2. SELECTING THE RIGHT PART NUMBER

A. Selecting by life and capacity

Bearings are normally selected to carry a given load for a given duration.

The traditional approach to bearing selection begins with the determination of applied forces and calculation of a bearing dynamic equivalent radial load (P). Using the "design life" (established from experience of successful performance of similar equipment L_{10}) and bearing speed (n), a "required dynamic radial load rating" (C_{90}) can be calculated and used to select a bearing part number from the bearing data tables.

It is suggested that the traditional approach to bearing selection be expanded to include life adjustment factors relating to a number of variables such as lubrication, load zone, alignment and useful life. Equations are included to permit a designer to do this on a limited basis.

$$C_{90} = \left(\frac{L_{10} \times n}{a \times 3000 \times 500} \right)^{\frac{1}{10/3}} \times P$$

C_{90} = required dynamic radial rating
L_{10} = design life
n = speed in rpm
P = dynamic equivalent radial load
a = life adjustment factor

1. Basic dynamic load rating

The basic philosophy of The Timken Company is to provide the most realistic bearing rating to assist our customers in the bearing selection process.

Since 1915, The Timken Company has developed specific rating methods for its tapered roller bearings. Customers have benefited by periodic bearing rating revisions which have been published only after thorough verification by extensive research effort and testing programs. The testing schedule, which is now established as an international "Quality Audit Program", randomly samples bearings as packaged in Timken distribution centers. The latest revision of Timken bearing ratings as printed in this publication was adopted in 1986. This revision was due to a significant improvement in bearing steel quality.

With the continued improvement of ratings, the environment in which the bearing operates must be carefully considered in the bearing selection process. In addition, the demand for greater energy efficiency and productivity requires more exacting specifications and places more stringent requirements on bearings. Therefore, it is essential that the designer is able to compare the reference conditions under which the ratings are established to those of the real-world environment.

The environmental reference conditions that relate to Timken published ratings are:

Load
$F_r = C_{90}$ or $F_a = C_{a90}$

Speed
n = 500 rev/min

Lubrication
Oil viscosity, 33 cSt @ 55°C
(155 SUS @ 130°F)

Bearing operating temperature
θ = 55°C (130°F)

Setting
Equivalent to 180° load zone

Alignment
An angle between the cone and cup centerlines of less than 0.0005 radian

Fatigue spall size
6 mm^2 (0.01 in^2)

Actual bearing operating environmental conditions may vary from one or all of these reference conditions. Therefore, it is necessary in the application design analysis and the bearing selection process to be able to evaluate and compensate for these differences. The traditional approach to bearing analysis and selection has been expanded in this publication to include certain environmental variables over and above load and speed that affect bearing life expectancy. Refer to the section of this book called Bearing Systems Analysis for a description of our in-depth approach.

In addition to bearing material and the controlled environmental conditions that exist in the testing programs, a bearing's rating is a function of its internal geometry – including cup raceway angle, roller diameter, and effective contact length between raceways and rollers. It also depends on the number of rollers in each row and the number of rows in the bearing. These parameters and a geometry-material factor are the basis of the equation from which the rating for each bearing is determined.

2. Timken dynamic load rating

Published ratings for Timken bearings include the basic dynamic radial load rating, C_{90} and $C_{90(2)}$, for single-row and two-row bearings respectively, and the basic dynamic thrust load rating, C_{a90}. These are based on a basic rating life of 90 million revolutions or 3000 hours at 500 rev/min.
The bearing rating method published by the International Organization for Standardization (ISO) and American Bearing Manufacturers Association (ABMA) is presently based on a rating life of one million revolutions. The ISO/ABMA rating is considered a reference value only, since applied loads equal to this rating could produce plastic deformation within a bearing. To determine the bearing load rating that will provide 90 million revolutions life, divide the ISO/ABMA roller bearing rating by:

$$\left(\frac{90{,}000{,}000}{1{,}000{,}000} \right)^{\frac{1}{10/3}} \text{ or } 3.857$$

However, a direct comparison between ratings of various manufacturers can be misleading because of differences in rating philosophy, material, manufacturing, and design.

Note: for the convenience of users, the bearing data tables show both the 90 million revolutions rating (C_{90}) and the 1 million revolutions rating (C_1).

Timken bearing load ratings are based on data obtained from standardized laboratory life tests.

2.1. K factor

The Timken Company also publishes K factors for its bearings. The K factor is the ratio of basic dynamic radial load rating to basic dynamic thrust load rating of a single-row bearing. This ratio assumes a 180 degree load zone for the basic dynamic radial load rating:

$$K = \frac{C_{90}}{C_{a\,90}}$$

The smaller the K factor the steeper the bearing cup angle becomes. This relationship is:

$K = 0.389 \cot \alpha$

B. Selecting by size

Timken tapered roller bearings cover a wide range of inch and metric bearing sizes. The bearing tables for the various types of bearings are listed in ascending order of bore, outside diameter and width. The bearing data tables list the most widely used cone/cup combinations. For a given application and dimensional constraints, the comprehensive range of metric and inch sizes should enable the optimum bearing to be selected. However, if you are unable to find the exact bearing for a specific application, please consult The Timken Company for details of the many other bearings which space prevents us from listing in this publication.

C. Selecting with a sales engineer or representative

The Timken Company not only sells products of the highest possible quality, but also offers its customers comprehensive design and technical support. Timken sales engineers and representatives can use sophisticated computer programs to solve most bearing application problems. If the application becomes too complex, our sales staff is supported by an in-house staff of graduate engineers and technicians, as well as advanced computer tools.

D. Selecting by bearing types

Depending on the load applied to the bearing, a selection can be made between:

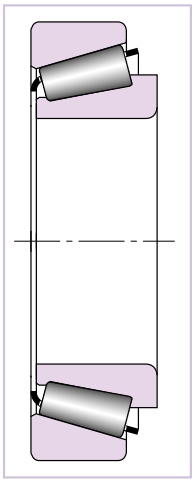
- a single-row bearing,
- a two-row bearing,
- a four-row bearing, relative to increasing radial load,
- a thrust bearing for very high axial load and no radial load.

1. Current bearing types

(Bearings marked * are listed in the Bearing Data Tables)

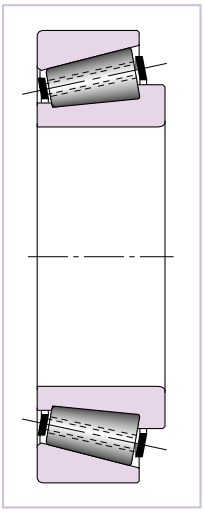
1.1. Single-row bearings - Most common types

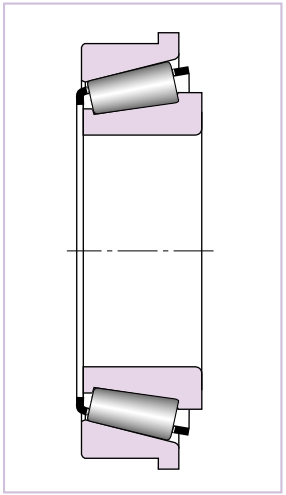
These bearings are usually mounted in pairs in an indirect or direct arrangement. During equipment assembly they need to be set to the required clearance (end play) or preload condition to optimize performance.



TS (Pressed steel cage)*
The TS bearing is especially suited to most automobile and industrial applications.

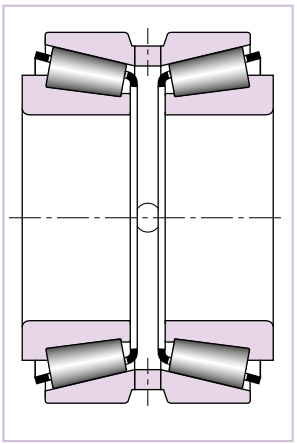
TS (Pin-type cage)*
Medium and large bore TS bearings can have more rollers (and increased load-carrying capacity) when designed with a pin-type cage.





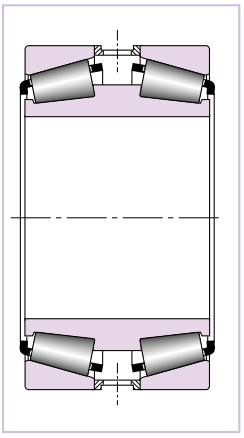
TSF (Flanged cup)*
The TSF bearing is popular in gear reduction units, modern automotive transaxles, transmissions and machine tool spindles.

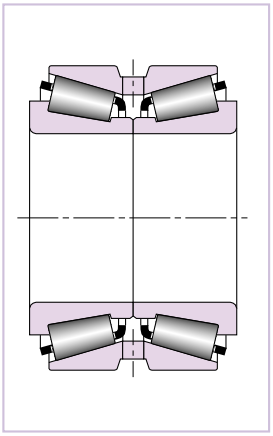
1.2. Two-row bearings



TDO
(2-row double-cup)*
TDO bearings are applied to heavy duty gear drives and a variety of other applications. These bearings can either be used at fixed or floating positions.

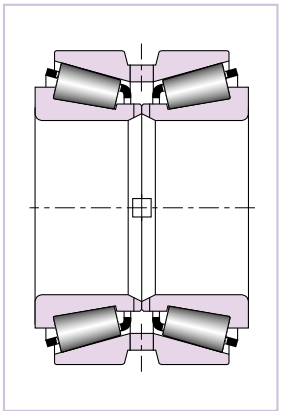
TDI (2-row double-cone)*
The TDI bearing is applied to gear reduction units, cranes, calender rolls and other industrial machinery. A similar bearing, TDIT*, is available with a tapered cone bore. The TDIT is designed for large adapter-type pillow blocks, rolling mill roll necks and calender rolls. TDI bearings are usually used at the fixed position.



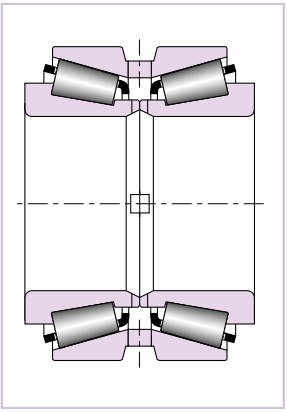


TNA
The TNA bearing is preset during manufacture and can be used at fixed or floating positions.

