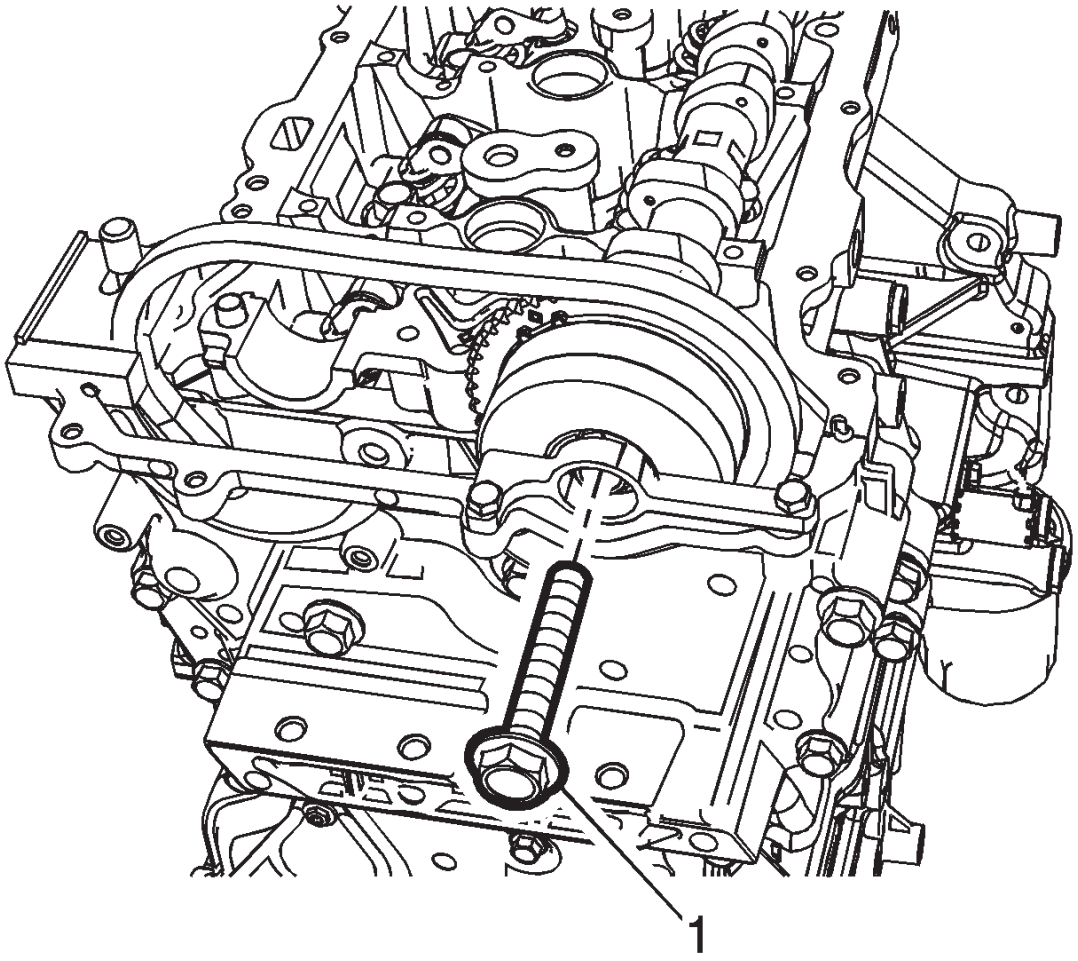

Fig. 152: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 N.m (22 lb ft) plus 100 degrees.
4. Lift and roll intake camshaft assembly from exhaust camshaft position over into original position.

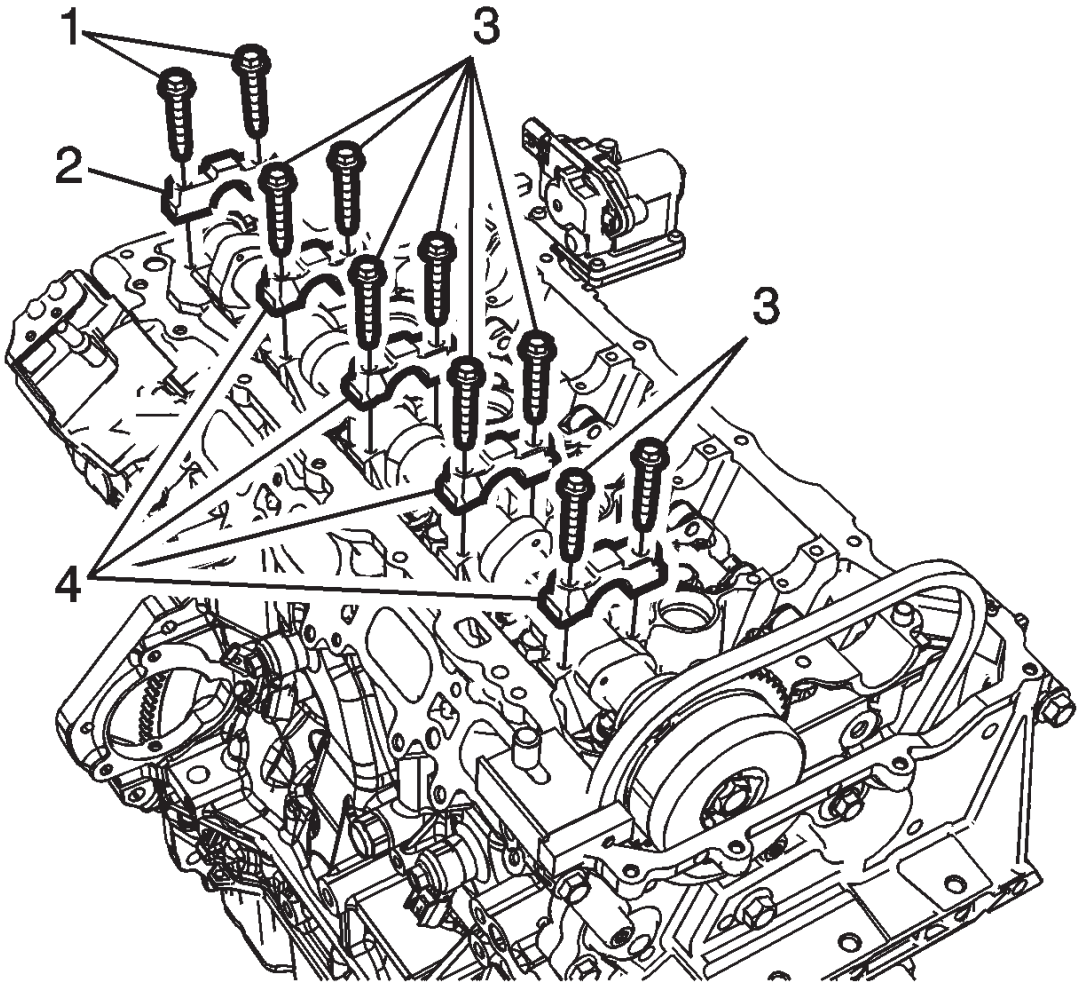

Fig. 153: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Apply lubricant to all lobes and journals prior to installing the camshafts.**

5. Set the intake camshaft on top of the roller followers in the camshaft bearing journals with the intake actuator timing mark at approximately the 11 O'clock position.

NOTE: **To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.**

6. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
7. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

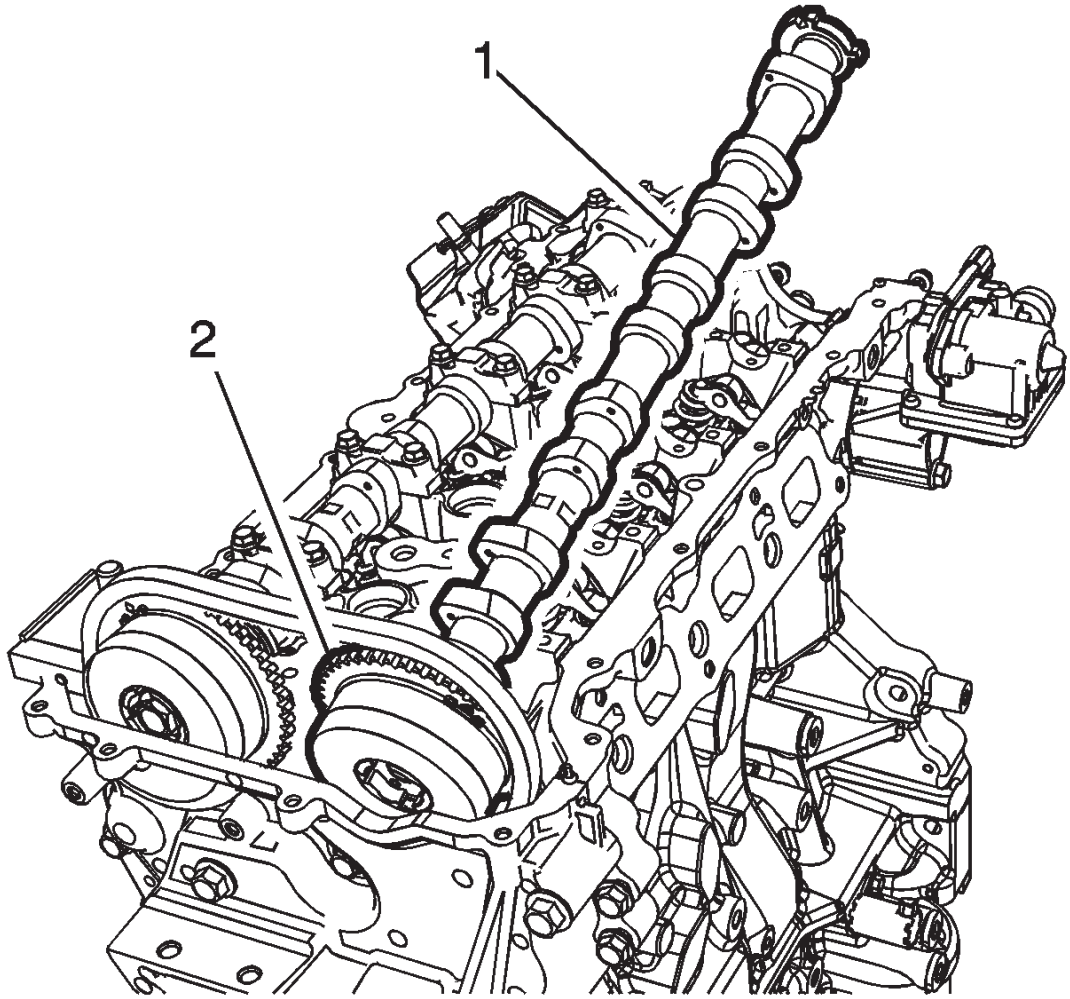

Fig. 154: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust camshaft (1) and camshaft actuator (2).

