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GEOMETRICAL OPTIMISATION OF THE YAWN ELIMINATION MECHANISM. PFAUTER MODEL USED FOR MUCN CONSTRUCTION BASED ON DIMENSION CHAINS

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Abstract:

MUCN secondary kinematical chains usually contain sprocket wheels mechanism for the construction existing yawn.

One of the most interesting cylindrical sprocket wheels mechanisms, having straight teeth, is the one called PFAUTER used for the yawn elimination in the case of tool machinery kinematical chains.

PFAUTER model solution is given by a driving wheel and two driven wheels. The driven wheels on half thick as the driving wheel, one of them being, fixed on the tree. The other one is free and has one less tooth than the fix wheel, both of them being in direct contact with the profile that corresponds the yawn existing between the driving wheel teeth.

Geometrical optimisation of the sprocket wheels, elements of the yawn eliminating mechanism, as PFAUTER model, is obtained in the paper applying prof. dr. ing. I.D. Lazarescu algebric method. This method solves the mechanical ensembles dimension chains.

1. INTRODUCTION

For the secondary kinematical chains construction of the numerical command tool machineries are used also sprocket wheels mechanisms.

Sprocket wheels construction must ensure the functioning precision of the gearing, for both rotating senses [3].

This problem can be solved by avoiding or by diminishing the yawn existing between the sprocket wheels flanks situated in direct contact.

Are well known more types of mechanisms and devices for the yawn elimination or diminishing. Some of them are presented in the paper.

A new solution to solve the above mentioned problem is the PFAUTER model that eliminates the yawn using a double gearing. One of the too gearing is moved asymmetrical and contains a free wheel and a pinion, characterised by a continuous friction between the adjacent flanks of the geared wheels.

The problem solved in the paper is strong connected with the sprocket wheels constructive forms and also, with the distance tolerance existing between the wheels axis centres. For this purpose can be used the algebraic method of the dimension chains solving, defined by prof. dr. ing. Lazarescu Ioan.

2. TYPES OF GEARINGS YAWN OPTIMISATION MECHANISMS AND DEVICES

In tool machines construction field are known different types of gearings yawn optimisation mechanisms and devices. Usually they are based on the elasticity property of the prestressed helicoidally arcs, used for the coupling process of two sprocket wheels. The two wheels are not identical; one is fixed and the other one is mobile, both of them being in contact with the driven wheel [1].

Under the pressure of the helicoidally arc the mobile sprocket wheel is moved in comparison with fixed one, under a certain angle. This movement is continued until the opposite flanks of the sprocket wheels have no yawn.

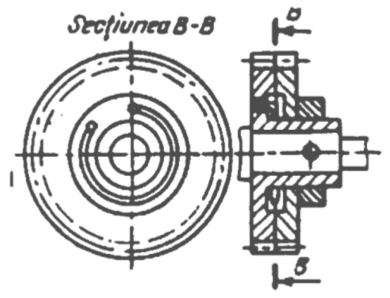


Figure 1 – Constructive solution for the yawn elimination

Another solution used in the case of the measurement devices uses a fixed wheel and a mobile wheel, both being in gearing with the driving wheel. They are in contact with the profiles that surround the yawn existing between the moving wheels teeth. This is by an arc that has a moment bigger then the moment transmitted by the wheel [3].

Another interesting solution for yawn elimination (2) is presented in figure 2. It is obtained with some disks (1) that are axially elastic fixed with screws (2) through some terminal disks (3) and an elastic diaphragm (4). The tangential force, that appears between the disks flanks, can be transmitted to the wheel hub with the help of an elastic wedge (6). This wedge permits the relative rotating of the disks (1) and ensures the uniform distribution of the moving force over the disks.

