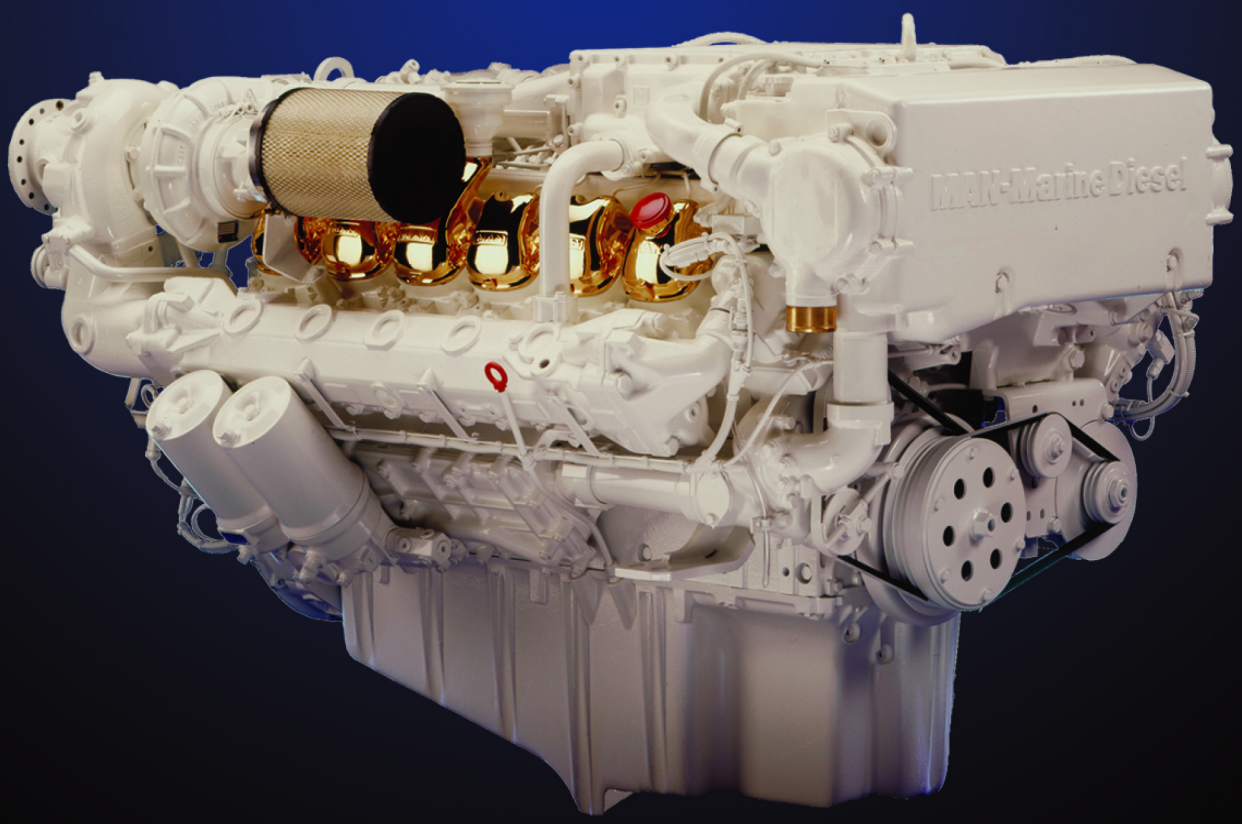
Engineering ◆ Data ◆ Setting values

MAN-Marine Diesel Engines

D 2848 LXE / LE 401 / 403 / 405
D 2840 LXE / LE 401 / 402 / 407
D 2842 LYE / LZE / LE 401 / 402 / 403 / 406 / 408 / 411 / 412 / 413



The purpose of this publication is to inform you about the checking values, setting data and technical details of MAN's 8, 10 and 12-cylinder high-performance marine Diesel engines.

It is intended to serve as a basis for maintenance and repair.

Yours faithfully,
MAN Nutzfahrzeuge Aktiengesellschaft
Werk Nürnberg

We reserve the right to make technical modifications in the course of further development.

MTDB Technical status: 05.2003 51.99493-8392

Contents

What do model designations mean?

All the engines dealt with here are related by design and together form a family.

The sequence of letters and numbers which make up the model designation reveal a number of characteristic properties of the engine in question to those familiar with the basic nomenclature.

We will explain the system using model D 2842 LYE as an example:

D	The “D” at the beginning of the model designation stands for **“Diesel”**.
28	The number “28” indicates that the engine has a 1**28** mm bore.
4	The “4” means 1**4**2 mm stroke.
2	The “2” shows that the engine has 12 cylinders. If there is a 0 here instead, the engine is a 10-cylinder model.
L	This letter stands for the German word “Ladeluftkühlung”, meaning **“intercooling”**.
Y	The development and power stages are represented by the letters “X”, “Y” and “Z”. Classifications Y and Z are found only with 12-cylinder engines.
E	“E” stands for the German word “Einbaumotor”, meaning **“installation engine”**, and distinguishes these engines from MAN vehicle engines.
401 / 4..	These are internal MAN development numbers. This engine generation was launched at the beginning of 1994 with modified turbocharger tuning and governor characteristic.

A brief history

The idea of developing a high power-density marine Diesel engine specifically suitable for light and fast planing boats had already become reality at the end of the seventies in the form of the D 2542 MLE.

As its classification shows, this engine is a 12-cylinder model with a bore of 125 mm and a stroke of 142 mm, making a swept volume of 20.91 l. With intercooling the engine was able to develop 478 kW (650 hp). Soon it was possible to increase its output to 700 hp.

Development work on a 10-cylinder model, D 2540 MLE, was progressing parallel to that on the 12-cylinder engine. The 10-cylinder model was capable of 405 kW (550 hp) at its debut.

Widening the bore to 128 mm and employing a modified injection process gave birth to the 560 kW (760 hp) model D 2842 LE. The total swept volume was thereby increased to 21.93 l.10 and 8-cylinder engines with ratings of 467 kW (635 hp) and 375 kW (510 hp) followed.

In 1988 radical modifications became necessary to further increase output without increasing swept volume. By improving the intercooling, increasing charge air pressure and reducing the compression ratio the output of the 12-cylinder engine was raised initially to 735 kW (1000 hp), subsequently to 809 kW (1100 hp). The 1000 hp variant bears the designation D 2842 LYE, the 1100 hp variant D 2842 LZE.

Comprehensive side measures were introduced at this stage of evolution to ensure that the engines met demands for smooth running characteristics and environmental compatibility even at this power output.

Worthy of mention in this context are:

- Injection pump with cylinder cutout
- Engine speed governor with charge-pressure dependent full-load stop
- Intake air preheating in warming-up phase

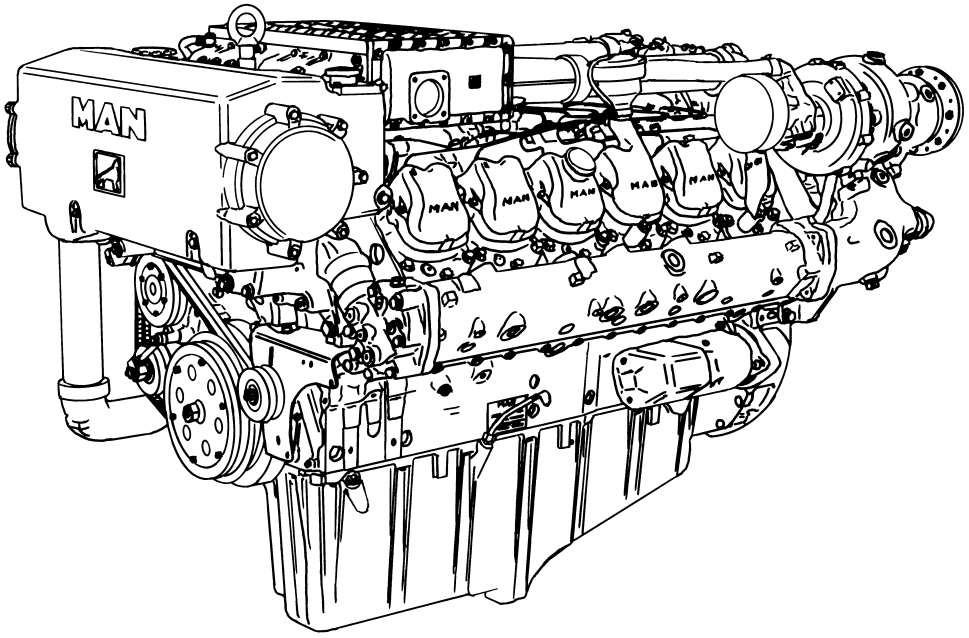
The 10-cylinder D 2840 LXE developing 603 kW (820 hp) was followed by the 8-cylinder D 2848 LXE with an output of 500 kW (680 hp).

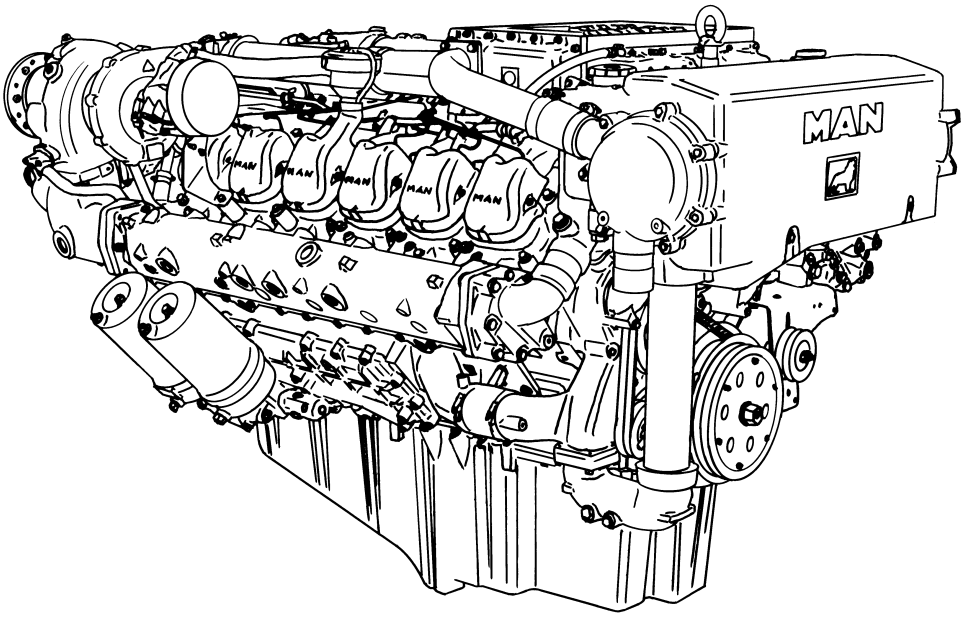
To meet demands for more power in the lower engine speed range, work started on the 401/402 engine generation at the start of 1994. Although the rated power was provisionally unchanged, torque was increased and progress made with respect to exhaust emissions.

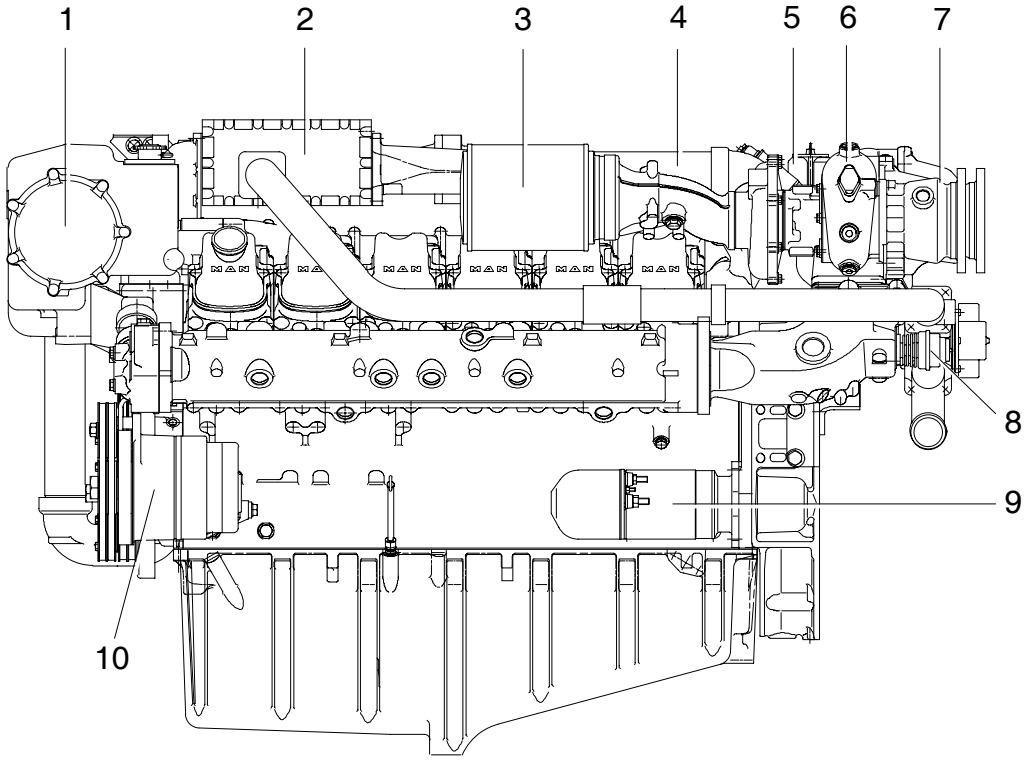
This has been achieved principally by means of retuned turbochargers with wastegates and injection pumps with K governors.

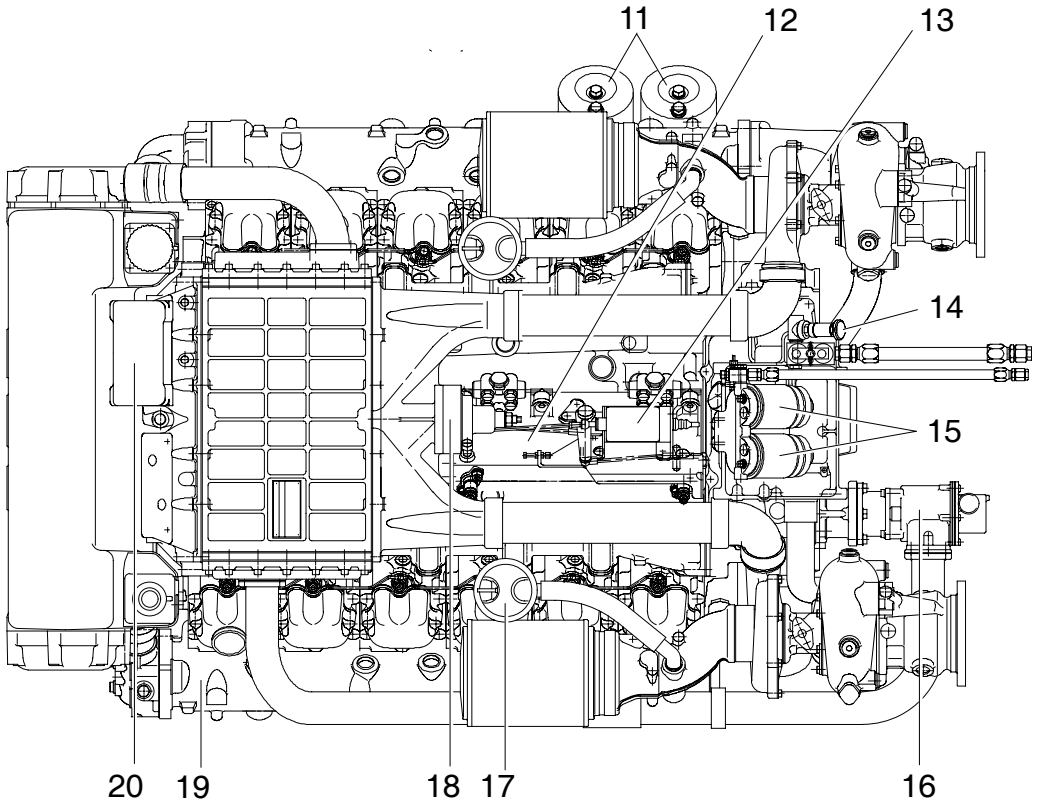
General engine data

Mode of operation	four-stroke, Diesel
Combustion process	direct injection
Design	V 90°
Bore / stroke	128 / 142 mm
Compression ratio	
D 2840 LE 402, D 2842 LE 403 / 405 / 412 / 413	15,5 : 1
all other engine models	13,5 : 1
Rotation viewed from flywheel	anti-clockwise
Engine rating	see model plate
Rated speed	see model plate









2553

Taking the 12-cylinder D 2842 LE 402 engine as an example, we shall explain the components of the engine singly using the adjacent drawing. The only difference between the general design of this engine and the 10 and 8-cylinder models, D 2840 LXE / LE 4.. and D 2848 LXE / LE 4.., is in the number of cylinders.

1 Heat exchanger and expansion tank

2 Sea water-cooled intercooler

3 Air filter

4 Charge air pipe

5 Fuel prefilter

6 Turbocharger with water-cooled turbine integrated into the engine cooling circuit

7 Diffuser

8 Wastegate

9 Starter

10 Alternator

11 Double oil filter

12 Injection pump with two fuel feed pumps in parallel

13 Engine shut down solenoid

14 Hand priming pump

15 Fuel filter

16 Sea water pump

17 Oil separator valve of crankcase breather

18 Charge air pressure equalisation valve

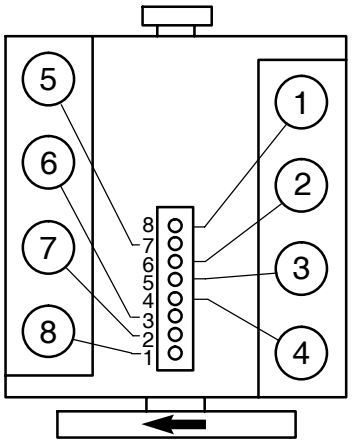
19 Exhaust manifold, water-cooled, integrated into the engine coolant circuit

20 Intake air preheating

Engine-specific data

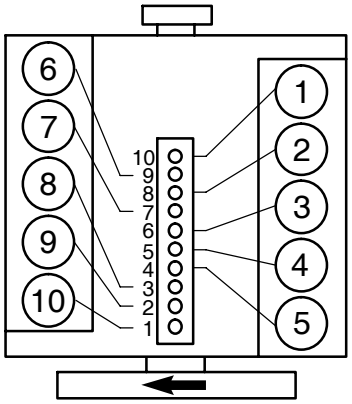
D 2848 LXE, D 2848 LE 4..

No. of cylinders	8
Swept volume	14,62 l
Firing sequence	
without cylinder cutout	1-5-7-2-6-3-4-8-1
with cylinder cutout	1-7-6-4-1
Firing interval	
without cylinder cutout	90°
with cylinder cutout	180°



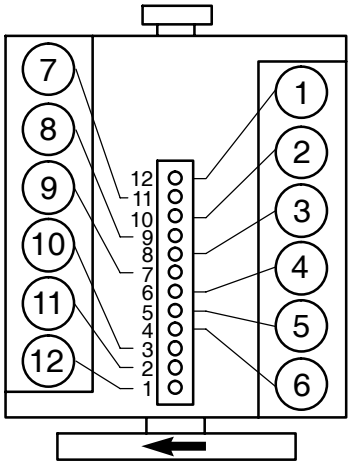
D 2840 LXE, D 2840 LE 4..

