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MINIMAL RADIUS OF BASIC CIRCLE OF CAM OF FLAT-FACED FOLLOWER

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ABSTRACT

Flat-faced follower is mechanism with rotational cam and with plate bar. It has important application in technics (motors, tool machines etc.). In target of contact of plate bar and cam in only one point, it is need that profile of cam would be convex on all length. This paper presents analysis of influence of single parameters of motion of this mechanism on value of minimal radius of basic circle of cam, in target satisfaction above-mentioned conditions.

Key words: mechanism, cam, flat-faced follower, basic circle

1. ANALYSIS OF FUNDAMENTAL PARAMETERS OF CONTACT OF PLATE BAR AND CAM OF FLAT-FACED FOLLOWER

On fig. 1. is shown flat-faced follower. Contact of plate bar and cam of this mechanism must be in only one point. In target of this condition it is need that profile of cam would be convex on all length of profile [1,2], so that is

$$R_k \rangle 0 . \qquad (1)$$

According theorem about composing of accelerations for point A of cam in which plate bar touch cam, by what we suppose constant angular velocity of cam, because geometric conditions of touch do not depend of kinematic state of rotation of cam, we can write [3]

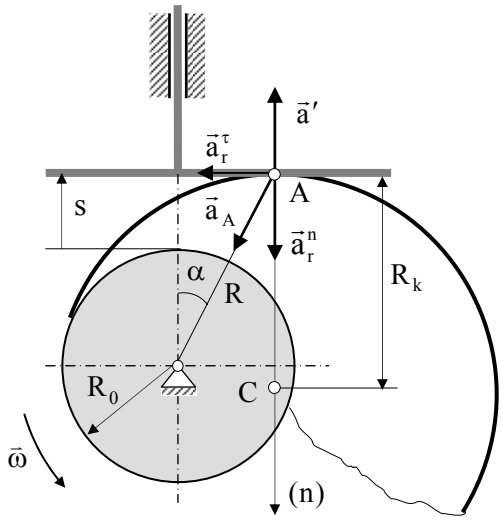

Figure 1. Analysis of acceleration of point of cam coinciding with plate bar of flat-faced follower

$$\vec{a}_A = \vec{a}' + \vec{a}_r^{\tau} + \vec{a}_r^{n}, \tag{2}$$

where is:

$\vec{a}'$ - acceleration of plate bar,

$\vec{a}_r^{\tau}$ - relative tangent acceleration of point of cam coinciding with plate bar (point A), having reference to plate bar.

$\vec{a}_r^{\tau}$ - relative normal acceleration of point A having reference to plate bar.

If we project term (2) on axis n (main normal on point A), we obtain

$$a_B \cos\alpha = -a' + a_r^{n},$$

or

$$R\omega^2 \cos\alpha = -\frac{d^2 s}{dt^2} + R_k \omega^2. \tag{3}$$

where is:

s - displacement of plate bar,

t - time,

ω - angular velocity of cam of mechanism,

R_k - radius of curve of profile of cam.

On the other hand is

$$R\cos\alpha = R_0 + s. \tag{4}$$

where is:

R_0 – radius of basic circle of cam.

For constant angular velocity of cam, acceleration of plate bar we can write

$$\frac{d^2 s}{dt^2} = \omega^2 \frac{d^2 s}{d\varphi^2}. \tag{5}$$

According terms (3), (4) and (5) we obtain

$$R_k = \frac{d^2 s}{d\varphi^2} + s + R_0. \tag{6}$$

In consideration of terms (1) and (6) we can write

$$\frac{d^2 s}{d\varphi^2} + s + R_0 \rangle 0,$$

and minimal radius of basic circle of cam is

$$R_{0\min} = \left(-s - \frac{d^2 s}{d\varphi^2} \right)_{\max}. \tag{7}$$

2. EXAMPLE

For Flat-faced follower it is need calculate minimal radius of basic circle of cam R_{0min}, so that profile of cam would be convex on all length.

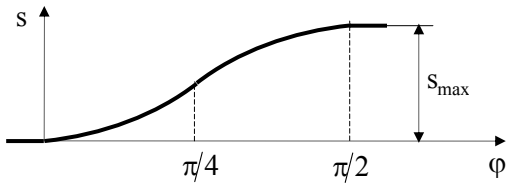

Figure 2. Law of motion plate bar by shown example

Law of motion of plate bar in interval: $0 \le \varphi \le \frac{\pi}{4}$ is: $s = \frac{240}{\pi^2}\varphi^2$ (mm), and in interval: $\frac{\pi}{4} \le \varphi \le \frac{\pi}{2}$ is: $s = -\frac{240}{\pi^2}\varphi^2 + \frac{240}{\pi}\varphi - 30$ (mm).

Solution

According term (20.35) minimal value of radius of basic circle of cam is

$$R_{0\min} = \left(-s - \frac{d^2 s}{d\varphi^2}\right)_{max}.$$

Value: $\left(-s - \frac{d^2 s}{d\varphi^2}\right)$, for interval: $0 \le \varphi \le \frac{\pi}{4}$ is:

$$-\left(s + \frac{d^2 s}{d\varphi^2}\right) = -\frac{240}{\pi^2}\left(\varphi^2 + 2\right),$$

and for: $\frac{\pi}{4} \le \varphi \le \frac{\pi}{2}$ is:

$$-\left(s + \frac{d^2 s}{d\varphi^2}\right) = \frac{240}{\pi^2}\varphi^2 - \frac{240}{\pi}\varphi + 30 + \frac{480}{\pi^2}.$$

Diagram of value: $\left(-s - \frac{d^2 s}{d\varphi^2}\right)$- (mm/s), in dependence of angle rotation of cam φ, is shown on fig. 3. According obtained values we can see that this value has maximum for: $\varphi = \frac{\pi}{4} + \varepsilon$, $(\varepsilon \to 0)$.

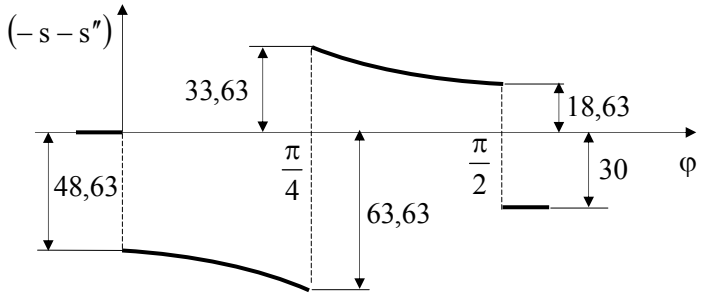

Figure 3. Diagram of value $(-s - s'')$ of plate bar in shown example (s –mm)

In this position is

$$-\left(s+\frac{d^2s}{d\varphi^2}\right)=\left(-s-\frac{d^2s}{d\varphi^2}\right)_{max}=33{,}63\,,$$

so that is

$$R_{0\min}=33{,}63 \quad \text{mm.}$$

3. CONCLUSION

General term which describe condition which must be satisfied that plate bar of flat-faced follower touch cam in only one point, is derived. From this term we can see that minimal radius of circle of cam depend of displacement of plate bar and of second derivation of placement by angle rotation of cam. In target illustration this problem, one example is shown.

4. REFERENCES

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