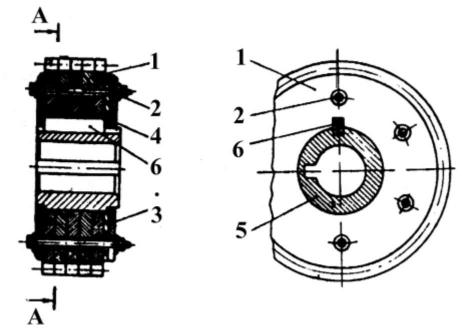
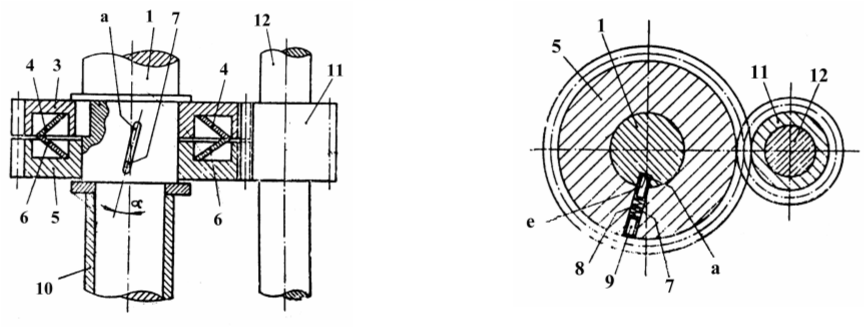


Figure 2 – Sprocket wheel having conjugate flanks parallelism errors autocompensation

Another device used to diminish or eliminate the yawn existing in the gearings (8) is presented in figure 3. Figure 3a contains the lateral view of a gearing partial section and figure 3b shows the transversal section of the same gearing.

The analysed gearing contains: a tree (1) having a partial collar in which is made a rectangular channel (a). This one forms a right angle (a) with the reference axis of the main tree (1). On the collar is fixed a sprocket wheel (3) with the help of a wedge (2). In the wheel is made, a circular channel (b) where is placed a disk arc (4) with the big base downward. On the main tree (1) with collar is placed a mobile sprocket wheel (5) identical with the fix sprocket wheel, in which is made another circular channel (1) where is placed a disk arc (6) with the big base upward. This disk arc is supported by the disk arc (4) with the big base downward.

The mobile sprocket wheel (5) is ensured against the axial movement with a jack (10) that has a collar in which exists a channel (d). In the channel is introduced a round peg (7), that has one of the ends (e) in the rectangular channel (a). This ends is maintained in channel (a) with a matched screw (9). The sprocket wheels (3, 5) gives a movement to the fixed sprocket wheel (11), placed on the secondary tree (12).



a b

Figure 3 – PFAUTER model device used to eliminate the yawn between the flanks

3. DEVICE FOR GEARING YAWN TAKING OVER

This solution given by PFAUTER Corporation is a new idea that appeared as a result of the rolling teeth milling machines modernising process.

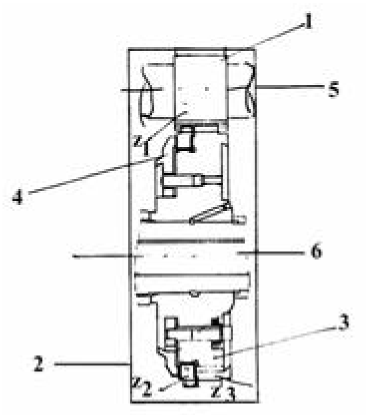


Figure 4 – PFAUTER model device used to take over the yawn between the flanks

PFAUTER model solution is presented in figure 4 and is contains a driving wheel 1, with Z_1 number of teeth, and two driven wheels 2, 3 with Z_2 and Z_3 teeth.

Wheels 1 and 3, having Z_1 and Z_3 number of teeth, represent the driven element, and have half the thickness of the driving free wheel 2 with Z_2 teeth. All three wheels have the same module, but different number of teeth.

The free wheel 2, with Z_2 teeth, has one tooth less then the wheel 3 with Z_3. This is a wheel with positive corrected teeth.

