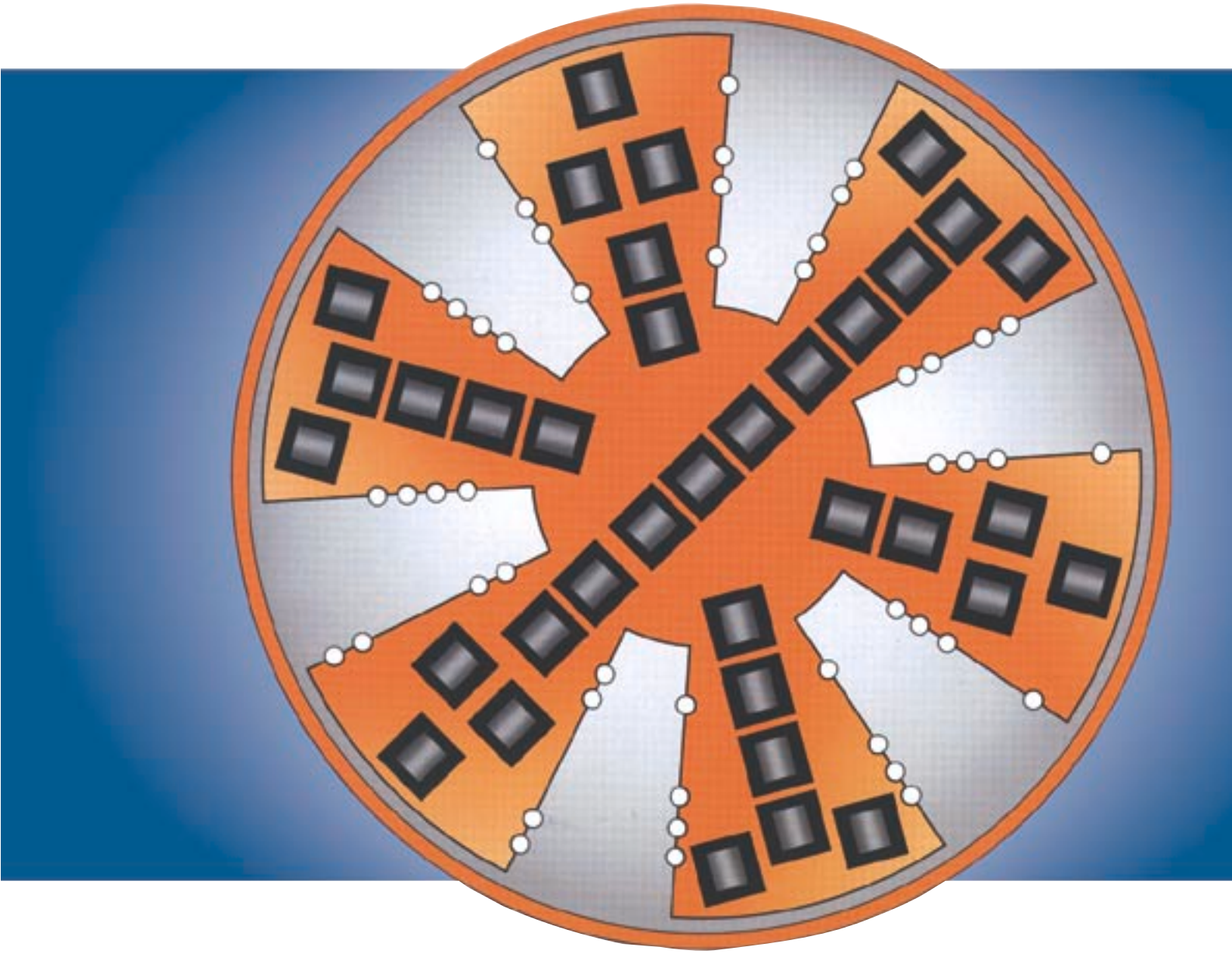
Rothe Erde Large-Diameter Antifriction Bearings.

Application: Tunneling Machines.



A ThyssenKrupp Technologies company

Rothe Erde

ThyssenKrupp

Hoesch Rothe Erde – successful large-diameter antifriction bearing technology

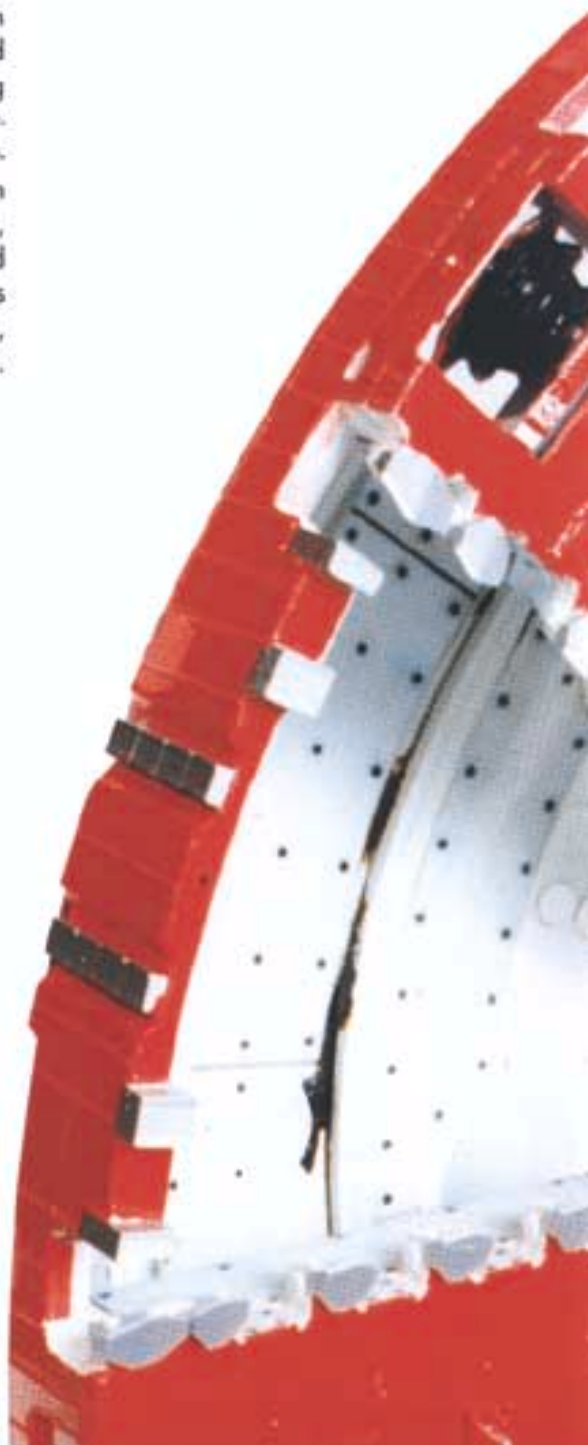
Rothe Erde bearings – worldwide renowned quality

