

**Magnum™ 250**  
**Magnum™ 280**  
**Magnum™ 310**  
**Magnum™ 340**  
**Magnum™ 380**  
**Magnum™ 310 Rowtrac™**  
**Magnum™ 340 Rowtrac™**  
**Magnum™ 380 Rowtrac™**  
**Continuously Variable Transmission (CVT)**  
**Tractor**

*PIN ZFRF05001 and above*

## SERVICE MANUAL

**Part number 47917643**

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September 2015





## SERVICE MANUAL

**Magnum™ 250 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 280 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 310 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 310 Rowtrac™ CVT TIER 4B [ZFRF05001 - ] , Magnum™ 340 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 340 Rowtrac™ CVT TIER 4B [ZFRF05001 - ] , Magnum™ 380 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 380 Rowtrac™ CVT TIER 4B [ZFRF05001 - ]**

## Link Product / Engine

| Product                                            | Market Product | Engine         |
|----------------------------------------------------|----------------|----------------|
| Magnum™ 250 CVT TIER 4B<br>[ZFRF05001 - ]          | North America  | F2CFE613G*B001 |
| Magnum™ 280 CVT TIER 4B<br>[ZFRF05001 - ]          | North America  | F2CFE614G*B002 |
| Magnum™ 310 CVT TIER 4B<br>[ZFRF05001 - ]          | North America  | F2CFE614D*B002 |
| Magnum™ 340 CVT TIER 4B<br>[ZFRF05001 - ]          | North America  | F2CFE614C*B002 |
| Magnum™ 380 CVT TIER 4B<br>[ZFRF05001 - ]          | North America  | F2CFE614A*B002 |
| Magnum™ 310 Rowtrac™ CVT<br>TIER 4B [ZFRF05001 - ] | North America  | F2CFE614D*B002 |
| Magnum™ 340 Rowtrac™ CVT<br>TIER 4B [ZFRF05001 - ] | North America  | F2CFE614C*B002 |
| Magnum™ 380 Rowtrac™ CVT<br>TIER 4B [ZFRF05001 - ] | North America  | F2CFE614A*B002 |

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# INTRODUCTION

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## **Foreword - Important notice regarding equipment servicing**

All repair and maintenance work listed in this manual must be carried out only by qualified dealership personnel, strictly complying with the instructions given, and using, whenever possible, the special tools.

Anyone who performs repair and maintenance operations without complying with the procedures provided herein shall be responsible for any subsequent damages.

The manufacturer and all the organizations of its distribution chain, including - without limitation - national, regional, or local dealers, reject any responsibility for damages caused by parts and/or components not approved by the manufacturer, including those used for the servicing or repair of the product manufactured or marketed by the manufacturer. In any case, no warranty is given or attributed on the product manufactured or marketed by the manufacturer in case of damages caused by parts and/or components not approved by the manufacturer.

The information in this manual is up-to-date at the date of the publication. It is the policy of the manufacturer for continuous improvement. Some information could not be updated due to modifications of a technical or commercial type, or changes to the laws and regulations of different countries.

In case of questions, refer to your CASE IH Sales and Service Networks.

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## Safety rules

### Personal safety



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible death or injury.

Throughout this manual you will find the signal words DANGER, WARNING, and CAUTION followed by special instructions. These precautions are intended for the personal safety of you and those working with you.

Read and understand all the safety messages in this manual before you operate or service the machine.

 DANGER indicates a hazardous situation that, if not avoided, will result in death or serious injury.

 WARNING indicates a hazardous situation that, if not avoided, could result in death or serious injury.

 CAUTION indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

### **FAILURE TO FOLLOW DANGER, WARNING, AND CAUTION MESSAGES COULD RESULT IN DEATH OR SERIOUS INJURY.**

### Machine safety

**NOTICE:** Notice indicates a situation that, if not avoided, could result in machine or property damage.

Throughout this manual you will find the signal word Notice followed by special instructions to prevent machine or property damage. The word Notice is used to address practices not related to personal safety.

### Information

**NOTE:** Note indicates additional information that clarifies steps, procedures, or other information in this manual.

Throughout this manual you will find the word Note followed by additional information about a step, procedure, or other information in the manual. The word Note is not intended to address personal safety or property damage.

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## Safety rules - General maintenance safety

### General maintenance safety

Keep the area used for servicing the machine clean and dry. Clean up spilled fluids.

Service the machine on a firm, level surface.

Install guards and shields after you service the machine.

Close all access doors and install all panels after servicing the machine.

Do not attempt to clean, lubricate, clear obstructions, or make adjustments to the machine while it is in motion or while the engine is running.

Always make sure that working area is clear of tools, parts, other persons and pets before you start operating the machine.

Unsupported hydraulic cylinders can lose pressure and drop the equipment, causing a crushing hazard. Do not leave equipment in a raised position while parked or during service, unless the equipment is securely supported.

Jack or lift the machine only at jack or lift points indicated in this manual.

Incorrect towing procedures can cause accidents. When you tow a disabled machine follow the procedure in this manual. Use only rigid tow bars.

Stop the engine, remove the key, and relieve pressure before you connect or disconnect fluid lines.

Stop the engine and remove the key before you connect or disconnect electrical connections.

Scalding can result from incorrect removal of coolant caps. Cooling systems operate under pressure. Hot coolant can spray out if you remove a cap while the system is hot. Allow the system to cool before you remove the cap. When you remove the cap, turn it slowly to allow pressure to escape before you completely remove the cap.

Replace damaged or worn tubes, hoses, electrical wiring, etc.

The engine, transmission, exhaust components, and hydraulic lines may become hot during operation. Take care when you service such components. Allow surfaces to cool before you handle or disconnect hot components. Wear protective equipment when appropriate.

When welding, follow the instructions in the manual. Always disconnect the battery before you weld on the machine. Always wash your hands after you handle battery components.



## **SERVICE MANUAL**

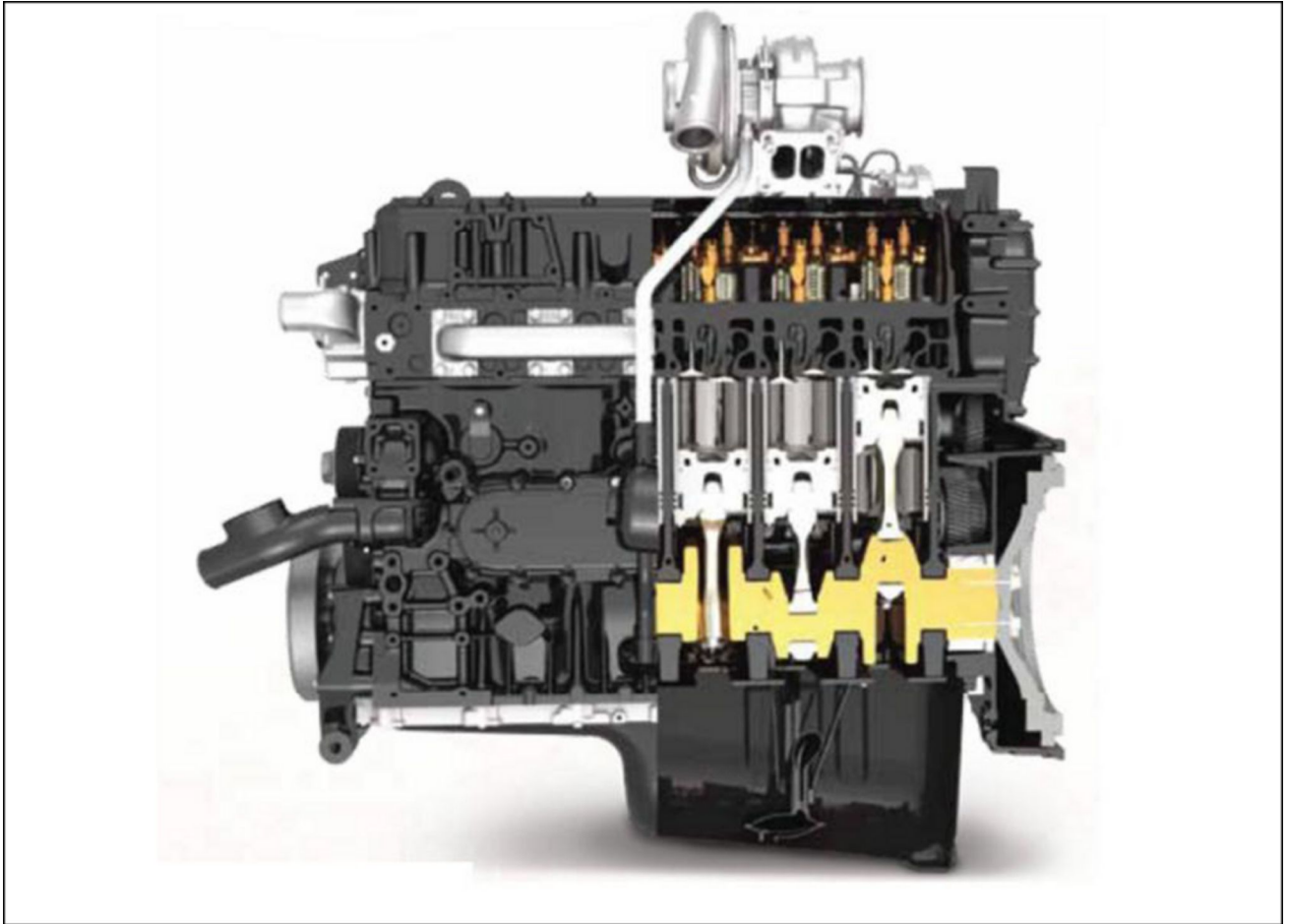
### **Engine**

**Magnum™ 250 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 280 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 310 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 310 Rowtrac™ CVT TIER 4B [ZFRF05001 - ] , Magnum™ 340 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 340 Rowtrac™ CVT TIER 4B [ZFRF05001 - ] , Magnum™ 380 CVT TIER 4B [ZFRF05001 - ] , Magnum™ 380 Rowtrac™ CVT TIER 4B [ZFRF05001 - ]**