No. of cylinders	10
Swept volume	18,27 l
Firing sequence	
without cylinder cutout	1-6-5-10-2-7-3-8-4-9-1
with cylinder cutout	1-5-2-3-4-1
Firing interval	
without cylinder cutout	90°, 54°, 90°, 54°...
with cylinder cutout	144°

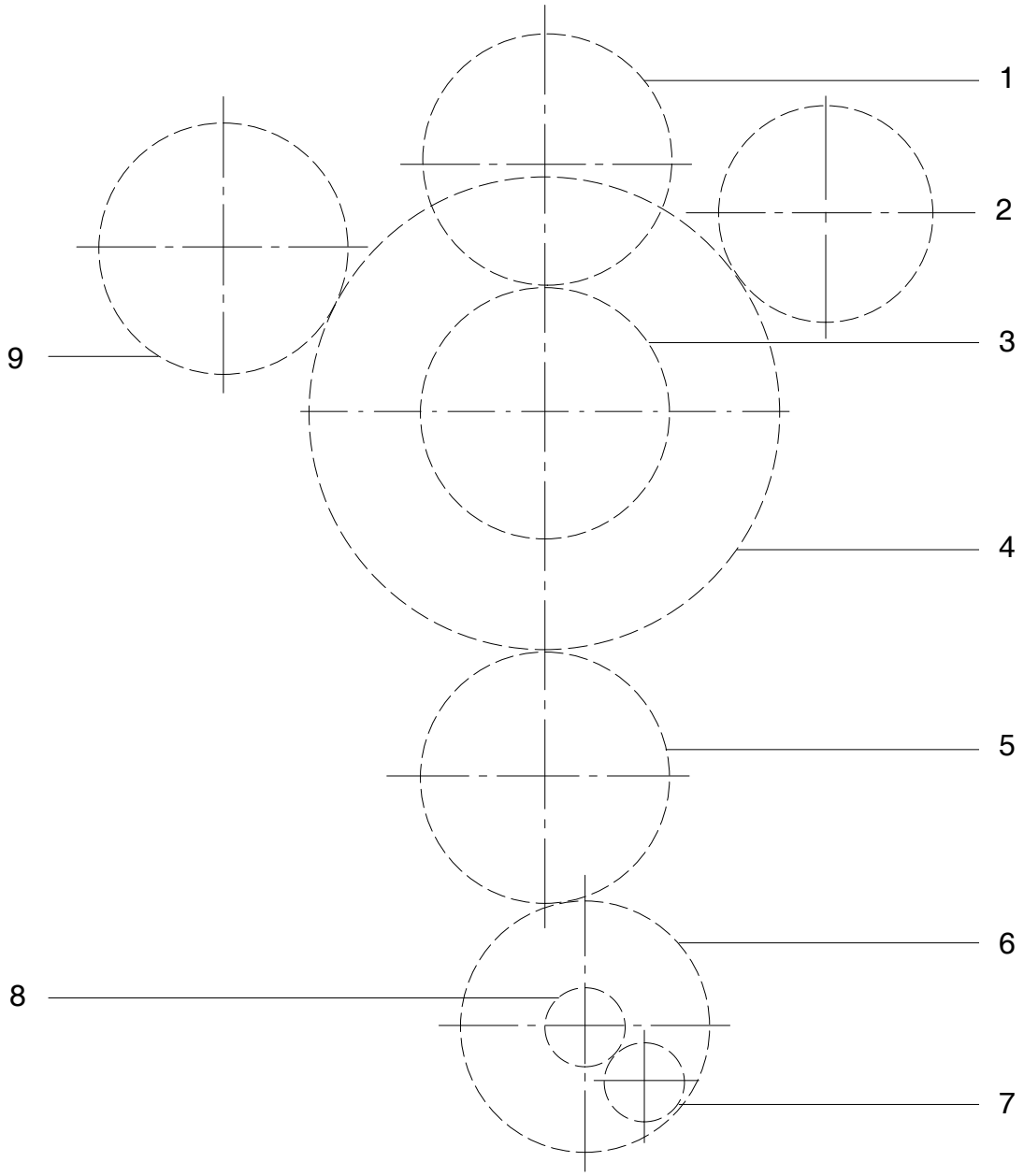


D 2842 LYE, D 2842 LZE, D 2842 LE 4..

No. of cylinders	12
Swept volume	21,93 l
Firing sequence	
without cylinder cutout	1-12-5-8-3-10-6-7-2-11-4-9-1
with cylinder cutout	1-5-3-6-2-4-1
Firing interval	
without cylinder cutout	90°, 30°, 90°, 30°...
with cylinder cutout	120°



Timing gear arrangement
(viewed from flywheel)



	Gear designation	No. of teeth	Module	Gear tooth cutting
1	Drive gear, injection pump	51	2,75	straight
2	Power take-off	34	2,75	helical (23°40')
3	Intermediate gear	51	2,75	straight
4	Drive gear, camshaft	86	2,75	helical (23°40')
5	Crankshaft gear	43	2,75	helical (23°40')
6	Drive gear, oil pump	44	2,75	helical (23°40')
7	Oil pump supply gear	7	6	straight
8	Oil pump supply gear	7	6	straight
9	Drive gear, sea water pump	40	2,75	helical (23°40')

Valve train
The checking values are valid for all engines dealt with in this publication

Valve clearance (when engine is cold)	inlet	0,25 mm ± 0,05 mm
	exhaust	0,40 mm ± 0,05 mm

Note: Starting with following engine numbers valve clearance has been changed:
D 2848 L: ...7678 001.... , D 2840 L: ...7661 035...., D 2842 L: ...7651 046....
See instruction label on valve cover! New values for valve clearance are:

Valve clearance (when engine is cold)	inlet	0,50 mm ± 0,05 mm
	exhaust	0,60 mm ± 0,05 mm

Why valve clearance?
The individual valve train components expand slightly as they warm up. Valve clearance ensures that the valves close safely and that an effective seal is formed even when the engine is warm.

Valve clearance too small:
The valves do not sit correctly on the valve seat inserts when closed and are therefore no longer able to conduct the heat to the cylinder head. In this situation the exhaust valves in particular are prone to burning because of the high thermal stress to which they are exposed as a result of the hot combustion gases which are constantly flowing past them.

Valve clearance too large:
The valve opening cross-sections are reduced and cylinder charging worsens. Valve train wear and valve noise is increased greatly.

Timing diagram

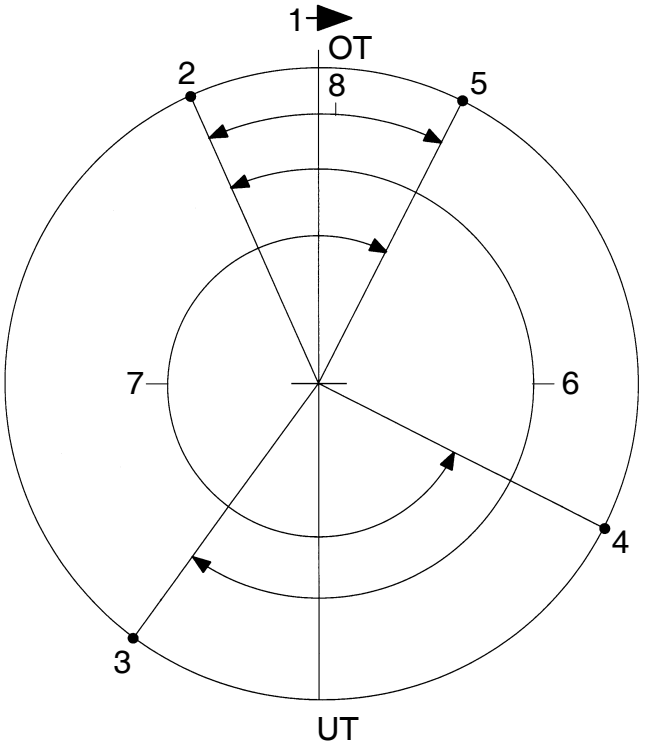
1 Direction of engine rotation (viewed from V-belt pulley)

2 Inlet opens 24° before TDC
3 Inlet closes 36° after BDC
4 Exhaust opens 63° before BDC
5 Exhaust closes 27° after TDC

6 Inlet open for 240°
7 Exhaust open for 270°
8 Overlap 51°

Figures in degrees refer to the crankshaft angle

Valve lift: 14,0 mm
(intake / exhaust)



Compression pressures

(Engine has run before the measurement and is warm to the touch)

good	bar	over 18
permissible	bar	16–18
in need of repair	bar	under 16
pressure difference (between individual cylinders)	bar	max. 4

Fuel system

Delivery rate of fuel supply pump:		D 2848 LXE D 2840 LXE D 2842 LYE / LZE	D 2848 LE 4.. D 2840 LE 4.. D 2842 LE 4..
n = 2300 rpm	l / h	500	750

Opening pressure of overflow valve (all engine models):

at injection pump	bar	1,3–1,8
at fuel filter	bar	3,0–3,5

Lubricating system

Oil pump feed rate:

The oil pumps have the following rotation speeds:
Oil pump speed: engine speed x 0.977 (i = 1.023)
(Feed rates with SAE 20 oil at 90°C and 6 bar.)

D 2848 LXE / LE 4..

n = 635 rpm	l / min	40
n = 2248 rpm	l / min	165

D 2840 LXE / LE 4..
(oil sump at front and flat oil pan)

n = 635 rpm	l / min	45
n = 2248 rpm	l / min	205

D 2842 LYE / LZE / LE 4..
and D 2840 L.. (oil sump at rear)

n = 635 rpm	l / min	43
n = 2248 rpm	l / min	205

Valve opening pressures in lubricating oil circuit:

Bypass valve for oil filter

Model: Mann	bar	2,2–2,8
Model: Hengst	bar	2,8–3,6

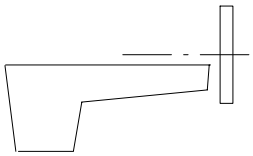
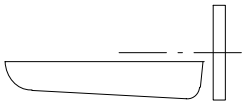
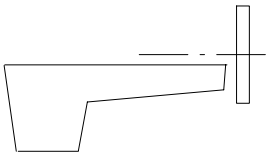
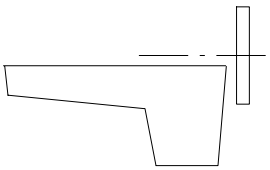
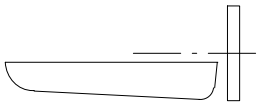
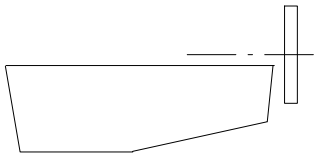
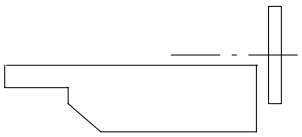
Oil pump pressure regulating valve	bar	9–10

Pressure valve of oil spray jets

Opening pressure	bar	1,6–1,9
Closing pressure	bar	1,3–1,6

Filling capacities

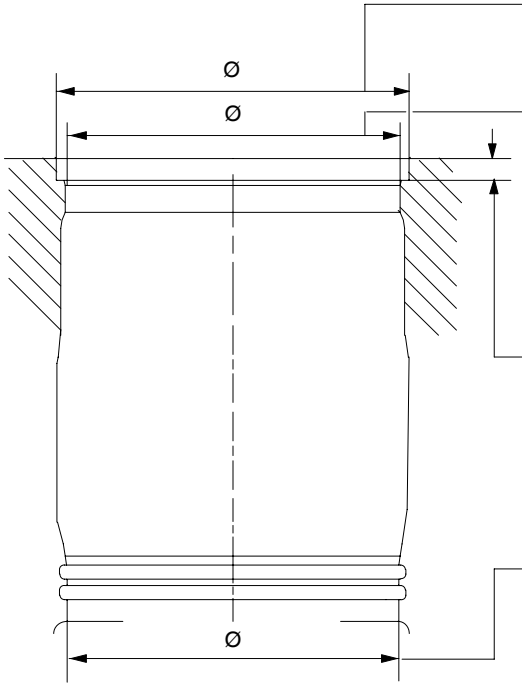
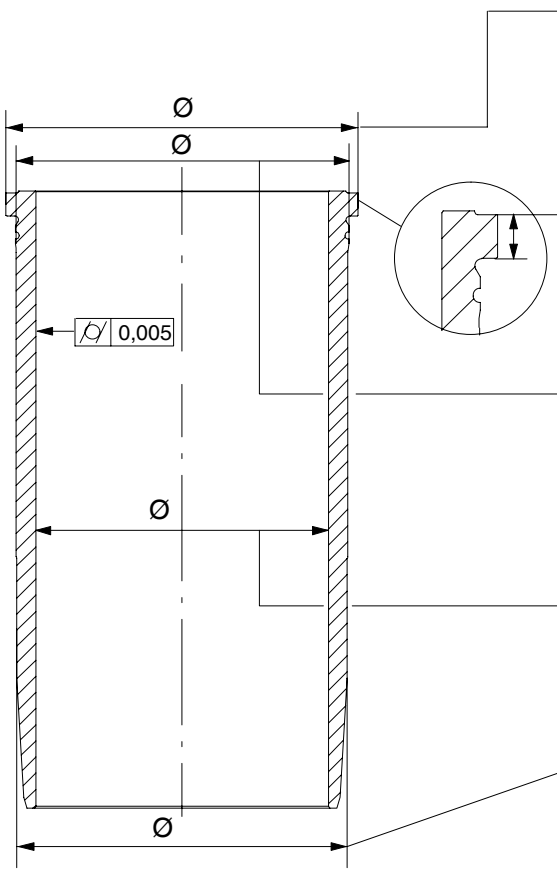
Oil

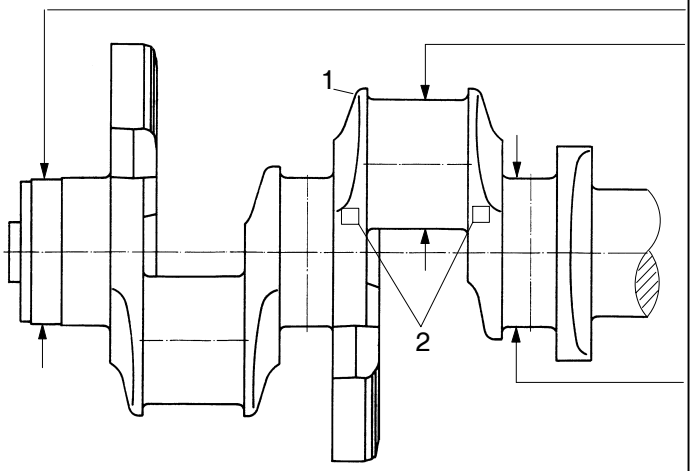
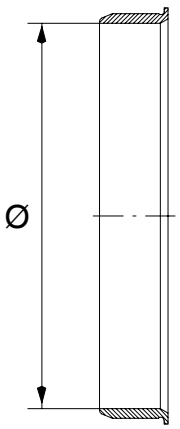
Engine model	Oil pan	Min. capacity	Max. capacity
D 2848 L..	deep 	12 l	18 l
D 2848 L..	flat 	20 l	24 l
D 2840 L..	deep sump OFW* 	14 l	22 l
D 2840 L..	deep sump FW* 	26 l	30 l
D 2840 L..	flat 	26 l	30 l
D 2842 L..	deep 	24 l	32 l
D 2842 L..	semi-flat 	22 l	30 l

*OFW = opposite end to flywheel, FW = adjacent to flywheel

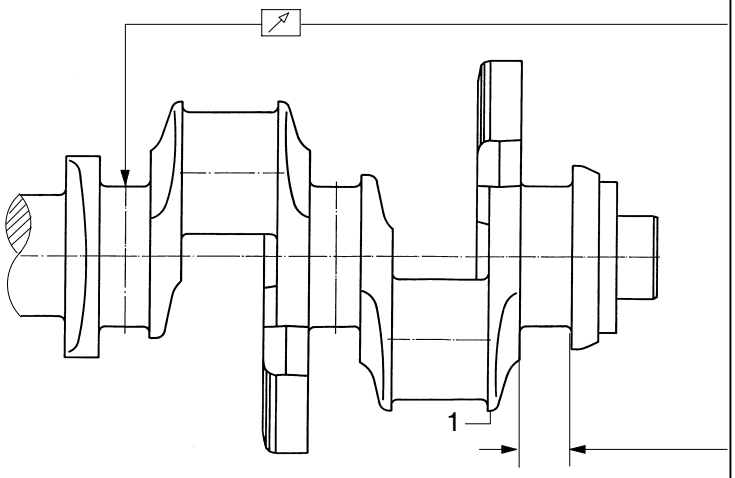
Coolant

Engine with heat exchanger	Litres
D 2848 LE 4..	63
D 2840 LE 4..	80
D 2842 LE 4..	96

Service Data	Dimensions Limiting values
Crankcase	
	153,90–154,00 mm standard 154,40–154,50 mm for cylinder liners with 0,5 and 1,0 mm larger outside Ø 145,80–145,84 mm standard 146,30–146,34 mm for cylinder liners with 0,5 mm larger outside diameter 146,80–146,84 mm for cylinder liners with 1,0 mm larger outside diameter 9,97–9,99 mm 144,50–144,54 mm standard 145,00–145,04 mm for cylinder liners with 0,5 mm larger outside diameter 145,50–145,54 mm for cylinder liners with 1,0 mm larger outside diameter
Cylinder liner	
	153,694–153,757 mm 154,194–154,257 with 0,5 and 1,0 mm larger outside diameter 10,030–10,050 mm 10,230–10,250 mm with 0,2 mm more flange height Liner protrusion above upper deck of crankcase: 0,04–0,08 mm 145,761–145,786 mm 146,261–146,286 mm with 0,5 mm larger outside diameter 146,761–146,786 mm with 1,0 mm larger outside diameter 127,990–128,010 Max. wear limit: 0,15 mm larger than basic size 144,432–144,457 mm 144,932–144,957 mm with 0,5 mm larger outside diameter 145,432–145,457 mm with 1,0 mm larger outside diameter

Service Data	Dimensions Limiting values
Crankshaft	
Crankshaft front end (opposite end to flywheel) 	99,987–100,022 mm 89.98–90,00 mm standard size 89,73–89,75 mm undersize 0,25 89,48–89,50 mm undersize 0,50 89,23–89,25 mm undersize 0,75 88,98–89,00 mm undersize 1,00 103,98–104,00 mm standard size 103,73–103,75 mm undersize 0,25 103,48–103,50 mm undersize 0,50 103,23–103,25 mm undersize 0,75 102,98–103,00 mm undersize 1,00 1 = Colour marking for size identification of crank pin diameter 2 = Colour marking for size identification of main bearing journal diameter undersize 0,25: red undersize 0,50: white undersize 0,75: yellow undersize 1,00: lilac max. axial clearance of crankshaft: 0,190–0,322 mm
Bearing race for crankshaft, front end 	Inner diameter: 99,907–99,942 mm

