(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 608 055 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.01.2024 Bulletin 2024/04

(21) Application number: **18306107.6**

(22) Date of filing: **10.08.2018**

(51) International Patent Classification (IPC):
B24B 13/005 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B24B 13/0055

(54) METHOD FOR MACHINING AN OPTICAL SURFACE OF AN OPTICAL LENS

VERFAHREN ZUR BEARBEITUNG EINER OPTISCHEN OBERFLÄCHE EINER OPTISCHEN LINSE

PROCÉDÉ D'USINAGE D'UNE SURFACE OPTIQUE D'UNE LENTILLE OPTIQUE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
12.02.2020 Bulletin 2020/07

(73) Proprietor: **Essilor International**
94220 Charenton-le-Pont (FR)

(72) Inventors:
- **MARTIN, Luc**
  94220 Charenton-le-Pont (FR)
- **BULTEZ, Xavier**
  94220 Charenton-le-Pont (FR)
- **PINAULT, Sebastien**
  94220 Charenton-le-Pont (FR)
- **MAUDERER, Michael**
  81825 Munich (DE)
- **SCHÄFER, Holger**
  6340 Baar (CH)
- **MOINE, Jérôme**
  94220 Charenton-le-Pont (FR)
- **KREIS, Michael**
  6340 Baar (FR)

(74) Representative: **Cabinet Novitech**
188 Grande rue Charles de Gaulle
94130 Nogent-sur-Marne (FR)

(56) References cited:
GB-A- 656 875
US-A- 2 573 668
US-A- 4 277 916
US-A- 5 611 252
US-B1- 6 382 790

EP 3 608 055 B1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a method for machining an optical surface of an optical lens, a machining device for machining the optical surface of an optical lens, and to a computer program product comprising one or more stored sequences of instructions corresponding to the method of the invention.

BACKGROUND OF THE INVENTION

[0002] An optical lens is typically made of plastic or glass material and generally has two opposing surfaces which co-operate with one another to converge or diverge light according to a required corrective prescription.

[0003] During the machining of an optical lens, in addition to the precision in manufacturing the surfaces, it is also essential for such surfaces to be perfectly aligned with one another both axially and angularly. Otherwise, the optical lens does not provide the optical effect for which it was designed, in particular the required corrective prescription.

[0004] Indeed, the relative positioning and shape of these surfaces has a direct impact on the effect of the optical lens on light.

[0005] Manufacturing of an optical lens to the required prescription requirements typically includes machining the surface of a semi-finished lens or lens blank. Typically, a semi-finished lens has a finished front surface and an unfinished back surface. By machining the back surface of the lens to remove material, the required shape and positioning of the back surface with respect to the front surface for the desired corrective prescription can be generated. Further surfacing operations of an optical lens can include chamfering, beveling, polishing, or coating the surface of a lens member in order to modify the optical surface.

[0006] During manufacturing of the lens, it is important that the semi-finished lens is securely maintained in a correct positioning.

[0007] In the state of the art, in order to hold in position, the semi-finished lens a lens blocker is used that is applied to the finished front surface at a precise angular and axial position.

[0008] The lens blocker acts as a gripping interface for the holding system during the manufacturing of the surface to be manufactured in particular during the cutting step and provides the semi-finished lens blank with a sufficient strength to counteract the force applied by the cutting tool.

[0009] During the manufacturing process of an optical lens a desired prism may be introduced. The desired prism may be either a prescription prism or a thinning prism.

[0010] The prism of the optical lens can be defined by the vector (αf, βf, Zf) which is perpendicular to the tangential plan at the prism reference point (PRP) of the optical lens; whereby αf corresponds to the prism amplitude, βf correspondents to the prism orientation and Zf the vertical position of the PRP.

[0011] The manufacturing of such desired prism requires that the semi-finished lens be oriented in a desired specific orientation with respect to the manufacturing tools. Such orientation is usually obtained by using a prismatic blocker enabling the semi-finished lens blank to be supported at a given inclination or tilt for the machining process.

[0012] Prismatic blockers typically require the use of resins or glues, therefore requiring long times to allow the adhesive material to set and cool down. Alternatively, the prism at blocking is applied through a lead-based low melting alloy.

[0013] US 6,382,790 B1 relates to a method for producing a multifocal correction lens.

[0014] Therefore, there is a need for a method of machining an optical lens that allows having a desired prism that would not present the prior art method drawbacks.

[0015] One object of the present invention is to provide such method.

SUMMARY OF THE INVENTION

[0016] To this end, the invention proposes a method for machining an optical surface of an optical lens as defined in claim 1.

[0017] Further embodiments of the method are defined in the dependent method claims.

[0018] The invention also relates to a machining device for machining the optical surface of an optical lens as defined in claim 7.

[0019] Further embodiments are defined in the dependent device claim.

[0020] The invention further relates to a computer program product comprising one or more stored sequences of instructions that are stored, for instance, on a non-transitory computer memory and that are accessible to a processor and which, when executed by the processor, causes the processor to carry out at least the steps of the method according to the invention.

