

**Knurling – Course: Techniques for Machining of Material. Instruction  
Examples for Practical Vocational Training**



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# Knurling – Course: Techniques for Machining of Material. Instruction Examples for Practical Vocational Training

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## Introduction

The present booklet contains 5 selected training examples which are intended to help practising and consolidating knowledge and skills acquired in the working technique knurling.

In order to facilitate the preparation and execution of the work, the necessary materials, working, measuring and testing tools and accessories are stated for each training example.

For the training examples 1, 4 and 5 the steel is specified according to the value of its tensile strength in the unit "Megapascal" (MPa).

We also recommend knowledge required in addition to knowledge of knurling which should be repeated before starting with the work.

Explanations to the working drawings are given before the specification of the technological sequence.

The specified sequence of operations for the individual training examples gives the steps necessary for the production of the parts. This sequence of operations should be strictly observed if good quality is to be achieved.

For each training example a working drawing is attached showing the required shapes and dimensions of the workpiece.

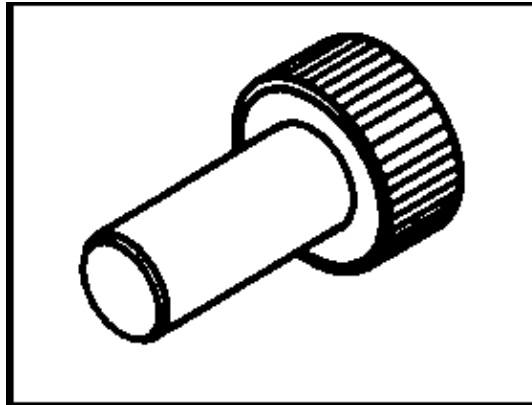
It is also possible to select other parts with greater or smaller dimensional variations.

The admissible deviations for sizes with no indication of tolerances may be taken from the table below.

<b>Nominal size</b>	<b>Admissible deviation in mm</b>
0.5 – 6	± 0.1
6 – 30	± 0.2
30 – 120	± 0.3
120 – 315	± 0.5

## Instruction example 7.1.: Locking screw

This example serves to practise straight knurling of simple cylindrical parts.



### Material

St 42 (steel with tensile strength up to 420 MPa)

### Dimensions

dia. 62 x 110 mm

### Working tools

Right-bent roughing tool, chuck key, straight knurling tool with straight pitch ( $t = 0.8$  mm)

### Measuring and testing tools

Vernier caliper

### Accessories

Hard chuck jaws, supporting plates, coolant and lubricant

### Required previous knowledge

Reading of drawings, measuring and testing, behaviour of material in chipless shaping, longitudinal turning and facing, use of coolants and lubricants

