METHOD OF ROUTING VARIABLE PITCH HELICAL SURFACE AND CONSTANT RADIUS PROFILE

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Known methods for producing a variable pitch screw surfaces are characterized by poor quality of the machined surface due to the low stiffness of the kinematic chain of the lead screw table to spindle, the complexity of adjusting to a given law of variation of the helical pitch of the surface. In this paper we solve the problem for the milling helical grooves with any law, changing thepitch.

Keywords: milling helical surfaces, variable pitch helix

In the context of large-scale and mass production is considered to be the most effective method of shaping flutes plastic deformation (hot pressing). This method – hot pressing is most effective, there is formed at the same time cutting the tail and part of the tool with minimal allowance for subsequent machining. methods for producing helical flutes by plastic deformation make it possible to produce flutes only with a constant angle of inclination of the helix. As methods of plastic deformation processes are accompanied by considerable heat, which can lead to a change in strength.

Getting flutes with variable helix angle of inclination, perhaps only by removing material. Consideration receiving flutes of twist drills to start the grinding process. Grinding is a process in which helical chip flutes formed in a workpiece of high speed steel or cemented carbide. The main advantages of the grinding process is that the geometric parameters of the flutes produced high precision and high quality work surfaces, as well as reducing manufacturing cycle of the tool. Maximum performance is achieved when grinding grooves by deep grinding. This method is compared with a multi-pass grinding performance advantage by grinding a groove in one pass. However, when grinding grooves increasing energy costs, there is difficulty tungsten recycling swarf, which mixes with the products of the grinding wheel wear (Fig. 1).

In terms of versatility obtain particle flutes used methods based on the removal of material (milling), this can be explained by the fact that the milling (Fig. 2) may simply change the geometry of the drill, the cross-sectional characteristics flute, core diameter, angle tilt flutes – w, the amount of back downward, the central angle that determines the width of the groove, which in turn makes it possible to, significant geometric parameters of twist drills, depending on the treated and the treatment material, cutting Regis-atoms, as well as take into account the stiffness and strength of the cutting tool.