[0021] The invention further relates to a computer readable medium comprising one or more stored sequences of instruction of a computer program product, wherein the one or more sequences of instructions are accessible to a processor and which, when executed by the processor, causes the processor to carry out the steps of the method according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Embodiments of the invention will now be described, by way of example only, and with reference to the following drawings in which:

- Figure 1 is a flow chart representing a method ac-

cording to the invention,

- Figure 2 is a perspective view of a lens blank to be machined,
- Figure 3 is a planar view of a preformed surface of a lens blank to be machined,
- Figure 4 is a cross-sectional view of a lens blank blocked on a lens blocker,
- Figure 5 is a cross-sectional view of a lens blank blocked on a lens blocker and clamped in a lens machining device, and
- Figure 6 is a schematic representation of a machining device adapted to move a machining tool so that it cooperates in a turning operation with lens blank that is driven in rotation.

[0023] Elements in the figures are illustrated for simplicity and clarity and have not necessarily been 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.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0024] The invention relates to a method for machining an optical surface of an optical lens starting from a lens blank.

[0025] As illustrated on figure 1, the method of the invention comprises at least:

- a lens blank providing step S1,
- a clamping step S2,
- a tilting step S3,
- a surface position determining step S4, and
- a machining tool configuration step S5.

[0026] During the lens blank providing step S1 a lens blank blocked on a lens blocker is provided.

[0027] The lens blank may be a semi-finished optical lens member. Alternatively, the lens blank may require that both surfaces be machined.

[0028] As illustrated on figure 2, a semi-finished lens member 10 has a preformed front surface 11 that, in use of the resulting finished optical lens, is disposed nearest the object being viewed and an opposing surface 12 to be modified by the manufacturing process to provide the back surface 13 of the finished optical lens, represented by the dotted line.

[0029] Opposing surface 12 is machined by a machining tool so that the back surface 13 is orientated with respect to and distanced from the front surface 11, according to the required optical prescription.

[0030] While in this embodiment of the invention, the back surface of the optical lens is formed by the machining process, it is to be understood, that in alternative embodiments of the invention both or either surfaces of the lens may be formed by the machining process.

[0031] Moreover, although the optical surface 13 to be manufactured is represented in Figure 2 as concave, it is to be appreciated that the optical surface 13 could equally well be convex or any other curved surface

With reference to Figure 3, reference manufacturing markings 111 may be provided on the preformed front surface 11 of the semi-finished lens member 10 as reference features for positioning purposes. The manufacturing markings 111 are visible through the semi-finished lens member 10 from the opposing side 12 of the lens member 10.

[0032] Referring now to Figure 4 and 5, a lens blocking device 20 for blocking lens member 10 in the correct positioning for manufacturing processes comprises a blocker 21, a blocking ring 22. A protection film, not represented, may be placed between the front surface 11 of the lens member 10 and the blocking device 20. Blocking cast material 24 is poured into the cavity defined by the lower front surface 11 of the optical lens 10, the blocker 21 and the blocking ring 22. The blocking cast material 24 cools to solidify in order to provide a blocking support for the optical lens 10 at the desired positioning for machining. The lower surface or bearing surface 241 of blocking material 241 acts as a reference surface for determining the thickness at the center of the lens member 10.

[0033] The lens blocking device may also be a vacuum blocking device wherein the semi-finished lens member is blocked against a blocking device using a vacuum.

[0034] Typically, the blocking device comprises a suction device. Such a device preferably comprises a first rotary shaft or rear mandrel ending with a suction chamber at the end intended to come into contact with the front surface of the semi-finished optical lens member blank. The suction chamber is connected to a suction group for generating the vacuum and comprises a gasket or other type of sealing elements capable of making a fluid tight coupling once such sealing elements are rested onto the front surface of the semi-finished optical lens member.

[0035] During the clamping step S2, the lens blocker holding the lens blank is clamped in a lens machining device. As illustrated on figure 5, the lens blocker 21 holding the lens blank 10 may be clamped using a clamping device 30, such as a clamp so as to allow the rotation of the lens blocker holding the lens blank about a rotation axis of the machining device.

[0036] As illustrated on figure 6, the lens blank 10 and the lens blocker are tilted relative to the rotation axis 40 of the lens machining device during the tilting step S3.

[0037] Advantageously, tilting the lens blocker in the lens machining device allows machining a desired prism without having to carry out a complex blocking process. Indeed, the lens blank may be blocked without considering a desired prism. Thus, making the blocking step much easier and allowing an easy use of for example vacuum blocking devices.

[0038] During the tilting step S3, the lens blank and lens blocker are tilted of a tilt angle β with the rotation

axis of the lens machining device. According to an embodiment of the invention, the angle β is smaller than or equal to 3°.

[0039] The position of the surface 13 to be machined is determined during the surface position determining step S4. The position of the surface 13 to be machined is determined based on the tilt angle β of the lens blank and the lens blocker relative to the rotation axis of the lens machining device.

[0040] According to a preferred embodiment of the invention, during the surface position determining step S4, the position of the surface to be machined is determined so that the angle α between the normal of the surface to be machined at the rotation axis of the lens machining device and the rotation axis of the lens machining device is smaller than or equal to 3°.

[0041] So as to facilitate the machining of the surface and to increase the quality of the machined surface, the angle α between the normal of the surface to be machined at the rotation axis of the lens machining device and the rotation axis of the lens machining device is to be as small as possible.

