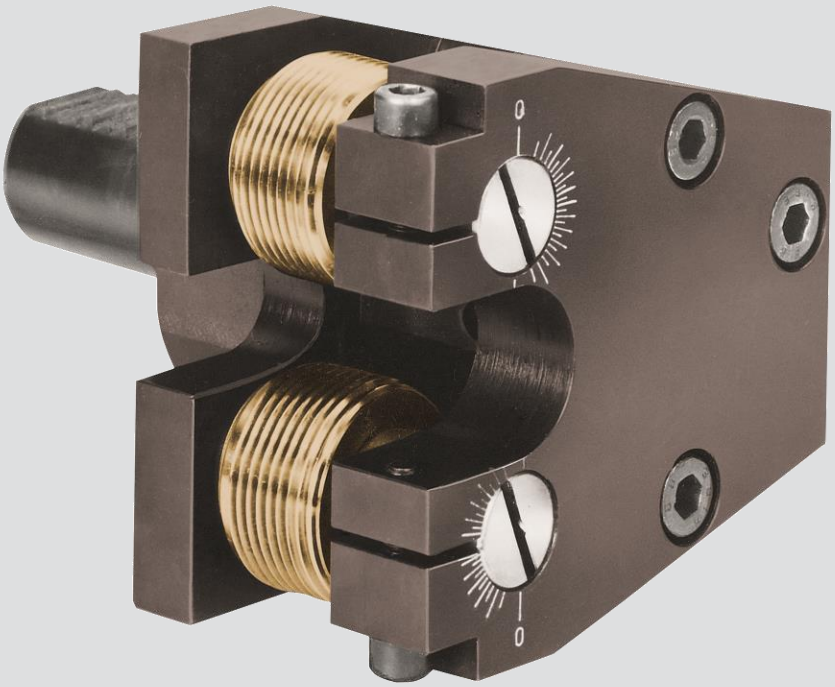
Operating Instruction
Axial Rolling System AC



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1. General

1.1 Introduction

The *rolling system* has been constructed according to the state of the art in accordance with the recognized safety rulesand standards and manufactured in accordance with TÜV-CERT DIN ISO 9001 and VDA 6.4.

The operatings instructions apply solely to *rolling system* described in the operating instructions.

Terms in italics are defined as a collective term at the appropriate place:

- In using the collective term the information relates to all single terms.
- In using the singular term the information relates solely to the single term.

NOTE

The collective term *rolling system* includes the single terms rolling head, all accessories, conumables, and spare parts.

The illustrations and information contained in these operating instructions are subject to technical changes that are necessary to improve the *rolling system*.

NOTE

Modifications or amendments to these operating instructions made at a later time can be found online under www.lmt-tools.de/dokumente-downloads.

The operating instructions are written with the intention to be read, understood and observed in all respects by those who are responsible for the use of the *rolling system*.

A safe and error-free use of the rolling system is only possible if the contents of the operating instructions are understood by the competent persons and observed in all respects.

NOTE

Work instructions are supplemented by position numbers.
Compare the information with the figure in Chapter 7.

Improper use of the *rolling system* can endanger people and cause property damage. No liability shall be assumed for any damage or malfunctions resulting from failure to observe these operating instructions.

NOTE

Note all warnings and safety instructions and the operating instructions for the machine.

Storage of the operating instructions

The entire operating instructions must be stored carefully and always kept with the *rolling system* as part of the product.

The operating instructions must be kept near the rolling system so that they are available to all persons working with the *rolling system* as required.

Warranty and technical support

We guarantee proper function of the delivered product with purchase.
We are not liable for damage in case of:

- improper use of the rolling system.
- use of non-original components.
- use of accessories not authorized by us.
- modifications undertaken without our authorization.
- use of damaged components,

Modifications to the components are permitted only after written agreement with us.

We undertake modifications to the *rolling system* to adapt the *rolling system* to the requirements of the operator. We inform the operator of the modifications and impact on the use of the rolling systems. The operating instructions describe the use of a *rolling system* without modifications.

If you encounter any problems or have any questions, please contact our Service Hotline, which will be glad to help.

We offer training specially tailored to your needs for your staff at your site. We also hold regular seminars in the LMT Group Academy, our subsidiaries and representatives.

1.2 Operator´s obligation diligence

The operator of the *rolling system* must ensure that

- the intended use of the *rolling system* is ensured at all times.
- the *rolling system* is always in a perfect and functioning condition.
- only qualified and authorized personnel assemble and operate the *rolling system* in accordance with these operating instructions.
- the qualified and authorized personnel are regularly informed about all these necessary rules of occupational safety and environmental protection.
- the qualified and authorized personnel are informed in detail about modifications made and their impact. .
- there is sufficient necessary protective equipment for the qualified and authorized personnel that is in good condition and that such equipment is worn.
- the operating instructions are available in legible condition and in full at the installation site of the *rolling system*.

1.3 Contact

Service-Hotline:

Team Rollen
Grabauer Strasse 24
21493 Schwarzenbek
Germany
Phone.: +49 4151 12 391
Fax: +49 4151 12 502
teamrollen@lmt-tools.com

LMT Group Academy:

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Postal address:
LMT Fette Werkzeugtechnik
GmbH & Co KG
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D-21484 Schwarzenbek

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GmbH & Co. KG
Grabauer Strasse 24
21493 Schwarzenek
Germany

1.4 Copyright

The copyright of these operating instructions remains with LMT Fette Werkzeugtechnik GmbH & Co. KG.

These operating instructions include regulations and technical drawings, which may be neither duplicated in full or in part, distributed or utilized for the purpose of competition or communicated to others.

Disclosure to third parties is not permitted.

We do not allow copying ot the *rolling systems* or parts of the *rolling systems*.

2. Safety

2.1 Explanation of symbols and instructions

All safety instructions and warnings in the operating instruction are structured as follows:

Danger level/Signal word

Type and source of the danger

Measures to avoid danger

Hazard symbols

The operating instructions differentiate between three hazard symbols, which allow an initial allocation of hazards. The yellow triangle indicates a general risk to people, property, animals or the environment.

Danger level

General danger to people, property, animals or the environment from the rolling system.
Measure to avoid the danger

The red, octagonal hazard symbol with the signal word IMPORTANT indicates a potentially harmful situation for the *rolling system*. Observing the operational steps, guidelines and instructions avoids damage to or destruction of the *rolling system*.

IMPORTANT

A potentially harmful situation for the *rolling systems*.

Fellow all operational steps, guidelines and instructions in order to avoid damage or destruction to the *rolling system*.

The third hazard symbol with the signal word NOTE indicates important information and tips for the user.

NOTE

No direct danger
Important information and additional tips for the user on using the *rolling system*.

Danger levels/Signal word

In the case of the yellow triangle the danger level indicates the degree of danger. Three danger levels are used. Each word is chracterized by a color that illustrate the danger levels.

CAUTION

The danger level indicates a hazard with a low level of risk which, if not avoided, may result in slight or moderate injury.

WARNING

The danger level indicates a hazard with a medium level of risk which, if not avoided, may result in death or serious injury.

DANGER

The danger level indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

Example:

DANGER
 General risk due to the use of the *rolling system* by unqualified or unauthorized personnel. Use of the *rolling system* only by qualified and authorized personnel.

2.2 Basic safety instruction

DANGER

General danger when using the *rolling system*.

Follow the operating instructions.

These include

- the basic safety instructions from the entire chapter 2 for the entire operating instructions,
- the preceding instructions for a particular chapter and
- the embedded instructions for a particular step.

Follow all local health and safety and operational safety regulations.

Chapter 2, Safety, informs you about the basic safety instructions to ensure safe and trouble-free use of the *rolling system*.

- Please contact the operator in the event of any changes to the *rolling system*.
- Refrain from any methods of working which could compromise safety.
- Only ever perform work on the rolling system when the machine is at standstill and if necessary take the *rolling system* out of the machine room.
- Before starting work on the *rolling system*, secure the drives and additional devices of the machine against accidental activation.
- Make sure there is sufficient space in the machine and pay attention to the risk of injury originating from adjacent tools and machine parts.
- Before any commissioning, check that the screws on the *rolling system* are tightened.

WARNING

The *rolling system* is made of various materials (e.g. nickel), which can trigger an allergic reaction.
General risk of injury from sharp edges.

Wear protective gloves and protective eyewear when using the *rolling systems*.

The weight of the rolling system may cause harm when it falls down.
General risk of injury during transportation/lifting of the rolling system.

- Ensure that the *rolling system* is protected of falling down or tipping over.
- Wear safety boot/hard-toed boot at all times. .
- Use suitable hoisting devices.

2.3 Intended use

IMPORTANT

The *rolling system* may only be used for the intended use.
Make sure that the *rolling system* is free of chips at all times.
Never apply force when using the *rolling system*.

The *rolling system* must only be used as a tool on a processing machine for chip-free manufacture of profiles on the outside of rationally symmetrical work pieces.

NOTE

Note that the *rolling system* is customized to the requirements specified by the operator.
Please contact our Service Hotline if you wish to use the *rolling system* in any way other that the agreed use.

The scope of application for the rolling system is to carry out a *rolling process*.
The *rolling process* includes the following manufacturing processes:

- threading
- knurling
- burnishing
- pipe forming
- reducing and
- Cold forming of rotationally symmetrical workpieces, to produce other profiles.

} *rolling process*

NOTE

The collective term *rolling process* includes the production processes of threading, knurling, burnishing, pipe forming, smoothing and cold forming of rotationally symmetrical workpieces for manufacturing other profiles.

Burnishing/Smoothing is a surface compression.
Sizing by smoothing, to perform a tolerance constriction, is not possible.

IMPORTANT

Be sure to use a torque wrench for all work on the rolling head and observe the tightening torque for each bolt (see chapter 3.7).

NOTE

Use other than the intended use is only allowed after written agreement with us.
Any use other than the intended use is considered improper use. We shall not be liable for any damage resulting from improper use. The risk is borne by the operator.

Intended use includes the observance of these operating instructions.

Coolants and lubricants

Liquids that are also used during machining are suitable as coolants and lubricants:

- emulsions in dilutions ranging from 1: 10 to 1: 20 (in some cases with high-pressure additives),
- low viscosity cutting oils and
- molybdenum (IV) sulfide.

NOTE

Observe the information and instructions provided by the manufacturer.

You can increase the service life of the rolls by using high-pressure additives, because high-pressure additives improve the sliding characteristics between the rolls and the workpiece.
Please contact our Service Hotline if you want to undertake dry processing with the *rolling system*.

IMPORTANT

Ensure that the cooling lubricant is free from chips or particles to prevent foreign bodies from being rolled into the thread and to prevent undue wear of the thread rolls and of the rolling head.

The rolling process is negatively affected by strong presence of swarf. Make sure that the rolling head is connected to the central lubrication/cooling system of the processing machine.
Install the rolling head into the processing machine in such a way as to ensure minimum exposure to chips directly. The chip guard included in the delivery should be used.

IMPORTANT

Only use coolants and lubricants for the rolling system that meet the above mentioned properties in ordert o avoid corrosion oft he rolling system.
Observe the stated storage temperature and relative humiditiy in order to prevent corrosion on the *rolling system*.

Reasonably foreseeable misuse

Reasonably foreseeable misuse of the rolling system includes:

- use of the rolling system by non-qualified or unauthorized personnel.
- leaving tools in the *rolling system*.
- over rolling the thread.
- rolling outside of the permissible rolling speed. .
- rolling outside of the permissible operating range.
- Non-compliance with the operating instructions.

IMPORTANT

Avoid any reasonably foreseeable misuse of the rolling system.
We are not liable for damage resulting misuse.

2.4 Authorized personnel and responsibilties

DANGER

General risk due to the use of the *rolling system* by unqualified or unauthorizied personnel.
Use of the *rolling system* only by qualified and authorizied personnel.

Authorizied personnel

- The *rolling system* may only be used by qualified and authorized personnel. These personnel must have received special instruction from the operator about possible hazards.
- The complete operating instructions must be read and understood by every person who deals with the use of the rolling system. We recommend the operator has this confirmed in writing.
- The qualification includes at least one mechanical technical training. In addition, we recommend staff training given by us at your site, training in our LMT Group Academy, our subsidiaries or our local representaitives.
- The operator is responsible for ensuring that work is undertaken by staff being trained only under the supervision of qualified and authorized personnel.
- The operator is responsible for ensuring that unauthorized persons have no access to the *rolling system* under any circumstances.

Responsibilities

- The operator must define all responsibilities for the use of the *rolling system* so that there are no ambiguities in terms of responsibility for safety aspects.

