OPERATING MANUAL
CUT KNURLING TOOL
RF1 231

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Please read this operating manual carefully. Correct assembly and handling of the tool will save you set-up time and allow you to achieve optimal results.

KNURLING PROFILES AND PODUCTION PROCESS

Series 231	
Machining direction	Knurling profiles on the workpiece: RAA / RBL / RBR
axial	Selection of knurling wheels: 1 x BR30° (right-hand use) 1 x BL30° (left-hand use) / 1 x AA (Left-hand use) / 1 x AA (Right-hand use)

Table 1: Knurling profiles

Knurling profile	Manufacturing process	Knurling profile	Manufacturing process
RAA knurl with straight pattern	Workpiece, Knurling RAA, Knurling wheel BR30°	RBL left-hand knurl 30°	Knurling wheel AA, Knurling RBL, Workpiece
	Knurling wheel BL30°, Knurling RAA, Workpiece	RBR right-hand knurl 30°	Knurling RBR, Workpiece, Knurling wheel AA

Table 2: Manufacturing process

Series 231 Swiss type turning lathe

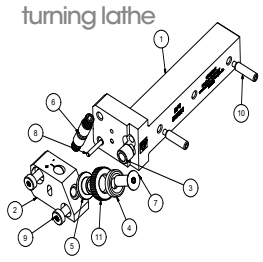

Fig. 1: Series 231 exploded drawing Swiss type turning lathe

Series 231 CNC- lathe

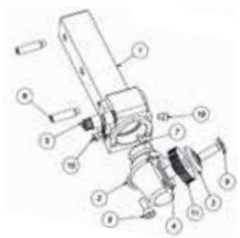

Fig. 2: Series 231 exploded drawing CNC-lathe

Ordering spare parts:
Please specify the tool number and the corresponding position number (see Fig. 1 – 2).

TOOL SETTING

1. General information

Produce a chamfer (30° – 45°) on the workpiece with a minimum width corresponding to half of the pitch of the knurling wheel on the start of the workpiece or after a plunge cut (cf. Figure 3 + 4). The concentricity of the workpiece must be max. 0.03 mm.
The centre height is integrated in the tool and corresponds to the upper shaft edge (Fig. 1 + Fig. 2, pos. 1).

2. Knurling wheel assembly

For mounting or replacement of the knurling wheel (Fig. 1, pos. 11; Fig. 2, pos. 11), first completely unscrew the countersunk screw (Fig. 2, pos. 9, Fig. 1, pos. 7) and remove the knurling wheel and bearing bush (Fig. 1, pos. 5; Fig. 2, pos. 4) and cover plate (Fig. 1, pos. 4; Fig. 2, pos. 3). Then fit the knurling wheel and the cover plate on the bearing bush and re-tighten with the countersunk screw.
Observe the torque specification in Table 3, chapter 7!

3. Tool setting

The following points correspond to the processes in Figure 3 and must be followed for optimal adjustment and use of the tool.

1. Clamping position
Clamp the tool at an angle of 90° to the workpiece and align (Fig. 3, ref. A). The clearance angle is integrated in the knurl cutting head (Fig. 1, pos. 2; Fig. 2, pos. 2)

2. Approach of the workpiece
Scratch the workpiece slightly with the tool. The maximum immersion depth should only be a few hundredths (Fig. 3, ref. B)

3. Check the knurl impression
Check to ensure the correct knurl impression. With correct use, the knurl impression is approx. 1/3 of the width of the knurling wheel (Fig. 4, ref. 4.1)

4. Correction of the clearance angle
If a knurl impression is created as shown in Figure 4, ref. 4.2 or 4.3, the clearance angle must be adjusted with the threaded pins (Fig. 1, pos. 10; Fig. 2, pos. 6) (Fig. 3, ref. D).
Then you can proceed with chapter 4, Adjustment of the profile depth.
Note: For machining of softer materials, such as brass, a higher clearance angle should be used (max. 5°)
The optimal setting must be determined in the process.