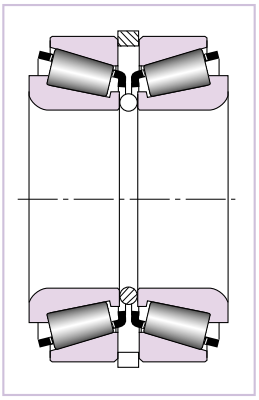
TNASW
(TNA with lubrication grooves)*
The TNASW bearing is used in sheaves and other dead shaft applications where lubrication is necessary through the shaft. This bearing can be used at fixed or floating positions.



TNASWE
(TNASW with extended ribs)*
The TNASWE bearing is extensively applied to crane sheaves and oil field drilling rig sheaves. This bearing is preset when manufactured.

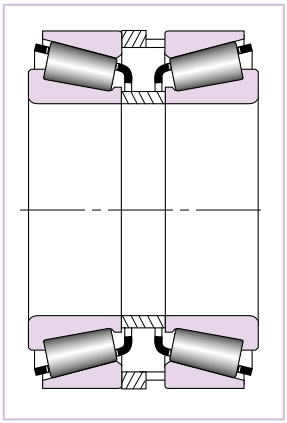


1.3. Spacer assemblies

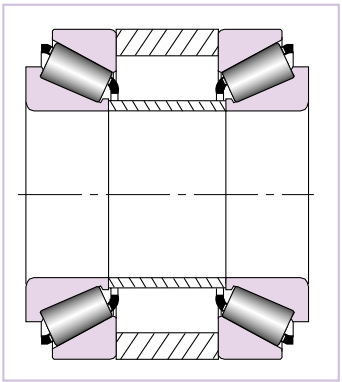


SS (2-row snap ring spacer assembly)*
The SS bearing is used in many applications where a two-row preset bearing is required with a close range of adjustment. A snap ring is used for axial location.

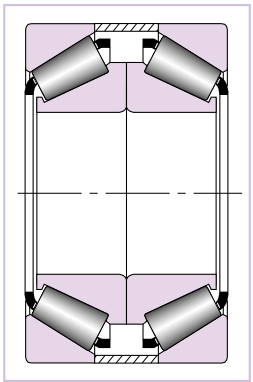
SR (2-row "SET-RIGHT"™ spacer assembly)*
The SR bearing is used in many applications where a two-row preset bearing is required with a close range of adjustment.



2TS-IM assembly and
2TS-DM assembly
Available in all TS sizes.



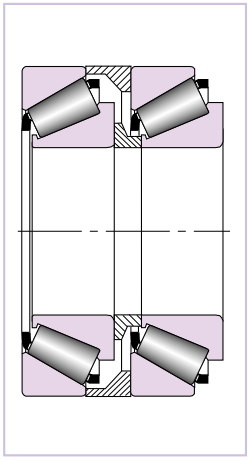
Indirect mounting



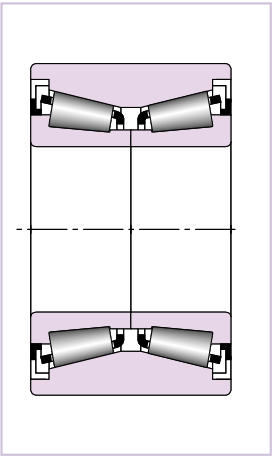
Direct mounting

The 2TS-IM/DM bearing assemblies are used in many applications, such as gear reduction units and industrial machines. These preset two-row assemblies are used at the fixed position, or as two single-row bearings spread apart.

2TS-TM assembly
(tandem arrangement)
The 2TS-TM bearing is applied to applications such as hydrostatic axial piston pumps and motors, where high axial loads are present.

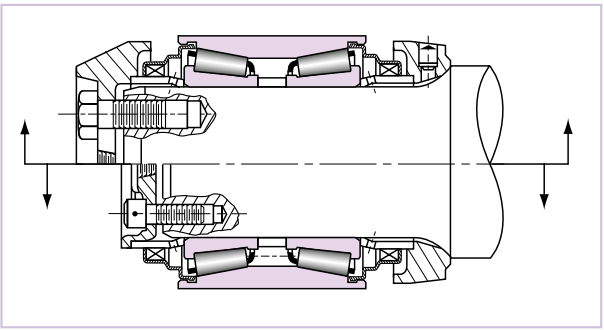


1.4. Package bearings



TDOUP - UNIPAC™
Originally designed for automotive wheels, the UNIPAC bearing can also be used in industrial applications. The UNIPAC bearing is a preset, prelubricated and sealed package bearing.

"AP"™ - ALL-PURPOSE*

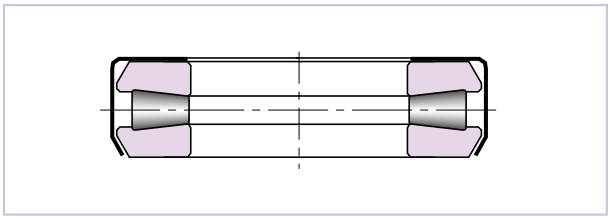


The "AP" bearing is furnished as a self-contained, preset, prelubricated and sealed assembly. Originally designed for railroad cars and locomotives, it is also used for crane wheels, table rolls and sheaves. These applications may require modifications to the end cap and backing ring and the addition of lubrication fittings.

TM = Trademark of The Timken Company

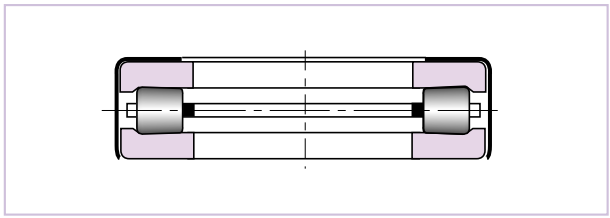
1.5. Thrust bearings

TTC (Cageless thrust bearing)*



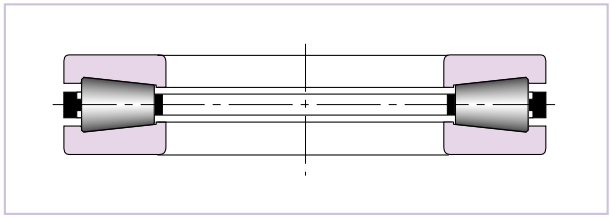
The TTC bearing is a self-contained assembly used in oscillating or slow rotating applications where pure thrust loads are applied.

TTSP (Caged thrust bearing)*



The TTSP bearing is used in automotive steering pivots and industrial applications where full rotation is not required.

TTHD (Heavy duty thrust bearing)*

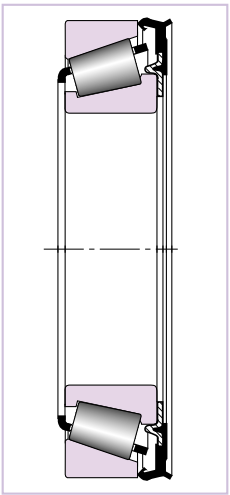


The TTHD bearing is designed for slow to moderately high-speed applications including oil well swivels, extruders and piercing mill thrust blocks. Where heavy thrust loads are involved.

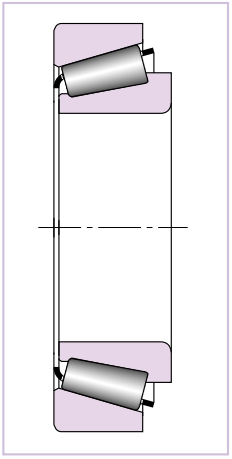
2. Sealed bearings

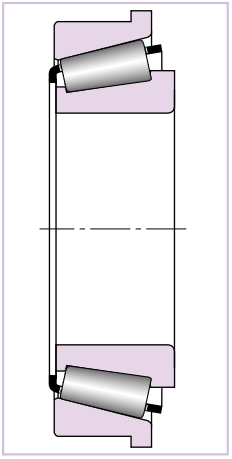
TSL (With DUO FACE®-PLUS seals)*

The TSL bearing is similar to the TS, but with a "DUO FACE-PLUS" seal pressed onto the O.D. of the cone rib. The TSL bearing is used in moderate to low speed applications, such as farm implement and boat trailer wheels, idler rollers and side delivery hay rakes.



3. Precision bearings





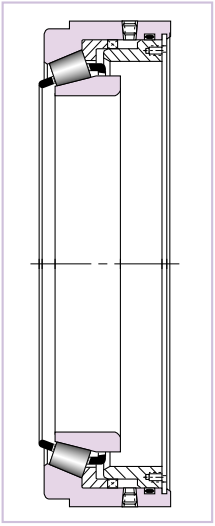
TS and TSF single-row bearings*

These bearings have to be mounted in pairs in an indirect or direct arrangement. They need to be set during equipment assembly for optimum performance.

Precision TS and TSF bearings are used typically in machine tool spindles.

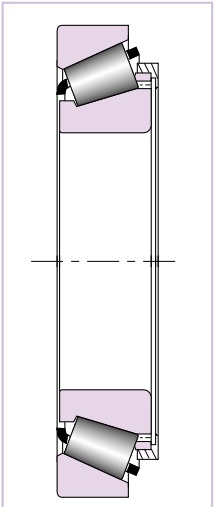
"Hydra-Rib"™ bearings TSHR*

The "Hydra-Rib" bearing is designed for applications where bearing preload setting is critical over a wide range of speeds and/or load conditions. The "Hydra-Rib" bearing is a typical machine tool bearing and is fitted to the spindle rear position with a TSMA or TS as the companion spindle nose bearing.

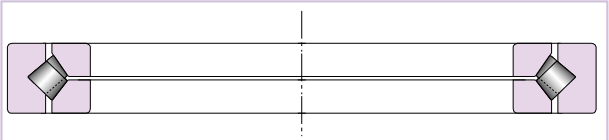


High speed bearings TSMA (with axial oil manifold)

The TSMA bearing is used in applications that speeds far exceed those for which standard bearings are designed. This bearing is normally used in the machine tool or aerospace industry.



