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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 PRODUCTION PROCESS

Series 241	
Machining direction	Knurling profiles on the workpiece: RGE30° / RGE45°
axial	Selection of knurling wheels: 2 x AA / 1 x BL15° / 1 x BR15°

Table 1: Knurling profiles

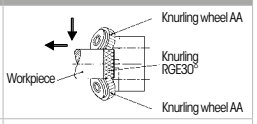
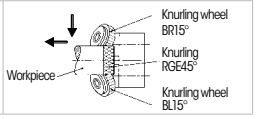
Knurling profile	Manufacturing process
RGE left-hand / right-hand knurling, raised points, 30°	
RGE left-hand / right-hand knurling, raised points, 45°	

Table 2: Manufacturing process

Series 241 Swiss typ turning lathe

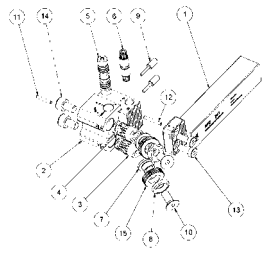


Fig. 1: Series 241 Swiss type turning lathe exploded drawing

Series 241 CNC-lathe

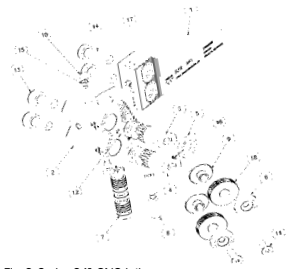


Fig. 2: Series 241 CNC-lathe exploded drawing

Ordering spare parts:
Please specify the tool number and the corresponding position number (see Fig. 1 – 4).

Designation	Torque	Pos. no.
M4 locking screw	3.4 Nm	Fig. 1, pos. 13 Fig. 2, pos. 14
M5 countersunk screw	3,5 Nm	Fig. 1, pos. 10 Fig. 2, pos. 11
M5 cylinder head screw	3,5 Nm	Fig. 1, pos. 14 Fig. 2, pos. 13

Table 3: Torque specifications

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. Fig. 4 + 5). The concentricity of the workpiece must be max. 0.03 mm.

2. Tool setting

The following points correspond to the processes in Figures 4 and 5 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. 4 + 5, ref. A)

② Centre height adjustment
In the condition as delivered, the centre height is at the upper edge of the shank (Fig. 1, pos. 1; Fig. 2, pos. 1). However, if this must be adjusted, slightly loosen both locking screws (Fig. 1, pos. 13; Fig. 2, pos. 14) of the cutting head. Then adjust the centre height of the knurling head by turning the spindle (Fig. 1, pos. 6; Fig. 2, pos. 8). Observe the mark for the respective shank dimensions (Fig. 4+5, ref. B). Then tighten the locking screws.

③ Clearance angle pre-setting
By adjusting the clearance angle of the knurled wheels, the diameter of the workpiece to be machine is adjusted. This is in the zero position in the condition upon delivery, where the two knurl holders are parallel to each other.

241 Swiss type turning lathe (Fig. 4):
– Loosening of the locking screws (Fig. 1, pos. 14)
– The clearance angle and the diameter to be machine can be increased by turning the spindle (Fig. 1, pos. 5) anticlockwise. In the process, the scale value corresponds to the adjusted diameter. (Example: 320° rotation anticlockwise = adjusted Ø 3 mm; 720° rotation clockwise = adjusted Ø 12 mm, based on the zero position) (Fig. 4, ref. C)
– Then re-tighten the locking screws (observe torque specifications, Table 3)