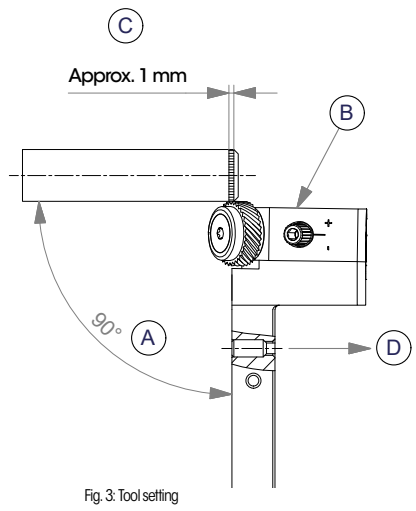

Fig. 3: Tool setting

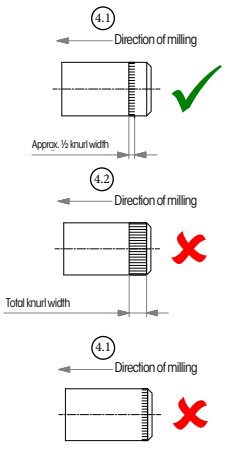

Fig. 4: Check of the knurl impression

APPLICATION

4. Adjustment of the profile depth and feed rate in X direction

The profile depth is set approx. 1mm behind the chamfer of the workpiece in the X direction and corresponds to approximately the half pitch p (with 90° flank angle), (cf. Fig. 3, ref. C). After reaching the limit depth, the dwell time of the tool should be 3 – 10 revolutions of the workpiece. Then move in the Z-direction until the desired knurl width is achieved. Disengage the tool while the spindle is rotating. The correct profile depth has been reached when the profile is knurled completely (Fig. 5, ref. 1). A new setting takes place when the profile is not completely formed (Fig. 5, ref. 2). Re-adjustment in the profile is possible, because the knurling wheels catch in the existing profile.
For guideline values for feed rate and cutting speed, please refer to Table 5, chapter 9.

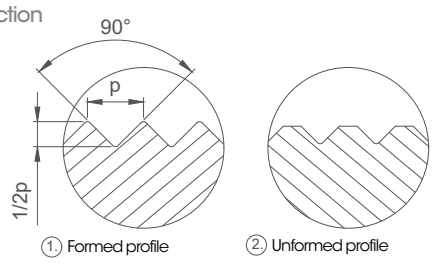

Fig. 5: Different profile pattern

Note: Setting the profile depth = $\frac{\text{pitch}}{2}$ (with 90° flank angle)

5. Error correction of the profile

If spirals are formed during production of RAA profile, a correction can be made by adjusting the knurling head. For this purpose, unscrew the locking screws (Fig. 1, pos. 9; Fig. 2, pos. 8) and, using the spindle (Fig. 1, pos. 6; Fig. 2, pos. 5), tilt the cutting head anticlockwise or clockwise (Fig. 6). The angle of RBL/RBR profiles can also be corrected with the same adjustment.
Then re-tighten the locking screws.

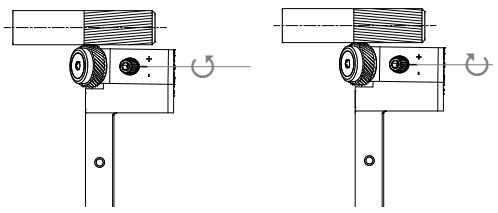

Fig. 6: Error correction in case spirals are formed in the profile

6. Modularity of the knurl holder

With this tool, the tool head can be installed modularly rotated 180°. The following points relate to the processes in Figure 7 and Figure 8 and must be observed precisely.

Series 231 Swiss type turning lathe (Fig. 7):
1. Unscrew the locking screws completely
2. Remove the knurl cutting head and knurling wheel
3. Position the centring sleeve in the upper centring
4. Rotate the knurl cutting head and knurling wheel 180° until the marks L and L line up
5. Then securely re-mount the head with the locking screws

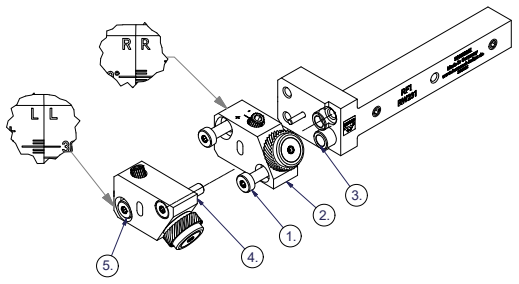

Fig. 7: 231LD conversion from R to L

Series 231 CNC-lathe (Fig. 8):
1. Unscrew cylinder head screw and threaded pins completely
2. Remove the knurl cutting head and knurling wheel
3. Turn the knurl cutting head 120° so that the knurling wheel lines up with the mark L
4. Slide feather key (Fig. 2, pos. 7) into the upper slot
5. Insert the head in the shank. Then screw in the cylinder head screw and threaded pins again and mount the cutting head

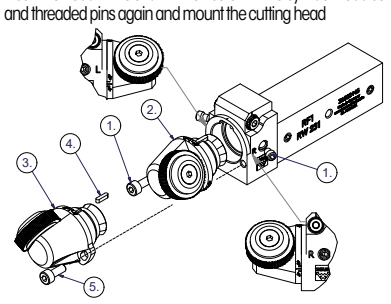

Fig. 8: 231KD conversion from R to L

Note: After conversion from right to left, the knurling wheel must be changed from BR30° to BL30° in order to produce the RAA profile!

