



BEARINGS



Ball, Tapered and Roller Bearings



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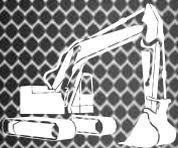
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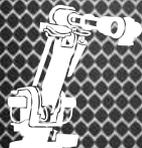
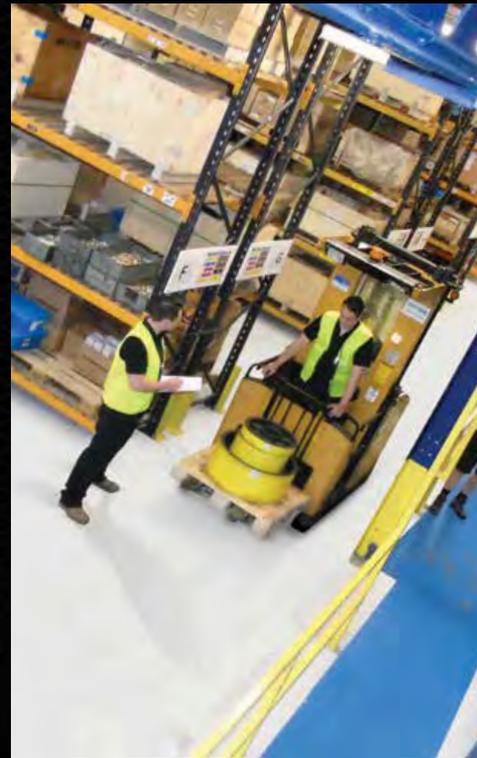
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4. SELECTING TYPE OF BEARING

Each type of bearing is characterized by specific properties unique to the given design and dimensions, which determine its suitability for the given type of application. Ball bearings for example are characterized by low friction and low noise. They are designed for translating medium-large radial as well as axial loads. They may be manufactured at higher precision enable them to operate at higher rpms. Due to their properties and affordability, they are among the most common types of bearings used. In contrast, spherical-roller bearings are designed for housings under high loads and are capable of compensating to a certain extent misalignments. They are thus particularly suitable for industrial use. It is thus important, when selecting the type of bearing, to consider various influences and to evaluate them according to their measure of importance for the given housing. The selection of a standard bearing is influenced particularly by:

- Load
- Available space
- Revolutions
- Precision of operation
- Alignment
- Slide-able axial movement
- Housing rigidity
- Installation and de-installation options
- Sealing methods

4.1 Loads

4.1.1 Radial loads

Bearings designed primarily for transferring radial loads are called radial bearings (fig. 4.1). They have a nominal contact angle of $\alpha \leq 45^\circ$. Line contact bearings are more suitable for higher radial loads than single-point contact bearings, and bearings with a full number of rolling bodies have a higher load capacity than corresponding bearings with a cage.

Ball bearings are designed for small and medium--large loads. N- and NU-type ball bearings can only be burdened radially. Different type radial bearings can transfer both radial as well as axial loads.

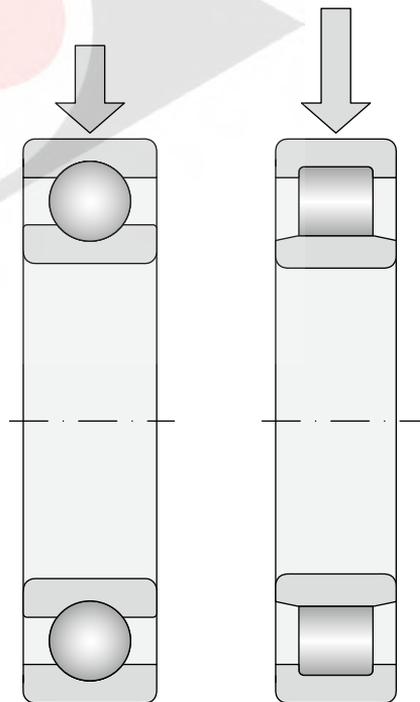


Fig. 4.1

4.1.2 Axial loads

Bearings designed mainly for axial loads (thrust ball bearings) have a contact angle $\alpha > 45^\circ$.

