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D E C I S I O N
of 25 September 2001

Case Number: T 0853/98 - 3.4.2

Application Number: 91306713.8

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IPC: G02C 7/04

Language of the proceedings: EN

Title of invention:
Method of producing lenses

Patentee:
JOHNSON & JOHNSON VISION PRODUCTS, INC.

Opponent:
OPTISCHE WERKE G. RODENSTOCK

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (confirmed)"

Decisions cited:
-

Catchword:
-

Case Number: T 0853/98 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 25 September 2001

Appellant: (Opponent)
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Respondent: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 20 July 1998 rejecting the opposition filed against European patent No. 0 472 291 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: A. G. Klein
B. J. Schachenmann

Summary of Facts and Submissions

I. The opposition filed against the European patent No. 0 472 291 (application No. 91 306 713.8) was rejected by the opposition division.

The opposition was based on the ground under Article 100(a) EPC that the claimed subject-matter did not involve an inventive step within the meaning of Article 56 EPC, in view of the following documents:

E1: US-A-4 289 387;

E2: US-A-4 613 217;

E3: "Optik: Physikalisch-technische Grundlagen und Anwendungen", H. Haferkorn, Verlag Harri Deutsch, Thun, 1981, pages 347 to 355; and

E4: "The principles of ophthalmic lenses", M. Jalie, 4th edition, 1984 (reprinted 1994), The Association of British Dispensing Opticians, London, GB, pages 12 to 15.

The patent as granted comprises a set of six claims of which claim 1, the only independent claim, reads as follows:

"A method of constructing a contact, intraocular or spectacle lens for focusing light on the retina of the eye comprising the steps of:

a) constructing a Fourier Transform function model that generates modulation transfer frequencies for the human eye and a preliminary lens, said lens having at least one rotationally symmetric surface defined by the equation:

$$X = \frac{Y^2}{r + [r^2 - (\kappa + 1) Y^2]^{1/2}} \quad (I)$$

where X is the aspheric surface point at position Y, r is the central radius, and ê is a commonly used aspheric constant, wherein the value of ê is less than or equal to -1,

b) performing an analysis using the model so constructed to trace light ray paths through the lens-eye system,

c) varying the value of the aspheric constant, ê, for the preliminary lens to achieve a lens-eye system with a trace of light ray paths optimized for sharpest focus by minimizing retinal spot size of said rays, and

d) forming a contact, intraocular or spectacle lens having at least one rotationally symmetric surface defined by equation (1) above, wherein X, Y and r are as defined above, and ê has the optimum value determined by step c) above."

II. The appellant (opponent) lodged an appeal against the decision of the opposition division, requesting that it be set aside and that the patent be revoked.

In addition to the documents already relied upon in the opposition procedure, the appellant in the appeal procedure referred to the following further citations:

E5: (Filed as "E4" and remembered by the board). "Aspherical surfaces used to minimize oblique astigmatic error, power error, and distortion of some high positive and negative power ophthalmic lenses", M. Katz, Applied Optics, vol. 21, No. 16, 15 August 1982, pages 2982 to 2991;

E6: "Maximum Attainable MTF for Rotationally Symmetric Lens Systems", B. R. Frieden, Journal of the Optical Society of America, vol. 59, No. 4, April 1969, pages 402 to 406; and

E7: "Use of the Modulation-Transfer Function (MTF) as an Aberration-Balancing Merit Function in Automatic Lens Design", W. B. King, Journal of the Optical Society of America, vol. 59, No. 9, September 1969, pages 1155 to 1158.

The respondent (proprietor of the patent) requested that the appeal be dismissed.

III. Oral proceeding were held on 25 September 2001, at the end of which the board announced its decision.

IV. The appellant's arguments in support of its request can be summarised as follows.

The claimed method in substance only comprises two distinct aspects, namely the provision of an adequately optimised hyperboloidal lens surface, and the consideration of the modulation-transfer function for its optimisation.

A lens with a hyperboloidal surface is known from document E1, where this particular surface is emphasized to allow reduction of the critical thickness of a lens, as compared to the thickness of the standard, so-called "Best Form" spherical lenses, and to achieve better correction of the peripheral aberrations.

Document E1 does not specify how the hyperboloidal surface is calculated from the Best Form spherical design, but since the vertex curvature is pre-defined, such calculation can only involve optimisation of the aspheric constant of the surface. The specification in tables I and II in column 3 of sagittal oblique vertex sphere power, oblique astigmatic error and mean oblique error for a 35° rotation of the eye from the optic axis also shows that lens optimisation involves consideration of the entire optical system comprising both the lens and the eye.

