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"Ball and Roller Bearings"

by Andrew H. Wilson

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THE CEDARGROVE SERIES OF

DISCOURSES, MEMOIRS AND ESSAYS

#72/2024

BALL AND ROLLER BEARINGS

by Andrew H. Wilson

March 2024

Abstract

This paper has two purposes: one is to encourage readers (if and when they need it) to call a ball bearing a 'ball bearing,' and a steel ball a 'steel ball'! This confusion has been of long-standing and came to my attention in 1954 at the hands of an expert, R.K. Allan. The other is to note some of the information Allan gave in his book about the history and development of *Rolling Bearings*…something I dealt with at first hand all these years ago as a technical sales engineer for the Skefko (SKF) Ball Bearing Company in England and Wales. There are a few illustrations.

About the Series

Principally, the Cedargrove Series is intended to preserve some of the research, writings and oral presentations that the author has completed over the past half-century or so, but has not yet published.

About the Author

He is a graduate in mechanical engineering (1949) and the liberal arts (1954). Now in his mid-nineties, he has held technical and administrative positions in the United Kingdom and technical, administrative, research and management positions in the Public Service of Canada, from which he retired almost 40 years ago. He became actively interested in the history of engineering on his appointment to chair the first History Committee of the Canadian Society for Mechanical Engineering (CSME) in 1975. He was later president of CSME and of its 'parent', the Engineering Institute of Canada (EIC). He also chaired the CCPE's Canadian Engineering Manpower Council (CEMC), the Canadian Association for the Club of Rome (CACOR), and both the EIC and CSME History Committees.

To Set the Scene…

The first point: I joined the Skefko Ball Bearing Company (SKF), in Luton, England, in September 1954 as a technical sales engineer. But before taking to the road, so to speak, the company gave me some training, which included sessions with its chief engineer, Robert K. Allan, by then one of the world's experts on the application of the company's products: ball and roller bearings and a number of related and specialized products, such as plumber blocks, needle roller bearings, and bearings of special design for use in automobiles, railway axles, and rolling mills.

In view of my future contacts with the company's customers, as well as with lay people in business generally, Allan made the point that they frequently confused steel balls with ball bearings. These *bearings,* he said, included inner and outer rings (to fit onto shafts and into the bearings' housings), cages to hold the balls in place, properly spaced and lubricated, and of course the steel balls! In his view, the balls on their own, even when acting as differently-housed bearings (as in some bicycle hubs?), are still just *steel balls!*

The same confusion did not apply, to the same extent apparently, to the other three main types of bearing made by SKF: the cylindrical roller, the tapered roller (similar to the Timken Company's products), and SKF's own spherical, or self-aligning, roller bearings.

Earlier, Allan had written a textbook called *Rolling Bearings,* (Pitman, London (1946)), which I have used as my source for this paper, but without the descriptions, formulae and most of the illustrations. I still have the copy he gave me, having used it from time to time in my work.

The History…

Of rust, friction and the use of lubricated bearings using the rolling principle…

Mechanical engineers in particular are very familiar with rust and the trouble it can cause. They are also very familiar with friction, its problems and their cures, with the loading and rotation of shafts, and the minimizing of energy expenditures. The point of using ball, roller and other similar bearings is to avoid both rust and friction and to encourage economy in the use of energy, while dealing with the imposed loading of the shafts they are carrying. The rust problem is usually solved by having the bearing in a 'container' filled with grease or oil, which also contributes to reducing friction. I will say no more about rust, but will concentrate on the anti-friction use of rolling bearings. But first, some history…

Allan pointed out in his book that primitive man was impressed by the fact that a de-branched tree trunk could be moved relatively easily on a flat surface and would roll by itself down a slope. And from the rolling trunk, the two-wheel-and-axle system eventually developed. Eventually, also, a single log became a weapon - a battering ram carried by several soldiers. Also, a pair or series of rollers with a flat board on top could be used to transport loads from one place to another, and suitably large stones could be substituted for the tree trunks - all this before B.C became A.D.

