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Miroslav VÁVRA[*], Jiří HAVLÍK[**]

THE GEOMETRY OF PIN GEARING

GEOMETRIE CÉVOVÉHO OZUBENÍ

Abstract

The article deals with creating formulas for calculating geometry of pin gearing when a pin-wheel is replaced by a pin-rack We are interested in creating such equations that are based on knowledge of known parameters given to calculate the geometry of pin gearing, similarly like the involute gearing. Equations of length meshing is also derived from the geometry.

Abstrakt

Článek se zabývá vytvořením rovnic pro výpočet geometrie cévového ozubení, kdy cévové kolo je nahrazeno cévovým hřebenem. Jedná se nám o vytvoření takových rovnic, aby se na základě znalosti známých parametrů dala vypočítat geometrie cévového ozubení, podobně jak u evolventního ozubení. Z geometrie je zde dále odvozena rovnice pro součinitel trvání záběru.

1 INTRODUCTION

The pin gearing is used not only as a driving movement member of the mining harvesters in the black coal mines but also as the mechanical transfer of lifting devices. An example of the pin gearing transfers usage, such as driving element of lifting device, is shown in Figure 1.1, where the pin gearing is driving a scissor lift platform by Serapid company.

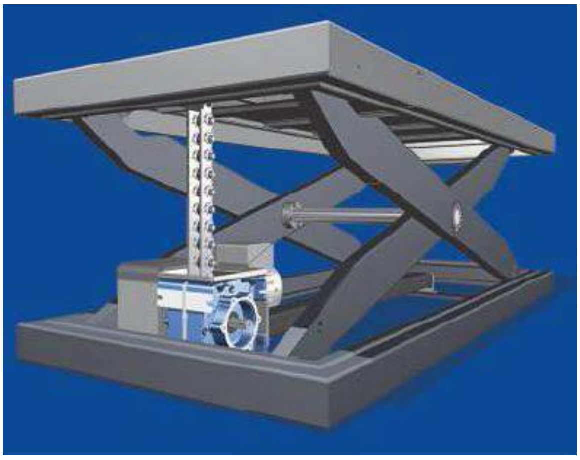

Fig. 1.1 Scissor lift platform of company Serapid.

[*] Ing. Miroslav VÁVRA, VŠB – Technical University of Ostrava, Faculty of Mechanical Engineering, Machine Parts and Mechanisms, 17. Listopadu 15, Ostrava, tel. (+420) 597 324 203, miroslav.vavra.st@vsb.cz
[**] doc. Ing. Jiří HAVLÍK, Ph.D, VŠB – Technical University of Ostrava, Faculty of Mechanical Engineering, Machine Parts and Mechanisms, 17. Listopadu 15, Ostrava, tel. (+420) 597 323 284, jiri.havlik@vsb.cz

This is a special type of transfer (see Fig. 1.2), where the wheel with involute gearing drives a pin-rack with pin radius ρ_c and pin pitch p_c. In this type of pin gearing the pitch line of pin-rack n is the tangent of he basic circle of the wheell d_b.

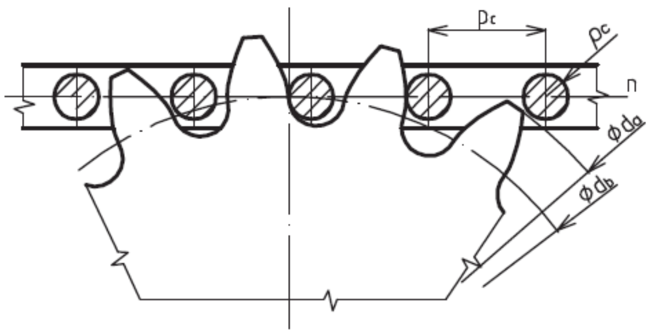

Fig. 1.2 Pin gearing.

2 GEOMETRY OF THE PIN GEARING

The tooth face of the tooth wheel is formed with involute e_1, e_2 and the base of the tooth wheel is formed with circle k.. The curves e_1, e_2, and k have a tangency point T on the base circle with diameter d_b Figure 2.1.

