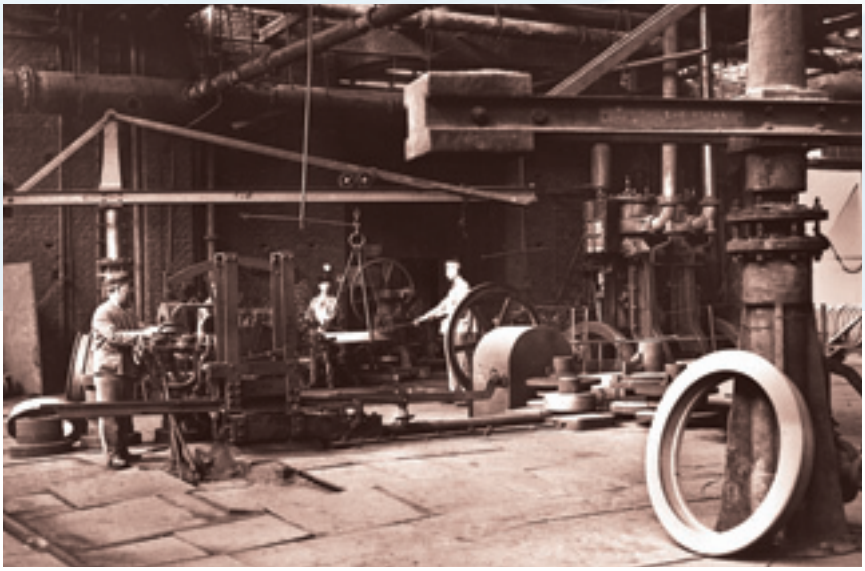
Rothe Erde® Rings

Rothe Erde

ThyssenKrupp

Rothe Erde®
Successful with seamless rolled rings

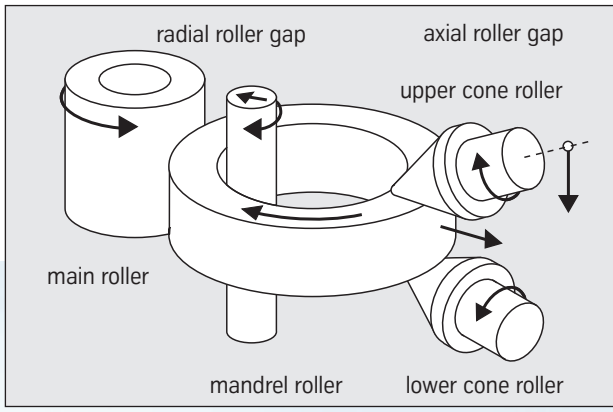


Ring discharge

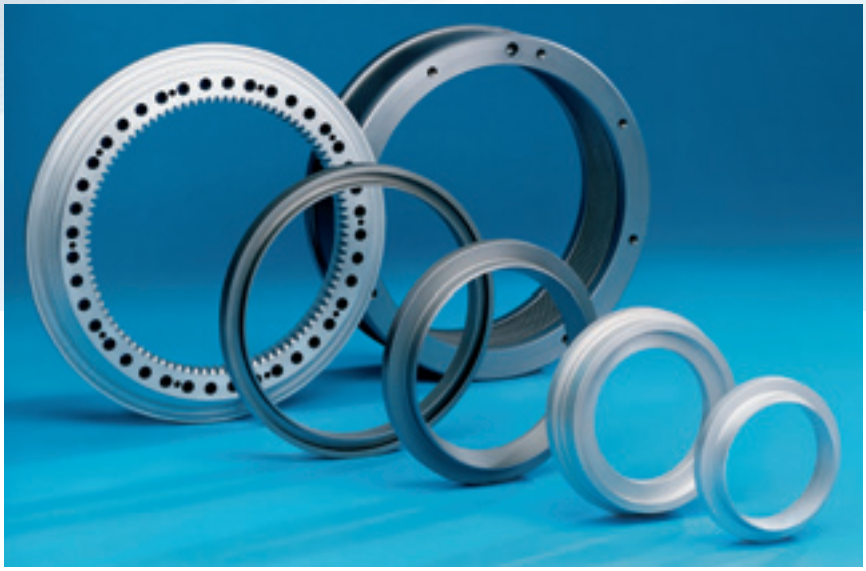
Rothe Erde is one of the world's leading manufacturers of seamless rolled rings.

The foundation for our success and capabilities in this sector is more than 100 years of experience in steel working. Extensive know-how in open and closed die forging was an excellent starting point for Rothe Erde to perfectly apply and continually develop its seamless rolled rings technology. This wealth of experience, gathered over many years, gives Rothe Erde the basis from which to actively take on the challenges of the markets of today and tomorrow.

Compared with other methods, e.g. ring production from heavy plate metal, the manufacture of seamless rings on ring rolling mills (radial-axial rolling mill technology) offers significant economic and technical advantages. Especially the tangential grain orientation, typical for a rolled ring, ensures isotropic mechanical properties over its entire circumference.



Geometrical model of a ring during the rolling process
(deformation zones shown schematically)

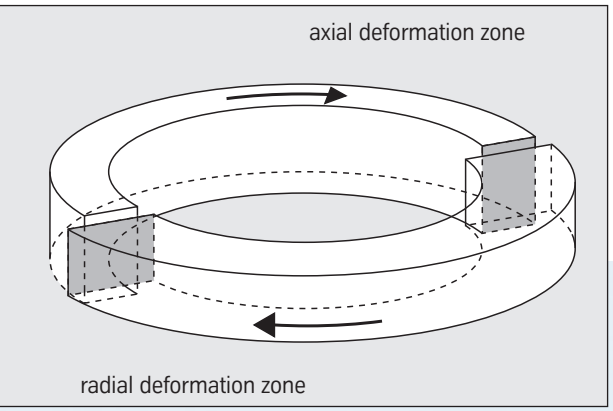


The fact that we listen to our customers has been instrumental in building our ability to offer convincing solutions for a multitude of problems.

Closeness to our customers worldwide is maintained by Rothe Erde's subsidiaries and branches in all of the major industrialized countries. Rothe Erde is your competent partner assisting you in finding and realizing application specific solutions.

Our production facilities in Germany, China and the U.S.A. supply seamless rolled rings according to your requirements, on time and to the highest quality. From application consulting, design engineering and production to our comprehensive customer service, all of our products and services comply with international standards:

- Quality assurance system compliant with DIN EN ISO 9001:2008,
- Environmental protection compliant with DIN EN ISO 14001:2004,
- Health and safety at work compliant with OHSAS 18001:2007 and
- Certified compliance with the Pressure Vessel Directive.



Flexibility
The basis for rationalized ring production

Rothe Erde holds in stock all conventional materials in various dimensions and adequate quantities. These materials include ingots and continuous cast grades, preformed and ESR materials as well as non-ferrous metals, in particular standard aluminum alloys. It is possible to meet nearly every customer request and keep to delivery deadlines.

Thanks to our worldwide connections, we can quickly procure materials which are not usually held in stock. In many cases we are able to suggest alternative materials with identical application properties.

