Additions, Revisions, or Updates

<table>
<thead>
<tr>
<th>Publication Number / Title</th>
<th>Platform</th>
<th>Section Title</th>
<th>Change</th>
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<tbody>
<tr>
<td>DDC-SVC-MAN-0081</td>
<td>DD Platform EuroIV</td>
<td>Description and Operation of the Gear Train</td>
<td>Made some minor terminology changes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Installation of the Gear Train</td>
<td>Made several improvements to clarify gear train installation.</td>
</tr>
<tr>
<td></td>
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<td>Checking and Adjusting Gear Lash with Camshaft Housing Removed</td>
<td>Added note regarding incorrect idler gear timing.</td>
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All information subject to change without notice.

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## 2 Description and Operation of Gear Train and Related Parts

The gear train is located at the rear of the engine. The gear train consists of intake and exhaust camshaft gears, idler gears No. 1, 2, 3, 4, 5, crankshaft gear, oil pump gear, fuel pump gear, air compressor gear, and Axial Power Turbine (APT) gear, if equipped.

![DD15 TC and DD16 Engine Gear Train](d010012a)

### Figure 1. DD15 TC and DD16 Engine Gear Train

<table>
<thead>
<tr>
<th>Number</th>
<th>Gear Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Idler Gear No. 1</td>
</tr>
<tr>
<td>2</td>
<td>Idler Gear No. 2</td>
</tr>
<tr>
<td>3</td>
<td>Idler Gear No. 3</td>
</tr>
<tr>
<td>4</td>
<td>Idler Gear No. 4</td>
</tr>
<tr>
<td>5</td>
<td>Idler Gear No. 5</td>
</tr>
<tr>
<td>6</td>
<td>Air Compressor Gear</td>
</tr>
<tr>
<td>7</td>
<td>High Pressure Fuel Pump Gear</td>
</tr>
<tr>
<td>8</td>
<td>Axial Power Turbine Gear</td>
</tr>
<tr>
<td>9</td>
<td>Crankshaft Gear</td>
</tr>
<tr>
<td>10</td>
<td>Oil Pump Gear</td>
</tr>
<tr>
<td>11</td>
<td>Camshaft Gear Exhaust</td>
</tr>
<tr>
<td>12</td>
<td>Camshaft Gear Intake</td>
</tr>
<tr>
<td>13</td>
<td>A. Level A</td>
</tr>
<tr>
<td>14</td>
<td>B. Level B</td>
</tr>
<tr>
<td>15</td>
<td>C. Level C</td>
</tr>
<tr>
<td>16</td>
<td>X. To Front of Engine</td>
</tr>
</tbody>
</table>

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The gear train on the DD Platform engines is located at the rear of the engine and has three levels. Level A consists of the outermost gears (closest to the flywheel), Level B consists of the middle gears, and Level C consists of the innermost gears (closest to the cylinder block). The gears in the gear train are both directly and indirectly driven by the crankshaft gear.

NOTE: On the DD13 and DD15 AT engines, there is no Axial Power Turbine (APT) and no idler gear No. 4. The only exception is a DD13 with a Rear Engine Power Takeoff (REPTO). Those engines use idler gear No. 4 to drive the PTO.

- Level A: The outermost gears include the crankshaft gear which drives the outer idler gear No. 1 and the oil pump gear. Idler gear No. 4 (if equipped) is on the crankshaft gear and the Axial Power Turbine (APT) drives the idler gear No. 4 when the APT is creating power. The APT can add additional torque to the crankshaft through idler gear No. 4 up to 260 N·m (192 lb·ft). These gears are all helical-cut.
- Level B: The middle gears include idler gear No. 1, which drives the air compressor gear and the idler gear No. 2. Idler gear No. 2 drives the high pressure fuel pump and idler gear No. 3. These gears are all straight-cut.
- Level C: The innermost gears include inner idler gear No. 3 which drives idler gear No. 5. Idler gear No. 5 drives both intake and exhaust camshafts. These gears are all straight-cut.

