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Directions for Use (No.:820304)

THE SPINDLE - SPEEDER

ZP - 10/X

MANUFACTURER:

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1. Use

The spindle-speeder is designed as a special accessories for milling or boring machines, jig bores, machining centres and exceptionally for drilling machines. The spindle-speeder accelerates the turning speed of the machine-tool spindle. This device is suitable for the high speed cutting (HSC) and protects the bearings of the machine-tool spindle against the premature wear owing to the high turning speed. The necessary turning speed reaches frequently the extreme limits of the running speed range of the machine tool.

2. Main Technical Data

Gear Ratio of the Planetary Gearing	1 : 6
Maximum Turning Speed of the High-Speed Spindle	20 000 min^{-1}
Power Output	4,5 kW
Chucking Capacity of the Collet Chuck (Range of Straight Shank Diameter)	0,5÷13,0mm
Type of the Spring Collet	ER20

Calculation of the Turning Speed of the Machine Spindle :

$$n_s = \frac{1000 \cdot v}{\pi \cdot d \cdot i} \quad [min^{-1}]$$

where
v - cutting speed [$m.min^{-1}$]
d - diameter of the tool [mm]
i - gear ratio of the spindlespeeder [1]

Calculation of the Feed s [$mm.min^{-1}$] :

$$s = z \cdot i \cdot s_z$$

where
z - number of teeth of the tool [1]
n_s - turning speed of the machine spindle [min^{-1}]
i - gear ratio of the spindlespeeder [1]
s_z - feed per tooth [min]

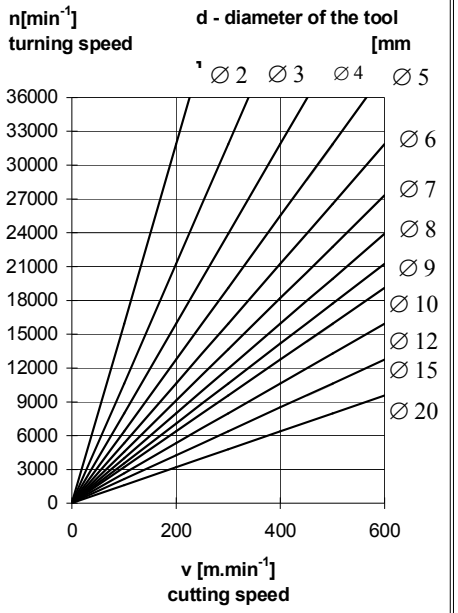
The feed per tooth is the basic value for correct choice of the feed. The initial value for non-ferrous materials is 1/100 of the tool diameter (d) and the feed per tooth is in the range of 0,02 - 0,005 d. The feed has to be reduced for machining of harder materials or by using smaller diameter tools and on the contrary. This value should not be lower than 0,01 mm for tools over 5 mm diameter and 0,005mm for smaller tools.

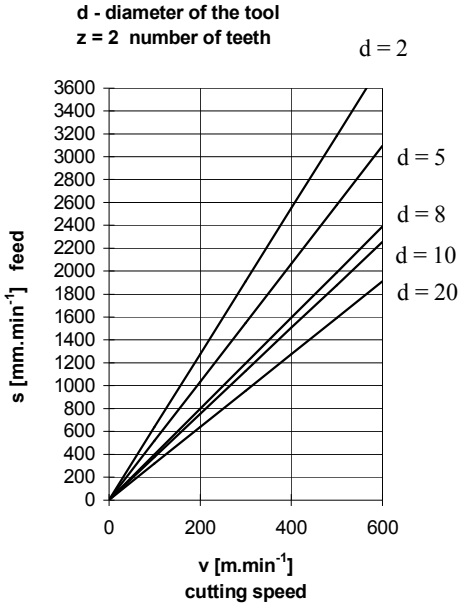
Cutting Depth of the Tool

The cutting depth by slot milling should not exceed the value of one half of the tool diameter, by one-sided milling can reach this depth the value of the tool diameter. The cutting depth has to be reduced with increasing depth of the slot.

