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Systems Operation Testing and Adjusting

1204E-E44TA and 1204E-E44TTA Industrial Engines

MK (Engine)
ML (Engine)

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Cylinder Block

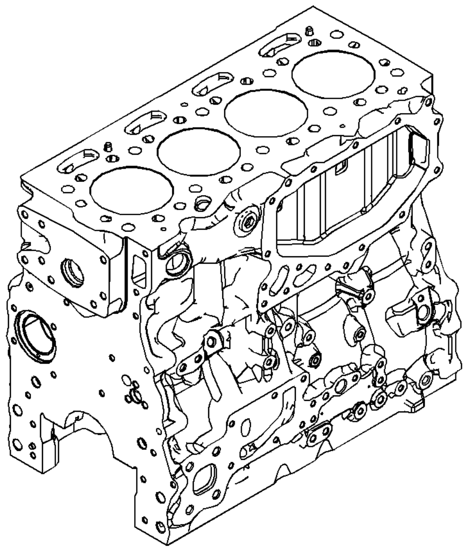

Illustration 7 g02149272

Typical example

The cast iron cylinder block for the four cylinder engine has four cylinders which are arranged in-line. The cylinder block is made of cast iron. The cylinder block provides support for the full length of the cylinder bores. The cylinder bores are machined into the block.

The cylinders are honed to a specially controlled finish in order to ensure long life and low oil consumption.

The cylinder block has five main bearings which support the crankshaft. Thrust washers are installed on both sides of number 3 main bearing in order to control the end play of the crankshaft. The thrust washers can only be installed one way.

Passages supply the lubrication for the crankshaft bearings. These passages are machined into the cylinder block.

Cooling passages are cast into the cylinder block in order to allow the circulation of coolant.

The cylinder block has a bush that is installed for the front camshaft journal. The other camshaft journals run directly in the cylinder block.

The engine has a cooling jet that is installed in the cylinder block for each cylinder. The piston cooling jet sprays lubricating oil onto the inner surface of the piston in order to cool the piston.

A Multi-Layered Steel (MLS) cylinder head gasket is used between the engine block and the cylinder head in order to seal combustion gases, water, and oil.

Cylinder Head

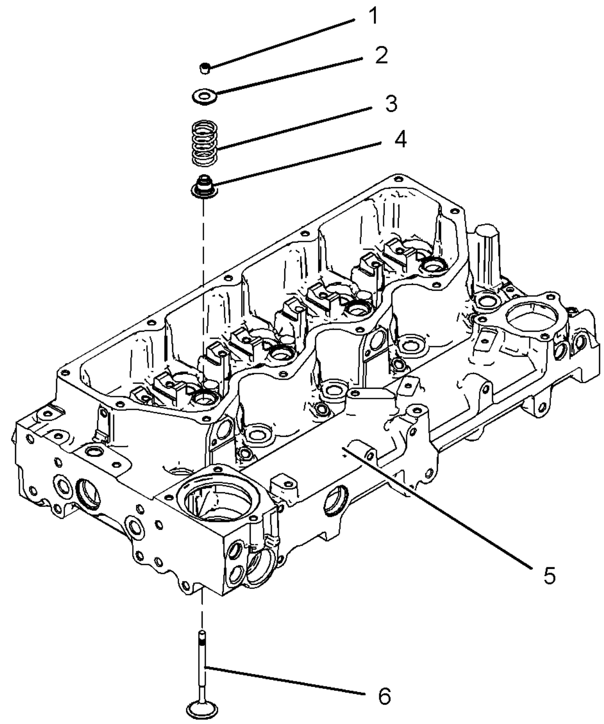

Illustration 8 g02466936

Typical example

(1) Valve keepers
(2) Valve spring retainer
(3) Valve spring

The engine has a cast iron cylinder head (5). The inlet manifold is integral within the cylinder head. There are two inlet valves and two exhaust valves for each cylinder. Each pair of valves (6) are connected by a valve bridge that is controlled by a pushrod valve system. The ports for the inlet valves are on the left side of the cylinder head. The ports for the exhaust valves are on the right side of the cylinder head. The valve stems move in valve guides that are pressed into the cylinder head. There is a renewable stem seal (4) that fits over the top of the valve guide. The valve seats are replaceable.

