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

(11) EP 1 897 991 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.03.2008 Bulletin 2008/11

(51) Int Cl.:
D21H 21/28 *(2006.01)* ***D21H 21/30*** *(2006.01)*

(21) Application number: **07115836.4**

(22) Date of filing: **06.09.2007**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **07.09.2006 SE 0601845**

(71) Applicant: **Arctic Paper AB**
411 01 Göteborg (SE)

(72) Inventors:
- **Olseke, Kjell**
  455 30, MUNKEDAL (SE)
- **Sehlin, Jan Olof**
  856 52, SUNDSVALL (SE)

(74) Representative: **Rådbo, Lars Olof et al**
Awapatent AB
Södra Hamngatan 37-41
Box 11394
404 28 Göteborg (SE)

(54) **Paper article having improved readability**

(57) A paper article comprising a wavelength converting material and/or a colorant is provided. The wavelength converting material has an absorption peak in the wavelength range of from 400 to 500 nm and an emission peak in the wavelength range of from 500 to 600 nm, while the colorant has an absorption peak in the wavelength range of from 600 to 700 nm. Such a paper article provides increased readability for persons suffering from cataract or cloudy vitreous body, and will have a preventive effect on the degeneration of the outer layer of the retina, and/or the development of myopia.

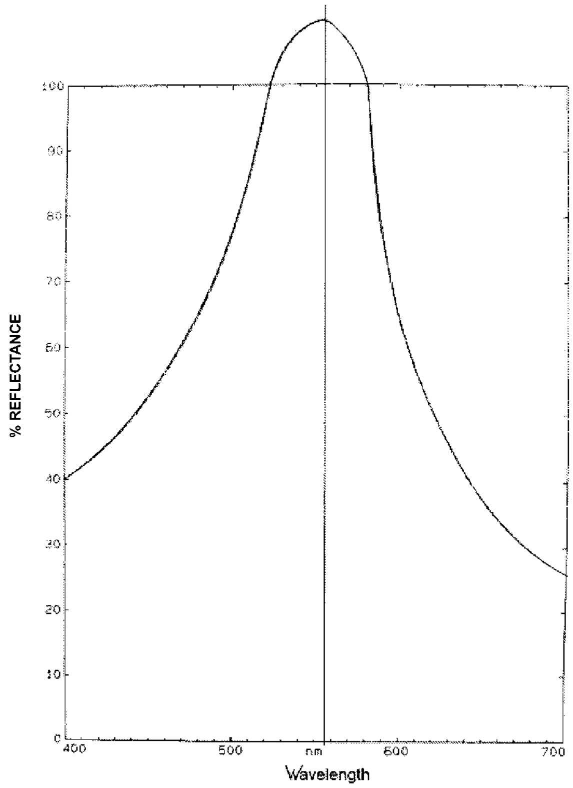

Fig. 3

EP 1 897 991 A2

Description

Technical field

[0001] The present invention relates to paper articles comprising wavelength converting material, to paper pulp for the production of such paper articles and to methods for the production of such paper articles.

Technical Background

[0002] Many people spend a major amount of time each day on reading. Society today is completely dependent on the literacy and reading ability of its citizens. Thus, people with a reading or other visual disability face major obstacles in everyday life.

[0003] Common eye disorders associated with light scattering include cataract and cloudy vitreous body. These disorders cause a disruption of the highly organized structure of the lens and the vitreous body, respectively. This results in a sharp fluctuation in the index of refraction, causing light to be scattered within the eye. Individuals with cataract and/or cloudy vitreous body have cloudy, opacified lenses and/or cloudy vitreous body, causing visual disturbances, unusual sensitivity of light and glare, and impaired restoring of clarity and colour perception. Daily functions such as reading and writing become difficult or impossible due to blurred vision.

[0004] Cataract and cloudy vitreous body usually affects old people; more than 50% of people over the age of 60 have some form of such a disorder, leading to readability problems.

[0005] Another eye disorder is degeneration of the outer layer of retina and fovea centralis with associated gradually loss of visibility.

[0006] Yet another common eye disorder is myopia, sometimes referred to as short-sightedness or near-sightedness. Myopia is a refractive defect of the eye in which light produces image focus at a point in front of the retina when accommodation is relaxed. A myopic person typically can see nearby objects clearly but distant objects appear blurred. Myopia afflicts 20 to 60 % of the adult population in the western world. Several studies have reported that near work, such as reading, is a major contributing factor in the development of myopia in children and young adults.

