OPERATING MANUAL
FORM KNURL TOOL
F701

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 F701		
	Machining direction	Knurling profiles on the workpiece: 
	radial and axial	Selection of knurling wheels: 1x AA | 1x BR | 1x BL

Table 1: Knurling profiles

Ordering spare parts:

Please specify the tool number and the corresponding position number (see Fig. 1 – 3).

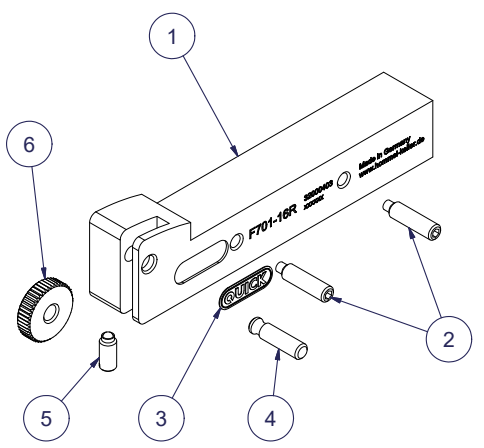


Fig. 1: Series F701 exploded drawing (swiss-type lathe))

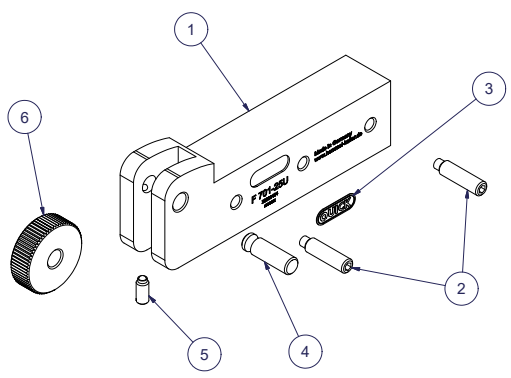


Fig. 2: Series F701 exploded drawing (CNC-Lathe)

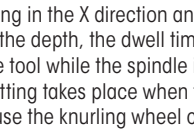
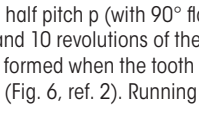
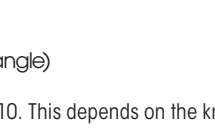
Knurling profile	Manufacturing process	Knurling profile	Manufacturing process
RAA knurl with straight pattern		RBL left-hand knurl 30°/45°	
		RBR right-hand knurl 30°/45°	

Table 2: Manufacturing process

1. General

The centre height corresponds to the shaft centre of the tool holder.
Der Rundlauf des Werkstücks darf max. 0,03 mm betragen.

2. Tool setting

TOOL SETTING

① Assembly of the knurling wheel with ClickPin system
The ClickPin system clamps the axle pin in a surrounding recess (Fig. 3, ref. 1). The axle pin is already pre-assembled upon delivery. With signs of wear, the axle pin can be replaced by pushing it to the side by hand (Fig. 3, ref. 2). This will disengage the ClickPin system and the axle pin can be removed. Slide the new axle pin into the hole (Fig. 3, ref. 3) until the ClickPin system engages in the surrounding notch (Fig. 3, ref. 4). If necessary, the ClickPin system can be adjusted by turning.

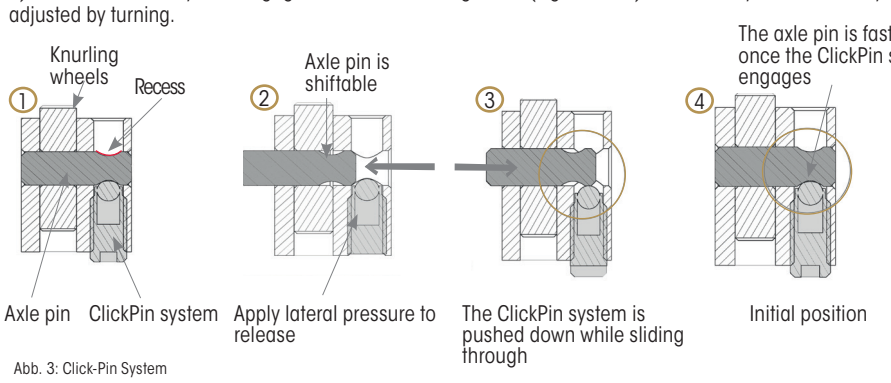


Abb. 3: Click-Pin System

Please note: It is not necessary to release the ClickPin system when changing the axle pin!

