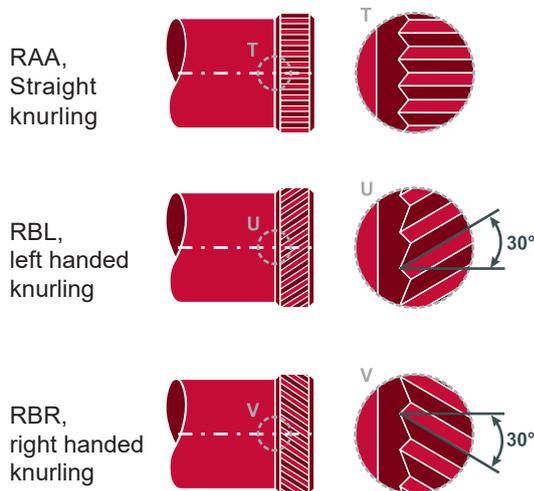


Knurling

What do medical instruments and electric motors have in common? Both objects have rolled knurlings but for completely different purposes. On the one hand the friction between medical instrument and physician glove has to be improved, on the other hand a rotor package has to be assembled on the rotor shaft.

Basics

Rolling of knurlings, or just knurling is defined in DIN 82. Here knurling is divided depending on orientation of axis of knurling in reference to workpiece axis (Fig .1).



Tab 1: Additional knurlings acc. to DIN 82

RGE	RGV	RKE	RKV
Left-Right Knurling, high tips	Left-Right Knurling, low tips	Cross (diamond) knurling, high tips	Cross (diamond) knurling, low tips

In contrast to rolling of splines with involute profiles or serrations, main geometric dimension of knurlings is the major diameter. Depending on each application this major diameter can also have very tight tolerances. The diameter is resulting from no. of teeth multiplied by pitch. Preferentially the pitch is chosen out of a geometric series of $t=0,5; 0,6; 0,8; 1; 1,2; 1,6$.

$$D_a = \frac{t \cdot z}{\pi}$$

D_a Major diameter
 t Pitch
 z No. of teeth

Fig 1: Knurlings acc. to DIN 82

Function

Knurlings are used to implement an economical friction- and shape-locked connection between shaft and hub. A hub made with a circular bore is pressed onto a part (shaft) with a knurling with a small oversize. This connection is non-detachably. Main application are shafts of electric motors or alternators of different sizes und different electric excitations. The rotor assembly with a copper winding and receiving body is assembled with the body of the rotor shaft.

Often the assembly process and therefore the durability of this connection can be controlled by measuring the needed assembly force. This force can only be constantly repeatable in case the moved material and resistance is constant. This can only be achieved if volume of moved material is constant (same no. of teeth) and the major diameter has to be formed with repeatable precision.

A special application are knurled parts in textile industry (Fig. 2). They are used in Ring Spinning machines for drawing and twisting of slivers.



Fig. 2: Textile cylinders

Rolling Process

For mass production the recommended process without any doubt is Cold Rolling. For low quantities forming with rolling head on a lathe can be used. Most important for forming of high quality knurls with precise diameters is a very rigid rolling machine with a backlash free drive chain concept.

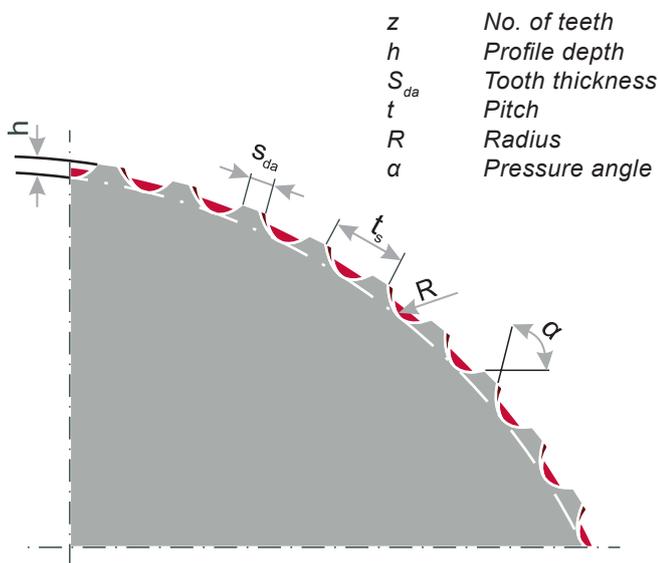


Fig. 3: Profile of knurling

This is how it can be guaranteed that the already set-up ground rolling dies achieve a high repeatability in pitch without any changes in no of rolled teeth. Additionally the usage of a feed-controlled Rolling Machines is recommended, e.g. by using a NC or modern PLC solution. Due to this solution the operator can work independently from changes like different material batches, hardnesses or inhomogeneities and can achieve a consistent high quality.

Infeed Knurling

For short knurlings (Fig. 4) the well known infeed rolling process can be used as already known from Thread Rolling. The knurling is rolled on complete length in one single process step. In common the workpieces will be centered in the work area one after another, the feed movement of Rolling Machine Slides starts while rolling dies are rotating and the knurling is formed within seconds.

Biggest advantage is the short cycle time. Disadvantage is the maximum knurling length limited by rolling force of used machine.



Fig. 4: Motor shafts

Thru-feed / Thru-force Knurling

If parts like rotating inductor shafts of big alternators (Fig. 5) shall be manufactured with long knurlings there are two different processes: Thrufeed rolling with swiveled knurl rolling dies or axial thru-force rolling. Both process types are working with knurl rolling dies with lead-in and lead-out area as well as calibration area. The main difference is only how to induce the movement of the part.

If swiveled rolling dies are used, the movement comes from axial force caused by swivel angles in thru-feed rolling. For each rolling die rotation a part of the energy is transformed into an axial component. In thru-force rolling process workpieces are pushed through the axially parallel rotating knurling dies by an electromechanical axis. Additional advantage: Combined infeed and thru-feed/thru-force process can be applied.

Selection of specific process is influenced by possible geometric limitations, overall flexibility and available machine technique.



Fig. 5: Rotating inductor shaft