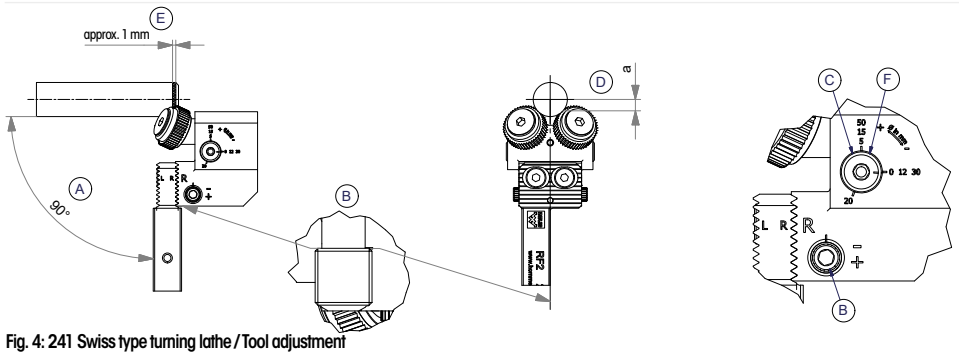


Fig. 4: 241 Swiss type turning lathe / Tool adjustment

241 CNC-lathe (Fig. 5):
– Loosening of the locking screws (Fig. 2, pos. 13)
– By turning the spindle (Fig. 2, pos. 7), the approximate diameter of the workpiece to be machine can be adjusted on the scale (Fig. 5, ref. C)
– Then re-tighten the locking screws (observe torque specifications, Table 3)

④ Approach position of the tool
The following formula can be used as a rough guideline for the approach position of the tool in X-direction.
This depends on the workpiece diameter to be machined and knurling wheels which are used (Fig. 4+5, ref. D).

$$\text{Approach position } a = \sqrt{(\text{radius of the workpiece})^2 - (c)^2}$$

Wheel Ø	Variable c
15	5.6
25	8.6

Table 4: Variable X for approach position

Then move the tool carefully to the workpiece until the knurling wheels rotate simultaneously. Correct the centre height as specified in chapter 2, if necessary

⑤ Check the knurl impression
With correct use, the knurl impression is approx. 1/3 of the width of the knurling wheel (Fig. 3, ref. 3.1)

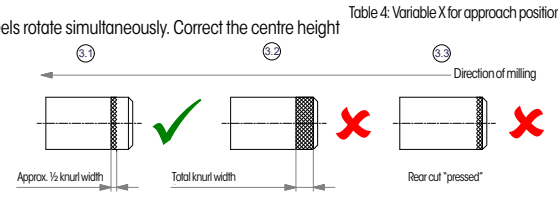


Fig. 3: Check of the knurl impression

⑥ Correction of the clearance angle
If a knurl impression is created as shown in Figure 3, ref. 3.2 or 3.3, the clearance angle of both knurling wheels must be corrected with the adjustment spindle (Fig. 1, pos. 5; Fig. 2, pos. 7). For this purpose, refer to chapter 2, ref. 3 "Clearance angle pre-setting".
Note: The optimal setting must be determined in the process!

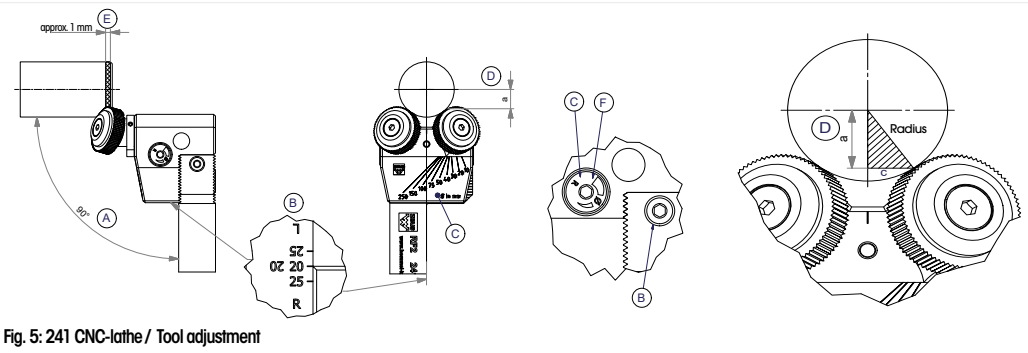


Fig. 5: 241 CNC-lathe / Tool adjustment

APPLICATION

3. Adjustment of the profile depth and feed rate in Z 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. 4+5, ref. E). 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. 6, ref. 1). A new setting takes place when the profile is not completely formed (Fig. 6, 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 6, chapter 7.

