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D E C I S I O N
of 13 January 2006

Case Number: T 1088/05 - 3.4.02

Application Number: 97303082.8

Publication Number: 0807841

IPC: G02B 26/02

Language of the proceedings: EN

Title of invention:
Improved optical modulator/switch

Applicant:
LUCENT TECHNOLOGIES INC.

Opponent:

-

Headword:

-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes) "

Decisions cited:

-

Catchword:

-



Case Number: T 1088/05 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 13 January 2006

Appellant:

LUCENT TECHNOLOGIES INC.
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Representative:

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Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 22 March 2005
refusing European application No. 97303082.8
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: A. G. Klein
Members: F. J. Narganes-Quijano
M. J. Vogel

Summary of Facts and Submissions

I. The appellant (applicant) has lodged an appeal against the decision of the examining division to refuse European patent application No. 97303082.8 (publication No. 0807841).

In its decision the examining division held that the subject-matter of claim 1 amended according to the request then on file did not involve an inventive step (Articles 52(1) and 56 EPC) with regard to the prior art represented by the following documents:

D3: EP-A-0420468,

D4: WO-A-9603670, and

D5: US-A-3708222.

The examining division found in particular that the closest state of the art was represented by document D3 disclosing an optical modulator including a concave reflector, and that the sole distinguishing feature of the device defined in claim 1 over the optical modulator of document D3 was the replacement of the concave reflector by a reflective zone plate having concentrically-disposed annular-shaped regions. According to the view of the examining division, a reflective zone plate as claimed can be considered as a Fresnel mirror, and the distinguishing feature was rendered obvious by the teaching of each of documents D4 and D5 relating to the replacement of a converging or focusing mirror by a Fresnel mirror.

II. With the grounds of appeal the appellant requested setting aside of the decision under appeal and the grant of a patent. The application documents then on file were the set of claims 1 to 10 considered by the examining division in the decision under appeal, description pages 1, 4 to 6, 9 to 11 and 13 to 15 filed with the letter dated 11 March 2003, and description pages 2, 3, 7, 8, 12, and 16 to 23 and drawing sheets 1/12 to 12/12 as originally filed.

In response to a telephone consultation with the rapporteur the results of which were dispatched with a communication dated 28 October 2005 together with attached sheets showing by way of example amendments to, among others, pages 1 and 2 of the description of the application, the appellant expressed with its letter dated 22 December 2005 its agreement to the amendments and filed a new set of amended claims 1 to 10 replacing the previous set of claims.

III. Independent claims 1, 8 and 9 as amended according to the present request of the appellant are worded as follows:

" 1. An optical modulator/switch comprising, :
a reflective zone plate (8, 8a) for receiving an incident optical signal (23) and returning a reflected optical signal that is focused at a location a predetermined distance from the reflective zone plate, the reflective zone plate being arranged to be moved between a first and a second state such that, in the first state, the reflective zone plate has a first orientation relative to the incident signal and the reflected signal follows a first path, and, in the

second state, the reflective zone plate has a second orientation relative to the incident signal and the reflected signal follows a second path wherein, the focal location lies along at least one of the paths; the reflective zone path being defined by (i) a central circular region enclosed by a first plurality of spaced, concentrically-disposed annular-shaped regions, both the circular and annular regions being of a first type (11) and (ii) a second plurality of regions of a second type (10) located between the spaced annular-shaped regions of the first type, the reflective zone plate having one of either a first or a second configuration, wherein in the first configuration, regions of the first type prevent negative contributions to the amplitude of the reflected optical signal from reaching the focal location and regions of the second type reflect positive contributions to the amplitude of the reflected optical signal to the focal location, or alternatively, in the second configuration, regions of the first type reflect positive contributions to the amplitude of the reflected signal to the focal location and regions of the second type prevent negative contributions to the amplitude of the reflected signal from reaching the focal location;

a zone-plate support (6, 6a), in which or on which the reflective zone plate is defined, the zone-plate support physically configured so that it moves in response to a force, changing the state of the zone plate from or to the first state, to or from the second state;

a conductive layer (2a) spaced from the zone-plate support; and

a controlled voltage source (18a) electrically connected to the zone-plate support and the layer."

" 8. A method for modulating an optical signal, comprising the steps of:

generating an electrostatic force according to a control signal, the electrostatic force causing a reflective zone plate (8,8a) to change between a first and a second orientation relative to the optical signal, the reflective zone plate-being defined by (i) a central circular region enclosed by a first plurality of spaced, concentrically-disposed annular-shaped regions, both the circular and annular regions being of a first type (11) and (ii) a second plurality of regions of a second type (10) located between the spaced annular-shaped regions of the first type, the reflective zone plate configured in one of two ways, wherein in the first configuration, regions of the first type prevent negative contributions to the amplitude of the reflected optical signal from reaching the focal location and regions of the second type reflect positive contributions to the amplitude of the reflected optical signal to the focal location, or alternatively, in the second configuration, regions of the first type reflect positive contributions to the amplitude of the reflected signal to the focal location and regions of the second type prevent negative contributions to the amplitude of the reflected signal from reaching the focal location; and

reflecting the optical signal off of the reflective zone plate, wherein,

the change in orientation of the reflective zone plate causes a change in a path of the optical signal reflected from the reflective zone plate so that in the first orientation, the optical signal is reflected to a predetermined location, and, in the second orientation,

the optical signal is not reflected to the predetermined location, the controlled change in optical path resulting in modulation of the optical signal."

