IMPLEMENTS








Operating Instructions:

Nr. TDX005350-2.4

Type TDX
Internal Roller Burnishing Tool

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1. General operating instructions

The TIZ Roller Burnishing Tool, type TDX, is our last product which is produced with the present technology. Design of the tool enables to produce a work with a high sensitivity and provides a long life usage. It is possible to realize a production with a 0.001 mm precision. It is easy to adjust, assemble and convert the spare parts.

They can be used with all machines, which process by rotating (CNC-controlled or universal lathes, machining centers, milling, drilling machines and special machines). Depending on the machine or the work, either the tool or the workpiece or both rotates during the process. The Internal Roller Burnishing Tools provide time and cost saving at the process of the workpieces.

These tools are capable to process all kinds of meterials with 1400 N/mm^ tensile s trength and hardness up to 42 - 45 HRC. The surfaces can be burnished to roughness values below Rz 1^m with high bearing ratio up to tp = 95 % by one pass (see chapter 4). The tool can process all workpieces with the same adjustment interior H7 tolerance a^er adjusting it to the size you wish to make process with.

The manufacturing costs you save are:

- Low burnishing cost
- Pre-machining and burnishing occur on the same machine, by this means the necessity of second machine and labour of fixing workpiece are removed.
- One setting, One pass,
- Very short process time,
- No saw dust or residue,
- Low energy consumption.

1.1 Purpose of using the tool

The TIZ Roller Burnishing Tool, type TDX, is only used for the aim of burnishing the internal surfaces of through and blind holes. Any other application contradicts with the main purpose. The manufacturer assumes no liability for the damaging results from such use. Such risks are assumed entirely by the user.

ATTENTION! The TIZ Roller Burnishing Tool, Type TDX is not suitable for calibrating or expanding workpieces. The personnel in charge must read carefully the operating and safety instructions before starting the work.

2. Safety instructions

The TIZ Roller Burnishing Tool, Type TDX, meet the current healt and safety standards. This manual contains important informations regarding operation and maintenance. Certain risks are always associated with the use of technical equipment. Therefore, please read the operating instructions carefully before operating the device. Always observe the safety instructions provided here for your own protection. Protect yourself and avoid damaging the tool. The correct procedure for avoiding the risks are described below :

- Do not touch the roller head of the tool or the workpiece during the process. Your hand may get cought in it!
- Never touch the rotating tool or the workpiece.
- Be sure that the workpiece and the tool shank fitted to the machine safely.
- During the process because of high rotation speed the rollers and its sides may become very hot. Do not touch it! You may be burned.
- Observe all the safety specifications for the machines which makes process by rotating. Wear comfortable and suitable clothes.
- The operator has to protect his hair during the process.

3. Tool design and function

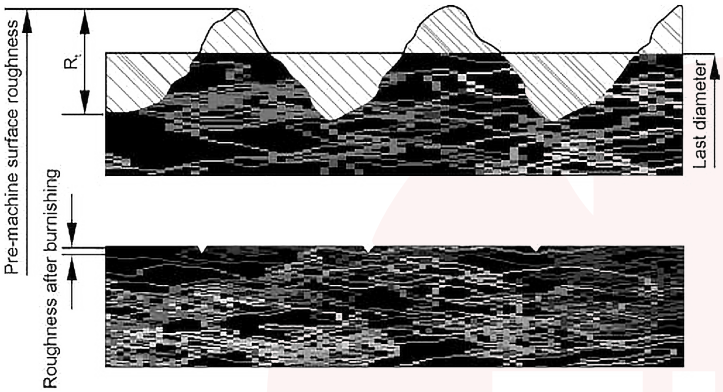
TIZ Roller Burnishing Tools, Type TDX, consists of a tool body and a roller head. The tool body has a precious adjustment mechanism. The roller head, including the cage (3), cone (1) and rollers (2) is available in two versions: one for through and one for blind holes. To one tool body, suitable roller heads in different diameters can be assembled. The tool is delivered with a morse taper or cylindrical shank. The tools bigger than 034 have unlimited rolling length, but smaller than 035 have a standart rolling length as 50 mm, the rolling length of long type is 100 mm. It is possible to produce the tools with a more longer rolling length.

Prinzip of the tool operation is like this; When the tool is correctly adjusted, it is ready to be used (the diameter adjustment procedure is described in Section 5). For generating the burnishing force, the diameter of the roller head must be larger than the diameter of the hole. The tool is fixed to the machine and it is gone into the hole of the workpiece with the determined revolution and feeding and the rotating tool retracts quickly after the operation. At this time the roller head becomes smaller and during the retraction leaves no marks on the burnished surface.

ATTENTION! Because several tool parts are connected with right-hand threads. While retracting the tool, is used cutting direction.

4. Preparation for the pre-machining

Roller burnishing is a suface finishing technique that smooths the surface with plastic deformation method. Smoothing process does not remove sawdust like grinding. In order it fills the gibbouses to the gaps. Thus it makes the surface more hard and smooth. This smooting process occurs with displacing the roughness at the top to the bottom. So the bottom of roughness is filled with the carried material and the smoothing process is completed (Fig. 1). You can see the positive effects below:



- Low surface roughness,
- High sectional bearing ratio,
- No protruding profile peaks,
- Favourable sliding properties,
- Increased hardness.

Figure 1 - Surface profiles after pre-machining and roller burnishing

Roller burnishing does not remove material from the workpiece, the size does not change. The form and the dimension changes according to the roughness depth. Therefore, the required accuracy for the finished component must be achieved in the pre-machining stage. During the pre-machining the shape and the dimension of the workpiece should be processed according to the tolerances or the dimension and the shape should be formed. The hole is processed according to the pre-machining roughness slightly smaller size. In order to determine a smaller size than the last size, only use Rt or Rz to measure the roughness. So you can get the burnishing tolerance. With the help of the formula you can define your burnishing tolerance.

Stock Allowance (0 - mm) = Pre-machining roughness depth Rz or Rt

Generally for pre-machining two steps lathing or like any other process should be applied. Pre-machining roughness could be chosen according to the characteristics of the workpiece and the roughness which is required after the roller burnishing process. According to the type of the workpiece and superfinish surface quality you can select the pre-machining roughness between 5 and 30 µm.

You can apply following lathening/turning formula to obtain surface profile suitable to roller burnishing after pre-machining.

Feed Rate (mm/rev.) = 0.5 x cutting edge radius (mm)

When they used lathening as pre-machining, it recommended use of 0,4 radius cutting insert with the feeding of 0,2 mm/rev.

These datas are important to select the proper cutting speed and pre-machining dimension for the best cutting. In order to have grooves on surface with measured or standard space and highness during pre-machining;

- selection of the optimum cutting speed,
- selection of the optimum cutting edge geometry,
- lubrication is a vital prerequisite.

The selection of cutting radius (R) smaller than 1 mm yields the best pre-machining

5. Operation with Roller Burnishing Tool

5.1 Tool setting

While processing the steel, cast iron, etc. materials, the axes of the tool and workpiece must be aligned to an accuracy of max. ± 0.05 mm. While processing the al imunium materials, the axes of the tool and workpiece must be aligned to an accuracy of max. ± 0.02 mm. During working with CNC lathes, a loose tool-holder is not recommended. The tool is flexible and can tolerate a little bit the general positioning errors .

5.2 Adjustment

Figure 2 - Adjustment Mechanism

First, diameter of the roller head must be set to the equal size to the workpiece diameter. The tool to do this the roller head thrusted into the hole and adjusted that it fits with no blank. Use the following procedure to adjust the tool.

ATTENTION! The description is done as if the shank of the tool is above, the roller head of the tool is below and in a vertical position (See the figure-2).

1. Set the tool to the machine.
2. Firstly you have to adjust the diameter of the tool smaller than the diameter of the hole. Therefore, by turning to left loose the adjustment nut luck (12) on the shank (13), by pulling back (direction A) the adjustment gear (10) turn the housing (9) to right. Go on with this process until you are sure that the roller head diameter is smaller than the hole diameter.
3. Put the roller head into the hole.
4. By pulling up the adjustment gear (direction A) begin to turn to left the housing. If the roller head slightly tights the hole, stop turning.
5. By pushing forwards (direction B) the adjustment gear, place it into its socket.
6. Tight the adjustment nut lock slightly by hand.
7. In order to adjust the tool for the last size, pull out the roller head out of the hole.
8. On the housing you can find an adjustment scale. The distance between every line is 0.0025 mm (by tools bigger than 080 mm it is 0.0050 mm). On the adjustment gear there is a point which shows you where it is situated on the scale. With the help of the lines on the scale and point, you can change the size of the tool (bigger or smaller). Now, increase the roller head like the tolerance in the hole (please look at the section of 5.3 for stock allowance which is recommended to leave). Therefore you have to loose the adjustment nut luck firstly, by pulling up the adjustment gear, (direction A) turn the housing to the left, so you can increase the roller head diameter as you wish.
9. By pushing forwards (direction B) the adjustment nut luck, place it into its socket.
10. Tight the adjustment nut lock.