The oblique entering of the milling tool in the machined material is suitable for protecting against zero-cutting speed in the tool axis. The down milling is usually more advantageous than up milling.

The below mentioned graphs represent the turning speed-cutting speed and feed-cutting speed relations by different diameters of tools and numbers of teeth.





Modern milling machines and machining centres offer the relative high turning speeds over 3000 rpm and feeds over 3000 mm.min^{-1}. But older machines with turning speeds at the maximum of 2000 rpm are still at disposal.

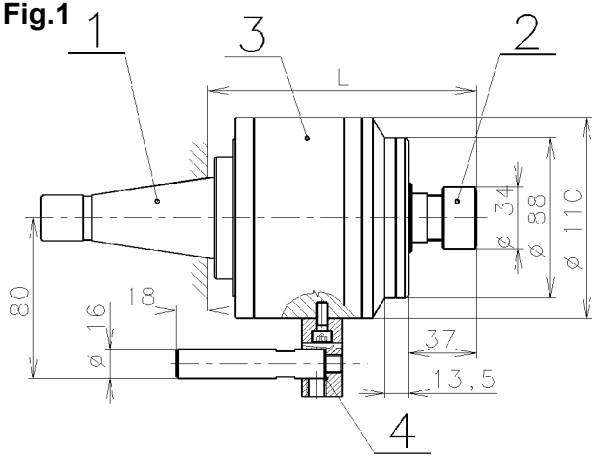
This problem may be solved by chucking of tools especially of smaller diameters in the spindlespeeder. This device multiplies the turning speed of the machine and makes possible to reach the recommended cutting speed. In addition this solution protects the bearings of the machine spindle against the premature wear by very high speeds of rotation.

3. Description of the Device

The spindle-speeder consists of four basic parts - the body with taper shank, the high-speed spindle with collet chuck, the mechanical planetary gearing and the arresting device that prevents the gear box from rotating and locks the position of the gear box regarding to the milling head of the machine.

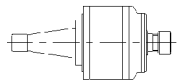
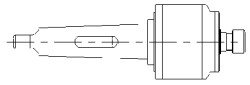
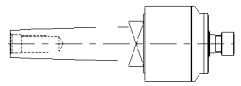
4. ZP-10/X Modification for the Hand Operated Tool Change

Fig.1



1 - Body with Taper Shank
2 - High-Speed Spindle
3 - Planetary Gear Box
4 - Arresting Device

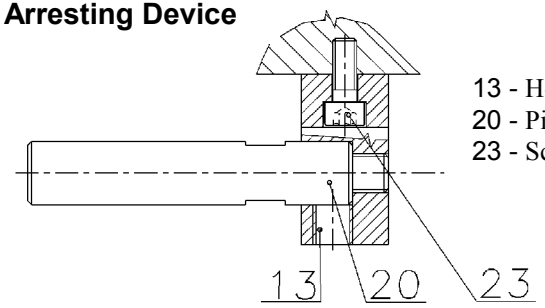
Assortment of Bodies - Taper Shanks

Code	Taper	Standard	Sketch	L [mm]	[kg]	
242.088	ISO 40	DIN 2080 ISO 297 ČSN 220430		145	6,6	■
242.095	ISO 50			149	8,4	■
242.019	Mk4	DIN 1806 ISO 296-63 ČSN 220430		143	6,5	□
242.026	Mk5			140	7,4	□
242.033	Mk6			142	10,0	□
242.040	Mk4 x M16	DIN 2207 ČSN 220422		164	6,6	□
242.057	Mk5 x M20			168	7,8	□
242.064	Mk6 x M24			177	12,0	□

■ Primary Offer □ for Demand

This modification of the spindle-speeder is designed for the use on the machine tools with hand operated tool change (is not suitable for the storage magazine of the tools).
The main dimensions of the spindle-speeder and two modifications of the arresting device are illustrated on the Fig. 1.

