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INFLUENCE OF TOOTH GEARING PARAMETERS ON FURNISH ACCURACY OF THE SURFACES OF PREPARATION AND THE TOOL

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Summary. The way of reception of longitudinal updating tools is described. The settlement dependencies for definition of a corner of axes submission are given, which provide achievement of longitudinal updating tools.

Key words: updating tools, angle of the crossing, a stain of contact

INTRODUCTION

Tooth gearing is one of the most widespread units in the design of modern mechanisms and machines. Manufacture and release of cogwheels is adjusted in all branches of mechanical engineering. More than 70% of all let out cogwheels make wheels of the raised accuracy whose gear wreath undergoes finishing processing. Now requirements of increase of productivity, accuracy and quality of processing, necessity of decrease of labour input have provided a wide circulation of finishing processing of gear wreaths with methods free rolling at crossed axes – sheving and honing. Operational parameters of cogwheels substantially depend on technological ways of their final processing.

Overwhelming majority of the cogwheels made in the autotractor industry, aircraft construction and machine-tool construction process with the help of such operations. The best productivity of furnish is provided with ways of sheving with submission of the tool under a corner to an axis of preparation [Kalashnikov and Kalashnikov 1985]. Now five methods have been developed in mechanical engineering sheving cogwheels-longitudinal, diagonal, tangential, „a short course" and cutting. The method of tangential sheving is characterized by presence of a tangent of the submission directed perpendicularly of an axis of a processable wheel (Fig. 1).

At such method of furnish the centre of crossing moves along a surface of a tooth sheving , cutting that deterioration of cutting edges occurs in regular intervals, stability of the tool raises. Feature sheving is a method of „a short course" in which submission of

3 preparations is directed perpendicularly to an axis sheving 2 (Fig. 2). One of the positive sides of this method is an opportunity of using sheving with a smaller width of a gear wreath at processing wheels with a greater width of a gear wreath in comparison with a tangential method [Suhorukov 1983].

STATEMENT OF PROBLEM

The significant efforts arising at processing cause elastic deformations of elements of technological system, the size of deformations of elements of technological system decreases with an increase of number of passes. At rapproachement sheving and a processable wheel as a result of radial submission the stain of contact is formed, except for that during processing the form and the sizes of a tooth of a processable wheel constantly vary, which results in constant change of conditions of contact of working surfaces sheving and preparations [A.L. Measurement's …1968, Suhorukov 1983].

It results in change of position of the centre of crossing during processing and as consequence in occurrence of an error of a direction of a tooth. Besides at definition of parameters of adjustment and calculation of width of a wreath of the tool it is necessary to take into account, alongside with geometrical parameters tooth gearing, the gearings of their change arising in the resulting cuttings of the tool. During incision sheving in processable preparation, the size cuttings allowance is maximal, which results in an increase of a stain of contact during processing. Furthermore, due to an increase of a stain of contact, effort of cutting reaches the maximal values, and the further introduction cutting tooth sheving in processable preparation does not occur. At this stage of sheving, the cylinder is rolled on rollings to the cylinder of processable preparation. The corner of crossing of axes sheving and preparations Σ' is not equal to the beginning of a working course to a settlement corner of crossing Σ (the skew of axes sheving takes place and preparations), and at forming rollings, the cylinder sheving makes corner ΔV (irreplaceable axes), that is the combined skew of axes of preparation and the tool takes place [Lycshin 1967].

Settlement dependences for definition of a corner irreplaceable axes, sheving and preparation look like a skew of axes:

$$tg\Delta V = \sin\Sigma\sqrt{\frac{\Delta a(2(r_0\cos^2\Sigma + r_1) - \cos^2\Sigma}{(r_0\cos^2\Sigma + r_1)(1+tg^2\Sigma)(r_o\cos^2\Sigma + r_1 - \Delta a\cos^2\Sigma)}} \quad 1)$$

$$\sin\Sigma' = tg\Sigma\sqrt{\frac{(r_0\cos^2\Sigma + r) - \Delta\alpha\cos^2\Sigma}{(r_0\cos^2\Sigma + r_1)(1+tg^2\Sigma)}} \quad (2)$$

where:

r_1 – radius rollings circles of preparation, mm;

r_o – radius rollings circles sheving , mm;

Δa – change of position of the centre of crossing of axes of preparation, and the tool, mm.