Air is drawn in through the air cleaner into the air inlet of the low-pressure turbocharger by the low-pressure turbocharger compressor wheel. The air is compressed to a pressure of about 75 kPa (11 psi) and heated to about 120° C (248° F). From the low-pressure turbocharger, the air passes to the high-pressure turbocharger. The air is compressed to a pressure of about 220 kPa (32 psi) and heated to about 240° C (464° F) before the air is forced to the aftercooler. The air flows through the aftercooler. The temperature of the compressed air lowers to about 55° C (131° F). Cooling of the inlet air assists the combustion efficiency of the engine. Increased combustion efficiency helps achieve the following benefits:

- Lower fuel consumption
- Increased power output
- Reduced NOx emission
- Reduced particulate emission

From the aftercooler, the air flows to the exhaust gas valve (NRS). A mixture of air and exhaust gas is then forced into the inlet manifold. Air flow from the inlet manifold to the cylinders is controlled by inlet valves. There are two inlet valves and two exhaust valves for each cylinder. The inlet valves open when the piston moves down on the intake stroke. When the inlet valves open, cooled compressed air from the inlet port is forced into the cylinder. The complete cycle consists of four strokes:

- Inlet
- Compression
- Power
- Exhaust

On the compression stroke, the piston moves back up the cylinder and the inlet valves close. The cool compressed air is compressed further. This additional compression generates more heat.

Note: If the cold starting system is operating, the glow plugs will also heat the air in the cylinder.

Just before the piston reaches the top center (TC) position, the ECM operates the electronic unit injector. Fuel is injected into the cylinder. The air/fuel mixture ignites. The ignition of the gases initiates the power stroke. Both the inlet and the exhaust valves are closed and the expanding gases force the piston downward toward the bottom center (BC) position.

From the BC position, the piston moves upward. The piston moving upward initiates the exhaust stroke. The exhaust valves open. The exhaust gases are forced through the open exhaust valves into the exhaust manifold.

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Cleanliness of Fuel System Components

Cleanliness of the Engine

NOTICE
It is important to maintain extreme cleanliness when working on the fuel system, since even tiny particles can cause engine or fuel system problems.

The entire engine should be washed with a high-pressure water system. Washing the engine will remove dirt and loose debris before a repair on the fuel system is started. Ensure that no high-pressure water is directed at the seals for the injectors.

Environment

When possible, the service area should be positively pressurized. Ensure that the components are not exposed to contamination from airborne dirt and debris. When a component is removed from the system, the exposed fuel connections must be closed off immediately with suitable sealing plugs. The sealing plugs should only be removed when the component is reconnected. The sealing plugs must not be reused. Dispose of the sealing plugs immediately after use. Contact your nearest Perkins distributor in order to obtain the correct sealing plugs.

New Components

High-pressure lines are not reusable. New high-pressure lines are manufactured for installation in one position only. When a high-pressure line is replaced, do not bend or distort the new line. Internal damage to the pipe may cause metallic particles to be introduced to the fuel.

All new fuel filters, high-pressure lines, tube assemblies, and components are supplied with sealing plugs. These sealing plugs should only be removed in order to install the new part. If the new component is not supplied with sealing plugs then the component should not be used.

The technician must wear suitable rubber gloves. The rubber gloves should be disposed of immediately after completion of the repair in order to prevent contamination of the system.

Refueling

In order to refuel the diesel fuel tank, the refueling pump and the fuel tank cap assembly must be clean and free from dirt and debris. Refueling should take place only when the ambient conditions are free from dust, wind, and rain.

Only use fuel that is free from contamination. Ultra Low Sulfur Diesel (ULSD) must be used. The content of sulfur in Ultra Low Sulfur Diesel (ULSD) fuel must be below 15 PPM 0.0015%.