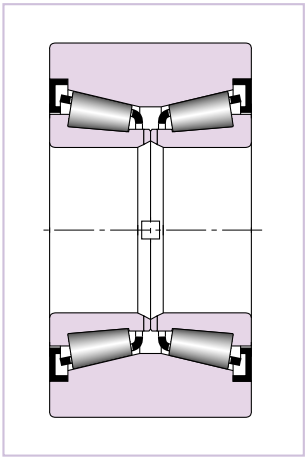
Crossed roller bearings TXR*

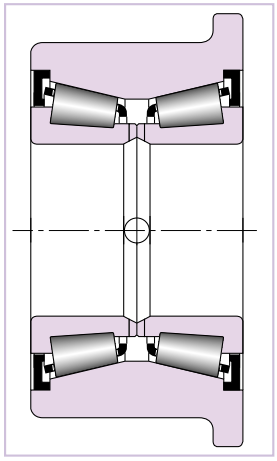


The crossed roller bearing is ideal for machine tool applications such as vertical boring mills, vertical grinding machine and other similar table bearing applications.

4. Other types of bearings

TNASWH / TNASWHF

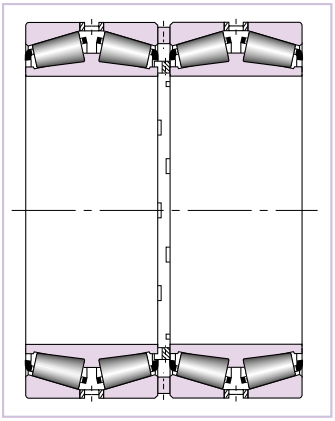




TNASWH bearings are applied to back-up rollers, coil conveyors, cars and (in the case of TNASWHF) equipment moving on rails.

5. Four-row bearings - most common types

These bearings are not listed by part numbers in this guide, but are featured in a separate Timken publication on the rolling mill industry.

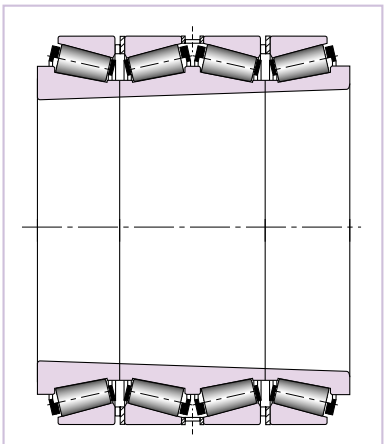


TQO (Straight bore 4-row assembly)

TQO bearings are applied to roll necks on low and medium-speed rolling mills.

TQITS (4-row tapered bore assembly)

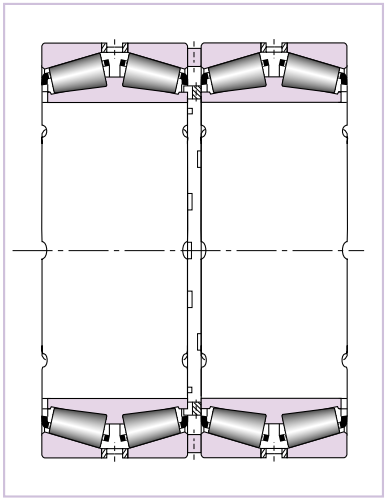
TQITS bearings are applied with a heavy interference fit on roll necks of high speed rolling mills.



TM = Trademark of the Timken Company

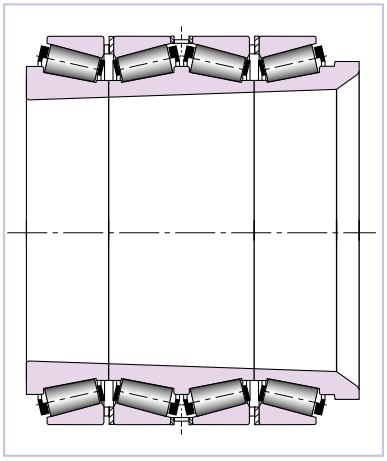
TQOW (TQO with cone face lubricant slots)

Similar to type TQO, except that the cone faces have lubrication slots at each face.



TQITSE (TQIT with extended cone)

The TQITSE bearing is similar to the TQITS, except the large bore cone has an extension to provide a hardened, concentric and smooth surface for radial lip seals.

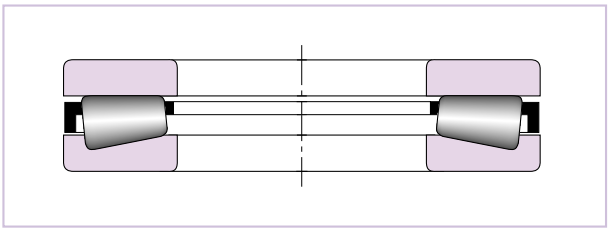


All roll neck bearings can be provided with grooves cut into the cone bores.

6. Heavy duty thrust bearings

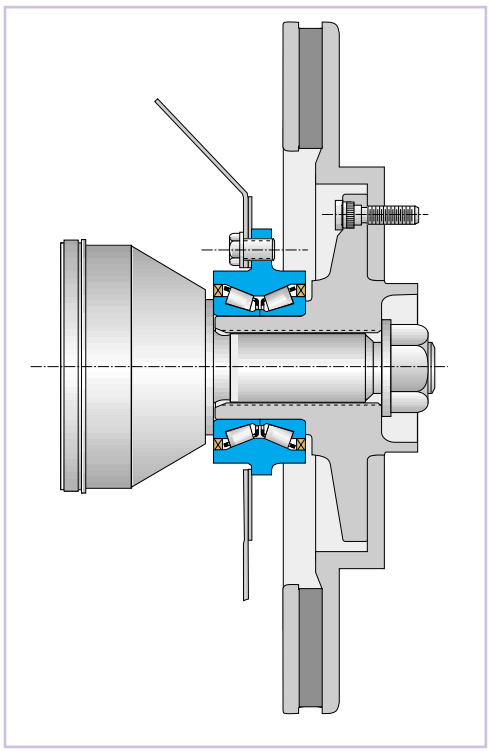
TTHDFL (TTHD with one flat race)

The TTHDFL bearing is similar to the TTHD. The TTHDFL bearing consists of one tapered thrust race, one flat thrust race, a cage and a set of rollers.

