20. Engine

Contents

Counterbalance (code 215):

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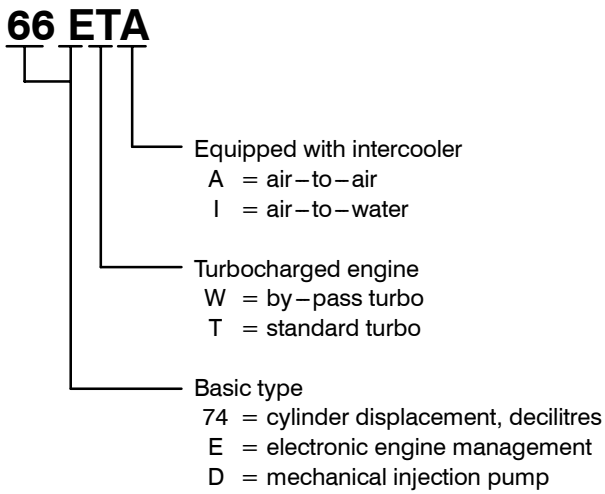
Technical specifications

Model	T 120	T 130	T 140
Designation	66 ET	66 ET	66 ETA
Type	Four - stroke direct injection diesel engine		
Turbocharged and intercooler	yes	yes	yes, intercooler
Number of cylinders	6	6	6
Numbering of cylinders (fr. front)	1–2–3–4–5–6	1–2–3–4–5–6	1–2–3–4–5–6
Cylinder bore, mm	108	108	108
Stroke, mm	120	120	120
Cylinder displacement, dm^3	6,6	6,6	6,6
Compression ratio	16,5:1	16,5:1	16,5:1
Max. output, DIN kW/(hp)/r/min (ISO 14396)	88/(120/2200)	99/(135/2200)	106,5/(145/1800)
Max Torque, Nm/r/min (ISO 14396)	505/1400	550/1400	655/1100
Max. no load speed, r/min	2400	2400	2000
Low idling speed, r/min	850	850	850

Model	T 160	T 170
Designation	66 ETA	74 ETA
Type	Four - stroke direct injection diesel engine	
Turbocharged and intercooler	yes, intercooler	yes, intercooler
Number of cylinders	6	6
Numbering of cylinders (fr. front)	1–2–3–4–5–6	1–2–3–4–5–6
Cylinder bore, mm	108	108
Stroke, mm	120	134
Cylinder displacement, dm^3	6,6	7,4
Compression ratio	16,5:1	16,5:1
Max. output, DIN kW/(hp)/r/min (ISO 14396)	117,5/(160/2100)	125/(170/2100)
Max Torque, Nm/r/min (ISO 14396)	650/1400	655/1400
Max. no load speed, r/min	2300	2300
Low idling speed, r/min	850	850

Engine type designations



Technical specifications

Model	T 180	T 190
Designation	74ETA	74ETA
Type	Four - stroke direct injection diesel engine	
Turbocharged	yes, intercooler	yes, intercooler
Number of cylinders	6	6
Numbering of cylinders (fr. front)	1–2–3–4–5–6	1–2–3–4–5–6
Cylinder bore, mm	108	108
Stroke, mm	134	134
Cylinder displacement, dm^3	7,4	7,4
Compression ratio	16,5:1	16,5:1
Max. output, DIN kW/(hp)/r/min (ISO 14396)	129/(175)/2100 139,5/(190)/2100 3)	129/(175)/2100 1) 139,5/(190)/2100 3) 154,5/(210)/2100 2)
Max Torque, Nm/r/min (ISO 14396)	660/1400 745/1400 3)	660/1400 1) 745/1400 3) 830/1400 2)
Max. no load speed, r/min	2300	2300
Low idling speed, r/min	850	850

1) Sigma Power model, the smaller output area. 2) Sigma Power model, the larger output area, the output/torque is available only from power take–off, 3) + Power output range.

Technical data

Cylinder block

Holes for guide pins . . . . . 13,250...13,320 mm
Main bearing housing diameter . . . . . 91,000...91,025 mm
Main bearing housing diameter (with bearing 8361 40950) . . . . . 92,000...92,025 mm
Cylinder liner location, diameter:
- upper end . . . . . 124,514...124,554 mm
- lower end . . . . . 123,000...123,040 mm
Inner diameter of camshaft bushing (fitted) . . . . . 50,010...50,070 mm
Height of cylinder block . . . . . 428,170...428,430 mm

Cylinder liners

Protrusion of cylinder liner above cylinder block top face . . . . . 0,030...0,080 mm
Max. permissible height difference between liners (under same head) . . . . . 0,02 mm
Outer diameter of cylinder liner guide:
- at upper end of liner . . . . . 124,475...124,500 mm
- at lower end of liner . . . . . 122,961...122,986 mm
Liner bore . . . . . 108,010...108,032 mm

Cylinder head

Height of the cylinder head . . . . . 104,800...105,000 mm
Height of the cylinder head after repair grinding (minium) . . . . . 104,000 mm
Inside diameter of the valve guide (not fitted) . . . . . 9,000...9,015 mm
Outside diameter of valve guide . . . . . 16,028...16,039 mm
Diameter of valve guide bore in cylinder head . . . . . 16,000...16,018
Position of valve guide top above cylinder head surface . . . . . 21 mm
Depth of valve head face below cylinder head surface:
- inlet valve . . . . . 0,7±0,05 mm (max. 2,20 mm)
- exhaust valve . . . . . 0,6±0,05 mm (max. 2,20 mm)
Angle of valve seat:
- inlet valve . . . . . 35°+20'
- exhaust valve . . . . . 45°+20'
Width of valve seat:
- inlet valve . . . . . 2,9...3,7 mm
- exhaust valve . . . . . 1,3...2,3 mm

