TIMKEN®

The Right Solution for the Rolling Mill Industry

THE TIMKEN COMPANY

"If you have an idea which you think is right, push it to a finish".

HENRY TIMKEN, 1831 - 1910

Demonstrating fascinating properties and offering an abundance of usages, metal soon played a pivotal role in man's history and its production rapidly became a strategic issue.

Not surprisingly, man has continuously striven over the centuries to improve the quality of metal and to find newer, faster and more cost-effective methods of producing it.

And there is no relief today, in a market increasingly marked by global competition, the heat is on as never before and it is putting heavier demands on the metal industry's approach to serving its markets. To survive, a new type of partnership is called for.

It requires a team spirit and truly joint effort by all the key players in the metal industry, the rolling mill builders, the mill operators and leading bearing suppliers such as The Timken Company, incidentally also a major steel producer.

We are committed to playing our part in developing such synergetic relationships both with our current customers and future partners.

Steel, especially alloy steel bars and tubing, is one of The Timken Company's two core businesses.

As in the Bearing Business, our sole mission in the steel sector is to continuously improve our products and enhance our customer service performance. Ultimately, we must add value to our customers' own applications.

This is the primary target all our company's key resources are focussed on, from technology and engineering, to systems management, production and marketing.

On-going improvement of product and service standards is a costly task and we, at The Timken Company, have consistently committed sizeable investments in new plants and new equipment for the manufacture of steel and bearings.

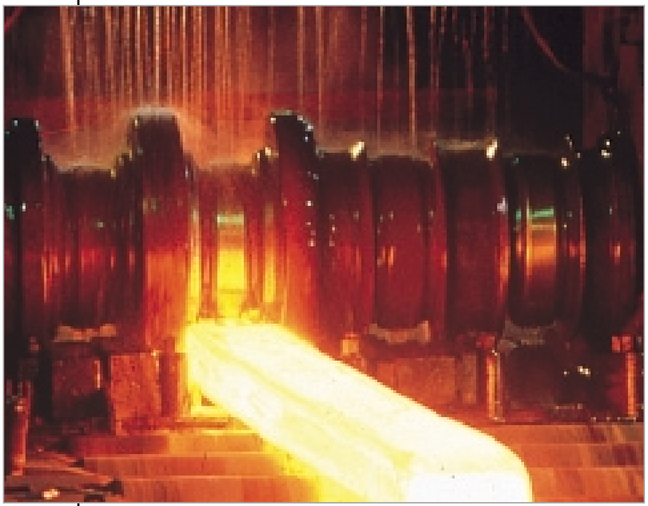
The market's need for better steels and higher performance bearings has encouraged us to produce ever cleaner steels over the years. In turn, this has allowed us to offer bearings with substantially enhanced performance characteristics.

Recognizing Your Needs

Cleaner Environment

Product Quality

Lower Maintenance Costs



Larger Reductions

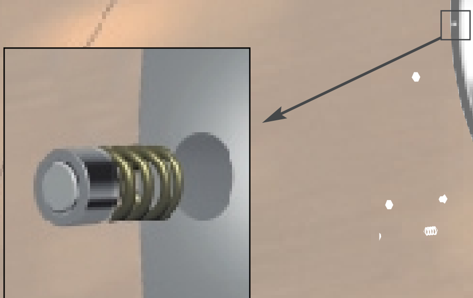
Higher Speeds

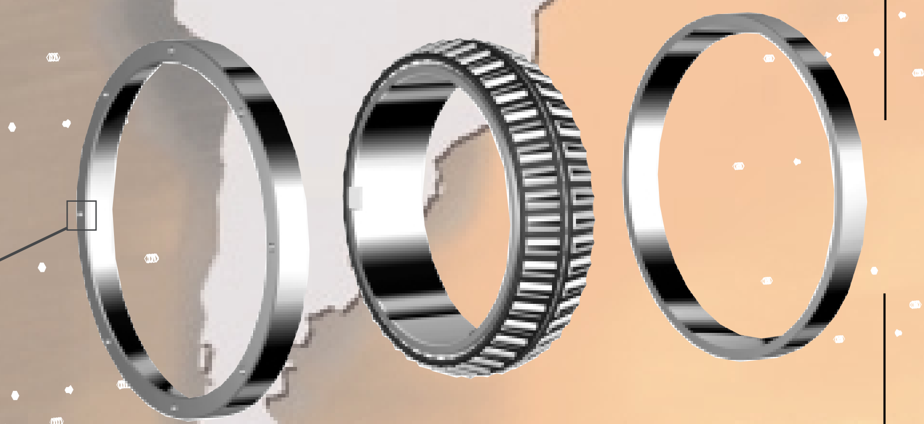
Serving Customers Profitably

Highly advanced manufacturing processes

Bearings reconditioning facilities

New Concepts



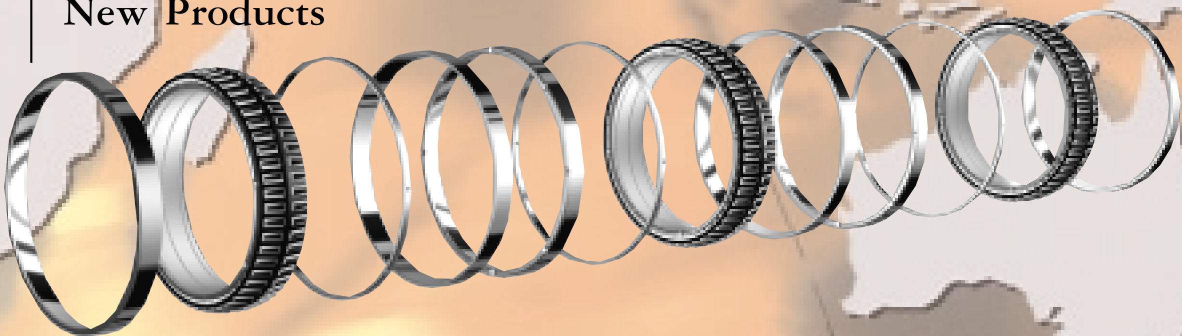


Worldwide Presence

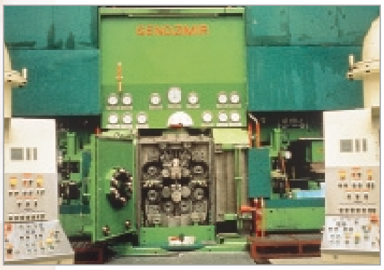
Experienced Service Engineers at your mill

Sales Engineers and Customer Engineering for application support

New Products



Your Benefits



Optimized bearing design and application performance is achieved thanks to a partnership right from the beginning of the mill design, through its build, production start-up and throughout all its operating life.

Lower maintenance costs due to higher bearing life per ton of metal produced, and consistent joint problem solving.

Increased Productivity

More Up-time
Higher Yield

Higher Product Quality

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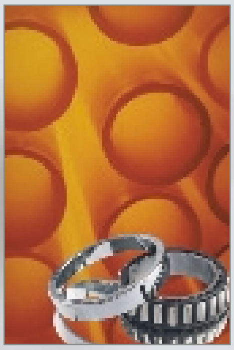

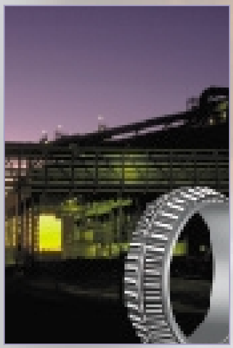

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1. Features and benefits of the tapered roller bearing that you may have forgotten

1.1. The components and possible combinations

1.1.1. Cone, cup, roller, cage (fig. 1-1)

Fig. 1-1
Components of a single row tapered roller bearing (type TS) : cone, cup, roller, cage.

Tapered roller bearings consist of four basic components. These are the inner race (cone), the outer race (cup), tapered rollers and a cage (roller retainer). The cage can be a stamped type as shown in fig. 1-1 or a pin type as shown on some bearings in fig. 1-2. The tapered rollers rotate between the inner and outer races whereas the cage is needed to evenly space the rollers.

1.1.2. Single row, double row, four-row, six-row, axial thrust bearings (fig. 1-2)

As you can see, any possible combination can be considered, from one row to multiple rows with light to heavy radial and/or axial capacity.

1. Features and benefits of the tapered roller bearing that you may have forgotten

1.1.3. Benefit for the designer

The tapered roller bearing, through the way it is designed and the variety of assembly options, will meet most of the needs of the designer and fit most of the space requirements imaginable.

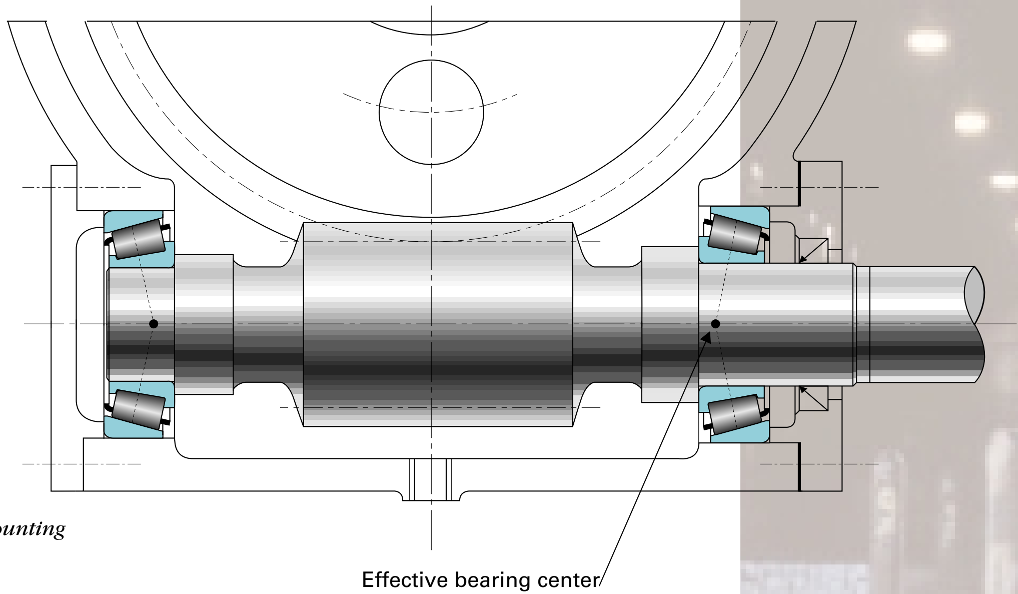

Fig. 1-3
Direct mounting

- The first choice is to mount one single row bearing against another. The bearings can be mounted "direct" with the effective centers (where the loads are applied) to the inside (fig. 1-3) or "indirect" with the effective centers to the outside (fig. 1-4). The distance between the two bearings is dependent on the application requirements.

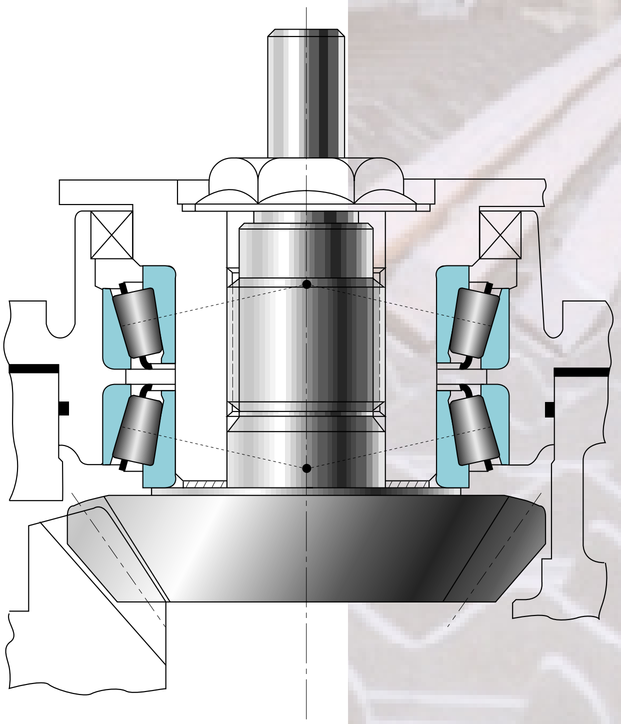

Fig. 1-4
Indirect mounting

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- Two-row bearing assemblies are commonly used in applications such as gear drives, shears, pinion stands, and coilers. They are "fixed" at one side to locate the shaft axially and "floating" at the other position to absorb any thermal expansion and/or tolerance build-up (fig. 1-5).
- Four-row assemblies are used mostly on roll neck applications, where high radial loads are carried and limited radial space is available (six-row assemblies have also been used successfully fig. 1-6). Axial loads can also be absorbed in either direction.

Fig. 1-5

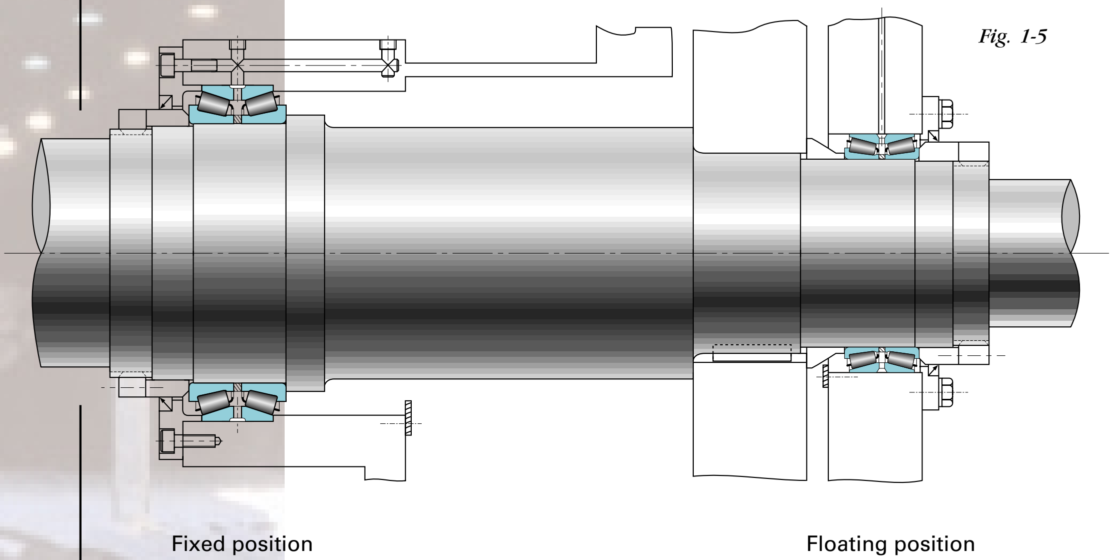
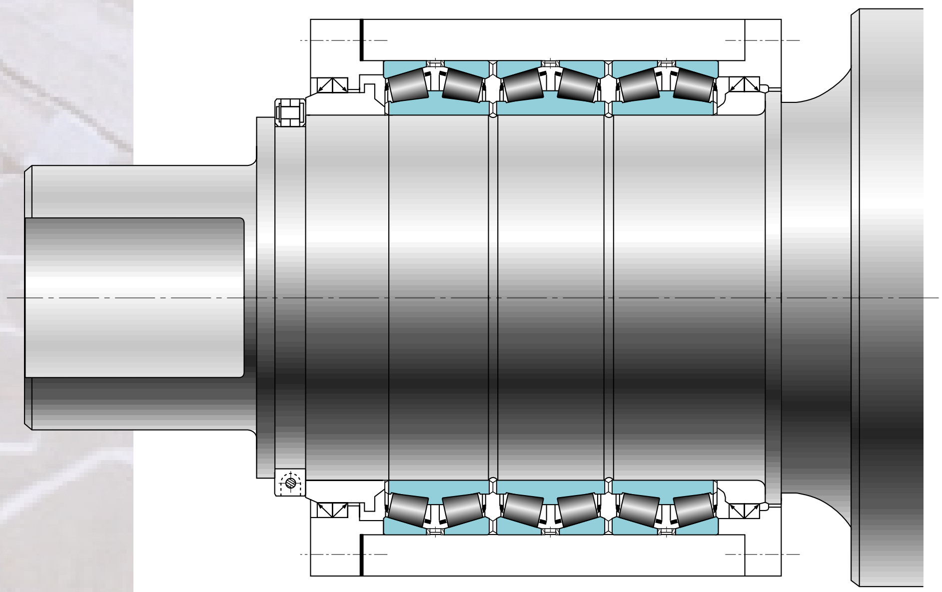


Fig. 1-6



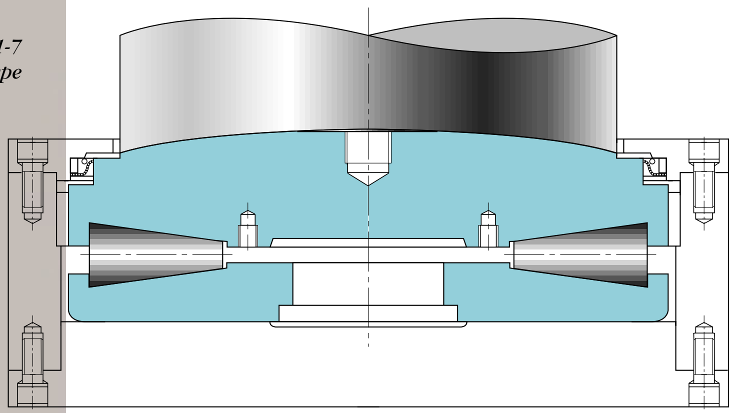


Fig. 1-7
Thrust bearing TTHD type

- In the case of heavy axial loads acting in one direction, such as in screw-down positions, heavy duty axial thrust bearings are available (fig. 1-7). If minimal radial space is available, a stack of steep angle TS bearings to achieve the required axial rating can be considered (fig. 1-8).

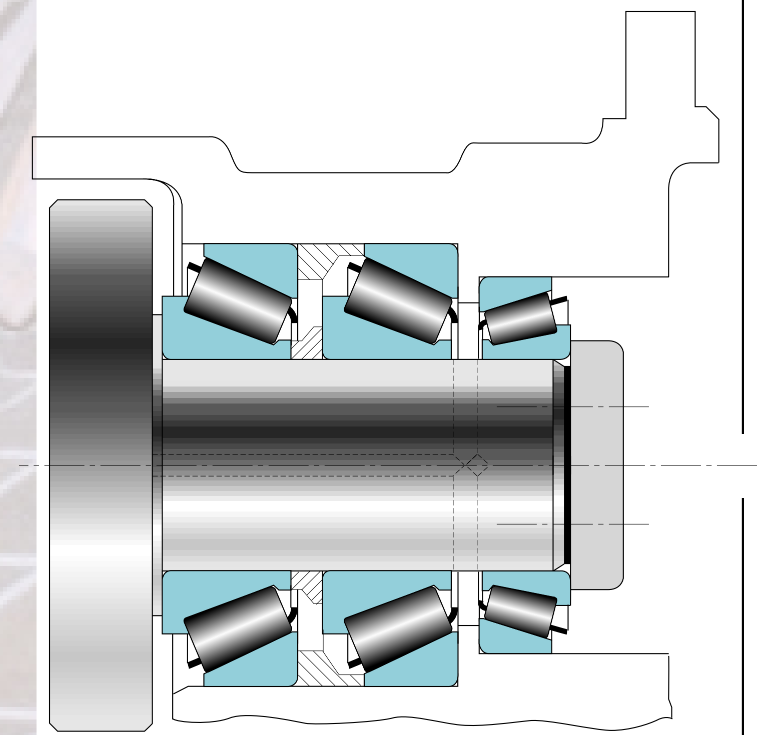


Fig. 1-8
Stacked TS assembly for axial loads

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- For work roll axial shift or roll crossing systems where high axial loads are acting in both directions, a steep angle, two-row bearing assembly can be used (fig. 1-9). If these axial loads are very high, the steep angle bearing can be substituted by a double axial thrust assembly (fig. 1-10).

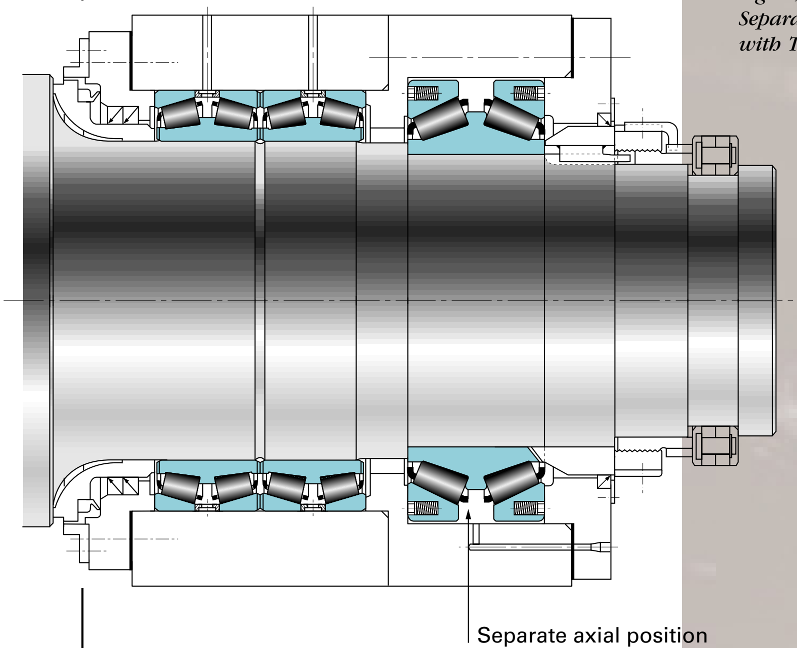


Fig. 1-9
Separate axial position with TDIK type bearing

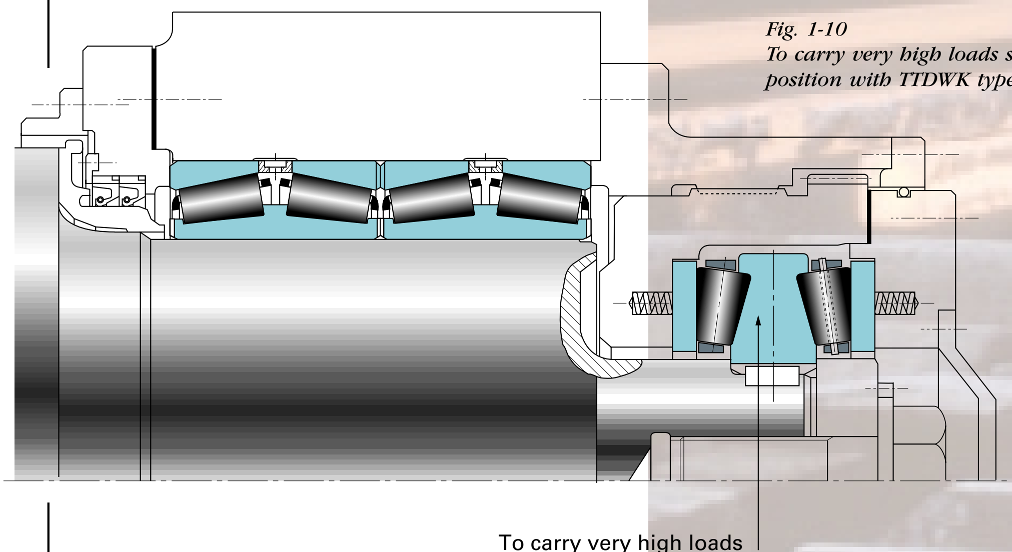


Fig. 1-10
To carry very high loads separate axial position with TTDWK type bearing

As you can see there are many possible combinations, and we would be very pleased to work with you to find the most appropriate solution for the successful performance of your application.

1.2. True rolling motion

1.2.1. What does it mean ?

The extensions of the raceways and rollers of a tapered roller bearing are designed to converge at a common point on the axis of rotation. This “on-apex” design means that any point along the raceways (cone, cup and roller) is subjected to the same circumferential speed (fig. 1-11).

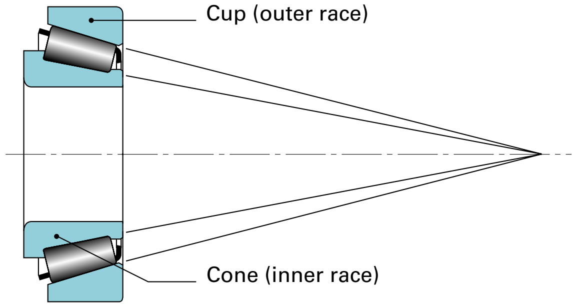


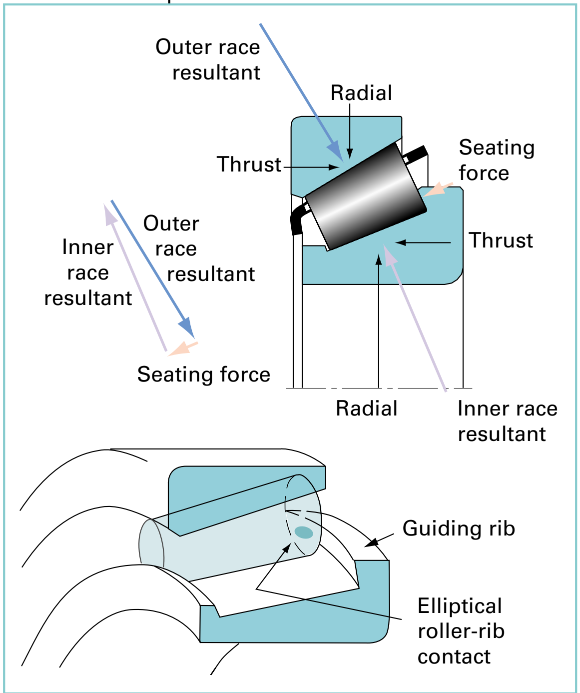
Fig. 1-11
On-apex design results in true rolling motion at all points along the roller body

1.2.2. Benefit for the application performance

This on-apex design helps eliminate any sliding effect on the part of the tapered roller bearing races carrying the bearing load. Therefore, wear and skewing of the rollers due to a possible sliding effect is extremely limited compared to other types of bearings. Life is enhanced and speed under average to high loads can be increased even under conventional lubrication methods.

1.3. Positive roller alignment

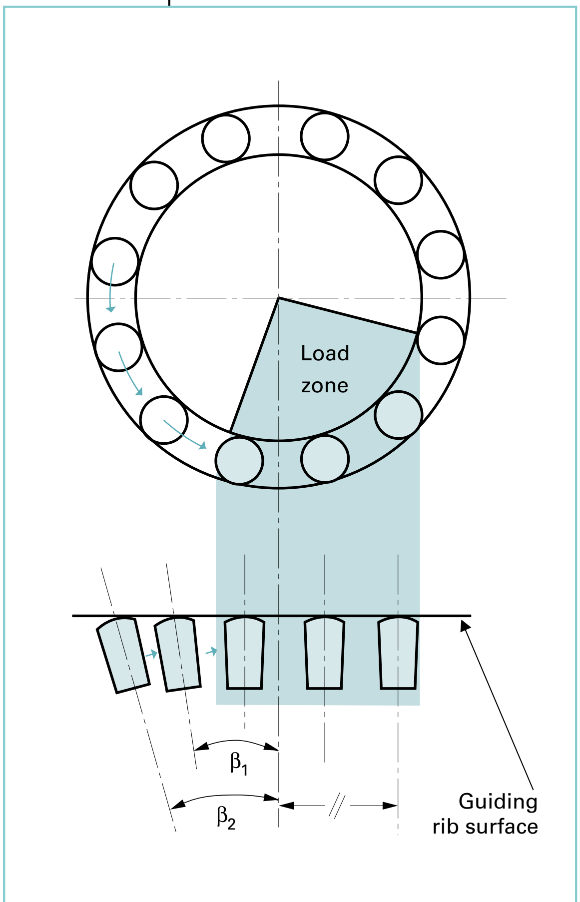
1.3.1. What does it mean ?



Positive roller alignment is one of the major features of tapered roller bearings. The tapered configuration of the roller not only ensures true rolling motion with long rolling contact line but also generates a eatingforce”,which pushes the roller against the large rib of the inner race. This seating force is a function of the different angles of the outer and inner races (see vector diagram fig. 1-12). It prevents the rollers from skewing off apex thereby always keeping them positively aligned and located against the inner race rib.

Fig. 1-12
Small seating force on the inner race rib keeps rollers aligned on the raceway

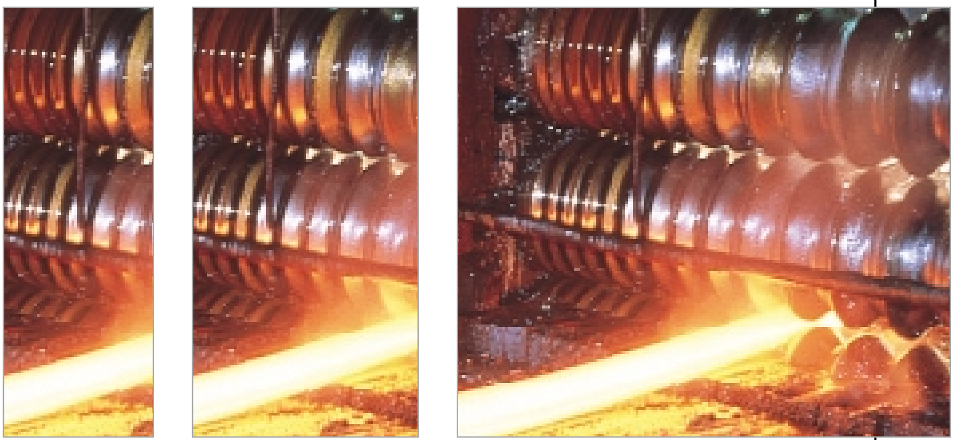
1.3.2. Benefit for the application performance



Bearing life can be compromised if roller skewing exits. This skewing is normally characterized by the angle β, fig. 1-13. In the load zone, and the transition into and out of the load zone, it is essential that rollers be properly aligned, or progressively brought into alignment by the dynamic forces exerted on the roller. Tapered roller bearings have the rib contact to help bring the rollers into proper alignment. Other types of bearings rely on the cage and race contacts to provide this alignment. Generally roller skewing and life effects related to this condition may become significant in, but are not necessarily limited to, applications where excess operating clearance or end play exists, and / or applications where high accelerations and decelerations may occur.

Fig. 1-13
With the tapered roller bearing guiding rib, rollers are progressively aligned when entering the load zone

1.4. High radial and axial capacity



1.4.1. What does it mean ?

Due to the tapered design, our bearing is able to carry a combination of significant radial and axial loads. Depending upon the anticipated application loads, a higher radial capacity series (shallow angle, fig. 1-14a) or a higher axial capacity series (steep angle, fig. 1-14b) can be chosen.

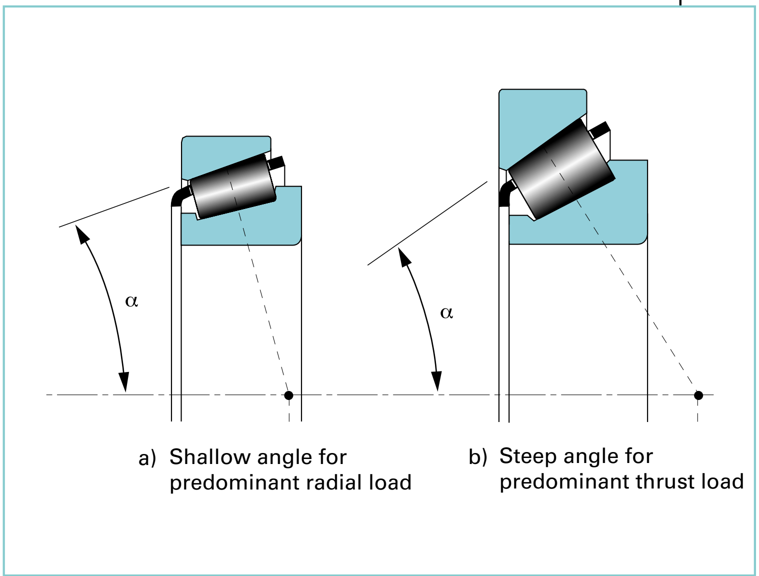


Fig. 1-14
Designs to support significant radial and thrust loads in any combination

1.4.2. Benefit for the designer

Even under high radial, axial or combined loads, any designer will be able to find the correct Timken tapered roller bearing to suit his specific needs in terms of maximum load carrying within the minimum space. (fig. 1-15). In most cases, there is no need for an additional axial bearing. This will contribute to a cost reduction of the application.

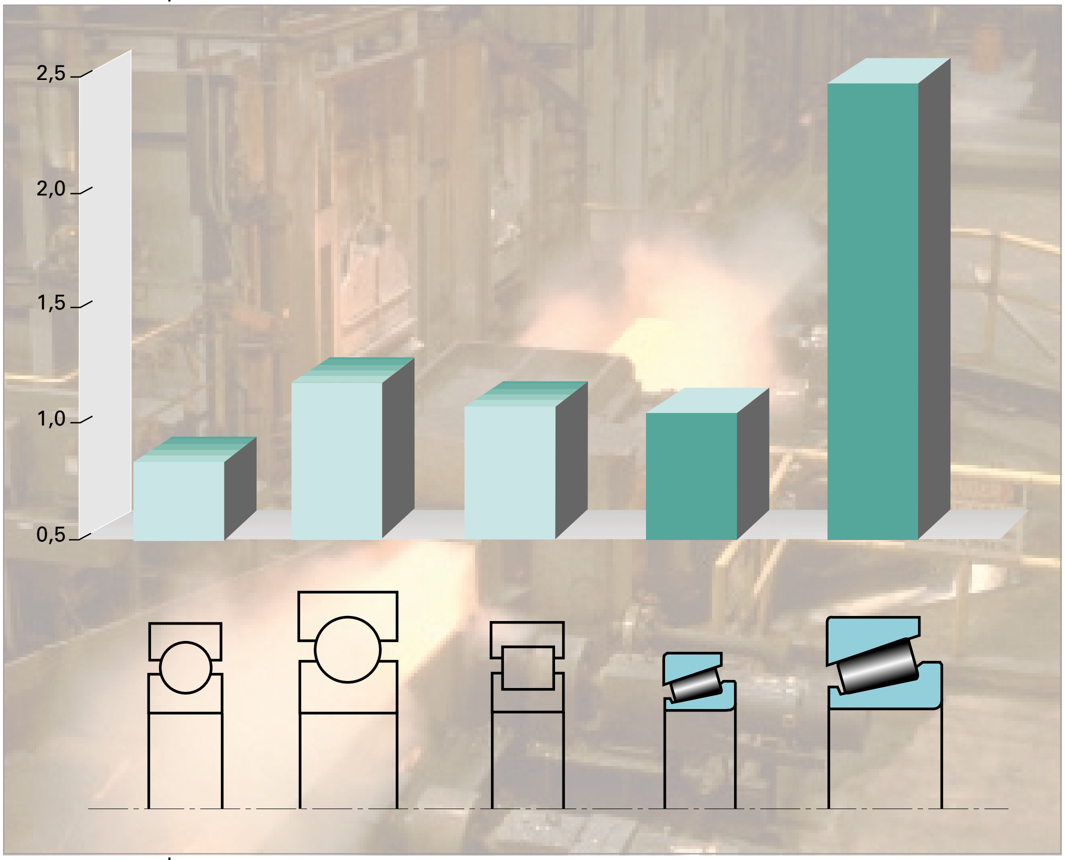


Fig. 1-15
About the same calculated fatigue life as for ball or cylindrical roller bearings can be achieved under the same combined axial/radial load by a tapered roller bearing of a much smaller outside diameter. Alternatively, a tapered roller bearing of the same outside diameter can achieve much greater fatigue life.

1.5. Adjustable internal endplay-preload

1.5.1. What does it mean ?

Any tapered roller bearing, being mounted as 2 single rows or as assemblies, can have its radial internal clearance adjusted to the specific requirement of the application. This internal radial clearance is in fact adjusted by moving axially the position of the outer ring relative to the inner ring (fig. 1-16). The radial clearance, which controls the load zone, is 1/2 to 1/5 of the axial displacement due to the tapered design. Therefore, adjusting the axial clearance enables you to obtain a very accurate resulting radial clearance "R" (fig. 1-17).

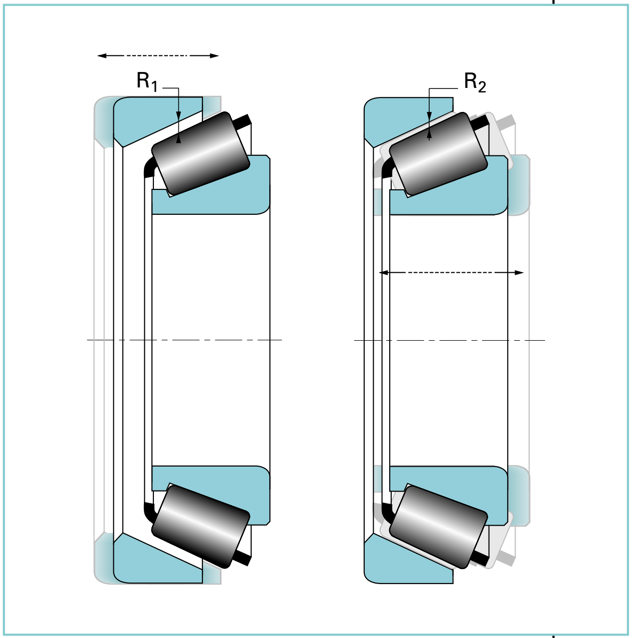


Fig. 1-16
Radial internal endplay "R", adjusted axially

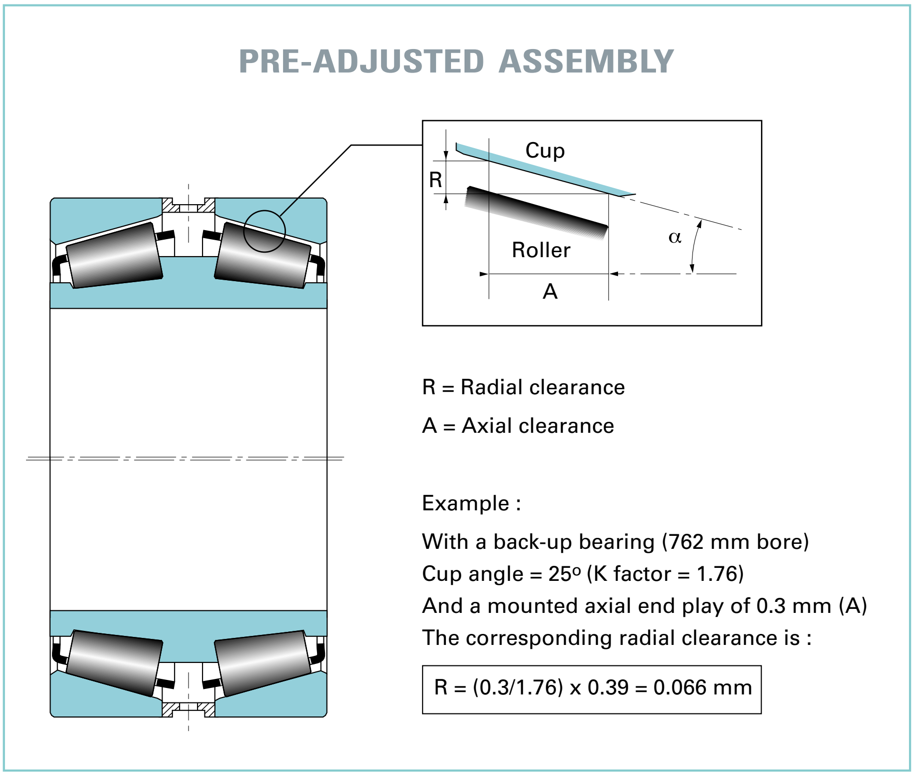


Fig. 1-17
Bearing internal clearance

Depending on the application needs, tapered roller bearings can be supplied pre-adjusted. If the application is such that very close adjustment is needed, the setting of the assembly can be easily achieved on site by correctly sizing the spacers. If necessary, our service engineers can support you with their experience.

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1.5.2. Benefit for the application performance

The life of your bearing is dependent on the load zone obtained under operating conditions ; the higher the load zone (up to a slight preload) the higher the life of the bearing (fig. 1-18). The tapered roller bearing design enables you to set the load zone very precisely, which results in optimum performance for your application.

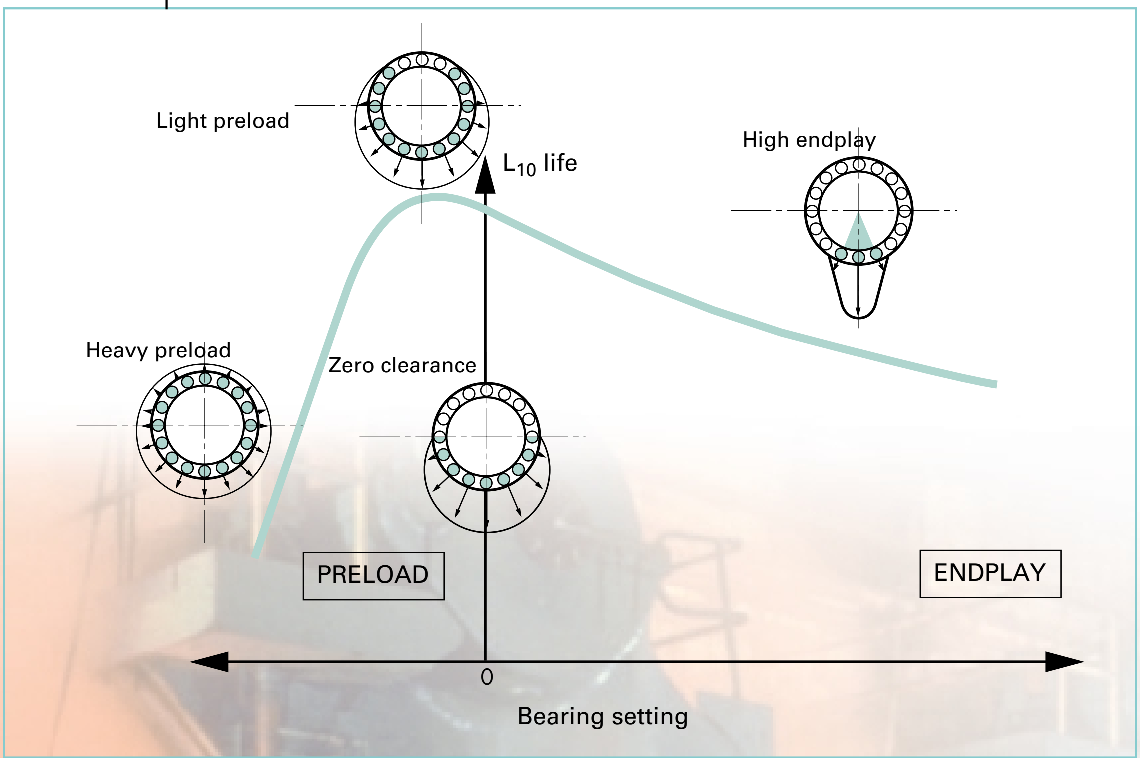
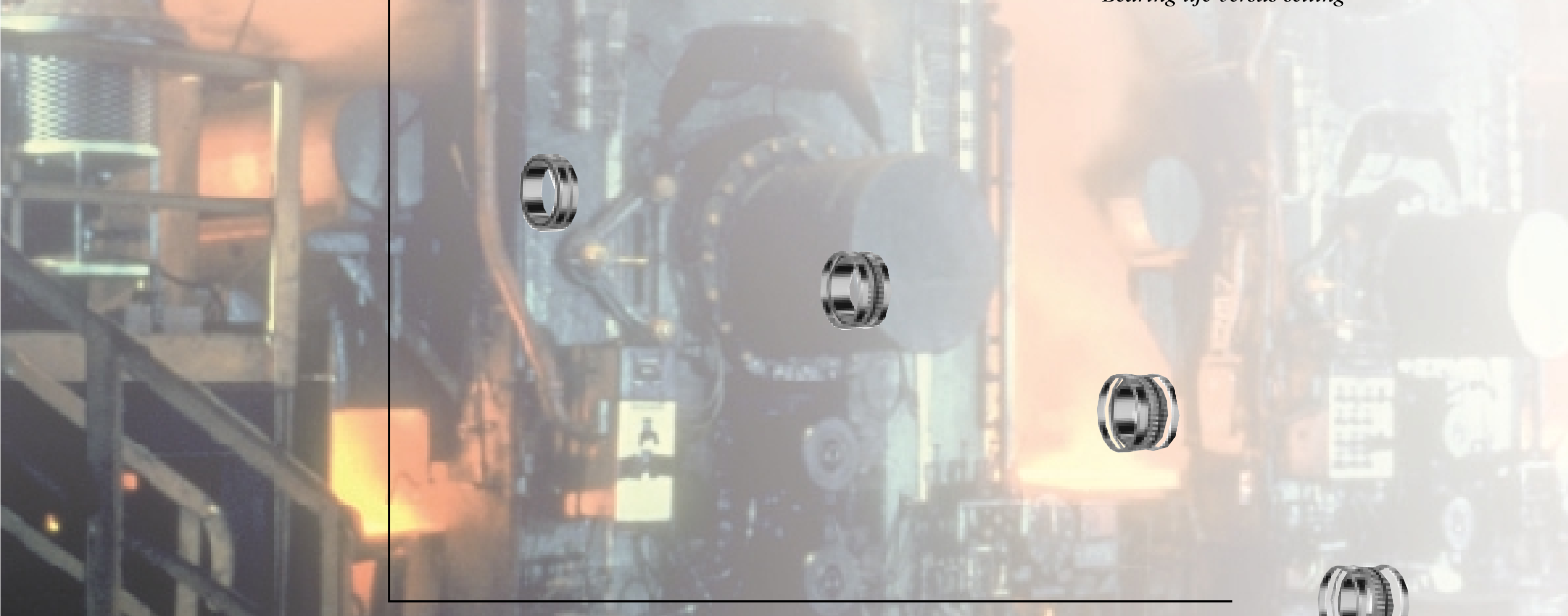


Fig. 1-18
Bearing life versus setting



1.6. Case carburized steel

1.6.1. What does it mean ?

Timken tapered roller bearings (rollers, inner and outer rings) are manufactured from low carbon alloy steels. Depending on the bearing size, appropriate quantities of the alloying elements are added to the steel melt to insure optimum properties in the finished product. Carbon is introduced during the heat treatment process into the surfaces of the bearing components to a depth sufficient to produce a hardened case that will sustain high bearing loads. This carbon as well as the addition of alloys added during the melting process assure the proper combination of a hard, fatigue-resistant case and a tough, ductile core (fig. 1-19).

These high quality alloys continue to be improved by The Timken Company steel division. We ensure the consistency of our steels worldwide regardless of where the bearing is manufactured.

Fig. 1-19
Hardened case of bearing components provides fatigue resistance and ductile core provides toughness

1.6.2. *Benefit for both builder and mill operator*

There will be reduced probability of sudden bearing seizure.

A fatigue crack can propagate completely through in a through-hardened component, whereas, a fatigue crack in case carburized bearings will generally stop at the ductile core.

This tough core will also improve your application performances under heavy shock loads. Indeed, the residual compressive stresses at the surface retard propagation of fatigue cracks. These residual compressive stresses also improve the bending fatigue resistance at the large rib undercut.

1.7. Separate inner and outer ring assembly

1.7.1. What does it mean ?

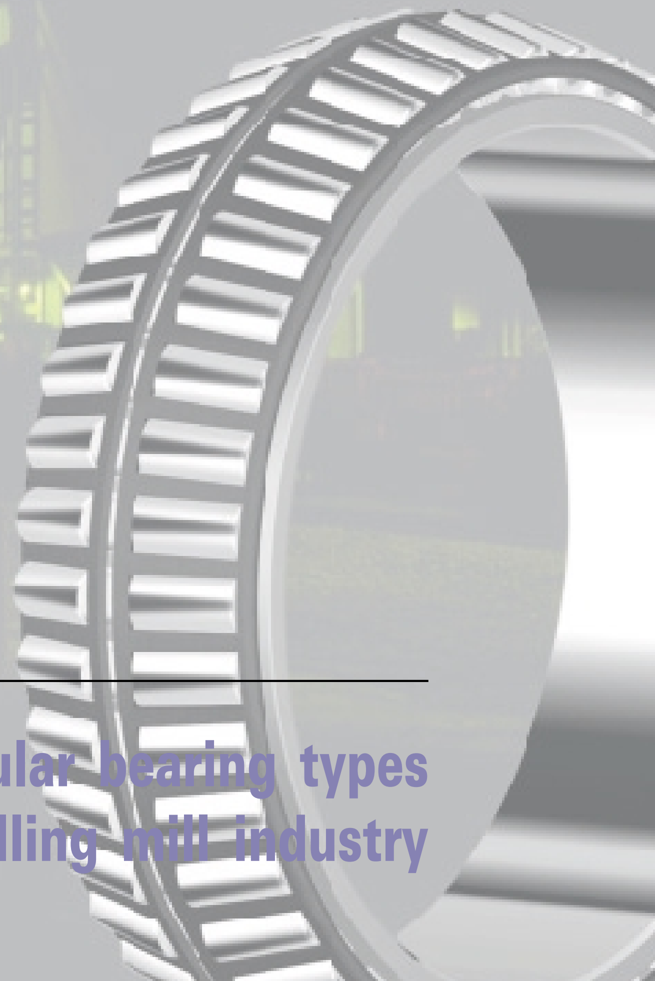
As shown in section 1.1., the tapered roller bearing is built with inner ring(s) and outer ring(s) which can be separated from each other (fig. 1-20). Often, with very heavy parts, it is convenient to mount the pieces separately for weight or safety reasons. The tapered roller bearing also offers the flexibility to be mounted as a unit.

1.7.2. Benefit for both builder and mill operator

Thanks to the separate inner and outer rings, the tapered roller bearing is very easy to handle for storage, mounting-dismounting and maintenance. With regards to maintenance, the components can be easily inspected and readjusted to the original factory specifications. Furthermore, if damage is noted beyond minor spalling, your bearing can be returned to The Timken Company for further inspection and reconditioning (see section 5.3.).

Fig. 1-20

The tapered roller bearing offers many solutions which will contribute to total application cost reduction. Mill builders will benefit from much simpler, less costly solutions, whereas mill operators can realize total operating and maintenance cost reductions.



2. Most popular bearing types in the rolling mill industry

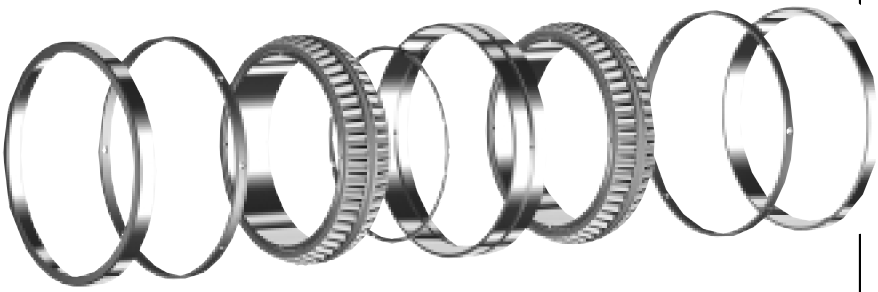
2.1. Mill stands

Rolls are subjected to very high radial loads and varying degrees of axial load. To carry these loads, or combined loads, roll neck bearings must have adequate contact surfaces, material strength properties, and internal geometry characteristics to provide appropriate and acceptable performance under these often very difficult operating conditions. Design options have traditionally been two, four, or six-row tapered roller bearings, or multi-row cylindrical bearings. In the case of tapered roller bearings, different duty classes have been developed to designate what type of loads the bearing is designed for. This duty class generally appears as a prefix letter in the bearing part number, i.e. L - light ; LM - light medium, M - medium, HM - heavy medium. Some of these bearings, designed as “balanced proportion”, are very popular and generally meet the needs of the designer ; they can also be designated as EE bearing types. Some other classes like H - heavy, HH - heavier than heavy, have also been developed for particularly heavy loaded applications.

2.1.1. Back-up rolls (2-high, 4-high, 6-high mills)

In order to accommodate installation and removal, tapered roll neck bearings are generally mounted loose on the roll necks given certain design parameters, and when experience suggests this design can be successful. When mill speeds, loads, and / or environmental conditions typically exceed 600 to 750 m/min. The Timken Company suggests cones of back up roll bearings be mounted with tight (interference) fits to avoid cone "creepage" (relative rotation on the roll neck). In the case of tapered roller back up roll bearings, designs generally use cones with tapered cone bores to facilitate mounting and dismounting.

TQOW

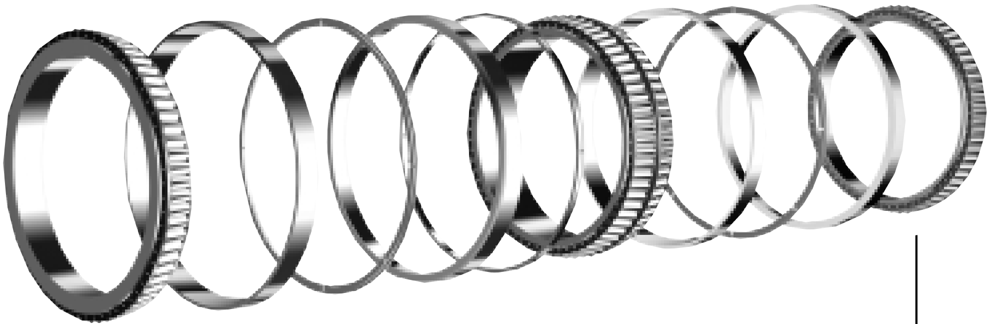


Composition : Two double cones, one cone spacer, two single cups, two cup spacers, one double cup.

Application : Mills with speeds up to 600-750 m/min (2000 to 2500 ft/min), according to loads.

Remarks : Preset assembly with spacers - possibility of resetting radial clearance by regrinding the spacers - mounted loose on the roll neck and in the chock - slots on cone faces for bearing shoulder and neck contact lubrication - can also be provided with spiral groove, and in 2TDIW version (see 2.1.2.).

TQITS

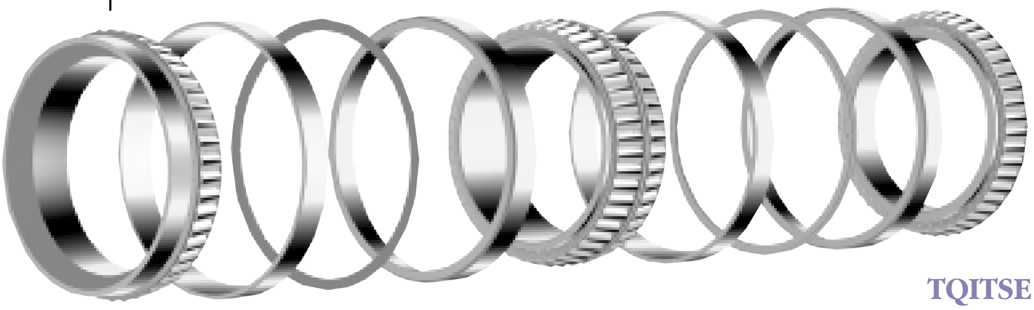


Composition : One double cone and two single cones all with matched tapered bores, four single cups, three cup spacers, no cone spacer.

Application : High speed mills, where strip speeds are greater than 600 to 750 m/min according to loads. We have successfully operated these assemblies at 2150 m/min (7000 ft/min) with oil-mist lubrication (note that oil-air lubrication would give the same results).

Remarks : Mounted tight on the roll neck - the tapered bore provides an accurate control of the interference fit - maximum stability of the roll due to the indirect mounting design - preset assemblies.

The TQITS exists also in a TQITSE version with an extended cone on the roll side. This extension provides an ideal surface for the chock seals, and further reduces the potential for seal damage when mounting on the roll neck. It also eliminates the need for a large fillet ring. The seal integration permits the bearing to be positioned closer to the roll face, which in turn improves the neck stiffness.

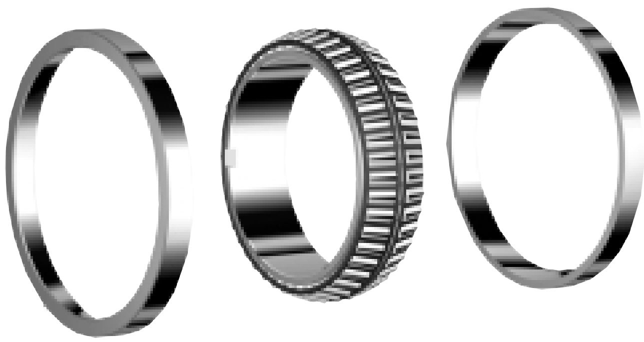


TQITSE

Precision

For applications which require very close product tolerances of less than 5 micrometers (200 microinches), we can provide our back-up roll bearings with extremely tightly controlled runouts. Examples of the products run on these mills are : aluminium or steel can stock...

TDIK



Composition : One double cone with keyways, two single cups (can also be considered with spring system in the cups).

Application : Used as a thrust bearing in addition to a back-up roll bearing with no axial capacity (e.g. oil film bearing).

Remarks : See section 2.1.3.

2TDIW

Composition : Two double cones, four single cups, three, two or no cup spacers.

Application : Same use as the TQOW bearing.

Remarks : The 2TDIW is fully interchangeable with the TQOW (same external dimensions, same capacity) - in case of combined axial/radial loads, the 2TDIW bearing offers better load distribution on its two central single cups than on the double cup present in the TQOW - fewer different components in case of bearing maintenance/rebuild - preset assemblies.

3TDIW

Composition : Three double cones, six single cups, five, three or no cup spacers.

Application : Same use as the TQOW/2TDIW bearings where high loads are applied and chock section is critical.

Remarks : Decrease in bearing outside diameter is compensated for by an increase in width - preset assemblies.

TDI

Composition : One double cone, two single cups, one cup spacer.

Application : Edgers and 2-high mill work rolls with low to medium loads. Revamp from plain bearings or spherical bearings.

Remarks : Can be delivered as a preset assembly - cups and cones normally mounted loose.

TDIT

Composition : One double cone with tapered bore, two single cups, one cup spacer.

Application : Bar and rod mills (where speeds are greater than 600 m/min - 2000 ft/min).

Remark : Preset assembly.

TNAT (S)

Composition : Two single cones with matched tapered bores (similar to the TQITS assembly), one double cup or two single cups + one cup spacer, no cone spacer.

Application : Used in bar and rod mills where the chocks are prestressed.

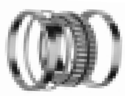
Remarks : Floating position achieved between cup O.D. and chock bore - preset assembly.

TDO

Composition : Two single cones, one double cup, one cone spacer.

Application : Cantilever profile mill and beam mill vertical rolls.

Remarks : Due to high loads, heavy duty bearings are generally used - double cup mounted tight in rotating and vertical rolls - can be delivered as a preset assembly.



For work rolls which are often changed in the mill, the ***Sealed concept*** *can be especially useful from an economic point of view. In fact, the grease consumption with a sealed bearing is dramatically decreased and operating and maintenance costs are heavily reduced. Note that sealed roll neck bearings can also be used on back-up rolls and in conjunction with oil-air and oil-mist lubrication.*

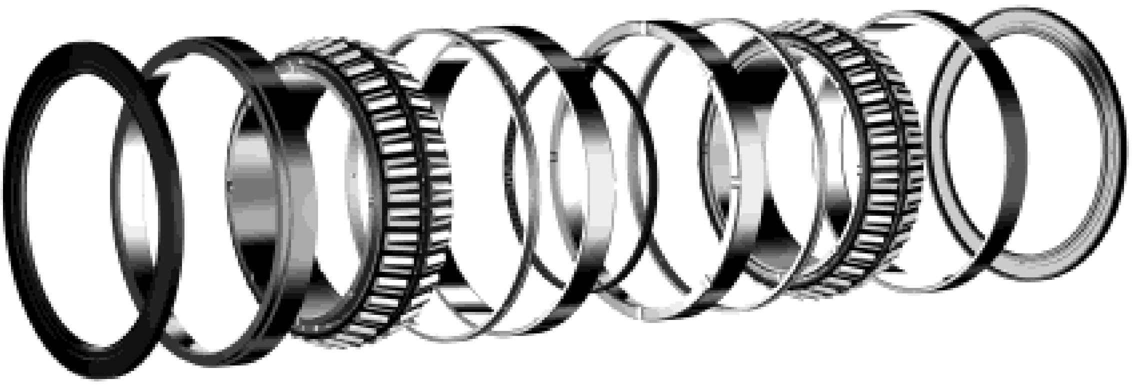
Sealed Roll Neck Bearings : SRNB

Composition : Same composition as the 2TDIW plus one bore seal (mounted in the bores between the 2 cones), one main seal at each end, sealed statically in the chock bore.

Application : Work rolls with excessive grease costs or, where lubricant leakage would be detrimental to the final product (skin pass mills...).

Remarks : The sealed roll neck bearing is supplied as a unitized, preset assembly with or without grease - regreasing intervals of 600 to 1000 hours are more likely, instead of at every roll change (however these intervals will depend on the operating and maintenance conditions at each mill site, and will have to be adjusted accordingly) - the bore seal concept further enables proper lubrication of the inner cone faces.

Narrow seal concept



Used in any mills, even running with high bending loads and relatively high speeds (up to 2000 m/min - 6600 ft/min). These bearings would typically have the same capacity as the unsealed four-row bearing in the same series.

The two in one main seal concept includes static sealing of the bearing outside diameter and a dynamic seal function which includes our elastohydrodynamic lip concept to minimize grease leakage.

TDIKSC

Composition : One double cone with keyways, two single cups (with or without spring system), main seals.

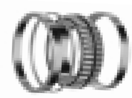
Application : Used as a thrust bearing on work roll or back-up roll applications, in addition to the roll neck bearing, where thrust loads are high.

Remarks : Design and mounting concepts are the same as the TDIK. This design offers the benefit of additional sealing to prevent bearing damage due to contamination ingress and improve lubricant retention. Sealing the bearing cavity also helps to protect the bearing during roll changes. The narrow seal concept (shown here) can be integrated to maximize capacity. This sealing concept encloses the bearing cavity and chock bore with one seal in a minimal amount of axial space. Main seals can also be mounted in seal carriers, with o-rings to seal at the cup OD. Sealed bearing designs utilizing the integral spring system are also available.

TQOWE-2TDIWE

The TQOWE-2TDIWE versions are provided with cone extensions to the outside of the bearing in order to accommodate chock seals.

This bearing design permits a fully integrated “chock-bearing” sealed system to be used and allows for an optimum chock seal running surface. It also reduces the risk of seal damage. In addition, this design enables you to take full advantage of the available space for maximum bearing capacity.



2.1.3. Work roll axial positions

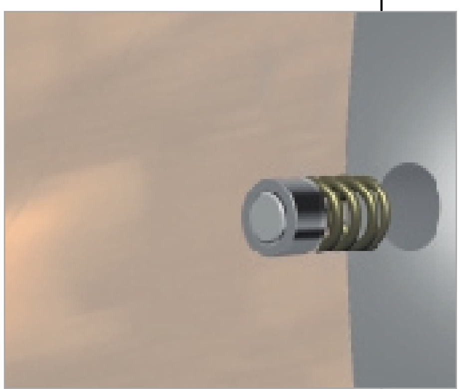
In most cases, when a tapered roller bearing is used on roll necks, no additional axial position is required. Nevertheless, for systems like axial shift or roll crossing, the thrust loads might be so high that an additional thrust bearing unit is needed. For these applications, The Timken Company has several solutions.

TDIK

Composition : One double cone with keyways, two single cups (with or without spring system).

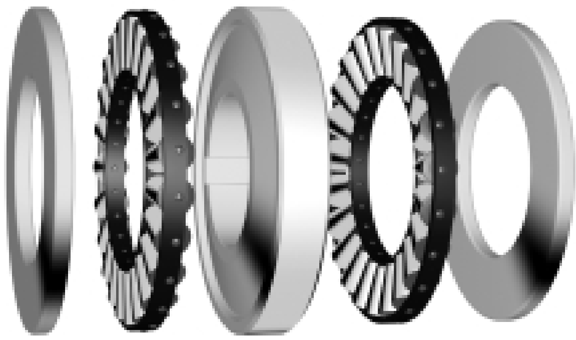
Application : Used as a thrust bearing in addition to a four-row or six-row bearing in mills where the thrust loads are high (for example with axial shift or roll crossing systems...) see fig. 1-9, page 21.

Remarks : These bearings are designed with steep angles to absorb thrust loads in either direction (low K factor) - mounted loose in the housing with 1 to 2 mm radial clearance to avoid any radial load interaction. Cones are also mounted with a loose fit.



The Timken Company has developed a version with a spring system in the cups, to ensure that the unloaded cup is always seated and thus, prevent any roller skewing. This is very important in such a position, and even more so with steep angle rollers. A spacer preset assembly unit is sometimes used, but in this case, the seating of the unloaded row is not necessarily assured.

TTDWK

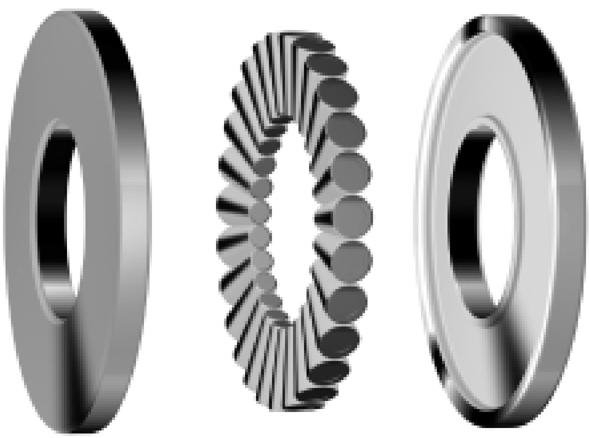


Composition : One double central tapered thrust ring, two outside flat thrust rings.

Application : Double acting thrust bearing used in medium speed applications and when axial loads are considerable such as beam mills or piercing mills.

Remarks : Mounted loose on the neck and in the housing - flat outside races - keyway in central ring bore - unloaded race can be seated with springs.

TTHD



Composition : Two tapered thrust rings.

Application : Thrust bearings of piercing mills, axial position on Sendzimir mills.

Remarks : Used only when axial loads are unidirectional - medium speed capability when provided with a cage - a cageless design is available for high loads and low speeds.

2.1.4. Screw-down systems

Screw-down systems are used to adjust the thickness of the rolled product. Bearings for such systems are basically static, and must be able to support the high rolling loads. Therefore, The Timken Company has developed a wide range of these heavy duty thrust bearings.

TTHDSV

and

TTHDSX

TTHDSX

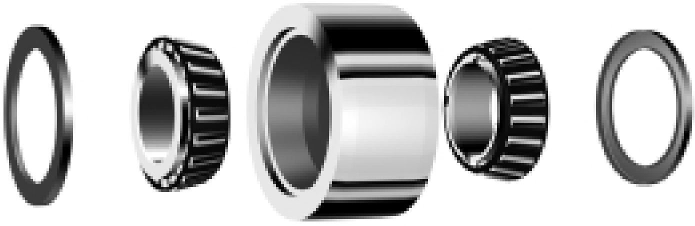
Composition : One lower race and one upper race provided with a special profile (concave or convex) to match the end of the screw or the adaptor between screw and bearing upper race.

Application : Screw-down thrust bearing.

Remarks : Cageless design for maximum capacity - concave design for TTHDSV and convex design for TTHDSX. Note that the bottom ring can also be provided with a flat race (TTHDFL).

Alternative : You can also use a standard TTHD bearing mounted on a concave or convex adaptor to match the end of the screw.

TNASWH



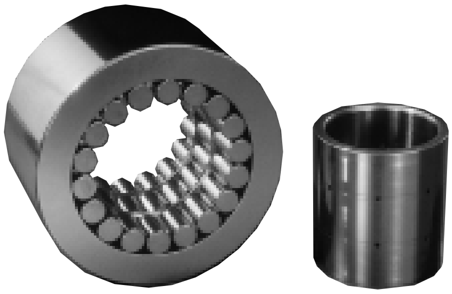
Composition : Two single cones, one heavy wall double cup and two closures to retain the lubricant.

Application : Sendzimir mills with base oil viscosity of 460 cSt at 40 °C and more.

Remarks : Preset assembly - heavy section cup to be used directly as a back-up roll - mounted loose on the stationary arbor - these bearings are provided in precision class with maximum outer ring wall section variation of 5 micrometers (200 microinches) in order to reach the tight tolerance requested on the final product - ability to regrind the outer ring several times - bearing section heights are classified within a 2.5 micrometer range (100 microinch range) in order to achieve good load sharing between the bearings of a same arbor.

Z-SPEXX

(cylindrical roller bearing for Sendzimir mills)



Composition : One single cylindrical inner ring, one heavy wall section outer ring and two or three sets of cylindrical rollers and roller retainers.

Application : Sendzimir mill with base oil viscosity down to a range of 10 to 15 cSt at 40 °C.

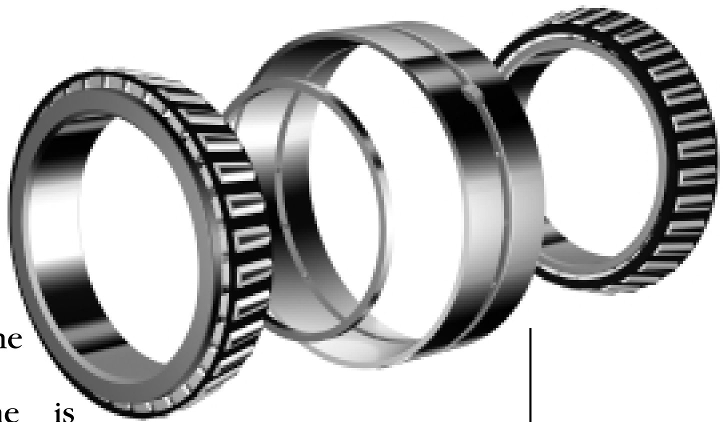
Remarks : Controlled radial clearance - high quality case carburized steel - customised internal geometry - enhanced finishes on the rolling surfaces - provided in precision class with maximum outer ring wall section variation of 5 micrometers (200 microinches) - ability to regrind the outer ring several times.

Latest bearing technology now offers Sendzimir mill operators a large reduction in their cost per ton rolled (improved gauge accuracy - high speed capability - ability to regrind the outer ring several times).

2.2. Mill drives, pinion stands, coilers and uncoilers

In these applications, most loads are combined radial and axial. The two-row tapered roller bearing assembly is therefore the most natural solution.

2.2.1. Double row indirect mounting



TDO

Composition : Two single cones, one cone spacer and one double cup.

Remarks : Preset assembly, the cone is mounted tight on the rotating shaft - the internal radial endplay is adjusted accordingly - high effective spread increases shaft stability - double cups mounted loose in the housings for both fixed and floating positions - holes and circular grooves are normally provided on the double cup for lubrication purposes, one counterbored hole is usually included ; this permits the provision of a locking pin to keep the loose-mounted cup from rotating at the "floating" position (this is then refered to as a "CD" cup).

2.2.2. Double row direct mounting

TDI

Composition : One double cone, two single cups, one cup spacer.

Remarks : TDI assemblies are normally used on the "fixed" position - Compared to a TDO of the same size, the TDI is smaller in width and can therefore be fitted within smaller envelopes - usually supplied preset - when used on rotating housing applications, axial float is achieved between cone and stationary shaft.

2.3. Auxiliary equipment

To give a global solution to rolling mill users and builders, The Timken Company provides you not only with bearings for the mill stands or the equipment directly linked to the stands but also bearings for the auxiliary equipment necessary in a mill.

In addition to the bearing types mentioned below, you can also refer to "The tapered roller bearing guide" or to your Timken Sales Engineer for more information.

2.3.1. TS bearing

For general purpose applications, the association of two single row bearings is a good solution for combined load carrying. The product range offered by The Timken Company will enable you to find the most cost effective solution for your application from a 10 mm (0.4 inch) bore up to 1500 mm (60 inches) and larger.

TS

Composition : One single cone and one single cup.

Application : Various equipment such as saws, guiding rolls, scrap choppers, small drives,...

Remarks : The TS is the most common tapered roller bearing which allows the designer a large choice of mountings - the TS bearing is always fitted as one of a pair, whether mounted directly or indirectly (fig. 1-3 and 1-4 p. 18).

2.3.2. Two-row TS assemblies

As already mentioned, preset TDI and TDO assemblies can be used in many applications.

The Timken Company also provides preset two-row TS assemblies. These assemblies exist in indirect mounting arrangements (2TSIM) and in direct mounting arrangements (2TSDM) and can be supplied to the required overall width by sizing the spacers accordingly. This increases the design flexibility even more.

2.3.3. Heavy section outer ring bearings

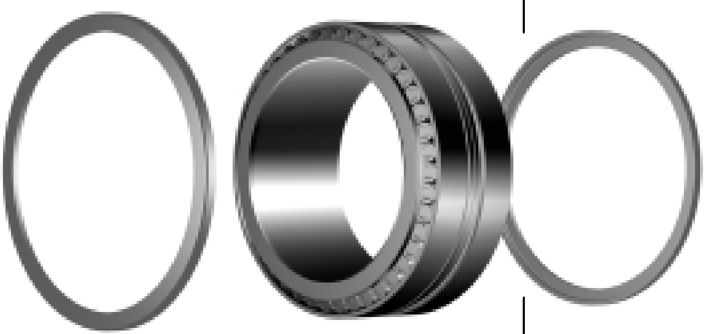
TNASWH and TNASWHF

In auxiliary rolling mill equipment, for example on backed-up roller levellers, the TNASWH assembly can be used as a support roll. The TNASWHF is similar to the TNASWH, with an additional flange provided on the cup. It is often used as a wheel in crane applications, on roll dismounting systems,...

TNASWHF

2.3.4. TDIV double row self-contained assembly

TDIV



Composition : Two single cups, one double cone, one cup spacer in two parts, one spacer retainer, two closures can be added for lubricant retention.

Application : Continuous caster with high loads low speeds...

Remarks : Indirect mounting design (similar to the TDO) - cageless for maximum capacity - preset and self-contained assembly - low to medium speeds.

TIMKEN

In order to simplify the work of designers, The Timken Company also offers a "ready to use" bearing assembly based on a TDO.

AP BEARING

AP (All Purpose)

Composition : Two single cones, one double extended and counterbored cup, one cone spacer, one backing ring, two radial lip seals plus wear rings and one end cap with venting or plug, cap screws and locking plate.

Application : Table rolls, crane wheels, sheaves,...

Remarks : The AP bearing is supplied as a preset, pre-lubricated and sealed package - this bearing is available in a multitude of different arrangements. For more information please refer to "The tapered roller bearing guide" and the booklet "AP bearings for industrial applications".

NOTE : most of our bearings are supplied with holes to accommodate your lubrication system

Page

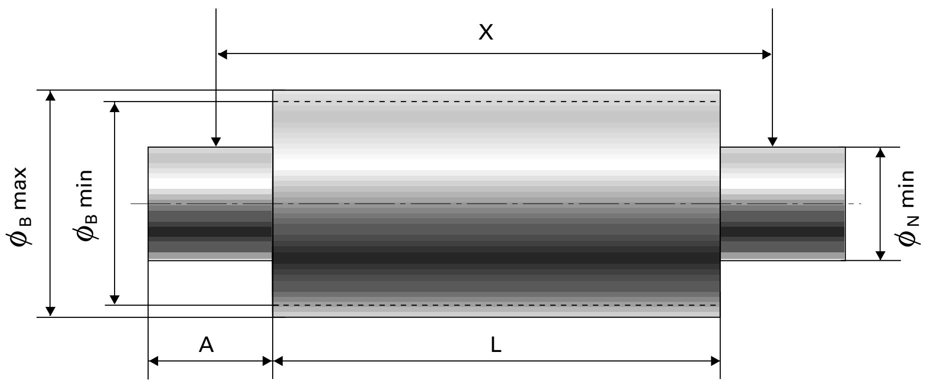
3. Selection of your bearing

3.1. Design and dimensional aspects for roll neck bearings

Roll neck bearings are selected based on a number of important factors, including applied loads, speed capabilities, precision / accuracy requirements, and size constraints (i.e. available space).

The principal selection parameters to consider when looking for a bearing to satisfy your roll needs are :

- type of mill and duty (hot, cold rolling strips or profiles,...),
- roll body size (maximum and minimum diameter, width),
- roll body material (allowable stresses ➪ minimum neck diameter and width),
- screw-down distance.



$\emptyset_N$ min = minimum neck diameter

$\emptyset_B$ min = minimum roll barrel diameter

$\emptyset_B$ max = maximum roll barrel diameter

A = neck length

L = barrel length

X = screw-down distance

Fig. 3-1
Critical bearing selection parameters

The above considerations will dictate the minimum remaining space left for the chock and the bearing.

Finally, in this space, it is important to then properly balance the bearing section height against the minimum chock section requirements.

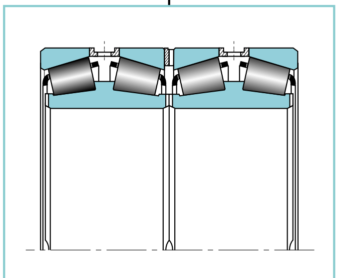


Fig. 3-2
Light section bearing LM type

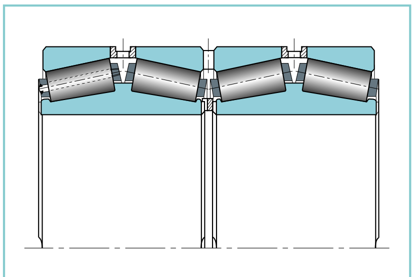


Fig. 3-3
Heavy section bearing
M or HM type

After a review of the size restrictions, an evaluation must be made of the bearing capacity as a function of the rolling schedule for each of the stands to ensure proper application performance. This is an interactive process to get the best balance between all mill components (roll - chock - bearing). This can only be achieved through a close partnership with the mill builder.

- In many cases, the quoted maximum rolling load will not be excessive for the defined roll diameter, thereby permitting a future load increase should an operator later intend to roll higher grade steels.
- Our roll neck bearing sizes, with bores ranging from 50 mm to about 1500 mm (2 to about 60 inches), were defined in order to find the best possible compromise between the two conflicting parameters "neck diameter and barrel diameter" in order to offer at the same time :

- the smallest possible chock outside dimensions thus allowing a satisfactory roll turn-down,
- the largest possible neck diameter to withstand today's rolling and bending loads and also be capable of coping with the trend towards increasing loads in the future.

3.1.1. Back-up rolls (2-high, 4-high, 6-high mills)

3.1.1.1. How to achieve the maximum performance in your available space

Our range of typical heavy duty back-up roll bearings was designed to fulfill the previously described requirements. These bearings usually allow on average a neck-to-barrel ratio of around 60 % (58 to 62 %) and a roll turn-down of around 10 % (8 % to 12 %) provided the chock section dimension “C” is satisfied as shown on fig. 3-4 below.

For particularly highly loaded mills we can run a Finite Element Analysis (FEA) to better evaluate the minimum chock sections (in the vertical as well as in the horizontal direction, even though the “C” section remains the most critical).

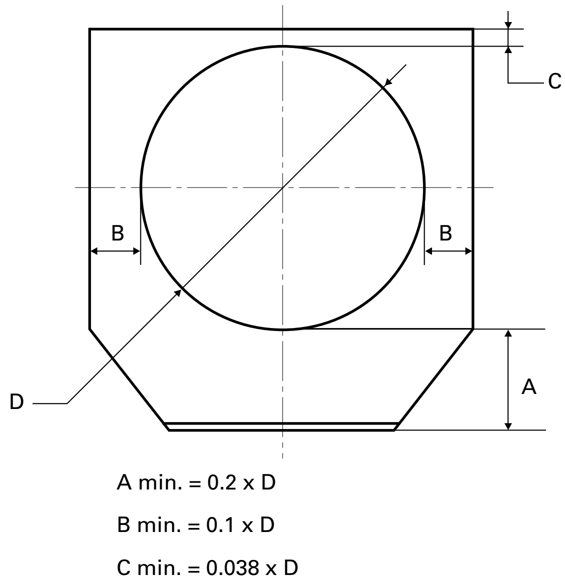


Fig. 3-4
Critical back-up roll chock sections

For more details regarding FEA, refer to chapter 3.3.

The average values of 60 % neck-to-barrel ratio and 10 % turn-down are achievable due to the fact that our heavy duty back-up roll bearing range is designed with a relatively shallow cup angle “2 α” and minimum cone and cup wall sections (fig. 3-5).

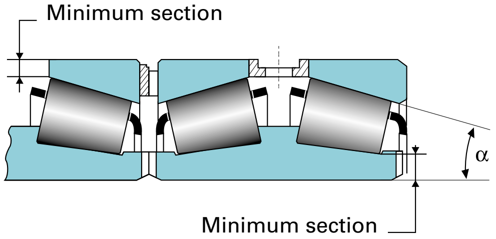


Fig. 3-5

These minimum sections are possible due to our high steel quality, our heat treatment processes and our long experience with case carburized steel.

These heavy duty bearings can easily be recognized, since their widths are always slightly greater (2 to 8 %) than their bores (fig. 3-6).

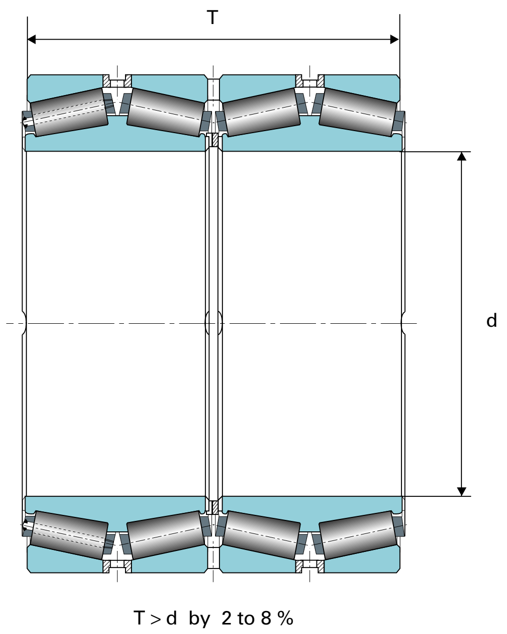


Fig. 3-6

They offer very good radial ratings due to the shallow angle and still offer enough axial capacity to avoid the need for a separate thrust bearing. The reduction in the number of bearings required on the back-up roll, also leads to a more compact chock design.

The tapered roller bearing has a radial rating approaching that of a 4-row cylindrical bearing of equal envelope dimensions. Bearing ratings are a function of numerous design parameters, and a discussion of ratings for tapered roller bearings is shown later in this book. Each bearing type has benefits and advantages. In the case of Timken tapered roller bearings, two such advantages are:

- **Close radial bearing clearance** : tapered roller bearings are axially adjusted with spacers to within close tolerances, and offer therefore an equivalent radial bearing clearance which is about 4.5 times smaller than the axial clearance (not achievable with other bearing types). This leads to an increased load zone and better control of load sharing over the four bearings rows which will result in an extended bearing life,
- **Proprietary Timken steel** which increases the material factor (critical in the rating equations).

Timken tapered roller bearings have proven to be very capable for high speed mills. With precise control of end play (internal clearance) and proper lubrication system design and function, experience has been successful for mill speeds up to 2100 m/min. (7000 FPM).

On rod and bar mills the trend for closer product tolerances also requires roll neck bearings with small radial clearances due to the fact that the top roll is changing load zone when the bar enters the roll groove (fig. 3-7).

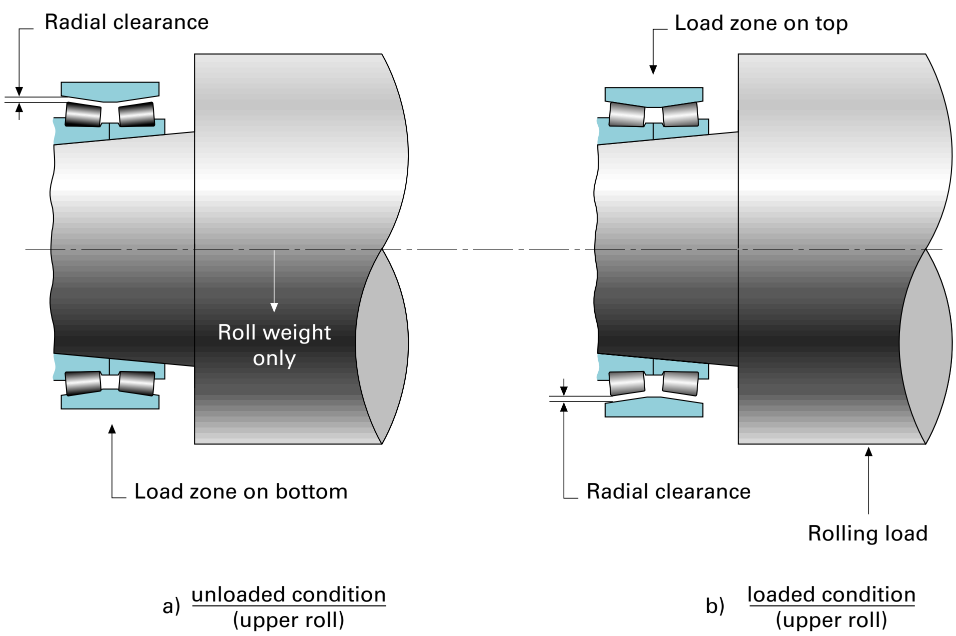


Fig. 3-7

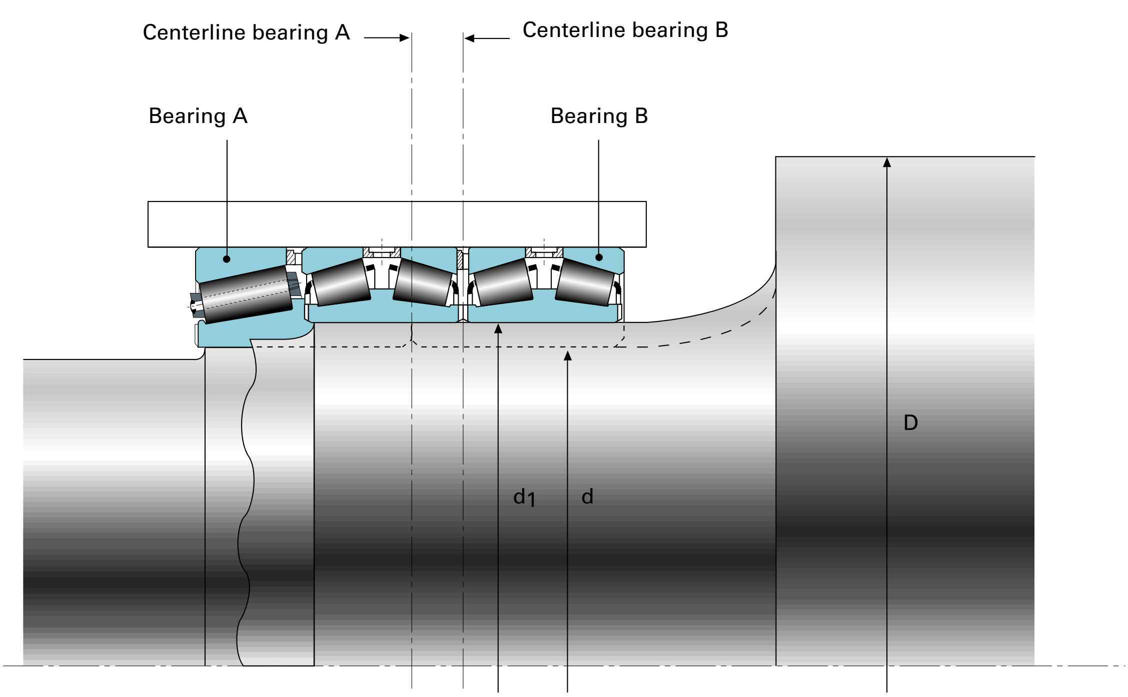
Example : for a bearing with a K factor of 1.76 and a mounted axial clearance of 0.100 mm (0.004 inch) the corresponding radial clearance would only be ~ 0.022 mm ± 0.007 (less than 0.001 inch ± 0.0003 inch).

The above describes most mills ; however please recognize that some mills will require a separate thrust bearing. For example : two-high profile mills, tube mills (piercing and elongator mills),...

This additional thrust capacity is required due to high axial loads or when a pass adjustment device is needed.

3.1.1.2. Neck design in very highly loaded applications

For extremely heavily loaded back-up rolls, which often run at slow speed, the conventional heavy duty bearing size (represented by bearing A) is no longer suitable. In these cases, a larger neck diameter is needed to cope with the higher bending stress (fig. 3-8) in accordance with the roll material.



d bore of heavy bearing d_1 bore of light bearing	$\frac{d}{D} \simeq 60$ %	$\frac{d_1}{D} \simeq 68$ %

Fig. 3-8

Therefore, lighter section bearings (represented by bearing B) are usually proposed with approximately the same outside diameter as the heavy duty bearings in order to maintain the required roll turn-down. These lighter bearings offer an increased neck-to-barrel ratio (d/D ≃ 68 %) and a smaller distance between the middle of the screw and the barrel face (shorter lever arm).

The decrease in bearing rating is compensated for by adding either or both of the following product attributes :

- vacuum remelted steel or other premium clean steels, which can increase bearing fatigue life by approximatively 2-3 times compared to current standard steels (fig. 3-9),

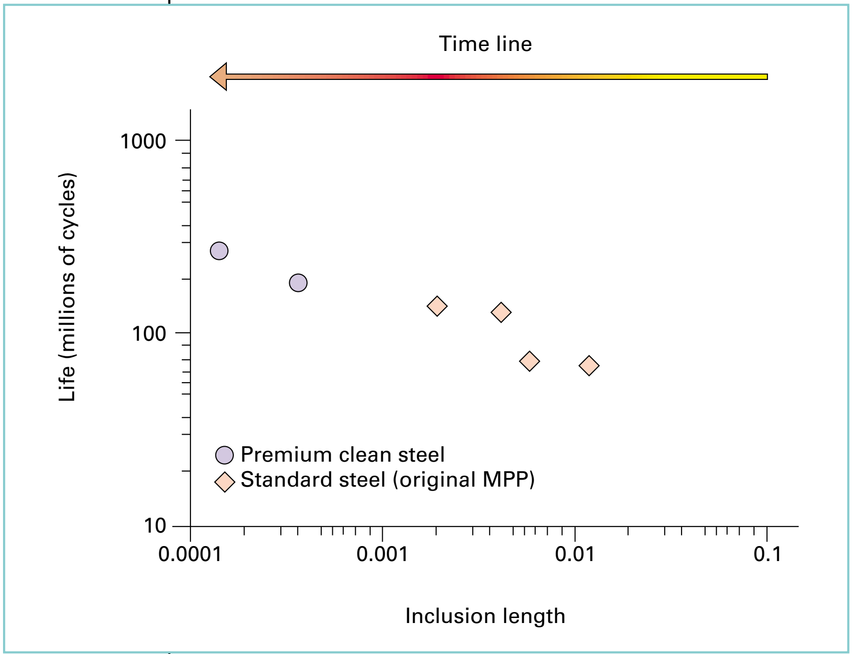


Fig. 3-9

- enhanced internal bearing geometry, which will reduce the roller-raceway end contact stresses and therefore avoid premature spalling (fig. 3-10).

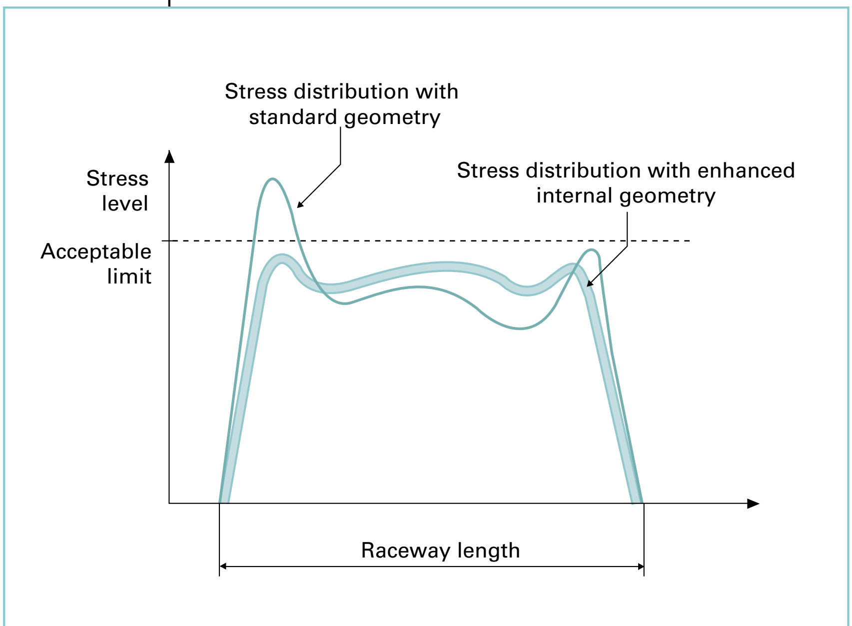


Fig. 3-10
Stress distribution along the roller raceway

These and other life enhancing features may be incorporated in your Timken bearing by contacting your local Timken sales representative.