② Clamping position of tool
Clamp the tool at an angle of 90° to the workpiece for a radial machining direction (Fig. 4).

③ Seting the clearance angle
In order to guarantee a better material flow during axial machining, correct the clearance angle of the knurling holder with the threaded pin in the shank (Fig. 1 + Fig. 2, Pos. 2) by 1-2° (Fig. 5). This depends on the materials to be machined or application problems which may arise.

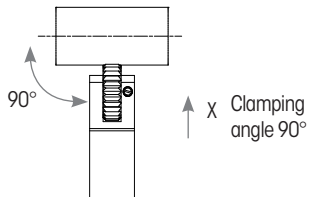


Fig. 4: Radial machining direction

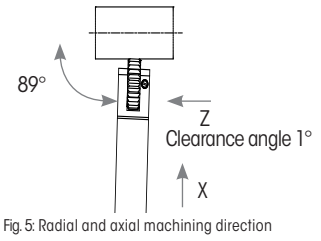


Fig. 5: Radial and axial machining direction

APPLICATION

3. Setting the profile depth

The profile depth is set by moving in the X direction and corresponds to approximately the half pitch p (with 90° flank angle), (Fig. 6). After reaching the depth, the dwell time of the tool should be between 3 and 10 revolutions of the workpiece. Then disengage the tool while the spindle is rotating. The profile is completely formed when the tooth tips are closed (Fig. 6, ref. 1). A new setting takes place when the profile is not completely formed (Fig. 6, ref. 2). Running into the profile again is possible, because the knurling wheel catches in the existing profile.
Note:

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

Guidelines for calculation of the material distortion are provided in Tables 5 – 7, chapter 10. This depends on the knurling profile, workpiece diameter and pitch.

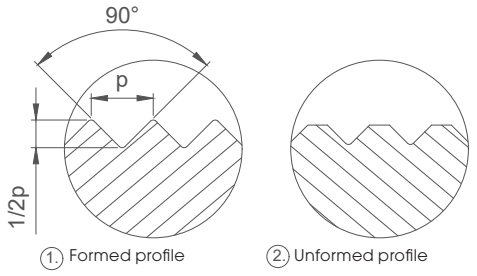


Fig. 6: Different profile pattern

4. Feed rate in Z direction

With axial knurling, first set the component in the X-direction (see chapter 3, Setting the profile depth). Then move in the Z-direction until the desired knurl width is achieved.
After reaching the width, the dwell time of the tool should be between 3 and 10 revolutions of the workpiece.
Guideline values for feed rate and cutting speed, please refer to Table 5, chapter 7.

5. Manufacturer's recommendation

Replace the axle pin (Fig. 1 + Fig. 2, Pos. 4) and knurling wheels (Fig 1 + Fig. 2, Pos. 6) after a reasonable number of cycles, no later than upon appearance of significant wear or deviating process parameters. Inspect the slot of the base holder for wear and widening. An adequate flow of coolant or cutting oil is recommended!