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## Engine - Overview

### The Cursor® 9



RAIL15TR00417GA 1

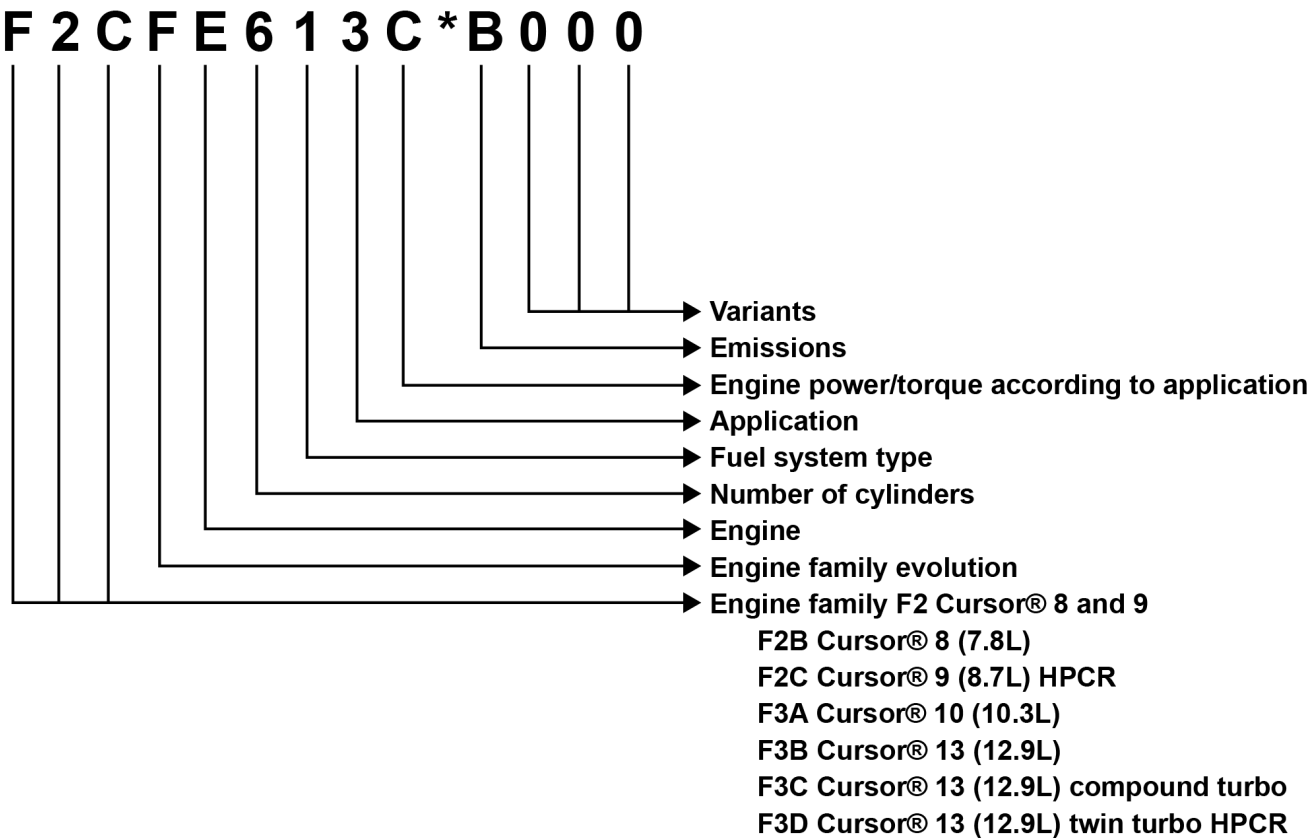
The **Cursor® 9** is a state of the art engine developed by Fiat Powertrain Technologies (FPT). The **Cursor® 9** used in the **Magnum™** tractors has some significant internal and external differences from **Cursor® 9** engines used in other CNH products. There are procedures specific to the **Magnum™** engines that are different from the **Cursor® 9** used in other CNH applications. These changes were made to fit the engine into the **Magnum™** series frames without losing our featured visibility around the hood and chassis.

The **Cursor® 9** engine was introduced in the CNH combines in 2006 and migrated into the **Steiger®** series tractors. It has proven itself to be a consistent reliable performer. The introduction in the **Magnum™** series brings it to new heights with up to **275 kW (374 Hp)** (rated) and **316 kW (429 Hp)** in power boost mode.

- 6 cylinder, 24 valve, turbocharged and aftercooled
- Single overhead cam with roller rocker arms
- Wastegate turbo/Electronic Variable Geometry Turbocharger (EVGT)
- High pressure common rail fuel system
- Selective Catalytic Reduction (SCR) emissions control
- TIER 4B compliant without internal or external Exhaust Gas Recirculation (EGR)

FPT model number designation

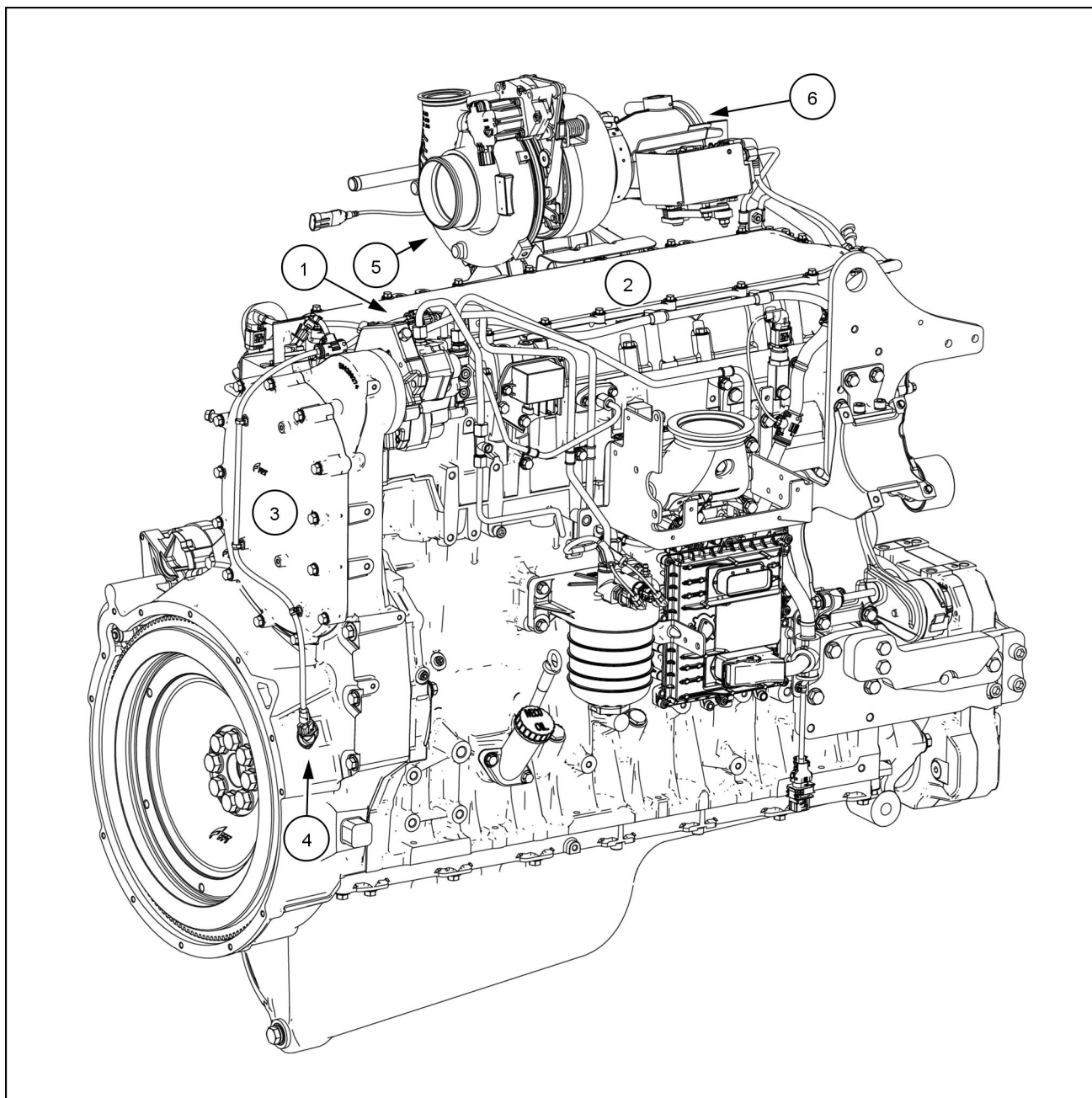
**NOTE:** The FPT engine designation code has evolved over the years. This is the best current information and may not be applicable to previous FPT engines.



RAIL15TR01380GA 2

## Visual external differences for Magnum™ tractor engines

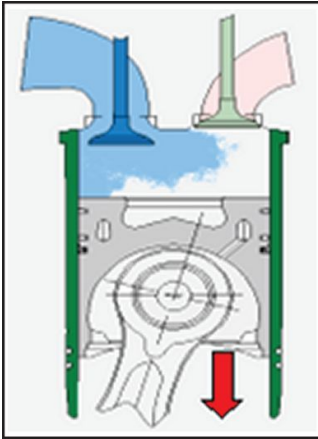
There are a few things that make the FPT **Cursor®** 9 engine used in the **Magnum™** tractors visually and mechanically different from other **Cursor®** 9 applications.



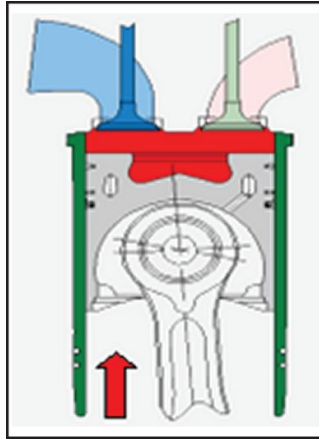
RAIL15TR00608GA 3

1. The fuel pump sits higher and closet to the center line of the engine.
2. A two piece valve cover assembly that allows for valve adjustment without removing the entire cover.
3. The rear cover is an oval shape where on other **Cursor®** 9 engines it's round.
4. The flywheel speed sensor is located on the right side of the engine, others have on the left side of the engine.
5. The turbocharger is moved higher and toward the center line of the engine.
6. Exhaust flap for TIER 4B.

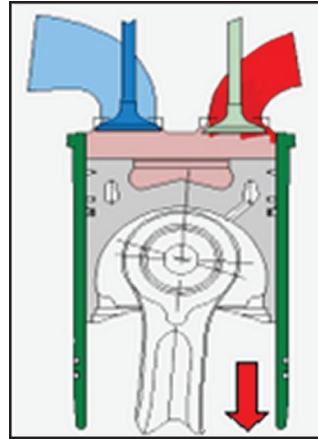
## Exhaust brake



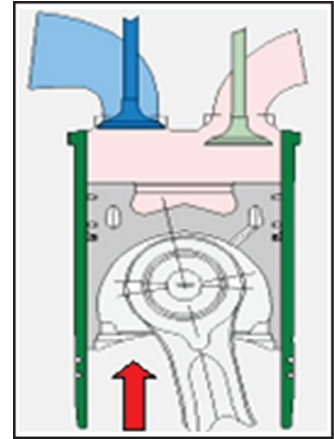
**Admission phase:**  
Intake of fresh air.



**Compression phase:**  
Energy is stored in the compressed air, braking effect increases with compression



**Top dead center:**  
Exhaust valves open, compressed air is released, energy is blown out.



**Exhaust phase:**  
Cylinder is empty, no energy exchange. Exhaust gases impact against the turbine, creating an additional braking effect.

All **Cursor®** engines are equipped with an advanced engine brake system: the Iveco Turbo Brake (IBT) system.

