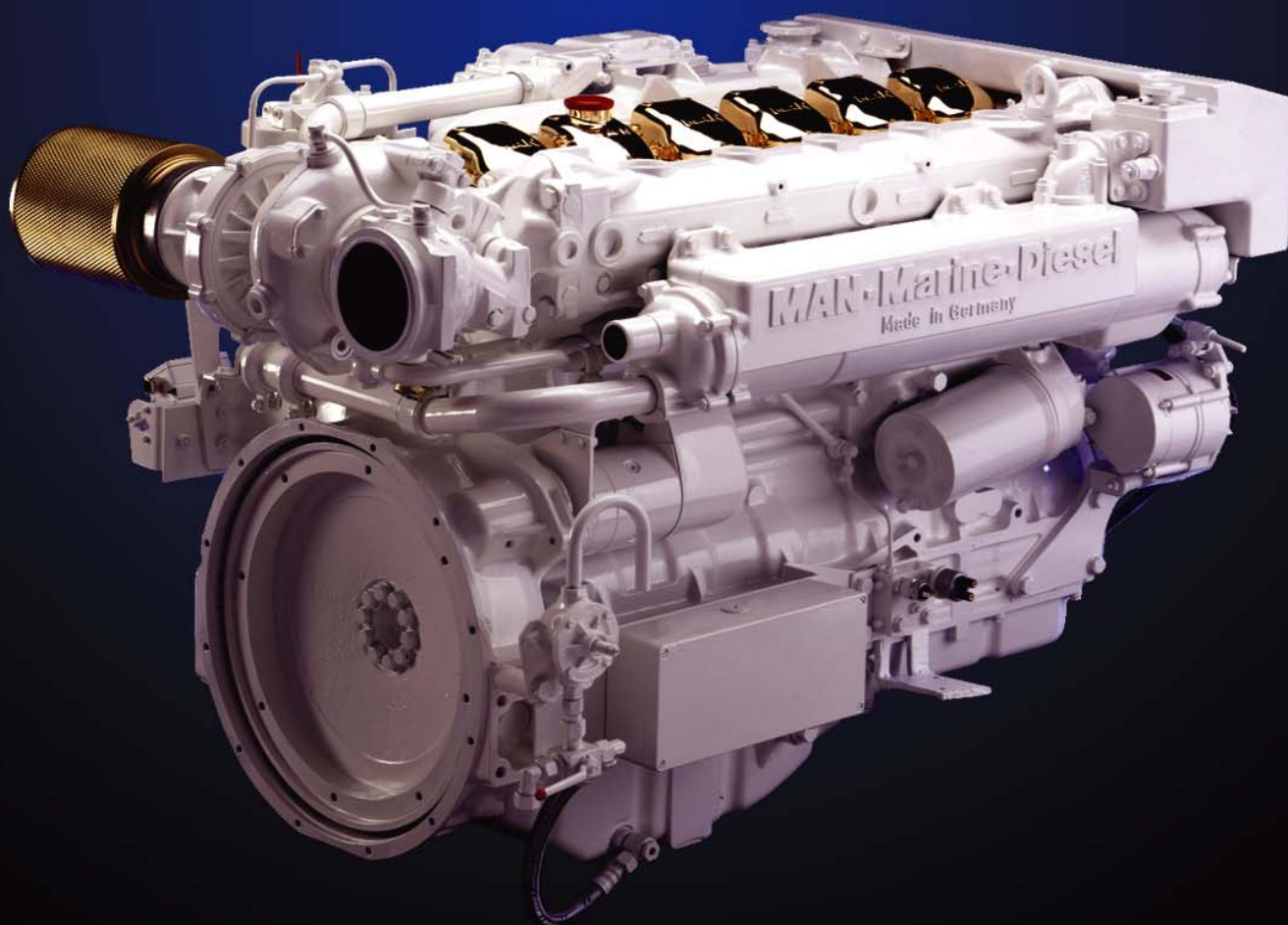


MAN marine Diesel engines Engineering ♦ Data ♦ Setting values



*D 2866 LXE
D 2866 LE 401 / 402 / 403 / 405
D 2876 LE 301
D 2876 LE 403*



The purpose of this publication is to inform you about the checking values, setting data and technical details of MAN's 6-cylinder high-performance marine Diesel engines.

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

Instructions

Important instructions which concern technical safety and protection of persons are emphasised as shown below.

**Danger:**

This refers to working and operating procedures which must be complied with so as not to endanger persons.

**Caution:**

This refers to working and operating procedures which must be complied with in order to prevent damage to or destruction of material.

**Note:**

Explanations that are useful for understanding the working or operating procedure to be performed.

MAN Nutzfahrzeuge Aktiengesellschaft
Nuremberg Works

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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 2866 LXE as an example:

- D The "D" at the beginning of the model designation stands for "**D**iesel".
- 28 The number "28" indicates that the engine has a **128** mm bore.
- 6 The first "6" means **160** mm stroke. This figure is, however, only approximate for this model. The actual stroke is 155 mm.
- 6 The second "6" refers to the number of cylinders, **6**.
- L This letter stands for the German word "**L**adeluftkühlung", meaning "intercooling".
- X The letter "X" represents a development and power stage.
- E "E" stands for the German word "**E**inbaumotor", meaning "installation engine", and distinguishes these engines from MAN vehicle engines.
- 4.. This is a internal MAN development number. 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 hydroplanes had already become reality at the beginning of the eighties in the form of the D 2566 MLE.

As its classification shows, this engine is a 6-cylinder model with a bore of 125 mm and a stroke of 155 mm, making a swept volume of 11,41 l. With intercooling the engine was able to develop 250 kW (340 hp) at 2200 rpm.

Widening the bore to 128 mm and employing a modified injection process gave birth to the 300 kW (408 hp) model D 2866 LE. The total swept volume was thereby increased to 11,97 l.

At the end of the eighties the output of the D 2866 LXE engine was increased to 324 kW (440 hp). The rated speed remained unchanged at 2200 rpm.

In 1994 drastic modifications were necessary to comply with the call for even more power at an unaltered piston displacement and a comparably low weight. An increase to 441 kW (600 hp) was achieved for the D 2866 LE401 engine through improving intercooling and increasing charge-air pressure.

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

Worthy of mention in this context are:

- Load-dependent charge-air temperature control for eliminating the formation of white smoke in the low-load range.
- Turbocharger with wastegate for increasing the torque in the lower speed range at improved exhaust emission.
- Engine speed governor with charge-pressure dependent full-load stop
- RQV-K governor for increased tractive power at low speeds.

These measures also contribute to keeping the stresses on the engine within limits despite high outputs, extending the engine service life and enhancing engine reliability.



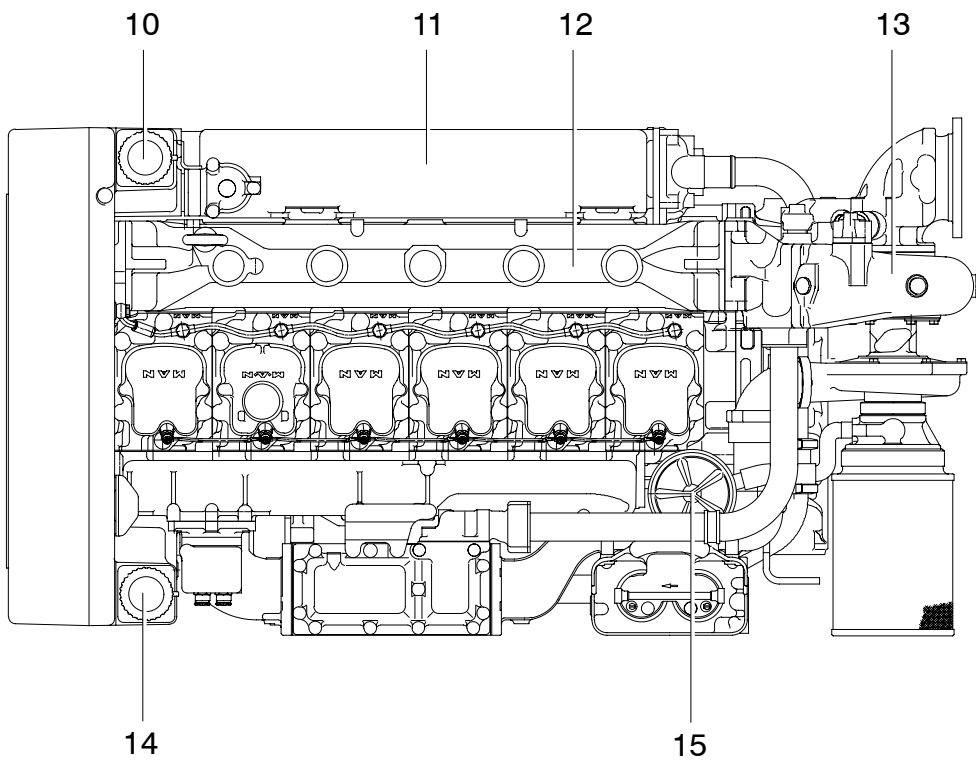
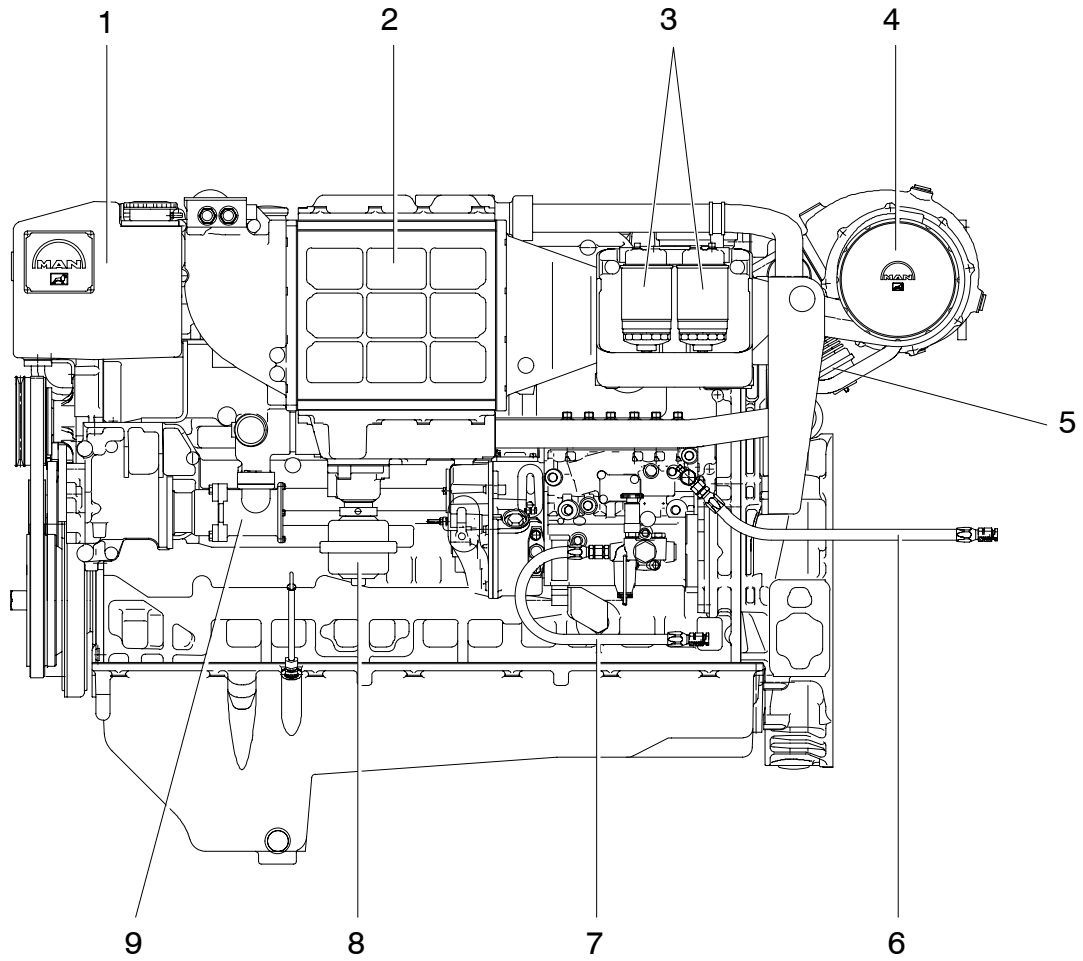
General engine data D 2866 LXE / LE 4..

| | |
|-------------------------------|---------------------|
| Mode of operation | four-stroke, Diesel |
| Combustion process | direct injection |
| Design | 6 cylinders in-line |
| Bore / stroke | 128 / 155 mm |
| Swept volume | 11,967 l |
| Compression ratio | 15,5 : 1 |
| Rotation viewed from flywheel | anti-clockwise |
| Firing order | 1-5-3-6-2-4-1 |
| Firing interval | 120° |
| Engine rating | see model plate |
| Rated speed | see model plate |

General engine data D 2876 LE 301 / 403

| | |
|-------------------------------|---------------------|
| Mode of operation | four-stroke, Diesel |
| Combustion process | direct injection |
| Design | 6 cylinders in-line |
| Bore / stroke | 128 / 166 mm |
| Swept volume | 12,816 l |
| Compression ratio | 15,5 : 1 |
| Rotation viewed from flywheel | anti-clockwise |
| Firing order | 1-5-3-6-2-4-1 |
| Firing interval | 120° |
| Engine rating | see model plate |
| Rated speed | see model plate |

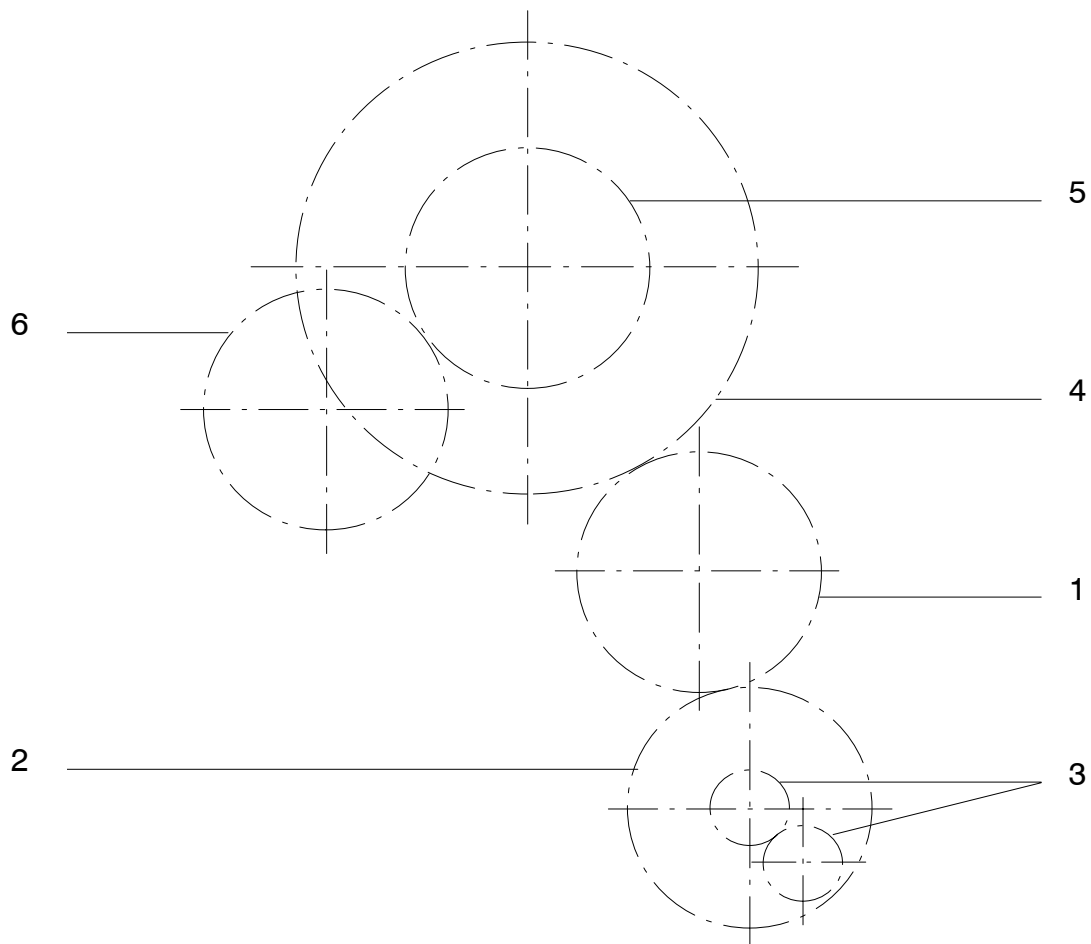
Technical features in summary



Taking the 6-cylinder D 2866 LE401 engine as an example, we shall explain the components of the engine singly using the adjacent drawing.