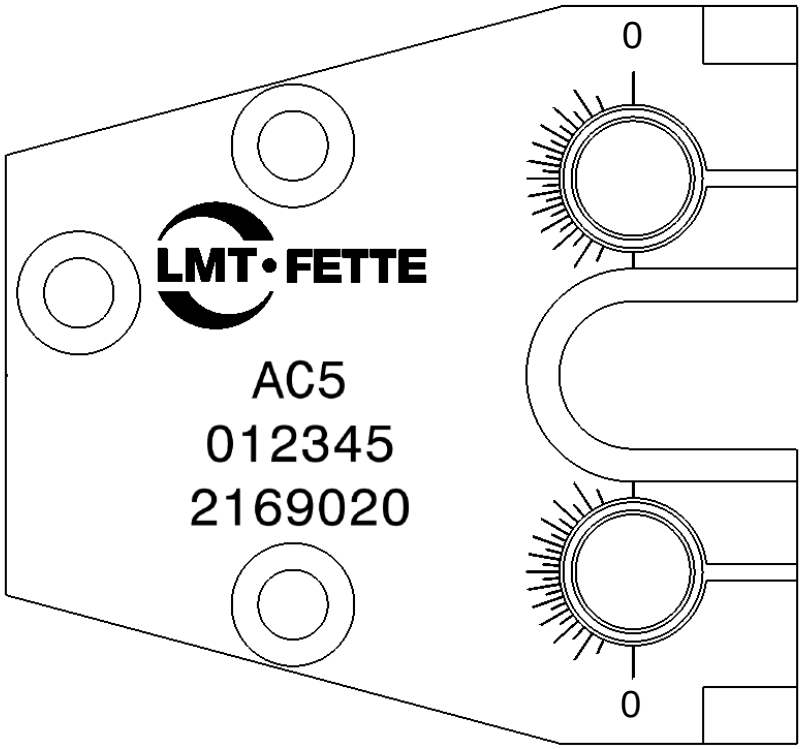
The operator must

3. The *rolling system*

The AC axial *rolling system* forms the required profile in the work-piece with axial feed direction.

The *rolling process* is performed by chipless cold forming.

Labeling of the *rolling systems*



LMT-Fette:		Company
AC5:		Rolling head description
	AC:	Type
	5:	Size
012345:		Serial-No.
2169020:		ID-No.

Figure 1: Labeling of the *rolling system* (Example: AC5)

The moduls of the *rolling system*

The *rolling system* consists of three components:

- Rolling head
- Machine adaption
- rolls

} *rolling system*

The three components of the r*olling systems* AC are shown in figure 2:

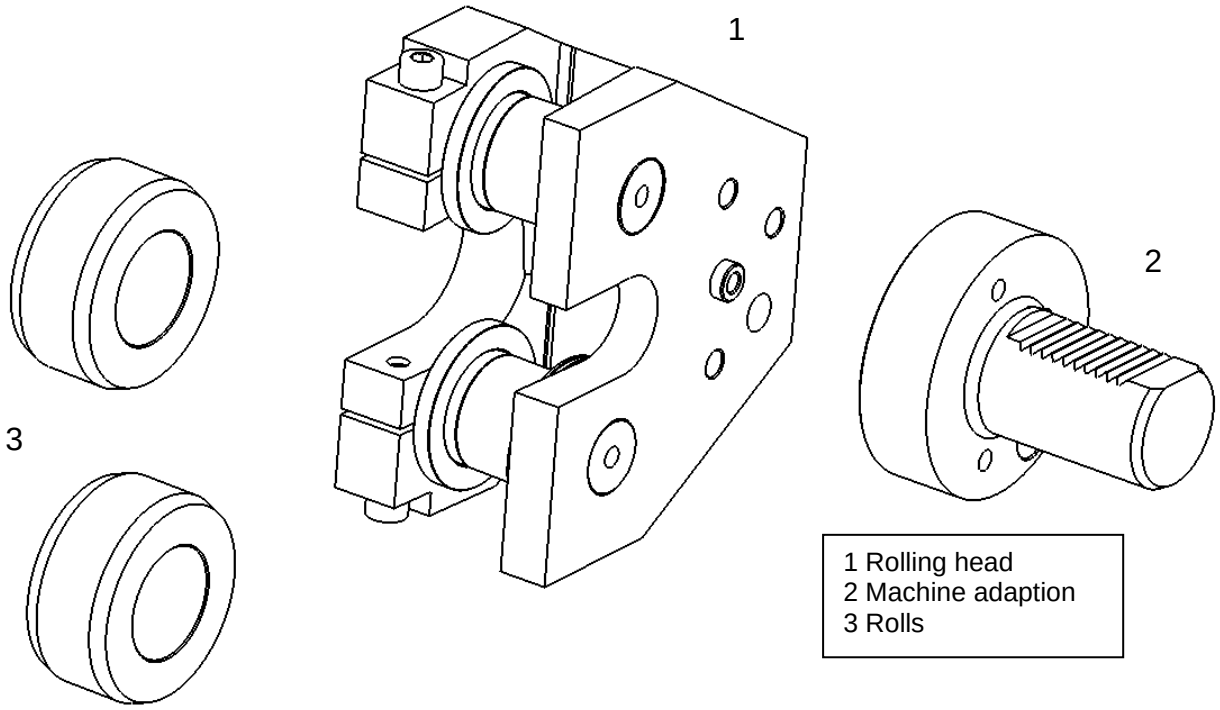


Figure 2: The three components of the AC *rolling systems*

The components of the *rolling system* are customized in order to fulfill the requirements of the specific application. Therefore each component is supplied separately.

3.1 Rolling Head

The rolling head is the centerpiece of a *rolling system*.

The present version is available in six different sizes:

- AC 2
- AC 3
- AC 4
- AC 5
- AC 6

- Special designed rolling head are labeled in same manner, but are complemented by the letter „X“ and a consecutively number.

The rolling head stores the rolls and comes with a joint point in order to be assembled with a machine adaption respectively rolling head holder (see Figure 3).

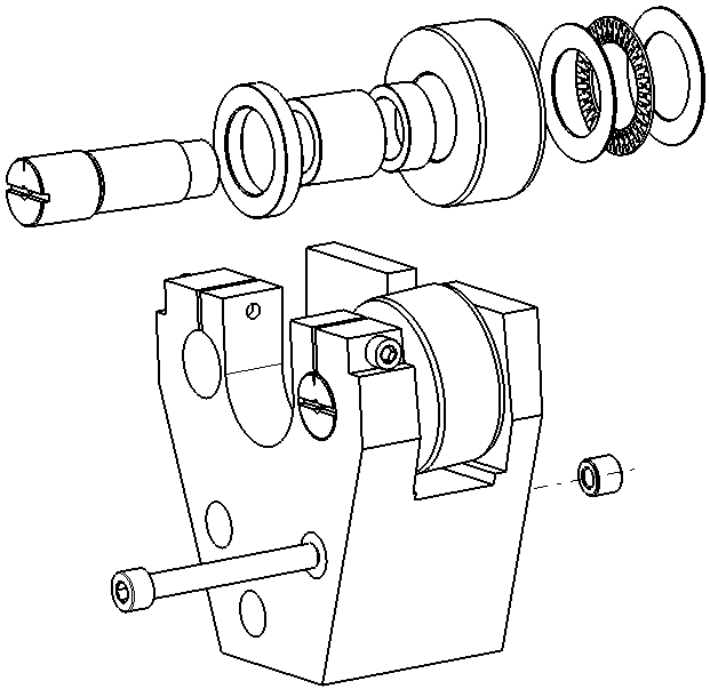


Figure 3: Example of rolling head type AC2-AC6

NOTE

Considering the used machine and the rolling head dimension we advise to choose the rolling head who will operate within the lower 2/3 of its working range.

3.2 Rolling Head Holder / Machine Adaption

Shanks according to DIN 69 880 (VDI) are available as standard for the use of AC type thread heads on CNC lathes. If the distance from the centre of the shank mounting hole to the outer edge of the turret plate is > 32.5 mm, a limited rolling length is to be expected. If a longer rolling length is required, the exact dimension from the centre of the shank bore to the outer edge of the turret plate must be specified.

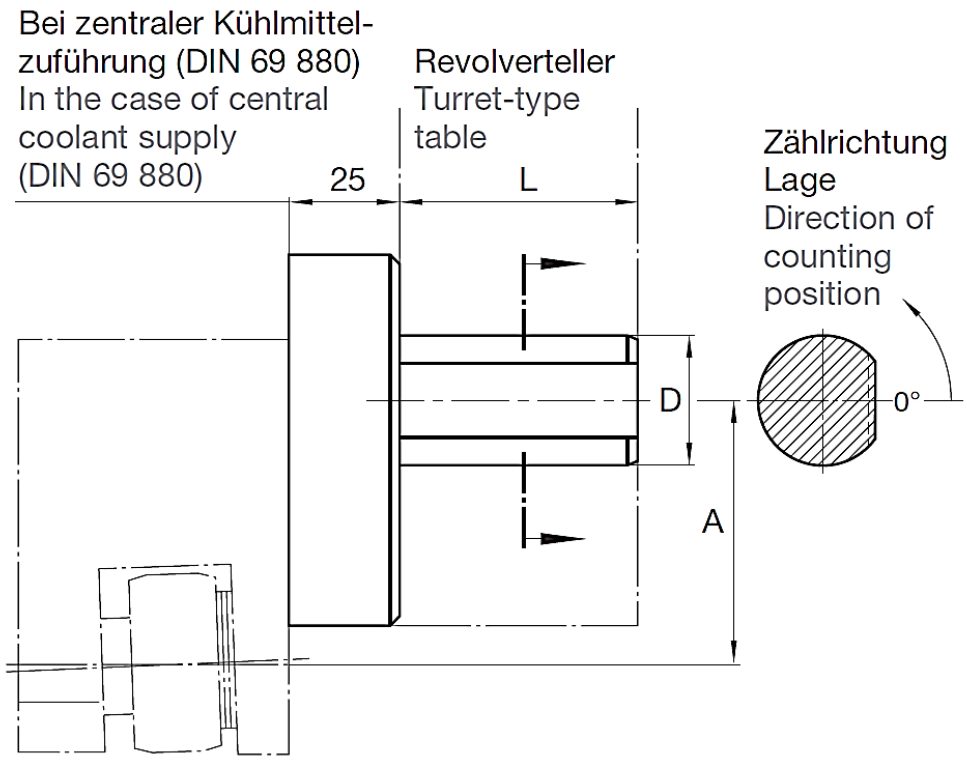


Figure 4: Shank mounting

The following shanks can be used on AC type heads.

Form	D [mm]	Position [°]	Application	Ident No.
DIN 69880	30	0°	AC2-AC6	1509453
DIN 69880	40	0°	AC2-AC6	1509462
DIN 69880	50	0°	AC2-AC6	2242752
Round	50	-	AC2-AC6	2168599

Table 1: Shank mountings for AC type rolling heads

Other shanks and adaptors are available on request.

3.3 Rolls

IMPORTANT

Use rolls only in the sets delivered by us. Do not combine rolls from different sets.

Check that the roll set number (serial number) is the same.

Labeling of the rolls

NOTE

The label on the rolls varies depending on the *rolling process*, but at the same point there is always

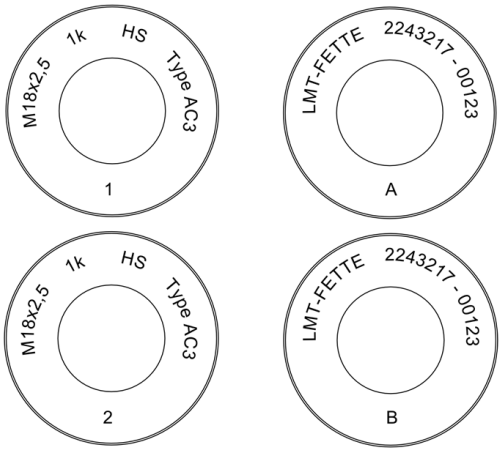
- the ID number
- the numbers (1, 2)
- the letters (A, B)

labeled on the rolls.

When contacting the Service Hotline always state the ID-number of the roll.

Respect the numbers (1, 2) and the letters (A, B) of the set of rolls when inserting the rolls into the *rolling system*.

Figure 5 shows an example of the labeling of the rolls.



M18x2,5	:	Thread dimensions
1K	:	Lead number
HS	:	Material of rolls
Type	:	AC3
2243217	:	ID number
00123	:	Serial No.
1	:	Number 1 or 2
A	:	Letter A or B

Figure 5: Labeling of the rolls

As standard, LMT Fette Werkzeugtechnik deliveres the following thread tolerances:

- 6g (for threads in acc. with DIN)
- 7e[1] (for threads in acc. with DIN)
- 2A (for UN threads in acc. with ANSI)

However, you can order any other thread tolerance.

[1] for trapezodial threads

Tool life

The tool life of the rolls is influenced by the following factors:

- material properties (particularly tensile strength and elongation at fracture)
- hardness increase behavior oft he material under cold forming
- degree of roll out of the profile
- execution of chamfers during workpiece preperation
- correct adjustment of the tool
- rolling speed and operating feed
- sufficient supply of clean coolant
- avoidance of chips on workpieces and rolls prior ro the rolling process
- profile roll start and run-out

Review your application and discuss it with our personnel (chapter 1.3). They will be pleased to give you useful advice with regard to the ideal design of your roll.

