CUTTING TOOL AND MANUFACTURING TECHNOLOGY FOR THE INTERNAL INVOLUTE GEARS GENERATING

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Abstract: *This paper make a short presentation of the require tools and the manufacturing technologies for the internal involutes gears machining. The paper occupied just whit the generating methods without to mentioning the rest of the gear manufacturing possibilities.*
Key words: *Cutting tools, Gear generating, Skiving, Hobbing whit ellipsoidal hobb, Shaving.*

1. INTRODUCTION

In opposition whit the manufacturing technology possibility of the external involutes gear in case of internal involutes gear is a just few manufacturing possibility. One of them the gear shaping is used in most of the case. The others manufacture methods for the gear manufacturing industry not present interest because the cutting tool or the designs of the machine tool present same difficulties.

The knowing continuous gear generated methods used by the industry or existing like a principle, used by some company just in special case are the follow: Shaping, Shaving, Skiving and Hobbing whit ellipsoidal hobb. Because the gear shaping are a knowledge methods in this paper we not presented.

2. THE CUTTING TOOL AND THE INTERNAL INVOLUTES GEAR MANUFACTURING TECHNOLOGY BY SHAVING

The shaving is a finishing method whit which is possible to repair the gear tooth form, reduced the tooth flank roughness, removing the tool marks of the previous cutting procedures and simultaneously it is possible to obtain the tooth relief of the addendum and dedendum.

This method are available just for the gear without heat treatment or gear whit low hardness next of the heat treatment.

Considering the manufacturing technology the gears before are shaving must be undercut by the previous tooth cutting method (fig.1.), they value depending on the machining allowance.

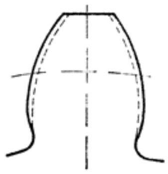
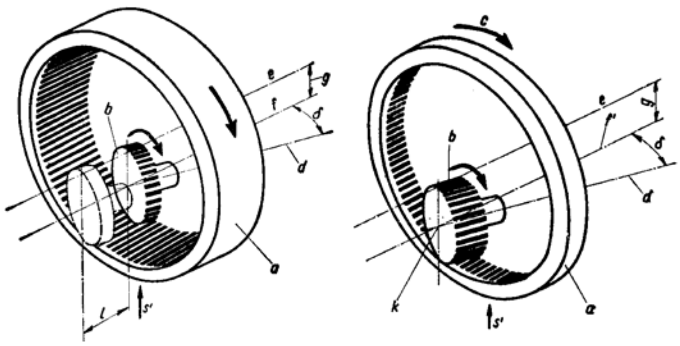


Fig.1. *The optimal position of the machining allowance for shaving [8]*

The machine tool must be satisfying the some restrictions specifically for the internal gears. The work piece are fixed in a special designed chuck what not obstruct the cutting tools in his moving and are able to drive the work piece. (The driving element is a work piece)



Longitudinal shaving   Radial feed shaving

Fig. 2. The internal gears shaving [8]

a – Work piece; b – Shaving tools; c – Driving direction; d – Axis of the tool; e – Axis of the work piece;
f – Direction of the feed;
g – Distance between axes;
s’ – Deep of cut;
δ - Angle between axes

The shaving tool whit the work piece constitutes a cylindrical gearing whit parallel axis (the Finrock system) or whit crossing axis.