Crankshaft rear end (adjacent to flywheel)



Max. permissible runout with crankshaft taken up in end bearings:

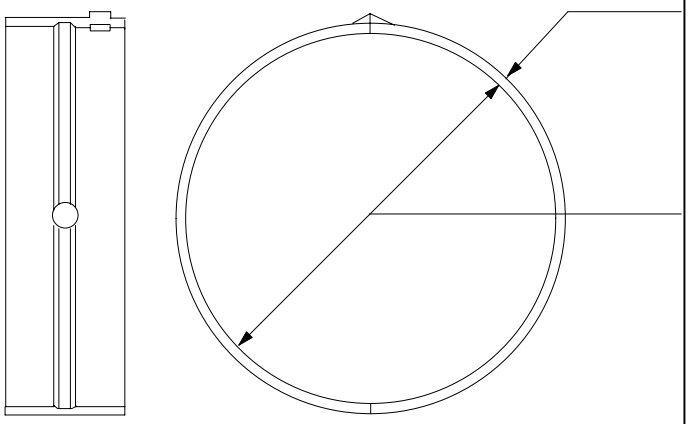
D 2848 L	at bearing 3	0,06 mm
D 2840 L	at bearing 3 and bearing 4	0,06 mm
D 2842 L	at bearing 4	0,08 mm

38,000–38,062 mm standard size
38,500–38,562 mm undersize 0,25
38,500–38,562 mm undersize 0,50
39,000–39,062 mm undersize 0,75
39,000–39,062 mm undersize 1,00

1 = Colour marking for size identification of thrust bearing journal length

undersize 0,25: red
undersize 0,50: white
undersize 0,75: yellow
undersize 1,00: lilac

Main bearing



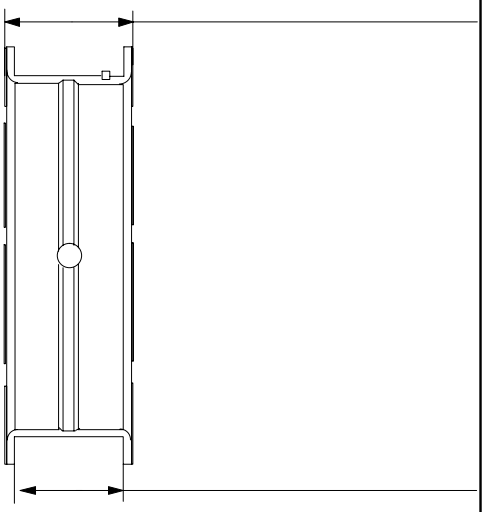
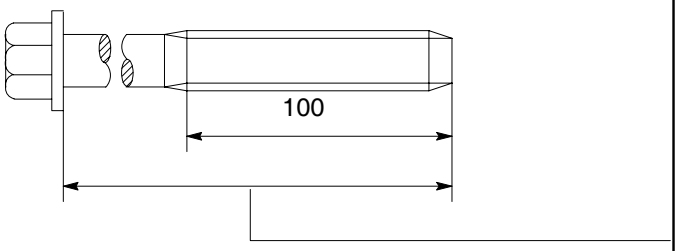
Data for wall thickness and bearing bore also apply to thrust bearing

3,455–3,467 mm standard size
3,580–3,592 mm undersize 0,25
3,705–3,717 mm undersize 0,50
3,830–3,842 mm undersize 0,75
3,955–3,967 mm undersize 1,00

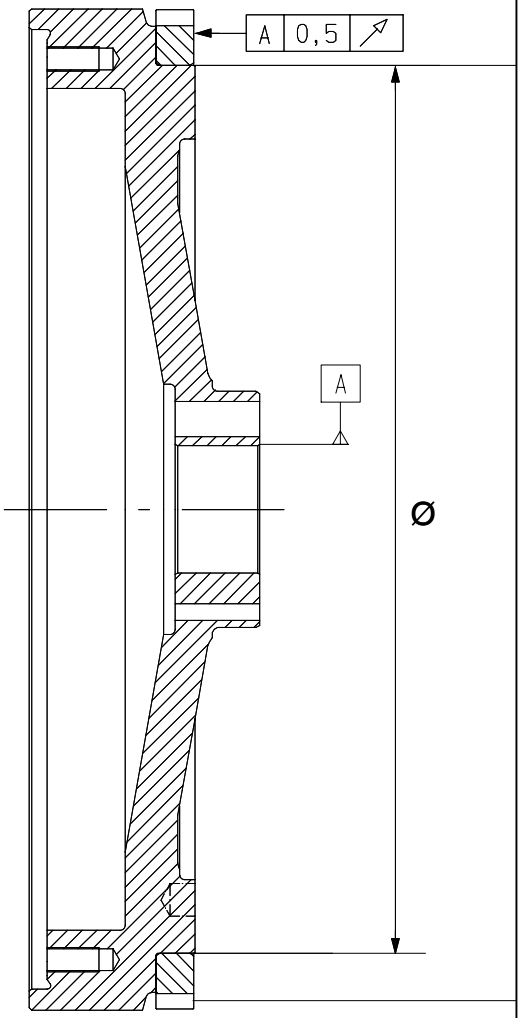
Bearing bore in installed condition
104,066–104,112 mm standard size
103,816–103,862 mm undersize 0,25
103,566–103,612 mm undersize 0,50
103,316–103,362 mm undersize 0,75
103,066–103,112 mm undersize 1,00

Spread: 0,3–1,2 mm

Marking:
top / bottom
standard size: 0958 / 0079
undersize 0,25: 0962 / 0081
undersize 0,50: 0964 / 0082
undersize 0,75: 0966 / 0083
undersize 1,00: 0968 / 0084

Service Data	Dimensions Limiting values
Thrust bearing 	3,363–3,388 mm standard size 3,613–3,638 mm undersize 0,25 3,613–3,638 mm undersize 0,50 3,863–3,888 mm undersize 0,75 3,863–3,888 mm undersize 1,00 Spread: 0,1–0,5 mm Marking: top / bottom standard size: 0164 / 0165 undersize 0,25: 0168 / 0169 undersize 0,50: 0170 / 0171 undersize 0,75: 0172 / 0173 undersize 1,00: 0174 / 0175 31,01–31,04 **Data for wall thickness and bearing bore see “main bearing”**
Mounting bolts for crankshaft bearing caps 	Length: During tightening the bolts are intentionally stressed beyond the yield point and therefore subjected to some permanent elongation each time they are tightened. When the bolt has reached its maximum length it must not be reused. new: 152,5–153 max. 154,5 mm

Flywheel and starter gear ring



Ø Flywheel:
432,490–432,645 mm (Ø 432 u9

Starter gear ring, inside diameter:
432,000–432,155 mm (Ø 432 H9)

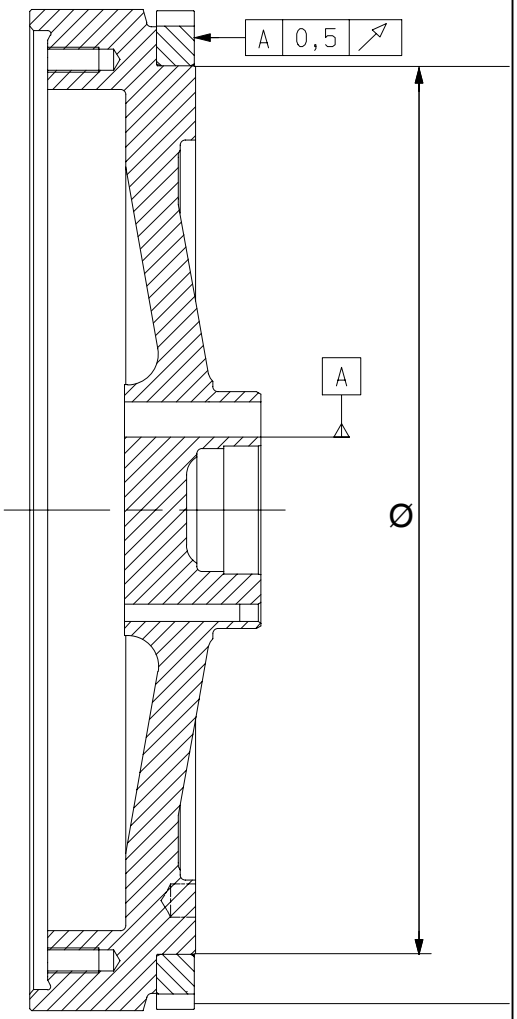
Interference: 0,335–0,645 mm
Installation temperature: 200–230 deg.C

m = 52,9 kg (with starter gear)
J = 1,975 kgm^2

Number of teeth: Z = 160, Module 3
Matching gear:
Starter pinion (Z = 9, gear ratio: i = 17,78)

Backlash: 0,6–0,9 mm

Flywheel and starter gear ring for D 2840 LE 403 and D 2842 LE 404



Ø Flywheel:
432,490–432,645 mm (Ø 432 u9)

Starter gear ring, inside diameter:
432,000–432,155 mm (Ø 432 H9

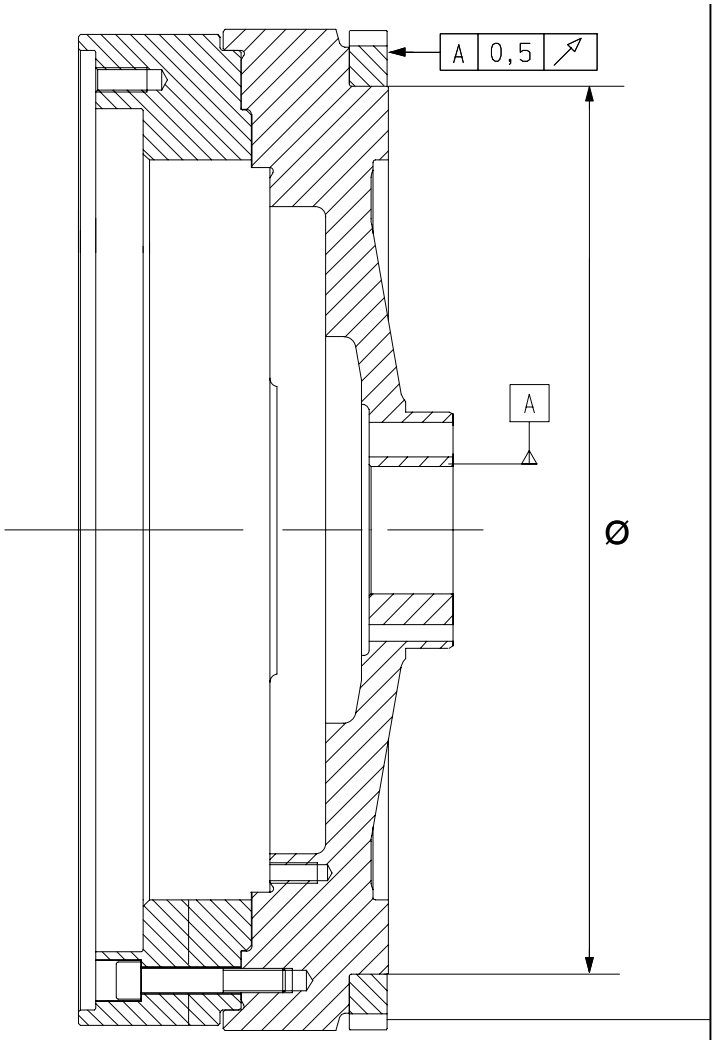
Interference: 0,335–0,645 mm
Installation temperature: 200–230 deg.C

m = 54,4 kg (with starter gear)
J = 1,921 kgm^2

Number of teeth: Z = 160, Module 3
Matching gear:
Starter pinion (Z = 9, gear ratio: i = 17,78)

Backlash: 0,6–0,9 mm

Flywheel with additional mass and starter gear ring



Ø Flywheel:
432,490–432,645 mm (Ø 432 u9)

Starter gear ring, inside diameter:
432,000–432,155 mm (Ø 432 H9)

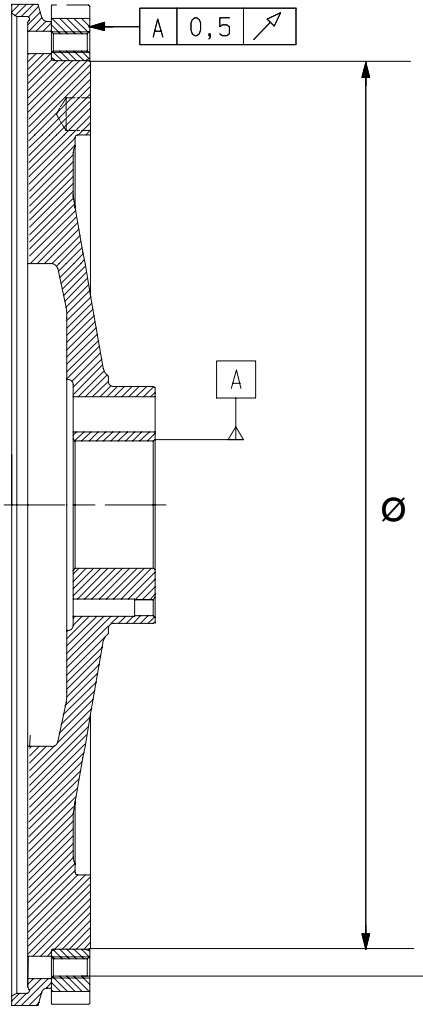
Interference: 0,335–0,645 mm
Installation temperature: 200–230 deg.C

m = 102 kg (with starter gear)
J = 4,12 kgm^2

Number of teeth: Z = 160, Module 3
Matching gear:
Starter pinion (Z = 9, gear ratio: i = 17,78)

Backlash: 0,6–0,9 mm

Flywheel for cardan-shaft coupling



Ø Flywheel:
432,490–432,645 mm (Ø 432 u9)

Starter gear ring, inside diameter:
432,000–432,155 mm (Ø 432 H9)

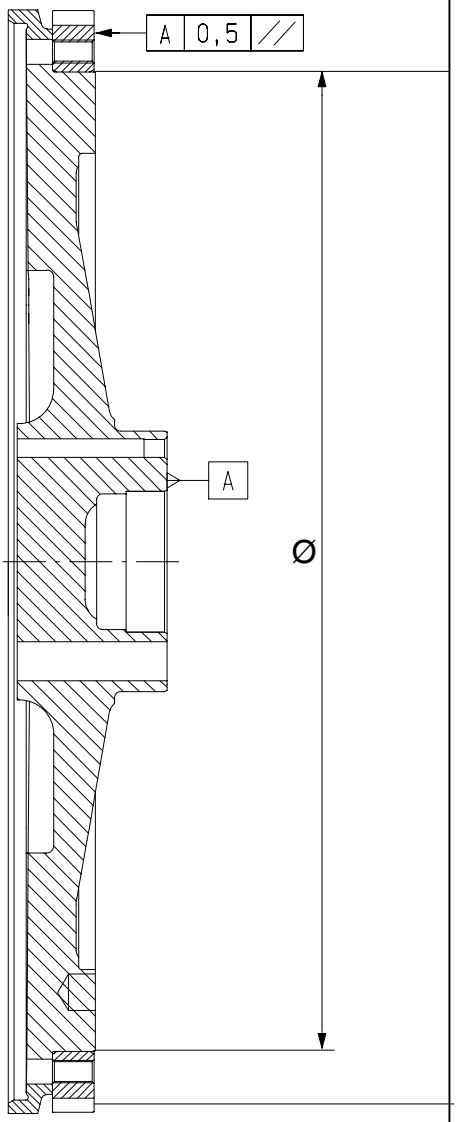
Interference: 0,335–0,645 mm
Installation temperature: 200–230 deg.C

m = 32,5 kg (with starter gear)
J = 1,10 kgm^2

Number of teeth: Z = 160, Module 3
Matching gear:
Starter pinion (Z = 9, gear ratio: i = 17,78)

Backlash: 0,6–0,9 mm

Flywheel for elastomer propshaft coupling



Ø Flywheel:
432,490–432,645 mm (Ø 432 u9)

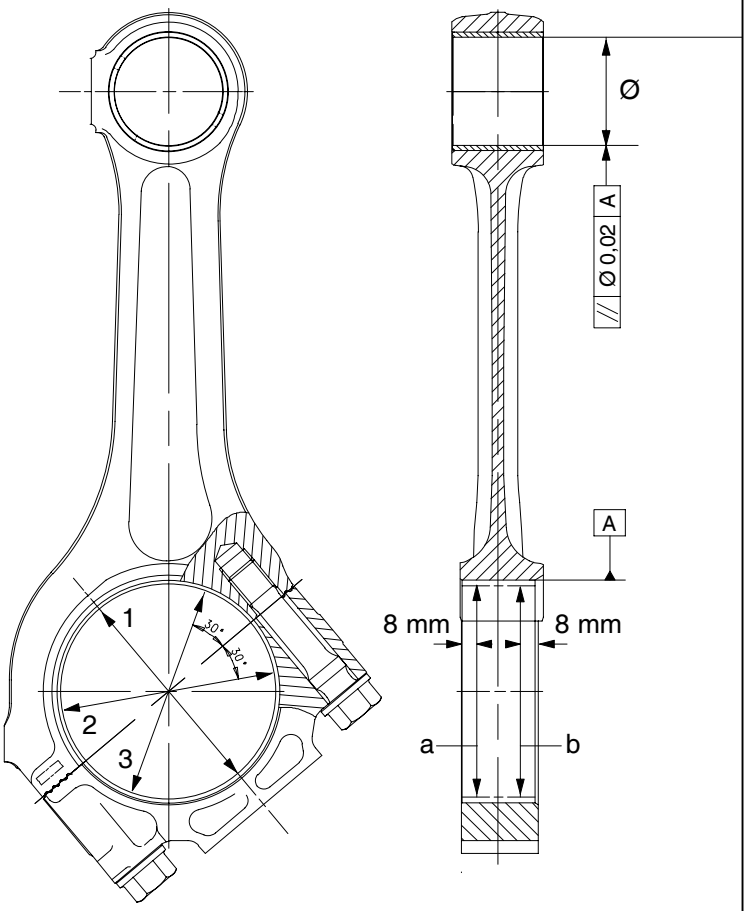
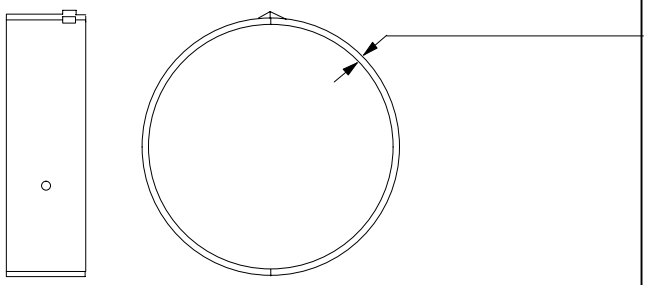
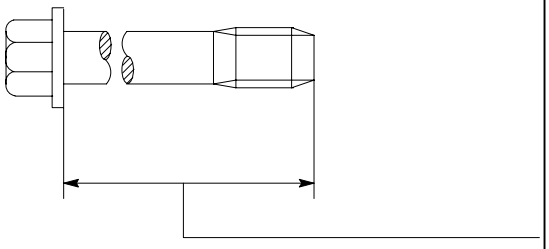
Starter gear ring, inside diameter:
432,000–432,155 mm (Ø 432 H9)

