



ENGINE REPAIR MANUAL

BACKHOE LOADER

F4GE9454H

F4GE9454J

F4GE9484D

F4HE9484A

F4HE9484C



READ, UNDERSTAND, AND FOLLOW ALL SAFETY PRECAUTIONS AND INSTRUCTIONS FOUND IN THIS MANUAL BEFORE OPERATING THE MACHINE.

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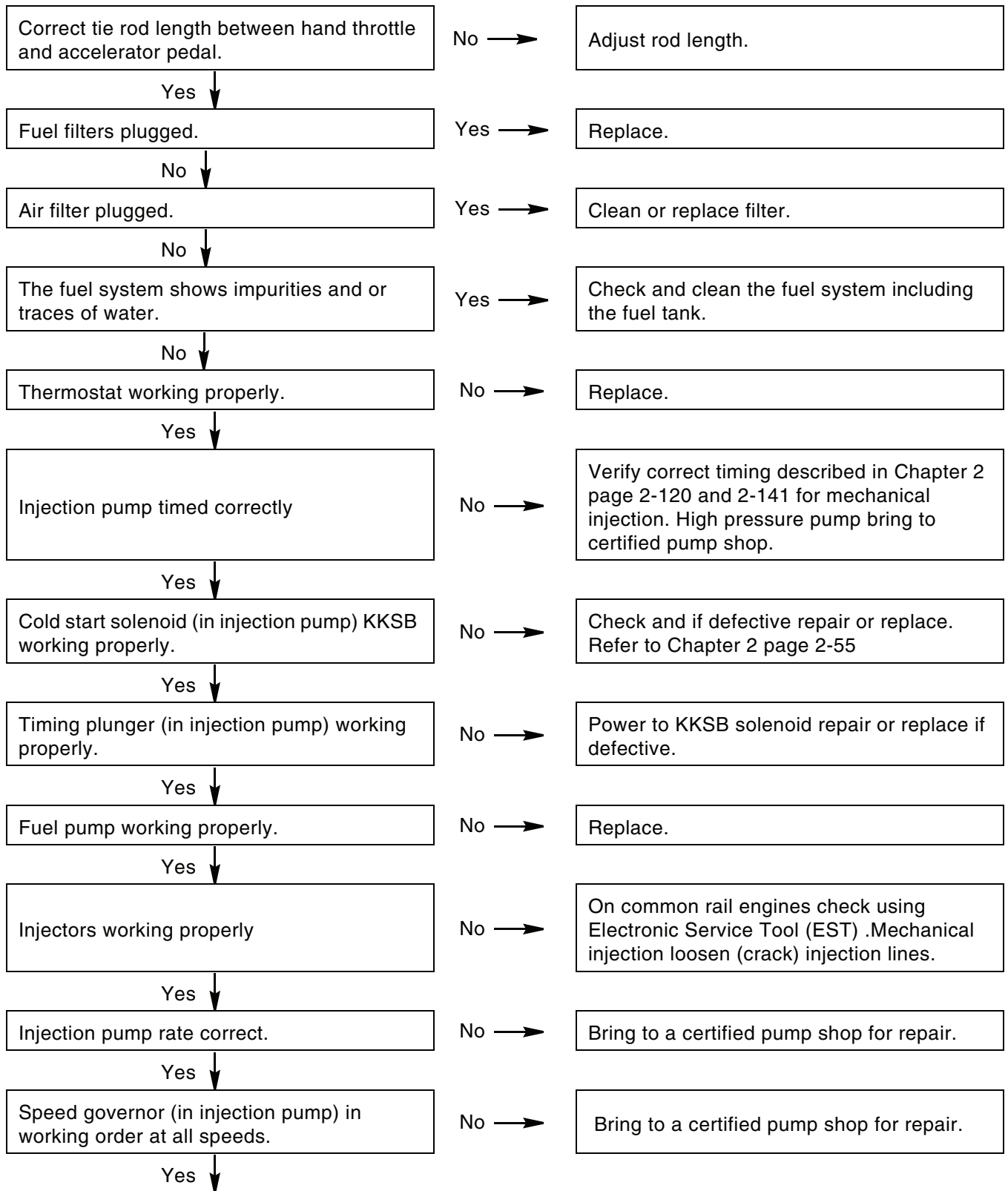
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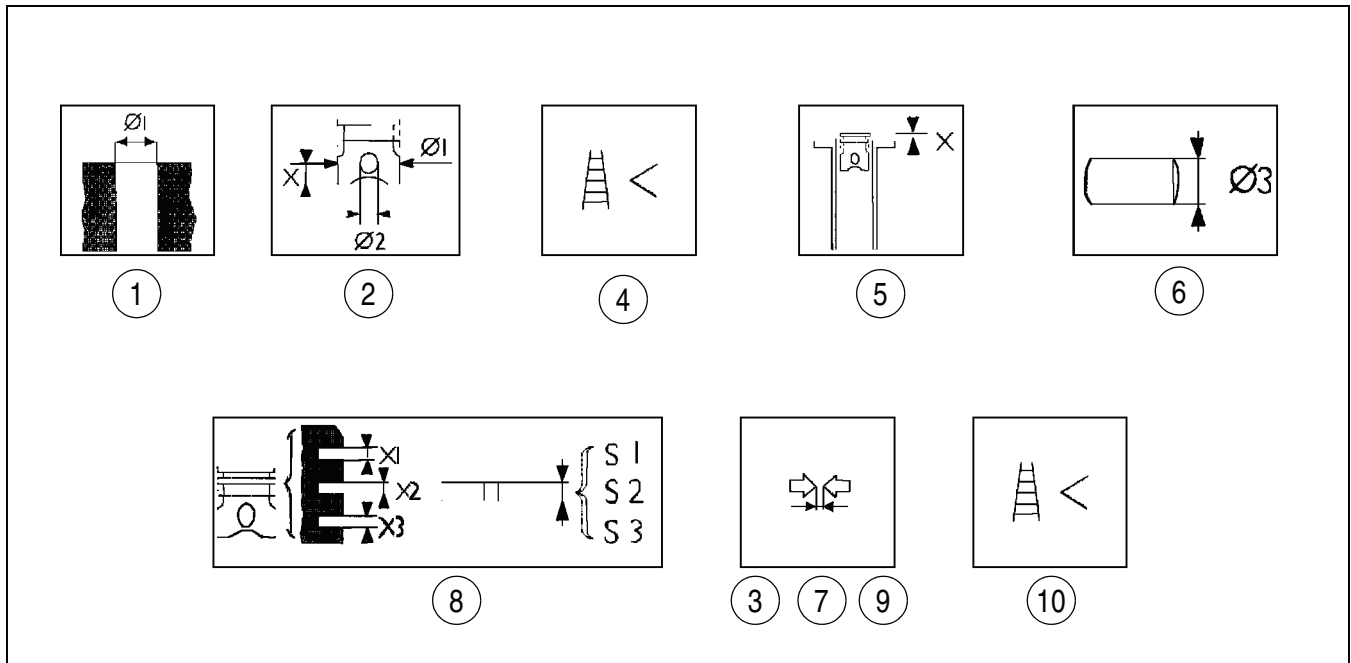
ENGINE LACKS POWER AND RUNS ERRATICALLY



CHAPTER 2
445TA ENGINE OVERHAUL
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CRANK GEAR COMPONENTS AND CYLINDER ASSEMBLY



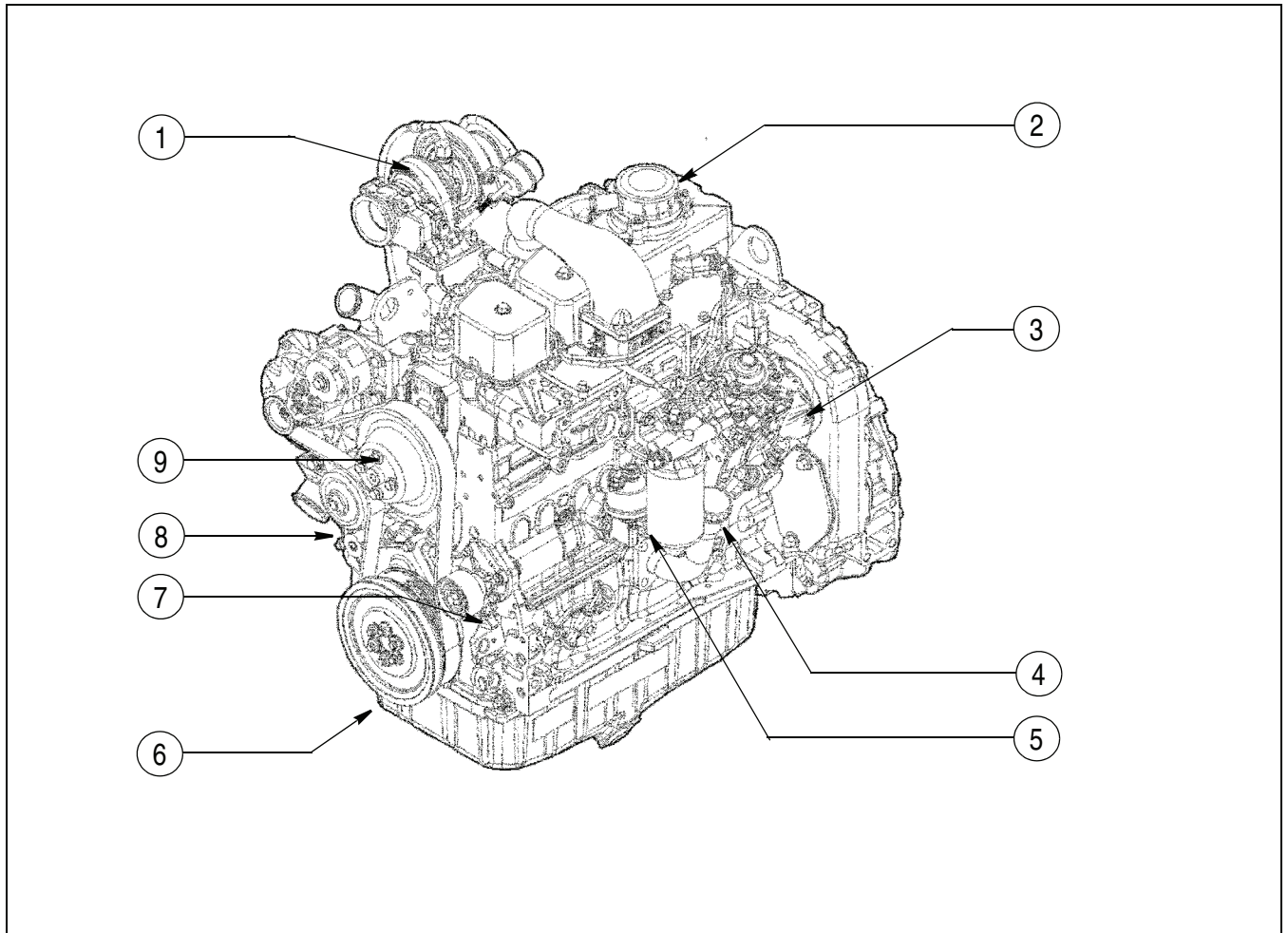
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Figure 2-7