When the rolls are worn, they must be replaced with new ones.

NOTE

Respect the numbers on the number side or the letters on the letters side for inserting the rolls:

- Roll 1 – Letter A
- Roll 2 – Letter B

For cylindrical workpieces and the following *rolling processes*, use the rolls on both sides to increase the service life:

- threading,
- knurling,
- burnishing and
- reducing (depending on the roll type)

3.4 Dimensions of the *rolling system*

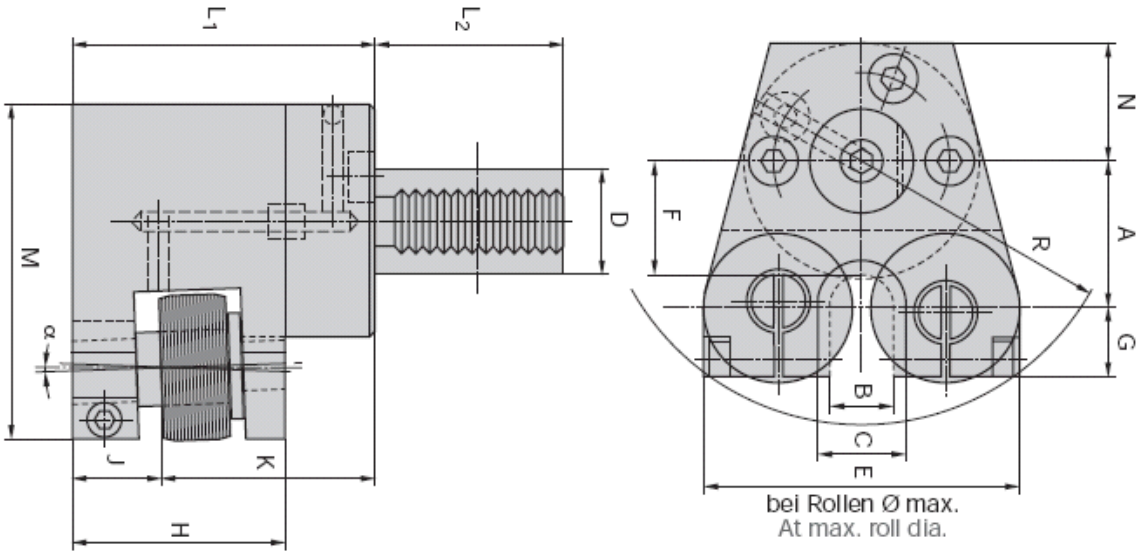


Figure 6: Dimensions of the *rolling system*

Rolling Head Type	AC2		AC3		AC4		AC5		AC6	
Ident No.	1509435		1514107		1518096		2169020		2169021	
	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
A	41,5	1,634	51	2,008	49	1,929	55	2,165	110	4,331
B	18	0,709	24	0,945	32	1,260	56	2,205	77	3,031
C	26	1,024	40	1,575	50	1,969	72	2,835	88	3,465
D	20; 30; 40; 50 0.787"; 1.181"; 1.575"; 1.968"				30; 40; 50; 60 1.181"; 1.575"; 1.968"; 2.362"					
E	91	3,583	127	5,000	156	6,142	193	7,598	203	7,992
F	32,5	1,280	39	1,535	33	1,299	27	1,063	71,5	2,815
G	20	0,787	25	0,984	33	1,299	33	1,299	33	1,299
H	62	2,441	68,5	2,697	78	3,071	78	3,071	78	3,071
J	25,3	0,996	27,1	1,067	28,5	1,122	29	1,142	28	1,102
K	61,7	2,429	66,4	2,614	74,5	2,933	74	2,913	75	2,953
L_1	87	3,425	93,5	3,681	103	4,055	103	4,055	103	4,055
L_2 (D=20)	40	1,575	40	1,575	---	---	---	---	---	---
L_2 (D=30)	55	2,165	55	2,165	55	2,165	55	2,165	55	2,165
L_2 (D=40)	63	2,480	63	2,480	63	2,480	63	2,480	63	2,480
L_2 (D=50)	78	3,071	78	3,071	78	3,071	78	3,071	78	3,071
L_2 (D=60)	---	---	---	---	94	3,701	94	3,701	94	3,701
M	96,5	3,799	118,5	4,665	122	4,803	128	5,039	183	7,205
N	35	1,378	42,5	1,673	40	1,575	40	1,575	40	1,575
R	76,5	3,012	99	3,898	113	4,449	126	4,961	175	6,890
α (inclination angle)	3°		2°40'		2°30'		1°		0°40'	

Table 2: Dimensions of the *rolling system* AC

3.5 Working ranges and rollable materials

Arbeitsbereiche Capacity range			
Rollkopf Rolling head	**zylindrische Gewinde** cylindrical threads		
	Außendurchmesser Major diameter **mm** | inch		**max. Steigung min. Gang /** max. Pitch min TPI
	min.	**max.**	
AC2	8 | $\frac{5}{16}$	16 | $\frac{5}{8}$	2 | 11
AC3	12 | $\frac{7}{16}$	22 | $\frac{7}{8}$	2,5 | 9
AC4	16 | $\frac{5}{8}$	30 | $1\frac{1}{8}$	3 | 9
AC5	26 | $\frac{3}{4}$	52 | $2\frac{1}{8}$	3 | 11
AC6	45 | $1\frac{1}{2}$	72 | $2\frac{3}{4}$	3 | 11

Table 3: Working ranges

Rollable materials

A large number of characteristics and properties influence the rollability of materials and the resulting profile quality. In order to reduce the complexity the chosen properties:

- elongation and
- tensile strength

enable an evaluation of the rollability of materials suitable for everyday use.

IMPORTANT

The following property values aren´t hard limits, rather empirical values who define the feasible.

Metallic materials with the following properties can be rolled with a *rolling system* TK EVO:

- elongation $\sigma_B \geq 7\%$ und
- tensile strenght $\sigma_Z \leq 1000\ MPa$

Please contact our Service Hotline if you wish to perform *rolling processes* outside of these limits or very near them.

3.6 Tightening torques

IMPORTANT

Observe the tightening torques.

Rolling Head	Position	ID-No.	Connection	Function	Dimensions	Tightening torque
Alle	9	2141937	Cap screw	Fastening rolling head – shank adapter	M8x65	**27,3 Nm**
AC2/AC2R	10	2141913	Cap screw	Clamping of roll axis	M6x25	**11,3 Nm**
AC3/AC3R	10	2141914	Cap screw	Clamping of roll axis	M6x30	**11,3 Nm**
AC4/AC4R	10	2141932	Cap screw	Clamping of roll axis	M8x40	**27,3 Nm**
AC5/AC5R	10	2141930	Cap screw	Clamping of roll axis	M8x30	**27,3 Nm**
AC6/AC6R	10	2141930	Cap screw	Clamping of roll axis	M8x30	**27,3 Nm**

Table 4: Tightening torques for the AC type *rolling systems*

3.7 Condition upon delivery

We deliver your *rolling system* in the following condition separately:

- the rolling head with tools
- the set of rolls
- machine adaption

NOTE

Please note that the delivered components are matched to the size of the *rolling system*. Only use the supplied components for the delivered *rolling system*.

The condition upon delivery is the proper storage condition.

CAUTION

The components of the rolling system are sprayed with a commercially available creeping oil to protect them against corrosion. Touching the oily surface of the components may result in skin irritations. Avoid skin contact, especially in case of allergies or open skin lesions.

Do not touch the oiled surface if you have an open lesion. Do not touch the oiled surface if you are worried about an allergic reaction. Call the service hotline to find out the contents of the creeping oil and check your tolerability.

4. Installation

IMPORTANT

Please contact our Service Hotline in the event of initial insallation of the *rolling system*.
We will gladly advise you on

- inserting the rolls into the *rolling system*,
- functional testing of the *rolling system*,
- inserting the rolling head into the rolling head holder, and
- installing the *rolling system* into the processing machine.

WARNING

General risk of injury from sharp edges.
The *rolling system* is made of various materials (e.g. nickel), which can trigger an allergic reaction.

Wear protective gloves and protective eyewear when using the *rolling systems*.

The weight of the rolling system may cause harm when it falls down.
General risk of injury during transportation/lifting of the rolling system.

- Ensure that the *rolling system* is protected of falling down or tipping over.
- Wear safety boot/hard-toed boot at all times. .
- Use suitable hoisting devices.

4.1 Machine requirements

Collision check

CAUTION

General risk of collision.

Don´t equipe the machine with a *rolling system* without a collision check.

Please contact our Service Hotline in the event of initial equipment or change of a *rolling system* on your machine. We will be happy to guide you through.

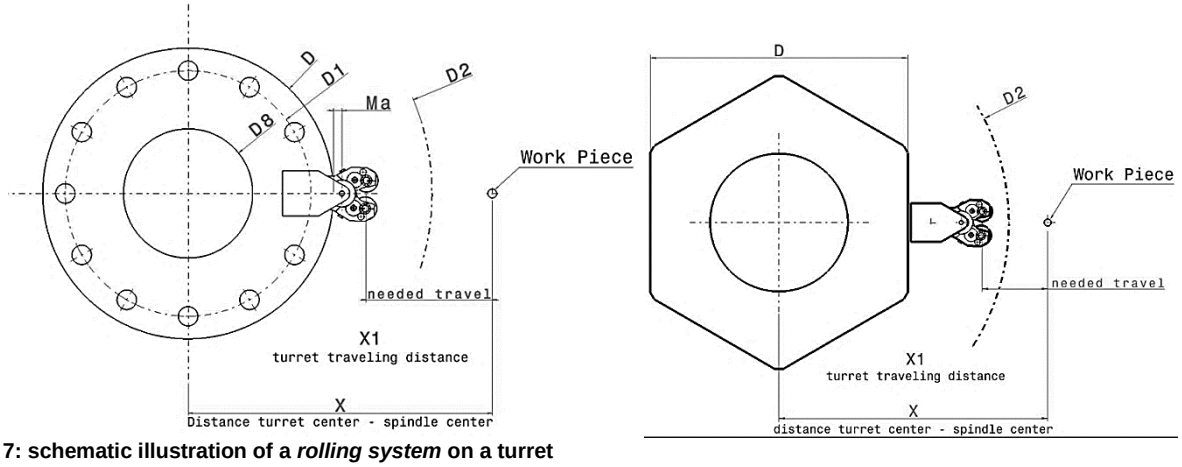


Figure 7: schematic illustration of a *rolling system* on a turret

NOTE

D turret outside dimenions
D1 inner turret dimenions
D2 max. swing circle-Ø
X2 turret center to workpiece center
X1 travel
X_H machine contact surface till joint point: rolling head/holder
X joint point: rolling head/holder till rolling center (workpiece center)

For a collision-free use of the *rolling system* dimensions must lay be within the max. swing circle-Ø.

See chapter 3.4 for *rolling system* dimensions.

4.2 Inserting the rolls into the *rolling system*

1. Loosen the cap screws (10) and remove the eccentric spindles (3).
2. Remove the carbide bushings (5), the bearing set (7) and the washer (8) on both sides.

IMPORTANT

Lubricate bore holes of the rolls (6), eccentric spindles (3), carbide bushings (5) and bearings thinly with molybdenum (IV) sulfide, e. g. Molykote.

3. Place the rolls (6) on the carbide bushings (5) and insert them in the jaws of the rolling head (2) so that either the number side or the letter side of the rolls faces to the front (thicker arm side).
4. The thrust bearing set (7) and the washer (8) must be placed behind the rolls (thinner arm side).
5. Then insert the eccentric spindles (3).
6. The marking on the end face of the eccentric pin (3) should then be placed on the outermost scale division (Plus).
7. Tighten the cap screws (10).