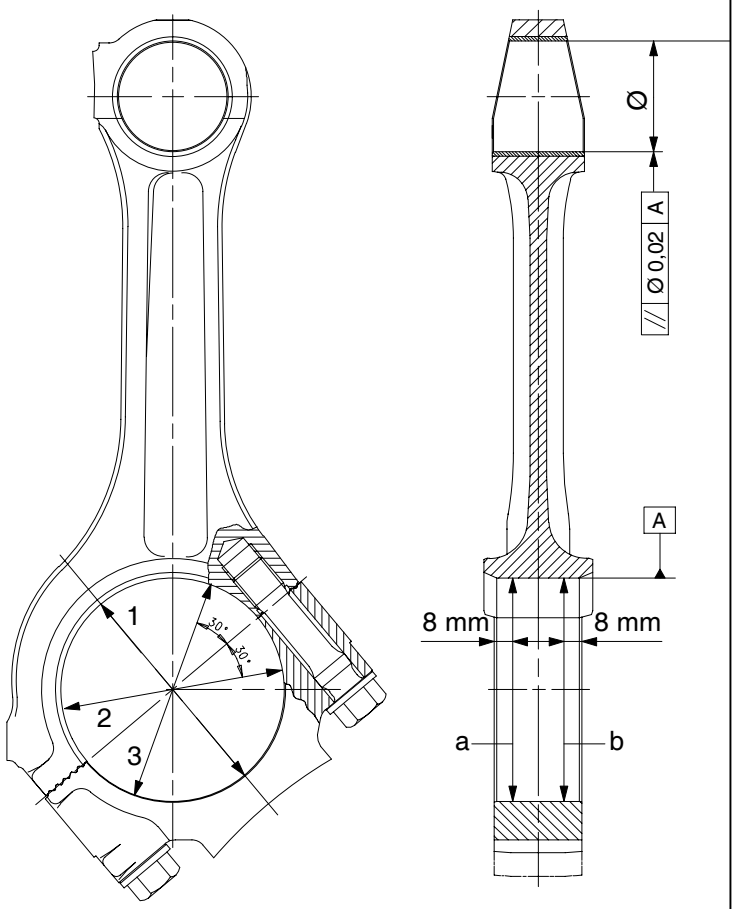
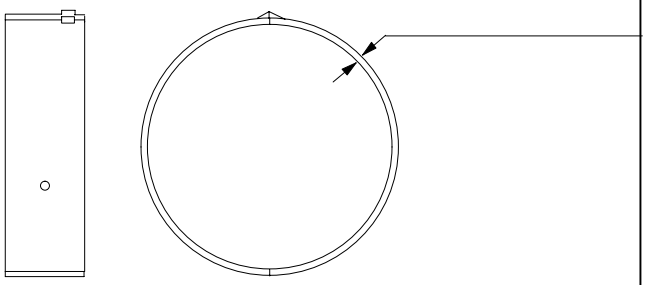
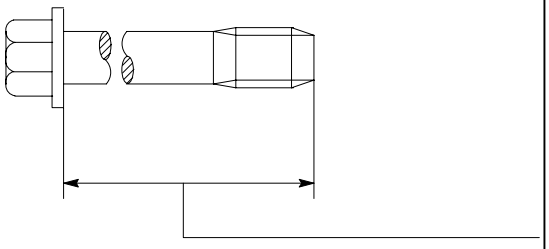
Interference: 0,335–0,645 mm
Installation temperature: 200–230°C

m = 38,5 kg (with starter gear)
J = 1,17 kgm^2

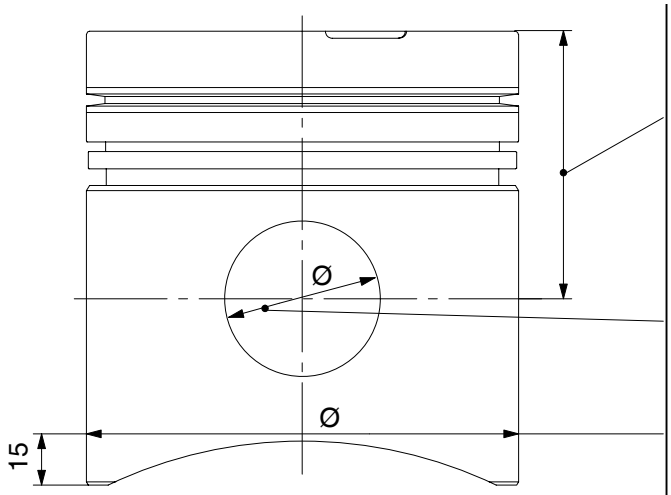
Number of teeth:Z = 160, Module 3
Matching gear: Starter pinion number of teeth: (Z= 9)

Backlash between: 0,6–0,9 mm

Service Data	Dimensions Limiting values
Connecting rods	
	46,055–46,065 mm Max. wear limit: 46,09 mm Bearing bore in directions 1, 2 and 3 and in planes a and b: 90,075–90, 120 mm Pre-condition: new big-end bearing in place, conrod assembled
Conrod bearing	
	2,463–2,473 mm standard size 2,588–2,598 mm undersize 0,25 2,713–2,723 mm undersize 0,50 2.838–2,848 mm undersize 0,75 2,963–2,973 mm undersize 1,00 Spread: 0,6–1,5 mm If signs of wear are present (scores, anti-wear coating damaged) change both bearing shells. Important: note installation position (upper half bearing shell has red mark on side)
Connecting rod bolt	
	Length: During tightening the bolts are intentionally stressed beyond the yield point and therefore subjected to some permanent elongation each time they are tightened. When the bolt has reached its maximum length it must not be reused. 51. 90020-0139: new: 67,2–67,5 mm, max. 69 mm

Service Data	Dimensions Limiting values
Connecting rods	
	46,055–46,065 mm Max. wear limit: 46,09 mm Bearing bore in directions 1, 2 and 3 and in planes a and b: 90,075–90, 120 mm Pre-condition: new big-end bearing in place, conrod assembled
Conrod bearing	
	2,463–2,473 mm standard size 2,588–2,598 mm undersize 0,25 2,713–2,723 mm undersize 0,50 2.838–2,848 mm undersize 0,75 2,963–2,973 mm undersize 1,00 Spread: 0,6–1,5 mm If signs of wear are present (scores, anti-wear coating damaged) change both bearing shells. Important: note installation position (upper half bearing shell has red mark on side)
Connecting rod bolt	
	Length: During tightening the bolts are intentionally stressed beyond the yield point and therefore subjected to some permanent elongation each time they are tightened. When the bolt has reached its maximum length it must not be reused. 51. 90020-0338: new: 68,2–68,5 mm, max. 69,5 mm

Piston (offset pistons, marked with “R” or “L” on top of piston)



Compression height: 81,250–81,300 mm
with undersize
0,2 mm: 81,050–81,100 mm
0,4 mm: 80,850–80,900 mm
0,6 mm: 80,650–80,700 mm

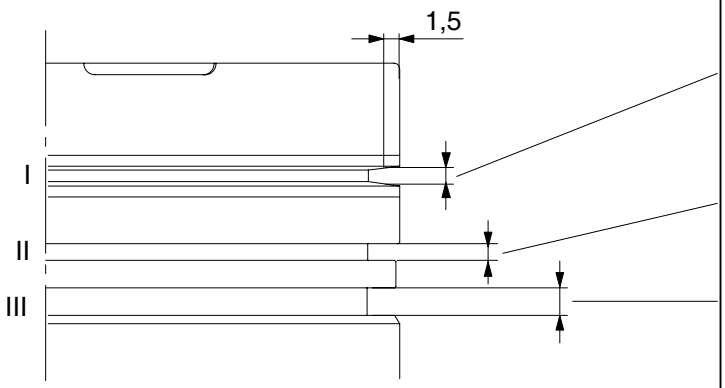
Piston protrusion above crankcase top:
0,01–0,38 mm

46,005–46,013 mm
Piston pin diameter:
45,994–46,000 mm

127,835–127,875 mm

Max. difference in weight per
engine piston set: 100g

Piston ring grooves

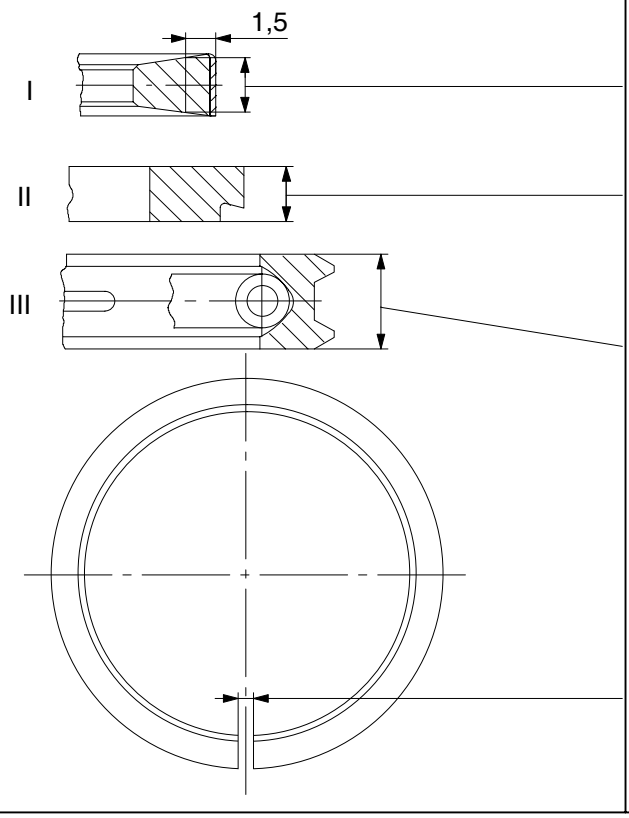


2,935–2,965 mm

3,040–3,060 mm

5,020–5,040 mm

Piston ring height / Piston ring axial play / Piston ring gap



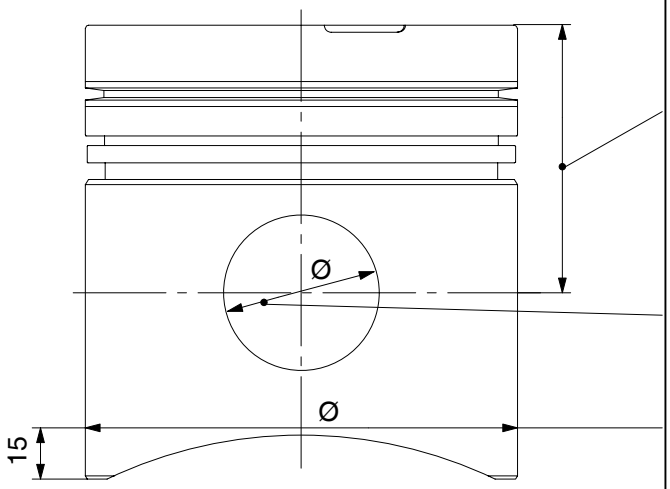
1st. ring – keystone-type ring:
height: 2,796–2,83 mm

2nd. ring – taper face ring:
height: 2,978–2,990 mm
axial play: 0,050–0,082 mm

3rd. ring – bevelled ring:
height: 4,978–4,990 mm
axial play: 0,030–0,062 mm

Ring gap:
1st.ring: 0,5–0,7 mm
2nd. ring:
(Goetze) 0,45–0,70 mm
(Riken) 0,40–0,65 mm
3rd. ring: 0,25–0,40 mm

Piston



Compression height: 81,250–81,300 mm
with undersize
0,2 mm: 81,050–81,100 mm
0,4 mm: 80,850–80,900 mm
0,6 mm: 80,650–80,700 mm

Piston protrusion above crankcase top:
0,01–0,38 mm

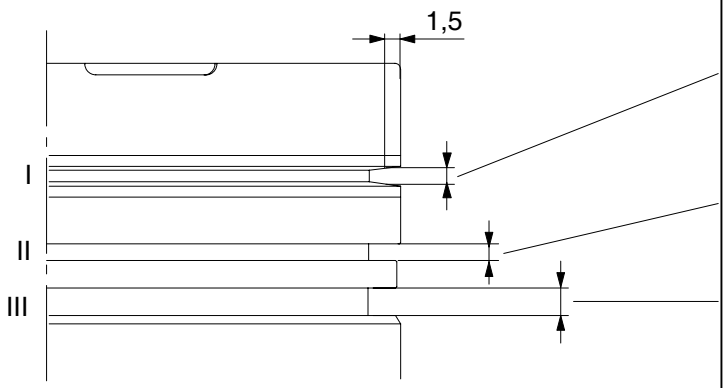
46,005–46,013 mm

Piston pin diameter:
45,994–46,000 mm

127,835 –127,875 mm

Max. difference in weight per
engine piston set: 100g

Piston ring grooves

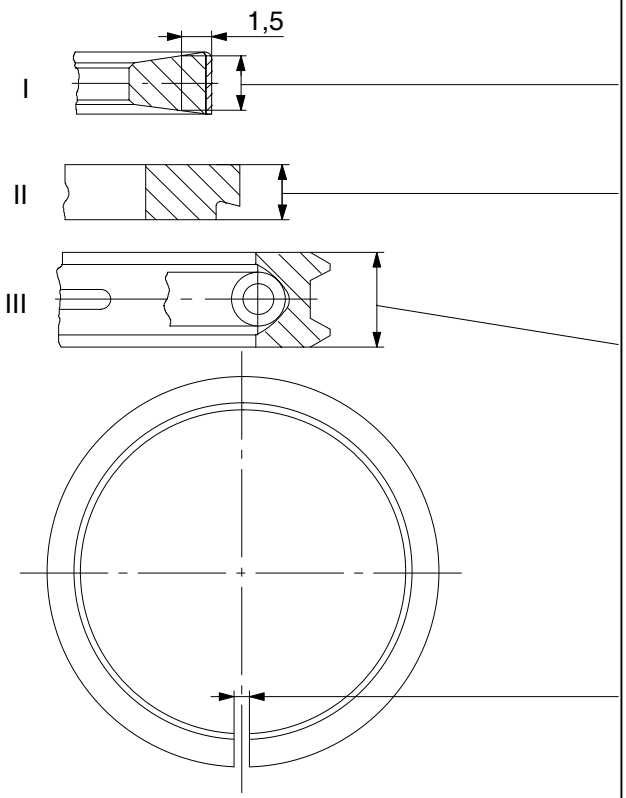


3,695–3,725 mm

3,040–3,060 mm

4,02–4,04 mm

Piston ring height / Piston ring axial play / Piston ring gap



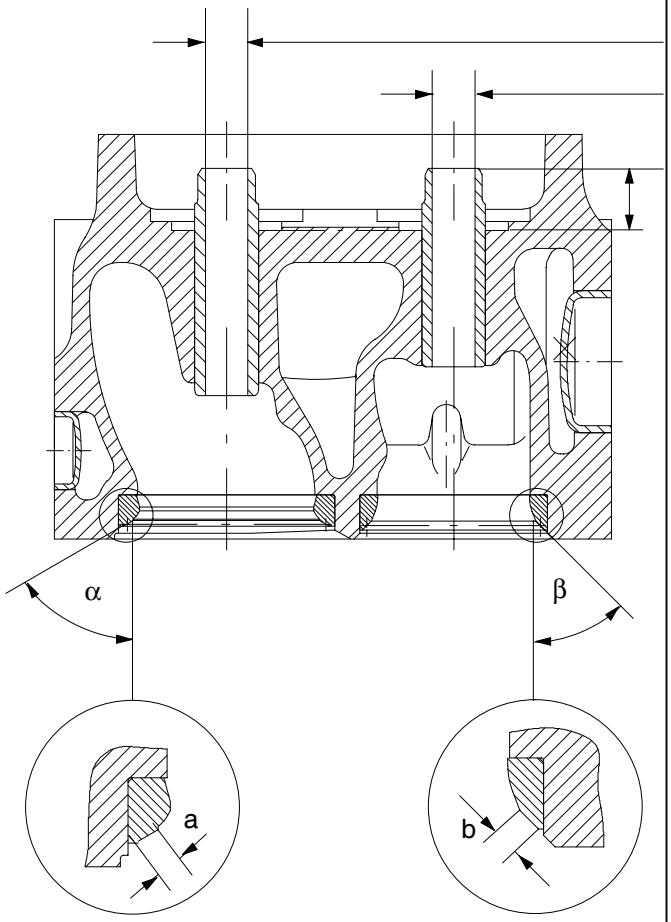
1st. ring – keystone-type ring:
height: 3,296–3,33 mm

2nd. ring – taper face ring:
height: 2,978–2,990 mm
axial play: 0,050–0,082 mm

3rd. ring – bevelled ring:
height: 3,975–3,990 mm
axial play: 0,030–0,065 mm

Ring gap:
1st.ring: 0,5–0,7 mm
2nd. ring: 0,45–0,70 mm
3rd. ring: 0,25–0,55 mm

Cylinder head



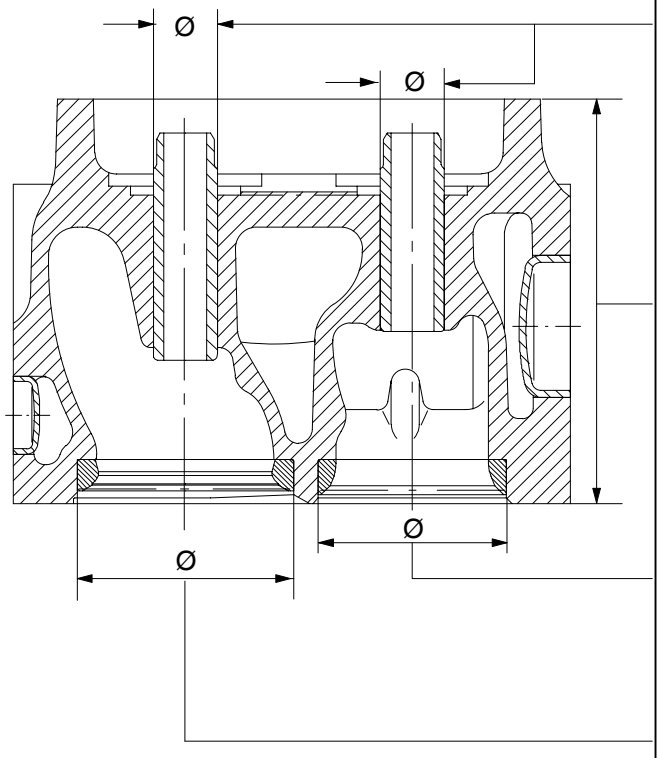
12,000–12,018 mm Intake valve

12,000–12,018 mm Exhaust valve

17,1–17,5 mm

Intake valve α = 60°
Exhaust valve β = 45°

a = 3,3–3,8 mm
b = 3,3–3,8 mm



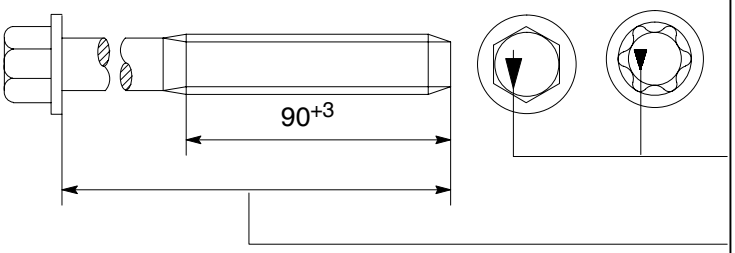
Valve guide bore in cylinder head:
18,000–18,018 mm
Valve guide outside diameter:
18,028–18,046 mm

standard: 113,9–114 mm
minimum: 112,9 mm
(observe specified dimensions for valve recess and injector projection, see pages 21, 31)

Valve seat insert bore in cylinder head:
53,00 –53,03 mm
Valve seat insert outside diameter:
53,10 –53,11 mm

Valve seat insert bore in cylinder head:
61,00 –61,03 mm
Valve seat insert outside diameter:
61,10–61,11 mm

Cylinder head bolts (hex head or Torx head)

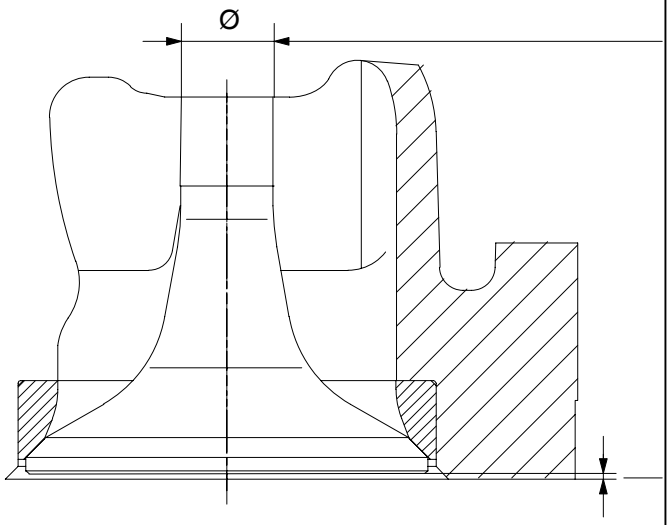


Length: During tightening the bolts are intentionally stressed beyond the yield point and therefore subjected to some permanent elongation each time they are tightened. When the bolt has reached its maximum length it must not be reused.