" 9. A method for switching an optical signal, comprising the steps of:

generating an electrostatic force in response to a control signal causing a reflective zone plate (8,8a) to move between a first orientation and a second orientation relative to the optical signal, the reflective zone plate being defined by (i) a central circular region enclosed by a first plurality of spaced, concentrically-disposed annular-shaped regions, both the circular and annular regions being of a first type (11) and (ii) a second plurality of regions of a second type (10) located between the spaced annular-shaped regions of the first type, the reflective zone plate configured in one of two ways, wherein in the first configuration, regions of the first type prevent negative contributions to the amplitude of the reflected optical signal from reaching the focal location and regions of the second type reflect positive contributions to the amplitude of the reflected optical signal to the focal location, or alternatively, in the second configuration, regions of the first type reflect positive contributions to the amplitude of the reflected signal to the focal location and regions of the second type prevent negative contributions to the amplitude of the reflected signal from reaching the focal location; and

reflecting the optical signal off of the reflective zone plate to a first waveguide (25) when the reflective zone plate is in the first orientation

and to a second waveguide (26) when the reflective zone plate is in the second orientation."

Claims 2 to 7 and 10 all refer back to claims 1 and 9, respectively.

IV. The arguments advanced by the appellant in support of its request can be summarised as follows:

The technical fields to which documents D4 and D5 pertain are so dissimilar to that of document D3 that the skilled person would not have considered the combination of the corresponding disclosures.

In addition, contrary to the examining division's view, the reflective zone plate of the invention is not a Fresnel mirror, and since none of references D4 and D5 teaches a zone plate, the combination of document D3 with document D4 or D5 does not result in the claimed invention. A zone plate is not a lens either, and even though a zone plate may perform the optical function of a lens, this does not support the correlation drawn by the examining division between a Fresnel reflector and a reflective zone plate.

Reasons for the Decision

1. The appeal is admissible.
2. *Amendments*

After due consideration of the amendments made to the claims and to the description of the application

according to the present request of the appellant, the Board is satisfied that the amended application documents comply with the formal requirements of the EPC, and in particular with those set forth in Article 123(2) EPC. More particularly, the optical modulator/switch defined in claim 1 is based on claim 1 as originally filed together with the passage at lines 11 to 13 of page 2 of the description of the application as originally filed; independent claims 8 and 9 respectively directed to a method of modulating and of switching an optical signal are respectively based on claims 6 and 7 and on claims 8 and 10 together with claim 1 as originally filed; and dependent claims 2 to 7 and 10 are based on claims 2 to 5, page 2, lines 16 and 17, page 2, lines 23 to 25, and claim 9 of the application as filed, respectively. Furthermore, the description has been appropriately amended and brought into conformity with the invention as defined in the amended claims (Article 84 EPC, second sentence and Rule 27(1) EPC).

3. *Claim 1 - Patentability under Article 52(1) EPC*

3.1 Novelty of the optical device defined in claim 1 upon which the contested decision is based was not contested by the examining division, and in this respect also the Board is satisfied that claim 1 amended according to the present request of the appellant defines novel subject-matter over the available prior art (Articles 52(1) and 54 EPC).

3.2 The Board concurs with the examining division in considering the disclosure of document D3 as representing the closest state of the art. This

document discloses a micromechanical light modulator for coupling optical signals between selected pairs of optical fibres so as to multiplex and/or demultiplex the optical signals (abstract and Figures 1 to 3). The modulator includes a cantilevered concave spherical mirror and a substrate located under the mirror arranged so that, when the electrical charge applied to the substrate is changed, the mirror is deflected between two positions (Figures 1 and 2, and column 2, lines 31 to 43 together with column 1, lines 11 to 25), the mirror being arranged in the two positions to focus and to reflectively couple light between different pairs of optical fibres (Figure 3 and column 2, line 44 to column 3, line 21).

The optical modulating and/or switching device defined in claim 1 differs essentially from the optical modulator disclosed in document D3 in that the optical coupling reflecting element is not a concave spherical mirror, but a zone plate designed to operate by reflection on the incoming optical signal and having the structural and functional features defined in the claim.

