MAK

C

M281 - M332C

Engine data

Stroke: 281 / 282	280	mm
Stroke: 331 / 332 / 332C	330	mm
Bore: 281 - 332C	240	mm
Speed: 281	720-750	rpm
Speed: 282	750-1000	rpm
Speed: 331 / 332C	720-900	rpm

Number of cylinders: 281 / 282
6 / 8 / 12

Number of cylinders: 332 / 332C
6 / 8

Main bearing
M281 - M332C

Inside Ø:	180	mm
Outside Ø:	192	mm

Big end bearing
M282 - M332C / 8 M281

Inside Ø:	170	mm
Outside Ø:	180	mm

6 M281

Inside Ø:	160	mm
Outside Ø:	170	mm

Engine operating data
Temperatures
Lub. oil
M282 - M332C

Inlet:	50 - 55	°C
Stationary engines	50 - 60	°c
Temperature rise:	6 - 10	°C *1

Lub. oil
M281 - M331

Inlet:	60 - 70	°C
Temperature rise:	6 - 10	°C *1

Engine operating data
Temperatures
Fresh water circulation cooling
M282 - M332C

Outlet:	80 - 85	°C
Temperature rise:	7 - 10	°C *1

M281 - M331

Outlet:	65 - 70	°C
Temperature rise:	7 - 10	°C

Charge air
M282 - M332C

Inlet:	45 - 60	°C

M281 - M331

Inlet:	70 - 80	°C

Pressures
M332C

Lub. oil	4.0 - 4.5	bar*2

M281 - 332

Lub. oil	4.0 - 4.5	bar*2

Fresh water circulation cooling:

M281 - M332C	2.5 - 5.0	bar

Nozzle cooling:

M281 - M332C	1.5 - 3.0	bar

Fuel pressure before injection pumps:

MDO	1.5 - 3.0	bar
HFO	4.0 - 5.0	bar

*1 = at nominal output

*2 = at nominal engine speed

Cylinder head

In-line engine M281 - M331

Vee-engine M281 - M282

The tightening torque for inserting the tie bolts is →
Molykote

M = 250 Nm

Cylinder head nuts
1st step →
Pretorque

M = 50 Nm

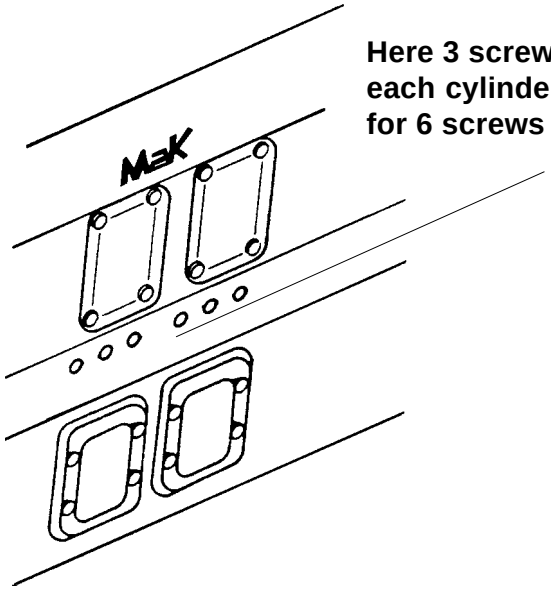
2nd step for 3 screws
(sketch) tighten with →

Dw = 200°

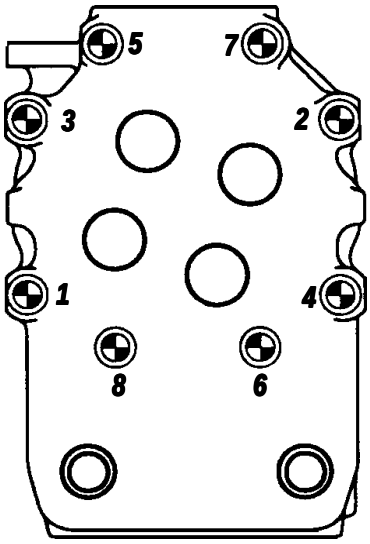
2nd step for 6 screws
(sketch) tighten with →
Oil

Dw = 240°

Tightening to the final torque step by step in the order: 1 - 2 3 - 4 5 - 6 7 - 8



Here 3 screws for each cylinder 200°, for 6 screws 240°



Later engines of the types M281 - M332 are equipped with the same engine housings as the type M332C so that the tightening torque of the type M332C is applicable. In case of doubt procced acc. to operating instructions.

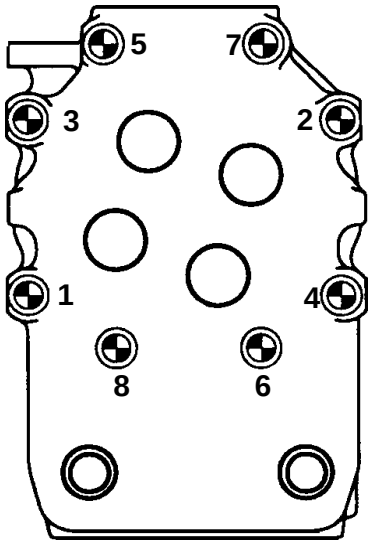
Cylinder head

In-line engine M281 - M332C

Vee-engine M281 - M282

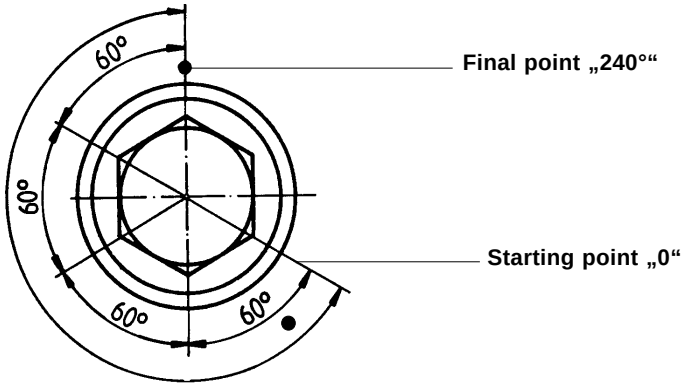
The tightening torque for inserting the tie bolts is → **M = 250 ± 25 Nm**
Molykote

1. Tighten nuts by hand with a pin **(approx. 50 Nm)**. Mark the cap nut position of a hexagon edge on the cylinder head.
2. Tighten nuts in the same sequence as shown in the sketch in 4 steps with → each. ***(4 hexagons) Oil***



Dw = 60°

Older engines have different tightening torques that cannot be clearly assigned to the respective engines. In case of doubt, tighten acc. to the value of the operating instructions.



Valve rocker

The studs for the valve rocker bracket are inserted in the cylinder head with Loctite.
The nuts **- 1 -** for the valve rocker bracket are tightened in 3 steps.

1st step → **M = 30 Nm**

2nd step → **M = 60 Nm**

3rd step → **M = 100 Nm**
Oil

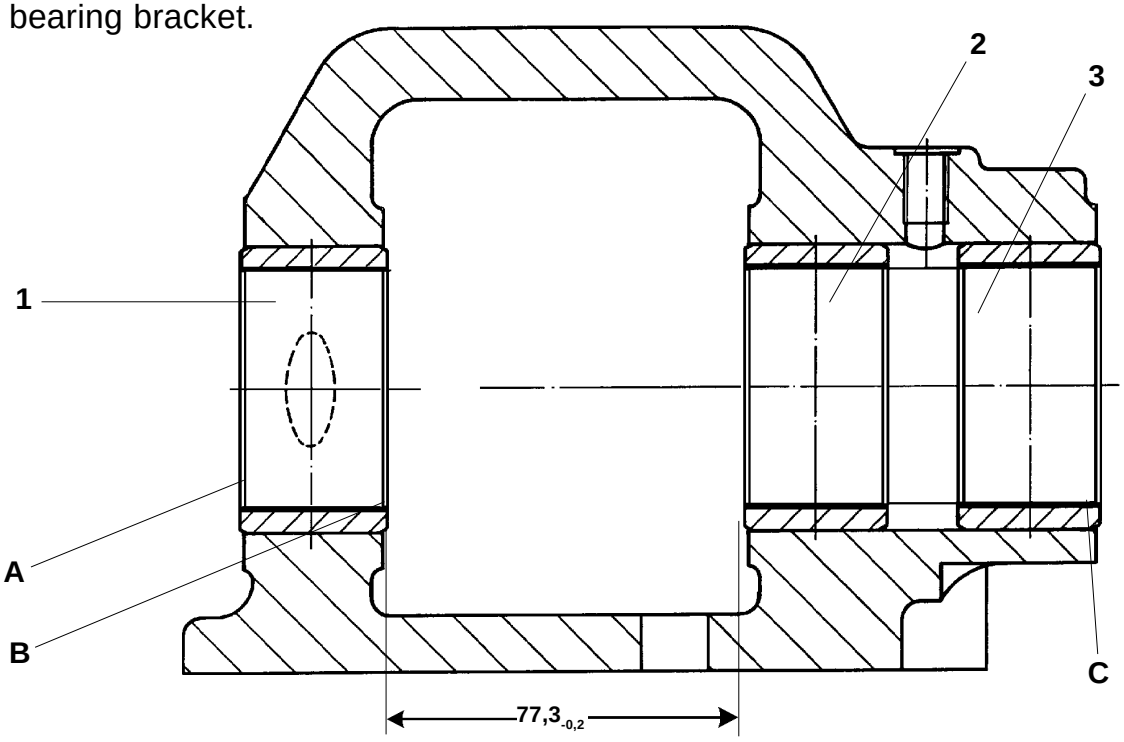
Cylinder head

In-line engine M281 - M332C

Vee-engine M282

Bearing bracket

Undercool the bushes **- 1 -, - 2 - and - 3 -** in liquid nitrogen before inserting them in the bearing bracket.

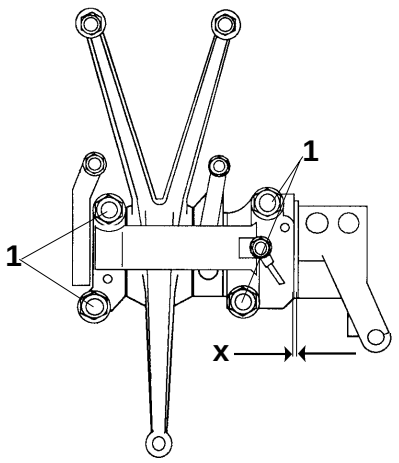


After freezing-in the reference dimension of the three bushes is **Ø** →

49.980 + 0.054 **mm**

At **- A -, - B - and - C -** the bushes must recede by → **0.50 mm**

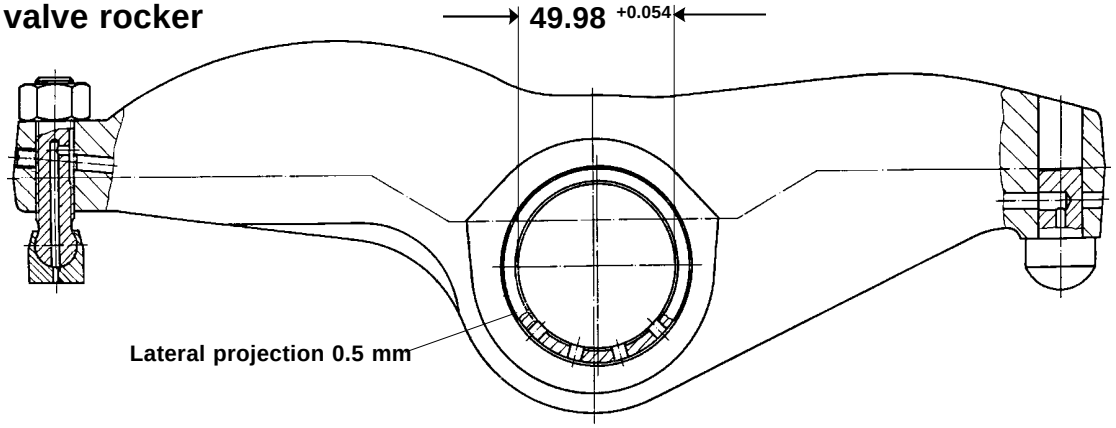
The clearance between bearing bracket and inlet valve rocker is →



0.20 mm

Cylinder head

Inlet valve rocker



In-line engine M281 - M331	Vee-engine M281

Valve clearance →

0.40	mm

Valve clearance the same with cold or hot engine.

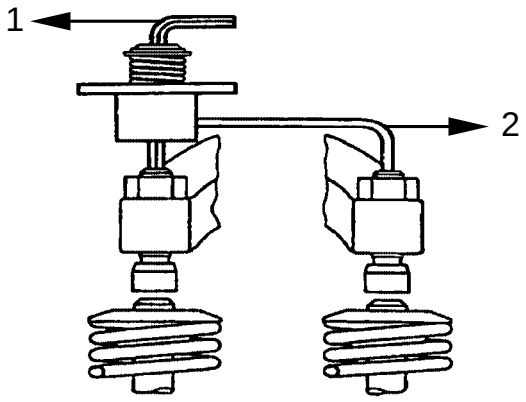
In-line engine M282 - M332C	Vee-engine M282

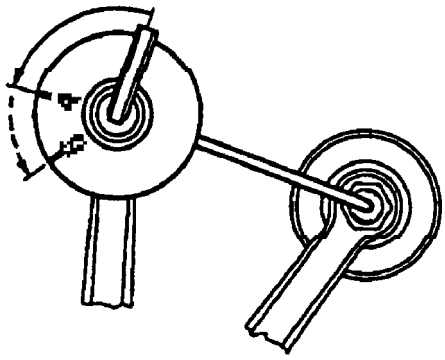
Valve clearance

Setting

1. Mount valve clearance adjuster. Insert Allen key **- 1 -** with bar **- 2 -** in the hexagonal recesses of the adjacent set screws of the inlet and exhaust valves.

2. Loosen counter nut, turn valve set screw by means of Allen key against valve. ***(Valve clearance = 0)***





Cylinder head

3. Turn 0-marking of the washer in coincidence with Allen key. (Starting position of the valve clearance setting.)

4. Keep valve clearance adjuster exactly in position, turn Allen key into:

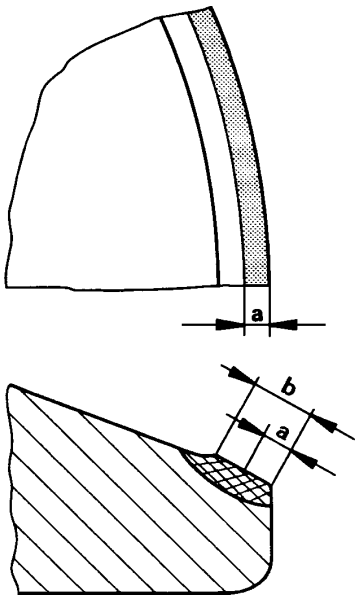
   position **„4“ = 0.4 mm** for inlet

   position **„6“ = 0.6 mm** for exhaust and lock valve clearance set screw by counter nut.
   Adjustment approx. 15 minutes after stopping the engine.

In-line engine M281 - M332C

Vee-engine M281 - M282

Valve stem, grinding



Apply small dots of the diamond paste Dp 30/10-15 my with a syringe to the seat surface of the new or remachined valve cone and distribute the paste equally. Thereafter the seat ring surface is to be sprayed with a thinner (F25) belonging to the diamond paste, for dilution and in order to increase the grip. Insert the oiled valve stem into the guide bush. Fasten the device to the valve head and grind the valve face and seat by hand applying a moderate pressure, rotating the device. The contact reflection **" a "** which is visible by the smooth grinding process shall be at least **30 %** of the seat width starting from the outside diameter. If the bearing characteristics described above are not reached, remachining of both sealing surfaces is necessary. After machining both seats have to be checked with a luminous magnifier. The fillet must not be refinished.
After machining round off the outside edge with a stone.
At " X " there is the separating line - base material - armoring.

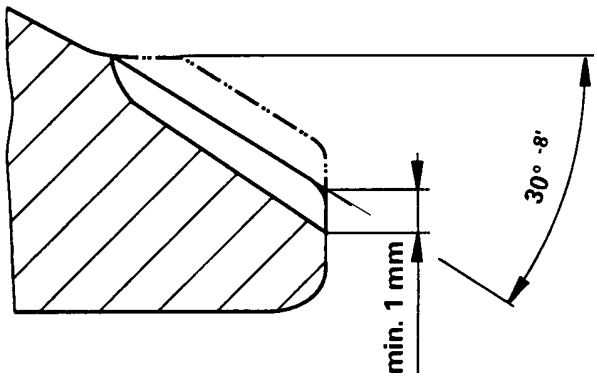
Cylinder head

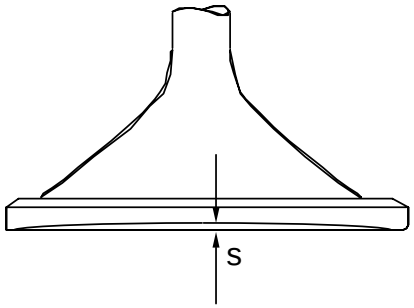
In-line engine M281 - M332C

Vee-engine M282

Not reusable are valve stems with:

1. Damages at the valve cone surface (cracks, blow-bys).
2. Corrosive abrasion of **> 2 %** from the plate diameter.
3. High-temperature corrosion **"S"** at the valve plate bottom of **> 1.5 mm** (sketch).
4. Extreme coarse pittings at the valveplate bottom (like paving stones).
5. Corrosion pits and mechanical damages in the area of the valve shaft, passage and valve plate.
6. Excess of the limit size for refinishing.