REF. NO.	ENGINE TYPE	F4GE9454H		F4GE9454J		F4GE9484D		F4HE9484A	F4HE9484C
		J601	J602	J600	J601	J601	J602	J101	J101 / J102
1	Cylinder bore.	104.000 to 104.024 mm. (4.0945 to 4.0954 in.)							
2	Pistons:								
	Measurement dimension.	X = 55.90 mm. (2.20 in.)							
	Outer diameter.	Ø1= 103.714 to 103.732 mm. (4.0832 to 4.0839 in.)							
	Pin seat.	Ø2= 38.010 to 38.016 mm. (1.4965 to 1.4967 in.)							
3	Piston - cylinder liners.	0.252 to 0.294 mm. (0.0099 to 0.0116 in.)							
4	Piston diameter.	Ø= 0.4 mm. (0.0157 in.)							
5	Protrusion of pistons from crankcase.	0.28 to 0.52 mm (0.01102 to 0.02047 in.)							
6	Piston pin.	Ø3= 37.994 to 38.000 mm. (1.4958 to 1.4961 in.)							
7	Piston pin-Pin seat.	0.01 to 0.022 mm. (0.0004 to 0.0009 in.)							
8	Piston ring grooves (measured on Ø of 99.0mm 3.898 in.)	X1= 2.705 to 2.735 mm. (0.1065 to 0.1077 in.)							
		X2= 2.44 to 2.46 mm. (0.0961 to 0.0969 in.)							
		X3= 4.03 to 4.05 mm. (0.1587 to 0.1594 in.)							
8	Piston rings (measured 1.5 mm 0.05905 in. away from external Ø).	S1= 2.560 to 2.605 mm. (0.1008 to 0.1026 in.)							
		S2= 2.350 to 2.380 mm. (0.0925 to 0.0937 in.)							
		S3= 3.970 to 3.990 mm. (0.1563 to 0.1571 in.)							
9	Piston rings - Slots.	1= 0.100 to 0.175 mm. (0.0039 to 0.0069 in.)							
		2= 0.060 to 0.110 mm. (0.0024 to 0.0043 in.)							
		3= 0.040 to 0.080 mm. (0.0016 to 0.0031 in.)							
10	Piston rings.	0.40 mm. (0.0157 in.)							

F4GE - ENGINES

F4GE9454H AND F4GE9454J ENGINE

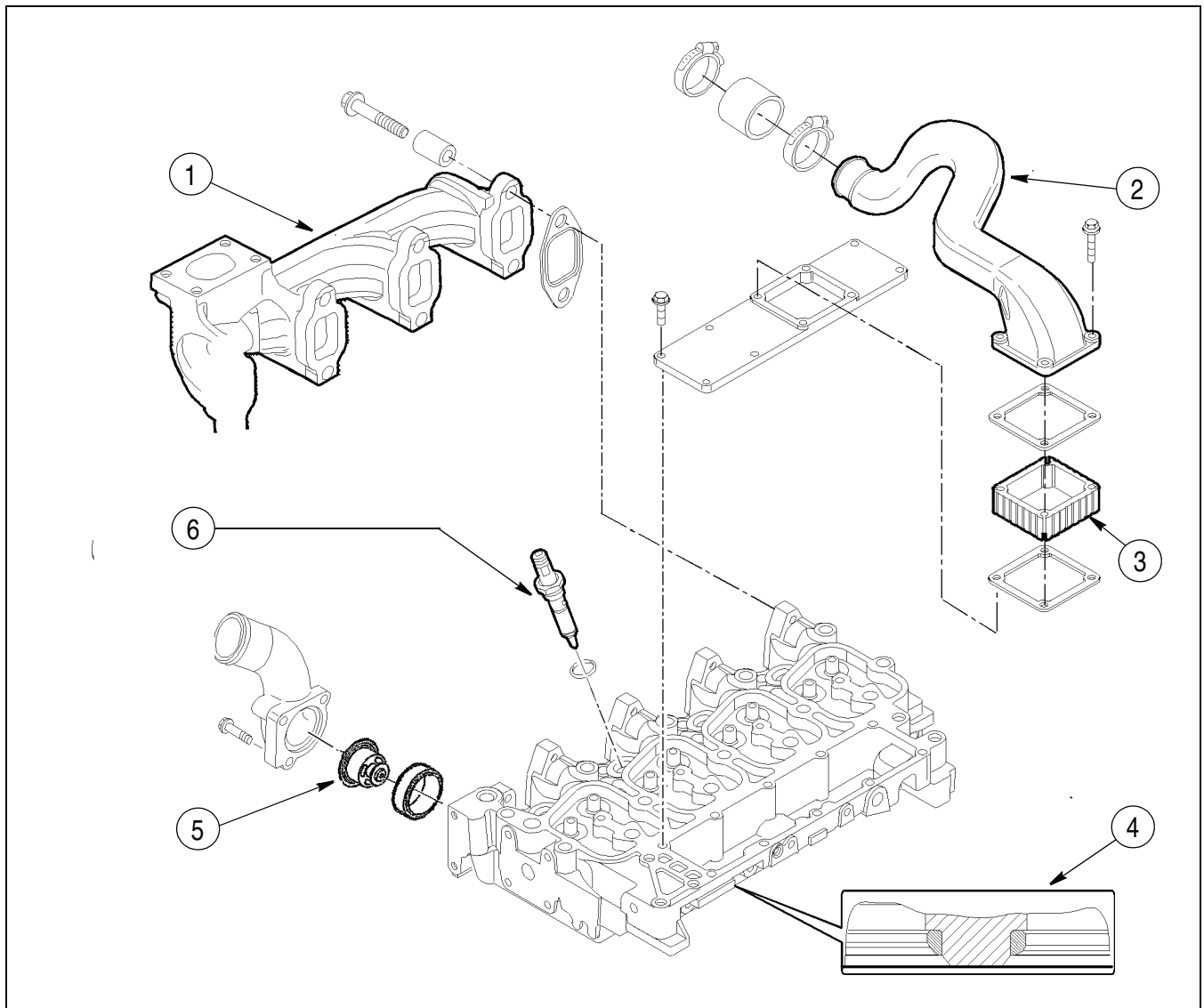


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Figure 2-12

- | | | |
|----------------------------------|----------------------|-----------------------|
| 1. TURBOCHARGER | 4. FUEL FILTER | 7. FIXED GUIDE PULLEY |
| 2. OIL VAPOR RECIRCULATION VALVE | 5. PRIMING PUMP | 8. WATER PUMP |
| 3. ROTARY INJECTION PUMP | 6. CRANKSHAFT PULLEY | 9. FAN PULLEY |

CYLINDER HEAD FOR F4GE9454H AND F4GE9454J ENGINES



BS06N194

Figure 2-23

DETAIL OF CYLINDER HEAD FOR F4GE9454H/J ENGINE WITH INSERTED VALVE SEATS

- | | | |
|---------------------|----------------|---------------|
| 1. EXHAUST MANIFOLD | 3. GRID HEATER | 5. THERMOSTAT |
| 2. INTAKE MANIFOLD | 4. VALVE SEAT | 6. INJECTOR |

