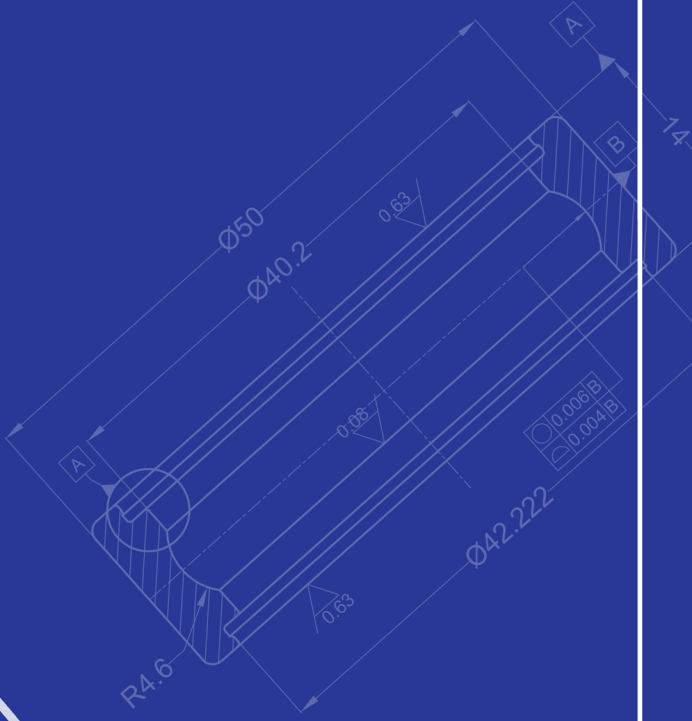
KYA

# Bearing Cages



Proper selection of cage design and materials is essential to the successful performance of a precision ball bearing. The basic purpose of a cage is to maintain uniform ball spacing, but it can also be designed to reduce torque, minimize heat build up or even provide part or all of the bearing's lubrication.

KYA deep-groove and angular contact bearings are available with many different types of cages to suit a variety of applications. Many factors enter into cage design and cage selection, including:

- Low coefficient of friction with ball and race materials
- Low tendency to gall or wear
- Ability to absorb and release lubricant
- Ability to provide a sacrificial lubricant
- Dimensional stability
- Compatible expansion rate with ball and ring materials
- Thermal stability
- Suitable density
- Adequate tensile strength
- Creep resistance
- Cost

Other factors are involved as well, depending on the complexity of the bearing application.

Over the years, KYA has developed and manufactured many specialized cages for unusual applications. Most of these applications demanded special engineering requirements, such as ultra-high-speed operation, a need for extra oil absorption, extreme environments and critical low torque situations. In addition, materials as diverse as silver-plated steel, bronze alloys and porous plastics have been used by Barden to create custom cage specifications for its customers.

## Deep Groove Bearing Cages

The principal cage designs for KYA deep-groove bearings are side entrance snap-in types (TA, TAT, TB, TQ, TMT), symmetrical types (Ribbon, W, T, TST) and tube type ball separator (ZA). Ribbon and W types are used at moderate speeds and are particularly suited for bearings with grease lubrication and seals or shields. Type W is a low-torque pressed metal cage developed by KYA , and is available in many miniature and instrument sizes. This two-piece ribbon cage is loosely clinched to prevent cage windup (a torque-increasing drawback of some cage designs) in sensitive low-torque applications.

For higher speeds, KYA offers the one-piece phenolic snap-in type TA cage in smaller bearing sizes and the two-piece riveted phenolic, aluminum-reinforced T cage for larger sizes. The aluminum reinforcement, a KYA first, provides additional strength, allowing this high-speed cage to be used in most standard width sealed or shielded bearings.

## Angular Contact Bearing Cages

In KYA angular contact bearings (types B and H), machined phenolic cages with high-speed capability are standard. These cages are outer ring land guided, which allows lubricant access to the most desired point — the inner ring/ball contact area. Centrifugal force carries lubricant outward during operation to reach the other areas of need.