[0042] Therefore, according to an embodiment of the invention, during the surface position determining step the position of the surface to be machined is determined so that the normal of the surface to be machined at the rotation axis of the lens machining device is co-linear with the rotation axis of the lens machining device.

[0043] In addition, or alternatively, during the surface position determining step the position of the surface 13 to be machined is positioned so that the angle β is a small as possible. For example, the surface 13 to be machined is positioned so that the normal of the surface to be machined 60 at the rotation axis of the lens machining device is co-linear with the rotation axis of the lens machining device.

[0044] According to an embodiment of the invention, during the tilting step the lens blank and lens blocker are tilted of an angle β determined so as the difference with the angle α between the normal of the surface to be machined at the rotation axis of the lens machining device and the rotation axis of the lens machining device is as small as possible.

[0045] The method of the invention may comprise an optimization process so as to determine the tilt angle and the position of the surface to be machined so that both angles α and β to be both as small as possible and as close as possible one from the other.

[0046] During the machining tool configuration step, the operational parameters of the lens machining tool are configured in order to manufacture the surface to be machined according to the determined surface position so that the desired optical properties of the optical lens are respected.

[0047] The skilled person may use any know method to determine the operational parameters depending on the type and shape of the machining tool.

[0048] As illustrated on figure 1, the method according to the invention may further comprise a surface machining step S6.

[0049] During the surface machining step S6, the surface of the optical lens blank to be machined is machined based on the operational parameters of the lens machining tool configured during the machining tool configuration step.

[0050] According to an embodiment of the invention, the clamping and tilting steps may be carried out simultaneously by having the clamping device of the machining device with a predetermined tilt relative to the rotation axis of the lens machining device. Advantageously, such embodiment is easier to implement for the machining operator.

[0051] The desired prism may than be adjusted by positioning the surface 13 to be machined during the surface positioning step S4.

[0052] As illustrated on figure 1, the method of the invention may further comprise a weight distribution determining step S31.

[0053] During the weight distribution determining step S31, a weight distribution of the lens blank and lens blocker around the rotation axis of the lens machining device is determined based on the tilt of the lens blank and lens blocker. Preferably the weight distribution is determined so as to reduce the effect of the centrifugal force that may apply to the lens blank when rotated about the rotation axis 40 when the weight distribution is not homogeneous.

[0054] According to an embodiment of the invention, during the weight distribution determining step S31, a weight distribution of the lens blank and lens blocker around the rotation axis of the lens machining device is determined so as to have a weight distribution as homogeneous as possible around the rotation axis 40 of the machining device.

[0055] For example, depending on the tilt angle and the surface to be machined, addition weights may be added to the lens blocker to as to homogenize the weight distribution around the axis of rotation reducing the stress applied to the rotation axis.

[0056] The invention further relates to a machining device for machining the optical surface of an optical lens. As illustrated on Figure 6, the machining device comprising at least a clamp 30, a processor 70 and a machining tool 80.

[0057] The machining device represented diagrammatically in figure 6 is adapted to drive in rotation about an axis 40 a lens blank 10 that is blocked on a lens blocker. The lens blocker is hold by a clamp 30 and tilted relative to the axis 40.

[0058] The machining device also drives movement in the directions 81 and 82 of a tool-carrier 80 to which a machining tool 83 is fixed.

[0059] According to an embodiment, the machining device may be adapted to machine with the tool 83 a surface with a constant depth of pass over the surface 12 of the lens blank. To this end, the machining device may synchronize the position of the tool 83 and the angular po-

sition of the lens blank in the direction 82 to follow the shape of the surface 12 and to apply the required depth of pass to it, in addition to its forward movement in the direction 81.

[0060] The clamp 30 is configure to clamp a lens blocker with a tilt angle relative to the rotation axis of the lens machining device.

[0061] According to an embodiment, the clamp may have a predetermined tilt angle relative to the rotation axis of the lens machining device, for example smaller than or equal to 3°.

[0062] Alternatively, the clamp may be configured to tilt the lens blank and lens blocker with an angle β, for example smaller than or equal to 3°.

[0063] The processor 70 is configured to determine the position of the surface to be machined based on the tilt angle of the lens blank and lens blocker relative to the rotation axis of the lens machining device.

[0064] Furthermore, the processor 70 is configured to determine the operational parameters of the lens machining tool 80 in order to manufacture the surface to be manufactured according to the determined surface position so that the desired optical properties of the optical lens are respected.

[0065] According to an embodiment of the invention, the processor 70 may further be configured to determine a weight distribution of the lens blank and lens blocker around the rotation axis of the lens machining device based on the tilt of the lens blank and lens blocker.

[0066] The invention has been described above with the aid of embodiments without limitation of the general inventive concept.

[0067] Many further modifications and variations will suggest themselves to those skilled in the art upon making reference to the foregoing illustrative embodiments, which are given by way of example only and which are not intended to limit the scope of the invention, that being determined solely by the appended claims. Any reference signs in the claims should not be construed as limiting the scope of the invention.

