

ACHIEVEMENTS OF STUDY CONCERNING WORM FACE GEAR MADE IN ROMANIA

Vasile Boloș

„Petru Maior” University of Tîrgu Mureș, Romania
vbolos@upm.ro

ABSTRACT

Worm face gears are a relatively new category of gear failure in 50 years in the USA. They are composed of a conical or cylindrical worm to engage the front wheel of a conical or flat. Geometric configuration to ensure a great contact ratio and lubrication between the flanks favorable conditions which allow their implementation of hardened steel, gray iron, bronze. Also they will produce big rapport of transmission in a single stage. Originally conceived by Illinois Tool Works Company Chicago they were taken and developed at the Institute of Mechanical Izhevsk (Russia). Experimental and theoretical developments were made in Britain, Germany, Hungary, Poland, Bulgaria and Romania. In the present paper is highlighted the concerns and the achievements of researchers from Romania in the period 1980-2009.

Keywords: gears, pinion, worm face gear, gearbox, spiroid

1. Introduction

Worm face gears are a family of gears with crossed axes appeared relatively recently in comparison with other gears in the same family (worm gears, hypoid gears).

Gears belonging to the family of worm face gears which can be included in the construction of gearboxes with crossed axes are made in five constructive variants. These are: worm face gear with cylindrical pinion (Fig.1), worm face gear with tapered pinion (Fig.2), worm face gear with reverse tapered pinion (Fig.3), dual worm face gear with cylindrical pinion (Fig.4) and dual worm face gear with tapered pinion



Fig. 1. Worm face gear with cylindrical pinion



Fig. 2. Worm face gear with tapered pinion

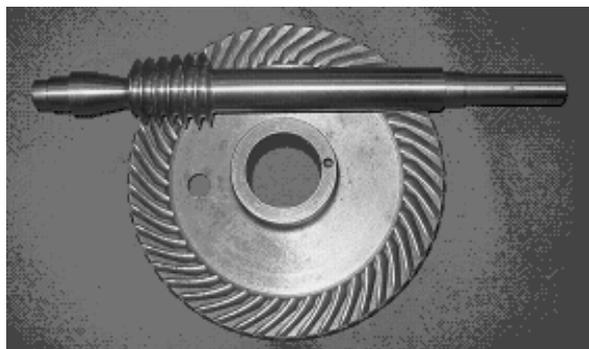


Fig. 3. Worm face gear with reverse tapered pinion



Fig. 4. Dual worm face gear with cylindrical pinion

This type of gear has some functional advantages of which some are required to be referred.

These advantages are due to the particular geometry of the worm face gears, which have to be mentioned: big rapport of transmission in a single stage (choose from 6:1 to more than 400:1), a great contact ratio (approx. 10-15% of the teeth being in a simultaneous gearing), the possibility of backlash adjustment during the assembling and after a period of functioning without any complications, as well as the possibility of using materials which can assure high safety during use; 30-50% more torque a smaller work envelope ; high efficiency, long life duty, lifetime lubrication, self locking; high shock strength

As elements which determine a relatively limited spread can be distinguished as follows:

- because each particular case follows an optimal size of gear, it requires a tool (hob) for this case, for small series production cost becomes relatively high;

- spiroide using worm gears with gear ratio less than 10:1 is difficult for gears made by cutting, so it is desirable that they are realized by sintering (or other methods), elements that require, in terms of economics, existence of a large manufacturing series.

Their constructive characteristics have made their application to be multiple, especially where traditional solutions have not given satisfaction, being found especially in aerospace that the special techniques.

The first patent [41,42,43] on Worm face gear with tapered pinion and its method of processing have been made in 1954 by American Oliver E. Saari of the company Illinois Tool Works - Chicago (USA). In the same year Albert S. Kobayshi of the same company first patented speed reducer using those gears [28].

Fred Bohle published in 1955 work [3] and in 1956 work [4] giving the geometric characteristics, functional and processing of worm

face gear with tapered pinion (spiroid gears) made from company Illinois Tool Works Chicago.

In 1956 Oliver E. Saari presented in the paper [40] mathematical foundations of worm face gear with tapered pinion (spiroid gear.)

In 1957 Oliver E. Saari filed patent [48] on . worm face gear with cylindrical pinion , the trading name of the company receives Illinois Tool Work of gear "Helicon".

WD Nelson (USA) makes a summary of issues related to design, processing and applications worm face gear with tapered pinion (spiroid gears) in the paper [35] published in 1957.

In 1958 Desideriu Maros (Romania)'s work [31] appears showing worm face gear with tapered pinion independently proposed by Oliver E. Saari, solution design, worm face gear with cylindrical pinion

V.A. Ovcinnikov and B.D. Zotov (USSR) in 1960 patented the method of hobbing the axial advance of wheels that engage with a Worm face gear with cylindrical pinion [37]. In 1961 W.D. Nelson in his [36] is widely known, the results of research company Illinois Tool Works of Chicago on worm face gear with tapered pinion (spiroid gears).

D.W. Dudley in the monograph [11], published in 1962, has substantial references worm face gear with tapered pinion and worm face gear with cylindrical pinion based on documentary material provided by the company Illinois Tool Works.

A.K. Georgiev (USSR) patent in 1966-type worm face gear with reverse tapered pinion [15].

A.M. Fefer (USSR) in 1968 patent worm face gear with cylindrical pinion with cylindrical worm different step on the two sides [13].

