

01-1120 Measuring, honing and silicon-lapping cylinder bores

Matching pistons to crankcase with numerical identification

Engine 119.960/970/972/974	Class identification	Index	Piston Ø ¹⁾	Cylinder Ø ²⁾
Standard size Std 96.5 Ø	0	52	96.483-96.493	96.498-96.503
	0+	53	96.488-96.498	96.503-96.508
	1	54	96.493-96.503	96.508-96.513
	1+	55	96.498-96.508	96.513-96.518
	2	56	96.503-96.513	96.518-96.523
1st repair size + 0.5	0		96.983-96.993	96.998-97.003
	1		96.993-97.003	97.008-97.013
	2		97.003-97.013	97.018-97.023
2nd repair size + 1.0	0		97.483-97.493	97.498-97.503
	1		97.493-97.503	97.508-97.513
	2		97.503-97.513	97.518-97.523

1) Group identification stamped on piston crown with color.

2) Group identification stamped at top next to cylinder bore.

Matching pistons to crankcase with letter identification

Engine 119.980/982/970/972/974	Group identification	Index	Piston Ø ³⁾	Cylinder Ø ²⁾
Standard size Std 96.5 Ø	A	52	96.482-96.495	96.500-96.508
	B	54	96.491-96.504	96.508-96.516
	C	56	96.499-96.512	96.516-96.524
1st repair size + 0.5	A		96.982-96.995	97.000-97.008
	B		96.991-97.004	97.008-97.016
	C		96.999-97.012	97.016-97.024
2nd repair size + 1.0	A		97.482-97.495	97.000-97.508
	B		97.491-97.504	97.508-97.516
	C		97.499-97.512	97.516-97.524

2) Group identification stamped at top next to cylinder bore.

3) Group identification stamped on piston crown.

Matching pistons to crankcase with numerical identification

Engine 119.971/975/981/985	Group identification	Index	Piston Ø ¹⁾	Cylinder Ø ²⁾
Standard size Std 92.0 Ø	0	52	91.983–91.993	91.998–92.003
	0+	53	91.988–91.998	92.003–92.008
	1	54	91.993–92.003	92.008–92.013
	1+	55	91.998–92.008	92.013–92.018
	2	56	92.003–92.013	92.018–92.023
1st repair size + 0.5	0		92.483–92.493	92.498–92.503
	1		92.493–92.503	92.508–92.513
	2		92.503–92.513	92.518–92.523
2nd repair size + 1.0	0		92.983–92.993	92.998–93.003
	1		92.993–93.003	93.008–93.013
	2		93.003–93.013	93.018–93.023

1) Group identification stamped on piston crown with color.

2) Size stamped at top next to cylinder bore.

Matching pistons to crankcase with letter identification

Engine 119.971/975/981/985	Group identification	Index	Piston Ø ³⁾	Cylinder Ø ²⁾
Standard size Std 92.0 Ø	A	52	91.982–91.995	92.000–92.008
	B	54	91.991–92.004	92.008–92.016
	C	56	91.999–92.012	92.016–92.024
1st repair size + 0.5	A		92.482–92.495	92.500–92.508
	B		92.491–92.504	92.508–92.516
	C		92.499–92.512	92.516–92.524
2nd repair size + 1.0	A		92.982–92.995	93.000–93.008
	B		92.991–93.004	93.008–93.016
	C		92.999–93.012	93.016–93.024

2) Group identification stamped at top next to cylinder bore.

3) Group identification stamped on piston crown.

Piston clearance	When new	0.004–0.026
	Wear limit	0.08
Maximum wear limit of cylinder bores in direction of travel or transverse direction at top and bottom reversal point of 1st piston ring		0.10

Machining tolerances

Permissible variation of cylinder shape	When new	0.013
	Wear limit	0.05
Permissible variation of rectangularity related to cylinder height		0.05
Averaged peak-to-valley height (Rz) after polishing		0.001
Averaged peak-to-valley height (Rz) after silicon-lapping		0.001 – 0.003
Permissible wave depth (Wt)	50 % of peak-to-valley height after silicone-lapping	
Chamfer of cylinder bores	see ill. step 14	

Note

See pistons, matching and dimensions 03–3165 for further tolerances and assignments.