Biodiesel may be used. The neat biodiesel must conform to the latest “EN14214 or ASTM D6751” (in the USA). The biodiesel can only be blended in mixture of up to 20% by volume in acceptable mineral diesel fuel meeting latest edition of “EN590 or ASTM D975 S15” designation.

In United States, Biodiesel blends of B6 to B20 must meet the requirements listed in the latest edition of “ASTM D7467” (B6 to B20) and must be of an API gravity of 30-45.

For more information, refer to Operation and Maintenance Manual, “Fluid Recommendations”.

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Fuel Injection

Introduction

Engines with a Single Turbocharger

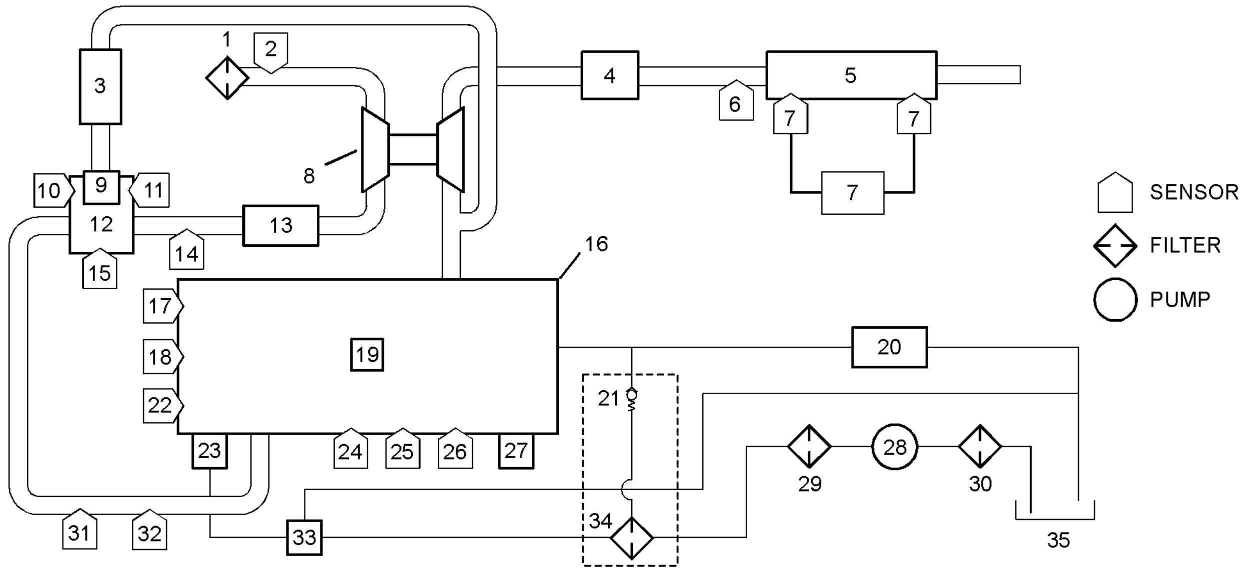

Illustration 37 g02420296

Typical example

(1) Air cleaner
(2) Air inlet temperature sensor
(3) Exhaust Cooler for the NOx Reduction System (NRS)
(4) Exhaust back pressure valve
(5) Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF)
(6) DPF inlet temperature sensor
(7) Soot sensor
(8) Turbocharger
(9) Valve for the NOx Reduction System (NRS)
(10) Temperature sensor for the NOx Reduction System (NRS)
(11) Inlet pressure sensor for the NOx Reduction System (NRS)
(12) Exhaust gas valve for the NOx Reduction System (NRS)
(13) Air-to-air aftercooler
(14) Wastegate regulator
(15) Outlet pressure sensor for the NOx Reduction System (NRS)
(16) Engine
(17) Coolant temperature sensor
(18) Crankshaft speed/timing sensor
(19) Electronic unit injectors
(20) Fuel cooler
(21) Fuel pressure relief valve
(22) Camshaft speed/timing sensor
(23) Fuel injection pump and fuel temperature sensor
(24) Fuel pressure sensor
(25) Oil pressure sensor
(26) Atmospheric pressure sensor
(27) ECM
(28) Fuel transfer pump
(29) Primary fuel filter
(30) Fuel strainer
(31) Inlet manifold pressure sensor
(32) Inlet manifold air temperature sensor
(33) Transfer pump inlet regulator
(34) Secondary fuel filter
(35) Fuel tank

Sensor Locations for the Engine

The illustrations in this section show the typical locations of the sensors for the industrial engine. Specific engines may appear different from the illustration due to differences in applications.

