



ENGINE REPAIR MANUAL

667TA/EEG

667TA/EEC

667TA/EBF

667TA/EED

667TA/EBJ

667TA/EDJ

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CHAPTER 1

667TA

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DIAGNOSTICS

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CHAPTER 1

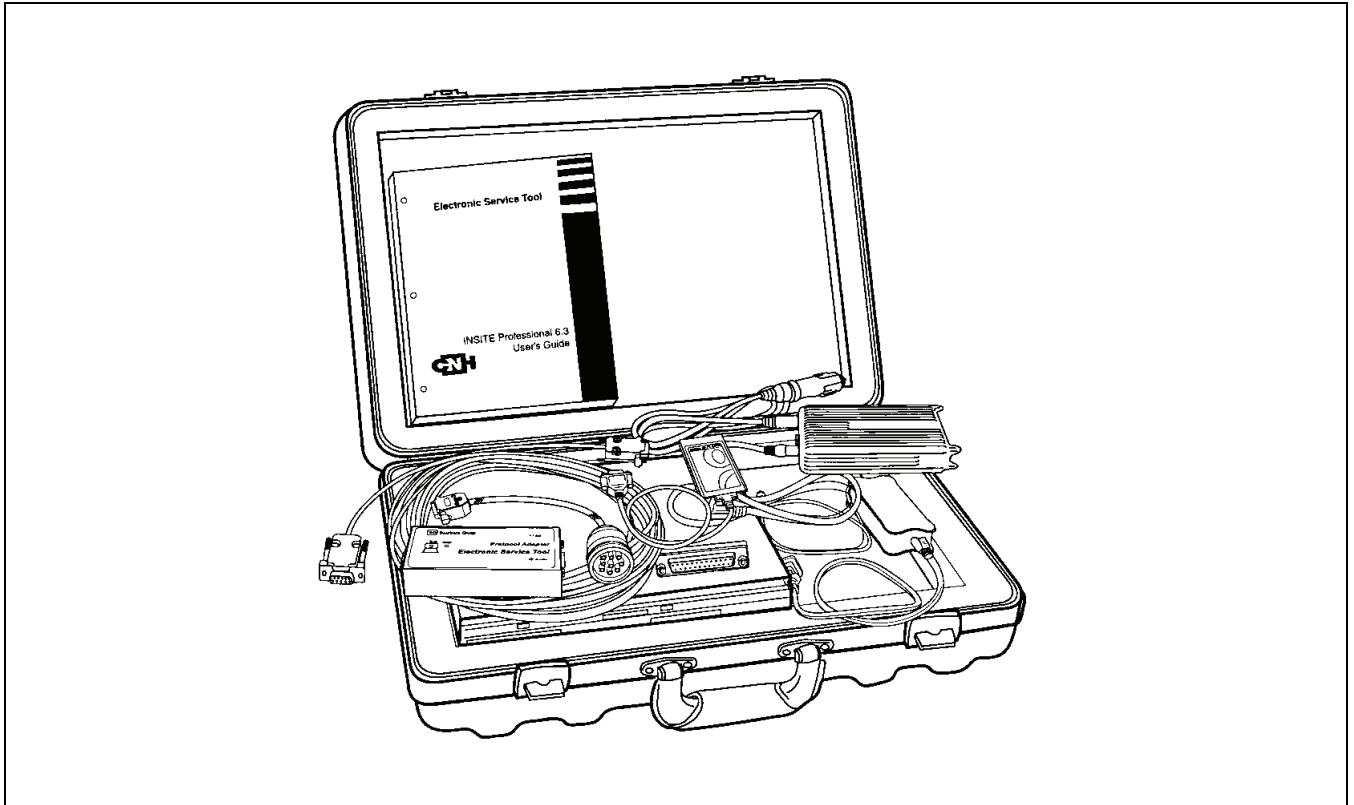
DIAGNOSTICS

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CNH- EST DIAGNOSTIC TOOL



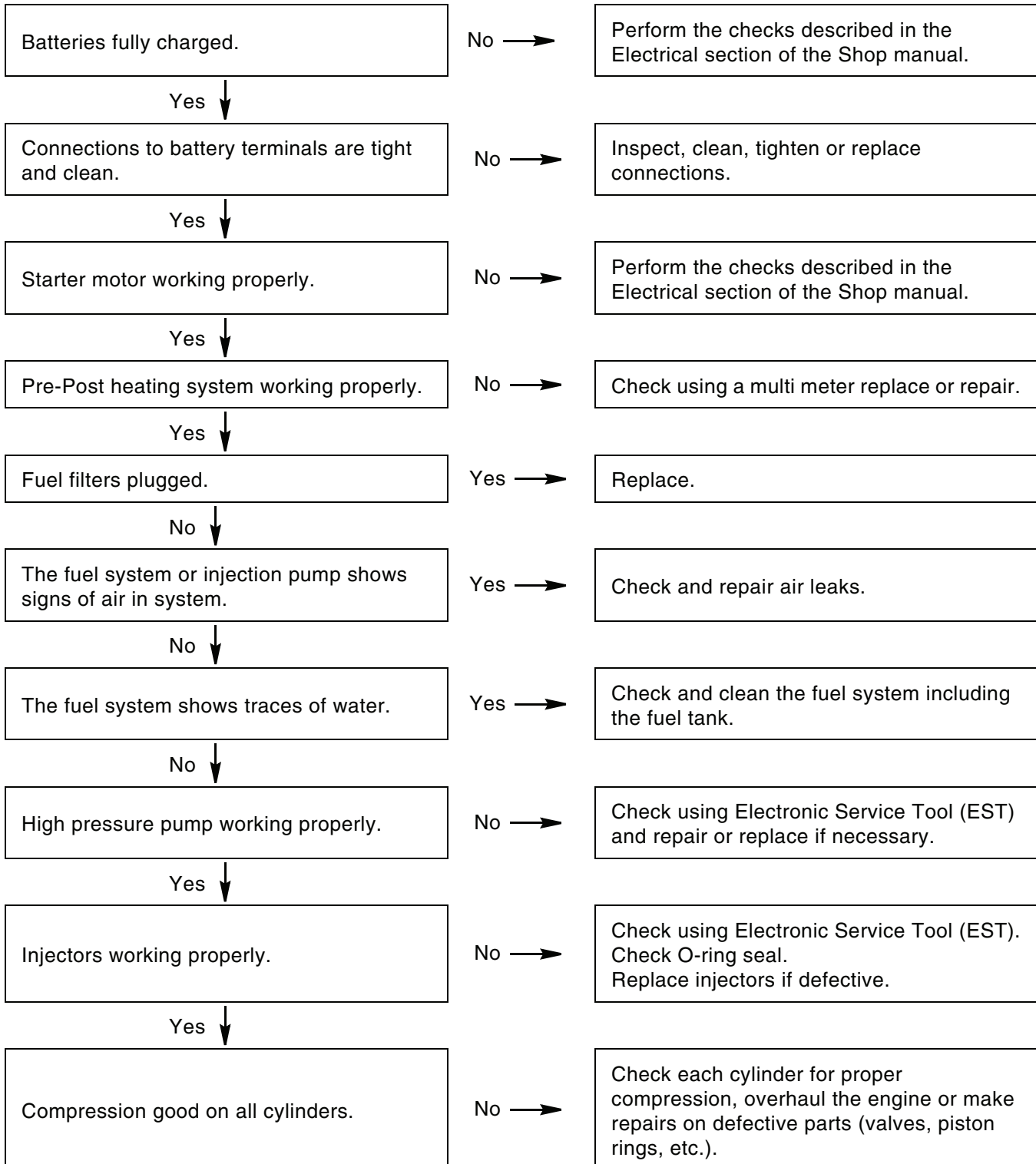
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Figure 1-1

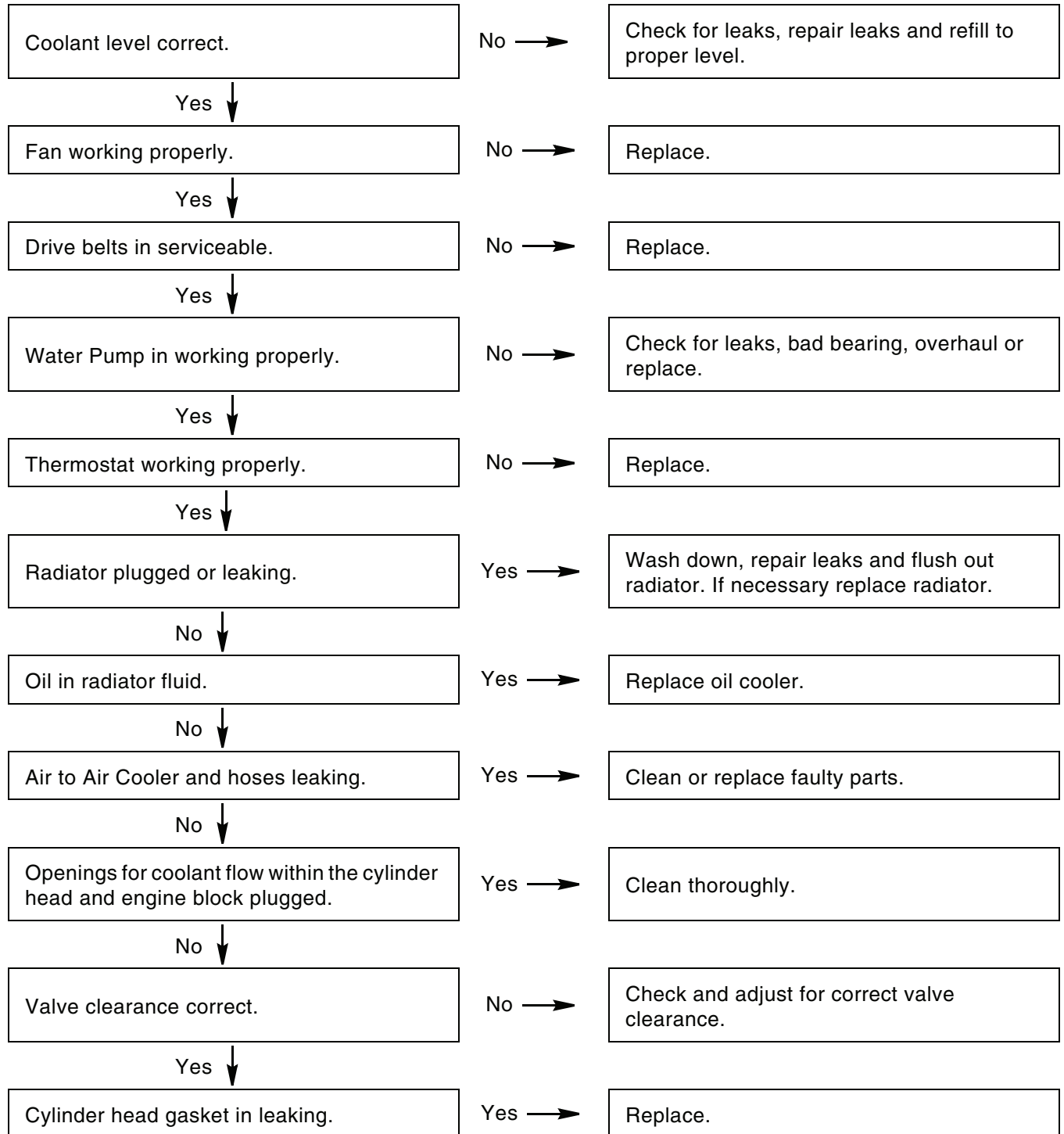
The EST system allows diagnoses on machines by detecting the operating parameters of electronic control components (control units, sensors etc.) and check flow rates, pressures and temperatures. It is also capable of reading fault codes on the engine. To help with troubleshooting the engine failure mode.

TROUBLESHOOTING

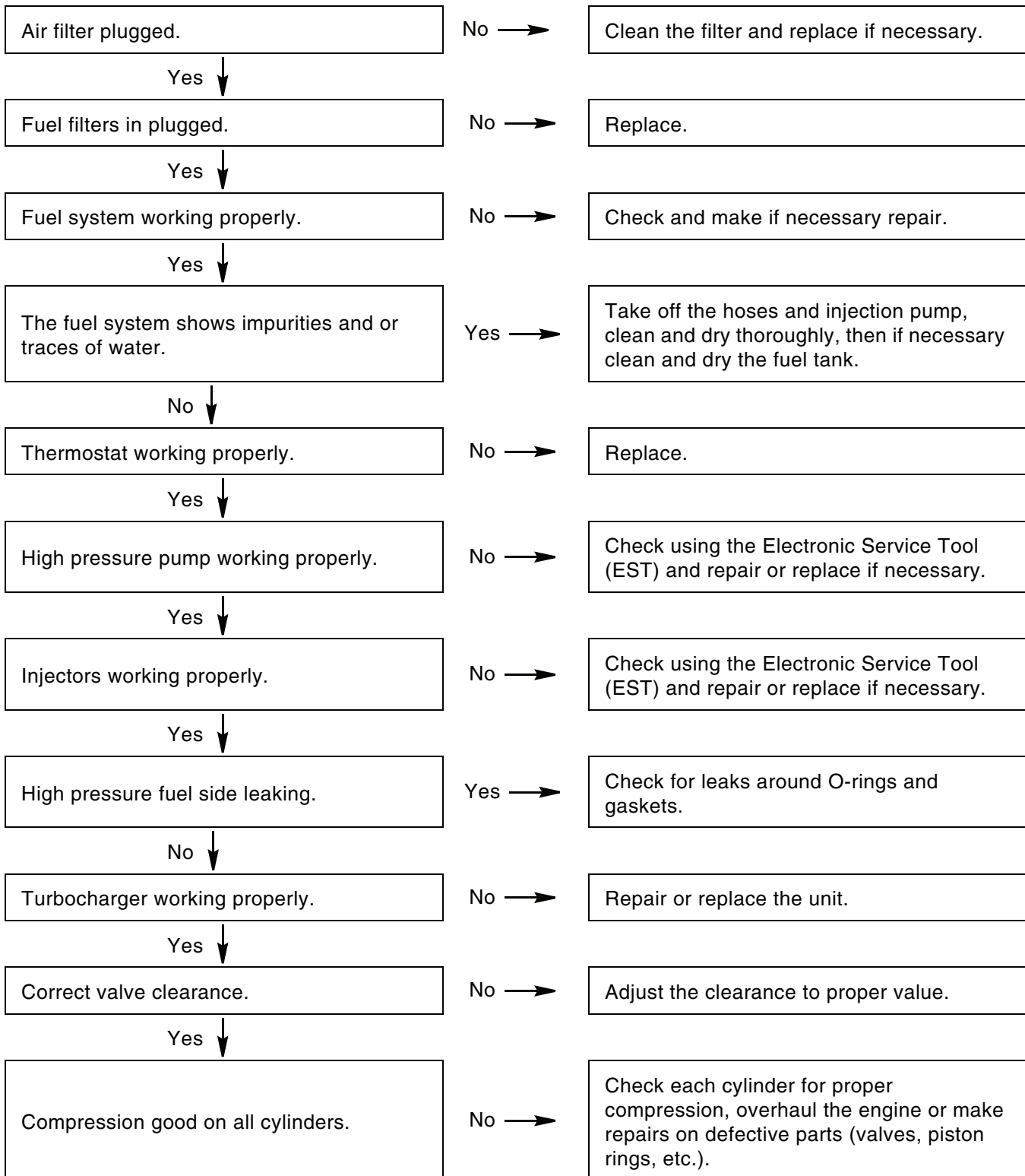
ENGINE WON'T START



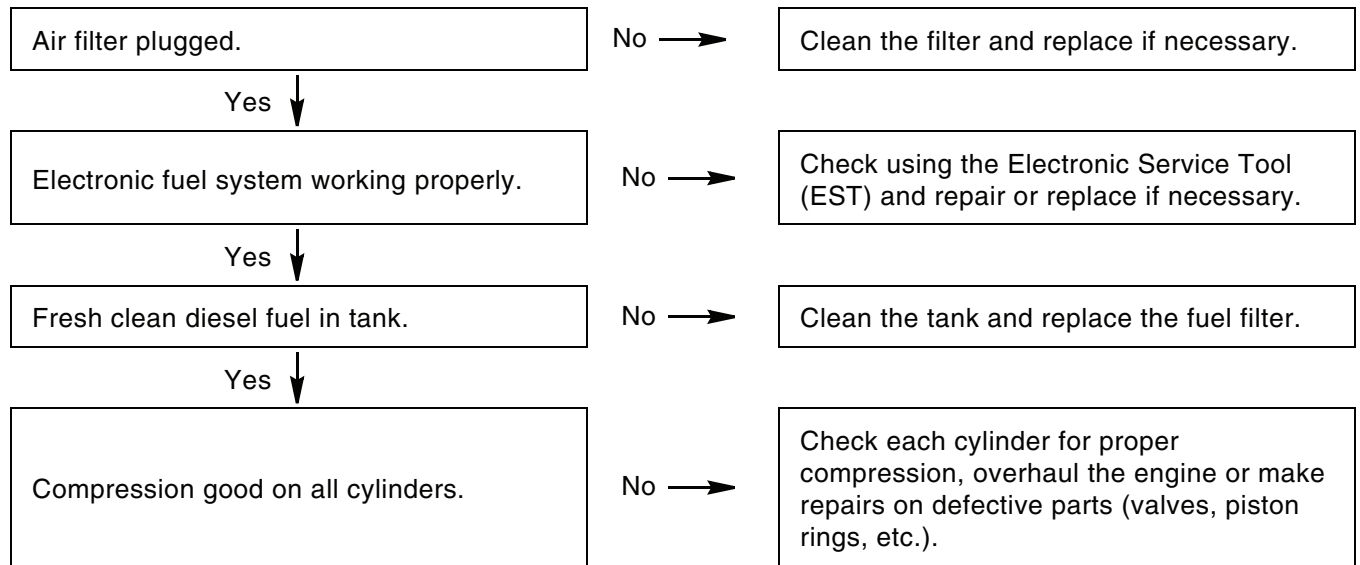
ENGINE OVERHEATS



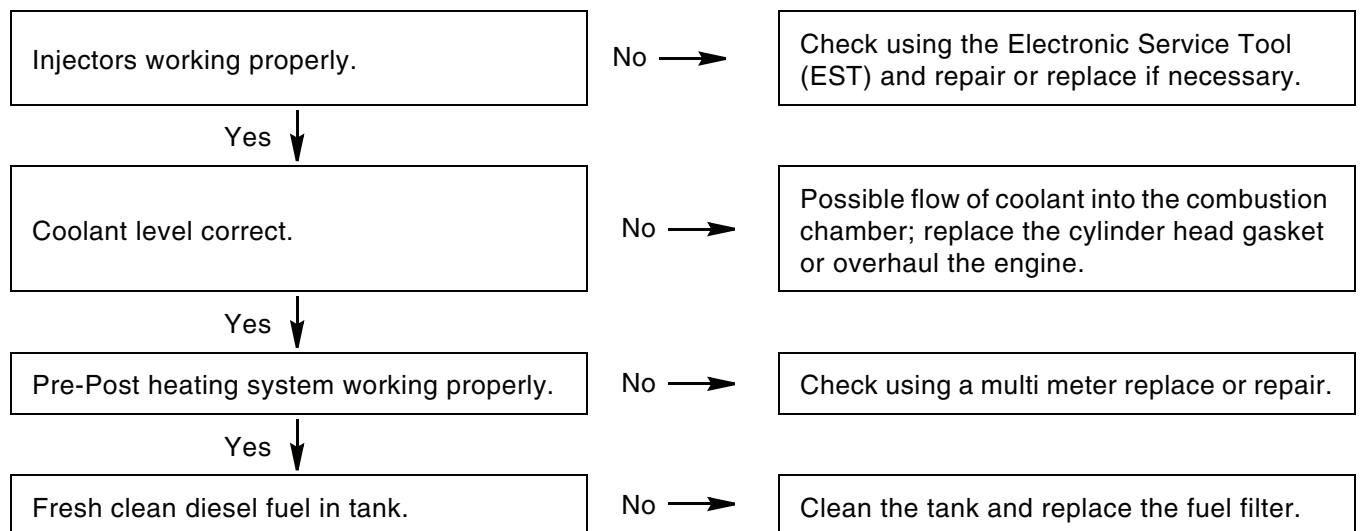
ENGINE LACKS POWER AND RUNS ERRATICALLY



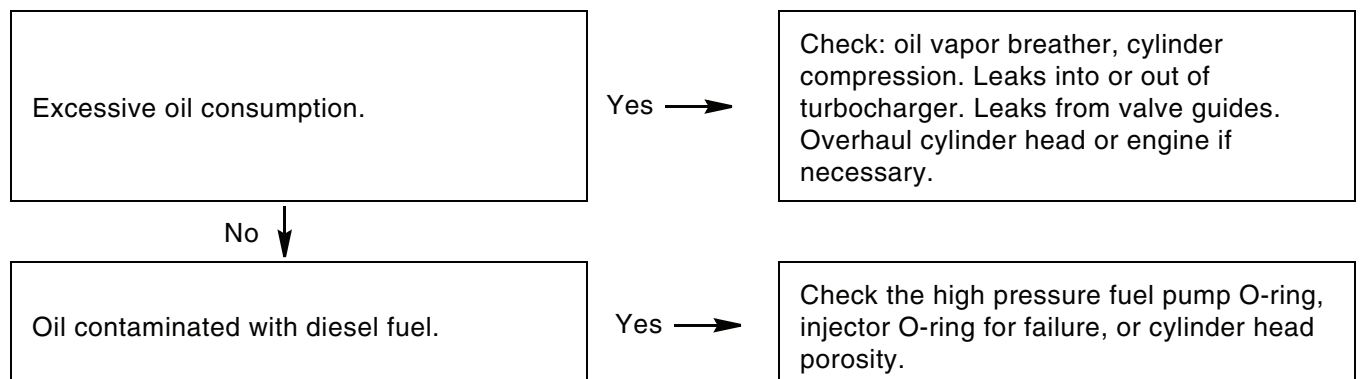
ENGINE EXHAUST SMOKE BLACK OR DARK GREY



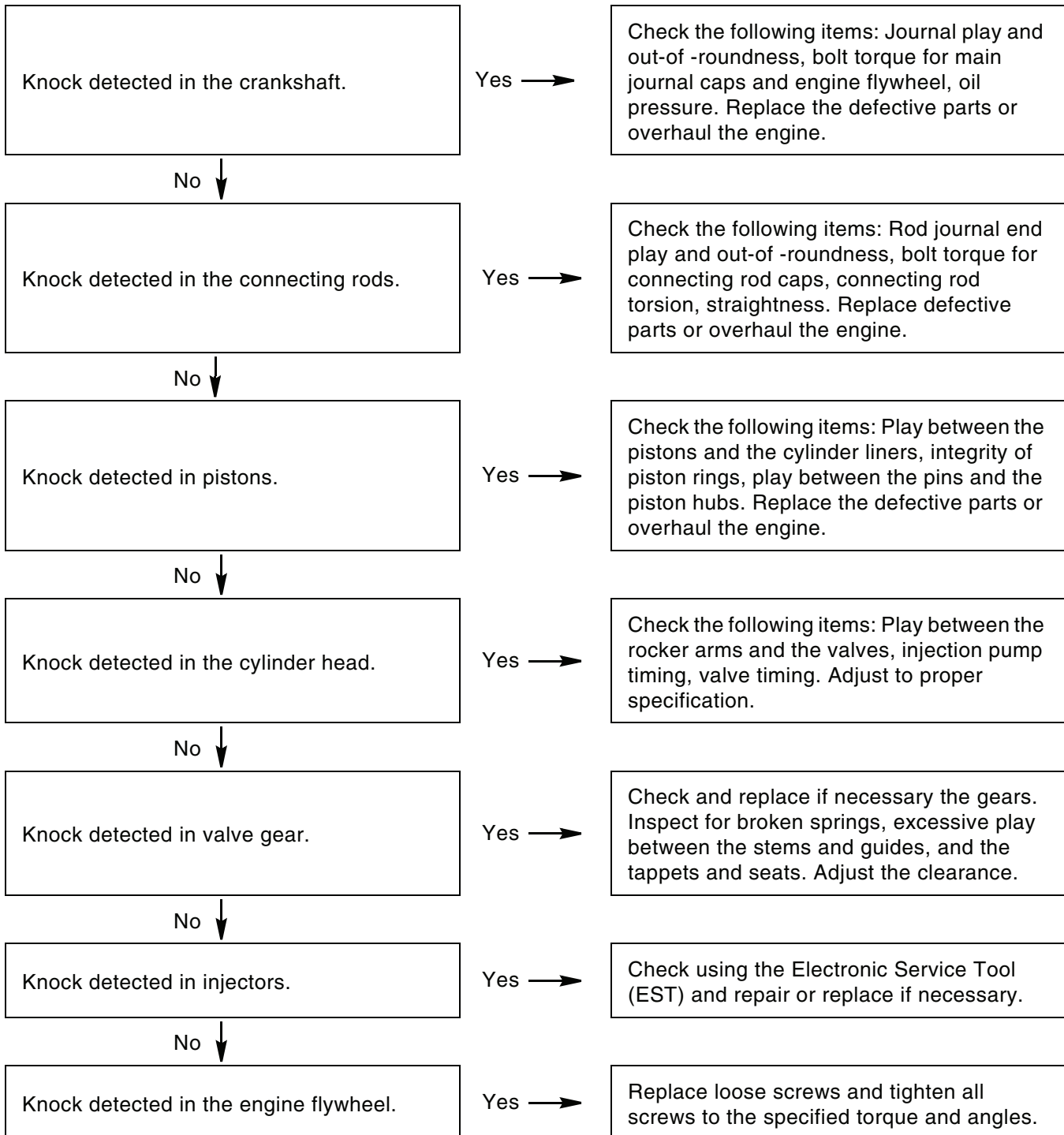
ENGINE EXHAUST SMOKE GREY (VERGING ON WHITE)



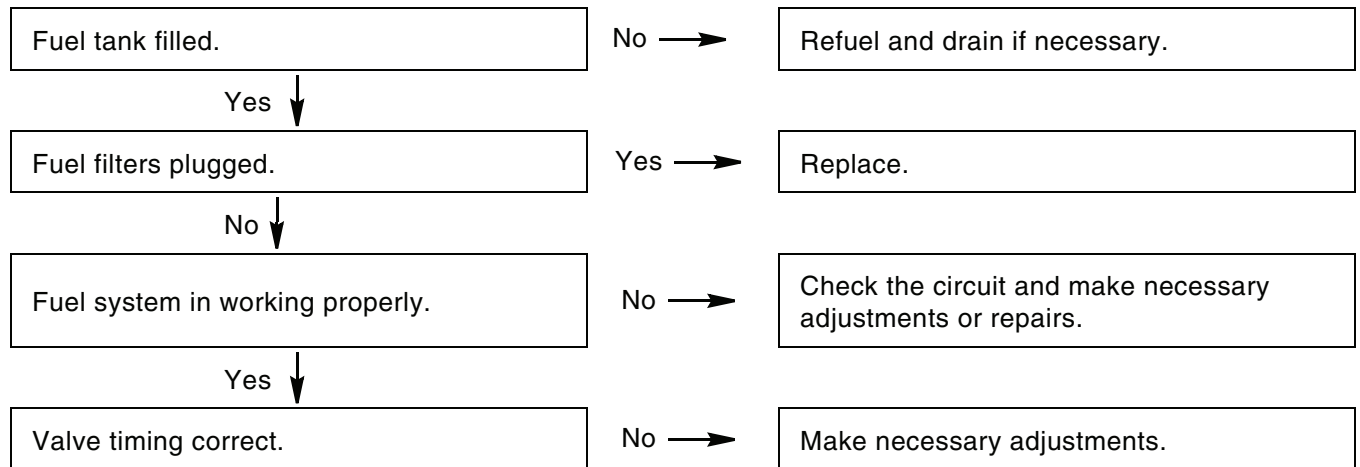
ENGINE EXHAUST SMOKE LIGHT BLUE



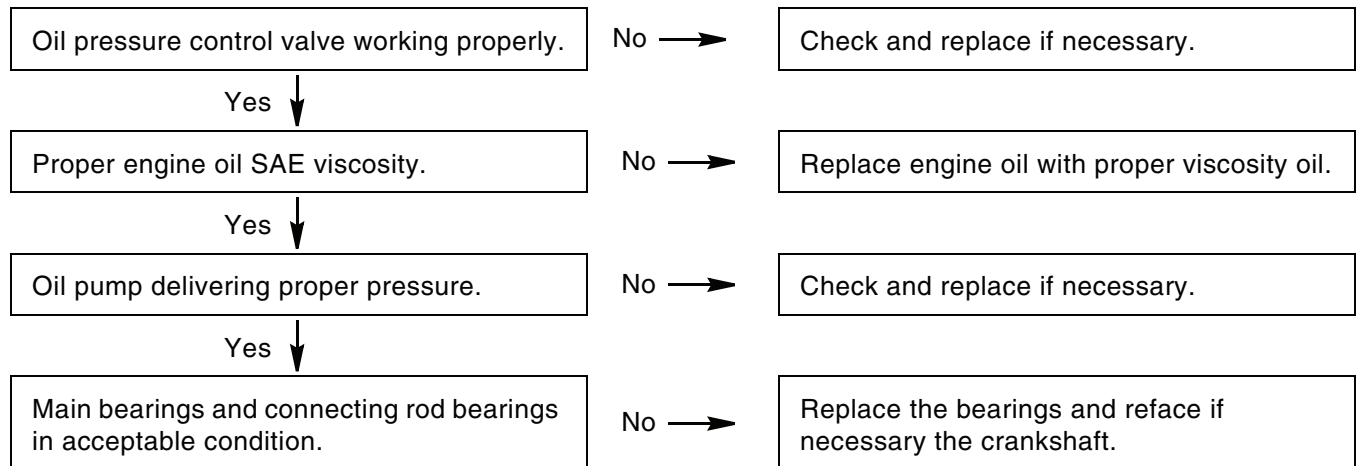
ENGINE KNOCKS IRREGULARLY



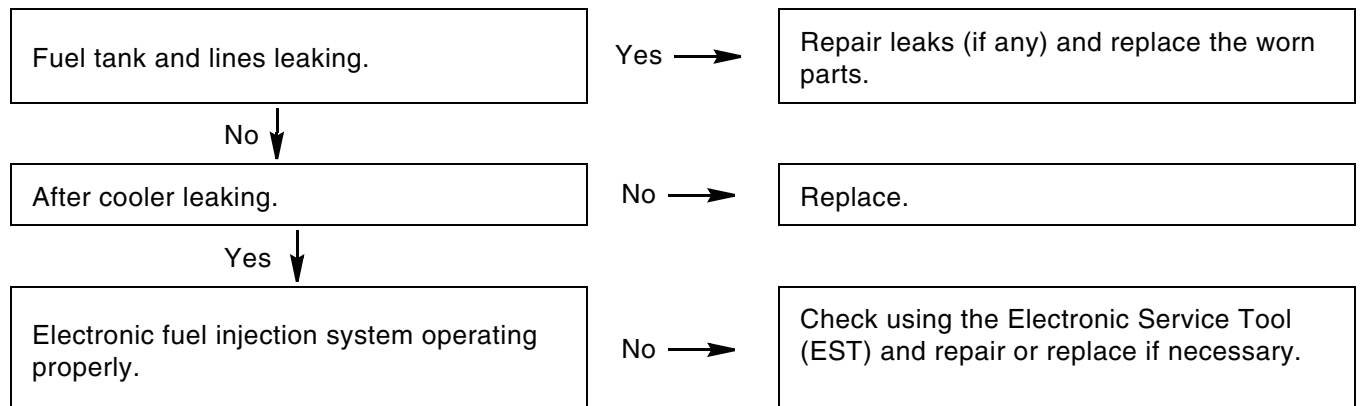
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EXCESSIVE FUEL CONSUMPTION



NOTES

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667TA

TIER III

667TA ENGINE OVERHAUL

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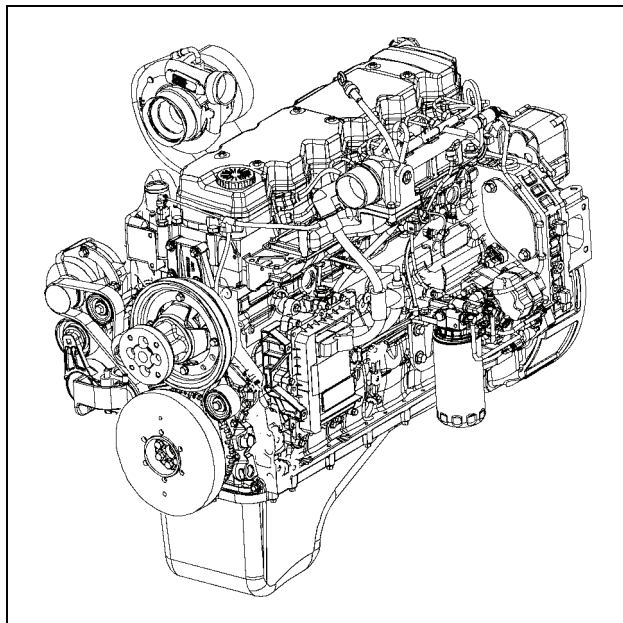
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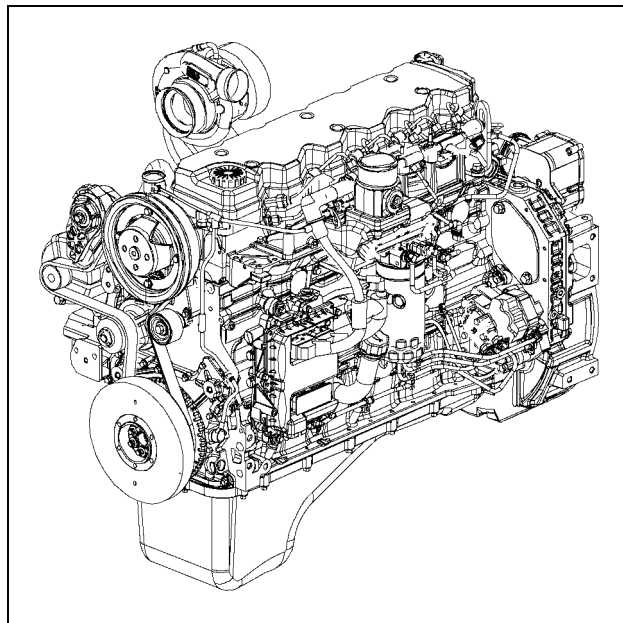
ENGINES



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Figure 2-1

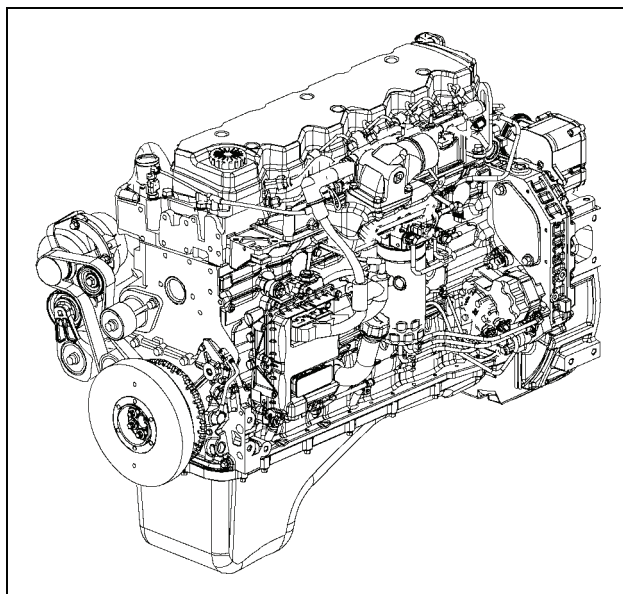
ENGINES: 667TA/EEG - 667TA/EEC



BS06K011

Figure 2-3

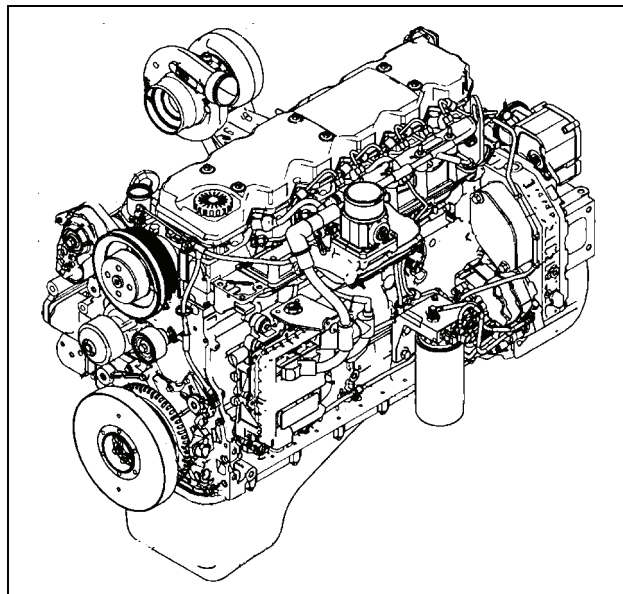
ENGINES 667TA/EED - 667TAEBF



BS06K012

Figure 2-2

ENGINES 667TA/EED - 667TAEBD



BS06K628

Figure 2-4

ENGINE 667TA/EDJ

CODING OF SOURCE ENGINES

ENGINE MODEL BREAKDOWN DISCRIPTION

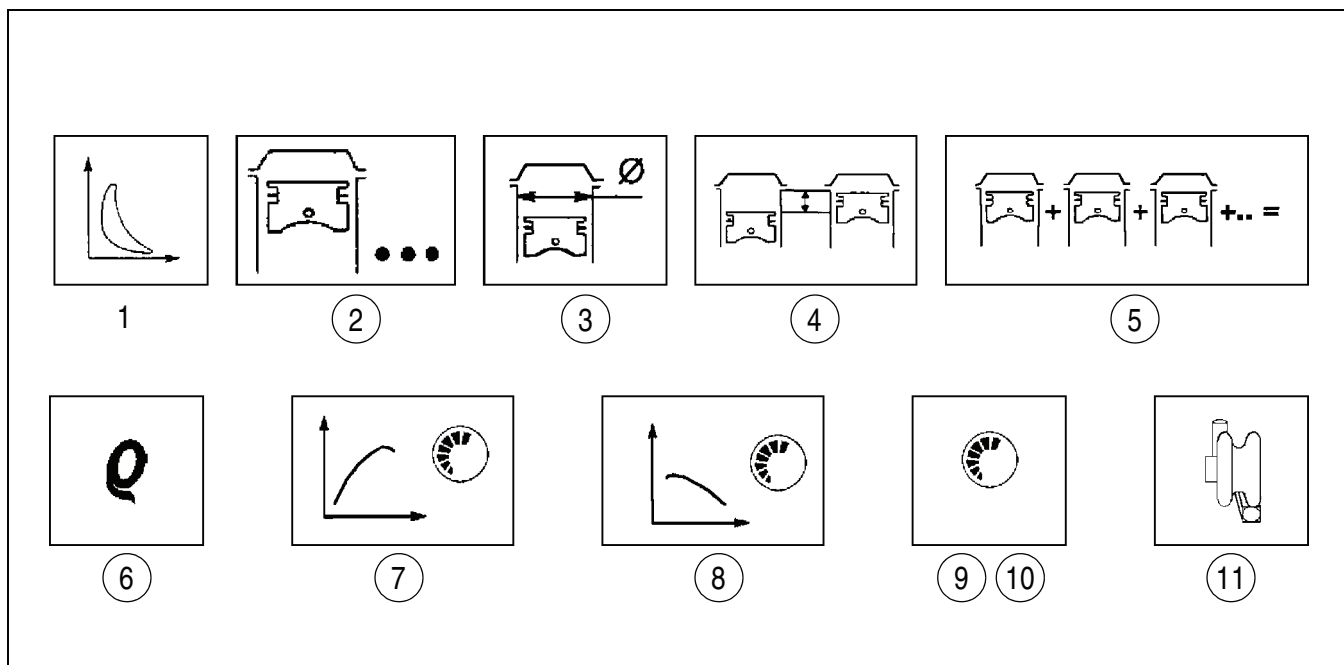
6	6	7	T	A	E	D	J
							Engine Calibration (Power) (D) J= 97 kW (130 H.P.) (E) G= 137 kW (183.7 H.P.) (E) D= 145 kW (194.4 H.P.) (E) C= 148 kW (198.5 H.P.) (B) F= 157 kW (210.5 H.P.) (B) D= 169kW (226.6 H.P.)
							Compression Ratio B = 16.5:1 > 130 kW (174 H.P.) D = 17.5:1 < 130 kW (174 H.P.) E = 17.5:1 > 130kW (174 H.P.) E = Electronic Injection (Common Rail)
							A = Intercooled
							T = Turbocharged
							67 = Total Displacement in Liters/ Cubic Inches- 6.7 Liters (409 Cubic Inches)
							6 = Number of Cylinders

ENGINE PROPERTIES

A	667TA	667TA	667TA	667TA	667TA	667TA
B	EEG	EEC	EBF	EED	EBD	EDJ
C	6 CYLINDERS					
D	6728 cm ³ (410.6 c.i.)					
E	137 kW (183.7 h.p.) 2100 rpm	148 kW (198.5 h.p.) 2100 rpm	157kW (210.5 h.p.) 2000 rpm	145kW (194.4 h.p.) 2000 rpm	169 kW (226.6 h.p.) 2000 rpm	97 kW (130.1 h.p.) 2200 rpm
F	Electronic Direct Injection					
G	Common Rail					
H	T.A.A. (Turbo Charged, Air to Air Cooling)					

- A. Type of engine
- B. Engine model
- C. Number of cylinders
- D. Total displacement
- E. Maximum power currently available
- F. Type of Injection
- G. Injection system
- H. Air supply system

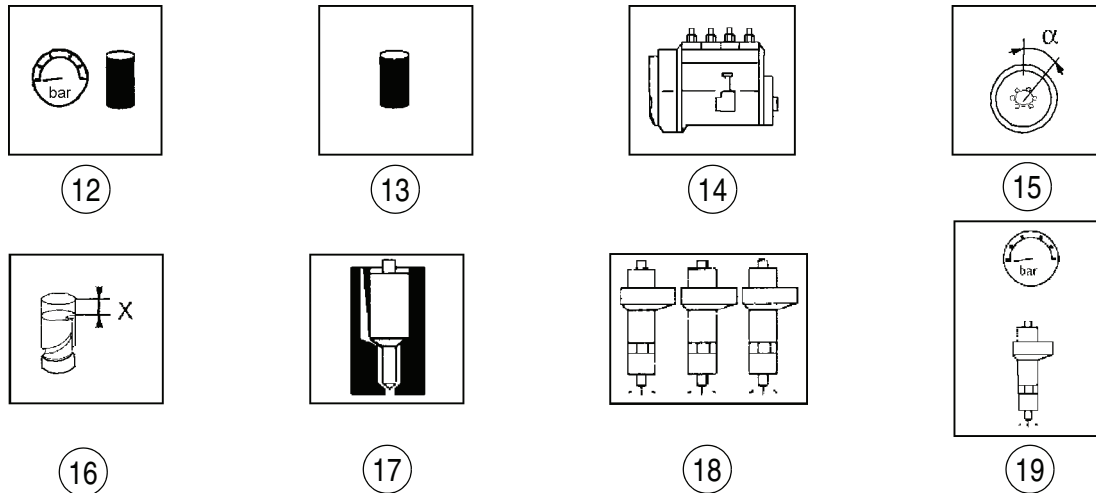
GENERAL ENGINE FEATURES



BS06K013

Figure 2-5

REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
1	Cycle	4- Stroke diesel engine					
	Air	T.A.A. (Turbo charged, Air to Air cooling)					
	Injection	Direct					
2	Number of cylinders	6 in-line					
3	Bore	104 mm (4.1 inches)					
4	Stroke	132 mm (5.2 inches)					
5	Total displacement	6728cm ³ (410.6 cubic inches)					
6	Compression ratio						
7	Maximum power rating (net power at flywheel ISO 14396)	137 kW	148 kW	157 kW	145 kW	169 kW	97 kW
		2100 rpm	2100 rpm	2000 rpm	2000 rpm	2000 rpm	2200 rpm
		184 hp	198 hp	211 hp	194 hp	227 hp	130 hp
		2100 rpm	2100 rpm	2000 rpm	2000 rpm	2000 rpm	2200 rpm
8	Maximum Torque	710 Nm	810 Nm	952 Nm	860 NM	1002 Nm	607 Nm
		1400 rpm	1400 rpm	1400 rpm	1400 rpm	1400 rpm	1400 rpm
		524 pound feet	597 pound feet	702 pound feet	634 pound feet	739 pound feet	607 pound feet
		1400 rpm	1400 rpm	1400 rpm	1400 rpm	1400 rpm	1400 rpm
9	No-load idle	700 rpm					
10	No-load peak rpm						
11	Boosting (type of turbocharger)	With intercooler HOLSET HX35					

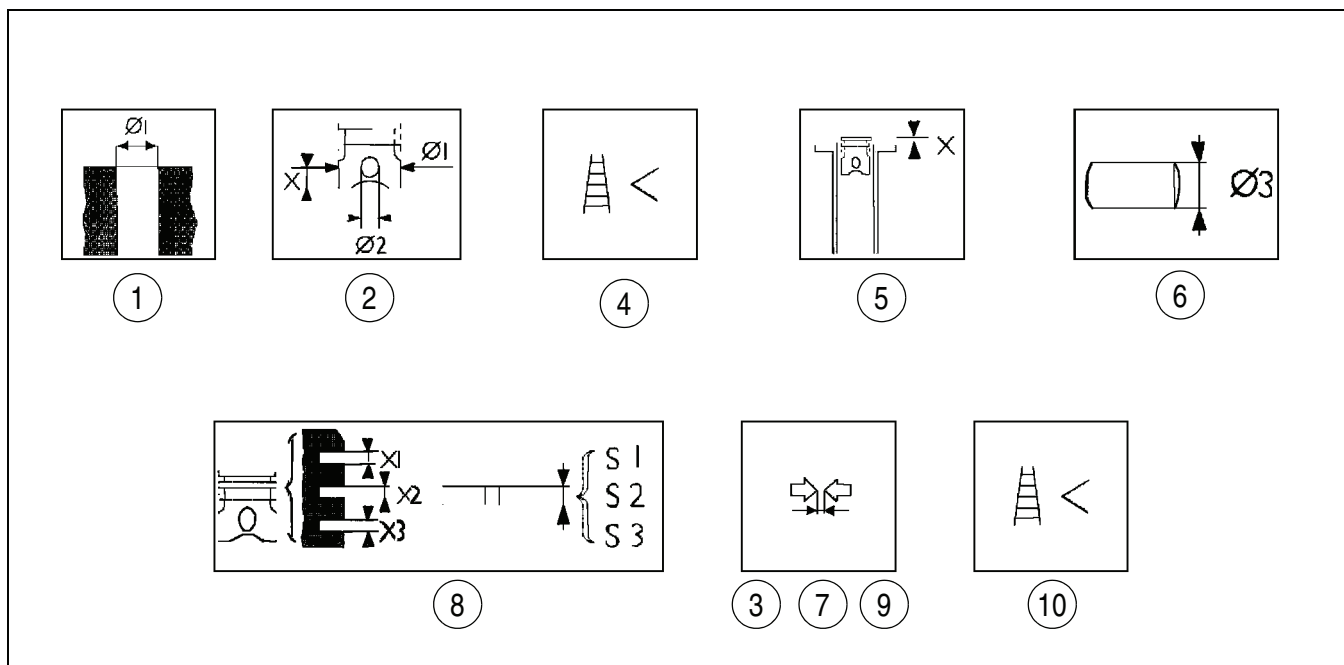


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Figure 2-6

REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
12	Lubrication.	Forced by means of gear pump. Oil psi control valve.					
	Oil pressure with hot engine: at idle rpm.	1.2 bar (17.4 psi)					
	Oil pressure with hot engine: at peak rpm.	3.8 bar (55.1 psi)					
13	Cooling.	Fluid					
	Water pump drive.	Belt					
	Thermostat start of opening temperature.	79 to 83° C (174 to 181° F)					83 to98° C (181 to 208° F)
14	Oil capacity 1st filling.	No Information Available		No Information Available			
	Oil capacity engine sump.	No Information Available		No Information Available			
	Oil capacity engine sump + filter.	17 litres (18 qt.)		19 litres (20 qt.)			
15	Feeding Bosch-type injection	High pressure Common Rail					
16	Pump setting	No Information Available					
17	Start of delivery	No Information Available					
18	Type of injector	CRIN 1		CRIN 2			CRIN 2
19	Injection sequence	1 -5 -3 -6 -2 -4					
20	Injection pressure	--		250 - 1600 bar	250 -1400 bar	250 -1600 bar	--
		--		3626 - 23206 psi	3626 - 20305 psi	3626 - 23206 psi	--

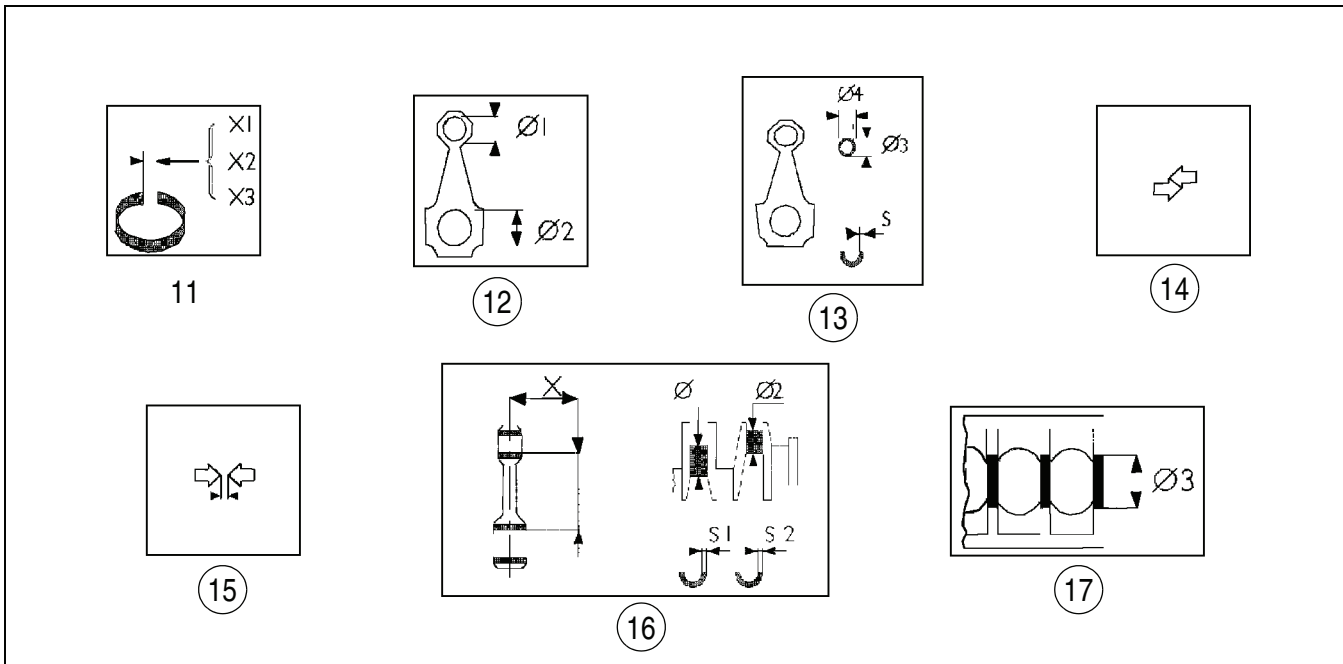
CRANK GEAR COMPONENTS AND CYLINDER ASSEMBLY



BS06K015

Figure 2-7

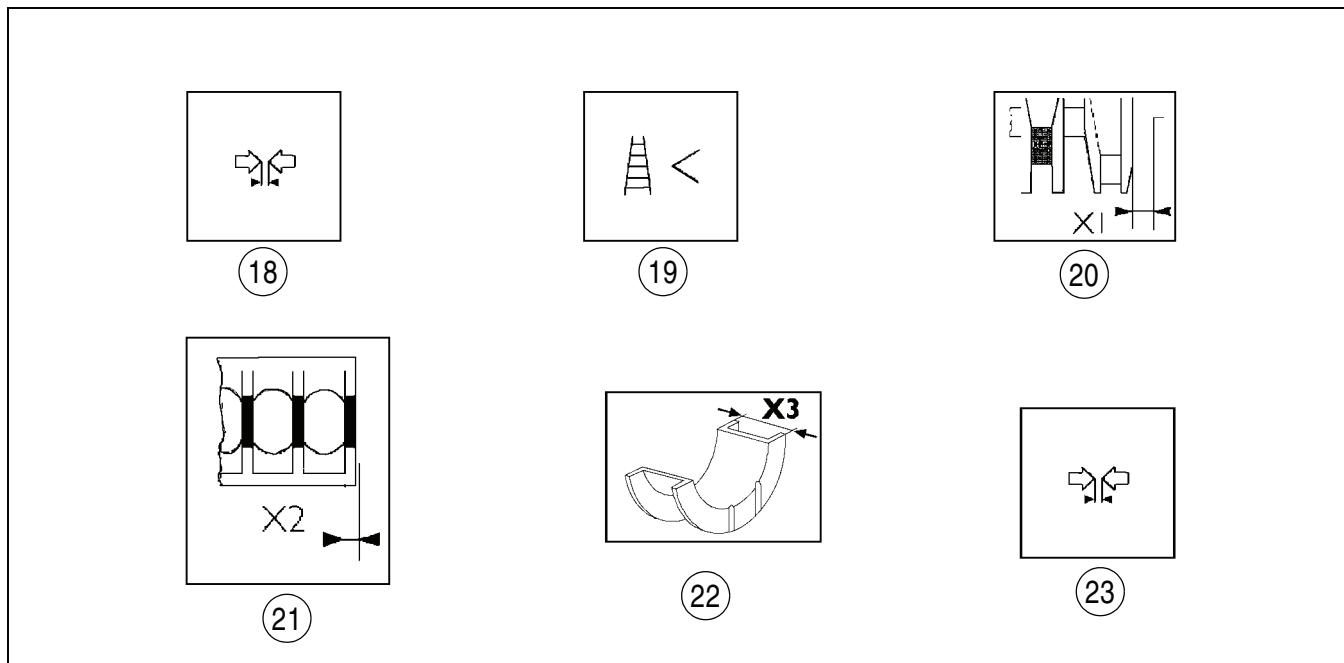
REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
1	Cylinder liners.	104.000 to 104.024 mm. (4.0945 to 4.0954 in.)					
2	Pistons:	Supplied as spares					
	Measurement dimension.	X = 49.5 mm. (1.948813 in.)					
	Outer diameter.	Ø1= 103.759 to 103.777 mm. (4.0850 to 4.0857 in.)					
	Pin seat.	Ø2= 38.010 to 38.016 mm. (1.4965 to 1.4967 in.)					
3	Piston - cylinder liners.	0.235 to 0.273 mm. (0.0093 to 0.0107 in.)					
4	Piston diameter.	Ø= 0.4 mm. (0.0157 in.)					
5	Protrusion of pistons from crankcase.	No Information Available					
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 101 mm 3.976366 in.)	X1= 2.705 to 2.735 mm. (0.1065 to 0.1077 in.)					
		X2= 2.420 to 2.440 mm. (0.0953 to 0.0961 in.)					
		X3= 4.03 to 4.05 mm. (0.1587 to 0.1594 in.)					
	Piston rings (measured 1.5 mm 0.05905494 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= 3.977 to 3.990 mm. (0.1566 to 0.1571 in.)					
9	Piston rings - Slots.	1= 0.100 to 0.175 mm. (0.0039 to 0.0069 in.)					
		2= 0.04 to 0.09 mm. (0.0016 to 0.0035 in.)					
		3= 0.04 to 0.083 mm. (0.0016 to 0.0033 in.)					
10	Piston rings.	0.4mm. (0.0157 in.)					



BS06K016

Figure 2-8

REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
11	Piston ring gaps in cylinder liner.	X1= 0.30 to 0.40 mm. (0.0118 to 0.0157 in.)					
		X2= 0.60 to 0.80 mm. (0.0236 to 0.0315 in.)					
		X3= 0.30 to 0.55 mm. (0.0118 to 0.0217 in.)					
12	Connecting rod small-end bearing seat.	Ø1= 40.987 to 41.553 mm. (1.6137 to 1.6147 in.)					
	Connecting rod bearing seat.	Ø2= 72.987 to 73.013 mm. (2.8735 to 2.8745 in.)					
13	Connecting rod small-end bearing diameter.						
	Outer	Ø4= 41.279 to 41.553 mm. (1.6252 to 1.6359 in.)					
	Inner	Ø3= 38.019 to 38.033 mm. (1.4968 to 1.4974 in.)					
14	Connecting rod small-end bearing seat.	0.266 to 0.566 mm. (0.0105 to 0.0223 in.)					
15	Piston pin - bearing.	0.019 to 0.039 mm. (0.0007 to 0.0015 in.)					
16	Measurement dimension.	No Information Available					
	Maximum error on connecting rod axis parallelism.	No Information Available					
	Journals	Ø1= 82.990 to 83.010 mm. (3.2673 to 3.2681 in.)					
	Crank pins	Ø2= 68.987 to 69.013 mm. (2.7160 to 2.7170 in.)					
	Main half bearings (supplied as spares).	S1= 2.456 to 2.464 mm. (0.0967 to 0.0970 in.)					
	Connecting rod half bearings.	S2= 1.955 to 1.968 mm. (0.0770 to 0.0775 in.)					
17	Main bearing- journals						
	Numbers 1, 7	Ø3 87.982 to 88.008 mm. (3.4638 to 3.4649 in.)					
	Numbers 2, 3, 4, 5, 6	Ø3= 87.977 to 88.013 mm. (3.4637 to 3.4651 in.)					

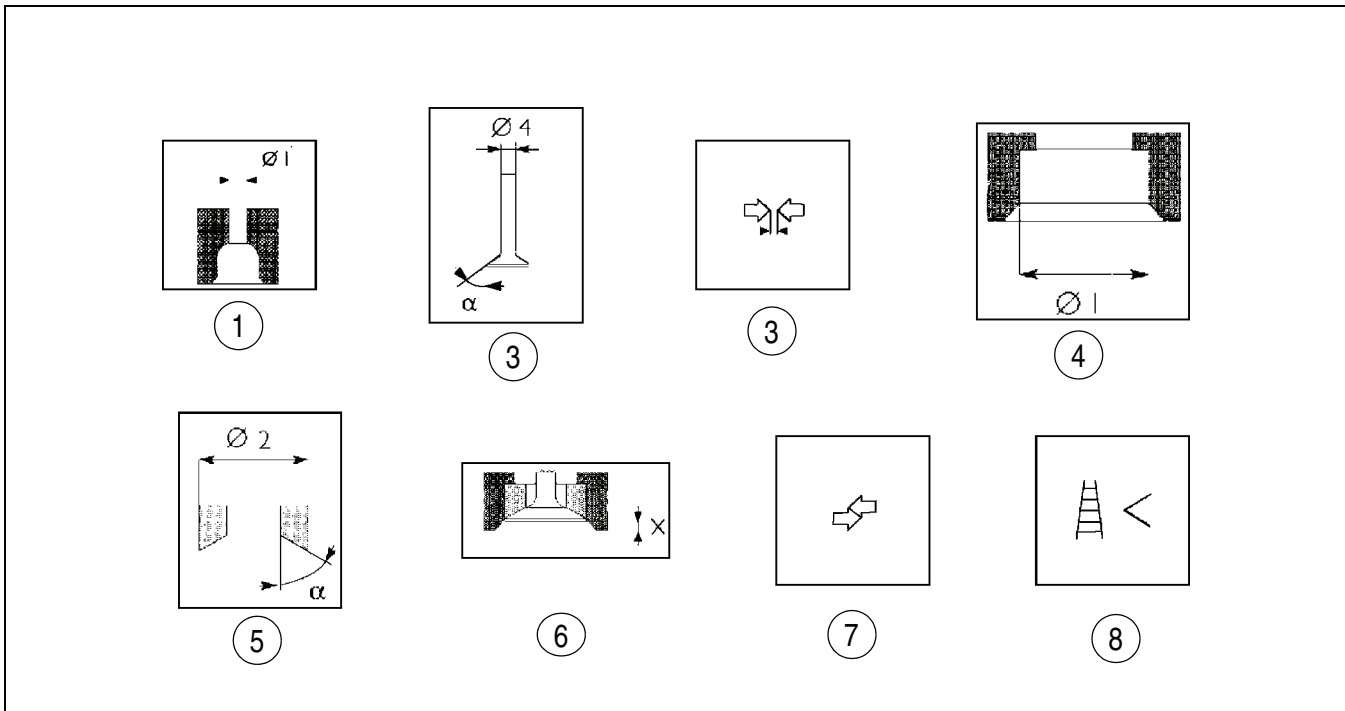


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Figure 2-9

REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
18	Half bearing- journals.						
	Numbers 1, 7	0.044 to 0.106 mm. (0.0017 to 0.0042 in.)					
	Numbers 2, 3, 4, 5, 6	0.041 to 0.103 mm. (0.0016 to 0.0041 in.)					
	Half bearing - crank pins.	0.039 to 0.111 mm. (0.0015 to 0.0044 in.)					
19	Main half bearings	+0.250 mm. (0.0098 in.)					
	Connecting rod half bearings.	+0.500 mm. (0.0197 in.)					
20	Main journal of thrust bearing.	X1= 37.475 to 37.545 mm. (1.4754 to 1.4781 in.)					
21	Main bearing housing of thrust bearing.	X2= 25.980 to 26.480 mm. (1.0228 to 1.0425 in.)					
22	Shoulder half ring.	X3= 37.280 to 37.380 mm. (1.4677 to 1.4716 in.)					
23	Crankshaft shoulder.	0.095 to 0.265 mm. (0.0037 to 0.0104 in.)					

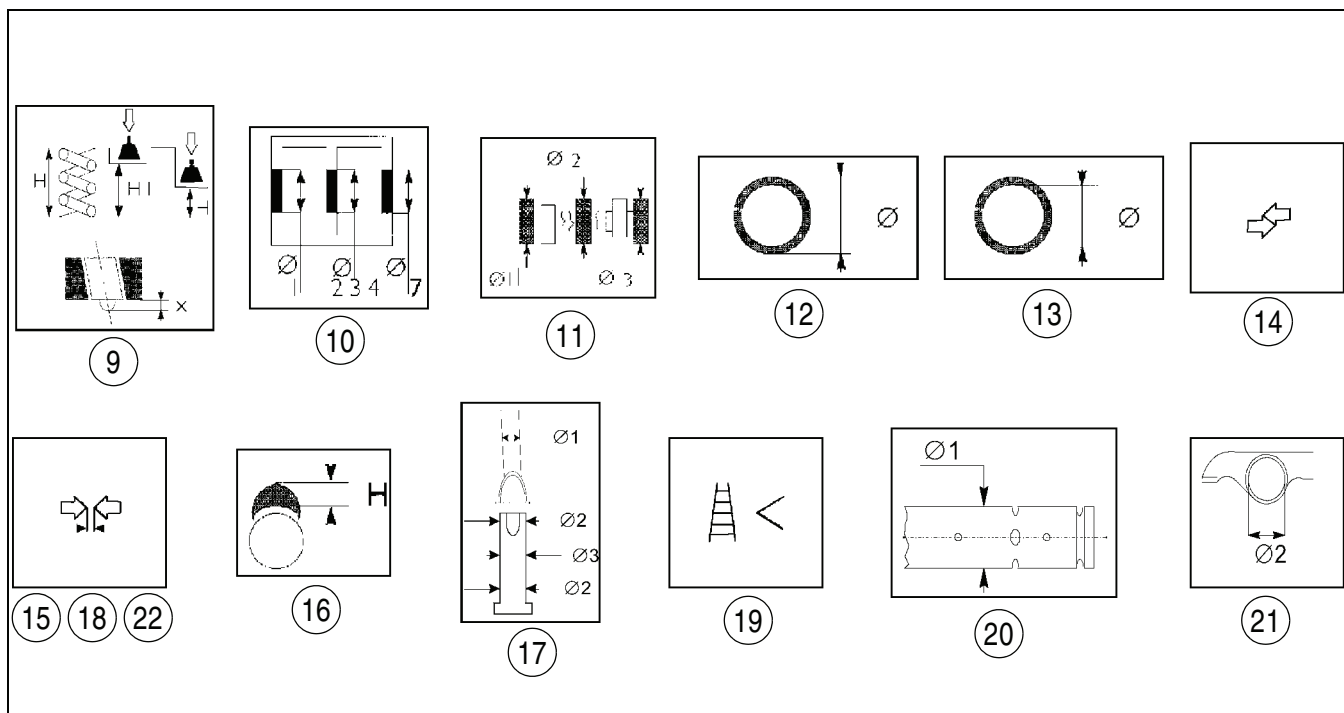
VALVE GEAR - CYLINDER ASSEMBLY



BS06K018

Figure 2-10

REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
1	Valve guide seats on cylinder head.	Ø1= 7.042 to 7.062 mm. (0.2772 to 0.2780 in.)					
2	Valves - Intake.	Ø4= 6.970 to 6.999 mm. (0.2744 to 0.2756 in.)					
		angle= 60° ± 0.25°					
	Valves - Exhaust.	Ø4= 6.970 to 6.999 mm. (0.2744 to 0.2756 in.)					
		angle= 45° ± 0.25°					
3	Valve stem and respective guide.	0.043 to 0.092 mm. (0.0017 to 0.0036 in.)					
4	seat on head for valve seat. - Intake.	34.837 to 34.863 mm. (1.3715 to 1.3725 in.)					
	seat on head for valve seat. - Exhaust.	34.837 to 34.863 mm. (1.3715 to 1.3726 in.)					
5	Valve seat outer diameter; angle of valve seats on cylinder head.						
	Intake.	Ø2= 34.917 to 34.931 mm. (1.3747 to 1.3752 in.)					
		angle= 60°					
	Exhaust.	Ø2= 34.917 to 34.931 mm. (1.374681 to 1.375232 in.)					
		angle= 45°					
6	Recessing. Intake valve	0.590 to 1.110 mm. (0.0232 to 0.0437 in.)					
	Recessing. Exhaust valve	0.960 to 1.480 mm. (0.0378 to 0.0583 in.)					
7	Between valve seat and head- Intake	0.054 to 0.094 mm. (0.0021 to 0.0037 in.)					
	Between valve seat and head- Exhaust	0.054 to 0.094 mm. (0.0021 to 0.0037 in.)					
8	Valve seats	No Information Available					



BS06K019

Figure 2-11

REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
9	Valve spring height: Free spring.	H= 47.750 mm. (1.8799 in.)					
	Under load of: 339.8 N $\pm$ 19 N (76.4 lbf $\pm$ 4.3 lbf).	H1= 35.330 mm. (1.3909 in.)					
	Under load of: 741.0 N $\pm$ 39 N (166.6 lbf $\pm$ 8.8 lbf).	H2= 25.200 mm. (0.9921 in.)					
	Injector protrusion.	X= Not Adjustable					
10	Seats for camshaft bearing.- number - 7	$\varnothing$ 7= 59.222 to 59.248 mm. (2.3316 to 2.3326 in.)					
	Seats for camshaft bearings.- numbers - 1, 2, 3, 4, 5, 6	$\varnothing$ 1-6= 54.089 to 54.139 mm. (2.1295 to 2.1315 in.)					
11	Camshaft main journals: 1 through 7	$\varnothing$ 1, 2, 3, 4, 5, 6, 7= 53.995 to 54.045 mm. (2.1258 to 2.1277 in.)					
12	External diameter of the bearing for the camshaft with a load of 3.3 kNm (741.8695 lbf).	$\varnothing$ = 59.222 to 59.248 mm. (2.3316 to 2.3326 in.)					
13	Camshaft bearing inner diameter.	$\varnothing$ = 54.083 to 54.147 mm. (2.1292 to 2.1318 in.)					
14	Bearing and seats in crankcase.	0.113 to 0.165 mm. (0.0044 to 0.0065 in.)					
15	Bearing and main journals.	0.038 to 0.162 mm. (0.0015 to 0.0064 in.)					
16	Useful cam lift- Intake.	6.045 mm. (0.2380 in.)					
	Useful cam lift- Exhaust.	7.239 mm. (0.2850 in.)					
17	Tappet plate seat in crankcase.	$\varnothing$ 1= 16.000 to 16.030 mm. (0.6299 to 0.6311 in.)					
	Tappet plate outside diameter.	$\varnothing$ 2= 15.924 to 15.954 mm. (0.6269 to 0.6281 in.)					
		$\varnothing$ 3= 15.960 to 15.970 mm. (0.6283 to 0.6287 in.)					
18	Between tappets and seat.	0.030 to 0.070 mm. (0.0012 to 0.0028 in.)					
19	Tappets.	No Information Available					
20	Rocker arm shaft.	$\varnothing$ 1= 21.965 to 21.977 mm. (0.8648 to 0.8652 in.)					
21	Rocker arms	$\varnothing$ 2= 22.001 to 22.0027 mm. (0.86618 to 0.86625 in.)					
22	Between rocker arm and spindle	0.024 to 0.0377 mm. (0.0009 to 0.0015 in.)					