Diameter of exhaust valve seat ring	44,070...44,132 mm
Diameter of exhaust valve seat rings recess	44,000...44,025 mm
Diameter of exhaust valve seat ring (overhaul part 8366 52269)	44,270...44,332 mm
Diameter of exhaust valve seal ring recess (overhaul part 8366 52269)	44,200...44,225 mm
Diameter of inlet valve seat ring	48,570...48,632 mm
Diameter of inlet valve seat ring recess	48,500...48,525 mm
Diameter of inlet valve seat ring (overhaul part 8368 55347)	48,770...48,832 mm
Diameter of inlet valve seat ring recess (overhaul part 8368 55347)	48,700...48,725 mm

Valves, rockers and tappets

With a valve clearance of 1,0 mm:	
- inlet valve opens	0°±2° B.T.D.C
- inlet valve closes	16°±2° A.B.D.C
- exhaust valve opens	39°±2° B.B.D.C
- exhaust valve closes	1°±2° A.T.D.C
Valve clearance cold and hot:	
- inlet valve	0,35 mm
- exhaust valve	0,35 mm
Angle of valve seat in cylinder head:	
- inlet valve	35°+20’
- exhaust valve	45°+20’
Width of valve seat in cylinder head:	
- inlet valve	2,9...3,7 mm
- exhaust valve	1,3...2,3 mm
Angle of valve face:	
- inlet valve	35°-20’
- exhaust valve	45°-20’
Outside diameter of valve head:	
- inlet valve	48 mm
- exhaust valve	41 mm
Max valve movement:	
- inlet valve	10,9 mm
- exhaust valve	12,1 mm
Inlet valve stem diameter	8,960...8,975 mm
Exhaust valve stem diameter	8,925...8,940 mm
Inlet valve stem clearance	0,025...0,055 mm
- Reject limit	0,30 mm
Exhaust valve stem clearance	0,060...0,090 mm
- Reject limit	0,35 mm
Inside diameter of valve guide before fitting	9,000...9,015 mm
Outside diameter of valve guide	16,028...16,039 mm
Diameter of valve guide bore in cylinder head	16,000...16,018 mm
Protrusion of valve guide top above cylinder head surface	21 mm
Depth of valve face below cylinder head surface:	
- inlet valve	0,7±0,05 mm (max. 2,20 mm)
- exhaust valve	0,6±0,05 mm (max. 2,20 mm)

Valve spring free length	69,8 mm
Spring pressure when spring compressed to a length of:	
- 48,6 mm	327±17 N
- 37,4 mm	500±23 N
Rocker arm shaft diameter	22,970...22,990
Diameter of rocker arm bore	23,000...23,021
Max. permissible push rod deflection (when free)	0,4 mm
Free length of rocker arm spring	80 mm
Spring pressure when spring compressed to a length 58 mm	80...100 N
Outside diameter of tappet	29,939...29,960 mm
Diameter of tappet bore in cylinder block	30,000...30,043 mm

Camshaft

Diameter of camshaft bearing journal no 1	49,925...49,950 mm
Diameter of camshaft bearing journals (others that no. 1)	49,885...49,910 mm
Diameter of camshaft bearing journals nos 2, 3 and 4 (66/74/84-engines)	49,865...49,890 mm
Inside diameter of camshaft bearing bushes (when fitted in position)	50,010...50,070 mm
Diameter of camshaft bearing bores (others than no. 1)	50,000...50,025 mm
Camshaft clearance in bearing bush no. 1	0,060...0,145 mm
Camshaft clearance in bearing bushes (others than no. 1)	0,090...0,140 mm
Camshaft clearance in bearing bushes nos 2, 3 and 4 (66/74/84-engines)	0,110...0,160 mm
Bearing bush tolerance in block (press fit)	0,025...0,080 mm
Diameter of bearing bush bore in block	55,620...55,650 mm
Camshaft end play with 0,5 mm gasket between cylinder block and timing gear housing and between timing gear housing and front cover	0,5...1,0 mm
Cam height (distance between back of cam and tip of cam):	
- inlet valve	41,180...41,430 mm
- exhaust valve	40,080...40,330 mm
Cam lift:	
- inlet valve	7,38 mm
- exhaust valve	8,28 mm
Camshaft max. permissible deflection (total indicator reading)	0,03 mm