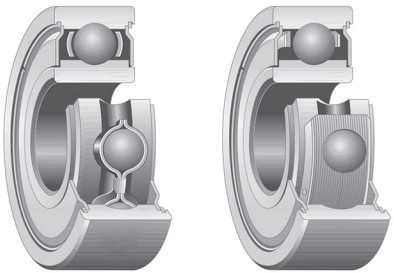
The larger H-type phenolic cage has a grooved bore to enhance dynamic cage stability. The B-type cage used in separable bearings has ball pockets which hold the balls in place when the inner ring is removed.

## Design Parameters

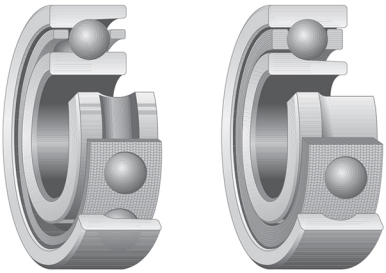
Cage loading is normally light, but various acceleration and centrifugal forces may cause cage loading. Also, it may be important for the cage to accommodate varying ball speeds that occur in certain applications due to heavy radial loads.

Cages are piloted (guided) by the balls or one of the rings. Typically, low to moderate speed cages are ball-piloted. Most high-speed cages have machined surfaces and are piloted by the land of either the inner or outer ring. The maximum bearing speed a cage can withstand for sustained periods can be expressed in dN. [dN = bearing bore (mm) × bearing speed (rpm)]. The number and size of balls are generally selected to give maximum capacity in the available space. In some specialized cases, the ball complement may be chosen on a basis of minimum torque, speed considerations or rigidity.

KYA also supplies cage designs which are not covered as a standard. Cage configuration and materials are not limited to those described here. When a standard cage does not meet your end-use requirements, the KYA Product Engineering Department should be consulted.



Typical Deep Groove spindle and turbine bearings (shielded) with ribbon Type cage (left) and type T cage (right).



Typical Angular Contact spindle and turbine bearings (non-separable, left; separable, right) with phenolic cages.

# NON-METALLIC

## Machined

Phenolic. A paper or cloth-filled thermosetting phenolic resin produced in either tubing or sheet form. As a cage material, its desirable characteristics are:

- Low coefficient of friction
- N on-galling
- Ability to adsorb or absorb lubricants
- D imensional stability in presence of lubricants and moisture
- Good strength-to-weight ratio
- Easily machined

BarTemp. A homogeneous blend of glass micro fibers, Teflon TFE resin, and molybdenum disulfide manufactured in sheet form. BarTemp was developed and patented by KYA BarTemp has the widest operating temperature range of all non-metallic cages (i.e., – 325˚F to +525˚F) and acts as a source of dry lubricant to the bearing.

D elrin Type 150. An acetal resin of the thermoplastic type having a unique set of strength, hardness, and low friction properties. Its maximum temperature is limited to 150˚F.

Teflon. Tetrafluorethylene resin of the thermosetting type. Of all the unfilled plastic materials, it has the lowest friction, best anti-galling properties and widest operating temperature range. It is insensitive to moisture, solvents and lubricants. Its use is limited to type ZA and as a coating on smaller metal cages.

M eldin 9000. A polyimide with a controlled pore size and volume. Capable of controlled release of a given amount of impregnated oil.

Vespel. A polyimide material containing 15% graphite by weight. Capable of operating on marginal lubrication conditions and at temperatures ranging from cryogenic to 500˚F.

Torlon. A poly(amide-imide) resin that can be compounded with PTFE and graphite. Maximum operating temperature 500˚F. Low thermal expansion, excellent chemical resistance.

## Molded

N ylon 6/6 (glass reinforced). A moldable filled thermoplastic with glass fibers added to impart stiffness and stability. Unaffected by lubricants and common solvents, but can be dissolved by phenols.