In 1971 A.K. Georgiev and VI Goldfarb patent Worm face gear with cylindrical pinion with curved sides [21].

E. Schrempp (USA) obtained patent in 1972 [48] for the variant of the Worm face gear with cylindrical pinion has symmetrical flanks.

A.K. Georgiev and V.A. Modzelevskii patent in 1973. Worm face gear with reverse tapered pinion having curved side walls [19].

In the USSR in 1977 is standard for first worm face gear (spirod gears), GOST 22850-77, which establishes the terminology and elements of the definition of these gears [53].

Constant concern for worm face gear [10,45,46,47,48], can be mentioned as Illinois Tools Works Company located in Chicago (USA) which since 1954 till now also manufactures gears and the Izhevsk Mechanical Institute (former USSR) where from 1959 until now under study these gears constantly[16,17,18,19,20,23,52]. Can be mentioned: Gears Davall Company (UK), Technical University Munich, University of

Dresden, Technical University of Budapest, University of Miskolc, and in Bulgaria and Poland, Slovakia.

Aspects far worm face gear have been studied abroad in several doctoral theses [1,2,14,26,27,29,50]..

2. Concernings Regarding the Study of the Worm Face Gear in Romania

In Romania, regarding the worm face gear, can make the following entries:

D. Maros, the work [31] published in 1958, makes reference to the first worm face gear with tapered pinion, on which occasion regardless of Oliver E. Saari version proposes a cylindrical auger;

V. Rohony in work [39] in 1974 presented very briefly this gear;

in 1978, N.S. Gheorghiu, I. Feimer and N. Ionescu in his [22] develops very briefly some theoretical issues related to worm face gear

In 1979, the Institute of Higher Education in Tg. Mureş (currently Petru Maior University), V. Bolos and Codruța Bolos are first flirtation physical implementation of a worm face gear with cylindrical pinion;

In 1982, V. Bolos made Worm face gear with cylindrical pinion presented to "Colloquium "Machines and cold technologies for processing high-productivity" of the Polytechnic Institute of Cluj-Napoca ;

In ..1983. V. Bolos, M. Codreanu and C. Bolos patent applications of these two gears used in construction machinery for weaving textile machinery manufactured in the company of Tg. Mures [6,7].

In 1985, V. Bolos doctoral dissertation [8] concerning worm face gear with cylindrical pinion (spiroid gears with cylindrical worm) under the direction prof. Gh. Petriceanu from Polytechnic Institute of Cluj-Napoca, Under this thesis is elaborated a model matrix - vector of cylindrical worm gear running - but the wheel flat and cylindrical worm gear-cutter technology - flat wheel that is the gear cutting machine in two variants : working version with advanced axial and tangential advance working version. The thesis contains references to the technological regime hobbing with hobb, so the processing of iron wheels and wheels of steel processing. I also examined aspects of contactless lines. A separate chapter presents the results of studies of port and operating noise in second gear made in the combination of materials nitrided steel - nodular cast iron (wheel) and nitrided steel (wheel).

N. Guju, in 1990, developing the work [24] a chapter on geometry type Spiroid and Helicon gears, being the position that these gears are cases of special type of hypoid gears.

M. Sudrijan, P. Cismas and I. Napău patent obtained in 1993 [51] for a worm face gear with cylindrical pinion (type ZK) - Wheel flat for use in construction machinery - tools;

Codruța Bolos, submitted in 1995, PhD thesis [5] which deals with issues Worm face gear with tapered pinion under scientific leadership of Prof. Gh Petriceanu at the Technical University of Cluj Napoca.

Bolos V, published in 1999 *Spiroid worm gearings. The hobbing of the plane wheels* (In Romanian language University Publishing House Petru Maior Targu Mures[9]

I Napău, 1999 thesis argues [33] under the leadership of Prof.V. Handra-Luca at the Technical University of Cluj Napoca, which addresses a number of specific problems . Worm face gear with cylindrical pinion patent [51].

Handra-Luca V, Napău I., Napău, M.; Napău Dacia-Ileana, Sudrijan. I publish in 2000 orthogonal book *Gears grinding wheels and axles cross*. The Publishing House of Science, Cluj Napoca [25]

In 2002, the study appears NASA/CR-2002-211895 *New Geometry of Worm Face Gear Drives With Conical and Cylindrical Worms: Generation, Simulation of meshing, and Stress Analysis Having* authored by Litvin, FL , Nava, A., Fan, Qi, Fuentes A; [30]

Ileana Dacia Napău, argues in his doctoral thesis in 2005 [33] under the leadership of Prof. Dr. Ing V. Maties at the Technical University of Cluj Napoca, which addresses a number of specific issues-wheel flat worm gears with localized contact.

Gear kinematics problems were taken into study and the University of Galati in the paper by Professor Oancea N [37]

E.N. Munteanu has submitted his doctoral thesis in 2009 entitled "Contribution to the optimization of processing technology gear worm-plan wheel with cross-axis" coordinated by Professor V. Csibi Technical University of Cluj-Napoca. [32]

Currently, under the direction of Professor Vasile Bolos are working on doctoral theses which examines four specific aspects Worm face gear with reverse tapered pinion, Dual worm face gear with cylindrical pinion and Worm face gear with cylindrical pinion with a simplified geometry.

3. Conclusions

- Worm face gear are a category of gear that certainly will address the future more than in machine building;

- Geometric complexity and technology implementation should be carried out further studies to shed light on many specific issues;

• It should achieve an international standard terminology that would allow a more rational drafting and realization of results. .

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