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(54) Title: METHOD FOR MACHINING A SURFACE OF AN OPTICAL LENS

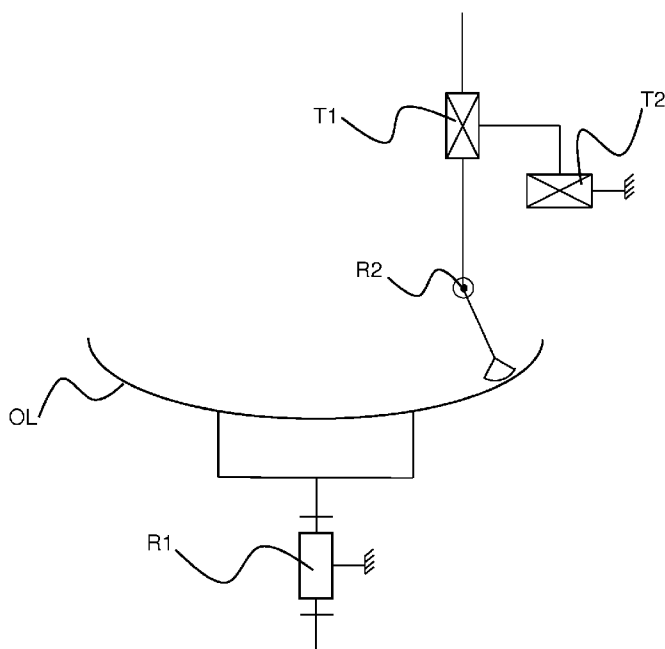


FIG.2a

(57) Abstract: Method of determining movement data representing the movement of a machining tool of an optical lens lathing device for machining optical surfaces part of a set of optical surfaces, comprising: - a greatest radial slope amplitude determining step during which the greatest radial slope amplitude of the optical surfaces of the set of optical surfaces is determined, - a machining tool selecting step during which a machining tool having a window angle greater than or equal to the greatest radial slope amplitude of the optical surfaces of the set of surfaces to be manufactured is selected, - a movement data determining step during which movement data representing the movement of the selected machining tool are determined and synchronized with the angular position of the optical surface driven in rotation.



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METHOD FOR MACHINING A SURFACE OF AN OPTICAL LENS

The invention relates to a method of determining movement data representing the movement of a machining
5 tool of an optical lens lathing device for machining optical surfaces part of a set of optical surfaces and to a method for machining an optical surface.

Some processes of preparing optical or ophthalmic lenses start with the selection of an unfinished or semi-
10 finished glass or plastic lens blank. Typically a semi-finished lens blank has a finished surface and an unfinished surface.

At least one of the surfaces of the lens blank has to be adapted so as to generate the required
15 corrective prescription.

By machining the unfinished surface of the lens blank, the required corrective prescription can be generated.

Thereafter, the surface having been machined is
20 polished and the peripheral edge of the thus processed lens blank is provided with a final desired contour thereby establishing a finished optical or ophthalmic lens. According to other processing methods, the finished ophthalmic lens can be directly processed from a lens
25 blank by machining both surfaces of the optical lens blank. The lens blank can be a plastic lens blank.

Reducing the time required for the machining step reduces the overall cost of the manufacturing process.

A solution for reducing the machining time
30 consists in increasing the infeed of the machining tool during the machining process.

One of the limits of the increase of the infeed of the machining tool is the quality of the produced

surface. However, the greater the radius of the machining tool, the greater the infeed of the machining tool can be increased without degrading the quality of the machined surface.

5 Machining tools have synthetic monocrystal diamond tips and therefore, increasing the radius of such diamond tip, increases the volume of synthetic monocrystal diamond to the power of 2 to 3. Thus, increasing the radius of the diamond tip increases the
10 cost of the machining tool and the machining process.

 The discussion of the background of the invention herein is included to explain the context of the invention. This is not to be taken as an admission that any of the material referred to was published, known or
15 part of the common general knowledge at the priority date of any of the claims.

 One object of the invention is to provide a method of machining an ophthalmic surface that does not present the drawbacks mentioned hereinabove.

20 To this end, the invention proposes a method of determining movement data representing the movement of a machining tool of an optical lens lathing device for machining optical surfaces part of a set of optical surfaces, wherein:

25 - the set of optical surfaces comprises at least one non rotationally symmetrical surface,
 - the optical lens lathing device comprises movement axis allowing relative movements between tool and optical surface according to :

30 o a first rotation axis,
 o a parallel translation axis substantially parallel to the first rotation axis,

- o a perpendicular translation axis substantially perpendicular to the first rotation axis, and
 - o a second rotation axis substantially perpendicular to the plan comprising the parallel and perpendicular translation axis,
- 5 - the optical lens lathing device being configured to drive in rotation an optical surface to be manufactured about the first rotation axis and to drive the machining tool relatively to the optical surface in translation
- 10 along the parallel and perpendicular translation axis and in rotation about the second rotation axis, and wherein the method comprises:
- a greatest radial slope amplitude determining step during which the greatest radial slope amplitude of the
- 15 optical surfaces of the set of optical surfaces is determined,
- a machining tool selecting step during which a machining tool having a window angle greater than or equal to the greatest radial slope amplitude of the
- 20 optical surfaces of the set of surfaces to be manufactured is selected,
- a movement data determining step during which movement data representing the movement of the selected machining tool along the perpendicular and parallel
- 25 translation axis and about the second rotation axis so as to machine the surface of the optical lens are determined and synchronized with the angular position of the optical surface driven in rotation about the first rotation axis.