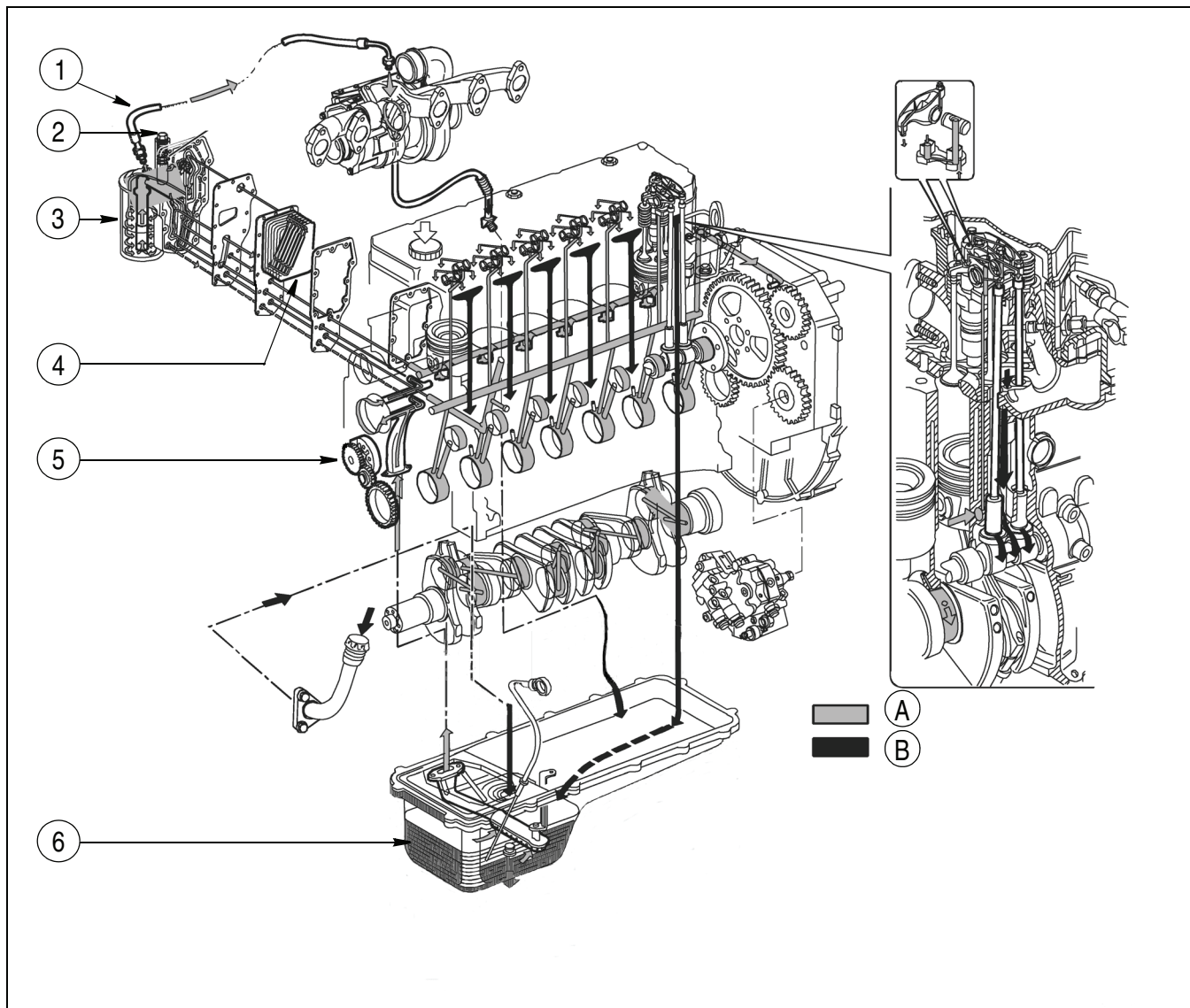
The cast iron cylinder head is machined to accommodate the following parts:

- Valve seats (4).
- Injectors (6).
- Thermostat (5).

The cylinder head is also fitted for the following components to be installed on to the cylinder head.

- Exhaust manifold (1).
- Intake manifold (2) with seat for grid heater (3).

ENGINE LUBRICATION - F4HE ENGINES



BS07D132

Figure 2-37

LUBRICATION SYSTEM LAYOUT FOR- F4HE ENGINES

(NOTE: THE ILLUSTRATION IS A 6 CYLINDER)

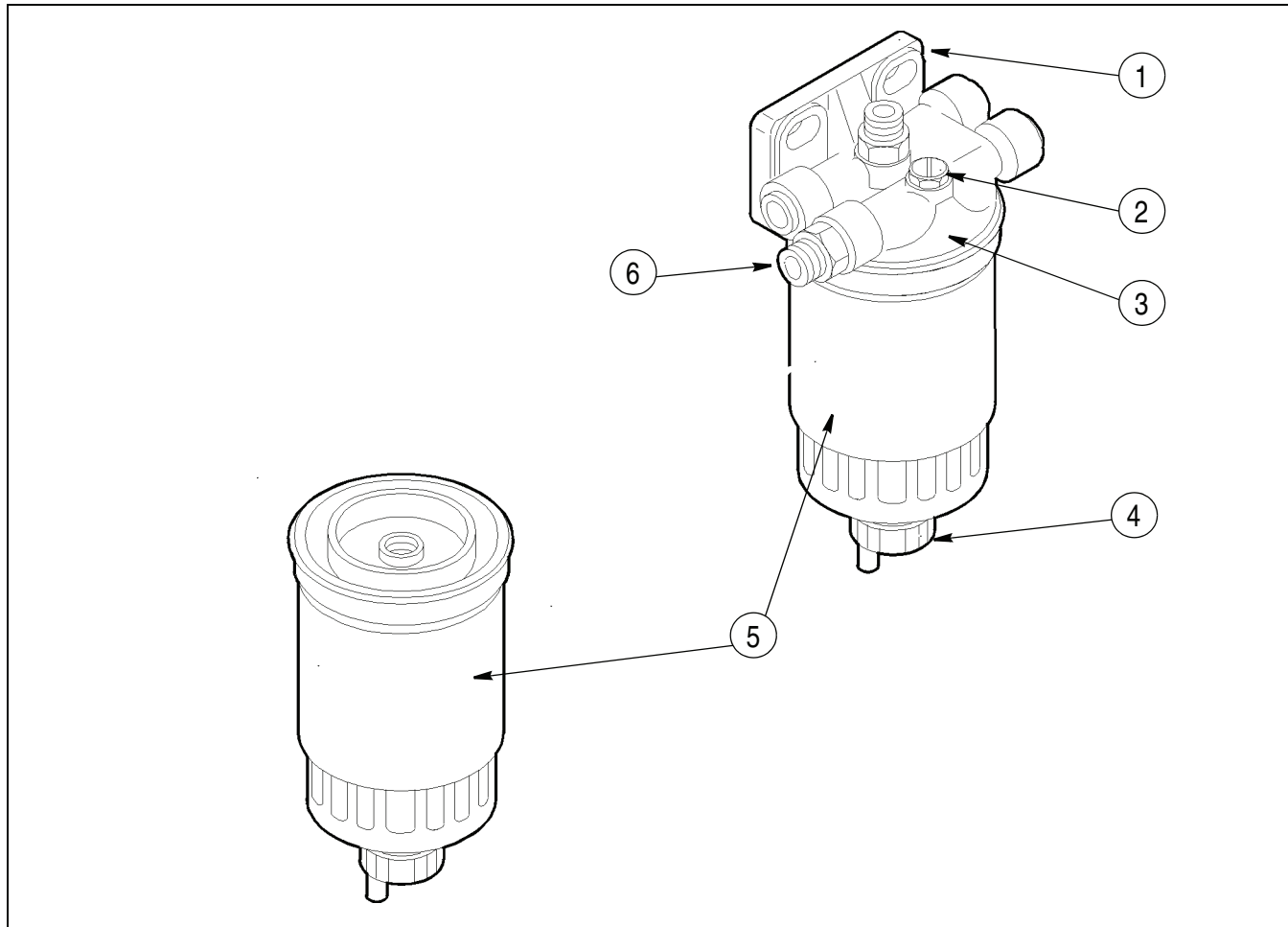
- | | | |
|-------------------------------------|-------------------|----------------------------|
| 1. TURBO OIL PRESSURE CONTROL VALVE | 4. HEAT EXCHANGER | A. PRESSURIZED OIL PATH |
| 2. BY-PASS VALVE | 5. OIL PUMP | B. GRAVITY OIL RETURN PATH |
| 3. CARTRIDGE- TYPE OIL FILTER | 6. OIL PAN (SUMP) | |

Pressurized lubrication is done with the following components:

- Gerotor oil pump (5) housed in the front of the engine block, driven by the spur tooth gear force fitted on the crankshaft.
- Heat exchanger (4) housed in the engine block, under the oil filter support.
- By-pass valve (2) for clogged oil filter cut off.
- Cartridge type oil filter (3)
- Oil pan (sump) (6)

MECHANICAL INJECTION FEEDING SYSTEM - F4GE ENGINES

FUEL FILTER



BS06N241

Figure 2-54

FUEL FILTER

1. FUEL FILTER BRACKET
2. AIR BLEEDING SCREW

3. FUEL HEATING RESISTOR
4. WATER DRAIN

5. FUEL FILTER
6. FUEL TEMPERATURE SENSOR

The fuel filter is located close to the feed and priming pump. The fuel filter provides a barrier trap for impurities and to separate water from the fuel.

On the filter bracket base there is a water drain screw. Equipment used in cold climate areas have a heater assembled into the bracket (to prevent the fuel from jelling), and a fuel temperature sensor. On some versions there is a water presence sensor located on the filter cartridge base.

RECOVER STRATEGIES

- Control of fuel leaks.

In the case of fuel supply problems, the system controls the engine with suitable constant power values obtained with a low number of rev and high torque values in order to inject the maximum quantity of fuel.

- Control of pressure in the rail.

When the pressure in the rail exceeds safety values, the engine reduces power.

- Synchronism problems

In the case of synchronism problems, faulty rev sensors, the system controls the engine by increasing the number of revs in order to improve interpretation of the signals.