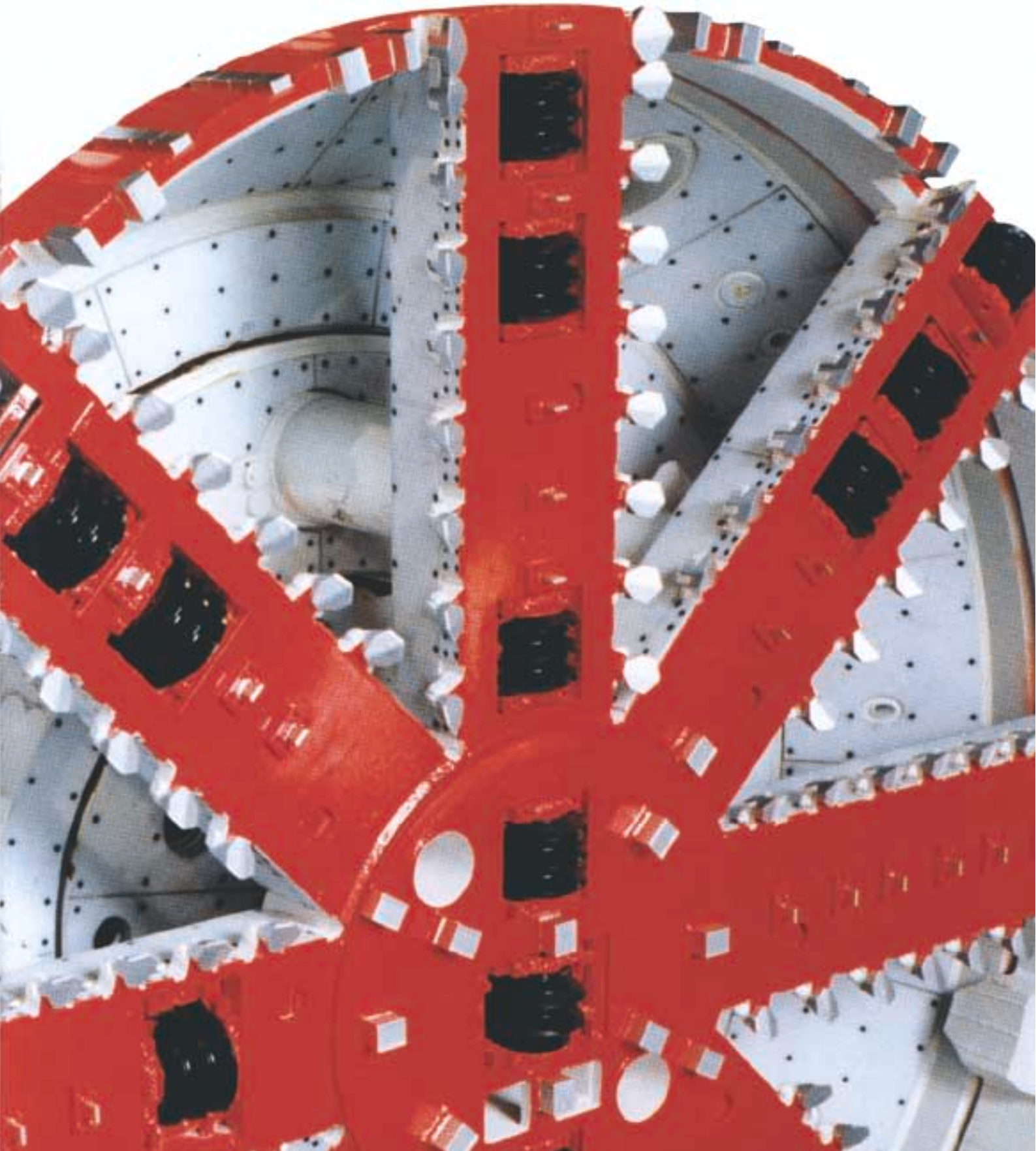
With its large-diameter antifriction bearings, HRE occupies an excellent worldwide market position. Rothe Erde bearings are manufactured in Germany and, by HRE subsidiaries, in Great Britain, Italy, Spain, the United States, Japan and Brazil. In addition, HRE's market presence in all major industrialised countries is maintained by our own network of distributors or sales agencies.

Total commitment to quality is common to both, our domestic and foreign production facilities. All service and production areas from applications consulting to design and manufacturing, including comprehensive customer service, are based on the international quality standard ISO 9001/EN 29001.

Innovative solutions for multiple tasks

Rothe Erde large-diameter antifriction bearings are available in a large variety of designs, configurations and dimensions. As field-proven structural elements, they are used in mechanical handling and material extraction equipment, in dockside, deck and construction cranes, in earth-moving machinery and mechanical engineering. Large-diameter antifriction bearings have also gained a foothold in many areas of modern technology, including industrial robots, solar and wind energy plants, communications systems, offshore equipment, and, last but not least, tunnelling machines.



