УДК 515.2:681.3

DETERMINATION OF THE PARAMETERS OF RELATIVE MOVEMENT OF SCREW DIGGERS BY THE CONJUGATION METHOD

Vanin V.V., Ph.D., prof,
Hrubych M.V. assistant
National Technical University of Ukraine
"Kyiv Polytechnic Institute named after I. Sikorsky" (Ukraine, Kyiv)

Annotation *- in this publication, a new method of designing screw surfaces of the working parts of root-harvesting machines is proposed for use, which is based on the theory of conjugation of two surfaces in which the base surface is a cone*

Keywords *- conjugated surfaces, base surface, normal vector, helical movement*

Formulation of the problem. In agricultural engineering there is an urgent need to create new methods of designing the working surfaces soil-tilling machines. One of these methods is the conjugation method, which is the basis for designing work surfaces.

Analysis of recent research. During surface construction geometric parameters and orientation of the basic working surfaces are important. First of all, this concerns the size of the installation angles of the working surfaces relative to the field plane and the axis of the rows of root crops; the mutual placement of paired squeeze diggers, as well as their kinematic characteristics.

Discarding certain conventions of disc and fork diggers, you can actually see the conjugated cone-like models of the interaction of the fork and disk digger, which are contained in the congruence of the directions of the forces acting on the soil monolith and the root crops placed in it (fig.1)

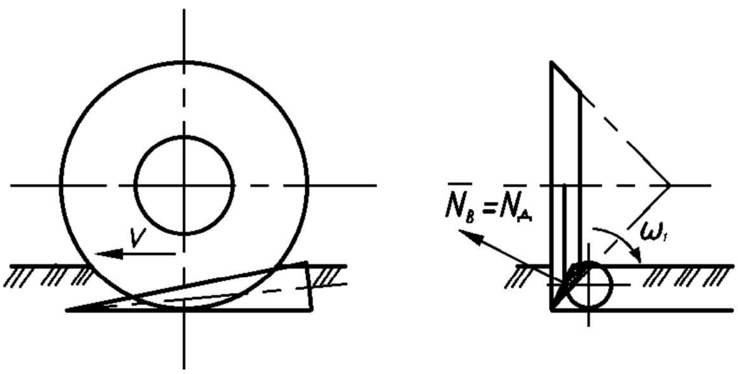

Fig.1 Scheme of surface interaction

The main part. The determination of the mutual orientation of the surfaces of the disk and diggers as conjugated indicates that there is a worm analogy of spatial engagement between them. It is known that worm gears and their surfaces are spatial with passing axis in which the shaping of surfaces occurs by the method of running in a fork-disk system for which the basic provisions of the theory of conjugate surfaces are valid and mandatory for this system:

- the conjugate surfaces of the points of contact have a common normal
- the vector of the normal drawn through the point of contact of the conjugate surfaces passes through the profiling poles
- the shape of the profile of conjugated surfaces is defined as absorbing successive positions from the conjugated profile of kinematic pairs

It is known that for conjugate surfaces at the point of contact of the original surface and the desired one, the normal vector **n** and the vector **v** of the relative movement speed of the points of the diggers of the "fork-disc" system will be placed perpendicular to each other. Mathematically, we can write this dependence through a scalar product:

$$\mathbf{n} \cdot \mathbf{v} = 0 \qquad (1)$$

If we take an arbitrary point A, which belongs to the surface of the fork digger, its position is determined by the value of the radius R_i of the conical surface and value Z_i distance from the XY plane. In parametric form it can be written as:

$$X = R_i \cos t; \quad Y = R_i \sin t; \quad Z = Z_0 + Z_i; \qquad (2)$$

where t is a variable parameter that fixes the position of the investigated point on a conical surface with a cross-sectional radius R_i.

Vector equation of the normal **n** to the conical surface of the fork digger, provided that its conical surface has an angle α at the base of the cone:

$$\mathbf{n} = \{sin\,\alpha \;\; cos\,t; sin\,\alpha \;\; sin\,t; cos\,\alpha\,\}; \qquad (3)$$

where t is the variable parameter and the equation, determines the normal of unit length.

The value of the speed **v** relative to the movement of an arbitrary point on the surface of the conical digger in the $X_1Y_1Z_1$ coordinate system is defined as the sum of two movements: rotational helical movement around axe Z_2 with a speed v_ω and forward motion along the axis of the helical movement.

The progressive component of the helical movement of the fork digger v_1 along the axis of helical movement is written in vector form by the following expression:

$$v_z = \{0; 0;\; p\omega\}; \qquad (4)$$

Then the rotation component v_ω of the helical movement of the fork digger is defined as the result of the vector product speed ω_l and vector N. This vector defines the distance from the rotation axis Z_2 to a given point on surface of the fork digger.

Follows from here:

$$\nu_{\omega} = \omega_l \times N;\ \omega_l = \{0; 0;\ \omega\}; \mathrm{N} = \mathrm{b} - \mathrm{r}; \quad (5)$$

where the value of the vector **r** is determined by the following equation:

$\mathbf{r} = \{R_i \cos t\,;\ R_i \sin t\,;\ Z_0 + Z_i\}$, the value **b** is described by the formula:

$$\mathbf{b} = \{0;\ -b; 0\};\ \nu_{\omega} = \{b\omega + R_i \sin t\,;\ -\omega R_i \cos t\,; 0\} \quad (6)$$

After transforming the mathematical expressions, we will get infinitives, the desired equation of the speed of relative motion, the system fork-disk:

$$v\ =\ v_z + v_{\omega} == \{b\omega + R_i \sin t\,;\ -\omega R_i \cos t\,; p\omega\} \quad (7)$$

Conclusions. 1. For researchers and engineers of soil-tilling machines, this information from the determination of relative movement parameters can serve as a starting point for searching when building new surfaces of diggers or correction of existing diggers.

2. At the same time, the obtained geometric models of the surfaces of the fork-disk system will allow to significantly expand the search for new constructions of the digger as much as the soil surface itself can be formed by an unlimited number of initial gas surfaces.

References

1. Pogoreliy L.V. and oth. Beet-harvesting machines (Constructing and account). – K.:

Technics, 1983. – 168 p.

2. Yurchuk V.P. Use of geometrical simulation at projection root-harvesting of machines //

Application geometry and engineering graphic.: KNUBA, 2000. – Is. 67. – p.181-184.

3. Pavlov A.V., Yurchuk V.P., Nadkernichnaya T.N., Yablonskyy P.N. Use of mathematical models at projection root-harvesting of machines // Application geometry and engineering graphic. – Melitopol: TDATA, 2000. – Is. 4.T.11. – P.39