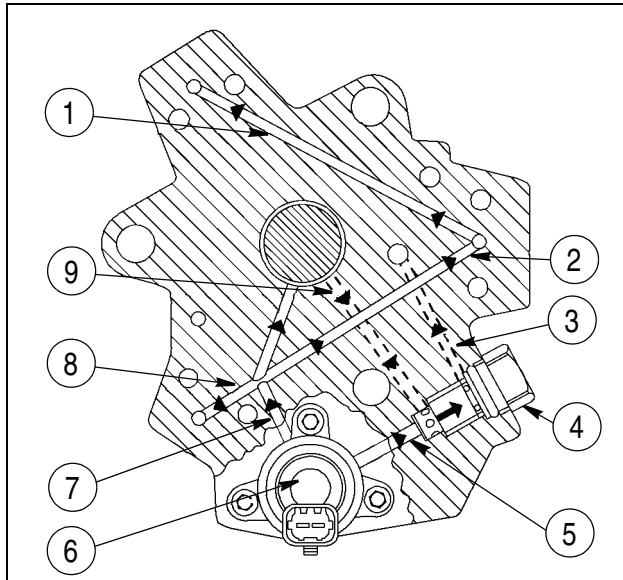
- Power restrictions as operating temperature increases.

When the temperature of the supercharging air rises above 88° C (190° F), power reduction is started, when a temperature of 120° C (248° F) is reached, performance is further reduced and is comparable to that of the same engine if it were aspirated.

- Reduction of power as reference temperature varies

In normal operating conditions, the system knows the supercharging air, oil and water temperatures.

If the temperature of the engine water is not available, the system takes the temperature of the oil as reference and when this reaches the threshold of 103° C (217° F), it starts to reduce the power available. On reaching 113° C (235° F), power is reduced to 50%.



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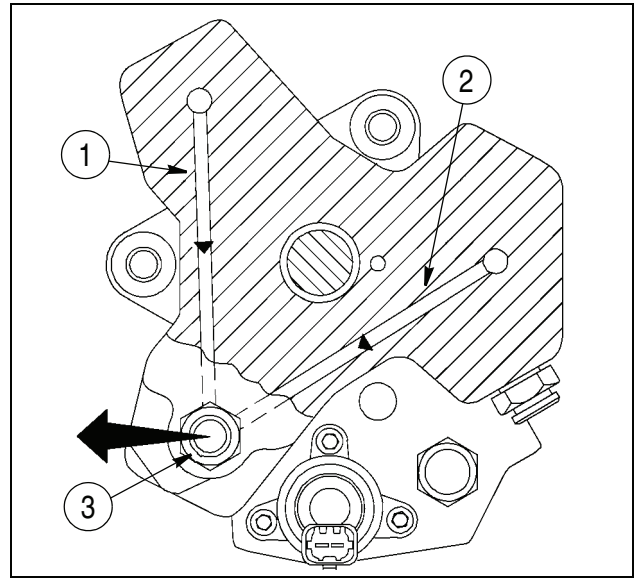
Figure 2-76

1. INLET TO HIGH PRESSURE PLUNGERS
2. INLET TO HIGH PRESSURE PLUNGERS
3. CHARGE PRESSURE REGULATOR DRAIN PASSAGE
4. CHARGE PRESSURE 5 BAR (72 PSI) REGULATOR VALVE
5. FUEL DISCHARGE FROM HIGH PRESSURE REGULATOR VALVE INLET
6. HIGH PRESSURE REGULATOR VALVE
7. MAIN PLUNGER SUPPLY PASSAGE
8. INLET TO HIGH PRESSURE PLUNGERS
9. PUMP LUBRICATION PASSAGES

The figure above shows the low pressure fuel passages inside the pump. The figure shows the main plungers supply passage (7), the individual plunger supply passages (1, 8, 2), the passages utilized for lubrication of the pump (9), the high pressure regulator (6), the 5 bar (72 psi) pressure regulator valve (4) and the fuel discharge passage (3).

The high pressure regulator (6) determines the quantity of fuel which the high pressure plungers deliver to the common rail. Excess fuel flows out through passage (5).

The regulator valve (4), is designed to maintain a constant pressure of 5 bar (72 psi.) at the high pressure regulator inlet.



BS06K065

Figure 2-77

1. FUEL EXHAUST FLUE
2. FUEL EXHAUST GALLERY
3. FUEL EXHAUST FLOWING FROM PUMP WITH CONNECTOR TO HIGH PRESSURE LINE FOR COMMON RAIL

The figure above shows the fuel flow under high pressure running through the exhaust galleries of the pumping elements.

THEORY OF OPERATION

The cylinder is filled through the cap intake valve only if the supply pressure is suitable to open the delivery valves set on the pumping elements about 2 bars (29 psi.).

The amount of fuel supplying the high pressure pump is metered by the high pressure regulator. The high pressure regulator is controlled by the EDC7UC31 control unit through a PWM (pulse width modulated) signal.

When fuel is sent to a pumping element, the corresponding piston is moving downwards (suction stroke). When the piston stroke is reversed, the intake valve closes and the fuel in the pumping element chamber, is compressed into the rail.

The generated pressure makes the exhaust valve open and the compressed fuel reaches the high pressure circuit.

The pumping element compresses the fuel till the top dead center (delivery stroke) is reached. Afterwards, the pressure decreases till the exhaust valve is closed.

The pumping element piston goes back towards the bottom dead center and the remaining fuel is decompressed.

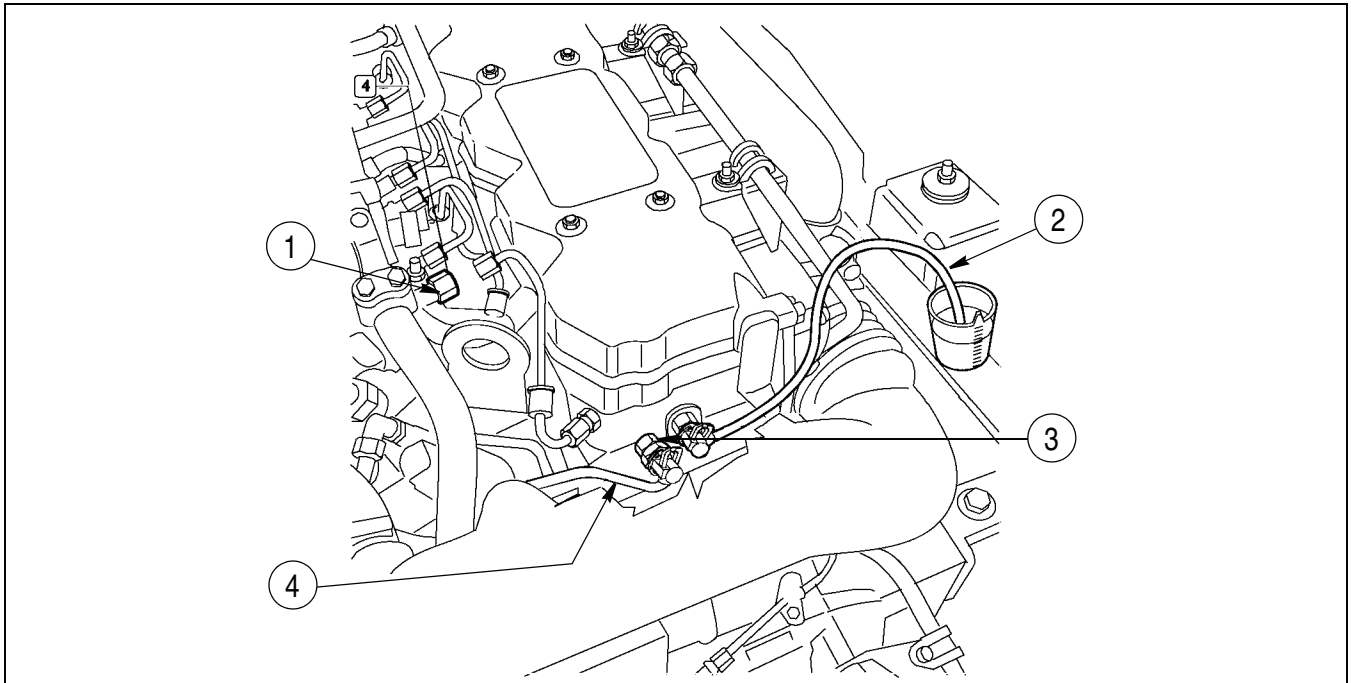
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BS06K220

Figure 2-90

Proceed with the injector fuel backflow tests as follows:

- Remove the duct (4) from the cylinder head.
- Plug it (3)
- Install a transparent line (2)

Make sure that the engine idling speed is correct. Check the quantity of fuel recirculation from the cylinder head.

The process for measuring the quantity of injector return fuel is:

- Engine idling and without air compressor or air conditioner on.
- engine temperature greater than 50°C (122°F).

The quantity of fuel that flows out must be no greater than 80ml. (2.7 oz.) of diesel per minute. Excessive recirculation more than 80ml. (2.7 oz.) of diesel per minute could be caused by:

- Incorrect coupling between one or more injectors and the related needles.
- Problem of internal leakage of the injector.

To identify the defective injector, follow the method as described below:

Measure the quantity of fuel flowing out in one minute from the coupling on the cylinder head. If recirculation exceeds 80 ml. (2.7 oz.) per minute, plug the rail outlet of one injector (1) at a time using the rail plugs in the test set.

The defective injector is the one when plugged causes a significant reduction in recirculated fuel.