Inlet and exhaust valve stem
Measuring distance **- S -** →

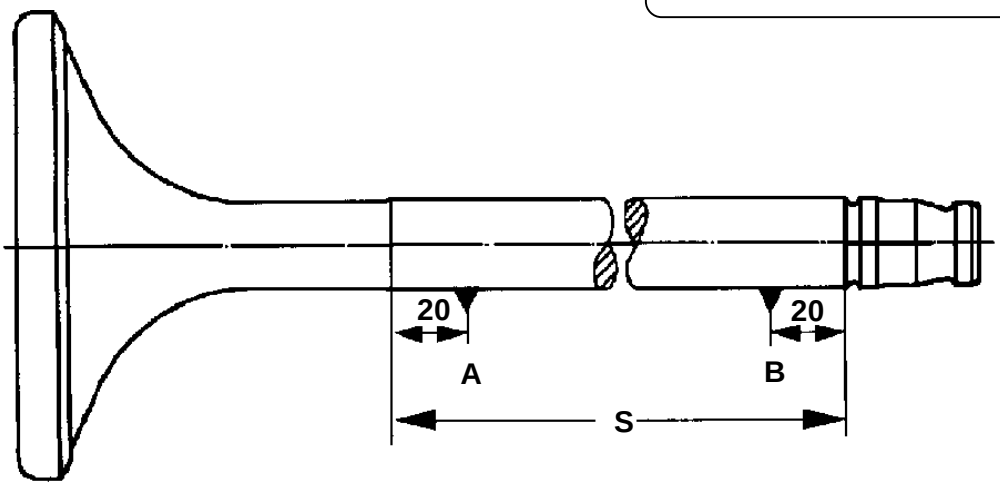
180.50	**mm**

At the below measuring distance and supporting points in **" A "** and **" B "** the eccentricity on the valve shaft must not exceed →

0.30	**mm**

The eccentricity on the valve cone must not exceed →

0.02	**mm**



Cylinder head

Valve seat rings
Fitting sequence:

1. Heat up cylinder head to **120 ° - 125 ° C**.

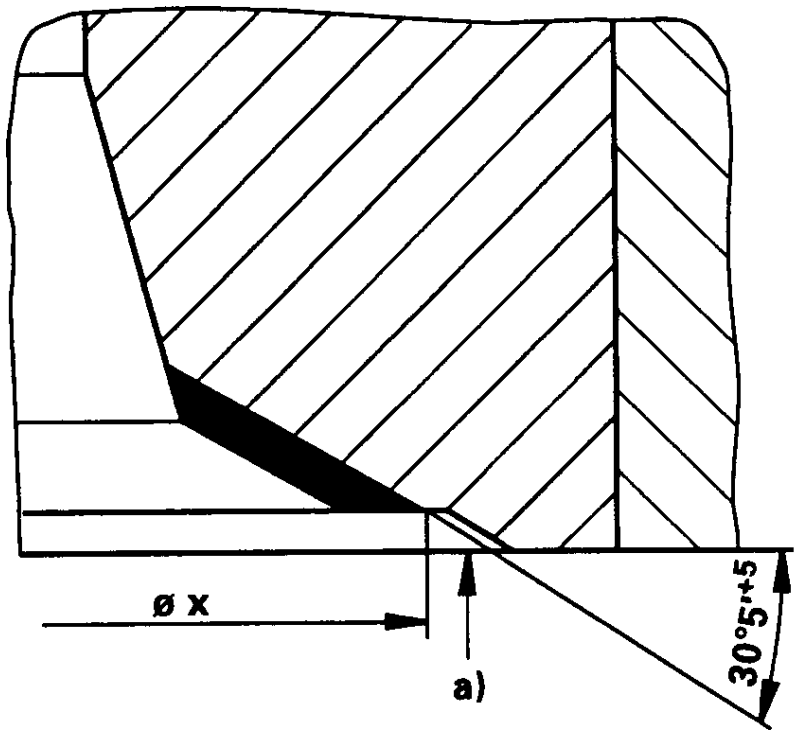
2. Undercool exhaust valve seat ring to **- 195 °C** before inserting it.

3. Insert inlet valve seat ring **without** undercooling.

4. After tight fit of the valve seat rings fasten by hold-down **1.20.7-92.22.00-08** for a short time.
   Tighten nut of the hold-down with → **M = 100 Nm**

   There must not be an air gap between the valve seat rings and the cylinder head with cold engine.

   When refinishing the valve seats, the dimensions as stated in the sketch are to be strictly observed.
   Dimension **Ø „x“** for refinishing = **81 mm.** At **„a“** no material may be taken off.

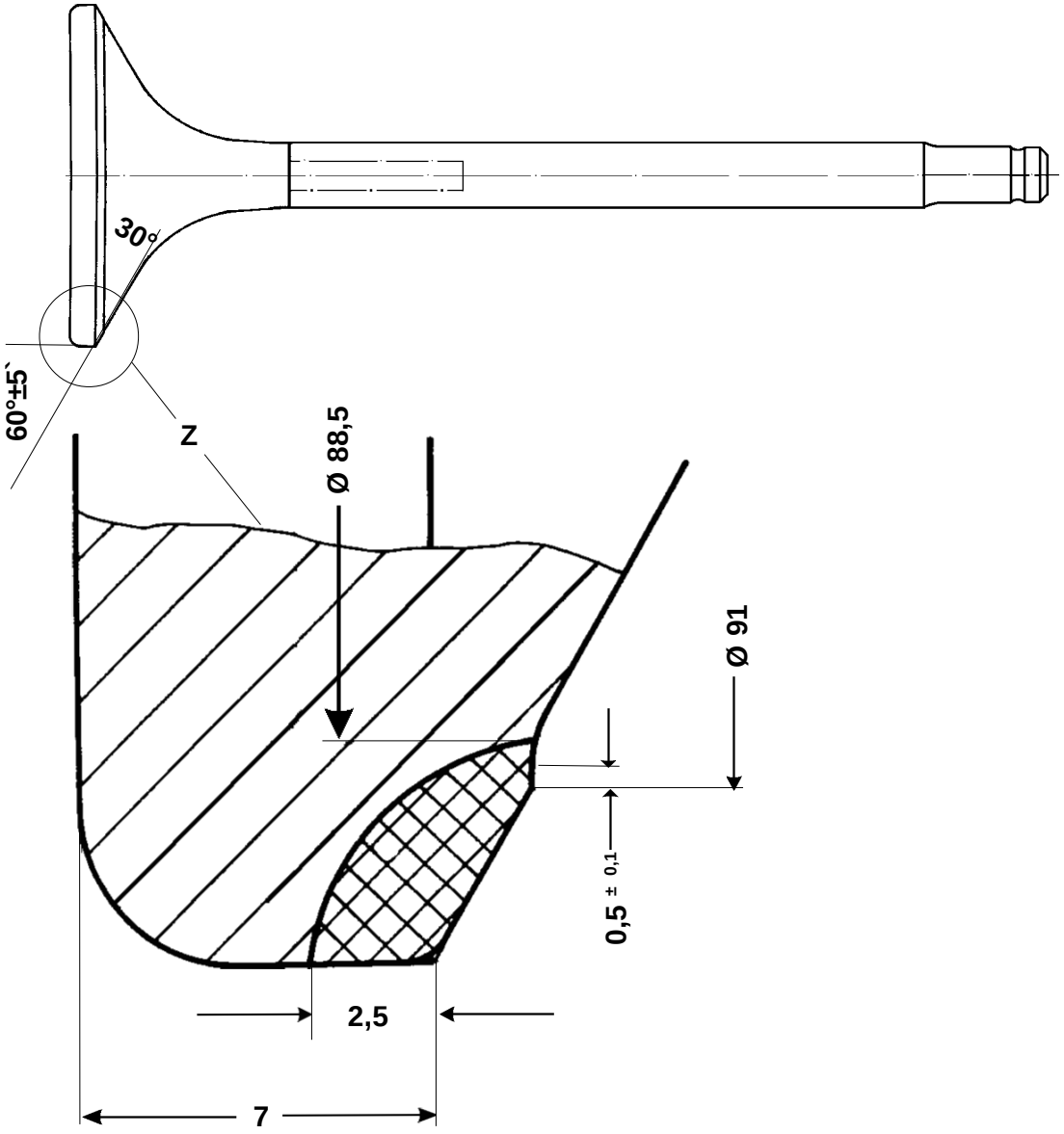


Cylinder head

In-line engine M281 - M331

Vee-engine M281

Rework valve stem



Cylinder head

In-line engine M281 - M331

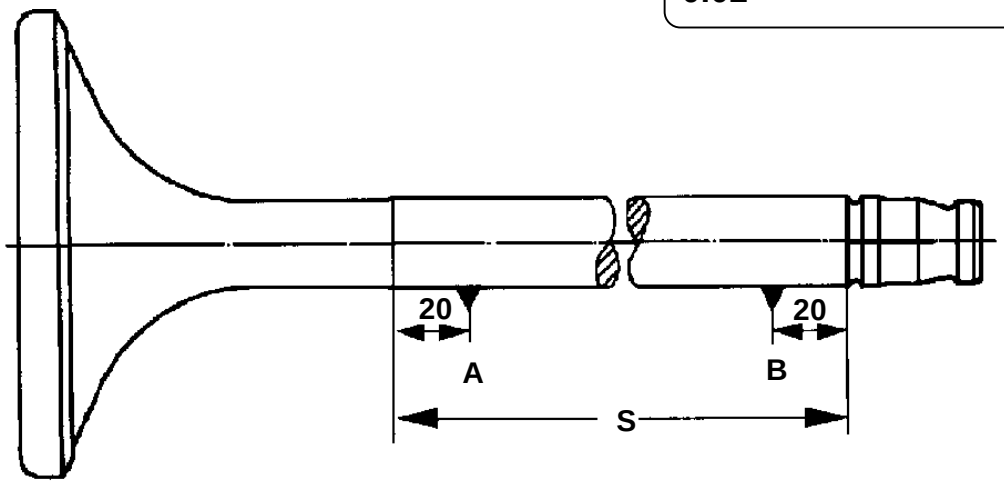
Vee-engine M281

Inlet and exhaust valve stem

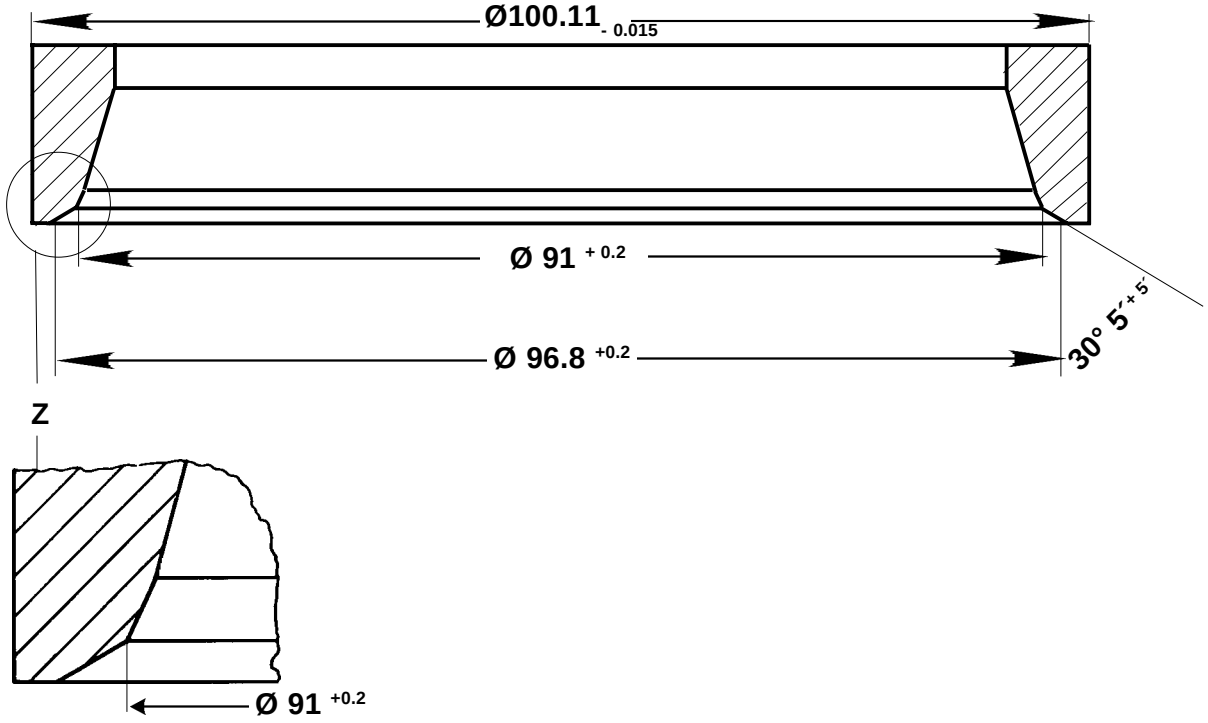
Measuring distance **- S -** → **141.50 mm**

At the below measuring distance and supporting points in **" A "** and **" B "** the eccentricity on the valve shaft must not exceed → **0.03 mm**

The eccentricity of the valve cone must not exceed → **0.02 mm**



Rework valve seat ring



Cylinder head

In-line engine M281 - M332C

Vee-engine M281 - M282

Fuel injection valve

Tighten nut **M16** with → **M = 90 Nm**
Oil

Tighten nuts **M12** with → **M = 40 Nm**
Oil

Tighten nozzle nut with → **M = 150 ± 10 Nm**
Oil

Charge air line

Tighten screws to cylinder head with → **M = 78 Nm**
Oil
Screws M12 x 30 DIN912

Piston

In-line engine M282 - M332C

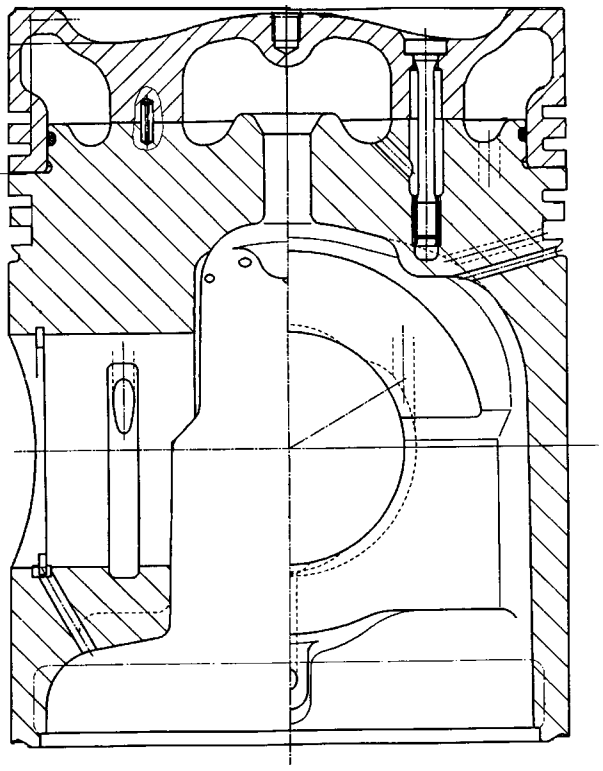
Vee-engine M282

1.20.6-26.70.00-01 / -02 / -03 / -05 / -06 and 1.30.6-26.70.00-01 / -02 / -03 / -50
Coat thread with paste „Molykote G-n“, screw head contact surface with „Led-Plate 250F“.

1. Tighten screws crosswise with → **M = 22 Nm**
2. Loosen screws once more.
3. Pretighten screws crosswise with → and tighten them with → **M = 10 Nm**

Dw = 45°

Check ! At → the screws must not be detachable. **M = 22 Nm**



Replace screws of the variants 1.20.6-26.70.00-01/-02/-03/-05 and 1.30.6-26.70.00-01/-02/-03/-50 as soon as the total length exceeds 67.50 mm.

Replace screws of the variants 1.30.6-26.70.00-05/-06/ as soon as the total length exceeds 84.50 mm.

The variant **1.20.6-26.70.00-05 / -06** and **1.30.7-26.70.00-05/-06** must have a clearance of **0.04 - 0.08 mm** at **- 1 -**. The piston screws are not tightened during measurement.

