OPERATING MANUAL

CUT KNURLING TOOL C602 / C622

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

KNURLING PROFILES AND PRODUCTION PROCESS

C602 / C622 series	
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

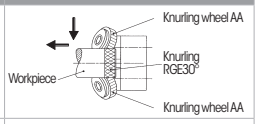
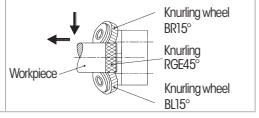
Knurling profile	Manufacturing process
RGE left-hand / right-hand knurling, raised points, 30°	
RGE left-hand / right-hand knurling, raised points, 45°	

Table 2: Manufacturing process

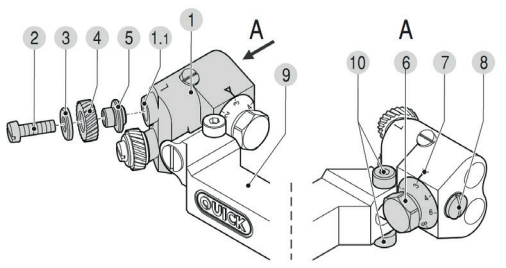


Fig. 1: Exploded drawing C602

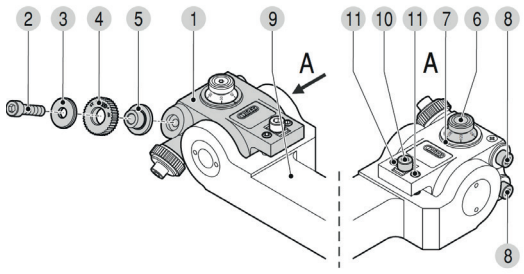


Fig. 2: Exploded drawing C622

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

TOOL ADJUSTMENT

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.
The centre height is integrated in the tool shank for version C602 and corresponds to the upper shank edge.
With variant C622, the centre height corresponds to the centre of the screw (Fig. 3, ref. C).
The concentricity of the workpiece must be max. 0.03 mm.

2. Knurling wheel assembly

For assembly of and / or changing the knurling wheels (Fig. 1, Pos. 4; Fig. 2, Pos. 4), first loosen the flat headed screw (Fig. 1, Pos. 2) or the cylinder head screw (Fig. 2, Pos. 2) completely and remove the knurling wheel and washer (Fig. 1, Pos. 3; Fig. 2, Pos. 3). Then fit the knurling wheel and the washer on the bearing bush (Fig. 1, Pos. 5; Fig. 2, Pos. 5) and re-tighten with the screw.
Observe the torque specification in Table 4, chapter 7.

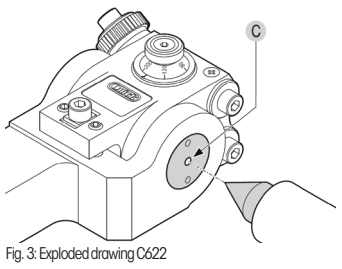


Fig. 3: Exploded drawing C622

3. Tool setting

① Clamping position
Clamp the tool at an angle of 90° to the workpiece.
② Adjustment of the workpiece diameter
By adjusting the clearance angle of the knurled wheels, the diameter of the workpiece to be machine is adjusted.
C602:
Loosen the slotted screw (Fig. 4, Pos. 8) and turn sub-drum (Fig. 4, Pos. 6) until the desired diameter matches the indexing (Fig. 4, Pos. 7). Then, tighten the slotted screw again.
C622:
Loosen the cylinder screws (Fig. 5, Pos. 8) and turn sub-drum (Fig. 4, Pos. 6) until the desired diameter matches the indexing (Fig. 5, Pos. 7). Then, re-tighten the cylinder screws.

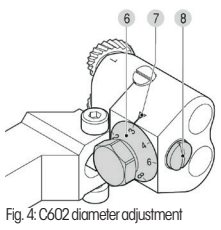


Fig. 4: C602 diameter adjustment

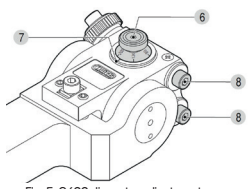


Fig. 5: C622 diameter adjustment

③ Approach of the workpiece and checking the centre height
The following formula can be used as a rough guideline for the approach position of the tool in X-direction. This value depends on the workpiece diameter to be machine and the tool type which is used (see Tab. 3 + Fig. 6).

