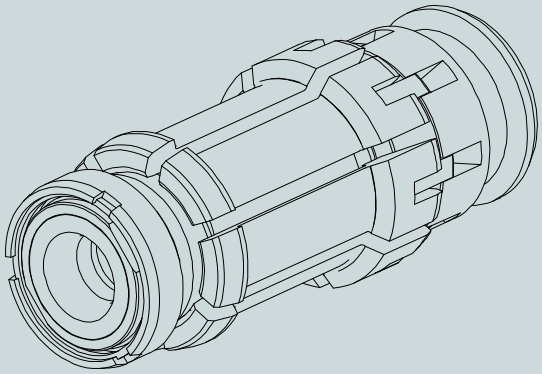
PRODUCT INFORMATION

OTT JAKOB Spanntechnik

CLAMPING UNIT

HSK-C



LONG-LIFE CLAMPING TECHNOLOGY INSIDE

HSK-C_PE_2017-04 // ENGLISH

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JAKOB GRUPPE

TABLE OF CONTENTS

symbol explanation:

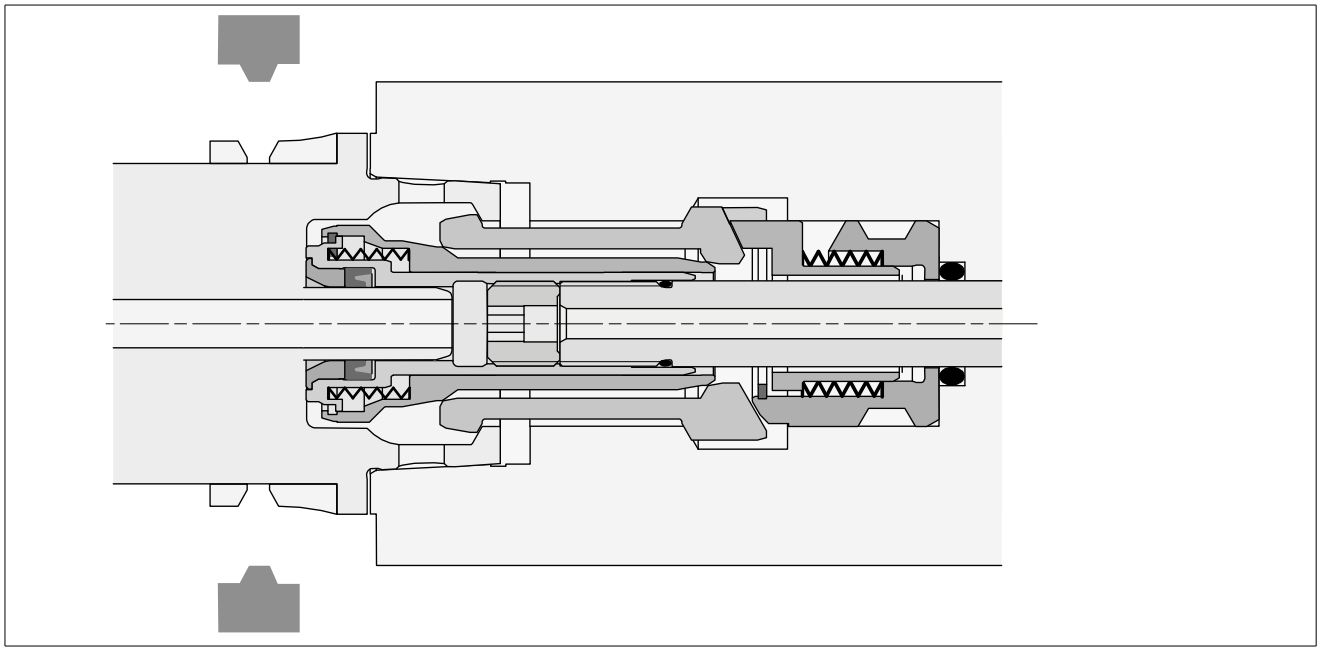
keep attention - dangerous!

keep attention - malfunction!

1 PRODUCT DESCRIPTION

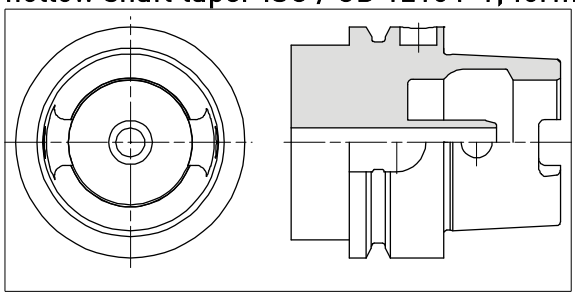
1.1 FEATURES

- Positive tool lock and parallel moving segments
- surface contact and high life expectancy
- high static and dynamic stiffness due to amplified force
- central coolant supply
- holding of the tool before and after clamping



1.2 STANDARD

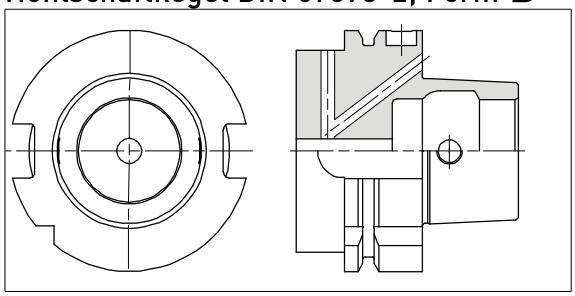
hollow shaft taper ISO / CD 12164-1; form A



features:
- central, axial coolant supply with KSM-tube
- keyways at the taper end

application:
- Bearbeitungszentren, Fräsmaschinen

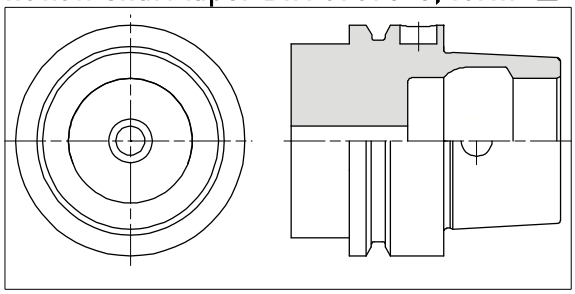
Hohlschaftkegel DIN 69893-2; Form B



features:
- decentralized coolant supply over the flange or central coolant supply through coolant tube
- enlarged flange
- keyways at the flange