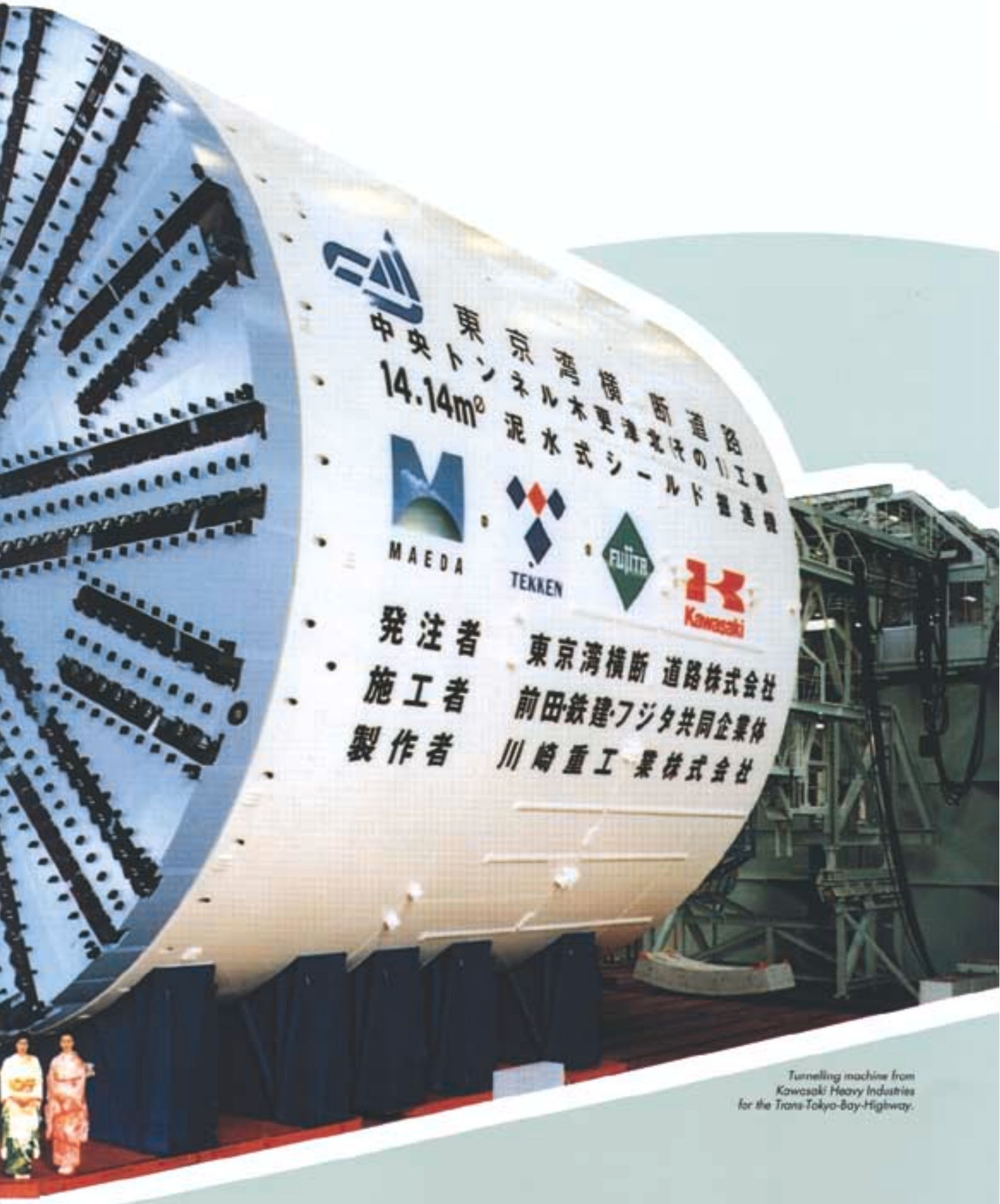


Rothe Erde large-diameter antifriction bearings for a Japanese tunnelling project

Increasing internationalisation and closer links between commercial centres require the speedy expansion of the necessary infrastructure. The best solution, both technically and ecologically, is proving to be underground tunnels.

The Channel Tunnel and the Trans-Tokyo-Bay-Highway, currently under construction, are two of the most prestigious tunnelling projects in the world.

The Trans-Tokyo-Bay-Highway, connecting the Tokyo area with the Chiba peninsula, will carry traffic over a 5 km-long bridge and through two 10 km-long, 14 m-wide tunnels. Eight gigantic tunnelling machines are being used for the tunnelling work. As in the construction of the Channel Tunnel, their cutter heads are mounted on Rothe Erde large-diameter antifriction bearings with diameters of up to 8.3 m and weighing over 40 tons.



Tunnelling machine from Kawasaki Heavy Industries for the Trans-Tokyo-Bay-Highway.

Custom-made for any tunnelling conditions

HRE's objective is to develop and produce optimum cutter head bearings meeting the various requirements posed by specific applications such as, for instance, hard-rock or soft-rock drilling.

The selection of a suitable bearing, e.g. four-point contact ball bearing, cross-roller bearing or three-row roller bearing, will depend on such criteria as load cycle, shock factor, tilting moment, torque, speed, and possibly change in the direction of rotation. Small tunnelling machines are mostly fitted with four-point contact ball bearings or cross-roller bearings, whilst the enourmous loads involved in larger machines will, in the majority of cases, require three-row roller bearings.

Computer-assisted quality test, gear.

Gears

Most Rothe Erde bearings for tunnelling machines are provided with gear rings. Cutting the gear into one of the bearing rings offers the advantage of not requiring a separate gear wheel, which saves on design effort and cost.

Gear specifications will depend on load and operating conditions. In cases where normalised or quenched and tempered gear rings are not adequate because of the high cutting and drilling forces involved, tooth hardening will be provided.

Depending on tooth module and ring diameter, this is accomplished by induction spin hardening, contour hardening or tooth flank hardening processes.

Final gear cutting after gear hardening offers the possibility of minimising tooth alignment errors and radial runout.

This production process allows HRE to achieve further quality improvements in the accuracy, quiet running and service life.

Elongation test

Bolts

The bolt connection greatly influences the functional safety of a large-diameter antifriction bearing. Therefore the fastening bolts must be adequately dimensioned and carefully preloaded and maintained. Concurrently with bearing development work, our R & D Centre carries out systematic analyses and tests on bolt connections.

Bolt rating is based on the results obtained as well as on VDI Regulation 2230. An optimum bolt connection requires circumferentially equispaced bolts, a rigid and torsion-proof companion structure, and a clamping length of at least five times the bolt diameter.

Seals

Any dirt penetrating into the bearing will significantly shorten its service life. This is why bearings installed in tunnelling machines are protected by sealing systems, which have been specially designed by the tunnelling machine manufacturers. A complex combination of bearing rings, seal supports and flanges holds the seals in place or provides the contact surfaces on which the seals run. The ring elements, which we have supplied for numerous sealing systems, in the form of split or solid rings, hardened and/or ground rings, have performed extremely well.

Lubrication

Depending on the application, bearings may be lubricated with either grease or oil. In today's tunnelling machines, they are predominantly lubricated with oil. It is possible to provide the channels for the lubrication of gear, raceways and sealing systems in the bearing rings themselves, avoiding additional lubrication lines outside the bearing.

