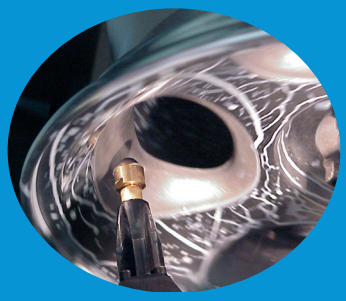
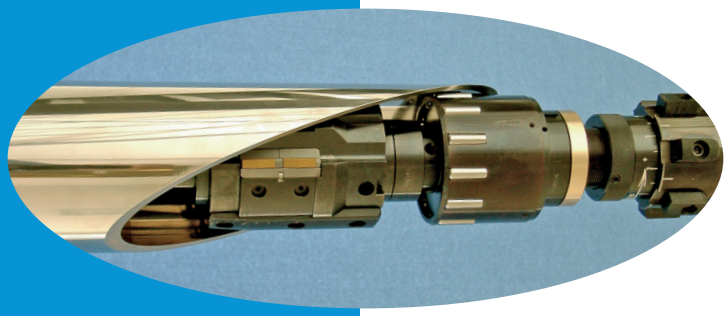
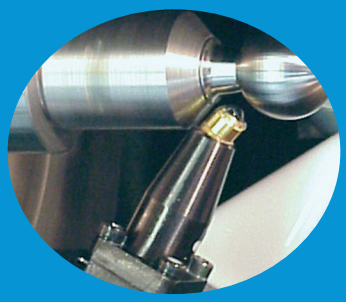
ECOROLL

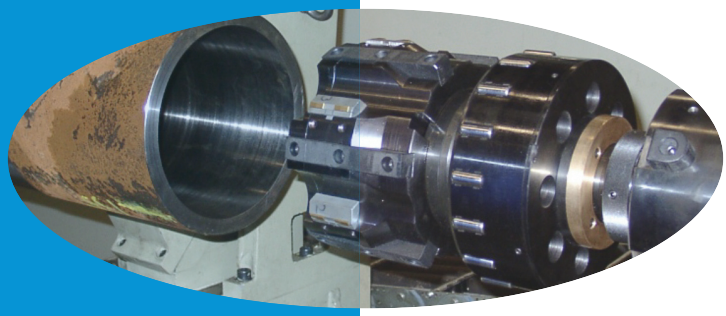


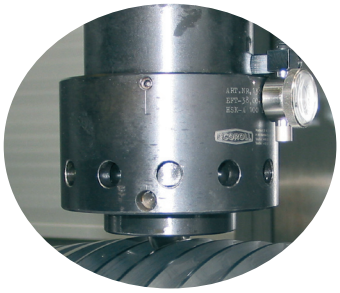
Tools & Solutions
for
Metal Surface Improvement

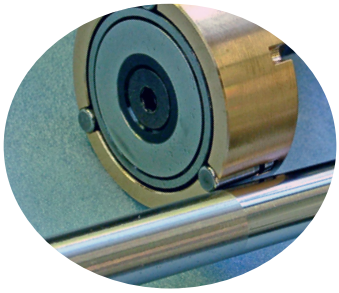




Roller burnishing,
Deep rolling,
Combined skive-burnishing







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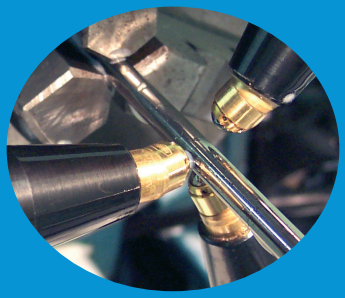


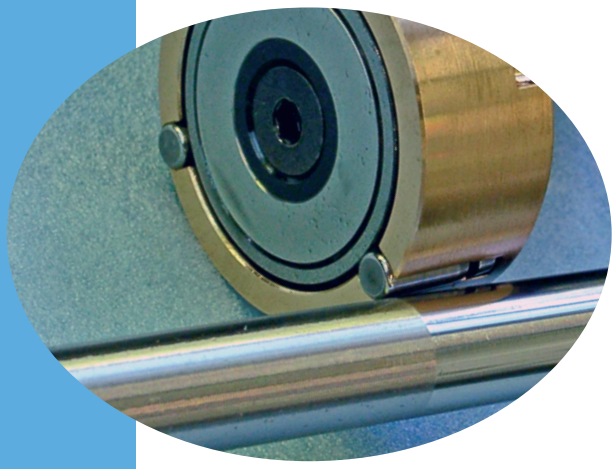
. . . for a smooth operation

ECOROLL AG Werkzeugtechnik & ECOROLL Corporation

We design, manufacture and sell high quality tools and machines for improving metal surfaces and components.

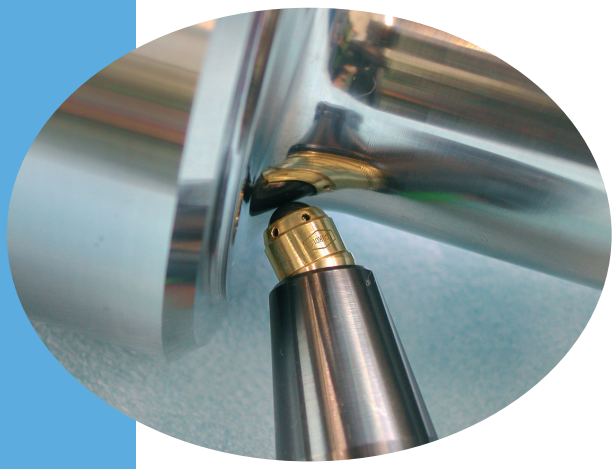
ECOROLL tools and solutions can be applied across a wide range of industries:

- *Automotive, aircraft and aerospace industries*
- *Machine and engine construction*
- *Power generation industry*
- *Oil and gas industry*
- *Medical technology*



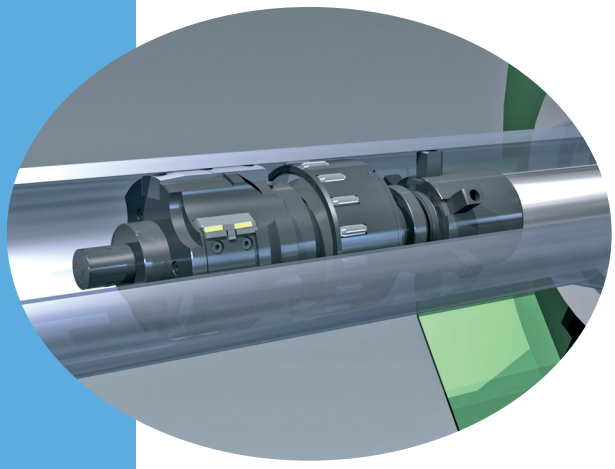
Roller burnishing

- *Produces mirror-finish surfaces*
- *Achieves a high surface bearing ratio*
- *Increases hardness, decreases friction and wear*
- *Short cycle, complete processing in one setting*



Deep rolling

- *Increases service life and fatigue strength*
- *Induces residual compressive stresses and work hardening in the surface layer*
- *Prevents or hinders stress corrosion crack formation or growth*
- *Produces mirror-finish surfaces*
- *Can process a wide variety of components*
- *Short cycle, complete processing in one setting*



Combined skive-burnishing

- *For hydraulic and pneumatic cylinders*
- *Mirror-finish surfaces decrease friction and wear*
- *Decreases irregularities in circular form*
- *Enhanced cutting speed up to 300 m per minute*
- *Feed rates of 3–6 mm per revolution*

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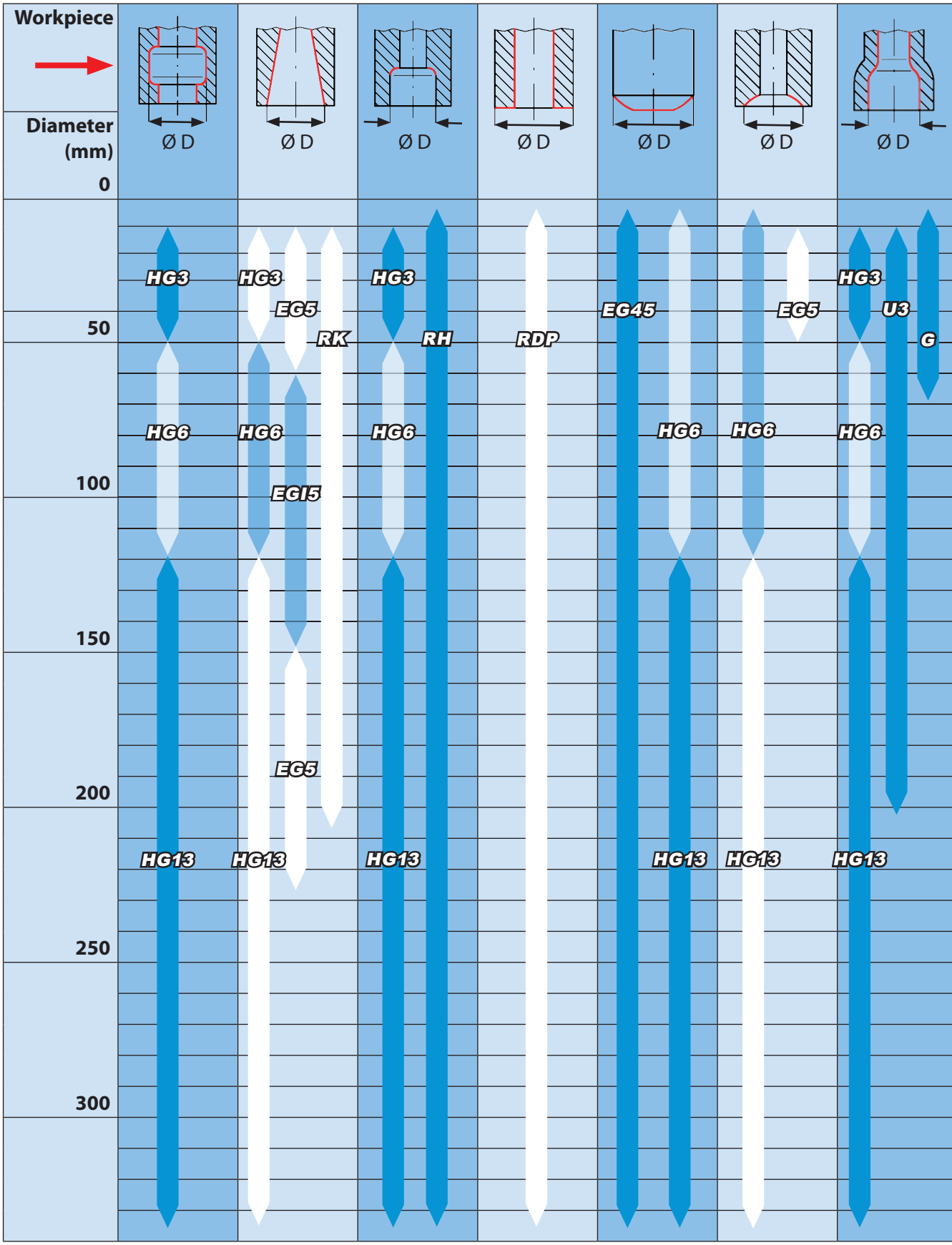
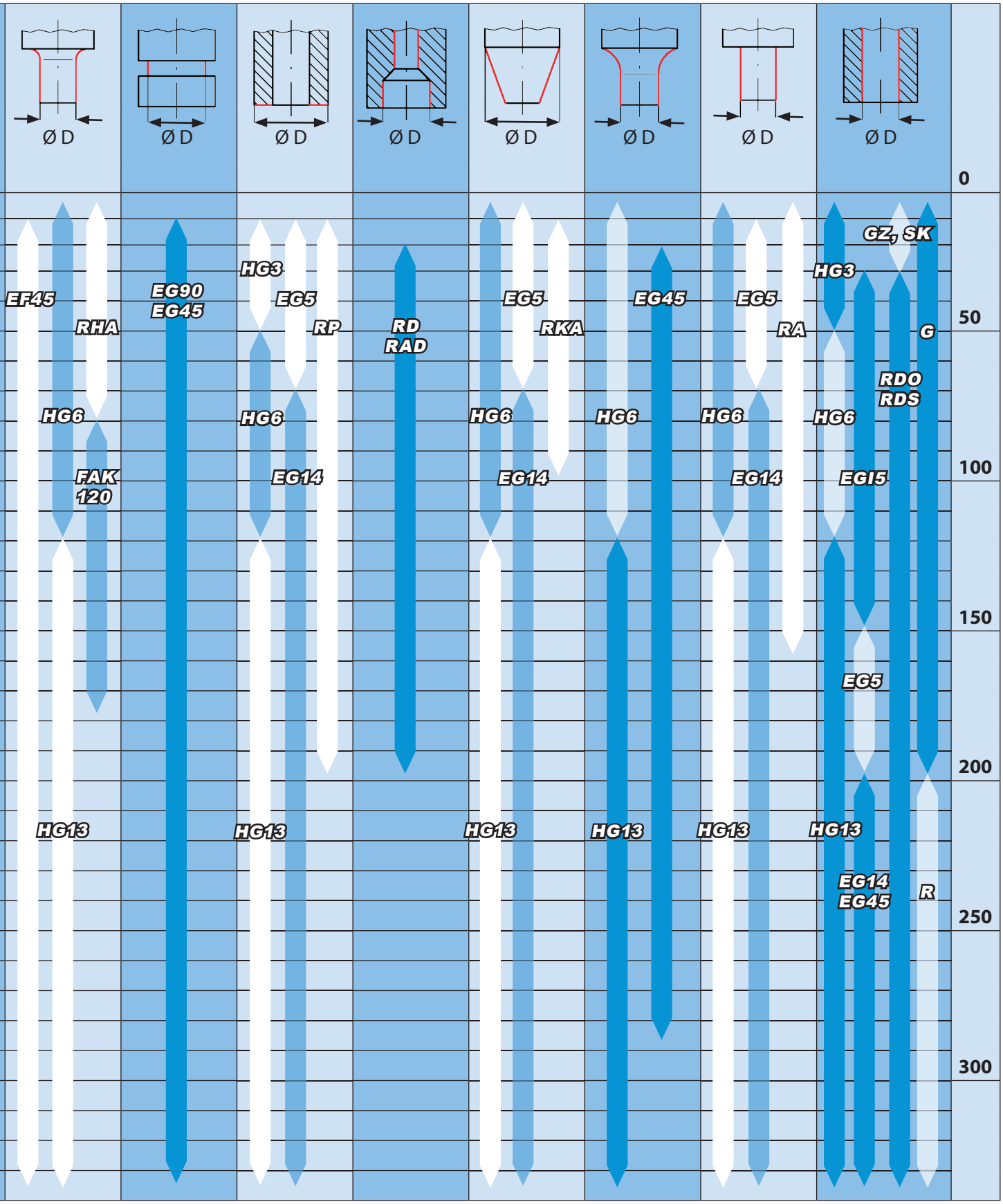
ECOROLL Product Selection





ECOROLL Tooling Technology

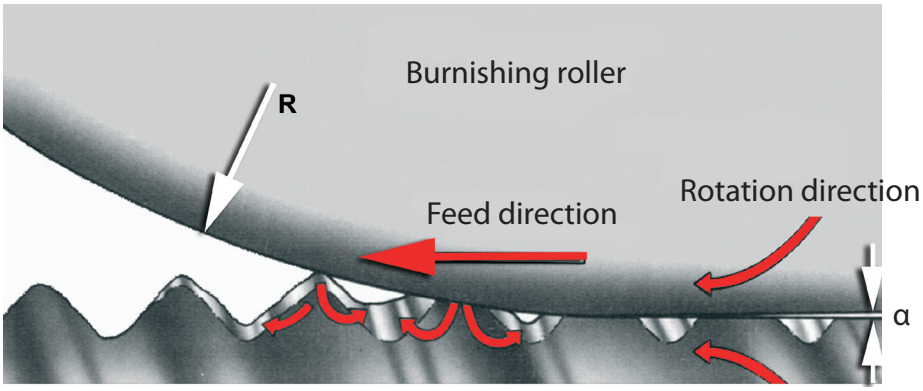
Based in Celle, Germany, ECOROLL AG Werkzeugtechnik is a mid-size company that designs, manufactures and sells tools and machines for improving the qualities of metal surfaces. These tools are used for roller burnishing, deep rolling and combined skive-burnishing applications (the latter developed especially for cylinder tubes). ECOROLL AG's presence is world-wide, including a subsidiary in the U.S. (ECOROLL Corporation in Milford, Ohio) and representatives in Korea, Japan, South Africa, Brazil, and many European countries.

The technology developed at ECOROLL AG can be applied across a broad spectrum of industries, including medical technology, the automotive industry, aircraft and aerospace, energy technology (wind turbines and the oil industry), and anywhere metal parts must be improved to increase service life or to facilitate better function.

Roller burnishing and deep rolling

ECOROLL is an industry leader in developing fundamental roller burnishing and deep rolling technology. In both processes one or more rollers or balls are pressed against the surface of a workpiece, plasticizing the material's top layer. At the contact point, the deep rolling force generates Hertzian contact stresses in the material's edge zone. If this stress is higher than the material's yield strength, the material near the surface starts to flow. As the ball or roller moves across the workpiece surface, the elastically deformed material springs back, pushing the now plastically deformed zone into compression. As long as the tool or the workpiece continues to rotate, this forming process continues over the entire workpiece surface.

By plastically deforming the workpiece's surface layer, both roller burnishing and deep rolling achieve a very smooth surface finish. The surface's peaks are pressed down, almost vertically, into the surface and the material then flows into the valleys between the peaks. The resulting smooth surface occurs not because the peaks are bent into the surface (a widely held, but false assumption), but because the material at the workpiece surface is plastically deformed — in other words, the material flows — and thus eliminates surface roughness.



The curved arrows pictured at the material's surface demonstrate how the material is displaced into the valleys between the peaks. Plastic deformation increases the roller's contact with the surface in that the applied rolling pressure (or burnishing force) affects the peaks that lie ahead of the roller's current position while causing the peaks at the point of contact to flow. The region found between the arrows labelled "rotation direction" in the figure above demonstrates how the material's surface is shaped during the roller burnishing or deep rolling process. The roller suppresses the plasticised material, preventing it from flowing backwards against the feed direction, while clearance angle α ensures that the surface is not over-burnished.

Both roller burnishing and deep rolling can take place right after an initial cutting process — such as turning, boring, reaming, milling or broaching — in the same setting. ECOROLL tools are compatible with conventional and CNC-controlled lathes, drills, milling machines and other machining centers. Moreover, these tools can process both regular (turned and bored) and irregular (milled or pressed) components. Special machines in mass production settings can also be set up to work with ECOROLL tools.

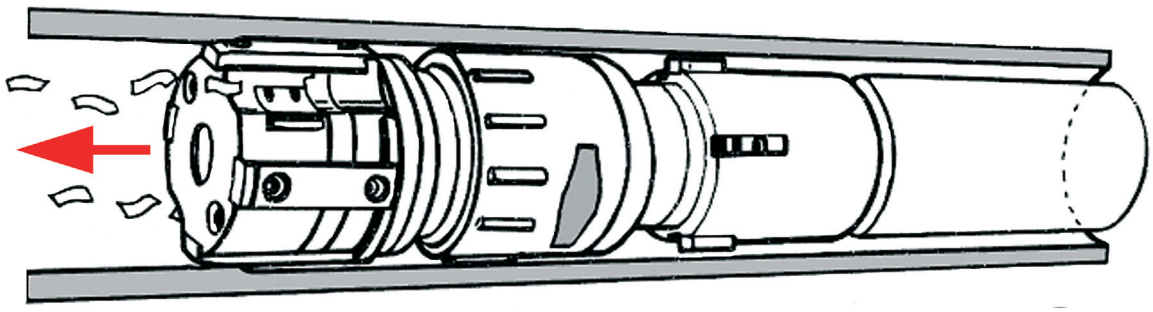
How does roller burnishing differ from deep rolling?

Some use the term "roller burnishing" to refer to both processes. To clarify for our customers the unique advantages of both processes, ECOROLL prefers to differentiate deep rolling from roller burnishing. Although the technological means are similar, the goals and results as well as the tools used for each process differ. When the application goal is to improve surface finish and/or increase bearing contact area, ECOROLL recommends roller burnishing. Deep rolling, on the other hand, offers a reliable process for increasing fatigue strength. That deep rolling simultaneously improves other surface qualities is, of course, beneficial but not as important in this case.

Deep rolling is similar to roller burnishing, but only this process combines burnishing, cold working and the generation of compressive stresses in the edge zone. Together, these three physical effects increase fatigue strength and reduce or even prevent stress corrosion cracking. As previously explained, rollers or balls appropriate for the particular task are pressed against the workpiece surface, plasticizing the material in the edge zone. When this plastic deformation takes place at or below room temperature, it is called "cold working." This process changes the surface's microstructure. The material characteristics achieved depend on the amount of cold work and the material's properties. Simultaneously, the deep rolling process induces compressive residual stresses. By precisely controlling the rolling pressure (or burnishing force), ECOROLL tools can produce the specific stress characteristics required for a given workpiece.

Combined skive-burnishing

The tools in ECOROLL's innovative OMEGA line combine skiving and roller burnishing to eliminate irregularities in circular form, such as rippling, that occur in the manufacture of hydraulic cylinders and other tubes. Although there are established processes for machining cylinders, the combination of skiving



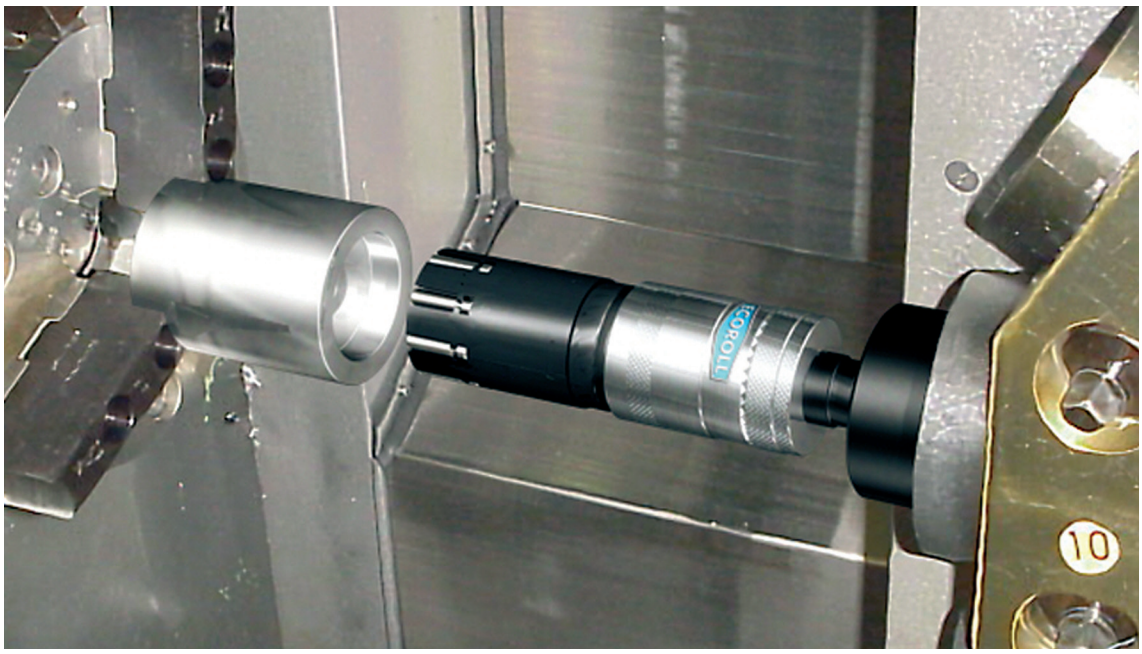
and roller burnishing offers an especially economical alternative. The OMEGA tools have proven effective for machining cylinders with diameters from 60 mm to 455 mm in lengths up to 10 m.

While the skiving head cuts the tube's inner surface to the exact size and form required, the roller head burnishes it. Several rollers positioned on the tool's circumference are pressed into the cylinder's inner wall. This process smoothes and forms the surface profile generated by skiving. The forming process increases hardness and enhances the wear and fatigue resistance of surfaces subject to dynamic load.

Mechanical Multiple Roller Tools

ECOROLL's multiple roller tools (types G, R, RD, RAD, RA) are specially designed to machine cylindrical bores (both through and blind holes), stepped bores and internal and external cylinder surfaces.

The RP, RDP, RK and RKA tools process similar non-cylindrical surfaces.



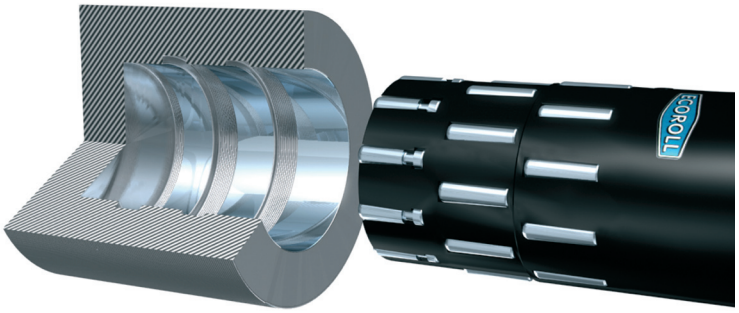
Type G roller burnishing tool on a CNC-controlled lathe.

These versatile tools feature convenient diameter adjustment and reliable, high-precision performance.

Type G roller burnishing tool with internal coolant.

The tools can be applied with CNC-controlled lathes, drills, milling machines and machining centers as well as with manually controlled machines.

Machining a connecting rod with a Type G tool.



Machining a three-section stepped bore with a Type RD tool.

In addition, the tools require minimal lubrication and the wear parts are easy to change.

Simple maintenance together with the short work cycle add up to considerable time-savings.

Machining a universal joint shaft with a Type RA tool.

Type G Tool Application: Cylindrical bores

Through holes, diameters 4 – 200 mm
Blind holes, diameters 6 – 200 mm

Features

- *For bore tolerances up to class IT8*
- *Type GE for bore tolerances up to class IT11, Ø 50 mm and larger*
- *Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45*
- *Achieves a surface quality of R_z < 1 µm (R_a ≤ 0.2 µm)*
- *For use on CNC-controlled lathes, drills, mills, and machining centers as well as manual machines*
- *Right hand rotation*

Basic tool design

- *Type G tools consist of a tool body and roller head.*
- *Tool body includes shank and burnishing diameter adjustment assembly with an adjustment increment of 1 µm.*
- *Tool shanks are Morse taper or cylindrical Weldon design. Specialized shanks also available.*
- *Roller head consists of cone, cage and rollers.*
- *Roller heads interchangeable within tool body diameter range. Optional self-feeding cages also available.*

Parameters

- *Circumferential speed: up to 250 m/min.*
- *Feed rate: 0.05 - 0.3 mm/rev./roller*
- *Rolling length: when the workpiece diameter is 36 mm or larger, the tool allows for unlimited rolling length. For smaller diameters, tools with standard rolling length are available.*

Specially designed versions available by request.

Tool body	Diameter range D (all measurements in mm)	Tool shank: Morse taper or cylindrical shank Ø e x f	a	b	c[1)]	d max.	i	l	Rolling length
G1.1	≥ 4 < 17	MK2 Ø 20h6 x 50	35	52	1.5	70	80	Rolling length + 8 mm	Standard rolling length: 50 mm
	≥ 17 < 21				2				
G1.2	≥ 21 < 33	MK2 Ø 20h6 x 50 Ø 25h6 x 56					80		
G1.3	≥ 33 < 36								
	≥ 36 < 50				3	74		89	Unlimited rolling length
G2	≥ 50 < 100	MK3 Ø 25h6 x 56	49	68		93	99	79	
G3	≥ 100 < 201[2)]	MK4 Ø 32h6 x 60	71	84	5	110	124	100	

NOTE: 1) *All measurements in mm. Measurement* **c** *does not apply for blind hole tools.*
2) *For workpieces with diameters larger than 201 mm, please see ECOROLL Type R tools.*

Advantages

- *Reliable, high precision performance*
- *Short cycle time*
- *Convenient diameter adjustment*
- *Minimal lubrication required (oil or emulsion)*
- *Tool automatically collapses when retracted to prevent surface damage*
- *Easy to change wear parts*

Tool body — **G1.2–25.00–1–50–MK** — *Shank*

Diameter *Design* *Rolling length*

How to order:

1. *Specify the tool body type and machining diameter (see following table).*
   Special diameter sizes (also in inches) are available upon request.

NOTE: *Depending on the application, blind hole tools may allow a larger range of settings than shown in the table.*

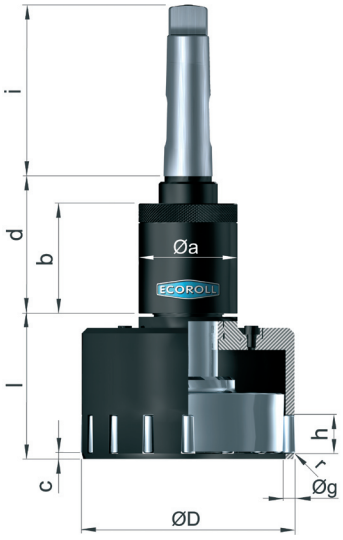
2. *Specify the design version:*
   - *1: through holes with non-feeding cage*
   - *2: through holes with self-feeding cage*
   - *3: blind holes with non-feeding cage*
3. *Specify the rolling length in mm: 100, 150, 200, 250, 300 (other lengths by request).*
4. *Specify the shank type:*
   - *MK: Morse taper*
   - *ZS: Cylindrical Weldon shank*

Tool body	Diameter D	Setting range through hole / blind hole[3]	Number of rollers[4]	Roller diameter Ø g x h	Roller radius r	Rolling length
	mm	- / + mm		mm		
G1.1 Ø ≥ 4 < 21	≥ 4 < 5	- 0.05 / + 0.2 / no blind hole	3	1 x 4	0.5	50
	≥ 5 < 6			1.5 x 6	1	
	≥ 6 < 8	- 0.05 / + 0.3 / - 0.05 / + 0.1		2 x 6 / 2 x 10[3]		
	≥ 8 < 10		4			
	≥ 10 < 11	- 0.05 / + 0.4 / - 0.05 / + 0.1		3 x 9	1.5	
	≥ 11 < 17		5			
	≥ 17 < 21	- 0.05 / + 0.6 / - 0.05 / + 0.1		5 x 16		
G1.2 Ø ≥ 21 < 33	≥ 21 < 25					
	≥ 25 < 33		6			
G1.3 Ø ≥ 33 < 50	≥ 33 < 36	- 0.05 / + 0.8 / - 0.05 / + 0.1				75
	≥ 36 < 38					unlimited
	≥ 38 < 50		8	8 x 25	2.5	
G2 Ø ≥ 50 < 100	≥ 50 < 86					
	≥ 86 < 100		12			
G3 Ø ≥ 100 < 201	≥ 100 < 170			14 x 35	4	
	≥ 170 < 201		16			

NOTE: ***3)*** *Depending on the application, blind hole tools may allow a larger range of settings than shown in the table.*
4) *Please exchange only complete sets of rollers. When ordering rollers, specify through or blind hole.*

Type R Tool Application: Cylindrical bores

Through holes, diameters 201 – 450 mm
Blind holes, diameters 201 – 450 mm



Features

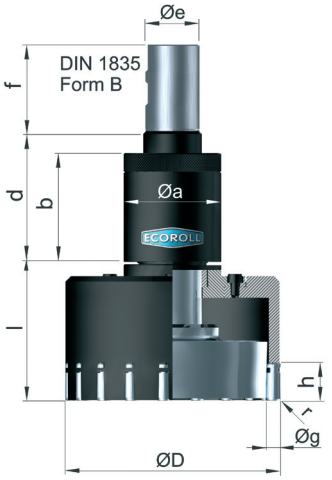
- *For bore tolerances up to class IT8*
- *Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45*
- *Tools achieve a surface quality of R_z < 1 µm (R_a ≤ 0.2 µm)*
- *For use on CNC-controlled lathes, drills, mills, and machining centers as well as manual machines*
- *Right hand rotation*

Advantages

- *Short cycle time*
- *Convenient diameter adjustment*
- *Minimal lubrication required (oil or emulsion)*
- *Tool automatically collapses when retracted to prevent surface damage*
- *Easy to change wear parts*

Basic tool design

- *Type R tools consist of a tool body and roller head.*
- *Tool body includes shank and diameter adjustment assembly.*
- *Adjustment assembly accommodates any size within the setting range.*
- *Specially designed rollers for bores with wide ring grooves or with cross holes. These rollers guarantee smooth tool operation and retraction.*



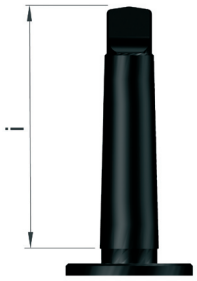
Parameters

- *Circumferential speed: up to 250 m/min.*
- *Feed rate: 0.10 - 0.4 mm/rev./roller*

Tool body	Diameter range D	Setting range through / blind hole[1]	Tool shank: Morse taper or cylindrical shank Ø e x f	Number of rollers[2]	Roller diameter Ø g x h	Roller radius r	a	b	c	d	i	l
	mm	- / + mm	mm		mm							
R5	≥ 201 < 255	-0.05 / +0.8 / -0.05 / +0.1	MK5 Ø 50 h6 x 80	16	14 x 35	4	90	100	5	125	156	134
	≥ 255 < 320			20								
	≥ 320 < 450			28								

NOTE: **1)** *Depending on the application, blind hole tools may allow a larger range of settings than shown in the table.*
2) *Please exchange only complete sets of rollers. When ordering rollers, specify through or blind hole.*

Type RD and RAD Tool Applications: Stepped bores and stepped shafts



Features

- *For bore tolerances up to class IT8*
- *Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45*
- *Tools achieve a surface quality of R_z < 1 µm (R_a = 0.2 µm)*
- *For use on CNC-controlled lathes, drills, mills, and machining centers as well as manual machines*
- *Right hand rotation*

Advantages

- *Short cycle time*
- *Eliminates the need for a second tool*
- *Convenient diameter adjustment*
- *Minimal lubrication required (oil or emulsion)*
- *Tool automatically collapses when retracted to prevent surface damage*
- *Easy to change wear parts*

Basic tool design

- *Type RD and RAD tools consist of a tool body and roller head.*
- *Tool body includes shank and two diameter adjustment assemblies for independent adjustment.*
- *Roller head consists of two external or internal cones, one double cage, and two sets of rollers.*
- *Standard for Type RD tools are Morse taper shanks; Type RAD has cylindrical shanks.*
- *Roller head is designed for specific workpiece dimensions.*

Parameters

- *Circumferential speed: up to 250 m/min.*
- *Feed rate: 0.10 - 0.4 mm/rev./roller*
- *Rolling length: the rolling length **h** as well as the step increment **g** is designed for specific workpiece dimensions. To avoid using more than one tool to process one workpiece, these tools can be equipped with very small step increments and up to three steps.*

Tool body	Diameter range D	Setting range through / blind hole	Tool shank: Morse taper or cylindrical shank Ø e x f	a	b	c[3)]	d min.	k	i
	mm	- / + mm	mm	mm					
RD1	≥ 16 < 50	-0.05 / +0.6 / -0.05 / +0.1	MK3 Ø 25 h6 x 60	53	110	3	12 and/or 0.6 x D	125	99
RD2	≥ 50 < 100	-0.05 / +0.8 / -0.05 / +0.1					30		
RD3	≥ 100 < 201		MK4 Ø 32 h6 x 60	75	150			168	124

		Setting range (through hole)	Tool shank Ø e x f	a1	a2	b min.	c min.	d min.	g min.	h min.
RAD1	≥ 12 < 25	-0.1 / +0.4	Ø 25 h6 x 56	96	65	130	30	0.8 x D	depends on the workpiece	
RAD2	≥ 25 < 51	-0.1 / +0.6	Ø 32 h6 x 60	140	105	160				

NOTE: 3) *No dimension **c** on blind hole tools.*

Type RA Tool Application: Cylindrical outer surfaces

Diameters 3 – 160 mm

Features

- *For bore tolerances up to class IT8*
- *Type RAP with compensating roller head for bore tolerances up to class IT11*
- *Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45*
- *Achieves a surface quality of R_z < 1 µm (R_a ≤ 0.2 µm)*
- *For use on CNC-controlled lathes, drills, mills, and machining centers as well as manual machines*
- *Right hand rotation*

Basic tool design

- *Type RA roller burnishing tools consist of a tool body and roller head.*
- *Tool body includes shank and diameter adjustment assembly.*
- *Cylindrical shanks standard (Morse taper shanks also available).*
- *Roller head consists of the external cone, cage, and rollers.*
- *Roller heads interchangeable within the diameter range for the tool body size.*

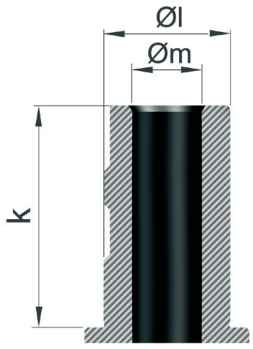
Parameters

- *Circumferential speed: up to 250 m/min.*
- *Feed rate: 0.05 - 0.3 mm/rev./roller*
- *Rolling length: when equipped with a standard shank, the tool's rolling length is limited (see the following table).*

  For longer workpieces ECOROLL® can supply roller burnishing tools for unlimited rolling length. These tools are equipped with a hollow, reinforced cylindrical shank.