Axial ball bearings and angular contact thrust ball bearings may, depending on the design, transfer axial loads in one or both directions (fig. 4.2a). In cases of extremely high axial loads, a thrust cylindrical roller or thrust roller bearings (fig. 4.2b). Other thrust bearings are only suitable for axial loads. Double direction bearings are designed for bi-directional axial loads.

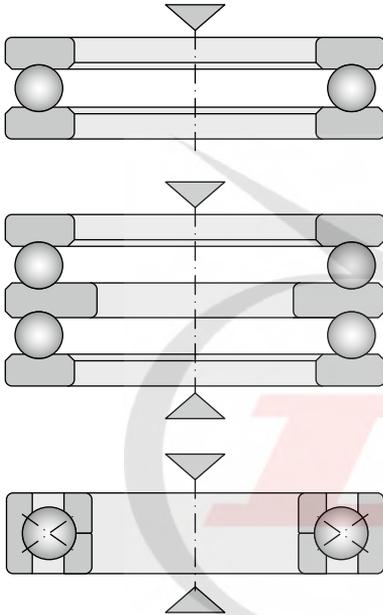


Fig. 4.2a

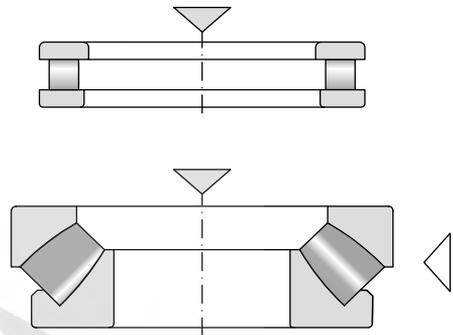


Fig. 4.2b

4.1.3 Combined loads

Combined loads are composed of simultaneously acting radial and axial loads.

Axial load capacity of a bearing depends on the angle of contact. The larger the angle, the larger the axial load bearing capacity of the bearing. Larger axial clearance in single row ball bearings increases their load bearing capacity. Single and double row angular contact ball bearings or tapered roller bearings are best for capturing combined loads (fig. 4.3a). Combined loads can also be borne by double row spherical roller bearings, thrust ball angular-contact bearings, and to a limited extent, also spherical roller thrust bearings. Self-aligning ball bearings, NJ, NUP, or NJ roller-contact bearings and NU bearings with HJ attachment rings (fig. 4.3b) can be used for combined loads with a relatively small axial component.

Single row angular contact ball bearings, tapered roller bearings, NJ roller-contact bearings, and NU+HJ and axial spherical roller bearings can only transfer unidirectional axial loads. If the arrangement of the active load changes, an additional bearing must be used. Combined single row angular contact ball bearings or single row tapered roller bearings are provided for best capturing such combined loads.

