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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 161 / 162	
Machining direction	Knurling profiles on the workpiece: RAA | RBL | RBR | RGE
radial / radial and axial	Selection of knurling wheels: 2 x AA | 2 x BR | 2 x BL | 1 x BR 1 x BL

Table 1: Knurling profiles

Knurling profile	Manufacturing process	Knurling profile	Manufacturing process
RAA knurl with straight pattern	Knurling RAA; Work-piece; Knurling wheel AA	RBL left-hand knurl 30°/45°	Workpiece; Knurling RBL; 2 x knurling wheel BR
RGE left-hand / right-hand knurling, Raised points, 30°/45°	Knurling RGE; Work-piece; 1 x knurling wheel BL 1 x knurling wheel BR	RBR right-hand knurl 30°/45°	Workpiece; Knurling RBR; 2 x knurling wheel BL

Table 2: Manufacturing process

Designation	Torque	Pos. no.
M4 Allen screw	7 Nm	Fig. 1, pos. 7 Fig. 3, pos. 7
M8 Allen screw	28 Nm	Fig. 2, pos. 9 Fig. 4, pos. 10
M3 set screw	2 Nm	Fig. 1, pos. 9 Fig. 3, pos. 10
M4 set screw	7 Nm	Fig. 2, pos. 13, pos. 12 Fig. 4, pos. 11, pos. 12

Table 3: Torque specifications

Series 161

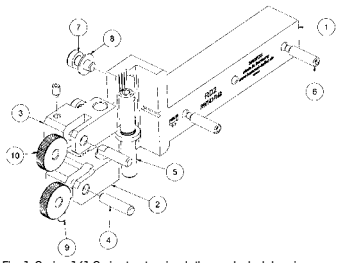

Fig. 1: Series 161 Swiss typ turning lathe exploded drawing

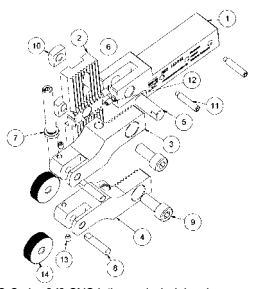

Fig. 2: Series 161 CNC-lathe exploded drawing

Series 162

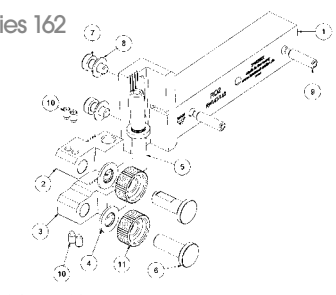

Fig. 3: Series 162 Swiss typ turning lathe exploded drawing

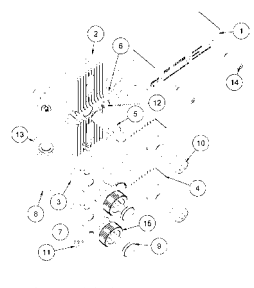

Fig. 4: Series 162 CNC-lathe exploded drawing

Ordering spare parts:

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

TOOL SETTING

1. Setting the centre height

The centre height is integrated in tool mount and corresponds to the upper shaft edge (Fig. 1 – 4, pos. 1).

2. Knurling wheel assembly

For installation or replacement of knurling wheels, unscrew both threaded pins (Fig. 1, pos. 9, Fig. 2, pos. 13; Fig. 3, pos. 10; Fig. 4, pos. 11) and remove the axle pins (Fig. 1, pos. 4; Fig. 2, pos. 8) or collar studs (Fig. 3, pos. 6; Fig. 4, pos. 9). Then mount the new knurling wheel with the axle pins and/or collar studs and clamp with the threaded pin. Ensure that the axle pin is clamped on the planar surface.