1.20.6-26.70.00-01 / -02 / -03 / -05 / -06 -	***M282 engines***
1.30.6-26.70.00-50 -	***M331 engines***
1.30.6-26.70.00-01 / -02 / -03 -	***M332 engines***
1.30.6-26.70.00-05 / -06 -	***M332C engines***

Piston

Ring grooves, wear limits

Piston **1.20.6-26.30.01-01 / -02 / -03 / -04 / -05 / -06 / -07 / -08**
1.20.6-26.40.01-02 / -03 / -04 / -05 / -06 / -07 / -08 / -09 / -10 / -11 / -12 / -13 / -14 / -15
1.20.6-26.60.01-02 / -03 **1.30.6-26.30.01-51 / -52**
1.30.6-26.70.00-50 **1.30.6-26.60.01-01 / -02**
1.30.6-26.70.00-01 / -02 / -03

Grooves	Grooves height	Ring height	Wear limit	Limit clearance
1	5,08 $^{+0,02}$	4,99 $_{-0,022}$	5,50	0,60
2	5,04 $^{+0,02}$	4,99 $_{-0,022}$	5,50	0,60
3	5,04 $^{+0,02}$	4,99 $_{-0,012}$	5,50	0,60
4	5,04 $^{+0,02}$	4,99 $_{-0,012}$	5,50	0,60
5	8,02 $^{+0,02}$	7,987 $_{-0,015}$	8,50	0,50

Piston **1.20.6-26.60.01-05 / -06**
1.20.6-26.70.00-01 / -02 / -03

Grooves	Grooves height	Ring height	Wear limit	Limit clearance
1	5,08 $^{+0,02}$	4,95 $_{-0,02}$	5,50	0,60
2	5,04 $^{+0,02}$	4,95 $_{-0,02}$	5,50	0,60
3	5,04 $^{+0,02}$	4,95 $_{-0,02}$	5,50	0,60
4	8,04 $^{+0,02}$	7,987 $_{-0,015}$	8,50	0,50

Piston

Ring grooves, wear limits

Piston **1.20.6-26.70.00-05**
1.30.6-26.70.00-05 / -06

Grooves	Grooves height	Ring height	Wear limit	Limit clearance
1	5,12 $^{+0,02}$	4,95 $_{-0,02}$	5,50	0,60
2	5,12 $^{+0,02}$	4,99 $_{-0,02}$	5,50	0,60
3	5,06 $^{+0,02}$	4,99 $_{-0,02}$	5,50	0,60
4	8,04 $^{+0,02}$	7,987 $_{-0,015}$	8,50	0,50

Piston M281

Aluminium piston
1.20.6-26.30.01-01 - charged

1.20.6-26.30.01-02 - uncharged

1.20.6-26.30.01-03 - charged - ring support

1.20.6-26.30.01-04 - charged

1.20.6-26.30.01-05 - uncharged

1.20.6-26.30.01-06 - charged - ring support

1.20.6-26.30.01-07 - uncharged - ring support

Piston

Piston M282

1.20.6-26.40.01-02 - charged

1.20.6-26.40.01-03 - charged - ring support

1.20.6-26.40.01-04 - uncharged

1.20.6-26.40.01-05 - charged

1.20.6-26.40.01-06 - charged - ring support

1.20.6-26.40.01-07 - uncharged

1.20.6-26.40.01-08 - charged - ring support

1.20.6-26.40.01-09 - charged - ring support

1.20.6-26.40.01-10 - charged - ring support

1.20.6-26.40.01-11 - charged - ring support

1.20.6-26.40.01-12 - charged - ring support

1.20.6-26.40.01-13 - uncharged - ring support

1.20.6-26.40.01-14 - charged - ring support

1.20.6-26.40.01-15 - charged - ring support

1.20.6-26.60.01-03 - charged - ring support

1.20.6-26.60.01-02 - charged - ring support

1.20.6-26.60.01-05 - charged - ring support

1.20.6-26.60.01-06 - charged - ring support

Piston

Piston M282

1.20.6-26.70.00-01 - ring grooves flame-hardened

1.20.6-26.70.00-02 - ring grooves flame-hardened

1.20.6-26.70.00-03 - ring grooves flame-hardened

1.20.6-26.70.00-05 - ring grooves flame-hardened

Piston M331

1.30.6-26.30.01-51 - charged - ring support

1.30.6-26.30.01-52 - charged - ring support

1.30.6-26.70.00-50 - ring grooves flame-hardened

Piston M332

1.30.6-26.60.01-01 - charged - ring support

1.30.6-26.60.01-02 - charged - ring support

1.30.6-26.70.00-02 - 1st ring groove chromium-plated

1.30.6-26.70.00-01 / -03 ring grooves flame-hardened

1.30.6-26.60.01-01 / -02

Piston M332 C

1.30.6-26.70.00-05 - ring grooves flame-hardened

1.30.6-26.70.00-06 - ring grooves flame-hardened

Piston

Piston rings M281

Piston 1.20.6-26.30.00-01 / -02 / -03 / -04 / -05 / -06 / -07 / -08

Ring groove		ring
1 + 2	Rectangular ring, chromium-plated	0.00.6-35.41.02-16
3 + 4	Rectangular ring	0.00.6-35.41.02-01
5	Oil scraper ring	0.00.6-35.41.02-03

Piston rings M282

Piston 1.20.6-26.40.01-02 / -03 / -04 / -05 / -06 / -07 / -08 / -09 / -10 / -11 / -12 / -13 / -14 / -15 and 1.20.6-26.60.01-03 / -02

Ring groove		ring
1 + 2	Rectangular ring, chromium-plated	0.00.6-35.41.02-16
3 + 4	Rectangular ring	0.00.6-35.41.02-01
5	Oil scraper ring	0.00.6-35.41.02-03

Piston 1.20.6-26.60.01-05 / -06 and 1.20.6-26.70.00-01 / -02 / -03

Ring groove		ring
1 - 3	Rectangular ring, chromium-plated	0.00.6-35.41.02-51
4	Oil scraper ring	0.00.6-35.41.02-29

Piston 1.20.6-26.70.00-01 / -02 / -03

Ring groove		ring
1 - 3	Rectangular ring	0.00.6-35.41.02-51
4	Oil scraper ring	0.00.6-35.41.02-59

Piston 1.20.6-26.70.00-05

Ring groove		ring
1	Compression ring, chromium-plated	0.00.7-35.41.02-60.1
2 + 3	Compression ring, chromium-plated	0.00.7-35.41.02-61
4	Oil scraper ring	0.00.6-35.41.02-62.1
		or 0.00.6-35.41.02-62.3

Piston

Piston rings M331

Piston 1.30.6-26.30.01-51 / -52

Ring groove		ring
1 + 2	Rectangular ring, chromium-plated	0.00.7-35.41.02-31
3	Compression ring, chromium-plated	0.00.7-35.41.02-46
4	Oil scraper ring	0.00.6-35.41.02-29

Piston 1.30.6-26.70.00-50

Ring groove		ring
1 + 2	Rectangular ring, chromium-plated	0.00.7-35.41.02-31
3	Compression ring, chromium-plated	0.00.7-35.41.02-46
4	Oil scraper ring	0.00.6-35.41.02-59

Piston rings M332

Piston 1.30.6-26.60.01-01 / -03

Ring groove		ring
1 + 2	Rectangular ring, chromium-plated	0.00.6-35.41.02-31
3	Compression ring, chromium-plated	0.00.6-35.41.02-46
4	Oil scraper ring	0.00.6-35.41.02-29

Piston 1.30.6-26.70.00-01 / -03

Ring groove		ring
1 + 2	Rectangular ring, chromium-plated	0.00.6-35.41.02-31
3	Compression ring, chromium-plated	0.00.6-35.41.02-46
4	Oil scraper ring	0.00.6-35.41.02-59

Piston 1.30.6-26.70.00-02

Ring groove		ring
1 + 2	Rectangular ring, three-sided chromium-plated	0.00.6-35.41.02-56
3	Compression ring, chromium-plated	0.00.6-35.41.02-46
4	Oil scraper ring	0.00.6-35.41.02-59

Piston rings M332 C

Piston 1.30.6-26.70.00-05 / -06

Ring groove		ring
1	Compression ring, chromium-plated	0.00.6-35.41.02-60.1
2 + 3	Compression ring, chromium-plated	0.00.6-35.41.02-61
4	Oil scraper ring	0.00.6-35.41.02-62.1
		or 0.00.6-35.41.02-62.3

Liner

Nominal size Ø (original size) →		**240.00 - 240.046**	**mm**
Wear limits			
Wear and tear value →		**0.80**	**mm**
Max. ovality →		**0.25**	**mm**
Wedge shape	Height →	**6.00**	**mm**
	Depth * →	**0.03**	**mm**

Wedge-shape indentation across the entire circumference, beginning at TDC 1st piston ring.

Canyon	Max. number →	**3**	
	Length →	**6.00**	**mm**
	Total width →	**3.00**	**mm**

Individual deep blow-through ducts in the area of the 1st piston ring (TDC)

Score	Number →	**3**	
	Length →	**140.00**	**mm**
	Depth →	**0.03**	**mm**

Hard vertical, linear friction marks.

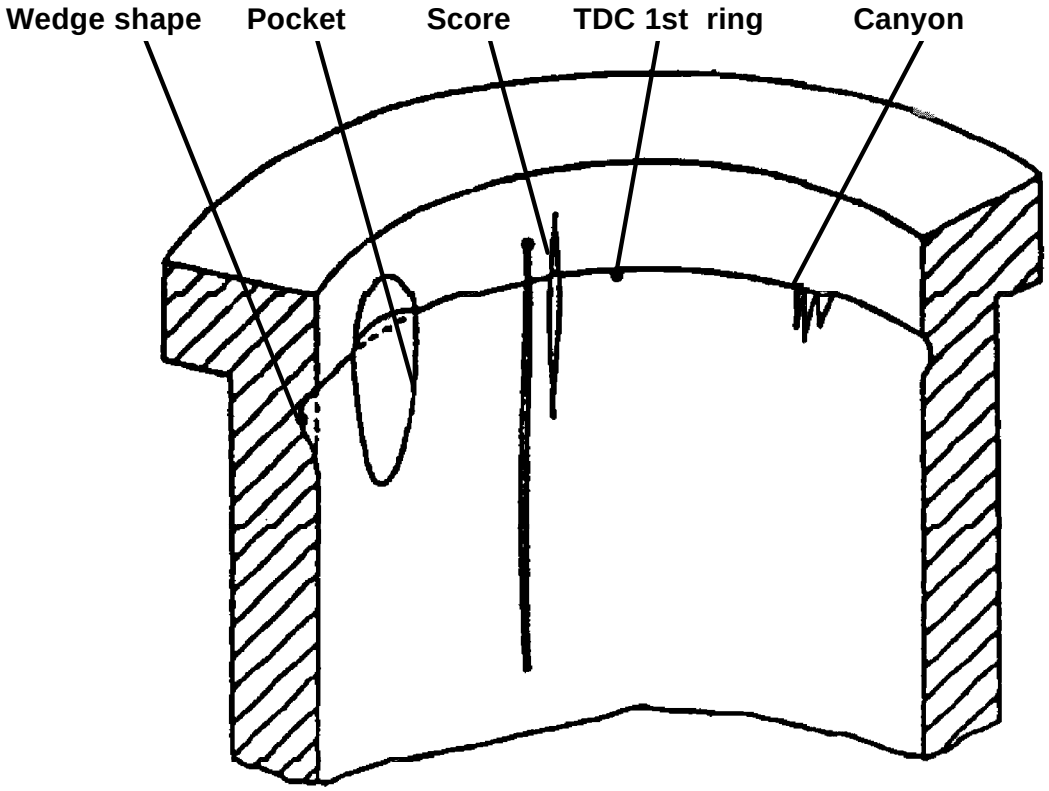
Pocket	Number →	**3**	
	Length →	**45.00**	**mm**
	Width * * →	**15.00**	**mm**
	Depth * →	**0.02**	**mm**

Areal, irregular indentations.

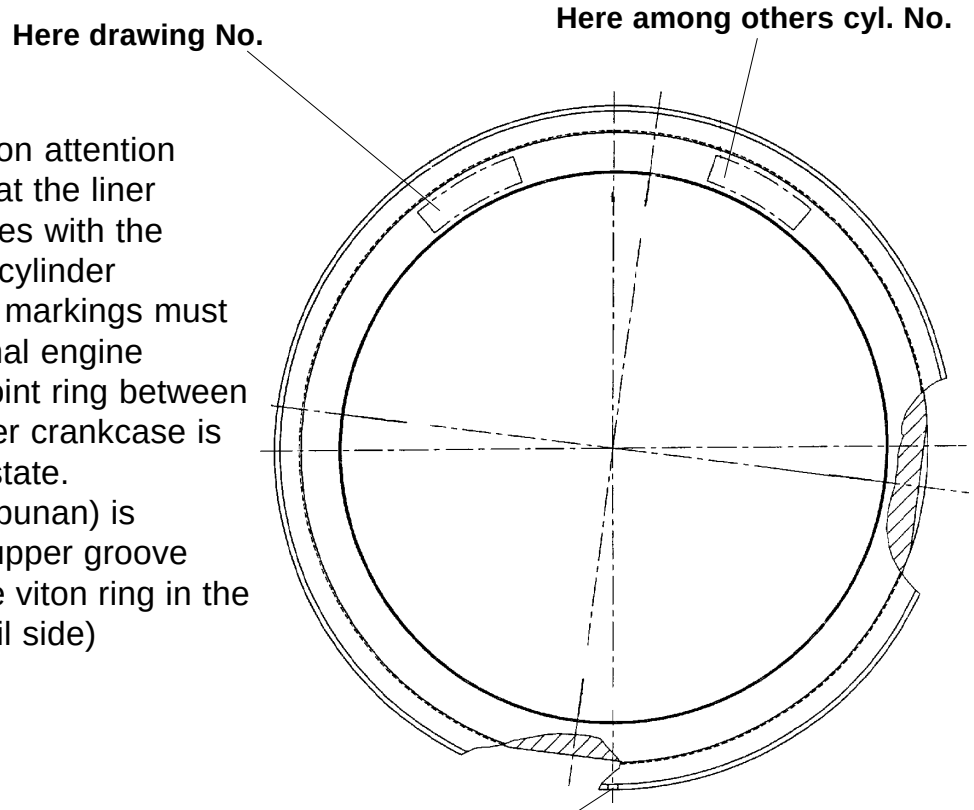
* ***Radius r ≥3 mm***

* * ***In circumferential direction.***

Liner

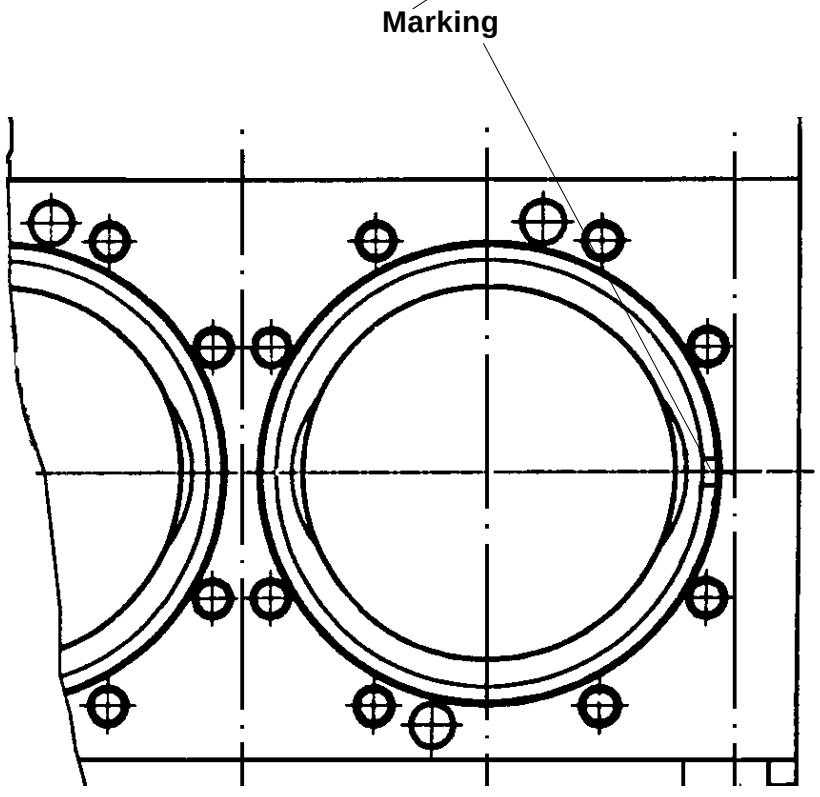


Liner



Installation

During installation attention must be paid that the liner marking coincides with the marking on the cylinder crankcase. The markings must run in longitudinal engine direction. The joint ring between liner and cylinder crankcase is inserted in dry state.
The O-ring (perbunan) is inserted in the upper groove (water side), the viton ring in the lower groove (oil side) untwisted.



Connecting rod

In-line engine M281 - M332

Vee-engine M281 - M282

Tightening torques

Big end bearing with **Ø 160mm**
Tighten screws with → ***Oil***

M = 500 Nm

Big end bearing with **Ø 170mm**
Pretighten connecting rods with oil groove in the bottom end by hand, then tighten with → ***Oil***

M = 700 Nm

Measurement of gap

1. Tighten nuts acc. to tightening specification.
2. Loosen on one side and measure the gap →

0.44 - 0.60 mm

3. After longer operation not below →

0.35 mm

In-line engine M332C

In-line engine M281 - M332

Vee-engine M281 - M282

Pretighten M332C and connecting rods without oil groove in the bottom endby hand, then tighten in two steps
Tightening acc. to torque

1st step →

M = 450 Nm

2nd step →

M = 860 Nm

Oil

Tightening torque

Tightening of big end bearing bolts whilst installed in the engine. Tighten nuts alternately in 2 steps until the **stamped cylinder figures** on the nuts and bearing caps coincide. ***Oil***

Connecting rod

New big end bearing bolts and nuts

When using new big end bearing bolts and nuts, always check the bolt extension and, if necessary retighten it. The position of the nut to the connecting rod must be marked on the nut by figure stamps.

Camshaft side → vertical numbers **-** exhaust side → horizontal numbers

A measurement of extension before and after tightening is necessary.

The extension is →	**0.65 ± 0.05 mm**

If **new big end bearing bolts** are used, the following tightening methods are possible:

Tightening according to torsional angle

1. Tighten nuts manually on exhaust gas side, on camshaft side there must be the full gap.

2. Tighten the gap on camshaft side to **„0“**, the existing gap on exhaust gas side also to **„0“**.
   Important is that the gap is „0“ on both sides.