Crankshaft

Crankpin diameter:	
- standard	67,981...68,000 mm
- 1. undersize 0,25 mm	67,731...67,750 mm
- 2. undersize 0,50 mm	67,481...67,500 mm
- 3. undersize 1,00 mm	66,981...67,000 mm
- 4. undersize 1,50 mm	66,481...66,500 mm
Crankpin length	40,000...40,160 mm
Main bearing journal diameter:	
- standard	84,985...85,020 mm
- 1st undersize 0,25 mm	84,735...84,770 mm
- 2nd undersize 0,50mm	84,485...84,520 mm
- 3rd undersize 1,00 mm	83,985...84,020 mm
- 4th undersize 1,50 mm	83,485...83,520 mm
Main bearing housing diameter (in cylinder block)	91,000...91,025 mm
Main bearing shell thickness:	
- standard	2,955...2,965 mm
- 1st undersize 0,25 mm	3,080...3,090 mm
- 2nd undersize 0,50 mm	3,205...3,215 mm
- 3rd undersize 1,00 mm	3,455...3,465 mm
- 4th undersize 1,50 mm	3,705...3,715 mm
- bearing 8361 40950	3,705...3,715 mm
Main bearing clearance	0,050...0,127 mm
Length of thrust bearing journal (journal nearest to flywheel):	
- standard (2 standard thrust plates)	45,000...45,080 mm
- 1st oversize (one std and one 0,1 mm overthick thrust plate)	45,100...45,180 mm
- 2nd oversize (one std and one 0,2 mm overthick thrust plate)	45,200...45,280 mm
- 3rd oversize (one 0,1 mm and one 0,2 mm overthick thrust plate)	45,300...45,380 mm
- 4th oversize (two 0,2 mm overthick thrust plates)	45,400...45,480 mm
Other crankshaft journals may not be ground longer.	
Crankshaft end float	0,100...0,380 mm
Max. permissible ovality and other deformity of crankpins or journals	0,03 mm
Crankshaft unbalance	1,0 Ncm max.
Balancing unit ring gear location, diameter (44-engines)	150,220...150,260 mm
Balancing unit ring gear I.D. (44-engines)	150,000...150,040 mm

Flywheel

Interference fit between ring gear-flywheel	0,425...0,600 mm
Before fitting the ring gear, heat up to a temperature of	150...200°C
Flywheel unbalance	1,0 Ncm max.
Max permissible axial wobble of flywheel clutch face, measured at inner edge of clutch face on diameter 200	0,06:ø200

Balancing unit, 44-engines

Tooth backlash:	
- crankshaft ring gear-balancer weight gear wheel	0,1...0,3 mm
- between the balancer weights gear wheels	0,05...0,250 mm
Balancing weights end float	0,1...0,3 mm
Shaft diameter at bearing surfaces	36,000...36,016 mm
Bearing bushing inner diameter (fitted)	36,050...36,075 mm
Diameter of holes in body for shafts, rear end	36,058...36,083 mm
Diameter of holes in body for shafts, front end	35,958...35,983 mm
Shim thickness, cylinder block-balancer unit	0,2 mm

Timing gears

Tooth backlash:	
Crankshaft-idler gear	0,05...0,25 mm
Idler gear-camshaft gear	0,05...0,25 mm
Idler gear-fuel injection pump gear	0,05...0,25 mm
Max. permissible side wobble of gears	0,05 mm
Idle gear (slide bearing)	
- Idler gear shaft, diameter	54,951...54,970 mm
- Inner diameter of idler gear bushing (fitted)	55,000...55,030 mm
Idle gear (slide bearing, 50 mm length shaft)	
- Idler gear shaft, diameter	55,151...55,170 mm
- Inner diameter of idler gear bushing (fitted)	55,200...55,230 mm
Inner diameter of Idler gear hole	60,000...60,030 mm
Camshaft gear hole diameter	32,000...32,025 mm
Camshaft end diameter	32,043...32,059 mm
Timing marks:	
Timing marks on gears are in alignment when the 1st cylinder piston is at its top dead centre between compression and power strokes.	
On crankshaft gear	2 dots on tooth
On idler gear:	
- against crankshaft gear mark	0 on tooth
- against camshaft gear mark	1 dot on tooth
- against fuel injection pump gear mark	1 dot on notch
On camshaft gear	1 dot on notch
On injection pump gear	1 dot on tooth

Connecting rod

Inside diameter of piston pin bush (with bush pressed into connecting rod)	40,025...40,040 mm
Outside diameter of piston pin bush	44,080...44,120 mm
Outside diameter of piston pin bush (oversize 8353 28326)	44,580...44,620 mm
Interference fit: connecting rod small end bushing-connecting rod	0,057...0,120 mm
Connecting rod small end bore	44,000...44,025 mm
Connecting rod small end bore (oversize bush)	44,500...44,525 mm
Connecting rod big end bore	71,730...71,749 mm
Big end bearing shell thickness:	
- standard	1,835...1,842 mm
- 1st undersize 0,25 mm	1,960...1,967 mm
- 2nd undersize 0,50 mm	2,085...2,092 mm
- 3rd undersize 1,00 mm	2,335...2,342 mm
- 4th undersize 1,50 mm	2,585...2,592 mm

Big-end bearing clearance . . . . . 0,046...0,098 mm
End float (side clearance) at big-end on crankshaft . . . . . 0,200...0,410 mm
Piston pin bushing location perpendicular to longitudinal axis of connecting rod to be within 0,15:100
Piston pin bushing location and big-end bearing location to be parallel to within 0,05:100
Weight marking (letter) at lower end.
Max. permissible weight difference between connecting rods in the same engine . . . . . 20 g
Position of connecting rod; weight marking at valve mechanism side (away from the combustion chamber in the piston)