GRAPHIC_1D

Figure 2-12

TORQUE SPECIFICATIONS

PART	TORQUE - Nm (lb.-ft.)
Cylinder head fastening bolt.	
1st phase.	
Bolts M12x1.75x70	45 to 55 Nm (33.2 to 40.6 lb.-ft.)
Bolts M12x1.75x140	35 to 45 Nm (25.8 to 33.2 lb.-ft.)
Bolts M12x1.75x180 (pre lubricate with oil)	65 to 75 Nm (47.9 to 55.3 lb.-ft.)
2nd phase additional rotation	90 degrees
3rd phase (only for bolts 140 and 180 mm long additional rotation)	90 degrees
Main bearing Caps.	
1st phase. (pre lubricate with oil)	44 to 56 Nm (32.5 to 41.3 lb.-ft.)
2nd phase.	74 to 86 Nm (54.6 to 63.4 lb.-ft.)
3rd phase. additional rotation.	90 ±5 degrees
Connecting rod cap fastening bolts.	
1st phase. (pre lubricate with oil)	55 to 65 Nm (40.6 to 47.9 lb.-ft.)
2nd phase. additional rotation	60 ±5 degrees
Engine flywheel fastening bolts.	
1st phase.	26 to 34 Nm (19.2 to 25.1 lb.-ft.)
2nd phase. additional rotation.	60 ± 5 degrees
Nut securing connector for injector supply.	45 to 50 Nm (33.2 to 36.9 lb.-ft.)
Sump (oil pan).	20 to 28Nm (14.8 to 20.7lb.-ft.)
Fuel filter.	Contact + 3/4 turn
Injection pump gear cover fastening bolts.	20 to 30 Nm (14.8 to 22.1 lb.-ft.)
Valve gear cover and case fastening bolts.	20 to 28Nm (14.8 to 20.7 lb.-ft.)
Intake manifold fastening bolts.	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Fuel pump fastening bolts.....	20 to 30 Nm (14.8 to 22.1 lb.-ft.)
Exhaust manifold fastening bolts.	48 to 58 Nm (35.4 to 42.8 lb.-ft.)
Valve cover fastening nuts.	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Rocker arm support fastening bolts.	31 to 41Nm (22.9 to 30.2 lb.-ft.)
Nut for rocker arm adjusting bolt.....	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Bolts fastening the pulley on the crankshaft.	
1st phase.....	45 to 55 Nm (33.2 to 40.6 lb.-ft.)
2nd phase additional rotation.	90 ±5 degrees
Cam shaft shoulder plate fastening bolts.....	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Fan support fastening bolts.	20 to 30 Nm (14.8 to 22.1 lb.-ft.)
Injection pump fastening bolts	7 to 17 Nm (5.2 to 12.5 lb.-ft.)
Fan pulley fastening bolts	37 to 49 Nm (27.3 to 36.1 lb.-ft.)
Turbocharger fastening bolts.	20 to 30 Nm (14.8 to 22.1 lb.-ft.)
Starter motor fastening bolts.	37 to 49 Nm (27.3 to 36.1 lb.-ft.)
Alternator fastening bolts.	37 to 49 Nm (27.3 to 36.1 lb.-ft.)
Water pump fastening bolts.	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Oil filter.....	Contact + 3/4 turn
Belt tensioner fastening bolts.....	37 to 49 Nm (27.3 to 36.1 lb.-ft.)
Water Oil cooler (heat exchanger) for EDC7UC31 control unit	
M6 bolt.....	8 to 12 Nm (5.9 to 8.9 lb.-ft.)
M8 bolt.....	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Oil pump and front cover fastening bolts	
1st stage	7 to 9 Nm (5.2 to 6.6 lb.-ft.)
2nd stage.....	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Cylinder bore lubrication jets fastening bolt.....	12 to 18 Nm (8.9 to 13.3 lb.-ft.)
Common Rail fastening bolts.....	20 to 28 Nm (14.8 to 20.7 lb.-ft.)
Boost temperature/pressure sensor on intake manifold	5 to 7 Nm (3.7 to 5.2 lb.-ft.)
Engine oil level sensor bolt	10 to 14 Nm (7.3 to 10.3 lb.-ft.)
Turbocharger to exhaust manifold fastening bolts	37 to 49 Nm (27.3 to 36.1 lb.-ft.)
Wiring duct securing bolt M6	8 to 12 Nm (5.9 to 8.9 lb.-ft.)
Support for electrical wiring for injector power supply bolt	20 to 28 Nm (14.8 to 20.7 lb.-ft.)

Fuel filter bracket

M12 bolt..... 69 to 85 Nm (50.9 to 62.7 lb.-ft.)

M8 bolt..... 20 to 28 Nm (14.8 to 20.7 lb.-ft.)

Flywheel casing

M10 bolt..... 75 to 95 Nm (55.3 to 70.1 lb.-ft.)

M12 bolt..... 44 to 55Nm (32.5 to 40.6 lb.-ft.)

Camshaft sensor fastening bolt 6 to 10 Nm (4.4 to 7.4 lb.-ft.)

Crankshaft sensor fastening bolt 6 to 10 Nm (4.4 to 7.4 lb.-ft.)

Engine coolant temperature sensor fastening bolt 17 to 23 Nm (12.5 to 17.0 lb.-ft.)

Oil pressure/temperature sensor fastening bolt..... 5 to 7 Nm 3.7 to 5.2 lb.-ft.)

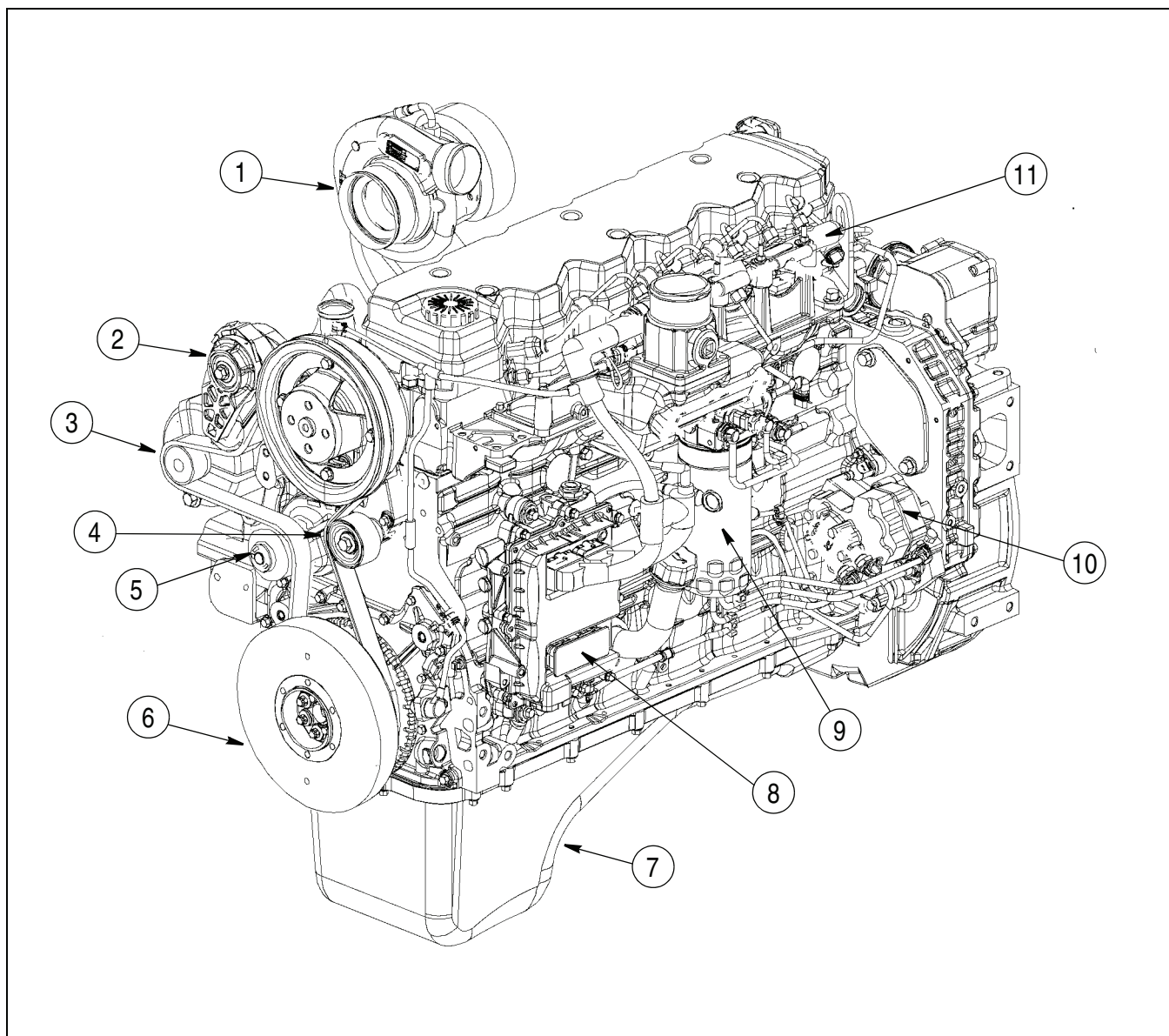
Fuel pressure sensor fastening bolt..... 30 to 40 Nm (22.1 to 29.5 lb.-ft.)

Fuel temperature sensor fastening bolt 17 to 23 Nm (12.5 to 17.0 lb.-ft.)

SPECIAL TOOLS

380000158.....	1-6 Nm dynametric (torque) screw driver for calibrating injector solenoid valve. connector check nut (Common Rail).
380000665.....	Tool for removing the crankshaft front seal.
380000663.....	Tool for removing the crankshaft rear seal.
380000671.....	Injector extracting tool.
380000666.....	Coupler for installing the crankshaft front seal.
380000664.....	Coupler for installing the crankshaft rear seal. (except engines: 667TA/EBF - 667TA/EED).
380000988.....	Tool for rotating the engine flywheel (except engines 667TA/EBF - 667TA/EED).
380001099.....	Tool for removing injectors.

667TA ENGINES



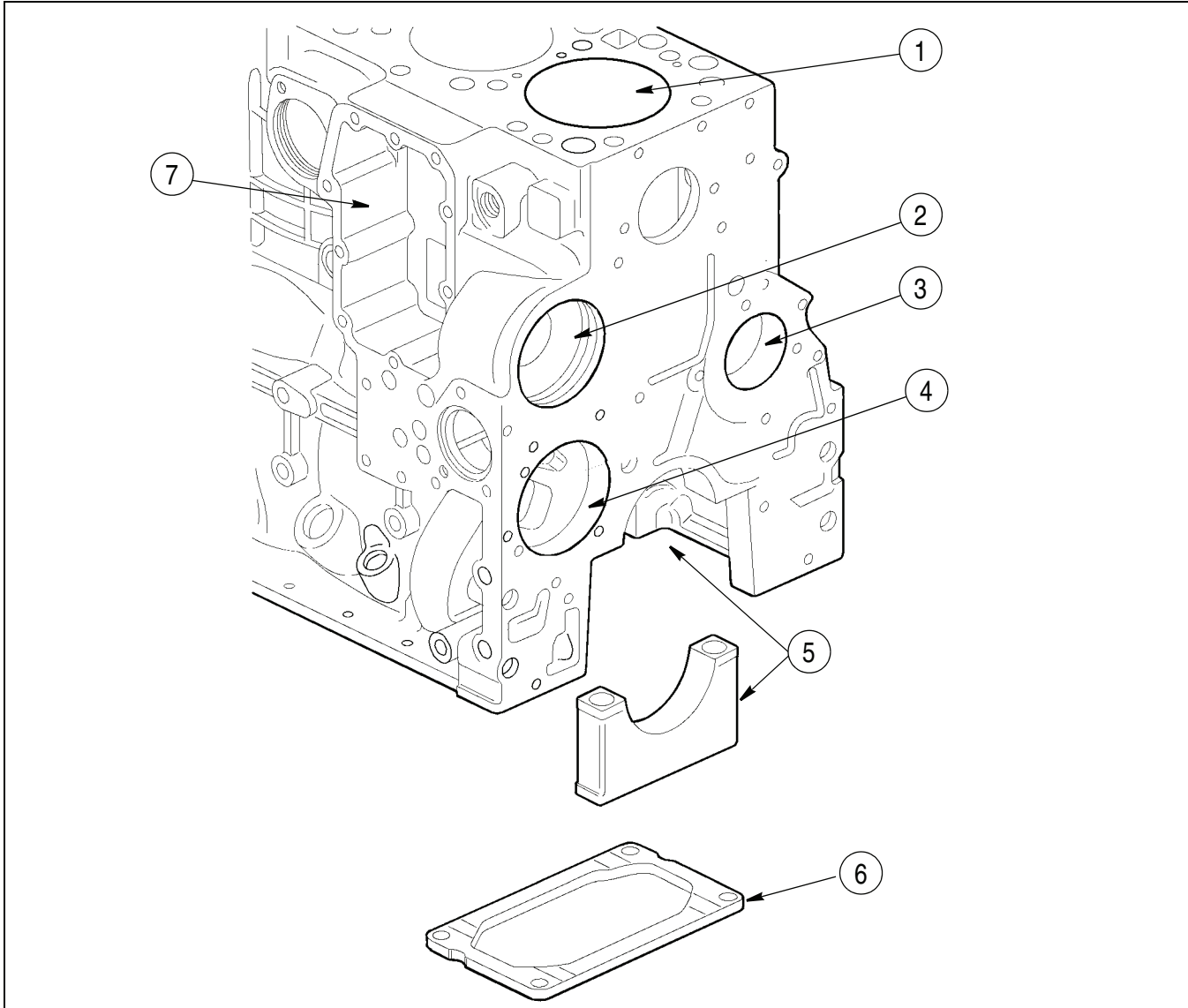
BS06K020

Figure 2-13

- | | | |
|-----------------------------|----------------------------|------------------------|
| 1. TURBOCHARGER | 5. WATER PUMP | 9. FUEL FILTER |
| 2. AUTOMATIC BELT TENSIONER | 6. DAMPER FLYWHEEL | 10. HIGH PRESSURE PUMP |
| 3. ALTERNATOR | 7. OIL PAN (SUMP) | 11. COMMON RAIL |
| 4. FIXED GUIDE PULLEY | 8. ELECTRONIC CONTROL UNIT | |

DESCRIPTION OF MAIN ENGINE COMPONENTS

ENGINE BLOCK



BS06K021

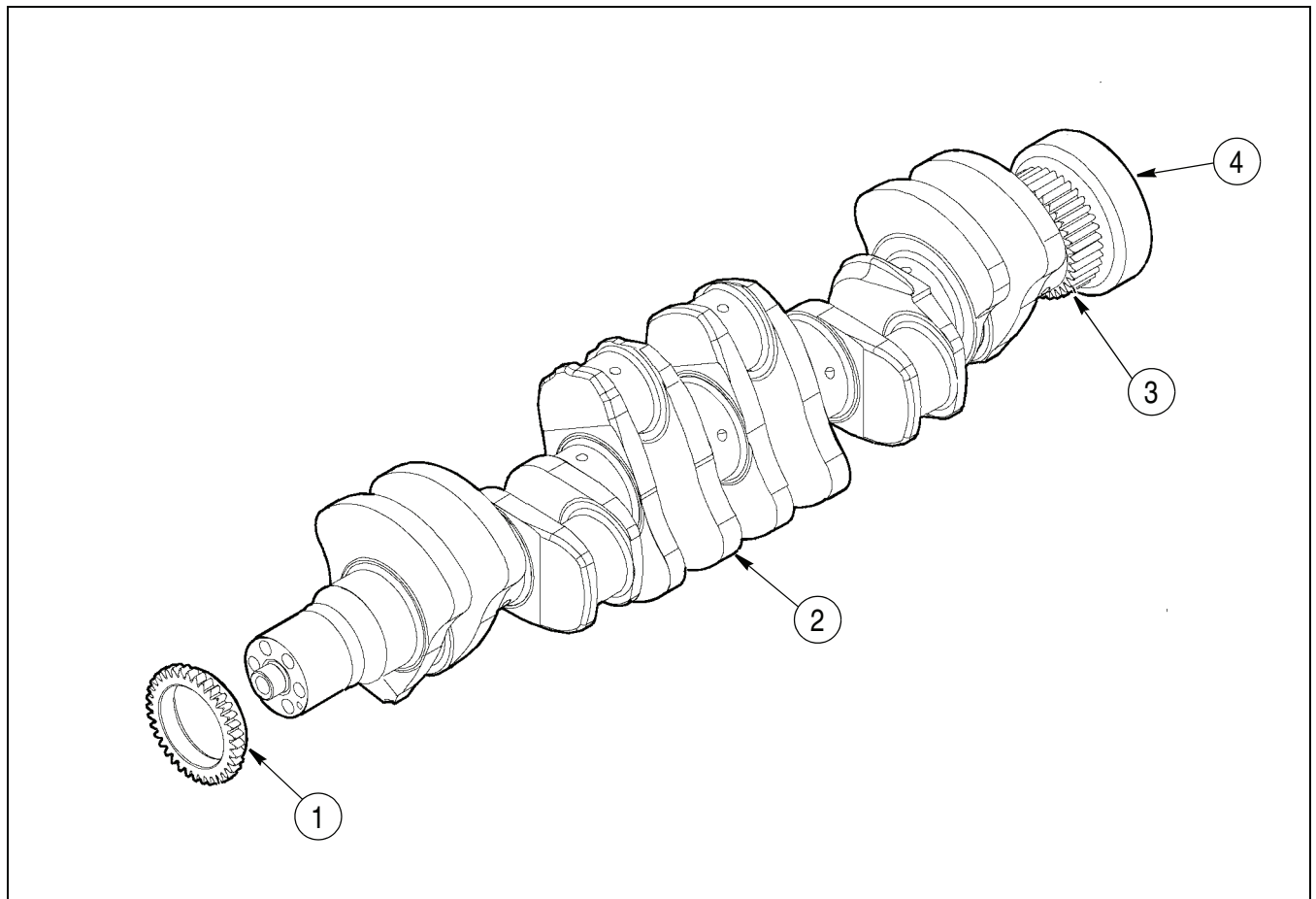
Figure 2-14

- | | | | |
|------------------|--|--------------------------------|---------------------|
| 1. CYLINDER BORE | 3. SEATS FOR CAMSHAFT BEARINGS AND TAPPETS | 5. MAIN BEARING HOUSINGS | 7. WATER/OIL COOLER |
| 2. WATER PUMP | 4. OIL PUMP | 6. CRANKSHAFT STIFFENING PLATE | |

The engine block consists of a cast iron structure containing the cylinder bores (1), the main bearing housings (5), and the following seats: for camshaft bearings (3), for the water/oil cooler (7), water pump (2), and oil pump (4). The block also incorporates the water jackets for cooling and the oil galleys for lubrication.

The crankshaft stiffening plate (6) is installed on the crankshaft main bearing cap bolts into the engine block and ensures greater resistance to mechanical stress.

CRANKSHAFT



BS06K022

Figure 2-15

1. OIL PUMP DRIVE GEAR 2. CRANKSHAFT 3. TIMING DRIVE GEAR 4. FLYWHEEL ATTACHMENT HUB

The crankshaft is made of steel and rests on seven induction hardened bearing journals. Drilled inside the crankshaft are a series of lubricating oil ducts.

The following items are pressed onto the front of the crankshaft: oil pump drive gear (1), speed sensor wheel, the vibration damper, and auxiliary equipment drive pulley.

The following items are force-fitted onto the rear of the crankshaft: timing gear (3), and the flywheel mounting hub (4).

The main bearing shells are made of steel with a antifriction alloy plating.

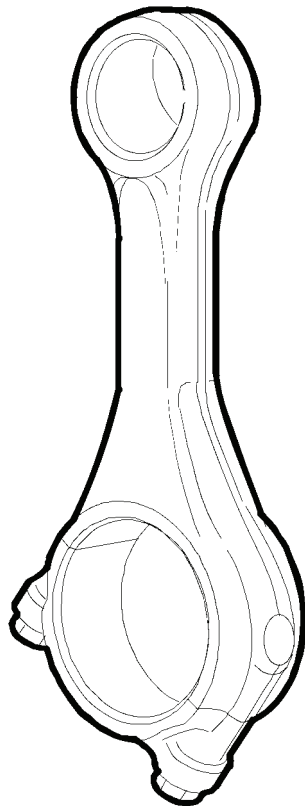
One of the main bearing shells is equipped with shoulders to limit crankshaft endplay.

The timing drive gear (3) and the flywheel attachment hub (4) are installed on the rear of the crankshaft with a force-fit and cannot be replaced.

CRANKSHAFT OIL SEALS

The front and rear seals are box type with radial seal. Remove with special tools 380000665 and 380000663. Install with special tools 380000666 and 380000664.

CONNECTING RODS



BS06K023

Figure 2-16

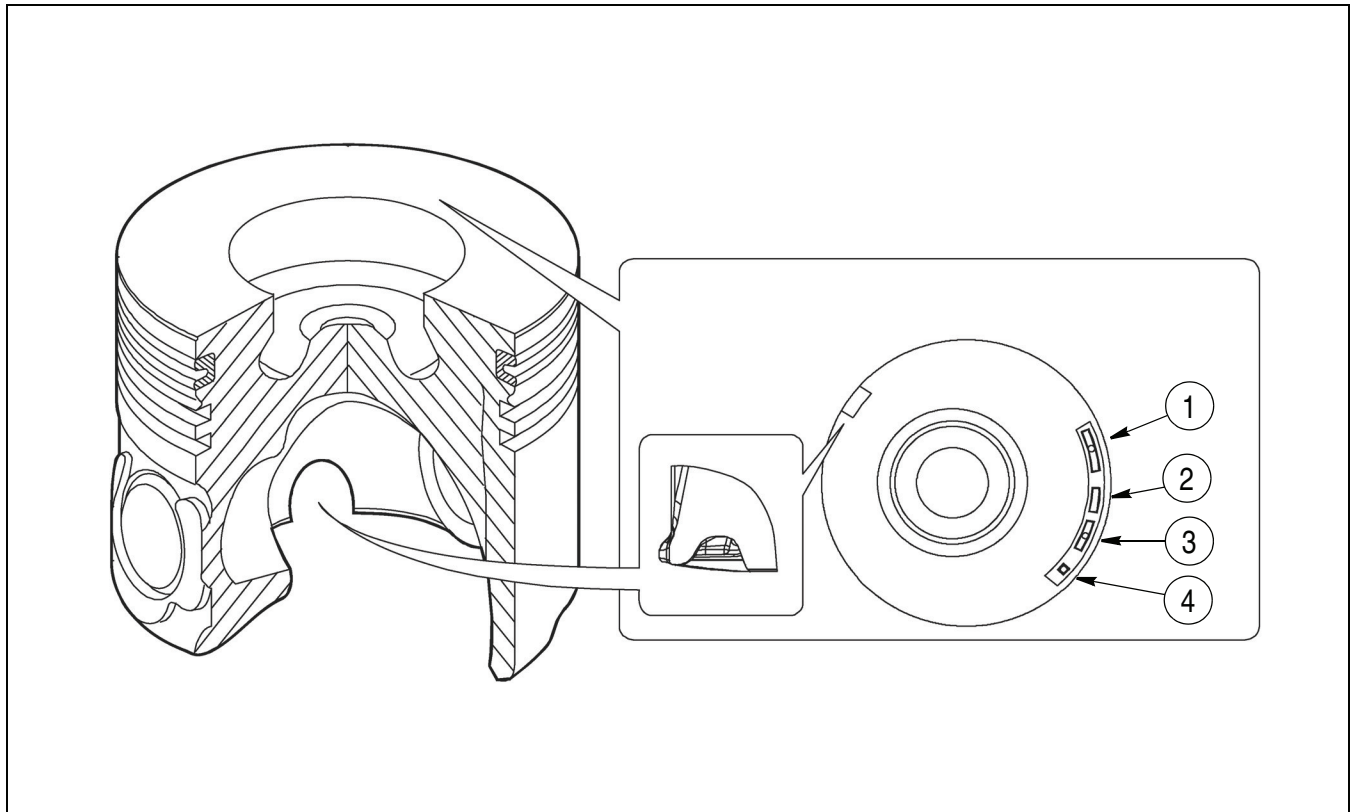
The connecting rods are forged steel, The connecting rod crankshaft ends are made with an oblique angle, with separation of rod and cap obtained by means of the innovative fracture splitting system rather than the conventional machining process.

The connecting rod crankshaft bearing shells are made of steel plated with an antifriction alloy.

Each connecting rod is marked:

- By a number on the connecting rod body and on the cap indicating the match and the cylinder in which they are assembled.
- By a letter on the connecting rod body indicating the weight class of the connecting rod installed in production.

PISTONS



BS06K024

Figure 2-17

The piston crown features a high turbulence combustion chamber. The underside of the piston crown is cooled by engine oil delivered by a spray nozzle installed in the crankcase.

There are three piston ring grooves with different functions and different geometry.

1st piston ring with trapezoidal (keystone) section, ceramic chrome plating.

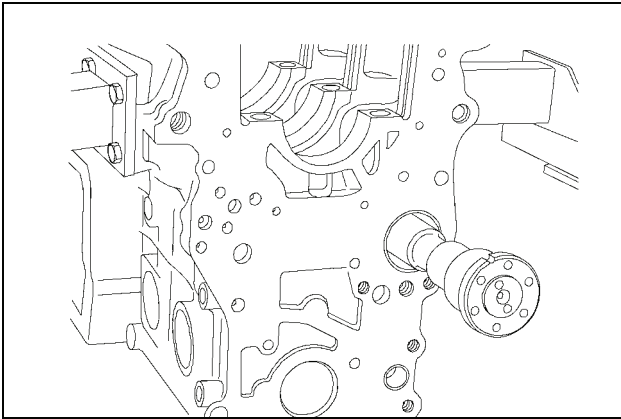
2nd piston ring with torsional conical rectangular section.

3rd piston ring with double oil ring wiper with internal spring.

The following reference data is engraved into the piston crown:

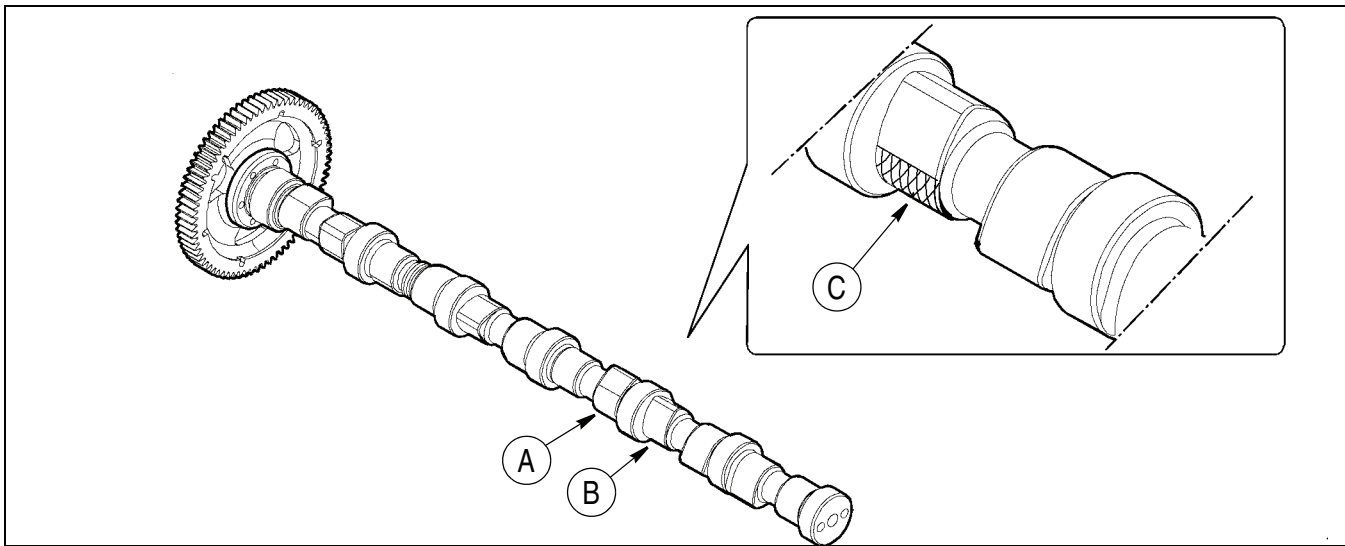
1. Spare part number and design modification number.
2. Stamping (facing the crankcase front side) indicating the mounting direction of the piston in the cylinder bore.
3. Date of manufacture.
4. Stamping indicating 1st recess insert testing.

CAMSHAFT



BS06K025

Figure 2-18



BS06K026

Figure 2-19

A. INTAKE VALVE LOBE

B. EXHAUST VALVE LOBE

C. EGR LOBE

The cam shaft is installed on 7 journals in the engine block.

The front and rear bearing housings are equipped with steel bearings plated with antifriction material assembled by means of a force-fit.

There are two cam lobes per cylinder.

- A. Intake valve lobe.
- B. Exhaust valve lobe.

The cam shaft is controlled directly by the crankshaft by means of rear spur tooth gears.

EGR EXHAUST GAS RECIRCULATION SYSTEM

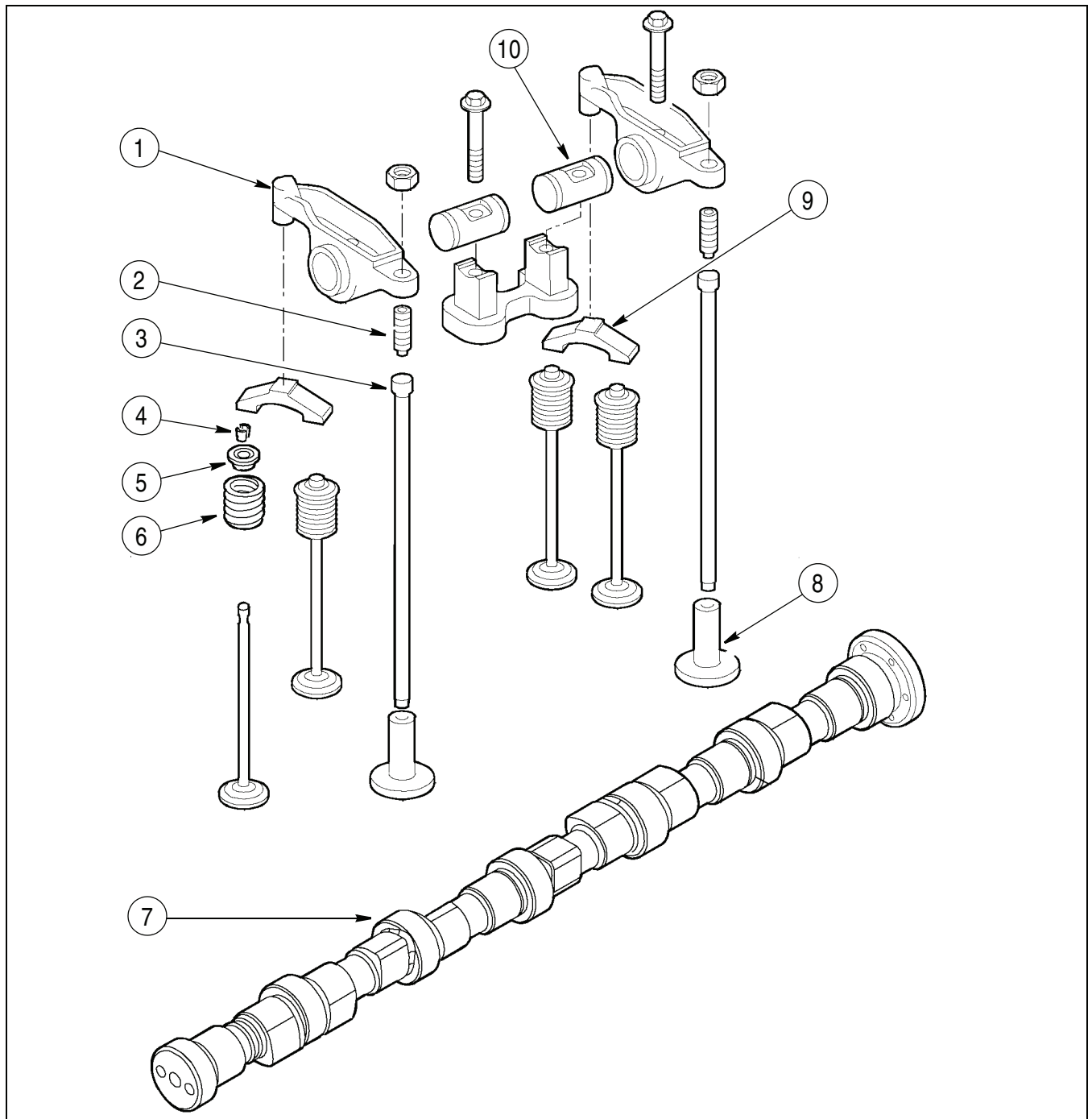
The exhaust gases can be partially returned back into the cylinders to lower the maximum combustion temperature which is responsible for the production of nitrogen oxides (NOx).

The exhaust gas recirculation system (EGR), lowers the combustion temperature by decreasing the concentration of oxygen in the combustion chamber. Creating an effective system to control the emission of NOx.

The internal EGR system exhaust cam design permits some of the exhaust gases to be returned back into the engine cylinders. This type of EGR, internal EGR is not provided with any electronically controlled element. The system is always on. Its configuration doesn't need any additional elements such as control valves, lines or heat exchangers.

The exhaust cam, beside the main lobe, has an additional lobe (C) compared to a cam without EGR. During the intake stroke of a cylinder this lobe permits a brief opening of the exhaust valve. This way recirculation is generated in the cylinder in the cylinder during the intake stroke due to the greater pressure of the exhaust gases compared to the intake gases.

VALVE CONTROL

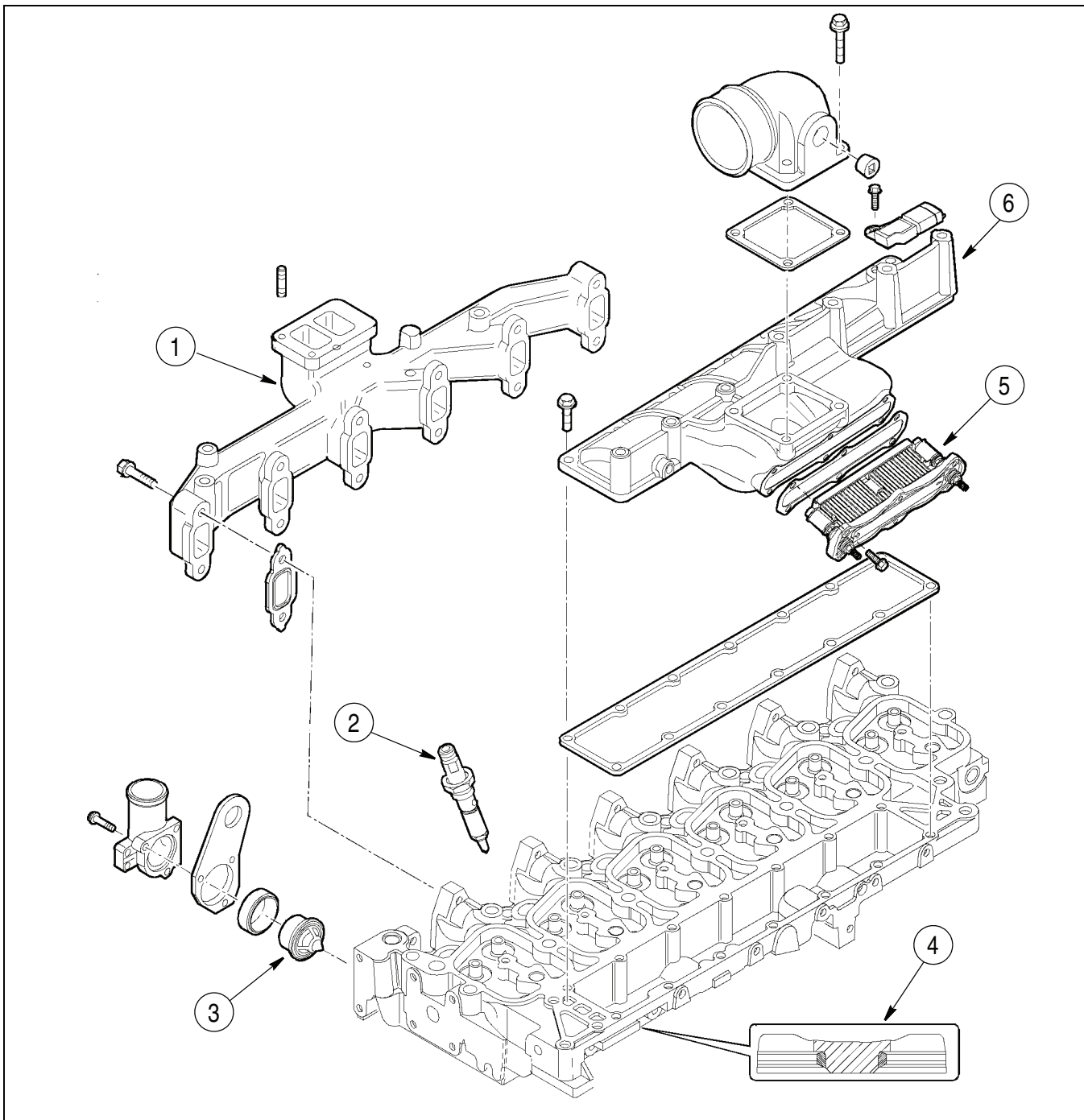


BS06K027

Figure 2-20

- | | | | | |
|-------------------|------------------------------------|----------------|-------------|--------------------|
| 1. ROCKER ARM | 3. PUSH ROD | 5. SPRING SEAT | 7. CAMSHAFT | 9. VALVE BRIDGE |
| 2. ADJUSTER SCREW | 4. VALVE SPRING RETAINER (KEEPERS) | 6. SPRING | 8. TAPPET | 10. ROCKER SPINDLE |

CYLINDER HEAD ENGINES: 667TA/EBF - 667TA/EBD - 667TA/EED



BS06K028

Figure 2-21

CYLINDER HEAD FOR ENGINES 667TA/EBF - 667TA/EBD - 667TA/EED

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

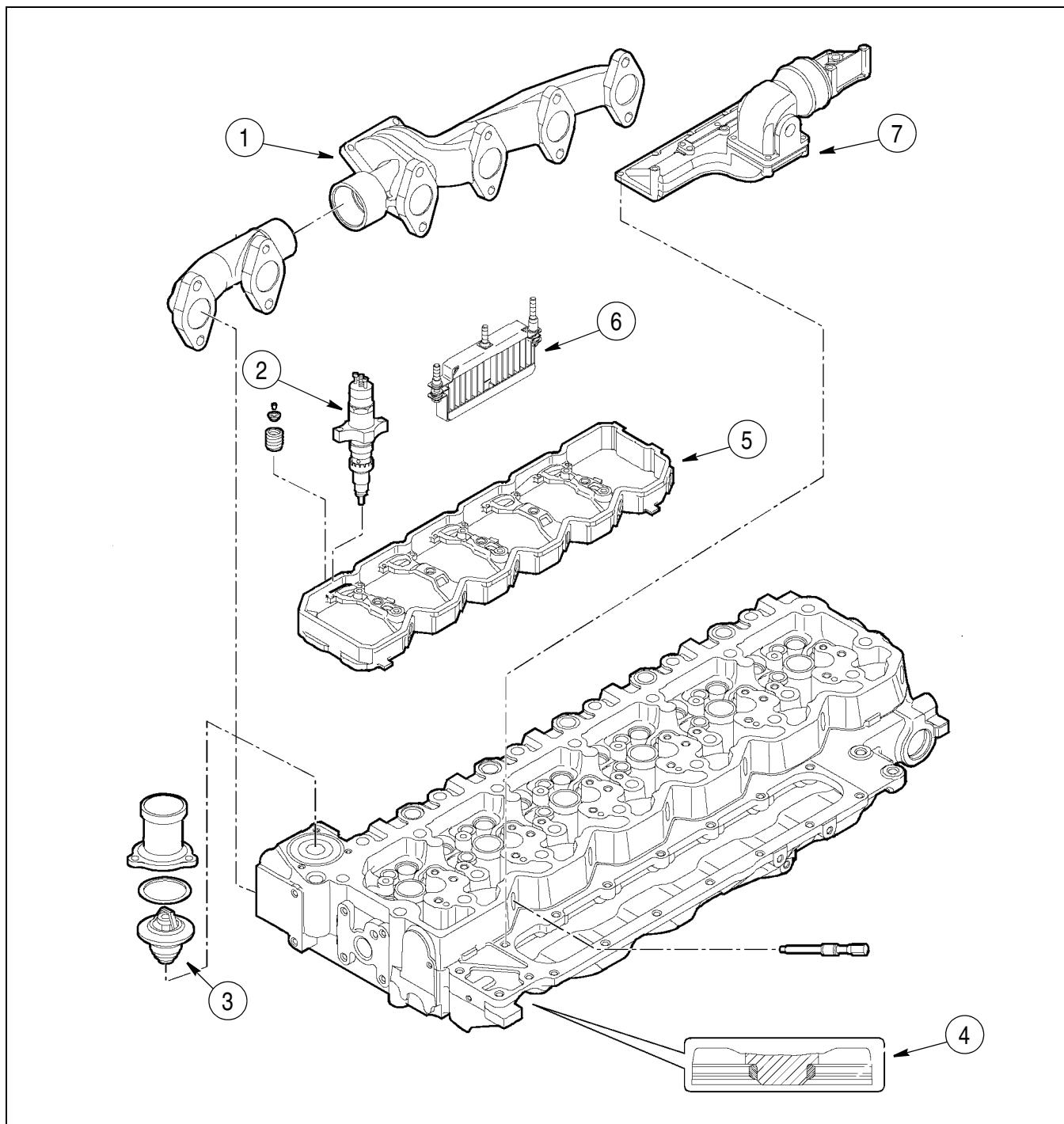
The cast iron cylinder head is machined to accommodate the following parts:

- Valve seats (4).
- Injectors (2).
- Thermostat (3).

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

- Exhaust manifold (1).
- Intake manifold (6) with seat for grid heater (5).

CYLINDER HEAD ENGINES: 667TA/EEG - 667TA/EEC



BS06K029

Figure 2-22

- | | | | |
|---------------------|---------------|--------------------------------|--------------------|
| 1. EXHAUST MANIFOLD | 3. THERMOSTAT | 5. SUPPORT WITH WIRING HARNESS | 7. INTAKE MANIFOLD |
| 2. INJECTOR | 4. VALVE SEAT | 6. GRID HEATER | |

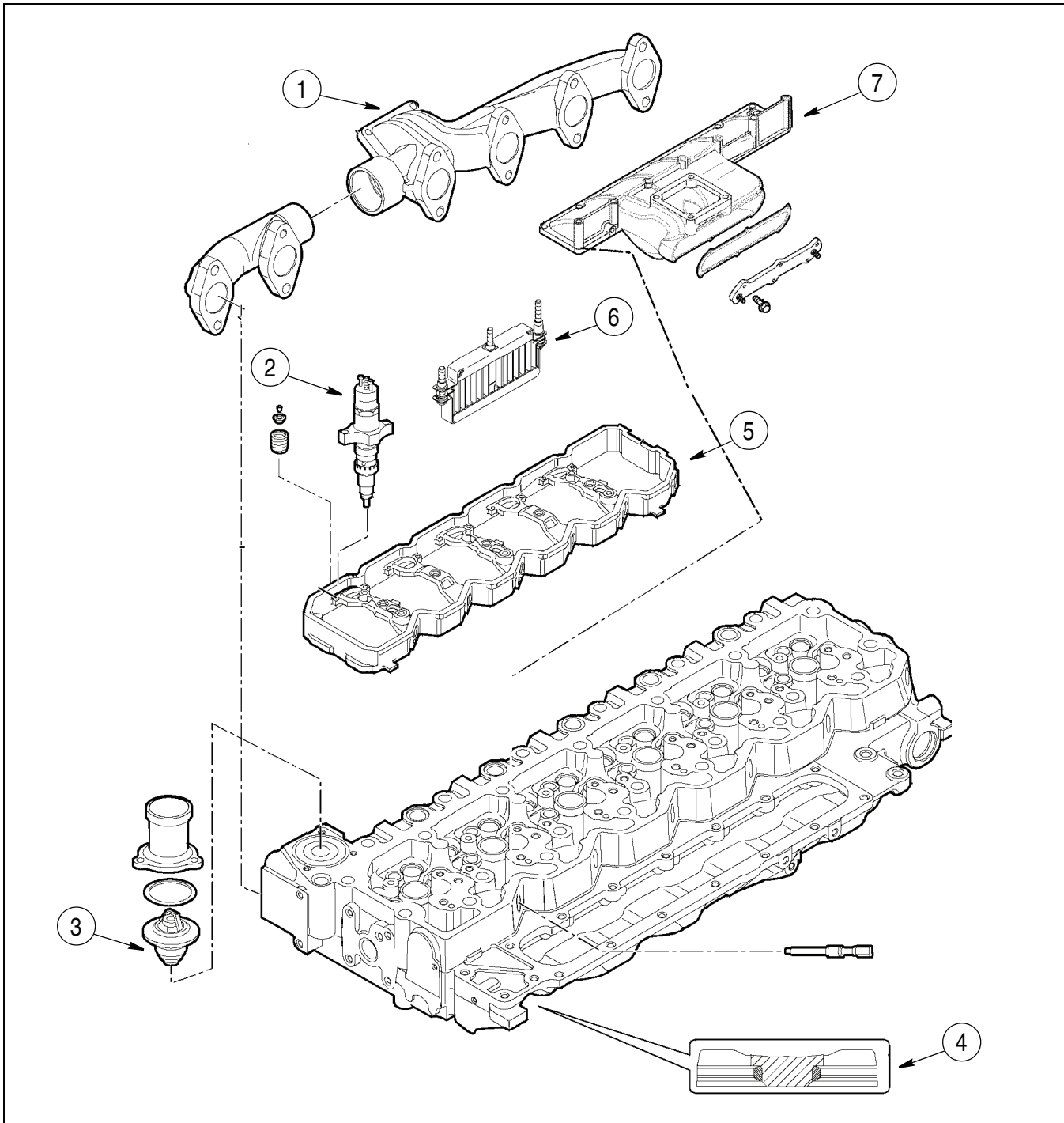
The cast iron cylinder head is machined to accommodate the following parts:

- valve seats (4).
- injectors (2).
- thermostat (3).

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

- exhaust manifold (1).
- intake manifold (7) with seat for grid heater (6).

CYLINDER HEAD ENGINE: 667TA/EDJ



BS06K136

Figure 2-23

- | | | | |
|---------------------|---------------|--------------------------------|--------------------|
| 1. EXHAUST MANIFOLD | 3. THERMOSTAT | 5. SUPPORT WITH WIRING HARNESS | 7. INTAKE MANIFOLD |
| 2. INJECTOR | 4. VALVE SEAT | 6. GRID HEATER | |

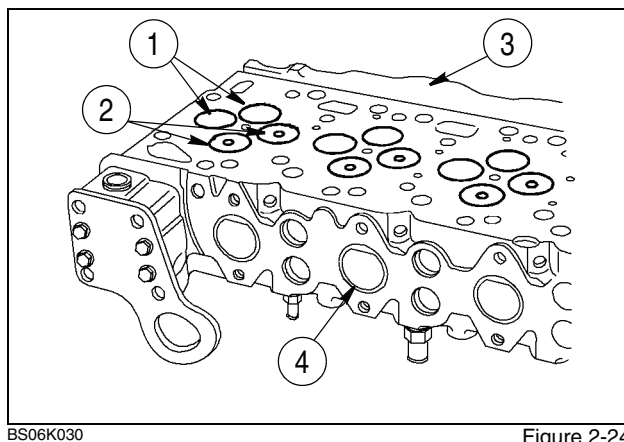
The cast iron cylinder head is machined to accommodate the following parts:

- valve seats (4).
- injectors (2).
- thermostat (3).

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

- exhaust manifold (1).
- intake manifold (7) with seat for grid heater (6).

VALVES AND VALVE SEATS



BS06K030

Figure 2-24

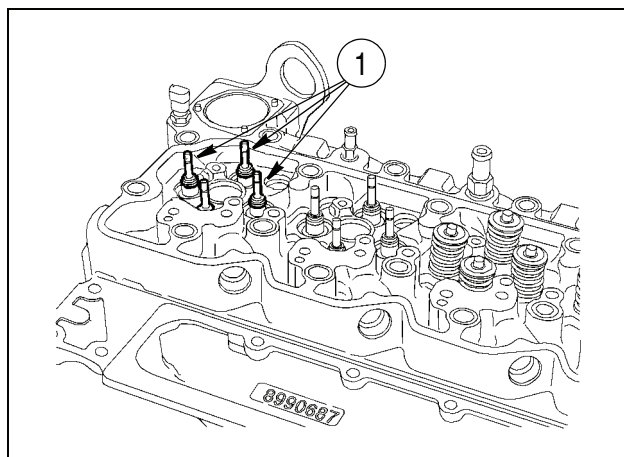
- | | |
|------------------|-----------------|
| 1. INTAKE VALVE | 3. INTAKE SIDE |
| 2. EXHAUST VALVE | 4. EXHAUST SIDE |

Valve seats have the following angles:

Exhaust valves- 45°

Intake valves- 60°

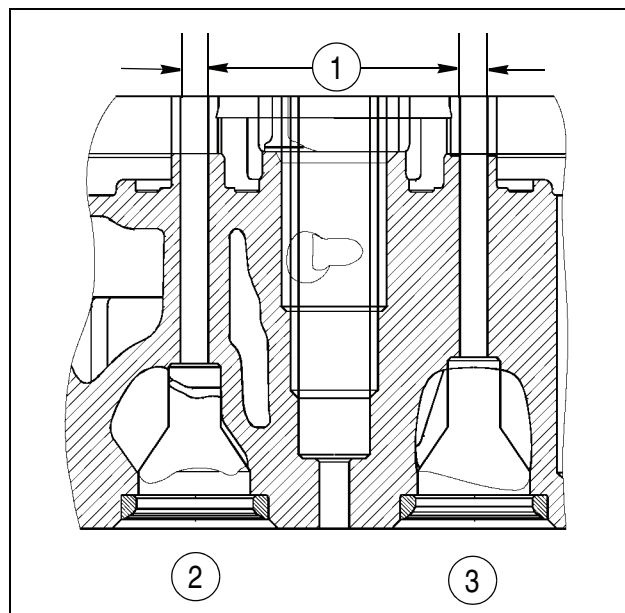
NOTE: Exhaust valves (2) have a distinctive indentation at the center of the head of the valve.



BS06K031

Figure 2-25

Oil seals (1) installed on the valve stems.



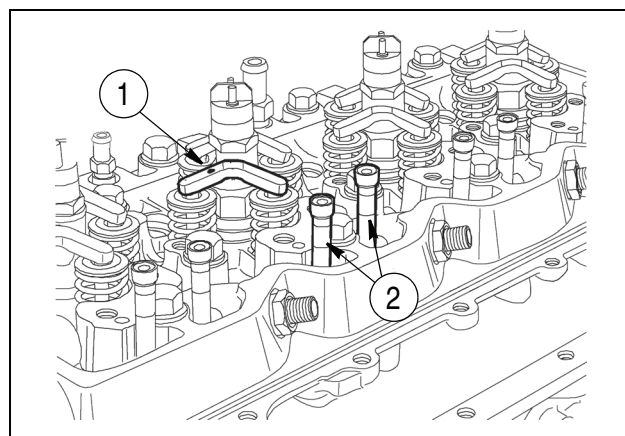
BS06K032

Figure 2-26

1. 7.042 TO 7.062MM (0.277 TO 0.278 IN)
2. INTAKE VALVES
3. EXHAUST VALVES

The cylinder head does not have guide inserts. The valve guide is machined directly into the head casting.

VALVE BRIDGES



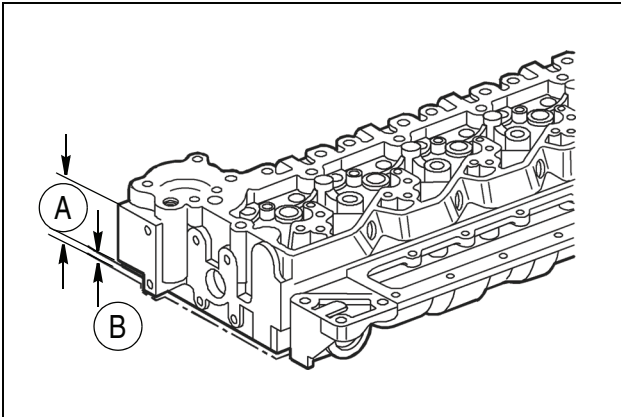
BS06K033

Figure 2-27

1. JUMPER
2. RODS

NOTE: When installing the cylinder head, the orientation of valve bridges must be positioned with marks (1) towards exhaust manifold.

ENGINE HEAD MACHINING



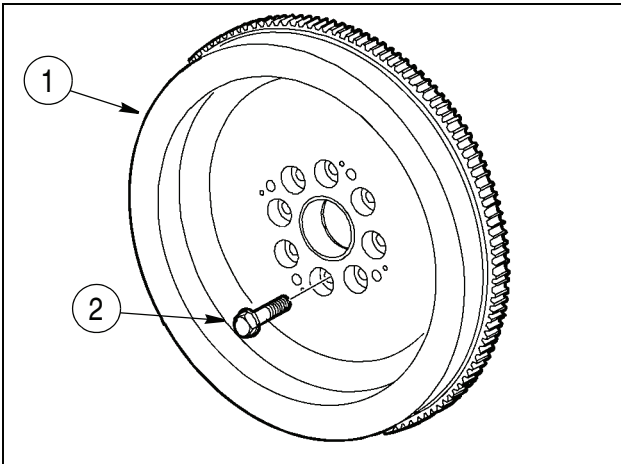
BS06K034

Figure 2-28

Cylinder head nominal thickness (A) is $105 \pm 0.25\text{mm}$. ($4.134 \pm 0.0098\text{ in.}$) and a maximum removal of material (B) must not exceed 0.13mm . (0.0051 in.).

ENGINE FLYWHEEL

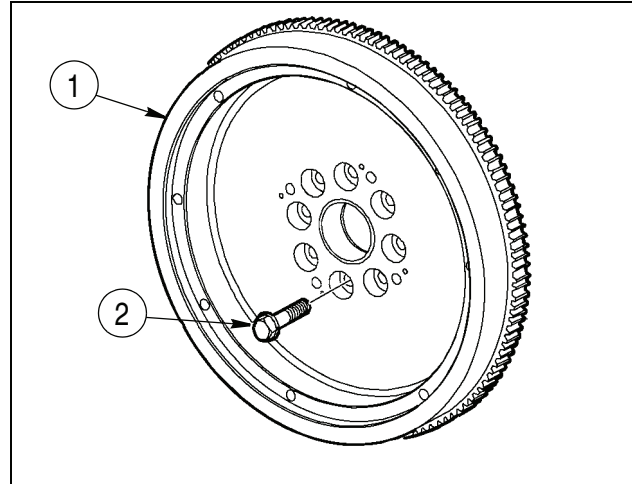
The flywheel (1) is not timed to the crankshaft and does not have any stamping, notch or reference hole for sensors or timing. Equal position of fastening bolt holes (2) allows it to be installed in any position.



BS06K035

Figure 2-29

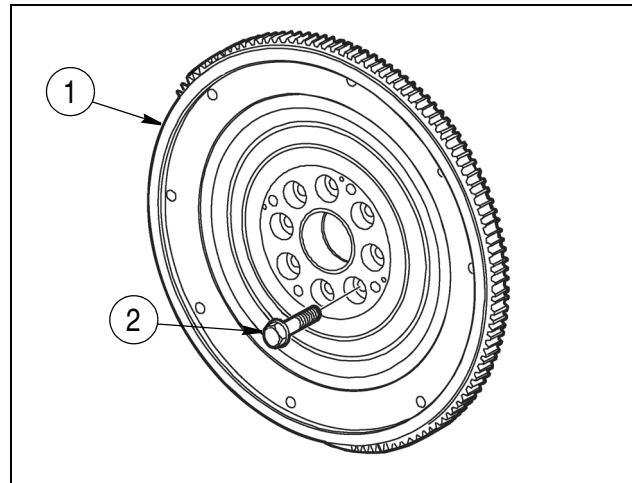
ENGINES: 667TA/EEG - 667TA/EEC



BS06K037

Figure 2-30

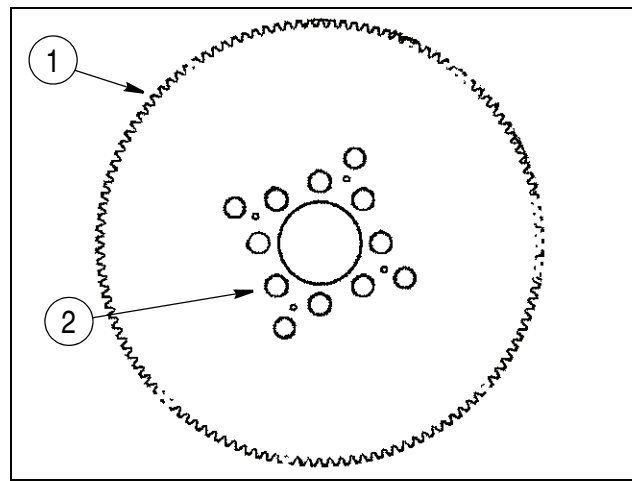
ENGINES: 667TA/EED - 667TA/EBD



BS06K036

Figure 2-31

ENGINES: 667TA/EBF - 667TA/EEED

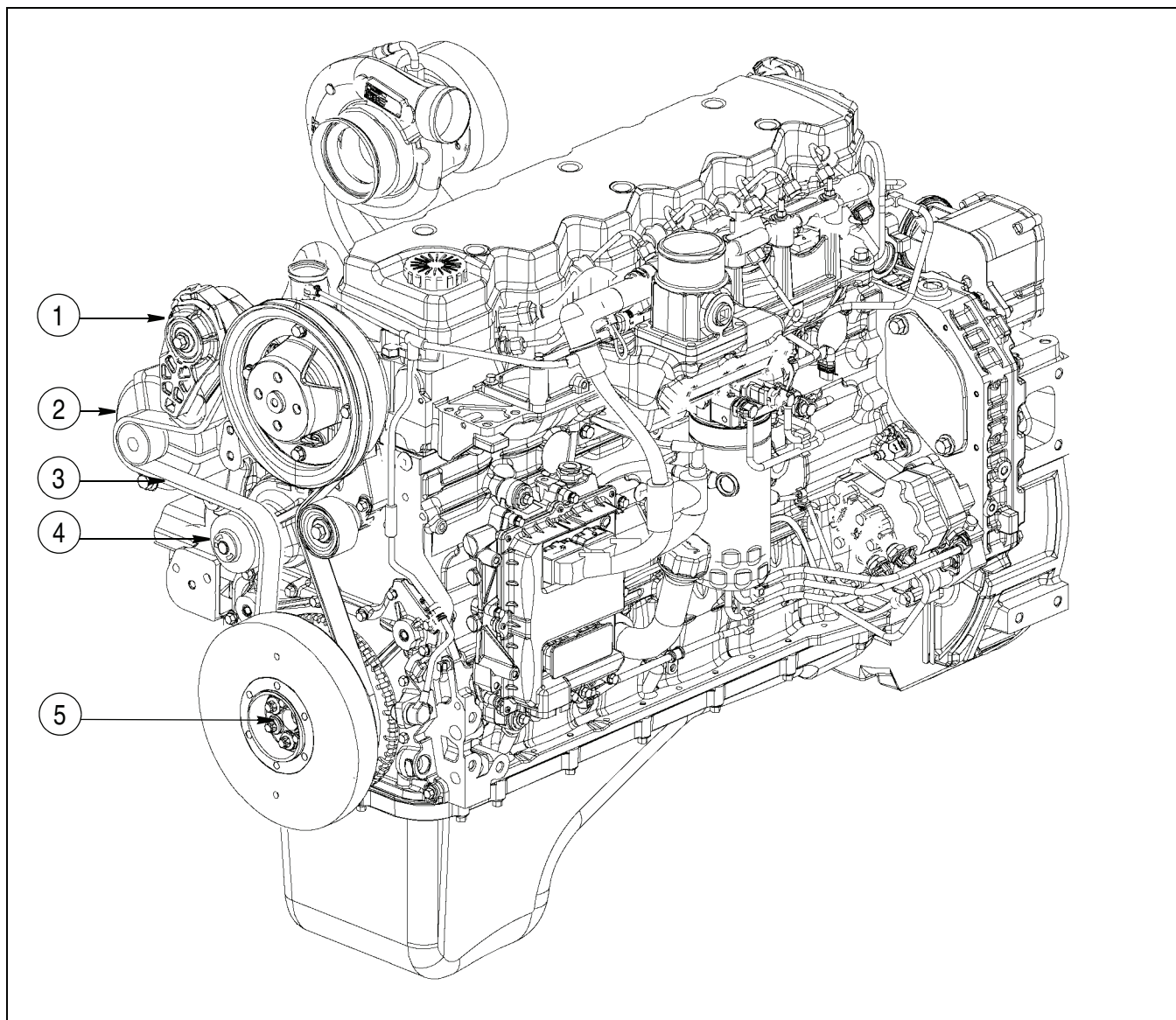


BS06K629

Figure 2-32

ENGINE: 667TA/EDJ

ACCESSORY EQUIPMENT DRIVE



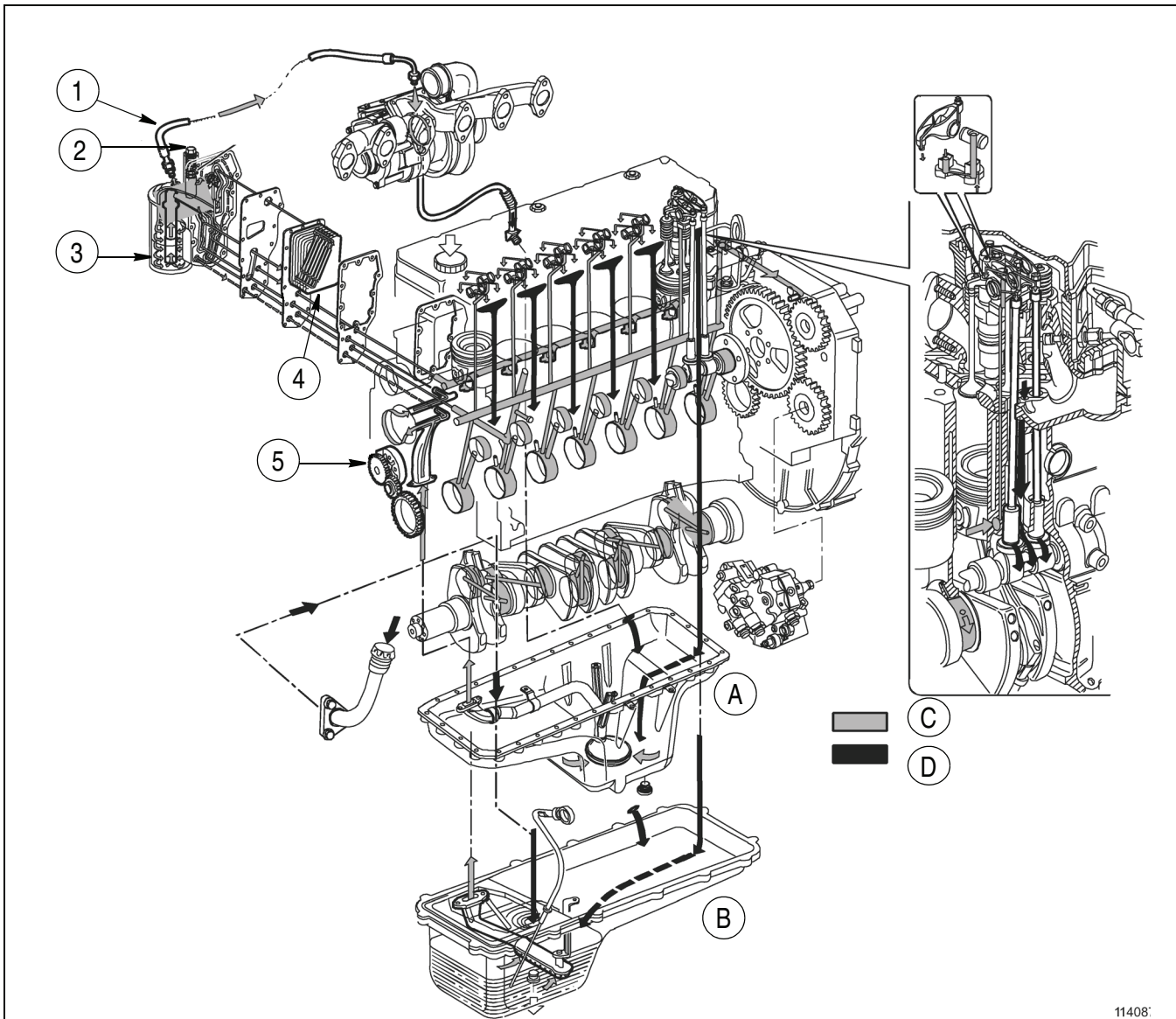
BS06K038

Figure 2-33

1. AUTOMATIC BELT TENSIONER 2. ALTERNATOR 3. POLY-V-BELT 4. WATER PUMP 5. CRANKSHAFT

A Poly-V-belt (3) transmits the rotation of the crankshaft (5) to water pump (4) and to the alternator (2). The tension of the belt is controlled by the automatic belt tensioner (1).