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

Knurling wheel Ø	Variable c
8.9	4.4

Table 3: Variable c for approach position

With correct adjustment of the centre height, both knurling edges are simultaneously engaged during the approach of the workpiece.
If this is not the case, the centre of rotation of the knurling tool must be adjusted (see chapter 6, Correction of the cutting head).

④ Clearance angle adjustment and checking the knurl impression
With correct use, the knurl impression is approx. 1/3 of the width of the knurling wheel (Fig. 7, ref. A). Ensure that the front cut of the knurling wheel immerses in the material approx. 1° – 2°. The maximum immersion depth should only be a few hundredths. If there is a knurl impression as shown in Figure 7, ref. B, a correction of the knurling wheels must be carried out (cf. chapter 3, ref. 2).

⑤ Knurl beginning
The beginning of the knurling takes place approx. 1 mm after the beginning of the workpiece (Fig. 8, ref. A).

Caution: Do not start knurling in the middle/ infront of the component! (Fig. 8, ref. B)

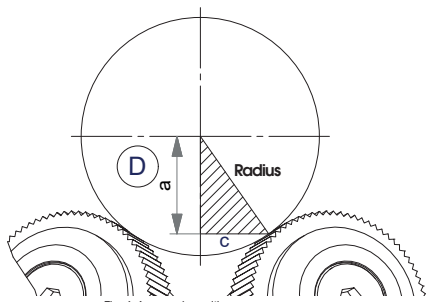


Fig. 6: Approach position a

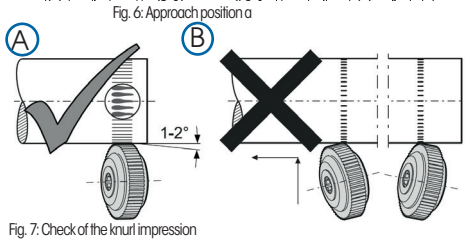


Fig. 7: Check of the knurl impression

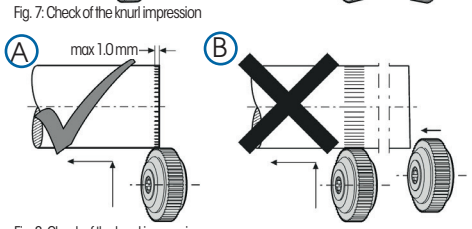


Fig. 8: Check of the knurl impression

APPLICATION

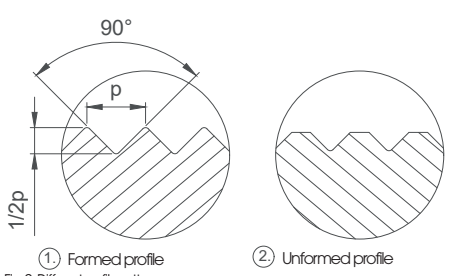
4. Setting of the profile depth and feed rate in X direction

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. 9). 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.
For guideline values for feed rate and cutting speed, please refer to Table 6, chapter 9.

$$\text{Setting of profile depth} = \frac{\text{Pitch}}{2}$$ With 90° flank angle

5. Checking the profile depth

The correct profile depth has been reached when the profile is knurled completely (Fig. 9, ref. 1). A new setting takes place when the profile is not completely formed (Fig. 9, ref. 2). Re-adjustment in the profile is possible, because the knurling wheels catch in the existing profile.
If the profile threads are uneven, a correction of the cutting head can be carried out (refer to chapter 6 for this purpose).



① Formed profile ② Unformed profile

Fig. 9: Different profile pattern

6. Correction of the cutting head

Correction of the cutting head must be carried out if both knurling wheels do not rotate simultaneously while approaching the workpiece or a profile with uneven profile threads is created.

C602 series
Adjustment can take place with the two fine-adjusting screws (Fig. 10, Pos. 10a + 10b). For this purpose, unscrew screw 10a and adjust the inclination with screw 10b or vice versa. After adjustment, tighten the opposite screw hand-tight.

C622 series
For this tool type, the locking screw must be loosened first (Fig. 11, Pos. 10). Then, the tool head must be adjusted with the two fine-adjusting screws (Fig. 11, Pos. 11). After adjustment of the working range, re-tighten the locking screw.