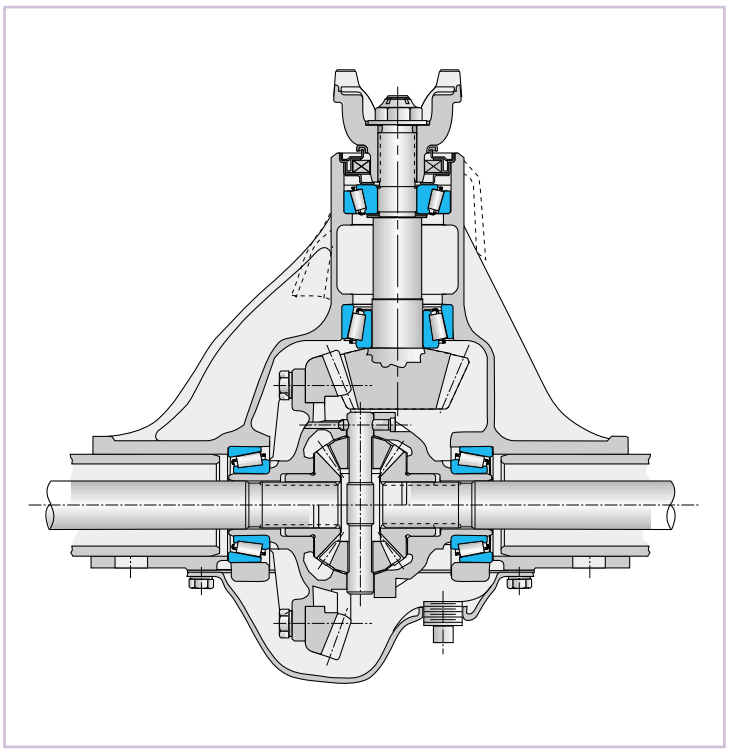


E. Examples of applications

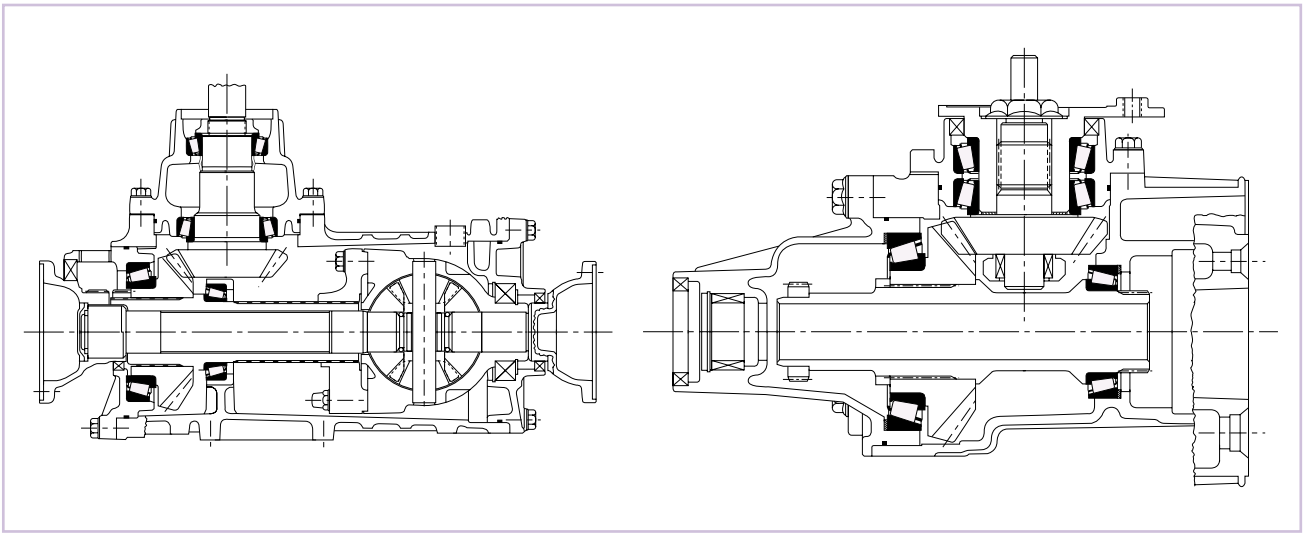
Automotive



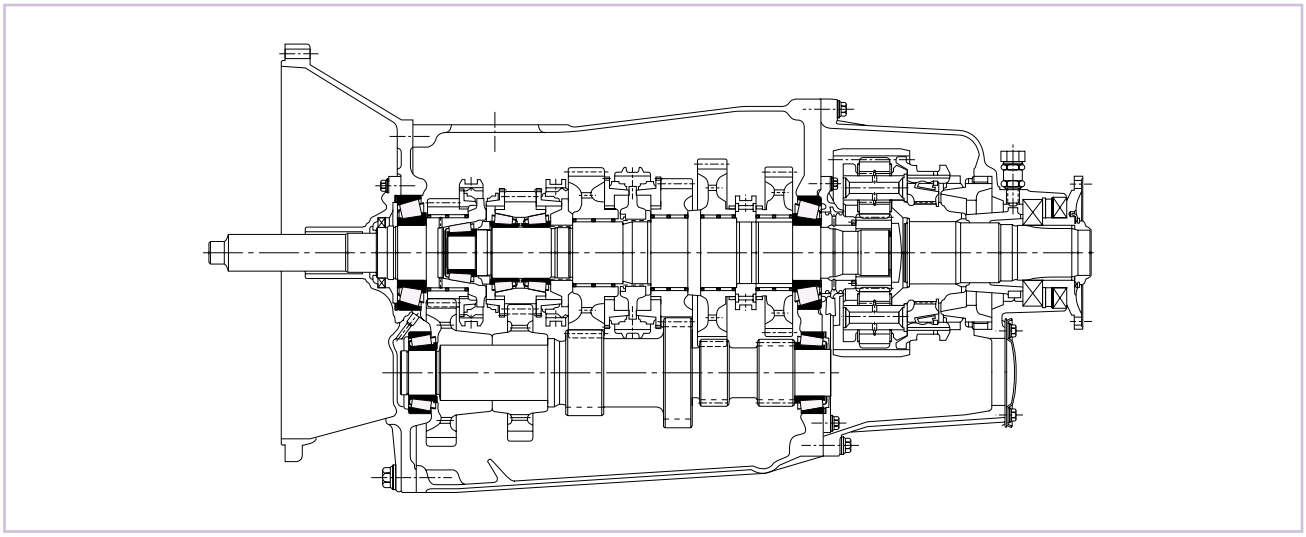
Front driving wheel rotating spindle



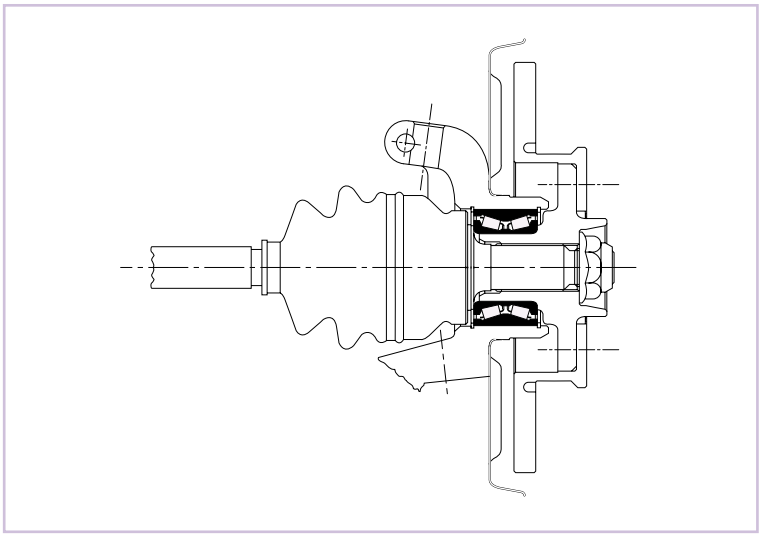
Hypoid axle center, overhung pinion-carrier



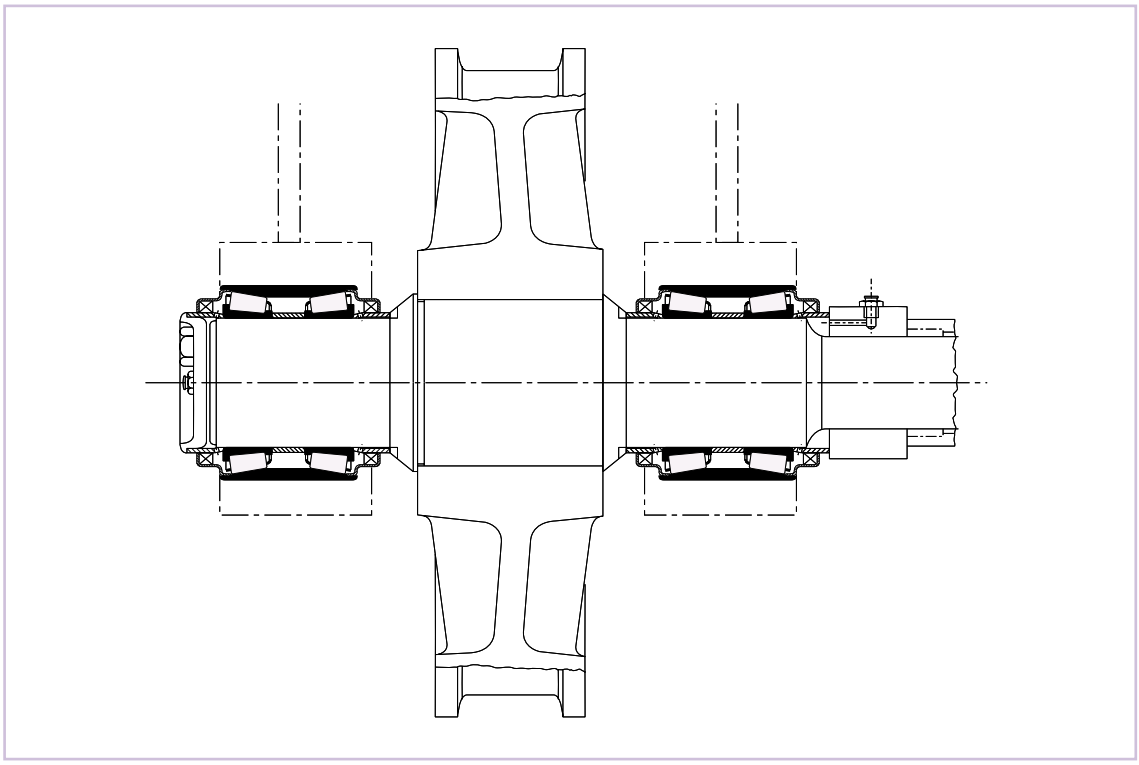
Four wheel drive passenger car - front and rear axles



