GENERAL METHOD FOR ITERATIVE INTERFERENCE EXCEPTIONS CONNECTED SURFACES KVAZIVINTOVYH

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Summary. In the research is considered the analytical model of forming of conjugating quasi helical surfaces. Basic technical parameters are modelled: transformation of initial quasi helical surface; a profile of curvilinear helicoid is in a cut, perpendicular axis of rotation; certain terms at that a center of curvature in the expedient point of certain area is for centroids, and also origins of interference at profiling of conjugating quasi helical surfaces.

Keywords: **iterative method, interference, coupled quasi helical surface.**

Raising of problem. Forming of conjugating quasi helical surfaces is indissolubly related to all industries of industry and types of production: by an engineering, aviation and machine-tool instrumental industries.

At planning of multiple-thread worm milling cutters with the corner of getting up over 6° it is happened some errors that considerably exceed admittances on making of conjugating quasi helical surfaces. Therefore development of iterative method of planning of exact, high-performance multiple-thread worm milling cutters with the large corner of getting up is actual enough.

Analysis of the last researches and publications. For the last decades in an engineer, machine-tool industry began widely to apply wares that have a difficult curvilinear profile, a curvilinear axis and a variable step.

At making of multiple-thread worm milling cutters the special attention should be spared to the manufacturability of wares that it costs to process the most productive instrument. Creation of methods of research of interference of conjugating quasi helical surfaces not only perfects technology of making, promotes the productivity but also allows to improve quality of the processed wares.

At developments of method of forming of conjugating quasi helical surfaces, it was envisaged that interference was not present at the contact of these surfaces.

The tasks, related to interference, arose out of practice and decision of them has a large practical value.

Formulation of aims of the article. To promote the productivity of calculation-graphic works and automatize the process of planning of conjugating quasi helical surfaces in relation to multiple-thread worm

milling cutters.

It is necessary to design the automated method of forming of conjugating quasi helical surfaces of multiple-thread worm milling cutters included interference. Exception of interference on the stage of planning of multiple-thread worm milling cutters, concerning for making of details in an engineering.

Basic part. Let a profile of quasi helical surface is in a cut perpendicular to its wasp of rotation, set in movable to the system of coordinates of X_1Y_1 as follows (1).

$$X_1 \begin{cases} f_1\ \varphi\ , \text{ если } \varphi \in \varphi_0, \varphi_1 \\ f_2\ \varphi\ , \text{ если } \varphi \in \varphi_1, \varphi_2 \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ f_k\ \varphi\ , \text{ если } \varphi \in \varphi_{k-1}, \varphi_k \end{cases} \quad Y_1 \begin{cases} g\ \varphi\ , \text{ если } \varphi \in \varphi_0, \varphi_1 \\ g_2\ \varphi\ , \text{ если } \varphi \in \varphi_1, \varphi_2 \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ g_k\ \varphi\ , \text{ если } \varphi \in \varphi_{k-1}, \varphi_k \end{cases} , \quad (1)$$

де $X_1 = f_1\ \varphi\ ;\ Y_1 = g_1\ \varphi$ – self-reactance equalization appropriate areas of *AB* with the parameter of curvilinear profile ℓ ;

φ_0, φ_1 – are limits of change of parameter of ℓ on the area of *AB*.

Let also for a curvilinear profile are executed ℓ next terms:

– condition of continuity:

$$f_i\ \varphi_i\ = f_{i+1}\ \varphi_i\ ; \qquad g_i\ \varphi_i\ = g_{i+1}\ \varphi_i\ ; \quad i = 1,2, \dots, k-1; \qquad (2)$$

– condition of first-order smoothness:

$$\frac{g_i'(\varphi_i)}{f_i'\ \varphi_i} = \frac{g_{i+1}\ \varphi_i}{f_{i+1}\ \varphi_i};\ i = 1,2, \dots, k-1; \qquad (3)$$

– in an interval between a profile ℓ and the center of gravity of *m* does not take place the crossing of normals to the profile ℓ between them.

Let define a condition, at that a center of curvature in the arbitrary point of *P* of area of *AB* is for centroid of *m*, that

$$O_1O^1 \geq r.$$

Formulas of transition from the movable system of coordinates of X_1Y_1 to immobile to the system *XY* looks like :

$$x = r \cdot \alpha + x_1 \cdot cos\alpha + y_1 \cdot sin\alpha;$$
$$y = r - x_1 + sin\alpha + y_1 \cdot cos\alpha.$$

