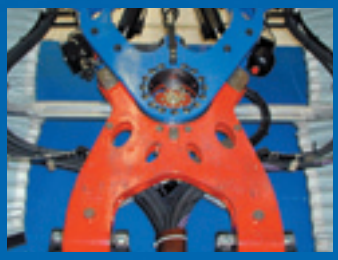
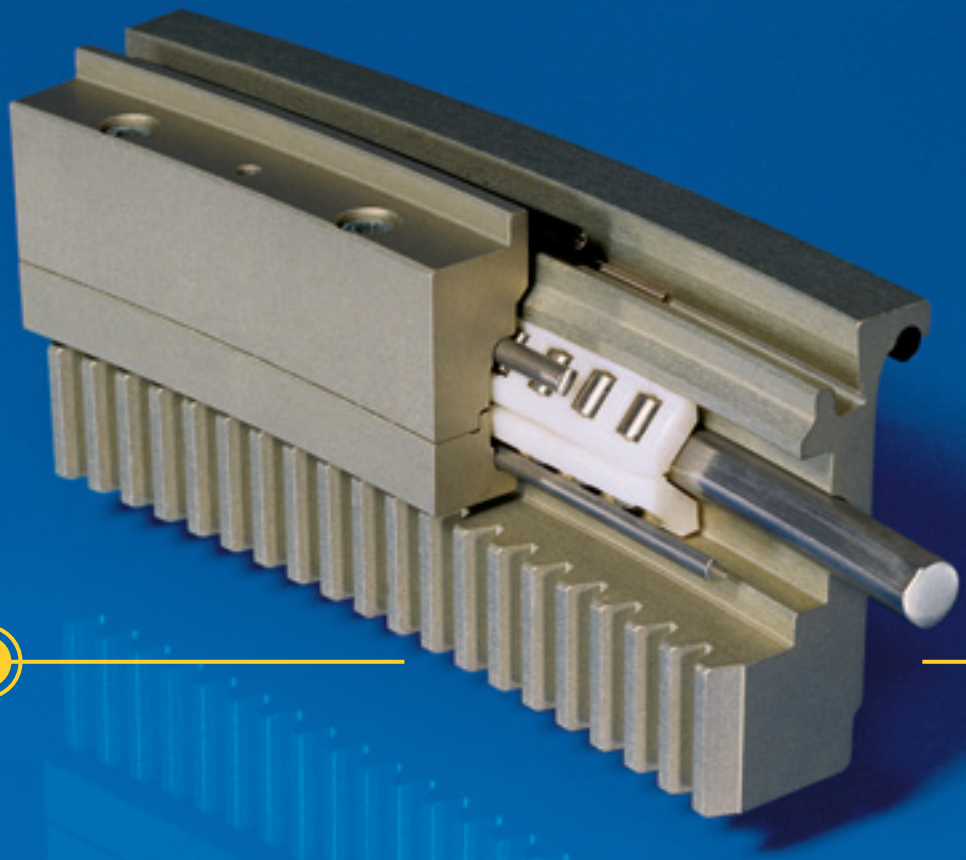
Rothe Erde® wire-race bearings.
The proven bearing concept.



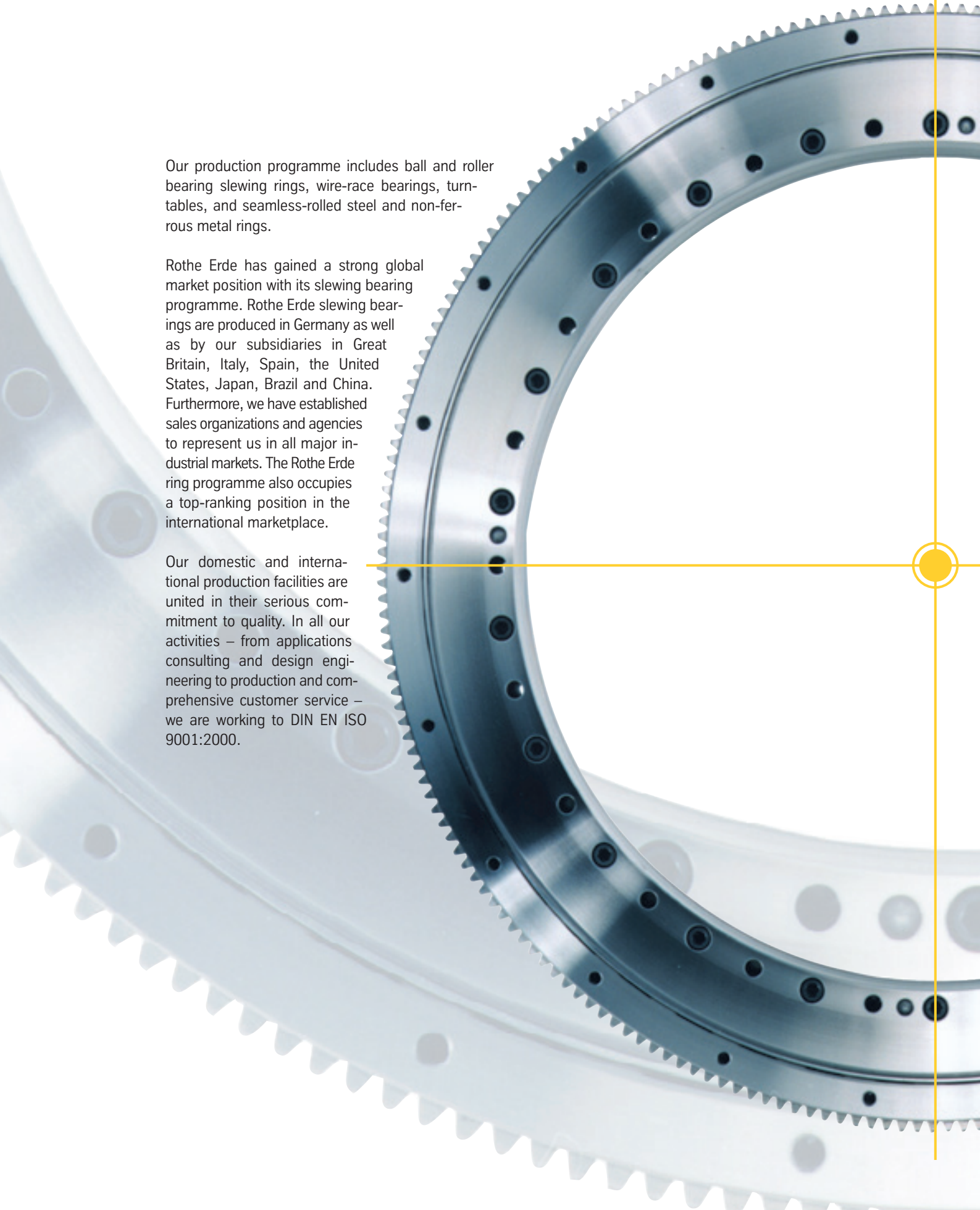


A ThyssenKrupp Technologies company

Rothe Erde

ThyssenKrupp

Global success with quality slewing bearings and rings.



