UNCONVENTIONAL CONSTRUCTION OF RADIAL PLANETARY BALL BEARINGS, TYPE 6/6

Romeo CIOARĂ[1], Vladimir MĂRĂSCU-KLEIN[2], Cristian PISARCIUC[3]

ABSTRACT:

Having as a principal objective increasing the value of the limited rotation speed of existing ball bearings, without however a significant change to their known technology, the authors of this paper have developed research concerning a new concept: planetary ball bearings.

The paper illustrates this concept by homogenous radial planetary ball bearings. It offers and describes obtaining solutions related to homogenous radial planetary ball bearings by adequate assembling of known and currently used radial ball bearings, as well as specific constructive solutions of homogenous radial planetary ball bearings. The paper is further supported by a number of 3D models of homogenous radial planetary ball bearings, and some of their possible performances.

KEYWORDS: Planetary bearings, Homogeneous radial planetary ball bearings

1. INTRODUCTION

Industrial applications include a wide range of bearing types, most of them standardized. Best known and most frequently used are radial ball bearings.

The present paper shows the possibility of obtaining homogeneous planetary bearings by combining two type 6 single-row radial ball bearings (STAS 1679-82) with each other.

The main objective that leads to creating these planetary ball bearings regardless of their constructive type was increasing the limited speed that can be sustained by the bearings.

The constructive solutions can be created without any modifications to the present technology of bearing manufacturing or with minimal modifications.

Before carrying out experimental research on any type of planetary bearings, some of the performances can be evaluated by comparison to similar performances of existing bearings that form the investigated planetary bearing. The increase of the maximum limited speed value can be estimated by using specially developed mathematical models.

2. HOMOGENEOUS RADIAL BALL BEARINGS, TYPE 6/6, OBTAINED BY ASSEMBLING

A type 6/6 radial ball bearing can be obtained by assembling two type 6 bearings one over the other (figure 1).

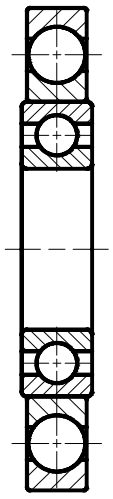

Fig. 1 Radial planetary ball bearing, homogeneous, type 6/6, obtained by assembling

Obviously, the inner diameter of the external bearing must be equal to the external diameter of the inner bearing. For any

combination, differences between the widths of the two component bearings can be identified, and also (significant) differences between their static and dynamic radial basic load ratings. These aspects are highlighted in table 1 (their values being those of [3]).

Table 1 Characteristics of the radial ball bearings that can constitute, by assembling, homogenous radial planetary ball bearings, with the inner diameter of 45mm

Inner bearing, (i)				External bearing, (e)				$(C)_e/(C)_i$	$(C_0)_e/(C_0)_i$
Symbol	B [mm]	Basic load rating [kN]		Symbol	B [mm]	Basic load rating [kN]			
		C	C_0			C	C_0		
16009	10	12	9,3	16015	13	23	20	1,92	2,15
				6015	20	31	26,6	2,58	2,86
				6215	25	52	42	4,33	4,52
				6315	37	89	73	7,42	7,85
				6415	45	120	117	10,00	12,58
6009	16	16,5	12,4	16015	13	23	20	1,39	1,61
				6015	20	31	26,6	1,88	2,15
				6215	25	52	42	3,15	3,39
				6315	37	89	73	5,39	5,89
				6415	45	120	117	7,27	9,44
6209	19	25,6	18,6	16017	14	27	25,5	1,05	1,37
				6017	22	38,5	34	1,50	1,83
				6217	28	65,4	54,1	2,55	2,91
				6317	41	104	91	4,06	4,89
				6417	52	136	138	5,31	7,42
6309	25	41,5	30,5	16020	16	34	33,5	0,82	1,10
				6020	24	47,5	42,5	1,14	1,39
				6220	34	95,8	80,6	2,31	2,64
				6320	47	136	134	3,28	4,39
6409	29	60,4	46,4	16024	19	46,5	47,5	0,77	1,02
				6024	28	66,5	62,5	1,10	1,35
				6224	40	119	114	1,97	2,46
				6324	55	170	183	2,81	3,94

The data in the table show that the most advantageous combinations would be 6024/6409 and 6020/6309 where even the widths of the component bearings are similar. Convenient would also be combinations 16017/6209, 16020/6309, 16015/6009 and 16024/6409.

