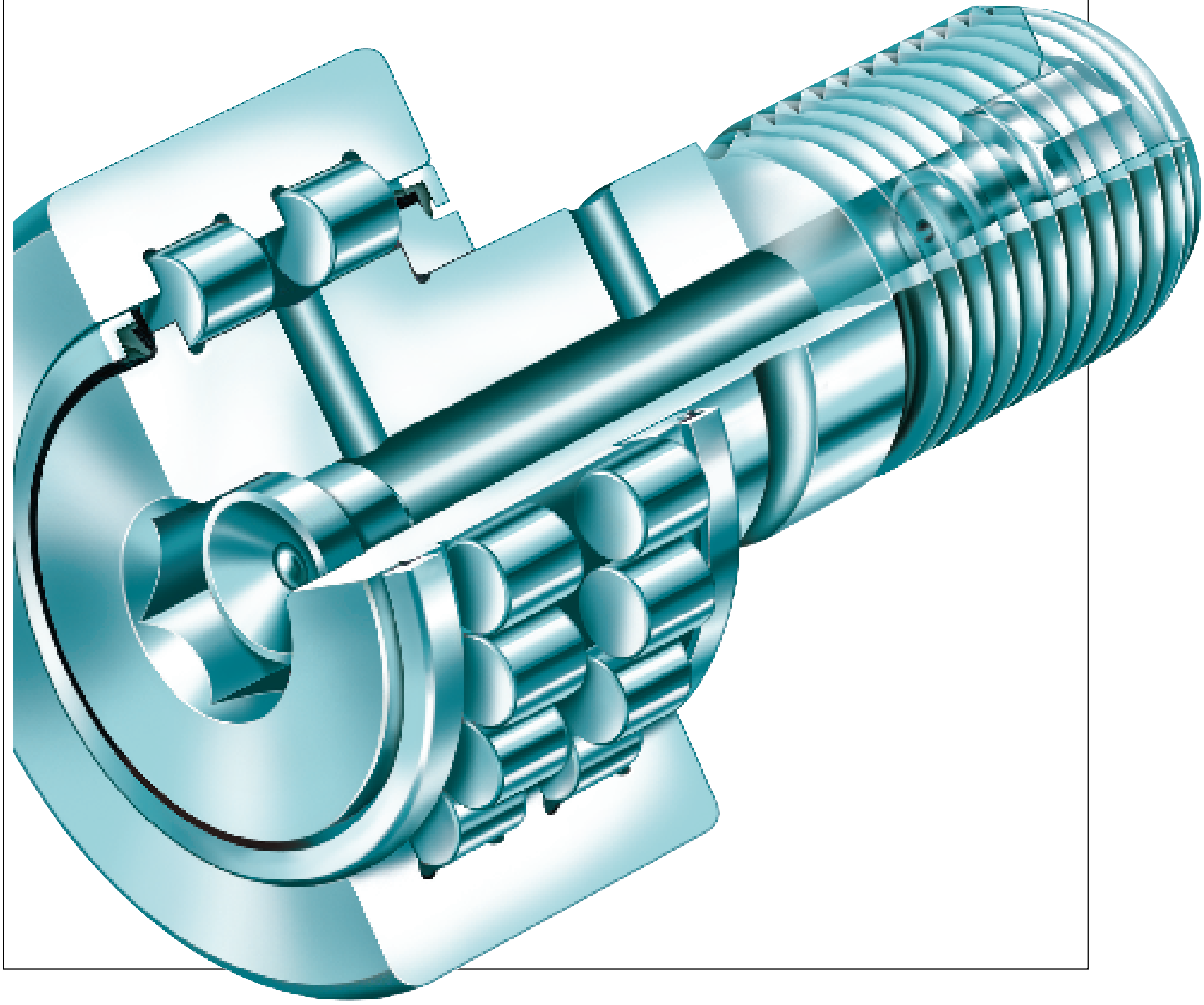

A new generation of yoke and stud type track rollers

Dipl.-Ing. Helmut Bode

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A new generation of yoke and stud type track rollers

Optimized design gives decisive increase in cost-efficiency

Dipl.-Ing. Helmut Bode

A comprehensive assessment of the cause of failures in yoke and stud type track rollers in relation to the specific application has shown that only a very small proportion of failures are caused by rolling contact fatigue. The factors which are far more significant for premature failure are wear of the outer ring, inadequate lubrication and tilted running. New designs have been developed which optimize the running characteristics of yoke and stud type track rollers and give significantly longer operating life values.