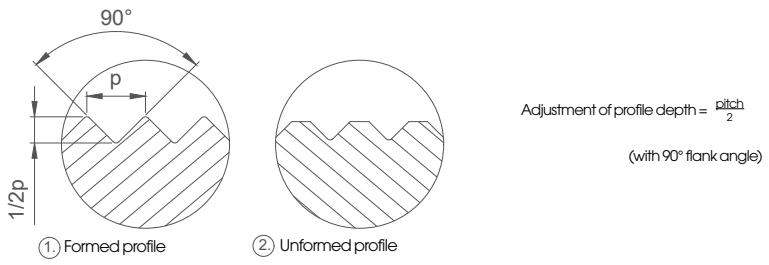


Fig. 6: Different profile pattern

$$\text{Adjustment of profile depth} = \frac{\text{pitch}}{2}$$

(with 90° flank angle)

4. Modularity of the knurl holder

With this tool type, the knurl holder and knurling wheels can be integrated modularly rotated 180°. This is necessary when using a tool in front of or behind the rotation centre.

Series 241 Swiss type turning lathe (Fig. 7)
① Unscrew the locking screws completely
② Remove the knurl cutting head and knurling wheel
③ Push the cylinder pin into the other side of the holder
④ Rotate the knurl cutting head 180° until the marks L and L line up
⑤ Re-mount the knurl cutting head securely with the locking screws
⑥ If necessary, correct the centre height as specified in chapter 2, ref. 2

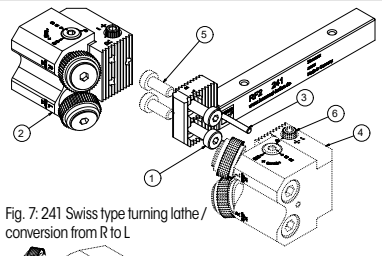


Fig. 7: 241 Swiss type turning lathe / conversion from R to L

Series 241 CNC-lathe (Fig. 8)
① Unscrew the locking screws completely
② Remove the knurl cutting head and knurling wheel
③ Rotate the knurl cutting head 180° until the marks L and L line up
④ Screw in both locking screws again and mount the cutting head securely
⑤ If necessary, correct the centre height as specified in chapter 2

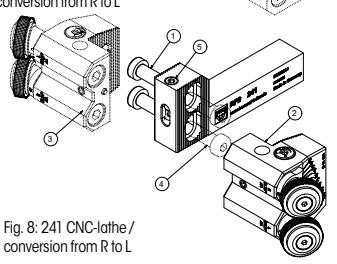


Fig. 8: 241 CNC-lathe / conversion from R to L

5. Manufacturer's recommendations

Replace the bearing bush (Fig. 1, pos. 7; Fig. 2, pos. 9), cover plate (Fig. 1, pos. 8; Fig. 2, pos. 6) and countersunk screw (Fig. 1, pos. 10; Fig. 2, pos. 11) after a reasonable number of cycles, no later than upon appearance of significant wear or deviating process parameters.

Note: A material distortion of min. 0.03 mm and max. 0.1 mm can arise during the machining.

6. Troubleshooting

IMPORTANT

Problem:	Reason / Cause:	Solution:
The 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 3
The profile is cut unevenly	– Deficient concentricity of the workpiece – Bending of the workpiece due to excessive projection	– Turn workpiece diameter – Check extension length and clamping pressure – Correct clearance angle as specified in chapter 2, ref. 6
Spirals are formed in the knurled profile	– Incorrect centre height – Workpiece deflects – Clearance angle is not correct – Feed rate value too high	– Correct the centre height as specified in chapter 2, ref. 2 – Check extension length / support workpiece – Correct clearance angle as specified in chapter 2, ref. 6 – Check cutting data as specified in chapter 7
Tooth base is knurled unevenly	Centre height is not correct	Adjust the centre height as specified in chapter 2, ref. 2
The finished diameter of the workpiece is not correct or has a cone	– Adjustment depth is not correct – Clearance angle adjustment not correct	– Adjust depth as specified in chapter 3 – Correct clearance angle as specified in chapter 2, ref. 6

Table 5: Troubleshooting

7. 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 6: Cutting speed and feed rate

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