Fig. 2 - Detail of the Arresting Device



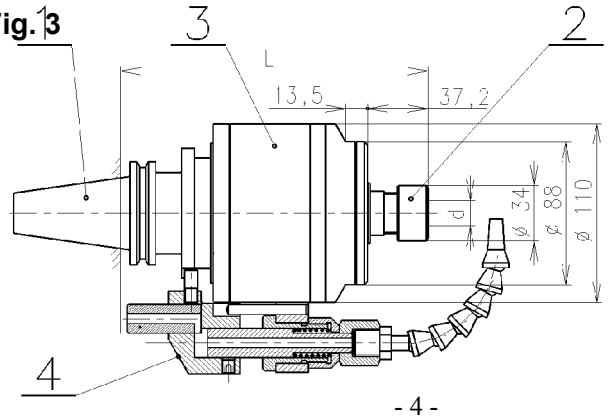
13 - Holder
20 - Pin
23 - Screw

The holder is screwed to the gear box of the device. The pin is screwed into the holder. There are two positions of the pin.
1. The axis of the pin is parallel to the axis of the device
2. The axis of the pin is normal to the axis of the device

5. ZP-10/X Modification for the Automatic Tool Change

This modification of the spindle-speeder is designed for the use on the machining centres, the device being stored in the storage magazine of the tools and the changing is carried on mechanically by the programmed cycle. The taper shank and the arresting device are modified. This modification of the device has three variations of the cutting-fluid application system (see the Fig. 5). The main dimensions of the spindle-speeder and modifications of the arresting device are illustrated on the Fig. 3 and 4.

Fig. 3



1 - Body with Taper Shank
2 - High-Speed Spindle
3 - Planetary Gear Box
4 - Arresting Device

Table of recommended cutting speeds and feeds per tooth for various tool materials including coatings and various machined materials.

Material Group	Cutting Speed v [m / min] K30F ▽▽▽ ▽▽ ▽	K30F TIN ▽▽▽ ▽▽ ▽	K30F TICN ▽▽▽ ▽▽ ▽	Cermet ▽▽▽ ▽▽	Feed s_z [mm/tooth] Cutter - ∅ / mm 2	5	10	20
unalloyed steels					0,02	0,04	0,06	0,10
bis 550 MPa	150 120 100	170 150 120	180 160 130	300 250	▽▽▽ x 1,3 TIN x 1,2			
bis 650 MPa	| | |	| | |	| | |	| |	▽▽ x 1,0 TICN x 1,2			
bis 850 MPa	100 70 50	120 100 70	130 110 80	200 160	▽ x 0,7			
alloy steels					0,015	0,03	0,05	0,08
low-alloy steels bis 700 MPa	120 100 80	140 120 100	150 130 110	250 200				
bis 850 MPa	| | |	| | |	| | |	| |	▽▽▽ x 1,3 TIN x 1,2			
high-alloy steels bis 800 Mpa	| | |	| | |	| | |	| |	▽▽ x 1,0 TICN x 1,2			
bis 1000 MPa	50 45 40	70 55 45	80 65 55	160 120	▽ x 0,7			
stainless steels					0,02	0,04	0,06	0,10
bis 550 Mpa	80 70 60		100 90	100	▽▽▽ x 1,3			
bis 700 MPa	| | |		| |	|	▽▽ x 1,0 TICN x 1,2			
bis 800 MPa	60 45 40		80 65	80	▽ x 0,7			
heat-resistant					0,02	0,04	0,06	0,10
bis 650 Mpa	70 60 45		90 80	90	▽▽▽ x 1,3			
bis 850 MPa	| | |		| |	|	▽▽ x 1,0 TICN x 1,2			
über 850 MPa	35 30 25		55 50	55	▽ x 0,7			
cast iron					0,03	0,06	0,10	0,16
bis 200 HB	140 120 90	160 130 100		600 500	▽▽▽ x 1,3 TIN x 1,2			
bis 250 HB	| | |	| | |		| |	▽▽ x 1,0 TIALN x 1,2			
bis 320 HB	90 75 80	100 90 70		450 400	▽ x 0,7			
Al-alloys					0,03	0,05	0,08	0,12
pure Al	400							
Si max.6 %	250				▽▽▽ x 1,3			
Si 7-12 %	200				▽▽ x 1,0 TIALN x 1,2			
Si over 12 %	150				▽ x 0,7			
Mg-alloys	250							
Ti-alloys	30 - 75		45 - 90		0,01	0,03	0,05	0,08
Cu-alloys	150 120 90				0,02	0,04	0,06	0,08
brass, bronze	200 160 120				0,01	0,03	0,05	0,08
plastics					0,02	0,04	0,06	0,08
thermoplastics	100							TIALN x 1,2