The tool is ready for processing.

Perform a roller burnishing application for the purpose of trial after adjustment. If the burnishing result is not as desired, increase the diameter step by step. Up to max. 5 trials, should be run for every workpiece. With same adjustment it can do an application, with all workpieces as long as tolerance class H7 is maintained. When the rollers, cone or cage are replaced the tool must be re-adjusted.

ATTENTION! If the tool has been placed in storage since the last use, (for instance, in the tool room), it may have become misadjusted during the interim. Consequently, repetion of the adjustment procedure is recommended before beginning work with a new series of workpieces.

5.3 Recommended Processing Parameters and Stock Allowance for TDX Type Tools

Diameter Range	Revo-lution	Feed Rate	Fe-eding	Stock allowance (SA) according to pre-machining surface roughness												
				Rz	EP	Rz	EP	Rz	EP	Rz	EP	Rz	EP	Rz	EP	Proses
mm	rev/dk	mm/ rev	mm/ min	µm	mm	µm	mm	µm	mm	µm	mm	µm	mm	µm	mm	
005 - 007	1000	0.45	450	5	0.006	10	0.011	15	0.016							Reaming or lathening
008 - 014	1000	0.60	600	5	0.006	10	0.011	15	0.016							
015 - 021	1000	0.75	750	5	0.008	10	0.013	15	0.018	20	0.023					
022 - 031	1000	0.75	750	5	0.009	10	0.014	15	0.019	20	0.024					
032 - 034	950	0.75	710	5	0.011	10	0.016	15	0.021	20	0.026					
035 - 040	800	0.90	720	5	0.012	10	0.017	15	0.022	20	0.027					
041 - 049	650	0.90	580	5	0.013	10	0.018	15	0.023	20	0.028					
050 - 060	530	1.20	630	5	0.015	10	0.020	15	0.025	20	0.030	25	0.035	30	0.040	
061 - 070	450	1.20	540	5	0.017	10	0.022	15	0.027	20	0.032	25	0.037	30	0.042	
071 - 080	400	1.20	480	5	0.019	10	0.024	15	0.029	20	0.034	25	0.039	30	0.044	
081 - 090	350	1.20	420	5	0.021	10	0.026	15	0.031	20	0.036	25	0.041	30	0.046	
091 - 100	320	1.20	380	5	0.023	10	0.028	15	0.033	20	0.038	25	0.043	30	0.048	
101 - 120	260	1.20	310	5	0.025	10	0.030	15	0.035	20	0.040	25	0.045	30	0.050	
121 - 140	230	1.50	340	5	0.029	10	0.034	15	0.039	20	0.044	25	0.049	30	0.054	
141 - 150	210	1.50	310	5	0.033	10	0.038	15	0.043	20	0.048	25	0.053	30	0.058	
151 - 160	200	1.80	360	5	0.035	10	0.040	15	0.045	20	0.050	25	0.055	30	0.060	
161 - 170	190	1.80	340	5	0.037	10	0.042	15	0.047	20	0.052	25	0.057	30	0.062	
171 -200	160	2.10	330	5	0.039	10	0.044	15	0.049	20	0.054	25	0.059	30	0.064	
201 - 230	140	2.40	330	5	0.045	10	0.050	15	0.055	20	0.060	25	0.065	30	0.070	
231 - 260	120	2.70	320	5	0.051	10	0.056	15	0.061	20	0.066	25	0.071	30	0.076	
261 - 280	110	3.00	330	5	0.057	10	0.062	15	0.065	20	0.070	25	0.075	30	0.080	
281 - 310	100	3.30	330	5	0.061	10	0.066	15	0.071	20	0.076	25	0.081	30	0.086	
311 -330	95	3.60	340	5	0.067	10	0.072	15	0.077	20	0.082	25	0.087	30	0.092	
331 - 350	90	3.90	350	5	0.071	10	0.076	15	0.081	20	0.086	25	0.091	30	0.096	

TABLE-1 Rz: Average roughness depth SA: Stock Allowance/ Rolling share

> Stock Allowance (SA) is shown on the Table 1. The datas which are calculated according to diameter and surface roughness are approximate. These datas can be variable according to material type, structure and hardness.

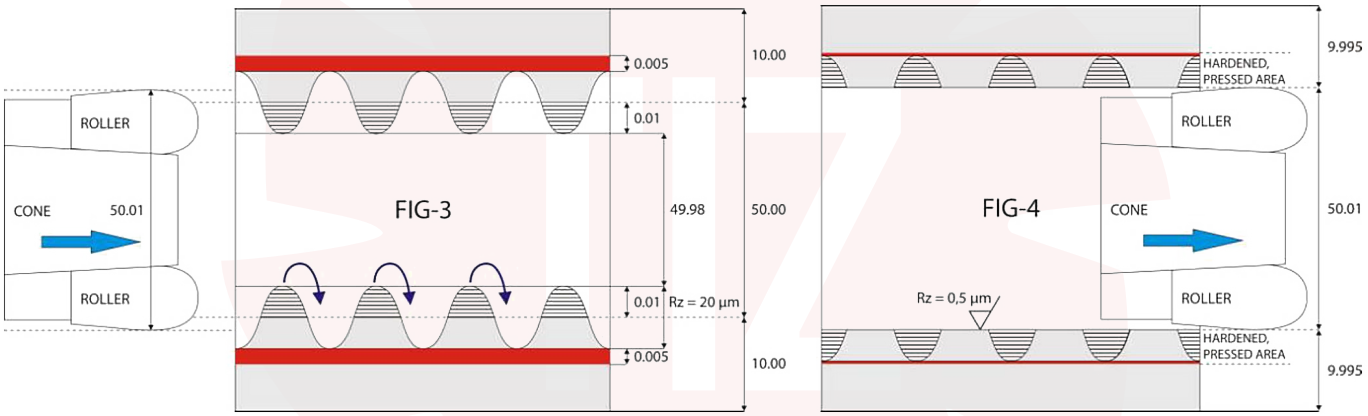
> Stock Allowance Range (SAR) can be variable related to such factors like a material type, material hardness and surface roughness after pre-machining. Because of this reason, it should be find after a few tests by trying. The Stock Allowance should be taken as approximate value for range, bottom and upper limit should be find by trying.

For example:
The hole of Steel material which diameter is 50 mm and surface roughness Rz 20 µm after turning will be burnished. For this;

- Stock Allownace should be approximate 0.03 mm (Please look at the red mark area on the table-1).
- The Stock Allowance Range can be one of them below examples. The range will founded by trial.

Example-1: Stock Allowance Range = 0,02 - 0,04 mm;
In this case hole diameter should be between 49,96-49,98
Example-2: Stock Allowance Range = 0,02 - 0,03 mm;
In this case hole diameter should be between 49,97-49,98
Example-3: Stock Allowance Range = 0,03 - 0,05 mm;
In this case hole diameter should be between 49,95-49,97

- Revolution: 530 rev./min.
- Feeding Rate: 1.2 mm/rev.
- Feeding : should be 630 mm/min (see Table-1)



2 different effects are occured during burnishing process as seen above figure.

First Effect; The peaks are filled up in the gaps by replacing.

Second Effect; in the figure-3 the area which is shown as red in the thickness of 0.005 mm get caught in as molecular.

As seen in the figure, these two different effects caused to dimensional changes. Size change amount in the first effect is 0.02 mm in diameter, Size change amount in the second effect is 0.01 in diameter mm. It is totally 0.03 mm.

ATTENTION! There could not be a molecular press in every material. Because of this moleculer press should not be taken into consideration while stok allowance calculating. If the molecular structure of the material is suitable for compression how much can be compressed can be found by trying and it added to the stock allowance.

Stock Allowance (µm) = Pre-machining roughness depth Rz (µm)

5.4 Direction of Rotation and Rotation

Rotation is applied in two ways. The tool rotates, the workpiece is fixed or workpiece rotates, the tool is fixed. The direction of tool or workpiece rotation is shown in the following figure.