Angle-of-rotation symbol

new: 167,5–168 mm, max. 170 mm
new: 143,5–144 mm, max. 146 mm
new: 108,5–109 mm, max. 111 mm

Valve recess



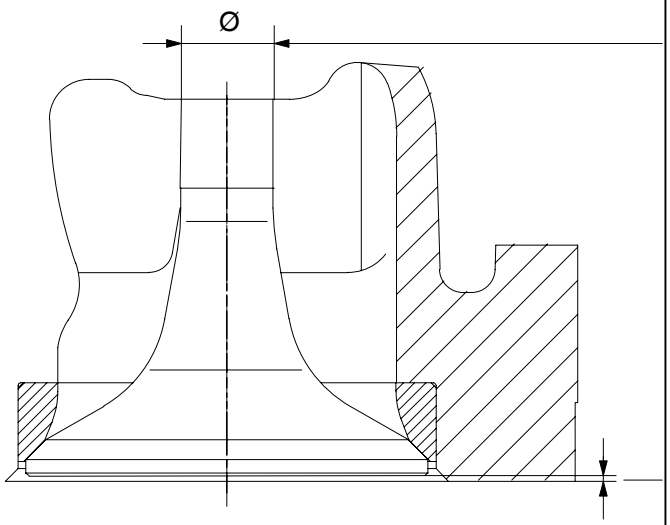
Intake valve: 11,968–11,982 mm
Exhaust valve: 11,943–11,957 mm

Max. wear limit: 0.1 mm below base dimension

Do not reuse valves with damaged chromium layer!

Valve recess for intake and exhaust valve:
0,7–1,3 mm

Inlet valve



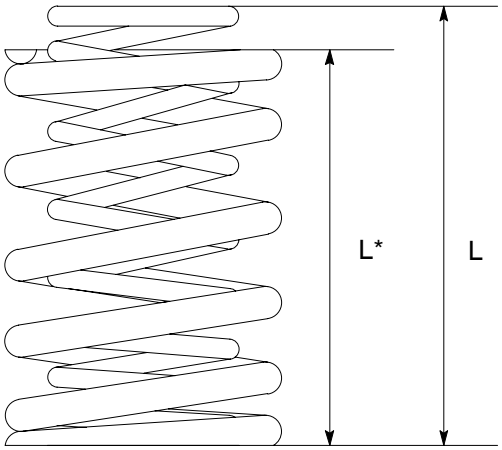
Intake valve: 11,968–11,982 mm
Exhaust valve: 11,943–11,957 mm

Max. wear limit: 0.1 mm below base dimension

Do not reuse valves with damaged chromium layer!

Valve recess for intake and exhaust valve:
0,7–1,3 mm

Exhaust valve

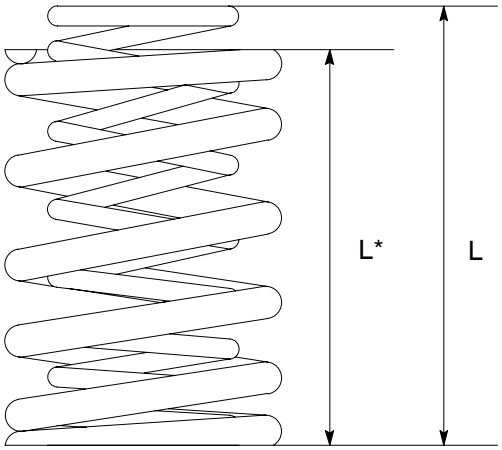


Inner spring:
Free length (L), approx. 65,5 mm
L = 46,3 mm: at spring force 128–152 N
L = 32,3 mm: at spring force 255–294 N

Outer spring:
Free length (L*), approx. 59 mm
L* = 46,8 mm: at spring force 324–353 N
L* = 32,8 mm: at spring force 696–755 N

The lowest spring force is at the same time the wear limit value.

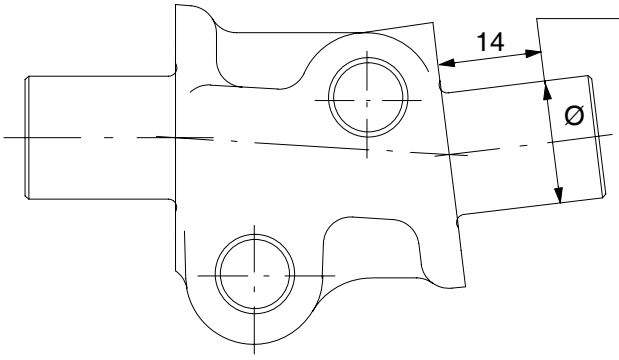
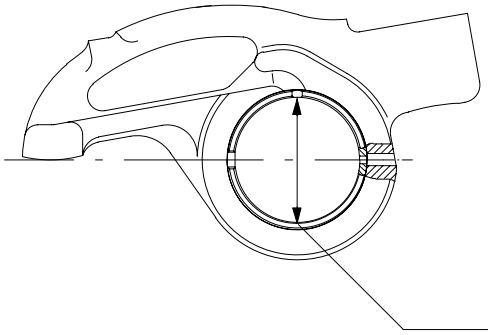
Exhaust valve

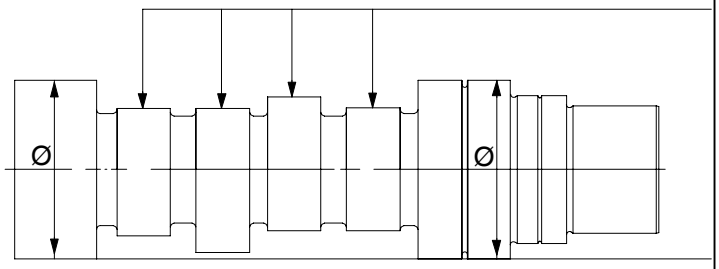
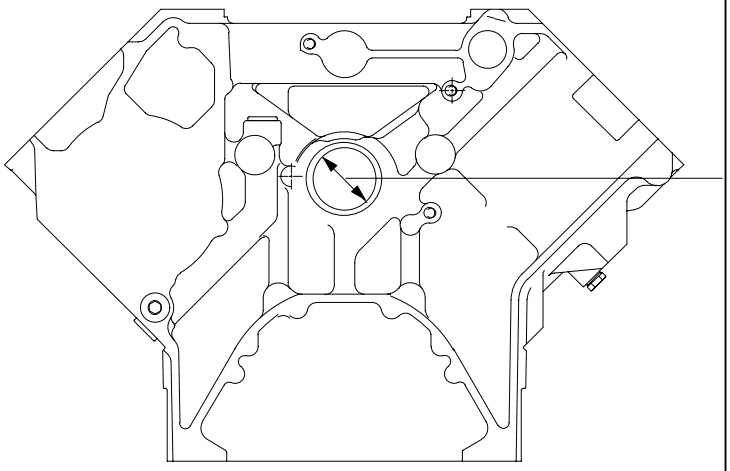
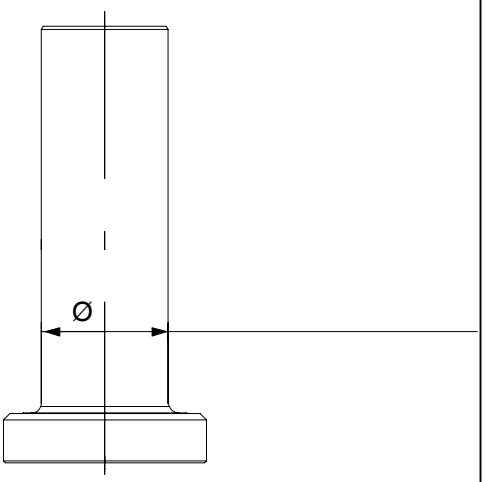


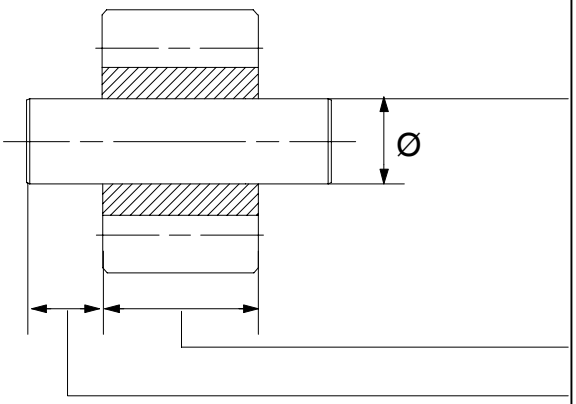
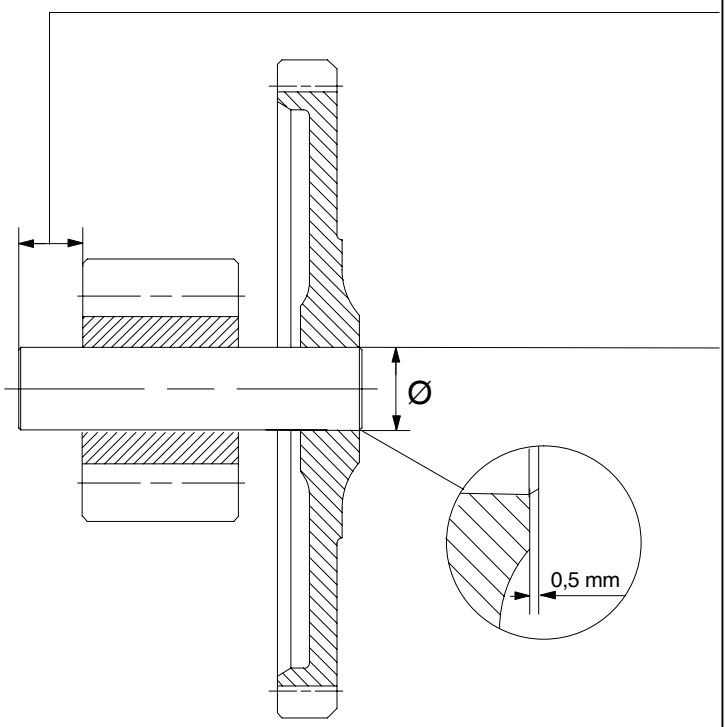
Inner spring:
Free length (L), approx. 65,5 mm
L = 46,3 mm: at spring force 131–155 N
L = 32,3 mm: at spring force 260–300 N

Outer spring:
Free length (L*), approx. 59 mm
L* = 46,8 mm: at spring force 330–360 N
L* = 32,8 mm: at spring force 710–770 N

The lowest spring force is at the same time the wear limit value.

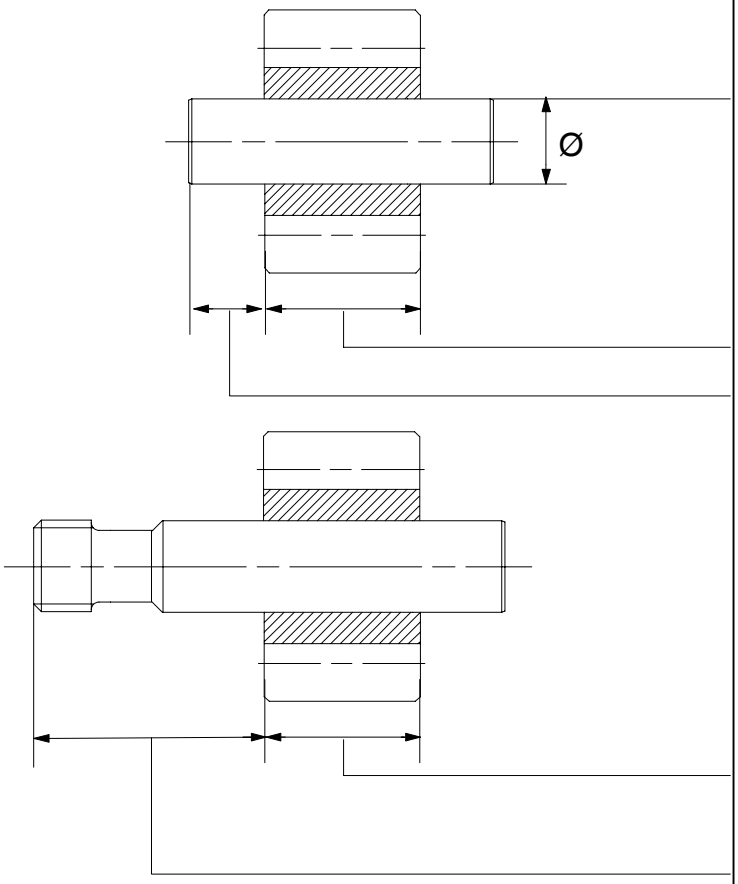
Service Data	Dimensions Limiting values
Valve train	
Rocker bracket 	24,967–24,980 mm
Rocker arm 	Rocker arm radial clearance: 0,025–0,054 mm Max. wear limit: 0,08 mm 25,005 –25,021 mm

Service Data	Dimensions Limiting values
Camshaft  	Change if signs of wear are present Camshaft axial clearance: 0,20–0,90 mm Max. wear limit: 1,5 mm 69,910–69,940 mm Backlash between crankshaft gear and camshaft gear: 0,118 mm–0,242 mm
Camshaft bearing 	70,000–70,030 mm or 70,070–70,090 mm for bush 5 (V8), 6 (V10) or 7 (V12) = bush at timing case end
Valve tappet  	Matching bore in crankcase: 20,000–20,021 mm 19,944–19,965 mm

Service Data	Dimensions Limiting values
Oil pump	
Two-gears oil pump for D 2848 L..	
Oil pump gear 	Shaft: 21,930–21,940 mm Matching bore in housing: 22,000–22,021 mm Radial clearance: 0,060–0,091 mm Housing depth: 43,000–43,039 mm Axial clearance: 0,050–0,128 mm 42,911–42,950 mm 11,5–11,7 mm
Drive gear with oil pump gear 	11,5–11,7 mm Shaft: 21,930–21,940 mm Bore in drive gear: 21,870–21,885 mm Pressing force: 12000 N Backlash: Drive gear and crankshaft gear: 0,099–0,451 mm

Two-gears double oil pump for D 2840 L..

Oil pump gear



Shaft: 17,930–17,940 mm
Matching bore in housing:
18,000–18,018 mm
Radial clearance: 0,060–0,088 mm

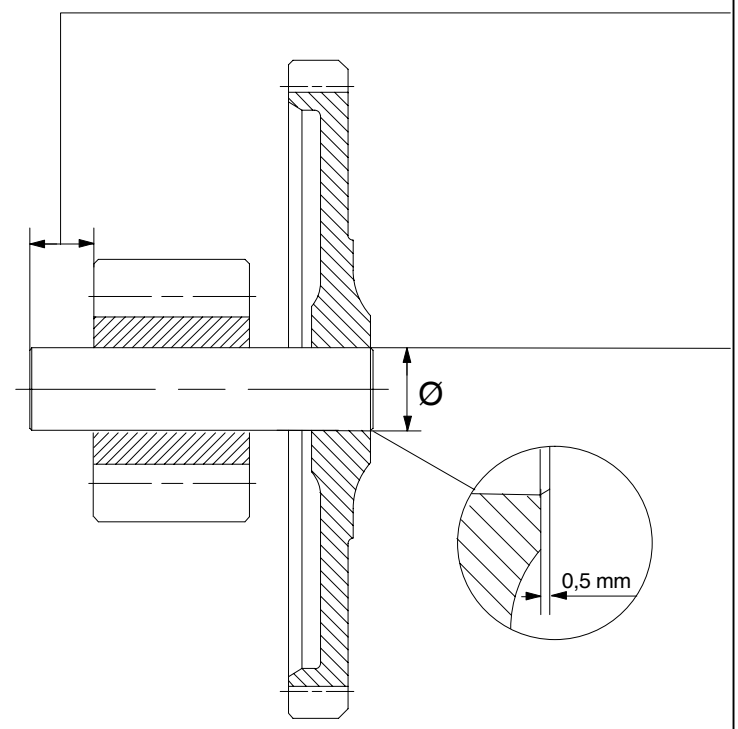
Housing depth: 28,000–28,033 mm
Axial clearance: 0,040–0,106 mm
27,927–27,960 mm

14,5 mm

27,927–27,960 mm

40,8–41,0 mm

Drive gear with oil pump gear



14,5 mm

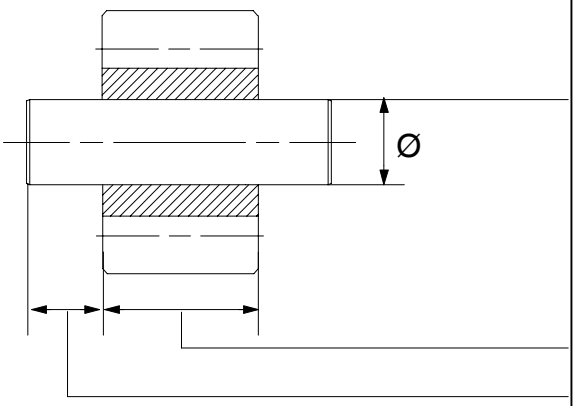
Shaft: 17,930–17,940 mm
Bore in drive gear:
17,885–17,870 mm
Pressing force: 10000 N

Backlash:
Drive gear and crankshaft gear:
0,099–0,451 mm

2565

Three-gears oil pump for D 2840 L.., D 2842 L..