The operating range of the boost pressure sensors is 39 to 400 kPa (6 to 58 psi).

The engine oil pressure sensor provides the ECM with a measurement of engine oil pressure. The ECM can warn the operator of possible conditions that can damage the engine. This includes the detection of an oil filter that is blocked.

The operating range for the engine oil pressure sensor .... 13 to 1200 kPa (2 to 174 psi)

Temperature Sensors

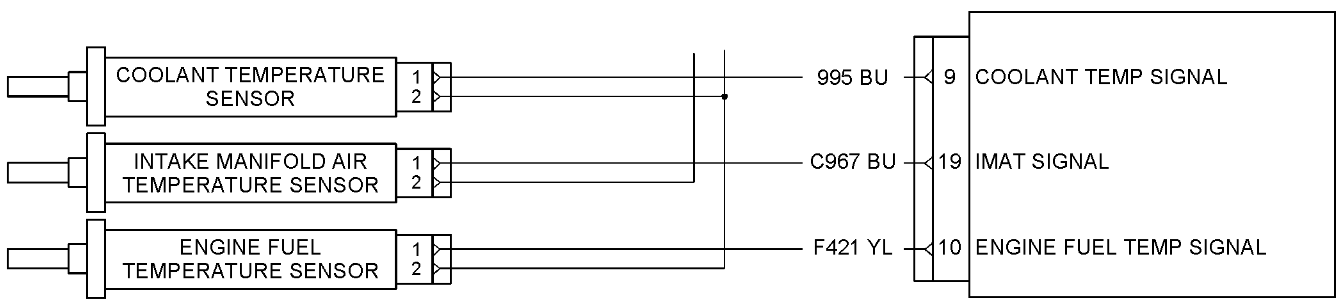

Illustration 52 g02139713

Schematic for the engine temperature sensors

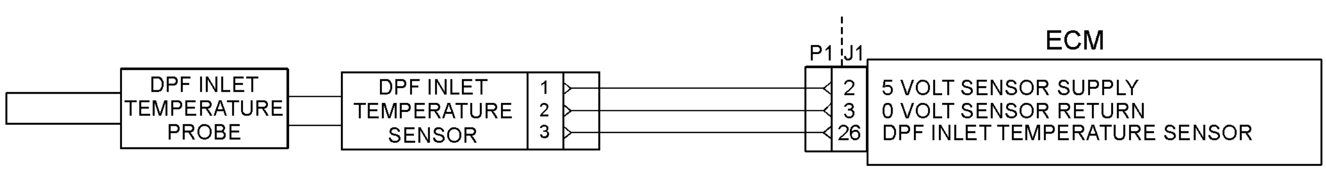

Illustration 53 g02139706

Schematic for the temperature sensors for the engine aftertreatment system

The air inlet temperature sensor and the coolant temperature sensor are passive sensors. Each sensor provides a temperature input to the ECM. The ECM controls following operations:

- Fuel delivery
- Injection timing

The operating range for the sensors ... −40° to 125°C (−40° to 257°F)

The operating range for the fuel temperature sensor .... −40° to 120°C (−40° to 248°F)

The sensors are also used for engine monitoring.

Testing and Adjusting Section

Fuel System

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Fuel System - Inspect

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorized personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, “General Hazard Information and High Pressure Fuel Lines” for safety information.

Refer to Systems Operation, Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

A problem with the components that transport fuel to the engine can cause low fuel pressure. This can decrease engine performance.

1. Check the fuel level in the fuel tank. Ensure that the vent in the fuel cap is not filled with dirt.
2. Check that the valve in the fuel return line is open before the engine is started.
3. Check all low-pressure fuel lines for fuel leakage. The fuel lines must be free from restrictions and faulty bends. Verify that the fuel return line is not collapsed.
4. Install new fuel filters.
5. Cut the old filter open with a suitable filter cutter. Inspect the filter for excess contamination. Determine the source of the contamination. Make the necessary repairs.