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 setting (see chapter 3, Setting the profile depth)
The profile has a double knurling	– Feed rate incorrect – Profile depth too large – Residence time in the engagement too long	– Adjust feed rate as specified in chapter 7 – Setting as specified in chapter 3 – Residence time should be between 3 and 10 revolutions of the workpiece
Irregular profile form	– Deficient concentricity of the workpiece – Warpage of the workpiece due to excessive projection	– Over-turn workpiece diameter – Check extension length and clamping pressure – Correct clearance angle as specified in chapter 2, ref. 3
Spangle collets on the profile	– Residence time of the tool in the engagement too long – Tooth pitch does not reach the workpiece	– Residence time should be between 3 and 10 revolutions of the workpiece – Check cutting data as specified in chapter 7 – Adjust rough turn diameter and / or pitch
Excessive material displacement at knurling end (axial)	– Feed rate value incorrect – Profile depth is not correct – Clearance angle is not correct	– Adjust feed rate as specified in chapter 7 – Setting as specified in chapter 3 – Correct clearance angle as specified in chapter 2, ref. 3
Spirals are formed in the profile	– Workpiece deflects – Clearance angle is not correct – Feed rate value too high – Incorrect centre height	– Check extension length / support workpiece – Correct clearance angle as specified in chapter 2, ref. 3 – Observe cutting data as specified in chapter 7 – Correct centre height
– Overpressure on the profile – Diameter reduction at the beginning of the knurling	– Depth adjustment too high – Incorrect approach position / setting outside of the workpiece	– Setting as specified in chapter 3 – Setting must take place in the component (observe chapter 3)
The finished diameter of the workpiece is too small	– Various material influences – Incorrect rough turn diameter	– Observe guidelines for the material displacement as specified in chapter 8 – Adjust rough turn diameter

Table 3: Troubleshooting

7. Guidelines for cutting speed and feed rate

Werkstoff	Werkstück Ø [mm]	Rändelrad Ø [mm]	Vc [m/min]		f [mm/U]					
					Radial		Axial			
							Teilung [mm]			
			von	bis	von	bis	> 0,3 < 0,5	> 0,5 < 1,0	> 1,0 < 1,5	> 1,5 < 2,0
Free-cutting steel	< 10	15	20	50	0.04	0.08	0.14	0.09	0.06	0.05
	10 – 40	15	25	55	0.05	0.10	0.20	0.13	0.10	0.07
	40 – 100	25	30	60	0.05	0.10	0.25	0.18	0.12	0.08
	100 – 250	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	15	15	40	0.04	0.08	0.12	0.08	0.05	0.04
	10 – 40	15	20	50	0.05	0.10	0.17	0.11	0.09	0.06
	40 – 100	25	25	50	0.05	0.10	0.21	0.15	0.10	0.07
	100 – 250	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	15	30	75	0.04	0.08	0.15	0.09	0.06	0.05
	10 – 40	15	40	85	0.05	0.10	0.21	0.14	0.11	0.07
	40 – 100	25	45	90	0.05	0.10	0.26	0.19	0.13	0.08
	100 – 250	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	15	25	60	0.04	0.08	0.18	0.11	0.08	0.06
	10 – 40	15	30	65	0.05	0.10	0.25	0.16	0.13	0.09
	40 – 100	25	35	70	0.05	0.10	0.31	0.23	0.15	0.10
	100 – 250	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 4: Cutting speed and feed rate

8. Material distortion

Teilung [mm]		0,3	0,4	0,5	0,6	0,7	0,8	1,0	1,2	1,5	1,6	2,0
Werkstoff	Werkstück Ø [mm]	Vergrößerung des Werkstückdurchmessers 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 5: Knurling profile acc. to DIN82: RAA

Teilung [mm]		0,3	0,4	0,5	0,6	0,7	0,8	1,0	1,2	1,5	1,6	2,0
Werkstoff	Werkstück Ø [mm]	Vergrößerung des Werkstückdurchmessers 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 6: Knurling profile acc. to DIN82: RBL30° / RBR30°

Teilung [mm]		0,3	0,4	0,5	0,6	0,7	0,8	1,0	1,2	1,5	1,6	2,0
Werkstoff	Werkstück Ø [mm]	Vergrößerung des Werkstückdurchmessers 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 7: Knurling profile acc. to DIN82: RGE30°

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