BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi“ din Iaşi,
Tomul LVI (LX), Fasc. 4A, 2010
Secţia
CONSTRUCŢII DE MAŞINI

NON-DIAMETRICAL FOUR POINT CONTACT BALL BEARINGS

BY

REZMIREŞ DANIEL*, BOCĂNEŢ VASILE*, MONFARDINI ALFREDO, RACOCEA CRISTINA***, RACOCEA CEZAR*****

Abstract: The paper presents a method to describe the quasi-static behaviour for convergent and divergent non diametrical four point contact ball bearings.

Key words: four point contact roller ball bearing, symmetrical, convergent, divergent, quasi-static analyse

1. Introduction

According to [1], this bearing type is a convergent structure (Fig.1) and includes an inner race heaving a rotational axis, an outer race sharing the rotational axis of the inner race, and a rolling bearing members (ball) constrained between the inner race and the outer race.

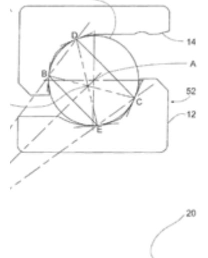

Fig. 1 - Convergent non-diametrical ball bearing type [1]

The contact points on each individual race form line converging to a common vertex on the bearing rotational axis. This paper shows the differences between a convergent or a divergent solution from the point of view of the contact pressure.

2. Convergent, symmetrical and divergent solutions

Figures 2 and 3 shows the convergent and divergent solutions geometry modelled as a derivative class of a 2 to 6 point contact points ball bearing [2,3] mathematical model.

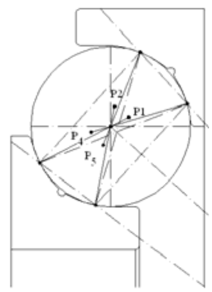

Fig. 2 - Convergent structure type

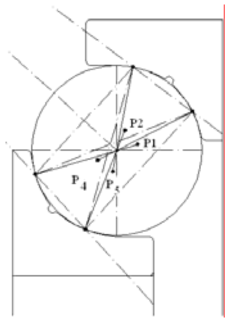

Fig. 3 - Divergent structure type

3. Convergent or divergent solution ? A case study.

In the present analysis a single ball were taken into account. A axial and a radial load, as a constant value, were considered and it act at the inner ring raceway and have to be supported by the analyzed ball. In this case the inner ring is considered as a rotational part of the bearing. For the two bearing types was considered a ball diameter dw=12 mm, pitch circle diameter D=100 mm, and 0.52 for the raceways conformities.

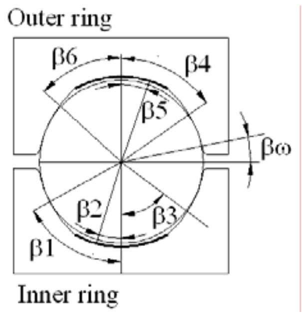

Fig. 4 - Original class structure

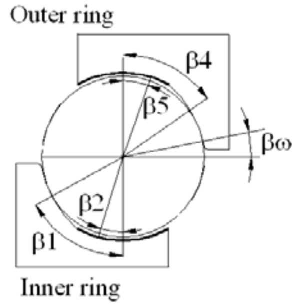

Fig. 5 - Derivative structure for no diametrical ball bearing

For the convergent bearing type the contact angles were considered (β1=63, β2=11, β3=0, β4=74, β5=22, β6=0). For the divergent bearing type the contact angles were considered (β1=74, β2=22, β3=0, β4=63, β5=11, β6=0). The axial force 2000N, and the radial force 1000N. The friction coefficient was considered as 0.08. The drag effect was not considered. The computational code take into account the minimum power losses by friction and return for the analyzed ball the ball angle βω and the minimum power losses, according to [4,5]. For different angular speed of the inner ring the results are presented as follows:

Table 1 - Power losses for convergent Pconv and divergent Pdiv bearing type as function of the inner ring speed ni.

ni, rpm	Pconv	Pdiv
10	0.69	0.57
1000	69	58
5000	352	299
10000	745	661
15000	1216	1146
20000	1801	1815
25000	2527	2722
30000	3418	3916

Table 2 - Ball angle for convergent βω conv and divergent βω div bearing type as function of the inner ring speed ni.