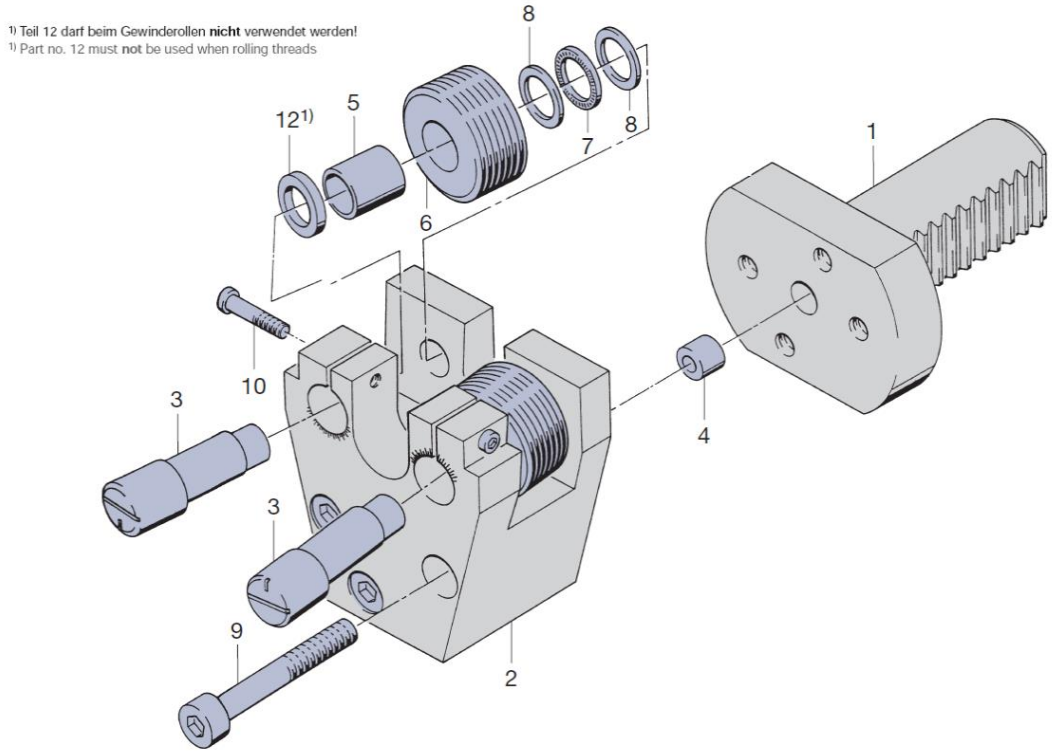


Figure 8: Exploded view

Checking the rolls

Move or rather rotate the rolls in order to check a smooth-running.

IMPORTANT

Contact our Service Hotline if you can´t move the rolls.

CAUTION

General risk of component breakage.

Don´t do a *roll process* if you can´t move the rolls.

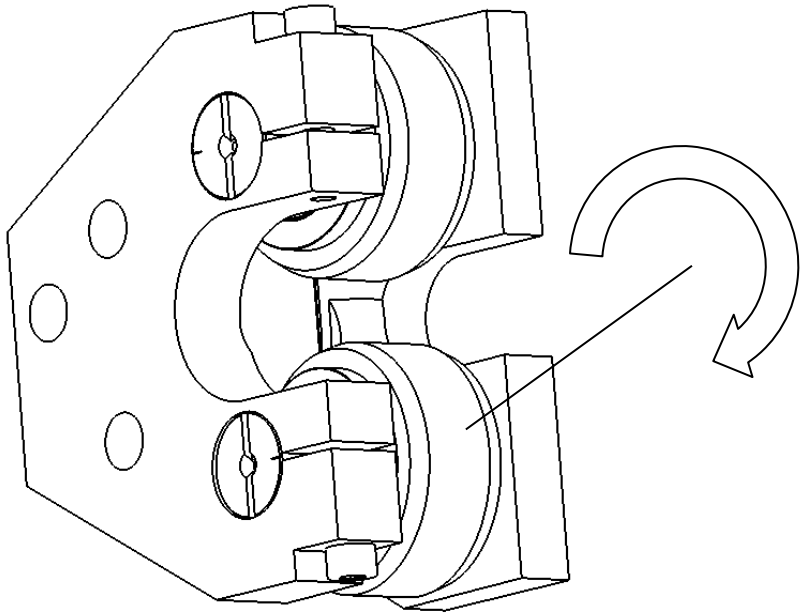


Figure 9: Checking the rolls

4.3 Adjusting the axle distance to workpiece dimension

The thread diameter is adjusted by two eccentric spindles (3).

1. To do this, loosen the cap screws (10),

2. hold the gauge block or similar, which corresponds to the core diameter of the thread, between the rolls (6) and turn the eccentric pins of the scale division on the front side of the roll holder (2) accordingly until the gauge block is firmly between the rolls.

3. Tighten the cap screws (10).

If the desired thread dimensions are not yet reached with the rolling head set in this way, i. e. if the rolled threads in the flank diameter are slightly too large, the eccentric bolts must be adjusted evenly (scale line = 0,025 mm)

IMPORTANT

Don´t perform a second *rolling process* on a once rolled profile.

4.4 Installing the *rolling system* in the processing machine

WARNING

General risk of injury from sharp edges.
The *rolling system* is made of various materials (e.g. nickel), which can trigger an allergic reaction.

Wear protective gloves and protective eyewear when using the *rolling systems*.

The weight of the rolling system may cause harm when it falls down.
General risk of injury during transportation/lifting of the rolling system.

- Ensure that the *rolling system* is protected of falling down or tipping over.
- Wear safety boot/hard-toed boot at all times. .
- Use suitable hoisting devices.

1. Check if you need suitable hoisting device.

2. Insert the *rolling system* in the processing machine.

3. Fix and secure the mounting position of the *rolling system*.

NOTE

Ensure the work piece is sufficiently clamped in the processing machine so that the torque generated by the *rolling process* can be absorbed.

If the rolling head is mounted on a turret with shank mount according to DIN 69 880, it is centrically aligned with the shank of the rolling head due to the correct position of the gearing. Minor inaccuracies must be compensated by loosening the cap screws (9) and turning the roll holder (2).

For round shafts, the entire rolling head is turned and then clamped.

For centric set-up, the rolling head is moved against the blank diameter of the workpiece. The rolling head or roll holder is turned until both rolls touch the workpiece at the same time.

NOTE

To program the workpiece center to the roll center, observe dimension "A" (see Fig. 10).

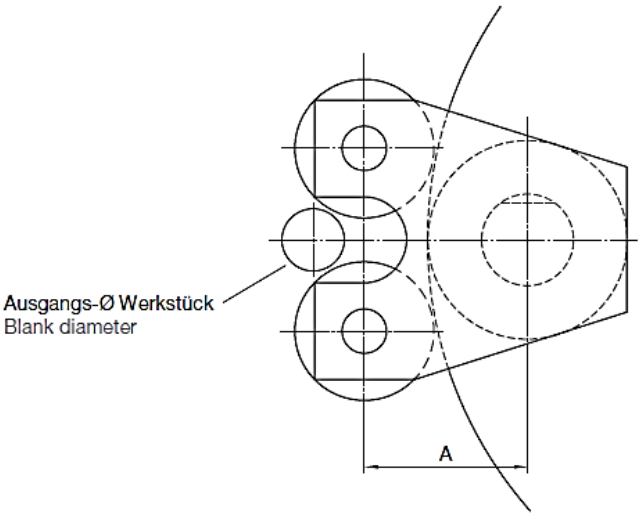


Figure 10: Adjustment of the rolling head

5. Operation

IMPORTANT

First follow the instruction in chapter 4, installation.

Please contact our Service Hotline in the event of initial commissioning of the *rolling system*.

We will gladly advice on:

- preparing the workpiece,
- defining the process variables and
- fine-adjusting the *rolling system*.

WARNING

General risk of injury from sharp edges.

The *rolling system* is made of various materials (e.g. nickel), which can trigger an allergic reaction.

Wear protective gloves and protective eyewear when using the *rolling systems*.

The weight of the rolling system may cause harm when it falls down.

General risk of injury during transportation/lifting of the rolling system.

- Ensure that the *rolling system* is protected of falling down or tipping over.
- Wear safety boot/hard-toed boot at all times. .
- Use suitable hoisting devices.

5.1 Vorbereitung des Werkstücks

Characteristics of threads

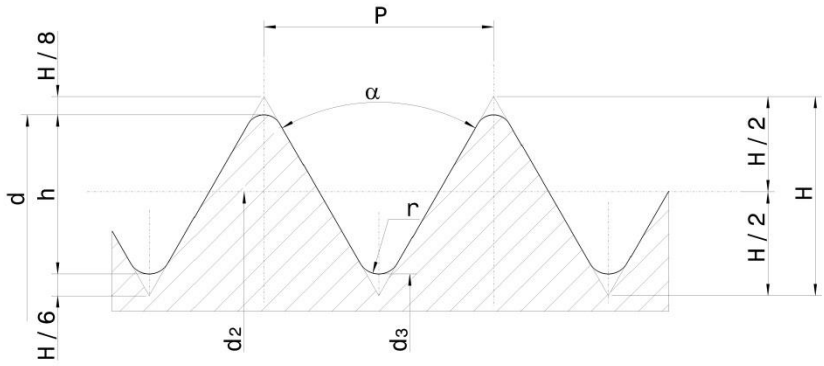


Figure 11: Characteristics of threads (e.g.: ISO metric threads)

NOTE

P : Thread pitch (for multiple threads: thread pitch) [mm]
α : Flank angle [°]
H : Theoretical profile height [mm]
h : Profile depth [mm]
r : Core radius [mm]
d : Nominal thread diameter [mm]
d_2 : Pitch diameter [mm]
d_3 : Core diameter [mm]

NOTE

For the geometry of the workpiece, note

- the blank diameter,
- the chamfer and
- the undercut.

Blank diameter

The resulting blank diameter must be complied with a tolerance of -0,02mm.

- for threading:

NOTE

$d_V \approx d_2 - 0{,}03$ mm

d_V : Blank diameter [mm]
d_2 : Pitch diameter [mm]

If you increase/decrease the blank diameter d_v, the nominal thread diameter d increases/decreases by three to five times as much.

- for knurling:

NOTE

$d_V \approx d - h_Z$

d_V : Blank diameter [mm]
d : Nomiinal thread diameter[mm]
h_Z : Tooth depth acc. to DIN [mm]

Chamfer

NOTE

Only chamfer the work piece under the following *rolling processes*:

- Threading,
- Knurling and,
- Cold forming of rotationally symmetrical work pieces, to produce other profiles.

Perform the chamfering in accordance with figure 15:

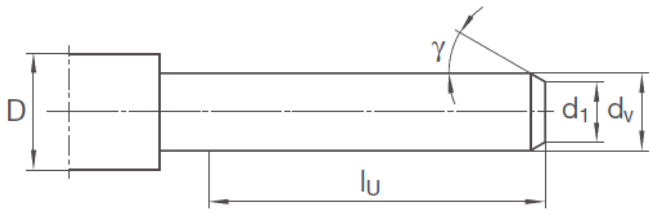


Figure 12: Preparing the work piece without undercut (thread runout)

NOTE

γ : Chamfer angle [°]
D : Collar diameter [mm]
d_1 : End face diameter [mm]
d_V : Blank diameter [mm]
l_U : length to be formed of the work piece

- The chamfer angle should be γ = 10°– 30°.
- The interior diameter d_1 must be smaller than the core diameter.

NOTE

$d_1 \leq d_3 - 0{,}1$ mm

d_1 : interior (end face) diameter [mm]
d_3 : core diameter [mm]

Undercut

NOTE

The minimum undercut (thread runout) g depends on:

- the rolling head size,
- the thread pitch and
- the thread roll lead.

1. Read off the rolling head size from the front plate of the *rolling system.*
2. Determine the thread pitch.
3. Determine the thread roll lead *b.*

NOTE

The thread roll lead *b* denotes the number of teeth that are in front of a full-profile tooth.
We distinguish between *b* = 1 K and *b* = 2 K.

The thread roll lead is shown in figure 13: and 14.

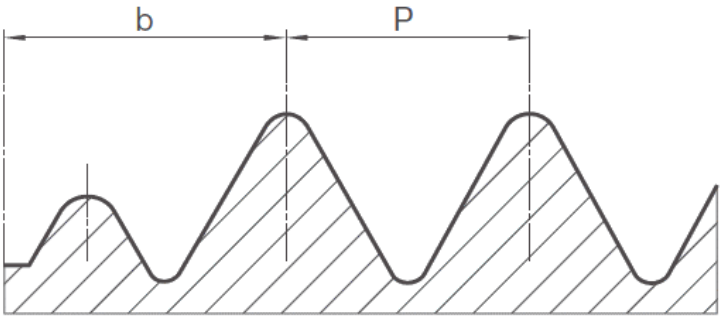


Figure 13: Thread roll lead 1 K

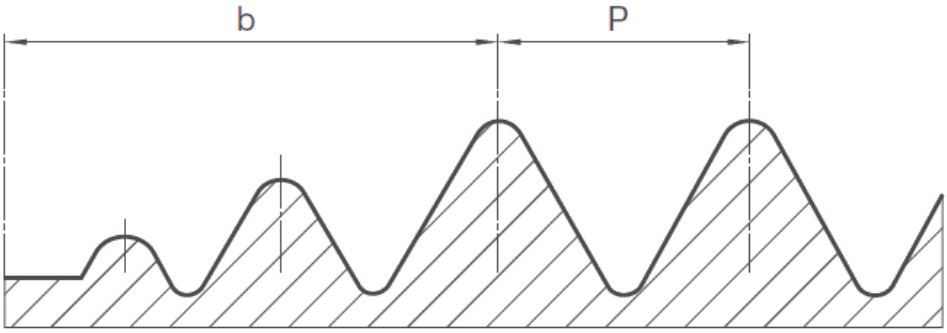


Figure 14: Thread roll lead 2 K

4. Read off the minimum undercut (thread runout) g using the values determined form table 5..

5. Perform the undercut and the two chamfers according to figure 15.

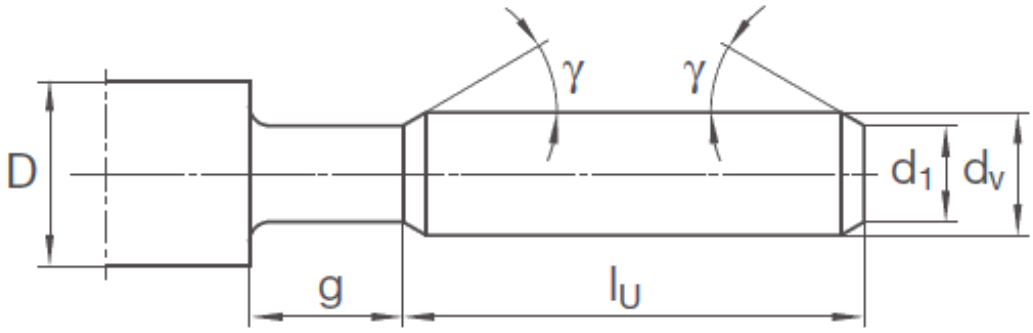


Figure 15: Preparing the work piece with undercut (thread runout)