3. Modular design

Swiss type turning lathe: (Fig. 5, top)

Series 161 – Form knurling — Jaw set for conversion to series 162: E-kit: 21BHR1673
Series 162 – Knurling up to a shoulder — Jaw set for conversion to series 161: E-kit: 21BHR1672

CNC-lathe: (Fig. 5, bottom)

Series 161 – Form knurling — Jaw set for conversion to series 161: E-kit: 21BHR1214
Series 162 – Knurling up to a shoulder — Jaw set for conversion to series 161: E-kit: 21BHR1213

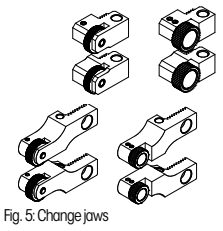

Fig. 5: Change jaws

4. Presetting of the tool

For adjustment of the working area, distance A1 must be defined first (Fig. 6).
This value can be determined according to the following calculation:

Distance A1 = desired finished diameter of the workpiece – nominal pitch of the knurling wheel

Example: Desired workpiece diameter = 17 mm, pitch 1.2 mm
Distance A1 = 17 mm – 1.2 mm – 15.8 mm

Caution! This calculation only applies for a 90° flank angle!

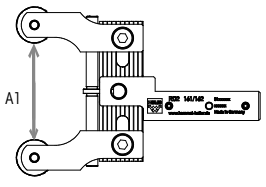

Fig. 6: Distance A1

Unscrew both Allen screws (Fig. 1, pos. 7; Fig. 2, pos. 9; Fig. 3, pos. 7; Fig. 4, pos. 10) and adjust the jaws (Fig. 1, pos. 2 + 3; Fig. 2, pos. 3 + 4; Fig. 3, pos. 2 + 3; Fig. 4, pos. 3 + 4) with the adjustment spindle (Fig. 1, pos. 5; Fig. 2, pos. 7; Fig. 3, pos. 5; Fig. 4, pos. 8). A calliper gauge is useful for measuring the distance. After adjustment of the working range, re-tighten the Allen screws.

Swiss typ turning lathe / CNC- lathe

Converting the jaws for knurling up to a shoulder:
– Completely unscrew Allen screws (Fig. 1, pos. 7; Fig. 2, pos. 9; Fig. 3, pos. 7; Fig. 4, pos. 10)
– Unscrew jaws with adjustment spindle (Fig. 1, pos. 5; Fig. 2, pos. 7; Fig. 3, pos. 5; Fig. 4, pos. 13) until removal
– Install other jaw version and move together with adjustment spindle (ensure that the jaws engage in the threads simultaneously and can be moved together symmetrically)
– Fasten Knurling jaw with Allen screws

Caution! Use of the tool behind the rotation centre necessitates a change of the shank version for the Swiss type turning lathe version

CNC-lathe:

Enlargement of the working range by changing the jaws (Fig. 7, right):
– Completely unscrew the Allen screw (Fig. 2, pos. 9; Fig. 4, pos. 10)
– Unscrew jaws with adjustment spindle (Fig. 2, pos. 7; Fig. 4, pos. 8) until removal
– Screw in the adjustment spindle rotated 180° (left-hand or right-hand thread)
– Install the jaws with the offset outward and move together with adjustment spindle (ensure that the jaws engage in the threads simultaneously and can be moved together symmetrically)
– Fix knurling jaw with Allen screws

Note: In the standard configuration, the tool is mounted with the offset toward the inside (Fig. 7, left)

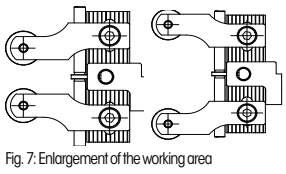

Fig. 7: Enlargement of the working area

5. Modularity of the mount unit

With a modular mounting plate, the CNC-lathe variant can be used in front of or behind the rotation centre. For this purpose, the threaded pin (Fig. 2, pos. 12; Fig. 4, pos. 12) must be loosened and the hinge pin (Fig. 2, pos. 5; Fig. 4, pos. 5) completely removed. Then rotate the mounting plate (Fig. 2, pos. 2; Fig. 4, pos. 2) and jaws (Fig. 2; Fig. 4, pos. 3 + 4) 180° and re-connect with the base holder using the hinge pin.