### Explanations to the working drawing

M 16: M = metric thread. 16 = nominal diameter

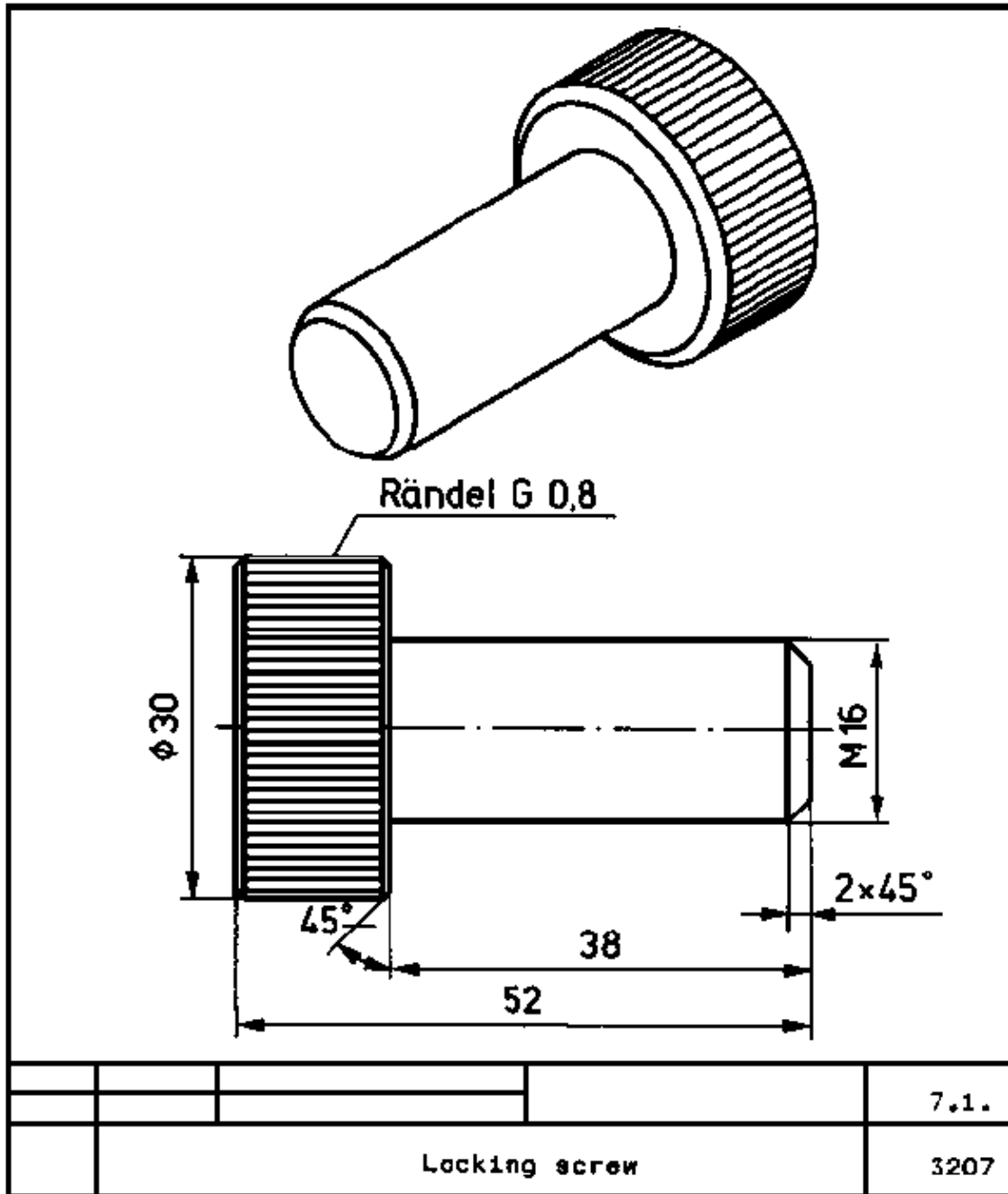
Straight knurling 0.8: straight knurling = straight wheel  
0.8 = tooth pitch 0.8 mm

### Sequence of operations

### Remarks

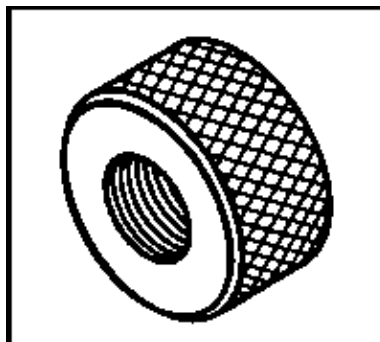
- |                           |   |
|---------------------------|---|
| 1. Dimensional inspection | dia. 30 x 14 mm   |
| 2. Clamping of workpiece  | Chucking – chuck jaws to chuck on dia. 16 mm, 30 mm deep. |

- |     |  |  |
|-----|--|--|
| 3.  | Clamping of tool to produce knurling diameter              | Right-bent roughing tool   |
| 4.  | Setting of cutting values for turning the outside diameter | For steel $v = 80$ m/min.<br>Surface finished.   |
| 5.  | Producing the knurling diameter                            | By experience it is known that diameter of finished part becomes bigger by approx. half the pitch (1/2 mm) of knurling tool, i.e. diameter to be turned smaller – $d = 30$ mm less $0.4$ mm = <u>29.6 mm</u> . |
| 6.  | Tool change for producing knurling                         | Width of knurling tool according to width of workpiece.<br>Knurling tool to be clamped approx. 1 mm below centre and at right angle to workpiece axis.   |
| 7.  | Setting of cutting values for straight knurling            | For steel $v = 6$ to $10$ m/min.<br>For St 42 $v = 10$ m/min to be selected.   |
| 8.  | Straight knurling of diameter                              | To be cooled and lubricated with diluted soluble oil or cutting oil (heavy pressing force results in high friction and heat).  |
| 9.  | Tool change for producing the chamfers                     | Right-bent roughing tool.  |
| 10. | Chamfering of workpiece                                    | Chamfering of workpiece after knurling is necessary because material is forced towards end faces, both ends $0.8 \times 45^\circ$ (chamfer = $t$ ).  |
| 11. | Unloading of workpiece                                     |  |
| 12. | Dimensional inspection                                     | Dimensional and visual inspection (cleanliness of knurling grooves).<br>Wheel of knurling tool to be cleaned by wire brush.  |



### Instruction example 7.2.: Ring thread gauge

This example serves to practise spiral knurling of simple cylindrical parts.