Claims

1. Method for machining an optical surface (13) of an optical lens (10), the method comprising:

   - a lens blank providing step (51), during which a lens blank blocked on a lens blocker (21) is provided,
   - a clamping step (S2), during which the lens blocker holding the lens blank is clamped in a lens machining device,
   - a tilting step (S3), during which the lens blank and lens blocker are tilted relative to the rotation axis of the lens machining device,
   - a surface position determining step (S4), during which the position of the surface to be machined is determined based on the tilt angle of the lens blank and lens blocker relative to the rotation axis of the lens machining device,
   - a machining tool configuration step (S5), during which the operational parameters of the lens machining tool are configured in order to manufacture the surface to be manufactured according to the determined surface position so that the desired optical properties of the optical lens are respected,

   wherein the method further comprising a surface machining step during which the surface of the optical lens blank to be machined is machined based on the operational parameters of the lens machining tool configured during the machining tool configuration step, and

   wherein during the surface position determining step the position of the surface to be machined is determined so that the angle α between the normal of the surface to be machined at the rotation axis of the lens machining device and the rotation axis of the lens machining device is smaller than or equal to 3°.

2. The method according to claim 1, wherein during the surface position determining step the position of the surface to be machined is determined so that the normal of the surface to be machined at the rotation axis of the lens machining device is co-linear with the rotation axis of the lens machining device.

3. The method according to any of the preceding claims, wherein during the tilting step the lens blank and lens blocker are tilted of an angle β with the rotation axis of the lens machining device smaller than or equal to 3°.

4. The method according to any of the preceding claims, wherein the method further comprises a weight distribution determining step during which a weight distribution of the lens blank and lens blocker around the rotation axis of the lens machining device is determined based on the tilt of the lens blank and lens blocker.

5. The method according to any of claims 1 to 4, wherein the clamping and tilting steps are carried out simultaneously by having the clamping device of the machining device with a predetermined tilt relative to the rotation axis of the lens machining device.

6. The method according to any of the preceding claims, further comprising a surface machining step during which the surface of the optical lens blank to be machined is machined based on the operational parameters of the lens machining tool configured during the machining tool configuration step.

7. Machining device for machining the optical surface (13) of an optical lens (10), the machining device comprising:

- a clamp configure to clamp a lens blocker (21) holding a lens blank (10) with a tilt angle relative to the rotation axis (40) of the lens machining device, and
- a processor (70) for determining the position of the surface to be machined based on the tilt angle of the lens blank (10) and lens blocker (21) relative to the rotation axis (40) of the lens machining device, and configuring the operational parameters of the lens machining tool in order to manufacture the surface to be manufactured according to the determined surface position so that the desired optical properties of the optical lens are respected, wherein the clamp is configured to tilt the lens blank (10) and lens blocker (21) with an angle β smaller than or equal to 3°

wherein the processor (70) is further configured to determine a weight distribution of the lens blank (10) and lens blocker (21) around the rotation axis of the lens machining device based on the tilt of the lens blank and lens blocker, and wherein weights are added depending on the tilt angle and the surface (13) to be machined.

8. The machining device according to claim 7, wherein the clamp has a predetermined tilt angle relative to the rotation axis of the lens machining device.

9. A computer program product comprising a set of instructions that are stored, for instance, on a non-transitory computer memory and that are accessible to a processor and which, when executed by the processor, causes the processor to carry out at least the steps of the method of any one of claims 1 to 6, wherein a data processing device comprises the processor adapted to store the one or more sequence of instructions and to carry out at least steps of the method of any one of claims 1 to 6.

10. A computer readable medium comprising one or more stored sequences of instruction of a computer program product of claim 9, wherein the one or more sequences of instructions are accessible to a processor and which, when executed by the processor, causes the processor to carry out the steps of the method of any one of claims 1 to 6.

Patentansprüche

1. Verfahren zur Bearbeitung einer optischen Oberfläche (13) einer optischen Linse (10), wobei das Verfahren umfasst:

- einen Linsenrohlingbereitstellungsschritt (S1), währenddessen ein Linsenrohling, der auf einem Linsenhalteteil ("Linsenblocker") (21) geblockt ist, bereitgestellt wird,
- einen Klemmschritt (S2), währenddessen der Linsenblocker, der den Linsenrohling hält, in eine Linsenbearbeitungsvorrichtung geklemmt wird,
- einen Kippschritt (S3), währenddessen der Linsenrohling und der Linsenblocker relativ zu der Rotationsachse der Linsenbearbeitungsvorrichtung gekippt werden,
- einen Oberflächenpositionsbestimmungsschritt (S4), währenddessen die Position der zu bearbeitenden Oberfläche basierend auf dem Kippwinkel des Linsenrohlings und Linsenblockers relativ zu der Rotationsachse der Linsenbearbeitungsvorrichtung bestimmt wird,
- einen Bearbeitungswerkzeugkonfigurationsschritt (S5), währenddessen die Betriebsparameter des Linsenbearbeitungswerkzeugs konfiguriert werden, um die zu fertigende Oberfläche gemäß der bestimmten Oberflächenposition so zu fertigen, dass die gewünschten optischen Eigenschaften der optischen Linse eingehalten werden,

wobei das Verfahren des Weiteren einen Oberflächenbearbeitungsschritt umfasst, währenddessen die Oberfläche des zu bearbeitenden optischen Linsenrohlings basierend auf den Betriebsparametern des Linsenbearbeitungswerkzeugs bearbeitet wird, die während des Bearbeitungswerkzeugkonfigurationsschritts konfiguriert wurden, und

wobei während des Oberflächenpositionsbestimmungsschritts die Position der zu bearbeitenden Oberfläche so bestimmt wird, dass der Winkel α zwischen der Normalen der zu bearbeitenden Oberfläche an der Rotationsachse der Linsenbearbeitungsvorrichtung und der Rotationsachse der Linsenbearbeitungsvorrichtung kleiner als oder gleich 3° ist.