- 1 Coolant expansion tank
- 2 Sea water-cooled intercooler
- 3 Fuel filter
- 4 Air filter
- 5 Waste Gate
- 6 Fuel return line
- 7 Fuel supply line
- 8 Three-way control valve for controlling the charge-air temperature
- 9 Sea water pump
- 10 Pressure relief valve at the coolant expansion tank
- 11 Heat exchanger
- 12 Exhaust manifold, water-cooled
- 13 Turbocharger, water-cooled
- 14 Coolant filler neck
- 15 Oil separator valve of crankcase breather

Timing gear arrangement



- 1 Crankshaft gear
- 2 Drive gear, oil pump
- 3 Oil pump supply gear

- 4 Drive gear, camshaft
- 5 Intermediate gear
- 6 Drive gear, injection pump

Valve train

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

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

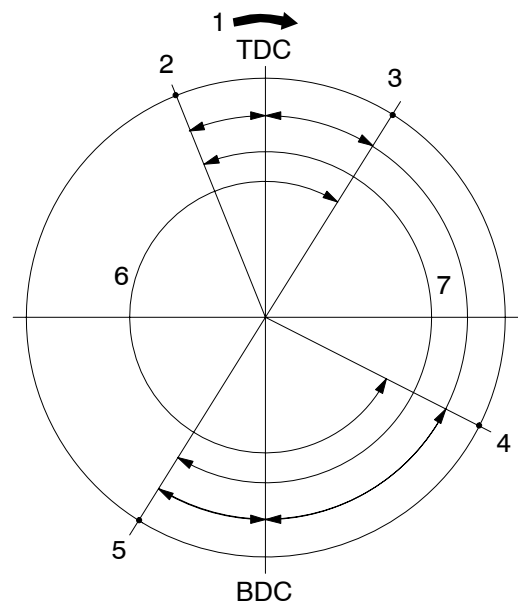
The valves do not sit correctly on the valve seat inserts when closed and are therefore no longer able to conduct the heat to the cylinder head. In this situation the exhaust valves in particular are prone to burning because of the high thermal stress to which they are exposed as a result of the hot 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 23° before TDC
- 3 Exhaust closes 30° after TDC
- 4 Exhaust opens 60° before BDC
- 5 D 2866 LE 4...: Inlet closes 37° after BDC
D 2876 LE 301 / 403: Inlet closes
37° after BDC
D 2866 LXE: Inlet closes 12° after BDC
- 6 Exhaust open for 270°
- 7 Inlet open for 240°



Figures in degrees refer to the crankshaft angle

Valve lift: 14 mm
(intake / exhaust)



Compression pressures

| | | |
|---|-----|----------|
| good | bar | over 28 |
| permissible | bar | 25–28 |
| in need of repair | bar | under 24 |
| pressure difference (between individual cylinders) | bar | max. 4 |

Fuel system

| | | | |
|---|-------|---------------|---------------|
| Delivery rate of fuel supply pump | | D 2866 LXE | D 2866 LE4.. |
| n = 2200 rpm | l / h | 150 | 250 |
| Delivery rate of fuel supply pump | | D 2876 LE 301 | D 2876 LE 403 |
| n = 1500 rpm | l / h | 310 | |
| n = 1800 rpm | l / h | 315 | 229 |
| Opening pressure of overflow valve (all engine models) at injection pump | bar | 1,3–1,8 | |

Lubricating system

Oil pump feed rates:

The rotation speeds are those of the pumps.

Oil pump speed: engine speed x 0.977 (i = 1.023)

(Feed rates with SAE 20 oil at 90°C and 6 bar.)

| | | |
|--|---------|-----|
| Oil pump (width of gear 34mm) | | |
| n = 635 rpm | l / min | 28 |
| n = 2150 rpm | l / min | 130 |
| Oil pump (width of gear 43mm) | | |
| n = 635 rpm | l / min | 40 |
| n = 2150 rpm | l / min | 155 |
| Oil pump (for oil pan with max. permissible inclination of 30 degrees) | | |
| n = 635 rpm | l / min | 63 |
| n = 2150 rpm | l / min | 250 |

Valve opening pressures in lubricating oil circuit:

Bypass valve for oil filter

| | | |
|------------------|-----|---|
| Opening pressure | bar | 2 |
| Closing pressure | bar | 4 |

Oil pump pressure regulating valve

| | | |
|--|-----|------|
| | bar | 9–10 |
|--|-----|------|

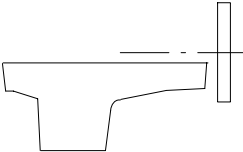
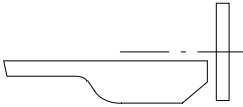
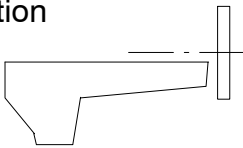
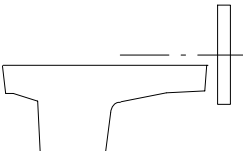
Pressure valve of oil spray jets

| | | |
|------------------|-----|---------|
| Opening pressure | bar | 1,9–2,1 |
| Closing pressure | bar | 1,4–1,6 |

Capacities



Oil filling capacities

| Engine model | Oil pan | | Min. capacity | Max. capacity |
|--------------|--------------------------------------|--|---------------|---------------|
| D 2866 L.. | deep |  | 14 l | 18 l |
| D 2866 L.. | flat |  | 16 l | 20 l |
| D 2866 L.. | deep, max. inclination 30 degrees |  | 14 l | 18 l |
| D 2876 L.. | deep |  | 26 l | 30 l |

Coolant

Engine with heat exchanger

Litres

D 2866 LE 4..

58

D 2876 LE 301 / 403

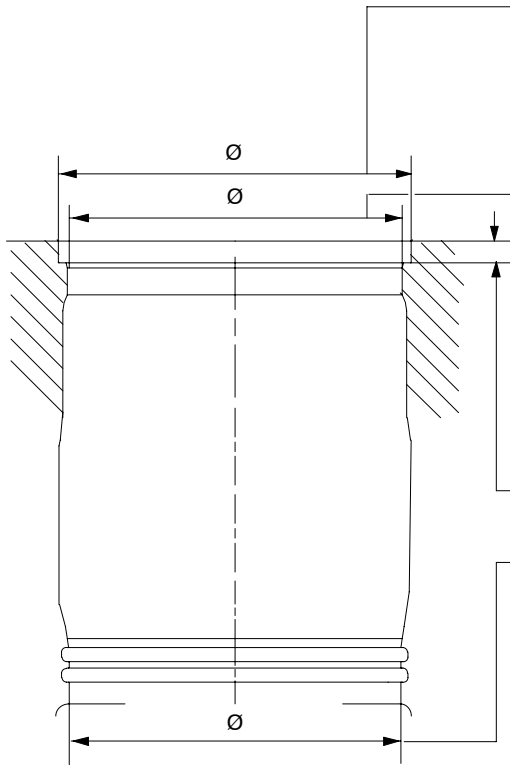
58

Service Data

Dimensions
Limiting values



Crankcase



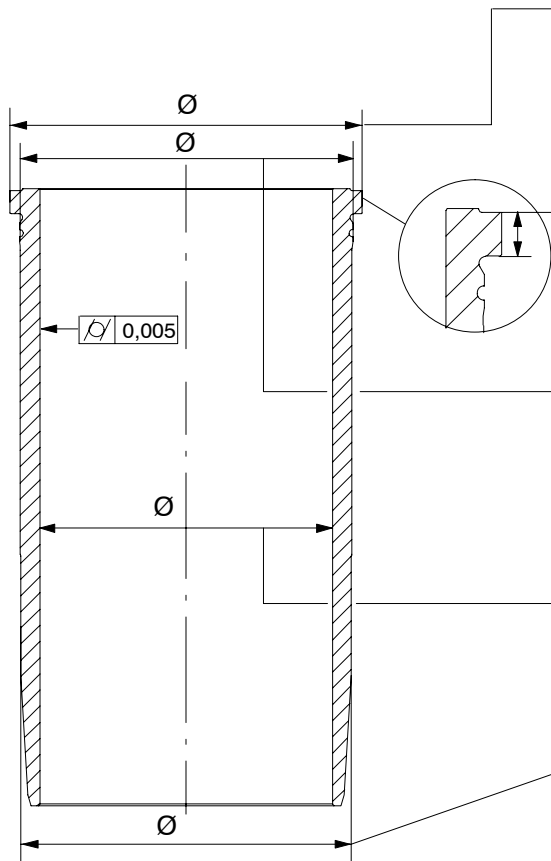
153,90–153,94 mm standard
for cylinder liners with 0,5 and 1,0 mm
outside diameter
154,40–154,44 mm

145,80–145,84 mm standard
for cylinder liners with 0,5 mm larger out-
side diameter
146,30–146,34 mm
for cylinder liners with 1,0 mm larger out-
side diameter
146,80–146,84 mm

9,955–10,025 mm

144,50–144,54 mm standard
for cylinder liners with 0,5 mm outside di-
ameter
145,00–145,04 mm
for cylinder liners with 1,0 mm larger out-
side diameter
145,50–145,54 mm

Cylinder liner



153,694–153,757 mm standard
154,194–154,257 mm with 0,5 and
1,0 mm larger outside diameter


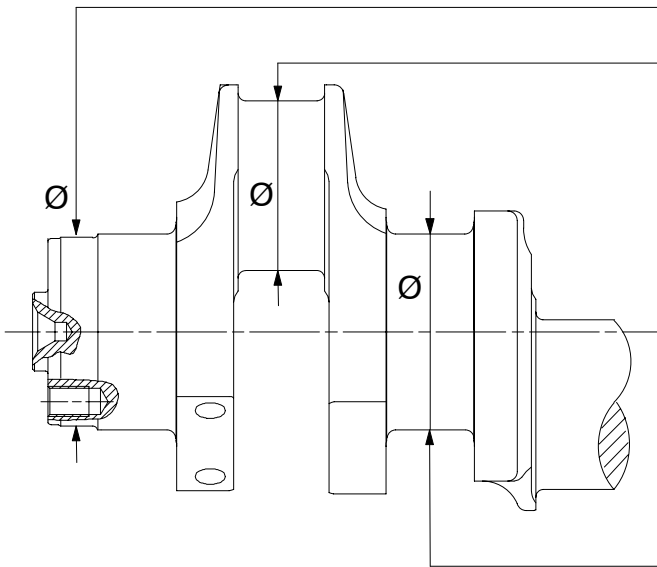
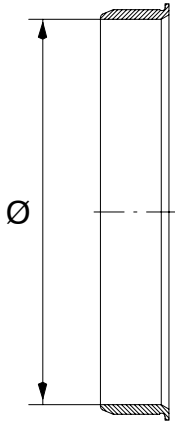
10,05–10,07 mm standard
10,55–10,57 mm with 0,5 mm more
flange height


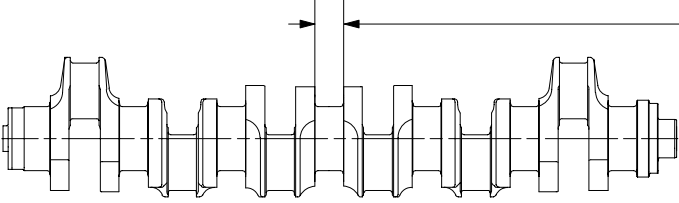
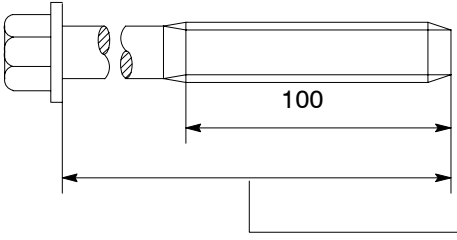
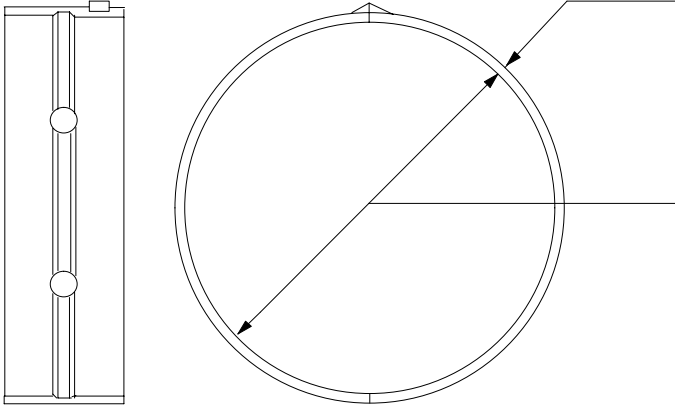
Max. permissible cylinder liner protrusion:
0,03–0,08 mm


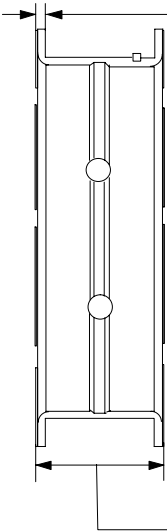
145,761–145,786 mm standard
146,261–146,286 mm with 0,5 mm
larger outside diameter
146,761–146,786 mm with 1,0 mm
larger outside diameter

127,990–128,010
Max. wear limit:
0,15 mm larger than basic size

144,432–144,457 mm standard
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)  | <p>99,985–100,020 mm</p> <p>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</p> <p>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</p> <p>max. axial clearance of crankshaft: 0,190–0,322 mm</p> | |
| Bearing race for crankshaft, front end  | <p>Inner diameter: 99,907–99,942 mm</p> | |

| Service Data | Dimensions Limiting values |  |
|---|--|--|
| <p>Thrust bearing journal</p>  | <p>46,000–46,062 mm standard size 46,500–46,562 mm undersize 0,25 46,500–46,562 mm undersize 0,50 47,000–47,062 mm undersize 0,75 47,000–47,062 mm undersize 1,00</p> | |
| <p>Mounting bolts for crankshaft bearing caps</p>  | <p>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</p> | |
| <p>Main bearing</p>  | <p>Data for wall thickness and bearing bore also apply to thrust bearing</p> <p>3,466–3,478 mm standard size 3,591–3,603 mm undersize 0,25 3,716–3,728 mm undersize 0,50 3,841–3,853 mm undersize 0,75 3,966–3,978 mm undersize 1,00</p> <p>Bearing bore in installed condition: 104,060–104,106 mm standard size 103,810–103,856 mm undersize 0,25 103,560–103,606 mm undersize 0,50 103,310–103,356 mm undersize 0,75 103,060–103,106 mm undersize 1,00</p> <p>Spread: 0,3–1,2 mm</p> <p>Marking: top / bottom 0005 / 0093 standard size 0011 / 0095 undersize 0,25 0013 / 0096 undersize 0,50 0015 / 0097 undersize 0,75 0017 / 0098 undersize 1,00</p> | |