# METALLIC

## Stamped

AISI 410 Stainless Steel. A general purpose martensitic (hardenable) grade of stainless steel, selected for general purpose use because of its corrosion resistance, wide usable temperature range, ability to be hardened and ability to be processed for snap-in cages.

AISI 430 Stainless Steel. A general purpose ferritic (non-hardenable by conventional methods) grade of stainless steel, selected for its corrosion resistance, wide usable temperature range, ductility, and ability to be processed (stamped and formed) for ribbon cages.

AISI 305 Stainless Steel. An austenitic stainless (not hardenable by conventional means). It is used as an alternate to AISI 430 in ribbon cages because of its low work hardening susceptibility.

## Machined

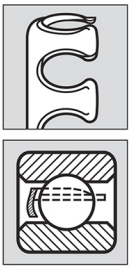
Bronze 80-10-10. A cast copper-tin-lead bronze. Its selection as a cage material is based on its bearing characteristics (non-galling, low friction, low wear, compatibility with lubricants) at elevated temperatures, up to 625˚F. This material meets the requirements of SAE CA937.

Iron-Silicon-Bronze. U sed in aircraft power applications and specified against AMS 4616, often with silver plating of .001" to .002" per AMS 2412 or AMS 2410. It has useful strength for temperatures to 625˚F.

AMS 6415 Low Alloy Steel. Also carries SAE 4340 designation. Used in hardened condition (Rc 28-35) with silver plating of .001" to .002" usually to AMS 2412. Has replaced iron-silicon-bronze in new aircraft power applications where speed, load, and temperature requirements have increased. Retains excellent strength characteristics to 800˚F. AMS 6414 is equivalent to AMS 6415, but is vacuum melted.

Maximum speed limits shown are for cage comparison purposes only.
See the product section of Catalog C-20 for actual bearing speedability.





Type: Snap-In*

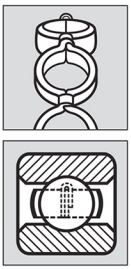
Description: Material: Stainless Steel AISI 410. One-piece, stamped, with coined ball pockets and polished surfaces. Side entry snap-in assembly. Inner ring land controlled.

Application: A general purpose cage available only in instrument sizes. Maximum ball size: 3/32". Maximum operating temperature of cage material: 600˚F. Maximum speed with oil or grease: 250,000 dN.

*No symbol used in nomenclature.

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Type: Two-Piece Ribbon*

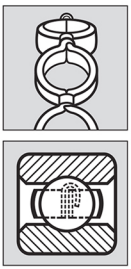
Description: Material: Stainless Steel AISI 430 or AISI 305. Two-piece, stamped ribbons to form ball pockets.

Application: A general purpose cage for bearings with 5mm or greater bores. Available for many instrument sizes and certain spindle and turbine sizes. Depending on the size, assembly of the cage halves is accomplished by tightly clinching tabs on one of the halves or by rivets. Maximum operating temperature of the cage material: 900˚. Maximum speed with oil or grease: 250,000 dN.

*No symbol used in nomenclature.

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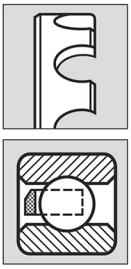
Type: W

Description: Material: Stainless Steel AISI 430 or AISI 305. Two-piece stamped ribbons to form ball pockets with loosely clinched tabs.

Application: The W cage is similar to the two-piece ribbon cage, but with one important difference: the cage halves are loosely clinched. The loose clinching prevents cage windup (a torque increasing drawback of some cage designs) in sensitive low torque applications. Available in instrument sizes up to R8. Maximum operating temperature of cage material: 900˚F. Maximum speed with oil or grease: 250,000 dN.

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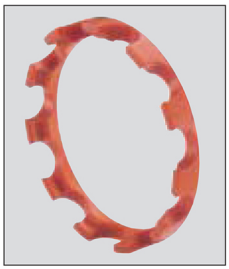


Type: TA

Description: A one-piece, side entry snap-in type machined from fiber reinforced phenolic.