Piston, rings and pin

Minimum distance between piston and cylinder head (measured with a piece of lead wire thought the injector location hole) . . . . . 0,900...1,150 mm
Piston diameter:
- 17 mm from lower edge (44/66-engines) . . . . . 107,873...107,887 mm
- 19 mm from lower edge (74-engines) . . . . . 107,883...107,897 mm
Pin bore in piston . . . . . 40,003...40,009 mm
Piston pin diameter . . . . . 39,991...40,000 mm
Width of ring grooves:
- 1st groove (right-angled ring) . . . . . 2,560...2,580 mm
- 2nd grove . . . . . 2,520...2,540 mm
- 3rd groove . . . . . 4,040...4,060 mm
Side clearance of piston rings in their grooves:
- 1st ring (right-angled ring) . . . . . 0,07...0,102 mm
- 2nd ring . . . . . 0,03...0,062 mm
- 3rd ring . . . . . 0,05...0,082 mm
- reject limit . . . . . 0,15 mm
Piston ring height (in direction of cylinder):
- 1st ring (right-angled ring) . . . . . 2,478...2,490 mm
- 2nd ring . . . . . 2,478...2,490 mm
- 3rd ring . . . . . 3,975...3,990 mm
Piston ring gap (with piston fitted in cylinder):
- 1st ring (wedge shaped ring) . . . . . 0,40...0,55 mm
- 1st ring (right-angled ring) . . . . . 0,30...0,45 mm
- 2nd ring . . . . . 0,60...0,80 mm
- 3rd ring . . . . . 0,30...0,60
- reject limit 1st and 3rd ring . . . . . 1,0 mm
- reject limit 2nd ring . . . . . 1,5 mm
Max. permissible weight difference between pistons in same engine . . . . . 25 g
Piston to be heated up to 100°C before fitting gudgeon pin.
Piston position in cylinder: combustion chamber of piston to face towards injector.

Lubricating system

Oil pressure at normal running temperature:
- at idling speed (min.) . . . . . 1,0 bar
- at running speed . . . . . 2,5...5,0 bar
Oil pressure regulating valve (engines w/o oil cooled piston)
Free length of oil pressure valve spring . . . . . 49,5 mm
Assembly length / load of oil pressure valve spring . . . . . 28,5 mm / 76 N
Oil pressure regulating valve (engines with oil cooled piston)
Free length of oil pressure valve spring . . . . . 49,8 mm
Assembly length / load of oil pressure valve spring . . . . . 28,5 mm / 127 N
Oil filter by-pass valve opens at a pressure difference of . . . . . 2±0,5 bar

Oil pump, 44-engines

Backlash between gears when crankshaft lies firmly against the lower side of main bearings:

- crankshaft gear-lubricating oil pump gear	0,05...0,25 mm
- between the pump gears	0,16...0,26 mm
Diameter of drive shaft at bearings for body and cover	17,966...17,984 mm
Diameter of shaft holes on body and cover	18,000...18,018 mm
Diameter of gear wheel hole	18,060...18,078 mm
Fixed shaft, diameter	18,028...18,039 mm
Protrusion of fixed shaft end below pump body face	0,5...1,0 mm
Thickness of cover gasket	0,06...0,08 mm
Outside diameter of gear	43,486...43,525 mm
Housing diameter	43,650...43,750 mm
Thickness of gears	24,000...24,027 mm
End play of gears	0,03...0,11 mm
Depth of housing	24,000...24,043 mm
Number of teeth on drive gear (33/44-engines)	55 pcs
Number of teeth on drive gear (44-engines)	60 pcs

Oil pump, 66– and 74–engines

Backlash between gears when crankshaft lies firmly against the lower side of main bearings:

- crankshaft gear-lubricating oil pump gear	0,05...0,25 mm
- between the pump gears	0,16...0,26 mm
Diameter of drive shaft at bearings for body and cover	17,966...17,984 mm
Diameter of drive shaft bearing hole on body and cover	18,000...18,018 mm
Diameter of fixed shaft at gear wheel	17,966...17,984 mm
Inner diameter of bearing for gear wheel which rotates on fixed shaft	18,000...18,018 mm
Fixed shaft in pump body, diameter	20,035...20,048 mm
Protrusion of fixed shaft end below pump body face	0,5 mm
Thickness of cover gasket	0,06...0,08 mm
Outer diameter of gear wheels	55,824...55,870 mm
Housing diameter	56,000...56,120 mm
Thickness of gears	32,000...32,027 mm
End play of gears	0,03...0,11 mm
Depth of housing	32,000...32,043 mm
Number of teeth on drive gears	46 pcs

Coolant pump, 44-engines

Outside diameter of bearing	52 mm
Diameter of bearing housing	51,979...52,009 mm
Shaft diameter at bearing	20,002...20,015 mm
Shaft diameter at impeller	15,907...15,920 mm
Impeller hole diameter	15,876...15,894 mm
Diameter of fan hub	0,3 Ncm max.
Max. permissible eccentricity of fan	±0,3 mm
The fan belt tension pushing from the middle, deflection from the line	10...15 mm

Coolant pump, 66– and 74–engines

Outside diameter of bearing	52 mm
Inside diameter of bearing housing in pump body	51,979...52,009 mm
Shaft diameter at bearing	19,980...19,993 mm
Shaft diameter at impeller	15,907...15,920 mm
Impeller hole diameter	15,876...15,894 mm
Diameter of the seal recess in the pump body	36,450...36,489 mm
Balancing precision of fan	0,3 Ncm max.
Belt deflection	10...15 mm
Pump equipped with reinforced bearing	
Outer diameter of the front bearing	95 mm
Bearing up diameter in water pump wheel	95,000...95,035 mm
Outer diameter of bearings position in pump frame	59,991...60,009 mm

Turbocharger

Schwitzer

	S1A	S1B	S2A	S2B
Axial clearance max.	0,14 mm	0,14 mm	0,14 mm	0,14 mm
Radial clearance (compressor end) max.	0,61 mm	0,51 mm	0,82 mm	0,95 mm
Compressor wheel locknut torque	6,8 Nm	8,1 Nm	10,2 Nm	15,6 Nm
Compressor housing screws torque	13,6 Nm	13,6 Nm	13,6 Nm	13,6 Nm
Turbine housing screws torque	21,0 Nm	21,0 Nm		21,0 Nm