By the time of the Renaissance and Leonardo da Vinci (late 15th-early 16th centuries) friction had been found to be of two kinds: sliding and rolling. Furthermore, the friction of bodies in contact was of four kinds: fluid on fluid; solid on solid; solid on fluid; and the motion of a wheel in contact with the ground (caused by contact, not rubbing). Da Vinci is thought to have used roller bearings with Archimedes screws that raised water from one level to another. By 1520 AD, cast iron balls were being used in place of stones in offensive warfare.

The first mention of spherical rolling bodies was by Benvenuto Cellini around 1534 AD. They were used to provide movement to a statue. In the mid-16th century. The engravings of George Bauer (also known as *Agricola*) and Ramelli showed machines with roller bearings. In 1699 AD, mention was made in papers by Amonton and von Leibnitz of the distinction between sliding and rolling friction. A design submitted by de Mondran in 1710 AD to the Paris Academy of Science for a carriage with wheels supported by 'anti-friction' rollers. Another document, by Fahy, showed a gun-carriage supported by similar bearings.

Early in the 18th century, England's Board of Longitude held a competition for the accurate determination of longitude at sea. One entrant, Henry Sully, apparently used 'anti-friction rollers' in his entry.

In the 1730s, a book on the construction of windmills referred to the use of rollers to support windmill roofs that had to be turned to catch the wind. The rollers were 'caged' to keep them in place.

In a 1938 article, Ronald Clark described a ball thrust bearing that was used in a rotating mill in Norwich, England in 1780. The balls ran in grooves having a larger radius than the balls themselves, and the lower ring had a steel band around it. Also, in 1794, what is probably the oldest roller bearing put to use, was found in 1909 when the vane was being renovated.

In 1805, Robert Stevenson used a roller in the lantern mechanism of one of his lighthouses and balls in the cranes used in its construction.

In 1820, Englishman James Harcourt obtained a patent for furniture castors that had steel balls to take the thrust load.

In 1824, Frenchman Joseph Vachier obtained a patent for a jib crane with copper rollers to take the load from the jib.

In 1829, Austrian Joseph Ressel was granted a patent for rollers and balls for machines and wagon axles to reduce friction and lubrication.

In 1857, patents were granted to Britons L.J. Brethon and J.W. Pascal for roller bearings for mills and for the lubrication of rolling bearings. That same year, P.A. de Fontaine-Moveau received a British patent for a 'footstep' bearing with steel balls running in a spherical track.

In 1862, a British patent was issued to W.E. Newton for a ball bearing for railway stock.

In 1863, C.C. Perley received an American patent for a bearing with several rows of balls to take the radial and thrust loads of marine propellers.

In 1866, Antoine, Baron de Gablenz, was issued a British patent for a bearing for bicycles. Such bearings began to appear in bicycles within a few years. In 1869, Frenchman F.J. Suriray obtained a French patent for a bicycle bearing with steel balls which ran in a cast-metal ring enclosed by the crankshaft bracket. In 1877, a British patent was issued to J.H. Hughes for a cycle bearing with conical or curved track surfaces and steel balls.

Allan noted in his book that, around 1883, the technical/commercial success of the bicycle had had a favourable and important influence on the manufacture of ball bearings (and steel balls!). In a note dated 1898, he also quotes a source as saying that the use of steel balls to reduce friction was being extended extensively and rapidly. But he cautioned that his Company (Skefko) had found that there could be variations in the compressive strengths of steel balls made by the same process.

In 1902, a British patent was issued to E.G. Hoffman for a single row ball bearing with a spherical outer track and a fitting flange on the outer ring.

In 1906, a British patent was issued to R.F. Hall for a cylindrical roller bearing.

In 1907, a Swedish patent was issued to S.G. Wingquist for a double-row ball bearing with a spherical outer track.

In 1910, a British patent was issued to the Hoffman Manufacturing Company Limited for a cylindrical roller bearing with grooved inner and outer rings.

In 1911, a British patent was issued to S.G. Wingquist for single-row and double-row self-aligning bearings with barrel-shaped rollers.