Commercial tools

Automatic cylinder repair machine
SUNNEN CK-10-G with honing oil filter and oil cooler
or CV 616

Honing head CK-3000 for dia. 76–127 mm
or CK-2600

SUNNEN honing oil MB 30¹⁾

Prehoning stone set C 30-A 53, 70 mm long²⁾

Final honing stone set C 30-J 84, 70 mm long²⁾

Polishing stone set C 30-C 03-81

Stone holder for felt insert CK-30 35

Felt insert holder set CK-3130

Felt insert C 30-F 85

SUNNEN silicon paste AN-30

Box for silicon paste and
felt inserts AN-35

Internal measuring instrument for 50 – 150 mm dia., with
0.01 mm indication and measuring point pressure relief,
e. g. SUNNEN GRM 2125

Setting micrometer for internal measuring instrument
GAM 2125 with setting range 50 – 200 mm, e.g. SUNNEN
CF-1000 M

1) When refilling approx. 170 liters.

2) These stones are available only with a length of 89 mm and must be shortened at the top to 70 mm with a hacksaw (see step 3).

Germany:

e. g. Hommel Handel GmbH
Donatusstraße 24, D-5000 Köln 71

other countries:

e. g. SUNNEN Products Comp.
USA-7910 Manchester
St. Louis, Mo. 63143

Hommel Handel Export Division
P.O. Box 1206
D-6806 Viernheim

Note

The light alloy cylinder bores are very sensitive to damage, scratching and also dirt and must therefore be handled with great care.

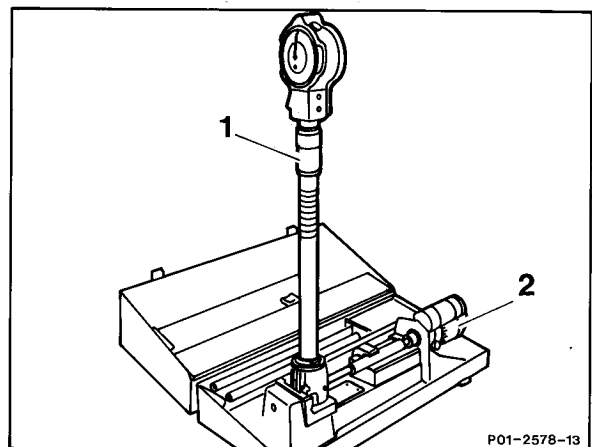
The cylinder bores should be adapted when honing to the sizes of the available repair size pistons with the Group No. 0, 1 or 2. The specified piston clearance must be observed.

Measuring

Use a measuring instrument with measuring point pressure relief for measuring the cylinder bores as the cylinder barrel will otherwise be scored by the measuring point tip and the measuring point tip of the instrument will wear prematurely.

Set the self-centering internal measuring instrument to the cylinder dia. before measuring. Measure the cylinder bores at a room temperature of 22 – 24 °C.

- 1 Internal measuring instrument
- 2 Setting micrometer



Following silicon-lapping (final state) it is only possible to measure the amount by which the aluminium surfaces stand back between the silicon crystals (0.5 – 1.5 μm) indirectly by means of the averaged peak-to-valley height (Rz).

The specified exposed depth of the silicon crystals results from the limited-time control during silicon-lapping and from the silicon paste used.

Honing and silicon-lapping

Where severe scoring and severe cylinder wear exists ($> 0.10\text{ mm}$) etc., the cylinder bores can be honed to the stated repair sizes.

The silicon crystals must be undamaged and be flattened on the cylinder surface following the honing operations.

After the honing operations (prehoning, final honing and polishing) it is essential to perform "silicon-lapping" based on the Sunnen method so that the silicon crystals are exposed.

If the "silicon-lapping" operation is not performed, this will inevitably result in piston seizure.