2. Verfahren nach Anspruch 1, wobei während des Oberflächenpositionsbestimmungsschritts die Position der zu bearbeitenden Oberfläche so bestimmt wird, dass die Normale der zu bearbeitenden Oberfläche an der Rotationsachse der Linsenbearbeitungsvorrichtung mit der Rotationsachse der Linsenbearbeitungsvorrichtung kolinear ist.

3. Verfahren nach einem der vorhergehenden Ansprüche, wobei während des Kippschritts der Linsenrohling und der Linsenblocker in einem Winkel β zu der Rotationsachse der Linsenbearbeitungsvorrichtung kleiner als oder gleich 3° gekippt werden.

4. Verfahren nach einem der vorhergehenden Ansprü-

che, wobei das Verfahren des Weiteren einen Gewichtsverteilungsbestimmungsschritt umfasst, währenddessen eine Gewichtsverteilung des Linsenrohlings und Linsenblockers um die Rotationsachse der Linsenbearbeitungsvorrichtung basierend auf der Kippung des Linsenrohlings und Linsenblockers bestimmt wird.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei der Klemmschritt und der Kippschritt simultan durchgeführt werden, indem die Klemmvorrichtung der Bearbeitungsvorrichtung mit einer vorbestimmten Kippung relativ zu der Rotationsachse der Linsenbearbeitungsvorrichtung vorgesehen ist.

6. Verfahren nach einem der vorhergehenden Ansprüche, des Weiteren umfassend einen Oberflächenbearbeitungsschritt, währenddessen die Oberfläche des zu bearbeitenden optischen Linsenrohlings basierend auf den Betriebsparametern des Linsenbearbeitungswerkzeugs bearbeitet wird, die während des Bearbeitungswerkzeugkonfigurationsschritts konfiguriert wurden.

7. Bearbeitungsvorrichtung zur Bearbeitung der optischen Oberfläche (13) einer optischen Linse (10), wobei die Bearbeitungsvorrichtung umfasst:

- eine Klemme, die zum Klemmen eines Linsenblockers (21), der einen Linsenrohling (10) hält, mit einem Kippwinkel relativ zu der Rotationsachse (40) der Linsenbearbeitungsvorrichtung konfiguriert ist, und
- einen Prozessor (70) zum Bestimmen der Position der zu bearbeitenden Oberfläche basierend auf dem Kippwinkel des Linsenrohlings (10) und Linsenblockers (21) relativ zu der Rotationsachse (40) der Linsenbearbeitungsvorrichtung, und zum Konfigurieren der Betriebsparameter des Linsenbearbeitungswerkzeugs, um die zu fertigende Oberfläche gemäß der bestimmten Oberflächenposition so zu fertigen, dass die gewünschten optischen Eigenschaften der optischen Linse eingehalten werden, wobei die Klemme konfiguriert ist, um den Linsenrohling (10) und den Linsenblocker (21) mit einem Winkel β kleiner als oder gleich 3° zu kippen,

wobei der Prozessor (70) des Weiteren konfiguriert ist, um eine Gewichtsverteilung des Linsenrohlings (10) und des Linsenblockers (21) um die Rotationsachse der Linsenbearbeitungsvorrichtung basierend auf der Kippung des Linsenrohlings und Linsenblockers zu bestimmen, und wobei in Abhängigkeit von dem Kippwinkel und der zu bearbeitenden Oberfläche (13) Gewichte zugefügt werden.

8. Bearbeitungsvorrichtung nach Anspruch 7, wobei die Klemme einen vorbestimmten Kippwinkel relativ zu der Rotationsachse der Linsenbearbeitungsvorrichtung hat.

9. Computerprogrammprodukt, umfassend einen Satz von Anweisungen, die beispielsweise auf einem nicht-flüchtigen Computerspeicher gespeichert sind, und die für einen Prozessor zugänglich sind, und die bei Ausführung durch den Prozessor bewirken, dass der Prozessor mindestens die Schritte des Verfahrens nach einem der Schritte 1 bis 6 ausführt, wobei eine Datenverarbeitungsvorrichtung den Prozessor umfasst, der eingerichtet ist, um die eine oder mehreren Sequenzen von Anweisungen zu speichern und mindestens Schritte des Verfahrens nach einem der Ansprüche 1 bis 6 auszuführen.

10. Computerlesbares Medium, umfassend eine oder mehrere gespeicherte Sequenzen von Anweisungen eines Computerprogrammprodukts nach Anspruch 9, wobei die eine oder mehreren Sequenzen von Anweisungen für einen Prozessor zugänglich sind, und die bei Ausführung durch den Prozessor bewirken, dass der Prozessor die Schritte des Verfahrens nach einem der Ansprüche 1 bis 6 ausführt.