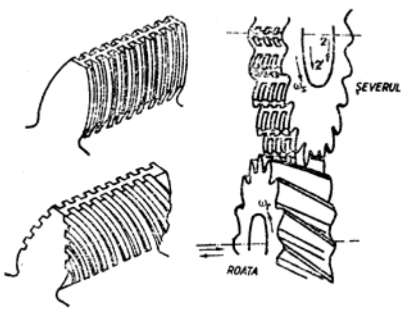


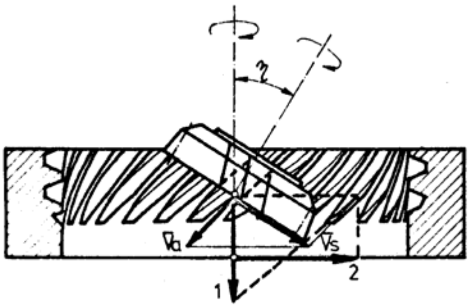
Fig.3. The shaving tool

To obtain the cutting geometry on the flank of the tooth are executed a series parallel and equidistance grooves (fig.3.). In this way it is possible to consider the shaving tools like a multitude of the elementary cutting tools, with they cutting edge along by this grooves.
The chips are removed by the pressure between the work piece and the cutting tools.

3. THE CUTTING TOOL AND THE INTERNAL INVOLUTES GEAR MANUFACTURING TECHNOLOGY BY SKIVING

Skiving are a gear or other cyclical repeated profiles continuously generating method. The tool and the work piece constitute a technological gearing whit crossing axis. In this technological gearing the work piece and the tool make just rotations in concordance whit the transmission ratio, and the tool have a secondary continuously moving, the feed moving following the work piece axis, (fig.4).

When the value of the teed are not considered the cutting speed resulted from the vector summation of the rotate velocity of the work piece and of the cutting tool.



V_a – Cutting speed;
V_s; V_p – Speed velocity of the tool and of the work piece;
1 – Direction of the feed;
2 – Direction of the gear generation.

Fig.4. *The principle of the internal gear skiving*

The form of the skiving tools are similar whit the shaping cutter, and they functional role are similarly whit the hobbing tools whit "z" beginning, (z – number of the gear tooth).

Spur gear and helical gear without restriction of the angle of the tooth β_g are possible to manufacturing whit this method; obtain increased productivity in comparison whit the gear shaping methods. The tool positions in accordance with work piece (fig.5.) and are determinate by the following adjusting parameter:

1- The inclination of the tool axis, (notated η) are in concordance whit the angle of the tooth of the tool and of the work piece; ($\eta = \beta_t \pm \beta_g$)

2- The distance between axis, notated **E**;

3- The axial displaced of the tool, notated $\mathbf{B_s}$;

4- The secondary inclination of the tool axis, notated **Ω**.

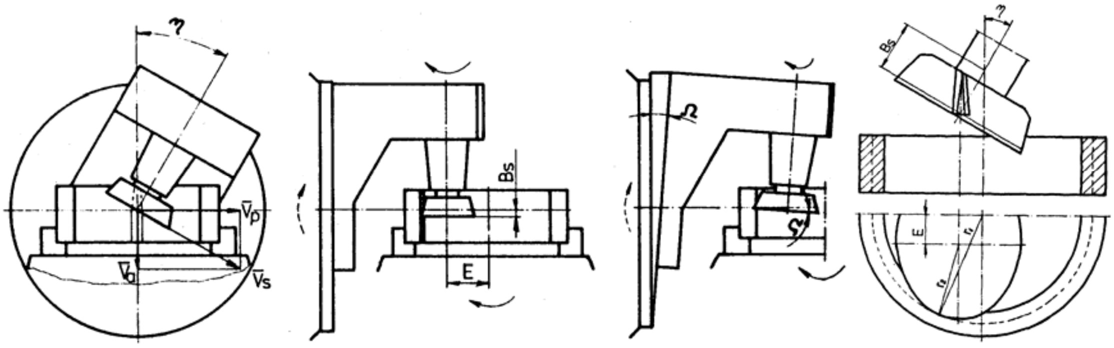


Fig.5. *The adjusting parameters of the skiving tool [5]*

The constructive form of the skiving tool is similar whit the Fellows type shaping tool. And the angle of the tooth β_t is from the recommended 25°...35° intervals.

The tooth flank is obtained whit profiling using a profile grinding machine or a CNC grinding machine. The profile of the tool is generated by computer.