application:
- machining centers, heavy milling machines

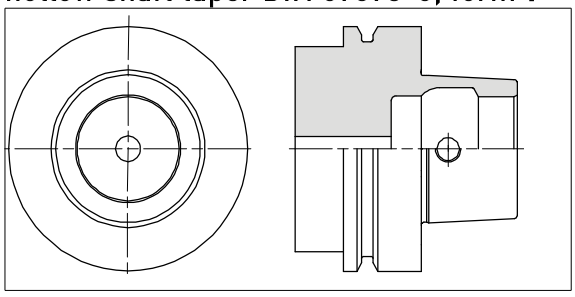
hollow shaft taper DIN 69893-5; form E



features:
- rotational symmetry without keyways

application:
- HSC-spindles

hollow shaft taper DIN 69893-6; form F



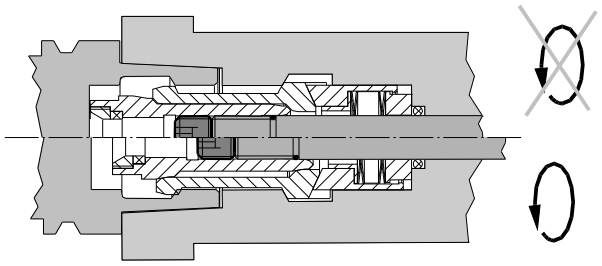
features:
- enlarged flange

application:
- HSC-spindles e. g. machining of wood and plastic

1.3 MEDIUM TRANSFER

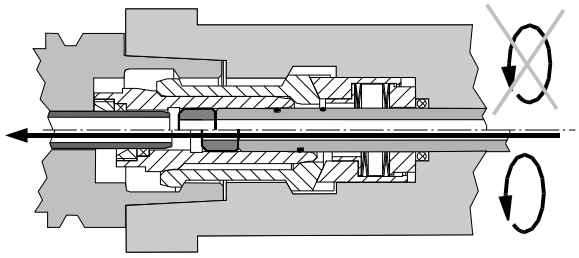
1

without transfer



2

axial transfer for open HSK-tool

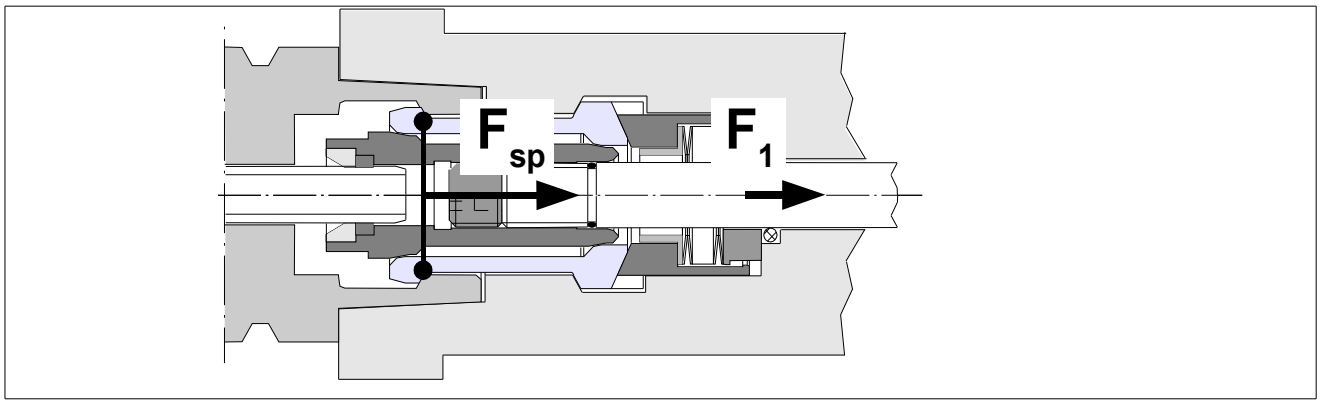


1.4 CEILING SPEED

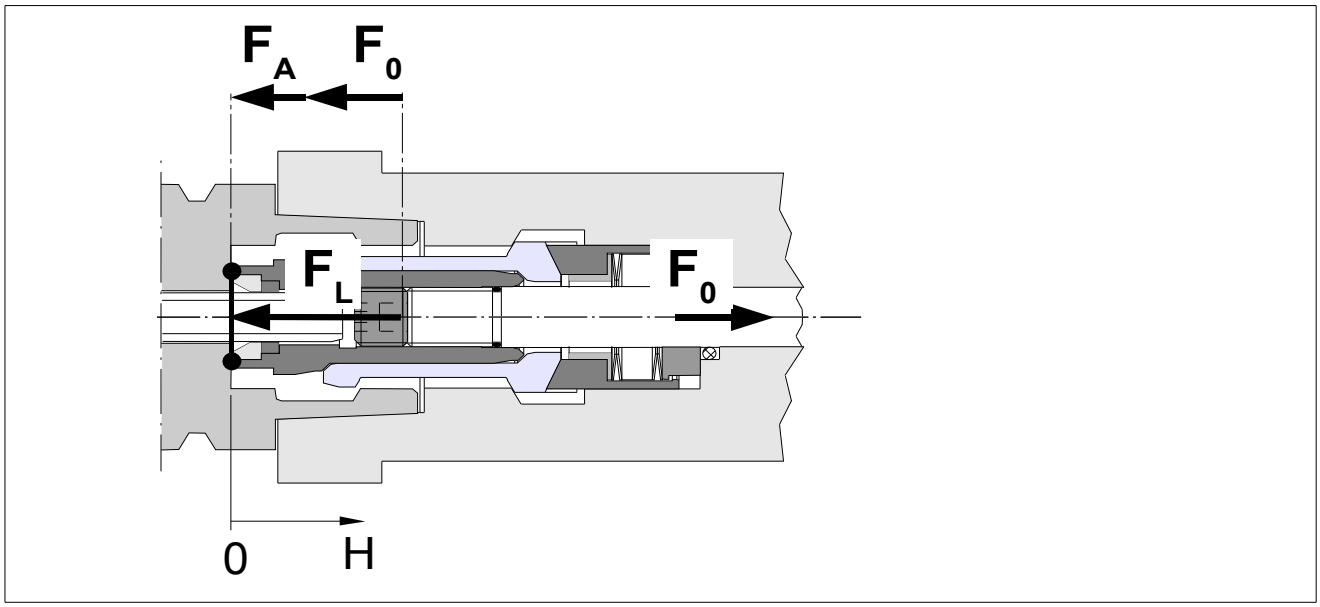
		nominal size						
		32	40	50	63	80	100	
tool standard	A	57294	45989	37336	27201	20897	15466	min-1
	B	-	46787	33115	25535	19223	14698	
	E	57279	45728	39367	32691	-	-	
	F	-	-	39170	31262	22967	-	

1.5 FORCES AT THE HSK-CLAMPING UNIT

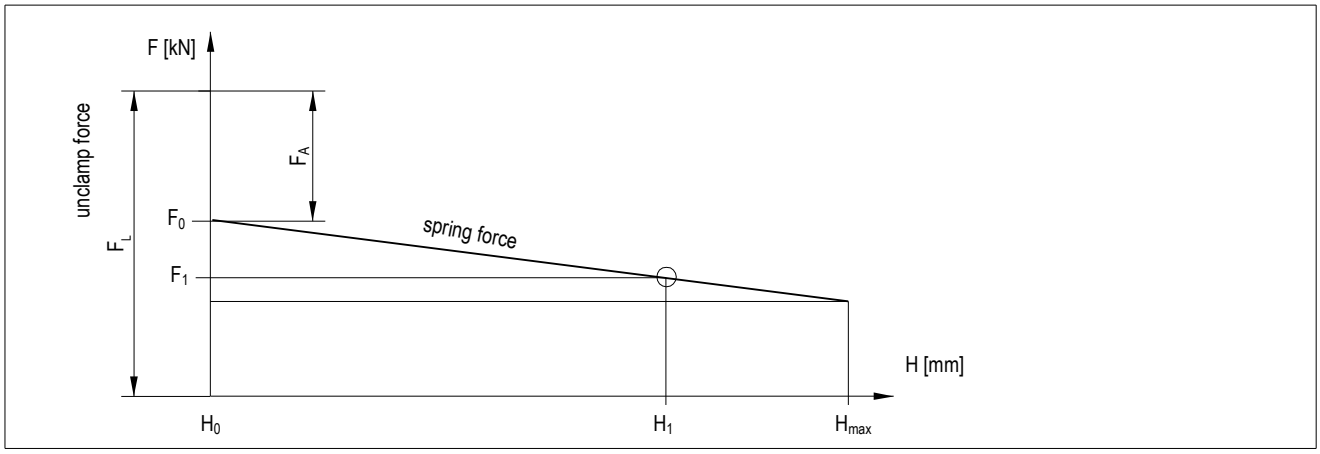
1.5.1 Clamped position



1.5.2 Unclamped position



1.5.3 Diagram



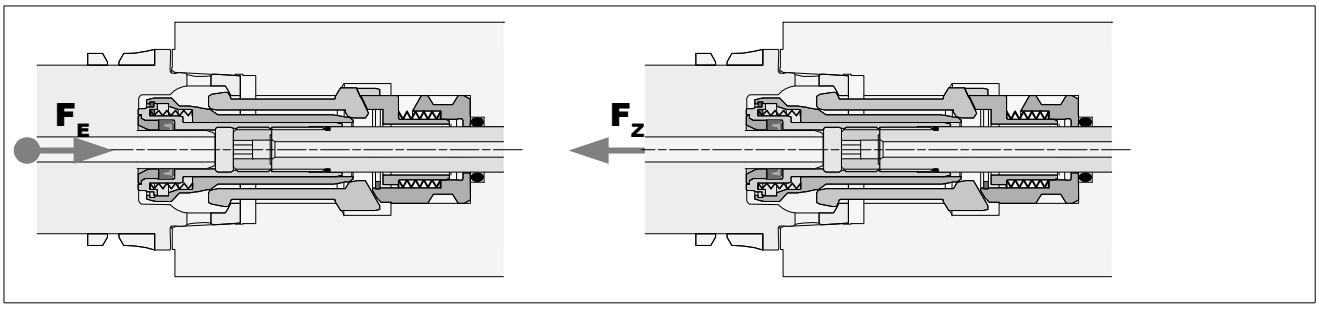
1.5.4 Force Table

			nominal size						
			32	**40**	**50**	**63**	**80**	**100**	
tool standard	**A**	F_{sp}	5	6,8	11	18	28	45	kN
		F_1 max.	1,6	2,15	3,5	5,7	8,9	14,2	
		F_A	0,9	1,3	2,2	3,2	5,2	7	
	B	F_{sp}		5	6,8	11	18	28	
		F_1 max.		1,6	2,15	3,5	5,7	8,9	
		F_A		1	1,7	2,9	4,6	6,9	
	E	F_{sp}	5	6,8	11	18			
		F_1 max.	1,6	2,15	3,5	5,7			
		F_A	1,1	1,7	2,9	4,7			
	F	F_{sp}			6,8	11	18		
		F_1 max.			2,15	3,5	5,7		
		F_A			1,9	3,4	5,6		

1.5.5 Transferable torque

		nominal size							
		32	40	50	63	80	100		
tool standard	A	14	24	48	97	190	365	Nm	transferable torque without keyways
	B	-	16	28	55	113	217		
	E	15	27	56	110	-	-		
	F	-	-	31	64	128	-		