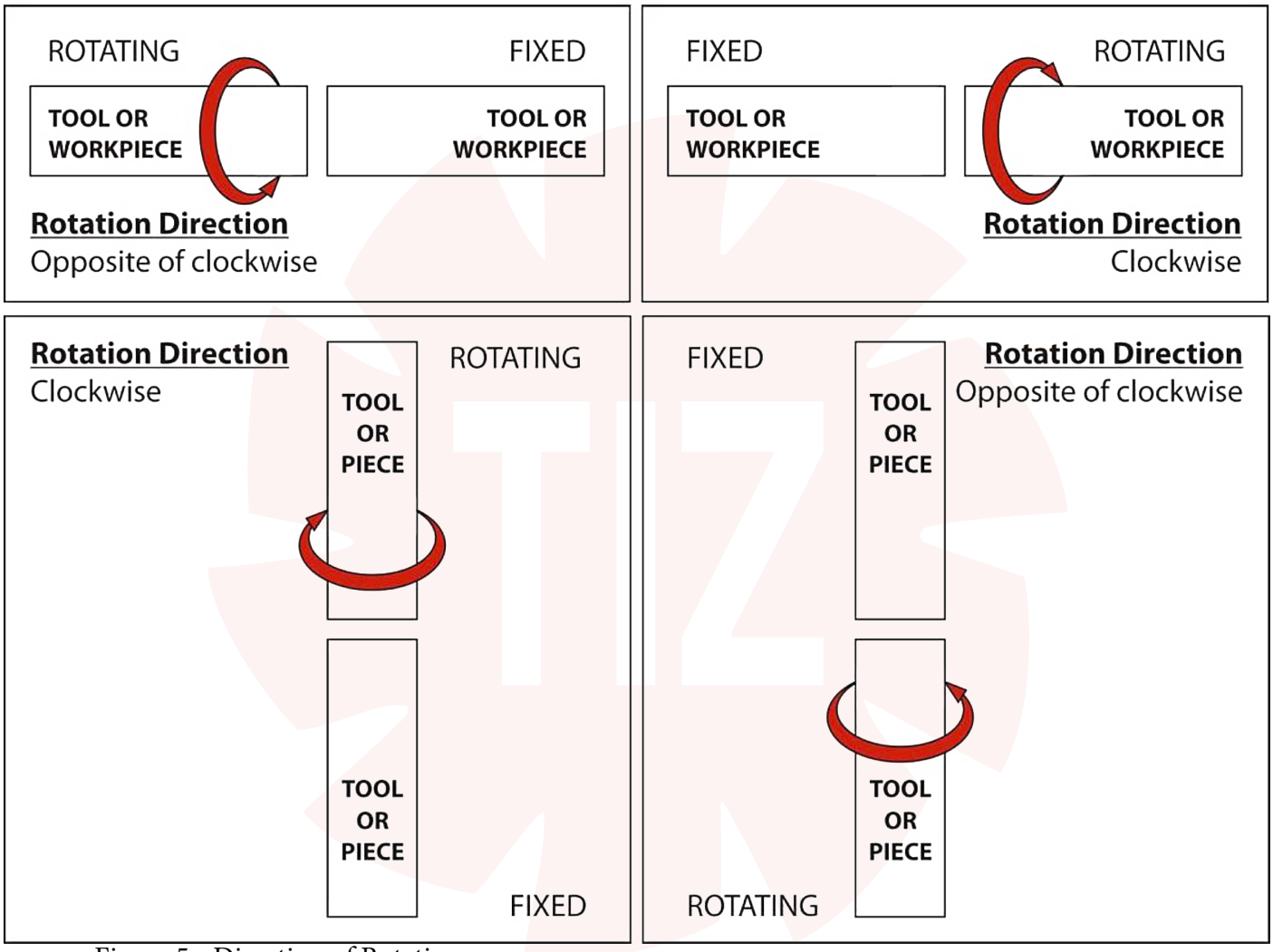


Figure 5 - Direction of Rotation

5.5 Feeding

Feeding can be changed depending on the roller quantity which are at the tool. Feeding is possible from 0.1 mm/rev. to 0.3 mm/rev. per roller according to surface quality which is intended. Please look on the table-1 at the section 5.3 for recommended feed rates according to diameter.
You can calculate the min. and max. feed speed with the formula below: Feed rate (mm/rev.) = Number of roller x between 0.10 - 0,30 mm/rev.

ATTENTION! Above mentioned formula and feeding is not valid on the through hole automatic feeding tools . Because these types tools provide the feeding self.

5.6 Revolution

The revolution rates could be chosen as shown in figure 6. Please look on the table-1 at the section 5.3 for recommended revolutions according to diameter.

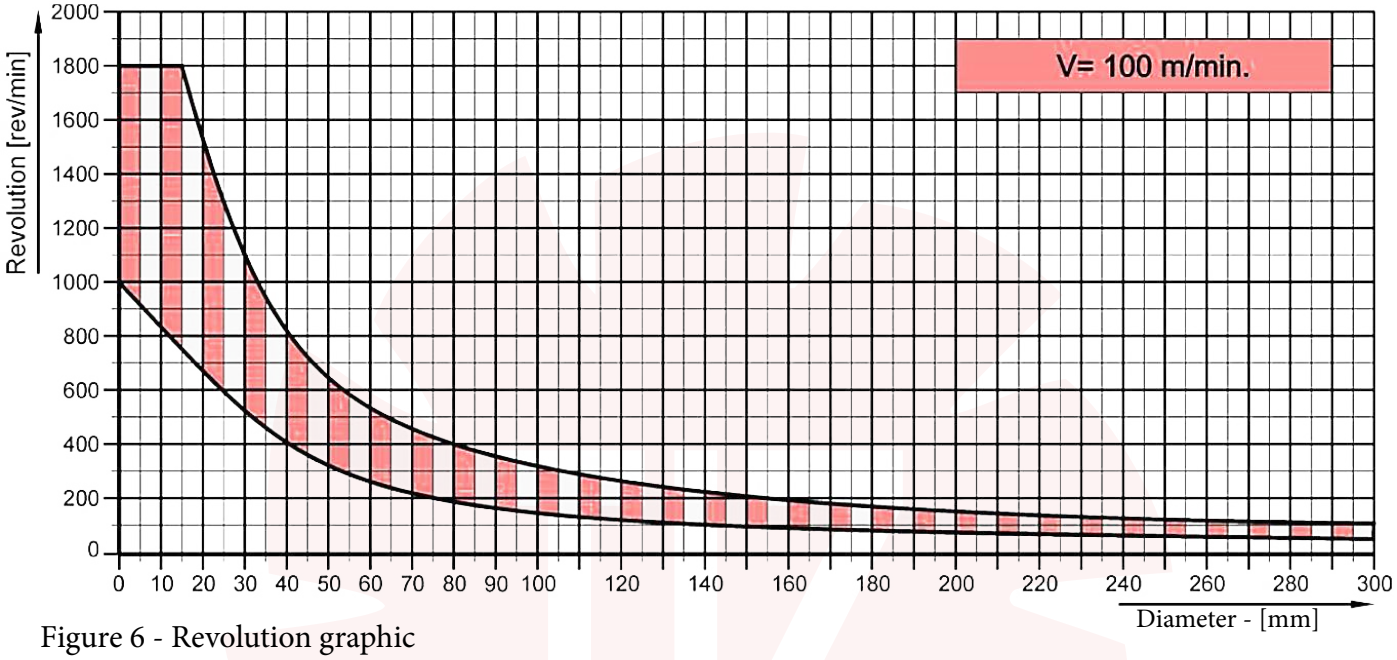


Figure 6 - Revolution graphic

The process parameters which are shown on the revolution graphic can be change up and down depending on the machine typ and workpiece. The circumferential speed is calculated according to the min. 50 m/min max. 100 m/min on this graphic.

- The max. revolution is 2500 rev/min. for the tools between 04 - 031 mm.
- The circumferential speed is possible up to max.250m/min. for the tools bigger than 031 mm.
- You can calculate the max. revolution for the tools bigger than 031 mm with the following Formula;

Revolution (rev./min.) = 250.000 / (0 x 3,14)

ATTENTION! Please apply1/4 revolution which is recommended on the Table-1 for through holes automatic feeding tools.

ATTENTION! Please apply 1/2 revolution which is recommended on the Table-1 for tools which are smaller than 035 mm and which have bigger than 100 mm Rolling length.

5.7 Coolant

The tool and workpiece has to be cooled and lubricated. For this, oil or emulsion are used. For most materials and workpieces a continuous supply of coolant-lubricant is adequate. It is not always possible to supply a continuous emulsion flow in the machine, without an indoor working area. Because of this, it is enough to lubricate the surface of the workpieces or tool with low viscosity oil (spindle oil, machine oil, hydraulic fluid). The coolant-lubricant or oil must be clean and free of sawdust, metal particles. Coolant-lubricant should be continuously filtered to a maximal mesh size of 40 µm. GG and GGG cast iron secrete small graphite particles during the roller burnishing prosess. This situation could cause break down, quick deformation and jamming of the tool. In addition to prevent this, supply coolant-lubricant at the possible highest flow rate. And after every operation flush the tool while it is rotating.