Quality management

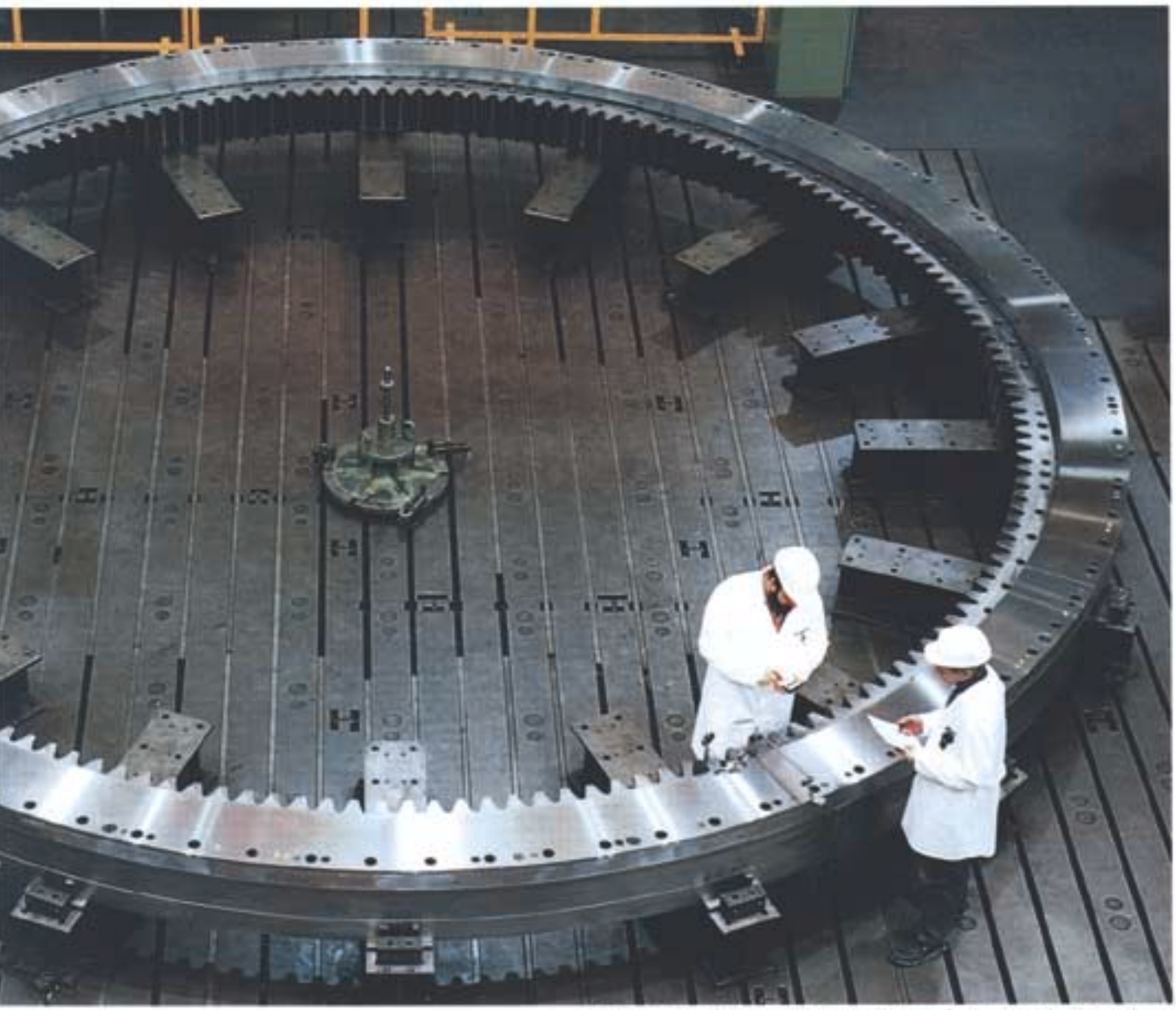
The comprehensive quality assurance system implemented within our company is based on the international quality standard ISO 9001/EN 29001.

These regulations relate primarily to the prevention of errors during all phases of production, from the design stage to customer service.

Ultrasonic testing of ring blanks.

Inductive raceway hardening – electronically controlled and monitored.

Crack test following magnafluxing.



Final acceptance of a 8.3 m dia. cutter head bearing for the Trans-Tokyo-Bay-Highway.

Our quality strategy makes these standards which have been verified and approved by recognised certification bodies binding for all HRE companies. The functional effectiveness of our quality assurance system is verified by regular internal audits as well as by external auditors.

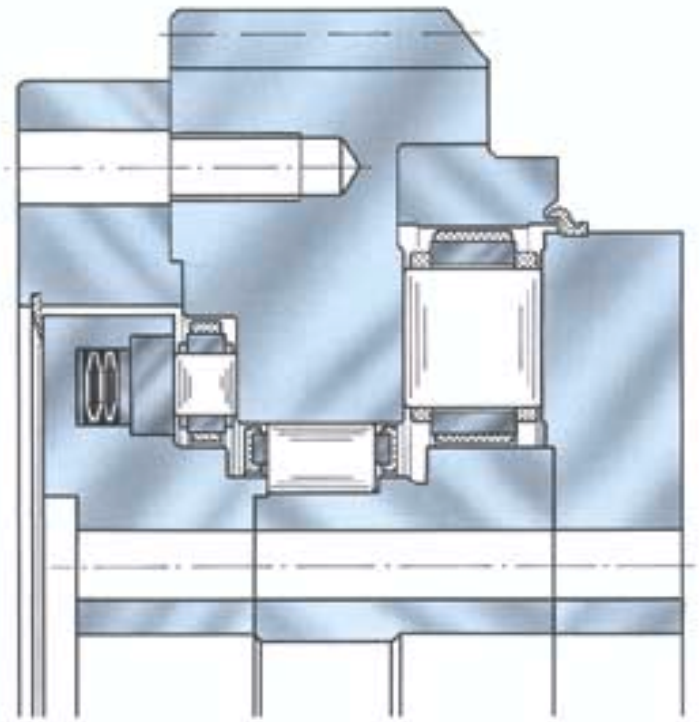
"Quality Assurance" is an independent sector within the organisation of our company. The additional use of quality representatives throughout the company, who, alongside their main duties, have received special training in quality assurance, further insures that the quality system is put into practice.

The HRE quality assurance system for large-diameter antifriction bearings is divided into quality planning, quality control and quality steering.

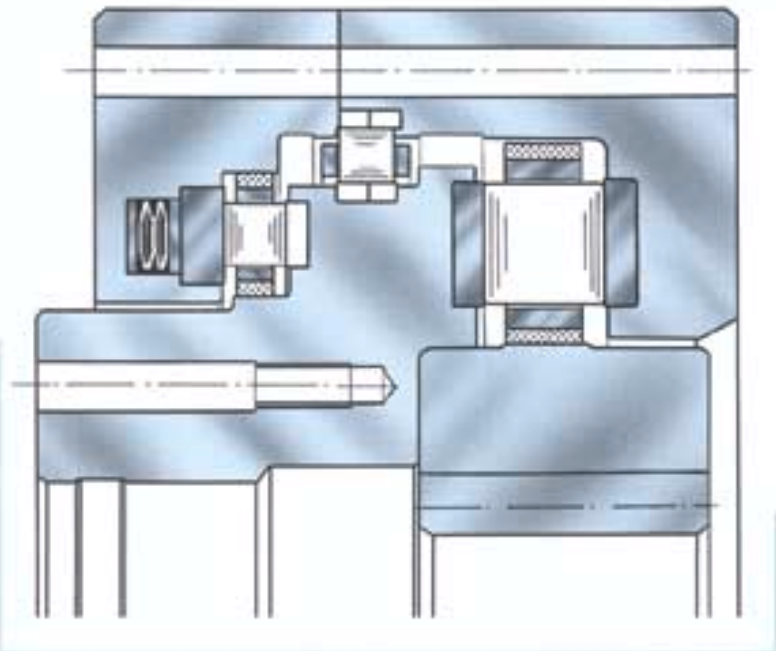
Tunnelling bearing designs and applications