Oil pump gear

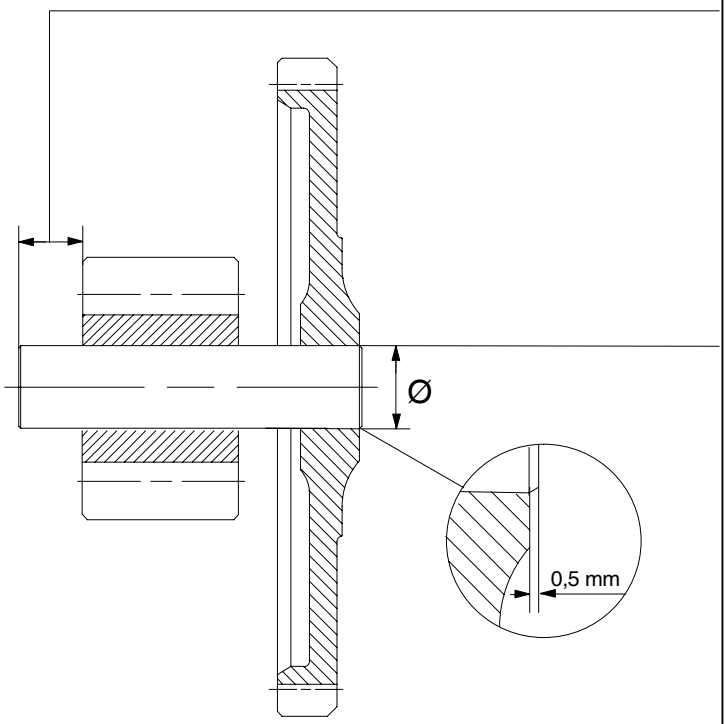


Shaft: 21,930–21,940 mm
Matching bore in housing:
22,000–22,021 mm
Radial clearance: 0,060–0,091 mm

Housing depth: 28,000–28,033 mm
Axial clearance: 0,040–0,106 mm
27,927–27,960 mm

14,5–14,7 mm

Drive gear with oil pump gear



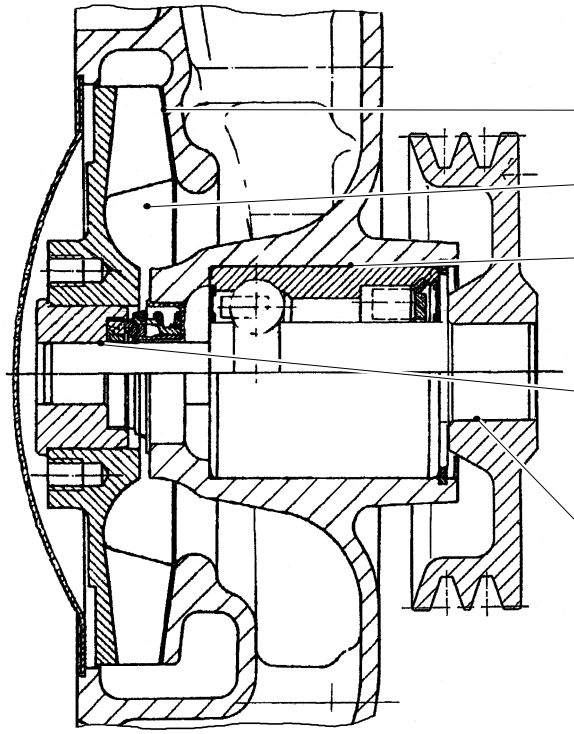
14,5–14,7 mm

Shaft: 21,930–21,940 mm
Bore in drive gear:
21,870–21,885 mm
Pressing force: 12000 N

Backlash:
Drive gear and crankshaft gear:
0,099–0,451 mm

Cooling system

Engine coolant pump



gap between housing and impeller:
0,3–0,4 mm

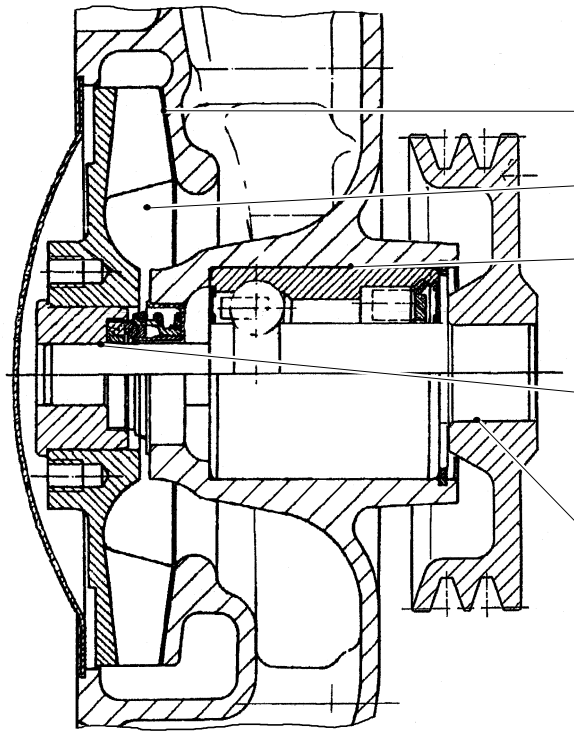
Ø impeller: 149,5–150 mm

Bearing seat in housing:
54,940–54,970 mm
Ø of bearing: 54,981–54,994 mm
Interference: 0,011–0,054 mm

Bore for bearing shaft in impeller:
15, 992–16,010 mm
Ø of bearing shaft: 16,045–16,056 mm
Interference: 0,035–0,064 mm

Hub bore:
25,000–25,021 mm
Ø of bearing shaft: 25,048–25,061 mm
Interference: 0,027–0,061 mm

Engine coolant pump
D 2848 LE 401 / 403 / 405
D 2842 LE 403 / 404 / 410 / 414 / 415 / 416 / 417



gap between housing and impeller:
0,3–0,4 mm

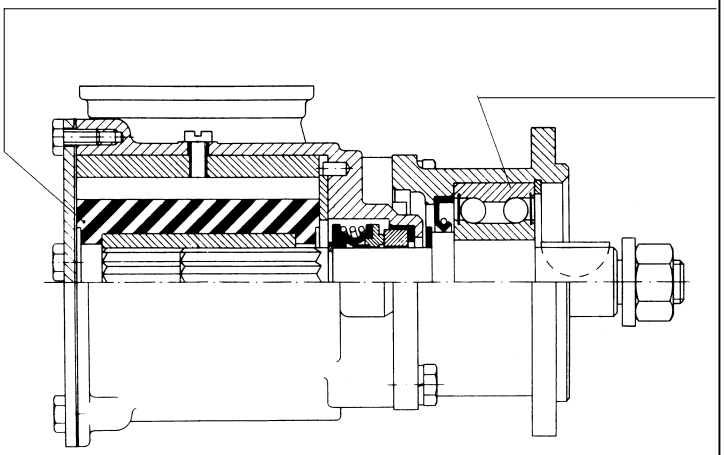
Ø impeller: 149,5–150 mm

Bearing seat in housing:
54,940–54,970 mm
Ø of bearing: 54,981–54,994 mm
Interference: 0,011–0,054 mm

Bore for bearing shaft in impeller:
15, 992–16,010 mm
Ø of bearing shaft: 16,045–16,056 mm
Interference: 0,035–0,064 mm

Hub bore:
25,000–25,021 mm
Ø of bearing shaft: 25,048–25,061 mm
Interference: 0,027–0,061 mm

Raw water pump 50.06500-7011



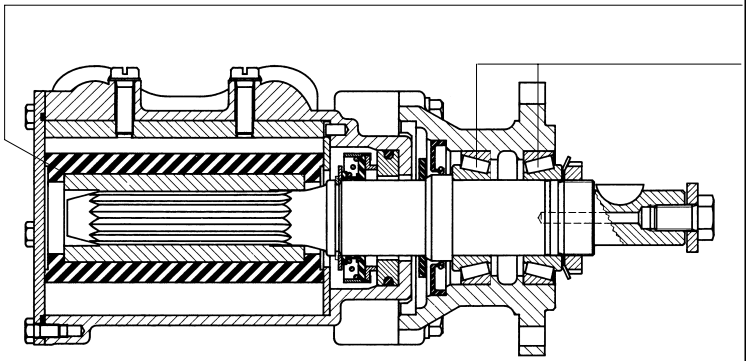
If impeller is worn, change it together with seals and small parts (repair kit)

If wear in bearing can be felt (free play in bearing), change the bearing

Speed of raw water pump:
1,075 x engine speed (i= 0,9302)

Use 9-vane impeller only! Treat impeller before installation with an acid-free lubricant and install in turning direction
Delivery rate at
engine speed n = 2300 rpm: 430 l / min

Raw water pump 51.06500-7025

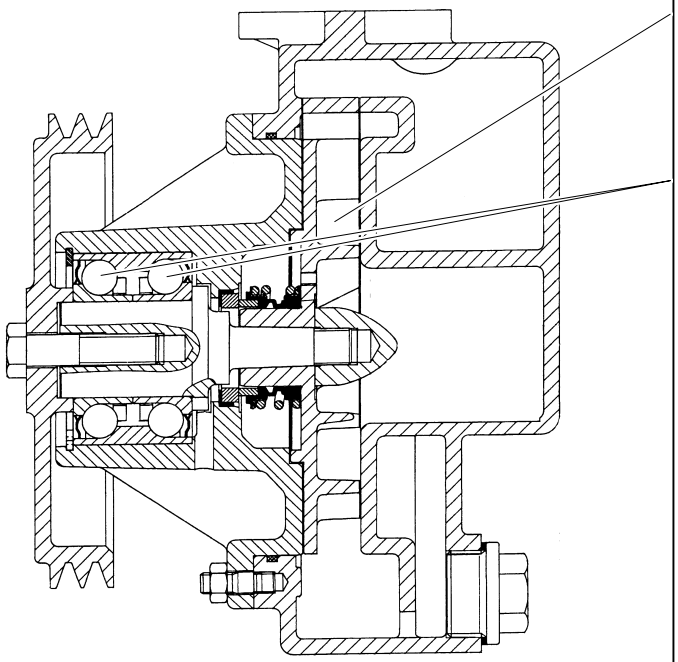


If impeller is worn, change it together with seals and small parts
If wear in bearing can be felt (free play in bearing), change the bearing

Speed of raw water pump:
1,075 x engine speed (i= 0,9302)

Treat impeller before installation with an acid-free lubricant and install in turning direction
Delivery rate at
engine speed n = 2300 rpm: 620 l / min

Raw water pump 51.06500-7031

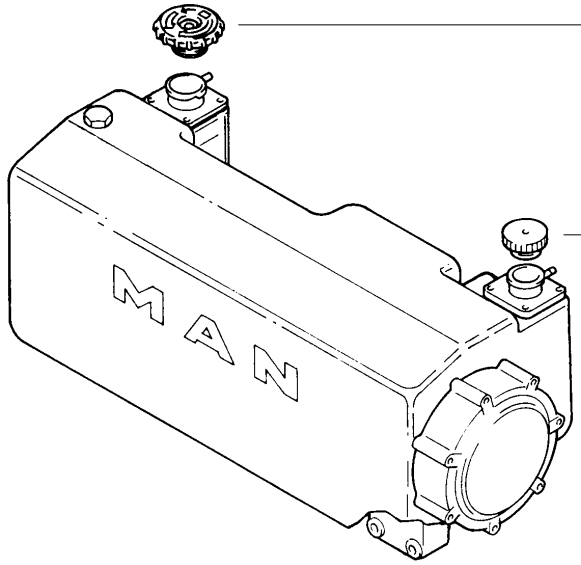


If impeller is worn, change it together with seals and small parts

If wear in bearing can be felt (free play in bearing), change the bearing

Delivery rate at
engine speed n = 1800 rpm: 540 l / min
engine speed n = 2300 rpm: 590 l / min

Cover for heat exchanger



Filler cap with safety valve:
Safety valve with imprint 1,0 opens at 0,85 bar–1,2 bar above atmospheric pressure. Safety valve with imprint 1,5 opens at 1,3 bar–1,7 bar above atmospheric pressure

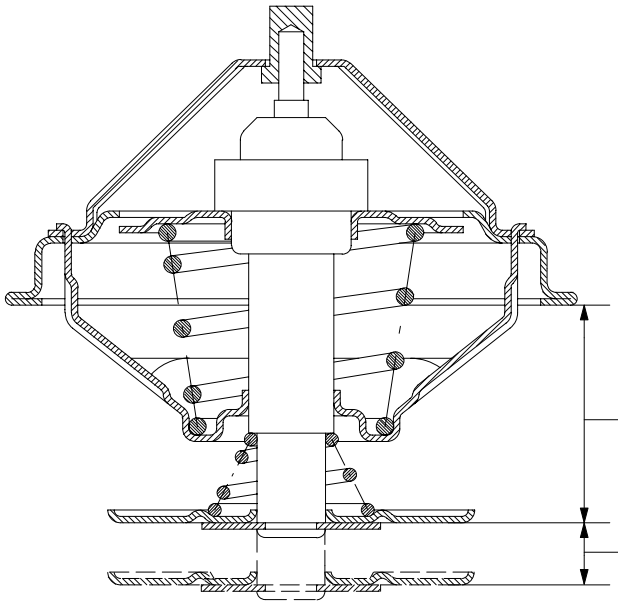
Valve cover:
Working valve with imprint 0,6 opens at 0,6 bar–0,7 bar above atmospheric pressure and 0,02 bar –0,08 bar below atmospheric pressure
Working valve with imprint 1,0 opens at 0,85 bar–1,15 bar above atmospheric pressure and 0,02 bar –0,08 bar below atmospheric pressure

Warning:
If the cap with the working valve is opened, there is the risk that it will not close tightly again afterwards.

The excess pressure required in the system will then no longer build up. Premature boiling occurs and coolant is lost.

To prevent damage to the engine open this cap only in exceptional circumstances or during service work and fit a new one as soon as possible.

Thermostat



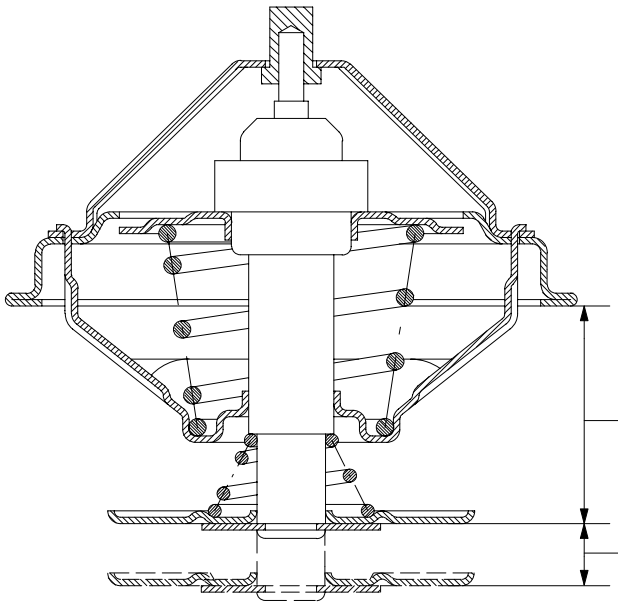
opening begins at: 79°C (±2°)
Fully open: 90°C

(The temperature for the start of opening is printed on the thermostat)

24,5–25,8 mm

Lift at least 8 mm at 90°C

Thermostat



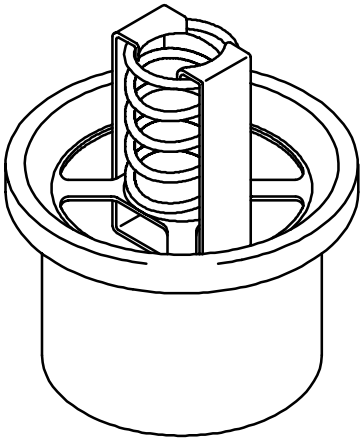
opening begins at: 71°C (±2°)
Fully open: 86°C

(The temperature for the start of opening is printed on the thermostat)

24,5–25,8 mm

Lift at least 8 mm at 86°C

Thermostat

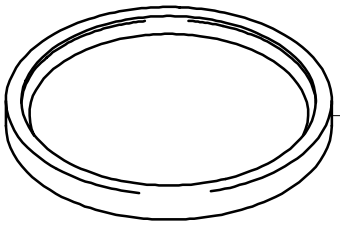


opening begins at: 79°C (±2°)
Fully open: 92°C (±2°)
Lift at least 9,5 mm at 92°C

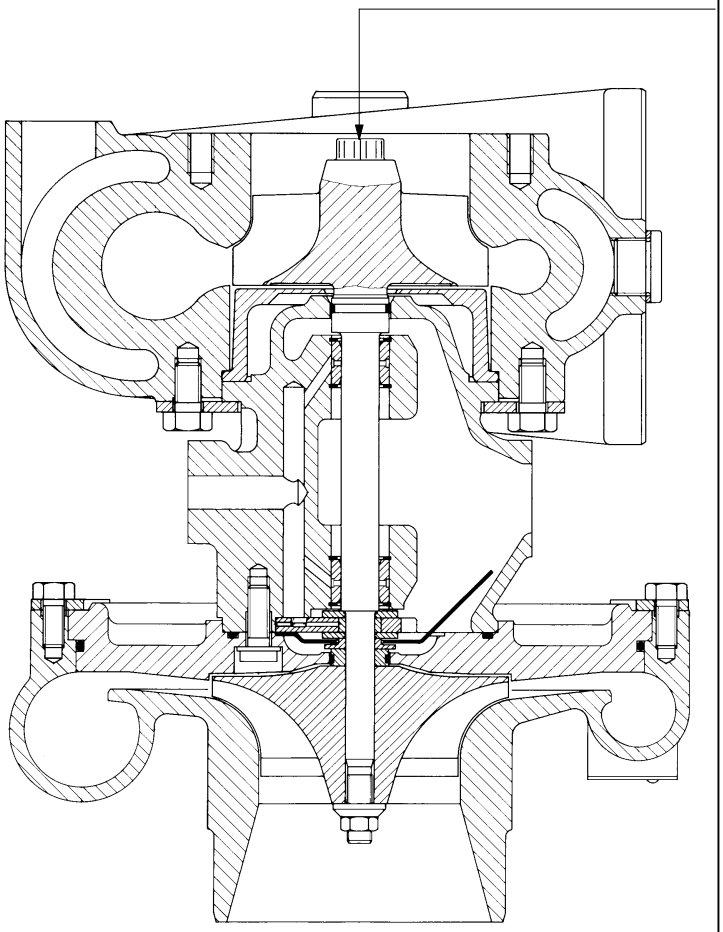
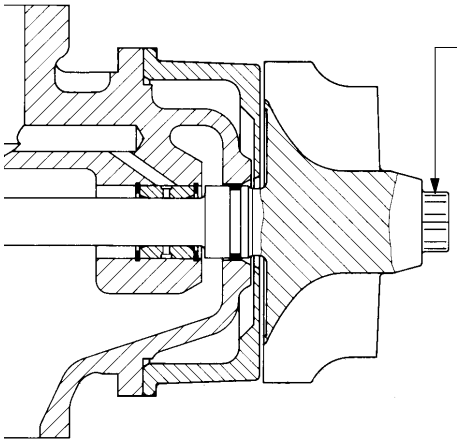
or

