ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

PROBLEMS ABOUT KINEMATICS GENERATION AT THE POLYHEDRAL TURNING

Iulian POPESCU, Ileana PASCU,
University of Craiova, Faculty of Mechanics,
mediu06@yahoo.com, i_pascu@yahoo.com

Keywords: polyhedral turning, epicycloids, device, strand.

Abstract: For achieving this study, the epicycloids generation principles and the turning process possibilities for prismatic parts, with polyhedral section are used. This paper presents the adequate relations for designing and they are provided examples. Also, it is verified the solutions by means experimental model.

1. INTRODUCTION.

At the complex pieces processing, with small dimensions, such as special screws, parts for cocks and so on, sometimes appear surfaces with quadratic or six-angle sections. Because these pieces are for mass quantity production and they work out on automatic chuck lathe, it has been searched solutions for these prismatic zones through turning processing, too. Thus, the part complete processing is ensured, from some fixing without part moving stopping and this increase much the capacity. This problem has been studied on different aspects [4,6,7]. Further on the using of the elongate epicycloids for approximate generation of these polyhedral section is studied.

2. THE EPICYCLOIDS MAKING.

It has been started from the epicycloids generation sheet, figure 1. The gear wheel 1 is fixed and gear wheel 2 has a rotary motion around the point O_1 with ω_b and another rotary motion, through OO_1 arm, around O_1, with ω_a. Because the moving is a development (on the development circles) through pursuance condition that the sectors AC and AB being equal, that is $\varphi = \psi$, they derive the equations of epicycloids generated by M point.

On the basis of reversing motion a rotary motion with ω_a spin velocity is assigned for the mechanism. Thus, the gear wheel 1, initial fastened, will spin with $-\omega_a$. Thus, it comes to the mechanism presented in figure 2.

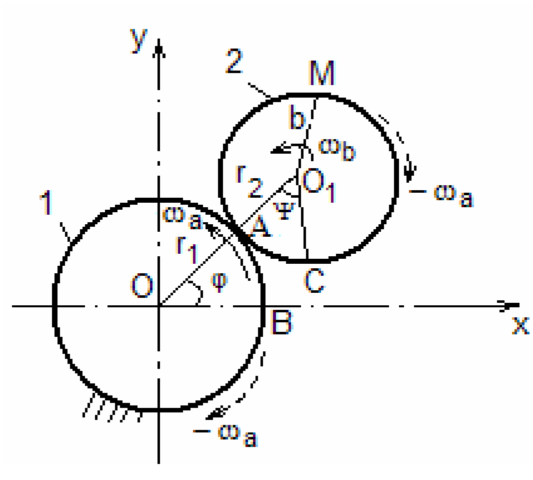

***Fig.1. The epicycloids generation sheet*.**

At this mechanism, the circles with r_3 and r_4 radius are in permanent contact having development without gliding. Their development is assured with two gear wheels with axis of rotation O and O_1.

In the figure 2 two axes systems have been plotted: fixed system xOy and package system x_1Oy_1 jointly with wheel with r_3 radius. The point M belong to the wheel with r_4 radius, spaced by radius r_5 from the point O_1, will describe in the slideable plane an elongated epicycloids.

From the figure 2, the followings relations are obtained:

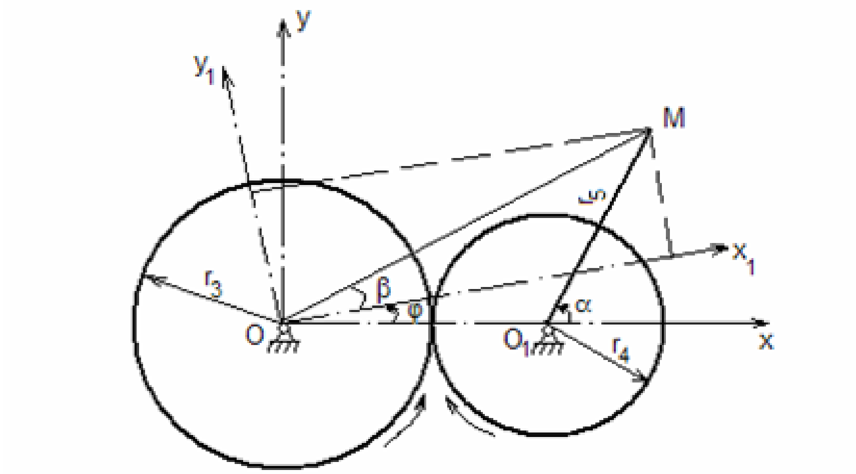

Fig.2. Basic diagram for epicycloids generation.