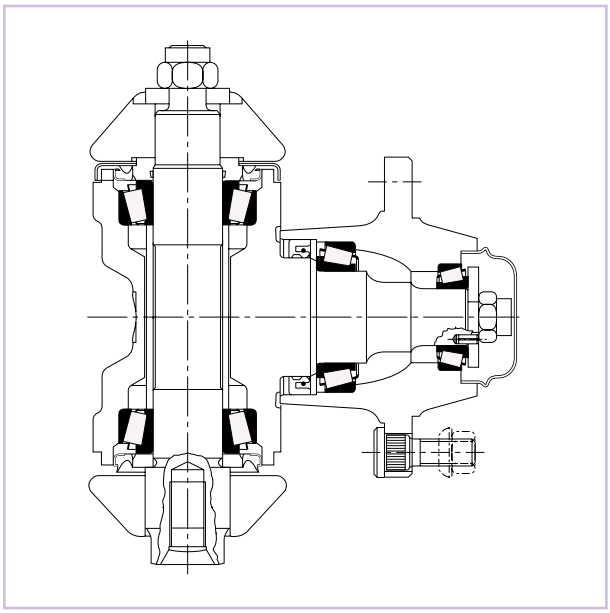
Truck gearbox/transmission



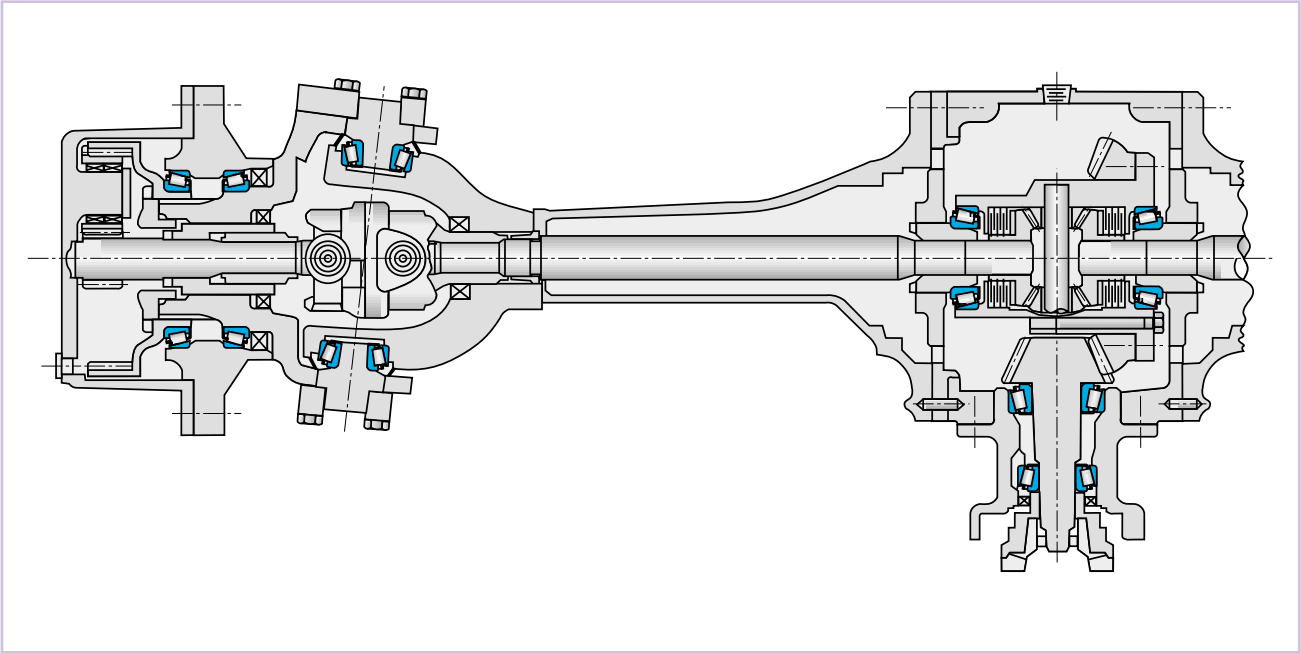
Front-wheel - UNIPAC bearing



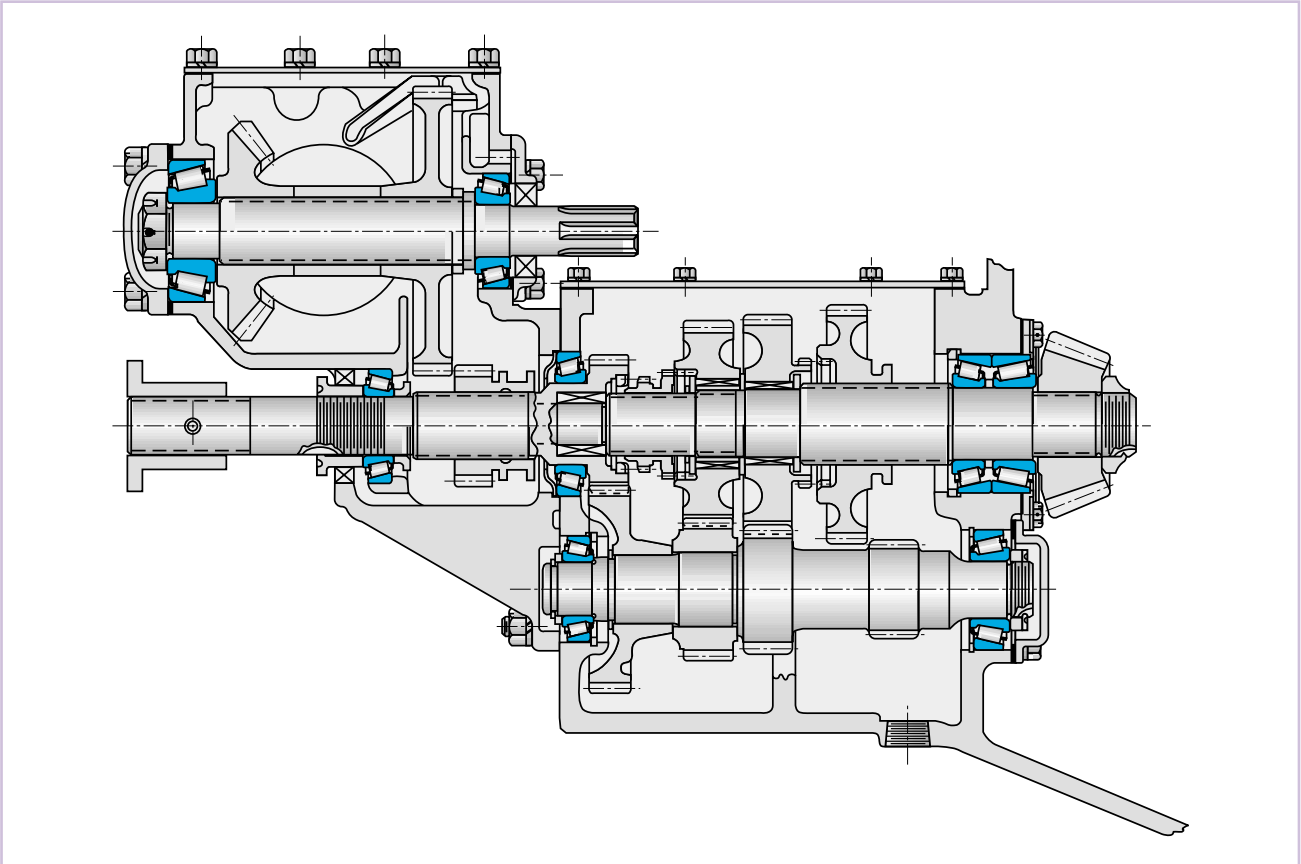
Heavy duty crane wheel - AP bearings