During processing tangential sheving corner ΔV reaches the greatest value at incision and at output sheving and comes nearer to zero value at the maximal deformations of technological system.

RESULTS OF RESEARCH

The length of a stain of contact in this case decreases, which results in incision cutting toots sheving on the big depth in the beginning and the end of an operation cycle. The length of a stain of contact is the function of tooth gearing parameters, and for a case of processing by a tangential method sheving the length of a line of contact will make not less than half of width of a tooth of preparation [Uminski 2003, Uminski and Krasowski 2005]. The error of a direction of a tooth in this case is defined on dependence:

$$F_\beta = b_1 tg\alpha_n \sin\Sigma \sqrt{\frac{\Delta\alpha(2(\mathrm{r}_0\cos^2\Sigma + \mathrm{r}_1) - \cos^2\Sigma)}{(\mathrm{r}_0\cos^2\Sigma + \mathrm{r}_1)(1+tg^2\Sigma)(\mathrm{r}_0\cos^2\Sigma + \mathrm{r}_1 - \Delta\alpha\cos^2\Sigma)}} \quad (3)$$

where:

F_β – an error of a direction of a tooth, mm;

α_n – a normal corner of gearing, a hailstones;

b_1 – width of a gear wreath of preparation, mm;

ΔV – size of a corner not parallel of axes, a hailstones.

$$F_{\beta 1,2} = \frac{tg(\Sigma^{\circ} - \Sigma)\sqrt{2gz}}{tg\ln(tg\beta_1 - tg\beta_0)} + 2b_1 tg\ln\sin\Sigma \sqrt{\frac{\Delta\alpha(2(r_0\cos^2\Sigma + r_1) - \cos^2\Sigma}{(r_0\cos^2\Sigma + r_1)(1+tg^2\Sigma)(r_0\cos^2\Sigma + r_1 - \Delta\alpha\cos^2\Sigma)}} \quad (4)$$

where:

$F_{\beta 1,2}$ – an error of a direction of a line of a tooth, mm;

$\Delta\Sigma$ – size of a corner of a skew of axes sheving and preparations, a hailstones;

Z – size cuttings an allowance, mm;

β_1 – a corner of an inclination of a line of a tooth of a processable wheel, a hailstones;

β_o – a corner of an inclination of a line of a tooth of the tool, a hailstones;

g – length of a line of gearing, mm.

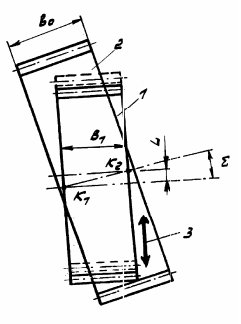

Fig. 1. The circuit tangentialsheving

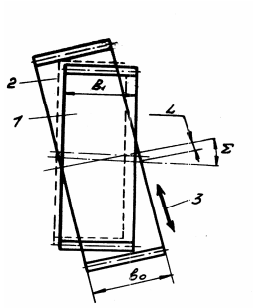

Fig. 2. The circuit sheving a method of „a short course”

Economic efficiency of the process of efficient sheving is defined at the cost of the used tool. For tangential and methods sheving cost of the tool is a little bit higher than " a short course » and than at any other sheving methods. It is caused by a greater width of a gear wreath such as sheving, complexity of their design and sharpening.

At a choice and designing of sheving for processing with submission of preparation under a corner to an axis sheving it is necessary to take into account, that the centre of crossing of axes moves from one end face to another. In this case there is a change of size of an intaking part. The size of width sheving is the major element of his design, and essentially influences productivity and quality of processing [Suhorukov and Evstegneev 1983]. The sharpest change of an intaking part occurs at tangential and „a short course” sheving methods. For maintenance of sufficient contact between teeth, a processable wheel and sheving, and also for reception of longitudinal updating wheel teeth, the sheving teeth should have concavity in a longitudinal direction. Cutting teeth sheving should be displaced one concerning another and are located on a screw line to compensate absence of longitudinal submission at removal of a shaving. The size of displacement teeth at transition from a tooth to a tooth is equal to the attitude of a step between teeth to the number of shaving teeth. An analysis of traditional dependences for a definition of width sheving for „a short course” sheving shows, that they take into account only the wicket a part of width of the tool, dependent on width of a gear wreath of preparation and a corner of crossing of axes of preparation and the tool. For the account of size of a main part shaving the system of readout not connected with making contour was used. Teeth gearing shaving with preparation is considered in two projections: radial and face.