Gear train noise is an indication of excessive gear lash, chipped or burred gear teeth. A rattling noise usually indicates excessive gear lash. A whining noise indicates too little gear lash. Therefore, when noise develops in a gear train, the gear train needs to be inspected.
3 Removal of the Gear Train

### Table 1.

<table>
<thead>
<tr>
<th>Tool Number</th>
<th>Tool Name</th>
<th>Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>J-46392 or W904589046300</td>
<td>Engine Barring Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-47486</td>
<td>Shoulder Bolt</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589001500</td>
<td>Top Dead Center Locating Pin</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589034000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07 DD13</td>
</tr>
<tr>
<td>W470589114000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07/EPA10/GHG14 DD13</td>
</tr>
<tr>
<td>W470589054000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07 DD15</td>
</tr>
<tr>
<td>W470589104000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07/EPA10/GHG14 DD15/16</td>
</tr>
</tbody>
</table>

**WARNING: PERSONAL INJURY**

To avoid injury, never remove any engine component while the engine is running.

Remove as follows:

1. Shut off the engine, apply the parking brake, chock the wheels, and perform any other applicable safety steps.

**CAUTION: ELECTRICAL SHOCK**

To avoid injury from electrical shock, use care when connecting battery cables. The magnetic switch studs are at battery voltage.

2. Disconnect the batteries. Refer to the Original Equipment Manufacturer (OEM) procedure.
3. Open the hood.
4. Remove the camshaft housing.
   - For the DD13 with short Bumper-to-Back-of-Cab (BBC): Refer to section "Removal of the Camshaft Housing".
   - For the DD13/15/16 with long BBC: Refer to section "Removal of the Camshaft Housing Assembly".
5. Remove the flywheel housing. Refer to section "Removal of the Flywheel Housing".
6. Remove the oil pump, oil suction manifold, and oil lines. Refer to section "Removal of the Oil Pump, Oil Suction Manifold, and Oil Lines".
7. Remove the air compressor. Refer to section "Removal of the Air Compressor".
8. For DD15 TC and DD16 engines, remove the Axial Power Turbine (APT) gear box. Refer to section "Removal of the DD15 and DD16 Axial Power Turbine Gear Box".

**NOTICE:** Use caution when removing the idler gears to prevent damage. The idler gear spindles may separate from the gears and could fall.

9. Remove idler gear No. 1 as an assembly with the spindle, thrust washers, gear, gear plate, and mounting bolts.
10. Remove idler gear No. 4 (if equipped) as an assembly with the spindle, thrust washer, gear, gear plate, and mounting bolts.
11. Remove the crank gear by sliding it off the crankshaft.

**NOTICE:** If idler No. 2 cannot be removed with the high pressure fuel pump in place, the pump is out of time and will have to be re-timed. With the engine at No. 1 Top Dead Center (TDC), the position of the pump timing plate should not cause interference.
12. Remove idler gear No. 2 as an assembly with the spindle, gear, gear plate, and mounting bolts.
13. Remove the adjustable idler gear No. 3 as an assembly with the spindle, gear, and mounting bolts.
14. Loosen the two mounting bolts for idler gear No. 5.
15. Install Shoulder Bolt (J-47486) through the No. 5 gear spindle into the cylinder head.
16. Remove idler gear No. 5 mounting bolts.
17. Carefully slide out the shoulder bolt while removing idler gear No. 5 and spindle.
4 Installation of the Gear Train

Table 2.

<table>
<thead>
<tr>
<th>Tool Number</th>
<th>Tool Name</th>
<th>Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>J-46392 or W904589046300</td>
<td>Engine Barring Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-48630</td>
<td>Crankshaft Top Dead Center Locating Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-47486</td>
<td>Shoulder Bolt</td>
<td>DD Platform</td>
</tr>
<tr>
<td>J-47487</td>
<td>Cantilever For Idler #3 Tool</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589001500</td>
<td>Top Dead Center Locating Pin</td>
<td>DD Platform</td>
</tr>
<tr>
<td>W470589034000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07 DD13</td>
</tr>
<tr>
<td>W470589114000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07/EPA10/GHG14 DD13</td>
</tr>
<tr>
<td>W470589054000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07 DD15</td>
</tr>
<tr>
<td>W470589104000</td>
<td>Camshaft Timing Tool</td>
<td>EPA07/EPA10/GHG14 DD15/16</td>
</tr>
</tbody>
</table>

Install as follows:

**NOTE:** Coat the inside of the gears, bushings, thrust washers, and spindles with clean engine oil before installation.

