

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN AND RELATING TO THE EDGE-GRINDING OF LENSES

(71) We, AGFA-GEVAERT AKTIENGESELLSCHAFT, a body corporate recognised under German Law, of Leverkusen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method and apparatus for the edge-grinding of lenses made of soft material, especially contact lenses.

It has previously been proposed to edge-grind lenses made of soft material (for example, silicon rubber, which is to be contrasted with hard materials such as those sold under the Registered Trade Marks Plexiglas and Makrolon) while they are held between two rotating spindles, and allow a stream of liquid cooling agent to flow over both the lens and the spindle ends in order to obtain a degree of rigidity. Furthermore, it is usual to carry out the centring of lenses with the aid of a highly viscous liquid.

The method in which a lens that is to be processed is clamped between rotating spindles is very complicated in operation. Added to this, there is the possibility of the lens being scratched as a result of relative movement between the lens and the bearing members, and also the risk of the lens breaking as a result of the treatment with liquid cooling agents.

It is an object of the invention to simplify the edge-grinding of lenses, to avoid the relative movement between lens and the bearing members, and to eliminate the need for treatment of the lens and spindle ends with liquid cooling agents.

The invention provides a method for edge-grinding a lens made of soft material, wherein the lens is placed on a rotatable lens receptacle which is set in rotation, the rotary motion of the lens is imparted to the lens, the lens is centred with respect to the lens receptacle, the centred lens is firmly held by means of suction in its centred

position on the lens receptacle, and edge-grinding is carried out on the centred and firmly held lens.

Advantageously the lens is placed onto the receptacle with a viscous liquid interpolated between the lens and the receptacle. The liquid is preferably an oil which does not affect the lens material and which prevents the lens from sliding off the receptacle.

The rotatable lens receptacle may be driven at, for example, a speed of approximately 1000 r.p.m.

Advantageously, the suction is effected by means of a vacuum pump through boreholes in the lens receptacle.

The invention also provides apparatus for edge-grinding a lens, which comprises a lens receiving member mounted for rotation about an axis, means for centring the lens with respect to the axis of rotation of the said member, means for enabling suction to be applied for releasably securing the lens to the lens receiving member, and a grinding member for grinding the edge of the lens.

Advantageously, the lens receptacle in each case has a convex curve to match the lens, with a flattened area towards the edge in order to achieve the optimum association of the lens edge with the grinding member, and the lens receptacle preferably has boreholes in the area of transition of the flattened region in order to ensure that grinding may be carried out on the under edge of the lens.

The lens may be centred with the aid of means arranged to be movable rectilinearly towards and away from the lens receptacle either in the direction of the axis of rotation of the lens receptacle or in a direction that extends at right angles to that axis, the means being formed with a surface or surfaces for engaging the edge of a lens mounted on the receptacle and the surface tapering, or the surfaces converging, in a direction away from the lens receptacle. Advantageously, the centring means is a fork movable in a bearing block in a direction perpendicular to the axis of

rotation of the lens receptacle, or a hollow member which is open at one end and which is movable in a direction coincident with the axis rotation of the lens receptacle.

5 The centring means may be a hollow member provided with an inner cone shaped or frusto-shaped recess.

10 It is furthermore of advantage if the grinding member has its effective component made of fine-grained silicon carbide bound with caoutchouc.

The result thereby achieved is that the grinding member, which may have a diameter within the range of from 10 to 15 millimetres, can be rotated at peripheral speeds of up to approximately 40 metres per second, for example, without leading to destruction of the grinding member owing to excessively high centrifugal forces.

20 Two forms of apparatus for edge-grinding lenses and constructed in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

25 Figure 1 is a diagrammatic axial cross-section taken through one form of apparatus; and

30 Figure 2 is diagrammatic plan view of a second form of apparatus.

Referring to Figure 1 of the accompanying drawings, the first form of apparatus comprises a rotatable spindle 1 which has a frusto-conical portion 1a coaxial with the spindle. The frusto-conical portion 1a guides a driver 2 which is hollow to form a cylindrical chamber 3, access to which is provided by a borehole 4. Two O-rings 5 and 6 co-operate with a collar 7, which does not rotate and which has a tube connection 8, to form a vacuum-tight seal for the borehole 4 leading to the hollow space 3. The two O-rings 5 and 6 are lubricated to reduce frictional forces. 40 Fitted onto the driver 2 there is a lens receptacle 9 which has holes 9a bored through it. The boreholes 9a lead into the hollow chamber 3. The lens receptacle 9 serves to support a contact lens 10 made of soft material. A grinding member 11 is fixed by its spindle 12 in a high-speed grinding machine which is not shown.