Material



16 Cr Mn 5 (low–alloy steel, alloy constituents: 0.16% carbon, 1.25% chromium, less than 1% manganese, rest iron)

### Dimensions

dia. 52 x 27 mm

### Working tools

Right–bent roughing tool, chuck key, spiral knurling tool with groove pitch ( $t = 1.2$  mm)

### Measuring and testing tools

Vernier caliper

### Accessories

Hard chuck jaws, arbor M 24, supporting plates, coolant and lubricant

### Required previous knowledge

Reading of drawings, measuring and testing, behaviour of material in chipless shaping, longitudinal turning and facing, use of coolants and lubricants

### Explanations to the working drawing

M 24: M = metric thread, 24 = nominal diameter

Spiral knurling 1.2: Spiral knurling: spiral knurling wheels at an angle of  $30^\circ$ .

1.2 = tooth pitch (groove distance) 1.2 mm

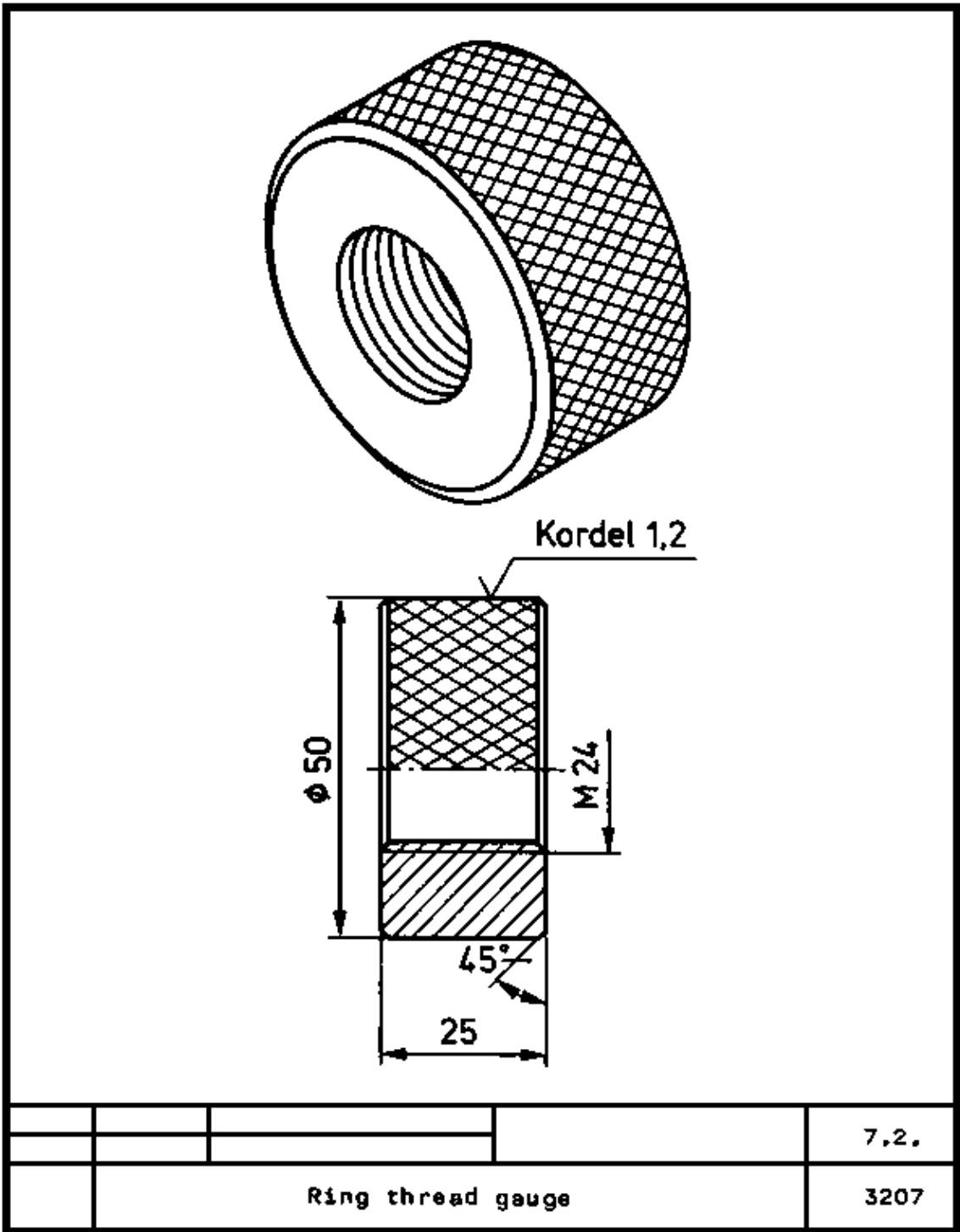
### **Sequence of operations**

### **Remarks**

- |   |  |
|---|--|
| 1. Dimensional inspection                             |  |
| 2. Clamping of workpiece                              | Chucking (hard jaws) – centre. Use arbor M 24 to mount ring thread gauge. Arbor to be produced with shoulder to give necessary distance between workpiece and chuck. |
| 3. Clamping of tool to produce knurling diameter      | Right–bent roughing tool.  |
| 4. Setting of cutting values for longitudinal turning |  |
| 5. Producing the knurling diameter                    | $t/2$ mm: $d = 50$ mm less $0.6$ mm = <u>49.4 mm</u>   |
| 6. Tool change for producing the knurling             | Spiral knurling tool to be clamped approx. 1 mm below centre and at right angle to workpiece axis.   |

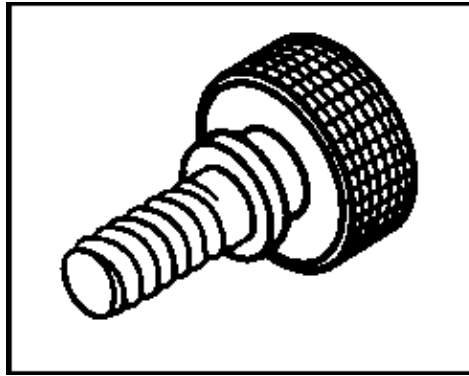
Matching edge bearing must fit well.