Our production programme includes ball and roller bearing slewing rings, wire-race bearings, turntables, and seamless-rolled steel and non-ferrous metal rings.

Rothe Erde has gained a strong global market position with its slewing bearing programme. Rothe Erde slewing bearings are produced in Germany as well as by our subsidiaries in Great Britain, Italy, Spain, the United States, Japan, Brazil and China. Furthermore, we have established sales organizations and agencies to represent us in all major industrial markets. The Rothe Erde ring programme also occupies a top-ranking position in the international marketplace.

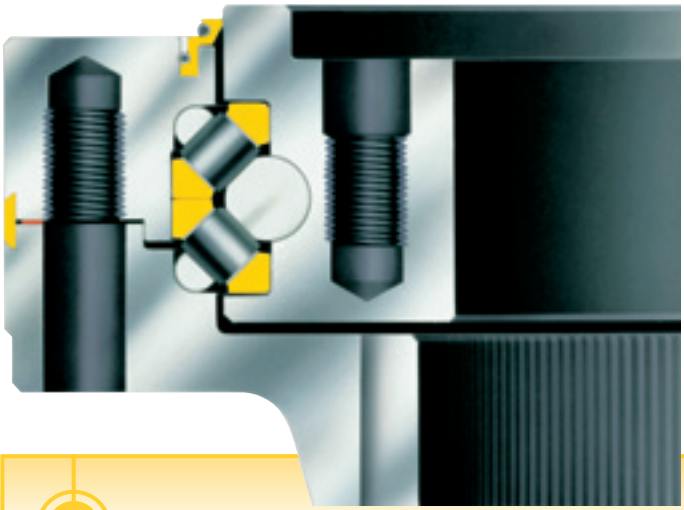
Our domestic and international production facilities are united in their serious commitment to quality. In all our activities – from applications consulting and design engineering to production and comprehensive customer service – we are working to DIN EN ISO 9001:2000.

Rothe Erde wire-race bearings are the product of dedicated research and development. The typical features of our wire-race bearings are the high-strength races for the rolling elements. A wire-race bearing system allows structural and material combinations as well as cross sections which are out of reach of any conventional antifriction bearing.

Dimensions, cross sections and the ring material of the bearings can be optimally matched to all application requirements. Depending on their purpose, Rothe Erde wire-race bearings can be ball bearings, roller bearings or a combination design of wire-race bearing and surface-hardened bearing. Rothe Erde wire-race bearings extend the range of applications for open-centre slewing bearings. They offer decisive advantages over conventional surface-hardened slewing bearing designs like high running accuracy, low and uniform torque resistance even when distorted, resistance to corrosion, low weight due to the surrounding aluminium alloy bearing rings and low maintenance.

Our bearing programme ranges from diameters as small as 80 mm to diameters of up to 14 m. Over 120,000 manufactured bearings bear witness to the success of this special antifriction bearing technology.

Rothe Erde wire-race bearings.
A successful bearing concept.

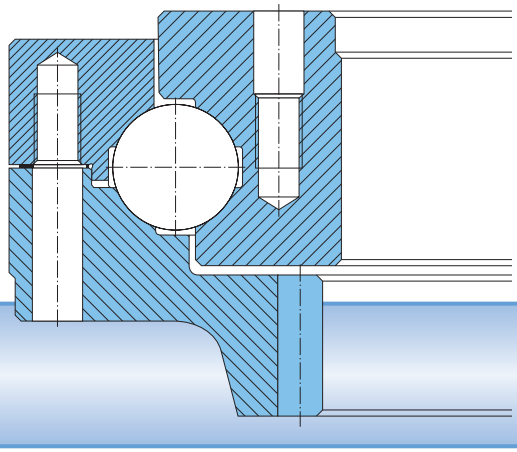


The surrounding bearing rings are not directly exposed to rolling friction, they do not have to be made from steel but can consist of non-ferrous metals, cast iron or synthetic materials. In particular, Rothe Erde wire-race bearings with light alloy bearing rings have gained special importance. The same load carrying capacity as that of comparable steel bearings is achieved by using an aluminium alloy of high mechanical strength as ring material. Compared to steel bearings of identical cross sections, aluminium wire-race bearings weigh approx. 60 % less.

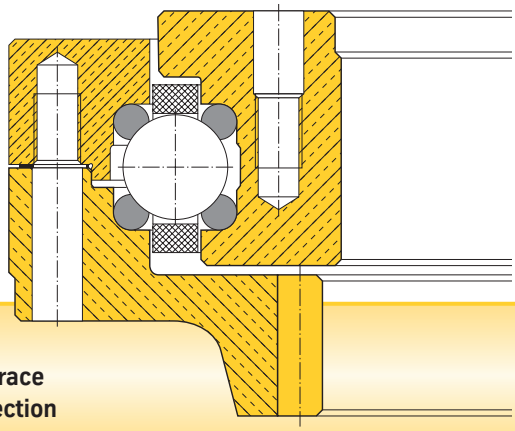
Tests at renowned institutes of technology as well as our own R&D work have demonstrated that the high mechanical strength of this wrought aluminium alloy means that the gearing can also be cut directly into one or more bearing rings.

A light alloy wire-race bearing can be made corrosion-proof and maintenance-free by using appropriate materials for the rolling elements and races. The corrosion behaviour of aluminium bearing rings can be significantly improved by a surface treatment.

Weight comparison.
Steel versus aluminium.



641 kg
Weight of the steel bearing



249 kg
Weight of the aluminium wire-race bearing with identical cross section

Weight comparison between light alloy and steel bearings equal in size with the same load-carrying capacity and an external diameter of 2200 mm.

61.2 %
Weight saved

Apart from the weight savings already mentioned Rothe Erde light alloy wire-race bearings are particularly advantageous in applications where the bearing is required to withstand shock loads and travelling vibrations. Due to aluminium's smaller modulus of elasticity in comparison with steel and the additional elastic deformation between the races and race beds in the bearing rings, shock loads are absorbed much more smoothly, so that brinelling in the races and striation can be prevented.

The high elasticity of the wrought aluminium alloy characterized by a low modulus of elasticity causes the elongation differential to be fully absorbed by the wire-race bearing.