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The essential pre-conditions for the stable cutting are continuous and unrestricted chip flow and sufficient cooling of the tool. The cutting depth in the slot should not exceed the half of the tool diameter. The value of the cutting depth should be reduced with increasing depth of the slot. The high-speed cutting requires the suitable machine tools with the sufficient stiffness, accuracy of the spindle bearings and the optimal range of turning speeds and feeds.

12. Essential Information about High-Speed Cutting

The principle of the high-speed cutting consists in machining by means of small diameter tools at high feed rates and optimal cutting speeds. The tool diameters range from 1 to 20 mm and the material removal rate U is characterized for milling by following formula

$$U = s_z \cdot z \cdot n \cdot h \quad [mm^3.min^{-1}] \qquad (1)$$

s_z - feed per tooth [mm]
z - number of teeth of the cutter [-]
n - turning speed of the cutter [min^{-1}]
h - cutting depth [mm]

Material removal rate according to the 1kW of the spindle input power for following materials is equal to:

- steel 10 - 20
- non-ferrous metals 40
- Al and Al-alloys [$cm^3.min^{-1}$]
- plastics 80 - 100

The shank cutters made of the finegrained carbide are especially suitable for the high-speed cutting. Jedná se o nástroje především zahraničních výrobců, jako např. JABRO TOOLS, RÜBIG a FORD, které jsou na tuzemském trhu dobře dostupné.

Assortment of the suitable tools:

shank end milling cutters - size range ∅1-∅32 mm number of teeth 3 a 4
slot cutters - size range ∅1-∅32 mm number of teeth 2
shank cutters - size range ∅2-∅20 mm number of teeth 1 a 2
die-sinking cutters - size range ∅1-∅25 mm number of teeth 2 a 4

The tools are straight-fluted or spiral-fluted with various helix angles. The suitable coatings TiN, TiCN or TiAlN improve the properties of the tools for the high-speed cutting. The recommendations for the optimal use are included in every catalogue.

Assortment of Bodies - Taper Shanks

Code	Taper	Standard	Cooling	L [mm]	[kg]	A [mm]	d_1 [mm]	
242.118	ISO 40	DIN 69871 ČSN 220434	A, AD + B	193	8,4	65	18	■
242.125	ISO 50		A, AD + B	191	10,7	85/110	18	■
242.224	ISO 40	ČSN 220432	A, AD	186	8,6	65	18	□
242.231	ISO 50		A, AD	182	10,4	85/110	18	□
242.194	CAT 40		A	193	8,4	62÷110	14÷18	□
242.200	CAT 50		A	191	10,7	62÷110	14÷18	□
242.163	MAS BT-40		A	186	8,6	62÷110	14÷18	□
242.170	MAS BT-50		A	194	11,5	62÷110	14÷18	□
242.170	MAS BT-50		A	194	11,5	62÷110	14÷18	□