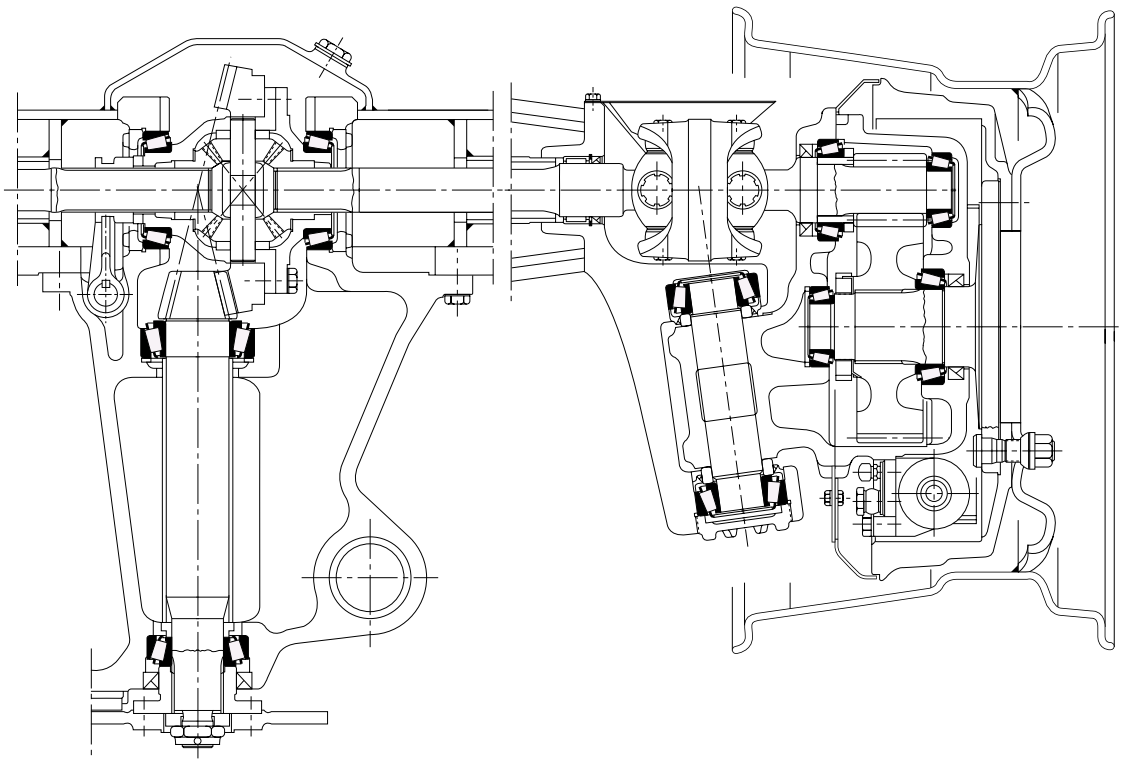
Lift truck steering axle



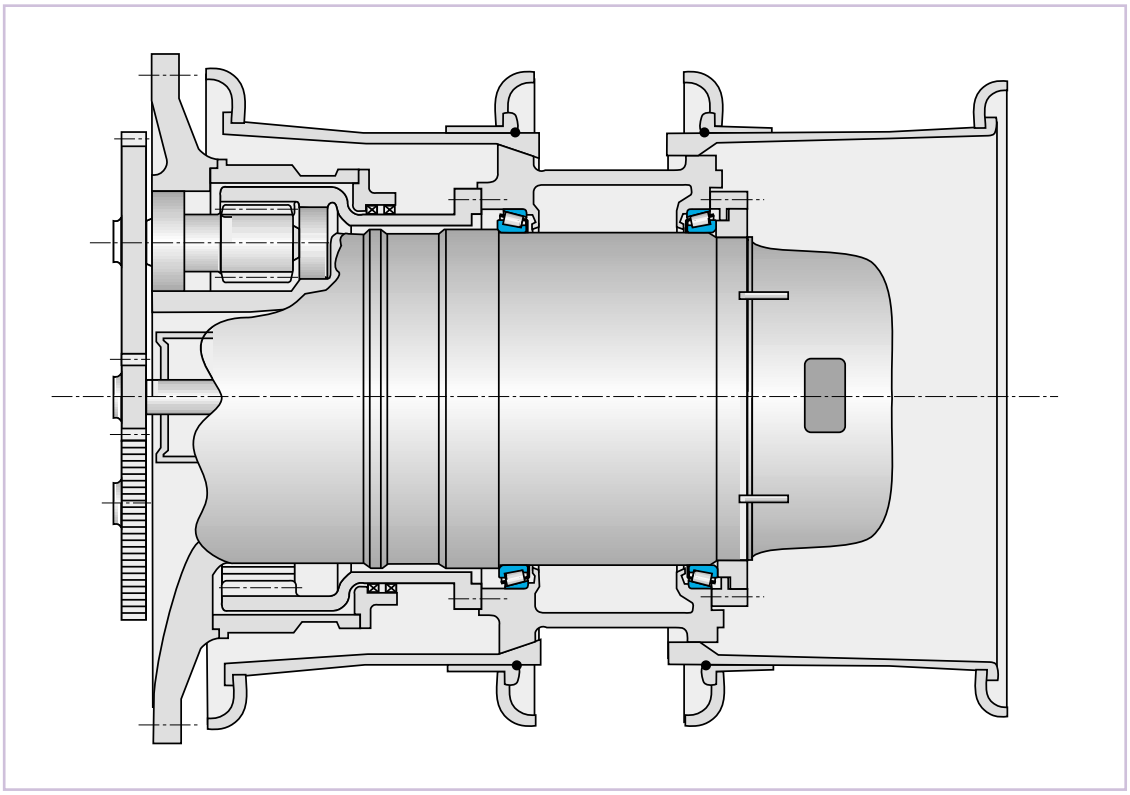
Farm tractor front wheel drive



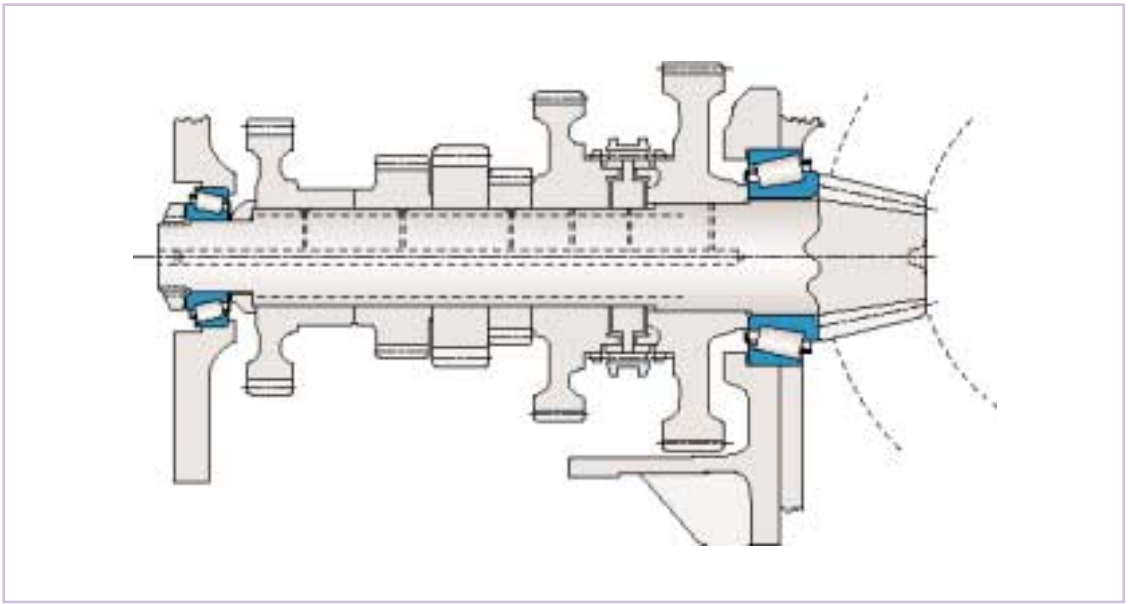
Farm tractor transmission and power take-off