Design types.
Various approaches to the solution.

Roller bearing slewing rings

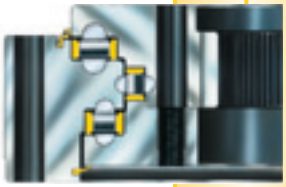


Fig. 1

Three-row wire-race roller bearing

Fig. 2

Cross-roller wire-race bearing

Fig. 3

Three-wire-race roller bearing

Fig. 4

Double-row inclined axis wire-race roller bearing

- Transmission of axial, radial and tilting moments
- Almost constant frictional torque even if deformed and in a slanted position
- High stiffness

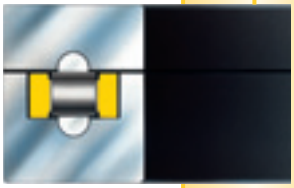
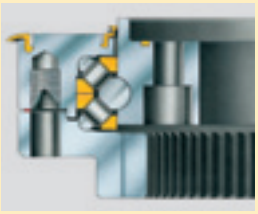


Fig. 5

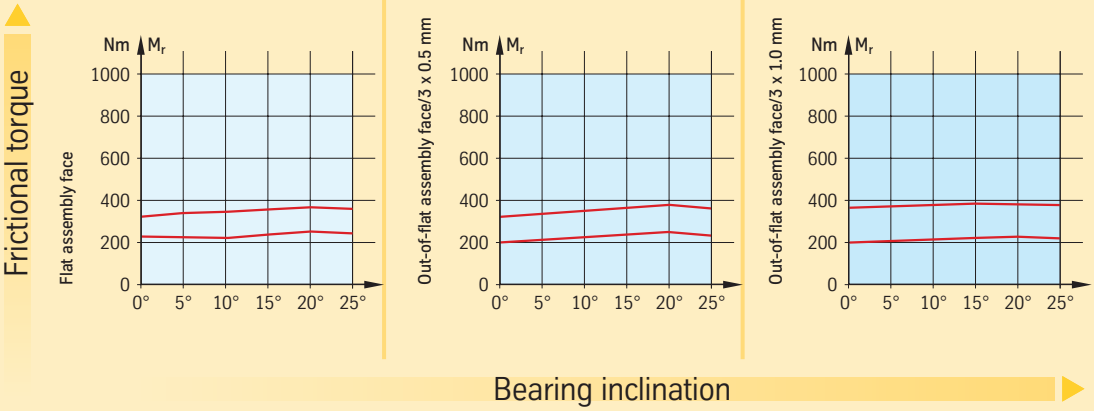
Fig. 6

Fig. 7



Three-wire-race roller bearing

Centric axial load
approx. 170 kN



Frictional torque M_r as a function of the bearing inclination and distortion

Single-row roller bearing slewing rings

Axial wire-race roller bearing

- Transmission of a purely radial or axial load component or simultaneous transmission of both load components
- High stiffness in load direction

Radial wire-race roller bearing

Single-row inclined axis wire-race roller bearing

Ball bearing slewing rings

Fig. 8

Single-row four-point wire-race ball bearing

- Transmission of axial, radial, and tilting moments

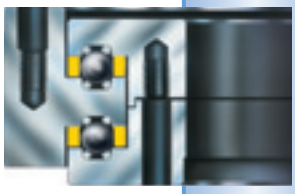


Fig. 9

Double-row four-point wire-race ball bearing

- Bilaterally acting to transmit high axial loads
- Self-retaining, i.e. the zero-play condition is always warranted, even under a different thermal expansion of the inner and outer bearing rings.

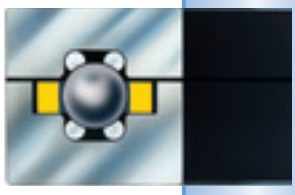


Fig. 10

Single-row axial four-point wire-race ball bearing

- Transmission of axial and a certain amount of radial loads

All bearings can on principle also be designed with external, internal and special gearing or with a separate gear ring.

Special designs.

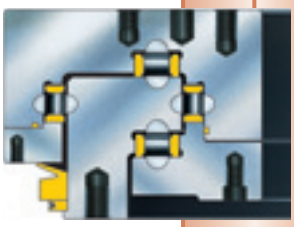


Fig. 11

Four-row wire-race roller bearing
Particularly designed to transmit loads due to the different expansion behaviour of the outer and inner companion structure or to prevent radial clearance in this context.

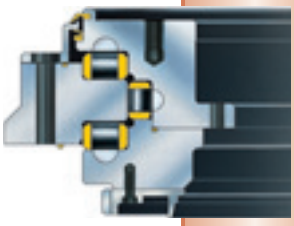


Fig. 12

Hybrid-type three-row wire-race roller bearing
The raceways of the outer ring are surface-hardened, the raceways of the inner rings have a wire filling. Particularly designed to compensate raceway tilts due to the expansion of the inner companion structure.

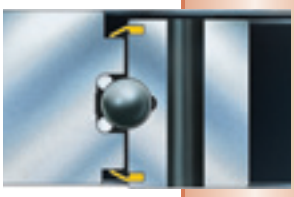


Fig. 13

Hybrid-type four-point wire-race ball bearing
The raceways of the inner ring are surface-hardened, the raceways of the outer ring have a wire filling. Particularly designed to enable the necessary cast design to act at the same time as outer ring.

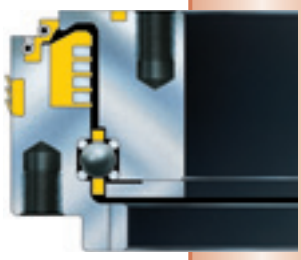


Fig. 14

Four-point wire-race ball bearing
With integrated 4-way slip ring and retaining ring with spring suspension system. Particularly designed for the transmission of electric current and limitation of the frictional torque in case of a major deformation of the companion structure. Furthermore equipped with earthing plugs to compensate the potential between the bearing rings.

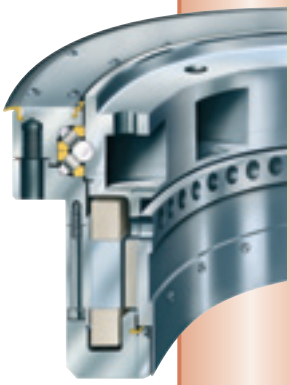


Fig. 15

Three-wire race bearing
With integrated ring motor. Particularly designed to integrate the drive into the bearing.