COMPOUND FILLET PROFILE

The use of a roll neck fillet with a conventional single radius has its limitations and would not give the most desirable fillet design either from a strength or a space limitation point of view.

Elliptical fillets offer the best characteristics, but are difficult to grind. Compound or two-radii fillets are a practical solution from the standpoint of roll grinding and offer a design that is quite similar to the true elliptical fillet contour.

Figure 3-11 shows the development of this compound radii fillet from two predetermined dimensions of height and length of fillet : "r_a" and "r_b" respectively.

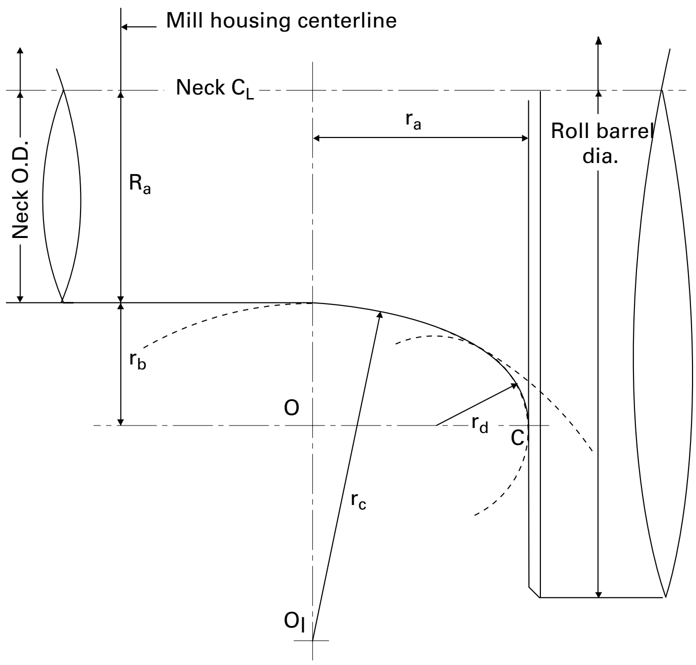


Fig. 3-11 Compound fillet radius

Below are the formulae used to calculate the major and minor radii for use in practical examples.

$$r_d = \left(\frac{4r_b - r_a}{3}\right) \qquad r_c = r_a + \frac{(r_a - r_b)^2}{2\,(r_b - r_d)}$$

where :

r_a = fillet length
(r_a is less than 2.5 r_b for practical purposes)

r_b = fillet height

r_c = major radius

r_d = minor radius

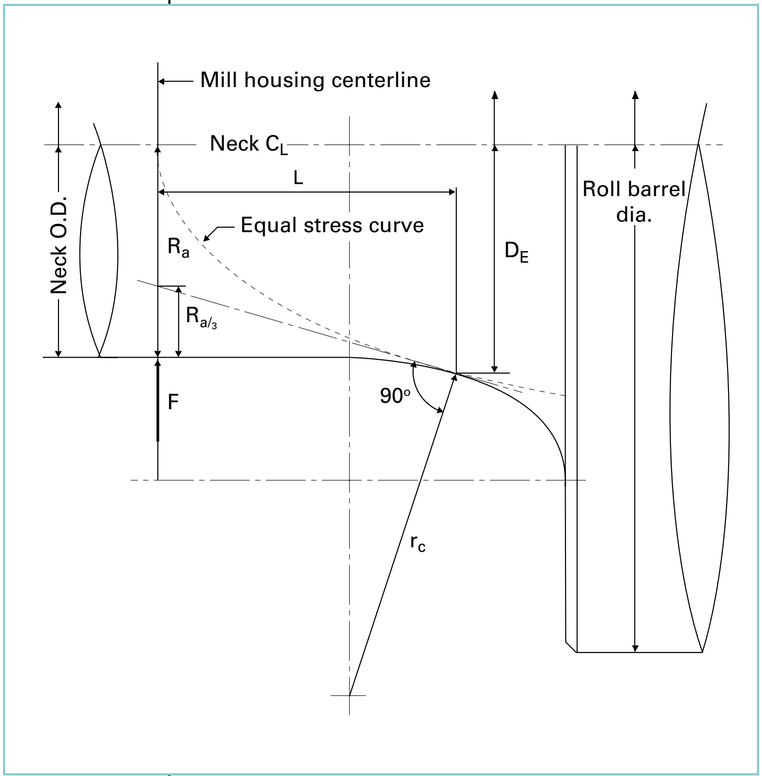


Fig. 3-12
Equal stress curve

Figure 3-12 shows the working diameter, D_E, and the working length, L, of the neck, which are used in calculating the bending stress. An equal stress curve is plotted to pass through, and be tangential to the major radius of the fillet. Equivalent neck diameter and effective working length of the neck can most conveniently be determined by a graphical solution.

Among other fillet designs normally considered, fig. 3-13 shows a design where the neck size is relatively small (neck-to-barrel ratio 40 to 50 %) in order to achieve a large roll turn-down. In this case, the neck diameter in the fillet area must be increased in order to keep the neck bending stress within acceptable limits.

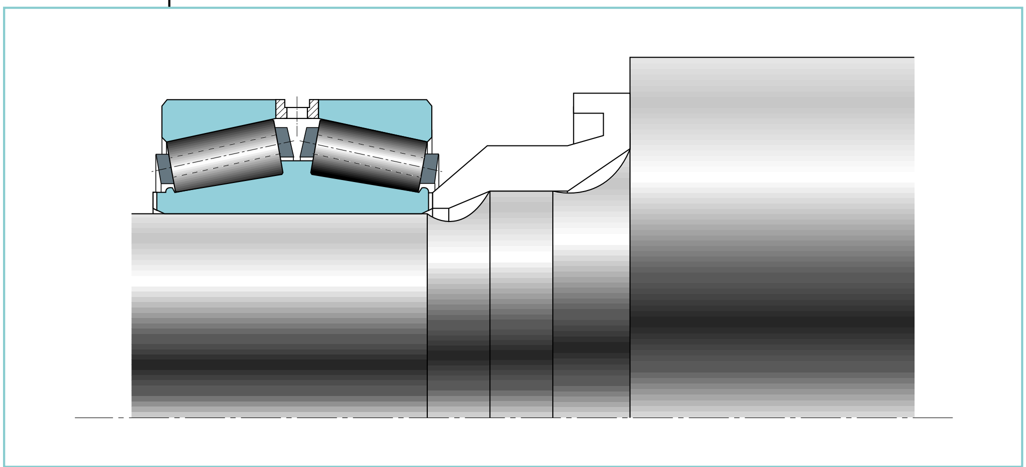


Fig. 3-13

Two types of roll neck bearing mountings are usually considered according to mill speed and load. TQOW/2TDIW/TDIW assemblies, where the cones are mounted loose, are appropriate for speeds up to 600 to 750 m/min (2000 to 2500 ft/min) depending on loads. Otherwise, TQITS/TDIT/TNAT assemblies with tight cone fits are needed. In addition, higher product accuracy is achieved with tight cone fits regardless of mill speed.

3.1.1.3. Loose-mounted cones

THE DIRECT MOUNTING ARRANGEMENT

The most popular type of roll neck bearing is designed around the direct mounting (DM) concept, either in the two-row (TDI) or in the four-row (TQOW/2TDIW) configuration (fig. 3-14).

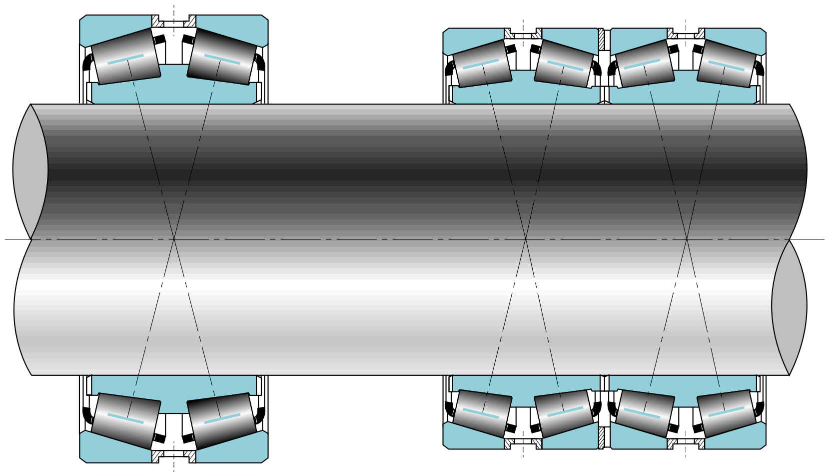


Fig. 3-14
Direct mountings

The cones are mounted with a loose fit which ranges from a minimum of 0.050 mm (0.002 inch) to a maximum of 0.600 mm (0.024 inch) according to bore size. Refer to chapter 6 for fitting practice guidelines.

The primary benefit of the loose fit is the quick mounting and removal of the complete chock unit from the roll necks during roll change.

Since slight creeping may occur between cone bore and roll neck, this additional clearance will permit presence of lubricant to prevent neck scuffing.

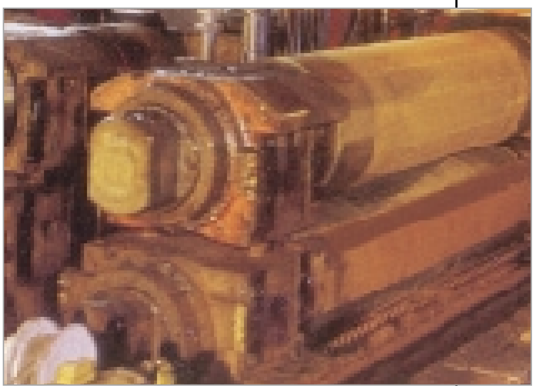


Fig. 3-15
Work rolls with loose-mounted bearings

TIMKEN

The “Direct Mounting” bearing design shown in fig. 3-16, requires that the cups are clamped in place to withstand the axial load induced by the radial load Fr, within the bearing, and to maintain the built-in lateral setting which the cup spacer provides.

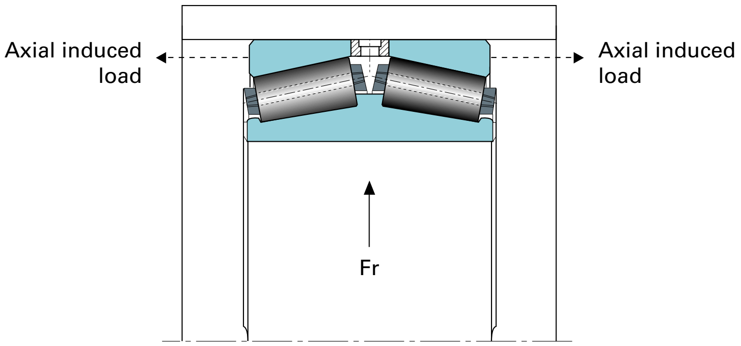


Fig. 3-16

This “Direct Mounting” design permits the cones to remain unclamped, which is necessary to enable the cones to creep freely on the neck. We suggest a resulting small axial gap of about 0.5 to 1 mm (0.020 to 0.040 inch) between the cone face and the cone retaining device.

This axial freedom of the cones allows roll thermal expansion to be absorbed between the bearing and the roll neck shoulders. Of course, minimum lubrication of the necks and of the cone bores is mandatory.

SPEED LIMITS

Loose-fitted TDI and TQOW assemblies have been selected and applied over many decades on roll necks of all kinds of mills operating at low to medium speeds with very satisfactory results. Most of these mills, depending on the loads applied and environmental conditions, are operating at speeds up to 800 m/min (2600 ft/min). We also have experience with mills running at 1000 m/min (3300 ft/min) product speed.

Scuffing and wear usually stay within acceptable limits during the life of the rolls, which is governed by the roll turn-down. Neck wear and other types of surface damage are also dependent upon the surface hardness of the roll neck (typical hardness : 33 Hrc) and the efficiency of the lubrication applied between neck and bore.

NECK LUBRICATION

Hot mill back-up rolls often stay in the mill for extended periods of time (several months on roughing stands), therefore, drillings are often provided to enable the necks to be easily lubricated (fig. 3-17).

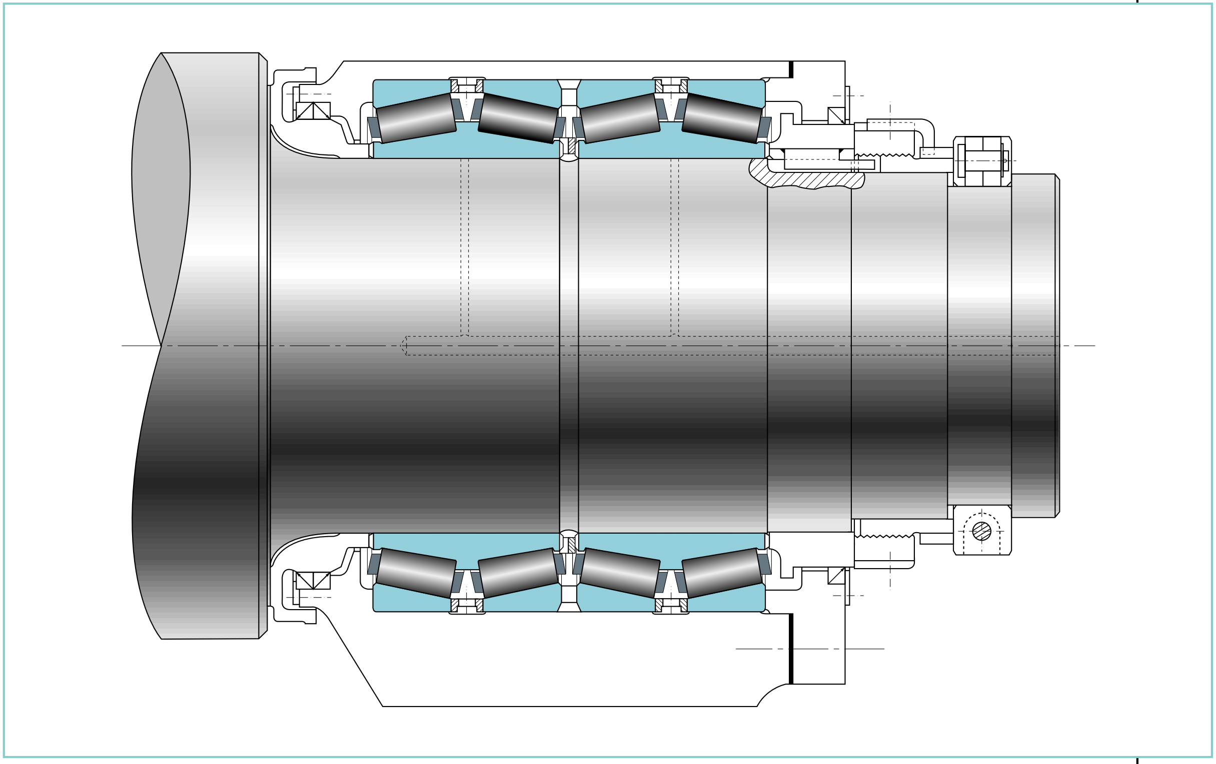
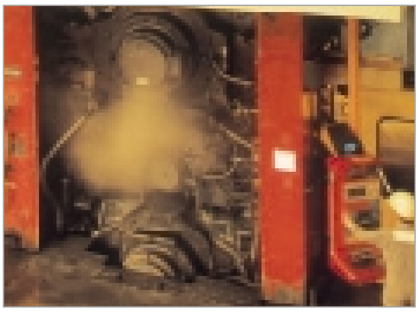


Fig. 3-17
Neck relubrication through drillings in the neck



The lubricant frequency and quantity will depend on the sealing efficiency of the system.

A range of new lubricants (grease pastes, sprays,...) has further improved the wear resistance of the necks.

With an oil-mist or oil-air system, lubricant can be introduced during operation to the neck through slots in the faces and holes provided in the ribs of the inner rings. This will supplement the initial neck/cone bore lubrication supplied at roll build-up.

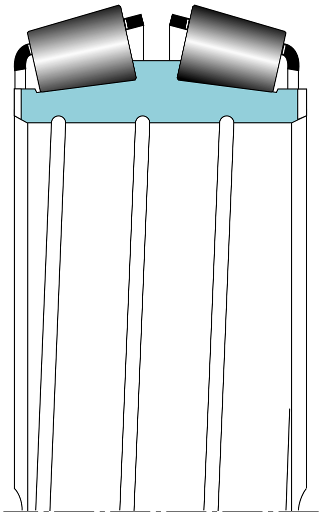


Fig. 3-18
Spiral groove in bearing bore

Spiral grooves in the cone bores can also help to retain the lubricant between the neck and inner ring (fig. 3-18).

Sealing arrangements incorporating extended cone ribs will allow a separate lubricant entry to be added between the fillet ring and the cone faces as shown in fig. 3-19. This design may be used instead of the drilled holes in the neck.

On cold strip mills, where the environment is less severe than on hot mills, the back-up roll necks experience very little wear even at high speeds (example : temper mills with product speeds as high as 1000 m/min - 3300 ft/min).

Cold aluminium mills, having operated for years, experience insignificant neck wear. This results in the operator being able to regrind the roll body without any need to regrind the neck, which supports the roll on the grinder.

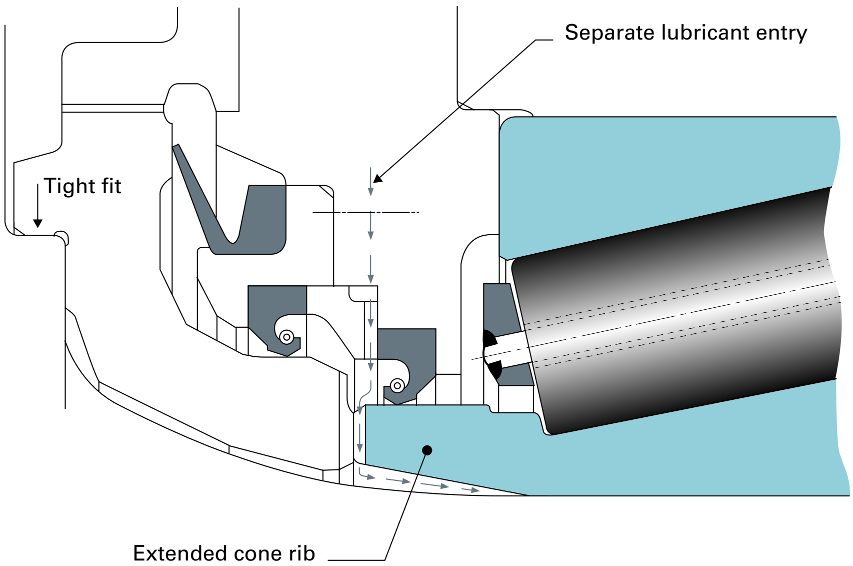


Fig. 3-19
Neck and shoulder lubrication via slots in the cone face

3.1.1.4. Tight-mounted cones

Loose-fitted inner rings on roll necks are no longer a viable proposition for rolling speeds above a range from 800 to 1000 m/min (2600 to 3300 ft/min) combined with high rolling loads, for instance, on cold reduction mills.

The solution is, therefore, to use a two or four-row tapered roller bearing which can easily be tight-fitted and removed from the roll necks.

The TQITS type (or its equivalent two-row TNATS) bearing with a tapered bore is obviously the route to go. Special bearings of this type (fig. 3-20a) have run at rolling speeds of around 2150 m/min (7000 ft/min).

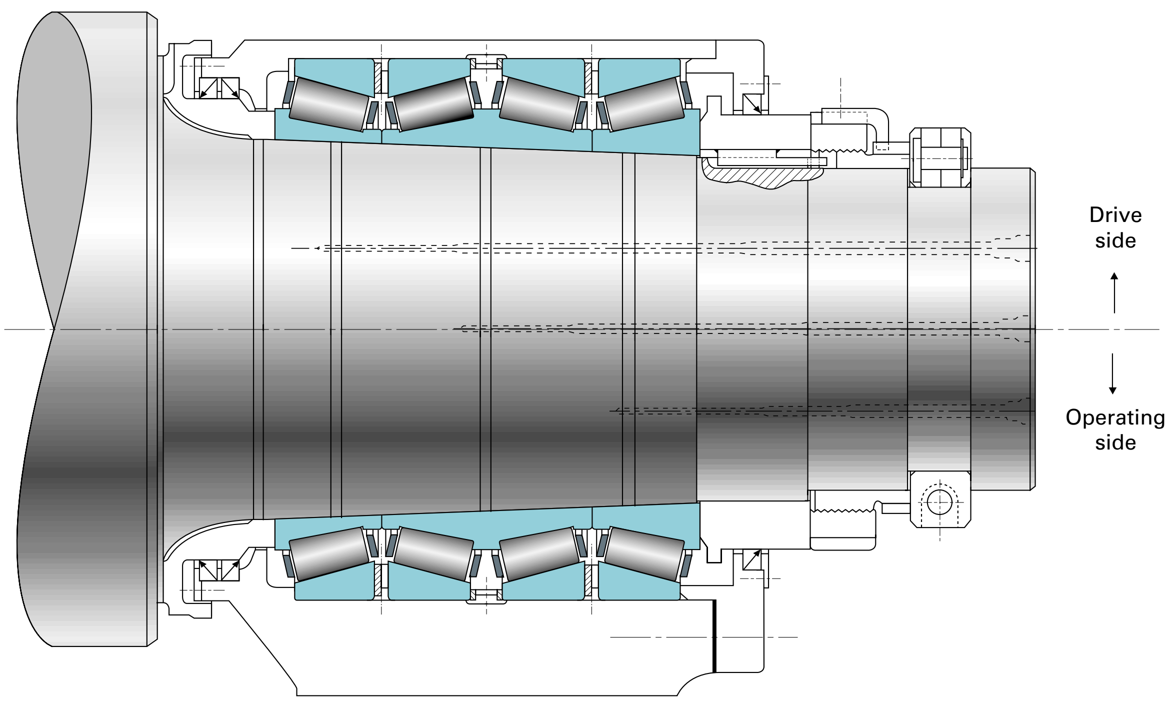


Fig. 3-20a

This assembly, when mounted in its chock, is usually pushed up the tapered neck with a hydraulic jack, or hydraulic wedge lock (fig. 3-20b). It can be removed simply by injecting oil underneath the cone via drillings and circular grooves provided in the roll necks. Reference pages 158-166 for more information on the assembly and removal of tapered bore bearings.

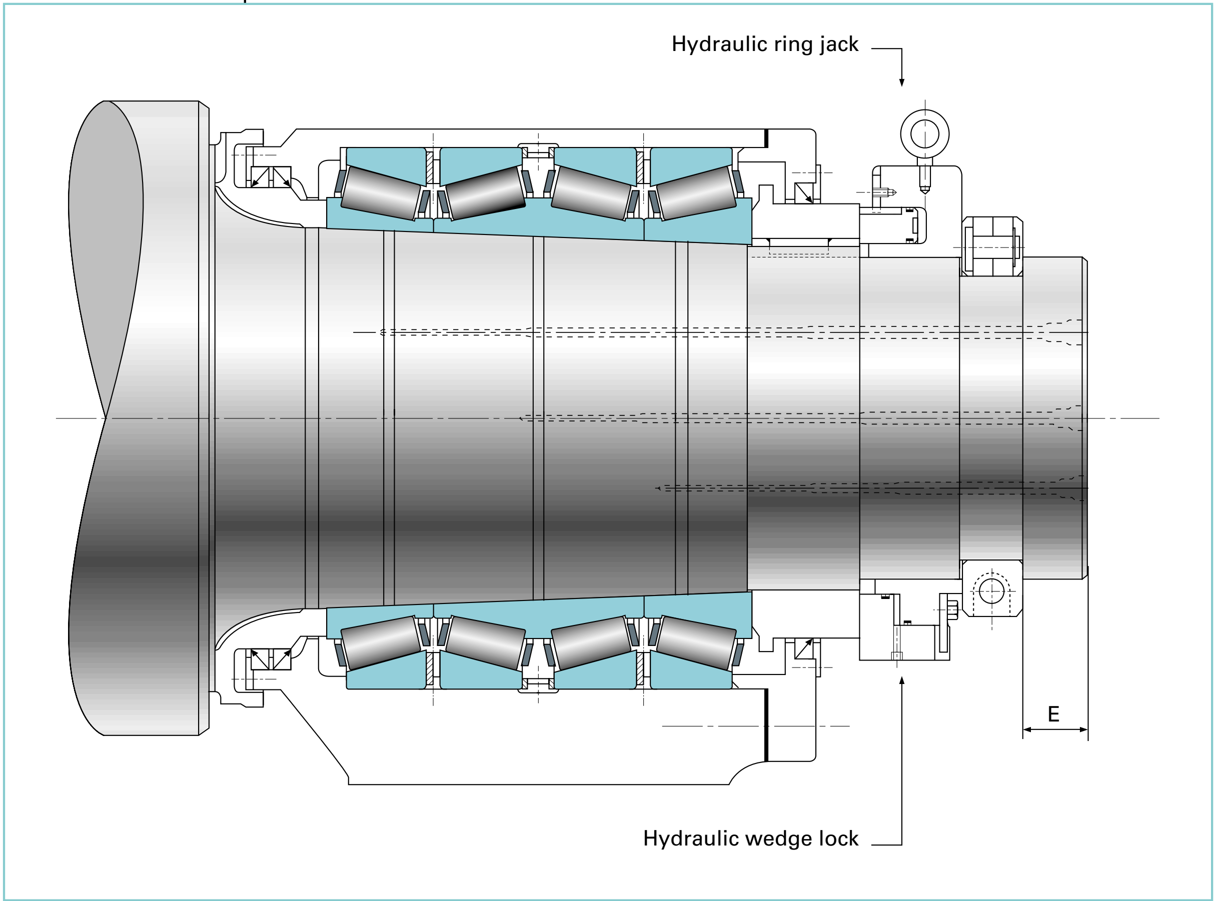


Fig. 3-20b
TQITS mounting with hydraulic ring jack or hydraulic wedge lock

The pressure required to seat such bearings can reach up to 400 bar (5800 psi) and is determined by the jack piston size which is normally provided in accordance with the selected bearing.

This same pressure is also sufficient to remove, individually, each of the 3 cones comprising the bearing (highest pressure required for the middle double cone).

We have selected a 1/12 taper for the bearing bore and neck diameter which provides a locking taper, but still allows easy removal. We advise using a heavy interference fit which permits the desired contact pressure between neck and inner ring bore to be achieved (the base cone being the inner one with the smallest section).

We can also use decreasing levels of interference fits for each of the 3 cones so that the contact pressure level defined on the inner cone is not exceeded. The push-up force and the hydraulic jack required can therefore be decreased. Such a decrease permits also the design of a narrower neck extension and hinged ring while still keeping the stresses within acceptable limits when the push-up force is applied ("E" on fig. 3-20b above).

THE INDIRECT MOUNTING ARRANGEMENT

The indirect mounting arrangement “IM” (fig. 3-21), two-row version (TNAT type) or four-row version (TQIT type), can be selected this time due to the fact that tight mounted cones are preferred.

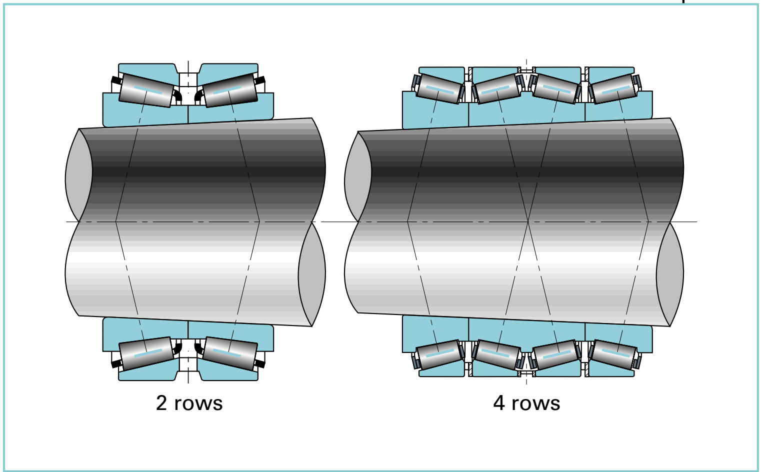


Fig. 3-21
Indirect mountings

With such an indirect mounting design the final endplay is obtained after mounting. In this design the cones are clamped axially in order to set the bearing and to withstand the induced axial load. It is then not necessary to clamp the cups, except for axial roll location (fig. 3-22).

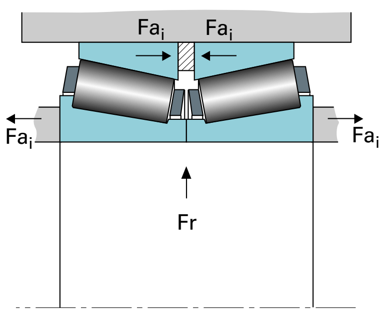


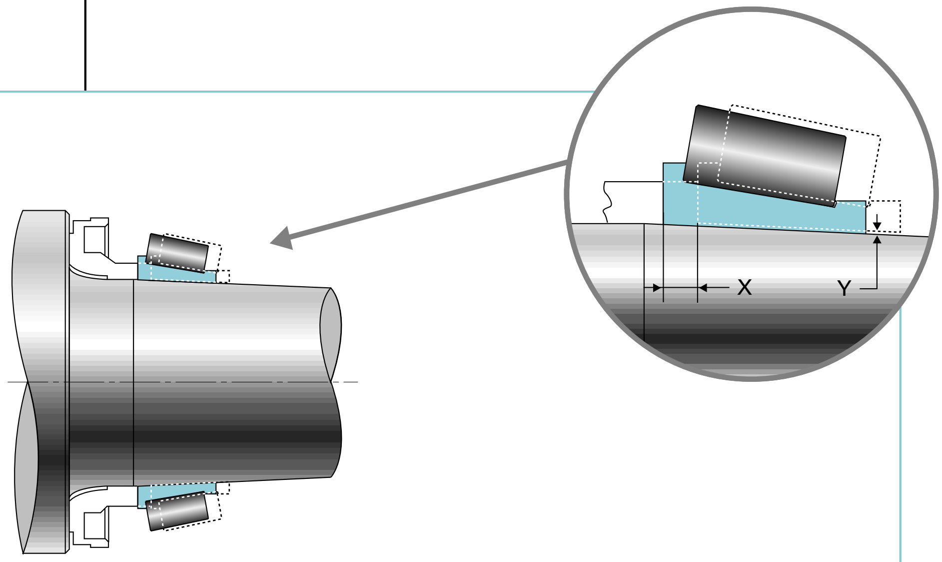
Fig. 3-22
Axial induced loads Fa_i

Some of the advantages offered by the TQIT type bearing are the following :

- higher roll neck rigidity due to increased spread of effective centers ; hence additional stability which maintains better contact between rollers and races, thus better load distribution over the rows,
- cups can be kept unclamped in one of the two chocks and can therefore float in the “lubricated” chock bore. Hence less load due to the overturning moment created by this chock when it moves axially in the mill frame window when roll expansion takes place,

- the tapered design concept in the bearing bore like the tapered rollers in the bearing itself (load zone control, good load sharing,...) enables the required nominal interference fit to be achieved within a very small tolerance range (for instance, only about 3 % of the fit for large bearings) (fig. 3-23). This means that the mounted internal bearing clearance is obtained within the same small tolerance range as the interference fit which governs the expansion of the cone races.

This very precise internal clearance is also essential for high-speed mills, with lubrication systems supplying only small quantities of oil to the bearing like oil-mist or oil-air systems. It will in fact help to better control the operating temperature,



X = push-up tolerance = fillet ring length tolerance + cone bore tolerance (expressed axially)

$Y = \frac{X}{12}$ = radial expansion tolerance

Example : for a TQITS of about 850 mm bore (about 34 inch), the interference fit required is of about 0.65 mm (about 0.025 inch) and $Y = \frac{\pm 0.051 \quad \pm 0.051}{12} = \pm 0.008$ mm (0.0003 inch)

Fig. 3-23
Tight control of the interference fit

- in heavily loaded applications, inner ring bore growth can occur after several years of operation. The corresponding loss of interference can easily be compensated for by reconditioning your bearing (regrinding of the inner ring faces). Note that the same interference loss would not be recoverable with straight bore bearings,
- possibility to readjust or change the initial setting, if required, due to a further increase of original maximum mill speed, by a simple operation of spacer re-sizing. Sizing differently the cup spacers is also a possibility to optimize load sharing.

The TQITS can also be supplied as an extended inner ring version (TQITSE) which provides the potential to incorporate a sealed system between chock and bearing (fig. 3-24).

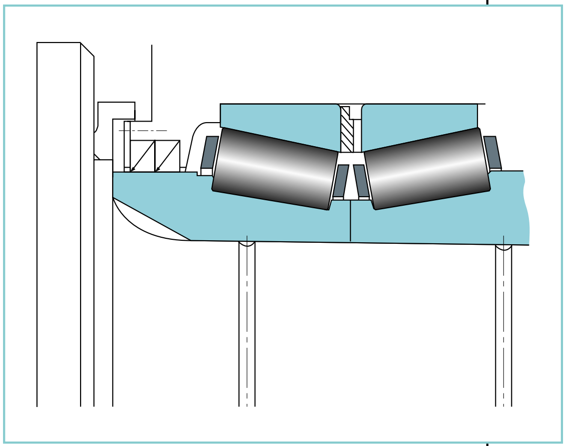


Fig. 3-24
TQITSE

Some of the advantages of the TQITSE are :

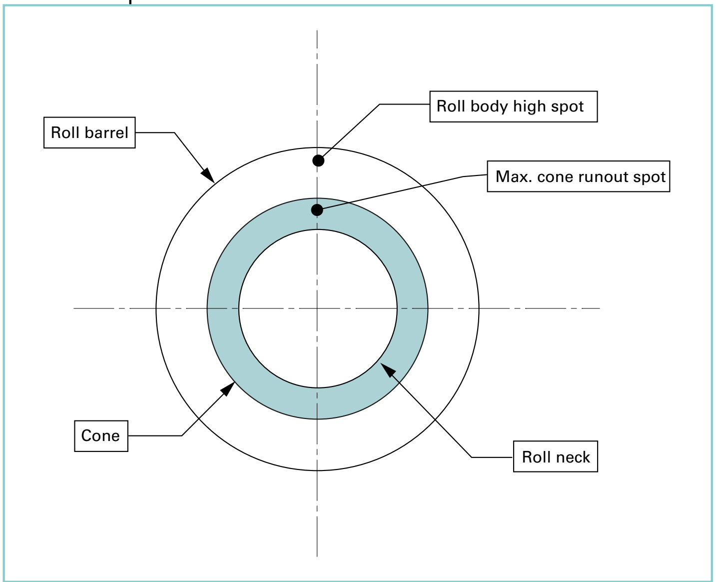
- no risk of damage to the lip seals during assembly,
- the lips of the seals can be pointed outwards in order to prevent coolant entries,
- at every roll change, the seal lips stay on the same ground, concentric and hardened bearing surface.

BEARING "RUNOUT"
(Precision grade roll neck bearings)

For high speed strip mills (and others as well) usually rolling light gauges for can stock..., the demand for high rotational accuracy back-up roll bearings has become an obvious must. Today's trend is to achieve strip thicknesses within a tolerance of less then 0.005 mm (i.e. ± 0.0025 mm ; ± 0.0001 inch).

We presently supply precision back-up roll bearings with runouts which enable you to match and even surpass the above market needs.

Our processes allow us to manufacture and control the wall thickness variation of the inner and outer ring races to within a few microns as well as to control the roller diameter variation within each bearing row.



In addition, we identify the high spot of each individual inner ring by marking it with a copper dot. This allows you to achieve an even higher precision within the "bearing-roll" system by matching the roll body and the inner ring high spots when the chocks are fitted on the roll necks (fig. 3-25).

Fig. 3-25
Achieving the best total runout

For high speed and often pre-stressed rod and bar mill stands, TQITS(E) or TNAT(E) bearings (fig. 3-26) with floating cups, are the ideal choice due to their excellent radial clearance control, and also with the current demand for always achieving better product tolerances on these types of mills.

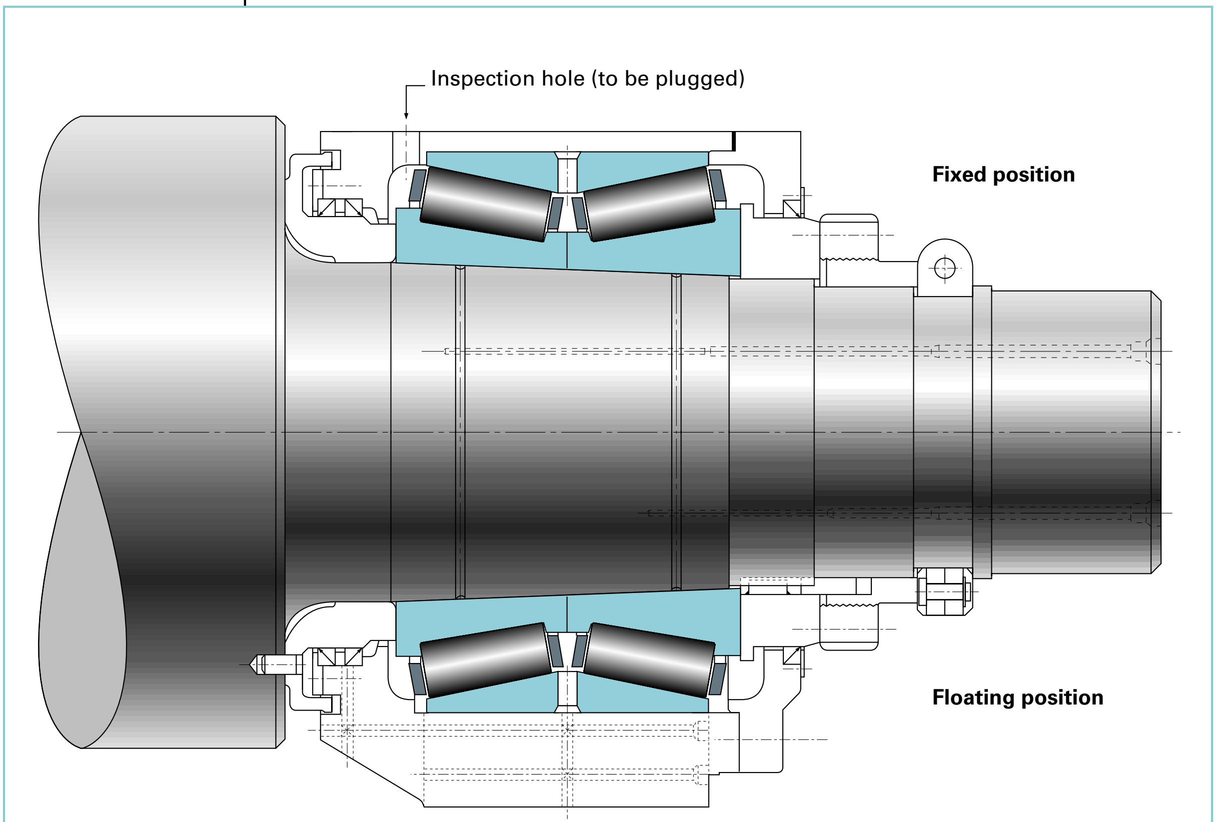


Fig. 3-26
TNAT mounting

3.1.2. Work rolls

Our range of typical work roll bearings is much more diverse as far as the bearing angles are concerned, compared to our range of heavy duty back-up roll bearings.

The work roll bearing has also a smaller section height and a much narrower width than a back-up roll bearing (fig. 3-27). This is due to the fact that loads are much less significant on work rolls, and because the chock sections in the vertical plane are very thin on the pass line side as well as on the opposite side where the work roll is backed up.

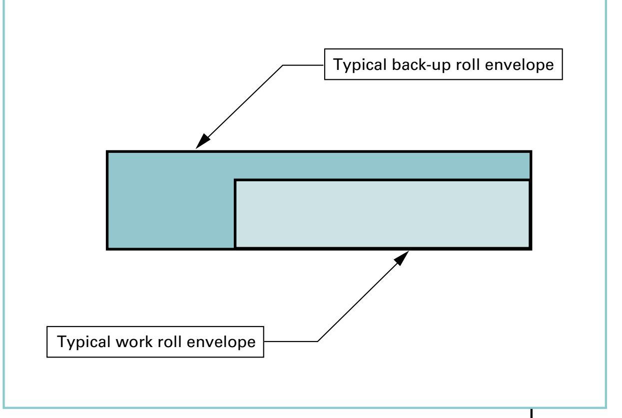


Fig. 3-27
Relative bearing envelopes

In order to achieve a 10 % average roll turn-down, these vertical chock sections represent about 12.5 % of the bearing outside radius, and sometimes, can be even smaller (fig. 3-28).

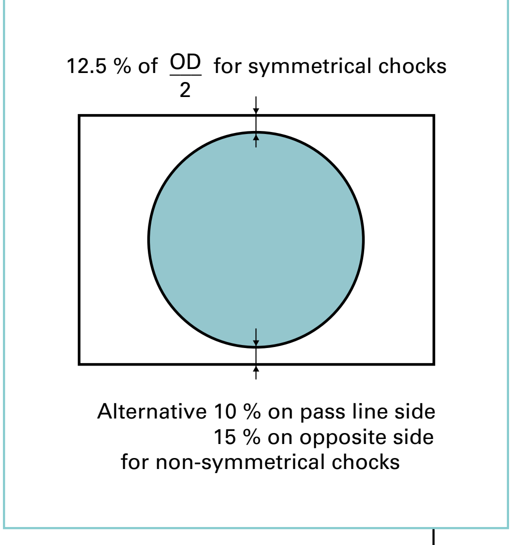


Fig. 3-28

On top of that, the neck diameter can vary greatly according to the material used for the rolls. Today, with the new materials used on the rolls, the neck-to-barrel ratio ranges around 45 to 50 % for cold mills where steel rolls are considered, and around 55 to 60 % for hot mills where various grades of cast iron rolls are used (past neck-to-barrel ratios were more likely 55 % and 62 % respectively).

Loose-mounted bearings

Due to frequent work roll changes, easy and fast mounting and removal of the chock-bearing system is mandatory. The loose-fitted four-row type bearing as described in the previous chapter 3.1.1.3., is the most widely used solution for both cold and hot strip mills rolling steel and non ferrous materials (fig. 3-29).

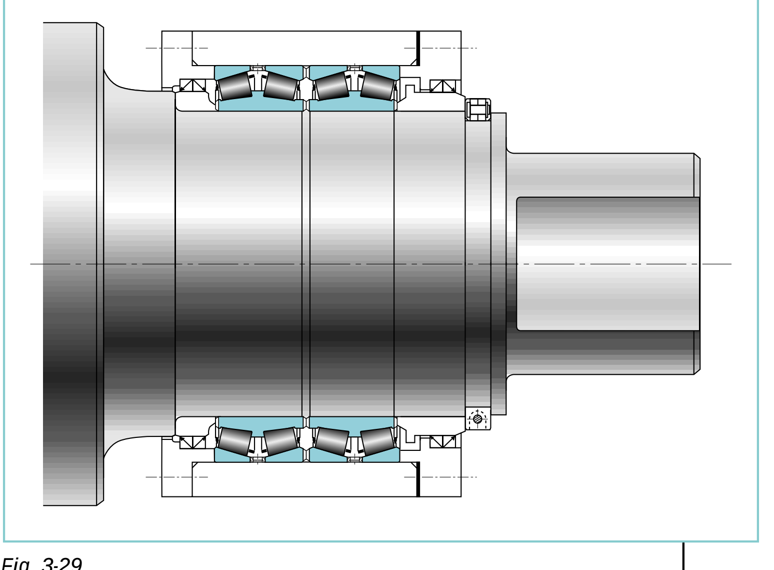


Fig. 3-29
Loose-fitted 2TDIW mounting

The loose-fitted concept is common practice in the industry regardless of the rolling speed. Neck wear stays most of the time within acceptable limits and is not an important factor influencing roll life.

On cold mills with steel rolls, although speed and roll lives are higher, neck wear is generally not a problem. A minimum amount of lubricant between neck and bearing bore has always minimized this phenomenon.

Only for a few high speed aluminium mills, it has been decided as a preventive manner to go along with tight-mounted tapered roller bearings.

Many existing mills have been designed with steeper angle work roll bearings compared to the back-up roll bearings. K factors ranging from 1 to 1.8 give enough axial rating to the four-row assembly in order to cope with the axial loads induced by "uncontrolled" roll crossing. Regular maintenance of the lateral chock wear plates limits the negative effect of this phenomenon on bearing life. These bearing selections can withstand axial loads equivalent to approximately 1 % of the rolling load.

The need for closer tolerances and higher quality finished product demands new rolling processes and production methods which increase the loads on the work roll bearings.

Roll bending and axial shift system are two examples that we will review in more detail.

3.1.2.1. Work roll bending practice

Greater loads are applied to the work roll chocks through positive and negative roll bending practice. This practice was introduced some 2 to 3 decades ago on cold strip mills in order to improve the strip shape and flatness qualities. During the past decade, bending loads have also been applied on hot strip mills to further improve the product quality.

"Quick roll change" devices were also introduced over the years, changing significantly the chock design (fig. 3-30). Loads are now applied differently to the chocks via pistons housed in the "piston block" which is fixed in the mill frame window.

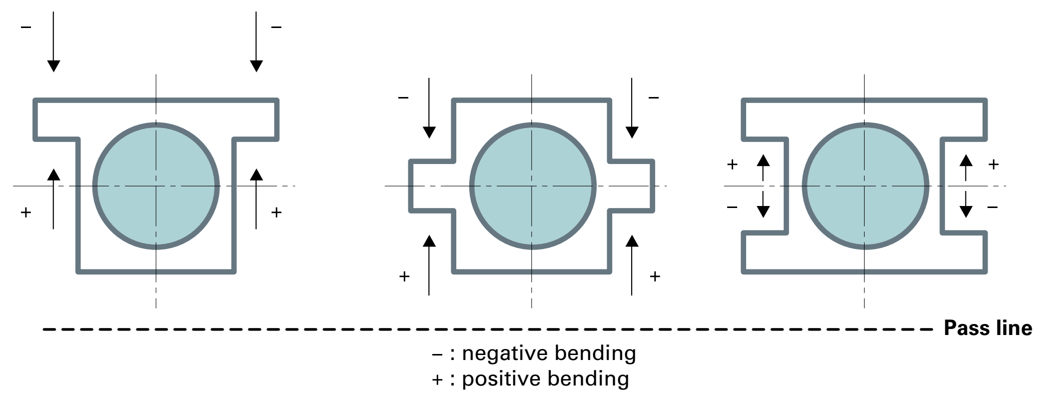


Fig. 3-30
Work roll chock designs

Bending loads (per chock) of about 60-80 metric tons on cold mills and up to 150-200 metric tons on hot mills are now currently used.

This, in combination with smaller chock sections, illustrates the fact that work roll bearing selection is no longer a routine as in the past when only balancing loads were applied.

Therefore, a more in-depth analysis (Finite Element Analysis or equivalent) sometimes has to be conducted in order to evaluate if the theoretical calculated life is still acceptable. This FEA has often shown 10 to 15 % life variation versus catalogue calculation due to the chock bore deformation which takes place with these higher applied loads (fig. 3-31).

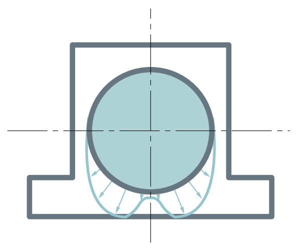
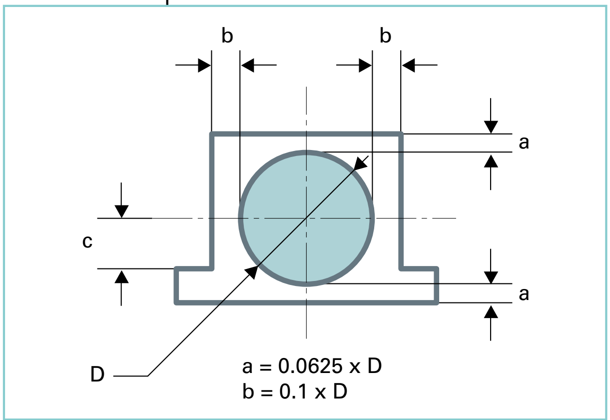


Fig. 3-31
Typical load distribution with negative bending

Such analysis has shown that the thin chock sections “a” (fig. 3-32) in the vertical plane are not the only important ones under a higher loading cycle. The lateral chock sections “b” and particularly the position “c” of the flange relative to the bore where the load is applied are very critical too.



NOTE : Finite element analysis even showed that roller load distribution could be improved significantly with slightly smaller chock sections than usual, considering the 12.5 % roll turn-down coefficient.

Fig. 3-32
Work roll chock sections

This emphasizes the fact that the neck size should be evaluated according to roll material and roll torque to enable the selection of the smallest possible bearing bore (neck-to-barrel ratios ~ 45-50 % for cold mills, 55-60 % for hot mills). This will then leave enough available material on the chocks to strengthen the sections in the vertical plane whenever it is technically feasible.

3.1.2.2. Radial position

The four-row tapered roller bearing of the TQOW type (or 2 TDIW type) is still the preferred solution throughout the industry, due to its characteristically superior load sharing and load zone control.

The six-row tapered roller bearing can also be considered in order to achieve the bearing rating required when strong necks are mandatory with minimum roll diameter without sacrificing the chock sections.

Such six-row bearings are already in use on the work rolls of several hot and cold aluminium mills and are also now designed into 4-high steckel mill work rolls.

With the usual retaining device, spacer + nut + split hinged ring, it is necessary at the mounting stage to tighten the nut in order to get all pieces in contact axially (fillet ring - bearing inner rings and spacer - outside spacer - nut system - split hinged ring as shown on fig. 3-17). Then, it is essential to unscrew the nut in order to leave an axial clearance of about 0.5 to 1 mm (0.02 to 0.04 inch) to enable free inner ring rotation (see also chapter 5.1.).

In the case of the 2TDIW concept (without cone spacer), the tolerance on overall inner ring width is controlled (see tabulation chapter 6) so that it makes it possible to eliminate the nut system and therefore the manual screw-unscrew operation. In this case, the only pieces needed to hold the bearing in place on the neck are the outside abutment ring (used also for seal seat) and the split hinged ring (see fig. 3-33).

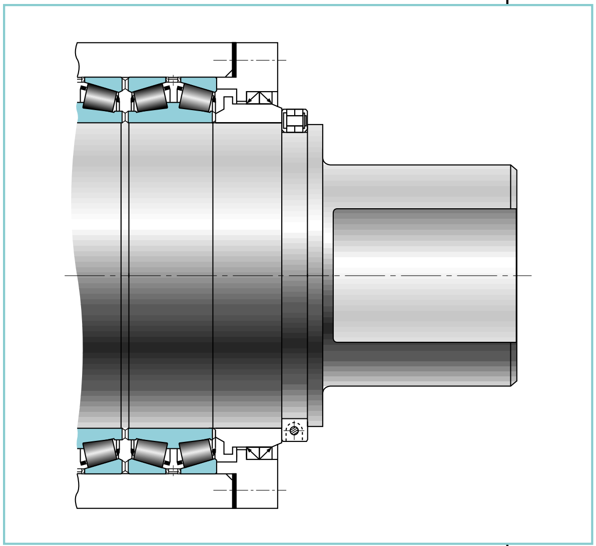


Fig. 3-33

This retaining system also provides security. It ensures that the cones are kept free axially with the recommended clearance.

THE 2 or 3 TDIW CONCEPT (no inner ring spacer), AN ADVANTAGE WHICH SIMPLIFIES THE NECK CLAMPING SYSTEM AND REDUCES THE MOUNTING TIME.

SEALED ROLL NECK BEARINGS

The trend towards Sealed Roll Neck Bearings (within the same overall size as the unsealed version) started in the late 70's. It developed and grew rapidly among operators, in particular on hot mills over this last decade.

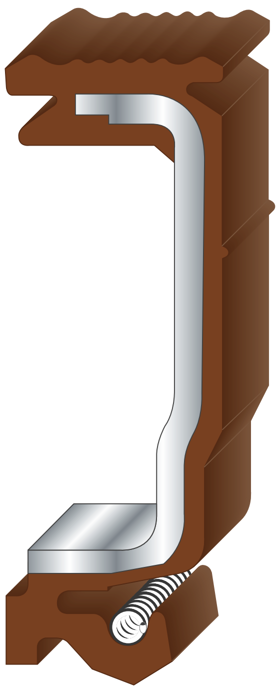


Fig. 3-34
"Two in one" main seal

This change was mainly driven by the need to drastically reduce grease consumption and maintenance costs. Chocks no longer need to be re-greased at each roll change as previously practiced, allowing also for cleaner mills and less contamination of roll coolants…

Re-greasing has now been extended by the operators to a frequency of about 500 to 1000 hours on cold mills. In addition general bearing inspection intervals have been extended to every 1000 to 1500 hours.

Furthermore, with the limitation of outside contamination and improved lubricant retention inside the bearing, enhanced greases have been developed. This should lead to an improvement in bearing performance if the “loads-bearing rating” ratio remains the same and if an adequate maintenance level is retained on the chock-bearing-neck system.

The possibility now to propose such enhanced greases is of particular importance not only for hot mills where rolls are abundantly water cooled, but also for high speed cold mills where the expected operating temperatures of the bearings are significant, namely around 100 °C (212 °F) or more.

The fact that the seals are built into the bearing at each end allows the seals to remain on their rubbing seats during frequent roll changes with no risk of damage. Nevertheless, the use of such bearings still requires a correct and well maintained chock sealing arrangement, particularly at the roll barrel face side.

(For more information, see also chapter 4.2.).

THE SEALED “CHOCK-BEARING” SYSTEM

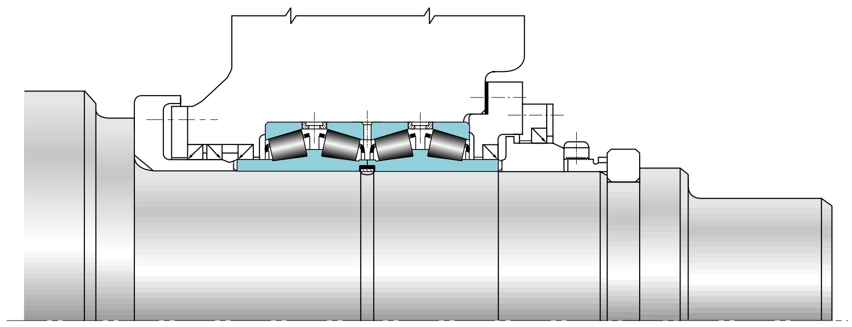


Fig. 3-35

The space necessary for the seal, even if small, often requires a small decrease in bearing rating. Another solution to avoid any decrease would be to use at the design stage, a four-row bearing with extended inner rings (TQOWE or 2TDIWE type) which will provide a sealed “chock-bearing” system (fig. 3-35).

3.1.2.3. Axial roll shifting systems and others

The introduction of axial shifting (fig. 3-36), roll crossing, or any other concept to further enhance strip shape and flatness, is another reason for paying much more attention to the selection of the bearing arrangement.

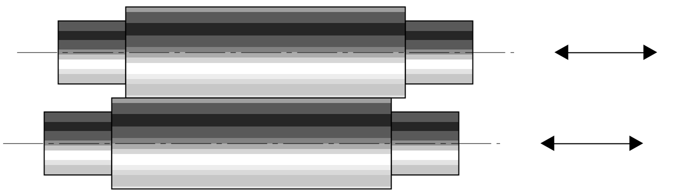


Fig. 3-36
Axial shift system

With these additional axial loads combined with the increased bending load, a separate axial bearing position might be required in order to still achieve satisfactory bearing performance.

Nevertheless, several mills equipped with such axial shift systems are still just mounted on four-row TQOW type bearings. These bearings then need a steeper angle to withstand the additional axial load.

For work rolls where higher axial loads up to 100 tons are used, the solution is to provide a separate axial tapered roller bearing on the fixed chock position (fig. 3-37).

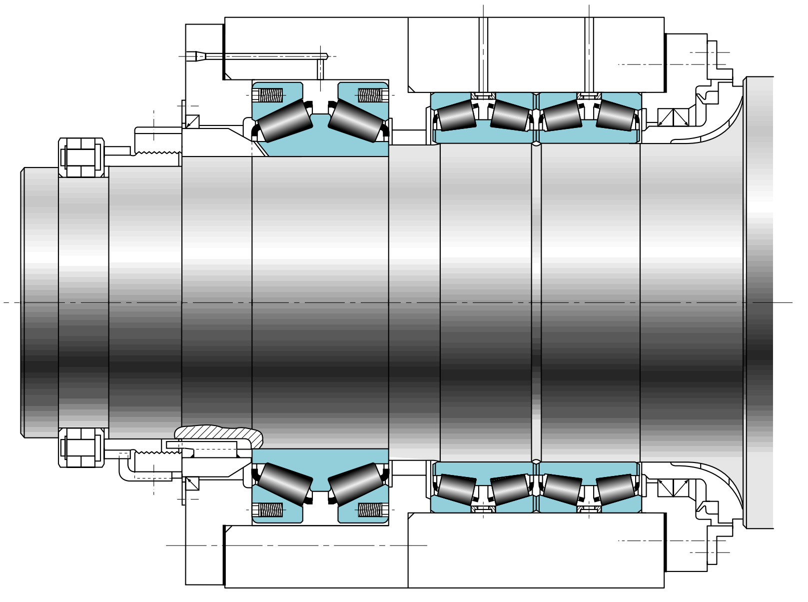


Fig. 3-37
Separate axial position in case of high axial loads

In those cases where a separate axial bearing is used, increased radial rating bearings can be selected with "K" factors ranging from 1.7 to 2.

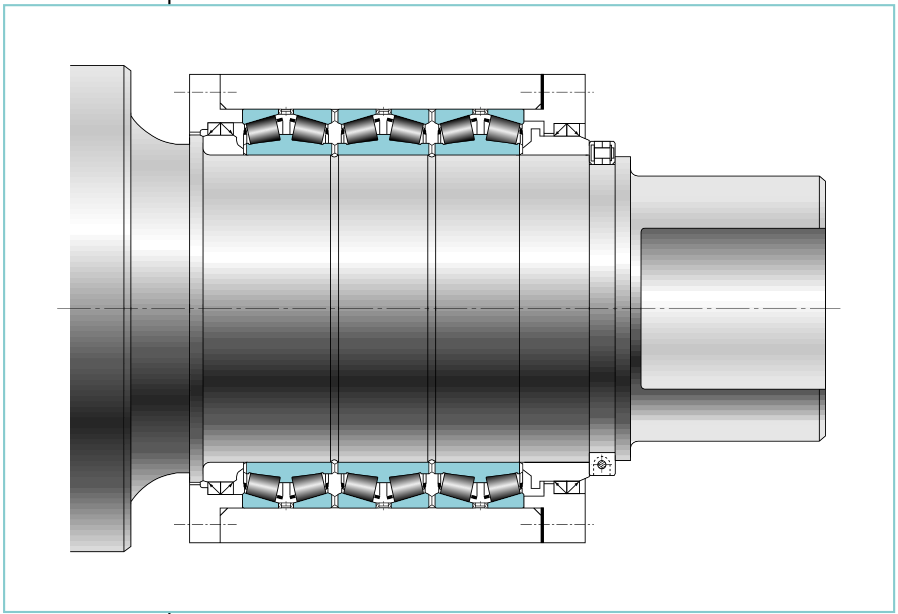


Fig. 3-38
Combined axial and radial position with a six-row bearing assembly

A six-row assembly would also increase the overall available axial rating and therefore, from the detailed loading conditions, we could evaluate if a separate axial bearing is still needed (fig. 3-38).

As the axial load can act in both directions, a two-row double acting thrust bearing is usually required. Presently, two-row tapered roller bearings of the Direct Mounting arrangement (TDIK type bearing, fig. 3-39) are mainly selected for the work rolls of hot mills where grease is the usual type of lubrication.

These steep angle bearings with K-factors generally below 1, usually have sufficient axial rating to cope with the increased loads. The outer rings are mounted in the chock with a substantial radial clearance in order to relieve it of radial loads (see fig. 3-39).

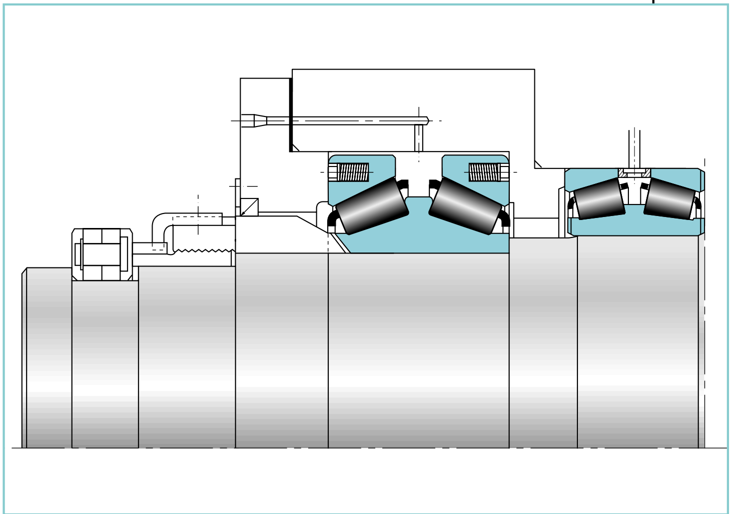
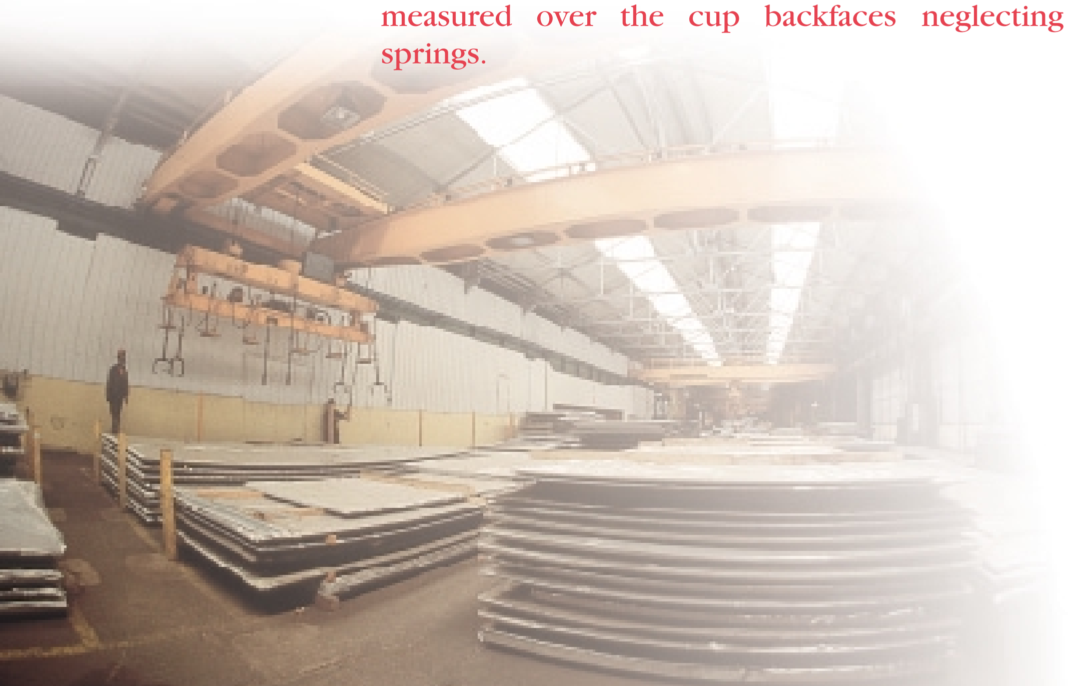


Fig. 3-39
Separate axial position with a TDIK bearing

As noted in Figure 3-39, piston/spring assemblies are integrated into the cups. The pistons protrude from each of the two cup backfaces to provide proper bearing preload. The distance from the cover's flange face to the chock shoulder must be controlled to establish this "spring preload". Generally, this distance should be 0.500mm (0.020") larger than the width measured over the cup backfaces neglecting the springs.



For this axial position, where the load is acting in both directions, it is also essential to seat the unloaded row in order to ensure proper contact between the rolling elements and therefore, perform safely with no risk of bearing cage failures, roller skewing,...

This is easily achieved by loading both cups axially with springs housed in the cup housing shoulders or even better, directly in the cups as shown on fig. 3-39.

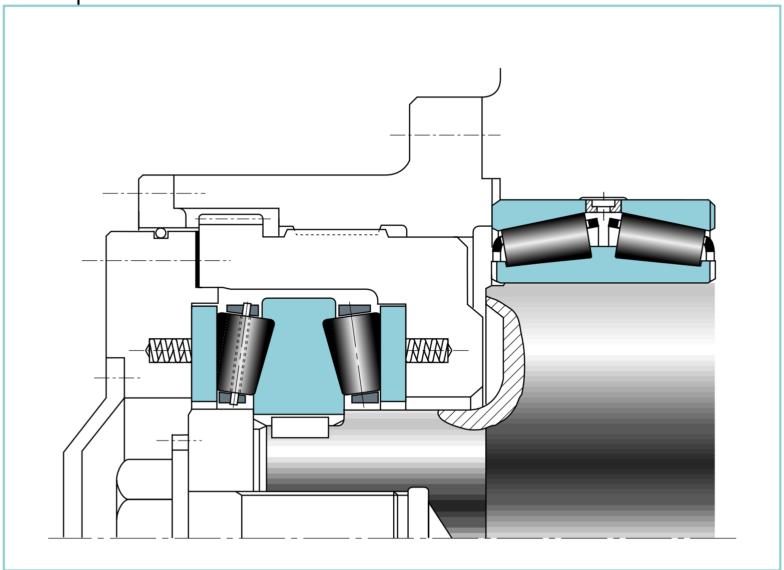


Fig. 3-40
Separate axial position with a TTDWK bearing

For cold mills where the speeds are much higher, an oil lubrication is usually provided at the axial position. The TDIK solution, depending on load and speed conditions, can be considered with the same lubrication as the radial bearing (grease/oil-air/oil-mist).

The TTDWK type double acting thrust bearing (fig. 3-40) offering higher axial ratings than the TDIK type bearing is an alternative choice when very high axial loads are anticipated.

3.1.2.4. Bearing lubrication

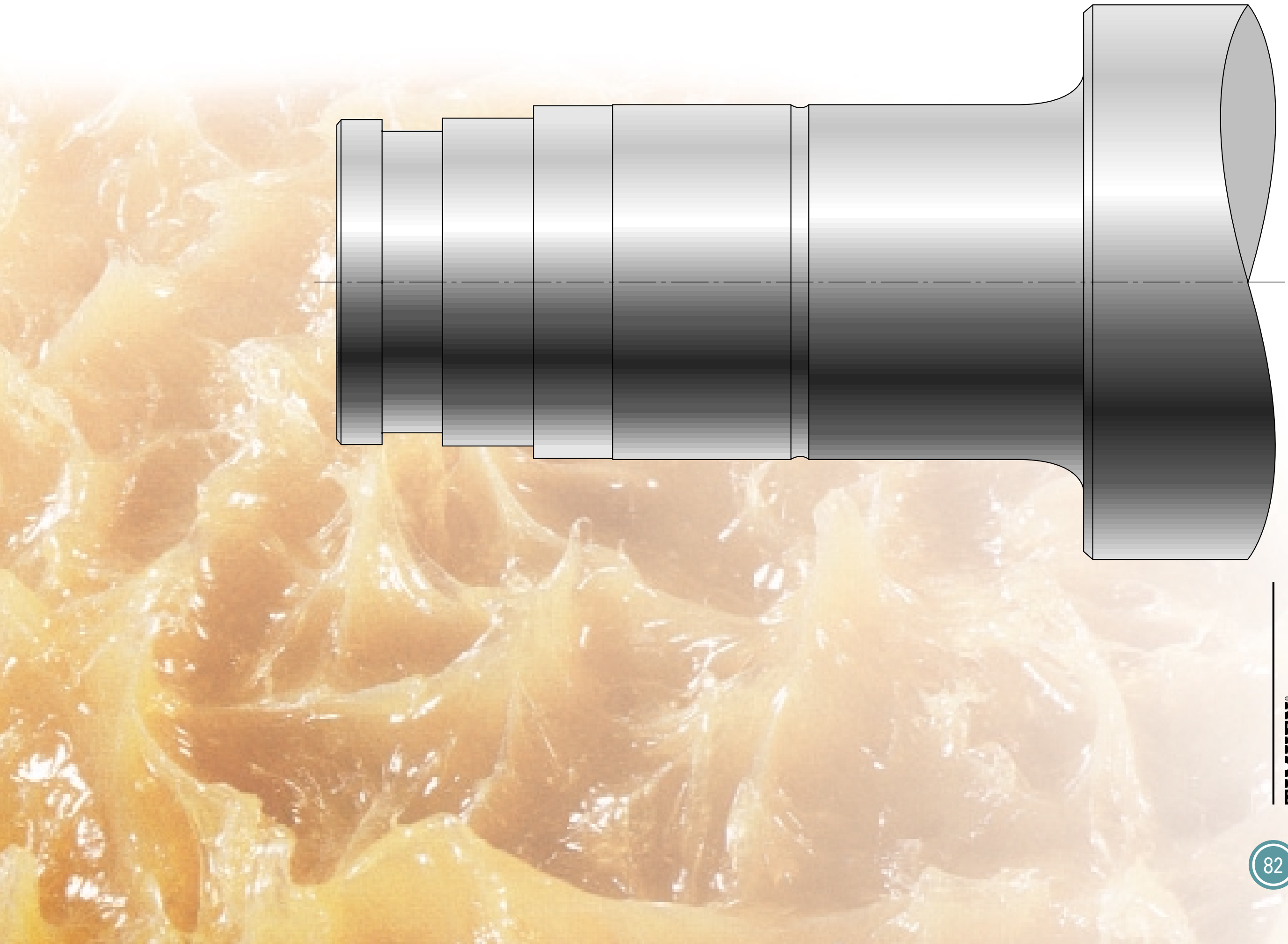
Hot and cold strip mill work roll bearings were traditionally grease lubricated for medium strip speed, whereas bearings for high speed cold strip mills and hot and cold aluminium mills were oil-mist lubricated.

Over the last decades, work roll bearings of existing cold steel mills, originally oil-mist lubricated and operating in most cases at speeds up to 1800 - 1900 m/min (6000 to 6300 ft/min), are now also grease lubricated due to the introduction of fast roll change devices with no connected lubrication pipes.

New high speed cold aluminium mills are however still designed to be oil lubricated but more and more with an oil-air system offering greater reliability (see also chapter 4).

3.1.2.5. Neck lubrication

An enhanced barrel side sealing arrangement with sealed bearings is still important to minimize coolant entry which could reach the necks, particularly, on mills where chocks are kept on the roll necks during roll barrel grinding and where these necks are not frequently coated with grease during roll changes.



Drillings are therefore often provided in the necks to be able to bring fresh grease to the bearing bore. This is also important on high speed cold mills in order to prevent the cones seizing on the necks. In this respect oil-mist or oil-air lubrication systems allow the neck to be continuously fed with some oil during operation.

Spiral grooves are commonly provided in the cone bore of roll neck bearings to help retain lubricant between the neck and inner ring. Special lubricant pastes and sprays can also be used to help minimize neck wear.

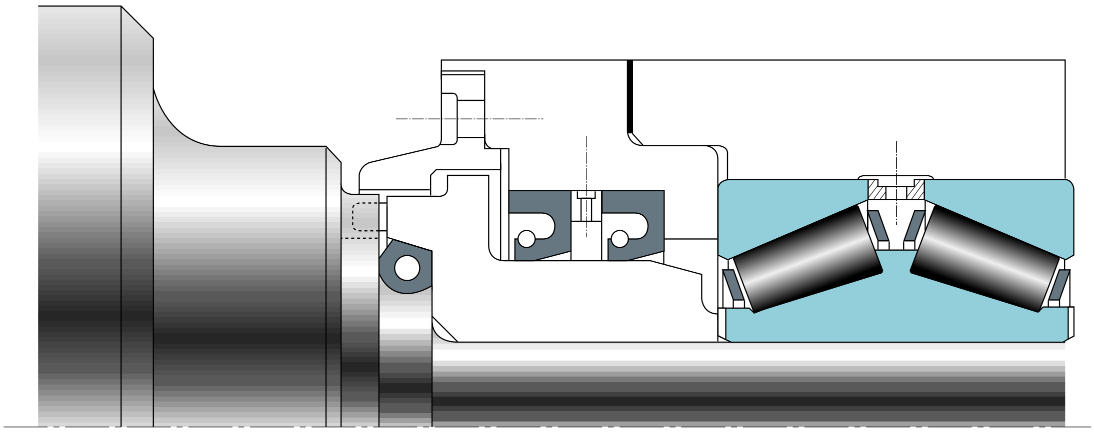


Fig. 3-41

A barrel side sealing arrangement as shown on fig. 3-41, with a loose-mounted fillet ring is an interesting alternative design and would enable a more elaborate sealing arrangement to be incorporated.

This loose-mounted fillet ring, remains a part of the chock assembly unit allowing the main chock seals to be kept on their seats during roll changes. These fillet rings must, of course, be prevented from rotating and sealed (to avoid any contaminant entering between neck and fillet ring bore).

3.1.3. Bearing related parts

3.1.3.1. Fillet ring designs

The fillet ring will locate the bearing and chock on the neck. Its design depends on the available space and on the level of sealing desired.

To show all of the possible variations would be impractical.

However, a number of arrangements (fig. 3-42) have been used successfully over the years to meet various types of operating conditions. Most of these are made up with one or two radial lip seals in combination with an axial "V-ring type" seal or a labyrinth, especially for wet rolling.

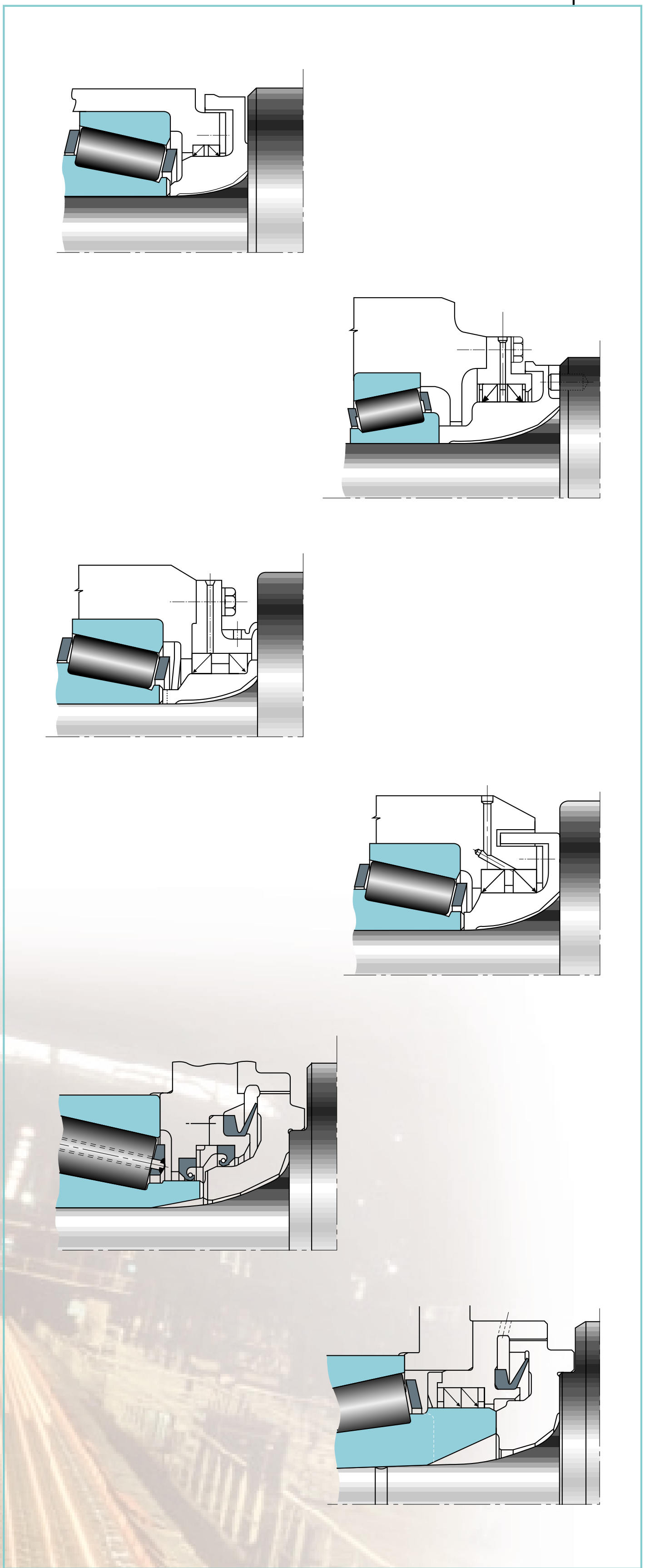
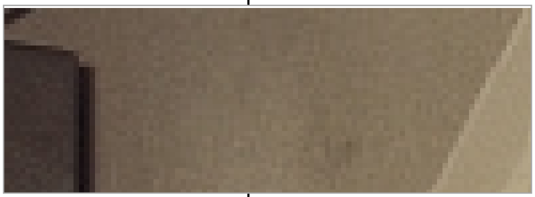


Fig. 3-42
Fillet ring designs

TIMKEN



Radial lip seals are used in both horizontal and vertical applications. Seal manufacturers have developed these seals to solve the lubrication problems found by rolling mill operating and maintenance departments. In the case where two radial lip seals are used as a unit, a lubricant entry between the two seals is required.

The fillet rings are generally mounted on the roll neck with a tight fit. This solves the problem of stopping the fillet ring rotating, and also helps to prevent the entry of rolling solution through the fillet ring inside diameter.

The fillet rings can also be mounted with a loose fit in order to use them on several rolls and thus limit their number (fig. 3-43, see also 3-41).

In this particular case, the fillet ring will form a unit with the bearing and the chock. A static "O" ring seal has then to be provided between the fillet ring and the neck to prevent entry of rolling solution. A key system is also incorporated to stop the fillet ring from rotating.

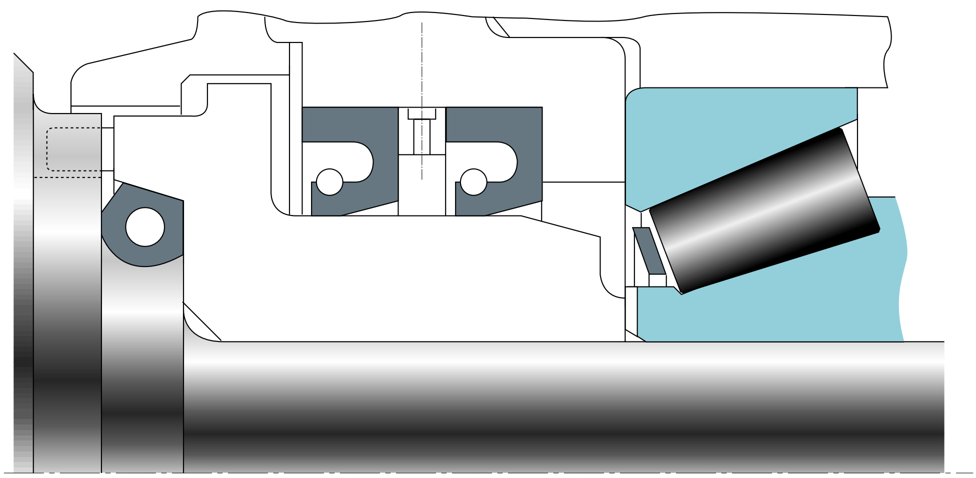


Fig. 3-43
Removable fillet ring design (stopped against rotation)

3.1.3.2. Inner ring retaining devices

The complete bearing assembly is held in place with a nut fitted over a keyed and threaded retaining ring. This ring is backed by a split hinged ring mounted in a groove on the roll neck extension (fig. 3-44).

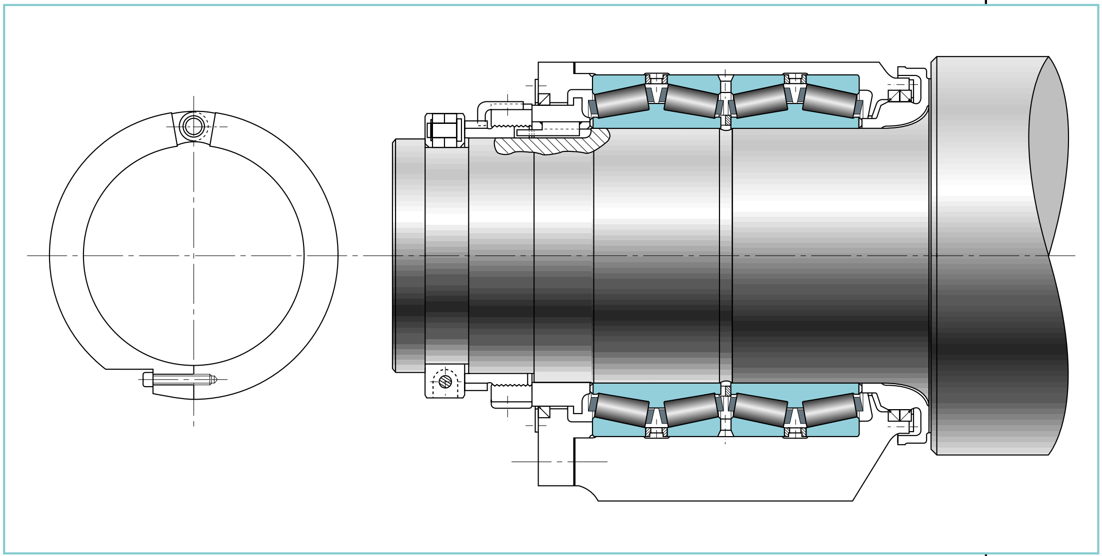


Fig. 3-44
Retaining device with standard nut, threaded ring and split hinged ring

This device is typically used with either loose or tight fit mounting.

Mounting and dismounting are rapidly achieved, as only a few nut revolutions are needed for assembly and only half a turn for disassembly. After the split hinged ring is removed, the nut and threaded ring can be taken from the neck as a unit. The bearing and chock assembly can then be removed from the neck. The detailed procedures relating to loose fit and tight fit mountings are explained in chapter 5.1.

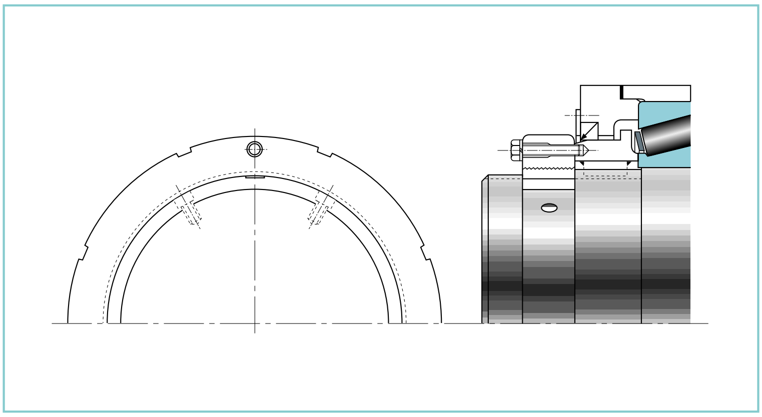


Fig. 3-45

Figure 3-45 shows an alternative device which could be considered where only a short neck extension is possible due to space limitations. Such an arrangement is often used on changeovers from other types of bearings.

On back-up rolls, an end-plate design can also be considered as shown on fig. 3-46.

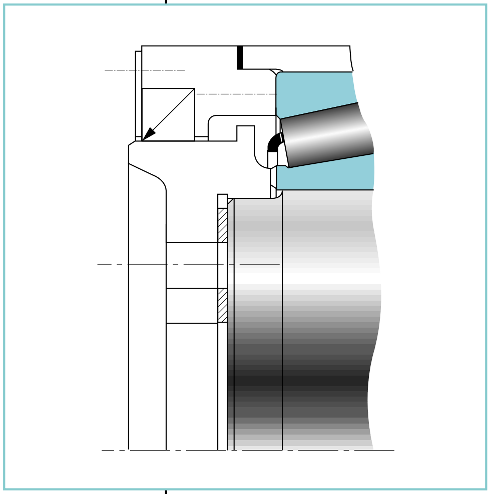


Fig. 3-46
End-plate design

Figure 3-47 is another alternative device which could be considered on driven work rolls where the largest extension coupling diameter is to be retained.

In order to further improve the mounting and dismounting time, and at the same time to reduce the cylinder cost, non adjustable systems as shown on fig. 3-33 are now used with the two or three TDIW bearing concept.

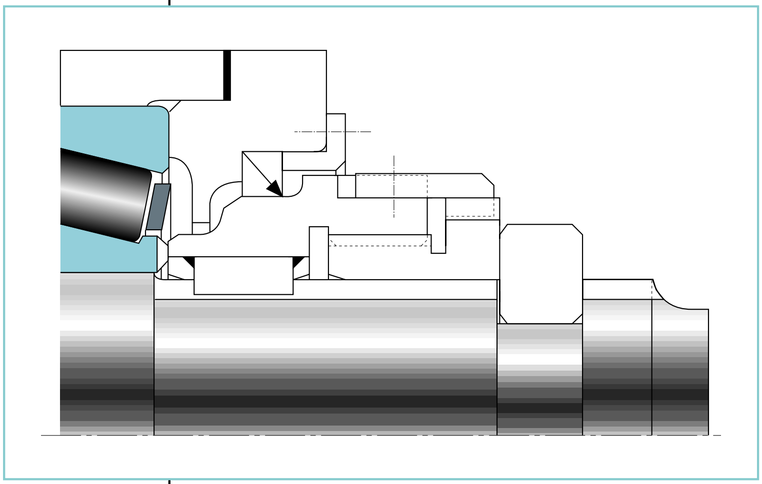


Fig. 3-47
Retaining device to avoid significant roll neck diameter decrease

Bearing selection not only takes into account the available bearing space but also the expected life of the bearing. This chapter deals with life calculation and clarifies the different ways this calculation can be accomplished and refined.

3.2. Bearing life

3.2.1. Basis for calculation

Bearing life is defined as the length of time, or the number of revolutions, until a fatigue spall of a specific size develops. This spall size, regardless of the size of the bearing, is defined by an area of 6 mm^2 (0.01 $inch^2$). However, due to the large size of rolling mill bearings, they can operate beyond this limit and we can expect a much greater life than calculated. This life depends on many different factors such as loading, speed, lubrication, fitting, setting, operating temperature, contamination, maintenance, plus many other environmental factors.

Due to all these factors, the life of an individual bearing is impossible to predict precisely. Also, bearings that may appear to be identical can exhibit considerable life scatter when tested under identical conditions. Remember also that statistically the life of multiple rows will always be less then the life of any given row in the system. For rolling mill bearings where it is impossible to test a large number of bearings, the long experience of The Timken Company will help you in your bearing life calculation.

TIMKEN®

3.2.1.1. L_{10} life

L_{10} life is the life that 90 percent of a group of apparently identical bearings will complete or exceed before the area of spalling reaches the defined 6 mm² (0.01 inch²) size criterion.

If handled, mounted, maintained, lubricated and used in the right way, the life of your tapered roller bearing will normally reach and even exceed the calculated L_{10} life.

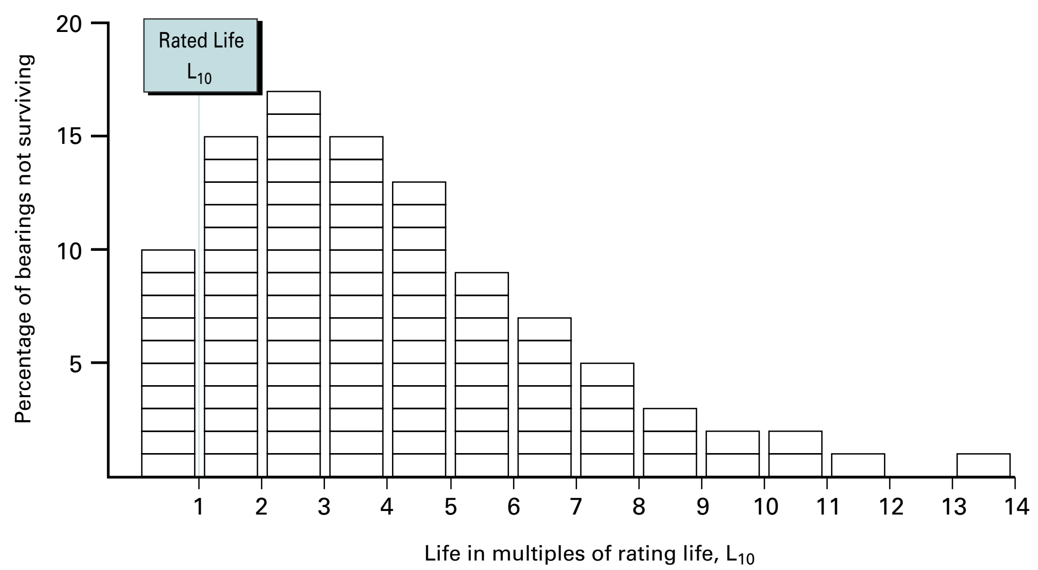


Fig. 3-48
Theoretical life frequency distribution of one hundred apparently identical bearings operating under similar conditions

If a sample of apparently identical bearings is run under specific laboratory conditions, 90 percent of these bearings can be expected to exhibit lives greater than the rated life. Then, only 10 percent of the bearings tested would have lives less than this rated life. Figure 3-48 shows bearing life scatter following a Weibull distribution function with a dispersion parameter equal to 1.5.

3.2.1.2. Bearing life equation

As you will see it in the following pages, there is more than just one bearing life calculation method, but in all cases the bearing life equation is :

$$L_{10} = \left(\frac{C}{P}\right)^{10/3} \times \frac{B}{n} \times a$$

L_{10} in hours
C = radial rating of the bearing in N or lbf ;
P = radial load or dynamic equivalent radial load applied on the bearing in N or lbf. The calculation of P depends on the method (ISO or Timken) with combined axial and radial loading ;
B = factor dependent on the method ; B = 1.5×10^6 for the Timken method (3000 hours at 500 rev/min) and $10^6/60$ for the ISO method ;
a = life adjustment factor ; a = 1, when environmental conditions are not considered ;
n = rotational speed in rev/min.

This can be illustrated as follows :

- Doubling load reduces life to one tenth. Reducing load by one half increases life by ten,
- Doubling speed reduces life by one half. Reducing speed by one half doubles life.

In fact, the different life calculation methods applied (ISO 281, Timken method...) differ by the selection of the parameters used (i.e. the Timken formulae is based on 90 million revolutions, whereas the others are based on 1 million revolutions).

3.2.2. Bearing ratings

Depending on the life calculation method used, the bearing ratings have to be selected accordingly. The "C_r" rating, based on one million revolutions, is used for the ISO method, and the "C_{90}" rating, based on 90 million revolutions, is utilized for the Timken method.

The Timken rating is also published based on 1 million revolutions :

$$C_1 = C_{90} \times 3.857$$

This will enable you to make a direct comparison between Timken bearings and those using ratings evaluated on a basis of 1 million revolutions. However, a direct comparison between ratings of various manufacturers can be misleading due to differences in rating philosophy, material, manufacturing and design.

In order to make a true geometrical comparison between the ratings of different bearing suppliers, only the rating defined following the ISO 281 equation should be used. However, by doing this, you do not take into account the different steel qualities from one supplier to another.

3.2.2.1. ISO 281 dynamic radial load rating C_r

This bearing rating equation is published by the International Organization for Standardization (ISO) and AFBMA. These ratings are not published by The Timken Company nor by any other bearing manufacturers. However, they can be obtained by contacting our company.