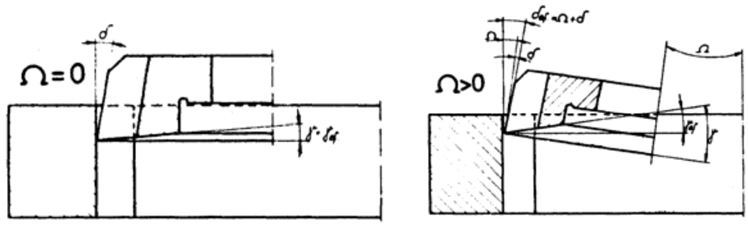


Fig.6. *The cutting geometry of the skiving tool in concordance whit **Ω** [5], [6]*

In the technological process are distinguished two stage the roughing and the finishing. Manufacturing in two stages have multiple economical benefits. In this manner the cutting speed have an optimal value, the used energy are low but must be use two different tools.

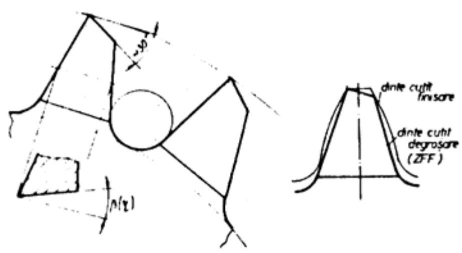


Fig.7. *The recommended finishing and roughing tool profile for skiving*

The finishing tool has an accurate form to generate the involutes and the roughing tool has a linear profile, easy to machining. In the (fig.7.) are presented the recommended finishing and roughing tool profile by the ZF Friedrichshafen Company.

4. THE CUTTING TOOL AND THE INTERNAL INVOLUTES GEAR MANUFACTURING TECHNOLOGY USING THE ELLIPSOIDAL HOBB

Knowing the principle of the external gears hobbing are realized the internal gear hobbing method, using the ellipsoidal hobb cutter. The method and the tool geometry are presented in the [9]. The principle of the method is presented in the (fig.8.).

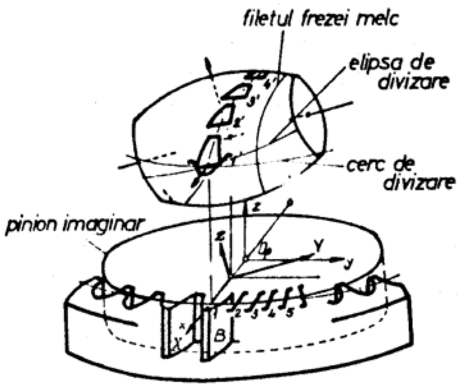


Fig.8. *The internal gear hobbing whit ellipsoidal hobb [9]*

The tool body have a special form (on the ellipsoidal surface are the hobb helix), therefore the each cutting edge of the ellipsoid hobb depending by the own position. Because each tooth of the ellipsoidal hobb is different, to obtain a tool without defects it is to need a very complex technological machining process. In consequence are introduced a cylindrical - conical substitute hobb (fig.9.). This substitute hobb is possible to machining on the universal machine tools.

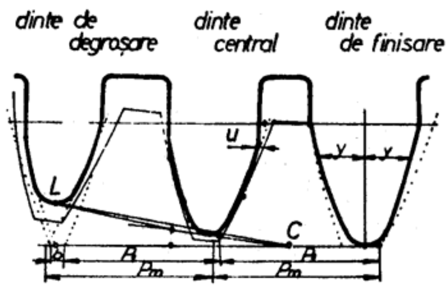


Fig.9. *The substitute hobb [9]*

The tool are formed from 1.5...2.5 helix and just one of this helix are for finishing. This special form needs an accurate design and a high precision chip removing process.

This method is not prevalent probability because the existing difficulties whit the tool is significant and the economical benefits are not simulative.

5. CONCLUSIONS

The manufacturing technology of the internal involutes gears are based on the gear shaping methods, a stable machining process.

Because the productivity of the shaping it is low, the new machining principle appeared but because exist some problems whit the tool or whit the machine tool, in the gear manufacturing industry is not applied.

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