1 Introduction

Due to their wide range of potential applications, yoke and stud type track rollers have built a broad appeal in the machine components market. The basic design of these products is essentially that of a conventional rolling bearing, except that they have a thick-walled outer ring. Stud type track rollers have a shaft stud at one end.

In the majority of applications, the outer ring is subjected to circumferential load, i.e. the outer ring rotates while the inner ring or stud remains stationary. The thick-walled outer ring prevents excessive deformation of the track roller and ensures that the rolling element set is uniformly loaded.

2 High basic load rating = long operating life?

In order to meet the high requirements on this machine component, the rolling element sets were designed primarily for optimum load ratings and thus for maximum fatigue life (Figure 1). This is often to the detriment of the lubricant resources and the optimum guidance characteristics of the rolling elements.

An assessment of the causes of failure in yoke and stud type track rollers in relation to the specific application over many years (Figure 2) gives some surprising results. It now becomes clear that only 10% of failures can be attributed to rolling contact fatigue. Failure is influenced much more frequently by wear of the outer ring, lubrication problems and tilted running. A long operating life for yoke and stud type track rollers is not necessarily achieved by maximizing the basic load ratings but by optimum lubrication, good tilted running behaviour and low wear of the outer ring. These issues have previously received too little consideration in design work.

3 A new generation of yoke and stud type track rollers

The aim in the new designs of yoke and stud type track rollers was therefore the provision of large grease reservoirs, the improvement of the tilted running behaviour and the Hertzian contact on the outer ring and the simplification of fitting and relubrication arrangements. These requirements have been fulfilled with the new series PWTR and PWKR. Figure 3 shows the significantly larger lubricant volume compared with the conventional design (Figure 1). Furthermore, the central rib ensures optimum guidance of the rolling elements, significantly improving tilted running behaviour. Contact seals on both sides retain the grease in the bearing and give protection against harmful external influences.

In the design of the grease reservoir, it must be ensured that the grease is not subjected to continuous overrolling (churning) by the rolling element set. This leads to a premature breakdown in the grease structure and a reduced grease operating life. In series PWTR and PWKR, the grease between the rolling elements sets can continuously dispense oil to the rolling element set.

These design improvements result in significantly longer operating life, as shown by running tests and practical experience.

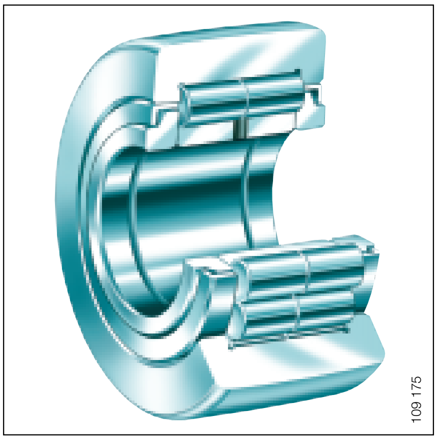


Figure 1 Yoke type track roller NUTR

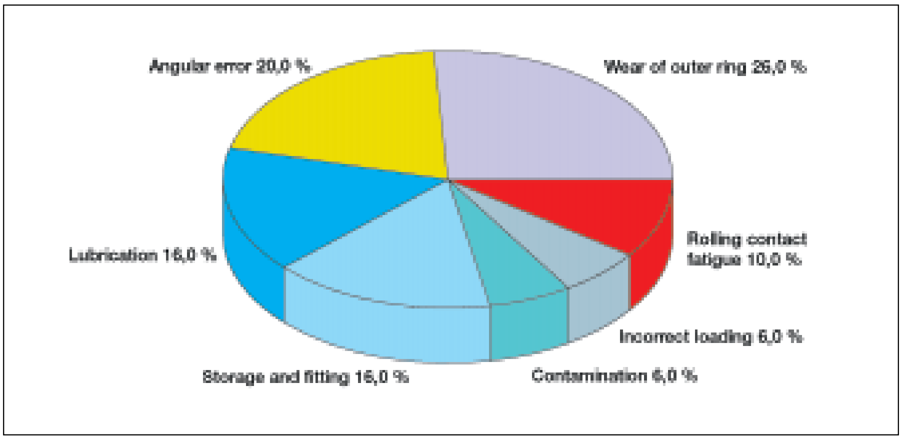


Figure 2 Yoke and stud type track rollers, causes of failure in relation to specific application

Running tests were carried out on a statistically sufficient number of test pieces of the sizes NUTR 2052 and PWTR 2052.2RS under the following conditions:

Bearing load	F = 5 100 N
Spreed	n = 1 900 1/min.
Grease:	Lithium soap grease with mineral oil base

The bearings were not relubricated during the test.