3. Mark the position of the nuts and then apply an angle of rotation of →
   (max. 2.5 hexagons)

   Dw = 140° + 10°

Gap measurement

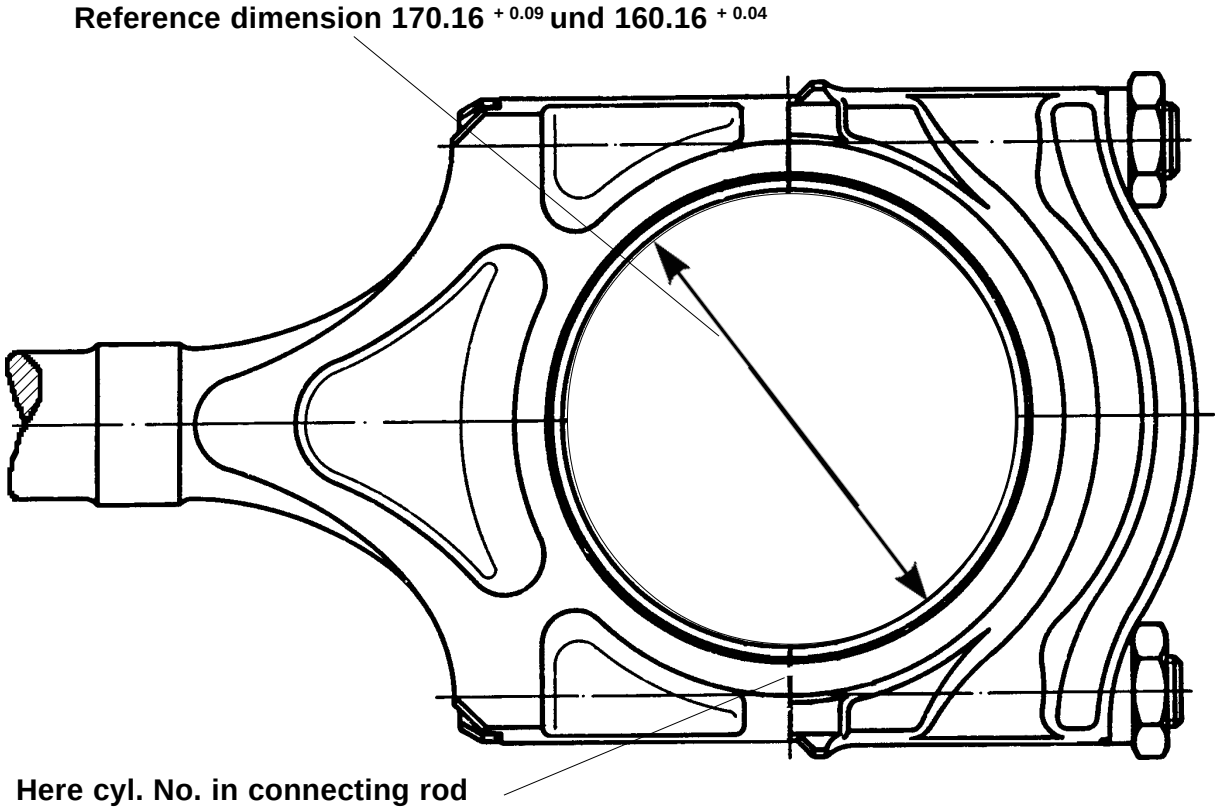
Tighten nuts on exhaust gas side until the markings of nut and bearing cap coincide.

Measure gap on camshaft side →	**0.65 - 0.70 mm**

Reference dimension after correct tightening

Bearing **Ø 160** →	**160.16 + 0.04 mm**
Bearing **Ø 170** →	**170.16 + 0.09 mm**
Bearing clearance **Ø 160 mm** →	**0.17 - 0.21 mm**
Bearing clearance **Ø 170 mm** →	**0.16 - 0.28 mm**
The clearance between piston pin bush and piston pin is →	**0.12 - 0.15 mm**

Connecting rod



Removal and fitting of piston pin bushes

In no case piston pin bushes must be pressed out. The piston pin bush must be tension-free. For this purpose the bush has to be sawed in or cut. After shrinking-in the piston pin bush must have

the reference dimension → **100.09 + 0.06 mm**

The bearing clearance is → **0.12 - 0.15 mm**

Marking

The connecting rods, screws and nuts are marked with vertical figures on camshaft side and horizontal figures on exhaust gas side.

Crankshaft bearing

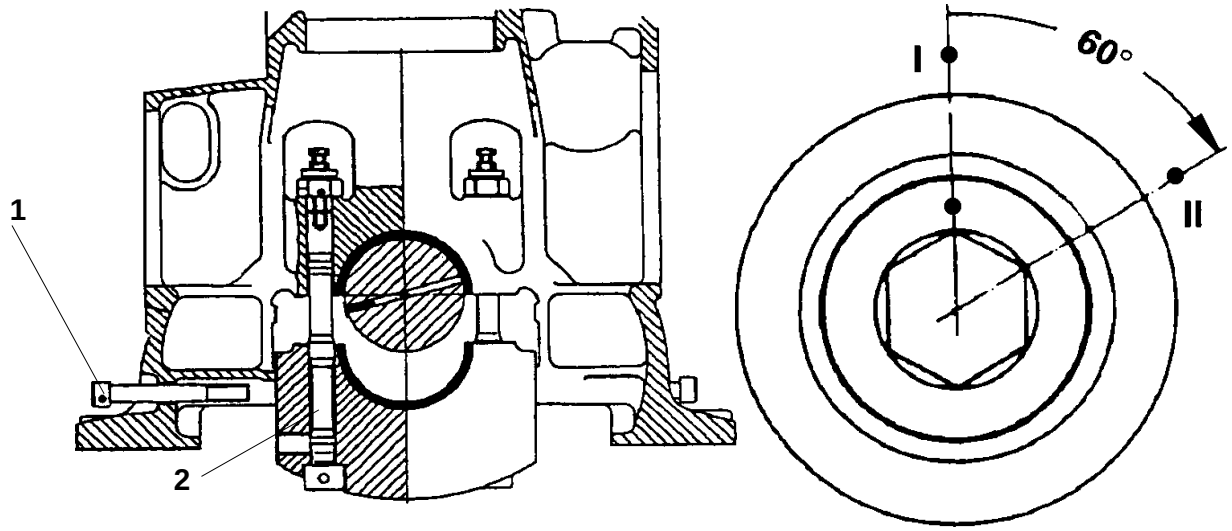
In-line engine M281- M332C

Tightening instructions

1. Tighten lateral bolts **- 1 -** manually with approx. **120 Nm** beginning on camshaft side.
2. Tighten bearing bolts **- 2 -** alternately stepwise until the line marks on the hexagon nuts and at the cylinder crankcase coincide.
3. Loosen bearing bolts once more and retighten them to avoid a setting of the bearing during operation.
4. Transfer marking **- I -** from cylinder crankcase on lateral bolts and tighten lateral bolts on camshaft side up to marking **- II -** beginning stepwise.

This corresponds to →
or approx. **550 Nm.** ***Oil***

Dw = 60°



Tightening instructions for new bearing bolts and nuts.

1. Measure unloaded bolt length.
2. Tighten hexagon nuts alternately stepwise until the total extension of each bolt is →

Δl = 0.70 - 0.76 mm

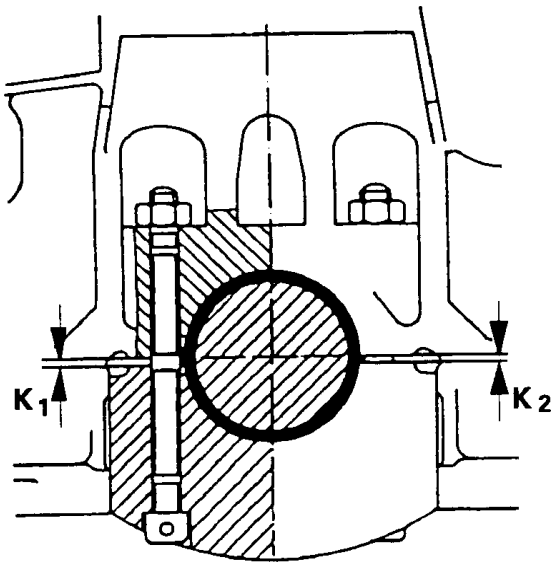
3. Transfer the marking at the cylinder crankcase to the hexagon nut. ***Oil***

Crankshaft bearing

In-line engine M281- M332C

Gap measurement

Turn the lateral bolts out, loosen them at the adjacent bearings by some pitches of thread. Loosen the hexagon nuts of the bearing bolts until the bearing cap is lowering, then tighten the bearing bolts alternately and steadily until the joint faces are slightly touching. Measure gap on both sides by means of a feeler gauge and add the values.



Gap K = K_1 + K_2

Gap

Normal main bearing →	**0.50 - 0.70**	**mm**
Limit value →	**0.45**	**mm**
Located main bearing →	**0.45 - 0.70**	**mm**
Limit value →	**0.33**	**mm**

Crankshaft bearing

Vee - engine 281 - 282

Tightening instructions
Tighten lateral screws by hand, beginning on B-side **(approx. 120 Nm)**

Lengthen main bearing bolts with → **P = 580 bar**
and tighten nuts.
Attention! The value P = 580 bar applies up to engine No. 40101

Lengthen main bearing bolts with → **P = 670 bar**
and tighten nuts.
Attention! The value P = 670 bar applies up to engine No. 40102
Attention! Exception: The engines from No. 40105 to 40108 are tightened with P = 580 bar.

Tighten lateral screws in two steps, beginning on B-side.

1st step → **M = 300 Nm**

2nd step → **M = 550 Nm**

Gap
Loosen screws, then lengthen with → **P = 18 bar**
and tighten nuts.
Measure gap **„K“** on A and B-side with feeler gauge and add the two measured values up. **„K“ = „K_1“ + „K_2“**

Gap normal bearing → **0.48 - 0.55 mm**

Limit value → **0.35 mm**

Gap locating bearing → **0.32 - 0.40 mm**

Limit value → **0.20 mm**

Counterweights

In-line engine M281 -M332

Vee-engine M281 - M282

Tightening instruction

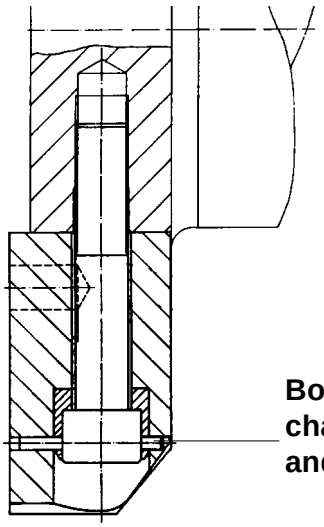
Tighten screws with →

Oil

Fillister-head screws M24x2x130 DIN 912

Pin 6x65 DIN1481

M = 500 Nm



Bore screw and chamfered wall and pin them

In-line engine M332C

Tightening instructions

1. Pretighten tension bolts with → **M = 100 Nm**
2. Mark tension bolts and counterweight by a felt-tip pen or chalk.
3. Tighten tension bolts alternately in 2 equal steps up to → **M = 620 Nm**

   Oil

Check: The marking of the tension bolt unter point 2 must have turned on by → **Dw = 60°**

Tension bolt M24x2x144

Gear drive

In-line engine M281 - M332C

Vee-engine M281 - M282

Gear wheel on crankshaft mounting

Press gear wheel against the fitted collar in the direction of the big crankshaft flange.

Tighten the fillister-head screws crosswise in several steps.

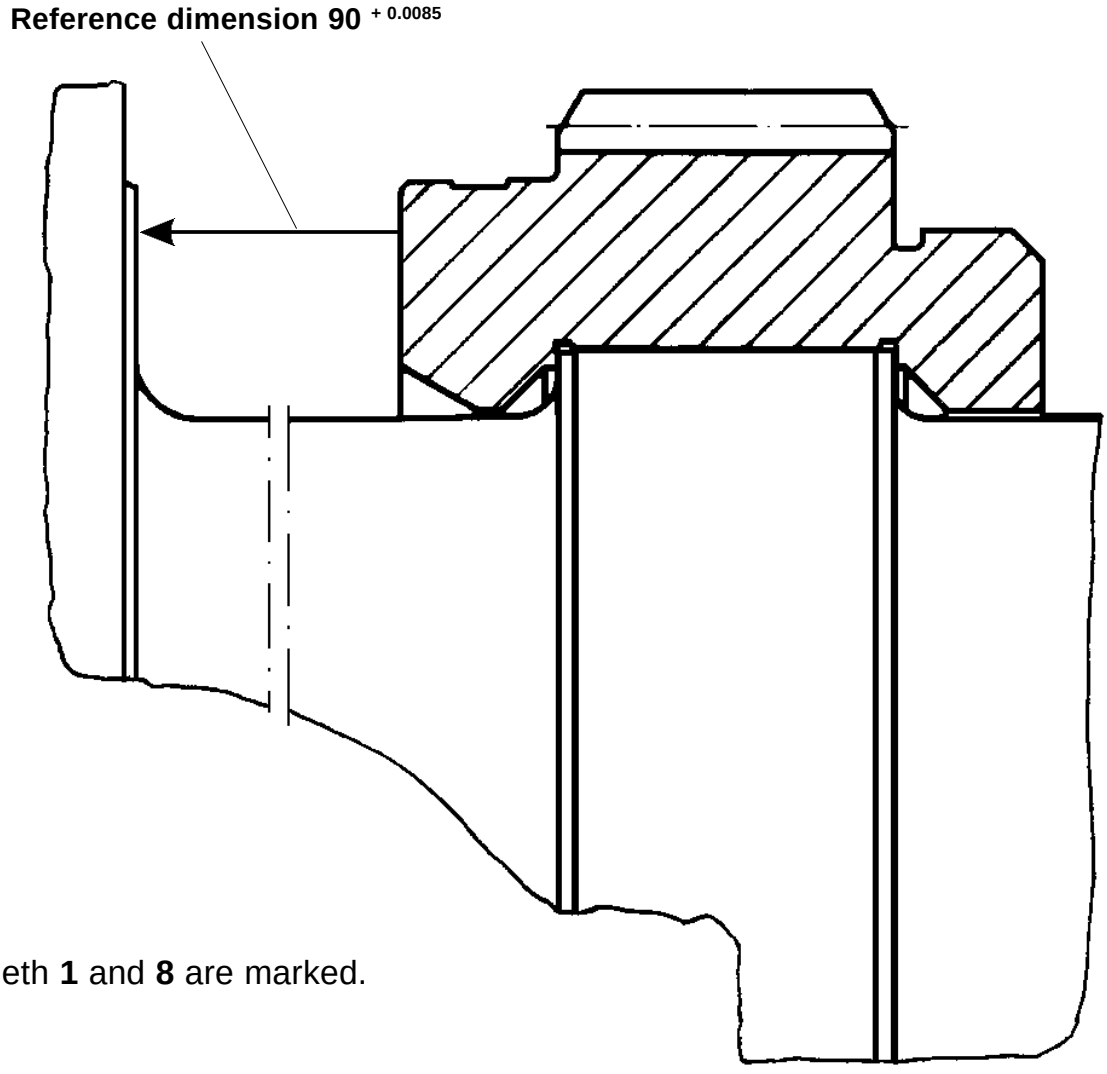
Tightening torque → **M = 100 Nm**

Screws M12 x 55 DIN 912

Lubricant: Oil or grease

The fillister-head screw is secured by a threaded pin **M6 x 10 DIN 914**. For that purpose the thread of the fillister-head screw is slightly bored.

Measure the reference dimension (sketch) → **$90^{+0.0085}$ mm**



The teeth **1** and **8** are marked.

Gear drive

In-line engine M281 - M332C

Vee-engine M281 - M282

Camshaft gear

1. Check the cone of the camshaft gear by blue paste, put it on the camshaft and tighten nut with abt. **100 Nm**.
2. Loosen nut again and remove camshaft gear. Check the blueing appearance, from the full-contact blueing appearance only a contact reflection displaced to the thick end is admissible.

Mechanical tightening

3_a. Put camshaft gear on the dry and grease-free cone, pretighten the hexagon nut with abt. **100 Nm**
and tighten with →

Dw = 240°

Hydraulic tightening

3_b. Put camshaft gear on cone as described under 3 and pretighten the hexagon nut with abt. **50 Nm**. Connect hydraulic pump and apply the pressure →

P = 1250 bar

then tighten the hexagon nut with →

Dw = 240°

Secure nut.

Loosening advice:
The nut may only be loosened by abt. 2 turns, otherwise the camshaft gear would come off.