Document E2 also relates to the optimisation of spectacle lenses in consideration of the lens-eye combination, as is evident from the data in Figures 9 and 10, which are given separately for the lens surface alone, the whole spectacle lens and the lens-eye combination in columns a, b and c respectively.

The passage from line 44 to line 50 in column 2 of this document explicitly teaches that the modulation-transfer function is the essential factor to be considered in the optimisation of the combined lens-eye system.

Consideration of the modulation-transfer function of an optical system so as to achieve maximum image contrast is a standard design tool in the art of optics, as is evidenced for instance by documents E3, E6 and E7, the publication of the two latter citations being as early as in 1969.

V. The respondent for its part stressed that the prior art citations on file failed to show any method for designing a lens which involved tracing light ray paths through the lens-eye system and optimisation on the basis of modulation transfer frequencies within the meaning of claim 1.

In the prior art methods, the lenses were designed in isolation from the eye, and calculated so as to provide refraction or astigmatism values so defined as to compensate for the measured eye error.

The skilled person had no reason to combine the teachings of documents E1 and E2, for the former was dedicated to rotationally symmetrical lens surfaces, whilst the latter proposed a complex, atoric surface, as developed by spline analysis.

Reasons for the Decision

1. The appeal is admissible.

2. *Novelty*

2.1 Document E1 discloses an ophthalmic spectacle lens having an hyperboloidal surface.

The document does not specify how this surface is constructed and optimised. It does not in particular disclose the construction of a Fourier Transform function model for the human eye and a preliminary lens as set out in paragraph a of present claim 1, nor the use of such a model to trace light ray paths through the lens-eye system in accordance with paragraph b, nor the varying of the aspheric constant ê for the preliminary lens to achieve a lens-eye system with a trace of light ray paths optimised for sharpest focus by minimising retinal spot size, as set out in paragraph c.

2.2 Document E2 discloses a spectacle lens having an astigmatic power. The lens has no hyperboloidal surface meeting the equation in paragraph a of present claim 1.

The method of constructing the surface comprises ascertaining the distribution of astigmatism for each viewing-axis angle of a particular eye to be corrected, individually calculating data as to principal curvature and as to principal-curvature direction for at least one point in every region of viewing-axis incidence with said first lens surface, said data for each point being such that the astigmatism of the spectacle lens and of the eye to be corrected are individually adapted to each other at each said point as to direction and extent. A complex deformation of said first surface is then calculated in such manner as to satisfy said data for each said point, the thus-calculated surface being twice continuously differentiable at each point in the surface (see the abstract and claim 10).

The lens construction method of document E2 indeed takes astigmatism of the eye to be corrected into consideration, but there is no disclosure in this document of a trace of light ray paths being optimised for sharpest focus by minimising retinal spot size of said rays.

In addition, the only passage of this document to refer to modulation-transfer functions (from line 44 to line 50 of column 2) merely states that "investigations of the modulation-transfer function have shown that optimum contrast transfer may exist with small amounts of the astigmatism", which justifies the recommendation in the same passage that it may be advantageous to allow for the combined lens-eye system an astigmatic error of a small amount. The indication that the utility of such recommendation was confirmed by investigations of the modulation-transfer function cannot however be read in the sense that the lens construction actually results from an optimisation based on moderation-transfer frequencies generated from a Fourier Transform function model within the meaning of paragraph a of claim 1.

2.3 Documents E4 and E5 do not relate to hyperboloidal lens surfaces either, the former document being dedicated to aspherical lenses of the "Best Form" standard and the latter to aspherical surfaces. There is no reference to Modulation-Transfer Functions in these documents.

2.4 Documents E3, E6 and E7 generally disclose the principles of modulation-transfer functions as used in the design of non specified optical systems. None of these documents relates to the construction of ophthalmic lenses, nor do they suggest to apply modulation-transfer analysis to optical systems including the human eye.

2.5 For these reasons, the subject-matter of claim 1 is novel within the meaning of Article 54 EPC.

3. *Inventive step*

3.1 The parties agreed to consider document E1 as disclosing the closest prior art. This is indeed the sole citation relied upon by the appellant to disclose an ophthalmic lens having at least one rotationally symmetric surface which may be described by the equation given in paragraph a of claim 1 of the patent in suit, which characterises a hyperboloidal shape. According to document E1 for minus forward lenses, it is the posterior lens surface which is of a hyperboloidal form, and for positive forward lenses the anterior surface. The opposing surface of the lens is preferably spherical, or toroidal if correction for astigmatism is required (see column 1, lines 32 to 54).

The hyperboloidal shape is defined by a variable p which has a value in the range from 0 to -4 (see claim 1), but the document does not provide any detail of a process from optimising such shape.