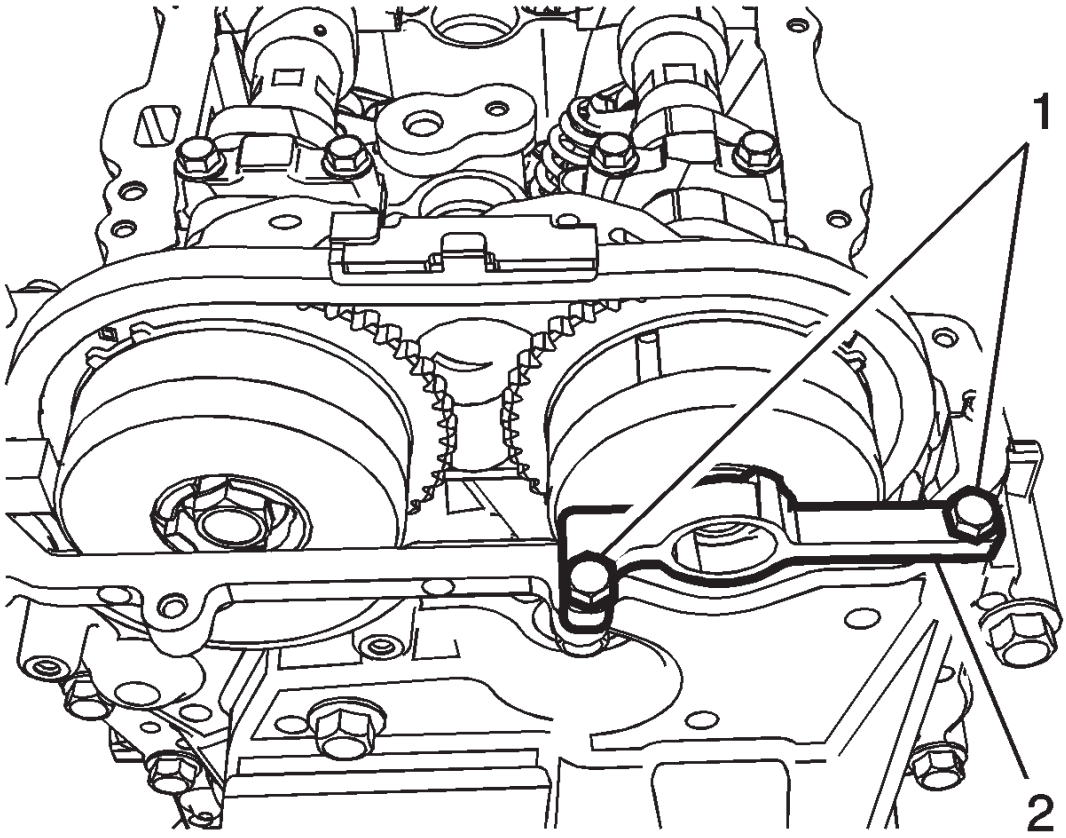

Fig. 155: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

9. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

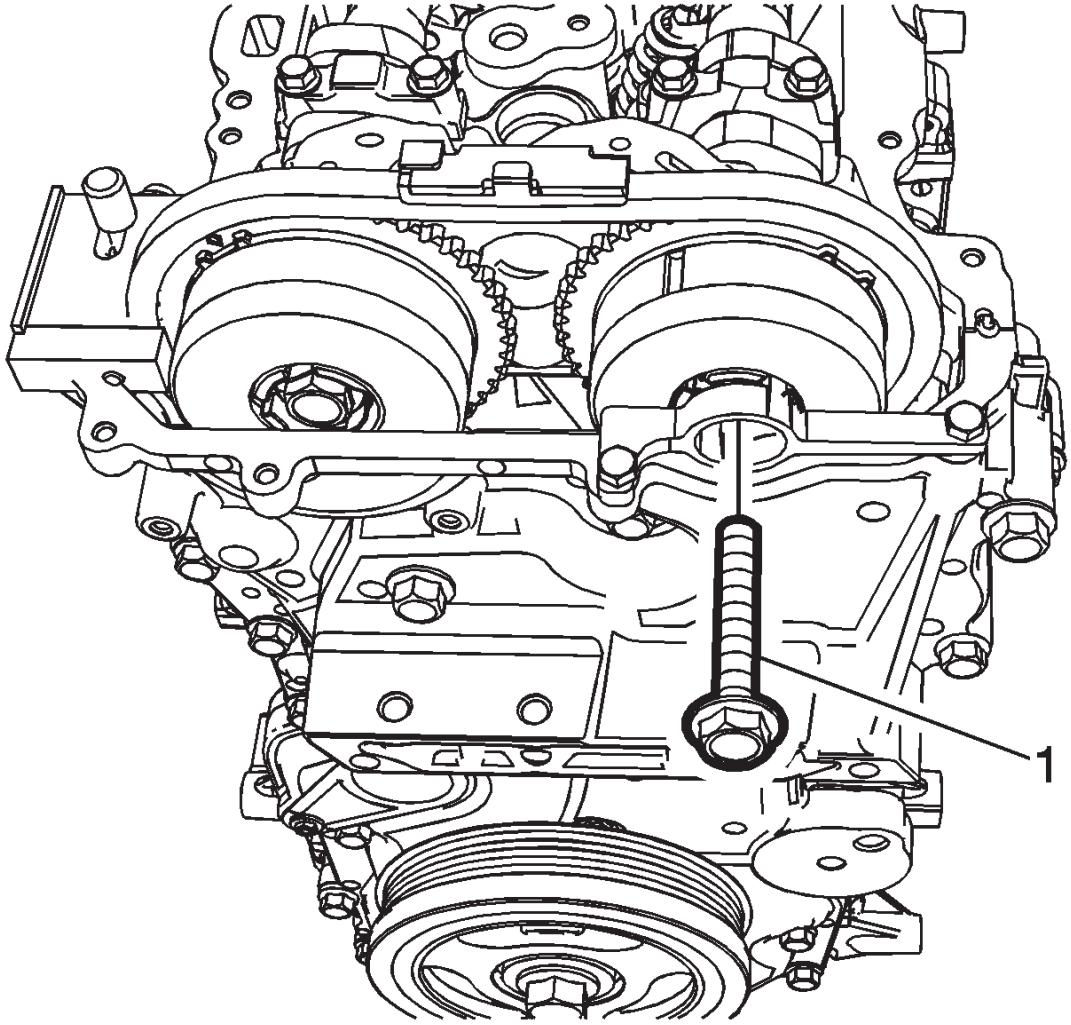

Fig. 156: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install a NEW camshaft actuator bolt (1) and tighten to 30 N.m (22 lb ft) plus 100 degrees.

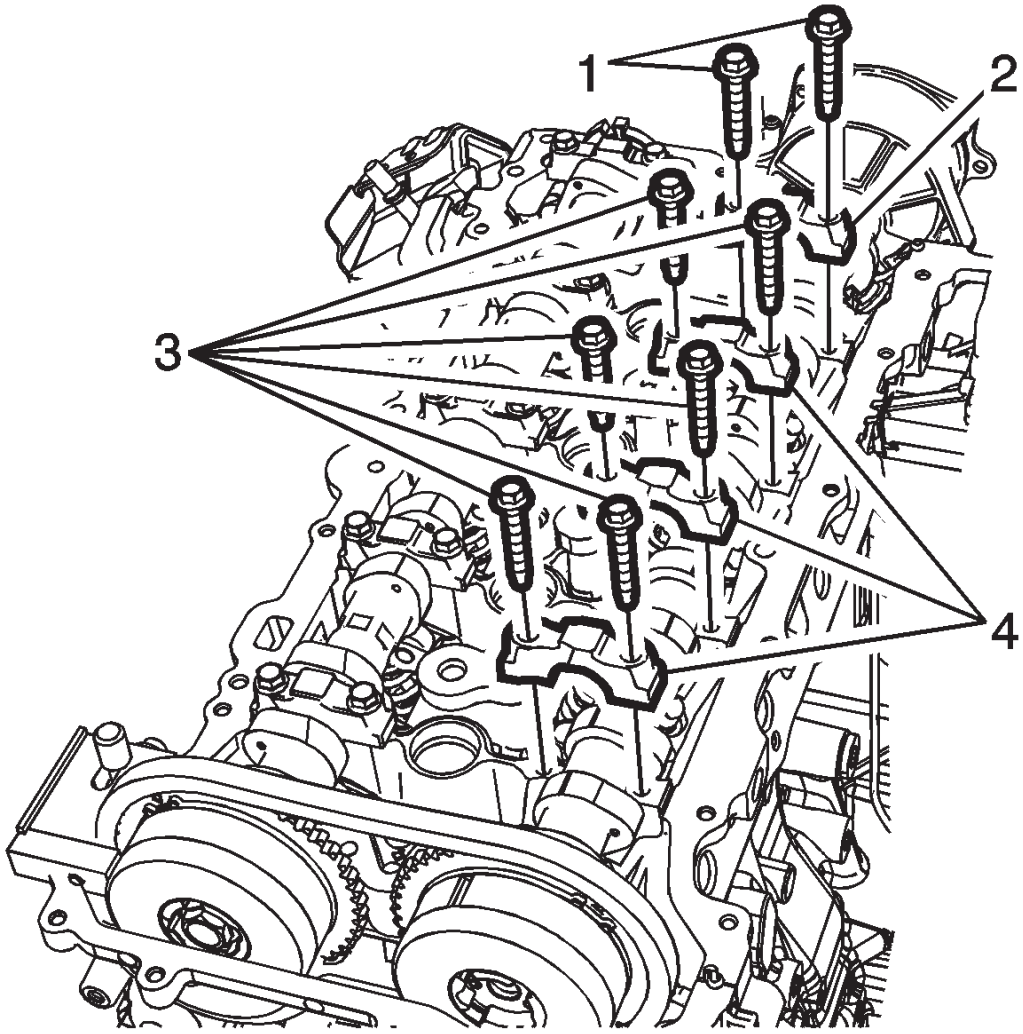

Fig. 157: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Apply lubricant to all lobes and journals prior to installing the camshafts.**

11. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: **To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.**

12. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
13. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

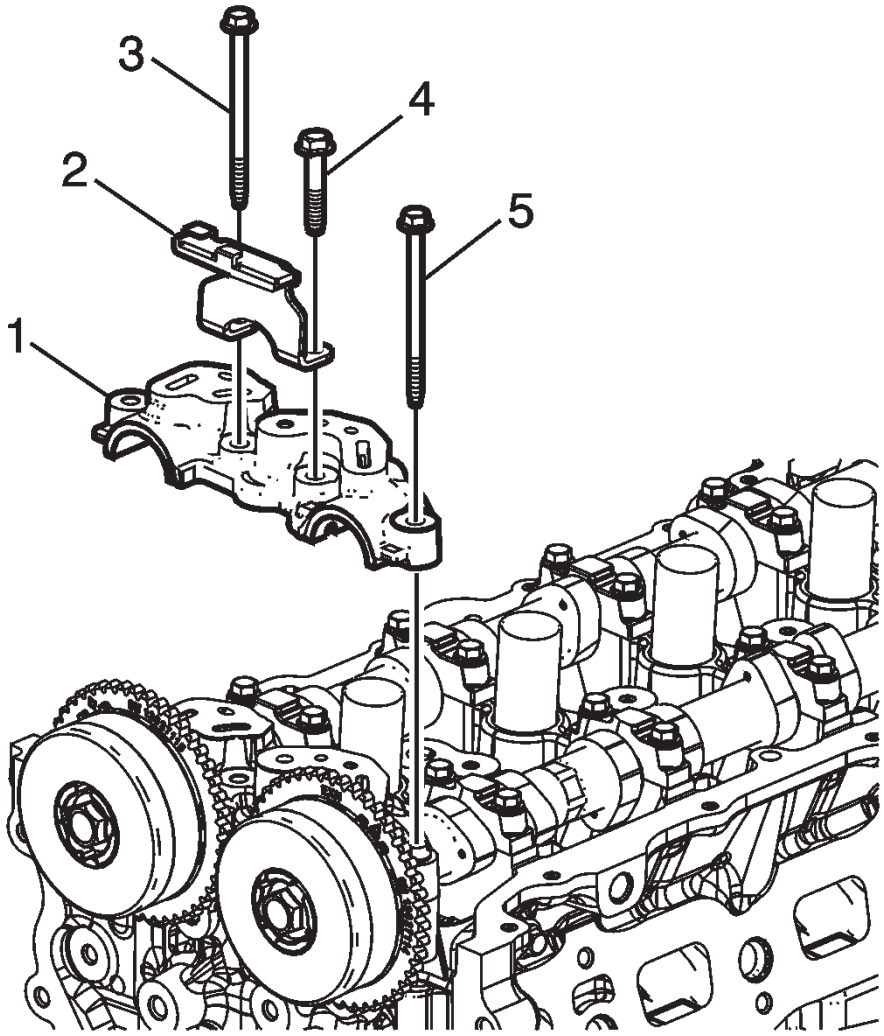

Fig. 158: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

14. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

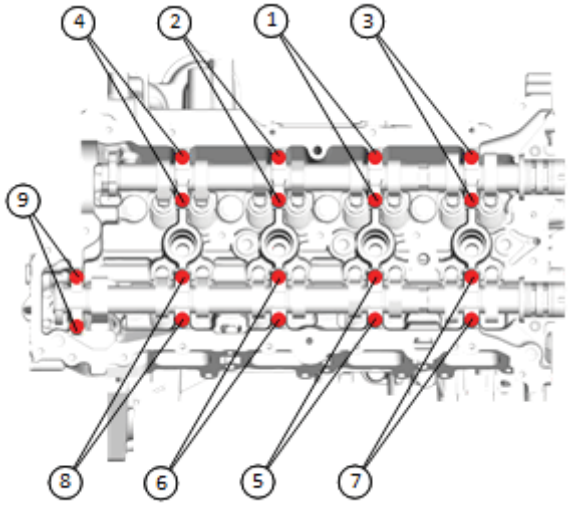

Fig. 159: Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: **During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.**

15. Tighten the camshaft cap bolts in sequence using the following procedure:

1. Tighten the camshaft cap bolts in sequence to 8 N.m (71 lb in).
2. Loosen both bolts in each cap in sequence to 180 degrees.
3. Tighten the camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

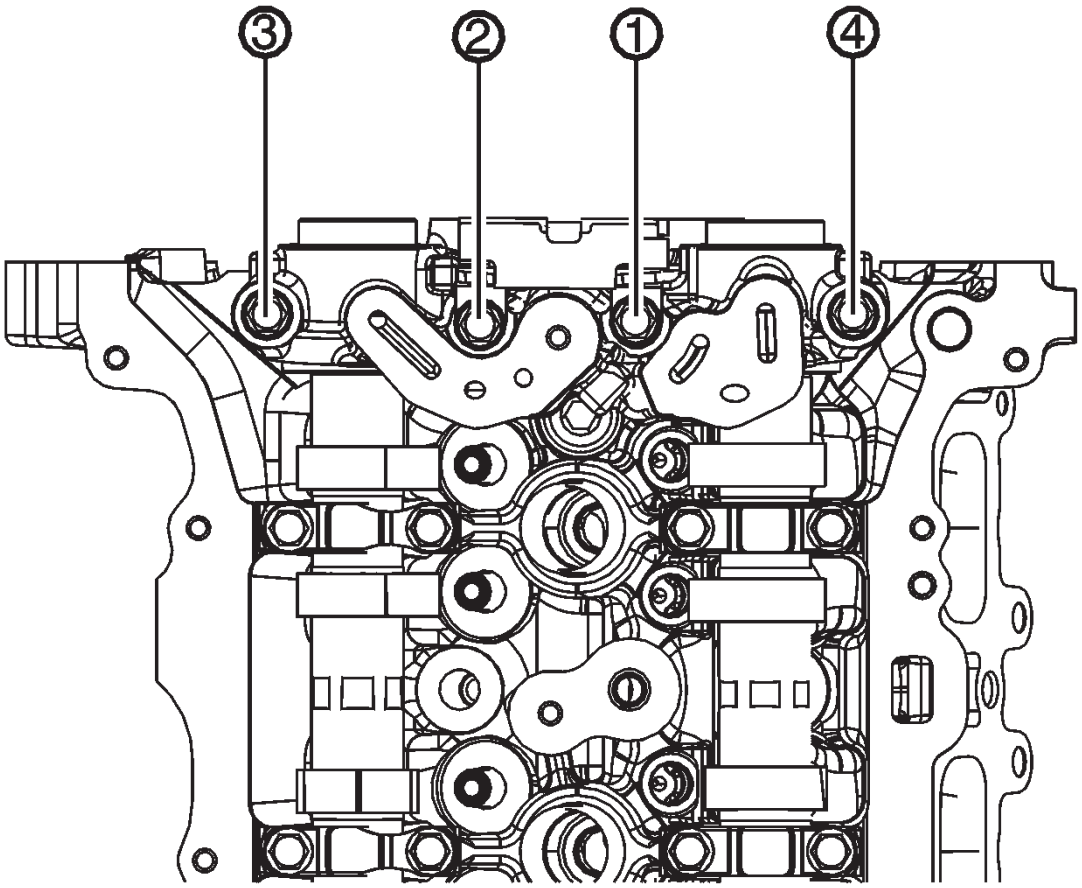

Fig. 160: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

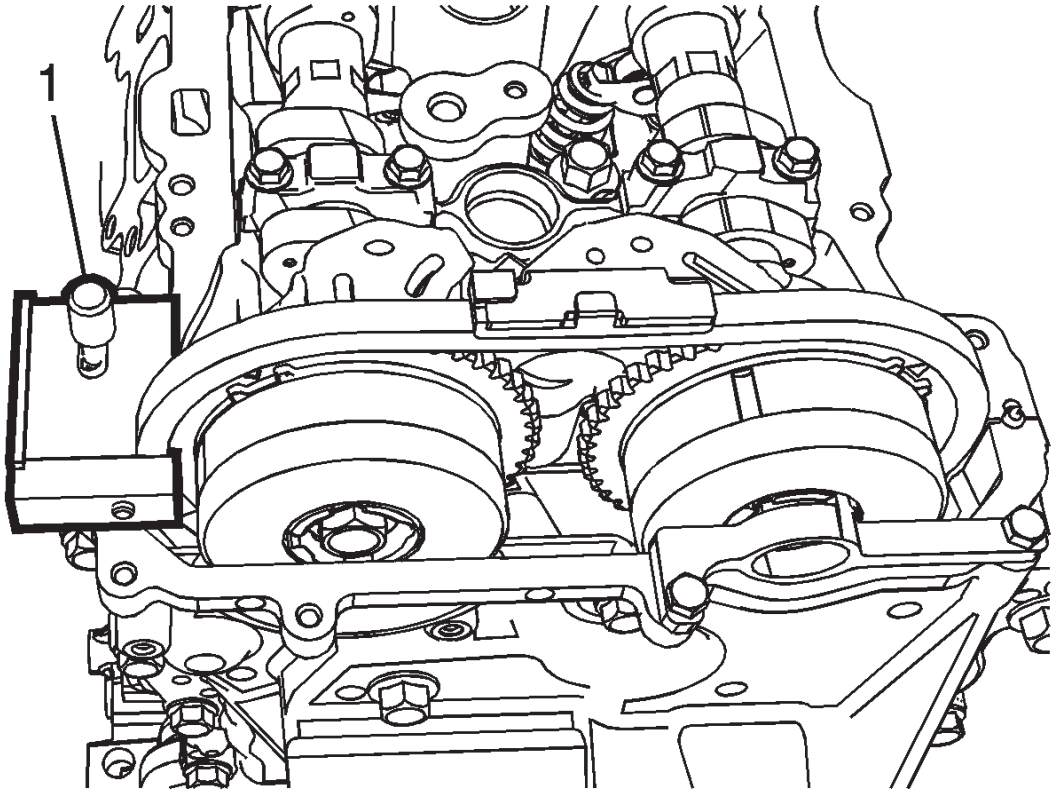

Fig. 161: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove **EN-50656** timing chain holding tool (1).
18. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
19. Install the high pressure fuel pump. Refer to **Fuel Pump Replacement** .