Figure 4 gives a comparison of the nominal (calculated) life and the actual life values. Series NUTR, which is designed for optimized basic rating life, had a mean running time which was about 14% of the rating life. All the test piece failures recorded were attributed to lubricant failure. Theoretically, the operating life would have been extended by regular relubrication of the track rollers during operation.

In practice, however, relubrication is inadequate or non-existent in most cases.

The new series PWTR gave a significantly longer operating life, although its rating life was actually shorter. The mean running time of all test pieces is 184% of the rating life. None of the test pieces achieved the end of the grease operating life [1].

4 Increased operating life

The bearing factor K_L [2] is an important parameter for determining the basic lubrication interval of rolling bearings. This factor takes into consideration the design, e.g. the track roller, and the grease reservoir. For the new series, this value was set at 0,6 which is almost twice that of conventional designs. Based on the results of the comprehensive tests, this value can be increased to 1,0 [3]. In practice, this gives significantly increased grease operating life and means that, in most applications, the bearing arrangements can be considered maintenance-free. Even under extreme operating conditions, where initial greasing of the bearings is not sufficient for the whole operating life, the relubrication intervals are increased several times over compared to their original values.

5 Improved tilted running behaviour

Due to the improved lubrication and the central rib guidance, these new yoke and stud type track rollers have significantly better tilted running behaviour. The substantial improvement in the guidance characteristics of the rolling elements leads to reduced axial friction, resulting in lower bearing temperatures and reduced strain on the lubricant.

Figure 5 shows the tilted running behaviour of the various designs in relation to