- Decompression engine brake
- Quick responding
- Integrated in the engine control
- Linked to cruise control
- Linked to EBS

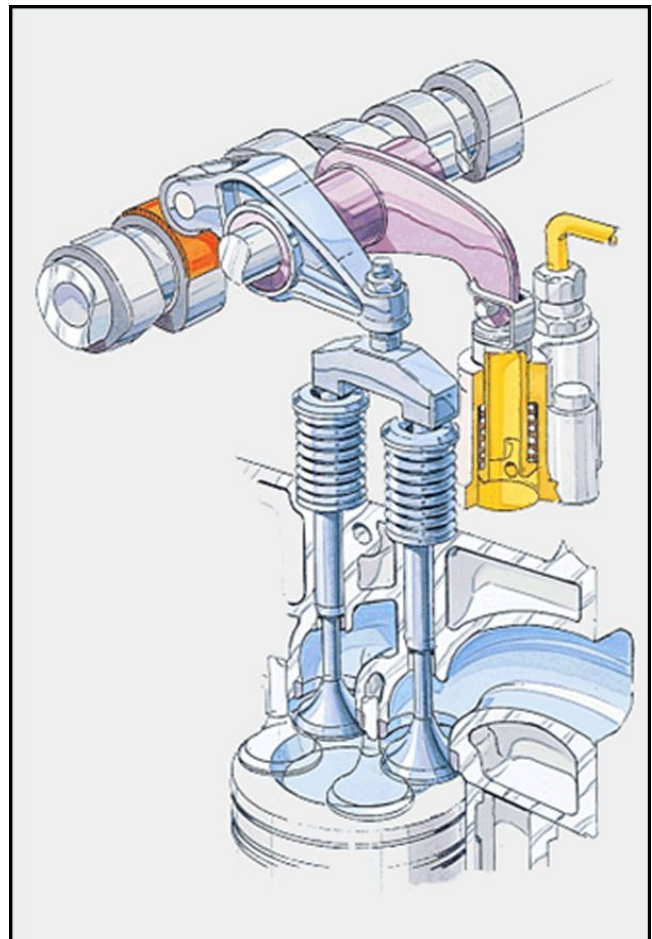
### Advantage

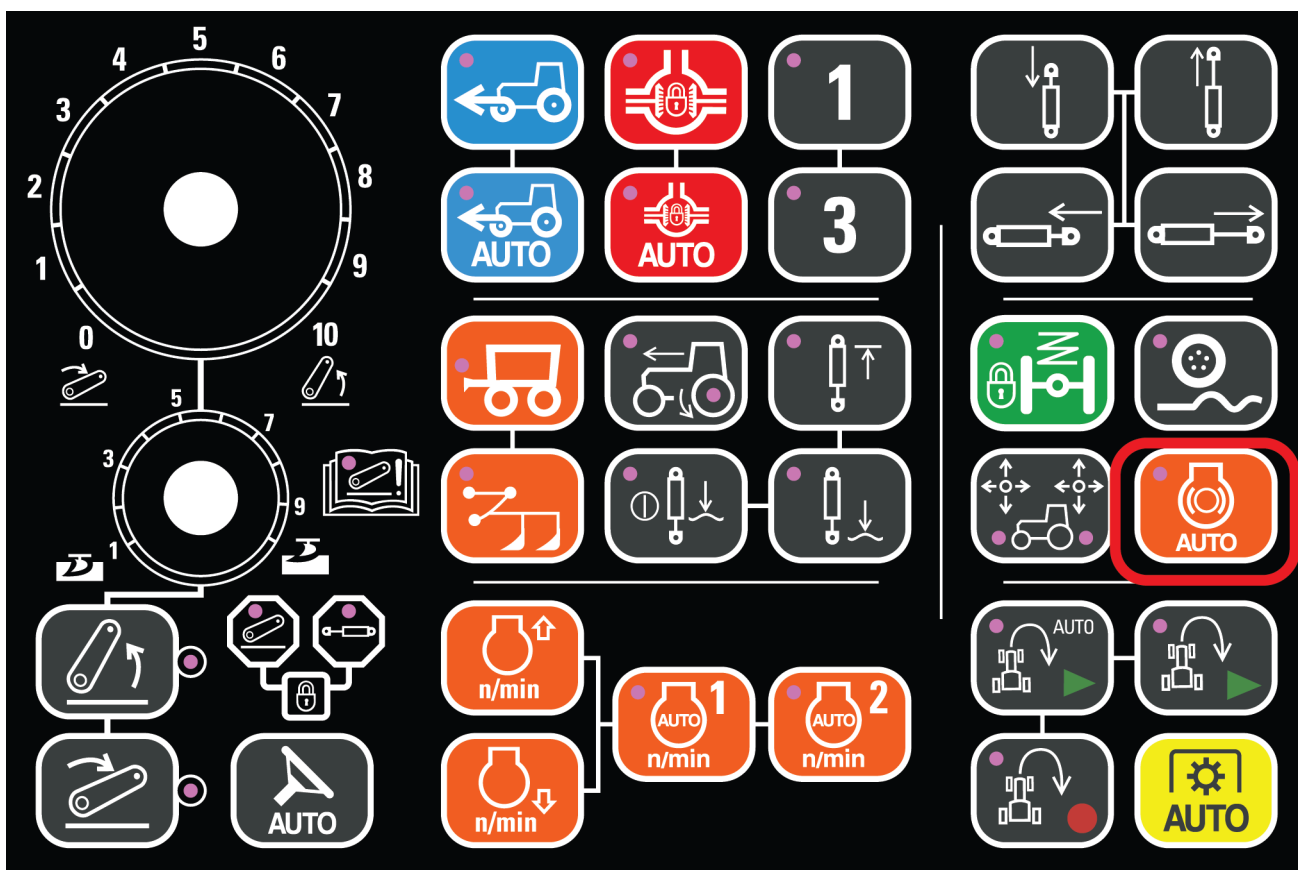
- Less brake pad wear
- Automatically engaged

### Benefit

- Reduced operation cost
- Operator ease

The engine brake is controlled by the Tractor Control Unit (TCU). The Electronic Service Tool (EST) is used to configure the TCU as to whether or not the tractor has an engine brake.



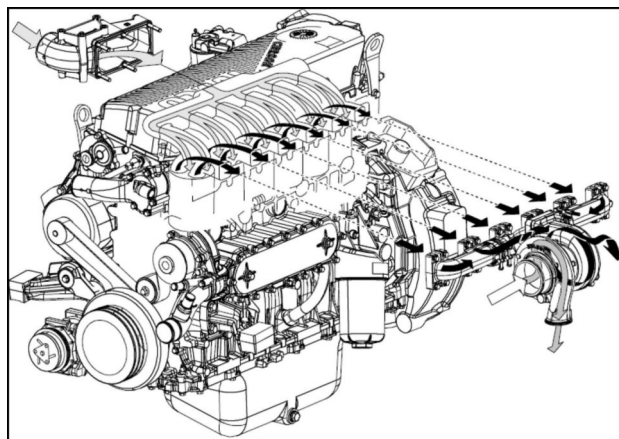


RAIL15TR00415GA 4

The engine brake switch on the Integrated Control Panel (ICP) activates the system. When the switch is activated, and the difference between the commanded (throttle) and actual engine speed exceeds a **30 %** threshold, the software activates the brake.

### Air Induction - cross flow cylinder head

The cylinder head is of the cross flow design, inlet on one side and exhaust on the other. This and four valves per cylinder give it excellent breathing ability and efficient temperature control. The air is supplied to the inlet by a waste-gate turbocharger or a Variable Geometry Turbocharger (VGT).

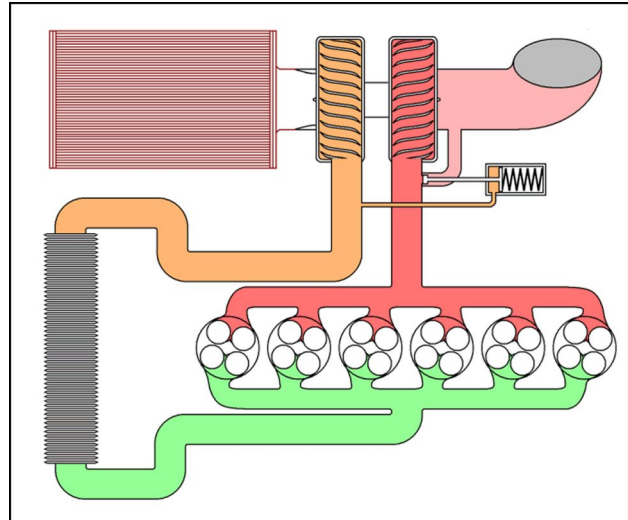


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## Wastegate turbocharger

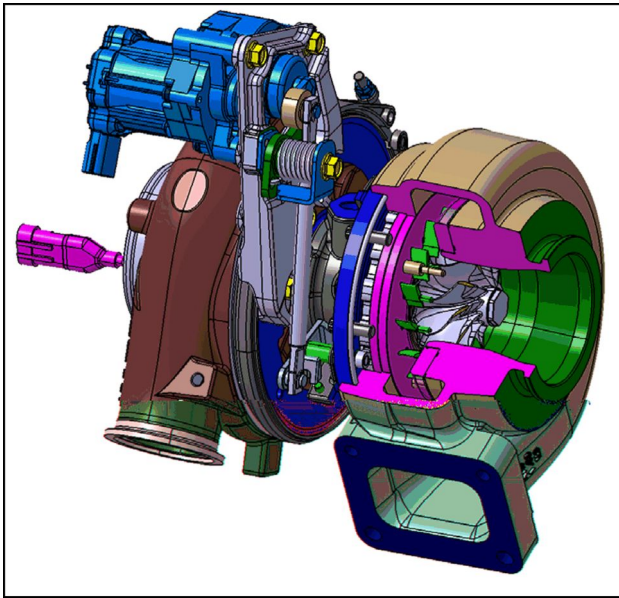
The wastegate turbocharger allows for a larger turbocharger to be installed producing higher boost pressures in the low and midrange rpm while not over-boosting at high rpm.

Intake pressure builds against a diaphragm in the wastegate and opens a valve allowing exhaust to bypass the turbine therefore slowing the compressor and limiting the pressure in the intake manifold.