30 Advantageously, the method according to the invention allows selecting a machining tool having a smaller window angle than the prior art methods. Thus, for a given radius of the machining tool the overall

volume of the machining tool can be reduced compared to the prior art methods, reducing the overall cost of the manufacturing process.

5 According to further embodiments which can be considered alone or in combination:

- during the movement data determining step, the movement data about the second rotation axis are determined so that during the machining of the optical surface the contact point of the machining tool changes within the window angle of the machining tool; and/or
- the method further comprises:
 - o a decomposition step during which the optical surface of the set of optical surface to be machined is decomposed in a rotationally symmetrical component and a non-rotationally symmetrical component, wherein the greatest radial slope in absolute value of the non-rotationally symmetrical component is smaller than or equal to the greatest radial slope amplitude of the optical surfaces of the set of surfaces to be manufactured, and
 - o during the movement data determining step, the rotation about the second rotation axis is determined so that along the surface to be machined, the angle between the axis of the machining tool and the normal at the rotationally symmetrical component of the optical surface is substantially constant; and/or
- during the decomposition step, the rotationally symmetrical component and the non-rotationally symmetrical component are determined so as to

minimize the amplitude of the translation movement of the machining tool along the parallel axis; and/or

- 5 - during the greatest radial slope amplitude determining step, the greatest radial slope amplitude is determined by determining the radial slope amplitude of each optical surface of the set of optical surfaces and by selecting the greatest radial slope amplitude of the optical surfaces of
10 the set of optical surfaces, the radial slope amplitude of each optical surface being determined along the circumscribed circle of the outer edge of each optical surface; and/or
- 15 - during the machining tool selecting step the machining tool has a window angle smaller than or equal to $GRSA + 10^\circ$, with GRSA the greatest radial slope amplitude of the optical surfaces of the set of surfaces to be manufactured; and/or
- 20 - the optical lens lathing device is configured so that the frequency of reversal of the translation movement of the machining tool along the parallel axis can be greater than or equal to the rotation frequency of the optical surface about the first rotation axis; and/or
- 25 - the optical lens lathing device is configured so that the frequency of reversal of translation of the machining tool along the perpendicular axis can be smaller than or equal to the rotation frequency of the optical surface about the first rotation axis;
30 and/or
- the optical lens lathing device is configured so that the frequency of reversal of rotation of the machining tool about the second rotation axis can be

smaller than or equal to the rotation frequency of the optical surface about the first rotation axis; and/or

- 5 - during the machining tool selecting step, for a given machining tool width, the machining tool having the smallest window angle so as to have the greatest radius is selected.

10 According to another aspect, the invention relates to a method for machining an optical surface, the method comprises:

- a lathe device providing step in which an optical lens lathe device comprising:
 - o a first rotation axis,
 - 15 o a parallel translation axis substantially parallel to the first rotation axis,
 - o a perpendicular translation axis substantially perpendicular to the first rotation axis, and
 - o a second rotation axis substantially perpendicular to the plan comprising the parallel and perpendicular translation axis is provided,
 - 20 o the optical lens lathe device being configured to drive in rotation the optical surface to be manufactured about the first rotation axis and to drive the machining tool in translation along the parallel and perpendicular translation axis and in rotation about the second rotation axis, and
 - 25 o the optical lens lathe device being configured to drive the machining tool in translation along the parallel and perpendicular translation axis and in rotation about the second rotation axis, and
- a machining step during which the optical surface is machined by driving in rotation about the first rotation axis the optical surface and having a machining tool of the optical lens lathe device move according to movement data determined using a method according to the invention, the machining tool being
- 30

the one selected during the machining tool selecting step.

According to further embodiments which can be
5 considered alone or in combination:

- the frequency of reversal of the translation movement of the machining tool along the parallel axis is greater than or equal to the rotation frequency of the optical surface about the first
10 rotation axis;
- the frequency of reversal of translation of the machining tool along the perpendicular axis is smaller than or equal to the rotation frequency of the optical surface about the first rotation axis;
- 15 - the rotation frequency of the machining tool about the second rotation axis is smaller than or equal to the rotation frequency of the optical surface about the first rotation axis.