6. Centring of the tool

Clamp the tool at an angle of 90° to the workpiece and align (Fig. 8). Approach the workpiece and ensure that the knurling wheels rotate simultaneously (Fig. 9).
Correct the centre height as necessary.

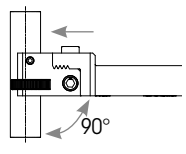

Fig. 8: Approach position (top view)

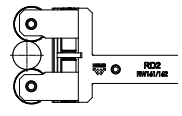

Fig. 9: Approach position (side view)

APPLICATION

7. Feed rate in X direction

Move with the tool and the pre-adjusted working area A1 in the component in the X-direction to the workpiece zero point until the diameter of the two knurling wheels are aligned with the workpiece diameter (Fig. 10). Then the limit position of the setting is reached. The feed rate must be observed during the process. After reaching the limit position, the dwell time of the tool should be between 3 and 10 revolutions of the workpiece. Then disengage the tool from the engagement.

8. Feed rate in Z direction

With movement in the axial direction, first move to the workpiece zero point (see chapter 7, Feed rate in X direction) and move parallel to the axis in the Z-direction after reaching the limit position until the desired knurl width is reached. After the limit position is reached, the dwell time should be 3 to 10 revolutions. Then disengage the tool from the engagement. For guideline values for feed rate and cutting speed, please refer Chapter 12, Table 5.

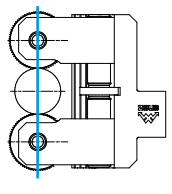

Fig. 10: Limit position during knurling

9. Checking the profile depth

The profile is completely formed when the tooth tips are closed (Fig. 11, ref. 1).
If the profile is not knurled completely (Fig. 11, ref. 2), reduce distance A1 according to chapter 4 and run the tool over the workpiece again. Running into the workpiece again is possible, because the knurling wheels catch in the existing profile.

Note: A guideline for calculation of the material distortion is provided in Tables 6 – 8 in chapter 13. This depends on the knurling profile, workpiece diameter and pitch.

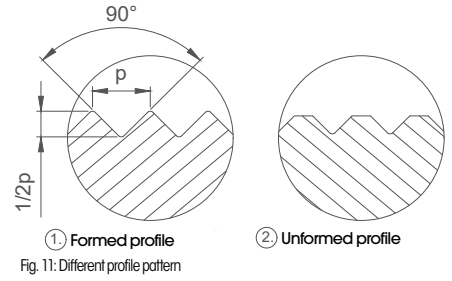

Fig. 11: Different profile pattern

IMPORTANT

10. Manufacturer's recommendations

Axle pins (Fig. 1, pos. 4; Fig. 2, pos. 8) and hinge pins (Fig. 3, pos. 6; Fig. 4, pos. 9), collar studs (Fig. 2+ 4, pos. 5) and races (Fig. 3, pos. 4; Fig. 4, pos. 7) should be replaced after a reasonable number of cycles, no later than upon appearance of significant wear or deviating process parameters. The slot of the jaws must also be inspected for wear or widening. An adequate flow of coolant or cutting oil is recommended!