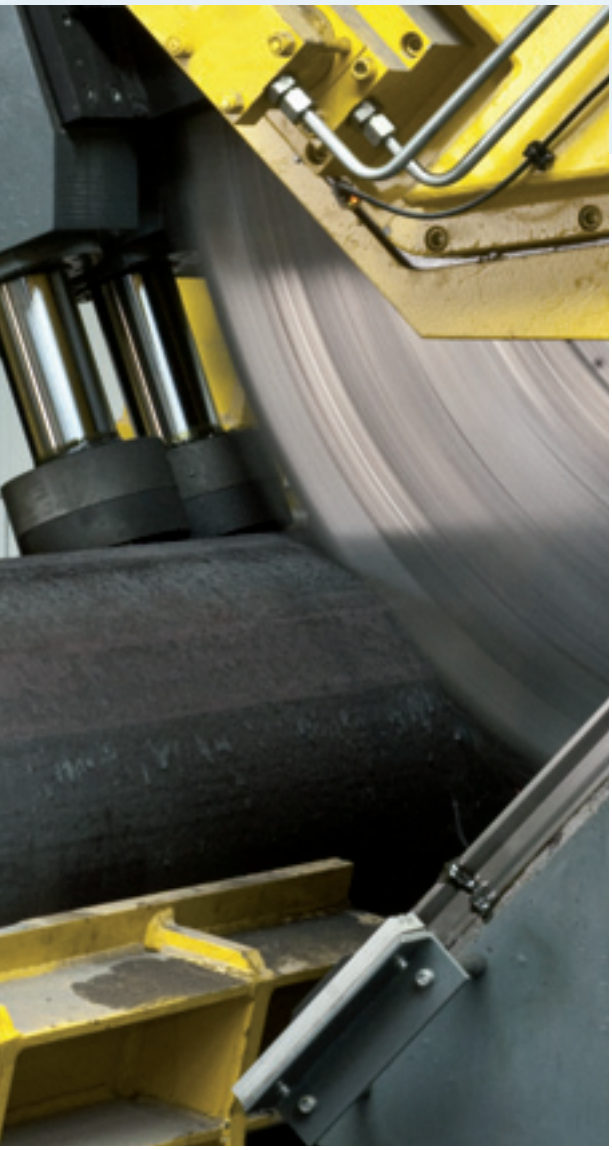
Short throughput times are an important prerequisite for timely delivery. We achieve these by highly flexible order planning and production control.

Optimizing the ring dimensions as early as the consultation phase further contributes to this flexibility.

Sawing station

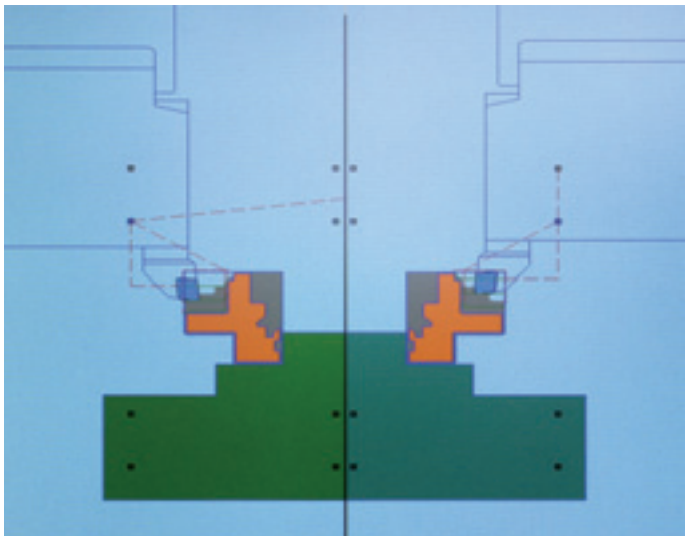
CAD-assisted optimization of ring geometry

Raw material ingots



The consequent adaptation of ring dimensions to the application purpose is further assisted by linked CAD and CNC programs. Depending on customer requirements, from the “simple” blank to the ready-to-install component.

The very tight manufacturing tolerances can only be achieved by precise adherence to the specified weights when the ingot is cut to length. This is ensured by modern high-powered saws with integrated weighing systems.



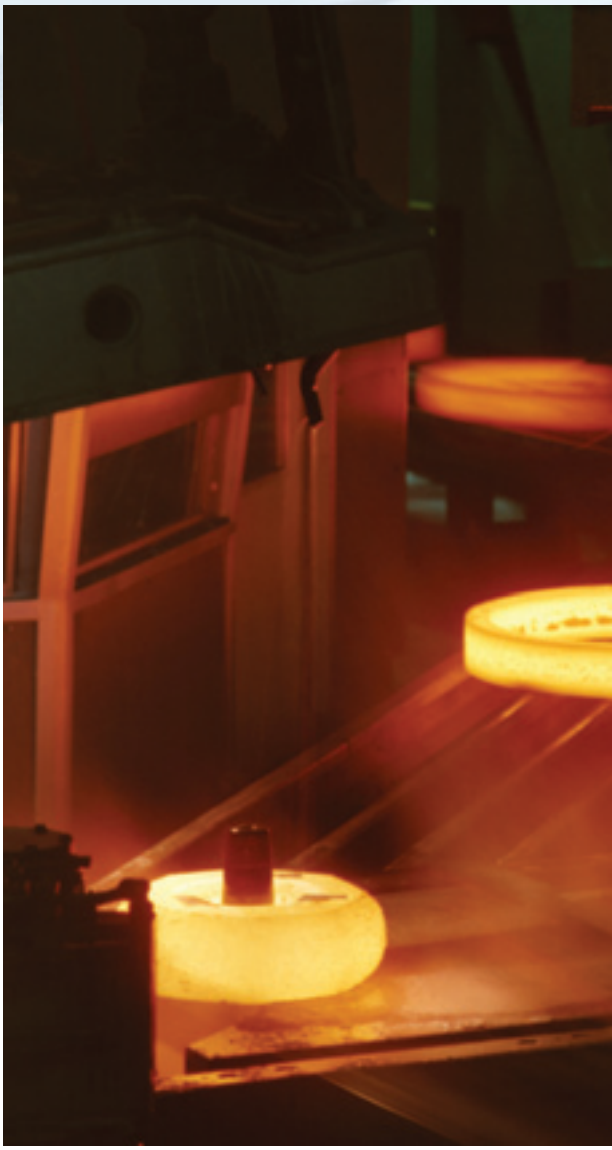
Simulation of CNC machining

Raw ingots being transported to the band saw

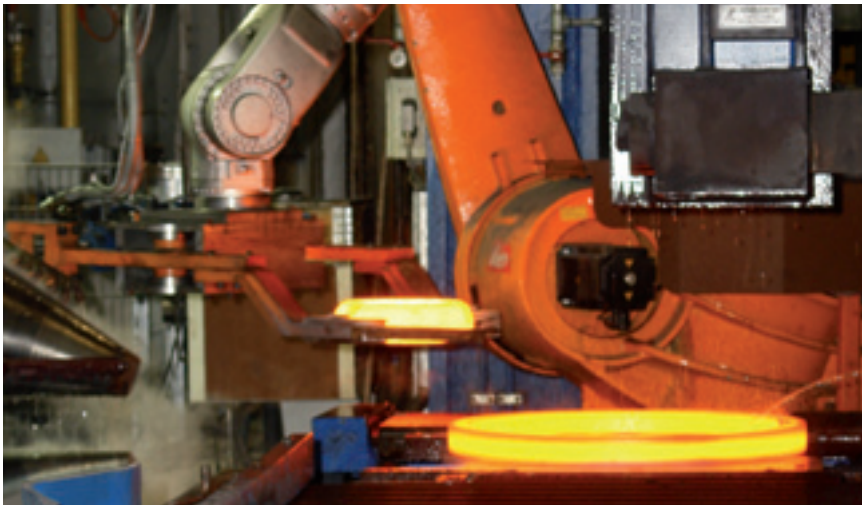
Productivity
A structured production system

Rothe Erde's rolling mills are among the most modern manufacturing plants of their type. They are equipped with CNC controls and cover a production range of 250 to 8000 millimeters outer diameter. They are the core elements of an electronically controlled, rationalized production flow with automatic loading, handling and conveying equipment.