Tool body	Diameter range D	Tool shank: Morse taper or cylindrical shank Ø e x f		a	b	c[1)]	d	i
	mm			mm				
RA1	≥ 3 < 12	Ø 20 h6 x 50 (MK2)	Ø 25 h6 x 60 x 15	55	45	21	81	80
RA2	≥ 12 < 25	Ø 25 h6 x 56 (MK3)	Ø 40 h6 x 70 x 28	73	65			99
RA3	≥ 25 < 55	Ø 40 h6 x 70 (MK4)	Ø 80 h6 x 90 x 57	114	105	28	108	124
RA4	≥ 55 < 85		Ø 110 h6 x 110 x 88	152	140			156
RA5	≥ 85 < 110	Ø 50 h6 x 80 (MK5)	Ø 150 h6 x 120 x 113	190	180	35	130	
RA6	≥ 110 < 160		Ø 190 h6 x 150 x 150[1)]	238	225			

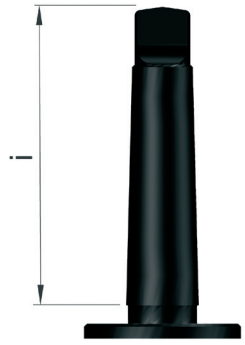
NOTE: 1) *Maximum diameter for unlimited rolling length is 145 mm.*



Advantages

- *Reliable, high precision performance*
- *Short cycle time*
- *Convenient diameter adjustment*
- *Minimal lubrication required (oil or emulsion)*
- *Tool automatically collapses when retracted to prevent surface damage*
- *Easy to change wear parts*

Tool body — **RA3–25.00–3–MK** — Shank
Diameter, Design



How to order:

1. *Specify the tool body type and machining diameter (see following table).*

NOTE: *Non-standard diameters are available by request.*

2. *Specify the design version:*
   - *3: with non-feeding cage*
   - *4: with self-feeding cage*
3. *Specify the shank type:*
   - *MK: Morse taper*
   - *ZS: Cylindrical shank (limited rolling length)*
   - *ZU: Hollow cylindrical shank (unlimited rolling length)*

Tool body	Diameter D	Setting range	Number of Rollers	Roller diameter Ø g x h	Roller radius r	Rolling length
	mm	- / + mm		mm		
RA1 Ø ≥ 3 < 12	≥ 3 < 6	- 0.2 / + 0.05	3	5 x 16 S	1.5	85
	≥ 6 < 8	- 0.4 / + 0.1				
	≥ 8 < 12		5			
RA2 Ø ≥ 12 < 25	≥ 12 < 17					
	≥ 17 < 25		7			
RA3 Ø ≥ 25 < 55	≥ 25 < 40	- 0.6 / + 0.1		8 x 25 S	2.5	110
	≥ 40 < 55		9			
RA4 Ø ≥ 55 < 85	≥ 55 < 85		11			
RA5 Ø ≥ 85 < 110	≥ 85 < 110		9	14 x 35 S	4	135
RA6 Ø ≥ 110 ≤ 160	≥ 110 < 160		11			

NOTE: 2) *Please exchange only complete sets of rollers.*

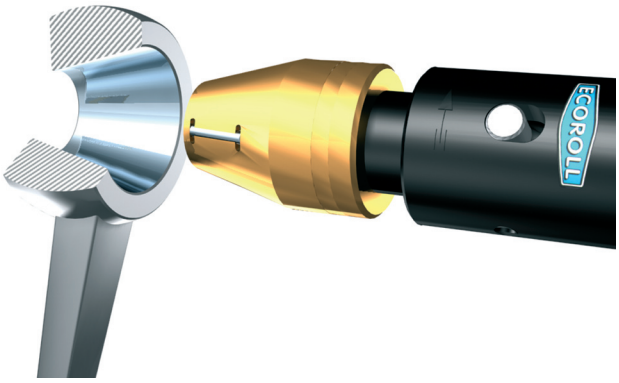
Type RP, RDP, RK, RKA Tool Applications: Non-cylindrical surfaces

Features

The RP, RDP, RK and RKA roller burnishing tools achieve outstanding results on non-cylindrical surfaces such as plane faces and internal and external tapered surfaces.

These tools work under axial load and can be used with almost any type of machine. Either the tool or the workpiece can rotate.

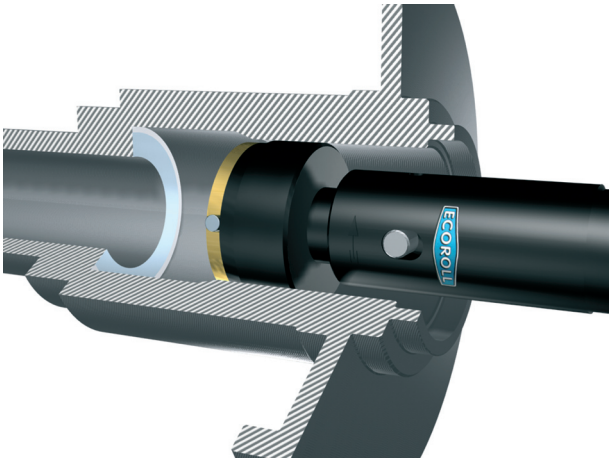
A flexible disc spring assembly transfers the axially directed rolling force from the machine to the roller head. The tools can be used to machine all metals with tensile strength up to 1400 N/mm² and maximum hardness of 45 HRC.



Machining a steering lever with a Type RK tool.

Advantages

- *Reliable, high precision performance*
- *Wide variety of applications*
- *Extremely short processing time*
- *Disc spring assembly facilitates consistent, high quality results*
- *Suitable for use with many different machines*
- *Standard tool shanks available: Morse taper, cylindrical, and VDI tool shanks*
- *Easy to change wear parts*



Machining a gear housing with a Type RP tool.

Basic tool design

Type RP, RDP, RK, and RKA roller burnishing tools consist of a tool body and roller head.

Tool bodies for the RP, RDP, RK and RKA tools come in four sizes: S1 to S4.

The tools are equipped with Morse taper shanks, but cylindrical shanks, shank DIN 69880 (VDI-shank) and shanks for other clamping systems are also available. In addition, the tool body includes a disc spring assembly specifically designed and arranged for each individual machining task.

Roller heads are produced according to the specific workpiece dimensions. The roller head unit is mounted onto the tool body and determines the tool's type.

The illustrations on the following page demonstrate both the modular system and the wide variety of combinations available.

Tool Design and Specifications

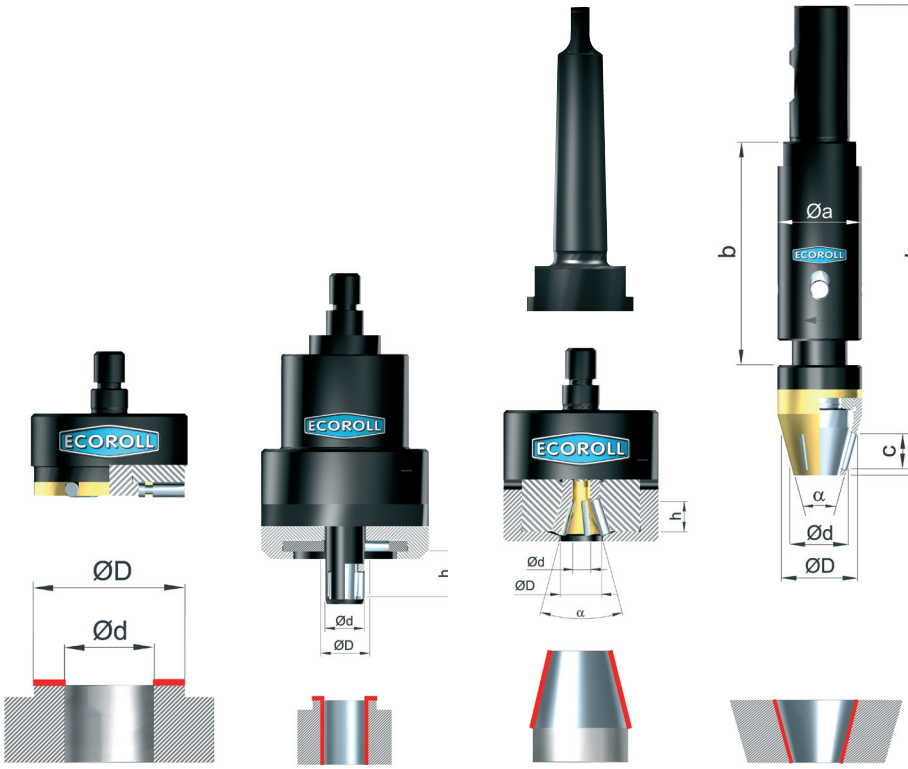
Available shanks:

Morse taper DIN 228 MK

Cylindrical shank DIN 1835 B, Form B ZS

Cylindrical shank DIN 69880 VDI

Available roller heads:



Tool application:

RP
Plane faces

RDP
Plane faces and cylindrical bores

RKA
External tapered surfaces

RK
Tapered bore holes

How to order:

The following table lists the standard dimensions for the tool bodies. Roller head dimensions and suitable tool body size depend on the workpiece dimensions and the material yield strength.

To ensure optimal tool design, please provide a drawing of the workpiece, including material specifications. If drawings are not available, provide the dimensions of the desired roller head and the material yield strength of the part to be burnished.

Tool type — **RK–60.6–45.0–30°–S3–MK** — *Shank*

- *Diameter D*
- *Diameter d*
- *Angle **α** (only for RK, RKA)*
- *Tool body*

Tool body	a	b	Maximum force	Standard shank
	mm		kN	
S1	26	66	3.9	MK1
S2	35	92	13.5	MK2
S3	45	107	21.6	MK3
S4	65	135	40.5	MK4

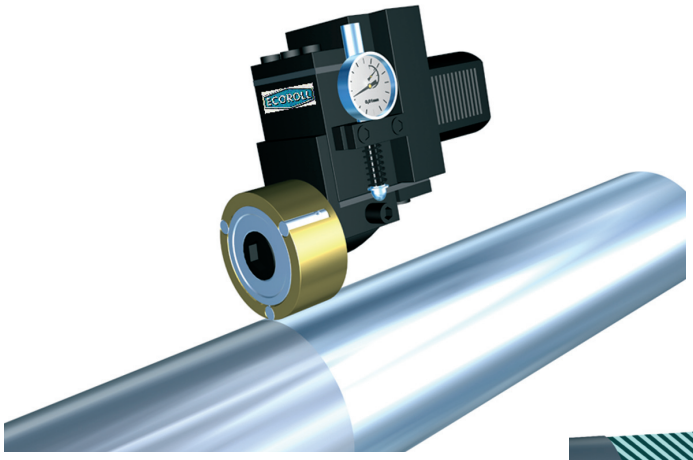
Mechanical Single Roller Tools

ECOROLL's mechanical single roller tools are designed to machine a wide variety of irregular surfaces, including specific contours, fillets, and grooves as well as cylindrical and tapered external surfaces and bores.

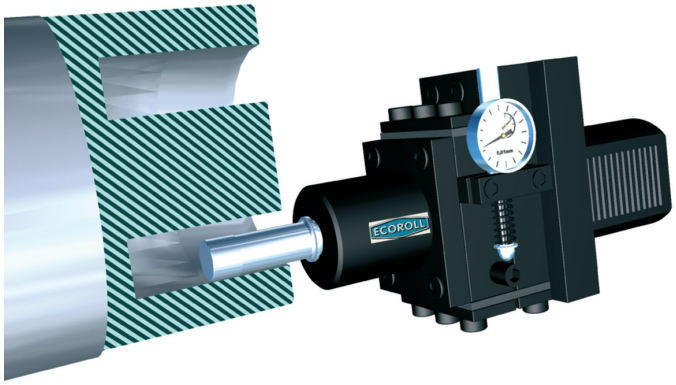
This group of tools includes types EG5, EG14 and EG45.

EG5

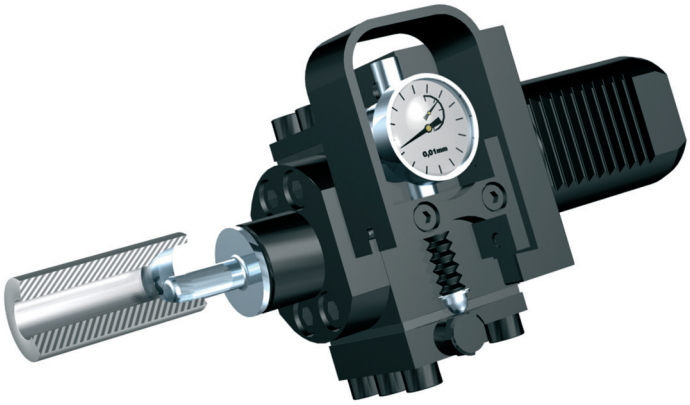
The EG tools consist of a tool body equipped with a tool shank, a spring assembly that allows the head to move with no play and very little friction, and an indicator that indirectly measures the burnishing force.



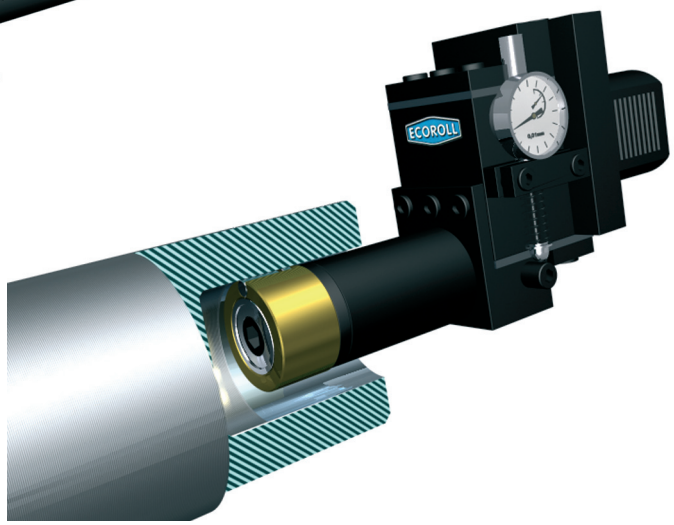
Machining a cylinder rod with a Type EG5 tool.



Machining a circular ring area with an EG5-xxF tool.

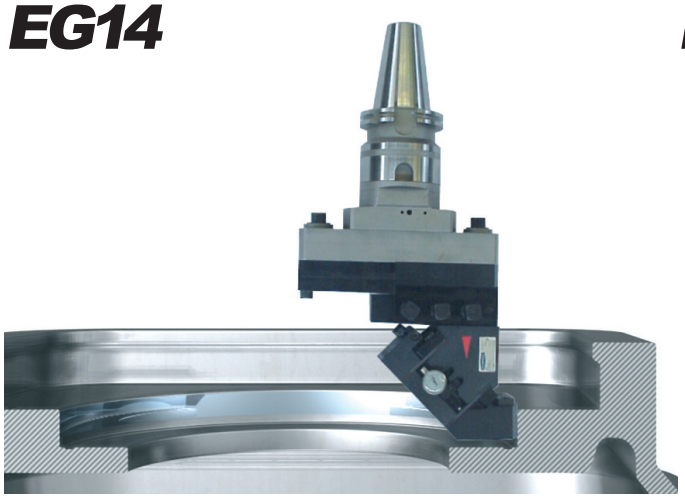


Machining a spherical surface with an EG5-08 tool.

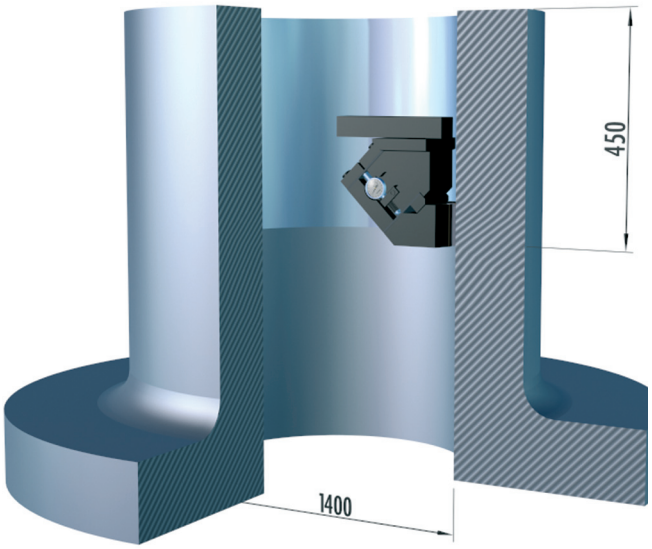


Machining a bore with an EGI-32 tool.

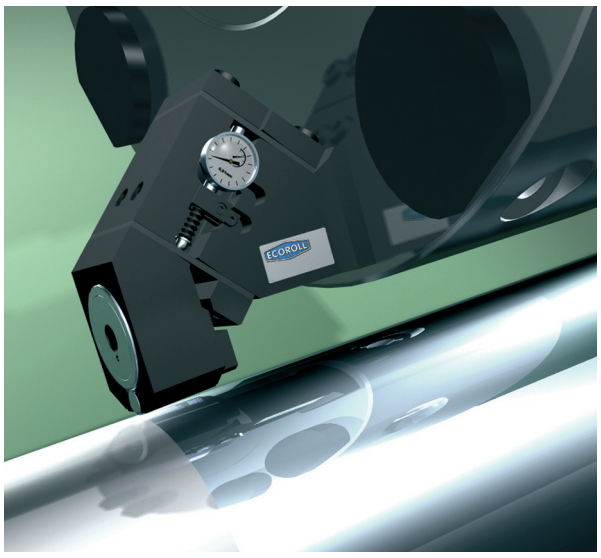
EG14



Machining a housing

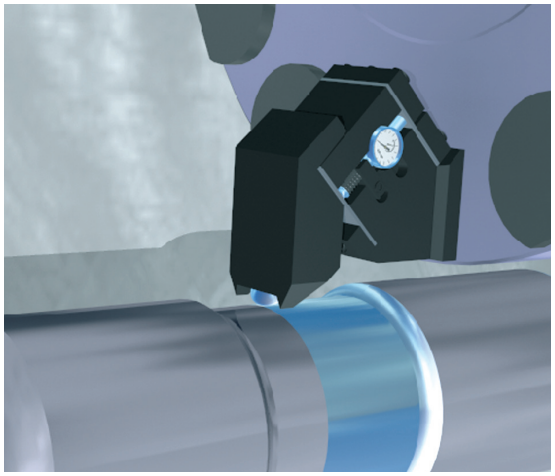


Machining a bearing housing

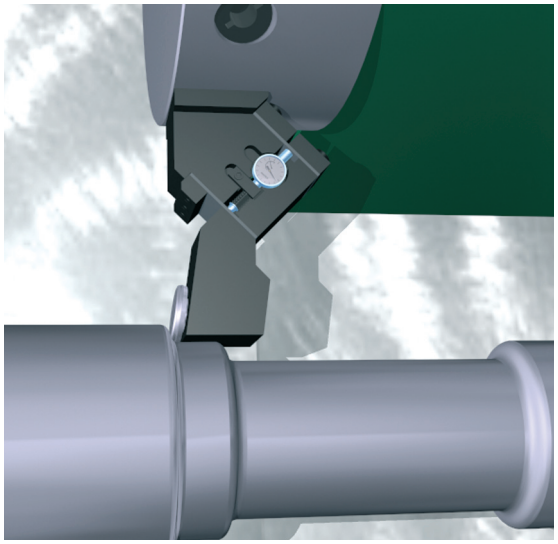


Machining a cylinder rod

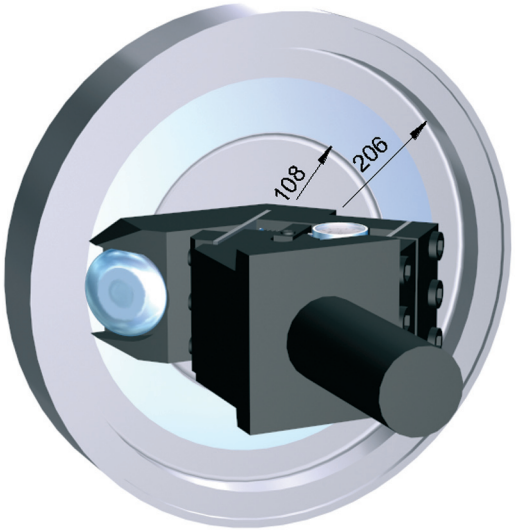
EG45



Machining a train axle with an EG45-40M tool.



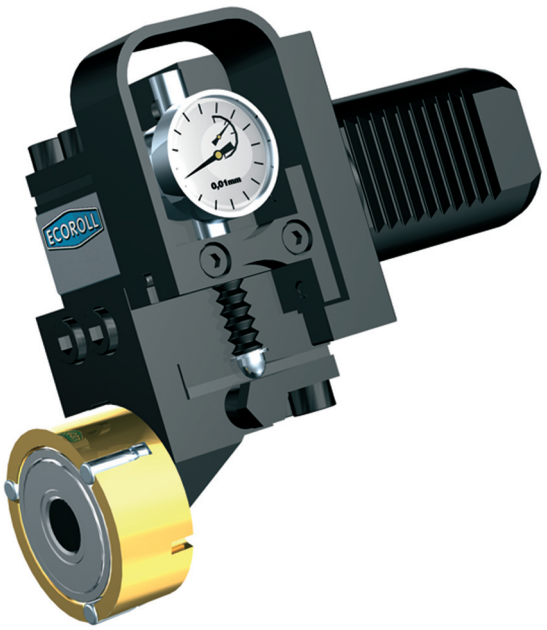
Machining a train axle with an EG45-45T tool.



Machining a flywheel with an EG45-40M tool.

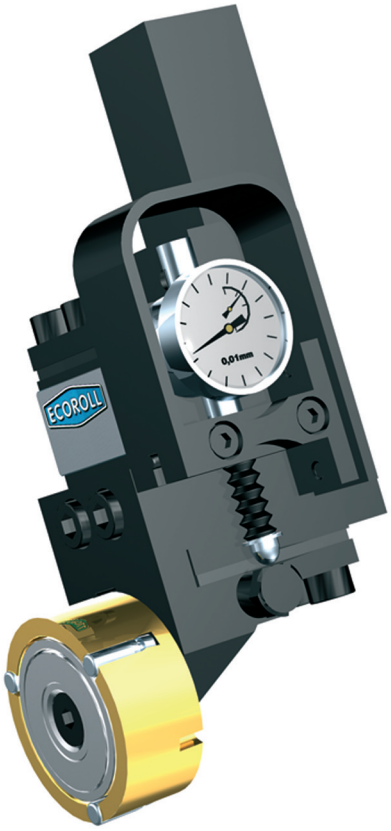
Type EG5 Tool Applications: Cylinders, faces, tapers and bores

Diameters 55 mm and larger



Features

- *Roller burnishing of cylindrical and tapered external surfaces, external or internal faces, and cylindrical and tapered bores (specially designed models available for tapers)*
- *For use with either CNC-controlled or conventional lathes*
- *Complete processing in one setting*
- *Achievable surface quality: R_z < 1 µm (R_a ≤ 0.2 µm)*
- *Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45*
- *Symmetrical construction allows either right or left hand operation*
- *Feed in the direction of the arrow label on the tool*
- *Roller can rotate in either direction*



Advantages

- *Short cycle time*
- *Eliminates set-up and auxiliary processing time*
- *For use with either CNC-controlled or conventional lathes*
- *No dust or grinding residue*
- *Minimal lubrication required (oil or emulsion)*
- *Variable burnishing force dependent on spring deflection*
- *Accurately measured burnishing force ensures consistent, high quality results*
- *Unrestricted roller face for roller burnishing shoulders and other edges*
- *Spring assembly allows roller head to move with no play and very low friction*
- *Modular construction allows these tools to be used in several configurations*
- *Easy to change wear parts*
- *Tool design includes fixed roller clearance angle **α***

Parameters

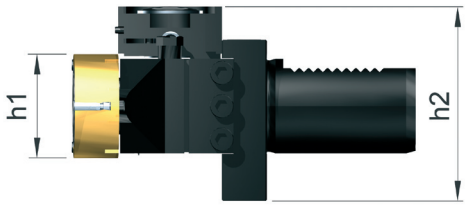
- *Maximum circumferential speed: 150 m/min.*
- *Maximum feed rate: 0.6 mm/rev.*
- *Maximum burnishing force: 3000 N*

Bore Application

with Design Version 1 (see illustrations, following page)

Bore depth (mm)	≤ 16	> 66
Smallest bore diameter (mm)	55	140

Tool Design and Specifications



Basic tool design

Type EG5 single roller burnishing tools consist of a tool body equipped with a tool shank, a spring assembly that allows the roller head to move with no play and very low friction, and a gauge that indicates the burnishing force as measured by spring deflection. An optional device transmits the values by cable or wireless signal to an external indicator.

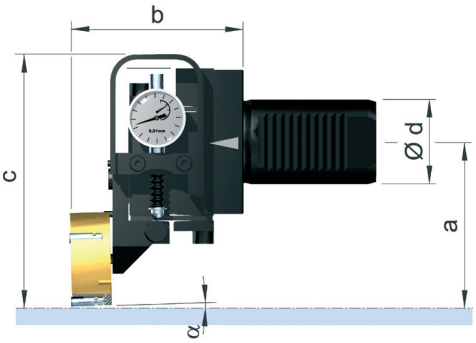
The roller head is attached to the flexible, spring-loaded section of the tool body. The roller head consists of a cage, which contains and guides the burnishing roller, and a support roller with a large-scale needle bearing. The cage also contains two spare rollers.

How to order:

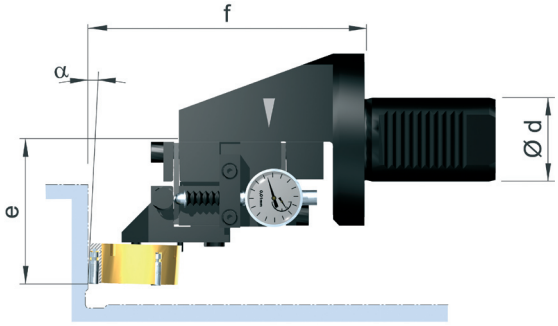
Four versions of this tool are available.
Please refer to the following illustrations and table.

Tool type — **EG5–3–VDI30** — *Shank: VDI = DIN 69880, SL = square shank*

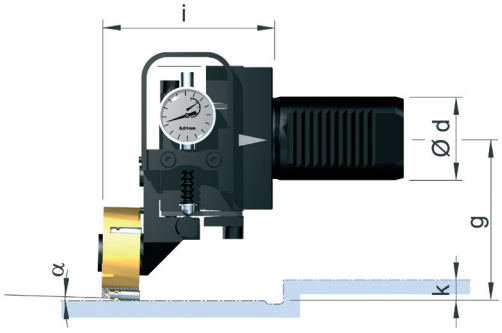
Design version: See illustrations. Specially designed tools for machining tapers by request.



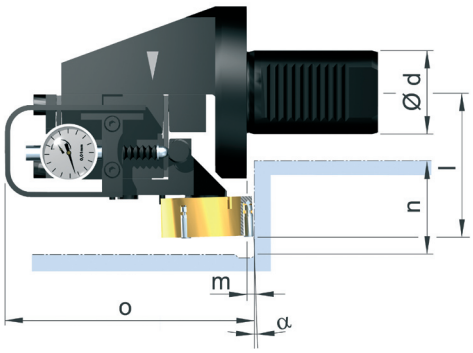
EG5, Design 1
Cylindrical surfaces



EG5, Design 2
Faces on the chuck side



EG5, Design 3
Cylindrical surfaces
Feed direction: toward tailstock



EG5, Design 4
Faces on the tailstock side

NOTE: *ECOROLL now delivers all EG tools with a coolant-lubricant supply. This table includes dimensions that do not take the coolant-lubricant supply into account. For information regarding the revised dimensions, please contact ECOROLL.*

Tool type	VDI shank Ø d[1] (mm)	Height (mm)		Square shank (mm)	Variable dimensions per design version (mm)											
					1			2		3			4			
		h_1	h_2	p[1]	a	b	c	e	f	g	i	k	l	m	n	o
EG5	20	45	67	16	78	82	120	64	111	78	84	10	84	3	44	120
	30		77	20				69								
	40		82	25					112							

NOTE: 1) *Optional sizes*

Type EG5 Tool Applications: Contours, fillets, groove flanks, short bores

Diameters 8.5 mm and larger

Features

- *For use with either CNC-controlled or conventional lathes*
- *Complete processing in one setting*
- *Achievable surface quality:*
  R_z < 1 µm (R_a = 0.2 µm)
- *Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45*
- *Modular construction allows these tools to be used in several configurations*
- *Symmetrical construction allows either right- or left-hand operation*
- *Rotates in either direction*

Advantages

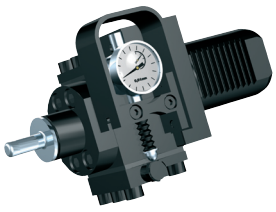
- *Short cycle time*
- *Eliminates set-up and auxiliary processing time*
- *No dust or grinding residue*
- *Minimal lubrication required (oil or emulsion)*
- *Accurately measured burnishing force ensures consistent, high quality results*
- *Unrestricted roller face makes roller burnishing of shoulders and other edges possible*
- *Easy to change wear parts*

Basic tool design

- *Tool body equipped with a tool shank, a spring assembly that allows the roller head to move with no play and very low friction*
- *Gauge that indicates the burnishing force*
- *Variable burnishing force dependent on spring deflection*
- *Feed in the direction of the arrow label on the tool*
- *Tool design includes fixed roller clearance angle* ***α***

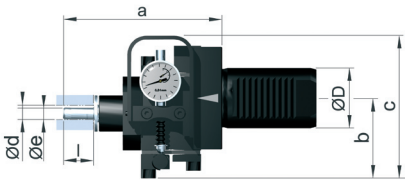
Parameters

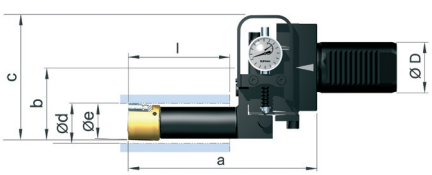
Tool	Circumferential speed	Feed rate
EG5-08F	80-100 m/min.	0.1-0.4 mm/ rev.
EGI5-32	80-150 m/min.	0.1-0.6 mm/rev.
EGI5		
EG5-40M	100-200 m/min.	0.1-0.8 mm/rev.
EG5-40M-45°		



EG5-08F

- *Roller burnishes groove flanks on the face or circumference and bores with diameters of 8.5 mm and larger*
- *Max. rolling depth: 20 mm for diameters of 8.5 mm and larger (EG5-08F)*
- *Max. rolling depth: 30 mm for diameters of 11.5 mm and larger (EG5-11F)*
- *Tool body's spring assembly positioned parallel to workpiece surface*
- *Floating roller head attached to the tool body's flexible, spring-loaded section*





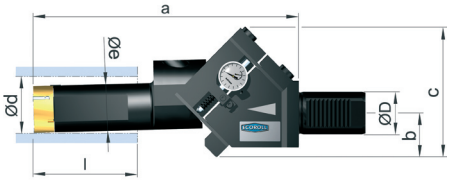
EGI5-32

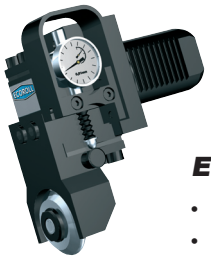
- *Roller burnishes bores with diameters of 32 mm and larger*
- *Maximum rolling length: 80 mm*
- *Tool body's spring assembly positioned parallel to workpiece surface*
- *Roller head attached to the tool body's flexible, spring-loaded section*
- *Roller head consists of a cage that guides the burnishing roller and a support roller with a large-scale needle bearing*

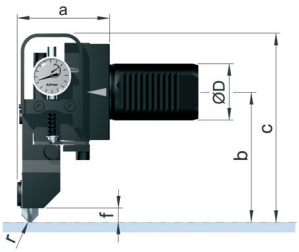
Tool Design and Specifications

EGI5

- *Roller burnishes bores with diameters of 55 mm and larger*
- *Maximum rolling length: 105 mm*
- *Tool body's spring assembly positioned at a 45° angle to workpiece surface*
- *Roller head attached to the tool body's flexible, spring-loaded section*
- *Roller head consists of a cage that guides the burnishing roller and a support roller with a large-scale needle bearing*
- *Cage also contains two spare rollers*

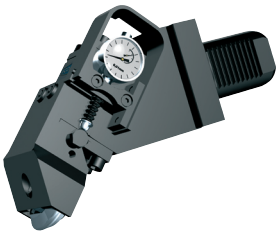


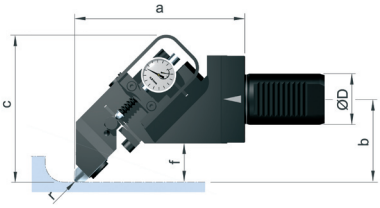




EG5-40M

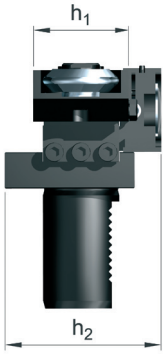
- *Roller burnishes contoured external surfaces*
- *For low and mid-level strength materials*
- *Tool body's spring assembly positioned parallel to workpiece surface*
- *Roller head attached to the tool body's flexible, spring-loaded section*
- *Extremely narrow roller with an integrated four-point bearing*





EG5-40M-45°

- *Roller burnishes cylindrical surfaces with connecting fillet radii up to the workpiece face*
- *For low and mid-level strength materials*
- *Tool body's spring assembly positioned at a 45° angle to workpiece surface*
- *Roller head attached to the tool body's flexible, spring-loaded section*
- *Extremely narrow roller with an integrated four-point bearing*



Tool type	VDI shank Ø D (mm)	Height (mm)		Square shank (mm)	Basic dimensions (mm)					
		h_1	h_2		a	b	c	d	e	l
EG5-08F	20,30,40	40	67-91	20 25 32	106	53	95	8.5 / 11.5	8 / 11	20/30
	50				117					
EGI5-32	20,30,40				150	58	99	32	24	80
	50				161					
EGI5	30, 40	63	81-90		252	41	122	55	44	100
	50									
										f
EG5-40M	20,30,40	50	67-91		66	92	134			10
	50				77					
EG5-40M-45°	20,30,40				136	65	115			30
	50				147					

NOTE: *ECOROLL now delivers all EG tools with a coolant-lubricant supply. This table includes dimensions that do not take the coolant-lubricant supply into account. For information regarding the revised dimensions, please contact ECOROLL.*

Type EG14 Tool Applications: External surfaces and bores, cylindrical and tapered

Diameters 120 mm and larger

Features

- *Machines cylindrical and tapered external surfaces, external or internal faces, and cylindrical and tapered bores (specially designed models available for tapers)*
- *For use with either CNC-controlled or conventional lathes*
- *Complete processing in one setting*
- *Achievable surface quality: R_z < 1 µm (R_a ≤ 0.2 µm)*
- *Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45*
- *Modular construction allows these tools to be used in several configurations*
- *Symmetrical construction allows either right- or left-hand operation*
- *Rotates in either direction*
- *Tool design includes fixed roller clearance angle **α***

Advantages

- *Short cycle time*
- *No auxiliary processing time necessary*
- *No dust or grinding residue*
- *Minimal lubrication required (oil or emulsion)*
- *Infinitely variable burnishing force*
- *Accurately measured burnishing force ensures consistent, high quality results*
- *Unrestricted roller face makes roller burnishing of shoulders and other edges possible*
- *Easy to change wear parts*

Parameters

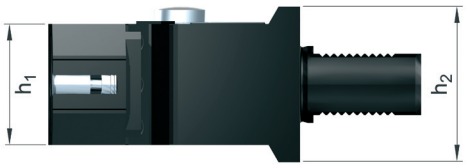
- *Maximum circumferential speed: 200 m/min.*
- *Maximum feed rate: 1 mm/rev.*
  ***NOTE**: Feed in the direction of the arrow label on the tool (see tools, following page)*
- *Maximum burnishing force: 10,000 N*

Bore Application

with Design Version 1 (see illustrations, following page)

Bore depth (mm)	≤ 25	≤ 50	> 50
Smallest bore diameter (mm)	120	150	180

Tool Design and Specifications



Basic tool design

Type EG14 single roller burnishing tools consist of a tool body equipped with a tool shank, a spring assembly that allows the roller head to move with no play and very low friction, and a gauge that indicates the burnishing force as measured by spring deflection. An optional device transmits the values by cable or wireless signal to an external indicator.