The basic dynamic load rating is function of :

$$C_r = b_m \times f_c \times (i \times L_{we} \times \cos \alpha)^{7/9} \times Z^{3/4} \times D_{we}^{29/27}$$

- C_r = radial rating in N
- b_m = material constant (ISO 281 latest issue specifies a factor of 1.1)
- f_c = geometry dependent factor
- i = number of bearing rows within the assembly
- L_{we} = effective roller contact length in mm *
- α = bearing half-included outer race angle *
- Z = number of rollers per bearing row
- D_{we} = mean roller diameter in mm *
- D_{pw} = pitch diameter of roller set in mm *

(see fig. 3-49)*

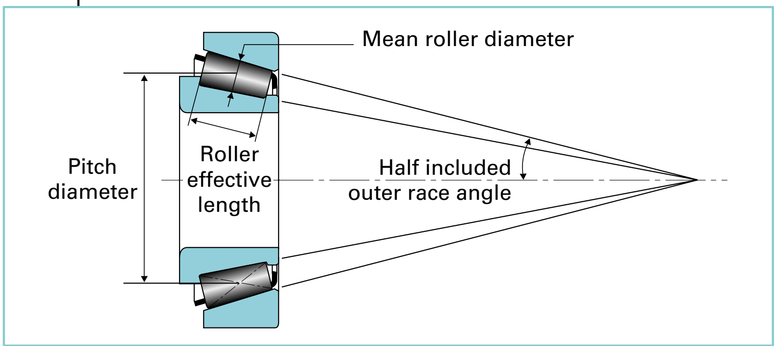
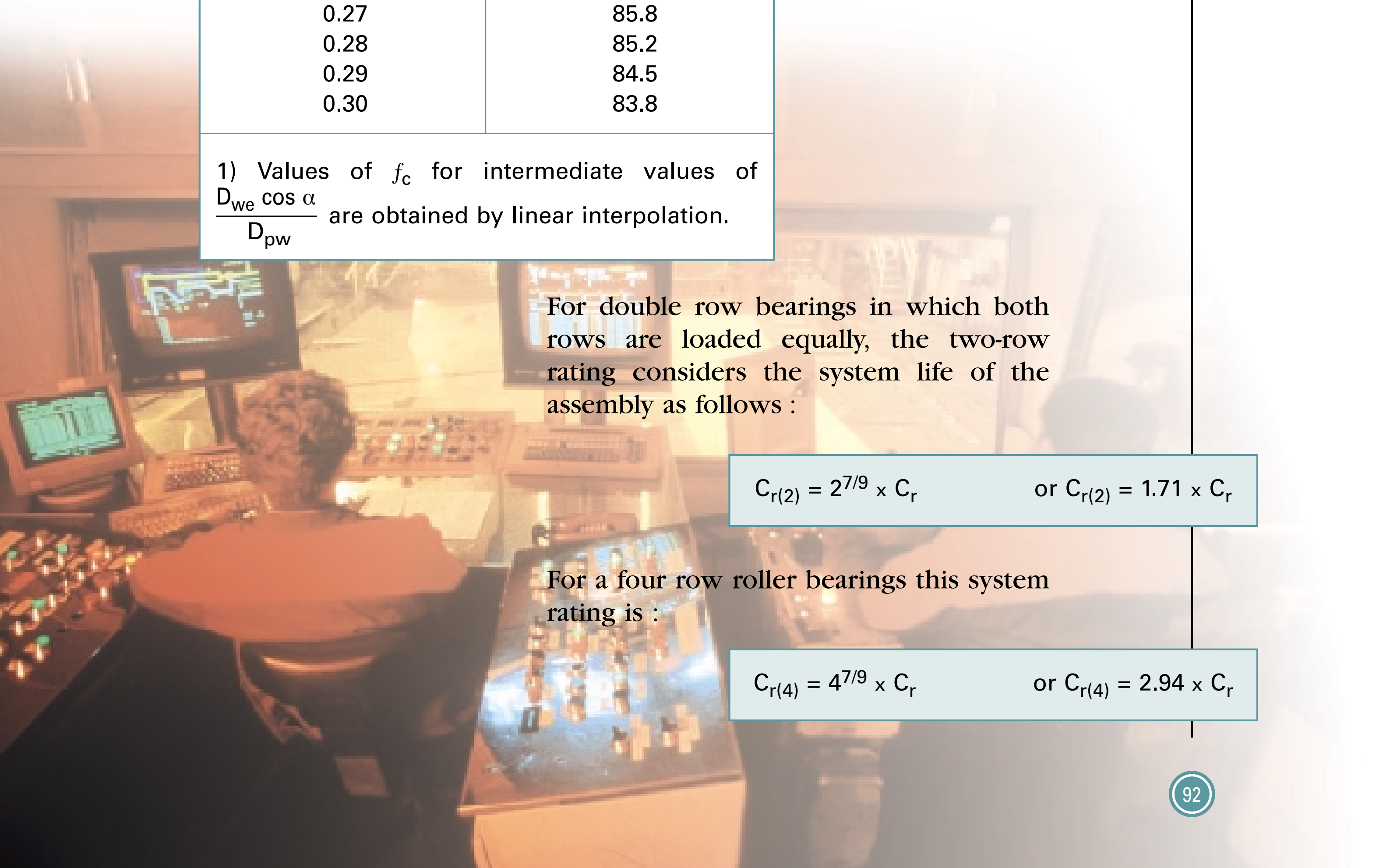


Fig. 3-49

Table 3-50
Maximum value of f_c for radial roller bearings

$\frac{D_{we} \cos \alpha}{D_{pw}}$ [1]	f_c
0.01	52.1
0.02	60.8
0.03	66.5
0.04	70.7
0.05	74.1
0.06	76.9
0.07	79.2
0.08	81.2
0.09	82.8
0.10	84.2
0.11	85.4
0.12	86.4
0.13	87.1
0.14	87.7
0.15	88.2
0.16	88.5
0.17	88.7
0.18	88.8
0.19	88.8
0.20	88.7
0.21	88.5
0.22	88.2
0.23	87.9
0.24	87.5
0.25	87.0
0.26	86.4
0.27	85.8
0.28	85.2
0.29	84.5
0.30	83.8

1) Values of f_c for intermediate values of $\frac{D_{we} \cos \alpha}{D_{pw}}$ are obtained by linear interpolation.

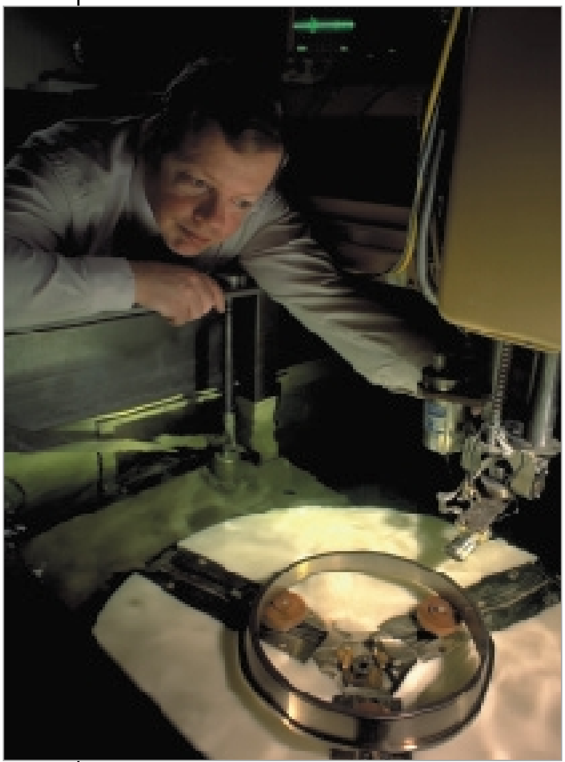


For double row bearings in which both rows are loaded equally, the two-row rating considers the system life of the assembly as follows :

$$C_{r(2)} = 2^{7/9} \times C_r \qquad \text{or } C_{r(2)} = 1.71 \times C_r$$

For a four row roller bearings this system rating is :

$$C_{r(4)} = 4^{7/9} \times C_r \qquad \text{or } C_{r(4)} = 2.94 \times C_r$$



3.2.2.2. Timken dynamic radial load rating C_{90}

Even though the ISO method allows you to compare different bearing suppliers, the basic philosophy of The Timken Company is to provide you with the most practical bearing rating for your bearing selection process. Since 1915 The Timken Company has developed and validated a specific rating method for its tapered roller bearings.

The published Timken C_{90} ratings are based on a basic rated life of 90 million revolutions or 3000 hours at 500 rev/min.

To assure consistent quality worldwide, we conduct extensive bearing fatigue life tests in our laboratories. These audit tests result in a high level of confidence in our ratings.

The basic dynamic load rating is used to estimate the life of a rotating bearing and is a function of :

$$C_{90} = M \times H \times (i \times L_{eff} \times \cos\alpha)^{4/5} \times Z^{7/10} \times D_{we}^{16/15}$$

C_{90} = radial rating in N
M = material constant
H = geometry dependent factor
i = number of bearing rows within the assembly
L_{eff} = effective roller contact length in mm *
α = bearing half included outer race angle *
Z = number of rollers per bearing row
D_{we} = mean roller diameter in mm *

(see fig. 3-49)*

A rating based on 90 million revolutions is more realistic as most applications equal or exceed this duration.

For double row bearings in which both rows are loaded equally, the two-row rating considers the system life of the assembly as follows :

$$C_{90(2)} = 2^{4/5} \times C_{90} \qquad \text{or } C_{90(2)} = 1.74 \times C_{90}$$

The basic radial load rating of a four-row assembly is taken as two times the double row rating :

$$C_{90(4)} = 2 \times C_{90(2)}$$

and for a six-row assembly as three times the double row rating :

$$C_{90(6)} = 3 \times C_{90(2)}$$

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

$$K = \frac{C_{90}}{C_{a90}}$$

The smaller the K factor, the steeper the bearing cup angle (fig. 3-51). The relationship can also be geometrically expressed as :

$$K = 0.389 \times \cot \alpha$$
α = half included outer race angle

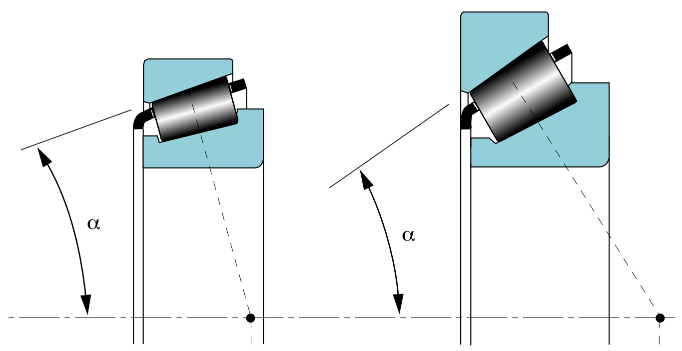


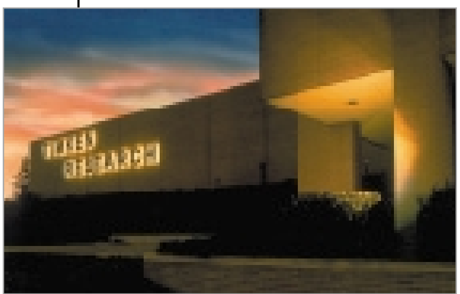
Fig. 3-51

3.2.3. L_{10} life calculation

The traditional approach to bearing life calculation begins with the determination of applied forces and calculation of a bearing dynamic equivalent radial load (P).

In rolling mill applications, the determination of the applied forces is dependent on a wide range of conditions given by your rolling schedules. It would, therefore, not be adequate to develop a standard calculation only based on the maximum load usually given. A realistic estimation of the bearing life can only be achieved on a project basis through a close partnership with your engineering departments. However, our previous experience with similar applications can provide a good starting point for initial evaluation.

Back-up roll bearings generally take the rolling load plus all the other loads generated in the system. The work roll bearings take the balancing load and positive/negative bending forces (if they exist). In some new mills, they also take the axial loads induced by the roll crossing and/or by axial shift systems. These axial loads can represent 1 to 5 % of the total rolling load depending on the system used.



When the applied loads on the bearings are known and the load cycle well defined, the life calculation will be more in line with the real bearing performance.

3.2.3.1. Single row bearing

Tapered roller bearings are ideally suited to carry all types of loads : radial, axial or any combination. Due to the tapered design of the bearing, a radial load will induce an axial reaction within the bearing which must be equally opposed to avoid separation of the inner and outer rings.

The ratio of the radial to the axial load (external axial load and induced load), the setting and the bearing included cup angle determine the load zone in a given bearing. This load zone is defined by an angle which delimits the rollers carrying the load. If all the rollers are in contact and carry the load, the load zone is referred to as being 360 degrees.

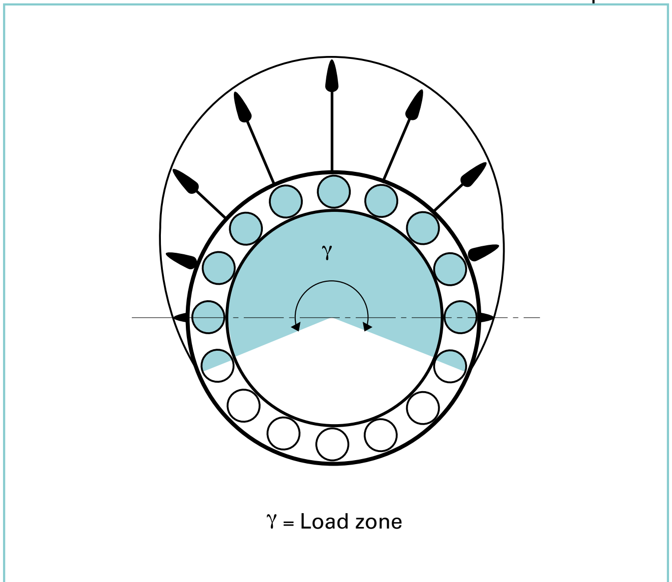
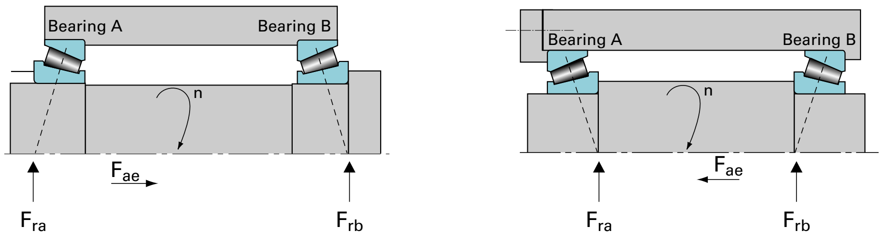


Fig. 3-52
Bearing load zone

In the case of combined loads, a dynamic equivalent radial load must be calculated to determine bearing life. The equations presented below give close approximations of the dynamic equivalent radial loads. More exact calculations using computer programs can be made that take into account such parameters as bearing spring rate, setting and supporting housing stiffness.

Combined radial and thrust load

Design (external thrust, F_{ae}, onto bearing A)



ISO method

Thrust condition

$$\frac{0.5\,F_{rA}}{Y_A} \le \frac{0.5\,F_{rB}}{Y_B} + F_{ae}$$

Net bearing thrust load

$$F_{aA} = \frac{0.5\,F_{rB}}{Y_B} + F_{ae}$$

$$F_{aB} = \frac{0.5\,F_{rB}}{Y_B}$$

Dynamic equivalent radial load

Bearing A

- $P_A = F_{rA}$ if $\frac{F_{aA}}{F_{rA}} \le e_A$,
- $P_A = 0.4\,F_{rA} + Y_A\,F_{aA}$ if $\frac{F_{aA}}{F_{rA}} > e_A$,

Bearing B

- $P_B = F_{rB}$

Thrust condition

$$\frac{0.5\,F_{rA}}{Y_A} > \frac{0.5\,F_{rB}}{Y_B} + F_{ae}$$

Net bearing thrust load

$$F_{aA} = \frac{0.5\,F_{rA}}{Y_A}$$

$$F_{aB} = \frac{0.5\,F_{rA}}{Y_A} - F_{ae}$$

Dynamic equivalent radial load

Bearing A

- $P_A = F_{rA}$

Bearing B

- $P_B = F_{rB}$ if $\frac{F_{aB}}{F_{rB}} \le e_B$
- $P_B = 0.4\,F_{rB} + Y_B\,F_{aB}$ if $\frac{F_{aB}}{F_{rB}} > e_B$,

L_{10} life

$$L_{10A} = \frac{10^6}{60n}\left(\frac{C_{1A}}{P_A}\right)^{10/3} \text{(hours)}$$

$$L_{10B} = \frac{10^6}{60n}\left(\frac{C_{1B}}{P_B}\right)^{10/3} \text{(hours)}$$

Timken method

Thrust condition

$$\frac{0.47\,F_{rA}}{K_A} \le \frac{0.47\,F_{rB}}{K_B} + F_{ae}$$

Net bearing thrust load

$$F_{aA} = \frac{0.47\,F_{rB}}{K_B} + F_{ae}$$

$$F_{aB} = \frac{0.47\,F_{rB}}{K_B}$$

Dynamic equivalent radial load

Bearing A

- $P_A = 0.4\,F_{rA} + K_A\,F_{aA}$
  if $P_A < F_{rA}$, $P_A = F_{rA}$

Bearing B

- $P_B = F_{rB}$

Thrust condition

$$\frac{0.47\,F_{rA}}{K_A} > \frac{0.47\,F_{rB}}{K_B} + F_{ae}$$

Net bearing thrust load

$$F_{aA} = \frac{0.47\,F_{rA}}{K_A}$$

$$F_{aB} = \frac{0.47\,F_{rA}}{K_A} - F_{ae}$$

Dynamic equivalent radial load

Bearing A

- $P_A = F_{rA}$

Bearing B

- $P_B = 0.4\,F_{rB} + K_B\,F_{aB}$
  if $P_B < F_{rB}$, $P_B = F_{rB}$

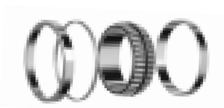
L_{10} life

$$L_{10A} = \left(\frac{C_{90A}}{P_A}\right)^{10/3} \times 3000 \times \frac{500}{n} \text{(hours)}$$

$$L_{10B} = \left(\frac{C_{90B}}{P_B}\right)^{10/3} \times 3000 \times \frac{500}{n} \text{(hours)}$$

ISO 281 factors

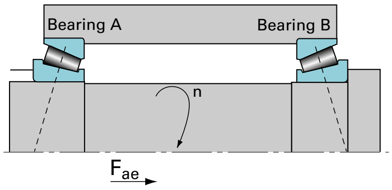
e	= 1.5	tan	α
Y	= 0.4	cot	α
Y_1	= 0.45	cot	α
Y_2	= 0.67	cot	α



3.2.3.2. Two-row bearing

Thrust load only

Design (external thrust, F_{ae}, onto bearing A)



ISO method	Timken method

ISO method

Thrust condition

$F_{aA} = F_{ae}$
$F_{aB} = 0$

Thrust load

$F_{aA} = F_{ae}$
$F_{aB} = 0$

Dynamic equivalent load

$P_A = Y_A \, F_{aA}$
$P_B = 0$

L_{10} life

$$L_{10A} = \frac{10^6}{60n}\left(\frac{C_{1A}}{P_A}\right)^{10/3}$$

$$L_{10B} = \frac{10^6}{60n}\left(\frac{C_{1B}}{P_B}\right)^{10/3}$$

Timken method

Thrust condition

$F_{aA} = F_{ae}$
$F_{aB} = 0$

Thrust load

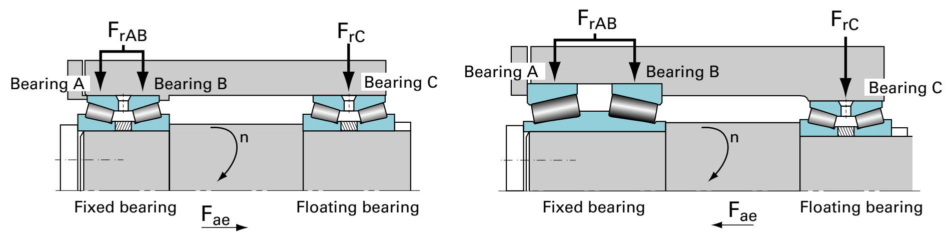
$F_{aA} = F_{ae}$
$F_{aB} = 0$

L_{10} life

$$L_{10A} = \left(\frac{C_{a90A}}{F_{aA}}\right)^{10/3} \times 3000 \times \frac{500}{n} \quad \text{(hours)}$$

$$L_{10B} = \left(\frac{C_{a90B}}{F_{aB}}\right)^{10/3} \times 3000 \times \frac{500}{n} \quad \text{(hours)}$$

Design (external thrust, F_{ae}, onto bearing A)



ISO method

Thrust condition

$$\frac{F_{ae}}{F_{rAB}} \leq e$$

Dynamic equivalent radial load

- $P_{AB} = F_{rAB} + Y_{1AB} F_{ae}$
- $P_C = F_{rC}$

Thrust condition

$$\frac{F_{ae}}{F_{rAB}} > e$$

Dynamic equivalent radial load

- $P_{AB} = 0.67 F_{rAB} + Y_{2AB} F_{ae}$
- $P_C = F_{rC}$

L_{10} life

$$L_{10AB} = \frac{10^6}{60n}\left(\frac{C_{1\,(2)}}{P_{AB}}\right)^{10/3} \text{ (hours)}$$

$$L_{10C} = \frac{10^6}{60n}\left(\frac{C_{1\,(2)}}{P_{C}}\right)^{10/3} \text{ (hours)}$$

Timken method

Thrust condition

$$F_{ae} > \frac{0.6\,F_{rAB}}{K_A}$$

Dynamic equivalent radial load

- $P_A = 0.4 F_{rAB} + K_A F_{ae}$
- $P_B = 0$
- $P_C = F_{rC}$

Thrust condition

$$F_{ae} \leq \frac{0.6\,F_{rAB}}{K_A}$$

Dynamic equivalent radial load

- $P_A = 0.5 F_{rAB} + 0.83 K_A F_{ae}$
- $P_B = 0.5 F_{rAB} - 0.83 K_A F_{ae}$
- $P_C = F_{rC}$

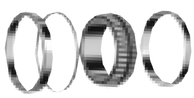
L_{10} life

$$L_{10A} = \left(\frac{C_{90A}}{P_A}\right)^{10/3} \text{x } 3000 \text{ x } \frac{500}{n} \text{ (hours)}$$

$$L_{10B} = \left(\frac{C_{90B}}{P_B}\right)^{10/3} \text{x } 3000 \text{ x } \frac{500}{n} \text{ (hours)}$$

$$L_{10C} = \left(\frac{C_{90(2)C}}{P_C}\right)^{10/3} \text{x } 3000 \text{ x } \frac{500}{n} \text{ (hours)}$$

$C_{90\,(2)}$ = dynamic radial load rating for 2 rows



3.2.3.3. Four-row and six-row bearings

PURE RADIAL LOAD

In the case where the axial load is too high, an additional thrust bearing is required to take this axial load. Then the four-row or six-row bearing is just carrying radial loads. In this case the life calculation is done by taking P equal to the radial load and by using the dynamic radial rating for 4 or 6 rows, which in fact, defines the system life of the bearing assembly. We can also have a close approximation by calculating the life in considering one fourth or one sixth of the radial loads and using the dynamic radial rating for one row.

COMBINED RADIAL AND AXIAL LOADS

When no additional thrust bearing is used, we consider that the life of the four or six-row bearing is almost equal to the life of the heaviest loaded pair of rows. Then refer to life calculation for a two-row bearing.

4-row case :

Due to the manufacturing tolerances in the bearing, we consider that for a four-row bearing the radial load is equally shared between each pair of rows and that the axial load is shared 40 % on one pair and 60 % on the other pair. The heaviest loaded pair takes in this case 50 % of the radial load and 60 % of the axial load.

6-row case :

We consider that the radial load is equally shared on each pair of rows and that one of the 3 pairs takes 40 % of the thrust load and the 2 others 30 % each. The heaviest loaded pair then takes 33 % of the radial load and 40 % of the axial load (fig. 3-53).

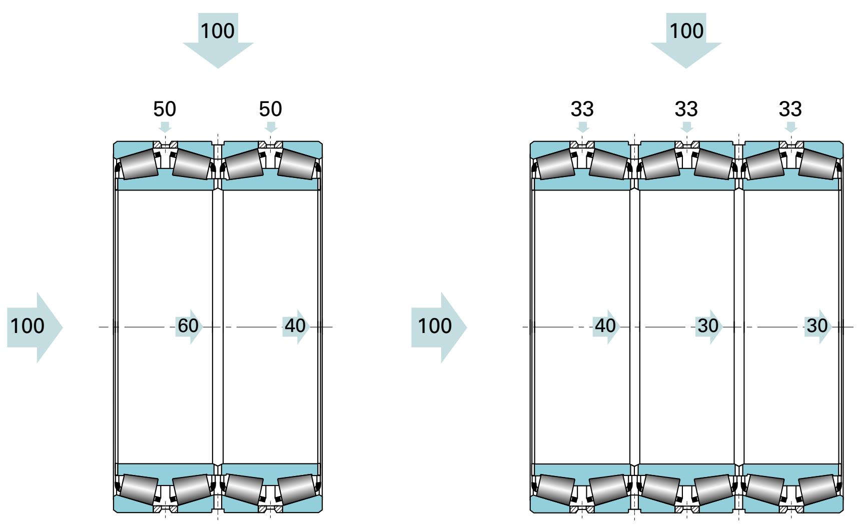


Fig. 3-53
The example shows direct mounted pairs (TQO, 3TDIW...) the same will apply to indirect mounted pairs (TQITS...)

3.2.3.4. Life calculation for a given load cycle

Rolling mills never work in only one defined condition. Therefore we need to calculate the life of the bearings at different loads/speeds/duration and summarize the results in a weighted bearing life, L_{10wt}. After the load cycle is defined (loads, speeds and percentage of time), the weighted L_{10} life is obtained as shown left.

$$L_{10wt} = \frac{100}{\dfrac{T_1}{L_{10(1)}} + \dfrac{T_2}{L_{10(2)}} + \dots + \dfrac{T_n}{L_{10(n)}}}$$

where :

- n = number of load conditions
- T = percentage of total load cycle time
- $L_{10(i)}$ = L_{10} life at each condition
- L_{10wt} = weighted bearing life

3.2.3.5. Slow rotating equipment

In some applications like continuous casters for instance, the speed of rotation is very slow (1 to 5 rev/min). Moreover in these types of applications, the loads are generally very high. Therefore, calculating bearing life does not provide correct information.

In these cases we calculate the contact stress profile between the rollers and the races with our Select-A-Nalysis tool. If the maximum stress is higher than 2750 MPa (or 400 ksi), we will provide you with a bearing having a modified internal geometry. This geometry will better balance the stress along the contact line (fig. 3-54).

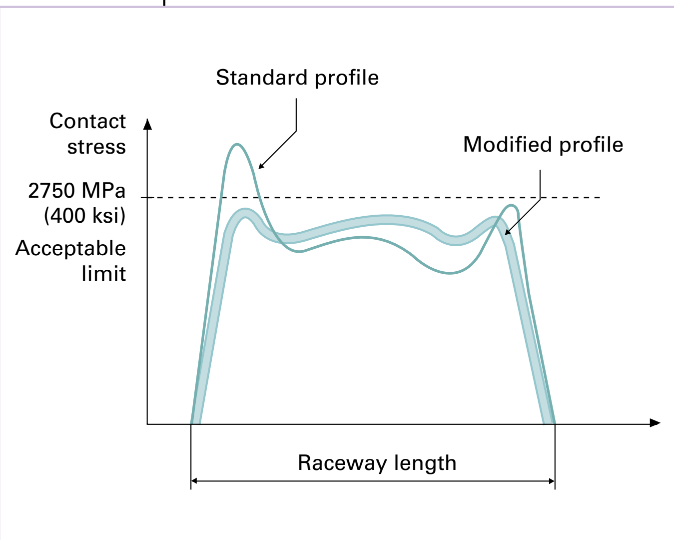


Fig. 3-54
Stress distribution along the roller raceway

A rough guideline that can be used to determine whether a modified profile is needed, is to calculate the P/C_{90} factor. If this factor is **greater than 3,** then you may require the special profile. In such a case, please contact The Timken Company for more in-depth analysis. Note that these bearings are generally supplied with solid rollers (stamped cage, pin type cage with pins outside the rollers or cageless).

3.2.4. Influence of setting

With the continuous improvement in our life analysis tools, we can now more accurately predict "true" bearing life as we consider the critical environmental factors that influence your application's performance. These factors must be carefully considered in the bearing selection process.

The L_{10} life calculation shown above is based on a 150 degree load zone and a misalignment of less than 0.0005 radian.

The load zone, which has direct influence on bearing life, is directly linked to the endplay/preload in the bearing (i.e. an endplay of zero is equal to a 180 degree load zone). **Adjusting this endplay/preload, and so the load zone is called "bearing setting".** Most of our bearings (2 rows or more) are preset assemblies, the setting being generally achieved through spacers. For single row bearings you have to achieve the correct setting by using for example shims.

Mounted setting (including the fitting effect)
+
Temperature effect (< 0 or > 0)
+
Elastic deformation in the bearing races

= Operating setting

As is it not possible to measure the setting under operating conditions, a common approach is to calculate the operating setting by taking into account the initial bench setting, the interference fits and the thermal expansion in the system.

Generally maximum life is obtained when the bearing is operating in slight preload (fig. 3-55).

Bearings are typically set-up in endplay at assembly, so that when the unit reaches a stable operating temperature, the final bearing clearance will be as close as possible to the desired setting.

A computer analysis can be provided to show the influence of preload or endplay on bearing life.

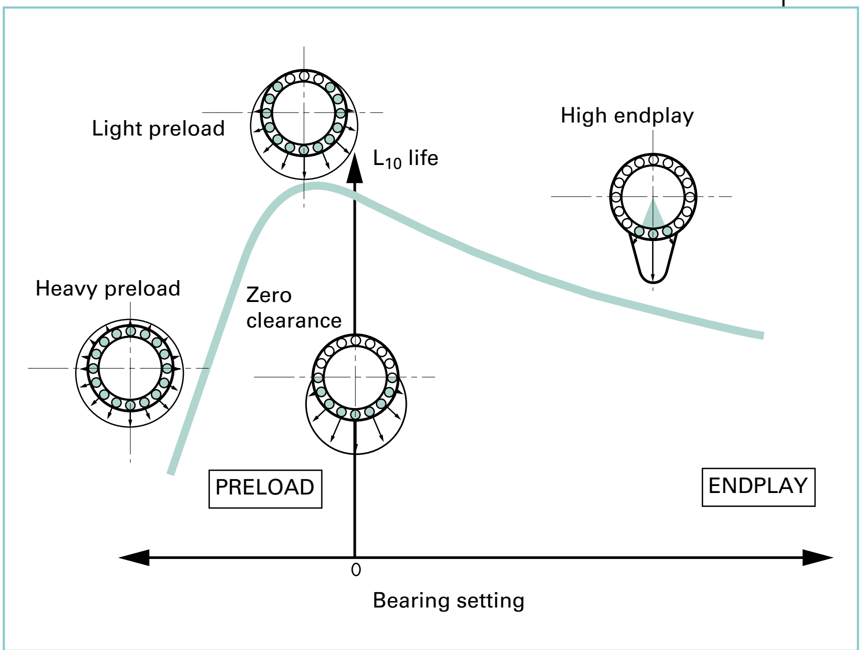
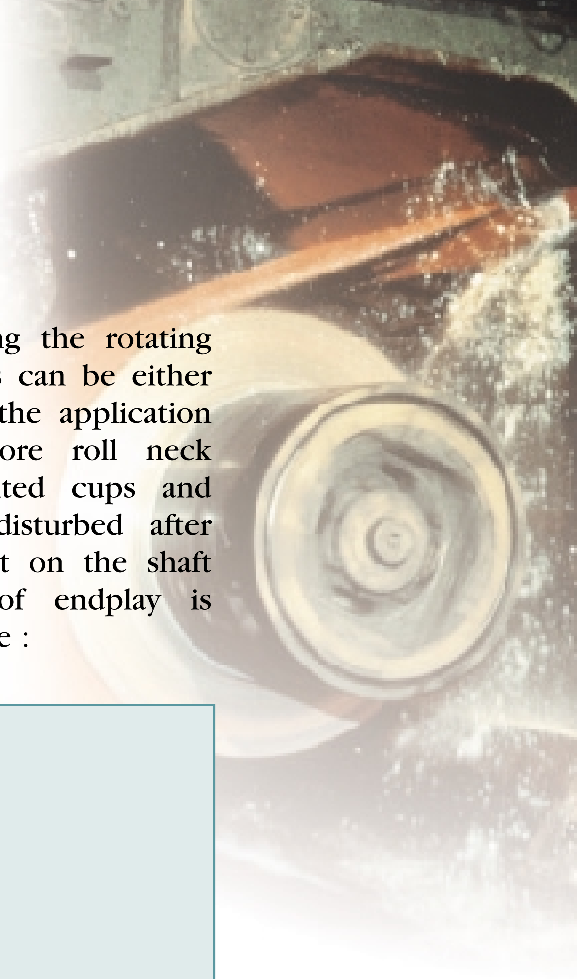


Fig. 3-55
Bearing life versus setting



3.2.4.1. Influence of fitting on the setting

A general rule consists of tight fitting the rotating members while stationary components can be either tight or loose-fitted as a function of the application design. Nevertheless, for straight bore roll neck bearings, as we suggest loose-mounted cups and cones, the bench endplay is not disturbed after mounting. For bearings mounted tight on the shaft and/or in the housing, the loss of endplay is determined using the following formulae :

Fit effect (one row)

Inner race mounted on a solid shaft :

$$EP\ Loss = 0.5 \left(\frac{K}{0.39}\right) \left(\frac{d}{d_o}\right) \delta_S$$

Inner race mounted on a hollow shaft or a sleeve :

$$EP\ Loss = 0.5 \left(\frac{K}{0.39}\right) \left(\frac{d}{d_o}\right) \left[\frac{1 - \left(\frac{d_S}{d}\right)^2}{1 - \left(\frac{d_S}{d_O}\right)^2}\right] \delta_S$$

Outer race mounted in a wall section housing :

$$EP\ Loss = 0.5 \left(\frac{K}{0.39}\right) \left(\frac{D_O}{D}\right) \left[\frac{1 - \left(\frac{D}{D_H}\right)^2}{1 - \left(\frac{D_O}{D_H}\right)^2}\right] \delta_H$$

Note : these equations apply only to ferrous shaft and housing.

These formulae can be used only in the case of simple shaft and housing designs. In those cases where the bearing is mounted on a sleeve with variable section, the calculation is more complex and you should contact The Timken Company.

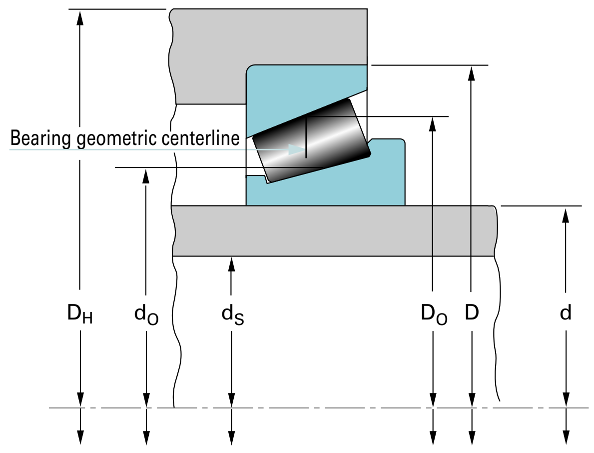


Fig. 3-56
Influence factors on fit

For high speed applications where a very accurate setting is required (high speed coilers, mill drives...), the spacer width adjustment, and so the setting, can be done after having measured the surfaces which will be fitted together. This eliminates the influence of the interference fit range in the setting.

δ_S = interference fit of inner race on shaft
δ_H = interference fit of outer race in housing
K = bearing K-factor
d = bearing bore diameter
d_O = mean inner race diameter
D = bearing outside diameter
D_O = mean outer race diameter
d_S = shaft inside diameter
D_H = housing outside diameter

In the case of tapered bore bearings, the interference fit is also well controlled (within less than 3 % of the entire tight fit for large bearings. Refer to chapter 3.1.1.4.) and therefore the loss of endplay due to the fitting can be predicted within a very close tolerance. Other techniques (such as tighter tolerances) that avoid individual spacer sizing are available if the bearing population is large enough.

3.2.4.2. Influence of temperature on the setting

Even if a bearing is properly mounted, we must account for the steady-state condition where the system has reached its operating temperature.

For high speed applications and, depending on lubrication, it is important to determine precisely the expected temperature gradient in order to calculate the loss of endplay. This gradient, based on our experience, varies greatly from one type of application to another.

When the temperature gradient between the cone and cup is known, the loss of endplay is determined as follows :

$$\text{EP loss} = \alpha \times \delta T \left[\frac{K_1 \times D_{01}}{(0.39 \times 2)} + \frac{K_2 \times D_{02}}{(0.39 \times 2)} \pm L \right]$$

α = coefficient of thermal expansion
(11×10^{-6} for ferrous shafts and housings based on °C)
(6×10^{-6} for ferrous shafts and housings based on °F)

D_{01} = mean outer race diameter for row 1

D_{02} = mean outer race diameter for row 2

K_1 = K factor of row 1

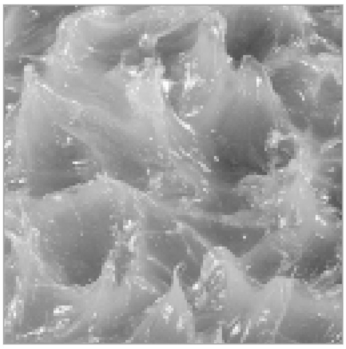
K_2 = K factor of row 2

δT = temperature gradient between shaft and housing in °C or °F

L = distance between bearing geometric centerlines
use positive values for direct mounting
negative values for indirect mounting

3.2.5. Influence of lubrication

Lubrication is a very important factor in the life of bearings. Life is directly linked to the lubricant film thickness. This film thickness depends on lubricant viscosity, operating temperature, load, speed and surface finish of the bearing. The Timken Company has developed a theory which adjusts the bearing life in accordance with your lubrication by calculating a lube factor.



This factor is mostly used when calculating applications other than roll necks. Nevertheless, in roll neck applications, we calculate the film thickness to select the right lubricant depending on operating conditions. We must also consider the ingress of contaminants which can be detrimental to the lubricant's function (a good sealing arrangement is therefore important).

For more general applications such as drives or miscellaneous equipment around the rolling mill, this factor can be very useful and provides an excellent method to calculate bearing life while taking lubrication, surface finish and, hence, film thickness into account. This sometimes permits a bearing selection to be downsized. In this case, please refer to The Tapered Roller Bearing Guide.

3.2.6. Influence of the material factor

The quality of the steel used in bearings is very important. Under repeated stress conditions, non metallic inclusions initiate the spalling process and thus a fatigue spall can develop.

The Timken Company, which develops and manufactures its own steel, has dramatically improved its quality over the years. Figure 3-57 shows the reduction in size and number of these inclusions over the years and their influence on life :

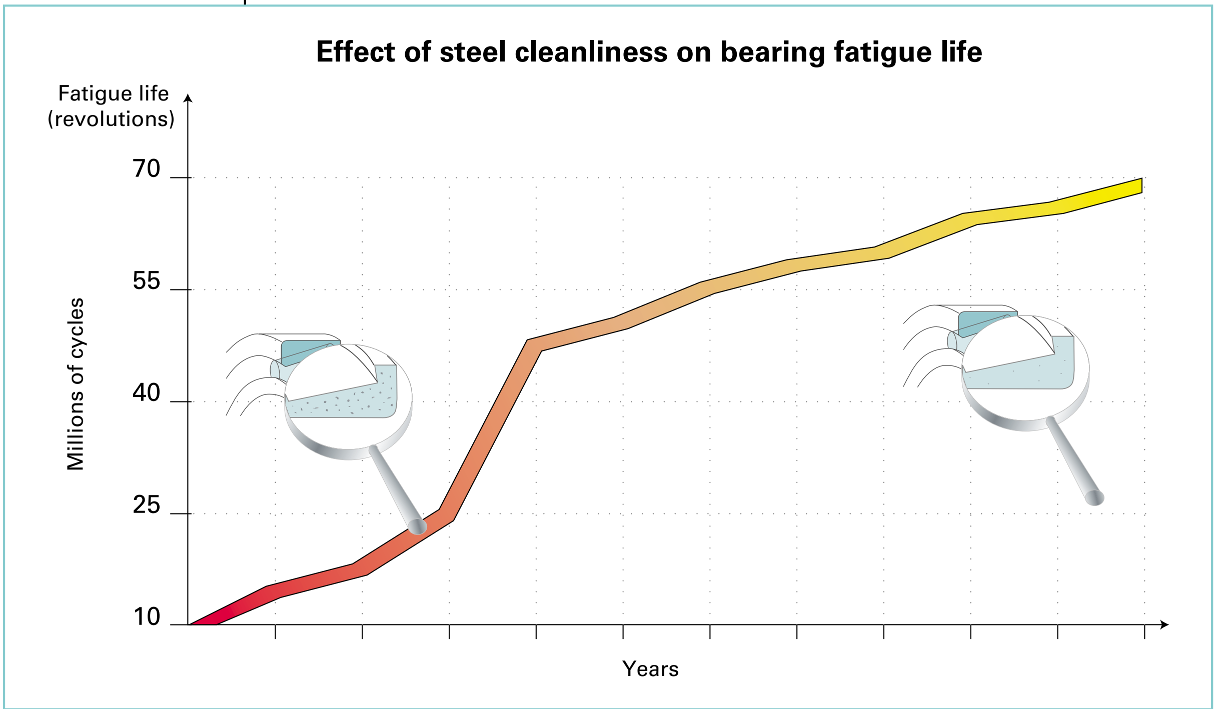


Fig. 3-57

Our life equation takes into account this material improvement through the adjustment of our steel quality factor "a_2". For Timken bearings, manufactured from electric furnace, ladle refined, bearing quality alloy, or carbon steel, a conservative factor of 1 is used.

Bearings can also be manufactured from other grades of premium clean steels made with various processes. These premium steels contain fewer and smaller impurities and provide the benefit of extending bearing fatigue life where it is limited by non-metallic inclusions. In these cases, life can sometimes by increased by a factor of 2-3.

3.3. Finite Element Analysis

Based on its long experience in bearing calculations, The Timken Company has developed several tools for more accurately performing life calculations by taking into account the environment of the bearing. A new calculation tool called SYSx, provides a finite element analysis approach to calculating the system deflections and life of the bearing.

For more accurate results, we can also conduct a full finite element analysis on the bearing housing. The chock is split into many elements and its behavior and the resultant stresses are determined under different load conditions.

Displacements are then calculated and the effect on bearing life is assessed. In some cases such analysis shows that even under significant chock deformation, bearing life can be greater than the expected life because load zones can increase due to the chock deformation. These analyses are not carried out for every bearing calculation, but are available for critical applications. For more information on finite element analysis, please contact The Timken Company.

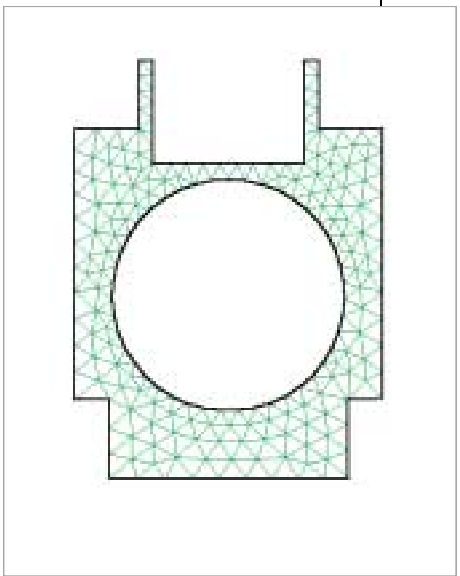


Fig. 3-58

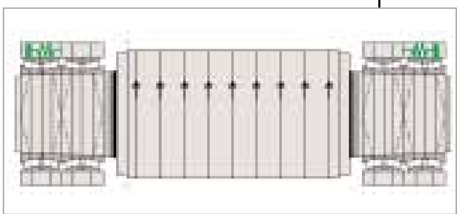


Fig. 3-59

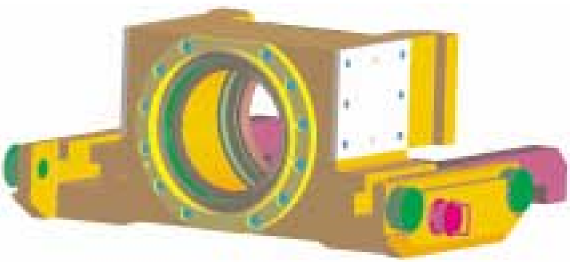


Fig. 3-60

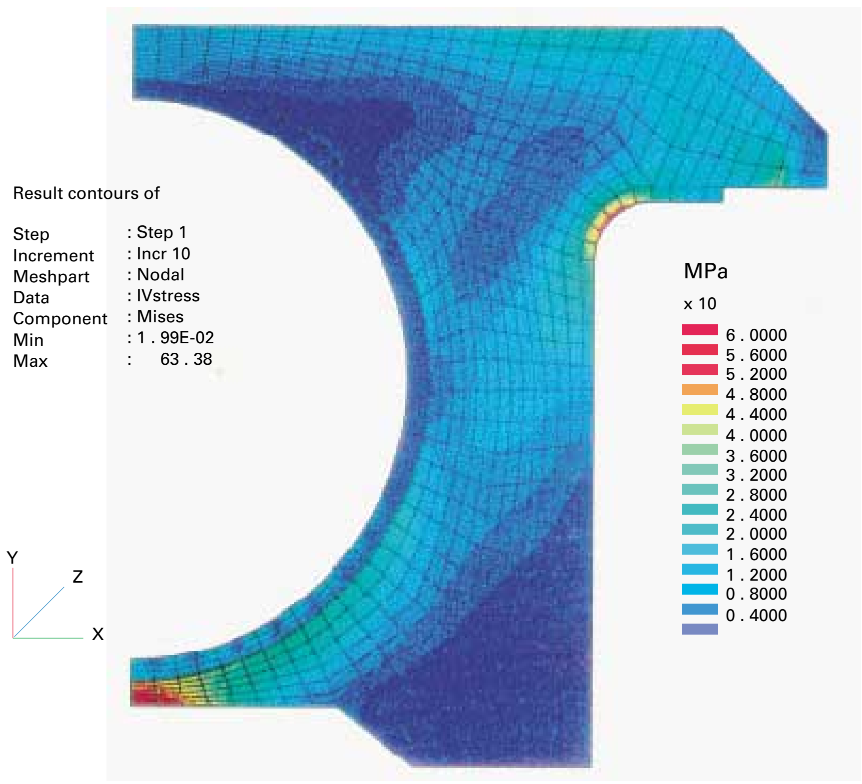


Fig. 3-61 Finite element Von Mises stresses

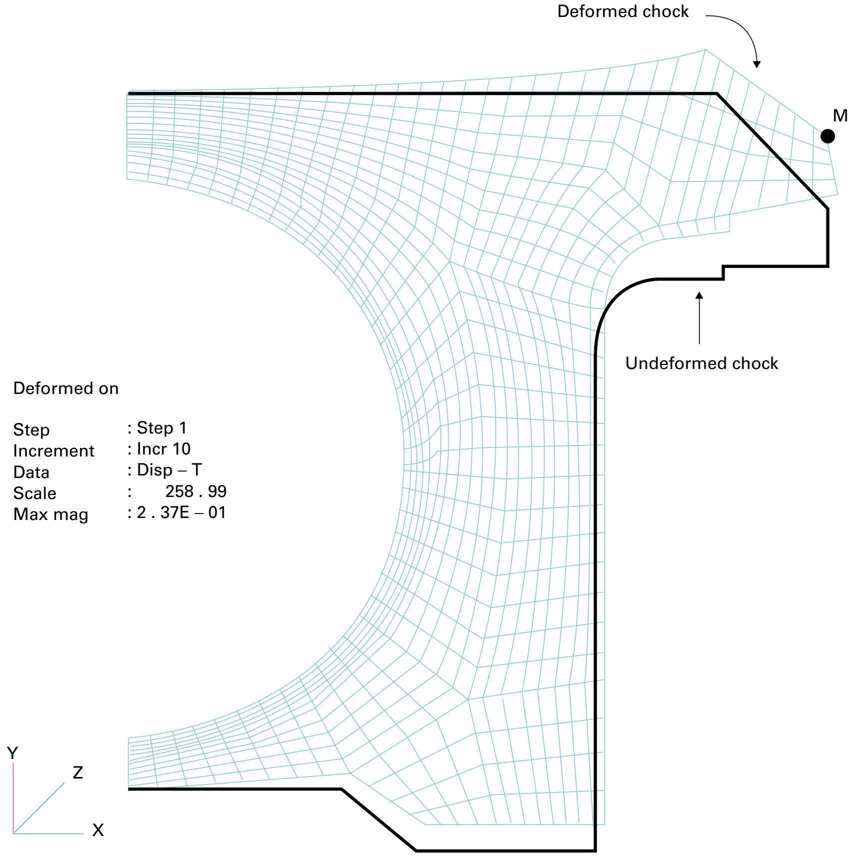


Fig. 3-62 Finite element deformation

4. Lubrication and sealing

4.1. Lubrication

Proper lubrication is essential for successful performance of your tapered roller bearing and thus to achieve the expected life. To have effective lubrication you must take into account the lubricant itself with the correct physical and chemical properties, the proper quantity of lubricant and the way of delivering it to the bearing. Of primary importance is the contact between the roller large end and the rib face.

Bearing performance can greatly vary according to how this contact is lubricated. On roll neck applications, the presence of water and rolling solutions makes this lubrication even more critical.

4.1.1. Basic lubricant functions

A bearing lubricant must perform three fundamental functions :

- Reduce friction and wear by separating adjacent surfaces and limiting metal-to-metal contact,
- Transfer heat from the bearing (with oil lubrication),
- Protect the bearing from corrosion and outside contaminants.

These functions include consideration of the lubrication and generated film thickness on the raceway (created by elastohydrodynamic effects) and on rib/roller end contact.

4.1.1.1. Elastohydrodynamic lubrication

Lubrication can be defined as the control of friction and wear between adjacent bearing surfaces by the development of a lubricant film between them.

The formation of a very thin elastohydrodynamic (EHD) lubricant film between adjacent surfaces depends on the elastic deformation of these surfaces and the hydrodynamic properties of the lubricant itself.

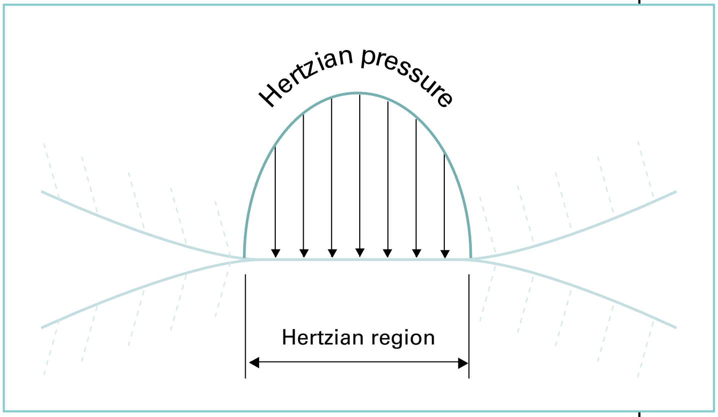


Fig. 4-1
Pressure distribution over contact area

When load is applied to a bearing, the surfaces of roller and race elastically deform and contact over a finite area. The contact between two elastic bodies - hertzian contact - gives rise to a pressure distribution over the region of contact with the maximum Hertzian pressure at the center as shown in fig. 4-1. Typical maximum Hertzian pressure in rolling element bearings, loaded to capacity, can exceed 1400 MPa (200000 psi). Hydrodynamic fluid pressures are generated in the inlet region just ahead of the Hertzian deformation area (fig. 4-2).

In the contact region, the hydrodynamic fluid pressure is trying to separate the two surfaces, while the load is trying to force them together. The high contact pressure in the inlet produces a rapid rise in viscosity which results in sufficiently high hydrodynamic film pressures to separate the two surfaces. Within the contact area, the lubricant pressure can increase to the point where the fluid may behave as a pseudo solid. The effect of high pressure on increasing viscosity is not uniform for all lubricants and depends on the pressure-viscosity characteristics of the particular fluid.

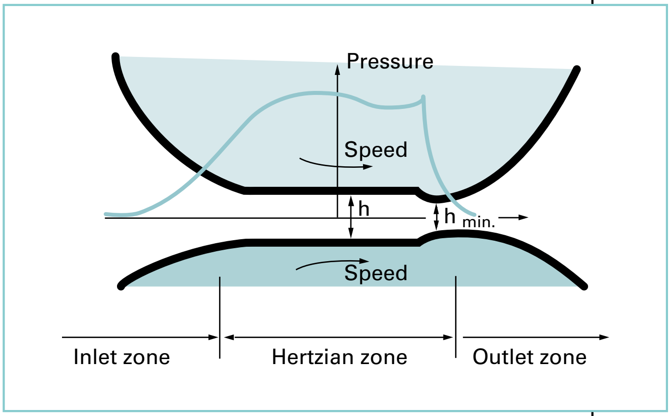


Fig. 4-2
Hydrodynamic fluid pressure separates contact surfaces

4.1.1.2. Film thickness on the raceway

The importance of the elastohydrodynamic lubrication mechanism lies in the fact that the lubricant film thickness between the two contacts is related to the bearing performance. The thickness of the generated film depends on the operating conditions such as :

- Surface velocity,
- Loads,
- Lubricant viscosity,
- Pressure/viscosity relationship.

Analytical relationships for calculating the minimum and the average film thickness have been developed :

Minimum film thickness (Dowson's equation) :

$$h_{min} = 2.65 \times (\mu \times V)^{0.7} \times \alpha^{0.54} \times W^{-0.13} \times R^{0.43} \times E'^{-0.03}$$

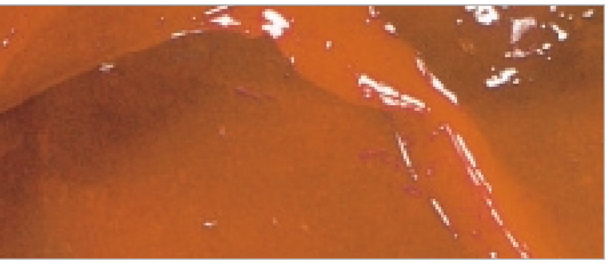
Average film thickness (Grubin's equation) :

$$h = 1.95 \times \left(\frac{E'}{W}\right)^{0.091} \times R^{0.364} \times (\alpha \times \mu \times V)^{0.727}$$

where :

h, h_{min}	=	average and minimum film thickness in m
μ	=	lubricant viscosity in Ns/m²
V	=	relative surface velocity in m/s
α	=	lubricant pressure viscosity coefficient (2.2×10^{-8} m²/N is a usual value)
W	=	load per unit length in N/m
R	=	$\frac{1}{1/R_1 + 1/R_2}$, R_1, R_2 surface radii of curvatures in m
E'	=	reduced Young modulus. $E' = 2.2 \times 10^{11}$ N/m² for steel on steel

The major factors influencing the lubricant film thickness are operating viscosity and speed whereas load has less influence.



The generated EHD film thickness is generally quite small - usually some tenths of micrometers (some microinches). These thin EHD films are often only slightly larger than the height of the individual asperities due to the roughness of the surfaces in contact. When surfaces are not fully separated, the EHD film leaves local areas of asperity contact which are vulnerable for the initiation of surface fatigue.

The fatigue life of a bearing is related in a complex way to speed, load, lubricant, temperature, setting and misalignment. The lubricant's role in this interaction is determined primarily by speed, viscosity and temperature ; the effect of these factors on bearing life can be dramatic. For example, in a test program, fig. 4-3a, two bearing test groups were subjected to conditions of constant speed and load. Different film thicknesses were achieved by varying operating temperature and oil grade, and thereby, oil operating viscosity. Life was dramatically reduced at higher temperatures, with lower viscosity, and thinner resultant films.

Test group	Temperature		Visc. @ Test Temp. mm²/sec (cSt)	EHD Film (h_{min})		Life %
	°C	°F		µm	µin	
A - 1	135	275	2.0	0.038	1.5	13 - 19
A - 2	66	150	19.4	0.264	10.4	100

Fig. 4-3a
Relative bearing fatigue life vs EHD film thickness
(constant speed - variable temperature)

Test group	Speed rev/min	EHD Film (h_{min})		Life %
		µm	µin	
B - 1	3600	0.102	4.0	100
B - 2	600	0.028	1.1	40

Fig. 4-3b
Relative bearing fatigue life vs EHD film thickness
(variable speed - constant temperature)

In another investigation, fig. 4-3b, viscosity and load were held constant, but speed was varied producing results similar to those in fig. 4-3a. Higher speeds produce thicker films and longer lives (i.e. more revolutions).

The selection of the correct lubricant for any application requires careful study of expected operational and environmental conditions. You can also refer to “The Timken tapered roller bearing guide”.

4.1.1.3. Film thickness at the rib/roller end contact

To ensure a good bearing performance, the contact area between the large end of the roller and the cone rib must also be separated by an adequate lubricant film. Even though the contact stresses at the rib and roller end juncture are much lower than those developed on the bearing raceways, there are applications where the oil film in the cone rib/roller end contact can be insufficient to prevent asperity contact. If severe enough, this can result in scoring and/or welding of the asperities. This may be related to speed, oil viscosity, load, or inadequate oil supply to the cone rib/roller contact. When severe operating conditions are anticipated, the use of a lubricant with an extreme pressure (EP) additive may help prevent scoring damage in the cone rib/roller end contact. EP additives are chemically complex materials which, when activated by localized high temperatures, form a low shear-strength film at the contact, thus preventing scoring.

4.1.1.4. Speed capability guidelines

The usual measure of the speed of a tapered roller bearing is the circumferential velocity of the midpoint of the inner race large end rib (fig. 4-4), and this may be calculated as :

Rib speed :

$$V_r = \frac{\pi D_m n}{60\,000} \quad \text{(m/s)} \qquad\qquad V_r = \frac{\pi D_m n}{12} \quad \text{(ft/min)}$$

where :

D_m	=	Inner race rib diameter	mm, in
n	=	Bearing speed	rev/min

The inner race rib diameter can be scaled from a drawing, or can be approximated as the average of the bearing inner and outer diameter.

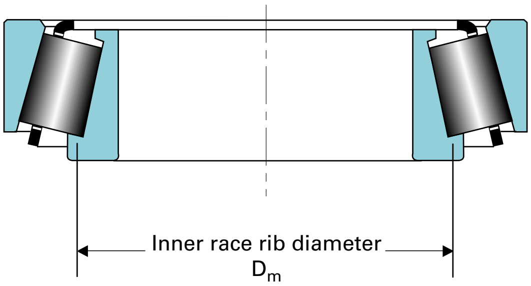


Fig. 4-4

Fig. 4-5 is a summary of guidelines relating to speed and temperature. There are no clear-cut speed limitations for tapered roller bearings regardless of the bearing design or lubrication systems. The Timken Company recommends that testing be performed for all new high speed applications.

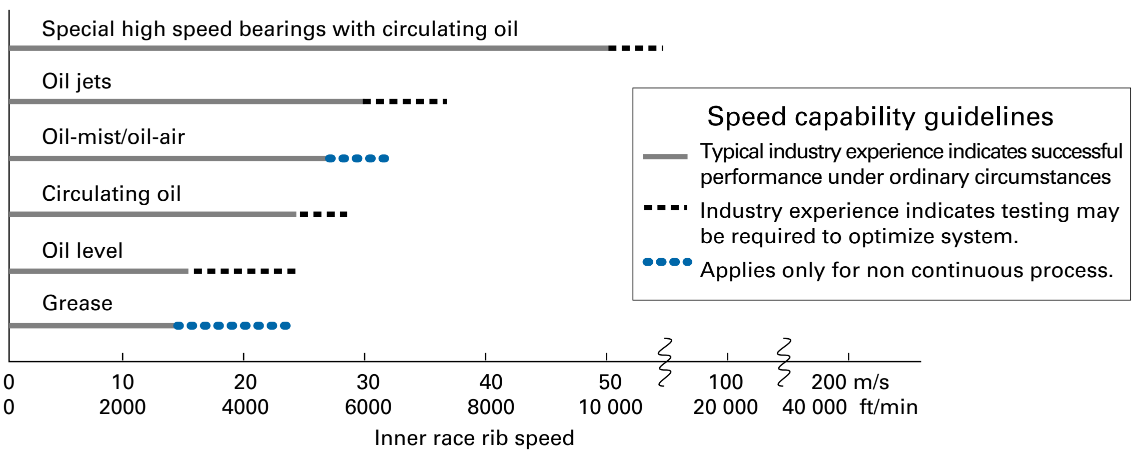


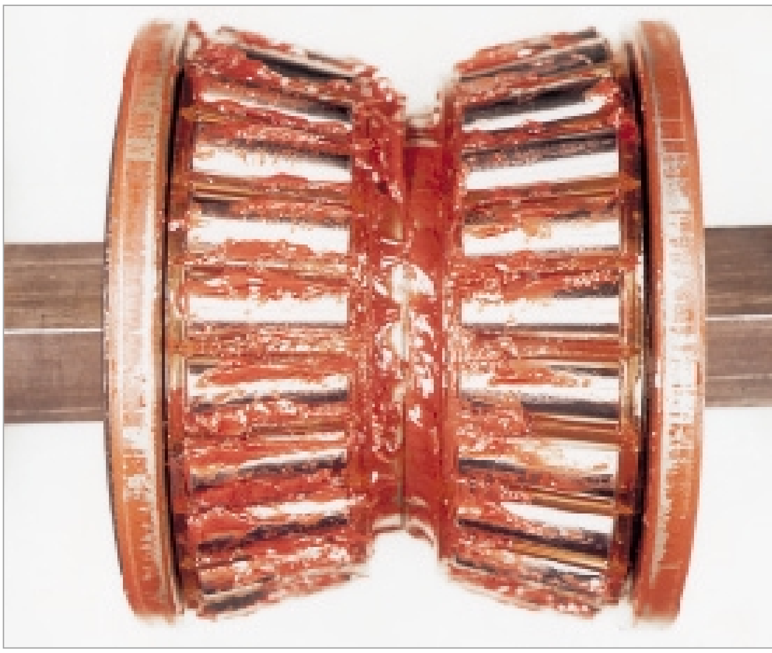
Fig. 4-5
Speed capability guidelines for various types of lubrication systems

4.1.2. Grease lubrication

Grease is a semi-solid product obtained by dispersion of a thickener in a base oil. The grease properties are therefore linked to the nature of the gelling agent and to the liquid lubricant. Most grease types also contain additives in order to obtain specific characteristics (water resistance, anti-oxidants, extreme pressure capabilities...).

Grease is a good solution for lubrication problems, the main advantages being :

- Simplified lubrication system,
- “Seal” effect,
- Limited leakage versus liquid lubricant,
- Good protection against corrosion even when the system is stopped.



Nevertheless, by using grease, bearings do not dissipate heat as it occurs with oil type lubrication. The bearing is more difficult to clean, and grease can sometimes capture contaminants which are detrimental to the bearing.

Different types of greases exist, depending on the thickener and the base oil used. To select the right grease, the important parameter to consider is the elastohydrodynamic film thickness in operating conditions. This film thickness is directly linked to the viscosity of the base oil.

4.1.2.1. Mill stands and highly loaded equipment

Grease type

Grease lubricated steel mill equipment, roll necks and auxiliary equipment such as table rolls, can be lubricated with what is commonly referred to as EP steel mill grease. Because of the nature of steel mill equipment, the grease must be a heavy duty product capable of withstanding heavy loads plus abnormal shock loading.

Suggested EP steel mill grease properties

Soap type :	Lithium or Calcium Sulfonate or equivalent
Consistency :	NLGI No.1 or No.2
Additives :	Corrosion and oxidation inhibitors Extreme pressure EP additive* –15.8 kg (35 lb) min. "OK" Timken load
Base oil :	Solvent refined petroleum or synthetic oil
Base oil viscosity : (at 40 °C)	Usually 320 to 460 cSt (contact the Timken Company for critical applications)
Viscosity index :	80 minimum
Pour point :	–10 °C maximum

*ASTM D2509

EP steel mill grease should not contain materials which are corrosive or abrasive to tapered roller bearings or seal material. The grease should have excellent mechanical and chemical stability and should not readily emulsify or wash out in the presence of water or mill emulsion.

It should contain inhibitors to provide long term protection against grease oxidation in high temperature applications, and protect the bearings from corrosion in the presence of moisture. The grease should also contain extreme pressure (EP) additives to prevent scoring in severe service.

A grease that maintains its stability and properties over a long service life is especially critical for sealed roll neck bearings.

Required grease quantity

To avoid the generation of heat, the bearing must not be "overgreased". The required quantity of grease is based on the free volume of the bearing calculated as follows :

$$V = \frac{\pi}{4} (D^2 - d^2)\ (T)\ -\ \frac{M}{A}$$

where :

V = free volume in the bearing (cm^3 - $inch^3$)
D = outer race O.D. (cm - inch)
d = inner race bore (cm - inch)
T = overall width (cm - inch)
M = bearing weight (kg - lb)
A = average steel density
7.8×10^{-3} kg/cm^3
0.2833 $lb/inch^3$

Depending on the application (speed...), we suggest to fill the bearing with a quantity of :

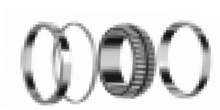
1/2 to 2/3 of V for conventional greases

To determine the corresponding weight of grease, an approximate density of 0.9 g/cm^3 (0.032 $lb/inch^3$) can be used.

Grease should be put between rollers and cage by forcing it under the cage, generally from the large end to the small end.

Regreasing cycle

Special attention must be payed to the regreasing of a bearing. In fact, overgreasing generates excessive heat and the bearing can burn up. After an initial fill with grease, the parameters which determine regreasing are : temperature (the higher the temperature, the quicker the grease will oxidize), seal efficiency and pollution. It is not possible to give a general guideline for regreasing because it depends on the efficiency of the sealing system and therefore must be based on experience. Nevertheless, it is general practice to regrease at every roll change for unsealed bearings and at every bearing inspection (about 500 to 1000 hours) for sealed roll neck bearings.



Speed capability

The Timken Company does generally not advise a grease type lubrication for rib speeds over 20 m/s (4000 ft/min) on roll neck applications. This relatively high value for grease lubrication is possible due to the non continuous operating mode.

4.1.2.2. Other equipment

We suggest using general purpose industrial grease :

Suggested general purpose industrial grease properties

Soap type :	Lithium 12-hydroxystearate, or equivalent
Consistency :	NLGI No.2
Additives :	Corrosion and oxidation inhibitors
Base oil :	Solvent refined petroleum oil
Base oil viscosity : (at 40°C)	100 to 320 cSt
Viscosity index :	80 minimum
Pour point :	–10 °C maximum

The suggested base-oil viscosity covers a fairly wide range. Lower viscosity products should be used in high speed and/or lightly loaded applications to minimize heat generation and torque. Higher viscosity products should be used in moderate to low speed applications and under heavy loads to maximize lubricant film thickness.

Grease is mostly used for moderate speeds and should, in general, not be used over 13 m/s (2600 ft/min) rib speed.

4.1.3. Oil lubrication

There are three basic types of oil lubricating systems used on most Timken bearing applications. The selection of a particular type of system is generally based on thermal considerations or the ability of the system to remove the heat generated by the bearing and/or the gear system in the application.

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4.1.3.1. Oil bath

Of all the oil systems, oil bath is certainly the simplest but also the most limited solution in terms of speed, due to its limited ability to transfer heat. It is only used for low to moderate speeds not in excess of 18 m/s (3600 ft/min) rib speed.

This type of lubrication system can be found on drives, pinion stands, coilers...

The bearings are in this case partially submerged in a static oil reservoir as shown in fig. 4-6.

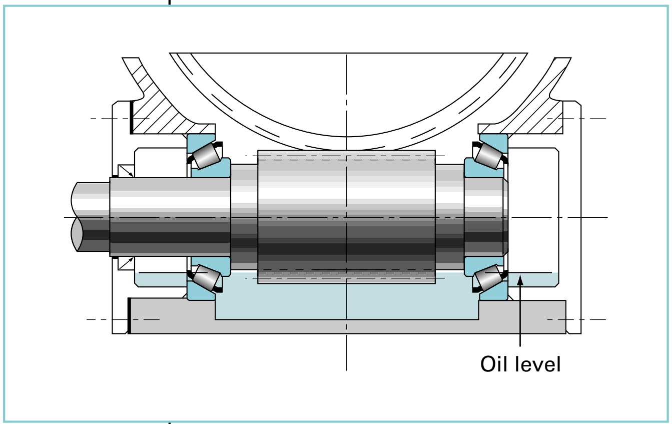


Fig. 4-6
Oil level system

With the oil bath system, as refill is generally not a frequent task, it is very important to insure effective sealing to maintain an adequate oil level. If the application is critical, it is also advisable to use sight gauges to monitor the oil level.

Heat dissipation can be improved if the oil is splashed on the entire inner surface of the housing. Most of the time, the gears will handle this job. The aim is then to recapture the oil and to channel it to the bearing. This is achieved by the use of oil catching devices as shown in fig. 4-7. As you can see, we always try to enter from the roller small end in order to take advantage of the natural pumping effect of the tapered roller bearing design. In order to maintain an oil level in the bearing, oil dam systems can be used as shown in the figure.

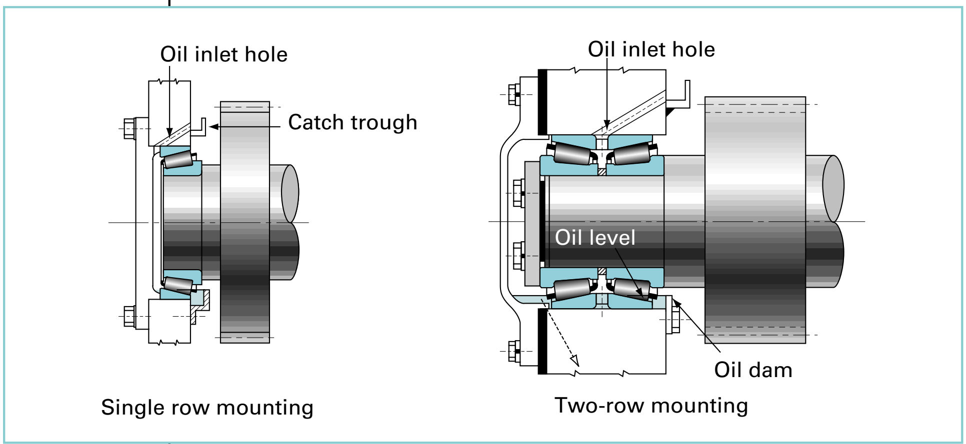
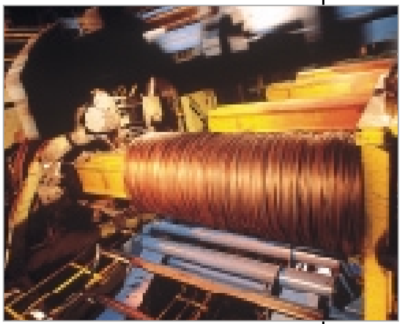


Fig. 4-7
Oil splash systems



Oil splash systems can be used at moderately high bearing speeds (even above 20 m/s - 4000 ft/min) if properly designed with a large oil reservoir and large cooling surfaces. Housing design will also have a major influence on the degree of cooling provided.

The oil is primarily selected from a viscosity standpoint which is dictated by application parameters such as :

- speed, load, and environmental factors,

Since viscosity varies inversely with temperature, the viscosity value must always be defined in relation to the expected operating temperature (which is also linked to the initial oil viscosity). In most of the above mentioned applications using oil bath, a petroleum type oil with a viscosity between 220 and 460 cSt at 40 °C is generally used. In order to improve the oil behavior, additives can be used. The most common are :

- extreme pressure “EP” additives, to prevent scoring under boundary lubrication conditions,
- oxidation inhibitors for increasing lubricant service life,
- rust or corrosion inhibitors to protect the bearing surfaces,
- antiwear agents.

4.1.3.2. Oil-mist / Oil-air

Oil-mist lubrication

On roll necks, oil-mist lubrication systems are usually considered when conventional grease lubrication is judged as being no longer safe and reliable, according to rolling speed either for work roll and/or back-up roll bearings.

Oil-mist lubrication, characterized by its low oil consumption, has proven to be very successful over the last decades for Timken bearing equipped roll necks operating at rolling speeds up to around 2100 m/min (7000 ft/min).

Tests conducted years ago to simulate continuous rolling operation even proved that oil-mist lubrication was still a reliable lubrication system ; as a matter of fact, the operating temperature of the bearing did stabilize when the mill was operated at maximum speed for a duration of about 5 hours at approximatively 2100 m/min (7000 ft/min). See fig. 4-8.

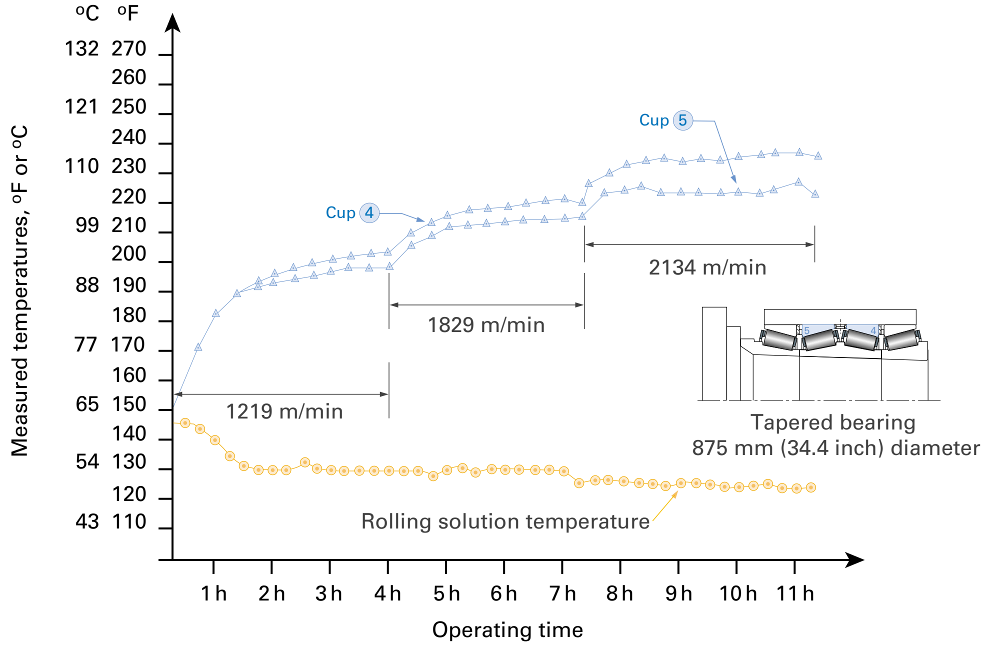


Fig. 4-8
Measured bearing temperatures for mist cooled tapered roller bearing at speeds to 2100 m/min (7000 ft/min) and 1000 tons separating force

The oil with such a lubrication system is atomized into fine particles in an oil-mist generator (oil size particles about 2 micrometers - 80 microinches on average) which are then conveyed by the low velocity (approx. 5 m/s - 16 ft/s) and low pressure (nominal 0.05 bar - 0.73 psi) air stream to the nozzles located in the drillings provided in the chocks.

These nozzles (usually 3 or 4 per chock) should be located in the chock bore in line with the lubricant entries provided in the bearings and seals (fig. 4-9).

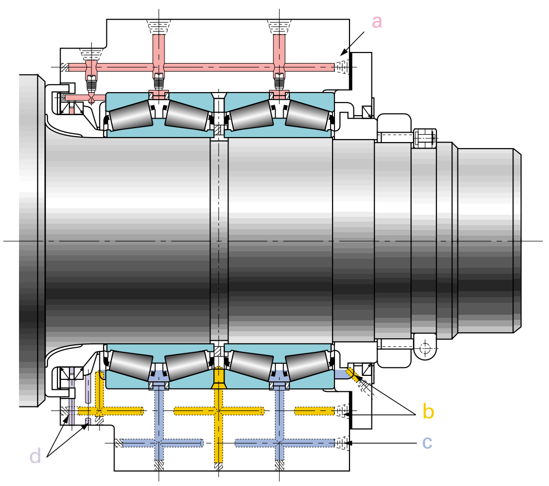


Fig. 4-9
General layout with TQOW/2TDIW type bearings

General instructions for TQOW/2TDIW type bearings

a) Oil entries
Provide one common axial entry hole, with leads to outer cup spacer, inner cup spacer and inner seal near top of chock. Reclassifying nozzles are applied into radial holes and into pipe tap holes adjacent to cup spacers and seal.

b) Combination vent and oil level
Locate vent holes at oil level height at center of bearing hole and inner end of chock hole to intersect a common axial hole. The outer vent may be placed in end cover.

c) Oil drainage
Drill holes to bottom dead center of cup spacers to intersect a common axial hole.

d) Combine vent and drain for inner seal at bottom dead center. Provide drain to remove rolling solution which may gain entry through seals.

The functions of the nozzles are :

- Firstly, to ensure the distribution and the control of the amount of oil-mist. This is achieved by the number/length/size of the holes per nozzle, and the distribution of these nozzles among the various points to be lubricated in a given chock (usually two per bearing and 1 or 2 for the lip seals fig. 4-10),

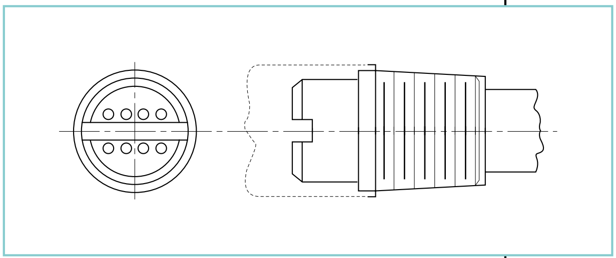
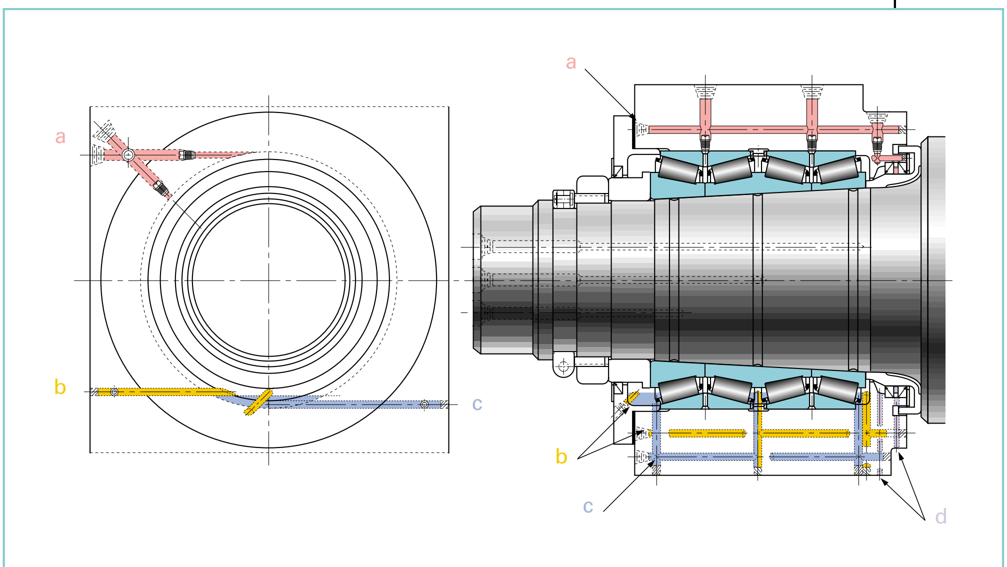


Fig. 4-10
Reclassifying nozzle

- Secondly, to increase the size of the fine oil particles suspended in the low velocity air stream just before entering the bearing. This is achieved by the turbulence created by the velocity increase when the oil-mist (lubricated air) is passing through the nozzle holes (these nozzles are also called reclassifying nozzles). In this respect, it is important to provide adequate venting in the chock, so as not to disturb the pressure drop through the nozzle holes and therefore, the mist velocity increase (vent holes area should be at least twice the area of all nozzle holes in the system). See fig. 4-9 and 4-11.

Note also that these venting holes will determine the minimum oil level within the bearing. This oil level is required during the start-up phase. It is also recommended to ensure that this level exists, particularly when starting the mill after a long period of non-operation.

Fig. 4-11
Oil-mist layout with TQIT type bearings



General instructions for TQIT type bearings

a) Oil entries

Provide one common axial entry hole with leads to center of outer cup, inner cup, and inner seal near top of chock. Reclassifying nozzles are applied into radial holes and into pipe tap holes adjacent each cup and seal.

b) Combination vent and oil level

Locate vent holes at oil level height at cup spacer hole and inner end of chock hole to intersect a common axial hole. The outer vent may be placed in end cover.

c) Oil drainage

Drill drain holes to bottom dead center at each end of chock and to the cup spacer to intersect common axial drain hole.

d) Combine vent and drain for inner seal at bottom dead center. Provide drain to remove rolling solution which may gain entry.

The amount of oil contained in the mist passing through the nozzle holes will partly exit condensed and partly in the form of a wet oil spray which is to be further extracted from the air when impinging at high velocity against the stationary and rotating elements of the bearing.

It is advisable to locate the nozzles directly within the bearing itself, i.e. in the cups or cup spacers, for high speed mills. This will therefore ensure that the oil is well distributed around the circumference of the bearing and is “directly” condensed “inside” the bearing as well as the oil which remained air-borne at the exit of the nozzles.

The bearings will therefore be more effectively lubricated as the wet oil spray impinges upon the rolling elements which will be continuously coated with a fine film of oil (fig. 4-12).

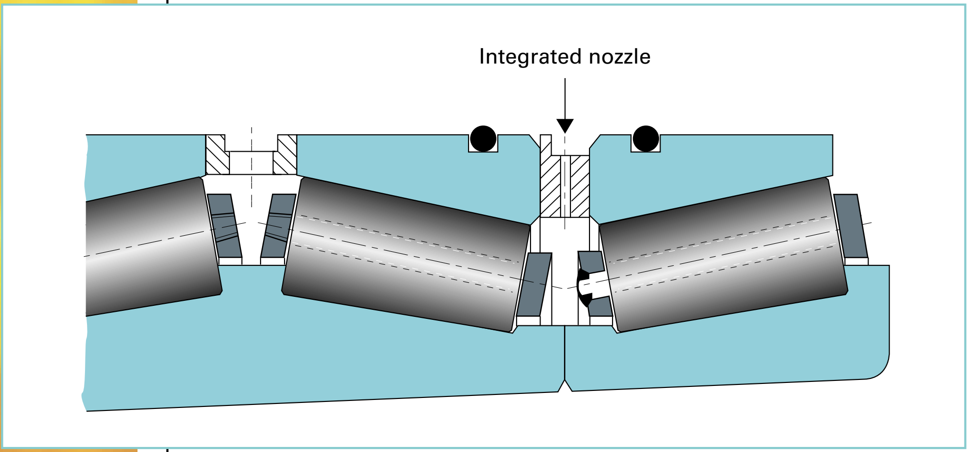


Fig. 4-12
Bearing with integrated nozzles

The amount of oil condensed at the exit of the nozzles and the amount of oil remaining air-borne is dependent upon the ratio *“length L of nozzle over nozzle hole diameter D”*.

For roll neck bearings, spray nozzles are usually selected with a *L/D* ratio of 20. This ratio will enable condensation of at least 50 % of the oil at the exit of the nozzle (standard nozzle hole size for such spray nozzles are designed with *D* = 1.7 mm - 0.067 inch, *L* = 35 mm - 1.38 inch).

If the installation is well engineered and designed, less than 10 % of the oil will remain air-borne at the exit of the chock. It is therefore essential to select oils which have very good mistability characteristics (additional air heaters to be used, max. possible viscosity around 460 cSt at 40 °C). However, contamination of the outside air by the remaining air-borne oil is normally minimized and almost nil, if the oil-mist escaping the chocks is conducted via a hose and pipe installation to an oil-mist collector which will extract the remaining oil.

Suggested rolling mill mist-oil properties

Base oil :	Solvent refined, high viscosity index petroleum oil or synthetic oil designed specifically for mist applications
Additives :	Corrosion and oxidation inhibitors Extreme pressure (EP) additive - 15.8 kg (35 lb) min. "OK" Timken load
Mistability :	Good total output, good oil to air ratio, additive package appropriate to the type of service required, and must not clog nozzles in service
Viscosity index :	80 minimum
Pour point :	–12 °C maximum
Viscosity grade :	320 to 460 cSt at 40 degrees °C (In the case of viscosities outside this range, consult The Timken Company.)

Oil consumption

The required quantity of oil with an oil-mist lubrication system is not specifically calculated based on heat generated within the bearings, but rather according to the size and number of rows of the bearing.

This is understandable as it would not make much sense to calculate an oil flow for a lubrication system consuming only a very small amount of oil.

However the minimum expected amount of oil to be consumed can be established once the quantity of oil-mist has been calculated based on the oil-mist density declared by the manufacturers of such oil-mist generators.

For example, a minimum oil/air ratio quoted is : 0.0066 to 0.0098 liter of oil (0.4 to 0.6 inch^3) per hour for every 28.3 liters per minute (1 ft^3 per minute) of air passing through the misting unit, with oils having a viscostiy of around 100 cSt at 40 °C and with no heaters (for any information related to your mill, please contact the oil-mist system manufacturer).

This allows the operator to check the efficient functioning of the installation by controlling periodically its oil consumption. For example, for a large size back-up roll bearing having a bore of about 860 mm (34 inch) the oil consumption is usually around 80 cm^3/hour (5 inch^3/hour) on average.

Oil-air lubrication

Oil-air lubrication has become very popular in recent years on roll neck bearings.

On a recently built 3-stand cold aluminium mill, the back-up rolls equipped with Timken TQIT bearings, having a bore size of 895 mm (35.2 inches), are lubricated by means of an oil-air lubrication system. The maximum rolling speed of this mill is around 1700 m/min (5600 ft/min).

With this type of lubrication the oil is no longer atomized before it is conveyed to the bearing by the air stream. Accordingly the air stream velocity and pressure can be much higher with no risk of condensation of the oil before entering the bearing.

Suggested rolling mill air-oil properties

Base oil :	Solvent refined, high viscosity index petroleum oil or synthetic oil
Additives :	Corrosion and oxidation inhibitors Extreme pressure (EP) additive - 15.8 kg (35 lb) min. “OK” Timken load
Viscosity index :	80 minimum
Pour point :	–12 °C maximum
Viscosity grade : recommended	320 to 68 cSt at 40 degrees °C (Higher viscosities can be selected for low speed mills. In these cases, please consult The Timken Company.)

The nozzle function, mandatory with oil-mist lubrication, is no longer needed.

The only requirement is to effectively distribute the oil droplets among the different lubrication points in the chock (i.e. the quantity of oil entering through the main entry hole of the chock has to be evenly shared among the different bearing rows and lip seal positions).

The possibility to operate with a higher air velocity and greater quantities of air which has not been heated for atomization reasons may also offer some additional cooling potential for the bearings.

The air pressure inside the bearing chamber (about 0.2 to 0.3 bar - 3 to 4.5 psi) may also better prevent ingress of rolling coolant depending on the proposed sealing and/or venting system.

Note: Air / oil systems may employ two or three entry points (shown). The air / oil system supplier should be consulted for design details. Venting can be achieved through drilled holes appropriately located, similar to an oil mist system. Or, it can be done directly through the seals. Consult the air / oil system supplier. The suggested "static" oil level, for start up purposes, is a minimum level corresponding to a dimension approximately 5 mm (0.2") above the small ID of the cup. Vents should be designed so as to prevent any leakage of rolling solution or contamination back into the bearing.

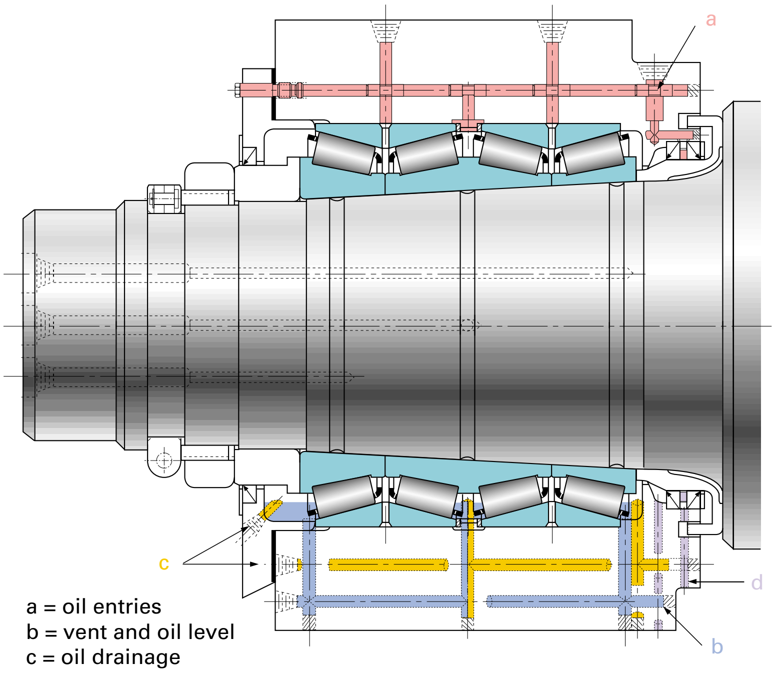


Fig. 4-13
General layout with TQIT bearings

Oil characteristics

For heavily loaded and low speed mills, such an oil-air lubrication system also allows very high oil viscosities to be selected (around 680 cSt at 40 °C or more) as the oil no longer has to be misted.

Oil consumption is usually lower, according to equipment suppliers, when compared with the quantity of oil consumed by an oil-mist system. These quantities are based on equations developed by the oil-air systems suppliers, and can be discussed and defined with them. As in all other lubrication systems, the proper oil-air quantities are finally set when the mill is tested in operation. The initial calculation is primarily used to define the size of the installation.

General comments on both oil-mist and oil-air systems

Such small quantities of oil used in either oil-mist or oil-air lubrication systems are of course not capable of removing the heat generated in the “chock/bearings” system of high speed mills. The equilibrium temperature will depend almost entirely on the heat dissipation capacity of the bearing’s surrounding parts (chocks and rolls) in order to be able to operate at a stabilized bearing operating temperature which is still considered safe. Our experience shows that our bearings can operate safely at temperatures up to 130 °C (270 °F).

The quantity of oil required has to be evaluated just to effectively lubricate the bearing races and rollers. In other words, this minimum quantity of oil is based on the surface of the bearing races to be "coated" and on the oil film thickness neccessary to separate the rolling and sliding surfaces.

The risk of having insufficient oil available at any moment is reduced due to the presence of the minimum oil level in the bottom of the chock and the safety oil pump which is usually specified with both types of lubrication systems. However, the position of the oil level in the bottom of the chock must be controlled properly in order to avoid additional heating due to oil churning, particularly for high speed mills. Usually the level should be just above the bearing outer races (as shown in fig 4-14).

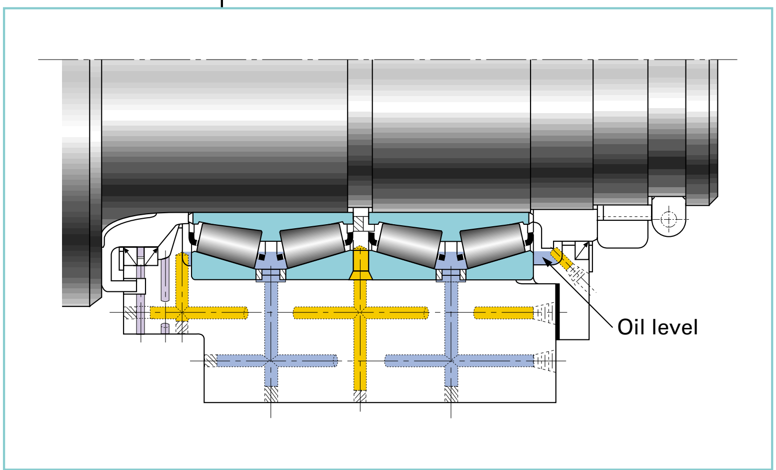


Fig. 4-14 Recommended oil level

The basic advantage of an oil-air lubrication system when evaluated and compared with an oil-mist lubrication system seems to be its greater reliability to supply a constant quantity of oil to the bearings at all times. This reliability is essential for a lubrication system designed to consume small quantities of oil.

As a matter of fact, the system is no longer dependent upon the selection of the right oil mistability characteristics and the well engineered and designed pipe and hose system.

The fact that the oil no longer has to be misted, eliminates the risk of pollution of the air. This potential problem exists with an oil-mist lubrication system *when only free venting* (no oil extractor) is used.

4.1.3.3. Oil circulation

These systems are used when there is a lot of heat to be dissipated in the application due to the different operating parameters. They can be used, for example, in medium to high speed gear drives as well as on some specific roll neck applications. They can also be gradually adapted to the required level of heat dissipation and if necessary an oil cooling unit can be added.

In a typical oil circulation system, as in figure 4-15, oil is pumped from a central reservoir to each bearing. Oil is introduced at the small end of the bearing and drained away at the large end to take advantage of the natural pumping action of the tapered roller bearing.