Revendications

1. Procédé destiné à usiner une surface optique (13) d'une lentille optique (10), le procédé comprenant :

- une étape d'obtention d'ébauche de lentille (S1), pendant laquelle une ébauche de lentille bloquée sur un dispositif de blocage de lentille (21) est obtenue,
- une étape de serrage (S2), pendant laquelle le dispositif de blocage de lentille maintenant l'ébauche de lentille est serré dans un dispositif d'usinage de lentille,
- une étape d'inclinaison (S3), pendant laquelle l'ébauche de lentille et le dispositif de blocage de lentille sont inclinés par rapport à l'axe de rotation du dispositif d'usinage de lentille,
- une étape de détermination de position de surface (S4), pendant laquelle la position de la surface devant être usinée est déterminée sur la base de l'angle d'inclinaison de l'ébauche de lentille et du dispositif de blocage de lentille par rapport à l'axe de rotation du dispositif d'usinage de lentille,
- une étape de configuration d'outil d'usinage (S5), pendant laquelle les paramètres opérationnels de l'outil d'usinage de lentille sont configurés afin de fabriquer la surface devant être fabriquée en fonction de la position de surface déterminée de telle sorte que les propriétés optiques souhaitées de la lentille optique sont res-

pectées,
dans lequel le procédé comprend en outre une étape d'usinage de surface pendant laquelle la surface de l'ébauche de lentille optique devant être usinée est usinée sur la base des paramètres opérationnels de l'outil d'usinage de lentille configuré pendant l'étape de configuration d'outil d'usinage, et
dans lequel, pendant l'étape de détermination de position de surface, la position de la surface devant être usinée est déterminée de telle sorte que l'angle α entre la normale à la surface devant être usinée au niveau de l'axe de rotation du dispositif d'usinage de lentille et l'axe de rotation du dispositif d'usinage de lentille est inférieur ou égal à 3°.

2. Procédé selon la revendication 1 dans lequel, pendant l'étape de détermination de position de surface, la position de la surface devant être usinée est déterminée de telle sorte que la normale à la surface devant être usinée au niveau de l'axe de rotation du dispositif d'usinage de lentille est colinéaire avec l'axe de rotation du dispositif d'usinage de lentille.

3. Procédé selon l'une quelconque des revendications précédentes dans lequel, pendant l'étape d'inclinaison, l'ébauche de lentille et le dispositif de blocage de lentille sont inclinés d'un angle β par rapport à l'axe de rotation du dispositif d'usinage de lentille inférieur ou égal à 30°.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel le procédé comprend en outre une étape de détermination de distribution de poids pendant laquelle une distribution de poids de l'ébauche de lentille et du dispositif de blocage de lentille autour de l'axe de rotation du dispositif d'usinage de lentille est déterminée sur la base de l'inclinaison de l'ébauche de lentille et du dispositif de blocage de lentille.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel les étapes de serrage et d'inclinaison sont réalisées simultanément en ayant le dispositif de serrage du dispositif d'usinage avec une inclinaison prédéterminée par rapport à l'axe de rotation du dispositif d'usinage de lentille.

6. Procédé selon l'une quelconque des revendications précédentes, comprenant en outre une étape d'usinage de surface pendant laquelle la surface de l'ébauche de lentille optique devant être usinée est usinée sur la base des paramètres opérationnels de l'outil d'usinage de lentille configuré pendant l'étape de configuration d'outil d'usinage.

7. Dispositif d'usinage destiné à usiner la surface optique (13) d'une lentille optique (10), le dispositif d'usinage comprenant :

- un dispositif de serrage configuré pour serrer un dispositif de blocage de lentille (21) maintenant une ébauche de lentille (10) avec un angle d'inclinaison par rapport à l'axe de rotation (40) du dispositif d'usinage de lentille, et
- un processeur (70) pour déterminer la position de la surface devant être usinée sur la base de l'angle d'inclinaison de l'ébauche de lentille (10) et du dispositif de blocage de lentille (21) par rapport à l'axe de rotation (40) du dispositif d'usinage de lentille, et configurer les paramètres opérationnels de l'outil d'usinage de lentille afin de fabriquer la surface devant être fabriquée en fonction de la position de surface déterminée de telle sorte que les propriétés optiques souhaitées de la lentille optique sont respectées, dans lequel le dispositif de serrage est configuré pour incliner l'ébauche de lentille (10) et le dispositif de blocage de lentille (21) d'un angle β inférieur ou égal à 3°,

dans lequel le processeur (70) est également configuré pour déterminer une distribution de poids de l'ébauche de lentille (10) et du dispositif de blocage de lentille (21) autour de l'axe de rotation du dispositif d'usinage de lentille sur la base de l'inclinaison de l'ébauche de lentille et du dispositif de blocage de lentille, et dans lequel des poids sont ajoutés en fonction de l'angle d'inclinaison et de la surface (13) devant être usinée.

8. Dispositif d'usinage selon la revendication 7, dans lequel le dispositif de serrage a un angle d'inclinaison prédéterminé par rapport à l'axe de rotation du dispositif d'usinage de lentille.

9. Produit-programme informatique comprenant un ensemble d'instructions qui sont stockées, par exemple, sur une mémoire informatique non transitoire et qui sont accessibles à un processeur et qui, lorsqu'elles sont exécutées par le processeur, conduisent le processeur à réaliser au moins les étapes du procédé de l'une quelconque des revendications 1 à 6,
dans lequel un dispositif de traitement de données comprend le processeur adapté pour stocker la ou les séquences d'instructions et pour réaliser au moins les étapes du procédé de l'une quelconque des revendications 1 à 6.