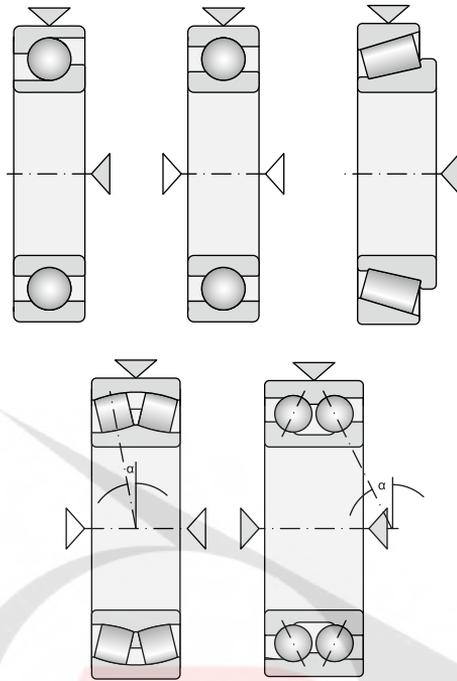


Fig. 4.3a

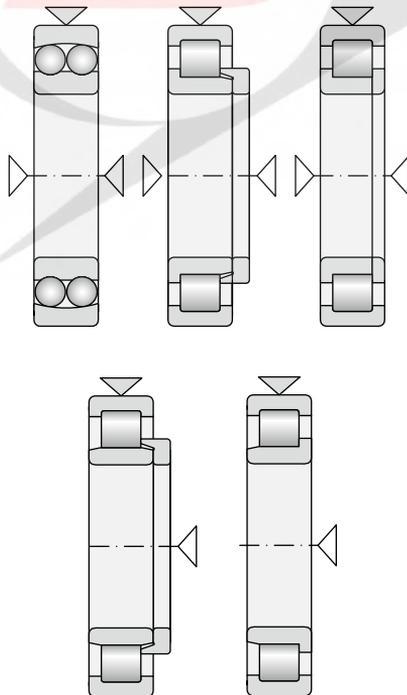
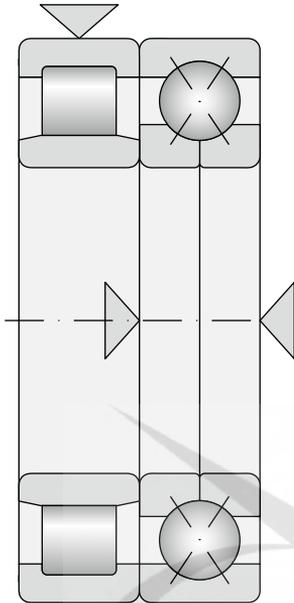


Fig. 4.3b



In addition to thrust bearings, ball bearings or four--point ball bearings can be used for capturing axial forces (fig. 4.4)

4.1.4 Torque load

If the load application point lies outside of the bearing axis, then an overturning torque is created. The use of a radial double row bearing or a double row angular contact ball bearing usually suffices for its transfer. The use of a pair of single row angular contact ball bearings or tapered roller bearings installed back-to-back in pairs (into an "O"), however, are preferred (fig. 4.5).

4.2 Available space

In certain circumstances, it presents as a limiting condition for the bearing design. In small-diameter housing, the single row ball bearing is most often

Fig. 4.4

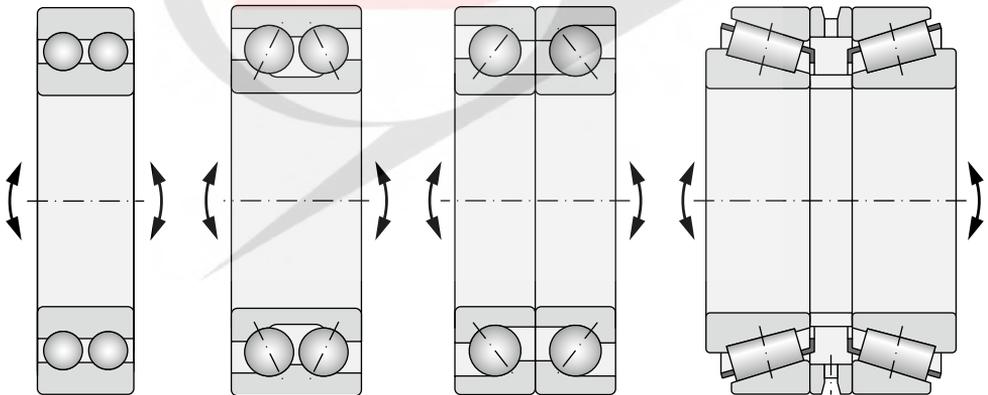


Fig. 4.5

applied (fig. 4.6). Cylindrical roller, spherical roller, and taper roller bearings may optionally be used for large diameter shafts (fig. 4.7). Various types of bearings also allow for a variety of types with various bearing section strengths. Where there is limited space in the radial or axial direction, bearings with a suitable cross--section are selected (fig. 4.8).