NOTE

g : undercut (profile outlet) [mm]
γ : chamfer angle [°]
D : shoulder diameter [mm]
d_1 : interior diameter [mm]
d_V : blank diameter [mm]
l_U : profile length

Stei-gung Pitch mm Zoll	An-lauf Lead	Rollkopfgröße Rolling head size											
		0	001	01 01-1	1 23	12	1223	2 233400 34 34-1	2T 3 32 3-1 45-1	4-1 56-1	3T 3-1T	4-1T 5-1 6700	5-1T 6a-1 6b-1
		mm | inch											
0,25 0.01	1 , 2 ,	0,438 | 0.017 0,688 | 0.027	0,417 | 0.016 0,667 | 0.026	0,417 | 0.016 0,667 | 0.026									
0,3 0.012	1 , 2 ,	0,475 | 0.019 0,775 | 0.031	0,550 | 0.022 0,850 | 0.033	0,550 | 0.022 0,850 | 0.033	0,500 | 0.020 0,800 | 0.031		0,450 | 0.018 0,750 | 0.030						
0,35 0.014	1 , 2 ,	0,588 | 0.023 0,938 | 0.037	0,583 | 0.023 0,933 | 0.037	0,683 | 0.027 1,033 | 0.041	0,558 | 0.022 0,908 | 0.036		0,583 | 0.023 0,933 | 0.037						
0,4 0.016	1 , 2 ,	0,700 | 0.028 1,100 | 0.043	0,767 | 0.03 1,167 | 0.046	0,667 | 0.026 1,067 | 0.042	0,767 | 0.030 1,167 | 0.046		0,667 | 0.026 1,067 | 0.042						
0,45 0.018	1 , 2 ,	0,738 | 0.029 1,188 | 0.047	0,875 | 0.034 1,325 | 0.052	0,800 | 0.031 1,250 | 0.049	0,825 | 0.032 1,275 | 0.050		0,775 | 0.031 1,225 | 0.048						
0,5 0.02	1 , 2 ,	0,875 | 0.034 1,375 | 0.054	0,833 | 0.033 1,333 | 0.052	0,833 | 0.033 1,333 | 0.052	0,833 | 0.033 1,333 | 0.052	0,833 | 0.033 1,333 | 0.052	0,833 | 0.033 1,333 | 0.052	0,833 | 0.033 1,333 | 0.052					
0,6	1 ,	1,150 |	0,900 | 0.035	0,900 | 0.035	1,000 | 0.039	1,000 | 0.039	1,100 | 0.043	1,100 | 0.043					

		0.045											
0.024	2 ,	1,750 | 0.069	1,100 | 0.043	1,500 | 0.059	1,600 | 0.063	1,600 | 0.063	1,700 | 0.067	1,700 | 0.067					
0,7	1 ,	1,025 | 0.040	1,167 | 0.046	1,267 | 0.050	1,317 | 0.052	1,217 | 0.048	1,167 | 0.046	1,367 | 0.054					
0.028	2 ,	1,725 | 0.068	1,867 | 0.073	1,967 | 0.077	2,017 | 0.079	1,917 | 0.075	1,867 | 0.073	2,067 | 0.081					
0,75	1 ,	1,188 | 0.047	1,375 | 0.054	1,375 | 0.054	1,250 | 0.049	1,250 | 0.049	1,125 | 0.044	1,125 | 0.044	1,375 | 0.054				
0.03	2 ,	1,938 | 0.076	2,125 | 0.084	2,125 | 0.084	2,000 | 0.079	2,000 | 0.079	1,875 | 0.074	1,875 | 0.074	2,125 | 0.084				
0,8	1 ,	1,400 | 0.055		1,533 | 0.060	1,233 | 0.049	1,333 | 0.052	1,533 | 0.060	1,333 | 0.052	1,433 | 0.056				
0.031	2 ,	2,200 | 0.087		2,333 | 0.092	2,033 | 0.08	2,133 | 0.084	2,333 | 0.092	2,133 | 0.084	2,233 | 0.088				
0,9	1 ,	1,525 | 0.060		1,550 | 0.061	1,350 | 0.053	1,650 | 0.065	1,750 | 0.069	1,600 | 0.063	1,400 | 0.055				
0.035	2 ,	2,425 | 0.095		2,450 | 0.096	2,250 | 0.089	2,550 | 0.1	2,650 | 0.104	2,500 | 0.098	2,300 | 0.091				
1,0	1 ,	1,750 | 0.069		1,667 | 0.066	1,667 | 0.066	1,667 | 0.066	1,667 | 0.066	1,667 | 0.066	1,667 | 0.066	1,667 | 0.066		1,667 | 0.066	
0.039	2 ,	2,750 | 0.108		2,667 | 0.105	2,667 | 0.105	2,667 | 0.105	2,667 | 0.105	2,667 | 0.105	2,667 | 0.105	2,667 | 0.105		2,667 | 0.105	
1,25	1 ,			2,083 | 0.082	2,083 | 0.082	1,833 | 0.072	2,208 | 0.087	2,083 | 0.082	2,083 | 0.082	2,083 | 0.082		2,083 | 0.082	
0.049	2 ,			3,333 | 0.131	3,333 | 0.131	3,083 | 0.121	3,458 | 0.136	3,333 | 0.131	3,333 | 0.131	3,333 | 0.131		3,333 | 0.131	
1,5	1 ,			2,250 | 0.089	2,500 | 0.098	2,500 | 0.098		2,750 | 0.108	2,250 | 0.089	2,500 | 0.098		2,250 | 0.089	2,750 | 0.108
0.059	2 ,			3,750 | 0.148	4,000 | 0.157	4,000 | 0.157		4,250 | 0.167	3,750 | 0.148	4,000 | 0.157		3,750 | 0.148	4,250 | 0.167
1,75	1 ,					2,792 | 0.110		3,276 | 0.129	3,145 | 0.124	3,042 | 0.120		2,792 | 0.110	3,417 | 0.135
0.069	2 ,					4,542 | 0.179		5,042 | 0.198	4,899 | 0.193	4,792 | 0.189		4,542 | 0.179	5,167 | 0.203
2,0	1 ,							3,333 | 0.131	3,833 | 0.151	3,333 | 0.131		3,292 | 0.130	3,333 | 0.131
0.079	2 ,							5,333 | 0.210	5,833 | 0.230	5,333 | 0.210		5,292 | 0.208	5,333 | 0.210
2,5	1 ,								4,150 | 0.163	4,167 | 0.164	4,167 | 0.164	4,135 | 0.163	4,167 | 0.164
0.098	2 ,								6,655 | 0.262	6,667 | 0.262	6,667 | 0.262	6,640 | 0.261	6,667 | 0.262
3,0	1 ,								5,488 | 0.216	4,983 | 0.196	4,500 | 0.177	5,476 | 0.216	4,500 | 0.177
0.118	2 ,								8,488 | 0.334	7,983 | 0.341	7,500 | 0.295	8,500 | 0.335	7,500 | 0.295
3,5	1 ,								6,083 | 0.239	6,807 | 0.268	5,833 | 0.230	6,555 | 0.258	6,333 | 0.249
0.138	2 ,								9,583 | 0.377	10,307 | 0.406	9,333 | 0.367	10,055 | 0.396	9,833 | 0.387
4,0	1 ,										6,167 | 0.243	6,680 | 0.263	7,667 | 0.302
0.157	2 ,										10,167 | 0.40	10,667 | 0.420	11,667 | 0.459
4,5	1 ,										7,000 | 0.276	11,748 | 0.463	7,750 | 0.305
0.177	2 ,										11,500 | 0.453	16,248 | 0.640	12,250 | 0.482
5,0	1 ,										8,333 | 0.328	8,357 | 0.329	8,333 | 0.328
0.197	2 ,										13,333 | 0.525	13,333 | 0.525	13,333 | 0.525
5,5	1 ,												9,417 | 0.371
0.217	2 ,												14,917 | 0.587
6,0	1 ,												
0.236	2 ,												

Table 5: Determining the undercut (thread runout in relation to thread roll lead) 1/2

Steigung (Gang pro Zoll) Pitch (TPI)	Anlauf Lead	Rollkopfgröße Rolling head size											
		0	001	01 01 -1	1 23	12	1223	2 233400 34 34-1	2T 3 32 3-1 45-1	4-1 56-1	3T 3-1T	4-1T 5-1 6700	5-1T 6a-1 6b-1
		mm | inch											
90	1 , 2 ,	0,546 | 0.021 0,828 | 0.033	0,445 | 0.018 0,727 | 0.029	0,535 | 0.021 0,817 | 0.032									
80	1 , 2 ,	0,582 | 0.023 0,900 | 0.035	0,532 | 0.021 0,850 | 0.033	0,602 | 0.024 0,919 | 0.036	0,557 | 0.022 0,875 | 0.034		0,534 | 0.021 0,852 | 0.034						
72	1 , 2 ,	0,588 | 0.023 0,911 | 0.036	0,558 | 0.022 0,911 | 0.036	0,646 | 0.025 0,999 | 0.039	0,675 | 0.027 1,028 | 0.040		0,528 | 0.021 0,881 | 0.035						
64	1 , 2 ,	0,725 | 0.029 1,122 | 0.044	0,589 | 0.023 0,986 | 0.039	0,699 | 0.028 1,096 | 0.043	0,619 | 0.024 1,016 | 0.040	0,707 | 0.028 1,104 | 0.043	0,714 | 0.028 1,111 | 0.044						
60	1 , 2 ,	0,722 | 0.028 1,145 | 0.045	0,821 | 0.032 1,244 | 0.049	0,629 | 0.025 1,052 | 0.041	0,803 | 0.032 1,226 | 0.048	0,783 | 0.031 1,206 | 0.047	0,726 | 0.029 1,149 | 0.045						
56	1 , 2 ,	0,709 | 0.028 1,163 | 0.046	0,852 | 0.034 1,306 | 0.051	0,763 | 0.030 1,217 | 0.048	0,766 | 0.030 1,220 | 0.048	0,855 | 0.034 1,309 | 0.052	0,720 | 0.028 1,174 | 0.046						
48	1 , 2 ,	0,958 | 0.038 1,487 | 0.059	0,944 | 0.037 1,472 | 0.058	0,856 | 0.034 1,385 | 0.055	0,976 | 0.038 1,505 | 0.059	0,798 | 0.031 1,327 | 0.052	1,005 | 0.040 1,534 | 0.060	0,831 | 0.033 1,360 | 0.054					
44	1 , 2 ,	0,971 | 0.038 1,548 | 0.061	1,000 | 0.039 1,577 | 0.062	0,480 | 0.019 1,057 | 0.042	0,961 | 0.038 1,538 | 0.061	0,903 | 0.036 1,480 | 0.058	1,038 | 0.041 1,615 | 0.064	0,864 | 0.034 1,441 | 0.057					
40	1 , 2 ,	0,984 | 0.039 1,619 | 0.064	1,066 | 0.042 1,700 | 0.067	0,978 | 0.038 1,613 | 0.063	0,938 | 0.037 1,891 | 0.074	1,025 | 0.040 1,661 | 0.065	1,073 | 0.042 1,708 | 0.067	1,216 | 0.048 1,851 | 0.073					
36	1 , 2 ,	1,353 | 0.053 2,059 | 0.081	1,147 | 0.045 1,853 | 0.073	1,235 | 0.049 1,941 | 0.076	1,264 | 0.050 1,970 | 0.078	1,176 | 0.046 1,882 | 0.074	1,117 | 0.044 1,823 | 0.072	1,293 | 0.051 1,999 | 0.079					
32	1 , 2 ,	1,419 | 0.056 2,214 | 0.087	1,250 | 0.049 2,044 | 0.080	1,559 | 0.061 2,353 | 0.093	1,281 | 0.050 2,074 | 0.082	1,368 | 0.054 2,162 | 0.085	1,574 | 0.062 2,368 | 0.093	1,399 | 0.055 2,192 | 0.086	1,516 | 0.060 2,310 | 0.091				
28	1 , 2 ,	1,506 | 0.059 2,413 | 0.095		1,523 | 0.060 2,430 | 0.096	1,755 | 0.069 2,663 | 0.105	1,616 | 0.064 2,523 | 0.099	1,710 | 0.067 2,617 | 0.103	1,535 | 0.060 2,442 | 0.096	1,767 | 0.070 2,674 | 0.105				
26	1 , 2 ,	1,801 | 0.071 2,778 | 0.109		1,743 | 0.069 2,720 | 0.107	1,801 | 0.071 2,778 | 0.109	1,766 | 0.070 2,743 | 0.108	1,789 | 0.070 2,766 | 0.109	1,858 | 0.073 2,836 | 0.112	1,916 | 0.075 2,893 | 0.114				
24	1 , 2 ,	1,620 | 0.064 2,678 | 0.105		2,002 | 0.079 3,060 | 0.120	1,858 | 0.073 2,915 | 0.115	1,944 | 0.077 3,002 | 0.118	1,887 | 0.074 2,944 | 0.116	1,712 | 0.067 2,771 | 0.109	2,097 | 0.083 3,154 | 0.124	1,952 | 0.077 3,010 | 0.118		1,661 | 0.065 2,719 | 0.107	