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Air in Fuel - Test

Table 1

Required Tools			
Tool	Part Number	Part Description	Qty
A	T400024	Sight gauge	1

NOTICE

Ensure that all adjustments and repairs that are carried out to the fuel system are performed by authorized personnel that have the correct training.

Before beginning ANY work on the fuel system, refer to Operation and Maintenance Manual, “General Hazard Information and High Pressure Fuel Lines” for safety information.

Refer to Systems Operation, Testing and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

Note: Ensure that the tools are stored with the caps in place. Store the tools in a clean plastic bag.

1. Ensure that the fuel level in the fuel tank is above the level of the suction pipe in the fuel tank.
2. Inspect the fuel system thoroughly for leaks. If necessary, repair the fuel system.
3. Check all low-pressure fuel lines from the fuel tank for restrictions. Replace any damaged components.
4. Prime the fuel system. Refer to Operation and Maintenance Manual, “Fuel System - Prime” for the correct procedure. If the electric fuel transfer pump is not operating, refer to Troubleshooting, “Fuel Pump Relay Circuit - Test”.
5. Start the engine. Refer to Operation and Maintenance Manual, “Starting the Engine” for the correct procedure. Check if the problem has been resolved. Run the engine at low idle speed for 5 minutes.
6. Stop the engine. Refer to Operation and Maintenance Manual, “Stopping the Engine” for the correct procedure.

1. Disconnect the pipe for the boost sensor (1) at the wastegate actuator (2). Connect an air supply to the wastegate actuator that can be adjusted accurately.

2. Install Tooling (A) to the turbocharger so that the end of the actuator rod (3) is in contact with Tooling (A). This will measure axial movement of the actuator rod (3).

3. Slowly apply air pressure to the wastegate so that the actuator rod (3) moves 1.0 mm (0.039 inch). Refer to Specifications, “Turbocharger” for the correct pressure for the wastegate. Ensure that the dial indicator returns to zero when the air pressure is released. Repeat the test several times. This will ensure that an accurate reading is obtained.

4. If the operation of the wastegate is not correct, the turbocharger will need to be replaced.

5. Repeat steps 2 to 3 in order to repeat the pressure test.

6. If the air pressure is correct, remove the air supply. Remove Tooling (A). Install the pipe for the boost sensor (1).

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Turbocharger - Inspect (Single Turbocharger)

WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Before you begin inspection of the turbocharger, be sure that the inlet air restriction is within the specifications for your engine. Be sure that the exhaust system restriction is within the specifications for your engine. Refer to Systems Operation, Testing, and Adjusting, “Air Inlet and Exhaust System - Inspect”.

The condition of the turbocharger will have definite effects on engine performance. Use the following inspections and procedures to determine the condition of the turbocharger.

- Inspection of the compressor and the compressor housing
- Inspection of the turbine wheel and the turbine housing
- Inspection of the wastegate

Inspection of the Compressor and the Compressor Housing

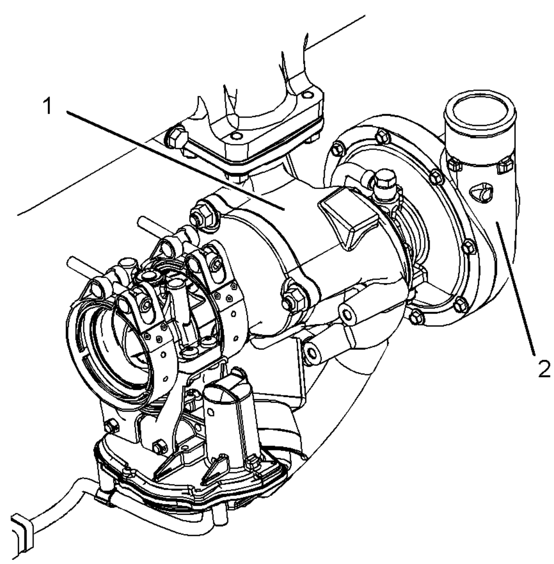

Illustration 70 g02334196

Typical example

(1) Turbine housing
(2) Compressor housing

1. Inspect the compressor wheel for damage from a foreign object. If there is damage, determine the source of the foreign object. Replace the turbocharger. If there is no damage, go to step 2.