20 According to a further aspect, the invention relates to a computer program product comprising one or more stored sequence of instruction that is accessible to a processor and which, when executed by the processor, causes the processor to carry out the steps o of the
25 methods according to the invention.

According to another aspect the invention relates to a program which makes a computer execute the method of the invention.

The invention also relates to a computer readable
30 medium carrying one or more sequences of instructions of the computer program according to the invention.

The invention further relates to a computer-readable storage medium having a program recorded

thereon; where the program makes the computer execute the method of the invention.

The invention relates to a device comprising a processor adapted to store one or more sequence of
5 instructions and to carry out at least one of the steps of a method according to the invention.

Unless specifically stated otherwise, as apparent from the following discussions, it is appreciated that throughout the specification discussions utilizing terms
10 such as "computing", "calculating", "generating", or the like, refer to the action and/or processes of a computer or computing system, or similar electronic computing device, that manipulate and/or transform data represented as physical, such as electronic, quantities within the
15 computing system's registers and/or memories into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission or display devices.

Embodiments of the present invention may include
20 apparatuses for performing the operations herein. This apparatus may be specially constructed for the desired purposes, or it may comprise a general purpose computer or Digital Signal Processor ("DSP") selectively activated or reconfigured by a computer program stored in the
25 computer. Such a computer program may be stored in a computer readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs)
30 electrically programmable read-only memories (EPROMs), electrically erasable and programmable read only memories (EEPROMs), magnetic or optical cards, or any other type

of media suitable for storing electronic instructions, and capable of being coupled to a computer system bus.

The processes and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct a more specialized apparatus to perform the desired method. The desired structure for a variety of these systems will appear from the description below. In addition, embodiments of the present invention are not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the inventions as described herein.

Non limiting embodiments of the invention will now be described with reference to the accompanying drawings wherein:

- 20 o figure 1 is a flowchart of the set of a method according to the invention,
- o figures 2a and 2b represent optical lens lathing devices that can be used to machine an optical lens according to the invention,
- 25 o figure 3a represents an optical lens surface with the surface frame reference,
- o figure 3b represents a radial profile of a manufactured surface of an optical lens,
- o figure 4 illustrates a top view of a machining tool used to machine an optical surface
- 30 o figure 5 is a flowchart of the set of a method according to the invention, and

o figure 6 is a flowchart of the set of a machining method according to the invention.

Elements in the figures are illustrated for simplicity and clarity and have not necessarily been
5 drawn to scale. For example, the dimensions of some of the elements in the figure may be exaggerated relative to other elements to help improve the understanding of the embodiments of the present invention.

10 According to an embodiment of the invention illustrated on figure 1, the method of determining movement data representing the movement of a machining tool of an optical lens lathing device for machining optical surfaces part of a set of optical surfaces
15 according to the invention, comprises:

- a greatest radial slope amplitude determining S1,
- a machining tool selecting step S2, and
- a movement data determining step S3.

20 According to an embodiment of the invention, the set of optical surfaces comprises at least one non-rotationally symmetrical surface.

The optical surfaces of the set of optical surfaces may be front or back surfaces of optical lens,
25 concave or convex surfaces.

Typically, the set of optical surfaces may correspond to the set of optical surface to be manufactured over a given period a time in a lab, for example in the next 24 hours.

30 Examples of optical lens lathing devices that can be used to machine the optical surface according to the movement data determined using the method according to the invention, are represented on figures 2a and 2b.

As illustrated on figures 2a and 2b, the optical lens lathing device comprises at least four movement axes comprising:

- 5 - a first rotation axis R1 arranged to drive in rotation the optical lens to be machined,
- a parallel translation axis T1 substantially parallel to the first rotation axis R1 arranged to drive in translation the machining tool in a direction parallel to the first rotation axis R1,
- 10 - a perpendicular translation axis T2 substantially perpendicular to the first rotation axis R1, arranged to drive in translation the machining tool in a direction perpendicular to the first rotation axis R1, and
- 15 - a second rotation axis R2 substantially perpendicular to the plan comprising the parallel T1 and perpendicular T2 translation axis.

20 The optical lens lathing device is configured to drive the machining tool relatively to the optical surface in translation along the parallel and perpendicular translation axis and in rotation about the second rotation axis.

25 According to an embodiment represented on figure 2a the second rotation axis R2 is on the machining tool side, whereas according to an embodiment represented on figure 2b the second rotation axis R2 is on the optical surface side.

30 The first rotation axis R1 may be in the plan defined by the parallel translation axis T1 and the perpendicular translation axis T2.

 According to an embodiment of the invention, the optical lens lathing device is configured so that the

frequency of reversal of the translation movement of the machining tool along the parallel axis can be greater than or equal to the rotation frequency of the optical surface about the first rotation axis.