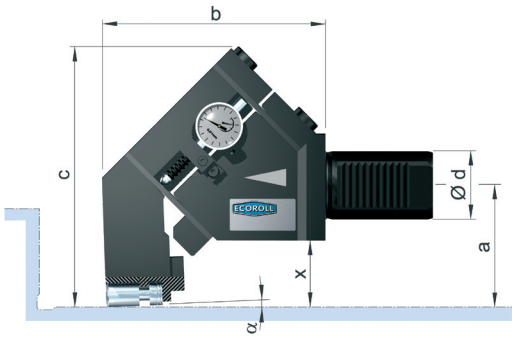
The roller head is attached to the flexible, spring-loaded section of the tool body. The roller head consists of a cage, which contains and guides the burnishing roller, and a support roller with a large-scale needle bearing.

How to order:

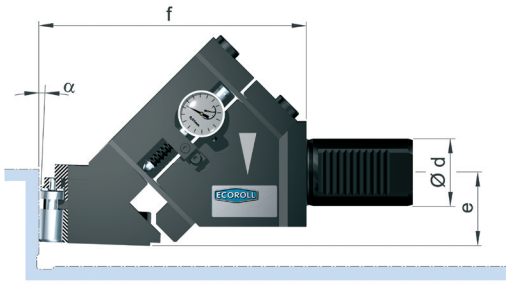
Four versions of this tool are available. Please refer to the following illustrations and table.

Tool type — **EG14–1–VDI50** — *Shank:*
VDI = DIN 69880, double toothed
SL = square shank
Specially designed shanks by request

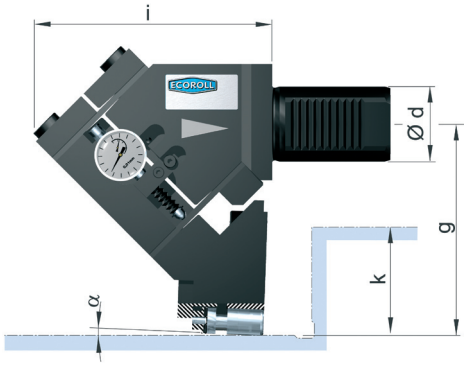
Design version: see illustrations. Specially designed tools for machining tapers by request.



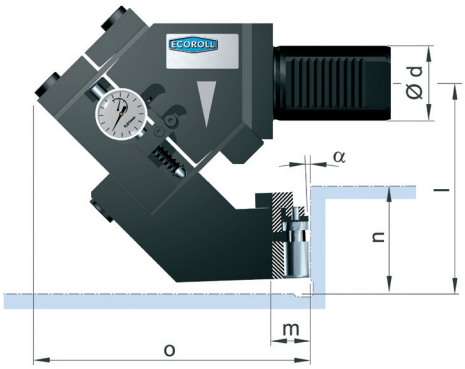
EG14, Design 1
Cylindrical surfaces



EG14, Design 2
Faces on the chuck side



EG14, Design 3
Cylindrical surfaces
Feed direction: toward tailstock



EG14, Design 4
Faces on the tailstock side

Tool type	VDI shank Ø d[1] (mm)	Height (mm)		Square shank (mm)	Variable dimensions per design version (mm)												
					1				2		3			4			
		h_1	h_2	p[1]	a	b	c	x	e	f	g	i	k	l	m	n	o
EG14	40	63	81	25 or 32	71	131	152	43	40	159	113	127	50	106	20	50	147
	50		90						45								
	60		110			150			50	166		124			13		

NOTE: 1) *Optional sizes*

ECOROLL now delivers all EG tools with a coolant-lubricant supply. This table includes dimensions that do not take the coolant-lubricant supply into account. For information regarding the revised dimensions, please contact ECOROLL.

Type EG45 Tool Applications: Fillets and contours

Features

- For use with either CNC-controlled or conventional lathes that can copy contours
- Complete processing in one setting
- Suitable for metals with tensile strength up to 1400 N/mm² and maximum hardness HRC ≤ 45
- Achievable surface quality: R_z < 1 µm (R_a = 0.2 µm)

EG45-40M

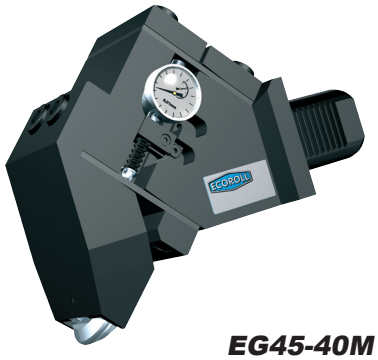
- Roller burnishes cylindrical surfaces with connecting fillet radii up to the workpiece face
- For materials with low to mid-level strength

EG45-45T

- Roller burnishes cylinders and faces in addition to connecting fillets up to a 75° inclination
- High burnishing force can machine high-strength materials

EG45-45F

- Roller burnishes convex and concave forms with a floating roller head specially adapted to the workpiece
- Operates in plunge-in or feed mode



EG45-40M

EG45-45T

Advantages

- Simultaneously eliminates micro-notches and induces residual compressive stresses through cold working
- Short cycle time
- Eliminates set-up and auxiliary processing time
- No dust or grinding residue
- Minimal lubrication required (oil or emulsion)
- Infinitely variable burnishing force
- Accurately measured burnishing force ensures consistent, high quality results
- Easy to change wear parts

Parameters

- Maximum circumferential speed: 300 m/min.
- Maximum feed rate: 1 mm/rev.

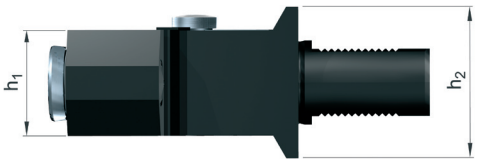
Radius Application

Tool type	Workpiece radius R to be burnished with roller radius r (mm)					
	0.8	1.2	1.6	2.5	4	6.3
EG45-40M	0.8 - 3	1.2 - 5	2.5 - 8	4 - 12	6 - 40	
EG45-45T	0.8 - 3	1.2 -5	2-8	3 - 12	5 - 20	8 - 63
EG45-45F	Rollers specially designed according to workpiece shape.					

Tool Application Ranges

Yield strength R_p0.2 N/mm²	≤ 160	≤ 250	≤ 400	≤ 630	≤ 1000
Workpiece Ø ≤ 25 mm	EG45-45T EG45-45F EG45-40M				EG45-45T EG45-45F
Workpiece Ø ≤ 100 mm	EG45-45T EG45-45F EG45-40M			EG45-45T EG45-45F	
Workpiece Ø ≤ 160 mm	EG45-45T EG45-45F EG45-40M		EG45-45T EG45-45F		
Workpiece Ø ≤ 250 mm	EG45-45T EG45-45F EG45-40M	EG45-45T EG45-45F			

Tool Design and Specifications



Basic tool design

Type EG45 single roller burnishing tools consist of a tool body equipped with a tool shank, a spring assembly that allows the roller head to move with no play and very low friction, and a dial indicator that indirectly measures the burnishing force.

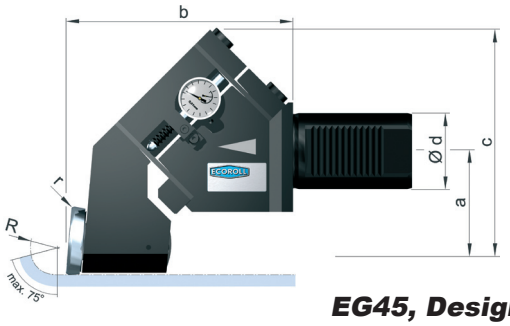
The roller head is attached to the flexible, spring-loaded section of the tool body. EG45-45T and -45F are equipped with floating rollers, and EG45-40M comes with a smaller roller. Because of its structure, EG45-40M has a lower load capacity.

How to order:

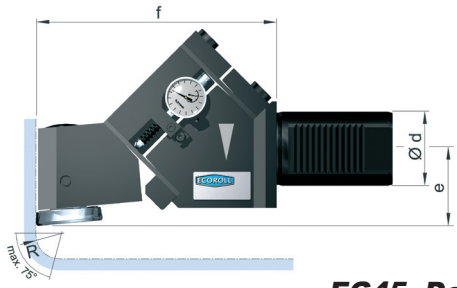
Four versions of this tool are available. Please refer to the following illustrations and table.

EG45–1–40M–R2.5–VDI50

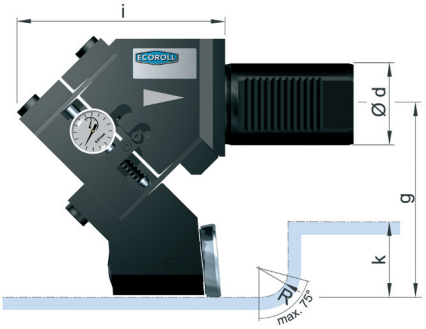
- EG45: *Tool type: Single roller burnishing tool with a spring system loaded at a 45° angle*
- 1: *Design version: see illustrations*
- 40M: *Roller diameter and design*
- R2.5: *Roller with radius of 2.5 mm*
- VDI50: *Shank VDI 50, SL=square shank*



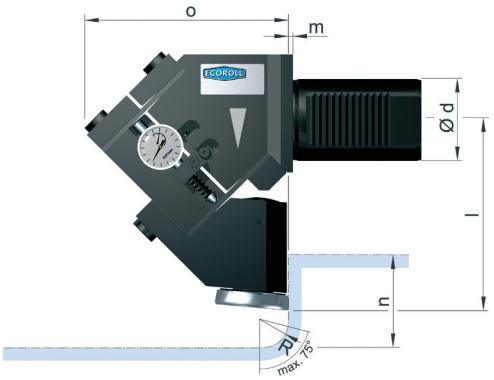
EG45, Design 1
Cylindrical surfaces,
including adjacent fillets



EG45, Design 2
Faces on the chuck side,
including adjacent fillets



EG45, Design 3
Cylindrical surfaces, including adjacent fillets
Feed direction: toward tailstock



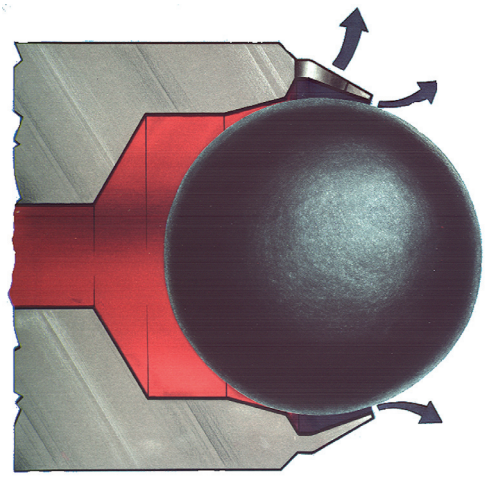
EG45, Design 4
Faces on the tailstock side,
including adjacent fillets

Tool type	VDI shank Ø d (mm)	Height (mm)		Square shank (mm)	Variable dimensions per design version (mm)											
					1			2		3			4			
		h_1	h_2	p	a	b	c	e	f	g	i	k	l	m	n	o
EG45-45T	40,50	63	81-110	25 or 32	81	149	162	52	163	118	127	48	116	3	72	124
	60					156			170		134					
EG45-40M	40,50				69	129	150			108	126					
	60					136					134					

ECOROLL now delivers all EG tools with a coolant-lubricant supply. This table includes dimensions that do not take the coolant-lubricant supply into account. For information regarding the revised dimensions, please contact ECOROLL.

Hydrostatic Tools

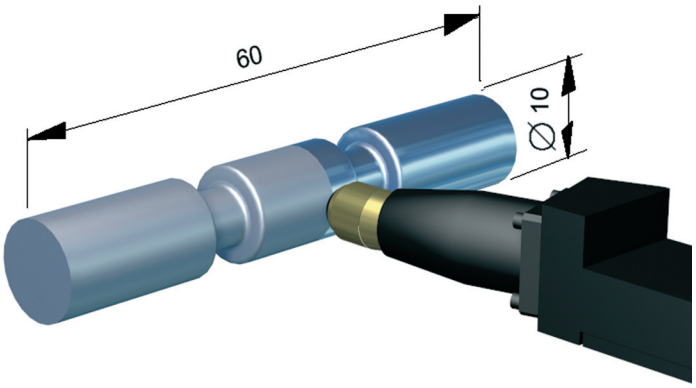
ECOROLL's hydrostatic HG tools can roller burnish and deep roll even the most complex contours and free-form surfaces. The HG tools can be applied with CNC-controlled lathes, drills, milling machines and machining centers as well as with manually controlled machines. HG tools can process materials up to a hardness of 65 HRC.



HG burnishing ball and ball retainer; arrows signify direction of fluid leakage

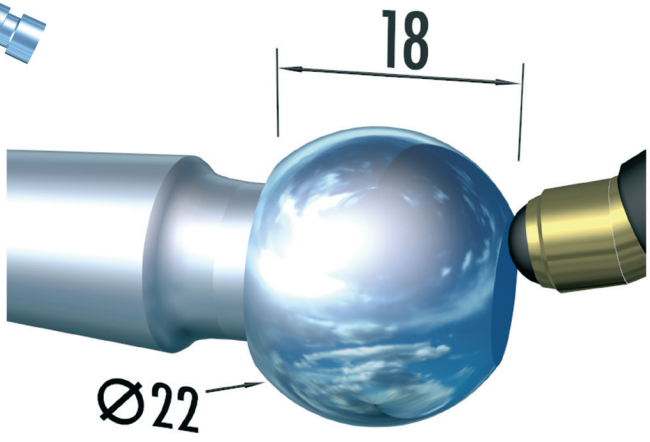
This group of tools includes types HG2 – HG25.

The unique HG tool design is based on a burnishing ball made of an especially hard material. This ball is hydrostatically suspended by pressurized liquid, either water soluble coolant or oil. The ECOROLL HGP line of pumps supply the tools with a consistent, controllable source of operating pressure. This pressure generates the burnishing force that is applied as the ball rotates against the workpiece surface.



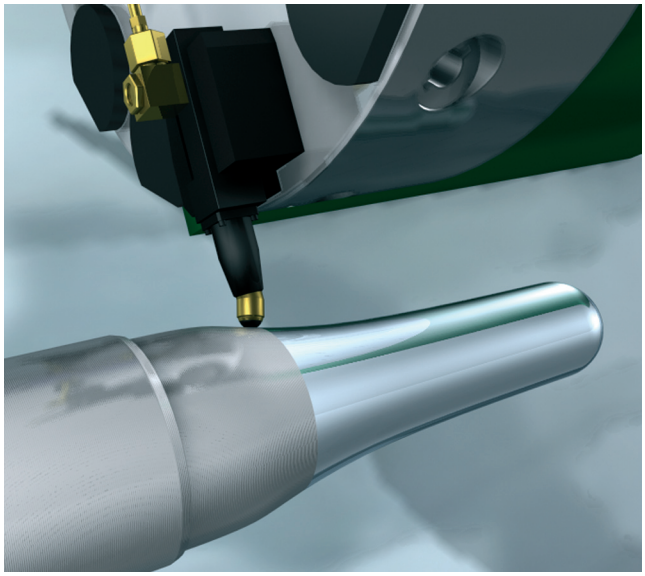
Machining a control valve piston with an HG6 tool to optimize sliding performance.

Deep rolling a valve with an HG6 tool to improve its fatigue strength.



Machining a ball stud with an HG6 tool.

Type HG Tool Applications: Complex contours and deep rolling



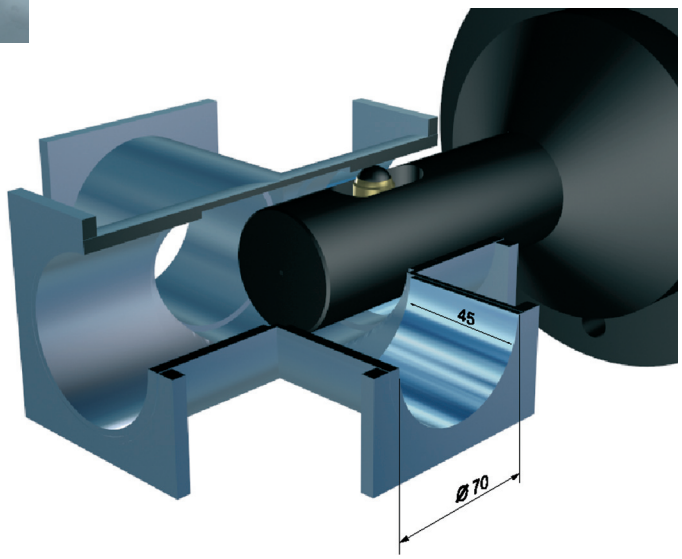
Machining a hard, contoured mandrel with an HG6 tool eliminates manual polishing.

The ECOROLL HG tools can often machine complex shapes that standard roller burnishing tools cannot.

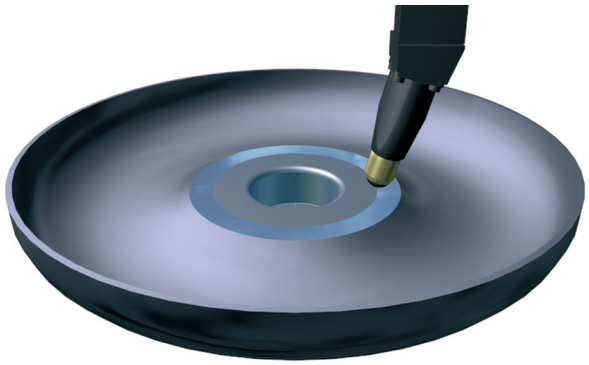
The hydrostatically loaded ball can freely rotate in any direction within the ball retainer, even at high speed.

The hydrostatic bearing maintains a supporting fluid film between the ball and the ball seat, independent of the distance between the tool and the workpiece.

The HG tool's unique following system enables the burnishing ball to follow the workpiece contour while maintaining a constant burnishing force.



Machining a valve housing with an HG13 tool.



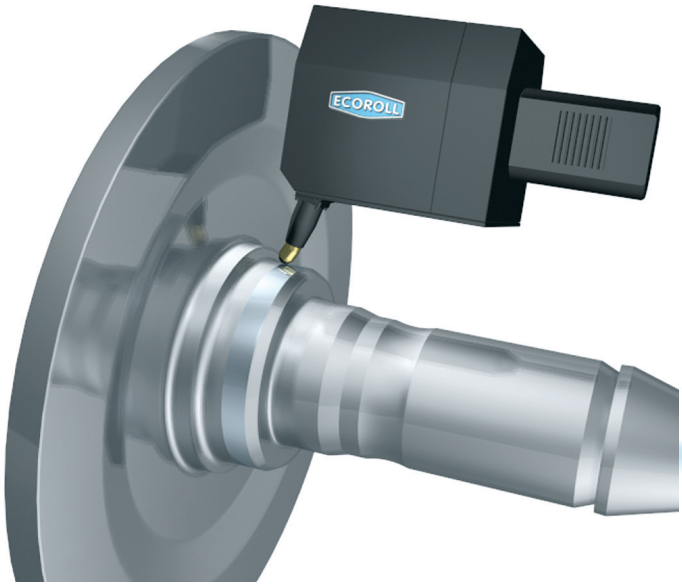
Roller burnishing a torque converter housing with an HG13 tool to improve its sliding properties.

Deep rolling with HG tools dramatically increases the fatigue strength and operating life of dynamically loaded parts and components contstructed of lightweight materials.

The process induces residual compressive stresses in the component's surface layer and simultaneously improves the material's strength and surface finish through plastic deformation, or cold working.

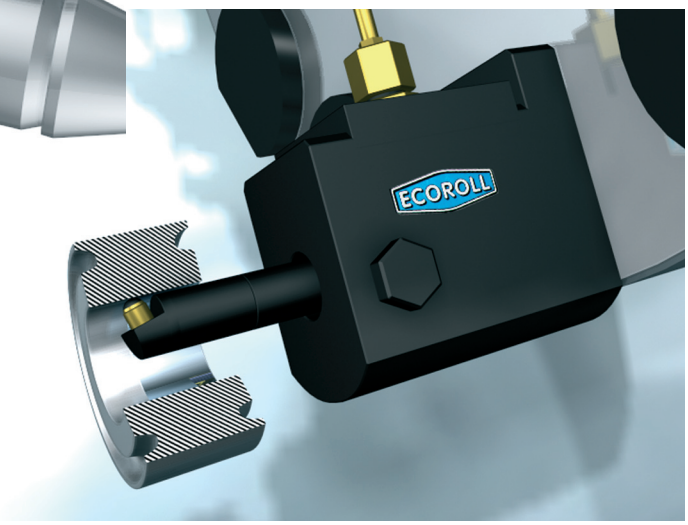
Type HG Tool Applications: Hard roller burnishing

With the exception of HG2 and HG25, the entire HG tool line can burnish hardened steel and other alloys with hardnesses up to 65 HRC.

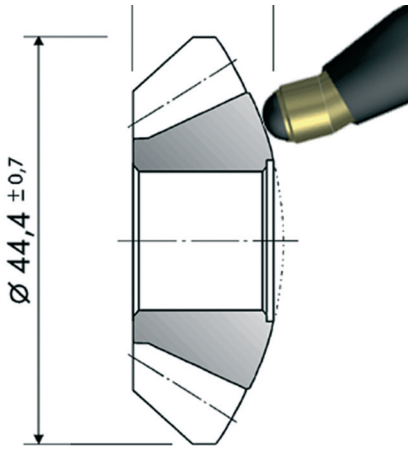


Deep rolling the fillet radius of an axle shaft to increase fatigue strength.

Using the HG line of tools reduces overall machining costs. One HG tool can be used for multiple applications.



Hard rolling a roller rocker arm with an HG6 tool eliminates an extra lapping operation.



Machining a bevel gear with an HG6 tool.

How to order:

HG tools are available in a wide variety of versions. Please refer to the information on page 35 and the naming conventions listed on the following page.

Tool type and ball size — **HG13–9–L–15°–SLK–25**

- *Design version*
  - *L = left-handed*
  - *R = right-handed*
  - *K = ball (HGx–6)*
  - *H = fillet (HGx–6)*
- *Setting angle* **α**
- *VDI = VDI shank*
  SL = square shank
  SLK = short square shank (tool holder DIN 89880)
- *Shank size*

Tool type and ball size — **HG6–5–E–90°–VDI20–Sauter**

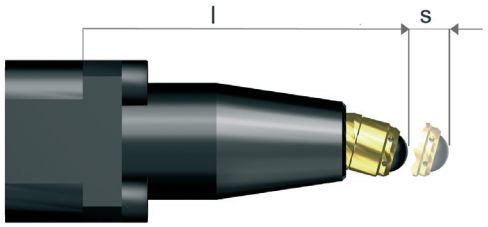
- *Design version*
  - *E = one burnishing element*
  - *Z = two burnishing elements*
- *Setting angle* **α**
- *VDI = VDI shank*
  SL = square shank
  SLK = short square shank (tool holder DIN 89880)
- *Turret head manufacturer (only HGx-5 and HGx-6)*

Hydrostatic Tool Design and Specifications

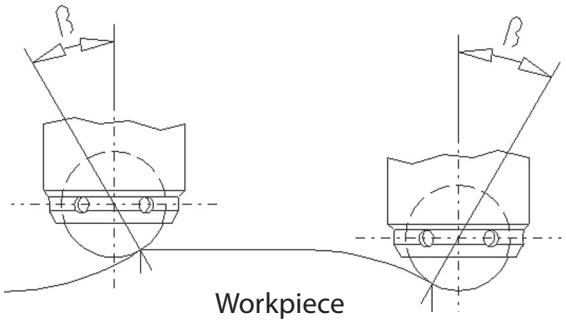
Ball size

The HG line features tools in a wide range of sizes with burnishing balls from 2 – 25 mm in diameter. The tools are classified according to approximate ball size. For example, the diameter of a ball in an HG6 tool is in the 6 mm range. To maximize the level of compressive residual stresses, use the tool with the largest possible ball diameter.

NOTE: *Workpiece contours ultimately determine ball size.*



HG ball size	Max. burnishing force	Max. angle range (ß)	Stroke (s)	Length (l)
HG2	90N	± 22.5°	2 mm	35 mm
HG3	250N	± 22.5°	4 mm	42 mm
HG4	500N	± 30°	5 mm	50 mm
HG6	1000N	± 30°	6 mm	50 mm
HG13	4000N	± 35°	8.5 mm	69 mm
HG25	4000N	± 30°	8.5 mm	82 mm



Design version

Because HG tools can be used across a wide spectum of applications, many different design versions are available. HG tools are classified by design version in addition to ball size. For example, an HG6-2 tool has a ball with a 6 mm diameter and is used for burnishing inner diameters. The following table lists the design versions and their related applications.

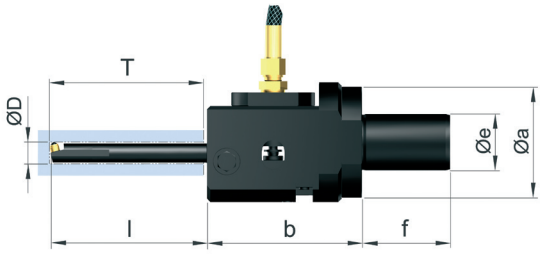
NOTE: *The tools are listed as follows: HG**x**-**y**, where **x** indicates the ball size and **y** the design version.*

HG design version	Application
HGx-1	internal diameters (cylindrical and tapered bores)
HGx-2	internal diameters (cylindrical bores)
HGx-4	internal diameters (narrow cylindrical bores)
HGx-5	complex contours (cylinders, tapers, faces, fillets, spheres)
HGx-6	spherical contours
HGx-7	faces and free-form surfaces
HGx-9	rotationally symmetrical surfaces (cylinders, tapers, faces, fillets, spheres)
HGx-10	spherical contours
HGx-11	special tool design versions (e.g. internal diameters – narrow cylindrical bores)
HGx-19	rotationally symmetrical surfaces (cylinders, tapers, faces, radii, slanted faces and other outer and inner contours)
HGx-20	3-point tool (3 burnishing balls), outer diameters of narrow cylinders
HGx-23	Complex external surfaces (such as transition area near steering knuckle radius)
HGx-29	2-point tool (2 burnishing balls), treats both sides of disc-like and thin-walled components (such as turbine blades) in one pass

Design Versions HGx-1, HGx-2, HGx-4, HGx-11
Application: Internal diameters

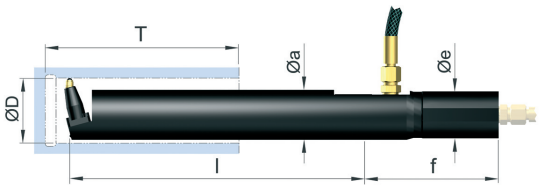
HGx-1

- For bore sizes ≥ 19 mm
- Available with burnishing balls up to 6 mm in diameter
- For use with lathes, boring mills and machining centers
- Available with rotating union DD for rotating applications (see page 37)
- Ball insert, mounted at the end of a lever, operated by the tool body's tracking system
- Initial diameter setting: adjust machine slide into approximate radial position
- Tracking system automatically fine-tunes diameter setting



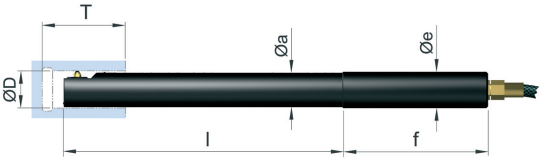
HGx-2

- For bore sizes ≥ 70 mm (HG6-2) and ≥ 125 mm (HG13-2)
- Similar to previous tools, but shank diameter = 50 mm
- Rigid shank allows rolling lengths of up to 800 mm
- Equipped with standard burnishing elements



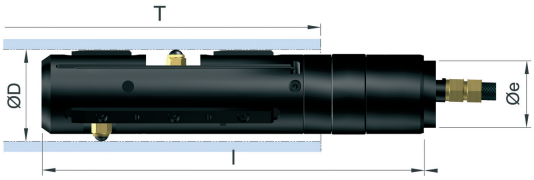
HGx-2P

- Available only with 6mm burnishing balls (HG6)
- For internal roller burnishing of narrow bores (similar to a boring bar)
- For use with boring bar holders on both conventional and CNC-controlled lathes
- Shank includes two clamping faces
- Maximum rolling length: 350 mm



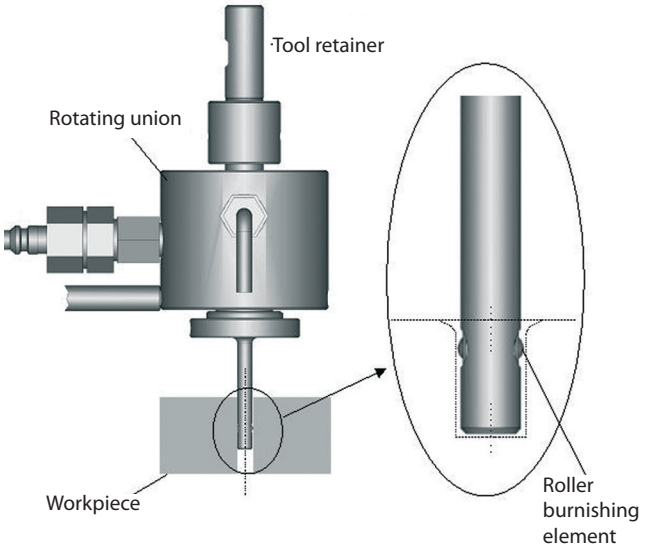
HGx-4

- For bore sizes 50 - 150 mm
- For use with deep hole boring machines
- Mounted on boring bar with standard BTA thread connection
- Unlimited rolling length
- Guide pads center the tool in the bore (approximate position)
- Allowable bore size variation: 2 mm



HGx-11 (Special version)

- For internal diameters (holes)
- Diameter sizes 6 - 33 mm
- Each diameter size requires a customized rolling head



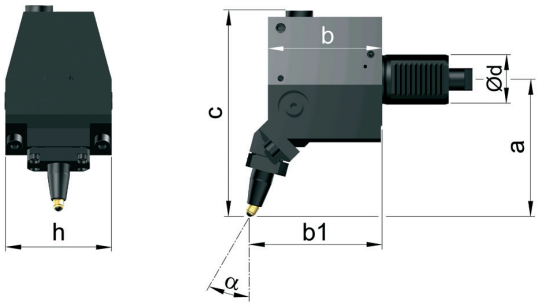
How to order:

HG tools are available in many versions.
Please refer to the the information on page 35 and the following naming conventions.