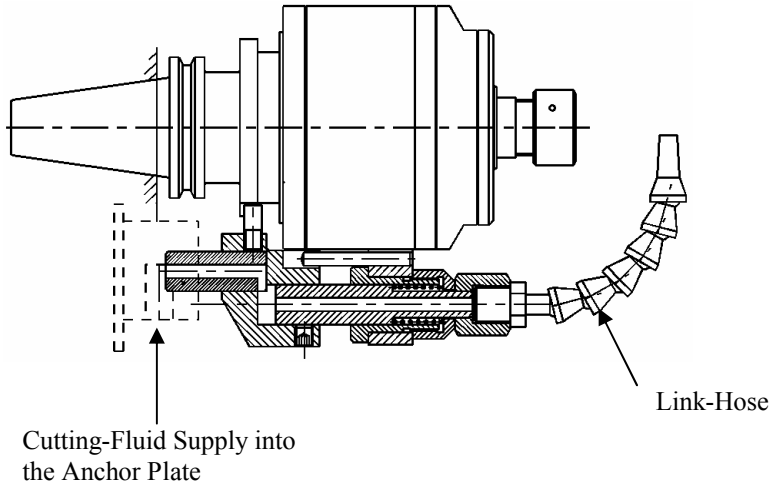
■ Primary Offer □ for Demand

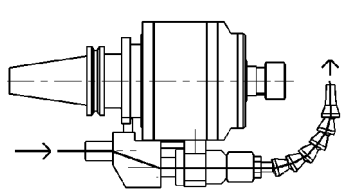
Alternatives of the cutting-fluid application system:

1. External supply (similar to the hand operated modification)
2. Bypass of the spindle speeder through the arresting device
3. Internal supply through the spindle-speeder and the tool

The basic alternative is the modification according to the point 2. The cutting-fluid is supplied to the anchor plate screwed on the milling head of the machine. The sprung pin of the arresting device is engaged in this anchor plate. The cutting-fluid flows through the arresting device and the link-hose to the cutting tool.

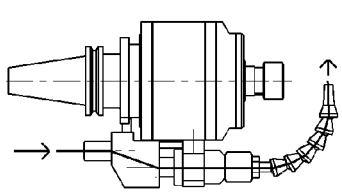
Fig.5





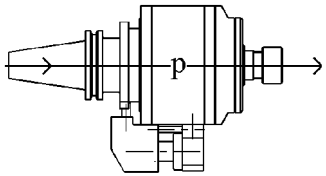
External supply

Typ **A**



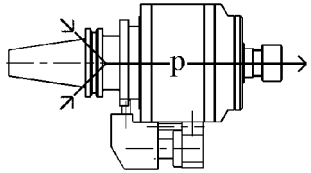
Bypass of the spindle speeder through the arresting device

Typ **AD**



Internal supply through the spindle-speeder and the tool

Typ **B**



Internal supply through the spindle-speeder and the tool

Description of the Arresting Device

Arresting device of the spindle-speeder adapted for the automatic tool change has two basic functions except for the cutting-fluid supply.

1. function - locking the position of the gear box against the milling head of the machine (preventing the gear box from rotating).

This function is realized by the sprung pin engaging in the hole of the anchor plate screwed on the milling head of the machine.

2. function - locking the position of the taper shank or the collar for the automatic tool change respectively against the sprung pin.

This function is realized by the swivel ring "K", placed below the collar of the taper shank and by the screw screwed normally in the sleeve of the sprung pin, perpendicular to its axis. In the working position this screw is outside the swivel ring and cannot rotate. In the rest position the spindle-speeder is removed from the spindle and the screw is pushed by the spring against the slot in the face of the ring. The ring has to be turned so that the screw may engage in the lock and thus may lock the position of the ring. (Fig. 6).

9. Maintenance

The maintenance of this device consists in the keeping of the operating mode, keeping the function parts clean especially the taper shank, collet chuck and arresting device and also in their corrosion prevention. The dirt and corrosion negatively affect the accuracy and reliability of the spindle-speeder.

The manufacturer does not recommend to dismantle this device by the user for the possibility of the incompetent repair contributing to the increase of the radial run-out of the spindle or to its seizing.