Application: A general purpose high-speed cage available in instrument sizes (1/32" ball minimum) and smaller spindle and turbine sizes. Maximum operating temperature of cage material: 300˚F. Maximum speed with oil or grease: 600,000 dN.

Maximum speed limits shown are for cage comparison purposes only.
See the product section of Catalog C-20 for actual bearing speedability.





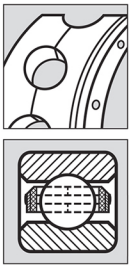
Type: TAT

Description: A one-piece, side entry snap-in type, machined from fiber reinforced phenolic. Inner ring controlled.

Application: A general purpose, moderate speed cage available in spindle and turbine sizes (100 & 200 series). Maximum operating temperature of cage material: 300˚F. Maximum speed with oil or grease: 400,000 dN.

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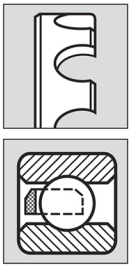
Type: T

Description: Machined from sheets of phenolic/aluminum laminate. Aluminum reinforcement bonded to the outboard faces — a KYA first — provides strength for high speed operation. Cage halves riveted at assembly.

Application: A general purpose, high-speed cage available in most deep groove sizes (instrument through 100, 200, 300 series), with ball size of 3/32" or greater. The T cage has the highest speed rating (dN) of any non-metallic deep groove cage. Aluminum reinforcement — a KYA first — provides additional strength and allows this high-speed cage to be used in most standard width sealed or shielded bearings. Maximum speed with oil: 1,000,000 dN; with grease: 650,000 dN. Maximum operating temperature: 300˚F.

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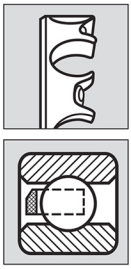
Type: TB

Description: Material: BarTemp. One-piece machined, side entry snap-in type. Inner ring controlled.

Application: BarTemp caged bearings are used where conventional lubricants would deteriorate quickly (high temperature), would cause excessive torque (lower temperatures), or would out-gas (vacuum). BarTemp bearings are meant to be used without conventional lubricants, because the BarTemp material itself provides a dry-film lubricant. As the bearing rotates, the balls rub off small quantities of the lubricant from the cage, depositing a light coating on the balls and then the raceways. Features of BarTemp bearings include reliable operation from – 325°F to +525°F, low torque at low temperature, ability to operate in a vacuum, and unlimited storage life. BarTemp cages are available in many miniature and instrument sizes (1/32" ball minimum) and some smaller spindle and turbine sizes. Maximum speed is 60,000 dN. Use of BarTemp bearings is somewhat limited, since they can only be lightly loaded due to the absence of conventional fluid lubrication. And, because they lack the corrosion protection provided by conventional lubrication, BarTemp bearings are only available in stainless steel. In operation, the cage pockets are slowly worn as the cage continually provides the dry film lubricant. Therefore, at least one shield is necessary in the event the balls would no longer retain the cage. Solid preload is not recommended because the dry film build-up will reduce internal clearances. This will cause the initial preload to increase and break down the film. Light spring preloads are acceptable.

Maximum speed limits shown are for cage comparison purposes only.
See the product section of Catalog C-20 for actual bearing speedability.





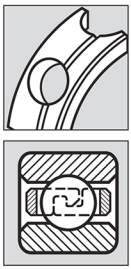
Type: TMT

Description: A one-piece, snap-in design molded of Nylon 6/6 with spherical ball pockets.

Application: A general purpose, moderate-speed cage available in a wide range of spindle and turbine sizes (100, 200, 300 series). Maximum operating temperature: 300˚F. Maximum speed with oil or grease: 300,000 dN.

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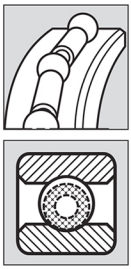
Type: TST Two-piece, snap together

Description: A unique design utilizing two machined phenolic halves which lock together at assembly to form a symmetric cage.