Tool type and ball size — **HG13–9–L–15°–SLK–25**

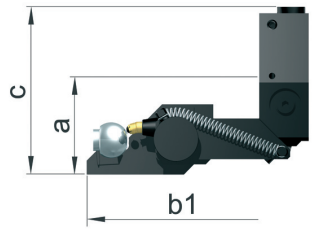
- Design version
  - L = left-handed
  - R = right-handed
  - K = ball (HGx–6)
  - H = fillet (HGx–6)
- Setting angle **α**
- Shank size
  - VDI = VDI shank
  - SL = square shank
  - SLK = short square shank (tool holder DIN 89880)

Design Versions HGx-5, HGx-6, HGx-9, HGx-10, HGx-19 Applications: Rotationally symmetrical surfaces and complex contours



HGx-5

- *Applied on CNC-controlled lathes equipped with tool drive systems*
- *Integrated high pressure pump eliminates the need for external pressure supply*
- *Simply insert the tool into the turret head and it is ready for operation*
- *Can be equipped with VDI-shanks (with diameters of 20 - 80 mm) for all conventional drive systems*
- *Symmetrical design and double-toothed shank allows right- or left-handed use*

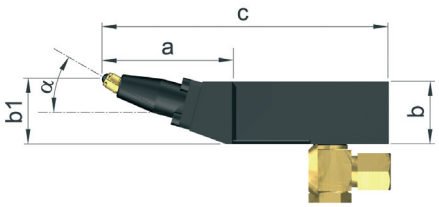


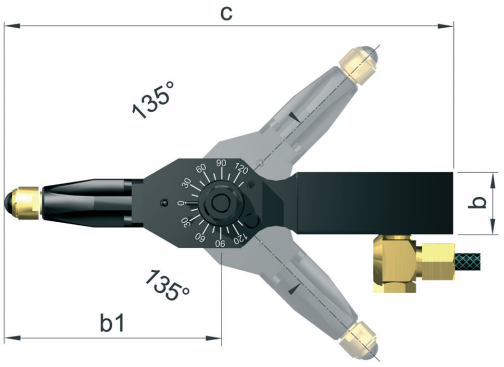
HGx-6

- *Similar to HGx-5, but with swiveling burnishing element for burnishing balls and rounded surfaces*
- *Integrated high pressure pump eliminates the need for external pressure supply*
- *HG13-6R roller burnishes fillets*

HGx-9

- *For use with conventional and CNC-controlled lathes*
- *Shank heights from 20 - 32 mm*
- *Both right- and left-handed tools available*
- *Setting angle range: 0 - 90° in 15° increments*
- *Pressure supplied through the shank either from the side or the rear*
- *HG2-9 for deep rolling only, comes with an integrated square shank, but adapters for mounting with standard square shanks are available*





HGx-10

- *Recommended for use with conventional and CNC-controlled lathes*
- *Designed to roller burnish spherical contours and fillets*
- *Swivelling device permits continuous adjustment of the inclination during the process*
- *Both right- and left-handed tools available with standardized square shank heights for standard tool-holding fixtures*

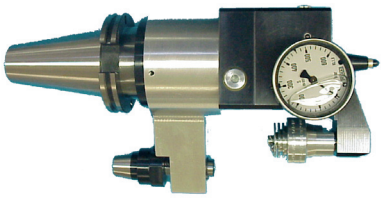
HGx-19

- *For roller burnishing and deep rolling hard materials up to 65 HRC*
- *Can machine all rotationally symmetrical and free-form surfaces*
- *Hydraulically generated burnishing force can be accurately measured and controlled, ensuring consistent, high quality results*
- *Equipped with VDI shank, cylindrical shank, HSK shank or Capto shank*

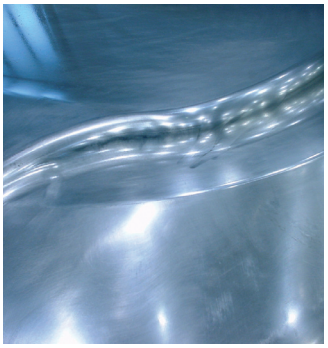
Design Versions HGx-7, HGx-20, HGx-23, HGx-29 Applications: Faces, free-form surfaces and outer diameters

HGx-7

- *For roller burnishing and deep rolling faces and free form surfaces on machining centres and milling machines*
- *For materials up to 65 HRC*
- *Complex shapes that cannot be machined with conventional roller burnishing tools can be treated with hydrostatic tools*
- *Integrated high pressure pump eliminates the need for external pressure supply*



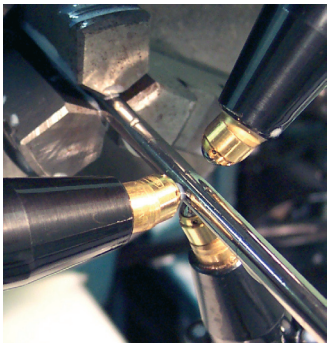
HG4-7



Free form surface

HGx-20

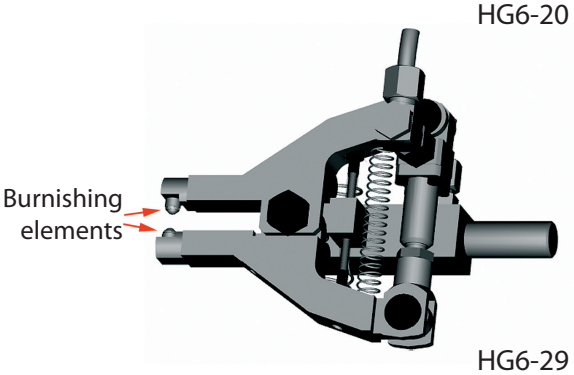
- *For roller burnishing and deep rolling the outer surfaces of thin cylinders (with diameters ≥ 0.5 mm)*
- *Integrated supports and two fixed burnishing elements prevent the workpiece from bending, while a third burnishing element deep rolls the surface*
- *Consistent product quality is ensured: the burnishing force depends on an outside pressure source that can be closely measured and monitored*
- *Equipped with three hydrostatically loaded roller burnishing balls*
- *Tool comes with a square shank, but other tool shanks are available*



HG6-20

HGx-23 *(not pictured)*

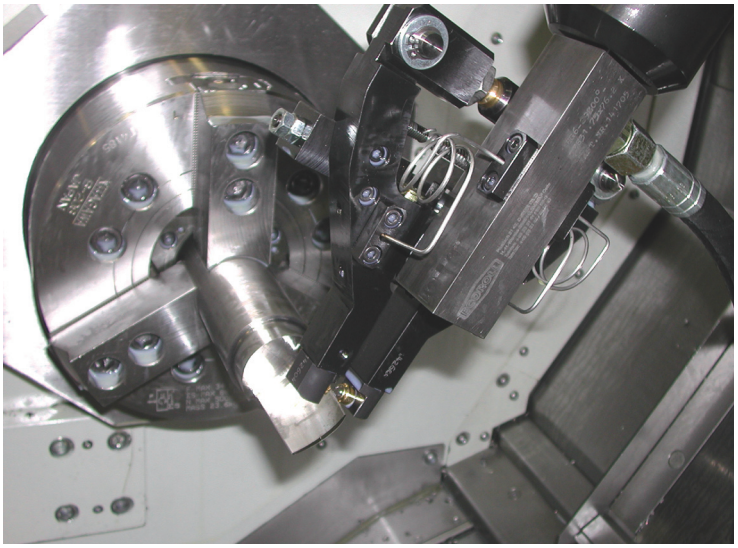
- *Specially designed to machine the outer contours of axles*
- *The workpiece remains static while the burnishing element rotates*
- *For materials up to 65 HRC*
- *Consistent product quality is ensured: the burnishing force depends on an outside pressure source that can be closely measured and monitored*



HG6-29

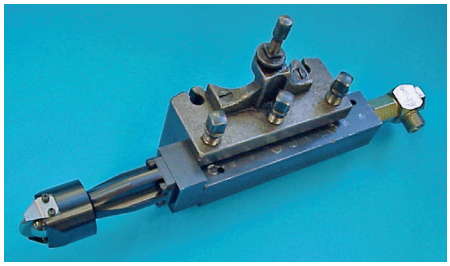
HGx-29

- *Designed to treat both sides of disc-like and thin-walled components such as turbine blades in one pass*
- *Can be used with both conventional and CNC-controlled machine tools*
- *Processes hardened materials up to a hardness of 65 HRC*
- *Consistent product quality is ensured: the burnishing force depends on an outside pressure source that can be closely measured and monitored*
- *Equipped with a cylindrical shank, but other standard tool shanks are available*



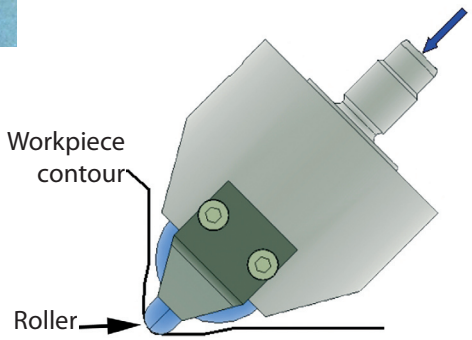
Festwalzen mit HG6-20

Design Version HG with HFR Roller Application: Deep rolling fillets



Features

- *Deep rolls small, hard-to-reach fillets (R < 2.5 mm)*
- *Deep rolls hardened workpieces up to 65 HRC*
- *Deep rolls in a plunge-in process with rolling forces up to 15 kN*
- *Operating pressure: 200 - 1500 bar*



Advantages

- *Noticeable increase in fatigue strength*
- *Improved surface quality*
- *Machining can be completed in one setting*
- *Extra hardening process unnecessary*

How to order HG tools

*The tools are listed as follows: HG**x**-**y**, where **x** indicates the ball size and **y** the design version. See also the naming conventions on pages 30 and 31. The lettered dimensions refer to the diagrams pictured with the respective tools.*

Tool	Diameter range D	Rolling length T	a	b	Ø e	f	l
HG6-1	≥ 19	50/80/125	106	131/161/206	40[1)]	136	60/90/135
HG6-2	≥ 70	200/400/600/800	53		50	145	T+40
HG6-2P	≥ 40	200/300	38		40	120	200/350
HG13-2	≥ 125	800	60		63	90	1000
HG13-4	≥ 50	unlimited	49		BTA boring bar thread lead per order		260

NOTES: 1) *With design version DD (rotating union) maximum shank Ø = 32 mm*

Tool	Ball D	Fillet R	a	b[2)]	b_1[2)]	c	d	h	Contact angle α
HG2-9E45°-SL		> 2.5	57	32	61	205		20 25 32	45°
HG2-9V70°-SL			68		72	216			10° or 80°
HG3-9E45°-SL		> 4	69		73	217			45°
HG3-9V70°-SL			80		84	228			10° or 80°
HG6-9._-SL(K)		> 5	66		33	216(148)			30°[3)]
HG13-9._-SL(K)		> 10	80		96	228(160)			
HG6-9E270-SL(K)		> 5			90	276(208)			adjust in 15° increments
HG13-9E270-SL(K)		> 10			111	298(230)			
HG6-5_°-VDI		> 5	100	89	142	130	20 or 30	50	30°[3)]
HG6-5_°-VDI		> 5	109	91	109	164	40 or 50	85 or 100	
HG13-5_°-VDI		> 10	128		162	178	60 or 80	125 or 160	
HG6-6_-VDI		8-25	by request				20 or 30	50	infinitely variable
HG6-6_-VDI40	8-70						40	85	
HG13-6_-VDI	50-250	20-80					40/50/60	by request	

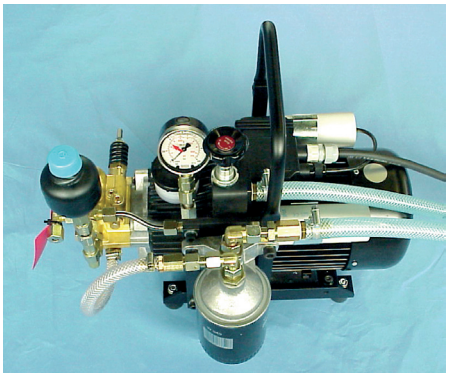
NOTES: 2) *For operation without VDI shank other values apply. Please ask ECOROLL.*
3) *Adapters can be converted to accommodate setting angles of 0°, 60° and 90°. Please request modified dimensions.*

Accessories for Type HG Tools: Type HGP High Pressure Pumps

HGP hydraulic pump units provide pressure to the HG "ballpoint" type hydrostatic tools or to other tools without integrated pumps.

Using the pump unit can prevent rounded workpiece edges in the areas where burnishing begins or ends. The unit gradually increases and decreases the rolling pressure. During deep rolling the unit can be used to create smooth transitions to unburnished areas.

- *Can be used with conventional lathes, machining centers, and CNC-controlled lathes without tool drives*
- *Portable or fixed versions available*
- *The pump runs with a standard three-phase motor; single phase motors available by request*
- *On CNC-controlled lathes the M-function can activate the pump and control pressure supplied to the tool*



HGP 3.0

HGP 3.7

How to order:

Pump type: see below

HGP3.0 — **Pump design: see below**

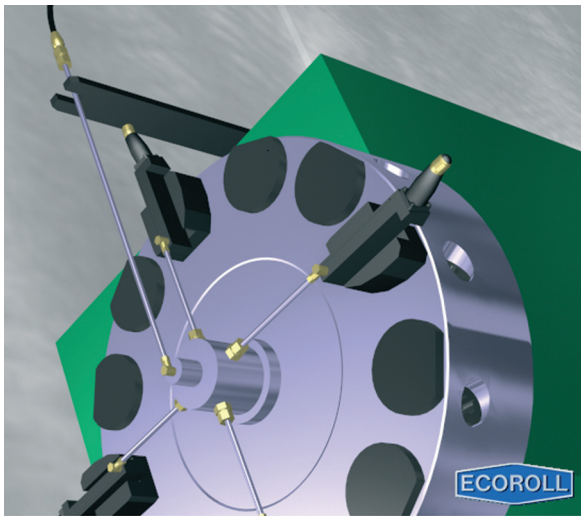
Pump type	Max. Pressure (bar)	Max. amount of burnishing elements (HG tool)				
		HG2	HG3	HG6	HG13	HG25
HGP3	200	12	10	8	6	6
HGP4	400	5	4	3	2	2

Pump Design	Description
.0	Portable (by hand), direct start/stop controls, pressure build-up without delay, no switch box
.2	Portable (on a cart), roller burnishing and deep rolling with pressure accumulator(s) and solenoid valve, CNC control with M-function or with manual control cable, includes switch box
.3	Integrated into the machine's coolant tank, roller burnishing and deep rolling without pressure accumulator, CNC control with M-function , no switch box
.4	Integrated into the machine's coolant tank, roller burnishing and deep rolling with pressure accumulator(s) and solenoid valve, CNC control with M-function, no switch box
.5	Portable (on a cart), roller burnishing and deep rolling with pressure accumulators and solenoid valve, CNC control with M-function or with manual control cable, includes switch box
.7	Portable (on a cart), roller burnishing and deep rolling without pressure accumulator, CNC control with M-function or with manual control cable, no switch box

Accessories for Type HG Tools: Integrated High Pressure Pump

- *Standard for HGx-5, HGx-6, HGx-7*
- *For use with CNC-controlled lathes equipped with tool drive systems and standard DIN 69880 tool mounts (VDI shank) with diameters of 20 - 80 mm*
- *Coolant (under low pressure) supplied through the turret head*
- *Tool drive system activates the pump*
- *Clockwise or counter-clockwise rotation*
- *Maximum speed of 3000 rpm*
- *Built-in pressure relief valve limits the maximum pressure to 400 bar*
- *Available pressure gauge for adjusting burnishing force*
- ***The machine tool must be equipped with a filter for the coolant lubricant (nominal mesh size ≤ 40 µm).***

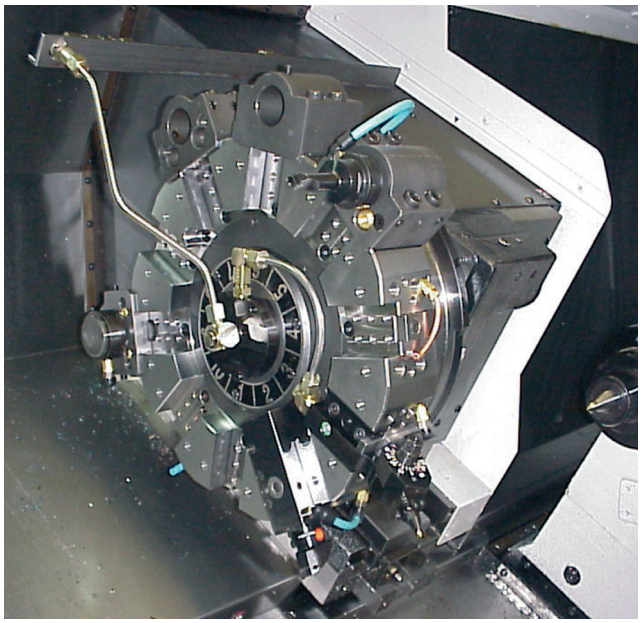
Accessories for Type HG Tools: DD Rotating Unions



DD/DS Rotating Union

On a CNC-controlled lathe without a tool drive system, the DS rotating union can supply up to four tools with high pressure emulsion.

This rotating union is centrally mounted on the face side of the turret. Fixed pressure lines run from the coupling's rotor to the tool(s). The coolant supply is connected to the rotating union's stator and to an external hydraulic pump unit (via a high pressure hose).



DD/DE Rotating Union

The DE rotating union supplies high pressure emulsion to just one tool.

Deep Rolling Tooling Technology

Advantages of deep rolling

Deep rolling significantly improves the surface layer characteristics of metal components subject to dynamic loading. This proven mechanical process has been successfully used for decades across a wide variety of industries to increase fatigue strength and service life. The process is especially well suited for treating rotationally symmetrical parts; however, with modern tooling technology the process can be used to treat free-form surfaces and thin-walled components as well.

Deep rolling can be used to treat:

- *material fatigue due to dynamic loading (e.g. rotating bending or torsion)*
- *stress concentration or notch effect due to sharp-edged transition zones, scoring or grooves from prior processing, pitting or fretting corrosion*
- *low fatigue strength due to residual tensile stress left by prior processing (e.g. welding or machining)*
- *stress corrosion cracking*
- *fatigue due to rolling contact*

Deep rolling is the only metal improvement process that induces residual compressive stresses and cold work while burnishing the workpiece's surface to a high quality finish. The deep rolling process combines these three effects to dramatically increase fatigue strength.

In deep rolling, one or more rollers or balls are pressed against the workpiece surface. When the pressure in the contact zone exceeds the material's yield point, the material in the surface layer is plasticized and formed. The resulting comparison stress depth profile according to Hertz demonstrates a maximum value just below the surface layer and reaches nearly zero deep in the workpiece. While the surface layer is plastically formed, at deeper levels only elastic formation occurs. The profile of the resulting compressive stresses always cycles toward a minimum value just at or below the workpiece surface where the greatest compressive stresses are induced.

During the process, the rollers subject the surface roughness peaks to the greatest load. As these peaks are pressed down, the material flows to the sides, filling the valleys and raising the valley level. The assumption that this process leads to surface compression is true only for porous materials. Depending on the application, deep rolling changes the workpiece diameter or dimensions only within the µ-range. Allowances can be made in the pre-machining stage to accommodate these slight variations.

Because the plastic deformation takes place below the material's recrystallization temperature, cold working is induced. The plastic forming process introduces disruptions into the material's lattice structure. The increased density caused by this structural change increases the surface layer's strength and can also prevent cracks or delay crack growth.

Deep rolling process

In its kinematics, the deep rolling process is similar to turning or milling. As shown in the illustrations on the next page, deep rolling can be performed as a plunge-in process with in-feed (for small radii), with linear feed, or with a special feed motion to accommodate free-form surfaces. To avoid the formation of steep inclines at the workpiece surface, the deep rolling force and pressure is built up slowly. This gradual increase prevents stress concentration.

Because the kinematics are relatively simple, the process can be applied on conventional machine tools. Deep rolling tools — including the hydrostatic HG "ballpoint" line — can also be used with CNC-controlled lathes and milling machines. On standard machines and machine tools, the components can be deep rolled right after cutting in the same setting. Specialized machines can be used to deep roll components such as crankshafts and piston rods in large series production.

Deep rolling: plunge-in process

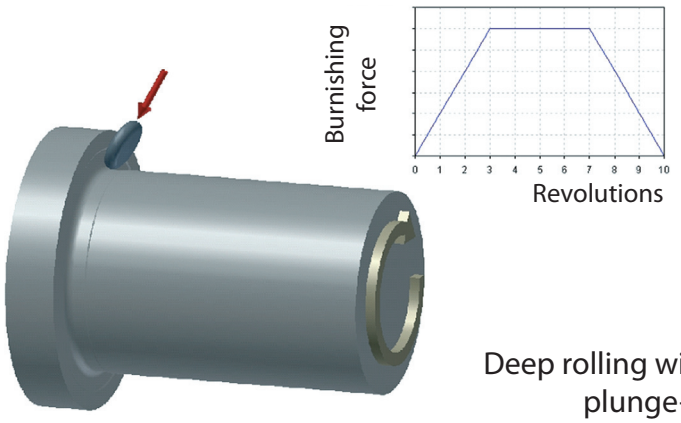
The profile rollers used in this process are specially designed for the radius of the fillet to be treated. The roller(s) are positioned such that the deep rolling force is concentrated on the area that experiences the highest tension or material fatigue under operating load.

The adjustable rollers incline automatically to match the workpiece form (the fillet radius in this example). As a result, the process distributes residual compressive stresses exactly as desired.

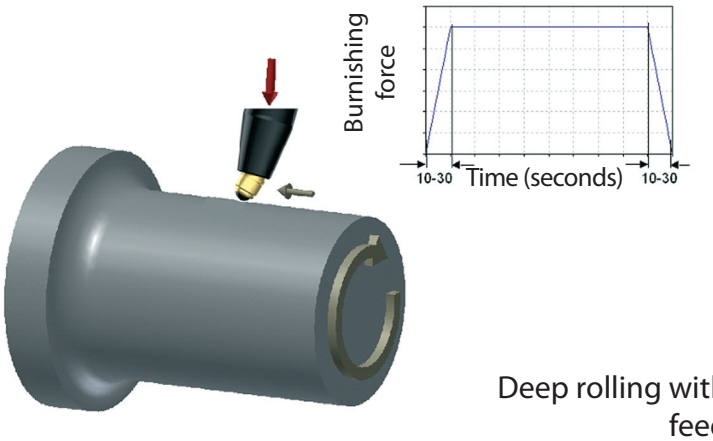
The plunge-in process requires two movements:

- *rotation (either the tool or workpiece rotates, depending on machine and workpiece type)*
- *in-feed (in the axial direction for multi-roller tools; in the direction of the deep rolling force for single roller tools)*

This process works well for narrow, hard-to-reach areas, such as screw threads or fillets with radii R < 4 mm.



Deep rolling with plunge-in

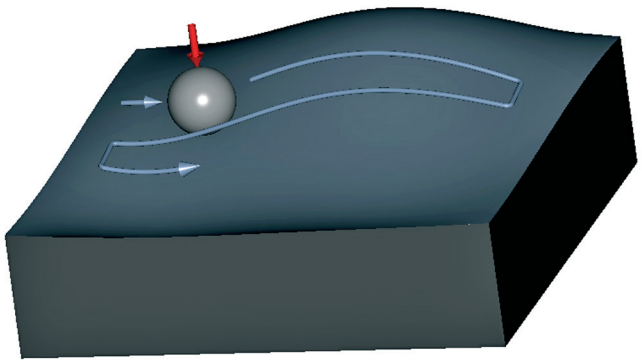


Deep rolling with feed

Deep rolling: feed process

This process works well for machining larger surfaces. The rotation and in-feed movements required for the plunge-in process are supplemented here by a simultaneous linear feed.

Both mechanical and hydrostatic tools can be used for this process.



Deep rolling a free-form surface

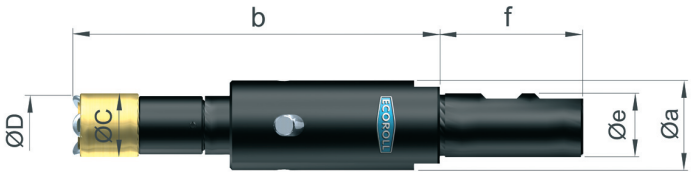
Deep rolling with hydrostatic tools

Hydrostatic "ballpoint" tools can deep roll not only rotationally symmetrical surfaces, but also flat and curved surfaces or free-form surfaces. The tool moves over the surface such that it creates parallel traces in the shape most advantageous for the particular component — for example, in a spiral or in nested squares. The hydrostatic bearing allows movement in all directions, so the feed direction can be changed even when the tool is fully engaged.

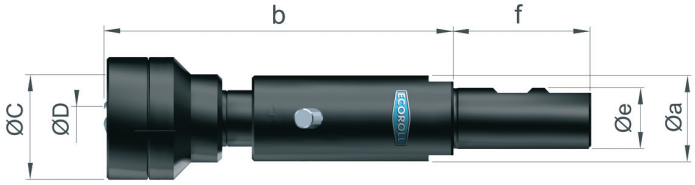
Monitoring and controlling the deep rolling force

The most important parameter in the process is the deep rolling force. With mechanical tools, this force is determined by measuring and monitoring spring deflection. Each tool has an individual spring characteristic. A gauge or a sensor records and measures the related spring deflection and thus the force. For tools that operate with a hydraulic system, the deep rolling force can be monitored by measuring the pressure.

Type RH Tool Applications:
Internal surfaces (fillets)



Type RHA Tool Applications:
External surfaces (chamfers)



Features

- *Deep rolling with the plunge-in process*
- *For use with CNC-controlled or conventional lathes*
- *Complete processing in one setting*
- *Either right- or left-hand operation*
- *Rotates in either direction*
- *Suspended rollers for even force distribution independent of production tolerances*

Advantages

Deep rolling combines the following three physical effects:

- *Induces deep residual compressive stresses which increase a component's fatigue strength (especially important during cyclic loading)*
- *Increases the surface layer's material strength through controlled cold working*
- *Improves surface finish, thus greatly reducing surface flaws where cracks can initiate*

Further advantages:

- *Cost effective: deep rolling can take place in one setting on a standard machining tool right after the cutting process.*
- *No set up time, just tool change*
- *No transport costs*
- *Low energy consumption*

Basic tool design

Type RH and RHA deep rolling tools consist of a tool body and roller head.

Tool body

- *Four different sizes available (S1 through S4)*
- *Standard shank: Morse taper or cylindrical shank, other mounting systems by request*
- *Equipped with a disc spring assembly*
- *Spring layers specifically designed and arranged for each machining task*

Roller head

- *Specially designed per workpiece dimensions*
- *Mounted onto the tool body*

Parameters

- *Maximum rolling force: 40 kN*
- *Maximum machining radius: 4.0 mm*
- *Maximum yield strength: 1400 N/mm²*
- *Machining diameter (RH): > 17 mm*
- *Machining diameter (RHA): > 4 mm*

Main dimensions (mm)					Shank Ø d (mm)
a	b	c	b_1	x	
26-65	depends upon workpiece				≥ 25

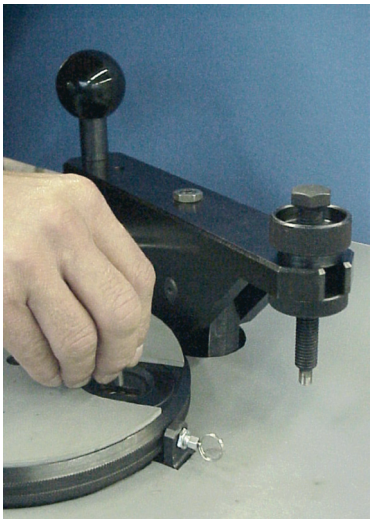
Type RHA Deep Rolling Machine

The ECOROLL Deep Rolling Machine, Type RHA, is designed to deep roll the transition radii on bolt and screw heads. Finished components are used in ***aerospace, power generation*** *and* ***high performance automobile applications****. Deep rolling increases cycles-to-failure so that treated components can function under high load conditions.*

Deep rolling increases the material's tensile strength to 1400 N/mm^2 or its yield strength to 1200 N/mm^2.

The diameter to length ratio on standard machine tools makes deep rolling these parts difficult, if not impossible. But due to its design and size, the RHA Deep Rolling Machine can be easily integrated into the production line. The standard RHA machine is designed for manual operation, but applications for automated producation are available by request.

The RHA machine deep rolls bolts and screws with various head types in a diameter range of 5–20 mm. The deep rolling head can be easily exchanged to accommodate various diameters. The maximum possible component length is 100 mm.



Type EF Tool Applications: Internal and external fillets

Features

- For use with CNC-controlled or conventional lathes
- Complete processing in one setting
- Symmetrical construction allows either right- or left-hand operation
- Rotates in either direction

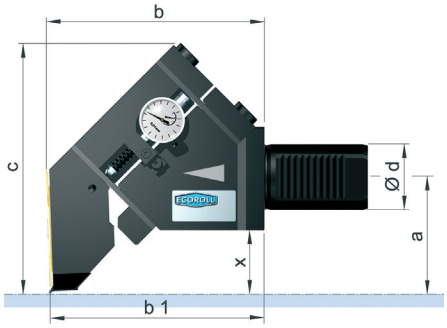
EF45

- Deep rolling with the plunge-in process
- One suspended roller
- Rolling force monitored by a dial gauge or sensor

EF90

- Deep rolls external thread root radii
- Deep rolls within the machine's thread cycle
- Axial floating roller compensates for marginal positioning errors
- Automatic roller angle alignment
- No conversion necessary to machine either right- or left-handed threads
- Roller made to fit component's thread root radius
- Integrated pre-loading mechanism, no further X-axis adjustment necessary

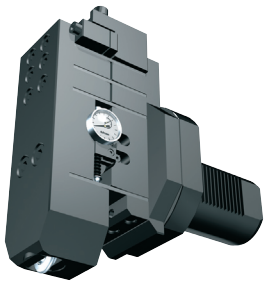
EF45



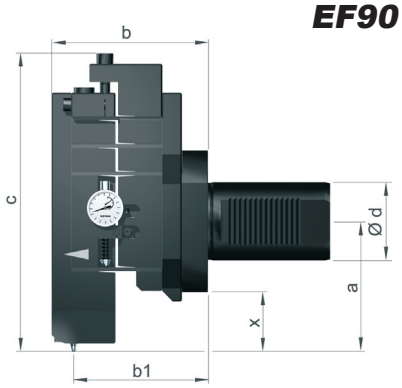
Basic tool design

Type EF deep rolling tools consist of a tool body equipped with a shank, a spring assembly that allows the roller head to move with no play and very low friction, and a dial gauge that indicates the burnishing force as measured by spring deflection. An optional device transmits the values by cable or wireless signal to an external indicator.

The roller head is attached to the flexible, spring-loaded section of the tool body. The flexible roller retainer moves in response to the radial or axial rolling forces on either side of the tool.



EF90



EF45

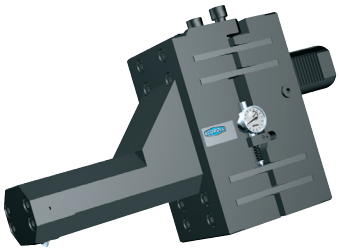
The roller is guided by a cage and supported by a support body with large-scale needle bearings.

EF90

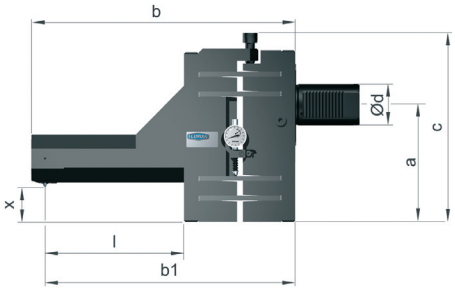
The roller is suspended within the roller retainer with a slide bearing bolt. In addition, the roller mount swings such that the roller automatically adjusts to the thread pitch. A set screw limits the roller's pivoting angle.

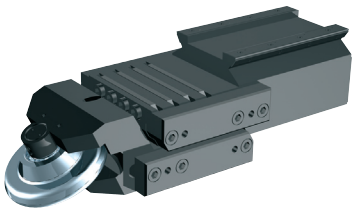
Tool type	Max. rolling force	Max. machining radius	Max. yield strength	Machining diameter	Main dimensions (mm)					Shank Ø d (mm)
	(kN)	(mm)	(N/mm²)	(mm)	a	b	c	b_1	x	
EF45-17	10	1.2	1400	10-250	71	133	152	130	38	≥ VDI 40
EF45-21	20	4.0		≥ 40						
EF90		1.6			100	120	228	103	45	

Type FAK Tool Applications: Internal and external fillets

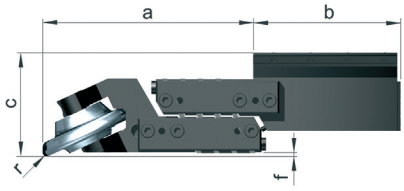


FAK025





FAK120



Features

- *For use with CNC-controlled or conventional lathes*
- *Complete processing in one setting*
- *Symmetrical construction allows either right- or left-hand operation*
- *Rotates in either direction*

FAK025

- *Deep rolls internal thread root radii*
- *Deep rolls within the machine's thread cycle*
- *Axial floating roller compensates for marginal positioning errors*
- *Automatic roller angle alignment*
- *No conversion necessary to machine either right- or left-handed threads*
- *Roller made to fit component's thread root radius*
- *Integrated pre-loading mechanism, no further X-axis adjustment necessary*

FAK120

- *Deep rolls fillets with the plunge-in process*
- *Deep rolls contours or large fillets with the in-feed process*
- *Roller unit includes axial/radial bearings for the in-feed process*
- *Rolling force monitored by a dial gauge or sensor*

Basic tool design

Type FAK deep rolling tools consist of a tool body equipped with a shank, a spring assembly that allows the roller head to move with no play and very low friction, and a dial gauge that indicates the burnishing force as measured by spring deflection. An optional device transmits the values by cable or wireless signal to an external indicator.

The roller head is attached to the flexible, spring-loaded section of the tool body. The flexible roller holder moves in response to the radial or axial rolling forces on either side of the tool.

FAK025

The roller is suspended within the roller retainer with a slide bearing bolt. In addition, the roller mount swings such that the roller automatically adjusts to the thread pitch. A set screw limits the roller's pivoting angle.

FAK120

The roller holder contains a finely machined, hardened roller with two tapered roller bearings.

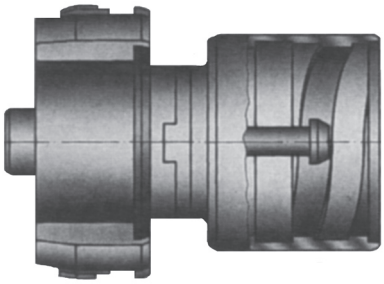
Tool type	Max. rolling force	Max. machining radius	Max. yield strength	Machining diameter	Main dimensions (mm)					Shank Ø d (mm)
	(kN)	(mm)	(N/mm²)	(mm)	a	b	c	b_1	x	
FAK025	20	1.6	1400	≥ 80	142	324	229	307	42	≥ VDI 40
FAK120	35	4.0			256	179	126			depends upon machine

Tools for Processing Cylinders

Type SK skiving heads work together with the Type GZ roller burnishing tools to process both seamless and welded precision steel cylinders. On the first pass, the SK skiving head skives the cylinder; on the second pass the GZ tool roller burnishes the surface.

Depending on the cylinder, the process can achieve a diameter tolerance of IT8 or IT9 and a surface finish of R_z = 15–30 µm.

Most often the tools are used with cylinder processing machine centers or trepanning machines with BTA systems. The quick, cost-effective process is environmentally sensitive as well: no dust, no residue.

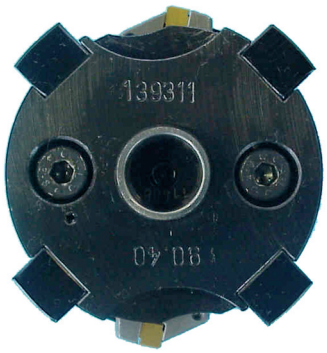


Basic design SK skiving head

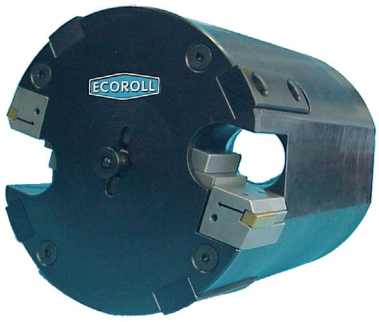
Type SK3 skiving head

Type SK Skiving Heads

- *All SK type skiving heads produce surfaces ideal for roller burnishing*
- *Adjustable knives float radially*
- *Cutting inserts easy to exchange*
- *Type SK-R skiving heads come with the RETRAC® system that prevents tool retraction marks*
- *Type SK1R skiving head for blind holes available upon request*

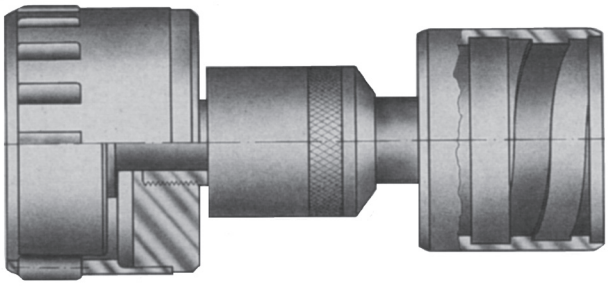


Type SK3 skiving head



Type SK1R skiving head

Type GZ Roller Burnishing Tools



Basic design GZ roller burnishing tool

Type GZ roller burnishing tool
for blind hole cylinders

Basic Type GZ roller burnishing tool

Type GZ roller burnishing tools work together with the Type SK skiving heads to process both seamless and welded precision steel cylinders.