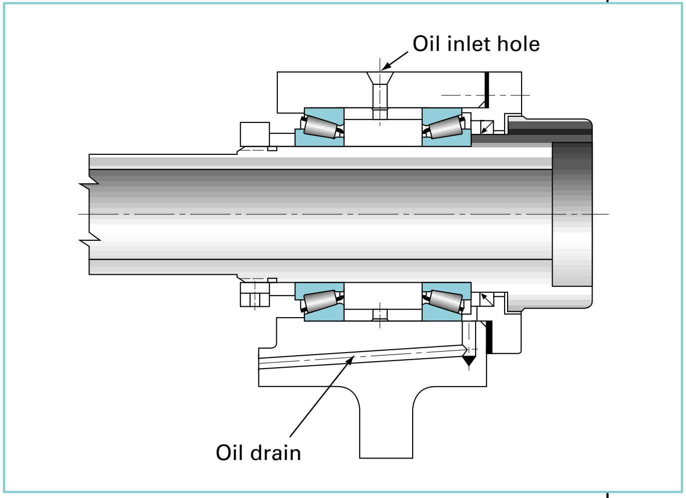


Fig. 4-15
Oil circulation system

This kind of circulation can be used for rib speeds up to 25 m/s (5000 ft/min).

If the rib speed exceeds the above value as on very high speed drives or coilers, forced feed systems with oil jets are then used (fig. 4–16). The jets are positioned to direct the oil to the space between the cage and the small cone rib.

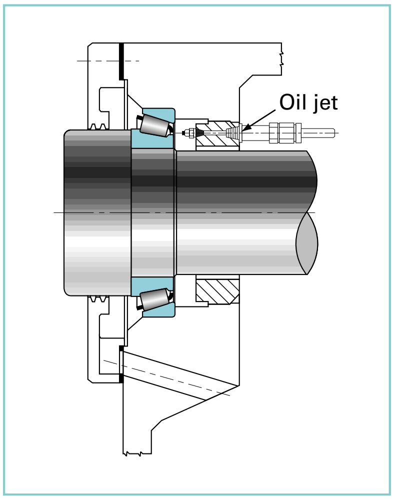


Fig. 4-16
Forced-feed oil system with oil jet

In addition, oil jet orifices, usually about 2.5 mm (0.1 inch) diameter, can be arranged around the circumference of the bearing to distribute oil at the small roller end for maximum cooling efficiency.

When the speeds are even higher (about 35 m/s - 7000 ft/min), oil jets in the top part of the housing can also be added to direct lubricant to the large roller ends, in order to ensure proper lubrication of the rib/roller end contact.

In both cases, a sufficiently large return hole must be provided in the housing to avoid oil churning and additional heat generation on the large roller end side.

$Q_{gen} = Q_{oil} + Q_{housing}$ (under stabilized operating temperature)

where :

Q_{gen}	= generated heat	W, Btu/min
Q_{oil}	= heat dissipated by the oil	W, Btu/min
Q_{hsg}	= heat dissipated by the housing	W, Btu/min

Oil flow will also be a critical parameter for the performance of this lubrication system. In fact, this flow will help to dissipate the balance of the temperature build-up which cannot be absorbed by the housing.

If the oil quantity is excessive, it will generate additional heat ; if it is too low, it will not absorb enough of the heat generated and in both cases, it will not be possible to stabilize the temperature.

In order to give a guidance for the oil quantities needed, the heat generated by the bearing can be calculated using the loads, the speed, the lubricant viscosity and the bearing internal characteristics.

Heat generation

Under normal operating conditions, most of the torque and heat generated by the bearing is due to the elastohydrodynamic losses at the roller/race contacts.

The heat generated by the bearing is a function of the rotational, speed and the running torque :

$$Q_{gen} = k_4 \, n \, M \qquad (1)$$

where :

Q_{gen}	= generated heat	W, Btu/min
M	= running torque	N.m, lb/inch
n	= rotational speed	rev/min
k_4	= see next page	

For a proper estimation of the heat generated, please refer to The Timken Tapered Roller Bearing Guide.

Heat dissipation by the circulating oil

The heat dissipated by a circulating oil system is given by the following equation :

$$Q_{oil} = k_5 \, f \, (\theta_o - \theta_i) \qquad (2)$$

If a circulating lubricant other than petroleum oil is used, the heat carried away by that lubricant will be :

$$Q_{oil} = k_6 \, C_p \rho f \, (\theta_o - \theta_i) \qquad (3)$$

If the lubricant flow is unrestricted on the outlet side of a bearing, the flow rate which can freely pass through the bearing depends on bearing size and internal geometry, direction of oil flow, bearing speed and lubricant properties.

A tapered roller bearing has a natural tendency to pump oil from the small to the large end of the rollers. For maximum oil flow and heat dissipation, the oil inlet should be adjacent to the small end of the rollers.

In a splash or oil level lubrication system, heat will be carried by convection to the inner walls of the housing. The heat dissipation rate with this lubrication method can be enhanced by using cooling coils in the housing sump.

k_4 Dimensional factor to calculate heat generation rate in equation (1)
k_4 = 0.105 for Q_{gen} in W when M in N.m
= 6.73 x 10^{-4} for Q_{gen} in Btu/min when M in lbf.in

k_5 Dimensional factor to calculate heat carried away by a petroleum oil in equation (2)
k_5 = 28 for Q_{oil} in W when f in l/min and θ in °C
= 0.42 for Q_{oil} in Btu/min when f in U.S. pt/min and θ inch °F

k_6 Dimensional factor to calculate heat carried away by a circulating fluid in equation (3)
k_6 = 1.67 x 10^{-5} for Q_{oil} in W
= 1.67 x 10^{-2} for Q_{oil} in Btu/min

Q_{oil}	Heat dissipation rate of circulating oil	W, Btu/min
θ_i	Oil inlet temperature	°C, °F
θ_o	Oil outlet temperature	°C, °F
C_p	Specific heat of lubricant	J/(kg x °C), Btu/(lb x °F)
f	Lubricant flow rate	l/min, U.S. pt/min
ρ	Lubricant density	kg/m^3, lb/ft^3

The main question left is how much heat is the housing dissipating, in order to be able to set the proper oil flow as per the above formulae. The answer to this question depends on each application and can only be determined after it has operated. Initially, for a new application, it can only be estimated. This estimate will enable to define the amount of heat being dissipated by the oil, and therefore, the predicted oil flow can be calculated in order to at least select an adequate pumping system (pressure, maximum flow).

As far as the final flow is concerned, it will be finalized after testing during the application start-up phase under all operating conditions.

4.1.4. Influence of contaminants and possible additives

Abrasive particles

The primary cause of bearing damage in a clean environment is the eventual fatigue of the races where rolling contact occurs. However, when particle contamination enters the bearing system, it is likely to cause damage such as bruising which will shorten bearing life.

Nevertheless, it has been recognized and demonstrated that case hardened steel is more tolerant to debris than through-hardened steel. Furthermore, when dirt from the environment or metallic wear debris from some component in the application is allowed to contaminate the lubricant, wear can become the predominant cause of bearing damage (fig. 4-17).

Fig. 4-17
Bearing damage due to particles

Bearings operating in a contaminated lubricant exhibit a high initial rate of wear. But, with no further contaminant ingress, this wear rate quickly diminishes, as the contamination particles are reduced in size when they pass through the bearing contact area during operation.

In general, the important parameters influencing bearing wear are contaminant particle size, concentration and hardness as well as lubricant film thickness. Increases in all of these parameters except film thickness, will increase bearing wear. Increasing lubricant viscosity will reduce bearing wear for a given contamination level.

When particle contamination is likely to have a significant effect on bearing performance, filtration equipment is suggested. Nominally 40 micrometers (0.0015 inch) rated filters are common for most industrial applications.

Water/rolling emulsions

Either dissolved or suspended water/rolling emulsions in lubricating oils or greases, can exert a detrimental influence on bearing fatigue life. Water/rolling emulsions can cause bearing etching which can also reduce bearing fatigue life. The exact life mechanism is not fully understood but it has been suggested that water/rolling emulsion enters microcracks in the bearing races which are caused by repeated stress cycles. This then leads to corrosion and hydrogen embrittlement in the microcracks which reduce the time required for these cracks to propagate to an unacceptable size.

Lubricant additives

Additives are materials, usually chemicals, which are added to lubricants to improve specific properties. Additives, when properly formulated into a lubricant, can increase lubricant life, provide greater resistance to corrosion, increase load-carrying capacity, and enhance other properties. However, additives are very complex, and therefore, should not be added indiscriminately in lubricants as a cure-all for all lubrication problems. The more common lubricant additives in the rolling mill industry are : extreme pressure additives to prevent scoring, antiwear agents, oxidation inhibitors, rust or corrosion inhibitors...

4.2. Sealing

4.2.1. Basic seal functions

In order to obtain the full service life of a bearing assembly, an efficient sealing device is imperative.

Dynamic seals which are a key component in a bearing system have two functions :

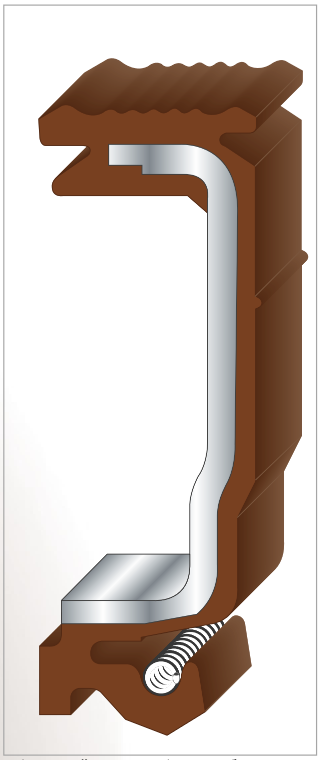
- to exclude the contaminants from the bearing system,
- to retain the lubricant inside the bearing.

The proper seal design is dependent upon which of these two functions is more critical and on the bearing operating conditions.

The selection of the proper seal design for any Timken bearing application should consider the type of lubricant, the foreign material to be kept out of the bearing chamber, the speed of the application, the expected operating temperature, the type of application and other general environmental and operating conditions. Foreign material such as dust, scale or any hard, gritty substance, will act as a lapping agent and cause rapid bearing wear. Water, rolling solution (acid) will deteriorate the lubricant, which results in bearing damage as well as loss of lubricant.

4.2.2. Seal types

There are two basic types of seals : contacting and non-contacting.



"Two in one" contacting seal

Contacting seals

With a contacting seal or rubbing seal, a physical contact usually occurs between the sealing members when no relative motion exists. They are frequently used in the lower to medium speed ranges where the heat generated by the contact forces is not excessive. There are two basic types of contacting seals : radial lip seals and face seals (fig. 4-18). They are currently the primary means of protecting tapered roller bearings. These radial lip seals used in the rolling mill industry are mainly manufactured in two different materials which are nitrile and floroelastomer (Viton...). These two materials can be used either for mineral oils or for synthetic oils. The nitrile seals are used for lip seat speed up to 14 m/s (2800 ft/min) and operating temperature up to 100 °C (212 °F). Above either of these two parameters, where high thermal stability and chemical resistance are required, floroelastomer seals are generally suggested (can be used up to 160 °C - 320 °F). A correct lip efficiency is obtained with a lip seat hardness of 45 - 60 HRC and a roughness R_a of 0.2 - 0.8 micrometer (8 - 30 microinches). These two recommendations help to establish and maintain a stable lubricant film, preserve the surface texture and prevent excessive seat wear.

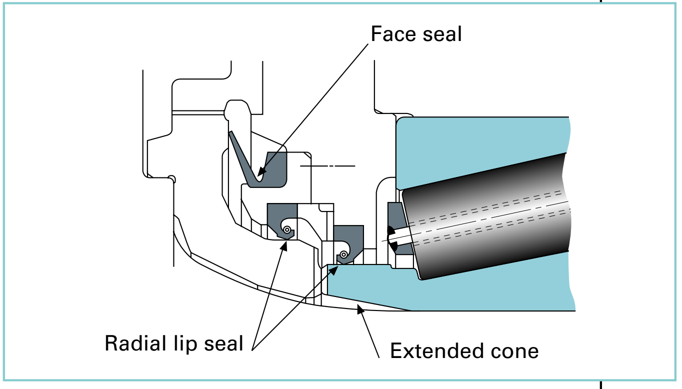


Fig. 4-18 Contacting seals

Non-contacting seals

Non-contacting seals include various types of labyrinth and hydrodynamic seals which maintain a clearance between the sealing elements. Leakage through these seals depends on the amount of clearance and the seals ability to reduce potential energy of the fluid that may enter the labyrinth. Labyrinth seals are produced in a variety of configurations. Theoretically, labyrinths are leakage reduction mechanisms but not leakage elimination mechanisms. Labyrinth seal leakage rates are directly proportional to radial clearance ; therefore, these clearances should be kept to a minimum. Non-contacting seals are often proposed for high speed (above 25 m/s - 5000 ft/min) where elastomer lip seals cannot be used.

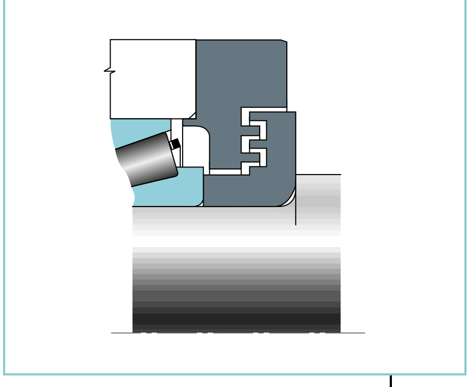
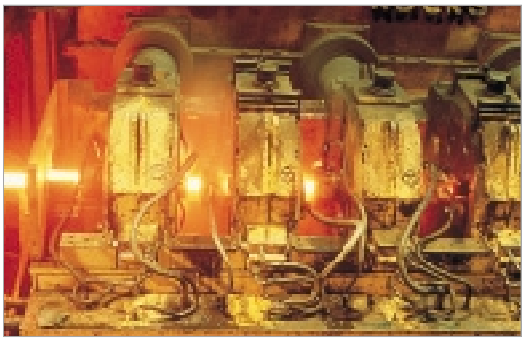


Fig. 4-19 Labyrinth

4.2.3. Sealing systems

4.2.3.1. Roll necks



A correct sealing arrangement, principally at the barrel side is required on roll neck applications in both ferrous and non ferrous mills. This is especially important during wet rolling where the rolling solution flows directly on the fillet ring and for bearings installed in a highly contaminated mill environment. Various sealing designs can be used, but to show all of these possible variations would be impractical.

The sealing design depends on the available space between the bearing and the barrel face which corresponds also to the fillet ring length. Some arrangements have been used successfully for a period of years to meet various types of operating conditions. Most of these are made up with one or two radial lip seals in combination with a face V ring type seal and/or with a labyrinth especially for wet rolling to offer additional protection.

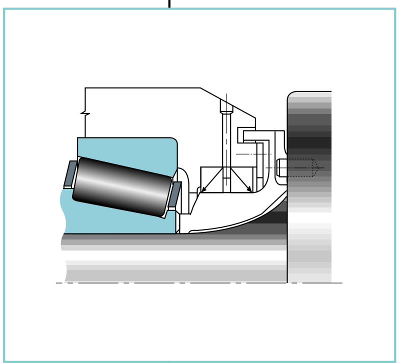


Fig. 4-20

Seal manufacturers have developed these seals to solve lubrication problems found by rolling mill production and maintenance departments. Figures 4-18 and 4-20 show various sealing designs. In the case where two radial lip seals are used as a unit, a lubricant entry between the two seals is required to prevent lips from rotating on a dry seat. The illustrated arrangements could vary slightly depending on the available space. The fillet rings are generally mounted tight on the roll necks to prevent the entry of the rolling solution through the fillet ring inside diameter.

In order to have the seals remaining with the chock and the bearing assembly, extended cones can be proposed as shown in figures 4-18. This design, which exists on loose-mounted (TQOWE) as well as on tight-fitted arrangements (TQITSE), permits the chock and bearing to become a sealed unit system. This eliminates the usual problem of handling damage and rolled-over seal lips as the seals are kept on their seats during roll change. In the case of the tapered bore TQITSE arrangements, this design is suggested only in cases where relatively rigid rolls and roll necks are used. It is also suggested that the extended cone rib contact directly against a shoulder on the roll, to provide a design where neck deflection is minimized.

On the retaining ring side, whatever the retaining device, one or possibly two radial lip seals are generally suggested

Sealed Roll Neck Bearings

Sealed roll neck bearings are designed to be completely interchangeable with the standard bearing. These bearings were developed to decrease grease consumption and provide additional protection against contamination ingress. The additional seals on the bearing will offer another barrier against contamination, however it is very important to keep the external chock sealing arrangement in place and well maintained.

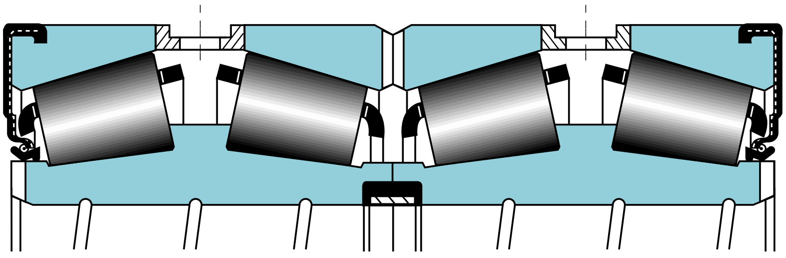


Fig. 4-22
Narrow seal concept

Static seals

In order to obtain a complete sealing of the bearings, we need also to consider static seals between non rotating parts. These sealings which are generally used between the cup cover and the housing (chock) could be obtained by using "O rings" or compressible gaskets. The same applies for the shaft and its components.

4.2.3.2. Auxiliary equipment

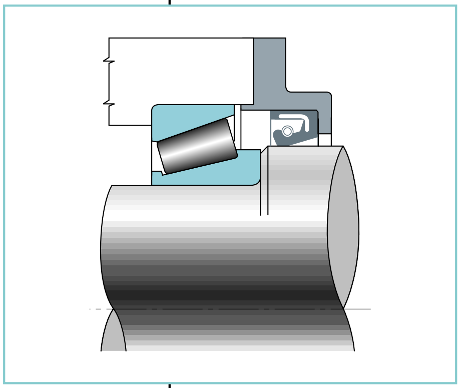


Fig. 4-23

Auxiliary equipment, for example : coilers, uncoilers, pinion stands, reducers and slitters are confronted less with a highly contaminated environment. In this case, less sophisticated sealing arrangements are required. Many types and styles of radial lip seals are commercially available to satisfy different sealing requirements.

In cleaner environments where the primary requirement is the retention of lubricant in the bearing housing, a single lip seal with the lip pointing inwards is often used.

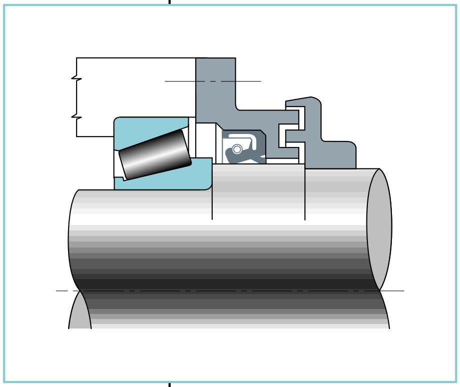


Fig. 4-24

In contaminated environments, the lip is usually pointed outwards as shown in figure 4-24.

In even more critical environments, a double lip seal or possibly two lip seals are often used. Additional flingers (labyrinth) should be used as a primary sealing where extremely dirty conditions are present so that the seal lip and sealing surface are protected to avoid wear and premature lip seal damage.

In the case of grease lubrication and clean environment, metal stamping closures can be used. Where environmental conditions are dirty, these stampings are used in combination with other closure elements to provide an effective labyrinth against the entry of contaminant.

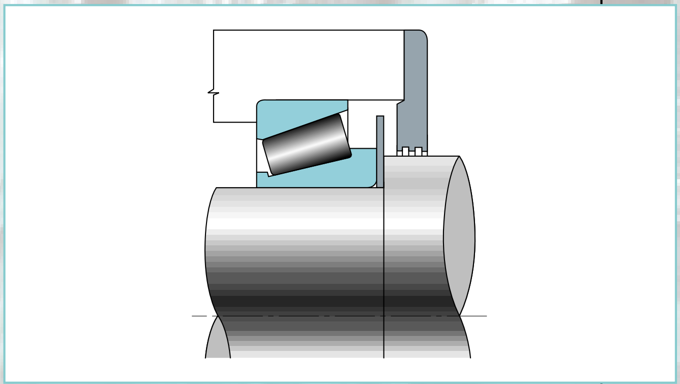


Fig. 4-25

For a more efficient retention of lubricant and exclusion of foreign matter, machined flingers with an annular groove closure provided on the stationary part are also used as shown in figure 4-25.

Many other sealing arrangements with a combination of different types of seals can also be designed.

4.2.3.3. Vertical applications

Vertical shaft applications require special sealing arrangements, especially when the bearings are lubricated with oil. A good approach is to prevent the oil from coming in direct contact with the seal.

In the case of oil circulation systems, flingers allowing a reservoir to be retained as shown in figure 4-26 is one of the best solutions. A drain located at the bottom of the reservoir will collect the oil.

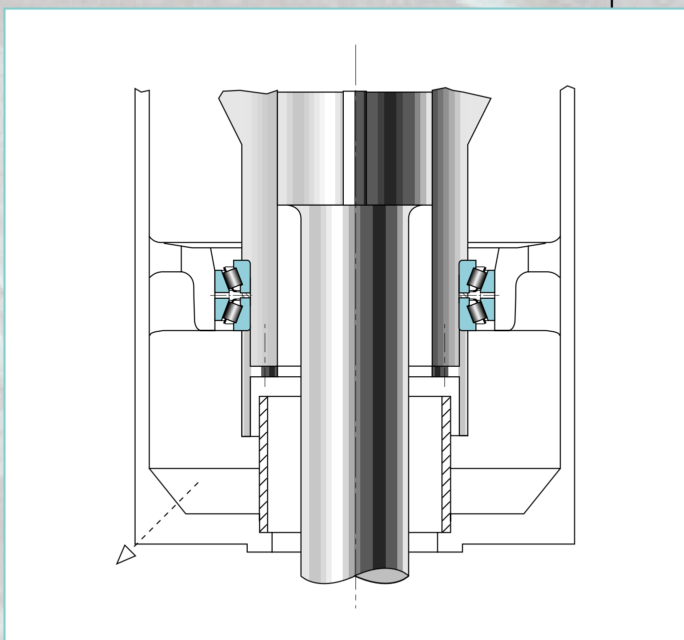


Fig. 4-26

In the case of a grease lubrication system used for example on vertical rolls, labyrinths combined with a radial lip seal are often incorporated.

Enhanced sealing can be obtained on the top of the roller (as shown in figure 4-27) if the labyrinths are designed above the roller face. This will prevent any water flowing directly into the bearing.

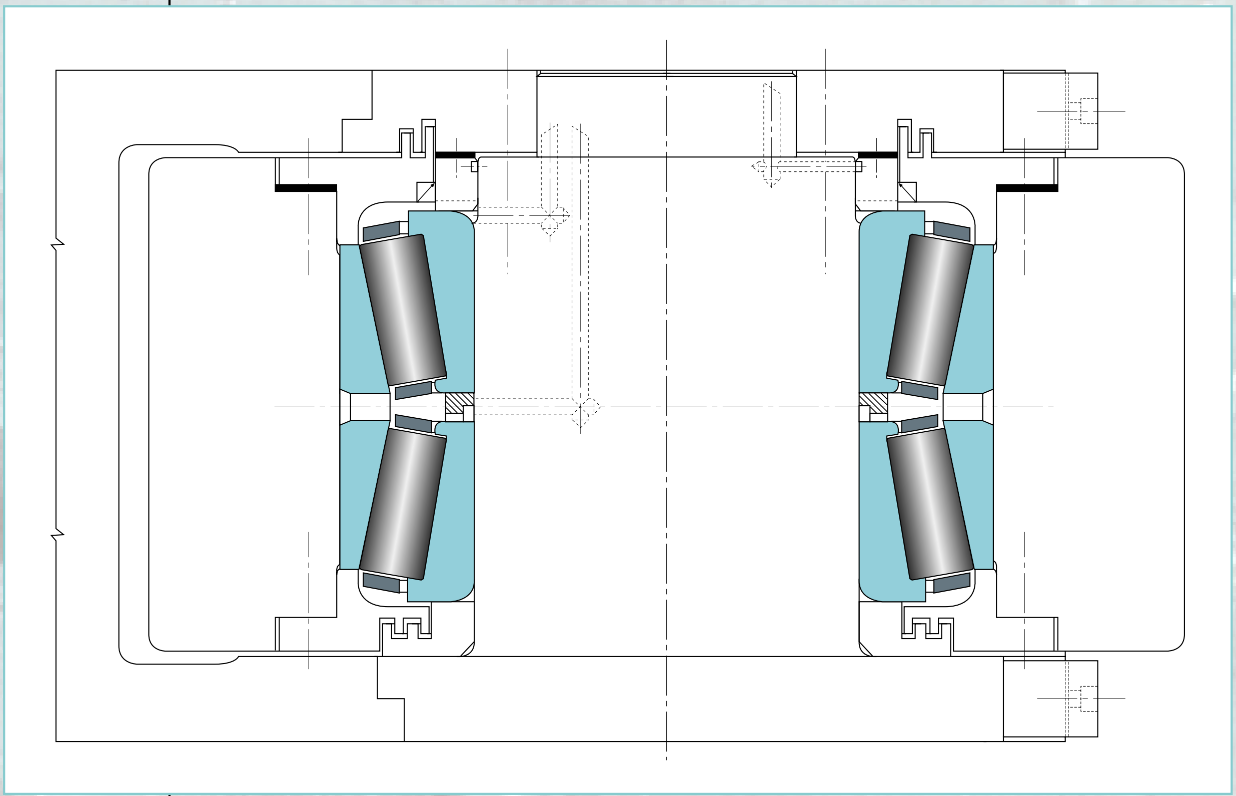


Fig. 4-27
Vertical roll sealing

Proper sealing design should always be a prime consideration in striving for maximum bearing performance.

Page

5. Mounting and maintenance practices

WARNING

Never spin a bearing with compressed air. The force of the compressed air may cause the rollers to be expelled with great velocity, creating a risk of serious bodily harm.

Proper bearing maintenance and handling practices are critical. Failure to follow installation instructions and to maintain proper lubrication can result in equipment failure, creating a risk of serious bodily harm.

Do not wash or clean bearings in an enclosed area. Solvent fumes are toxic and explosive. Make absolutely certain there is adequate ventilation and no open flame, welding or smoking in the area. Rubber gloves should always be worn to protect skin from the solvents. Failure to follow these precautions creates a risk of serious bodily harm.

If a hammer and mild steel bar are used for bearing removal, fragments from the hammer, bar, or the bearing can be released with sufficient velocity to create a risk of serious bodily injury including damage to your eyes.

5.1. Installation procedures and typical mountings

5.1.1. Bearing marking procedure

5.1.1.1. Bearing identification

The **Part Number** is marked on every Timken part (cones, cups, spacers). The cup number is marked on the cup back face of single cups and on the front face of double cups. For single cones the number is shown on the cone back face, and on the front face for double cones.

The **Serial Number** is also etched on all components to indicate the manufacturing sequence. All cups, cones and spacers in one bearing assembly will be marked with the same serial number and should be kept together.

The **Timken name** and the manufacturing source is also indicated on each cup and cone.

The **bench endplay (BEP) or bench preload (BPL) value** for preset assemblies and the corresponding spacer width are shown on the outside diameter of the cup and cone spacers.

5.1.1.2. Marking for correct stacking sequence

When a bearing assembly is stacked up, the proper assembly sequence must be followed in order for the bearing to have the correct setting.

The Timken Company uses a lettering system to ensure proper stacking.

This lettering system applies to all assemblies with 3 or more rows (see figures 5-1, 5-2 and 5-3). The components of the assembly are lettered in alphabetical order. These letters are marked on each side of the cups and cones after the serial number, whereas the spacers are marked on the outside diameters.

A bearing can be stacked with either the first letter end down or the last letter down, but the parts must be kept in the proper sequence. Each spacer (cone spacer or cup spacer) must be placed in its corresponding gap.

Every preset assembly has a serial number and all parts of that bearing must be kept together.

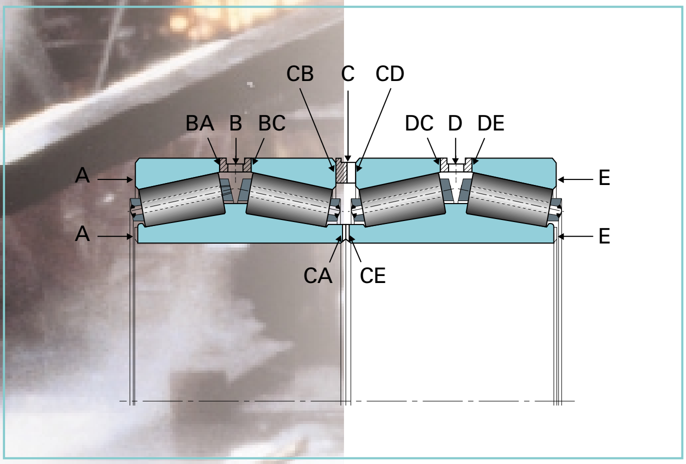


Fig. 5-1
Stacking sequence for 2TDIWE

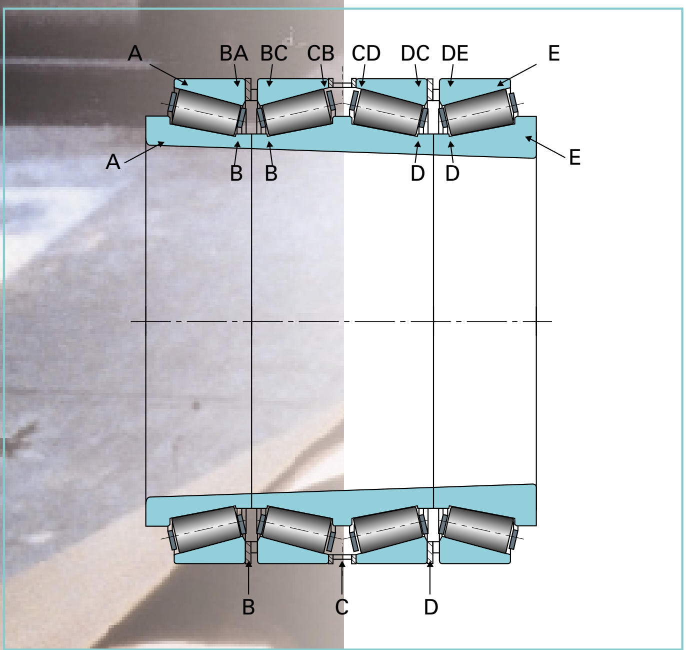
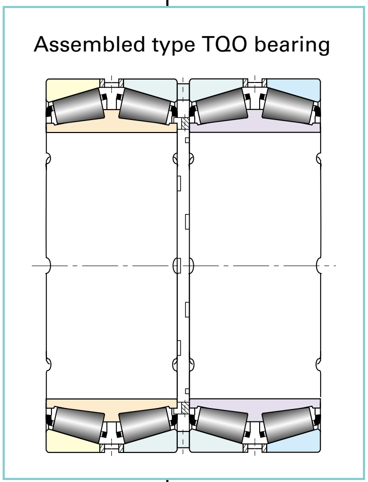


Fig. 5-2
Stacking sequence for TQITS



5.1.1.3. Cup load zone marking

Since the bearing cups are stationary in the chocks, only one part of the cup carries the rolling load at any one time. This portion is called the load zone.

Most roll neck bearing cups are marked on their faces to show four quadrants. These markings on the cup back and front faces enable you to keep a record of which quadrants have been used in the load zone. A good practice is to mount the bearing with quadrant number 1 of each cup in the load zone, then go through 2, 3, 4 on subsequent inspections ; then repeat the procedure starting at 1. The Roll Neck Bearing Service Record card (see chapter 5.2.4.2.) offers an excellent means of keeping a record of the cup load zones that have been used.

The rotation of the cups at every inspection will extend the useful life of the bearing by incrementally distributing the load over the entire cup raceway.

In all cases, any spall in the cup raceway which has been cleaned off should be kept out of the load zone when the bearing is re-mounted in the chock.

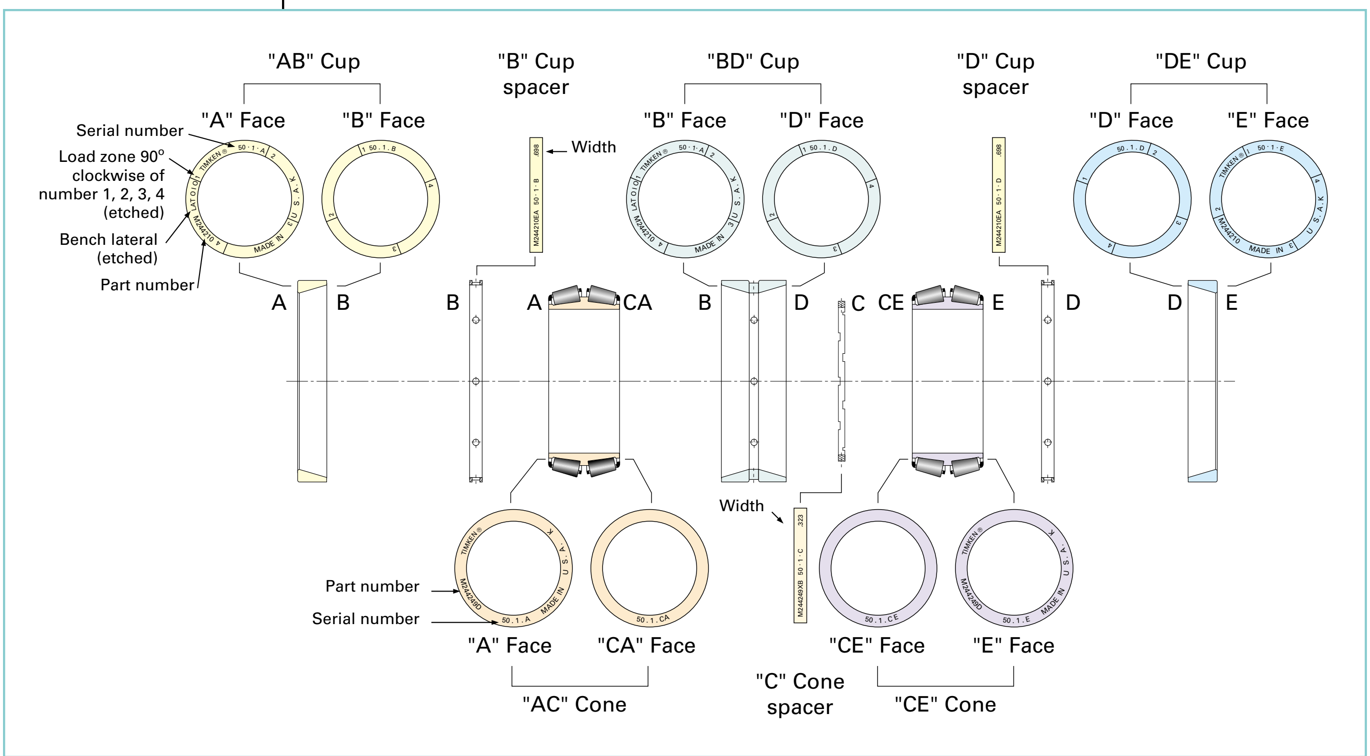
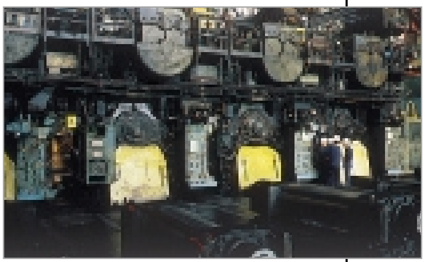


Fig. 5-3
Marking of Timken TQO bearings

5.1.2. Mill stands

5.1.2.1. Back-up rolls

Typical mounting of four-row tapered roller bearings for mill rolls are :



- TQOW or 2TDIW assemblies

These straight bore bearings are used in cases where the cones are mounted with a loose fit on the roll neck.

- TQITS or TQITSE assemblies

These tapered bore bearings are used on roll necks of high-speed and precision mills. Tapered bore cones are used in order to give an interference fit on the roll neck.

TQOW - 2 TDIW assemblies

Figures 5-4 and 5-5 show a TQOW four-row bearing and a 2TDIW four-row bearing mounted on a roll neck. One chock is fixed in the housing window with keeper plates, while the opposite chock is allowed to float.

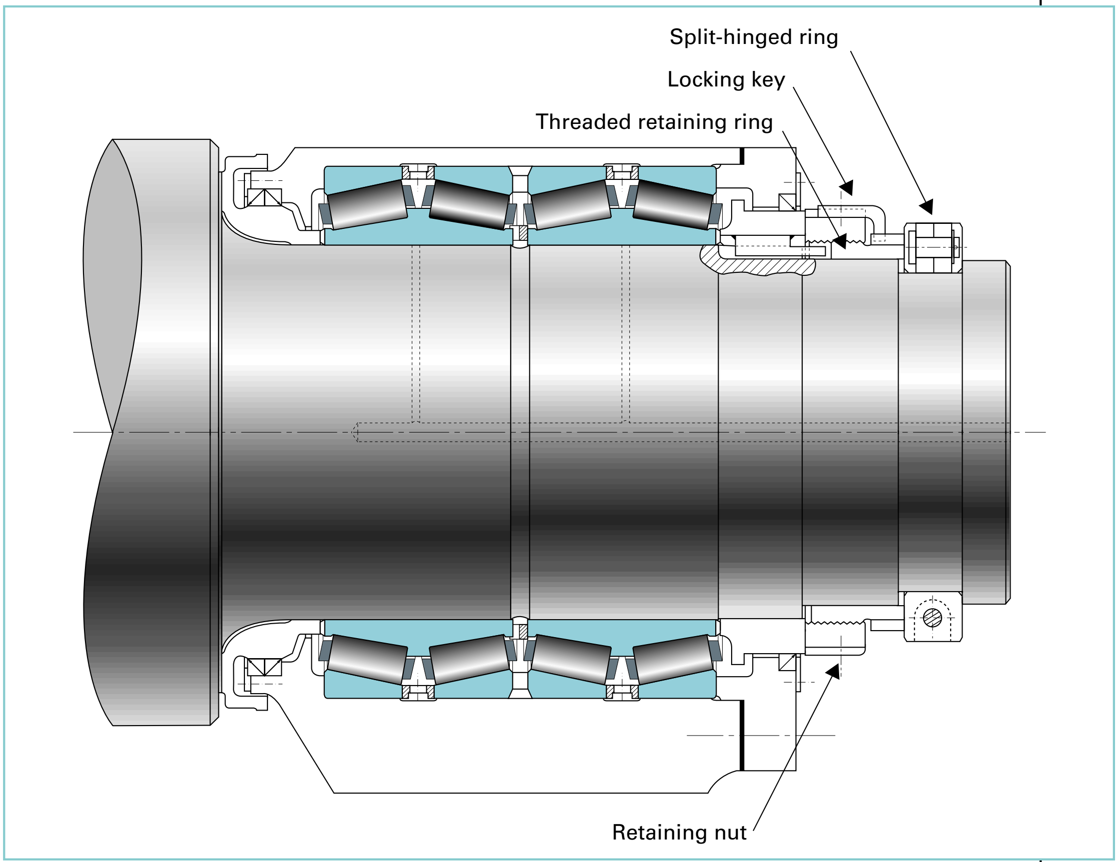
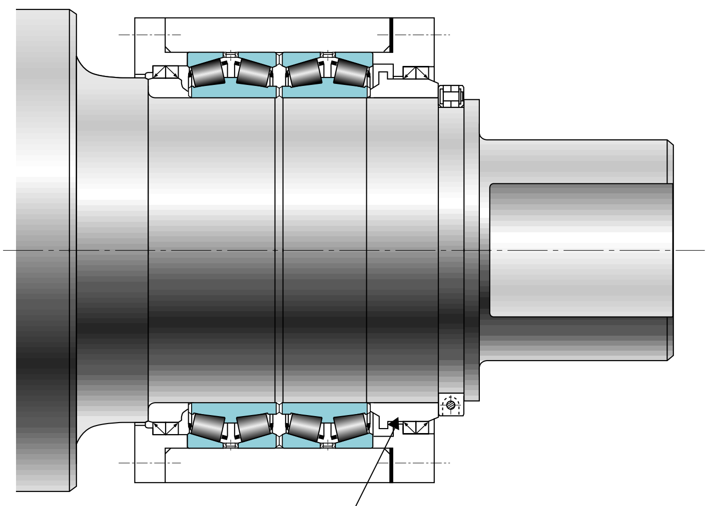


Fig. 5-4
TQOW mounting arrangement with retaining nut

Fig. 5-5
2TDIW mounting arrangement without retaining nut and with tight tolerances



The cups are clamped up axially in all arrangements. The low to medium speeds allow the cones to be mounted with a loose fit on the roll neck. An axial gap of 0.500 to 1 mm (0.020 inch to 0.040 inch), or even more for large bearings, is provided to prevent wear to the cone faces in case they creep on the roll neck. The common approach is to use a retaining nut (fig. 5-4). This nut should possess a number of slots on its periphery as an aid to locking it into the correct position. The number of slots corresponds generally to twice the pitch in millimeters, which allows the required axial clearance to be achieved with just one slot on the threaded retaining ring. A locking key is then used to prevent the nut from rotating. This gap can also be achieved by holding very tight width tolerances on the bearing (less than 0.500 mm (0.02 inch) in total tolerance) and on the retaining ring. The retaining nut is then no longer necessary (fig. 5-5). This axial clearance also allows minor float to take place through the loose cone fit.

Slots are generally provided in the cone front faces (TQOW and 2TDIW types) to allow the lubricant to migrate between the neck surface and the bearing bore. In cases where slots do not exist on the cone faces (TQO type), these slots should be provided in the intermediate ring and the fillet ring faces. These faces should generally have a hardness of approximately 55 to 60 HRC in order to prevent excessive wear.

The chock and bearing assembly can then be removed as a complete unit from the neck by unlocking and removing the retaining device. This unit can be easily transferred from one roll to another whilst protecting the rolling elements and preventing any possible contamination of the bearing.

Mounting procedures for TQOW and 2TDIW bearings

As the cones are mounted with a loose fit, the bearing can easily be installed on the roll neck after having been fitted previously in its chock.

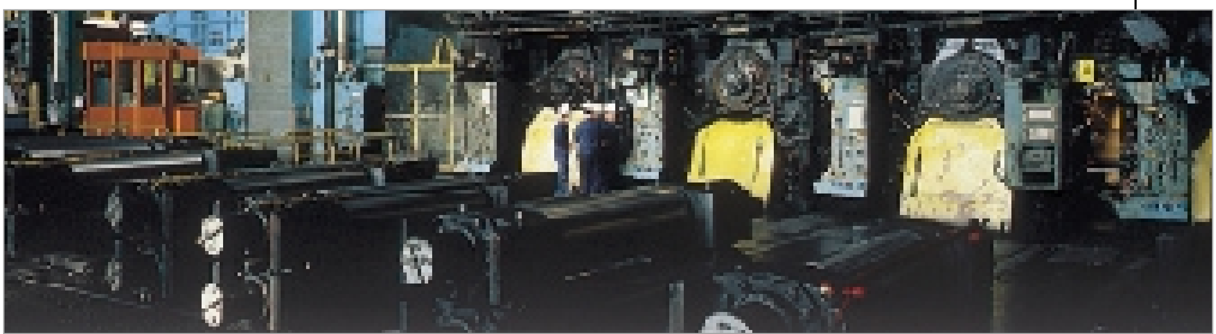
The assembly procedure consists of the following :

1. Clean the roll neck well and coat it with lubricant to prevent scuffing and wear,
2. Mount the bearing and chock assembly on the roll neck,
3. Install the retaining device :
   - Assemble the split-hinged ring in the retaining groove on the neck. The mounting procedure will then be completed for those cases where no retaining nut unit is used.
   - In cases where a retaining nut unit is used, back off the retaining nut by some tenths of mm (some hundredths of inch) depending on the type of mill and lock. This will be achieved after having reached zero axial clearance through the cones. Finally mount and secure the key into the nearest available hole.

Dismounting procedures for TQOW and 2TDIW bearings

The disassembly procedure consists of the following :

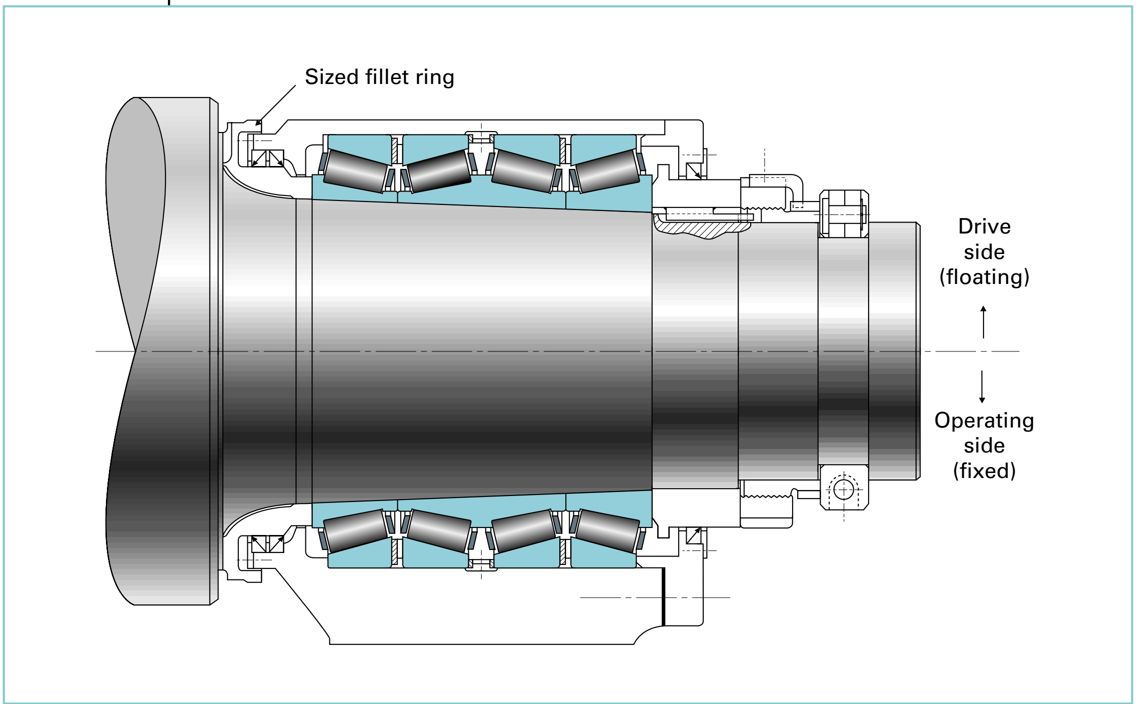
1. Support the mill roll on the barrel outside diameter. Make certain that the chock does not carry any of the mill roll weight,
2. Remove the split-hinged ring (after having, if necessary, loosened the nut about one-half turn if such a device is used),
3. Dismount the bearing and chock assembly from the neck.

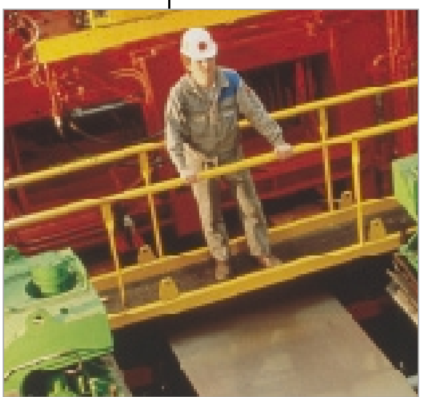


TQITS assembly

Figure 5-6 shows a TQITS four-row bearing mounted on a roll neck. The cups of this bearing type are only clamped on the fixed or operating side. On the floating or drive side, the cups are permitted to float axially in the chock bore due to clearances between the cup and the cover faces. The drive side is not only permitted to float through the cups of the bearing, but also through the chocks in the mill frame window. This arrangement permits free expansion and contraction of the roll caused by variations in roll temperatures.

Fig. 5-6





The cones are mounted on a 1/12 tapered neck and pushed-up against a correctly sized fillet ring and retained through a suitable clamping system. A clean dry roll neck is required to maintain maximum holding power of the interference fit between cone and neck. The sized fillet ring will provide the correct interference fit between the cone and the roll neck. As the cone bores are ground to a tolerance of less than 0.008 mm (0.0003 inch), all bearings are interchangeable on all roll necks.

The TQITS tapered bore bearing, using tight-fitted cones, meets all requirements for high-speed mills. The tight fit and the indirect mounting arrangement provide greater stability between the cones and the neck. This results in a better load sharing between the four rows of the bearing. This design permits improved fillet contours and larger necks, resulting in lower neck stress and deflections.

A tight fit of 0.00075 mm per mm bore (0.00075 inch per inch bore), is generally applied, which corresponds to a contact pressure of 14 to 15 MPa (2000 to 2200 psi) for the inner cone, which has the smallest section. In order to reduce the push-up force required to press the three cones together, we propose a stepped tight fit for the double center cone and for the heavy section outer cone. Lesser tight fits are suggested in order to keep the same contact pressure as for the inner cone. By considering the same tight fit for the three cones, the contact pressure will be higher for the double center cone and for the outer cone because of their larger sections (with the stepped tight fit, the push-up force will be decreased by about 20 %).

TQITSE assembly

Figure 5-7 shows a TQITSE four-row bearing with an extension on the inner race adjacent to the roll to provide a hardened, concentric and smooth surface for the radial lip seals.

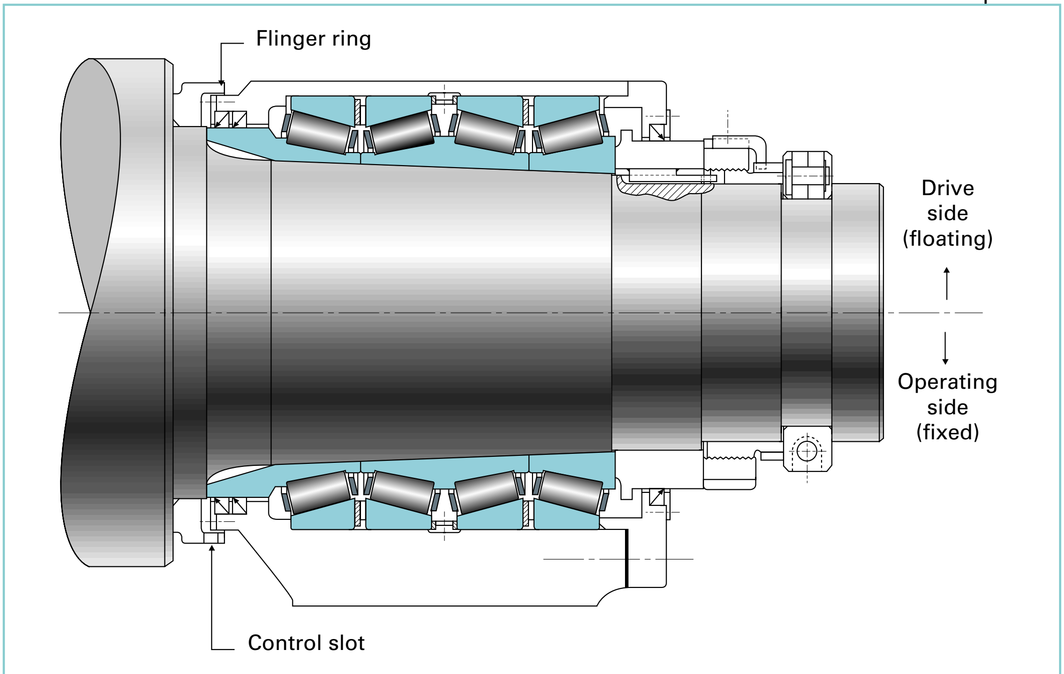


Fig. 5-7a

This extended cone bearing design has the following advantages over the original type TQITS bearing design :

- Seal seat is hardened, ground and concentric with the bearing races,
- Chock and bearing become a sealed unit assembly,
- Seal lips point outwards for maximum effectiveness,
- Cone extension protects seals during handling,

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- Fillet ring is eliminated or shortened,
- Roll neck rigidity is increased by bringing the bearing centerline closer to the roll body,
- Shorter and less expensive rolls are used.

The addition of a flinger ring pressed onto the roll shoulder effectively improves further the overall sealing efficiency. This added closure protects the seals from damage, particularly where severe water, scale and rolling solution problems are anticipated. A slot or a hole should be provided at the outside diameter of this flinger ring to allow visual confirmation that the bearing is pressed securely against the roll shoulder at assembly (fig. 5-7a).

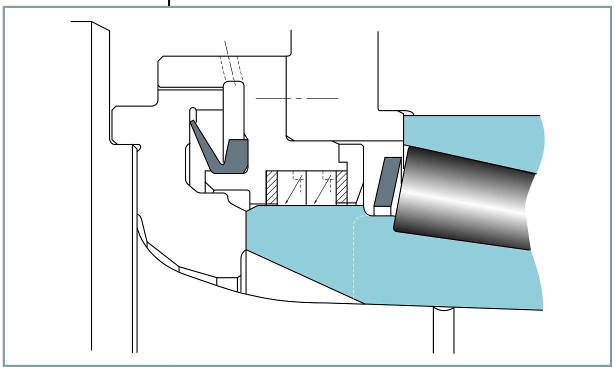


Fig. 5-7b

Sometimes a small fillet ring is added (fig. 5-7b) to avoid barrel face grinding to the correct cone tight fit definition. This small fillet ring will then replace the function of the flinger ring. This design will also permit a better neck compound radius.

Measuring tools for tapered roll necks

The Timken Company will assist original equipment mill designers and mill operators in using and procuring the tools required for the efficient assembly and handling of tapered-bore roll neck bearings. The following typical designs have been proven on many mill designs.

1. Sine bar for roll neck taper and size checking

Figure 5-8 shows a sine bar mounted on a tapered neck.

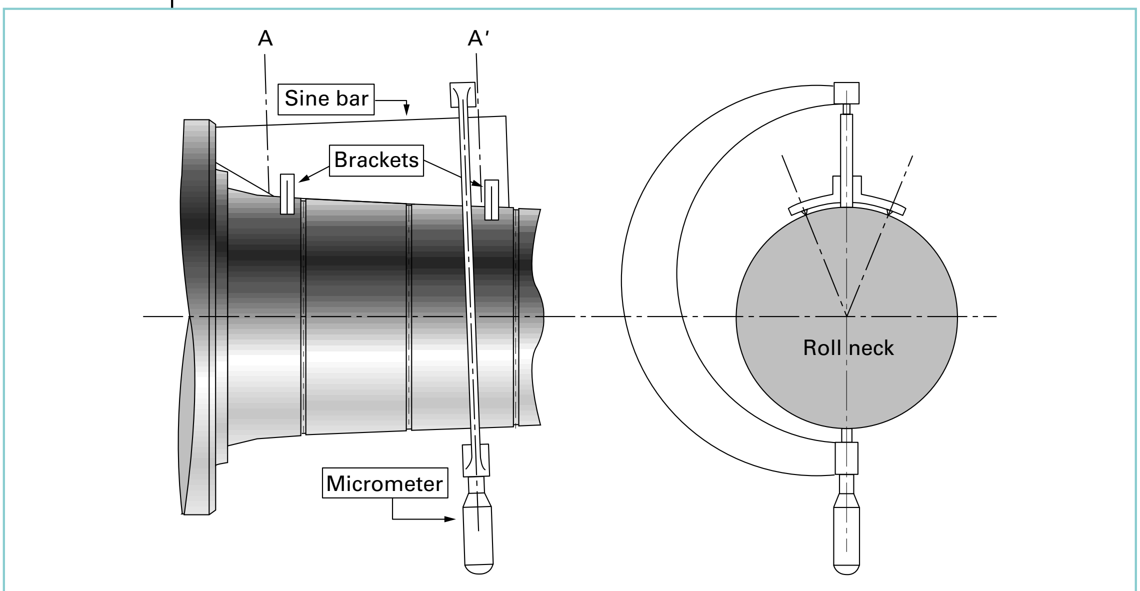


Fig. 5-8

The sine bar permits the roll neck taper and size to be checked using a conventional OD micrometer. By taking micrometer readings at both ends of the sine bar and comparing them, the taper of the neck can be checked. The procedure used is the following :

1. Clean the surfaces of the roll neck, backing shoulder and sine bar pads.
2. Place the sine bar on the roll neck and move it up the taper until the sine bar contacts the roll barrel end face. Adjust the legs of the sine bar so that the bar rests on the roll in a vertical radial plane containing the roll axis.
3. Check with a light to see that the sine bar is in contact with the roll neck and the backing shoulder.
4. Use OD micrometers to check across the sine bar pads and the roll neck.

- To have the correct angle, the difference between the measurements made in A and A' (fig. 5-8) must not exceed 0.025 mm (0.001 inch) for the larger bearings.
- In addition, for size control with no fillet ring (TQITSE) both A and A' measurements must meet the value B marked on the sine bar.

If there are indications that the roll is out of round, another measurement should be made at 90° from the first measurement.

Sine bars can be provided by The Timken Company.

2. Ring gauge for fillet ring length definition

Figure 5-9 shows how the roll necks are made interchangeable with any chock and bearing assembly. This figure illustrates the tight-fitted fillet ring in place (against the barrel face). To determine its length "L" for the particular neck on which it will be fitted, a ring gauge is generally used (if requested, The Timken company can supply this tool).

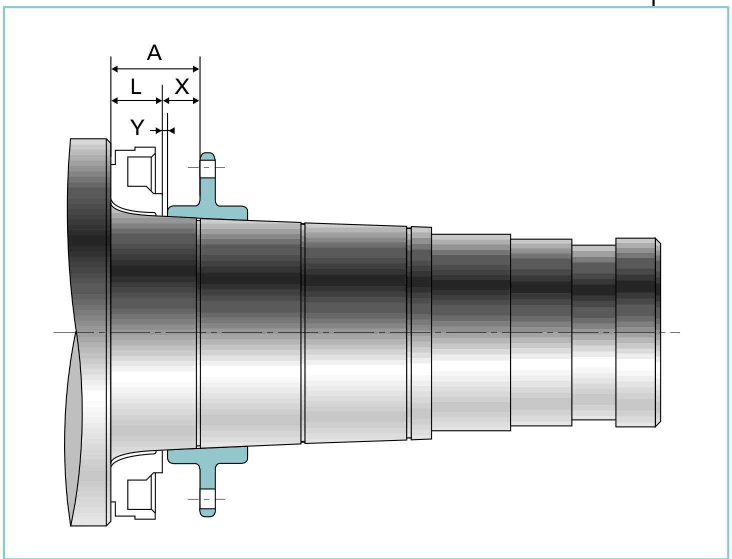
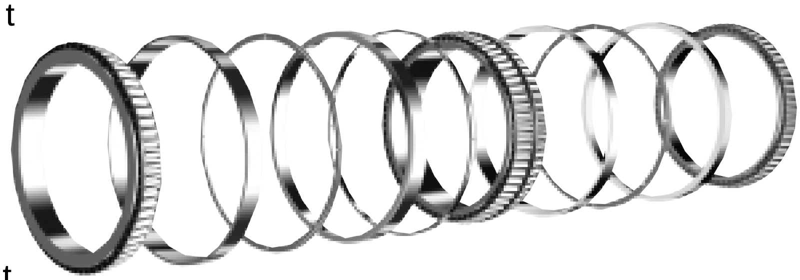


Fig. 5-9

First, the ring gauge is mounted on the neck with a hand-tight fit. The fillet ring will be ground to a length “L” obtained as the difference between the dimension “A” (the measured distance between the ring gauge flange face and the roll barrel face) and the dimension “X” which is etched on the ring gauge flange. In most cases the fillet ring length is finished ground after it is mounted on the roll neck in order to achieve the best geometry (squareness and parallelism). To allow for this, enough material stock must be available.



A second dimension “Y” is also etched on the ring gauge flange, which gives the required distance between the ring gauge face and the fillet ring face. This value is used to verify the fillet ring length “L” after it is mounted on the roll neck.

The fillet ring will then remain as a permanent part of the roll neck throughout the life of the roll. When the roll has served its useful life and is discarded, the fillet ring may be removed and used on another roll. However, the same measuring procedure described above must be followed to re-establish the correct fillet ring length for the new neck.

The same procedure as described above is also required for those cases where a small fillet ring is used with the TQITSE (extended cone) bearing assembly.

In the case where the extended cone of a TQITSE bearing assembly is directly in contact with the barrel face, the above tool is not necessary. It could nevertheless be used to check whether the roll neck has been correctly sized.

Mounting procedures for TQITS and TQITSE bearings

Different mounting procedures can be considered to mount a four-row tapered bore bearing on the roll neck after having been previously fitted in its chock.

1. Hydraulic ring jack

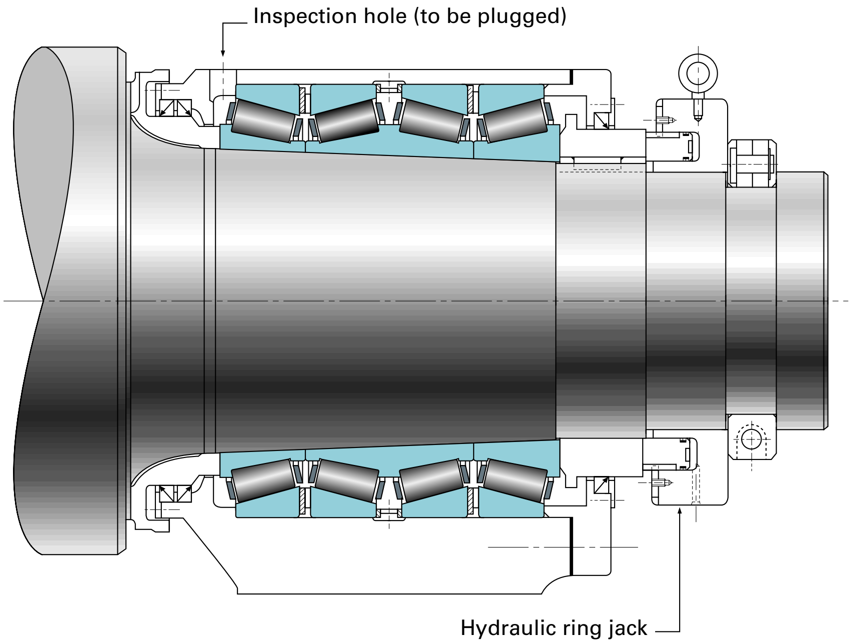


Fig. 5-10
Mounting with a hydraulic ring jack

Figure 5-10 shows a complete bearing and chock assembly mounted on the roll neck using a hydraulic ring jack. The assembly procedure consists of the following :

1. Remove all oil and/or grease from the surface of the roll neck and cone bore. Pay attention to ensure that there will be no lubricant leakage from the bearing during this operation,
2. Assemble the bearing and chock on the roll neck,
3. Assemble the hydraulic ring jack in place. The piston of the ring jack must be fully contracted,
4. Assemble the split-hinged ring in the groove on the neck.

5 Apply hydraulic pressure to the hydraulic ring jack with a suitable hydraulic pump. Care should be taken to ensure that the pressure used to mount the bearing does not exceed the shear stress limit of the split-hinged ring backing shoulder (push-up pressure is normally between 30 and 40 MPa - 4400 and 5800 psi),

6 Using a feeler gauge, check through the inspection hole to ensure that the cones are seated against the fillet ring or against the roll shoulder for the extended cone version,

7 Release the pressure and back off the piston,

8 Remove the split-hinged ring,

9 Remove the hydraulic jack,

10 Install the appropriate clamping device,

11 Re-install the split-hinged ring,

12 Clamp the bearing assembly tightly in place and lock to the next tightest position. The clamping device must be positively clamped in order to maintain the tight fit obtained with the hydraulic jack.

The clamping nut possesses a number of equally spaced slots on its periphery to help rotate it into position. The threaded retaining ring normally has one extra hole or slot more which allows positive clamping to be achieved with incremental steps of about 0.050 mm (0.002 inch). A locking key is then used to prevent the retaining nut rotating.

2. Hydraulic wedge lock

Figure 5-11 shows a complete bearing and chock assembly mounted on the roll neck using a hydraulic wedge lock.

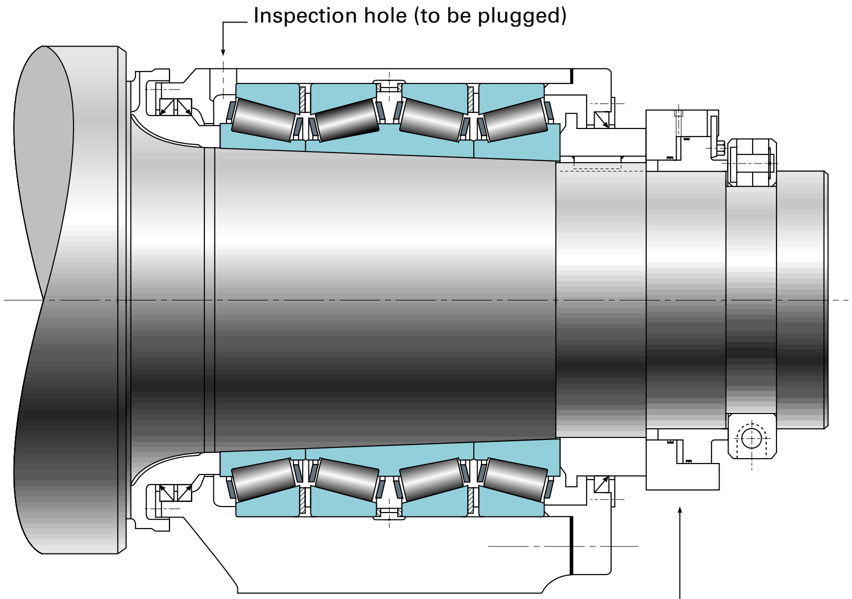


Fig. 5-11
Mounting with a hydraulic wedge lock

This device enables rapid mounting of the bearing on the neck and follows the same procedure for the first 6 steps as for the hydraulic ring jack. Make sure that the wedge lock ring is fully contracted during assembly on the roll neck.

1 - 6 as per hydraulic ring jack procedure,

7 Release the pressure and plug the hydraulic entrance,

8 With the wedge lock ring held stationary, rotate the outer wedge lock ring in the direction of the arrow and lock with a locking plate at the next tightest position.

The inner and outer rings will have a number of slots which allows the operator to obtain a positive clamp-up with incremental steps of about 0.050 mm (0.002 inch). The wedge lock is an integral part of the "neck/bearing/chock" system.

3. Hydraulic pump

The hydraulic pump used to operate the hydraulic jack or wedge lock system should have adequate volumetric and pressure capacity for assembly and disassembly of tapered-bore four-row bearings. Adequate metering valves, couplings and hoses are part of the pump system.

Motor-powered pumps up to 40 l/min (10 galls/min) maximum capacity and with maximum pressures of at least 55 MPa (8000 psi) are required for the largest size bearings. Consult The Timken Company for more information on available systems. Note that this pump will also be used to dismount the tight-fitted cones from the neck.

4. Bearing assembly using a hydraulic jig arrangement

Figure 5-12 shows a method which permits the mounting of the bearings on both ends of the roll neck at the same time. This solution is called the cradle method or the hydraulic jig arrangement. Such a method is especially beneficial when width restrictions on the roll neck do not allow room for a hydraulic ring jack. Also when the neck size is small (rod and bar mills), several stands are involved and push-up forces are taken over by the frame.

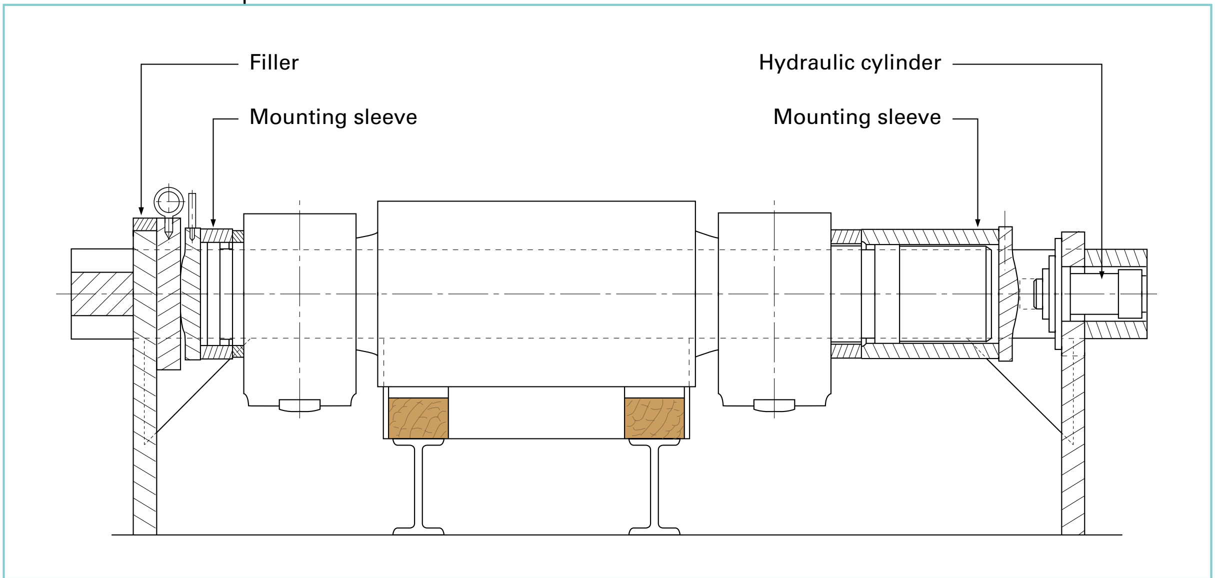


Fig. 5-12
Mounting with a hydraulic jig

Dismounting procedures for TQITS and TQITSE bearings

The TQITS or TQITSE tapered bore bearings mounted on the roll neck are generally disassembled by using an oil pressure system. Such a system requires one or three axial holes, and radial holes leading to grooves under the outer, center and inner bearing cones. These radial holes and oil grooves around the neck outside diameter for each cone are located at the approximate neutral pressure zone for each cone section. The locations of these radial holes and grooves are :

- outer single cone : 1/3 of the roller length from the large end
- middle double cone : centerline of the cone
- inner single cone : 1/3 of the roller length from the large end

See fig. 5-13a

It is not necessary to loosen the front chock cover screws when removing the bearing and chock assemblies from the roll neck.

1. Hydraulic device using the "three-hole" removal system

Figure 5-13a shows the bearing applied to the tapered neck, with the three rifle-drilled axial holes illustrated. Each hole connects with one of the three radial holes leading to grooves under the outer, center and inner bearing cones. The three axial holes are marked 1 to 3 and are to be used in this sequence. Hole number 1 corresponds to the outer cone, number 2 to the double center cone and number 3 to the inner cone. The sequence for bearing and chock removal is as follows :

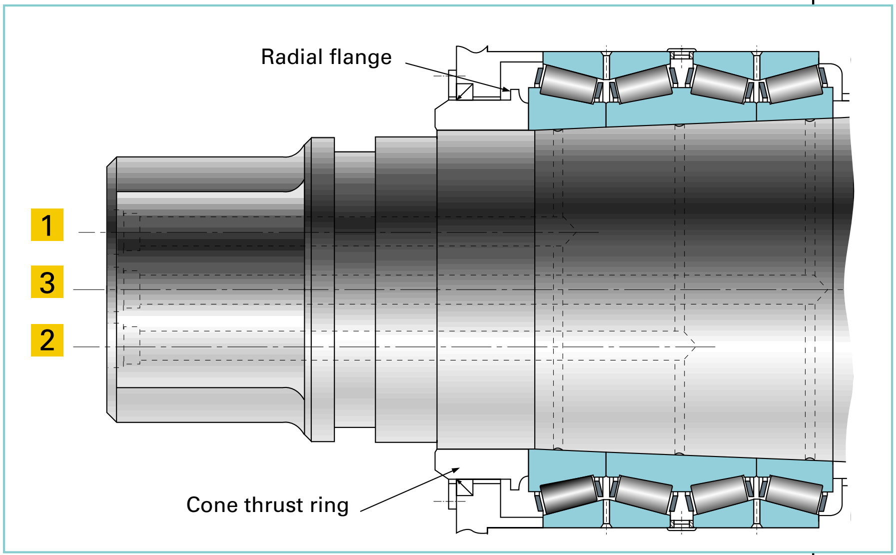


Fig. 5-13a

1 Support the roll on the barrel outside diameter. Make certain that the chock does not carry any of the roll weight,

2 Loosen the nut about one-half turn and remove the split-hinged ring. Then slide the nut and threaded ring from the neck (keep the chock attached on the crane throughout the whole operation for safety reasons),

3 Connect the hydraulic pump to the axial oil hole (1), which intersects the radial hole leading to the groove under the outer cone,

4 Apply sufficient oil pressure to expand the cone and loosen it from the neck. A radial flange is provided on the cone thrust ring in order to limit the axial displacement of the outer cone. Fig. 5-13b shows the cone position after it has been removed,

5 Connect the hydraulic pump to the axial oil hole (2), which intersects the radial hole leading to the groove under the center double cone. Apply pressure. The entire chock assembly follows the double cone as shown in figure 5-13c,

6 Connect the hydraulic pump to the axial oil hole (3), which intersects the radial hole leading to the groove under the inner cone. Apply pressure, so the inner cone is removed as shown in figure 5-13d,

7 Remove the "chock-bearing" unit from the neck.

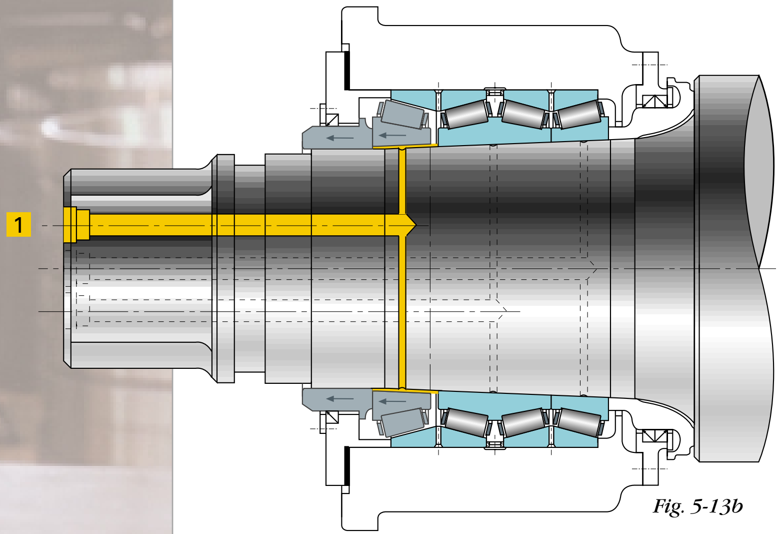


Fig. 5-13b

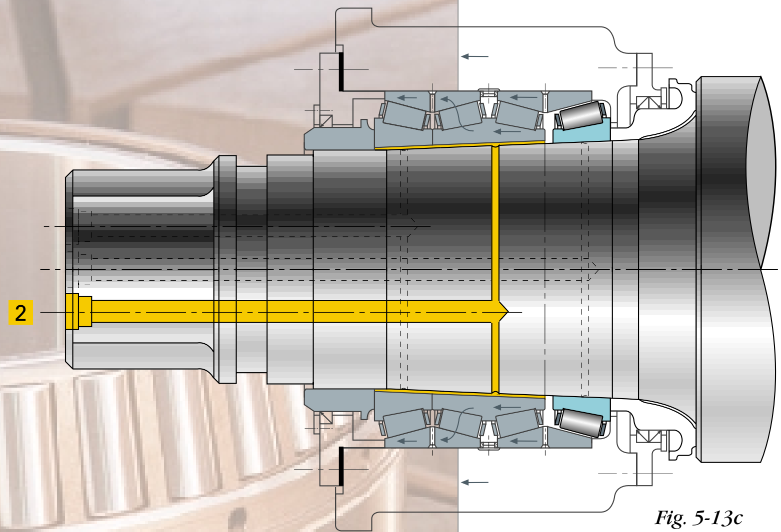


Fig. 5-13c

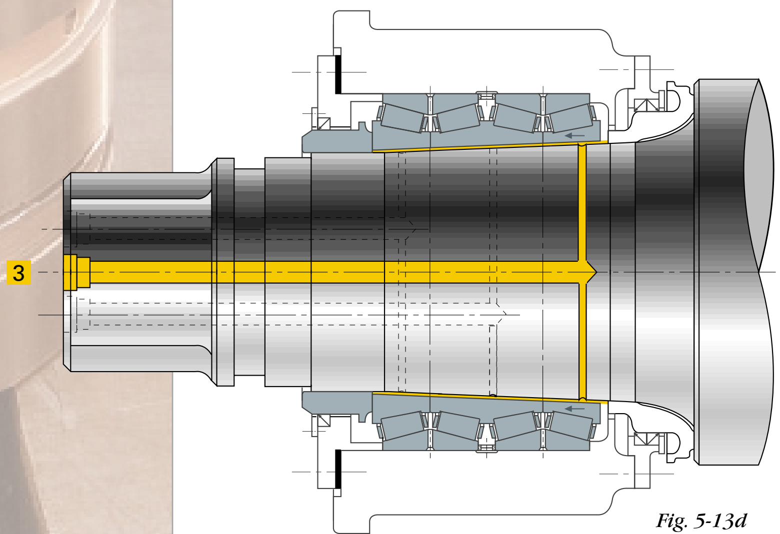


Fig. 5-13d

2. Hydraulic device using the "single-hole" removal system

Figures 5-14 shows a single axial hole joining each of the three radial holes leading to the three bearing cones. The single hole system is not only more economical, but also presents the advantage of permitting the use of a hydraulic ram which confines the oil pressure to a smaller area in the hole. This tends to reduce the danger of oil pressure loss due to roll neck porosity. Such a device could be also used for smaller rolls where there is a section limitation.

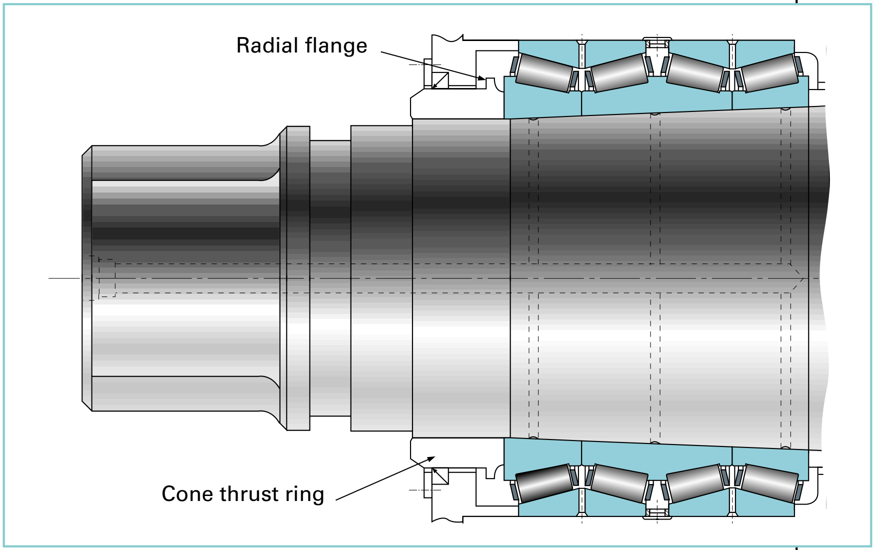


Fig. 5-14a

The hydraulic pressure ram is adjusted axially to certain bench marks on the ram housing in keeping with the particular bearing cone that is being removed. The outer, center and inner cones are removed in their relative order in strict accordance with the general method indicated in the "three hole" system. O-rings, proper clamping sleeves and take-up nuts are used to confine the oil to each radial hole as necessary. The sequence for bearing and chock removal is as follows :

The release of each cone can be readily detected by both sound and touch because of a light "bump" emanating from the chock.

1. Locate the ram head to bench mark 1 under the radial hole leading to the groove under the outer cone. Compress the O-rings in the ram head to seal oil pressure. Apply oil pressure to remove the outer cone in accordance with fig. 5-14b,
2. Decompress the O-rings and move the ram to bench mark 2 under the radial hole leading to the double center cone. Compress the O-rings, apply pressure and remove the center cone in accordance with fig. 5-14c. The entire chock assembly will follow the double cone,
3. Decompress the O-rings and move the ram to bench mark 3 under the radial hole leading to the inner cone. Compress the O-rings, apply pressure and remove the inner cone in accordance with fig. 5-14d,
4. Remove the "chock-bearing" unit from the neck.

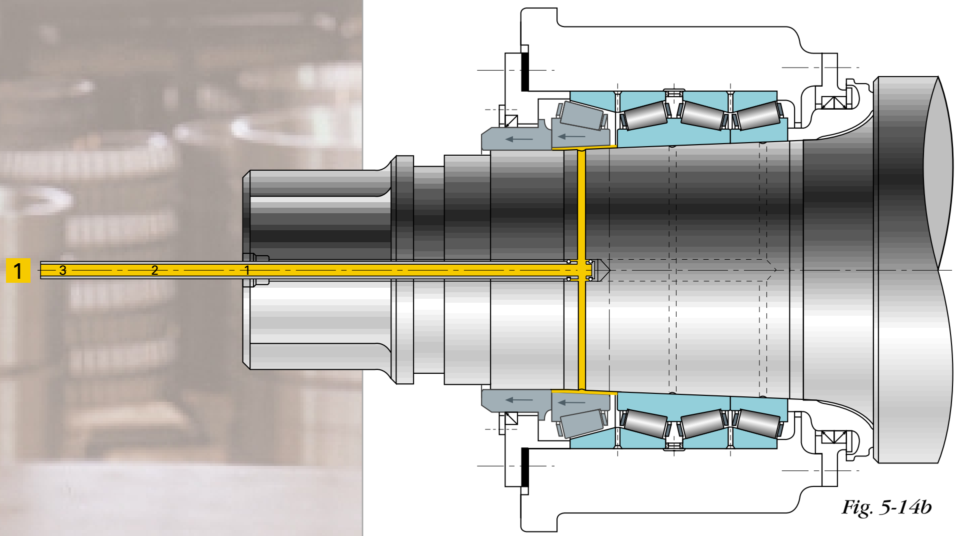


Fig. 5-14b

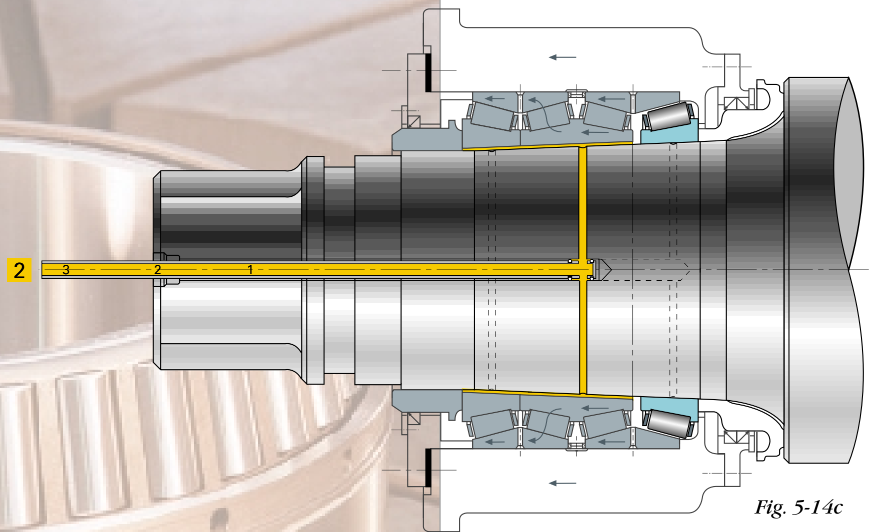


Fig. 5-14c

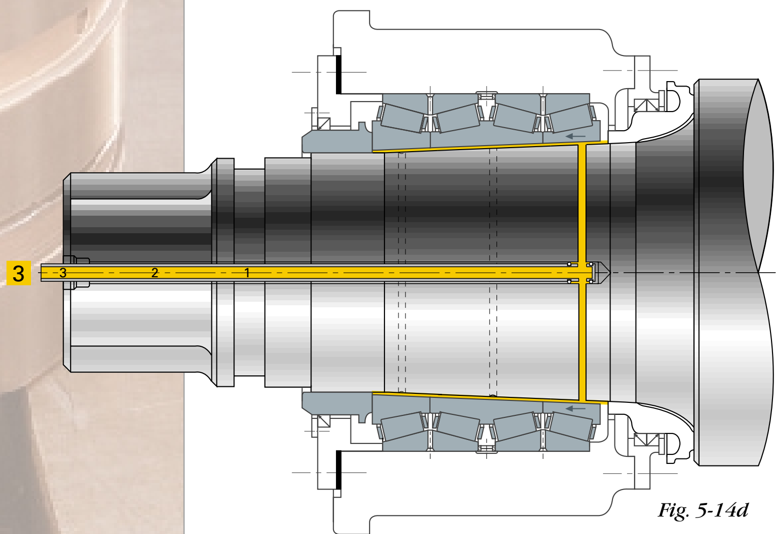


Fig. 5-14d

3. Mechanical disassembly

An alternative method for smaller bearing (up to 250 mm - 10 inches bore) removal, is to provide a puller that engages the chock and pulls the chock and bearing from the roll neck. To eliminate any possibility of cage damage to the inboard bearing cone, a TQITSE bearing with a cone puller shoulder as shown in the figure 5-15 has been designed.

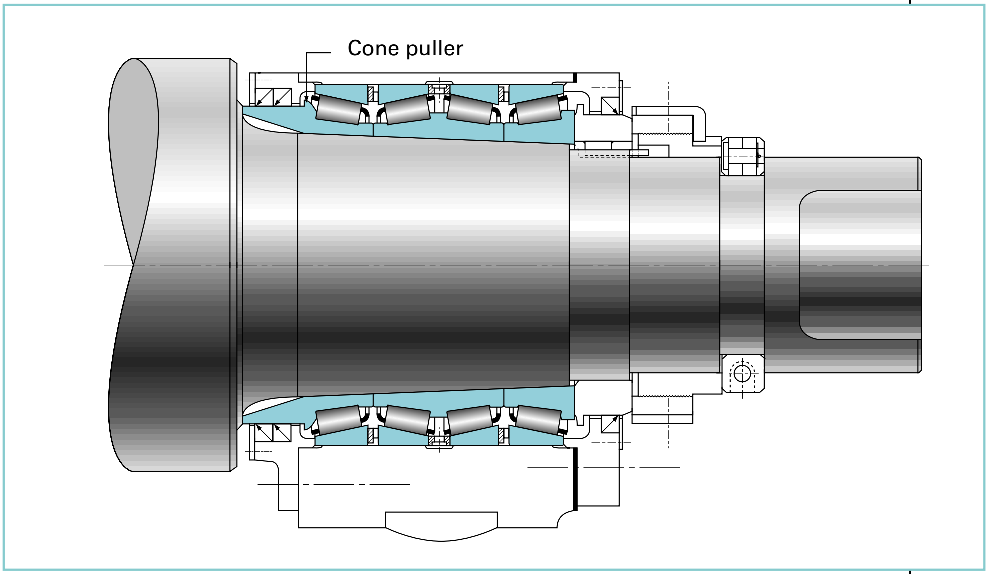


Fig. 5-15

With proper chock design (fillet ring) a similar arrangement is also possible with the TQITS bearing.

This reduces roll cost considerably by eliminating the drilling of axial and radial holes in the roll necks that are normally provided with a hydraulic removal system. This type of dismounting is mostly used for multi-stand mills such as bar and rod mills (the same applies to TNAT assemblies).

5.1.2.2. Work rolls

Work roll bearings are mostly mounted with loose fits on the roll necks. In addition to TQOW and 2TDIW assemblies, 3TDIW bearings can also be used (fig. 5-16).

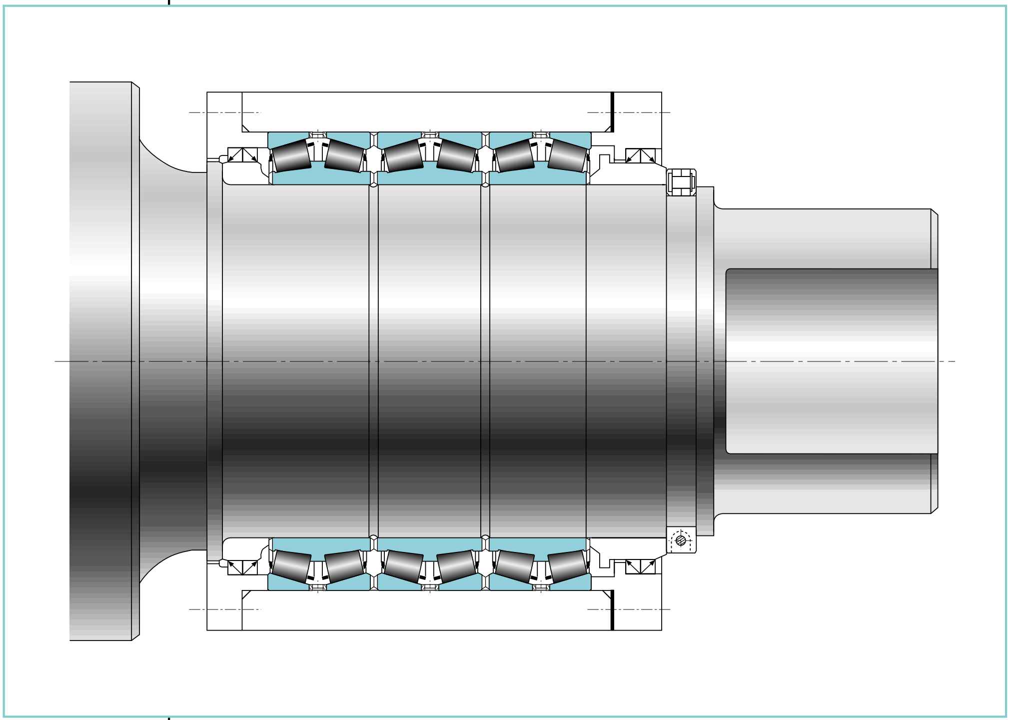


Fig. 5-16

The detailed procedures for the assembly and disassembly are the same as described in the back-up roll chapter.

The current trend is that operators favor the elimination of the threaded retaining ring and nut unit which requires manual adjustment and replace it with only an intermediate ring. Considering the frequency of work roll changes, this solution permits a perceptible time saving but requires tighter bearing tolerances as far as the cone overall width is concerned. This is possible by using a 2TDIW or a 3TDIW assembly (tolerances are listed in the bearing tolerance tables, see chapter 6).

Sealed roll neck bearings

The mountings shown in figure 5-17 illustrate higher standards for sealed roll neck bearings. These designs are completely interchangeable with standard TQOW or 2TDIW assemblies sizes.

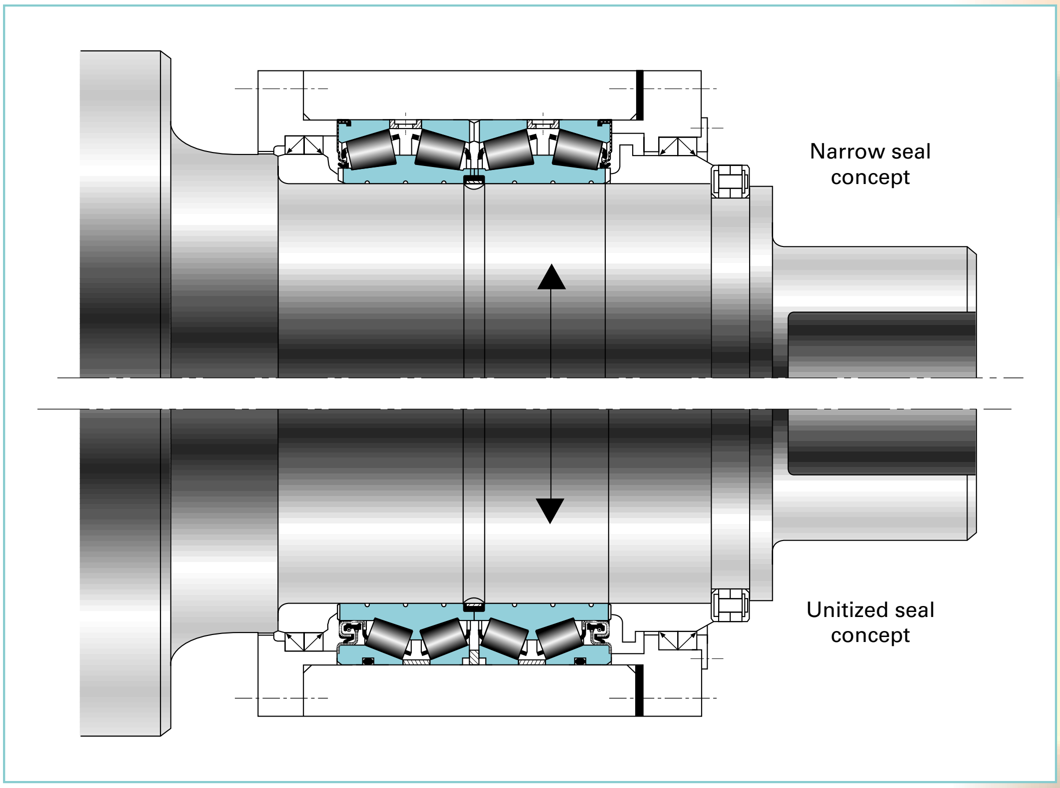


Fig. 5-17
Sealed Roll Neck Bearings

The main seal at each end allows you to have a pre-greased assembly, and provides additional protection against contaminant ingress. This bearing could be mounted pre-greased, in which case, the whole assembly is mounted as a unit into the chock. The tool used to assemble the bearing into the chock is shown in section 5.2.1.3. The chock seals used at the fillet ring and at the front side should still be properly maintained in order to keep their efficiency against water or coolant mixed with solid contaminants.