Geometrical teeth gearing parameters determining length and position in space of a line of gearing, and also length and an arrangement on its active part are considered. Besides, in traditional dependences position of an active part of a line of gearing on all its length concerning pole teeth gearings and change of this position on measure cuttings and deteriorations of the tool, resulting in occurrence of the raw sites in end face teeth preparations [Ponomarev *et al.* 1984] is not taken into account. Cuttings and deterioration of the tool substantially influence size of a face corner of gearing, in a pole its size decreases. Accuracy and quality of processing at sheving by the method of „a short course” will be defined by radius of the basic circle of preparation r_{b1}, a face corner of gearing in a pole α_{wto}, a face corner of pressure at the head of a tooth α_{at1}. Therefore,

for full processing teeth on width in settlement dependences for definition of width of a wreath of the tool it is necessary to take into account minimal values of size α_{wto} .

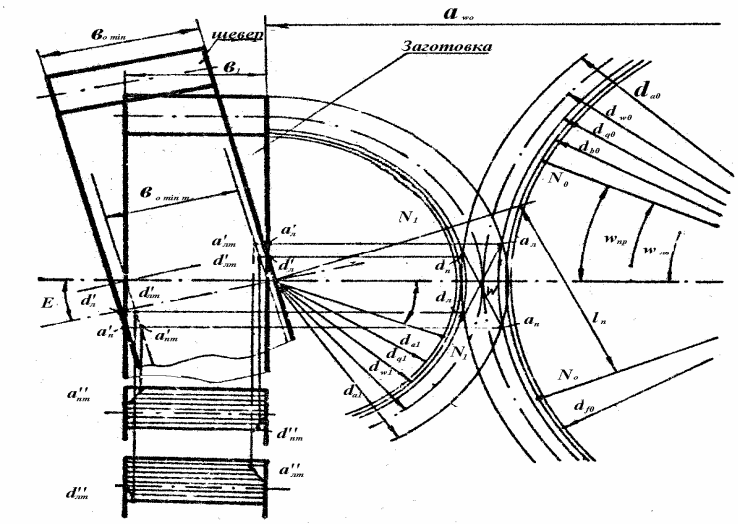

Fig. 3. Influence of teeth gearing parameters for width shaving

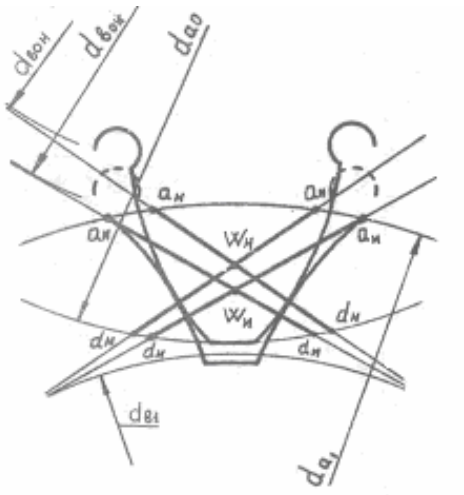

Fig. 4. Influence of independent teeth gearing parameters on the size of the main part of a tool

Calculation of dependence for definition of width of a gear wreath shaving for processing by a method looks like „a short course”:

$$b_o = b_1 \cdot \cos\sum + db_1 \cos\alpha_{\omega tн} \cdot \sin\sum(tg\alpha_{at1} - tg\alpha_{wtн}) \tag{5}$$

where:

$\alpha_{wtн}$ – a face corner of gearing worn out shaving, a hailstones,

$\sum$ – a corner of crossing of axes of preparation and the tool, a hailstones,

b_1 – width of a gear wreath of preparation, mm,

b_o – width of a gear wreath shaving, mm.