On the camshaft gear the teeth **1**, **51** and **52** are marked

Backlash:

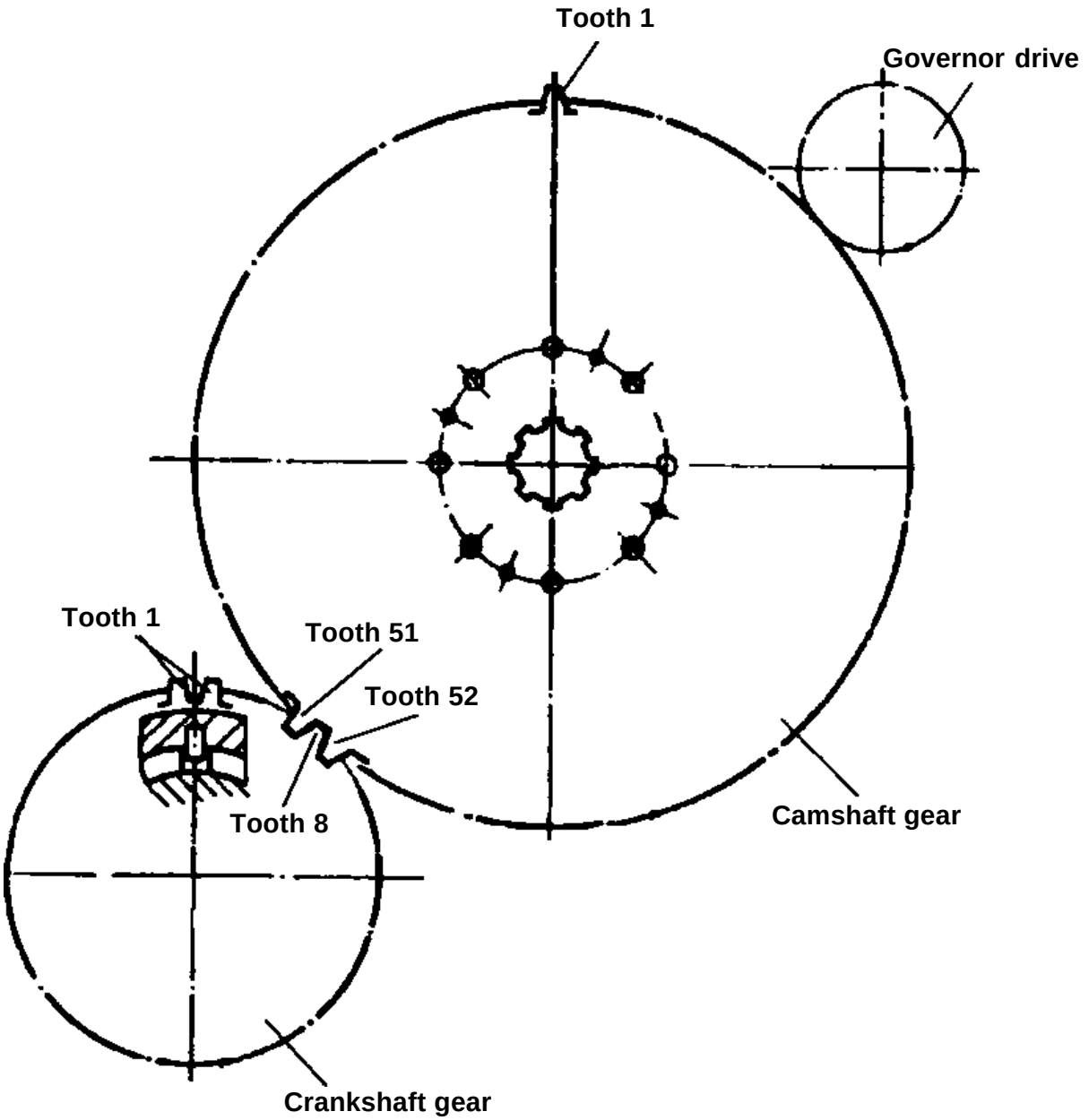
The backlash between crankshaft gear and camshaft gear as well as between camshaft gear and governor drive gear is →

0.20 ± 0.05 mm

Gear drive

Setting port type

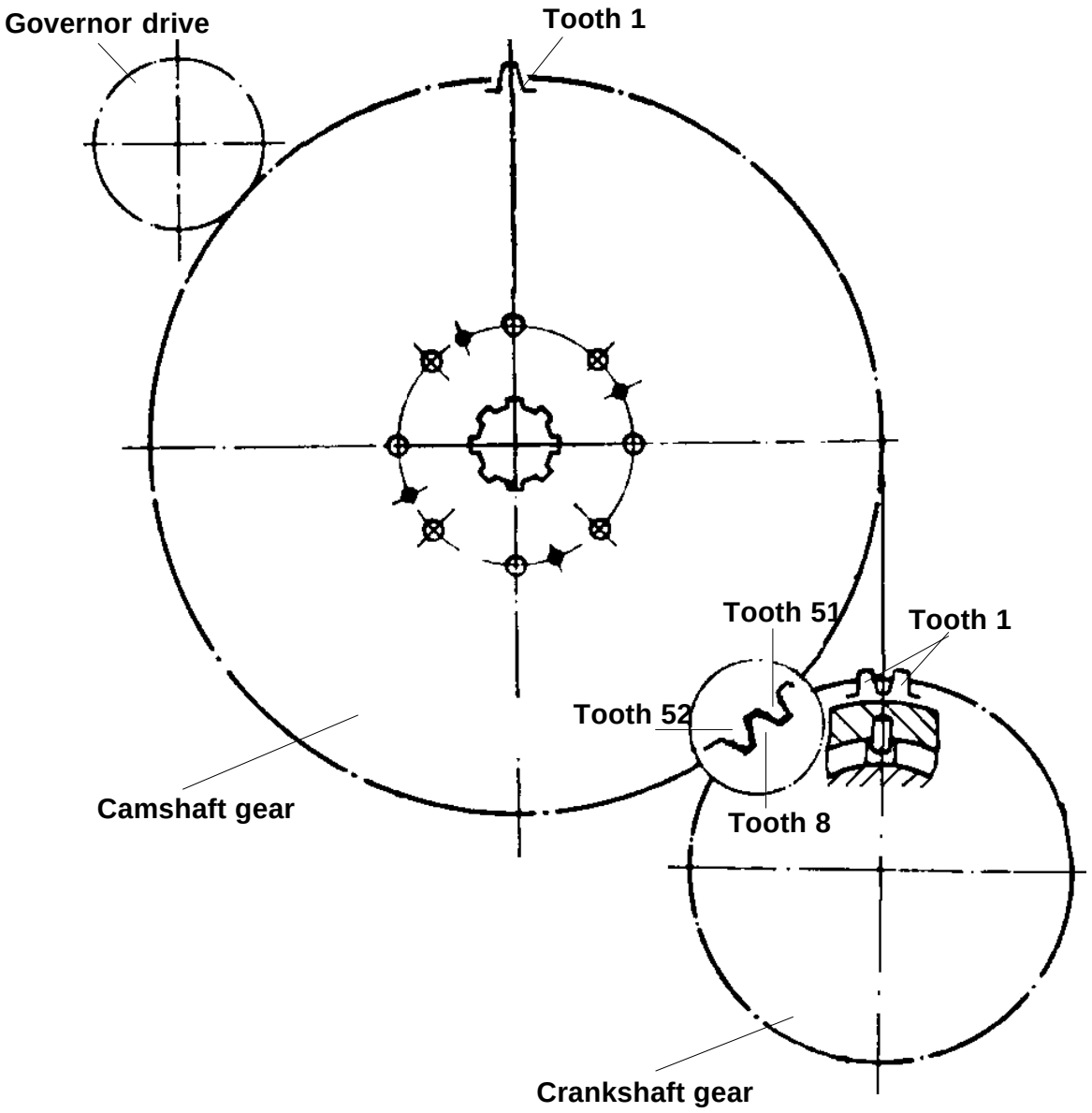
Piston cyl. 1 in TDC



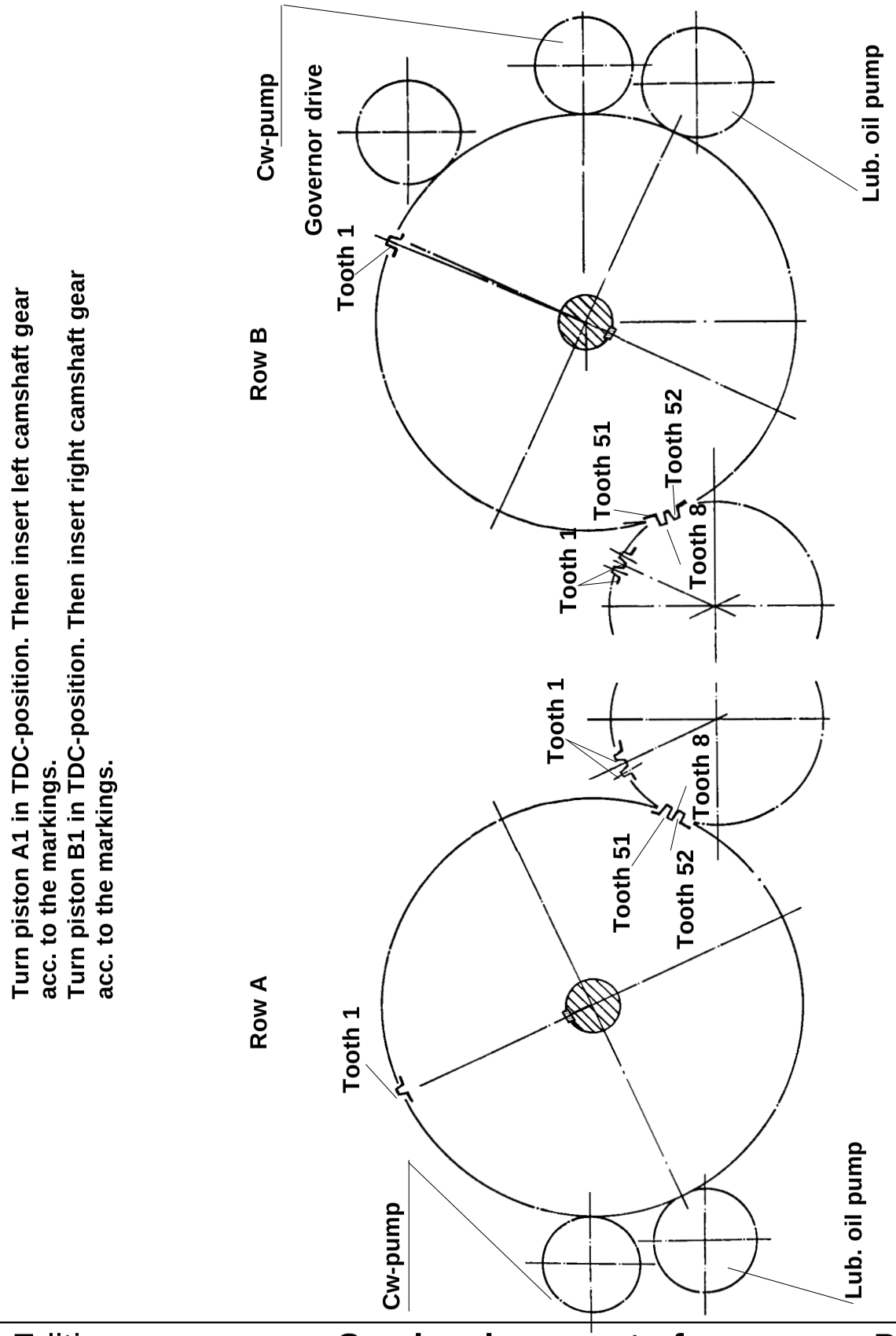
Gear drive

Setting stb-type

Piston cyl. 1 in TDC



Gear drive


Turn piston A1 in TDC-position. Then insert left camshaft gear acc. to the markings.
Turn piston B1 in TDC-position. Then insert right camshaft gear acc. to the markings.
Row A
Row B
Cw-pump
Governor drive
Lub. oil pump
Tooth 1
Tooth 8
Tooth 51
Tooth 52

Governor drive

In-line engine

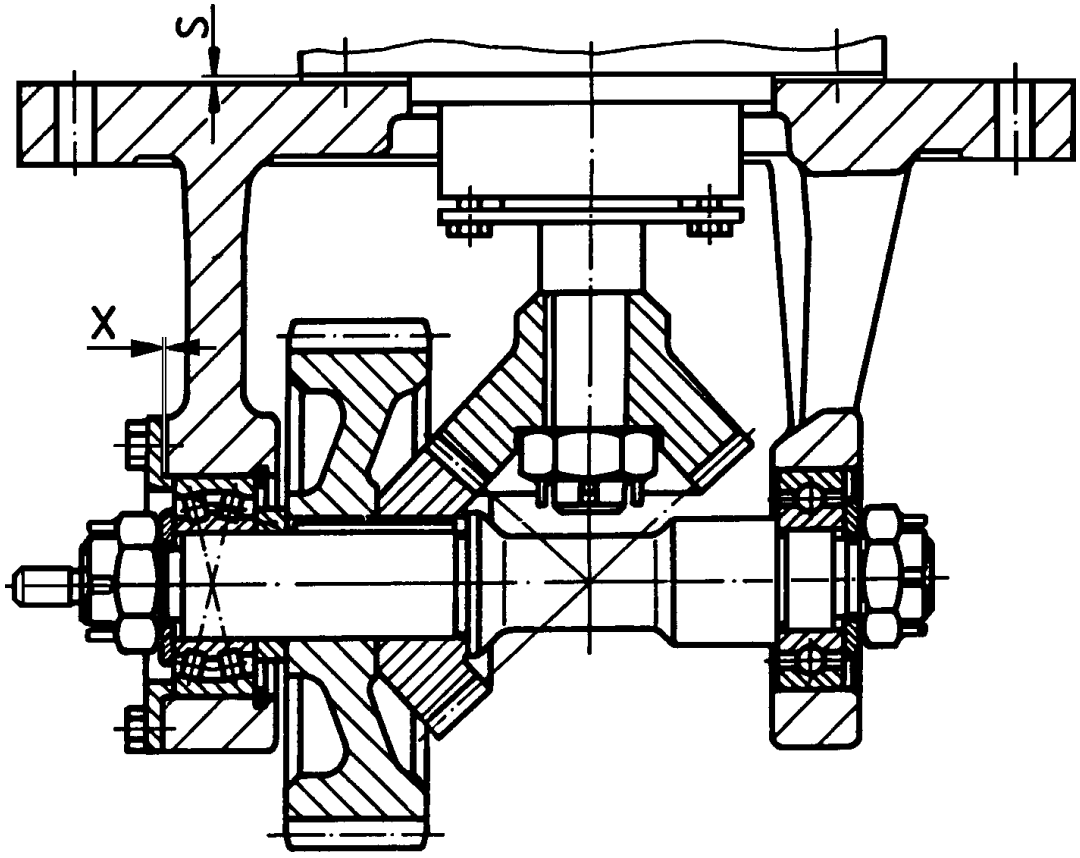
Adjustment

1. Mount governor drive according to the sketch. Use 4 thickness gauges of the same size. The backlash of **0.1 mm** and aligning of the tooth ends are attained by shifting the shaft with its bearings in horizontal direction (dimension „X“) and by choosing the size of the thickness gauges in vertical direction (dimension „S“).

2. Coat tooth flanks of a bevel gear with blueing paste. Execute some revolutions in running direction. Is the bearing pattern as shown in figure **0** on page **78 not** attained, the position of the flanks resp. the bearing pattern must be corrected (in this connection see page **78**).

3. After adjustment of the bearing pattern figure **0** on page **78**, turn off spacer bush on governor and spacer for dimension „X“.
   Turning-off dimension: Spacer bush = size of thickness gauge „S“
   Spacer = dimension „X“