5 The optical lens lathing device may be configured so that the frequency of reversal of translation of the machining tool along the perpendicular axis can be smaller than or equal to the rotation frequency of the optical surface about the first rotation axis.

10 According to an embodiment of the invention, the optical lens lathing device is configured so that the rotation frequency of the machining tool about the second rotation axis is smaller than or equal to the rotation frequency of the optical surface about the first rotation
15 axis.

During the greatest radial slope determining step S1, the greatest radial slope amplitude of the optical surfaces of the set of optical surfaces is determined.

20 The radial slope is defined in reference to figures 3a and 3b.

As represented on figure 3a, an optical surface is associated with a surface frame of reference (X,Y,Z) centered on the reference point C of the surface. One can define the rotational frame of reference (U,V,Z) centered
25 on the reference point C of the surface frame of reference and defined as having an angle θ between the X and U axes.

As represented on figure 3b, for a given value of the angle θ , the radial profile corresponds to the
30 section of the surface in the plan (C,U,Z). For each point of the radial profile, the radial slope is the angle τ between the tangent of the radial profile and the axis U.

For a given value of the coordinate along the U axis with the angle θ from 0° to 360° one can determine the amplitude of radial slope as being the absolute value of the difference between the greatest and smallest radial slope when the angle θ varies from 0° to 360° .

The greatest amplitude of radial slope for a surface can be determined by determining the amplitudes radial slopes along the U axis.

According to the invention, during the greatest radial slope determining step, the greatest radial slope amplitude of each optical surface of the set of optical surfaces is determined so as to determine the greatest radial slope over the set of optical surfaces.

According to an embodiment of the invention, the greatest radial slope amplitude may be determined by determining the radial slope amplitude of each optical surface of the set of optical surfaces and by selecting the greatest radial slope amplitude of the optical surfaces of the set of optical surfaces, the radial slope amplitude of each optical surface being determined along the circumscribed circle of the outer edge of each optical surface. According to an embodiment, the center of the circumscribed circle corresponds to the center of rotation of the surface, i.e. the point of the surface that belongs to the first rotation axis R1 when the surface is being rotated. Thus, the center of the circumscribed circle may be different based on the position of the surface when being rotated about the first rotation axis R1. During the machining tool selecting step, a machining tool is selected. The machining tool is selected so as to have a window angle α greater than or equal to the greatest radial slope

amplitude of the optical surfaces of the set of surfaces to be manufactured.

As illustrated on figure 4, the chord CH of the machining tool is linked to the window angle α of the machining tool.

Since, the price of the machining tool is linked to the chord CH, it is interesting to select a machining tool having the smallest window angle as possible.

Therefore, according to an embodiment of the invention, the machining tool selected has a window angle α greater than or equal to GRSA and smaller than or equal to GRSA +10°, for example smaller than or equal to GRSA +5°, with GRSA being the greatest radial slope amplitude of the optical surfaces of the set of surfaces to be manufactured.

According to an embodiment, so as to have the greatest radius, during the machining tool selecting step, for a given machining tool chord CH, the machining tool having the smallest window angle is selected. In other words, for a given price, the machining tool having the greatest radius and allowing manufacturing the set of surfaces can be selected.

During the movement determining step S3, movement data representing the movement of the selected machining tool along the perpendicular and parallel translation axes and about the second rotation axis so as to machine the surface of the optical lens are determined. The movements of the machining tool along the perpendicular, parallel and second rotation axes are synchronized with the angular position of the optical surface driven in rotation about the first rotation axis.

According to an embodiment of the invention, the movement data, in particular the movement data about the

second rotation axis are determined so that, during the machining of the optical surface, the contact point of the machining tool changes within the window angle of the machining tool.

5 In the sense of the invention, the contact point of the machining tool is the point of the machining tool that is tangent to the machined surface.

Advantageously, having the contact point change, allows having a frequency of reversal of rotation about
10 the second rotation axis smaller than or equal to the rotation frequency of the optical surface. Thus, the machining process is easier to implement.

As illustrated on figure 5, according to an embodiment of the invention, the method may comprise
15 prior to the movement data determining step S3 a decomposition step S30.

During the decomposition step S30, each optical surface of the set of optical surfaces is decomposed in a rotationally symmetrical component and a non-rotationally
20 symmetrical component.

Such decomposition can be carried out by any method known from the person skilled in the art. Preferably, the decomposition of each surface is done so that the greatest radial slope in absolute value of the
25 non-rotationally symmetrical component of the surface is smaller than or equal to the greatest radial slope amplitude of the optical surfaces of the set of surfaces to be manufactured.

According to such embodiment, during the movement
30 data determining step, the rotation movement about the second rotation axis is determined so that along the surface to be manufactured, the angle between the axis of the machining tool and the normal at the rotationally

symmetrical component of the optical surface is substantially constant.

In other words, according to such embodiment, the movement data about the second rotation axis are
5 determined according to the rotationally symmetrical component of each optical surface to be machined. Thus, the movement data about the second rotation axis are simplified and so is the lathing device.

