

2. ANGULAR-CONTACT RADIAL BALL BEARINGS

ŁOZYSKA TOCZNE

ROLLING BEARINGS

CUSCINETTI



SKA TOCZNE

ŁOZYSKA TOCZ

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INTRODUCTION:

2. Angular-contact radial ball bearings

Dimension series

- **single-row single-direction**
- 718.. 719.. 70.. 72.. 73.. 74..
- **double-row double-direction**
- 38.. 39.. 30.. 32.. 33..
- **single-row double-direction**
- Q19.. Q10.. Q12.. Q2.. Q3..
- QJ19.., QJ10.., QJ12.., QJ2.., QJ3..

2.1. Angular-contact single-row radial ball bearings

2.1.1. Structure

Single-row angular-contact single-direction radial ball bearings are not separable and consist of an outer ring, an inner ring and a cage with balls. The cage is guided on the inner ring ("B" after the cage designation), or on the outer ring ("A" after the cage designation) or solely on the balls (no letter after the cage designation).

The basic feature differentiating angular contact ball bearings from regular ball bearings is a different construction of the inner guided track of the outer ring. The track is positioned axially in one direction. Owing to that fact such bearings can carry considerable axial loads exactly in this direction.



Fig.6 Single-row angular-contact radial ball bearing

We can set apart several makes of guided tracks of bearings conformably to their contact angles:

- **25°** - **A** or **AC** or **E** designation behind the bearing's symbol
- **26°** - **AA** designation behind the bearing's symbol
- **40°** - **B** designation behind the bearing's symbol
- **15°** - **C** designation behind the bearing's symbol
- **12°** - **CA** designation behind the bearing's symbol – special high-speed versions
- **10°** - **CB** designation behind the bearing's symbol - special high-speed versions

Dimension series are in direct relation to the angle of the inner track:

- for narrow and light series as 718.., 719.., 70..the angles A and C are most often used, e.g. 7016 ATBP4, 7000 CTBP4,
- for medium 72.. series the angles A, B, C are used, e.g. 7206 B, 7210 C, 7209 ATBP5,
- for wide and heavy series as 73.., 74.. one uses most often the angle B, e.g. 7322 BM.

2.1.2. Cages

The cages of single-row angular contact single-direction radial ball bearings in the standard accuracy class are made most frequently of thermoplastic material – polyamide strengthened with glass fiber, whose limiting operating temperature equals 120°C - or are stamped from steel sheet, and for larger bearings steel or solid brazen cages are usually used.

For high-speed bearings, which are first of all designed for bearing mounting of machine tools' spindles, massive cages are made of thermohardening material – textolite (T marking). The cages, because of their low weight, have a low moment of inertia, what in turn enables them to reach very high rotational speed. Also the vibration level of textolite cages is the lowest in comparison with cages made of other materials, and continuous operation temperature of heat-hardening material can be above 100°C.

2.1.3. Features

Single-row angular-contact single-direction radial ball bearings are characterized by ability to carry combined loads. Besides typical radial load they also carry axial load in one direction (see contact angle).

Bearings in A and C version reach high rotational speed at small axial load. However it is indispensable for a bearing to get applied a minimum axial force to operate properly. This issue has been thoroughly discussed in Chapter VII. The B version concentrates, above all, on carrying axial loads at medium rotational speed. Angular-contact single-row single-direction radial ball bearings are particularly sensitive to errors of alignment and shaft deflection errors.

Axial loads in opposite direction to the track's diagonal are unacceptable.

2.1.4. Assembling bearings in pairs

Angular-contact single-row single-direction radial ball bearings can operate in units consisting of some individual bearings. Taking into account the necessity for carrying combined loads the bearings are positioned in relation to each other in an appropriate way:

- **X** – oblique internal bearing tracks are directed to the inside of the arrangement
- **O** - oblique internal bearing tracks are directed to the outside of the arrangement
- **TANDEM** – all bearings are positioned in such a way that their oblique tracks point out in the same direction.

Note: Rated rotational speed of bearings assembled in pairs is considerably lower than the velocity of individual bearings building the arrangement.

2.1.5. Application

Because of their features single-row angular-contact single-direction radial ball bearings find application in all branches of industry. Wherever even very small axial loads make the use of regular ball bearings impossible, angular-contact ball bearings seem optimal and relatively reasonable solution in economic terms and the combination of the special cage making with the high accuracy class enables reaching high rotational parameters and high precision of bearing mounting. The angular-contact bearings have been for years the market-leader in the field of bearing mounting of tool machines' spindles.

2.1.6. Modern solutions

High-speed angular-contact bearings for machine tools' spindles

The last few years have seen extraordinarily quick pace of engineering development that brought about many new solutions in the field of bearing mounting of machine tools' spindles. Increasing requirements regarding velocity, operating temperature, precision, reliability, and vibration level forced designers of the angular-contact bearings to develop elements meeting the above mentioned conditions. While regular angular-contact bearings have been manufactured for a long time, high-speed and hybrid bearings represent the latest technical solutions. Outside dimensions of these bearings are standardized. Redesigned internal construction and smaller balls made of special steel or ceramics allow to obtain even better parameters.



Fig.7 Single-row angular-contact high-speed radial ball bearing with solid cage made of textolite

2.2. Double-row angular-contact radial ball bearings

2.2.1. Structure

Double-row angular-contact ball bearing corresponds in its construction to a pair of angular-contact single-row ball bearings in the open arrangement ("O"). We can set apart several makings of guided tracks of these bearings conformably to their contact angles:

- **25° - B** designation behind the bearing's symbol
- **32°** - no designation behind the bearing's symbol
- **35°** - no designation behind the bearing's symbol
- **45° - D or DA** designation behind the bearing's symbol (detached internal ring)



Fig.8 Double-row angular-contact radial ball bearing, opened version

2.2.2. Cages

There are types with a steel cage, brazen cage and a cage made from polyamide in sealed 2RS as well as ZZ variants.

2.2.3. Features and application

The bearing can accommodate heavy radial loads and axial loads in both directions. It is especially suitable for bearing mountings from which rigid guidance in axial direction is demanded. Double-row angular-contact double-direction ball bearings are particularly sensitive to errors of alignment. A variant of double-row angular-contact ball bearings is widely implemented in the automobile industry, especially in the hubs units of car wheels. But the construction of these bearings is very specific, most often with a split inner ring and other, untypical sizes and designations. They are ever more fully integrated with a hub.



Fig.9 Single-row angular-contact double-direction radial ball bearing with a split inner ring, Q-type



Fig.10 Single-row angular-contact double-direction radial ball bearing with split inner rings, QJ-type

2.3. Single-row angular-contact double-direction radial ball bearings

Another name for four-point contact ball bearings with a split ring.

2.3.1. Structure

They are angular-contact single-row ball bearings, the tracks of which are shaped in such a way, that axial loads can be carried in both directions. They are dismountable bearings, whereas - depending on the type - the inner or the outer ring is split. The contact angle of Q-series bearings is 23° and QJ-series bearings 35° .

2.3.2. Cages

There are construction solutions based on steel, brazen and polyamide cages

2.3.3. Features and application

These bearings can support axial loads in both directions, but they should not be used in places where strictly radial loads may occur. They obtain large load capacity in the axial direction through the large number of balls, considerable height of track lips and the contact angle of 23° or 35° .

The Q- and QJ-series bearings take definitely less space in the axial direction than corresponding angular-contact double-row bearings. It is of special importance when the bearing-closed pair size is vital to the whole construction. And detachability of these bearings makes individual ring mounting possible.

Single-row double-direction angular-contact radial ball bearing are particularly sensitive to errors of alignment.