ENGINE LUBRICATION



BS06K039

11408

Figure 2-34

- | | | |
|-------------------------------------|-------------------------------|-------------|
| 1. TURBO OIL PRESSURE CONTROL VALVE | 3. CARTRIDGE -TYPE OIL FILTER | 5. OIL PUMP |
| 2. BY-PASS VALVE | 4. OIL / WATER COOLER | |

A. OIL PAN: 667TA/EED - 667TA/EBD

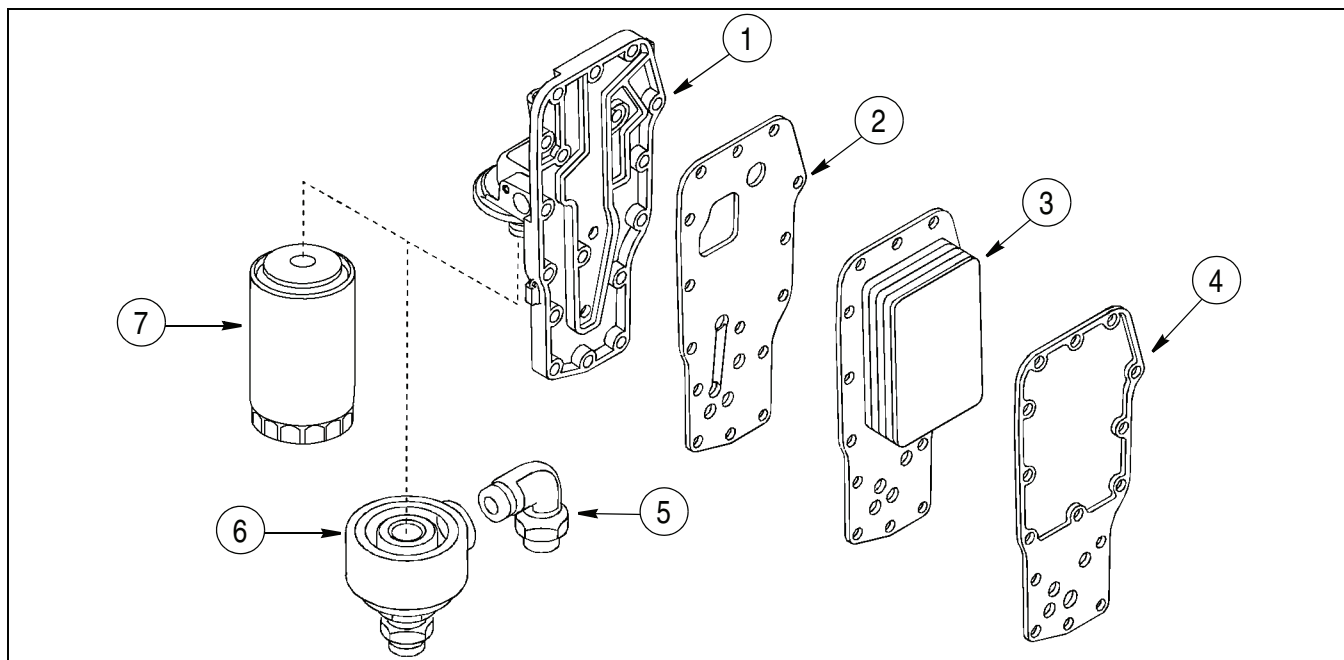
B. OIL PAN: 667TA/EEG - 667TA/EEC - 667TA/EBF - 667TA/EED - 667TA/EDJ

C. PRESSURIZED OIL PATH

D. GRAVITY OIL RETURN PATH

Pressurized lubrication is 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; water / oil cooler (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 COOLER



BS06K040

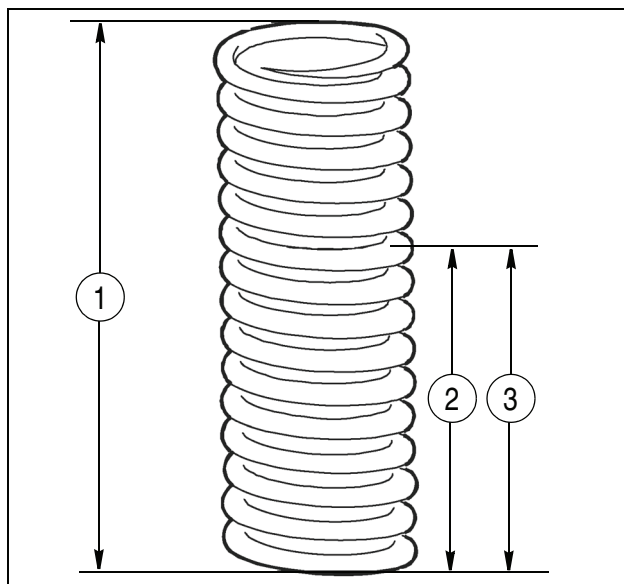
Figure 2-35

- | | | | |
|------------------------|---|--------------------------|---------------|
| 1. HEAT EXCHANGER BODY | 3. WATER / OIL COOLER | 5. OIL RETURN TO FILTER* | 7. OIL FILTER |
| 2. INNER GASKET | 4. GASKET (BETWEEN COOLER AND ENGINE BLOCK) | 6. OIL FLOW FROM FILTER* | |

* Only engines: 667TA/EEG - 667TA/EEC.

BY-PASS VALVE

OIL PRESSURE CONTROL VALVE



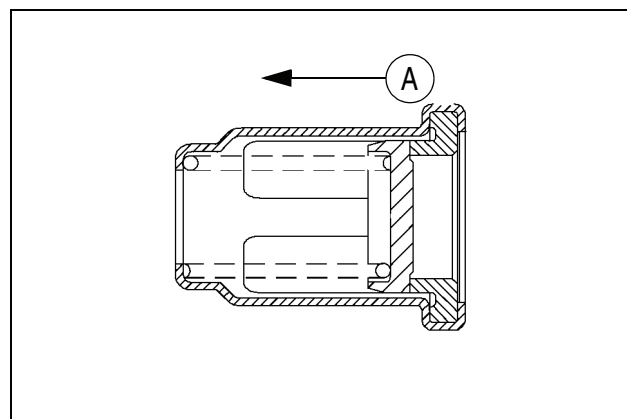
BS06K041

Figure 2-36

1. 66MM (2.589 IN)
2. 41.25MM (1.624 IN)
3. 136.9 ± 10.5 N (30.8 ± 2.36 LBF)

Calibration at 100°C (212°F) oil temperature.

- minimum pressure 1.2 bar (17.4 psi).
- maximum pressure 3.8 bar (55.1 psi).



BS06K042

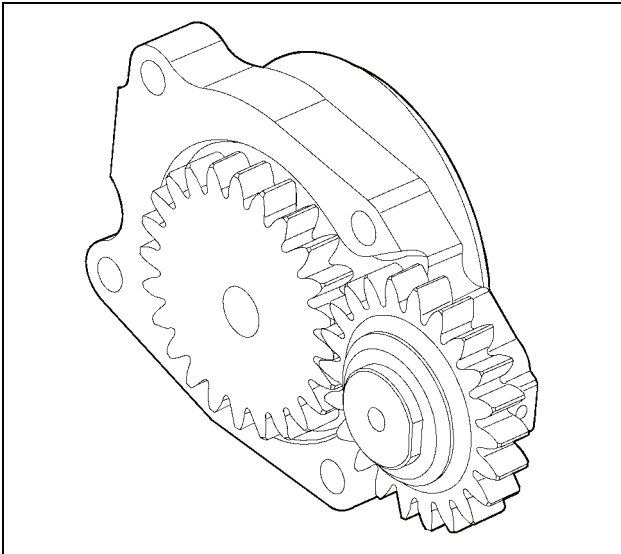
Figure 2-37

A. DIRECTION OF FLOW

Blow-by-max:

20cm³/min (.68oz/min) with 0.83 bar (12 psi) pressure at 26.7° C (80° F) oil temperature.

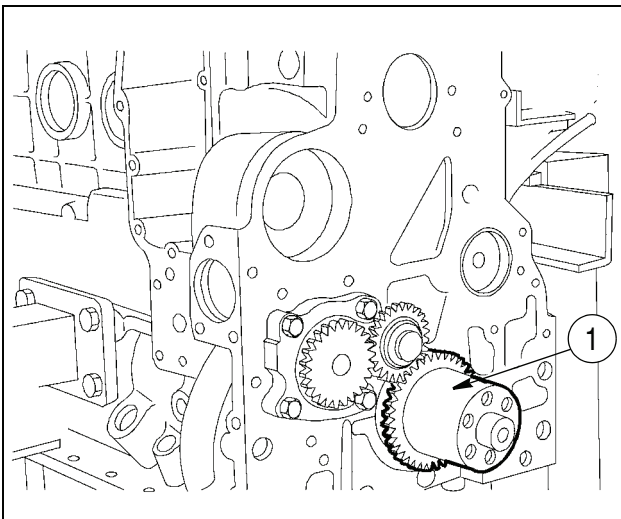
OIL PUMP



BS06K043

Figure 2-38

OIL PUMP

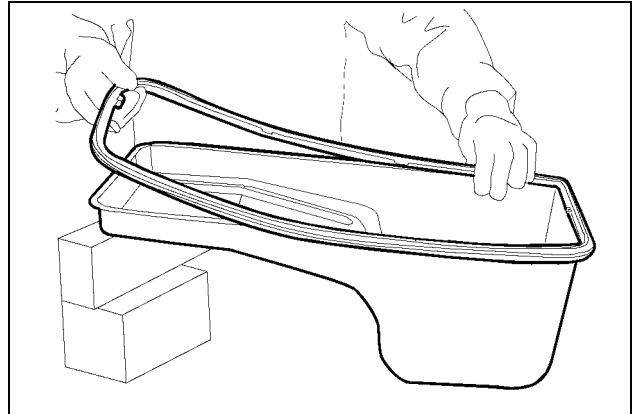


BS06K044

Figure 2-39

1.-Crankshaft with oil pump drive gear

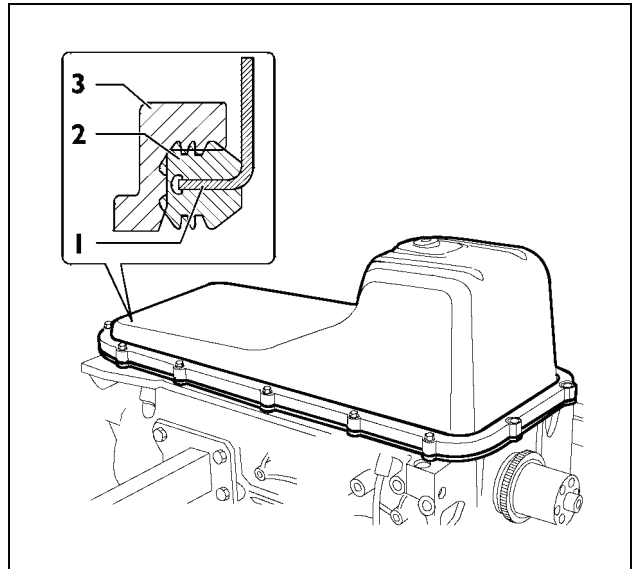
OIL PAN (SUMP) ENGINES: 667TA/EEG- 667TA/EEC- 667TA/EBF- 667TA/EED- 667TA/EDJ



BS06K045

Figure 2-40

OIL PAN GASKET INSTALLATION



BS06K046

Figure 2-41

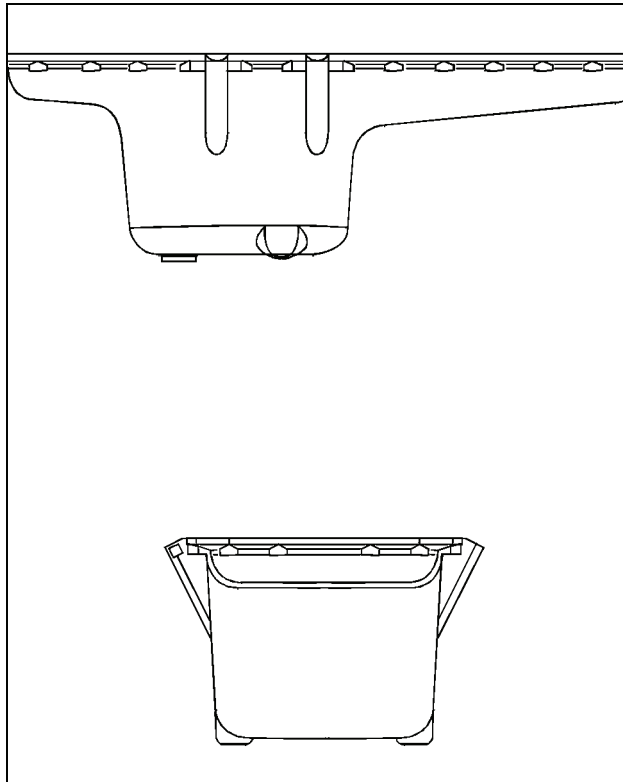
STEEL OIL PAN (SUMP)

CROSS SECTIONAL VIEW OF OIL PAN GASKET

The steel oil pan (sump) (1) is secured to the engine block by an aluminium plate (3) and a rubber gasket (2). See figure 2-41.

The C-section rubber gasket (2), installed on the edge of the oil pan, enhances sealing properties and also reduces noise levels.

**OIL PAN (SUMP) ENGINES: 667TA/EED-
667TA/EBD**



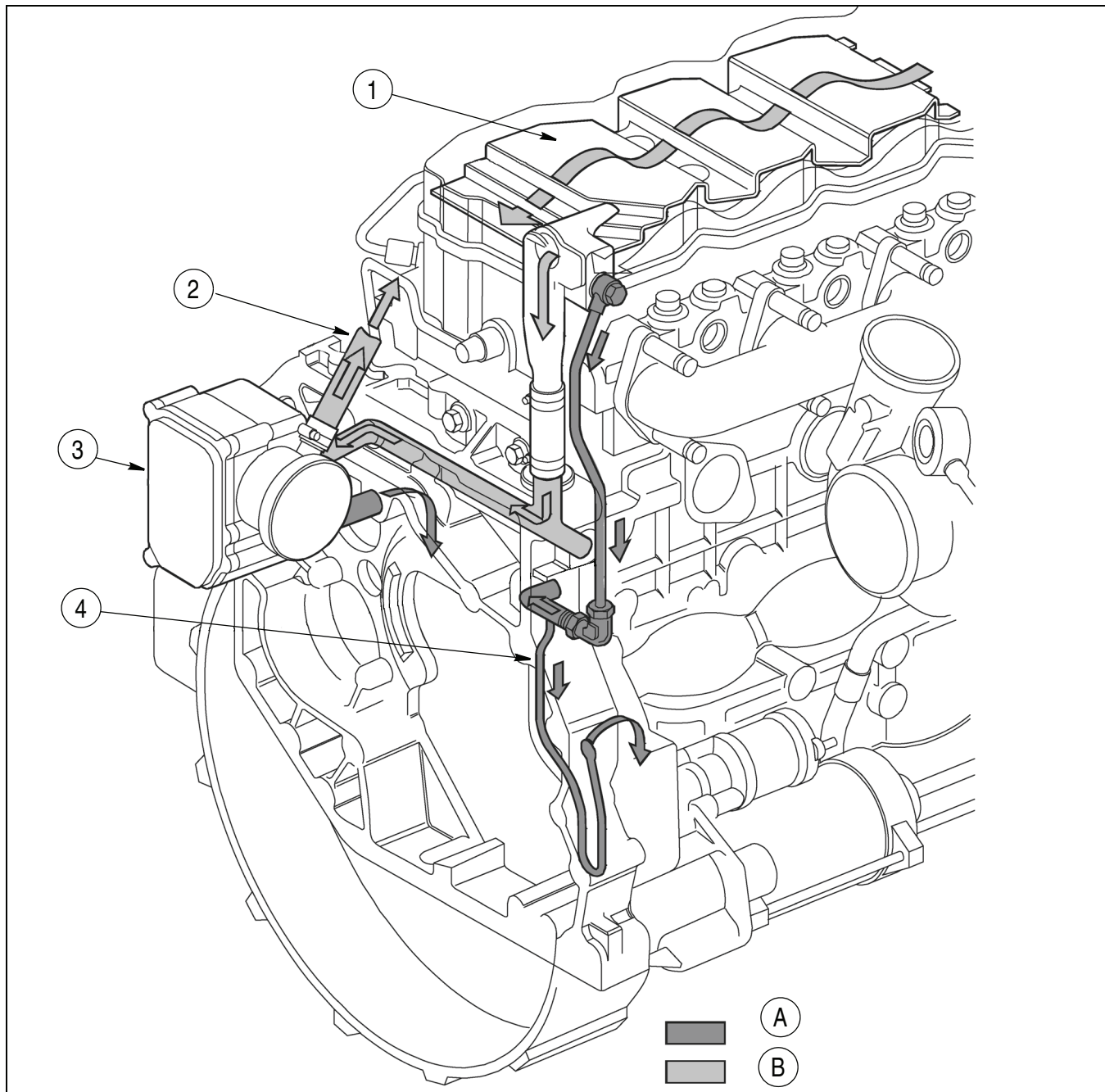
BS06K047

Figure 2-42

CAST IRON OIL PAN (SUMP)

The cast iron oil pan (sump) is fastened to the engine block by bolts with interposed flat washers and a thin gasket.

ENGINE OIL VAPOR RECIRCULATION



BS06K048

Figure 2-43

1. PRE-SEPARATOR

2. RECIRCULATION TO INTAKE

3. BLOW-BY FILTER

4. RETURN TO ENGINE

A. OIL CONDENSATE

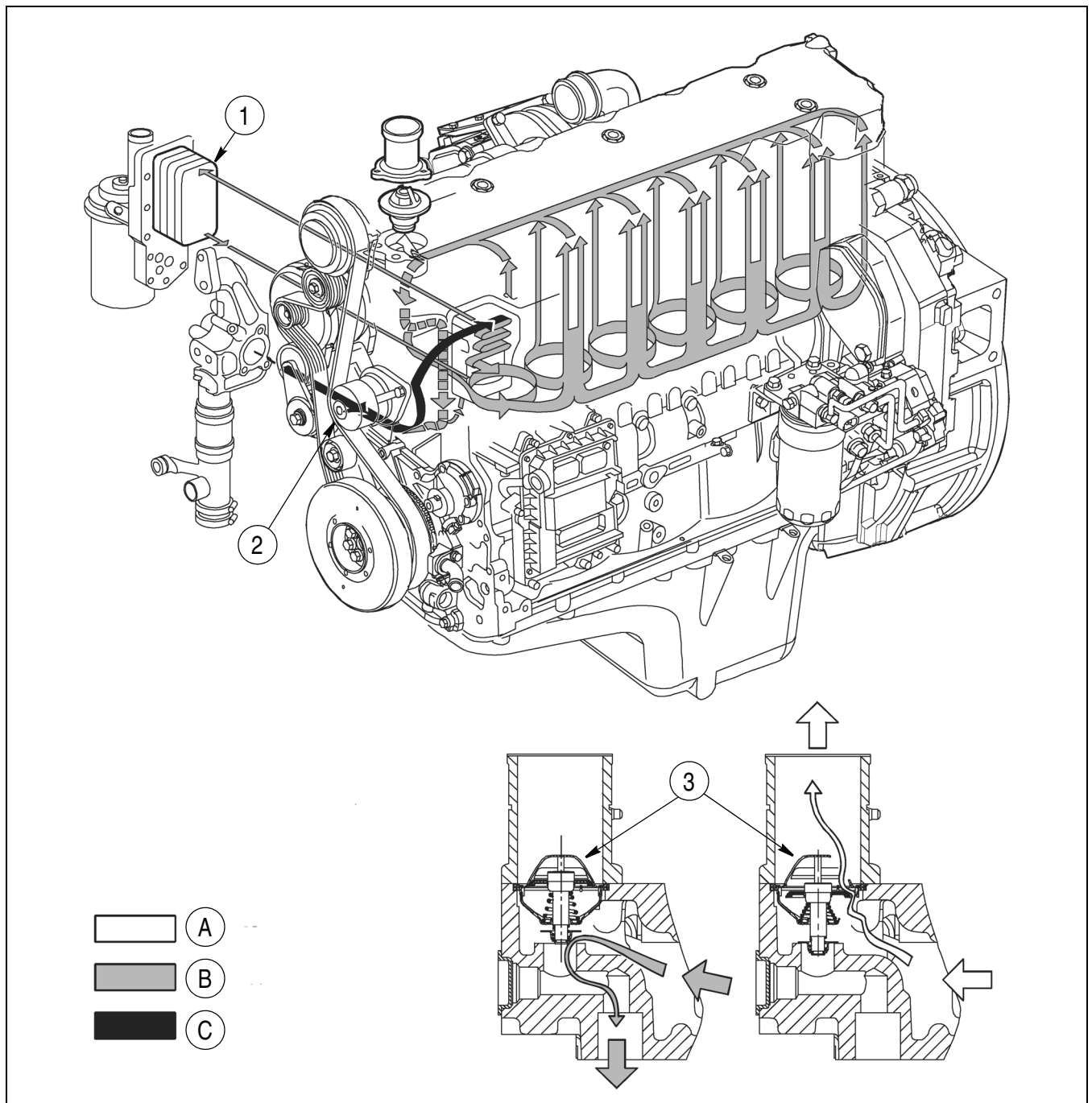
B. OIL VAPORS

BLOW-BY RECIRCULATION

The rocker cover has a blow-by pre-separator (1), designed to increase the outlet velocity of blow-by oil vapor while condensing them partially. Condensed oil returns to the oil pan (sump) while residual vapors are collected and routed through the blow-by filter (3).

In blow-by filter (3) a portion of the vapors partially condense and return to the oil pan (sump) through line (4), while the remaining is recirculated to the engine intake, by line (2).

ENGINE COOLING



BS06K049

Figure 2-44

1. OIL COOLER
2. WATER PUMP

3. THERMOSTAT
A. WATER FROM THERMOSTAT OUTLET

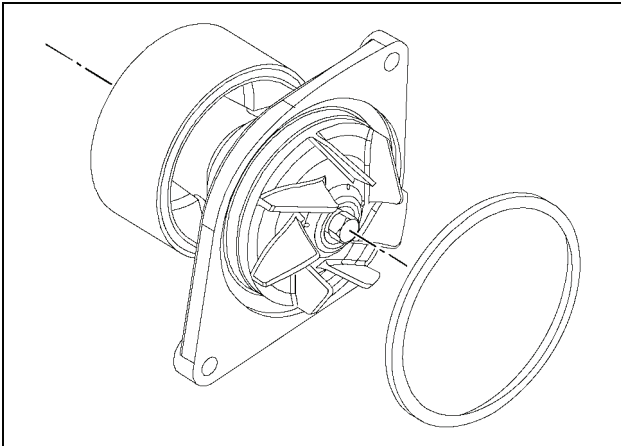
B. WATER RECIRCULATING IN ENGINE
C. WATER TO PUMP INLET

The engine cooling system is a closed circuit circulation type and is made up of the following components:

- Oil cooler used to cool the lubricating oil, see oil cooler page 2-31.
- Centrifugal water pump, housed in the front of the engine block.

- Thermostat, used to regulate coolant flow.

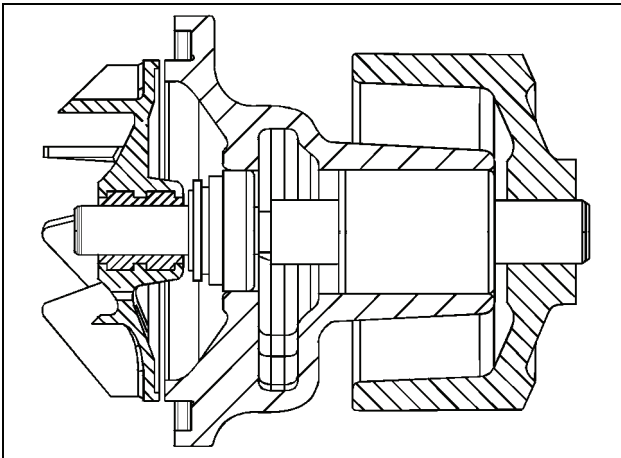
WATER PUMP



BS06K050

Figure 2-45

WATER PUMP



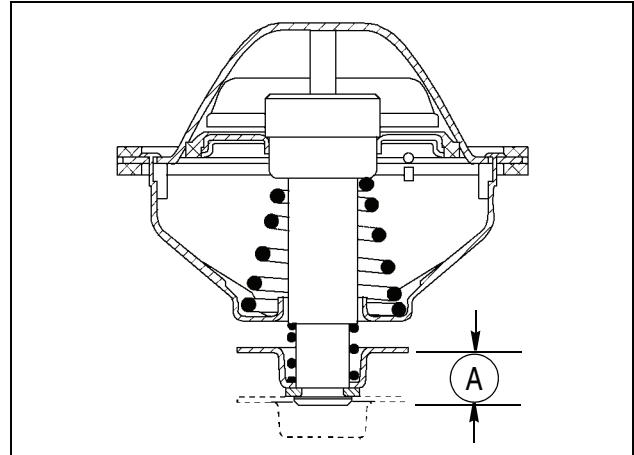
BS06K051

Figure 2-46

WATER PUMP CROSS SECTION

The water pump is housed in a cavity in the front of the engine block, and is driven by a Poly-V belt. The water pump is sealed to the block by a rubber ring.

The engine temperature is controlled by a thermostat.



BS06K052

Figure 2-47

THERMOSTAT

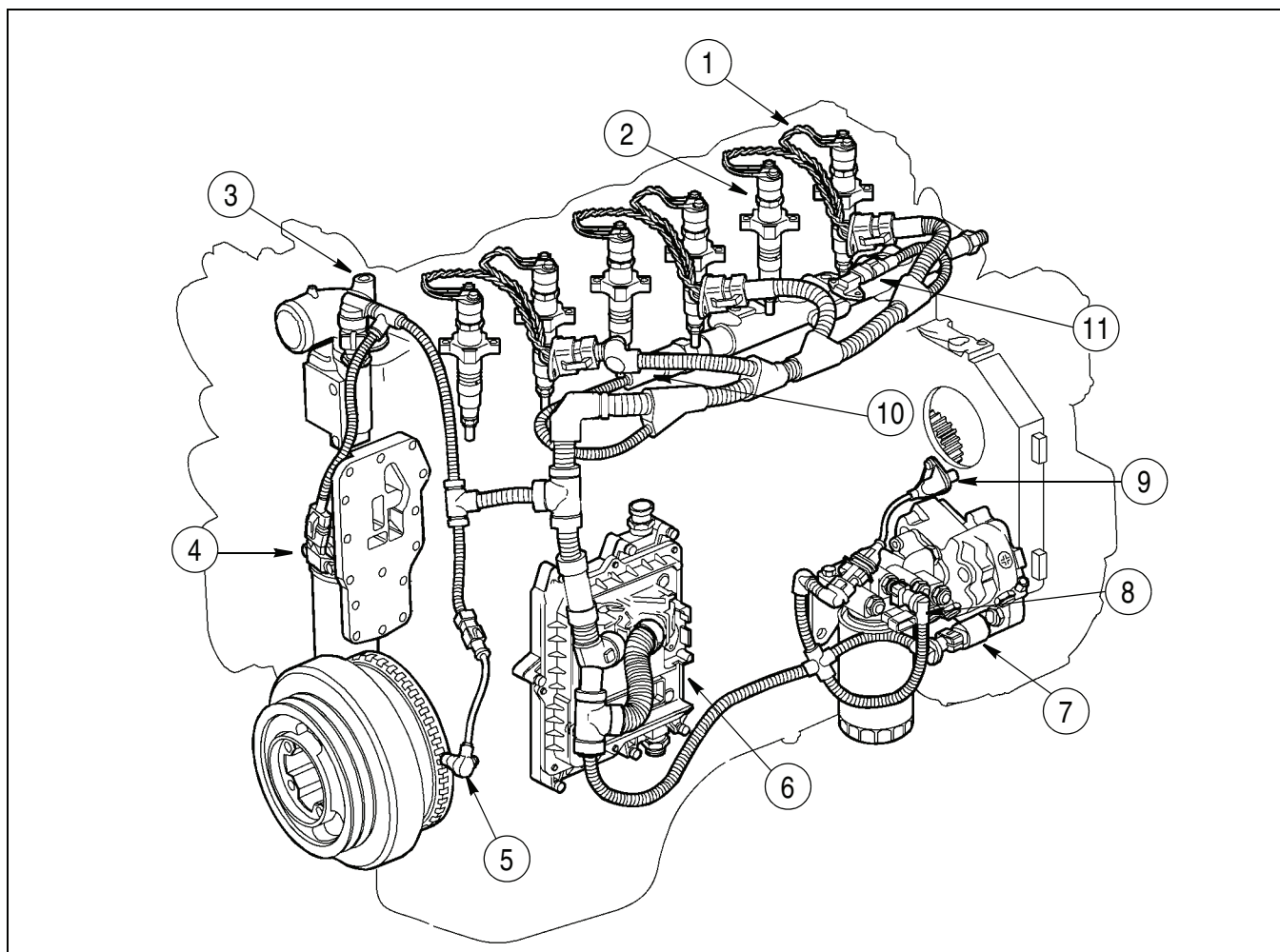
A. STROKE STARTS AT 96° C (204° F) $\geq$ 7.5MM (.30 IN).

Thermostat opening for engines:

667TA/EEG, EEC, EBF, EED, EBD= 79 to 83° C
(174 to 181° F).

667TA/EDJ= 83 to 98° C (181 to 208° F).

HIGH PRESSURE ELECTRONIC INJECTION SYSTEM (COMMON RAIL)



BS06K053

Figure 2-48

- | | | |
|-----------------------------------|---------------------------------|---------------------------------|
| 1. HARNESS TO INJECTORS | 5. CRANKSHAFT SENSOR | 9. CAMSHAFT SENSOR |
| 2. ELECTRO-INJECTOR | 6. EDC7UC31 CONTROL UNIT | 10. FUEL PRESSURE SENSOR |
| 3. COOLANT TEMP. SENSOR | 7. PRESSURE REGULATOR | 11. BOOST TEMP. PRESSURE SENSOR |
| 4. ENGINE OIL AND PRESSURE SENSOR | 8. FUEL HEATER AND TEMP. SENSOR | |

Extremely high injection pressures are necessary in order to reduce PARTICULAR emissions.

The common rail system makes it possible to inject fuel at pressures of up to 1450 - 1600 bar (21030 - 23206 psi), while the injection precision obtained by EDC7UC31 electronic control of the system serves to optimize operation of the engine while limiting emissions and fuel consumption.

For engines more powerful than 152 kW (203 hp.), the CRIN2 injectors have DLLA nozzles that work up to a pressure of 1600 bar (23206 psi), while engines less powerful than 152 kW (203 hp.) are fitted with DSLA nozzles which work with pressures up to 1450 bar (21030 psi.)

EDC7UC31 -ELECTRONIC CONTROL UNIT OPERATION

ENGINE PREHEATING ELEMENT CONTROL

Pre-post heating is activated when even just one of the water, air or fuel temperature sensors detects a temperature of less than 5° C (41° F).

PHASE RECOGNITION

Signals transmitted by the camshaft and crankshaft sensors determine the cylinder which fuel must be injected.

INJECTION CONTROL

Information transmitted by the sensors, the control unit determines and regulates pressure and modifies the pre-injection and main injection mode.

INJECTION PRESSURE CLOSED LOOP CONTROL

Engine load, determined by processing of data transmitted by the various sensors, and the control unit. Governs the regulator to maintain injection pressure at constant optimal values.

PILOT AND MAIN INJECTION ADVANCE CONTROL

Signals transmitted by various sensors to the control unit, determines the optimum injection point on the basis of internal mapping.

IDLE SPEED CONTROL

The control unit processes signals transmitted by the various sensors and adjusts the quantity of fuel injected.

It also controls the pressure regulator and modulates injection duration of the electro-injectors. Within specific limits, the control unit also monitors battery voltage.

OVERHEATING PROTECTION

If the water temperature reaches 110° C (230° F) the control unit reduces engine performance.

When the temperature returns below 100° C (212° F) the engine resumes normal operation. In some applications, the intake manifold temperature is the reference temperature.

MAXIMUM ENGINE SPEED LIMITING

Depending on the application, the control unit memory can contain appropriate engine speed limits. When the engine speed surpasses these limits, the control unit activates power reduction by controlling turn on time of the electro-injectors. In some applications, the maximum limiting response consists in stopping the engine.

CUT OFF

Fuel cut-off release is managed by the control unit with the following logical interventions:

- deactivation of the electro-injectors.
- reactivation of electro-injectors immediately prior to arrival at idle speed.
- control of fuel pressure regulator.

SMOKE CONTROL UNDER ACCELERATION

With intense load demands, signals received from the boost temperature pressure sensor and the crankshaft sensor, the control unit manages the pressure regulator and modulates the activation time of the electro-injectors to prevent the emission of smoke from the exhaust.

AFTER ENGINE SHUT DOWN

After the engine is stopped, the control unit microprocessor saves various parameters to the EEPROM memory, including the fault log so that they will be available the next time the engine is started.

CONTROL OF WORKING SPEED IN NORMAL OPERATING CONDITIONS

Each time work load varies, the control unit adjusts torque to maintain the engine in maximum power conditions. If the load causes a reduction in power, the control unit increases torque i.e. it increases the amount of fuel injected in order to restore the engine to maximum power.

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.

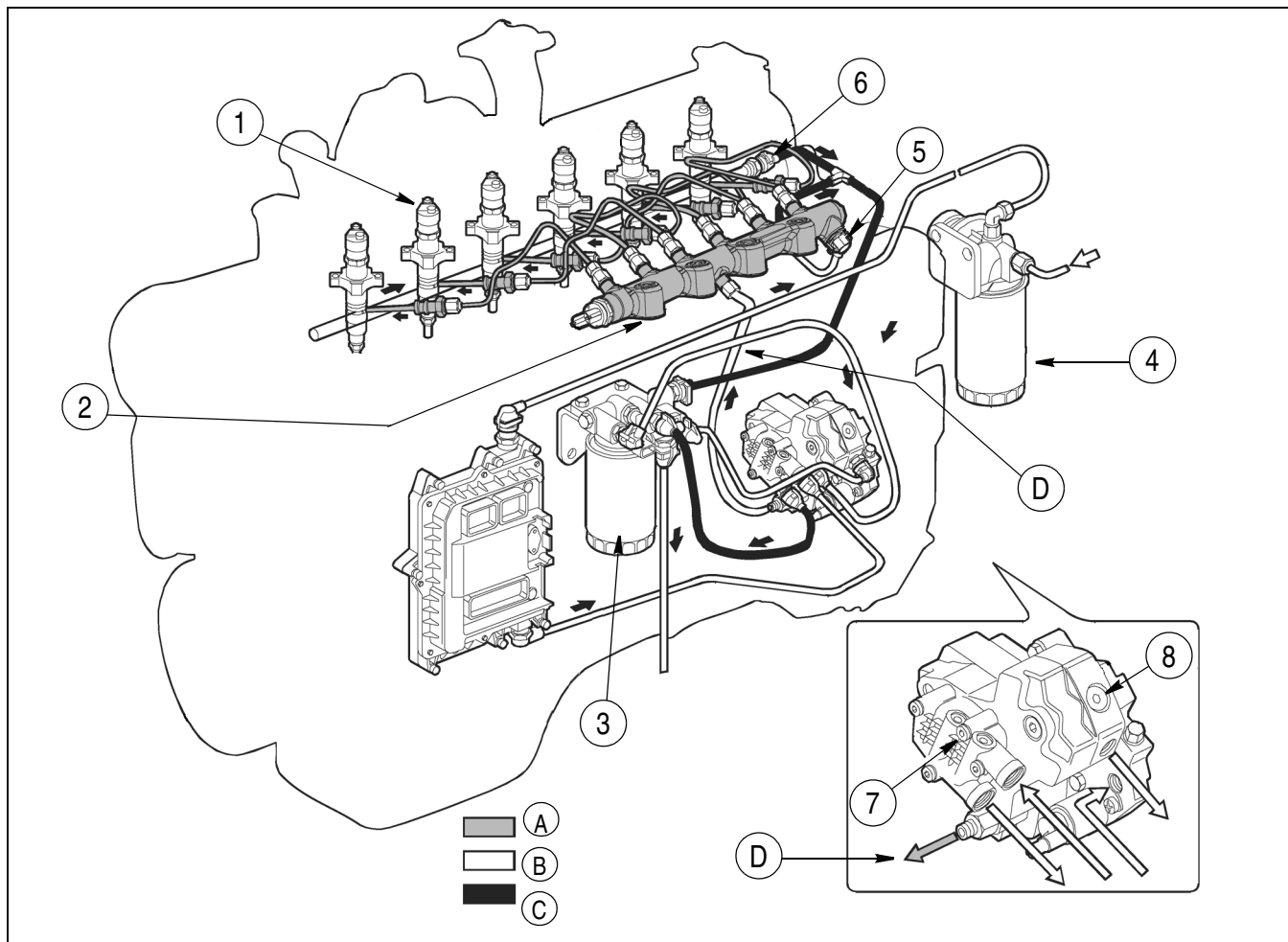
When the temperature of the supercharging air rises above 88° C (190° F), power reduction is started, when a temperature of 120° C (248° F) is reached, performance is further reduced and is comparable to that of the same engine if it were aspirated.

- 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%.

FUEL SUPPLY SYSTEM



BS06K054

Figure 2-49

- | | | | |
|---------------------|--|---------------------------------------|-------------------------------------|
| 1. ELECTRO-INJECTOR | 4. PRE-FILTER | 7. LOW PRESSURE GEAR TYPE CHARGE PUMP | B. LOW PRESSURE |
| 2. COMMON RAIL | 5. COMMON RAIL PRESSURE RELIEF VALVE | 8. HIGH PRESSURE PUMP | C. FUEL RETURN |
| 3. FUEL FILTER | 6. BACK PRESSURE REGULATOR FOR FUEL RETURN | A. HIGH PRESSURE | D. HIGH PRESSURE FROM PUMP TERMINAL |

The common rail system has a high pressure pump that constantly keeps the fuel supply at a very high pressure, not dependent on the phase of the cylinder that must receive the injection. The high pressure fuel is stored in a pipeline (the common rail) that is shared by all electro- injectors.

This means that there is always a supply of fuel available at the electro- injector inlet at the injection pressure determined by the EDC7UC31 electronic control unit.

When the solenoid valve of an electro- injector is energized by the EDC7UC31 electronic control unit, fuel taken directly from the common rail is injected into the corresponding cylinder.

The fuel system is composed of a low pressure circuit and a high pressure circuit.

The high pressure circuit consists of the following lines:

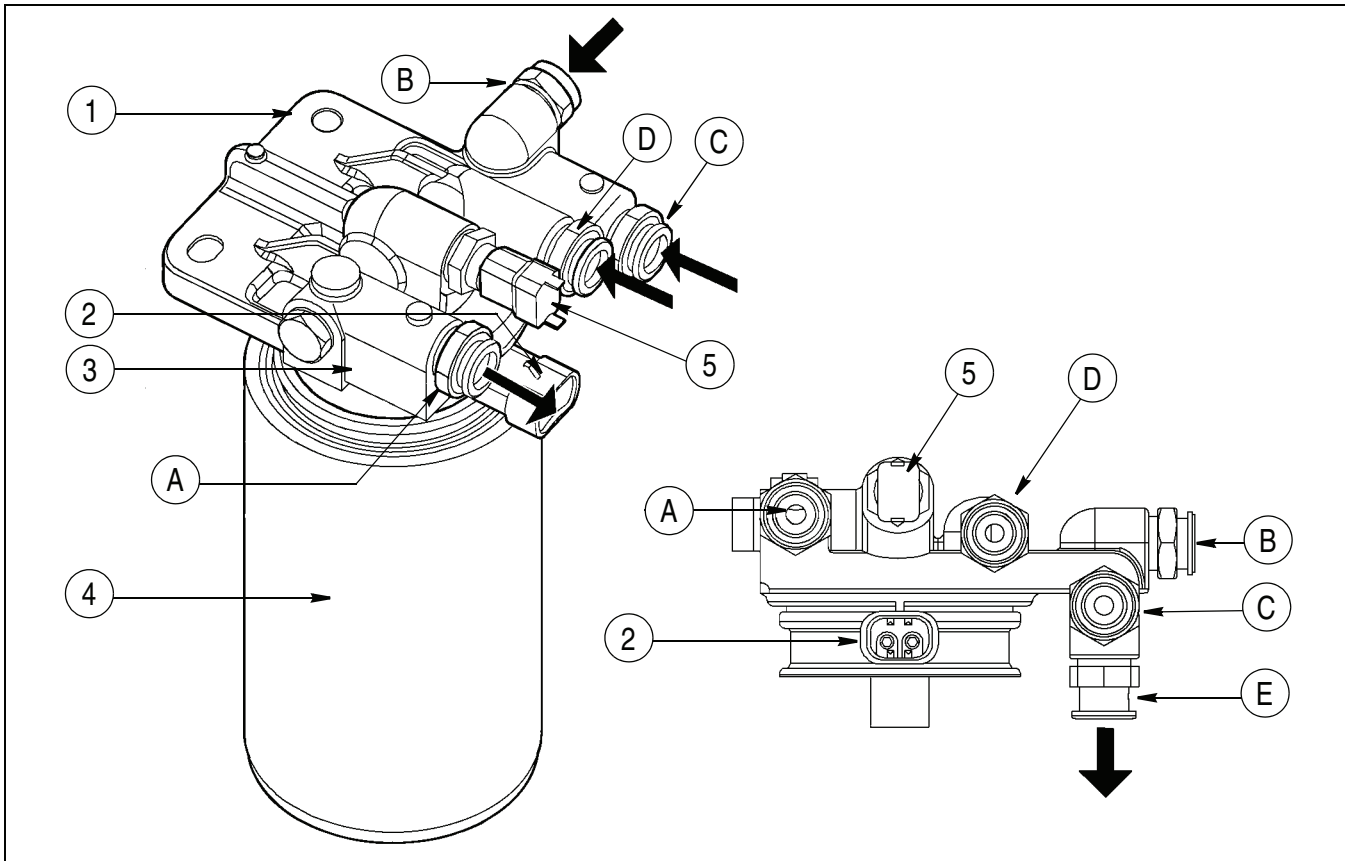
- Line connecting the high pressure pump outlet to the common rail.
- Lines supplying the electro-injectors from the common rail.

The low pressure circuit is composed of the following lines:

- Fuel line from fuel tank to prefilter.
- Lines supplying the mechanical supply pump through the heat exchanger of the control unit, the manual priming pump and the pre filter.

The fuel system is completed by the fuel return from the common rail, injectors and high pressure pump cooling circuit.

FUEL FILTER



BS06K056

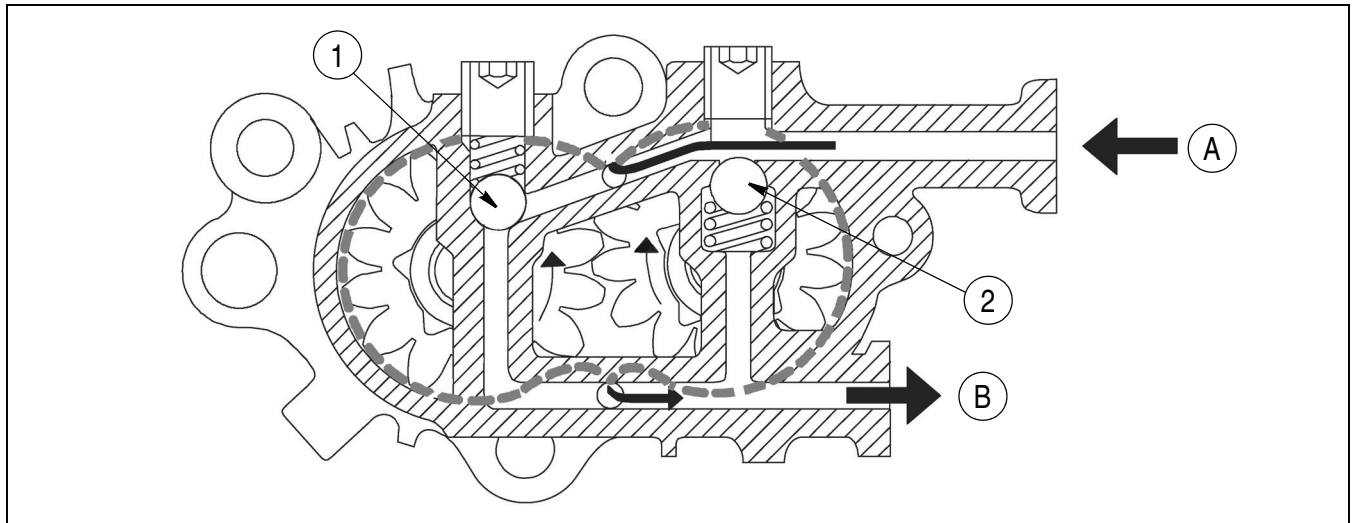
Figure 2-51

- | | |
|----------------------------|---|
| 1. FUEL FILTER BRACKET | A. OUTLET CONNECTION TO HIGH PRESSURE PUMP |
| 2. FUEL HEATER CONNECTOR | B. COMMON RAIL, CYLINDER HEAD INJECTORS DISCHARGE LINE INLET CONNECTION |
| 3. ELECTRIC FUEL HEATER | C. CONNECTION TO HIGH PRESSURE PUMP DISCHARGE LINE |
| 4. FUEL FILTER | D. INLET CONNECTION FROM FEED PUMP |
| 5. FUEL TEMPERATURE SENSOR | E. OUTLET CONNECTION TO FUEL TANK |

The fuel filter is installed on the engine cylinder block in the circuit between supply pump and high pressure pump (CP3).

The heater is activated if the fuel temperature is less than 0° C (32° F) and is heated until the fuel reaches 5° C (41° F). Fuel temperature is monitored by the EDC7UC31 control unit.

MECHANICAL SUPPLY PUMP- NORMAL OPERATING CONDITION



BS06K057

Figure 2-52

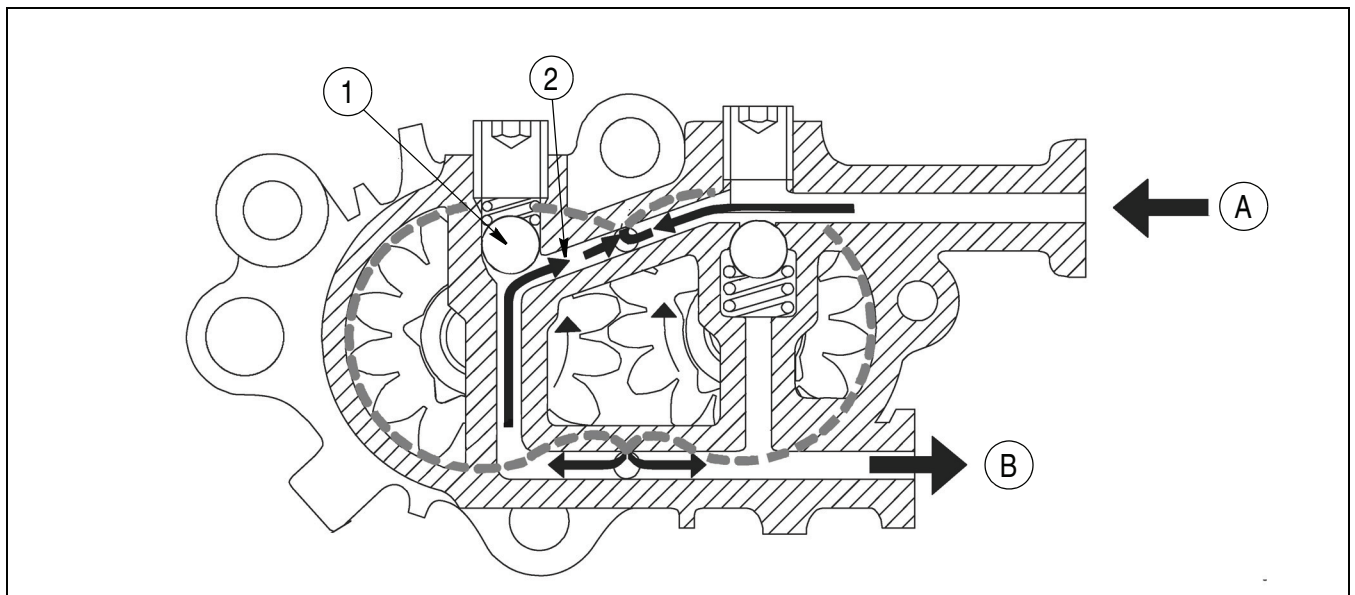
- | | |
|---|--------------------------|
| 1. PRESSURE SAFETY VALVE | A. FUEL INLET FROM TANK |
| 2. PRIMING BY-PASS VALVE IN CLOSED POSITION | B. FUEL OUTLET TO FILTER |

The charge gear pump, installed on the rear of the high pressure pump, draws fuel from the tank through the pre-filter and sends it through the main fuel filter to the high pressure pump.

The feed pump is driven by the high pressure pump shaft.

In normal operating conditions the flow in the feed pump enters port (A), flows around the outside of the gears and out through port (B).

MECHANICAL SUPPLY PUMP- OUTLET OVERPRESSURE CONDITION



BS06K058

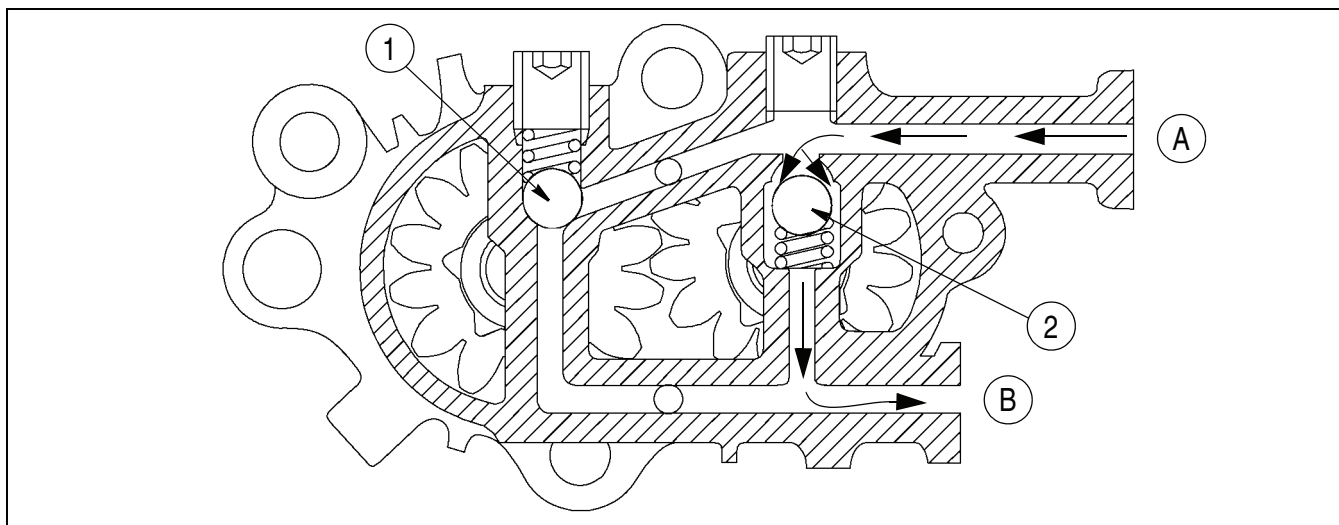
Figure 2-53

- | | |
|--------------------------|--------------------------|
| 1. PRESSURE SAFETY VALVE | A. FUEL INLET FROM TANK |
| 2. BY-PASS PORT | B. FUEL OUTLET TO FILTER |

Pressure safety valve (1) opens when pump outlet pressure (B), is excessive due to filter restriction or charge pressure regulator malfunction. The pressure of the fuel would then overcome the force exerted by

spring (1) allowing fuel to flow to the pump inlet through passage (2).

FUEL SYSTEM BLEEDING



BS06K059

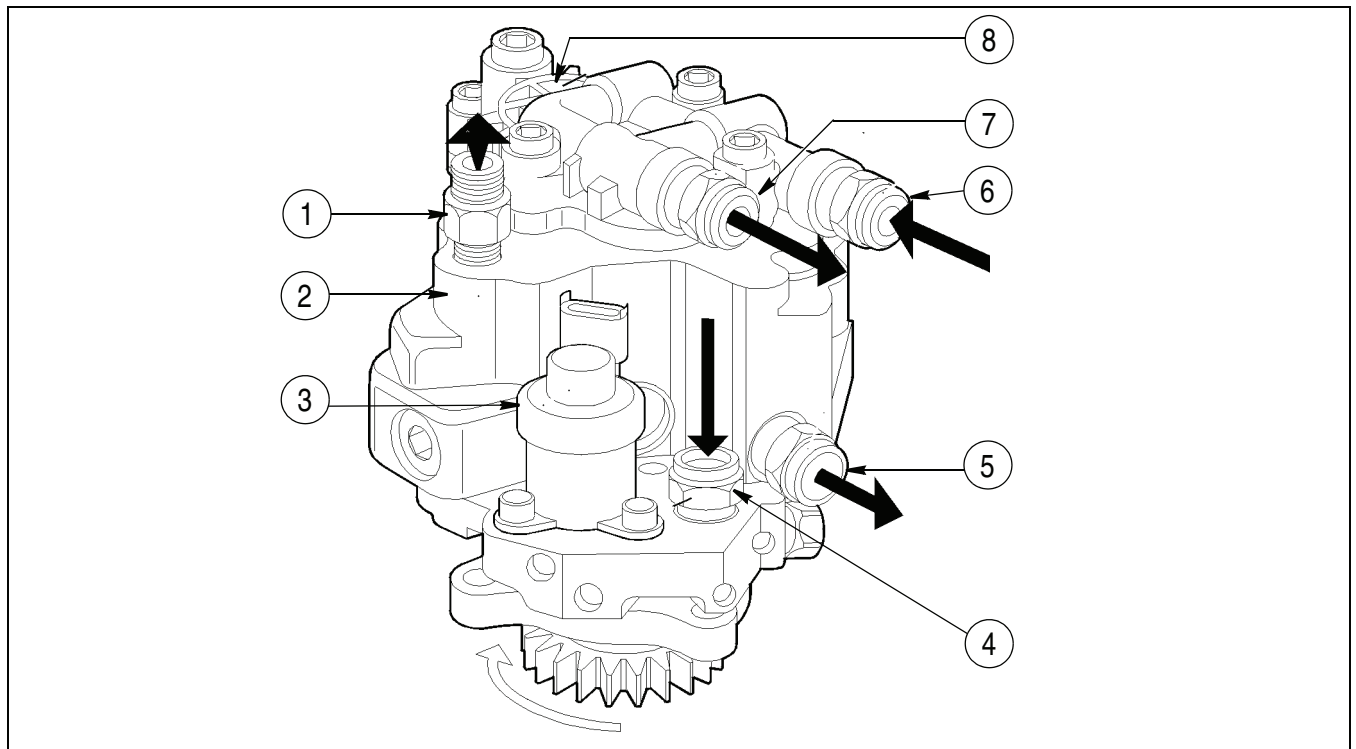
Figure 2-54

- | | |
|---|--------------------------|
| 1. PRESSURE SAFETY VALVE | A. FUEL INLET FROM TANK |
| 2. PRIMING BY-PASS VALVE IN CLOSED POSITION | B. FUEL OUTLET TO FILTER |

The by-pass valve (2) opens when, the engine is turned off. The supply system has to be filled with the manual priming pump.

When activating the hand pump the by-pass valve (2) is opened due to inlet pressure, this allows the fuel flow to outlet (B).

HIGH PRESSURE PUMP TYPE CP3.3



BS06K060

Figure 2-55

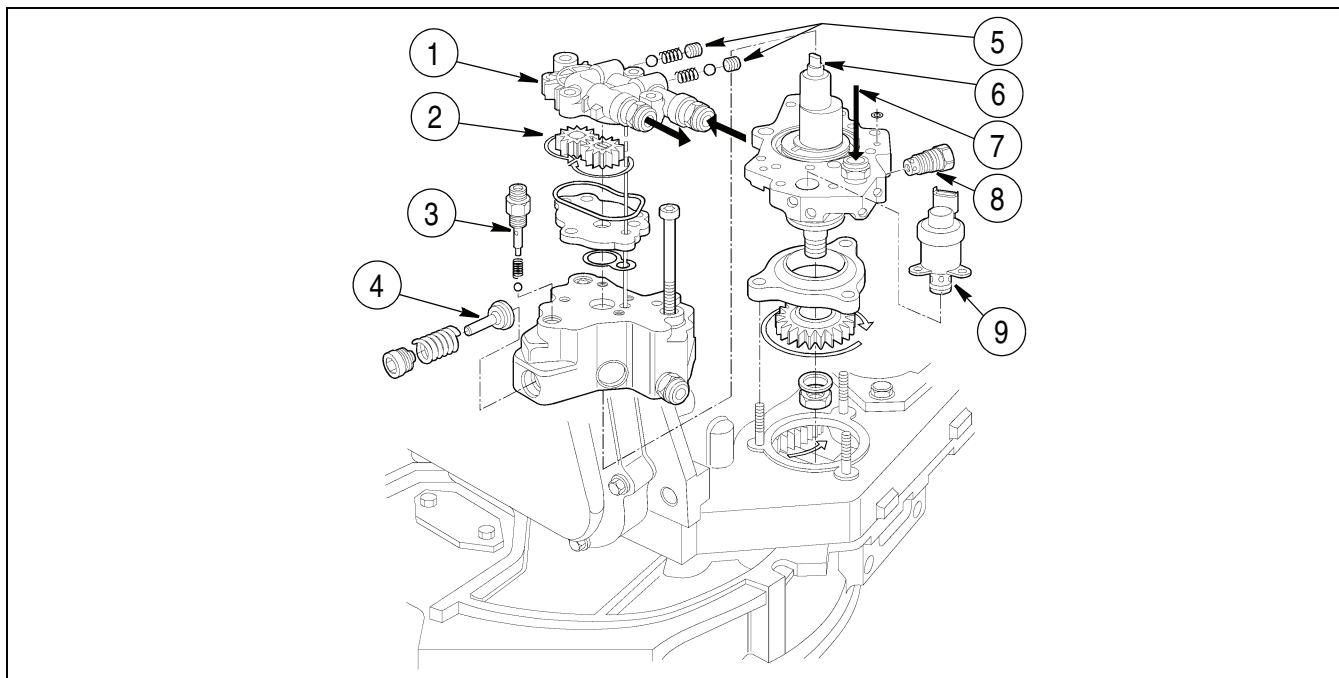
HIGH PRESSURE PUMP

1. FUEL OUTLET CONNECTION TO RAIL
2. HIGH PRESSURE PUMP
3. HIGH PRESSURE REGULATOR
4. FUEL INLET CONNECTION FROM FILTER
5. FUEL DRAIN RETURN CONNECTION TO FILTER BRACKET
6. FUEL INLET CONNECTION FROM CONTROL UNIT HEAT EXCHANGER
7. FUEL OUTLET CONNECTION FROM MECHANICAL PUMP TO FILTER
8. MECHANICAL GEAR CHARGE PUMP

The high pressure pump has 3 radial plungers driven by the cam gear. The pump does not need to be timed.

On the rear of the high pressure pump is the mechanical gear feed pump which is driven by the high pressure pump shaft.

IMPORTANT: *The high pressure pump unit can not be overhauled, there are no adjustments.*



BS06K061

Figure 2-56

EXPLODED VIEW OF HIGH PRESSURE PUMP

- | | | |
|---|---|---|
| 1. MECHANICAL GEAR CHARGE FEED PUMP | 4. INDIVIDUAL HIGH PRESSURE PUMP PLUNGER (1 OF 3) | 7. HIGH PRESSURE PUMP FUEL INLET FROM FILTER |
| 2. GEAR SET | 5. BY-PASS VALVES ON FEED PUMP | 8. 5 BAR (72 PSI) LOW PRESSURE FUEL REGULATOR VALVE |
| 3. HIGH PRESSURE FUEL DELIVERY VALVE TO COMMON RAIL | 6. PUMP SHAFT | 9. HIGH PRESSURE REGULATOR SOLENOID VALVE |

HIGH PRESSURE PUMP INSIDE STRUCTURE

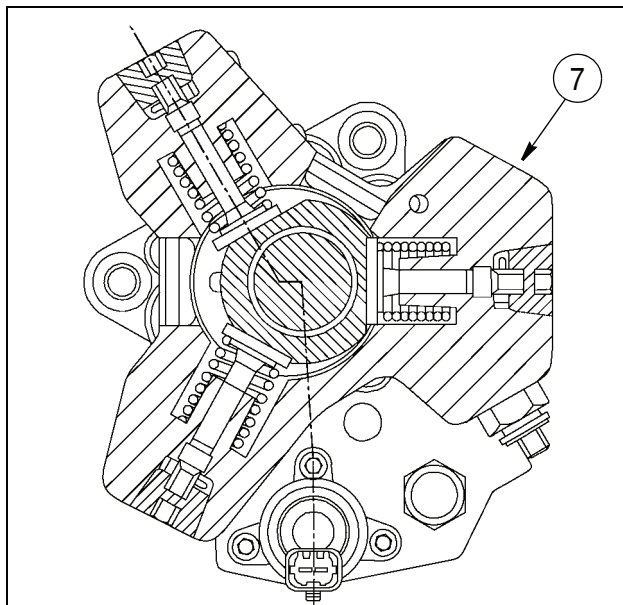


Figure 2-57

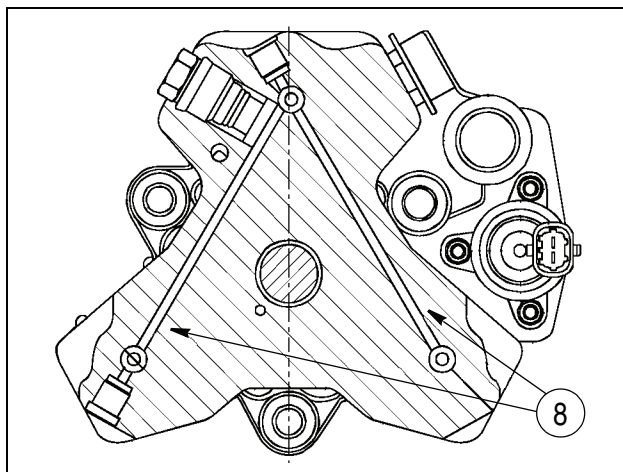


Figure 2-58

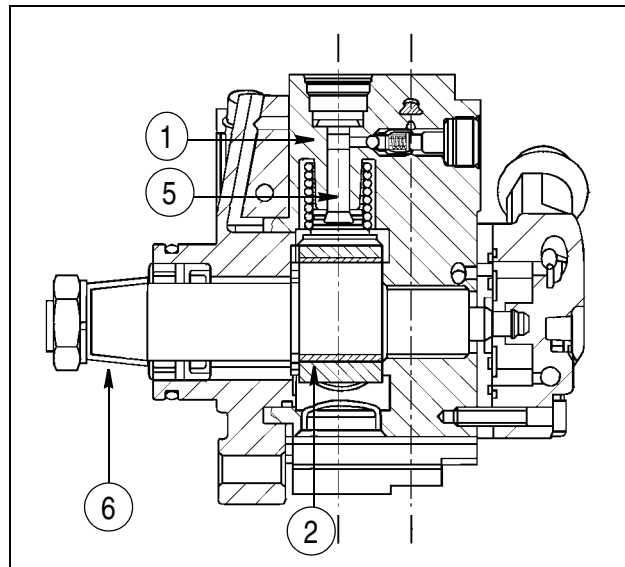


Figure 2-59

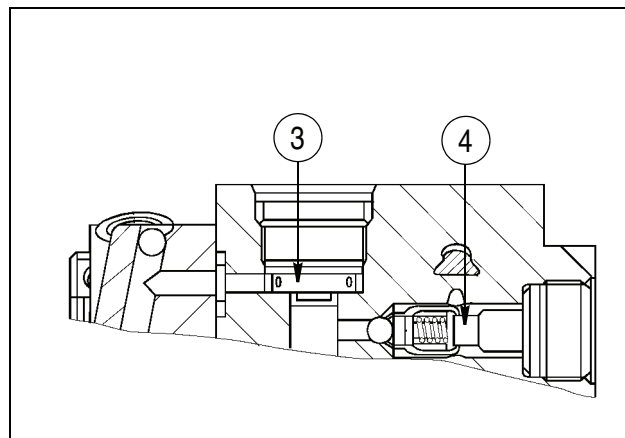


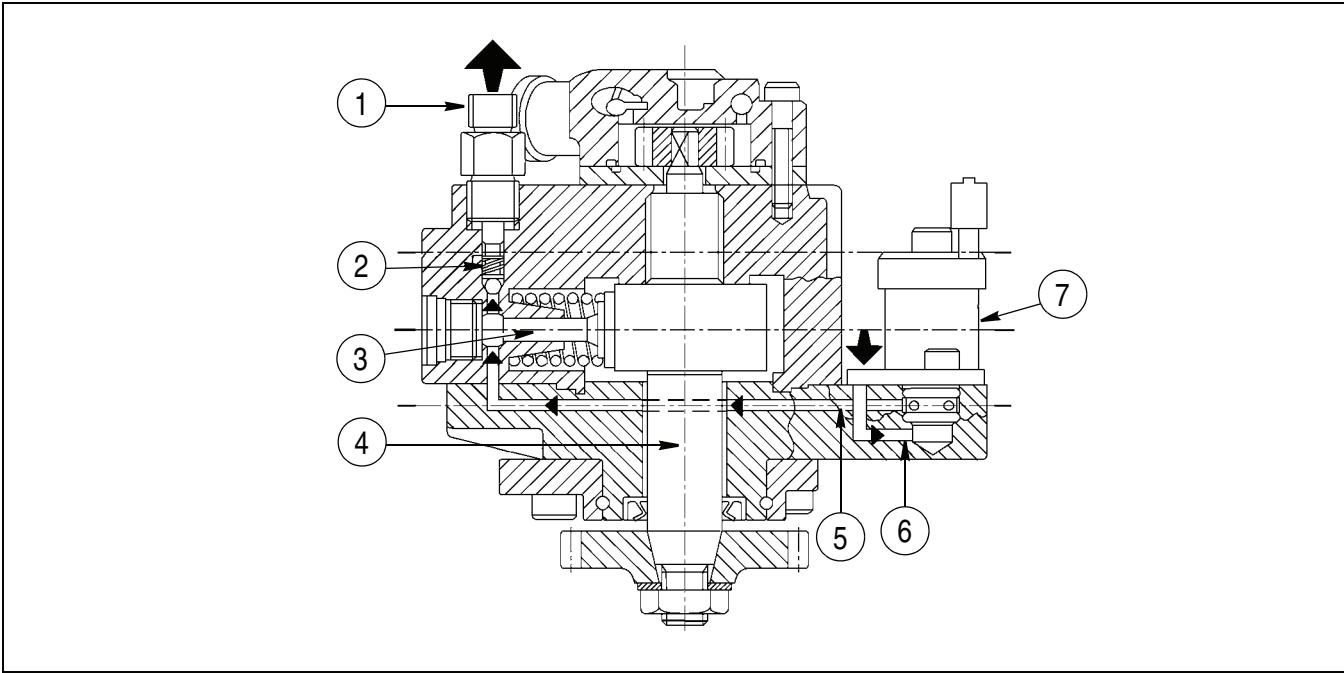
Figure 2-60

- | | |
|------------------------|--|
| 1. CYLINDER | 5. PISTON |
| 2. THREE LOBE ELEMENT | 6. PUMP SHAFT |
| 3. CAP INTAKE VALVE | 7. LOW PRESSURE FUEL INLET |
| 4. BALL DELIVERY VALVE | 8. PUMPING ELEMENTS SUPPLYING FUEL DUCTS |

Pumping unit is composed of:

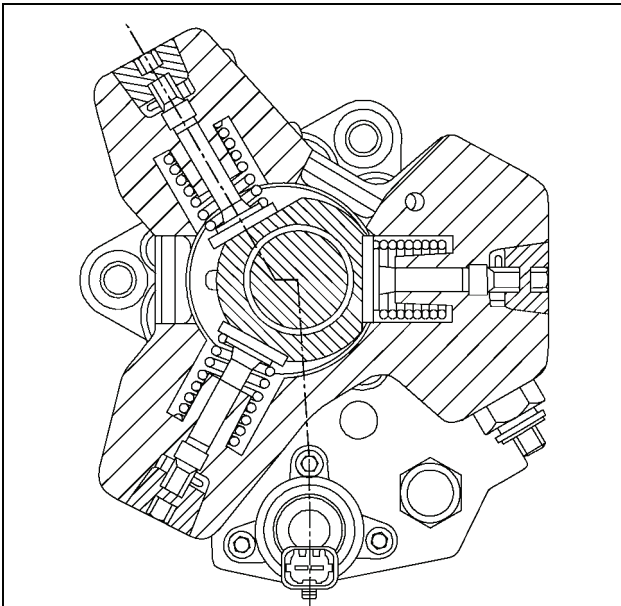
- Three pistons (5) which are actuated by a three lobe element (2) on the pump shaft (6). When the shaft (6) rotates, the three lobe element (2) actuates the piston (5), pumping high pressure fuel past the ball delivery valve (4) to the common rail.