11. Troubleshooting

Problem:	Reason / Cause:	Solution:
The knurled profile is not completely formed, surface on the tooth tip	– The profile depth setting is not correct – Radial adjustment not down to limit depth	– Adjust distance A1 as specified in chapter 4 – Move in X-direction to workpiece zero point (see chapter 7)
The profile has a double knurling	– Feed rate incorrect – Profile depth too large – Dwell time in the engagement too long	– Adjust feed rate according to chapter 12 (see Table 5) – Correct the distance as specified in chapter 4 – Dwell time should be between 3 and 10 revolutions of the workpiece
Irregular profile form	Knurling wheels are uneven in the engagement due to deficient assembly of the knurling jaws	Check the adjustment of the curling jaws as specified in chapter 4
Spangle collets on the profile	– Dwell time of the tool in the engagement too long	– Dwell time should be between 3 and 10 revolutions of the workpiece
Excessive material distortion at knurling end (axial)	– Feed rate value incorrect – Profile depth is not correct – Material flow not favourable	– Adjust feed rate as specified in chapter 12 – Adjust distance as specified in chapter 4 – Use of rollers with 60° chamfer
The finished diameter of the workpiece is too small	Adjustment depth too large, overpressure on the profile	– Adjust distance as specified in chapter 4 – Observe material distortion as specified in chapter 13
– Overpressure on the profile – Diameter reduction at the beginning of the knurling	– Depth adjustment too large – Incorrect approach position / setting outside of the workpiece	– Correct distance A1 as specified in chapter 4 – Setting must take place in the component (observe chapter 7)

Table 4: Troubleshooting

12. 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	20	50	0.04	0.08	0.14	0.09	0.06	0.05
	10 – 40	15 / 20	25	55	0.05	0.10	0.20	0.13	0.10	0.07
	40 – 100	20 / 25	30	60	0.05	0.10	0.25	0.18	0.12	0.08
	100 – 250	20 / 25	30	60	0.05	0.10	0.30	0.20	0.13	0.09
	> 250	25	30	60	0.05	0.10	0.32	0.21	0.14	0.10
Stainless steel	< 10	10 / 15	15	40	0.04	0.08	0.12	0.08	0.05	0.04
	10 – 40	15 / 20	20	50	0.05	0.10	0.17	0.11	0.09	0.06
	40 – 100	20 / 25	25	50	0.05	0.10	0.21	0.15	0.10	0.07
	100 – 250	20 / 25	25	50	0.05	0.10	0.26	0.17	0.11	0.08
	> 250	25	25	50	0.05	0.10	0.27	0.18	0.12	0.09
Brass	< 10	10 / 15	30	75	0.04	0.08	0.15	0.09	0.06	0.05
	10 – 40	15 / 20	40	85	0.05	0.10	0.21	0.14	0.11	0.07
	40 – 100	20 / 25	45	90	0.05	0.10	0.26	0.19	0.13	0.08
	100 – 250	20 / 25	45	90	0.05	0.10	0.32	0.21	0.14	0.09
	> 250	25	45	90	0.05	0.10	0.34	0.22	0.15	0.11
Aluminium	< 10	10 / 15	25	60	0.04	0.08	0.18	0.11	0.08	0.06
	10 – 40	15 / 20	30	65	0.05	0.10	0.25	0.16	0.13	0.09
	40 – 100	20 / 25	35	70	0.05	0.10	0.31	0.23	0.15	0.10
	100 – 250	20 / 25	35	70	0.05	0.10	0.38	0.25	0.16	0.11
	> 250	25	35	70	0.05	0.10	0.40	0.26	0.18	0.13

Table 5: Cutting speed and feed rate

13. Material distortion

Pitch [mm]		0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	2.0
Material	Workpiece Ø [mm]	Enlargement of workpiece diameter in mm										
Free-cutting steel	5	0.08	0.14	0.18	0.22	0.27	0.29	0.35	0.50	–	–	–
	15	0.08	0.14	0.18	0.23	0.30	0.40	0.44	0.50	0.60	0.65	0.70
	25	0.08	0.15	0.23	0.24	0.28	0.35	0.44	0.53	0.62	0.70	0.98
Stainless steel	5	0.10	0.15	0.20	0.25	0.28	0.30	0.42	0.41	–	–	–
	15	0.10	0.15	0.19	0.25	0.30	0.34	0.45	0.51	0.60	–	–
	25	0.10	0.14	0.20	0.26	0.31	0.33	0.43	0.50	0.62	–	–
Brass	5	0.08	0.12	0.18	0.20	0.21	0.22	0.25	0.28	–	–	–
	15	0.10	0.14	0.20	0.26	0.28	0.29	0.35	0.41	0.44	0.48	0.55
	25	0.10	0.15	0.20	0.25	0.28	0.30	0.36	0.43	0.46	0.50	0.53
Aluminium	5	0.09	0.15	0.19	0.23	0.28	0.30	0.41	0.40	–	–	–
	15	0.10	0.15	0.19	0.26	0.29	0.33	0.45	0.51	0.57	0.65	–
	25	0.09	0.15	0.19	0.26	0.29	0.32	0.45	0.52	0.59	0.65	0.75