$$x_{M_1} = OM\cos\beta; \quad y_{M_1} = OM\sin\beta; \qquad (1)$$

where:

$$OM^2 = (r_3 + r_4)^2 + r_5^2 - 2(r_3 + r_4)r_5\cos(\pi - \alpha); \qquad (2)$$

and β results from equation:

$$\frac{r_5}{\sin(\varphi + \beta)} = \frac{OM}{\sin(\pi - \alpha)}; \qquad (3)$$

Also, it obtains:

$$\alpha = -\varphi\frac{z_1}{z_2}; \qquad (4)$$

and the size of jaw for the hexangle is:

$$s = 2(r_3 + r_4 - r_5)\,. \qquad (5)$$

It is complied with established relation of Swedish engineers E.Dalgren and D. Svinson:

$$n_p \cdot L = n_s \cdot c\,, \qquad (6)$$

where: n_p is piece rotary motion and drill chuck has a rotary motion with n_s speed.
Thus, using a number of c lathe tools, a polygon with L sides is obtained.

3. PROCESSED DATA

For polyhedral turning device projecting, followings relations are used:

$$\begin{gathered} n_p \cdot L = n_c \cdot c\,; \\ i_{sp} = \frac{n_s}{n_p} = \frac{L}{c} = \frac{x_1}{x_2} = \frac{r_1}{r_2}; \qquad (7) \\ r_1 + r_2 = r_3 + r_4\,; \\ s = 2(r_3 + r_4 - r_5). \end{gathered}$$

where: i_{sp} is reduction ratio of moving from cutting tool to piece, while z_1 and z_2 are the gear teeth numbers which ensured this rate gear reduction (r_1 and r_2 are division radius of these sprocket wheels).

The basic data are: number of polygon sides L, tools number c and size of polygon jaw s. It adopted the gear modulus and gear teeth number for the small gear wheel, radius r_3 and from the equations presented above result the others values.

4. EXPERIMENTAL RESEARCH

Starting the figure 2, an experimental model has been realized, of principle, which had been plotted different epicycloids.

In the figures 3, 4 and 5 the experimental model structure is presented.

In the figure 3 is observed that the gear pair actuated through a crank, the development gear wheels and pencils that plot the epicycloids; this can be placed on the different holes at dissimilar diameters.

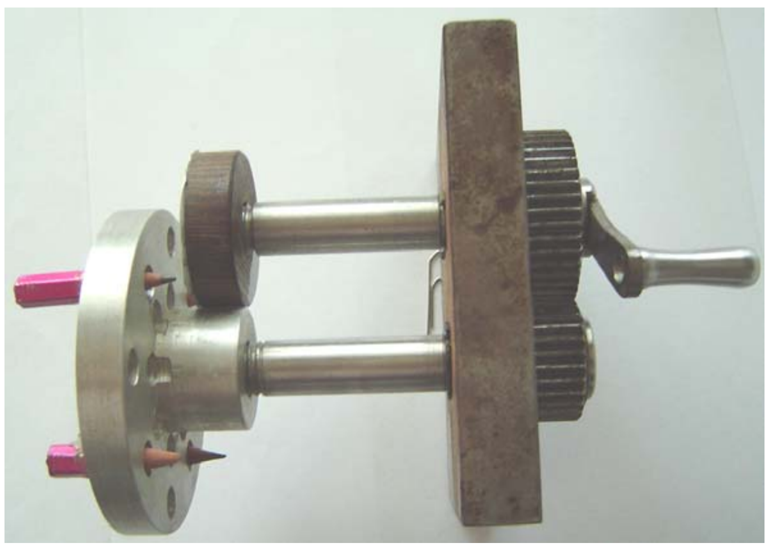

Fig.3. The experimental model.