The Channel Tunnel

The Channel Tunnel extends more than 50 km under the English Channel, from Folkstone on the English coast to Sangatte on the French coast. Over 7.5 million cubic meters of marl and limestone had to be removed to make way for the two 7.6 m dia. railway tunnels and the 4.8 m dia. service tunnel. The excavation work was accomplished in 12 sections by eleven gigantic drilling machines, each weighing up to 1,000 tons and measuring 170 m in length. The manufacturers of eight of these tunnelling machines opted for Rothe Erde large-diameter antifriction bearing technology. HRE supplied three-row roller bearings with outer diameters of between 3.9 m and 5.9 m, which were specially designed to withstand the severe operating conditions.



Company:	James Howden & Company, GB
Machine/application:	Tunnelling machine for the running tunnel on the British landside of the Channel Tunnel, dia.: 7.6 m.
Cutter head bearing:	Rothe Erde three-row roller bearing, surface-hardened raceways, contour-hardened gear teeth, one-piece design.
	O.D.: = 5162.4 mm
	I.D.: = 4350.0 mm
	Overall height: = 435.0 mm



Cutter head equipped with a segmented roller bearing

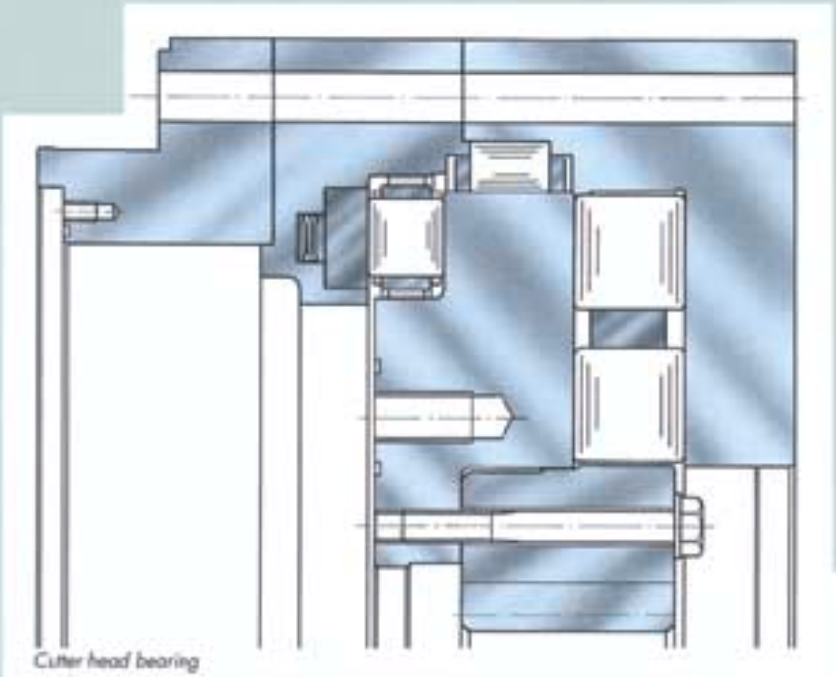
Difficult transport or assembly conditions sometimes require the use of segmented bearings. Depending on the application, such bearings can either have surface-hardened raceways or through-hardened raceway inserts. Example: A spare bearing which had been ordered for the Channel Tunnel but was then never needed.

Company:	Robbins Markham Joint Venture, GB
Machine/application:	Tunnelling machine for the British seaside running tunnel of the Channel Tunnel, dia.: 7.6 m.
Cutter head bearing:	Rothe Erde three-row roller bearing, surface-hardened raceways, contour-hardened gear teeth, one-piece design. O.D.: = 5280.0 mm I.D.: = 4597.2 mm Overall height: = 460.0 mm
Spare bearing:	Rothe Erde three-row roller bearing, through-hardened raceway inserts, contour-hardened gear teeth, segmented design.

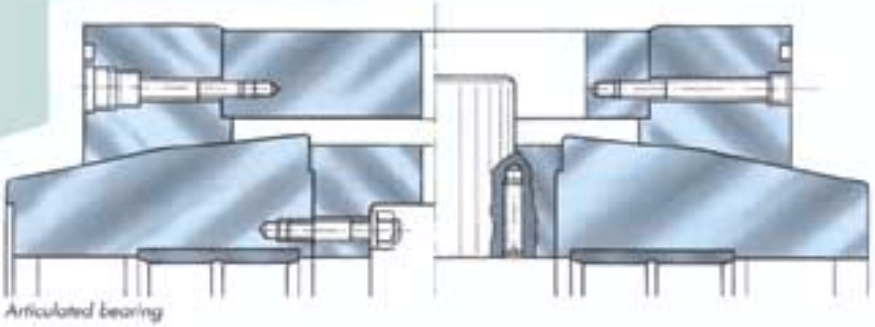
Cutter head equipped with a roller bearing

Company:	Kawasaki Heavy Industries Ltd., Japan
Machine/application:	Tunnelling machine for the flood tunnel of the "Kanada River Water Regulation" project of the City of Tokyo, dia.: 13.94 m.
Cutter head bearing:	Rothe Erde three-row roller bearing, surface-hardened raceways, tooth flank hardening, segmented design.
	O.D.: = 8327.0 mm
	I.D.: = 7120.0 mm
	Overall height: = 460.0 mm

Large-diameter antifriction bearings of similar design are installed in the tunnelling machines for the Trans-Tokyo-Bay-Highway.



