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Trochoidal Slot Milling

V. A. Grechishnikov[a], *, Yu. E. Petukhov[a], P. M. Pivkin[a], V. B. Romanov[a], E. A. Ryabov[b], **, S. Yu. Yurasov[b], and O. I. Yurasova[b]

[a]Stankin Moscow State Technical University, Moscow, Russia
[b]Naberezhnye Chelny Institute, Kazan Federal University, Naberezhnye Chelny, Russia
**e-mail: v.grechishnikov@stankin.ru*
***e-mail: docfile@yandex.ru*

Abstract—Parameter specification in the trochoidal machining of a slot of constant width is considered. A formula is proposed for the displacement increment of the shaping circle as a function of the cutting depth.

Keywords: trochoidal machining, slot machining, contour displacement

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With the large-scale introduction of numerically controlled machine tools in manufacturing, better approaches to the selection of the milling trajectory are required [1]. One option is trochoidal milling, which is used in CAM systems to cut slots in continuous materials [2]. CAM systems offer great freedom in trajectory selection but rely on the programmer's depth of knowledge.

Typically, the machining of a slot or contour is not the only operation performed in a particular setup. Consequently, with a large number of tools and operating cycles, it is difficult to write a satisfactory machining program in the CAM system. The programmer must pay close attention. In addition, the system must be checked, since errors in writing the software may only be corrected using the CAM system [3]. That complicates the preparations for machining a particular part, especially in short production runs. A remedy here is to write a slot-machining subprogram with a trochoidal-milling cycle in the basic numerical control software.

In classical trochoidal machining, the slot contour is formed by successive displacement of the shaping circles, whose diameter is equal to the slot width. Each contour is machined by the circular interpolation of a smaller-diameter mill. In that case, more than 50% of the mill displacements are nonproductive.

Delcam, the company that proposed the notion of trochoidal milling, recommends D milling in that case, with a mill whose diameter is 50–60% of the slot width. In experiments using the Vortex machining strategy (patented by Delcam), in which the cutting depth is constant, the optimal sector angle of the mill in shaping is found to be 46° [4]. Thus, on the basis of those figures, we arrive at a machining procedure in which the maximum cutting depth is no more than 15% of the mill diameter with displacement of the shaping circles by an increment P [5–20].

In the general case, the machining program in the Sinumerik numerical system takes the following parametric form (Fig. 1).

For the straight section of the slot:

r1=1; operator

n1; initial frame of cycle

g1x=r50+(r1–1)*r2*cos(r3)+r11 y=r51+(r1–1)*r2*sin(r3)+r12 f=r4*3; accelerated motion to point of insertion

g3x=r50+(r1–1)*r2*cos(r3)+r13 y=r51+(r1–1)*r2*sin(r3)+r14 i=AC(r50+r1*r2*cos(r3)) j=AC(r51+r1*r2*sin(r3)) f=r4; machining

r1=r1+1; operator increment

ifr1<r5/r2goton1; condition for return to initial frame.

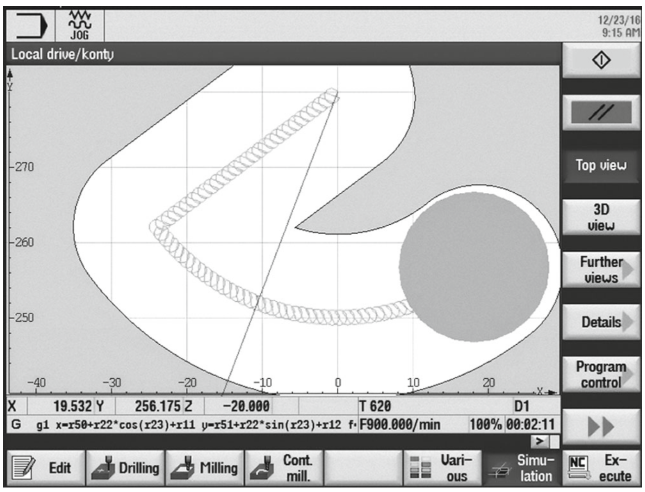

Fig. 1. Trochoidal machining trajectory.