**NOTICE:** Inspect the alignment pin in the crankshaft gear for straightness before installing the gear. A bent pin can result in engine timing codes due to the important relationship between the flywheel and gear train timing.

1. Install the crankshaft gear on the crankshaft.
2. Rotate the crankshaft to Top Dead Center (TDC) on cylinder number one, if not already positioned. Install and lock Crankshaft TDC Locating Tool into place with bolt. See figure below.

3. Install spindle into idler gear No. 5.
4. Install idler gear No. 5 assembly onto the cylinder head using Shoulder Bolt (J-47486).
5. Install the two idler gear No. 5 mounting bolts and hand-tighten. Remove the Shoulder Bolt. Torque the mounting bolts to 60 to 65 N·m (44 to 48 lb·ft).
6. Install the spindle into idler gear No. 3. Loosely install idler gear No. 3, spindle, and mounting bolts to the cylinder block.
7. Install the cantilever tool (J-47487) onto idler gear No. 3.

8. Snug the No. 3 idler gear mounting bolts.

**NOTE:** When idler gear No. 3 and Cantilever Tool for idler No. 3 tool are installed to the cylinder block, the Cantilever Tool should come off the gear with ease. If the tool is not easily removed, that is an indication No. 3 idler is not timed correctly.

9. Remove the cantilever tool (J-47487) from idler gear No. 3.
10. Install a dial indicator onto the cylinder block and position the stem to rest between the teeth on the large gear of idler gear No. 3. Zero-out the dial indicator.
11. Hold idler gear No. 5 with a screwdriver and move idler gear No. 3 by hand to check gear lash between No. 3 and No. 5 idlers.
12. The lash reading on the dial indicator should be 0.079 to 0.305 mm (0.003 to 0.012 in.). If the lash is not within specification, some slight adjustment may be needed for idler No.3.
13. When the correct gear lash is established, torque idler gear No. 3 to 60 to 65 N·m (44 to 48 lb·ft).
14. Install the Cantilever Tool onto idler gear No. 3. Again, it should slide on and off with ease.
15. Install the spindle and gear plate onto idler gear No. 2.

**NOTICE:** If idler gear No. 2 cannot be installed with the high pressure fuel pump in place, the pump is out of time and will have to be re-timed. With the engine at No. 1 Top Dead Center (TDC), the position of the pump timing plate should not cause interference. The high pressure pump does not need to be removed to re-time. The drive gear can be rotated with a strap wrench until the pump is in time. Refer to section "Installation of the High Pressure Fuel Pump - Three-Filter System" or Refer to section "Installation of the High Pressure Fuel Pump – Two Filter System ".

16. Mesh idler gear No. 2 assembly with idler gear No. 3 and the high pressure fuel pump drive gear; seat the gear assembly onto the cylinder block. Install the three mounting bolts and torque to 100 N·m (73 lb·ft).
17. Install the thrust washers and spindle onto the idler gear No. 1.

**NOTE:** For ease of idler gear No. 1 installation, roll the gear up and into idler gear No. 2.

18. Install the idler gear No. 1 assembly to the cylinder block by engaging the teeth of idler gear No. 1 into the crankshaft gear, and then roll the gear upward into idler gear No. 2. Install the gear cover plate and the three mounting bolts. Torque the bolts to 100 N·m (73 lb·ft).
19. Install the air compressor. Refer to section "Installation of the Air Compressor".
NOTE: When installing idler gear No. 4 (if equipped), verify that the part number on the gear is facing the cylinder block.