In the figure 4 is presented a bird's eye view of experimental model, with the pencils normal on plane that will be plotted the vertical lines.

The experimental model dimensions are calculated on the basis of followings relations:

$$L = 6\ ;\ c = 4;\ s = 10;$$

$$i_{sp} = \frac{L}{c} = \frac{6}{4} = 1{,}5\ .$$

It adopts: $m = 1$; $z_2 = 28$ teeth;

And it results:

$$z_1 = 1{,}5 \cdot 28 = 42 \text{ teeth};$$
$$r_1 = 21 \text{ mm};\ r_2 = 14 \text{ mm};$$
$$r_3 + r_4 - r_5 = 5 \text{ mm};$$
$$r_5 = r_1 + r_2 - 5 = 30 \text{ mm}.$$

In the figure 5 is shown a fragment of the plotted epicycloids strands.

Fig.4. Bird's eye view of experimental model.

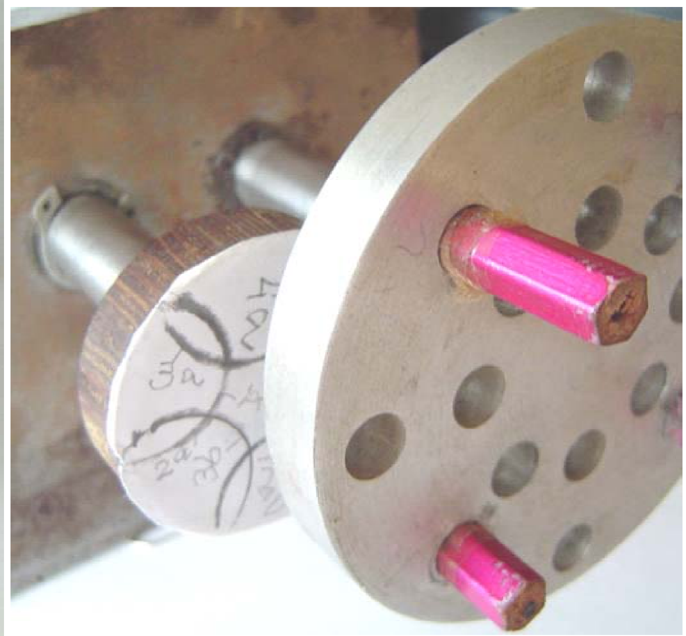

Fig.5. A fragment of the plotted epicycloids strands.

5. THE OBTAINED RESULTS

The basic data of the experimental model was: r_3 = 20 mm; r_4 = 15 mm; r_5 = 30 mm.

Also, the spur gearing driving had the gear wheels with 42 teeth (on the O axis) and 28 teeth (on the O_1 axis).

Four pencils have been mounted (that objectified the tools lathe, situated at a real device on the plate periphery), shifted with 90^0 among others and obtained the image from figure 6.

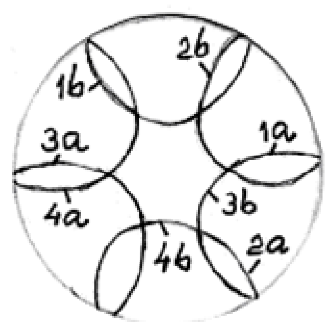

Fig.6. The plotted epicycloids.

Followings conclusions are established:

- when the pencil come into contact with the paper, a strand is plotted, such that which is noted with 1a;
- to the second rotation, the same pencil plots another strand, 1b;
- the followings pencils plot another strands, in the same manner;
- in some cases, the same strands are plotted on the distinct tools (1a and 3b, 2a and 4b).

In table 1 is presented the zones of interface positions plotted from each tool at 4 complete rotations, consecutively, of the drill chuck.

It determines the covering of more tools on the same curves section. This situation is advantageously because there is a feed motion at turning, too, and so the prism has to be handled in length, not only in section.

Also, is observed that the paths in fourth rotation are likewise with the paths on the first rotation.

Tabel 1. The zones of interface positions plotted from each tool.