[0007] Kröger and Binder (British Journal of Ophthalmology 84 (2000) pp 890-893) have demonstrated the relevance of the spectral environment for the accommodation demand of the human eye. It was concluded that the selective removal of wavelengths in the 600 to 700 nm range of the visible spectrum, which are normally available to the eye during reading, would lessen the accommodation demand on the eye and hence slow the progression of myopia, which is considered to be driven by the accommodative activity.

[0008] It was suggested that the use of textbook paper, which selectively absorbs wavelengths in the range of 600 to 700 nm, would be beneficial in the prevention of near-work induced myopia. However, no such paper has yet been produced, possibly because the use of light absorbing pigments renders the paper more or less darkly coloured and thus unsuitable for use as a printing paper.

[0009] Accordingly, there is a need for paper with improved readability characteristics, in the sense that information printed on the paper is more easily read by persons with impaired vision due to such disorders as cataract and cloudy vitreous body. Further, there is a need for paper which generally demands less accommodative effort of the eye, hence having a reduced tendency to induce myopia, and which has a colour tone that is acceptable for printing purposes.

Summary of the Invention

[0010] It is an object of the present invention to at least partly overcome the drawbacks of the prior art, and thus to provide a paper article having improved properties in terms of readability for persons suffering from cataract and/or cloudy vitreous body.

[0011] A further object is to provide a paper article having improved properties in terms of readability for persons having cataract and cloudy vitreous body and having decreased tendency to induce myopia and prevent degeneration of the outer layer of retina.

[0012] These objects are at least partly achieved by means of a paper article according to the appended claims.

[0013] The present inventors have surprisingly found that a paper article according to the invention, having reduced reflection in the ranges 400 to 500 nm, and increased reflection in the range 500 to 600 nm has improved readability for persons suffering from cataract or cloudy vitreous body, and that such a paper will have preventive effect on the degeneration of the outer layer of the retina. Thus, in a first aspect the present invention provides a paper article comprising a short wavelength converting material being essentially homogenously distributed throughout the area of the paper article and having an absorption peak in the wavelength range of from 400 to 500 nm and an emission peak in the wavelength range of from 500 to 600 nm.

[0014] A typical human eye typically only responds to wavelengths within the visible spectrum, which is defined as the portion of the electromagnetic spectrum having a wavelength range of from 400 to 700 nm. However, the eye responds more to some wavelengths of light than others, even within the visible spectrum. A light-adapted eye typically has its maximum accommodative capacity at about 555 nm, in the green-yellowish region of the optical spectrum.

[0015] Light in the wavelength interval of from 400 to 500 nm causes a major portion of the disturbing light scattering effects leading to the impaired vision in persons suffering from cataract or cloudy vitreous body. By reducing the reflection from the paper article in the wavelength interval 400 to 500 nm, these scattering effects are reduced, hence increasing the readability.

[0016] Further, by reducing the reflection from the paper article in the wavelength interval 400 to 500 nm the degeneration of the outer layer of retina will be prevented.

[0017] Light absorbed in the wavelength range 400 to 500 nm is converted by the short wavelength converting material and is emitted as light in the wavelength range 500 to 600 nm, which range includes the wavelengths where the human eye has its maximum sensitivity. Thus, the paper article will appear as being of a bright colour tone, which will further improve the readability of information printed on the paper article.

[0018] In embodiments of the present invention, the paper article may comprise a colorant being essentially homogenously distributed throughout the area of the paper article and having an absorption peak in the wavelength range of from 600 to 700 nm.

[0019] Light in the wavelength interval of from 600 to 700 nm is at least partly responsible for inducing myopia. Hence, by reducing the reflection from the paper article in this wavelength interval, paper articles of the present invention will have a reduced tendency to induce myopia.

[0020] Since light absorbed in the wavelength range 400 to 500 nm is converted by the wavelength converting material and is emitted as light in the wavelength range 500 to 600 nm, which range includes the wavelengths where the human eye has its maximum sensitivity, the paper article will appear as being of a bright colour tone, even though the reflection of light in the wavelength intervals 400 to 500 nm and 600 to 700 nm is reduced.

[0021] A paper article comprising a colorant being essentially homogenously distributed throughout the area of the paper article and having an absorption peak in the wavelength range of from 600 to 700 nm forms a contemplated aspect of the invention.

[0022] In embodiments of the present invention, the paper article may also comprise glass micro spheres, which will increase the total reflection perpendicularly to the surface of the paper article.

[0023] In further aspects, the present invention provides a method for the production of paper article of the present invention and paper pulp for use in the production of paper articles of the present invention.

[0024] These and further aspects and advantages of the present invention will now be described in the following detailed description of the present invention, with reference to the appended drawings.

Brief description of the drawings

[0025]

Figure 1 depicts the spectral distribution of light reflected by a paper article according to an experiment described below.