4. Mount governor drive completely.

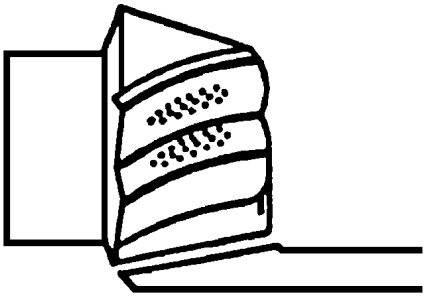


Governor drive

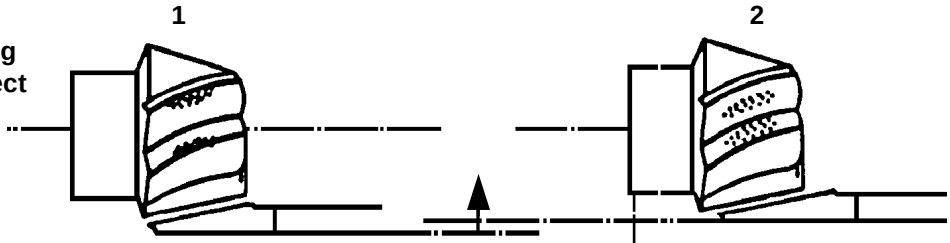
In-line engine

0

Bearing pattern not loaded

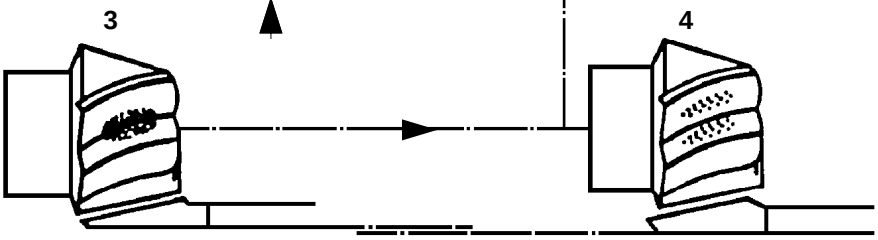


1. Bearing pattern wrong
2. Bearing pattern correct

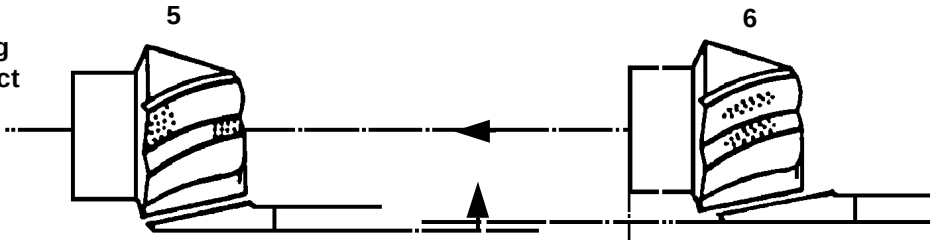


Vertical displacement of bearing pattern

3. Bearing pattern wrong
4. Bearing pattern correct

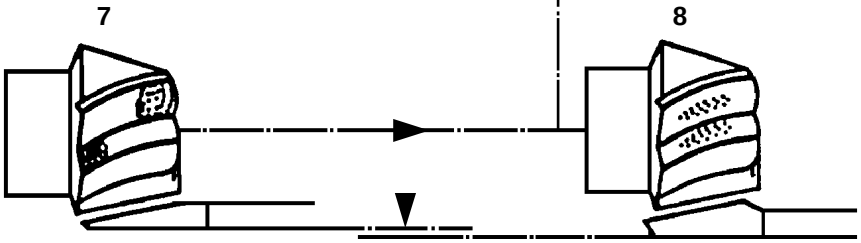


5. Bearing pattern wrong
6. Bearing pattern correct



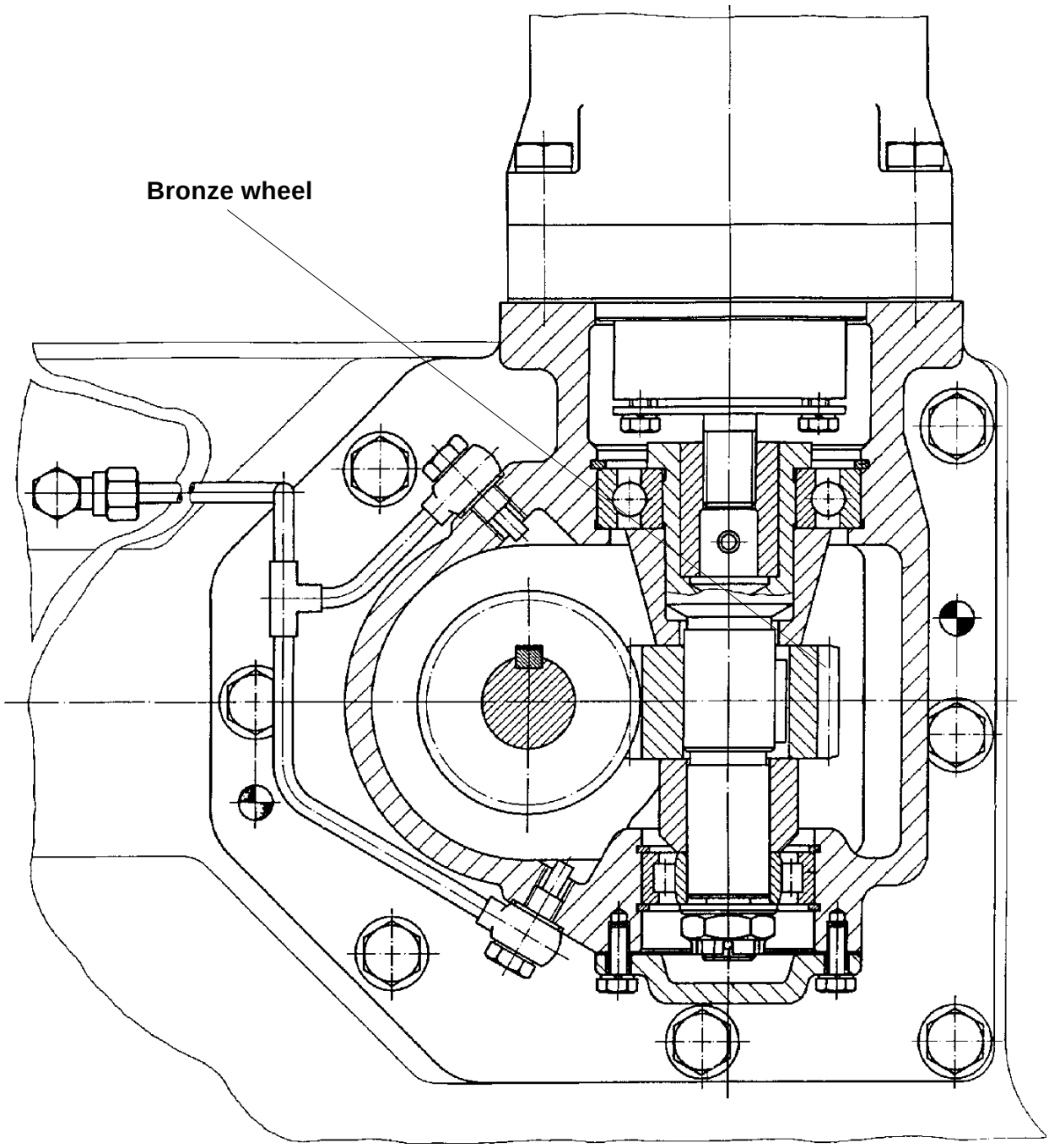
Longitudinal displacement of bearing pattern

7. Bearing pattern wrong
8. Bearing pattern correct



Governor drive

Vee-engine M281 - M282

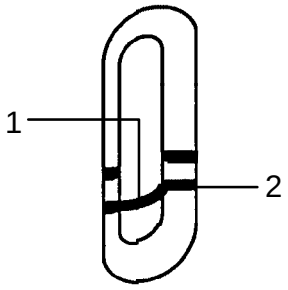


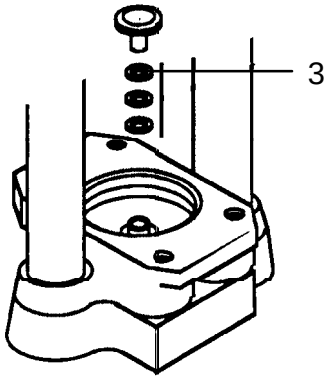
Fuel injection pumps

In-line engine | **Vee-engine**

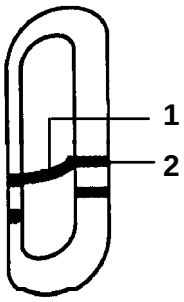
Basic setting

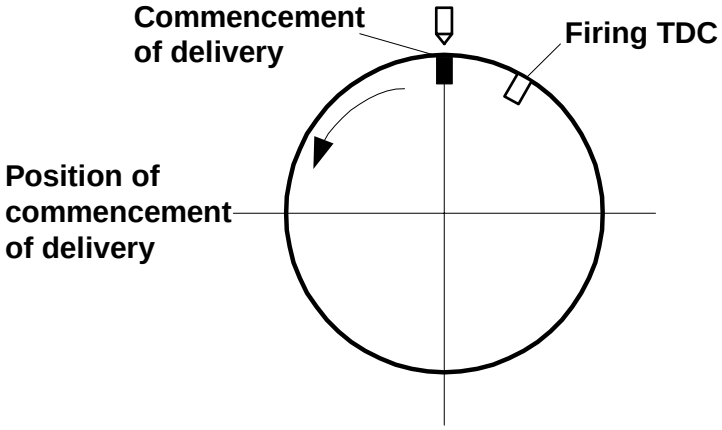
1. The roller must rest on the cam base circle.
2. Now a coincidence of line marks **- 1 - 2 -** must be visible in the window of the fuel injection pump.





3. In case of deviations the coincidence of line marks has to be attained by adding or removing shims **- 3 -**.
4. It would be helpful to use the reference dimension **„5.5 mm“** measured from top edge of pressure piece **- 4 -** to contact surface of intermediate flange **- 5 -**. The pre-stroke is **„4 mm“**.





Shims are available of the following sizes: **2.8 - 3.0 - 3.2 - 3.4 - 3.6 - 3.8**.

Check of commencement of delivery

1. Check coincidence of piston-TDC and dead center marking on the flywheel.
2. Turn engine in the sense of rotation until coincidence of line marks is attained.
3. In case of deviations of the commencement of delivery of ± 1° the fuel cams must be readjusted.

Fuel injection pumps

In-line engine M281 - M332C

Vee-engine M281 - M282

The following pumps are in operation:

Injection pumps	Reference dimension „Y“	Pre-stroke „X“	Engine
PF 1C 160 CS 1705	6.1 mm	4.6 mm	M 282 (n=1050 rpm)
PF 1C 150 CS 1708	6.1 mm	4.6 mm	M 281 - M 282
PF 1C 160 CS 1721	6.1 mm	4.6 mm	M 282 (Lok- a. vee-engine)
PF 1C 180 CS 1730	5.4 mm	5.0 mm	M 281 - M 331
PF 1C 180 CS 1756	5.4 mm	4.0 mm	M 332
PF 1C 180 CS 1783	5.4 mm	4.0 mm	M 282 - M 331 - M332
PF 1CV 200 AS 46	5.5 mm	4.0 mm	M 282 - M 332
PF 1C 180 CS 1793	5.5 mm	4.0 mm	M 282 - M332
PF 1CC 200 AS 53 MDO	5.5 mm	4.0 mm	M 282 - M 332 C
PF 1CV 200 BVH 325	5.5 mm	4.0 mm	M 332 C HFO
PF 1CV 200 AS 56	5.5 mm	4.0 mm	M 332 C MDO
PF 1CV 200 AS 57	5.5 mm	4.0 mm	M 332 C MDO a. HFO

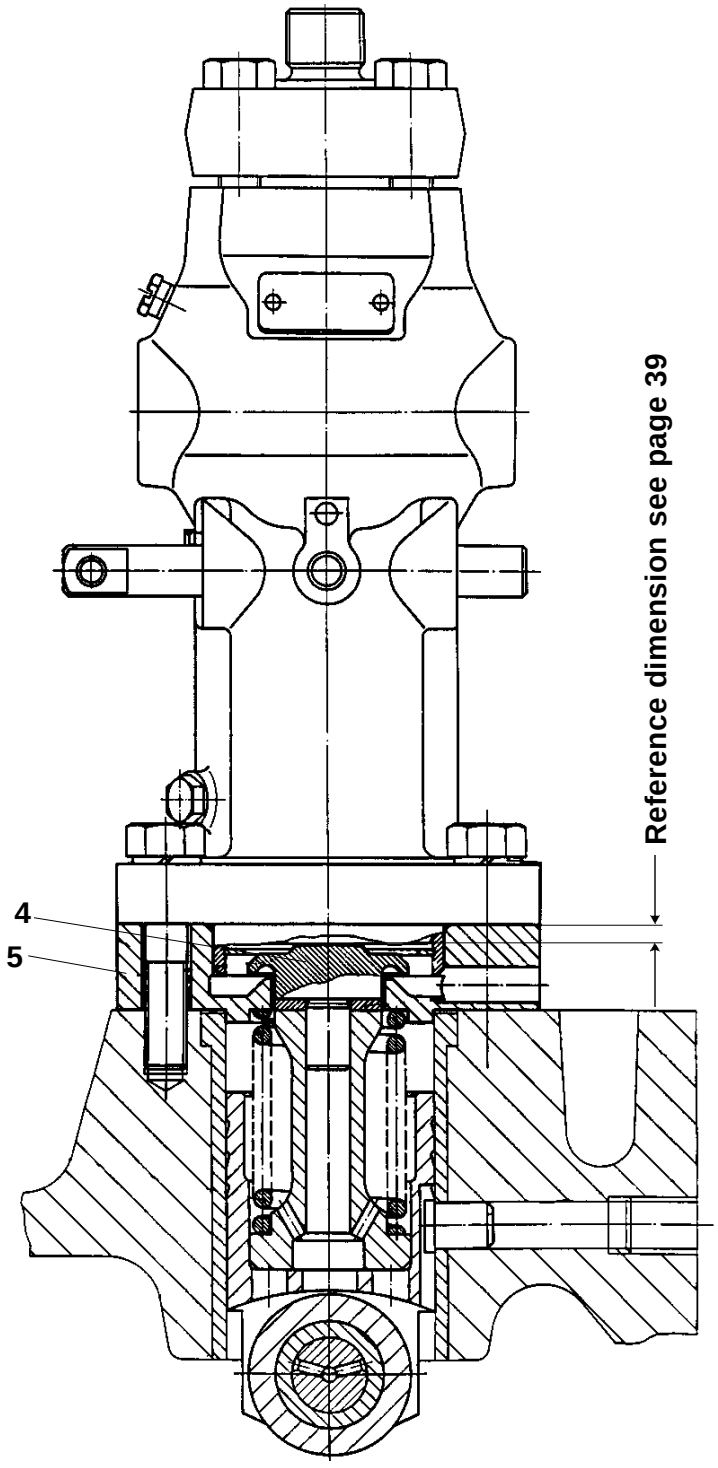
Tightening torques

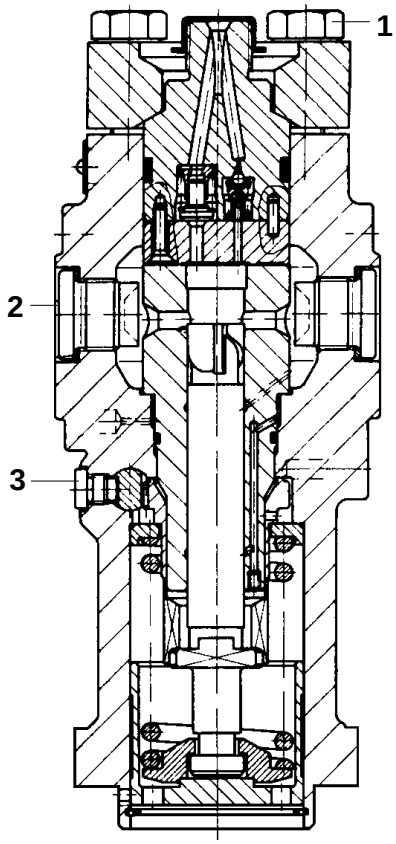
Tighten screws **- 1 -** ***M14*** with →	**M = 100 + 10 Nm**
Tighten screws **- 1 -** ***M12*** with →	**M = 70 + 10 Nm**
Tighten screws **- 2 -** with →	**M = 80 + 10 Nm**
Tighten screws **- 3 -** with →	**M = 10 + 5 Nm**
Tighten screws for the fuel pipes with →	**M = 40 + 5 Nm**

Fuel injection pumps

In-line engine M281 - M332C

Vee-engine M281 - M282





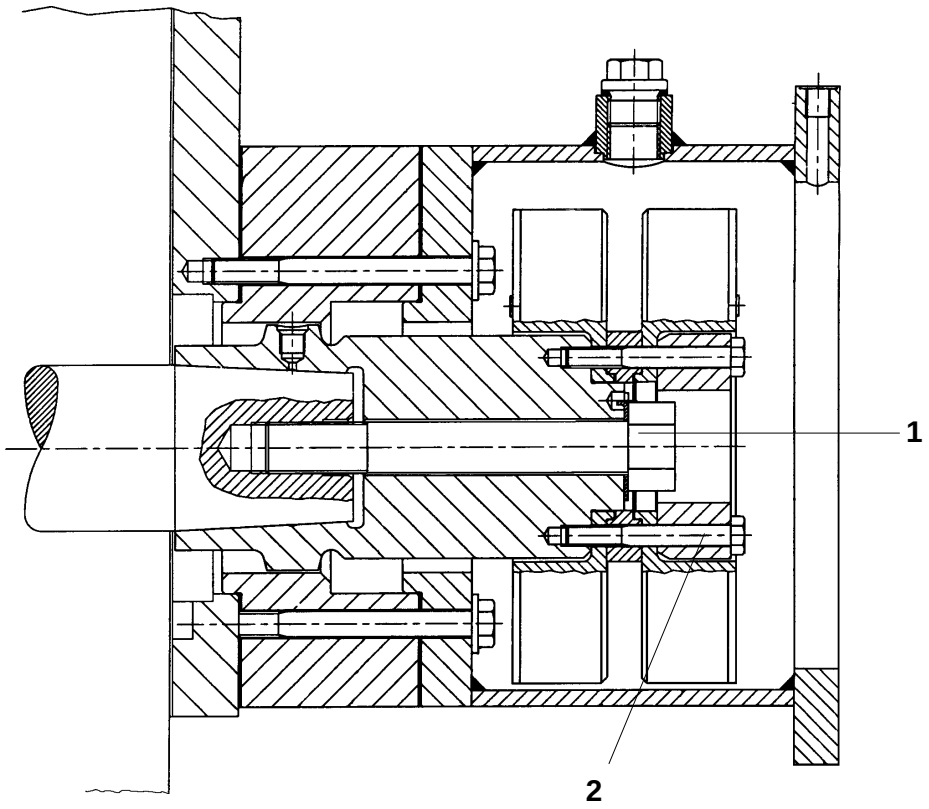
Camshaft

In-line engine M332 C

Vibration damper

The 8-cylinder engines are provided with 2 vibration dampers.