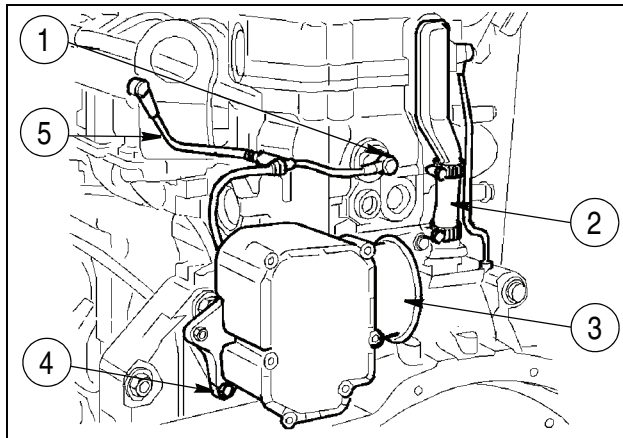
NOTE: When changing an injector it is necessary to change the duct.

After identifying the injectors / ducts with high fuel recirculation, check the torque of the ducts, 45 - 55 Nm (33.2 - 40.6 pound-feet), if they are loose tighten. Then check the recirculation values again.

If the torque is correct, remove the line and check the spherical end towards the injector is not out of round, replace if necessary. Recheck recirculation value.

If the duct is not out of shape, replace the injector.

STEP 8



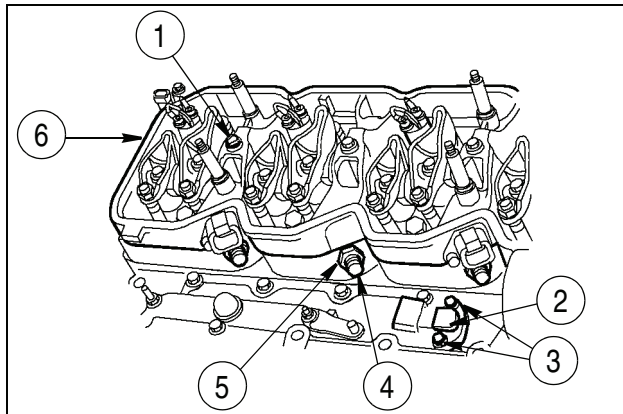
BS06K227

Figure 2-127

Disconnect line (5) from fuel return pressure limiter (1) as shown in step 3 page 2-89.

Remove the nut, loosen the retainer collar and disconnect the oil vapor line (2). Remove bolts (4) and take off the blow-by filter (3).

STEP 9



BS06K228

Figure 2-128

Remove nuts and remove the tappet cover including the gasket.

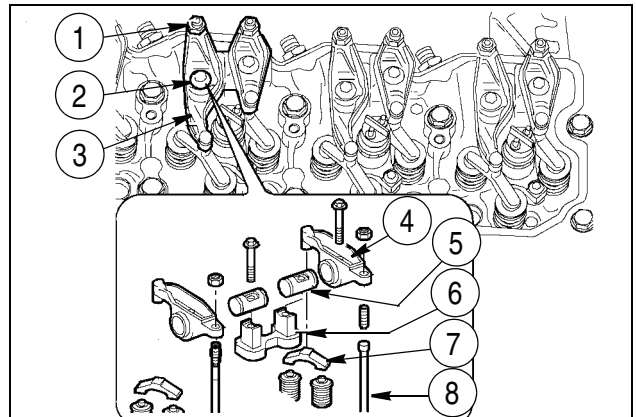
Remove bolts (1) and disconnect the injector wiring housing (6) complete with gasket.

Remove bolts (3) and detach the boost temperature/pressure sensor (2).

Remove nuts (5) and remove the fuel inlet connectors (4).

IMPORTANT: *Disassembled fuel inlet connectors (4) must not be used again. They must be replaced with new ones.*

STEP 10



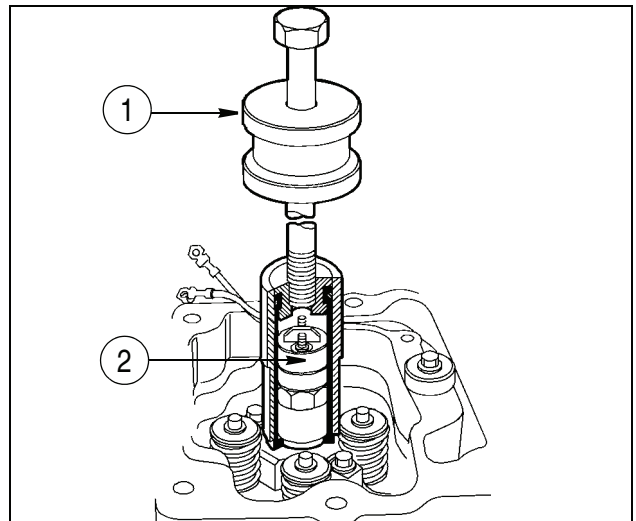
BS06K229

Figure 2-129

Loosen tappet adjusting nuts (1) and unscrew the adjusters.

Remove bolts (2), remove the rocker assembly (3), consisting of bracket (6), rockers (4), shafts (5) and remove jumpers (7) from valves. Remove rods (8).

STEP 11

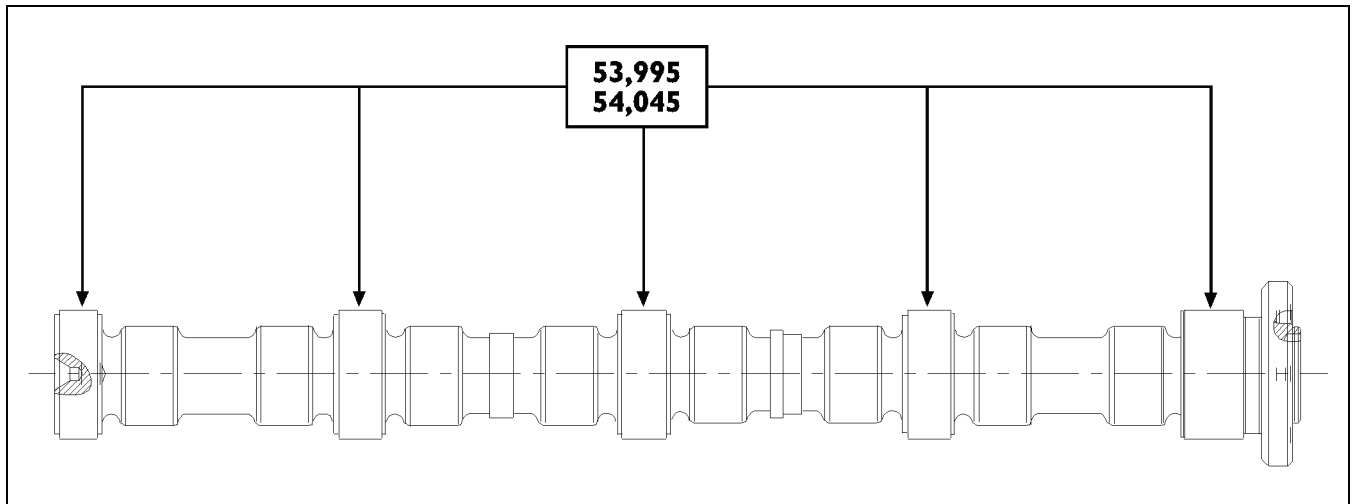


BS06K230

Figure 2-130

Remove injector fastening bolts. Use Special Tool 380001099 (1) to remove injectors (2) from the cylinder head.

CAMSHAFT



BS06N270

Figure 2-167

MAIN FEATURES OF CAMSHAFT

The camshaft support journals and lobe surfaces must be perfectly smooth. If they show signs of seizing and scoring, replace the camshaft and respective bearings.

For F4HE engines:

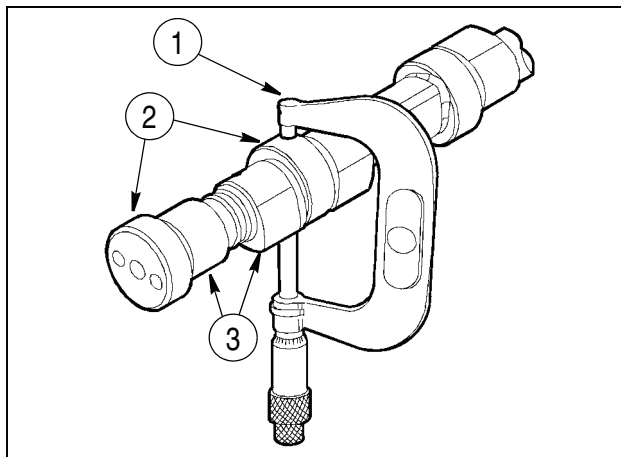
6.045 mm (0.238 inches) for Exhaust.

7.528 mm (0.296 inches) for Intake .

If different values are found than specifications, replace the camshaft.

CHECKING ECCENTRIC LIFT AND BEARING SURFACE

STEP 47



BS06K266

Figure 2-168

Check the camshaft with a micrometer (1). The journal surface (2) must not have greater than 0.04 mm (0.0016 inches) of wear otherwise replace camshaft. Check the diameter of the camshaft bearing journals with a micrometer (1) on two axis perpendicular to each other.

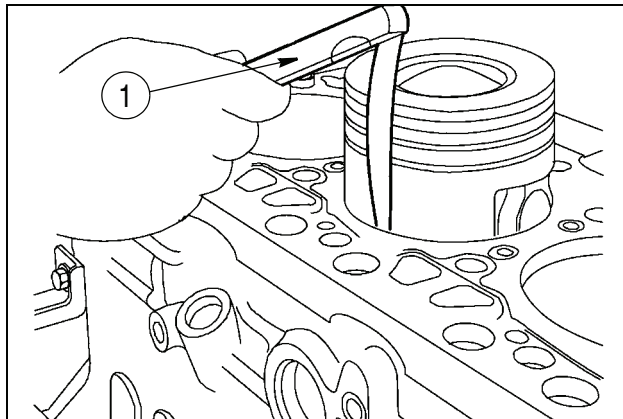
Also check the eccentric (lobe) lift (3) which must be equal to.