Schwitzer

	S100	S200	S300
Axial clearance max.	0,10 mm	0,10 mm	0,12 mm
Radial clearance (compressor end) max.	0,82 mm	0,88 mm	0,88 mm
Compressor wheel locknut torque	6,8 Nm	13,6 Nm	20,3 Nm
Compressor housing screws torque	13,6 Nm	13,6 Nm	13,6 Nm
Turbine housing screws torque	21,0 Nm	21,0 Nm	21,0 Nm

Tightening torques

Object	Nm
Cylinder head bolts and nuts	80 Nm + 90° + 90°
Cylinder head studs to cylinder block	30
Main bearing screws	200
Connecting rod screws	40 Nm + 90°
Crankshaft nut, 33/44	600
Crankshaft nut, 66/74/84	1000
Crankshaft pulley screws	30
Crankshaft pulley screws, 84	80
Flywheel screws	150
Flywheel screws, 84	200
Flywheel housing screws:	
- M12	110
- M10	60
Idler gear screws, 33/44/66:	
- M10	60
- M14	200
Idler gear screws (with ball bearing), 66/74/84:	
- M14	180
- M8	22
Piston cooling valve	30
Oil pump retaining screws	60
Oil cooler connecting piece	60
Coolant pump pulley screw, 33/44	80
Coolant pump pulley nut, 66/74	120
Coolant pump gear nut, 84	180
Belt tightener screw	48
Exhaust manifold screws	50
Injector attaching nuts (on studs)	15
Injector nozzle sleeve	60

Always use the torque values listed in the following tables when specific torque values are not available.
Use a washer with the aluminium parts.

Thread	Strength class	
	8.8	10.9
M8	25 Nm	35 Nm
M10	50 Nm	75 Nm

Cylinder head

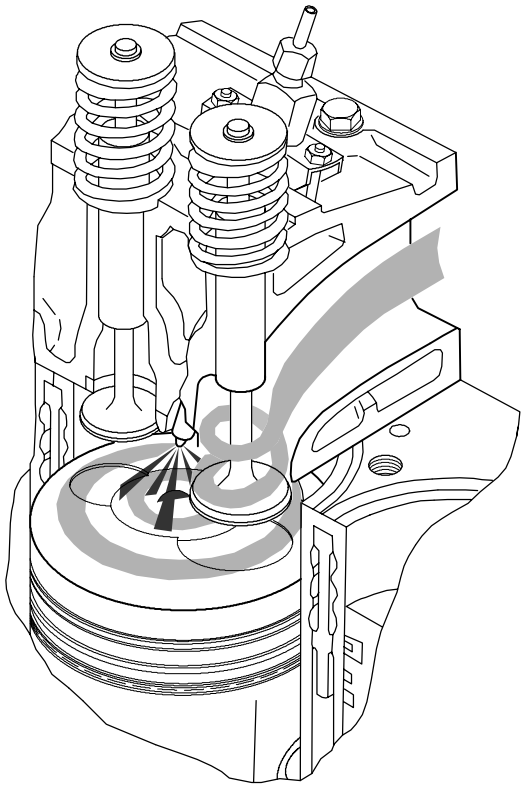
44-engines have one cylinder head. 66– and 74-engines have two cylinder heads which are exchangeable with each other. Each cylinder has its own inlet and exhaust ports located on either side of the head. Between hot exhaust valves a cool inlet valve is fitted to balance the thermal load.

Cylinder head bolts are high tensile bolts which are tightened up to yield limit using angle tightening principle. Due to the large stretch the tightening forces are kept constant during the whole lifetime and retightening is unnecessary.

The injector locations are machined directly into the cylinder head. The inlet and exhaust valve guides are identical and can be interchanged. Exhaust valves are fitted with separate valve seat rings. Also the engines with high output are equipped with separate inlet valve seats.

Valve mechanism

The valve mechanism is operated by the camshaft which is located in the cylinder block. The drive is transferred with the help of tappets and push rods. The camshaft gear wheel is fitted with a press fit and fixed with a key. Each bearing is lubricated by the force feed lubrication system through drilled oilways in the cylinder block.



Crank mechanism

The crankshaft is forged from chrome alloy special steel and is induction hardened at the bearing and sealing surfaces. This makes it possible to grind bearings four times without a new heat treatment. Gear wheels are located at the front end of the crankshaft. They are a press fit, and drive the idler wheel and oil pump. In addition, the front end of the crankshaft has splines for the hub of the V-belt pulley. An oil deflector ring is fitted between the hub and gear wheel, and a dust shield is fitted on the hub in order to protect the seal.

The crankshaft is supported on the cylinder block by main bearings which are placed on both sides of each cylinder. Thus there is one main bearing more than cylinders. The crankshaft thrust washers are placed in both sides of the rearmost main bearing.

At the rear end of the crankshaft there is fitted a flywheel on which is a press-fit a starter ring gear. The forged connecting rod has an I-section cross-section. The bearing location at the bottom end of the connecting rod is fracture-split, and the bearing cup is secured by two special elongated screws. The upper part has a wedge-shaped bearing location, in which the piston pin bearing bushing is fitted with a press fit.

The piston is made of an eutectic aluminium alloy. In the upper face of the piston there is a combustion chamber. The shape of the chamber is intended to maximise the mixture of air and fuel. The upper ring location is formed in a cast iron ring which is cast in the piston. In addition, the piston is graphite coated to ensure correct running-in.