7. Setting of cutting values for spiral knurling  
 $v = 6 - 10$  m/min. For low-alloy steel  
 $v = 6$  m/min to be selected.
8. Spiral knurling of diameter  
To be cooled and lubricated with soluble oil or cutting high (heavy pressing force results in high friction and heat). When longitudinal feed is used, feed must correspond to spiral-knurling pitch to avoid overlapping.
9. Tool change for chamfering  
Right-bent roughing tool.
10. Chamfering of workpiece  
Chamfers  $1.2 \text{ mm} \times 45^\circ$  each (chamfer = t).  
Chamfering to be done after knurling because material is forced towards end faces.  
 $v$  like for producing outside diameter.
11. Unloading of workpiece
12. Dimensional inspection  
Dimensional and visual inspection. Wheels of spiral knurling tool to be cleaned by wire brush.



**Instruction example 7.3.: Knurled screw**

This example serves to practise cross knurling of non-metallic materials.



Material

Thermosetting plastics

Dimensions

dia. 34 x 58 mm

Working tools

Right-bent roughing tool, chuck key, cross knurling tool with groove pitch 0.8 mm (used for hard rubber, plastics)

Measuring and testing tools

Vernier caliper

Accessories

Soft chuck jaws which can be internally turned, supporting plates, coolant and lubricant

Required previous knowledge

Reading of drawings, measuring and testing, behaviour of material in chipless shaping, internal turning of jaws, longitudinal turning and facing, use of coolants and lubricants

Explanations to the working drawing

M 12: M = metric thread, 12 = nominal diameter

R 3: 3 mm radius

Cross knurling 0.8: Cross knurling = tooth pitch crossing at 90°, 0.8 = tooth pitch of 0.8 mm