Furthermore, during the decomposition step S30,
10 the rotationally symmetrical component and the non-rotationally symmetrical component can be determined so as to minimize the amplitude of the translation movement and the successive temporal derivative of the translation movement, i.e. speed, acceleration etc..., of the machining
15 tool along the parallel axis.

Advantageously, such embodiment allows using a lathing device having a frequency of reversal of translation, respectively rotation, of the machining tool along the perpendicular axis, respectively about the
20 second rotation axis smaller than or equal to the rotation frequency of the optical surface about the first rotation axis.

Advantageously, such embodiment allows either at equal performance reducing the dimension of the engine of
25 the machining device or at equal dimension of the engine increasing the frequency leading to a shorter machining time and thus greater productivity.

As illustrated on figure 6, the invention further
30 relates to a method for machining a set of optical surfaces. Such method may comprise:

- a lathing device providing step S10,
- a greatest radial slope amplitude determining S1,

- a machining tool selecting step S2,
- a movement data determining step S3, and
- a machining step S4.

5 During the lathing device providing step S10, an optical lens lathing device as described previously and for example illustrated on figures 2a or 2b is provided.

 The greatest radial slope amplitude determining S1, machining tool selecting step S2 and movement data
10 determining step S3 are as described previously. In particular the method may comprise prior to the movement data determining step S3 a decomposition step S30 as described previously.

 During the machining step S4, the optical surface
15 is machined by driving the optical surface in rotation about the first rotation axis and by having a machining tool of the optical lens lathing device move according to movement data determined during the movement data determining step S3.

20 The invention has been described above with the aid of embodiments without limitation of the general inventive concept.

CLAIMS

1. Method of determining movement data representing the movement of a machining tool of an optical lens lathing device for machining optical surfaces part of a set of optical surfaces, wherein
- 5 - the set of optical surfaces comprises at least one non rotationally symmetrical surface,
- the optical lens lathing device comprises movement axis allowing relative movements between tool and optical surface according to :
- 10 o a first rotation axis,
- o a parallel translation axis substantially parallel to the first rotation axis,
- 15 o a perpendicular translation axis substantially perpendicular to the first rotation axis, and
- o a second rotation axis substantially perpendicular to the plan comprising the parallel and perpendicular translation axis,
- 20 - the optical lens lathing device being configured to drive in rotation an optical surface to be manufactured about the first rotation axis and to drive the machining tool relatively to the optical surface in translation along the parallel and perpendicular translation axis and
- 25 in rotation about the second rotation axis, and wherein the method comprises:
- a greatest radial slope amplitude determining step during which the greatest radial slope amplitude of the optical surfaces of the set of optical surfaces is
- 30 determined,
- a machining tool selecting step during which a machining tool having a window angle greater than or equal to the greatest radial slope amplitude of the

optical surfaces of the set of surfaces to be manufactured is selected,

- a movement data determining step during which movement data representing the movement of the selected machining tool along the perpendicular and parallel translation axis and about the second rotation axis so as to machine the surface of the optical lens are determined and synchronized with the angular position of the optical surface driven in rotation about the first rotation axis.

10

2. The method according to claim 1, wherein during the movement data determining step, the movement data about the second rotation axis are determined so that during the machining of the optical surface the contact point of the machining tool changes within the window angle of the machining tool.

15

3. The method according to claim 1 or 2, wherein the method further comprises:

20

- a decomposition step during which the optical surface of the set of optical surface to be machined is decomposed in a rotationally symmetrical component and a non-rotationally symmetrical component, wherein the greatest radial slope in absolute value of the non-rotationally symmetrical component is smaller than or equal to the greatest radial slope amplitude of the optical surfaces of the set of surfaces to be manufactured, and

25

- during the movement data determining step, the rotation about the second rotation axis is determined so that along the surface to be machined, the angle between the axis of the machining tool and the normal at the

30

rotationally symmetrical component of the optical surface is substantially constant

4. The method according to any of the preceding claims,
5 wherein during the greatest radial slope amplitude determining step, the greatest radial slope amplitude is determined by determining the radial slope amplitude of each optical surface of the set of optical surfaces and by selecting the greatest radial slope amplitude of the
10 optical surfaces of the set of optical surfaces, the radial slope amplitude of each optical surface being determined along the circumscribed circle of the outer edge of each optical surface.

15 5. The method according to any of the preceding claims, wherein during the machining tool selecting step the machining tool has a window angle smaller than or equal to $GRSA + 10^\circ$, with GRSA being the greatest radial slope amplitude of the optical surfaces of the set of surfaces
20 to be manufactured.

6. The method according to any of the preceding claims, wherein the optical lens lathing device is configured so that the frequency of reversal of the translation
25 movement of the machining tool along the parallel axis can be greater than or equal to the rotation frequency of the optical surface about the first rotation axis.