Figure 2 depicts the spectral distribution of light reflected by a paper article according to another experiment described below.

Figure 3 depicts the spectral distribution of reflected light obtainable by a paper article according to a preferred embodiment of the present invention.

Detailed description of the invention

[0026] The present invention relates to a paper article comprising a wavelength converting material.

[0027] The paper article may for example be in the form of, but is not limited to, printing paper, newspaper paper, magazine paper, book paper and the like.

[0028] A preferred application of a paper of the present invention is as pages in a book, booklet or the like, where the sheets typically have a weight up to 120 g/m^2.

[0029] As used herein, the term "wavelength converting material" and related terms, such as "wavelength converting compound", refers to a material that absorbs light at a certain wavelength in order to emit light at another wavelength. Examples of such wavelength converting materials include fluorescent materials and phosphorescent materials. Upon absorption of light, electrons in the material become excited to a higher energy level. Upon relaxation back from the higher energy levels, the excess energy is released from the material in form of photons (light).

[0030] The wavelength converting material of the invention should have an absorption peak in a wavelength range of from 400-500 nm, and an emission peak in a wavelength range of from 500 to 600 nm. Such wavelength converting material is hereinafter referred to as a "short wavelength converting material".

[0031] The human eye has its optimal accommodative capacity at wavelengths in the proximity of 555 nm. Resulting from this evolutionary effect is the increased accommodative demand placed on the eye during near work in an artificially illuminated environment, as artificial light generally comprises a higher intensity of red wavelengths, compared to natural daylight. The reduction of the intensity in the wavelength interval of blue-green light (400 to 500 nm) with the accompanying increment of the intensity in the green-yellow wavelength range (500 to 600 nm) results in a paper article where the reflected light has a the spectral distribution to which the eye more easily adapts.

[0032] Light in the wavelength interval of from 400 to 500 nm causes a major portion of the disturbing light scattering effects leading to the impaired vision in persons suffering from cataract or and cloudy vitreous body. By reducing the reflection from the paper article in the wavelength interval 400 to 500 nm, these scattering effects are reduced, hence increasing the readability.

[0033] Further, by reducing the reflection from the paper article in the wavelength interval 400 to 500 nm the degeneration of the outer layer of retina will be prevented.

[0034] The use of a short wavelength converting material according to the invention results in a paper article having colour tone acceptable for use in printing applications.

[0035] Preferably, in order to more closely agree with the accommodative capacity of the eye, the light emission peak is in the wavelength range of 540 to 570 nm, and more preferably in the range of 550 to 560 nm.

[0036] As used herein the term "accommodation" refers to the ability of the eye to alter its focus so that clear images of both close and distant objects can be formed on the retina.

[0037] For the purpose of increasing the readability, the paper article of the present invention comprises wavelength converting material in such amounts that the coefficient of reflection ΔR for a wavelength within the wavelength range of the emission peak of the short wavelength converting material, i.e. in the range of from 500 to 600 nm, preferably in the range of from 540 to 570 nm, is at least 0,9, preferably at least 1, such as at least 1,10, for example at least 1,20.

[0038] As used herein, the coefficient of reflection ΔR is defined as the ratio of the amplitude of the reflected wave and the amplitude of the incident wave.

[0039] The short wavelength converting material may include one or more compounds. For example, the short wavelength converting material may comprise only fluorescent compounds, only phosphorescent compounds or any mixture of fluorescent and phosphorescent compounds, to achieve the absorption peak in the range of from 400 to 500 nm, and the emission peak in the range of from 500 to 600 nm.

[0040] The short wavelength converting material, and thus the wavelength converting compounds, may be fluorescent and/or phosphorescent.

[0041] Many short wavelength converting, e.g. fluorescent and/or phosphorescent, compounds that have absorption peak in the wavelength range of from 400 to 500 nm and emission wavelength peak in the wavelength range of from 500 to 600 nm are known to those skilled in the art.

[0042] The concentration of the short wavelength converting compound(s) is selected to achieve the desired physical and optical properties of the paper article. Thus, the concentration depends on, for example, the absorbance and the quantum yield of the wavelength converting compound.

[0043] The wavelength converting material may be added to the paper in the paper forming process. For example, the wavelength converting material may be comprised, and essentially evenly distributed, in the fibrous cellulosic web constituting the paper base. The wavelength converting material may also be comprised in a surface-binding layer of the paper article, or in a surface coating layer of the paper article.