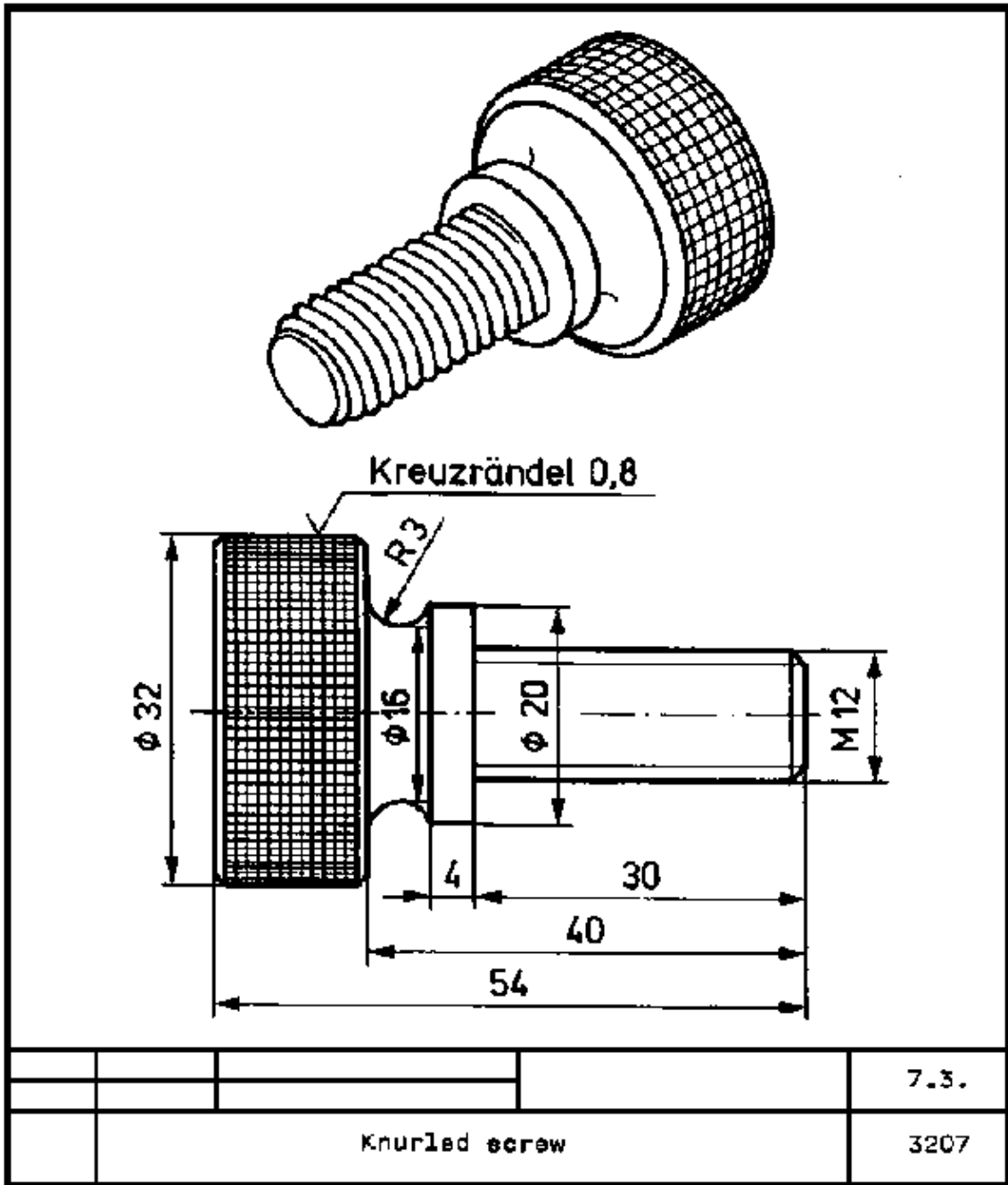
All surfaces finished.

**Sequence of operations**

**Remarks**

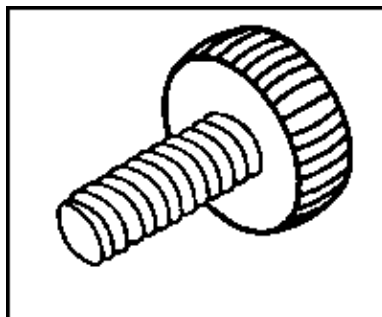
- |  |  |
|--|--|
| 1. Dimensional inspection                        |  |
| 2. Clamping of workpiece                         | Chucking – soft chuck jaws to be internally turned for dia. 12 mm. |
| 3. Clamping of tool to produce knurling diameter | Right-bent roughing tool.  |