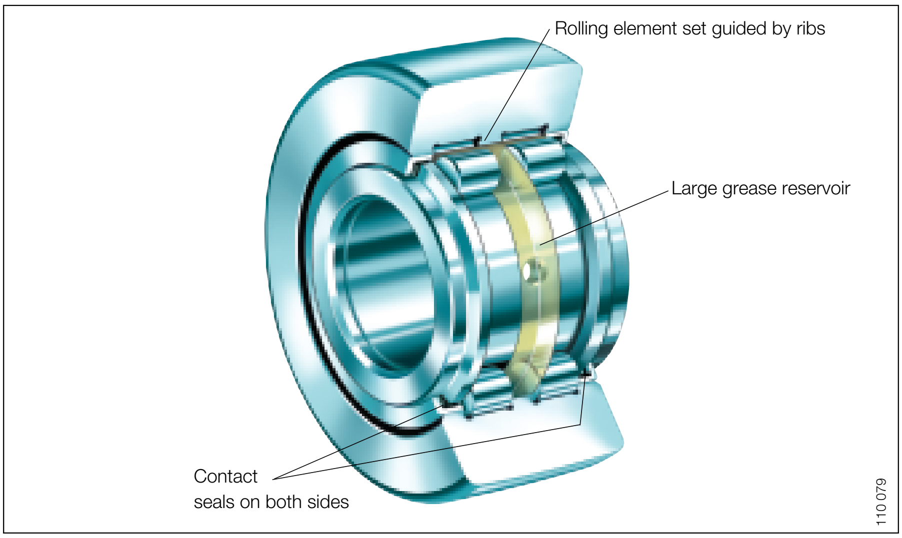


Figure 3 Yoke type track roller PWTR

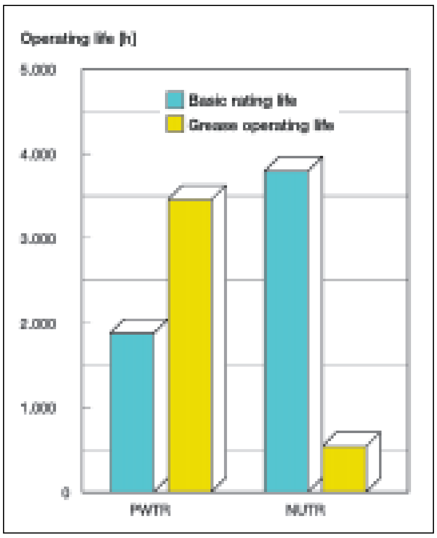


Figure 4 Operating life of yoke and stud type track rollers

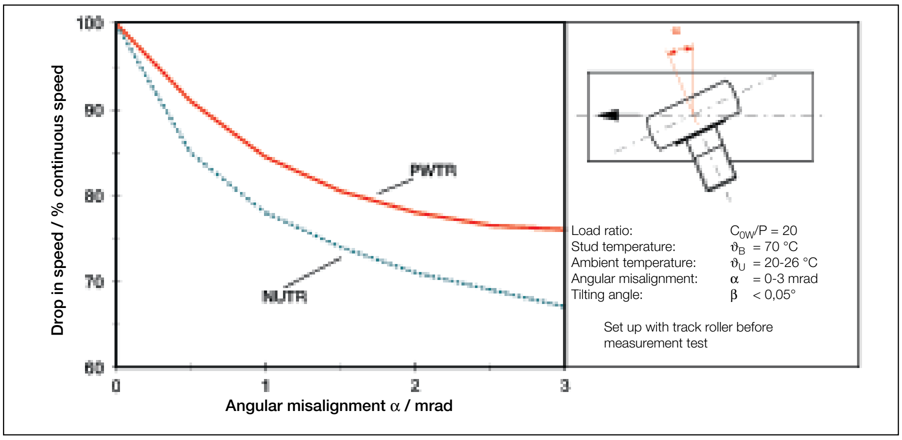


Figure 5 Continuous speed under tilted running of PWTR/NUTR

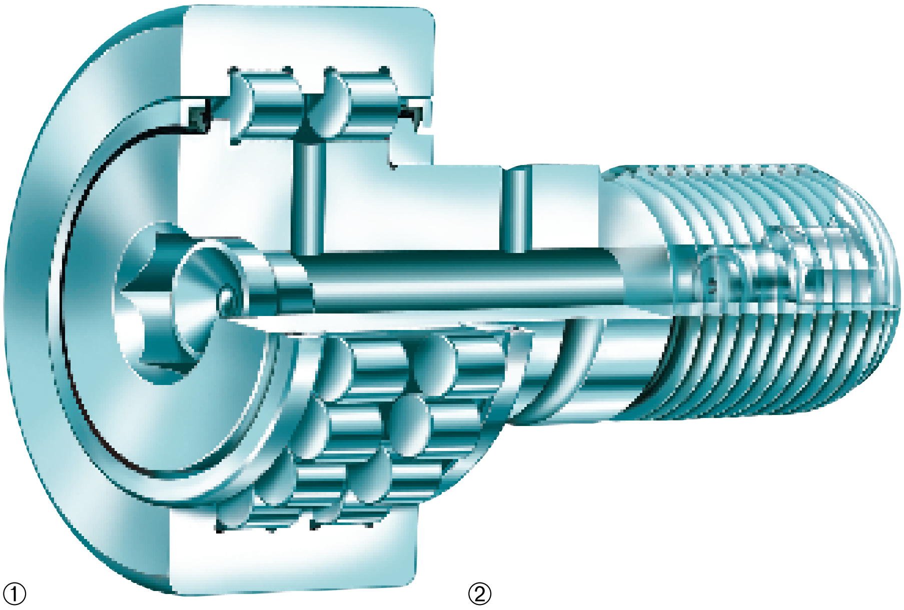
speed and based on a maximum bearing temperature of +70°C. This demonstrates that, as the angular error increases, the speed decrease in the new design PWTR is not only lower than with the design NUTR but that the curve has a noticeable asymptotic character. With α tilted running angle a of more than 2 mrad (about 0,1°), no additional decrease in speed is recorded [4].

6 Simplified fitting and relubrication facility

Although the relubrication intervals for the new series have been significantly increased and this means that the bearings are greased for life in most cases, a relubrication facility must sometimes be provided. This applies in particular to the series NUKR and NUTR which are designed for optimum basic load rating.

The design work required with stud type track rollers is usually very high since a relubrication facility from several sides must be offered. For the first time, the new designs allow a hexagonal socket for simplified fitting; relubrication can be carried out through this hexagonal socket.

Figure 6 shows relubrication by a conventional grease gun and the facility for connecting the bearing to a central lubrication system using an adapter (special accessory). Such solutions could not previously be applied in combination with a hexagonal socket.