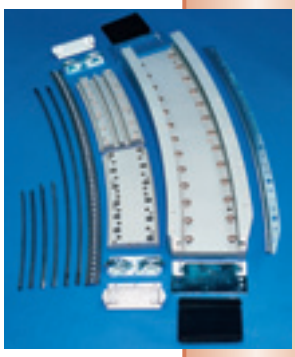
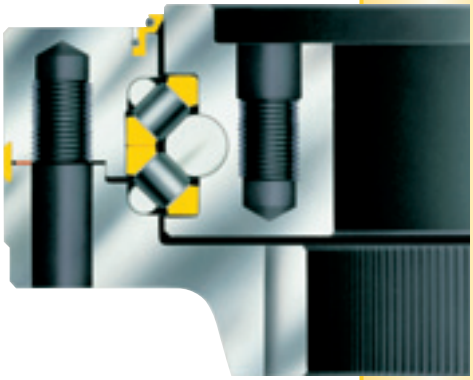
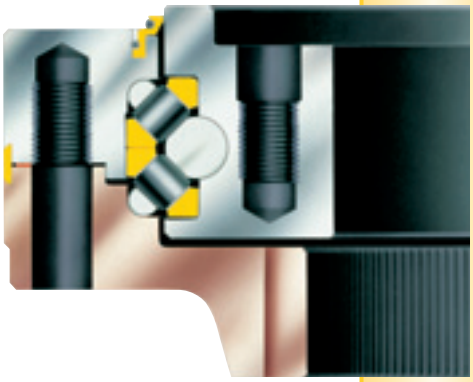


Fig. 16

Segmented wire-race ball bearing
Particularly designed for limited available space.

Bearing components.
The possibilities.





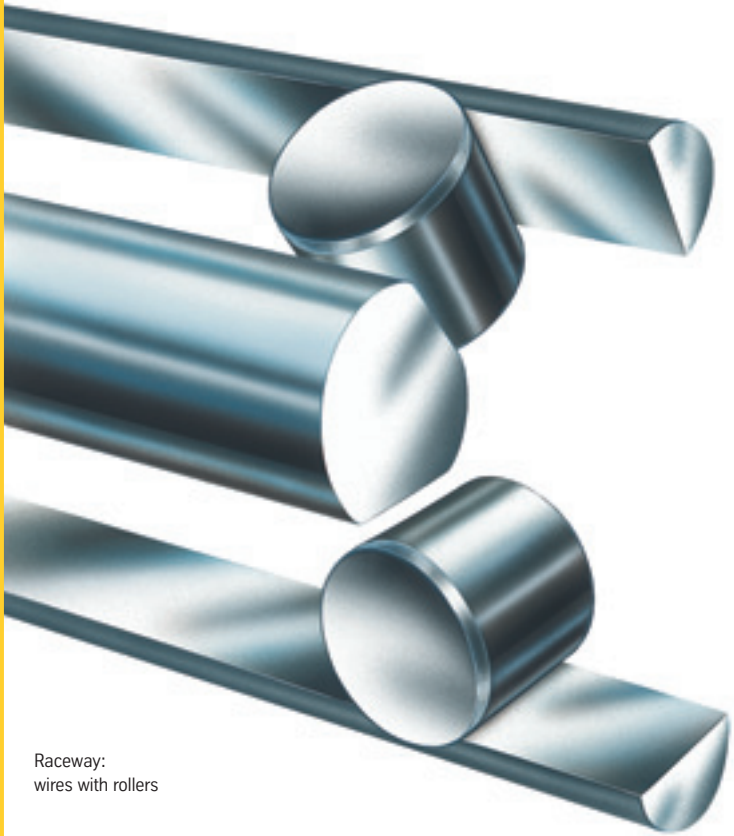
Wire races
- Hardened or naturally hardened steels

Rolling elements
- Bearing steel, also corrosion-resistant

Bearing rings
- Aluminium
  Surface: corrosion-proof
- Steel normalized or hardened and tempered
  Surface: corrosion-proof
- Stainless steel, selection as required
  (e.g. acid-resistant steels)
- Special steels, selection as required
  (e.g. magnetoresistive steels)
- Bronze
  (e.g. seawater-resistant bronze)

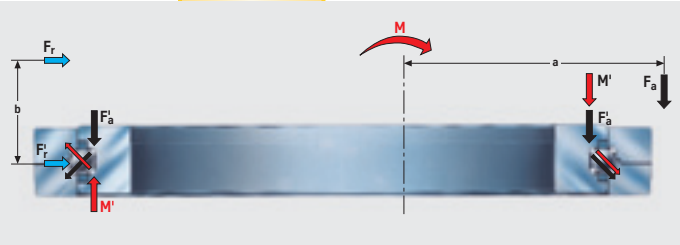
Gear rings
- The material can be selected as for the bearing rings.
- The gearing cut into the ring can be hardened.

Material combinations
- Material combinations in one bearing are also possible (e.g. rings of aluminium and gear ring of hardened and tempered steel).



Raceway:
wires with rollers

Design and dimensioning.
Mobilizing engineering solutions.



Bearing stress

Requirement
Structures with slewing bearings normally require design types which are able to transmit all occurring loads with one bearing. These are normally axial, radial and tilting moments.

These bearings must furthermore be suited to withstand the complete spectrum of operating conditions, as for example
- High and low temperatures including temperature fluctuations
- Overpressures and negative pressures
- Deformations of the companion structure
- Weight limits
- Limitation of the frictional torque
- Low maintenance
- Corrosion resistance
- Magnetoresistive behaviour
- Open center to run through supply lines or as access opening

Design and dimensioning
The bearings are individually designed and dimensioned for every application, this means that the buyer is not required to customize to specified geometries of catalogue bearings and characteristics but the bearing can be designed according to the customer's structure and the specification.

A newly developed Rothe Erde computer programme is available to dimension the bearing. This is based on the finite element method (FEM) and can also consider companion structures and their behaviour under load when requested by the customer.