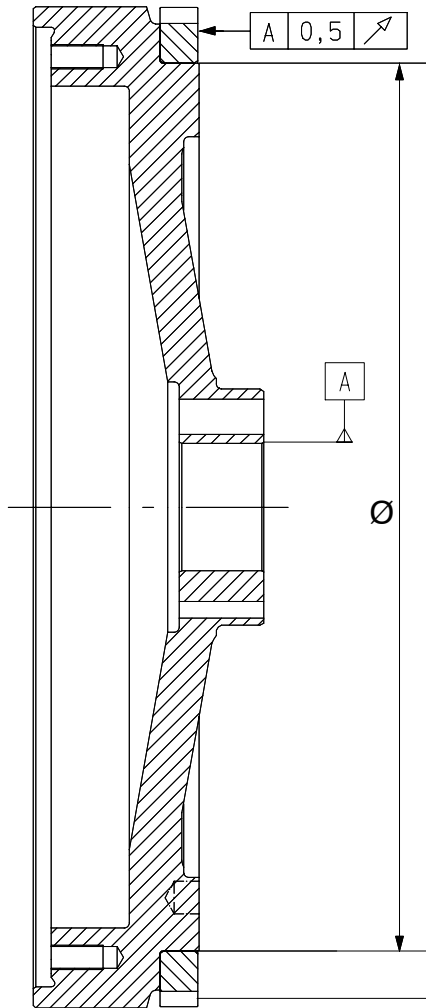
| Service Data | Dimensions Limiting values |  |
|--|--|--|
| <p>Thrust bearing</p>  | <p>3,363–3,388 mm standard size 3,613–3,638 mm undersize 0,25 3,613–3,638 mm undersize 0,50 3,863–3,888 mm undersize 0,75 3,863–3,888 mm undersize 1,00 Spread: 0,1–0,5 mm Marking: top / bottom 0017 / 0018 standard size 0023 / 0024 undersize 0,25 0025 / 0026 undersize 0,50 0027 / 0028 undersize 0,75 0029 / 0030 undersize 1,00</p> <p>45,74–45,81 mm standard size 46,24–46,31 mm undersize 0,25 46,24–46,31 mm undersize 0,50 46,74–46,81 mm undersize 0,75 46,74–46,81 mm undersize 1,00 Data for wall thickness and bearing bore see "main bearing"</p> | |
| | | |

Service Data

Dimensions
Limiting values



Flywheel (SAE #14)



Ø Flywheel:
432,490–432,645 mm

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

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

$m = 52,9$ kg (with starter gear)
 $J = 2,003$ kgm²

Number of teeth: $Z = 160$, Modulus 3
Matching gear: Starter pinion
Number of teeth: 9

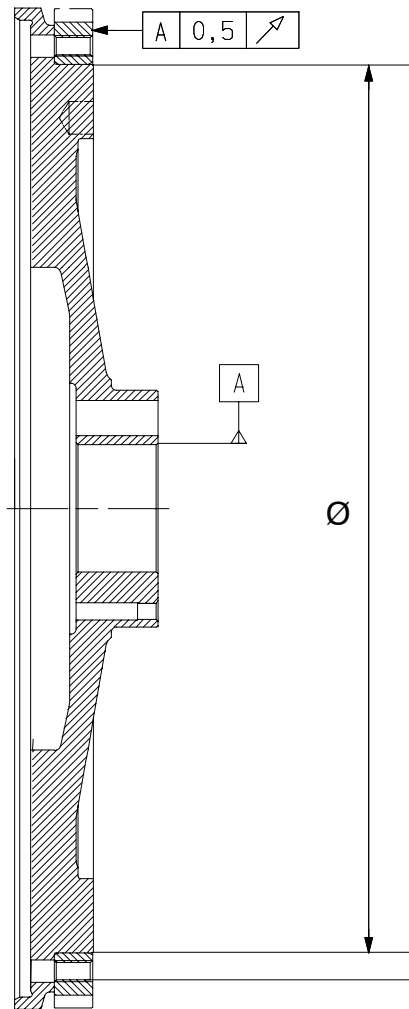
Backlash: 0,6–0,9 mm

Service Data

Dimensions
Limiting values



Flywheel for cardan-shaft coupling



Ø Flywheel:
432,490–432,645 mm

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

Installation temperature: 200–230 deg.C

$m = 32,5$ kg (with starter gear)
 $J = 1,10$ kgm²

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

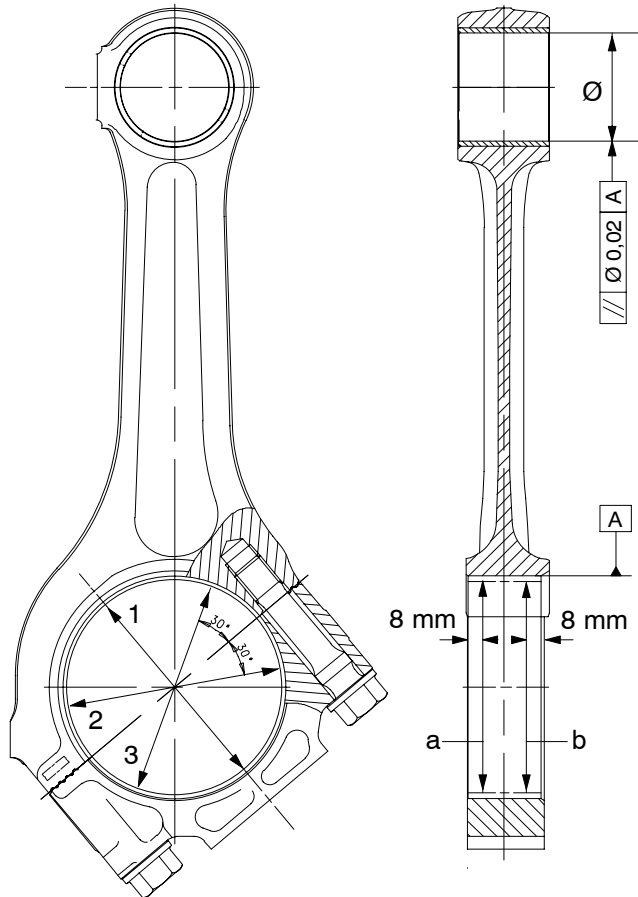
Backlash: 0,6–0,9 mm

Service Data

Dimensions
Limiting values



Connecting rods

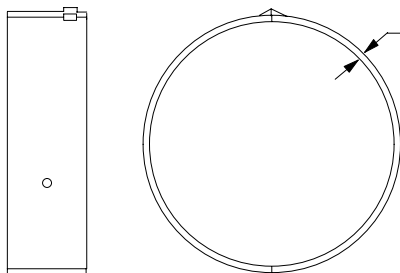


46,055–46,065 mm

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

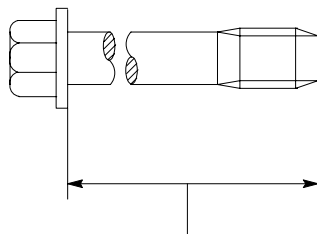


2,468–2,478 mm standard size
2,593–2,603 mm undersize 0,25
2,718–2,728 mm undersize 0,50
2,843–2,853 mm undersize 0,75
2,968–2,978 mm undersize 0,1,00
Spread: 0,6–1,5 mm

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 or yellow 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:

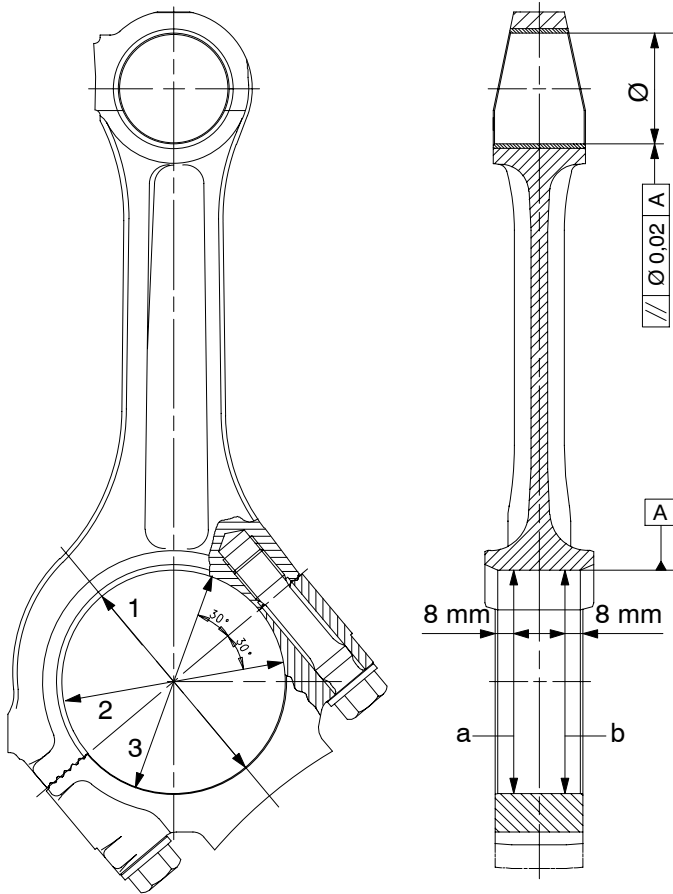
new: 67,2–67,5 mm, max. 69 mm

Service Data

Dimensions
Limiting values



Connecting rods



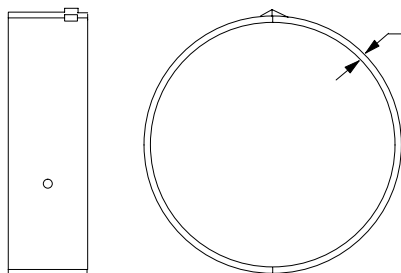
46,055–46,065 mm

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,
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Conrod bearing

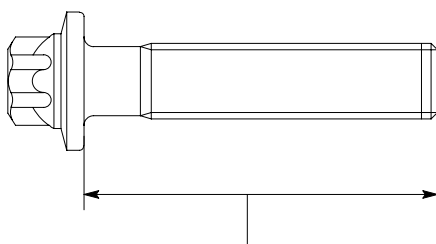


2,468–2,478 mm standard size
2,593–2,603 mm undersize 0,25
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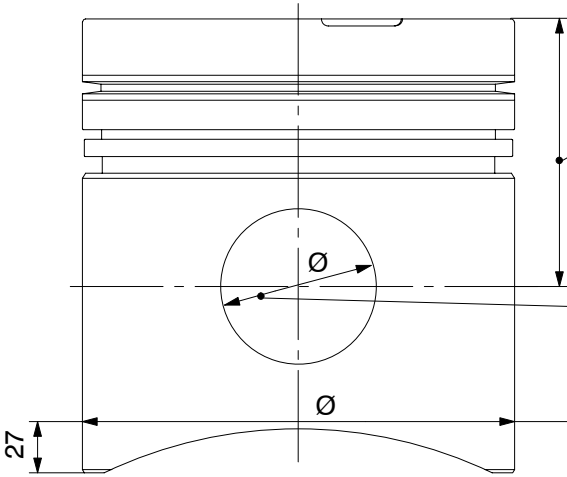
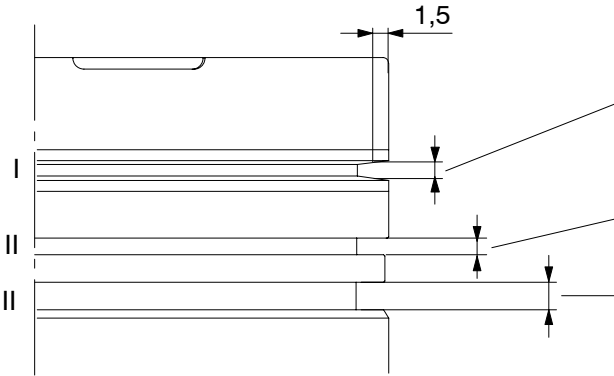
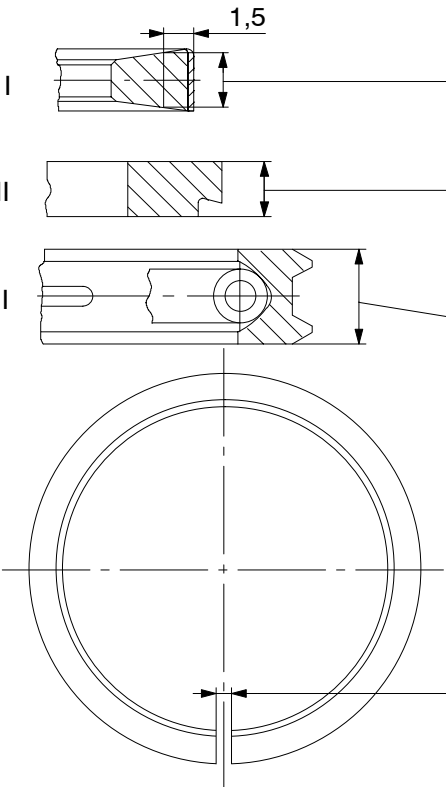
Important: note installation position (upper half bearing shell has red or yellow mark on side)


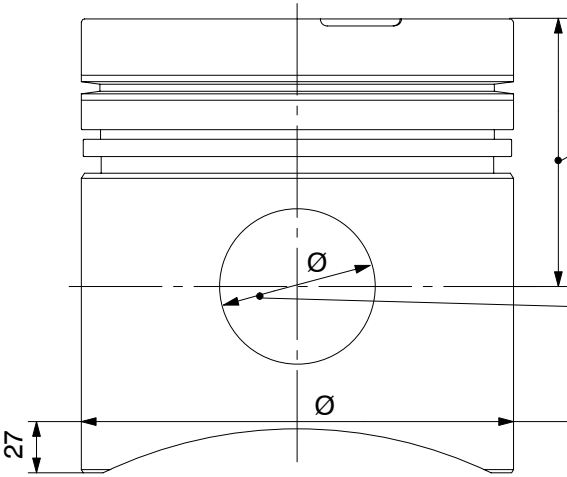
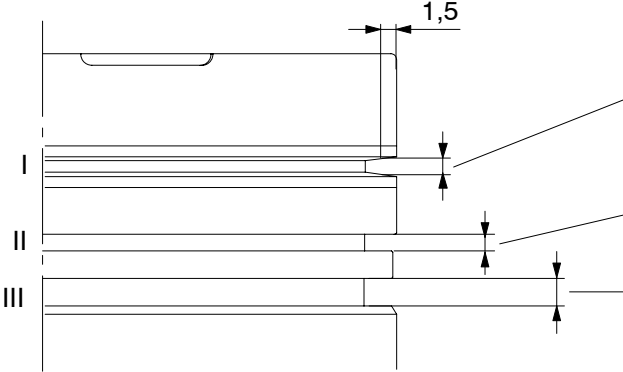
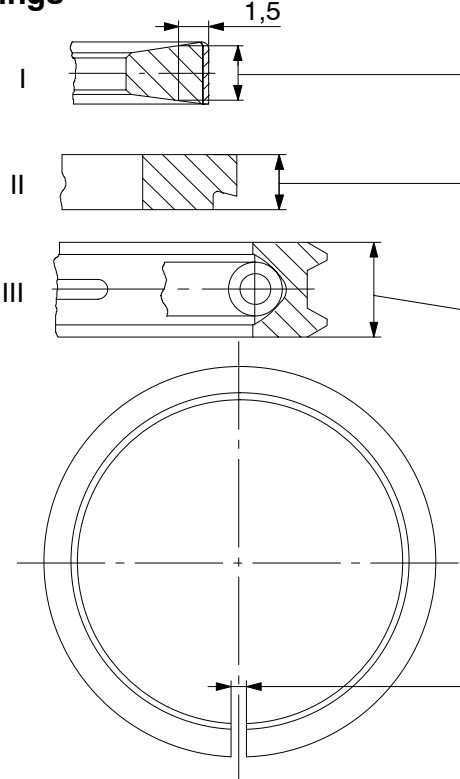
Connecting rod bolt