Exception: The engine Nos. 33744 up to 33755



Tighten screw - 1 - with → **M = 350 Nm**

Tighten screws **- 2 -** with → **M = 34 Nm**

Cam stud M20 x 2 x73 and M20 x 2 x 143
Hexagon screw M8 x 65 DIN 931

Camshaft

In-line engine M281 - M332C

Vee-engine M281 - M282

Split fuel cams for non-reversible engines

Engine	Stroke	Series design	Split repair cam
6 / 12 M281		1.30.7-32.32.01-01 repl. -07 oil hydraulic mounting	1.20.7-32.35.00-02
6 / 12 M281	15	1.30.7-32.32.01-03	1.20.7-32.35.00-02
6 / 12 M281 - 6 M331	15	1.30.7-32.32.01-05 repl. -07	1.20.7-32.35.00-02
6 M331 / 332 - 8 M332	16	1.30.7-32.32.01-02 repl. -06	1.20.7-32.35.00-06
6 M331 / 332 - 8 M332	16	1.30.7-32.32.01-04 repl. -06	1.20.7-32.35.00-06
6 M332 - M332C	16	1.30.7-32.32.01-08	1.20.7-32.35.00-06
8 M282 DB	15	1.20.7-32.32.01-01 on cam holder	1.20.7-32.35.00-03
8 M282 DB	15	1.20.7-32.32.01-02	1.20.7-32.35.00-03
6 / 12 M282 - 8 M282	16	1.20.7-32.32.01-03 repl. -07	1.20.7-32.35.00-05
8 M282 DB	15	1.20.7-32.32.01-04 repl. -06	1.20.7-32.35.00-03
6 / 12 M282 - 8 M282	16	1.20.7-32.32.01-05 repl. -07	1.20.7-32.35.00-05
6 / 12 M282	16	1.20.7-32.32.01-08	1.20.7-32.35.00-05

Tightening torque for 1.30.7-32.35.00-02 / -03

Tighten screws with → ***Molykote***

M = 22.5 ± 2 Nm

Tightening torque for 1.30.7-32.35.00-05 / -06

Tighten screws with → ***Molykote***

M = 40 Nm

If 1.30.7-32.35.00-05 is delivered in exchange for the cams 1.20.7-32.32.01-03 / - 05 / - 07, the enclosed pin is inapplicable. It is only used in exchange for 1.20.7-32.32.01-08.

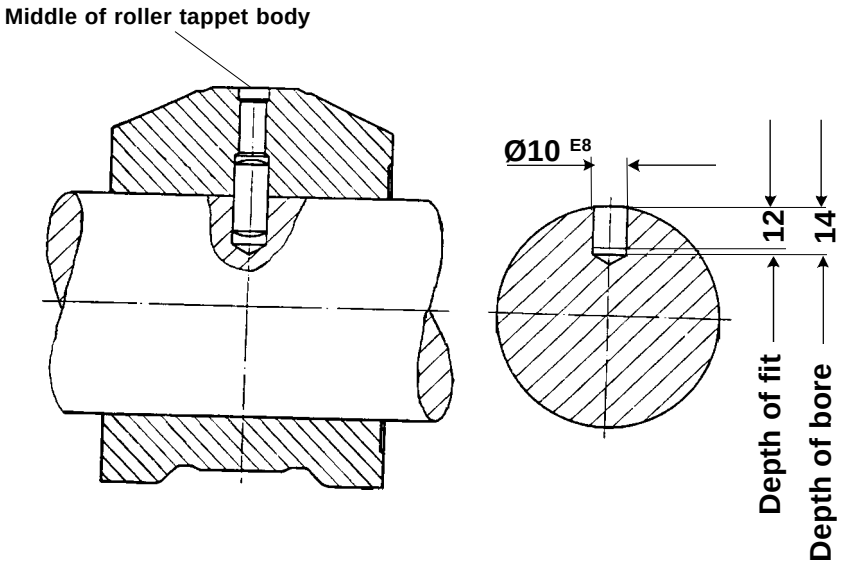
If 1.30.7-32.35.00-06 is delivered in exchange for the cams 1.20.7-32.32.01-02 / - 04 / - 06, the enclosed pin is inapplicable. It is only used in exchange for 1.20.7-32.32.01-08.

Camshaft

In-line engine M281 - M332C

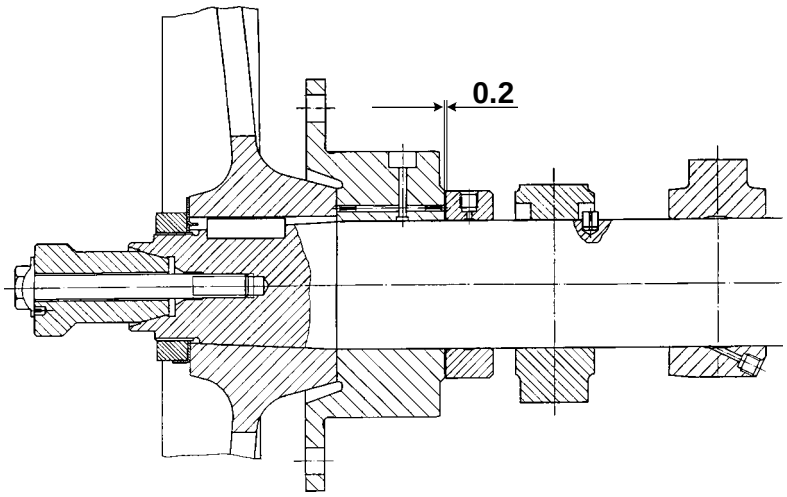
Vee-engine M281 - M282

Mounting instruction for replacement of 1.30.7-32.32.01-08 Bore in camshaft with boring device 00.00-3247



Mounting exhaust cam cyl. 1

If in case of repair the exhaust cam for cyl. 1 must be mounted, the installed set collar has to be disassembled and removed, for lack of space, too. Instead of the set collar the clip 1.20.7.31.99.00-01 is fitted and the demanded end clearance of the camshaft of **0.20 mm** set hereby.



Vee-engine cylinder bank B

Here the unsplit exhaust cam (series cam) must be mounted for cyl. 1. A constructional solution for the split type is not possible.

Pretighten screws manually and alternately in small steps with →
Molykote

M = 30 ± 2 Nm

Camshaft

In-line engine M281 - M332C

Vee-engine M281 - M282

Split inlet cams for non-reversible engines

Engine	Stroke	Series design	Split repair cam
M282 / M332 / M332C	18,4	1.20.7-32.12.01-07 repl. -09	1.20.7-32.13.00-01
M282 / 6 M332	18,4	1.20.7-32.12.01-08	1.20.7-32.13.00-02
M282 / M331 / M332	17	1.30.7-32.12.01-12	1.20.7-32.13.00-03
M282 / M331 / M332	17	1.30.7-32.12.01-13	1.20.7-32.13.00-04
M282 / M331 / M332	17	1.30.7-32.12.01-14	1.20.7-32.13.00-05
M281	17	1.30.7-32.17.01-05	1.20.7-32.13.00-06

Tightening torque for inlet and exhaust cam

Tighten screws with → ***Molykote***

M = 22.5 ± 2 Nm

Split exhaust cans for non-reversible engines

Engine	Stroke	Series design	Split repair cam
M281	17	1.20.7-32.22.01-02	1.20.7-32.23.00-01
6 M281 / 6 M331	17	1.30.7-32.22.01-03 repl. -14	1.20.7-32.23.00-01
8 M282 DB	17	1.30.7-32.22.01-05 repl. -13	1.20.7-32.23.00-02
8 M282 DB	17	1.30.7-32.22.01-07 repl. -13	1.20.7-32.23.00-02
6 M281 / 6 M331	17	1.30.7-32.22.01-08 repl. -14	1.20.7-32.23.00-01
6 M281 / 6 M331	17	1.30.7-32.22.01-09 repl. -14	1.20.7-32.23.00-01
8 M282 / 8 M331	17	1.32.7-32.22.01-02 repl. 1.30.7-32.22.01-07	1.20.7-32.2300-02
M 282 / M332 / M332C	16	1.30.7-32.22.01-12 repl. -16	1.20.7-32.23.00-04
8 M282 / 8 M332 / M332C	17	1.30.7-32.22.01-15	1.20.7-32.23.00-03

Starting air distributor

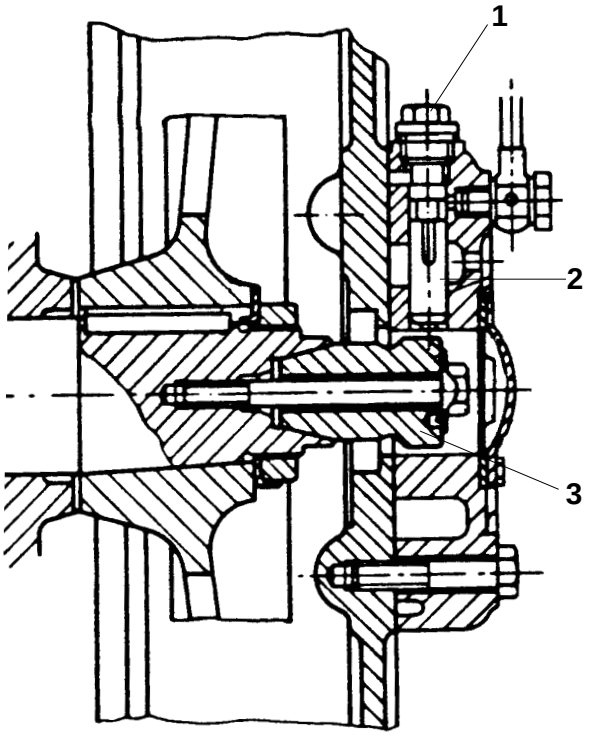
Starting cam

Setting and checkup

1. Turn cylinder 1 in TDC position (firing position).

2. Take a pocket lamp and watch the bore of the locking screw **- 1 -** on the control piston **- 2 -**.

3. Turn the starting cam until the light slit is just visible. Now the starting cam **- 3 -** has reached the position „starting process released“.



Flywheel mounting

In-line engine M281 - M332C

Mounting 1.30.7-73.10.00-02/ -03/ -04

Tighten nuts with → **M = 400 Nm**

Oil

Castle nuts M22 x 1.5 DIN935

Mounting 1.30.7-73.10.00-05/ -06/ -07/ -10/ -11/ -16/ -18/ -20/ -22/ -23/ -24/ -25/ -30/ - 31/ -33

Tighten nuts with → **M = 500 Nm**

Oil

Castle nuts M24 x 1.5 DIN935

Mounting 1.30.7-73.10.00-14/ -15

Pretighten nuts with → **M = 100 Nm**

and tighten with → **Dw = 150°**

Molykote

Castle nuts M24 x 1.5 DIN935 to coupling side

Hexagon nuts M24 x 1.5 DIN934 to crankshaft side

Mountings 1.30.7-73.10.00-26/ -28

Pretighten nuts with → **M = 100 Nm**

and tighten with → **M = 650 Nm**

Molykote

-26 hexagon screws M24 x 220 10.9 DIN931 with clamping nuts M24 DIN 6925

-28 hexagon screws M24 x 170 10.9 DIN931 with clamping nuts M24 DIN 6925

Mounting 1.30.7-73.10.00-29 generator flange connection

Tighten nuts with → **M = 1730 Nm**

Oil

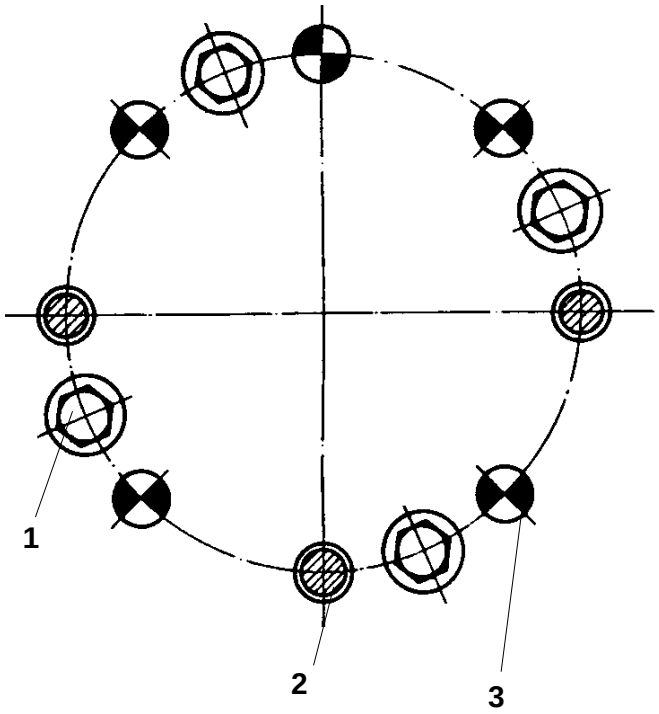
Clamping nuts M36 DIN6925

Flywheel mounting

In-line engine M281 - M332C

The flywheels are bored together with the crankshaft and reamed to **Ø 27 ^{H7}** .
27 ^{H7} → 27 - 27.021
The reamed bolts have 2 mm oversize and are ground according to the bore dimensions.

Arrangement of the reamed, tie and fitting bolts for the variants 1.30.7-73.10.00-16/ -17/ -18/ -20/ -22/ -24/ -31/ -33



1 → Fitting bolts

2 → Tie bolts

3 → Reamed bolts

Flywheel mounting

Vee-engine M281 - M282

Mounting 1.21.7-73.10.00-02/ -06/ -10

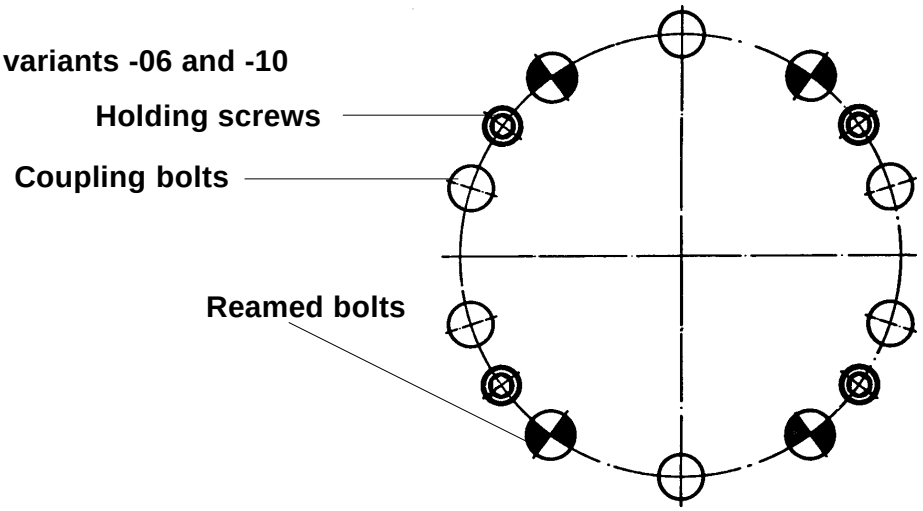
Tighten nuts with → **M = 1000 Nm**

Oil

Variant -02 with 10 reamed bolts

Variants -06 and -10 with 4 reamed bolts and 6 coupling bolts.

Arrangement for the variants -06 and -10



End casing

In-line engine M281 - M332C

Mounting without power take-off

1.30.7-63.10.00-08

Tighten screws with → **M = 330 Nm**

Oil

Screws M20 x 2 x 60 SK DIN961

1.30.7-63.10.00-10

Tighten screws with → **M = 450 Nm**

Oil

Screws M20 x 2 x 65 SK DIN961

1.30.7-63.10.00-12 / -13

Tighten scews with → **M = 450 Nm**

Oil

Screws M20 x 2 x 125 SK DIN960

1.30.7-63.10.00-16 / -17 / -20* / -21

Pretighten screws with → **M = 250 Nm**

and tighten with → **Dw = 60°**

Oil

Tie bolts M20 x 2 x 118, spanner size 30

var. -20 without vibration damper

1.30.7-63.10.00-25

Pretighten screws with → **M = 175 Nm**

and tighten with → **Dw = 120°**

Oil

Tie bolts M20 x 2 x 188, spanner size 30

DIN 960 hexagon screws with shaft

DIN 961 hexagon screws with thread up to the head

End casing

In-line engine M281 - M332C

Mounting with power take-off

1.30.7-63.10.00-07 / -09

Tighten screws with → **M = 330 Nm**

Oil

Screws M20 x 2 x 60 SK DIN961

1.30.7-63.10.00-11

Tighten screws with → **M = 450 Nm**

Oil

Screws M20 x 2 x 65 SK DIN961

1.30.7-63.10.00-14 / -15

Tighten screws with → **M = 450 Nm**

Oil

Screws M20 x 2 x 125 SK DIN961

1.30.7-63.10.00-18 / -19

Pretighten screws with → **M = 250 Nm**

and tighten with → **Dw = 60°**

Oil

Tie bolts M20 x 2 x 118 spanner size 30

1.30.7-63.10.00-22

Pretighten screws with → **M = 175 Nm**

and tighten with → **Dw = 120°**

Oil

Tie bolts M20 x 2 x 188 spanner size 30

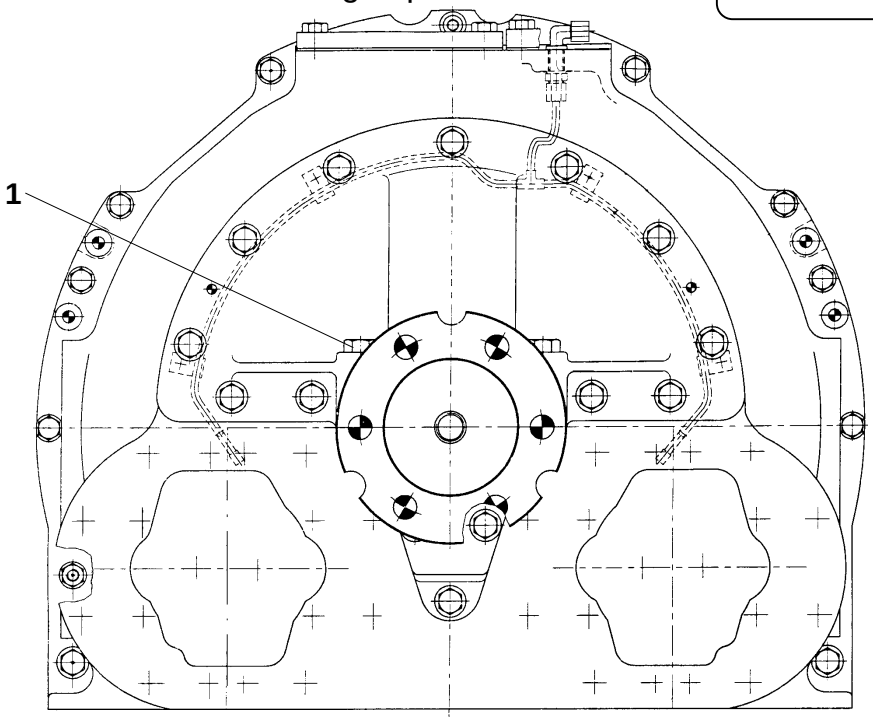
End casing

In-line engine M281 - M332C

Mounting with power take-off

Tighten screws **- 1 -** for bearing cap with → ***Oil***

M = 200 Nm



Mounting with and without power take-off

Tighten screws for gear rim with → ***Oil***

Screws M12 x 65 SK DIN 931

M = 60 Nm

Additional flywheel mass

If an engine is provided with an additional flywheel mass, this is fitted to a mounting shaft. This mounting shaft is led outwards like a power take-off. The additional flywheel mass is reamed together with the flange of the mounting shaft to 0 22 ^{H7}.