Bearing unloaded

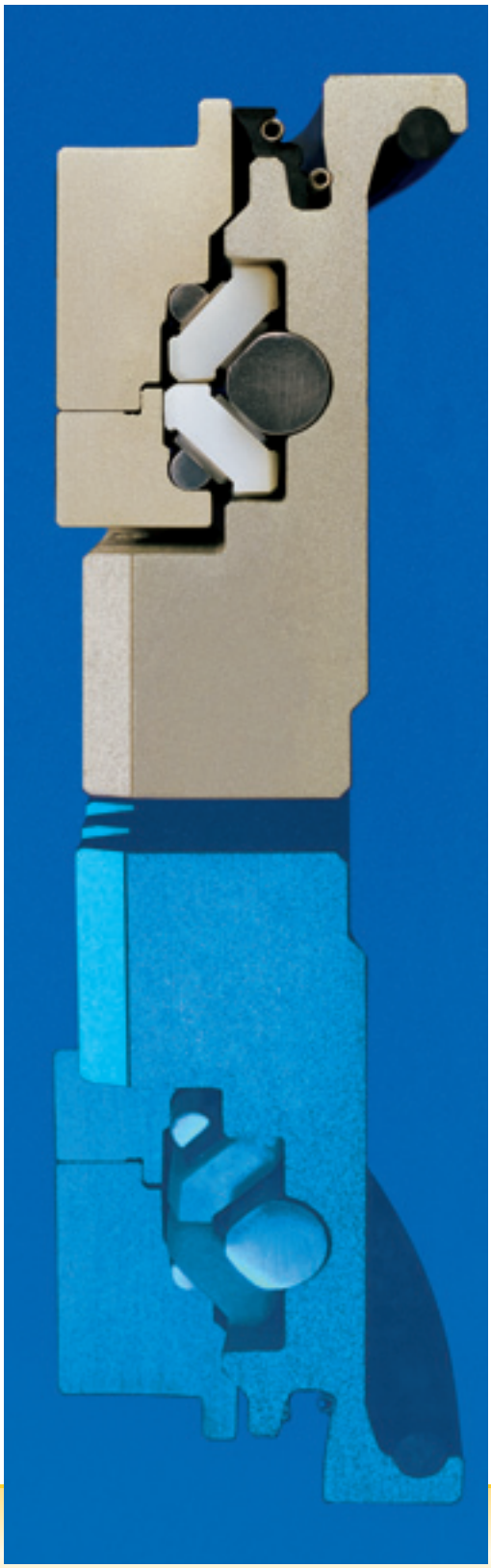
Bearing under load
(exaggerate illustration)

Result: The Rothe Erde wire-race bearing
Rothe Erde wire-race bearings fulfill the described requirements. Due to the fact that the rolling elements do not roll on the bearing rings but on the wires which are in the bearing rings, the material selection and material combination of the components are nearly unlimited.

Decades of experience in design and production and not at least the 120,000 bearings serving in practice confirm that this bearing concept is right.

We are ready to develop a tailor-made solution for new applications at any time.

In addition, wire-race bearings offer the possibility of a more economical repair since it is often sufficient to replace individual components such as wire races, rolling elements, spacers and seals in order to reuse a repaired bearing.

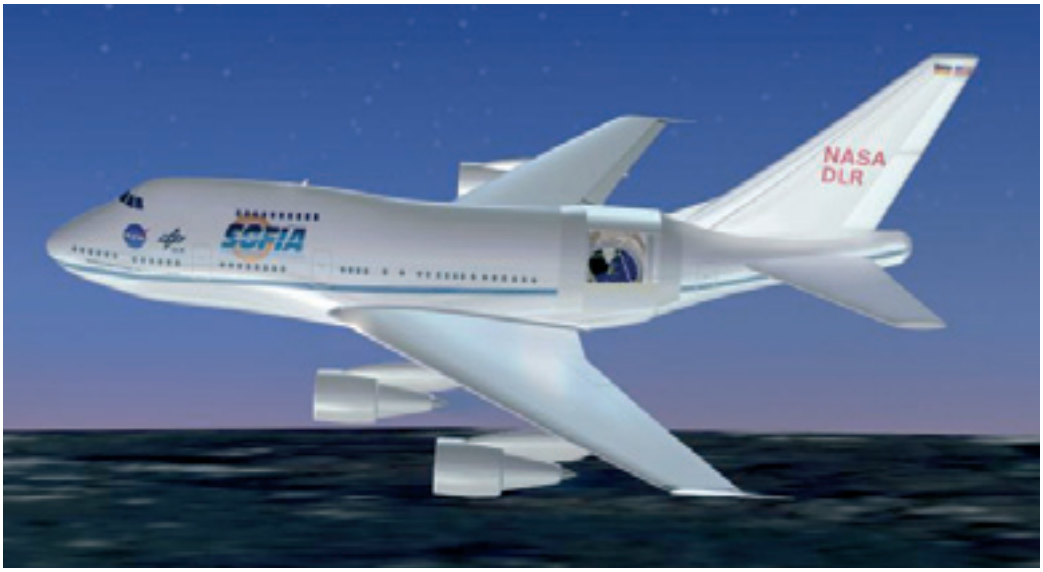


Application examples for wire-race bearings.

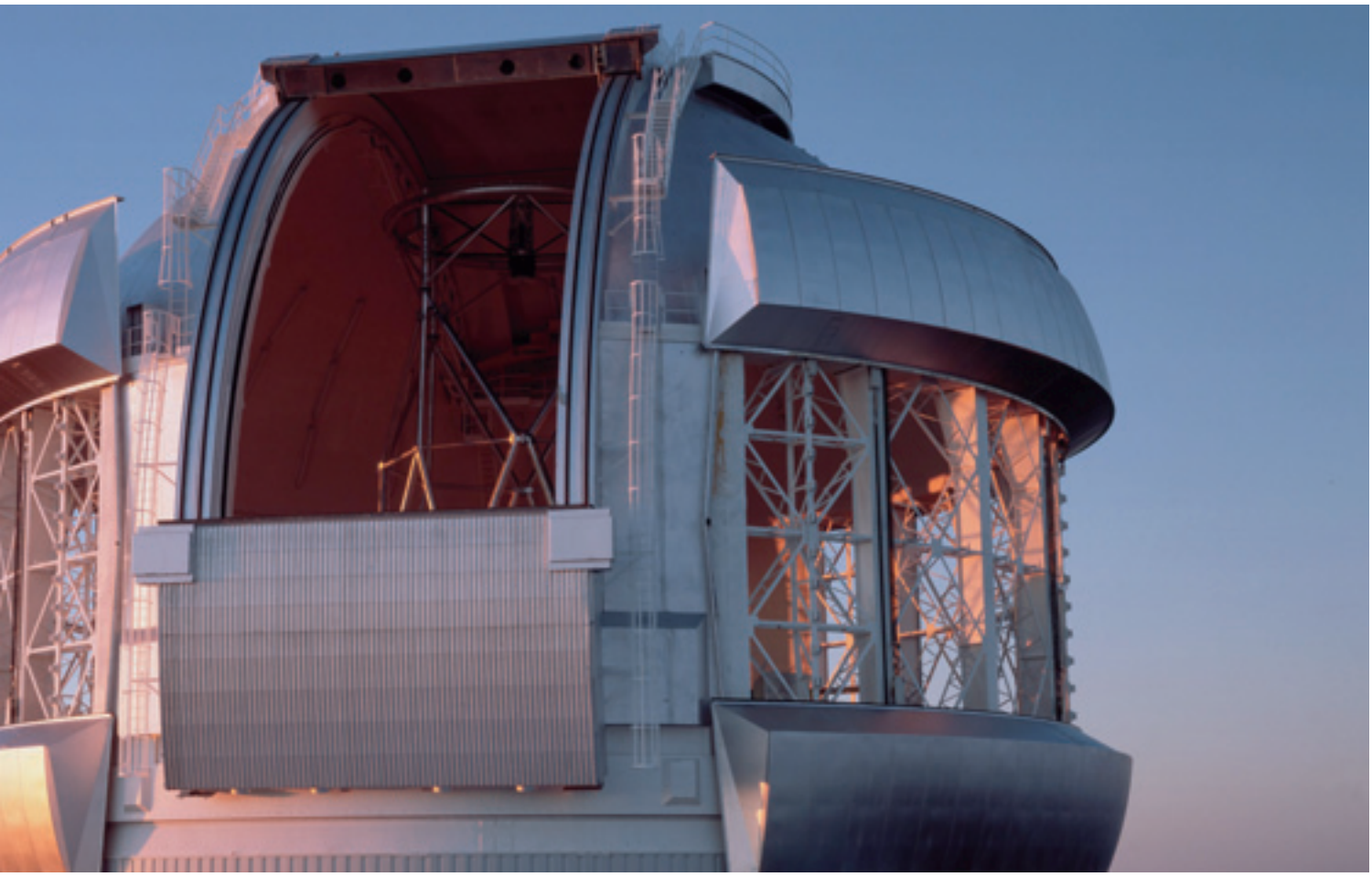
SOFIA – stratosphere observatory for infrared astronomy
For this project, Rothe Erde delivered an aluminum three-row wire-race roller bearing with a bolted steel gear ring for the rough adjustment of the telescope. The telescope is in the rear of a converted Boeing 747.