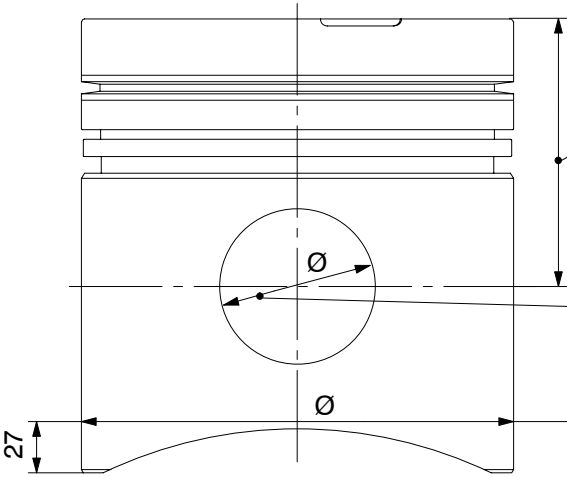
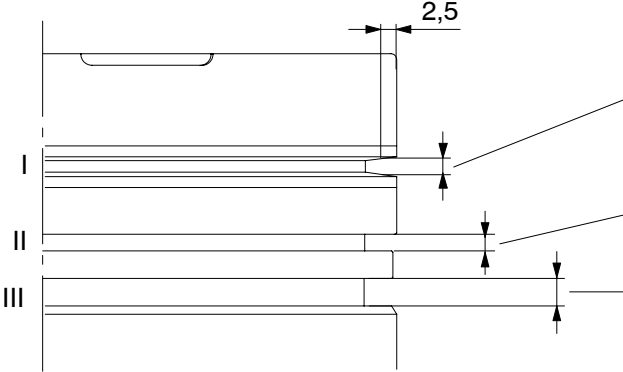
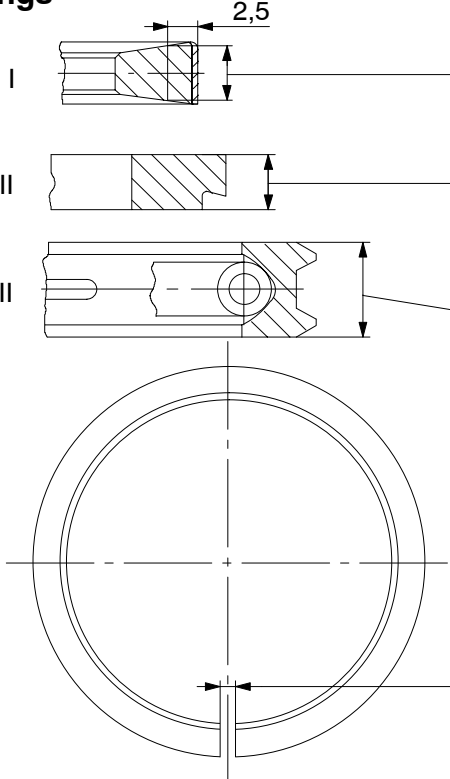



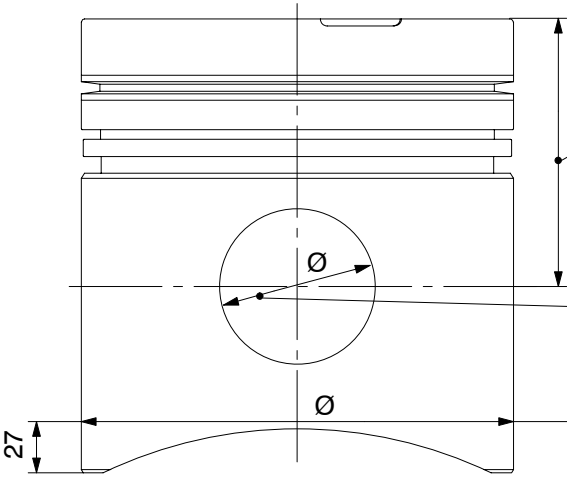
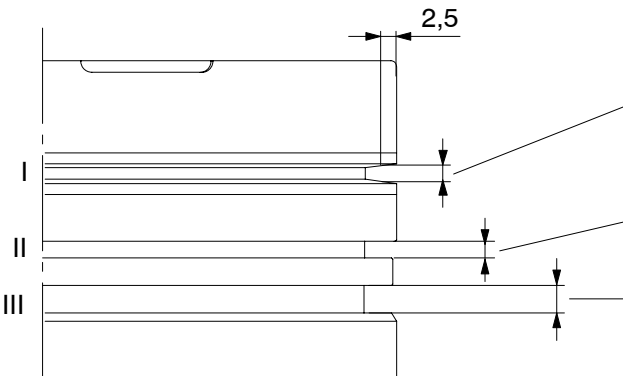
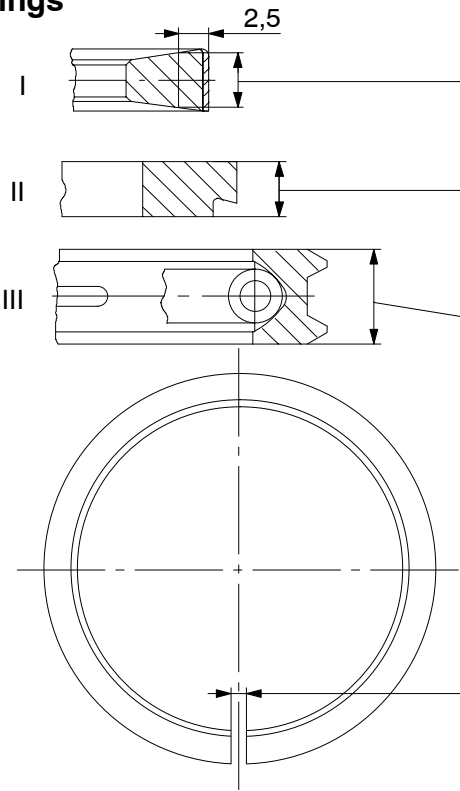
Length: During tightening the bolts are intentionally stressed beyond the yield point and therefore subjected to some permanent elongation each time they are tightened.


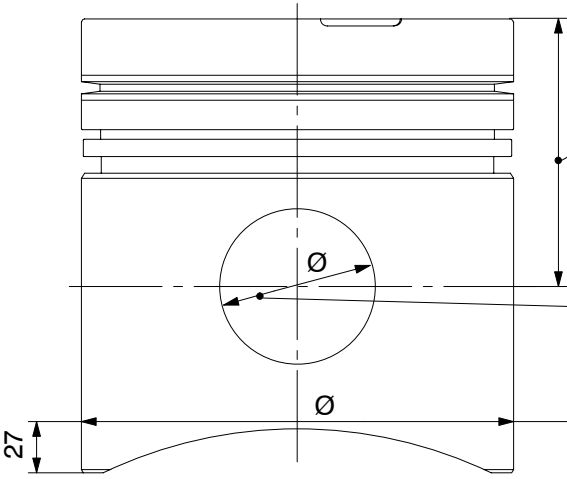
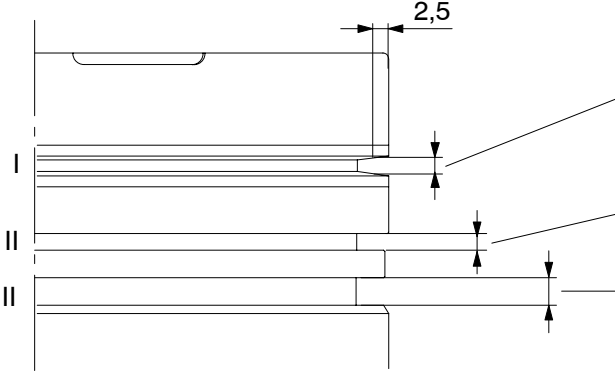
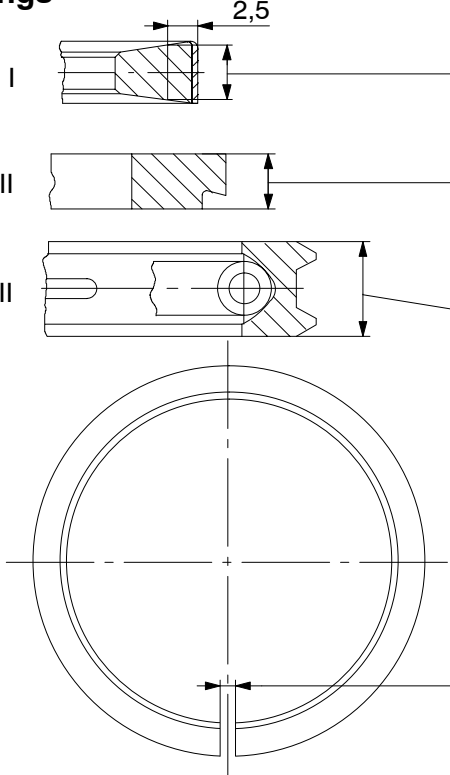
Torx bolt M14x1.5


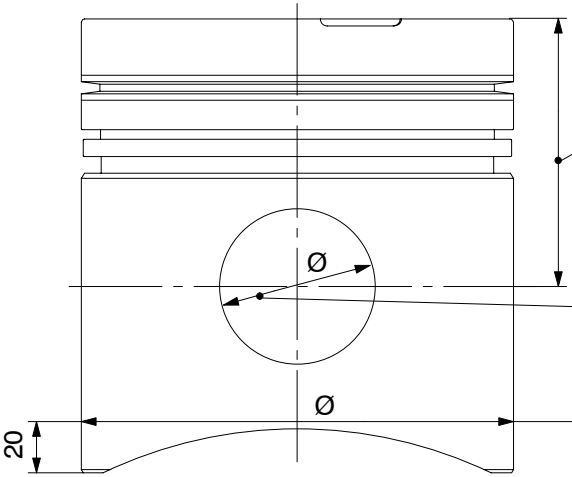
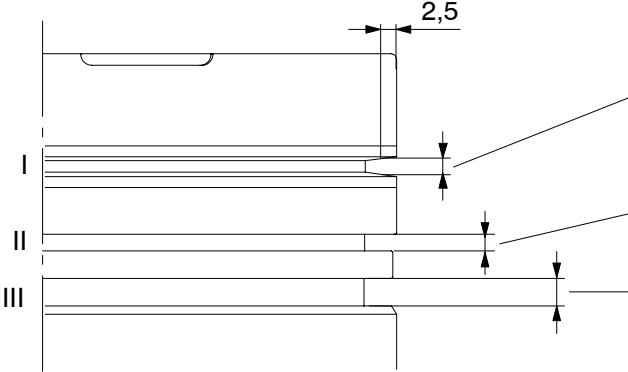
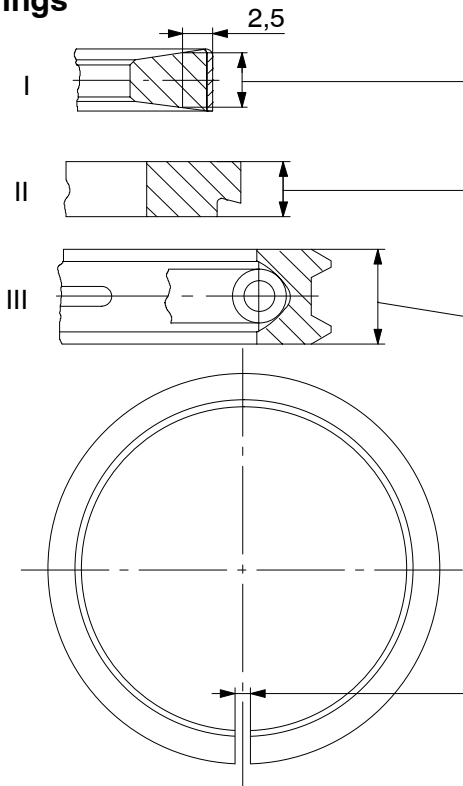
| Service Data | Dimensions Limiting values |  |
|--|--|--|
| <p>Piston 51.02511-0055</p>  | <p>Compression height: 89,70–89,75 mm with undersize 0,2 mm: 89,50–89,55 mm 0,4 mm: 89,30–89,35 mm 0,6 mm: 89,10–89,15 mm</p> <p>Piston protrusion above crankcase top: 0,013–0,331 mm</p> <p>46,003–46,009 mm Piston pin diameter: 45,994–46,000 mm</p> <p>127,850–127,880 mm</p> <p>Max. difference in weight per engine piston set: max. 100g</p> | |
| <p>Piston ring grooves</p>  | <p>3,195–3,225 mm</p> <p>3,040–3,060 mm</p> <p>5,020–5,040 mm</p> | |
| <p>Piston rings</p>  | <p>1st. ring–keystone-type ring: height: 3,075–3,095 mm</p> <p>2nd. ring–taper face ring: height: 2,978–2,990 mm axial play: 0,050–0,082 mm</p> <p>3rd. ring–bevelled ring: height: 4,978–4,990 mm axial play: 0,030–0,062 mm</p> <p>Ring gap: 1st. ring: 0,35–0,55 mm 2nd. ring: (Goetze) 0,45–0,70 mm (Riken) 0,40–0,65 mm 3rd. ring: 0,25–0,40 mm</p> | |

| Service Data | Dimensions Limiting values |  |
|--|--|--|
| <p>Piston 51.02511-0177</p>  | <p>Compression height: 89,70–89,75 mm with undersize 0,2 mm: 89,50–89,55 mm 0,4 mm: 89,30–89,35 mm 0,6 mm: 89,10–89,15 mm</p> <p>Piston protrusion above crankcase top: 0,013–0,331 mm</p> <p>46,003–46,013 mm</p> <p>Piston pin diameter: 45,994–46,000 mm</p> <p>127,840–127,880 mm</p> <p>Max. difference in weight per engine piston set: max. 100g</p> | |
| <p>Piston ring grooves</p>  | <p>3,195–3,225 mm</p> <p>3,040–3,060 mm</p> <p>5,020–5,040 mm</p> | |
| <p>Piston rings</p>  | <p>1st. ring–keystone-type ring: height: 3,075–3,095 mm</p> <p>2nd. ring–taper face ring: height: 2,978–2,990 mm axial play: 0,050–0,082 mm</p> <p>3rd. ring–bevelled ring: height: 4,978–4,990 mm axial play: 0,030–0,062 mm</p> <p>Ring gap: 1st. ring: 0,35–0,55 mm or 0,5–0,7 mm</p> <p>2nd. ring: (Goetze) 0,45–0,70 mm (Riken) 0,40–0,65 mm</p> <p>3rd. ring: 0,25–0,40 mm</p> | |