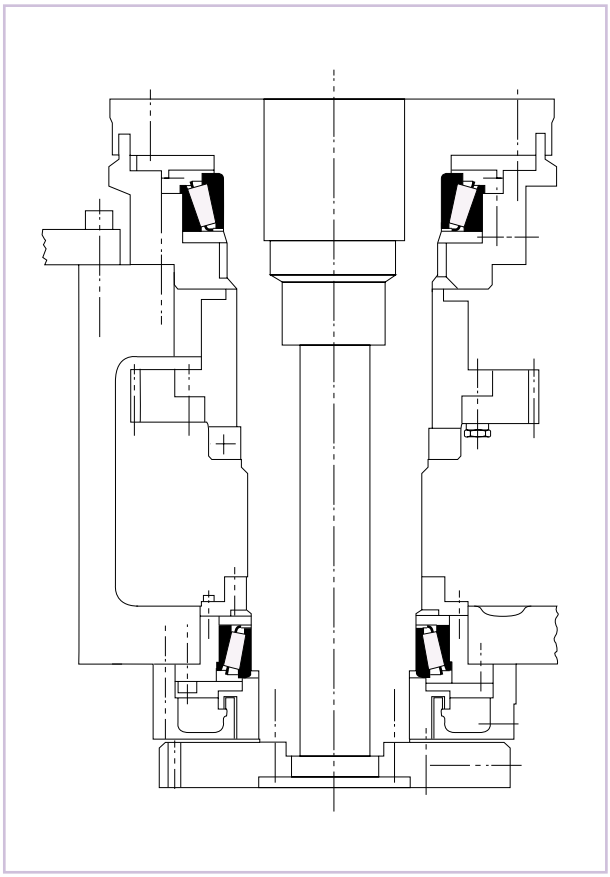
Loader front or rear axles



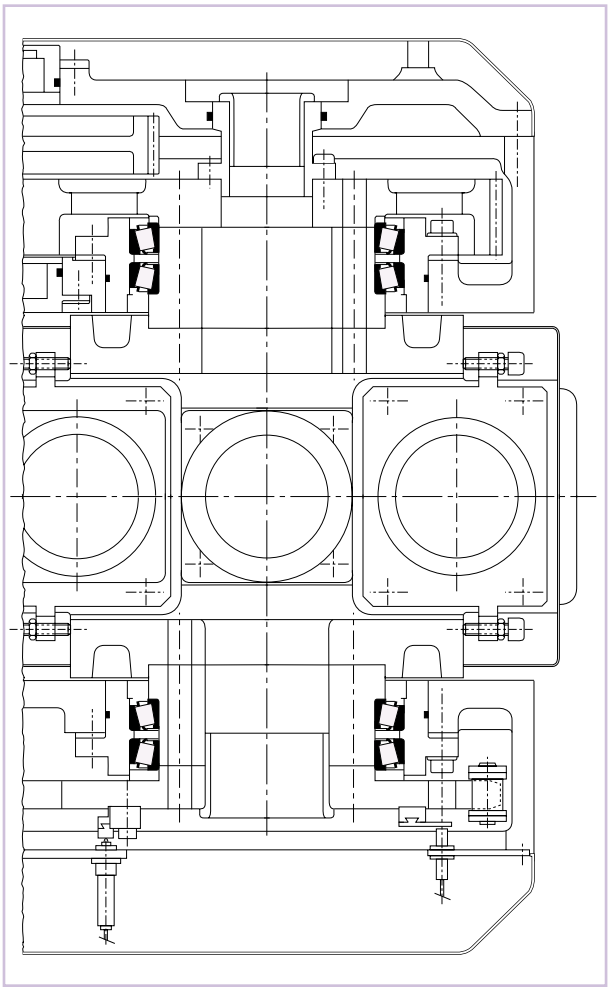
Off-highway truck motorized wheel



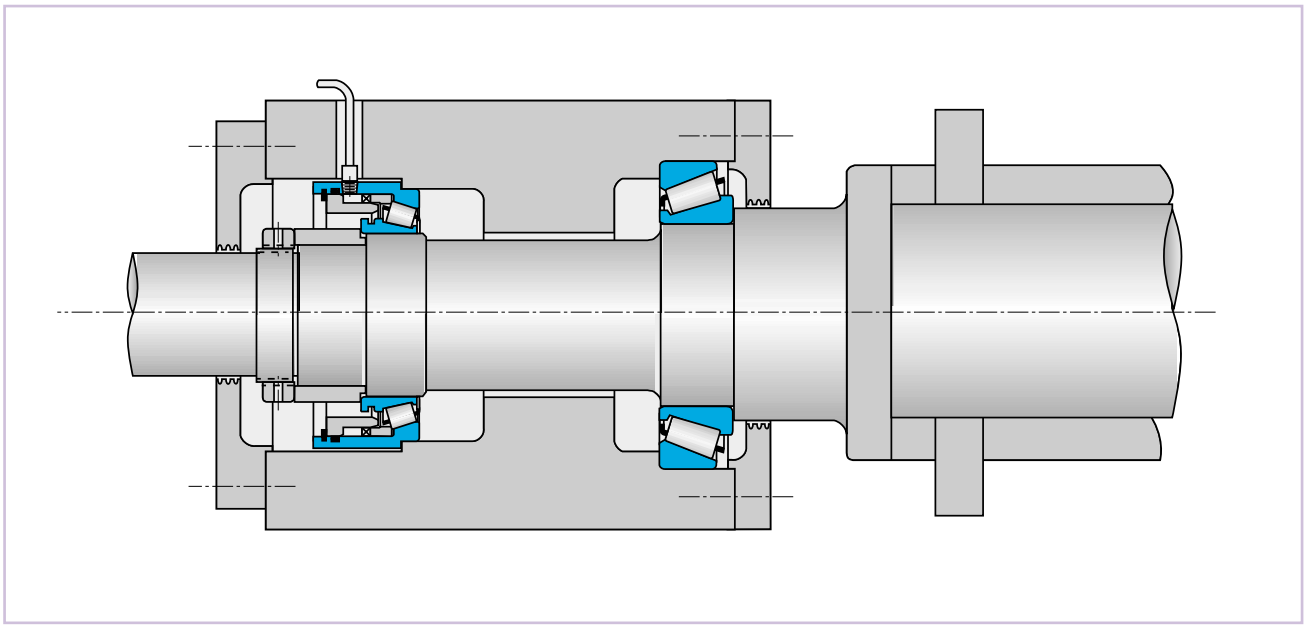
Farm tractor



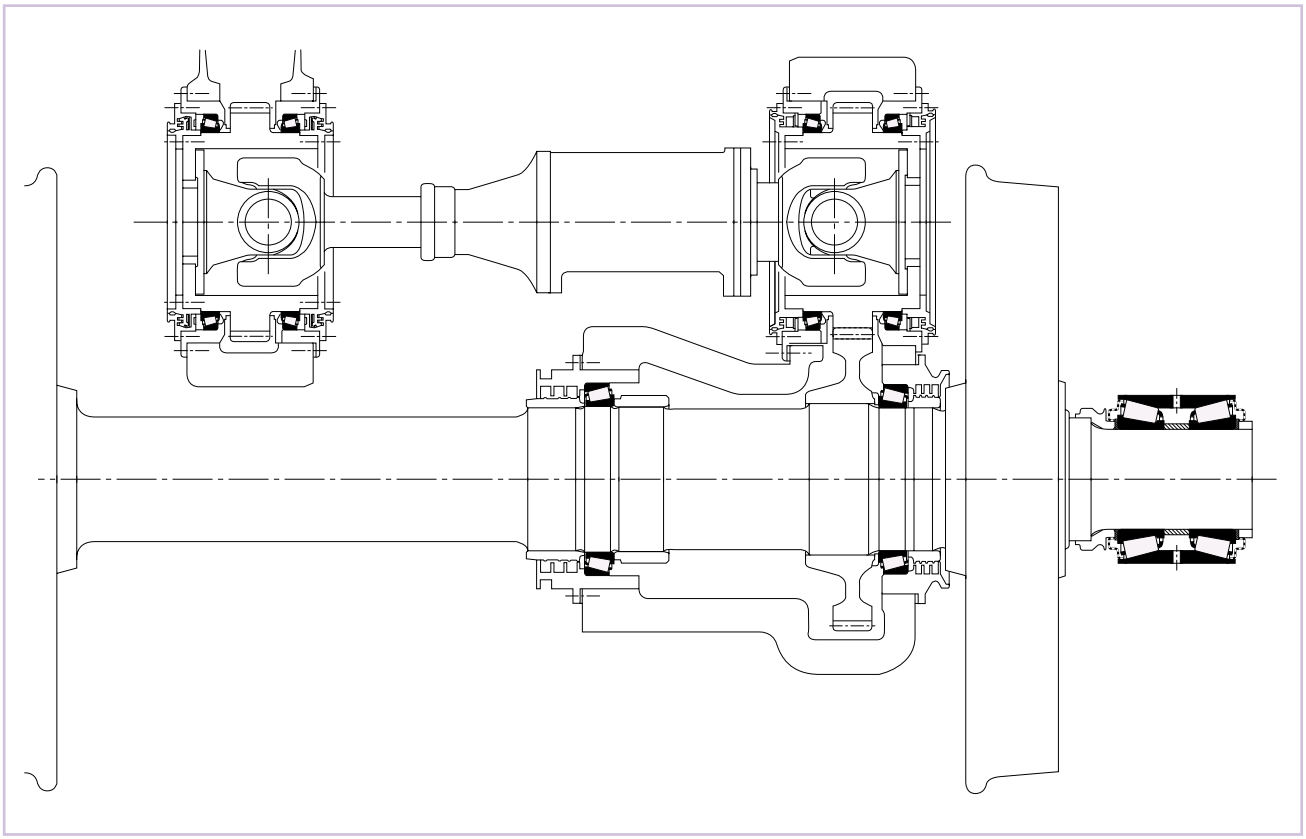
Vertical machining center



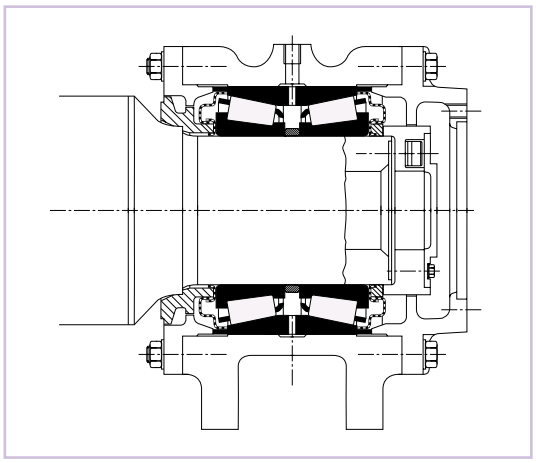
Robot articulation



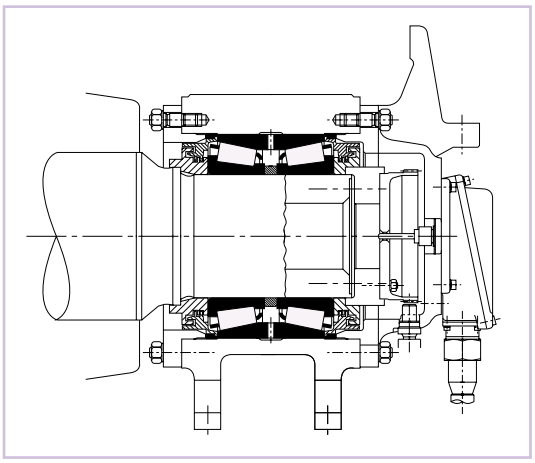
Machine tool spindle using a Hydra-Rib



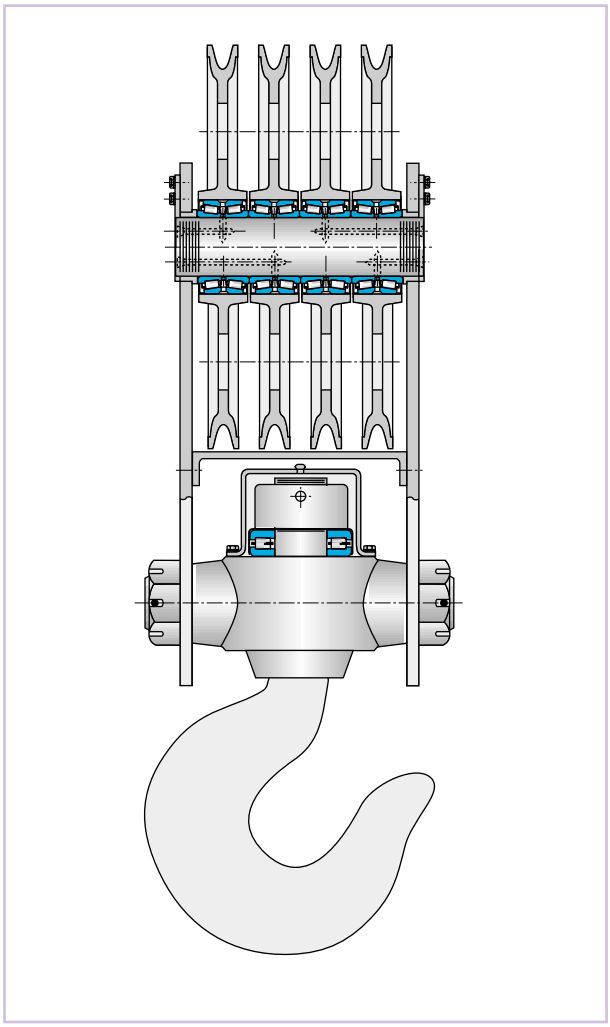
High speed train - transmission and wheels