22	1, 2,	1,845 0.073 3,000 0.118		1,728 0.068 2,883 0.113	1,912 0.075 3,067 0.121	2,147 0.085 3,303 0.130	1,991 0.078 3,147 0.124	2,108 0.083 3,263 0.128	1,720 0.068 2,875 0.113	1,910 0.075 3,065 0.121		1,713 0.067 2,868 0.113	
20	1, 2,	2,413 0.095 3,683 0.145		2,037 0.080 3,307 0.130	1,996 0.079 3,267 0.129	2,402 0.095 3,672 0.145	2,132 0.084 3,402 0.134	1,957 0.077 3,227 0.127	1,916 0.075 3,187 0.125	2,512 0.099 3,782 0.149		2,431 0.096 3,701 0.146	
19	1, 2,				2,376 0.094 3,713 0.146	2,213 0.087 3,550 0.140	2,543 0.100 3,880 0.153	2,202 0.087 3,537 0.139	2,027 0.080 3,364 0.132	2,521 0.099 3,858 0.152		2,173 0.086 3,510 0.138	
18	1, 2,				2,090 0.082 3,502 0.138	2,708 0.107 4,119 0.162	2,297 0.090 3,708 0.146	2,474 0.097 3,886 0.153	2,152 0.085 3,563 0.140	2,536 0.100 3,947 0.155		2,536 0.100 3,952 0.156	2,660 0.105 4,071 0.160
16	1, 2,				3,000 0.118 4,589 0.181	2,295 0.090 3,883 0.153		2,324 0.091 3,913 0.154	2,443 0.096 4,031 0.159	2,561 0.101 4,149 0.163		2,797 0.110 4,385 0.173	3,033 0.119 4,621 0.182
14	1, 2,				3,267 0.129 5,081 0.200			3,046 0.120 4,860 0.191	2,826 0.111 4,640 0.183	3,511 0.138 5,325 0.210		3,069 0.121 4,883 0.192	2,628 0.103 4,441 0.175
13	1, 2,							3,486 0.137 5,441 0.214	3,056 0.120 5,010 0.197	3,602 0.142 5,556 0.219		3,717 0.146 5,671 0.223	2,855 0.112 4,809 0.189
12	1, 2,							4,002 0.158 6,119 0.241	3,327 0.131 5,443 0.214	3,710 0.146 5,826 0.229		3,417 0.135 5,534 0.218	3,125 0.123 5,241 0.206
11	1, 2,							3,459 0.136 5,767 0.227	3,649 0.144 5,957 0.235	3,840 0.151 6,149 0.242		4,223 0.166 6,531 0.257	3,450 0.136 5,758 0.227
10	1, 2,							4,074 0.160 6,614 0.260	4,033 0.159 6,562 0.258	3,994 0.157 6,534 0.257	3,911 0.154 6,493 0.256	3,914 0.154 6,453 0.254	3,834 0.151 6,374 0.251
9	1, 2,							4,826 0.190 7,648 0.301	4,491 0.177 7,327 0.288	4,183 0.165 6,991 0.275	5,271 0.208 8,093 0.319	4,949 0.195 7,771 0.306	4,305 0.169 7,127 0.281
8	1, 2,							4,179 0.165 7,354 0.290	5,092 0.200 8,267 0.325	6,041 0.238 9,161 0.361	5,330 0.210 8,505 0.335	4,654 0.183 7,829 0.308	4,892 0.193 8,067 0.318
7	1, 2,								5,847 0.230 9,476 0.373	6,523 0.257 10,152 0.400	5,427 0.214 9,056 0.357	6,070 0.239 9,698 0.382	5,645 0.222 9,274 0.365
6	1, 2,								6,856 0.270 11,089 0.437	7,240 0.2851 11,473 0.452	7,623 0.300 11,856 0.467	8,006 0.315 12,239 0.482	6,657 0.262 10,890 0.429
5	1, 2,										13,267 0.522 18,347 0.722	8,100 0.319 13,180 0.519	8,147 0.3211 13,133 0.517
4 1/2	1, 2,										9,975 0.393 15,619 0.615		9,006 0.355 14,615 0.575
4	1, 2,										9,033 0.356 15,383 0.606		10,183 0.401 16,533 0.651
3 1/2	1, 2,												11,696 0.460 18,953 0.746
3	1, 2,												13,711 0.540 22,178 0.873

Table 6: Determining the undercut (thread runout in relation to thread roll lead) 2/2

5.2 Rolling porcess and feed

AC *rolling system* were primarily developed for rolling threads of unlimited length. The individual steps of the axial rolling process are illustrated in Fig. 16. The rolling head is moved in the tangential direction to the center of the workpiece (A) and then the rolling head is pressed axially against the workpiece (Z), with the feed rate corresponding to the pitch of the thread to be rolled.

After reaching the thread length, the rolling head is withdrawn tangentially in rapid motion (X). The feed rate must remain switched on during the axial rolling process.

Arbeitsweise bei Aufnahme des Werkstückes zwischen Spitzen
Procedure when the workpiece is mounted between centers

A Der auf dem Revolver aufgenommene AC-Rollkopf wird in tangentialer Richtung auf Werkstückmitte gebracht.
The AC rolling head mounted on the turret is moved to the workpiece center in the tangential direction.

Z Rollvorgang in axialer Richtung.
Rolling process in the axial direction.

X Rollen werden in tangentialer Richtung zurückgezogen.
The rolls are withdrawn tangentially.

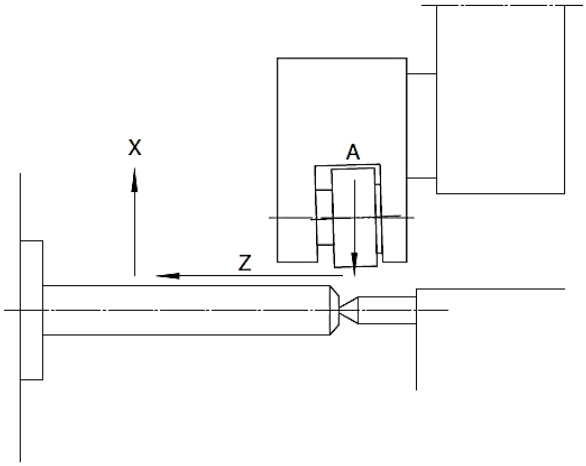


Figure 16: The rolling process

Operating feed

In principle, the axial rolling head has its own feed rate, which corresponds to the respective thread pitch. The dimensions that can be produced with the respective rolling head can be found in the catalogue.

The rolling head is pressed onto the workpiece by the drive unit of the machine tool (conventional or CNC) or by hand. If the rolling head has caught hold of the material to be processed, it automatically moves on in the working direction.

NOTE

With axial thread rolling, the machine tool has "only" a tracking function.
Select the machine feed 5% smaller than the thread lead.

Due to the elongation of the material during forming, the machine feed rate is approx. 5% smaller than the pitch of the thread to be produced.

Example:
Thread M20 x 1.5 / Pitch 1.5 mm
Machine feed rate approx. 5% lower: 1.47 mm/revolution

Rolling head angle and lead angle

As long the outer diameter of the work piece matches the working range of the rolling head, you can manufacture any type of thread. The limitation however is the rolling head angle in reference to the lead angle of thread.

NOTE

Metric, UN-, BS-, BA- und similar threads can be manufactured with the same rolling head as long the deviation between the rolling head angle and thread lead angle is below ±30%.

When operating near the limit or when you are unsure, please contact our Service Hotline, we will assist you.

NOTE

By definition:

$$\alpha = \arctan \frac{p}{\pi \cdot D}$$

α = thread lead angle [°]

p = lead [mm]

D = pitch-Ø [mm]

Rolling head	Roll inclination
AC2	3°
AC3	2°40’
AC4	2°30’
AC5	1
AC6	0°40’

Table 7: Inclination of the rolls

5.3 Rolling speed and machine speed

Rolling speed

NOTE

Determine the rolling speed depending on the material of the work piece, using Table 8.

Recommended rolling speeds depending on the material:

- V-thread: select the value specified in the table
- Trapezoidal and round thread: select 50% of the stated value of the table

Symbols: ☺ good rollability ☹ rollable ☹ conditionally rollable

Material	Tensile strength N/mm²	Material code	Material number	Rollability	Rolling speed m/min
Ferrous metals					
General structure steels	500	S235JRC	1.0120	☺	40-80
	500-600	S550GD	1.0531	☺	30-60
	750-900	C50	1.0540	☺	20-50
	630-850	C45E	1.1191	☺	20-50
Case hardening steel	590-780	C15E	1.1141	☺	40-70
	780-1080	16MnCr5	1.7131	☹	30-50
Nitriding steels	780	34CrAl6	1.8504	☹	20-50
	900-1300	31CrMoV9	1.8519	☹	20-40
Free cutting steels	350-530	10S10	1.0711	☺	30-60
	360-760	11SMnPb30	1.0718	☺	30-60
	590-830	35S20	1.0726	☺	30-60
Heat treatable steels	630-780	C35	1.0501	☺	40-70
	850-1000	C60E	1.1221	☹	30-60
	1100-1300	42CrMo4	1.7225	☹	20-50
	1250-1450	30CrMoV9	1.7707	☹	20-40
	1200-1400	34CrNiMo6	1.6582	☹	20-40
	1100-1300	51CrV4	1.8159	☹	20-40
Tool steels	800-850	X210Cr12	1.2080	☹	30-50
	800-1000	X130W5	1.2453	☹	20-40
	760-810	115CrV3	1.2210	☹	30-50
High speed steel	920	HS6-5-2C	1.3343	☹	20-40
	880	HS6-5-2-5	1.3243	☹	20-40
Stainless steels	650-730	X12Cr13	1.4006	☹	30-50
	800-950	X17CrNi16-2	1.4057	☹	30-50
	650-850	X14CrMoS17	1.4104	☹	30-50
	500-700	X5CrNi18-10	1.4301	☺	35-55
	500-750	X8CrNiS18-9	1.4305	☺	35-55
	500-700	X5CrNiMo17-12-2	1.4401	☹	30-50
	500-700	X6CrNiMoTi17-12-2	1.4571	☹	30-50
Cast steels	380-530	GE200	1.0420	☺	40-60
	540	G36Mn5	1.1176	☺	40-60
	1000-1200	G50CrMo4	1.7232	☹	30-50
Malleable cast iron	450	EN-GJMB-450-06	EN-JM 1140	☹	30-60
	650	EN-GJMB-650-02	EN-JM 1180	☹	30-60
Cast iron	400	EN-GJS-400-15	EN-JS 1030	☺	30-60
	500	EN-GJS-500-7	EN-JS 1050	☹	30-50
	600	EN-GJS-600-3	EN-JS 1060	☹	30-50
High temperature materials	≥970	NiCo20Cr20CoMoTi (Nimonic 263)	2.4650	☹	30-50
	700-950	NiMo16Cr15W (Hastelloy C276)	2.4819	☹	20-40

Nickel alloys	580-800	NiCr15Fe (Inconell 600)	2.4816	☹	20-40
Non-ferrous metals					
Copper	240-300	E-Cu	CW004A	☺	40-80
Copper alloys (Brass	310	CuZn37	CW508L (R310)	☺	40-80
	410	CuZn38Pb2	CW608N (R410)	😐	40-70
	360	CuZn38Pb2	CW608N (R360)	☺	40-70
	430	CuZn39Pb3	CW614N (R430)	😐	40-70
Aluminium alloys	150-240	AlMg2	EN AW-5251	☺	40-70
	160-310	AlSi1MgMn	EN AW-6082	😐	40-70
	220-350	AlZn4,5Mg1	EN AW-7020	☹	30-50
	220-440	AlCu4Mg1	EN AW-2024	😐	30-50
	275-540	AlZn5,5MgCu	EN AW-7075	😐	30-50
Titanium alloys	390-540	Ti2	3.7035	☺	30-60
	540-650	TiCu2	3.7124	☺	30-60
	750-950	TiAl5Sn2,5	3.7115	😐	30-60
	1030-1100	Ti6Al4V	3.7164.7	😐	20-40

Table 8: Recommended rolling speed depending on the material

Tensile strength (yield) and elongation at fracture of the material:

For materials with high tensile strength, operate at 20-30 m/min. Bear in mind that the rolling speed depends on the tensile strength. Choose low rolling speeds for high tensile strength, and for low tensile strength choose high rolling speeds.