55 Mounted above the lens receptacle 9 is a sleeve or cap H, the interior of which is of frusto-conical form and which is coaxial with the lens receptacle. The sleeve or cap H can be moved in the direction of the arrow C to allow the sleeve or cap to engage the periphery of the lens 10 to centre it with respect to the lens receptacle 9, and the sleeve or cap can be moved in the reverse direction to disengage the lens.

65 In operation, the lens 10 is placed onto the receptacle 9 with a viscous liquid, which may be water, alcohol, silicon oil, glycerine

or a mixture of more than one of these liquids, and which is preferably an oil that does not affect the lens, interposed between the lens and the receptacle. The spindle 1 is then set in rotation. The rotary movement is transmitted to the lens 10, the rotational speed advantageously being approximately 1000 r.p.m. If the liquid between the lens 10 and the receptacle 9 has the correct viscosity, the lens 10 does not slide off the receptacle 9.

In order to centre the lens 10 with respect to the receptacle 9, the sleeve or cap H is moved in the direction of the arrow C so that it is carefully brought into contact with the edge of the lens. The movement of the sleeve or cap H is continued until the lens 10 is centred. By switching on a vacuum pump which is not shown, the pressure in the chamber 3 is reduced and, as a result of the boreholes 9a in the lens receptacle 9, the lens 10 is pressed onto the lens receptacle 9 in the centred position. The sleeve or cap H is then moved in the reverse direction so that it disengages the lens 10.

Because the lens 10 is fixed on its receptacle 9, the edge of the lens 10 can be ground by means of the grinding member 11. The grinding member 11 advantageously has its effective component made of fine-grained silicon carbide which is bound with caoutchouc. With the grinding member 11 rotating at peripheral speeds of approximately 5 metres per second, the edge of the lens 10 can be brought to the required shape within an economically acceptable time. In practice, the grinding speed may be increased without difficulty to up to 40 metres per second. The shape of the edge of the lens 10 may be influenced by suitable profiles of the grinding member 11. In order to achieve improved association between the lens edge and the grinding member 11, the radius of the receptacle 9 may be altered in accordance with experiments, or the lens 10 may be turned over.

Referring to Figure 2 of the accompanying drawings, the second form of apparatus is the same as the first form except that the sleeve or cap H is replaced by a fork member having two prongs 13a and 13b, and a stem 14, which is slidably mounted in a bearing block so that it can move in each of the two opposite directions indicated by the arrows A and B. As can be seen in Figure 2, the prongs 13a and 13b of the fork member diverge towards their free ends and are disposed symmetrically with respect to the stem 14, the axis of which intersects the axis of rotation of the lens receptacle 9.

The second form of apparatus operates in the same manner as the first form of apparatus except that the centring of the

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lens is effected by the fork member. For this purpose, the fork member is moved in the direction of the arrow A so that the prongs 13a and 13b are carefully brought into contact with the edge of the lens 10. When the lens 10 has been brought into a concentric position with respect to the receptacle 9, the fork member is moved in the direction of the arrow B to disengage the prongs 13a and 13b from the lens and allow edge-grinding of the lens to proceed.