| Service Data | Dimensions Limiting values |  |
|--|---|--|
| <p>Piston 51.02511-0245</p>  | <p>Compression height: 89,70–89,75 mm with undersize 0,2 mm: 89,50–89,55 mm 0,4 mm: 89,30–89,35 mm 0,6 mm: 89,10–89,15 mm</p> <p>Piston protrusion above crankcase top: 0,013–0,331 mm</p> <p>46,005–46,013 mm Piston pin diameter: 45,994–46,000 mm</p> <p>127,825–127,865 mm Max. difference in weight per engine piston set: max. 100g</p> | |
| <p>Piston ring grooves</p>  | <p>2,935–2,965 mm</p> <p>3,040–3,060 mm</p> <p>5,020–5,040 mm</p> | |
| <p>Piston rings</p>  | <p>1st. ring–keystone-type ring: height: 2,796–2,83 mm</p> <p>2nd. ring–taper face ring: height: 2,978–2,990 mm axial play: 0,050–0,082 mm</p> <p>3rd. ring–bevelled ring: height: 4,978–4,990 mm axial play: 0,030–0,062 mm</p> <p>Ring gap: 1st. ring: 0,35–0,55 mm or 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</p> | |

| Service Data | Dimensions Limiting values |  |
|--|--|--|
| <p>Piston 51.02511-0268</p>  | <p>Compression height: 89,70–89,75 mm with undersize 0,2 mm: 89,50–89,55 mm 0,4 mm: 89,30–89,35 mm 0,6 mm: 89,10–89,15 mm</p> <p>Piston protrusion above crankcase top: 0,013–0,331 mm</p> <p>46,005–46,013 mm Piston pin diameter: 45,994–46,000 mm</p> <p>127,835–127,875 mm</p> <p>Max. difference in weight per engine piston set: max. 100g</p> | |
| <p>Piston ring grooves</p>  | <p>3,695–3,725 mm</p> <p>3,040–3,060 mm</p> <p>4,020–4,040 mm</p> | |
| <p>Piston rings</p>  | <p>1st. ring–keystone-type ring: height: 3,296–3,330 mm</p> <p>2nd. ring–taper face ring: height: 2,978–2,990 mm axial play: 0,050–0,082 mm</p> <p>3rd. ring–bevelled ring: height: 3,975–3,990 mm axial play: 0,030–0,065 mm</p> <p>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: 0,25–0,55 mm</p> | |

| Service Data | Dimensions Limiting values |  |
|--|--|--|
| <p>Piston 51.02511-0374</p>  | <p>Compression height: 89,70–89,75 mm with undersize 0,2 mm: 89,50–89,55 mm 0,4 mm: 89,30–89,35 mm 0,6 mm: 89,10–89,15 mm</p> <p>Piston protrusion above crankcase top: 0,013–0,331 mm</p> <p>46,008–46,016 mm Piston pin diameter: 45,994–46,000 mm</p> <p>127,960–127,990 mm 127,1–127,15 (oval)</p> <p>Max. difference in weight per engine piston set: max. 100g</p> | |
| <p>Piston ring grooves</p>  | <p>3,470–3,500 mm</p> <p>3,050–3,070 mm</p> <p>4,020–4,040 mm</p> | |
| <p>Piston rings</p>  | <p>1st. ring–keystone-type ring: height: 3,296–3,330 mm</p> <p>2nd. ring–taper face ring: height: 2,978–2,990 mm axial play: 0,050–0,082 mm</p> <p>3rd. ring–bevelled ring: height: 3,975–3,990 mm axial play: 0,030–0,065 mm</p> <p>Ring gap: 1st. ring: 0,5–0,7 mm 2nd. ring: 0,45–0,70 mm 3rd. ring: 0,25–0,55 mm</p> | |

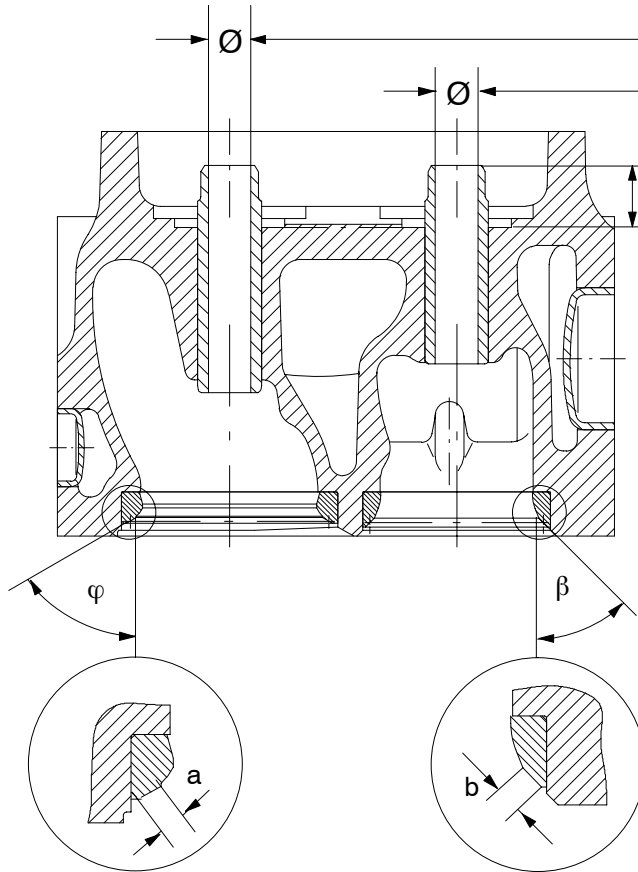
| Service Data | Dimensions Limiting values |  |
|--|--|--|
| <p>Piston 51.02511-0537 (D 2876 LE 301 / 403)</p>  | <p>Compression height: 79,20–79,25 mm with undersize 0,2 mm: 79,00–79,05 mm 0,4 mm: 78,80–78,85 mm 0,6 mm: 78,60–78,65 mm</p> <p>Piston protrusion above crankcase top: 0,013–0,331 mm</p> <p>50.032–50,058 mm Piston pin diameter: 49,994–50,000 mm 127,838–127,872 mm Max. difference in weight per engine piston set: max. 100g</p> | |
| <p>Piston ring grooves</p>  | <p>3,445–3,475 mm</p> <p>3,040–3,060 mm</p> <p>4,020–4,040 mm</p> | |
| <p>Piston rings</p>  | <p>1st. ring–keystone-type ring: height: 3,296–3,330 mm</p> <p>2nd. ring–taper face ring: height: 2,978–2,990 mm axial play: 0,050–0,082 mm</p> <p>3rd. ring–bevelled ring: height: 3,975–3,990 mm axial play: 0,030–0,065 mm</p> <p>Ring gap: 1st. ring: 0,5–0,7 mm 2nd. ring: 0,45–0,70 mm 3rd. ring: 0,25–0,55 mm</p> | |

Service Data

Dimensions
Limiting values



Cylinder head

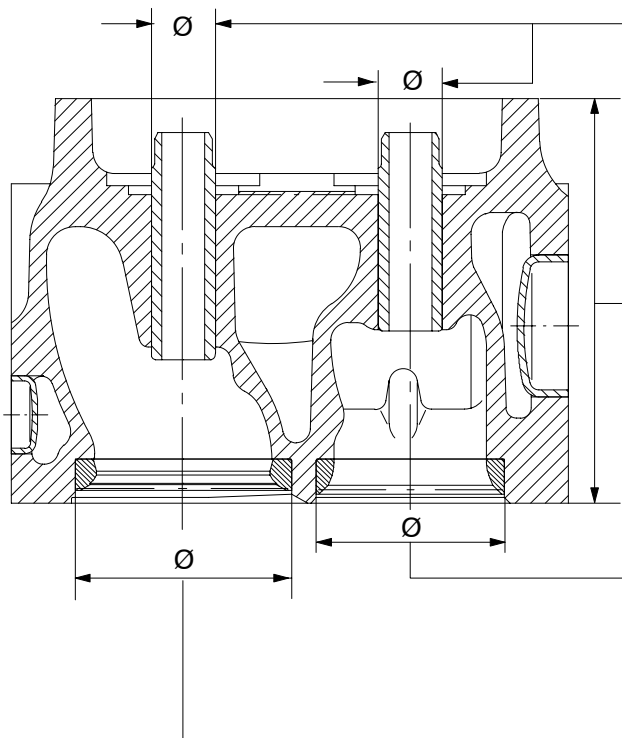


12,000–12,018 mm Intake valve guide
12,000–12,018 mm Exhaust valve guide

17,1–17,5 mm

Intake valve $\varphi = 60^\circ$
Exhaust valve $\beta = 45^\circ$

a = 3,3–3,8 mm
b = 3,3–3,8 mm


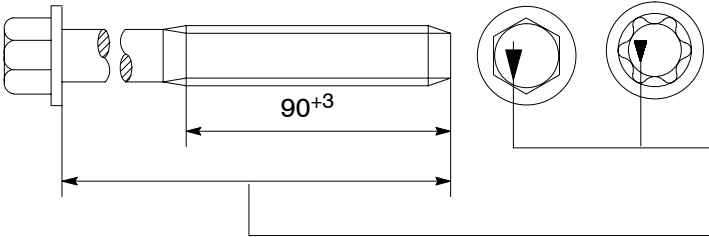
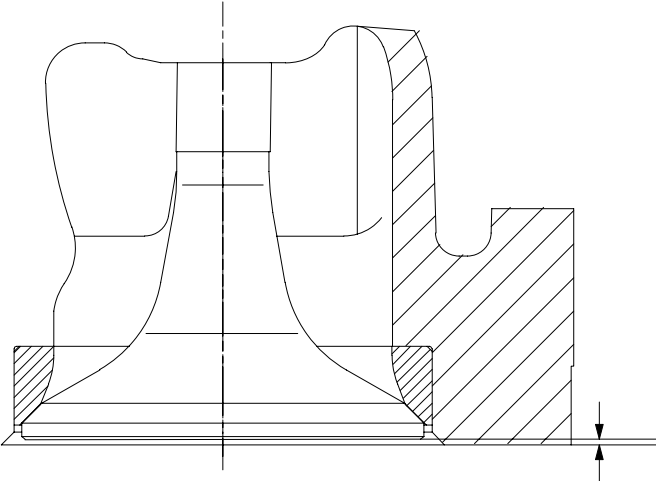
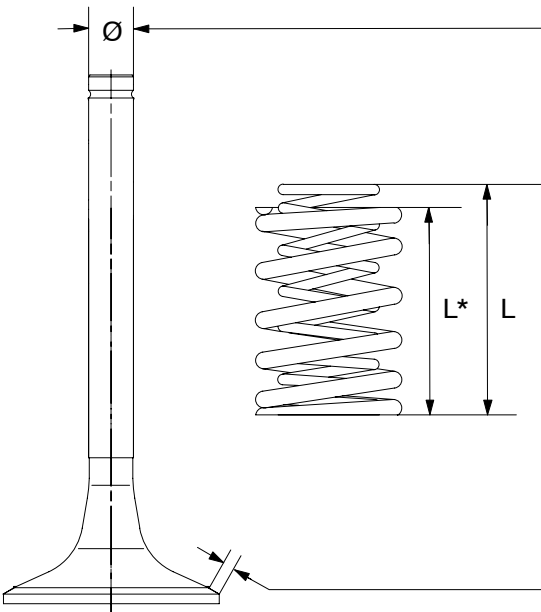


Valve guide bore in cylinder head:
18,000–18,018 mm
Valve guide outside diameter:
standard size: 18,028–18,046 mm

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

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

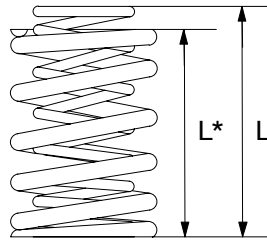
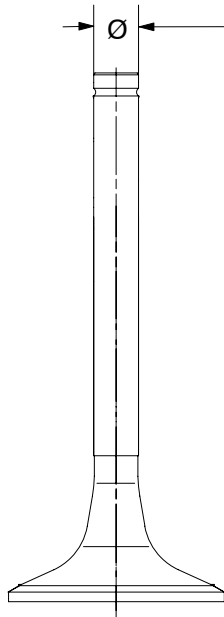
| Service Data | Dimensions Limiting values |  |
|---|---|--|
| <p>Cylinder head bolts</p>  | <p>Length: During tightening the bolts are intentionally stressed beyond the yield point and therefore subjected to some permanent elongation each time they are tightened. When the bolt has reached its maximum length it must not be reused.</p> <p>Angle-of-rotation symbol</p> <p>51.90020-0268 and 51.90490-0022 new: 167,5-168 mm, max. 170 mm 51.90020-0269 and 51.90490-0023 new: 143,5-144 mm, max. 146 mm 51.90020-0270 and 51.90490-0024 new: 108,5-109 mm, max. 111 mm</p> | |
| <p>Valve recess</p>  | <p>Valve recess for intake and exhaust valve: 0,7-1,3 mm</p> | |
| <p>Inlet valve</p>  | <p>11,969-11,980 mm Radial clearance: 0,020-0,049 mm Max. wear limit: 0,1 mm</p> <p>Valve springs:</p> <p>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</p> <p>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</p> <p>Valve cone face: 3,3-4,3 mm Valve seat (= grinding face): 2-2,5 mm</p> | |

Service Data

Dimensions
Limiting values



Inlet valve D 2876 LE 301 / 403



11,968–11,982 mm

Valve springs:

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

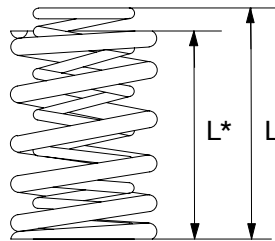
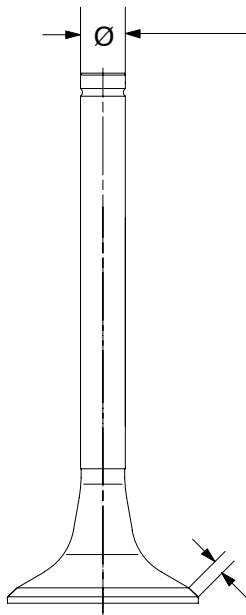
Outer spring:

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

Exhaust valve



11,944–11,955 mm

Radial clearance: 0,045–0,074 mm

Max. wear limit: 0,1 mm

Valve springs:

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:


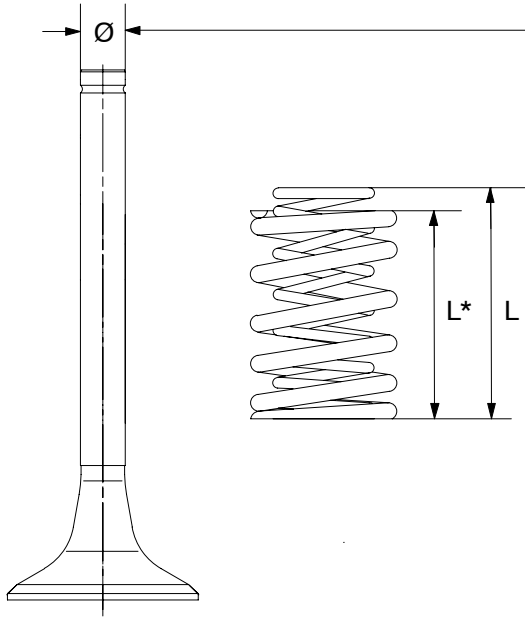
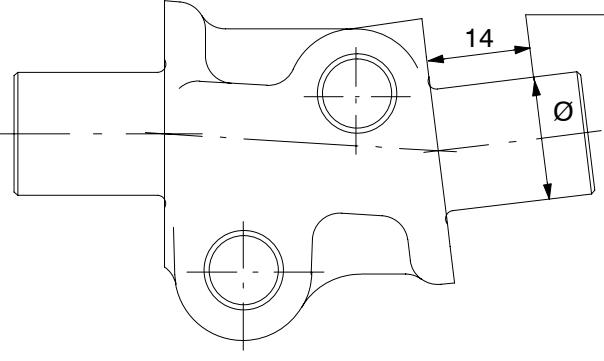
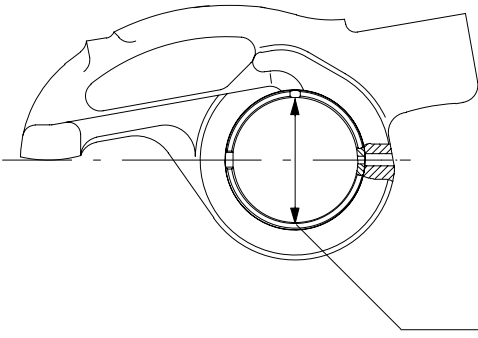
Free length (L*), approx. 59 mm