10. Accessories

The spindle-speeder is delivered to the user in the wooden box with following accessories:

1. Open end wrench 27 DIN 894
2. Open end wrench 30 DIN 894
3. The spring collets individually ordered by the user according to the Tab. 2 on the 9th page.

The arresting device is the integral part of the spindle-speeder.

11. Order of the Spindle-speeder

It is necessary to specify the code number characterizing all important data according to the Fig. 1 and 2 with needful tables as well.

In the order of the modification for the automatic tool change specify the parameters A and d1 of the arresting device (Fig.6).

The spring collets are ordered according to the code number as a special item.

8. Operating Mode

Although this device is manufactured high precisely, it is necessary to pay attention to its running-in for preventing of troubles such as a higher noise or increasing of temperature etc.

Running-in Directions:

I. Period - input speed 500 rpm, running time 2 h

II.Period - input speed 800 - 900 rpm, running time 5 h, without loading

III.Period - input speed 1600 - 1700 rpm, running time 10 h, without loading

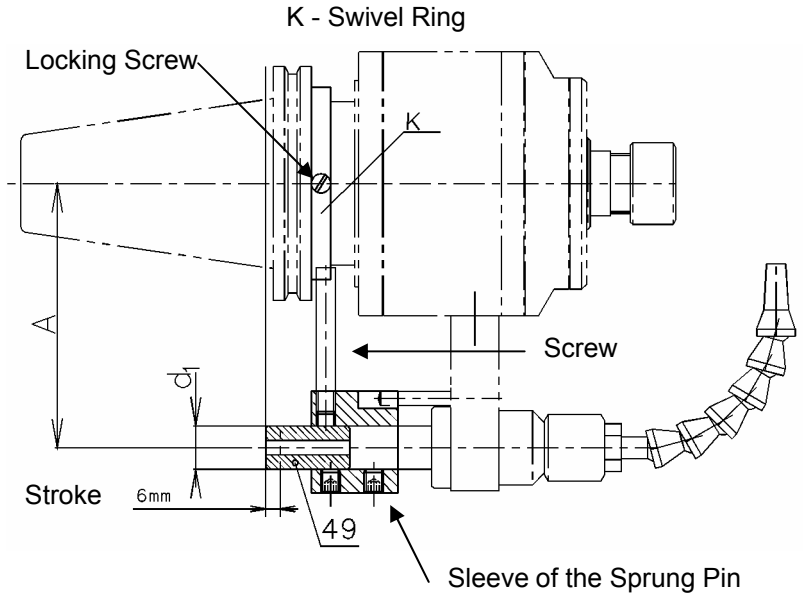
Directions for Use:

Running-in of this device is the important pre-condition for its operation. We recommend this obligatory operating mode for the first 500 hours.

Output Speed (rpm)	Operation Time (min)	Pause (min)
16000 - 20000	15	30
12000 - 16000	30	30
do 12000	60	30

The operating mode has to be adapted for reaching of the warranted service life. The temperature can increase up to the maximum of 60°C. The warranty of the service life is derived from the load capacity of the bearings and from the life of the lubricating grease. We recommend to check the spindle-speeder and refill the lubrication grease after 2500 hours of operation. The manufacturer offers this service.