The following operations can only be performed with a honing machine with honing oil filter and oil cooler.

The silicon particles must be filtered out of the honing oil.

The honing oil must be cooled to a constant temperature of 20 °C to avoid excessive heating of the crankcase.

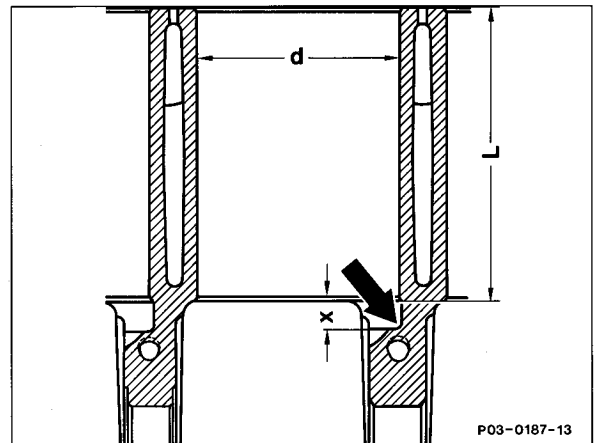
Only the specified honing oil may be used to achieve good honing quality.

1 Prepare honing machine CK-10-G.

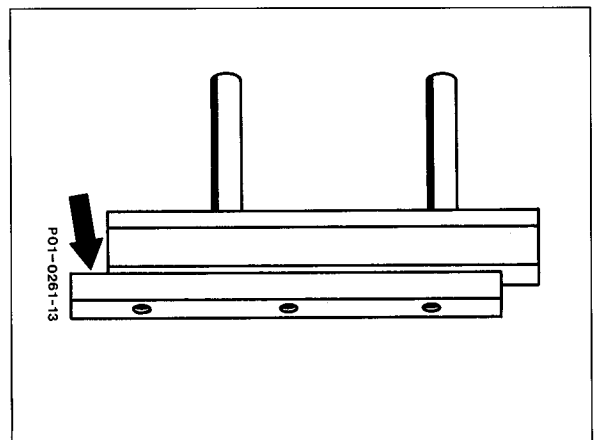
Perform all the honing and lapping operations without the direction guide shoes.

The honing stone runout (arrow) size x:

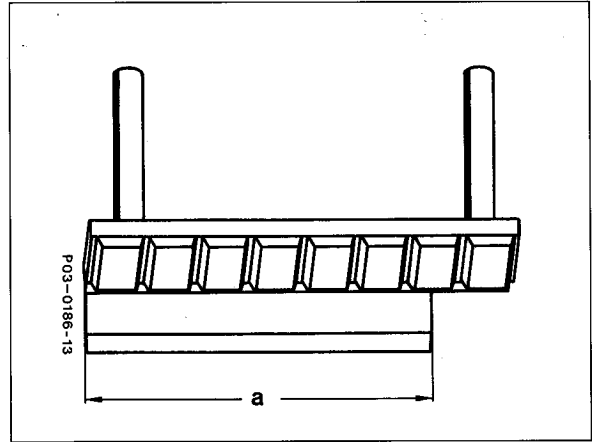
Engine 119.96	14 mm
Engine 119.97	13.5 mm



2 Cut off projection of bronze bars at bottom of main guide shoe (arrow) as only approx. 14 mm undercut for the honing stone runout is available at the cylinders.

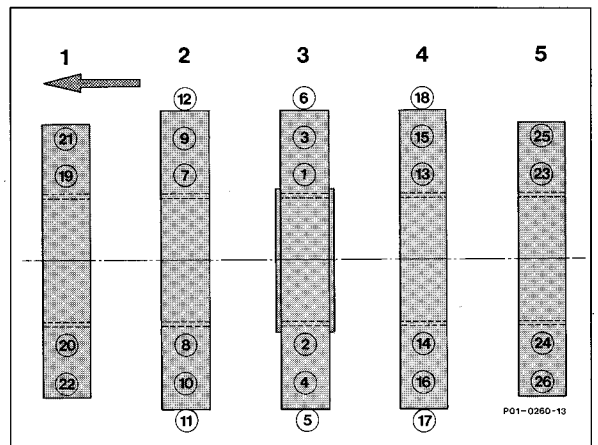


3 The specified stone sets of 89 mm length must be shortened to 70 mm. Only the honing stone, not the holder, should be cut off at the top with a hacksaw.