Geometry based on the known quantities:

ρ ... tooth system base radius,

p_c... pin pitch of pin-rack,

z ... number of teeth

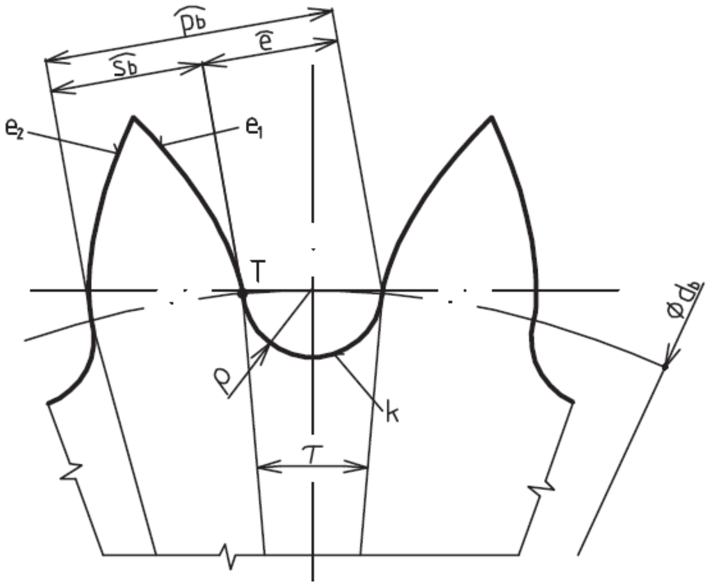

Fig. 2.1 Pin gearing wheel with sharp teeth.

For geometry of this type of pin gearing must be true that the pitch pin p_c is equal to pitch teeth p_b on the basic circle. Furthermore, from the geometry results the equation:

$$\pi \cdot d_b = p_b \cdot z \cdot \qquad (2.1)$$

From the equation (2.1) the diameter of the basic circle can be expressed

$$d_b = \frac{z \cdot p_b}{\pi} \cdot \qquad (2.2)$$

2.1 Tooth thickness on the basic circle

Tooth thickness on the basic circle s_b can be expressed on the basis of figure 2.1 with the equation

$$\widehat{s}_b = \widehat{p}_b - \widehat{e}\,, \qquad (2.3)$$

where $\hat{e}$ is tooth space width, which can be expressed with the equation

$$\widehat{e} = \tau \cdot \frac{d_b}{2}\,, \qquad (2.4)$$

where τ is the angle of the tooth space. The angle τ is derived from the figure 2.2 and equation of the angle τ is

$$\tau = 2 \cdot \mathrm{arctg} \frac{\rho}{r_b} \cdot \qquad (2.5)$$

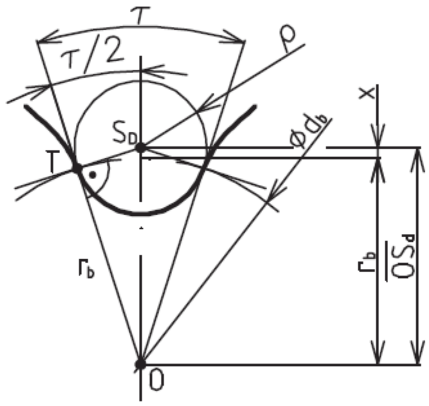

Fig. 2.2 Detail of base fillet of the pin gearing wheel.

2.2 Maximum pin radius

When tooth wheel is in meshing with pin-rack it is considered that center of pin radius ρ_c is on the basic circle d_b of tooth wheel. It also means the condition that

$$\rho_c \le \rho - x\,, \qquad (2.6)$$

Where dimension x is shown in Figure 2.3, and it is the subtraction between distance OS_d and radius r_b

$$x = \overline{OS}_d - r_b = \sqrt{r_b^2 + \rho^2} - r_b \cdot \qquad (2.7)$$

2.3 Tooth thickness at any point

The solution of the tooth thickness at any point is based on the tooth thickness on the basic circle s_b (2.4). Central angle τ_y can be, with the aid of Figure 2.3 and the knowledge of the geometry of involute, expressed as

