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KNURLING PROFILES AND PRODUCTION PROCESS

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.

Series 141 / 142	
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

Ordering spare parts:

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

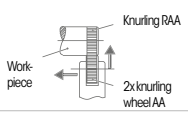
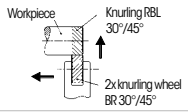
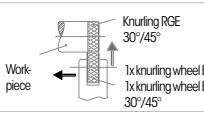
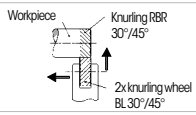
Knurling profile	Manufacturing process	Knurling profile	Manufacturing process
RAA knurl with straight pattern		RBL left-hand knurl 30°/45°	
RGE left-hand/ right-hand knurling, Raised points, 30°/45°		RBR right-hand knurl 30°/45°	

Table 2: Manufacturing process

Series 141

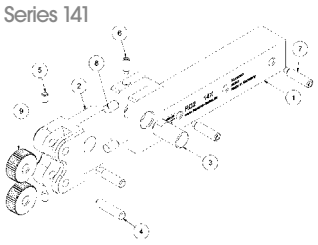


Fig. 1: Series 141 exploded drawing

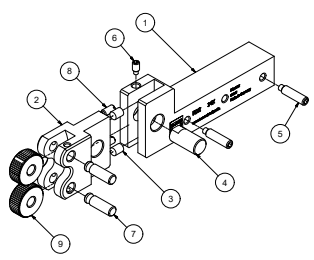


Fig. 2: Series 141 / click pin exploded drawing

Series 142

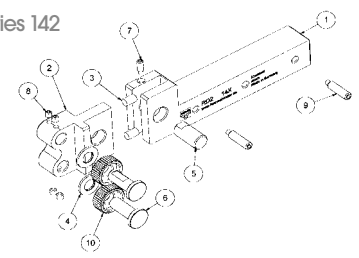


Fig. 3: Series 142 exploded drawing

TOOL SETTING

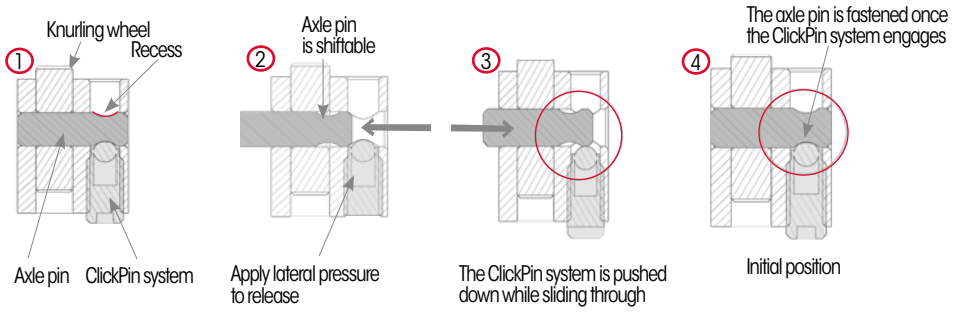


Fig. 4: ClickPin system

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

The ClickPin system clamps the axle pin in a surrounding recess (Fig. 4, 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. 4, ref. 2). This will disengage the ClickPin system and the axle pin can be removed. Slide the new axle pin into the hole (Fig. 4, ref. 3) until the ClickPin system engages in the surrounding notch (Fig. 4, ref. 4). If necessary, the ClickPin system can be adjusted by turning.

1. Setting the centre height

The centre height is integrated in tool mount and corresponds to the upper shaft edge (Fig. 1, pos. 1; Fig. 2, pos. 1).

2. Assembly of the knurling wheel with ClickPin system

3. Clamping position of tool

Clamp the tool at an angle of 90° to the workpiece for a radial machining direction (Fig. 5).

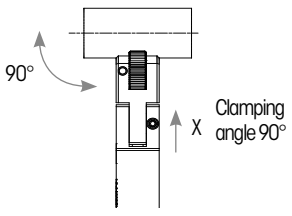


Fig. 5: Radial machining direction

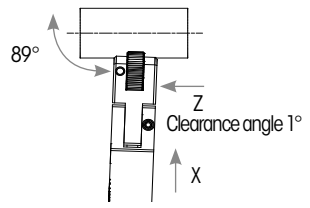


Fig. 6: Radial and axial machining direction

4. Setting 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, pos. 7; Fig. 2, pos. 5; Fig. 3, pos. 9) by 1-2°.

5. 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. For this purpose, unscrew the cylinder screw (Fig. 1, pos. 6; Fig. 2, pos. 6; Fig. 3, pos. 7) and remove the hinge pin (Fig. 1, pos. 3; Fig. 2, pos. 4; Fig. 3, pos. 5). Then remove the knurl holder (Fig. 1, pos. 2, Fig. 2, pos. 2; Fig. 3, pos. 2) and knurling wheels, rotate 180° and insert it in the slot of the tool shank. Re-insert the hinge pin to fasten the knurl holder and tighten the cylinder screw.