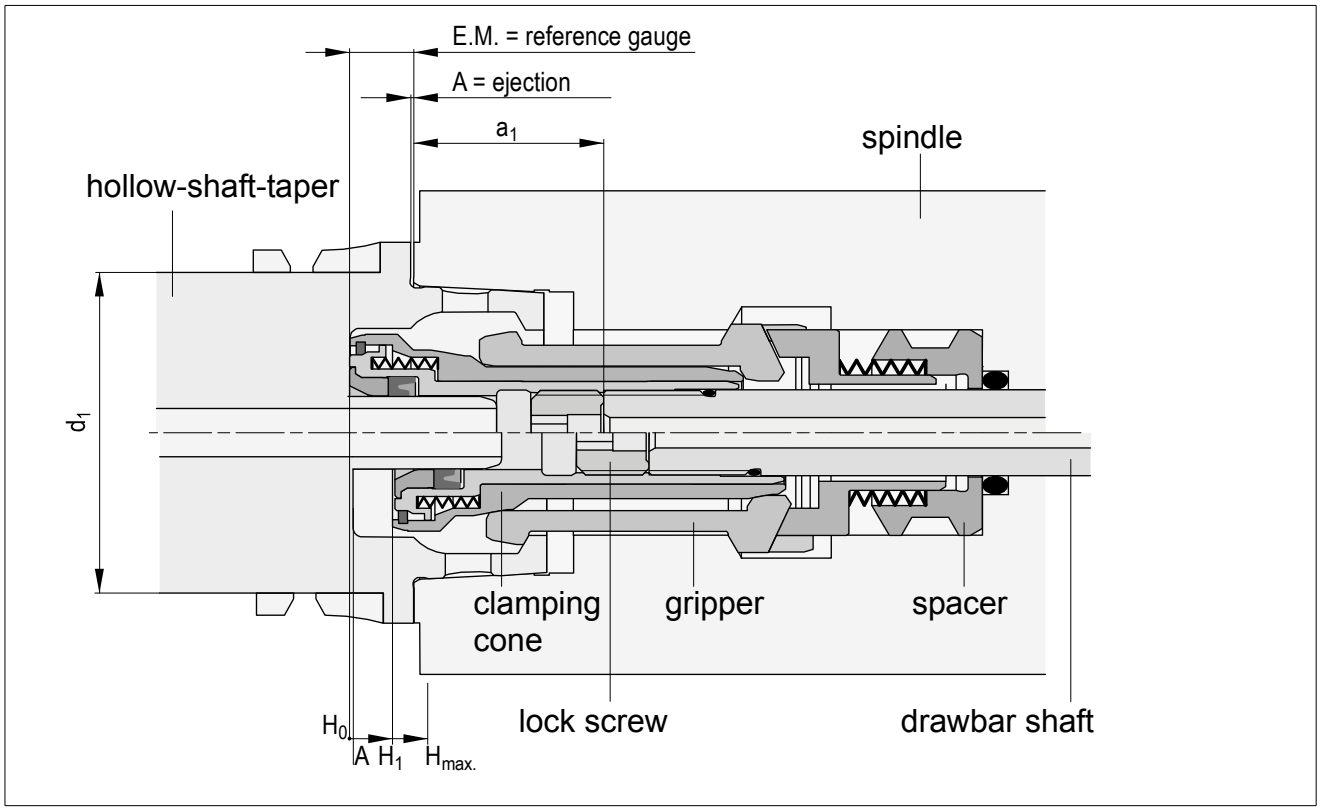
1.5.6 Push-In-Force / Pull-Out-Force



nominal size d_1	push-in-force F_E [N]	pull-out-force F_Z [N] +/- 25 %
A32	~ 25	~ 100
A40	~ 40	~ 120
A50	~ 60	~ 250
A63		~ 100
	~ 40	~ 200
	~ 60	~ 270
	~ 70	~ 340
	~ 80	~ 400
		~ 550
A80	~ 90	~ 300
	~ 67	~ 200
A100	~100	~ 300
	~180	~ 500

1.6 DIMENSION

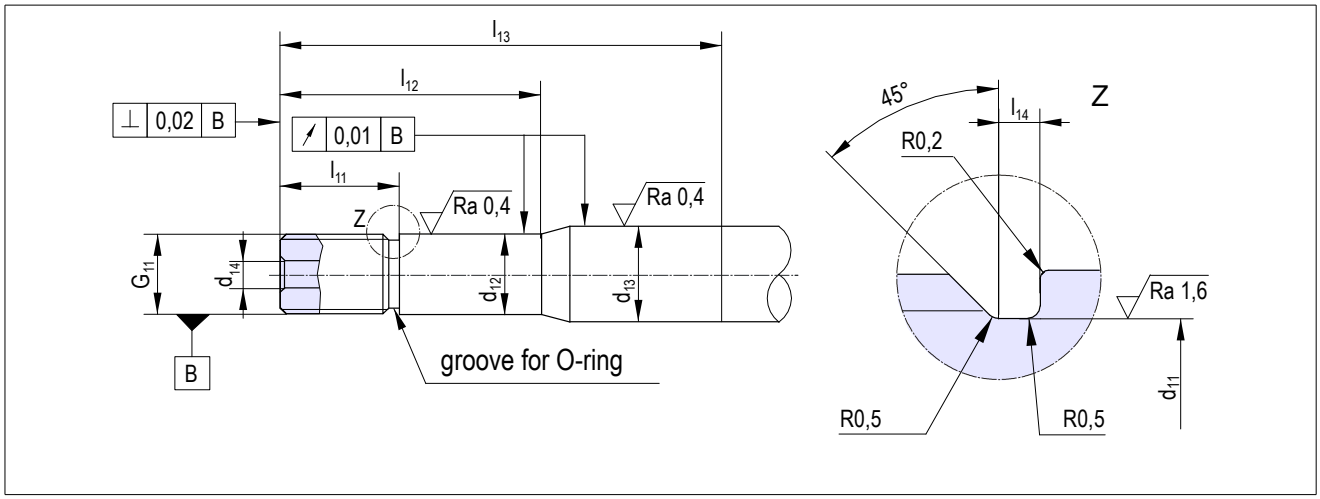
1.6.1 Clamping Unit



	d_1 form A	**32**	**40**	**50**	**63**	**80**	**100**
	d_1 form B	**40**	**50**	**63**	**80**	**100**	**125**
	d_1 form E	**32**	**40**	**50**	**63**		
	d_1 form F		**50**	**63**	**80**		
[mm]	**A**	0,5	0,5	0,5	0,5	0,5	0,5
	E.M. ±0,1	8,5	8,5	10,5	10,5	13	13
	$H_{max.}$	7,5	8	9	10	11	12,5
	H_1	5,1	5,6	6,4	7,4	8,3	9,15
	SW_1	12	15	18	24	27	36
	SW_2	3	4	4	5	6	6
	a_1	19,5	27	26,5	31,5	31,5	34,5

(Information about form A / form B / form E / form F ⇨ # 1.2 // 5)

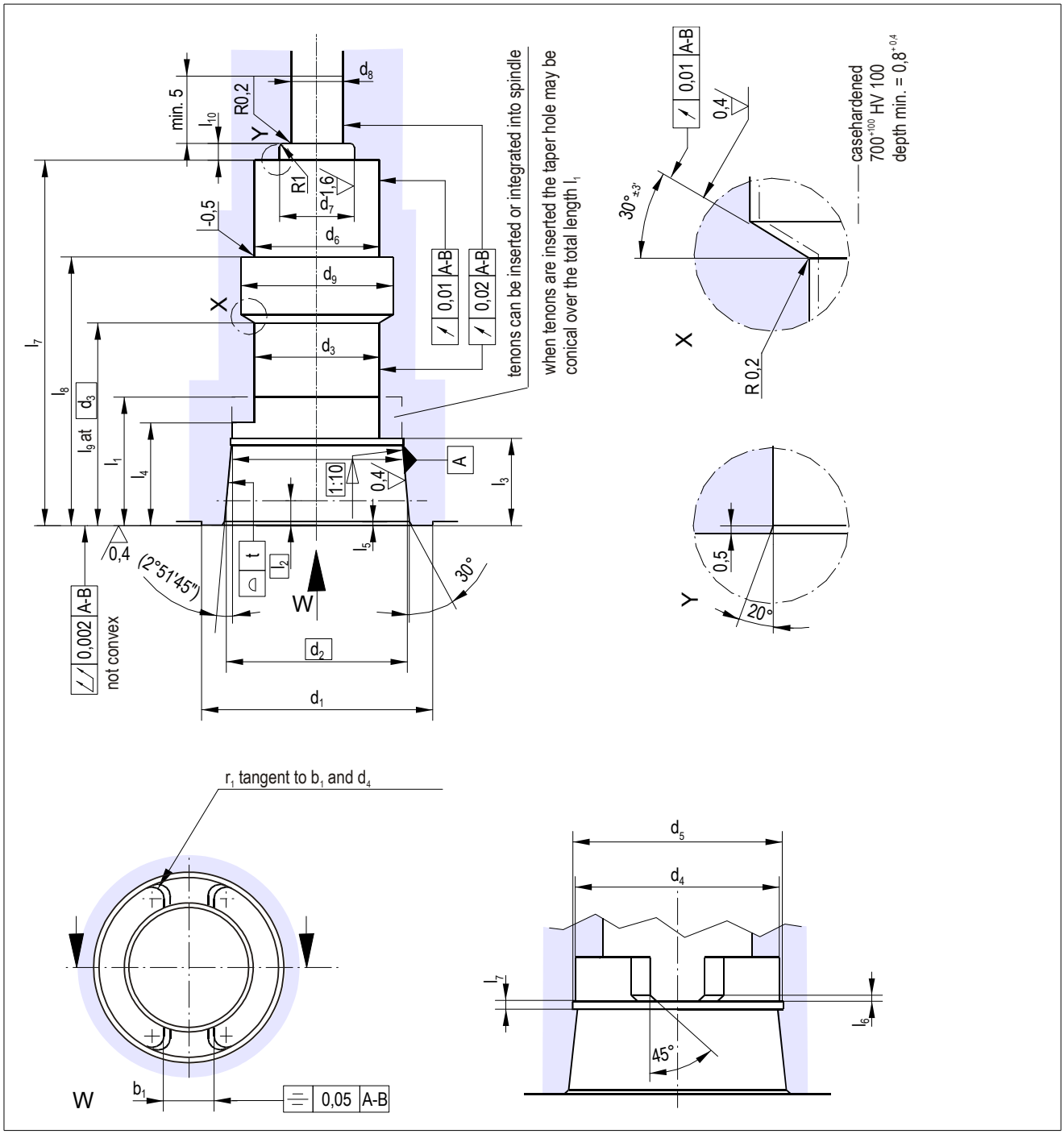
1.6.2 Drawbar



	d_1 form A		32	40	50	63	80	100
	d_1 form B		40	50	63	80	100	125
	d_1 form E		32	40	50	63		
	d_1 form F			50	63	80		
[mm]	d_{11}	-0,1	4,6	6	7,9	11,9	13,9	13,9
	d_{12}		$6,2_{g7}$	$8,2_{g7}$	$10,2_{g7}$	$14,2_{g7}$	$16,2_{g7}$	$16,2_{h8}$
	d_{13}		-	-	-	-	-	18_{g7}
	d_{14} max.		2,5	3	4	5	6	6
	G_{11}	-4g	M6	M8	M10	M14x1,5	M16x1,5	M16x1,5
	l_{11}		9	14	16	18,5	21,5	32
	l_{12}		50	60	67	76	80	50
	l_{13}		-	-	-	-	-	101
	l_{14}		$1^{+0,1}$	$1,4^{+0,1}$	$1,4^{+0,1}$	$1,4^{+0,1}$	$1,4^{+0,1}$	$1,4^{+0,1}$

For information only; not a manufacturing drawing!