$$\tau_y = \tau_b - 2 \cdot \mathrm{inv}\alpha_y \cdot \qquad (2.8)$$

By expressing the angles in equation (2.8) we get

$$\frac{2s_y}{d_y} = \frac{2s_b}{d_b} - 2\mathrm{inv}\alpha_y, \tag{2.9}$$

from which it is expressed s_y

$$s_y = d_y\left(\frac{s_b}{d_b} - 2\mathrm{inv}\alpha_y\right). \tag{2.10}$$

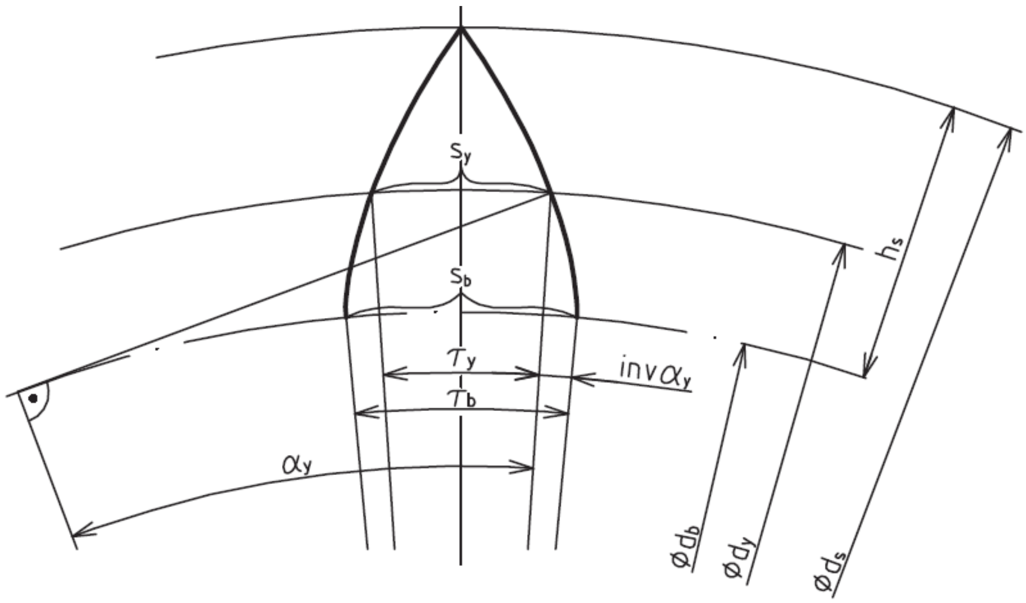

Fig. 2.3 The tooth with at any diameter.

2.4 Pointed tooth height

The maximum possible tooth height corresponds with a pointed tooth, which must be true that

$$\mathrm{inv}\alpha_s = \frac{\tau_b}{2}. \tag{2.11}$$

Then diameter d_b for the pointed tooth can be calculated as

$$d_s = \frac{d_b}{\cos\alpha_s}. \tag{2.12}$$

The resulting equation for the pointed tooth height is

$$h_s = \frac{d_s - d_b}{2}. \tag{2.13}$$

2.5 Minimum tooth thickness at the tip diameter

For the gears there are selected minimum tooth thickness s_a = 0.4m at the tempered teeth and s_a = 0.25m at the wheel without heat treatment according to (1). The module m is determined for the gear for pitch circle d. Tooth wheel in pin gearing has basic circle d_b equal to pitch circle d. Then, the module can be calculated

$$m = \frac{p_b}{\pi}. \tag{2.14}$$

2.6 Length of path of contact

Figure 2.4 implies that the length of path of contact is defined as the distance of point E, when the pin first touches the tooth, and a point F, when the pin stops touchimg the tooth. Length of path of contact can be expressed by the following equation

$$\overline{EF} = g_\alpha = \frac{d_b}{2}\tan\alpha_a \cdot \tag{2.15}$$

Substituting equation (2.2) into equation (2.15) we get equation

$$g_\alpha = \frac{z \cdot p_c}{2 \cdot \pi} \cdot \tan\alpha_a \cdot \tag{2.16}$$

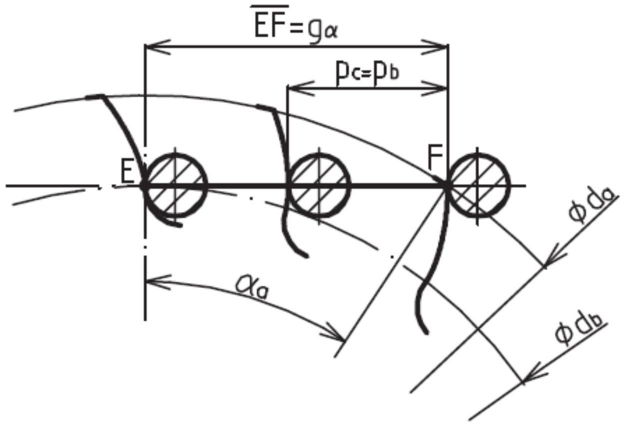

Fig. 2.4 – Lenght of path of contact.

2.7 Meshing coefficient

Meshing coefficient is defined by changing number of teeth in meshing. Meshing coefficient ε_α is defined as

$$\varepsilon_\alpha = \frac{g_\alpha}{p_c} = \frac{\frac{z \cdot p_c}{2\pi}}{p_c} \cdot \tan\alpha_a = \frac{z}{2\pi}\tan\alpha_a \cdot \tag{2.17}$$

Extreme value $\varepsilon_\alpha = 1$ corresponds with the extreme case when only one tooth is in the meshing. Meshing coefficient must be $\varepsilon_\alpha > 1$ for real pin gearing.

3 CONCLUSIONS

Equations have been created, which describe the geometry of the tooth of pin gearing. Further meshing coefficient was derived for pin gearing. The knowledge of geometry of a tooth will be used to strength control pin gearing, which I will deal with in my dissertation

REFERENCES

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