10. Support lisible par ordinateur comprenant une ou plusieurs séquences d'instructions stockées d'un produit-programme informatique de la revendication 9, dans lequel la ou les séquences d'instructions sont accessibles à un processeur et qui, lorsqu'elles sont

exécutées par le processeur, conduisent le processeur à réaliser les étapes du procédé de l'une quelconque des revendications 1 à 6.

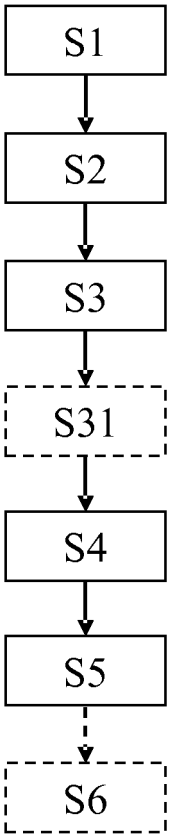

Figure 1

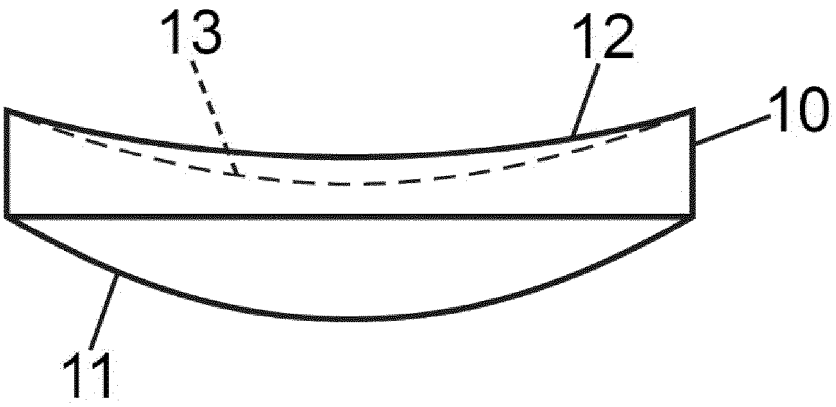

Figure 2

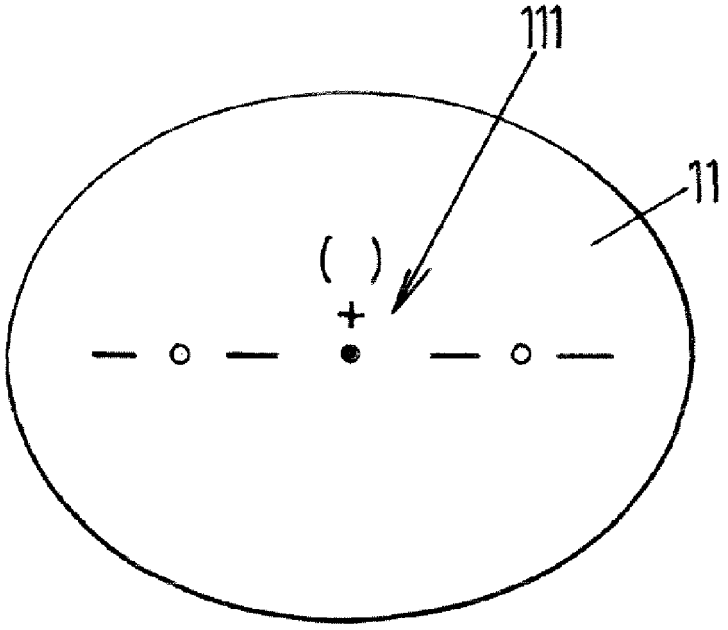

Figure 3

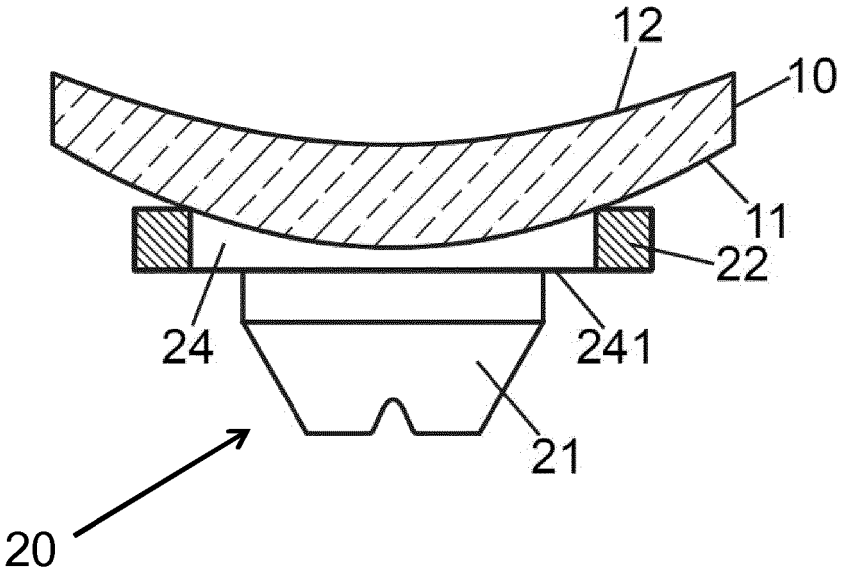

Figure 4

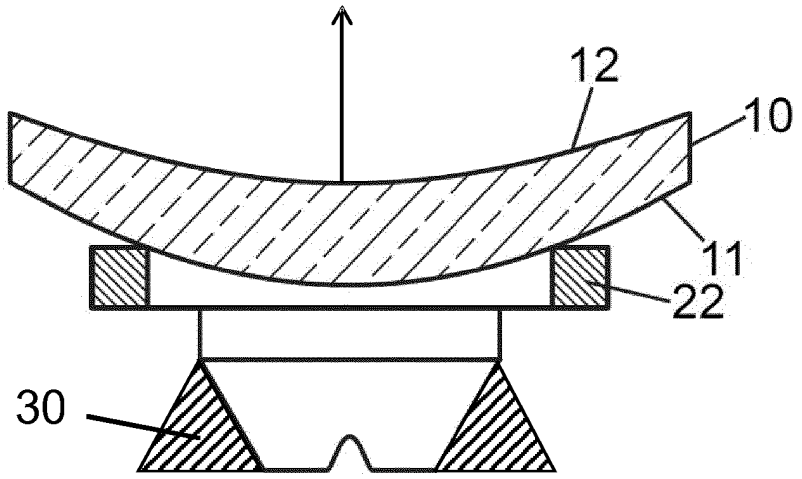

Figure 5

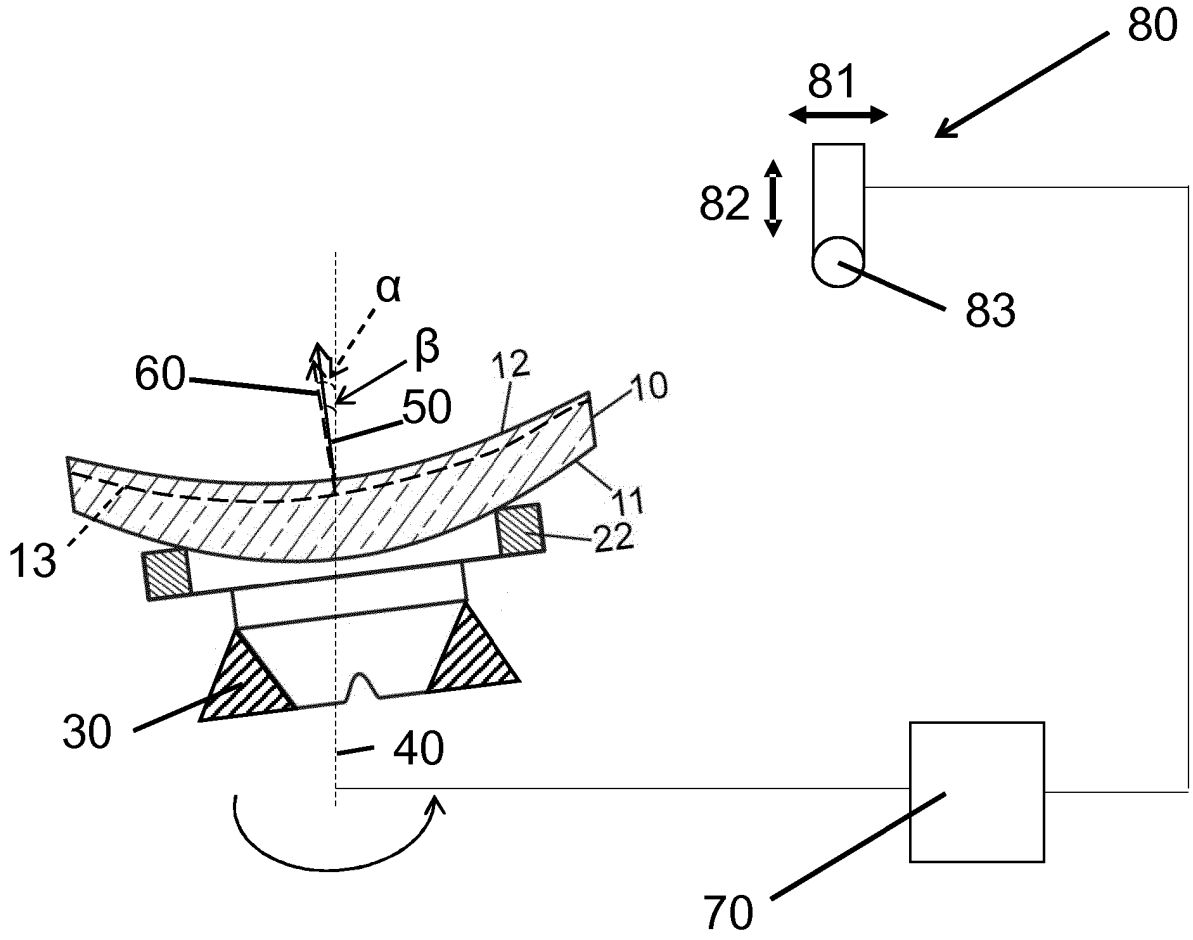

Figure 6

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 6382790 B1 **[0013]**