1.6.3 Spindle inside contour HSK form A



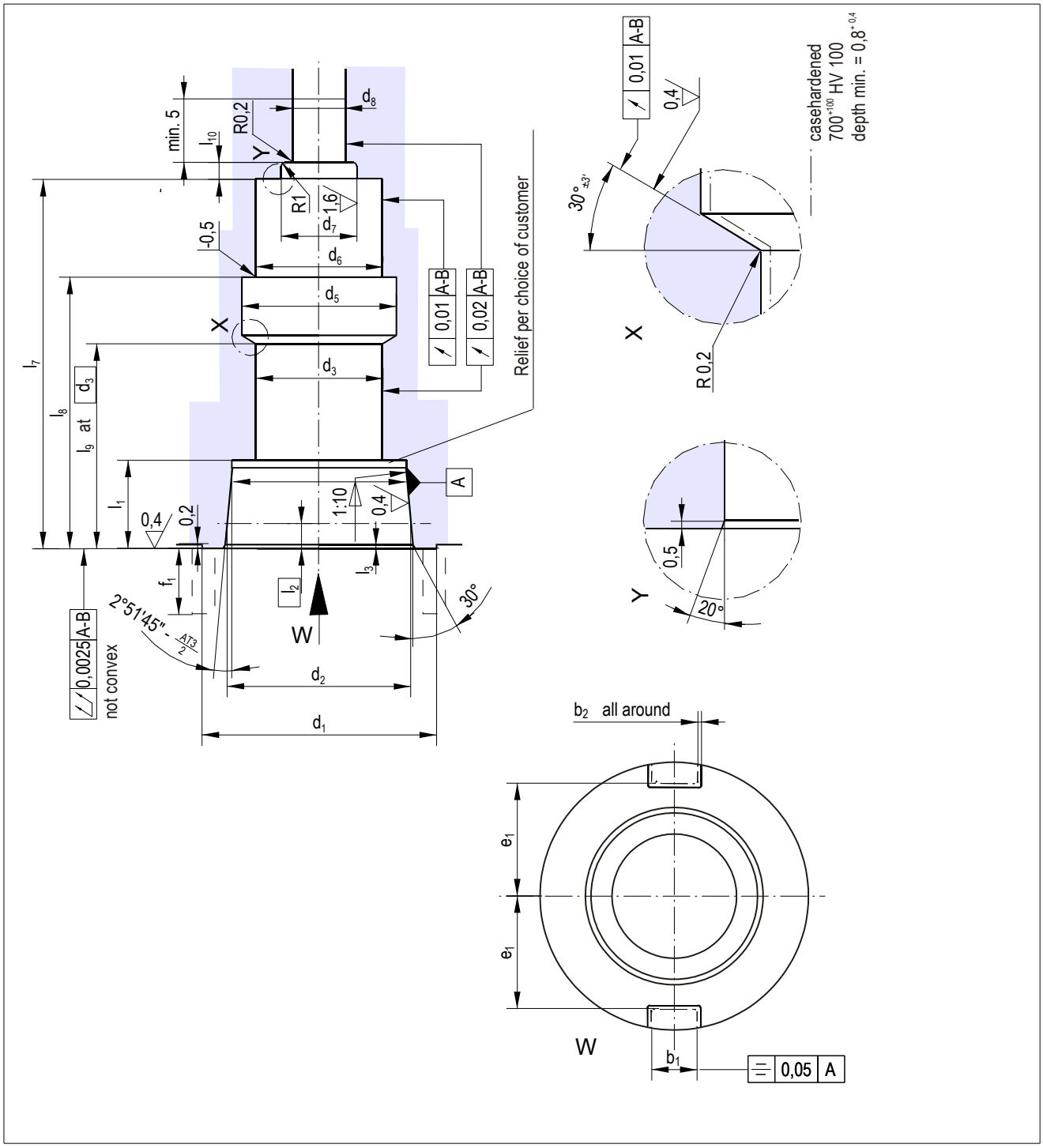
		d_1		32	40	50	63	80	100
ISO / CD 12164-2 *	[mm]	b_1	±0,05	6,8	7,8	10,3	12,3	15,8	19,78
		d_2		23,998	29,998	37,998	47,998	59,997	74,997
		d_3	H10	17	21	26	34	42	53
		d_4	+0,1	23,28	29,06	36,85	46,53	58,1	72,6
		d_5	+0,2	23,8	29,6	37,5	47,2	58,8	73,4
		l_1	+0,2	16,5	20,5	25,5	33	41	51
		l_2		3,2	4	5	6,3	8	10
		l_3	+0,2	11,4	14,4	17,9	22,4	28,4	35,4
		l_4	+0,2	13,4	16,9	20,9	26,4	32,4	40,4
		l_5		0,8	0,8	1	1	1,5	1,5
		l_6	+0,1	1	1	1,5	1,5	2	2
		l_7	±0,1	2,0	2,0	2,0	2,5	3,0	3,0
		r_1	-0,05	1,5	2	2,5	3	4	5
		t **		0,0015	0,0015	0,0020	0,0020	0,0025	0,0030
clamping unit	[mm]	d_6	H6	17	21	26	34	42	53
		d_7	+0,1	10,3	13,2	15,2	20,4	22,4	24,2
		d_8	+0,1	6,6	8,6	10,6	14,6	16,6	18,4
		d_9	+0,2	22,5	26,5	33	41,6	50	63
		l_7	-0,2	62,5	78	84	94	98	124
		l_8	±0,1	43	58	61	69	72	93
		l_9	js8 at d_3	30	44	45	52	56	70
		l_{10}	+0,2	3	3,6	3,6	4,2	4,2	4,2

The dimensions in the clamping unit section are for spindle speeds up to 10000 rpm. For higher spindle speeds we recommend to reduce the tolerance of dimension d_8 and the runout. Please let us know if you need additional information.

* see update standard
** see ISO 1101 and ISO 3040

For information only; not a manufacturing drawing!

1.6.4 Spindle inside contour HSK form B



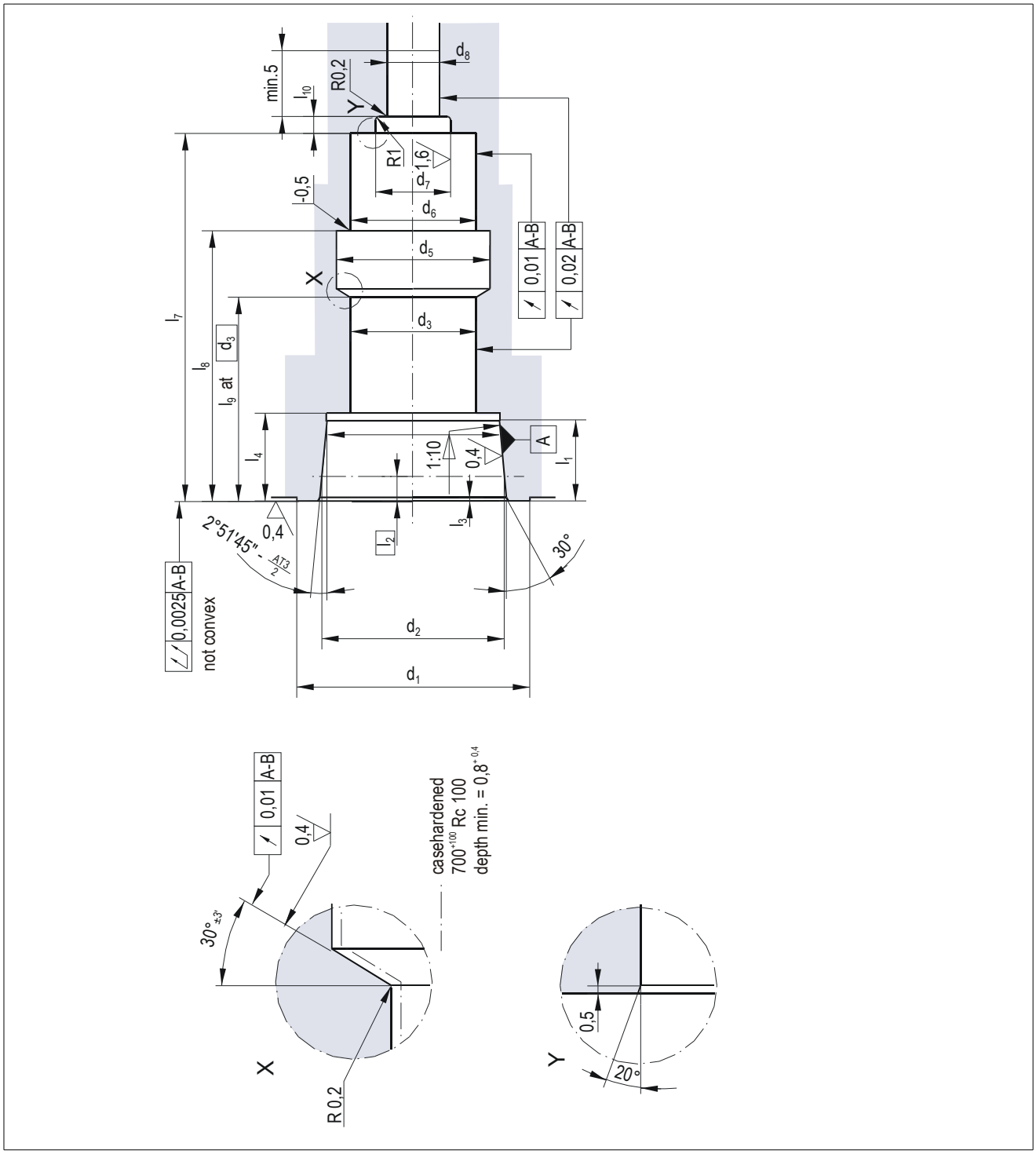
		d_1		40	50	63	80	100	125
E DIN 69063-2 1997-04*	[mm]	b_1	+0,05 -0,05	9,9	11,9	15,9	17,9	19,9	24,9
		b_2		1	1	1	1	2	2
		d_2		24	30	38	48	60	75
				0	0	0	0	0	0
				-0,003	-0,003	-0,004	-0,004	-0,005	-0,006
		d_3	H10	17	21	26	34	42	53
		e_1	+0,2 0	16,2	20,2	25,2	31,7	40,2	50,2
		f_1	max.	19,5	25,5	25,5	25,5	28,5	28,5
		l_1	+0,3 0	16,5	20,5	25,5	33	41	51
		l_2		3,2	4	5	6,3	8	10
		l_3		0,8	0,8	1	1	1,5	1,5
clamping unit	[mm]	d_5	+0,2	22,5	26,5	33	41,6	50	63
		d_6	H6	17	21	26	34	42	53
		d_7	+0,1	10,3	13,2	15,2	20,4	22,4	24,2
		d_8	+0,1	6,6	8,6	10,6	14,6	16,6	18,4
		l_7	-0,2	62,5	78	84	94	98	124
		l_8	±0,1	43	58	61	69	72	93
		l_9	js8 at d_3	30	44	45	52	56	70
		l_{10}	+0,2	3	3,6	3,6	4,2	4,2	4,2