[0044] In a preferred embodiment, the paper article comprises, in addition to the wavelength converting material discussed above, a colorant having an absorption peak in the range of from 600 to 700 nm. The colorant may be a purely absorbing colorant, or may alternatively comprise a wavelength converting material, hereinafter referred to as a "long wavelength converting material", for example a fluorescent and/or phosphorescent colorant having an emission peak above 700 nm, i.e. outside the visual wavelength range. Alternatively, or in addition, the long wavelength converting material has an emission peak in the wavelength range of from 500 to 600 nm. Figure 3 illustrates the spectral distribution of reflected light from a paper article comprising a combination of the colorant and the short wavelength converting material discussed above, which may be obtained in this preferred embodiment of the invention.

[0045] A paper article comprising a colorant having an absorption peak in the range of from 600 to 700 nm forms a contemplated aspect of the invention.

[0046] The absorption of light in the wavelength range 600 to 700 nm leads to a reduced reflection of light in this wavelength range.

[0047] Thus, such papers will, as discussed above, have a reduced tendency to induce myopia.

[0048] The combination of the colorant, absorbing light in the wavelength range 600 to 700 nm, with the short wavelength converting material discussed above, absorbing light in the wavelength range 400 to 500, and emitting light in the wavelength range 500 to 600 nm, is thus beneficial, both in terms of increased readability for people suffering from cataract or cloudy vitreous body and in terms of reduced tendency of inducing myopia and degeneration of retina.

[0049] Further, the absorption of light in the range 600 to 700 nm leads to a darkening of the paper article. However, since the short wavelength converting material increases the reflection of light in the wavelength range near the wavelengths of maximum accommodation for the eye, i.e. 500 to 600 nm, the paper will still be perceived as having an acceptable colour tone, on which paper text and other information can be printed.

[0050] In the embodiment, where the paper article only comprises a colorant having an absorption peak in the wavelength range of 600 to 700 nm, the paper article will have a slightly dark colour. However, when the colorant comprises a long wavelength converting material having an emission peak in the range 500 to 600 nm, the paper will be perceived as having an acceptable colour tone.

[0051] It is preferred that the paper article comprises wavelength converting material in such amounts that the coefficient of reflection ΔR is at least 0,9, preferably at least 1, such as at least 1,10, for example at least 1,20, for a wavelength within the wavelength range of the emission peak of the short wavelength converting material, i.e. in the range of from 500 to 600 nm wavelength range, preferably in the range of from 540 to 570 nm.

[0052] Due to the beneficial properties of paper articles of the present invention in terms of reducing the induction of myopia, paper articles of the present invention for purposes of treating myopia, such as to prevent the onset of myopia, to prevent progression of myopia and to therapeutically treat myopia, form an especially contemplated aspect of the present invention.

[0053] As used herein, the term "treatment" refers to both preventive and therapeutic treatment.

[0054] Many colorants having absorption in the wavelength range of from 600 to 700 nm are known to those skilled in the art.

[0055] In addition, many fluorescent and/or phosphorescent colorants that have an absorption peak in the wavelength range of from 600 to 700 nm and an emission wavelength peak in the wavelength range of above 700 nm are known to those skilled in the art.

[0056] As with the short wavelength converting material, the colorant can be added to the paper in the paper forming process. For example, the colorant may be comprised, and essentially homogenously distributed, in the fibrous cellulosic web constituting the paper base. The colorant may also be comprised in a surface-binding layer of the paper article, or in a surface coating layer of the paper article.

[0057] In the above description, the short wavelength converting material and the colorant are described as two separate chemical entities. However, according to one embodiment, the invention provides a paper article comprising a wavelength converting material evenly distributed over the area of the article, where the wavelength converting material has an absorption peak in the range of from 400-500 nm, an emission peak in the range of from 500-600 nm, and further an absorption peak in the range of from 600-700 nm. In addition, such wavelength converting material may also provide an emission peak at a wavelength of above 700 nm and/or in the range of from 500-600 nm.

[0058] In embodiments, paper articles of the present invention may comprise glass micro spheres, for example in the fibrous network of the paper article or as a partially covering coating on the surface of the paper article.

[0059] Such glass micro spheres can be used to increase the reflectance in the direction perpendicular to the paper surface.

[0060] The glass micro spheres typically have a mean particle diameter of 5 μm or less.

[0061] The glass micro spheres may be contained in the paper article at a concentration of up to 24 % by weight of the paper article.

[0062] Typically, the glass micro spheres are essentially homogenously distributed throughout the area of the paper article.

[0063] The glass micro spheres may be arranged essentially homogenously throughout the thickness of the paper article or may be concentrated in a certain layer of the paper article, such as a top layer or an intermediate layer.

[0064] A paper article of the present invention may further comprise pigments, dyes and other additives as commonly used in the art of paper manufacturing.