Manipulator



RAW 63/1 ring rolling mill



RAW 63/2 ring rolling mill

Elaborate CNC ring rolling programs allow previously unattainable reproducibility in the manufacture of seamless rolled rings.

It is therefore possible to select the most suitable and economical production equipment for each ring type, size or quantity required.

Preheating furnaces with high precision control and supervising systems allow the processing of each material at its material-specific temperature range.

The hydraulic presses integrated into the production flows are adapted to the capacities of the respective ring rolling mills.

Economical material usage in its ring production is a matter of course for Rothe Erde. Optimization during the forming stage contributes to assuring optimum material utilization while saving costs for the customer.

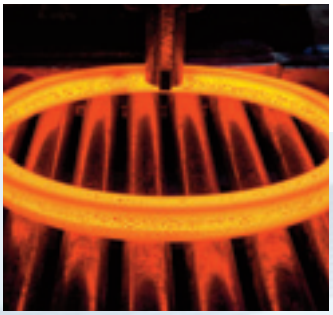
RAW 200 loading equipment

Due to their diversity, the applications of rolled rings require a large number of different cross sections and dimensions. Modern ring rolling technology is flexible enough to meet such requirements. Some of Rothe Erde's manufacturing capabilities are illustrated on this page.

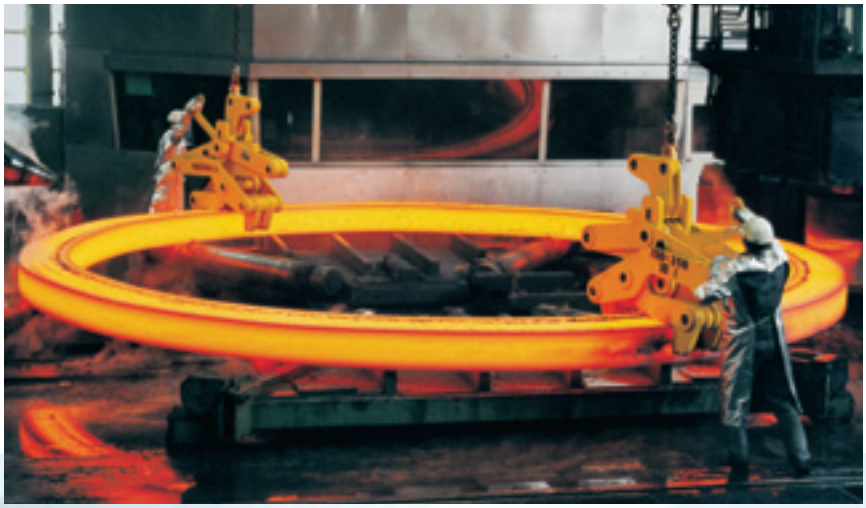
The limit values indicated are not always transferable to higher-alloyed materials with high deformation resistance.

If the ring dimensions reach two limit values in combination, the rollability must be analyzed separately. It is possible to adjust the mechanical properties by appropriate heat treatment for the whole production range.

A complete illustration of all forming capabilities is, of course, not possible here. For further information, or for assistance with your particular needs, please contact our Customer Consultation Dept.



Ring on conveyor rollers



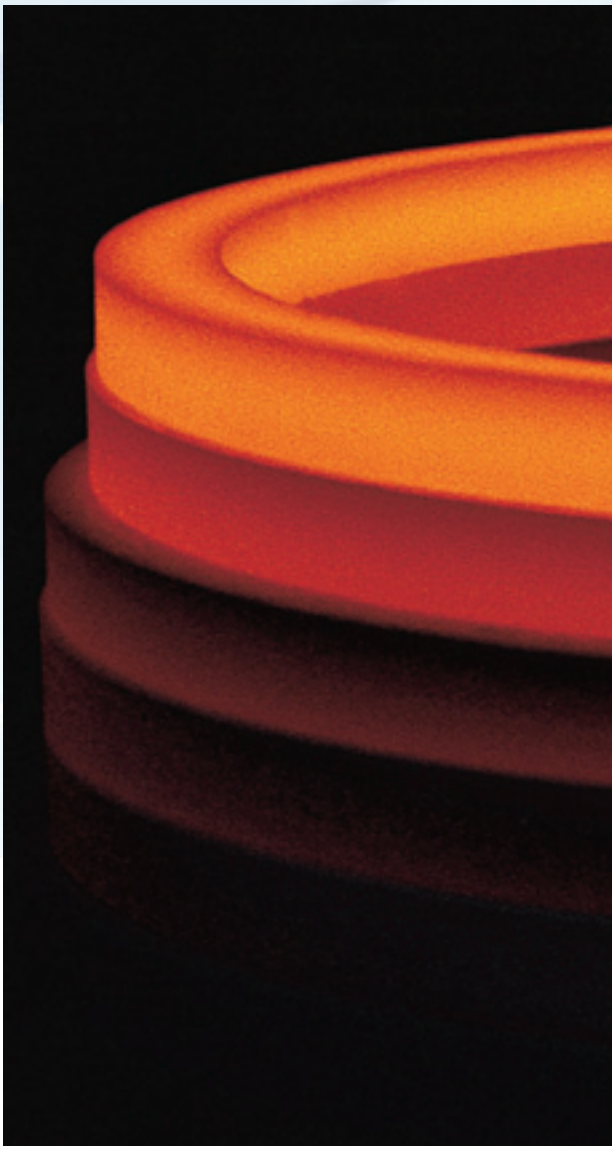
RAW 500 ring rolling mill

Individuality
Material-specific heat treatment and processing

The achievement of optimum processing and application properties in modern materials relies on material-specific heat treatment processes. In addition to know-how and experience, this requires the most advanced technical equipment and procedures. This is the only way that allows a specific extraction of the material qualities demanded for the purpose.

Apart from the standard processes like normalizing, annealing, soft annealing, etc., program-controlled processes allow precise adherence to time-temperature specifications for special materials.

The existing installations also meet the stringent requirements for aviation and space applications.

