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(54) The way of machining of spherical surfaces and the device for its realization

(57) The development of a machining process of spherical surfaces and the device for its realization, integrated by a uniform intention of the invention, is put as a basis of the claimed invention.

A modification of the scheme of machining is ensured by a realization of tool feeding for penetration into the workpiece material by a force, acting in an offered direction. This mechanism allows increasing contact pressure in those points of a machined surface at a distance from an axis of rotation and consequently (as well as the cutting velocity) is promptly diminished to zero. Thus, creating conditions of contact pressure redistribution allows completely or partly a modification of the cutting velocity at the various contact points, leading to levelling a velocity of oversize removal at the profile of a workpiece and increasing of the exactitude and efficiency of machining process. Furthermore, the possibility of machining spherical workpieces having height of the spherical surface exceeding its radius may be attained more efficiently, compared to existing ones.

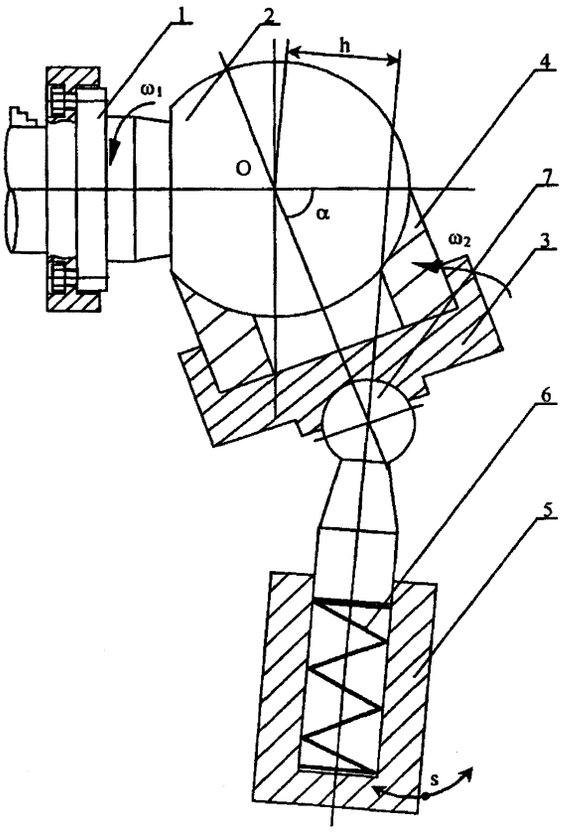

Fig. 1

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Description

[0001] Inventions deals with the machining of spherical surfaces, mainly of spherical workpieces with an open or not open central hole, or of spherical face parts of rods, made of composites or other materials. They may be used in oil, auto tractor, aviation and other fields of industry, and also for machining of hip-joint ceramic balls.

[0002] The way of machining of spherical surfaces of workpieces and namely rods with a spherical end, includes:

a) a disposition containing the tool and a number of workpieces displaced in a circular direction, with their axes intersecting at the center of a machined spherical surface (used as a reference surface),
b) rotation of the tool over its own axis,
c) placement of the tool inner face in contact to a spherical surface (to be machined)
d) feeding of the tool, ready to start the material removal processes, by forced rotation of workpieces over an axis passing through the center of a machined spherical surface, under a right angle to a plane formed by the axes of workpieces and the tool

(see no 94016719 patent of the Russian Federation, the International classification 6 B23B5/40, B24B11/10, published 1996.01.10, bulletin No 1).

[0003] The finishing process of spherical surfaces, and namely in the case of optical workpieces being parts of a full-sphere, includes:

a) a disposition containing a rotating tool under an angle to a workpiece with their axes intersecting at the center of a machined spherical surface (used as a reference surface),
b) the forced rotation of the workpiece over its own axis,
c) placement of the tool inner face in contact to a spherical surface
d) feeding of the tool

(see no 92012175 patent of the Russian Federation, the International classification 7 B24B11/10, published 1995.03.20, bulletin no 8).

[0004] The device for carrying out the machining of spherical surfaces of rod workpieces, contains:

a) a forced-rotating tool holder and
b) a mandrel for fixing a number of workpieces, arranged in a circular direction and with their axes intersecting at the center of a machined (reference) spherical surface, so that their axes of rotation to intersect under a right angle at the center of this spherical surface.

(see no 94016719 patent of the Russian Federation, the International classification 6 B23B5/40, B24B11/10, published 1996.01.10, bulletin no 1).

[0005] The device for carrying out the machining of spherical, namely optical workpieces, contains:

a) a forced-rotating mandrel for fixing of a workpiece and
b) holder for the rotating tool, arranged so that

1) the axes of rotation of the tool and a workpiece to intersect under an angle at the center of a spherical (reference) surface,
2) the tool completely covering the workpiece, and
3) to achieve the combination of workpiece and tool faces

(see no 92012175 patent of the Russian Federation, the International classification 7 B24B 11/10, published 1992.03.30, bulletin no 12).