The dimensions in the clamping unit section are for spindle speeds up to 10000 rpm. For higher spindle speeds we recommend to reduce the tolerance of dimension d_8 and the runout. Please let us know if you need additional information.

* see update standard

For information only; not a manufacturing drawing!

1.6.5 Spindle inside contour HSK form E



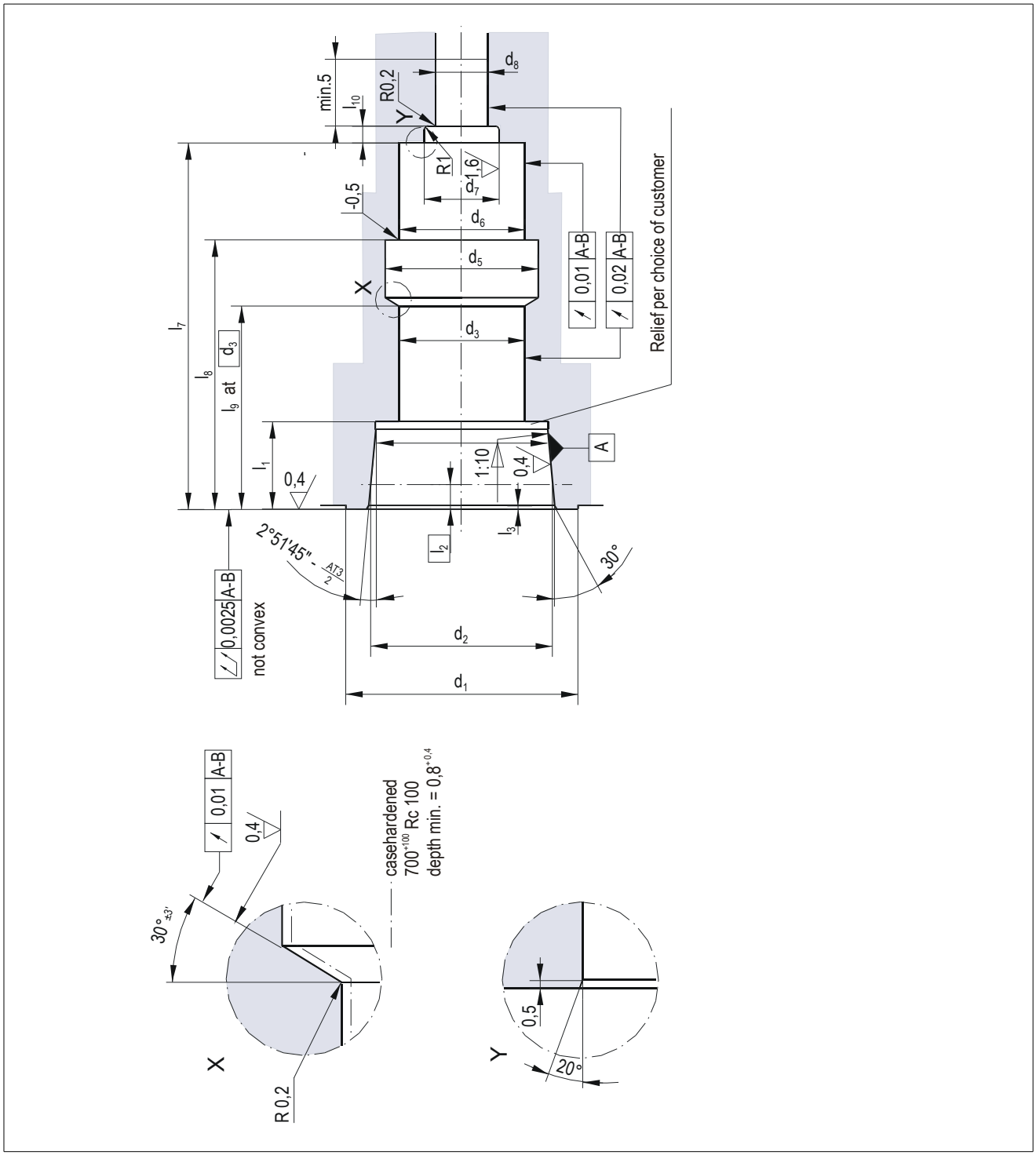
		d_1		32	40	50	63
DIN V 69063-5 1996-01 *	[mm]	d_2		24	30	38	48
				-0,001	-0,002	-0,003	-0,003
				-0,003	-0,004	-0,006	-0,007
		l_1		16	20	25	32
		l_2		3,2	4	5	6,3
		l_3		0,8	0,85	1	1
		l_4		16,5	20,5	25,5	33
clamping unit	[mm]	d_3	H10	17	21	26	34
		d_5	+0,2	22,5	26,5	33	41,6
		d_6	H6	17	21	26	34
		d_7	+0,1	10,3	13,2	15,2	20,4
		d_8	+0,1	6,6	8,6	10,6	14,6
		l_7	-0,2	62,5	78	84	94
		l_8	±0,1	43	58	61	69
		l_9	js8 at d_3	30	44	45	52
		l_{10}	+0,2	3	3,6	3,6	4,2

The dimensions in the clamping unit section are for spindle speeds up to 10000 rpm. For higher spindle speeds we recommend to reduce the tolerance of dimension d_8 and the runout. Please let us know if you need additional information.

* see update standard

For information only; not a manufacturing drawing!

1.6.6 Spindle inside contour HSK form F



		d_1		50	63	80
DIN V 69063-6 1996-01 *	[mm]	d_2		30	38	48
				-0,002	-0,003	-0,003
				-0,004	-0,006	-0,007
		d_3	H10	21	26	34
		l_1	+0,2	20,5	25,5	33
		l_2		4	5	6,3
		l_3	+0,2	0,8	1	1
clamping unit	[mm]	d_5	+0,2	26,5	33	41,6
		d_6	H6	21	26	34
		d_7	+0,1	13,2	15,2	20,4
		d_8	+0,1	8,6	10,6	14,6
		l_7	-0,2	78	84	94
		l_8	±0,1	58	61	69
		l_9	js8 at d_3	44	45	52
		l_{10}	+0,2	3,6	3,6	4,2

The dimensions in the clamping unit section are for spindle speeds up to 10000 rpm. For higher spindle speeds we recommend to reduce the tolerance of dimension d_8 and the runout. Please let us know if you need additional information.

* see update standard

For information only; not a manufacturing drawing!

