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A KINEMATICS OF ECCENTRIC CUTTING OF THREADS ON LATHE MACHINE

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ABSTRACT
The device for eccentric cutting of threads enables the production of thread with high cutting speed, good quality of cutting and reduced time of cutting. So, this eccentric cutting is an example of high-productive cutting of threads
This paper shows a kinematics of cutting process in external thread. The analyze of chip diameter and calculation of engine power are done as well.
Keywords: kinematics, eccentric cutting, thread.

1. INTRODUCTION
Production of the threads is one of the most difficult operations of production. The thread could be produced with operation with cutting and deformation. Operation with plastic deformation is rolling. The most common operations with cutting are:
- turning,
- milling,
- drilling with thread cutters,
- polishing, etc.

The cutting speed of turning is very small (cca. 15 - 30 m/min) compared with other turning operation. The quality of production is small and the cutting time is very long, so it is not productive method. The production of the thread with device [1-5] shown on Figure 1. represents a new method for production of threads with higher speed of cutting and, in same time, with higher productivity compared with classical methods (production of thread with lathe tool with help of the leading spindle of lathe machine.
Project represents the whole device (aggregate) which is placed in front of lathe machine. The head with lathe tools produces the main rotation with a high speed with simultaneous low longitudinal mowing, while working part placed in contraction part of main spindle making slow miscellaneous rotation. The porter of the head with lathe tools is placed like special device on the porter of the tool and in that way produces longitudinal mowing.
Eccentric cutting of threads is basically process of production of threads by milling. During the production, tooth of milling tool is replaced with turning tools. They are placed within device – "head for cutting". External cutting of threads is produced with two different ways; depending on placement of workpiece and head of cutting: the workpiece is into head and workpiece is out of head.

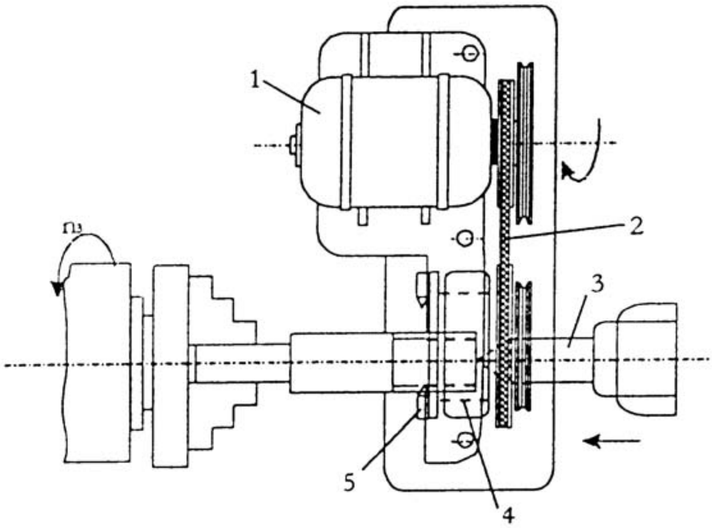

Figure 1. Scheme of device (1- electric engine, 2-transmission belt, 3- dead centres, 4 -bearing, 5-cutting head)

2. KINEMATCS RELATIONS IN CASE OF HIGH – PRODUCTIVE CUTTING OF THREADS

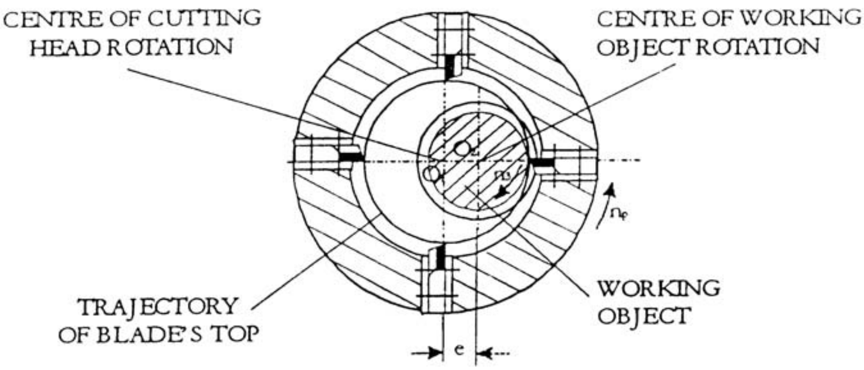

Figure 2. Kinematics of eccentric cutting

Following parameters are determined:
d_p – workpiece diameter (main diameter of thread) = 48 mm (M48)
d_1 – internal diameter of thread = 42.587 mm
D_g– diameter of head of cutting $D_g = 1.4 – 1.6\ d_p$ = 75 mm
e – eccentricity (distance between axis of workpiece and axis of head) = 16.2065 mm
z – number of lathe tools in head – 4