7. The method according to any of the preceding claims,
30 wherein the optical lens lathing device is configured so that the frequency of reversal of translation of the machining tool along the perpendicular axis can be smaller than or equal to the rotation frequency of the optical surface about the first rotation axis.

8. The method according to any of the preceding claims,
wherein the frequency of reversal of rotation of the
machining tool about the second rotation axis is smaller
5 than or equal to the rotation frequency of the optical
surface about the first rotation axis.

9. The method according to any of the preceding claims,
wherein during the machining tool selecting step, for a
10 given machining tool width, the machining tool having the
smallest window angle so as to have the greatest radius
is selected.

10. Method for machining an optical surface, the method
15 comprises:

- a lathe device providing step in which an optical lens
lathe device comprising:

- o a first rotation axis,
- o a parallel translation axis substantially parallel
20 to the first rotation axis,
- o a perpendicular translation axis substantially
perpendicular to the first rotation axis, and
- o a second rotation axis substantially perpendicular
to the plan comprising the parallel and
25 perpendicular translation axis is provided,
- o the optical lens lathe device being configured to
drive in rotation the optical surface to be
manufactured about the first rotation axis and to
drive the machining tool in translation along the
30 parallel and perpendicular translation axis and in
rotation about the second rotation axis, and

- a machining step during which the optical surface is
machined by driving in rotation about the first rotation

axis the optical surface and having a machining tool of the optical lens lathe device move according to movement data determined using a method according to any of claims 1 to 9, the machining tool being the one selected during
5 the machining tool selecting step.

11. The method according to claim 10, wherein the frequency of reversal of the translation movement of the machining tool along the parallel axis is greater than or
10 equal to the rotation frequency of the optical surface about the first rotation axis.

12. The method according to claim 10 or 11, wherein the frequency of reversal of translation of the machining
15 tool along the perpendicular axis is smaller than or equal to the rotation frequency of the optical surface about the first rotation axis.

13. The method according to any of claims 10 to 12,
20 wherein the rotation frequency of the machining tool about the second rotation axis is smaller than or equal to the rotation frequency of the optical surface about the first rotation axis.

25 14. A computer program product comprising one or more stored sequences of instructions that are accessible to a processor and which, when executed by the processor, causes the processor to carry out the steps of any of claims 1 to 13.

30

15. A computer readable medium carrying one or more sequences of instructions of the computer program product of claim 14.

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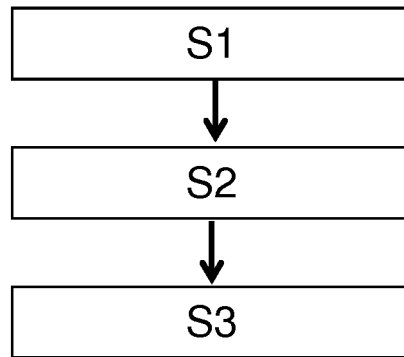