ATTENTION! The emulsion should be sheld continuously during high revolution process or machining of long workpieces which causes the tool become hot.

5.8 Roller burnishing operation

Using type of the tools can be change depending on the tool type and used machine.

5.8.1 Using on the drill machine

Type 1: Operation with through hole - automatic (self) feeding tool

Small workpieces which weights is light can process as serial by holding hand. The tool is fixed to the holder of drill machine. The tool rotates, the workpiece is fixed. The tool is rotated by reducing in the percentage of %50 of revolution which is calculated at min. (See the figure-3). Rotation of the workpiece is obstructed by holding hand. The hole is contacted at axial position. The tool hold the workpiece and starts to pull it self. When the rollers go out from the backside of the hole the roller burnishing operation is to be completed. The workpiece pull speedily down or the cage sleeve holding by hand is moved and the diameter is to get smaller. The workpiece is seperate from the tool by pulling down.

ATTENTION! Should use necessarily thick glove by working hand with the tool. Do not do any application by hand to the holes which's rolling share smaller than 0,05 mm. Do not do any application by hand to the workpieces which are sharpe edged

Heavy and big workpieces can not be processed by holding hand. Because of this the workpiece should be fked on the drill table. The workpiece can fixed on the table as axial, or it can be settle mobil to right-left, forward-back but the moving upwards of the workpiece should be prevented at free setting. Process should be completed in order to be free feeding of the tool (feeding should not be given from machine also the tool will do feeding it self). During the process drill arm should be free, if needed the arm is supported slightly by hand.

Type 3: Operation with blind hole - machine feeding tool

The tool is fixed to the holder of drill machine. The tool rotates, the workpiece is fixed. The tool is rotated by reducing in the percentage of %50 of revolution which is calculated at min. (See the figure-3). The workpiece can be fixed on the drill table as axial to tool. Go in the hole with revolution and feeding which is calculated before. When the rollers come to ground of the hole the roller burnishing operation is to be completed, the tool is pulled upward, machine is to be stopped. It is recommended not to contact of the rollers to the hole ground.

5.8.2 Using on the Universal Lathe machine

Type 1: Operation with through hole - automatic (self) feeding tool
The tool is fixed to the tailstock of lathe machine. The tailstock should be free and able to move on the slide. The workpiece rotates, the tool is fixed. The workpiece is rotated by revolution which is calculated before. The tool is contacted to the hole at axial position, the tool holds the workpiece and moves together with tailstock into the hole. When the rollers go out from the backside of the hole, the roller burnishing operation is to be completed, the chuck is rotated to reverse direction, tailstock pulls back, machine is to be stopped.

ATTENTION! While using the tools which at tailstock on Universal lathe machine, especially at tools, which have small diameter, the weight of the tailstock could not enable to feed the tool it self.

Ty pe 2: Operation with through hole - machine feeding tool
The tool is fixed to the tailstock of lathe machine. The workpiece rotates, the tool is fixed. The workpiece is rotated by revolution which is calculated before. It is gone into the hole as manuel in axial position with tool. When the rollers go out from the backside of the hole the roller burnishing operation is completed. The machine is to be stopped and the tool pulls back, machine is to be stopped.

Type 3: Operation with blind hole - machine feeding tool
The tool is fixed to the tailstock of lathe machine. The workpiece rotates, the tool is fixed. The workpiece is rotated by revolution which is calculated before. It is gone into the hole as manuel in axial position with tool. When the rollers come to ground of the hole the roller burnishing operation is completed. The machine is stopped and the tool pulls back, machine is stopped. It is recommended not to contact of the rollers to the hole ground.

5.8.3 Using on the CNC lathe, machining centers, milling machines etc.

Type 1: Operation with through hole - automatic (self) feeding tool
It is not suitable for these machines.

Type 2: Operation with through hole - machine feeding tool
The tool is fixed to the holder of machine. It is gone in the hole with revolution and feeding which is calculated before. When the rollers go out from the backside of the hole the roller burnishing operation is completed, the tool is pulled speedily back and later the machine is stopped.

Type 3: Operation with blind hole - machine feeding tool

The tool is fixed to the holder of machine. It is gone in the hole with revolution and feeding which is calculated before. When the rollers come to ground of the hole the roller burnishing operation is completed, the tool is pulled speedily back and later the machine is stopped. It is recommended not to contact of the rollers to the hole ground.

6. Trouble-shooting

Trouble

1. Workpiece surface not sufficiently smooth after burnishing.

Possible Causes / Solutions
a. The present tool diameter adjustment is too small (Burnishing force is too low)
b. Surface quality of the pre-machined workpiece is not enough for the roller burnishing (Surface is too rough).

2. Workpiece surface with scaling, residual roughness or taking.

a. The present tool diameter adjustment is too large (Burnishing force is too high)
b. The feed rate is too low.
c. Hole tolerance is bigger than H7.

3. Flawed workpiece surface after burnishing.

a. The workpiece surface, burnishing rollers, coolant-lubricant or oil are not clean (exp.: particles of metal and sawdust).
b. During the workpiece lathing faulty machining or flawed of the surface. Causes;

- Lathe feeding speed is too high.
- Cutting insert radius is too small.
- Cutting speed is too low.
- Cutting edges are worn (too much pre-machining).
- Cutter material is unsuitable.
- Insufficient cutting allowance (not enough stock was removed).

4. The tool or workpiece becomes too hot. Material builds up (bulges) in front of the burnishing rollers.

a. Tool not properly positioned at the workpiece surface (Tool is feeding at the wrong axis or inclined position in the hole).
b. Adjustment of the tool is too large or the hole diameter is too small.
c. Hole diameter is tapered (conical).
d. Feeding speed is too low.
e. Revolution is too low.

5. Burnished surface undulates.

a. Feeding speed is too high.
b. The surface already undulates after cutting process, but these undulation is smoothed after roller burnishing. The undulation stays under the surface. It can be seen only with eye. It doesn't mean that the surface undulates.
c. Roller set includes a mixture of rollers from different tolerance classes.

6. The hole is deformed at the front and rear edges.

a. Tool not properly positioned at the workpiece surface
(Tool is feeding at the wrong axis or inclined position in the hole).
b. Tool and hole axes not properly aligned.
c. Diameter adjustment of the roller head is too large.
d. Large disparities in workpiece wall thickness.
e. Workpiece wall thickness is too thin.

7. Workpiece out of round after burnishing.

a. Tool not properly positioned at the workpiece surface
(Tool is feeding at the wrong axis or inclined position in the hole).
b. Tool and hole axes not properly aligned.
c. Diameter adjustment of the roller head is too large.
d. Especially wall thickness of the workpiece is too thin.
e. Wall thickness of the workpiece is variable.
f. Feed rate is too low.
g. Revolution is too low.

8. Even though the adjustment of the tool diameter is made larger, the hole diameter doesn't change or increase anymore.

a. The surface is fully burnished. There is no roughness to the burnish. Even though the adjustment of the tool diameter is enlarged, there will no an enlargement in the hole. Also it causes scale on the surface.
b. The tool has already been set to the largest possible diameter.

9. The tool with self-feeding releases during burnishing or it pulls out of the tool holder when burnishing with machine feeding.

a. In any case, machine feeding speed must be higher than the self-feeding speed of the tool. The machine feeding speed is too low.
b. Tool not properly positioned at the workpiece surface (Tool is feeding at the wrong axis or inclined position in the hole).
c. Tool and hole axes not properly aligned.
d. Diameter adjustment of the roller head is too large.

10. Tool diameter changes erratically.

a. Adjustment nut lock (12) is loose, not completely tighten.
b. Adjustment gear (10) is not properly positioned its socket.

11. Irregular markings on the workpiece surface.

a. The roller(s) is/are worn. The rollers (2) set must be replaced.
b. The cone (1) is worn. Replace the cone.

12. Striped markings on workpiece surface.

a. Retract tool while it is still rotating.

7. Maintenance, conversion and assembly

7.1 Maintenance

After finishing daily usage of the tool, especially roller head (if needed, please disassemble it) should be cleaned. The roller head can be cleaned by dip in a vessel and moving up and down in it which is full with kerosene. In addition this cleaning can be applied during the operation as periodic per a few parts, too. After cleaned the tool should be entirely oiled and keep in his own box.