- |   |  |
|---|--|
| 4. Setting of cutting values                    |  |
| 5. Producing the knurling diameter              | $t/2: d = 32 \text{ mm less } 0.4 \text{ mm} = \underline{31.6 \text{ mm}}$  |
| 6. Tool change for producing knurling           | Cross knurling tool to be clamped approx. 1 mm below centre and at right angle to workpiece axis.  |
| 7. Setting of cutting values for cross knurling | $v = 6 - 10 \text{ m/min}$ – since soft material<br>$v = 10 \text{ m/min}$ to be selected.   |
| 8. Cross knurling of diameter                   | To be cooled and lubricated with diluted soluble oil or petroleum.   |
| 9. Tool change for chamfering                   | Right-bent roughing tool   |
| 10. Chamfering of workpiece                     | Chamfers $0.8 \times 45^\circ$ each (chamfer = t).<br>Chamfering after knurling because material is also forced towards end faces.<br>$v$ like for turning of outside diameter |
| 11. Unloading of workpiece                      |  |
| 12. Dimensional inspection                      | Dimensional and visual inspection (cleanliness of grooves). Cross knurling wheel to be cleaned by wire brush.  |



### Instruction example 7.4.: Control knob

This example serves to practise straight knurling of convex parts.



Material

St 34 (St = steel, 34 = tensile strength up to 340 MPa)

Dimensions

dia. 44 x 65 mm

Working tools

Right–offset side–cutting tool, radius turning tool, chuck key, hollow (concave) knurling tool

Measuring and testing tools

Vernier caliper, radius gauge

Accessories

Hard chuck jaws, supporting plates, coolant and lubricant

Required previous knowledge

Reading of drawings, measuring and testing, behaviour of material in chipless shaping, longitudinal turning and facing, use of coolants and lubricants

Explanations to the working drawing

M 16: M = metric thread, 16 = nominal diameter

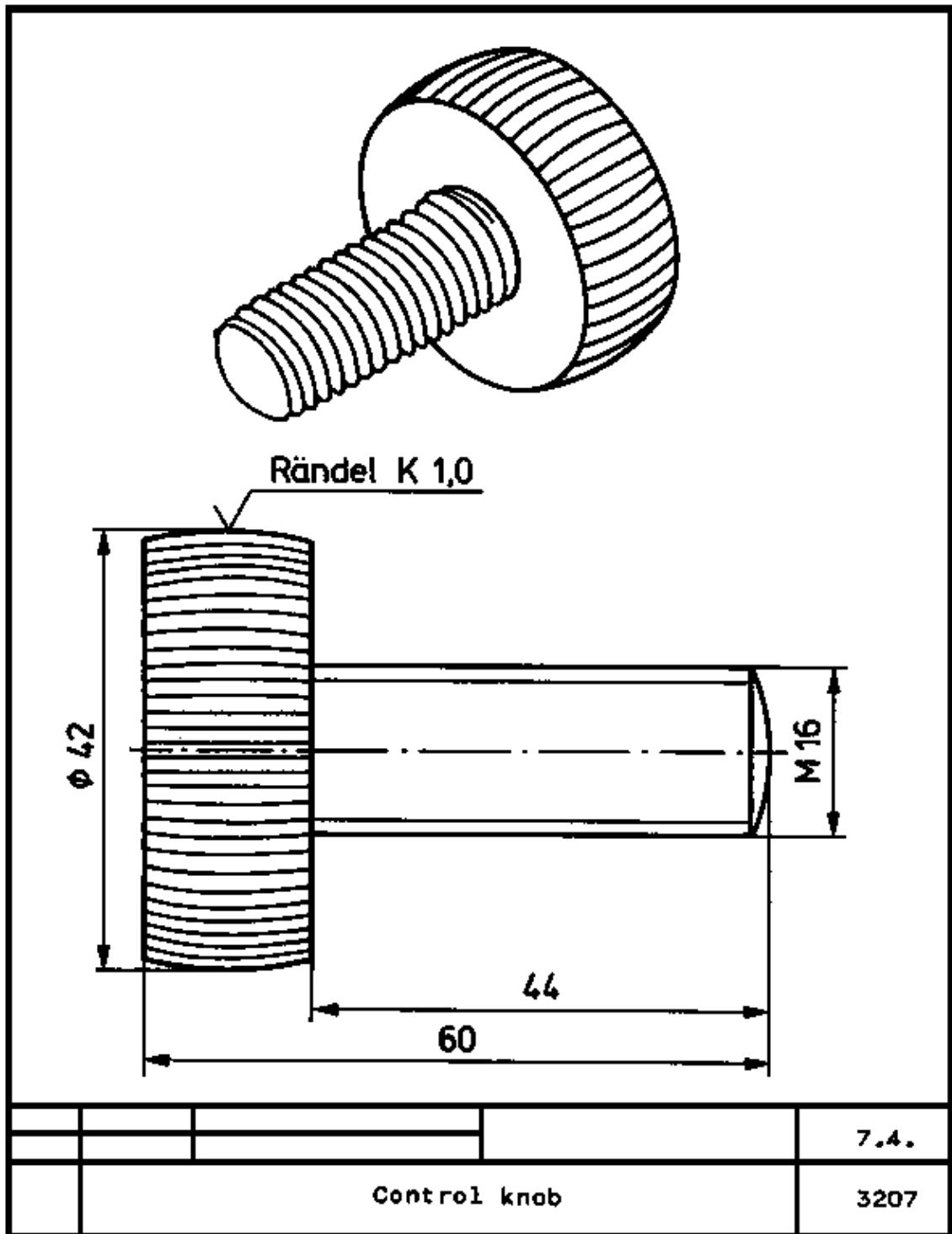
Straight knurling K 1.0: K = hollow (concave) knurling wheel 1.0 = tooth pitch 1 mm