OPERATING PRINCIPAL



BS06K063

Figure 2-61



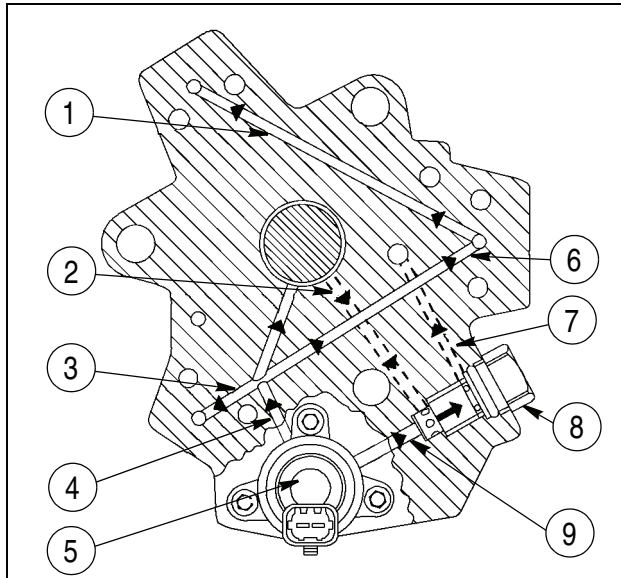
BS06K160

Figure 2-62

- | | | | |
|----------------------------------|--------------------------|--------------------------------------|----------------------------|
| 1. OUTLET FOR RAIL DELIVERY LINE | 3. HIGH PRESSURE PLUNGER | 5. PLUNGER SUPPLY PASSAGE | 7. HIGH PRESSURE REGULATOR |
| 2. RAIL DELIVERY VALVE | 4. PUMP SHAFT | 6. PRESSURE REGULATOR SUPPLY PASSAGE | |

High pressure plunger (3) rides on the cam installed on the pump shaft (4). In the intake phase the plunger is supplied with fuel through the supply passage (5). The quantity of fuel to supply to the plunger is determined by pressure regulator (7). The pressure regulator controls high pressure pump outlet flow based on PWM (pulse width modulated) command received from the EDC7UC31 control unit.

During the plunger compression phase the fuel reaches sufficient pressure to open the common rail delivery valve (2) and is forced through outlet (1) to the common rail.



BS06K064

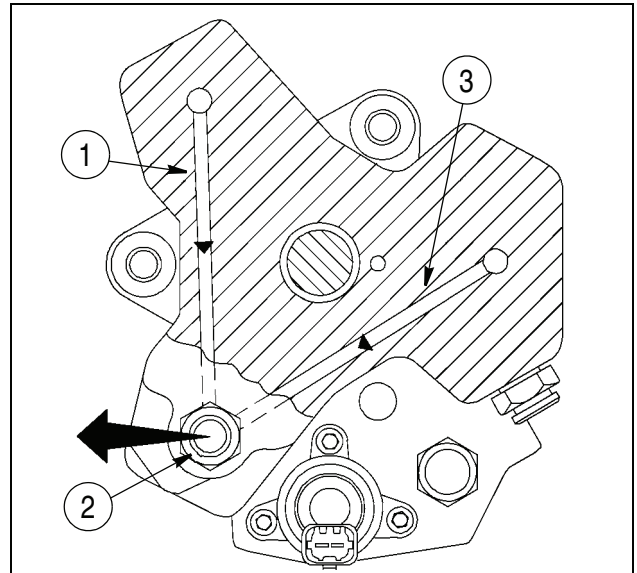
Figure 2-63

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

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

The high pressure regulator (5) determines the quantity of fuel which the high pressure plungers deliver to the common rail. Excess fuel flows out through passage (9).

The regulator valve (8), is designed to maintain a constant pressure of 5 bar (72 psi.) at the high pressure regulator inlet.



BS06K065

Figure 2-64

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

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.

When the pumping element chamber pressure becomes less than the supply pressure, the intake valve is again opened and the cycle is repeated.

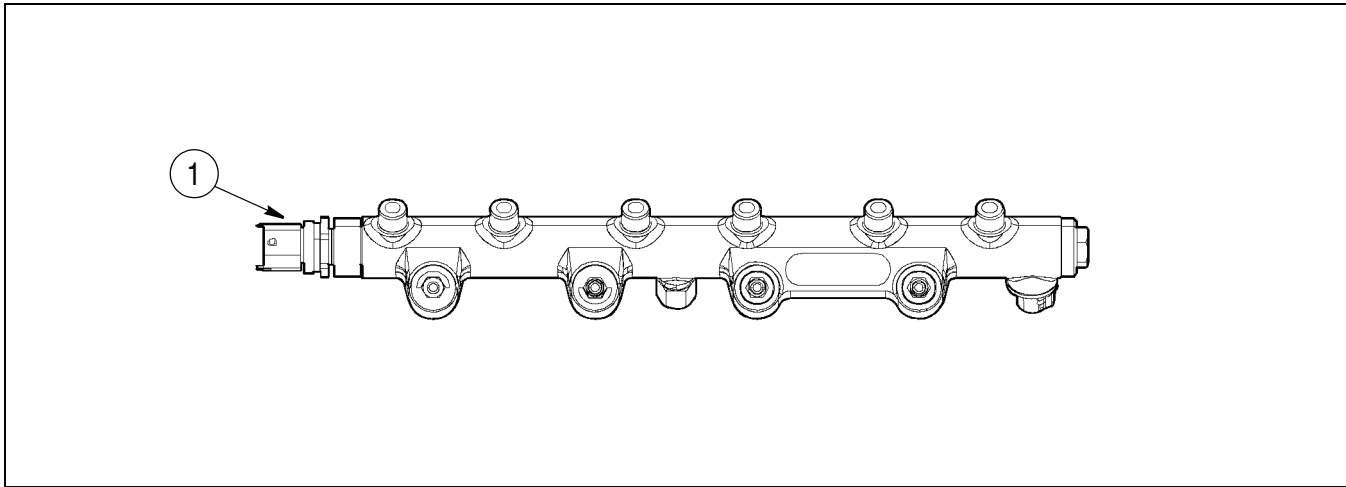
The rail delivery pressure is modulated between 250 and 1600 bars (3625 to 23206 psi.) by the EDC7UC31 control unit, through the pressure regulator solenoid valve.

The pump is lubricated and cooled by the fuel.

The pump replacement time on the engine is highly reduced in comparison with traditional injection pumps, because it does not require timing.

IMPORTANT: *If the line between the fuel filter and high pressure pump is to be removed or replaced, be sure that components are absolutely clean.*

COMMON RAIL



BS06K066

Figure 2-65

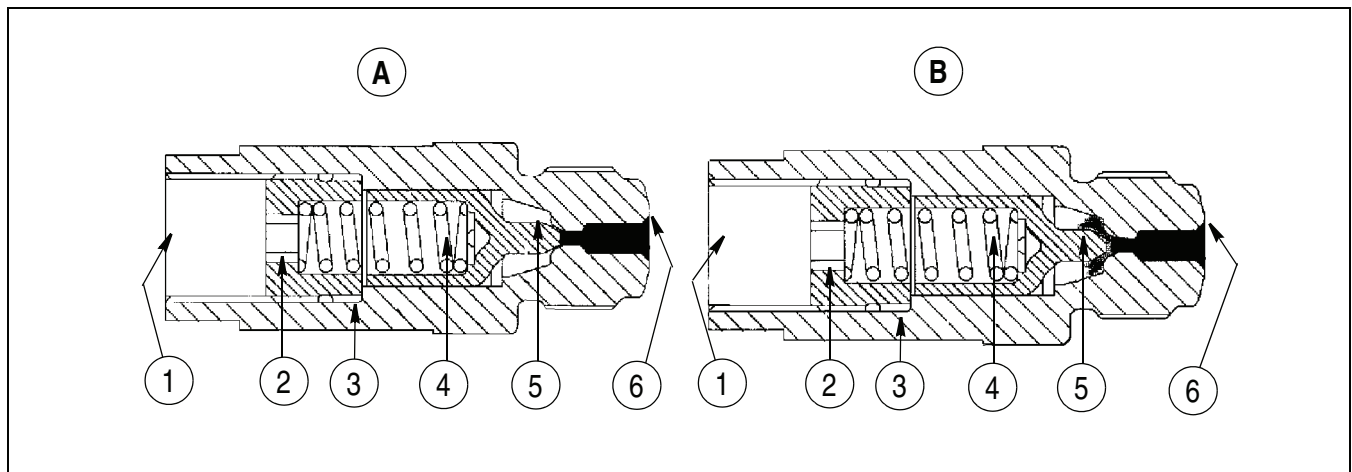
COMMON RAIL

The common rail volume is a high pressure fuel storage device. It has a small volume to allow a rapid pressurization at startup, at slow idle and in case of high flow rates.

It has enough volume to minimize system spikes caused by injector opening and closings and by the high pressure pump operation. This function is further enhanced by a calibrated orifice between the high pressure pump and the common rail.

A fuel rail pressure sensor (1) is screwed into the common rail. The signal sent by this sensor to the EDC7UC31 control unit, and is then feed back to the common rail pressure sensor and corrected if necessary.

COMMON RAIL PRESSURE RELIEF VALVE



BS06K067

Figure 2-66

COMMON RAIL PRESSURE RELIEF VALVE

- | | | |
|--------------------------|-----------|-----------------|
| 1. DIRECT TANK DISCHARGE | 3. BODY | 5. SMALL PISTON |
| 2. STOP | 4. SPRING | 6. SEAT ON RAIL |
- A. NORMALLY, THE TAPERED PISTON (5) END STAYS CLOSED THE DISCHARGE IS DIVERTED TO THE FUEL TANK.
- B. IF 1750 BAR FUEL PRESSURE IS EXCEEDED IN THE RAIL, THE SMALL PISTON MOVES AND THE EXCESS PRESSURE IS DISCHARGED INTO THE FUEL TANK.

The common rail pressure relief valve is installed at one end of the common rail, it is designed to protect the systems components in case of excessive increase of pressure buildup.

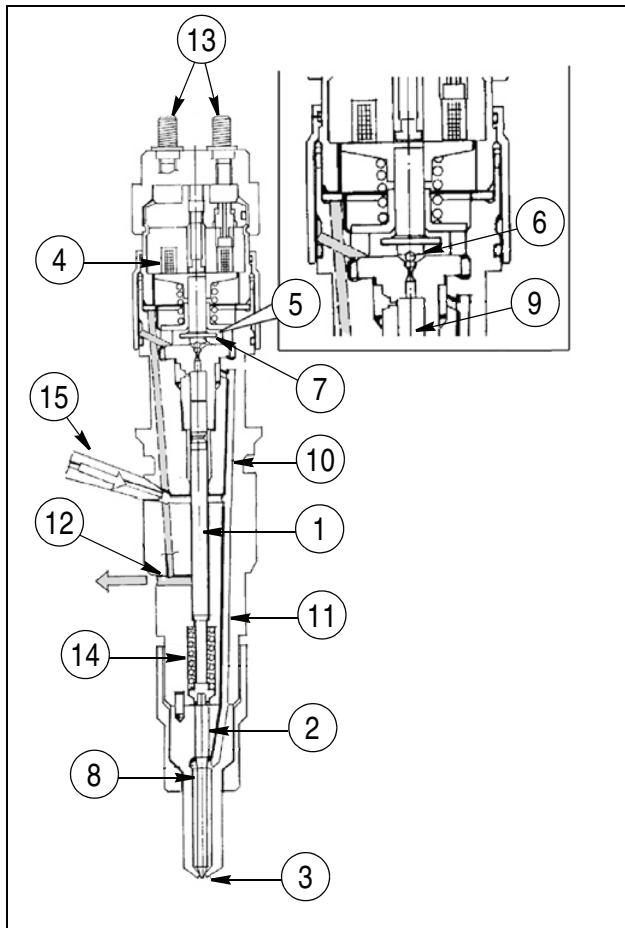
The valve can be single stage (as the ones shown above) or two stage with two working limits for pressure relief 1750 bar and 800 bar (25381 psi. and 11603 psi.).

In the second case, when the pressure within the high pressure system reaches 1750 bar (25381 psi.), the valve is activated as a single stage one to exhaust the fuel and consequently reduce the pressure until reaching the proper pressure. Then it reduces the pressure into the common rail to approximately 800 bar (11603 psi.).

The relief valve enables engine operation at limited performance, avoiding fuel overheating and safeguarding the system

If the dual stage relief valve opening pressure is reached, the EDC7UC31 control unit stops operation of the pressure regulator. The high pressure pump will then operate at maximum delivery to the common rail, and a failure code will be stored.

ELECTRO-INJECTOR



BS06K068

Figure 2-67

INJECTOR IN REST POSITION

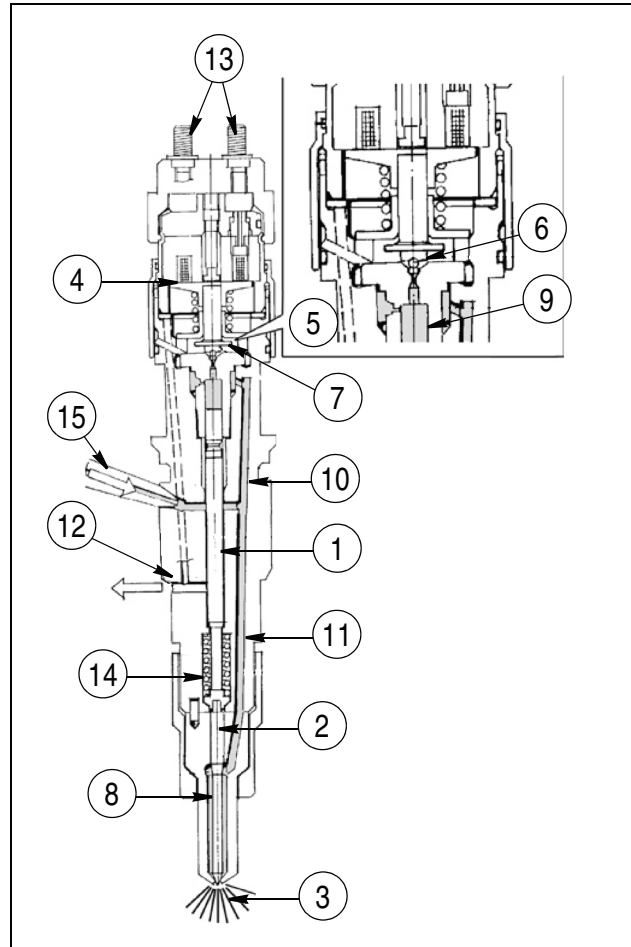
- | | |
|---------------------|------------------------------|
| 1. PRESSURE ROD | 9. CONTROL VOLUME |
| 2. PLUNGER | 10. CONTROL DUCT |
| 3. NOZZLE | 11. SUPPLY DUCT |
| 4. COIL | 12. CONTROL FUEL OUTLET |
| 5. PILOT VALVE | 13. ELECTRIC CONNECTION |
| 6. BALL SHUTTER | 14. SPRING |
| 7. CONTROL AREA | 15. HIGH PRESSURE FUEL INLET |
| 8. PRESSURE CHAMBER | |

The injector is similar to the conventional injectors, except for the absence of plunger return springs.

The injector can be considered in terms of two basic parts:

- Actuator- spray nozzle composed of pressure rod (1), plunger (2) and nozzle (3).
- Control solenoid valve composed of coil (4) and pilot valve (5).

The solenoid valve controls spray nozzle plunger lift.



BS06K069

Figure 2-68

INJECTION START

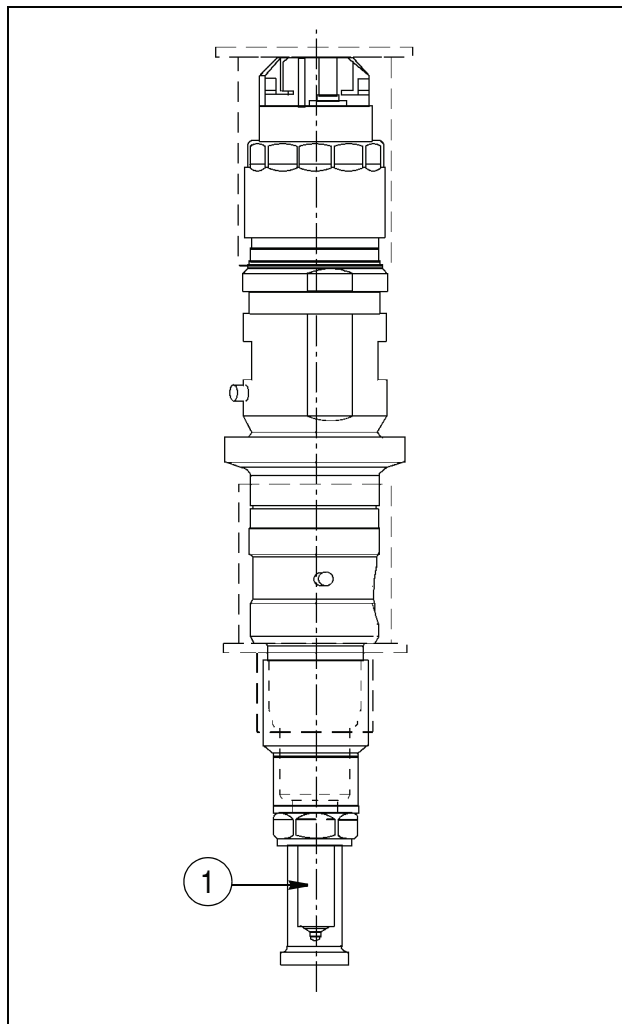
When coil (4) is energized, it makes ball shutter (6) move upwards. The control volume (9) fuel flows towards control fuel outlet (12) making a pressure drop occur in control volume (9). Simultaneously the fuel pressure into pressure chamber (8) makes plunger (2) lift, causing injection of fuel into the cylinder.

INJECTION END

When coil (4) is de-energized, shutter ball (6) goes back to its closed position to restore a balance of forces to make plunger (2) go back to its closed position and end the injection cycle.

IMPORTANT: The injector has no serviceable parts inside, so it is not repairable.

ELECTRO-INJECTOR



BS06K070

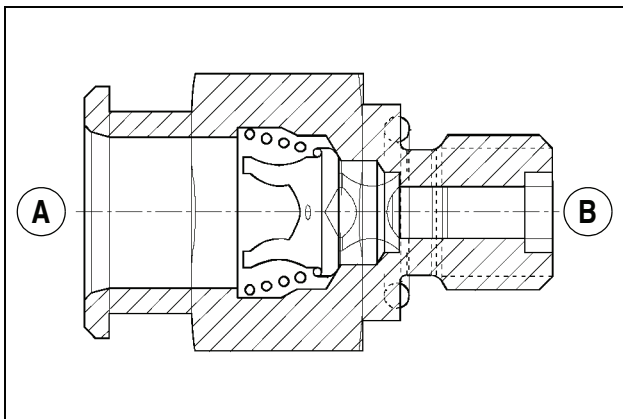
Figure 2-69

1. JET

The injectors are Bosch CRIN 1 and CRIN 2. The jets are installed according to power developed by the engine.

Injectors	Jet	Engines	Pressures	
			Minimal operating pressure	Nominal operating pressure
CRIN 1	not available	667TA/EEG - 667TA/EEC	not available	not available
CRIN 2	DLLA 137 PV 3	667TA/EBF - 667TA/EBD	250 bar (3626 psi.)	1600 bar (23206 psi.)
CRIN 2	DSL 143 PV 3	667TA/EED	250 bar (3626 psi.)	1400 bar (20305 psi.)
CRIN 2	not available	667TA/EDJ	250 bar (3626 psi.)	1400 bar (20305 psi.)

PRESSURE LIMITER FOR FUEL RETURN



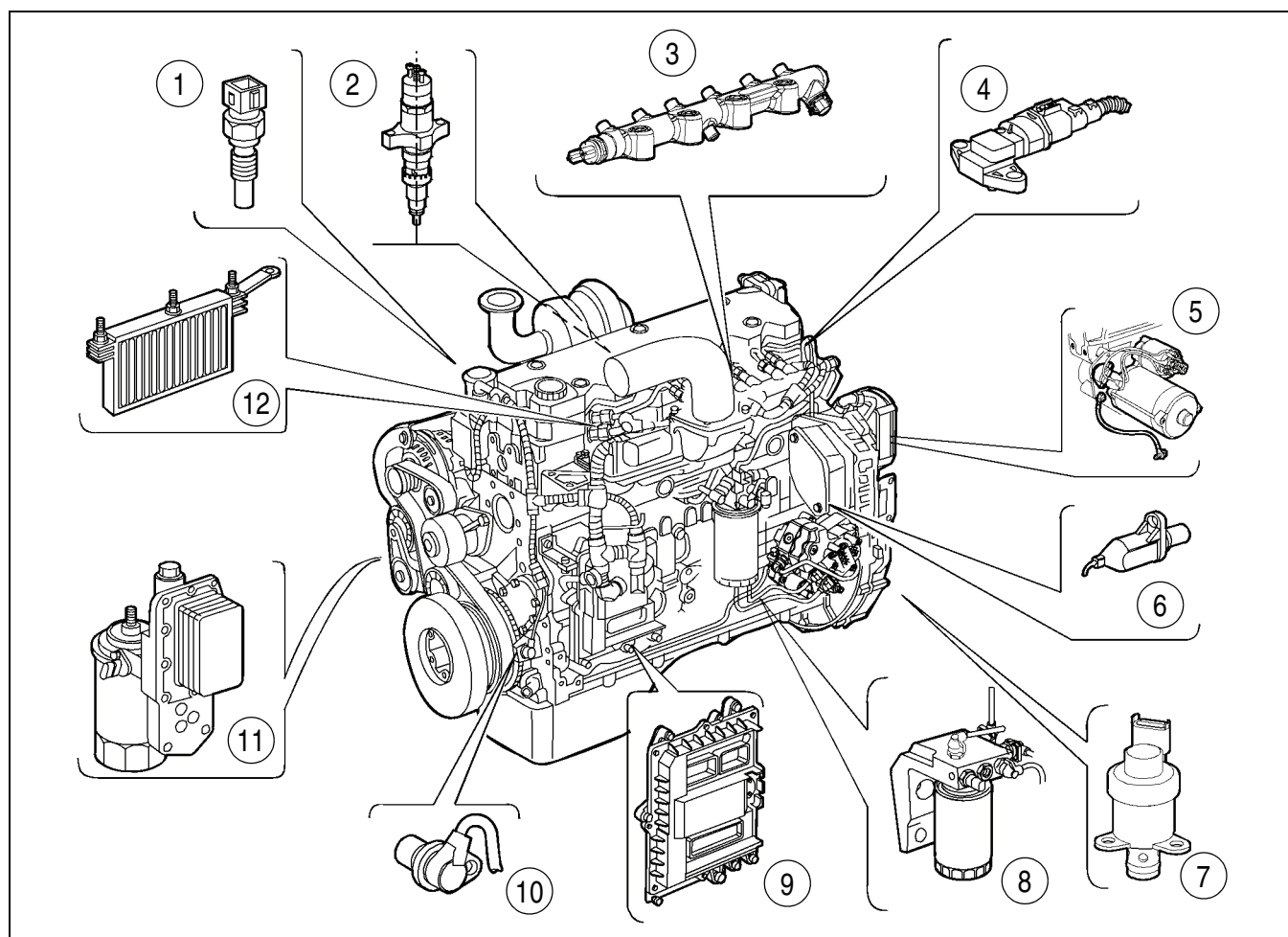
BS06K071

Figure 2-70

- A. TO FUEL TANK
- B. FROM INJECTORS

The pressure limiter for the fuel return is housed on the rear of the cylinder head, and adjusts the pressure of the fuel returning from injectors at a pressure of 1.3 to 2.0 bars (18.9 to 29 psi.). By maintaining this pressure to the return fuel, the fuel vapor formation inside the injectors is avoided, optimizing fuel spraying and combustion.

LOCATION OF THE MAIN ELECTRICAL COMPONENTS



BS06K072

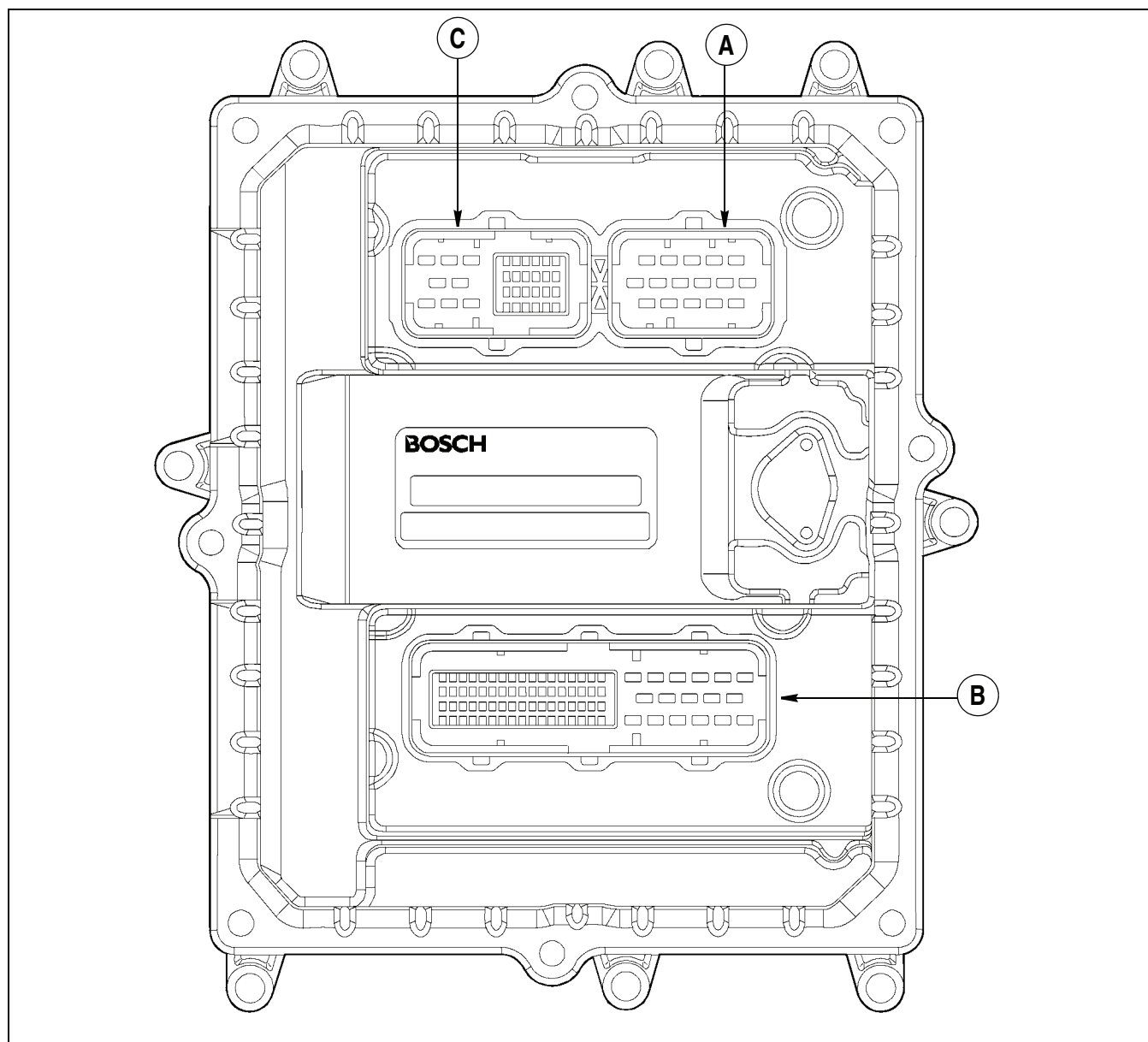
Figure 2-71

- | | |
|--------------------------------------|--|
| 1. COOLANT TEMPERATURE SENSOR | 7. SOLENOID VALVE FOR PRESSURE REGULATOR |
| 2. ELECTRO-INJECTOR | 8. FUEL TEMPERATURE SENSOR |
| 3. FUEL RAIL PRESSURE SENSOR | 9. EDC7UC31 ELECTRONIC CONTROL UNIT |
| 4. BOOST TEMPERATURE/PRESSURE SENSOR | 10. CRANKSHAFT SENSOR |
| 5. STARTER MOTOR | 11. ENGINE OIL PRESSURE/TEMPERATURE SENSOR |
| 6. CAMSHAFT SENSOR | 12. HEATING ELEMENT FOR PRE-POST HEATING |

The engine is controlled by the EDC7UC31 electronic control module. The control module is installed on flexible mounts to reduce vibration transmitted by the engine. The fuel heat exchanger removes heat from the controller due to the high voltages needed for firing the injectors. It removes the heat from the controller and loses it in the fuel cooler. It also picks up some engine heat when it is returned from the cylinder head. The unit is supplied with a 20 amp fuse. The main relay used to supply the power to the system is located inside the control unit.

Through the engine control module, it is possible to verify the correct operations of the engine and also help troubleshoot problems with error codes generated from the EDC7UC31 control module.

EDC7UC31 ELECTRONIC CONTROL UNIT



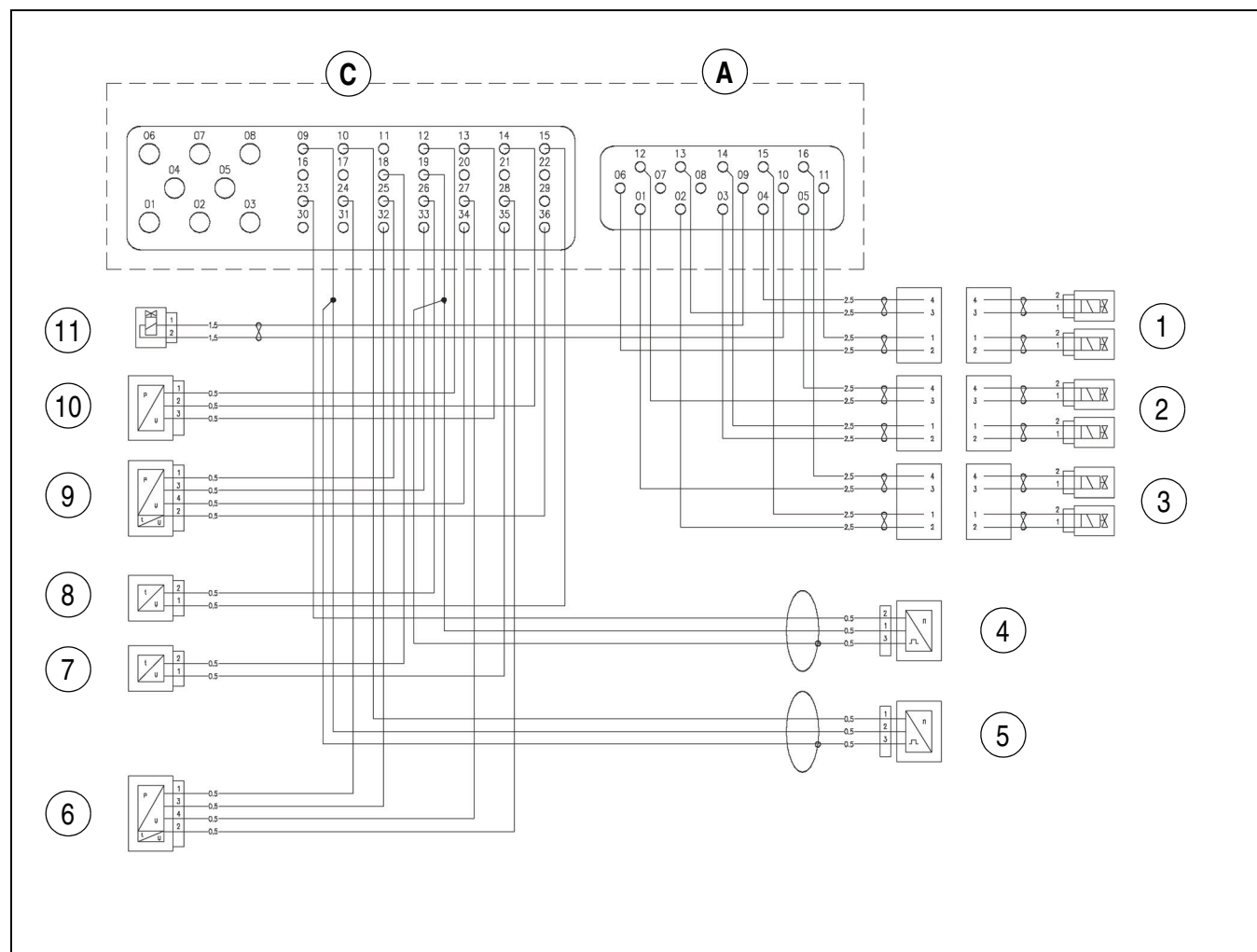
BS06K073

Figure 2-72

EDC7UC31 ELECTRONIC CONTROL UNIT

- A. CONNECTOR TO INJECTORS
- B. CONNECTOR FOR POWER INPUT AND FUNCTIONS PROVIDED FOR IN THE APPLICATION
- C. CONNECTOR TO SENSORS

CABLING CONNECTOR PINOUT ON ENGINE



BS06K074

Figure 2-73

CONNECTOR / CABLING DIAGRAM

- | | |
|---|--|
| A. CONNECTOR A (INJECTORS) EDC7UC31 ECU (POWER) | 5. CAMSHAFT SENSOR |
| B. CONNECTOR B NOT SHOWN (SEE NOTE BELOW) | 6. OIL PRESSURE AND TEMPERATURE SENSOR |
| C. CONNECTOR C (SENSORS) EDC7UC31 ECU (SIGNAL) | 7. FUEL TEMPERATURE |
| 1. INJECTORS FOR CYLINDERS 1-2 | 8. COOLANT TEMPERATURE SENSOR |
| 2. INJECTORS FOR CYLINDERS 3-4 | 9. BOOST AIR TEMPERATURE AND PRESSURE SENSOR |
| 3. INJECTORS FOR CYLINDERS 5-6 | 10. COMMON RAIL PRESSURE SENSOR |
| 4. CRANKSHAFT SENSOR | 11. FUEL HIGH PRESSURE REGULATOR SENSOR |

NOTE: Connector B is not shown because it is specific to the machine application see the particular machine schematic.

CONNECTOR (A) INJECTORS PINOUT DIAGRAM

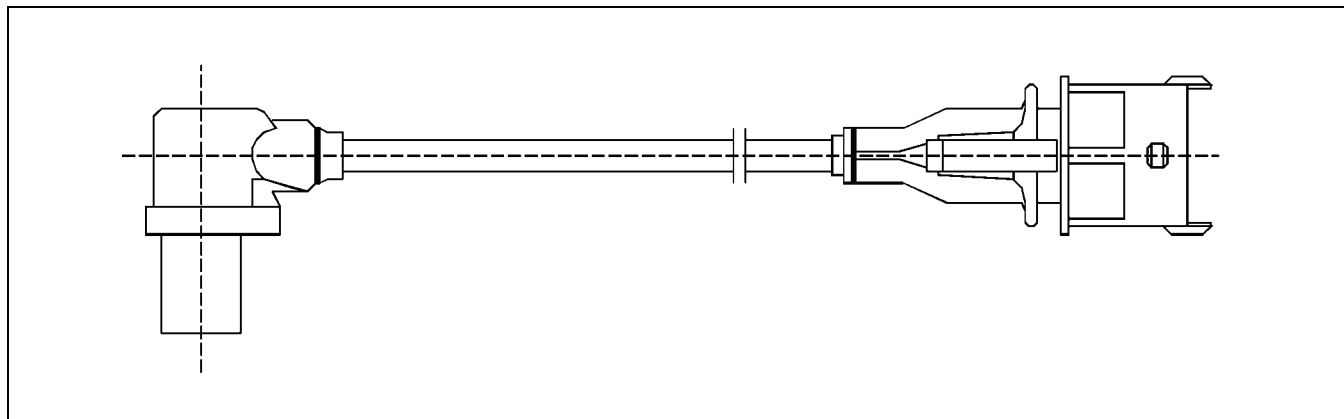
EDC7UC31 ECU PIN	FUNCTION
1.	Cylinder 5 injector
2.	Cylinder 6 injector
3.	Cylinder 4 injector
4.	Cylinder 1 injector
5.	Cylinder 3 injector
6.	Cylinder 2 injector
7.	not used
8.	not used
9.	High pressure regulator with fuel metering
10.	High pressure regulator with fuel metering
11.	Cylinder 2 injector
12.	Cylinder 3 injector
13.	Cylinder 1 injector
14.	Cylinder 4 injector
15.	Cylinder 6 injector
16.	Cylinder 5 injector

NOTE: Connector B is not shown because it is specific to the machine application see the particular machine schematic.

CONNECTOR (C) SENSORS PINOUT DIAGRAM

EDC7UC31 ECU PIN	FUNCTION
1.	Not Used
2.	Not Used
3.	Not Used
4.	Not Used
5.	Not Used
6.	Not Used
7.	Not Used
8.	Not Used
9.	Camshaft speed sensor - Signal
10.	Camshaft speed sensor - Ground
11.	Not Used
12.	Common rail temperature and pressure sensor - Ground
13.	Common rail temperature and pressure sensor - Positive
14.	Common rail temperature and pressure sensor - Signal
15.	Coolant temperature sensor - Signal
16.	Not Used
17.	Not Used
18.	Fuel temperature sensor - Signal
19.	Crankshaft speed sensor - Ground
20.	Not Used
21.	Not Used
22.	Not Used
23.	Crankshaft speed sensor - Signal
24.	Engine oil pressure and temperature sensor - Ground
25.	Boost intake pressure sensor - Ground
26.	Coolant temperature sensor - Ground
27.	Oil pressure sensor - Signal
28.	Oil temperature sensor - Signal
29.	Not Used
30.	Not Used
31.	Not Used
32.	Engine oil pressure and temperature sensor - Positive
33.	Boost intake pressure sensor - Positive
34.	Boost intake pressure sensor - Signal
35.	Fuel temperature sensor - Signal
36.	Boost intake temperature sensor - Signal

CRANKSHAFT SENSOR



BS06K075

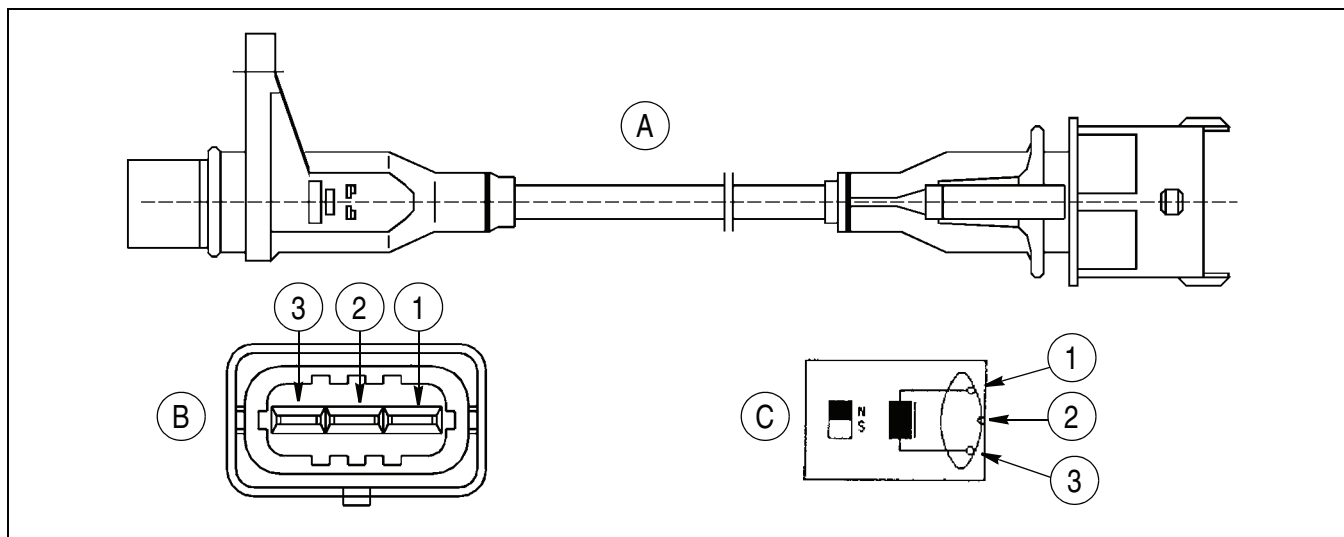
Figure 2-74

CRANKSHAFT SENSOR

The crankshaft sensor is an inductive sensor located at the front left hand side of the engine. The crankshaft sensor produces signals obtained from magnetic flux field through the openings in a phonic wheel fitted on the crankshaft.

The crankshaft sensor is connected to the EDC -7 control unit on pins 19C - 23C. The sensor impedance is approximately 900 ohms.

CAMSHAFT SENSOR



BS06K076

Figure 2-75

A. CAMSHAFT SENSOR

B. CONNECTOR

C. WIRING DIAGRAM

Reference	Description	EDC7UC31 ECU	
		Camshaft sensor	Timing sensor
1	Signal	19C	10C
2	Signal	23C	9C
3	Shield		

BOOST TEMPERATURE - PRESSURE SENSOR

This component incorporates a temperature sensor and a pressure sensor all in one unit.

Installed on the intake manifold, the sensor measures the temperature and boost pressure, which serves to make an accurate calculation of the quantity of fuel to be injected in each cycle.

The sensor is connected to the EDC7UC31 electronic control unit on pins 25C - 36C - 33C - 34C.

The sensor is supplied with 5 volts.

Voltage at the sensor output is proportional to the detected pressure or temperature.

- Pin 25C - 36C Temperature
- Pin 33C - 34C Pressure

ENGINE OIL TEMPERATURE - PRESSURE SENSOR

This component incorporates a temperature sensor and a pressure sensor all in one unit.

The engine oil temperature-pressure sensor is installed on the engine oil filter bracket in a vertical position. This sensor measures the engine oil temperature and pressure.

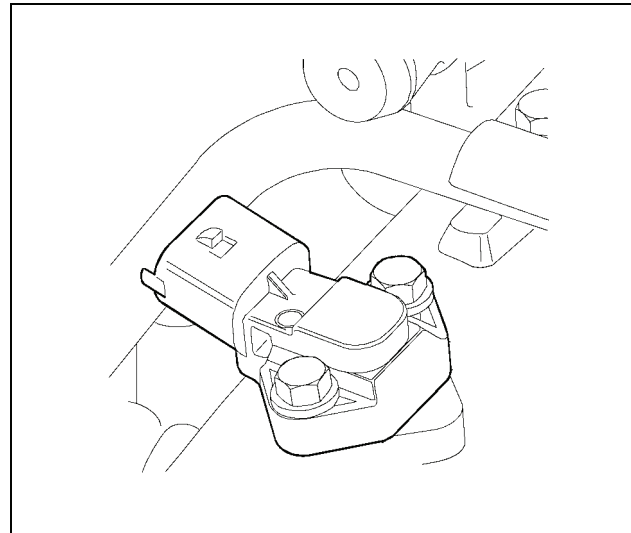
The sensor is connected to the EDC7UC31 electronic control unit on pins 24C - 28C - 32C - 27C.

The sensor is supplied with 5 volts. The pressure signal is transmitted to the EDC7UC31 electronic control unit which in turn, sends a signal to the instrument panel gauge and low pressure warning light.

The oil temperature is not displayed on any gauges this value is used exclusively by the control unit.

Pin 24C - 28C Temperature

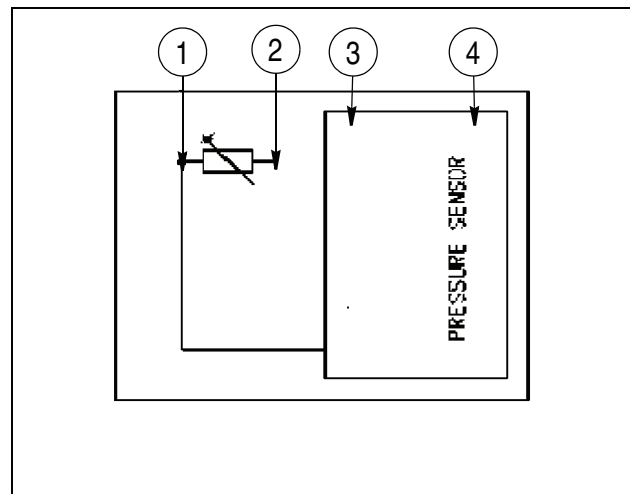
Pin 32C - 27C Pressure



BS06K077

Figure 2-76

PRESSURE - TEMPERATURE SENSOR

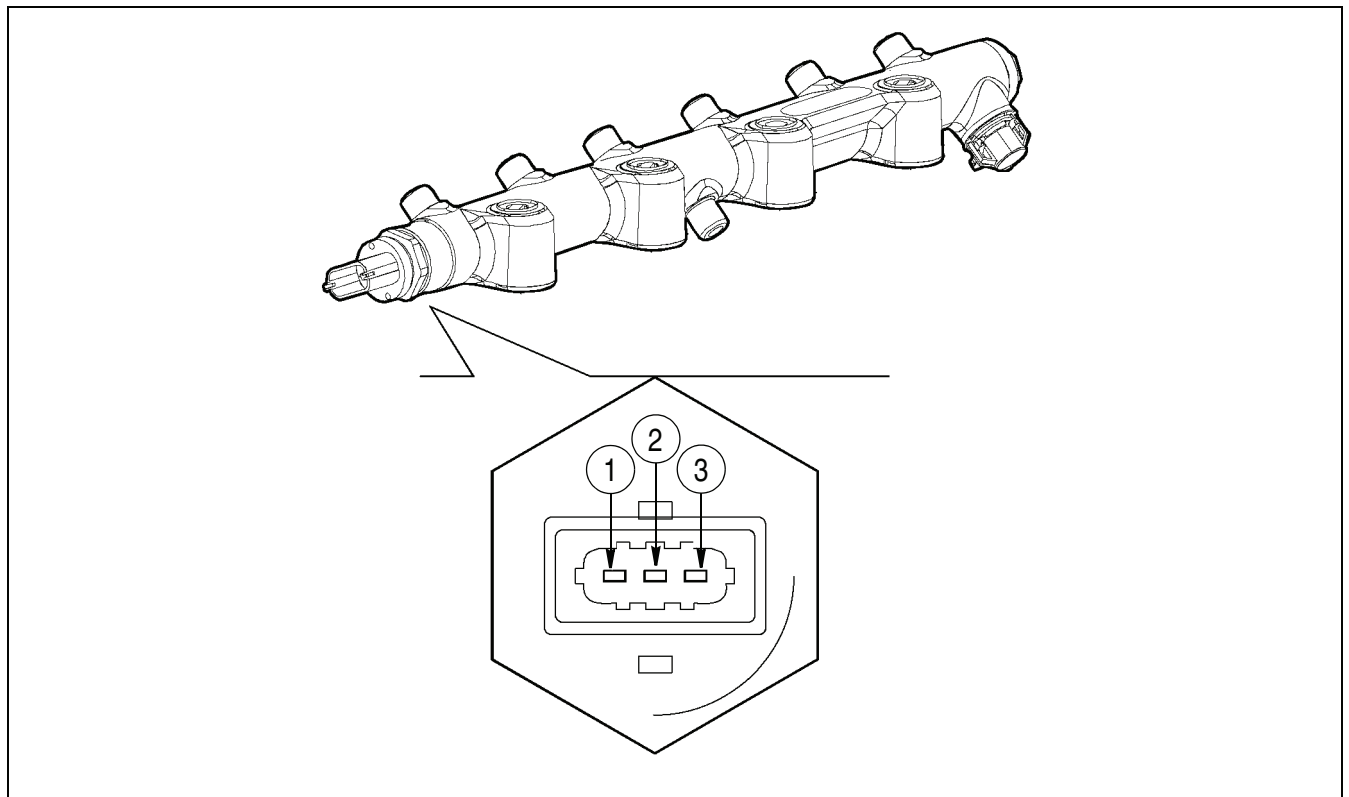


BS06K078

Figure 2-77

Reference	Description	EDC7UC31 Control unit pin number	
		Oil	Air
1	Ground	24C	25C
2	EDC7UC31 control unit- Signal (temperature)	28C	36C
3	+5 volt power supplied to sensor	32C	33C
4	Signal (pressure)	27C	34C

COMMON RAIL FUEL PRESSURE SENSOR



BS06K079

Figure 2-78

COMMON RAIL FUEL PRESSURE SENSOR CONNECTOR

Reference	Description	EDC7UC31 control unit pin
1	Ground	12C
2	Signal	14C
3	Power supply	13C

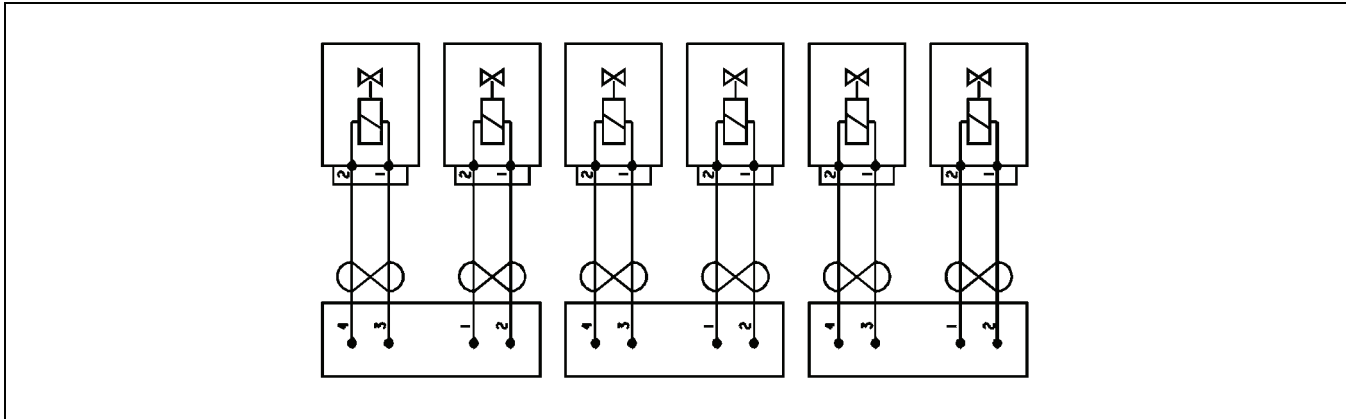
The fuel rail pressure sensor is installed on one end of the common rail, this sensor measures the internal fuel pressure and feeds back this information to the EDC7UC31 control unit.

The injection pressure value is used as a pressure control feedback signal and to determine the duration of the electrical pulse for the injection command.

This sensor is connected to the EDC7UC31 control unit on pins 12C - 14C - 13C.

The power supplied to sensor is 5 volts.

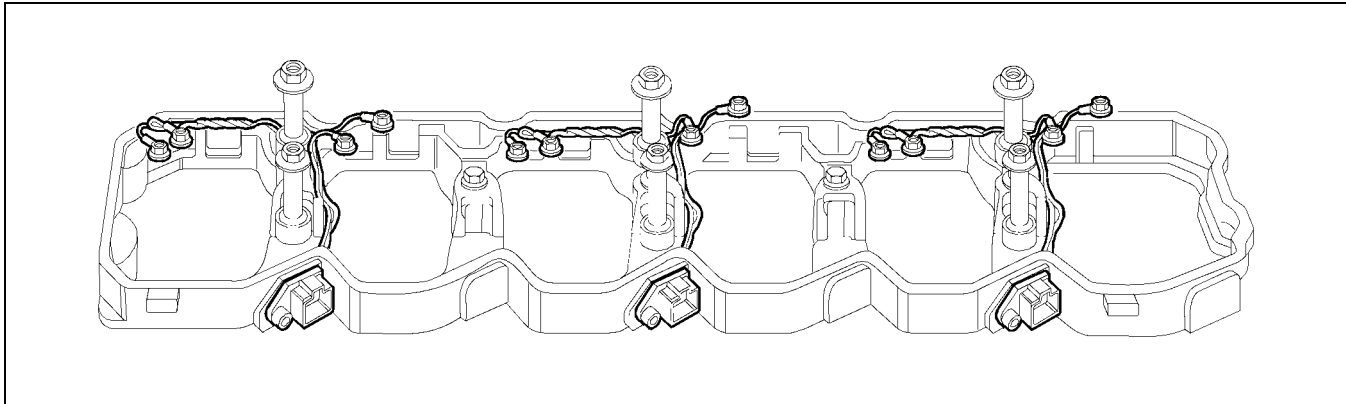
ELECTRO-INJECTORS



BS06K080

Figure 2-79

INJECTOR WIRE HARNESS LAYOUT



BS06K081

Figure 2-80

INJECTOR WIRE HARNESS

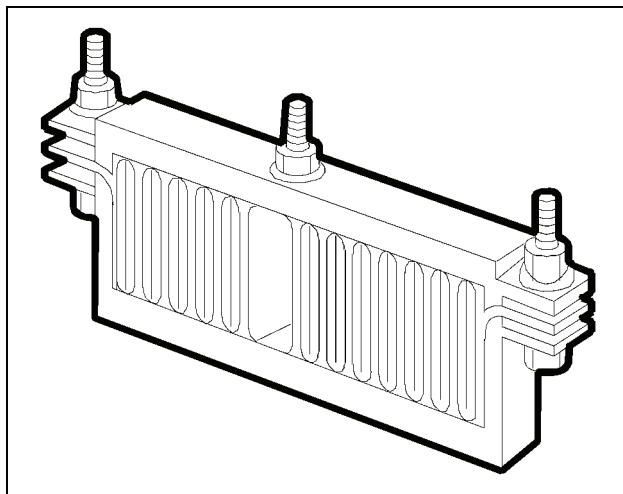
The electro-injectors are a normally Closed (N.C.) solenoid valve.

The impedance of the coil of each injector is 0.56 - 0.57 ohms.

Each injector is connected to the EDC7UC31 control unit on connector A.

Reference		Description	EDC7UC31 control unit pin
CONNECTOR 1	1	Cylinder 2 injector	11A
	2	Cylinder 2 injector	6A
	3	Cylinder 1 injector	13A
	4	Cylinder 1 injector	4A
CONNECTOR 2	1	Cylinder 4 injector	14A
	2	Cylinder 4 injector	3A
	3	Cylinder 3 injector	12A
	4	Cylinder 3 injector	5A
CONNECTOR 3	1	Cylinder 6 injector	15A
	2	Cylinder 6 injector	2A
	3	Cylinder 5 injector	1A
	4	Cylinder 5 injector	16A

INTAKE AIR PRE-POST RESISTANCE HEATER AND RELAY



BS06K082

Figure 2-81

GRID PLATE HEATER

The pre-post grid plate heater is located on the intake manifold.

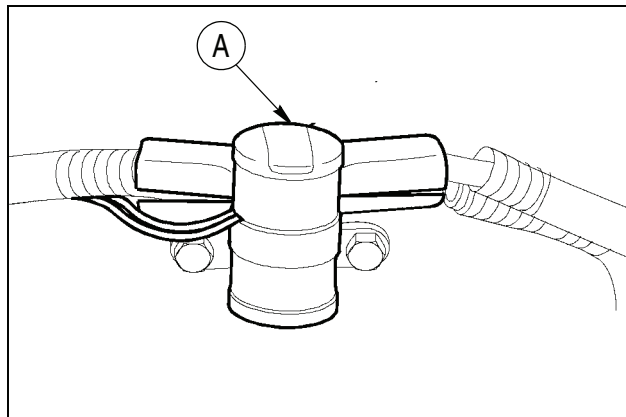
The purpose of the grid plate heater is to heat the air in pre-post heating operations. The grid plate heater is powered by a relay on the chassis.

The impedance of the grid plate heater is approximately 0.5 ohms.



WARNING: Starting fluids or aids, such as ether, must not be used to help start this engine. The use of these starting fluids or aids will cause severe internal damage to the engine and can also cause personal injury.

50-41



BS06K083

Figure 2-82

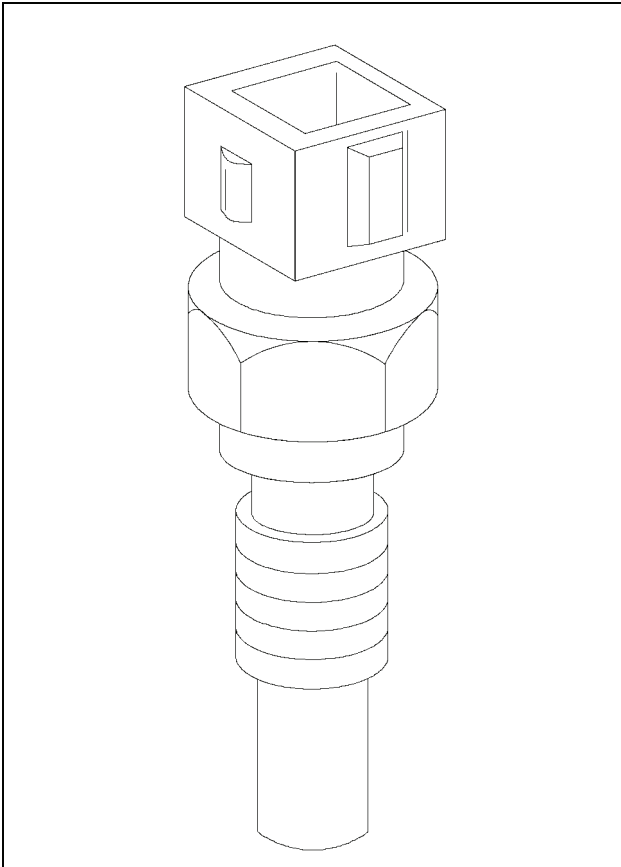
GRID PLATE HEATER CONTROL RELAY

The control relay is connected to the EDC7UC31 control unit B connector.

The relay is tripped with water and or fuel temperature below 5° C (41° F).

The relay impedance is approximately 15 ohms.

COOLANT TEMPERATURE SENSOR



BS06K209

Figure 2-83

COOLANT TEMPERATURE SENSOR

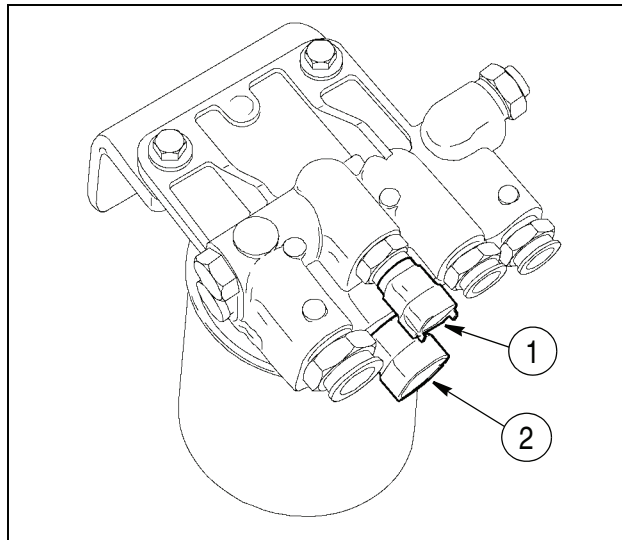
The coolant temperature sensor is a variable resistance sensor able to read the coolant temperature in order to provide the EDC7UC31 control unit with an indication of the temperature status of the engine.

The same signal is utilized by the control unit to drive an instrument panel gauge, if present.

This sensor is connected to the EDC7UC31 control unit on pins 15C - 26C.

The impedance of the coolant temperature sensor at 20° C (68° F) is approximately 2.5 k (2500) ohms.

FUEL TEMPERATURE SENSOR



BS06K210

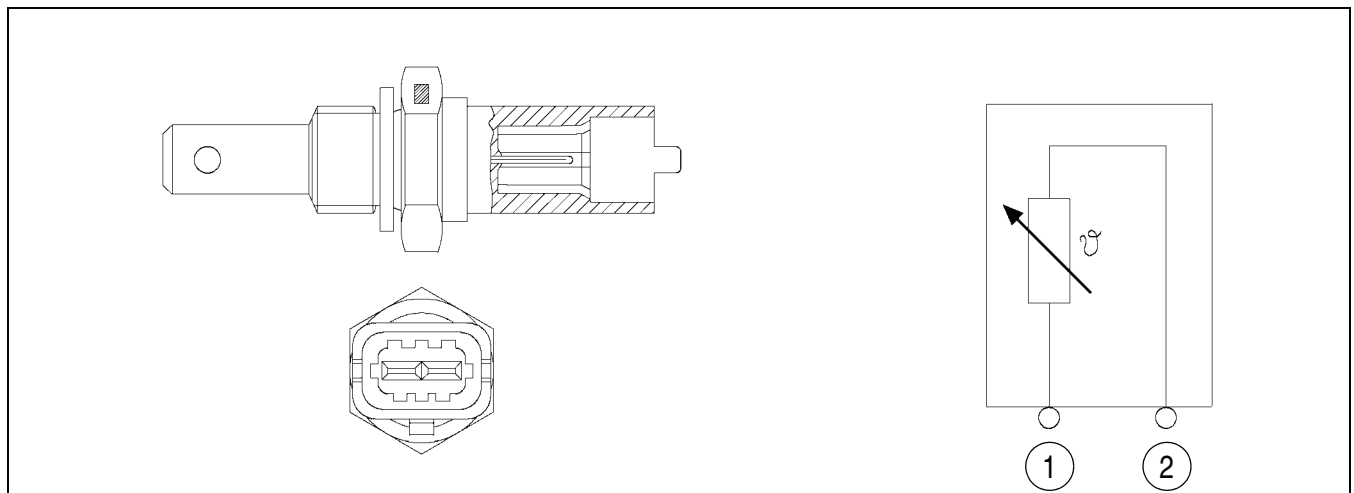
Figure 2-84

1. FUEL TEMPERATURE SENSOR
2. FILTER HEATER RELAY

This sensor detects the fuel temperature so the EDC7UC31 control unit can precisely inject the fuel required.

The fuel temperature sensor is connected to the EDC7UC31 control unit on pins 35C - 18C.

The sensor impedance at 20° C (68° F) is approximately 2.5 k (2500) ohms.