Machine speed

NOTE

The machine speed is calculated as follows:

$$n = \frac{1000 \cdot v}{d_A \cdot \pi} \quad [\text{min}^{-1}]$$

n : machine speed [min^{-1}]

v : rolling speed [m/min]

d_A : blank diameter [mm]

5.4 Driving power and torque

The thread is gradually generated in axial direction. Therefore, the thread length does not influence the power requirements.

NOTE

The required driving power is calculated as follows:

$$N \approx 0{,}174 \cdot 10^{-6} \cdot C \cdot \delta_B \cdot p \cdot d \cdot n \quad [kW]$$

N: driving power
C: shape factor (V.thread: 1 | trapezoidal and round thread: 2)
δ_B: Tensile strength [N/mm²]
p: thread lead [mm]
d: nominal thread diameter [mm]
n: machine speed [min^{-1}]

NOTE

The required torque is calculated as follows:

$$M = \frac{9740 * N}{n} \; [Nm]$$

M: torque [Nm]
N: driving power [kW]
n: machine speed [min^{-1}]

NOTE

The machine speed is calculated as follows:

$$n = \frac{1000 \cdot v}{d_A \cdot \pi} \quad n = \frac{1000 \cdot v}{d_A \cdot \pi} \; [\text{min}^{-1}]$$

n : machine speed [min^{-1}]
v : rolling speed [m/min]
d_A: blank diameter [mm]

NOTE

Example: **M 20 x 2,5**

Nominal thread dia.	d = 20 mm
Thread lead	p = 2,5 mm
Tensile strength	δ_B = 700 N/mm^2
Machine speed	n = 600 min^{-1}
Forming factor	C = 1

Driving power:

$$N = 0{,}174 * 10^{-6} * 1 * 700 * 2{,}5 * 20 * 600$$

$$N = 3{,}65kW$$

Torque:

$$M = \frac{9740 * 3{,}65}{600}\ [Nm]$$

$$M = 59{,}25\ Nm$$

5.5 Rolling time

NOTE

Rolling time for threading and cold-forming of rotationally symmetrical workpieces for manufacturing other profiles

$$t_R \approx \frac{60 * L}{n * P} [sec]$$

t_R : rolling time [sec]
L : roll length [mm]
n : machine speed [min^{-1}]
P : thread lead [mm]

NOTE

Rolling time for burnishing and knurling

Determine the rolling speed using the rolling head constant k:

- Determine the rolling head constant k
- Determine the rolling time

$$t_R \approx \frac{60 * L}{n * d_V * k} [sec]$$

t_R : rolling time [sec]
L : roll length [mm]
n : machine speed [min^{-1}]
d_V : blank diameter [mm]
k : rolling head constant

Rolling head size	Constant k
AC2	0,16
AC3	0,15
AC4	0,14
AC5	0,05
AC6	0,04

Table 9: Determining the rolling head constant k

5.6 Fine adjustment of the *rolling system*

Following our instructions, you will probably produce a non-completely formed profile tooth. If the pitch diameter is too large or the external diameter too small, make the following adjustments:

1. Decrease the roll adjustment on the scale.

2. As a result of reducing the axle distance, more material is pressed into the tooth crest. This automatically increases the external diameter of the thread.

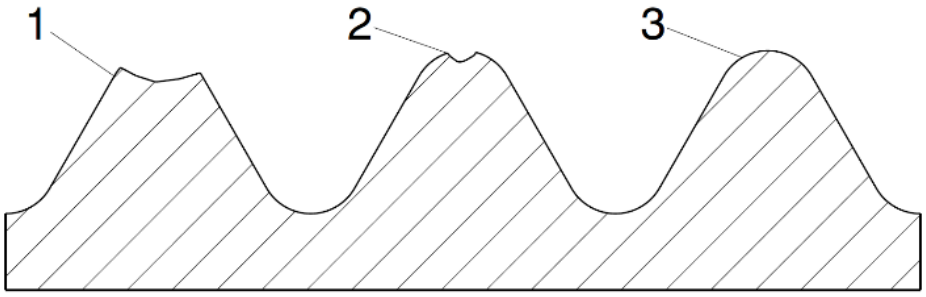


Figure 17: Degree of forming at the profile tooth

Closely inspect the rolled profile. Figure 17 shows the possible degrees of forming of a profile tooth:

- Tooth 1 represents a profile tooth that is **not completely formed.** This degree of forming normally yields a stable profile. In most applications this degree of forming I aimed for.
- Tooth 2 represents a thread tooth that is **completely formed**. This degree of forming is used to meet the highest requirements in optics and tightness.
- Tooth 3 represents a profile tooth that is **overformed**.

NOTE

Bear in mind, that the degree of forming effects the produced diameter. Check the produced dimension, to ensure that they meet the tolerances.

NOTE

After rolling, the work piece external diameter d must not have a burnished finish and must not be overformed in the profile crests. This leads to increased roll wear.

By closing the rolling head, more material is pressed into the thread top. Thus, the outer diameter of the thread automatically becomes larger.

- If the flank diameter is correct after closing the rolling head, the thread tooth, however, is excessively shaped, than you have to reduce the original diameter so that less material will flow into the thread top. Under these circumstances, the rolling head possibly can be opened easily.
- If the flank diameter is correct after closing the rolling head, the outer diameter, however, is too small, you have to increase the original diameter. Thus, more material will flow into the tooth top. Possibly, you will have to close the rolling head as well..

5.7 Special applications

Knurling head AC…R

The AC thread rolling head can also be used in the tangential grooving process for the production of groove profiles, form recesses, for smoothing profile grooves and the like (if there is no thread pitch). Then the max. profile length = roll width. This rolling head has eccentric bolts placed parallel to the axis and the type reference AC... R. It is only fed tangentially to the workpiece to be machined up to approx. axis centre and pulled back radially again.
For smoothing operations, it is a necessary that the blank diameter is within a tolerance of + 0.015 mm.

Knurling in tangential direction

The following shapes can be rolled in the grooving process:

- Knurls according to DIN 82 (RAA, RGE)
- smoothing
- free designs

Here the maximum working width equals the roll width.

Rolling head	Roll width
AC2R	20 mm
AC3R	25 mm
AC4R	30 mm
AC5R	30 mm
AC6R	30 mm

Table 10: Roll width

When knurling in tangential direction, the path of the turret slide is composed as follows:

Rapid traverse forward → working stroke → rapid decline

The "rapid traverse forward" is to be interpreted as the maximum distance in such a way that it is completed before the start of the actual working stroke.
The working stroke is the theoretical path AV of the rolling head from the time of the first contact between the rolls and the workpiece to the final position "rolls over the axis of the workpiece". The working stroke for knurling is shown in the table below.
The actual working path should be completed within W = 30 workpiece revolutions.
Depending on the strength of the material and the span length, this path can vary by ± 50%.

NOTE

The feed rate is calculated from the following formula.

$s = \frac{AV}{W}$ [mm/U]

W = Number of workpiece revolutions

The feed rate is calculated from the following formula:

$V = \frac{AV * n}{W}$ [mm/min]

The roll time is calculated from the following formula:

$t_r = \frac{60 * W}{n}$ [s]

The return path should be carried out within a further 5 workpiece revolutions.
.

Working stroke depending on rolling head and knurling pitch (AV)								
Rolling head	Rolling head							
	0,5	0,6	0,8	1,0	1,2	1,5	1,6	2,0
AC2R	AC2R	AC2R	AC2R	AC2R	AC2R	AC2R	AC2R	AC2R
AC3R	AC3R	AC3R	AC3R	AC3R	AC3R	AC3R	AC3R	AC3R
AC4R	AC4R	AC4R	AC4R	AC4R	AC4R	AC4R	AC4R	AC4R
AC5R	AC5R	AC5R	AC5R	AC5R	AC5R	AC5R	AC5R	AC5R
AC6R	AC6R	AC6R	AC6R	AC6R	AC6R	AC6R	AC6R	AC6R

Table 11: Knurling pitches

NOTE

The rolling time is calculated from the following formula:

$t_R = \frac{60*L}{n*d*k}$ [s]

The feed rate is calculated from the following formula:

$s = d * k$ [mm/u]

with:

L = Rolling length [mm]
d = Blank diameter [mm]
n = Machine speed [min^{-1}]
k = Rolling head constant

The value "k" is given in the following table:

Rolling head	constant k
AC2	0,16
AC3	0,15
AC4	0,14
AC5	0,05
AC6	0,04

Table 12: Rolling head constant

Knurling accodring to DIN 82

The following table shows the usual pitch and tooth heights at a gap angle of 90°.

pitch t in mm	Tooth height in mm
0,5	0,23
0,6	0,25
0,8	0,37
1,0	0,47
1,2	0,50
1,5	0,64
1,6	0,75
2,0	0,95

Table 13: Tooth height depending on pitch

According to DIN 82, for knurling, the nominal diameter is given as the outside diameter of the workpiece.
The outer diameter "d" of the workpiece is calculated approximately from the workpiece outer diameter minus tooth height.

NOTE

It is recommended to install an additional washer (12) when using knurled and smoothing rolls

Thread rolling on tubes

NOTE

Thread rolling on seamless drawn tubes depends on the existing tube wall thickness. In general, roll tests are required if the following ratio is given:
Pipe bore / thread core -Ø ≥ 0,65

6. Disassembly after operation

IMPORTANT

Please conctact our Service Hotline in the event of dismounting:

- removing the *rolling system* from the processing machine.
- dismounting the rolling head.
- dismounting the rolling head holder.
- dismounting the thread rolls.

Check all modules of the *rolling system* for wear and damage. Please contact the operator if you notice wear or wear on a component of the *rolling system*.

CAUTION

Risk of injuries the hands!

During decommissioning, dismounting or disposal activities there is a risk of sustaining injuries caused by rough, sharp surfaces of transport crates, boxes, pallets or packaging aides.

Wear safety gloves to avoid injuries by cutting.

WARNING

General risk of injury from sharp edges.
The *rolling system* is made of various materials (e.g. nickel), which can trigger an allergic reaction.

Wear protective gloves and protective eyewear when using the *rolling systems*.

The weight of the rolling system may cause harm when it falls down.
General risk of injury during transportation/lifting of the rolling system.

- Ensure that the *rolling system* is protected of falling down or tipping over.
- Wear safety boot/hard-toed boot at all times. .
- Use suitable hoisting devices.

6.1 Removing the *rolling system* from the processing machine

WARNING

Risk of burns from the hot surface of the *rolling system*.

Only remove the *rolling system* after the *rolling system* has cooled down.

Risk of cuts due to chips adhering to the rolling system.
Remove any chips adhering to the system from the *rolling system* before removing the *rolling system* form the processing machine.

1. Check if you need and have suitable hoisting devices
   - We recommend the use of hoisting devices for the transportation of F RN *rolling systems*
   - Place the hoisting device on a suitable area. You will find a bore hole for a ring bolt on the outer surface of the *rolling system.*

NOTE

Suitable hoisting devices are for example:

- A sling
- Hoisting Chain
- Lift cable

Please contact your occupational safety specialist before transportating the *rolling system*.

2. Make sure that the rolling system or components do not fall down.

3. Unclamp the *rollig system* in the processing machine.

4. Remove *the rolling system*.

6.2 Removing the rolls

1. Loosen the cap screw (Item 7) and pull out the axis (Item 3).
2. Use your hand to secure the thread rolls and the washer.
3. Remove the roll and the washer.

NOTE

Use only thread rolls with the same set number (thread size, type of head, code number, roll width and roll type).
It is essential to lubricate the roll holes and the axles with molybdenum sulphide grease (e. g. Molykote).

After the roll change, check the rolled profile. If, in particular, the outside diameter is not correct, compensate for this by changing the rolling head setting.

7. Wear parts, parts list

Wear parts

NOTE

Wear parts are:

- The rolls (Item 6),
- The washer (Item 8),
- The Axis (Item 3),
- The carbide bushings (Item 5).

Contact the operator if you notice any signs of wear on a component of the rolling system.

Parts list

NOTE

When reordering rolling heads, spare parts, shank adapters and thread rolls, make sure to state the designation and ID number contained in the signature.