The tightening torque of the nuts ***M20 x 2*** is →

M = 280 Nm

End casing

Vee-engine M281-M282

Vibration damper mounting 1.21.7-62.59.00-01 and end casing 1.21.7-63.30.00-03/-04
with and without power take-off

Tighten screws **- 1 -** with →
Oil
Hexagon screws M20 x 2 x 50 DIN961

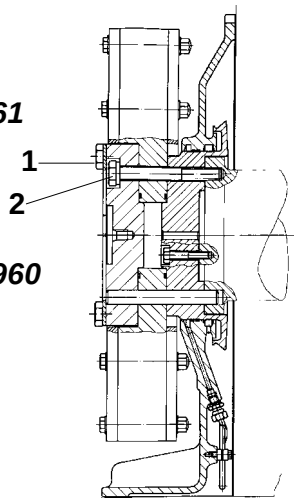
M = 330 Nm

Tighten screws **- 2 -** with →
Oil
Hexagon screws M20 x 2 x 160 DIN960

M = 450 Nm

Tighten screws **M12** with →
Oil

M = 60 Nm



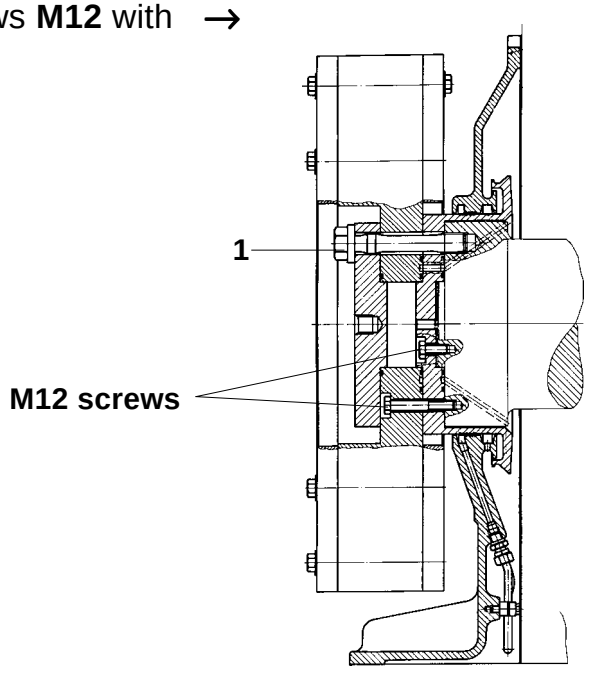
End casing 1.21.7-63.30.00-05

Tighten tie bolts **- 1 -** with →
Oil
Tie bolts M24 x 2 x 130

M = 1000 Nm

Tighten screws **M12** with →
Oil

M = 60 Nm



Lub. oil pump mounting

In-line engine M281 - M332C

Vee-engine M281 - M282

Lub. oil pump mounting

1. Coat cone of gear wheel with blue paste and mount it.

2. Tighten castle nut with → **M = 100 Nm**
   and loosen again.
   Remove the gear wheel and check
   the blueing appearance. In case of deviations from the full-contact blueing appearance only a contact reflection displaced to the thick end is admissible.

3. Mount gear wheel on the dry, grease-free cone,
   pretighten castle nut with → **M = 100 Nm**

   and tighten with → **Dw = 60°**
   Secure nut by split pin. ***Oil***
   Nut M20 x 1.5

The backlash is → **0.20 - 0.50 mm**

Vee-engine M281 - M282

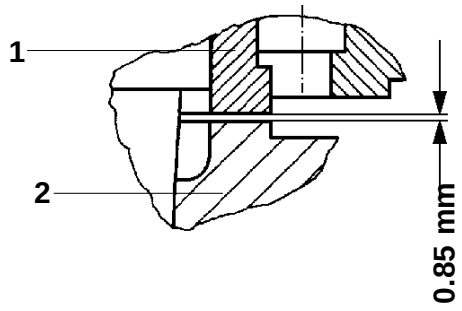
The backlash is → **0.20 mm**

Cooling water pump mounting

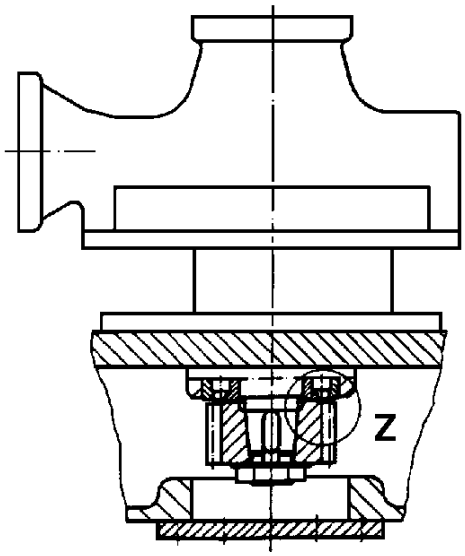
In-line engine M281 - M332C

Vee-engine M281 - M282

Cooling water pump mounting at gear box
If a new pump is fitted, the gear wheel of the existing pump must be modified. The dimension between the inner ring **- 1 -** of the cylinder roller bearing and the gear wheel **- 2 -** must be **0.85 mm**. In this position there must be a full-contact blueing appearance. If not, the gear wheel must be refinished until a full-contact blueing appearance is attained.



To check the blueing appearance the clamping nut of the gear wheel must be tightened with **120 Nm**.



Tightening torque for clamping nut of gear wheel.
Pretighten clamping nut manually **(abt. 50 Nm)** and tighten with →
The shaft must be easily turnable. Secure nut with locking plate.
Hexagon nut M30 x 1.5, spanner size 41.

Dw = 180°

Cooling water pump mounting

In-line engine M281 - M332C

Cooling water pump mounting at end casing

1. Coat cone of gear wheel with blue paste and mount it.

2. Tighten hexagon screw with → **M = 100 Nm**
   and loosen again. Remove gear wheel and check blueing appearance. In case of deviations from the full-contact blueing appearance, only a contact reflection displaced to the thicker end is admissible.

3. Mount gear wheel on the dry, grease-free cone and tighten hexagon screw with → **M = 160 Nm**

Hexagon screw M16 x 80 DIN 931
Lubricant: Oil

The backlash for both mounting variants is → **0.15 - 0.23 mm**

Fuel pump mounting

In-line engine M281 - M332C

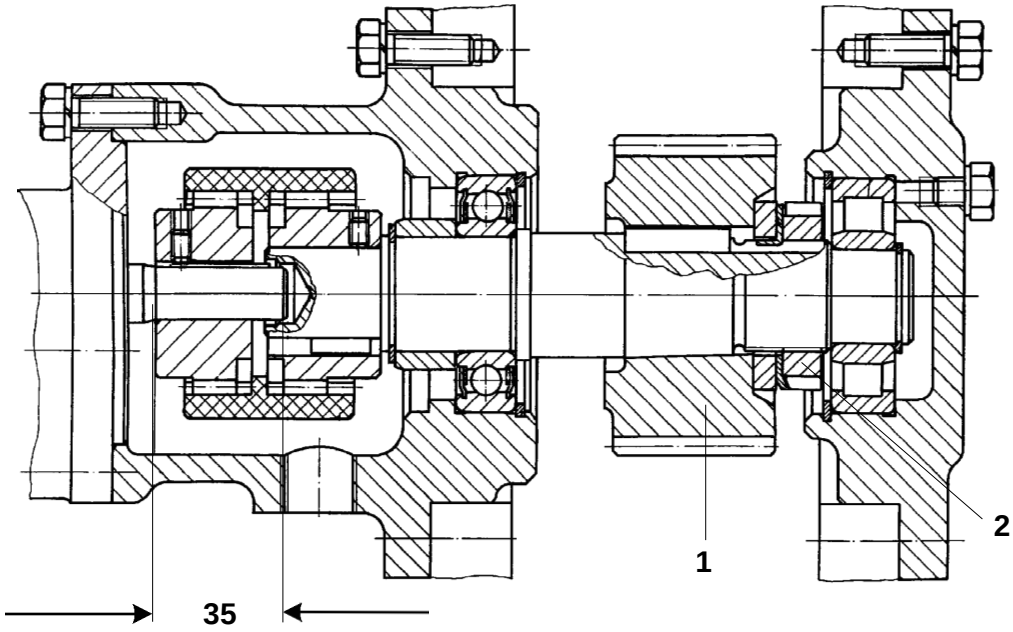
Vee-engine M281 - M282

Fuel pump mounting

Coat cone of gear wheel **- 1 -** with blue paste, pretighten nut **- 2 -** manually and tighten with → (1/2 turn of nut)

Dw = 180°

Nut M30 x 1.5 DIN 1804
If requested, the pump can also be used as fuel transfer pump.



Coat the shaft of the fuel pump and the appertaining coupling half with Loctite 290 and fit them in a way that the dimension as stated in the sketch is observed. Heat the other coupling half up to **150°C** and draw it up to the shaft stop. Fix the coupling halves with the locking screws, secure the locking screws with Loctite 290.

Turbocharger mounting

In-line engine M281 - M332C

For the older engines there are no tightening values. It can only be refered to the tightening values for the DIN-screws in general part of the engineer's handbook.

Mounting VTR251 Coupling side 1.20.7-72.50.00-06 / - 07
Opposite side of coupling 1.20.7-72.55.00-06 / - 08

Tighten screws ***M20x2x45 DIN961*** with → **M = 360 Nm**
Oil

Tighten screws ***M16x100 DIN912*** with → **M = 170 Nm**
Oil

Mounting VTR251 Coupling side 1.20.7-72.50.00-09 / - 10 / -12 / -13
Opposite side of coupling 1.20.7-72.55.00-09 / -10 / -12

Tighten screws ***M20x2x80 DIN961*** with → **M = 285 Nm**
Oil

Tighten screws ***M16x100 DIN912*** with → **M = 170 Nm**
Oil

For the variants 1.20.7-72.55.00-10 / -12 additionally:

Tighten screws ***M20x2x120 DIN960*** with → **M = 285 Nm**
Oil

Mounting TCU NR24/R Coupling side 1.20.7-72.50.00-14 / - 15
Opposite side of coupling 1.20.7-72.55.00-13 / - 14

Tighten screws ***M20*** with → **M = 360 Nm**
Oil
Screws M20x2x80 DIN961
Tighten screws ***M16*** with → **M = 210 Nm**
Oil

1.20.7-72.50.00-14 and 1.20.7-72.55.00-13 M16x55 DIN931; M16x70 DIN931 ; M16x100 DIN931

1.20.7-72.50.00-15 and 1.20.7-72.55.00-14 M16x65 DIN931; M16x70 DIN931 ; M16x100 DIN931

Turbocharger mounting

In-line engine M281 - M332C

Mounting VTC **Coupling side** **1.20.7-72.50.00-17**

Tighten screws ***M20x120 DIN912*** with → **M = 360 Nm**
Oil

Tighten screws ***M20x2x90 DIN961*** with → **M = 500 Nm**
Oil

Tighten screws ***M16*** with → **M = 210 Nm**
Oil
M16x100 DIN912 and M16x110 DIN931

Mounting RR 212 **Coupling side** **1.20.7-72.50.00-12**
Opposite side of coupling **1.20.7-72.55.00-12**

Tighten screws ***M20x2x120 DIN960*** with → **M = 285 Nm**
Oil

Tighten screws ***M16*** with → **M = 170 Nm**
Oil
M16x70 DIN931 and M16x100 DIN912

Mounting RR 212 **Opposite side of coupling** **1.20.7-72.55.00-11**

Tighten screws ***M20x2x45 DIN961*** with → **M = 360 Nm**
Oil

Tighten screws ***M16x100 DIN912*** with → **M = 170 Nm**
Oil

Vee-engine M281 - M282

Mounting VTC

Tighten screws ***M20*** with → **M = 360 Nm**
Oil
M20x2x100 DIN960 and M20x2x170 DIN960

Tighten screws ***M16x100 DIN931*** with → **M = 170 Nm**
Oil

Designation	Length mm	Breadth mm	Height mm	Weight kg
Engine housing				
6M 281 / 282 / 331 / 332	2000	940	1120	2740
8M 281 / 282 / 331 / 332	2640	940	1120	3190
12M 281 / 282	2331	1085	1280	4000
Engine housing with liners				
6M 281 / 282 / 331 / 332	2000	940	1415	2800
8M 281 / 282 / 331 / 332	2640	940	1415	3300
12M 281 / 282	2331	1085	1280	5056
Liner				
All in-line and Vee-type engines	615		299	90
Normal main bearing				
All in-line engines		74	192	2
12M 281 / 282		71	212	2,2
Located main bearing				
All in-line engines		90	225	4,3
12M 281 / 282		95	248	4,5
Big end bearing				
All in-line engines		74	170	1,8
12M 281 / 282		70	180	1,6
Oil sump				
6M 281 / 282 / 331 / 332	2295	660	225	112
8M 281 / 282 / 331 / 332	2935	660	225	150
12M 281 / 282	2668	668	265/445	151/240
Crankshaft				
6M 281	2245		440	675
6M 282	2245		440	705
6M 331 / 332	2245		500	740

Designation	Length mm	Breadth mm	Height mm	Weight kg
Crankshaft				
8M 282	**2885**		**440**	**910**
8M 331 / 332	**2885**		**500**	**960**
12M 281 / 282	**2604**		**521**	**830**
Gear wheel on crankshaft				
All in-line and Vee-type engines		**96**	**277**	**17,4**
Connecting rod				
6M 281	**781**	**86**	**245**	**28,5**
All other in-line engines	**799**	**86**	**250**	**29**
12M 281 / 282	**805**	**86**	**238**	**30**
Piston (light metal)				
6M and 8M 281 / 282	**360**		**240**	**22**
6M and 8M 331	**320**		**240**	**20**
6M and 8M 332	**311**		**240**	**20**
Cylinder head compl.				
8M 281 / 6 and 8M 331	**490**	**318**	**438**	**105**
6M 282 and 8M 282 / 332	**490**	**318**	**438**	**115**
12 M 281 / 282	**485**	**310**	**360**	**107**
Camshaft compl.				
6M 281 / 282 / 331 / 332	**2102**		**135**	**100**
8M 282 / 331 / 332	**2742**		**135**	**120**
12M 281 / 282	**2426**		**140**	**128**
Gear wheel on camshaft				
6M and 8M 331 / 332 6M 281		**89**	**542**	**28**
6M and 8M 282		**90**	**542**	**35**
12M 281 / 282		**50**	**542**	**27**

Designation	Length mm	Breadth mm	Height mm	Weight kg
Turbocharger				
BBC RR180	**587**		**400**	**75**
BBC VTR160	**680**		**410**	**135**
BBC VTR200	**789**		**460**	**195**
BBC VTR201	**968**		**460**	**280**
BBC VTR250	**979**		**580**	**335**
BBC VTR251	**1170**		**580**	**380**
Woodward governor				
UG 8 D	**402**	**146**	**133**	**23**
PGA	**432**	**237**	**580/690**	**60**
Gear box				
All in-line engines	**1006**	**125**	**1115**	**96**
12M 281 / 282	**1620**	**125**	**888**	**141**
Intermediate wheel		**70**	**376**	**13,5**
Centrifugal cooling water pump	**310**	**250**	**296**	**32**
Sea water pump	**410**	**310**	**500**	**55**
End casing	**680**	**202**	**558**	**58**
Gear for oil pump drive				
6M and 8M 282		**55**	**303**	**6,6**
6M 281 / 331 / 332		**55**	**331**	**6,6**
Lub.- oil pump				
All in-line engines	**465**	**210**	**245**	**45**
12M 281 / 282	**511**	**273**	**354**	**110**
Charge air cooler				
6M 281 / 282 / 331 and 12M282	**675**	**375**	**360**	**155**
6M 282 / 332	**375**	**375**	**360**	**167**

Designation	Length mm	Breadth mm	Height mm	Weight kg
Charge air cooler				
8M 282 / 331 / 332	**675**	**375**	**420**	**191**
8M 282 / 332	**845**	**395**	**420**	**230**
Holset-damper				
6M 282 and 8M 282 / 331 / 332		**76**	**470**	**73**
12M 281 / 282		**100**	**630**	**225**
Charge air duct				
6M 281 / 282 / 331 / 332	**2000**	**300**	**365**	**175**
8M 282 / 331 / 332	**2640**	**300**	**365**	**220**
Total weight of engine without flywheel				
6M 281				**7800**
8M 281				**9400**
6M 282 / 331 / 332				**8100/8560**
8M 282 / 331 / 332				**10300**
12M 281 / 282				**12700**