- 3.3 In the decision under appeal the examining division considered that a reflective zone plate in a modulator as that disclosed in document D3 merely constitutes an alternative technically equivalent to a concave spherical mirror. However, assuming for the sake of argument that no technical effect is achieved by the replacement in the modulator of document D3 of the concave spherical mirror by a reflective zone plate as claimed so that the problem solved by the claimed invention over the disclosure of document D3 would only

reside in the provision of an equivalent alternative, the Board is unable to follow the further contention of the examining division that the claimed subject-matter would then result in an obvious way from the teaching of documents D4 and D5.

Document D4 teaches the replacement in an image display apparatus of an imaging concave mirror by a Fresnel mirror (Figure 5 together with page 3, lines 21 and 22 and lines 32 to 36), and document D5 teaches the replacement in a vehicle of a conventional rear-view mirror by a Fresnel mirror (abstract and Figures 3 to 7, and column 1, lines 29 to 32 and column 2, lines 1 to 36). Assuming that the skilled person would have seen in these teachings a solution to the problem of providing an equivalent to the optical modulator of document D3, the application of the corresponding teachings would then have at the most suggested the replacement of the concave spherical mirror of document D3 by a Fresnel mirror, not however by a zone plate as required by the subject-matter of claim 1.

The Board notes in this respect from its own knowledge in the field that a zone plate (also conventionally called a Fresnel zone plate, see document US-A-5161059 cited in the search report, column 3, line 12 *ff.*) and a Fresnel mirror or reflector, although sharing common features such as the similar pattern appearance, constitute two different optical devices that operate optically quite differently. More specifically, both devices are generally constituted by a concentric arrangement of annular elements; nonetheless, while the width of the annular elements of a zone plate is of the order of the wavelength of the light (see for instance

US-A-5161059, *supra*, column 5, lines 16 to 29 and 61 to 65 together with Figures 1A to 1C), in the case of a Fresnel reflector the width of the elements is orders of magnitude greater than the wavelength of the light (*cf.* document D5 where the Fresnel mirror has 50 to 200 annular elements per inch (column 2, lines 21 to 24) and therefore the width of the annular elements is three orders of magnitude greater than the wavelength of visible light). Thus, a Fresnel mirror is generally constituted by annular segments of a conventional curved mirror all projected on a common plane (see Figures 2 and 4 of document D5, and Figure 5 of document D4) and consequently, although diffraction phenomena cannot be excluded in such an arrangement, the Fresnel mirror primarily operates by ordinary reflection on the annular segments all having the same focal length. A reflective zone plate, on the other hand, is a purely diffractive element constituted by a diffractive pattern of concentric annular zones and operating primarily by Fresnel diffraction so that light reflectively diffracted by annular zones having alternate optical properties as claimed constructively interferes at a focal point the position of which depends on parameters such as the width and the number of the annular elements, and the wavelength of the light.

It follows from the above considerations that, contrary to the view expressed by examining division in the decision under appeal, a reflective zone plate as that defined in claim 1 cannot be considered a Fresnel lens. Accordingly, the application of the teachings of documents D4 and D5 to the modulator device of document D3 would not result in an optical modulator including a

zone plate having the structural and functional features of the zone plate defined in claim 1.

- 3.4 In view of the foregoing, the Board concludes that the subject-matter of claim 1 does not result in an obvious way from the prior art considered by the examining division. In addition, after consideration of the remaining documents on file, the Board is satisfied that the subject-matter of claim 1 involves an inventive step over the available prior art (Articles 52(1) and 56 EPC).

4. *Claims 2 to 10*

Independent claims 9 and 10 are respectively directed to a method of modulating and of switching an optical signal, the steps of the respective methods being essentially in one-to-one correspondence with the functional features of the different means of the optical modulator/switch defined in claim 1.

Dependent claims 2 to 7 and 10 concern particular embodiments of the subject-matter of claims 1 and 9, respectively.

It follows that claims 2 to 10 also define patentable subject-matter under Articles 52(1), 54 and 56 EPC for reasons analogous to those put forward in point 3 above with regard to the subject-matter of claim 1.

5. In view of the above, the decision under appeal is to be set aside. In addition, being satisfied that the patent application as amended according to the present request of the appellant and the invention to which it

relates meet the requirements of the EPC (Article 97(2) EPC), the Board, in accordance with Article 111(1) EPC, considers it appropriate to exercise favourably the power within the competence of the examining division to order grant of a patent.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following application documents:
 - claims 1 to 10 filed with the letter dated 22 December 2005;
 - description pages 3, 7, 8, 12 and 16 to 23 as originally filed, description pages 4 to 6, 9 to 11 and 13 to 15 filed with the letter dated 11 March 2003, and description pages 1 and 2 as annexed to the official communication of the Board dated 28 October 2005, and
 - drawing sheets 1/12 to 12/12 as originally filed.

The Registrar:

The Chairman:

P. Martorana

A. G. Klein