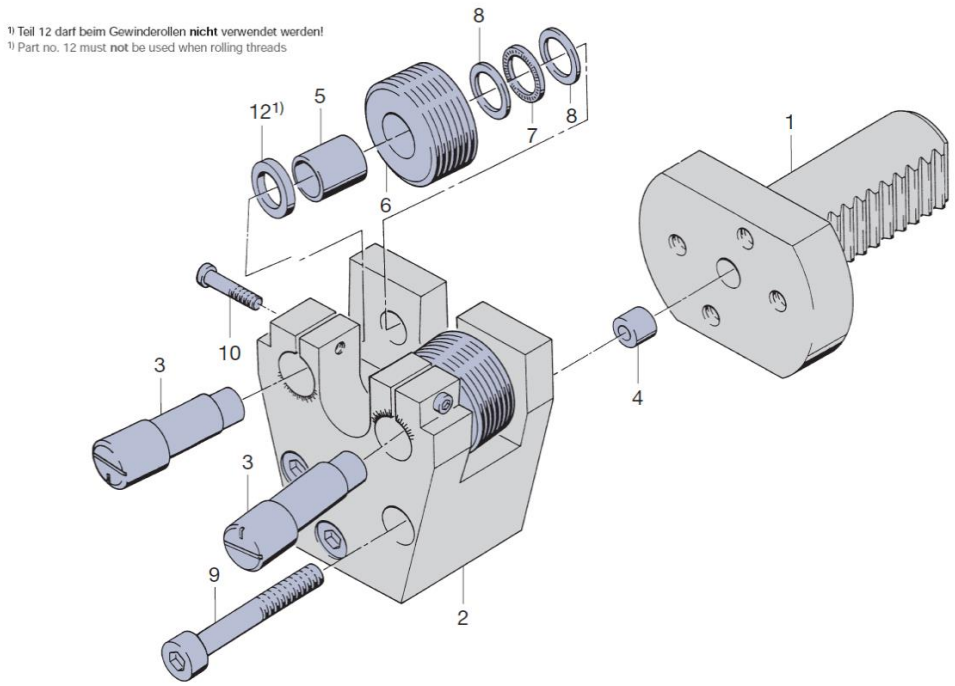


Figure 18: Exploded view AC2

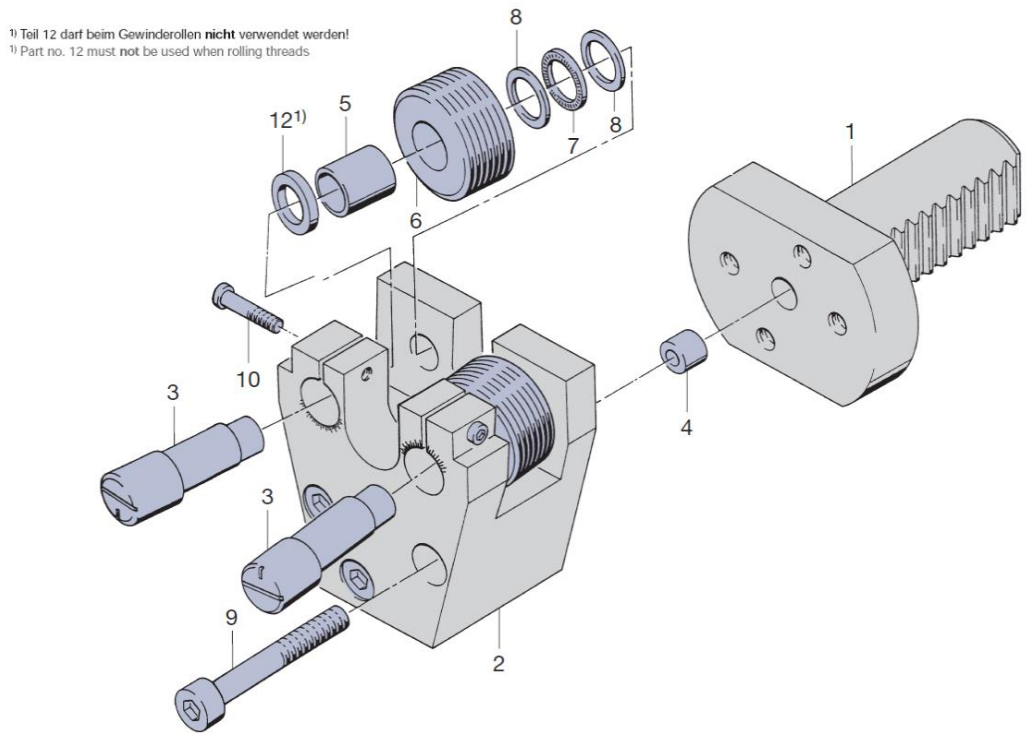


Figure 19: Exploded view AC2-AC6

The following tool data apply to the standard rolling head versions. Separate dimensional drawings and spare parts lists are available for special heads (marked with an "X"). Rolling heads for left-hand thread and their spare parts are available on request.

Rolling head			AC2	AC3	AC4	AC5	AC6
Position	No. Of	Designation	Ident No.	Ident No.	Ident No.	Ident No.	Ident No.
1	1	Shank	See Table				
2	1	Roll holder	2166965	2166957	2166956	2169024	2169026
3	2	Eccentric spindles	2166962	2166960	2166955	2166955	2166955
4	1	Centreing bushing	2166961	2166961	2166961	2166961	2166961
5	2	Carbide bushing	2167329	2165072	2167324	2167324	2167324
5.1	2	Carbide bushing	-	2165073	2167374	2167374	2167374
6	2	Roll	See individual case				
7	2	Thrust needle bearing cage	2149264	2149265	2167376	2167376	2167376
8	4	Thrust bearing race	2148882	2127472	2167377	2167377	2167377
9	3	Cap screw	2141937	2141937	2141937	2141937	2141937
10	2	Cap screw	2141913	2141914	2141932	2141930	2141930
12	2	Washer, Only when using knurling rolls or burnishing rolls	2166964	2166959	2166954	2166954	2166954

Table 14: Components of the rolling heads AC2 - AC6

Exploded view rolling heads type AC2R - AC6R

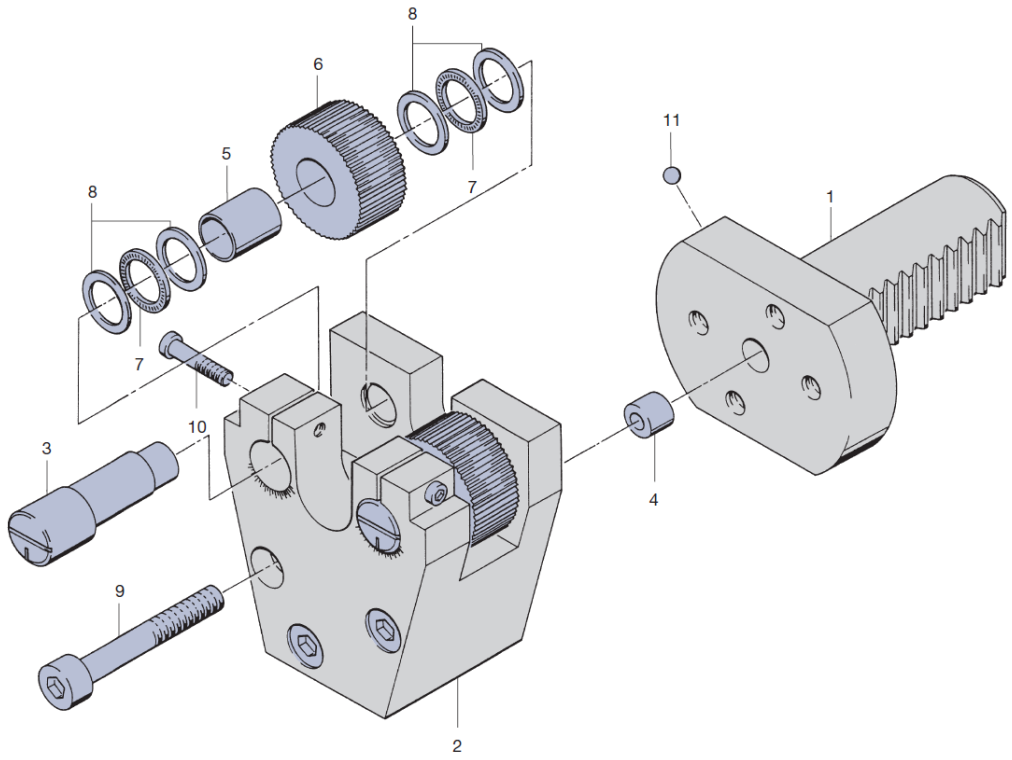


Figure 20: Exploded-view AC2R-AC6R

Rolling head			AC2R	AC3R	AC4R	AC5R	AC6R
Position	No. of	Designation	Ident No.	Ident No.	Ident No.	Position	No. of
1	1	Shank	See Table				
2	1	Roll holder	2166963	2166958	2166953	2	1
3	2	Eccentric spindles	2166962	2166960	2166955	3	2
4	1	Centreing bushing	2166961	2166961	2166961	4	1
5	2	Carbide bushing	2164887	2165072	2167324	5	2
6	2	Knurling or burnishing rolls	See individual case				
7	4	Thrust needle bearing cage	2149264	2167387	2167378	7	4
8	8	Thrust bearing race	2148882	2167388	2167379	8	8
9	3	Cap screw	2141937	2141937	2141937	9	3
10	2	Cap screw	2141913	2141914	2141932	10	2

Table 15: Components of the rolling heads AC2 - AC6R

8. Maintenance

Maintenance

Daily:
Check all components oft he *rollings system* for wear and damage.

Weekly:
1. Follow the instructions in chapter 6.
2. Follow the instructions in chapter 4.

Maintenance when replacing the roll set

1. Follow instructions in chapter 6.
2. Follow instructions in chapter 4.

Maintenance intervals

Be sure do adhere to the maintenance intervals listed in table 16. If the *rolling system* is used under more difficult conditions, the cleaning and maintenance intervals must be shorter.

Interval	Activity	Desricption
Weekly (preferable daily)	Machine operator	- Check the rolls for wear or other damages. - Clean the rolls from chips.
Weekly	Machine setter	- Lubricate the rolls and the roll axis with molybdenumsulfide (e.g. Molykote).

Table 16: Cleaning and maintenance intervals

9. Storage

NOTE

The storage state is the condition upon delivery.

1. Follow the instruction in Chapter 6.
2. Conserve the *rolling system*.
3. Store the *rolling system*.

Storage temperature: –10 °C maximal +30 °C
Relative humidity: < 60 %

10. Disposal

NOTE

Dispose the rolling system with harmful coatings such as oils and fats properly. Improper disposal of the used materials is harmful to the environment. When you dispose materials, comply with national and local regulations.

Ensure that all national and local safety requirements are met:

- After discarding the rolling head, sorted disposal must be performed.
- Seperate iron, non-ferrous metals, etc.
- Grease, oils and objects and lines which are soiled with grease or oil must be disposed separately.

11. Troubleshooting

NOTE

Perform a visual and functional inspection prior to each troubleshooting.

	Fault	Cause	Solution
1	Conical profile	a) Rolling head holder worn out	a) Replace the rolling head holder with a new holder
		b) Roll axis worn	b) Replace roll axis if wear Ø > 0,03mm
		c)Misalignment of head and part (≥0,2mm error)	c) realign rolling system and part
		d) blank diameter taperad	d) manufacture a cylindrical blank diameter
2	Profile out of tolerance	a) Incorrect rolling head setting	a) Renew rolling head set up
		b) Incorrect blank diameter (too big / too small)	b) accurate pre-machining
3	Pitch error	a) Misalignment of head and part (≥0,2mm error)	a) realign rolling system and part
		b) Wrong roll	b) use correct roll
		c) Material not rollable	c) check and follow table 8
		d) Incorrect feed	d) choose feed rate according to chapter 5.2
4	Roll breakage	a) Inapproprate chamfer	a) chamfering according to chapter 5.1
		b) Blank diameter too big	b) accurate pre-machining of blank diameter (chapter 5.1)
		c) Rolling head setting too tight	c) adjust the rolling head (chapter 4.3)
		d) Misalignment	d) realign the machine
		e) Material too hard	e) only roll on materials with max. material strength of 1000N/mm² or lower
		f) Too much material transforming	f)choose bigger rolling head
		g) Rolled with overload	g) adjust the rolling head (chapter 4.3)
5	Extended roll wear	a) Material with bad rollability	a) check and follow table 8
		b) Examination of rolling speed	b) check and follow table 8
		c) Elongation properties inadequate	c) choose different material
		d) Not enough coolant	d) start using coolant, readjust coolant nozzles, increase coolant pressure
		e) Inapproprate chamfer	e) chamfering according to chapter 5.1
6	Profile not smooth	a) Workpiece deflection	a) increase workpiece support
		b) Inapproprate chamfer	b) chamfering according to chapter 5.1
		c) Rolling speed too large or too small	c) check and follow table 8
		d) Too much or too little power for pushing on to the workpiece	d) Adjust the pressing/psuhing force

Table 17:Troubleshooting

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