TDIK assembly - thrust position

Figure 5-18 shows a TDIK two-row bearing mounted at the axial position. This bearing type is always mounted in combination with a radial four or six-row bearing on work rolls at the fixed position. Such an assembly is used on work rolls where an axial shift or roll crossing system is incorporated in order to prevent the radial bearing from absorbing axial loads. This thrust position can be located either at the operator side or at the drive side.

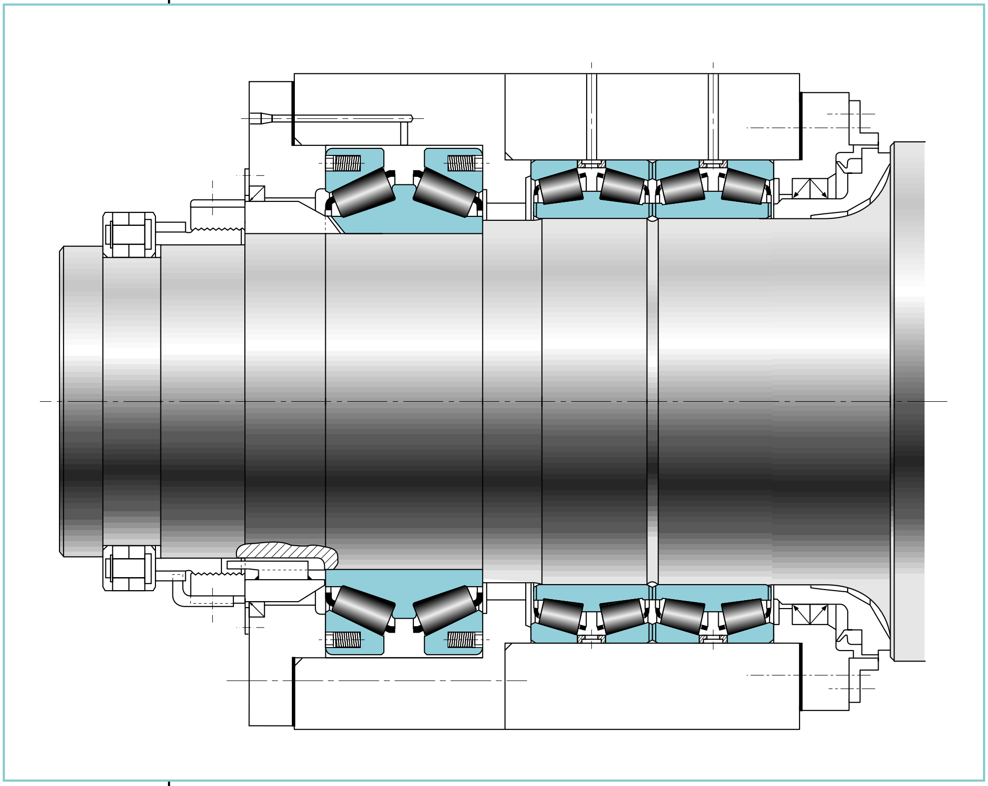


Fig. 5-18

The bearing can be mounted in a separate housing (front cover) or directly into the chock. An identical cone retaining device as used for the radial bearings is generally considered. The spring system incorporated into the two cups, enables the unloaded cup to remain seated on its set of rollers and therefore avoids roller skewing. The spring stroke is achieved by using thin metal shims between the flange and the housing. The spring system then develops the correct axial force which will seat the unloaded row. A diametrical clearance of about 2 to 3 mm (about 0.1 inch) is required between the cups and the housing bore to prevent any radial loading at the thrust position. A keyway is provided in the cone in order to stop the cone rotating.

A preset TDIK assembly mounted into a carrier is sometimes proposed instead of the spring system incorporated in the cups. TDIK bearings used in existing mills where the springs are incorporated in the housing would be mounted in a similar manner to the TDIK assembly with spring system. All these assemblies are dimensionally interchangeable.

TTDWK - thrust position

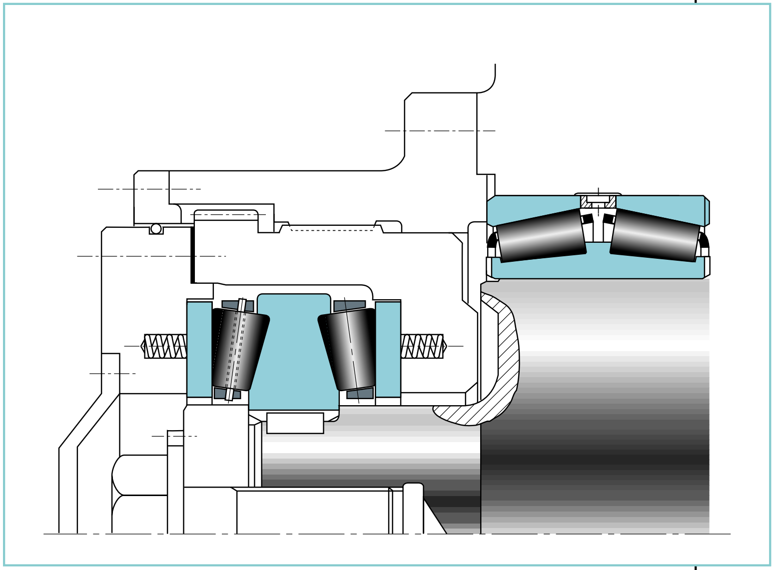


Fig. 5-19

Figure 5-19 shows a TTDWK two-row bearing mounted in a thrust position. This double acting thrust bearing is always mounted in combination with a radial four or six-row bearing on the work roll at the fixed position. Such an assembly is principally used on structural mills where the axial loads are unusually high and from either direction by rolling of non symmetrical shapes. This bearing is generally mounted on a separate housing to form a unit which will be fixed on the chock. Due to its “flat race” design, this bearing permits radial float and is therefore unable to share radial loads. The flat races are not axially clamped, but adjusted in order to obtain the required axial clearance of about 0.500 mm (0.020 inch) allowing the springs to develop the correct axial force to seat the unloaded row. A key-way is generally provided in the center double race ring in order to stop it rotating. Figure 5-19 shows a structural mill where roll positioning is established through the auxiliary thrust unit with the roll being moved axially through the bore of the radial bearing.

5.1.2.3. Chock and cover features for correct bearing operation

Chock cover gasket or shim selection

After the whole bearing assembly is mounted into the chock, the front cover should be mounted without the compressible gasket and four equally spaced bolts tightened up evenly, until the cover is uniformly seated against the bearing cup.

The gap between the cover flange and the face of the chock is measured in three different places and the average gap is determined. The gasket (or gaskets depending on the gap width) should be equal to the width of the gap plus 15 to 25 percent to allow for compression of the gasket. The 15 to 25 percent figure is for cork or other similar compressible gasket material (if harder or softer material is used, adjust the above mentionned percentage accordingly).

After the defined compressible gasket is put in place, remount the cover and pull up on the bolts until the initial measured gap is reached. The bolts should be tightened back and forth across the chock to permit uniform compression of the gasket pack and avoid possible distortion of the cup spacer. To ensure that the gasket is compressed evenly and the cups properly clamped, notch the gasket in four places prior to installation. This permits four areas to be re-measured after installation. **The final bolt torque applied should be compared with the torque suggested by the Timken Company according to loading conditions of the particular application.**

Compressible gaskets are now frequently replaced by peelable shims. This solution allows the required torque to be applied according to the loading conditions without the risk of collapsing the cup spacers.

In this case, the gap measurement procedure will be the same ; the retained shim thickness must then be slightly smaller than the gap measured (usually 0.050mm - .002 inch depending on the peelable shim) in order to obtain positive clamping. The solution using shims requires the addition of an O-ring to obtain a proper sealing between the cover and the chock. The tightening torque applied onto the bolts depends on their size.

Caution : the compressible gasket thickness or the peelable shim thickness defined for a bearing should not be used for another bearing assembly because of the overall cup width variation.

Chock mounting practice - keeper plate - rocking plate

Figure 5-20 shows a cross sectional arrangement of a 4-high mill where four-row bearings are mounted on the necks of back-up and work rolls.

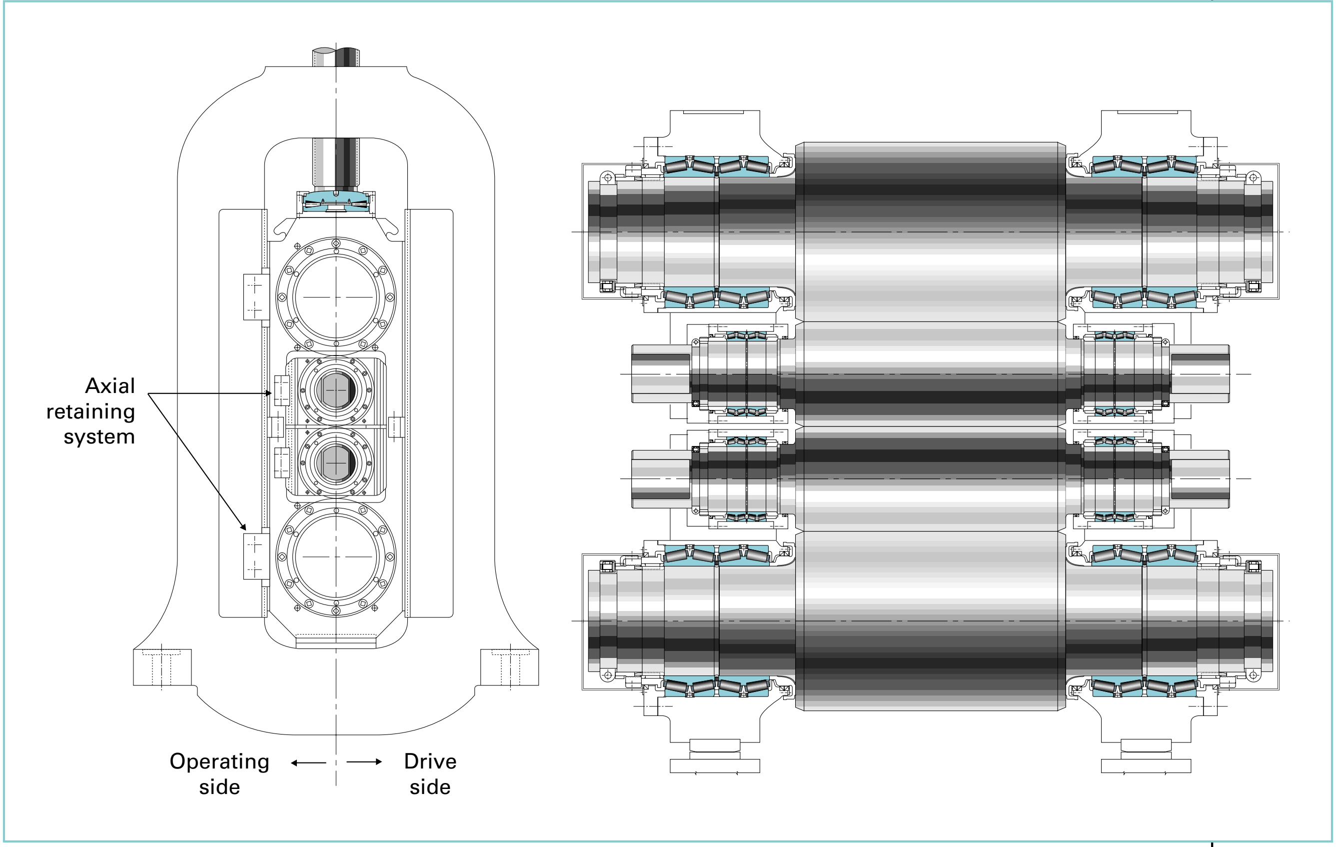


Fig. 5-20

The end view shows different arrangements to the left and right of the vertical centerline. The left-hand view corresponds to the operating side which shows the bearing chocks fixed to the mill housing. The right-hand view corresponds to the drive side with the chocks free to float in the window.

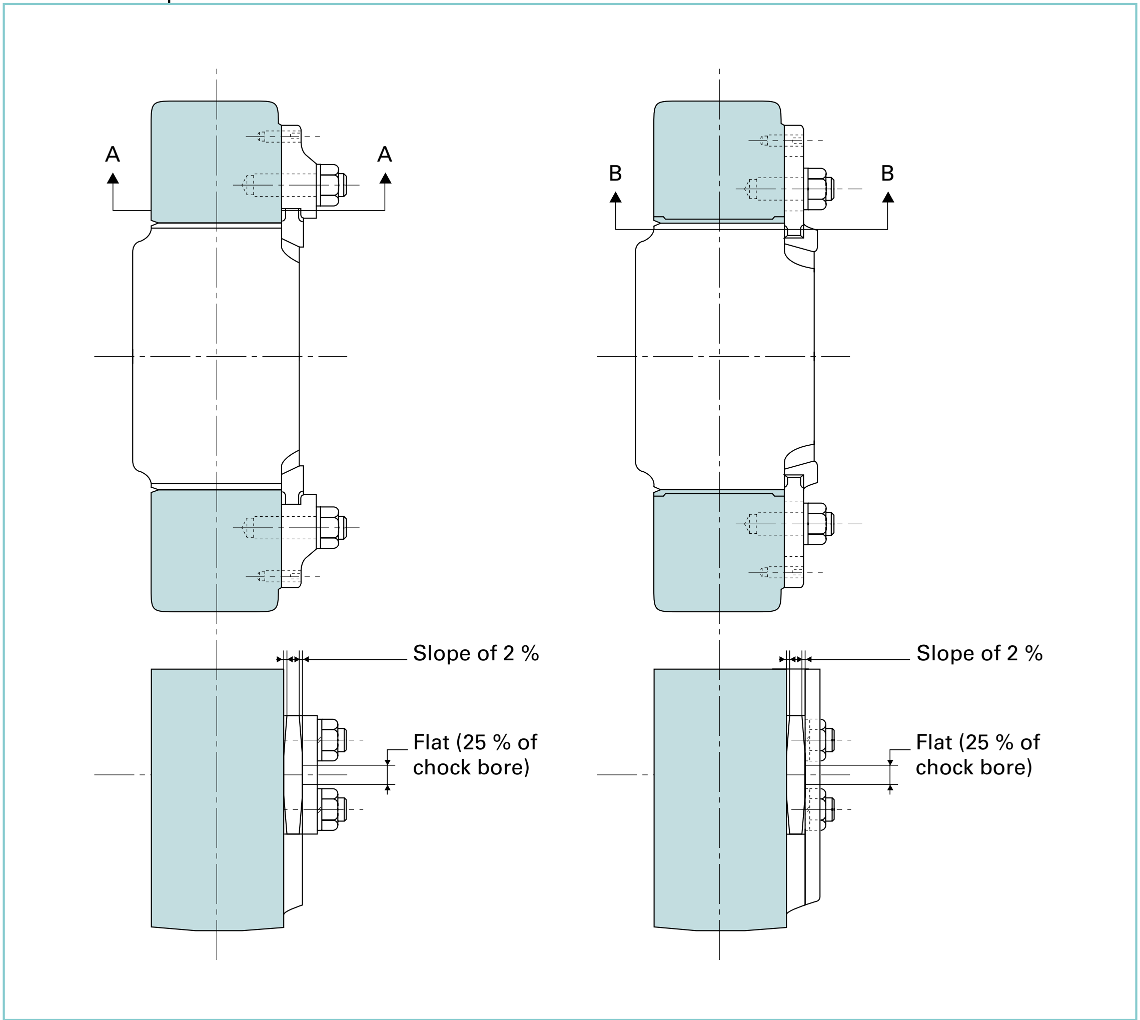


Fig. 5-21

The keeper plates on the operating side are set over flanges on the chock face and are bevelled as shown in figure 5-21. This permits the chock to rock and follow the normal deflection of the roll and the neck. The keeper plates on the work rolls are similarly designed with a flat and a double chamfer at both ends to permit complete flexibility between the work roll chock and the legs of the back-up roll chocks or the piston blocks in which they are mounted. This flexibility assures that the thrust loads developed in the mill are carried into the bearing without a significant overturning moment, should misalignment occur between the normal axes of the work rolls and the axes of the back-up rolls.

Figure 5-22 shows a usual method of mounting the work roll in the legs of the back-up roll chocks. The work roll chocks are fixed against axial movement into the back-up roll chocks on the operating side of the mill and are allowed to float on the drive side of the mill. Sufficient clearance between the work roll chocks and the back-up roll chock legs must be permitted to allow the work roll chocks to float freely. Wear plates are generally used between the work roll chocks and the back-up roll chock legs as well as between back-up roll chocks and the window.

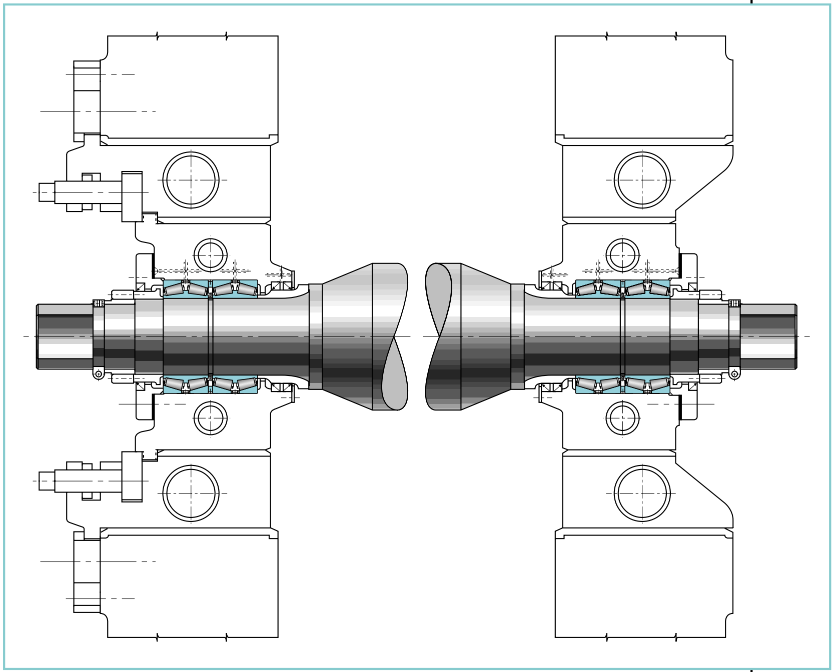


Fig. 5-22

The top back-up roll chock is separated from the screw-down seat by a thrust unit equipped with a thrust bearing. The rocker aligning device between the bottom of the back-up roll chocks and the base of the window permits these chocks to rock in order to follow the roll and neck deflections. Different rocker designs are shown in figure 5-23.

Wear plates should be checked on a regular basis to prevent introducing roll crossing and/or misalignment which adversely influence bearing life.

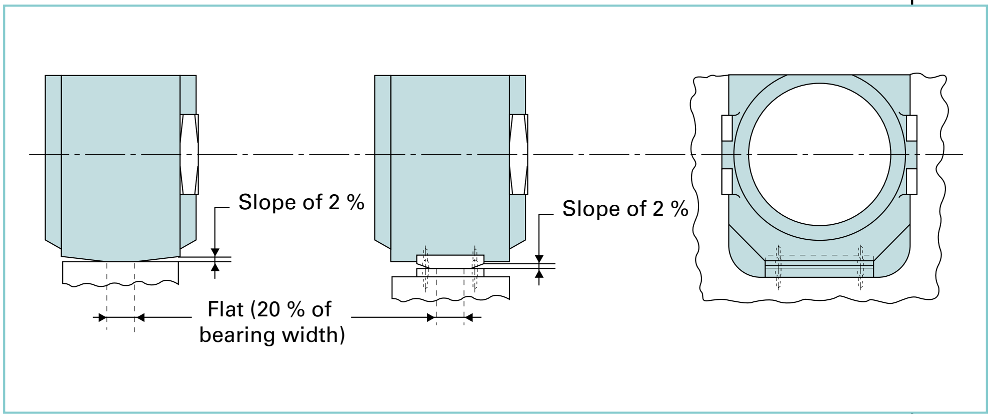
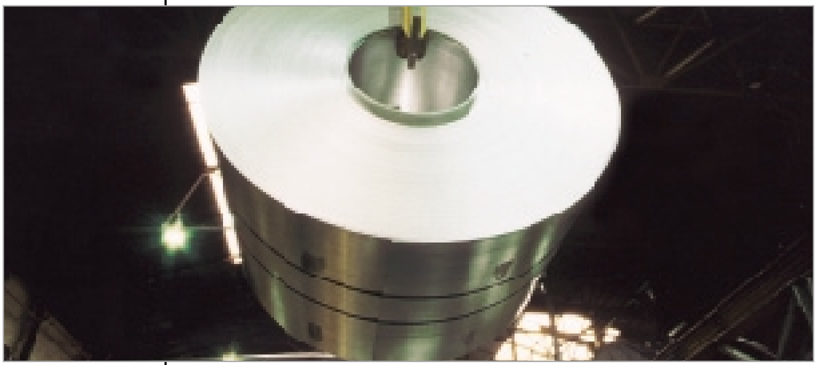


Fig. 5-23



5.1.3. Typical mountings

Aluminium strip caster

Figure 5-24 shows a four-row bearing mounted on a roll neck of an aluminium slab caster. The mounting principle and the corresponding guidelines are the same as those described for the TQOW-2TDIW assemblies in the chapter 5.1.2.1. In all cases the bearings are mounted with loose cones and cups. Because the aluminium strip casters work with extremely high radial loads and slow speeds (less than 5 rev/min.) bearings with solid rollers are used. Bearings with stamped cages could be used, but to increase the number of rollers (rating) pin type cage bearings with pins outside (between the rollers) are often used. Optimized roller profile is also required due to the loading conditions.

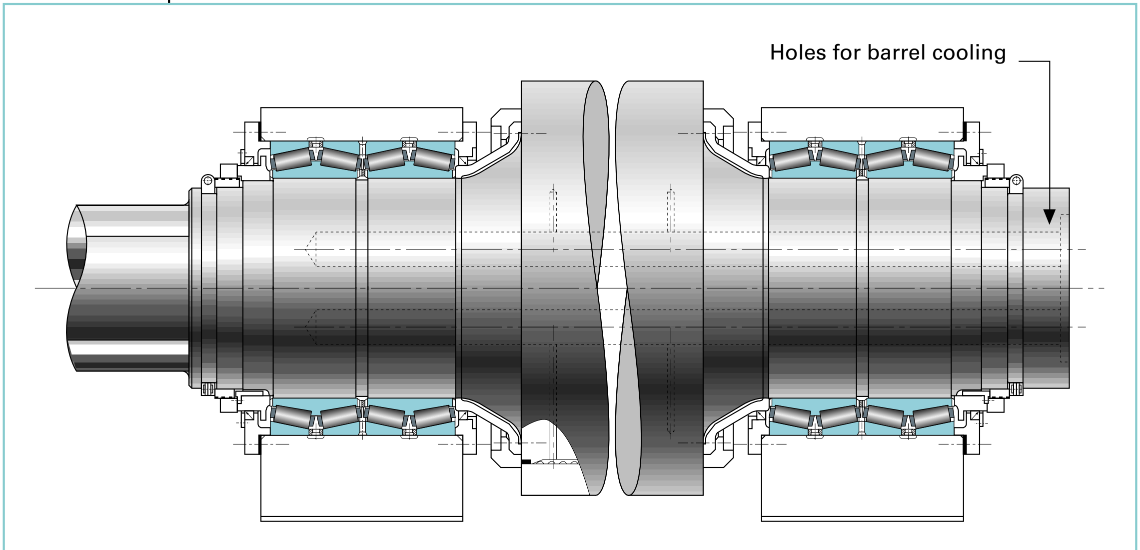


Fig. 5-24

This type of application where the barrel is in contact with the molten aluminium (high temperature), requires integral barrel cooling to minimize large temperature differences between neck and barrel and also between neck and chock. Make sure to properly reconnect the cooling device when using the roll again.

Vertical rolls for beam mills

The design shown in figure 5-25 uses a heavy-duty two-row TDO bearing assembly with a cone spacer mounted with tight fit in the roll bore. Nevertheless, TQO and TQI bearing types are also used depending on roll widths. As the space limitations are often a problem in this type of application, the cups are clamped in position by covers that also contain the labyrinth closure arrangement.

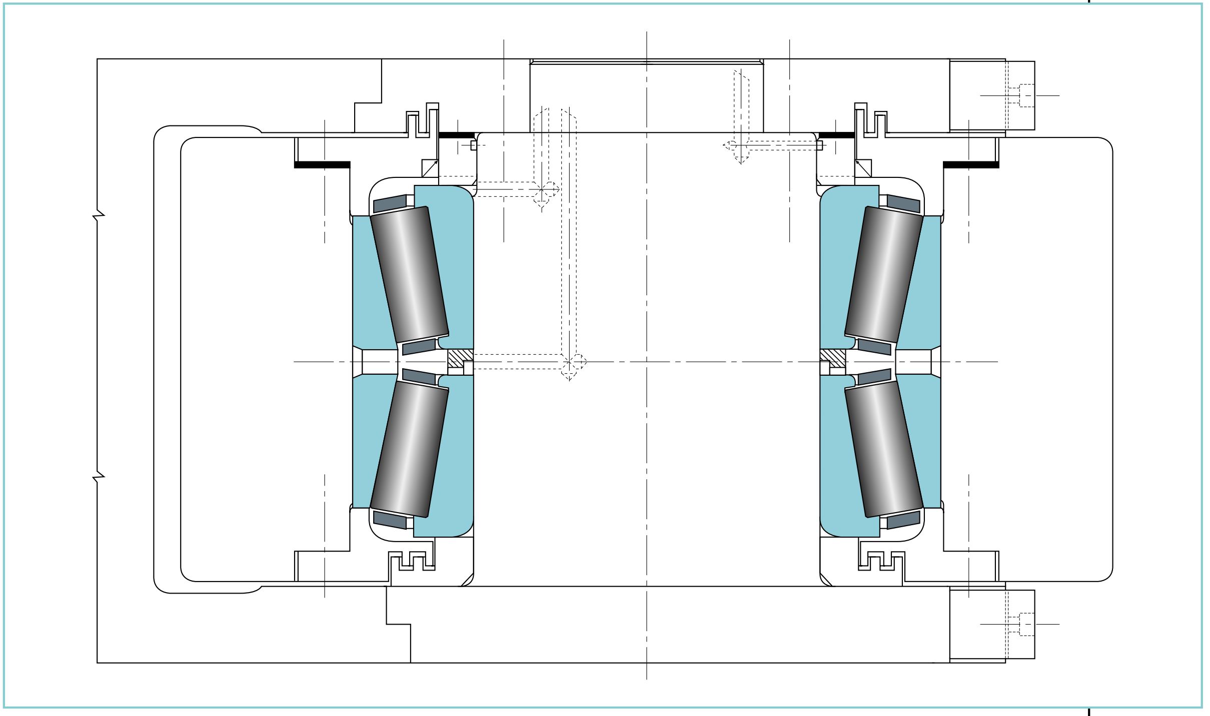
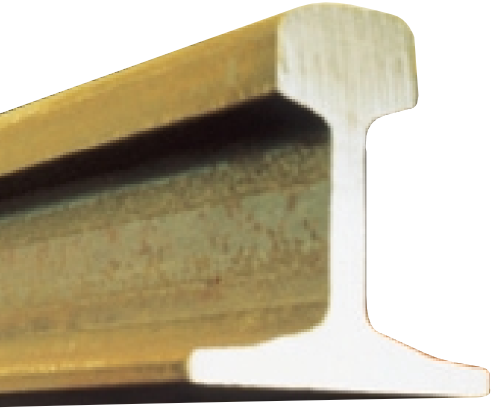


Fig. 5-25
Vertical roll design with a TDO bearing

On the top side, the labyrinth is located above the roll face in order to prevent water and scale from going directly into the bearing. An additional lip seal can also be provided depending on the concept of the frame.

Cone clamping is provided through the stationary shaft by an endplate. The cones are mounted with a loose fit on the shaft.



Grease lubrication is applied to the center of the bearing through the holes in the cone spacer. As this is a vertical application, a grease entrance above the bearing through access slots is also suggested to lubricate the top row and to remove the contaminated grease. Due to the severe operating environment, the bearing is usually hooked into a continuous lubrication system to ensure better protection.

Rod and bar mills

TDIW assembly - radial position

Figure 5-26 shows a TDIW two-row bearing mounted on a roll neck. In many hot mill installations where speeds are relatively low to medium, a TDIW is used to take the mill separating forces, instead of the more conventional four-row bearing. On changeover from other types of bearings, a TDIW is often the only solution due to the space limitations.

The mounting principle and the corresponding guidelines described for the TQOW - 2TDIW assemblies could also be applied for the TDIW two-row bearing.

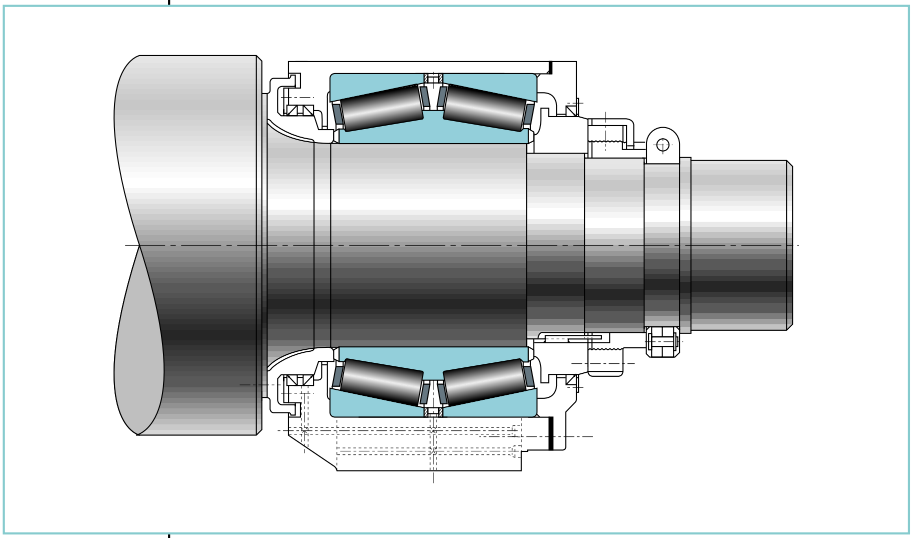


Fig. 5-26

TDIT - TNAT assemblies

Figure 5-27 shows a TDIT two-row tapered bore bearing mounted on a tapered roll neck to the desired tight fit of the cone. This bearing type is suitable for high-speed mills subjected to medium and low separating forces.

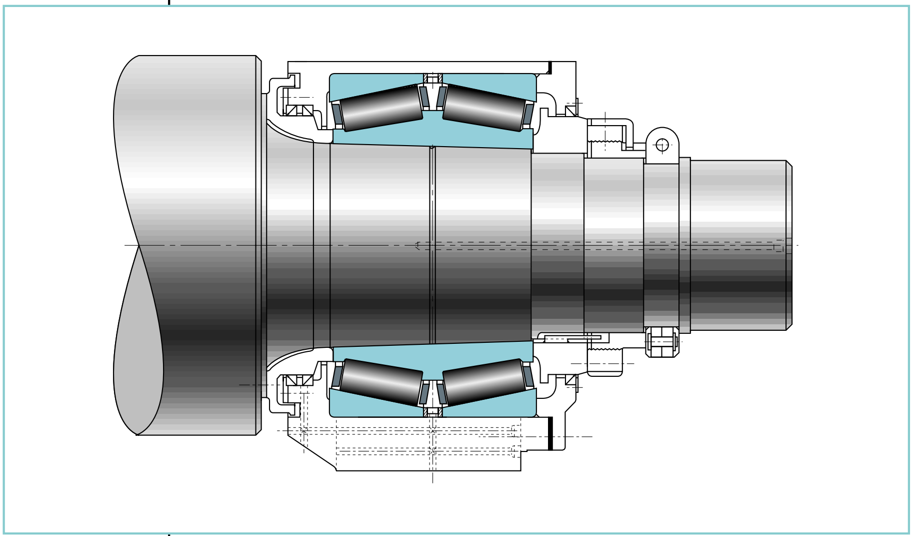


Fig. 5-27

These bearings are assembled on a tapered roll neck against a properly sized fillet ring to assure a proper tight fit on the cone. The bearing and chock are a unitized assembly. It is important that an adequate chock floating device is provided to accommodate the roll thermal expansion.

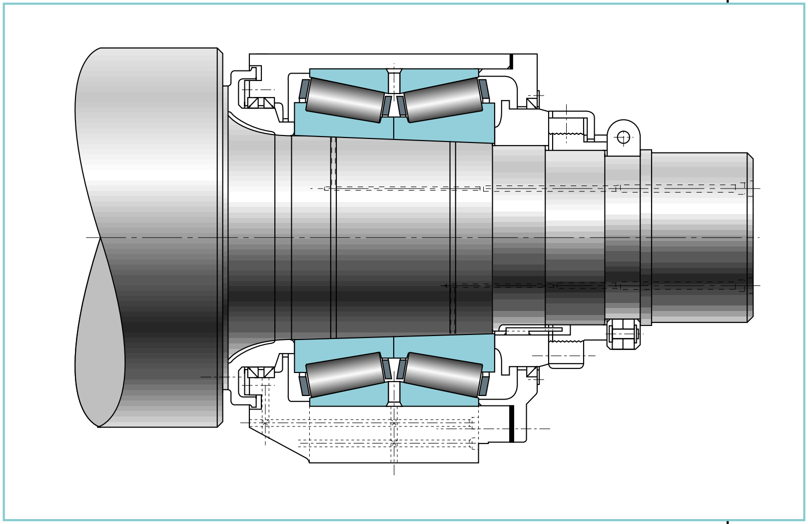


Fig. 5-28

A TNAT two-row tapered bore bearing as shown in figure 5-28 is used in the case of pre-stressed mills where both chocks are fixed. On the floating side, a gap is provided between the cover and the double cup to permit axial cup displacement.

The dismounting and mounting procedures on and from the roll neck are the same as in the chapter "TQITS assemblies".

Screw-down systems

The heavy duty thrust bearing makes the connection between the screw-down and the top roll chock. The bearing selection is based on the maximum given rolling load as well as on the screw diameter.

Figure 5-29 shows the mounting of the TTHDSX thrust bearing. The top face of the upper ring is generally convex as illustrated, but could be also concave depending on the screw end profile. Such a spherical seat allows easy rocking of the chock.

This type of bearing can either be supplied with two taper races or with one flat bottom race. The design with a flat bottom race allows a lateral movement and could be required depending on the type of mounting arrangement. In the cases where a taper bottom race is used, it must be mounted with radial clearance to allow correct alignment between the two races.

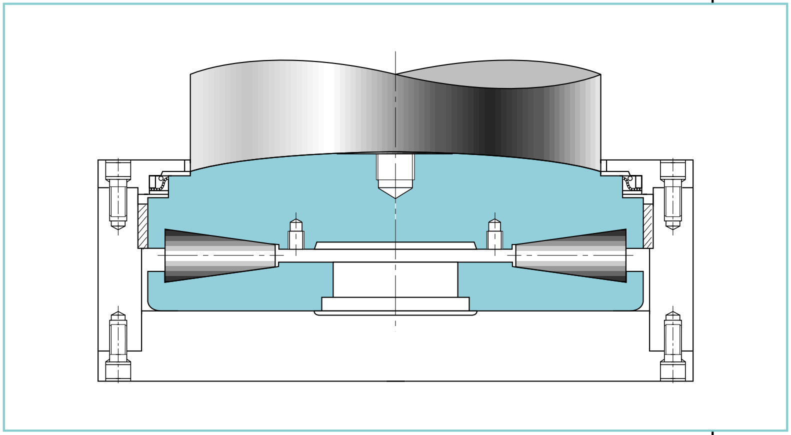


Fig. 5-29

Sealing, which is particularly important on hot mills, is obtained with the use of radial lip seals. Adequate lubrication is maintained by filling the bearing chamber with a high quality EP oil having a viscosity of approximately 460 cSt at 40 °C.

Tube stretch reducing mill, sizing and extracting mill

The high-speed mill shown in figure 5-30 uses standard type TDO bearings on the roll and gear shafts. The cones on the input shaft are mounted with a tight fit and the cups are mounted with a loose fit.

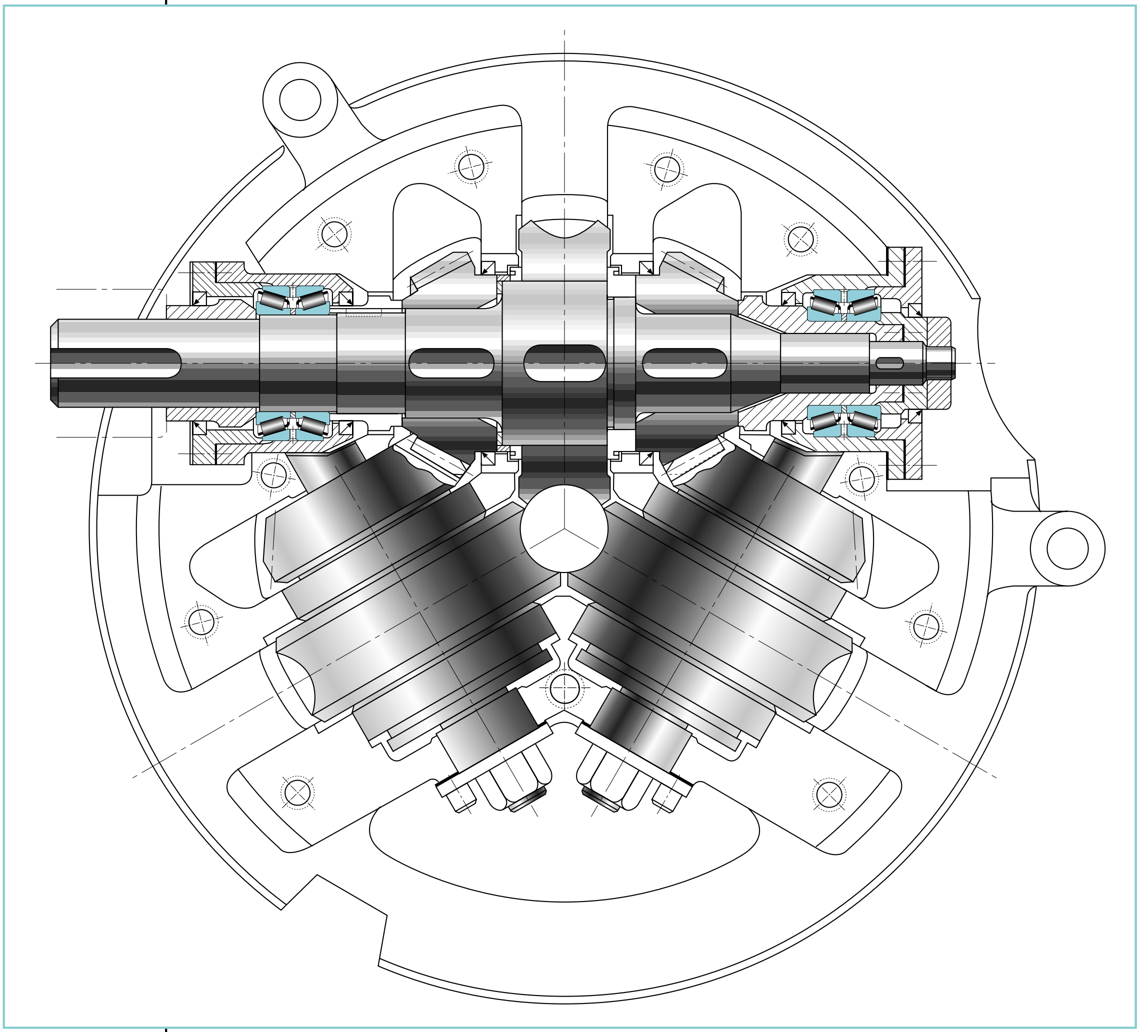


Fig. 5-30

Axial roll location is provided by using shims between the main housing and the fixed cup carrier. The cup carrier on the drive side of the input shaft is floating and allowed to find its own axial position.

In the non-driven rolls, TDI bearings are used to permit free floating through the cones at the floating position.

Mill drive and pinion stands

Figure 5-31 shows a pinion stand with helical gears. On such applications, generally two-row TDOCD bearing assemblies with cone spacers are used at all positions. One bearing on each shaft is fixed by a cup cover and a housing shoulder. The other bearing mounted on the opposite side is free to float in the housing.

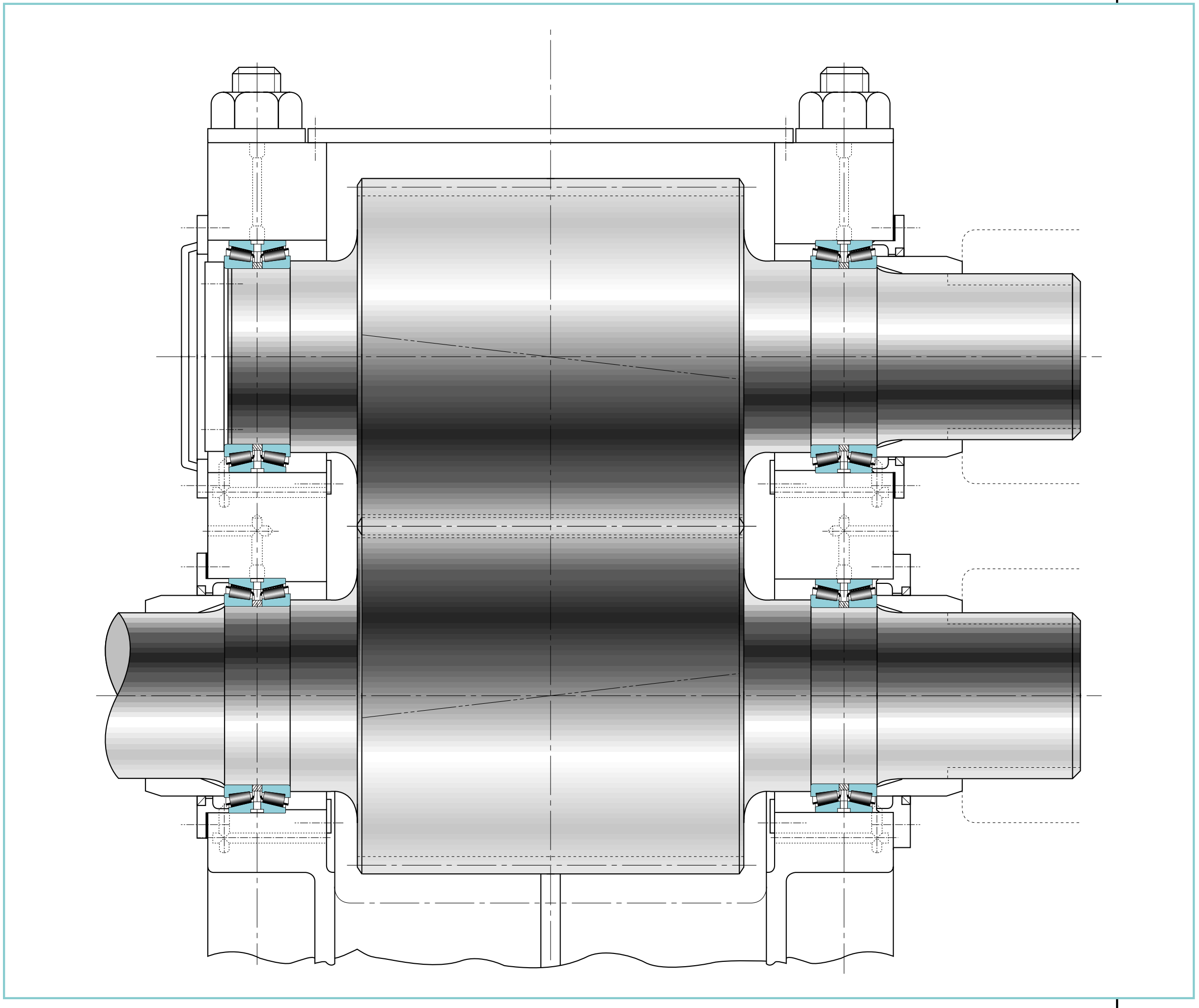


Fig. 5-31

For high speeds, in order to prevent any rotation of the cups mounted on the floating positions (loose and axially free), we suggest using a locking pin located in the radial hole of the cup. The pin diameter is sized to obtain the correct axial clearance between the pin and the hole in the double cup, allowing the necessary shaft axial movement. In addition, a radial hole is also provided in the pin allowing an oil entrance to the center of the bearing.

For high-speed mill drives, the bearing setting is optimized by grinding the spacers at assembly, which is an advantageous feature of the tapered roller bearings, as required lives can be many years.

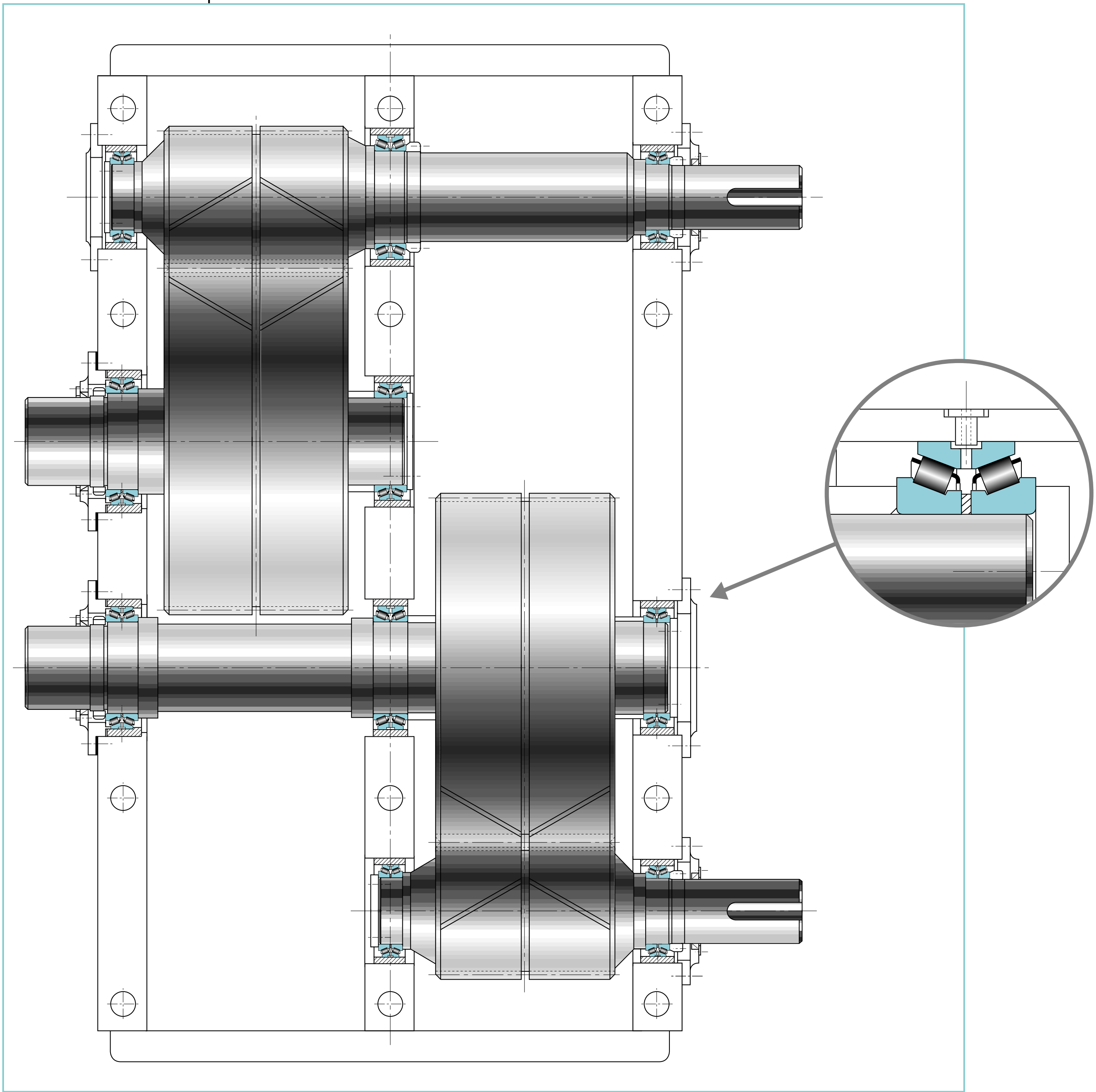


Fig. 5-32

Figure 5-32 shows a twin drive and pinion stand with herringbone gears (double helical gears). Two-row TDOCD bearing assemblies with cone spacers are used at all positions. In the case where all shafts are equipped with herringbone gears, only one fixed bearing position is selected. The bearing mounted on the opposite end is free to float in the housing as well as all other positions on this mill drive. The current trend is to mount the bearing into a carrier in order to have the possibility to replace the cup seat easily if necessary.

Coiler

Figure 5-33 shows the mounting arrangement of a high-speed coiler (up to 1500 rev/min mandrel speed). The mandrel main shaft support consists of 2 TDOCD bearing assemblies with cone spacers at both fixed and floating positions. The cones of these two bearings are axially clamped. The fixed position obtained by a cup cover and a housing shoulder is generally used at the "adjacent mandrel" position in order to achieve greater stability.

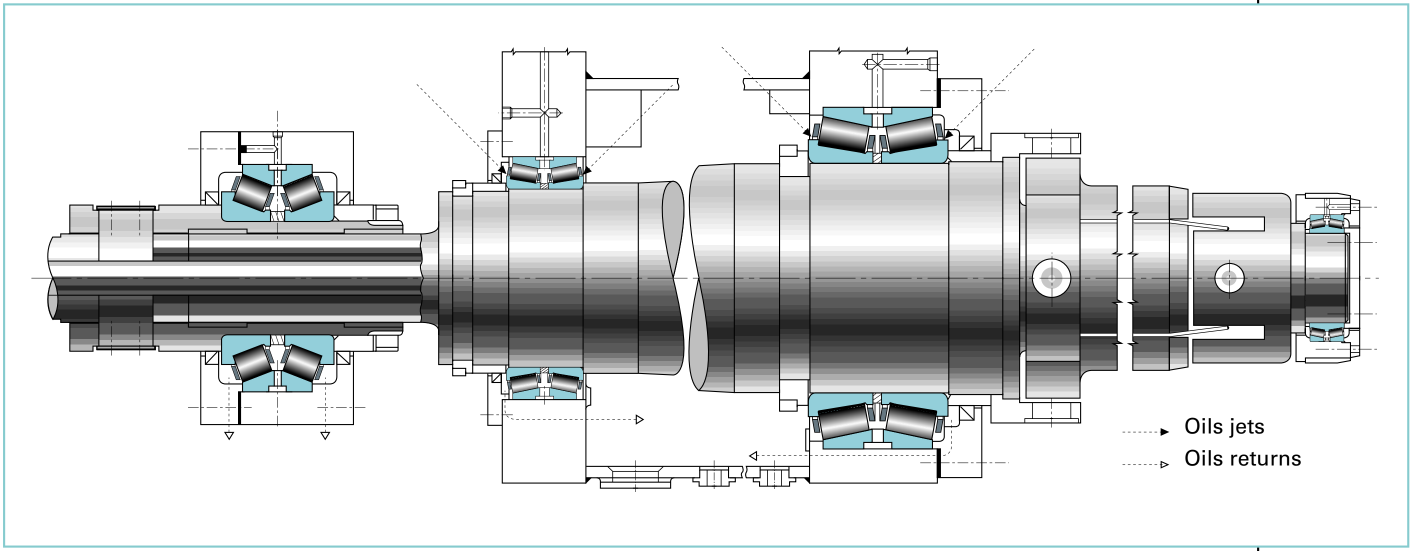


Fig. 5-33

The outboard support is a two-row TDI bearing assembly with a cup spacer that is mounted in a cartridge having a smaller outside diameter than the inside coil diameter to allow coil dismounting. This outboard support which is also called the third support is used for high coil weight in order to minimize the coil shaft deflection.

A steep angle two-row TDO bearing assembly with a cone spacer is used as the thrust unit. This unit is used to actuate the mandrel expansion system and is frequently replaced by a hydraulic rotating cylinder.

Because of the high speeds involved, proper lubrication plays an important part in the successful operation of this type of equipment. The large diameter main support bearings are lubricated by a pressurized oil flow to the center of the double cups (oil viscosity of around 320 cSt at 40 °C). Oil jets directed to each cone rib provide additional lubrication and cooling. Large drains from the outside of the main housing prevent a build-up of oil which could result in excessive churning at these locations. The smaller thrust unit TDO bearing may be lubricated with a pressurized circulating oil system directed to the center of the double cup. Again, large drains prevent the build-up of oil in the bearing. Additional heat may be removed by an oil cooler. The small outboard support TDI bearing has proven satisfactory with grease lubrication.

Mandrel seamless tube mill

The mandrel shown in figure 5-34 uses four-row bearings. The cones are mounted with a loose fit.

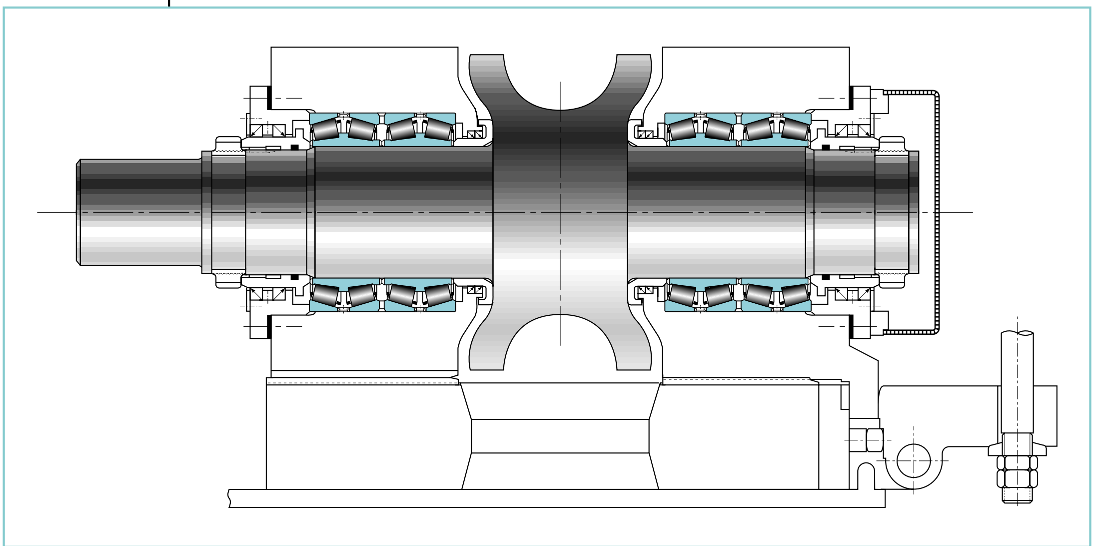


Fig. 5-34

Accurate pass alignment is maintained by referencing the location of the roll groove to the fixed chock. This is accomplished by close tolerance control between the back face of the outer race and the front face of the inner race of the tapered roller bearing (close stand tolerance).

Slitter

Two-row TDO bearings are used at the six positions of the upper and lower slitter shafts in the design shown in figure 5-35. Depending on the strip thickness which is to be cut and the required knife gap adjustment, precision bearings (class 3 or 0 for inch size or class C or B for metric size) are often used.

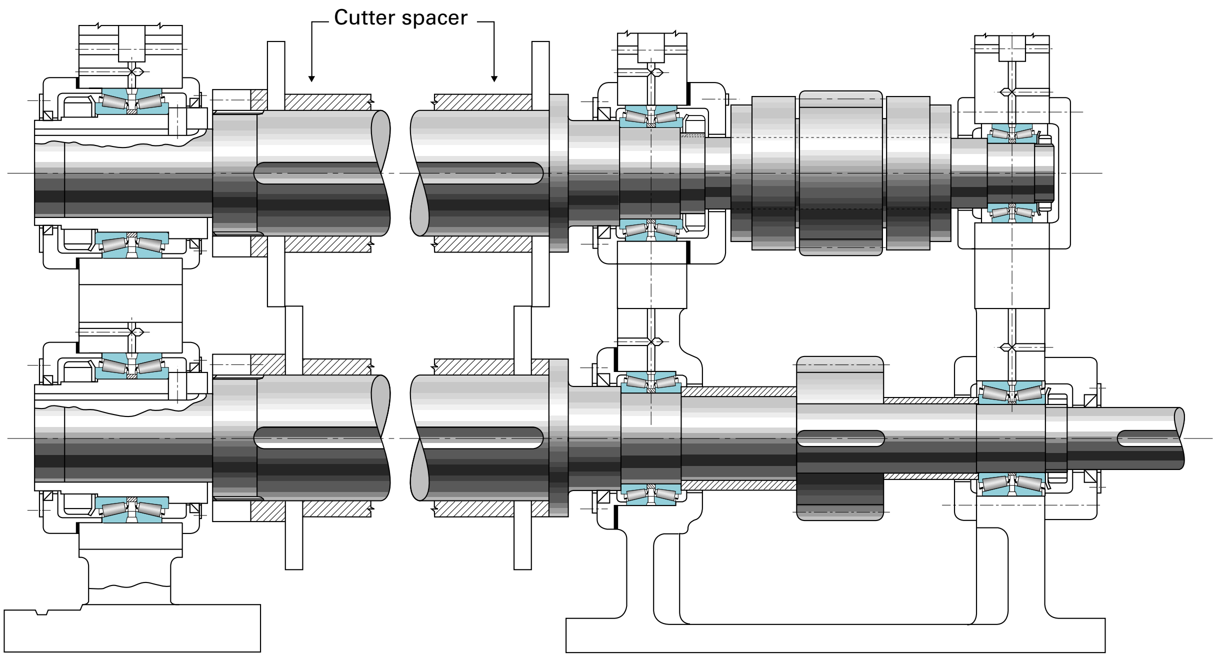


Fig. 5-35

The cutter's location as well as the axial adjustment between the top and bottom shafts is obtained by grinding the cutter spacers to the correct length. A close setting of the bearing is required to achieve the very small axial clearance allowed between the overlapping knives (sometimes less than 0.02 mm - 0.0008 inch).

The movable outboard housing positions are equipped with TDO bearings. The sleeve on which the bearing is mounted is keyed to the shaft to eliminate shaft wear. This unit assembly provides the advantage of having a bearing completely protected from foreign matter during cutter changes. These bearings are axially clamped into the supporting housing, while the sleeve is permitted to float on the shaft.

The TDO bearings used at the center positions of each of the shafts are fixed against end movement. Those used at the position adjacent to the input are free to float in the housing.

The alternative design in figure 5-36 shows the fixed side of a slitter arbor. A TS single row bearing is located at the front or nose position, and a Hydra-Rib^{TM} bearing is located at the set-up or rear position.

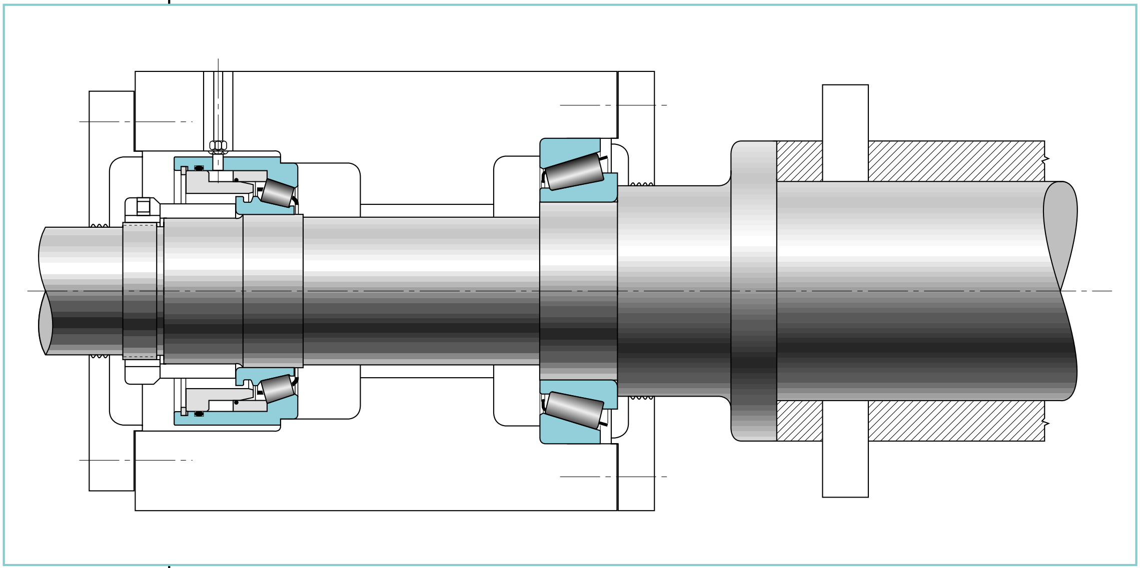


Fig. 5-36

The Hydra-Rib bearing has a floating outer race rib in contact with the large roller ends instead of the usual fixed inner race rib. This floating rib operates within a sealed cavity at a pressure controlled by an appropriate hydraulic or pneumatic pressure system (from 3 to 7 bar - 45 to 100 psi). Changing the pressure consequently changes the pre-load in the system.

The controlled pressure enables the floating rib to maintain constant preload even when differential thermal expansion occurs in the bearing system during the working cycle. By changing the pressure, a variable preload setting can readily be achieved. This unique bearing concept allows you to control the bearing setting which permits closer knife gap adjustment, resulting in better slitting and longer knife life than with a conventional design.

TM = Trademark of The Timken Company

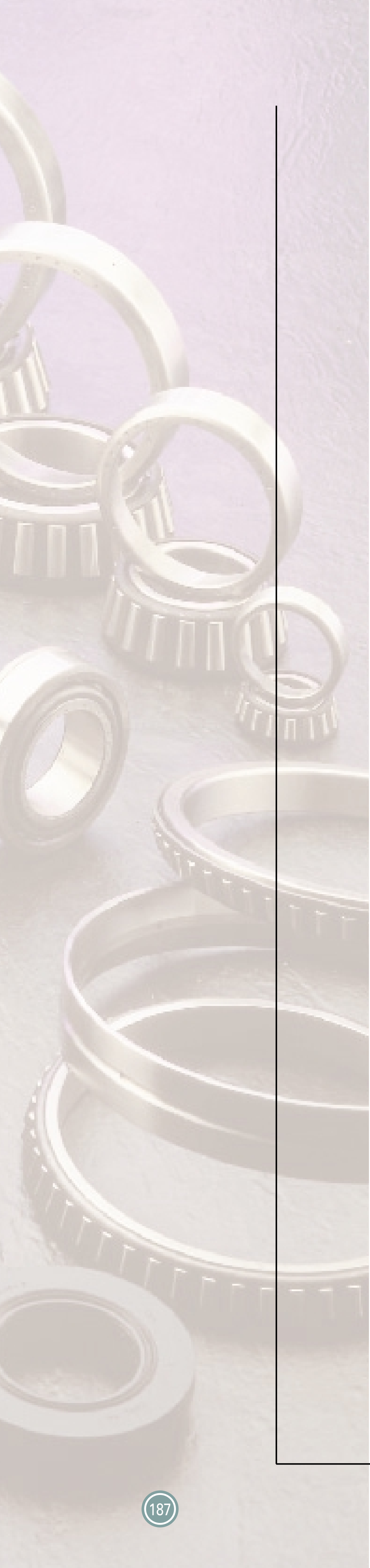
5.2. Maintenance

5.2.1. General remarks

5.2.1.1. Cleaning

Cleaning of the bearing should remove any accumulation of scale, water, old lubricant, or any other contaminants which can cause excessive wear in the bearings. There are different cleaning methods and solutions available, depending on the size or number of bearings you will be cleaning. A few small bearings may be cleaned with light oil or other commercial solvents.

For large bearings or large quantities of bearings, cleaning can be done in cleaning tanks using an appropriate solvent (neutral oil for example) which could be heated. This solvent will depend upon the type of lubricant used and the local environmental laws. Hot water solutions are often used as a final cleaning or rinse after the initial cleaning in a hot oil tank. The cleaning tank should have provisions for heating the oil or water solution as well as for agitating or re-circulating the solution. After cleaning, the bearings should be covered with a coating of light oil to protect against rusting, if they are not to be inspected immediately.



5.2.1.2. Packaging and storage

Packaging criteria for large bearings

Free contact between rollers and cup race should be avoided during shipping and transportation due to the possible vibrations that can occur. The assembled bearing must be fixed in its box to prevent movement of cones and cups. The packaging is also dependent on the transport type ; by air for example it must exclude dirt, dust and moisture.

Bearing assemblies are packed in corrugated boxes or in wooden boxes according to their sizes, but first the cones, cups or assemblies are wrapped in plastic. Often they are put on pallets and secured with steel bands. When shipped to tropical countries or where risks of moisture exist, a desiccant is placed in the packaging to absorb humidity. Special packaging can also be provided depending on the situation and expected time of storage before use.

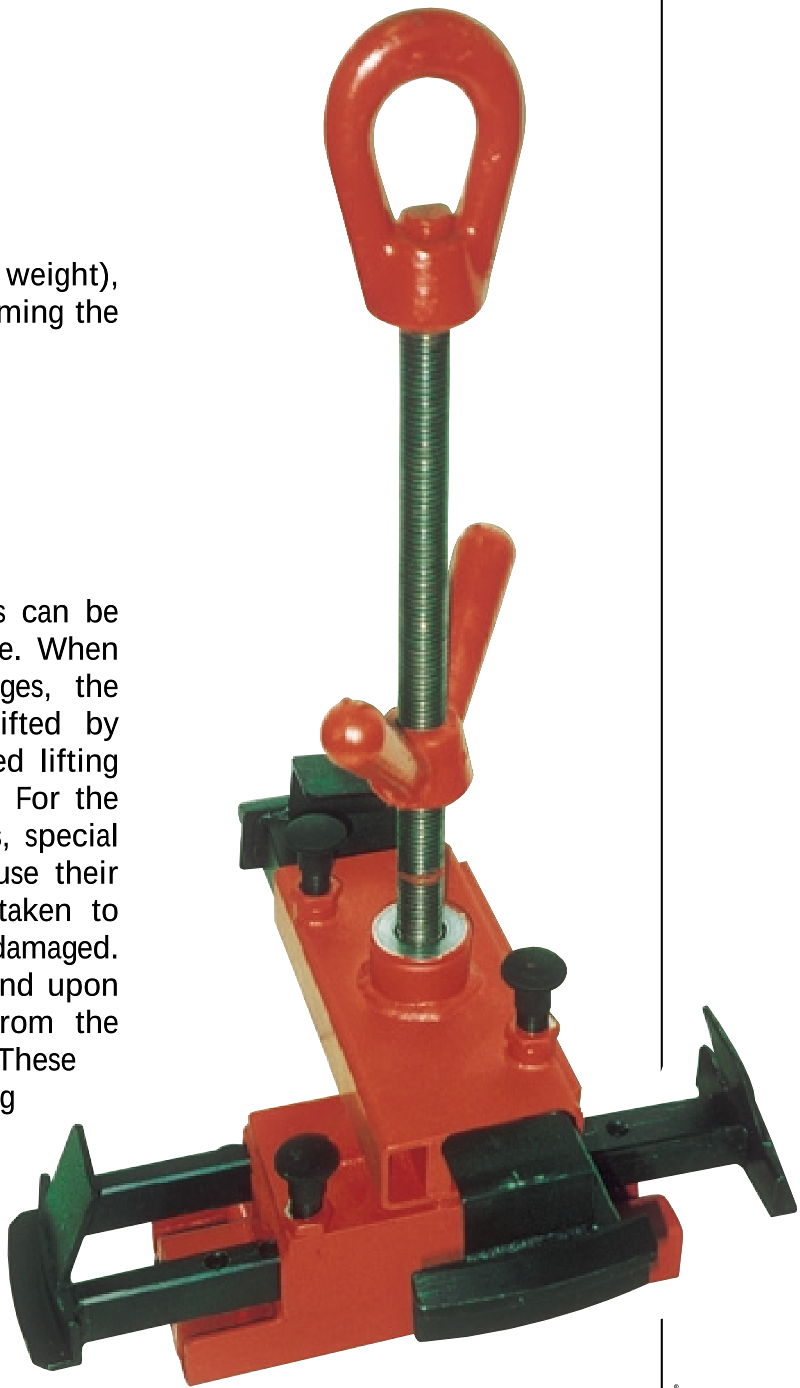
Storage criteria for large bearings

Bearings should always be placed in a horizontal position (vertical bearing axis) in order to avoid cone or cup ovality. The bearings should be stored in their original boxes and in a dry place. If the packaging and storage conditions are ideal, a bearing assembly could still retain its initial performance potential even after more than ten years.

5.2.1.3. Handling tools

Roll neck bearings should be handled carefully when they are mounted into or removed from the chock to ensure optimum performance.

Different tools can be used depending on bearing size, weight, cage type, and if bearing parts are assembled separately or as a unit (i.e. sealed bearings).

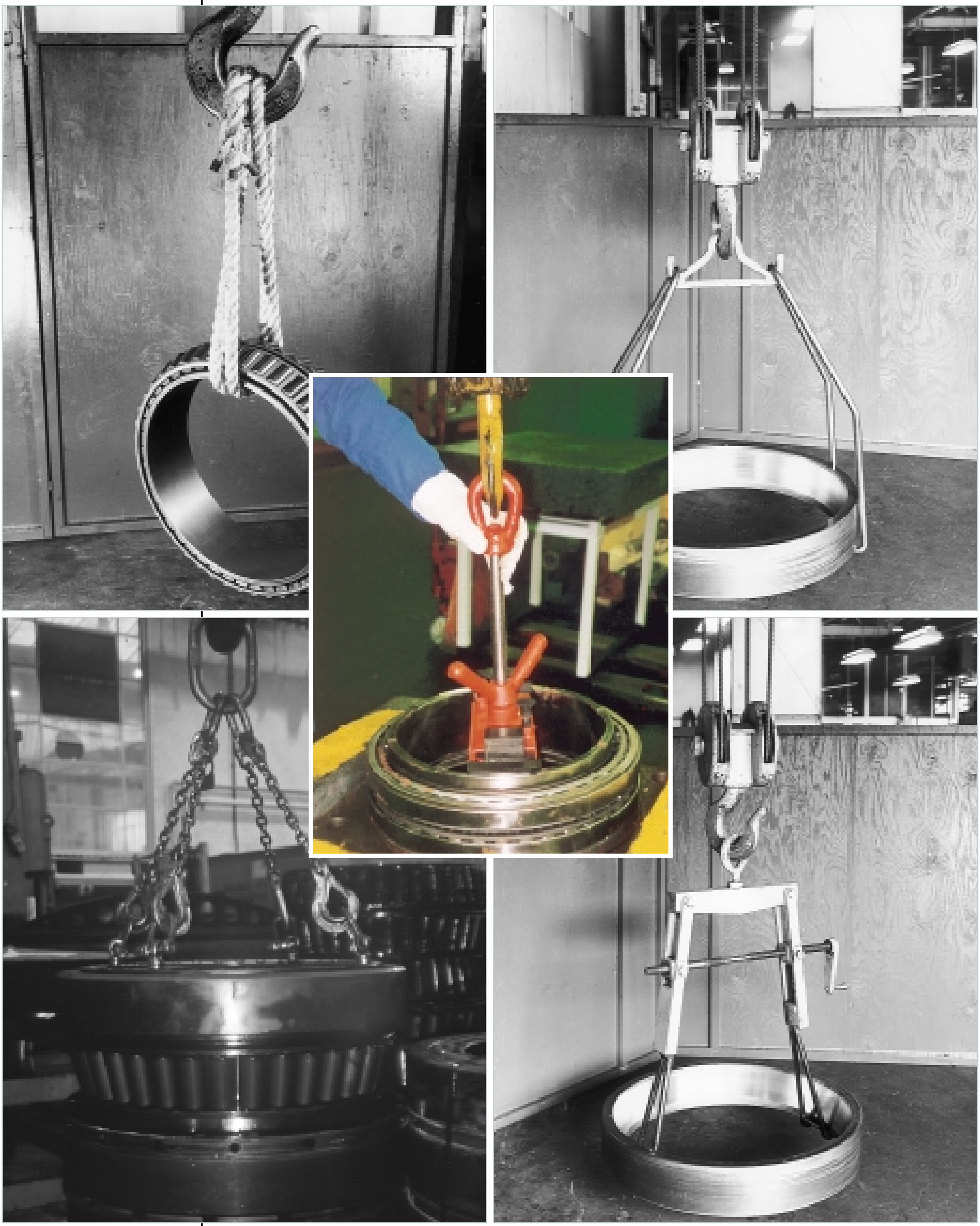


Small bearing sizes

For small bearing sizes (low weight), handling is generally manual, assuming the operator's safety is assured.

Large bearing sizes

For these bearings different tools can be used depending on the cage type. When the bearings have pin type cages, the single and double cones are lifted by screwing eye-bolts in the threaded lifting holes provided in the cage rings. For the other cones using stamped cages, special tools are used. Often operators use their own tools but care should be taken to ensure that the bearing is not damaged. For the cups, the tools will depend upon the way the cup is handled (from the inside or from the outside). These tools, as well as different lifting methods are shown on next page. Generally, the cups are first mounted on the cone before they are fitted into the chock.

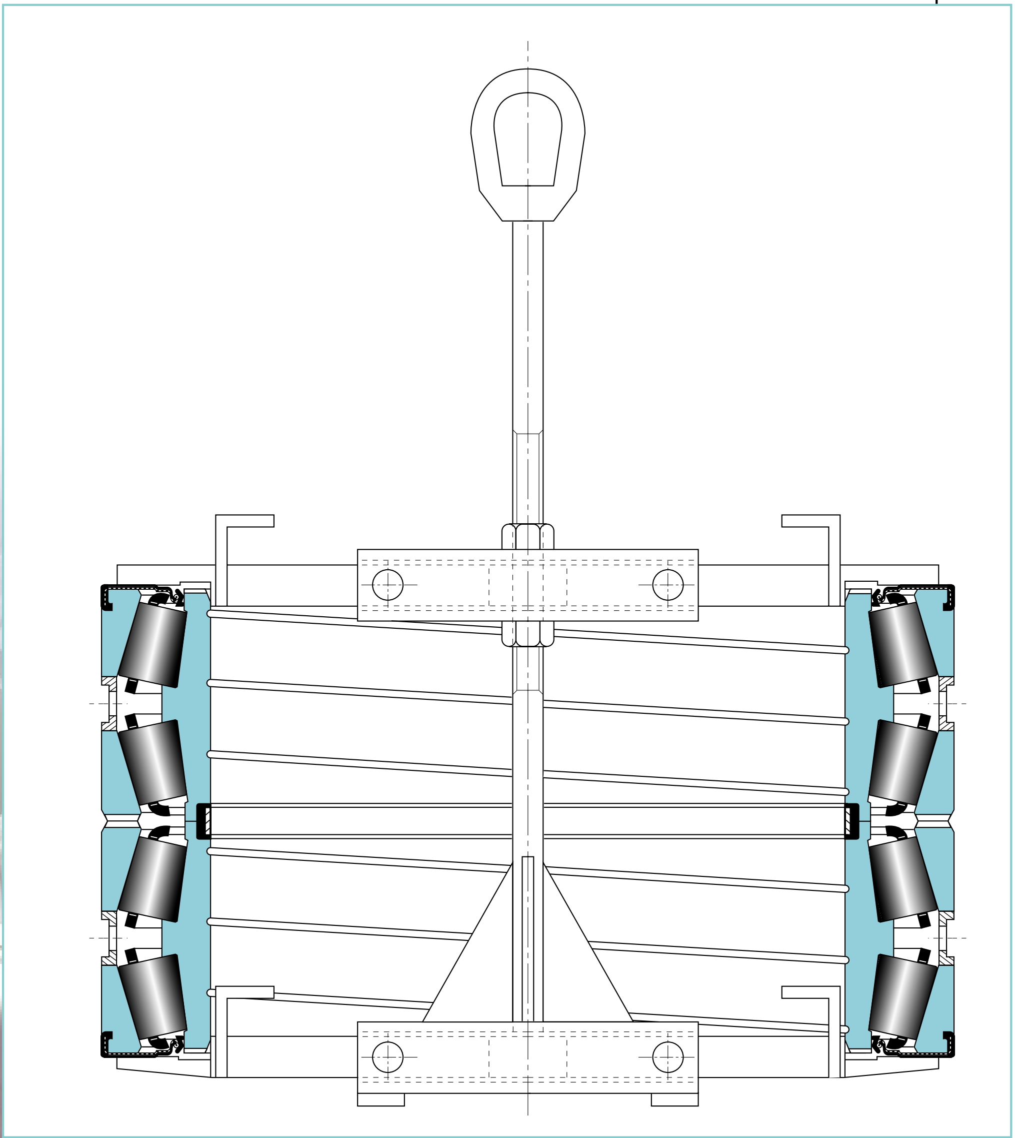


All these tools must be checked on a regular basis for safety reasons.

Sealed bearings

As these bearings are pre-greased, the handling and the mounting into the chock should be made as an assembled unit. The handling of this bearing is shown in the figure 5-37. This solution can also be used in the case where the customer wishes to mount a standard non-greased two or four-row assembly as an unit.

Fig. 5-37



5.2.2. Bench End Play (BEP) readjustment recommendations

Bearings can be checked periodically for wear in order to determine if the initial BEP needs to be readjusted.

5.2.2.1. BEP measurement

For bench endplay measurements, the bearing should be stacked on a flat, solid surface with the lower cup supported in a counterbored base fixture in order to have cage clearance and allow free rotation of the bearing.

Any time the bearing is stacked up, whether for measurements, in which case the cups and cones spacers are left out, or for assembly in the chock, the proper stacking sequence must be followed in order to have the correct setting clearance (see bearing marking procedure chapter 5.1.1.).

It is necessary to load the bearing being measured to properly seat all the parts as shown in fig. 5-38.

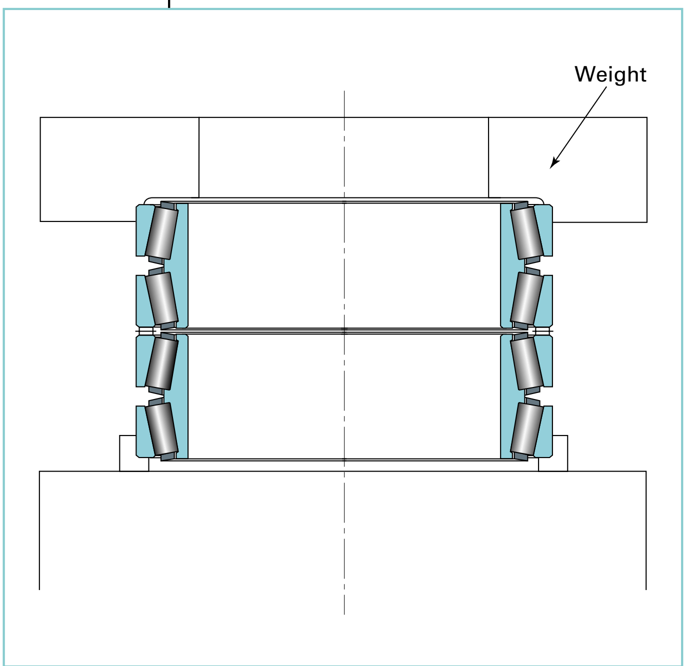


Fig. 5-38

The weight used should be centered on the bearing cup outside diameter and counterbored to clear the cage to allow free rotation. Bearings, especially those with considerable service, need this weight as their parts may have become out-of-round and still need to be seated properly. The load applied should be equal at least to the weight of the bearing being measured. For large bearings which require a lifting system to apply the weight, the lifting chains are kept in place for safety reasons with some slack at all times. Timken Service Engineers are available to give guidance on the use of these fixtures as well as to instruct maintenance personnel on bearing measurement procedures.

After weighting the bearing, all the parts must be rotated separately to seat the rollers. A light oil should be applied to help seating and to protect the bearing.

Considerable rotation of the bearing may be necessary to fully seat the parts, particularly on those bearings with long service. Proper roller seating can easily be checked by trying to insert a 0.05 mm (0.002 inch) feeler gauge between the large end of the rollers and the cone rib. All four sets of rollers should be checked for seating at four different locations.

With all parts seated, the spaces A_1 and A_2 between the cups and the cone space B_1 (TQOW) are measured at four places 90 degrees apart around the bearing (fig. 5-39a).

The average of the four readings for each space is then obtained and used as the width for the space. The corresponding cup and cone spacers are then measured to obtain their actual width. In order to check if the spacer width is parallel within 0.025 mm (0.001 inch), a measurement at four places 90 degrees apart is required.

After these measurements are done, the difference between the spacer width and the gap gives the bench endplay.

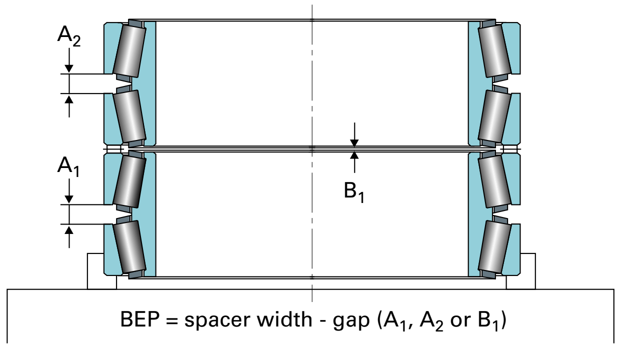


Fig. 5-39a
TQO BEP measurement

For BEP measurements between the two inner rows of a 2TDIW assembly, we suggest adding a master cup spacer, which allows a gap B_2 between the inner cone front faces of a 2TDIW assembly and permits an easy BEP measurement (see fig. 5-39b). The middle cup spacer from another bearing assembly could be used as the master cup spacer.

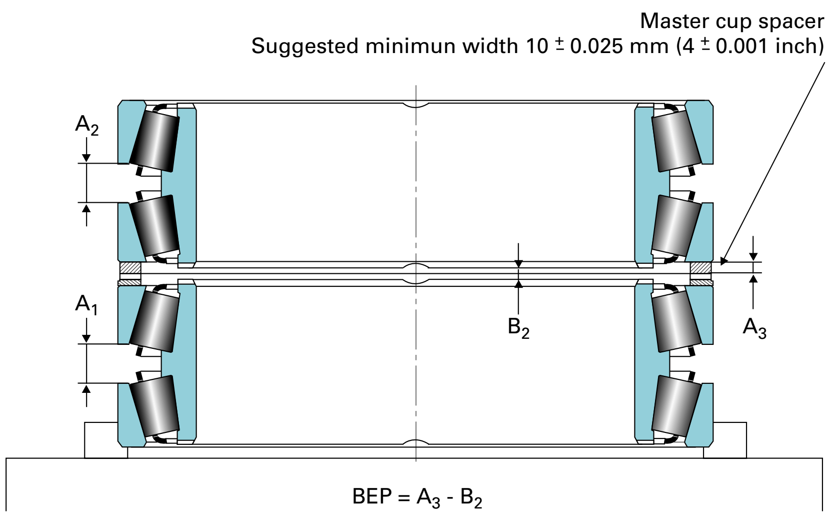


Fig. 5-39b
2TDIW BEP measurement on middle rows

Knowing the master cup spacer width, you can easily link the measured gap to the real BEP. The master width has to be defined according to the measuring tools (at least 10 mm - 0.4 inch) to provide sufficient measurable gap between the inner cone front faces.

5.2.2.2. BEP readjustment for spacer assemblies

The bearing setting can be readjusted in the TQOW bearings to the required amount by regrinding each spacer. For 2TDIW bearings the middle cup spacer (narrow) has to be replaced as its width must be increased, according to the measured endplay (note : it is also possible to grind the cone inner face).

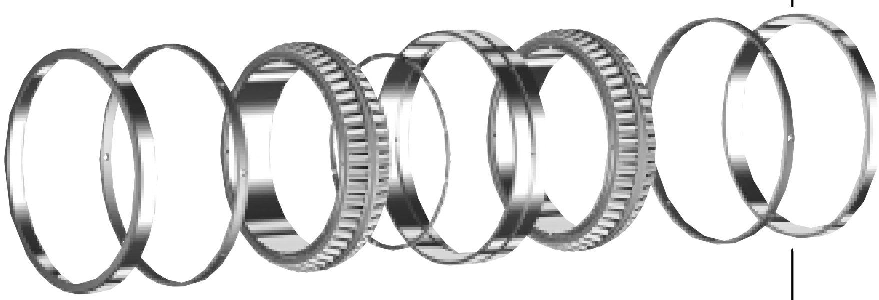
Usually it is not necessary to reset the bearing until the endplay has reached twice its original value. For instance, on a bearing with a 0.304 mm (0.012 inch) original endplay, regrinding or replacement of the spacers would not be necessary until the bearing measurement shows 0.608 mm (0.024 inch) endplay in the bearing.

Bearing endplay readjustment

Original endplay in bearing (new)	0.304 mm (0.012 inch)
Regrind spacers when endplay doubles to	0.608 mm (0.024 inch)
Regrind spacers to provide 1-1/2 times original endplay	0.456 mm (0.018 inch)

The general rule when re-setting a bearing assembly is to provide one and a half times the original bearing endplay. If the new bearing had called for 0.304 mm (0.012 inch) endplay, regrind the spacer to provide 0.456 mm (0.018 inch) endplay. This is a safety factor to ensure that the setting is not too tight. Above is shown a sample calculation for a bearing with an original endplay of 0.304 mm (0.012 inch). The measurements of the gap and spacer width should be recorded.

After cleaning and inspection the bearing assembly must be protected to prevent any corrosion.



5.2.3. Relubrication and seal maintenance

When grease is used to lubricate the bearings, each cone is usually packed with grease as the parts are being assembled in the chock. Take care not to put too much grease in the bearing, otherwise the bearing could generate excessive heat (please refer to chapter 4). Grease can be applied to the cone by hand. Additional grease should be added through the grease fittings after the bearing is completely assembled in the chock.

When circulating oil, oil-mist or oil-air lubrication is used, a light coating of oil should be applied to the components as they are assembled. Additional oil must be added to provide the required oil level after the chock is set upright.

Before mounting the seals, be sure that they are not damaged. This inspection can easily be done by tracing with your fingers around the circumference of the seal lip. If any damage is found, the seal must be replaced. You must pay close attention during the mounting of the chock on the roll neck not to damage the seal (seal lip roll-over).

For the correct selection and amount of lubricant, please refer to chapter 4 or contact a Timken sales or service engineer.

5.2.4. Chock and neck inspections

5.2.4.1. Chock inspection

To make a complete chock inspection, the bearing assembly must be removed. The chock should be cleaned out thoroughly and all lubrication and vent holes blown out with air. If oil mist lubrication is used, special attention should be given to ensure that the mist re-classifier fittings are clean. Heavy corrosion or fretting in the chock bore should be buffed or polished out. Also, periodic checks (one per year) for bore size and out-of-roundness should be made and recorded. Chocks can become distorted after long periods of service. Suggestions for permissible chock bore out-of-roundness and over-size limits due to service are shown in fig. 5-40.

Fig. 5-40

Permissible changes in chock bores from service

Cup outside diameter (mm-inch)	Maximum chock bore "out-of-roundness" (mm-inch)	Maximum chock bore over normal cup outside diameter (mm-inch)
0 to 304.8 0 to 12	0.15 0.006	+ 0.23 + 0.009
+ 304.8 to 609.6 + 12 to 24	0.30 0.012	+ 0.46 + 0.018
+ 609.6 to 914.4 + 24 to 36	0.46 0.018	+ 0.70 + 0.027
+ 914.4 to 1219.2 + 36 to 48	0.61 0.024	+ 0.92 + 0.036
+ 1219.2 to 1524.0 + 48 to 60	0.76 0.030	+ 1.22 + 0.048
+ 1524.0 + 60	0.91 0.036	+ 1.52 + 0.060

Backing shoulders in the chock should be free of burrs to permit proper seating of the cups.

Burrs can work loose in service and may get into the bearing. Backing shoulders on the cover plates should also be free of burrs. Also all seals should be checked thoroughly and replaced if worn badly or torn. Seals play a major role in getting good service from the bearings and great care should be taken to keep effective seals in the chocks at all time.

Keeper plates and rocker plates should be inspected to make sure they are in good condition, with proper bevels permitting the chocks to rock and align themselves under roll neck deflection conditions.

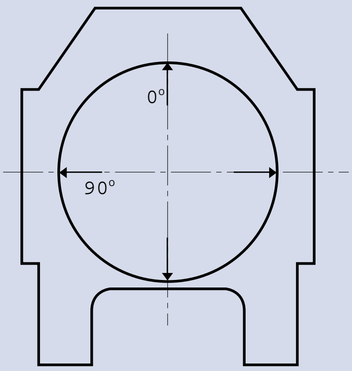
A record of each chock inspection and measurement should be kept by the maintenance department and chock repairs made when necessary. A typical chock record card is illustrated in fig. 5-41.

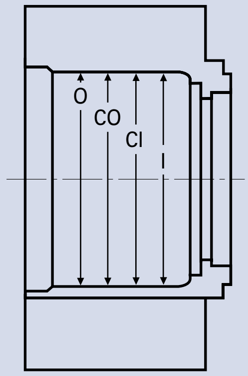
CHOCK BORE RECORD SHEET

Chock builder.. Date ....

Mill user.. Service rep. ....

Type chock : Back-up roll ( ) Work roll ( ) Type mill ....



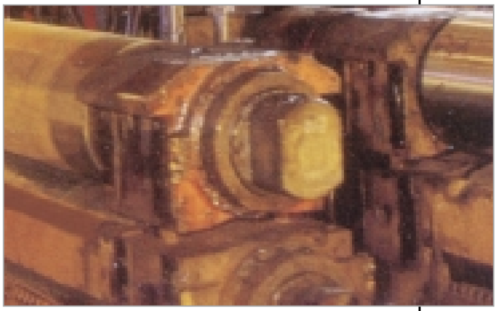


Chock bore print size..

Chock	Position		0°	90°	Average
		O			
		CO			
		CI			
		I			
		O			
		CO			
		CI			
		I			
		O			
		CO			
		CI			
		I			

Fig. 5-41

Before assembling the bearing into the chock bore, check the record card to make sure which load zone or quadrant is to be used. A mark could be made on the chock face in order to easily align all cups. A light coating of oil or grease in the bore of the chock will help reduce fretting or corrosion between the cups and the chock bore in service.



5.2.4.2. Neck inspection

Fig. 5-42

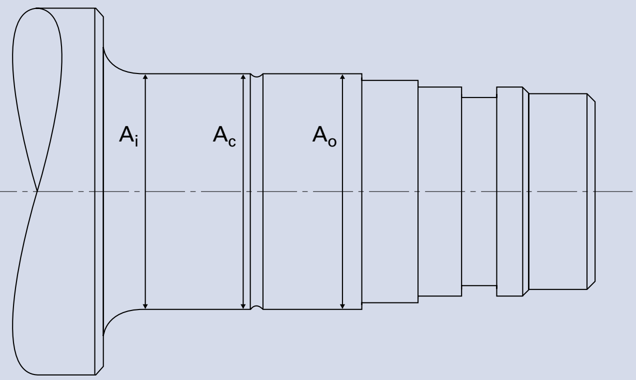
Cone bore over (mm-inch)	Cone bore inclusive (mm-inch)	Permissible minimum neck diameter below normal bearing cone bore
– 0	76.2 3	– 0.30 – 0.012
76.2 3	101.6 4	– 0.38 – 0.015
101.6 4	127.0 5	– 0.46 – 0.018
127.0 5	152.4 6	– 0.53 – 0.021
152.4 6	203.2 8	– 0.61 – 0.024
203.2 8	304.8 12	– 0.69 – 0.027
304.8 12	609.6 24	– 0.91 – 0.036
609.6 24	914.4 36	– 1.22 – 0.048
914.4 36	– –	– 1.52 – 0.060

After cleaning, the roll neck should be inspected and checked for size and general condition. Suggestions for permissible service wear limits on roll necks are shown in fig. 5-42.