WHAT WE CLAIM IS:—

1. A method for edge-grinding a lens made of soft material, wherein the lens is placed on a rotatable lens receptacle which is set in rotation, the rotary motion of the lens receptacle is imparted to the lens, the lens is centred with respect to the lens receptacle, the centred lens is firmly held by means of suction in its centred position on the lens receptacle, and edge-grinding is carried out on the centred and firmly held lens.
2. A method as claimed in Claim 1, wherein the lens is a contact lens.
3. A method as claimed in Claim 1 or Claim 2, wherein a viscous liquid is interpolated between the lens and the lens receptacle.
4. A method as claimed in Claim 3, wherein the viscous liquid is an oil.
5. A method as claimed in any one of Claims 1 to 4, wherein the lens is centred with the aid of means arranged to be movable rectilinearly towards and away from the lens receptacle either in the direction of the axis of rotation of the lens receptacle or in a direction that extends at right angles to that axis, the means being formed with a surface or surfaces suitable for engaging the edge of a lens mounted on the lens receptacle and the surface tapering, or the surfaces converging, in a direction away from the lens receptacle.
6. A method as claimed in Claim 5, wherein the lens is centred with the aid of a fork member which can move only in a fixed direction that is at right-angles to the axis of rotation of the lens receptacle and in a direction opposite to the said fixed direction.
7. A method as claimed in Claim 5, wherein the lens is centred with the aid of a hollow member which is open at one end and the axis of which is substantially coincident with the axis of rotation of the lens receptacle and which is movable axially.
8. A method as claimed in any one of Claims 1 to 7, wherein the lens receptacle is rotated at approximately 1000 r.p.m.
9. A method as claimed in any one of Claims 1 to 7, wherein the suction is applied through bores in the lens receptacle.

10. A method as claimed in any one of Claims 1 to 9, wherein the suction is derived from a vacuum pump.

11. Apparatus for edge-grinding a lens, which comprises a lens-receiving member mounted for rotation about an axis, means for centring the lens with respect to the axis of rotation of the said member, means for enabling suction to be applied for releasably securing the lens to the lens-receiving member, and a grinding member for grinding the edge of the lens.

12. Apparatus as claimed in Claim 10, wherein the lens-receiving member is removably mounted to enable it to be interchanged with another such member.

13. Apparatus as claimed in Claim 11 or Claim 12, wherein the means for centring the lens comprises means arranged to be movable rectilinearly towards and away from the lens-receiving member either in the direction of the axis of rotation of the lens-receiving member or in a direction that extends at right-angles to that axis, the means being formed with a surface or surfaces for engaging the edge of a lens mounted on the lens-receiving member and the surface tapering, or the surfaces converging, in a direction away from the lens-receiving member.

14. Apparatus as claimed in Claim 13, wherein the means for centring the lens comprises a fork member mounted so as to be movable only in a fixed direction that is at right angles to the axis of rotation of the lens-receiving member in a direction opposite to the said fixed direction, and wherein the opposed inner surfaces of the prongs of the fork member converge away from their free ends.

15. Apparatus as claimed in Claim 14, wherein the means for centring the lens comprises a hollow member which is open at one end and of which the axis is substantially coincident with the axis of rotation of the lens-receiving member, which is movable to-and-fro in an axial direction, and of which the internal surface tapers in a direction away from the lens-receiving member.

16. Apparatus as claimed in Claim 15, wherein the interior of the hollow members is of conical or frusto-conical form.

17. Apparatus as claimed in any one of Claims 11 to 16, wherein the central portion of the lens-receiving surface of the lens-receiving member is convex and the outer portion of the surface is flattened.

18. Apparatus as claimed in any one of Claims 11 to 17, wherein the lens-receiving member is formed with bores through which suction can be applied.

19. Apparatus as claimed in Claim 17 and Claim 18, wherein the bores open into the lens-receiving surface in the region of



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lens is effected by the fork member. For this purpose, the fork member is moved in the direction of the arrow A so that the prongs 13a and 13b are carefully brought into contact with the edge of the lens 10. When the lens 10 has been brought into a concentric position with respect to the receptacle 9, the fork member is moved in the direction of the arrow B to disengage the prongs 13a and 13b from the lens and allow edge-grinding of the lens to proceed.

WHAT WE CLAIM IS:—

1. A method for edge-grinding a lens made of soft material, wherein the lens is placed on a rotatable lens receptacle which is set in rotation, the rotary motion of the lens receptacle is imparted to the lens, the lens is centred with respect to the lens receptacle, the centred lens is firmly held by means of suction in its centred position on the lens receptacle, and edge-grinding is carried out on the centred and firmly held lens.