The piston has three rings. The upper molybdenum-coated ring has a wedge-shaped cross-section. On some slight supercharged engines the upper ring is right-angled. The middle ring is tapered and it fits into its groove. The taper taking up the clearance. The oil control ring is spring loaded and it has a two-stage, chromed scraping edge.

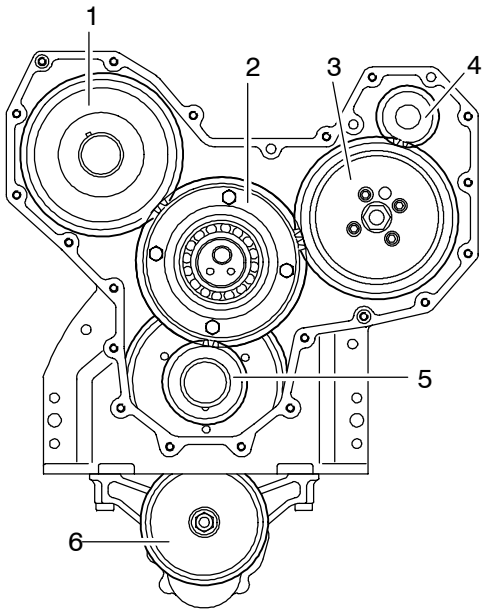
Some four-cylinder engines (44) are equipped with a balancer unit. The eccentric weights, which rotate at twice the engine speed, even out the vibration forces exerted by the movement of the pistons and the crank mechanism.

Timing gears

The timing gear train consists of hardened, helically cut gear wheels. The gears are encased by the timing gear casing which is fitted to the front of the engine. The timing gear drives the camshaft, fuel injection pump and oil pump.

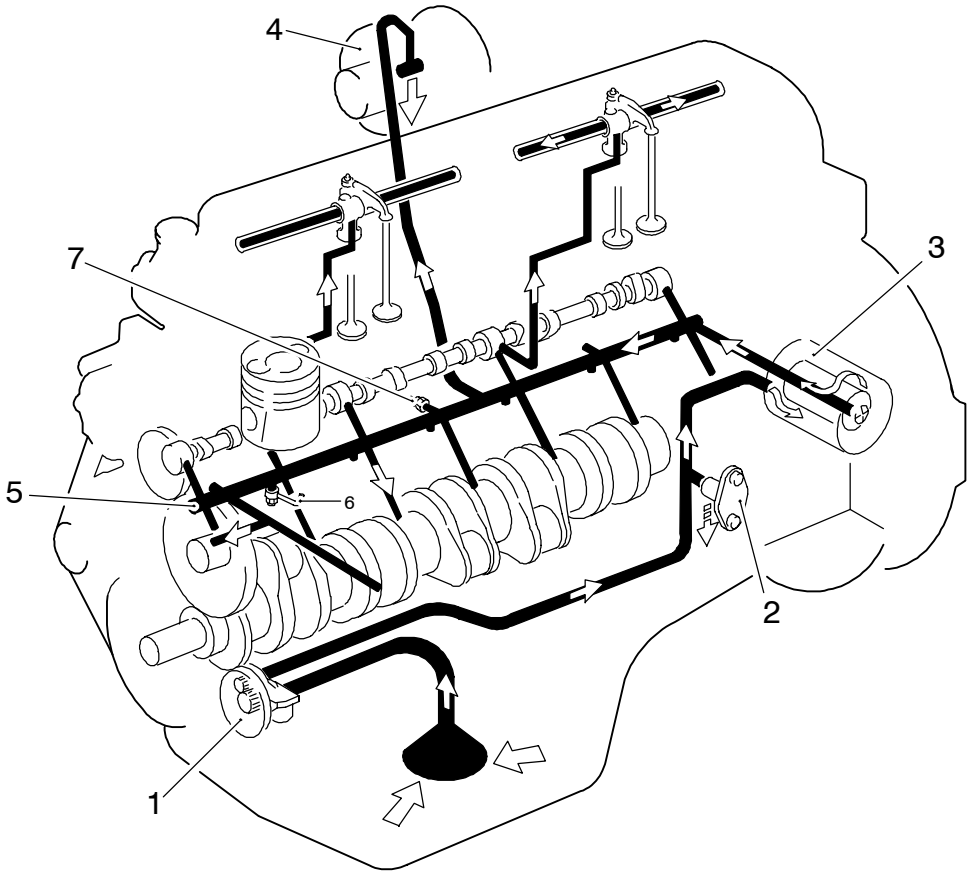
If the engine is equipped with a hydraulic pump, it is driven via a gear or a separate drive unit.

The idler gear is supported with a bearing sleeve / ball bearing (66– and 74-engines) on the shaft on the front face of the cylinder block. Two different dimensions of gear and shaft is used.



1. Camshaft gear
2. Idler gear
3. Injection pump gear
4. Coolant pump gear
5. Crankshaft gears
6. Oil pump gear

Lubricating system



Lubricating system (66– and 74-engines)
1. Oil pump
2. Oil pressure regulating valve
3. Oil filter
4. Turbocharger
5. Main oil gallery
6. Piston cooling nozzle
7. Oil pressure sensor

The engine has a pressure lubricating system in which the oil pump (gear pump) is attached to the cylinder block lower face. The oil is sucked up by the pump through a suction strainer. After the pump the oil is led through an oilway to the oil pressure regulating valve via the oil cooler to the oil filter. After the filter, the oil is led through the main oil gallery from which oilways branch out. The oil is led through the oilways in the main bearings and through the crankshaft to the big-end bearings.