[0006] Common faults of the above-mentioned machining processes and devices are a rather low accuracy in the machining of a spherical surface. It depends on the positioning accuracy of the tool in reference with the workpiece and on the tool wear. Moreover, the machining of a spherical surface having height exceeding its radius is not possible. It must be noted that there are not spherical optical workpieces having height less than the radius of the full- sphere.

[0007] The development of a machining process of spherical surfaces and the device for its realization, integrated by a uniform intention of the invention, is put as a basis of the claimed invention. A modification of the scheme of machining is ensured by a realization of feeding on penetration with force, acting in an offered direction. This mechanism allows increasing of contact pressure in those points of a machined surface at a distance from an axis of rotation and consequently (as well as the cutting velocity) is promptly diminished to zero. Thus, an increase of an oversize removal is attained at these points. As the corollary, a possibility of machining of spherical workpieces having height exceeding their radius is ensured. Since, there are no spherical optical workpieces full-sphere having height less than the radius of the full-sphere, a way of machining of such spherical surfaces is proposed, including:

a) placement of the rotating tool in a certain angle with reference to a workpiece with their axes intersecting at the centre of a machined spherical surface,
b) forced-rotation of the workpiece over its own axis,
c) placement of the tool by its face in contact with a spherical surface and
d) feeding of the tool, ready to start the penetration into the workpiece,
and adding the following differences:
e) the tool lies freely on its axis, and

f) tool feeding is realized by force acting in a certain direction from the centre of a spherical surface, forming an the acute angle between the tool and the workpiece axes.

[0008] It is also developed a device for machining of spherical surfaces, containing:

a) a forced-rotating mandrel for fixing the workpiece and
b) a tool holder the rotating tool, located so that the axes of rotation of the tool and the workpiece intersect at the centre of the machined spherical surface,
and adding the following differences:
c) the tool holder lies on a spherical bearing, which is elastically pressed to it in a plane formed by the tool and the workpiece axes, forming an acute angle.

[0009] Optimum solution may be attained, if

- a spherical bearing, on which the tool holder is lied, has a possibility to change the pressing direction, but each time in a direction of an evocative acute angle formed by the intersection of the tool and the workpiece axes, and
- a floating mandrel for fixing of the workpiece is used.

[0010] The cause-effect relationship between sum of signs, which are claimed and engineering outcomes, which are achieved owing to their realization, consists of the following:

Due to a hold-down force of a tool acting at a certain distance from the centre of a machined spherical surface that may be realized for date of claim only under condition of realization of the offered device (a unity of claimed intentions consists of it), the moment of force causes the appropriate non-symmetric redistribution of contact pressure in a direction of those points of a machined surface, the distance of which from an axis of rotation is promptly diminished up to zero. The velocity of oversize removal at any point of the machined surface is directly proportional to the product of the contact pressure and the cutting velocity for a free abrading. Taking into account an increase or decrease of contact pressure in a direction of the indicated points, it is possible to augment or diminish the velocity of oversize removal at these points. Thus, creation of conditions for the above mentioned redistribution of contact pressure allows completely or partly a modification of the cutting velocity at in these points. The modification of cutting velocity allows levelling a velocity of oversize removal at the profile of a workpiece. Thereof the heightening of the exactitude and efficiency of machining process is ensured. Technological possibilities of the device simultaneously extend due to such scheme of machining.

[0011] A possibility of machining spherical workpieces having height of the spherical surface exceeding its radius is ensured.

[0012] The device for machining of spherical surfaces contains (Fig. 1) a forced-rotating floating mandrel 1 for fixing the workpiece 2, so that the centre of its spherical surface lies on its axis of rotation and a tool holder 3 which is located with the axes of rotation of the tool 4 and the workpiece 2 intersecting at the centre of a spherical surface. The tool holder 3 lies in a spherical bearing 5 which is elastically pressed to it by means of an elastic element 6 in the plane formed by the axes of tool 4 and workpiece 2, forming an acute angle. Due to the spherical bearing 5, the tool 4 lays freely with its face in contact with a spherical surface and rotates over its own axis.

Claims

1. A way of machining of spherical surfaces, including:

a) laying of the rotating tool under an angle with reference to a workpiece with their axes intersecting at the centre of a machined spherical surface,
b) forced-rotation of workpieces over their own axis,
c) tool positioning by its face in contact with a spherical surface and
d) feeding of the tool ready to start penetration into the workpiece material, and adding the following differences:
e) the tool lies freely on its axis, and
f) tool feeding is realized by a force acting in a certain direction with relevance to the centre of a spherical surface, forming an acute angle between the tool and workpiece axes.