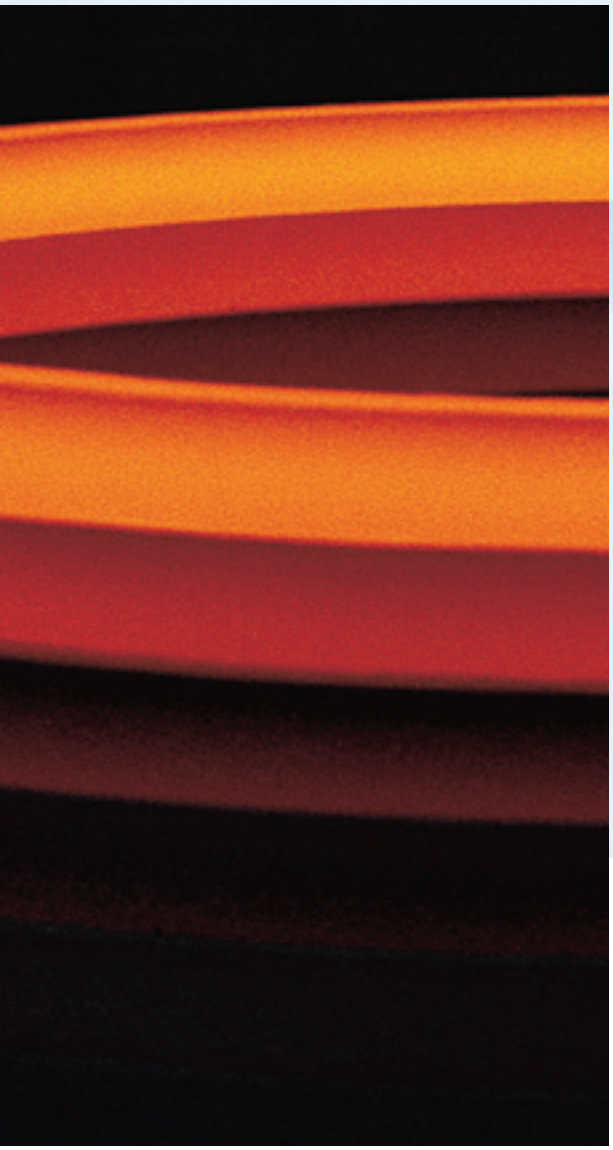


Rolled rings on the cooling bed

Bell-type annealing plant with 3 workstations

Heat treatment with a manipulator for large ring diameters

Gear cutting with a milling cutter



We not only supply rings “as-rolled“ but will also carry out all kinds of machining in our highly capable mechanical production section, on request.

This includes turning, drilling and especially gear cutting. Proven facilities are available for tip circle diameters from 400 to 8000 mm:

Internal gear cutting with straight teeth or external gear cutting with straight/angled teeth, and depending on the stresses that must be withstood, with inductive tooth flank or root hardening. Special procedures such as ni-triding complement our program.

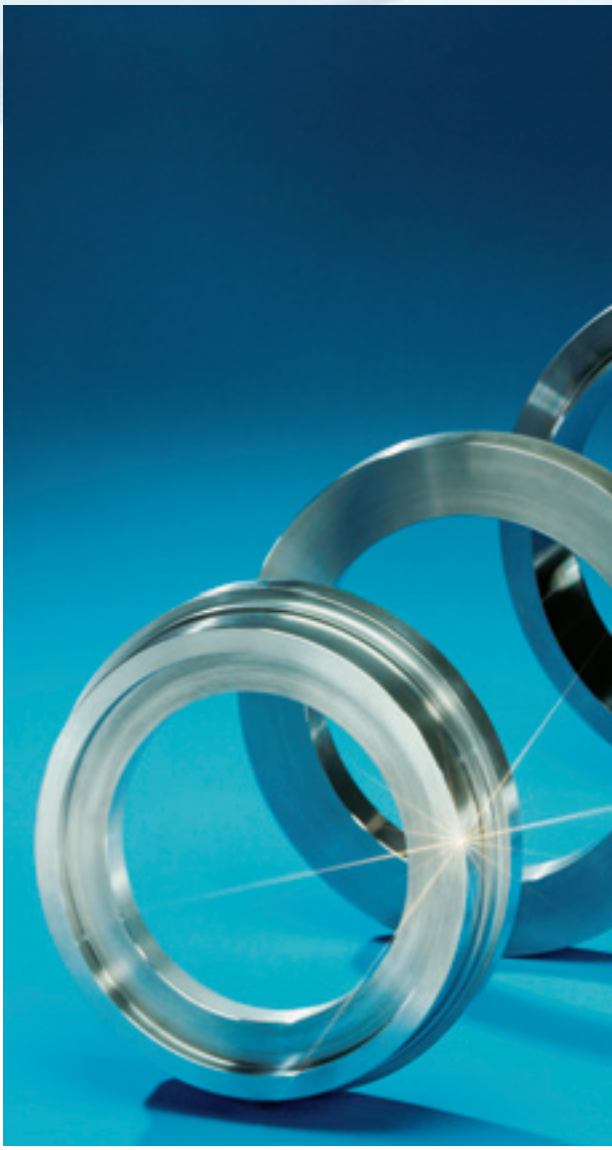
CNC processing center

Finish-turned rings

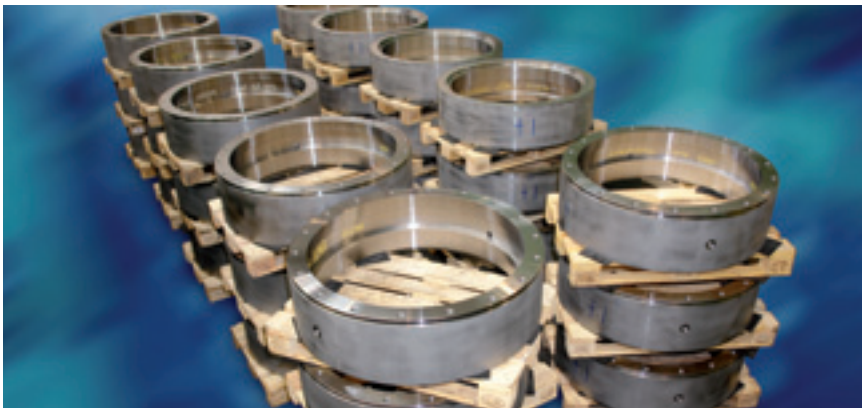
Universality
A single program for individual applications

Seamless rolled rings are gaining more and more importance as structural elements. A few examples of applications:

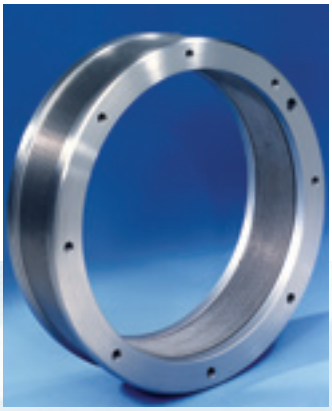
- Wind power plants
- High-power gears
- Mechanical engineering
- Offshore technology
- Rings and supporting rings for slewing bearings



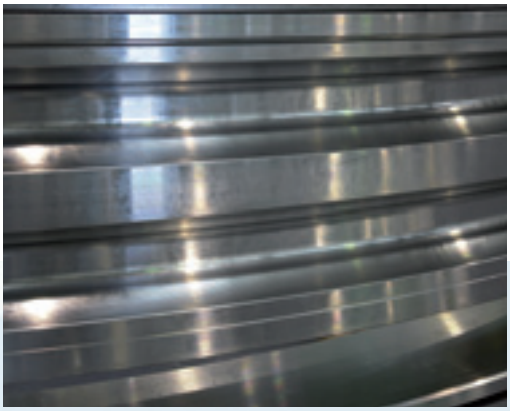
Machined rings for mechanical engineering