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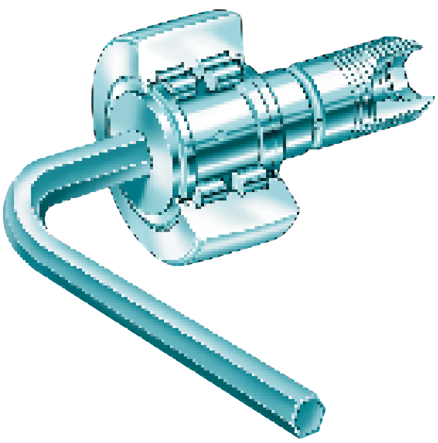

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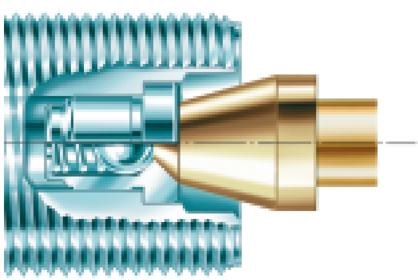

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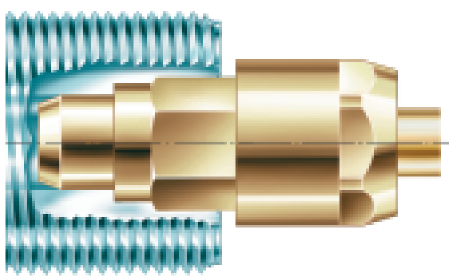

Figure 6 New generation of yoke and stud type track rollers. Hexagonal socket with relubrication facility on both sides
① Simplified assembly due to hexagonal pocket at both ends
② Relubrication facility for grease lubrication via lubrication nipple at both ends
③ Connection to central lubrication system possible at both ends via adapter (special accessory)

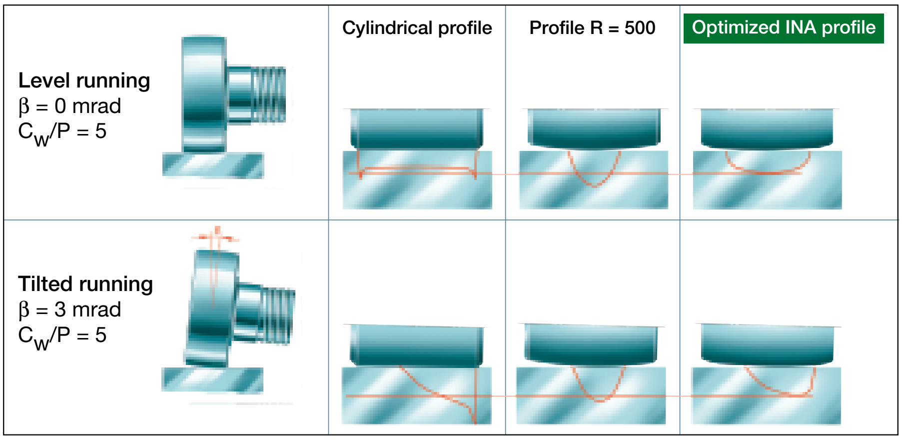

Figure 7 Influence of provile on Hertzian pressure. Optimized INA outer ring profile compared with conventional profiles

7 Optimized outer profile

With the new generation of yoke and stud type track rollers, it has been possible not only to achieve significant improvements in lubrication and tilted running behaviour but also to optimize the wear behaviour of the outer ring. From the causes of failure in relation to the specific application shown in Figure 2, it is noticeable that the most frequent reason for failure is wear of the outer ring.

Wear investigations have shown that wear between the outer ring and the mating track can be significantly reduced by correct material selection and,as far as possible, by minimal lubrication. However, these investigations also show that the load at the contact surface has a disproportionate influence on the wear [5]. It is therefore important to reduce the Hertzian pressure at the contact point. On the basis of exhaustive calculations and tests, the outer ring profile has been optimized to give a substantial reduction in Hertzian pressure whether the track roller is fitted with precise alignment or with an angular error.

Figure 7 shows the superiority of the new profile compared to the cylindrical profile and the conventional radius R = 500 mm. In addition to the improvements in grease operating life and tilted running behaviour, it has been possible to significantly reduce the Hertzian pressure at the contact point between the outer ring and mating track. In addition to improved rigidity, this also improves the fatigue life, especially of the mating track. In conjunction with correct material selection [2], this leads to a significant reduction in wear.

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Dipl.-Ing. Helmut Bode is Industrial Sector Manager for Production Machinery at INA Wälzlager Schaeffler oHG, Herzogenaurach (Germany)

INA Canada Inc.

2871 Plymouth Drive
Oakville
Ontario L6H 5S5
Tel. +1/905/829-27 50
Fax +1/905/829-25 63
E-Mail sales@ca.ina.com
www.ina.com

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