The oil is further directed from the main gallery to the turbocharger and to a possible compressor. In addition, the camshaft bearing points and the valve mechanism get their lubrication oil via the main oil gallery.

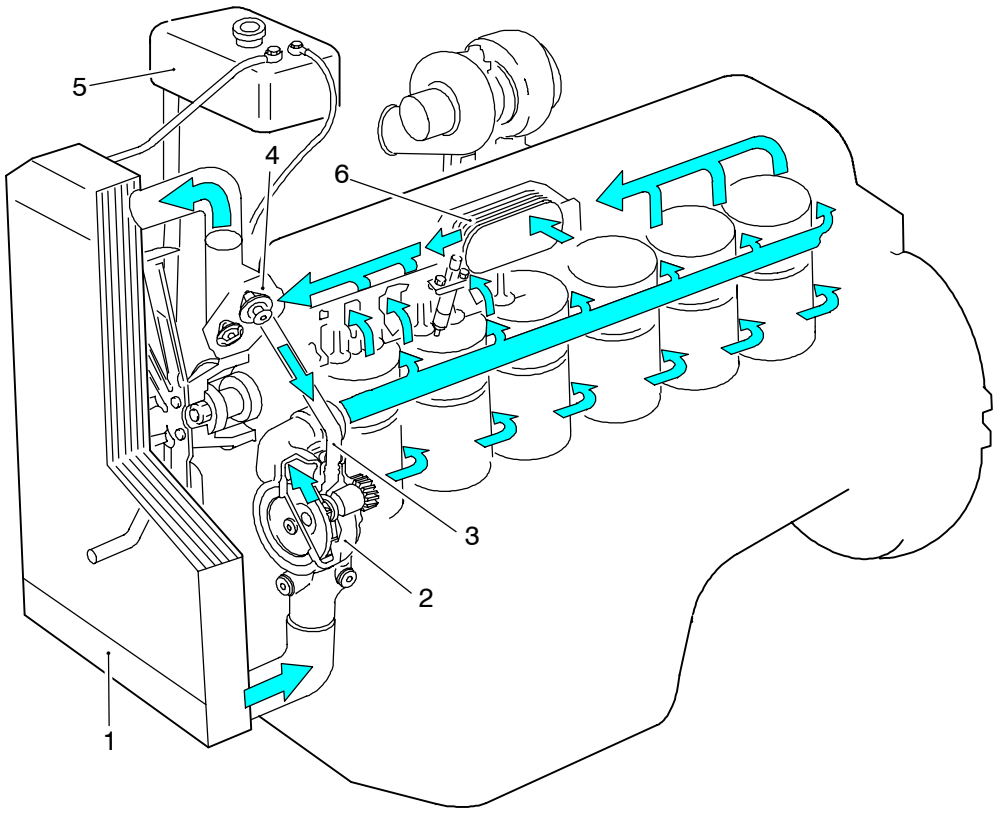
The undersides of the pistons of the engines with high output are always cooled by the oil spray when the oil pressure is more than 3 bar.

The oil pressure regulating valve is located under the oil filter on the left side of the engine. The regulating valve keeps the oil pressure constant, independent of the engine speed. At working speed the oil pressure is 2,5 to 5 bar depending on the temperature and the quality of lubricating oil. At idling the pressure is 1,0 bar minimum.

The oil filter is of main flow type. It has a replaceable cartridge mounted on the left side of the engine. At the bottom of the oil filter cartridge there is a by-pass valve for cold start or possible clogging of the filter.

Some engine types are equipped with a oil cooler located between the cylinder block and the oil filter. All oil that circulates through the filter also goes through the cooler and is cooled by the engine coolant circulating in the oil cooler.

Cooling system



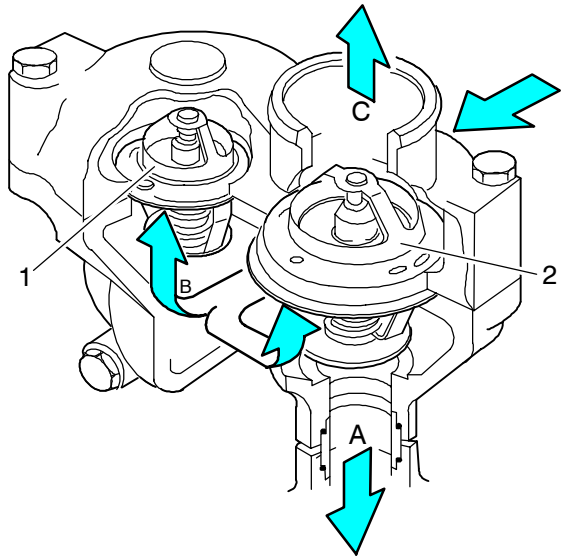
Cooling system
1. Radiator
2. Coolant pump
3. By pass pipe
4. Thermostats
5. Expansion tank
6. Oil cooler

The coolant pump is attached to the front face of the cylinder block and the thermostat housing is mounted above it.