Wheels 2 and 3, with Z_2 and Z_3, teeth are in direct contact with wheel 1 with Z_1.Their profiles surrounds the yawn between the moving wheel teeth. A flange 4 acts on the free wheel 2, by some screws 5 and fixing arcs 6, disposed on the wheel 3 body. This way the gearing yawn is taken over in both rotating senses. The flange acts the way mentioned before by a friction material disposed on its frontal surface.

The problem analysed in the paper is how to optimise the distance tolerances existing between wheels 1 and 3 axis and wheels 1 and 2 axis.

4. TOLERANCES OPTIMISATION BETWEEN THE SPROCKET WHEELS AXIS CENTERS. PFAUTER MODEL FOR YAWN TAKING OVER

PFAUTER model device for flanks yawn taking over (figure 4) is characterised by a zero gearing, not moved. This gearing contains wheels 1 and 3 with Z_1 and Z_3 number of teeth, having $?_1 = ?_3 = 0$. This PFAUTER device contains another gearing, asymmetrically moved, formed with wheels 1 and 2, with Z_1 and Z_2 teeth. Its movement is positive $?_s = ?_1 + ?_2 > 0$ and $a > a_0$.

To obtain a normal and clear device functioning must be put the condition that the distances between the axis of the two gearings to be equal:

$$A_{13} = A_{12} \tag{1}$$

Knowing that:

$$A_{13} = R_{r1} + R_{r3} \tag{2}$$

and

$$A_{13} = R_{r1} + R_{r2} \tag{3}$$

If the axis distribution variation is noted with ?A can be written like:

$$?A = A_{13} - A_{12} = ? \cdot m \tag{4}$$

where ? is the variation coefficient of the distance between the axis.

Replacing A_{13} and A_{12} with their values, in relation (1), results:

$$\frac{m}{2}(Z_1 + Z_3)\cos a_0 = m\left(\frac{Z_1 + Z_2}{2} + ?\right)\cos a \tag{5}$$

From the expression (5) above can be obtained:

$$? = \frac{Z_1 + Z_2}{2}\left(\frac{\cos a_0}{\cos a} - 1\right) \quad (6)$$

So, the positive movement of wheel 2 is developed with $?_s$ movement coefficient:

$$?_s = ?_1 + ?_2 > 0 \quad (7)$$

Because $?_1 = 0$ results that $?_s = ?_2$, when:

$$?_2 > ? \quad (8)$$

As a result, the highness *h* of the wheel 2 teeth will be:

$$h = m[(2f_0 + c_0) - (?_2 - ?)] \quad (9)$$

$$\mathrm{inv}a = 2\frac{?_2}{Z_1 + Z_2}\mathrm{tg}a + \mathrm{inv}a_0 \quad (10)$$

Starting by basically equation of dimensions chain (3) can be easily calculated distance tolerances between the axes. Also, is used the tolerances theory axion developed by prof. dr. ing. I.D. Lazarescu.

$$T_R = \sum Tj; \quad A_{SR} = \sum ASj; \quad A_{ir} = \sum Aij \quad (11)$$

The maximum resulting dimension is equal or less then the maximum compounds dimensions sum. The minimum resulting dimension is equal or less then the minimum compounds dimensions. This way is ensured a fit between the flanks with minimum yawn from 4 JC precision classes. Flanks regularity is about R_a = 0,8 µm and the sprocket wheels are executed extremely precise.

5. CONCLUSIONS

1. In the case of the yawn elimination mechanism for the straight teeth sprocket wheels, as PFAUTER model, the fit tolerance existing between the pair of wheels and the commune wheel is equal to the sum of the construction tolerances of the components quotes.
2. The eliminating mechanism yawn existing between the straight teeth sprocket wheels flanks, as PFAUTER, ensures the continuous linear contact between the conjugated sprocket wheels flanks. This model can be used successfully for the advance mechanism of the numerical command tool machineries.

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