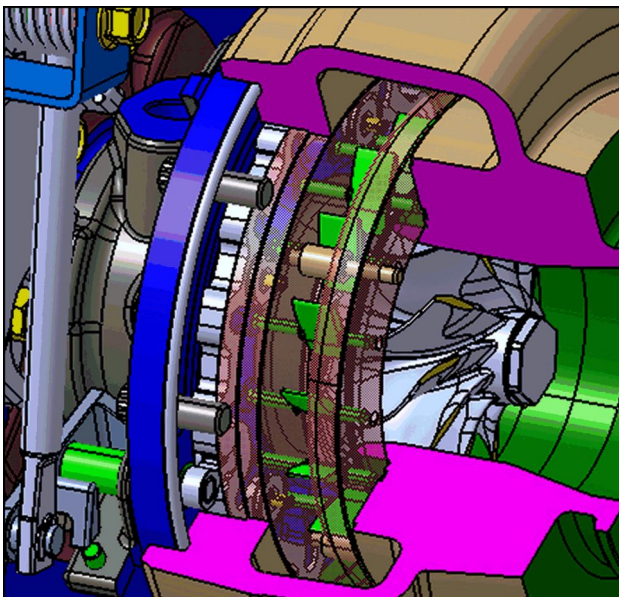
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## Electronically Variable Geometry Turbocharger (eVGT)



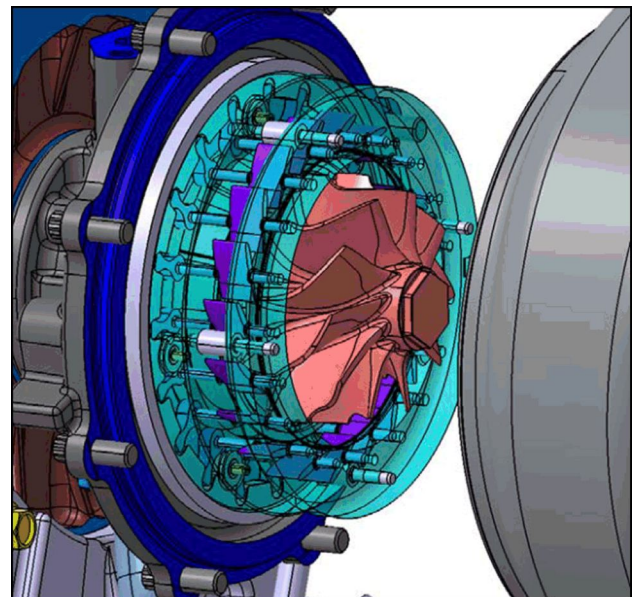
RAIL15TR00383BA 7

The electronically Variable Geometry Turbocharger (eVGT) is used on the TIER 4A **Magnum™** 370 and TIER 4B **Magnum™** 280, 310, 340 and 380. . The eVGT is electronically controlled by the Engine Control Unit (ECU).



RAIL15TR00395BA 8

Vaness open (low boost)



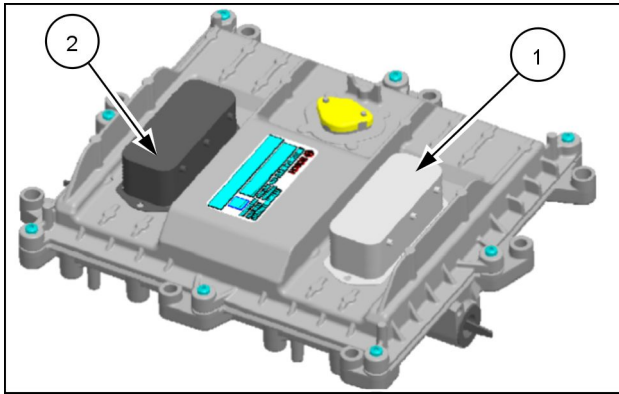
RAIL15TR00394BA 9

Vaness closed (high boost)

The eVGT uses a series of aerodynamic vanes to direct exhaust toward the turbine controlling both the velocity and angle the exhaust contacts the turbine. This gives the ECU the ability to dynamically “tune” the boost pressure at any given engine speed and load, Improving performance and fuel economy.

Fully open the velocity slows and the angle is decreased therefore the turbine and compressor turn slower producing less boost. When needed, the vanes close increasing the velocity and angle, therefore increasing turbine and compressor speed, producing higher boost anytime it is needed across the entire operating range of the engine.

## EDC17CV41



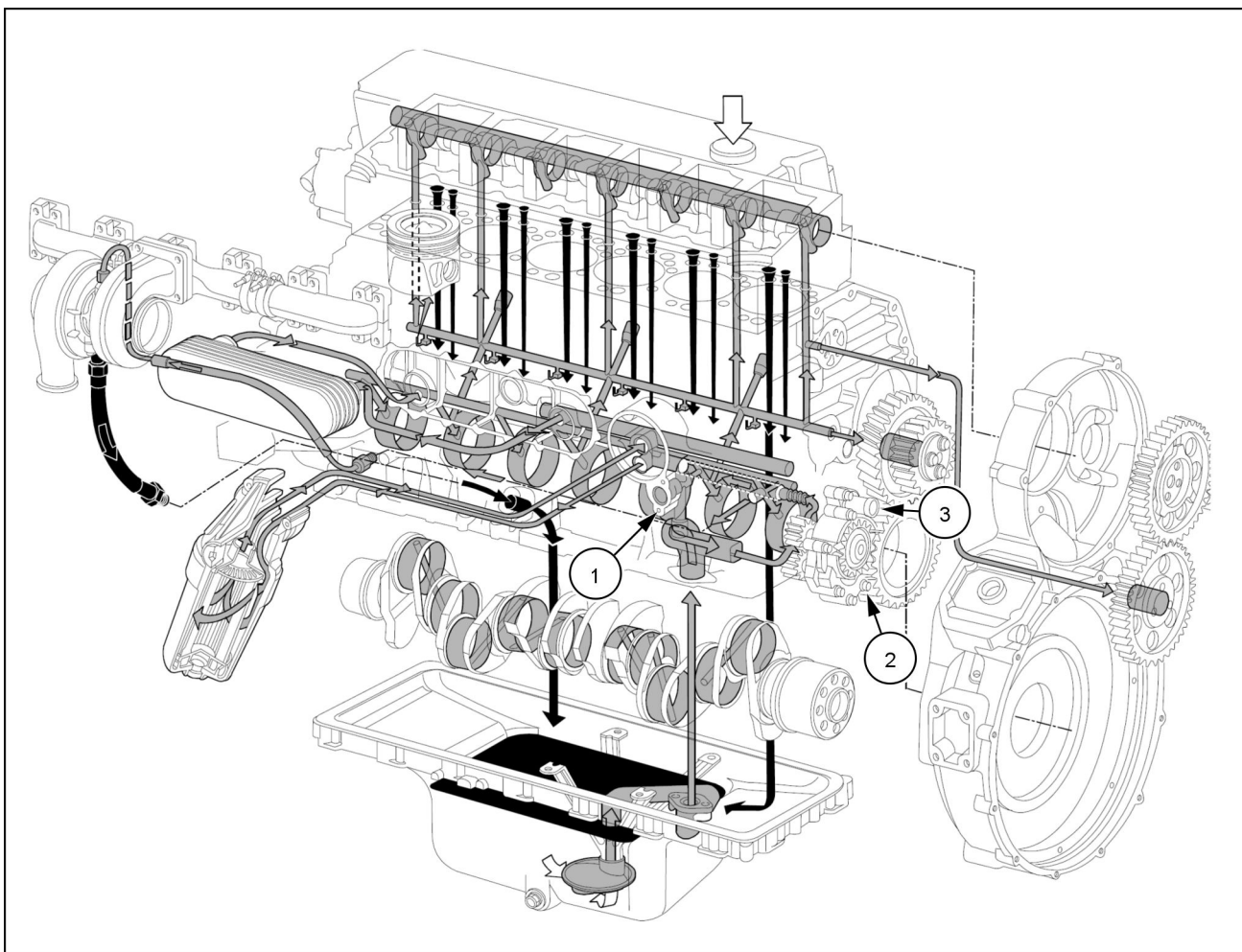
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A new Engine Control Unit (ECU) is used on TIER 4B engines, the EDC17CV41. It is used on FPT engines from the **4.5 L** NEF to the **12.9 L Cursor®** engines. It has two 96-pin electrical connectors: one for the engine components and one for the tractor connections. Pin connections will be common for all the CNH/FPT engines using this controller.

1. Tractor connector
2. Engine connector

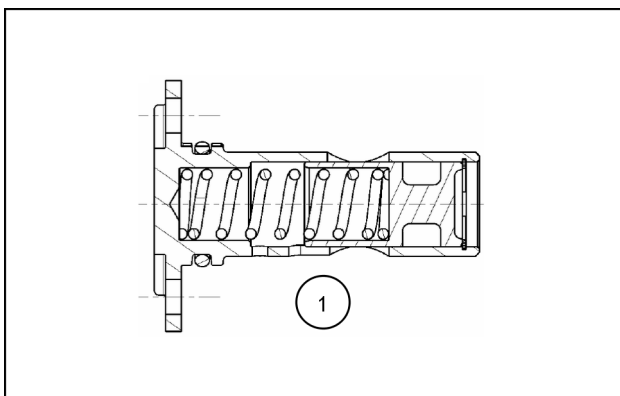
The EDC17CV41 controls all engine and Selective Catalytic Reduction (SCR) functions.

## Lubrication System

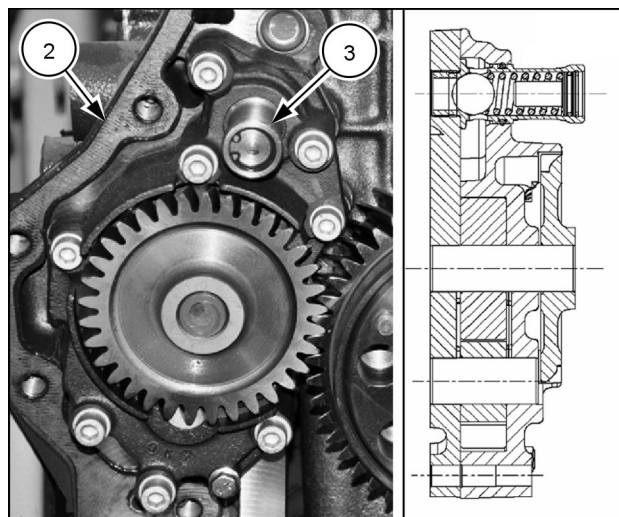


RAIL15TR00416GA 11

Oil pressure is controlled by a **5 bar (72.5 psi)** relief valve (1) in the oil galley coming from the gear type oil pump (2) located behind the rear cover of the engine. The oil pump also has an over pressurization relief valve (3) set at approximately **10 bar (145 psi)**.



RAIL15TR00367AA 12



RAIL15TR00389BA 13

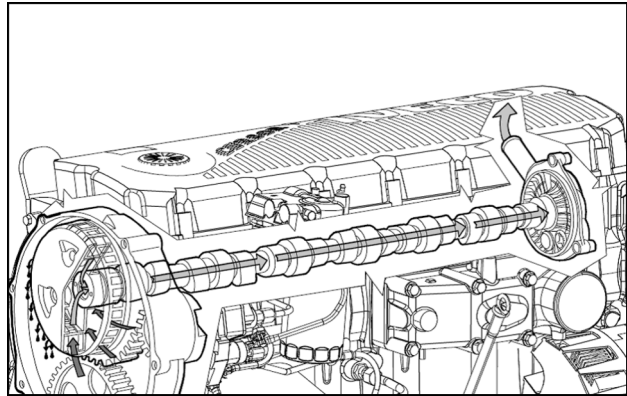
A **5 bar (72.5 psi)** oil pressure control valve (1) is located on the left hand side of the engine. The oil pump assembly (2) includes an over pressurization relief valve (3) that protects the pump. The valve opens at **9.4 - 10.8 bar (136.3 - 156.6 psi)**.