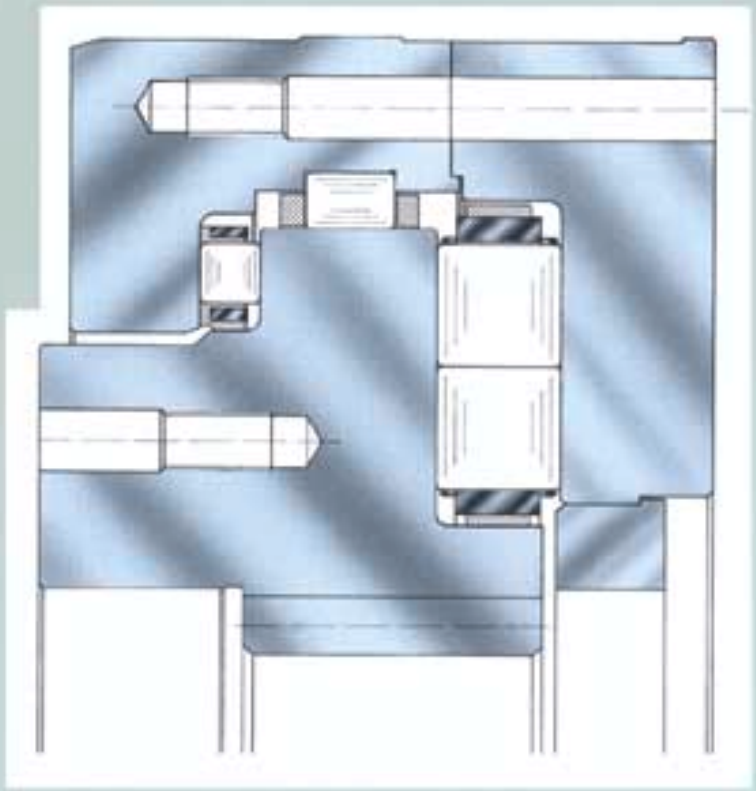
Cutter head bearing



Articulated bearing

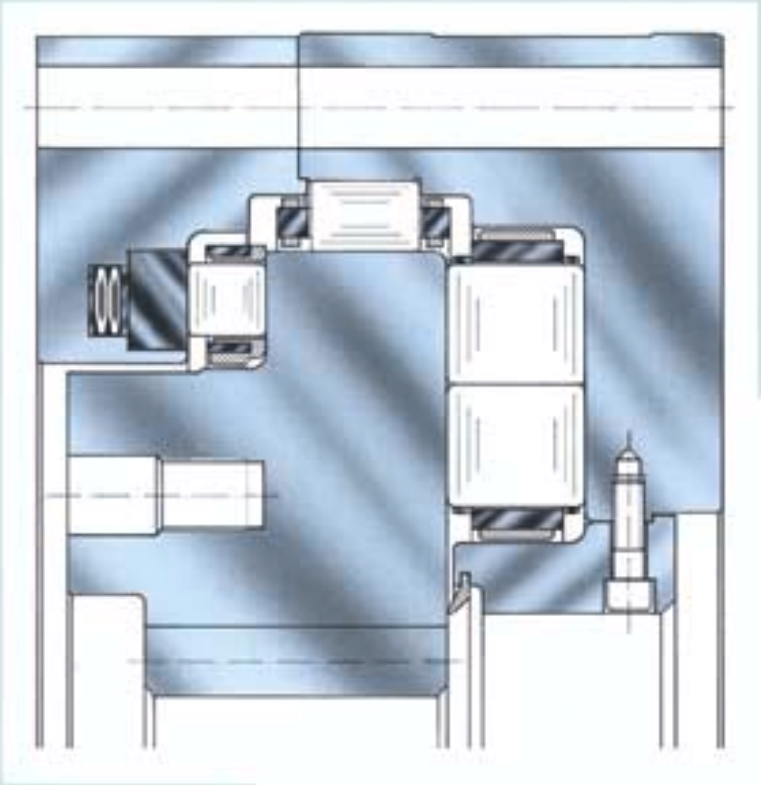
Cutter head equipped with a roller bearing and an articulated bearing

Company:	Herrenknecht GmbH, Germany
Machine/application:	Mix-shield tunnelling machine for the Mülheim/Ruhr subway tunnels, dia.: 6.9 m.
Cutter head bearing:	Rothe Erde three-row roller bearing, surface-hardened raceways, contour-hardened gear teeth, one-piece design.
	O.D.: = 3000.0 mm
	I.D.: = 1940.0 mm
	Overall height: = 690.0 mm
Articulated bearing:	Rothe Erde sliding bearing
	O.D.: = 3444.0 mm
	I.D.: = 3001.5 mm
	Overall height: = 800.0 mm



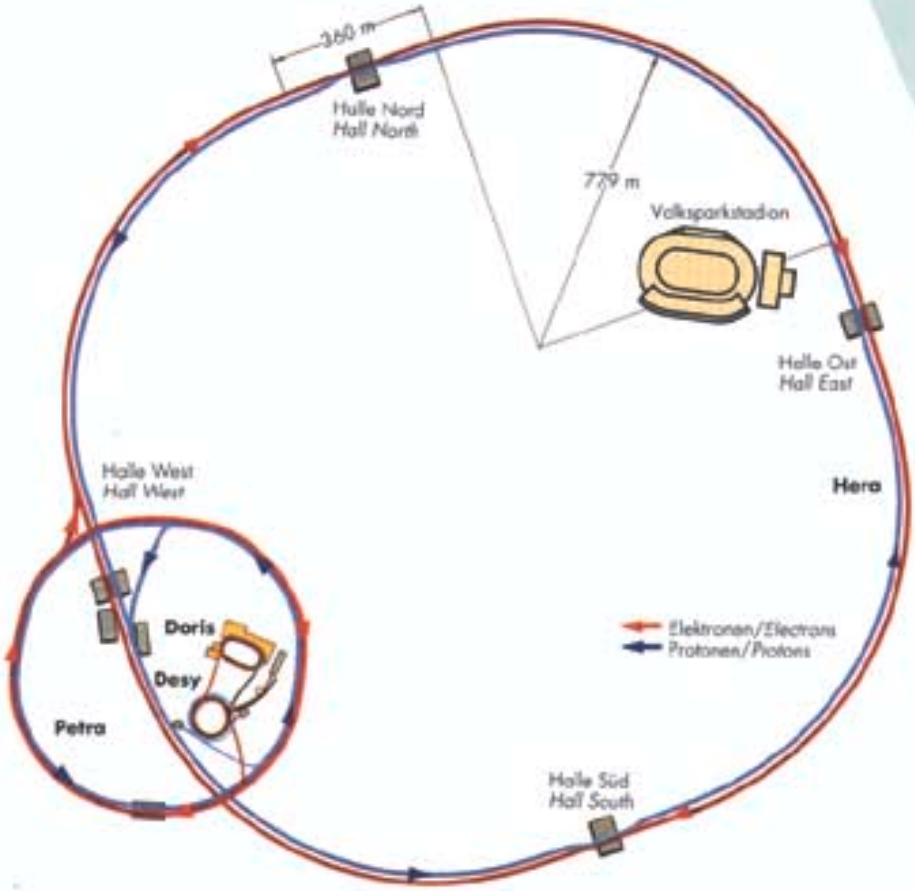
Cutter head equipped with a roller bearing