Gear rings



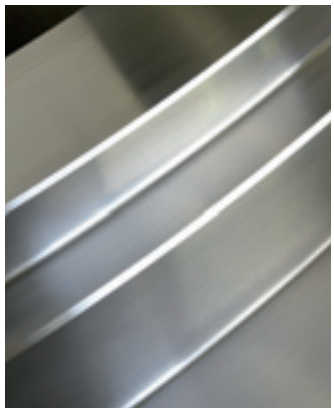
Rings for bulk-feed presses



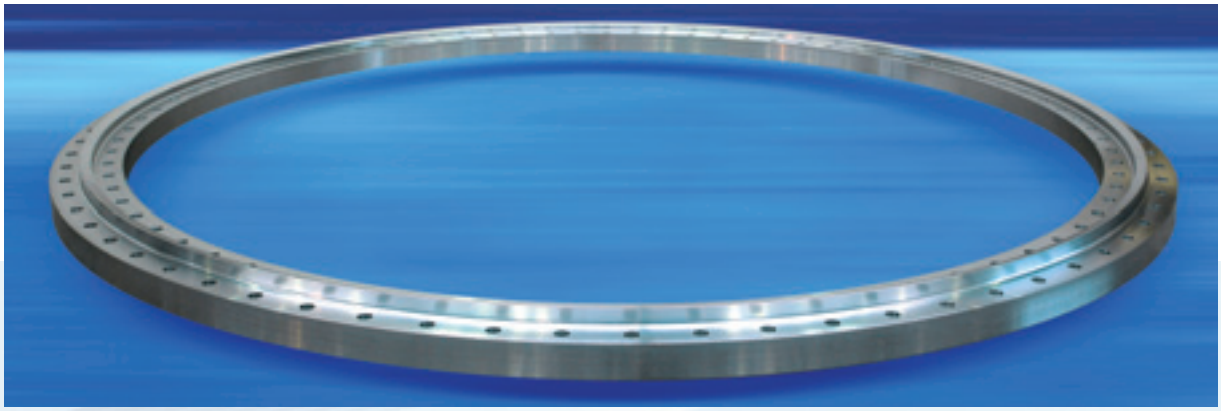
Rings for slewing bearings

- Turbines
- Generators
- Transformers
- Hydraulic motors
- Large valves
- Pipelines
- Textile machinery
- Tanks/pressure vessels
- Gear rings
- Aerospace and spaceflight
- Bulk-feed presses
- Steel mills

Finish-machined flanged rings



Scanner ring

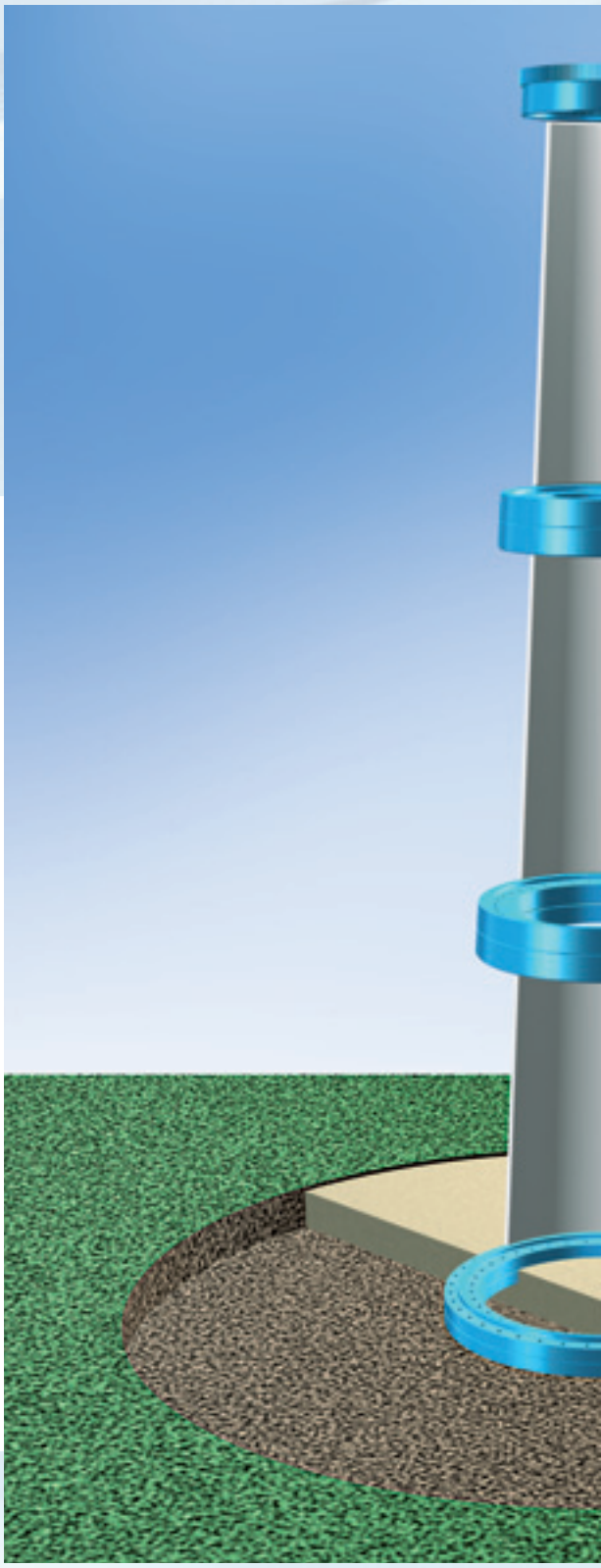


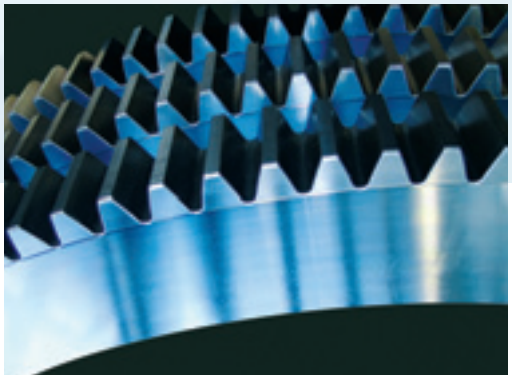
6 m flange for a wind power plant

Specialization

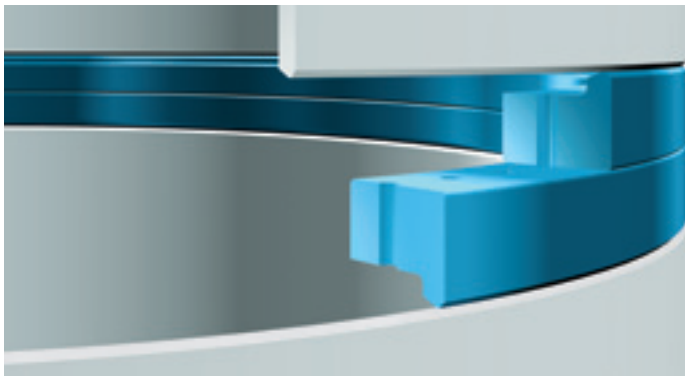
Rings for wind power plants, onshore and offshore applications

We are certified to produce rings for:
- Wind towers and foundation sections,
- Gears units,
- Shaft-hub connections (rings for shrink rings) and
- Brake disks.

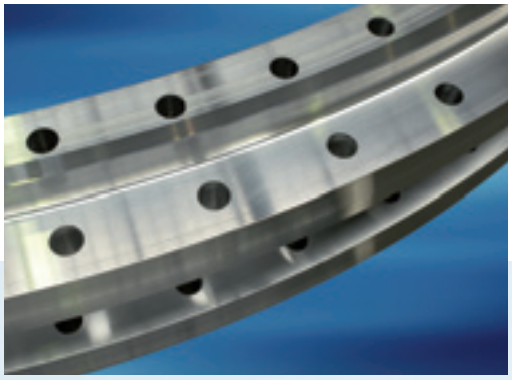




Gear rings



Tower flange connection



Tower flange

Quality
Rothe Erde® MaQUS management system

MaQUS – the integrated management system from Rothe Erde is comprised of the following elements:

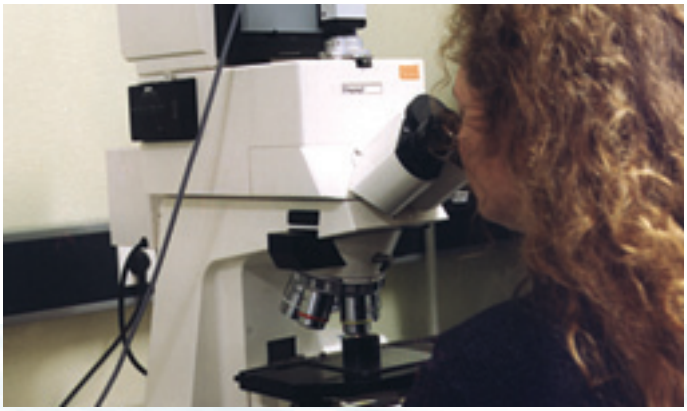
- Quality assurance system compliant with DIN EN ISO 9001:2008,
- Environmental protection compliant with DIN EN ISO 14001:2004 and
- Health and safety at work compliant with OHSAS 18001:2007.