## Blow-by recirculation

Blow-by is controlled by a rotary filter bolted to the rear of the camshaft. As the cam turns excess oil is thrown off by centrifugal force, finer oil is filtered out.

The blow-by then passes through the center of the camshaft and exits at the front.

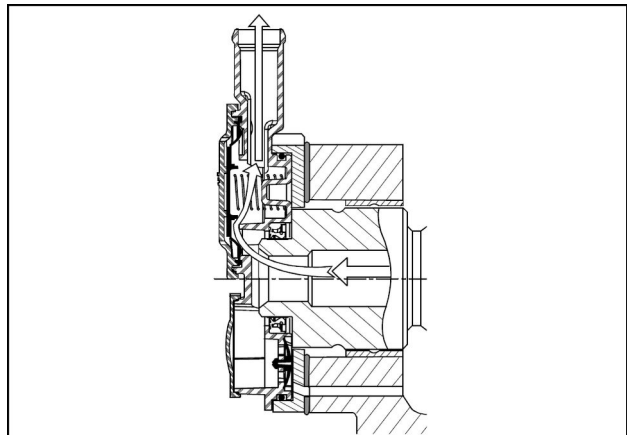
This filter must be replaced at regular intervals or the engine will build up excessive pressure in the crank case.



RAIL15TR00366AA 14

Built into the cover at the front is a valve that allows blow-by pressures out, but will not allow atmospheric pressure into the crankcase.

This filtered air is directed back into the inlet and re-burned.



RAIL15TR00377BA 15

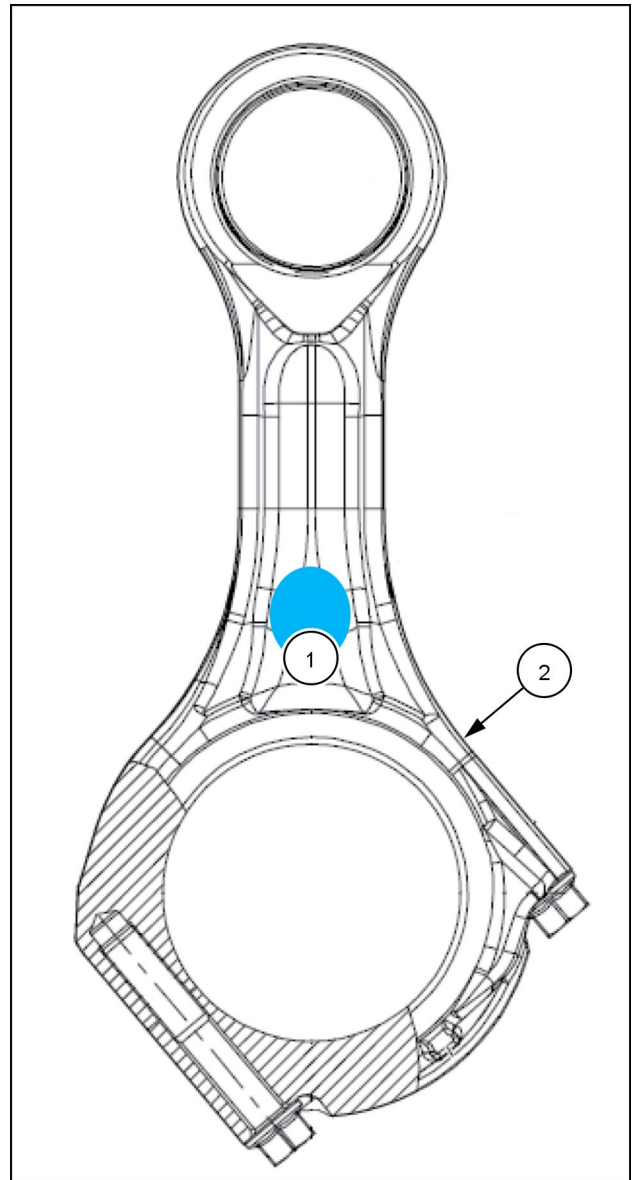
## Connecting Rods

Connecting rods must all be the same weight class in an engine. The weight class is identified by a color swatch on the connecting rod.

There are three classes of crankshaft bearing diameters (bore size) on the connecting rod. The bore size is marked by a color code on the rod. The oil clearance is determined by the connecting rod bore size and the crankshaft journal size. Based on connecting rod bore diameter and the crankshaft journal diameter a bearing set must be determined.

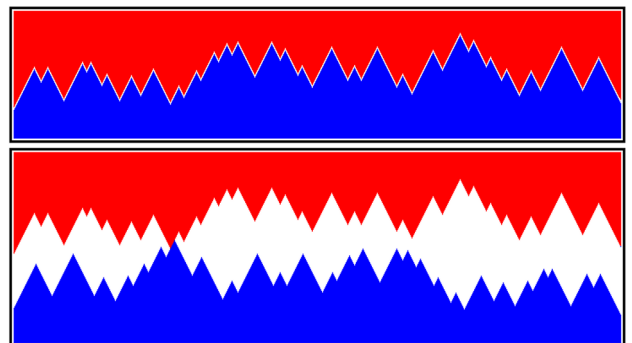
Connecting rods are the fracture split type. Care must be taken when handling these rods as any damage to the cap/rod mating area requires that the rod be replaced.

| Connecting rod weight, class and color | Bore diameter and color designation |        |
|----------------------------------------|-------------------------------------|--------|
| 3450 – 3470 grams<br>Grade A, Yellow   | 85.987 - 58.996                     | Yellow |
|                                        | 85.997 - 86.005                     | Green  |
|                                        | 86.006 - 86.013                     | Blue   |
| 3471 – 3490 grams<br>Grade B, Green    | 85.987 - 58.996                     | Yellow |
|                                        | 85.997 - 86.005                     | Green  |
|                                        | 86.006 - 86.013                     | Blue   |
| 3491 – 3510 grams<br>Grade C, Blue     | 85.987 - 58.996                     | Yellow |
|                                        | 85.997 - 86.005                     | Green  |
|                                        | 86.006 - 86.013                     | Blue   |



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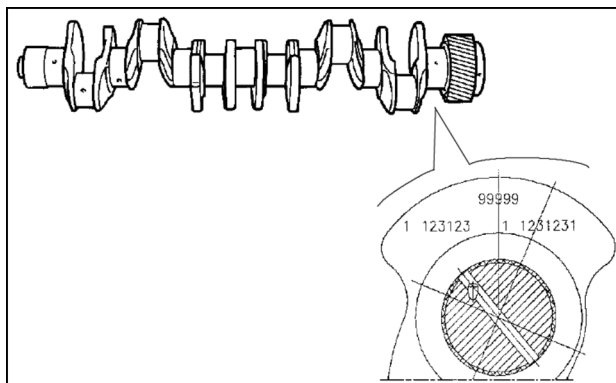
Fracture split rods give nearly perfect alignment. In both examples the red (rod) profiles are identical as are the blue (cap) profiles. In the top example the rod fits perfectly with the cap. In the lower example the rod is in the same position but the cap is reversed, here the material peaks align peak to peak and keeps cap from mating with the rod.



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## Crankshaft

- The crankshaft are classified in three classes: there are three classes for the connecting rod journals and three classes for the main journals.
- The crankshaft journal sizes are stamped on the rear flyweight for both the connecting rod journals and the main journals.
- Six digits for the connecting rods and seven digits for the mains.
- The crankshaft may have been ground - **0.127 mm** undersize from the factory. A (1) preceding the six digits is a standard crankshaft, a (2) preceding is for a crankshaft that has been ground undersize.
- The main bearing bores in the block are classed 1,2, or 3 and are located on the rear of the block lower right hand side. If the classifications are not found, the crankshaft must be measured and classified for each journal.



CRANKIDENTIFY 18

## Standard crankshaft connecting rod bearing selection

| Standard crankshaft<br>connecting rod journals | Connecting rod bore    |                       |                      |
|------------------------------------------------|------------------------|-----------------------|----------------------|
|                                                | Class (1) Yellow paint | Class (2) Green paint | Class (3) Blue paint |
| Class (1) 81.915 to 81.925 mm                  | Green                  | Green                 | Yellow               |
|                                                | Green                  | Yellow                | Yellow               |
| Class (2) 81.925 to 81.935 mm                  | Red                    | Green                 | Green                |
|                                                | Green                  | Green                 | Yellow               |
| Class (3) 81.935 to 81.945 mm                  | Red                    | Red                   | Green                |
|                                                | Red                    | Green                 | Green                |

**NOTE:** It may be necessary to mix two bearing shells in one journal.

## 0.127 mm under-size crankshaft connecting rod bearing selection

| - 0.127 mm Standard<br>crankshaft connecting rod<br>journals | Connecting rod bore    |                       |                      |
|--------------------------------------------------------------|------------------------|-----------------------|----------------------|
|                                                              | Class (1) Yellow paint | Class (2) Green paint | Class (3) Blue paint |
| Class (1) 81.789 to 81.799 mm                                | Green/Black            | Green/Black           | Yellow/Black         |
|                                                              | Green/Black            | Yellow/Black          | Yellow/Black         |
| Class (2) 81.799 to 81.809 mm                                | Red/Black              | Green/Black           | Green/Black          |
|                                                              | Green/Black            | Green/Black           | Yellow/Black         |
| Class (3) 81.809 to 81.819 mm                                | Red/Black              | Red/Black             | Green/Black          |
|                                                              | Red/Black              | Green/Black           | Green/Black          |

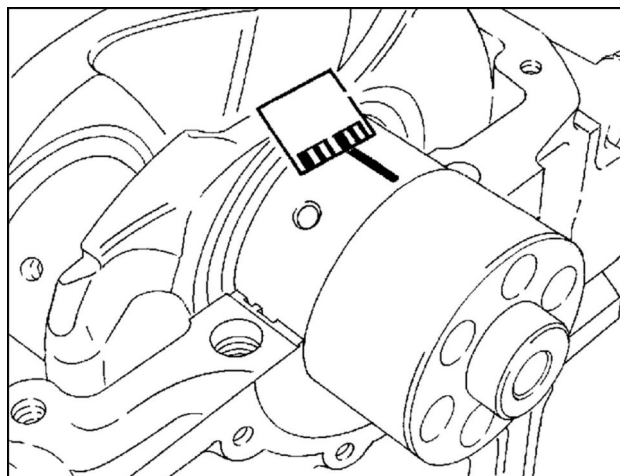
## Standard crankshaft main bearing selection

| Standard crankshaft journals  | Main bearing bore fit class |           |           |
|-------------------------------|-----------------------------|-----------|-----------|
|                               | Class (1)                   | Class (2) | Class (3) |
| Class (1) 92.970 to 92.980 mm | Green                       | Green     | Yellow    |
|                               | Green                       | Yellow    | Yellow    |
| Class (2) 92.980 to 92.990 mm | Red                         | Green     | Green     |
|                               | Green                       | Green     | Yellow    |
| Class (3) 92.990 to 93.000 mm | Red                         | Red       | Green     |
|                               | Red                         | Green     | Green     |

## 0.127 mm under-size crankshaft main bearing selection

| Standard crankshaft journals  | Main bearing bore fit class |              |              |
|-------------------------------|-----------------------------|--------------|--------------|
|                               | Class (1)                   | Class (2)    | Class (3)    |
| Class (1) 92.843 to 92.853 mm | Green/Black                 | Green/Black  | Yellow/Black |
|                               | Green/Black                 | Yellow/Black | Yellow/Black |
| Class (2) 92.853 to 92.863 mm | Red/Black                   | Green/Black  | Green/Black  |
|                               | Green/Black                 | Green/Black  | Yellow/Black |
| Class (3) 92.863 to 93.872 mm | Red/Black                   | Red/Black    | Green/Black  |
|                               | Red/Black                   | Green/Black  | Green/Black  |

With the variables in the bearing selection process, it is always a good idea to use a plastic gauge to test each journal for proper clearance.