$$v_g = \frac{D_g \cdot n_g \cdot \pi}{1000}\left[\frac{m}{\min}\right],\ v_g = 500\ \text{m/min} \quad ...\ (1)$$

$$n_g = \frac{1000 \cdot v_g}{\pi \cdot D_g} = \frac{1000 \cdot 500}{\pi \cdot 75} \approx 2000 \min^{-1} \quad \text{... (2)}$$

$$v_p = \frac{\pi \cdot d_p \cdot n_p}{1000}\left[m/\min\right], \text{ v}_\text{p} = 5 \text{ m/min} \quad \text{... (3)}$$

$$n_p = \frac{1000 \cdot v_p}{\pi \cdot d_p} = \frac{1000 \cdot 5}{\pi \cdot 48} \approx 31.5 \min^{-1} \quad \text{... (4)}$$

The time needy for coming of new tool is:

$$t = \frac{1}{n_g \cdot z} = \frac{1}{2000 \cdot 4} = 0.000125 \min \quad \text{... (5)}$$

In this time, workpiece turns of x revolution:

$$t = \frac{x}{n_p} \Rightarrow x = n_p \cdot t = 31.5 \cdot 0.000125 = 0.0039375 rev \quad \text{... (6)}$$

This x revolution is equal to angle α :

$$\frac{1}{0.0039375} = \frac{360^0}{\alpha} \Rightarrow \alpha = 1.4175^0 \quad \text{... (7)}$$

The length of arc on workpiece cut by one lathe tool is:

$$s_z = r_1 \cdot \widehat{\alpha} = 21.2935 \cdot 1.4175 \cdot \frac{\pi}{180} = 0.5268 mm \quad \text{… (8)}$$

where is r_1 internal radius of thread.

2.1. Analyses of chip intersection

$$\sin\frac{\alpha}{2} = \frac{a}{r_1} \Rightarrow a = r_1 \cdot \sin\frac{\alpha}{2} = 0.2634 mm \quad \text{… (9)}$$

$$tg\frac{\alpha}{2} = \frac{b}{a} \Rightarrow b = a \cdot tg\frac{\alpha}{2} = 0.0033 mm \quad \text{… (10)}$$

The angle α is small and therefore $2a = s_z$ and $\delta = b$.

$$\delta = 0.0033 mm \quad \text{… (11)}$$

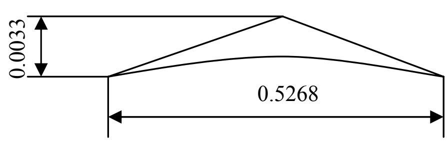

Figure 3. Chip intersection

2.2. Calculation of a power of engine

Maximal area of chip is:

$A = 0.002\ mm^2$

Specific cutting force K_{sm} is calculated according to:

$$K_{sm} = \frac{C_k}{A^{\frac{1}{\varepsilon_k}}} = 12200 \frac{N}{mm^2} \qquad \dots (12)$$

where are:

$C_k = 4400\ N/mm^2$

$\varepsilon_k = 6.1$

The main cutting force is

$$F_1 = K_{sm} \cdot A = 12200 \cdot 0.002 = 24.4 N \qquad \dots (13)$$

The engine power can be calculated according to:

$$P_{EM} = \frac{F_1 \cdot v}{\xi_1 \cdot \eta_1 \cdot \eta_2} = \frac{24.4 \cdot 8.5}{0.95 \cdot 0.95 \cdot 0.95} = 242 W \qquad \dots (14)$$

where are:

F_1 – main cutting force

$\xi_1 = 0.95$ - factor depending of angle of belt

$\eta_1 = 0.95$ - transmission ratio of belt

$\eta_2 = 0.95$ - transmission ratio of bearings

$v = v_g + v_p = 505$ m/min = 8.5 m/s

The standard power of engine of 1 kW is chosen.

3. CONCLUSION

Production of threads with eccentric cutting on lathe machine is high-productive method due to high cutting speed with higher quality of products. This method decreases the time of production for about 90% in comparison to threads made by classical method on lathe machine.

The chip intersection is very small and therefore it can be used electric engine with small power. The device is made as prototype.

The further research will be focused on stability of the system: machine-device-workpiece which has not researched yet, as well as using of coolant in this method.

4. REFERENCES

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