[0065] A paper article of the present invention can be manufactured by standard paper making methods and processes, where the above described short wavelength converting material and/or colorant is/are added to or contained in the paper pulp to be processed into paper articles, or can be added in the paper making process, or added as a surface application to the paper article formed by said paper making process.

[0066] A typical paper making process includes the steps of providing a paper pulp, forming an aqueous slurry containing the paper pulp, forming a wet sheet of the aqueous slurry, and drying the wet sheet into a paper article, such as a paper sheet. The process may additionally contain many intermediate steps, such as rolling steps, which are commonly known to those skilled in the paper manufacturing.

[0067] The short wavelength converting material and/or, the colorant can be added at any suitable step in this paper forming process. For example, the short wavelength converting material and/or the colorant can be added to the aqueous slurry containing the paper pulp, can be added at the step of forming the aqueous slurry to a wet sheet, before or after drying the wet sheet into a dry paper, etc. The short wavelength converting material and the colorant can be added in the same or in different process steps. Typically, the short wavelength converting material and/or the colorant is/are added as a surface application to the paper article formed by said paper forming process, i.e. in a surface binding layer of the paper article, or in a surface coating layer of the paper article.

[0068] The particulars concerning the short wavelength converting material and the colorant in such methods are as described above in connection with the paper article of the present invention.

[0069] A paper pulp, containing the short wavelength converting material as described above and/or the colorant, which paper pulp can be used in a paper making to obtain paper articles of the present invention, forms a contemplated aspect of the present invention.

[0070] The particulars concerning the short wavelength converting material and the colorant in such a paper pulp are as described above in connection with the paper article of the present invention.

[0071] The above description of embodiments of the invention and the following examples are not intended to limit the scope of the present invention, but to serve as illustrative examples of possible embodiments. Those skilled in the art will realize that several modifications and variations are possible within the scope of the appended claims.

Examples

[0072] The present invention will now be further described with reference to examples describing the optical properties of paper articles of the present invention.

Example 1 (Reference): Reflectance from standard paper

[0073] Hardwood pulp at an amount of 75% and Softwood pulp at an amount of 25% counted as total pulp amount was mixed, and the mixed pulp was beated to 25 degrees Schopper-Riegler.

[0074] During mixing, $Al_2(SO_4)_3$ 0,8%, Sandofix EC 1%, Cationic starch 2% and filler Calcium Carbonate ($CaCO_3$) 22%, was added to the mixed pulp. Percentages are in weight % of the mixed pulp.

[0075] A sheet of suffficent grammage was formed in a laboratory former, the sheet was couched off and pressed in between laboratory blankets and dried in a laboratory oven.

[0076] The reflectance of the paper sheet was measured over the range of from 400 to 700 nm in a Minolta CM-3700d device.

[0077] The resulting reflectance graph is shown in figure 1, showing an essentially flat reflectance curve over the total visible wavelength range.

Example 2: Reflectance from paper with fluorescent material

[0078] A paper sheet was produced as in example 1 above, except for that a fluorescent material, BASF Gelb 226 plv, was added to the mixed pulp at a concentration of 0,02%, during heavy mixing.

[0079] The reflectance of the paper sheet was measured over the range of from 400 to 700 nm in a Minolta CM-3700d device.

[0080] The resulting reflectance graph is shown in figure 2. The reflectance curve shows a drastic reduction of the reflectance in the 400 to 500 nm range, and a drastic increase in reflection in the 500 to 600 nm range, with a peak reflection of approximately 105% at 550 nm.

Claims

1. A paper article, comprising a short wavelength converting material being essentially homogenously distributed throughout the area of said paper article and having an absorption peak in the wavelength range of from 400 to 500 nm and an emission peak in the wavelength range of from 500 to 600 nm; and/or a colorant having an absorption peak in the wavelength range of from 600 to 700 nm.

2. A paper article according to claim 1, wherein said emission peak of said short wavelength converting material is in the wavelength range of from 540 to 570 nm.

3. A paper article according to claim 2, wherein said emission peak of said short wavelength converting material is in the wavelength range of from 550 to 560 nm.

4. A paper article according to any one of the claims 1-3, wherein the coefficient of reflection ΔR is at least 1 for a wavelength within the wavelength range of said emission peak of said short wavelength converting material.

5. A paper article according any one of the preceding claims, wherein said colorant comprises a long wavelength converting material having an emission peak in the wavelength range above 700 nm.

6. A paper article according to any one of the preceding claims, wherein said colorant comprises a long wavelength converting material having an emission peak in the wavelength range of from 500 to 600 nm.

7. A paper article according to any of the preceding claims, wherein said short wavelength converting material and said colorant comprises at least one fluorescent and/or phosphorescent compound.