BS06K211

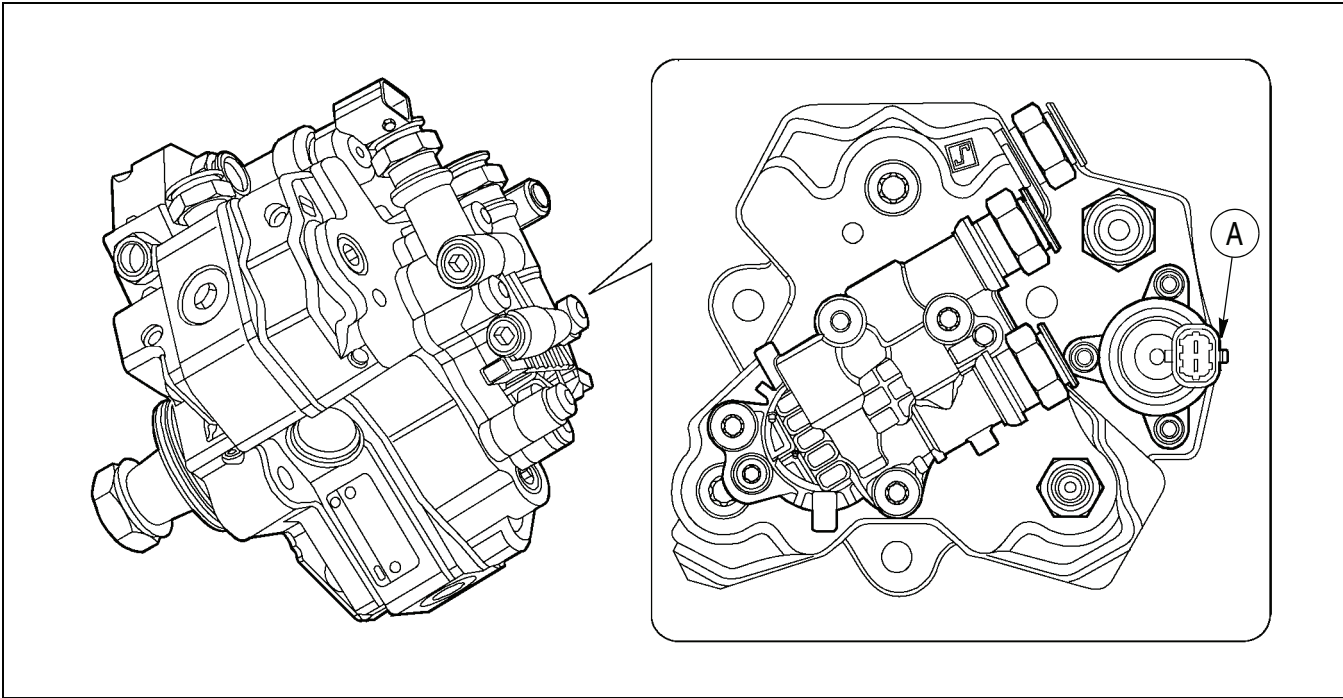
Figure 2-85

FILTER HEATER RELAY

The EDC7UC31 control unit activates the filter heater relay when fuel temp drops below 5° C (41° F)

Reference	Description	EDC7UC31 Control unit Pin	
		Coolant	Fuel
1	Ground	15C	35C
2	Temperature Signal	26C	18C

HIGH PRESSURE PUMP - PRESSURE REGULATOR



BS06K212

Figure 2-86

A. PRESSURE REGULATOR

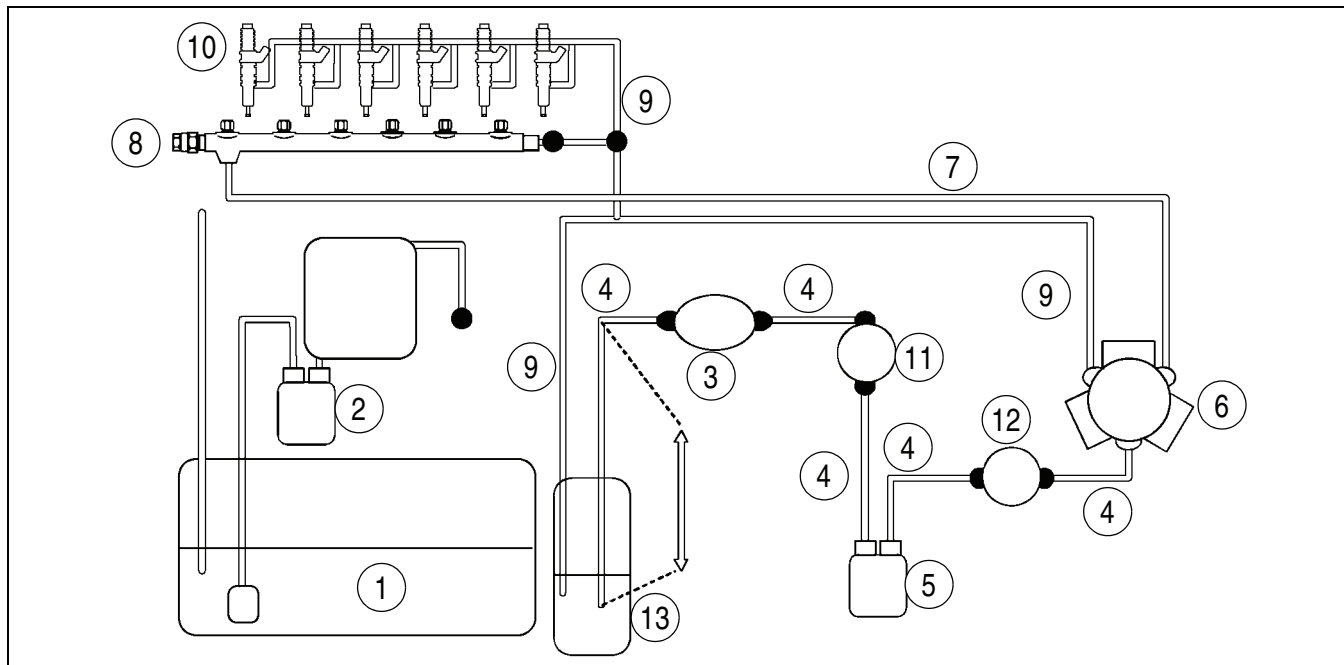
The quantity of fuel supplied to the high pressure pump is controlled by the supply pressure regulator solenoid valve. The high pressure regulator is controlled by the EDC7UC31 control unit.

Delivery pressure to the common rail is modulated between 250 and 1600 bar (3626 and 23206 psi) by the EDC7UC31 control unit by controlling the high pressure regulator solenoid valve.

- This component is a Normally Open solenoid valve.
- The solenoid is connected to the EDC7UC31 control unit on pins 9A - 10A.
- The solenoid valve impedance is approximately 3.2 ohms.

CHECKING THE FUEL SYSTEM

LOW PRESSURE SUPPLY TEST

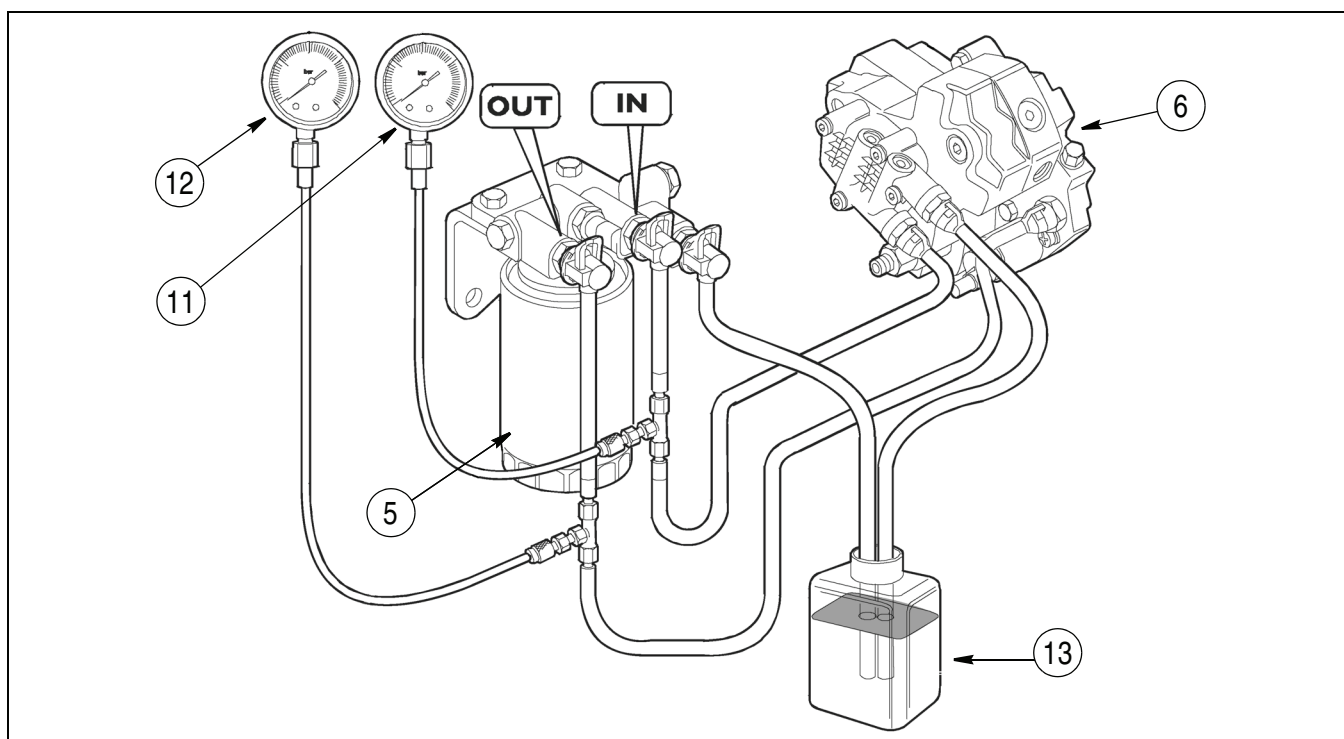


BS06K214

Figure 2-87

DIAGRAM OF SET UP OF COMPONENTS FOR SPECIFIC TEST

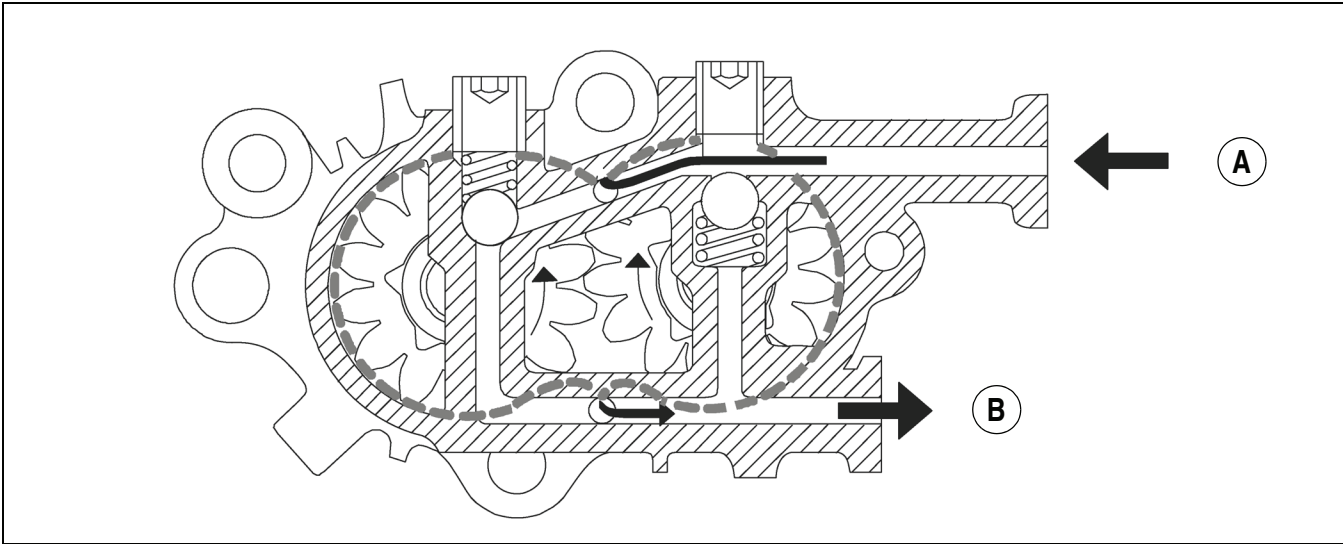
- | | | |
|--------------------------|--------------------------|---|
| 1. FUEL TANK | 6. HIGH PRESSURE PUMP | 11. M1 PRESSURE GAUGE 0-15 BAR FUEL FILTER INLET |
| 2. PREFILTER | 7. HIGH PRESSURE CIRCUIT | 12. M2 PRESSURE GAUGE FUEL FILTER OUTLET |
| 3. LOW-PRESSURE PUMP | 8. COMMON RAIL | 13. EXTERNAL CONTAINER PLACED 1M (39 IN) BELOW ENGINE |
| 4. FUEL DELIVERY CIRCUIT | 9. FUEL RECIRCULATION | |
| 5. FUEL FILTER | 10. INJECTORS | |



BS06K215

Figure 2-88

LOW -PRESSURE PUMP



BS06K216

Figure 2-89

The function of the gear pump is to supply the high pressure pump. It is driven by the shaft of the high pressure pump and is installed on the rear portion of the high pressure pump.

Under normal operating conditions, the flow of fuel inside the pump is as shown in the figure above.

With the fuel system pressurized, a fully charged battery and an external fuel supply placed 1m (39 in.) below the engine. The engine must start within 20 seconds of activation of the starter motor. If the pump is not able to draw fuel to the engine and start the engine the low pressure pump is probably defective.

After starting the engine, check the pressure at 1500 rpm.

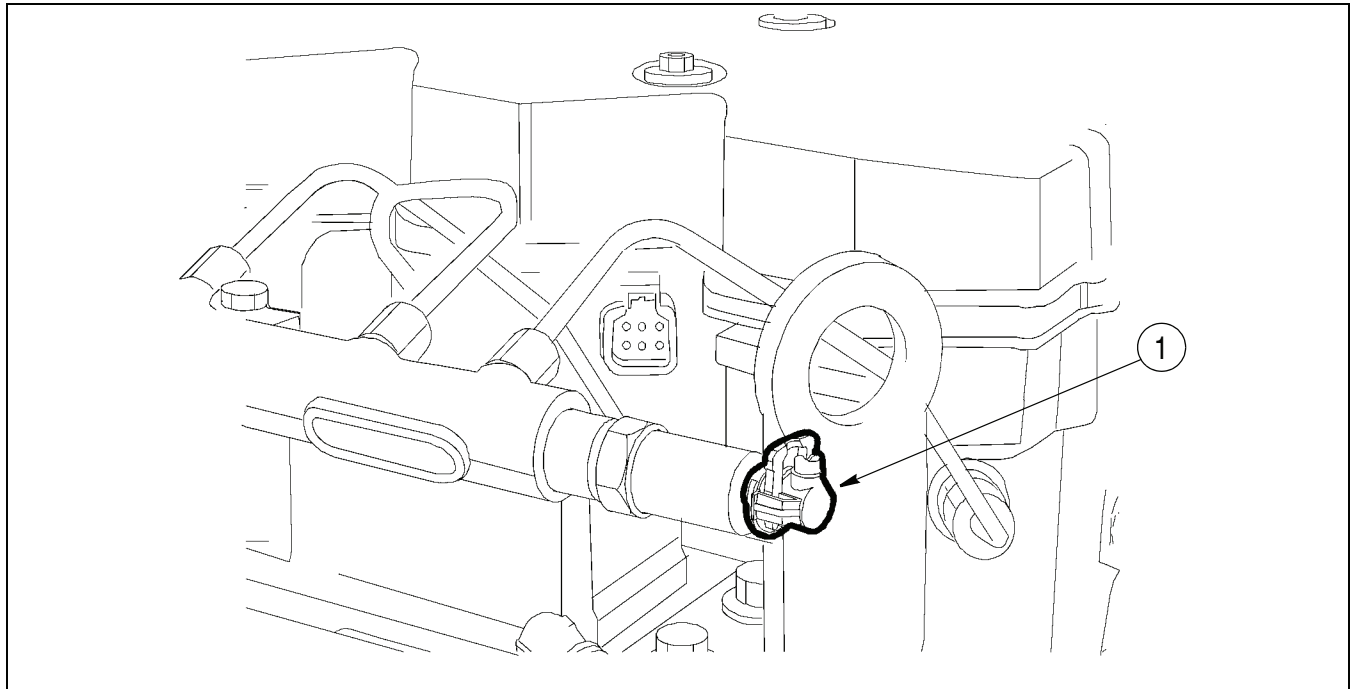
On pressure gauge M1- (11) it must be between 6 and 9 bar (87 and 130 psi.)

- If lower than 6 bar (87 psi.) replace pump
- If higher than 9 bar (130 psi.) replace the fuel filter.

On pressure gauge M2- (12) it must be greater than 5 bar (72.5 psi.)

- If lower, replace the fuel filter
- If the trouble persists, check the seals on the couplings of the fuel filter bracket and the high pressure pump inlet.

TEST ON THE PRESSURE RELIEF VALVE ON THE COMMON RAIL



BS06K217

Figure 2-90

The pressure relief valve is installed on the end of the common rail, its function is to protect the systems components if any malfunction causes and excessive increase in the pressure of the high pressure system.

Disconnect recirculation line (1) from the pressure relief valve and plug with the VOSS fitting from the test set.

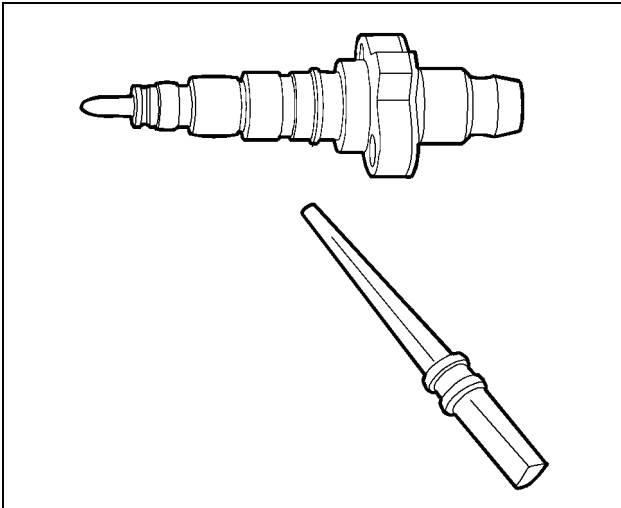
No diesel must come out of the valve at any engine speed. If the diagnostic system signals a fault code "Engine - backfill valve control", it means that the EDC7UC31 control unit has recognized that the valve has opened after a significant change in the pressure of the rail greater than 1700 bar (24656 psi.). Since its opening is to be considered a consequence of abnormal increase in pressure, the valve is NOT defective even though a great amount of diesel flows out.

IMPORTANT: *Information acquired to date shows that the sensor is rarely defective.*

If the valve seeps diesel without a fault code, then replace the valve.

With the common rail pressure sensor disconnected and a fault code is generated, with the rail pressure is at 710 bar (10298 psi.) measurable with the diagnostic instrument, the trouble is in the wiring and not the component.

TEST ON FUEL BACKFLOW FROM THE RETURN

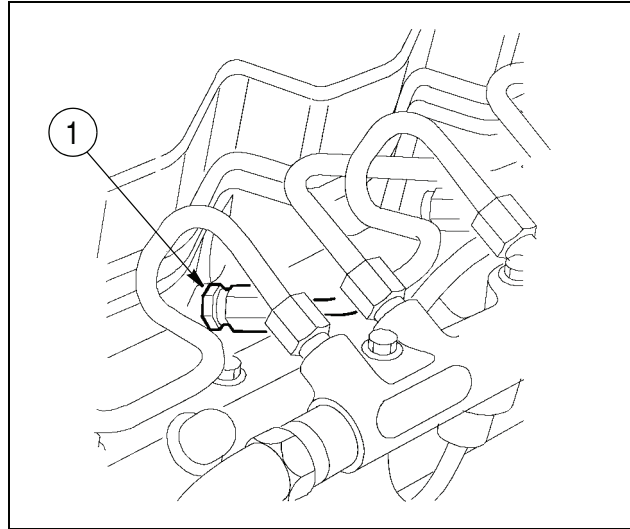


BS06K218

Figure 2-91

Tests on fuel backflow from the return establishes the operating status of the injectors. The engine speed and power are controlled through the injectors. The power required by the user, through the accelerator, is converted into the quantity of fuel injected per cycle. This in turn is converted into microseconds of injector opening according to the rail pressure.

NOTE: *The injectors may have problems of both a mechanical and a electrical nature. Therefore before proceeding with the following analysis, it is wise to rule out the presence of water in the tank and the fuel prefilter.*



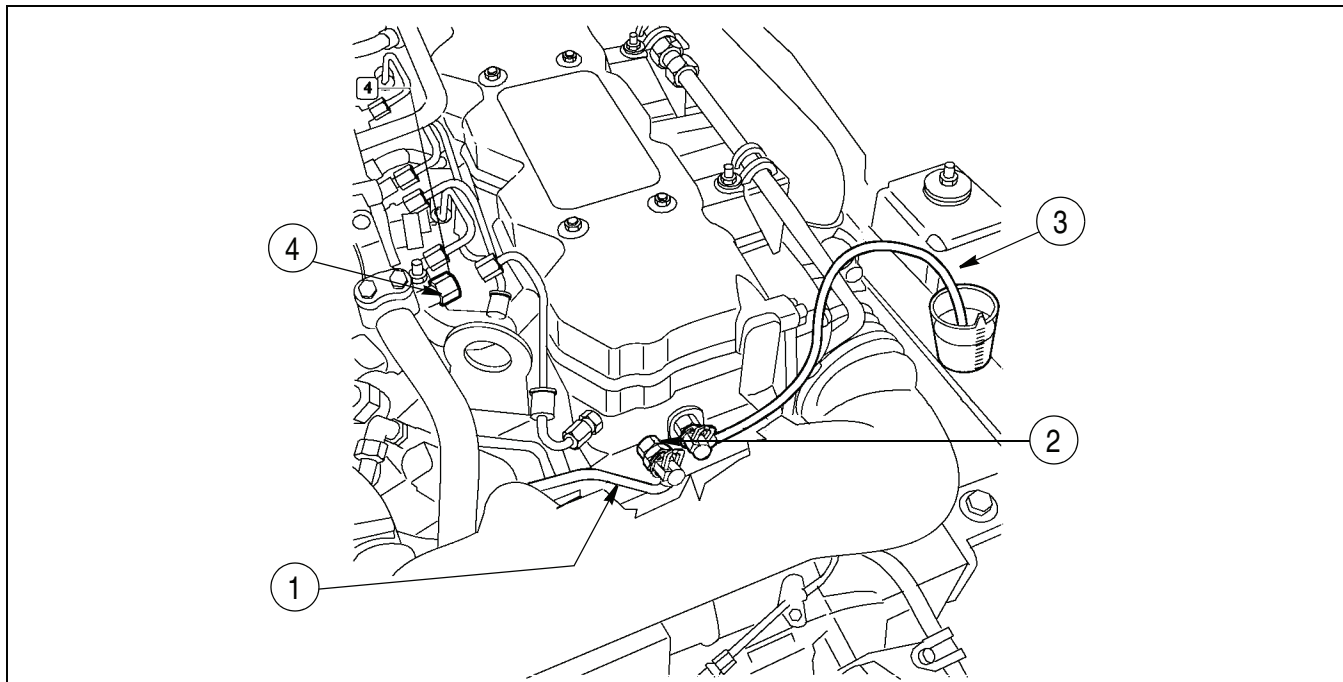
BS06K219

Figure 2-92

1. INJECTOR DUCT LOCKING NUT

When the EDC7UC31 control unit warning light comes on during acceleration and/or cold start trouble, make sure the following check is done.

- Check torque of the nut (1) locking the injector duct on the cylinder head. The torque setting is 45 - 55 Nm (33.2 - 40.6 lb.- ft.).



BS06K220

Figure 2-93

Proceed with the injector fuel backflow tests as follows:

- Remove the duct (1) from the cylinder head.
- Plug it (2)
- Install a transparent line (3)

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 (4) 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 lb.- ft), 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 and duct. Check the recirculation value again.

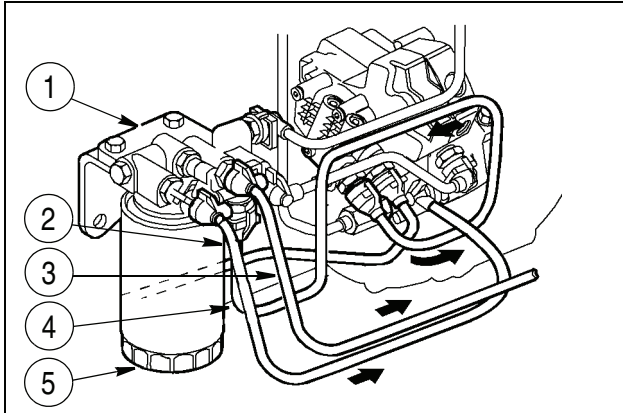
ENGINE OVERHAUL ON THE BENCH

DISASSEMBLING THE ENGINE

STEP 1

Drain the engine oil by removing the plug from the oil pan (sump).

STEP 2



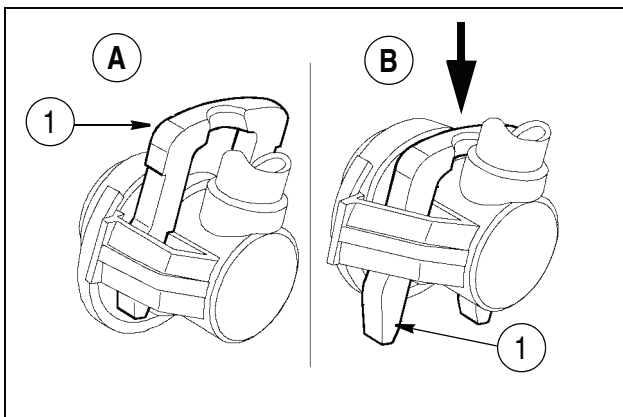
BS06K221

Figure 2-94

Apply the brackets for fastening the engine to the engine stand as follows (working from the left side of the engine).

- Use a suitable tool to remove the fuel filter (5) from the fuel filter bracket (1).
- Disconnect the low pressure lines (2, 3, 4) from the fuel filter bracket (1).
- Remove the fuel filter bracket (1) from the engine block.

STEP 3

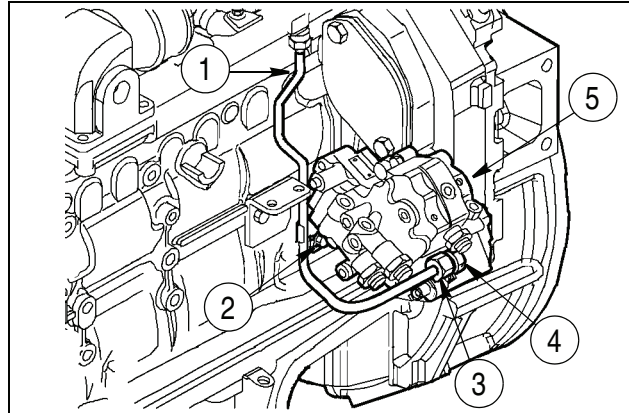


BS06K222

Figure 2-95

IMPORTANT: Push clamp (1), as shown in figure B to disconnect the low pressure fuel lines (2, 3, 4) from the corresponding connections. After disconnecting the line, reset the clamp (1) in locking position figure A to prevent distortion to the clamp.

STEP 4



BS06K223

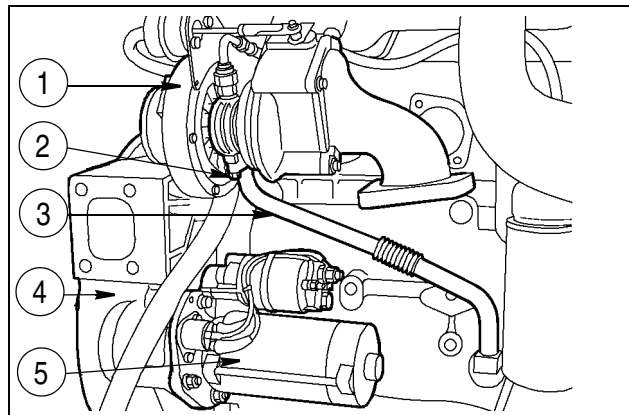
Figure 2-96

Disconnect fuel line (1) from common rail and from high pressure pump (5) and remove it by taking out securing bolts (2).

IMPORTANT: When loosening fitting (3) of fuel line (1), it is necessary to use a suitable wrench to prevent fitting (4) of high pressure pump (5) from rotating.

STEP 5

From the Right Side:



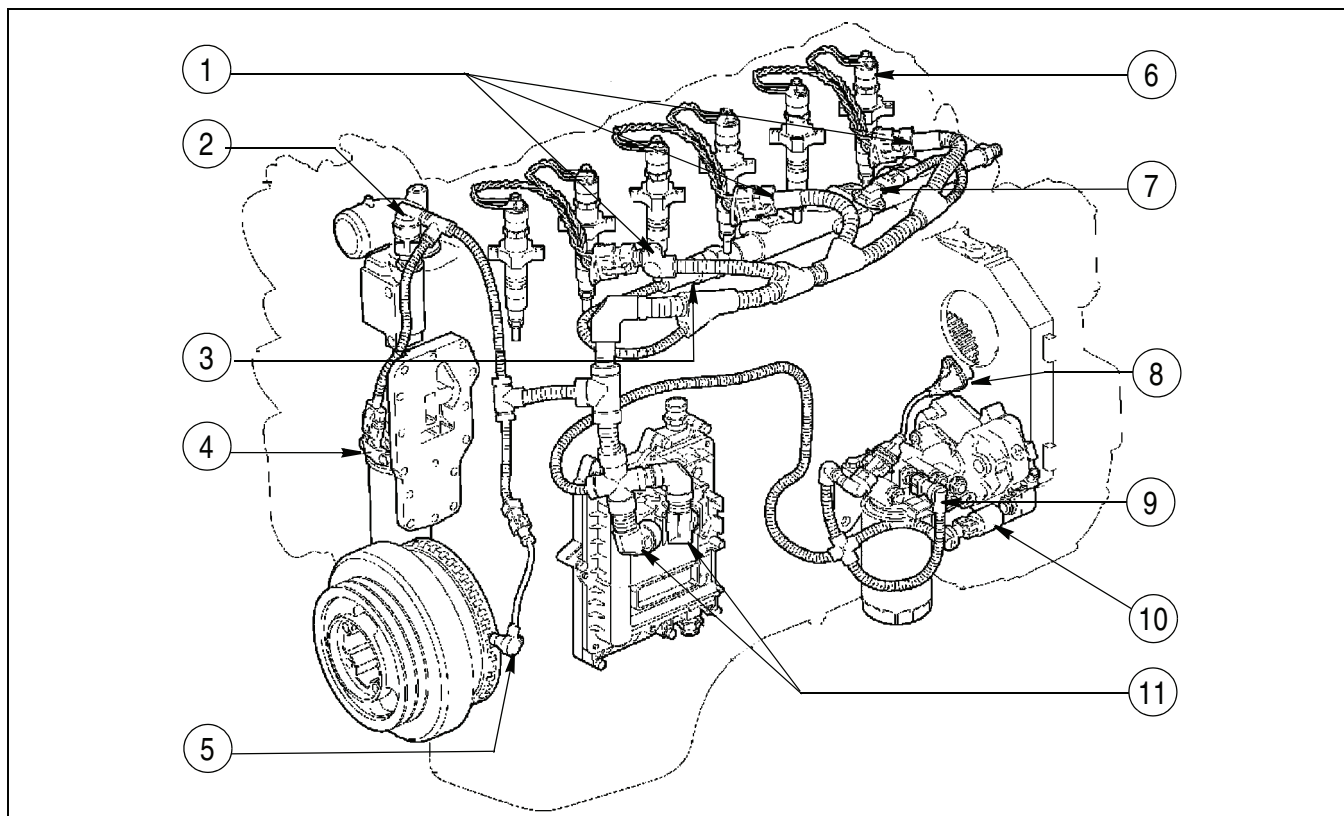
BS06K224

Figure 2-97

Remove the mounting bolts (2) and remove the oil line (3) from the Turbo-charger (1) from the engine block.

Remove the starter (5) from the flywheel housing (4)
Secure the engine to a engine stand.

STEP 6



BS06K225

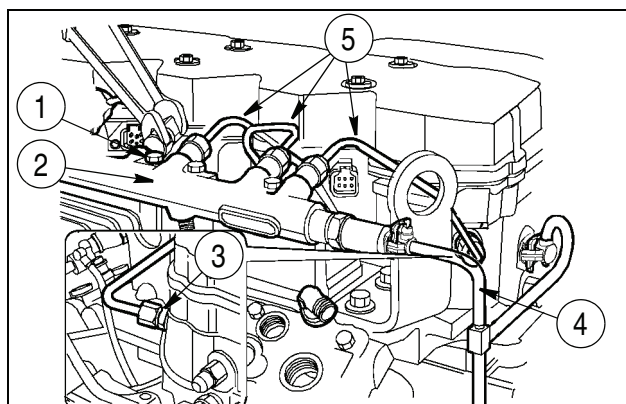
Figure 2-98

- | | | |
|--------------------------------------|--------------------------------------|------------------------------------|
| 1. INJECTOR CONNECTIONS | 5. CRANKSHAFT SPEED SENSOR | 9. FUEL HEATER- TEMPERATURE SENSOR |
| 2. ENGINE COOLANT TEMPERATURE SENSOR | 6. INJECTOR | 10. HIGH PRESSURE REGULATOR |
| 3. COMMON RAIL FUEL PRESSURE SENSOR | 7. BOOST TEMPERATURE-PRESSURE SENSOR | 11. EDC7UC31 CONTROL UNIT |
| 4. OIL TEMPERATURE- PRESSURE SENSOR | 8. CAMSHAFT SENSOR | |

Disconnect the engine cable by disconnecting the following connectors:

- Connectors (1) from injector wiring (6)
- Engine coolant temperature sensor on the thermostat (2)
- Common rail fuel pressure sensor (3)
- Crankshaft speed sensor (5)
- Boost pressure / temperature sensor (7)
- Camshaft sensor (8)
- High pressure regulator (10)
- EDC7UC31 control unit (11)

STEP 7



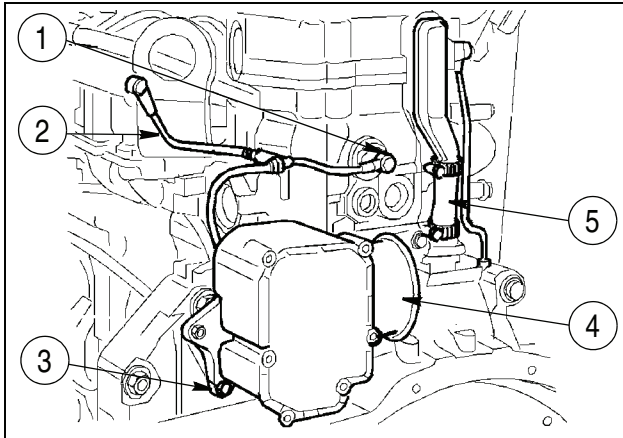
BS06K226

Figure 2-99

Disconnect from the common rail (2):

- Fuel line (4) according to procedure on step 3 page 2-72
- Fuel lines (5)
- Injector manifolds (3)
- Remove the bolts (1) and disconnect the common rail (2)

STEP 8



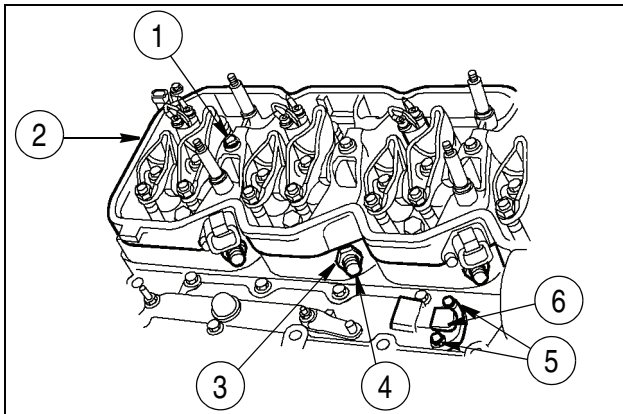
BS06K227

Figure 2-100

Disconnect line (2) from fuel return pressure limiter (1) as shown in step 3 page 2-72.

Remove the nut, loosen the retainer collar and disconnect the oil vapor line (5). Remove bolts (3) and take off the blow-by filter (4).

STEP 9



BS06K228

Figure 2-101

Remove nuts and remove the tappet cover including the gasket.

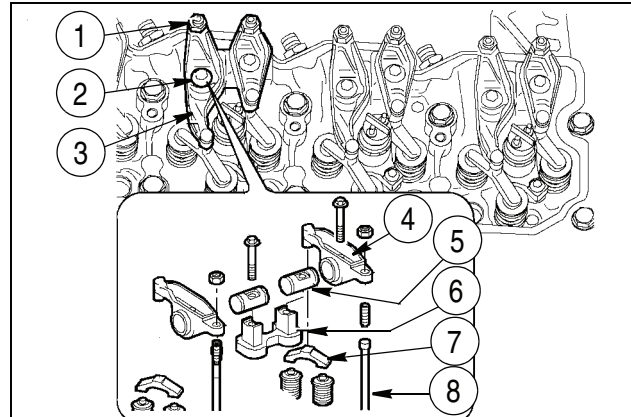
Remove bolts (1) and disconnect the injector wiring housing (2) complete with gasket.

Remove bolts (5) and detach the boost temperature/pressure sensor (6).

Remove nuts (3) 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



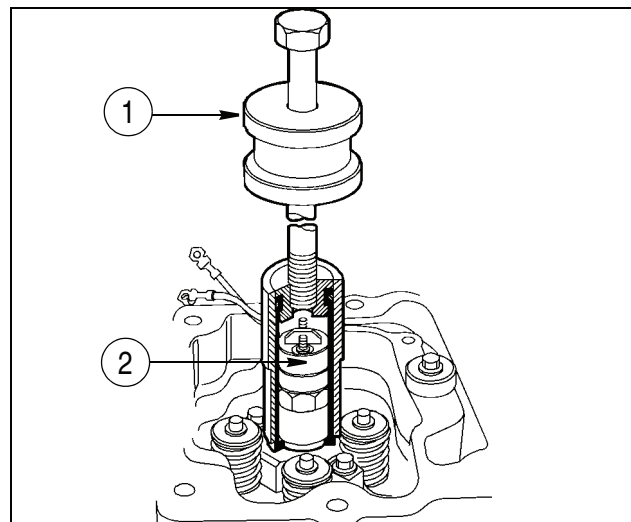
BS06K229

Figure 2-102

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

Remove the 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

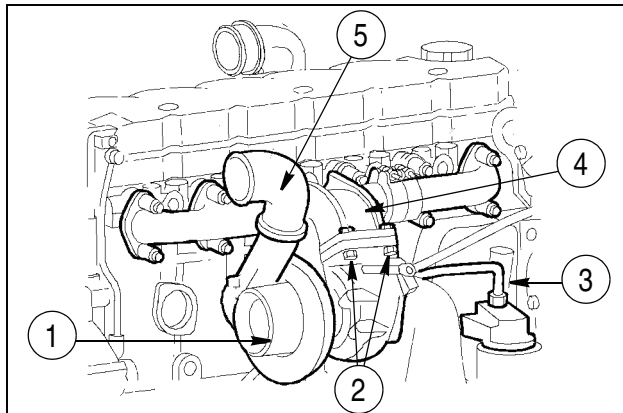


BS06K230

Figure 2-103

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

STEP 12



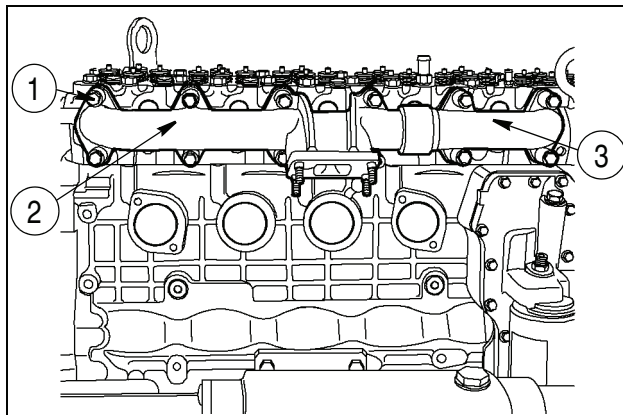
BS06K231

Figure 2-104

Remove shroud (5), if present from turbocharger (1). Disconnect oil line (3) from heat exchanger oil filter bracket.

Remove nuts (2) and detach turbocharger (1) from exhaust manifold (4).

STEP 13

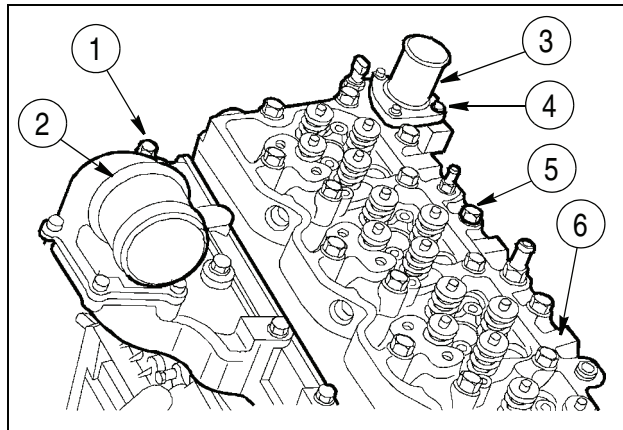


BS06K232

Figure 2-105

Remove securing bolts (1) and remove exhaust manifold in two sections (2 and 3) with related gaskets.

STEP 14



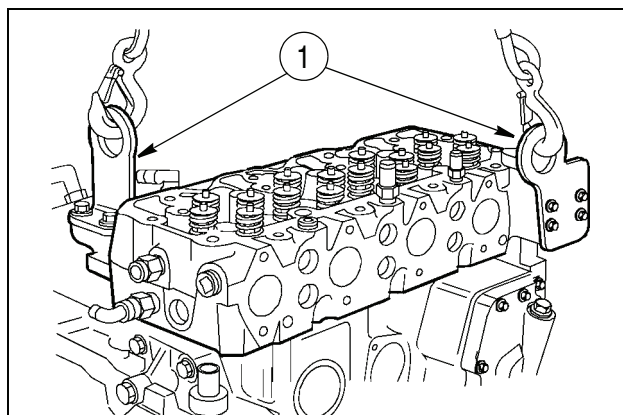
BS06K233

Figure 2-106

Remove bolts (1) and disconnect intake manifold and heater air shroud (2). Remove the bolts (4), and take off the thermostat housing (3) and the thermostat under the housing.

Remove the cylinder head (6), fastening bolts(5).

STEP 15

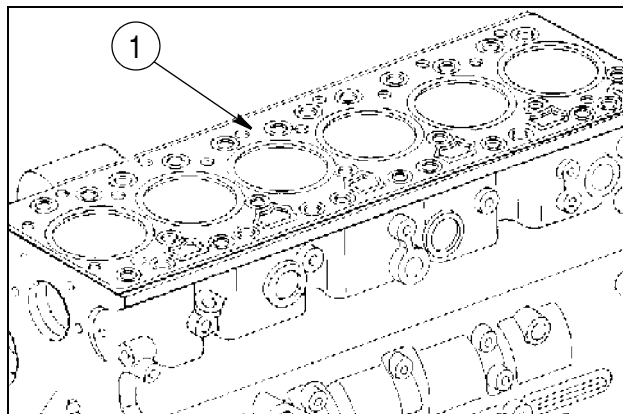


BS06K234

Figure 2-107

Attach brackets (1) to cylinder head and remove cylinder head from block using a hoist.

STEP 16

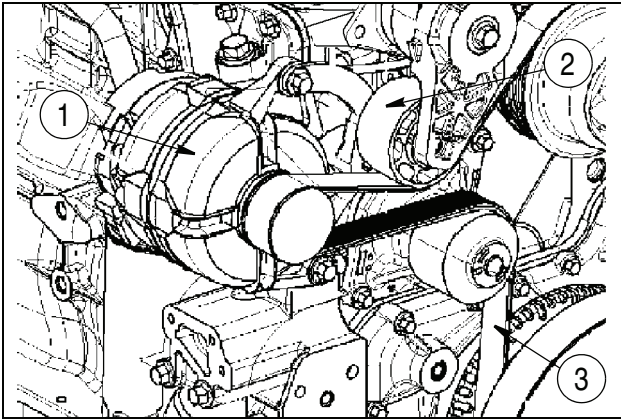


BS06K235

Figure 2-108

Remove cylinder head gasket (1).

STEP 17



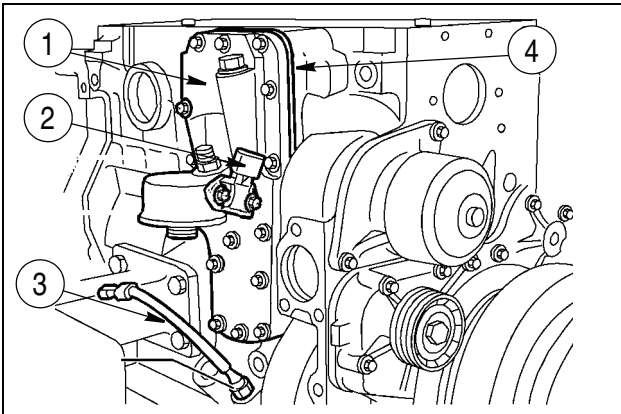
BS06K236

Figure 2-109

Release the drive belt tensioner (2) and remove the belt (3) from the pulleys. Then remove the belt tensioner (2).

Loosen bolts holding the alternator to bracket and remove the alternator (1).

STEP 18



BS06K237

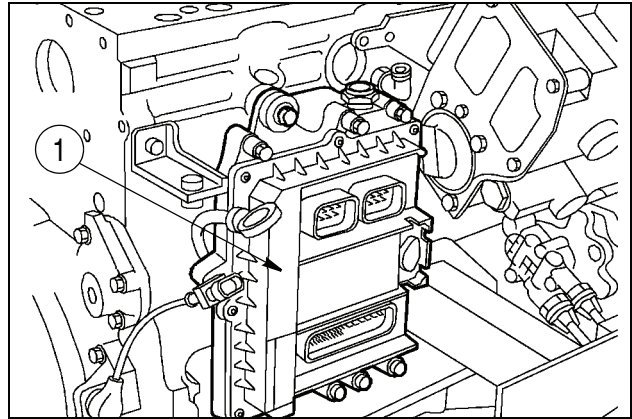
Figure 2-110

Take out bolts and remove the oil temperature-pressure sensor (2).

Take out bolts and then remove heat exchanger/ oil filter bracket (1) and intermediate plate (4) and relevant gaskets.

Remove the oil level sensor (3).

STEP 19

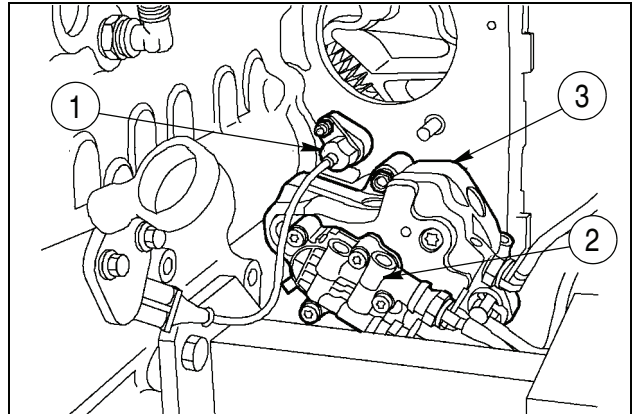


BS06K238

Figure 2-111

Remove the bolts and disconnect the EDC7UC31 control unit (1), including the heat exchanger.

STEP 20

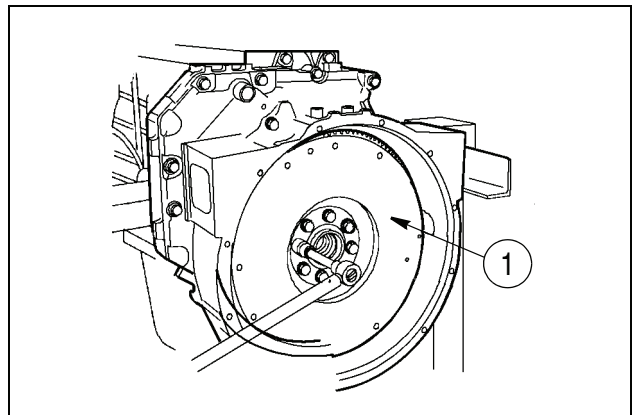


BS06K239

Figure 2-112

Remove the nut and disconnect the timing sensor (1). Remove the nuts and disconnect the high pressure pump (3) including the feed pump (2).

STEP 21

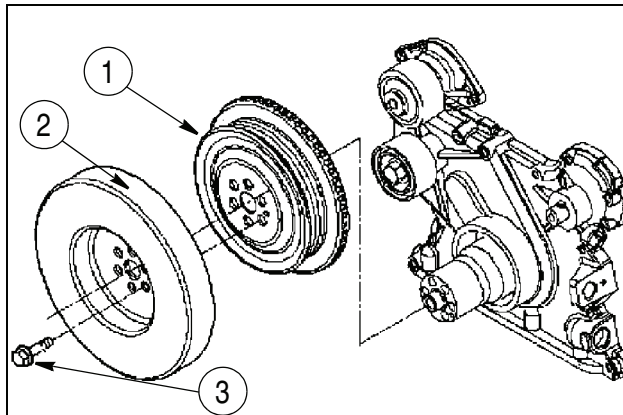


BS06K240

Figure 2-113

Loosen bolts on flywheel (1) but do not remove the flywheel.

STEP 22

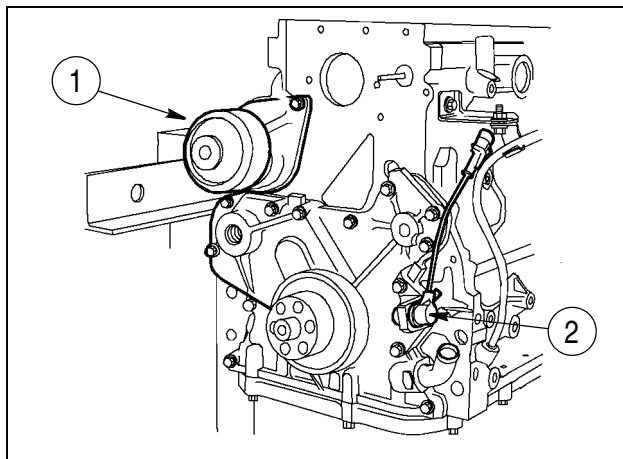


BS06K241

Figure 2-114

Remove the bolts (3) and take off the damping flywheel (2) and the pulley (1).

STEP 23

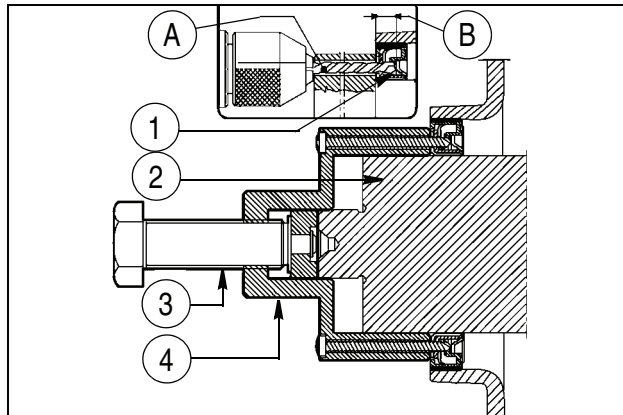


BS06K242

Figure 2-115

Remove the bolts and disconnect the water pump (1). Remove the bolt and disconnect the engine speed sensor (2).

STEP 24



BS06K243

Figure 2-116

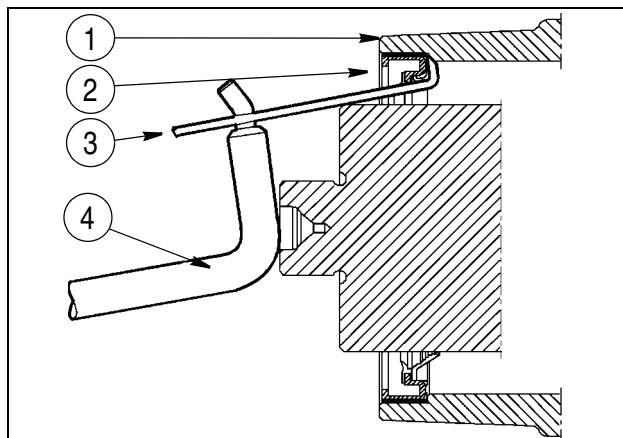
Place Special Tool 380000665 (4) to the front of the crankshaft (2).

Working through the guide holes of Special Tool 380000665 (4), drill into the internal seal ring (1) with a 3.5mm (9/64 in.) drill bit (A) to a depth of 5mm (3/16 in.) (B).

Secure Special Tool 380000665 (4) to the ring (1) by screwing down the six bolts supplied with tool to the crankshaft front cover.

Now extract seal ring (1) by tightening bolt (3).

STEP 25

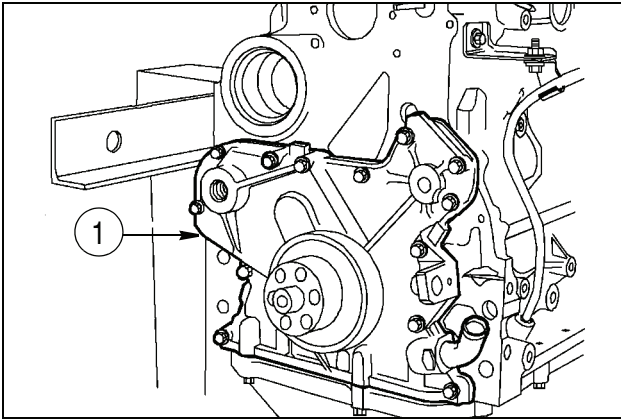


BS06K244

Figure 2-117

Using the pry bar (3) and the lever (4), remove the external seal ring (2) from the front cover (1).

STEP 26



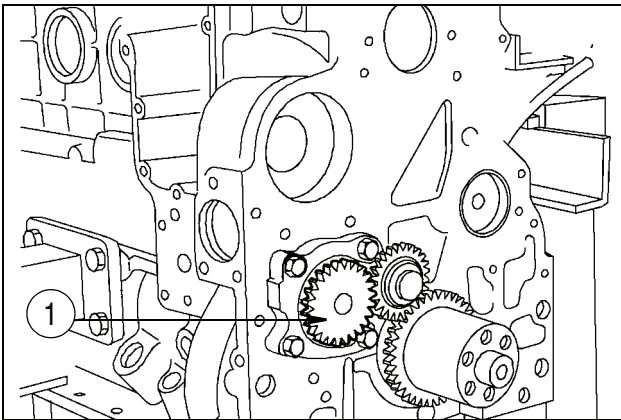
BS06K245

Figure 2-118

Remove the bolts and take off the front cover (1).

IMPORTANT: Note the installation position of the bolts because they are different lengths.

STEP 27



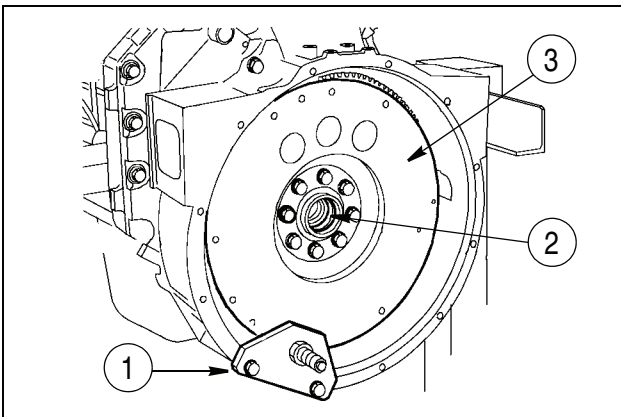
BS06K246

Figure 2-119

Remove bolts and take off gear oil pump (1).

IMPORTANT: Oil pump (1) can not be repaired.

STEP 28

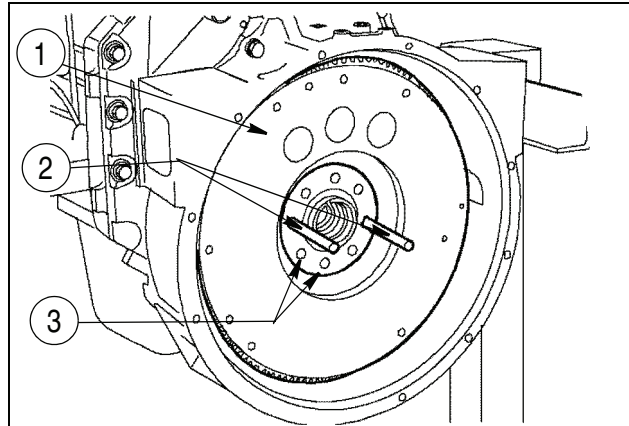


BS06K247ID

Figure 2-120

Remove tool (1) remove bolts securing flywheel (3) to crankshaft (2).

STEP 29



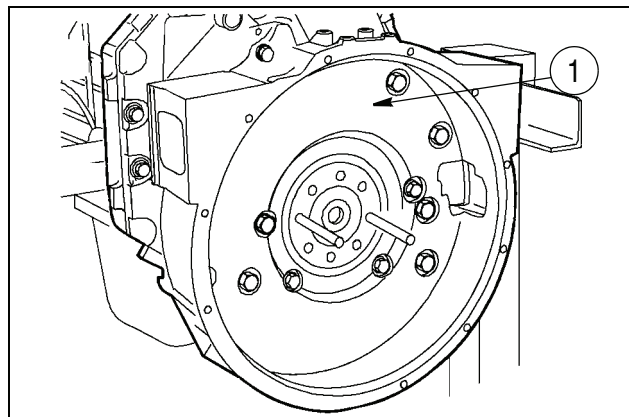
BS06K248

Figure 2-121

Screw two pins (2) of adequate length into the crankshaft holes (3).

Remove the flywheel (1) with a hoist.

STEP 30



BS06K249

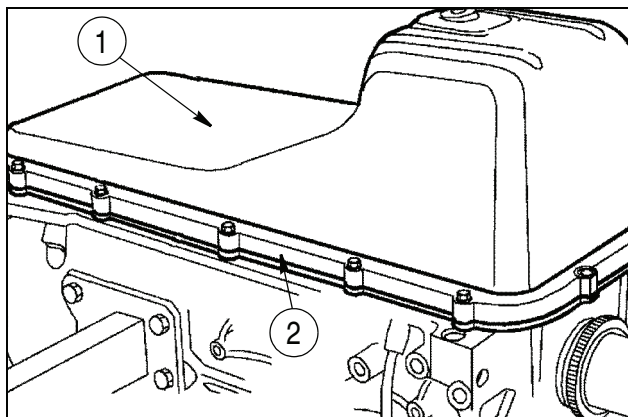
Figure 2-122

Remove bolts and take off rear cover (1).

IMPORTANT: Note the installation position of the bolts because they are different lengths.

STEP 31

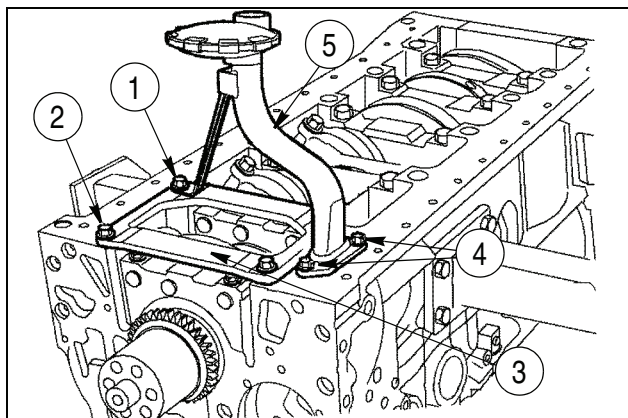
Turn engine upside down



NOTE: Only on engines 667TA/EEG- /EEC- /EBF- /EED- /EDJ.

Remove the bolts, plate (2) and oil pan (sump) (1).

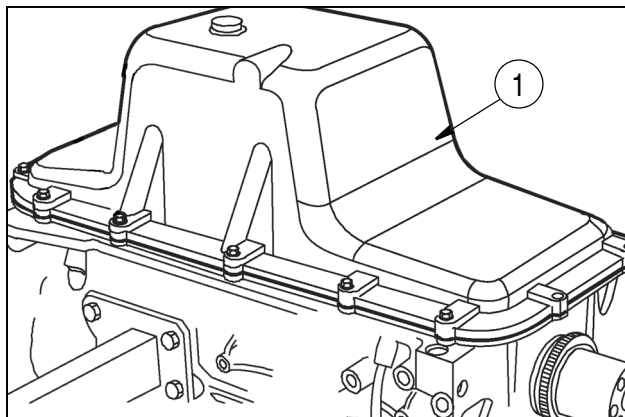
STEP 32



NOTE: Only on engines 667TA/EEG- /EEC- /EBF- /EED- /EDJ.

Remove the bolts (1 and 4) and remove the oil suction tube (5). Remove the bolts (2) and remove the stiffening plate (3).

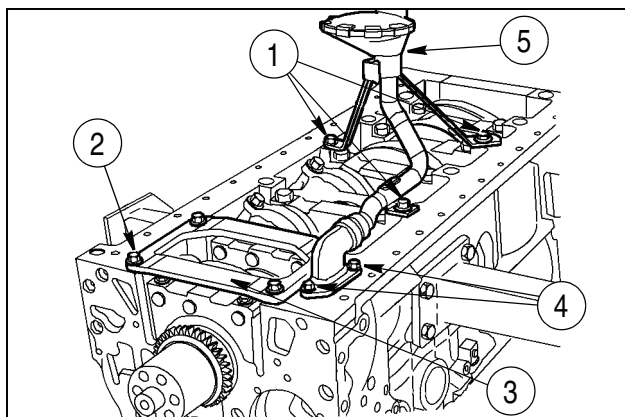
STEP 33



NOTE: Only on engines 667TA/EED- /EBD.

Remove bolts and oil pan (sump) (1).

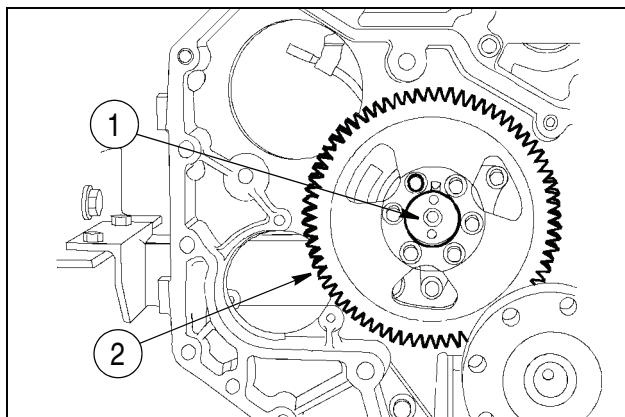
STEP 34



NOTE: Only on engines 667TA/EED- /EBD.

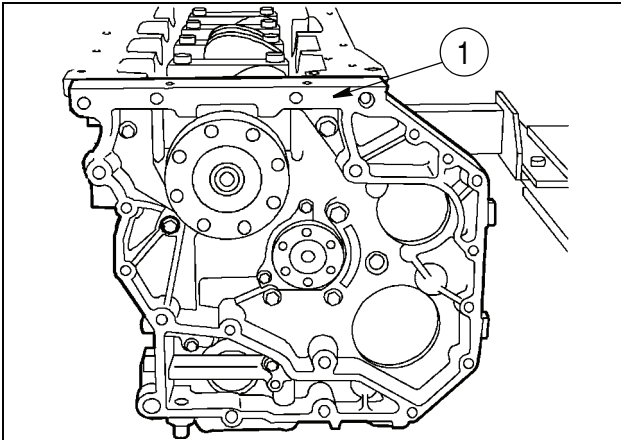
Remove bolts (1 and 4) and remove oil suction tube (5). Remove bolts (2) and remove stiffening plate (3).

STEP 35



Remove bolts and take gear (2) off of camshaft (1)

STEP 36



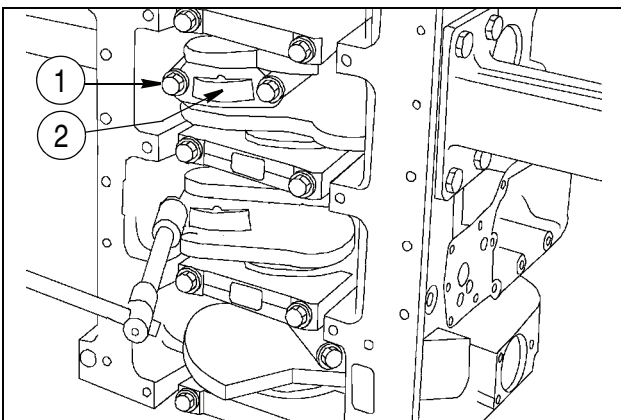
BS06K255

Figure 2-128

Remove bolts and take off timing gear case (1).

IMPORTANT: Note the installation position of the bolts because they are different lengths.

STEP 37



BS06K256

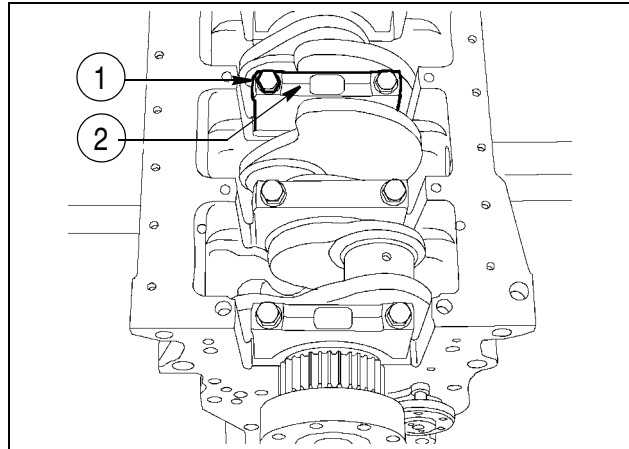
Figure 2-129

Remove bolts (1), then take off connecting rod caps (2).

Remove the pistons (complete with connecting rods) from the crankcase.

IMPORTANT: Half bearings must be kept in their respective housings: If they have to be reused, they must be installed in the same position they had prior to being removed.

STEP 38

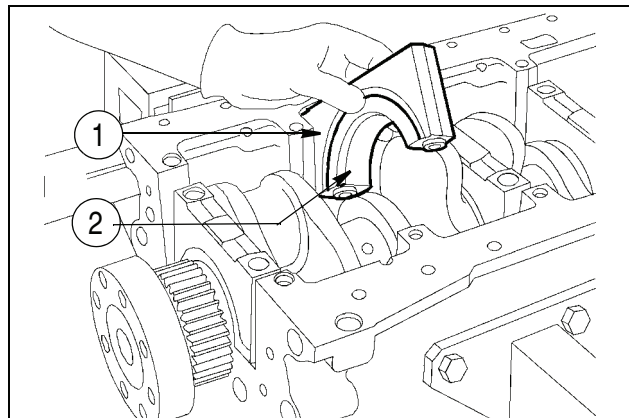


BS06K257

Figure 2-130

Remove bolts (1) and take off the main bearing journals (2).

STEP 39



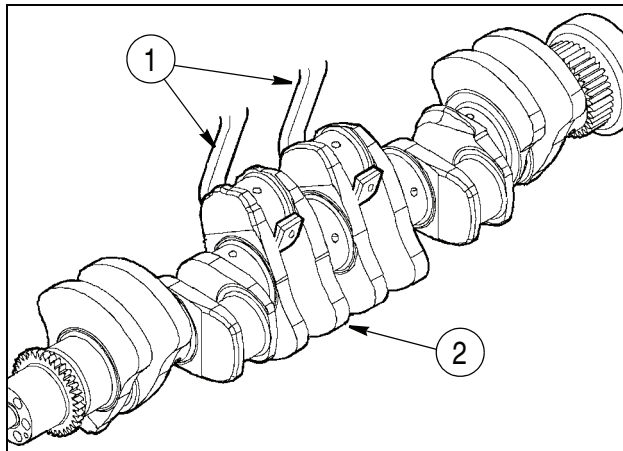
BS06K258

Figure 2-131

The main bearing journal cap (1) and its respective thrust bearing (2) have a shoulder to control crankshaft endplay.