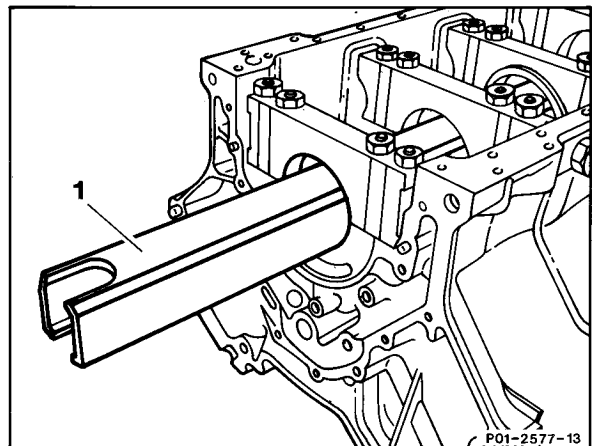


Size a = 70 mm

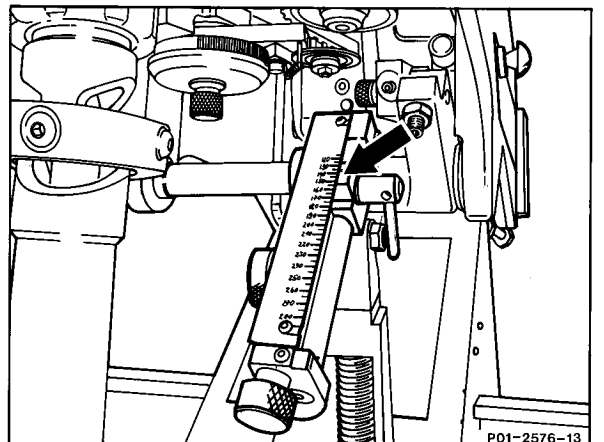
4 Tighten crankshaft bearing cap bolts and nuts to 50 Nm in the order of the tightening diagram.



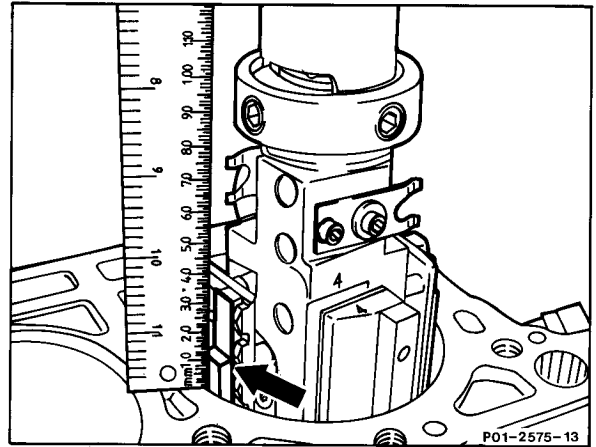
5 Fix disassembled and cleaned crankcase with crankshaft bearing caps installed and tightened in the honing machine with the square steel bar (1).