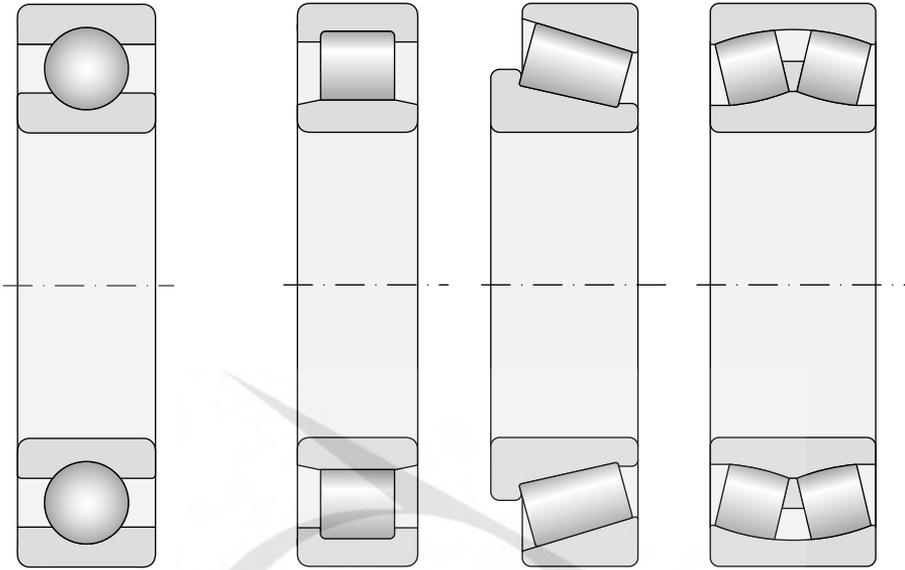


Fig. 4.6

Fig. 4.7

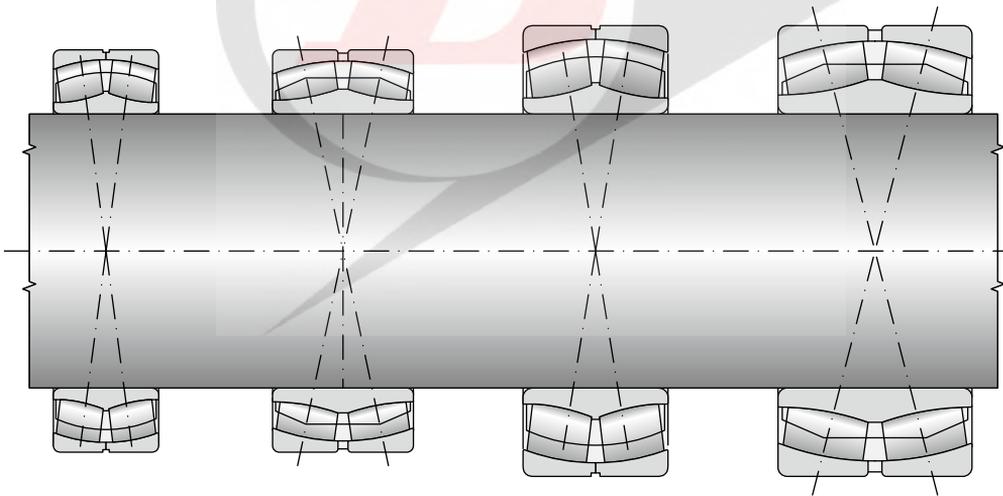


Fig. 4.8

4.3 Revolutions

Low-friction bearings should be used in housing subjected to high revolutions. Among such bearings are single-row ball bearings for purely radial loads. Angular-contact ball bearings in combined loads equally generate little heat. Both types of bearings are thus the most suitable for high revolution applications. Single row cylindrical roller bearings are additionally suitable for high revolutions.

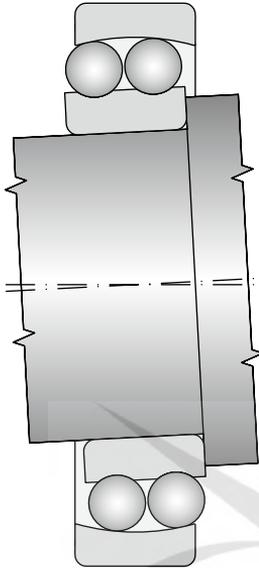


Fig. 4.9a

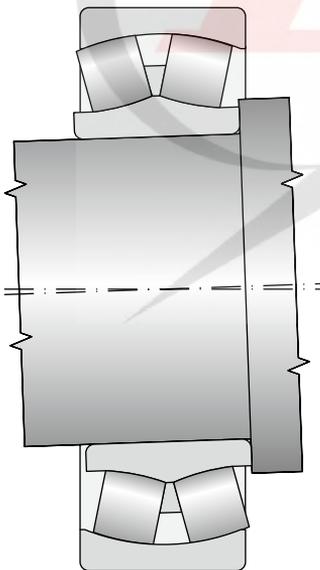


Fig. 4.9b

From a design aspect, the rpms in thrust bearings are always lower than those of radial bearings.