- *Applied with cylinder processing machine centers or trepanning machines with BTA systems*
- *Achieves a diameter tolerance of IT8 or IT9 and a surface finish of R_z < 1 µm*
- *Tool feed in either direction*
- *Quick, cost-effective work cycle*
- *Simple diameter adjustment*
- *Reliable, high precision operation*
- *Wear parts are easy to exchange*
- *Roller head automatically collapses at the end of the process, preventing tool retraction marks*

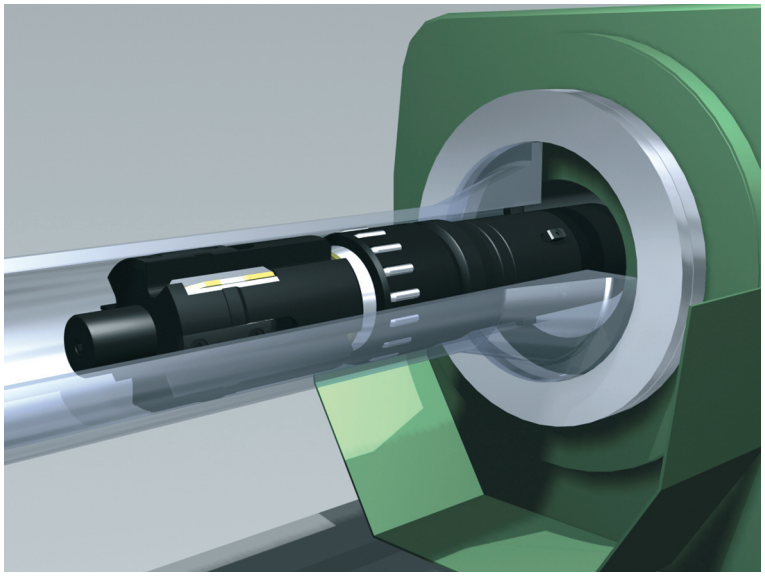
Combined Skive-Burnishing Tools

ECOROLL's combined skive-burnishing tools provide a cost-efficient and environmentally sensitive method for machining the inner surfaces of cylinders in just one step. This line of tools includes types RDS and RDO as well as the innovative Omega skiving head system.

The combined skive-burnishing tools are designed to finish seamless or welded cold drawn precision tubes after counter boring (including welded and drawn DOM tubes, seamless cold drawn DIN EN 10305-1 tubes, or hot rolled steel tubes).

Type RDS tool

The skiving head cuts the tube's inner surface to the exact size and form required, while the roller head burnishes it. This simultaneous skiving and burnishing results in a short overall process time.



Type RDSE tool

Through cold working, this forming process achieves a large surface contact area, low surface roughness and increased hardness. Thus, in contrast to honed tubes, the burnished cylinder surface has better sliding and wear properties.

ECOROLL skive-burnishing tools can be used with specially designed cylinder processing machines or trepanning machines with BTA boring systems. In addition, special versions are available for use with alternative thread connections, including Sandvik or Sierra.

NOTE: *The machine tool supplies the working pressure to the tool via a high pressure hose with a quick coupling connection. When the process is complete, the pressure is released, and the skiving knives and the rolling head collapse. The tool can be quickly retracted without damaging the finished surface.*

Type RDS Tool Application: Cylinders, inner surfaces

Diameters 38 – 60 mm

The RDS tool equipped with the RETRAC® system is designed to machine short cylinders up to 6 m long (depending upon the cylinder's diameter and the stiffness of the boring bar). The work cycle is extremely short because skiving and burnishing take place in one pass.

RDS tools feature the following advantages:

- *Floating skiving knife with two reversible, high performance cutting inserts*
- *Knife adjusts easily by replacing the wedges*
- *Automatic coupling and separation with hydraulic RETRAC® cylinder incorporated in the boring bar*
- *Manual roller head diameter adjustment*
- *Patented choke disc concentrates the coolant-lubricant in the chip chambers*
- *Hydraulic RETRAC® device retracts knife and roller head when the process is finished, preventing damage to the finished workpiece*

Design versions

NOTE: *To order combined skive-burnishing tools, please consult the table on page 51.*

1. ***RDS**: standard skive-burnishing tool for diameters 38 – 60 mm*
2. ***RDSS**: offers increased cutting performance with two skiving knives arranged at a 90° offset*
3. ***RDSQ**: equipped with extended knives and support pads for skiving cylinders with cross holes*
4. ***RDSE**: high performance tool with flexible roller head*
   - *Roller head diameter self-adjusts to compensate for variable cylinder elasticity and diameter tolerances*
   - *Maintains constant burnishing force for even surface quality*
   - *Burnishing force adjusted hydraulically with RETRAC® system*
   - *Adapts easily and with reproducible results to a variety of material strengths and surface condition requirements*
   - *Unique flex-joint compensates for possible boring bar misalignment*

Type RDO "Omega" Tool Application: Cylinders, inner surfaces

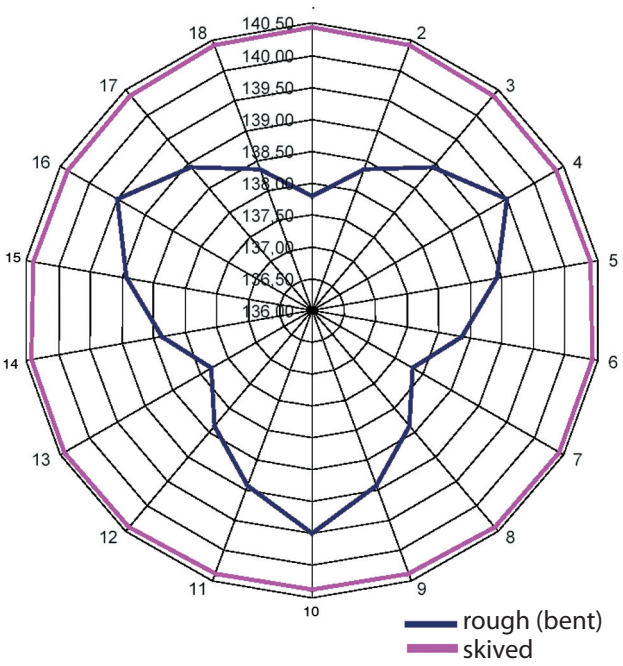
Diameters 60 – 455 mm

A long-standing problem in this diameter range increases with diameter size: large diameter tubes with relatively low wall thickness exhibit greater irregularities in their circular form due to cold drawing or the straightening process. Conventional skiving heads can correct these irregularities only in certain circumstances. After such a conventional machining process, spiral-shaped waves may appear along the entire length of the cylinder's inner surface, creating a so-called rippling effect.

Cylinder with rippling problem

The RDO skive-burnishing tools equipped with the OMEGA skiving head offer an innovative solution to this problem. The following trial demonstrates the tools' effectiveness.

Cylinder tubes with dimensions 156 mm x 8.5 mm were bent on the in-feed end into a polygonal shape with roughly three sides, in which the diameter varied in a range from 1 – 1.7 mm.

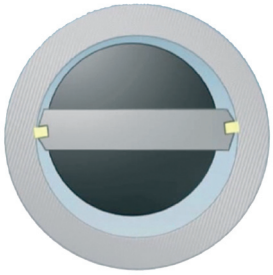


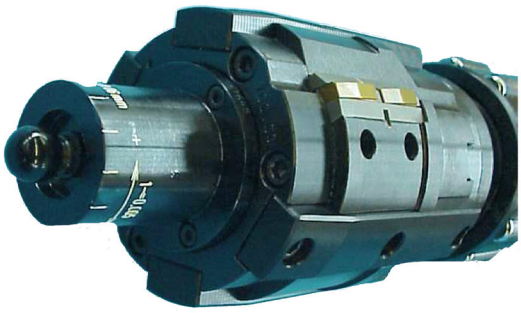
Improving the cylinder's circular form

<u>Summary of the trial results:</u>
After bending, the tubes exhibited irregularities in circular form of up to 1.7 mm. After skiving with an RDO tool, the infeed end of the tubes demonstrated a maximum irregularity of just 0.07 mm. At 150 mm from the infeed end (6 mm from the tube's opposite end) the maximum circular form irregularity measured just 0.02 mm. Positive results in production continue to confirm these trial results.

"Omega" Skiving Head

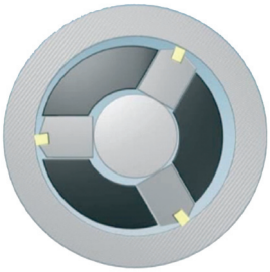
While the OMEGA skiving head cuts the cylinder's inner surface to the exact size and form required, the roller head burnishes it. The simultaneous skiving and burnishing process, together with increased cutting performance (cutting speeds up to 300 m per minute and feeds of 3 – 6 mm per revolution), result in substantial cost savings. The OMEGA skiving head is equipped with two, three or six floating knives arranged to work in concert.

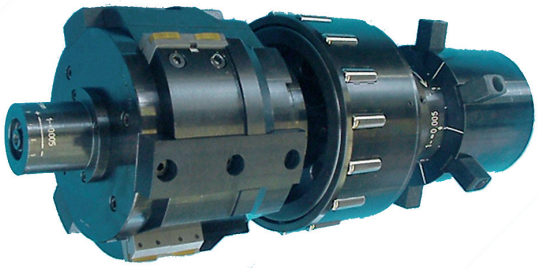




For simple applications with no rippling:

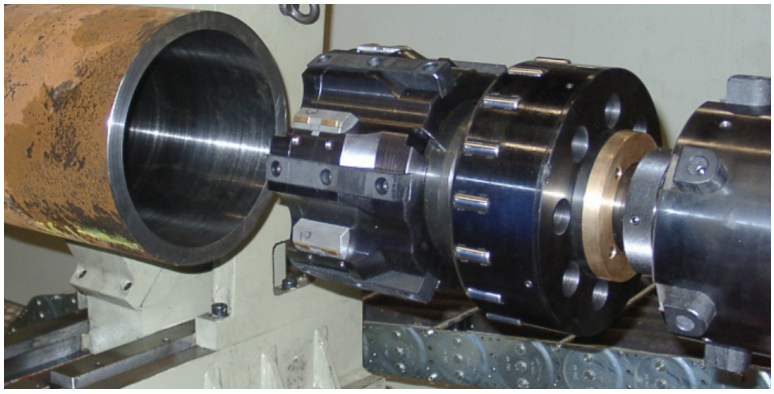
*an economical version with **2 knives***





For applications with moderate rippling in a diameter range of 60 – 400 mm:

*a version with **2 – 3 knives***



For difficult applications that require substantial form correction in a diameter range of 205 – 400 mm :

*a version with **6 knives***

The knives center themselves automatically so that each removes chips of nearly the same thickness regardless of cylinder form deviation. Thus, RDO tools with OMEGA skiving heads skive the tube clean without removing large amounts of material. This innovative knife arrangement markedly improves the tube's circular form while preventing the formation of ripples and polygon-shaped bores.

"Omega" skiving knife design versions

The skiving knives are available in two versions. The standard design, Version M, has two cutting inserts arranged one behind the other. With a cutting insert in front and a support insert behind, Version Q works especially well for cross holes.

Converting from Version M to Q is easy: simply replace the cutting insert with a support insert.

The support inserts improve the cylinder's form by:

- *Guiding the knives at the beginning of the skiving process*
- *Limiting the oscillation of the knives, thereby reducing rippling along the length of the cylinder*
- *Supporting the knives over the cross holes*

*A precisely scaled central adjusting screw allows the knives to be adjusted even when they are already mounted in the tool. The knives no longer need to be pre-adjusted. (**NOTE:** the 6-knife OMEGA skiving head occasionally requires pre-adjustment.) The only reason for disassembling the knives is to turn them (to expose the other cutting edge) or to exchange them.*

Advantages:

- *Less machine down time due to central adjusting screw*
- *Quicker mounting and disassembly of the skiving knives*

The skiving head and the rolling head are connected through a new interface. The complete skiving head can be removed by unscrewing two set screws even while the RDO tool is still mounted in the machine.

Advantages:

- *Less time required to exchange rollers and cage*
- *Machine down time reduced*

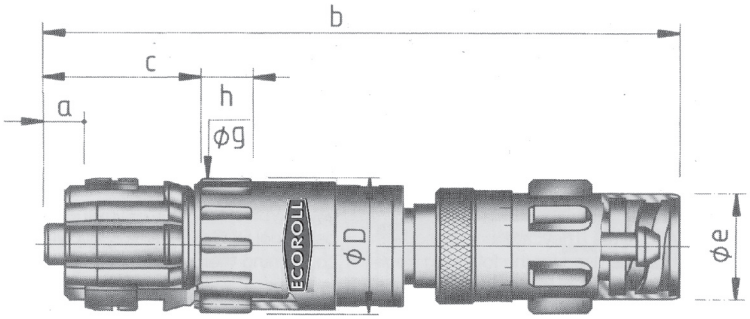
Recommended operating parameters

Diameter, machining allowance (mm)	Height offset, cutting inserts (mm)
0.6 - 2.0	0.2
1.2 - 2.4	0.4
1.6 - 3.0	0.6

Combined Skive-Burnishing Tools Technical Data

NOTE:

- *The tool retainer is a BTA thread or an S-thread with a compressed air connection.*
- *Separate skiving and roller burnishing operations are recommended for diameters larger than 455 mm. Separate skiving heads are available in this range to improve circular form and/or machining allowance to less than 3 mm.*
- ***All dimensions in mm***



Tool type	Diameter range D	BTA boring bar Ø e	Skiving knives		Roller head			Main dimensions		
			Diameter Range	Cross-section	Range	Number of rollers	Roller Ø g x h	a	b	c
RDS11	≥ 38 < 44	33	Nominal Ø ± 0.04	20 x 14	-0.05/-0.2	8	6 x 20	12	275	67
RDS21.1	≥ 44 < 50	36		18 x 18	-0.05/+0.3				304	86
RDS21.2	≥ 50 < 55	43						16	301	81
	≥ 55 < 60									
RDSQ11	≥ 38 < 44	33	Nominal Ø ± 0.04	20 x 18	-0.05/+0.2			12	275	67
RDSQ21.1	≥ 44 < 50	36		18 x 18	-0.05/+0.3				304	86
RDSQ21.2	≥ 50 < 55	43						16	301	81
	≥ 55 < 60									
RDO34.1	≥ 60 < 70	47	≥ 60 < 63	50 x 17	-0.05/+0.3	12	8 x 25	110	430	200
			≥ 63 < 70		-0.05/+0.5					
RDO34.2	≥ 70 < 80	56	≥ 70 < 80	50 x 18					437	207
	≥ 80 < 100	68	≥ 80 < 100							
RDO44.1	≥ 100 < 120	82	≥ 100 < 120				14 x 35	120	482	
RDO44.2	≥ 120 < 140	106	≥ 120 < 140							
RDO54.1	≥ 140 < 170	118	≥ 140 < 170	60 x 24				121	540	241
RDO54.2	≥ 170 < 205	142	≥ 170 < 205			16				
RDO64.1	≥ 205 < 255	178	≥ 205 < 255	60 x 32				125	609	282
	≥ 255 < 305		≥ 255 < 305			20				
RDO64.2	≥ 305 < 455	226	≥ 305 < 325					136	641	326
		*	≥ 325 < 455							

** Depends on existing boring bar*

Recommend operating parameters

Tool type	Diameter range mm	Rippling problem?	Cutting speed m/min.	Feed mm/rev.	Motor capacity kW
RDSR / RDSQ	≥ 38 < 60	none	180	2	20
RDO2 (2 knives)	≥ 60 < 400		300	3	30 - 50
RDO3 (3 knives)	≥ 60 < 400	moderate		4	
RDO6 (6 knives)	≥ 205 < 455	substantial		6	75

Type FA Deep Rolling Tools Application: Large thread root radii

For deep rolling dynamically loaded parts, such as the large external threads as used in the oil industry, to increase fatigue strength

The deep rolling process significantly increases the amount of load cycles a component can endure without fracturing. The fatigue strength is dramatically improved. Only deep rolling combines the following three advantageous physical effects:

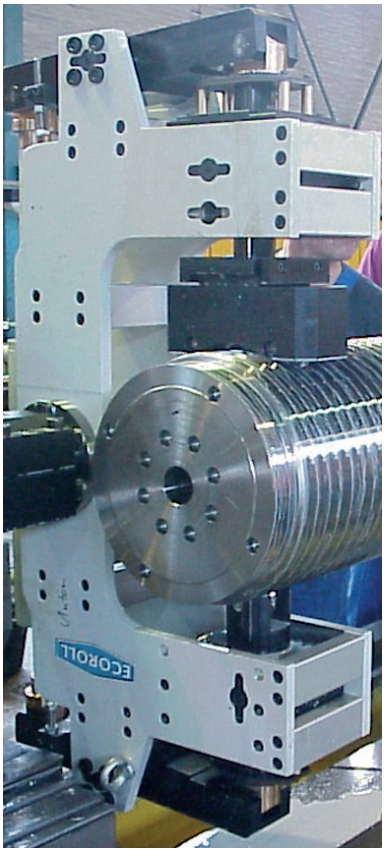
Deep rolling

- *smoothes the surface (prevents micro-notches and cracking),*
- *generates cold work hardening (increases material strength)*
- *and induces compressive residual stresses in the surface edge layer.*

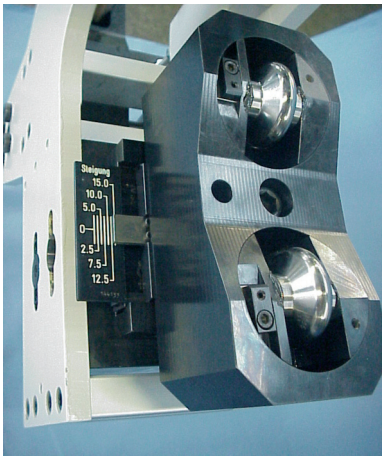
Features

Under normal operating conditions, the highest tension is concentrated in the thread root. The deep rolling process focuses on the thread root radius.

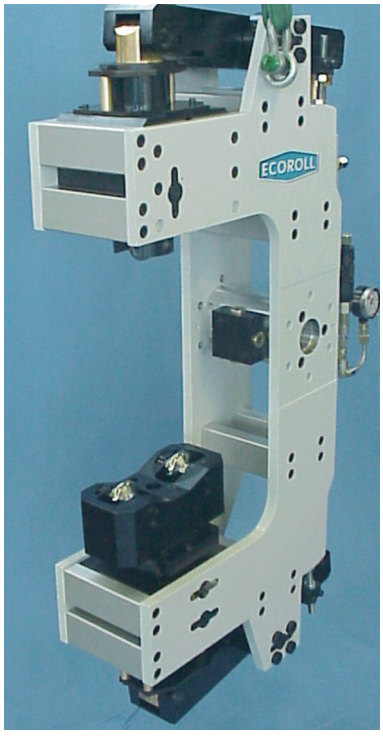
- *Even conical threads can be processed with the tool's automatic adjustment mechanism.*
- *FA tools are designed to be applied with CNC-controlled lathes.*
- *No deep rolling force is transferred from an FA tool to the machine tool. The C-bracket form allows the tool to accommodate all of the forces.*
- *Deep rolling forces up to 60 kN are possible.*
- *Deep rolling is suitable for metals with tensile strength up to 1400 N/mm² or a yield strength up to 1200 N/mm².*
- *An hydraulic cylinder transfers the deep rolling force to the tool. An external hydraulic unit is activated to build up pressure in the hydraulic cylinder. The hydraulic pressure and thus the deep rolling force remain constant and can compensate for workpiece tolerances and machine positioning errors.*
- *The FA tool rollers are positioned at an offset relative to the thread and are seated such that they can move freely. During the application, the rollers are always properly positioned in the thread root without sideways tension.*



Applying the FA deep rolling tool



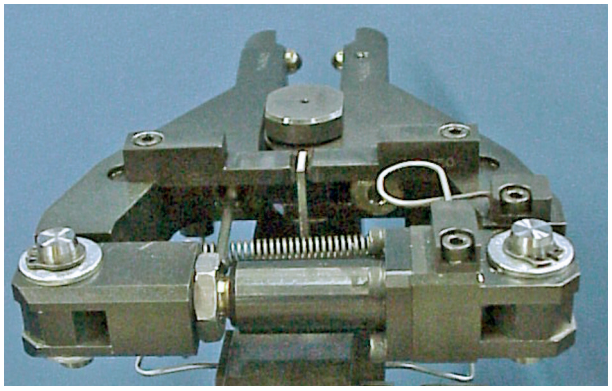
Roller position



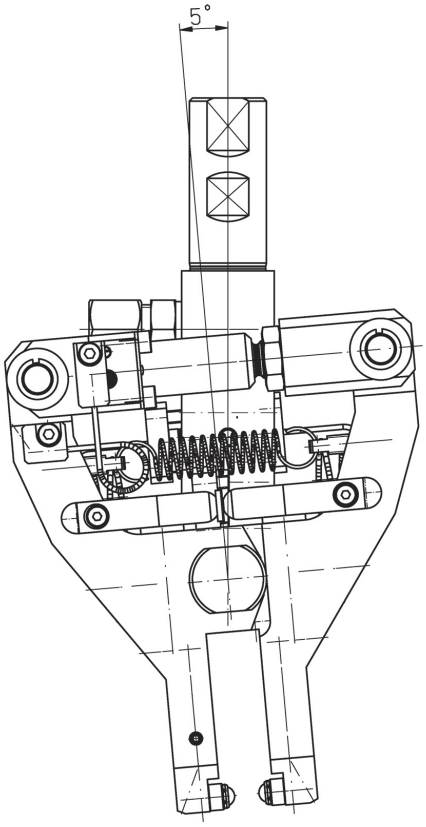
FA deep rolling tool

Type HGx-29 Hydrostatic Deep Rolling Tool Applications: Disc-like and thin-walled components

Economical method for increasing the fatigue strength of thin-walled, complex components and free-form surfaces, such as turbine blades



Tool version HG6-29Z



Both ball inserts follow the workpiece surface.

Based on the proven hydrostatic HG tool design, this tool is equipped with two burnishing elements mounted in a pliers-shaped arrangement. This design allows the burnishing force to balance out on both sides of the workpiece such that no force is transferred to the machine tool.

In addition, because the burnishing elements can move and rotate freely, the workpiece cannot shift into an unstable or undesirable position.

The tool guides the roller burnishing balls in parallel traces over the workpiece. Either a specifically defined area or the entire workpiece can be treated.

Features

- *Deep rolling substantially increases fatigue strength*
- *Can be applied on both conventional and CNC-contolled lathes*
- *Eliminates protruding peaks to generate smooth surfaces with favorable tribomechanical properties*
- *Operates with a pressure-dependent burnishing force — the process is easy to control and reproduce*
- *Features rotating burnishing elements that adjust to complex shapes with a compensation stroke of up to 8.5 mm*

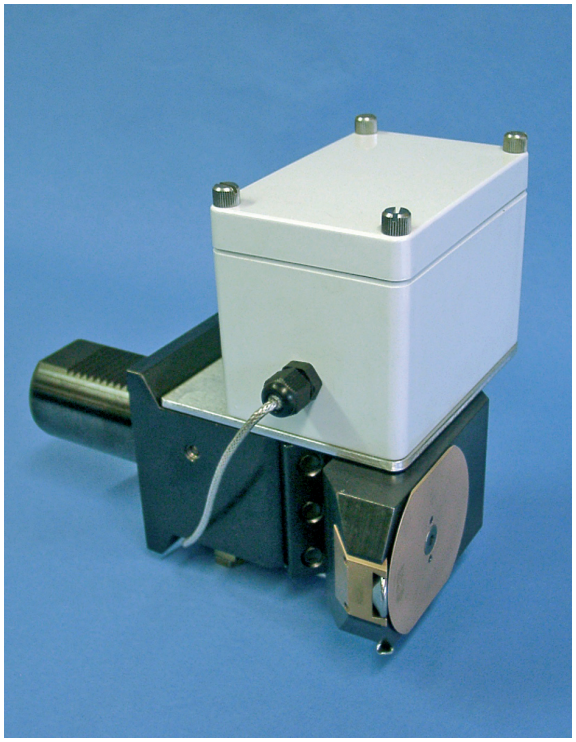
Tool Function

- *An external hydraulic pump unit supplies the working pressure to the tool via a high pressure hose.*
- *When the hydraulic pump unit is activated, the ball inserts move toward each other until they contact the workpiece surface. The working pressure (as set on the hydaulic pump unit) slowly builds up.*
- *During the process, both ball inserts follow the workpiece surface within a deviation of 5° right or left.*
- *In addition to the 8.5 mm compensation stroke, the HGx-29 is designed to pivot on its axis (or "float") in order to compensate for positioning errors and to process free form contours. This extra freedom of movement makes it possible to treat complex free-form surfaces such as turbine blades.*

Force Monitoring Systems for EF and HG Deep Rolling Tools

In deep rolling, the operating parameters significantly influence the improvement in the workpiece's fatigue strength and service life. That's why ECOROLL continues to work toward a solution for directly monitoring deep rolling parameters during the process.

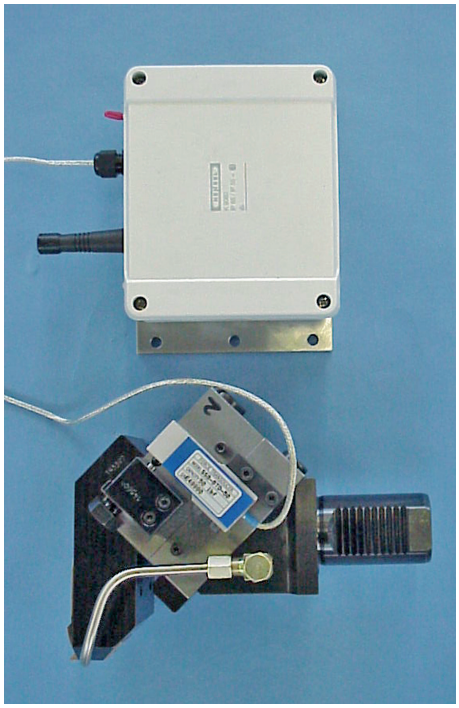
The most important parameter is the burnishing force. On ECOROLL EF tools, this force can already be determined by measuring the the deformation of the springs that supply the force. This value is displayed on a gauge and can be converted into a burnishing force value by using a spring deflection diagram.



Telemetry unit transmitter shown mounted on an EF tool

Recently ECOROLL has developed a wireless telemetry unit that transmits burnishing force data from the deep rolling tool to an external display. With this unit, operators can monitor and control the burnishing force during the process.

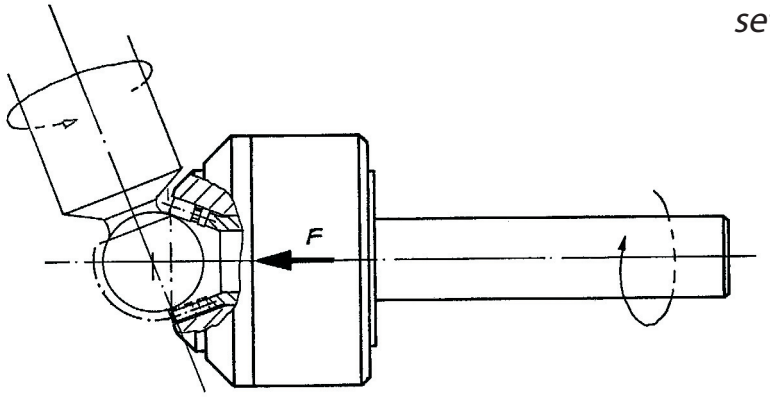
Future developments include a force monitoring system for all ECOROLL deep rolling tools in the EF and HG lines. This unit will display and analyze the progressive development of the burnishing force during the process. This unit will dramatically improve process reliability while reducing the output of defective parts.



Connecting the transmitter to the deep rolling tool

Type RKAK Roller Burnishing Tool
Application: Spherical surfaces

RKAK tool in operation



How the RKAK tool works

Features

- *Can be applied on almost all machine tools with rotating components*
- *All ductile metals up to a hardness of 45 HRC and a tensile strength of 1400 N/mm² can be treated*
- *On pre-machined surfaces, a surface quality of $R_z < 1$ µm ($R_a \leq 0.2$ µm) can be achieved in one pass*

Advantages

- *Can be applied on CNC-controlled and conventional lathes*
- *Complete processing in one setting*
  - *Short work cycle*
  - *Extraneous set-up and auxilliary processing time eliminated*
  - *No dust or grinding residue*
  - *Minimal lubrication required*
    (Oil or emulsion)

How it works

During the roller burnishing process, the rollers are pressed against the spherical workpiece surface. This movement applies the required burnishing force (F), which is generated by the springs. The workpiece's rotational speed determines the feed rate.

Operating parameters

- *Circumferential speed: 100 m/min.*
- *Feed rate: 0.05 – 0.20 mm per roller*

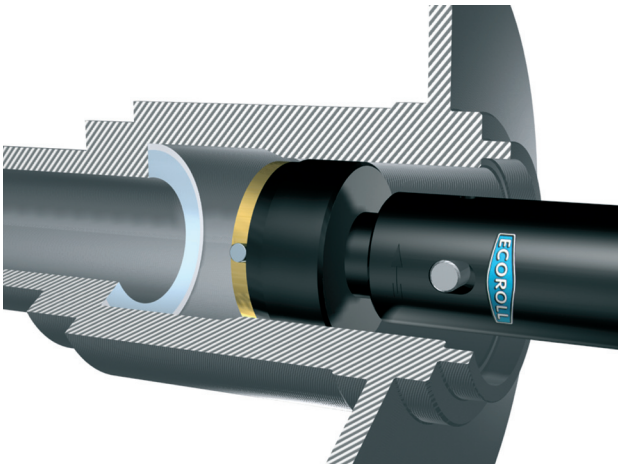
Application Examples: Table of Contents

Application process	Tool, Application		No.
Roller burnishing with multiple roller tools	RP	Gear box	201
	RA	Protector for sensor	202
	RP	Valve seat	203
	RK	Steering lever	204
	G	Rear wheel carrier	205
	G	Connecting rod	206
	RD	Valve body	208
	G	Hydraulic cylinder	209
	RA	Drive shaft	210
Roller burnishing with single roller tools	HG	Seal insert	301
	HG	Swivel bearing	302
	EG	Bearing housing	303
	HG	Seal cone	304
	EG	Ring cylinder	305
	HG	Bevel gear	306
	HG	Control valve piston	307
	HG	Servo piston	308
	HG	Taper bolt	309
	EG	Piston rod	310
	EG	Seal bushing	311
	EG	Crank shaft	312
	HG	Guide tube	313
	HG	Steel mill roller	314
	HG	Extrusion tool core	315
	HG	Rotary seal surface	316
	EG	Fly wheel	317
	HG	Ball stud	318
	HG	Brake piston	319
	HG	Cam shaft	320

Application process	Tool, Application		No.
Roller burnishing with single roller tools	HG	Valve cap	321
	HG	Torque converter housing	322
	HG	Valve	323
	HG	Clutch disc	324
	EG	Half pipe	325
	HG	Valve housing	326
	HG	Brake drum	327
	HG	Glass forming mandrel	330
	HG	Roller for rocker arm	331
	HG	Helix shaft	332
	HG	Mandrel for injection mold	333
	HG	Punch	334
	HG	Control piston	335
	HG	Axle shaft / Gear shaft	336
Deep Rolling	HG	Angle gear shaft	337
	HG	Turbine wheel	501
	HG	Securing bore	502
	HG	Taper pin hole	503
	HG	Tension bolt	504
	HG	Flexible shaft	505
	EF	API thread pin	506
	HG	Tie bar	507
	HG	Crank shaft	508
	EF	Cylinder liner	509
	HG	Wheel flange	510
	EF	High strength screw	511
	HG	Hollow shaft	512
	EF	Aircraft wheel rim	513
	HG	Aircraft shock strut	514

APPLICATION EXAMPLE **201**

Gear box



WORKPIECE
Gear box
Part of
Rail vehicle engine
Required finish
R_z < 1 µm
Material
C45
Tensile strength
680 N/mm²

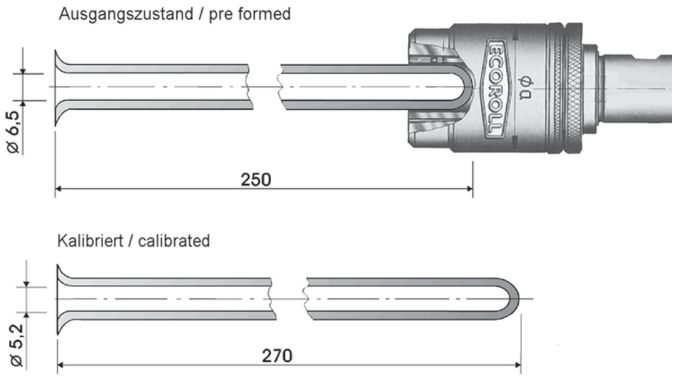
TOOL
Multiple roller face tool RP
Machine
Milling center
Rotation speed (RPM)
80
Process time
12 seconds

MACHINING TASK
- ***Achieve surface specification not attainable by cutting***

RESULTS/ADVANTAGES
- ***Improved product quality***
- ***Shorter process time***

APPLICATION EXAMPLE **202**

Protector for sensor



WORKPIECE
Temperature sensor protector
Part of
Industrial washing machine
Material
Stainless steel 1.4301

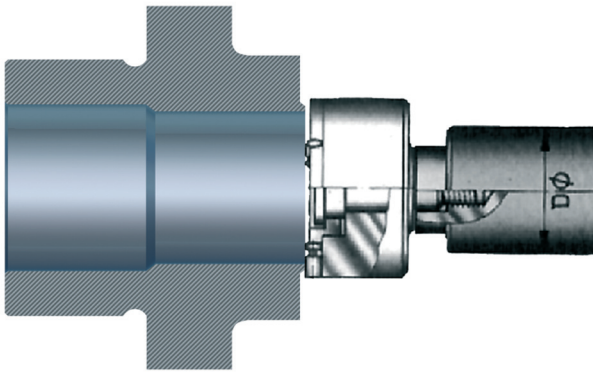
TOOL
RA
Machine
Conventional lathe
Speed (m/min.)
4
Rotation speed (RPM)
180
Feed rate (mm/rev.)
0.3
Process time
4.4 minutes

MACHINING TASK
- ***Improve heat transmission by reducing inner diameter from 6.5 to 5.2 mm***

RESULTS/ADVANTAGES
- ***Improved accuracy and sensitivity***

Valve seat

APPLICATION EXAMPLE **203**



WORKPIECE
Valve seat
Part of
Valve housing
Required finish
R_z < 1 µm
Material
Stainless steel
Tensile strength
700-800 N/mm²

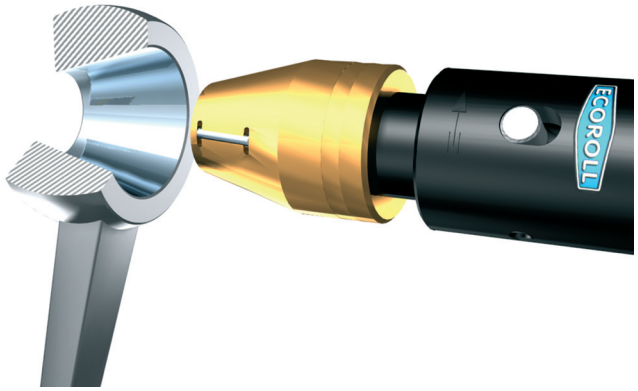
TOOL
RP-30.00-25.00-Mk
Machine
CNC lathe
Rotation speed (RPM)
60
Burnishing force
400 N
Process time
10 seconds

MACHINING TASK
Finish the seal face in one setting after turning

RESULTS/ADVANTAGES
- ***R_z < 0.5 µm***
- ***Polishing operation eliminated***

Steering lever

APPLICATION EXAMPLE **204**



WORKPIECE
Steering lever
Part of
Front axle, passenger car
Required finish
R_z < 2 µm
Material
Forged steel
Tensile strength
1100 N/mm²