IMPORTANT: Take note of the mounting position of the main bearings and thrust bearings: If they have to be reused again, they must be installed in the same position they had prior to being removed.

STEP 40

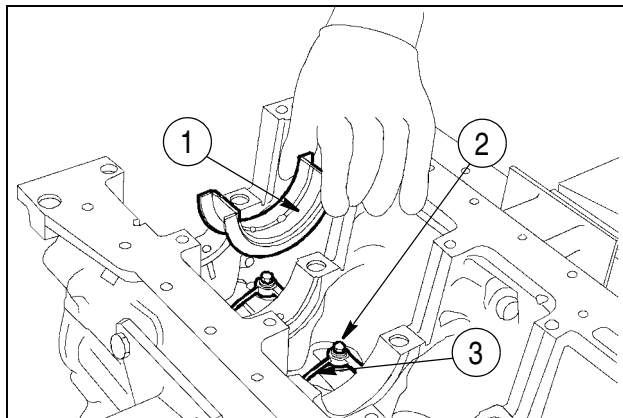


BS06K259

Figure 2-132

Remove crankshaft (2) from crankcase by means of a suitable tool (1) and a hoist.

STEP 41



BS06K260

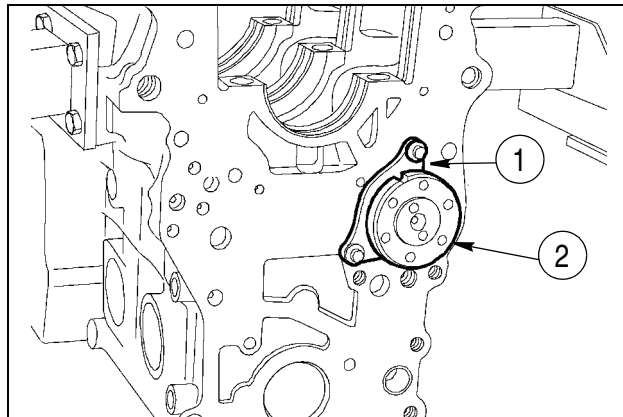
Figure 2-133

Take off main half bearings (1).

Remove bolts (2) and take off oil nozzles (3).

IMPORTANT: Take note of the mounting position of the main bearings and thrush bearings: If they have to be reused again, they must be installed in the same position they had prior to being removed.

STEP 42



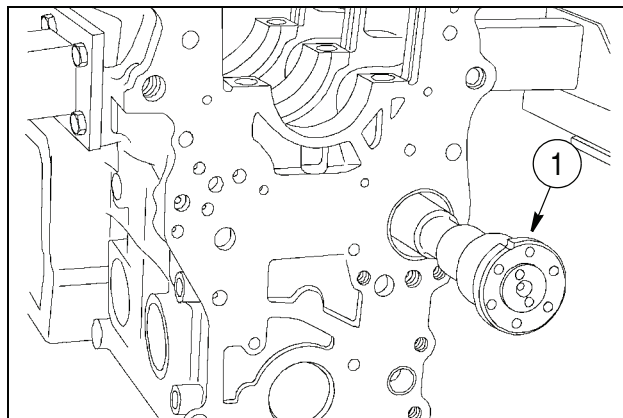
BS06K261

Figure 2-134

Remove bolts and take off camshaft (2), retaining plate (1).

IMPORTANT: Note plate (1) mounting position.

STEP 43

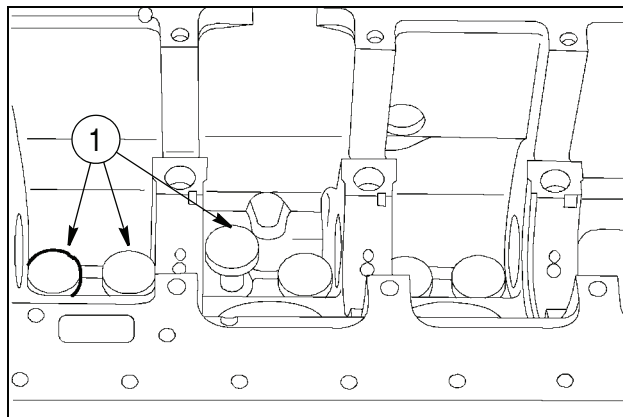


BS06K262

Figure 2-135

Carefully remove camshaft (1) from engine crankcase.

STEP 44



BS06K263

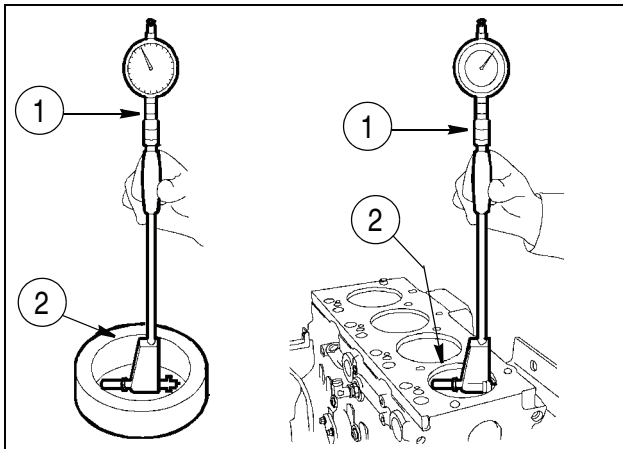
Figure 2-136

Remove tappets (1) from the engine crankcase.

CHECKS AND SPECIFICATIONS ON ENGINE CRANKCASE

CHECKS AND MEASUREMENTS

STEP 45



BS06K264

Figure 2-137

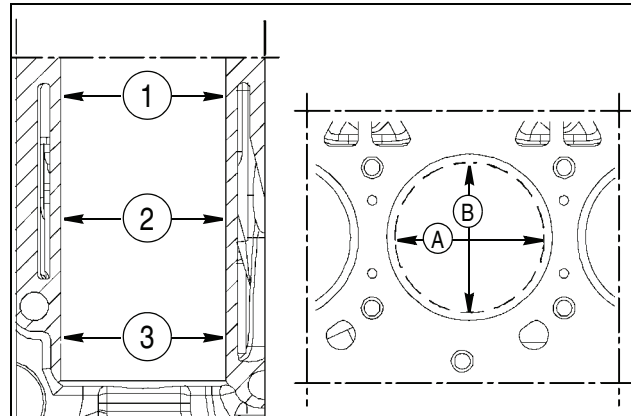
After the engine has been disassembled, clean the block thoroughly.

Check the crankcase carefully for cracks. Check the condition of freeze plugs. They must be replaced if they are rusty or their sealing properties are in doubt. Inspect the cylinder bore surfaces, they must not show traces of seizing, scoring, out-of-roundness, taper or excessive wear.

Check the cylinder bore inner diameter (in order to measure the amount of out-of-roundness, taper and wear) a bore gauge (1) equipped with a dial indicator, check the cylinder bore diameter (2).

IMPORTANT: *If no ring gauge is available, use a micrometer to perform the test.*

STEP 46



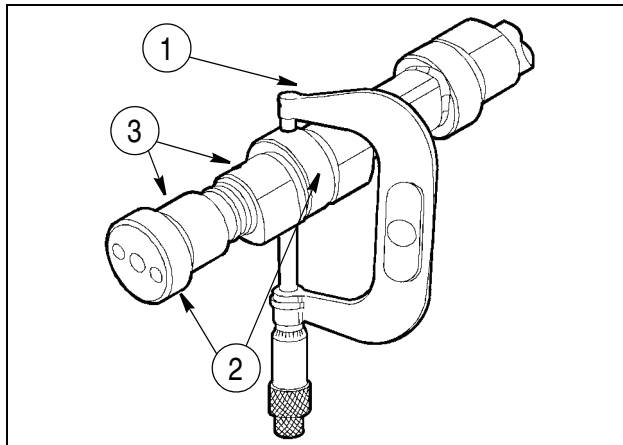
BS06K265

Figure 2-138

Measurements must be taken for each cylinder, at three different heights (1,2,3) of the bore and on two planes perpendicular to each other. One parallel to the engine longitudinal axis (A), the other perpendicular (B), the greatest amount of wear is usually found on the (B) plane, and during the first measurement. When detecting out-of-roundness, taper or wear, in the cylinder bore, they must be bored and resurfaced. Cylinder bore reconditioning must be done in standard increments of over sized pistons and rings.

CHECKING THE ECCENTRIC LIFT AND BEARING SURFACE

STEP 47



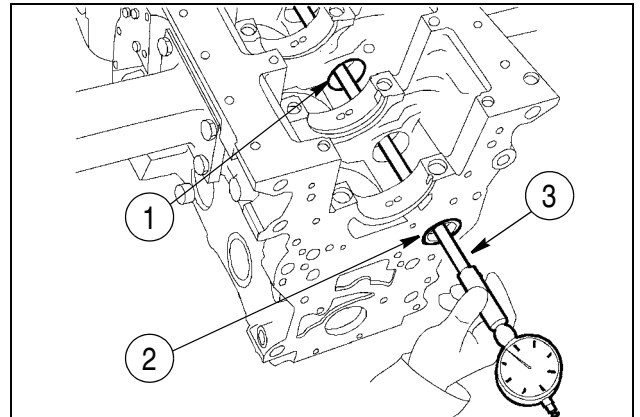
BS06K266

Figure 2-139

Check camshaft with a micrometer (1) the bearing surface (2) measurement must not have greater than 0.04 mm (0.0016 in.) of wear otherwise replace camshaft. Also check the eccentric (lobe) lift (3), which must be equal to 7.582 mm (0.2985 in.) for exhaust eccentric (lobes). And 6.045 mm (0.2380 in.) for intake eccentrics (lobes). If different values are found than specifications replace the camshaft. Check the diameter of camshaft support journals with a micrometer (1) on two axis perpendicular to each other.

BEARINGS

STEP 48



BS06K267

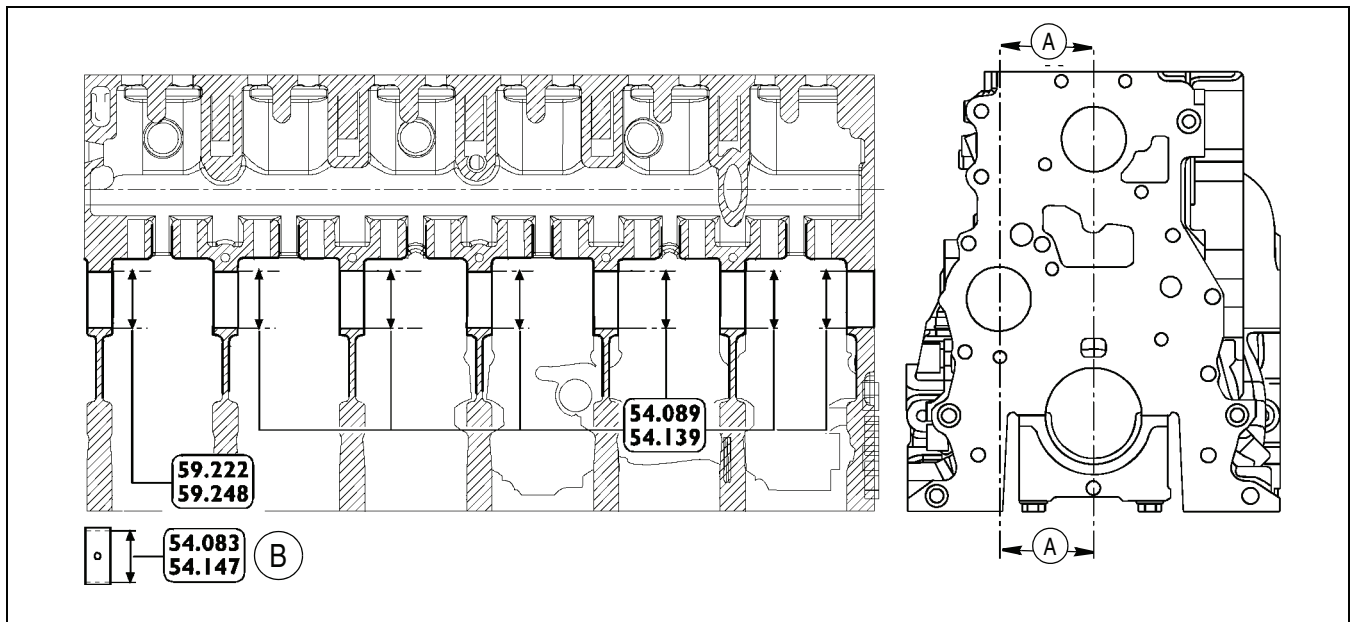
Figure 2-140

The camshaft bearings (2) must be force-fitted into their respective seats.

The inner surfaces must show no traces of seizing or wear.

Use a bore gauge (3) to measure the diameter of front and rear bearings (2) and of camshaft intermediate seats (1).

Measurements must be taken on two axis perpendicular to each other.



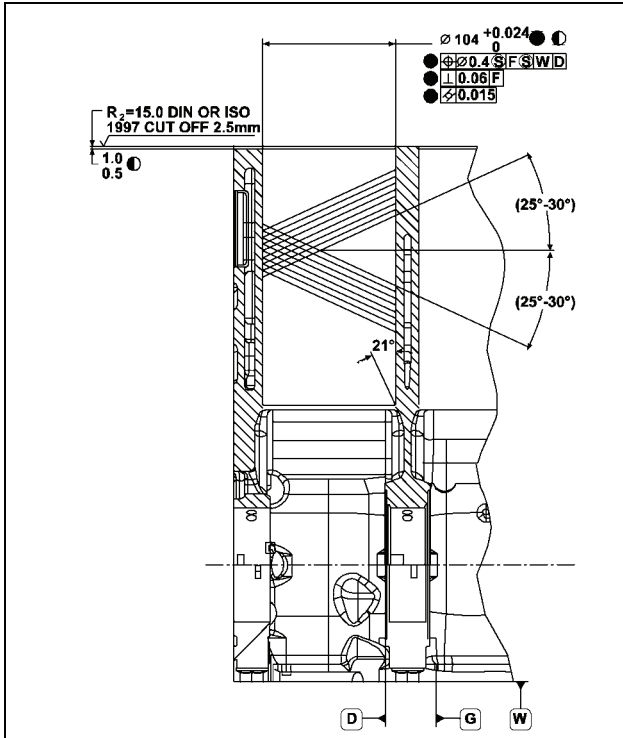
BS06K268

Figure 2-141

MAIN FEATURES OF CAMSHAFT BEARINGS AND THEIR RESPECTIVE SEATS

B-DIMENSIONS AFTER DRIVING THE BEARING

STEP 49



BS06K269

Figure 2-142

CYLINDER BORE DIMENSIONS AND SPECIFICATIONS

IMPORTANT: In case of reconditioning all the bores must be machined to the standard increments of over sized bores 0.5mm (0.02in.).

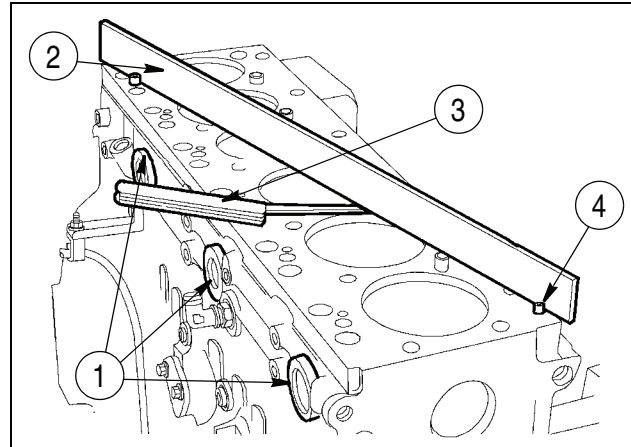
Check the main bearing seats as follows:

- Install the bed caps on the supports without bearing.
- Tighten the fastening bolts to the specified torque.
- Check with a internal comparator, that the seat diameter is the same as the specified value.

If a value is found out of tolerance replace crankcase.

CHECKING THE CRANKCASE CYLINDER HEAD MATING SURFACE

STEP 50



BS06K270

Figure 2-143

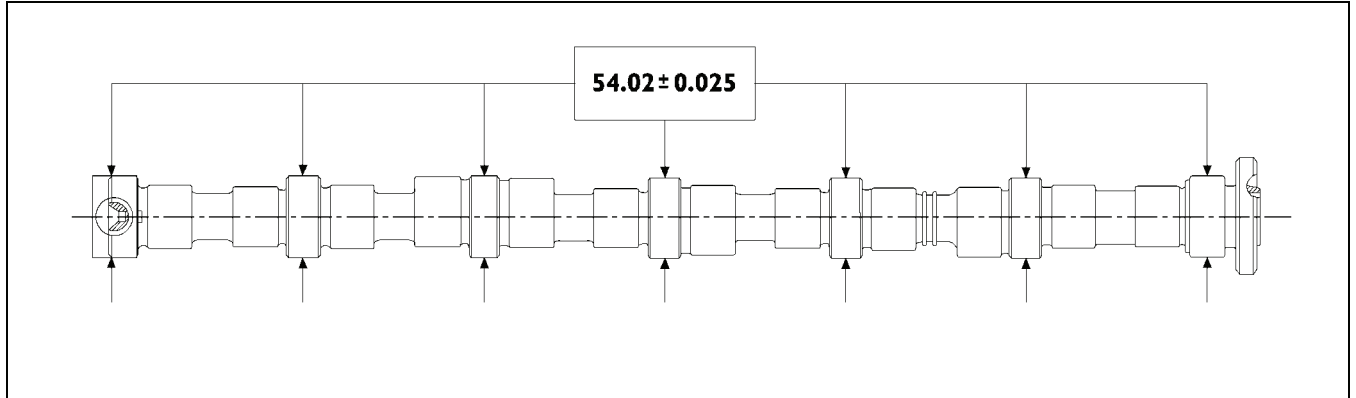
Verify that the crankcase cylinder head mating surface does not show any warping. This check can be accomplished by taking out dowels (4), with a straight edge (2) and a thickness gauge (3). If there are any deformed areas, resurface the block. The warpage must not be greater than 0.075mm (0.0030 in.).

IMPORTANT: When the repair work has been completed, check that the protrusion of the piston from the bore is not greater than the specified value.

After flattening, restore the bore countersink, as shown on page 2-84.

CAMSHAFT TIMING

STEP 51



BS06K271

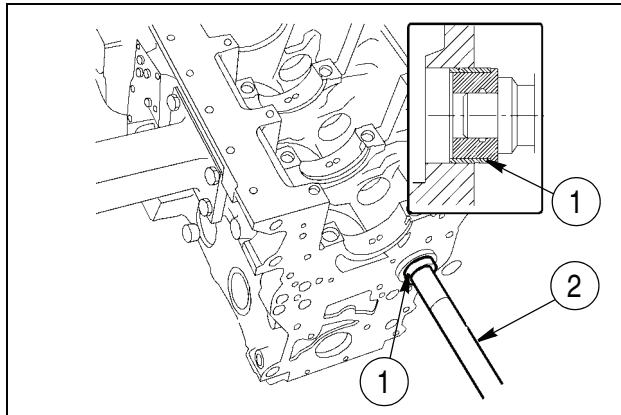
Figure 2-144

MAIN FEATURES OF CAMSHAFT

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

REPLACING THE CAM BEARINGS

STEP 52



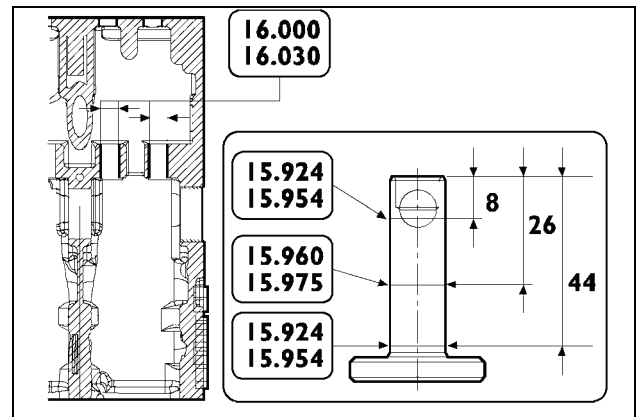
BS06K272

Figure 2-145

When replacing the bearing (1) use a striker (2) and a suitable driver to install.

IMPORTANT: When installing, the bearing (1) must be aligned so that the lubrication holes are aligned with the holes on the engine block seat.

TAPPETS



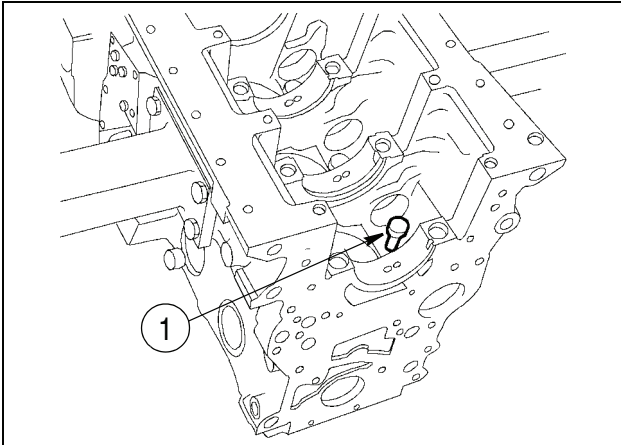
BS06K273

Figure 2-146

MAIN FEATURES OF TAPPETS AND THEIR RESPECTIVE SEATS ON THE CRANKCASE

INSTALLING THE TAPPETS AND CAMSHAFT

STEP 53

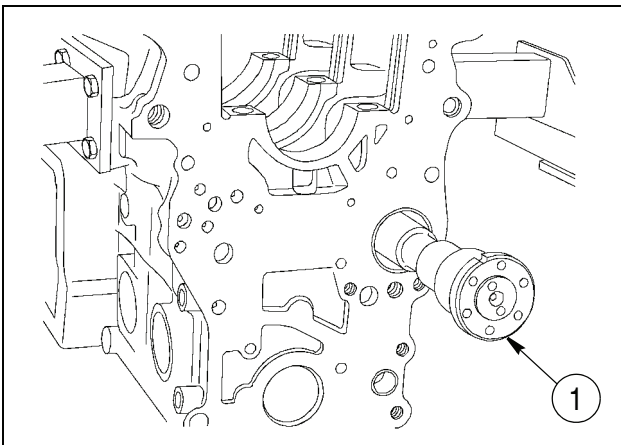


BS06K274

Figure 2-147

Lubricate tappets (1) and install them into their respective seats of the engine block.

STEP 54

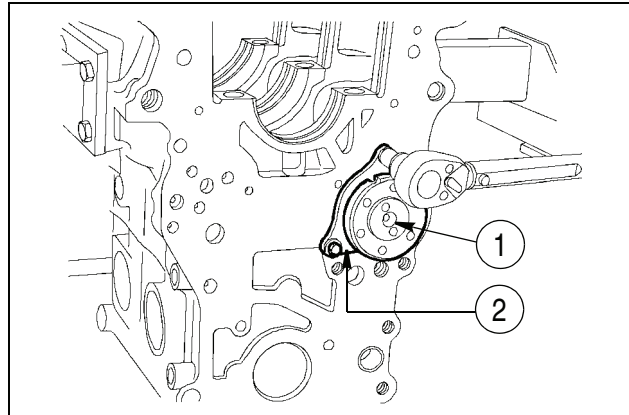


BS06K275

Figure 2-148

lubricate the camshaft support bearings and install camshaft (1) taking care not to damage the bearings or support seats.

STEP 55

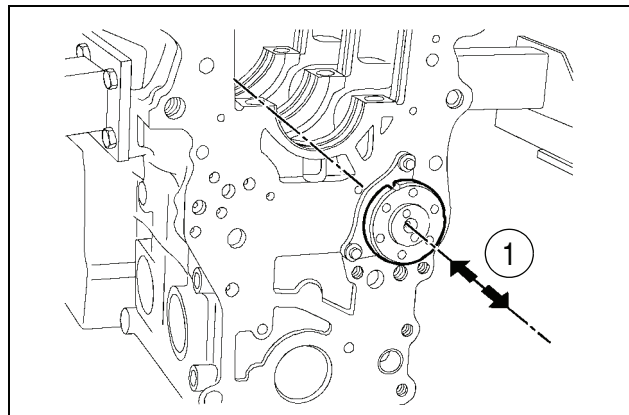


BS06K276

Figure 2-149

Place camshaft (1), retaining plate (2) with the slotted hole facing the engine block upper side and the stamping facing the operator, then tighten bolts to the specified torque 20 to 30 Nm (14.8 to 22.1 lb.-ft.).

STEP 56

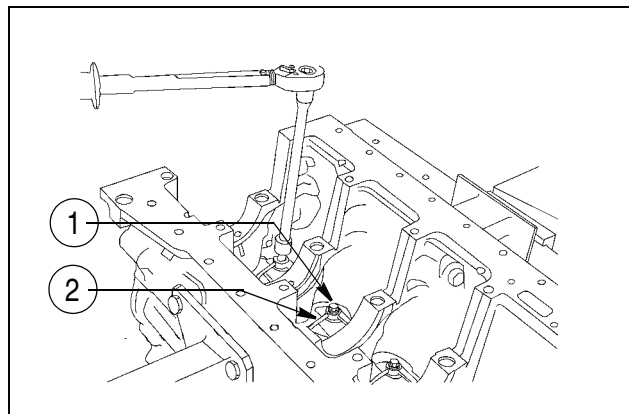


BS06K277

Figure 2-150

Check the camshaft end play (1). It must be between 0.13 - 0.23 mm (0.005 - 0.009 in.).

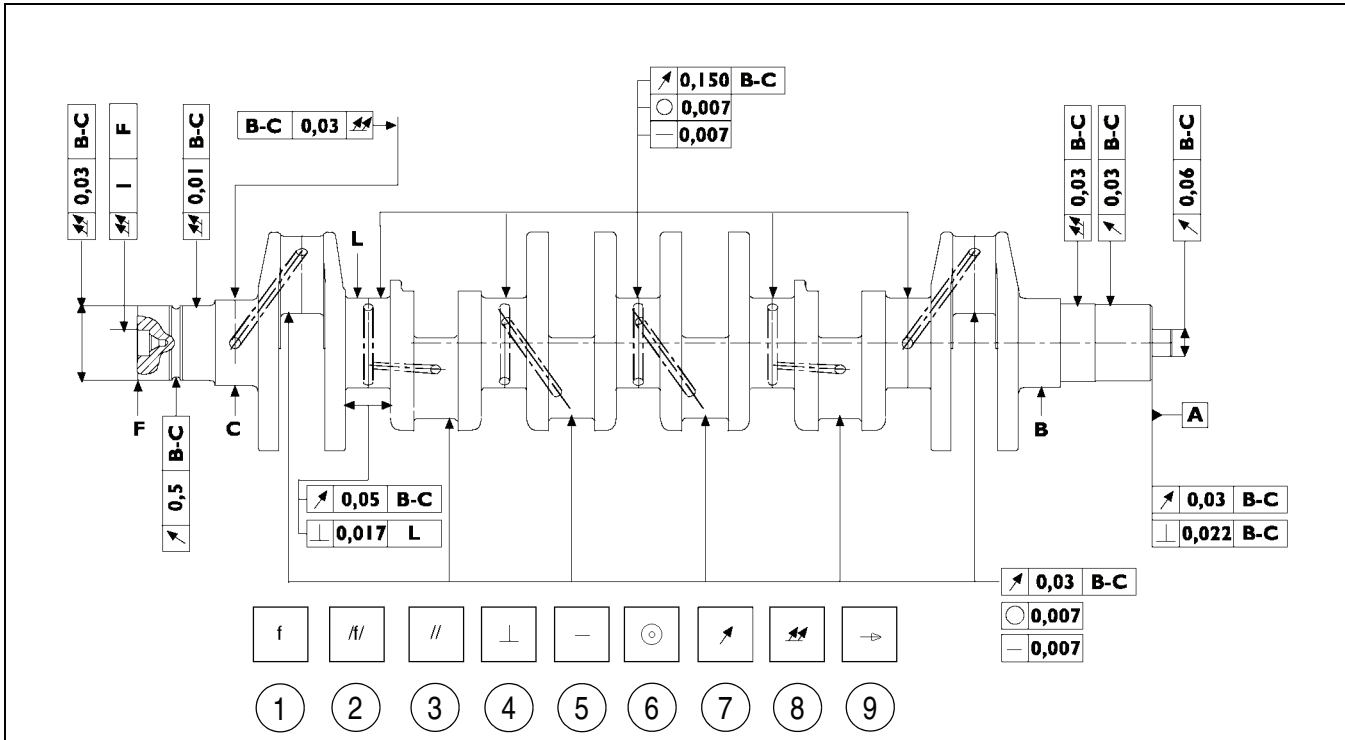
STEP 57



BS06K278

Figure 2-151

Install nozzles (2) and tighten fastening bolts (1) using general bolt torque specifications.

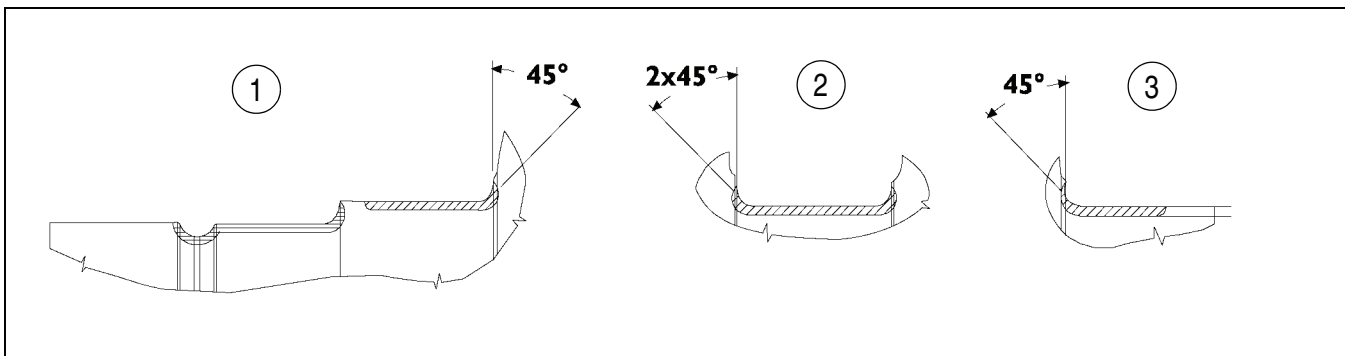


BS06K281

Figure 2-154

MAIN TOLERANCES OF THE CRANKSHAFT

TOLERANCES CONCERNING	TOLERANCE-RELATED-FEATURE	GRAPHIC SYMBOL
SHAPE	Roundness	1
	Cylindrical	2
ORIENTATION	Parallelism	3
	Perpendicularity	4
	Straightness	5
POSITION	Concentricity or Coaxially	6
OSCILLATION	Circular Oscillation	7
	Total Oscillation	8
	Taper	9



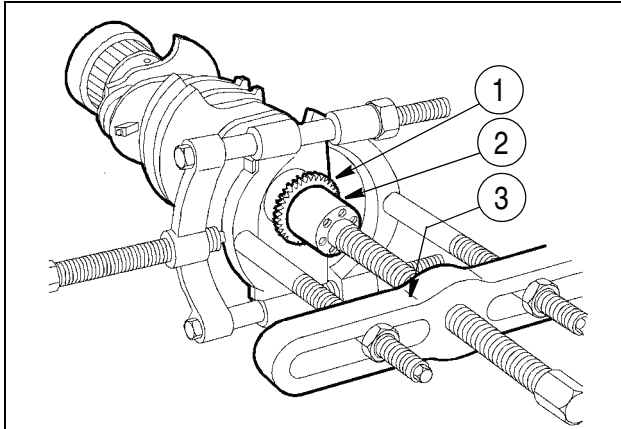
BS06K282

Figure 2-155

1. BEARINGS ON TIMING SIDE
2. BEARINGS ON TIMING SIDE
3. FIRST BEARING ON UPPER SIDE

REPLACING THE OIL PUMP DRIVE GEARS

STEP 59



BS06K283

Figure 2-156

Verify that the teeth of gear (1) are not damaged or worn, otherwise proceed with removal by means of a suitable extractor (3) force-fitted on drive shaft (2).

When installing the new gear, the gear must be heated for 10 minutes in a small furnace at a temperature of $160^{\circ}\text{C} \pm 10\%$ ($320^{\circ}\text{F} \pm 10\%$) and force onto the crankshaft.

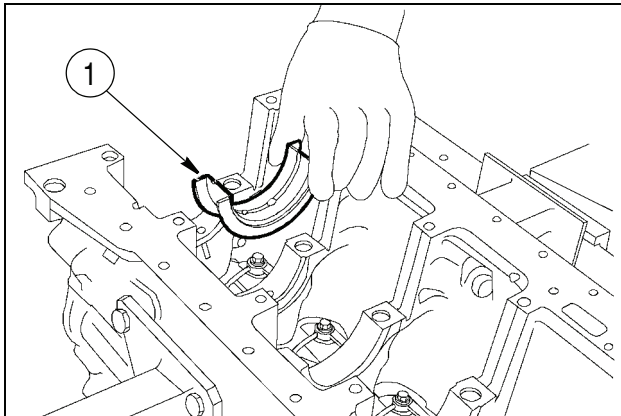


WARNING: Always wear heat protective gloves to prevent burning your hands.

SM121A

INSTALLING THE MAIN BEARINGS

STEP 60



BS06K284

Figure 2-157

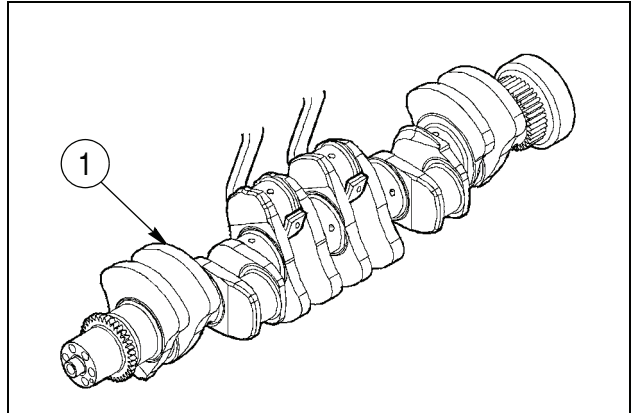
IMPORTANT: If main bearings do not need replacing, they must be installed in the same order and position they had prior to being taken off.

IMPORTANT: Main bearings (1) are supplied as spares, with incrementally reduced inner diameters by 0.25 - 0.50 mm (0.0098 - 0.0197 in.).

Thoroughly clean the main half bearings (1) with lubrication holes, then install them into their seats.

MEASURING THE JOURNAL ASSEMBLY PLAY

STEP 61



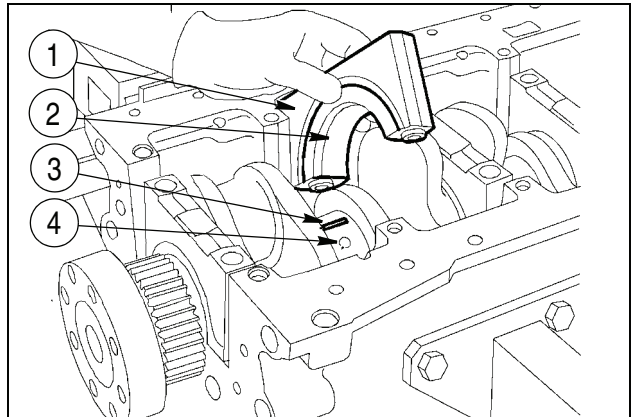
BS06K285

Figure 2-158

Install the crankshaft (1) in engine block.

Check the play between the crankshaft journals and their respective bearings by following the procedure below.

STEP 62



BS06K286

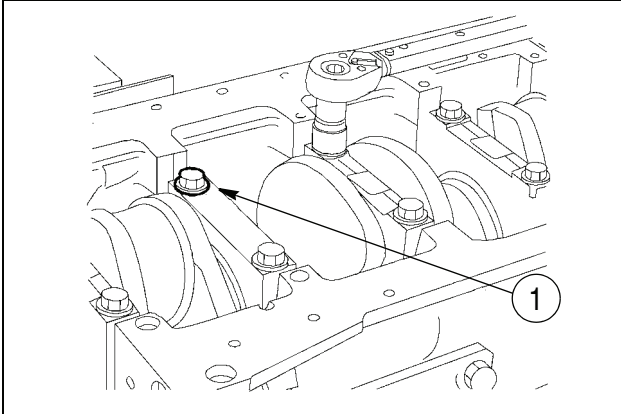
Figure 2-159

Thoroughly clean the parts to eliminate any foreign material and oil.

Place a piece of gauged wire (3) parallel to the axis of the crankshaft pins (4).

Install caps (1), complete with half bearings (2), on their respective supports.

STEP 63



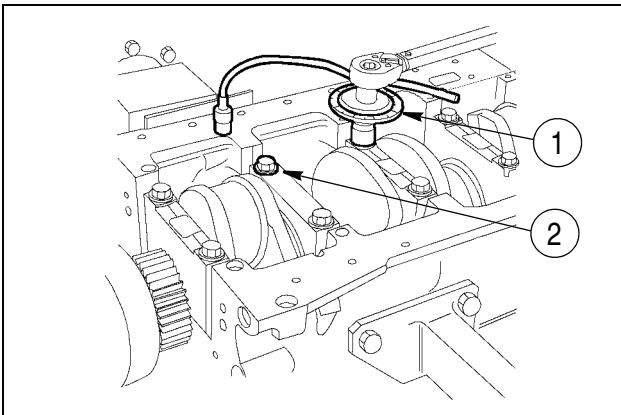
BS06K287

Figure 2-160

Fasten pre-lubricated bolts (1) by tightening them in three phases.

- 1st phase with a torque wrench at 44 - 56 Nm (32.5 - 41.3 lbf ft.).
- 2nd phase with a torque wrench at 74 - 86 Nm (54.6 - 63.4 lbf ft.).

STEP 64

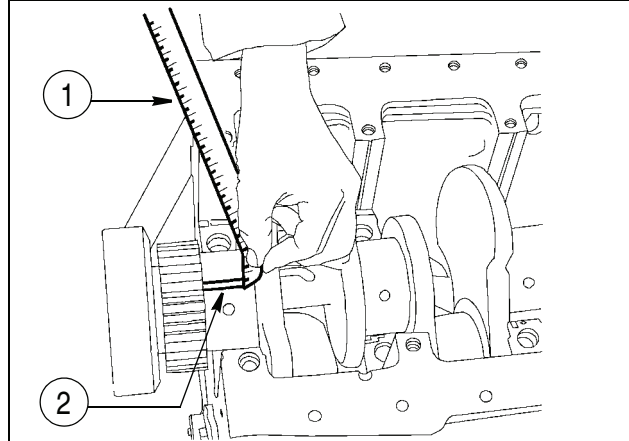


BS06K288

Figure 2-161

- 3rd phase with a suitable tool (1) placed as shown, tighten bolts (2) further to an angle of $90^\circ \pm 5^\circ$

STEP 65



BS06K289

Figure 2-162

Take the caps off the supports.

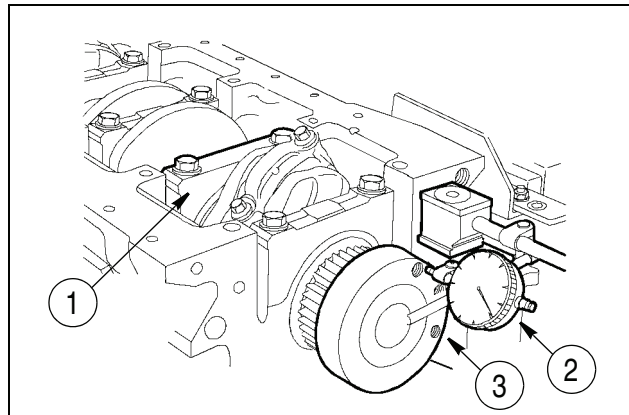
The play between the main bearings and the pins can be found by comparing the width of the calibrated wire (2) at the narrowest point with the scale on the envelope (1) containing the calibrated wire.

The numbers on the scale indicate the backlash in mm. (inches).

Replace the half bearings and repeat the check if a different backlash value is found. Once the specified backlash is obtained, lubricate the main bearings and install the supports by tightening the fastening bolts as previously described.

CHECKING CRANKSHAFT SHOULDER PLAY

STEP 66



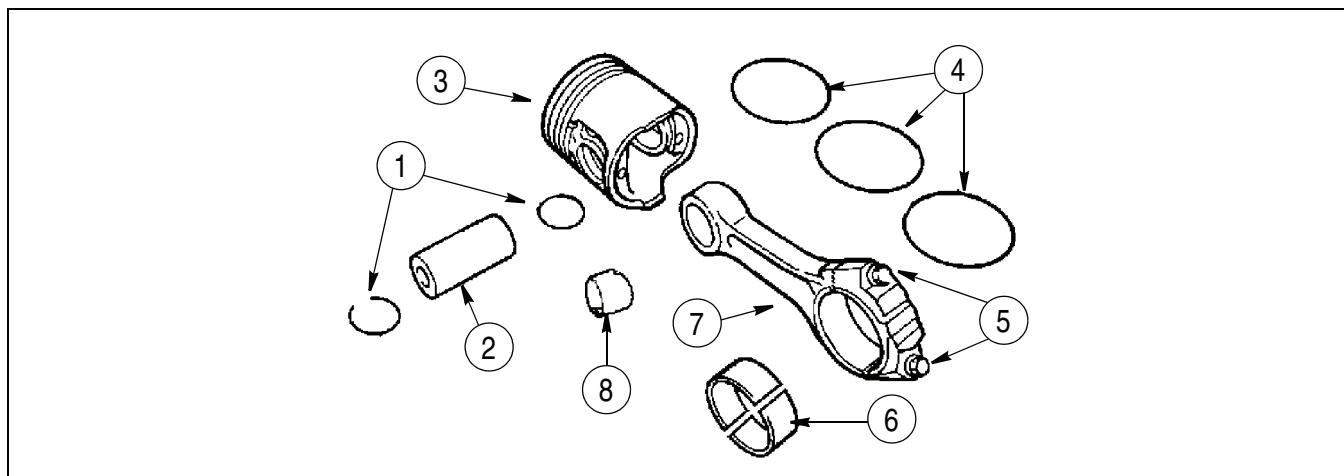
BS06K290

Figure 2-163

The shoulder play is checked by placing a magnetic comparator (2) on the drive shaft (3) as shown in the figure: normal assembly play is 0.068 to 0.410 mm (0.0027 to 0.0161 in.).

If play falls out of the window, replace the main thrust half bearings of the second last rear support (1) and repeat the clearance check between output shaft pins and main half bearings.

CONNECTING ROD-PISTON ASSEMBLY

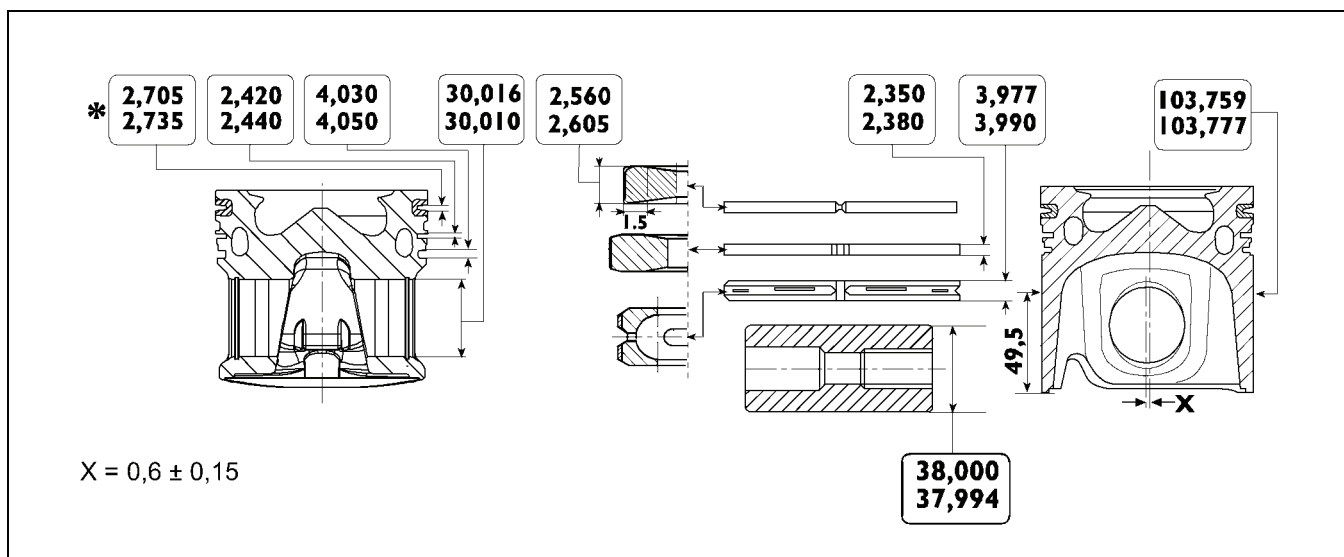


BS06K291

Figure 2-164

PARTS MAKING UP THE CONNECTING ROD - PISTON ASSEMBLY

- | | | | |
|--------------------|-----------------|------------------|-------------------|
| 1. RETAINING RINGS | 3. PISTON | 5. ROD CAP BOLTS | 7. CONNECTING ROD |
| 2. WRIST PIN | 4. PISTON RINGS | 6. HALF BEARINGS | 8. BEARING |



BS06K296

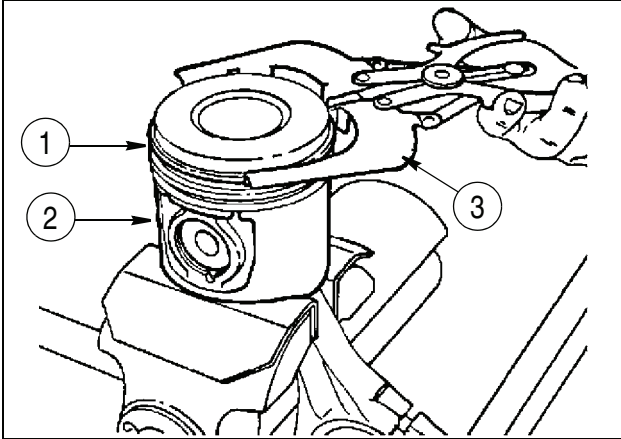
Figure 2-165

DATA ON PISTON, PINS AND SPRING RINGS

* DIMENSION IS TAKEN ON 101 MM DIAMETER

IMPORTANT: *Pistons are supplied as spares
incriminated in sizes by 0.4mm (0.016 in.)*

STEP 67

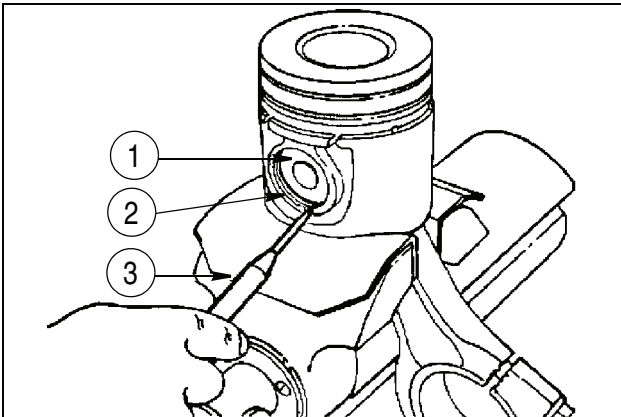


BS06K292

Figure 2-166

Taking piston rings (1) off piston (2) by means of pliers (3).

STEP 68



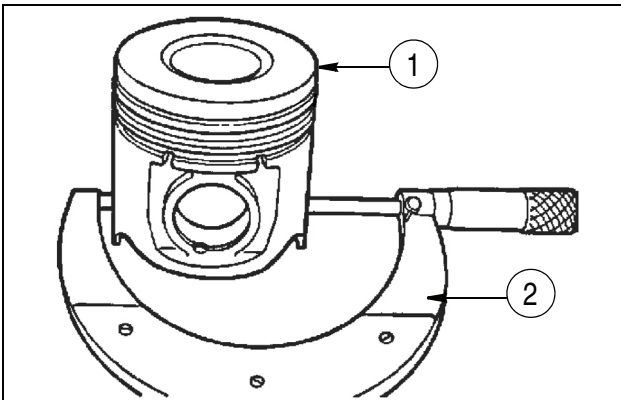
BS06K293

Figure 2-167

The piston rings (2) retaining the piston pin (1) are removed by means of a scribe (3).

MEASURING THE PISTON DIAMETER

STEP 69



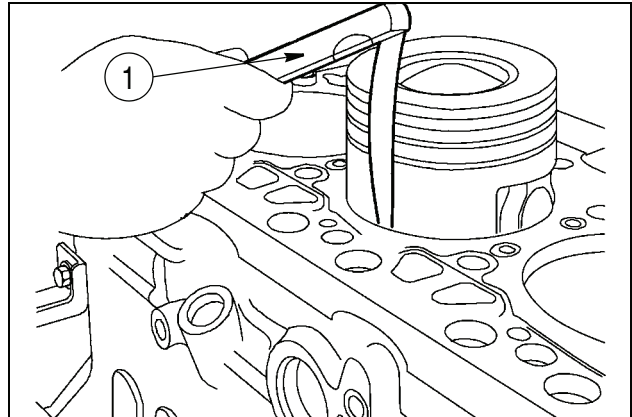
BS06K294

Figure 2-168

Measuring the piston diameter (1) by means of a micrometer (2) to determine the assembly play.

IMPORTANT: The diameter must be measured 49.5mm (1.95 in.) from the piston skirt base.

STEP 70



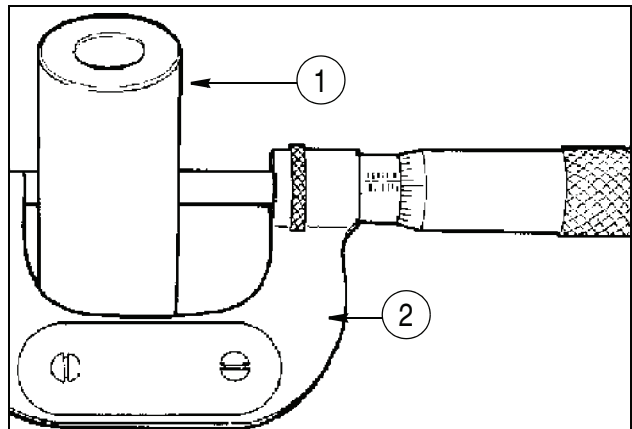
BS06K295

Figure 2-169

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

PISTON PINS

STEP 71



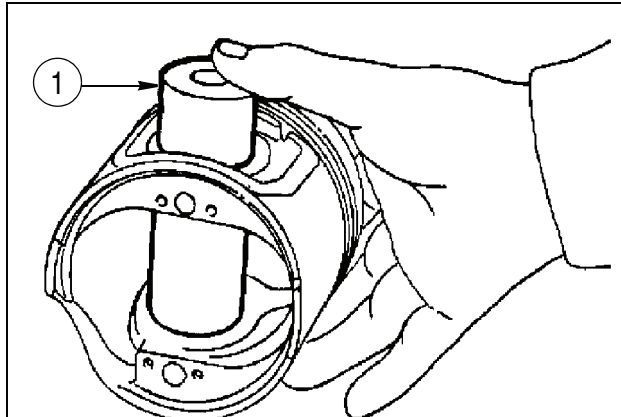
BS06K297

Figure 2-170

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

CONDITIONS FOR CORRECT PIN/PISTON MATCHING

STEP 72



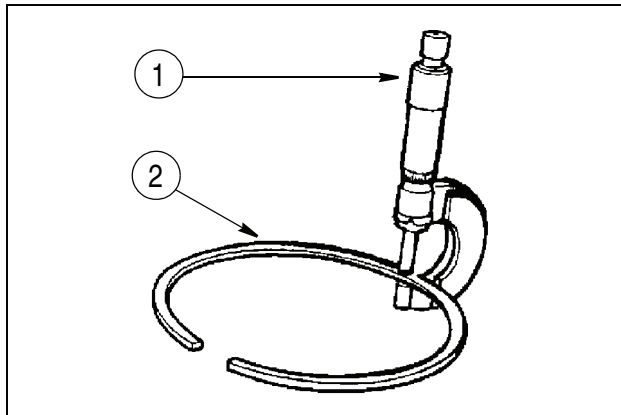
BS06K298

Figure 2-171

Lubricate 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.

PISTON RINGS

STEP 73

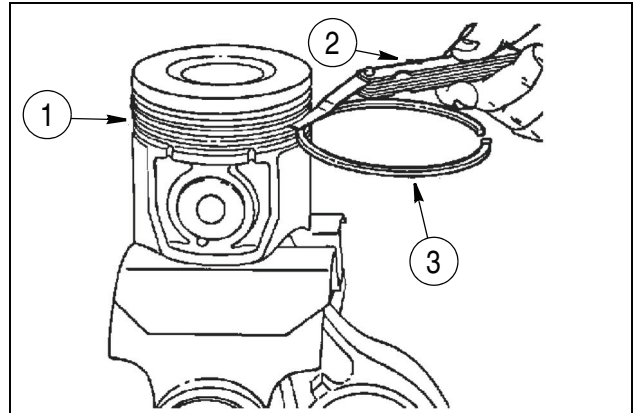


BS06K299

Figure 2-172

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

STEP 74

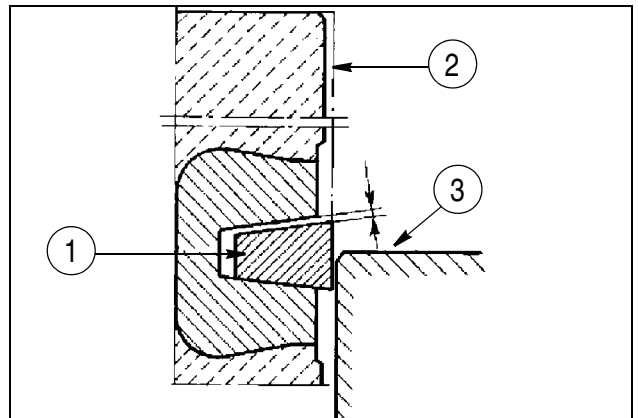


BS06K300

Figure 2-173

Use a thickness gauge (2) to check the play between the seal rings (3) of the 2nd and 3rd slot and the respective seats on piston (1).

STEP 75



BS06K301

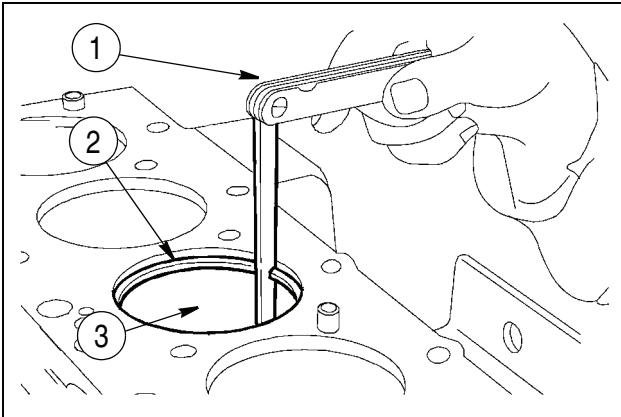
Figure 2-174

SCHEME FOR MEASURING PLAY X FOR THE TRAPEZOIDAL RING

Due to the peculiar shape of the two trapezoidal cross-sectioned seal ring, the play between the slot and the ring itself must be measured as follows.

- Allow piston (1) to protrude from the engine block so that ring (2) protrudes out half way from the cylinder bore (3).
- In this position, check by means of a thickness gauge, the play (X) between the ring and the slot. The value must correspond to the specified value.

STEP 76

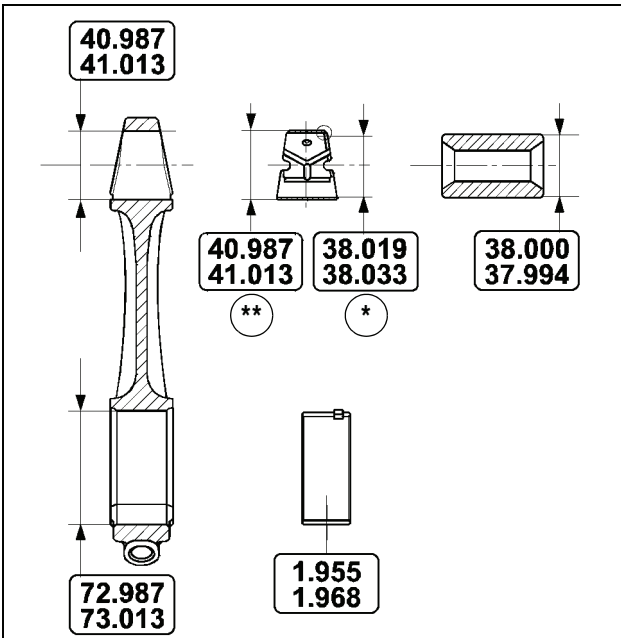


BS06K302

Figure 2-175

Measure the piston ring gap (2) inserted into cylinder bore (3) by means of a thickness gauge (1).

CONNECTING RODS



BS06K303

Figure 2-176

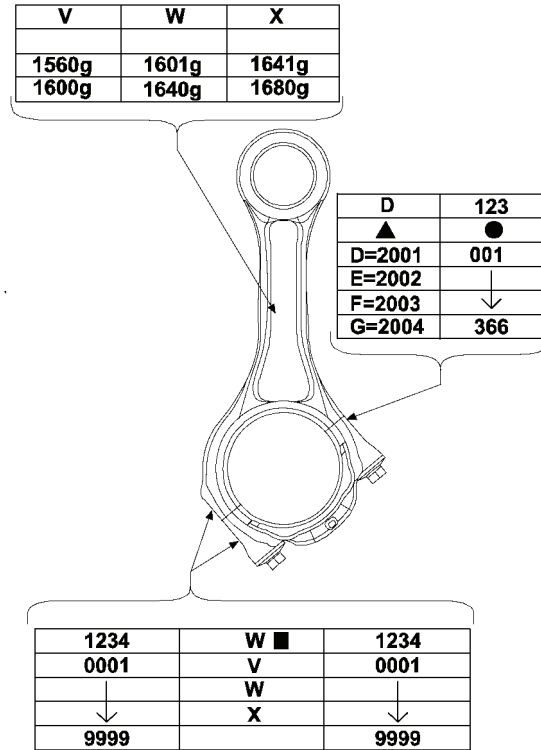
MAIN DATA OF CONNECTING ROD, PISTON PIN BEARING AND HALF BEARINGS

* Value of inner diameter to be obtained after driving in connecting rod small-end and refacing by means of a reamer.

** This dimension cannot be measured in released condition.

IMPORTANT: The connecting rod-connecting rod cap matching surfaces are knurled to ensure better match.

Therefore, it is recommended not to remove knurls.



BS06K304

Figure 2-177

IMPORTANT: Each connecting rod is marked as follows:

- By a number (on the body and cap) which indicates the connecting rod match and the cylinder on which it is installed. In case of replacement, it is necessary to number the new connecting rod with the same number as the replaced one.
- By letter (on the connecting rod body) which indicates the weight class of the factory-assembled connecting rod.

V- 1560 to 1600 (marked in yellow)

W- 1601 to 1640 (marked in green)

X- 1641 to 1680 (marked in blue)

Replacement rods are supplied class W and marked in green.

Material removal is not permitted.

BEARINGS

STEP 77

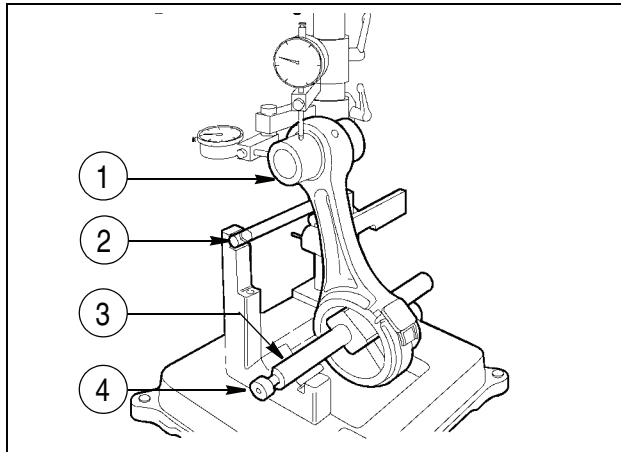
Verify that the bearings in the connecting rod small-end is not loosened and does not show traces of scoring or seizing. If it does replace them.

Removing and reassembling are carried out with the same suitable driver.

When driving the bearings, make sure that the holes allowing oil to flow onto the bearing and the connecting rod small-end correspond to each other. Use a reamer to reface the bearing to obtain the required diameter.

CHECKING THE CONNECTING RODS

STEP 78



BS06K305

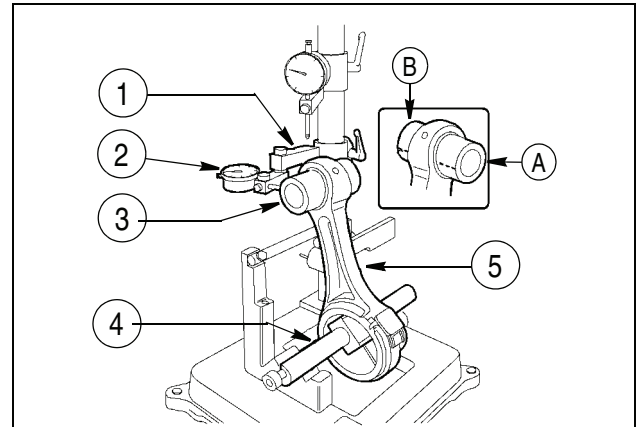
Figure 2-178

Check the centerlines of the connecting rods (1) are parallel using proper device (5) as follows.

- Install connecting rod (1) on tool (5) spindle, then secure it by means of bolt (4).
- Place spindle (3) on V-blocks by putting connecting rod (1) on stop bar (2).

CHECKING THE TWISTING

STEP 79



BS06K306

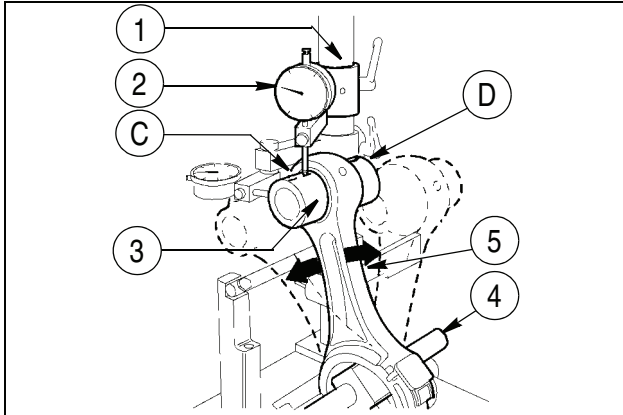
Figure 2-179

Check connecting rod torsion (5) by comparing two points (A and B) of pin (3) on the horizontal plane of the connecting rod axis.

Place comparator (2) support (1) so that the comparator is preloaded by approximately 0.5mm (.02 in.) on pin (3) at point A, then set comparator (2) to zero. Move spindle (4) with connecting rod (5), then compare the deviation (if any) on opposite side (B) of pin (3). The difference between A and B must not be greater than 0.08mm (0.003 in.).

CHECKING THE FLEXING

STEP 80



BS06K307

Figure 2-180

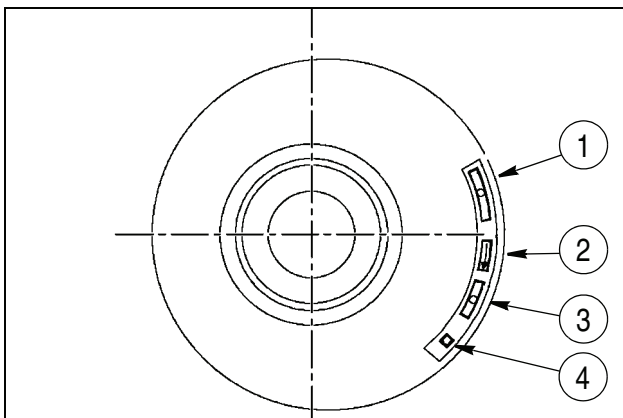
Check connecting rod flexing (5) by comparing two points (C) and (D) of pin (3) on the vertical plane of the connecting rod axis.

Place comparator (2) vertical support (1) so that the comparator rests on pin (3) at point (C).

Swing the connecting rod back and forth, looking for the highest position of the pin. Under such condition, set comparator (2) to zero.

Move the spindle with connecting rod (5) and repeat the highest point check on opposite side (D) of pin (3). The difference between points (C) and (D) must not be greater than 0.08 mm (0.003 in.).

INSTALLING CONNECTING ROD-PISTON ASSEMBLY CONNECTING ROD-PISTON COUPLING



BS06K308

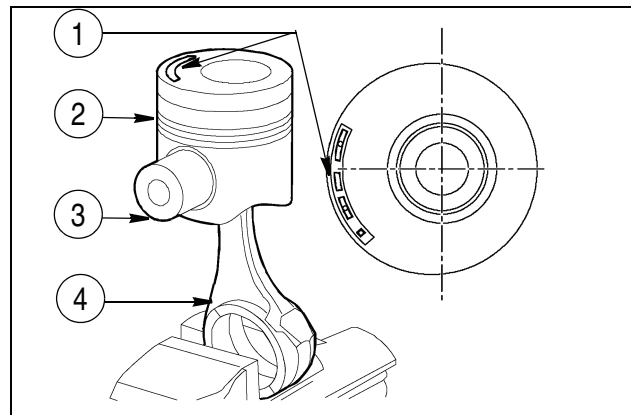
Figure 2-181

The following reference data is engraved on the piston crown.

1. Part number and design modification number
2. Arrow showing piston assembly direction into cylinder bore, this arrow shall face the front key of the engine block.
3. Manufacture date

4. Marking showing 1st slot insert testing.

STEP 81

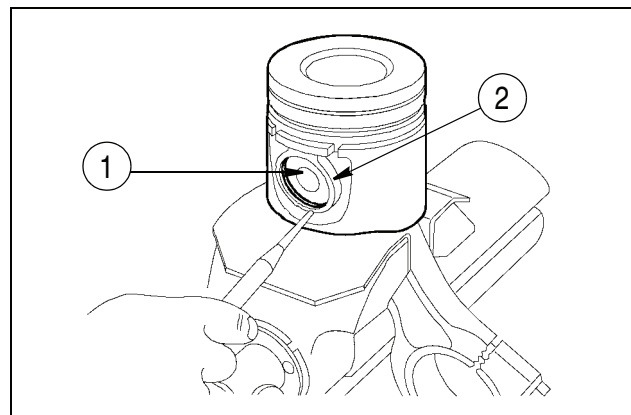


BS06K309

Figure 2-182

Connect piston (2) to connecting rod (4) by means of pin (3) so reference inscription (1) for installing piston (2) in the cylinder bore and the numbers stamped on connecting rod (4) can be seen as shown in the figure.