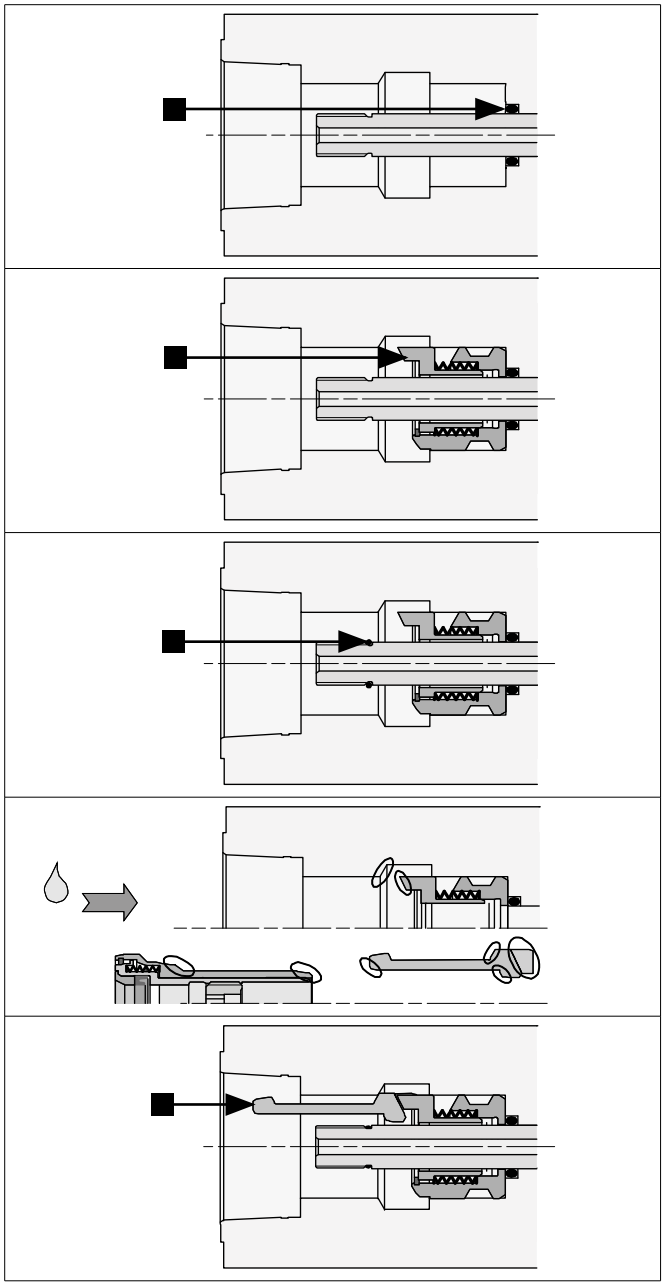
1.7 ORDER NUMBER

clamping unit	pull-out-force	order number
HSK A32 C	100 N	95.600.155.2.6
HSK A40 C	150 N	95.600.065.2.6
	230 N	95.600.065.2.6 V01
HSK A50 C	250 N	95.600.150.2.6
HSK A63 C	400 N	95.600.052.2.6
	200 N	95.600.052.2.6 V01
	270 N	95.600.052.2.6 V02
	100 N	95.600.052.2.6 V03
	550 N	95.600.052.2.6 V04
	340 N	95.600.052.2.6 V05
HSK A80 C	300 N	95.600.053.2.6
	200 N	95.600.053.2.6 V01
HSK A100 C	300 N	95.600.057.2.6
	500 N	95.600.057.2.6 V01

2 ASSEMBLY

2.1 CLAMPING UNIT HSK-C

- Clean spindle inside contour
- make sure that edges are properly rounded
- grease O-rings



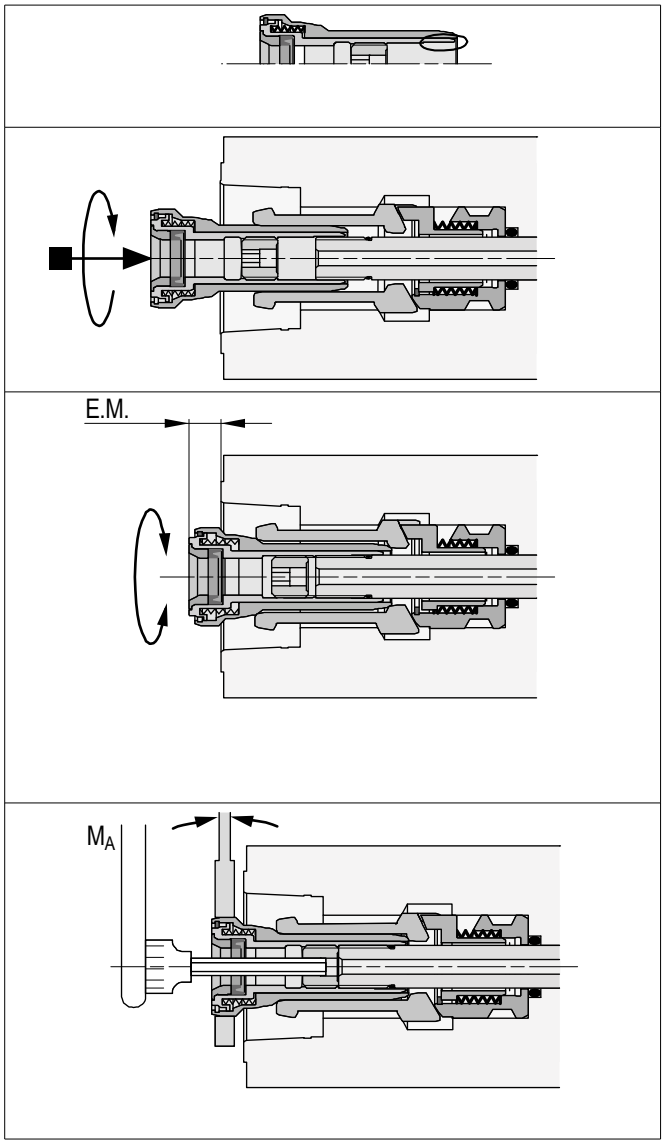
- mount o-ring in the spindle

- grease spacer with mounting grease
- push spacer into spindle and check for ease of movement

- mount o-ring on the drawbar
  Protective sleeve obtainable:
  HSK A 63: 95.601.169.4.1

- grease area of contact
  ➔METAFLUX-Paste 70-8508
  or
  ➔KLÜBER-Paste ME 31-52
  do not mix the grease!

- snap gripper segments in the spacer; ensure that the numbers match



- grease clamping cone with mounting grease

- screw clamping cone (pre-assembled with seal, protective sleeve and lock screw) on to the drawbar shaft at maximum to the setting dimension; do not continue to turn since otherwise the o-ring on the drawbar shaft will be damaged!

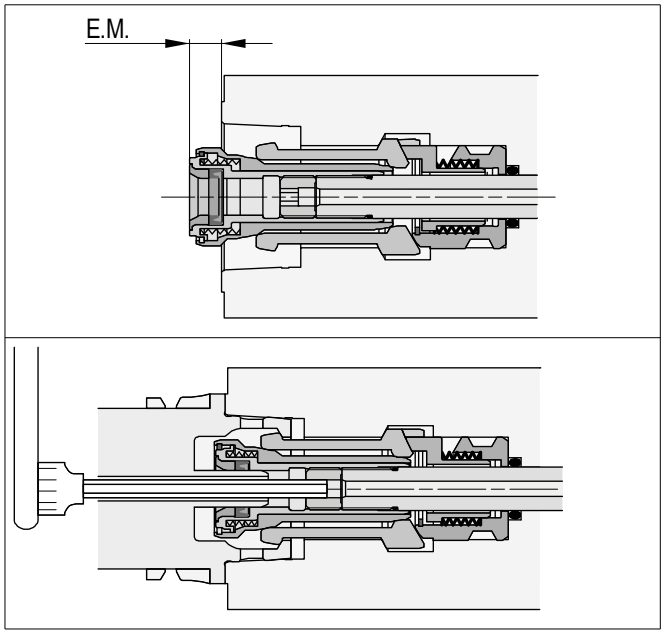
in unclamped position:
- adjust gauge dimension E.M.

gauge dimension:
- A32 / B40 / E32: 8,5 mm
- A40 / B50 / E40 / F50: 8,5 mm
- A50 / B63 / E50/ F63: 10,5 mm
- A63 / B80 / E63 / F80: 10,5 mm
- A80 / B100: 13 mm
- A100 / B125: 13 mm

- tighten the lock screw

tightening torque:
- A32 / B40 / E32: 10 Nm
- A40 / B50 / E40 / F50: 15 Nm
- A50 / B63 / E50/ F63: 20 Nm
- A63 / B80 / E63 / F80: 30 Nm
- A80 / B100: 30 Nm
- A100 / B125: 50 Nm

2.1.1 Check after approx. 100 strokes



In unclamped position

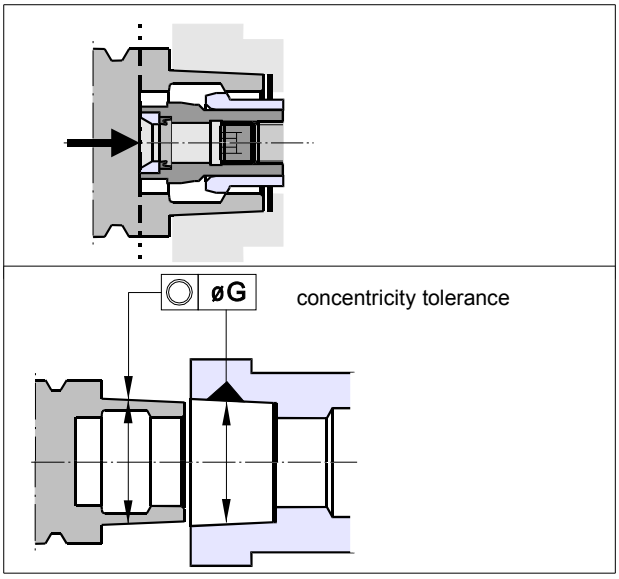
- Check dimension gauge E.M.

- re-tighten through a clamped tool

3 OPERATION

No rotation without clamped tool!
Only use technically perfect tools!