4.4 Precision of operation

Bearings with normal diameter precision and operation (precision class P0) are sufficient for the most housing. In more demanding housing, e.g. for fitting machine tool spindles, bearings with higher precision must be used. Such bearings are designated by pre-cision classes P6, P6E, P6X, P5, P5A, P4, P4A, P2, SP, UP. In the text, which is located at the beginning of individual tables, you are provided with more detailed information about precision classes, in which individual types are produced.

4.5 Alignment

With regard to manufacturing inaccuracies and spindle deflections, mutual inclinations of bearing rings occur in the housing. This phenomenon should be expected and it is necessary to select bearings that compensate for the misalignment and installation inaccuracy. Self-aligning ball bearings (fig. 4.9a), double row spherical roller bearings (fig. 4.9b), and thrust spherical roller bearings (fig. 4.9c), are such types. The angle of inclination of such bearings depends on the type, size, and load. High rigidity bearings, such as cylindrical roller bearing or ball bearings, can compensate for small misalignments, assuming that they are unburdened.

4.6 Sliding axial movement

A fixed axial and free axial bearing is general used for supporting shafts, while the fixed axial bearing provides shaft guidance in both directions and the free axial bearing compensation for the axial change in length and thermal expansion. If axial displacement of thermally expanding components is prevented, then uncontrolled axial overloading of firmly fixed bearings may result.

Bearings that can carry combined loads are most suitable for capturing axial forces. Bearings that are best able to afford axial movement are NU and N cylindrical roller bearings (fig. 4.10). If ball or cylindrical roller bearings are used as free bearings, then one of the bearing rings (usually the outer) must be attached freely (fig. 4.11).