Table 6: Knurling profile acc. to DIN82 RAA

Pitch [mm]		0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	2.0
Material	Workpiece Ø [mm]	Enlargement of workpiece diameter in mm										
Free-cutting steel	5	0.11	0.15	0.20	0.24	0.28	0.34	0.45	0.55	–	–	–
	15	0.11	0.15	0.22	0.26	0.30	0.35	0.45	0.52	0.67	0.73	0.85
	25	0.11	0.14	0.23	0.25	0.28	0.36	0.45	0.56	0.70	0.72	0.90
Stainless steel	5	0.09	0.14	0.19	0.25	0.31	0.34	0.45	0.52	–	–	–
	15	0.12	0.20	0.23	0.31	0.35	0.40	0.51	0.62	0.66	0.73	0.97
	25	0.12	0.18	0.24	0.27	0.37	0.39	0.49	0.59	0.80	0.84	0.96
Brass	5	0.10	0.14	0.20	0.23	0.24	0.28	0.33	0.37	–	–	–
	15	0.10	0.15	0.21	0.23	0.24	0.31	0.41	0.47	0.53	0.55	0.63
	25	0.11	0.15	0.22	0.22	0.25	0.30	0.40	0.45	0.55	0.61	0.68
Aluminium	5	0.12	0.14	0.21	0.24	0.29	0.34	0.41	0.51	–	–	–
	15	0.12	0.18	0.23	0.26	0.36	0.40	0.50	0.56	0.56	0.61	0.75
	25	0.12	0.18	0.25	0.28	0.37	0.39	0.50	0.58	0.77	0.82	0.96

Table 7: Knurling profile acc. to DIN82 RBL30° / RBR30°

Pitch [mm]		0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	2.0
Material	Workpiece Ø [mm]	Enlargement of workpiece diameter in mm										
Free-cutting steel	5	0.12	0.16	0.20	0.25	0.33	0.41	0.55	0.65	–	–	–
	15	0.13	0.22	0.30	0.32	0.35	0.41	0.52	0.62	0.67	0.81	0.95
	25	0.12	0.18	0.28	0.32	0.35	0.38	0.55	0.67	0.77	0.87	0.98
Stainless steel	5	0.11	0.20	0.25	0.30	0.36	0.39	0.55	0.55	–	–	–
	15	0.10	0.14	0.21	0.24	0.29	0.34	0.43	0.53	0.66	0.72	0.88
	25	0.11	0.13	0.20	0.25	0.28	0.32	0.44	0.52	0.67	0.70	0.83
Brass	5	0.12	0.13	0.16	0.20	0.24	0.28	0.32	0.38	–	–	–
	15	0.12	0.16	0.18	0.24	0.28	0.30	0.39	0.40	0.48	0.52	0.63
	25	0.12	0.17	0.22	0.23	0.27	0.30	0.38	0.41	0.48	0.50	0.63
Aluminium	5	0.10	0.15	0.21	0.25	0.33	0.36	0.50	0.57	–	–	–
	15	0.11	0.14	0.20	0.25	0.28	0.33	0.43	0.54	0.67	0.71	0.89
	25	0.11	0.15	0.22	0.25	0.29	0.34	0.44	0.53	0.68	0.69	0.88

Table 8: Knurling profile acc. to DIN82 RGE30°

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