For F4GE engines:

11.02 mm (0.434 inches) for Exhaust.

10.74 mm (0.423 inches) for Intake.

STEP 68



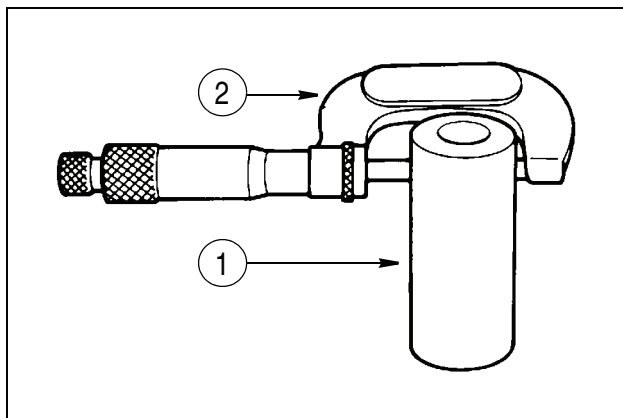
BS06K295

Figure 2-195

The play between the piston and the cylinder bore can also be measured by means of a thickness gauge (1) as shown in figure.

PISTON PINS

STEP 69



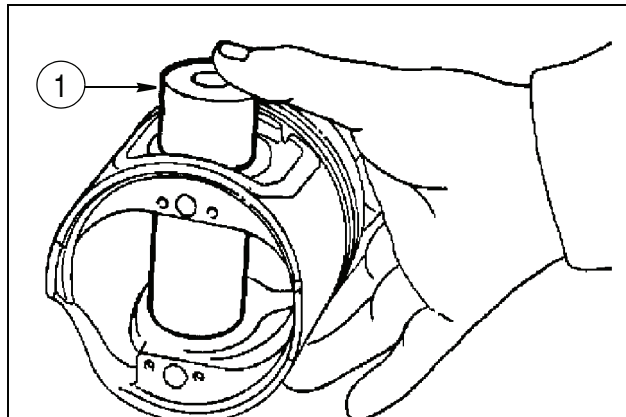
BS06N299

Figure 2-196

Measure the piston pin diameter (1) by means of a micrometer (2).

CONDITIONS FOR CORRECT PIN/PISTON MATCHING

STEP 70

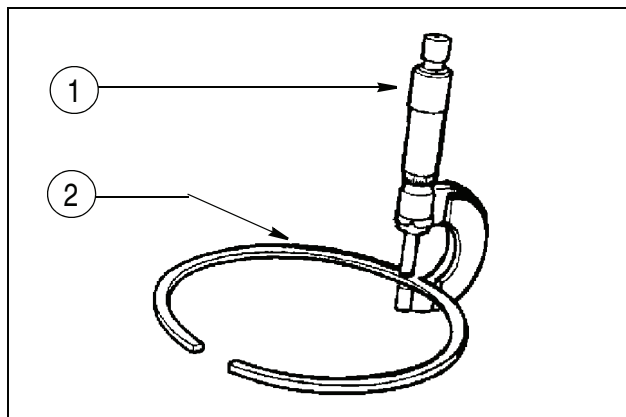


BS06K298

Figure 2-197

Lubricate piston pin (1) and its respective seat on piston hubs with engine oil, the pin must be inserted into the piston by pressing with your fingers slightly and must not slide out due to gravity.

STEP 71



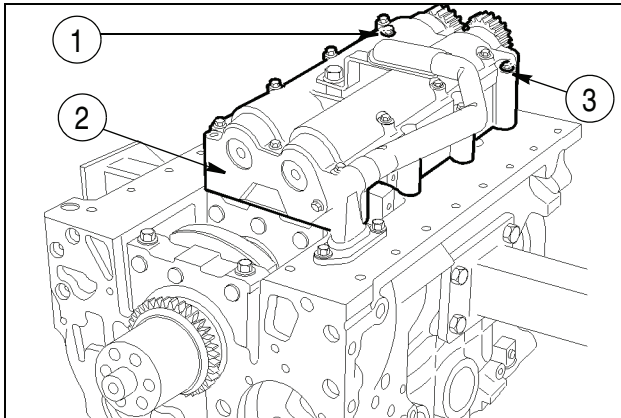
BS06K299

Figure 2-198

Check the thickness of piston rings (2) by means of a micrometer (1).

ASSEMBLING COUNTER BALANCER - F4GE ENGINES

STEP 101



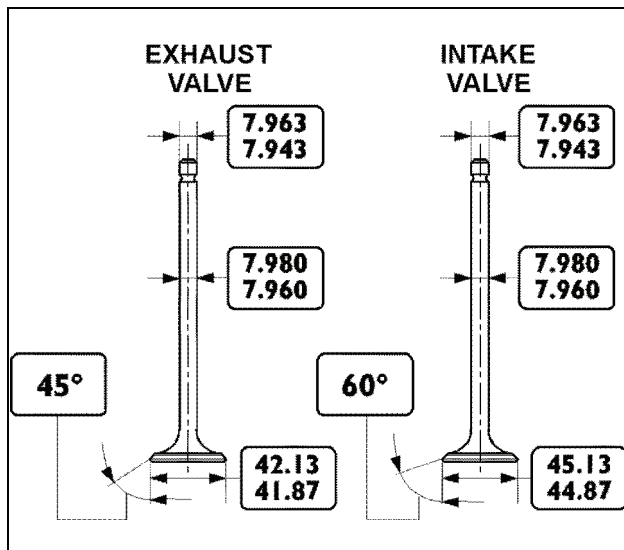
BS06N307

Figure 2-228

Turn engine over and install the counter balancer (2) and tighten the bolts (3) to 40 to 56 Nm (29.5 to 41.3 pound-feet)

Remove the counter balancer locking pin (1).

VALVES



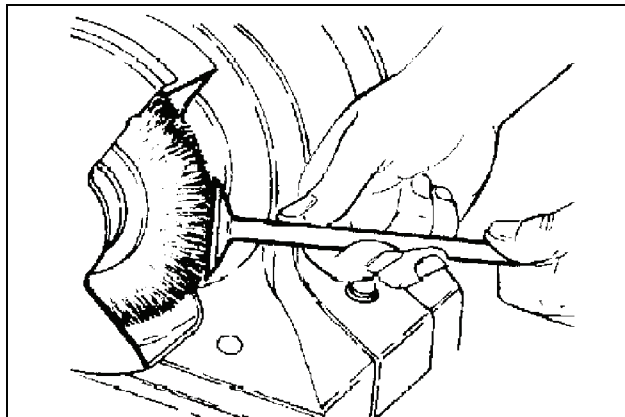
BS06N330

Figure 2-259

MAIN DATA OF INTAKE AND EXHAUST VALVES

VALVE DESCALING, CHECK AND GRINDING

STEP 129



BS06K359

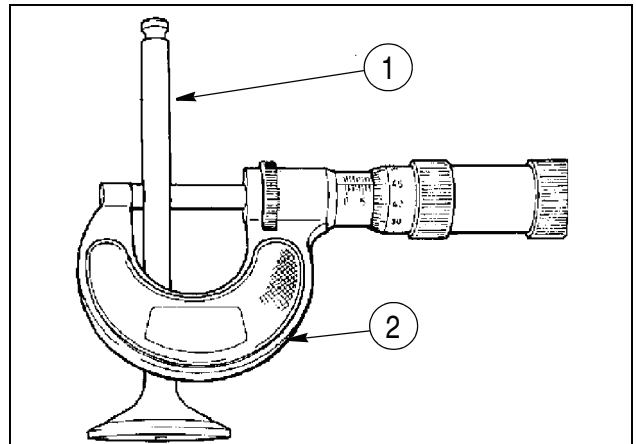
Figure 2-260

Remove the carbon deposits from the valves by means of the special metal brush.

Verify that the valves do not show traces of seizing, scoring or burns.

Adjust if required, the valve seats with the proper grinder, removing the least amount of material possible.

STEP 130



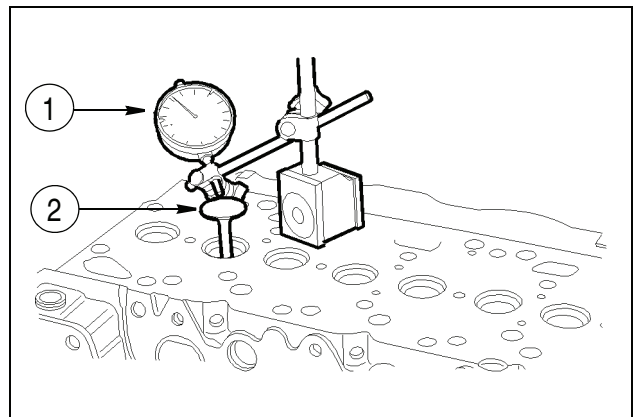
BS06K360

Figure 2-261

Use a micrometer (2) to measure valve stem (1), which must be equal to 7.943 to 7.963 mm (0.313 to 0.314 inches)

CHECKING VALVE GUIDE WEAR

STEP 131



BS06N332

Figure 2-262

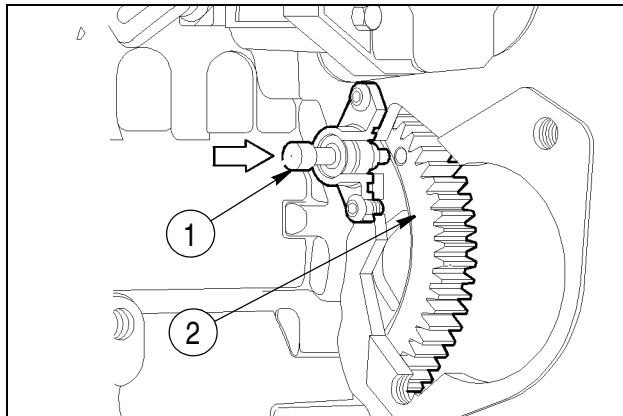
Check can be made by means of a magnetic dial indicator (1) placed as shown. Assembly play must be equal to 0.056 to 0.096 mm (0.002 to 0.004 inches).