8. A paper article according to any of the preceding claims, further comprising glass micro spheres.

9. A paper article according to claim 8, wherein said glass micro spheres have a mean diameter of 5 μm or less.

10. A paper pulp for the production of paper articles, comprising a short wavelength converting material having an absorption peak in the wavelength range of from 400 to 500 nm and an emission peak in the wavelength range of from 500 to 600 nm, and/or a colorant having an absorption peak in the wavelength range of from 600 to 700 nm.

11. A paper pulp according to claim 10, wherein said colorant comprises a long wavelength converting material having an emission peak in the wavelength range above 700 nm.

12. A paper pulp according to claim 10 or 11, wherein said colorant comprises a long wavelength converting material having an emission peak in the wavelength range of from 500 to 600 nm.

13. A method for the production of paper articles, comprising:

- providing a paper pulp; and
- subjecting said paper pulp to a paper article forming process,

said method being **characterized in that** a short wavelength converting material, having an absorption peak in the wavelength range of from 400 to 500 nm and an emission peak in the wavelength range of from 500 to 600 nm, and/or a colorant having an absorption peak in the wavelength range of from 600 to 700 nm is/are added.

14. A method according to claim 13, wherein said short wavelength converting material and/or said colorant is/are added in the paper article forming process.

15. A method according to claim 13 or 14, wherein said short wavelength converting material and/or said colorant is/are added as a surface application to the paper article formed by said paper forming process

16. Paper article according to claim 1-9, for use in treatment of myopia.

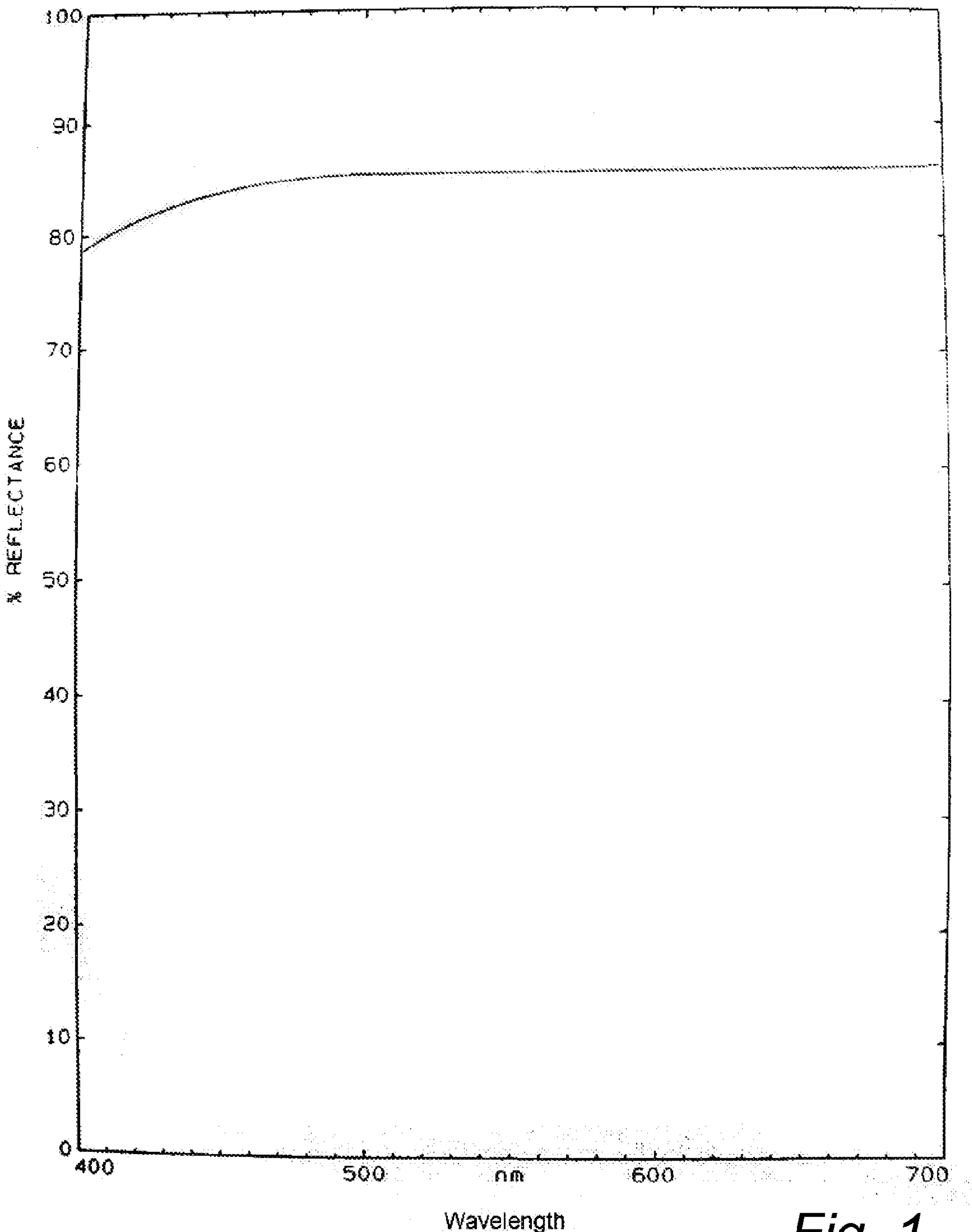
% REFLECTANCE
100
90
80
70
60
50
40
30
20
10
0
400
500
nm
600
700
Wavelength