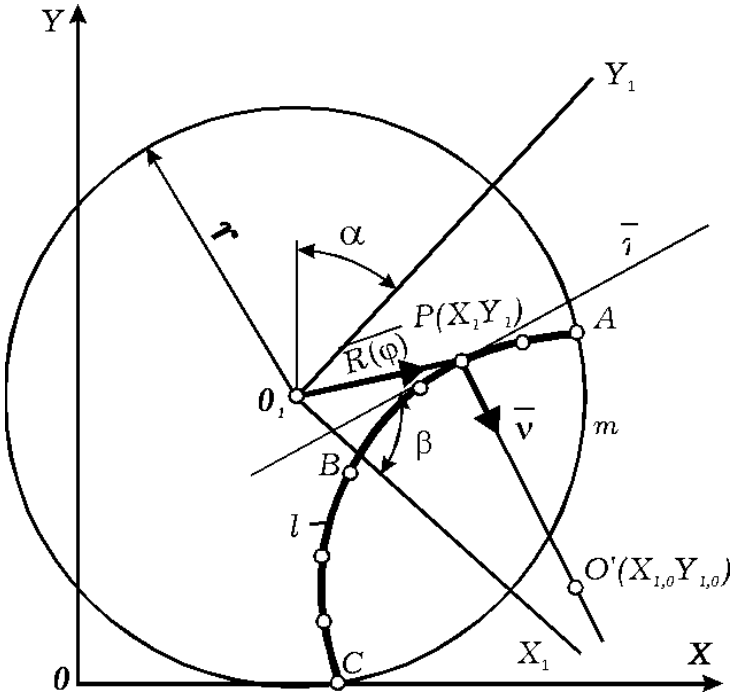

Fig. 1. A profile of quasi helical surface is in a cut, perpendicular to wasp of rotation

It is known that the radius of curvature ρ crooked in an arbitrary point is determined as $\rho = \frac{x_1'+y_1'^{\frac{3}{2}}}{x_1' \cdot y_1'' - x_1'' \cdot y_1'}$.

Then the center of curvature of O_1 is determined as follows:

$$O_1O^1 = R(\varphi) + \nu \cdot \rho, \tag{4}$$

where $R\ \varphi$ – radius - vector point of P in the system of coordinates of X_1Y_1;

ν – it is an unit normal vector in the point of P.

Thus

$$x_{1,0} = x_1 - \rho \cdot \sin\beta\,;$$
$$y_{1,0} = x_1 - \rho \cdot \cos\beta\,; \tag{5}$$

A corner β determines position of unit tangent vector τ in the system of coordinates of X_1Y_1, thus

$$\cos\beta = \frac{x_1'}{\sqrt{x_1'^2 + y_1'^2}}; \qquad \sin\beta = \frac{y_1'}{\sqrt{x_1'^2 + y_1'^2}}\,. \tag{6}$$

After transformations will get:

$$x_{1,0} = x_1 - \frac{y_1' \ x_1'^2 + y_1'^2}{x_1' \cdot y_1'' - x_1'' \cdot y_1'}; \qquad y_{1,0} = xy_1 - \frac{y_1' \ x_1'^2 + y_1'^2}{x_1' \cdot y_1'' - x_1'' \cdot y_1'} . \quad (7)$$

Condition of $O_1O^1 \geq r$ analytically it is possible to express thus:

$$x_{1,0}^2 + y_{1,0}^2 \geq r^2. \quad (8)$$

Deciding together equalization (5) and (8), will get

$$x_1^2 + y_1^2 + \rho^2 + 2\rho\,(y_1 \cos\beta - x_1 \sin\beta) \geq r^2.$$

The condition of exception of interference also will be determined by the general decision of equalizations (7) and (8)

$$x_1^2 + y_1^2 + \frac{(x_1'^2 + y_1'^2)^3}{x_1' \cdot y_1'' - x_1'' \cdot y_1'} + 2 \cdot \frac{y_1 \cdot x_1' - x_1 \cdot y_1'}{x_1' \cdot y_1'' - x_1'' \cdot y_1'} \cdot \ x_1'^2 + y_1'^2 \ \geq r^2.$$

Determination of profile of initial instrumental surface $\Sigma_{A,}$ conjugating with the set curvilinear surface Σ_B, comes true on such chart Equalization of profile wares in the immobile system of coordinates of *XY* at a turn on a corner α looks like :

$$x = r \cdot \alpha + x_i \cos\alpha + y_i \sin\alpha;$$
$$y = r - x_i \sin\alpha + y_i \cos\alpha; \quad (9)$$

where $x_i = f_i\ \varphi$, if $\varphi\epsilon\ \varphi_{i-1}, \varphi_i$, $i = 1,2, \dots, k; y_i = g_i\ \varphi$.

From the condition of collinearity of tangent vector to the profile wares and instrumental surface in tangency:

$$\frac{dx}{d\alpha} \cdot \frac{dy}{d\varphi} - \frac{dx}{d\varphi} \cdot \frac{dy}{d\alpha} = 0.$$

Deciding determinant (10), will get equalization of parameters Σ_A and Σ_B

$$\varphi = h_\iota\ \alpha \ , \quad (11)$$

if $\varphi\epsilon\ \varphi_{i-1}, \varphi_i$, $i = 1,2, \dots, k.$

Deciding together equalization (11) and (9) , will get equalization of profile of initial instrumental surface in the immobile system of coordinates of *XY* if $\varphi\epsilon\ [\varphi\_\ (i - 1), \varphi\_\ i\ ]$, $i=1,2.,k.$

$$x = r\alpha + f_i(h_\iota\ \alpha\ ) \cdot \cos\alpha + g_i\ \ h_\iota\ \alpha \quad \sin\alpha$$

$$y = r - f_i \quad h_\iota \ \alpha \quad \cdot \sin\alpha + g_i \quad h_\iota \ \alpha \quad cos\,\alpha \qquad (12)$$

Conclusions.

1. The designed method of conjugating quasi helical surfaces allows to get the grapho-analitical model of creation of surfaces in relation to modern technologies .
3. A way is opened to treatment of details with difficult surfaces on machine-tools with a programmatic management .
4. Possibility of substantial increase of exactness of planning and making of toolpiece appeared in relation to multiple-thread worm milling cutters.

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