7.2 Conversion of the spare parts

In the manufacturing process type TDX tools, are used materials which provided optimum service life. The tool has so designed and produced that it will have high precision work capability. It is easy to work, use and assembly. So the tool can be used for a long time without breaking and can produce at high quality and speed. Rollers, cone and cage are spare parts, which are the mostly worn. These spare parts should be replaced sometimes because of the metal becomes tired and worn. The procedure differs according to the size range.

7.2.1 Conversion of the spare parts and assembly between Ø005 - Ø021

Cage (3): Turn the housing nut (4) so you can take it out from its thread. Step by step take out the thrust ring (5), spring (6), thrust ring (7) and cage (3). Vertical position of the tool is recommended for this purpose. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Take out the rollers which are located in the cage slots by pushing them from outside to the inside. Lubricate the new cage slots generously or surround the slots with the sticky band from outside, put the rollers from inside to the slots. For reassembly, these steps are performed in reversed order. Pull out the sticky band or clean the grease. Roller (2): Turn the housing nut (4) so you can take it out from its thread. Step by step, take out the thrust ring (5), spring (6), thrust ring (7) and cage (3). Vertical position of the tool is recommended for this purpose. Take out the rollers which are located in the cage slots by pushing them from outside to the inside. Lubricate the new cage slots generously or surround the slots with the sticky band from outside, put the new rollers from inside to the slots. For reassembly, these steps are performed in reversed order. Pull out the sticky band or clean the grease.

Important note: Replace the rollers absolutely as a set. Don't assemble the rollers onto the tool which are in the different tolerance classes and don't mix the rollers to eachother which are in the different tolerance classes.

Cone (1): Turn the housing nut (4) so you can take it out ^om its thread. Step by step take out the thrust ring (5), spring (6), thrust ring (7) and cage (3). Vertical position of the tool is recommended for this purpose. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Turn the cone (1) so you can take it out from its thread. Replace the cone with the new one by performing in reserved order. Pull out the sticky band or clean the grease.

7.2.2 Conversion of the spare parts and assembly between 0022 - 0049

Cage (3): Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Pull out the cage from the socket. Take out the rollers which are located in the cage slots by pushing them from outside to the inside. Lubricate the new cage slots generously or surround outside of the slots with the sticky band, put the rollers from inside to the slots. Reassembly the cage how you pulled it out. Pull out the sticky band or clean the grease.

Roller (2): Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Pull out the cage from the socket. Take out the rollers which are located in the cage slots by pushing them from outside to the inside. Lubricate the cage slots generously or surround outside of the slots with the sticky band, put the new rollers from inside to the slots. Reassembly the cage how you pulled it out. Pull out the sticky band or clean the grease. Important note: Replace rollers absolutely as a sets. Don't assemble the rollers onto the tool which are in the different tolerance classes and don't mix the rollers to eachother which are in the different tolerance classes.

Cone (1): Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Pull out the cage from the socket. Turn the cone (1) so you can take it out from its thread. Replace the cone with the new one by performing in reserved order. Pull out the sticky band or clean the grease.

7.2.3 Conversion of the spare parts and assembly between 0050 - 0350

Cage (3): Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Pull out the cage from the socket. Take out the rollers which are located in the cage slots by pushing them from outside to the inside. Lubricate the new cage slots generously or surround outside of the slots with the sticky band, putt the rollers from inside to the slots. Reassembly the cage how you pulled it out. Pull out the sticky band or clean the grease.

Roller (2): Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Pull out the cage from the socket. Take out the rollers which are located in the cage slots by pushing them from outside to the inside. Lubricate the cage slots generously or surround outside of the slots with the sticky band, put the new rollers from inside to the slots. Reassembly the cage how you pulled it out. Pull out the sticky band or clean the grease. Important note: Replace rollers absolutely as a set. Don't assemble the rollers onto the tool which are in the different tolerance classes and don't mix the rollers to eachother which are in the different tolerance classes.

Cone (1): Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Pull out the cage from the socket. Turn the screw (18) to pull out the cone (1) so you can take it out from its thread. Take out the conical ring (17). Pull out the cone to the backward direction. Replace the cone with the new one by performing in reserved order. Pull out the sticky band or clean the grease.

ATTENTiON! During the conversion of rollers be careful that the rollers are in the same tolerance class. Do not confuse the orders aiming spare rollers with another group rollers. (Put definitive coloured signs on the roller package).

7.3 Conversion of the Roller Head

Roller heads in the different diameters can be assembled onto the same tool body, which fits to it. On the table below, you can select the proper roller heads for the proper body. Forexample: TDX1.3-50 tool body is proper for the 032,00-1-50 roller head. The cage sleeve (15) is not included to the roller head. Check if there is a proper cage sleeve for the roller head. If not provide the roller head with the cage sleeve together.

Table 2 : Choice table of the tool body and roller head

Tool Body		Roller Head			
Body Nr.	Rolling Length	Diameter Range	Process Type	Length	Code of the Cage Sleeve
TDX1.1	-	005,00 - 014,00	1 / 2 / 3	50	-
		006,00 - 014,00		100	-
TDX1.2	50	015,00 - 021,00	1 / 2 / 3	50	-
		022,00 - 024,00			TYDX3001
		025,00 - 031,00			TYDX3007
	100	015,00 - 021,00		100	-
		022,00 - 024,00			TYDX3002
		025,00 - 031,00			TYDX3008
TDX1.3	50	032,00 - 0,34,00	1 / 2 / 3	50	TYDX3013
	100	032,00 - 0,34,00		100	TYDX3014
	UNL	035,00 - 036,00		-	TYDX3019
		037,00 - 040,00			TYDX3020
		041,00 - 045,00			TYDX3021
		046,00 - 049,00			TYDX3022
TDX2	UNL	050,00 - 051,00	1 / 2 / 3	-	TYDX3023
		052,00 - 054,00			TYDX3024
		055,00 - 057,00			TYDX3025
		058,00 - 060,00			TYDX3026
		061,00 - 063,00			TYDX3027
		064,00 - 066,00			TYDX3028
		067,00 - 069,00			TYDX3029
		070,00 - 072,00			TYDX3030
		073,00 - 075,00			TYDX3031
		076,00 - 078,00			TYDX3032
		079,00 - 080,00			TYDX3033
TDX3	UNL	081,00 - 160,00	1 / 2 / 3	-	DIFFERENT FOR EVERY DIA.
TDX4	UNL	161,00 - 350,00	1 / 2 / 3	-	DIFFERENT FOR EVERY DIA.

Process Types:
1. Through hole self-feeding
2. Through hole machine feeding
3. Blind hole machine feeding

Beside it, the tools can be converted from the through hole version to the blind hole version or the opposite by exchanging the cage, cone and rollers.

7.3.1 Conversion of the roller head and assembly between 0005 - 0021

Turn the housing nut (4) so you can take it out from its thread. Step by step pull out the thrust ring (5), spring (6), thrust ring (7) and cage (3). Vertical position of the tool is recommended for this purpose. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Turn the cone (1) so you take it out from its thread. To assembling the parts of the roller head onto the body, steps are performed in reversed order.

7.3.2 Conversion of the roller head and assembly between 0022 - 0031

Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Pull out the cage from the socket. Turn the cone (1) so you can take it out from its thread. Follow the steps below to change the cage sleeve (15). If the roller head is suitable to the cage sleeve, you don't need to change the cage sleeve (See the table-2). Turn the housing nut (4) so you can take it out from its thread. Step by step pull out the thrust ring (5), spring (6), thrust ring (7) and cage sleeve. Vertical position of the tool is recommended for this purpose. For assembling the parts of the roller head onto the body, steps are performed in reversed order.

7.3.3 Conversion of the roller head and assembly between 0032 - 0049

Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Pull out the cage from the socket. Turn the cone (1) so you can take it out from its thread. Follow the steps below to change the cage sleeve (15). If the roller head is suitable to the cage sleeve, you don't need to change the cage sleeve (See the table-2). Turn the housing nut (4) so you can take it out from its thread. (housing nut (4) and cage sleeve (15) are assembled eachother step by step cage sleeve, housing nut (4), thrust ring (5), spring (6), thrust ring (7), locking ring (16)). Disassembly the housing nut and cage sleeve and assembly the removed parts to the new Cage sleeve. For assembling the parts of the roller head onto the body, steps are performed in reversed order.