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - EXHAUST

Special Tools

- **EN-50656** Holding Tool
- **EN 50793** Locking Tool

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

Removal Procedure

NOTE: **Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.**

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.

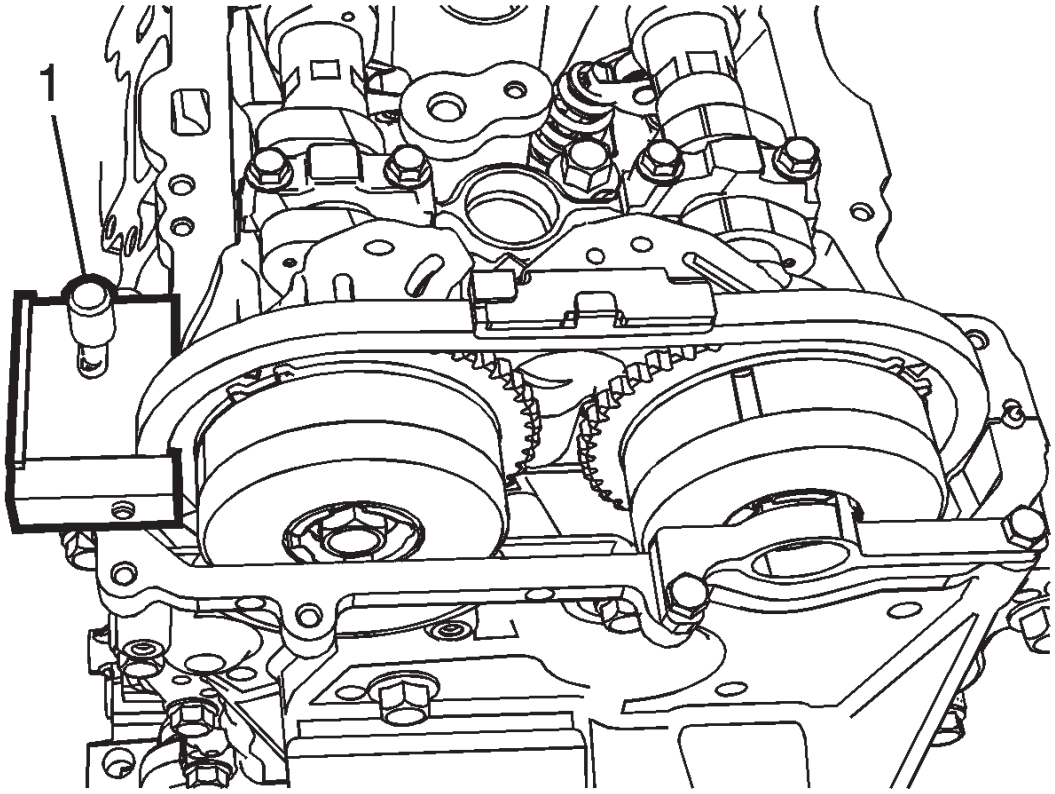

Fig. 162: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the EN-50656 Holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.**

2. Install **EN-50656** timing chain holding tool (1) and tighten to 8 N.m (71 lb in).

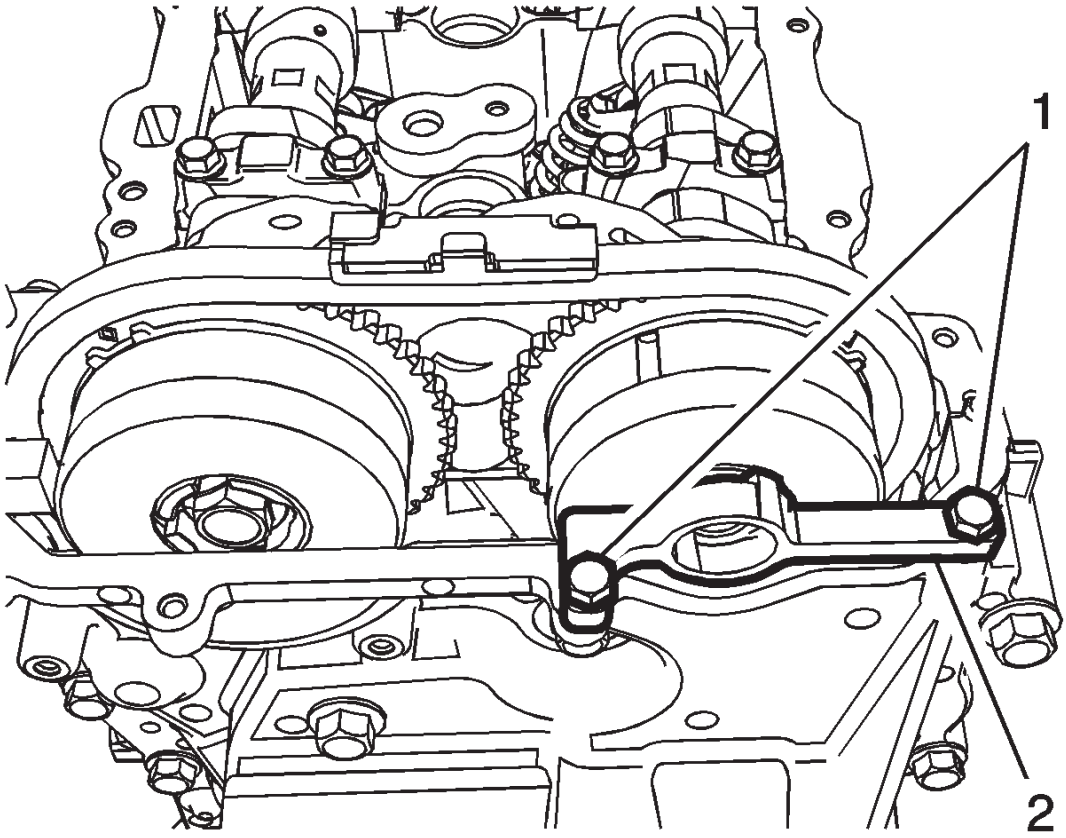

Fig. 163: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Ensure to mark actuator sprocket and chain before removal.**

3. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

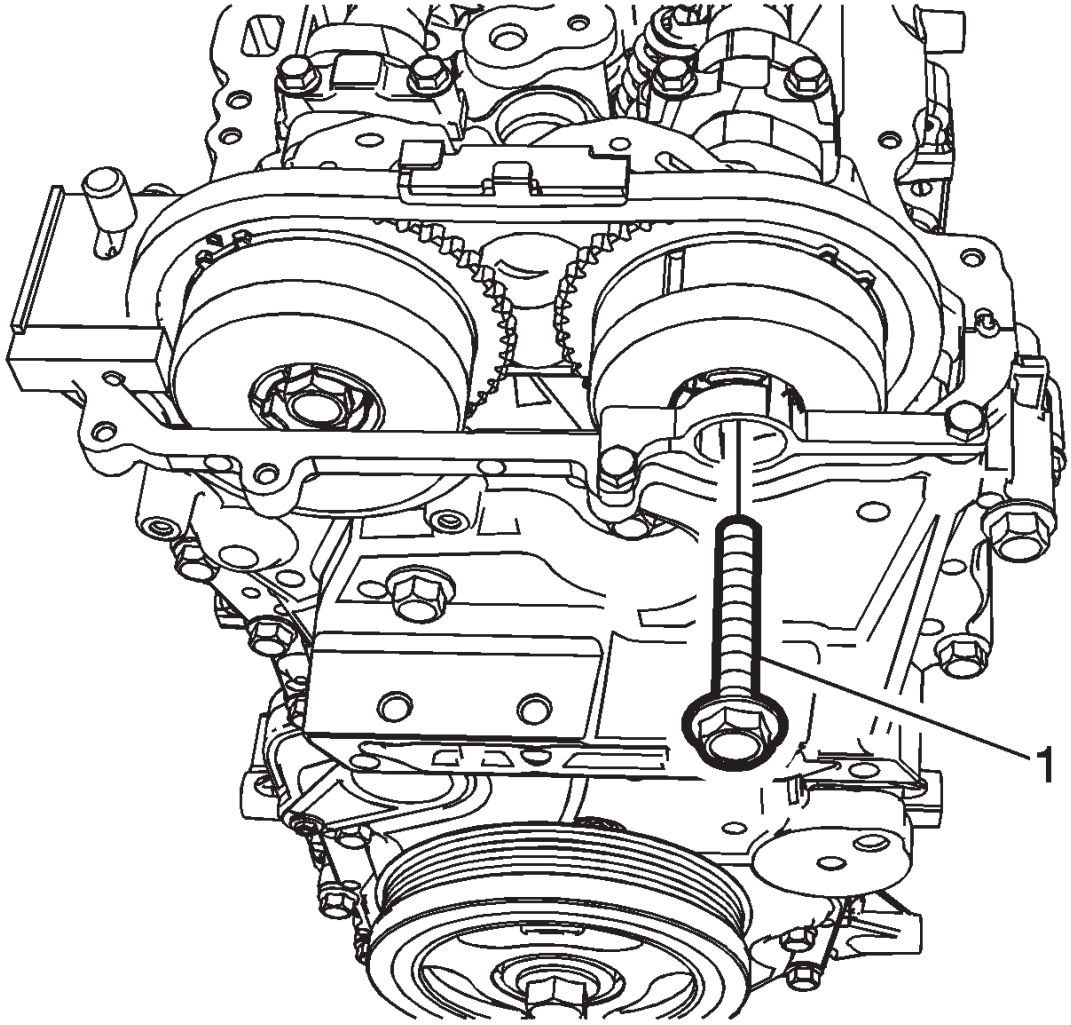

Fig. 164: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the camshaft actuator bolt (1).