The data in table 1 also reveal the possibility of obtaining, by assembling, radial planetary ball bearings by mounting two identical bearings in the inner row, figure 2. From this point of view, advantageous are the combinations where the values of the fractions $(C)_e/(C)_I$ and $(C_0)_e/(C_0)_I$ are approximately 2. An even situation would be $B_e/B_i \approx 2$. These requirements are well satisfied by combinations 16015/(2x16009), 6015/(2x6009), 6224/(2x6409), and acceptably by 6015/(2x16009) and 6220/(2x6309).

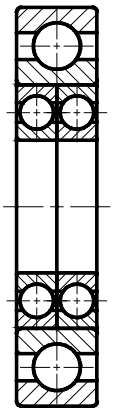

Fig. 2 Radial planetary ball bearing, type 6/(2x6), obtained by assembling

Type 6/6 homogenous radial planetary ball bearings obtained by assembling, can not sustain axial loads, given the potential axial displacement between the two bearings of the assembly.

3. HOMOGENOUS RADIAL PLANETARY BALL BEARINGS, TYPE 6/6

A type 6/6 homogenous radial planetary ball bearing, differs from a radial planetary ball bearing of similar type obtained by assembling two single-row radial ball bearings, by the fact that the external race of the inner bearing and the inner race of the external bearing represent a sole shared body, i.e. the intermediary race of the planetary bearing, figure 3.

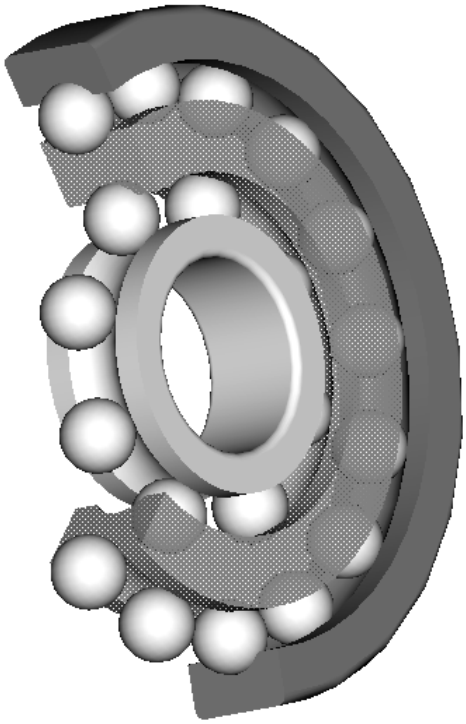

Fig. 3 Homogenous radial planetary ball bearing, type 6/6, with equal ball radii on both rows.
3D image created in ProEngineer

In homogenous radial planetary ball bearings it is important that both dynamic and static basic load rating ensured by the two rows of balls have close values. The basic load rating of the planetary bearing is determined by the minimal of the corresponding values ensured by its two layers, so that any unbalancing is economically inefficient. The basic load rating surplus in one layer can not be effectively used. The equalizing of the values of C and C_0 can be achieved by adequate determination of the number and radii of the balls on the two levels of the planetary bearing.

In this context it should be mentioned that for the single-row radial ball bearings, the increase of overall size determines an increase of ball radius, race widths and basic load ratings.

If in type 6/6 homogenous radial planetary bearings balls of the same radius are used in both layers, as shown in figure 3, the amount of balls in the exterior layer will be greater than in the inner layer. This implicitly determines the basic load rating corresponding to the external layer to be (considerably) higher than that corresponding to the inner layer. In order to equalize these values, the balls in the inner layer must have a (considerably) greater radius, even if their number decreases. Such a bearing is presented in figure 4.