Quality assurance uses all of the latest procedures for destructive and non-destructive material testing. Special quality tests are carried out in close cooperation with external specialist labs and ThyssenKrupp AG.

In all cases, the most advanced measuring and analysis techniques are used:

- Light and stereo microscopes with electronic image memory and printer,
- Scanning electron microscopes with EDX analysis,
- Electron beam microprobe (EMA),
- Deformation dilatometer and
- Quantitative image analysis (IBAS).

3-coordinate measuring instrument



Metallographic microstructure analysis

Scanning electron microscope

Ultrasonic testing

Rothe Erde is accredited by all leading classification and acceptance agencies such as Technischer Überwachungsverein (TÜV), Lloyd's Register (LR), Det Norske Veritas (DNV), Bureau Veritas (BV), American Bureau of Shipping (ABS), Germanischer Lloyd (GL) and China Classification Society Europe (CCS).

Materials
International standards

Worldwide operations increasingly need to be familiar with and respect international standards. It is, therefore, important to know to what extent identical analyses or application-identical material properties are meeting requirements.

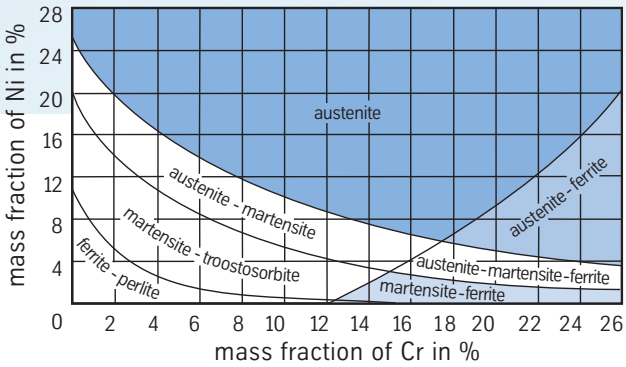
The following tables show various international standards applicable for unalloyed structural steels, quenched and tempered steels, high-alloyed steels and wrought aluminum alloys. Considering the multitude of formable materials, these lists cannot be comprehensive. Please contact the Rothe Erde Customer Consultation Dept. for more information.

Unalloyed structural steels

EN 10025	DIN 17100	Great Britain BS	France NF	Italy UNI	Sweden SS/SIS	Spain UNE	USA ASTM	Japan JIS
S 185	ST 33	–	A 33	FE 320	1300-00	A 310-0	283 G. A	
S 235 JR	RST 37-2	40 B	–	–	1312-00	AE 235 B-FN	284 G. B	–
S 235 J0	ST 37-3 U/N	40 C/D	E 24-3/4	FE 360 C/D	–	AE 235 C/D	–	–
S 235 J2	–	–	–	–	–	–	–	–
S 275 JR	ST 44-2	43 B	E 28-2	FE 430 B	1412-00	AE 275 B	–	–
S 275 J0	St 44-3 U/N	43 C/D	E 28-3/4	FE 430 C/D	1414-00	AE 275 C/D	572 G. 42	SM 41 C
S 275 J2	–	–	–	–	1414-01	–	–	–
S 355 JR	–	50 B	E 36-2	FE 510 B	–	AE 355 B	–	–
S 355 J0	ST 52-3 U/N	50 C/D	E 36-3	FE 510 C/D	–	AE 355 C/D	440	SM 53 B/C
S 355 J2	–	50 DD	E 36-4	–	–	–	–	–
S 450 J0	–	50 B	–	–	–	–	–	–
E 295	ST 50-2	–	A 50-2	FE 490	1550-00	A 490	572 G. 55	SS 50
E 335	ST 60-2	55 C	A 60-2	FE 590	1650-00	A 590	572 G. 65	SM 58
E 360	ST 70-2	–	A 70-2	FE 690	1655-00	A 690	–	–

Quenched and tempered steels

EN 10083	DIN 17200	Great Britain BS	France NF	Italy UNI	Sweden SS/SIS	Spain UNE	USA SAE/AISI	Japan JIS
C 22	C 22	050 A 20	–	–	–	–	1020	–
C 35	C 35	060 A 35	AF 55 C 35	–	1572	–	1035	–
C 45	C 45	080 M 46	AF 65 C 45	–	1672	–	1045	–
C 55	C 55	070 M 55	AF 70 C 55	–	1674	–	1055	–
C 60	C 60	080 A 62	–	–	–	–	1060	–
C 22 E/R	Ck/Cm 22	070 M 20	XC 18/u	C 25	–	Ck 25	–	S 22 C
C 35 E/R	Ck/Cm 35	080 M 36	XC 38 H1/u	C 35	–	Ck 35/1	–	S 35 C
C 45 E/R	Ck/Cm 45	080 M 46	XC 45 H1/u	C 45	–	Ck 45/1	–	S 45 C
C 55 E/R	Ck/Cm 55	070 M 55	XC 55 H1/u	C 55	–	Ck 55/1	–	S 55 C
C 60 E/R	Ck/Cm 60	070 M 60	–	C 60	–	–	–	S 58 C
28 Mn 6	28 Mn 6	150 Mn 28	38 C 2	–	2120	36 Mn 6	1330	SMn 1
38 Cr 2	38 Cr 2	120 M 36	38 C 2	–	–	–	–	SMn 2
46 Cr 2	46 Cr 2	605 M 36	42 C 2	–	–	–	–	SMn 3
34 Cr 4	34 Cr 4	530 M 32	32 C 2	–	–	–	5132	SCr 2
37 Cr 4	37 Cr 4	530 M 36	38 C 4	–	–	38 Cr 4	5135	SCr 3
41 Cr 4	41 Cr 4	530 M 40	42 C 4	41 Cr 4	–	42 Cr 4	5140	SCr 4
25 CrMo 4	25 CrMo 4	708 M 25	25 CD 4	25 CrMo 4	2225	30 CrMo 4	4130	SCM 2
34 CrMo 4	34 CrMo 4	708 M 32	34 CD 4	35 CrMo 4	2234	35 CrMo 4	4137	SCM 3
42 CrMo 4	42 CrMo 4	708 M 40	42 CD 4	42 CrMo 4	2244	40 CrMo 4	4140	SNC M 4
34 CrNiMo 6	34 CrNiMo 6	817 M 40	35 CD 6	30 NiCrMo 12	2541	40 NiCrMo 7	4340	SNC M 9
30 CrNiMo 8	30 CrNiMo 8	823 M 30	30 NCD 8	–	2534	32 NiCrMo 16	–	SNC M 5
51 CrV 4	50 CrV 4	735 A 50	50 CV 4	50 CrV 4	–	–	6150	SUP 10