A record of each neck inspection and measurements should be kept by the maintenance department and neck repairs made when necessary. A typical neck record card is illustrated in fig. 5-43.

ROLL NECK RECORD SHEET

Roll Number............................



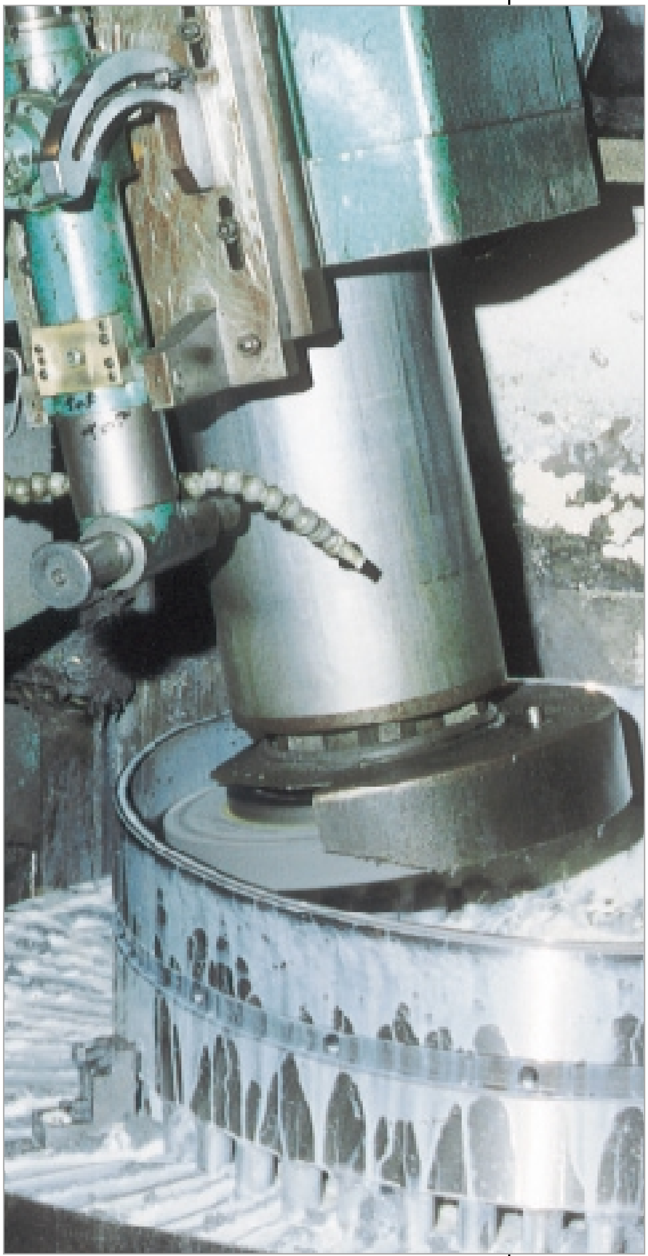
Date		Drive end		Operating end	
		0°	90°	0°	90°
	A_o				
	A_c				
	A_i				
	A_o				
	A_c				
	A_i				
	A_o				
	A_c				
	A_i				

Fig. 5-43

Make sure any raised nicks or gouges on the roll neck are stoned or filed down before re-assembly. Heavy burrs can cause difficulties in assembling the cones on the neck, particularly on new rolls with nominal sized necks. The seal rubbing surfaces should be polished or repaired if required. Sharp edges that could cut the seal lip at assembly should be removed.

Coat the neck with lubricant to help combat scuffing. Also the seal rubbing surfaces should be lubricated to help ease the seals over the chamfered edge. Careful handling of the chock and bearing while sliding it on or off the roll neck will help prevent a large proportion of the most commonly found seal damage.

5.3. Saving money by reconditioning your roll neck bearings

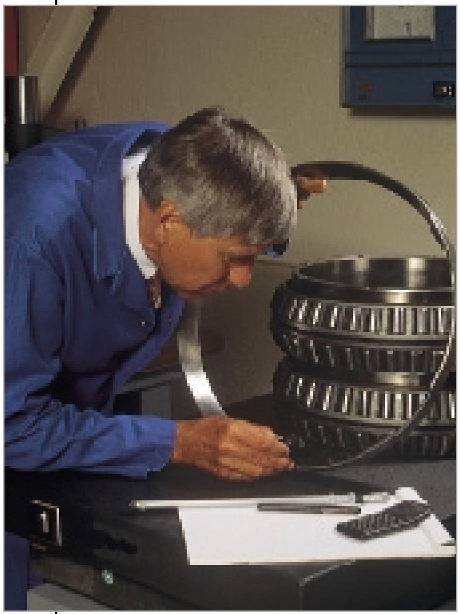


Roll neck tapered roller bearings can withstand very high loads, shocks and speeds. Nevertheless, depending on the operating conditions (possible overload,...) and the environment factors (mill column and chocks conditions, lubrication system...), life can vary dramatically from one mill to another, even with identical type of mills. The maintenance department can play a major role in extending bearing life and preventing mill breakdown time.

Timken Company Service Engineers can help you in your workshop by controlling the bearings and giving you a proper diagnosis of the situation. They can also train your maintenance people in the different causes of bearing damage and give you advice about the future actions to take.

5.3.1. Bearing damage analysis

Damage to bearings while handling before and during installation and damage caused by pollution, improper setting, lubrication and operating conditions create, by far, the largest percentage of premature trouble.

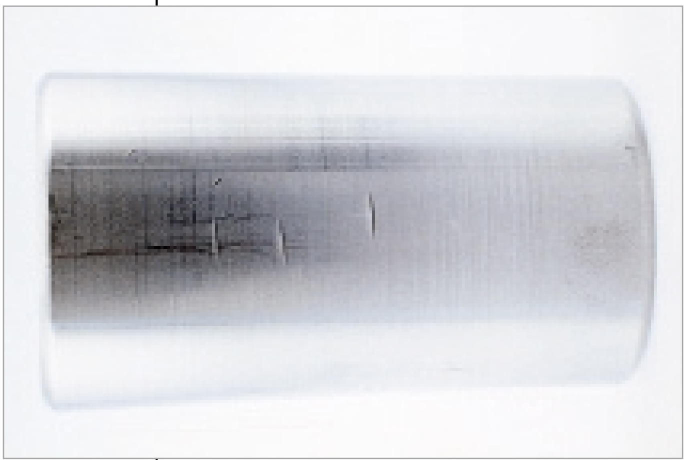


In many cases the damage can be identified by the appearance of the bearing, but it is not easy and sometimes it is impossible to determine the exact cause of that damage. As an example, a bearing with scored and heat discolored roller ends and rib is easily identified as a burned-up bearing and damaged beyond further use. The cause of the burning or damage, however, might be traced to any of a number of things such as insufficient or improper lubrication. It may be the wrong type of lubricant or the wrong system for supplying lubricant. Perhaps a lighter/heavier viscosity, or an extreme pressure additive is needed rather than a straight mineral oil...

From this it can be seen that simple examination of a bearing will not reveal the cause of the trouble. It can reveal if the bearing is good for further service, but often it is necessary to make a thorough and complete investigation of the mounting, installation and parts affecting the bearing operation to determine the cause of the damage. Unless the true cause of the damage is found and corrected, the replacement bearing will be damaged in the same manner and again there will be premature trouble.

The following pages give information on different modes of damage which is intended to caution users and alert them to take preventive action.

Typical damage found on rolling mill bearings

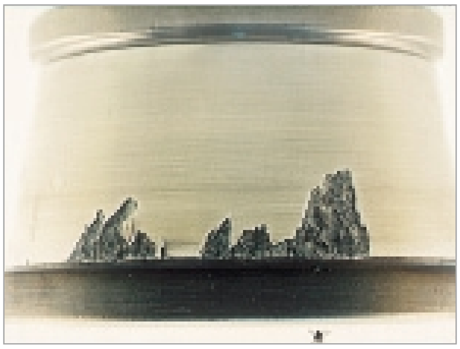


Nicks due to improper handling / mounting

Spalling caused by :

a) Geometric stress concentration due to shocks on the cup face

b) Geometric stress concentration on the cup due to misalignment



c) Geometric stress concentration on the cone due to misalignment

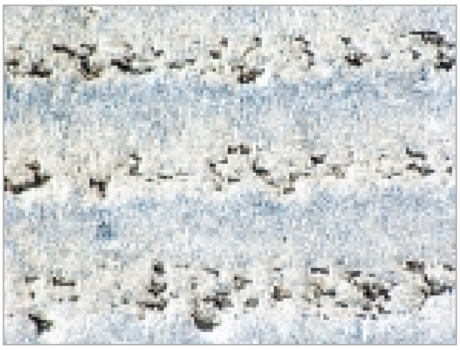
Cage damage

Cone rib scoring and heating due to inadequate lubrication

Roller end scoring and heating due to poor lubrication

Abrasive wear

Cage pocket wear from excessive endplay



Electric arc fluting

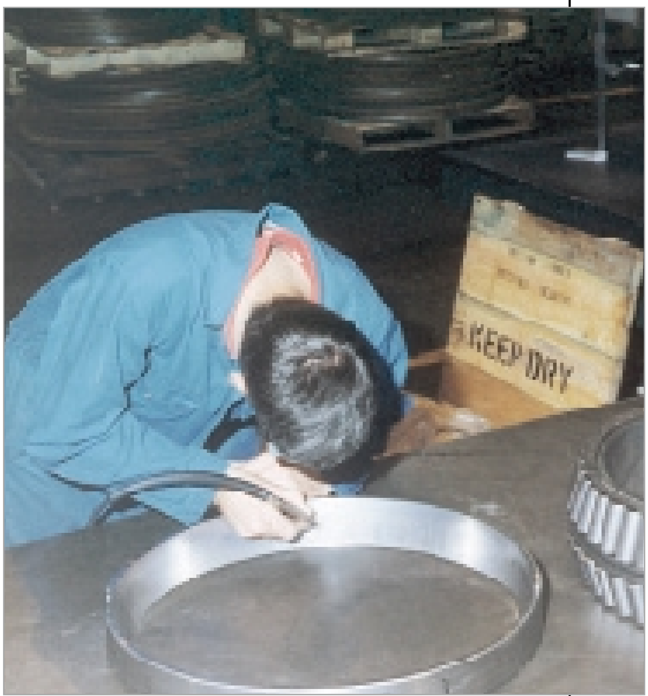
Moisture etching

Spalling due to moisture etching

Cage deformation due to bad handling

5.3.2. Possible in-house reconditioning

Due to its modular concept (separate inner and outer rings), the tapered roller bearing can be easily controlled and reconditioned within most mill operator's maintenance workshops. After first cleaning each of the components, the maintenance department can assess the condition of the bearing and decide on future actions. Different cases may exist :



- After several months or years of operation, the internal endplay may have increased in the bearing due to wear initiated by the presence of miscellaneous contaminants (water, hard particles, emulsion additives,...). This endplay should be precisely measured and the spacers and/or components faces must be reground accordingly to regain the optimum load zone.

- The combination of high contact stresses and non metallic particles in the bearing steel may have initiated spalling on the races. These spalls often occur first on the cups where the load is mainly applied in the same portion. If the spall does not exceed a certain size, the operator can hand grind the spall until all sharp edges are removed. When using pin type cages, you can also check the cone race for spalls by taking out the roller where the pin is threaded in the cage ring.

If you are not equipped to carry out this type of maintenance yourself, we are able to do this reconditioning operation for you.

In any case, you can request the help of our service engineers for advice. See also chapter 5.1. and 5.2.

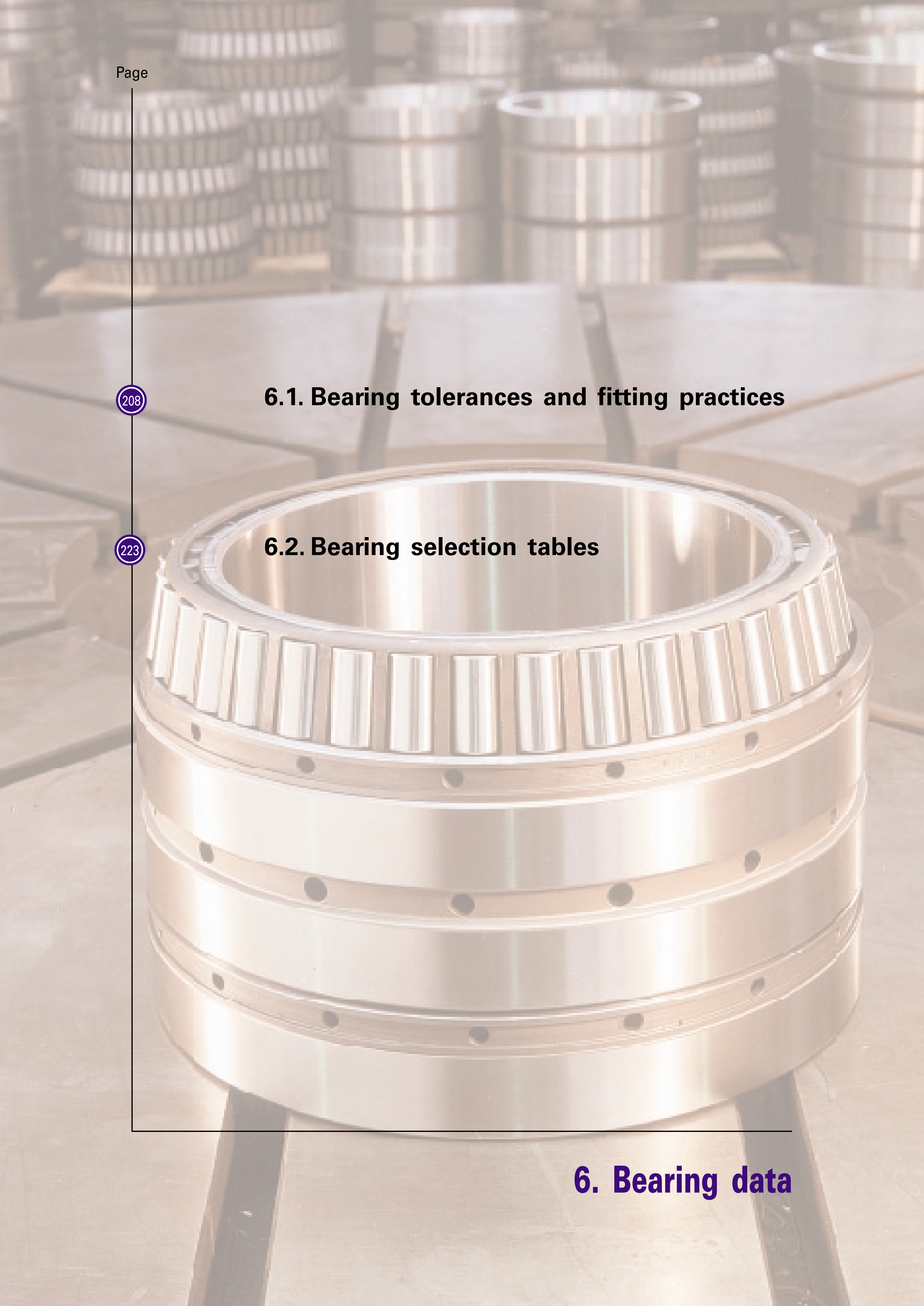
5.3.3. Timken bearing reconditioning facility

For expensive bearings or in some very urgent situations, The Timken Company offers the option to re-condition your bearing at several sites around the World (Europe, USA,...).

After a proper cost estimation, your bearing will be repaired in one of our dedicated facilities. Bearing components will be re-ground or replaced and you will receive back, a reconditioned bearing that should provide several more years service.

Large back-up roll bearings have achieved a total life of more than 30 years after having been repaired several times in our facilities.

Our service engineers and sales engineers are able to provide you with full information on any of your repair requirements.



6. Bearing data

Inch bearing tolerances

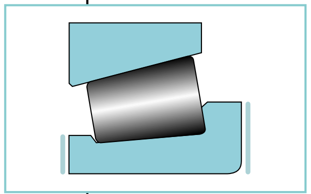
CONE BORE TOLERANCES

For cone bore tolerances please refer to the bearing fitting tables (page 216)

CUP O.D. TOLERANCES

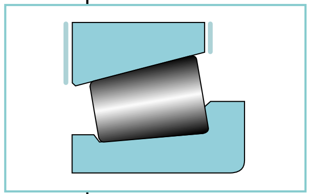
For cup O.D. tolerances please refer to the bearing fitting tables (page 216)

CONE WIDTH TOLERANCES, micrometers (inch)



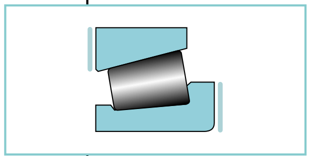
Bearing types	Bore range	Class 4		Class 2	
		Min	Max	Min	Max
Single and double cones	All sizes	–254 –0.0100	+76 +0.0030	–254 –0.0100	+76 +0.0030

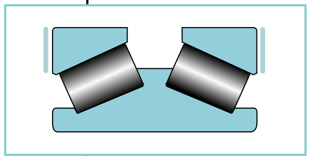
CUP WIDTH TOLERANCES, micrometers (inch)

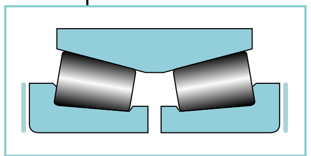


Bearing types	O.D. range	Class 4		Class 2	
		Min	Max	Min	Max
Single and double cups	All sizes	–254 –0.0100	+51 +0.0020	–254 –0.0100	+51 +0.0020

Inch bearing tolerances

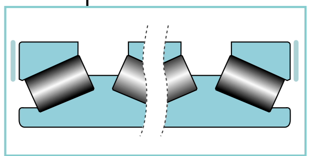






OVERALL BEARING WIDTH (T) TOLERANCES, micrometers (inch)

Bore range, mm (in) over	incl.	Bearing types	Class 4 Min	Class 4 Max	Class 2 Min	Class 2 Max	Bearing types	Class 4 Min	Class 4 Max	Class 2 Min	Class 2 Max
0 0	101.600 4.000	TS	0 0	+203 +0.0080	0 0	+203 +0.0080	2 ROWS	0 0	+406 +0.0160	0 0	+406 +0.0160
101.600 4.000	304.800 12.000		–254 –0.0100	+356 +0.0140	0 0	+203 +0.0080		–508 –0.0200	+711 +0.0280	–203 –0.0080	+406 +0.0160
304.800 12.000	609.600 24.000		– –	– –	–381 –0.0150	+381 +0.0150		– –	– –	–762 –0.0300	+762 +0.0300
609.600 24.000	– –		–381 –0.0150	+381 +0.0150	– –	– –		–762 –0.0300	+762 +0.0300	– –	– –



OVERALL BEARING WIDTH (T) TOLERANCES, micrometers (inch)

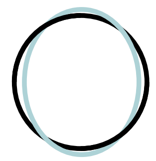
Bore range, mm (in)	Bearing types	Class 4 Min	Class 4 Max	Class 2 Min	Class 2 Max	Bearing types	Class 4 Min	Class 4 Max	Class 2 Min	Class 2 Max
All sizes	2TDIW	–762 –0.0300	+762 +0.0300	–762 –0.0300	+762 +0.0300	TQO SRNB	–1524 –0.0600	+1524 +0.0600	–1524 –0.0600	+1524 +0.0600

2TDIW CONE OVERALL WIDTH (B) TOLERANCES FOR ASSEMBLIES WITH ABBUTING CONES, micrometers (inch)

+ 152 – 508 (+ 0.006 – 0.020)

Tighter tolerances can nevertheless be provided on both cone and cup overall widths according to your needs. Overall bearing width tolerances do not take into account the tolerance on the BPL/BEP.

Inch bearing tolerances



ASSEMBLED BEARING MAXIMUM RADIAL RUNOUT, micrometers (inch)

Bearing types	O.D. range, mm (in) over	O.D. range, mm (in) incl.	Class 4	Class 2	Class 3	Class 0
All bearing types	0 0	304.800 12.000	51 0.00200	38 0.00150	8 0.00030	4 0.00015
	304.800 12.000	609.600 24.000	51 0.00200	38 0.00150	18 0.00070	– –
	609.600 24.000	914.400 36.000	76 0.00300	51 0.00200	51 0.00200	– –
	914.400 36.000		76 0.00300	– –	76 0.00300	– –

Class 3 and 0 : mainly used on Z-mill bearings

Metric bearing tolerances

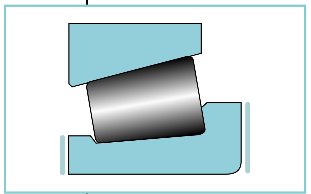
CONE BORE TOLERANCES

For cone bore tolerances please refer to the bearing fitting tables (page 217)

CUP O.D. TOLERANCES

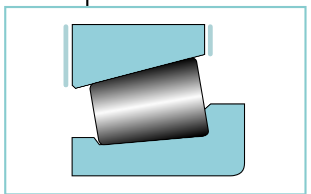
For cup O.D. tolerances please refer to the bearing fitting tables (page 217)

CONE WIDTH TOLERANCES, micrometers



Bearing types	Bore range, mm over	incl.	Class K Min	Max	Class N Min	Max
Single and double cones	10.000	50.000	–100	+0	–50	+0
	50.000	120.000	–150	+0	–50	+0
	120.000	315.000	–200	+0	–50	+0
	315.000	500.000	–250	+0	–50	+0
	500.000	630.000	–250	+0	–	–
	630.000	1200.000	–300	+0	–	–
	1200.000	–	–350	+0	–	–

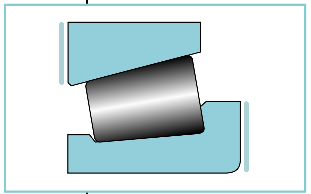
CUP WIDTH TOLERANCES, micrometers



Bearing types	O.D. range, mm over	incl.	Class K Min	Max	Class N Min	Max
Single and double cups	18.000	80.000	–150	+0	–100	+0
	80.000	180.000	–200	+0	–100	+0
	180.000	400.000	–250	+0	–100	+0
	400.000	500.000	–300	+0	–100	+0
	500.000	800.000	–300	+0	–	–
	800.000	1200.000	–350	+0	–	–
	1200.000	–	–400	+0	–	–

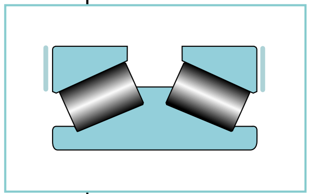
Metric bearing tolerances

OVERALL BEARING WIDTH (T) TOLERANCES, micrometers

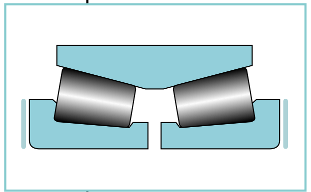


Bearing types	Bore range, mm over	incl.	Class K Min	Class K Max	Class N Min	Class N Max
TS	10.000	80.000	0	+200	0	+100
	80.000	120.000	–200	+200	0	+100
	120.000	250.000	–250	+350	0	+150
	250.000	315.000	–250	+350	0	+200
	315.000	500.000	–400	+400	0	+200
	500.000	800.000	–400	+400	–	–
	800.000	–	–450	+450	–	–

OVERALL BEARING WIDTH (T) TOLERANCES, micrometers



Bearing types	Bore range, mm over	incl.	Class K Min	Class K Max	Class N Min	Class N Max
TDI	10.000	50.000	–100	+400	–50	+200
	50.000	80.000	–150	+400	–50	+200
	80.000	120.000	–550	+400	–50	+200
	120.000	250.000	–600	+400	–50	+300
	250.000	315.000	–600	+400	–50	+400
	315.000	400.000	–650	+400	–50	+400
	400.000	500.000	–850	+500	–50	+400
	500.000	630.000	–850	+500	–	–
	630.000	800.000	–900	+500	–	–
	800.000	1000.000	–900	+600	–	–
	1000.000	1200.000	–1000	+600	–	–
	1200.000	–	–1150	+700	–	–



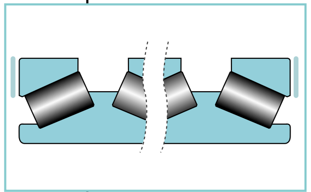
Metric bearing tolerances

OVERALL BEARING WIDTH (T) TOLERANCES, micrometers

Bearing types	Bore range, mm		Cup O.D. range, mm		Class K		Class N	
	over	incl.	over	incl.	Min	Max	Min	Max
TDO	10.000	80.000	18.000	80.000	–150	+400	–100	+200
			80.000	180.000	–200	+400	–100	+200
	80.000	120.000	80.000	180.000	–600	+400	–100	+200
			180.000	400.000	–650	+400	–100	+200
	120.000	250.000	120.000	180.000	–600	+400	–100	+300
			180.000	400.000	–650	+400	–100	+300
			400.000	500.000	–700	+400	–100	+300
	250.000	400.000	250.000	400.000	–650	+400	–100	+400
			400.000	500.000	–700	+400	–100	+400
			500.000	800.000	–700	+400	–	–
	400.000	500.000	400.000	500.000	–900	+500	–100	+400
			500.000	800.000	–900	+500	–	–
			800.000	1200.000	–950	+500	–	–
	500.000	800.000	500.000	800.000	–900	+500	–	–
			800.000	1200.000	–950	+500	–	–
			1200.000	–	–1000	+500	–	–
	800.000	1000.000	800.000	1200.000	–950	+600	–	–
			1200.000	–	–1000	+600	–	–
	1000.000	1200.000	1000.000	1200.000	–1050	+600	–	–
			1200.000	–	–1100	+600	–	–
	1200.000	–	1200.000	–	–1200	+700	–	–

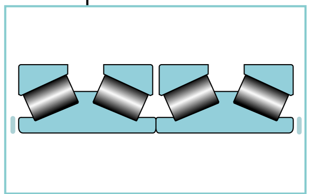
Metric bearing tolerances

OVERALL BEARING WIDTH (T) TOLERANCES, micrometers



Bore range		Bearing types	Class K		Class N		Bearing types	Class K		Class N	
			Min	Max	Min	Max		Min	Max	Min	Max
0.000	500.000	2TDIW	–800	+800	–800	+800	TQO SRNB	–1600	+1600	–1600	+1600
500.000	800.000		–800	+800	–	–		–1600	+1600	–	–
800.000	–		–900	+900	–	–		–1600	+1600	–	–

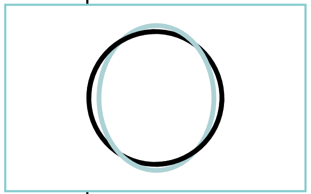
OVERALL CONE WIDTH (B) TOLERANCES FOR ASSEMBLIES WITH ABBUTING CONES, micrometers



Bearing types	Bore range, mm		Class K		Class N	
	over	Incl.	Min	Max	Min	Max
2TDIW	10.000	50.000	–200	+0	–100	+0
	50.000	120.000	–300	+0	–100	+0
	120.000	315.000	–400	+0	–100	+0
	315.000	500.000	–500	+0	–100	+0
	500.000	630.000	–500	+0	–	–
	630.000	1200.000	–600	+0	–	–
	1200.000	–	–700	+0	–	–

Tighter tolerances can nevertheless be provided on both cone and cup overall widths according to your needs. Overall bearing width tolerances do not take into account the tolerance on the BPL/BEP.

Metric bearing tolerances



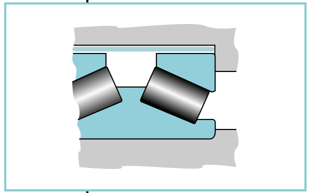
ASSEMBLED BEARING MAXIMUM RADIAL RUNOUT, micrometers

Bearing types	O.D. range, mm over	incl.	Class K	Class N	Class C	Class B
All bearing types		30	18	18	5	3
	30	50	20	20	6	3
	50	80	25	25	6	4
	80	120	35	35	6	4
	120	150	40	40	7	4
	150	180	45	45	8	4
	180	250	50	50	10	5
	250	265	60	60	11	5
	265	315	60	60	11	5
	315	400	70	70	13	–
	400	500	80	80	18	–
	500	630	100	–	25	–
	630	800	120	–	35	–
	800	1000	140	–	50	–
	1000	1200	160	–	60	–
	1200	1600	180	–	80	–
	1600	2000	200	–	–	–

Class C and B : mainly used on Z-mill bearings

Fitting guidelines for inch bearings - roll neck applications

Bearing classes 4 and 2

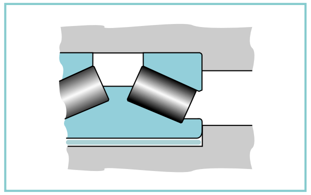


HOUSING BORE

Deviation from nominal (minimum) bearing O.D. and resultant fit, micrometers (inch)

O.D. range, mm (in)		Cup O.D. tolerance		Cup seat deviation	Resultant fit
Over	Incl.	Class 4	Class 2		
0 0	304.800 12.000	0 0	0 0	+51 +0.0020	26L 0.0010L
		+25 +0.0010	+25 +0.0010	+76 +0.0030	76L 0.0030L
304.800 12.000	609.600 24.000	0 0	0 0	+102 +0.0040	51L 0.0020L
		+51 +0.0020	+51 +0.0020	+152 +0.0060	152L 0.0060L
609.600 24.000	914.400 36.000	0 0	0 0	+152 +0.0060	76L 0.0030L
		+76 +0.0030	+76 +0.0030	+229 +0.0090	229L 0.0090L
914.400 36.000	1219.200 48.000	0 0	– –	+203 +0.0080	102L 0.0040L
		+102 +0.0040	– –	+305 +0.0120	305L 0.0120L
1219.200 48.000	1524.000 60.000	0 0	– –	+254 +0.0100	127L 0.0050L
		+127 0.0050	– –	+381 +0.0150	381L 0.0150L
1524.000 60.000		0 0	– –	+305 +0.0120	178L 0.0070L
		+127 0.0050	– –	+432 +0.0170	432L 0.0170L

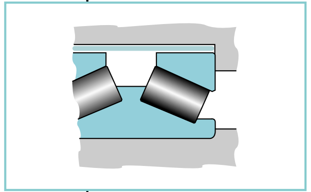
L = Loose



SHAFT O.D.

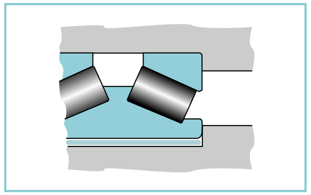
Deviation from nominal (minimum) bearing bore and resultant fit, micrometers (inch)

Bore range, mm (in)		Cone bore tolerance		Cone seat deviation	Resultant fit
Over	Incl.	Class 4	Class 2		
0 0	76.200 3.000	0 0	0 0	–51 –0.0020	51L 0.0020L
		+13 +0.0005	+13 +0.0005	–76 –0.0030	89L 0.0035L
76.200 3.000	101.600 4.000	0 0	0 0	–76 –0.0030	76L 0.0030L
		+25 +0.0010	+25 +0.0010	–102 –0.0040	127L 0.0050L
101.600 4.000	127.000 5.000	0 0	0 0	–102 –0.0040	102L 0.0040L
		+25 +0.0010	+25 +0.0010	–127 –0.0050	152L 0.0060L
127.000 5.000	152.400 6.000	0 0	0 00	–127 –0.0050	127L 0.0050L
		+25 +0.0010	+25 +0.0010	–152 –0.0060	177L 0.0070L
152.400 6.000	203.200 8.000	0 0	0 0	–152 –0.0060	152L 0.0060L
		+25 +0.0010	+25 +0.0010	–178 –0.0070	203L 0.0080L
203.200 8.000	304.800 12.000	0 0	0 0	–178 –0.0070	178L 0.0070L
		+25 +0.0010	+25 +0.0010	–203 –0.0080	228L 0.0090L
304.800 12.000	609.600 24.000	– –	0 0.0000	–203 –0.0080	203L 0.0080L
		– –	+51 +0.0020	–254 –0.0100	305L 0.0120L
609.600 24.000	914.400 36.000	0 0	– –	–254 –0.0100	254L 0.0100L
		+76 +0.0030	– –	–330 –0.0130	406L 0.0160L
914.400 36.000	1219.200 48.000	0 0	– –	–305 –0.0120	305L 0.0120L
		+102 +0.0040	– –	–406 –0.0160	508L 0.0200L
1219.200 48.000		0 0	– –	–305 –0.0120	305L 0.0120L
		+127 +0.0050	– –	–432 –0.0170	559L 0.0220L



Fitting guidelines for metric bearings - roll neck applications

Bearing classes K and N



HOUSING BORE

Deviation from nominal (maximum) bearing O.D. and resultant fit, micrometers

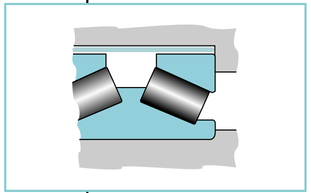
O.D. range, mm		Cup O.D. tolerance		Cup seat deviation		Resultant fit
Over	Incl.	Class K	Class N			
30.000	50.000	–14 0	–14 0	F6	+41 +25	55L 25L
50.000	80.000	–16 0	–16 0	F6	+49 +30	65L 30L
80.000	120.000	–18 0	–18 0	F6	+58 +36	76L 36L
120.000	150.000	–20 0	–20 0	F6	+68 +43	88L 43L
150.000	180.000	–25 0	–25 0	F6	+68 +43	93L 43L
180.000	250.000	–30 0	–30 0	F6	+79 +50	109L 50L
250.000	315.000	–35 0	–35 0	F6	+88 +56	123L 56L
315.000	400.000	–40 0	–40 0	F7	+119 +62	159L 62L
400.000	500.000	–45 0	–45 0	F7	+131 +68	176L 68L
500.000	630.000	–50 0	–50 0	F7	+146 +76	196L 76L
630.000	800.000	–80 0	– –	F7	+160 +80	240L 80L
800.000	1000.000	–100 0	– –	F7	+176 +86	276L 86L
1000.000	1200.000	–130 0	– –	F7	+203 +98	333L 98L
1200.000	1250.000	–165 0	– –	F7	+203 +98	368L 98L
1250.000	1600.000	–165 0	– –	F7	+235 +110	400L 110L
1600.000	2000.000	–200 0	– –	F7	+270 +120	470L 120L

SHAFT O.D.

Deviation from nominal (maximum) bearing bore and resultant fit, micrometers

Bore range, mm		Cone bore tolerance		Cone seat deviation		Resultant fit
Over	Incl.	Class K	Class N			
30.000	50.000	–12 0	–12 0	e7	–50 –75	38L 75L
50.000	80.000	–15 0	–15 0	e7	–60 –90	45L 90L
80.000	120.000	–20 0	–20 0	d7	–120 –155	100L 155L
120.000	180.000	–25 0	–25 0	d7	–145 –185	120L 185L
180.000	250.000	–30 0	–30 0	d7	–170 –216	140L 216L
250.000	315.000	–35 0	–35 0	d7	–190 –242	155L 242L
315.000	400.000	–40 0	–40 0	d7	–210 –267	170L 267L
400.000	500.000	–45 0	–45 0	d7	–230 –293	185L 293L
500.000	630.000	–50 0	– –	d7	–260 –330	210L 330L
630.000	800.000	–80 0	– –	quality 7	–320 –400	240L 400L
800.000	1000.000	–100 0	– –	quality 7	–360 –450	260L 450L
1000.000	1200.000	–130 0	– –	quality 7	–425 –530	295L 530L
1200.000	1250.000	–150 0	– –	quality 7	–425 –530	275L 530L
1250.000	1600.000	-150 0	– –	quality 7	–475 –600	325L 600L

L = Loose



Fitting guidelines for inch bearings - Industrial equipment

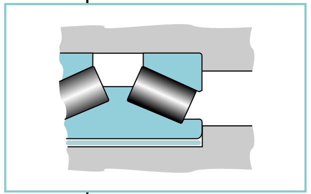
Bearing classes 4 and 2

HOUSING BORE

Deviation from nominal (minimum) bearing O.D. and resultant fit, micrometers (inch)

O.D. range, mm (in)		Cup O.D. tolerances, µm (in)		Stationary housing Floating or clamped race		Stationary housing Adjustable race		Stationary or rotating housing Non-adjustable race or in carrier or sheave - clamped race		Rotating housing Sheave - unclamped race	
over	incl.	Class 4	Class 2	Cup seat deviation	Resultant fit	Cup seat deviation	Resultant fit	Cup seat deviation	Resultant fit	Cup seat deviation	Resultant fit
0 0	76.200 3.000	0 0	0 0	+51 +0.0020	26L 0.0010L	0 +0	25T 0.0010T	−38 −0.0015	63T 0.0025T	−76 −0.0030	101T 0.0040T
		+25 +0.0010	+25 +0.0010	+76 +0.0030	76L 0.0030L	+25 +0.0010	25L 0.0010L	−13 −0.0005	13T 0.0005T	−51 −0.0020	51T 0.0020T
76.200 3.000	127.000 5.000	0 0	0 0	+51 +0.0020	26L 0.0010L	0 0	25T 0.0010T	−51 −0.0020	76T 0.0030T	−76 −0.0030	101T 0.0040T
		+25 +0.0010	+25 +0.0010	+76 +0.0030	76L 0.0030L	+25 +0.0010	25L 0.0010L	−25 −0.0010	25T 0.0010T	−51 −0.0020	51T 0.0020T
127.000 5.000	304.800 12.000	0 0	0 0	+51 +0.0020	26L 0.0010L	0 0	25T 0.0010T	−51 −0.0020	76T 0.0030T	−76 −0.0030	101T 0.0040T
		+25 +0.0010	+25 +0.0010	+76 +0.0030	76L 0.0030L	+51 +0.0020	51L 0.0020L	−25 −0.0010	25T 0.0010T	−51 −0.0020	51T 0.0020T
304.800 12.000	609.600 24.000	0 0	0 0	+102 +0.0040	51L 0.0020L	+26 +0.0010	25T 0.0010T	−76 −0.0030	127T 0.0050T	−102 −0.0040	153T 0.0060T
		+51 +0.0020	+51 +0.0020	+152 +0.0060	152L 0.0060L	+76 +0.0030	76L 0.0030L	−25 −0.0010	25T 0.0010T	−51 −0.0020	51T 0.0020T
609.600 24.000	914.400 36.000	0 0	0 0	+152 +0.0060	76L 0.0030L	+51 +0.0020	25T 0.0010T	−102 −0.0040	178T 0.0070T	−127 −0.0050	203T 0.0080T
		+76 +0.0030	+76 +0.0030	+229 +0.0090	229L 0.0090L	+127 +0.0050	127L 0.0050L	−25 −0.0010	25T 0.0010T	−51 −0.0020	51T 0.0020T
914.400 36.000	1219.200 48.000	0 0	– –	+204 +0.0080	102L 0.0040L	+76 +0.0030	25T 0.0010T	−127 −0.0050	229T 0.0090T	−153 −0.0060	255T 0.0100T
		+102 +0.0040	– –	+305 +0.0120	305L 0.0120L	+178 +0.0070	178L 0.0070L	−25 −0.0010	25T 0.0010T	−51 −0.0020	51T 0.0020T
1219.200 48.000	– –	0 0	– –	+254 +0.0100	127L 0.0050L	+102 +0.0040	25T 0.0010T	−152 −0.0060	279T 0.0110T	−178 −0.0070	305T 0.0120T
		+127 +0.0050	– –	+381 +0.0150	381L 0.0150L	+229 +0.0090L	229L 0.0090L	−25 −0.0010	25T 0.0010T	−51 −0.0020	51T 0.0020T

L = Loose T = Tight



Fitting guidelines for inch bearings - Industrial equipment

Bearing classes 4 and 2

SHAFT O.D.

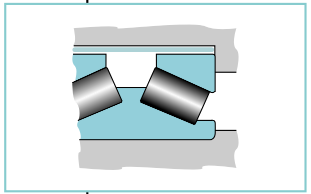
Deviation from nominal (minimum) bearing bore and resultant fit, micrometers

Range mm		Cone bore Tolerance µm Class 4		Cone bore Tolerance µm Class 2		Rotating shaft Ground constant loads with moderate shock Cone seat deviation		Rotating shaft Resultant fit		Rotating or stationary shaft Unground or ground heavy loads, high speed or shock Cone seat deviation		Rotating or stationary shaft Resultant fit	
over	incl.	Min	Max	Min	Max	Min	Max			Min	Max		
0	76,2	0	+13	0	+13	+25	+38	12T	38T	+38	+64	25T	64T
76,2	88,9									+38	+64	13T	64T
88,9	114,3									+51	+76	25T	76T
114,3	139,7									+64	+89	38T	89T
139,7	165,1									+76	+102	51T	102T
165,1	190,5	0	+25	0	+25	+38	+64	13T	64T	+89	+114	64T	114T
190,5	215,9									+102	+127	76T	127T
215,9	241,3									+114	+140	89T	140T
241,3	266,7									+127	+152	102T	152T
266,7	292,1									+140	+165	114T	165T
292,1	304,8									+152	+178	127T	178T
304,8	317,5									+152	+203	101T	203T
317,5	342,9									+165	+216	114T	216T
342,9	368,3									+178	+229	127T	229T
368,3	393,7									+190	+241	139T	241T
393,7	419,1									+203	+254	152T	254T
419,1	444,5	–	–	0	+51	+76	+127	127T	25T	+216	+267	165T	267T
444,5	469,9									+229	+279	178T	279T
469,9	495,3									+241	+292	190T	292T
495,3	520,7									+254	+305	203T	305T
520,7	546,1									+267	+318	216T	318T
546,1	571,5									+279	+330	228T	330T
571,5	596,9									+292	+343	241T	343T
596,9	609,6									+305	+356	254T	356T
609,6	914,4	0	+76	–	–	+114	+190	38T	190T	+305	+381	229T	381T
914,4	1219,2	0	+102	–	–	+150	+252	48T	252T	+305	+406	203T	406T
1219,2	–	0	+127	–	–	+178	+305	51T	305T	+305	+431	178T	431T

Deviation from nominal (minimum) bearing bore and resultant fit, inch

Range in		Cone bore Tolerance in Class 4		Cone bore Tolerance in Class 2		Rotating shaft Ground constant loads with moderate shock Cone seat deviation		Rotating shaft Resultant fit		Rotating or stationary shaft Unground or ground heavy loads, high speed or shock Cone seat deviation		Rotating or stationary shaft Resultant fit	
over	incl.	Min	Max	Min	Max	Min	Max			Min	Max		
0	3.0000	0	+0.0005	0	+0.0005	+0.0010	+0.0015	0.0005T	0.0015T	+0.0015	+0.0025	0.0010T	0.0025T
3.0000	3.5000									+0.0015	+0.0025	0.0005T	0.0025T
3.5000	4.5000									+0.0020	+0.0030	0.0010T	0.0030T
4.5000	5.5000									+0.0025	+0.0035	0.0015T	0.0035T
5.5000	6.5000									+0.0030	+0.0040	0.0020T	0.0040T
6.5000	7.5000	0	+0.0010	0	+0.0010	+0.0015	+0.0025	0.0005T	0.0025T	+0.0035	+0.0045	0.0025T	0.0045T
7.5000	8.5000									+0.0040	+0.0050	0.0030T	0.0050T
8.5000	9.5000									+0.0045	+0.0055	0.0035T	0.0055T
9.5000	10.5000									+0.0050	+0.0060	0.0040T	0.0060T
10.5000	11.5000									+0.0055	+0.0065	0.0045T	0.0065T
11.5000	12.0000									+0.0060	+0.0070	0.0050T	0.0070T
12.0000	12.5000									+0.0060	+0.0080	0.0040T	0.0080T
12.5000	13.5000									+0.0065	+0.0085	0.0045T	0.0085T
13.5000	14.5000									+0.0070	+0.0090	0.0050T	0.0090T
14.5000	15.5000									+0.0075	+0.0095	0.0055T	0.0095T
15.5000	16.5000									+0.0080	+0.0100	0.0060T	0.0100T
16.5000	17.5000	–	–	0	+0.0020	+0.0030	+0.0050	0.0010T	0.0050T	+0.0085	+0.0105	0.0065T	0.0105T
17.5000	18.5000									+0.0090	+0.0110	0.0070T	0.0110T
18.5000	19.5000									+0.0095	+0.0115	0.0075T	0.0115T
19.5000	20.5000									+0.0100	+0.0120	0.0080T	0.0120T
20.5000	21.5000									+0.0105	+0.0125	0.0085T	0.0125T
21.5000	22.5000									+0.0110	+0.0130	0.0090T	0.0130T
22.5000	23.5000									+0.0115	+0.0135	0.0095T	0.0135T
23.5000	24.0000									+0.0120	+0.0140	0.0100T	0.0140T
24.0000	36.0000	0	+0.0030	–	–	+0.0045	+0.0075	0.0015T	0.0075T	+0.0120	+0.0150	0.0090T	0.0150T
36.0000	48.0000	0	+0.0040	–	–	+0.0060	+0.0100	0.0020T	0.0100T	+0.0120	+0.0160	0.0080T	0.0160T
48.0000		0	+0.0050	–	–	+0.0070	+0.0120	0.0020T	0.0120T	+0.0120	+0.0170	0.0070T	0.0170T

T = Tight



Fitting guidelines for metric bearings - industrial equipment

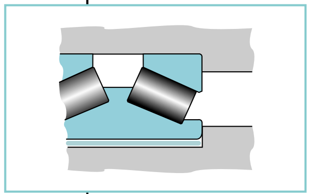
Bearing classes K and N

HOUSING BORE

Deviation from nominal (maximum) bearing O.D. and resultant fit, micrometers

Cup O.D. Range mm		Cup O.D. Tolerance µm				Stationary housing – Floating or clamped race				Stationary housing – Adjustable race				Stationary housing – Non-adjustable race or in carrier				Rotating housing – Non-adjustable race or in carrier or sheave - clamped race			
		Class K		Class N		Cup seat deviation			Resultant fit	Cup seat deviation			Resultant fit	Cup seat deviation			Resultant fit	Cup seat deviation			Resultant fit
over	incl.	Min	Max	Min	Max		Min	Max			Min	Max			Min	Max			Min	Max	
18	30	-12	0	–12	0	G7	+7	+28	40L 7L	J7	–9	+12	24L 9T	P7	–35	–14	2T 35T	R7	–41	–20	8T 41T
30	50	–14	0	–14	0	G7	+9	+34	48L 9L	J7	–11	+14	28L 11T	P7	–42	–17	3T 42T	R7	–50	–25	11T 50T
50	65	–16	0	–16	0	G7	+10	+40	56L 10L	J7	–12	+18	34L 12T	P7	–51	–21	5T 51T	R7	–60	–30	14T 60T
65	80																		–62	–32	16T 62T
80	100	–18	0	–18	0	G7	+12	+47	65L 12L	J7	–13	+22	40L 13T	P7	–59	–24	6T 59T	R7	–73	–38	20T 73T
100	120																		–76	–41	23T 76T
120	140	–20	0	–20	0	G7	+14	+54	74L 14L	J7	–14	+26	46L 14T	P7	–68	–28	8T 68T	R7	–88	–48	28T 88T
140	150																		–90	–50	30T 90T
150	160	–25	0	–25	0	G7	+14	+54	79L 14L	J7	–14	+26	51L 14T	P7	–68	–28	3T 68T	R7	–90	–50	25T 90T
160	180																		–93	–53	28T 93T
180	200	–30	0	–30	0	G7	+15	+61	91L 15L	J7	–16	+30	60L 16T	P7	–79	–33	3T 79T	R7	–106	–60	30T 106T
200	225																		–109	–63	33T 109T
225	250																		–113	–67	37T 113T
250	280	–35	0	–35	0	G7	+17	+69	104L 17L	J7	–16	+36	71L 16T	P7	–88	–36	1T 88T	R7	–126	–74	39T 126T
280	315																		–130	–78	43T 130T
315	355	–40	0	–40	0	F7	+62	+119	159L 62L	J7	–18	+39	79L 18T	P7	–98	–41	1T 98T	R7	–144	–87	47T 144T
355	400																		–150	–93	53T 150T
400	450	–45	0	–45	0	F7	+68	+131	176L 68L	J7	–20	+43	88L 20T	P7	–108	–45	0 108T	R7	–166	–103	58T 166T
450	500																		–172	–109	64T 172T
500	560	–50	0	–50	0	F7	+76	+146	196L 76L	JS7	–35	+35	85L 35T	P7	–148	–78	28T 148T	R7	–220	–150	100T 220T
560	630																		–225	–155	105T 225T
630	710	–80	0	–	–	F7	+80	+160	240L 80L	JS7	–40	+40	120L 40T	P7	–168	–88	8T 168T	R7	–255	–175	95T 255T
710	800																		–265	–185	105T 265T
800	900	–100	0	–	–	F7	+86	+176	276L 86L	JS7	–45	+45	145L 45T	P7	–190	–100	0T 190T	R7	–300	–210	110T 300T
900	1000																		–310	–220	120T 310T

L = Loose T = Tight



Fitting guidelines for metric bearings - industrial equipment

Bearing classes K and N

SHAFT O.D.

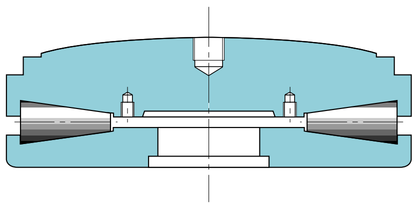
Deviation from nominal (maximum) bearing bore and resultant fit micrometers

Cone bore						Rotating shaft Ground Constant loads with moderate shock					Rotating or stationary shaft Unground or ground Heavy loads, high speed or shock				
Range mm		Tolerance µm				Cone seat deviation			Resultant fit		Cone seat deviation			Resultant fit	
		Class K		Class N											
over	incl.	Min	Max	Min	Max		Min	Max	Min	Max		Min	Max	Min	Max
10	18	-12	0	-12	0	m6	+7	+18	7T	30T	n6	+12	+23	12T	35T
18	30	-12	0	-12	0	m6	+8	+21	8T	33T	n6	+15	+28	15T	40T
30	50	-12	0	-12	0	m6	+9	+25	9T	37T	n6	+17	+33	17T	45T
50	80	-15	0	-15	0	m6	+11	+30	11T	45T	n6	+20	+39	20T	54T
80	120	-20	0	-20	0	m6	+13	+35	13T	55T	n6	+23	+45	23T	65T
120	180	-25	0	-25	0	m6	+15	+40	15T	65T	p6	+43	+68	43T	93T
180	200	-30	0	-30	0	m6	+17	+46	17T	76T	r6	+77	+106	77T	136T
200	225											+80	+109	80T	139T
225	250											+84	+113	84T	143T
250	280	-35	0	-35	0	m6	+20	+52	20T	87T	r6	+94	+126	94T	161T
280	315											+98	+130	98T	165T
315	355	-40	0	-40	0	n6	+37	+73	37T	113T	r6	+108	+144	108T	184T
355	400											+114	+150	114T	190T
400	450	-45	0	-45	0	n6	+40	+80	40T	125T	r6	+126	+166	126T	211T
450	500											+132	+172	132T	217T
500	560	-50	0	-	-	n6	+44	+88	44T	138T	r6	+150	+194	150T	244T
560	630											+155	+199	155T	249T
630	710	-80	0	-	-	n7	+50	+130	50T	210T	r7	+175	+255	175T	335T
710	800											+185	+265	185T	345T
800	900	-100	0	-	-	n7	+56	+146	56T	246T	r7	+210	+300	210T	400T
900	1000											+220	+310	220T	410T

T = Tight

TTHDSX / TTHDSV

"Mainly used on rolling mill screw down systems"



General information

- other configurations, with inner flat races on the bottom ring are/can be made,
- for TTHD with flat top surface, please refer to our Tapered roller bearing guide.
- TTHD bearings can be supplied with or without a cage.

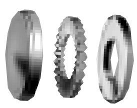


Fig. 1 : TTHDSX

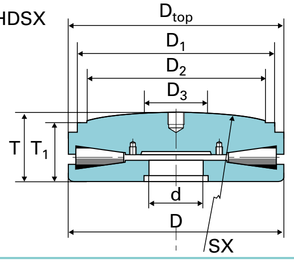
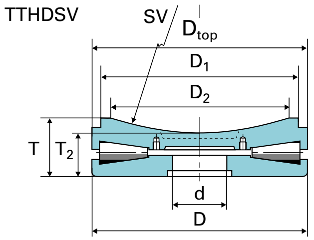


Fig. 2 : TTHDSV



Notes :

Other types of TTHD thrust bearings are shown in our Tapered roller bearing guide,

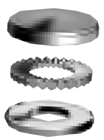
Any other size can be considered to fit your design requirements,

no bore in bottom race.

TTHDSX - TTHDSV

Dimensions, mm (in)						Ratings, N (lbf)	Dimensions, mm (in)					Mass kg (lb)	Bearing series
d	Bottom race D	Top race D_{top}	T	T_1	T_2	C axial	D_1	D_2	D_3	Figure 1 SX	Figure 2 SV		
76.200 3.0000	161.925 6.3750	161.925 6.3750	49.212 1.9375	55.580 2.1882		1250000 281000	161.920 6.3748	127.000 5.0000	31.750 1.2500	457.200 18.0000		7 14	**T311**
76.200 3.0000	215.900 8.5000	215.900 8.5000	65.088 2.5625	74.630 2.9382		2160000 485000	203.200 8.0000	171.450 6.7500	50.800 2.0000	508.000 20.0000		17 36	**T411**
101.600 4.0000	266.700 10.5000	266.700 10.5000	79.375 3.1250	92.080 3.6252		3260000 730000	247.650 9.7500	215.900 8.5000	63.500 2.5000	609.600 24.0000		31 68	**T511**
127.000 5.0000	266.700 10.5000	266.700 10.5000	79.375 3.1250	92.080 3.6252		3260000 730000	247.650 9.7500	215.900 8.5000	63.500 2.5000	609.600 24.0000		30 66	**T511**
101.600 4.0000	266.700 10.5000	266.700 10.5000	79.375 3.1250		65.890 2.5941	3260000 730000	247.650 9.7500	228.600 9.0000	76.200 3.0000		609.600 24.0000	26 57	**T511**
#	317.500 12.5000	317.500 12.5000	87.312 3.4375	98.420 3.8748		4750000 1060000	292.100 11.5000	228.600 9.0000	76.200 3.0000	762.000 30.0000		48 106	**T611**
152.400 6.0000	317.500 12.5000	317.500 12.5000	87.312 3.4375	100.030 3.9382		4750000 1060000	292.100 11.5000	228.600 9.0000	76.200 3.0000	711.200 28.0000		44 97	**T611**
152.400 6.0000	317.500 12.5000	317.500 12.5000	87.312 3.4375	98.420 3.8748		4750000 1060000	292.100 11.5000	228.600 9.0000	76.200 3.0000	762.000 30.0000		44 97	**T611**
152.400 6.0000	317.500 12.5000	317.500 12.5000	87.312 3.4375	98.420 3.8748		4750000 1060000	292.100 11.5000	228.600 9.0000	76.200 3.0000	755.650 29.7500		46 101	**T611**
#	368.300 14.5000	368.300 14.5000	104.775 4.1250		84.120 3.3118	6350000 1430000		292.100 11.5000	152.400 6.0000		622.300 24.5000	73 161	**T711**
177.800 7.0000	368.300 14.5000	368.300 14.5000	104.775 4.1250		85.720 3.3748	6350000 1430000		292.100 11.5000	152.400 6.0000		622.300 24.5000	67 147	**T711**
177.800 7.0000	368.300 14.5000	368.300 14.5000	101.600 4.0000	120.650 4.7500		6350000 1430000		298.450 11.7500	101.600 4.0000	762.000 30.0000		75 165	**T711**
#	419.100 16.5000	412.750 16.2500	123.825 4.8750		90.470 3.5618	8100000 1820000		342.900 13.5000	177.800 7.0000		508.000 20.0000	104 229	**T811**
203.200 8.0000	419.100 16.5000	412.750 16.2500	115.888 4.5625	136.570 5.3768		8100000 1820000	388.920 15.3118	342.900 13.5000	114.300 4.5000	838.700 33.0197		106 233	**T811**
203.200 8.0000	419.100 16.5000	419.100 16.5000	123.825 4.8750		90.470 3.5618	8100000 1820000	388.920 15.3118	342.900 13.5000	177.800 7.0000		508.000 20.0000	92 202	**T811**
#	482.600 19.0000	482.600 19.0000	150.622 5.9300	171.250 6.7421		11050000 2480000	457.200 18.0000	419.100 16.5000	152.400 6.0000	1295.400 51.0000		203 447	**T9030**
168.275 6.6250	482.600 19.0000	482.600 19.0000	131.762 5.1875	152.400 6.0000		11050000 2480000	457.200 18.0000	419.100 16.5000	152.400 6.0000	1295.400 51.0000		168 370	**T9030**
168.275 6.6250	482.600 19.0000	482.600 19.0000	131.762 5.1875	158.750 6.2500		11050000 2480000	457.200 18.0000	419.100 16.5000	152.400 6.0000	1066.800 42.0000		168 370	**T9030**

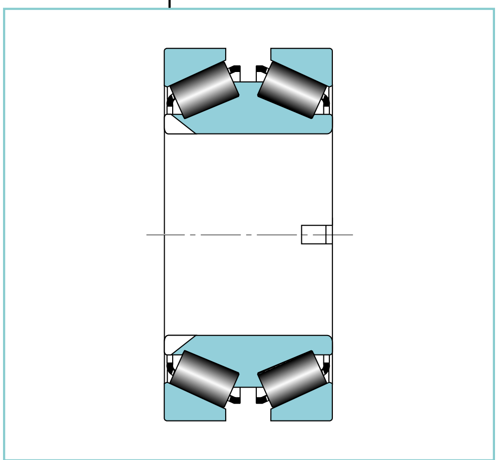
	Dimensions, mm (in)						Ratings, N (lbf)	Dimensions, mm (in)					Mass kg (lb)	Bearing series
	d	Bottom race D	Top race D_{top}	T	T_1	T_2	C axial	D_1	D_2	D_3	Figure 1 SX	Figure 2 SV		
	#	482.600 19.0000	482.600 19.0000	166.000 6.5354		126.210 4.9689	11050000 2480000		428.620 16.8748	203.200 8.0000		635.000 25.0000	194 427	T9030
	168.275 6.6250	482.600 19.0000	482.600 19.0000	146.050 5.7500		106.380 4.1882	13900000 3130000		428.620 16.8748	177.800 7.0000		635.000 25.0000	162 356	EX9440
	228.600 9.0000	482.600 19.0000	482.600 19.0000	131.762 5.1875	152.400 6.0000		10850000 2440000	457.200 18.0000	419.100 16.5000	177.800 7.0000	1295.400 51.0000		164 361	T911
	228.600 9.0000	482.600 19.0000	482.600 19.0000	146.050 5.7500		106.380 4.1882	10850000 2440000		428.620 16.8748	203.200 8.0000		635.000 25.0000	148 326	T911
	228.600 9.0000	482.600 19.0000	482.600 19.0000	114.300 4.5000	152.400 6.0000		10850000 2440000		444.500 17.5000	152.400 6.0000	895.350 35.2500		169 372	T911
	254.000 10.0000	539.750 21.2500	539.750 21.2500	158.750 6.2500		122.240 4.8126	13750000 3090000		406.400 16.0000	203.200 8.0000		635.000 25.0000	218 480	T1011
	254.000 10.0000	539.750 21.2500	539.750 21.2500	158.750 6.2500		117.480 4.6252	13750000 3090000	495.300 19.5000	434.980 17.1252	203.200 8.0000		635.000 25.0000	199 438	T1011
	254.000 10.0000	539.750 21.2500	539.750 21.2500	158.750 6.2500		117.480 4.6252	13750000 3090000	495.300 19.5000	434.980 17.1252	203.200 8.0000		635.000 25.0000	199 438	T1011
	254.000 10.0000	539.750 21.2500	539.750 21.2500	149.225 5.8750	174.620 6.8748		13750000 3090000	508.000 20.0000	447.680 17.6252	127.000 5.0000	1066.800 42.0000		226 497	T1011
	234.950 9.2500	546.100 21.5000	546.100 21.5000	171.450 6.7500		111.120 4.3748	16050000 3600000	508.000 20.0000	431.800 17.0000	203.200 8.0000		558.800 22.0000	257 565	T9250
	139.700 5.5000	546.100 21.5000	549.275 21.6250	155.575 6.1250	179.370 7.0618		16050000 3600000	508.000 20.0000	457.200 18.0000	152.400 6.0000	1295.400 51.0000		266 585	T9250
	139.700 5.5000	546.100 21.5000	549.275 21.6250	155.575 6.1250	179.370 7.0618		16050000 3600000	508.000 20.0000	457.200 18.0000	152.400 6.0000	1295.400 51.0000		265 583	T9250
	234.950 9.2500	546.100 21.5000	549.275 21.6250	155.575 6.1250	179.370 7.0618		16050000 3600000	508.000 20.0000	457.200 18.0000	152.400 6.0000	1295.400 51.0000		253 557	T9250
	234.950 9.2500	546.100 21.5000	546.100 21.5000	168.275 6.6250		124.610 4.9059	16050000 3600000	520.700 20.5000	457.200 18.0000	203.200 8.0000		641.350 25.2500	222 488	T9250
	279.400 11.0000	603.250 23.7500	603.250 23.7500	161.925 6.3750	187.320 7.3748		17950000 4050000	571.500 22.5000	482.600 19.0000	152.400 6.0000	1308.100 51.5000		308 678	T1120
	168.275 6.6250	635.000 25.0000	638.175 25.1250	177.800 7.0000	206.380 8.1252		22600000 5100000	596.500 23.4843	508.000 20.0000	177.800 7.0000	1422.400 56.0000		*	T8920
	431.800 17.0000	939.800 37.0000	942.975 37.1250	260.350 10.2500	304.800 12.0000		44400000 9950000	714.400 28.1260	762.000 30.0000	254.000 10.0000	2000.250 78.7500		1260 2772	T17020
	304.800 12.0000	1143.000 45.0000	1146.175 45.1250	317.500 12.5000	393.700 15.5000		73000000 16500000	999.600 39.3543	999.600 39.3543	304.800 12.0000	2000.250 78.7500		2532 5570	T12040



TIMKEN

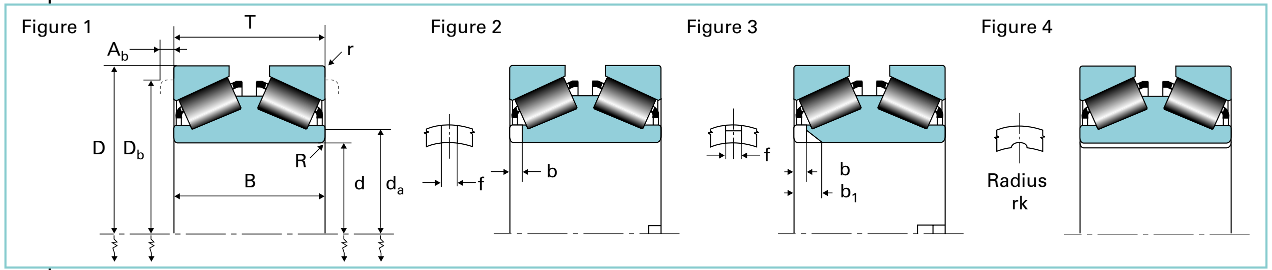
TDIK

"Used on axial positions for work rolls when the axial loads are high, or on back-up roll thrust positions if required".



General information

R	Shaft maximum fillet radius,
d_a	Shaft shoulder diameter,
r	Housing maximum radius,
D_b	Housing shoulder diameter to be used also for cage clearance,
A_b	Axial cage clearance,
Cage	S = Stamped ; P = Pin type,
Key way	Note that for fig. 3, "b" can be equal to zero,
Usage	BUR = more likely as a morgoil thrust bearing on a back-up roll, WR = more likely as a work roll axial bearing.



Notes :

All series can be provided with an integrated spring system in the cups,

Any other size can be considered to fit your design requirements,

† dimension indicated is maximum value,

* contact your Timken sales engineer,

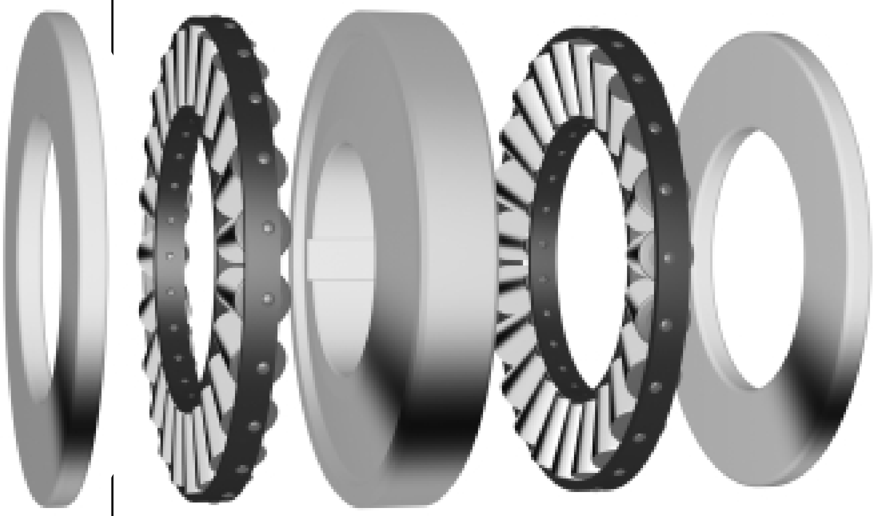
A_b contact your Timken sales engineer.

TDIK

for axial positions

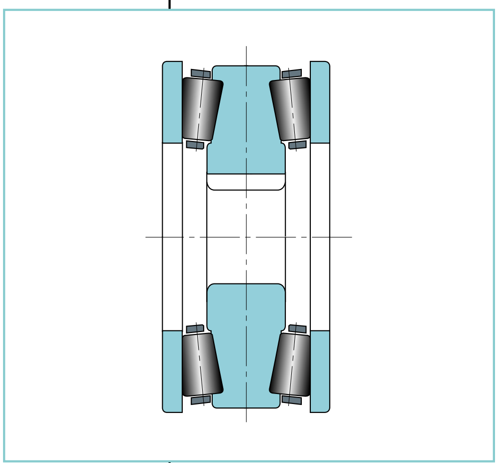
Dimensions, mm (in)				Ratings, N (lbf) 1 million revolutions			90 million revolutions			Static axial	Dimensions, mm (in)				Cage	Dimensions, mm (in) Keyway				Mass kg (lb)	Bearing series	Common usage	Figure
d	D	T	B	$C_{1(1)}$	e	Y	C_{a90}	$C_{90(1)}$	K	C_{a0}	R	d_a	r	D_b		f	b	b_1	rk				
63.500 2.5000	140.030 5.5130	66.090 2.6020	65.989 2.5980	158000 35600	0.87	0.69	60900 13700	41100 9230	0.67	487000 109000	2.3 0.09	78.9 3.11	2.3 0.09	117.0 4.61	S					5 10	**78000**	WR	1
127.000 5.0000	228.600 9.0000	160.338 6.3125	151.244 5.9545	348000 78300	0.74	0.81	114000 25600	90200 20300	0.79	1040000 235000	1.5 0.06	144.0 5.67	3.3 0.13	197.0 7.76	S					22 49	**97000**	WR	1
†160.000 6.2992	343.000 13.5039	160.000 6.2992	160.000 6.2992	960400 215800	0.55	0.74	345000 77500	249000 56000	0.72	3310000 743800	3.3 0.13	190.0 7.48	3.3 0.13	280.0 11.02	S	30.00 1.181		25.00 0.984		*	**H936300**	WR	3
215.900 8.5000	330.200 13.0000	193.675 7.6250	193.675 7.6250	685000 154000	0.55	1.09	168000 37700	178000 39900	1.06	2140000 482000	3.3 0.13	238.0 9.37	3.3 0.13	300.0 11.81	S					53 116	**9900**	WR	1
215.900 8.5000	355.600 14.0000	127.000 5.0000	130.175 5.1250	703000 158000	0.59	1.02	184000 41400	182000 41000	0.99	2440000 548000	6.4 0.25	249.0 9.80	3.3 0.13	318.0 12.52	S					50 110	**96000**	WR	1
228.600 9.0000	431.800 17.0000	158.750 6.2500	158.750 6.2500	1090000 245000	0.88	0.68	427000 96000	282000 63500	0.66	4130000 929000	6.4 0.25	271.5 10.69	6.4 0.25	375.0 14.76	P					102 225	**113000**	WR	1
260.350 10.2500	419.100 16.5000	158.750 6.2500	155.575 6.1250	1100000 248000	0.6	0.99	296000 66500	286000 64200	0.97	3540000 795000	3.3 0.13	289.0 11.38	3.3 0.13	376.0 14.80	S					80 176	**435000**	WR	1
260.350 10.2500	444.500 17.5000	196.850 7.7500	196.850 7.7500	1580000 355000	0.55	1.10	383000 86100	410000 92100	1.07	4250000 956000	6.4 0.25	295.5 11.63	3.3 0.13	399.0 15.71	P					120 263	**823000**	WR	1
276.225 10.8750	381.000 15.0000	95.250 3.7500	88.900 3.5000	454000 102000	0.58	1.03	117000 26400	118000 26500	1.00	1600000 359000	3.3 0.13	297.0 11.69	3.3 0.13	354.0 13.94	S					29 65	**89000**	WR	1
†300.000 11.8110	†460.000 18.1102	180.000 7.0866	180.000 7.0866	1340000 300000	0.82	0.73	484000 109000	346000 77800	0.71	5970000 1340000	2.5 0.10	330.0 12.99	*	*	S	51.30 2.008	7.50 0.295	25.40 1.000	– –	* -	**HM957500**	WR	3
†300.000 11.8110	†480.000 18.8976	180.000 7.0866	180.000 7.0866	1340000 300000	0.82	0.73	484000 109000	346000 77800	0.71	5970000 1340000	2.5 0.10	330.0 12.99	4.1 0.16	427.0 16.81	S	51.30 2.008	7.50 0.295	25.40 1.000	– –	120 263	**HM957500**	WR	3
305.000 12.0079	559.948 22.0452	200.000 7.8740	169.977 6.6920	1570000 353000	1.09	0.55	760000 171000	407000 91500	0.54	8180000 1840000	3.3 0.13	348.5 13.72	2.0 0.08	479.0 18.86	P					205 451	**HM959300**	BUR	1
305.000 12.0079	559.867 22.0420	170.434 6.7100	169.977 6.6920	1520000 341000	0.87	0.69	583000 131000	393000 88400	0.67	6130000 1380000	3.3 0.13	346.0 13.62	1.5 0.06	485.0 19.09	P					171 377	**HM959600**	BUR	1
305.034 12.0092	559.816 22.0400	199.263 7.8450	200.000 7.8740	1470000 331000	1.09	0.55	713000 160000	382000 85900	0.54	7470000 1680000	3.3 0.13	348.0 13.70	3.3 0.13	478.0 18.82	S	50.80 2.000	25.40 1.000	39.67 1.562	– –	209 460	**HM959300**	BUR	3
305.034 12.0092	499.948 19.6830	200.025 7.8750	200.025 7.8750	1330000 299000	0.87	0.69	512000 115000	345000 77600	0.67	6410000 1440000	3.3 0.13	346.0 13.62	6.4 0.25	442.0 17.40	S	51.31 2.020	17.45 0.687	34.92 1.375	8.15 0.321	146 321	**HM959700**	BUR	3 & 4
317.754 12.5100	499.948 19.6830	200.025 7.8750	200.025 7.8750	1140000 257000	1.17	0.51	594000 134000	296000 66600	0.50	6440000 1450000	6.4 0.25	348.0 13.71	6.4 0.25	438.0 17.24	P					*	**M959400**	BUR	1
343,052 13,5060	457,098 17,9960	123,825 4,8750	122,238 4,8125	725000 163000	0,71	0,84	255000 57400	209000 47000	0,82	4020000 905000	1,5 0,06	361,95 14,25	3,3 0,13	423 16,65	S	* *	* *	* *	* *	55 122	**LM961500**	WR	1
365.608 14.3940	514.350 20.2500	140.000 5.5118	144.000 5.6693	987400 221900	0.74	0.81	324000 72800	256000 57500	0.79	4800000 1078700	2.5 0.10	389.9 15.35	4.1 0.16	468.1 18.43	S	40.00 1.575		20.00 0.787		91 200	*	WR	3

Dimensions, mm (in)				Ratings, N (lbf) 1 million revolutions			90 million revolutions			Static axial	Dimensions, mm (in)				Cage	Dimensions, mm (in) Keyway				Mass kg (lb)	Bearing series	Common usage	Figure
d	D	T	B	$C_{1(1)}$	e	Y	C_{a90}	$C_{90(1)}$	K	C_{a0}	R	d_a	r	D_b		f	b	b_1	rk				
†390.000 15.3543	570.000 22.4409	180.000 7.0866	180.000 7.0866	1730000 389000	0.73	0.82	561000 126000	448000 101000	0.80	8180000 1840000	2.0 0.08	421.0 16.57	6.4 0.25	513.0 20.20	S	32.00 1.260	11.70 0.461			154 339	**M966700**	WR	2
390.000 15,3543	570.000 22,4090	180.000 7,0866	180.000 7,0866	* *	1.27	0.47	* *	* *	0.46	* *	3,5 0,14	422.91 16,65	6.4 0,25	491 19,33	S	51.3 2,0197		20 0,7874		134 295	**LM966800**	WR	Spec.
†390.000 15.3543	570.000 22.4409	200.000 7.8740	200.000 7.8740	1730000 389000	0.73	0.82	561000 126000	448000 101000	0.80	8180000 1840000	2.0 0.08	421.0 16.57	6.4 0.25	513.0 20.20	S	32.00 1.260	11.70 0.461			165 363	**M966700**	WR	2
399.948 15.7460	649.834 25.5840	240.335 9.4620	240.000 9.4488	2150000 484000	0.92	0.65	879000 198000	559000 126000	0.64	12900000 2890000	3.0 0.12	456.0 17.95	6.0 0.24	573.0 22.56	S	64.29 2.531	19.05 0.750	44.45 1.750	11.25 0.443	314 691	**M969200**	BUR	3 & 4
400.000 15.7480	649.950 25.5886	199.263 7.8450	200.000 7.8740	1840000 413000	0.87	0.69	707000 159000	477000 107000	0.67	9090000 2040000	3.3 0.13	446.0 17.56	6.4 0.25	585.0 23.03	S					257 566	**M969800**	BUR	1
399.964 15.7466	649.950 25.5886	200.000 7.8740	200.000 7.8740	1970000 443000	0.87	0.69	757000 170000	511000 115000	0.67	10000000 2260000	3.3 0.13	446.0 17.56	6.4 0.25	585.0 23.03	P	50.80 2.000	19.05 0.750		11.28 0.444	257 566	**M969800**	BUR	2 & 4
431.800 17.0000	571.500 22.5000	136.525 5.3750	133.350 5.2500	1210000 271000	0.55	1.10	292000 65700	312000 70200	1.07	4470000 1010000	1.5 0.06	453.0 17.83	3.3 0.13	537.0 21.14	S					92 203	**LM869400**	WR	1
482.600 19.0000	733.425 28.8750	199.263 7.8450	200.000 7.8740	2140000 480000	0.78	0.77	740000 166000	554000 124000	0.75	9630000 2160000	3.3 0.13	534.0 21.02	3.3 0.13	663.0 26.10	S	50.80 2.000	20.62 0.812	47.63 1.875		275 604	**LM974500**	BUR	3
482.600 19.0000	733.425 28.8750	200.000 7.8740	200.000 7.8740	2230000 501000	0.78	0.77	773000 174000	578000 130000	0.75	10200000 2300000	6.4 0.25	531.0 20.91	3.3 0.13	663.0 26.10	P	50.80 2.000	19.05 0.750			287 631	**LM974500**	BUR	2
508.000 20.0000	733.425 28.8750	200.000 7.8740	200.000 7.8740	2250000 505000	0.87	0.69	863000 194000	582000 131000	0.67	12700000 2870000	3.3 0.13	*	4.8 0.19	675.0 26.57	P					*	**LM975300**	BUR	*
509.948 20.0767	733.425 28.8750	200.025 7.8750	200.025 7.8750	2120000 477000	0.87	0.69	815000 183000	550000 124000	0.67	11700000 2640000	3.3 0.13	552.0 21.73	4.8 0.19	675.0 26.57	S	50.80 2.000	17.45 0.687	38.10 1.500		265 583	**LM975300**	BUR	3
558.800 22.0000	660.400 26.0000	95.250 3.7500	92.075 3.6250	764000 172000	0.55	1.10	185000 41600	198000 44500	1.07	3240000 728000	1.5 0.06	576.0 22.68	3.3 0.13	636.0 25.04	S					52 115	**LL876400**	WR	1
635.000 25.0000	939.800 37.0000	304.800 12.0000	304.800 12.0000	4480000 1010000	0.58	1.04	1140000 257000	1160000 261000	1.01	15900000 3580000	3.3 0.13	684.0 26.93	6.4 0.25	873.0 34.37	P					707 1559	**LM881200**	BUR	1
685.800 27.0000	939.800 37.0000	227.838 8.9700	234.950 9.2500	2738600 615400	0.87	0.69	1060000 238200	710000 159600	0.67	19900000 4471900	6.4 0.25	*	3.3 0.13	*	S					356 783	**LM982400**	BUR	3
†800.000 31.4961	†1100.00 43.3071	300.000 11.8110	300.000 11.8110	4740000 1070000	0.78	0.77	1640000 369000	1230000 276000	0.75	30500000 6850000	1.5 0.06	852.0 33.54	6.0 0.24	1010.0 39.76	P	75.90 2.988	22.00 0.866			866 1906	**LM985000**	BUR	2



TTDWK

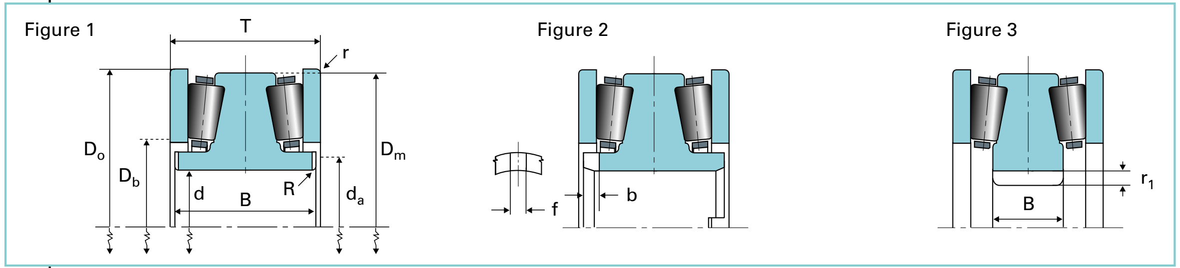
"Mainly used on work roll axial position when the axial thrust is very high and cannot be taken over by a more conventional tapered roller bearing design".



General information

- Fig. 1 middle ring provided with oil slots in faces,
- TTDWK assemblies can be provided with an outside spacer for bearing internal clearance,

R Shaft maximum fillet radius,
d_a Shaft shoulder diameter,
r Housing maximum radius,
D_b Housing shoulder diameter.



Notes :

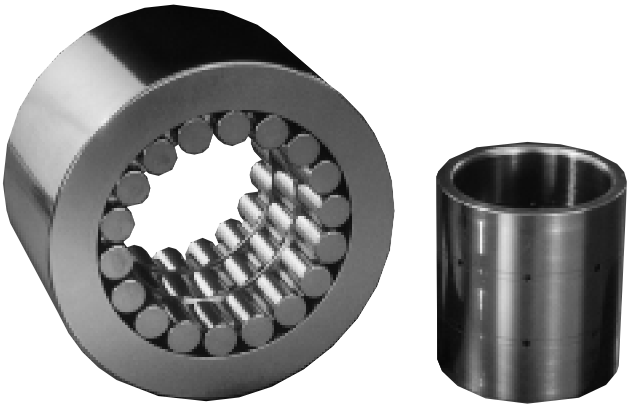
Any other size can be considered to fit your design requirements,

† dimension indicated is maximum value,

* contact your Timken sales engineer.

TTDWK

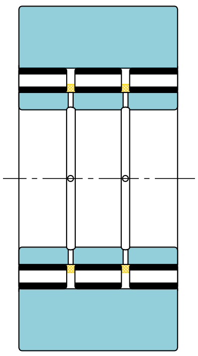
Dimensions, mm (in)					Ratings, N (lbf)			Dimensions, mm (in)							Mass kg (lb)	Bearing series	Figure
					1 million revolutions	90 million revolutions	Static axial	Shaft		Housing		Keyway					
d	D_o	D_m	T	B	C_{a1}	C_{a90}	C_{a0}	R	d_a	r	D_b	f	b	r_1			
142,000 5,5906	293,000 11,5354	304,800 12,0000	130,000 5,1181	55,000 2,1654	1900000 426200	494000 111000	6510000 1460000	1,5 0,06	162,0 6,38	3,3 0,13	168,0 6,61	30,0 1,18	- -	9,0 0,4	*	**T660**	3
170,000 6,6929	249,970 9,8413	246,888 9,7200	70,000 2,7559	19,000 0,7480	7020000 163000	1820000 25400	408000 113000	1,5 0,06	175,0 6,90	3,3 0,13	198,0 7,80	30,0 1,18	- -	6,0 0,2	*	**T730**	3
180,000 7,0866	279,975 11,0226	275,000 10,8268	90,000 3,5433	31,826 1,2530	725000 163000	188000 42200	2990000 672000	1,5 0,06	185,5 7,30	3,3 0,13	208,0 8,20	30,0 1,18	- -	6,0 0,2	*	**T770**	3
203,200 8,0000	407,415 16,0400	406,400 16,0000	152,400 6,0000	152,400 6,0000	2850000 639300	740000 166000	11900000 2670000	4,8 0,19	235,0 9,25	2,0 0,08	260,4 10,30	- -	- -	- -	*	**T8010**	1
250,000 9,8425	379,949 14,9586	375,000 14,7638	100,000 3,9370	36,576 1,4400	1351000 304000	350000 78700	6010000 1350000	1,5 0,06	261,6 10,30	3,3 0,13	300,0 11,80	30,0 1,18	- -	7,0 0,3	*	**T1080**	3
260,350 10,2500	542,035 21,3400	533,400 21,0000	222,250 8,7500	222,250 8,7500	5570000 1249500	1445000 324000	21600000 4850000	7,1 0,28	304,8 12,00	2,0 0,08	355,6 14,00	- -	- -	- -	*	**T10250**	1
360,000 14,1732	600,000 23,6220	580,000 22,8346	230,000 9,0551	110,000 4,3307	3630000 814000	941000 212000	15600000 3510000	13,0 0,51	400,0 15,75	4,1 0,16	440,0 17,30	40,0 1,57	- -	16,0 0,6	92 203	**T13200**	3
482,000 18,9764	657,600 25,8898	654,100 25,7520	170,000 6,6929	160,000 6,2992	3580000 803000	928500 208000	*	2,0 0,08	509,0 20,04	6,0 0,24	525,0 20,67	40,0 1,57	20,0 0,79	- -	*	*****	2



ZSPEXX - TNASWH

"Used on Sendzimir mills as back up rolls"

(tapered version only if adequate oil viscosity
Consult your Timken sales engineer)



General information

Outer ring/inner ring section tolerance
4 micrometers maximum

Bore and O.D. tolerance
0/+ 0.013 mm (0.0005 inch) up to 304.8 mm
0/+ 0.025 mm (0.001 inch) above 304.8 mm

Width tolerance
0/+ 0.025 mm (0.001 inch)

Precision Runouts less than 7 micrometers (0.00027 inch)

Fig. 1 : ZSPEXX

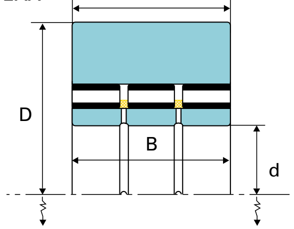
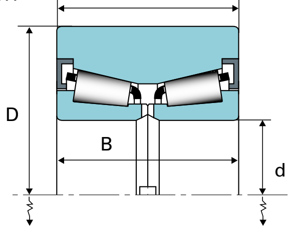


Fig. 2 : TNASWH



Notes :

Any other size can be considered to fit your design requirements,

† dimension indicated is maximum value,

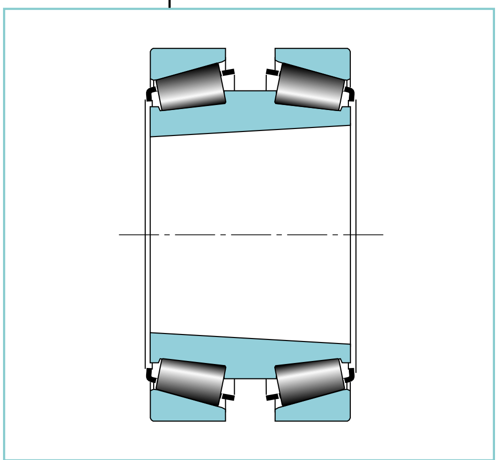
* contact your Timken sales engineer,

Bearing without cage.

ZSPEXX TNASWH

Zmill Type	Dimensions, mm (in)				Ratings, N (lbf)										Bearing series	Figure
					1 million revolutions					90 million revolutions						
	d	D	T	B	$C_{1(2)}$	$C_{1(3)}$	e	Y_1	Y_2	$C_{90(1)}$	$C_{90(2)}$	$C_{90(3)}$	C_{a90}	K		
ZR-24	44.450 (1.7500)	120.000 (4.7244)	63.094 (2.4840)	66.675 (2.6250)	204430 (45900)	–	0.28	2.37	3.53	30500 (6850)	53000 (11900)	–	14800 (3330)	2.06	**435**	2
ZR-24	†55.000 (2.1654)	†120.000 (4.7244)	49.896 (1.9644)	52.070 (2.0500)	167790 (37680)	–	0.35	1.91	2.85	25000 (5610)	43500 (9770)	–	15100 (3400)	1.65	**385**	2
ZR-33	†70.000 (2.7559)	†160.000 (6.2992)	87.889 (3.4602)	89.840 (3.5370)	375690 (84470)	–	0.33	2.02	3.00	55900 (12600)	97400 (21900)	–	34700 (7790)	1.61	**635**	2
ZR-23	99.995 (3.9368)	224.996 (8.8581)	117.000 (4.6063)	119.855 (4.7187)	759870 (170870)	–	0.33	2.02	3.00	113000 (25400)	197000 (44300)	–	64900 (14600)	1.74	**H221600**	2
ZR-23	99.995 (3.9368)	224.996 (8.8581)	119.974 (4.7234)	119.939 (4.7220)	–	851000 (191240)	–	–	–	–	–	220630 (49580)	–	–	**RZ-23AB**#	1
ZR-23	99.995 (3.9368)	224.996 (8.8581)	119.974 (4.7234)	119.939 (4.7220)	–	795000 (178650)	–	–	–	–	–	206110 (46320)	–	–	**RZ-23AA**	1
ZR-22	†130.000 (5.1181)	†300.000 (11.8110)	157.998 (6.2204)	160.000 (6.2992)	1396310 (314360)	–	0.33	2.10	3.13	208000 (46800)	362000 (81500)	–	119000 (26600)	1.76	**HH229000**	2
ZR-22	†130.000 (5.1181)	†300.000 (11.8110)	169.321 (6.6662)	172.496 (6.7912)	1527450 (343290)	–	0.32	2.10	3.13	227000 (51100)	396000 (89000)	–	125000 (28100)	1.82	**HH228300**	2
ZR-22	†130.000 (5.1181)	†300.000 (11.8110)	172.616 (6.7959)	172.618 (6.7960)	–	1592000 (357750)	–	–	–	–	–	412730 (92750)	–	–	**RZ-22AA**	1
ZR-21	179.984 (7.0860)	406.400 (16.0000)	220.665 (8.6876)	223.830 (8.8122)	2765620 (621010)	–	0.33	2.03	3.02	412000 (92500)	717000 (161000)	–	234000 (52700)	1.76	**EH239500**	2
ZR-21	179.984 (7.0860)	406.400 (16.0000)	171.016 (6.7329)	170.993 (6.7320)		2094000 (470560)	–	–	–	–	–	542880 (122000)	–	–	**RZ-21AA**	1

TDIT - TNAT



General information

R	Shaft maximum fillet radius,
d_a or d_b	Shaft shoulder diameter,
r	Housing maximum radius,
D_a or D_b	Housing shoulder diameter to be used also for cage clearance,
A_a or A_b	Axial cage clearance,
Cage	S = Stamped ; P = Pin type,
Bore	Diameter d = maximun bore.

Fig. 1 : TDIT

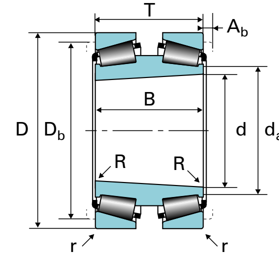
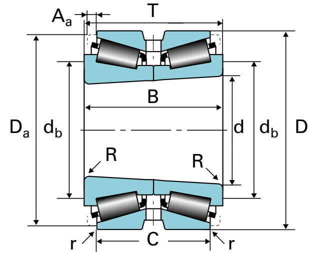


Fig. 2 : TNAT



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† dimension indicated is maximum value,

* contact your Timken sales engineer.