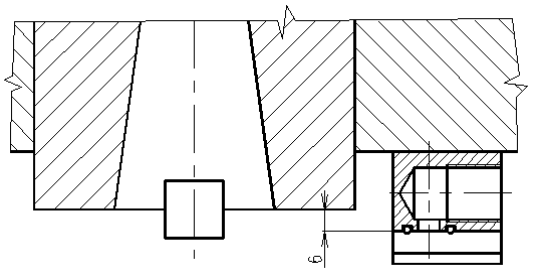
Fig.6

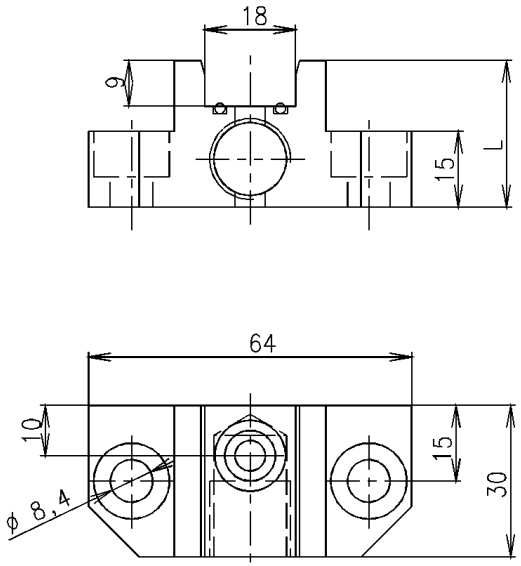


6. Clamping of the Device on the Machine Tool

The device is clamped by means of the taper shank in the machine spindle. Clean contact surfaces make possible reaching the prescribed accuracy i.e. the radial run-out of the cutting tool chucked in the spindle-speeder. Every damage of the taper shank or of the spindle taper bore deteriorates the centring of the tool. Fixing of the arresting device is the important pre-condition for the safe and smooth running of the spindle-speeder. The arresting pin has to be supported backlash-free from both sides. The design of the anchor plate is represented on the fig. 7

Fig.7





7. Chucking of Cutting Tools

Cutting tools - drills or shank cutters- are chucked by means of the straight shank in the collet chuck of the high-speed spindle. The chucking capacity of the collets type ER20 is specified in the table. The basic series of collets are delivered commonly, the supplementary series are delivered as a special accessories for the comparatively higher selling price.

Method of Chucking:

Screw off the nut of the collet chuck, insert the suitable collet in this nut and screw on both parts on the thread of the high-speed spindle. Insert the cutting tool (drill or shank cutter) in the collet and tighten reasonably the nut. Control the uniform clamping of the collet and the tool as well, subsequently tighten the nut by means of two wrenches (size 27 and 30) and control the radial run-out of the tool.

If the value of the radial run-out is over the limit, loosen the nut slightly, turn the collet with the tool through 90 degrees and retighten the nut. Even though the taper bore of the chuck and the collet are machined accurately still the precise chucking demands a certain skill and patience for achieving of the warranted accuracy (see Tab. 2). The perfect clean contact surfaces are the important pre-condition for the precise chucking at any time.

Attention!

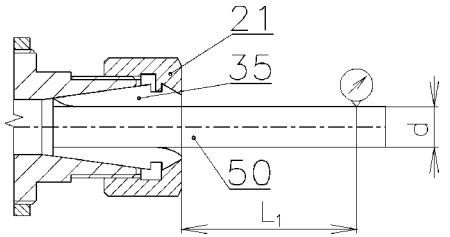
Don´t use the mallet for tightening or loosening of the nut, don´t strike on the wrench!

Table No.2

Offer of the Collets Type ER20

Chucking Capacity [mm]	Code	Chucking Capacity [mm]	Code
1,0 – 0,5	281.803	11,0 – 10,0	281.520
1,5 – 1,0	281.810	12,0 – 11,0	281.537
2,0 – 1,5	281.827	13,0 – 12,0	281.544
2,5 – 2,0	281.834		
3,0 – 2,5	281.841		
3,5 – 3,0	281.858		
4,0 – 3,5	281.856		
5,0 – 4,0	281.872		
6,0 – 5,0	281.889		
7,0 – 6,0	281.896		
8,0 – 7,0	281.902		
9,0 – 8,0	281.919		
10,0 – 9,0	281.926		

Accuracy of the Tool Chucking



21 – Nut
35 – Collet
50 – Measuring Pin

d [mm]		L_1 [mm]	MAX ↗ [mm]
MIN.	MAX.		ER 20
1,0	1,6	4,0	0,02
1,6	3,0	7,5	
3,0	6,0	15	
6,0	10,0	25,0	
10,0	13,0	32	0,025