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CLASSIFICATION OF HELICAL SURFACES

In modern engineering, products with complex surfaces are widely used, the whole variety of which can be divided into tools for reproducing similar parts and the actual parts by their use in engineering and technology. Often the tool has a more complex surface than the workpiece. A significant part of complex surfaces are screw surfaces.

For the first time, the questions of the theory of helical surfaces in the design of cutting tools and the classification of helical surfaces (Figure 1.) were outlined in the work of V.S. Lukshin.

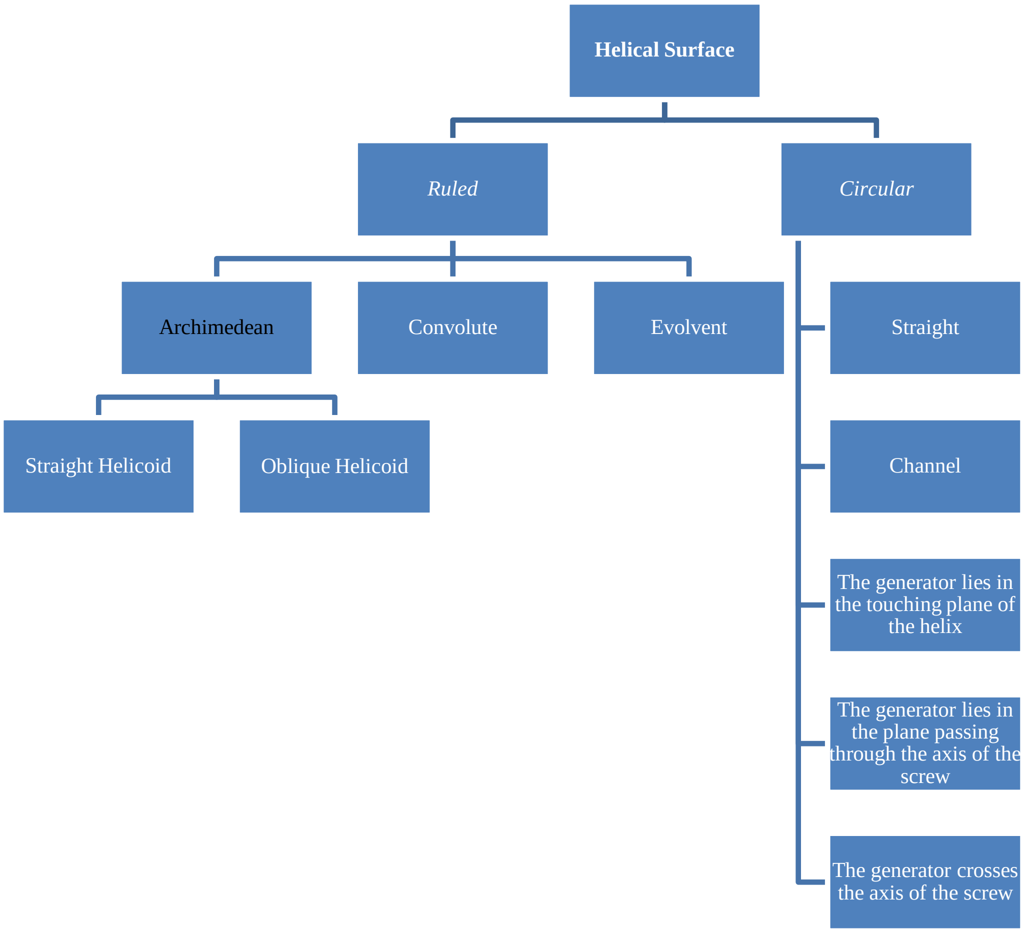

Figure 1. The classification of helical surfaces

In this work, a cylindrical helical surface, both ruled and circular, was considered [1]. A helical surface is defined as a surface described by a line that rotates at a constant angular velocity around a fixed axis and simultaneously moves translationally at a constant speed along this axis. Helical motion is considered to be a complex motion, which consists of a translational motion, parallel to the axis and at the same time rotational movement around this axis. Any screw surface can move by itself and through bending can be superimposed on the surface of rotation [2; 3]. When crossing the axis of rotation, which forms the axis of rotation, it is accepted to call the helical surface closed, otherwise open. By the form forming the helical surface are also circular and ruled. In addition, the helical surface is divided by position relative to the screw axis of the generator. The surface formed by the ordinary helical movement of the line forming is called the ordinary helical surface. Ruled helical surfaces are the surface, which forms a straight line. When the closed helical surface is crossed by an end plane, an Archimedean spiral or Archimedean helicoid is formed in the cross section. A helicoid is called straight when the axis of the propeller is perpendicular (screw conoid), in other cases – oblique helicoid (Figure 2.).