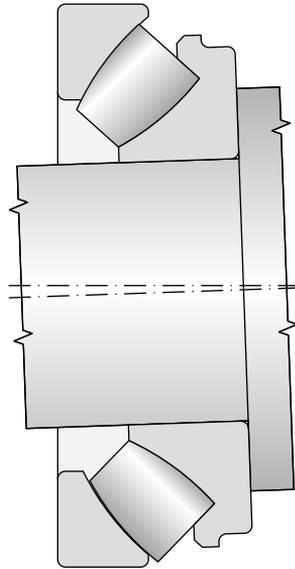


Fig. 4.9c

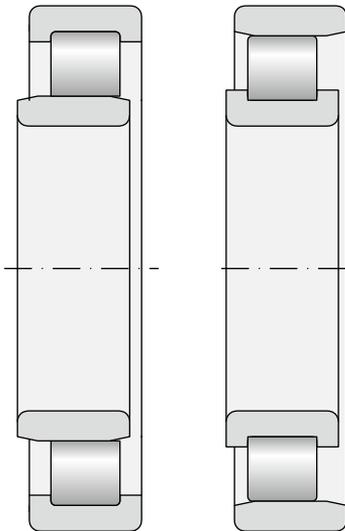


Fig. 4.10

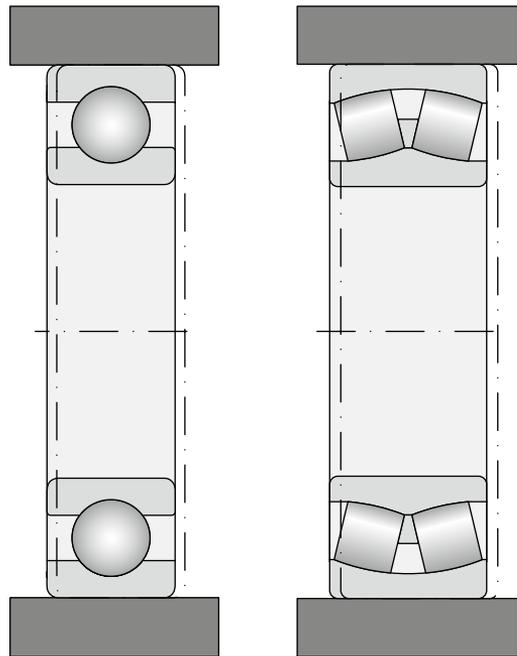


Fig. 4.11

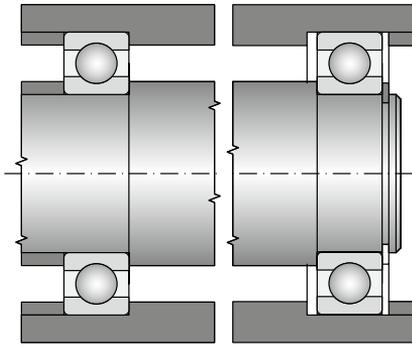


Fig. 4.12a

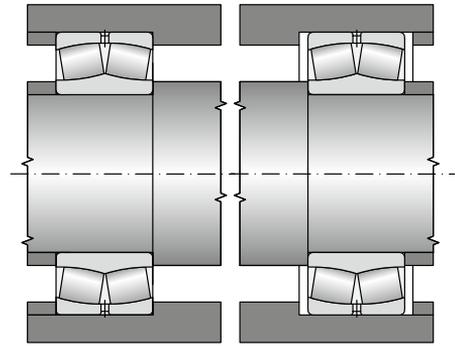


Fig. 4.12b

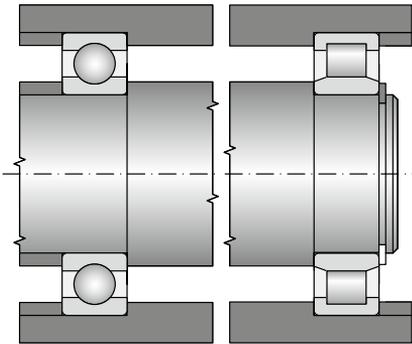


Fig. 4.12c

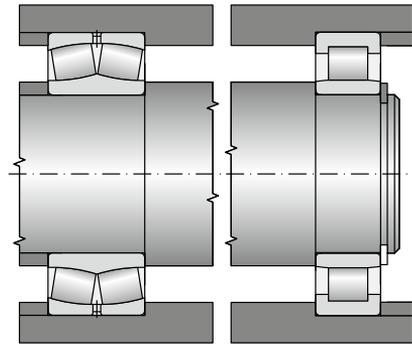


Fig. 4.12d

Examples of axially guided and free axial bearing supports are illustrated in figures 4.12a to 4.12

- a) Axially guided ball bearing, free axial ball bearing
- b) Axially guided spherical-roller bearing, free axial cylindrical roller bearing
- c) Axially guided ball bearing, free axial NU cylindrical roller bearing
- d) Axially guided spherical-roller bearing, free axial NU roller-contact bearing
- e) Axially guided double-row angular-contact ball bearing, axially free NU cylindrical roller bearing
- f) Axially guided four-point contact ball bearing and an NU cylindrical roller bearing, free axial NU roller-contact bearing
- g) Axially guided double-row tapered-roller bearing, free axial NU cylindrical roller bearing
- h) Axially guided NUP cylindrical roller bearing, free axial NU cylindrical roller bearing