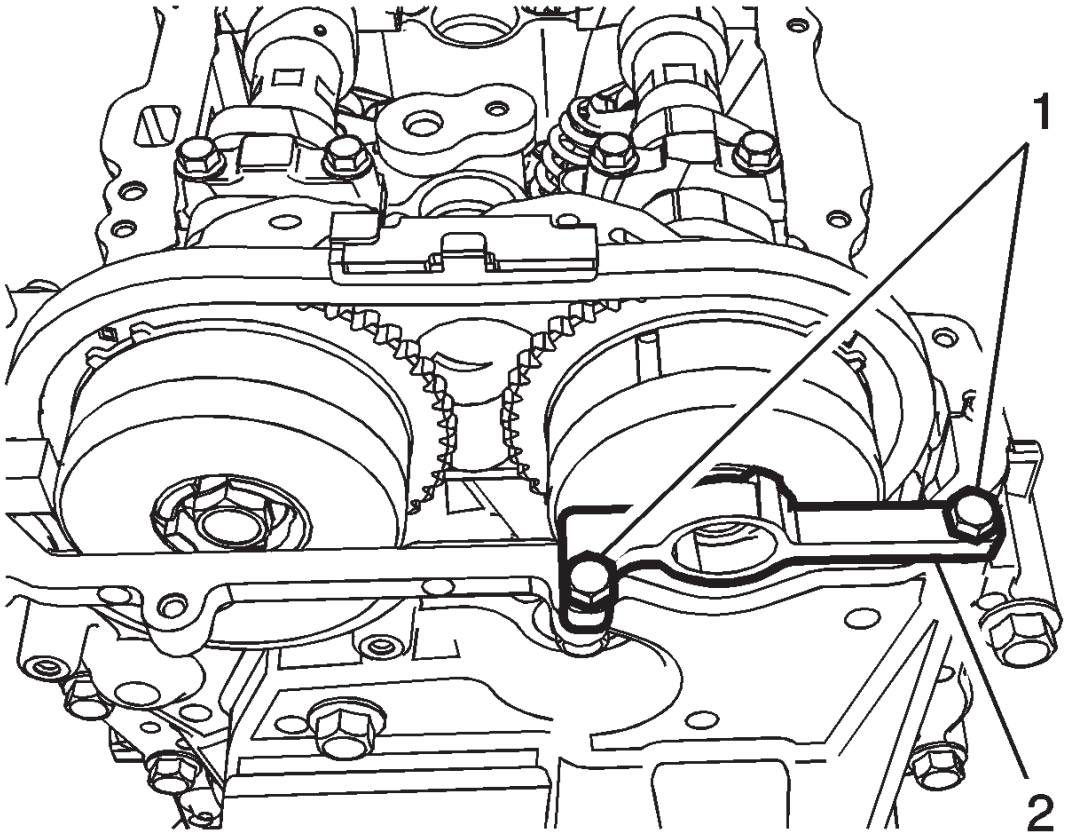

Fig. 165: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-50793** holding tool (2).

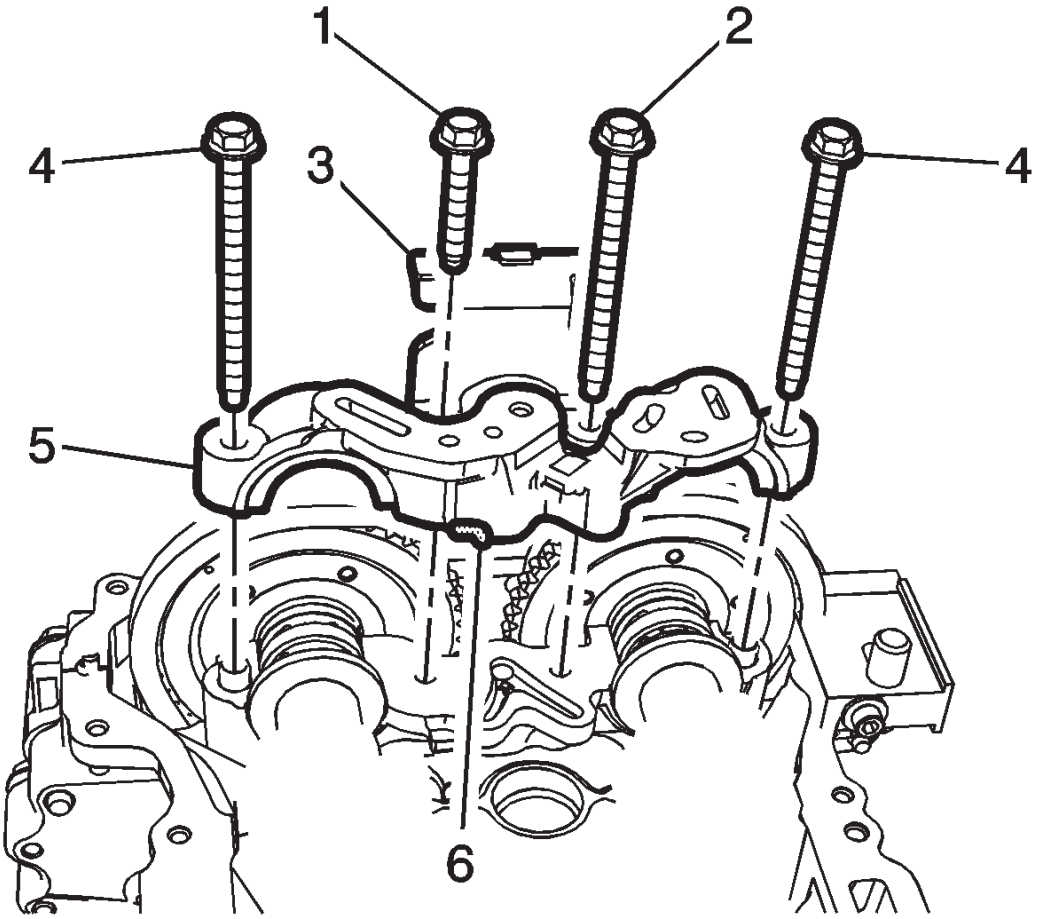

Fig. 166: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper timing chain guide bolts (1, 2).
7. Remove the upper timing chain guide (3).
8. Remove the camshaft front bearing cap bolts (4).

NOTE: **Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.**

9. Remove the camshaft front bearing cap (5).

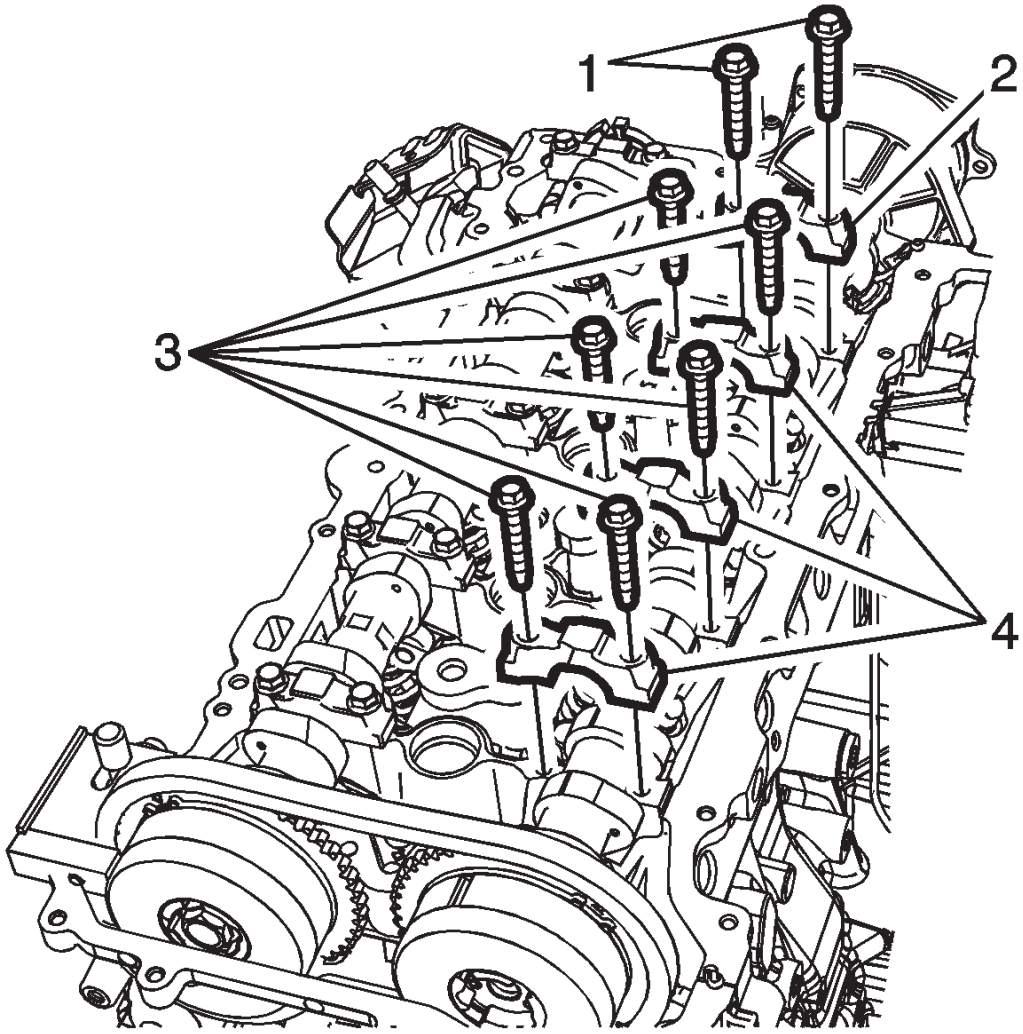

Fig. 167: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

10. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

11. Mark the camshaft caps (4) to ensure they are installed in the same position.
12. Remove the exhaust camshaft cap bolts (3).
13. Remove the camshaft caps (4).