20. With the cone of idler gear No. 4 facing outward, install the thrust washer onto the spindle; then install the spindle into idler gear No. 4.
21. Mesh idler gear No. 4 assembly with the crankshaft gear and install the assembly to the cylinder block. Install the gear cover plate and the four mounting bolts. Torque the bolts to 100 N·m (73 lb·ft).
22. For all DD Platform engines, ensure that idler gear No. 1 is flush with the rear of the crankshaft gear. For engines equipped with a No. 4 idler gear, ensure idler No. 4 is flush with the front of the crankshaft gear.
23. Install the camshaft housing.
   For the DD13 with short Bumper-to-Back-of-Cab (BBC): Refer to section "Installation of the Camshaft Housing"
   For the DD13/15/16 with long BBC: Refer to section "Installation of the Camshaft Housing Assembly"
24. Install the Crankshaft TDC Locating Tool, the No. 3 idler Cantilever Tool, and the Camshaft Timing Tool, if they were previously removed. Ensure all tools install easily and verify the entire gear train is in time.
25. Remove all of the timing tools from the gear train.
26. For DD15 TC and DD16 engines, install the Axial Power Turbine (APT) gear box. Refer to section "Installation of the DD15 and DD16 Axial Power Turbine Gear Box".
27. Install the air compressor. Refer to section "Installation of the Air Compressor".
28. Install the oil pump, oil suction manifold, and oil lines. Refer to section "Installation of the Oil Pump, Oil Suction Manifold, and Oil Lines".
29. Install the flywheel housing. Refer to section "Installation of the Flywheel Housing".
30. Prime the lubrication system. Refer to section "Priming the Engine Lubrication System".

CAUTION: ELECTRICAL SHOCK
To avoid injury from electrical shock, use care when connecting battery cables. The magnetic switch studs are at battery voltage.

31. Connect the batteries. Refer to the OEM procedure.

WARNING: PERSONAL INJURY
To avoid injury before starting and running the engine, ensure the vehicle is parked on a level surface, parking brake is set, and the wheels are blocked.

WARNING: PERSONAL INJURY
Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.
- Always start and operate an engine in a well ventilated area.
- If operating an engine in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system or emission control system.

32. Start the engine and inspect for leaks.
33. Close the hood.
5 Checking and Adjusting Gear Lash with Camshaft Housing Removed

Check as follows:
1. Install a magnetic base-dial indicator gauge on the cylinder head.
2. Set the dial indicator pointer on idler gear No. 5 as shown below.

3. Turn idler gear No. 5 counterclockwise (viewed from front of engine) until "0" lash is present, then zero the gauge on the dial indicator.
4. Check the gear lash by turning the idler gear No. 5 stop-to-stop, verify that the lash reading on the dial indicator is 0.079 to 0.305 mm (0.004 to 0.012 in.).

**NOTE:** Do not adjust the gear lash to correct a gear train that is out of time. If both camshafts are half a tooth out of time, this is an indication one of the idler gears is one tooth out of time. The flywheel housing will need to be removed and timing tools installed on the crankshaft gear and No.3 idler gear.

5. If the gear lash is not within specification, continue with the following steps to adjust.
6. Remove the access cover for the idler gear No. 3 mounting bolts.
7. Loosen the two No. 3 idler gear bolts and then snug by hand.
8. Install a magnetic base dial indicator gauge onto the cylinder head.
9. Set the dial indicator pointer on the No. 5 idler gear as shown below.
10. Turn idler gear No. 5 counterclockwise (viewed from front of engine) until "0" lash is present, then zero the gauge on the dial indicator.

**NOTE:** Rotating idler gear No. 5 counterclockwise (viewed from front of engine) will result in zero gear lash. Rotating idler gear No. 5 clockwise (viewed from front of engine) will result in maximum gear lash.

11. Push idler gear No. 5 clockwise (viewed from front of engine) until desired gear lash is achieved.
12. Hand-tighten the two mounting bolts for No. 3 idler gear.
13. Check gear lash by turning idler gear No. 5 stop-to-stop. Verify the lash reading on the dial indicator is 0.079 to 0.305 mm (0.003 to 0.012 in.).
14. If gear lash is within specification, torque idler gear No. 3 mounting bolts to 60 to 65 N·m (44 to 48 lb·ft).
15. Install access cover for No.3 idler and tighten the bolts.
16. Install the camshaft housing.
   For the DD13 with short Bumper-to-Back-of-Cab (BBC): Refer to section "Installation of the Camshaft Housing"
   For the DD13/15/16 with long BBC: Refer to section "Installation of the Camshaft Housing Assembly"