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## Camshaft installation and timing

When timing or adjusting valves it is critical to position the A, B, C or D holes in the center of the view hole **(1)** at the bottom of the bell housing. Serious engine damage can occur if procedures are not followed carefully.

- A. TDC 3 and 4
- B. TDC 1 and 6
- C. TDC 2 and 5
- D. **54 °** before TDC 1 and 6

When timing or adjusting valves it is critical to position the A, B, C or D holes in the center of the view hole **(1)** at the bottom of the bell housing. Serious engine damage can occur if procedures are not followed carefully.

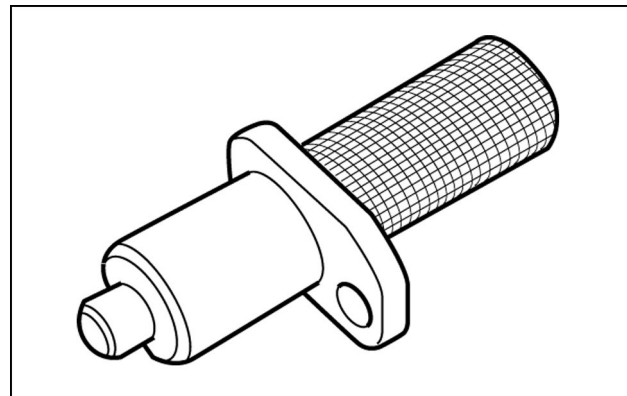
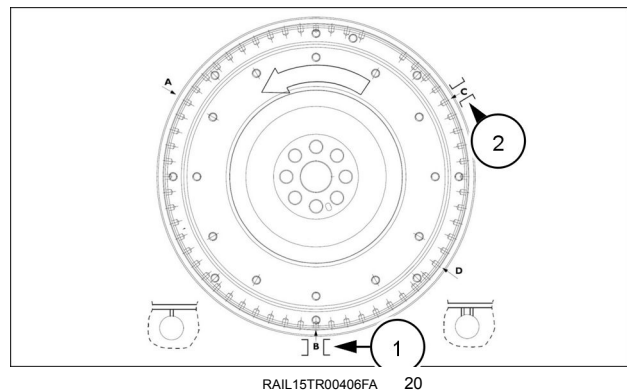
**NOTE:** All references to flywheel rotation will be made as viewed from the rear of the engine.

**NOTE:** The A, B and C holes are marked with one hash mark (I) and the D' hole with two hash marks (II).

Position the flywheel at TDC 1 and 6, the B hole at the bottom. This can be done by locating the D hole at the bottom view hole in the bell housing, and then turning the flywheel counterclockwise until the B hole appears.

Once the flywheel is in this position, it should be pinned in position with the flywheel pinning tool **380000150** in the sensor hole.

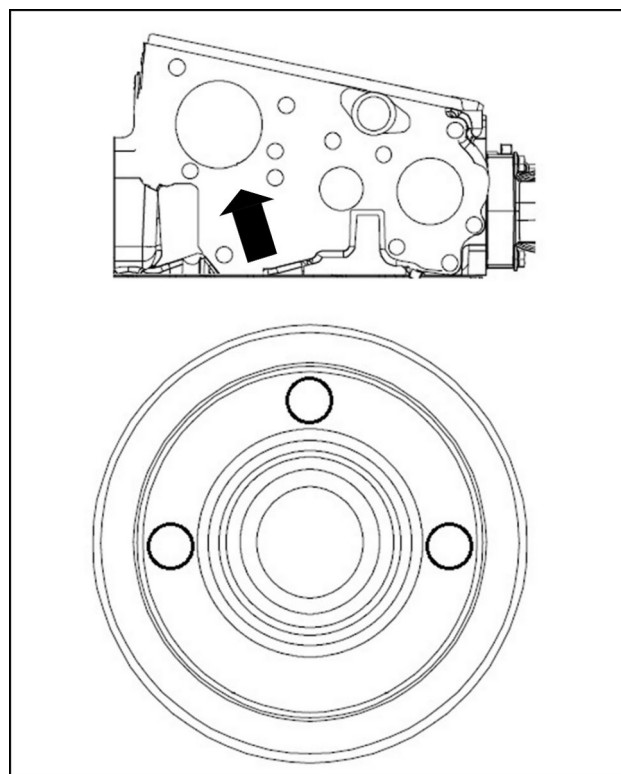
The engine is now ready to have the camshaft installed.



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Install the camshaft with the three holes (viewed from the front) in the 9, 12 and 3 o'clock position.

**NOTE:** Do not trust the back of the cam for positioning.



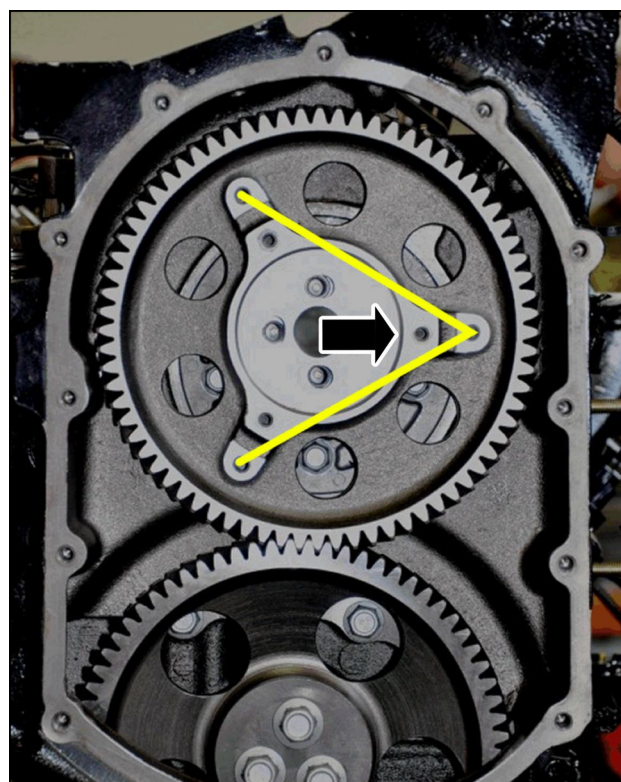
RAIL15TR00380BA 22

Install the camshaft gear as shown.

In **Magnum™** tractors, the cam drive must be installed with the three phonic wheel mounting holes making an arrow pointing to the right. If this is not done, the phonic wheel will not be able to be timed.

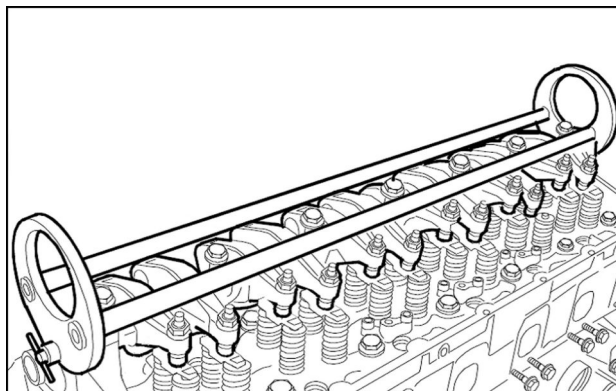
The slotted holes must be centered on the camshaft bolt holes to make fine adjustments to the cam later in this process.

Install the bolts and tighten, but do not torque yet; they will be loosened later in this procedure.



RAIL15TR00378BA 23

Install the rocker arm shaft assembly using tool number: **380000149**.



RAIL15TR00374AA 24

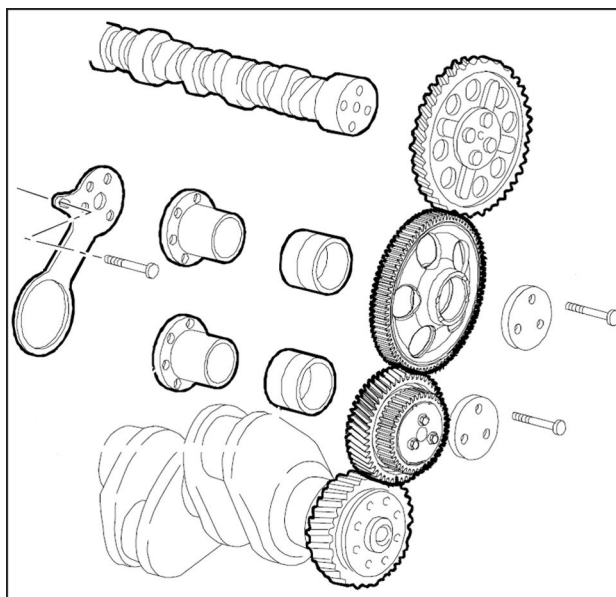
## Camshaft timing

The double idler gear location is fixed. The upper single idler gear location can be adjusted and is used to set the back lash between the idler gear and the camshaft gear.

This back lash has to be checked and set since this is an overhead camshaft engine. All for the gear train is mounted to the block except the camshaft gear which is mounted to the cylinder head. Set the back lash before the rocker arm assembly is installed.

Use a dial indicator to measure the camshaft gear to idler back lash. Only measure the back lash between the upper idler gear and the camshaft gear. Install the dial indicator tangential to a camshaft gear tooth. Hold the idler so that it does not move and rock the camshaft gear.

Correct back lash is **0.080 - 0.180 mm (0.003 - 0.007 in)**.

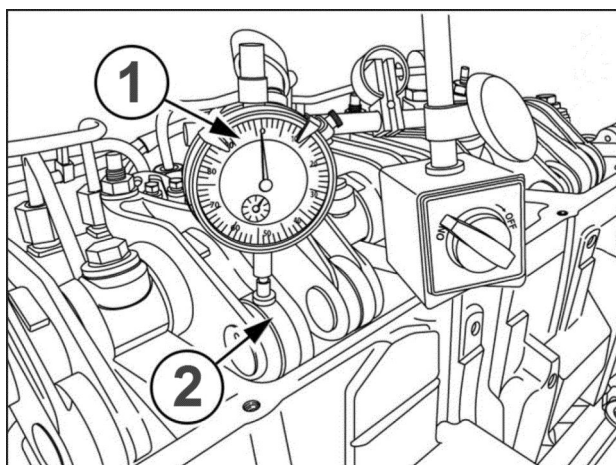


RAIL15TR01370BA 25

Rotate the flywheel clockwise until the D hole appears in the bottom view hole. Install a dial indicator **(1)** on the number 3 exhaust valve rocker arm camshaft roller **(2)** as shown.