The Tool	First rotation	Second rotation	Third rotation	Fourth rotation
1	1a, 1b	3a, 1a	1b, 3a	1a, 1b
4	2a, 2b	4a, 2a	2b, 4a	2a, 2b
3	3a, 3b	1b, 3a	3b, 1b	3a, 3b
2	4a, 2a	2b, 4a	3a, 2b	4a, 2a

With the performed computer programmer have been plotted elongated epicycloids as follows:

- figure 7: one tool – one rotation;
- figure 8: one tool – two rotations;
- figure 9: two tools on the 90^0 staggered – one rotation;
- figure 10: two tools on the 90^0 staggered – two rotations.

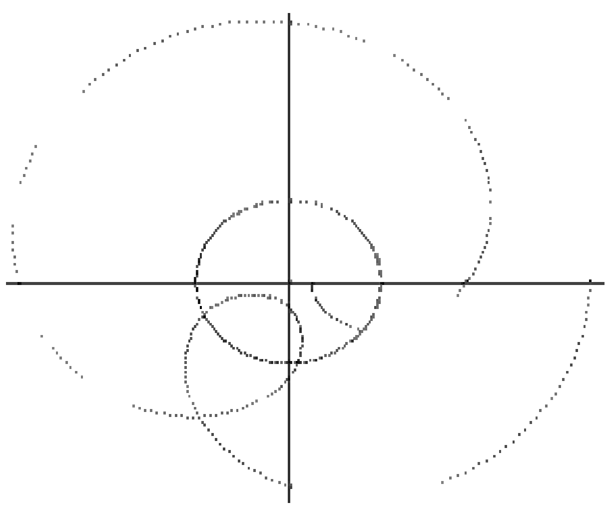

Fig.7. Elongated epicycloids obtained from one tool – one rotation.

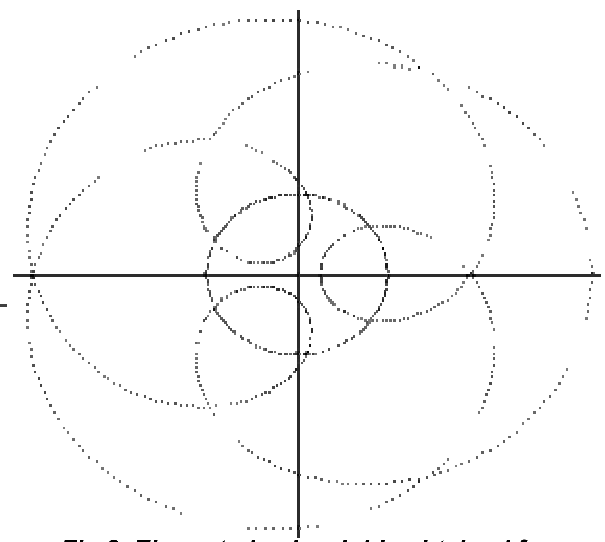

Fig.8. Elongated epicycloids obtained from one tool – two rotations.

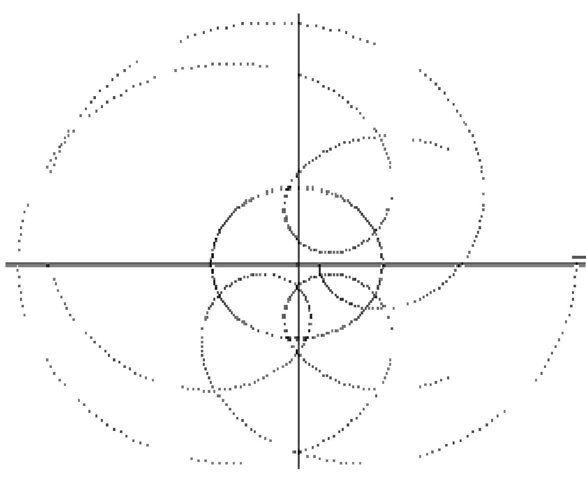

Fig.9. Elongated epicycloids obtained from two tools on the 90^0 staggered – one rotation.

