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**D E C I S I O N**  
**of 11 April 2002**

**Case Number:** T 0197/99 - 3.4.2  
**Application Number:** 91101004.9  
**Publication Number:** 0441206  
**IPC:** G02B 3/08, G02B 13/18, G02B 23/00

**Language of the proceedings:** EN

**Title of invention:**

Optical element employing aspherical and binary grating  
optical surfaces

**Patentee:**

Hughes Aircraft Company

**Opponent:**

Koninklijke Philips Electronics N.V.  
Asahi Kogaku Kogyo K. K.

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 56, 111(2)

**Keyword:**

"Main request and auxiliary request 1: inventive step - no"  
"Auxiliary requests 2 and 3: remittal to first instance for  
further prosecution"

**Decisions cited:**

-

**Catchword:**

-





Case Number: T 0197/99 - 3.4.2

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.2**  
**of 11 April 2002**

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**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted 3 December 1998  
revoking European patent No. 0 441 206 pursuant  
to Article 102(1) EPC.

**Composition of the Board:**

**Chairman:** E. Turrini

**Members:** M. P. Stock  
V. Di Cerbo

## Summary of Facts and Submissions

- I. The appellant (patent proprietor) has appealed against the decision of the opposition division revoking the European patent number 0 441 206 (application number 91 101 004.9).
- II. Opposition was filed against the patent as a whole by opponent I (respondent I) and against claims 1 to 7 as granted by opponent II (respondent II). Both oppositions were based on the ground under Article 100(a) EPC that the subject-matter of the patent was not new or did not involve an inventive step (Articles 52(1), 54 and 56 EPC).

The opposition division did not consider the subject-matter of claim 1 as granted to involve an inventive step with regard to the following documents:

D2: US-A-4 340 283

D4: Optical Engineering, vol. 28, No. 6, June 1989, pages 605 to 608

[D4 corresponds to another document of the same authors (Swanson and Veldkamp) referred to as D1 in this procedure and mentioned in the description of the contested patent at page 2, lines 25 to 29.]

D8: "Synthese optischer Systeme", H. Haferkorn und W. Richter, Verlag der Wissenschaften, Berlin 1984, Inhaltsverzeichnis, Seiten 141 to 148

- III. Oral proceedings before the board took place on 11 April 2002 in the presence of the appellant and the

respondents. In the oral proceedings reference was made to D4 and the following document:

D10: SPIE, vol. 1052, Holographic Optics: Optically and Computer Generated, 1989, pages 25 to 30

At the end of the oral proceedings the decision of the board was given.

IV. The appellant requested that the decision under appeal be set aside and that a patent be maintained on the basis of claim 1 according to the main request or the auxiliary request 1, both filed with letter dated 7 October 1999. For the case of the refusal of these requests, the appellant requested remittal of the case to the first instance for further prosecution on the basis of auxiliary requests 2 and 3 filed with letter dated 11 March 2002.

The respondents requested that the appeal be dismissed.

Claim 1 according to the appellant's main request reads as follows:

"1. An optical element (12) for reducing aberration in an optical system, said optical element having first (14) and second (16) surfaces, said first surface being an (sic a) refractive surface and said second surface being a diffractive surface,  
said second surface (16) being a binary grating surface approximating a Kinoform profile (18),  
characterised by  
said first surface (14) being an aspherical surface."

Claim 1 according to the appellant's auxiliary request 1 reads as follows:

"1. An optical element (12) for reducing aberration in an optical system, said optical element having first (14) and second (16) surfaces, said first surface being an (sic a) refractive surface and said second surface being a diffractive surface,

said second surface (16) being a binary grating surface approximating a Kinoform profile (18) for eliminating the spherochromatism and the primary chromatic aberration of the optical element, characterised by

said first surface (14) being an aspherical surface for minimizing the spherical aberration of the optical element."

Claim 1 and the further independent claim 5 according to the appellant's auxiliary request 2 read as follows:

"1. A telescope system (100) having an optical axis (0) comprising:

a) a first positive meniscus optical element (102) on said optical axis (0) having a first convex surface (104) and a second concave surface (106), said first surface (104) being an aspherical surface and said second surface (106) being a binary grating surface;

b) a first negative meniscus optical element (107) on said optical axis (0) behind said first positive meniscus optical element (102) and having first (108) and second (110) concave surfaces, said first surface (108) being a binary grating surface

and said second surface (110) being an aspherical surface;

c) said binary grating surfaces (106, 108) comprising a plurality of concentric rings (24), each ring (24) having a series of phase level steps (28) for approximating a Kinoform profile (18);

d) a positive power optical element (112) on said common optical axis (0) behind said first negative meniscus optical element (107), having surfaces (114, 116) which are substantially spherical; and

e) a second negative meniscus optical element (118) on said optical axis (0) behind said positive power optical element (112)."