During the flight, a sort of “sliding roof” opens to enable the telescope to make astronomic observations in the infrared range.

SOFIA is a joint German/American project (DLR/NASA) to explore the universe. The infrared telescope was produced by order of Deutsches Zentrum für Luft- und Raumfahrt (DLR) e.V. with funds from the German Federal Ministry for Education and Research (Bundesministerium für Bildung und Forschung, BMBF).



Computer image of SOFIA



Gemini telescope

Gemini – Optical telescopes
Rothe Erde delivered two three-row wire-race roller bearings for the two Gemini telescopes. The bearing rings are made of aluminium. The bearings enable the adjustment of the M2 mirror.

In addition, a surface-hardened three-row precision bearing was supplied to adjust the M3 mirror. Astronomic faculties use these telescopes for their extensive research.

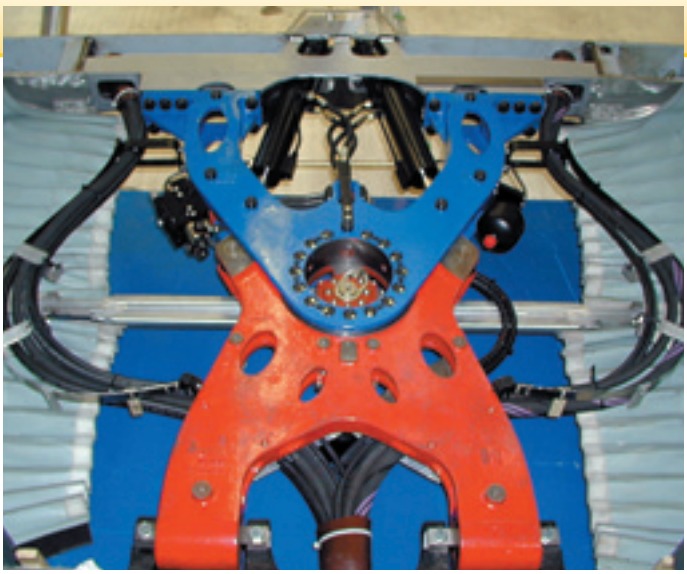
One of these telescopes is located in Hawaii, the other in Chile.

Gemini barrel

Articulated buses
Rothe Erde supplies hybrid-type four-point bearings for the articulation of buses, consisting of a wire-race bearing part and a surface-hardened part.

The majority of the articulated buses are referred to as pushers, i.e. the engine and entire drive unit are located in the rear section, in the trailer.

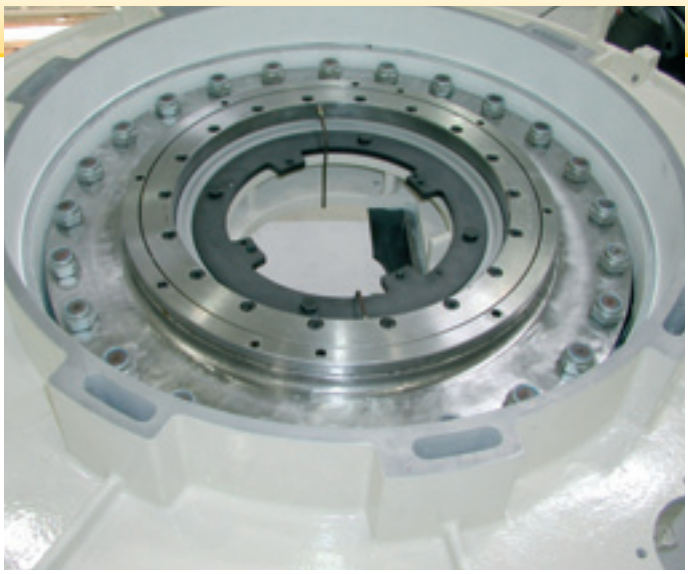
This concept puts a lot of specific requirements on the articulation, such as buckling stability, for instance, which is achieved by means of a complicated electronically-controlled damping system.



Mechanism of articulated buses

Trolley bus, Berne

Electric light bulb production
Rothe Erde wire-race bearings are used in indexing tables for the production of electric light bulbs. The production of electric light bulbs causes strong vibrations on the machine. Rothe Erde slewing bearings absorb them without any problem. When the bearings are repaired, the raceway systems can furthermore be readjusted to the original delivery condition.



Mounting situation – production of electric light bulbs

MaQUS.
The integrated management system of Rothe Erde.