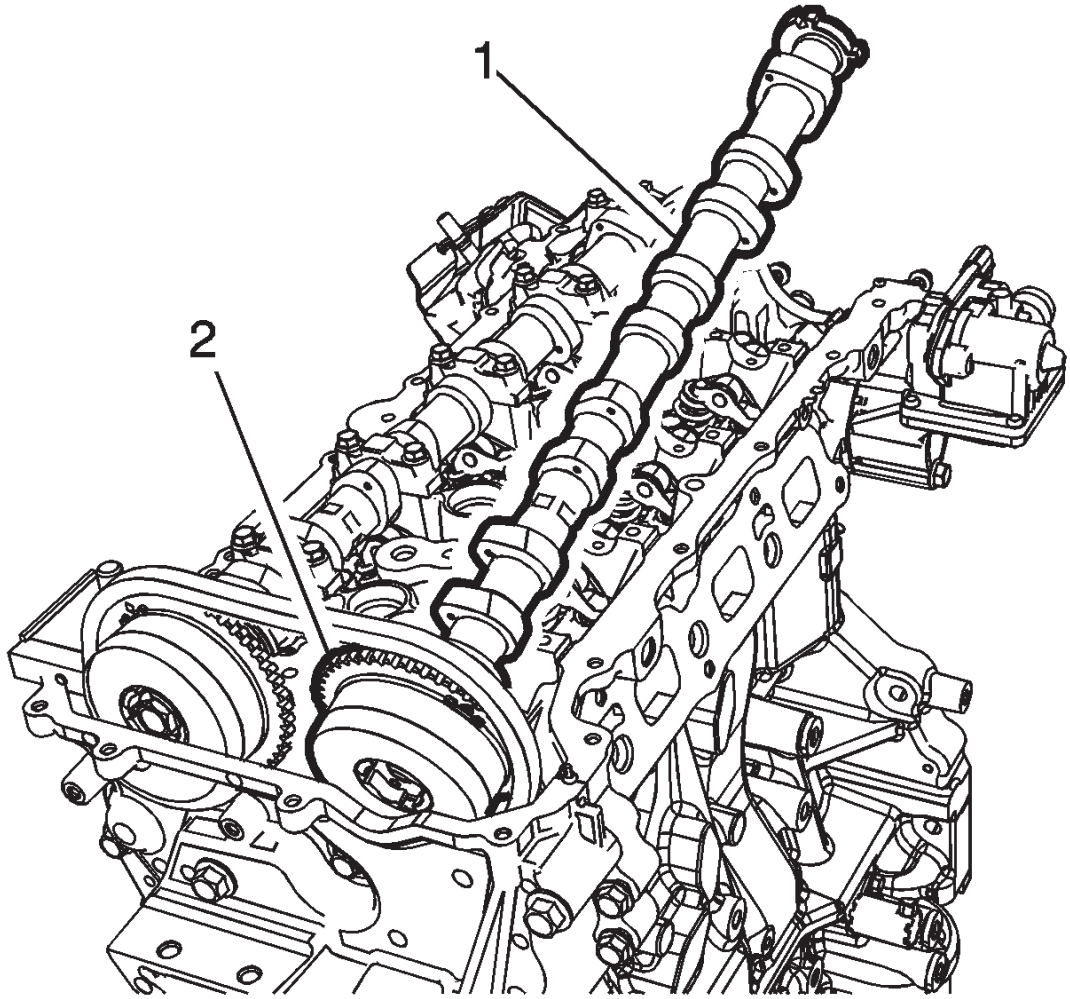

Fig. 168: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

14. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

NOTE: **If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.**

15. Replace the camshaft if necessary.

Installation Procedure

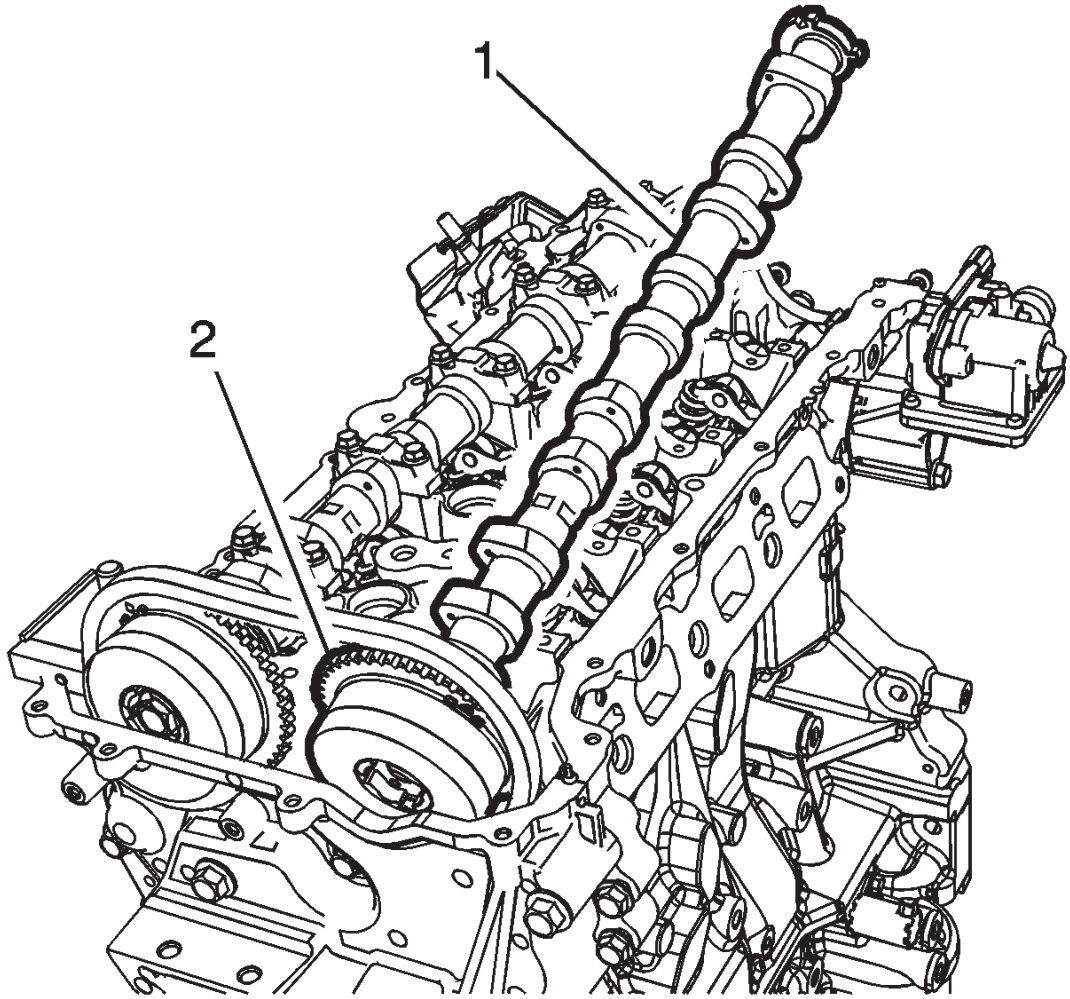

Fig. 169: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust camshaft (1) and camshaft actuator (2).