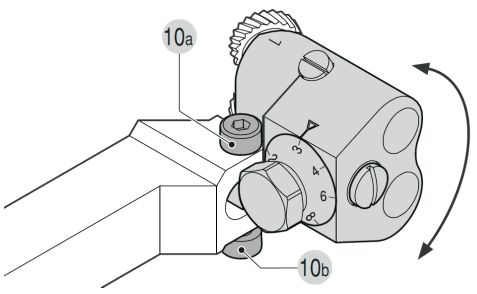


Fig. 10 Correction of the cutting head C602

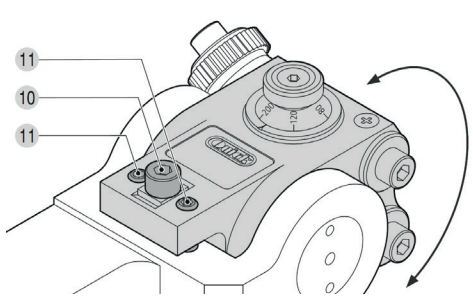


Fig. 11: Correction of the cutting head C622

7. Manufacturer's recommendation

Replace the bearing bush (Fig. 1, Pos. 5; Fig. 2, Pos. 5), washer (Fig. 1, Pos. 3; Fig. 2, Pos. 3), flat-headed screw (Fig. 1, Pos. 2) and cylinder head screw (Fig. 2, Pos. 2) 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 displacement of min. 0.03 mm and max. 0.1 mm can arise during the cut knurling.
If the screws loosen (Fig. 1, Pos. 2; Fig. 2, Pos. 2) during the process, use of LOCTITE® threadlocker is highly recommended.
Ensure that the bearing surfaces of the knurl holders are free from chips and inspect regularly for damage.
The optimal setting must be determined in the process.

IMPORTANT

Designation	Torque	Pos. no.
M2.6 flat head screw	0.3 Nm	Fig. 1, Pos. 2
M2.6 fine-adjusting screw	0.85 Nm	Fig. 1, Pos. 10
M3 clamping screw	1,49 Nm	Fig. 1, Pos. 8
M8 cylinder screw	5 Nm	Fig. 2, Pos. 2 + 8 + 10
M8 fine-adjusting screw	5 Nm	Fig. 2, Pos. 11

Table 4: Torque specifications

8. Troubleshooting

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 4
The profile is cut unevenly	– Deficient concentricity of the workpiece – Warpage of the workpiece due to excessive projection	– Over-turn workpiece diameter – Check extension length and clamping pressure
Tooth base is knurled unevenly	Centre height is not correct	Correct centre height (see chapter 1)
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 4 – Correct the clearance angle as specified in chapter 3, ref. 2

Table 5: Troubleshooting

9. Guidelines for cutting speed and feed rates

Material	Workpiece Ø [mm]	Knurling wheel Ø [mm]	Vc [m/min] from	Vc [m/min] to	f [mm/rotation] Radial from	Radial to	Axial Pitch [mm] >0.3 <0.5	>0.5 <1.0	>1.0 <1.5	>1.5 <2.0
Free-cutting steel	<10	8.9 / 14.5 / 21.5	40	70	0.04	0.08	0.20	0.13	0.08	0.07
	10–40	8.9 / 14.5 / 21.5 / 32 / 42	50	90	0.05	0.10	0.28	0.18	0.14	0.10
	40–100	14.5 / 21.5 / 32 / 42	65	110	0.05	0.10	0.35	0.25	0.17	0.11
	100–250	21.5 / 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	8.9 / 14.5 / 21.5	22	40	0.04	0.08	0.14	0.09	0.06	0.05
	10–40	8.9 / 14.5 / 21.5 / 32 / 42	30	50	0.05	0.10	0.20	0.13	0.10	0.07
	40–100	14.5 / 21.5 / 32 / 42	35	60	0.05	0.10	0.25	0.18	0.12	0.08
	100–250	21.5 / 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	8.9 / 14.5 / 21.5	55	100	0.04	0.08	0.22	0.14	0.09	0.08
	10–40	8.9 / 14.5 / 21.5 / 32 / 42	70	125	0.05	0.10	0.31	0.20	0.15	0.11
	40–100	14.5 / 21.5 / 32 / 42	90	155	0.05	0.10	0.39	0.28	0.18	0.12
	100–250	21.5 / 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	8.9 / 14.5 / 21.5	70	120	0.04	0.08	0.12	0.08	0.05	0.04
	10–40	8.9 / 14.5 / 21.5 / 32 / 42	80	150	0.05	0.10	0.17	0.11	0.08	0.06
	40–100	14.5 / 21.5 / 32 / 42	110	160	0.05	0.10	0.21	0.15	0.10	0.07
	100–250	21.5 / 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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