"5. A telescope system (10) comprising:

a) a positive meniscus optical element (12) having a first convex surface (14) and a second concave surface (16), said first surface (14) being an aspherical surface and said second surface (16) being a binary grating surface (16), said binary grating surface (16) comprising a plurality of concentric rings (24), each ring (24) having a series of phase level steps (28) for approximating a Kinoform profile (18);

b) a negative meniscus optical element (56), aligned on a common optical axis (0) behind said positive meniscus optical element (12)."

For claim 1 and the further independent claim 4 according to auxiliary request 3, reference is made to



the appellant's letter dated 11.03.02.

- V. The arguments of the appellant in support of the main request and the auxiliary request 1 can be summarised as follows:

The subject-matter of claim 1 differs from the closest prior art, which is represented by D4, in that the first surface is an aspherical surface. This solves the technical problem of eliminating spherochromatism introduced by the binary grating surface. According to D4 the binary grating on the second surface reduces both the spherical and chromatic aberrations. Therefore a person skilled in the art has no incentive to use an aspherical first surface.

A combination of the closest prior art D4 with D10 does also not result in the subject-matter of claim 1. D10 makes reference to D4 and recognises that in an optical hybrid element having a spherical first surface and a binary grating on a second surface according to D4, spherochromatism is the dominating aberration. According to D10 the solution to this problem is the use of a second hybrid element. This teaches away from the present invention.

- VI. The arguments of respondent I with respect of the main request and the auxiliary request 1 are summarised as follows.

The subject-matter of claim 1 lacks an inventive step since it is obvious from either D4, D10 or a combination of D4 and D10.

In fact the patent starts from D4 disclosing an optical

element from which the subject-matter of claim 1 differs in that the first surface is an aspherical surface. According to the patent this solves the problem of spherochromatism introduced by the binary grating on the second surface. In D4 it is explicitly stated that the spherical aberration of a lens can be eliminated by making it an asphere. In D4 such an aspherical surface, which is costly, is avoided since the binary grating on the second surface reduces both the spherical and chromatic aberrations. However, it is evident that spherical aberration can as well be corrected by an aspherical surface.

It is indicated in D10 at page 26, third paragraph, first sentence, that the binary grating element introduces intolerable spherochromatism in fast systems. Therefore the skilled person is led to using an aspherical surface as is suggested in the second and third sentence of the cited paragraph.

VII. With respect to the main request and the auxiliary request 1 respondent II has argued as follows:

The subject-matter of claim 1 differs from what is disclosed in D4 by the first surface being an aspherical surface. This aspherical surface has the effect of correcting for spherical aberration. However, this effect is general knowledge, as is indicated e.g. also in D4.

Moreover, it is described in document D10 that for certain applications, the lens according to D4 suffers from spherochromatism generated by the diffracting surface. However, the skilled person knows that spherical aberration can be corrected for by other

means, namely by an aspherical surface (see D4), which would be the first surface in claim 1. The remaining chromatic aberration can be corrected for by the second diffracting surface.

Respondent II emphasised that all features of the claimed invention with their corresponding effects are present in D4 or D10. Only economic reasons could have prevented the skilled person from employing an aspherical refracting surface together with a binary grating surface approximating a Kinoform profile in one hybrid optical element.

## **Reasons for the Decision**

### *1. Admissibility of the appeal*

The appeal complies with the provisions of Articles 106 to 108 and Rule 64 EPC and is therefore admissible.

### *2. Inventive step of the subject-matter of claim 1 according to the main request*

- 2.1 D4, see section 4 at page 607, discloses an optical element (infrared refractive/diffractive element) for reducing aberration in an optical system, said optical element having first and second surfaces, said first surface being a refractive surface (spherical lens surface) and said second surface being a diffractive surface, wherein said second surface is a binary grating surface approximating a Kinoform profile (Figure 1(a) shows a profile which is known in the art as a Kinoform profile, see title of reference 2 cited at page 608 under "7. References" (reference 2 is

referred to at page 605, left-hand column, last paragraph)).

It is stated in D4: "By allowing the refractive part of the lens to do the majority of focusing, the diffractive surface only has to correct for aberrations" (see page 607, right column, third paragraph, second sentence) and "The diffractive surface is correcting for both spherical and chromatic aberrations simultaneously" (see page 607, right-hand column, penultimate paragraph, last sentence). Hence D4 discloses an optical element according to the preamble of claim 1.