L* = 46,8 mm: at spring force 324–353 N

L* = 32,8 mm: at spring force 696–755 N

Valve cone: 3,97–4,0 mm

Valve seat (= grinding face): 2–2,5 mm

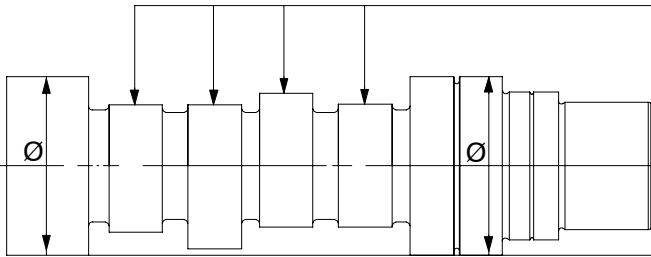
| Service Data | Dimensions Limiting values |  |
|---|---|--|
| <p>Exhaust valve D 2876 LE 301 / 403</p>  | <p>11,945–11,955 mm</p> <p>Valve springs:</p> <p>Inner spring: Free length (L), approx. 65,5 mm L = 46,3 mm at spring force 128–152 N L = 32,3 mm at spring force 255–294 N</p> <p>Outer spring: 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</p> | |
| <p>Valve train</p> | | |
| <p>Rocker bracket</p>  | <p>24,967–24,980 mm</p> | |
| <p>Rocker arm</p>  | <p>Rocker arm radial clearance: 0,025–0,054 mm Max. wear limit: 0,08 mm</p> <p>25,005 –25,021 mm</p> | |

Service Data

Dimensions
Limiting values



Camshaft



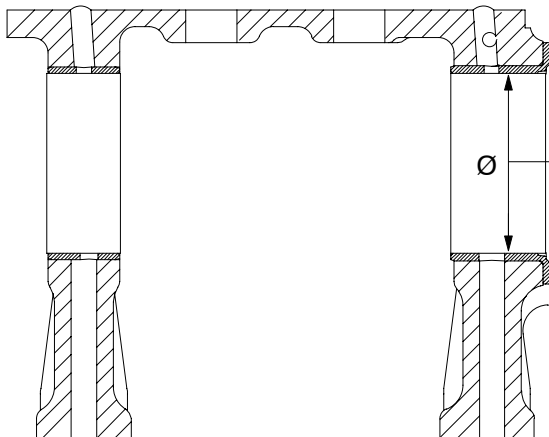
Change if signs of wear are present

Camshaft axial clearance:
0,20–0,90 mm
Max. wear limit: 1,5 mm

69,910–69,940 mm

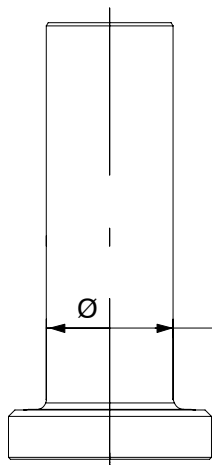
Backlash between
crankshaft gear and camshaft gear:
0,128 mm–0,252 mm

Camshaft bearing




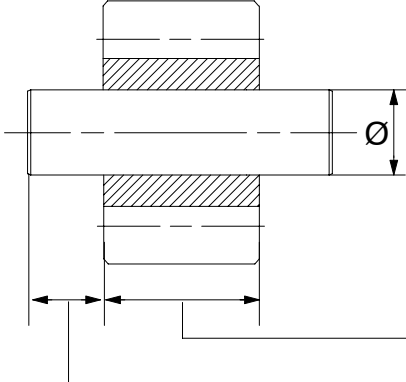
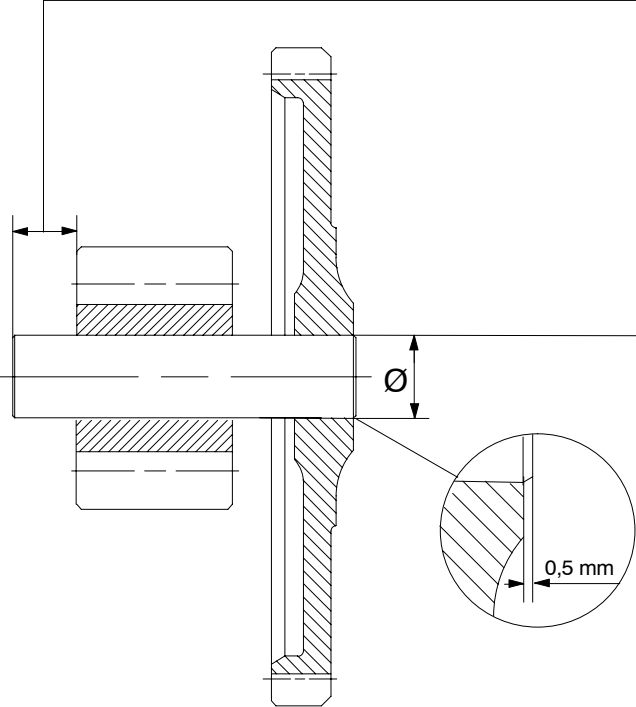
70,000–70,030 mm


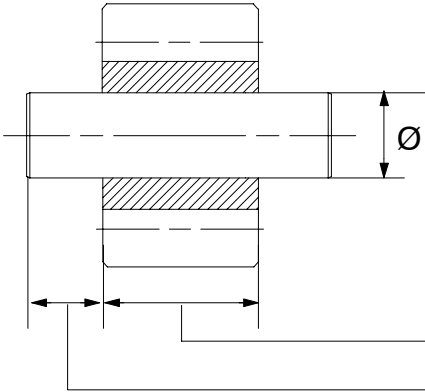
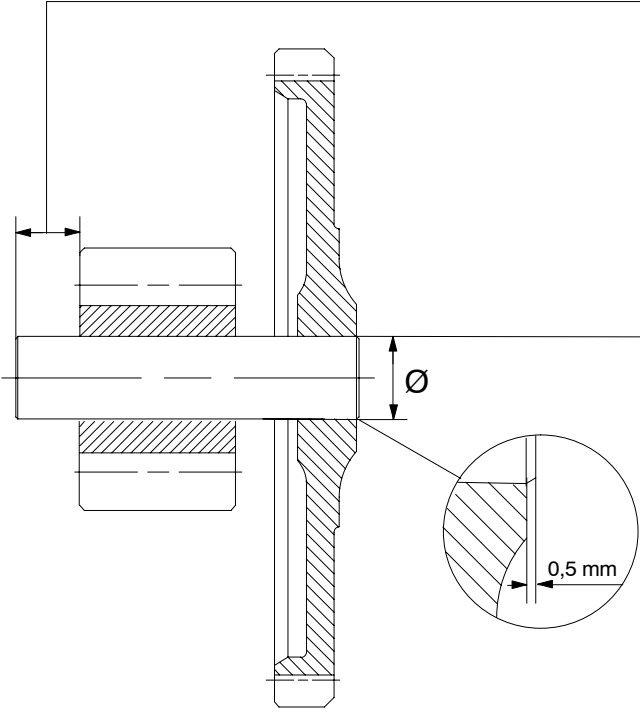
Valve tappet


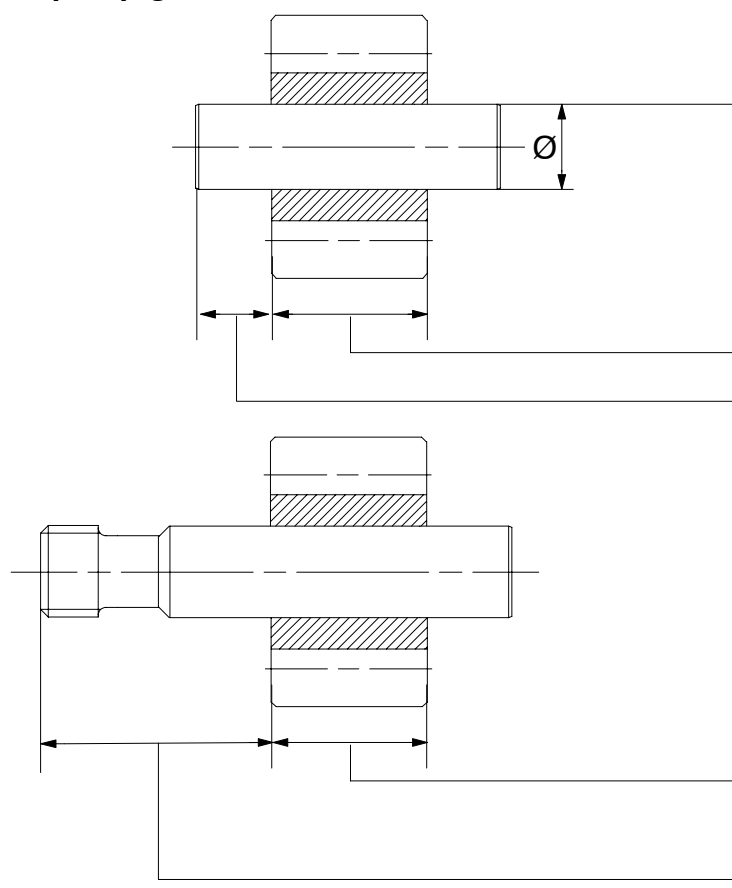
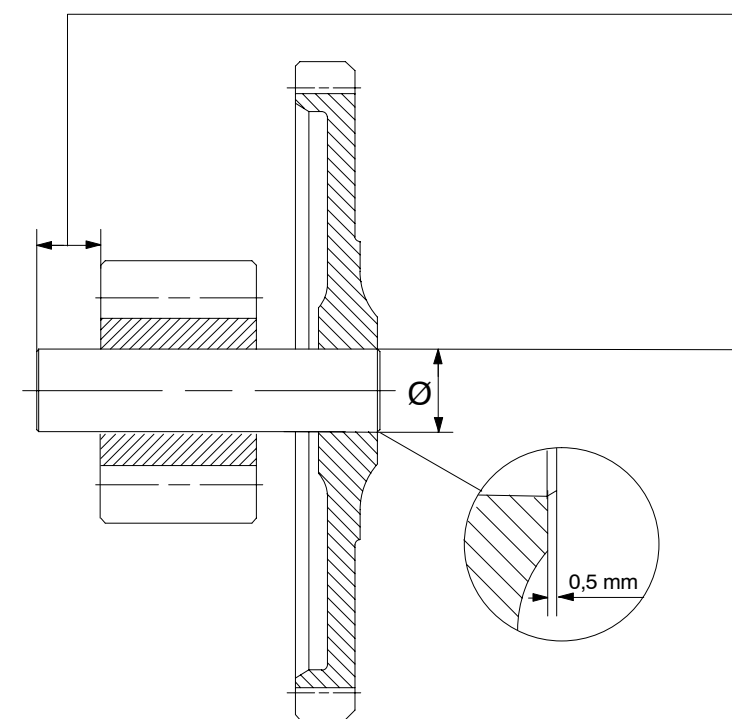


Matching bore in crankcase:
20,000–20,021 mm standard size
20,250–20,271 mm oversize

19,944–19,965 mm standard size
20,194–20,215 mm oversize

| Service Data | Dimensions Limiting values |  |
|---|--|--|
| Oil pump | | |
| Oilpump for deep and flat oil pans (width of gear: 34 mm) | | |
| 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: 34,000–34,039 mm Gear axial clearance: 0,050–0,128 mm 33,911–33,950 mm 14,5 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 | |

| Service Data | Dimensions Limiting values |  |
|---|--|--|
| Oilpump for deep and flat oil pans (width of gear: 43 mm) | | |
| 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 Gear axial play: 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 | |

| Service Data | Dimensions Limiting values |  |
|---|---|--|
| <p>Double oil pump for oil pan, max. ≤ 30 deg.</p> | | |
| <p>Oil pump gear</p>  | <p>Shaft: 17,930–17,940 mm Matching bore in housing: 18,000–18,018 mm Radial clearance: 0,060–0,088 mm</p> <p>Housing depth: 34,000–34,039 mm Radial clearance: 0,050–0,128 mm 33,911–33,950 mm 14,5 mm</p> <p>33,911–33,950 mm</p> <p>40,8–41,0 mm</p> | |
| <p>Drive gear with oil pump gear</p>  | <p>14,5 mm</p> <p>Shaft: 17,930–17,940 mm Bore in drive gear: 17,885–17,870 mm Pressing force: 10000 N</p> <p>Backlash: Drive gear and crankshaft gear: 0,099–0,451 mm</p> | |

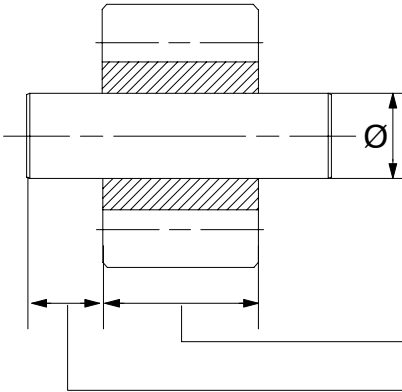
Service Data

Dimensions
Limiting values



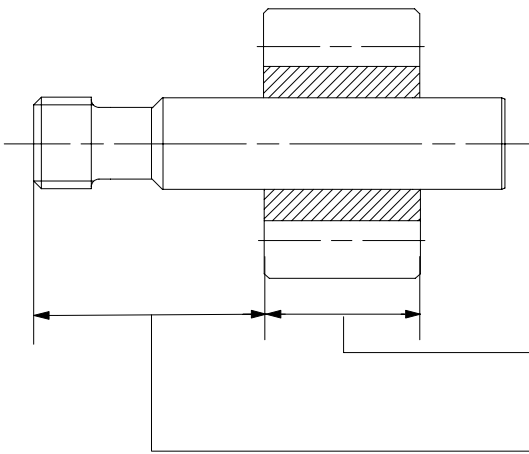
Double oil pump for oil pan, max. ≤ 30 deg.