3.1 TOOL INSERTING



Do not insert tool into the spindle taper when rotating!
The tool has to be inserted all the way to the plane surface of the clamping cone to prevent misclamping!

Our recommendation for the concentricity tolerance for tool changing as well as the maximum force on the plane surface on the clamping cone is shown in the table below:

standard size	E 25	A 32 B 40 E 32	A 40 B 50 E 40 F 50	A 50 B 63 E 50 F 63	A 63 B 80 E 63 F 80	A 80 B 100	A 100 B 125	A 125 B 160	A 160
concentricity (øG) [mm]	0,6	0,7	0,7	0,8	0,8	1,0	1,0	1,0	1,2
tool changer force max. [kN]	1	1	1,4	2,2	3,6	5,6	9	9	9

3.2 OPERATING CONDITIONS

- Avoid additional stress contributed to force from brackets or any other connection and or support, proximity switches
- impact loads < 25 g
- the spring must be protected against corrosive media and dirt exposure
- the tool interface must be free of chips and substantial cooling lubricant residue
- allowable temperature 10° C (on the inside of the spindle)

3.3 INTERN COOLING SUPPLY

- Because of possible damage at the coolant tube interface (tube/seal) we recommend drainage holes in the tool interface area
- during installation of tool:
  pressure in clamp chamber p < 0,5 bar
- In order to minimize wear, the coolant tube at the interface of the gripper assembly and tool should be shaped as follows:
  - minimum and easy going and angular flexing (per ISO 12164-1)
  - ground
- Operation with coolant is only permitted if free flow is guaranteed. Therefore, you must only use tool holders with coolant tubes and tools with coolant thru holes. Otherwise, it is possible that the spindle gets flooded or the seals are damaged by the pressure spikes.

3.4 COOLANT

Guidelines and technical specifications for the coolant use in the machine:

Coolant use must conform to the current regulations of the legislation and the professional association.

Our products are to the greatest possible extent protected by the materials used or by means of a passivated surface against corrosion and therefore suited for use with water. The rate of corrosion is strongly dependent on the contents of the media (e.g. chlorine is very much increasing the rate of corrosion), as well as the environment in which the products are being operated (e.g. the difference in electrical potential between rotor and stator in spindles).

Suitable protective measures such as the utilization of corrosion inhibitors will extend the service life in every way.

Furthermore, you must only use coolants which conform with the specs listed on the table below.

Parameter / test procedure	Limited values
Corrosion protection according to DIN 51360 section 2	No corrosion after 2 hours
Elastomer compatibility	No change of the shore hardness and/or the elongation OTT-JAKOB applies FKM (VITON®)
Nonferrous metal compatibility	No corrosion on copper, brass and aluminum parts
Glue residue after slow evaporation at 50 degrees	Non sticky! No residue! Easily removable.

3.5 GENERAL

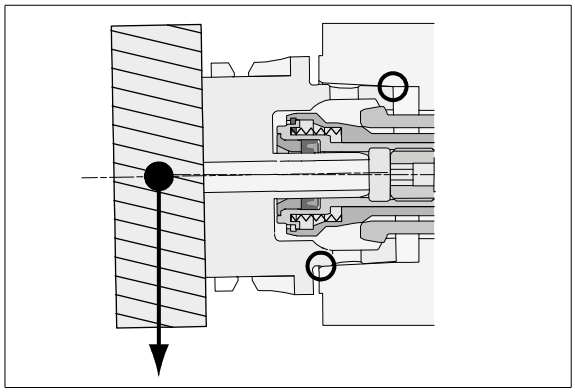
- Recommendation: install a limit switch for the drawbar
- Follow maintenance intervals!

3.6 HOLDING FUNCTION

The Power Drawbar features a holding function for the tool. When the power drawbar is positioned for tool change, the tools are held by a specified force in the tool change position. With automatic tool changing, the tool changer must be rigidly designed to withstand the tool pull forces.

Forces occurred by acceleration in the different axis, as well as, the cleaning process using air or coolant, could be greater than the holding forces developed by the drawbar and could push out the tool. Therefore, make sure that the external forces are smaller than the actual holding forces.

Especially quick acting ejecting cylinders accelerate the tool so much that the holding function of the power drawbar could be overcome. The adjustments for the unlocking function must also suit this situation. For vertical tool change, the weight of the tools must also be considered.



At horizontal application pay attention to the wear at the support points because of the dumping tool.

4 MAINTENANCE

4.1 MAINTENANCE INTERVALS

To guarantee the function of the power drawbar the following maintenance intervals must be adhered to.

Every week

- Check the packing ring in the clamping unit (visual check)
- Check the gripper if it is polluted or damaged; is it sufficient greased? (visual check)
  Please see below:
  The regrease cycle depends on the loss of lubrication of the clamping unit.
  Cause for the loss of lubrication:
  - Seal in the clamping cone is defective
  - Type of medium used can desolve grease
  - Cleaning spray from outside directly on the clamping unit etc

  Regrease clamping unit → #4.2 // 29

Every six month or after 200.000 tool changes at the latest

- In unclamped position: Check dimension gauge E.M.
- counter through a clamped tool again.
- Test Pull-in-force (we recommend:use Power-Check):
  If the pull-in-force is smaller than 70% of the nominal value, following procedures have to be performed in the following sequence:
  - regrease (→ #4.2 // 29) and test pull-in force again
  - exchange gripper and test again
  - exchange drawbar completely
- check pull-out-force
  For example: Use a spring scale with drag indicator
  Attach the spring scale to a HSK tool holder and pull gradually and coaxially. Consider the weight of the tool.
  If the pull-out-force is less than 75% of the nominal value, then exchange out the gripper assembly.

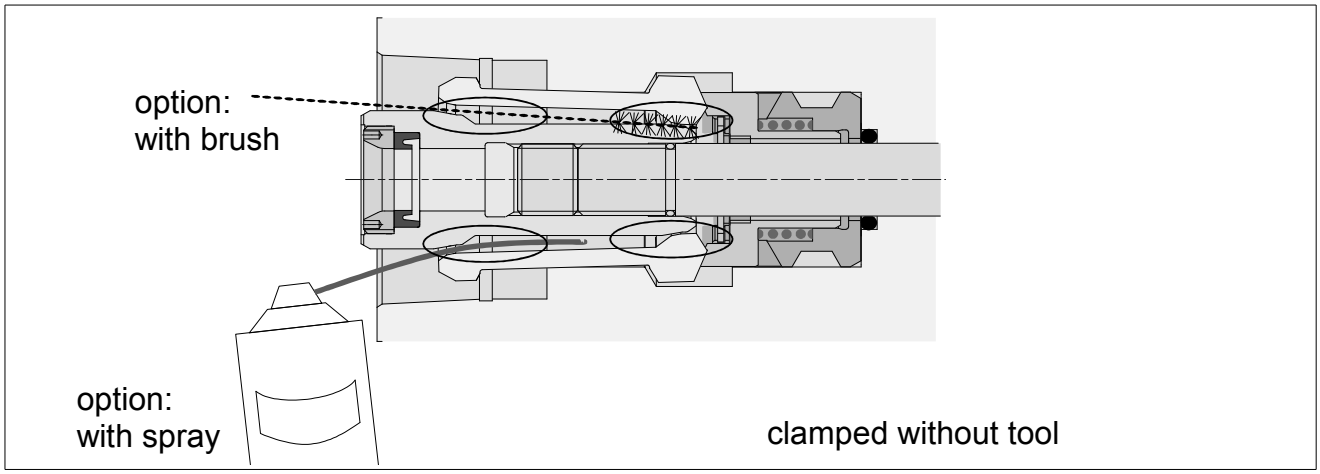
Every year or after 500.000 tool changes at the latest

- Exchange the packing ring → #4.4 // 30

4.2 REGREASE CLAMPING UNIT

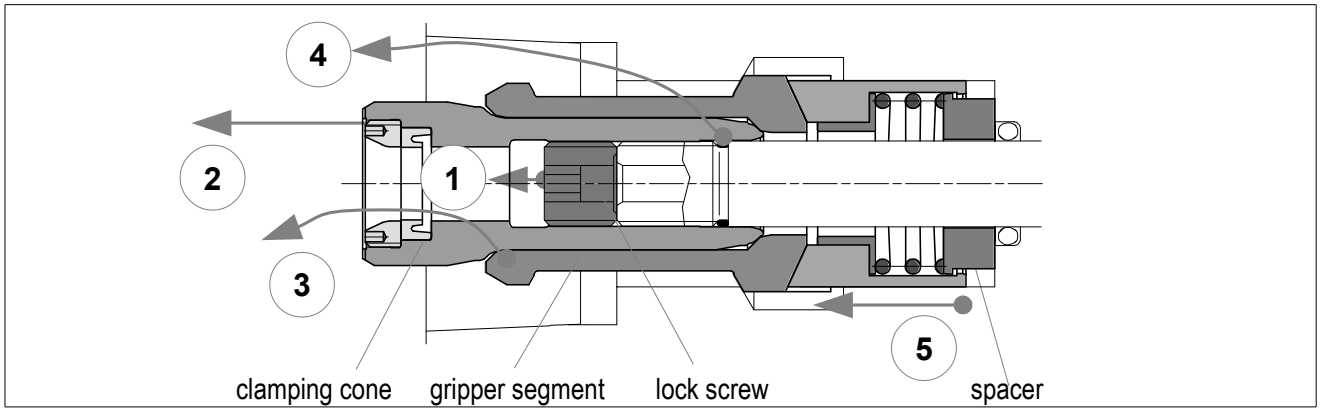
Note: take only grease of one company; do not mix the grease!