STEP 82



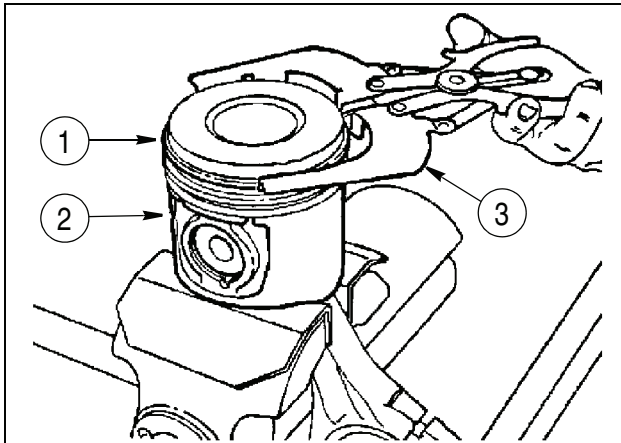
BS06K310

Figure 2-183

insert pin (1) fastening split rings (2)

INSTALLING THE PISTON RINGS

STEP 83



BS06K311

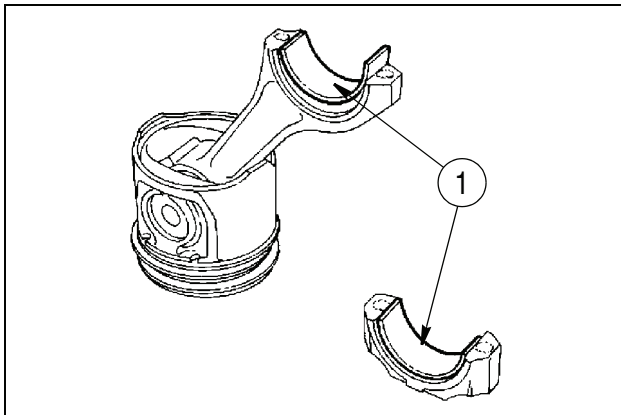
Figure 2-184

Use pliers (3) to install piston rings (1) on piston (2). The rings must be installed with the writing "TOP" facing upwards and they should be inserted so that the ring opens are turned so that they are offset to each other by 120°.

IMPORTANT: Spare piston rings are supplied in the following dimensions:

- Standard, marked with yellow paint.
- Oversized by 0.4mm (0.016 in.), marked with yellow/green paint.

STEP 84



BS06K312

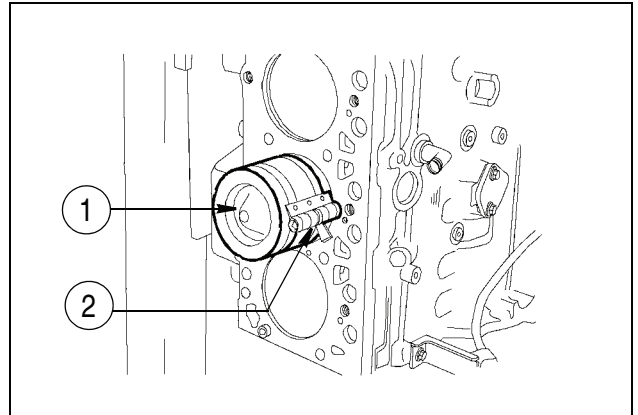
Figure 2-185

Install the half bearings (1) both on the connecting rod and the cap.

IMPORTANT: If connecting rod bearings do not need replacing, they must be installed in the same order and position they had prior to being taken off. No matching operation must be carried out on half bearings.

INSTALLING THE CONNECTING ROD-PISTON ASSEMBLIES IN THE CYLINDER BORES

STEP 85



BS06K313

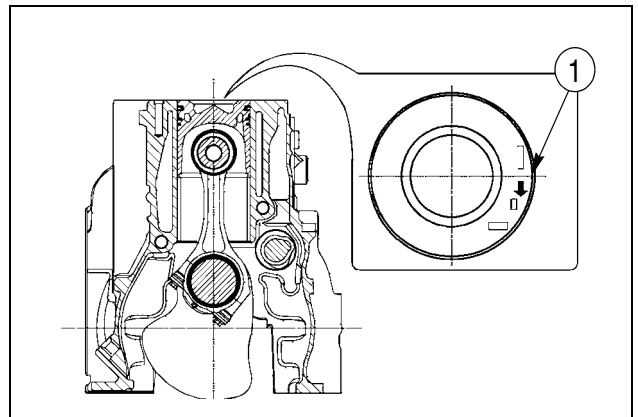
Figure 2-186

Lubricate thoroughly the pistons, including the piston rings and the cylinder bore inside.

Use band (2) to install the connecting rod-piston assemblies (1) into the cylinder bores verify that:

- The number of each connecting rod corresponds to the cap matching number.

STEP 86



BS06K314

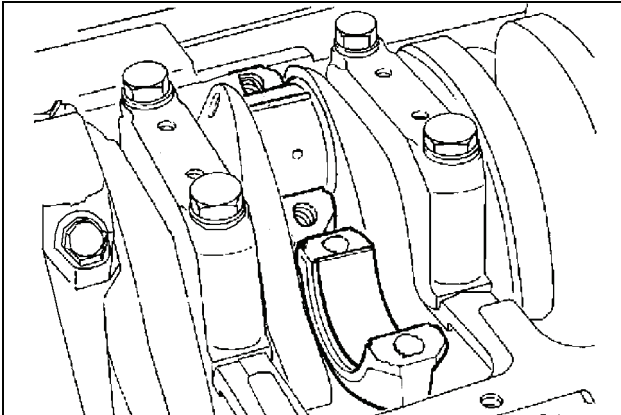
Figure 2-187

SCHEME FOR INSTALLING THE CONNECTING ROD-PISTON ASSEMBLY INTO THE TUNNEL

- The piston ring apertures are offset to each other by 120°.
- All the connecting rod-piston assemblies weigh the same.
- The writing stamped on the piston crown (1) faces the engine block front side, the notch on the piston skirt corresponds to the position of oil nozzles.

MEASURING CRANK PIN ASSEMBLY PLAY

STEP 87

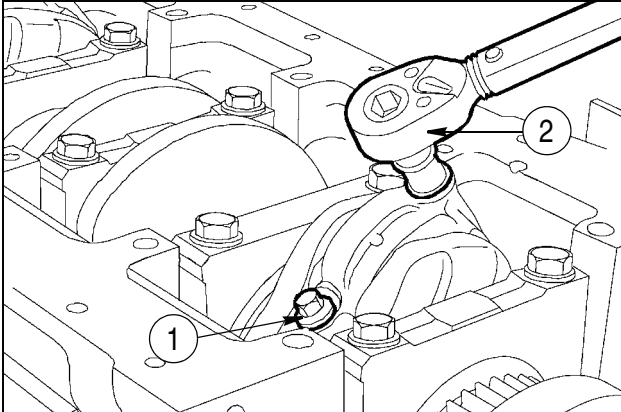


BS06K315 Figure 2-188

The play can be measured by following the procedure below.

- Thoroughly clean the parts and eliminate any traces of oil.
- Place a piece of gauged wire (2) on crankshaft pins (1).
- Install the connecting rod caps (3) with their respective half bearings (4).

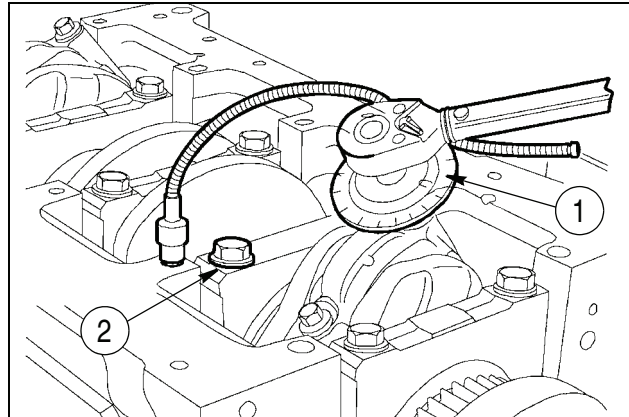
STEP 88



BS06K316 Figure 2-189

Tighten bolts (1) previously lubricated with engine oil to the specified torque by means of a torque wrench (2).

STEP 89

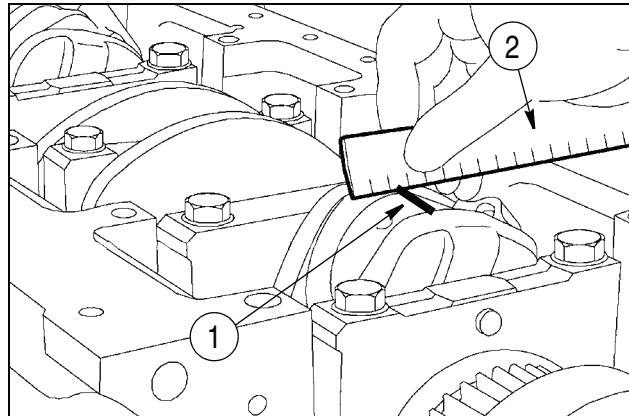


BS06K317

Figure 2-190

Apply a proper tool (1) on the compass wrench, then tighten bolts (2) further in a crisscross sequence. See torque specifications on page 2-14.

STEP 90



BS06K318

Figure 2-191

Take off the cap and calculate the existing play by comparing the width of gauged wire (1) with the scale graduation shown on the wire envelope (2).

STEP 91

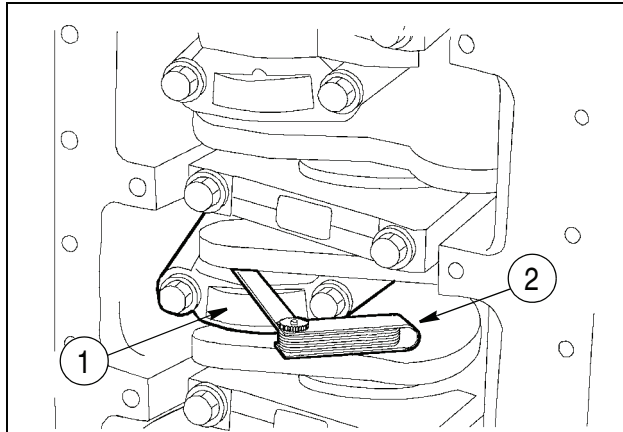


Figure 2-192

If the measured play is different from the specified, replace half bearings and repeat the check. Once the specified play has been obtained, lubricate the connecting rod half bearings and install them by tightening the connecting rod cap fastening bolts to specified torque see Torque Specs. on page 2-14.

IMPORTANT: Prior to installing the connecting rod cap fastening bolts verify that the diameter of the diameter measured at the middle of the thread length is not smaller than 0.1mm (0.004 in.) of the diameter measured at about 10mm (0.39 in.) from the bolt end.

Manually check that connecting rods (1) slide axially on the crankshaft pins, and that the end play measured by means of a thickness gauge (2) is 0.10 to 0.33mm (0.004 to 0.013 in.)

CHECKING PISTON PROTRUSION

STEP 92

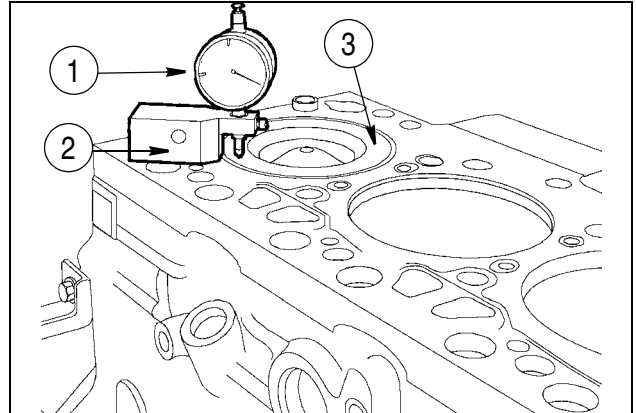


Figure 2-193

After the connecting rod-piston assemblies have been installed, check with a dial indicator (1) equipped with base (2), the protrusion of pistons (3) at the top dead center relative to the engine block upper plane. Protrusion shall be 0.28 - 0.52 mm (0.011 - 0.0205 in.)

TIMING GEAR CASE

STEP 93

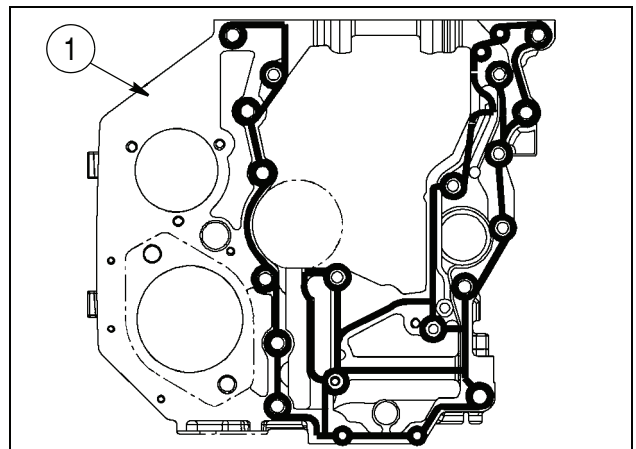
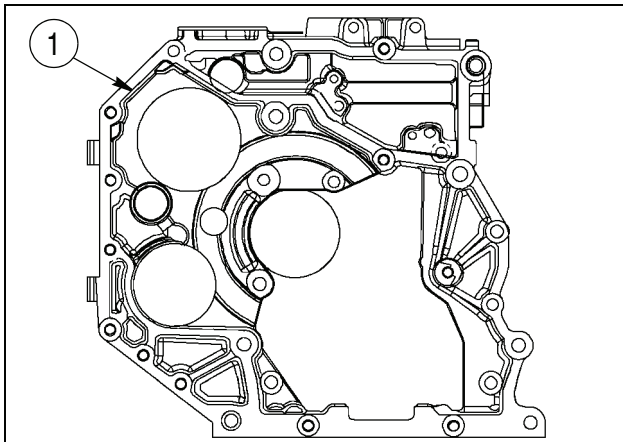


Figure 2-194

SEALANT APPLICATION AREA

Thoroughly clean timing gear box case (1) and the engine block. To obtain a good seal the surface must be clean. Apply a bead of LOCTITE 5205 to the case a few millimeters in diameter. It should be uniform in size without air bubbles, thin areas or voids. Any imperfection should be corrected as soon as possible. Avoid the use of excessive sealant to seal the joint. Excessive sealant could come out from the joint sides and cause lubrication passage clogging. After applying the sealant, the joint should be assembled within (10 - 20 minutes).

STEP 94



BS06K322

Figure 2-195

DIAGRAM FOR TIGHTENING THE REAR TIMING GEAR CASE FASTENING BOLTS

Reconnect the case (1) to the engine block. Screw the fastening bolts in the same position found at removal and tighten them to the following torque values in the sequence shown below.

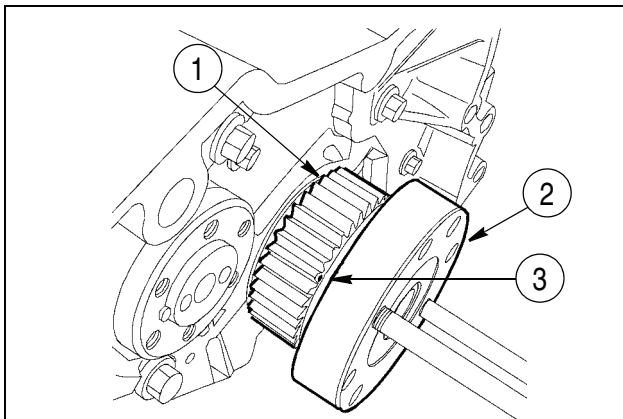
Bolts M12 65 to 89 Nm (48 to 66 lbf. -ft.)

Bolts M8 20 to 28 Nm (15 to 21 lbf. -ft.)

Bolts M10 42 to 52 Nm (31 to 38 lbf. -ft.)

VALVE TIMING

STEP 95

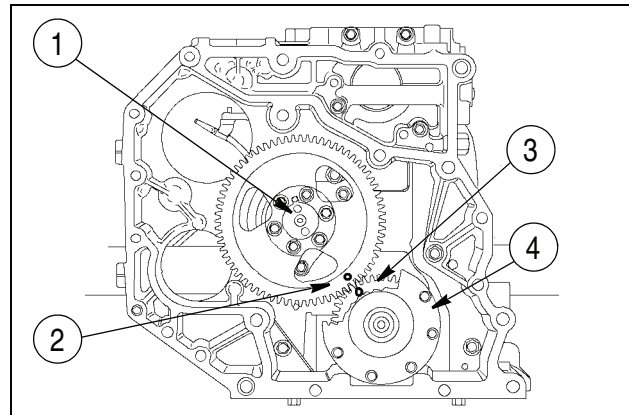


BS06K323

Figure 2-196

Mark with a felt tip pen the tooth (3) of the drive gear (1) installed on the crankshaft (2), having the mark (→) for timing on the side surface.

STEP 96

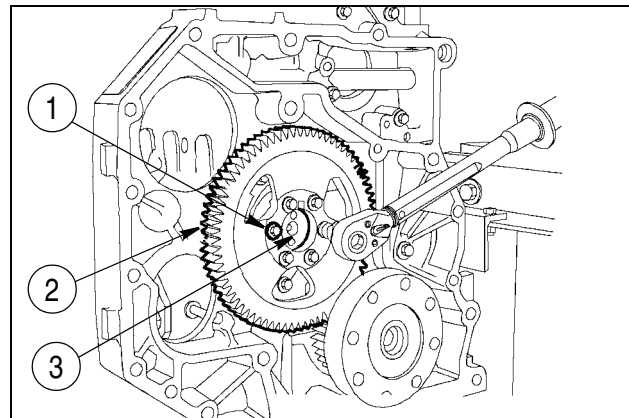


BS06K324

Figure 2-197

Turn crankshaft (4) and camshaft (1) so that when installing the driven gear (2) on the camshaft the marks on the gears (2 and 3) are aligned.

STEP 97



BS06K325

Figure 2-198

Install fastening bolts (1) fastening gear (2) to camshaft (3) and tighten using general bolt torque specifications.

FLYWHEEL COVER CASE

STEP 98

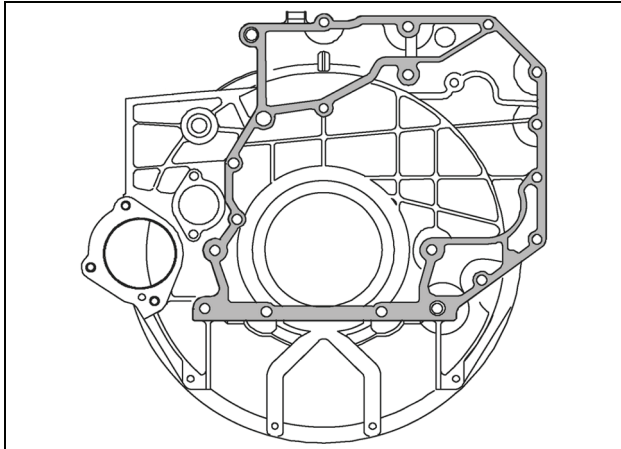
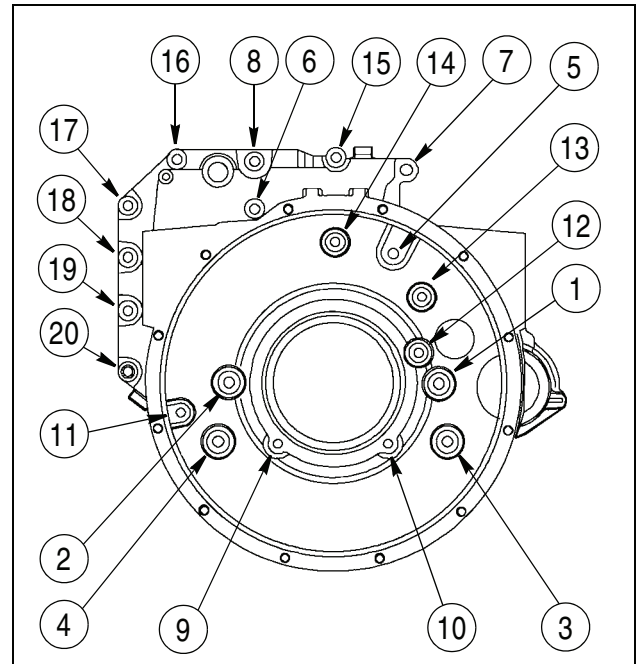


Figure 2-199

SEALANT APPLICATION AREA FOR FLYWHEEL COVER CASE

Thoroughly clean the flywheel housing and timing gear case mating surfaces. A good seal is only obtained by a clean surface area to be sealed. Apply a bead of LOCTITE 5205 to the case a few millimeters in diameter. It should be uniform in size without air bubbles, thin areas or voids. Any imperfection should be corrected as soon as possible. Avoid the use of excessive sealant to seal the joint. Excessive sealant could come out from the joint sides and cause lubrication passage clogging. After applying the sealant, the joint should be assembled within (10 - 20 minutes).

STEP 99



BS06K327

Figure 2-200

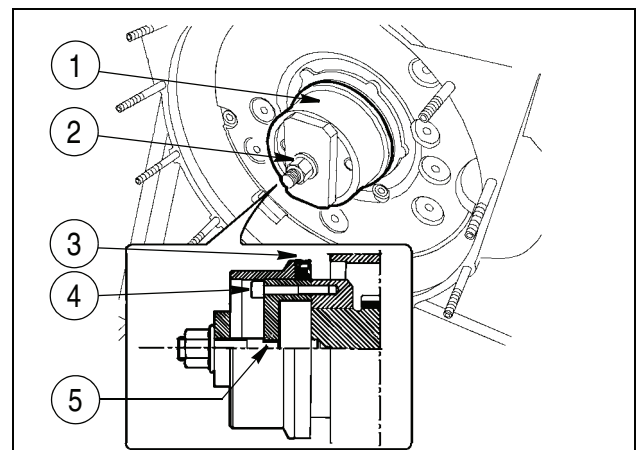
TIGHTENING SEQUENCE FOR FLYWHEEL HOUSING FASTENING BOLTS

Reconnect housing to engine block, screw the fastening bolts back in the same position that they were removed. tighten them to the following torque values in the sequence shown in the figure above.

Bolts M2 75 to 95 Nm (55 to 70 lbf ft.)

Bolts M10 32 to 53 Nm (32 to 39 lbf ft.)

STEP 100



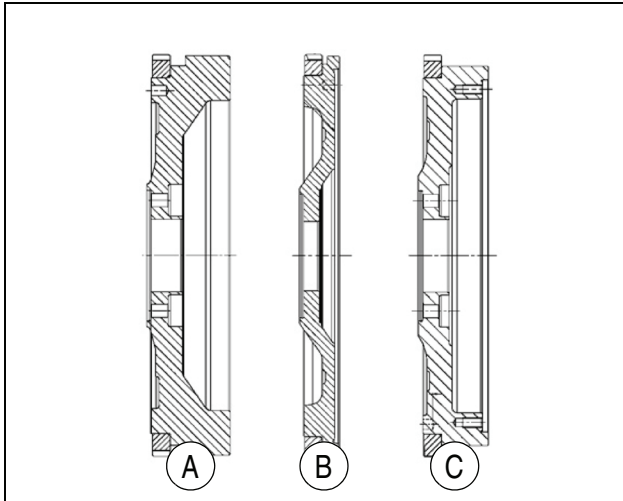
BS06K328

Figure 2-201

Apply part (5) of Special Tool 380000664 on crankshaft rear shank (6), secure it with bolts (4) and force-fit the new seal ring (3).

Position part (1) on part (5), then screw nut (2) to fully mount seal ring (3) in flywheel housing (7).

ENGINE FLYWHEEL



BS06K329

Figure 2-202

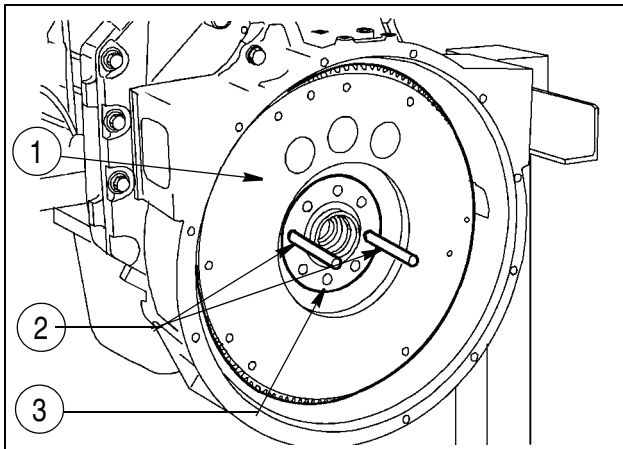
- A. ENGINES: 667TA/EEG - 667TA/EEC
B. ENGINES: 667TA/EBF - 667TA/EED - 667TA/EDJ
C. ENGINES: 667TA/EED - 667TA/EBD

REPLACING ENGINE FLYWHEEL RING GEAR

STEP 101

Check the condition of ring gear teeth. If breaks or excessive tooth wear is found, remove the ring gear from the engine flywheel by using appropriate beater. Then install the new gear ring after heating it to 150° C (302° F) for 15 to 20 minutes. Chamfering on the ring gear must face the engine flywheel.

STEP 102

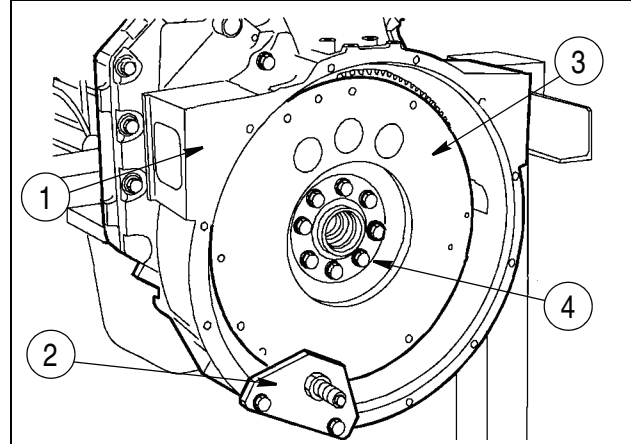


BS06K330

Figure 2-203

Screw two pins (2) of suitable length into the shaft holes (3), then remove the engine flywheel (1) by means of suitable harness and a hoist.

STEP 103



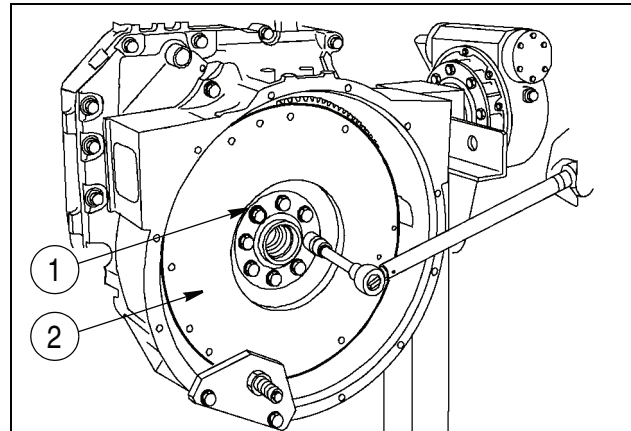
BS06K331

Figure 2-204

Apply tool (2), except for (667TA/EEG - 667TA/EEC engines) to the flywheel case (1) to stop engine flywheel (3) rotation.

Tighten bolts (4) fastening engine flywheel (3) to the crankshaft.

STEP 104



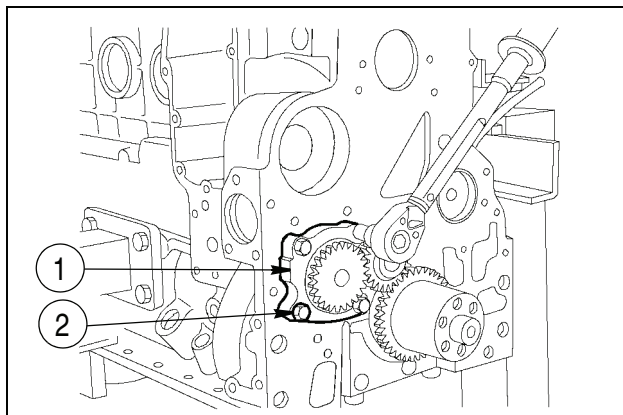
BS06K332

Figure 2-205

Tighten engine flywheel (2) fastening bolts (1) in two separate phases.

- 1st phase- tighten to a torque of 26 to 34 Nm (19 to 25 lbf ft.)
- 2nd phase- Tighten to 60° ± 5°

STEP 105



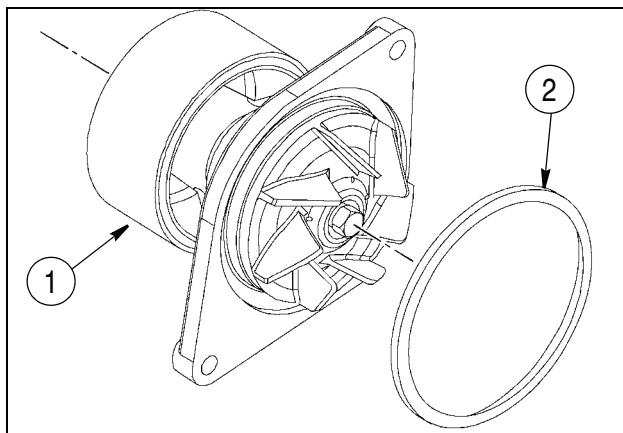
BS06K333

Figure 2-206

Install oil pump (1).

Screw fastening bolts (2) and tighten them to the specified torque 20 to 30 Nm (14.8 to 22.1 lb.-ft.).

STEP 106

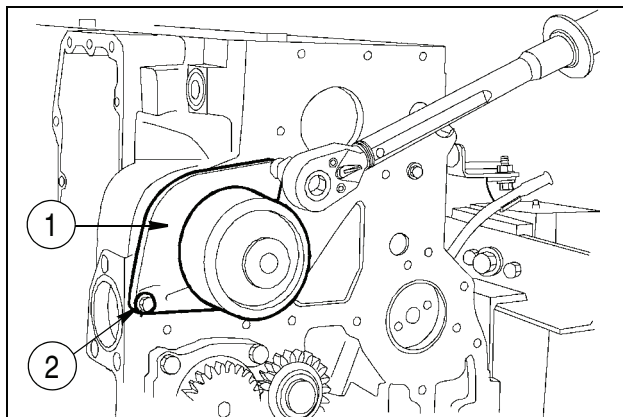


BS06K334

Figure 2-207

Apply a new seal ring (2) to the water pump (1).

STEP 107



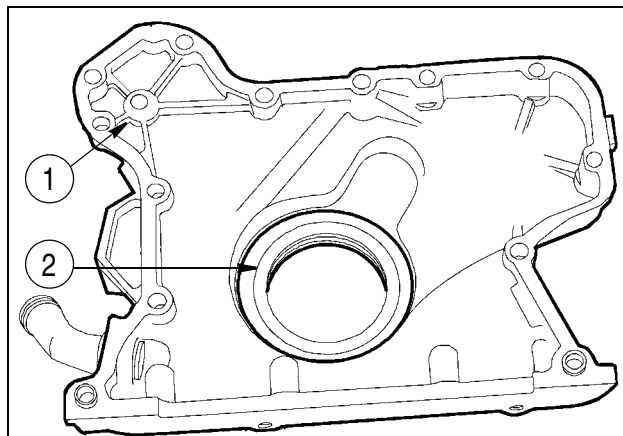
BS06K335

Figure 2-208

Install water pump (1).

Fasten bolts (2) and tighten them to 20 to 30 Nm (14.8 to 22.1 lb.-ft.) specified torque.

STEP 108

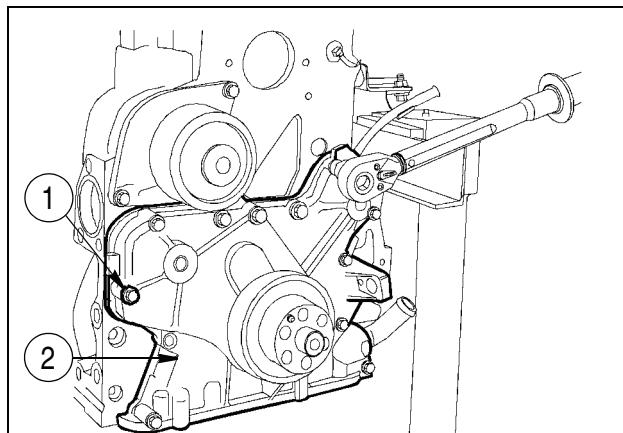


BS06K336

Figure 2-209

Take seal ring (2) off front cover (1), clean surfaces thoroughly and apply Loctite 5205 sealant to the surfaces.

STEP 109

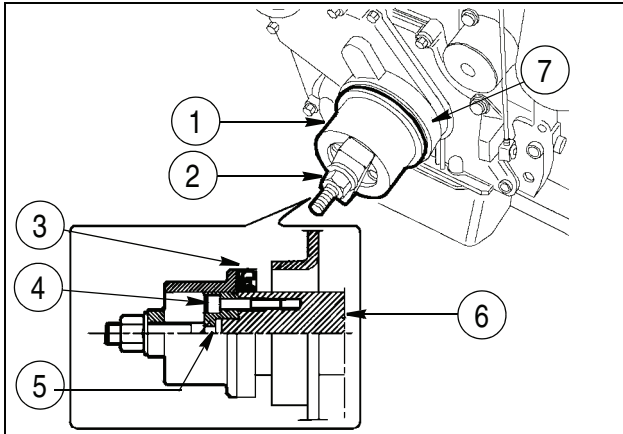


BS06K337

Figure 2-210

Thoroughly clean the surface of the front cover (2) and attach it, with fastening bolts (1) and tighten them to 20 to 30 Nm (14.8 to 22.1 lb.-ft.) specified torque.

STEP 110



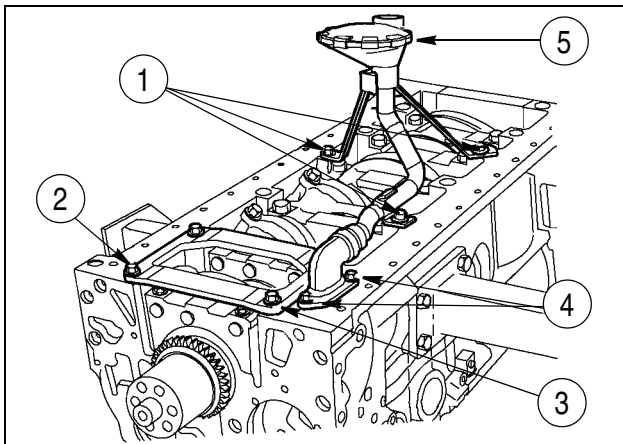
BS06K338

Figure 2-211

Apply special tool (5) 380000666 on crankshaft front shank (6), secure it with bolts (4) and force-fit the new seal ring (3). Position part (1) on part (5), then screw nut (2) to fully mount seal ring (3) in the front cover (7).

STEP 111

Only on engines 667TA/EED- /EBD- /EDJ

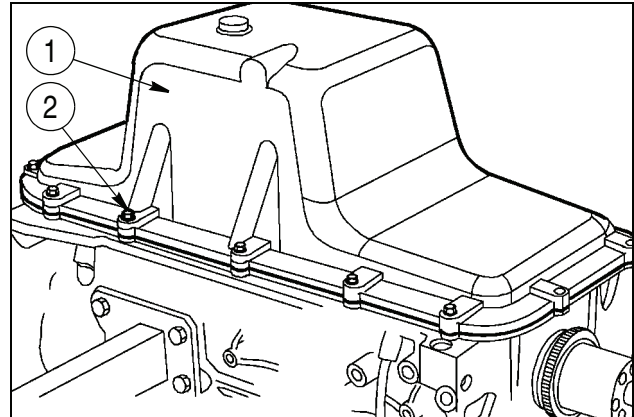


BS06K339

Figure 2-212

Install plate (3) and strainer (5), then screw down fastening bolts (1-2-4) and tighten to the general bolt torque specifications in the repair manual.

STEP 112



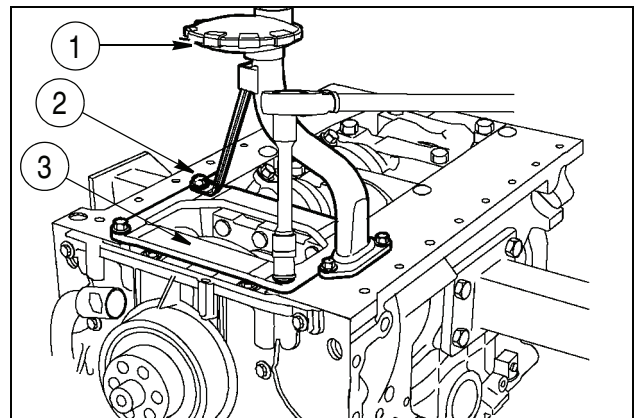
BS06K340

Figure 2-213

Install gasket on cast iron oil pan (sump) (1). And tighten to the general bolt torque specifications in the repair manual.

STEP 113

Only on engines 667TA/EEG- /EEC- /EBF- /EED

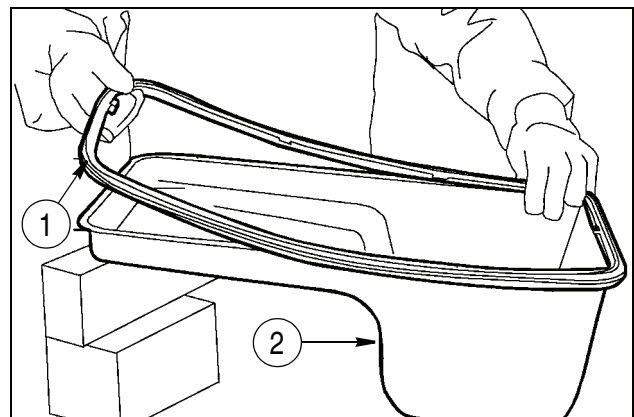


BS06K341

Figure 2-214

Install plate (3), the oil pick up tube (1) and tighten the fastening bolts (2).

STEP 114

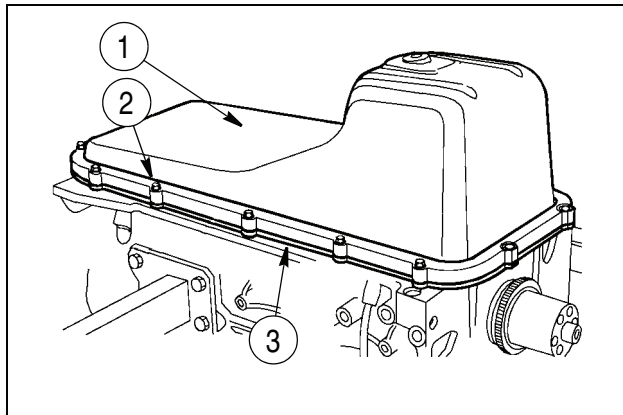


BS06K342

Figure 2-215

Set the gasket (1) on the steel oil pan (sump) (2).

STEP 115

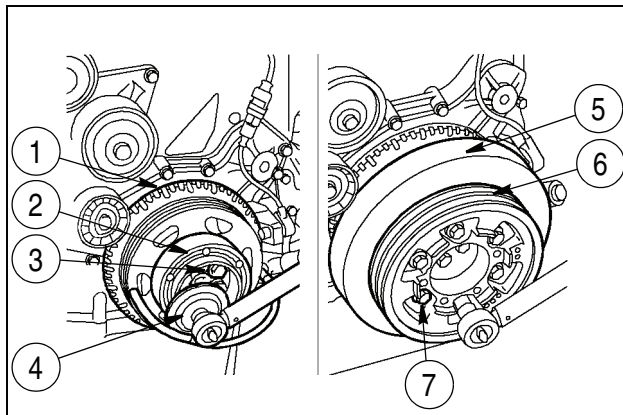


BS06K343

Figure 2-216

Install the oil pan (sump) (1) and apply the aluminium plate (3) to it. Tighten the bolts (2), to the general bolt torque specifications in the repair manual.

STEP 116



BS06K344

Figure 2-217

Install the phonic wheel (1) and hub (2) on crankshaft.

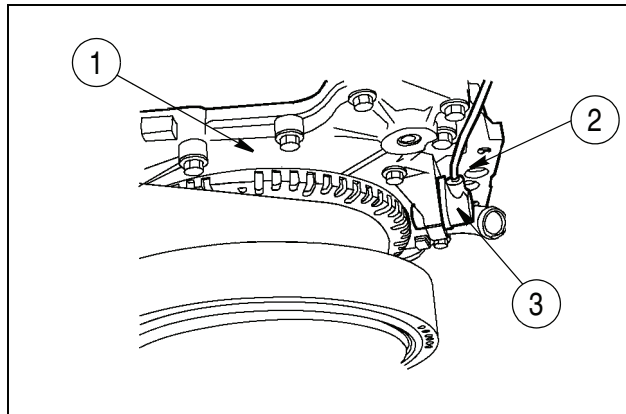
Tighten fastening bolts in two steps.

- 1st step- tighten with a torque wrench to 45 to 55Nm (33 to 40 lbf ft.)
- 2nd step- torque to 90° angle with degree wheel (4)

Install damper flywheel (5) and pulley (6).

Install fastening bolts (7) - torque to 61 to 75 Nm (45 to 55 lbf ft.)

STEP 117



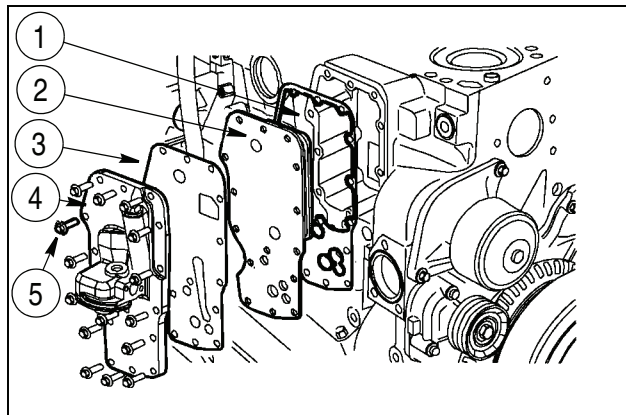
BS06K345

Figure 2-218

Install a new seal ring on RPM sensor (3).

Install RPM sensor (3) on front cover (1) and tighten screw (2), to the general bolt torque specifications in the repair manual.

STEP 118



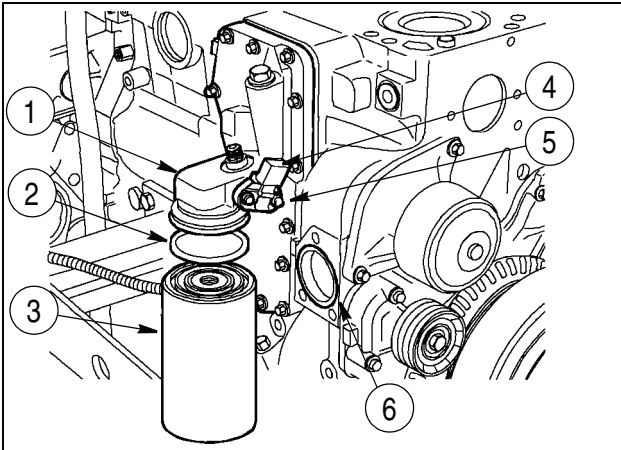
BS06K346

Figure 2-219

Install the following items on the engine block: a new gasket (1), heat exchanger (2), a new gasket (3), and oil filter bracket (4).

Fasten bolts (5) and tighten to 20 to 30 Nm (14.8 to 22.1 lb.-ft.) the specified torque.

STEP 119



BS06K347

Figure 2-220

Lubricate the sealing ring (2) with engine oil and set it on the oil filter (3).

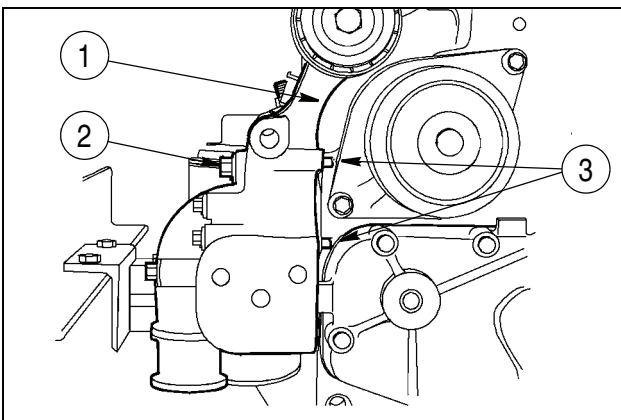
Screw oil filter (3) on the oil filter bracket (1) till gasket makes contact with bracket and then tighten an additional 3/4 turn (except for 667TA/EEG and 667TAEEC engines)

Apply a new sealing ring on the oil temperature/pressure sensor (4) and install it on oil filter bracket (1).

Tighten bolts (5) to 20 Nm (14.8 lb.-ft.) max the specified torque.

Install a new sealing ring (6) in the engine block seat.

STEP 120



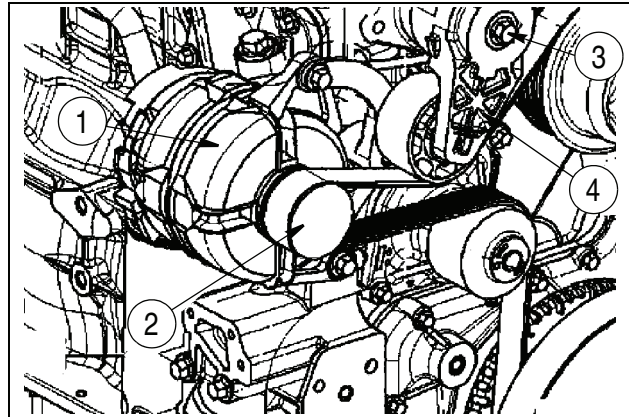
BS06K348

Figure 2-221

Position the alternator support (1) so that pins (3) are set against the engine block.

Tighten the bolts (2) to 40 to 50 Nm (29.5 to 36.9 lb.-ft.) the specified torque.

STEP 121



BS06K349

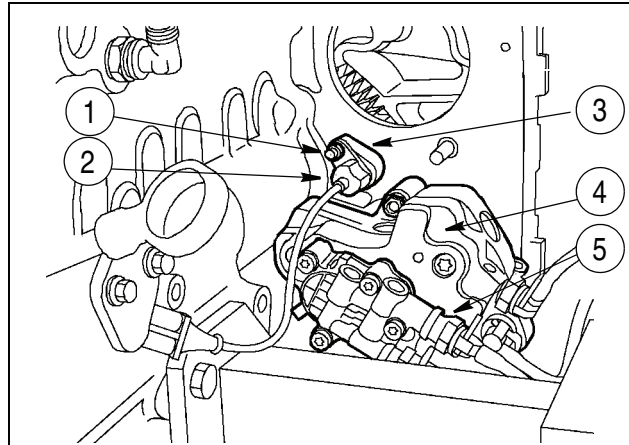
Figure 2-222

Reconnect alternator (1) and tighten the bolts to 40 to 50 Nm (29.5 to 36.9 lb.-ft.) the specified torque.

Reconnect automatic tensioner (4) and tighten bolt (3) to 40 to 50 Nm (29.5 to 36.9lb.-ft.)specified torque.

Turn the automatic belt tensioner (4) to install the belt (2) on pulleys and guide rollers.

STEP 122

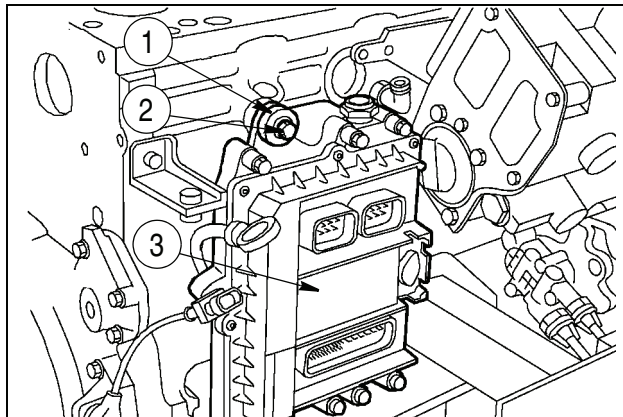


BS06K350

Figure 2-223

Install the high pressure pump (4) including the feed pump (5) and tighten the nuts to the specified torque. Install the support (3) with a new sealing ring, the timing sensor (2) with a new sealing ring and tighten the fastening nut (1), to the general bolt torque specifications in the repair manual.

STEP 123



BS06K351

Figure 2-224

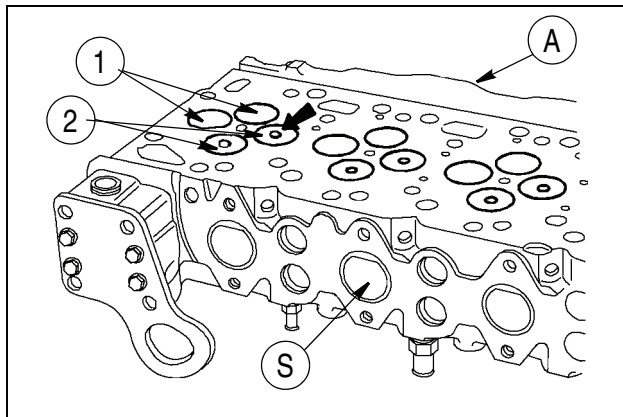
Install the EDC7UC31 electronic control unit (3) including the heat exchanger to the engine block and tighten the bolts (2), to the general bolt torque specifications in the repair manual.

IMPORTANT: Replace the vibration damper elements (1).

CYLINDER HEAD

REMOVING THE VALVES

STEP 124



BS06K352

Figure 2-225

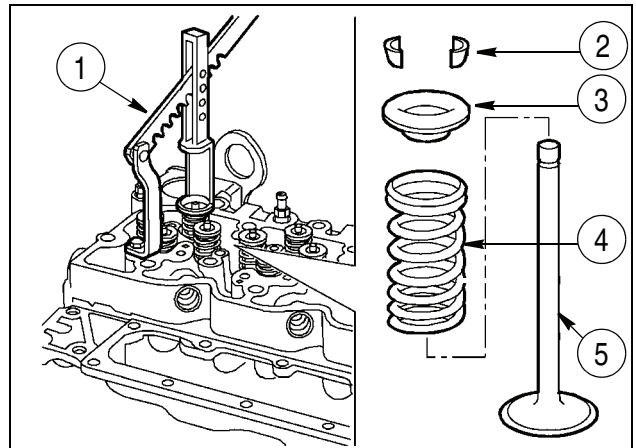
Intake (1) and exhaust (2) valves have heads with the same diameter.

The central notch (→) of the exhaust valve (2) head distinguishes it from the intake valve.

IMPORTANT: Should cylinder head valves not be replaced, number them before removing in order to install them in the same position.

A = Intake side S = Exhaust side

STEP 125



BS06K353

Figure 2-226

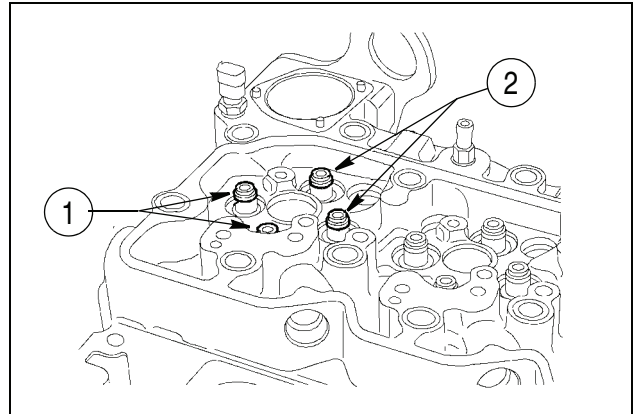
Valves can be removed with a valve spring compressor tool (1) by pressing slightly on collar (3) so that lock cones (2) can be removed by compressing springs (4).

Then remove collar (3) and springs (4).

Repeat the operation on all valves.

Turn the head upside down and remove the valves (5).

STEP 126



BS06K354

Figure 2-227

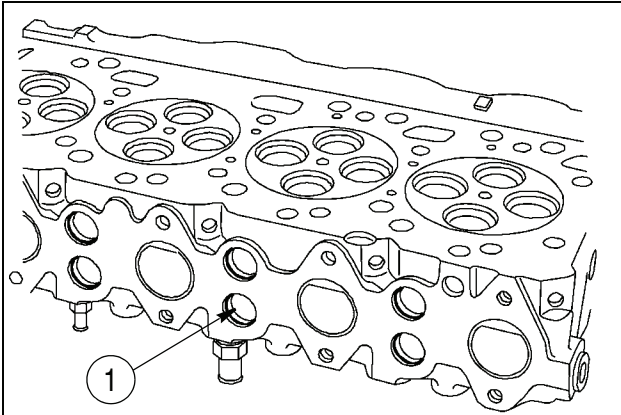
Remove the sealing rings (1 and 2) from the valve guides.

IMPORTANT: Sealing rings (1) for intake valves are yellow.

Sealing rings (2) for exhaust valves are green.

CHECKING CYLINDER HEAD WATER SEAL

STEP 127



BS06K355 Figure 2-228

Check the water seal by means of suitable equipment.

Use pump to feed water heated to 90° C (194° F) at a pressure of 2 to 3 bar (29 to 43 psi.)

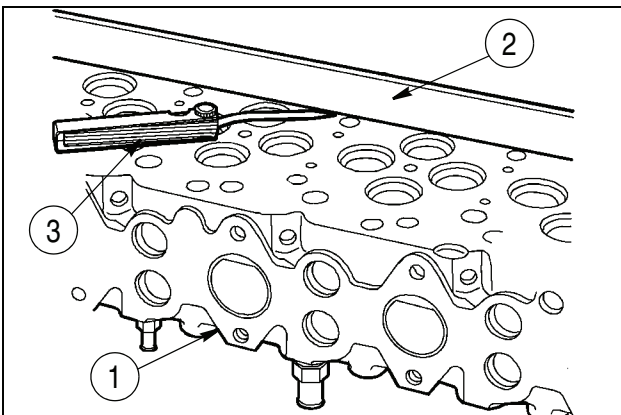
If leaks are detected from the freeze plugs, they must be replaced by using a suitable beater for removal and reassembling operations.

IMPORTANT: Prior to installing the freeze plugs, apply water repellent sealant to them.

If leaks are detected from the cylinder head, the cylinder head must be replaced.

CHECKING THE CYLINDER HEAD MATING SURFACE

STEP 128



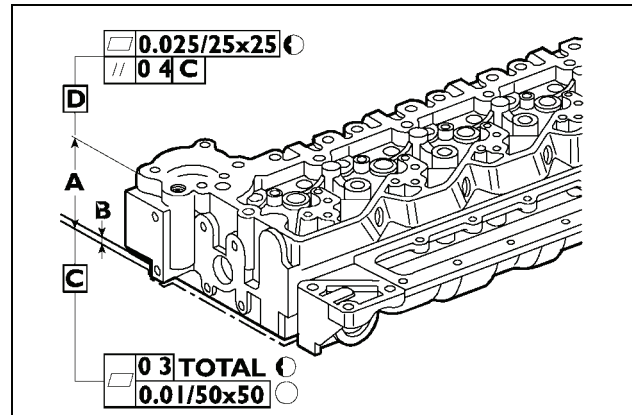
BS06K356 Figure 2-229

The plane of the supporting surface of the head (1) to cylinder cluster is checked by means of a straight edge (2) and a thickness gauge (3).

The warping found on the entire length of the cylinder head must not be greater than 0.20mm (.008 in.).

If greater values are found, reface the cylinder head according to values given in the next step.

STEP 129

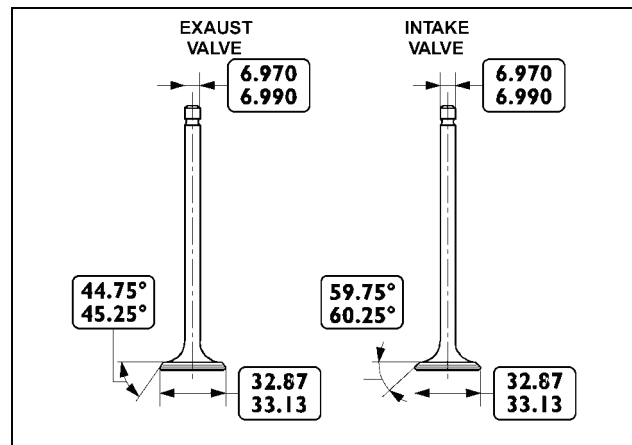


BS06K357 Figure 2-230

The rated thickness "A" of the cylinder head is $105 \pm 0.25\text{mm}$ ($4.134 \pm 0.0099\text{ in.}$). Maximum allowed metal removal must not exceed thickness "B" by 0.13 mm (0.005 in.).

IMPORTANT: After grinding, check valve sinking. Regrind the valve seats if necessary, to obtain the specified value

VALVES

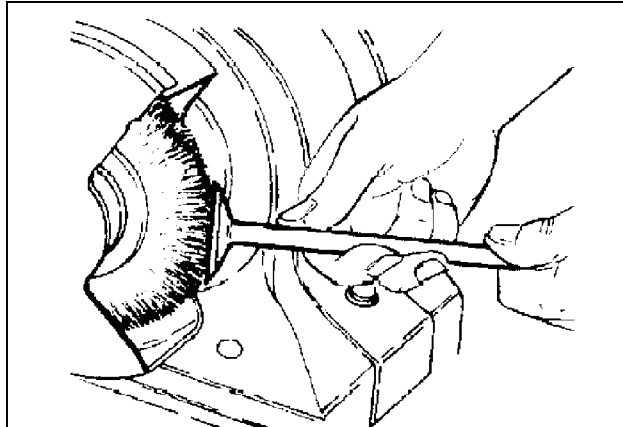


BS06K358 Figure 2-231

INTAKE AND EXHAUST VALVE MAIN DATA

VALVE CLEANING, CHECK AND GRINDING

STEP 130



BS06K359

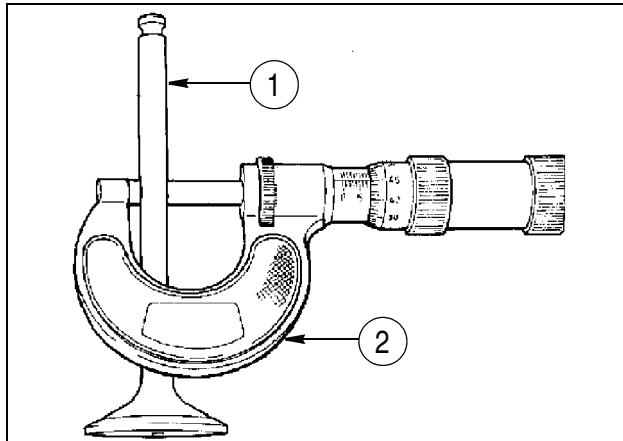
Figure 2-232

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

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

Reface if necessary the valve seats by grinding, removing as little material as possible.

STEP 131



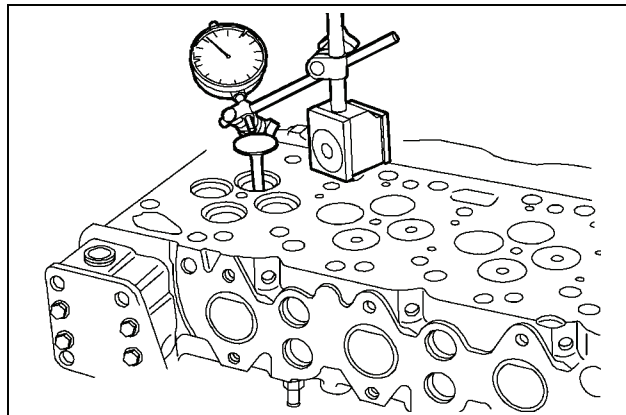
BS06K360

Figure 2-233

Use a micrometer (2) to measure valve stem (1), which must be equal to 6.97 to 6.99mm (0.2744 to 0.2751 in.)

CHECKING ASSEMBLY PLAY, AND VALVE CENTERING

STEP 132



BS06K361

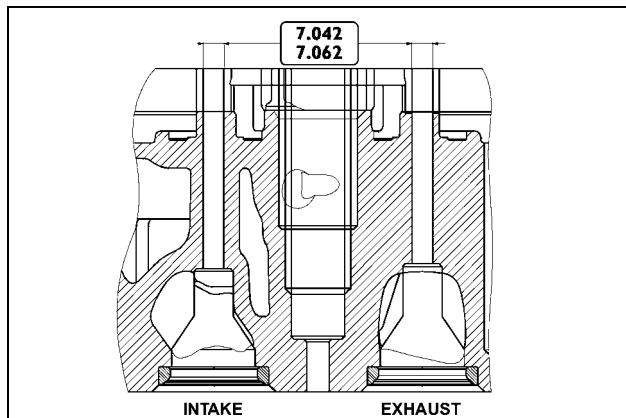
Figure 2-234

Use a magnetic comparator (1) placed as shown. Assembly play must be equal to 0.039 to 0.079 mm (0.0015 to 0.0031 in.)

Turn valve (2) and check that the centering error is not exceeding 0.03 mm (0.0011 in.)

VALVE GUIDE

STEP 133



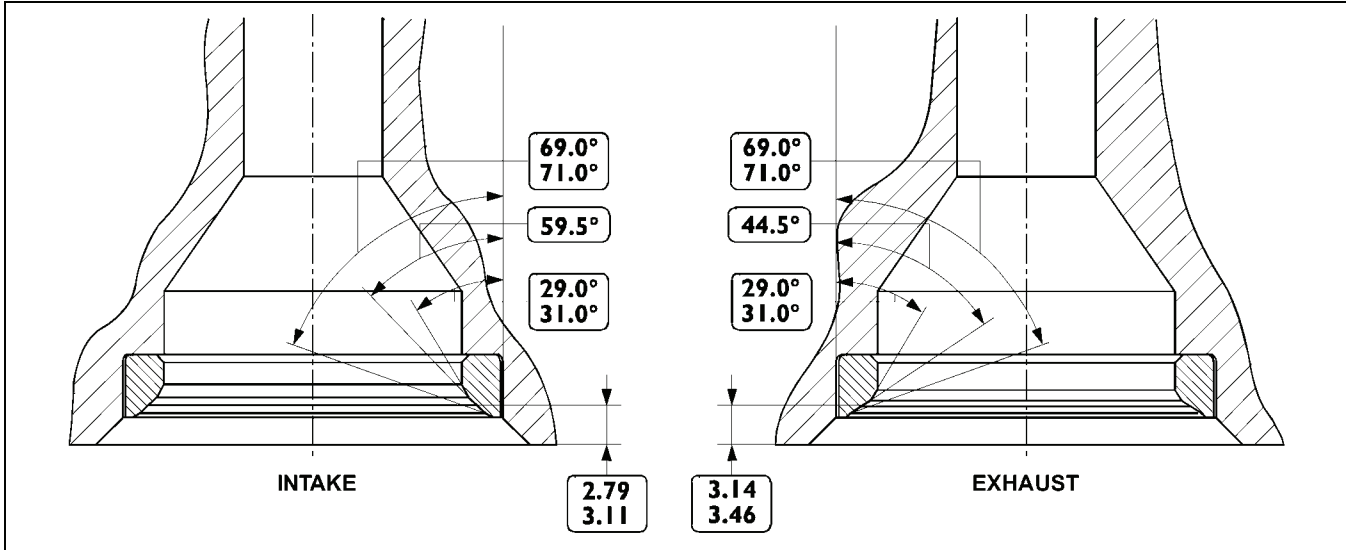
BS06K362

Figure 2-235

Use a bore gauge to measure the valve guide inner diameter, which must be equal to 7.042 to 7.062 mm (0.2772 to 0.2780 in.)

VALVE SEATS

VALVE SEAT RECONDITIONING-REPLACEMENT

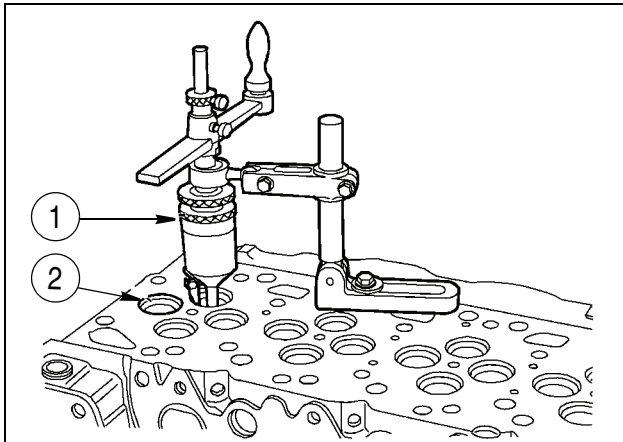


BS06K364

Figure 2-236

MAIN DATA ON VALVE SEATS ON CYLINDER HEAD

STEP 134

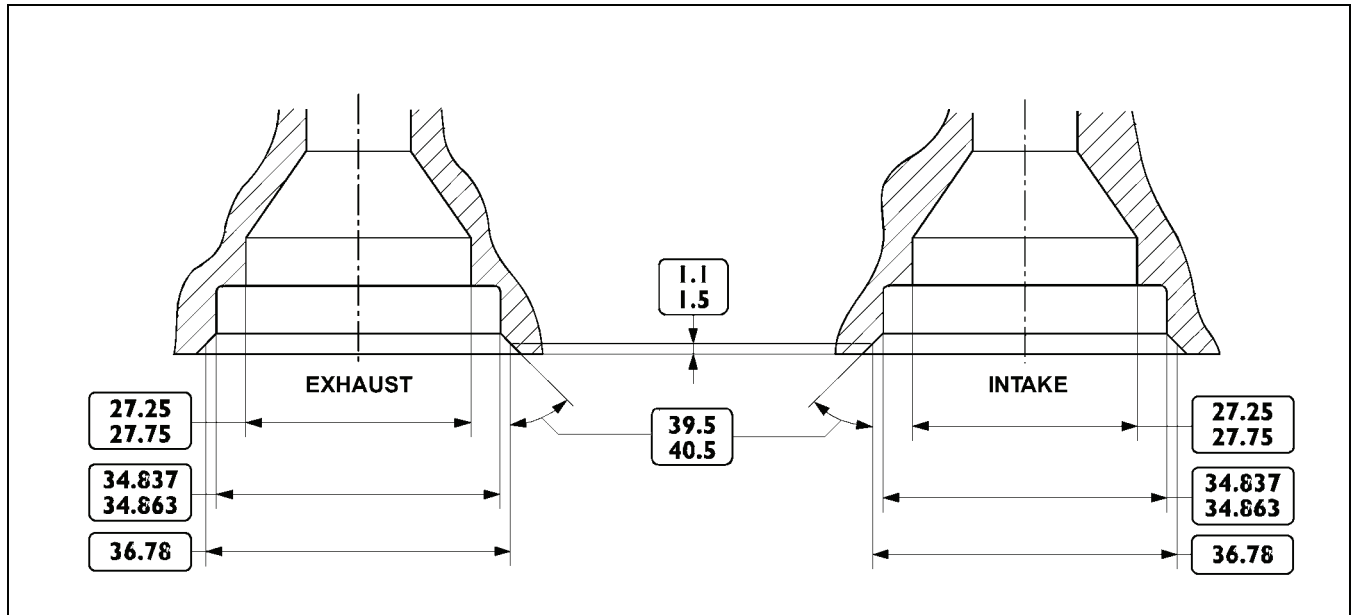


BS06K363

Figure 2-237

Check valve seats (2) if slight scoring or burrs are found, regrind seats with tool (1) according to the angle values shown in figure 2-236 above.