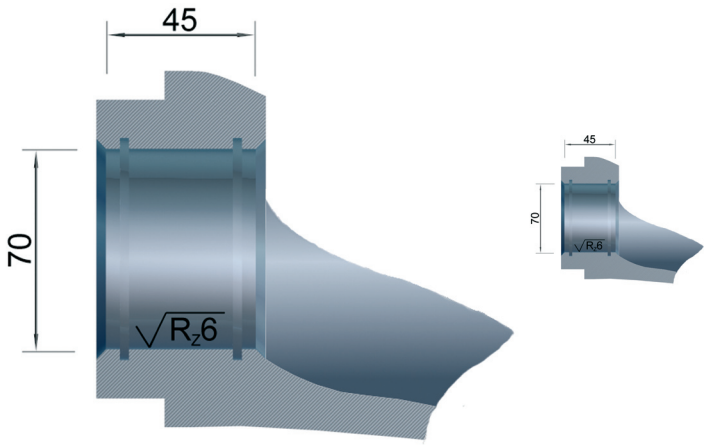
TOOL
RK
Machine
Transfer machine
Rotation speed (RPM)
300
Feed rate (mm/rev.)
0.4
Load (N)
700
Process time
3 seconds

MACHINING TASK
Roller burnish the hole after reaming

RESULTS/ADVANTAGES
- ***R_z < 1.5 µm and high load bearing surface ratio for tight fit and good load transmission***
- ***Short process time***

APPLICATION EXAMPLE **205**

Rear wheel carrier



WORKPIECE
Rear wheel carrier
Part of
Rear axle, passenger car
Required finish
R_z < 6 µm
Material
Nodular cast iron
Tensile strength
400 N/mm²

TOOL
G2-70.00-1-ZS25
Machine
Transfer machine
Speed (m/min.) ***150***
Rotation speed (RPM) ***680***
Feed rate (mm/rev.) ***1.6***
Process time ***2.5 seconds***

MACHINING TASK
- ***Cutting alone cannot guarantee the R_z < 4 µm finish required for series production***

RESULTS/ADVANTAGES
- ***Roller burnishing achieves surface requirement with a short process time***
- ***Higher feed rate facilitates quicker pre-machining process***

APPLICATION EXAMPLE **206**

Connecting rod

WORKPIECE
Connection rod
Part of
Combustion engine
Required finish
R_z < 2 µm
Material
Forged steel or bearing alloy

TOOL
G1.3-42.00
Speed (m/min.) ***160***
Rotation speed (RPM) ***1200***
Feed rate (mm/rev.) ***0.8***

G1.2-22.00
Speed (m/min.) ***110***
Rotation speed (RPM) ***1600***
Feed rate (mm/rev.) ***0.6***

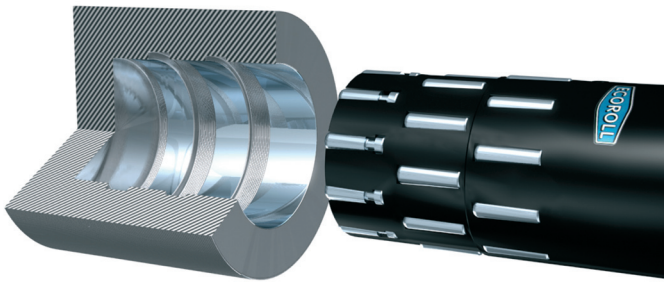
Process time
1.3 seconds

MACHINING TASK
Roller burnish both bores

RESULTS/ADVANTAGES
- ***Optimal bore surface***
- ***Improved fit of bearing bush in small eye***

APPLICATION EXAMPLE **208**

Valve body



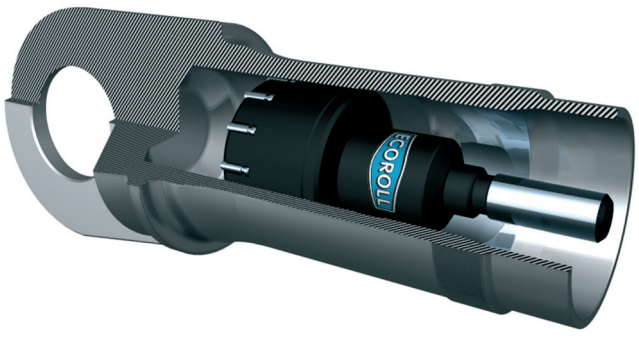
WORKPIECE
Valve body
Part of
Control armature
Required finish
R_z < 2 µm
Material
Stainless steel
Tensile strength
400 N/mm²

TOOL
RD special version with 3-step diameter 44 / 45 / 46 mm
Machine
CNC lathe
Speed (m/min.) ***150***
Rotation speed (RPM) ***1060***
Feed rate (mm/rev.) ***0.5***
Process time
1.7 seconds

RESULTS/ADVANTAGES
- ***2 operations and 2 tool changes eliminated***
- ***Time saved: about 20 seconds per part***

APPLICATION EXAMPLE **209**

Hydraulic cylinder



WORKPIECE
Hydraulic cylinder
Part of
Rotor blade adjustment for helicopter
Required finish
R_z < 2 µm
Material
Steel
Hardness
40 HRC
Tensile strength
1000 N/mm²

TOOL
G
Machine
CNC lathe
Speed (m/min.) ***150***
Rotation speed (RPM) ***1000***
Feed rate (mm/rev.) ***0.5***
Process time
42 seconds

RESULTS/ADVANTAGES
Reduced friction and wear on seal

APPLICATION EXAMPLE **210**

Drive shaft

WORKPIECE
Drive shaft
Part of
Hydraulic motor
Required finish
R_z < 1 µm
Material ***Steel***
Hardness ***40 HRC***
Tensile strength
1000 N/mm²

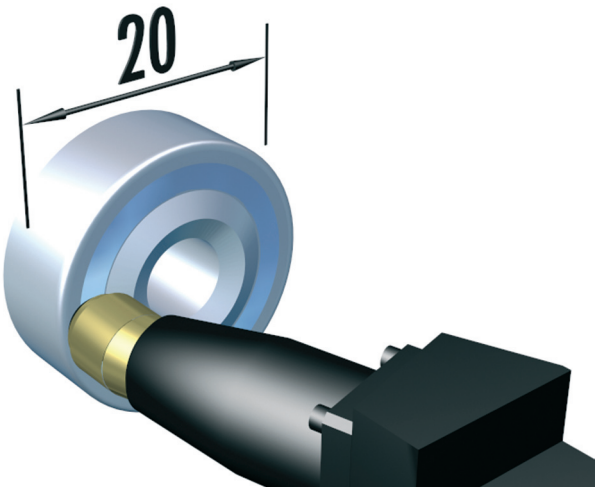
TOOL
Multiple roller burnishing tool RA
Machine
Milling center
Speed (m/min.) ***150***
Rotation speed (RPM) ***2800***
Feed rate (mm/rev.) ***0.3***
Process time
1.2 seconds per end

MACHINING TASK
High load bearing surface ratio required for good load transmission

RESULTS/ADVANTAGES
- ***Improved product quality***
- ***Shorter process time***

APPLICATION EXAMPLE **301**

Seal insert



WORKPIECE
Seal insert
Part of
Valve
Required finish
R_z < 1 µm
Material
Stainless steel
Tensile strength
500-750 N/mm²

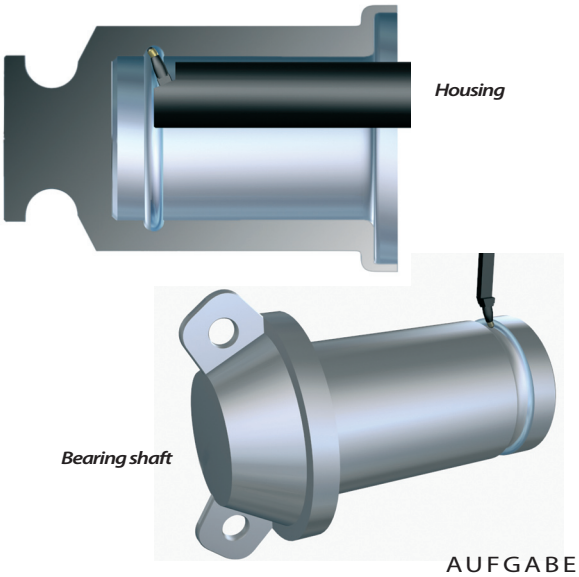
TOOL
HG6-9L00°-SL25
Machine
Multi-spindle lathe
Rotation speed (RPM) 950
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***60***
Process time
2.5 seconds

MACHINING TASK
Roller burnish profiled seal face after turning

RESULTS/ADVANTAGES
Hand polishing eliminated

APPLICATION EXAMPLE **302**

Swivel bearing



WORKPIECE
Swivel bearing
Part of
Excavator shovel
Required finish
R_z < 2 µm
Material
Nodular cast iron
Hardness ***58-62 HRC***

TOOL
HG6-2 and HG6-9
Machine ***CNC lathe***
Speed (m/min.) ***100***
Rotation speed (RPM) ***220***
Feed rate (mm/rev.) ***0.1***
Pressure (bar)***300***
Process time ***53 seconds***

AUFGABE

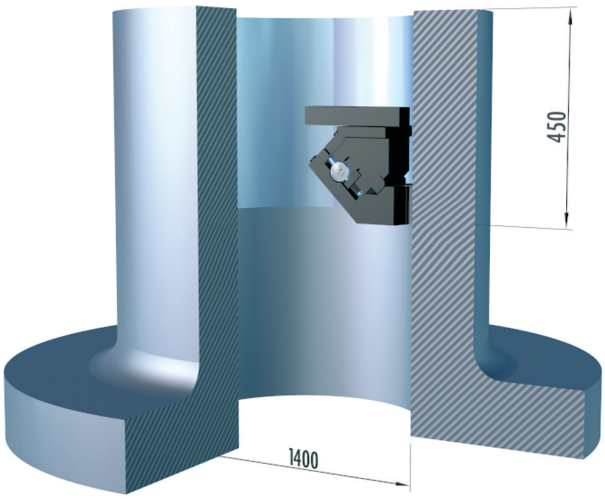
- ***In the assembled part, the grooves in the housing and the shaft form a race filled with steel balls to create a four-point bearing***
- ***The task is to hard turn and hard roller burnish the ball races***

RESULTS/ADVANTAGES

- ***Improved bearing capacity***
- ***Shorter process time***

APPLICATION EXAMPLE **303**

Bearing housing



WORKPIECE
Bearing housing
Part of ***Roller press***
Required finish ***R_z < 3 µm***
Material
Nodular cast iron
Hardness ***170 HRB***

TOOL
EG14
Machine
Vertical lathe
Speed (m/min.) ***80***
Rotation speed (RPM) ***18***
Feed rate (mm/rev.) ***0.4***
Dial gauge indication (mm) ***0.5***
Process time ***62 minutes***

MACHINING TASK

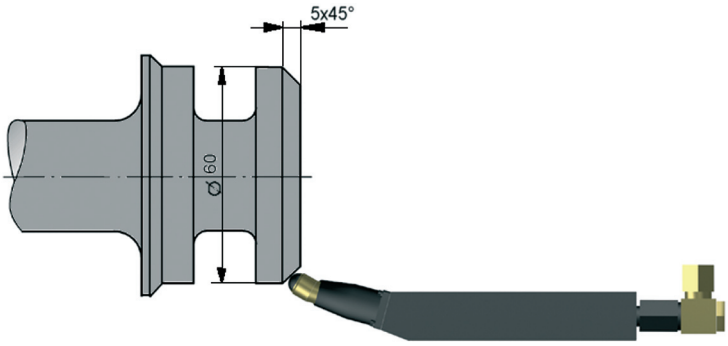
- ***Required surface quality cannot be guaranteed by other processes such as grinding***
- ***The grinding wheel clogs and causes inconsistent surface quality***
- ***The EG14 tool replaces the cutting chisel after turning and is held by the boring bar (not shown)***

RESULTS/ADVANTAGES

- ***Reliable, reproducible process***
- ***Short process time***
- ***Elimination of 3-5 hours polishing time***

APPLICATION EXAMPLE **304**

Seal cone



WORKPIECE
Seal cone
Part of
Fluid valve
Required finish
R_z < 1 µm
Material
Stainless steel
Yield strength
240 N/mm²

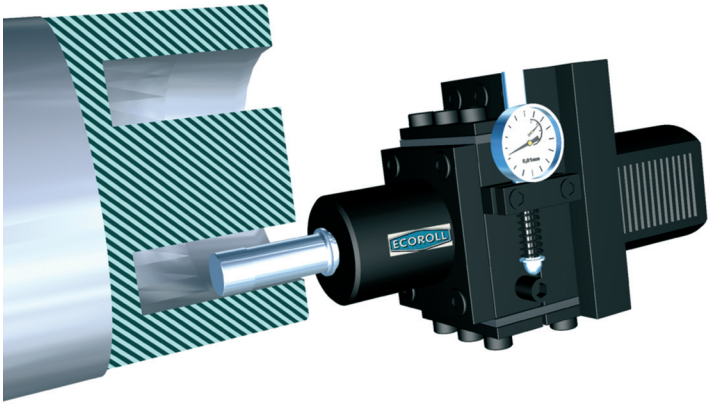
TOOL
HG6-9E30°-SL25
Machine
CNC lathe
Speed (m/min.) ***180***
Rotation speed (RPM) ***950***
Feed rate (mm/rev.) ***1***
Pressure (bar) ***80***
Process time
5.3 seconds

MACHINING TASK
HG is the best choice for rounding corners

RESULTS/ADVANTAGES
Eliminates a separate polishing operation

APPLICATION EXAMPLE **305**

Ring cylinder



WORKPIECE
Ring cylinder
Part of
Hydraulic clutch
Required finish
R_z < 2 µm
Material ***Ck60***
Tensile strength
740 N/mm²

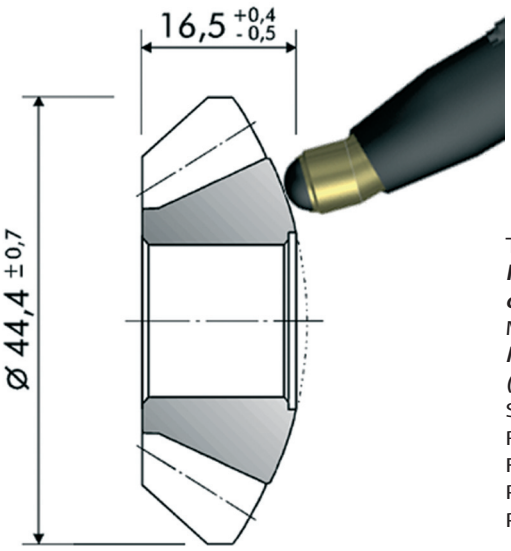
TOOL
EG5-12F-VDI40
Machine
CNC lathe
Speed (m/min.) ***80***
Rotation speed (RPM) ***210***
Feed rate (mm/rev.) ***0.2***
Dial gauge indication (mm) ***1.0***
Process time
57 seconds per surface

MACHINING TASK
- ***Roller burnish inner and outer diameters of the ring cylinder in succession with the same tool in one setting***
- ***This tool can be used for many different diameter sizes***

RESULTS/ADVANTAGES
- ***Reliable process***
- ***Reduces part rejects***
- ***Polishing operation no longer necessary***

Bevel gear

APPLICATION EXAMPLE **306**



WORKPIECE
Bevel gear
Part of
Passenger car, differential gear
Required finish R_z ***< 2 µm***
Material ***16CD4***
Hardness ***42 HRC***
Tensile strength ***1000 N/mm²***

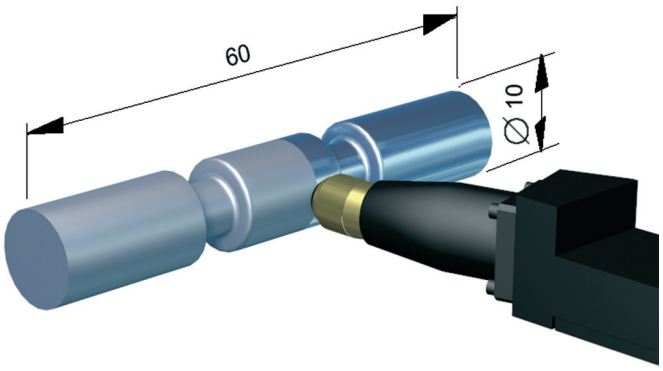
TOOL
HG6 burnishing element on a special tool holder
Machine
Multi-spindle lathe (index MS250)
Speed (m/min) ***150***
Rotation speed (RPM) ***1500***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***150***
Process time ***4 seconds***

MACHINING TASK
- ***Roller burnish the spherical zone without axial feed***
- ***Tool automatically follows the contour***

RESULTS/ADVANTAGES
- ***Gear comes back from processing ready for use***

Control valve piston

APPLICATION EXAMPLE **307**



WORKPIECE
Control valve piston
Part of
Compressed air control valve
Required finish
R_z ***< 1 µm***
Material ***C-Steel***
Tensile strength
1000 N/mm²

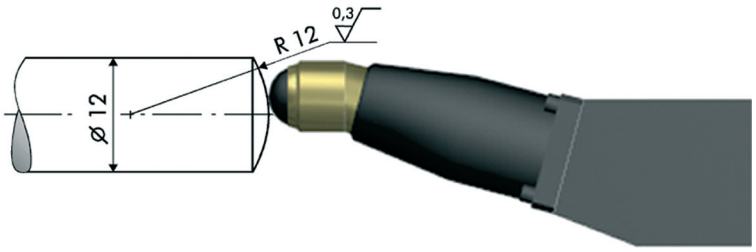
TOOL
HG6-9E00°-SL20
Machine
CNC lathe
Speed (m/min.) ***94***
Rotation speed (RPM) ***3000***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***100***
Process time ***12 seconds***

MACHINING TASK
Machine the surface to ensure optimum performance when piston slides through O-rings

RESULTS/ADVANTAGES
- ***Component completely finished in one setting***
- ***Roller burnished surfaces facilitate better, more reliable function***

APPLICATION EXAMPLE **308**

Servo piston



WORKPIECE
Servo piston
Part of
ABS brake system
Required finish
R_a ≤ 0.3 µm
Material
Carbon steel
Tensile strength
600 N/mm²

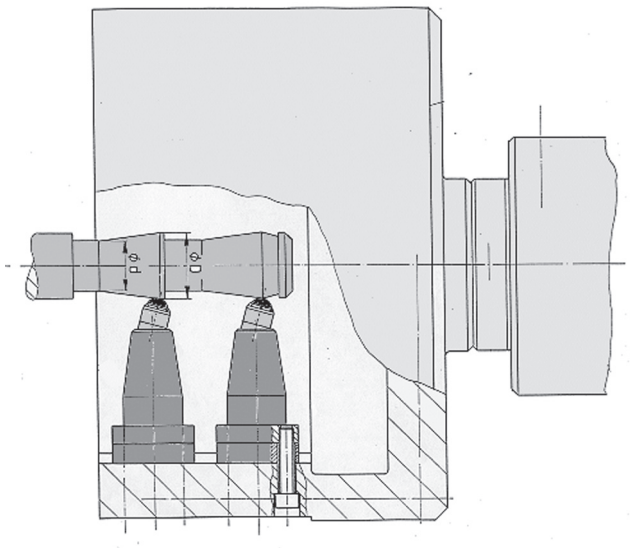
TOOL
HG6-9E00°-SL25
Machine
Multi-spindle lathe
Speed (m/min.) ***230***
Rotation speed (RPM) ***6000***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***120***
Process time ***0.6 seconds***

MACHINING TASK
Roller burnish rounded end, including center

RESULTS/ADVANTAGES
Eliminates separate operation for polishing the rounded end

APPLICATION EXAMPLE **309**

Taper bolt



WORKPIECE
Taper bolt
Part of
High strength tap bolt
Required finish
R_z < 1.5 µm to avoid galling
Material
Stainless steel
Hardness ***300 HV***

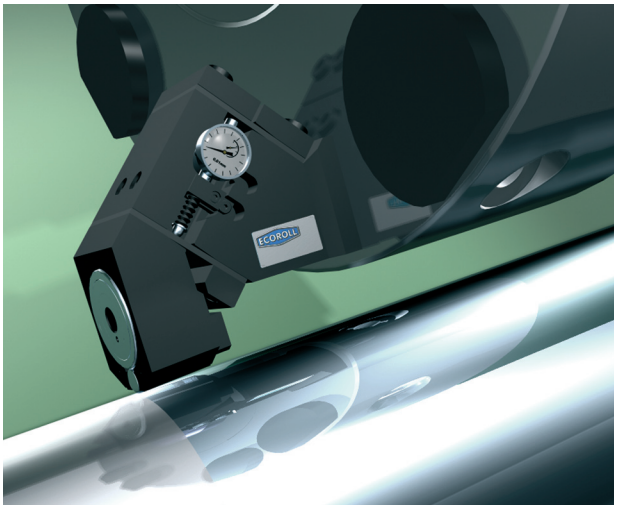
TOOL
HG6-11.2 (rotating) with 6-8 burnishing elements
Machine
Round table lathe
Speed (m/min.) ***40-60***
Rotational speed (RPM) ***1000***
Feed rate (mm/rev.) ***0.3***
Pressure (bar) ***120***
Process time ***3-4 seconds***

MACHINING TASK
In order for tap bolts to be approved for use, the taper must be roller burnished

RESULTS/ADVANTAGES
- ***Galling prevented***
- ***Reliable product at lower cost***

Piston rod

APPLICATION EXAMPLE **310**



Example:
Diameter = 85 mm
Length = 715 mm

WORKPIECE
Piston rod
Part of
Hydraulic cylinder
Required finish
R_z < 1.5 µm
Material ***C60V***
Hardness ***40 HRC***
Tensile strength
1000 N/mm²

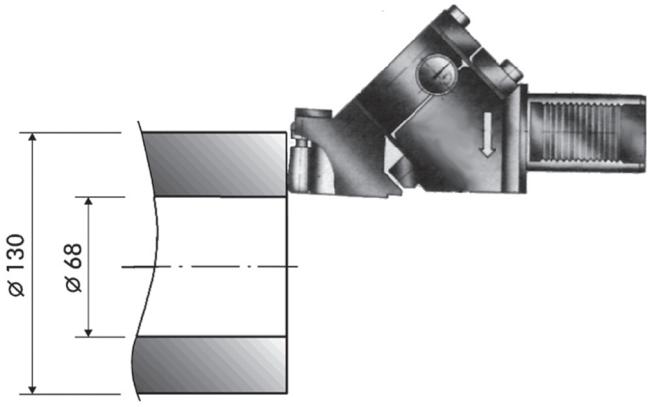
TOOL
EG14-1-VDI50
Machine ***CNC lathe***
Speed (m/min.) ***135***
Rotational speed (RPM) ***500***
Feed rate (mm/rev.) ***0.2***
Dial gauge indication (mm) ***0.7***
Process time ***7.1 minutes***

MACHINING TASK
- ***Roller burnishing followed by chrome plating***
- ***After buffing, the part is ready to use***

RESULTS/ADVANTAGES
- ***Process requires less chromium***
- ***No grinding necessary before or after chrome plating***
- ***Roller burnished seal surface has better sliding properties***

Seal bushing

APPLICATION EXAMPLE **311**



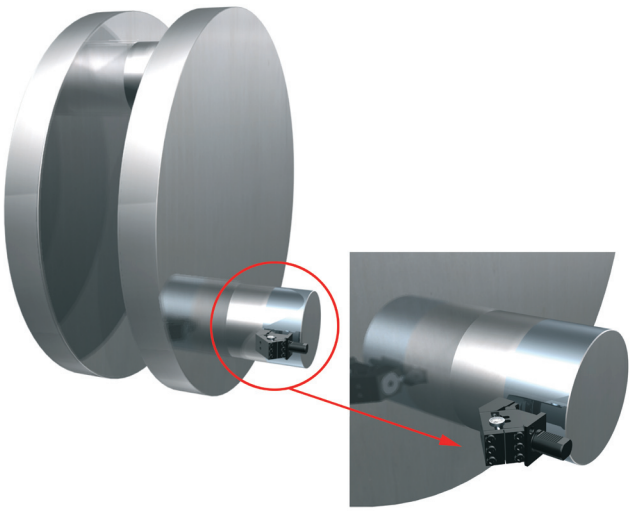
WORKPIECE
Seal bushing
Part of
Valve
Required finish
R_z < 1 µm
Material ***Aluminum alloy***
Tensile strength
300 N/mm²

TOOL
EG14-2-VDI40
Machine
CNC lathe
Speed (m/min)
100 (constant)
Rotational speed (RPM)
250-470
Feed rate (mm/rev.) ***0.2***
Dial gauge indication (mm) ***0.5***
Process time ***29 seconds***

RESULTS/ADVANTAGES
- ***Improved seal quality***
- ***Shorter process time***

APPLICATION EXAMPLE **312**

Crank shaft



WORKPIECE
Crank shaft
Part of
Piston pump for drilling in mud
Required finish R_z ***< 4 µm***
Material ***Heat treated steel***
Hardness ***42 HRC***
Tensile strength
1100 N/mm²

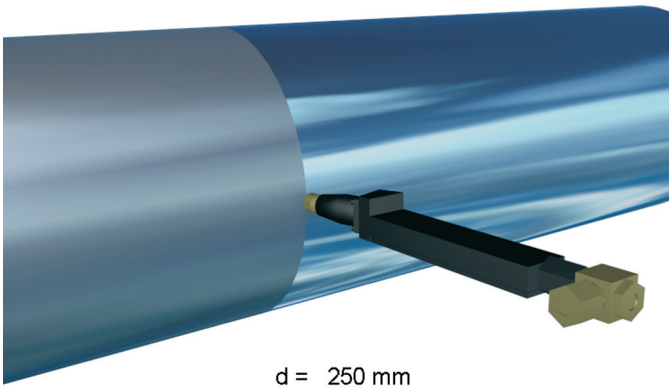
TOOL
EG14-1-SL32
Machine
CNC lathe
Speed (m/min.) ***19***
Rotation speed (RPM) ***20***
Feed rate (mm/rev.) ***0.8***
Dial gauge indication (mm) ***1.1***
Process time
18 minutes, 40 seconds

MACHINING TASK
Because the eccentric mass requires a slow machining speed, turning alone cannot produce the required finish

RESULTS/ADVANTAGES
- ***EG14 makes it possible to finish the part on the lathe instead of hand polishing***
- ***12 hours saved per part***

APPLICATION EXAMPLE **313**

Guide tube



WORKPIECE
Guide tube
Part of
Hydraulic car lift
Required finish
R_z ***< 2 µm***
Material ***Steel (St 52)***
Tensile strength
600 N/mm²

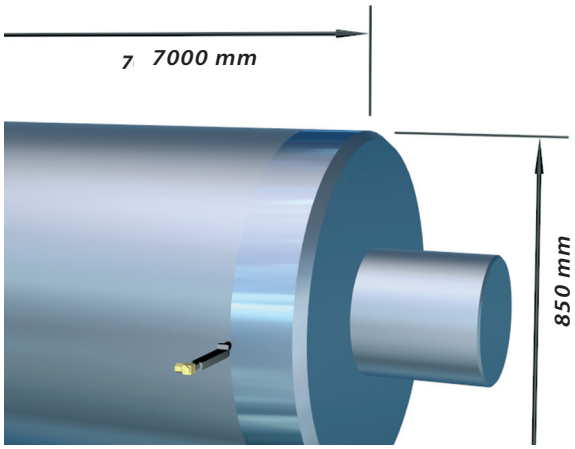
TOOL
HG13-9R15°-SL25
Machine
Conventional lathe
Speed (m/min.) ***240***
Rotation speed
(RPM) ***300***
Feed rate (mm/rev.) ***0.5***
Pressure (bar) ***120***
Process time ***17 minutes***

MACHINING TASK
Roller burnish cold drawn precision tubes after performing centerless grinding

RESULTS/ADVANTAGES
No pre-process turning necessary because the hydrostatic tool compensates for the tube's diameter tolerances

Steel mill roller

APPLICATION EXAMPLE **314**



WORKPIECE
Steel mill roller
Part of
Sheet metal mill
Required finish
Increased hardness
Material ***Chilled cast iron***
Hardness ***65 Shore B***

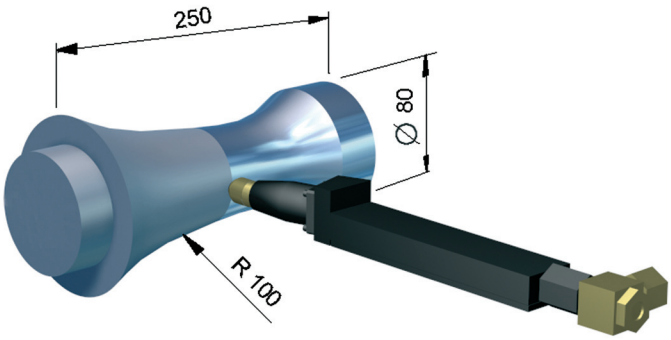
TOOL
HG13-9R15°-SL32 with hydraulic pump HGP1.8 with coolant-lubricant tank
Machine
Roller lathe
Speed (m/min) ***250***
Rotation speed (RPM) ***93***
Feed rate (mm/rev.) ***0.25***
Pressure (bar) ***250***
Process time ***5 hours***

MACHINING TASK
Increase hardness to improve fatigue strength and service life

RESULTS/ADVANTAGES
Hardness increased to 70 Shore

Extrusion tool core

APPLICATION EXAMPLE **315**



WORKPIECE
Extrusion tool core
Part of
Plastic tube extrusion tool
Required finish
R_z < 1 µm
Material
Stainless steel
Tensile strength
750 N/mm²

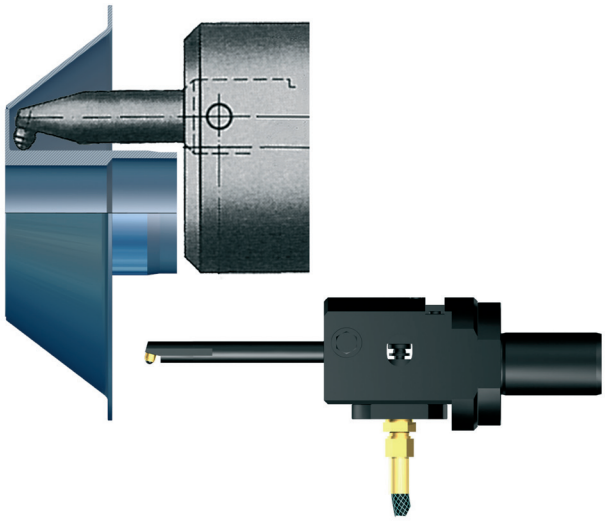
TOOL
HG13-9R00°-SL25
Machine
CNC lathe
Speed (m/min.) ***200***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***90***
Process time ***3 minutes***

MACHINING TASK
Roller burnish surface to better facilitate the plastic extrusion process

RESULTS/ADVANTAGES
- ***Shorter process: 1.5 hours saved per part***
- ***No hand polishing required***

APPLICATION EXAMPLE **316**

Rotary seal surface



WORKPIECE
Rotary seal surface
Part of
Torque converter
Required finish
R_a = 0.2 - 0.4 µm
Material
Carbonized steel
Hardness ***58-60 HRC***

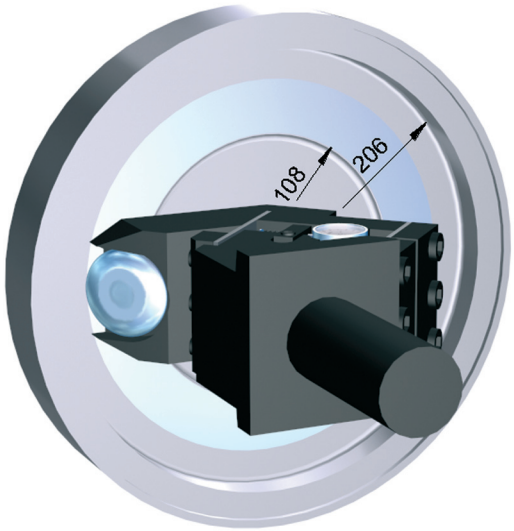
TOOL
HG6-1E15°-ZS40
Machine ***CNC lathe***
Speed (m/min.) ***150***
Rotation speed (RPM) ***1060***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***400***
Process time ***25 seconds***

MACHINING TASK
- ***This seal surface is difficult to reach with a grinding wheel***
- ***The surface is hard turned and subsequently hard roller burnished***

RESULTS/ADVANTAGES
- ***Short process time***
- ***Optimal surface structure: plateaus without peaks, shallow residual roughness facilitates seal lubrication and tight seal***

APPLICATION EXAMPLE **317**

Fly wheel



WORKPIECE
Fly wheel
Part of
Passenger car
Required finish ***R_z < 6 µm (Production tolerance)***
Material ***Nodular cast iron***
Tensile strength ***400 N/mm²***

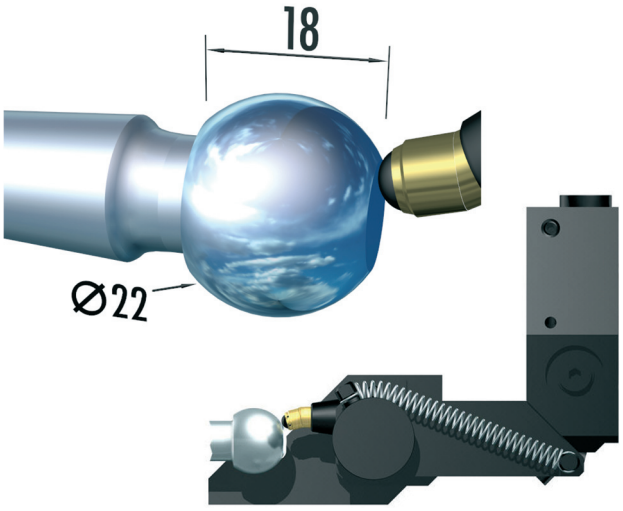
TOOL
EG45-1-40M-VDI40
Machine
CNC lathe
Speed (m/min.) ***150***
Rotation speed (RPM) ***300***
Feed rate (mm/rev.) ***0.5***
Dial gauge indication (mm) ***0.4***
Process time ***19 seconds***

MACHINING TASK
- ***Technical drawing specified a finish of R_z < 12 µm to be achieved by turning alone***
- ***About 10% of the parts were rejected because they were too rough and could not be reworked due to tight tolerance***

RESULTS/ADVANTAGES
- ***Reliable process eliminates excess roughness and reduces part reject rate***

Ball stud

APPLICATION EXAMPLE **318**



WORKPIECE
Ball stud
Part of
Passenger car
Required finish
R_z < 2 µm
Material
Forged steel
Tensile strength
1000 N/mm²

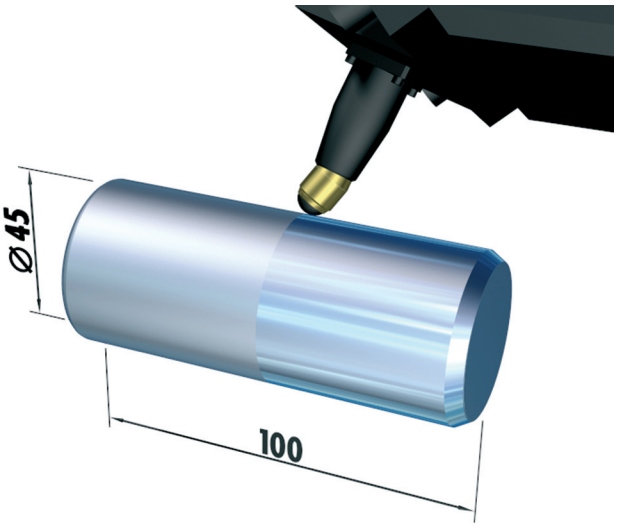
TOOL
HG6-6K22-VDI40
Machine ***CNC lathe***
Speed (m/min.)
250 (constant)
Rotation speed (RPM)
variable
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***160***
Process time ***3.8 seconds***