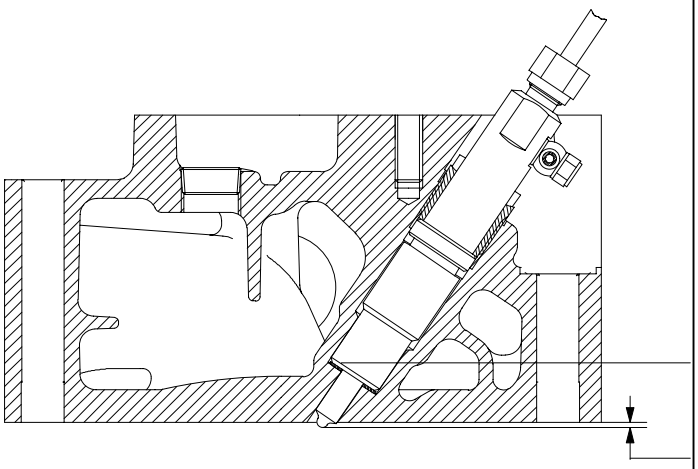
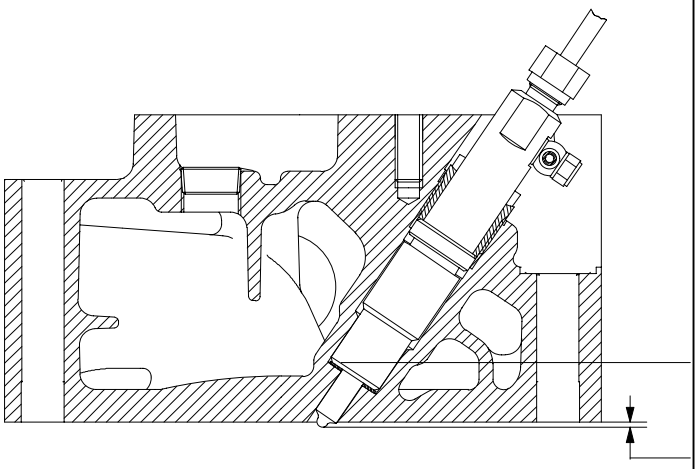
opening begins at: 82°C (±2°)
Fully open: 95°C (±2°)
Lift at least 9,5 mm at 95°C

(The temperature for the start of opening is printed on the thermostat)

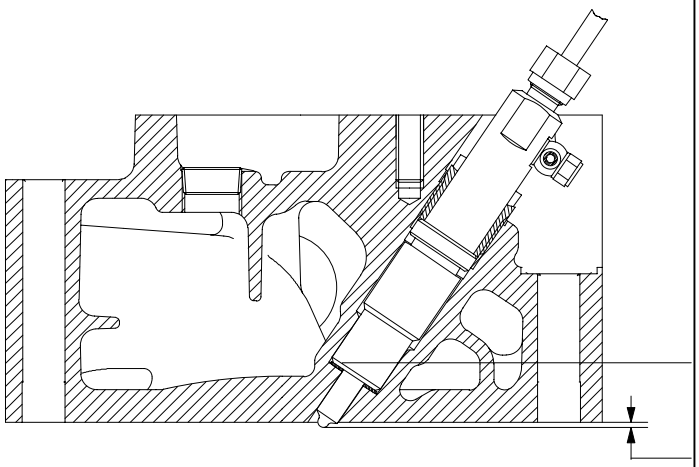


Change seal if thermostat is removed

Service Data	Dimensions Limiting values
Turbocharger	
Axial clearance 	Axial clearance: max. 0,16 mm for turbochargers KKK K27,K31, K33, K36 and all engines D 284.LXE / LYE / LZE / LE4..
Radial clearance 	Radial clearance: for KKK K27 max. 0,43 mm (D 2848 LE401) for KKK K31 max. 0,45 mm (D 2848 LE403 / LE405) D 2840 LE402 / D 2840 LE403, D 2842 LE403 / D 2842 LE 405) for KKK K33 max. 0,45 mm (D 2848 LXE) for KKK K36 max. 0,58 mm (D 2840 LXE / D 2840 LE401, D 2842 LYE / LZE / LE401 / LE402 / LE404 / LE406 / LE408 / LE 410 / LE 411)

Service Data	Dimensions Limiting values
Injecton nozzles	
Projection above cylinder head contact surfaces D 2840 LXE, D 2842 LYE up to engine serial number ... 6143 095 .... 	**Note:** Offset nozzle protrusion after grinding the cylinder head interface. Nozzle DLLA 136 S 1002 (four-hole nozzle) Adjust nozzle protrusion by using Cu sealing rings of different thickness. These sealing rings are available in thicknesses of 0,5 / 1,0 / 1,5 / 2,0 / 2,5 / 3,0 mm 1,76 – 2,59 mm
Projection above cylinder head contact surfaces all engines D 2848 LXE, D 2848 LE 401 and D 2840 LXE / LE.., D 2842 LYE / LZE / LE4.. engine serial number and up ... 6143 096 .... 	**Note:** Offset nozzle protrusion after grinding the cylinder head interface. Nozzle DLLA 146 P ... (five and six-hole nozzles) Adjust nozzle protrusion by using Cu sealing rings of different thickness. These sealing rings are available in thicknesses of 0,5 / 1,0 / 1,5 / 2,0 / 2,5 / 3,0 mm 2,42 – 3,25 mm

Projection above cylinder head contact surfaces
D 2842 LE 403
and D 2842 LE 404 / 410 / 414 / 415 / 416 / 417



Note:
Offset nozzle protrusion after grinding the cylinder head interface.

Nozzle DLLA 146 P 708
(five hole nozzles)

Adjust nozzle protrusion by using Cu sealing rings of different thickness. These sealing rings are available in thicknesses of 0,5 / 1,0 / 1,5 / 2,0 / 2,5 / 3,0 mm

2,55 – 3,24 mm

Injectors

Engine model	Type of injector (Bosch)	Discharge pressure, (bar) Injector (new / run)	Number of holes / hole Ø
D 2848 LXE	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2848 LE 401	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2848 LE 403	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2848 LE 405	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2840 LXE up to engine number ... 6143 095	DLLA 136 S 1002	295 (+ 8) / 280	4 / 0,43 mm
D 2840 LXE engine number and up ... 6143 096	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2840 LE 401	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2840 LE 402	DLLA 144 P 184	295 (+ 8) / 280	4 / 0,398 mm
D 2840 LE 403	DLLA 146 P 708	290 (+ 8) / 280	5 / 0,406 mm
D 2840 LE 407	DLLA 146 P 203	290 (+ 8) / 280	5 / 0,406 mm
D 2842 LYE up to engine number ... 6143 095	DLLA 136 S 1002	295 (+ 8) / 280	4 / 0,43 mm
D 2842 LYE engine number and up ... 6143 096	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LZE	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 401	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 402	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 403	DLLA 146 P 581	295 (+ 8) / 280	6 / 0,312 mm
D 2842 LE 404	DLLA 146 P 708	290 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 405	DLLA 146 P 581	295 (+ 8) / 280	6 / 0,312 mm
D 2842 LE 406	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 407	DLLA 146 P 708	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 408	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm

Injectors

Engine model	Type of injector (Bosch)	Discharge pressure, (bar) Injector (new / run)	Number of holes / hole Ø
D 2842 LE 410	DLLA 146 P 708	290 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 411	DLLA 146 P 203	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 412	DLLA 146 P 581	295 (+ 8) / 280	6 / 0,312 mm
D 2842 LE 413	DLLA 146 P 581	295 (+ 8) / 280	6 / 0,312 mm
D 2842 LE 414	DLLA 146 P 708	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 415	DLLA 146 P 708	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 416	DLLA 146 P 708	295 (+ 8) / 280	5 / 0,406 mm
D 2842 LE 417	DLLA 146 P 708	295 (+ 8) / 280	5 / 0,406 mm

Start of delivery

Model		Start of delivery / deg. before TDC
D 2848 LXE	up to engine no. ... 6190 999 .... up to engine no. ... 6191 001	16±1 22±1
D 2848 LE 401		22±1
D 2848 LE 403	up to engine no. ... 9211 019 .... engine no. and up ... 9211 020	24±1 18±1
D 2848 LE 405	up to engine no. ... 9261 016 .... engine no. and up ... 9261 017	21±1 15±1
D 2840 LXE	up to engine no. ... 6143 095 .... engine no. and up ... 6143 096	23±1 24±1
D 2840 LE 401		24±1
D 2840 LE 402	with optimised consumption with optimised NO_x	15±0,5 12±0,5
D 2840 LE 403	up to engine no. ... 9218 038 .... engine no. and up ... 9218 039	24±1 21±1
D 2840 LE 407	with optimised consumption with optimised NO_x	24±0,5 22±0,5
D 2842 LYE	up to engine no. ... 6143 095 .... engine no. and up ... 6143 096	18±1 24±1
D 2842 LZE	up to engine no. ... 6143 095 .... engine no. and up ... 6143 096	23±1 24±1
D 2842 LE 401		22±1
D 2842 LE 402		22±1
D 2842 LE 403	with optimised consumption with optimised NO_X	15±0,5 12±0,5
D 2842 LE 404	up to engine no. ... 9029 044 .... engine no. and up ... 9029 045	23±1 20±1
D 2842 LE 405		15±0,5
D 2840 LE 406	with optimised consumption with optimised NO_x	24±0,5 21±0,5
D 2842 LE 407		20±0,5

Start of delivery

Model		Start of delivery / deg. before TDC
D 2842 LE 408	up to engine no. ... 9044 035 .... engine no. and up ... 9044 036	20±0,5 18±0,5
D 2842 LE 410		19±0,5
D 2842 LE 411		18±0,5
D 2842 LE 412		13±0,5
D 2842 LE 413		16±0,5
D 2842 LE 414		20±0,5
D 2842 LE 415		19±0,5
D 2842 LE 416		20±0,5
D 2842 LE 417		20±0,5

Injection pumps and governers

all engines: Bosch In-line pump with variable speed governor

Engine model	Injection pump	Governor
D 2848 LXE P = 500 kW / 2300 rpm	PE8 P120 A 520 LV 17789	RQV 250-1150 PAV19234
D 2848 LE 401 P = 500 kW / 2300 rpm	PE8 P120 A 520 LS 7818-2	RQV 300-1150 PA1039-2K
D 2848 LE 401 P = 397 kW / 2100 rpm	PE8 P120 A 520 LS 7818-2	RQV 300-1050 PAV21270K
D 2848 LE 403 P = 588 kW / 2300 rpm	PE8 P120 A 520 LS 8518	RQV 325-1150 PA1039-3K
D 2848 LE 405 P = 478 kW / 2100 rpm	PE8 P120 A 520 LV	RQV 300-1050 PAV
D 2840 LXE P = 603 kW / 2300 rpm up to engine number ...6143 095....	PE10 P120 A 520 LV 17899 or PE10 P120 A 520 LS 7825	RQV 250-1150 PAV19234 or RQV 250-1150 PA 902-3
D 2840 LXE P = 603 kW / 2300 rpm engine number and up ...6143 096....	PE10 P120 A 520 LV 17899 or PE10 P120 A 520 LS 7825-1	RQV 250-1150 PAV19234 or RQV 250-1150 PA 902-3
D 2840 LE 401 P = 478 kW / 2100 rpm	PE10 P120 A 520 LV 19382 or PE10 P120 A 520 LS 7853	RQV 300-1050 PAV21272K
D 2840 LE 401 P = 603 kW / 2300 rpm	PE10 P120 A 520 LV 19382 or PE10 P120 A 520 LS 7853	RQV 300-1150 PAV21076K or RQV 300-1150 PA1039-2K
D 2840 LE 402 P = 441 kW / 1800 rpm	PE10 P120 A 520 LV	RQV 300-900 PAV
D 2840 LE 403 P = 772 kW / 2300 rpm	PE10 P120 A 520 LS 8523	M (S) 5-EDC
D 2840 LE 407 P = 772 kW / 2300 rpm	PE10 P120 A 520 LS 7853	RQV 300-1150 PA1039-2K
D 2842 LYE P = 588 kW / 2100 rpm	PE12 P120 A 520 LV 17898 or PE12 P120 A 520 LS 7824	RQV 300-1050 PAV19766

Injection pumps and governers

all engines: Bosch In-line pump with variable speed governor

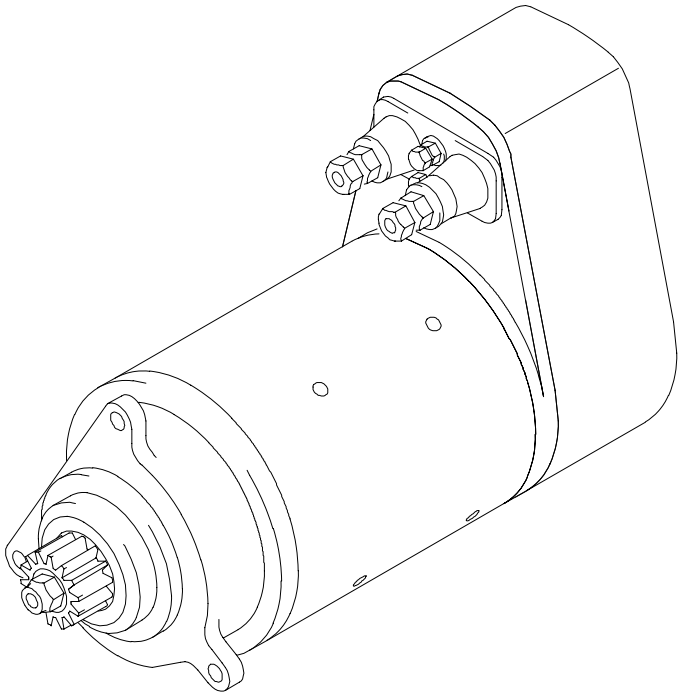
Engine model	Injection pump	Governor
D 2842 LYE P = 735 kW / 2300 rpm	PE12 P120 A 520 LV 17898 or PE12 P120 A 520 LS 7824	RQV 250-1150 PAV19235 or RQV 300-1150 PA 902-3
D 2842 LYE with electronic governor	PE12 P120 A 520 LV 17898 or PE12 P120 A 520 LS 7824	RQ 1200 PAV18952
D 2842 LZE P = 809 kW / 2300 rpm	PE12 P120 A 520 LV 18128 or PE12 P120 A 520 LS 7829	RQV 250-1150 PAV19535 or RQV 300-1150 PA943-1
D 2842 LE 401 P = 588 kW / 2100 rpm	PE12 P120 A 520 LS 7829-1	RQV 300-1050 PAV21271K
D 2842 LE 401 P = 735 kW / 2300 rpm	PE12 P120 A 520 LS 7829-1	RQV 300-1150 PAV21076K or RQV 300-1150 PA1039-1K
D 2842 LE 402 P = 809 kW / 2300 rpm	PE12 P120 A 520 LS 7829-1	RQV 300-1150 PAV21075K or RQV 300-1150 PA 1039K
D 2842 LE 403 P = 529 kW / 1800 rpm	PE12 P120 A 520 LV	RQV 300-900 PAV
D 2842 LE 404 P = 956 kW / 2300 rpm	PE12 P120 A 520 LV or PE12 P120 A 520 LS 8525	M (S) 5-EDC
D 2842 LE 406 P = 882 kW / 2300 rpm	PE12 P120 A 520 LS 8507	RQV 300-1150 PA1039-3K
D 2842 LE 407 P = 882 kW / 2300 rpm	PE12 P120 A 520 LS 8525	M (S) 5-EDC
D 2842 LE 408 P = 735 kW / 2100 rpm	PE12 P120 A 520 LS 8507	RQV 300-1050 PA1039-4K
D 2842 LE 410 P = 809 kW / 2300 rpm P = 809 kW / 2100 rpm	PE12 P120 A 520 LS 8525	M (S) 5-EDC
D 2842 LE 411 P = 735 kW / 2300 rpm	PE12 P120 A 520 LS 8507	RQV 300-1150 PA1039-3K

Injection pumps and governers

all engines: Bosch In-line pump with variable speed governor

Engine model	Injection pump	Governor
D 2842 LE 412 P = 588 kW / 1800 rpm	PE12 P120 A 520 LS 8531	RQV 300-900 PAV
D 2842 LE 413 P = 735 kW / 2100 rpm	PE12 P120 A 520 LV	RQV 300-1050 PAV
D 2842 LE 414 P = 809 kW / 2300 rpm	PE12 P120 A 520 LV	M (S) 5-EDC
D 2842LE 415 P = 809 kW / 2100 rpm	PE12 P120 A 520 LS 8525	M (S) 5-EDC
D 2842 LE 416 P = 809 kW / 2100 rpm	PE12 P120 A 520 LS 8525	M (S) 5-EDC
D 2842 LE 417 P = 824 kW / 2300 rpm	PE12 P120 A 520 LS 8525	M (S) 5-EDC

Starter



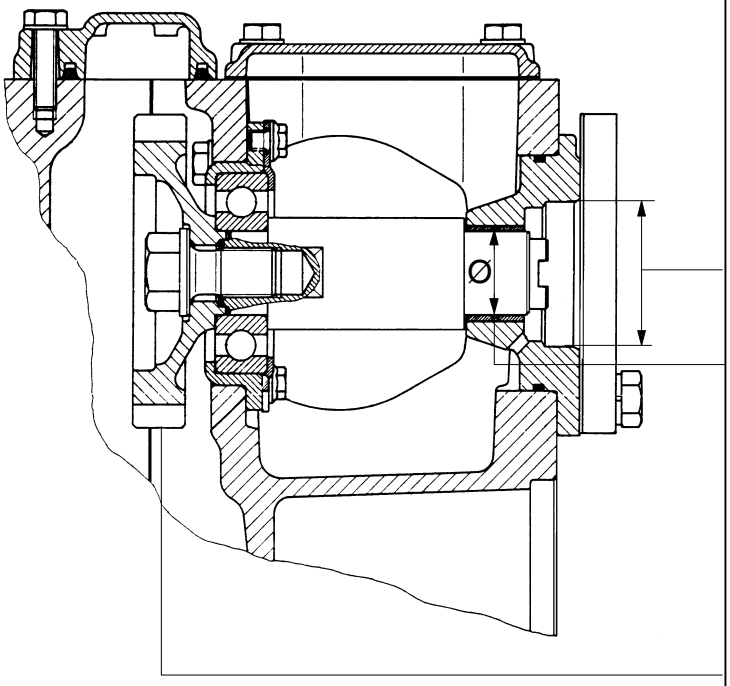
Manufacturer: Bosch
Type: KB
Operation: sliding-gear type