In 1920, a British patent was issued to Aktiebolsget Svenska Kullagerfabriken (SKF), Sweden, for roller bearings in which one ring had an outer track of spherical form, and the rollers were convex or concave.

In 1925, a British patent was issued to Georg Hoffmann for bearings for big ends or gudgeon pins of high-speed connecting rods.

In 1931, a British patent was issued to the the SKF Ball Bearing Company and H.R. Zetterstrom for a housing in two parts, which were angularly adjustable, so that the unit could be adapted to suit supports of various shapes (the plumber block).

In 1932, a British patent was issued to the Timken Roller Bearing Company for a double-row taper roller bearing.

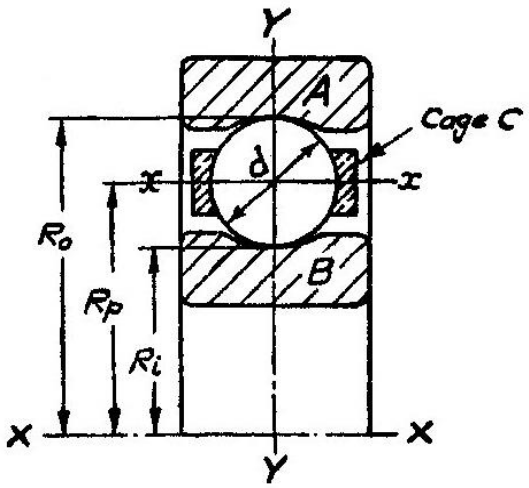
In 1934, a British patent was issued to British Timken Ltd. for a double-row taper roller bearing with a spherical inner track.

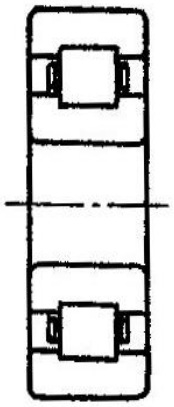
In 1940, a British patent was issued to Aktiebolaget Svensks Kullagerfabriken for roller bearings, both radial and thrust, having roller ends shaped so as to induce hydrodynamic lubrication between them and the flanges against which they were bearing.

Obviously, patents were also issued after those noted in Allan's book. For the purposes of this paper, however, the historical review is limited to that book.

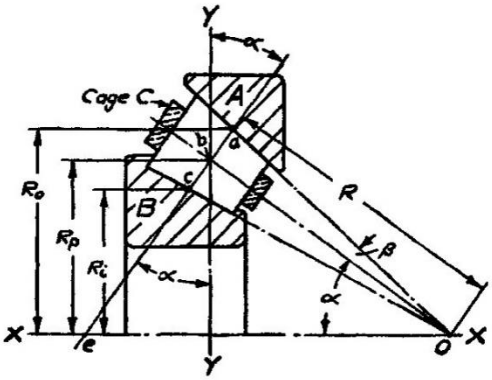
Also…when I was employed by SKF, its main British competition came from these companies: ball and roller bearings - Hoffman Manufacturing and Ransome and Marles; and taper roller bearings - Timken. SKF alone did spherical roller bearings.) Also, Allan's book was published in 1946.)

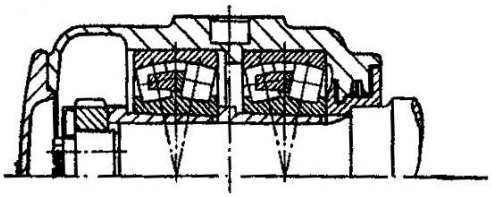
Some Examples of Mounted Bearings…





Single-row ball bearing Cylindrical roller bearing





Taper roller radial bearing

Spherical roller bearing assembly

Sources…

R.K. Allan, *Rolling Bearings: A Comprehensive Treatise;* Pitman & Sons Ltd., London, Second Edition, 1946

Wikipedia; How did Da Vinci improve the Archimedes screw?

The illustrations were taken from R.K. Allan's book, pages 48, 23, 48 and 252.