ni rpm	βω conv	βω div
10	-57.8	-59.6
1000	-57.8	-59.6
5000	-57.6	-59.4
10000	-57	-58.8
15000	-56.1	-57.8
20000	-54.9	-56.5
25000	-53.4	-55
30000	-51.7	-53.3

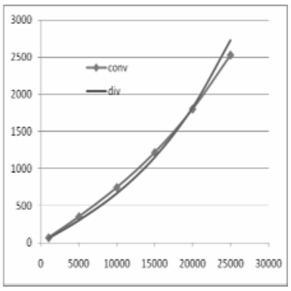

Fig. 6 - Minimum power losses for the and convergent and divergent structures

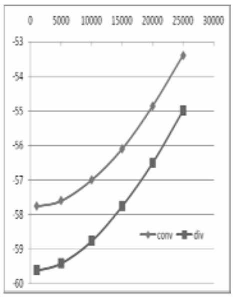

Fig. 7 - Ball angle for the convergent divergent structures

Table 3 - Contact pressure for the considered ball taking into account the convergent and the divergent geometry and the contact number

	Pconv, MPa				Pdiv, MPa			
	Pc1	Pc2	Pc4	Pc5	Pd1	Pd2	Pd4	Pd5
10	2335	870	2117	1396	2180	1541	2224	781
5000	2335	870	2113	1416	2180	1541	2223	835
10000	2335	870	2102	1471	2180	1541	2218	966
15000	2335	870	2083	1556	2180	1541	2209	1131
20000	2335	870	2056	1660	2180	1541	2196	1304
30000	2335	870	1979	1905	2180	1541	2160	1645

Table 4 - Load distribution for the considered ball taking into account the convergent and the divergent geometry and the contact index.

	Qconv, N				Qdiv, N			
	Qc1	Qc2	Qc4	Qc5	Qd1	Qd2	Qd4	Qd5
10	2168	102	1819	575	1820	547	2169	101
5000	2168	102	1810	599	1820	547	2164	124
10000	2168	102	1781	673	1820	547	2149	192
15000	2168	102	1733	795	1820	547	2123	308
20000	2168	102	1667	967	1820	547	2087	472
30000	2168	102	1486	1461	1820	547	1987	984

5. Conclusion

The mathematic model shows that the divergent geometry fits better for moderate speeds till the convergent geometry can work better for very high speed. For the divergent geometry the centrifugal force is better shared versus the convergent structure. In the presents analysis for inner ring speeds less than 20 000 rpm the divergent solution works better like the convergent solution.

Received May 03rd 2010

** S.C Sirca S.A. – Piatra Neamt*
*** S.C. Rima Spa - Italy*
**** "Gheorghe Asachi" Technical University of Iaşi*
e-mail: cracocea@netscape.net

R E F E R E N C E S

1. United States patent US 20090034895A1 – 5.feb.2009
2. R e z m i r e s D., B o c a n e t V., M o n f a r d i n i A., – *Rulment Radial axial cu bile, cu rigiditate radiala discontinua.* Brevet de inventie A00613 / 2007
3. R e z m i r e s D., B o c a n e t V., M o n f a r d i n i A., R a c o c e a R.C., R a c o c e a C.C., *A New Class of Ball Bearings. Ball Bearings with 4, 5, or 6 Contact Points*. International Multidisciplinary Conference. 8th Edition, Nyiregyhaza, Hungary, May 21-22 2009
4. R e z m i r e s D., *Cercetari teoretice si experimentale privind dinamica rulmentilor radial oscilanti cu role butoi*, - teza de doctorat. http://daniel-rezmires.tripod.com, 2003.
5. R e z m i r e s D., R a c o c e a C., *Modelling of the ball bearing geometry using the object oriented programming,*, Bul, IPI., Tomul L, Fasc 6A., ACME, Iasi 2004

RULMENŢI ASIMETRICI CU 4 PUNCTE DE CONTACT

Lucrarea prezinta o modalitate de calcul a parametrilor cvasi statici si cvasi dinamici ai rulmentlor cu 4 puncte de contact cu geometrie asimetrica. Sunt prezentate comparativ avantaje si dezavantajele a doua tipuri noi de gemetrii de rulmenti unul brevetat in SUA si unul brevetat de catre SIRCA SA si Rima Spa. Metoda de comparatie a fost calculul puterii minime consumate prin frecare, pentru o singura bila, la nivelul celor 4 tribocontacte. Analiza releva faptul ca solutia SUA prezinta un caz particular al solutiei dezvoltate de catre Sirca si Rima.