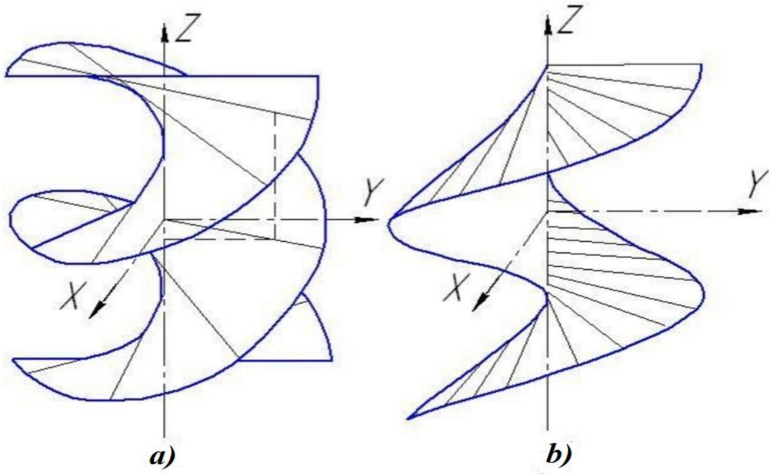

Figure 2. Helicoid (a - straight; b - oblique)

When crossing the end plane of an open ruled helical surface in cross section, an evolvent is obtained. In the case of an ordinary involute, the surface is called an involute, otherwise, in the case when the involute is elongated or shortened, it is convolute. Thus, a convolute screw surface can be considered the most common case.

Circular helical surfaces are surfaces whose L is a circle (Figure 3.). A channel helical surface is obtained under the condition that the surface that goes around the sphere and has a radius in its helical motion. If the axis of the screw is perpendicular to the plane of the circle, we obtain a helical surface of the direct type.

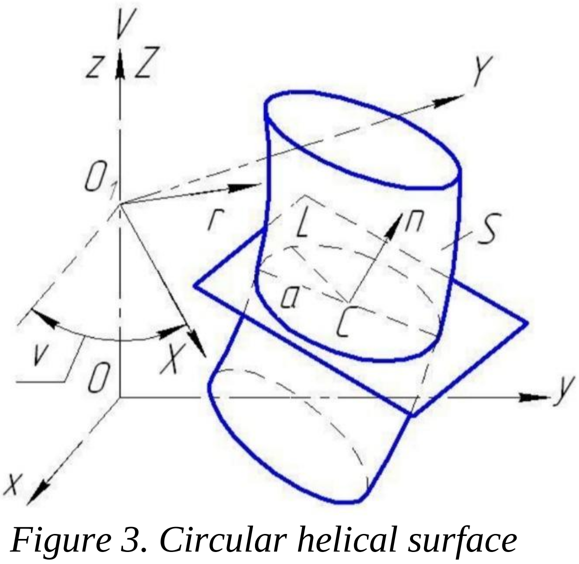

Figure 3. Circular helical surface

A complex motion, which consists of a rotational motion around a constant axis and simultaneously translational parallel to this axis, is a helical surface with variable pitch, which are cylindrical and conical.

Complex helical surfaces are characterized by variable generatrix and variable pitch, which also includes the helical surface on the sphere. Variable parameters are the pitch H and the angle ω of the helical groove angle. At a constant angle of inclination, the pitch of the screw groove changes, and, conversely, at a constant pitch, the angle of inclination is a variable parameter.

Among the variety of tools with a screw surface, a large group consists of spherical mills, which are used for machining radius sections of body parts, dies and molds. Modern industry, widely using machine tools with numerical control, currently needs a large number of spherical cutters with high performance at the lowest possible cost.

Grinding wheels are mainly used for machining helical surfaces, the profiling of which, provided there are no undercuts and incomplete formation of the groove profile, is one of the most labor-intensive tasks in instrumental production since the profile of the helical surface in any of the sections does not correspond to the profile of the forming grinding the circle. In addition, the method of crossing a sphere with a direct Archimedean helicoid is used to determine the guiding helical surface, which itself is a complex surface and leads to complex calculations. Methods for determining the production profile of the grinding wheel are designed for conical and cylindrical surfaces, while the most common and complex is the helical surface on the sphere.

To exclude the zone with zero speeds, there is a technique for designing and manufacturing a spherical cutter with a group arrangement of the helical flute. However, this design has significant drawbacks in the form of complexity in manufacturing and a small number of teeth on the end, which is caused by the number of groups. Some manufacturers of spherical mills with the same arrangement of the helical chip groove zone with zero speeds are avoided by making a center hole on the end. In this case, the zone with zero speeds is excluded, but over time the hole is clogged with chips.

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