2. Turn the rotating assembly by hand. While you turn the assembly, push the assembly sideways. The assembly should turn freely. The compressor wheel should not rub the compressor housing. The turbocharger must be replaced if the compressor wheel rubs the compressor wheel housing. If there is no rubbing or scraping, go to step 3.

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Increased Engine Oil Temperature - Inspect

Look for a restriction in the oil passages of the oil cooler. The oil temperature may be higher than normal when the engine is operating. In such a case, the oil cooler may have a restriction.

Concentricity of the Flywheel Housing

Note: This check must be made with the flywheel and the starter removed and the bolts for the flywheel housing tightened lightly.

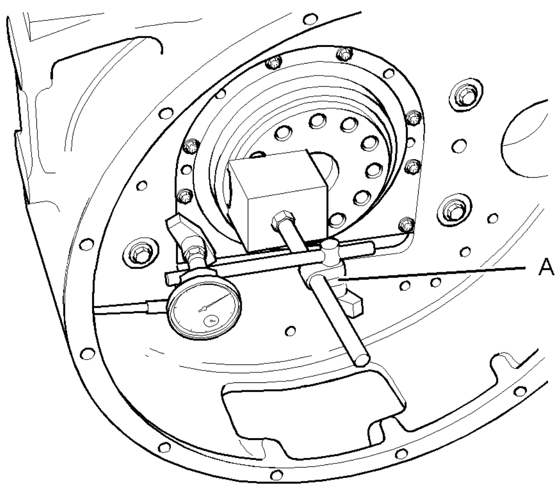

Illustration 93 g01199468

Typical example

1. Install Tooling (A). See illustration 93.

2. Set the pointer of the dial indicator to 0 mm (0 inch).

3. Check the concentricity at intervals of 45 degrees around the flywheel housing.

4. Calculate the difference between the lowest measurement and the highest measurement. This difference must not be greater than the limit that is given in Table 13.

Note: Any necessary adjustment must be made on the flywheel housing. Then, recheck the concentricity.

Alignment of the Flywheel Housing

Note: This check must be made with the flywheel and the starter removed and the bolts for the flywheel housing tightened to the correct torque.

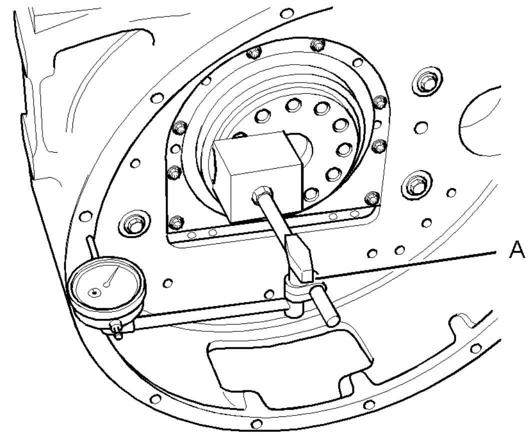

Illustration 94 g01199467

Typical example

1. Install Tooling (A). See illustration 94.

2. Set the pointer of the dial indicator to 0 mm (0 inch).

3. Check the alignment at intervals of 45 degrees around the flywheel housing.

4. Calculate the difference between the lowest measurement and the highest measurement. This difference must not be greater than the limit that is given in Table 13.

Note: Any necessary adjustment must be made on the flywheel housing.

Table 13

Limits for Flywheel Housing Runout and Alignment (Total Indicator Reading)	
Bore of the Housing Flange	**Maximum Limit (Total Indicator Reading)**
410 mm (16.14 inch)	0.25 mm (0.010 inch)
448 mm (17.63 inch)	0.28 mm (0.011 inch)

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