FIG.1

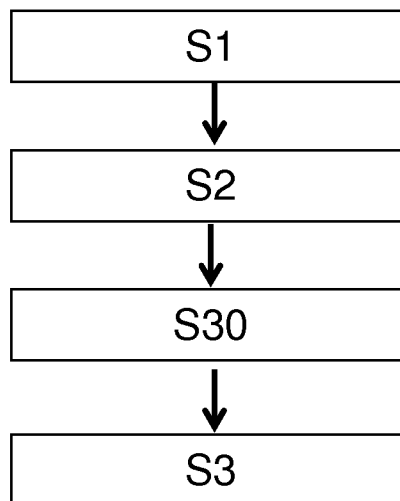


FIG.5

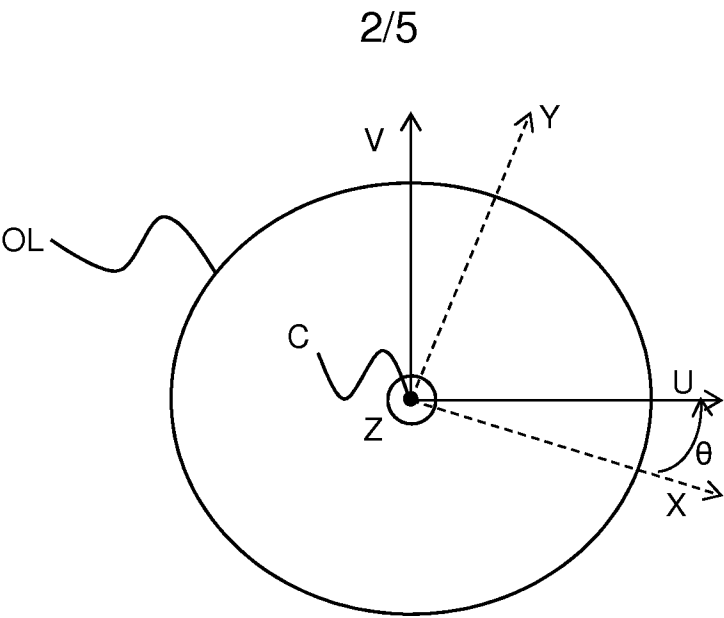


FIG.3a

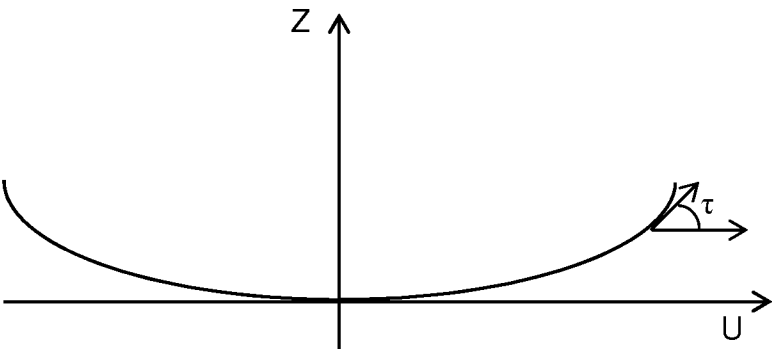


FIG.3b

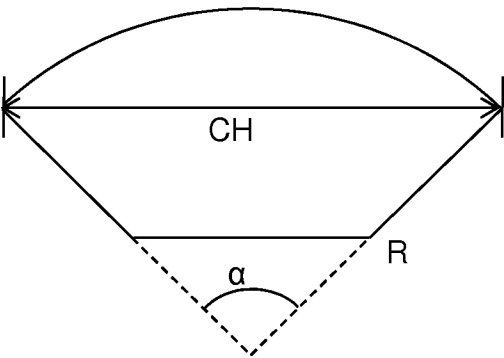


FIG.4

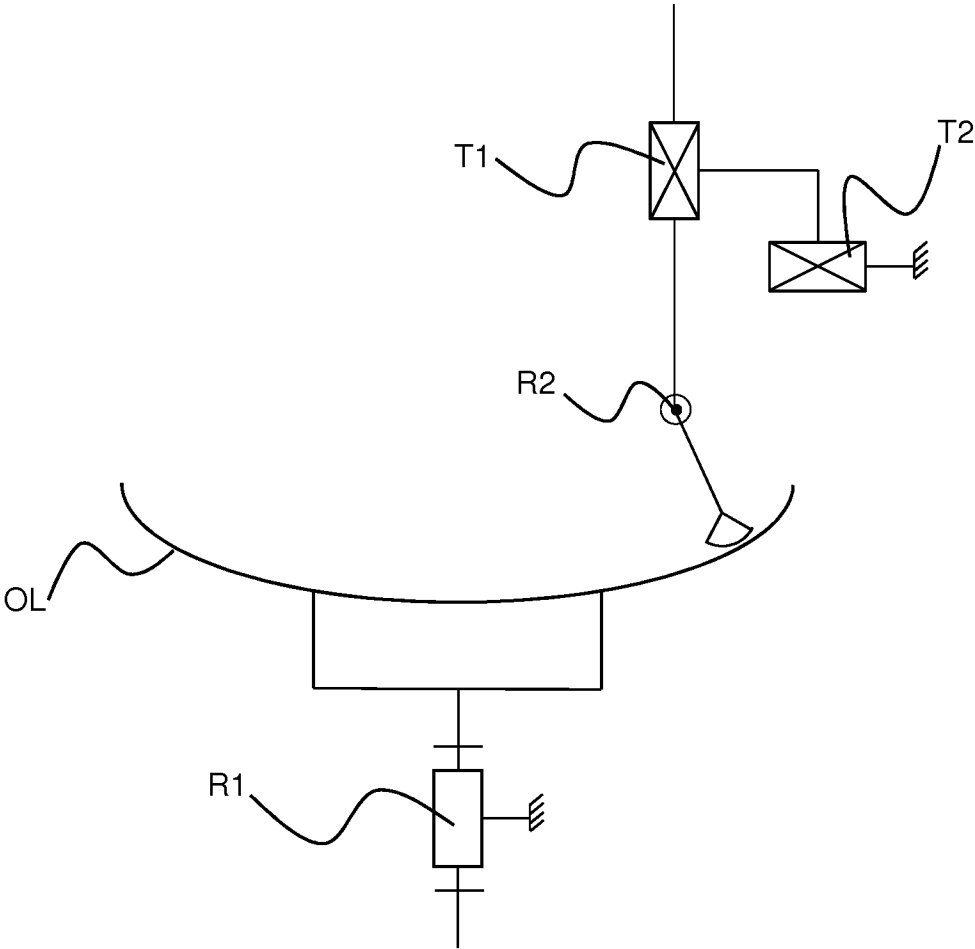


FIG.2a

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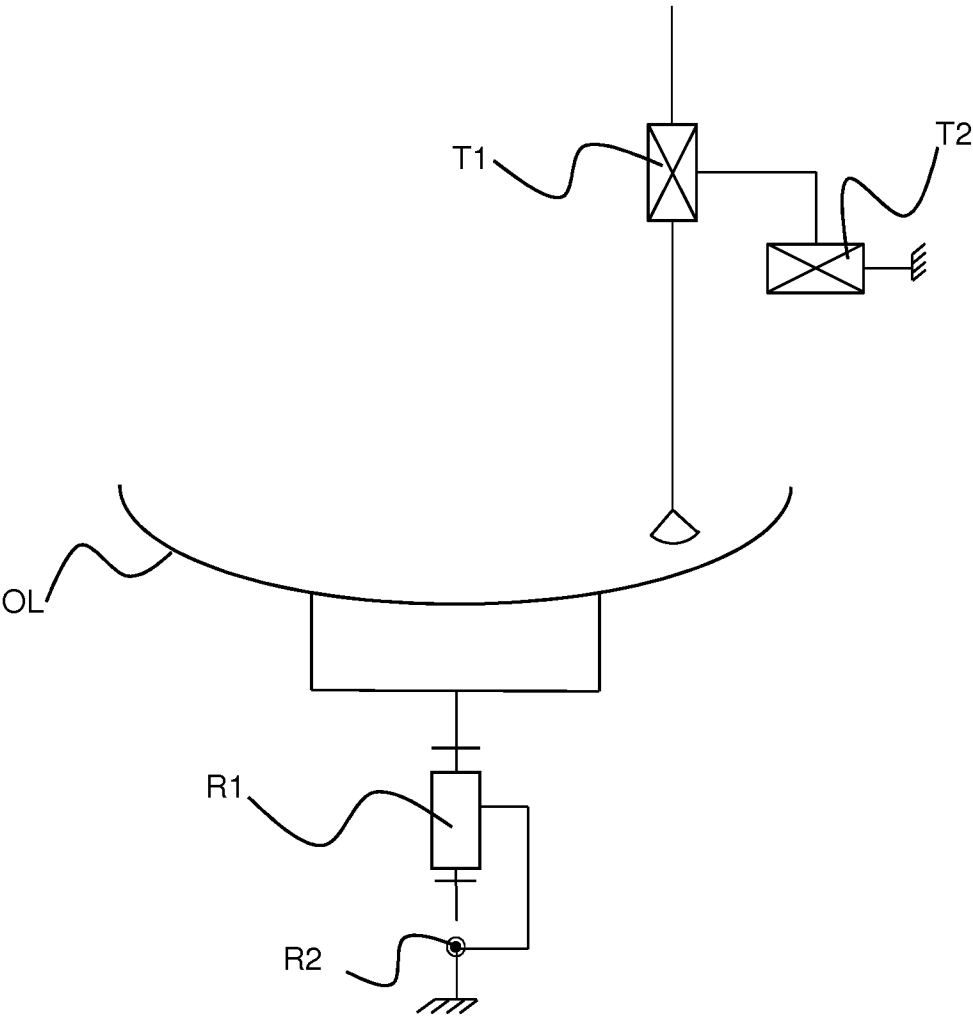


FIG.2b

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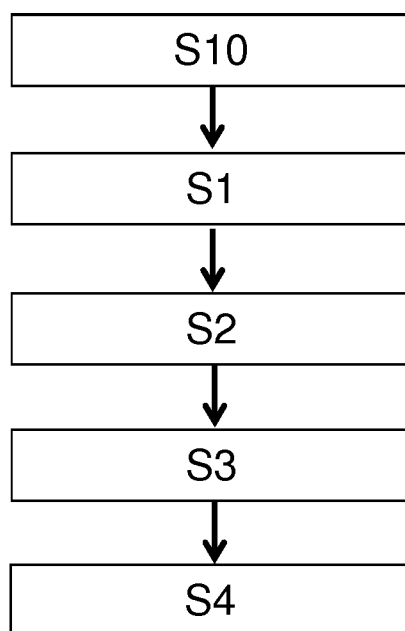


FIG.6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/072535

A. CLASSIFICATION OF SUBJECT MATTER
INV. B24B13/06 B24B47/22
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B24B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 184 132 A1 (ESSILOR INT [FR]) 12 May 2010 (2010-05-12) the whole document -----	1-15
A	US 4 956 944 A (ANDO MANABU [JP] ET AL) 18 September 1990 (1990-09-18) figures 1B,4-9 -----	1-15
A	US 6 382 790 B1 (GIROD DENIS [FR]) 7 May 2002 (2002-05-07) figures 1-9 -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

6 December 2013

Date of mailing of the international search report

16/12/2013

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Koller, Stefan

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/072535

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