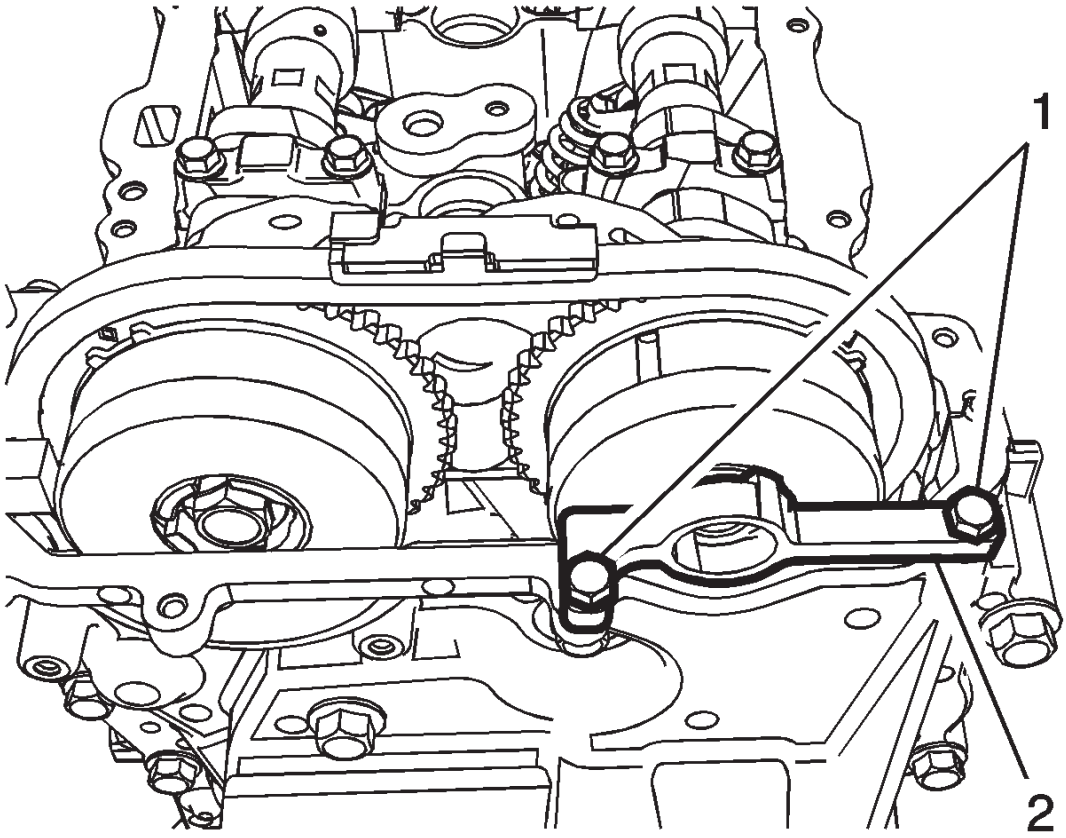

Fig. 170: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

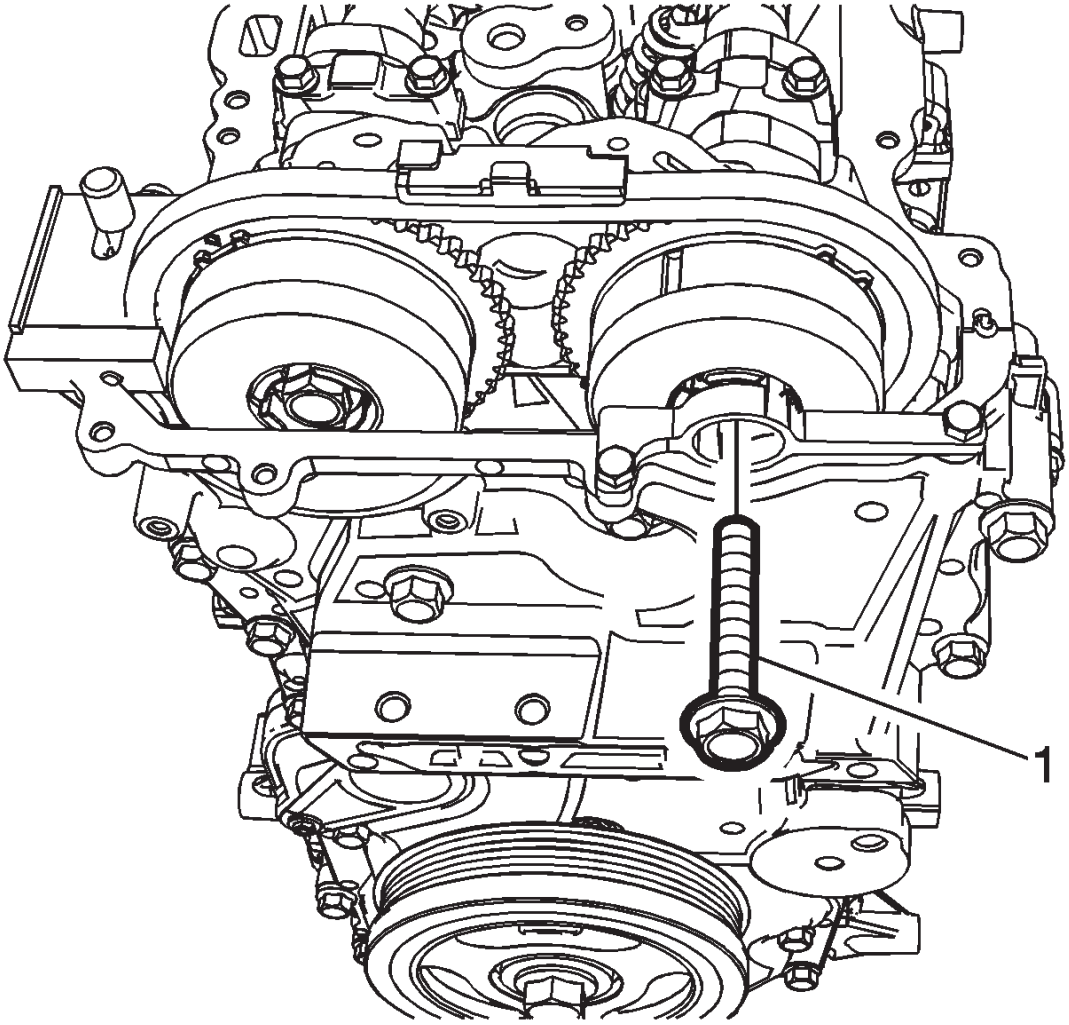

Fig. 171: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 N.m (22 lb ft) plus 100 degrees.

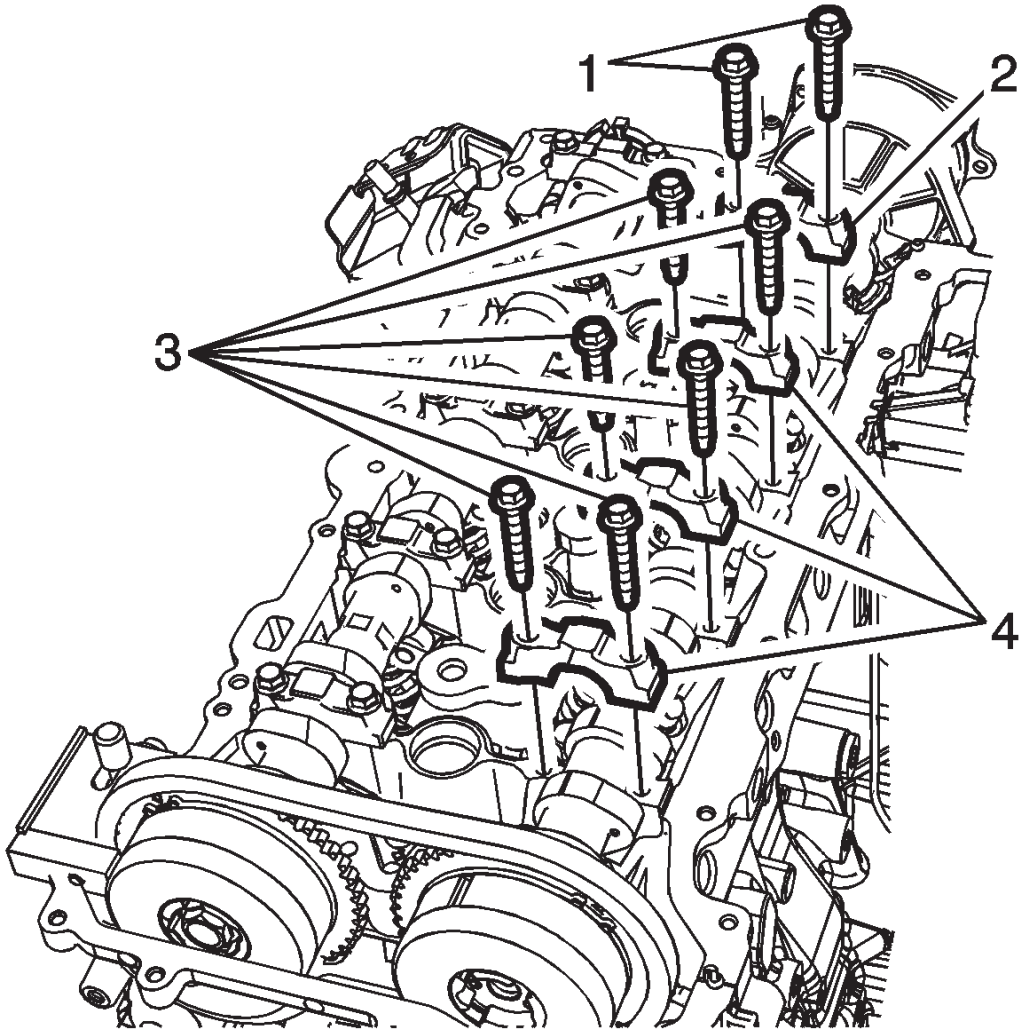

Fig. 172: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

4. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

5. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
6. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