7. Manufacturer's recommendations

Replace the bearing bush (Fig. 1, pos. 5; Fig. 2, pos. 4), cover plate (Fig. 1, pos. 4; Fig. 2, pos. 3) and countersunk screw (Fig. 1, pos. 7; Fig. 2, pos. 9) after a reasonable number of cycles, no later than upon appearance of significant wear or deviating process parameters.
An adequate flow of coolant or cutting oil is recommended!
Note: A material distortion of min. 0.03 mm and max. 0.1 mm can arise during the machining.
Note: Extension length of the knurl cutting wheel in the X-direction is approx. Y = 5 mm (Fig. 9).

Extension length Y = 5 mm

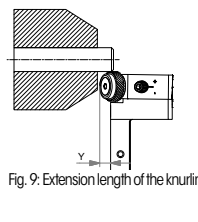

Fig. 9: Extension length of the knurling wheel in X direction

Designation	Torque	Pos. no.
M4 locking screw	3.5 Nm	Fig. 1, pos. 9 Fig. 2, pos. 8
M5 countersunk screw	3,5 Nm	Fig. 1, pos. 7 Fig. 2, pos. 9

Table 3: Torque specifications

8. Troubleshooting

IMPORTANT

Problem:	Reason / Cause:	Solution:
The knurled profile is not completely formed, surface on the tooth tip	The profile depth setting is not correct	Adjust the profile depth setting as specified in chapter 4
Knurled profile is knurled unevenly	– Deficient concentricity of the workpiece – Bending of the workpiece due to excessive projection	– Turn workpiece diameter – Check extension length and clamping pressure – Support workpiece
Spirals are formed in the knurled profile	– Workpiece deflects – Incorrect adjustment or incorrect approach – Tilt of the cutting head incorrect	– Check extension length / support workpiece – Adjustment of the profile depth takes place in the component (cf. chapter 4) – Adjust the tilt of the cutting head (cf. chapter 5)
The finished diameter of the workpiece is not correct or has a cone	– The profile depth setting is not correct – Clearance angle adjustment of the tool is incorrect	– Adjust the profile depth setting as specified in chapter 4 – Correct the clearance angle as specified in chapter 3

Table 4: Troubleshooting

9. Guidelines for cutting speed and feed rates

Material	Workpiece Ø [mm]	Knurling wheel Ø [mm]	Vc [m/min]		f [mm/U]					
					Radial		Axial			
							Pitch [mm]			
			from	to	from	to	> 0.3 < 0.5	> 0.5 < 1.0	> 1.0 < 1.5	> 1.5 < 2.0
Free-cutting steel	< 10	10 / 15	40	70	0.04	0.08	0.20	0.13	0.08	0.07
	10 – 40	15/25	50	90	0.05	0.10	0.28	0.18	0.14	0.10
	40 – 100	25/32/42	65	110	0.05	0.10	0.35	0.25	0.17	0.11
	100 – 250	25/32/42	65	110	0.05	0.10	0.42	0.28	0.18	0.13
	> 250	32/42	80	100	0.05	0.10	0.45	0.29	0.20	0.14
Stainless steel	< 10	10 / 15	22	40	0.04	0.08	0.14	0.09	0.06	0.05
	10 – 40	15/25	30	50	0.05	0.10	0.20	0.13	0.10	0.07
	40 – 100	25/32/42	35	60	0.05	0.10	0.25	0.18	0.12	0.08
	100 – 250	25/32/42	35	60	0.05	0.10	0.29	0.20	0.13	0.09
	> 250	32/42	45	55	0.05	0.10	0.31	0.21	0.14	0.10
Brass	< 10	10 / 15	55	100	0.04	0.08	0.22	0.14	0.09	0.08
	10 – 40	15/25	70	125	0.05	0.10	0.31	0.20	0.15	0.11
	40 – 100	25/32/42	90	155	0.05	0.10	0.39	0.28	0.18	0.12
	100 – 250	25/32/42	90	155	0.05	0.10	0.46	0.31	0.20	0.14
	> 250	32/42	115	140	0.05	0.10	0.49	0.32	0.22	0.15
Aluminium	< 10	10 / 15	70	120	0.04	0.08	0.12	0.08	0.05	0.04
	10 – 40	15/25	80	150	0.05	0.10	0.17	0.11	0.08	0.06
	40 – 100	25/32/42	110	160	0.05	0.10	0.21	0.15	0.10	0.07
	100 – 250	25/32/42	110	160	0.05	0.10	0.25	0.17	0.11	0.08
	> 250	32/42	130	150	0.05	0.10	0.27	0.18	0.12	0.08

Table 5: Cutting speed and feed rate

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