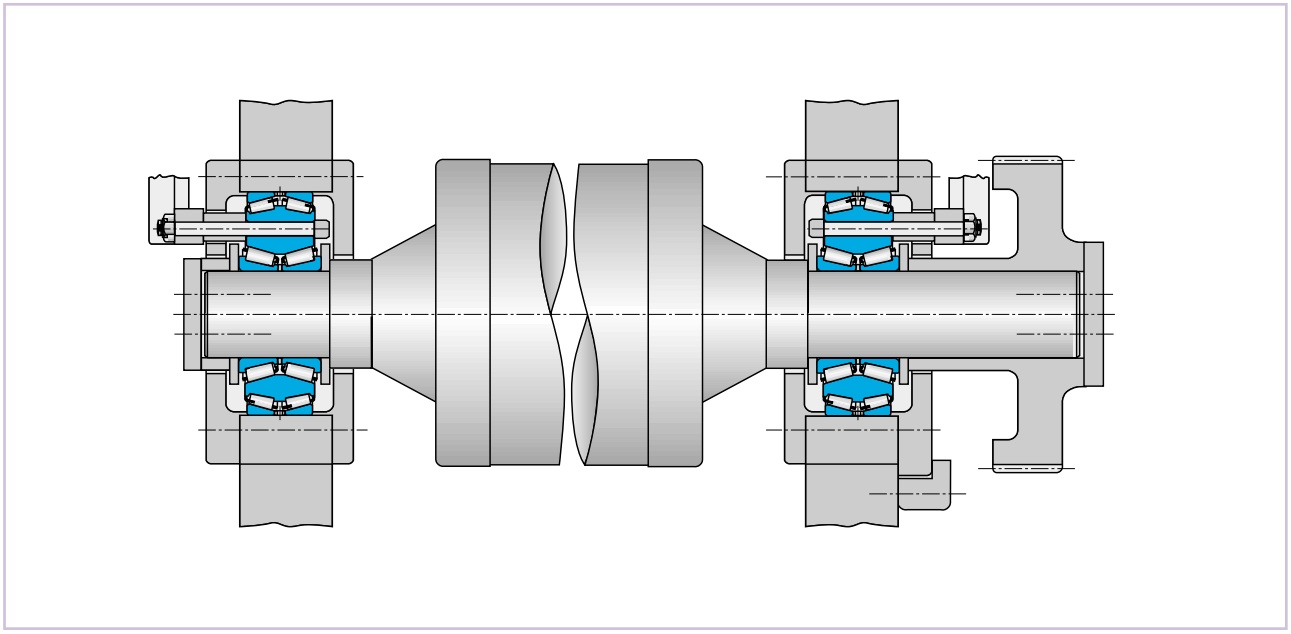
High speed locomotive axle journal



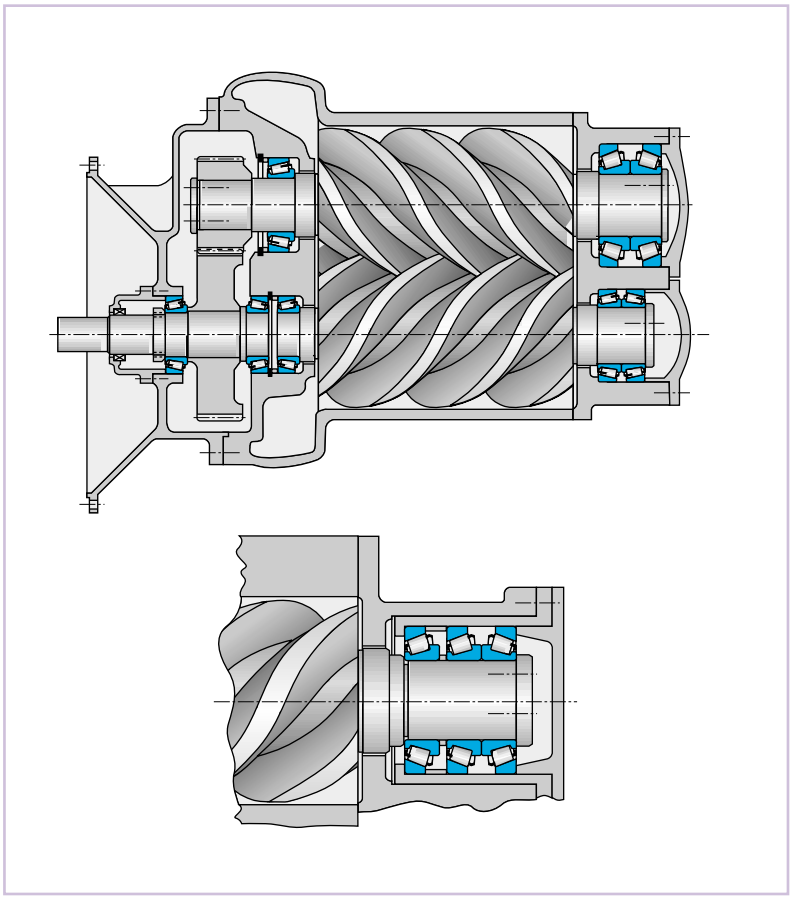
High speed train axle journal



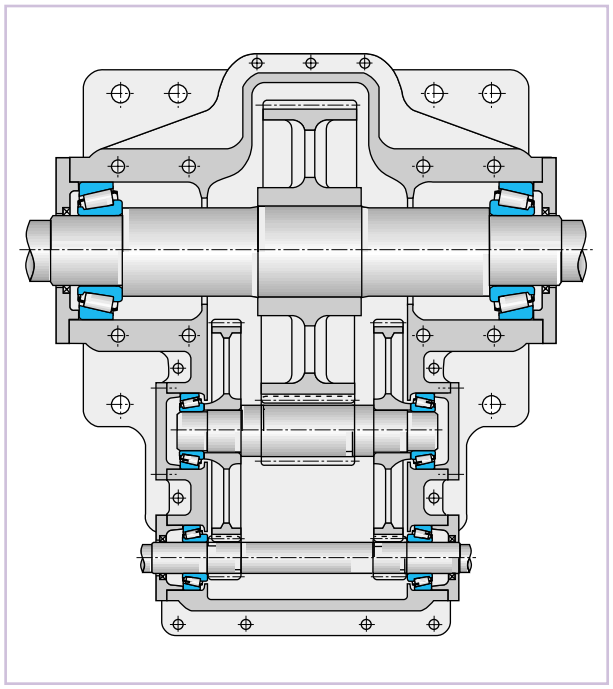
Heavy duty crane block with four shoaves



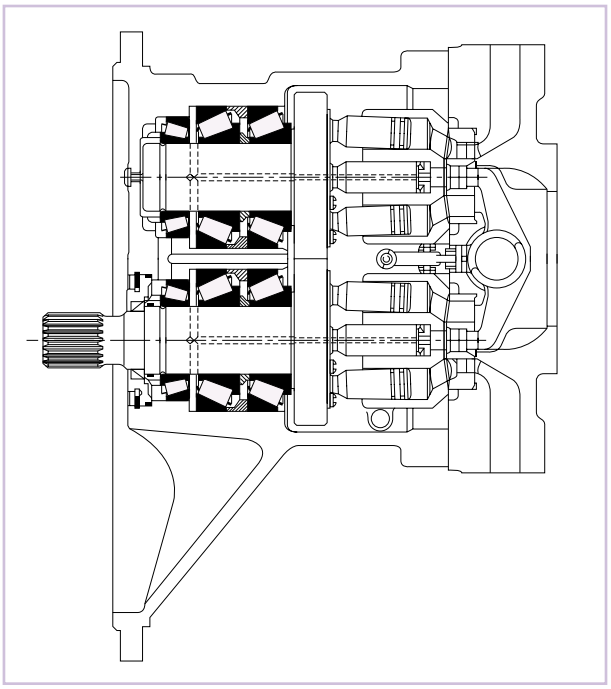
Printing press eccentric configuration



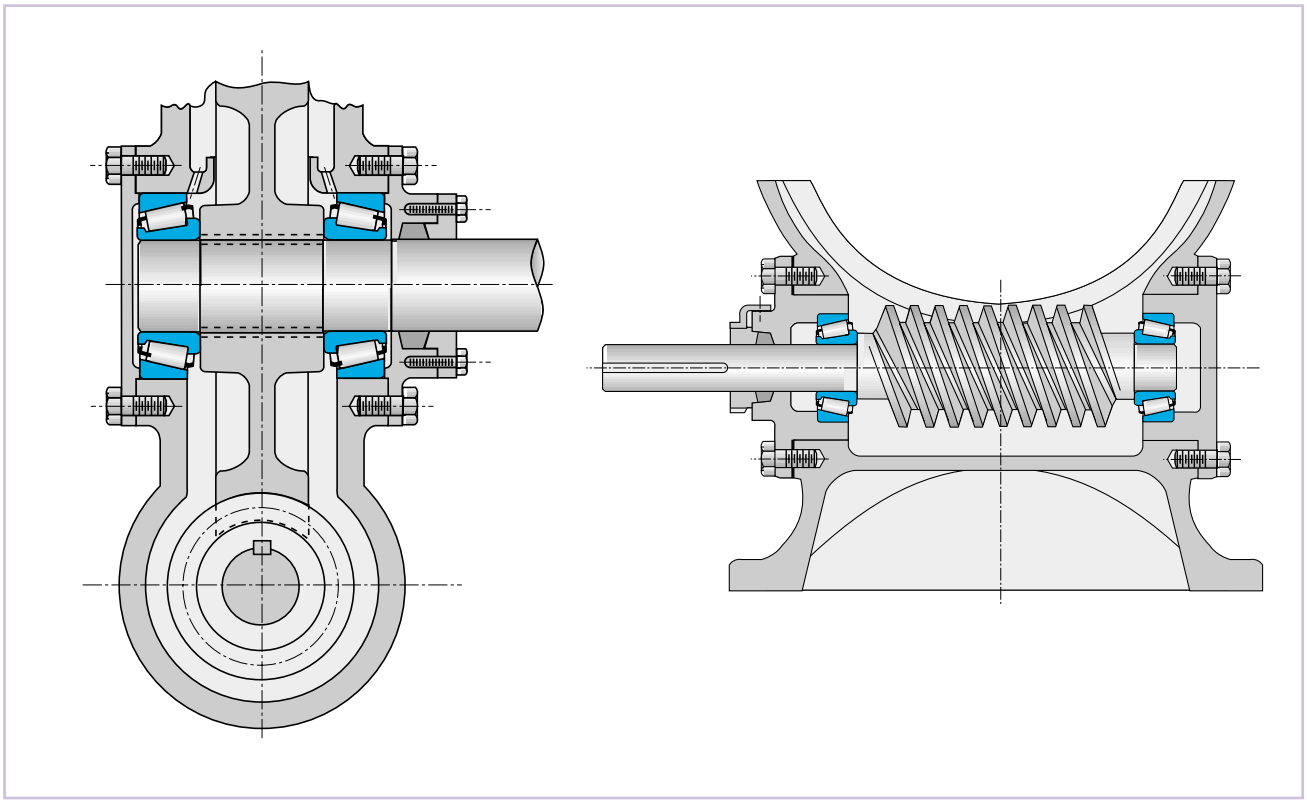
Rotary compressor design



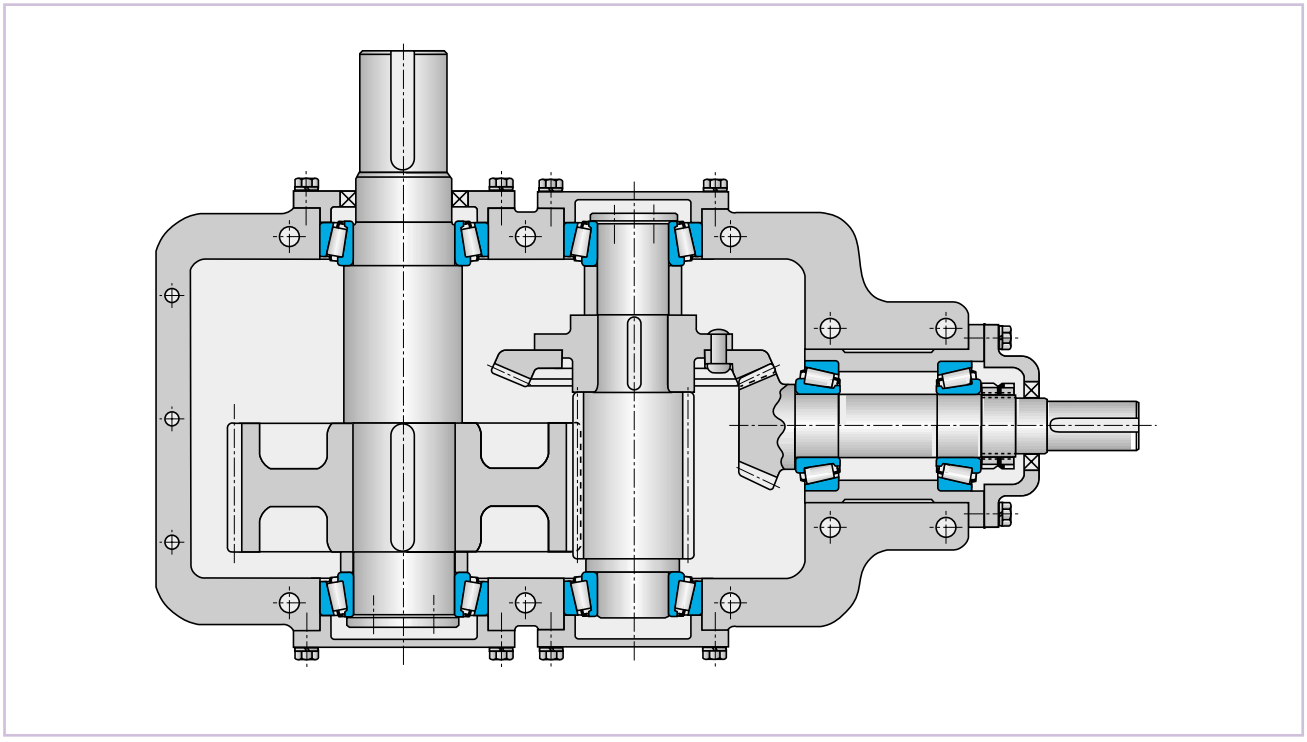
Gear drive system



Hydrostatic pump



Worm gear drive



Spiral gear drive

Notes