In the majority of traditional settlement dependences of width of a main part it is compensated by amendments on discrepancy of installation and manufacturing of preparation.

Cuttings and deterioration shaving substantially influence size of a corner of gearing in a pole, its size can decrease with 22° (for the new tool) up to 17° after several cuttings [Suhorukov, Evstegneev 1983, Ponomarev *et al.* 1984]. For a case tangential sheving settlement dependence looks like:

$$b_o = \frac{b_1}{\cos\sum} + d_{b1}\cos\alpha\omega tн \cdot \sin\sum(tg\alpha at_1 - tg\alpha\omega tн \tag{6}$$

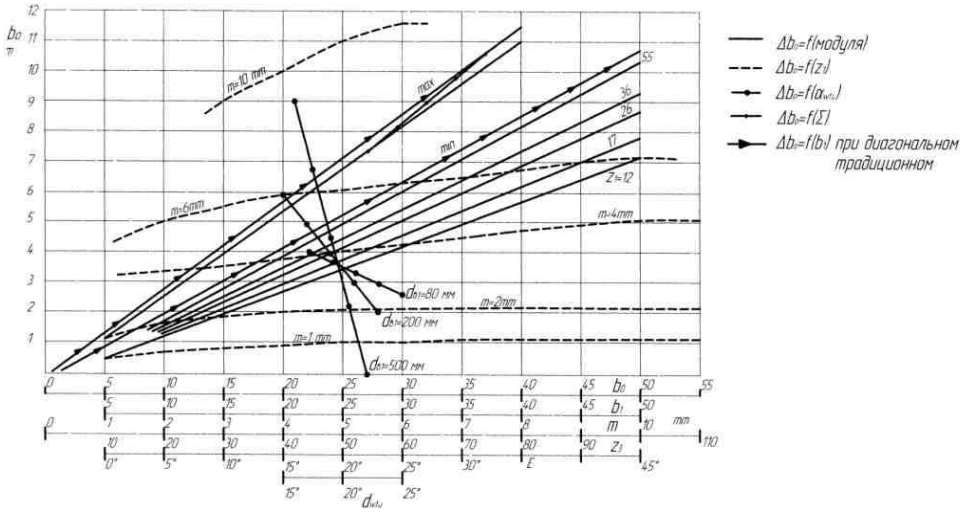

Fig. 5. Influence of independent teeth gearing parameters (numbers of teeth preparations z_1, the module m, changes of a corner α_{wto} on a measure cuttings and a corner of crossing $\sum$) on the size of the main sheving part Δb_0

In the same Figure in the graphic form dependences, which characterize influence on width shaving, amendments on discrepancy of installation of preparation, operations of trailer switches are given. The use of the developed technique dismisses the greatest effect at width of a wreath sheving for processing with the module more than 5 mm and less 2 mm and the teeth number t z_1 less than 40 and more than 60, and also in case of

processing sheving which has passed few cuttings. Time cuttings in size sheving at calculation by the traditional and developed technique makes 10–15 percent.

CONCLUSIONS

The carried out analytical and experimental researches allow to draw the conclusion that arising in the beginning and the end of an operation cycle of deformation of technological system result in the change of a corner of crossing of axes sheving and preparations and as consequence to occurrence of an error of a direction of a tooth. Change of size cuttings allowance during processing results in the displacement of a stain of contact along a tooth of preparation. The greatest error of a direction of a tooth corresponds to the preparations having the greatest radial palpation. Reduction of an error of a direction of a tooth is reached at an increase of teeth number. Analytical researches of teeth gearings of the tool and preparation at crossed axes have allowed to receive settlement dependences for definition of parameters of adjustment of the technological system, taking into account cuttings of the tool during processing. At definition of parameters of adjustment of technological system and calculations of width of the tool for sheving by the method of „a short course" it is necessary to take into account the change of geometrical parameters of tool gearings, arising as a result of deterioration of the tool. High efficiency and accuracy of furnish in this case is reached.

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