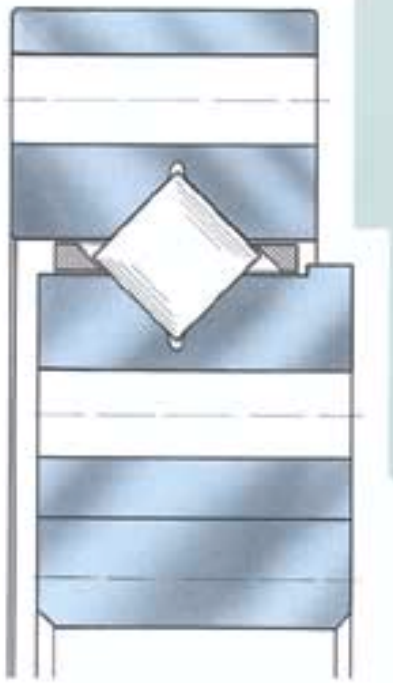
Company:	Lovat Tunnel Equipment Inc., Canada
Machine/application:	Tunnelling machine for a railway tunnel under the St. Clair river between Sarnia, Ontario/Canada and Port Huron, Michigan/USA, dia.: 9.25 m.
Cutter head bearing:	Rothe Erde three-row roller bearing, surface-hardened raceways, contour-hardened gear teeth, one-piece design.
O.D.:	= 6000.0 mm
I.D.:	= 5285.0 mm
Overall height:	= 442.0 mm



Cutter head equipped with a roller bearing

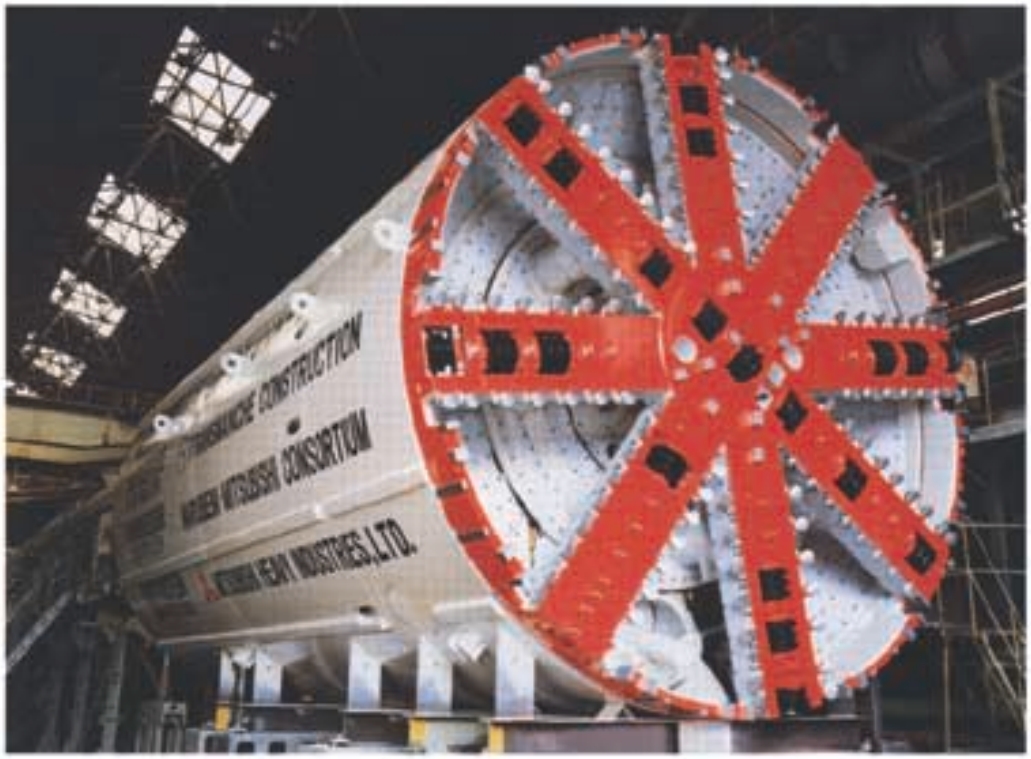
Company:	Voest Alpine Tunneltechnik GmbH, Germany
Machine/application:	Tunnelling machine for a 6.5 km long link gallery through granite in Dong Hae, South Korea, dia.: 4.5 m.
Cutter head bearing:	Rothe Erde three-row roller bearing, surface-hardened raceways, contour-hardened gear teeth, one-piece design.
	O.D.: = 3500.0 mm
	I.D.: = 2743.0 mm
	Overall height: = 450.0 mm





Cutter head equipped with a cross-roller bearing

Company:	Herrenknecht GmbH, Germany
Machine/application:	Mix-shield tunnelling machine for the 6.3 km long proton-electron storage ring HERA of the German National Research Centre for Particle Physics (DESY) in Hamburg, dia.: 6.0 m.
Cutter head bearing:	Rothe Erde single-row cross-roller bearing, surface-hardened raceways, contour-hardened gear-teeth, one-piece design.
O.D.:	= 2223.0 mm
I.D.:	= 1782.0 mm
Overall height:	= 127.0 mm

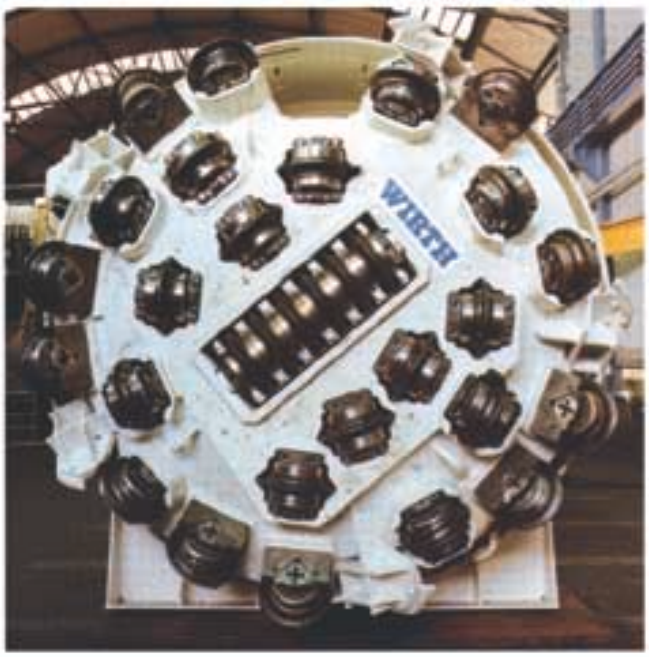


Company: Mitsubishi Heavy Industries Ltd., Japan

Machine/application: Tunnelling machine for the service tunnel on the French landside of the Channel Tunnel, dia.: 4.8 m.

Company: Wirth Maschinen- und Bohrgeräte-Fabrik GmbH, Germany

Machine/application: Tunnelling machine for a water conduit project in Ulsan/South Korea, dia.: 3.5 m.



Company: Atlas Copco/The Robbins Company, U.S.A.