Oil pump gear




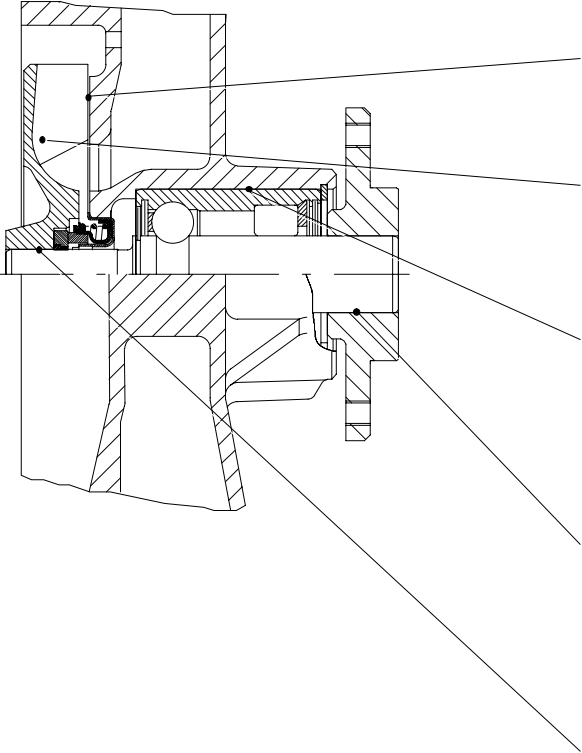
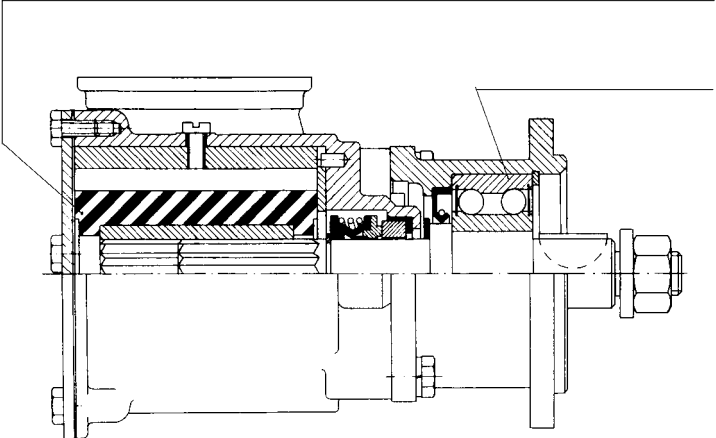
Shaft: 17,93 – 17,94 mm
Matching bore in housing:
18,000–18,018 mm
Radial clearance: 0,060–0,088 mm

Housing depth: 38,000–38,039 mm
Radial clearance: 0,050–0,088 mm
37,911–37,950 mm
14,5 mm



37,911–37,950 mm

40,8–41,0 mm

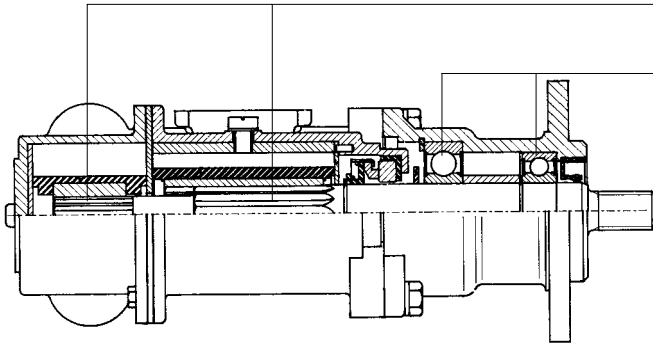
| Service Data | Dimensions Limiting values |  |
|---|--|--|
| Cooling system | | |
| Coolant pump  | <p>gap between housing and impeller: 0,5–0,9 mm</p> <p>Ø impeller: 135,5–136 mm</p> <p>Bearing seat in housing: 54,940–54,970 mm Ø of bearing: 54,981–54,994 mm Interference: 0,011–0,054 mm</p> <p>Hub bore: 25,000–25,021 mm Ø of bearing shaft: 25,048–25,061 mm Interference: 0,027–0,061 mm</p> <p>Bore for bearing shaft in impeller: 16,000–16,018 mm Ø of bearing shaft: 16,045–16,056 mm Interference: 0,027–0,056 mm</p> | |
| Sea water pump (D 2866 LE401 only, up to engine number ... 8120 999)  | <p>If impeller is worn, change it together with seals (treat with an acid-free lubricant and install in turning direction)</p> <p>If wear in bearing can be felt (air in bearing), change the bearing</p> <p>Speed of sea water pump: 1,53 x engine speed (i = 0,65)</p> | |

Service Data

Dimensions
Limiting values



**Sea water pump (D 2866 LE401 only,
engine number and up ... 8121 001)**

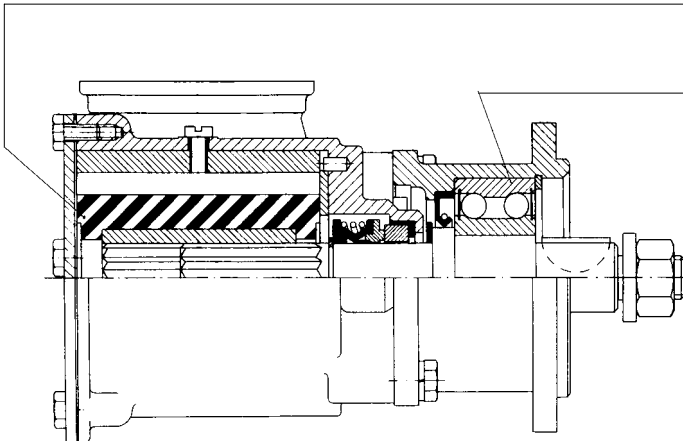


If impeller is worn, change it together with seals (treat with an acid-free lubricant and install in turning direction)

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

Speed of sea water pump:
 $1,53 \times \text{engine speed (i = 0,65)}$

**Sea water pump 51.06500-7026
(D 2876 LE 301 / 403)**



If impeller is worn, change it together with seals (treat with an acid-free lubricant and install in turning direction)

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

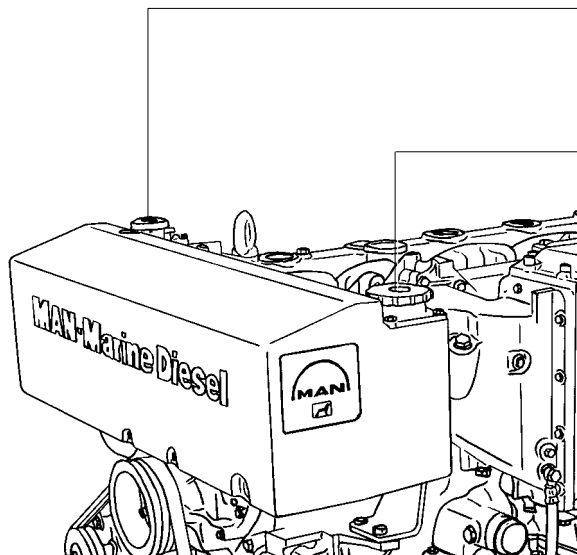
Speed of sea water pump:
 $1,53 \times \text{engine speed (i = 0,65)}$

Service Data

Dimensions
Limiting values



Cover for heat exchanger



Working valve opens at 0,85–1,15 bar above and 0,02–0,08 bar below atmospheric pressure

Filler cap with safety valve:
Safety valve opens at 0,85–1,2 bar above atmospheric pressure (imprint: 1,0), 1,3–1,7 bar above atmospheric pressure (imprint: 1,5 LR1103)

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.

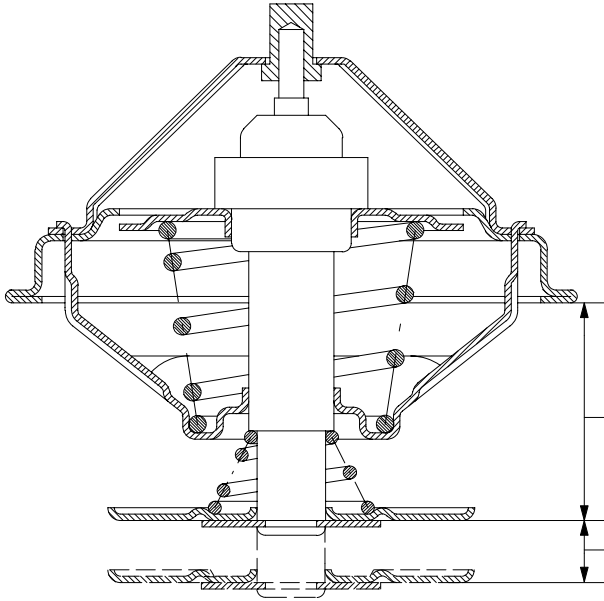
To prevent damage to the engine open this cap only in exceptional circumstances and fit a new one as soon as possible.

Service Data

Dimensions
Limiting values



Thermostat for D 2866 LXE

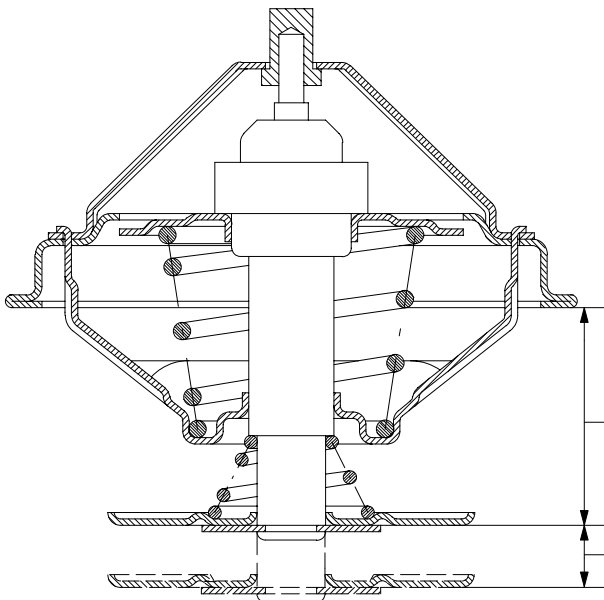


Opening begins at: 79 °C ($\pm 2^\circ$)
Fully open: 94 °C

24,5–25,8 mm

Lift at least 8 mm at 94 °C

Thermostat for D 2866 LE 4.. D 2876 LE 301 / 403



up to engine number ... 8515 999
Opening begins at: 71 °C ($\pm 2^\circ$)
Fully open: 86 °C

engine number and up ... 8516 001
Opening begins at: 83 °C ($\pm 2^\circ$)
Fully open: 95 °C

24,5–25,8 mm

Lift at least 8 mm at 86 °C

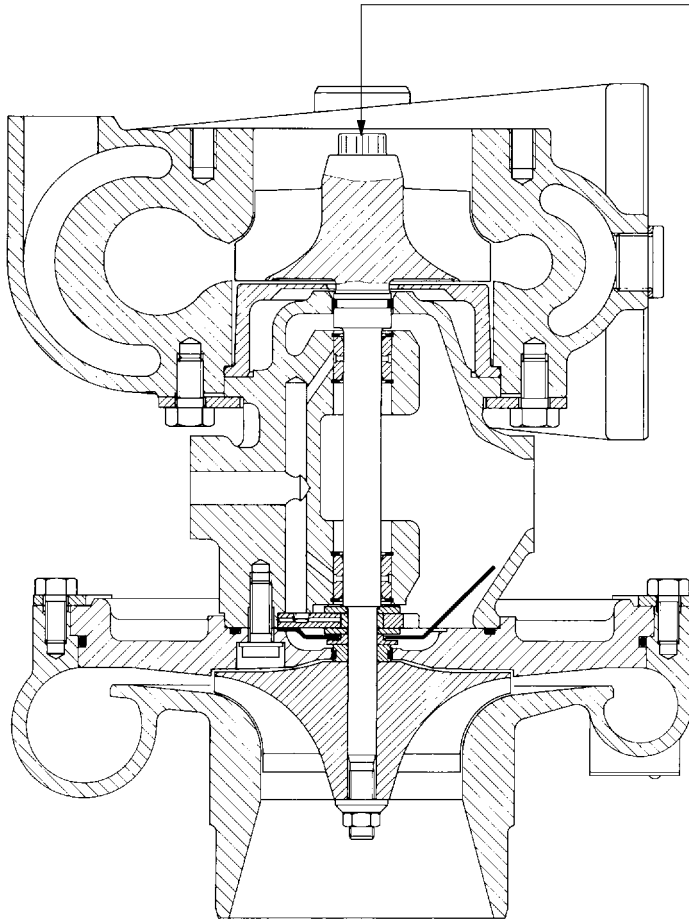
Service Data

Dimensions
Limiting values



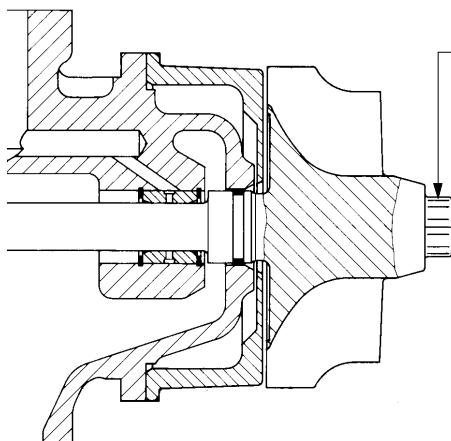
Turbocharger

Axial clearance



Max. axial clearance: max. 0,16 mm
for turbochargers KKK K36
and all engines D 2866 LXE / LE4...,
D 2876 LE 301 / 403

Radial clearance



Max. radial clearance: 0,58 mm

for turbochargers KKK K36
and all engines D 2866 LXE / LE4...,
D 2876 LE 301 / 403

Service Data

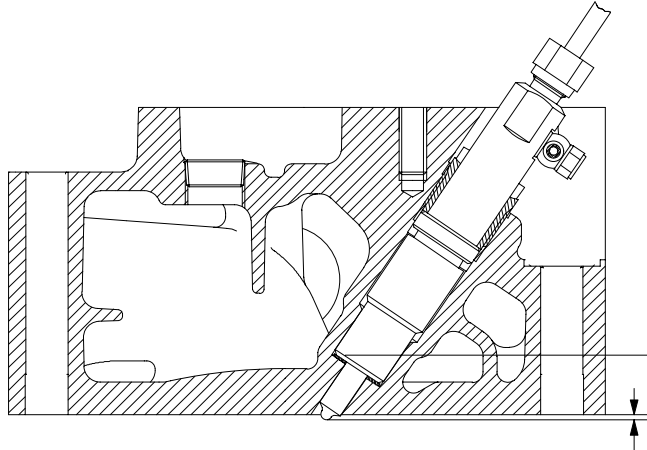
Dimensions
Limiting values



Injection nozzles

Projection above cylinder head contact surfaces

for nozzle DLLA 136 S 1002 with injector KDAL 80 S41

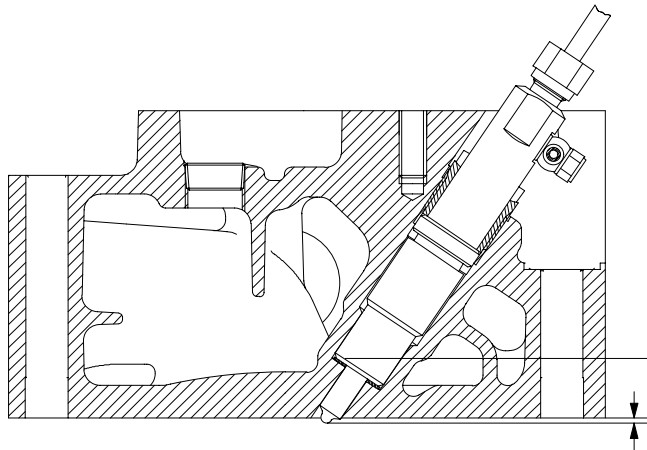


Eliminate nozzle protrusion by using Cu sealing rings of different thickness. These sealing rings are available in thicknesses of 0,5 / 1,0 / 1,5 / 2,0 / 2,5 / 3,0 mm

1,76–2,59 mm

Projection above cylinder head contact surfaces

for nozzle DLLA 146 P 166 with injector KDEL 82 P7 and nozzle DLLA 152 P 486 with injector KDEL 82 P30