Application: A general purpose cage similar to the T cage but without the aluminum side plates and rivets. Available in spindle and turbine sizes (30, 100, 200, 300 series). Maximum speed 750,000 dN with oil, 600,000 dN with grease for larger sizes. Consult KYA for dN values on smaller sizes. Maximum operating temperature: 300˚F.

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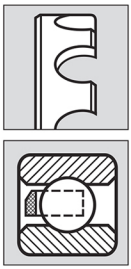
Type: ZA

Description: Individual hollow cylinders of Teflon placed between balls.

Application: The ZA separators are used in low-speed, low-torque applications. They have low sensitivity to torque peaks and misalignment and are popular in gimbal applications. If used without conventional lubricants, bearing material should be stainless steel. Available in miniature, instrument, and 500 Series. Maximum speed: 5,000 dN. Operating temperature range: –325° to +450°F.

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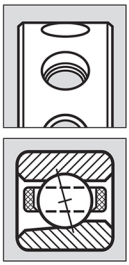
Type: TQ

Description: Material: Delrin. One-piece, machined, snap-in cage.

Application: A high-speed, quiet cage available in the miniature sizes, having a ball size of at least 1/32". Maximum operating temperature: 150°F. Maximum speed with oil or grease: 600,000 dN. Continuous or repetitive lubrication is required.

Maximum speed limits shown are for cage comparison purposes only.
See the product section of Catalog C-20 for actual bearing speedability.





Type: B*

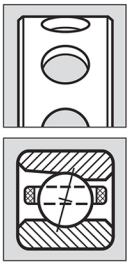
Description: Material: Fiber reinforced phenolic. A one-piece machined cage whose ball pockets are designed to retain the balls with the outer ring if the separable inner ring is removed.

Application: High-speed, general purpose. Outer ring controlled except for R2B and R2-5B sizes. Available in instrument sizes and certain spindle and turbine sizes. Maximum operating temperature: 300˚F. Maximum speed: 1,200,000 dN with oil, 850,000 dN with grease.

*No symbol used in nomenclature.

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Type: H*

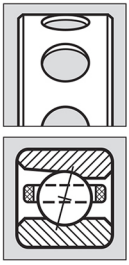
Description: Material: Fiber reinforced phenolic. A one-piece machined cage with cylindrical ball pockets.

Application: High-speed, general purpose cage available in instrument sizes and in all spindle and turbine sizes. In spindle sizes above 104H and 204H, these cages have a unique feature which greatly improves cage stability. This patented design (U.S. Patent #3,685,877) features two grooves in the cage bore, each one parallel to the cage faces and intersecting the outer edge of the ball pockets. Maximum operating temperature: 300˚F. Maximum speed: 1,200,000 dN with oil, 850,000 dN with grease.

*No symbol used in nomenclature.

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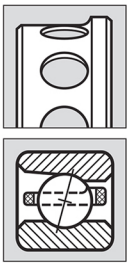
Type: JB

Description: Material: 80-10-10 bronze. One piece, machined with cylindrical ball pockets. Outer ring controlled.

Application: For high-speed, high-temperature, thrust loaded applications where continuous oil lubrication is provided. Grease lubrication is not recommended. This design calls for minimum lubrication conditions such as oil mist. Synthetic oils will stain this material. Maximum temperature: 625˚F. Maximum velocity with oil lubrication: 1,500,000 dN. Usually allows more balls than JH type.

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Type: JH

Description: Material: 80-10-10 bronze. One piece, machined with cylindrical ball pockets. Outer ring controlled. Can be used in H, B, and J type bearings.

Application: For high-speed, high-temperature, applications where continuous oil lubrication is provided. Grease lubrication is not recommended. This differs from the JB type, in that the cage, although outer ring controlled, rides at the ball pitch circle. Depending on the application, the sturdier JH type may be more durable than JB. Synthetic oils will stain this material. Maximum operating temperature: 625˚F. Maximum speed with oil lubrication: 1,500,000 dN.