Starter pinion:
Number of teeth: Z = 9
Modulus: 3

D 2848 LXE standard
Output: 5,4 kW
Voltage: 24 V
Short-circuit current: 1800 A
(at 20°C, battery capacity: 170 Ah,
feed line 1mΩ / m)

D 2848 LXE optional,
all D 2840 L.. / D 2842 L..
Output: 6,6 kW
Voltage: 24 V
Short-circuit current: 1910 A
(at 20°C, battery capacity: 210 Ah,
feed line 1mΩ / m)

Power take-off for hydraulic pump



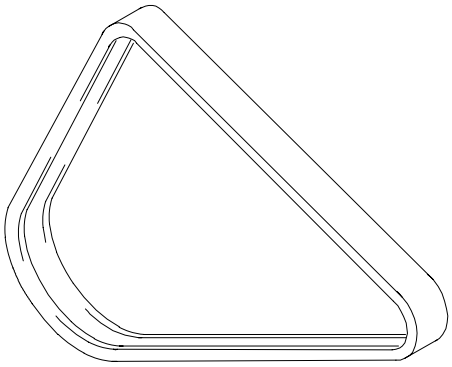
52,000 – 52,046 mm

Pin diameter: 29,959 – 29,980 mm
Bearing bore: 30,020 – 30,041 mm

Speed of power take-off:
engine speed x 1,26 (i = 0,791)

Backlash: 0,098 – 0,330 mm

V-belts / Powerband

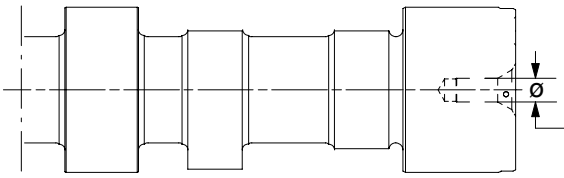


Change damaged V-belts (cracks, wear, oil)

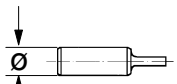
Measuring tension with
tension tester

Drive belt width	Tension forces according to the kg graduation on the tester		
	New installation		When servicing after long running time
	Installation	After 10 min. running time	
2/3VX	90–100	80–90	60
3/3VX	135–150	120–135	90

Drive dog for angle drive



9,96–9,969 mm



9,991–10 mm

Retightening cylinder head bolts on new engines
(engine cold or warm)

Erster Nachzug der Zylinderkopfschrauben erledigt

First retightening of cylinder-head-bolts completed

Spare part No. 51.97801-0211

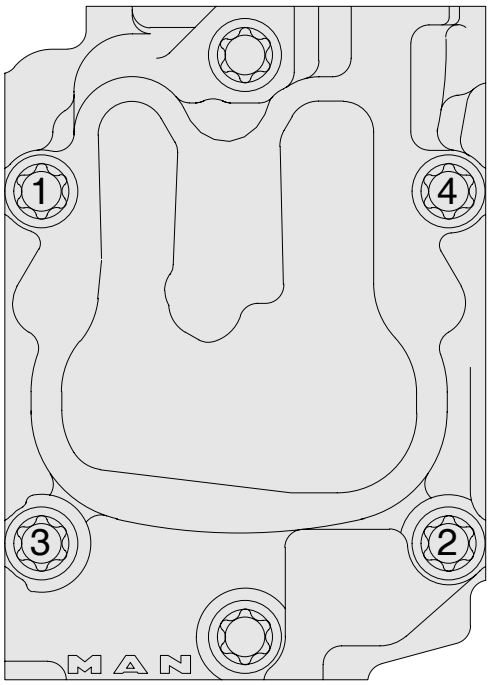
The cylinder heads are mounted with cylinder head bolts which are tightened by the angle-of-rotation method. On new engines the cylinder head bolts are tightened up for the first time at the factory after the engine has been broken in.
The sticker **"First retightening of cylinder head bolts ..."** is then attached to one of the cylinder head covers.

After the first 400 hours of operation retighten cylinder head bolts 1 to 4 in the order shown in Tightening diagram **"1"** by a further 90° (1/4 revolution).

The two outer screws (intake and exhaust sides) must not be retightened.

Note:
The cylinder-head bolts to be retightened must not be loosened; they are to be tightened further from their current position by 90° (1/4 turn).

Intake side / injector



Exhaust side

Tightening diagram **"1"**

Zweiter Nachzug der Zylinderkopfschrauben erledigt

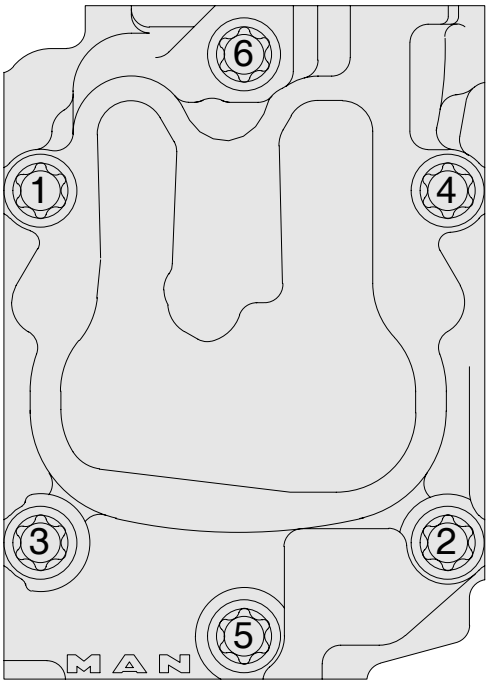
Second retightening of cylinder-head-bolts completed

Spare part No. 51.97801-0212

Remove the sticker **"First retightening of cylinder head bolts ..."** and attach the sticker **"Second retightening of cylinder head bolts** ..." to show that the cylinder head bolts have been retightened for the second time.

Tightening cylinder head bolts after a repair
(engine cold)

Intake side / injector



Exhaust side

Tightening diagram **"2"**

Before inserting the cylinder head bolts oil them with engine oil on the thread (not to the bore) and coat the contact face of the bolt head with "Optimoly White T" assembly paste. Do not use any oils or oil additives that contain MoS_2. The bolts must be tightened by the angle-of-rotation method as shown in Tightening diagram **"2"**.

- 1st pretightening step = to 10 Nm
- 2nd pretightening step = to 80 Nm
- 3rd pretightening step = to 150 Nm
- 4th pretightening step = turn by 90°
- Final tightening = turn by 90°

Adjust valve clearance.

Retightening cylinder head bolts after repairs
(engine cold or warm)
in accordance with SI 88 05 20/0

After the first 10 to 20 hours of operation after a repair turn the cylinder head bolts by a further 90° (1/4 revolution) in the order shown in Tightening diagram **"2"**.
The cylinder head bolts to be retightened must not be loosened first, but simply tightened by a further 90° (1/4 revolution) from their original position.
Attach the sticker **"First retightening of cylinder head bolts ..."** (Remove any other stickers which may already be attached).
After the first 400 hours of operation after a repair tighten cylinder head bolts 1 to 4 in the order shown in Tightening diagram **"1"** again by a further 90° (1/4 revolution).
The two outside screws (intake and exhaust side) must not be retightened.
Attach the sticker **"Second retightening of cylinder head bolts ..."**.

Note:
When a cylinder head has been removed the cylinder head gasket must always be changed.

Note:
All screws and bolts not listed in the following table must be tightened according to the guiding values of MAN works standard N 269. Apply a light film of oil to all screws and bolts before they are fitted!

Plugs

DIN 908
- M 14 x 1,5, M 16 x 1,5 . . . . . 80 Nm
- M 18 x 1,5, M 22 x 1,5 . . . . . 100 Nm
- M 24 x 1,5, M 26 x 1,5 . . . . . 120 Nm
- M 30 x 1,5 . . . . . 150 Nm

DIN 7604
- AM 10 x 1, M 12 x 1,5 . . . . . 50 Nm
- AM 14 x 1,5 . . . . . 80 Nm

Crankcase, crankshaft assembly

Engine mounting to crankcase M 14, 12.9 . . . . . 225 Nm
Timing case to crankcase M 10, 12.9 . . . . . 75 Nm
Timing case to crankcase M 12 x 1,5, 12.9 . . . . . 100 Nm
Thrust washer to timing case M 8, 12.9 . . . . . 40 Nm
Timing case cover to crankcase M 8, 10.9 . . . . . 25 Nm
Crankshaft bearing caps to crankcase M 18 x 2
- initial torque . . . . . 300–330 Nm
- rotation angle . . . . . 90–100°

Crankshaft main bearing caps (side)
- Hex bolt M 12 x 1,5 x 85, 10.9 (06.01494–4316)
  - initial torque . . . . . 80 Nm
  - rotation angle . . . . . 90°
- Hex collar bolt M 12 x 1,5 x 85, 12.9 (51.90020–0382)
  - initial torque . . . . . 80 Nm
  - rotation angle . . . . . 180°

Counterweight to crankshaft M 14 x 1,5
- initial torque . . . . . 100–120 Nm
- rotation angle . . . . . 90–100°

Counterweight to crankshaft M 16 x 1,5
- initial torque . . . . . 140–160 Nm
- rotation angle . . . . . 90–100°

Vibration damper hub to crankshaft
- Length of the bolt shank 75 mm, M16 x 1,5, 10.9 . . . . . 260 Nm
- Length of the bolt shank 100 mm, M16 x 1,5, 10.9
  - initial torque . . . . . 100 Nm
  - 1st rotation angle . . . . . 90–100°
  - 2nd rotation angle . . . . . 90–100°

Flywheel to crankshaft M16 x 1,5 (see also pages 17, 19, 20)
- initial torque . . . . . 100 Nm
- 1st rotation angle . . . . . 90–100°
- 2nd rotation angle . . . . . 90–100°

Tightening torque guide values

Crankcase, crankshaft assembly

Connecting rod bearing caps M16 x 1,5 or M14 x 1,5
- initial torque . . . . . 100–110 Nm
- rotation angle . . . . . 90–100°

Cylinder head

Rocker arm bracket to cylinder head . . . . . 65 Nm
Locknut on valve adjusting screw . . . . . 50 Nm

Timing devices

Adjusting segment to camshaft gear M10 . . . . . 90 Nm
Adjusting segment to intermediate gear M10 . . . . . 90 Nm

Lubrication system

Oil pump to crankcase M8, 8.8 . . . . . 22 Nm
Oil pump cover M8, 8.8 . . . . . 22 Nm
Oil cooler to oil filter head M8, 8.8 . . . . . 22 Nm
Filter bowl to oil filter head M12, 12.9 . . . . . 50 Nm
Oil pan to crankcase . . . . . 22 Nm
Plug (oil drain plug) in oil pan M26 x 1,5 . . . . . 80 Nm
Oil jet flange to crankcase M14 x 1,5 . . . . . 70 Nm

Exhaust / Intake manifolds

Exhaust manifold to cylinder head M10 . . . . . 50 Nm
Intake pipe to cylinder head M8, 8.8 . . . . . 22 Nm

Fuel system

Injector to cylinder head M28 x 1,5 . . . . . 120–125 Nm
Nozzle tensioning nut . . . . . 45 Nm
Fuel filter M12, 8.8 . . . . . 80 Nm
Pressure pipe to injector and injection pump
- initial torque . . . . . 10 Nm
- rotation angle for first installation . . . . . 60°
- rotation angle for following installation . . . . . 30°

Starter / alternator

Starter to timing case M12 x 1,5 . . . . . 80 Nm
V-belt pulley on alternator M14 x 1,5 and M16 x 1,5 . . . . . 40–50 Nm
V-belt pulley on alternator M24 x 1,5 . . . . . 120–150 Nm

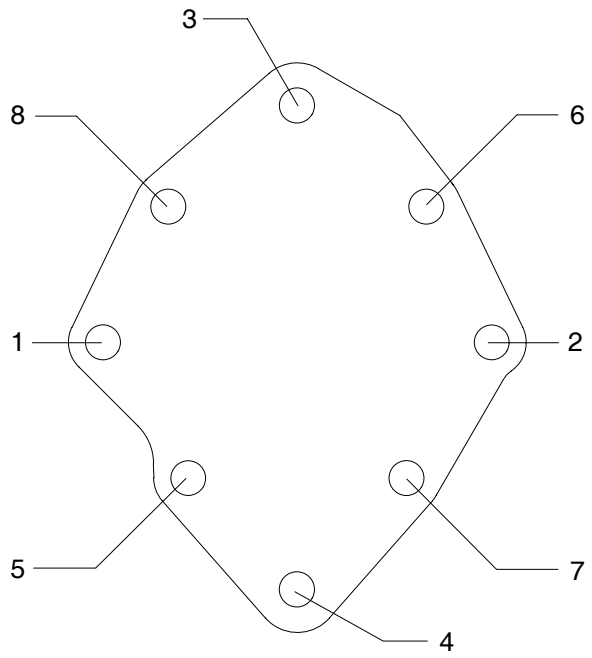
Power take-off for raw water pump

Nut for drive gear on PTO shaft (punch lock after final tightening) . . . . . 300–320 Nm

Power take-off for hydraulic pump

Bolt for drive gear on PTO shaft . . . . . 360 Nm

Flange of exhaust manifold



8-hole flange

Order of tightening:
1–2–3–4–5–6–7–8
or
2–1–4–3–6–5–8–7

Tightening:	100–110 Nm
Retightening after 1–2 hours of operation:	100–110 Nm

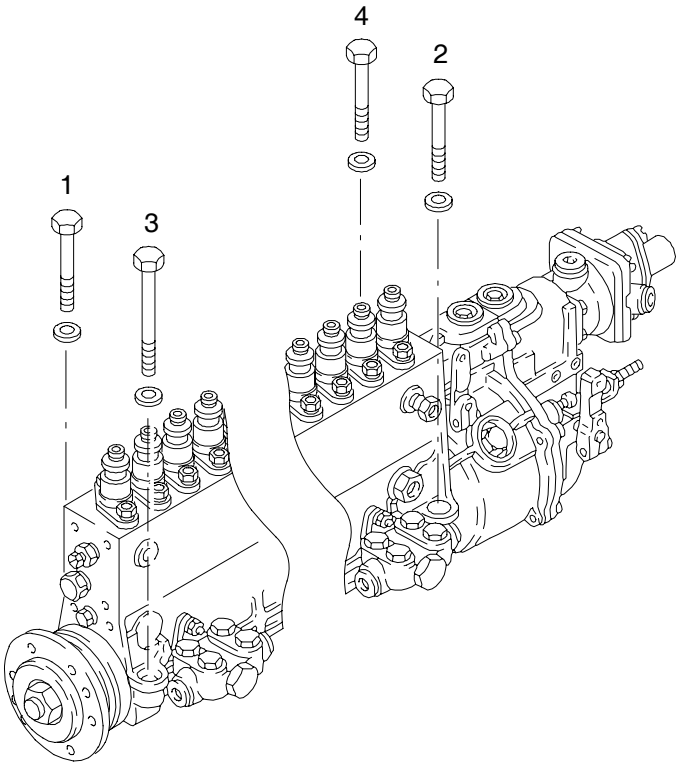
4-hole flange

Order of tightening: crosswise

Tightening: according to Works Standard M 3059, see page 57.

Tightening torque values, injection pumps

D 2848 L.., D 2840 L..

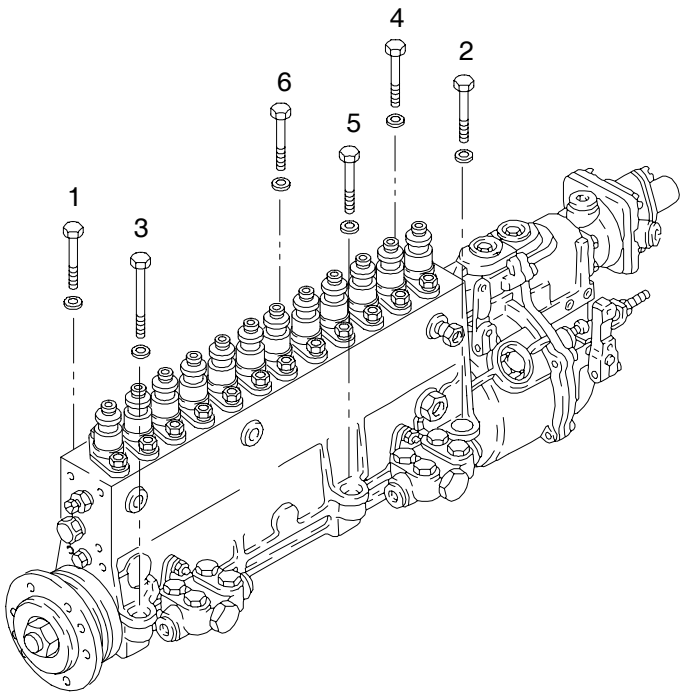


Order of tightening: 1–2–3–4
in the steps:

1. initial torque: 10 Nm
2. initial torque: 50–55 Nm
3. final torque: 90°

Bracket tightening method effective only if bolts of the strength class 8.8 (no more) are used.

D 2842 L..



Order of tightening: 1–2–3–4–5–6
in the steps:

1. initial torque: 10 Nm
2. initial torque: 50–55 Nm
3. final torque: 90°

Bracket tightening method effective only if bolts of the strength class 8.8 (no more) are used.

Tightening torque guide values

Tightening torque values according to Works Standard M 3059

Bolts / nuts with external or internal hexagon, head without collar or flange

Thread size x pitch	Grade / Tightening torque in Nm		
	for **8.8 / 8**	for **10.9 / 10**	for **12.9 / 12**
M 4	2,5	4,0	4,5
M 5	5,0	7,5	9,0
M 6	9,0	13,0	15,0
M 7	14,0	20,0	25,0
M 8	22,0	30,0	35,0
M 8 x 1	23,0	35,0	40,0
M 10	45,0	65,0	75,0
M 10 x 1,25	45,0	65,0	75,0
M 10 x 1	50,0	70,0	85,0
M 12	75,0	105,0	125,0
M 12 x 1,5	75,0	110,0	130,0
M 12 x 1,25	80,0	115,0	135,0
M 14	115,0	170,0	200,0
M 14 x 1,5	125,0	185,0	215,0
M 16	180,0	260,0	310,0
M 16 x 1,5	190,0	280,0	330,0
M 18	260,0	370,0	430,0
M 18 x 2	270,0	290,0	450,0
M 18 x 1,5	290,0	410,0	480,0
M 20	360,0	520,0	600,0
M 20 x 2	380,0	540,0	630,0
M 20 x 1,5	400,0	570,0	670,0
M 22	490,0	700,0	820,0
M 22 x 2	510,0	730,0	860,0
M 22 x 1,5	540,0	770,0	900,0
M 24	620,0	890,0	1040,0
M 24 x 2	680,0	960,0	1130,0
M 24 x 1,5	740,0	1030,0	1220,0

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