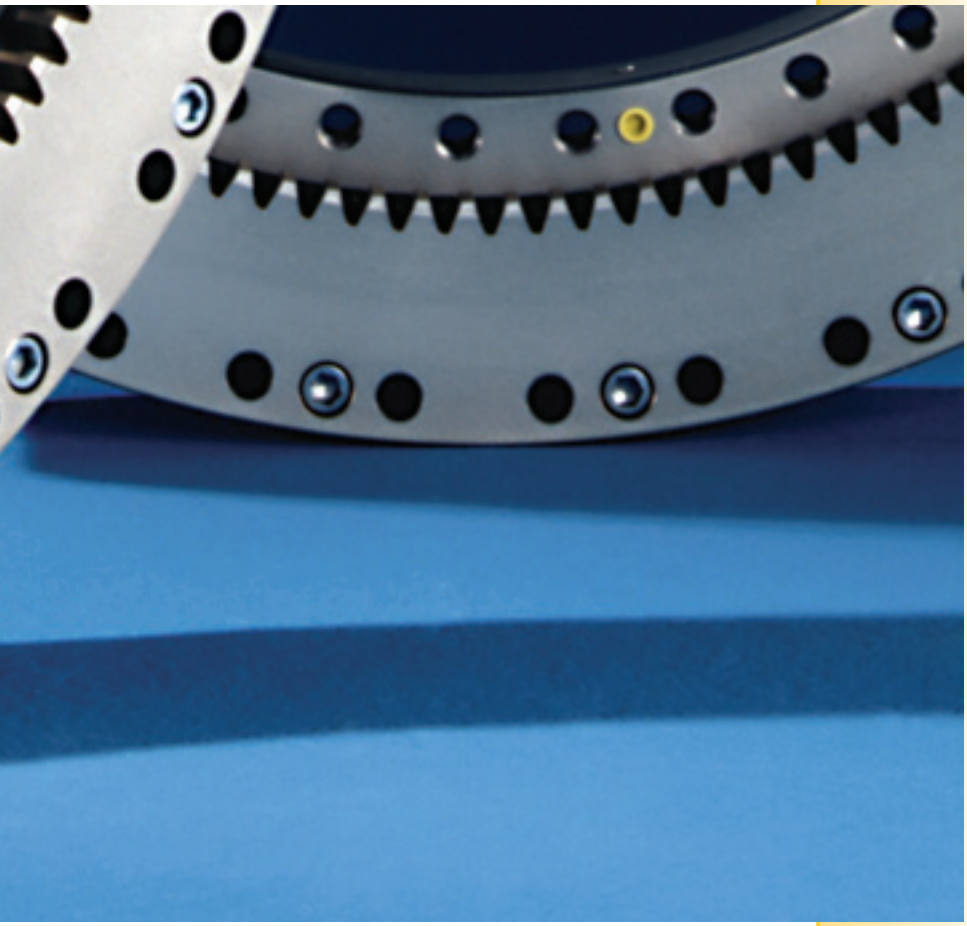
The integrated management system of Rothe Erde consists of the following elements:

- Quality assurance system after DIN EN ISO 9001:2000,
- Environmental control after DIN/ISO 14001 and
- Industrial safety after OHSAS 18001.

Rothe Erde is conscious of its responsibilities towards its staff, its business partners and the general public.

It is the declared aim to cultivate and strengthen customer relations, to manufacture products of the highest quality and to minimize harmful consequences to the environment, the general public and to property. Preserving resources and continuously improving procedures are important elements in company policy.

Rothe Erde products are designed and manufactured in accordance with the internal definitions of the company and customer requirements, taking as a basis approved and assured calculation methods, design guidelines and manufacturing methods.



Quality assurance, environmental protection and safety are Rothe Erde's economic success factors.

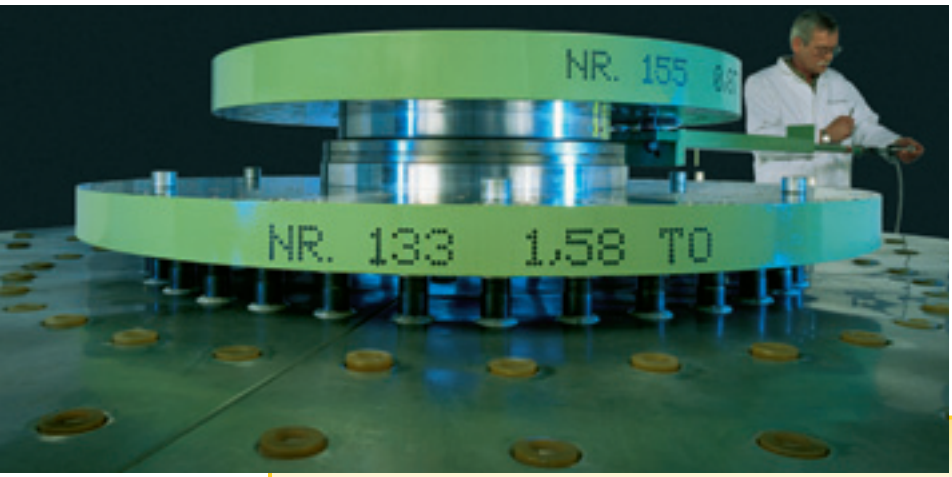
The basis of the management system is the documentation of all processes and sequences as defined by the procedural rules and working instructions with consideration for the requirements of laws, regulations, guidelines, specifications and agreements.

Effective quality assurance, environmental control, industrial and mechanical safety can only be achieved with motivated personnel. A regular exchange of experience hand-in-hand with training and further education enhances the awareness of personnel at all levels and improves both expertise and the responsibility for actions.

Research and development.

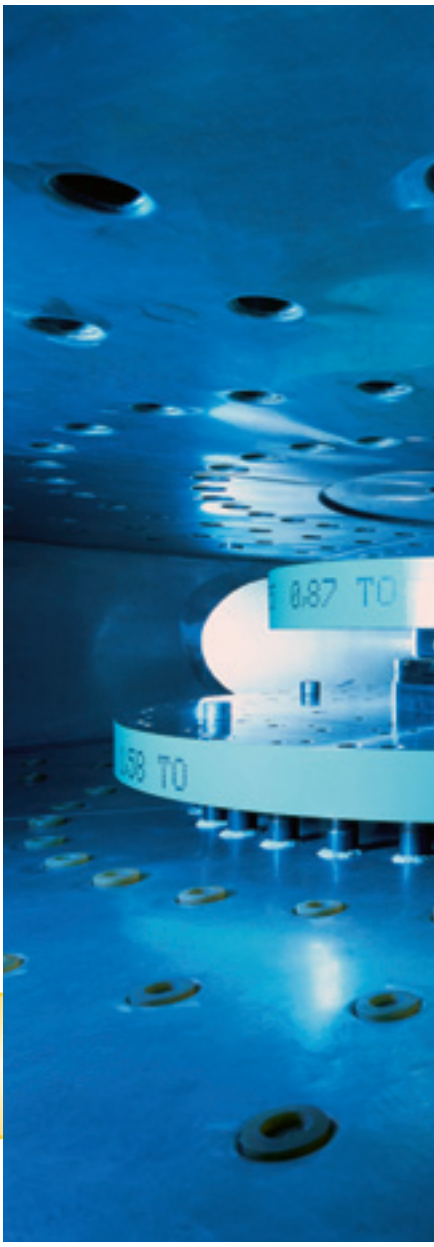
Using the most modern technologies, the Rothe Erde Research and Development Centre subjects all new bearing designs to relentless and assiduous testing. It investigates further developments and prepares groundbreaking, practical solutions. Findings, experience and new ideas are thus transferred into products for the market as a whole and for specific customers.