All surfaces finished.

<u>Sequence of operations</u>	<u>Remarks</u>
1. Dimensional inspection	
2. Clamping of workpiece	Chucking in hard chuck jaws 40 mm deep.
3. Clamping of tool to produce outside diameter	Right–offset side–cutting tool.
4. Setting of cutting values	
5. Producing the outside diameter	$t/2: d = 42 \text{ mm less } 0.5 \text{ mm} = \underline{41.5 \text{ mm}}$
6. Tool change for producing the radius	Form turning tool to be selected according to radius of knurling tool.
7. Setting of cutting values	Form turning tool is made of high–speed steel – $v = 25 - 50 \text{ m/min.}$ $v = 25 \text{ m/min}$ to be selected for form turning.

- |     |                                       |  |
|-----|---------------------------------------|--|
| 8.  | Producing the radius                  | Radius turning tool to be in centre position.  |
| 9.  | Tool change for producing knurling    | Straight knurling tool to be clamped approx. 1 mm below centre and at right angle to workpiece axis.   |
| 10. | Setting of cutting values             | $v = 6 - 10$ m/min, since concave knurling wheel<br>$v = 6$ m/min to be selected.  |
| 11. | Straight knurling of diameter         | To be cooled and lubricated with soluble oil or cutting oil. First knurling to be done with one feed setting, if possible.<br>Tool to be positioned over full width – central position is essential<br>Operation must not last longer than necessary since surface gets harder and more brittle because of pressure. |
| 12. | Deburring of edges of knurled portion | Material is forced towards end faces forming burr.   |
| 13. | Unloading of workpiece                |  |
| 14. | Dimensional inspection                | Dimensional and visual inspection (cleanliness of knurling grooves).<br>Knurling wheel to be cleaned by wire brush.  |

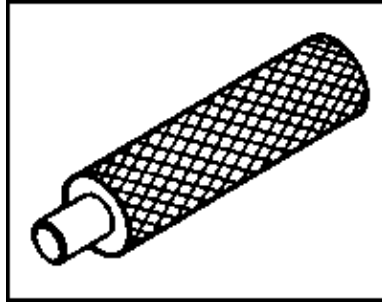




### Instruction example 7.5.: Grip

This example serves to practise spiral knurling of long parts by means of the longitudinal feed.