2. The device for machining of spherical surfaces, containing:

a) a forced-rotating mandrel for fixing the workpiece and
b) a tool holder for the rotating tool, located so that the axes of rotation of tool and workpiece intersect at the centre of a machined spherical surface, and adding the following differences:
c) the tool holder lies on a spherical bearing, which is elastically pressed to it in a plane formed by the tool and the workpiece axes, forming an acute angle.

3. The device on item 2, which differs in layout, so that

the spherical bearing on which the tool holder lies has a possibility to change direction of pressing, but each time in the direction of the evocative acute angle formed by the tool and the workpiece axes.

4. The device on item 2, which differs that the mandrel for fixing a workpiece is floating.

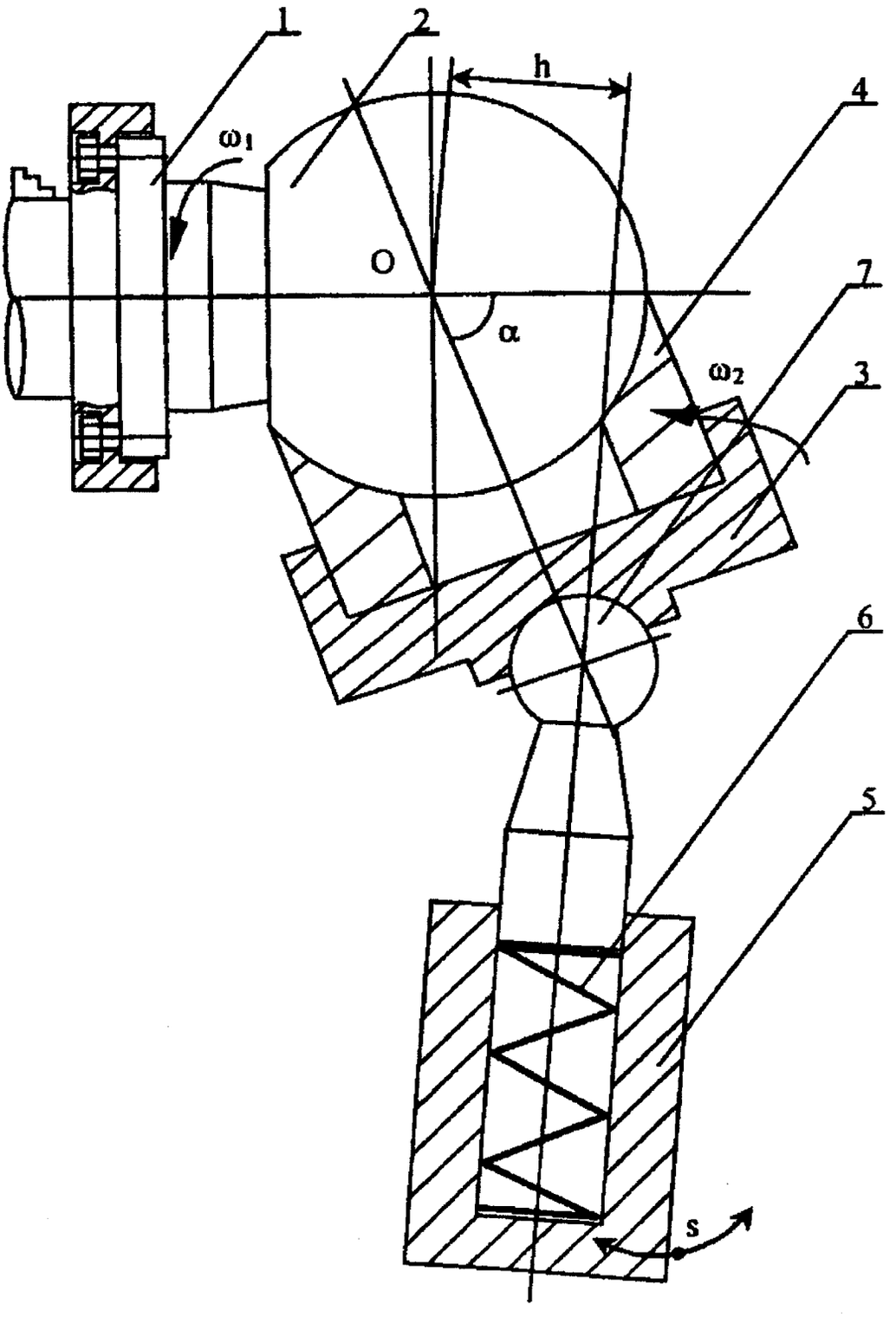

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 03 38 6024

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 June 2005	Eschbach, D

CATEGORY OF CITED DOCUMENTS

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