Fig. 1

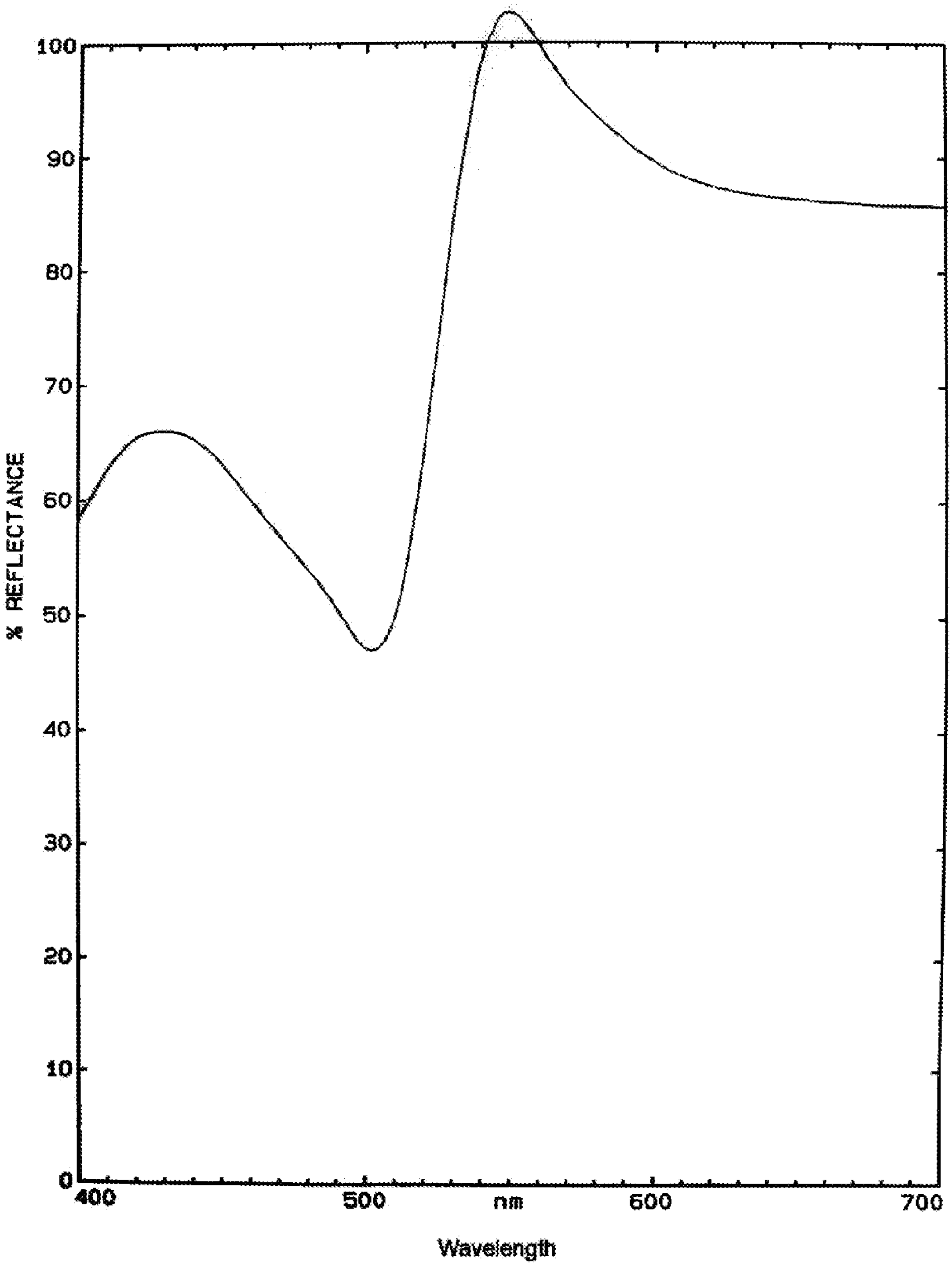
100
90
80
70
60
50
40
30
20
10
0
% REFLECTANCE
400
500
nm
600
700
Wavelength