Check, by turning valve (2) and making sure that the centering error does not exceed 0.03 mm (0.001 inches).

INJECTION PUMP TIMING

The following two steps (step 158, 159) are two ways of finding Top Dead Center (TDC)

STEP 158



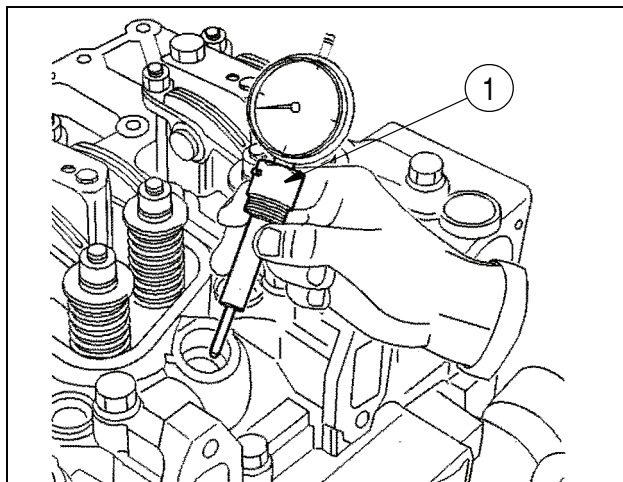
BS06N305

Figure 2-292

SEARCHING FOR TDC WITH GEAR BLOCKING PIN

Turn the flywheel until, the pin (1) can be inserted into the gear (2). This will put the engine at Top Dead Center (TDC) of the number 1 cylinder.

STEP 159



BS07C720

Figure 2-293

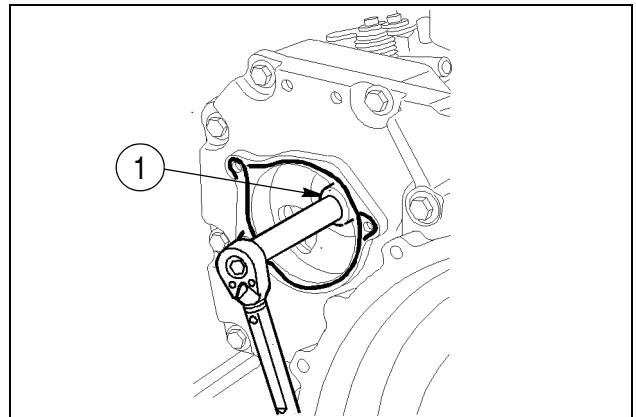
FINDING TDC WITH FALSE INJECTOR

Remove the rocker cover from the number one cylinder, remove the number one injector and place dial indicator (1) to set the number one cylinder to TDC (end of compression stroke). Pre-load the dial indicator.

Rotate engine until you find the maximum value on the dial indicator, and then check that both the intake and exhaust valves are closed (both exhaust and intake pushrods should be loose).

Once TDC has been obtained lock the flywheel with acceptable tool to prevent engine from turning.

STEP 160



BS06N316

Figure 2-294

Tighten the already installed lock washer and nut (1) on the back side of the injector pump drive shaft. Tighten to specified torque.

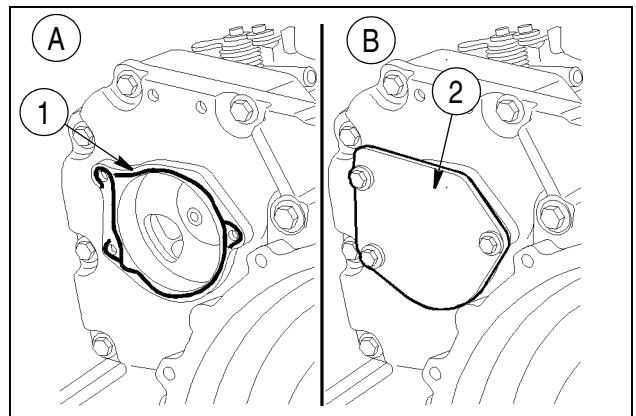
1st phase- 15 to 20 Nm (11 to 14.8 pound-feet)

2nd phase- 90 to 95 Nm (66 to 70 pound-feet)

NOTE: Make sure that the injector pump drive shaft does not move when tightening the nut.

WARNING: Be careful not to drop the nut and washer inside engine.

STEP 161

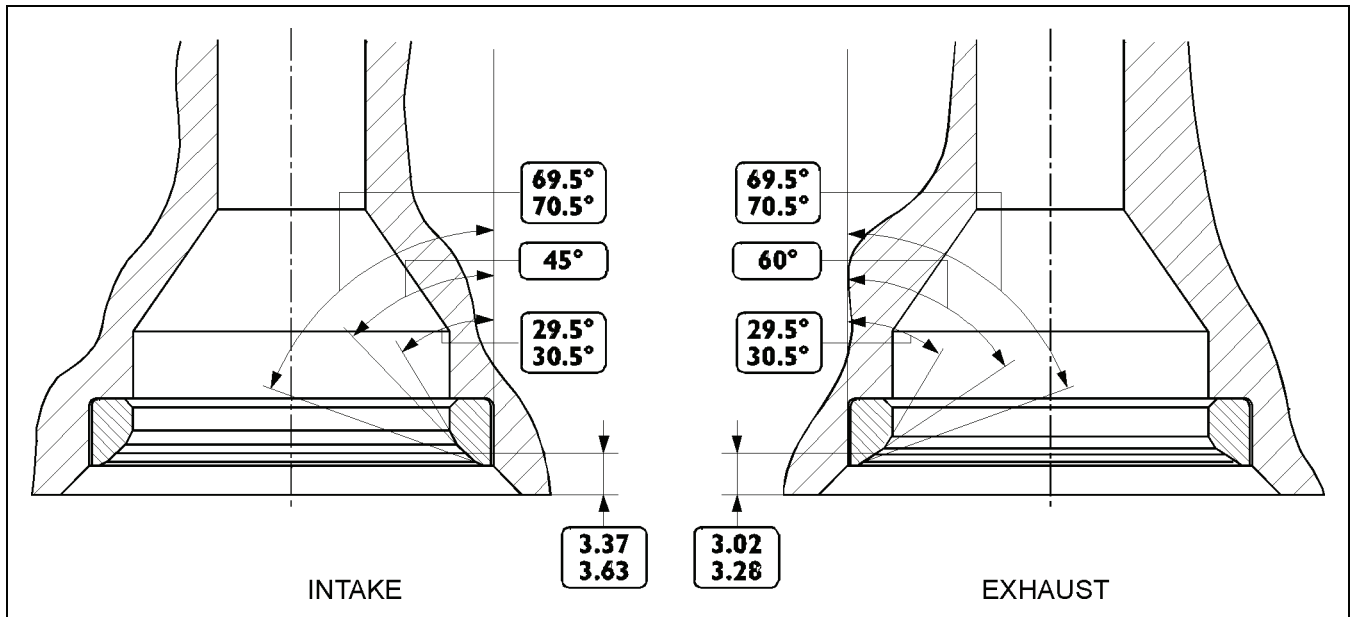


BS06N317

Figure 2-295

Apply Loctite 5205 sealant (1) as shown in figure (A). Then install the cover (2) and tighten bolts to specified torque.

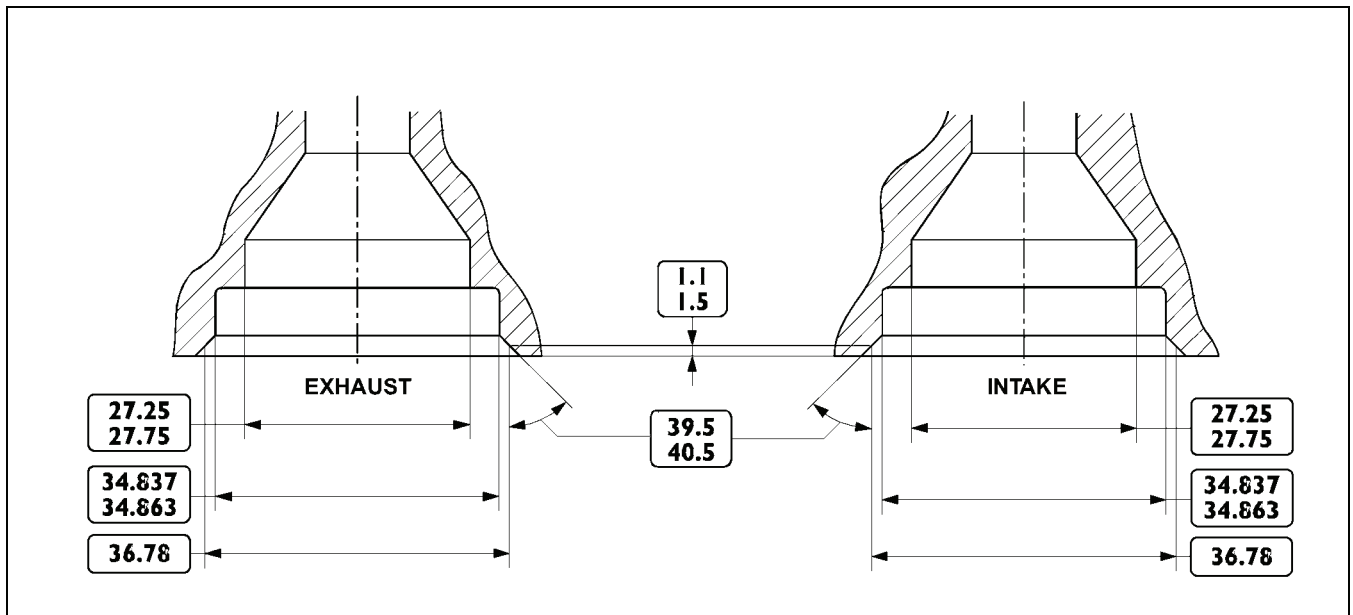
M8 bolts- 20 to 28 Nm (14.8 to 20.7 pound-feet).