Preload the dial indicator **6.00 mm (0.24 in)**.

Rotate the engine clockwise until the dial indicator stops moving: lift up on the valve end of the rocker arm to take any clearance or play out and to verify that you are on the inner base circle of the camshaft, the lowest point.



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Zero the dial indicator at this point.

On Tier III and later **Cursor®** 9 engines, rotate the engine counterclockwise until the dial indicator reads **5.29 mm (0.21 in) ± 0.05 mm (0.002 in)**. Check to see if the D hole is in the window and that the timing pin will lock the flywheel.

If the D hole is not centered in the window and the flywheel cannot be locked:

1. Loosen the four bolts that retain the camshaft gear.
2. Rotate the flywheel until the D hole is in the timing window and the flywheel can be locked.
3. Tighten the four bolts that hold the camshaft gear to the camshaft.

Now, verify the timing by turning the engine clockwise **10 - 20 °** and then back counterclockwise until the D hole is in the timing window and the timing pin will lock the flywheel. Verify the reading on the dial indicator is **5.29 mm (0.21 in) ± 0.05 mm (0.002 in)**.

**NOTE:** For engines without an engine brake engine serial numbers 25342 and after, set backlash to use **4.70 mm (0.19 in)**.

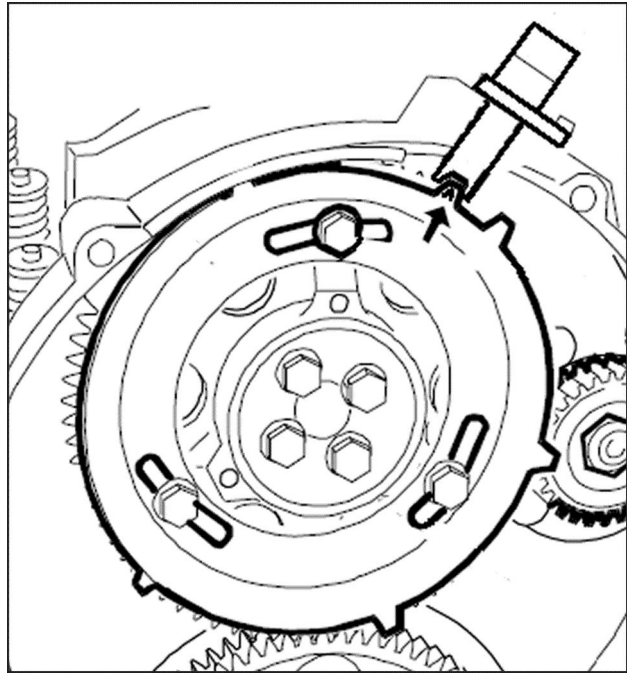
**NOTE:** For engines with or without an engine brake prior to engine serial number 25342, set backlash to use **5.29 mm (0.21 in)**.

Repeat the above procedure if necessary to obtain the specified timing. Once timing is within the specified range tighten the camshaft gear retaining bolt to specified torque.

Ultimately timing for the cam on a **Magnum™** TIER 4 engine is: **5.29 mm (0.21 in)** lift on number 3 exhaust rocker arm at **54 °** before Top Dead Center (TDC) 1 and 6, which is the D hole on the flywheel, visible through the hole in the bottom of the bell housing.

## Phonic wheel adjustment

Using the phonic wheel timing fork (special tool **380000151**) with the flywheel locked in the D position, install the phonic wheel so the timing fork engages the phonic wheel tooth with the “Λ” mark. Tighten the phonic wheel retaining bolts to the specified torque.

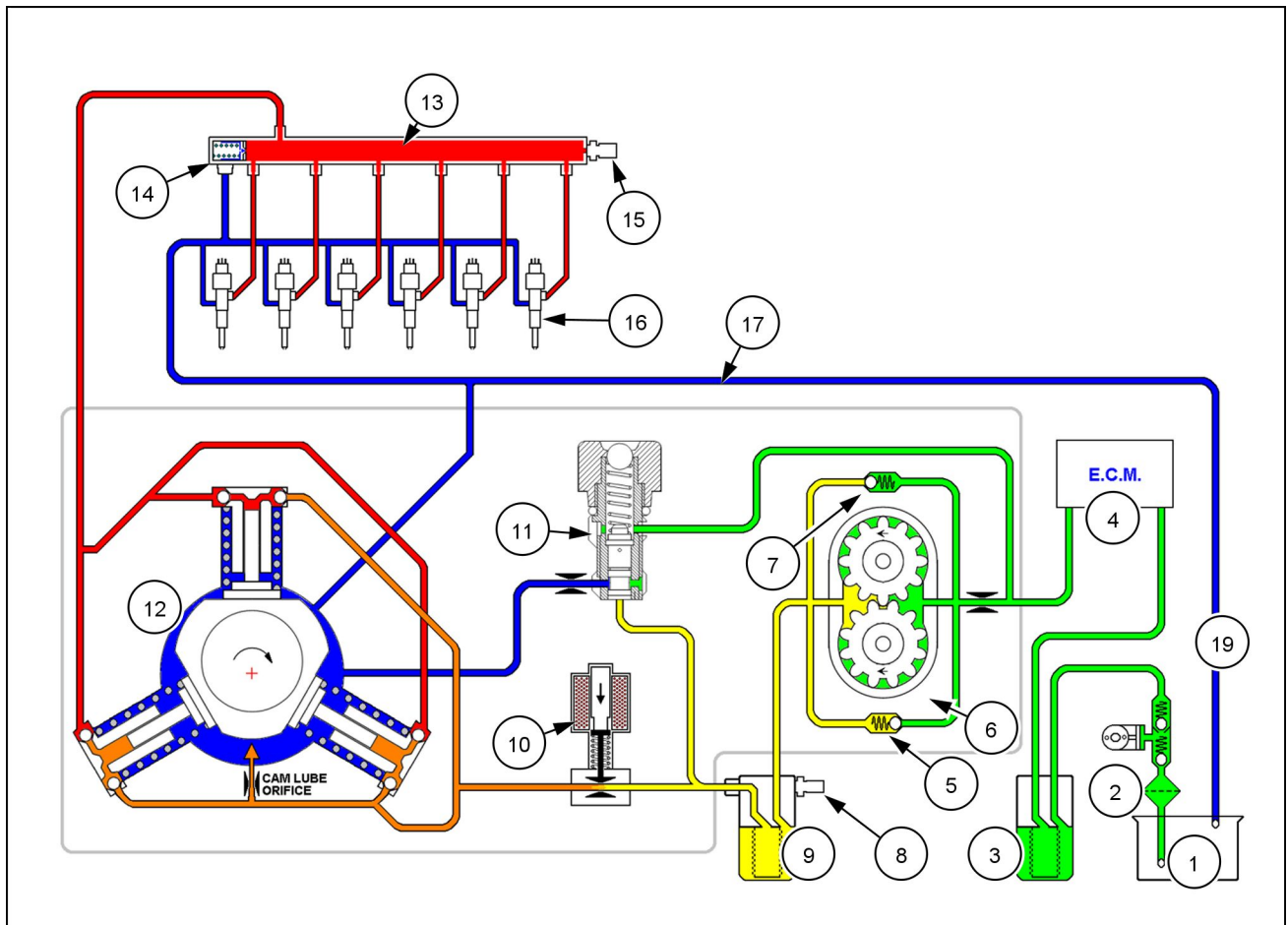


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## Adjusting the valve lash

| Flywheel | Cylinder |                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B        | 1        | <ul style="list-style-type: none"><li>• The valves can only be adjusted when the piston is at TDC firing.</li><li>• Rotate the engine counterclockwise to the B hole (the first hole after the hole with the double mark). Use the timing pin to lock the flywheel.</li><li>• Now adjust the valves on cylinder number 1.</li><li>• Use the chart to the left to determine which hole to use to adjust the valves.</li></ul> |
| A        | 4        |                                                                                                                                                                                                                                                                                                                                                                                                                              |
| C        | 2        |                                                                                                                                                                                                                                                                                                                                                                                                                              |
| B        | 6        |                                                                                                                                                                                                                                                                                                                                                                                                                              |
| A        | 3        |                                                                                                                                                                                                                                                                                                                                                                                                                              |
| C        | 5        |                                                                                                                                                                                                                                                                                                                                                                                                                              |