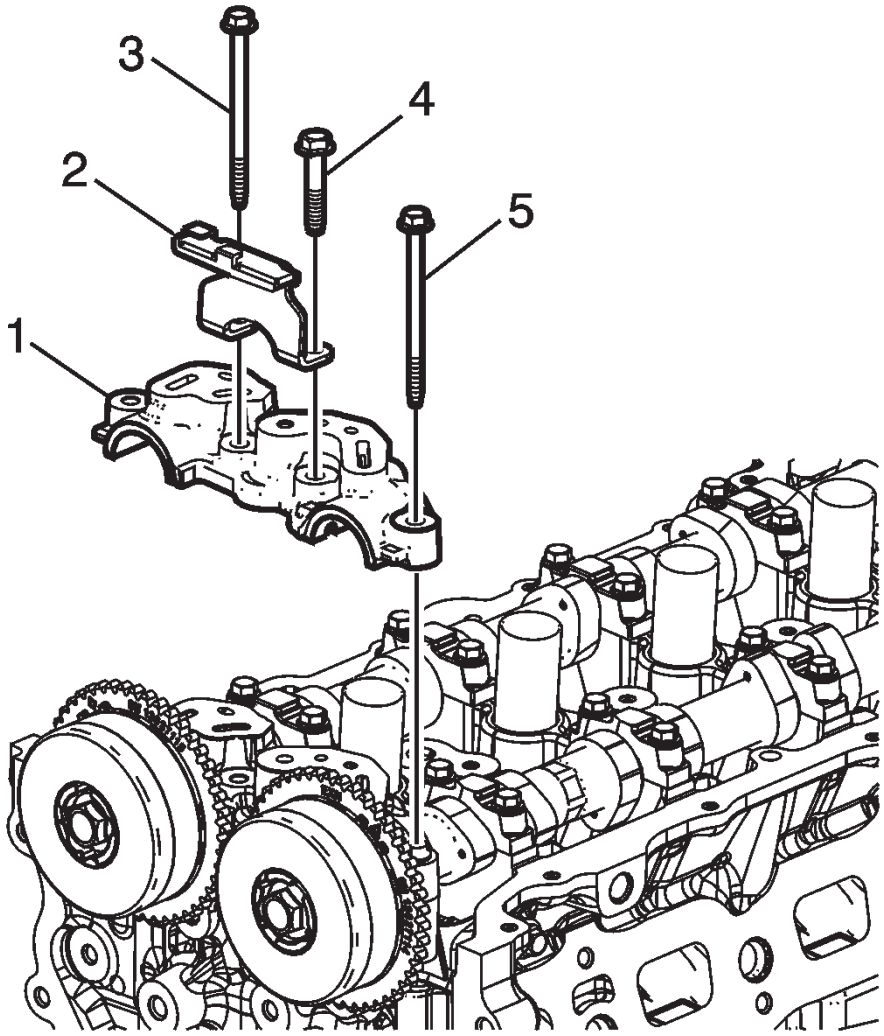

Fig. 173: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

7. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

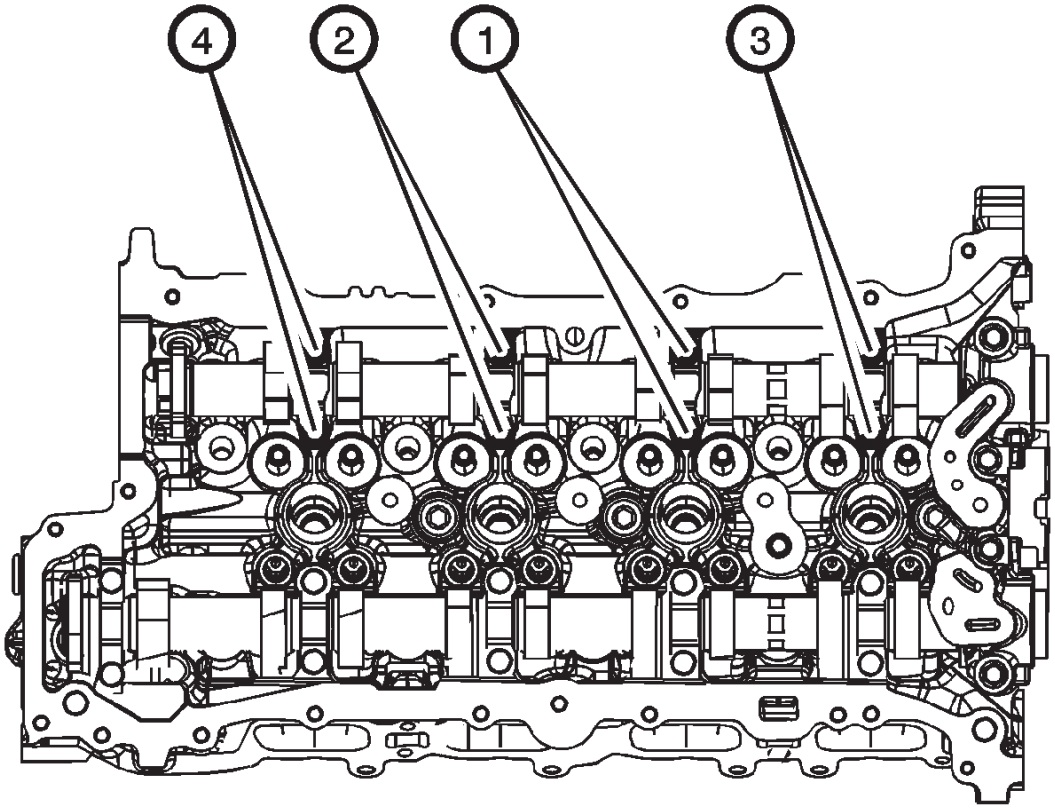

Fig. 174: Camshaft Cap Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: **During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.**

8. Install the camshaft cap bolts in sequence using the following procedure:
    1. Tighten the camshaft cap bolts in sequence to 8 N.m (71 lb in).
    2. Loosen both bolts in each cap in sequence to 180 degrees.
    3. Tighten the camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

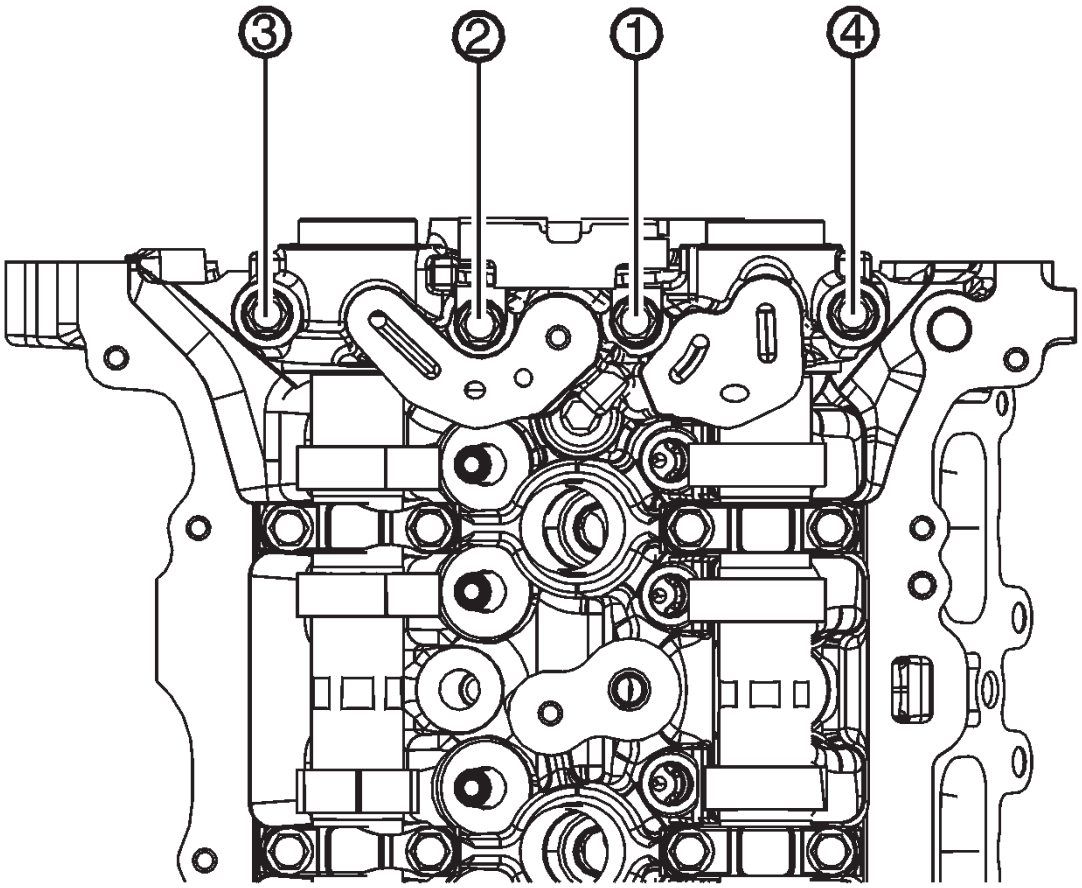

Fig. 175: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

9. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

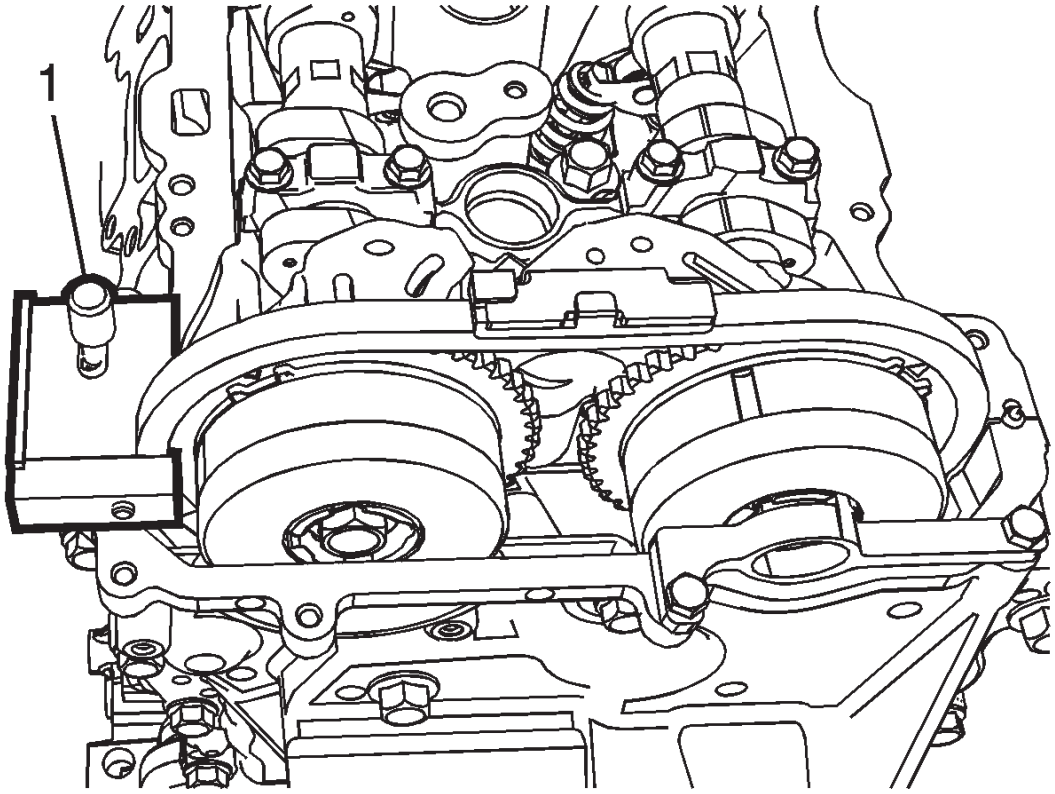

Fig. 176: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove **EN-50656** timing chain holding tool (1).
11. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

CAMSHAFT COVER HEAT SHIELD REPLACEMENT (LCV)