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Process and Tool for Machining of Small Size Spherical Surfaces

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Abstract

In the paper there are presented some peculiar items of manufacturing there duced-sized inner spherical surfaces. It is presented an original designed process of such type of the surfaces. There are underlined the characteristics of the presented process, the details of the tool used as well as the main advantages offered by them.
Keywords*: tool, spherical surfaces.*

1. Theoretical aspects

It is known that the machining of spherical surfaces using universal machine tools, especially turning lathes, can be achieved by using either special devices or shaped tools.

The suitable devices, usually, guides the tool according to a circular forward movement, achieving the generator path in a kinetic way. In the second case the generator contour line it is directly materialized by the shape of the tool profile.

Using of the shaped tools leads to obtaining of much favorable technical and economical parameters for machining process. So that, it is recommended to use the shaped tools for machining internal and external spherical surfaces, for the case of small size areas the materialization of the generator contour line being the most rational in order to achieve suitable productivity and quality.

Should the length of the generator line exceed certain limits, those limits imposed by the machining process stability, the spherical turning kinetic devices must be used.

So, it appears that, when possible, for small and medium size items, in the conditions of large manufacturing series, the machining of spherical surfaces is done by using shaped tools. However the manufacturing process of such tools is rather complex and it is imposing a high manpower as well as suitable technological equipment.

This paper is proposing to highlight several aspects connected with the machining of the small size spherical surfaces, according to a simple method, using as a tool just a circular disc (material ***Rp3*** high speed steel).
The procedure is applicable in case of machining the spherical surfaces (***D < 50*** mm) particularly on standard turning lathe.

The tool (1), figure 1, is set in the cross keyway of the tool holder (2) which in its turn is mounted into the movable tailstock of the lathe.

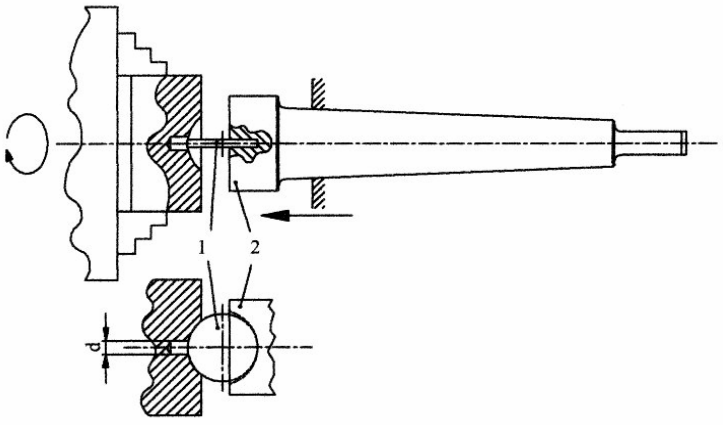

Figure 1

The well processing it is conditioned by the correct positioning of the tool at the beginning of the machining operation. This is achieving by drilling a centering frontal hole, for technological purpose, comply with ***g*** < ***d*** condition, where:

g – is the thickness of the disc;

d – the diameter of the centering hole.

Figure 2 shows the generation method for a spherical surface of radius ***R***, using the disc tool. It can be found that:

$$R = \sqrt{\left[R_1^2 + \left(\frac{g}{2}\right)^2\right]} \qquad (1)$$

where:

R_1 – radius of the tool disc;

g - thickness of the tool disc.

From (2) for a required radius ***R*** and adopting a certain thickness ***g***, it can be found the tool radius:

$$R_1 = \frac{1}{2}\sqrt{\left(4R^2 - g^2\right)} \qquad (2)$$

At a certain point ***P*** of the cutting edge, the tool setting angle α_u will be (figure 2):

$$\alpha = arct\left(\frac{g}{2R_u}\right) \qquad (3)$$

where:

$$R_u = R_1 \cos\alpha_u \qquad (4)$$

so:

$$\alpha_u = arctg\left(\frac{g}{2R_1 \cos\alpha_u}\right)$$

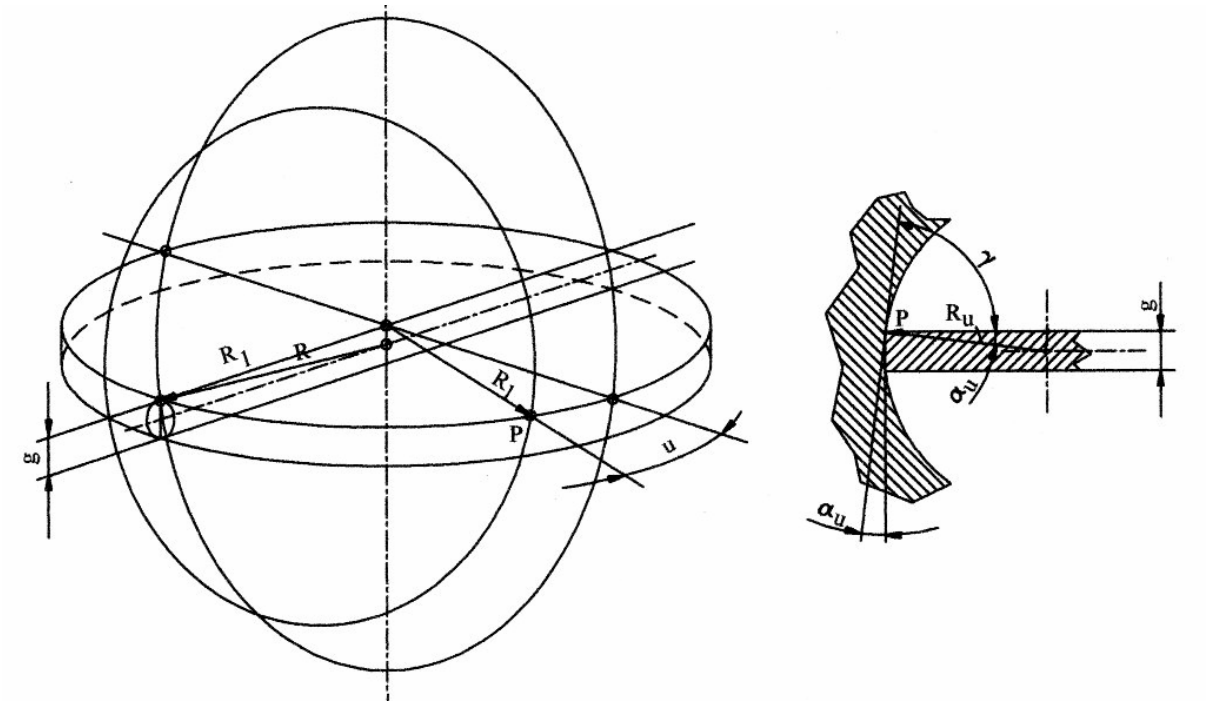

Figure 2

By replacing R_1:

$$\alpha_u = arctg\left(\frac{g}{\cos\alpha_u\sqrt{\left(4R^2 - g^2\right)}}\right) \qquad (5)$$

resulting:

$$\left(\alpha_{u\max}\right)_{u\to\frac{\pi}{2}} = \frac{\pi}{2} \qquad (6)$$

$$\left(\alpha_{u\,max}\right)_{u\to 0} = arctg\left(\frac{g}{\sqrt{4R^2 - g^2}}\right) \qquad (7)$$

Now by noting $(\alpha_a)_{nec} = \alpha_0$ from (7) results:

$$tg\alpha_0 = \frac{g}{\sqrt{4R^2 - g^2}} \qquad (8)$$

and explicit depending on ***g*** it found:

$$g = 2R \cdot tg\alpha_0\sqrt{1 + \left(tg\alpha_0\right)^2} \qquad (9)$$

The equations (2) and (9) allow dimensional definition of the disc tool according to prescribed radius ***R*** of the spherical surface, object to machining, and a setting angle α_{nec} of a value which is adopted according to the recommendations.

3. Conclusions

The using such kind of disc tools, as per our presentation, in order to machine small size spherical surfaces, have the following advantages:

- enables the obtaining of high dimensional accuracy and very good finishing quality of the resulted spherical surface (back rake angle, $\gamma < 0$, on the entire length of the cutting edge, see figure 2);
- presents a certain stability for the machining process, since the tool is working with both opposite cutting edges, which leads to a well balanced couple of the resulting cutting forces;
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- do not requires special machines but, according to the item configuration and the available facilities, ordinary machine tools can be used (turning lathes, drilling machines etc.);
- there is no need for special technologies in order to manufacture the tools, since they are very simple and easy to execute in normal conditions;
- calculation of the dimensional parameters of the tool (***d; g***) can be easily done by using specific software.

To conclude, the presented process method is imposing in the frame of internal spherical surfaces machining due to both, the simplicity and the offered economical and qualitative advantages.

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Procedeu şi sculă pentru prelucrarea suprafețelor sferice de dimensiuni mici

Rezumat

În lucrare sunt prezentate câteva elemente particulare din domeniul prelucrărilor prin aşchiere a suprafețelor sferice interioare de dimensiuni reduse, respectiv un procedeu original de realizare a acestui gen de suprafețe. Sunt evidențiate atât caracteristicile procedeului, detaliile constructive ale sulei precum şi principalele avantaje oferite de acestea.

Traitez et outillez pour usiner de petite dimension surfaces sphériques

Résumé

Dans le papier là sont présenté quelques articles particuliers de fabriquer des surfaces sphériques intérieures duced de taille là. Il est présenté un original conçu processus de tel type des surfaces. Là est souligné le caractéristiques du processus présenté, les détails de l'outil ont utilisé comme bien comme les principaux avantages ont offert par eux.
Mots-clé: outils, sphérique, surfaces