7.3.4 Conversion of the roller head and assembly between 0050 - 0350

Loosen the 3 piece of screws (14) on the cage (3) by turning a few revolutions. Before disassembling the rollers (2) and the cage, they should be generously greased or a sticky band should be applied to hold the rollers in the slots of the cage. Pull out the cage from the socket. Turn the screw (18) so you can take it out from its thread. Pull out the conical Ring (17). Pull out the cone retracting to the back direction. Follow the steps below to change the cage sleeve (15). If the roller head is suitable to the cage sleeve, you don't need to change the cage sleeve (See the table-2). Turn the housing nut (4) so you can take it out from its thread. (housing nut

8. Lists of the spare part

Between 05 - 021 mm			
Pos.	Name of the part	Quantity	Code
1	CONE	1	*
2	ROLLER	*	*
3	CAGE	1	*
4	HOUSING NUT	1	TYDX1001
5	THRUST RING	1	TYDX0901
6	SPRING	1	TYDX0701
7	THRUST RING	1	TYDX0901
8	BALL BEARING	1	TYDX0601
9	HOUSING	1	TYDX0501
10	ADJUSTMENT GEAR	1	TYDX0301
11	PIN	1	TYDX0401
12	ADJUST. NUT LOCK	1	TYDX0101
13	SHANK	1	*

Between 022 - 031 mm			
Pos.	Name of the part	Quantity	Code
1	CONE	1	*
2	ROLLER	*	*
3	CAGE	1	*
4	HOUSING NUT	1	TYDX1001
5	THRUST RING	1	TYDX0901
6	SPRING	1	TYDX0701
7	THRUST RING	1	TYDX0901
8	BALL BEARING	1	TYDX0601
9	HOUSING	1	TYDX0501
10	ADJUSTMENT GEAR	1	TYDX0301
11	PIN	1	TYDX0401
12	ADJUST. NUT LOCK	1	TYDX0101
13	SHANK	1	*
14	SCREW	3	TYDX1101
15	CAGE SLEEVE	1	*

* The Part Code and Quantity are variable. Please ask TIZ

Between 032 - 049 mm			
Pos.	Name of the part	Quantity	Code
1	CONE	1	*
2	ROLLER	*	*
3	CAGE	1	*
4	HOUSING NUT	1	TYDX1001
5	THRUST RING	1	TYDX0901
6	SPRING	1	TYDX0701
7	THRUST RING	1	TYDX0901
8	BALL BEARING	1	TYDX0601
9	HOUSING	1	TYDX0501
10	ADJUSTMENT GEAR	1	TYDX0301
11	PIN	1	TYDX0401
12	ADJUST. NUT LOCK	1	TYDX0101
13	SHANK	1	*
14	SCREW		TYDX1101
15	CAGE SLEEVE	1	*
16	LOCKING RING	1	TYDX1201

Between 050 - 080 mm			
Pos.	Name of the part	Quantity	Code
1	CONE	1	*
2	ROLLER	*	*
3	CAGE		*
4	HOUSING NUT		TYDX1002
5	THRUST RING		TYDX0902
6	SPRING		TYDX0702
7	THRUST RING		TYDX0902
8	BALL BEARING		TYDX0602
9	HOUSING		TYDX0502
10	ADJUSTMENT GEAR		TYDX0302
11	PIN		TYDX0402
12	ADJUST. NUT LOCK		TYDX0102
13	SHANK		*
14	SCREW		TYDX1102
15	CAGE SLEEVE		*
16	LOCKING RING		TYDX1202
17	CONICAL RING		TYDX1401
18	SCREW		TYDX1501
19	WEDGE		TYDX1301

Between 081 - 0160 mm			
Pos.	Name of the part	Quantity	Code
1	CONE	1	*
2	ROLLER	*	*
3	CAGE	1	*
4	HOUSING NUT	1	TYDX1003
5	THRUST RING	1	TYDX0903
6	SPRING	1	TYDX0703
7	THRUST RING	1	TYDX0903
8	BALL BEARING	1	TYDX0603
9	HOUSING	1	TYDX0503
10	ADJUSTMENT GEAR	1	TYDX0303
11	PIN	1	TYDX0403
12	ADJUST. NUT LOCK	1	TYDX0103
13	SHANK	1	*
14	SCREW		TYDX1103
15	CAGE SLEEVE	1	*
16	LOCKING RING	1	TYDX1203
17	CONICAL RING	1	TYDX1402
18	SCREW	1	TYDX1502
19	WEDGE	1	TYDX1302

Between 0161 - 0350 mm			
Pos.	Name of the part	Quantity	Code
1	CONE	1	*
2	ROLLER	*	*
3	CAGE		*
4	HOUSING NUT		TYDX1004
5	THRUST RING		TYDX0904
6	SPRING		TYDX0704
7	THRUST RING		TYDX0904
8	BALL BEARING		TYDX0604
9	HOUSING		TYDX0504
10	ADJUSTMENT GEAR		TYDX0304
11	PIN		TYDX0404
12	ADJUST. NUT LOCK		TYDX0104
13	SHANK		*
14	SCREW		TYDX1104
15	CAGE SLEEVE		*
16	LOCKING RING		TYDX1204
17	CONICAL RING		TYDX1403
18	SCREW		TYDX1503
19	WEDGE		TYDX1303

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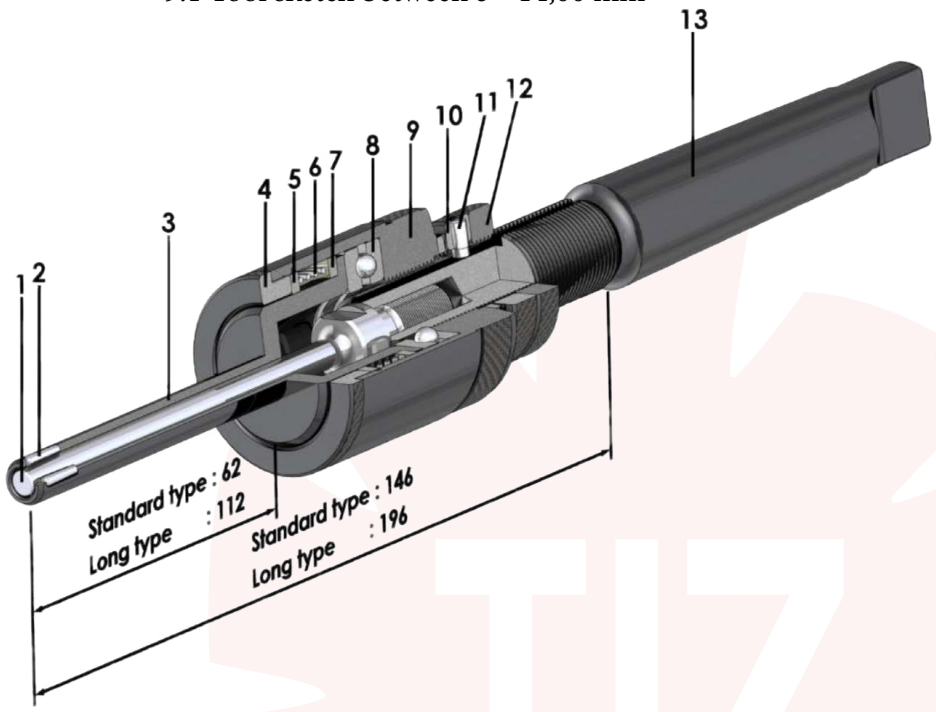
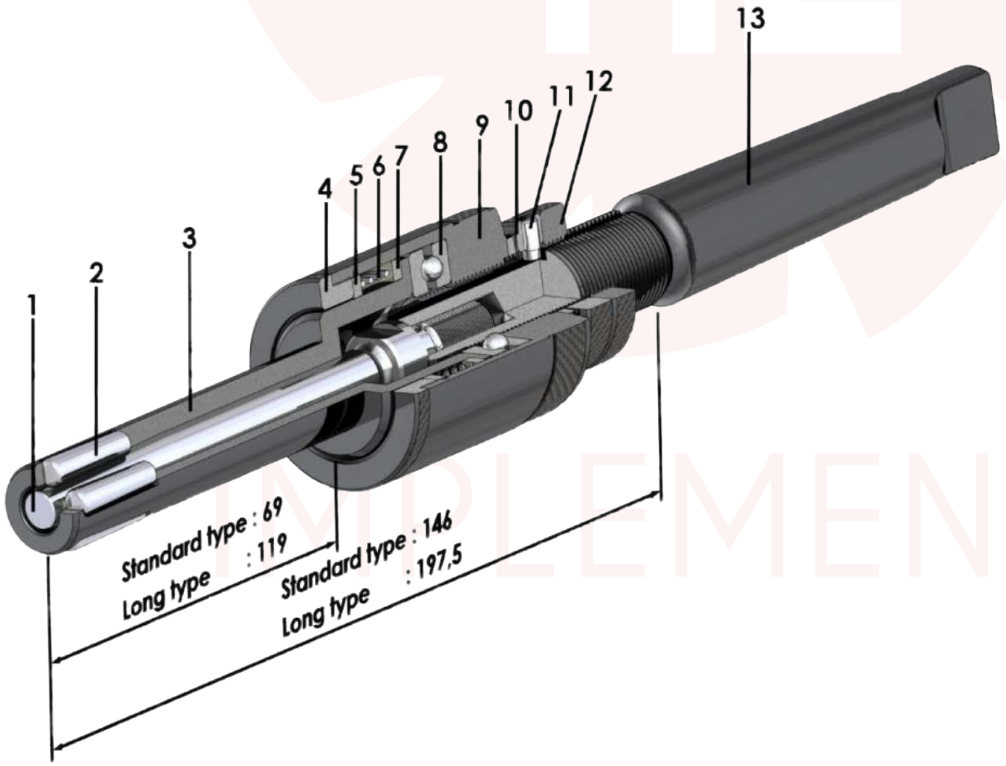
9. Sketchs of the tools