Fig. 2

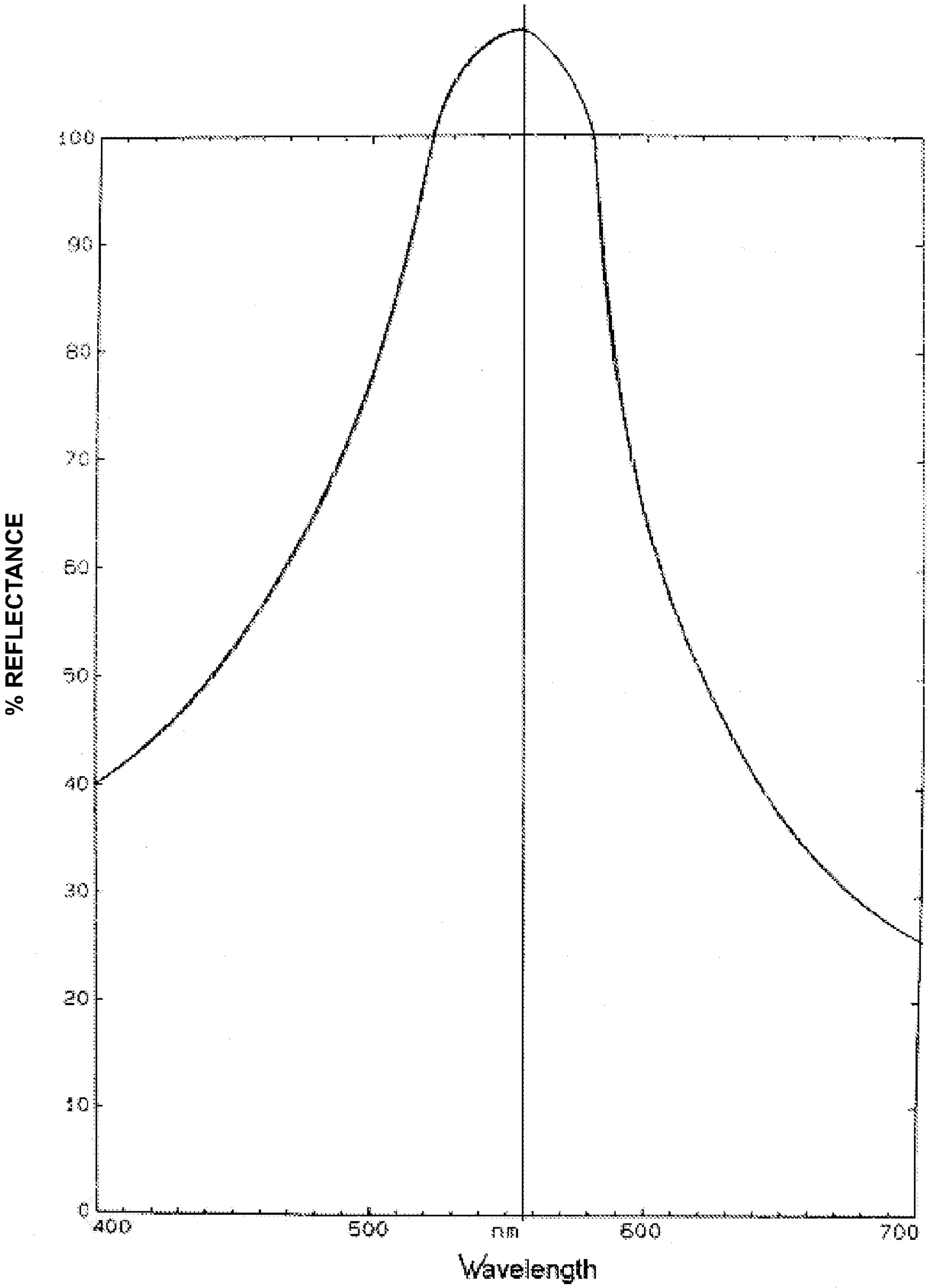
% REFLECTANCE
100
90
80
70
60
50
40
30
20
10
0
400
500
nm
600
700
Wavelength

Fig. 3

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.

Non-patent literature cited in the description

- **KRÖGER ; BINDER.** *British Journal of Ophthalmology,* 2000, vol. 84, 890-893 **[0007]**