Regrease in assembled condition



If very dirty: take clamping unit out and clean.
Then grease clamping unit and reassemble → #2.1 // 21

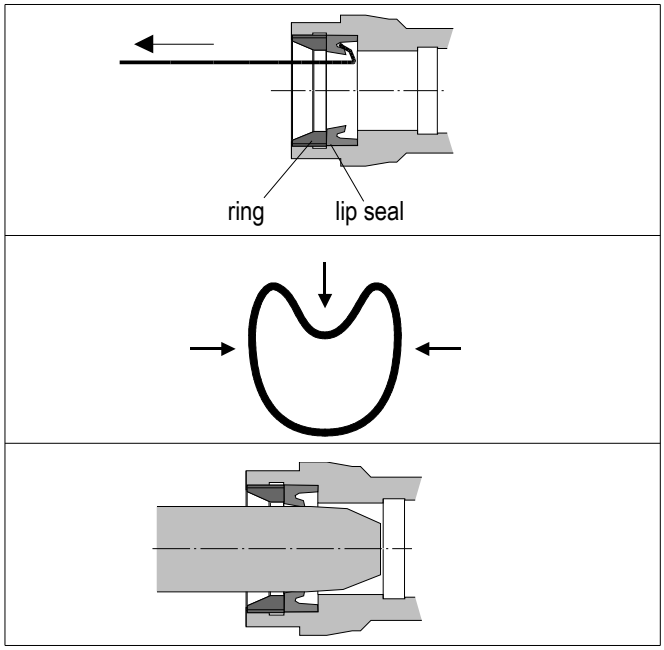
4.3 DISASSEMBLE CLAMPING UNIT HSK



In unclamped position:
1. loosen lock screw
2. unscrew clamping cone
3. remove gripper segments with light tilting movements
4. remove O-ring from drawbar
5. remove spacer with it use 2 long nose pliers or tweezers

4.4 EXCHANGE OF THE LIP SEAL

For dismounting the lip seal it is not necessary to take away the ring. Only when the ring is damaged it must be exchanged.



- Take away the damaged lip seal with a hook or pliers
- Compress the lip ring and build in; look for the build in position
- press the seal with a blunt object against the lining
- take a mandrel to bring it in the finaly position

4.5 BREAK OF A GRIPPER SEGMENT

- If one of the gripper segments should break, the complete clamping unit needs to be replaced!

4.6 GREASE FOR HSK-CALMPING UNIT

name	quantity	order-no.
* METAFLUX-grease-paste Nr. 70-8508	4 g	0.929100.012
METAFLUX-moly-spray Nr. 70-81	400 ml	06.21001.017
METAFLUX-moly-spray Nr. 70-82	400 ml	06.21001.010
KLÜBER-grease-paste ME 31-52	10 g	06.21001.014
KLÜBER-spray ALTEMP Q NB 50	400 ml	06.21001.015

* first equipment

Note: take only grease of one company; do not mix the grease!

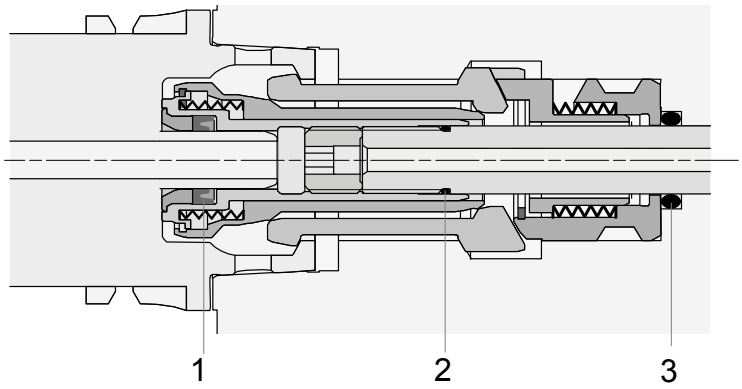
METAFLUX	Metaflux AG Industriestraße 11 CH-4313 Möhlin Tel.: +41-61-851 08 00 Fax: +41-61-851 08 08	KLÜBER	Klüber Lubrication München KG Postfach 701047 D-81310 München Tel.: (0 89) 78 76 –0 Fax: (0 89) 78 76 -333
	TECHNO-SERVICE GmbH Detmolder Straße 515 D-33605 Bielefeld Tel.: (05 21) 9 24 44 –0 Fax: (05 21) 20 74 32		

Aid for regreasing with paste in mounted state (clamped without tool):

name	HSK-size	order-no.
brush	A32 - A100	06.16001.001

4.7 SPARE PARTS

Lip seal / O-rings

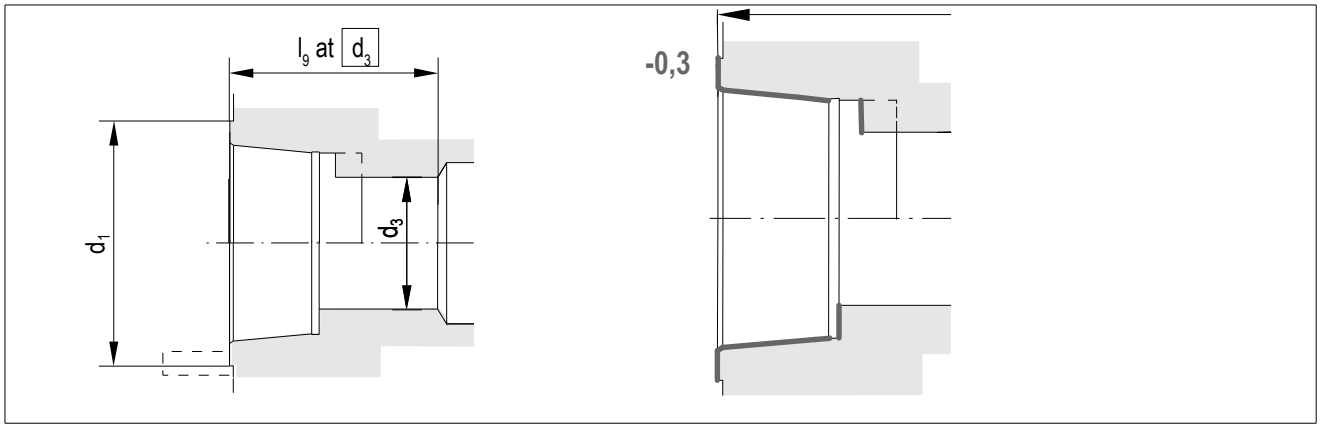


clamping unit HSK C		lip seal	O-rings	
nominal size	complete	1	2	3
A32 / B40 / E32	95.600.155.2.6	0.926030.110 6 x 10 x 3	0.926010.205 4,5 x 1,0	0.926010.233 6,3 x 2,4
A40 / B50 / E40	95.600.065.2.6	0.926030.112 8 x 14 x 4	0.926010.044 6,0 x 1,5	0.926010.047 8,0 x 3,0
A50 / B63 / E50	95.600.150.2.6	0.926030.111 10 x 15 x 3,5	0.926010.170 8,0 x 1,5	0.926010.172 10,0 x 3,0
A63 / B80 / E63	95.600.052.2.6	0.926030.117 12 x 18,5 x 4,5	0.926010.321 11,5 x 1,5	0.926010.164 13,87 x 3,53
A80 / B100	95.600.053.2.6	0.926030.108 14 x 20 x 4,8	0.926010.167 14,0 x 1,5	0.926010.173 16,0 x 3,5
A100 / B125	95.600.057.2.6	0.926030.109 16 x 24 x 5,5	0.926010.167 14,0 x 1,5	0.926010.169 18,0 x 3,5
			material: viton, hardness 80 SHORE A	

4.8 REPAIR-CLAMPING-UNITS HSK C-E

If fashioning necessary, we have repair-clamping-units.

Fashioning receiver



nominal size	pull-out-force [N]	clamping unit HSK C complete	l 9	repair-clamping unit HSK C-E **0,3** complete	l 9
A32	100	95.600.155.2.6	30	-	
A40	120	95.600.065.2.6	44	-	
A50	250	95.600.150.2.6	45	-	
A63	400	95.600.052.2.6	52	95.600.136.9.6	51,7
A63	200	95.600.052.2.6 V01	52	95.600.136.9.6 V01	51,7
A63	270	95.600.052.2.6 V02	52	95.600.136.9.6 V02	51,7
A63	100	95.600.052.2.6 V03	52	95.600.136.9.6 V03	51,7
A63	550	95.600.052.2.6 V04	52	95.600.136.9.6 V04	51,7
A80	300	95.600.053.2.6	56	95.600.141.9.6	55,7
A80	200	95.600.053.2.6 V01	56	95.600.141.9.6 V01	55,7
A100	300	95.600.057.2.6	70	95.600.145.9.6	69,7
A100	500	95.600.057.2.6 V01	70	95.600.145.9.6 V01	69,7

4.9 TROUBLE SHOOTING HSK-C

trouble	reason
tool is not pulled in correctly	gage dimension out of adjustment
	lock screw got loose
	wrong or faulty spindle-inside-contour
	wrong or faulty tool-inside-contour
	spring stack broken (travel not sufficient)
	clamping unit worn out
	tool feed not correct
	air blow off prevents tool from seating during tool change
tool is pulled out during work cycle	gripper segments, clamping cone or drawbar broken
	tool shank broken
	springs broken
	pull-in force not sufficient
when in hold position, tool falls out of the spindle	tool is released thru cleaning air blast
	tool is pushed out of the spindle thru cleaning air blast
	axial acceleration too high
	unclamping speed too high
	gripper assembly worn - holding force insufficient
loss of pull force	lack of lubrication on clamping set