Research and development is one of the central fields of our product development. In cooperation with the technical departments, the bearings and their components are developed and tested here under most different conditions. Amongst other things, this includes tests at high or sub-zero temperatures ranging from - 60 °C to 250 °C, frictional torque measurements and stiffness measurements. Investigations ordered by the customer are also possible.

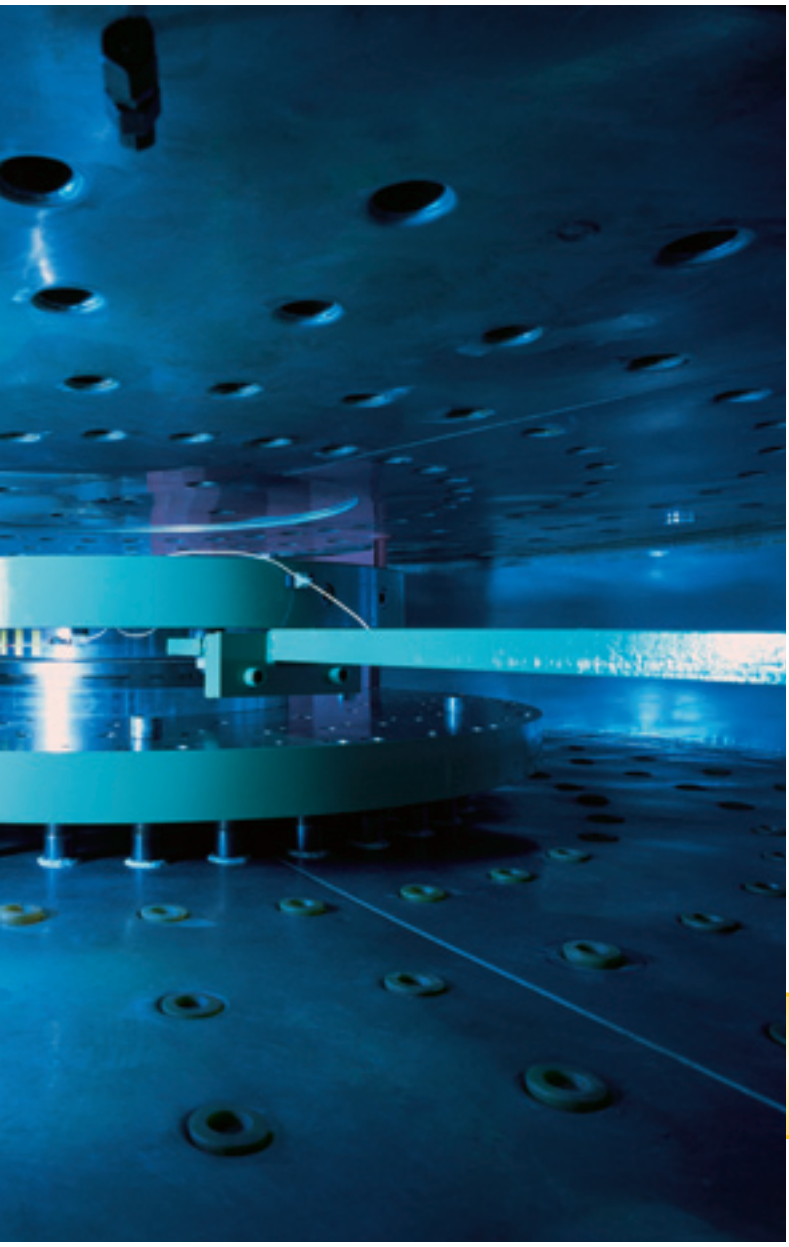


Frictional torque measurement at room temperature

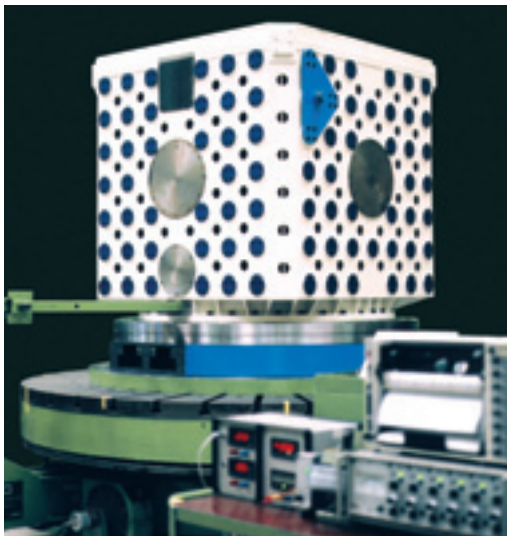
Frictional torque measurement at sub-zero temperature in the climatic test chamber



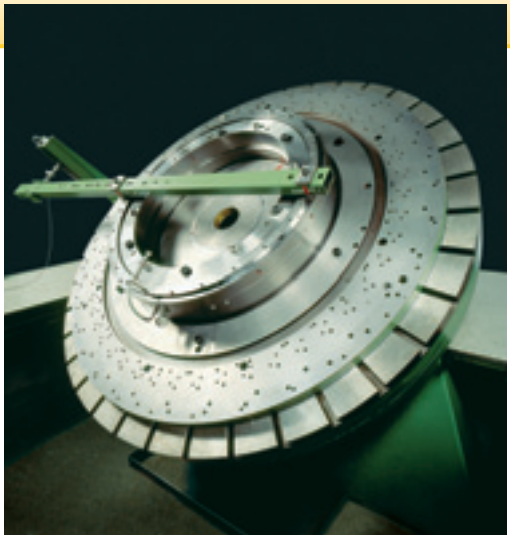
Climatic test chamber



Tightness test ("splash water test") of a wire-race bearing with integrated slip rings for electric current transmission (see page 8, fig. 14)



Frictional torque measurement with original companion structure of the Gemini telescope.



Frictional torque measurement in a slanted position

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