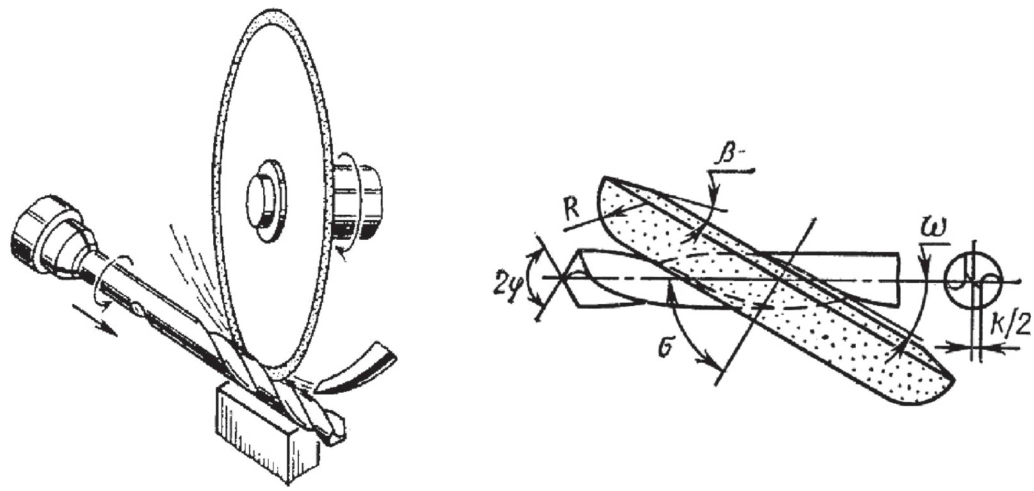

Fig. 1. Grinding helical flutes

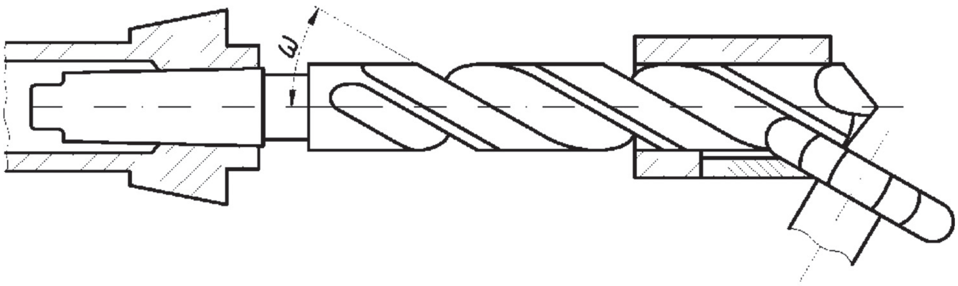

Fig. 2. Milling helical flutes

There are several inventions which provides some methods for producing the helical chip flutes. For example, in [1] describes a method for the formation of helical flutes variable pitch on bodies of revolution using the tool heads. Tool heads are on the spindle with parallel axes. Bits perform main rotational cutting motion, and then cut into the workpiece, then consistently performed four movements: billet rotation, longitudinal movement of the workpiece or tool, moving the tool along the axis of the coordinate system, tool heads rotate about an axis which is compensated-siruyut change the helix angle of inclination.

The invention is proposed to handle Neff spiral groove cutters. The essence of this method consists in the following, the workpiece is fixed in a special holder, and then draw in nonrotating center of the tool is based on a mandrel in a support angle ω to the axis of the workpiece. Imparting rotational movement between tool and workpiece while supplying step caliper t, strand form helical groove helix angle which is ω. In operation [2] proposed a method for obtaining helical surfaces with a predetermined inclination angle of helical flutes and the profile of a circular arc rotating tool. In [3] the method of forming the helical flutes of constant pitch in parts with a non-cylindrical core. The blank report helical movement, and the tool – the movement of rotation, at the same time carrying out its withdrawal from the axis of the workpiece. The above methods for producing helical surfaces are characterized by poor quality of the machined surface due to the low rigidity of the kinematic chain and the complexity of the adjustment to a given law of variation of the helical surface step.

For cutting spiral grooves is supposed to use universal milling machines and modernized universal dividing head. The machine must be able to turn the table and the longitudinal axis of the slider supply (trunk) with the spindle. The most suitable for this purpose are tool machines with optional rotary table, for example, a series of machines WF1, WF2, WF3, WF4 company Khuth.

Upgrading universal dividing head is to apply additional kinematic chains to create additional torque movement workpiece at a variable rate [4].

The implementation of this scheme involves the use of dividing head with additional devices and tailstock. The workpiece is fixed in the chuck dividing head and tailstock center is urged. Table pre-rotated with the rotary plate at an angle lifting screw groove corresponding to the largest step:

$$\lambda = \text{arctg}\left(\frac{t_{max}}{\pi D}\right), \quad (1)$$

where t_{max} – highest pitch of the helical groove; D – workpiece diameter.

The table with the workpiece makes uniform translational movement along the axis of the workpiece at a speed – S_1 from the machine drive. From the additional rotation of the shaft of the machine drive is transmitted to the guitar interchangeable gears with a gear ratio – i_1, which is set at the initial value of the pitch helical groove by the following relationship:

t_0 mm move the table
with the workpiece → 1 workpiece turnover

Thus, a uniform rotation of the workpiece component – n.

To get a variable pitch helical groove on the uniform rotation of the workpiece is superimposed alternating rotation, providing a step increase Δt_i helical groove compared with the initial value t_0:

$$\Delta t_i = t_i - t_0, \quad (2)$$

where t_i – the current value step helical groove.

For alternating rotational movement of the workpiece with an additional shaft through a guitar replacement wheels is transmitted to the cam. Profile of the cam is constructed with a view to ensuring a predetermined law of variation of pitch helical groove [5]. Gear ratio – i_k guitar changeable gears configured so that when the workpiece is moved to its full length of thread helical groove – L cam rotates Θ_p its working profile:

$$L \text{ mm table travel} \to \frac{\Theta_p}{360} \text{ cam turnover,}$$

where Θ_p – working angle in degrees of cam profile.

Rack and pinion mechanism converts the translational movement of the cam follower mechanism into a rotational movement of the gear. From the rack and pinion mechanism is transmitted to the rotation power that increases the torque value to ensure sufficient force during cutting. From steering rotation is transmitted to the guitar interchangeable gears with gear ratio i_y.