MACHINING TASK
- ***The tool moves in a programmed arc around the ball's center***
- ***The burnishing element's lever is connected to a stop pin located behind the ball, which enables the element to swivel around the ball***

RESULTS/ADVANTAGES
- ***R_z < 1.6 µm achieved***

Brake piston

APPLICATION EXAMPLE **319**



WORKPIECE
Brake piston
Part of
Rail vehicle brakes
Required finish ***R_z < 2 µm***
(Hard roller burnishing)
Material
Cr-Ni Steel
Hardness ***58-60 HRC***

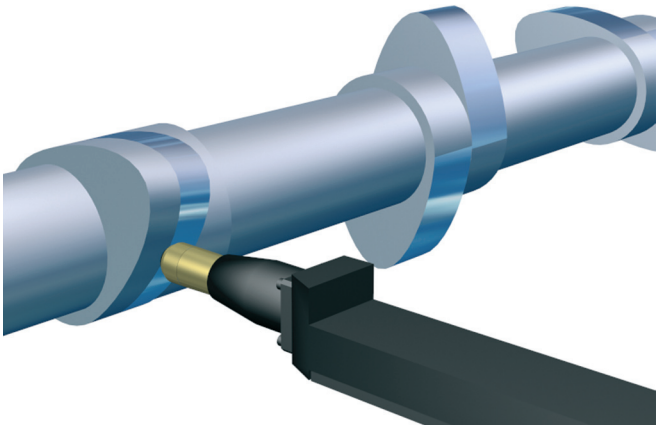
TOOL
HG6-5E00°-VDI40
Machine
CNC lathe
Speed (m/min.) ***100***
Rotation speed
(RPM) ***720***
Feed rate (mm/rev.) ***0.08***
Pressure (bar) ***400***
Process time ***1.7 minutes***

MACHINING TASK
- ***Final surface roughness is measured over the entire surface***
- ***Part rejection rate of 5 - 10% because parts are rejected when just one section is too rough***

RESULTS/ADVANTAGES
- ***Higher process reliability***
- ***Shorter process time***
- ***No resetting necessary***
- ***Lead-in chamfers are easily burnished***

APPLICATION EXAMPLE **320**

Cam shaft



WORKPIECE
Cam shaft
Part of
Passenger car engine
Required finish
R_z < 2 µm
(Reduce friction)
Material
Chilled cast iron
Hardness ***55 HRC***

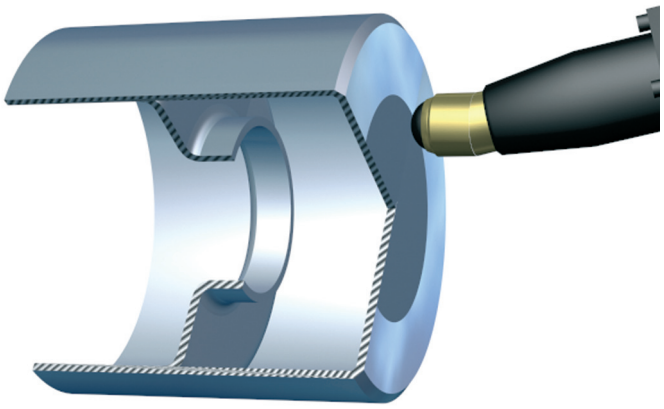
TOOL
HG6-9 special version with extended stroke
Machine
Lathe
Rotation speed (RPM) ***40***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***200***

MACHINING TASK
Hard roller burnishing to reduce coefficient of friction and increase wear resistance

RESULTS/ADVANTAGES
- ***Friction reduced by 20%***
- ***Hardness increased by 6%***

APPLICATION EXAMPLE **321**

Valve cap



WORKPIECE
Valve cap
Part of
Passenger car engine
Required finish
R_z < 2 µm
Material
Chilled cast iron
Hardness ***58 HRC***

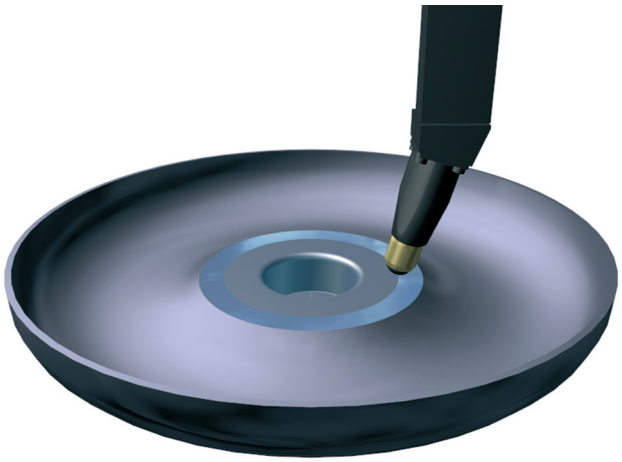
TOOL
HG6-9R00°-SL25
Machine
Conventional lathe
Speed (m/min.) ***100***
Feed rate
(mm/rev.) ***0.08***
Pressure (bar) ***250***
Process time ***16 seconds***

MACHINING TASK
Increase hardness and service life

RESULTS/ADVANTAGES
Service life increased 50% in actual engine, though these results were not repeated in the engine test stand

APPLICATION EXAMPLE **322**

Torque converter housing



WORKPIECE
Torque converter housing
Part of
Automatic gear for passenger car
Required finish
R_z < 4 µm
Material
Steel (St 35)
Tensile strength
450 N/mm²

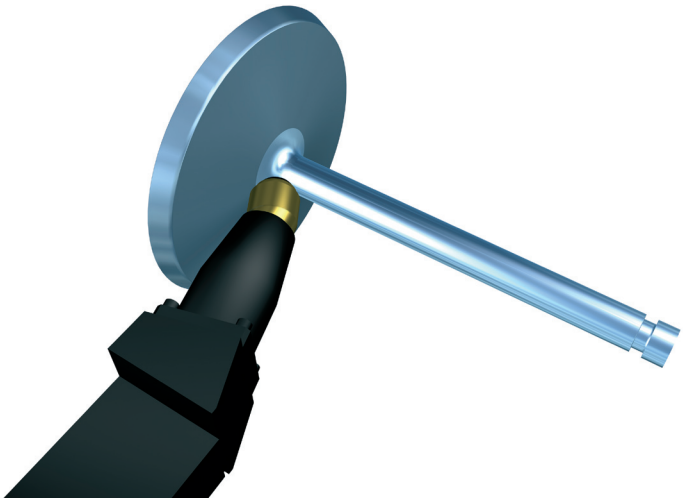
TOOL
HG13-9L15°-SL25
Machine
Vertical lathe
Speed (m/min.) ***200***
Rotation speed (RPM) ***1270***
Feed rate (mm/rev.) ***0.25***
Pressure (bar) ***80***
Process time ***36 seconds***

MACHINING TASK
Surface requires good sliding properties

RESULTS/ADVANTAGES
- ***Surface finish of R_z < 4 µm achieved (better than specified)***
- ***Short process time***

APPLICATION EXAMPLE **323**

Valve



WORKPIECE
Valve
Part of
Diesel engine
Required finish
Increased fatigue strength
Material ***Steel***
Hardness ***55 HRC***

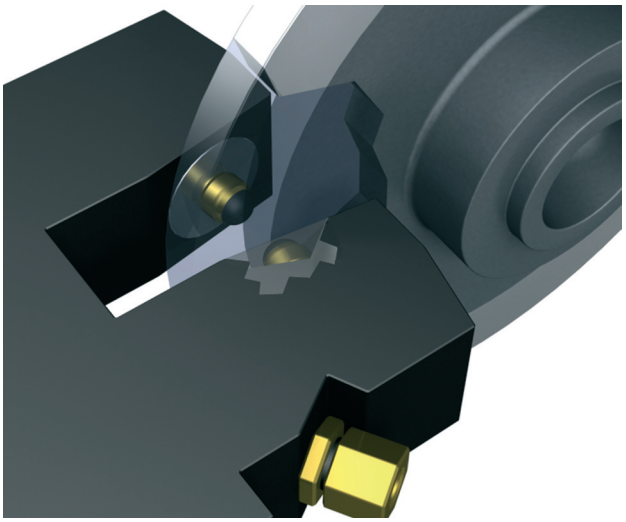
TOOL
HG13-9E270°-SL25
Machine
CNC lathe
Speed (m/min.) ***150***
Rotation speed (RPM) ***1200***
Feed rate (mm/rev.) ***0.25***
Pressure (bar) ***250***
Process time ***2.5 minutes***

MACHINING TASK
Deep rolling of lower shaft, radius and disc in 2 zones

RESULTS/ADVANTAGES
Improved product quality: fatigue strength increased 250%

APPLICATION EXAMPLE **324**

Clutch disc



WORKPIECE
Clutch disc /Brake disc
Part of
Truck drive train
Required finish
R_z < 4 µm
Material ***Nodular iron***
Tensile strength
600 N/mm²

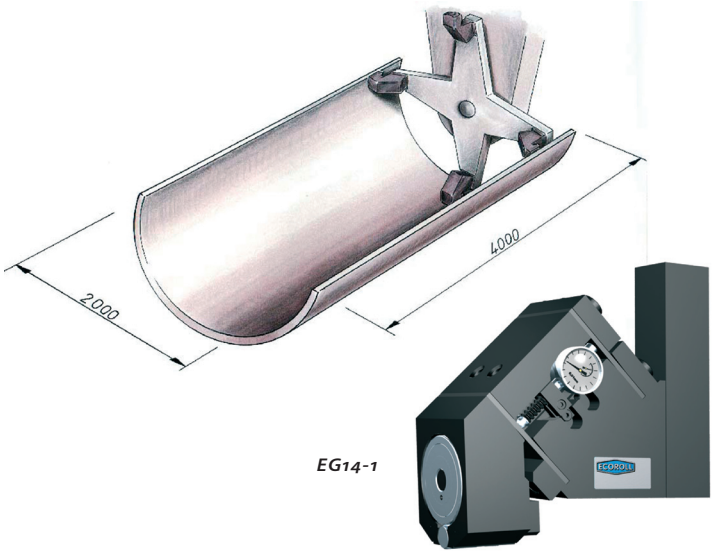
TOOL
HG13-11.3P with
2 burnishing elements
Machine
Double spindle
CNC lathe
Speed (m/min.) ***250***
Rotation speed (RPM)
470
Feed rate (mm/rev.) ***0.2***
Pressure (bar) ***120***
Process time ***32 seconds***

MACHINING TASK
To machine both sides simultaneously

RESULTS/ADVANTAGES
Significant cost reduction due to
- ***greater feed rate during turning***
- ***longer cutting insert service life***
- ***fewer tool changes***

APPLICATION EXAMPLE **325**

Half pipe



EG14-1

WORKPIECE
Half pipe
Part of
Industrial rotary iron
Required finish ***R_z < 3 µm***
Material ***Stainless steel***
Yield strength
200 N/mm²

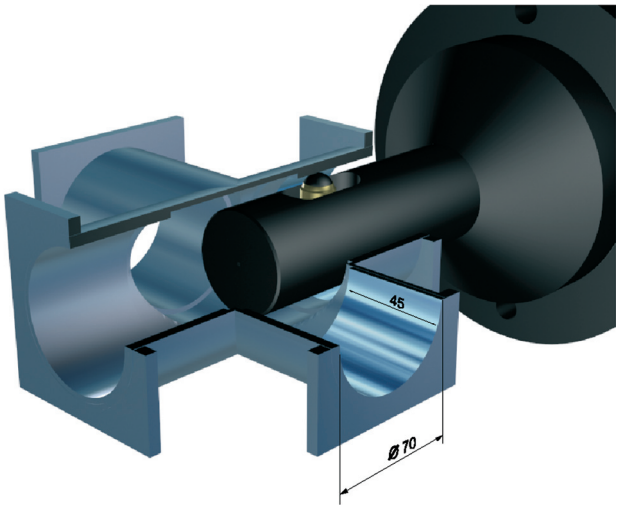
TOOL
4 x EG14-1-SL00
on a 4 wing tool carrier
Machine
Special milling machine
Speed (m/min.) ***50***
Rotation speed (RPM) ***7***
Feed rate (mm/rev.) ***3.2***
Dial gauge indication
(mm) ***0.8***
Process time
157 minutes

MACHINING TASK
- ***Roller burnishing after cutting in one setting***
- ***EG tools replace lathe cutting tools***

RESULTS/ADVANTAGES
- ***Shorter process time: no grinding and subsequent hand polishing required***

Valve housing

APPLICATION EXAMPLE **326**



WORKPIECE
Valve housing
Part of
Armature
Required finish
R_z < 1 µm
Material ***Stainless steel***
Tensile strength
400 N/mm²

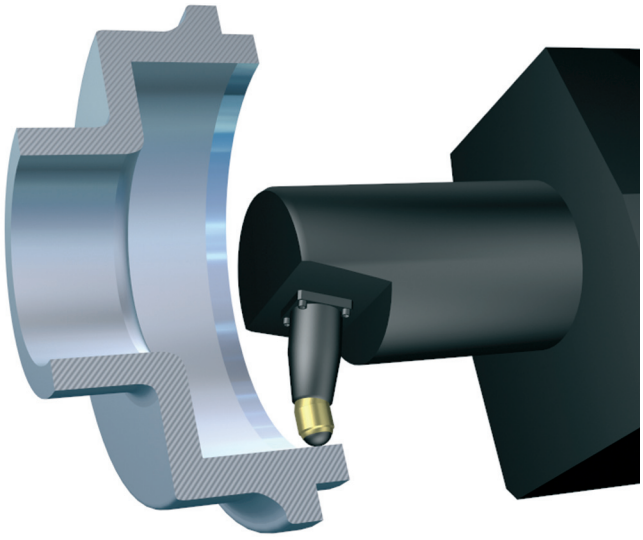
TOOL
HG13-4X
Machine
Special machine
Speed (m/min.) ***200***
Rotation speed (RPM) ***900***
Feed rate (mm/rev.) ***0.2***
Pressure (bar) ***100***
Process time ***15 seconds***

MACHINING TASK
- ***Roller burnish and expand liners***
- ***Low wall thickness and large bore tolerance (Ø 70$^{+0,2}$ mm) require a tool with automatic adjustment and constant burnishing force independent of actual diameter size***

RESULTS/ADVANTAGES
- ***Process is 20 minutes shorter***
- ***Required surface finish achieved***
- ***Liner fit improved***

Brake drum

APPLICATION EXAMPLE **327**



WORKPIECE
Brake drum
Part of
Motorcycle
Required finish
R_z < 4 µm
Material ***Nodular cast iron***

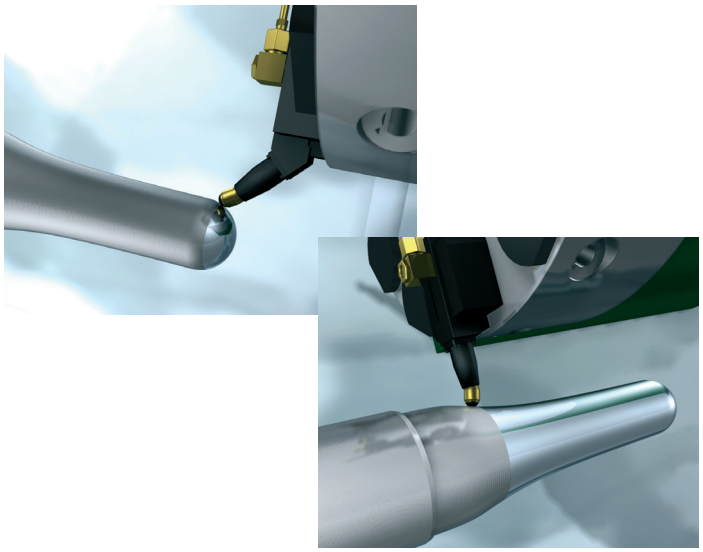
TOOL
HG6-2
Machine
CNC lathe
Speed (m/min.) ***180***
Rotation speed (RPM) ***380***
Feed rate (mm/rev.) ***0.2***
Pressure (bar) ***100***
Process time ***40 seconds***

MACHINING TASK
- ***Roller burnish brake surfaces to reduce the effect of wear on brake quality***
- ***To achieve the required finish, the tool must have automatic diameter adjustment and provide constant burnishing force, independent of diameter size***

RESULTS/ADVANTAGES
- ***Less wear***
- ***Better part reliability***

APPLICATION EXAMPLE **330**

Glass forming mandrel



WORKPIECE
Glass forming mandrel
Part of
Form for glass bottles
Required finish
R_z < 2 µm
Material ***Steel***
Hardness ***55 HRC***
Average Ø (mm) ***35***
Average length (mm) ***135***

TOOL
HG6-9L65°-SLK20
HG6-9L15°-SLK20
Machine
CNC lathe
Speed (m/min.) ***200***
Rotation speed (RPM) ***1800***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***300***
Process time ***45 seconds***

MACHINING TASK
- ***Roller burnish the surface in one setting after turning***
- ***The surface is split into 2 zones:***
  1. ***Rounded end from its center to about 60°***
  2. ***Remaining contour***

RESULTS/ADVANTAGES
- ***Process is shortened: no hand polishing required***
- ***Increased surface hardness***
- ***Consistent quality***

APPLICATION EXAMPLE **331**

Roller for rocker arm

WORKPIECE
Roller for rocker arm
Part of
Diesel engine
Required finish
$R_{max.}$ < 1 µm
Material
Case-hardened steel
Hardness ***59-63 HRC***
Bore diameter (mm) ***45***
Length (mm) ***50***

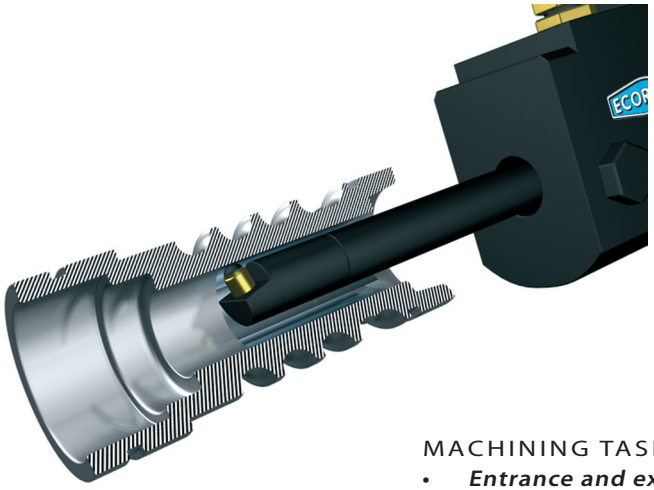
TOOL
HG6-1-VDI40
Machine
CNC lathe
Speed (m/min.) ***125***
Rotation speed (RPM) ***900***
Feed rate (mm/rev.) ***0.08***
Pressure (bar) ***400***
Process time ***43 seconds***

MACHINING TASK
Roller burnishing in one setting after hard turning

RESULTS/ADVANTAGES
Process time saved: no separate lapping operation required

Helix shaft

APPLICATION EXAMPLE **332**



WORKPIECE
Helix shaft
Part of
Injection molding machine
Required finish R_z ***< 1 µm***
Material ***Heat treated steel***
Hardness ***55 HRC***
Bore diameter (mm) ***26***
Length (mm) ***80***

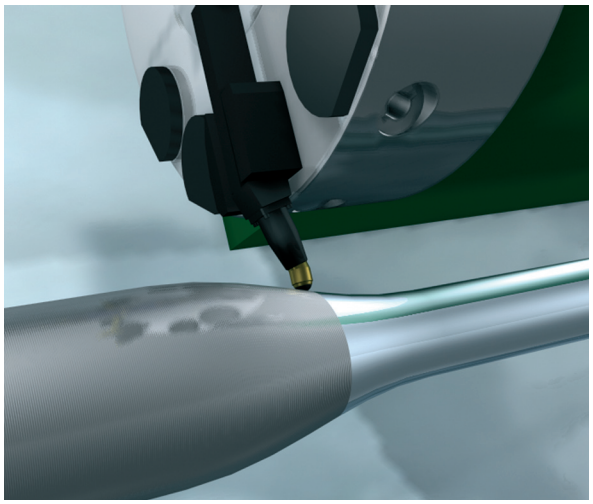
TOOL
HG6-1-VDI40 with hydraulic pump unit HGP1.4
Machine
CNC lathe
Speed (m/min.) ***73***
Rotation speed (RPM) ***900***
Feed rate (mm/rev.) ***0.08***
Pressure (bar) ***300***
Process time ***67 seconds***

MACHINING TASK
- ***Entrance and exit side edges remain sharp due to controlled build-up and release of pressure***
- ***Both faces are finished by turning after the bore is roller burnished***
- ***The machine's M-function controls the hydraulic unit for precise start and stop***

RESULTS/ADVANTAGES
- ***Process time saved: no separate honing operation required***
- ***Higher bearing ratio and increased hardness***

Mandrel for injection mold

APPLICATION EXAMPLE **333**



WORKPIECE
Mandrel for injection mold
Part of
Plastic injection mold
Required finish
R_z ***< 1 µm***
Material ***Tool steel***
Hardness ***48-52 HRC***
Average Ø (mm) ***45***
Length (mm) ***250***

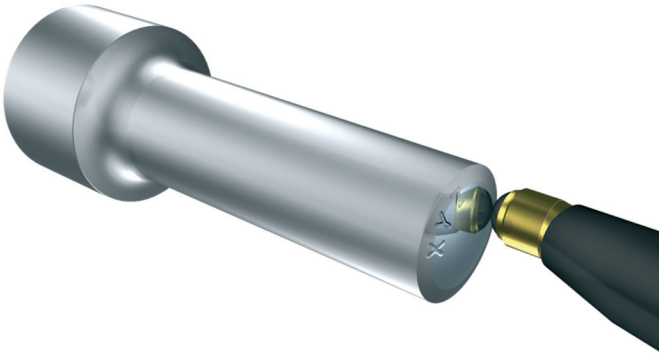
TOOL
HG6-11E00°-VDI20 with hydraulic pump unit HGP1.3
Machine ***CNC lathe***
Speed (m/min.) ***180***
Average rotation speed (RPM) ***1280***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***250***
Process time ***120 seconds***

MACHINING TASK
- ***Hard roller burnish the contour in one setting after hard turning***
- ***Controlled by the machine's program, the tool moves parallel to the contour***
- ***The integrated following system allows the tool to maintain consistent burnishing force***

RESULTS/ADVANTAGES
- ***No manual polishing required***

Punch

APPLICATION EXAMPLE **334**



WORKPIECE
Punch
Part of
Forming tool
Required finish
R_a < 0.1 µm
Material ***Tool steel***
Hardness ***64 +1 HRC***
Diameter (mm) ***15***

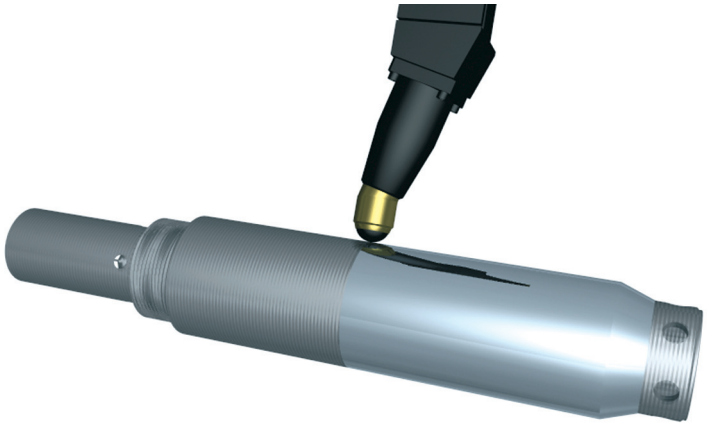
TOOL
HG6-9E00°-SL25 with hydraulic pump unit HGP1.3
Machine
CNC lathe
Speed (m/min.) ***40***
Average rotation speed (RPM) ***640***
Feed rate (mm/rev.) ***0.08***
Pressure (bar) ***400***
Process time ***18 seconds***

MACHINING TASK
Hard roller burnish the entire rounded end, including the center and engraved lettering

RESULTS/ADVANTAGES
Process time saved: no hand polishing required

Control piston

APPLICATION EXAMPLE **335**



WORKPIECE
Control piston
Part of
Hydraulic valve
Required finish
R_z < 1 µm
Material
Vacuum hardened steel
Hardness ***52 HRC***
Diameter (mm) ***25***
Length (mm) ***80***

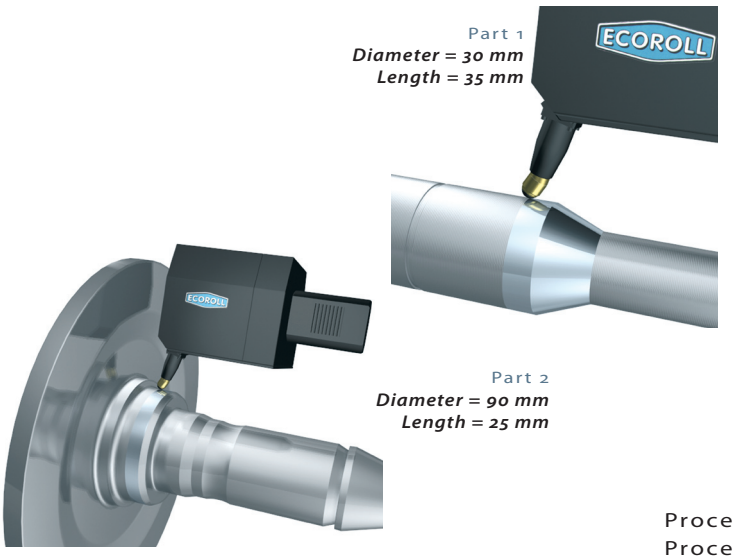
TOOL
HG6-9E00°-SL25
Machine ***CNC lathe***
Speed (m/min.) ***120***
Rotation speed (RPM) ***1530***
Feed rate (mm/rev.) ***0.08***
Pressure (bar) ***320***
Process time ***39 seconds***

MACHINING TASK
Roller burnishing takes place in one setting after hard turning

RESULTS/ADVANTAGES
Process time saved: no subsequent honing or grinding necessary

APPLICATION EXAMPLE **336**

Axle shaft / Gear shaft



WORKPIECE
Axle shaft / Gear shaft
Part of ***Tractor***
Required finish
R_z < 0.8 - 2.5 µm
Material ***Case hardened steel***
Hardness ***58-60 HRC***

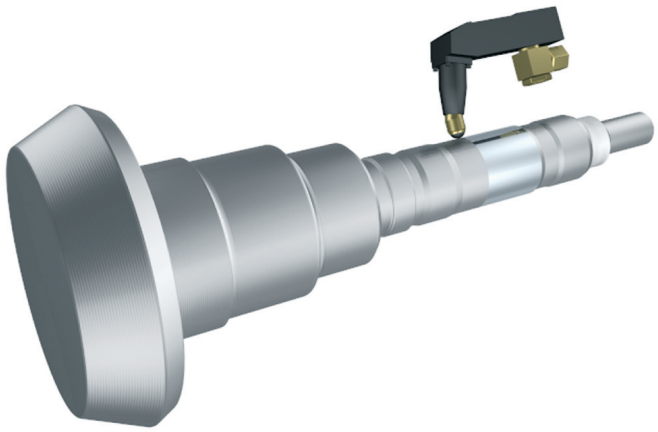
TOOL
Driven tool HG6-5E30°-VDI40 with integrated pump
Machine ***CNC lathe***
Speed (m/min.) ***150***
Rotation speed (Part 1) (RPM) ***1600***
Rotation speed (Part 2) (RPM) ***530***
Feed rate (mm/rev.) ***0.1***
Pressure (bar) ***400***
Process time (Part 1) ***13 seconds***
Process time (Part 2) ***28 seconds***

MACHINING TASK
- ***Roller burnish rotary seal surfaces and needle bearings after hard turning***
- ***Deep roll the fillet radius on Part 2 to increase fatigue strength***

RESULTS/ADVANTAGES
- ***Shorter process time: no grinding required***
- ***Improved product quality and service life***

APPLICATION EXAMPLE **337**

Angle gear shaft



WORKPIECE
Gear shaft with various diameters
Part of
Automotive gear
Required finish
R_z < 1 µm
Material
Case hardened steel
Hardness ***60-62 HRC***

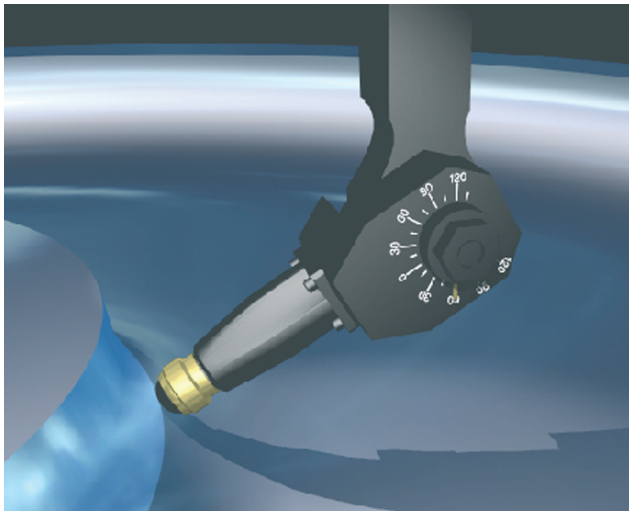
TOOL
HG6-9
Machine
CNC lathe
Speed (m/min.) ***150***
Feed rate (mm/rev.) ***0.2***
Pressure (bar) ***400***
Process time
3 seconds

MACHINING TASK
Hard roller burnish the seal and bearing seats after hard turning

RESULTS/ADVANTAGES
Shorter process time: no grinding required

APPLICATION EXAMPLE **501**

Turbine wheel



WORKPIECE
Turbine wheel
Part of
Steam turbine
Required finish
Eliminate stress corrosion cracking
Material
Heat treated steel
Hardness ***45 HRC***
Tensile strength
1200 N/mm²

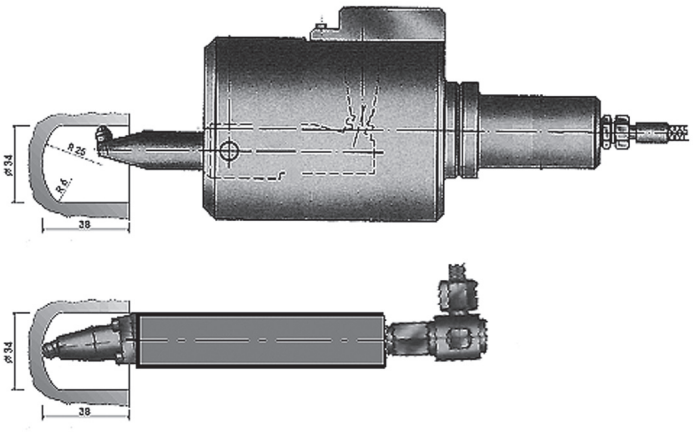
TOOL
HG13-9E270°-SL32
Machine
Vertical lathe
Speed (m/min.) ***100***
Rotation speed (RPM) ***25-40***
Feed rate (mm/rev.) ***0.44***
Pressure (bar) ***200***
Process time ***60 minutes***

MACHINING TASK
- ***Deep roll the curved area between the hub and outer rim***
- ***The workpiece is divided into zones, each machined with a unique tool angle that corresponds to the average local surface inclination***

RESULTS/ADVANTAGES
- ***Compressive residual stresses generated in one setting after turning***

APPLICATION EXAMPLE **502**

Securing bore



WORKPIECE
Securing bore
Part of
Steam turbine wheel disc
Material
Heat treated steel
Hardness ***45 HRC***
Tensile strength
1300 N/mm²

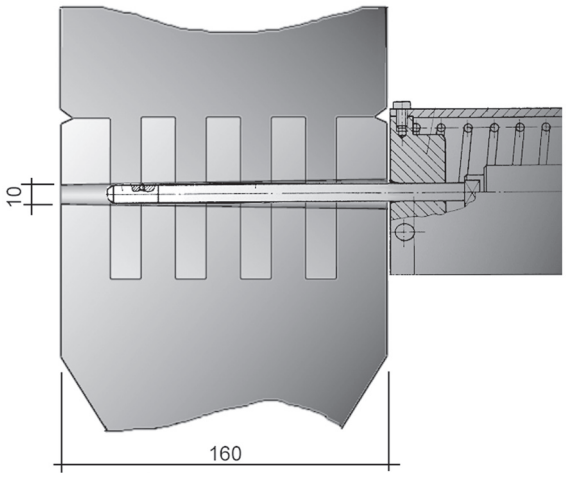
TOOL
HG6-1E15°ZS40DD
HG6-1E20°ZS40DD
Machine
Milling center
Rotation speed (RPM) ***90***
Feed rate (mm/rev.) ***0.25***
Pressure (bar) ***250***
Process time ***15 minutes***

MACHINING TASK
- ***Deep roll the cylindrical section and underside, including the center***

RESULTS/ADVANTAGES
- ***For the first time improving the fatigue life of this critical section is possible***
- ***No other known process achieves these results***

Taper pin hole

APPLICATION EXAMPLE **503**



WORKPIECE
Taper pin hole
Part of
Steam turbine wheel disc
Material
Heat treated steel
Hardness ***45 HRC***
Tensile strength
1300 N/mm²

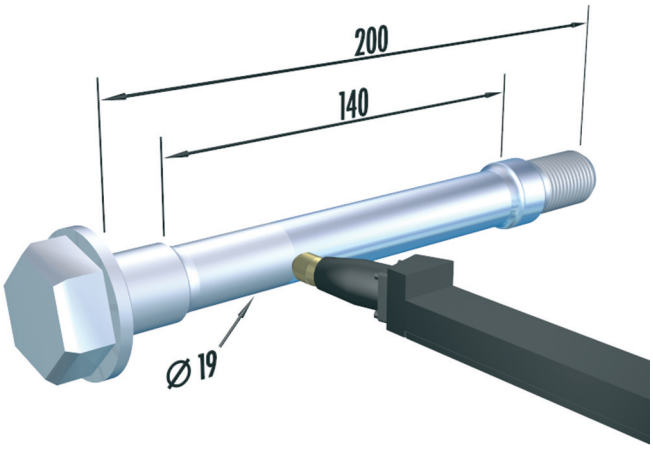
TOOL
HG3-11
Machine
Vertical drill
Speed (m/min.) ***25***
Rotation speed (RPM) ***660***
Feed rate (mm/rev.) ***0.2***
Pressure (bar) ***250***
Process time ***75 seconds***

MACHINING TASK
- ***Eliminate stress corrosion cracking by introducing compressive residual stresses***
- ***2 hydrostatic burnishing balls arranged opposite each other guarantee consistent burnishing force***

RESULTS/ADVANTAGES
- ***This operation replaces shot peening***

Tension bolt

APPLICATION EXAMPLE **504**



WORKPIECE
Tension bolt
Part of
Aircraft engine suspension
Material ***Titanium alloy***
Tensile strength
1600 N/mm²

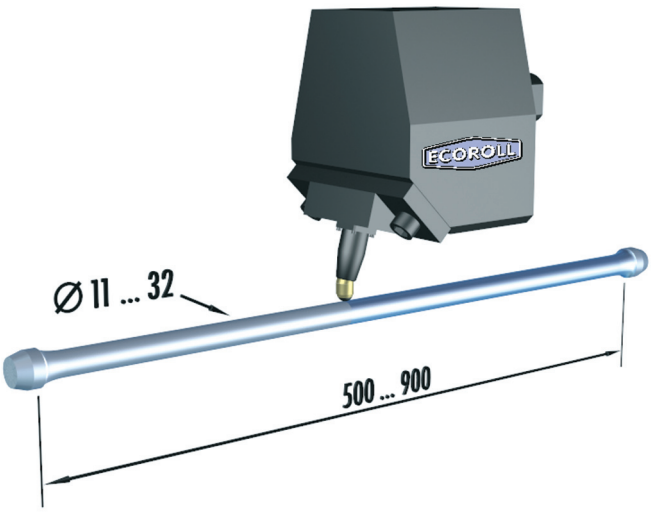
TOOL
HG6-9R00°-SL25
Machine
CNC lathe
Speed (m/min.) ***60***
Rotation speed (RPM) ***1000***
Feed rate (mm/rev.) ***0.3***
Pressure (bar) ***250***
Process time ***28 seconds***