STEP 135



BS06K365

Figure 2-238

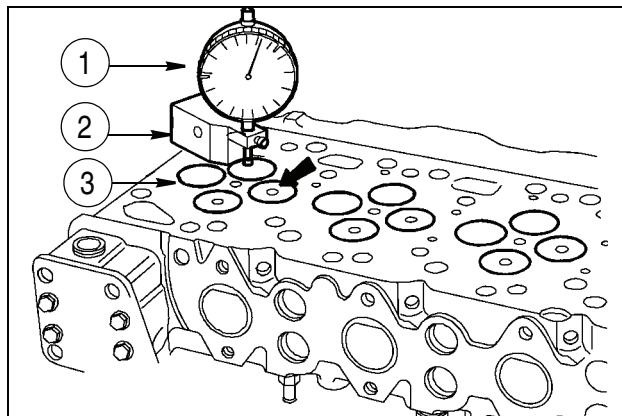
MAIN DATA ON VALVE SEATS

If the valve seats cannot be resealed, just by grinding, replace them with replacement parts. By using tool (1, in step 134) 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 134) according to the values shown in figure 2-238 above.

STEP 136



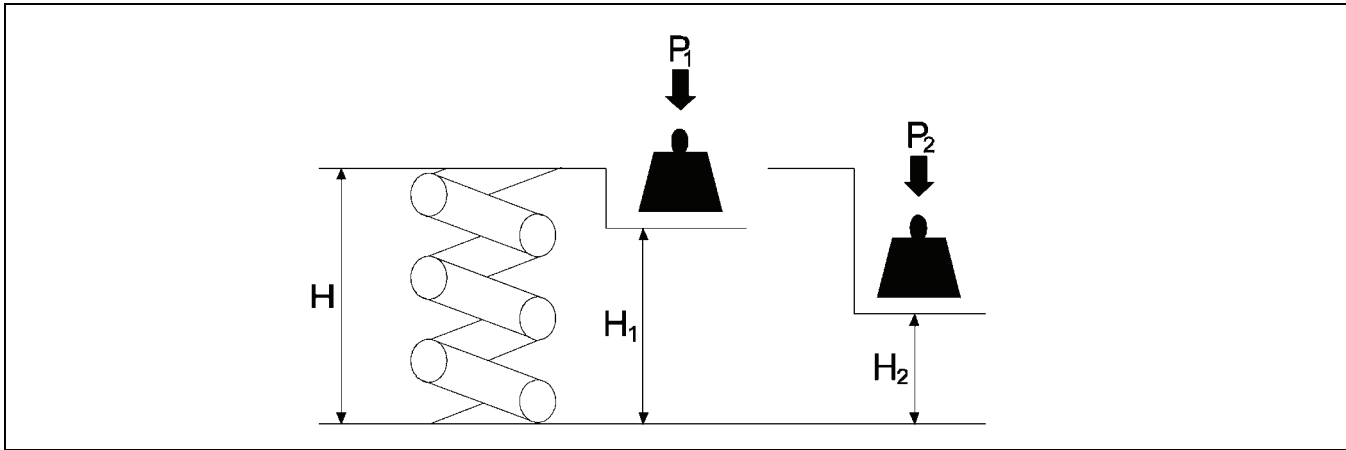
BS06K366

Figure 2-239

After the reconditioning operations, verify by means of base (2) and dial indicator (1), that valve hollow (3) corresponds to the specified value.

VALVE SPRINGS

STEP 137



BS06K367

Figure 2-240

MAIN DATA FOR INTAKE AND EXHAUST VALVE SPRING CHECK

Height		Under a load of	
	mm		N
H	47.75	Free	
H1	35.33	P	339.8 ± 9 N
H2	25.20	P2	741 ± 39 N

CYLINDER HEAD

STEP 138

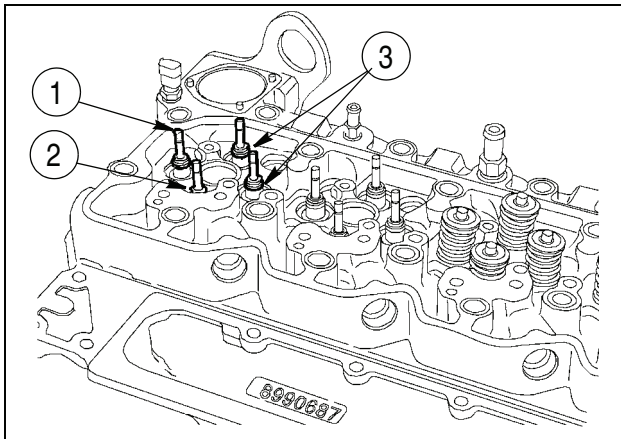


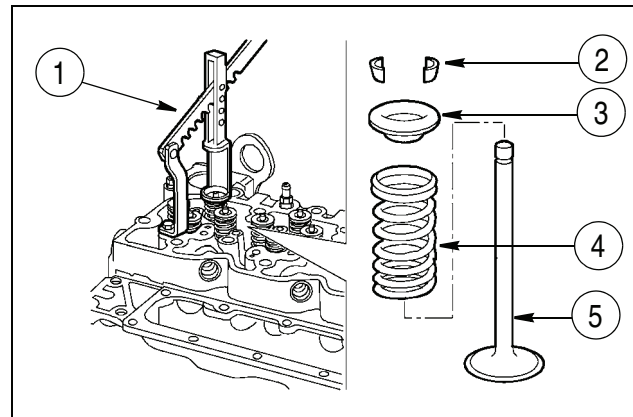
Figure 2-241

Lubricate the valve stem (1) and insert into the respective valve guide according to the position marked when disassembling.

Install seal rings (2 and 3) into the valve guide.

IMPORTANT: Seal rings (2) for intake valves are yellow. Seal rings (3) for exhaust valves are green.

STEP 139



BS06K369

Figure 2-242

Position spring (4) and upper collar (3) on the cylinder head. Use tool (1) to compress spring (4) and lock the parts to the valve by means of lock cones (2).

INSTALLING THE CYLINDER HEAD

STEP 140

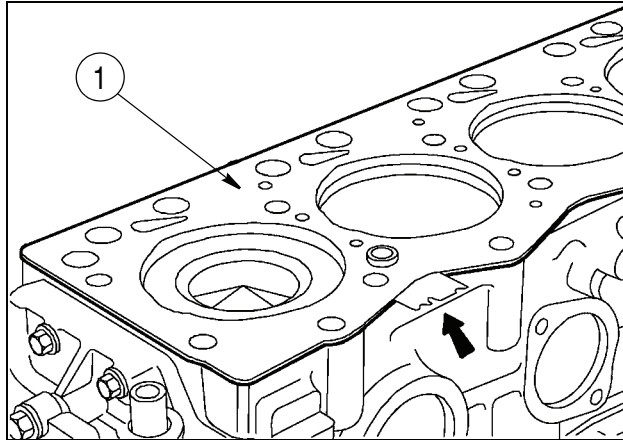


Figure 2-243

Verify that the cylinder head and the engine block mating surfaces are both clean.

Take care not to damage the cylinder head gasket.

Set the cylinder head gasket (1) with the writing "TOP" (1) facing the head.

The arrow shows the point where the gasket thickness is given.

IMPORTANT: Prior to reusing the cylinder head fastening bolts, verify that they do not show traces of wear, deformations or corrosion. If they do replace them.

STEP 141

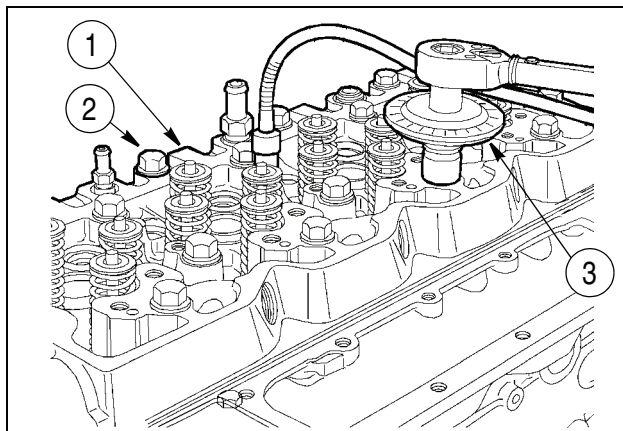


Figure 2-244

Install cylinder head (1), attach bolts (2) and tighten them in three successive steps according to the procedure in the following figure (step 142).

STEP 142

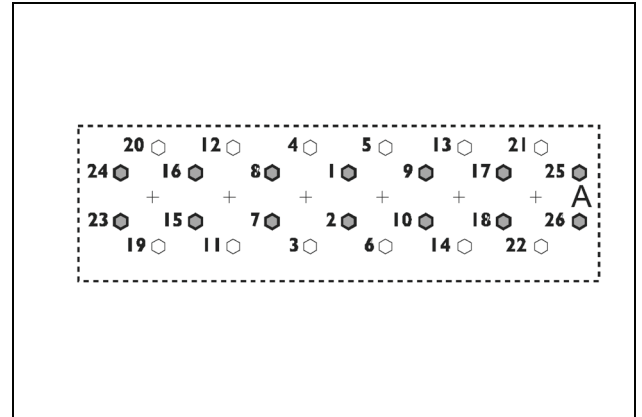


Figure 2-245

1. NON SHADED BOLTS- 12X1.75X130 MM
2. SHADED BOLTS- 12X1.75X150 MM

Cylinder head fastening bolt tightening sequence:

- 1st phase: Pre-fastening by means of torque wrench.

Bolt 12x1.75x130 mm- (1)- 30 - 40 Nm
(22 - 30 lbf ft.)

Bolt 12x1.75x150 mm- (2)- 50 - 60 Nm
(37 - 44 lbf ft.)

- 2nd phase: Angle tightening: $90^\circ \pm 5^\circ$ - with tool (3)
- 3rd phase: Angle tightening: $90^\circ \pm 5^\circ$ - with tool (3)

A= Front side

INSTALLING INJECTORS

STEP 143

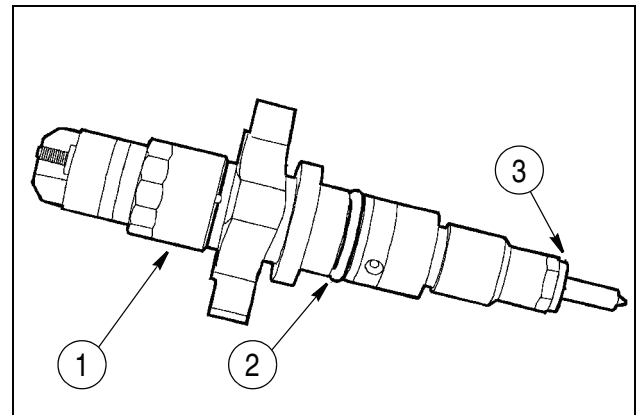
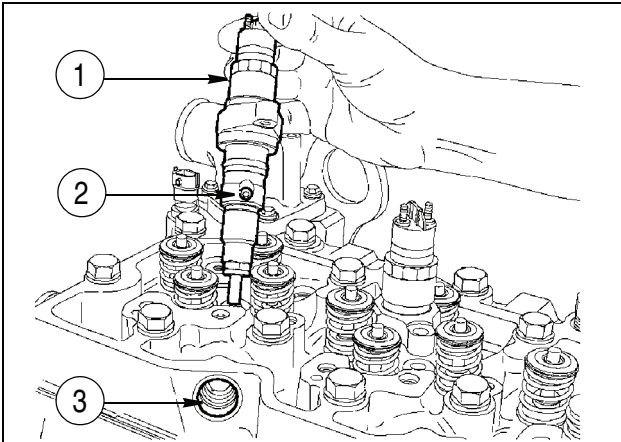


Figure 2-246

Install a new sealing ring (2) lubricated with vaseline and a new sealing washer (3) on injector (1).

STEP 144

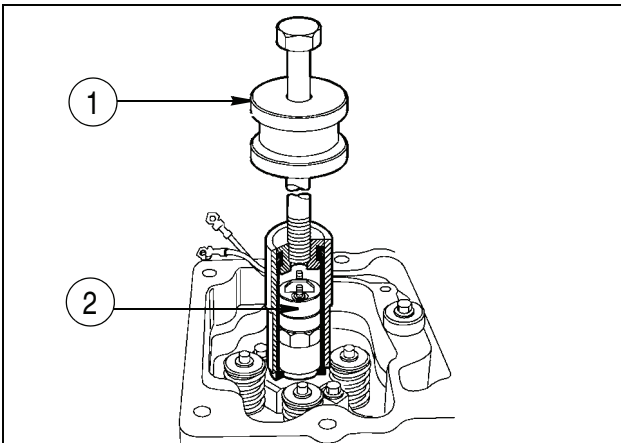


BS06K374

Figure 2-247

Install injectors (1) on the cylinder head seats, directed so that the fuel inlet hole (2) is facing the fuel manifold seat (3) side

STEP 145



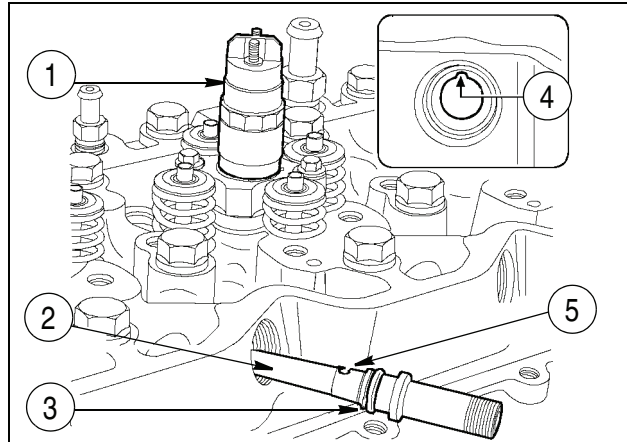
BS06K375

Figure 2-248

Use Special Tool 380001099 (1) to install the injector (2) into its seat.

Screw injector fastening bolts without tightening them.

STEP 146



BS06K376

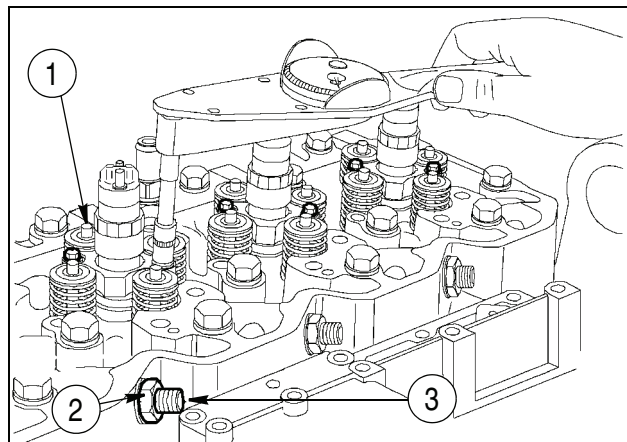
Figure 2-249

Install a new sealing ring (3) lubricated with vaseline on the fuel manifold (2) and install it into the cylinder head seat so that the positioning ball (5) is lined up with the notch in the housing (4).

IMPORTANT: *Disassembled fuel manifolds (2) must not be reused, they need to be replaced with new ones.*

IMPORTANT: *During this operation, the injector (1) shall be moved so that the manifold (2) is properly inserted into the fuel inlet hole.*

STEP 147



BS06K377

Figure 2-250

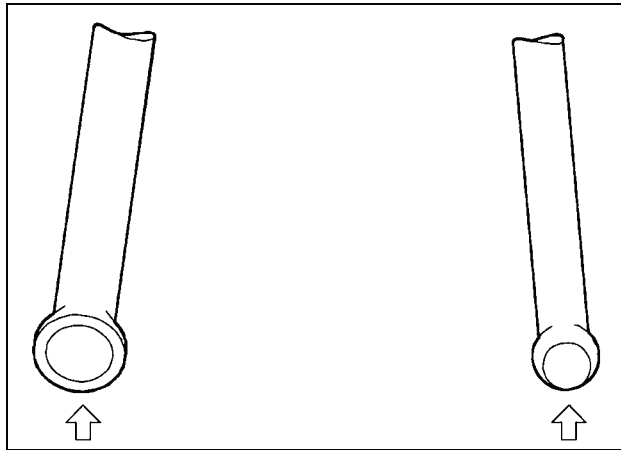
Use a torque wrench to tighten gradually and alternating the injector fastening bolts (1) to 7.7 - 9.3 Nm (5.7 - 6.9 lbf ft.).

Screw the fastening nuts (2) on the fuel manifold (3) without locking them.

Tighten the fuel manifold (3) fastening nuts (2) to 50 Nm (36.9 lbf ft.) of torque.

RODS AND TAPPETS

STEP 148

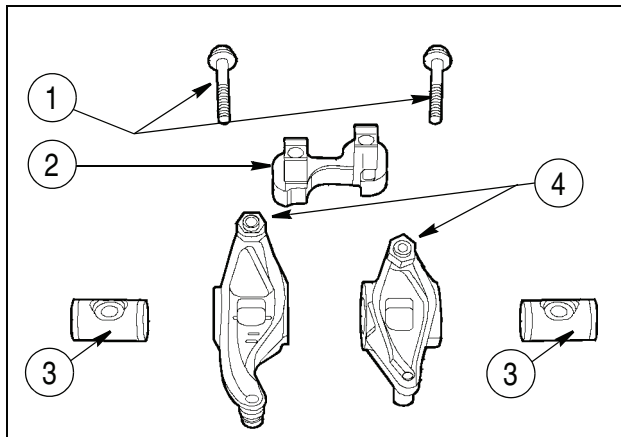


BS06K378

Figure 2-251

Rocker control rods should not be distorted. The ball seats in touch with the rocker adjusting bolt and with tappets (arrows) should not show any signs of seizing or wear, otherwise replace them. Intake and exhaust valve control rods are identical and therefore interchangeable.

ROCKER ARM ASSEMBLY



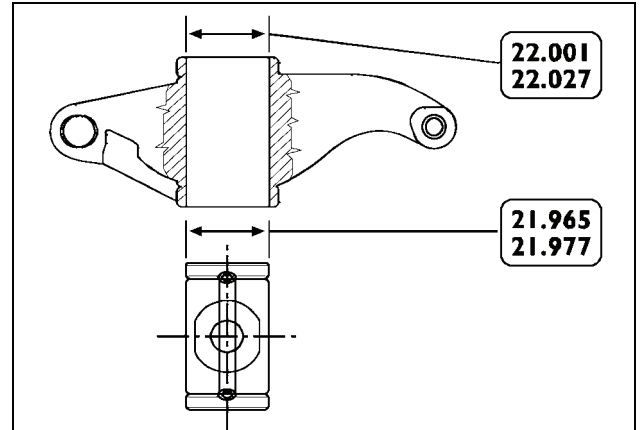
BS06K379

Figure 2-252

PARTS MAKING UP THE ROCKER ARM ASSEMBLY

1. BOLTS
2. SUPPORT
3. ARBOR
4. ROCKER ARM

STEP 149



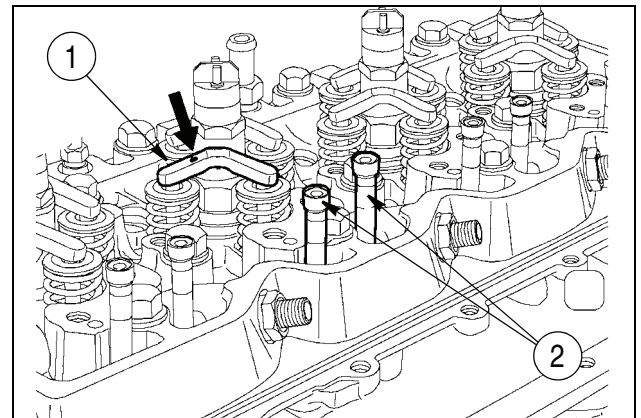
BS06K380

Figure 2-253

MAIN DATA OF ARBOR-ROCKER ARM

Check that shaft/rocker coupling surfaces are not showing excessive wear or any damage.

STEP 150



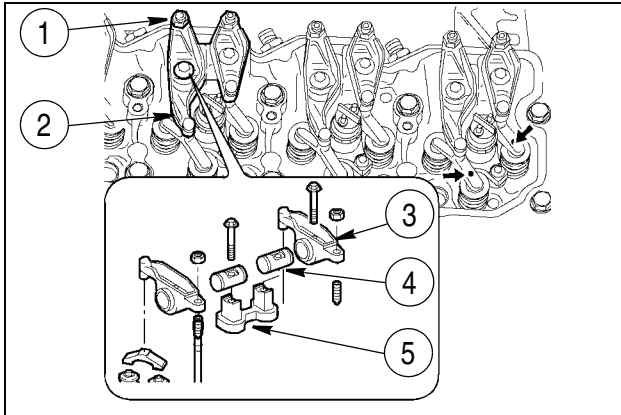
BS06K381

Figure 2-254

Install the rods (2).

Position jumpers (1) on valves with marks (→) facing the exhaust manifold.

STEP 151



BS06K382

Figure 2-255

Check tappet adjusters (1) that they are loose to prevent their balking on the rods (2, figure 2-254) when installing the rocker assembly.

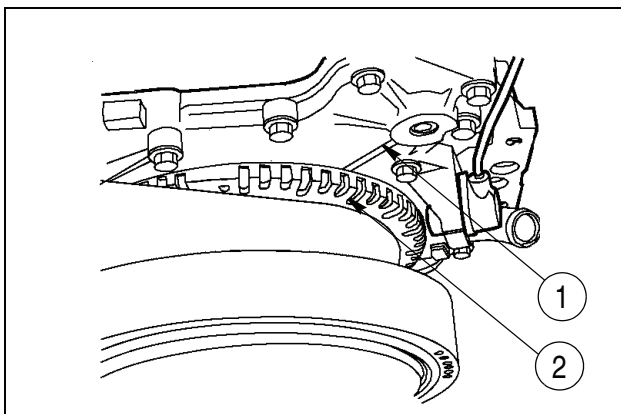
Then install the rocker assembly consisting of:

bracket (5), rockers (3), shafts (4), and secure them to the cylinder head by tightening the fastening bolts (2) to 36 Nm (26.5 lbf ft.) of specified torque.

LOCATING TOP DEAD CENTER (TDC)

IMPORTANT: Due to the additional lobe for the Internal EGR, each cylinder must be adjusted by taking it to the T.D.C. (top dead center) and adjusting the clearance of both valves on every cylinder.

STEP 152



BS06K345

Figure 2-256

1. ENGINE BLOCK 2. TONE WHEEL

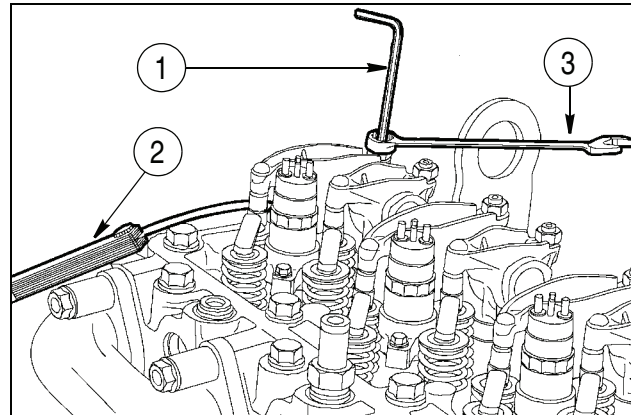
- Remove the injector from the number one cylinder.
- Rotate engine over using Special Tool 380000988 to bring the number one cylinder to the highest point using a dial indicator. Check to see if push rods are loose, if they are not rotate the engine 360° now they should be loose.
- Put a reference mark on tone wheel (1) and the engine block (2).

STEP 153

Measure the circumference of the tone wheel and divide by 3. Starting from the reference mark on tone wheel put on in step 152. Put the other two marks of the calculated length on the tone wheel.

VALVE CLEARANCE ADJUSTMENT

STEP 154



BS06K383

Figure 2-257

Adjust clearance between rockers and valves using set screw wrench (1), box wrench (3) and feeler gauge (2).

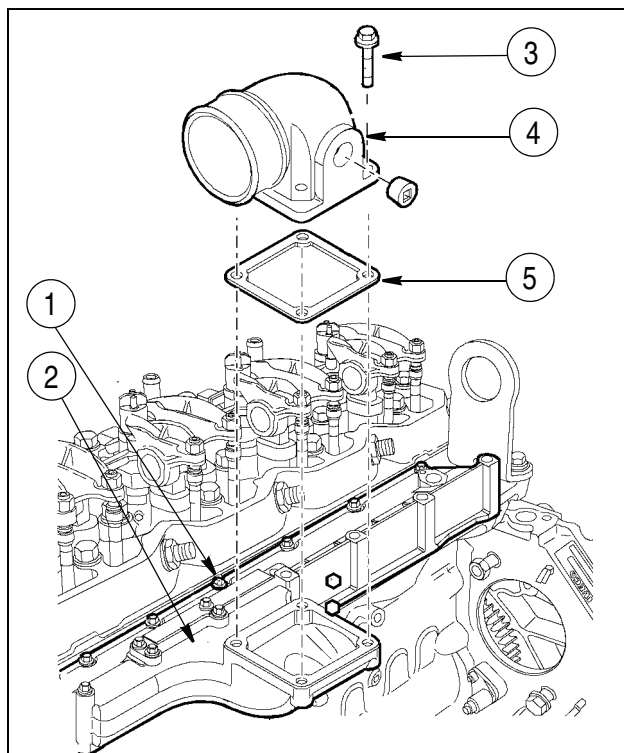
Working clearance shall be as follows:

- Intake valves: 0.20 - 0.30 mm (0.008 - 0.012 in.)
- Exhaust valves: 0.46 - 0.56 mm (0.18 - 0.022 in.)

NOTE: Firing Order (1- 5- 3- 6- 2- 4)

- Adjust the valves for cylinder number 1.
- Rotate to the next reference mark and adjust valve clearance for cylinder number 5.
- Rotate to the next reference mark and adjust valve clearance for cylinder number 3. This should be one complete revolution of the tone wheel.
- Rotate to the next reference mark and adjust valve clearance for cylinder number 6.
- Rotate to the next reference mark and adjust valve clearance for cylinder number 2.
- Rotate to the next reference mark and adjust valve clearance for cylinder number 4. There should have been two complete revolutions of the tone wheel and all of the valves should be set.
- Reinstall the number one injector.

STEP 155



BS06K384

Figure 2-258

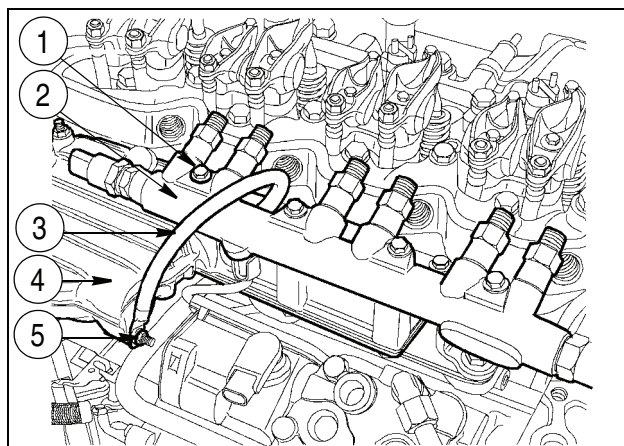
Apply Loctite 5999 to the contact surfaces of intake manifold (1) and install the manifold and heater to the cylinder head.

Screw in bolts (2) and tighten to 20 to 30 Nm (14.8 to 22.1 lb.- ft.) the specified torque.

Install air intake (4) with a new gasket (5) and tighten bolts (3) to the general bolt torque specifications in the repair manual.

The figure shows the air intake for 667TA/EEG - 667TA/EEC engines.

STEP 156

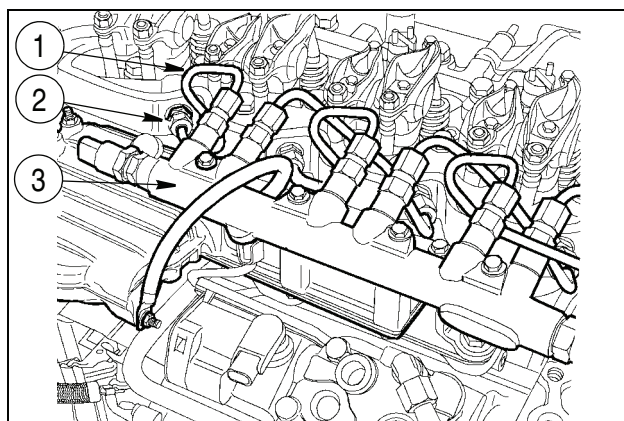


BS06K385

Figure 2-259

Install the rail (2) and tighten the bolts (1) to the general bolt torque specifications in the repair manual. Connect the ground cable (3) to the intake manifold (4) and tighten the fastening nut (5) to 20 to 30 Nm (14.8 to 22.1 lb.- ft.) the specified torque.

STEP 157



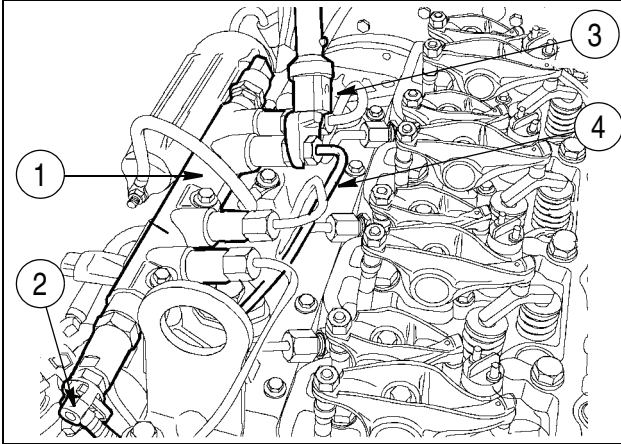
BS06K386

Figure 2-260

Connect new fuel lines (1) to rail (3) and injector manifolds (2).

IMPORTANT: When ever fuel lines (1) are removed they should always be replaced with new ones

STEP 158



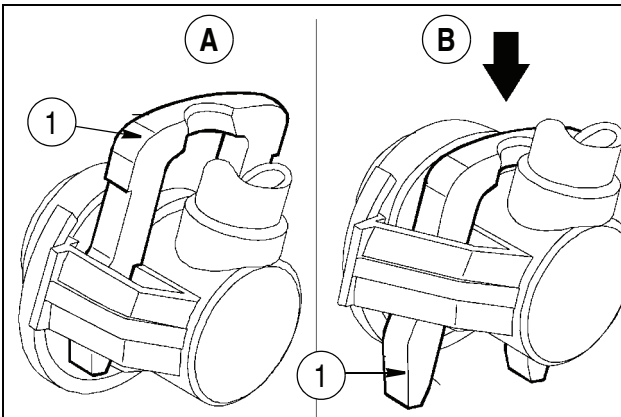
BS06K387

Figure 2-261

Connect the fuel line (4) to rail (2) following the procedure shown in the following figure (step 157).

IMPORTANT: Fuel line (4) connections shall be tighten to 20 Nm (14.8 lb.-ft.) of torque, using the proper box wrench and the torque wrench 380000158 (3).

STEP 159



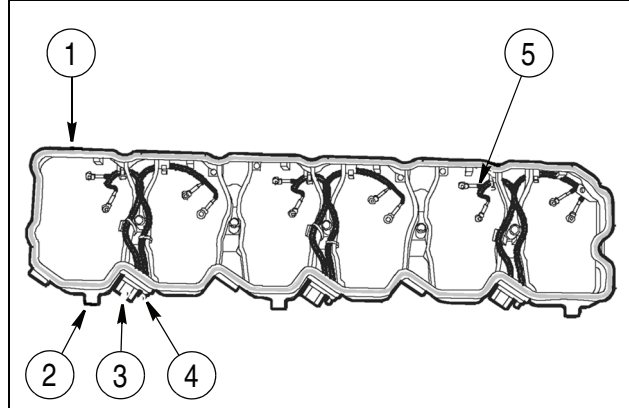
BS06K388

Figure 2-262

Press the clamp (1) in arrow direction (Figure B) and connect the line to the rail (2), figure 2-260), reset the clamp to the initial locking position (Figure A).

IMPORTANT: Check for proper fuel line connection.

STEP 160

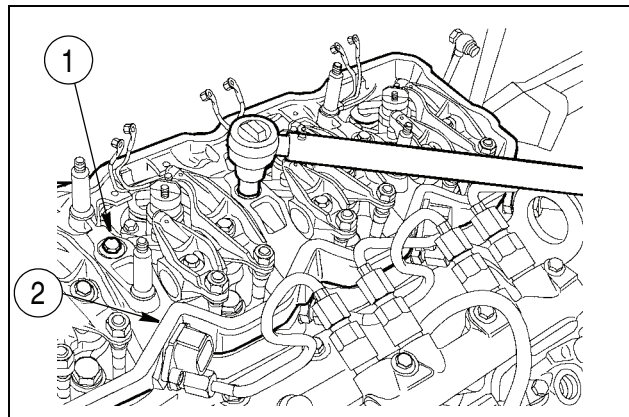


BS06K389

Figure 2-263

Check wiring cable (5) condition, replace it if damaged, by cutting the support (2) clamps and removing the bolts (4) that secure it to connectors (3). Install a new gasket (1) on the support (2).

STEP 161



BS06K390

Figure 2-264

Install the wiring support (2) and tighten the bolts (1) to the general bolt torque specifications in the repair manual.

STEP 162

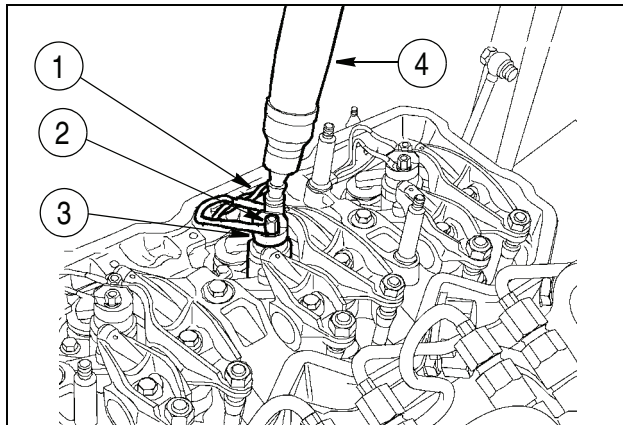


Figure 2-265

Connect the electrical cables (1) to the injectors (3) and use Special Tool 380000158 torque wrench (4) to tighten the fastening nuts (2) to the general bolt torque specifications in the repair manual.

STEP 163

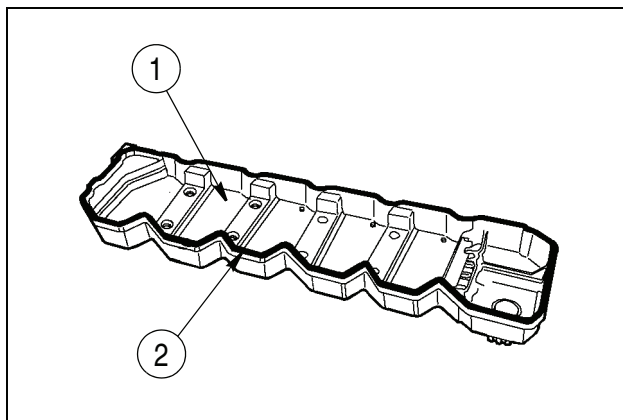


Figure 2-266

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

STEP 164

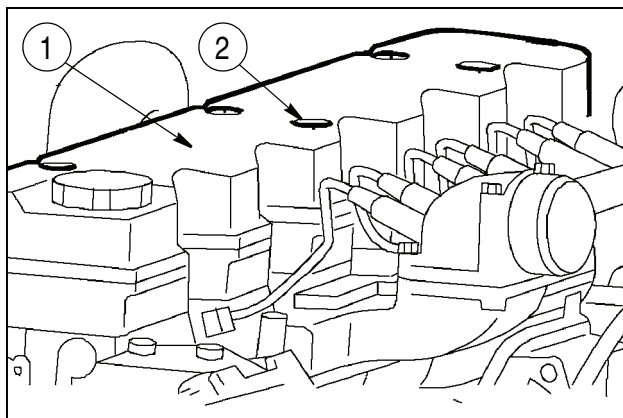


Figure 2-267

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.

STEP 165

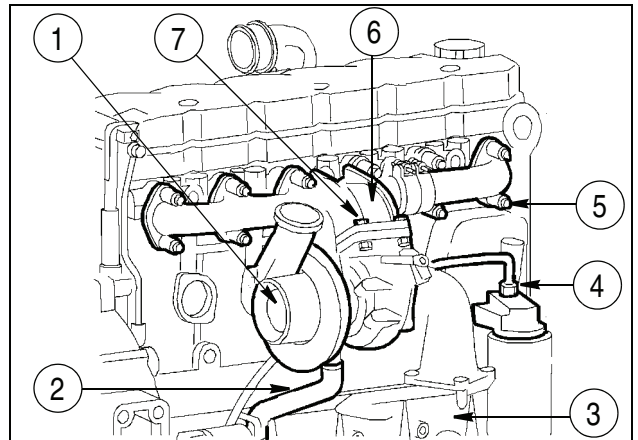


Figure 2-268

Re-attach exhaust manifold (6) with new gaskets. Screw securing bolts (5) and tighten them to 48 to 58 Nm (35.4 to 42.8 lb.-ft.) the specified torque.

Re-attach turbo-charger (1) to exhaust collector (6) with a new gasket and tighten securing nuts (7) to 20 to 30 Nm (14.8 to 22.1 lb.-ft.) the specified torque.

Connect line (2) to turbo-charger (1) support (3).

Connect oil line (4) to heat exchanger support.

STEP 166

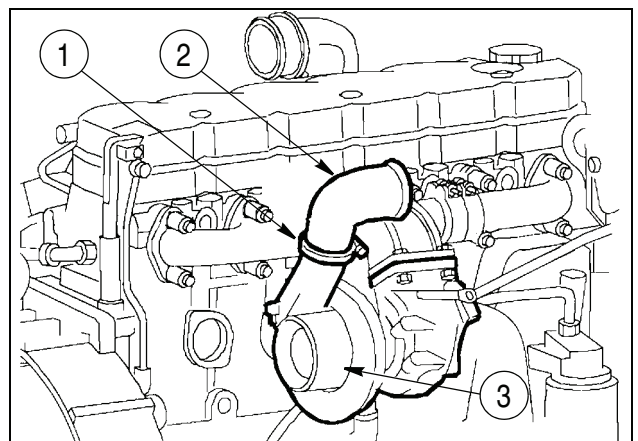
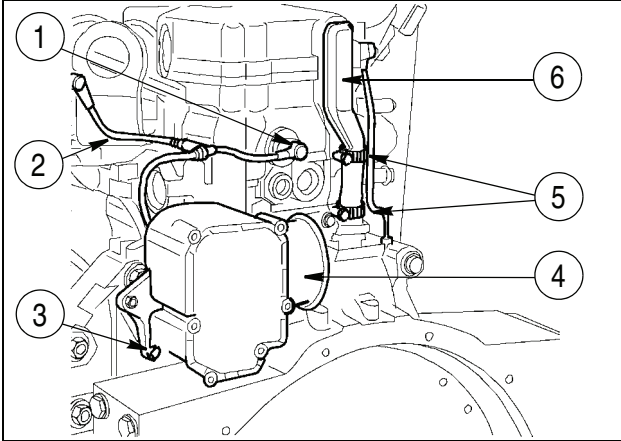


Figure 2-269

Connect the air duct (2) to the turbo-charger (3) and lock it with clamp (1).

STEP 167



BS06K396

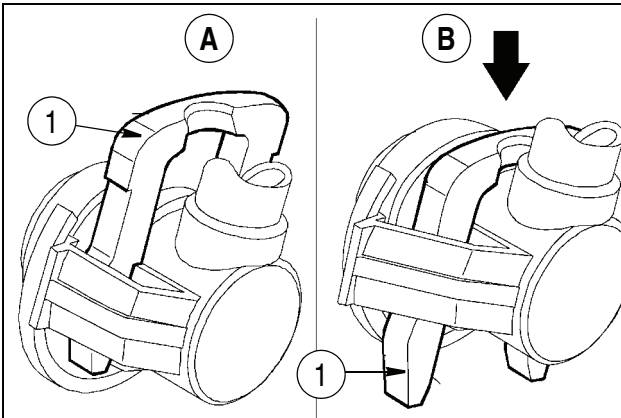
Figure 2-270

Insert the blow-by filter (4) tightening the bolts.

Connect the line (6) and attach the oil vapor recovery line with clamp (5).

Connect the line (2) to the pressure-limiter device (1) by the figure below (step 166).

STEP 168



BS06K388

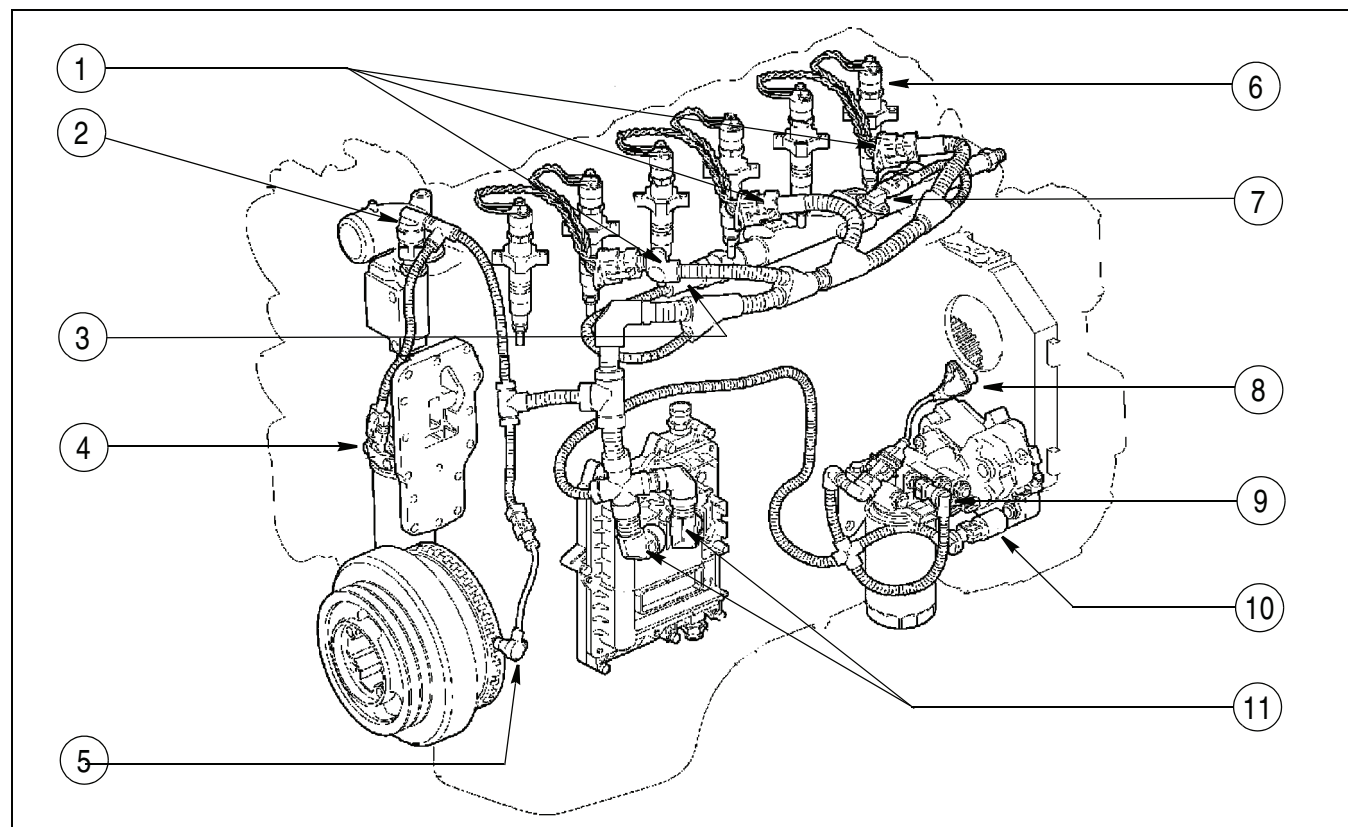
Figure 2-271

Press the clamp (1) in arrow direction (Figure B) and connect the line. Reset the clamp to the initial locking position (Figure A).

IMPORTANT: Check for proper fuel line connection.

WIRING HARNESS CONNECTIONS TO ENGINE

STEP 169



BS06K398

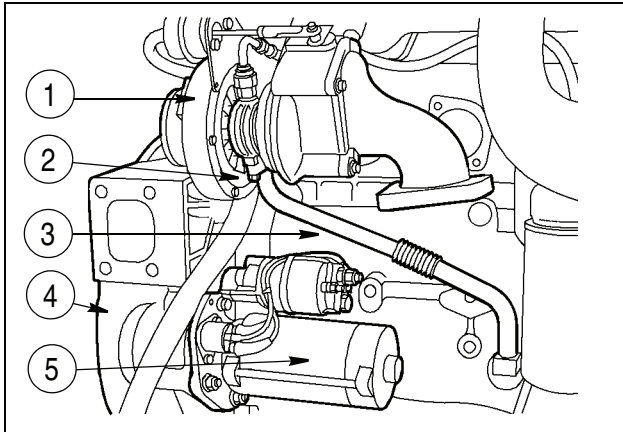
Figure 2-272

- | | | |
|--------------------------------------|--|--------------------------------|
| 1. CONNECTIONS FOR ELECTRO-INJECTORS | 5. CRANKSHAFT SENSOR | 9. FUEL HEATER AND TEMP SENSOR |
| 2. ENGINE COOLANT TEMPERATURE SENSOR | 6. ELECTRO-INJECTOR | 10. HIGH PRESSURE REGULATOR |
| 3. COMMON RAIL FUEL PRESSURE SENSOR | 7. BOOST TEMPERATURE AND PRESSURE SENSOR | 11. EDC7UC31 CONTROL UNIT |
| 4. OIL TEMPERATURE-PRESSURE SENSOR | 8. CAMSHAFT SENSOR | |

Re-attach engine cable by connecting electro-injectors (6) wiring connectors (1), air pressure/temperature sensor (7), common rail pressure sensor (3), EDC7UC31 electronic control unit (11), high pressure pump sensor (10), camshaft sensor (8), engine coolant temperature sensor on thermostat (2), crankshaft sensor (5).

Apply rocker lever to engine lifting hooks, hook the rocker lever to a hoist and detach the engine from rotating stand. Remove brackets.

STEP 170



BS06K399

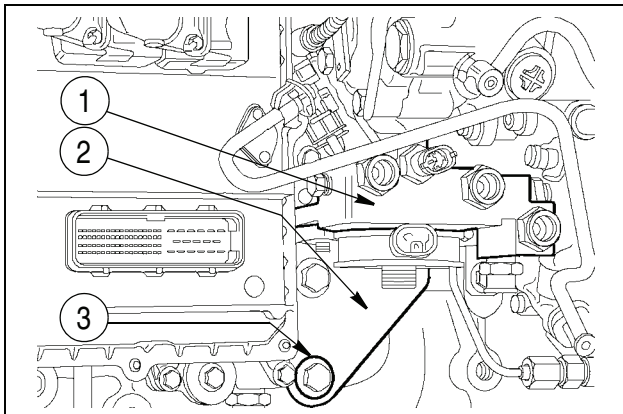
Figure 2-273

Complete engine installation as follows.

From the right side:

- Install the starter (5) to the flywheel housing (4) and tighten the fastening nuts to 50 to 60 Nm (36.9 to 44.3 lb.-ft.) the specified torque.
- Install the oil line (3) with a new sealing ring into the engine block and secure it to the turbo-charger (1) by the bolts (2) and tighten to 20 to 30 Nm (14.8 to 22.1 lb.-ft.) the specified torque.

STEP 171

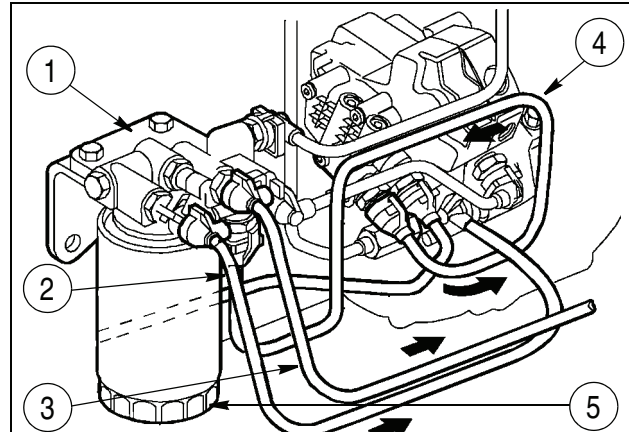


BS06K400

Figure 2-274

Install the bracket (2) including the fuel filter bracket (1) to the engine block, tighten the bolts (3) to the general bolt torque specifications in the repair manual.

STEP 172

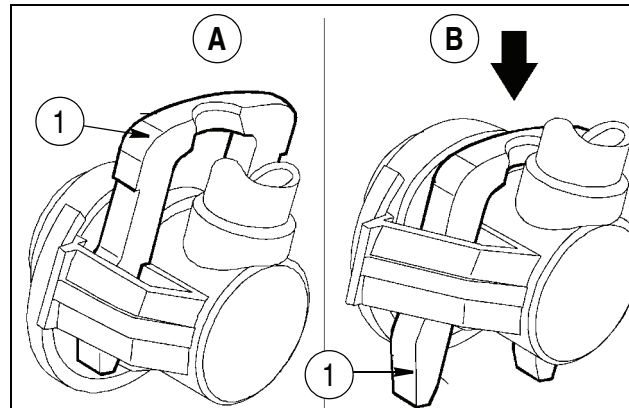


BS06K401

Figure 2-275

By hand screw on the fuel filter to the bracket (1). Tighten the fuel filter 3/4 of a turn after the gasket makes contact with the bracket. Connect the fuel lines (2,3,4) to the relevant support connections (1) as shown in the following figure (step 171).

STEP 173



BS06K388

Figure 2-276

Press the clamp (1) as shown in (figure B).

After connecting the line reset the clamp (1) to the initial locking position (A), to prevent deformations.

NOTE: when installation is complete, fill engine with the proper lubricating oil.

CHAPTER 3

667TA

TIER III

CHARGING AND START-UP

CNH America LLC reserves the right to make improvements in design or changes in specifications at any time without incurring any obligation to install them on units previously sold.

All data given in this publication is subject to production variations. Dimensions and weights are only approximate. Illustrations do not necessarily show products in standard condition. For exact information about any particular product, please consult your Dealer

Revision History			
Issue	Issue Date	Applicable Machines	Remarks
First Edition	11-2006	667TA/EEG 667TA/EEC 667TA/EBF 667TA/EED 667TA/EBJ 667TA/EDJ	87519804 NA

CHAPTER 3

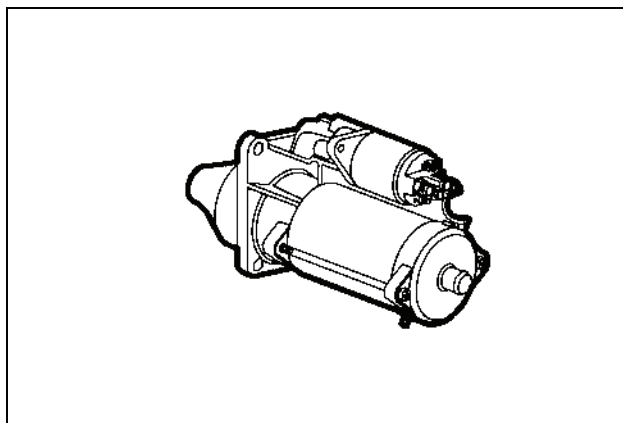
CHARGING AND START-UP

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NOTES

STARTER MOTOR



BS06K403

Figure 3-1

Manufacture- BOSCH - 24 Volt - 4kW
For Engines: 667TA/EEG
667TA/EEC

Manufacture- ISKRA - 24 Volt - 4kW
For Engines: 667TA/EBF
667TA/EED

Manufacture- Denso - 24 Volt - 7.8kW
For Engine: 667TA/EDJ

QUICK DIAGNOSIS

Fault	Possible Causes	Remedy
Dragging torque insufficient	1.- Batteries run down	Recharge or Replace
	2.- Circuit connections oxidized or loose	Replace the component
	3.- Brushes damaged or worn	Replace the component
	4.- Short-circuit in field windings	Replace the component
	5.-Open or short circuit in armature	Replace the component
	6.- Out of round bushings	Replace the component
Dragging torque sufficient, but the engine won't start	Free wheel or faulty electro-magnet	Replace the component
Pinion won't engage	Bevelled ring gear	Restore

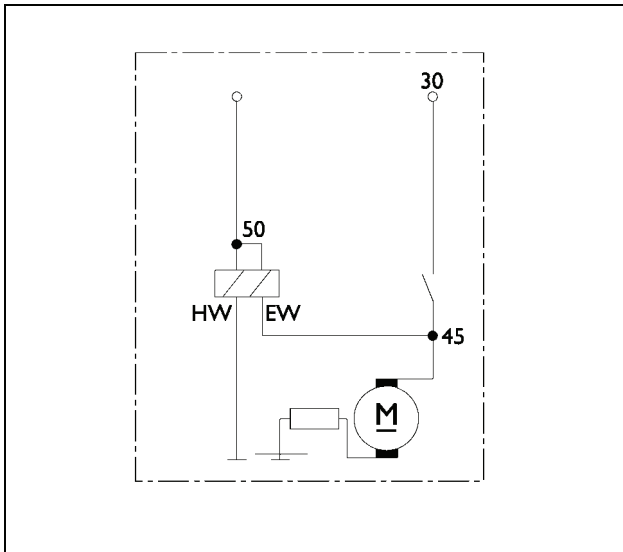
BOSCH 24 VOLT - 4 KW STARTER

6- pole type with series excitation and engagement by means of a fork controlled by an electromagnet.

Clockwise direction of rotation

Rated voltage- 24 volts

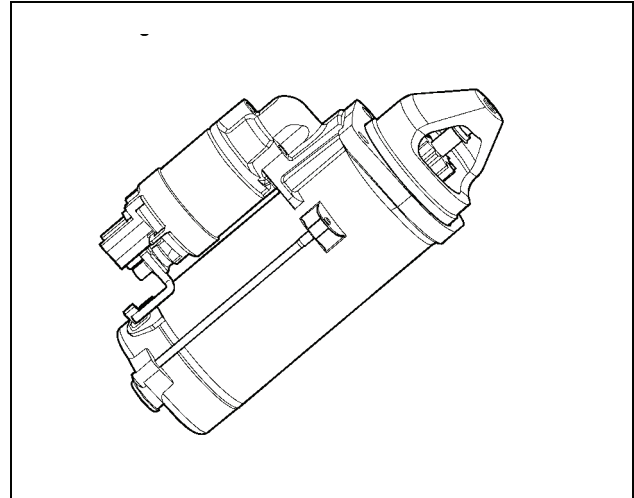
Power- 4 kW



BS06K404

Figure 3-2

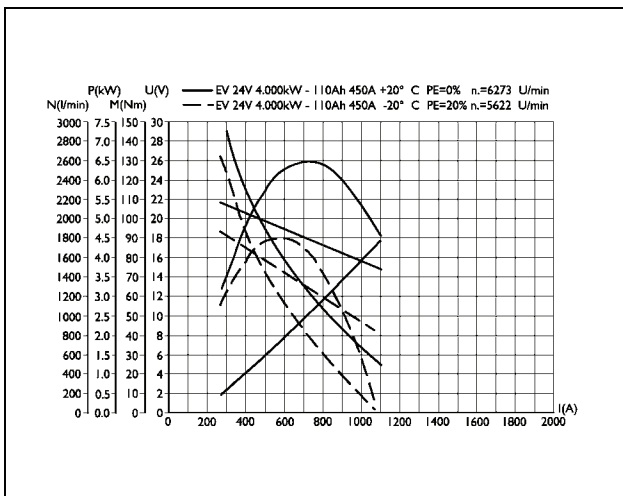
WIRING DIAGRAM



BS06K406

Figure 3-4

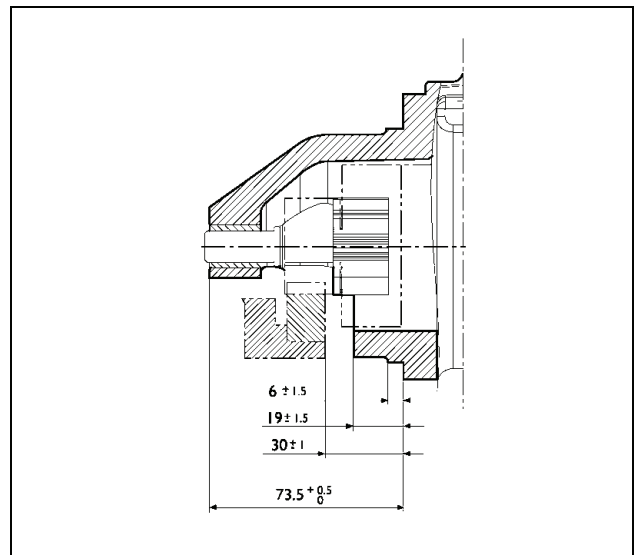
3/4 VIEW



BS06K405

Figure 3-3

CHARACTERISTIC CURVES



BS06K407

Figure 3-5

PINION ADJUSTER

ISKRA 24 VOLT - 4 KW STARTER

Fork mesh type, driven by an electromagnet.

Clockwise direction of rotation

Rated voltage- 24 volts

Power- 4kW

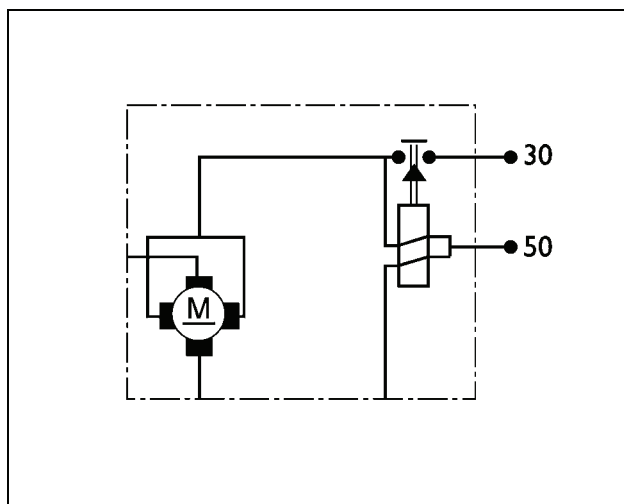


Figure 3-6

WIRING DIAGRAM

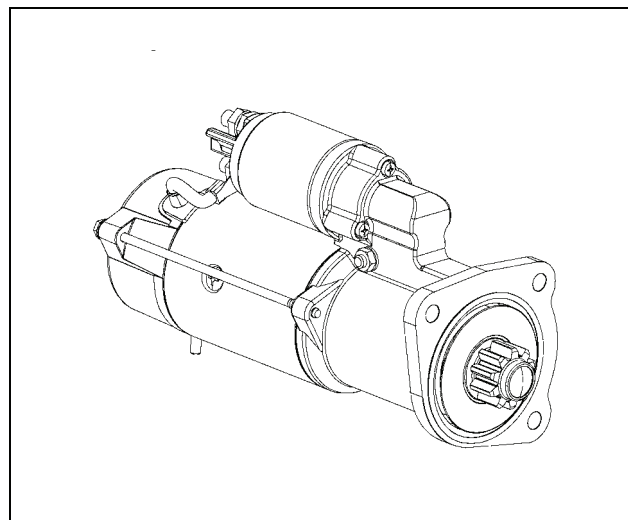


Figure 3-7

3/4 VIEW

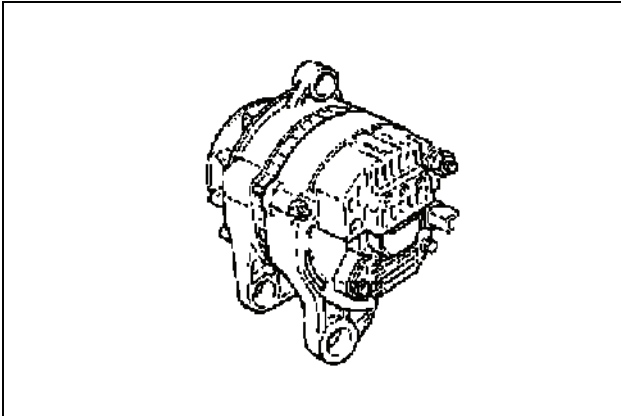
DENSO 24VOLT - 7.8KW STARTER

There is no information at time of print on this starter.

Used on the 667TA/EDJ engine.

ALTERNATOR

Manufacture - BOSCH
Part number- NCBI 28 V 35-70 A
For engines: 667TA/EEG
667TA/EEC
667TA/EDJ



BS06K410

Figure 3-8

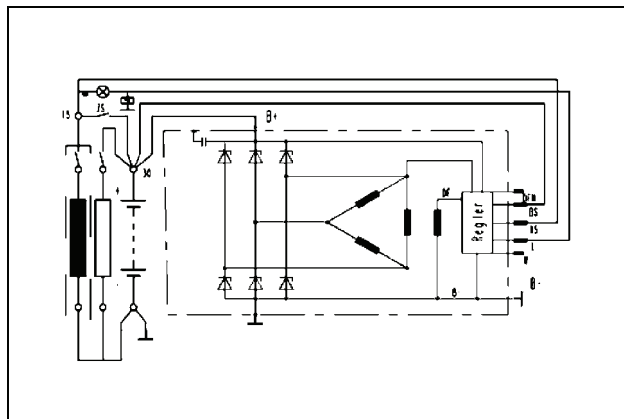
QUICK DIAGNOSIS

Fault	Possible causes	Remedy
No recharge	1. Open in recharge circuit (warning light, fuse, connector, etc.)	Check the recharge circuit connections. Clean and tighten the cable terminals on the alternator and battery.
	2. Voltage regulator not working	Replace the component
	3. Open rotor winding	Replace the component
	4. Worn brushes	Replace the component
Poor recharge	1. Loose belt	Check automatic belt tensioner
	2. Faulty voltage regulator	Replace the component
	3. Excessive wear of rotor rings or brushes	Replace the component
	4. Short-circuited diodes	Replace the component
	5. Short-circuited rotor windings	Replace the component
Excessive recharge	1. Loose circuit connections	Check the connections to terminals and cable terminals of batteries, starter motor and alternator
	2. Voltage regulator not working	
	3. Faulty ground	Check ground connections

BOSCH: NCBI 28 VOLT 35-70 AMP

Three-phase type, claw-type rotor, 11 diode rectifier and electronic voltage regulator.

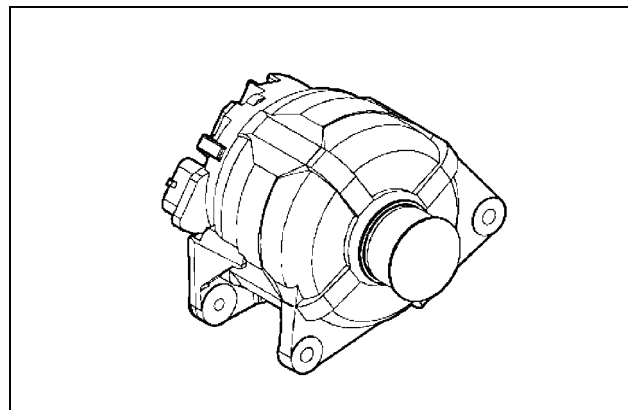
Direction of rotation- (control side) clockwise
Current delivered at $6.000 \text{ min}^{-1} \geq 55 \text{ amps}$
Rated voltage- 28.5 volts



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Figure 3-9

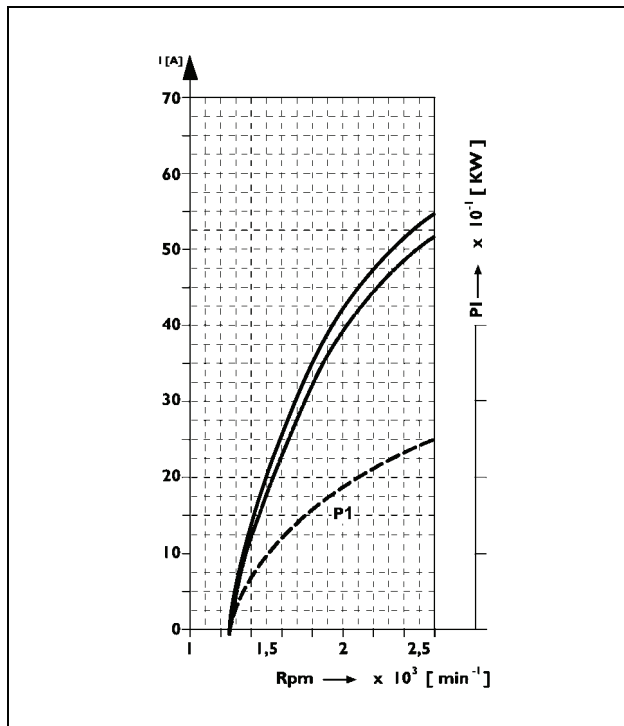
WIRING DIAGRAM



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Figure 3-11

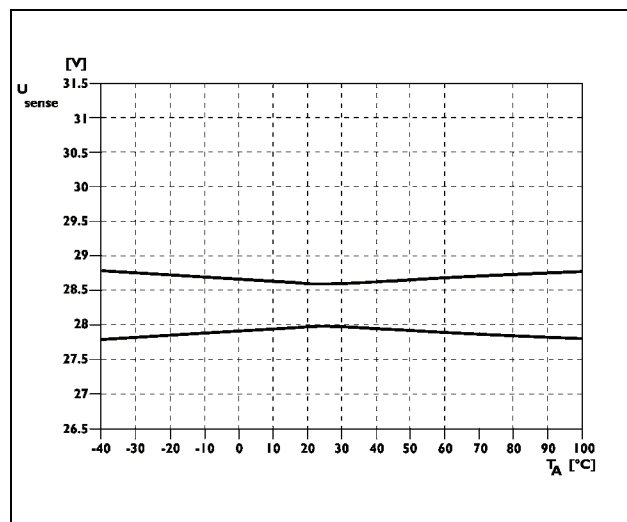
3/4 VIEW



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Figure 3-10

CHARACTERISTIC CURVES OF CURRENT DELIVERY



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Figure 3-12

CHARACTERISTIC CURVES OF VOLTAGE REGULATOR

NOTES