9.1 Tool sketch between 5 - 14,00 mm



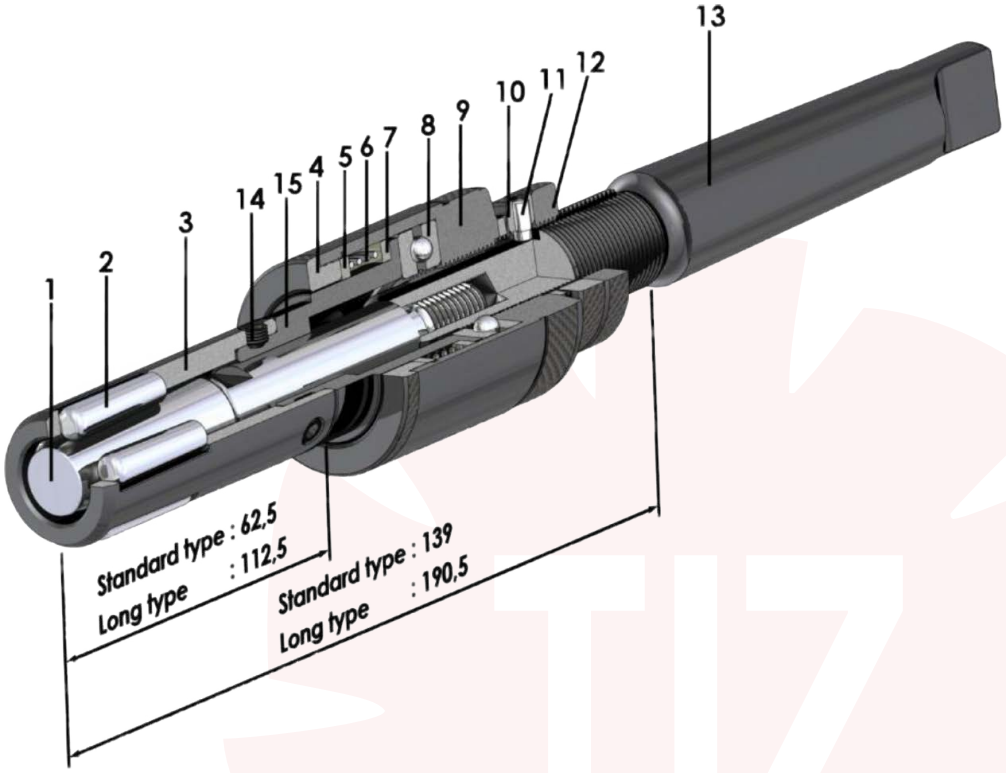
1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank

9.2 Tool sketch between 15 - 21,00 mm



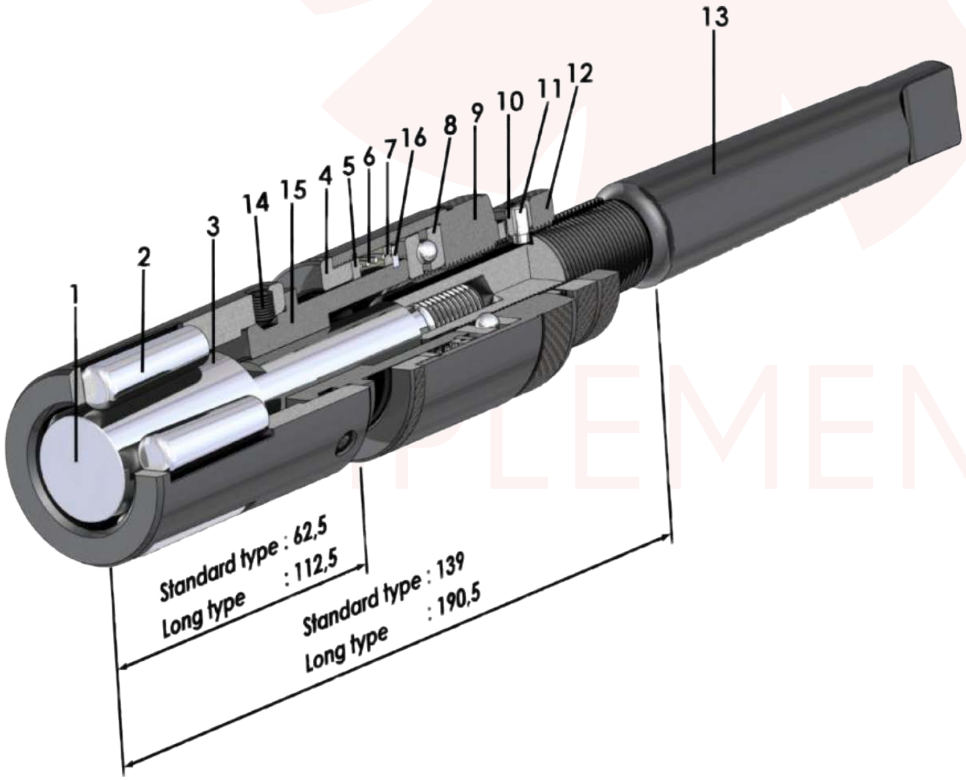
1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank

9.3 Tool sketch between 22 - 31,00 mm



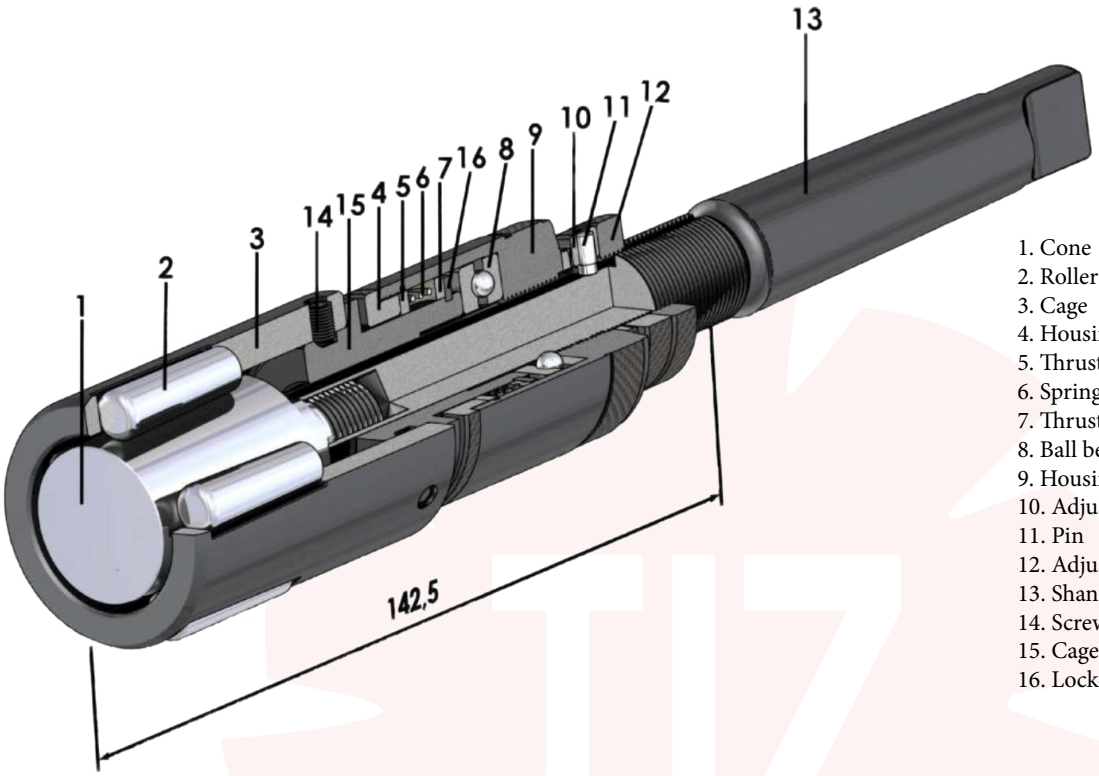
1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank
14. Screw
15. Cage sleeve