The guitar is used for correcting the increment step size and is configured so that when you move the pusher to the radius difference Δr operating cam site provides a full step increments Δt the entire length of cutting portion of the helix. The number of revolutions of the workpiece required for the implementation of this increment $\frac{\Delta t}{L}$. The consistency condition:

$$\frac{\Delta r}{\pi \cdot m \cdot z} \text{ rev gear} \to \frac{\Delta t}{L} \text{ workpiece speed.}$$

Summation of the rotation by the two branches of the kinematic chain is made on the mechanism of differential. Uniform rotation comes from the guitar to the central driving wheel differential mechanism. Variable speed comes from the guitar to the carrier of the differential mechanism. The total rotation is removed from the driven gear and enters the dividing head mechanism, which is fixed to the workpiece spindle.

Thus, rotation is performed alternating the total workpiece, which in accordance with a uniform movement of the workpiece along its axis of helical cutting grooves provides variable pitch.

For carrying out the method is also applicable conical cutter, which is mounted on the mandrel. The mandrel is installed in the spindle slide and is supported by an earring [6]. Bevel cutter receives rotation at – n_f.

To ensure a gradual increase in the radius of the profile helical groove, conical mill together with the slider performs feed motion – S_f along its axis. Feed rate – S_f is selected so that during the movement of the workpiece along its axis by a length section of the helical groove – L, Hiller moved along its axis by the length of the working area – L_f

$$S_f = \frac{L_f}{L} \cdot S_1. \qquad (3)$$

To implement this method, you must properly shaped cam. To do this, an equation cam radius depending on its angle of rotation. Consider the example of derivation of the linear law increment helix blanks:

$$\Delta t_i = k_t \cdot x, \qquad (4)$$

where k_t – the proportionality factor:

$$k_t = \frac{t_{\max} - t_{\min}}{L}, \qquad (5)$$

where $t_{\max}$ – the greatest step helix blank; L – current coordinate along the axis of the workpiece.

The equation of the kinematic balance to the compatibility condition. We proceed from the limits to the current coordinates:

$$\Delta r_i = \Delta R_{ki}\left(\Theta_i\right). \qquad (5)$$

The equation defines the cam profile necessary to ensure uniform increment helical groove, in the absence of eccentricity between the pusher and cam axis.

Widespread serially-produced independent swing-separating devices Markets independent controllers, makes it possible to apply the principles of numerical control. This can greatly simplify the scheme cutting helical grooves and facilitate the changeover process system.

Another variant of the scheme cutting helical grooves with variable step involves the use of universal milling machine with horizontal spindle, equipped with a digital device indicating the position of the machine working bodies. These machines have the encoders in the coordinates. The sequence of impulses coming from the sensor mounted on the lead screw longitudinal table is converted into an analog signal using a digital to analog converter. The signal is then converted into alternating with the necessary frequency. To do this, set controlled oscillator frequency. Next, the resulting frequency is transmitted to the divider, which reduces the integer times the frequency supplied to it. The frequency divider is supplied to the electronic switch, which is controlled by a stepper motor.

The region of existence of the processing circuits depends on the tool and the machine parameters. The minimum radius of the helical groove cavity is defined by the minimum possible radius of the tool.

The mandrel diameter is determined from the condition necessary to ensure the rigidity and vibration resistance, which in turn depends on the quality requirements of the treated surface and productivity.

Hence a minimum standard 16 mm diameter mandrel, the minimum radius of the cutter and, consequently, grooves and depressions 20 mm.

Widespread mass-produced independent swing-separating devices Markets independent controllers, makes it possible to apply the principles of numerical control. This can greatly simplify the scheme cutting helical grooves and facilitate the changeover process system.

In turn, there are several problems associated with milling flutes:

1. The high cost of the tool material.

2. Complex geometric shape of the cutting wedge which hinders productivity tool in the design process/

3. The complexity of manufacturing technology cutters.

Thus, to reduce the time and simplify the design tool technology, the acute problem of the calculation of such mills. The calculation is made on-vysokoproiz-performance computing, so for correct calculation is necessary to analyze the methods of obtaining such milling tool surface.

Thus, the article received a set of equations to determine the law of variation of pitch helical groove that turns out high enough quality

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