6 Set stroke setting (cylinder length) on the stroke scale (arrow) according to the "prehoning" table.

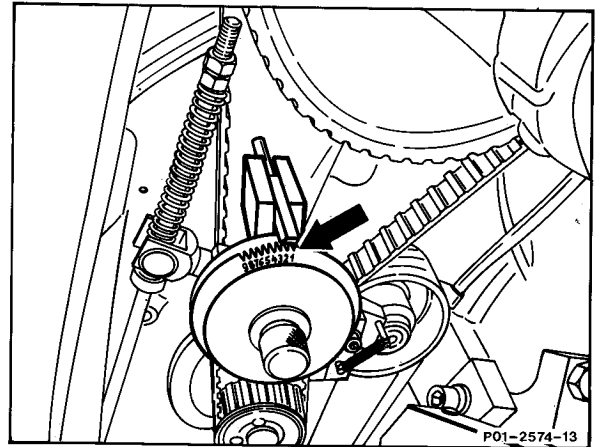


7 Set stone projection (arrow) with the gauge according to the table.



8 Set feed (arrow) according to table.

9 Set strokes/min and rpm according to table.



Prehoning

Setting of honing machine

Engine	119.960	119.970 119.974	119.971
Cylinder dia. setting for 1st repair size (+ 0.5)	96.5 mm	96.5 mm	92.0 mm
Cylinder length (L)	154 mm		137.5 mm
Stroke setting	156 mm		140 mm
Revolutions/min		125	
Strokes/min		49 (CK-10-G)	57 (CV616)
Feed		4	
Stone projection		approx. 12 mm	
Prehoning stone set		C 30-A 53 (C30-J55)	
Indication %		approx. 30	
Stock removal/min		0.07 mm	
Feed scale/stock removal		10 graduations/0.05 mm	

10 Prehone all the cylinder bores at full honing oil feed up to approx. 0.08 mm before final size otherwise the silicon crystals will be torn out or destroyed by the cutting pressure.



A deviation of approx. +0.02 mm is obtained when measuring immediately after pre honing as a result of heating.

The heating of the crankcase is dependent among other things on the outside temperature.

11 Insert stone set for final honing and cut to length as described in step 3.

12 Set honing machine according to the "precision honing" table.

Precision honing

Setting of honing machine

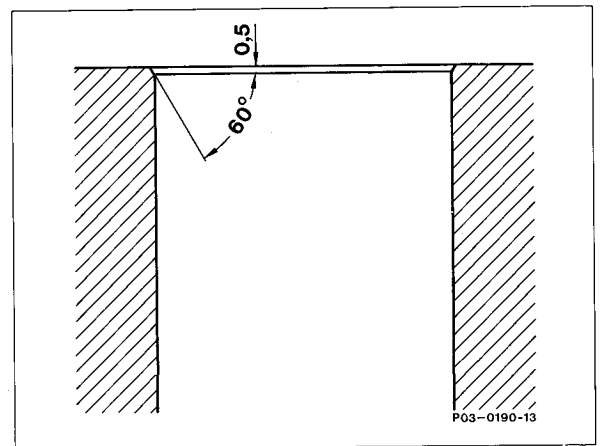
Engine	119.960	119.970 119.974	119.971
Cylinder dia. setting for 1st repair size (+0.5)	96.92 mm	96.92 mm	92.42 mm
Cylinder length (L)	154 mm		137.5 mm
Stroke setting	156 mm		140 mm
Revolutions/min		125	
Strokes/min		49 (CK-10-G) 57 (CV616)	
Feed		3	
Stone projection		approx. 12 mm	
Precision honing stone set		C 30-J 84	
Indication %		approx. 30	
Stock removal/min		0.05 mm	
Feed scale/stock removal		10 graduations/0.05 mm	

13 Precision-hone all cylinder bores at full honing oil feed up to approx. 0.02 mm before final size.

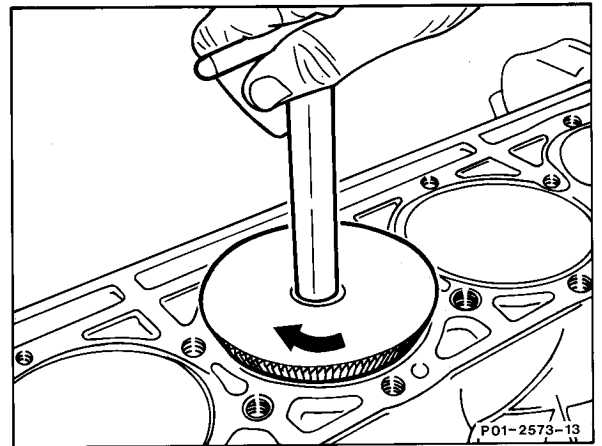


A deviation of approx. +0.01 mm is obtained when measuring directly after precision-honing as a result of heating. Heating of the crankcase is dependent among other things on the outside temperature.