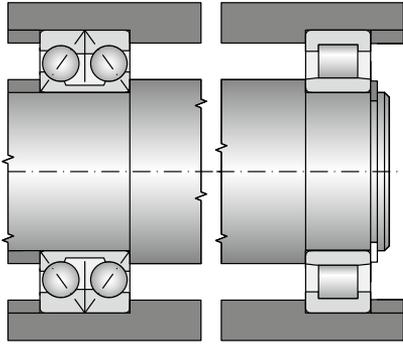


Fig. 4.12e

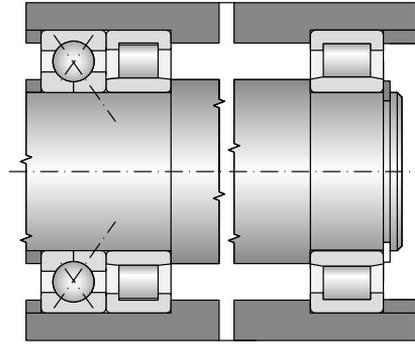


Fig. 4.12f

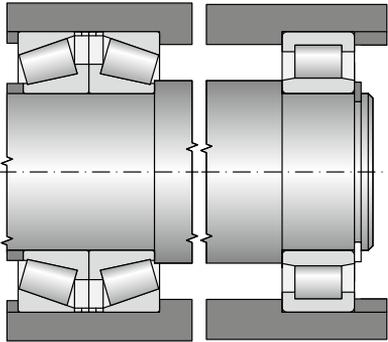


Fig. 4.12g

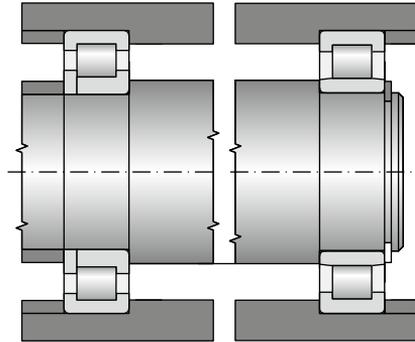


Fig. 4.12h

4.7 Support rigidity

The support rigidity expresses the force required to achieve a defined deflection when using a flexible support. High rigidity is demanded, for example when supporting the main spindle in machine tools and pinion gear sets.

The rigidity of line-contact bearings such as, e.g. cylindrical roller bearing and tapered roller bearings is higher than in ball bearings due to the contact ratios between the rolling elements and raceways.

The bearings are pre-stressed to increase their rigidity.

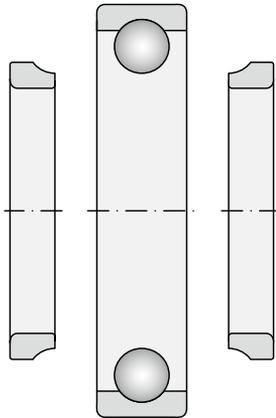


Fig. 4.13a

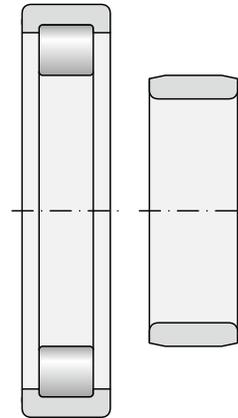


Fig. 4.13b

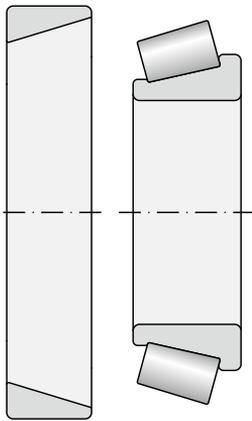


Fig. 4.13c

4.8 Installation options

4.8.1 Bearings with a cylindrical bore

These bearings are more easily installed and removed, if they can be taken apart. This particularly applies for bearings within a fixed housing. Separable bearings are also suitable for use where frequent installation and removal are required. A ring with roller elements may be installed separately, irrespective of the second ring (fig. 4.13a – 4.13c).

four-point contact ball bearing (obr.
4.13a) NU cylindrical roller bearing (fig.
4.13b) tapered-roller bearing (fig. 4.13c)

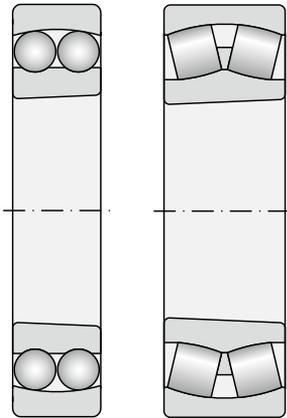


Fig. 4.14

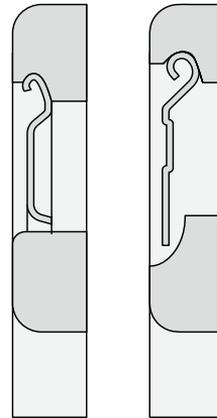


Fig. 4.15

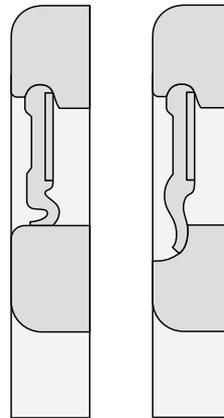


Fig. 4.16

4.8.2 Bearings with a tapered bore

Bearings with a tapered bore (fig. 4.14) are installed on a conical or cylindrical shaft using a adapter sleeve or withdrawal sleeve. The radial clearance of bearings can be set during installation. Installation and removal of bearings is relatively simple.

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