BS07D077

Figure 2-323

MAIN DATA ON VALVE SEATS ON CYLINDER HEAD F4HE ENGINES



BS06K365

Figure 2-324

MAIN DATA ON VALVE SEATS

If the valve seats cannot be resealed, just by grinding, replace them with replacement parts. By using tool (1, in step 14) to remove as much material as possible from the valve seats (taking care not to damage the cylinder head) until they can be extracted from the cylinder head using a punch.

Heat the cylinder head to 80° to 100° C (176° to 212° F) and using the proper beater, install the new valve seats (previously cooled) into the heated cylinder head.

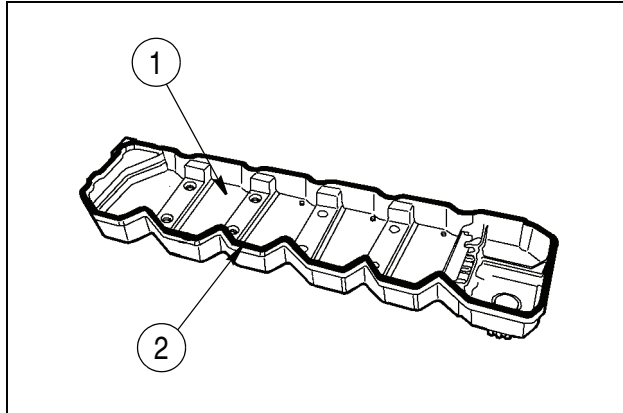
Recondition the valve seats with tool (1 in step 14) according to the values shown on page 2-151 figure 2-321 .

WARNING: Always wear heat protective gloves to prevent burning your hands when handling heated parts.

SM121A

INSTALLING TAPPET COVER

STEP 42

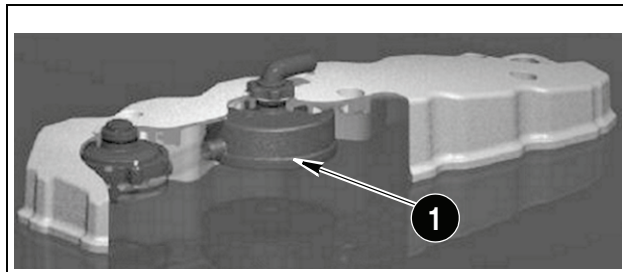


BS06K392

Figure 2-352

Install a new gasket (2) on the tappet cover (1).

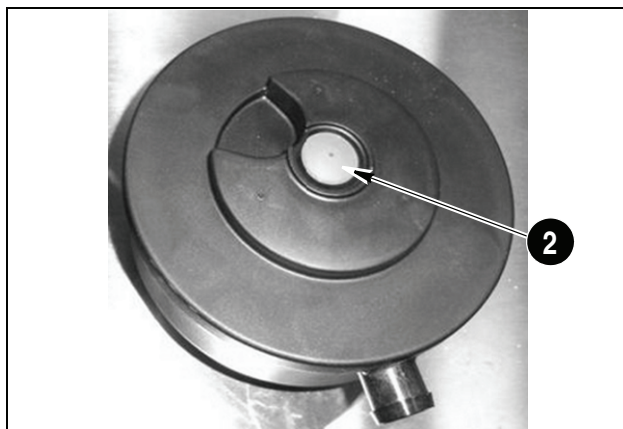
STEP 43



BS07G387

Figure 2-353

1. BLOW-BY FILTER



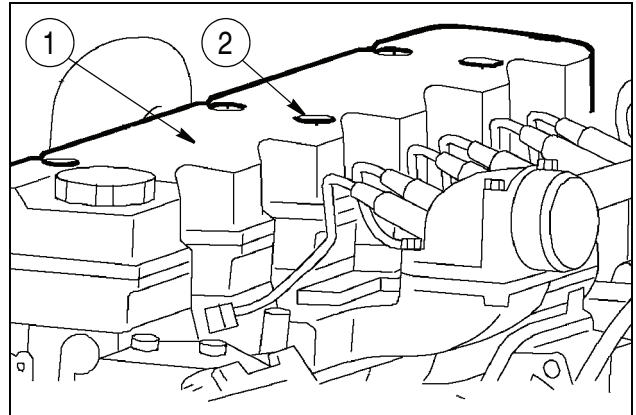
BS07G388

Figure 2-354

2. CHECK VALVE INSTALLED IN THE BLOW-BY FILTER

Make sure the check valve (2) is installed in the blow-by filter (1) located in the tappet cover. If not replace the filter.

STEP 44



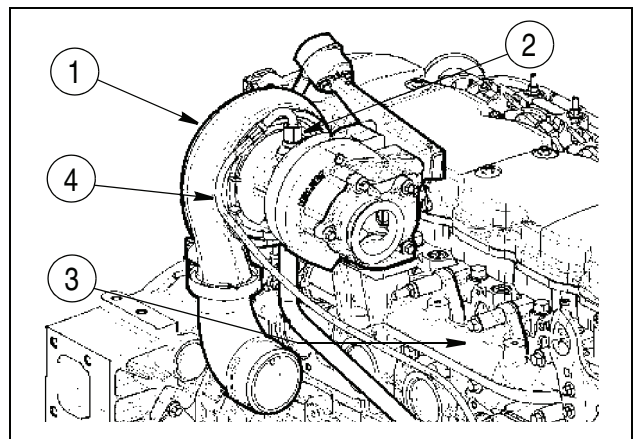
BS06K393

Figure 2-355

Install the tappet cover (1) and tighten the nuts (2) to 20 to 30 Nm (14.8 to 22.1 lb.-ft.) the specified torque.

EXHAUST MANIFOLD / TURBO INSTALLATION

STEP 45



BS07D073

Figure 2-356

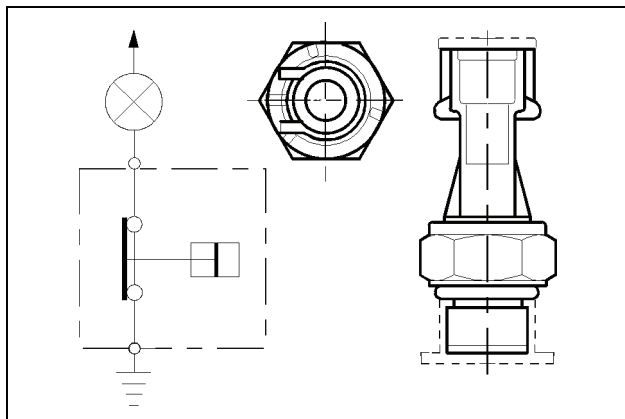
Re-attach exhaust manifold (3) with new gaskets. Install bolts and tighten them to:
M10 bolts- 48 to 58 Nm (35.4 to 42.8 pound-feet).

Re-attach turbo-charger (1) to exhaust collector, with a new gasket and tighten nuts to:
M8 nuts- 20 to 30 Nm (14.8 to 22.1 pound-feet).

Connect the oil pipeline (4) to the support of the heat exchanger. Attach the oil line to the line fitting on the turbocharger (2) tighten nut to:

M12 nut- 8 to 12 Nm (5.9 to 8.9 pound-feet).

OIL PRESSURE SENSOR



BS07C727

Figure 3-5

Oil pressure sensor is installed to the engine crankcase on the engines left hand side.

Specifications:

Working voltage: 12 to 24 volts

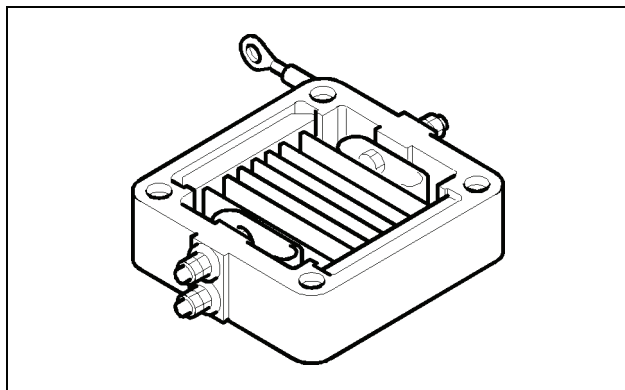
Contact closure

Upon lower pressure: 0.2 bar (2.9 psi)

Contact opening

Upon higher pressure: 0.9 bar (13 psi)

GRID HEATER



BS07C729

Figure 3-6

Grid heater is a resistor installed in the intake manifold. It is used to heat the intake air during cold weather starting.

The grid heater is controlled by the grid heater control unit located very close to the engine. Which is activated when temperature is below 5° C (41° F)

Specifications:

Working voltage: depending on equipment
12 volt or 24 volt.

Maximum air flow: 2cc / min

Pressure: 138 kPa (20 psi)

Impedance : Approximately 0.5 Ohm.

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