14 Chamfer cylinder bores according to the sketch prior to "polishing".



15 For chamfering, use a suitable handmilling cutter with an angle as shown in the sketch above.



16 Insert stone set for polishing.

New polishing stones should be corrected in the tightest cylinder bore before starting machining.

17 Set honing machine according to "polishing" table.

Polishing

Setting of honing machine

Engine	119.960	119.970 119.974	119.971
Cylinder dia. setting for 1st repair size (+ 0.5)	96.98 mm	96.98 mm	92.48 mm
Cylinder length (L)	154 mm		137.5 mm
Stroke setting	156 mm		140 mm
Revolutions/min		125	
Strokes/min		49 (CK-10-G)	57 (CV616)
Feed		2	
Stone projection		approx. 12 mm	
Polishing stone set		C 30-C 03-81	
Indication %		approx. 30	
Stock removal/min		0.01 mm	
Feed scale/stock removal		10 graduations/0.01 mm	

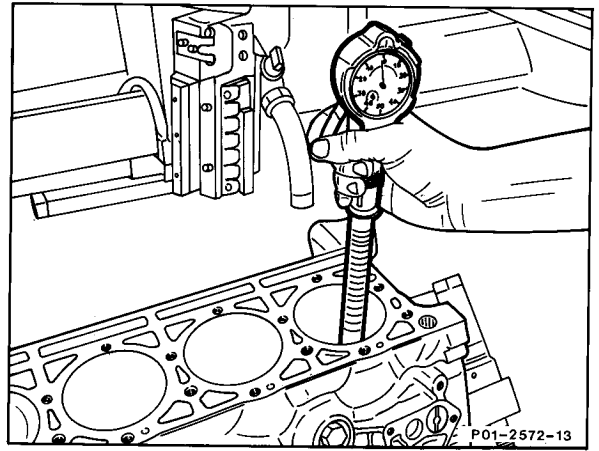
18 Polish all cylinder bores at full honing oil feed up to end size.

19 Allow crankcase to cool.

20 Measure cylinder bores.

When performing this step, allow for the required cylinder dia. (Group No.) for the existing pistons and the specified piston clearance.

Re-polish once again if necessary.

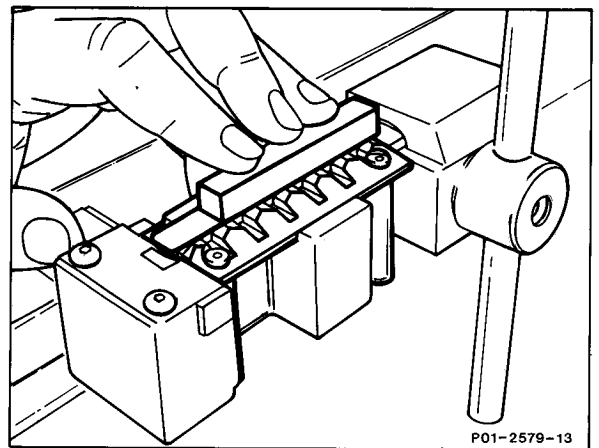


21 Clean cylinder walls with filtered honing oil so that all silicon particles are removed and do not cause any scratches during the subsequent silicon-lapping operation.