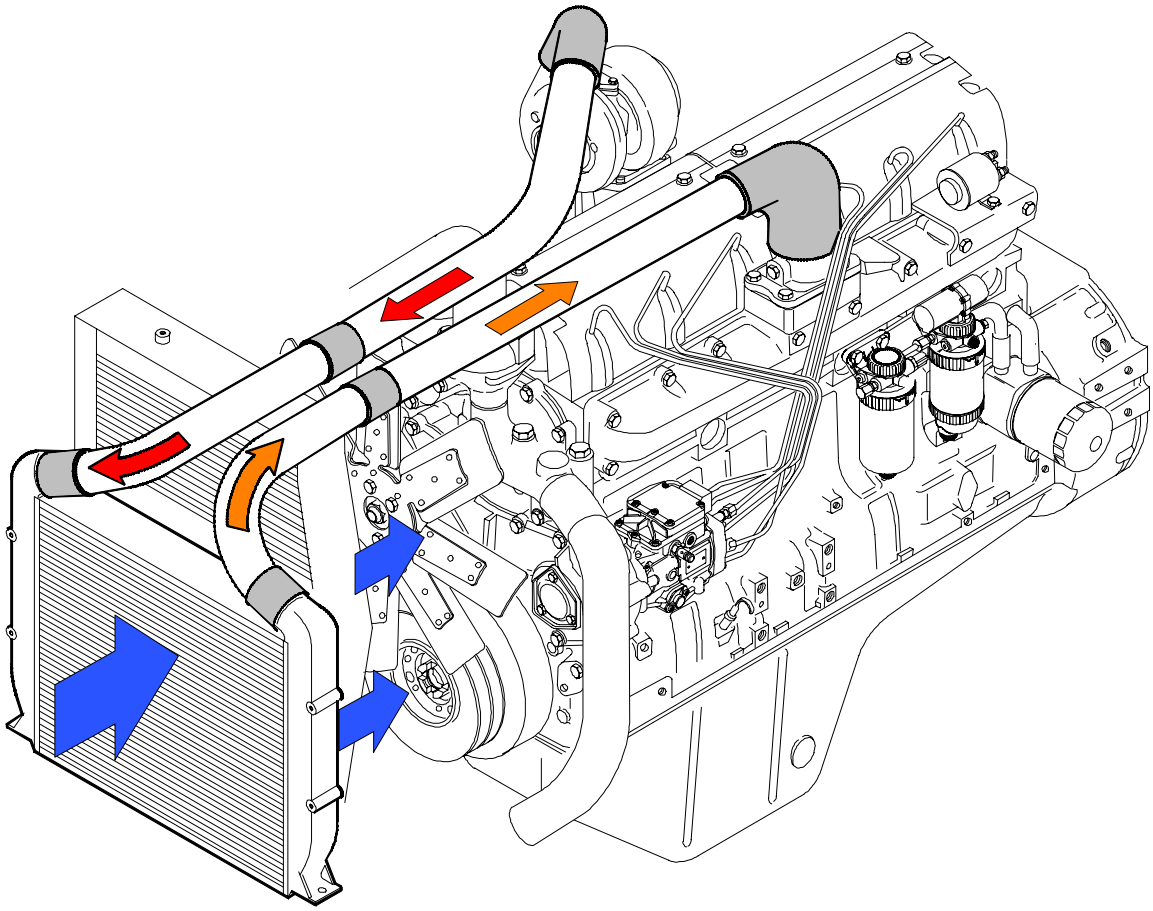
On 84-engines, the gear driven coolant pump is attached to the front face of the timing gear housing. The thermostat housing is mounted on front end of the cylinder head.

The system has the internal liquid circulation via the by-pass pipe. The circulation is regulated by the 2-way thermostat. This arrangement ensures a steady warming-up of the engine under all conditions.

In some 66- and 74-engines and 84-engines there are two separate thermostats where one of them is steering the by-pass of coolant liquid. The thermostats differ in types and opening temperatures. When the coolant temperature is below the thermostat opening temperature the coolant (A) circulates through the by-pass hole into the coolant pump. The smaller, singleacting thermostat (1) opens first (at 79°C) letting one part of the coolant (B) into the radiator. Following the load increase, also the other thermostat (2) opens (at 83°C). This is a double-acting type which closes the by-pass hole when it opens and directs the coolant (C) into the radiator. These engine models do not have any separate winter-type thermostats.



Inlet and exhaust system



The filter system for the engine inlet air comprises a cyclone type pre-cleaner, and a paper filter which acts as the main filter. The incoming air is made to rotate in the cyclone pre-cleaner. This causes most of the impurities to settle out and collect in the cyclone pre-cleaner dust collector. The paper filter comprises one or two replaceable filter elements. The paper is corrugated and surrounded by a metal support.

The impurities in the air collect at the larger filter element which can be cleaned when necessary. The inner safety filter prevents impurities form entering the engine should the main filter element break, or be fitted incorrectly.

A mechanical or electrical service indicator can be mounted on the filter housing or on the inlet pipe to show when the filter cartridge is clogged. The inlet system also includes the hoses between the air cleaner and the turbocharger and the turbocharger and the intake manifold.

The exhaust manifold is attached to the cylinder head with high tensile bolts without a separate gasket. Retightening of the manifold bolts is unnecessary.

The turbocharger is a turbo-compressor driven by exhaust gas. The compact design of the turbocharger is fast to react even during low revolutions. The turbocharger is lubricated and cooled by the lubrication system of the engine. EWA-engine is equipped with a by-pass turbocharger where excessive air pressure is adjusted by a so-called by-pass channel. The boost pressure is adjusted correctly by the manufacturer, and must not be changed afterwards.

The compressed air is cooled on the air-to-air basis. The air coming from the turbocharger has a temperature abt. 150°C which is cooled by the cooling air of the engine. The intercooler's cell is ideally installed in front of the radiator or side-by-side with radiator. The cooling of the compressed air stabilises the combustion, irrespective of the temperature, and minimises the thermal and mechanical load of the engine thus lowering nitric oxides (NOx) and particles (PT). Certain engine versions can also be equipped with an air-to-water intercooler. In that case, the engine specification is ETI.