2. A method as claimed in Claim 1, wherein the lens is a contact lens.

3. A method as claimed in Claim 1 or Claim 2, wherein a viscous liquid is interpolated between the lens and the lens receptacle.

4. A method as claimed in Claim 3, wherein the viscous liquid is an oil.

5. A method as claimed in any one of Claims 1 to 4, wherein the lens is centred with the aid of means arranged to be movable rectilinearly towards and away from the lens receptacle either in the direction of the axis of rotation of the lens receptacle or in a direction that extends at right angles to that axis, the means being formed with a surface or surfaces suitable for engaging the edge of a lens mounted on the lens receptacle and the surface tapering, or the surfaces converging, in a direction away from the lens receptacle.

6. A method as claimed in Claim 5, wherein the lens is centred with the aid of a fork member which can move only in a fixed direction that is at right-angles to the axis of rotation of the lens receptacle and in a direction opposite to the said fixed direction.

7. A method as claimed in Claim 5, wherein the lens is centred with the aid of a hollow member which is open at one end and the axis of which is substantially coincident with the axis of rotation of the lens receptacle and which is movable axially.

8. A method as claimed in any one of Claims 1 to 7, wherein the lens receptacle is rotated at approximately 1000 r.p.m.

9. A method as claimed in any one of Claims 1 to 7, wherein the suction is applied through bores in the lens receptacle.

10. A method as claimed in any one of Claims 1 to 9, wherein the suction is derived from a vacuum pump.

11. Apparatus for edge-grinding a lens, which comprises a lens-receiving member mounted for rotation about an axis, means for centring the lens with respect to the axis of rotation of the said member, means for enabling suction to be applied for releasably securing the lens to the lens-receiving member, and a grinding member for grinding the edge of the lens.

12. Apparatus as claimed in Claim 10, wherein the lens-receiving member is removably mounted to enable it to be interchanged with another such member.

13. Apparatus as claimed in Claim 11 or Claim 12, wherein the means for centring the lens comprises means arranged to be movable rectilinearly towards and away from the lens-receiving member either in the direction of the axis of rotation of the lens-receiving member or in a direction that extends at right-angles to that axis, the means being formed with a surface or surfaces for engaging the edge of a lens mounted on the lens-receiving member and the surface tapering, or the surfaces converging, in a direction away from the lens-receiving member.

14. Apparatus as claimed in Claim 13, wherein the means for centring the lens comprises a fork member mounted so as to be movable only in a fixed direction that is at right angles to the axis of rotation of the lens-receiving member in a direction opposite to the said fixed direction, and wherein the opposed inner surfaces of the prongs of the fork member converge away from their free ends.

15. Apparatus as claimed in Claim 14, wherein the means for centring the lens comprises a hollow member which is open at one end and of which the axis is substantially coincident with the axis of rotation of the lens-receiving member, which is movable to-and-fro in an axial direction, and of which the internal surface tapers in a direction away from the lens-receiving member.

16. Apparatus as claimed in Claim 15, wherein the interior of the hollow members is of conical or frusto-conical form.

17. Apparatus as claimed in any one of Claims 11 to 16, wherein the central portion of the lens-receiving surface of the lens-receiving member is convex and the outer portion of the surface is flattened.

18. Apparatus as claimed in any one of Claims 11 to 17, wherein the lens-receiving member is formed with bores through which suction can be applied.

19. Apparatus as claimed in Claim 17 and Claim 18, wherein the bores open into the lens-receiving surface in the region of

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transition from the convex portion to the flattened portion of the surface.

5 20. Apparatus as claimed in any one of Claims 11 to 19, wherein the grinding member comprises silicon carbide bound with caoutchouc.

10 21. Apparatus as claimed in Claim 20, which includes means for driving the grinding member at a peripheral speed of up to 40 metres per second.

22. Apparatus for edge-grinding a lens substantially as hereinbefore described with reference to, and as shown in, Figure 1 of the accompanying drawings.

23. Apparatus for edge-grinding a lens substantially as hereinbefore described with reference to, and as shown in, Figure 1 of the accompanying drawings, modified substantially as hereinbefore described with reference to, and as shown in, Figure 2 of the accompanying drawings.

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