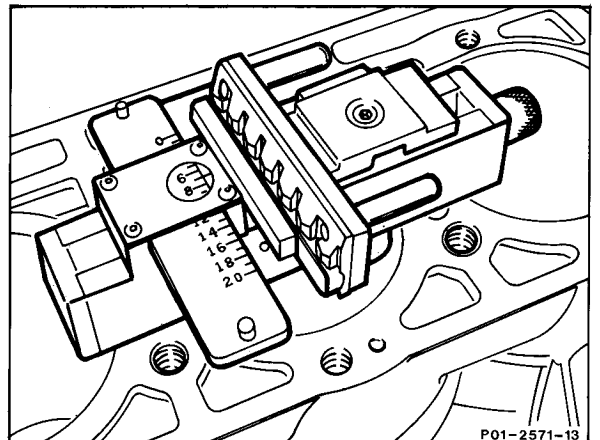
22 Press felt inserts C 30-F 85 into the holders CK-3130 and the latter into the stone holders CK-3035.



After pressing in the felt inserts, remove all material deposits on the holder.



23 Perform setting of cylinder diameter with the setting gauge.



24 Soak felt inserts with filtered honing oil and insert into the honing head.

25 Shut off honing oil feed.

26 Set honing machine according to "silicon-lapping" table.

Silicon-lapping

Setting of honing machine

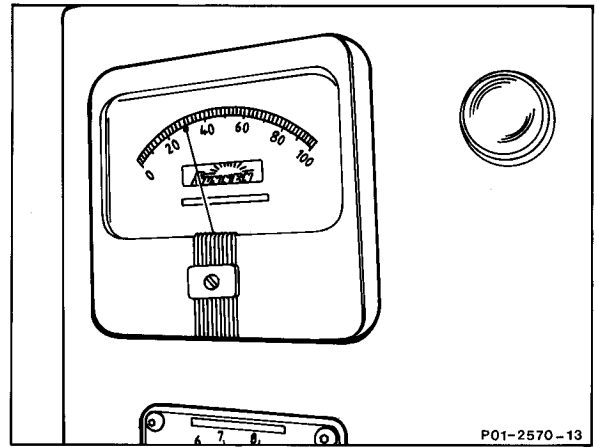
Engine	119.960	119.970 119.974	119.971
Cylinder dia. setting for 1st repair size (+0.5)	97 mm	97 mm	92.5 mm
Cylinder length	154 mm	137.5 mm	
Stroke setting	140 mm	124 mm	
Revolutions/min		185 (CK-10-G)	230 (CV616)
Strokes/min		73 (CK-10-G)	80 (CV616)
Infeed		2	
Felt insert projection		2 mm	
Felt insert		C 30-F 85	
Indication %		ca. 30	
Stock removal/min		not measurable	
Feed scale		18 graduations approx. 70 seconds operation	

27 Thoroughly stir AN-30 silicon paste and then rub into the dry cylinder walls fully.

28 Likewise apply silicon paste to felt inserts.

29 Introduce honing head with felt inserts into cylinder bore.

30 With honing machine running, slowly turn the feed wheel to the right until the indicating instrument has reached 30 %.

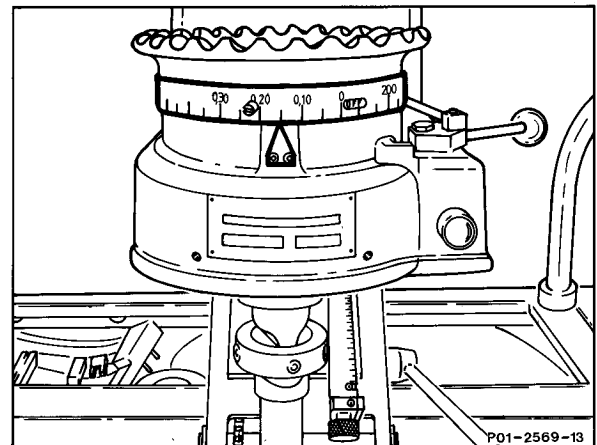


31 Set feed scale to 18 graduations.

The honing machine switches off after approx. 70 seconds. The cylinder surface then has a mat appearance.

No honing angle is visible.

The peak-to-valley height is 0.001 – 0.003 mm.



32 Thoroughly clean all silicon paste residues from cylinder bores with filtered honing oil and a suitable soft-bristle brush and dry cylinder bores.

Used silicon paste must not be re-used!