9.4 Tool sketch between 32 - 34,00 mm



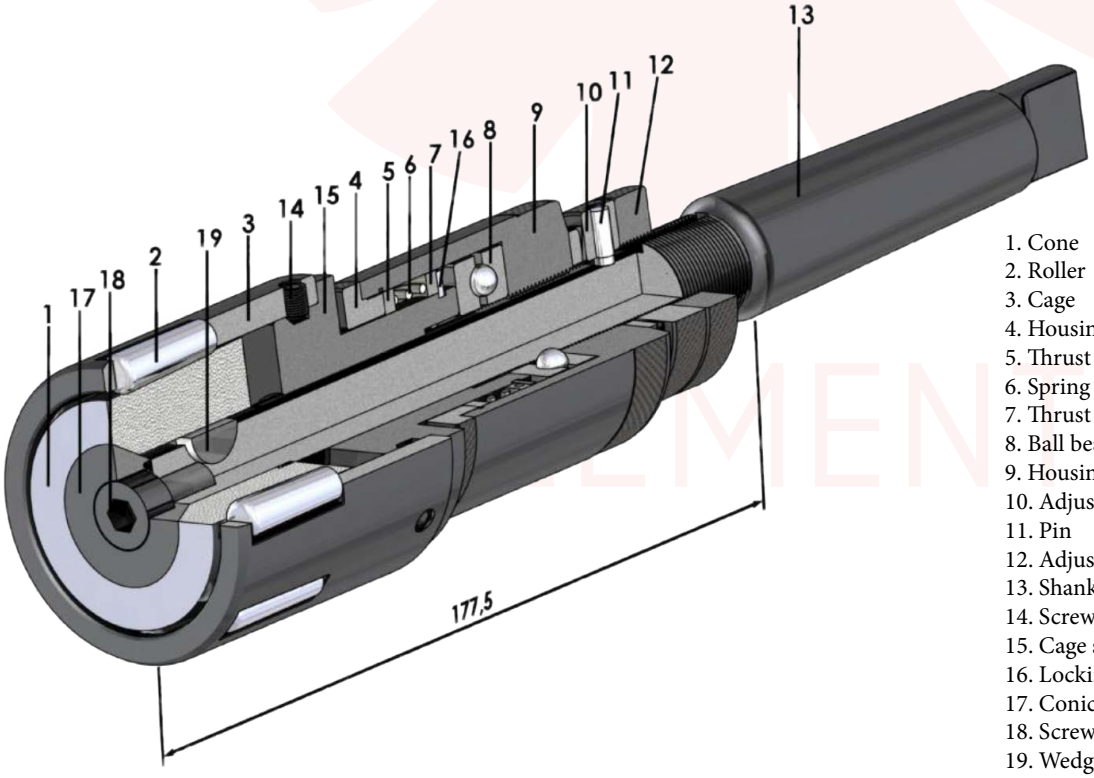
1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank
14. Screw
15. Cage sleeve
16. Locking ring

9.5 Tool sketch between 35 - 49,00 mm



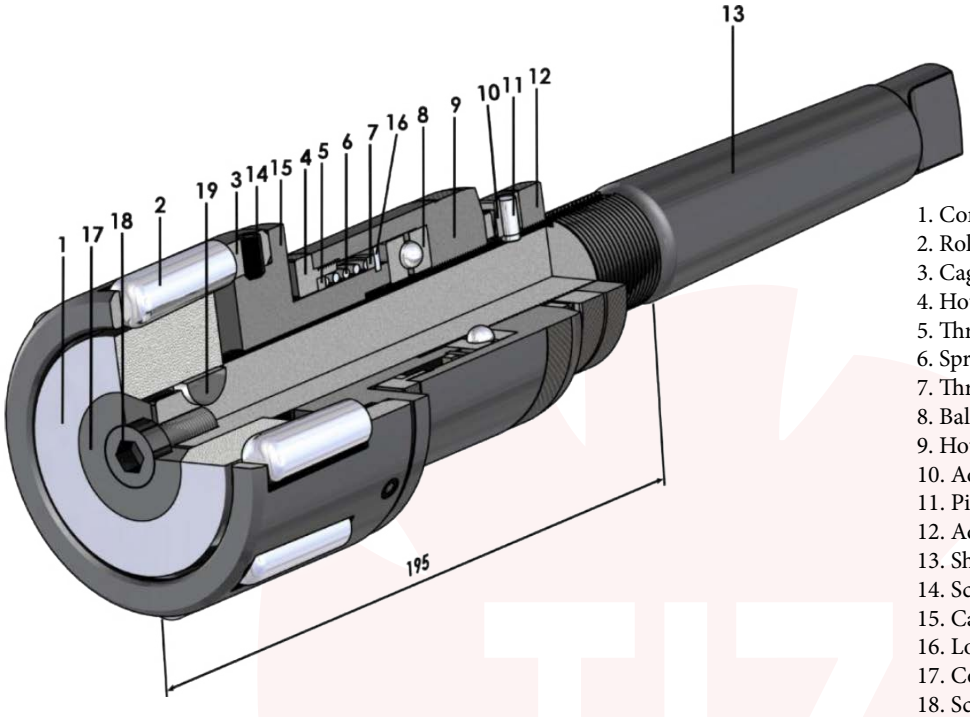
1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank
14. Screw
15. Cage sleeve
16. Locking ring

9.6 Tool sketch between 50 - 80,00 mm



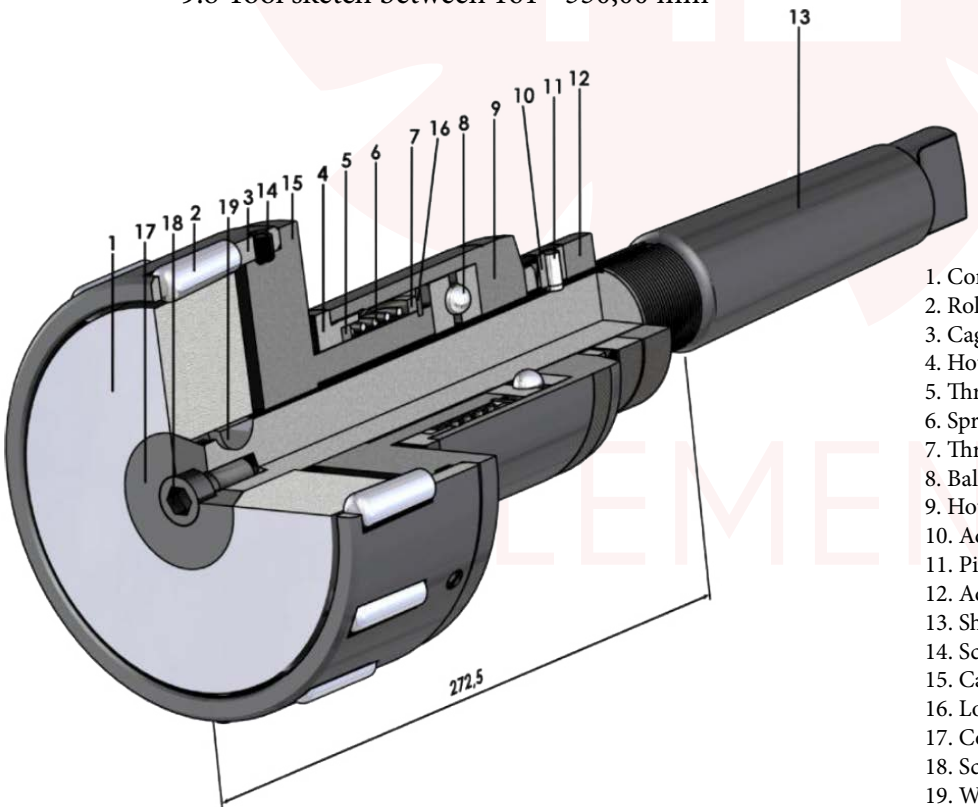
1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank
14. Screw
15. Cage sleeve
16. Locking ring
17. Conical ring
18. Screw
19. Wedge

9.7 Tool sketch between 81 - 160,00 mm



1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank
14. Screw
15. Cage sleeve
16. Locking ring
17. Conical ring
18. Screw
19. Wedge

9.8 Tool sketch between 161 - 350,00 mm



1. Cone
2. Roller
3. Cage
4. Housing nut
5. Thrust ring
6. Spring
7. Thrust ring
8. Ball bearing
9. Housing
10. Adjustment gear
11. Pin
12. Adjustment nut lock
13. Shank
14. Screw
15. Cage sleeve
16. Locking ring
17. Conical ring
18. Screw
19. Wedge