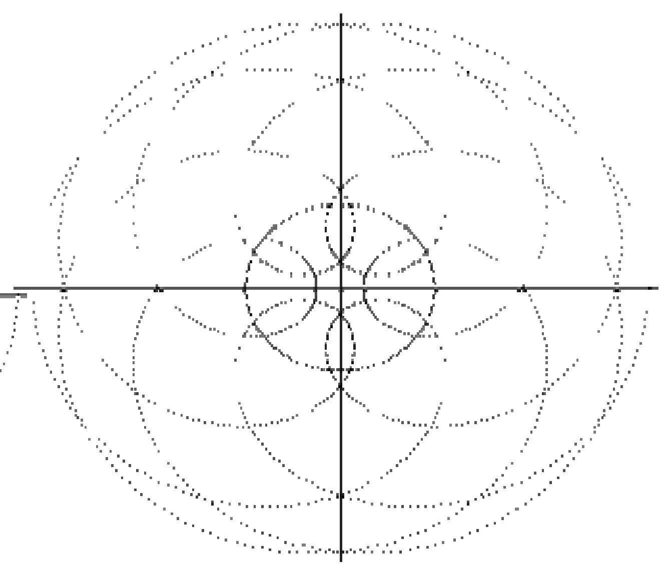

Fig.10. Elongated epicycloids obtained from two tools on the 90^0 staggered – two rotations.

It results that only two tools, on the 90^0 staggered, can generate the curvilinear side of a hexangle.

Thus, in the figure 11 is shown a feasibleness of a square generation using such basic data the followings: s = 14 mm; c = 3; L = 4; z_2 = 30 teeth; r_3 = 25 mm.

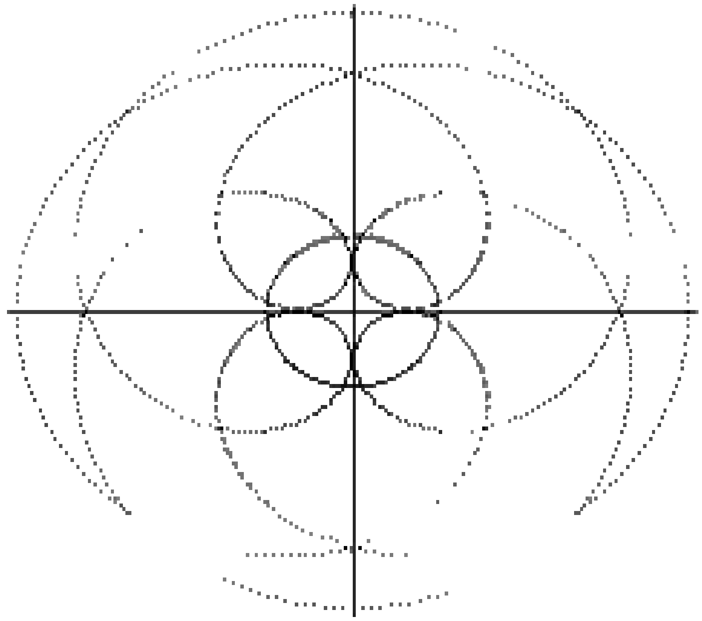

Fig.11. A square generation.

6. CONCLUSIONS

a. Kinematics generation of some elongated epicycloids allows the approximation of some polyhedral sections of some pieces turned processed.
b. This method is advantageously because decreases the processing time for some gross production pieces.
c. The established relations permit the designing of such devices.
d. The experimental model permitted the testing of theoretical views.

REFERENCES:

[1] Bagiu, L., Tolerances and fits , Helicon Publishing House, Timisoara, 1994.
[2] Bulgaru, M., A method for quality assurance fixed on the contact localisation, Proceedings of 6-th International DAAM Symposium, Krakow, Poland, pp.63-67, 1996.
[3] Chase, S., Kenneth, W., Dimensioning and Tolerances Handbook, Paul J. Drake Jr. Publishing House, McGraw Hill, New York, USA, 1999.
[4] Maros, D., Mechanisms, Printing House of Polytechnic Institute Cluj-Napoca, 1980.
[5] Pascu, C.I., Tolerances and fits, Universitaria Printing House, Craiova, ISBN 973-742-127-2, 2007.
[6] Poluianov, V.T., Tehnologhiceskaia modernizatia metalorejuscih stankov, Moskva, Sberdlovsk, 1975.
[7] Popescu, I., Mechanisms. New algorithm programmers, Universitaria Printing House, Craiova, 1999.