TDIT - TNAT

Dimensions, mm (in)						Ratings, N (lbf)									Dimensions, mm (in)					Cage	Mass kg (lb)	Bearing series	Figure
						1 million revolutions				90 million revolutions				Static									
d	Taper	D	T	B	C	$C_{1(2)}$	e	Y_1	Y_2	$C_{90(1)}$	$C_{90(2)}$	C_{a90}	K	$C_{0(2)}$	R	d_a-d_b	r	D_a-D_b	A_a-A_b				
100.210 3.9453	1:19.2	168.275 6.6250	95.250 3.7500	95.250 3.7500		427000 95900	0.47	1.43	2.14	63500 14300	111000 24900	51200 11500	1.24	772000 173400	0.8 0.03	112.0 4.41	3.3 0.13	149.0 5.87	5.0 0.20	S	8 18	**675**	1
101.600 4.0000	1:12	190.500 7.5000	117.475 4.6250	127.000 5.0000		860000 193000	0.33	2.02	3.00	128000 28800	223000 50100	73400 16500	1.74	1384000 312000	0.8 0.03	116.1 4.57	3.3 0.13	171.0 6.73	8.0 0.30	S	15 33	**HH221400**	1
115.888 4.5625	1:19.2	190.500 7.5000	107.950 4.2500	111.125 4.7350		586000 132000	0.42	1.62	2.42	87300 19600	152000 34200	62200 14000	1.40	1086000 244000	1.5 0.06	126.0 4.96	3.3 0.13	171.0 6.73	6.5 0.26	S	11 25	**71000**	1
127.000 5.0000	1:12	182.562 7.1875	76.200 3.0000	76.200 3.0000		432000 97100	0.31	2.21	3.29	64300 14500	112000 25200	33600 7550	1.91	986000 222000	1.5 0.06	134.9 5.31	3.3 0.13	168.0 6.61	4.5 0.18	S	7 15	**48200**	1
131.201 5.1654	1:12	196.850 7.7500	101.600 4.0000	101.600 4.0000	85.725 3.3750	593000 133000	0.34	1.96	2.92	88200 19800	154000 34500	52000 11700	1.70	1250000 282000	3.5 0.14	146.0 5.75	0.8 0.03	190.0 7.48	6.5 0.26	S	11 24	**67300**	2
133.350 5.2500	1:12	203.200 8.0000	92.075 3.6250	92.075 3.6250		593000 133000	0.34	1.96	2.92	88200 19800	154000 34500	52000 11700	1.70	1250000 282000	1.5 0.06	143.0 5.63	3.3 0.13	183.0 7.20	4.0 0.16	S	11 24	**67300**	1
136.525 5.3750	1:12	215.900 8.5000	123.825 4.8750	123.825 4.8750		616000 138000	0.49	1.38	2.06	91700 20600	160000 35900	76500 17200	1.20	1228000 276000	1.5 0.06	148.1 5.83	3.3 0.13	196.0 7.72	5.5 0.22	S	14 31	**74000**	1
142.875 5.6250	1:12	200.025 7.8750	77.788 3.0625	74.612 2.9375		462000 104000	0.34	2.01	2.99	68800 15500	120000 26900	39600 8900	1.74	1120000 252000	0.8 0.03	150.9 5.94	3.3 0.13	185.0 7.28	3.5 0.14	S	8 17	**48600**	1
144.480 5.6882	1:12	222.250 8.7500	100.010 3.9374	100.010 3.9374	76.200 3.0000	607000 136000	0.33	2.03	3.02	90400 20300	157000 35400	51500 11600	1.76	1336000 300000	3.5 0.14	168.9 6.65	0.8 0.03	213.0 8.39	9.5 0.36	S	14 31	**M231600**	2
147.638 5.8125	1:12	241.300 9.5000	133.350 5.2500	132.334 5.2100		830000 187000	0.44	1.53	2.27	124000 27800	215000 48400	93600 21000	1.32	1620000 364000	1.5 0.06	162.6 6.40	3.3 0.13	215.0 8.46	5.5 0.22	S	22 49	**82000**	1
152.400 6.0000	1:12	222.250 8.7500	84.138 3.3125	84.138 3.3125		607000 136000	0.33	2.03	3.02	90400 20300	157000 35400	51500 11600	1.76	1336000 300000	1.5 0.06	164.6 6.48	1.5 0.06	207.0 8.15	4.5 0.18	S	12 26	**M231600**	1
152.400 6.0000	1:12	254.000 10.0000	120.650 4.7500	120.650 4.7500		1060000 239000	0.41	1.66	2.47	158000 35600	276000 62000	110000 24800	1.43	2060000 462000	1.5 0.06	169.9 6.69	3.3 0.13	227.0 8.94	8.0 0.30	S	25 56	**99000**	1
165.100 6.5000	1:12	269.875 10.6250	146.050 5.7500	146.050 5.7500		1470000 329000	0.33	2.03	3.02	218000 49000	380000 85400	124000 27900	1.76	3040000 682000	1.5 0.06	184.4 7.26	3.3 0.13	244.0 9.61	*	S	35 78	**H234600**	1
180.975 7.1250	1:12	288.925 11.3750	158.750 6.2500	158.750 6.2500		1060000 239000	0.47	1.44	2.15	159000 35600	276000 62000	127000 28600	1.25	2140000 484000	1.5 0.06	198.1 7.80	3.3 0.13	259.0 10.20	10.5 0.40	S	33 73	**94000**	1
190.236 7.4896	1:12	288.925 11.3750	111.125 4.3750	111.125 4.3750		984000 221000	0.36	1.89	2.81	147000 33000	255000 57400	89700 20200	1.63	2120000 478000	1.5 0.06	212.1 8.35	3.3 0.13	265.0 10.43	*	S	26 58	**82700**	1
190.500 7.5000	1:12	365.049 14.3720	158.750 6.2500	152.400 6.0000		1880000 423000	0.40	1.68	2.50	280000 63000	488000 110000	193000 43300	1.45	3640000 818000	3.3 0.13	217.9 8.58	3.3 0.13	329.0 12.95	4.5 0.18	S	73 161	**420000**	1
198.438 7.8125	1:12	282.575 11.1250	87.312 3.4375	87.312 3.4375		684000 154000	0.51	1.33	1.97	102000 22900	177000 39800	88700 19900	1.15	1752000 394000	0.8 0.03	215.9 8.50	3.3 0.13	260.0 10.24	5.0 0.20	S	19 41	**67900**	1
209.550 8.2500	1:12	317.500 12.5000	184.150 7.2500	184.150 7.2500		1180000 265000	0.52	1.29	1.92	175000 39500	306000 68700	157000 35300	1.12	2580000 580000	1.5 0.06	227.1 8.94	3.3 0.13	286.0 11.26	8.5 0.34	S	45 101	**93000**	1

Dimensions, mm (in)						Ratings, N (lbf)									Dimensions, mm (in)					Cage	Mass kg (lb)	Bearing series	Figure
						1 million revolutions				90 million revolutions				Static									
d	Taper	D	T	B	C	$C_{1(2)}$	e	Y_1	Y_2	$C_{90(1)}$	$C_{90(2)}$	C_{a90}	K	$C_{0(2)}$	R	d_a-d_b	r	D_a-D_b	A_a-A_b				
219.936 8.6589	1:12	314.325 12.3750	115.888 4.5625	123.822 4.8749		1190000 267000	0.33	2.03	3.02	177000 39700	308000 69200	101000 22600	1.76	2740000 616000	1.5 0.06	235.0 9.25	3.3 0.13	293.0 11.54	6.5 0.26	S	32 71	**M244200**	1
215.448 8.4822	1:12	314.325 12.3750	131.763 5.1875	131.765 5.1876	106.362 4.1875	1190000 267000	0.33	2.03	3.02	177000 39700	308000 69200	101000 22600	1.76	2740000 616000	6.4 0.25	249.9 9.84	1.5 0.06	300.0 11.81	12.0 0.48	S	*	**M244200**	2
252.412 9.9375	1:12	358.775 14.1250	130.175 5.1250	139.700 5.5000		1560000 351000	0.33	2.03	3.02	232000 52200	405000 91000	132000 29700	1.76	3700000 832000	1.5 0.06	270.0 10.63	3.3 0.13	335.0 13.19	7.5 0.30	S	46 101	**M249700**	1
258.763 10.1875	1:12	358.775 14.1250	152.400 6.0000	152.400 6.0000	117.475 4.6250	1560000 351000	0.33	2.03	3.02	232000 52200	405000 91000	132000 29700	1.76	3700000 832000	3.3 0.13	278.1 10.95	1.5 0.06	343.3 13.50	13.5 0.54	S	46 102	**M249700**	2
266.700 10.5000	1:12	355.600 14.0000	107.950 4.2500	109.538 4.3125		1200000 269000	0.36	1.87	2.79	178000 40100	310000 69800	110000 24700	1.62	3020000 678000	1.5 0.06	280.9 11.06	3.3 0.13	335.0 13.19	7.0 0.28	S	30 67	**LM451300**	1
280.000 11.0236	1:12	409.981 16.1410	206.375 8.1250	206.375 8.1250		1480000 333000	0.39	1.75	2.60	221000 49600	384000 86400	146000 32800	1.51	3320000 748000	3.3 0.13	307.1 12.09	3.3 0.13	379.0 14.92	4.0 0.16	S	77 172	**128000**	1
288.925 11.3750	1:12	406.400 16.0000	144.462 5.6875	144.462 5.6875		2030000 457000	0.34	2.00	2.97	302000 68000	526000 118000	175000 39300	1.73	5040000 1134000	3.3 0.13	309.9 12.20	3.3 0.13	379.0 14.92	*	P	63 138	**M255400**	1
297.523 11.7135	1:12	422.275 16.6250	150.813 5.9375	160.338 6.3125		2210000 498000	0.34	2.00	2.99	330000 74100	574000 129000	190000 42700	1.73	5540000 1244000	3.3 0.13	322.1 12.68	3.3 0.13	394.0 15.51	*	P	75 167	**HM256800**	1
303.212 11.9375	1:12	495.300 19.5000	263.525 10.3750	263.525 10.3750		4900000 1100000	0.33	2.03	3.02	729000 164000	1270000 285000	415000 93300	1.76	11300000 2540000	3.3 0.13	335.3 13.20	6.4 0.25	448.0 17.64	*	P	218 485	**HH258200**	1
304.800 12.0000	1:12	422.275 16.6250	174.625 6.8750	174.625 6.8750	136.525 5.3750	2210000 498000	0.34	2.00	2.99	330000 74100	574000 129000	190000 42700	1.73	5540000 1244000	6.4 0.25	334.0 13.15	1.5 0.06	403.0 15.88	*	P	73 162	**HM256800**	2
333.375 13.1250	1:12	469.900 18.5000	166.688 6.5625	166.688 6.5625		2730000 614000	0.33	2.02	3.00	407000 91400	708000 159000	233000 52400	1.74	6920000 1554000	3.3 0.13	357.1 14.06	3.3 0.13	439.0 17.28	*	P	97 216	**HM261000**	1
333.375 13.1250	1:12	523.875 20.6250	185.738 7.3125	185.738 7.3125		3380000 760000	0.33	2.03	3.02	504000 113000	877000 197000	287000 64500	1.76	8680000 1954000	3.3 0.13	373.9 14.72	6.4 0.25	487.0 19.17	*	P	164 365	**HM265000**	1
336.550 13.2500	1:12	469.900 18.5000	190.500 7.5000	190.500 7.5000	152.400 6.0000	2510000 565000	0.33	2.02	3.00	374000 84200	652000 147000	215000 48200	1.74	6140000 1382000	6.4 0.25	366.0 14.41	1.5 0.06	449.0 17.68	*	P	97 216	**HM261000**	2
346.075 13.6250	1:12	488.950 19.2500	174.625 6.8750	174.625 6.8750		2950000 663000	0.33	2.02	3.00	439000 98700	765000 172000	252000 56600	1.74	7520000 1690000	3.3 0.13	367.0 14.45	3.3 0.13	456.0 17.95	*	P	113 250	**HM262700**	1
349.250 13.7500	1:12	457.200 18.0000	120.650 4.7500	120.650 4.7500		1610000 361000	0.32	2.12	3.15	239000 53800	417000 93600	131000 29400	1.83	4540000 1020000	1.5 0.06	377.0 14.84	3.3 0.13	434.0 17.09	*	S	55 123	**LM263100**	1
352.425 13.8750	1:12	488.950 19.2500	199.898 7.8700	200.025 7.8750	158.750 6.2500	2950000 663000	0.33	2.02	3.00	439000 98700	765000 172000	252000 56600	1.74	7520000 1690000	6.4 0.25	383.0 15.08	1.5 0.06	467.0 18.39	*	P	*	**HM262700**	2
368.300 14.5000	1:12	523.875 20.6250	185.738 7.3125	185.738 7.3125		3380000 760000	0.33	2.03	3.02	504000 113000	877000 197000	287000 64500	1.76	8680000 1954000	3.3 0.13	394.0 15.51	6.4 0.25	487.0 19.17	*	P	137 304	**HM265000**	1
384.175 15.1250	1:12	546.100 21.5000	193.675 7.6250	193.675 7.6250		3660000 823000	0.33	2.03	3.02	545000 123000	950000 213000	311000 69800	1.76	9460000 2120000	3.3 0.13	406.9 16.02	6.4 0.25	507.0 19.96	*	P	158 351	**HM266400**	1
390.525 15.3750	1:12	546.100 21.5000	222.250 8.7500	- -	177.800 7.0000	3664200 821900	0.33	2.03	3.02	545000 123000	950000 213000	311000 69800	1.76	9480000 2140000	6.4 0.25	423.0 16.65	1.5 0.06	519.0 20.43	*	P	*	**HM266400**	2
415.925 16.3750	1:12	590.550 23.2500	209.550 8.2500	209.550 8.2500		4250000 955000	0.33	2.03	3.02	633000 142000	1100000 248000	360000 81000	1.76	11100000 2500000	3.3 0.13	441.0 17.36	6.4 0.25	548.9 21.61	*	P	197 437	**M268700**	1
423.863 16.6875	1:12	590.550 23.2500	244.348 9.6200	- -	193.675 7.6250	4242700 951700	0.33	2.03	3.02	633000 142000	1100000 248000	360000 81000	1.76	11100000 2500000	6.4 0.25	459.0 18.07	1.5 0.06	561.0 22.09	*	P	*	**M268700**	2
447.675 17.6250	1:12	635.000 25.0000	223.838 8.8125	223.838 8.8125		4880000 1100000	0.33	2.03	3.02	726000 163000	1260000 284000	413000 92900	1.76	12860000 2900000	3.3 0.13	474.0 18.66	6.4 0.25	591.0 23.27	*	P	243 540	**M270700**	1

Fig. 1 : TDIT

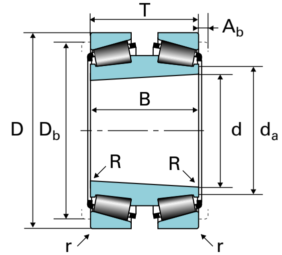
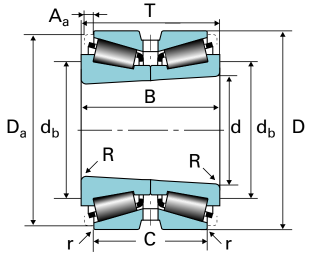


Fig. 2 : TNAT



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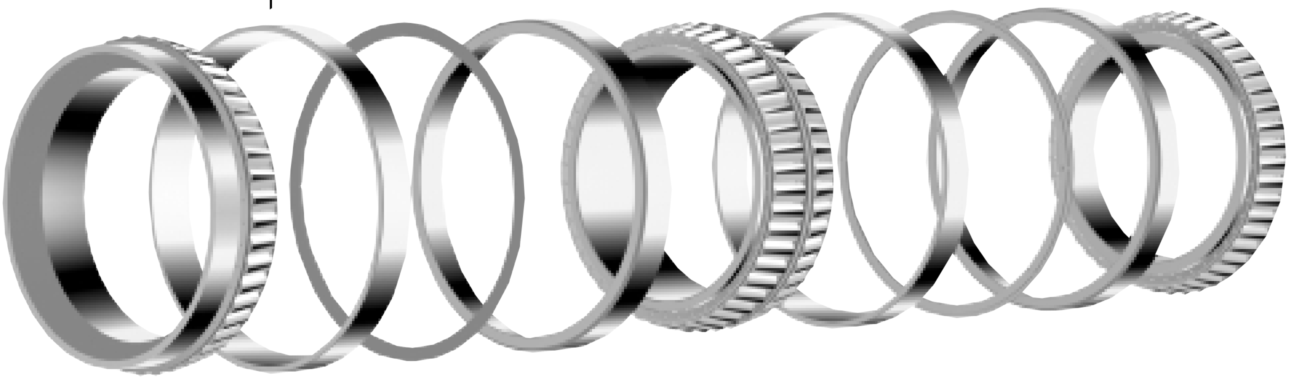
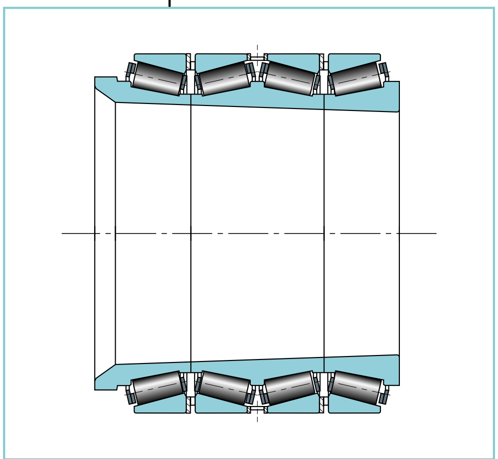
TDIT - TNAT

Dimensions, mm (in)						Ratings, N (lbf)									Dimensions, mm (in)					Cage	Mass kg (lb)	Bearing series	Figure
						1 million revolutions				90 million revolutions				Static									
d	Taper	D	T	B	C	$C_{1(2)}$	e	Y_1	Y_2	$C_{90(1)}$	$C_{90(2)}$	C_{a90}	K	$C_{0(2)}$	R	d_a-d_b	r	D_a-D_b	A_a-A_b				
453.390 17.8500	1:12	635.000 25.0000	257.048 10.1200	- -	206.375 8.1250	4859800 1090100	0.33	2.03	3.02	726000 163000	1260000 284000	413000 92900	1.76	12780000 2880000	6.4 0.25	490.0 19.29	1.5 0.06	606.0 23.86	*	P	*	**M270700**	2
479.425 18.8750	1:12	679.450 26.7500	238.125 9.3750	238.125 9.3750		5550000 1250000	0.33	2.03	3.02	827000 186000	1440000 324000	471000 106000	1.76	14800000 3320000	3.3 0.13	507.0 19.96	6.4 0.25	633.0 24.92	*	P	300 667	**M272700**	1
488.950 19.2500	1:12	679.450 26.7500	276.225 10.8750	- -	222.250 8.7500	5554100 1245900	0.33	2.03	3.02	827000 186000	1440000 324000	471000 106000	1.76	14760000 3320000	6.4 0.25	525.0 20.70	1.5 0.06	648.0 25.51	*	P	*	**M272700**	2
501.650 19.7500	1:12	711.200 28.0000	250.825 9.8750	250.825 9.8750		6030000 1360000	0.33	2.03	3.02	898000 202000	1560000 351000	511000 115000	1.76	16140000 3640000	3.3 0.13	533.9 21.02	6.4 0.25	663.0 26.10	*	P	344 764	**M274100**	1
519.112 20.4375	1:12	736.600 29.0000	258.762 10.1875	258.762 10.1875		6440000 1450000	0.33	2.03	3.02	959000 216000	1670000 375000	546000 123000	1.76	17340000 3900000	3.3 0.13	562.0 22.13	6.4 0.25	684.0 26.93	*	P	391 869	**M275300**	1
530.225 20.8750	1:12	736.600 29.0000	301.498 11.8700	- -	241.300 9.5000	6441200 1444900	0.33	2.03	3.02	959000 216000	1670000 375000	546000 123000	1.76	16800000 3780000	6.4 0.25	0.0	1.5 0.06	0.0 0.00	*	P	*	**M275300**	2
571.500 22.5000	1:12	812.800 32.0000	285.750 11.2500	296.862 11.6875		7740000 1740000	0.33	2.03	3.02	1150000 259000	2010000 451000	656000 147000	1.76	21200000 4740000	3.3 0.13	609.0 23.98	6.4 0.25	756.0 29.76	*	P	515 1144	**M278700**	1
582.613 22.9375	1:12	812.800 32.0000	333.375 13.1250	- -	263.525 10.3750	7752600 1739000	0.33	2.03	3.02	1150000 259000	2010000 451000	656000 147000	1.76	21000000 4740000	SPCL	615.0 24.21	1.5 0.06	774.0 30.47	*	P	*	**M278700***	2



TQITS - TQITSE



General information

d_b	Shaft shoulder diameter,
r	Housing maximum radius,
D_a	Housing shoulder diameter to be used also for cage clearance,
Cage	S = Stamped ; P = Pin type,
d_1	Rib diameter for lip seal.
Bore	Diameter d = maximun bore.

TQITS-TQITSE

Fig. 1 : TQITS

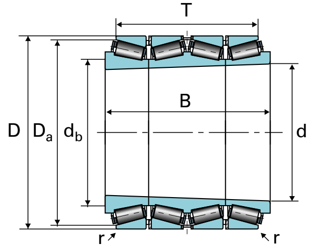
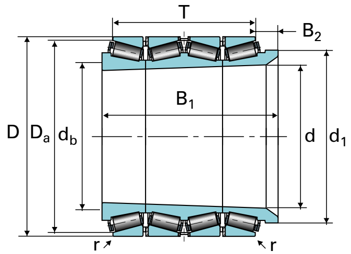


Fig. 2 : TQITSE



Notes :

Following series can all be proposed in TQITSE versions,

Any other size can be considered to fit your design requirements,

† dimension indicated is maximum value,

* contact your Timken sales engineer.

TQITS - TQITSE

Dimensions, mm (in)							Ratings, N (lbf)									Dimensions, mm (in)			Cage	Mass kg (lb)		Bearing series	Figure
							1 million revolutions				90 million revolutions				Static								
d	D	T	B	B_1	B_2	d_1	$C_{1(4)}$	e	Y_1	Y_2	$C_{90(1)}$	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	d_b	r	D_a		TQITS	TQITSE		
78.580 3.0937	127.000 5.0000	114.300 4.5000	130.175 5.1250	-	–	–	520000 116800	0.42	1.61	2.40	38700 8690	134600 30200	27700 6230	1.39	888000 199200	101.0 3.98	0.8 0.03	121.0 4.76	S	*	*	**42600**	1
123.033 4.8438	174.625 6.8750	134.938 5.3125	150.812 5.9375	–	–	–	788000 177200	0.33	2.03	3.02	58700 13200	204000 46000	33400 7510	1.76	1688000 379600	140.0 5.51	0.8 0.03	168.0 6.61	S	13 28	–	**M224700**	1
165.456 6.5140	229.946 9.0530	142.875 5.6250	165.100 6.5000	203.200 8.0000	49.212 1.9375	203.200 8.0000	1012000 228000	0.40	1.68	2.50	75400 16900	262000 59000	51900 11700	1.45	2172000 488000	188.0 7.40	0.8 0.03	223.0 8.78	S	21 46	23 51	**LM533700**	1 & 2
170.655 6.7187	225.425 8.8750	152.400 6.0000	168.275 6.6250	204.788 8.0625	44.450 1.7500	203.200 8.0000	978000 220000	0.38	1.76	2.62	72800 16400	254000 57000	47800 10700	1.52	2540000 572000	187.0 7.36	0.8 0.03	218.0 8.58	S	20 45	22 48	**46700**	1 & 2
175.781 6.9205	260.502 10.2560	142.900 5.6260	171.450 6.7500	–	–	–	1318000 296000	0.40	1.68	2.50	98200 22100	342000 76800	67500 15200	1.45	2256000 508000	196.0 7.72	0.8 0.03	247.0 9.72	S	29 65	–	**LM535600**	1
175.781 6.9205	260.502 10.2560	142.900 5.6260	–	212.725 8.3750	55.550 2.1870	215.900 8.5000	1318000 296000	0.40	1.68	2.50	98200 22100	342000 76800	67500 15200	1.45	2256000 508000	196.0 7.72	0.8 0.03	247.0 9.72	S	–	31 68	**LM535600**	2
190.500 7.5000	260.350 10.2500	169.073 6.6564	192.883 7.5938	234.158 9.2188	53.180 2.0937	228.600 9.0000	1264000 284000	0.40	1.70	2.53	94100 21200	328000 73600	63900 14400	1.47	3000000 676000	216.0 8.50	0.8 0.03	251.0 9.88	S	33 72	35 77	**LM538600**	1 & 2
191.226 7.5286	269.875 10.6250	203.200 8.0000	228.600 9.0000	–	–	–	1768000 398000	0.33	2.03	3.02	132000 29600	458000 103000	74900 16800	1.76	3996000 900000	213.0 8.37	1.5 0.06	256.0 10.08	S	44 97	–	**M238800**	1
193.807 7.6302	269.875 10.6250	214.310 8.4374	–	279.397 10.9999	52.388 2.0625	234.950 9.2500	1768000 398000	0.33	2.03	3.02	132000 29600	458000 103000	74900 16800	1.76	3996000 900000	213.0 8.37	1.5 0.06	256.0 10.08	S	–	48 106	**M238800**	2
195.301 7.6890	259.969 10.2350	144.465 5.6876	161.925 6.3750	206.375 8.1250	53.180 2.0937	234.950 9.2500	1092000 246000	0.33	2.03	3.02	81400 18300	284000 63800	46300 10400	1.76	2416000 544000	216.0 8.50	0.8 0.03	252.0 9.92	S	24 53	26 57	**LM239500**	1 & 2
200.820 7.9063	284.162 11.1875	219.075 8.6250	239.715 9.4376	282.578 11.1251	53.183 2.0938	241.300 9.5000	1818000 408000	0.33	2.03	3.02	135000 30400	472000 106000	77000 17300	1.76	4000000 904000	229.0 9.02	1.5 0.06	272.0 10.71	S	52 115	58 128	**M240600**	1 & 2
207.167 8.1562	292.100 11.5000	222.250 8.7500	246.065 9.6876	286.545 11.2813	52.388 2.0625	254.000 10.0000	2040000 460000	0.33	2.03	3.02	152000 34300	530000 119400	86800 19500	1.76	4680000 1052000	231.0 9.08	1.5 0.06	279.0 10.98	S	55 121	63 139	**M241500**	1 & 2
207.962 8.1875	279.400 11.0000	168.275 6.6250	190.500 7.5000	227.805 8.9687	48.417 1.9062	254.000 10.0000	1314000 296000	0.46	1.46	2.17	97900 22000	340000 76600	77700 17500	1.26	3264000 732000	235.0 9.27	0.8 0.03	271.0 10.67	S	35 78	39 86	**LM741300**	1 & 2
219.075 8.6250	288.925 11.3750	168.275 6.6250	190.500 7.5000	236.538 9.3125	57.150 2.2500	257.175 10.1250	1386000 312000	0.48	1.40	2.09	103000 23200	360000 80800	85000 19100	1.21	3568000 800000	241.0 9.47	0.8 0.03	280.0 11.02	S	35 77	38 84	**LM742700**	1 & 2
225.425 8.8750	314.325 12.3750	230.188 9.0625	255.588 10.0625	296.862 11.6875	53.975 2.1250	273.050 10.7500	2380000 534000	0.33	2.03	3.02	177000 39700	616000 138400	101000 22600	1.76	5480000 1232000	253.0 9.95	1.5 0.06	300.0 11.81	S	66 145	72 159	**M244200**	1 & 2
228.600 9.0000	311.150 12.2500	190.500 7.5000	212.725 8.3750	260.350 10.2500	58.738 2.3125	273.050 10.7500	1838000 414000	0.33	2.03	3.02	137000 30800	476000 107200	77900 17500	1.76	4160000 932000	256.0 10.06	1.5 0.06	300.0 11.81	S	49 108	55 121	**LM245100**	1 & 2
247.650 9.7500	327.025 12.8750	187.325 7.3750	209.550 8.2500	257.175 10.1250	58.738 2.3125	292.100 11.5000	1936000 436000	0.32	2.10	3.13	144000 32400	502000 112800	79200 17800	1.82	4560000 1028000	272.0 10.70	1.5 0.06	316.0 12.44	S	50 110	57 126	**LM247700**	1 & 2
258.762 10.1875	358.775 14.1250	257.175 10.1250	292.100 11.5000	336.550 13.2500	61.912 2.4375	314.325 12.3750	3120000 702000	0.33	2.03	3.02	232000 52200	810000 182000	132000 29700	1.76	7400000 1664000	282.0 11.09	1.5 0.06	343.0 13.50	S	98 216	105 231	**M249700**	1 & 2

Dimensions, mm (in)							Ratings, N (lbf)									Dimensions, mm (in)			Cage	Mass kg (lb)		Bearing series	Figure
							1 million revolutions				90 million revolutions				Static								
d	D	T	B	B_1	B_2	d_1	$C_{1(4)}$	e	Y_1	Y_2	$C_{90(1)}$	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	d_b	r	D_a		TQITS	TQITSE		
271.462	381.000	269.875	301.625	357.188	71.438	342.900	3560000	0.33	2.03	3.02	266000	924000	151000	1.76	8600000	306.0	1.5	364.0	P	107	118	**M252300**	1 & 2
10.6875	15.0000	10.6250	11.8750	14.0625	2.8125	13.5000	802000				59700	208000	34000		1936000	12.05	0.06	14.32		236	260		
290.000	407.000	288.000	320.000	375.000	71.000	355.600	4060000	0.34	2.00	2.97	302000	1052000	175000	1.73	10080000	326.0	1.5	388.0	P	123	134	**M255400**	1 & 2
11.4173	16.0216	11.3386	12.5984	14.7638	2.7953	14.0000	914000				68000	236000	39300		2268000	12.84	0.06	15.28		271	295		
304.800	422.275	296.862	334.962	390.525	74.612	368.300	4420000	0.34	2.00	2.99	330000	1148000	190000	1.73	11080000	338.0	1.5	403.0	P	158	168	**HM256800**	1 & 2
12.0000	16.6250	11.6875	13.1875	15.3750	2.9375	14.5000	996000				74100	258000	42700		2488000	13.31	0.06	15.88		348	370		
320.000	422.275	261.424	290.000	336.000	60.287	374.650	3360000	0.32	2.11	3.15	251000	872000	137000	1.83	8920000	354.0	1.5	406.0	S	109	121	**LM258600**	1 & 2
12.5984	16.6250	10.2923	11.4173	13.2283	2.3735	14.7500	756000				56300	196200	30800		2008000	13.94	0.06	15.98		240	266		
323.850	447.675	323.850	358.775	414.338	73.025	388.938	5000000	0.33	2.02	3.00	372000	1294000	213000	1.74	12560000	351.0	1.5	428.0	P	186	200	**HM259000**	1 & 2
12.7500	17.6250	12.7500	14.1250	16.3125	2.8750	15.3125	1122000				83600	290000	47900		2824000	13.83	0.06	16.84		410	442		
339.936	469.900	299.200	350.000	–	–	–	4260000	0.33	2.03	3.02	318000	1106000	181000	1.76	10720000	388.0	1.5	451.0	S	193	–	**M262400**	1
13.3833	18.5000	11.7795	13.7795				958000				71400	248000	40600		2408000	15.29	0.06	17.75		425			
352.425	488.950	342.900	384.175	438.150	74.612	431.800	5900000	0.33	2.02	3.00	439000	1530000	252000	1.74	15040000	387.0	1.5	467.0	P	242	258	**HM262700**	1 & 2
13.8750	19.2500	13.5000	15.1250	17.2500	2.9375	17.0000	1326000				98700	344000	56600		3380000	15.24	0.06	18.39		533	569		
358.775	488.950	300.038	341.312	396.875	76.200	431.800	5160000	0.33	2.03	3.02	384000	1336000	218000	1.76	12760000	398.0	1.5	467.0	P	198	209	**M263300**	1 & 2
14.1250	19.2500	11.8125	13.4375	15.6250	3.0000	17.0000	1158000				86200	300000	49100		2868000	15.66	0.06	18.39		436	461		
371.475	523.875	366.713	411.163	465.138	76.200	457.200	6765600	0.33	2.03	3.02	504000	1754000	287000	1.76	17440000	410.2	6.4	499.1	P	314	335	**HM265000**	1 & 2
14.6250	20.6250	14.4375	16.1875	18.3125	3.0000	18.0000	1517600				113060	393450	64380		3912070	16.15	0.25	19.65		692	738		
376.809	519.862	342.900	381.000	438.150	76.200	457.200	5900000	0.33	2.03	3.02	439000	1530000	250000	1.76	14680000	424.0	3.3	499.0	P	255	272	**M265300**	1 & 2
14.8350	20.4670	13.5000	15.0000	17.2500	3.0000	18.0000	1326000				98800	344000	56200		3304000	16.70	0.13	19.64		562	600		
390.525	546.100	384.175	428.625	495.300	88.900	482.600	7320000	0.33	2.03	3.02	545000	1900000	311000	1.76	18920000	427.0	1.5	520.0	P	348	371	**HM266400**	1 & 2
15.3750	21.5000	15.1250	16.8750	19.5000	3.5000	19.0000	1646000				123000	426000	69800		4240000	16.82	0.06	20.47		767	818		
419.100	590.550	419.100	469.900	534.988	90.488	514.350	8500000	0.33	2.03	3.02	633000	2200000	360000	1.76	22200000	459.0	1.5	562.0	P	433	460	**M268700**	1 & 2
16.5000	23.2500	16.5000	18.5000	21.0625	3.5625	20.2500	1910000				142000	496000	81000		5000000	18.06	0.06	22.13		954	1014		
453.390	635.000	446.088	496.888	585.788	114.300	558.800	9760000	0.33	2.03	3.02	726000	2520000	413000	1.76	25720000	494.0	1.5	605.0	P	547	583	**M270700**	1 & 2
17.8500	25.0000	17.5625	19.5625	23.0625	4.5000	22.0000	2200000				163000	568000	92900		5800000	19.46	0.06	23.82		1206	1286		
488.950	679.450	479.425	533.400	628.650	122.238	598.488	11100000	0.33	2.03	3.02	827000	2880000	471000	1.76	29600000	526.0	1.5	648.0	P	660	685	**M272700**	1 & 2
19.2500	26.7500	18.8750	21.0000	24.7500	4.8125	23.5625	2500000				186000	648000	106000		6640000	20.71	0.06	25.52		1455	1511		
508.000	695.325	393.700	450.850	520.700	98.425	620.712	9140000	0.33	2.03	3.02	680000	2360000	387000	1.76	22960000	562.0	1.5	663.0	P	545	568	**LM274000**	1 & 2
20.0000	27.3750	15.5000	17.7500	20.5000	3.8750	24.4375	2060000				153000	532000	87100		5160000	22.13	0.06	26.09		1202	1252		
530.225	736.600	519.112	579.438	654.050	104.775	647.700	12880000	0.33	2.03	3.02	959000	3340000	546000	1.76	34680000	595.0	1.5	702.0	P	864	916	**M275300**	1 & 2
20.8750	29.0000	20.4375	22.8125	25.7500	4.1250	25.5000	2900000				216000	750000	123000		7800000	23.43	0.06	27.65		1904	2019		
547.688	761.873	536.575	600.075	692.150	123.825	673.100	13700000	0.33	2.03	3.02	1020000	3540000	580000	1.76	37000000	586.0	1.5	726.0	P	930	986	**M276400**	1 & 2
21.5625	29.9950	21.1250	23.6250	27.2500	4.8750	26.5000	3080000				229000	798000	130000		8320000	23.08	0.06	28.57		2050	2173		
581.025	812.800	571.500	641.350	709.613	103.188	711.200	15737400	0.33	2.03	3.02	920000	4080000	669000	1.76	43200000	625.1	1.5	773.7	P	1126	1204	**M278700**	1 & 2
22.8750	32.0000	22.5000	25.2500	27.9375	4.0625	28.0000	3530100				206370	915210	150070		9690440	24.61	0.06	30.46		2482	2654		
604.838	787.400	369.888	420.688	487.362	92.075	711.200	9320000	0.33	2.03	3.02	694000	2420000	395000	1.76	26000000	664.0	1.5	759.0	P	578	613	**LM280000**	1 & 2
23.8125	31.0000	14.5625	16.5625	19.1875	3.6250	28.0000	2100000				156000	544000	88800		5840000	26.14	0.06	29.88		1274	1351		
644.525	857.250	523.875	590.550	665.162	107.950	762.000	13980000	0.33	2.03	3.02	1040000	3620000	593000	1.76	41600000	719.0	1.5	824.0	P	1006	1066	**LM281000**	1 & 2
25.3750	33.7500	20.6250	23.2500	26.1875	4.2500	30.0000	3140000				234000	816000	133000		9320000	28.32	0.06	32.46		2217	2349		
669.671	933.450	649.288	725.488	790.575	103.188	812.800	20000000	0.33	2.03	3.02	1490000	5180000	848000	1.76	55600000	754.0	1.5	890.0	P	1702	1819	**M281600**	1 & 2
26.3650	36.7500	25.5625	28.5625	31.1250	4.0625	32.0000	4500000				335000	1166000	191000		12480000	29.69	0.06	35.02		3751	4009		
744.538	1035.050	727.075	812.800	881.062	111.125	901.700	24400000	0.33	2.03	3.02	1810000	6320000	1030000	1.76	68400000	837.0	1.5	987.0	P	2363	2517	**M283400**	1 & 2
29.3125	40.7500	28.6250	32.0000	34.6875	4.3750	35.5000	5480000				407000	1418000	232000		15440000	32.95	0.06	38.84		5208	5547		

Fig. 1 : TQITS

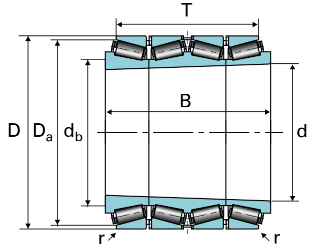
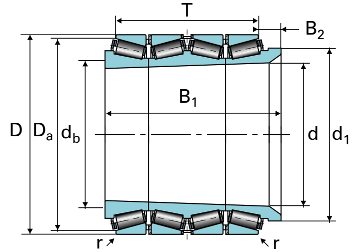


Fig. 2 : TQITSE



Notes :

Following series can all be proposed in TQITSE versions,

Any other size can be considered to fit your design requirements,

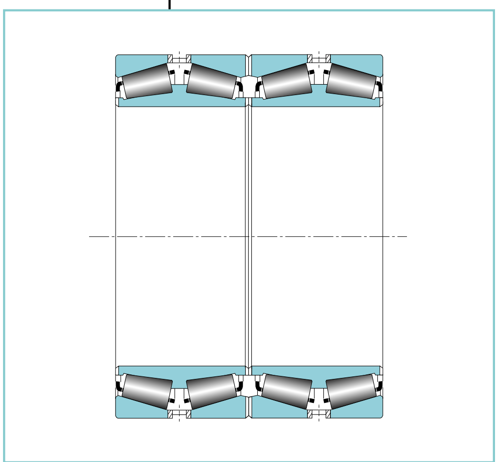
† dimension indicated is maximum value,

* contact your Timken sales engineer.

TQITS - TQITSE

Dimensions, mm (in)							Ratings, N (lbf)									Dimensions, mm (in)			Cage	Mass kg (lb)		Bearing series	Figure
							1 million revolutions				90 million revolutions				Static								
d	D	T	B	B_1	B_2	d_1	$C_{1(4)}$	e	Y_1	Y_2	$C_{90(1)}$	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	d_b	r	D_a		TQITS	TQITSE		
749.300 29.5000	990.600 39.0000	577.000 22.7166	650.000 25.5906	725.000 28.5434	111.500 4.3898	889.000 35.0000	17800000 4000000	0.33	2.03	3.02	1330000 298000	4620000 1038000	754000 170000	1.76	54000000 12200000	792.0 31.18	3.3 0.13	953.0 37.50	P	1522 3355	1619 3569	**LM283600**	1 & 2
777.875 30.6250	1079.500 42.5000	755.650 29.7500	844.550 33.2500	919.162 36.1875	119.062 4.6875	933.450 36.7500	26200000 5900000	0.33	2.03	3.02	1950000 439000	6800000 1528000	1110000 250000	1.76	74400000 16680000	873.0 34.36	3.3 0.13	1028.0 40.48	P	2634 5807	2813 6201	**M284200**	1 & 2
828.675 32.6250	1143.000 45.0000	733.425 28.8750	825.500 32.5000	898.525 35.3750	119.062 4.6875	990.600 39.0000	27400000 6160000	0.33	2.03	3.02	2040000 458000	7100000 1596000	1160000 261000	1.76	76800000 17280000	924.0 36.39	3.3 0.13	1089.0 42.88	P	2773 6113	2963 6532	**LM285500**	1 & 2
838.200 33.0000	1143.000 45.0000	619.125 24.3750	711.200 28.0000	787.400 31.0000	122.238 4.8125	844.550 33.2500	22400000 5060000	0.33	2.03	3.02	1670000 376000	5820000 1310000	953000 214000	1.76	60000000 13440000	924.0 36.39	3.3 0.13	1089.0 42.88	P	2246 4951	2431 5359	**LM285700**	1 & 2
863.600 34.0000	1130.300 44.5000	644.525 25.3750	717.550 28.2500	798.512 31.4375	117.475 4.6250	1009.650 39.7500	22200000 5000000	0.33	2.03	3.02	1660000 373000	5780000 1298000	944000 212000	1.76	69600000 15680000	957.0 37.68	3.3 0.13	1090.0 42.93	P	2107 4645	2184 4815	**LM286200**	1 & 2
872.769 34.3610	1181.100 46.5000	628.650 24.7500	714.375 28.1250	793.750 31.2500	122.238 4.8125	1028.700 40.5000	24400000 5500000	0.33	2.03	3.02	1820000 409000	6340000 1426000	1040000 233000	1.76	66800000 15000000	962.0 37.89	3.3 0.13	1131.0 44.51	P	2444 5388	2575 5677	**LM286400**	1 & 2
895.350 35.2500	1212.850 47.7500	784.225 30.8750	873.125 34.3750	–	–	–	30400000 6820000	0.33	2.03	3.02	2260000 508000	7880000 1770000	1290000 289000	1.76	89200000 20000000	997.0 39.24	3.3 0.13	1164.0 45.81	P	3215 7088	–	**LM286700**	1
1004.634 39.5525	1308.100 51.5000	730.250 28.7500	812.800 32.0000	920.750 36.2500	149.225 5.8750	1193.800 47.0000	28400000 6400000	0.33	2.03	3.02	2120000 476000	7380000 1656000	1200000 271000	1.76	91600000 20600000	1109.0 43.67	3.3 0.13	1260.0 49.60	P	3193 7039	3385 7463	**LM288100**	1 & 2

TQOW - TQOWE
2TDIW - SRNB



General information

R	Shaft maximum fillet radius,
d_a	Shaft shoulder diameter,
r	Housing maximum radius,
D_b	Housing shoulder diameter to be used also for cage clearance,
A_b	Axial cage clearance,
Cage	S = Stamped ; P = Pin type,
Usage	BUR = used more likely on back- up roll,
	WR = used more likely on work roll,
d_1	Rib diameter for lip seal.

Fig. 1 : TQOW

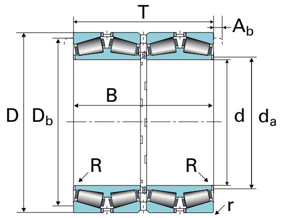


Fig. 2 : TQOWE

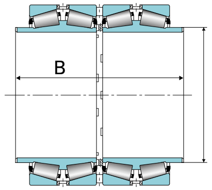


Fig. 3 : 2TDIW

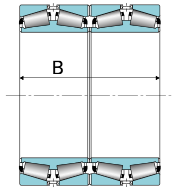
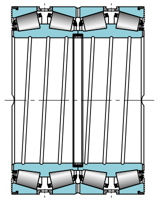


Fig. 4 : SRNB (narrow seal)



Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

Any other size can be fitted to your design requirements,

All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

† dimension is maximum value,

* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
				TQOWE	1 million revolutions				90 million revolutions				Static										
d	D	T	B	d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
50.800 2.0000	83.337 3.2810	92.075 3.6250	92.075 3.6250		196000 44000	0.36	1.90	2.83	14600 3280	50800 11420	8880 2000	1.64	355200 80000	1.5 0.06	58.0 2.28	1.5 0.06	74.0 2.91	3.5 0.14	S	2 4	**L305600**	WR	1
69.850 2.7500	103.188 4.0625	95.250 3.7500	95.250 3.7500		216000 48400	0.46	1.46	2.18	16000 3610	55800 12560	12700 2850	1.27	444000 100000	1.5 0.06	78.0 3.07	1.5 0.06	94.0 3.70	3.0 0.12	S	3 6	**L713000**	WR	1
76.200 3.0000	115.888 4.5625	115.888 4.5625	115.888 4.5625		402000 90400	0.27	2.48	3.69	29900 6720	104200 23400	13900 3130	2.15	744000 167200	0.8 0.03	83.0 3.27	1.5 0.06	107.0 4.21	* *	S	4 10	**LM114800**	WR	1
82.550 3.2500	117.475 4.6250	103.185 4.0624	104.775 4.1250		290000 65400	0.31	2.19	3.26	21700 4870	75400 16940	11400 2570	1.90	588000 132400	1.5 0.06	90.0 3.54	1.5 0.06	109.0 4.29	4.0 0.16	S	4 8	**L116100**	WR	1
85.725 3.3750	123.825 4.8750	92.078 3.6251	95.250 3.7500		298000 67200	0.33	2.05	3.05	22200 5000	77400 17400	12600 2820	1.77	624000 140800	0.8 0.03	93.0 3.66	1.5 0.06	116.0 4.57	4.0 0.16	S	4 8	**L217800**	WR	1
85.725 3.3750	136.525 5.3750	130.175 5.1250	133.604 5.2600		498000 112000	0.45	1.51	2.25	37100 8330	129200 29000	28200 6340	1.31	864000 194400	3.5 0.14	93.0 3.66	3.3 0.13	122.0 4.80	* *	S	7 15	**495**	WR	1
88.900 3.5000	123.825 4.8750	103.190 4.0626	103.190 4.0626		298000 67200	0.33	2.05	3.05	22200 5000	77400 17400	12600 2820	1.77	624000 140800	1.5 0.06	97.0 3.82	1.5 0.06	116.0 4.57	4.0 0.16	S	4 8	**L217800**	WR	1
92.075 3.6250	149.225 5.8750	130.172 5.1249	124.615 4.9061		526000 118000	0.49	1.37	2.04	39100 8790	136200 30600	33000 7410	1.19	964000 217200	1.5 0.06	103.0 4.06	3.3 0.13	134.0 5.28	4.0 0.16	S	9 19	**42000**	WR	1 & 3
95.250 3.7500	136.525 5.3750	122.235 4.8124	122.235 4.8124		450000 101200	0.28	2.38	3.54	33500 7530	116600 26200	16300 3660	2.06	908000 204400	0.8 0.03	102.0 4.02	2.3 0.09	126.0 4.96	* *	S	6 13	**LM119300**	WR	1
107.950 4.2500	146.050 5.7500	106.365 4.1876	106.365 4.1876		310000 69600	0.39	1.72	2.56	23100 5180	80200 18040	15500 3480	1.49	700000 157600	1.5 0.06	116.0 4.57	1.5 0.06	136.0 5.35	3.5 0.14	S	5 11	**L521900**	WR	1
107.950 4.2500	152.400 6.0000	138.112 5.4375	138.112 5.4375		574000 129200	0.28	2.39	3.56	42800 9610	149000 33400	20700 4650	2.07	1248000 280800	0.8 0.03	115.0 4.53	3.3 0.13	140.0 5.51	* *	S	8 17	**LM121900**	WR	1
120.134 4.7297	174.625 6.8750	139.703 5.5001	141.288 5.5625		788000 177200	0.33	2.03	3.02	58700 13200	204000 46000	33400 7510	1.76	1688000 379600	0.8 0.03	129.0 5.08	1.5 0.06	162.0 6.38	* *	S	11 24	**M224700**	WR	1
120.650 4.7500	161.925 6.3750	106.365 4.1876	106.365 4.1876		340000 76400	0.43	1.55	2.31	25300 5680	88000 19780	18800 4230	1.34	824000 185600	1.5 0.06	129.0 5.08	1.5 0.06	151.0 5.94	3.5 0.14	S	6 13	**L624500**	WR	1
120.650 4.7500	166.688 6.5625	152.413 6.0000	152.400 6.0000		674000 151400	0.29	2.30	3.42	50200 11300	174600 39200	25200 5670	1.99	1516000 341200	0.8 0.03	128.0 5.04	3.3 0.13	154.0 6.06	* *	S	10 21	**LM124400**	WR	1
120.650 4.7500	166.688 6.5625	152.413 6.0005	152.413 6.0000		674000 151400	0.29	2.30	3.42	50200 11300	174600 39200	25200 5670	1.99	1516000 341200	0.8 0.03	128.0 5.04	3.3 0.13	154.0 6.06	* *	S	10 21	**LM124400**	WR	1
120.650 4.7500	174.625 6.8750	139.703 5.5001	141.288 5.5625		788000 177200	0.33	2.03	3.02	58700 13200	204000 46000	33400 7510	1.76	1688000 379600	0.8 0.03	129.0 5.08	1.5 0.06	162.0 6.38	3.5 0.14	S	12 27	**M224700**	WR. BUR	1
127.000 5.0000	182.562 7.1875	158.750 6.2500	158.750 6.2500		864000 194200	0.31	2.21	3.29	64300 14500	224000 50400	33600 7550	1.91	1972000 444000	1.5 0.06	137.0 5.39	3.3 0.13	168.0 6.61	4.5 0.18	S	14 30	**48200**	WR. BUR	1
130.175 5.1250	196.850 7.7500	200.025 7.8750	200.025 7.8750		1186000 266000	0.34	1.96	2.92	88200 19800	308000 69000	52000 11700	1.70	2500000 564000	1.5 0.06	142.0 5.59	3.3 0.13	180.0 7.09	4.0 0.16	S	21 47	**67300**	WR	1

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
133.350 5.2500	196.850 7.7500	193.675 7.6250	193.675 7.6250		1186000 266000	0.34	1.96	2.92	88200 19800	308000 69000	52000 11700	1.70	2500000 564000	1.5 0.06	145.0 5.71	3.3 0.13	180.0 7.09	* *	S	20 45	**67300**	WR	1
136.525 5.3750	190.500 7.5000	161.925 6.3750	161.925 6.3750		912000 206000	0.32	2.10	3.13	67900 15300	236000 53200	37300 8390	1.82	2168000 488000	1.5 0.06	144.0 5.67	3.3 0.13	177.0 6.97	4.0 0.16	S	14 31	**48300**	WR. BUR	1
139.700 5.5000	200.025 7.8750	160.340 6.3126	157.960 6.2189		924000 208000	0.34	2.01	2.99	68800 15500	240000 53800	39600 8900	1.74	2240000 504000	0.8 0.03	150.0 5.91	3.3 0.13	185.0 7.28	3.5 0.14	S	17 37	**48600**	WR	1
139.700 5.5000	200.025 7.8750	160.340 6.3126	160.340 6.3126		208000 924000	0.34	2.01	2.99	15500 68800	53800 240000	8900 39600	1.74	504000 2240000	0.8 0.03	150.0 5.91	3.3 0.13	185.0 7.28	* *	S	17 36	**48600**	WR	1
139.700 5.5000	222.250 8.7500	127.000 5.0000	127.000 5.0000		179000 796000	0.44	1.55	2.30	13300 59300	46400 206000	9970 44400	1.34	308000 1368000	3.5 0.14	156.0 6.14	3.3 0.13	204.0 8.03	* *	S	16 35	**73000**	WR	1
146.050 5.7500	244.475 9.6250	187.325 7.3750	192.087 7.5625		292000 1296000	0.35	1.92	2.85	21700 96400	75400 336000	13100 58100	1.66	536000 2380000	1.5 0.06	162.1 6.38	3.3 0.13	225.0 8.86	* *	S	33 73	**81000**	WR	1
146.050 5.7500	244.475 9.6250	187.325 7.3750	192.088 7.5625		292000 1296000	0.35	1.92	2.85	21700 96400	75400 336000	13100 58100	1.66	536000 2380000	3.3 0.13	165.1 6.50	3.3 0.13	225.0 8.86	* *	S	33 73	**81000**	WR	1
149.975 5.9045	222.250 8.7500	174.625 6.8750	174.625 6.8750		272000 1214000	0.33	2.03	3.02	20300 90400	70800 314000	11600 51500	1.76	600000 2672000	1.5 0.06	164.5 6.48	1.5 0.06	207.0 8.15	* *	S	24 52	**M231600**	WR	1
152.400 6.0000	222.250 8.7500	174.625 6.8750	174.625 6.8750		1214000 272000	0.33	2.03	3.02	90400 20300	314000 70800	51500 11600	1.76	2672000 600000	1.5 0.06	164.0 6.46	1.5 0.06	207.0 8.10	4.5 0.18	S	23 51	**M231600**	BUR	1
152.400 6.0000	244.475 9.6250	187.325 7.3750	192.087 7.5625		292000 1296000	0.35	1.92	2.85	21700 96400	75400 336000	13100 58100	1.66	536000 2380000	1.5 0.06	166.1 6.54	3.3 0.13	225.0 8.86	* *	S	31 69	**81000**	WR	1
152.400 6.0000	298.450 11.7500	231.775 9.1250	231.775 9.1250		530000 2360000	0.33	2.03	3.02	39500 176000	137400 612000	22500 99900	1.76	812000 3608000	3.3 0.13	175.0 6.89	3.3 0.13	272.0 10.71	* *	S	71 157	**517000**	WR	1
158.750 6.2500	304.800 12.0000	233.365 9.1876	238.227 9.3790		2060000 462000	0.36	1.87	2.78	153000 34500	534000 120000	94500 21200	1.62	3468000 780000	3.3 0.13	186.0 7.32	3.3 0.13	279.0 10.98	* *	S	78 173	**280000**	WR	1
165.100 6.5000	225.425 8.8750	168.275 6.6250	165.100 6.5000		978000 220000	0.38	1.76	2.62	72800 16400	254000 57000	47800 10700	1.52	2540000 572000	0.8 0.03	175.0 6.89	3.3 0.13	209.0 8.23	2.5 0.1	S	21 45	**46700**	WR	1
168.275 6.6250	247.650 9.7500	192.088 7.5625	192.088 7.5625		294000 1306000	0.44	1.53	2.28	21900 97200	76200 338000	16500 73200	1.33	700000 3116000	1.5 0.06	190.0 7.48	3.3 0.13	229.0 9.02	* *	S	32 70	**67700**	WR	1
177.800 7.0000	247.650 9.7500	192.088 7.5625	192.088 7.5625		1306000 294000	0.44	1.54	2.29	97200 21900	338000 76200	73200 16500	1.33	3116000 700000	1.5 0.06	190.0 7.48	3.3 0.13	229.0 9.02	5.0 0.2	S	28 61	**67700**	WR	1
177.800 7.0000	247.650 9.7500	192.088 7.5625	195.650 7.7030		294000 1306000	0.44	1.53	2.28	21900 97200	76200 338000	16500 73200	1.33	700000 3116000	1.5 0.06	187.0 7.36	3.3 0.13	229.0 9.02	* *	S	28 62	**67700**	WR	1
177.800 7.0000	273.050 10.7500	234.947 9.2499	234.950 9.2500		1822000 410000	0.53	1.28	1.91	136000 30500	472000 106200	122000 27400	1.11	3916000 880000	1.5 0.06	195.0 7.68	3.3 0.13	249.0 9.80	4.0 0.16	S	54 120	**82600**	WR	1
177.800 7.0000	279.400 11.0000	234.947 9.2499	234.950 9.2500		410000 1822000	0.53	1.28	1.91	30500 136000	106200 472000	27400 122000	1.11	880000 3916000	1.5 0.06	195.0 7.68	3.3 0.13	251.0 9.88	* *	S	54 119	**82600**	WR	1
177.800 7.0000	285.750 11.2500	222.245 8.7498	222.250 8.7500		356000 1580000	0.43	1.56	2.32	26400 118000	92000 410000	19600 87200	1.35	652000 2892000	1.5 0.06	194.0 7.64	3.3 0.13	261.0 10.28	* *	S	52 114	**91000**	WR	1
177.800 7.0000	288.925 11.3750	263.525 10.3750	263.525 10.3750		478000 2120000	0.47	1.44	2.15	35600 159000	124000 552000	28600 127000	1.25	968000 4280000	1.5 0.06	195.0 7.68	3.3 0.13	259.0 10.20	* *	S	62 138	**94000**	WR	1
177.800 7.0000	288.925 11.3750	266.700 10.5000	266.700 10.5000		2660000 598000	0.32	2.12	3.15	198000 44500	688000 154800	108000 24300	1.83	4960000 1112000	1.5 0.06	194.0 7.64	3.3 0.13	266.0 10.47	9.0 0.35	S	67 147	**HM237500**	BUR	1
177.800 7.0000	304.800 12.0000	233.365 9.1876	238.227 9.3790		2060000 462000	0.36	1.87	2.78	153000 34500	534000 120000	94500 21200	1.62	3468000 780000	3.3 0.13	199.9 7.87	3.3 0.13	279.0 10.98	* *	S	69 153	**280000**	WR	1

Fig. 1 : TQOW

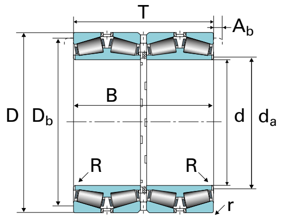


Fig. 2 : TQOWE

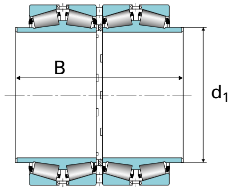


Fig. 3 : 2TDIW

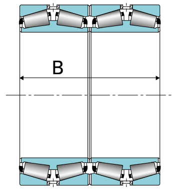
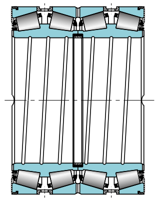


Fig. 4 : SRNB (narrow seal)



Notes :

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All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

† dimension is maximum value,

* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
177.800 7.0000	330.200 13.0000	234.950 9.2500	234.950 9.2500		520000 2320000	0.38	1.75	2.61	38700 172000	134800 600000	25500 113000	1.52	940000 4200000	1.5 0.06	200.0 7.87	3.3 0.13	299.0 11.77	* *	S	89 197	**210000**	WR	1
187.325 7.3750	269.875 10.6250	211.138 8.3125	211.138 8.3125		1768000 398000	0.33	2.03	3.02	132000 29600	458000 103000	74900 16800	1.76	3996000 900000	1.5 0.06	200.0 7.87	3.3 0.13	250.0 9.84	6.0 0.24	S	39 87	**M238800**	BUR	1
190.500 7.5000	266.700 10.5000	188.912 7.4375	187.325 7.3750		1342000 302000	0.48	1.41	2.11	99900 22500	348000 78200	81700 18400	1.22	3340000 752000	1.5 0.06	204.0 8.03	3.3 0.13	246.0 9.69	4.0 0.16	S	32 70	**67800**	WR	1 & 3
190.500 7.5000	266.700 10.5000	188.912 7.4375	188.912 7.4375		302000 1342000	0.48	1.41	2.10	22500 99900	78200 348000	18400 81700	1.22	752000 3340000	1.5 0.06	204.0 8.03	3.3 0.13	246.0 9.69	* *	S	32 70	**67800**	WR	1
190.500 7.5000	330.200 13.0000	234.950 9.2500	234.950 9.2500		2320000 520000	0.38	1.75	2.61	172000 38700	600000 134800	113000 25500	1.52	4200000 940000	3.3 0.13	213.0 8.39	3.3 0.13	299.0 11.77	* *	S	77 170	**210000**	WR	1
190.500 7.5000	330.200 13.0000	234.950 9.2500	238.125 9.3750		520000 2320000	0.38	1.75	2.61	38700 172000	134800 600000	25500 113000	1.52	940000 4200000	3.3 0.13	213.0 8.39	3.3 0.13	299.0 11.77	* *	S	83 183	**210000**	WR	1
190.500 7.5000	368.300 14.5000	387.350 15.2500	387.350 15.2500		3760000 846000	0.40	1.67	2.49	280000 63000	976000 220000	193000 43300	1.45 -	7280000 1636000	3.3 0.13	221.0 8.70	3.3 0.13	331.0 13.03	* *	S	171 376	**420000**	WR	3
196.850 7.7500	298.450 11.7500	174.628 6.8751	174.628 6.8751		1462000 328000	0.44	1.52	2.27	109000 24500	380000 85200	82500 18600	1.32	3056000 688000	1.5 0.06	214.0 8.43	3.3 0.13	277.0 10.91	* *	S	44 98	**8900**	WR	1
198.438 7.8125	284.162 11.1875	225.425 8.8750	225.425 8.8750		1946000 438000	0.33	2.03	3.02	145000 32600	504000 113400	82500 18600	1.76	4440000 996000	1.5 0.06	212.0 8.35	3.3 0.13	264.0 10.39	* *	S	46 102	**M240600**	BUR	1
203.200 8.0000	317.500 12.5000	209.550 8.2500	215.900 8.5000		406000 1802000	0.31	2.15	3.20	30200 134000	105000 468000	16200 72000	1.86	808000 3600000	3.3 0.13	224.0 8.82	3.3 0.13	293.9 11.57	* *	S	64 140	**132000**	WR	1
203.200 8.0000	317.500 12.5000	209.550 8.2500	209.550 8.2500		406000 1802000	0.31	2.15	3.20	30200 134000	105000 468000	16200 72000	1.86	808000 3600000	3.3 0.13	224.0 8.82	3.3 0.13	293.9 11.57	* *	S	63 139	**132000**	WR	1
203.200 8.0000	317.500 12.5000	223.042 8.7812	223.042 8.7812		424000 1890000	0.49	1.38	2.06	31600 141000	110200 490000	26300 117000	1.20	872000 3872000	1.5 0.06	221.0 8.70	3.3 0.13	292.0 11.50	* *	S	63 138	**93500**	WR	1
203.200 8.0000	317.500 12.5000	266.700 10.5000	266.700 10.5000		2360000 530000	0.52	1.29	1.92	175000 39500	612000 137400	157000 35300	1.12	5160000 1160000	1.5 0.06	222.0 8.74	3.3 0.13	286.0 11.26	8.5 0.33	S	90 198	**93000**	WR	1 & 3
203.200 8.0000	317.500 12.5000	336.550 13.2500	336.550 13.2500		2360000 530000	0.52	1.29	1.92	175000 39500	612000 137400	157000 35300	1.12 -	5160000 1160000	6.4 0.25	226.9 8.93	3.3 0.13	286.0 11.26	* *	S	89 195	**93000**	WR	3
203.352 8.0060	298.450 11.7500	174.628 6.8751	174.628 6.8751		1462000 328000	0.44	1.52	2.27	109000 24500	380000 85200	82500 18600	1.32	3056000 688000	1.5 0.06	218.0 8.58	3.3 0.13	277.0 10.91	* *	S	42 93	**8900**	WR	1
206.375 8.1250	282.575 11.1250	184.150 7.2500	184.150 7.2500		308000 1368000	0.51	1.33	1.98	22900 102000	79600 354000	19900 88700	1.15	788000 3504000	0.8 0.03	219.0 8.62	3.3 0.13	260.0 10.24	* *	S	35 77	**67900**	WR	1
206.375 8.1250	282.575 11.1250	190.500 7.5000	190.500 7.5000		1368000 308000	0.51	1.33	1.97	102000 22900	354000 79600	88700 19900	1.15	3504000 788000	0.8 0.03	219.0 8.62	3.3 0.13	260.0 10.24	5.0 0.2	S	35 77	**67900**	WR	1
207.000 8.1496	279.975 11.0226	170.000 6.6929	170.000 6.6929		1300000 292000	0.32	2.11	3.14	96700 21700	336000 75800	52900 11900	1.83 -	2712000 608000	1.5 0.06	219.0 8.62	1.5 0.06	262.0 10.31	* *	S	27 59	**LM241700**	WR	4

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
215.900 8.5000	288.925 11.3750	177.800 7.0000	177.800 7.0000		1386000 312000	0.48	1.40	2.09	103000 23200	360000 80800	85000 19100	1.21	3568000 800000	0.8 0.03	229.4 9.03	3.3 0.13	267.0 10.51	5.0 0.2	S	33 73	**LM742700**	WR	1
215.900 8.5000	355.600 14.0000	260.350 10.2500	260.350 10.2500		612000 2720000	0.33	2.04	3.04	45500 202000	158400 704000	25700 114000	1.77	1256000 5600000	1.5 0.06	237.0 9.33	1.5 0.06	329.0 12.95	* *	S	100 220	**130000**	WR	1
215.900 8.5000	355.600 14.0000	269.875 10.6250	273.050 10.7500		550000 2440000	0.59	1.14	1.70	41000 182000	142600 634000	41400 184000	0.99	1276000 5680000	6.4 0.25	249.0 9.80	3.3 0.13	318.0 12.52	* *	S	72 158	**96000**	WR	1
216.103 8.5080	330.200 13.0000	263.525 10.3750	269.875 10.6250		536000 2380000	0.55	1.22	1.82	39900 178000	139000 618000	37700 168000	1.06	1200000 5360000	1.5 0.06	235.0 9.25	3.3 0.13	300.0 11.81	* *	S	83 182	**9900**	WR	1
220.662 8.6875	314.325 12.3750	239.712 9.4375	239.712 9.4375		2380000 534000	0.33	2.03	3.02	177000 39700	616000 138400	101000 22600	1.76	5480000 1232000	1.5 0.06	235.0 9.25	3.3 0.13	293.0 11.54	6.5 0.26	S	61 134	**M244200**	WR. BUR	1
220.662 8.6875	314.325 12.3750	239.712 9.4375	239.712 9.4375		534000 2380000	0.28	2.39	3.56	39800 177000	138600 616000	19200 85600	2.07	1148000 5120000	1.5 0.06	235.0 9.25	1.5 0.06	293.0 11.54	* *	S	55 121	**M144400**	WR	4
225.425 8.8750	355.600 14.0000	260.350 10.2500	260.350 10.2500		612000 2720000	0.33	2.04	3.04	45500 202000	158400 704000	25700 114000	1.77	1256000 5600000	5.5 0.22	252.0 9.92	1.5 0.06	329.0 12.95	* *	S	93 204	**130000**	WR	1
228.600 9.0000	311.150 12.2500	200.025 7.8750	200.025 7.8750		1838000 414000	0.33	2.03	3.02	137000 30800	476000 107200	77900 17500	1.76	4160000 932000	1.5 0.06	242.0 9.53	3.3 0.13	293.0 11.54	* *	S	42 93	**LM245100**	WR	1
228.600 9.0000	355.600 14.0000	260.350 10.2500	266.700 10.5000		612000 2720000	0.33	2.04	3.04	45500 202000	158400 704000	25700 114000	1.77	1256000 5600000	1.5 0.06	247.0 9.72	1.5 0.06	329.0 12.95	* *	S	93 204	**130000**	WR	1
228.600 9.0000	355.600 14.0000	260.350 10.2500	260.350 10.2500		612000 2720000	0.33	2.04	3.04	45500 202000	158400 704000	25700 114000	1.77	1256000 5600000	1.5 0.06	247.0 9.72	1.5 0.06	329.0 12.95	* *	S	92 202	**130000**	WR	1
228.600 9.0000	355.600 14.0000	260.350 10.2500	260.350 10.2500		612000 2720000	0.33	2.04	3.04	45500 202000	158400 704000	25700 114000	1.77	1256000 5600000	5.5 0.22	255.0 10.04	1.5 0.06	329.0 12.95	* *	S	92 202	**130000**	WR	1
228.600 9.0000	400.050 15.7500	296.875 11.6880	296.875 11.6880		856000 3800000	0.31	2.18	3.25	63700 283000	222000 986000	33700 150000	1.89	1648000 7320000	3.3 0.13	256.0 10.08	3.3 0.13	367.0 14.45	* *	S	154 340	**529000**	WR	1
228.600 9.0000	425.450 16.7500	361.950 14.2500	361.950 14.2500		1038000 4620000	0.33	2.03	3.02	77300 344000	270000 1198000	44000 196000	1.76	1924000 8560000	3.5 0.14	259.0 10.20	6.4 0.25	381.0 15.00	* *	S	231 510	**700000**	WR	1
234.950 9.2500	327.025 12.8750	196.850 7.7500	196.850 7.7500		180000 404000	0.41	1.66	2.47	134000 30100	466000 105000	93300 21000	1.44	4280000 960000	1.5 0.06	250.0 9.84	3.3 0.13	305.0 12.01	6.0 0.24	S	53 117	**8500**	WR	1
234.950 9.2500	328.625 12.9380	196.850 7.7500	196.850 7.7500		1800000 404000	0.41	1.66	2.47	134000 30100	466000 105000	93300 21000	1.44	4280000 960000	1.5 0.06	250.0 9.84	3.3 0.13	306.0 12.05	* *	S	55 120	**8500**	WR	1
234.950 9.2500	384.175 15.1250	457.995 18.0313	457.995 18.0313		5720000 1286000	0.33	2.03	3.02	426000 95700	1482000 334000	242000 54500	1.76 -	12440000 2796000	1.5 0.06	259.0 10.20	6.4 0.25	346.0 13.62	* *	S	205 452	**H247500**	WR	3
240.000 9.4488	338.000 13.3071	248.000 9.7638	248.000 9.7638		544000 2420000	0.36	1.87	2.78	40500 180000	141200 628000	25000 111000	1.62	1304000 5800000	4.0 0.16	261.0 10.28	3.3 0.13	317.0 12.48	* *	S	70 155	**M447700**	WR	1
241.224 9.4970	349.148 13.7460	228.600 9.0000	228.600 9.0000		506000 2260000	0.35	1.90	2.83	37700 168000	131400 584000	22800 101000	1.65	1128000 5000000	1.5 0.06	257.0 10.12	3.3 0.13	325.0 12.80	* *	S	70 155	**127000**	WR	1
241.224 9.4970	355.498 13.9960	228.600 9.0000	228.600 9.0000		506000 2260000	0.35	1.90	2.83	37700 168000	131400 584000	22800 101000	1.65	1128000 5000000	1.5 0.06	257.0 10.12	3.3 0.13	327.0 12.87	* *	S	77 170	**127000**	WR	1
241.478 9.5070	349.148 13.7460	228.600 9.0000	228.600 9.0000		2260000 506000	0.35	1.91	2.85	168000 37700	584000 131400	101000 22800	1.65	5000000 1128000	1.5 0.06	258.0 10.16	3.3 0.13	325.0 12.80	6.0 0.24	S	77 170	**127000**	WR	1
241.478 9.5070	349.148 13.7460	228.600 9.0000	228.600 9.0000		506000 2260000	0.35	1.90	2.83	37700 168000	131400 584000	22800 101000	1.65	1128000 5000000	1.5 0.06	258.0 10.16	3.3 0.13	325.0 12.80	* *	S	70 155	**127000**	WR	1
241.478 9.5070	349.148 13.7460	228.600 9.0000	228.600 9.0000		2300000 516000	0.36	1.89	2.82	171000 38500	596000 134000	104000 23500	1.64 -	5160000 1164000	1.5 0.06	259.0 10.20	6.4 0.25	328.0 12.91	* *	S	69 151	**LM348900**	WR	4

TIMKEN

Fig. 1 : TQOW

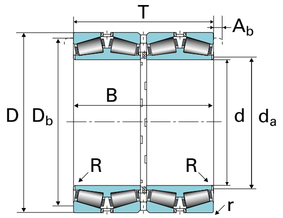


Fig. 2 : TQOWE

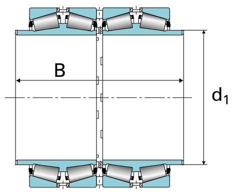


Fig. 3 : 2TDIW

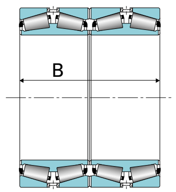
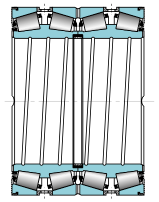


Fig. 4 : SRNB
(narrow seal)



Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

Any other size can be considered to fit your design requirements,

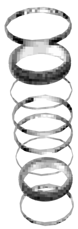
All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

† dimension is maximum value,

* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
				TQOWE	1 million revolutions				90 million revolutions				Static										
d	D	T	B	d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
241.478 9.5070	349.148 13.7460	228.600 9.0000	228.600 9.0000		2300000 516000	0.36	1.89	2.82	171000 38500	596000 134000	104000 23500	1.64 -	5160000 1164000	1.5 0.06	259.0 10.20	6.4 0.25	328.0 12.91	* *	S	69 151	**LM348900**	WR	4
241.478 9.5070	350.838 13.8125	228.600 9.0000	228.600 9.0000		506000 2260000	0.35	1.90	2.83	37700 168000	131400 584000	22800 101000	1.65	1128000 5000000	1.5 0.06	258.0 10.16	3.3 0.13	325.0 12.80	* *	S	73 161	**127000**	WR	1
241.478 9.5070	355.498 13.9960	228.600 9.0000	228.600 9.0000		506000 2260000	0.35	1.90	2.83	37700 168000	131400 584000	22800 101000	1.65	1128000 5000000	1.5 0.06	258.0 10.16	3.3 0.13	327.0 12.87	* *	S	77 170	**127000**	WR	1
244.000 9.6063	329.950 12.9902	206.000 8.1102	246.000 9.6850		1936000 436000	0.32	2.10	3.13	144000 32400	502000 112800	79200 17800	1.82 -	4560000 1028000	3.0 0.12	262.0 10.31	3.3 0.13	312.0 12.28	* *	S	70 154	**LM247700**	WR	2
244.475 9.6250	327.025 12.8750	193.675 7.6250	193.675 7.6250		1936000 436000	0.32	2.1	3.13	144000 32400	502000 112800	79200 17800	1.82	4560000 1028000	1.5 0.06	257.0 10.12	3.3 0.13	310.0 12.20	* *	S	45 99	**LM247700**	WR	1
244.475 9.6250	327.025 12.8750	193.675 7.6250	231.775 9.1250		1936000 436000	0.32	2.1	3.13	144000 32400	502000 112800	79200 17800	1.82	4560000 1028000	1.5 0.06	261.0 10.28	3.3 0.13	310.0 12.20	* *	S	48 105	**LM247700**	WR	2
244.475 9.6250	381.000 15.0000	304.800 12.0000	304.800 12.0000		696000 3100000	0.52	1.30	1.94	51800 231000	180600 804000	45800 204000	1.13	1524000 6760000	3.3 0.13	269.0 10.59	4.8 0.19	343.0 13.50	* *	S	126 277	**126000**	WR	1
247.650 9.7500	400.050 15.7500	253.995 9.9998	253.995 9.9998		636000 2820000	0.40	1.71	2.54	47300 210000	164600 732000	31900 142000	1.48	1304000 5800000	1.5 0.06	271.0 10.67	6.4 0.25	366.0 14.41	* *	S	121 267	**220000**	WR	1
247.650 9.7500	406.400 16.0000	447.675 17.6250	450.850 17.7500		6700000 1508000	0.33	2.03	3.02	499000 112000	1740000 390000	284000 63900	1.76 -	15080000 3384000	3.3 0.13	278.0 10.94	6.4 0.25	366.0 14.41	* *	P	246 541	**HH249900**	WR	3
250.825 9.8750	431.724 16.9970	298.453 11.7501	298.453 11.7501		1034000 4600000	0.33	2.03	3.02	77000 343000	268000 1194000	43900 195000	1.76	1900000 8440000	3.5 0.14	278.0 10.94	3.5 0.14	397.0 15.63	* *	P	186 411	**HM252300**	WR	1
250.825 9.8750	431.724 16.9970	298.453 11.7501	298.453 11.7501		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	3.5 0.14	278.0 10.94	3.5 0.14	397.0 15.63	* *	S	174 383	**HM252300**	WR	1
254.000 10.0000	358.775 14.1250	269.875 10.6250	269.875 10.6250		3120000 702000	0.33	2.03	3.02	232000 52200	810000 182000	132000 29700	1.76	7400000 1664000	3.3 0.13	273.0 10.75	3.3 0.13	335.0 13.19	7.5 0.3	S	87 191	**M249700**	BUR	1
254.000 10.0000	358.775 14.1250	269.876 10.6250	269.876 10.6250		3140000 704000	0.31	2.20	3.28	233000 52500	812000 182800	122000 27400	1.91 -	6880000 1544000	1.5 0.06	272.0 10.71	6.4 0.25	338.0 13.31	* *	S	80 177	**M149500**	WR	4
254.000 10.0000	422.275 16.6250	305.595 12.0313	305.595 12.0313		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	3.5 0.14	281.0 11.06	3.3 0.13	392.0 15.43	* *	S	166 366	**HM252300**	WR	1
254.000 10.0000	422.275 16.6250	311.150 12.2500	311.150 12.2500		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	3.5 0.14	281.0 11.06	3.3 0.13	392.0 15.43	* *	S	167 368	**HM252300**	WR	1
254.000 10.0000	431.724 16.9970	298.453 11.7501	298.453 11.7501		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	3.5 0.14	281.0 11.06	3.5 0.14	397.0 15.63	* *	S	178 392	**HM252300**	WR	1
254.000 10.0000	444.500 17.5000	279.400 11.0000	279.400 11.0000		902000 4020000	0.34	1.97	2.94	67200 299000	234000 1040000	39200 175000	1.71	1568000 6960000	3.3 0.13	281.9 11.10	6.4 0.25	404.9 15.94	* *	P	189 416	**822000**	WR	1
260.350 10.2500	365.125 14.3750	228.600 9.0000	228.600 9.0000		522000 2320000	0.38	1.80	2.68	38800 173000	135200 602000	24900 111000	1.56	1196000 5320000	3.3 0.13	280.0 11.02	6.4 0.25	339.0 13.35	* *	S	71 155	**134000**	WR	1



Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d$_1$	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
260.350 10.2500	400.050 15.7500	253.995 9.9998	253.995 9.9998		636000 2820000	0.40	1.71	2.54	47300 210000	164600 732000	31900 142000	1.48	1304000 5800000	6.4 0.25	290.0 11.42	6.4 0.25	366.0 14.41	* *	S	112 246	**220000**	WR	1
260.350 10.2500	400.050 15.7500	253.995 9.9998	255.585 10.0624		636000 2820000	0.40	1.71	2.54	47300 210000	164600 732000	31900 142000	1.48	1304000 5800000	1.5 0.06	280.0 11.02	6.4 0.25	366.0 14.41	* *	S	112 248	**220000**	WR	1
260.350 10.2500	400.050 15.7500	254.000 10.0000	254.000 10.0000		2820000 636000	0.40	1.71	2.54	210000 47300	732000 164600	142000 31900	1.48	5800000 1304000	6.4 0.25	290.0 11.42	6.4 0.25	366.0 14.41	* *	S	106 234	**220000**	WR	1
260.350 10.2500	406.400 16.0000	317.500 12.5000	317.500 12.5000		900000 4000000	0.33	2.02	3.01	67000 298000	234000 1038000	38200 170000	1.75	1912000 8520000	6.4 0.25	287.3 11.31	3.3 0.13	376.0 14.80	* *	S	152 336	**324000**	WR	1
260.350 10.2500	419.100 16.5000	330.200 13.0000	330.200 13.0000		862000 3840000	0.60	1.12	1.67	64200 286000	224000 994000	66500 296000	0.97	1804000 8040000	3.3 0.13	289.0 11.38	3.3 0.13	376.0 14.80	* *	S	173 380	**435000**	WR	1
260.350 10.2500	422.275 16.6250	305.595 12.0313	305.595 12.0313		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	3.5 0.14	285.0 11.22	3.3 0.13	392.0 15.43	* *	S	160 354	**HM252300**	WR	1
260.350 10.2500	422.275 16.6250	311.150 12.2500	311.150 12.2500		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	3.5 0.14	285.0 11.22	3.3 0.13	392.0 15.43	* *	S	161 355	**HM252300**	WR	1
260.350 10.2500	422.275 16.6250	317.500 12.5000	317.500 12.5000		1034000 4600000	0.33	2.03	3.02	77000 343000	268000 1194000	43900 195000	1.76	1900000 8440000	6.4 0.25	291.0 11.46	3.3 0.13	392.0 15.43	* *	P	169 372	**HM252300**	WR	1
260.350 10.2500	422.275 16.6250	317.500 12.5000	317.500 12.5000		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	6.4 0.25	291.0 11.46	3.3 0.13	392.0 15.43	* *	S	163 360	**HM252300**	WR	1
260.350 10.2500	431.724 16.9970	298.453 11.7501	298.453 11.7501		1004000 4460000	0.33	2.03	3.02	74700 332000	260000 1156000	42500 189000	1.76	1820000 8080000	3.5 0.14	285.0 11.22	3.5 0.14	397.0 15.63	* *	S	172 380	**HM252300**	WR	1
266.700 10.5000	355.600 14.0000	224.600 8.8426	228.600 9.0000		2280000 510000	0.36	1.87	2.78	169000 38000	588000 132400	104000 23400	1.62 -	5520000 1240000	1.5 0.06	281.0 11.06	3.3 0.13	339.0 13.35	* *	S	58 129	**LM451400**	WR	4
266.700 10.5000	355.600 14.0000	228.600 9.0000	230.188 9.0625		240000 538000	0.36	1.87	2.79	178000 40100	620000 139600	110000 24700	1.62	6040000 1350000	1.5 0.06	281.0 11.06	3.3 0.13	335.0 13.19	7.0 0.28	S	61 135	**LM451300**	WR	1 & 3
266.700 10.5000	355.600 14.0000	228.600 9.0000	235.331 9.2650		538000 2400000	0.36	1.87	2.78	40100 178000	139600 620000	24700 110000	1.62	1356000 6040000	1.5 0.06	281.0 11.06	3.3 0.13	335.0 13.19	* *	S	61 135	**LM451300**	WR	1
266.700 10.5000	357.200 14.0630	228.600 9.0000	230.188 9.0625		538000 2400000	0.36	1.87	2.78	40100 178000	139600 620000	24700 110000	1.62	1356000 6040000	1.5 0.06	281.0 11.06	3.3 0.13	335.0 13.19	* *	S	63 138	**LM451300**	WR	1
266.700 10.5000	393.700 15.5000	269.878 10.6251	269.878 10.6251		678000 3020000	0.40	1.67	2.49	50400 224000	175600 782000	34700 154000	1.45	1436000 6400000	3.3 0.13	290.0 11.42	6.4 0.25	366.0 14.41	* *	S	104 230	**275000**	WR	1
266.700 10.5000	406.400 16.0000	260.355 10.2502	268.288 10.5625		678000 3020000	0.40	1.67	2.49	50400 224000	175600 782000	34700 154000	1.45	1436000 6400000	3.3 0.13	290.0 11.42	6.4 0.25	373.0 14.69	* *	S	116 255	**275000**	WR	1
269.875 10.6250	381.000 15.0000	282.575 11.1250	282.575 11.1250		3420000 768000	0.33	2.03	3.02	255000 57200	886000 199200	145000 32600	1.76	8120000 1820000	3.3 0.13	290.0 11.42	3.3 0.13	356.0 14.02	8.5 0.33	S	104 229	**M252300**	BUR	1
269.875 10.6250	381.000 15.0000	282.576 11.1250	282.576 11.1250		3300000 740000	0.33	2.03	3.02	245000 55200	854000 192200	140000 31400	1.76 -	7640000 1716000	3.3 0.13	291.0 11.46	3.3 0.13	353.0 13.90	* *	S	98 215	**M252500**	WR	4
273.050 10.7500	380.898 14.9960	244.475 9.6250	244.475 9.6250		554000 2460000	0.43	1.56	2.32	41300 184000	143600 640000	30500 136000	1.35	1548000 6880000	1.5 0.06	293.0 11.54	3.3 0.13	356.0 14.02	* *	S	90 198	**LM654600**	WR	1
276.225 10.8750	381.000 15.0000	193.675 7.6250	193.675 7.6250		356000 1582000	0.59	1.15	1.72	26500 118000	92200 410000	26400 117000	1.00	848000 3764000	3.3 0.13	297.0 11.69	3.3 0.13	354.0 13.94	* *	S	64 142	**89000**	WR	1
276.225 10.8750	381.000 15.0000	209.550 8.2500	209.550 8.2500		356000 1582000	0.59	1.15	1.72	26500 118000	92200 410000	26400 117000	1.00	848000 3764000	3.3 0.13	297.0 11.69	6.4 0.25	348.0 13.70	* *	S	67 149	**89000**	WR	1
276.225 10.8750	393.700 15.5000	269.878 10.6251	269.878 10.6251		3020000 678000	0.4	1.68	2.5	224000 50400	782000 175600	154000 34700	1.45	6400000 1436000	1.5 0.06	294.0 11.57	6.4 0.25	366.0 14.41	4.5 0.18	S	103 223	**275000**	WR	1

TQOW-TQOWE 2TDIW-SRNB

Fig. 1 : TQOW

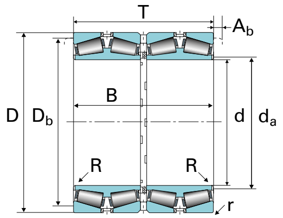


Fig. 2 : TQOWE

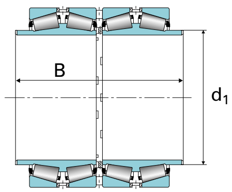


Fig. 3 : 2TDIW

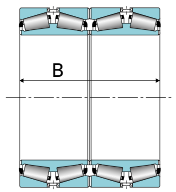
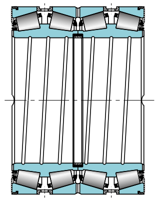


Fig. 4 : SRNB (narrow seal)



Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

Any other size can be considered to fit your designrequirements,

All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

† dimension is maximum value,

* contact your Timken sales engineer.