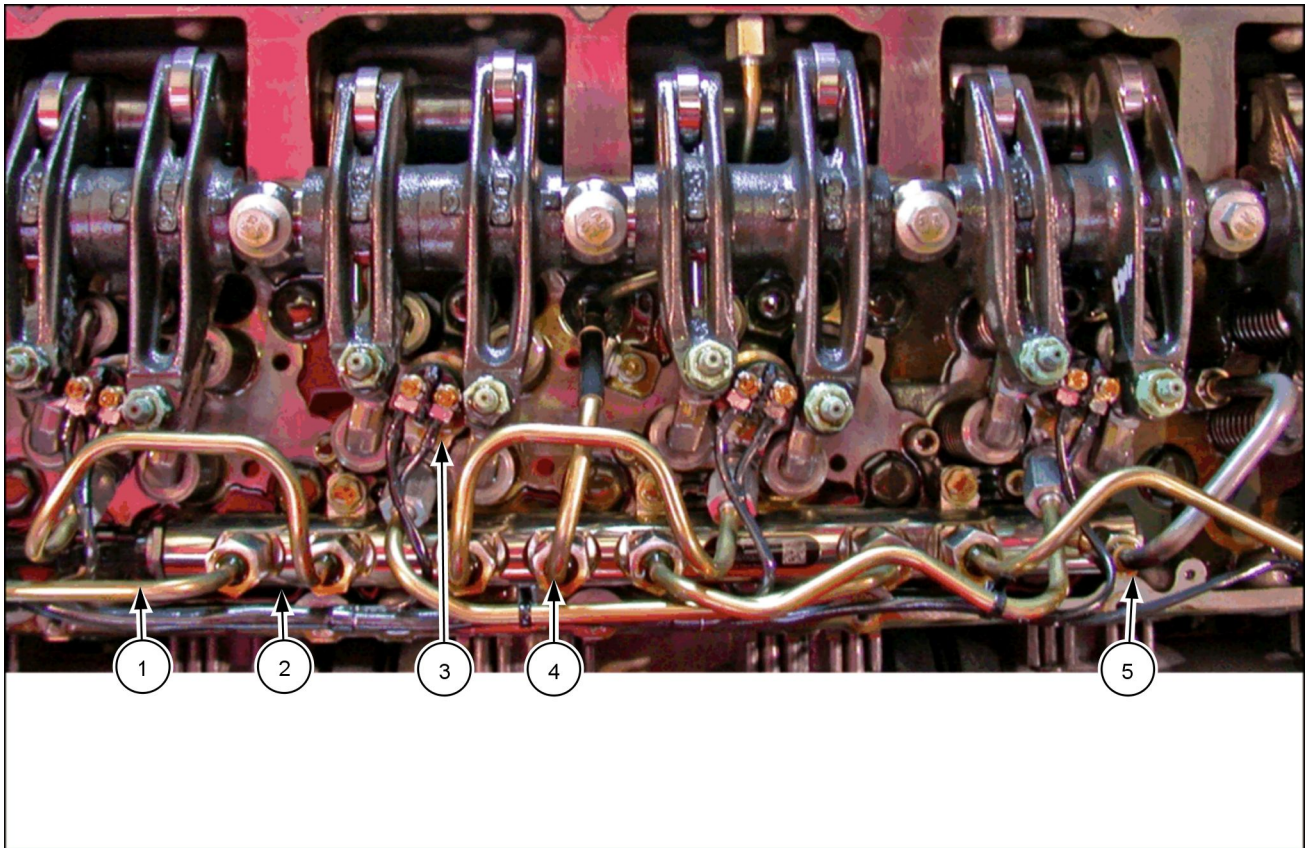
## Fuel system



RAIL15TR00414GA 28

- |                                                               |                                            |
|---------------------------------------------------------------|--------------------------------------------|
| 1) Inlet from tank                                            | 10) Regulator (Mprop) valve                |
| 2) Lift pump                                                  | 11) <b>5.0 bar (72.5 psi)</b> relief valve |
| 3) Primary fuel filter                                        | 12) High pressure pump                     |
| 4) Engine control module                                      | 13) Common rail                            |
| 5) <b>13.8 - 34.5 kPa (2.0 - 5.0 psi)</b> 2-5 psi check valve | 14) High pressure relief                   |
| 6) Gear pump                                                  | 15) Rail pressure sensor                   |
| 7) <b>5.0 bar (72.5 psi)</b> relief valve                     | 16) Injector                               |
| 8) Fuel temp sender                                           | 17) Return line                            |
| 9) Secondary fuel filter                                      | 18) Cooler                                 |
|                                                               | 19) Filter/separator(option)               |

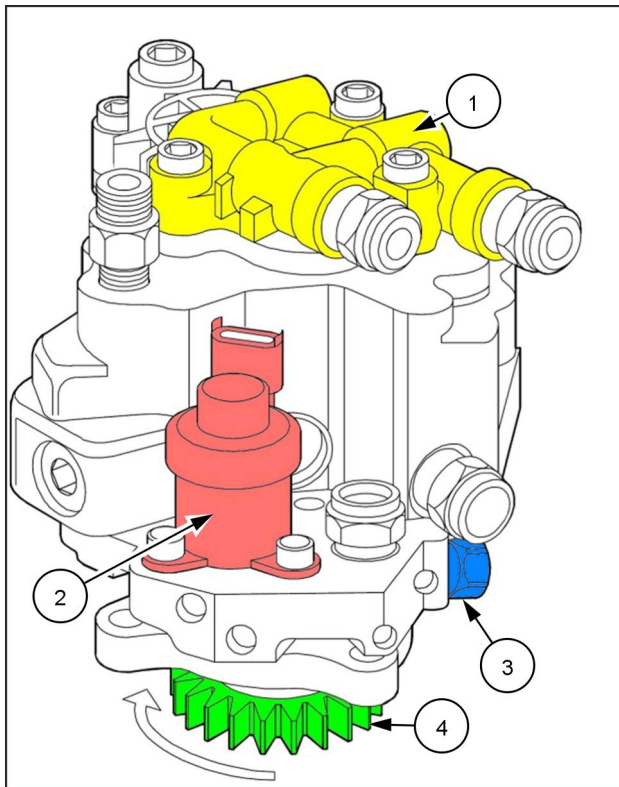
## High Pressure Common Rail (HPCR)



RAIL15TR000407FA 29

- |                    |                                   |
|--------------------|-----------------------------------|
| 1. Pressure sensor | 4. Supply from high pressure pump |
| 2. Common rail     | 5. Relief valve                   |
| 3. Injector        |                                   |

## Fuel pump assembly



RAIL15TR00384BA 30

These are the components of the fuel pump that are available separately through parts

1. Low pressure gear pump.
2. Regulator valve (Mprop). 3.2Ω PWM. Controls low pressure supply to high pressure pump, therefore, the common rail pressure.
3. **5.0 bar (72.5 psi)** low pressure control valve.

**NOTE:** There are two **5.0 bar (72.5 psi)** pressure valves: one in the gear pump and this one in the pump body.

4. Drive gear.

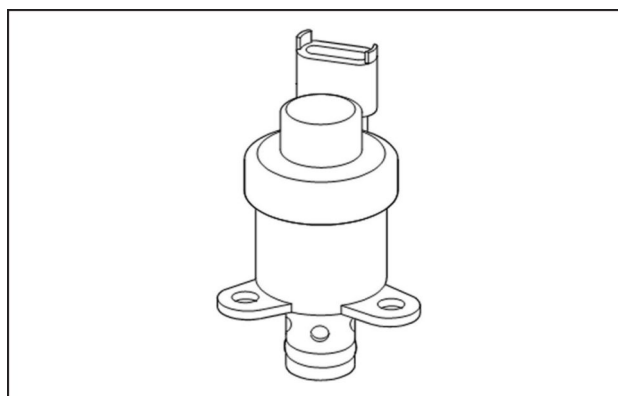
## Fuel system Components

### Pressure regulator

Located on the high pressure pump, it regulates the amount of fuel supplied to the high pressure pump on the basis of signals received from the Engine Control Unit (ECU) by modulating the duty-cycle. This allows pressure variation inside the common rail.

The pressure regulator is normally open. The high pressure pump is therefore in maximum delivery mode if no signal is sent by the ECU unit.

The regulator is Pulse Width Modulated (PWM); it receives **12 V** (battery voltage) from the ECU. The ECU completes and varies the current by controlling the ground. The regulator is not polarity sensitive. Resistance if checked should be about **3.2  $\Omega$** .

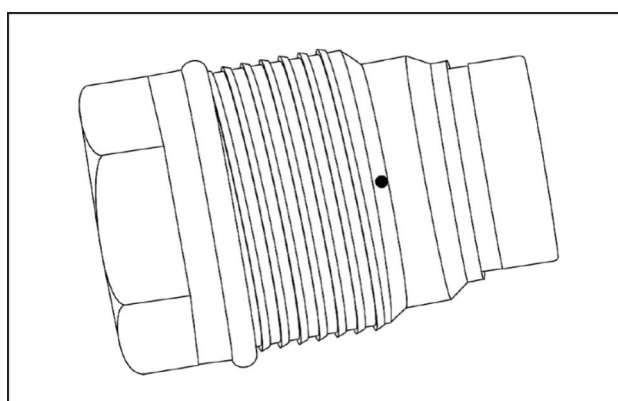


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### Common rail relief valve

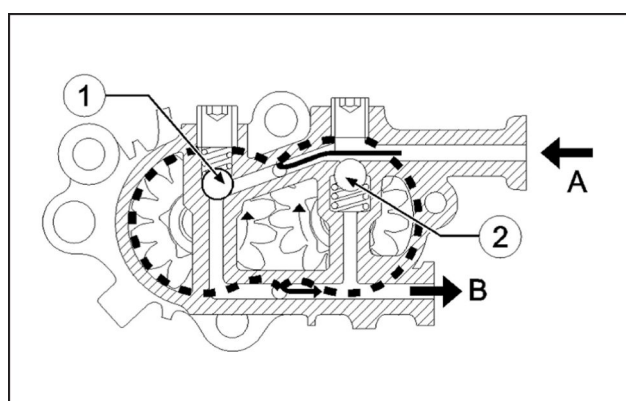
The common rail relief valve is mounted on the end of the common rail. It functions to protect the system's components in case of a failure of the rail pressure sensor or the pressure regulator that could cause the high pressure pump to provide more fuel than the system can safely handle.

The common rail relief valve is a two stage valve. When the rail pressure reaches **2000 bar (29000 psi)**, the valve opens and will drop the common rail pressure to approximately **1000 bar (14500 psi)**. This allows the engine to be operated but at reduced power.



RAIL15TR00368AA 32

### Low pressure gear pump



RAIL15TR00372AA 33

The fuel supply transfer pump is a gear pump located on the back of the CP3 high pressure pump. The transfer pump is shaft driven off the CP3 high pressure pump shaft.

(A) Supply fuel drawn from pre-filter

(B) Supply fuel to final filter

(1) Fuel supply relief valve **5.0 bar (72.5 psi)**

(2) Supply pump bypass valve (for bleeding)



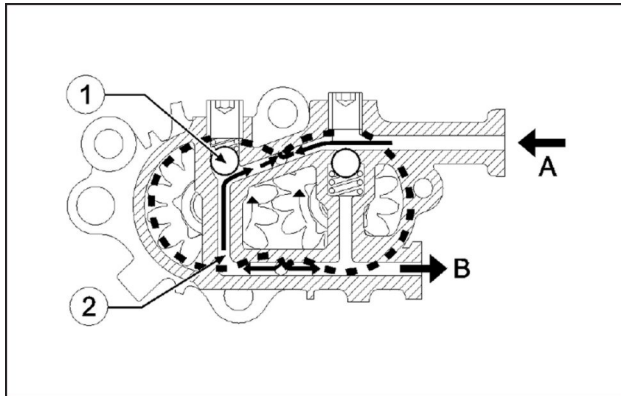
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### Pressure control mode

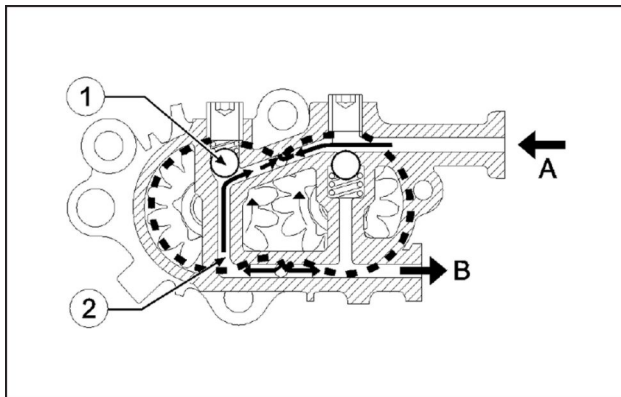


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When the fuel Pressure exceeds **5.0 bar (72.5 psi)**, the supply pump relief valve open opens and fuel is routed to the inlet side of the pump.

- (A) Supply fuel drawn from pre-filter
- (B) Supply fuel to final filter
- (1) Fuel supply relief valve **5.0 bar (72.5 psi)**
- (2) Supply pump bypass valve (for bleeding)

### Bypass mode



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During lift pump operation, fuel will bypass the gear pump through a check valve that opens at about **0.138 - 0.345 bar (2.0 - 5.0 psi)**.

- (A) Supply fuel drawn from pre-filter
- (B) Supply fuel to final filter
- (1) Fuel supply relief valve **5.0 bar (72.5 psi)**
- (2) Supply pump bypass valve (for bleeding)

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