3.2 Accordingly, the technical problem underlying the claimed subject-matter as defined objectively on the basis of the closest prior art is to propose a method of constructing a lens having a surface of a hyperboloidal shape as described in document E1, so as to achieve optimal vision correction.

3.3 This technical problem is solved in accordance with the method defined in claim 1 essentially in that a Fourier Transform function model that generates modulation transfer frequencies for the human eye and a preliminary hyperboloidal lens is constructed (see paragraph a of claim 1), which is used to trace light ray paths through the lens-eye system for analysing (see paragraph b), the value of the aspheric constant ê of the hyperboloidal surface shape being varied so as to achieve a lens-eye system with a trace of light ray paths optimised for sharpest focus by minimising retinal spot size of said rays (see paragraph c).

3.4 The prior art citations on file do not in the board's opinion suggest the claimed solution in an obvious manner.

In particular, document E2, the sole citation to evoke the concept of the modulation-transfer function in conjunction with ophthalmic lenses, is dedicated to a spectacle lens for the correction of astigmatism of the eye. In order to overcome the unsatisfactory astigmatism correction of the well-known toric surfaces, which cannot sufficiently correct defective vision of the eye for all viewing directions (see column 1, lines 19 to 23), the document proposes a complex deformed lens surface, referred to as an atoric surface, which is so designed that for each elemental region of said lens surface the principal curvatures and the principal curvature-directions are such that the astigmatism of the spectacle lens and of the eye to be corrected are adapted to each other as to direction and extent. The document explicitly stresses that with the deformed lens surface it discloses there is no mathematical relationship between the intersection curves which are formed with said surface by planes passing through the optical axis of the lens (see column 1, lines 47 to 60).

Thus, document E2 does not relate to the type of hyperboloidal lens surfaces which the method of claim 1 attempts to optimise.

Moreover, document E2 is dedicated to the design of a lens surface for correcting astigmatism, even if such surface may be integrated in a spectacle lens which also provides correction of spherical ametropia, as the appellant correctly deduced from Figures 9 and 10. Thus, if the skilled person strived at integrating the teaching of document E2 in the closest prior art lens design of document E1, he would primarily apply the construction method of document E2 to the lens surface of document E1 which is actually intended for the correction of astigmatism i.e. to the surface opposite the hyperboloidal surface, rather than to this hyperboliodal surface itself (see document E1, column 1, lines 52 to 54).

The board is also unable to endorse the appellant's interpretation of the only sentence in document E2 referring to the modulation-transfer function to the effect that it teaches use of such function as a basis for the lens surface optimisation process(see column 2, lines 44 to 49: "It may also be advantageous to allow for the combined lens-eye system an astigmatic error of a small amount which increases with the visual angle, since investigation of the modulation-transfer function have shown that optimum contrast transfer may exist with small amounts of the astigmatism"). When read without the benefit of hindsight, this sentence in the board's opinion can only be interpreted in the sense that investigations of the modulation-transfer function were performed on a system which already included a deformed atoric surface as disclosed in document E2, so as to confirm the benefit of a small residual astigmatic error. The document does not however afford any support for the appellant's view that it is the modulation-transfer function analysis which served as a basis for the calculation of the deformed surface.

Thus, although it is established that analysis of the modulation-transfer function of an optical system is a known option in the art of designing optical systems in general, as is evidenced e.g. by documents E3, E6, and E7, the appellant did not establish to the board's satisfaction that the skilled person would indeed have envisaged it also for the construction of ophthalmic lenses.

As indicated in the specification of the patent in suit, the claimed method also involves the developing of a composite eye model to take into account the geometrical and optical characteristics of the various elements and interfaces in the eye, on which to apply optical ray paths tracing techniques (see column 4, lines 16 to 58).

Document E2 and document E5 in this respect both show that the eye and its refraction errors may indeed be taken into consideration in the construction of an ophthalmic lens, in particular in conjunction with the compensation of oblique astigmatism for various orientations of the viewing axis (see Figure 1 in both documents, with the schematic representation of the center of rotation of the eye). These documents do not however disclose ray paths tracing techniques through such composite eye model as encompassed by the patent.

Finally document E4 was cited only in illustration of the so-called "Best Form" spherical lenses of which the hyperboloidal lens of document E1 is a further development.

3.5 For these reasons, the line of arguments relied upon by the appellant does not in the board's judgement cast doubts on the patentability of the method set out in claim 1.

The same conclusion applies to the method defined in claims 2 to 6, by virtue of the appendance of there cliams to claim 1.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

P. Martorana E. Turrini