1	Ferritic and martensitic steels
2	Austenitic-ferritic steels
3	Austenitic steels

High-alloyed steels

	Steel grade DIN 17440/SEW 400 Mat. No.	Short name 683/13	ISO-standard	EURO-standard 88-86	Great Britain BS	France NF	Sweden SS/SIS	Spain UNE	USA Canada AISI UNS	Japan JIS
1	1.4000	X 6 Cr 13	1	X 6 Cr 13	403 S 17	Z 6 C 13	(2301)	3110	410 S	410 S
	1.4002	X 6 CrAl 13	2	X 6 CrAl 13	405 S 17	Z 6 CA 13	–	3111	405	405
	1.4006	X 10 Cr 13	3	X 10 Cr 13	(410 S 21)	(Z 12 C 13)	2302	(3401)	(410)	(410)
	1.4104	X 12 CrMoS 17	9 a	X 14 CrMoS 17	–	Z 10 CF 17	2383	3117	–	430 F
	1.4105	X 4 CrMoS 18	–	–	–	–	–	–	–	–
	1.4510	X 6 CrTi 17	8 b	X 5 CrTi 17	–	Z 8 CT 17	2326	3114	439	430 LX
	1.4512	X 6 CrTi 12	1 Ti	X 6 CrTi 12	409 S 19	Z 6 CT 12	–	–	409	409
	1.4021	X 20 Cr 13	4	X 20 Cr 13	(420 S 29)	(Z 20 C 13)	2303	3402	(S 42010)	420 J 1
	1.4024	X 15 Cr 13	3	X 15 Cr 13	(420 S 29)	(Z 12 C 13)	2302	(3401)	(410)	(410)
	1.4028	X 30 Cr 13	5	X 30 Cr 13	420 S 45	(Z 30 C 13)	2304	3403	420 B	420 J 2
	1.4031	X 38 Cr 13	–	X 40 Cr 13	–	(Z 40 C 14)	–	(3404)	420 X	420 J 2
	1.4034	X 46 Cr 13	–	X 45 Cr 13	–	Z 40 C 13	–	3405	420 C	–
	1.4057	X 20 CrNi 17 2	9 b	X 19 CrNi 17 2	431 S 29	Z 15 CN 16.02	2321	3427	431	431
	1.4112	X 90 CrMoV 18	–	–	–	(Z 90 CDV 18)	–	–	(440 B)	440 B
	1.4116	X 45 CrMoV 15	–	–	–	(Z 50 CD 13)	–	–	–	–
	1.4120	X 20 CrMo 13	–	–	–	Z 20 CD 13	–	–	–	–
	1.4122	X 35 CrMo 17	–	–	–	–	–	–	–	–
	1.4125	X 105 CrMo 17	–	–	–	Z 100 CD 17	–	–	440 C	440 C
	1.4418	X 4 CrNiMo 16 5	–	–	–	Z 5 CND 17.05	2387	–	–	–
2	1.4460	X 4 CrNiMoN 27 5 2	–	–	–	(Z 8 CND 26.05)	2324	–	329	(329 J 1)
	1.4462	X 2 CrNiMoN 22 5 3	–	–	–	Z 2 CND 22.5 AZ	2377	–	S 31803	–
3	1.4301	X 5 CrNi 18 10	11	X 5 CrNi 18 10	304 S 15/16/31	Z 6 CN 18.09	2332	3504	304	304
	1.4303	X 5 CrNi 18 12	13	X 5 CrNi 18 12	305 S 19	Z 4 CN 18.12	–	3513	(305)	305 J 1
	1.4305	X 10 CrNiS 18 9	17	X 10 CrNiS 18 9	303 S 31	Z 10 CNF 18.09	2346	3508	303	303
	1.4306	X 2 CrNi 19 11	10	X 2 CrNi 18 10	304 S 11	Z 2 CN 18.10	2352	3503	304 L	304 L
	1.4311	X 2 CrNiN 18 10	10 N	X 2 CrNiN 18 10	(304 S 61)	Z 2 CN 18.10 AZ	2371	–	304 LN	304 LN
	1.4541	X 6 CrNiTi 18 10	15	X 6 CrNiTi 18 10	321 S 31	Z 6 CNT 18.10	2337	3523	321	321
	1.4550	X 6 CrNiNb 18 10	16	X 6 CrNiNb 18 10	347 S 31	Z 6 CNNb 18.10	2338	3524	347	347
	1.4401	X 5 CrNiMo 17 12 2	20	X 5 CrNiMo 17 12 2	316 S 31	Z 6 CND 17.11	2347	3534	316	316
	1.4404	X 2 CrNiMo 17 13 2	19	X 2 CrNiMo 17 13 2	316 S 11	Z 2 CND 17.12	2348	3533	316 L	316 L
	1.4406	X 2 CrNiMoN 17 12 2	19 N	X 2 CrNiMoN 17 12 2	(316 S 61)	Z 2 CND 17.12 AZ	–	–	316 LN	316 LN
	1.4429	X 2 CrNiMoN 17 13 3	19 a N	X 2 CrNiMoN 17 13 3	(316 S 63)	Z 2 CND 17.13 AZ	2375	3534	316 LN	316 LN
	1.4435	X 2 CrNiMo 18 14 3	19 a	–	316 S 13	Z 2 CND 17.13	2353	3533	316 L	316 L
	1.4436	X 5 CrNiMo 17 13 3	20 a	X 5 CrNiMo 17 13 3	316 S 33	Z 6 CND 17.12	2343	–	316	316
	1.4438	X 2 CrNiMo 18 16 4	24	X 2 CrNiMo 18 16 4	317 S 12	Z 2 CND 19.15	2367	–	(317 L)	317 L
	1.4439	X 2 CrNiMoN 17 13 5	–	X 2 CrNiMoN 17 13 5	–	–	–	–	–	–
	1.4539	X 1 NiCrMoCu 25 20 5	A-4	–	–	Z 1 CNDU 25.20	2562	–	–	–
	1.4571	X 6 CrNiMoTi 17 12 2	21	X 6 CrNiMoTi 17 12 2	320 S 31	Z 6 CNDT 17.12	2350	3535	316 Ti	–