APPLICATION

6. Approach position of the tool

The workpiece can be scratched slightly with the tool in order to determine the approach position. In the process, ensure that both knurling wheels are simultaneously in the engagement.

Alternatively, the exact approach position can be calculated for CNC programming with the following formula. This value depends on the knurling rollers which are in use, as well as the radius of the workpiece and shows the approach position a, relative to the rotation centre (Fig. 7).
Caution: An additional safety clearance must be observed based on workpiece tolerances.

$$a = r_W - \left| \left(r_W * \sin\left(\arcsin\left(\frac{c}{(r_w + r_R) * 2} \right) \right) \right) * \tan\left(\frac{\arcsin\left(\frac{c}{(r_W + r_R) * 2} \right)}{2} \right) \right|$$

Legend: r_W = *Radius of the workpiece*
r_R = *Radius of the knurling roller*
c = *Variable according to Table 3*

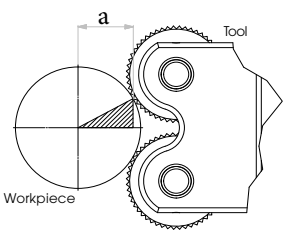


Fig. 7: Approach position in X direction

Knurling wheel Ø	Variable c
10	11
15	18
20	22
25	30

Table 3: Variable c for approach position

7. Setting the profile depth

The profile depth is set in the component by moving in the X direction and corresponds to approximately the half pitch p (with 90° flank angle), (Fig. 8). 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. 8, ref. 1). A new setting takes place when the profile is not formed (Fig. 8, ref. 2). Running into the profile again is possible, because the knurling wheels catch in the existing profile. Guidelines for calculation of the material distortion are provided in Tables 6 – 8 in chapter 12, Material distortion table. This depends on the knurling profile, workpiece diameter and pitch.

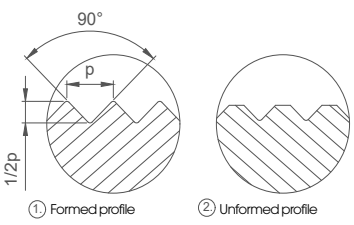


Fig. 8: Different profile pattern

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

8. Feed rate in Z direction

With axial knurling, first adjust in the X-direction of the component and then move in the Z-direction until the desired knurl width is reached. For guideline values for feed rate and cutting speed, please refer to Table 5, chapter 11.

9. Manufacturer's recommendation

Replace the axle pin (Fig. 1, pos. 4; Fig. 2, pos. 7; Fig. 3, pos. 6) or collar stud (Fig. 3, pos. 6) and race (Fig. 3, pos. 4) and ClickPin system (Fig. 2, pos. 8) after a reasonable number of cycles, no later than upon appearance of significant wear or deviating process parameters. Inspect the slot of the knurl holder for wear and widening. An adequate flow of coolant or cutting oil is recommended!

10. 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 7, Setting the profile depth)
The profile has a double knurling	– Feed rate incorrect – Profile depth too large – Dwell time in the engagement too long	– Adjust feed rate as specified in chapter 11 – Adjust setting as specified in chapter 7 – Dwell time should be between 3 and 10 revolutions of the workpiece
Irregular profile form – On the diameter	– Deficient concentricity of the workpiece – Bending of the workpiece due to excessive projection	– Turn workpiece diameter – Check extension length and clamping pressure – Correct the clearance angle as specified in chapter 4
Spirals are formed in the profile	– Workpiece deflects – Clearance angle is not correct – Feed rate value too high	– Check extension length / support workpiece – Correct the clearance angle as specified in chapter 4 – Observe cutting data as specified in chapter 11
Spangle collets on the profile	– Dwell time of the tool in the engagement too long – Tooth pitch does not reach the workpiece	– Dwell time should be between 3 and 10 revolutions of the workpiece – Check cutting data as specified in chapter 11 – Adjust rough turn diameter and / or pitch
Excessive material distortion 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 11 – Adjust setting as specified in chapter 7 – Correct the clearance angle as specified in chapter 4
– Overpressure on the profile – Diameter reduction at the beginning of the knurling	– Depth adjustment too high – Incorrect approach position / setting outside of the workpiece	– Adjust setting as specified in chapter 7 – Setting must take place in the component (observe chapter 7)

Table 4: Troubleshooting

11. Guidelines for cutting speed and feed rate

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

12. Material distortion table

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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