Material



St 36 (steel with minimum tensile strength of up to 360 MPa)

Dimensions

dia. 26 x 110 mm

Working tools

Right-bent roughing tool, boring tool for corner work, chuck key, spiral knurling tool with groove pitch (t = 1.0 mm)

Measuring and testing tools

Vernier caliper

Accessories

Soft chuck jaws, supporting plates, live centre

Required previous knowledge

Reading of drawings, measuring and testing, behaviour of material in chipless shaping, internal turning of jaws, longitudinal turning and facing, use of coolants and lubricants

Explanations to the working drawing

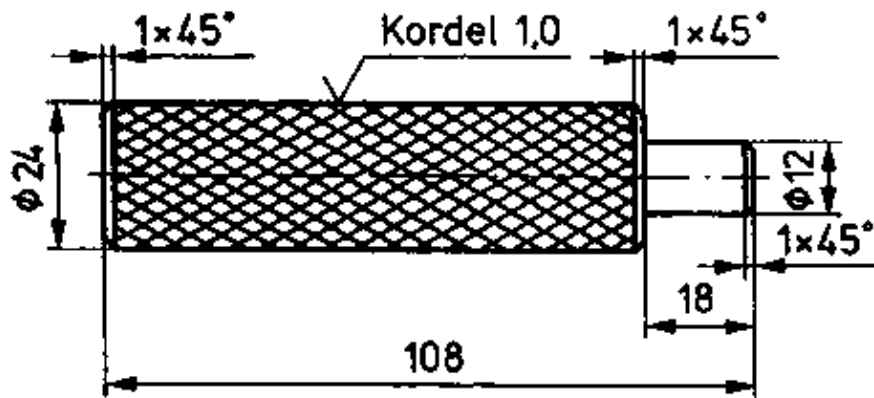
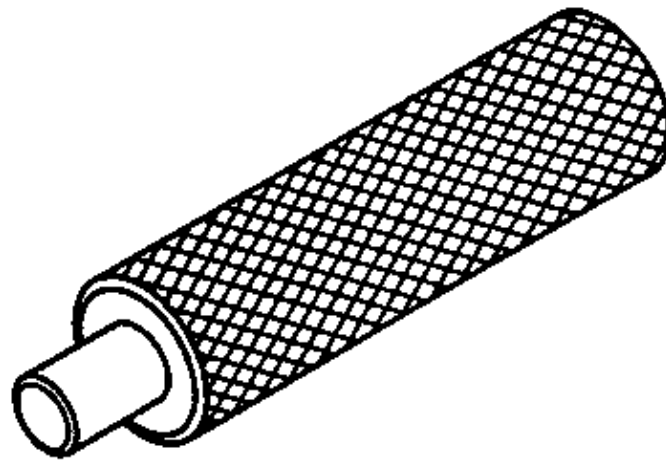
Spiral knurling 1.0: Spiral knurling: spiral knurling wheels at an angle of 30°  
 1.0 = tooth pitch (groove distance) 1 mm

**Sequence of operations**

**Remarks**

- |    |  |   |
|----|--|---|
| 1. | Dimensional inspection                             |   |
| 2. | Internal turning of soft jaws                      | Boring tool for corner work, depth 15 mm for dia. 12 mm |
| 3. | Clamping of workpiece                              | Chucking and with life centre                           |
| 4. | Clamping of tool to produce knurling diameter      | Right-bent roughing tool                                |
| 5. | Setting of cutting values for longitudinal turning |   |

- |     |   |  |
|-----|---|--|
| 6.  | Producing the knurling diameter               | $t/2: d = 24 \text{ mm less } 0.5 \text{ mm} = \underline{23.5 \text{ mm}}$  |
| 7.  | Tool change for producing knurling            | Spiral knurling tool to be clamped approx. 1 mm below centre and at right angle to workpiece axis.<br>Matching edge bearing must fit well.   |
| 8.  | Setting of cutting values for spiral knurling | $v = 6 - 10 \text{ m/min}$ , simple steel –<br>$v = 10 \text{ m/min}$ to be selected.  |
| 9.  | Spiral knurling of diameter                   | To be cooled and lubricated with diluted soluble oil – high pressing force and long portion result in high friction and heat. Starting position of tool not to be over full width immediately. Longitudinal feed must be according to spiral–knurling pitch to avoid overlapping. First knurling with one feed setting. Operation not to last longer than necessary because material gets harder and more brittle by cold forming. |
| 10. | Tool change for chamfering                    | Right–bent roughing tool.  |
| 11. | Chamfering of workpiece                       | Chamfers $1 \times 45^\circ$ (chamfer = t)<br>$v$ like for producing the knurling diameter.  |
| 12. | Unloading of workpiece                        |  |
| 13. | Dimensional inspection                        |  |



			7.5.
	Grip		3207