2.2 The present invention is based on the recognition that such a refractive/diffractive optical element suffers from spherochromatism introduced by the diffractive binary grating surface, see description of the contested patent, page 2, lines 30 to 31. The solution to this problem according to the characterising portion of claim 1, is to make the refractive surface aspherical. According to the description, page 3, lines 21 to 23, the aspherical surface avoids much of the spherical aberration, whereas the binary grating surface eliminates spherochromatism.

2.3 The problem underlying the present invention is also addressed in D10, which makes reference to D1 (= D4) and states that for a singlet lens having a diffractive structure on the second surface (binary grating surface) spherochromatism becomes the dominating aberration, see page 25, last four lines. This aberration can be tolerated in slow ( $F/2.4$ ) systems but not in fast ( $F/1$ ) systems, see "5. Summary" at page 28. The solution offered in D10 for avoiding

spherochromatism is to replace the singlet lens by a two-element system (doublet), i.e. two refractive/diffractive lenses, see page 26, the paragraph below Table 1. However, such a doublet system approaches the performance of a conventional triplet system only for a reduced field of view ( $FOV = \pm 2.0^\circ$ ), see Table 1, first row and last row, first line. In contrast to that a two-element system with one conventional aspheric surface (conventional aspheric doublet), equals the performance of the conventional triplet, see page 26, Table 1, first two rows, and penultimate paragraph. This was a clear indication for a person skilled in the art that a singlet lens employing an aspheric first surface and a diffractive binary grating second surface would have comparable spherical and chromatic aberrations.

2.4 It was therefore obvious for the skilled person starting from the optical element disclosed in D4, to make the first surface aspherical in order to avoid spherochromatism.

3. *Inventive step of the subject-matter of claim 1 according to auxiliary request 1*

3.1 Claim 1 of the auxiliary request 1 is distinguished from claim 1 of the main request by assigning the respective functions to the two surfaces of the optical element. However, it is evident that the aspherical refracting surface will be designed for minimising spherical aberration and that chromatic aberrations are then reduced by the diffracting surface due to its compensating effect, since a refractive surface has a wavelength dispersion proportional to the wavelength and a diffractive surface has a wavelength dispersion

proportional to the inverse of the wavelength, see D4, page 605, left-hand column, penultimate paragraph.

4. *Arguments of the appellant*

4.1 The appellant has argued that D4 teaches that in an optical element employing a spherical first surface and a binary grating second surface both spherical and chromatic aberrations are reduced. Therefore there would be no incentive for the skilled person to use an aspherical surface.

4.3 However, the board is of the opinion that D4 also confirms the general knowledge of the skilled person that spherical aberration can be corrected by an aspherical surface, see page 605, left-hand column, second paragraph. Furthermore, it is indicated in D4 at page 607, right-hand column, fifth paragraph referring to Figure 5 that such an aspherical surface does not affect the chromatic aberrations. However, the skilled person would expect that the remaining chromatic aberrations could be cancelled by a diffracting surface having inverse wavelength dispersion, see page 605, left-hand column, penultimate paragraph, and item 3.1 above. The statement in D4, that the diffractive surface corrects for both spherical and chromatic aberrations is understood in the sense that the combination of a diffracting surface with a spherical surface is superior to a combination of an aspherical with a spherical surface, as can be seen from a comparison of Figures 5(b) and 6.

4.4 Moreover, the appellant has put forward the argument that the combination of D4 with D10 does not result in the invention since D10 provides a different solution,

namely two hybrid elements.

- 4.5 This argument can not be accepted by the board since it ignores the statements and results given in D4, related to elements employing aspheric surfaces, see item 2.3 above. It appears that the authors of D10 were interested in replacing elements employing spherical surfaces (Conventional triplet systems) by hybrid elements having spherical first and binary grating second surfaces, and avoiding the use of aspherical surfaces for the obvious reasons outlined at page 25, second paragraph. However, the skilled person derives also from D10 that an aspherical surface would be the choice for minimum chromatic effects, see page 26, penultimate paragraph.
5. Therefore, taking into due account the essential arguments of the appellant, it is concluded that the subject-matter of claim 1 according to the main request and the auxiliary request 1 does not involve an inventive step within the meaning of Article 56 EPC.
6. The independent claims according to the auxiliary requests 2 and 3 filed with letter dated 11.03.02 are based on independent claims 8 and 12 as granted. The opposition division had neither decided nor commented on these claims. Therefore the board exercises its discretion under Article 111(2) EPC to remit the case to the opposition division for further prosecution in order to give the parties the opportunity to have those requests considered at two instances.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The case is remitted to the opposition division for further prosecution on the basis of auxiliary requests 2 and 3 (the main request and the auxiliary request 1 being rejected as not allowable).

The Registrar:

The Chairman:

P. Martorana

E. Turrini