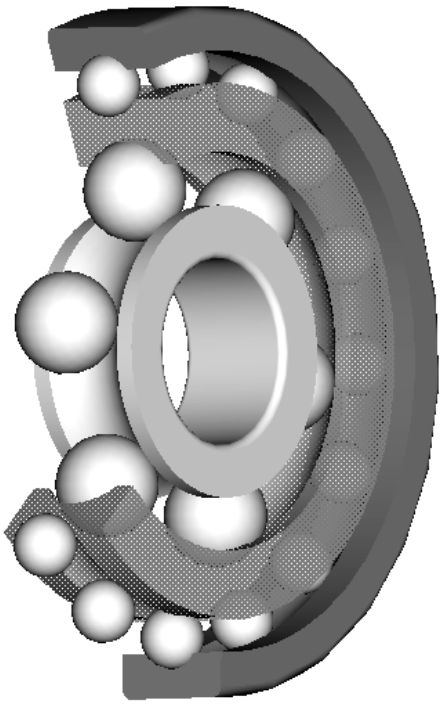

Fig. 4 Radial planetary ball bearing, homogenous, type 6/6, inner ball radius greater than the external ball radius
3D image created in ProEngineer

After increasing ball radius in the inner layer, a decreasing of ball radius in the external layer can also be decided upon, without or (preferably) with a modification of the number of balls.
The opposite case – type 6/6 homogenous radial planetary ball bearing with decreased inner layer ball radius and increased external layer ball radius, as presented in figure 5 – is also possible, but not recommended.
For this kind of structure, the previously mentioned unbalancing is significantly amplified.

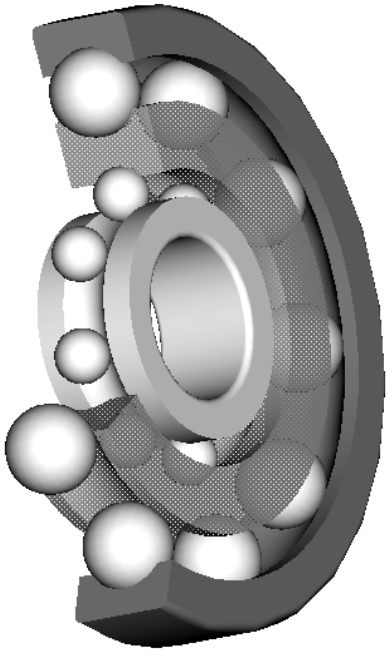

Fig. 5 Homogenous radial planetary ball bearing, type 6/6, with the inner layer ball radius smaller than external layer ball radius.
3D image created in ProEngineer

Although type 6/6 homogenous radial planetary ball bearings can be obtained by assembling, like the one in figure 2, proper radial planetary ball bearings are not homogenous, but mixed, of type 6/4. The two radial ball bearings in the inner layer are equivalent to a radial-axial two-row ball bearing.

4. CONCLUSIONS

Planetary bearings are specially designed for high rotation speed axles and shafts. Planetary bearings can be distinctive individual structures, or can be obtained by adequate assembling of already existing bearings. In the first case, the establishing of the value of the (theoretical) maximum limited speed is determined based on specially developed mathematical models. In the second case, the maximum limited speed is the sum of the maximum limited speeds of the bearings in both layers that compose the planetary bearing.
The diversity of bearing types allows the designing of a large number of different planetary bearings types that can be either homogenous or mixed [1, 2].
Their construction must primarily take into consideration the balancing of the static and dynamic basic load rating ensured by the two layers of roller bodies. This objective can be achieved by adequately establishing the radii and number of balls in the two layers.

REFERENCES

[1] Romeo CIOARĂ, Cristian PISARCIUC, *Rulment planetar radial, cu bile,* Patent claim no. a 2004-01145, 22 December 2004, OSIM, Romania
[2] Romeo CIOARĂ, Cristian PISARCIUC, *Rulment planetar radial, cu bile,* Patent claim no. a 2004-01146, 22 December 2004, OSIM, Romania
[3] Mihai GAFIŢEANU ş.a., *Rulmenţi. Proiectare şi tehnologie*, Editura Tehnică, Bucureşti, 1985

AUTHORS

1 Associate Prof. PhD. Romeo CIOARĂ,
Transilvania University of Brasov, Romania,
E-mail cioarar@unitbv.ro, +40 268 318853
2 Prof. PhD. Vladimir MĂRĂSCU-KLEIN,
Transilvania University of Brasov, Romania,
E-mail klein@unitbv.ro, +40 723 320281
3 Associate Prof. PhD. Cristian PISARCIUC,
Transilvania University of Brasov, Romania,
E-mail pisarciuc.c@unitbv.ro, +40 726 348514