Eliminate 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

Service Data



Injectors

| Engine model | Type of injector nozzle (Bosch) | Discharge pressure (bar) Injector new / run | Number of holes / hole Ø |
|---|---------------------------------|--|--------------------------|
| D 2866 LXE up to engine number ... 6876 999 | DLLA 136 S 1002 | 220 (+8) / 220 (+8) | 4 / 0,43 mm |
| D 2866 LXE engine number and up ... 6877 001 | DLLA 146 P 166 | 295 (+8) / 280 (+8) | 4 / 0,412 mm |
| D 2866 LE4.. up to engine number ... 8580 999 | DLLA 152 P 486 | 340 (+10) / 320 (+10) | 6 / 0,346 mm |
| D 2866 LE4.. engine number and up ... 8581 001 | DLLA 152 P 486+ | 340 (+10) / 320 (+10) | 6 / 0,346 mm |
| D 2876 LE301 / 403 | DLLA 152 P 486+ | 340 (+10) / 320 (+10) | 6 / 0,346 mm |

Injector for nozzle DLLA 136 S 1002: KDAL 80 S41
 Injector for nozzle DLLA 146 P 166: KDEL 82 P7
 Injector for nozzle DLLA 152 P 486: KDEL 82 P30

Service Data



Start of delivery (marine propulsion engines)

| Model | Start of delivery / deg. before TDC |
|--|-------------------------------------|
| D 2866 LXE (324 kW / 2200 1/min) up to engine number ... 6876 999 | 15 |
| D 2866 LXE (324 kW / 2200 1/min) engine number and up ... 6877 001 | 24 |
| D 2866 LXE (250 kW / 1800 1/min) | 19 |
| D 2866 LXE (279 kW / 1800 1/min) | 19 |
| D 2866 LXE (294 kW / 2100 1/min) | 20 |
| D 2866 LXE (300 kW / 2200 1/min) | 24 |
| D 2866 LE401 (441 kW / 2200 1/min) | 18±0,5 |
| D 2866 LE402 (368 kW / 2200 1/min) | 18±0,5 |
| D 2866 LE403 (368 kW / 2100 1/min) | 14±0,5 |
| D 2866 LE405 (449 kW / 2200 1/min) | 19±0,5 |
| D 2876 LE403 (331 kW / 1800 1/min) | 14 |

Start of delivery (Auxiliary marine engines)

| | |
|---|----|
| D 2866 LXE (constant speed 1500 1/min) | 17 |
| D 2866 LXE (constant speed 1800 1/min) | 17 |
| D 2876 LE 301 (constant speed 1500 1/min) | 13 |
| D 2876 LE 301 (constant speed 1800 1/min) | 15 |

Service Data



Injection pumps and governors

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

Marine propulsion engines


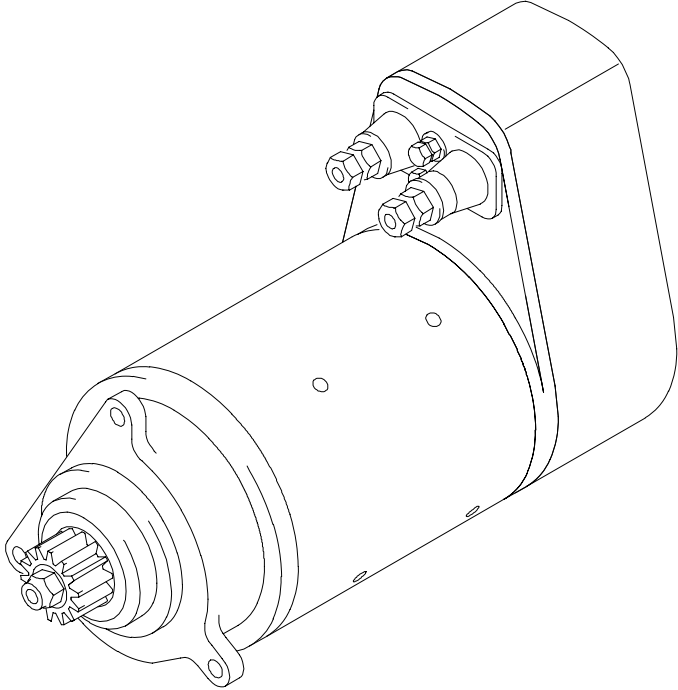
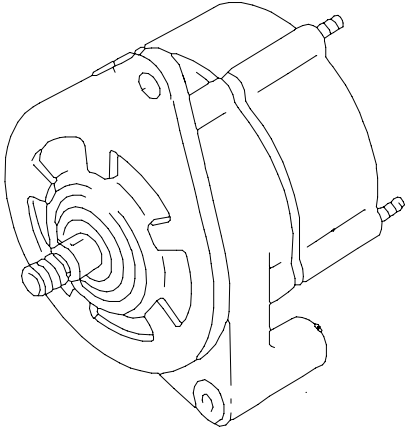
| Engine model | Injection pump | Governor |
|--|---|--|
| D 2866 LXE P = 324 kW / 2200 1/min up to engine number ... 6876 999 ... | PES 6 P120 A 720 LV16500 or PES 6 P120 A 720 LS3167 | RQV 300-1100 PAV 17449 or RQV 300-1100 PA 667-2 |
| D 2866 LXE P = 324 kW / 2200 1/min engine number and up ... 6877 001 | PES 6 P120 A 720 LV18994 or PES 6 P120 A 720 LS7209-1 | RQV 300-1100 PAV 20433K or RQV 300-1100 PA 1006K |
| D 2866 LXE P = 250 kW / 1800 1/min | PES 6 P120 A 720 LV18994 or PES 6 P120 A 720 LS7209-1 | RQV 300-1100 PAV 20796K |
| D 2866 LXE P = 279 kW / 1800 1/min | PES 6 P120 A 720 LV18994 or PES 6 P120 A 720 LS7209-1 | RQV 300-1100 PAV 20636K |
| D 2866 LXE P = 294 kW / 2100 1/min | PES 6 P120 A 720 LV18994 or PES 6 P120 A 720 LS7209-1 | RQV 300-1100 PAV 20637K |
| D 2866 LXE P = 300 kW / 2200 1/min | PES 6 P120 A 720 LV18994 or PES 6 P120 A 720 LS7209-1 | RQV 300-1100 PAV 20794K |
| D 2866 LE401 / LE403 | PES 6 R120 720 LS 1505 | RQV 300-1100 R3K |
| D 2866 LE402 P = 368 kW / 2200 1/min | PES 6 P120 A 720 LS7209-3 | RQV 300-1000 PA 1006-2K |
| D 2866 LE405 P = 368 kW / 2200 1/min | PES 6 P120 A 720 LS1505-1 | RQV 300-1000 R3K |
| D 2876 LE403 P = 331 kW / 1800 1/min | PES 6 R120 / 720 LV | RQV 300-900 RV |

Service Data



Auxiliary marine engines at constant speed

| | | |
|---|---|---|
| D 2866 LXE P = 215 kW / 1500 1/min | PES 6 P120 A 720 LV18899 or PES 6 P120 A 720 LS7244 | RQ 750 PAV 20594 or RQ 750 PA 981-1 |
| D 2866 LXE P = 245 kW / 1800 1/min | PES 6 P120 A 720 LV18899 or PES 6 P120 A 720 LS7244 | RQ 900 PAV 20595 |
| D 2866 LXE P = 244 kW / 1500 1/min | PES 6 P120 A 720 LV18899 or PES 6 P120 A 720 LS7244 | RQ 750 PAV 20594 or RQ 750 PA 981-1 |
| D 2866 LXE P = 280 kW / 1800 1/min | PES 6 P120 A 720 LV18899 or PES 6 P120 A 720 LS7244 | RQ 900 PAV 20595 |
| D 2876 LE301 P = 345 kW / 1500 1/min | PES 6 R120 / 700 LS 1520 | GAC |
| D 2876 LE301 P = 390 kW / 1800 1/min | PES 6 R120 / 700 LS 1520 | GAC |

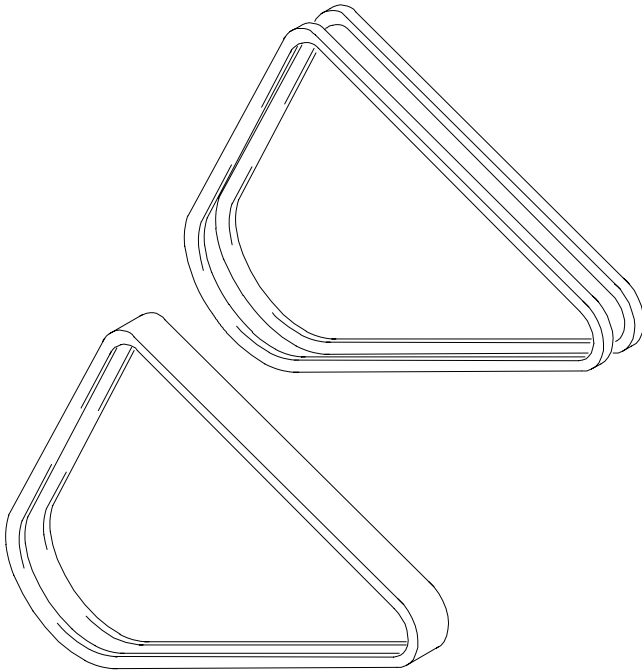
| Service Data | Dimensions Limiting values |  |
|---|--|--|
| Starter | | |
|  | <p> Manufacturer: Bosch Type: KB Operation: sliding-gear type </p> <p> Starter pinion: Number of teeth: 9 Modulus: 3 </p> <p> Output: 5,4 kW Voltage: 24 V </p> | |
| Alternator | | |
|  | <p> Manufacturer: Bosch Type: N1 Design: 2-pole, insulated Operation: Threephase current Voltage: 28V Max. current: 55A </p> <p>or (optional equipment)</p> <p> Manufacturer: Bosch Type: T1 Design: 2-pole, insulated Operation: Threephase current Voltage: 28V Max. current: 85A </p> <p>or (optional equipment)</p> <p> Manufacturer: Bosch Type: T1 Design: 2-pole, insulated Operation: Threephase current Voltage: 28V Max. current: 120A </p> | |

Service Data

Dimensions
Limiting values



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 | |
| 12,5 | 50-55 | 45-50 | 35 |
| 2/3VX | 90-100 | 70-80 | 60 |

Retightening cylinder head bolts on new engines

(engine cold or warm)

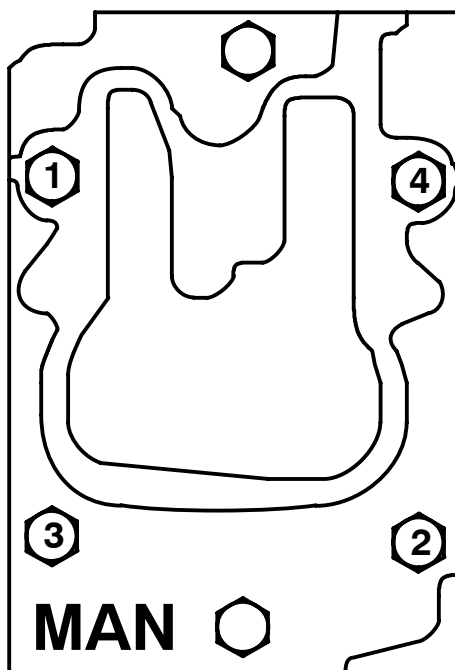
in accordance with SI 88 05 20/0

Erster Nachzug der Zylinderkopfschrauben erledigt gemäß SI 88 05 20/0

First retightening of cylinder-head-bolts completed according to SI 88 05 20/0

Spare part No. 51.97801-0211

Intake side / injector



Exhaust side

Tightening diagram "1"

Zweiter Nachzug der Zylinderkopfschrauben erledigt gemäß SI 88 05 20/0

Second retightening of cylinder-head-bolts completed according to SI 88 05 20/0

Spare part No. 51.97801-0212

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.



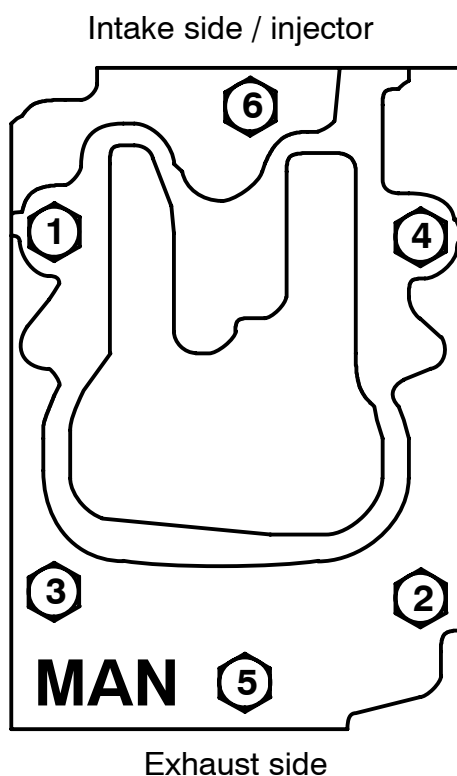
Note:

The cylinder head bolts to be retightened must not be loosened first, but simply tightened by a further 90° (1/4 revolution) from their actual position.

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)

in accordance with SI 88 05 20/0



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 MoS₂. 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 actual 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.

Tightening torque guide values



Note: All screws and bolts not listed in the following table must be tightened according to the guiding values of MAN works standard M 3059.

Apply a light film of oil to all screws and bolts before they are fitted!

Plugs

DIN 908

| | |
|----------------------------|--------|
| M14 x 1,5, M16 x 1,5 | 80 Nm |
| M18 x 1,5, M22 x 1,5 | 100 Nm |
| M24 x 1,5, M26 x 1,5 | 120 Nm |
| M30 x 1,5 | 150 Nm |

DIN 7604

| | |
|---------------------------|-------|
| AM10 x 1, M12 x 1,5 | 50 Nm |
| AM14 x 1,5 | 80 Nm |

Crankcase, crankshaft assembly

| | |
|---|-------------|
| Engine mounting to crankcase M14, 12.9 | 225 Nm |
| Timing case to crankcase M10, 12.9 | 75 Nm |
| Thrust washer to timing case M8, 12.9 | 40 Nm |
| Crankshaft bearing caps to crankcase M18 x 2 | |
| initial torque | 300–330 Nm |
| rotation angle | 90–100° |
| Counterweight to crankshaft M16 x 1,5 | |
| initial torque | 100–110 Nm |
| rotation angle | 90–100° |
| Vibration damper hub to crankshaft M16 x 1,5, 10.9 | 260 Nm |
| Crankshaft extension for power take-off at front | |
| Hex bolt M16 x 1,5, 12.9 | 350 Nm |
| Crankshaft extension for power take-off at front, Collar bolt M16 x 1,5 | |
| initial torque | 200 Nm |
| rotation angle | 90° |
| Flywheel to crankshaft M16 x 1,5 | |
| initial torque | 250–260 Nm |
| rotation angle | 90–100° |
| Connecting rod bearing caps M16 x 1,5 | |
| initial torque | 100–110 Nm |
| rotation angle | 90 bis 100° |

Cylinder head

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

Tightening torque guide values



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

| | |
|---|------------|
| Injection pump drive gear M8, 12.9 | 38 Nm |
| 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 timer 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 |

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 |



| | | | |
|----------------------------------|------------|--------------------------------------|------------------------|
| A | | O | |
| Alternator | 45 | Oil pump | 31 |
| C | | P | |
| Camshaft | 30 | Piston | 20 |
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**MAN Nutzfahrzeuge Aktiengesellschaft
Geschäftseinheit Motoren**

**Vogelweiherstraße 33
D-90441 Nürnberg**

Printed in Germany

51.99493-8402