Machine/application: Tunnelling machine for a transfer tunnel of the Lesotho-Highlands-Water-Project

Company: Ishikawajima-Harima Heavy Industries Co., Ltd., Japan

Machine/application: Tunnelling machine for the Trans-Tokyo-Bay-Highway

Company: Hitachi Zosen Corporation, Japan

Machine/application: Tunnelling machine for the Tokyo subway

References

Germany

Gebr. Eickhoff Maschinenfabrik und Eisengießerei mbH

Noell Service und Maschinentechnik GmbH

Voest-Alpine Tunneltechnik GmbH

Herrenknecht GmbH

Westfalia Becorit

Paurat GmbH

Wirth Maschinen- und Bohrgeräte-Fabrik GmbH

M & W
Maschinen- und Werkzeugbau GmbH

France

FCB
Fives Cail Babcock
Usines de Lille

Great Britain

Markham & Co. Ltd.

James Howden & Company

Dosco Overseas Engineering

Anderson Strathclyde PLC

Decon Engineering

Canada

Lovat Tunnel Equipment Inc.

U.S.A.

Terra Form Footing Co.

Carl Decker, Inc.

Boretec, Inc.

American Augers, Inc.

Atlas Copco/The Robbins Company

Brazil

Equipamentos Industriais Unideutsch Ltda.

Etesco Construções e Comércio Ltda.

Montenge Montagens Industriais Ltda.

Japan

Kawasaki Heavy Industries Ltd.

Mitsubishi Heavy Industries Ltd.

Ishikawajima-Harima Heavy Industries Co., Ltd.

Hitachi Zosen Corporation

Hitachi Construction Machinery Co., Ltd.

Kokudo Industries Co., Ltd.

NKK Corporation

Mitsui Engineering & Shipbuilding Co., Ltd.

Okumura Kikai Seisaku Co., Ltd.

Kajima Corporation

Nishimatsu Construction Co., Ltd.

Kumagai Gumi Co., Ltd.

Fukuyama Kyodo Kiko Co., Ltd.

Ohbayashi Corporation Co., Ltd.

Komatsu Ltd.

Sumitomo Heavy Industries Ltd.

Ohshima Kogyo Co., Ltd.

Nippon Koki Co., Ltd.

Nakatani Co., Ltd.

Osaka Jack Co., Ltd.

Kayaba Industry Co., Ltd.

Please contact us for further information on our large-diameter antifriction bearings.

Our application engineers will be pleased to discuss your bearing requirements with you.

Head Office

Rothe Erde GmbH
Tremoniastrasse 5-11
D-44137 Dortmund
Phone: +49 (2 31) 186-0
Fax: +49 (2 31) 186-25 00
E-mail: rotheerde@tkt-re.thyssenkrupp.com
Internet: www.rotheerde.com

Offices in Germany

Berlin
Rothe Erde GmbH
Geschäftsstelle Berlin
Wittestrasse 30 J
D-13509 Berlin
Phone: +49 (30) 89 79 14-18
Fax: +49 (30) 89 79 14-33
E-mail: rotheerde.gsberlin@tkt-re.thyssenkrupp.com

North
Rothe Erde GmbH
Geschäftsstelle Nord
Am Pferdemarkt 31
D-30853 Langenhagen
Phone: +49 (5 11) 7 25 35 69-0
Fax: +49 (5 11) 7 25 35 69-9
E-mail: rotheerde.gsnord@tkt-re.thyssenkrupp.com

South
Rothe Erde GmbH
Geschäftsstelle Süd
Am Ostkai 15
D-70327 Stuttgart
Phone: +49 (7 11) 3 27 79 19-0
Fax: +49 (7 11) 3 27 79 19-9
E-mail: rotheerde.gssued@tkt-re.thyssenkrupp.com

Subsidiaries

Brazil
Robrasa
Rolamentos Especiais
Rothe Erde Ltda.
Rua Lidia Blank, No. 48
BRA-CEP 09913-010, Diadema,
São Paulo
Phone: +55 (11) 40 57 48 77
Fax: +55 (11) 40 55 38 92
E-mail: robrasa@ibm.net
Internet: www.robrasa.ind.br

China
Xuzhou Rothe Erde Slewing
Bearing Co., Ltd.
Wanzhai, Northern Suburb,
VRC-Xuzhou 221007, Jiangsu
Phone: +86 (5 16) 7 76 71 70
Fax: +86 (5 16) 7 76 90 00
E-mail: xuzhou_rothe_erde@xreb.com
Internet: www.xreb.com

France
Roballo France S.à r.l.
30, Boulevard Bellerive
F-92566 Rueil Malmaison CEDEX
Phone: +33 (1) 41 39 00 90
Fax: +33 (1) 41 39 00 99
E-mail: roballofra@wanadoo.fr

Great Britain
Roballo Engineering Co. Ltd.
Mill Hill
North West Industrial Estate
GB-Peterlee,
Co. Durham SR8 2HR
Phone: +44 (1 91) 5 18 56 00
Fax: +44 (1 91) 5 86 90 96
E-mail: info@roballo.co.uk
Internet: www.roballo.co.uk

India
Rothe Erde GmbH
Liaison Office India
6 E, "Gee Gee Emerald"
151, Village Road
Nungambakkam
IND-Chennai 600 034
Phone: +91 (44) 8 23 63 14
Fax: +91 (44) 8 23 56 55
E-mail: re_india@vsnl.net
Internet: www.rotheerdeindia.com

Italy
Rothe Erde-Metallurgica Rossi
S.p.A.
Viale Kennedy, 56
I-25010 Visano (Brescia)
Phone: +39 (0 30) 95 20-1
Fax: +39 (0 30) 95 20-3 00
E-mail: mri@rotheerde.it
Internet: www.rotheerde.it

Japan
Nippon Roballo Co., Ltd.
Atagoyama-Bengoshi Bldg. 6-7
Atago 1-Chome
J-Minato-ku/Tokyo
Phone: +81 (3) 34 34 43 41
Fax: +81 (3) 34 34 43 40
E-mail: info@roballo.co.jp
Internet: www.roballo.co.jp

Spain
Roteisa
Rothe Erde Ibérica S.A.
Carretera Castellón, km. 7
Polígono Industrial „La Cartuja"
E-50720 La Cartuja Baja
(Zaragoza)
Phone: +34 (9 76) 50 04 80
Fax: +34 (9 76) 50 01 54
E-mail: roteisa@roteisa.es
Internet: www.roteisa.es

USA
Rotek Incorporated
1400 South Chillicothe Rd.
P.O. Box 312
USA-Aurora, Ohio 44202
Phone: +1 (3 30) 5 62 40 00
Fax: +1 (3 30) 5 62 46 20
E-mail: sales@rotek-inc.com
Internet: www.rotek-inc.com

Rothe Erde