MACHINING TASK
Deep rolling to improve fatigue strength

RESULTS/ADVANTAGES
- ***Required results were achieved***
- ***The process was approved for use within about 10 weeks***

Flexible shaft

APPLICATION EXAMPLE **505**



WORKPIECE
Flexible shaft
Part of
Eccentric screw pump
Material
Heat treated steel
Tensile strength
1600 N/mm²

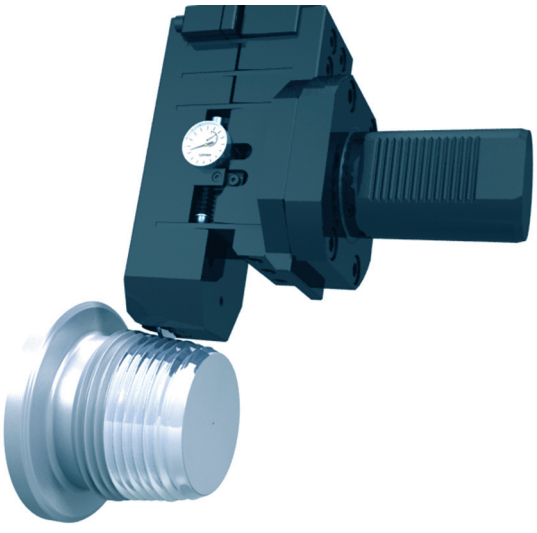
TOOL
HG6-5E00°-VDI50
Machine
CNC lathe
Speed (m/min.) ***100***
Feed rate (mm/rev.) ***0.3***
Pressure (bar) ***350***

MACHINING TASK

RESULTS/ADVANTAGES
Fatigue strength increased by 40%

API thread pin

APPLICATION EXAMPLE **506**



WORKPIECE
API thread pin (tapered)
Part of
Connector for petroleum deep drilling apparatus
Required result
Greater service strength
Material ***42 CrMo 4 V***
Tensile strength ***1200 N/mm²***
Yield strength ***900 N/mm²***

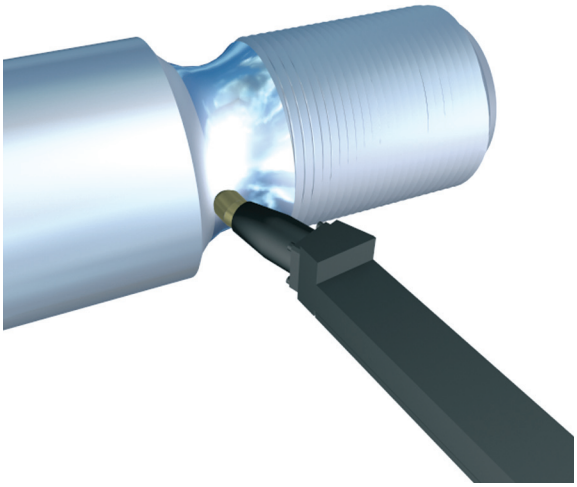
TOOL
EF90-025-R0.8-VDI50
Machine
CNC lathe
Speed (m/min.) ***20***
Rotation speed (RPM) ***53***
Feed rate (mm/rev.) ***6.35***
Dial gauge indication (mm) ***0.9***
Burnishing force (N) ***8500***
Process time ***53 seconds***

MACHINING TASK
- ***Previously, threads could not be deep rolled on CNC lathes***
- ***Before, the time-consuming process involved a separate machining operation on conventional lathes***

RESULTS/ADVANTAGES
- ***Process time shortened***
- ***No extra time required for transportation and resetting***

Tie bar

APPLICATION EXAMPLE **507**



WORKPIECE
Tie bar
Part of
Injection molding machine
Material
Heat treated steel
Hardness ***42 HRC***
Tensile strength
1000 N/mm²
Yield strength ***650 N/mm²***
Diameter (mm) ***32-100***

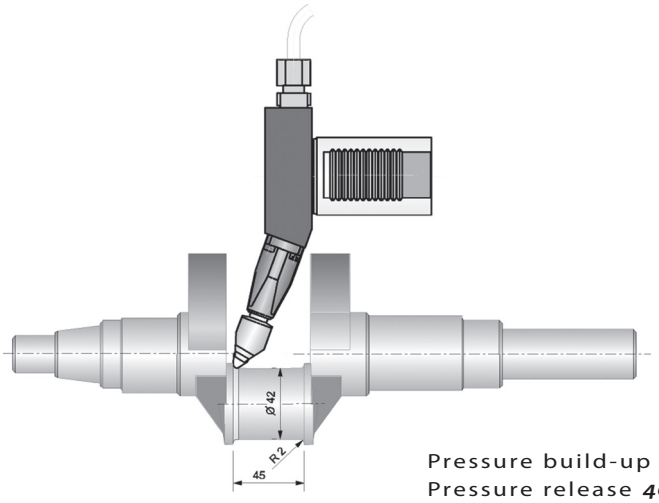
TOOL
HG6-9R00°-SL32
Rotation speed
(RPM) ***100***
Feed rate (mm/rev.) ***0.2***
Pressure (bar) ***350***
Process time ***2.5 minutes***

MACHINING TASK
- ***Components failed due to fatigue in the thread undercut***
- ***Deep rolling to increase fatigue strength***

RESULTS/ADVANTAGES
- ***In the test stand, deep rolled components withstood required stress without failing***
- ***Shorter process time because deep rolling can take place in one setting after turning***

Crank shaft

APPLICATION EXAMPLE **508**



WORKPIECE
Crank shaft
Part of
Piston air compressor
Material ***Nodular cast iron***
Hardness ***55 HRC***

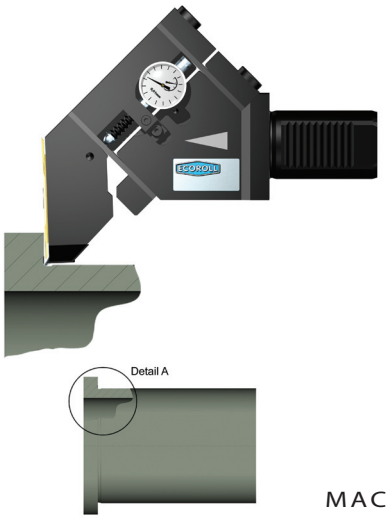
TOOL
HG13R with profile roller
Machine
CNC lathe
Speed (m/min.) ***8***
Rotation speed (RPM) ***60***
Feed rate (mm/rev.) ***0***
(plunge process)
Pressure (bar) ***400***
Pressure build-up ***0–>400 bar, hold pressure steady***
Pressure release ***400–>50 bar***
(for build-up and release allow 5 seconds each)
Process time ***30 seconds***

MACHINING TASK
- ***Deep roll crank shaft fillets***
- ***The crank shafts are fixed in the center for deep rolling***
- ***The machine is equipped with 2 tools, each arranged at a different angle***
- ***The fillets are deep rolled in succession***

RESULTS/ADVANTAGES
- ***Distinct improvement in service strength and product reliability***

Cylinder liner

APPLICATION EXAMPLE **509**



WORKPIECE
Cylinder liner
Part of
Marine diesel engine
Material ***Nodular cast iron***
Tensile strength ***400 N/mm²***
Outer diameter (mm) ***ca. 300***
Fillet radius (mm) ***2.5***

TOOL
EF45-1-VDI40
Machine ***CNC lathe***
Speed (m/min.) ***50***
Rotation speed (RPM) ***50***
Feed rate (mm/rev.) ***0***
(plunge process)
Burnishing force (kN) ***10***
Process time ***18 seconds***

MACHINING TASK

- ***Deep roll the fillet to prevent fatigue cracks in the fillet radius due to the notch effect and cyclic bending***
- ***Deep rolling takes place in one setting after turning using this CNC-controlled loading cycle:***
  1. ***Build up burnishing force 0–>10 kN***
  2. ***Hold burnishing force constant (10 kN)***
  3. ***Decrease burnishing force 10–>0 kN***

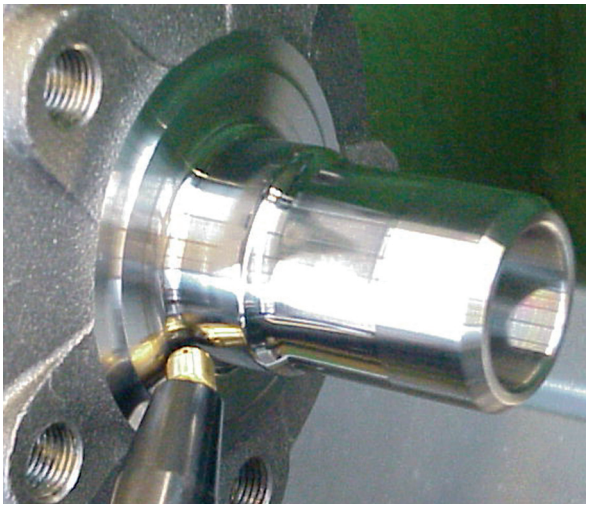
  Allow 5 rotations for each step

RESULTS/ADVANTAGES

- ***According to customer test results, fatigue strength doubled***

Wheel flange

APPLICATION EXAMPLE **510**



WORKPIECE
Wheel flange
Part of
Front axle, passenger car
Material ***Cast steel***
Hardness ***40 HRC***
Tensile strength ***1000 N/mm²***
Yield strength ***700 N/mm²***
Outer diameters (mm)
38 and 45
Fillet radius (mm) ***5***

TOOL
HG6-9R30°-SLK25 and
HG6-9R60°-SLK25
Machine ***CNC lathe***
Speed (m/min.) ***100***
Rotation speed (RPM) ***800***
Feed rate (mm/rev.) ***0.2***
Pressure (bar) ***250***
Process time ***25 seconds***

MACHINING TASK

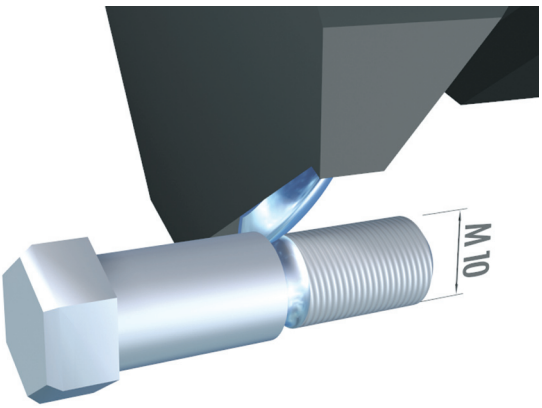
- ***Deep roll fillet radii (both outer diameters and the face are machined in the same operation)***
- ***The workpiece is divided into 2 different zones and each is processed with a different tool angle setting***

RESULTS/ADVANTAGES

- ***According to customer test results, the components are fatigue resistant***
- ***Greater service reliabiity***

High strength screw

APPLICATION EXAMPLE **511**



WORKPIECE
High strength screw
Part of
Front axle, passenger car
Material ***Steel (forged blanks)***
Hardness ***48 HRC***
Tensile strength
1400 N/mm²
Yield strength
1000 N/mm²
Fillet radius (mm) ***2***

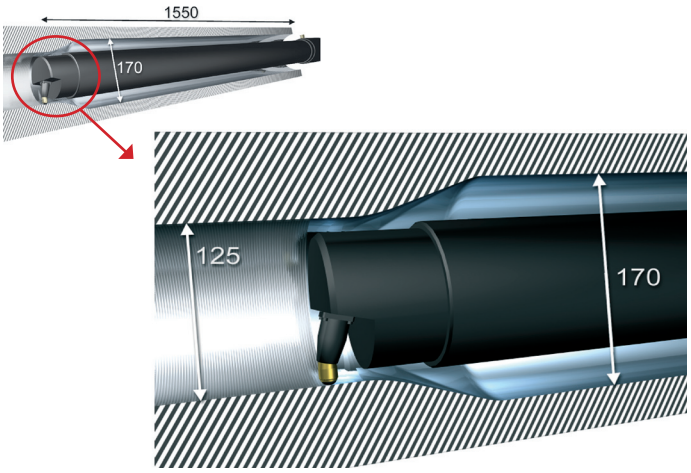
TOOL
EF45
Machine ***CNC lathe***
Speed (m/min.) ***5***
Rotation speed (RPM) ***140***
Process time ***7 seconds***

MACHINING TASK
- ***Deep roll fillet radii***
- ***Due to the notch effect, the thread undercut is the critical zone***
- ***The thread undercut is deep rolled in one setting after turning in a plunge process***

RESULTS/ADVANTAGES
- ***According to customer test results, the components are fatigue resistant***
- ***Greater service reliability***

Hollow shaft

APPLICATION EXAMPLE **512**



WORKPIECE
Hollow shaft
Part of
Special machine
Material ***Steel***
Tensile strength
1100 N/mm²

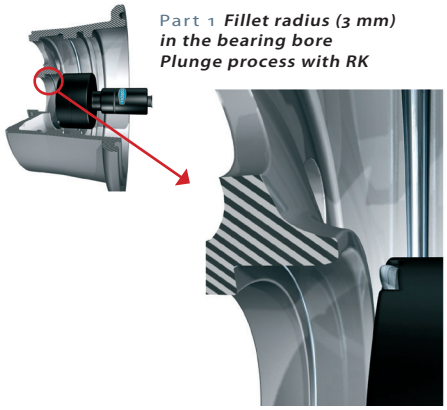
TOOL
HG13-2
Machine
CNC lathe
Speed (m/min.) ***120***
Rotation speed (RPM) ***225***
Feed rate (mm/rev.) ***0.5***
Pressure (bar) ***130***
Process time ***14 minutes***

MACHINING TASK
- ***The stepped bore suffers from the notch effect and its impact increases when grooves are produced in the surface during machining***
- ***Deep roll the shaft to minimize notch effect (corrosion cracking) and increase service strength***

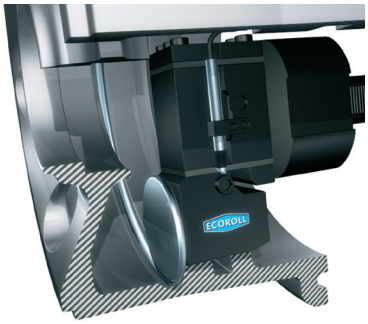
RESULTS/ADVANTAGES
- ***This operation requires less time than other processes that increase hardness***
- ***Increased reliability***
- ***No transport costs (the process takes place in one setting after turning)***

APPLICATION EXAMPLE **513**

Aircraft wheel rim



Part 1 ***Fillet radius (3 mm) in the bearing bore Plunge process with RK***



Part 2 ***Fillet radius (6 mm) in the wheel rim body Feed process with EF90***

WORKPIECE
Wheel rim
Part of
Aircraft
Material
Aluminum alloy

TOOL (Part 1)
RK
Machine ***CNC lathe***
Speed (m/min.) ***40***
Rotation speed (RPM) ***140***
Process time ***6 seconds***

WERKZEUG (Part 2)
EF90
Machine ***CNC lathe***
Speed (m/min.) ***150***
Rotation speed (RPM) ***140***
Feed rate (mm/rev.) ***0.3***
Process time ***15 seconds***

MACHINING TASK

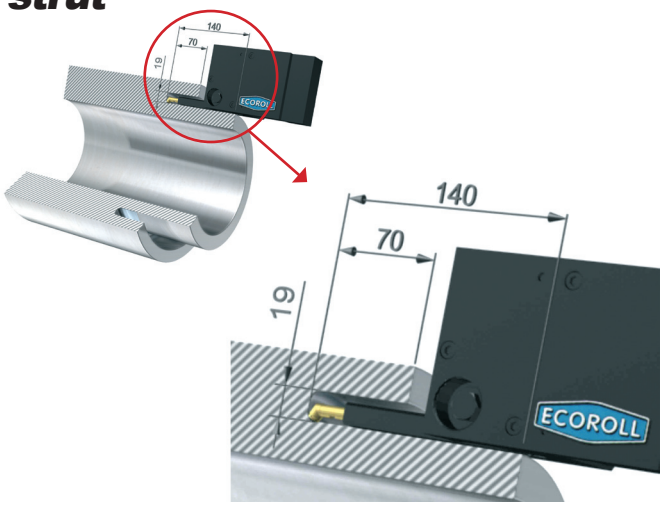
- ***The RK tool deep rolls the bearing bore's undercut in a plunge process in about 15 revolutions***
- ***The EF90 deep rolls the fillet radius in the wheel rim body, executing a program-controlled curve***

RESULTS/ADVANTAGES

- ***5-fold improvement in service strength***

ANWENDUNGSBEISPIEL
APPLICATION EXAMPLE **514**

Flugzeugfederbein / Aircraft shock strut



WORKPIECE
Shock strut
Part of
Aircraft

TOOL
HG6-1
Machine
CNC lathe
Speed (m/min.) ***100***
Rotation speed (RPM) ***270***
Feed rate (mm/rev.) ***0.3***
Process time ***110 seconds***

MACHINING TASK

- ***The face cut-in suffers from the notch effect and its impact increases when grooves are produced in the surface during machining***
- ***Deep roll the face cut-in to minimize notch effect (corrosion cracking) and increase service strength***

RESULTS/ADVANTAGES

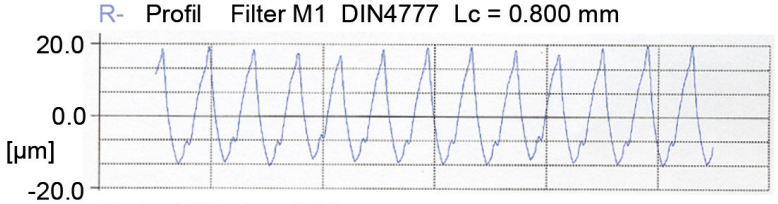
- ***The finished component meets requirements***

After the application . . .

A uniquely smooth surface results when roller burnishing or deep rolling plastically deforms the surface material. After the application, the surface exhibits the following characteristics:

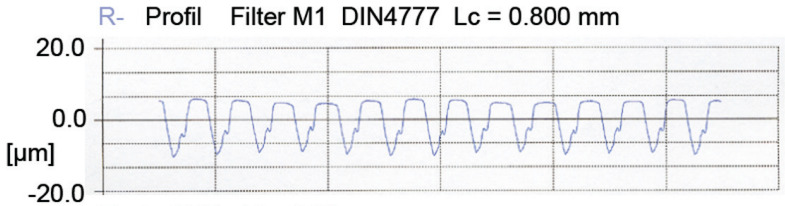
- *Low surface roughness*
- *High surface contact ratio*
- *No pronounced peaks*
- *Increased hardness and wear resistance*
- *Remaining surface roughness accommodates lubrication*

TURNED



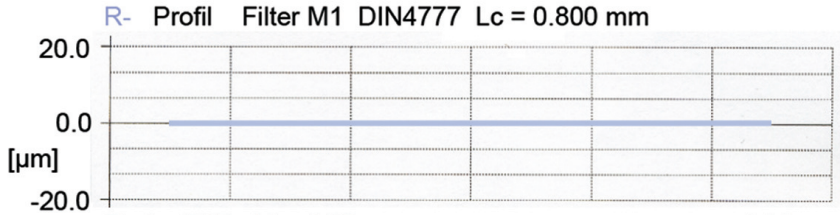
Rt	33.56 µm	4.80
Rmax	33.44 µm	
Rz	32.40 µm	
Ra	8.74 µm	
R3z	0.00 µm	

LIGHTLY ROLLER BURNISHED



Rt	16.34 µm	4.80
Rmax	16.34 µm	
Rz	15.54 µm	
Ra	4.91 µm	
R3z	0.00 µm	

ROLLER BURNISHED



Rt	0.18 µm	4.80
Rmax	0.18 µm	
Rz	0.16 µm	
Ra	0.02 µm	
R3z	0.00 µm	

Surface Measurement Parameters

Arithmetical mean roughness, R_a (CLA, AA)

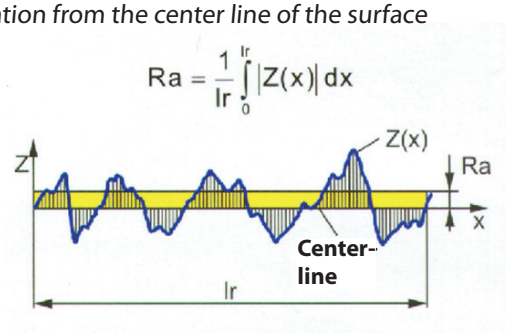
DIN EN ISO 4287

*The arithmetical mean of the absolute values of the **y**-coordinates that correspond to the surface roughness profile.*

*Statistically speaking, R_a also describes the mean arithmetical deviation from the center line of the surface roughness **y**-coordinates.*

R_a has little significance. It does not exhibit sensitivity relative to extreme profile peaks and valleys.

- *R_a corresponds to measuring section **lr**.*
- *R_a is of little statistical value.*
- *Individual outliers are not taken into account.*
- *Widespread in the USA and Europe.*
- *Historically, the first parameter that could be measured.*



Maximum roughness depth, R_z (CLA, AA)

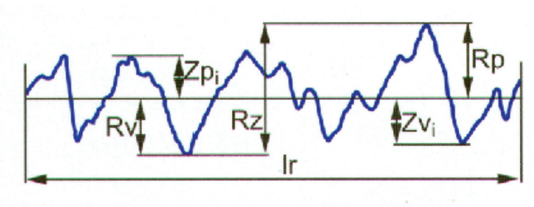
DIN EN ISO 4287

A value based on the height of the largest profile peak R_p and the depth of the deepest profile valley R_v within a given measuring section of the surface roughness profile.

R_z, or the vertical distance between the highest and the lowest points of the surface roughness profile, provides a way to measure the range of y-coordinates that correspond to surface roughness.

*Because as a rule R_z is calculated as an arithmetical mean based on the maximum roughness depth of five measuring sections **lr**, this parameter expresses the average roughness according to DIN 4768. R_p expresses the smoothing depth defined earlier in DIN 4762.*

- *R_z corresponds to measuring section **lr**.*
- *According to DIN 4768, R_z expresses the average of five measuring sections **lr**.*
- *Only up to a fifth of the outliers are taken into account.*
- *R_z can be used to measure bearing and sliding surfaces as well as press or interference fits.*



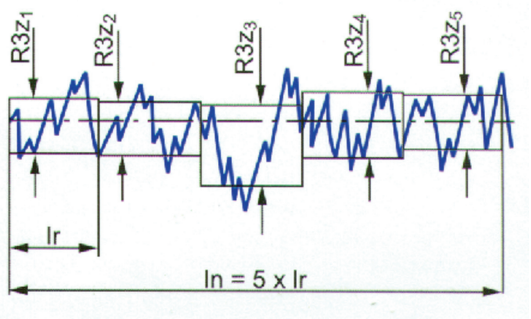
Daimler Benz Parameter, R_{3z} (Factory Standard)

Daimler Benz Factory Standard N3 1007

*The arithmetical mean of five individual surface roughness values: R_{3z1} to R_{3z5}. Each surface roughness value is defined as the vertical distance between the third-largest profile peak and the third-deepest profile valley within measuring section **lr**.*

To measure R_{3z} both a vertical and a horizontal threshold must be set.

- *R_{3z} corresponds to measuring section **ln**.*
- *R_{3z} is the vertical distance between the third-largest profile peak and the third-deepest profile valley within measuring section **lr**.*
- *R_{3z} can only be calculated when there are three peaks and three valleys in a given measuring section.*
- *R_{3z} can be used to evaluate porous or sintered surfaces.*



Appendix

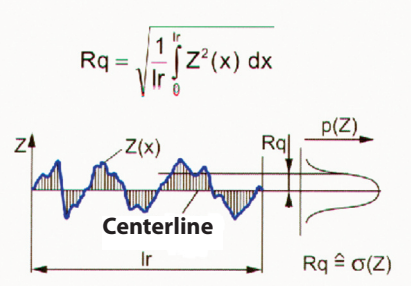
Quadratic mean roughness, R_q (RMS)

DIN EN ISO 4287

Quadratic average value of the y-coordinates that correspond to the surface roughness profile.

*Because R_q, or the mean quadratic deviation from the center line of the surface profile's **y**-coordinates, expresses the standard deviation of the profile's ordinates, it is more statistically significant than R_a.*

- *R_q corresponds to measuring section **lr**.*
- *R_q has greater statistical value than R_a (R_q, ca. 1.1 x R_a).*
- *Because R_q expresses the standard deviation of the profile peaks (and valleys) distributed over a given area, it can provide significant statistical information regarding a surface profile.*



Drawing specifications according to DIN ISO 1302

a = roughness value in µm

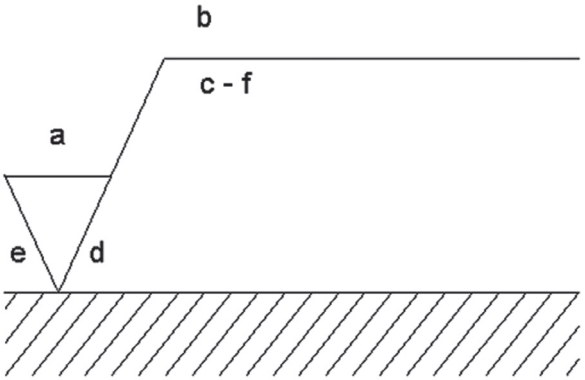
b = production process, surface treatment, coating

c = reference length

d = direction of grooves

e = machining tolerance

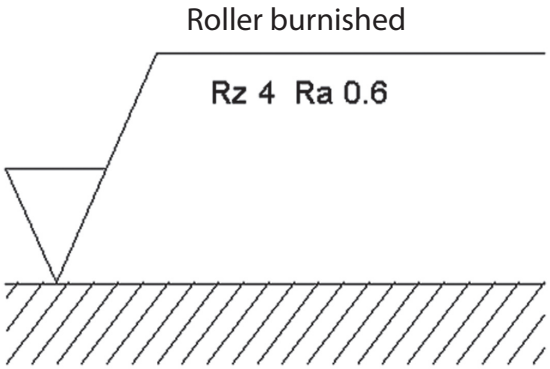
f = other roughness parameters



Drawing specifications: Examples

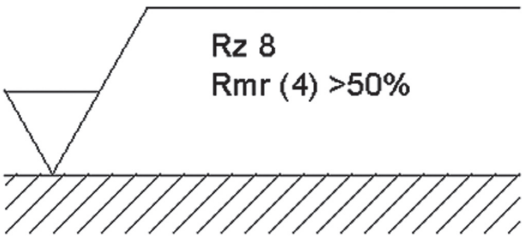
<u>Drawing 1</u>

- *Maximum roughness up to R_z = 4 µm*
- *R_a value up to 0.6 µm*
- *Machining process: roller burnishing*



<u>Drawing 2</u>

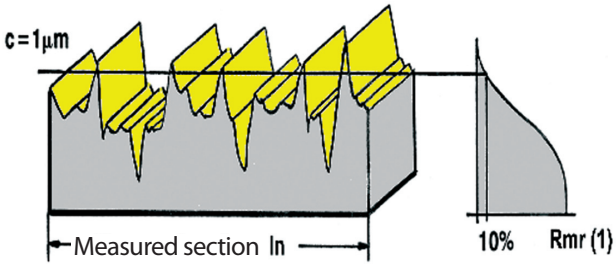
- *Maximum roughness up to R_z = 8 µm*
- *Percentage of material at the surface: R_{mr} > 50 % measured at a cutting depth of 4 µm*



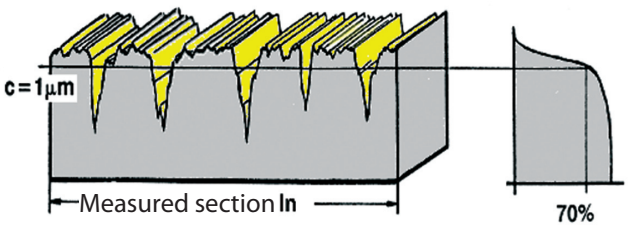
Surface Characteristics

Surface structure determines wear behavior

- *A surface's structure determines its wear behavior.*
- *On sliding surfaces, protruding peaks can lead to increased friction and premature wear.*
- *Plateau-like surfaces with pronounced grooves provide good lubrication and the best sliding properties.*
- *The profile characteristics demonstrated by the material curve provide quick information regarding the surface structure.*



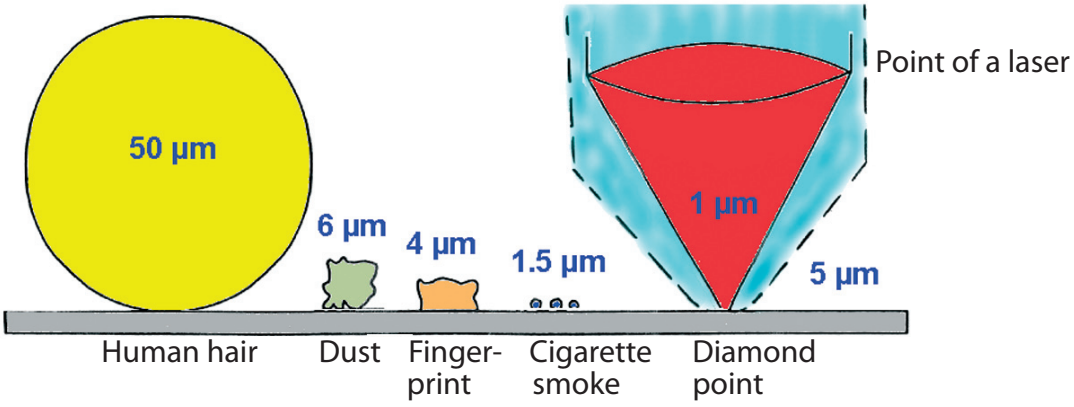
Surface profile with a low percentage of material and poor wear behavior ("Skinny" material curve)



Surface profile with a higher percentage of material at the surface and better wear behavior ("Fat" material curve)

An Overview of µ

It's easy to describe the fractional size of a µm: one, two or three places after the decimal point. This graphic presents µ in a different context.



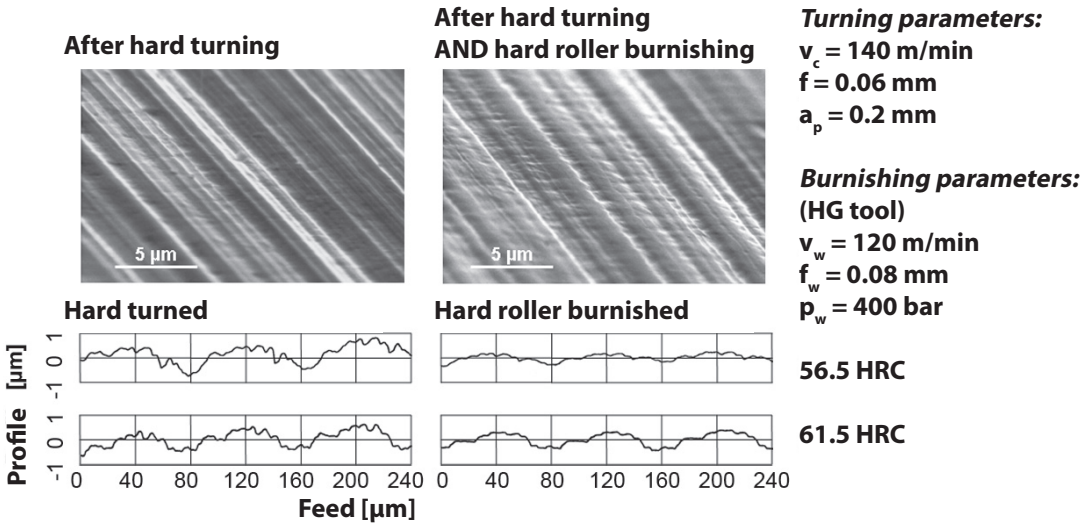
NOTE: *This information presented courtesy of Hommelwerke GmbH, www.hommelwerke.de*

Appendix

Why use roller burnishing and deep rolling?

Improved surface and part quality

No other technology combines three advantageous physical effects to improve a metal component's edge zone. Roller burnishing and deep rolling generate a uniquely smooth surface while inducing compressive stresses and cold work in the surface layer. The compressive stresses counteract external load forces, dramatically increasing component fatigue strength. This technology saves production costs while significantly improving the treated parts.



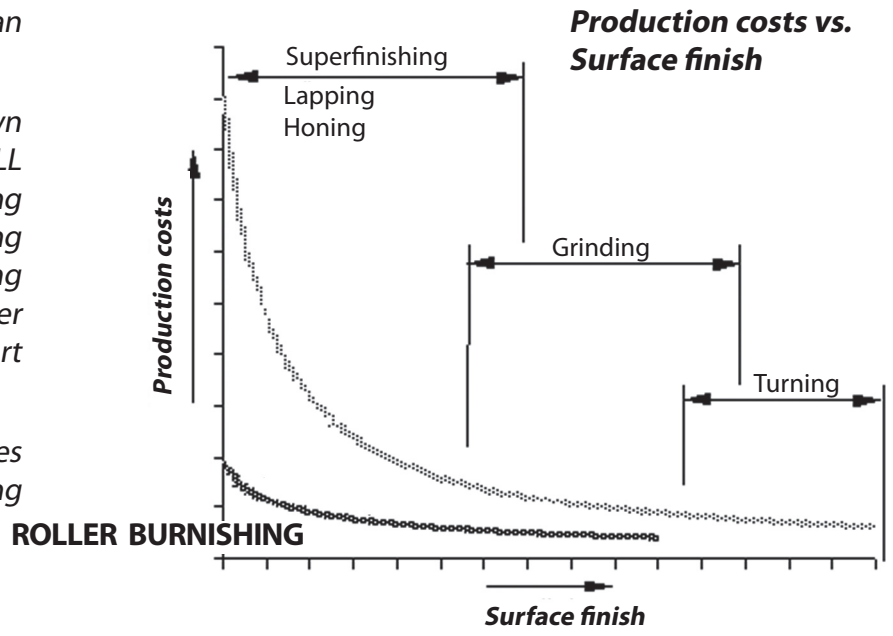
Source:
Werkzeugmaschinenlabor at the RWTH (Technical University) at Aachen

Reduce costs

Substantial cost savings are realized when expensive technologies such as grinding or honing are replaced by a more cost effective treatment. Cost savings accrue first of all because the roller burnishing and deep rolling work cycle is significantly shorter than the alternative processes.

Non-productive time is cut down dramatically because ECOROLL roller burnishing and deep rolling tools offer complete processing on one machine in one setting with no change-over. It's no longer necessary to transport the part between two or more machines.

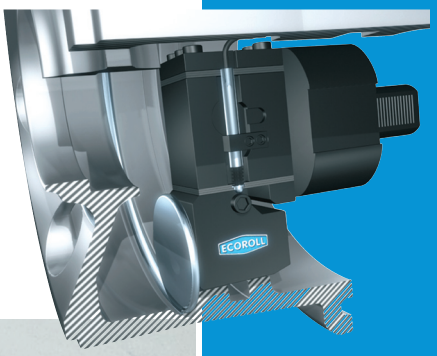
And finally, these processes produce no dust or residue, saving disposal costs.



Tools & Solutions

for

Metal Surface Improvement



Increased fatigue strength

Smooth surfaces

. . . for a smooth operation

ECOROLL