Wrought aluminum alloys

DIN 1725	DIN 17007	ISO	Int. Reg. Record (AA)	Great Britain BS (old)	France NF (old)	Italy UNI	Sweden SS/SIS	Spain UNE	Japan JIS (old)
AlMn 1	3.0515	Al-Mn 1	3103	N 3	–	3568	4054	L-3810	–
AlMnCu	3.0517	Al-Mn 1 Cu	3003	–	A-M 1	7780	–	–	A 2 x 3
AlMn 1 Mg 1	3.0526	–	3004	–	A-MG 1	6361	–	L-3820	–
AlMg 1	3.3315	Al-Mg 1	(5005 A)	N 41	A-G 06	5764	4106	L-3350	A 2 x 8
AlMg 1,5	3.3316	Al-Mg 1,5	(5050 B)	–	–	3573	–	L-3380	–
AlMg 3	3.3535	Al-Mg 3	5754	–	A-G 3 M	3575	4133	L-3390	–
AlMg 4,5	3.3345	–	5082	–	A-G 4,5	5420	–	–	–
AlMg 5	3.3555	Al-Mg 5	5056 A	N 6	–	3576	4146	L-3320	A 2 x 2
AlMg 2,7 Mn	3.3537	Al-Mg 3 Mn	5454	N 51	A-G 2,5 MC	7789	–	–	(A 2 x 9)
AlMg 4 Mn	3.3545	Al-Mg 4 Mn	5086	–	A-G 4 MC	5452	–	L-3322	–
AlMg 4,5 Mn	3.3547	Al-Mg 4,5 Mn	5083	N 8	A-G 4,5 MC	7790	4140	L-3321	A 2 x 7
AlMgSiCu	3.3211	Al-Mg 1 SiCu	6061	H 20	A-GSUC	6170	–	L-3420	A 2 x 4
AlMgSi 1	–	Al-Si 1 MgMn	6082	H 30	A-SGM 07	3571	4212	L-3451	–
–	–	Al-Si 1 Mg	6351	–	–	–	–	–	–
AlCu 2,5 Mg 0,5	3.1305	Al-Cu 2 Mg	2117	3 L 86	A-U 2 G	3577	–	L-3180	A 3 x 3
AlCuMg 1	3.1325	Al-Cu 4 MgSi	2017 A	–	A-U 4 G	3579	–	L-3120	A 3 x 2
AlCuMg 2	3.1355	Al-Cu 4 Mg 1	2024	–	A-U 4 G 1	3583	–	L-3140	A 3 x 4
AlCuSiMn	3.1255	Al-Cu 4 SiMg	2014	H 15	A-U 4 SG	3581	4338	L-3130	A 3 x 1
–	–	–	2001	–	A-U 6 MGT	–	–	–	–
AlZn 1	3.4415	Al-Zn 1	7072	–	A-Z 1	–	–	L-3721	–
AlZn 4,5 Mg 1	3.4335	Al-Zn 4,5 Mg 1	7020	H 17	A-Z 5 G	7791	4425	L-3741	7 N 01
(AlZn 5 Mg)	–	–	7005	–	–	–	–	–	–
AlZnMgCu 0,5	3.4345	–	7022	–	A-Z 4 GU	–	–	–	–
AlZnMgCu 1,5	3.4365	Al-Zn 6 MgCu	7075	2 L 95	A-Z 5 GU	3735	–	L-3710	A 3 x 6
(AlZn 8 MgCu)	(3.4394)	–	7049 A	–	A-Z 8 GU	3737	–	–	–
(AlCu 63)	–	–	2219	–	–	–	–	–	–
(AlZnMg 2 Cu 1,7 Zr)	–	–	7010	–	–	–	–	–	–

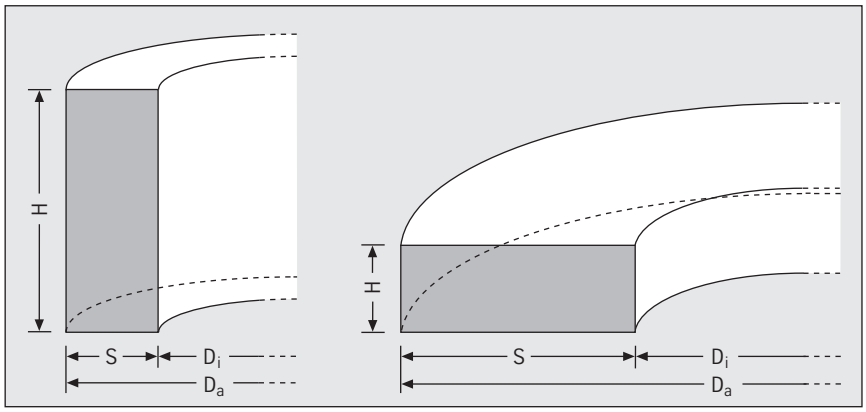
All the information presented in this brochure has been carefully compiled and reviewed. Rothe Erde cannot be held responsible for any errors or omissions.

We reserve the right to make technical modifications and additions in the interests of technical advancement.

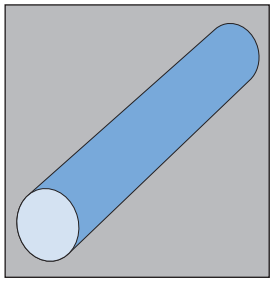
Manufacturing range in medium-alloyed steels

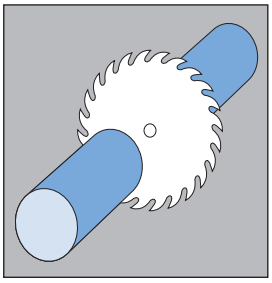
Geometrical forms from cylinder to disk shapes:

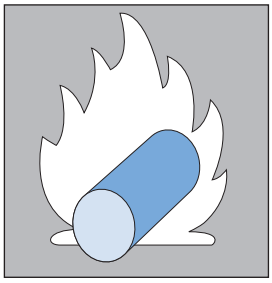
D_a max.:	8000 mm
D_a min.:	250 mm
D_i min.:	150 mm
Height H:	20 - 900 mm
Wall thickness S max.:	700 mm
Weight:	20 - 30000 kg

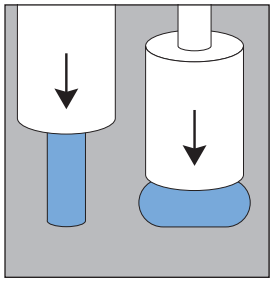


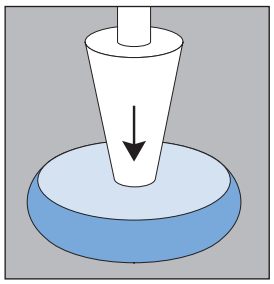
Production flow

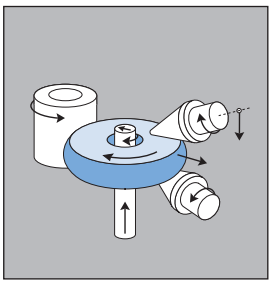

Raw material

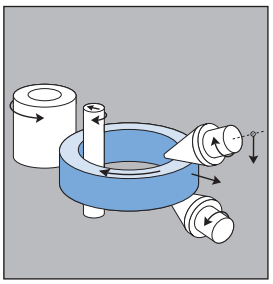

Sawing

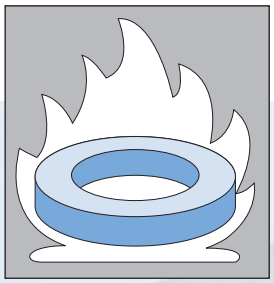

Heating

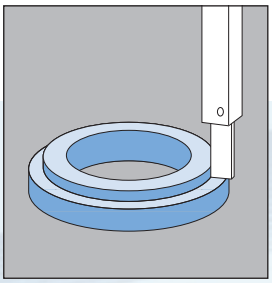

Upsetting

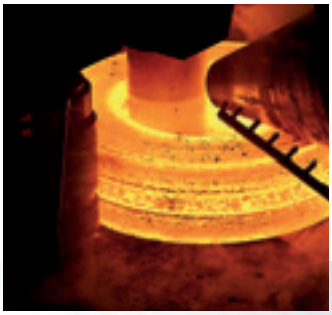

Punching

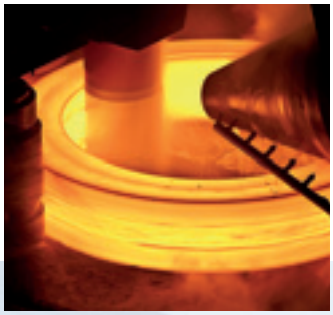

Rolling

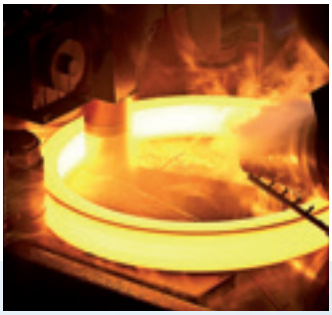

Rolling


Heat treatment


Mechanical machining







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