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
276.225 10.8750	406.400 16.0000	260.355 10.2502	268.288 10.5625		678000 3020000	0.40	1.67	2.49	50400 224000	175600 782000	34700 154000	1.45	1436000 6400000	1.5 0.06	293.6 11.56	6.4 0.25	373.0 14.69	* *	S	115 252	**275000**	WR	1
279.400 11.0000	393.700 15.5000	269.875 10.6250	269.875 10.6250		3540000 794000	0.43	1.57	2.34	263000 59200	916000 206000	193000 43500	1.36	7320000 1644000	1.5 0.06	294.0 11.57	6.4 0.25	368.0 14.49	* *	S	96 211	**M652900**	WR	3
279.400 11.0000	393.700 15.5000	269.875 10.6250	269.875 10.6250		2980000 670000	0.38	1.77	2.64	222000 49900	774000 173800	145000 32500	1.54	6680000 1500000	1.5 0.06	297.0 11.69	6.4 0.25	368.0 14.49	* *	S	99 218	**135000**	WR	1
279.400 11.0000	393.700 15.5000	269.875 10.6250	269.875 10.6250		2980000 670000	0.39	1.72	2.56	222000 49900	774000 173800	149000 33500	1.49 -	7680000 1724000	1.5 0.06	306.0 12.05	2.0 0.08	360.0 14.17	* *	S	101 224	**M554900**	WR	4
279.400 11.0000	457.200 18.0000	536.575 21.1250	536.575 21.1250		8440000 1898000	0.33	2.03	3.02	628000 141000	2180000 492000	358000 80400	1.76 -	19280000 4320000	1.5 0.06	309.0 12.17	6.4 0.25	412.0 16.22	* *	P	352 776	**HH255100**	WR	3
279.400 11.0000	469.900 18.5000	349.250 13.7500	349.250 13.7500		1080000 4800000	0.38	1.79	2.66	80300 357000	280000 1244000	52000 231000	1.55	2108000 9400000	6.4 0.25	314.0 12.36	3.3 0.13	430.0 16.93	* *	S	233 514	**722000**	WR	1
279.400 11.0000	469.900 18.5000	390.525 15.3750	384.175 15.1250		4800000 1080000	0.38	1.79	2.66	357000 80300	1244000 280000	231000 52000	1.55	9400000 2108000	9.7 0.38	321.0 12.64	3.3 0.13	430.0 16.93	5.5 0.22	S	254 560	**722000**	-	1
279.400 11.0000	495.300 19.5000	384.175 15.1250	384.175 15.1250		4620000 1038000	0.40	1.67	2.49	343000 77200	1196000 268000	236000 53100	1.45 -	8360000 1884000	1.5 0.06	310.0 12.20	3.3 0.13	459.0 18.07	* *	P	266 586	**940000**	WR	3
279.578 11.0070	380.898 14.9960	244.474 9.6250	245.800 9.6250		554000 2460000	0.43	1.56	2.32	41300 184000	143600 640000	30500 136000	1.35	1548000 6880000	1.5 0.06	297.0 11.69	3.3 0.13	356.0 14.02	* *	S	86 189	**LM654600**	WR	1
279.578 11.0070	380.898 14.9960	244.475 9.6250	244.475 9.6770		554000 2460000	0.43	1.56	2.32	41300 184000	143600 640000	30500 136000	1.35	1548000 6880000	1.5 0.06	297.0 11.69	3.3 0.13	356.0 14.02	* *	S	84 186	**LM654600**	WR	1
279.578 11.0070	381.000 15.0000	193.675 7.6250	193.675 7.6250		356000 1582000	0.59	1.15	1.72	26500 118000	92200 410000	26400 117000	1.00	848000 3764000	3.3 0.13	299.0 11.77	3.3 0.13	354.0 13.94	* *	S	62 137	**89000**	WR	1
279.578 11.0070	381.000 15.0000	209.550 8.2500	209.550 8.2500		356000 1582000	0.59	1.15	1.72	26500 118000	92200 410000	26400 117000	1.00	848000 3764000	3.3 0.13	299.0 11.77	6.4 0.25	348.0 13.70	* *	S	65 144	**89000**	WR	1
285.750 11.2500	380.898 14.9960	244.475 9.6250	244.475 9.6250		2460000 554000	0.43	1.56	2.33	184000 41300	640000 143600	136000 30500	1.35	6880000 1548000	1.5 0.06	302.0 11.89	3.3 0.13	356.0 14.02	4.5 0.18	S	80 176	**LM654600**	WR	1
285.750 11.2500	380.900 14.9960	244.475 9.6250	244.475 9.6250		2500000 562000	0.33	2.03	3.02	186000 41800	648000 145600	106000 23800	1.76 -	5680000 1280000	1.5 0.06	301.0 11.85	3.3 0.13	367.0 14.45	* *	S	68 151	**LM254300**	WR	4
288.925 11.3750	406.400 16.0000	298.450 11.7500	298.450 11.7500		4060000 914000	0.34	2.00	2.97	302000 68000	1052000 236000	175000 39300	1.73	10080000 2268000	3.3 0.13	310.0 12.20	3.3 0.13	379.0 14.92	* *	P	127 280	**M255400**	BUR	1 & 3
292.100 11.5000	422.275 16.6250	269.875 10.6250	269.875 10.6250		834000 3720000	0.32	2.11	3.14	62100 276000	216000 962000	34000 151000	1.83	1848000 8200000	3.1 0.13	314.2 12.37	3.3 0.13	395.0 15.55	* *	P	126 277	**330000**	WR	1
292.100 11.5000	476.250 18.7500	292.100 11.5000	292.100 11.5000		1010000 4500000	0.29	2.31	3.44	75200 334000	262000 1164000	37600 167000	2.00	1788000 7960000	1.5 0.06	314.0 12.36	3.3 0.13	442.0 17.40	* *	P	197 435	**920000**	WR	1
294.975 11.6132	389.949 15.3523	220.000 8.6614	260.000 10.2362	315.595 12.4250	2500000 564000	0.33	2.03	3.02	187000 42000	650000 146200	106000 23900	1.76 -	6080000 1368000	Spec	313.0 12.32	3.3 0.13	370.0 14.57	* *	S	93 206	**LM255700**	WR	2

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
				TQOWE	1 million revolutions				90 million revolutions				Static										
d	D	T	B	d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
295.000 11.6142	389.950 15.3524	220.000 8.6614	220.000 8.6614		2540000 570000	0.34	1.97	2.94	188000 42400	656000 147600	110000 24800	1.71 -	5880000 1320000	1.5 0.06	310.0 12.20	3.3 0.13	374.0 14.72	* *	S	65 143	**LM355300**	WR	4
298.450 11.7500	438.048 17.2460	279.400 11.0000	279.400 11.0000		828000 3680000	0.33	2.03	3.02	61700 274000	214000 956000	35000 156000	1.76	1848000 8240000	3.3 0.13	323.0 12.72	3.3 0.13	410.0 16.14	* *	S	136 299	**329000**	WR	1
298.450 11.7500	444.500 17.5000	241.300 9.5000	241.300 9.5000		594000 2640000	0.38	1.79	2.66	44200 196000	153800 684000	28600 127000	1.55	1248000 5560000	8.0 0.31	332.0 13.07	1.5 0.06	416.0 16.38	* *	S	126 277	**290000**	WR	1
298.450 11.7500	447.675 17.6250	327.025 12.8750	327.025 12.8750		1122000 5000000	0.34	2.01	2.99	83600 372000	290000 1294000	47900 213000	1.74	2824000 12560000	3.3 0.13	326.0 12.83	3.3 0.13	418.0 16.46	* *	P	189 417	**HM259000**	WR	1
299.974 11.8100	440.000 17.3208	279.400 11.0000	280.988 11.0625		688000 3060000	0.42	1.62	2.41	51200 228000	178400 794000	36500 162000	1.40	1604000 7120000	3.3 0.13	324.0 12.76	4.8 0.19	407.0 16.02	* *	S	143 315	**129000**	WR	1
300.038 11.8125	422.275 16.6250	311.150 11.7860	311.150 11.7860		4420000 4420000	0.34	2.00	2.99	330000 330000	1148000 1148000	190000 190000	1.73	11080000 11080000	3.3 0.13	322.0 12.68	3.3 0.13	394.0 15.51	* *	P	141 310	**HM256800**	BUR	1
300.038 11.8125	422.275 16.6250	311.150 12.2500	311.150 12.2500		996000 996000	0.34	2.00	2.97	74100 74100	258000 258000	42700 42700	1.73	2488000 2488000	3.3 0.13	322.0 12.68	3.3 0.13	394.0 15.51	* *	P	141 311	**HM256800**	WR	1
304.648 11.9940	438.048 17.2460	279.400 11.0000	280.990 11.0626		3760000 844000	0.47	1.43	2.12	279000 62800	972000 218000	226000 50800	1.24	8200000 1848000	3.3 0.13	328.0 12.91	4.8 0.19	407.0 16.02	* *	S	130 286	**M757400**	WR	1
304.648 11.9940	438.048 17.2460	279.400 11.0000	280.988 11.0625		688000 3060000	0.42	1.62	2.41	51200 228000	178400 794000	36500 162000	1.40	1604000 7120000	3.3 0.13	327.0 12.87	4.8 0.19	406.0 15.98	* *	S	133 293	**129000**	WR	1
304.648 11.9940	438.048 17.2460	279.400 11.0000	279.400 11.0000		828000 3680000	0.33	2.03	3.02	61700 274000	214000 956000	35000 156000	1.76	1848000 8240000	3.3 0.13	327.0 12.87	3.3 0.13	410.0 16.14	* *	S	132 292	**329000**	WR	1
304.648 11.9940	438.048 17.2460	279.400 11.0000	279.400 11.0000		846000 3760000	0.33	2.03	3.02	63000 280000	220000 976000	35800 159000	1.76	1908000 8480000	3.3 0.13	327.0 12.87	3.3 0.13	410.0 16.14	* *	P	137 303	**329000**	WR	1
304.648 11.9940	438.048 17.2460	279.400 11.0000	280.990 11.0626		3920000 882000	0.33	2.02	3.01	292000 65700	1018000 228000	167000 37600	1.75 -	8320000 1872000	3.3 0.13	328.0 12.91	1.5 0.06	407.0 16.02	* *	S	130 286	**M257600**	WR	4
304.800 12.0000	419.100 16.5000	269.875 10.6250	269.875 10.6250		3560000 800000	0.33	2.03	3.02	265000 59500	922000 208000	151000 33900	1.76	8480000 1908000	1.5 0.06	322.0 12.68	6.4 0.25	392.0 15.45	* *	S	105 231	**M257100**	WR	1
304.800 12.0000	444.500 17.5000	241.300 9.5000	241.300 9.5000		594000 2640000	0.38	1.79	2.66	44200 196000	153800 684000	28600 127000	1.55	1248000 5560000	8.0 0.31	337.0 13.27	1.5 0.06	416.0 16.38	* *	S	121 266	**290000**	WR	1
304.800 12.0000	444.500 17.5000	241.300 9.5000	247.650 9.7500		594000 2640000	0.38	1.79	2.66	44200 196000	153800 684000	28600 127000	1.55	1248000 5560000	8.0 0.31	330.2 13.00	1.5 0.06	416.0 16.38	* *	S	121 267	**290000**	WR	1
304.800 12.0000	495.300 19.5000	285.750 11.2500	285.750 11.2500		4620000 1038000	0.40	1.68	2.50	343000 77200	1196000 268000	236000 53100	1.45	8360000 1884000	1.5 0.06	329.0 12.95	3.3 0.13	459.0 18.01	* *	P	211 465	**940000**	WR	1
304.800 12.0000	495.300 19.5000	292.100 11.5000	292.100 11.5000		1038000 4620000	0.40	1.67	2.49	77200 343000	268000 1196000	53100 236000	1.45	1884000 8360000	1.5 0.06	329.0 12.95	3.3 0.13	459.0 18.07	* *	P	215 474	**940000**	WR	1
304.800 12.0000	495.300 19.5000	384.175 15.1250	384.175 15.1250		4620000 1038000	0.40	1.67	2.49	343000 77200	1196000 268000	236000 53100	1.45 -	8360000 1884000	1.5 0.06	329.0 12.95	3.3 0.13	459.0 18.07	* *	P	220 486	**940000**	WR	3
304.800 12.0000	501.650 19.7500	336.547 13.2499	336.550 13.2500		6120000 1376000	0.33	2.03	3.02	456000 102000	1586000 356000	259000 58300	1.76	11080000 2492000	3.3 0.13	332.0 13.07	6.4 0.25	464.0 18.27	* *	P	272 599	**HM258900**	BUR	1
304.902 12.0040	412.648 16.2460	266.700 10.5000	266.700 10.5000		3320000 746000	0.32	2.12	3.15	247000 55600	860000 193600	135000 30300	1.83	8560000 1924000	3.3 0.13	325.0 12.80	3.3 0.13	388.0 15.28	* *	S	107 236	**M257200**	WR	1
304.902 12.0040	412.648 16.2460	266.700 10.5000	266.700 10.5000		3260000 734000	0.33	2.03	3.02	243000 54700	846000 190400	138000 31100	1.76 -	7760000 1748000	3.3 0.13	318.0 12.52	3.3 0.13	395.0 15.55	* *	S	97 213	**LM257100**	WR	4
305.000 12.0079	438.048 17.2460	279.400 11.0000	280.990 11.0626		3920000 882000	0.33	2.02	3.01	292000 65700	1018000 228000	167000 37600	1.75 -	8320000 1872000	3.3 0.13	328.0 12.91	4.8 0.19	415.0 16.34	* *	S	133 277	**M257600**	WR	3

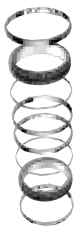


Fig. 1 : TQOW

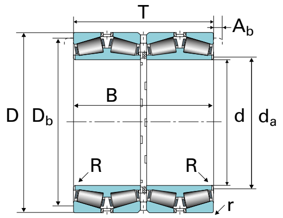


Fig. 2 : TQOWE

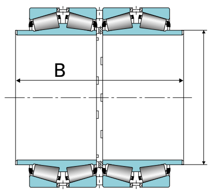


Fig. 3 : 2TDIW

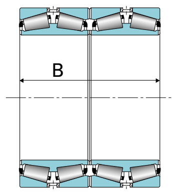
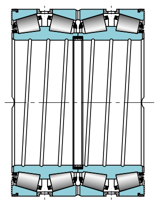


Fig. 4 : SRNB (narrow seal)



Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

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All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

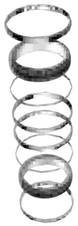
† dimension is maximum value,

* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

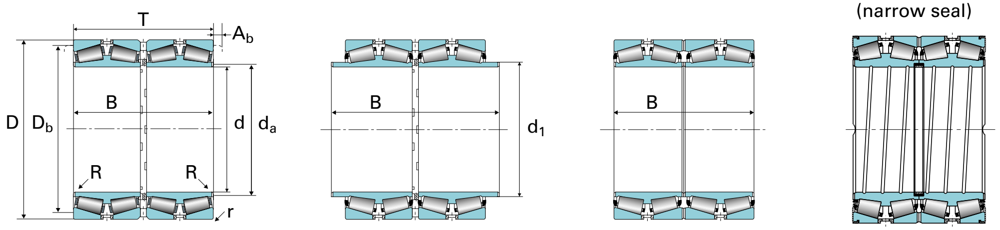
Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
305.001 12.0079	438.048 17.2460	279.400 11.0000	280.988 11.0625		688000 3060000	0.42	1.62	2.41	51200 228000	178400 794000	36500 162000	1.40	1604000 7120000	3.3 0.13	328.0 12.91	4.8 0.19	406.0 15.98	* *	S	130 293	**129000**	WR	1
305.001 12.0079	438.048 17.2460	279.400 11.0000	#REF! 11.0626		844000 3760000	0.47	1.43	2.13	62800 279000	218000 972000	50800 226000	1.24	1848000 8200000	3.3 0.13	328.0 12.91	4.8 0.19	407.0 16.02	* *	S	130 286	**M757400**	WR	1
317.500 12.5000	422.275 16.6250	269.875 10.6250	269.875 10.6250		3360000 756000	0.32	2.11	3.15	251000 56300	872000 196200	137000 30800	1.83	8920000 2008000	1.5 0.06	334.0 13.15	3.3 0.13	398.0 15.67	* *	S	102 224	**LM258600**	WR	1 & 3
317.500 12.5000	422.275 16.6250	269.875 10.6250	269.875 10.6250		3320000 746000	0.32	2.11	3.14	247000 55500	860000 193200	135000 30300	1.83 -	8040000 1804000	3.3 0.13	336.0 13.23	1.7 0.07	395.0 15.55	* *	S	98 215	**LM258400**	WR	4
317.500 12.5000	447.675 17.6250	327.025 12.8750	327.025 12.8750		4600000 1034000	0.33	2.02	3.00	342000 76900	1192000 268000	196000 44100	1.74	11160000 2512000	3.3 0.13	340.0 13.39	3.3 0.13	418.0 16.46	9.5 0.37	S	162 358	**HM259000**	BUR	1
317.500 12.5000	447.675 17.6250	327.025 12.8750	327.025 12.8750		5000000 1122000	0.33	2.02	3.00	372000 83600	1294000 290000	213000 47900	1.74	12560000 2824000	3.3 0.13	340.0 13.39	3.3 0.13	418.0 16.46	* *	P	166 366	**HM259000**	BUR	1
317.500 12.5000	447.675 17.6250	327.025 12.8750	334.490 13.1690		1034000 4600000	0.34	2.01	2.99	76900 342000	268000 1192000	44100 196000	1.74	2512000 11160000	3.3 0.13	340.0 13.39	3.3 0.13	418.0 16.46	* *	S	162 358	**HM259000**	WR	1
317.500 12.5000	647.700 25.5000	419.100 16.5000	419.100 16.5000		2300000 10240000	0.28	2.42	3.61	171000 762000	596000 2660000	81500 363000	2.10	3340000 14880000	1.5 0.06	350.0 13.78	3.3 0.13	600.0 23.62	* *	P	635 1401	**140000**	WR	1
317.500 12.5000	647.700 25.5000	419.100 16.5000	419.100 16.5000		2300000 10240000	0.28	2.42	3.61	171000 762000	596000 2660000	81500 363000	2.10	3340000 14880000	0.8 0.03	348.0 13.70	3.3 0.13	600.0 23.62	* *	P	648 1429	**140000**	WR	1
317.500 12.5000	673.100 26.5000	419.100 16.5000	419.100 16.5000		2300000 10240000	0.28	2.42	3.61	171000 762000	596000 2660000	81500 363000	2.10	3340000 14880000	1.5 0.06	350.0 13.78	3.3 0.13	611.9 24.09	* *	P	729 1606	**140000**	WR	1
330.200 13.0000	444.500 17.5000	301.625 11.8750	301.625 11.8750		4180000 940000	0.33	2.03	3.02	311000 70000	1084000 244000	177000 39800	1.76	11000000 2476000	3.3 0.13	351.0 13.82	3.3 0.13	418.0 16.46	* *	P	132 291	**M260100**	WR. BUR	1
330.200 13.0000	482.600 19.0000	311.150 12.2500	311.150 12.2500		960000 4260000	0.39	1.72	2.56	71400 318000	248000 1106000	47800 213000	1.49	2092000 9280000	1.5 0.06	351.0 13.82	3.3 0.13	449.0 17.68	* *	S	169 373	**526000**	WR	1
330.302 13.0040	438.023 17.2450	254.000 10.0000	247.650 10.0000		2500000 564000	0.46	1.47	2.19	187000 41900	650000 146000	146000 32810	1.27	6360000 1432000	1.5 0.06	347.0 13.66	3.3 0.13	412.0 16.22	* *	S	99 218	**138000**	WR	1
333.375 13.1250	469.900 18.5000	342.900 13.5000	342.900 13.5000		5020000 1130000	0.33	2.02	3.00	374000 84200	1304000 294000	215000 48200	1.74	12280000 2764000	3.3 0.13	357.0 14.06	3.3 0.13	439.0 17.28	* *	S	183 403	**HM261000**	BUR	1
333.375 13.1250	469.900 18.5000	342.900 13.5000	342.900 13.5000		5460000 1228000	0.33	2.02	3.00	407000 91400	1416000 318000	233000 52400	1.74	13840000 3108000	3.3 0.13	357.0 14.06	3.3 0.13	439.0 17.28	* *	P	189 417	**HM261000**	BUR	1
341.312 13.4375	457.098 17.9960	254.000 10.0000	254.000 10.0000		702000 3120000	0.47	1.43	2.13	52300 233000	182200 810000	42400 188000	1.24	1728000 7680000	1.5 0.06	359.0 14.13	3.3 0.13	432.0 17.01	* *	S	114 250	**LM761600**	WR	1
341.313 13.4375	457.098 17.9960	254.000 10.0000	254.000 10.0000		3120000 702000	0.47	1.43	2.13	233000 52300	810000 182200	188000 42400	1.24 -	7680000 1728000	1.5 0.06	359.0 14.13	3.3 0.13	430.0 16.93	* *	S	111 245	**LM761600**	WR	4
342.900 13.5000	533.400 21.0000	301.625 11.8750	307.975 12.1250		1156000 5140000	0.33	2.03	3.02	86000 383000	300000 1332000	49000 218000	1.76	2248000 10000000	3.3 0.13	370.0 14.57	3.3 0.13	501.0 19.72	* *	P	250 551	**970000**	WR	1

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
342.900 13.5000	571.500 22.5000	342.900 13.5000	342.900 13.5000		1504000 6700000	0.34	2.01	2.99	112000 498000	390000 1734000	64400 286000	1.74	2684000 11960000	3.3 0.13	373.9 14.72	6.4 0.25	528.1 20.79	* *	P	348 768	**536000**	WR	1
343.000 13.5039	460.000 18.1102	240.000 9.4488	280.000 11.0236	368.173 14.4950	3120000 702000	0.47	1.43	2.13	233000 52300	810000 182200	188000 42400	1.24 -	7680000 1728000	4.3 0.17	364.0 14.33	3.3 0.13	435.0 17.13	* *	S	116 255	**LM761600**	WR	2
343.052 13.5060	457.098 17.9960	247.300 9.7360	254.000 10.0000		3120000 702000	0.47	1.43	2.13	233000 52300	810000 182200	188000 42400	1.24 -	7680000 1728000	1.5 0.06	365.0 14.37	3.3 0.13	434.0 17.09	* *	S	110 242	**LM761600**	WR	4
343.052 13.5060	457.098 17.9960	254.000 10.0000	254.000 10.0000		3120000 702000	0.47	1.43	2.12	233000 53300	810000 182200	188000 42400	1.24	7680000 1728000	1.5 0.06	361.0 14.21	3.3 0.13	432.0 17.01	* *	S	109 240	**LM761600**	WR	1 & 3
343.052 13.5060	457.098 17.9960	254.000 10.0000	254.000 10.0000		3120000 702000	0.47	1.43	2.12	233000 52300	810000 182200	188000 42400	1.24	7680000 1728000	1.5 0.06	361.0 14.21	3.3 0.13	430.0 16.93	* *	S	110 242	**LM761600**	WR	4
343.052 13.5060	457.098 17.9960	254.000 10.0000	323.850 14.3250		3120000 702000	0.47	1.43	2.12	233000 52300	810000 182200	188000 42400	1.24	7680000 1728000	1.5 0.06	361.0 14.21	3.3 0.13	432.0 17.01	* *	S	115 253	**LM761600**	WR	2
343.052 13.5060	457.098 17.9960	254.000 10.0000	254.000 10.0000		2300000 632000	0.71	0.95	1.41	209000 47000	728000 163800	255000 57400	0.82	7760000 1744000	1.5 0.06	362.0 14.25	3.3 0.13	423.0 16.65	* *	S	113 249	**LM961500**	WR	1
343.052 13.5060	457.098 17.9960	254.000 10.0000	323.850 12.7500	368.1730 14.4950	702000 3120000	0.47	1.43	2.13	52300 233000	182200 810000	42400 188000	1.24	1728000 7680000	1.5 0.06	361.0 14.21	3.3 0.13	432.0 17.01	* *	S	118 261	**LM761600**	WR	2
343.052 13.5060	457.098 17.9960	254.000 10.0000	254.000 10.0000		702000 3120000	0.47	1.43	2.13	52300 233000	182200 810000	42400 188000	1.24	1728000 7680000	1.5 0.06	365.0 14.37	2.5 0.10	430.0 16.93	* *	S	109 240	**LM761600**	WR	4
343.052 13.5060	457.098 17.9960	254.000 10.0000	257.360 10.1322		632000 2800000	0.71	0.95	1.41	47000 209000	163800 728000	57400 255000	0.82	1744000 7760000	1.5 0.06	361.7 14.25	3.3 0.13	423.0 16.65	* *	S	114 251	**LM961500**	WR	1
343.052 13.5060	457.098 17.9960	254.000 10.0000	254.000 10.0000		3120000 702000	0.47	1.43	2.13	233000 52300	810000 182200	188000 42400	1.24 -	7680000 1728000	1.5 0.06	365.0 14.37	3.3 0.13	434.0 17.09	* *	S	109 241	**LM761600**	WR	4
346.075 13.6250	457.098 17.9960	254.000 10.0000	254.000 10.0000		2420000 546000	0.48	1.41	2.10	181000 40700	630000 141600	149000 33400	1.22	6200000 1392000	1.5 0.06	363.0 14.29	3.3 0.13	430.0 16.93	* *	S	102 225	**133000**	WR	1
346.075 13.6250	488.950 19.2500	358.775 14.1250	358.775 14.1250		5900000 1326000	0.33	2.02	3.00	439000 98700	1530000 344000	252000 56600	1.74	15040000 3380000	3.3 0.13	371.0 14.61	3.3 0.13	456.0 17.95	* *	P	225 496	**HM262700**	BUR	1
346.075 13.6250	488.950 19.2500	358.775 14.1250	364.668 14.3570		1248000 5540000	0.34	2.01	2.99	92900 413000	324000 1438000	53200 237000	1.74	3096000 13760000	3.3 0.13	371.0 14.61	3.3 0.13	456.0 17.95	* *	S	216 477	**HM262700**	WR	1
347.662 13.6875	469.900 18.5000	260.350 10.2500	260.350 10.2500		4040000 908000	0.33	2.03	3.02	301000 67600	1046000 236000	171000 38500	1.76	9760000 2192000	1.5 0.06	365.0 14.37	3.3 0.13	444.0 17.48	* *	P	129 285	**LM262400**	WR	1
347.662 13.6875	469.900 18.5000	292.100 11.5000	292.100 11.5000		4260000 958000	0.33	2.03	3.02	318000 71400	1106000 248000	181000 40600	1.76	10720000 2408000	3.3 0.13	369.0 14.53	3.3 0.13	443.0 17.44	* *	S	142 313	**M262400**	BUR	1
347.662 13.6875	469.900 18.5000	292.100 11.5000	292.100 11.5000		958000 4260000	0.33	2.03	3.02	71400 318000	248000 1106000	40600 181000	1.76	2408000 10720000	3.3 0.13	369.0 14.53	3.3 0.13	443.0 17.44	* *	S	144 318	**M262400**	WR	1
355.600 14.0000	444.500 17.5000	241.300 9.5000	241.300 9.5000		2500000 562000	0.31	2.20	3.27	186000 41900	648000 145800	98000 22000	1.90	7880000 1776000	1.5 0.06	370.0 14.57	3.3 0.13	422.0 16.61	6.0 0.24	S	88 194	**L163100**	WR	1
355.600 14.0000	457.200 18.0000	252.412 9.9375	252.412 9.9375		3220000 722000	0.32	2.12	3.15	239000 53800	834000 187200	131000 29400	1.83	9080000 2040000	1.5 0.06	372.0 14.65	3.3 0.13	434.0 17.09	* *	S	107 236	**LM263100**	WR	1
355.600 14.0000	457.200 18.0000	252.412 9.9375	323.850 12.7500	380.238 14.9700	3220000 722000	0.32	2.12	3.15	239000 53800	834000 187200	131000 29400	1.83	9080000 2040000	1.5 0.06	372.0 14.65	3.3 0.13	434.0 17.09	* *	S	111 244	**LM263100**	WR	2
355.600 14.0000	482.600 19.0000	265.876 10.4676	269.876 10.6250		3580000 806000	0.45	1.49	2.22	267000 60000	930000 210000	207000 46400	1.29 -	8480000 1904000	1.5 0.06	374.0 14.72	3.3 0.13	459.0 18.07	* *	S	133 293	**LM763500**	WR	4
355.600 14.0000	482.600 19.0000	269.875 10.6250	269.875 10.6250		824000 3660000	0.47	1.43	2.13	61300 273000	214000 950000	49600 221000	1.24	2012000 8960000	1.5 0.06	375.0 14.76	3.3 0.13	453.0 17.83	* *	S	135 297	**LM763400**	WR	1



TQOW-TQOWE 2TDIW-SRNB

Fig. 1 : TQOW   Fig. 2 : TQOWE   Fig. 3 : 2TDIW   Fig. 4 : SRNB (narrow seal)



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† dimension is maximum value,

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Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
355.600 14.0000	482.600 19.0000	269.875 10.6250	330.200 13.0000	383.9794 15.1173	824000 3660000	0.47	1.43	2.13	61300 273000	214000 950000	49600 221000	1.24	2012000 8960000	1.5 0.06	375.0 14.76	3.3 0.13	453.0 17.83	* *	S	147 324	**LM763400**	WR	2
355.600 14.0000	482.600 19.0000	269.875 10.6250	269.875 10.6250		824000 3660000	0.47	1.43	2.13	61300 273000	214000 950000	49600 221000	1.24	2012000 8960000	1.5 0.06	375.0 14.76	6.4 0.25	450.0 17.72	* *	S	134 296	**LM763400**	WR	1
355.600 14.0000	482.600 19.0000	330.200 13.0000	330.200 13.0000	387.350 15.2500	3660000 824000	0.47	1.43	2.13	273000 61300	950000 214000	221000 49600	1.24 -	8960000 2012000	1.5 0.06	375.0 14.76	3.3 0.13	457.0 17.99	* *	S	147 323	**LM763400**	WR	2
355.600 14.0000	488.950 19.2500	261.110 10.2800	265.110 10.4374		3580000 806000	0.45	1.49	2.22	267000 60000	930000 210000	207000 46400	1.29 -	8480000 1904000	1.5 0.06	374.0 14.72	3.3 0.13	462.0 18.19	* *	S	139 308	**LM763500**	WR	4
355.600 14.0000	488.950 19.2500	265.112 10.4374	265.112 10.4375		824000 3660000	0.47	1.43	2.13	61300 273000	214000 950000	49600 221000	1.24	2012000 8960000	1.5 0.06	375.0 14.76	3.3 0.13	456.0 17.95	* *	S	143 315	**LM763400**	WR	1
355.600 14.0000	488.950 19.2500	317.500 12.5000	317.500 12.5000		5160000 1158000	0.33	2.03	3.02	384000 86200	1336000 300000	218000 49100	1.76	12760000 2868000	1.5 0.06	374.0 14.72	3.3 0.13	459.0 18.07	* *	P	179 394	**M263300**	BUR	1
355.600 14.0000	488.950 19.2500	317.500 12.5000	317.500 12.5000		4600000 1032000	0.33	2.03	3.02	342000 76900	1190000 268000	195000 43800	1.76 -	10920000 2456000	1.5 0.06	374.0 14.72	3.3 0.13	456.0 17.95	* *	S	170 374	**M263600**	WR	4
355.600 14.0000	501.650 19.7500	260.350 10.2500	260.350 10.2500		704000 3140000	0.44	1.53	2.28	52400 233000	182400 812000	39500 176000	1.33	1680000 7480000	3.3 0.13	382.0 15.04	3.3 0.13	472.0 18.58	* *	S	152 334	**230000**	WR	1
355.600 14.0000	514.350 20.2500	260.350 10.2500	260.350 10.2500		3140000 704000	0.44	1.53	2.28	233000 52400	812000 182400	176000 39500	1.33	7480000 1680000	3.3 0.13	382.0 15.04	3.3 0.13	478.0 18.82	* *	S	174 383	**230000**	WR	1
356.387 14.0310	482.600 19.0000	222.250 8.7500	222.250 8.7500		1870000 420000	0.5	1.35	2.01	139000 31300	484000 109000	119000 26800	1.17	4440000 1000000	1.5 0.06	375.0 14.76	6.4 0.25	451.0 17.76	3.5 0.14	S	113 248	**160000**	WR	1
368.300 14.5000	523.875 20.6250	382.588 15.0625	382.588 15.0625		6760000 1520000	0.33	2.03	3.02	504000 113000	1754000 394000	287000 64500	1.76	17360000 3908000	3.3 0.13	394.0 15.51	6.4 0.25	487.0 19.17	* *	P	275 606	**HM265000**	BUR	1
368.300 14.5000	596.900 23.5000	342.900 13.5000	342.900 13.5000		1362000 6060000	0.41	1.63	2.42	101000 451000	352000 1570000	71900 320000	1.41	2720000 12120000	6.4 0.25	408.0 16.06	6.4 0.25	552.0 21.73	* *	P	368 811	**180000**	WR	1
374.650 14.7500	501.650 19.7500	260.350 10.2500	250.825 9.8750		3640000 818000	0.47	1.43	2.12	271000 60900	944000 212000	219000 49300	1.24	8760000 1972000	1.5 0.06	393.0 15.47	3.3 0.13	472.0 18.58	* *	S	136 300	**LM765100**	WR	1
374.650 14.7500	501.650 19.7500	260.350 10.2500	260.350 10.2500		704000 3140000	0.44	1.53	2.28	52400 233000	182400 812000	39500 176000	1.33	1680000 7480000	1.5 0.06	393.0 15.47	3.3 0.13	472.0 18.58	* *	S	135 297	**230000**	WR	1
374.650 14.7500	501.650 19.7500	260.350 10.2500	260.350 10.2500		818000 3640000	0.47	1.43	2.13	60900 271000	212000 944000	49300 219000	1.24	1972000 8760000	1.5 0.06	393.0 15.47	3.3 0.13	472.0 18.58	* *	S	136 300	**LM765100**	WR	1
374.650 14.7500	514.350 20.2500	260.350 10.2500	260.350 10.2500		704000 3140000	0.44	1.53	2.28	52400 233000	182400 812000	39500 176000	1.33	1680000 7480000	1.5 0.06	393.0 15.47	3.3 0.13	478.0 18.82	* *	S	157 346	**230000**	WR	1
375.000 14.7638	499.949 19.6830	249.986 9.8420	289.752 11.4076	403.225 15.8750	3640000 818000	0.47	1.43	2.13	271000 60900	944000 212000	219000 49300	1.24 -	8760000 1972000	4.3 0.17	393.0 15.47	2.0 0.08	472.0 18.58	* *	S	134 296	**LM765100**	WR	2
384.175 15.1250	546.100 21.5000	400.050 15.7500	400.050 15.7500		6740000 1516000	0.33	2.03	3.02	502000 113000	1750000 394000	286000 64300	1.76	16840000 3784000	3.3 0.13	411.0 16.18	6.4 0.25	507.0 19.96	12.0 0.47	S	304 670	**HM266400**	BUR	1

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d1	C1(4)	e	Y1	Y2	C90	C90(4)	Ca90	K	C0(4)	R	da	r	Db	Ab					
384.175 15.1250	546.100 21.5000	514.350 20.2500	514.350 20.2500		6740000 1516000	0.33	2.03	3.02	502000 113000	1750000 394000	286000 64300	1.76 -	16840000 3784000	3.3 0.13	411.0 16.18	6.4 0.25	507.0 19.96	* *	P	368 812	**HM266400**	WR	3
385.762 15.1875	514.350 20.2500	317.500 12.5000	317.500 12.5000		4620000 1038000	0.42	1.61	2.40	344000 77300	1198000 270000	246000 55400	1.40	12640000 2840000	3.3 0.13	409.0 16.10	3.3 0.13	482.0 18.98	8.0 0.31	S	185 404	**LM665900**	WR	1 & 3
393.700 15.5000	546.100 21.5000	288.925 11.3750	288.925 11.3750		726000 3240000	0.48	1.42	2.11	54100 241000	188400 838000	44100 196000	1.23	1804000 8040000	3.3 0.13	420.0 16.54	6.4 0.25	504.0 19.84	* *	S	195 429	**234000**	WR	1
393.700 15.5000	546.100 21.5000	288.925 11.3750	288.925 11.3750		1006000 4480000	0.48	1.42	2.11	74900 333000	260000 1160000	60800 270000	1.23	2524000 11240000	1.5 0.06	418.0 16.46	6.4 0.25	510.0 20.08	* *	S	204 451	**LM767700**	WR	1
400.050 15.7500	609.600 24.0000	317.500 12.5000	317.500 12.5000		1232000 5480000	0.38	1.75	2.61	91700 408000	320000 1420000	60200 268000	1.52	2580000 11480000	3.5 0.14	432.0 17.01	6.4 0.25	567.0 22.32	* *	P	309 680	**910000**	WR	1
406.400 16.0000	546.100 21.5000	288.924 11.3750	288.924 11.3750		4400000 988000	0.43	1.58	2.35	327000 73500	1138000 256000	238000 53500	1.37 -	10600000 2380000	1.5 0.06	425.0 16.73	5.0 0.20	510.0 20.08	* *	S	196 398	**LM667700**	WR	4
406.400 16.0000	546.100 21.5000	288.925 11.3750	288.925 11.3750		4800000 1080000	0.47	1.42	2.12	358000 80500	1246000 280000	290000 65300	1.23	12440000 2796000	1.5 0.06	427.0 16.81	6.4 0.25	510.0 20.28	* *	P	196 432	**LM767700**	WR	1
406.400 16.0000	546.100 21.5000	288.925 11.3750	288.925 11.3750		4480000 1006000	0.47	1.42	2.12	333000 74900	1160000 260000	270000 60800	1.23	11240000 2524000	1.5 0.06	427.0 16.81	6.4 0.25	510.0 20.08	* *	S	186 409	**LM767700**	WR	1
406.400 16.0000	546.100 21.5000	288.925 11.3750	288.925 11.3750		726000 3240000	0.48	1.42	2.11	54100 241000	188400 838000	44100 196000	1.23	1804000 8040000	1.5 0.06	425.0 16.73	6.4 0.25	504.0 19.84	* *	S	180 392	**234000**	WR	1
406.400 16.0000	546.100 21.5000	330.000 12.9921	330.000 12.9921		5560000 1250000	0.42	1.62	2.41	414000 93000	1442000 324000	296000 66500	1.40	15760000 3544000	1.5 0.06	425.0 16.73	6.4 0.25	510.0 20.08	* *	P	226 497	**M667900**	WR	3
406.400 16.0000	546.100 21.5000	330.000 12.9921	330.000 12.9921		4480000 1006000	0.47	1.42	2.12	333000 74900	1160000 260000	270000 60600	1.23	11240000 2524000	1.5 0.06	433.0 17.05	6.4 0.25	501.0 19.72	* *	S	232 510	**LM767700**	WR	4
406.400 16.0000	558.800 22.0000	254.000 10.0000	255.588 10.0625		726000 3240000	0.48	1.42	2.11	54100 241000	188400 838000	44100 196000	1.23	1804000 8040000	1.5 0.06	425.0 16.73	6.4 0.25	516.0 20.31	* *	S	186 410	**234000**	WR	1
406.400 16.0000	562.000 22.1260	381.000 15.0000	386.000 15.2000		7100000 1594000	0.33	2.03	3.02	528000 119000	1838000 414000	301000 67600	1.76 -	17840000 4000000	3.3 0.13	432.0 17.01	6.4 0.25	528.0 20.79	* *	P	287 634	**M267900**	WR	3
406.400 16.0000	565.150 22.2500	381.000 15.0000	381.000 15.0000		7100000 1594000	0.33	2.03	3.02	528000 119000	1838000 414000	301000 67600	1.76 -	17840000 4000000	3.3 0.13	432.0 17.01	6.4 0.25	528.0 20.79	* *	P	288 634	**M267900**	WR	1
406.400 16.0000	574.675 22.6250	250.030 9.8437	266.697 10.4999		742000 3300000	0.50	1.35	2.01	55200 246000	192200 856000	47000 209000	1.17	1884000 8400000	3.3 0.13	435.0 17.13	3.3 0.13	534.0 21.02	* *	S	211 465	**285000**	WR	1
406.400 16.0000	590.550 23.2500	400.050 15.7500	400.050 15.7500		1772000 7880000	0.33	2.08	3.09	132000 587000	460000 2040000	73400 327000	1.80	4280000 19080000	3.3 0.13	435.0 17.13	6.4 0.25	549.0 21.61	* *	P	370 815	**833000**	WR	1
406.400 16.0000	609.600 24.0000	317.500 12.5000	317.500 12.5000		1232000 5480000	0.38	1.75	2.61	91700 408000	320000 1420000	60200 268000	1.52	2580000 11480000	3.5 0.14	437.0 17.20	6.4 0.25	567.0 22.32	* *	P	321 707	**910000**	WR	1
409.575 16.1250	546.100 21.5000	334.962 13.1875	334.962 13.1875		5020000 1130000	0.42	1.62	2.41	374000 84200	1304000 294000	268000 60100	1.40	13680000 3072000	1.5 0.06	431.0 16.97	6.4 0.25	510.0 20.08	9.0 0.35	S	217 477	**M667900**	WR	1
409.575 16.1250	546.100 21.5000	334.962 13.1875	334.962 13.1875		5560000 1250000	0.42	1.62	2.41	414000 93000	1442000 324000	296000 66500	1.40	15760000 3544000	1.5 0.06	428.0 16.87	6.4 0.25	510.0 20.08	* *	P	226 497	**M667900**	WR	1 & 3
409.575 16.1250	546.100 21.5000	334.962 13.1875	334.962 13.1875		5020000 1130000	0.42	1.62	2.41	374000 84200	1304000 294000	268000 60100	1.40 -	13680000 3072000	1.5 0.06	431.0 16.97	6.4 0.25	510.0 20.08	* *	S	213 469	**M667900**	WR	3
409.575 16.1250	546.100 21.5000	334.962 13.1875	334.962 13.1875		5120000 1152000	0.42	1.62	2.41	382000 85800	1328000 298000	273000 61300	1.40 -	13160000 2956000	1.5 0.06	430.0 16.93	6.4 0.25	507.0 19.96	* *	S	208 458	**LM667800**	WR	4
409.575 16.1250	546.100 21.5000	334.962 13.1875	334.962 13.1875		5560000 1250000	0.42	1.62	2.41	414000 93000	1442000 324000	296000 66500	1.40 -	15760000 3544000	5.0 0.20	428.5 16.87	6.4 0.25	510.0 20.08	* *	P	222 490	**M667900**	WR	3

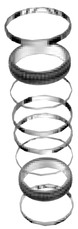


Fig. 1 : TQOW

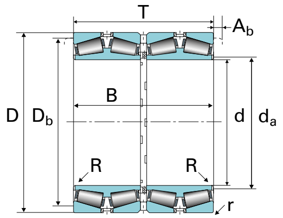


Fig. 2 : TQOWE

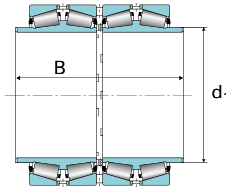


Fig. 3 : 2TDIW

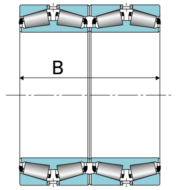
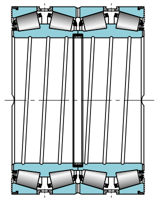


Fig. 4 : SRNB (narrow seal)



Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

Any other size can be considered to fit your designrequirements,

All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

† dimension is maximum value,

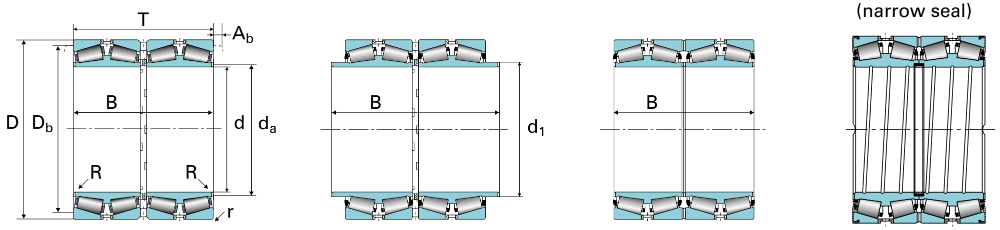
* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
409.575 16.1250	546.100 21.5000	334.962 13.1875	334.962 13.1875		5120000 1152000	0.42	1.62	2.41	382000 85800	1328000 298000	273000 61300	1.40 -	13160000 2956000	1.5 0.06	430.0 16.93	6.4 0.25	507.0 19.96	* *	S	208 458	**LM667800**	WR	4
409.575 16.1250	546.100 21.5000	334.962 13.1875	334.962 13.1875		5560000 1250000	0.42	1.62	2.41	414000 93000	1442000 324000	296000 66500	1.40 -	15760000 3544000	5.0 0.20	428.5 16.87	6.4 0.25	510.0 20.08	* *	P	222 490	**M667900**	WR	3
409.575 16.1250	546.100 21.5000	400.000 15.7480	400.000 15.7480		4840000 1090000	0.42	1.62	2.41	361000 81100	1256000 282000	258000 58000	1.40 -	12960000 2916000	5.0 0.20	428.5 16.87	6.4 0.25	510.0 20.08	* *	P	244 539	**M667900**	WR	3
415.925 16.3750	590.550 23.2500	434.975 17.1250	434.975 17.1250		8500000 1910000	0.33	2.03	3.02	633000 142000	2200000 496000	360000 81000	1.76	22200000 5000000	3.3 0.13	444.0 17.48	6.4 0.25	549.0 21.61	* *	P	396 872	**M268700**	BUR	1
415.925 16.3750	590.550 23.2500	434.975 17.1250	447.000 17.6000		1910000 8500000	0.33	2.03	3.02	142000 633000	496000 2200000	81000 360000	1.76	5000000 22200000	3.3 0.13	444.0 17.48	6.4 0.25	548.9 21.61	* *	P	396 873	**M268700**	WR	1
418.000 16.4567	571.500 22.5000	336.550 13.2500	343.250 13.5140		5420000 1220000	0.44	1.53	2.28	404000 90800	1408000 316000	303000 68100	1.33 -	15480000 3480000	1.5 0.06	443.0 17.44	6.4 0.25	534.0 21.02	* *	S	262 578	**LM769300**	WR	3
419.100 16.5000	622.300 24.5000	317.500 12.5000	320.370 12.6130		1374000 6100000	0.38	1.75	2.61	102000 455000	356000 1584000	67300 299000	1.52	2700000 12000000	3.5 0.14	449.0 17.68	6.8 0.27	581.9 22.91	* *	P	318 701	**260000**	WR	1
431.800 17.0000	571.500 22.5000	279.400 11.0000	279.400 11.0000		4200000 944000	0.55	1.24	1.84	312000 70200	1088000 244000	292000 65700	1.07	11240000 2528000	1.5 0.06	453.0 17.83	3.3 0.13	537.0 21.14	5.0 0.2	S	188 414	**LM869400**	WR	1
431.800 17.0000	571.500 22.5000	279.400 11.0000	279.400 11.0000		928000 4120000	0.38	1.75	2.61	69100 307000	240000 1070000	45600 203000	1.52	2484000 11040000	1.5 0.06	449.1 17.68	3.3 0.13	540.0 21.26	* *	S	193 426	**239000**	WR	1
431.800 17.0000	571.500 22.5000	279.400 11.0000	279.400 11.0000		944000 4200000	0.55	1.23	1.84	70200 312000	244000 1088000	65700 292000	1.07	2528000 11240000	38.1 1.50	453.0 17.83	3.3 0.13	537.0 21.14	* *	S	187 412	**LM869400**	WR	1
431.800 17.0000	571.500 22.5000	336.550 13.2500	336.550 13.2500		56800000 1278000	0.44	1.54	2.29	423000 95100	1474000 332000	317000 71300	1.33	16520000 3716000	1.5 0.06	453.0 17.83	6.4 0.25	534.0 21.02	* *	P	239 526	**LM769300**	WR. BUR	1
431.800 17.0000	571.500 22.5000	336.550 13.2500	336.550 13.2500		5420000 1220000	0.44	1.54	2.29	404000 90800	1408000 316000	303000 68100	1.33	15480000 3480000	1.5 0.06	453.0 17.83	6.4 0.25	534.0 21.02	* *	S	237 522	**LM769300**	WR. BUR	1 & 3
431.800 17.0000	571.500 22.5000	336.550 13.2500	336.550 13.2500		1278000 5680000	0.44	1.53	2.28	95100 423000	332000 1474000	71300 317000	1.33	3716000 16520000	1.5 0.06	453.0 17.83	6.4 0.25	534.0 21.02	* *	P	240 529	**LM769300**	WR	1
431.800 17.0000	571.500 22.5000	336.550 13.2500	336.550 13.2500		5420000 1220000	0.31	2.20	3.28	404000 90800	1406000 316000	211000 47400	1.91 -	13720000 3088000	1.5 0.06	452.0 17.80	1.5 0.06	537.0 21.14	* *	S	220 484	**LM169300**	WR	4
431.800 17.0000	571.500 22.5000	400.000 15.7480	406.710 16.0120		5420000 1220000	0.44	1.53	2.28	404000 90800	1408000 316000	303000 68100	1.33 -	15480000 3480000	1.5 0.06	453.0 17.83	6.4 0.25	534.0 21.02	* *	S	272 599	**LM769300**	WR	3
431.800 17.0080	609.524 23.9970	317.500 12.5000	317.500 12.5000		1320000 5880000	0.35	1.94	2.89	98300 437000	342000 1522000	58400 260000	1.68	3076000 13680000	3.5 0.14	459.0 18.07	6.4 0.25	570.0 22.44	* *	P	392 656	**736000**	WR	1
431.800 17.0000	635.000 25.0000	355.600 14.0000	355.600 14.0000		1622000 7220000	0.32	2.10	3.13	121000 537000	420000 1870000	66300 295000	1.82	3640000 16200000	6.4 0.25	468.1 18.43	6.4 0.25	591.1 23.27	* *	P	298 864	**931000**	WR	1
440.000 17.3228	590.000 23.2283	480.000 18.8976	480.000 18.8976		6480000 1454000	0.33	2.03	3.02	482000 108000	1678000 378000	274000 61700	1.76 -	17800000 40000000	1.5 0.06	478.0 18.82	3.0 0.12	555.0 21.85	* *	S	349 769	**M270400**	WR	4

Dimensions, mm (in)					Ratings, N (lbf)										Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static											
d	D	T	B	TQOWE d1	C1(4)	e	Y1	Y2	C90	C90(4)	Ca90	K	C0(4)	R	da	r	Db	Ab						
447.675 17.6250	635.000 25.0000	463.550 18.2500	463.550 18.2500		9760000 2200000	0.33	2.03	3.02	726000 163000	2520000 568000	413000 92900	1.76	25720000 5800000	3.3 0.13	478.0 18.82	6.4 0.25	591.0 23.27	* *	P	490 1079	**M270700**	BUR	1 & 3
449.948 17.7145	594.949 23.4232	368.000 14.4882	368.000 14.4882		6340000 1424000	0.30	2.26	3.37	471000 106000	1642000 368000	241000 54100	1.96 -	16560000 3724000	3.0 0.12	481.6 18.96	6.0 0.24	567.0 22.32	* *	S	264 583	**LM170400**	WR	4
449.949 17.7145	594.949 23.4232	368.000 14.4882	375.315 14.7762		6480000 1454000	0.33	2.03	3.02	482000 108000	1678000 378000	274000 61700	1.76 -	17800000 40000000	3.0 0.12	474.0 18.66	6.0 0.24	561.0 22.09	* *	S	274 604	**M270400**	WR	3
450.000 17.7165	595.000 23.4252	368.000 14.4882	368.000 14.4882		6800000 1530000	0.33	2.03	3.02	507000 114000	1764000 396000	289000 64900	1.76	19120000 4320000	3.0 0.12	474.0 18.66	6.0 0.24	561.0 22.09	* *	P	283 623	**M270400**	WR. BUR	1
450.000 17.7165	595.000 23.4252	368.000 14.4882	368.000 14.4882		6480000 1454000	0.33	2.03	3.02	482000 108000	1678000 378000	274000 61700	1.76	17800000 4000000	3.0 0.12	474.0 18.66	6.0 0.24	561.0 22.09	* *	S	274 604	**M270400**	WR. BUR	3
456.790 17.9840	761.873 29.9950	444.500 17.5000	444.500 17.5000		2660000 11860000	0.32	2.11	3.14	198000 882000	690000 3080000	108000 482000	1.83	5400000 24000000	6.4 0.25	513.0 20.20	6.4 0.25	708.0 27.87	* *	P	855 1885	**423000**	WR	1
456.794 17.9840	761.873 29.9950	527.050 20.7500	527.050 20.7500		2720000 12120000	0.44	1.52	2.27	203000 902000	706000 3140000	153000 681000	1.32	5600000 24840000	3.3 0.13	500.0 19.69	6.4 0.25	696.0 27.40	* *	P	1119 2467	**425000**	BUR	1
457.073 17.9950	730.148 28.7460	419.100 16.5000	419.100 16.5000		2160000 9640000	0.39	1.72	2.56	161000 718000	562000 2500000	109000 483000	1.49	4400000 19480000	1.5 0.06	491.0 19.33	6.4 0.25	675.0 26.57	* *	P	683 1507	**670000**	WR	1
457.200 18.0000	596.900 23.5000	279.400 11.0000	276.225 10.8750		4460000 1004000	0.47	1.43	2.12	333000 74800	1158000 260000	269000 60500	1.24	11240000 2528000	1.5 0.06	478.0 18.82	3.3 0.13	567.0 22.32	* *	S	190 419	**L770800**	WR	1 & 3
457.200 18.0000	596.900 23.5000	279.400 11.0000	276.225 10.8750		3680000 828000	0.54	1.24	1.85	274000 61700	956000 214000	255000 57400	1.07	9080000 2040000	1.5 0.06	478.0 18.82	3.3 0.13	567.0 22.32	* *	S	182 401	**L871300**	WR	4
457.200 18.0000	596.900 23.5000	279.400 11.0000	279.400 11.0000		946000 4200000	0.41	1.66	2.47	70500 313000	246000 1092000	48800 217000	1.44	2596000 11560000	1.5 0.06	478.0 18.82	3.3 0.13	567.0 22.32	* *	S	199 439	**244000**	WR	1
457.200 18.0000	596.900 23.5000	279.400 11.0000	279.400 11.0000		1004000 4460000	0.47	1.43	2.13	74800 333000	260000 1158000	60500 269000	1.24	2528000 11240000	1.5 0.06	478.0 18.82	3.3 0.13	567.0 22.32	* *	S	190 420	**L770800**	WR	1
457.200 18.0000	596.900 23.5000	279.400 11.0000	279.400 11.0000		4460000 994000	0.47	1.43	2.13	333000 74000	1158000 258000	269000 51800	1.24 -	11240000 2424000	1.5 0.06	478.0 19.11	3.3 0.25	567.0 22.56	* *	S	185 408	**L770800**	WR	3
457.200 18.0000	596.900 23.5000	279.400 11.0000	279.400 11.0000		4420000 1004000	0.41	1.65	2.46	329000 74800	1146000 260000	231000 60500	1.43 -	10800000 2528000	1.5 0.06	478.0 18.82	3.3 0.13	573.0 22.32	* *	S	191 422	**L670800**	WR	4
457.200 18.0000	660.400 26.0000	323.850 12.7500	323.850 12.7500		1352000 6020000	0.38	1.80	2.68	101000 448000	350000 1558000	64400 287000	1.56	3264000 14520000	3.3 0.13	489.0 19.25	6.4 0.25	614.9 24.21	* *	P	373 823	**737000**	WR	1
457.200 18.0000	749.808 29.5200	444.500 17.5000	444.500 17.5000		2660000 11860000	0.32	2.11	3.14	198000 882000	690000 3080000	108000 482000	1.83	5400000 24000000	6.4 0.25	515.0 20.28	6.4 0.25	702.0 27.64	* *	P	817 1801	**423000**	WR	1
460.000 18.1102	586.000 23.0709	266.000 10.4724	266.000 10.4724		996000 4420000	0.47	1.44	2.15	74100 330000	258000 1148000	59400 264000	1.25	2492000 11080000	4.0 0.16	480.0 18.90	7.0 0.28	555.0 21.85	* *	S	163 358	**L770500**	WR	1
460.000 18.1102	625.000 24.6063	421.000 16.5748	421.000 16.5748		8420000 1896000	0.33	2.03	3.02	628000 141000	2180000 492000	357000 80300	1.76	23000000 5160000	3.0 0.12	486.0 19.13	8.9 0.35	585.0 23.02	* *	P	378 833	**M271100**	WR. BUR	1
475.000 18.7008	620.000 24.4094	380.000 14.9606	380.000 14.9606		7640000 1716000	0.31	2.15	3.20	569000 128000	1980000 446000	305000 68600	1.86 -	20240000 4560000	2.5 0.10	496.0 19.53	5.0 0.20	588.0 23.15	* *	P	297 654	**M171600**	WR	3
475.000 18.7008	620.000 24.4094	380.000 14.9606	380.000 14.9606		6620000 1490000	0.35	1.94	2.89	494000 111000	1718000 386000	295000 66200	1.68 -	18720000 4200000	3.3 0.13	500.0 19.69	6.4 0.25	585.0 23.03	* *	S	298 657	**LM371900**	WR	3
482.600 19.0000	615.950 24.2500	330.200 13.0000	330.200 13.0000		5780000 1298000	0.33	2.03	3.02	430000 96700	1498000 336000	245000 55000	1.76	16400000 3684000	3.3 0.13	504.0 19.84	6.4 0.25	585.0 23.02	10.0 0.39	S	235 518	**LM272200**	WR	1 & 3
482.600 19.0000	615.950 24.2500	330.200 13.0000	419.100 16.5000		5780000 1298000	0.33	2.03	3.02	430000 96700	1498000 336000	245000 55000	1.76	16400000 3684000	3.5 0.14	507.0 19.96	6.4 0.25	585.0 23.02	10.0 0.39	S	253 557	**LM272200**	WR	2

Fig. 1 : TQOW Fig. 2 : TQOWE Fig. 3 : 2TDIW Fig. 4 : SRNB (narrow seal)



Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

Any other size can be considered to fit your designrequirements,

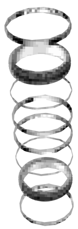
All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

† dimension is maximum value,

* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
				TQOWE	1 million revolutions				90 million revolutions				Static										
d	D	T	B	d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
482.600 19.0000	615.950 24.2500	330.200 13.0000	330.200 13.0000		5260000 1180000	0.43	1.57	2.34	391000 87900	1362000 306000	288000 64700	1.36	13560000 3048000	6.4 0.25	509.0 20.02	6.4 0.25	585.0 23.02	* *	S	219 482	**LM672100**	WR	4
482.600 19.0000	615.950 24.2500	330.200 13.0000	406.400 16.0000	514.0960 20.2400	1298000 5780000	0.33	2.03	3.02	96700 430000	336000 1498000	55000 245000	1.76	3684000 16400000	4.0 0.16	507.0 19.96	6.4 0.25	585.0 23.03	* *	S	250 552	**LM272200**	WR	1
482.600 19.0000	615.950 24.2500	330.200 13.0000	330.200 13.0000		1246000 5540000	0.33	2.03	3.02	92800 413000	324000 1438000	52800 235000	1.76	3516000 15640000	6.4 0.25	510.0 20.08	2.5 0.10	579.0 22.80	* *	S	230 506	**LM272300**	WR	4
482.600 19.0000	615.950 24.2500	330.200 13.0000	406.400 16.0000	514.096 20.2400	5540000 1246000	0.33	2.03	3.02	413000 92800	1438000 324000	235000 52800	1.76 -	15640000 3516000	6.4 0.25	510.0 20.08	6.4 0.25	585.0 23.03	* *	S	243 536	**LM272300**	WR	4
482.600 19.0000	615.950 24.2500	330.200 13.0000	330.200 13.0000		5540000 1246000	0.33	2.03	3.02	413000 92800	1438000 324000	235000 52800	1.76 -	15640000 3516000	6.4 0.25	510.0 20.08	6.4 0.25	591.0 23.27	* *	S	229 506	**LM272300**	WR	4
482.600 19.0000	615.950 24.2500	330.200 13.0000	330.200 13.0000		5780000 1298000	0.33	2.03	3.02	430000 96700	1498000 336000	245000 55000	1.76 -	16400000 3684000	6.4 0.25	510.0 20.08	6.4 0.25	585.0 23.03	* *	S	236 521	**LM272200**	WR	3
482.600 19.0000	615.950 24.2500	377.825 14.8750	406.400 16.0000	514.096 20.2400	5780000 1298000	0.33	2.03	3.02	430000 96700	1498000 336000	245000 55000	1.76 -	16400000 3684000	5.0 0.20	507.0 19.96	6.4 0.25	582.0 22.91	* *	S	263 581	**LM272200**	WR	4
482.600 19.0000	615.950 24.2500	420.000 16.5354	420.000 16.5354		5540000 1246000	0.33	2.03	3.02	413000 92800	1438000 324000	235000 52800	1.76 -	15640000 3516000	6.4 0.25	510.0 20.08	6.4 0.25	585.0 23.03	* *	S	264 582	**LM272300**	WR	4
482.600 19.0000	635.000 25.0000	421.000 16.5748	421.000 16.5748		7780000 1752000	0.33	2.03	3.02	580000 130000	2020000 454000	330000 74200	1.76	22360000 5040000	3.0 0.12	507.0 19.96	6.4 0.25	603.0 23.74	* *	P	359 791	**M272400**	WR. BUR	1
482.600 19.0000	647.700 25.5000	417.512 16.4375	417.512 16.4375		8440000 1898000	0.33	2.03	3.02	629000 141000	2180000 492000	358000 80500	1.76	23840000 5360000	3.3 0.13	510.0 20.08	6.4 0.25	609.0 23.98	* *	P	400 881	**M272600**	WR. BUR	1
488.950 19.2500	660.400 26.0000	361.950 14.2500	365.125 14.3750		1586000 7060000	0.31	2.19	3.26	118000 525000	412000 1828000	62000 276000	1.90	4120000 18360000	3.3 0.13	516.0 20.31	6.4 0.25	624.0 24.57	* *	P	357 787	**640000**	WR	1
489.026 19.2530	634.873 24.9950	320.675 12.6250	320.675 12.6250		5540000 1244000	0.47	1.43	2.12	412000 92700	1436000 322000	334000 75000	1.24	15480000 3484000	3.3 0.13	516.0 20.31	3.3 0.13	600.0 23.62	8.5 0.33	S	254 559	**LM772700**	WR	1
489.026 19.2530	634.873 24.9950	320.675 12.6250	320.675 12.6250		5580000 1254000	0.34	1.97	2.94	415000 93400	1446000 326000	242000 54500	1.71 -	14840000 3336000	3.3 0.13	519.0 20.43	6.4 0.25	609.0 23.98	* *	S	245 541	**LM372800**	WR	4
500.000 19.6850	730.000 28.7402	420.000 16.5354	425.700 16.7614		2040000 9040000	0.33	2.03	3.02	151000 674000	528000 2340000	86200 384000	1.76	5080000 22640000	5.0 0.20	537.0 21.14	5.0 0.20	681.0 26.81	* *	S	610 1345	**LM275000**	WR	1
500.000 19.6850	730.000 28.7402	420.000 16.5354	420.000 16.5354		1966000 8740000	0.48	1.41	2.10	146000 651000	510000 2260000	120000 535000	1.22	4960000 22080000	5.0 0.20	540.0 21.26	5.0 0.20	675.0 26.57	* *	S	595 1312	**LM774700**	WR	1
501.650 19.7500	673.100 26.5000	387.350 15.2500	400.050 15.7500		1738000 7740000	0.31	2.15	3.20	129000 576000	450000 2000000	69500 309000	1.86	4680000 20800000	3.3 0.13	530.0 20.87	6.4 0.25	636.0 25.04	* *	P	395 872	**641000**	WR	1
501.650 19.7500	711.200 28.0000	520.700 20.5000	520.700 20.5000		12000000 2720000	0.33	2.03	3.02	898000 202000	3120000 702000	511000 115000	1.76	32280000 7280000	3.3 0.13	534.0 21.02	6.4 0.25	663.0 26.10	* *	P	691 1522	**M274100**	BUR	1
508.000 20.0000	695.325 27.3750	415.925 16.3750	415.925 16.3750		9140000 2060000	0.33	2.03	3.02	680000 153000	2360000 532000	387000 87100	1.76	22960000 5160000	3.3 0.13	537.0 21.12	6.0 0.24	654.0 25.75	* *	P	475 1046	**LM274000**	WR	1



Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
508.000 20.0000	762.000 30.0000	463.550 18.2500	463.550 18.2500		2360000 10520000	0.38	1.78	2.65	176000 783000	614000 2720000	114000 509000	1.54	5360000 23920000	6.4 0.25	550.7 21.68	6.4 0.25	710.9 27.99	* *	P	752 1658	**531000**	WR	1
510.000 20.0787	655.000 25.7874	379.000 14.9213	377.000 14.8425		7791500 1750900	0.33	2.03	3.02	579000 130110	2020000 453930	390330 87710	1.76	21170000 4760000	1.6 0.06	531.0 20.91	6.4 0.25	624.0 24.60	12.0 0.47	S	313 689	*	WR	3
510.000 20.0787	655.000 25.7874	379.000 14.9213	379.000 14.9213		6940000 1558000	0.33	2.07	3.08	516000 116000	1798000 404000	288000 64700	1.79 -	20120000 4520000	1.5 0.06	531.0 20.91	6.6 0.26	627.0 24.69	* *	S	307 676	**LM273900**	WR	4
514.350 20.2500	673.100 26.5000	422.275 16.6250	422.275 16.6250		8460000 1904000	0.32	2.12	3.15	631000 142000	2200000 494000	344000 77400	1.83	25160000 5640000	3.3 0.13	540.0 21.26	6.4 0.25	636.0 25.04	* *	P	408 899	**LM274400**	WR. BUR	1
514.350 20.2500	673.100 26.5000	422.275 16.6250	422.275 16.6250		8100000 1820000	0.32	2.12	3.15	603000 135000	2100000 472000	329000 74000	1.83	23600000 5320000	3.3 0.13	540.0 21.26	6.4 0.25	636.0 25.04	* *	P	400 881	**LM274400**	WR. BUR	1 & 3
519.112 20.4375	736.600 29.0000	536.575 21.1250	536.575 21.1250		12880000 2900000	0.33	2.03	3.02	959000 216000	3340000 750000	546000 123000	1.76	34680000 7800000	3.3 0.13	552.0 21.73	6.4 0.25	684.0 26.92	* *	P	791 1742	**M275300**	BUR	1 & 3
520.700 20.5000	711.200 28.0000	400.050 15.7500	400.050 15.7500		8780000 1976000	0.33	2.03	3.02	654000 147000	2280000 512000	373000 83800	1.76	22920000 5160000	3.3 0.13	549.0 21.61	6.4 0.25	672.0 26.46	* *	P	476 1049	**LM275300**	WR	3
536.575 21.1250	761.873 29.9950	558.800 22.0000	558.800 22.0000		3080000 13700000	0.33	2.03	3.02	229000 1020000	798000 3540000	130000 580000	1.76	8320000 37000000	3.3 0.13	564.0 22.20	6.4 0.25	711.0 27.99	* *	P	851 1875	**M276400**	BUR	1
550.000 21.6535	675.000 26.5748	300.000 11.8110	300.000 11.8110		5400100 1213510	0.29	2.05	3.05	402000 90340	1400000 314610	201000 45170	2.00	16000000 3595510	3.0 0.12	573.0 22.56	3.0 0.12	633.0 24.90	5.0 0.2	S	*	*	WR	1 & 3
558.800 22.0000	736.600 29.0000	322.268 12.6877	322.265 12.6876		7060000 1588000	0.34	1.97	2.93	526000 118000	1830000 412000	308000 69300	1.70	18320000 4120000	3.3 0.13	585.0 23.03	6.4 0.25	699.0 27.52	* *	P	378 833	**843000**	WR	1 & 3
558.800 22.0000	736.600 29.0000	322.268 12.6877	322.268 12.6877		1588000 7060000	0.34	1.96	2.92	118000 526000	412000 1830000	69300 308000	1.70	4120000 18320000	3.3 0.13	585.0 23.03	6.4 0.25	699.0 27.52	* *	P	377 831	**843000**	WR	1
558.800 22.0000	736.600 29.0000	409.575 16.1250	409.575 16.1250		8780000 1974000	0.35	1.95	2.90	653000 147000	2280000 512000	387000 87100	1.69	25480000 5720000	3.3 0.13	588.0 23.15	6.4 0.25	696.0 27.40	* *	P	482 1062	**LM377400**	BUR	1
558.800 22.0000	736.600 29.0000	409.575 16.1250	409.575 16.1250		8500000 1914000	0.35	1.95	2.90	634000 142000	2200000 496000	376000 84400	1.69 -	24360000 5480000	3.0 0.12	588.0 23.15	6.4 0.25	696.0 27.40	* *	S	466 1026	**LM377400**	BUR	3
558.800 22.0000	736.600 29.0000	457.200 18.0000	455.612 17.9375		10080000 2260000	0.33	2.03	3.02	751000 169000	2620000 58800	428000 96100	1.76	29320000 6600000	3.3 0.13	588.0 23.15	6.4 0.25	696.0 27.40	* *	P	535 1178	**LM277100**	BUR	1
558.800 22.0000	736.600 29.0000	457.200 18.0000	457.200 18.0000		2260000 10080000	0.33	2.03	3.02	169000 751000	588000 2620000	96100 428000	1.76	6600000 29320000	3.3 0.13	588.0 23.15	6.4 0.25	696.0 27.40	* *	P	536 1181	**LM277100**	WR	1
558.800 22.0000	736.600 29.0000	540.000 21.2598	540.000 21.2598		10080000 2260000	0.33	2.03	3.02	751000 169000	2620000 588000	428000 96100	1.76 -	29320000 6600000	3.3 0.13	588.0 23.15	6.4 0.25	696.0 27.40	* *	P	577 1272	**LM277100**	BUR	3
571.500 22.5000	812.800 32.0000	593.725 23.3750	593.725 23.3750		3480000 15480000	0.33	2.03	3.02	259000 1150000	902000 4020000	147000 656000	1.76	9480000 42400000	3.3 0.13	609.0 23.98	6.4 0.25	756.0 29.76	* *	P	1022 2253	**M278700**	BUR	1
584.200 23.0000	762.000 30.0000	401.638 15.8125	396.875 15.6250		8280000 1860000	0.47	1.43	2.12	616000 139000	2140000 482000	499000 112000	1.24	23520000 5280000	3.3 0.13	615.0 24.21	6.4 0.25	717.0 28.23	*	S	468 1031	**LM778500**	WR	1
584.200 23.0000	901.700 35.5000	539.747 21.2499	539.747 21.2499		3340000 14820000	0.33	2.03	3.02	248000 1100000	864000 3840000	141000 626000	1.76	6840000 30360000	3.3 0.13	624.0 24.57	9.7 0.38	843.0 33.19	* *	P	1191 2626	**660000**	BUR	1
584.200 23.0000	901.700 35.5000	539.750 21.2500	539.750 21.2500		3600000 16000000	0.33	2.03	3.02	268000 1190000	932000 4140000	152000 676000	1.76	7400000 32880000	3.3 0.13	624.0 24.57	9.7 0.38	843.0 33.19	* *	P	1290 2845	**665000**	BUR	1
585.788 23.0625	771.525 30.3750	479.425 18.8750	479.425 18.8750		11240000 2520000	0.33	2.03	3.02	836000 188000	2920000 654000	476000 107000	1.76	33120000 7440000	3.3 0.13	615.0 24.21	6.4 0.25	726.0 28.58	* *	P	606 1335	**LM278800**	BUR	1
585.788 23.0625	771.525 30.3750	479.425 18.8750	479.425 18.8750		2520000 11240000	0.33	2.03	3.02	188000 836000	654000 2920000	107000 476000	1.76	7440000 33120000	6.4 0.25	616.0 24.25	6.4 0.25	726.0 28.58	* *	P	605 1333	**LM278800**	BUR	1

TIMKEN

Fig. 1 : TQOW

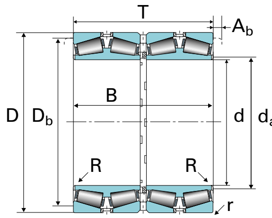


Fig. 2 : TQOWE

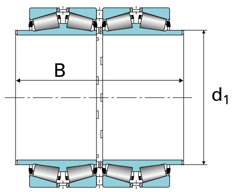


Fig. 3 : 2TDIW

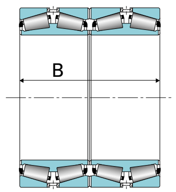
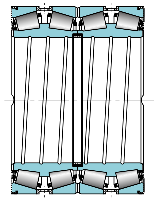


Fig. 4 : SRNB
(narrow seal)



Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

Any other size can be considered to fit your designrequirements,

All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

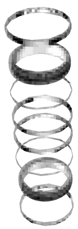
† dimension is maximum value,

* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d1	C1(4)	e	Y1	Y2	C90	C90(4)	Ca90	K	C0(4)	R	da	r	Db	Ab					
595.312 23.4375	844.550 33.2500	615.950 24.2500	615.950 24.2500		16600000 3740000	0.33	2.03	3.02	1240000 278000	4300000 968000	704000 158000	1.76	45600000 10240000	3.3 0.13	633.0 24.92	6.4 0.25	786.0 30.94	* *	P	1155 2544	**M280000**	BUR	1 & 3
603.250 23.7500	857.250 33.7500	622.300 24.5000	622.300 24.5000		17120000 3860000	0.33	2.03	3.02	1280000 287000	4440000 998000	726000 163000	1.76	47200000 10600000	3.3 0.13	642.0 25.28	6.4 0.25	798.0 31.42	* *	P	1208 2661	**M280200**	BUR	1 & 3
609.600 24.0000	787.400 31.0000	361.950 14.2500	361.950 14.2500		7780000 1749000	0.37	1.82	2.71	579000 130000	2020000 452000	367000 82600	1.58	22480000 5040000	3.3 0.13	636.0 25.04	6.4 0.25	747.0 29.41	* *	P	467 1029	**649000**	WR	1
609.600 24.0000	787.400 31.0000	361.950 14.2500	361.950 14.2500		6980000 1568000	0.37	1.82	2.71	519000 117000	1808000 406000	330000 74100	1.58	19640000 4400000	6.4 0.25	642.0 25.28	6.4 0.25	747.0 29.41	* *	P	455 1002	**L480200**	WR	4
609.600 24.0000	813.562 32.0300	479.425 18.8750	479.425 18.8750		11460000 2580000	0.33	2.03	3.02	854000 192000	2980000 668000	486000 109000	1.76	31840000 7160000	3.0 0.12	639.0 25.16	6.4 0.25	771.0 30.35	* *	P	698 1539	**LM280200**	BUR	1
609.600 24.0000	863.600 34.0000	660.400 26.0000	660.400 26.0000		18020000 4040000	0.33	2.03	3.02	1340000 302000	4680000 1050000	764000 172000	1.76	48800000 11000000	3.3 0.13	648.0 25.51	6.4 0.25	807.0 31.77	* *	P	1263 2782	**M280300**	BUR	1
635.000 25.0000	901.700 35.5000	654.050 25.7500	654.050 25.7500		18740000 4220000	0.33	2.03	3.02	1400000 314000	4860000 1092000	794000 179000	1.76	51600000 11640000	3.3 0.13	675.0 26.57	6.4 0.25	843.0 33.19	* *	P	1437 3165	**M281000**	BUR	1
646.112 25.4375	857.250 33.7500	542.925 21.3750	542.925 21.3750		13980000 3140000	0.33	2.03	3.02	1040000 234000	3620000 816000	593000 133000	1.76	41600000 9320000	3.3 0.13	678.0 26.69	6.4 0.25	810.0 31.89	* *	P	873 1923	**LM281000**	BUR	1 & 3
647.700 25.5000	1028.700 40.5000	565.150 22.2500	565.150 22.2500		4300000 19140000	0.31	2.15	3.20	320000 1430000	1116000 4960000	172000 767000	1.86	8960000 39800000	11.0 0.43	713.5 28.09	6.4 0.25	960.0 37.80	* *	P	1795 3958	**424000**	BUR	1
649.925 25.5876	914.898 36.0196	674.000 26.5354	672.000 26.4567		19780000 4440000	0.33	2.03	3.02	1470000 331000	5120000 1154000	839000 189000	1.76	54800000 12320000	3.5 0.14	690.0 27.17	6.0 0.24	855.0 33.66	* *	P	1437 3165	**M281300**	BUR	1
659.925 25.9813	854.923 33.6584	318.480 12.5386	400.842 15.7812	708.025 27.8750	6380000 1434000	0.35	1.92	2.86	475000 107000	1654000 372000	286000 64200	1.66	17360000 3904000	5.0 0.20	693.0 27.28	9.7 0.38	807.0 31.77	* *	S	457 1007	**749000**	WR	2
659.925 25.9813	1069.899 42.1220	648.002 25.5119	648.002 25.5119		5020000 22400000	0.31	2.18	3.25	373000 1660000	1300000 5780000	198000 881000	1.89	10640000 47200000	6.0 0.24	717.0 28.23	10.0 0.39	990.0 38.98	* *	P	2365 5213	**428000**	BUR	1
660.400 26.0000	812.800 32.0000	365.125 14.3750	365.125 14.3750		8140000 1830000	0.33	2.03	3.02	606000 136000	2120000 474000	345000 77600	1.76	26480000 5960000	3.3 0.13	683.0 26.89	6.4 0.25	777.0 30.59	* *	P	415 914	**L281100**	WR	1
660.400 26.0000	812.800 32.0000	365.125 14.3750	373.000 14.3750		1830000 1696000	0.33	2.03	3.02	136000 126000	474000 440000	77600 71900	1.76	5960000 5360000	3.3 0.13	682.8 27.05	6.4 0.25	777.0 30.59	* 0.43	P	398 877	**L281100**	WR	1
660.400 26.0000	812.800 32.0000	365.126 14.3750	365.126 14.6850		7540000 8140000	0.33	2.03	3.02	561000 606000	1954000 2120000	320000 345000	1.76	23760000 26480000	3.3 0.13	687.0 26.88	6.4 0.25	777.0 30.59	11.0 *	S	398 912	**L281100**	WR	1 & 3
660.400 26.0000	1066.800 42.0000	647.703 25.5001	647.703 25.5001		5020000 22400000	0.31	2.18	3.25	373000 1660000	1300000 5780000	198000 881000	1.89	10640000 47200000	6.4 0.25	717.0 28.23	6.4 0.25	990.0 38.98	* *	P	2315 5104	**428000**	BUR	1
682.625 26.8750	965.200 38.0000	701.675 27.6250	701.675 27.6250		4800000 21400000	0.33	2.03	3.02	357000 1590000	1242000 5520000	203000 903000	1.76	13360000 59600000	3.3 0.13	723.0 28.46	6.4 0.25	900.0 35.43	* *	P	1726 3805	**M282200**	BUR	1
685.800 27.0000	876.300 34.5000	355.600 14.0000	352.425 13.8750		8200000 1842000	0.42	1.62	2.42	610000 137000	2120000 478000	434000 97700	1.40	25200000 5680000	3.3 0.13	717.0 28.23	6.4 0.25	831.0 32.72	* *	P	549 1209	**655000**	WR	1

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
685.800 27.0000	876.300 34.5000	355.600 14.0000	434.975 17.1250	730.250 28.7500	8200000 184200	0.42	1.62	2.42	610000 137000	2120000 478000	434000 97700	1.40	25200000 5680000	3.3 0.13	717.0 28.23	6.4 0.25	831.0 32.72	* *	P	578 1274	**655000**	WR	2
685.800 27.0000	876.300 34.5000	355.600 14.0000	355.600 14.0000		1842000 8200000	0.42	1.62	2.41	137000 610000	478000 2120000	97700 434000	1.40	5680000 25200000	3.3 0.13	717.0 28.23	6.4 0.25	831.0 32.72	* *	P	546 1203	**655000**	BUR	1
685.800 27.0000	876.300 34.5000	355.600 14.0000	457.200 18.0000	735.3300 28.9500	1842000 8200000	0.42	1.62	2.41	137000 610000	478000 2120000	97700 434000	1.40	5680000 25200000	3.3 0.13	717.0 28.23	6.4 0.25	831.0 32.72	* *	P	587 1293	**655000**	BUR	2
685.800 27.0000	876.300 34.5000	355.600 14.0000	355.600 14.0000		8220000 1846000	0.33	2.03	3.02	611000 137000	2120000 478000	348000 78200	1.76 -	21920000 4920000	1.5 0.06	714.0 28.11	2.0 0.08	834.0 32.83	* *	S	491 1083	**L282000**	BUR	4
708.025 27.8750	930.275 36.6250	565.150 22.2500	565.150 22.2500		15820000 3560000	0.33	2.03	3.02	1180000 265000	4100000 922000	670000 151000	1.76	48000000 10840000	3.3 0.13	741.0 29.17	6.4 0.25	879.0 34.61	* *	P	1061 2337	**LM282500**	BUR	1
710.000 27.9528	900.000 35.4331	410.000 16.1417	410.000 16.1417		9780000 2200000	0.52	1.29	1.92	728000 164000	2540000 570000	654000 147000	1.11	30520000 6880000	3.3 0.13	741.0 29.17	6.4 0.25	852.0 33.54	* *	P	633 1394	**L882400**	WR	1
711.200 28.0000	914.400 36.0000	317.500 12.5000	317.500 12.5000		7100000 1596000	0.38	1.77	2.64	529000 119000	1840000 414000	344000 77400	1.54	20760000 4680000	3.3 0.13	744.0 29.29	6.4 0.25	873.0 34.37	* *	P	537 1183	**755000**	WR	1
711.200 28.0000	914.400 36.0000	317.500 12.5000	425.450 16.7500	774.700 30.5000	6540000 1472000	0.38	1.77	2.64	488000 110000	1698000 382000	318000 71400	1.54	18520000 4160000	8.0 0.31	753.0 29.65	6.4 0.25	873.0 34.32	* *	S	572 1259	**755000**	WR	2
711.200 28.0000	914.400 36.0000	317.500 12.5000	317.500 12.5000		1596000 7100000	0.38	1.78	2.65	119000 529000	414000 1840000	77400 344000	1.54	4680000 20760000	16.0 0.63	756.0 29.76	6.4 0.25	873.0 34.37	* *	P	536 1183	**755000**	BUR	1
711.200 28.0000	914.400 36.0000	355.600 14.0000	355.600 14.0000		7100000 1596000	0.38	1.78	2.65	529000 119000	1840000 414000	344000 77400	1.54 -	20760000 4680000	3.3 0.13	744.0 29.29	6.4 0.25	873.0 34.37	* *	P	553 1219	**755000**	WR	3
714.375 28.1250	1016.000 40.0000	704.850 27.7500	704.850 27.7500		22000000 4940000	0.35	1.92	2.86	1640000 368000	5700000 1282000	984000 221000	1.66	63200000 14240000	3.3 0.13	759.0 29.88	6.4 0.25	948.0 37.32	* *	P	1909 4205	**M383200**	BUR	1
717.550 28.2500	946.150 37.2500	565.150 22.2500	565.150 22.2500		15920000 3580000	0.33	2.03	3.02	1190000 267000	4120000 928000	675000 152000	1.76	48800000 10920000	3.3 0.13	753.0 29.65	6.4 0.25	894.0 35.20	* *	P	1127 2482	**LM282800**	BUR	1
730.250 28.7500	1035.050 40.7500	755.650 29.7500	755.650 29.7500		24400000 5480000	0.33	2.03	3.02	1810000 407000	6320000 1418000	1030000 232000	1.76	68400000 15440000	3.3 0.13	774.0 30.47	6.4 0.25	966.0 38.03	* *	P	1536 3387	**M283400**	BUR	1
749.300 29.5000	990.600 39.0000	605.000 23.8189	605.000 23.8189		17800000 4000000	0.33	2.03	3.02	1330000 298000	4620000 1038000	754000 170000	1.76 -	54000000 12200000	3.3 0.13	786.0 30.94	6.4 0.25	936.0 36.85	* *	P	1306 2878	**LM283600**	BUR	3
749.300 29.5000	1066.800 42.0000	736.600 29.0000	736.600 29.0000		5460000 24400000	0.33	2.04	3.04	407000 1810000	1418000 6300000	230000 1020000	1.77	14560000 64800000	9.2 0.36	806.5 31.75	12.7 0.50	996.0 39.21	* *	P	2147 4734	**325000**	WR	1
749.300 29.5000	1130.300 44.5000	685.800 27.0000	685.800 27.0000		5280000 23400000	0.49	1.38	2.06	393000 1750000	1368000 6080000	328000 1460000	1.20	12880000 57200000	6.4 0.25	820.0 32.28	9.7 0.38	1045.0 41.14	* *	P	2448 5397	**731000**	BUR	1
749.300 29.5000	1181.100 46.5000	736.600 29.0000	736.600 29.0000		5720000 25400000	0.38	1.80	2.68	426000 1890000	1482000 6600000	273000 1210000	1.56	13560000 60400000	6.4 0.25	813.0 32.01	12.7 0.50	1085.0 42.72	* *	P	3020 6657	**690000**	BUR	1
762.000 30.0000	1066.800 42.0000	736.600 29.0000	723.900 28.5000		24000000 5400000	0.33	2.03	3.02	1790000 403000	6240000 1402000	1020000 229000	1.76	67600000 15240000	12.7 0.50	819.0 32.24	12.7 0.50	996.0 39.21	* *	P	2140 4718	**M284100**	BUR	1
762.000 30.0000	1066.800 42.0000	736.600 29.0000	736.600 29.0000		5400000 24000000	0.33	2.03	3.02	403000 1790000	1402000 6240000	229000 1020000	1.76	15240000 67600000	9.3 0.36	819.0 32.24	12.7 0.50	996.0 39.21	* *	P	2140 4719	**M284100**	BUR	1
762.000 30.0000	1079.500 42.5000	787.400 31.0000	787.400 31.0000		26200000 5900000	0.33	2.03	3.02	1950000 439000	6800000 1528000	1110000 250000	1.76	74400000 16680000	4.8 0.19	810.0 31.89	12.7 0.50	1005.0 39.57	* *	P	2401 5289	**M284200**	BUR	1
762.000 30.0000	1110.000 43.7008	685.800 27.0000	685.800 27.0000		5280000 23400000	0.49	1.38	2.06	393000 1750000	1368000 6080000	328000 1460000	1.20	12880000 57200000	6.4 0.25	821.9 32.36	9.7 0.38	992.9 39.09	* *	P	2273 5011	**731000**	BUR	1
762.000 30.0000	1219.200 48.0000	812.800 32.0000	812.800 32.0000		6640000 29600000	0.36	1.89	2.82	494000 2200000	1722000 7660000	301000 1340000	1.64	15200000 67600000	6.4 0.25	828.0 32.60	12.7 0.50	1125.0 44.29	* *	P	3666 8083	**528000**	WR	1



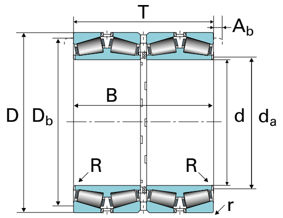


Fig. 1 : TQOW

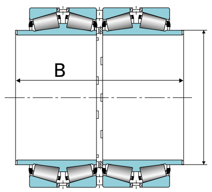


Fig. 2 : TQOWE

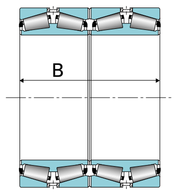


Fig. 3 : 2TDIW

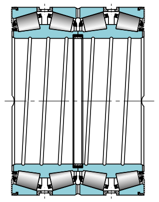


Fig. 4 : SRNB (narrow seal)

Notes :

Following series can all be proposed in 2TDIW design or with extensions and a sealed version can be studied,

Any other size can be considered to fit your designrequirements,

All series can be supplied with lubricant slots in the cone faces and with spiral grooves in cone bores if required,

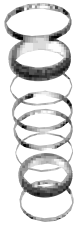
† dimension is maximum value,

* contact your Timken sales engineer.

TQOW-TQOWE 2TDIW-SRNB

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
762.000 30.0000	1295.400 51.0000	647.700 25.5000	647.700 25.5000		5720000 25400000	0.38	1.75	2.61	425000 1890000	1482000 6580000	279000 1240000	1.52	13640000 60800000	6.4 0.25	852.0 33.54	6.4 0.25	1210.0 47.64	* *	P	3622 7985	**433000**	BUR	1
774.700 30.5000	1219.873 48.0265	838.474 33.0108	838.474 33.0108		6840000 30400000	0.39	1.72	2.56	509000 2260000	1772000 7880000	341000 1520000	1.49	17320000 77200000	6.4 0.25	843.0 33.19	12.7 0.50	1125.0 44.29	* *	P	3767 8304	**631000**	BUR	1
779.924 30.7057	1219.873 48.0265	838.474 33.0108	838.474 33.0108		6840000 30400000	0.39	1.72	2.56	509000 2260000	1772000 7880000	341000 1520000	1.49	17320000 77200000	6.4 0.25	849.0 33.43	12.7 0.50	1125.0 44.29	* *	P	3736 8236	**631000**	BUR	1
779.924 30.7057	1219.873 48.0265	843.483 33.2080	843.483 33.2080		6840000 30400000	0.39	1.72	2.56	509000 2260000	1772000 7880000	341000 1520000	1.49	17320000 77200000	6.4 0.25	849.0 33.43	12.7 0.50	1125.0 44.29	* *	P	3741 8247	**631000**	BUR	1
787.400 31.0000	1219.200 48.0000	838.200 33.0000	838.200 33.0000		6840000 30400000	0.39	1.72	2.56	509000 2260000	1772000 7880000	341000 1520000	1.49	17320000 77200000	6.4 0.25	852.0 33.54	12.7 0.50	1125.0 44.29	* *	P	3663 8075	**631000**	BUR	1
825.500 32.5000	1168.400 46.0000	844.550 33.2500	844.550 33.2500		30600000 6860000	0.33	2.03	3.02	2270000 511000	7920000 1780000	1290000 291000	1.76	87600000 19640000	4.8 0.19	879.0 34.61	12.7 0.50	1085.0 42.72	* *	P	3025 6668	**M285800**	BUR	1 & 3
825.500 32.5000	1169.920 46.0600	844.550 33.2500	844.550 33.2500		30600000 6860000	0.33	2.03	3.02	2270000 511000	7920000 1780000	1290000 291000	1.76 -	87600000 19640000	4.8 0.19	879.0 34.61	12.7 0.50	1085.0 42.72	* *	P	3011 6638	**M285800**	BUR	3
863.600 34.0000	1130.300 44.5000	669.925 26.3750	669.925 26.3750		22200000 5000000	0.33	2.03	3.02	1660000 373000	5780000 1298000	944000 212000	1.76	69600000 15680000	4.8 0.19	906.0 35.67	12.7 0.50	1065.0 41.93	* *	P	1837 4046	**LM286200**	BUR	1 & 3
863.600 34.0000	1181.100 46.5000	666.750 26.2500	666.750 26.2500		24400000 5500000	0.33	2.03	3.02	1820000 409000	6340000 1426000	1040000 233000	1.76	66800000 15000000	4.8 0.19	909.0 35.79	12.7 0.50	1110.0 43.70	* *	P	2234 4921	**LM286400**	BUR	1
863.600 34.0000	1219.200 48.0000	889.000 35.0000	876.300 34.5000		33000000 7440000	0.33	2.03	3.02	2460000 554000	8580000 1928000	1400000 315000	1.76	95200000 21440000	4.8 0.19	918.0 36.14	12.7 0.50	1135.0 44.69	* *	P	3340 7357	**547000**	BUR	1 & 3
877.888 34.5625	1219.873 48.0265	844.550 33.2500	844.550 33.2500		30400000 6820000	0.33	2.03	3.02	2260000 508000	7880000 1770000	1290000 289000	1.76	89200000 20000000	4.8 0.19	930.0 36.61	12.7 0.50	1136.0 44.69	* *	P	3001 6610	**LM286700**	BUR	3
901.700 35.5000	1295.400 51.0000	914.400 36.0000	901.700 35.5000		38200000 8600000	0.34	2.01	2.99	2850000 640000	9920000 2220000	1640000 368000	1.74	106000000 23840000	4.8 0.19	960.0 37.80	12.7 0.50	1205.0 47.44	* *	P	2749 6060	**634000**	BUR	1
901.700 35.5000	1295.400 51.0000	914.400 36.0000	914.400 36.0000		8600000 38200000	0.34	2.01	2.99	640000 2850000	2220000 9920000	368000 1640000	1.74	23840000 106000000	4.8 0.19	960.0 37.80	12.7 0.50	1205.0 47.44	* *	P	2749 6060	**634000**	BUR	1
938.212 36.9375	1270.000 50.0000	825.500 32.5000	825.500 32.5000		31200000 7000000	0.33	2.03	3.02	2320000 521000	8080000 1814000	1320000 297000	1.76	94400000 21200000	4.8 0.19	990.0 38.98	12.7 0.50	1190.0 46.85	* *	P	3124 6881	**LM287600**	BUR	1 & 3
939.800 37.0000	1333.500 52.5000	952.500 37.5000	952.500 37.5000		39000000 8780000	0.33	2.03	3.02	2910000 653000	10120000 2280000	1650000 372000	1.76	113600000 25600000	4.8 0.19	999.0 39.33	12.7 0.50	1240.0 48.82	* *	P	4436 9771	**LM287800**	BUR	1 & 3
939.800 37.0000	1333.500 52.5000	952.500 37.5000	1069.975 42.1250	1031.113 40.5950	39000000 8780000	0.33	2.03	3.02	2910000 653000	10120000 2280000	1650000 372000	1.76	110400000 25600000	4.8 0.19	1010.0 39.76	12.7 0.50	1240.0 48.82	* *	P	4522 9959	**LM287800**	BUR	2
939.800 37.0000	1333.500 52.5000	952.500 37.5000	1011.238 39.8125	0.0000 40.5950	8780000 39000000	0.33	2.03	3.02	653000 2910000	2280000 10120000	372000 1650000	1.76	25600000 113600000	4.8 0.19	999.0 39.33	12.7 0.50	1240.0 48.82	* *	P	4561 10056	**LM287800**	BUR	2
1006.475 39.6250	1295.400 51.0000	764.000 30.0787	764.000 30.0787		27800000 6220000	0.33	2.03	3.02	2060000 464000	7180000 1616000	1170000 264000	1.76	94000000 21080000	4.8 0.19	1055.0 41.54	12.7 0.50	1225.0 48.23	* *	P	2630 5793	**LM288200**	BUR	1

Dimensions, mm (in)					Ratings, N (lbf)									Dimension, mm (in)					Cage	Mass kg (lb)	Bearing series	Usage	Figure
					1 million revolutions				90 million revolutions				Static										
d	D	T	B	TQOWE d_1	$C_{1(4)}$	e	Y_1	Y_2	C_{90}	$C_{90(4)}$	C_{a90}	K	$C_{0(4)}$	R	d_a	r	D_b	A_b					
1070.000 42.1260	1400.000 55.1181	890.000 35.0394	890.000 35.0394		35200000 7920000	0.33	2.03	3.02	2630000 590000	9140000 2060000	1500000 336000	1.76	118400000 26640000	5.0 0.20	1120.0 44.09	13.0 0.51	1320.0 51.97	* *	P	3753 8267	**LM288400**	BUR	3
1139.825 44.8750	1509.712 59.4375	923.925 36.3750	923.925 36.3750		42043000 9447870	0.33	2.03	3.02	3130000 703370	10900000 2449440	1780000 400000	1.76	122000000 27415730	4.8 0.19	1200.0 47.24	12.7 0.50	1410.0 55.50	* *	P	4306 9485	*	WR	1 & 3
1140.000 44.8819	1510.000 59.4488	923.925 36.3750	923.925 36.3750		42000000 9460000	0.33	2.03	3.02	3130000 704000	10900000 2460000	1780000 400000	1.76 -	122000000 27440000	4.8 0.19	1195.0 47.05	12.7 0.50	1430.0 56.30	* *	P	4424 9752	**LM288600**	BUR	3
1200.150 47.2500	1593.850 62.7500	990.600 39.0000	990.600 39.0000		46200000 10380000	0.33	2.03	3.02	3440000 773000	11980000 2700000	1960000 440000	1.76	148000000 33280000	4.8 0.19	1260.0 49.61	12.7 0.50	1500.0 59.06	* *	P	5619 12377	**LM288900**	BUR	1
1346.200 53.0000	1729.740 68.1000	1143.000 45.0000	1143.000 45.0000		55000000 12380000	0.28	2.42	3.61	4100000 921000	14260000 3200000	1950000 438000	2.10 -	198000000 44400000	4.8 0.19	1405.0 55.31	12.7 0.50	1645.0 64.76	* *	P	7076 15601	**LM189200**	BUR	3
1500.000 59.0551	1915.000 75.3937	1105.000 43.5039	1220.000 48.0315		58000000 13020000	0.33	2.03	3.02	4310000 970000	15020000 3380000	2460000 552000	1.76	211200000 47600000	Spec	1577.0 62.09	13.0 0.51	1815.0 71.46	10.0 0.4	P	8182 18022	**L289400**	BUR	3



7 Glossary

2TSDM

two TS bearing assembly-direct mounting

2TSIM

two TS bearing assembly-indirect mounting

α

half included cup angle

APEX (on-apex design)

rollers, outer and inner rings raceways are all meeting at the same point on the bearing axis

BEP (Bench enplay)

axial clearance within a bearing assembly before mounting

BPL (Bench preload)

axial preload within a bearing assembly before mounting

BRG

bearing

$C_{0(1)}$, $C_{0(2)}$, $C_{0(4)}$, $C_{0(6)}$

static capacity for 1, 2, 4, 6 rows respectively

$C_{1(1)}$, $C_{1(2)}$, $C_{1(4)}$, $C_{1(6)}$

radial capacity based on 1 million revolutions for 1, 2, 4, 6 rows respectively

$C_{90(1)}$, $C_{90(2)}$, $C_{90(4)}$, $C_{90(6)}$,

radial capacity based on 90 million revolutions for 1, 2, 4, 6 rows respectively

C_{a1}

axial capacity based on 1 million revolutions for 1 row

C_{a90}

axial capacity based on 90 million revolutions for 1 row

CAGE "machined"

fully machined metal cage

CAGE "pin type"

cages made of pins passing through/or between (pin outside) the rollers and welded at both ends to outside cage rings

CAGE "stamped"

cage formed from a steel plate and then pocket-stamped

CAGE CLEARANCE

clearance needed around the bearing cage in order to avoid any contact with other components

CLEARANCE "axial"

axial possible displacement between one inner ring and its corresponding outer ring within a system of 2 tapered bearing rows

CLEARANCE "radial"

radial possible displacement between the inner rings and the outer rings within a system of 2 tapered bearing rows

CONE

bearing inner ring

CONE BACK FACE

large cone face

CONE FRONT FACE

small cone face

cSt

censtitokes : viscosity unit

CUP

bearing outer ring

CUP BACK FACE

large cup face

CUP FRONT FACE

small cup face

DIRECT MOUNTING

within a 2 rows system, the effective centers of the rows are directed to the inside

EFFECTIVE BEARING CENTER

point on the axis of the bearing where the load is applied

EFFECTIVE BEARING SPREAD

distance between 2 bearings effective centers

EFFECTIVE ROLLER LENGTH

raceway length of the roller which supports the load

EXTENDED RIB

inner ring front or back face which has been lengthened to act as a seal seat

GEOMETRIC BEARING CENTER

on bearing axis, perpendicular projection of the middle of the roller length

HALF INCLUDED CUP ANGLE "α"

half of the cup angle (defined by its races)

HARDNESS HRC

Timken tapered roller bearings have surface hardnesses ranging from 58 to 62 HRC

INDIRECT MOUNTING

within a 2 row system, the effective centers of the rows are directed to the outside

INDUCED LOAD "axial"

axial component of the outside radial load when decomposed following the cup race half angle

K FACTOR

used in Timken calculation :
$K = 0.389 \times \cot \alpha$;
K = ratio between radial and axial capacity

LIFE : L_{10}

calculated life reached by 90 % of the bearings

LIFE : SYSTEM

takes into account the combined lives of the different bearing rows.
The system life is always lower than the lowest single component life

LOAD ZONE

portion of the bearing which is submitted to the load

MEAN ROLLER DIAMETER

roller diameter measured at the center of the race

MEP (mounted endplay)

radial or axial clearance remaining in the bearing when mounted in the application

MISALIGNMENT

angle between the inner ring and the outer ring axes

RIB ROLLER END CONTACT

elliptical contact between the spherical roller large end and the internal face of the large inner ring rib

RIB (cone small rib)

rib on the inner ring back face, helps to keep the rollers and the cage onto the inner ring

RIB (cone large rib)

rib used to maintain, guide and align the rollers in the bearing assembly

ROLLER

truncated cone rolling element of the bearing. (Generally 15 to 50 rollers in a row depending on the bearing size)

ROLLING CONTACT

contact between the roller races and the inner and outer rings raceways

RUNOUT "radial"

precision of rotation measured radially on an assembled bearing.

SKEWING

positive or negative misalignment of the roller on the cone raceway

SLIDING CONTACT

contact beetween the large roller end and the large cone rib

STACKED BEARINGS

assembly of several TS bearings with all effective centers in the same direction

STEEL "CEVM"

consumable electrode vacuum re-melted steel

STEEL "ESR"

electro-slag re-melted steel

STEEL "VAR"

vacuum arc re-melted steel

SRNB

sealed roll neck bearing

TRUE ROLLING MOTION

along the raceway of a roller, all points are turning at the same speed due to the tapered concept

Main conversions

in (inch)	**1 in = 25.4 mm**
lb (pounds)	**1 lb = 0.45 kg**
l (liter)	**1 l = 0.0353 ft^3** **1 l = 61.02in^3** **1 l = 1000 cm^3**
m (meter)	**1 m = 3.28 ft**
mm (millimeter)	**1 mm = 0.03937 in**
N (newton)	**1 N = 0.225 lbf**
bar	**1 bar = 10^5 Pa**
psi (pound pers quare inch)	**1 psi = 6894 Pa** **1 psi = 0.0689 bar**

For North and South America and Asia-Pacific :
THE TIMKEN COMPANY
1835 Dueber Ave., S.W.
Canton, Ohio 44706 U.S.A.

For Europe, Africa and West Asia :
THE TIMKEN COMPANY
2, rue Timken - B.P. 89
68002 COLMAR CEDEX-FRANCE

YOUR CONTACT :

To get the best performance out of the application, especially when operating conditions are critical, we encourage the customer to discuss the application with The Timken Company.

Nevertheless, actual bearing performance is affected by many factors beyond the control of The Timken Company. Therefore, the feasibility of all bearing applications should be validated by the customer.

Proper bearing maintenance and handling practices are critical. Failure to follow installation instructions and to maintain proper lubrication can result in equipment failure, creating a risk of serious bodily harm.

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