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Datasheet for the decision of 23 October 2007

Case Number: T 1364/05 - 3.4.02

Application Number: 00302052.6

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Language of the proceedings: EN

Title of invention:
Receiving system for free-space optical communications

Applicant:
Lucent Technologies Inc.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1364/05 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 23 October 2007

Appellant: Lucent Technologies Inc.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 20 June 2005 refusing European application No. 00302052.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. G. Klein
Members: F. Maaswinkel
C. Rennie-Smith

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal, received on 25 July 2005, against the decision of the examining division, dispatched on 20 June 2005, refusing the European patent application No. 00302052.6. The fee for the appeal was paid on 25 July 2005. The statement setting out the grounds of appeal was received on 10 October 2005.

II. In its decision, the examining division held that the patent application did not meet the requirements of Article 52 EPC because the subject-matter of claim 1 was not new in the meaning of Article 54(1) and (2) with respect to the disclosure in document D2 (JP-A-07 110 526). The subject-matter of the dependent claims did not involve an inventive step (Article 56 EPC).

III. With the statement of grounds of appeal the appellant requested that the set of claims on which the decision under appeal was based be considered as its main request and it also filed a further set of claims as a an auxiliary request.

IV. In a Communication pursuant to Article 11(1) RPBA accompanying a summons to oral proceedings the board, referring to a family member of document D2 (D2a: US-A-5 570 140), expressed its preliminary opinion that the subject-matter of claim 1 appeared to be anticipated by the disclosure in this document. As to the further claims, reference was made to document D4 (US-A-4 975 926) which disclosed in Figure 9 a receiver for a free-space communication system. Furthermore the board of its own motion (Article 114(1) EPC) made reference to

documents D5 and D6 which would appear to disclose, in combination with the teaching of document D4, relevant subject-matter for the issue of inventive step:

D5: Applied Optics vol. 16, pages 2677 - 2683 (October 1977), M. Collares-Perreira et al: "Lens-mirror combinations with maximal concentration";

D6: SPIE, vol. 1528 Nonimaging Optics: Maximum Efficiency Light Transfer (1991), pages 88 - 92, Xiaohui Ning: "Application of non-imaging optical concentrators to infrared energy detection".

V. Oral proceedings took place on 23 October 2007. At the oral proceedings the appellant filed new sets of claims according to a main and an auxiliary request replacing the previous requests and requested that a patent be granted on the basis of the claims of either this main or auxiliary request. The board gave its decision at the end of the oral proceedings.

VI. The wording of claim 1 of the main request reads as follows:

"A free-space optical information communications receiving system capable of carrying Gigabit per second baud communications rates or greater, comprising:

a Fresnel lens (16) for receiving an optical communication signal (14) carrying data;

a detector (32) having a sensing surface area (34), the sensing surface area being oriented to receive the communication signal emerging from the concentrator (250) and convert the information in the communication signal into an electrical signal and

a concentrator (50) arranged between the Fresnel lens (16) and the detector (32)

characterized in, that

the concentrator is a tapered concentrator (50) having a first end surface area (22) larger than a second end surface area (26) and being in direct optical communication with the Fresnel lens, and

that the tapered concentrator has an inner core (252) having a first index of refraction and an outer layer (254) having a second index of refraction lower than the first index of refraction".

Claims 2 to 12 of this request are dependent claims.

The wording of claim 1 of the auxiliary request is as that of claim 1 according to the main request with the additional features at the end of the claim:

"(...than the first index of refraction) and

that a gap (43) of less than 10 microns lies between the tapered concentrator and the sensing surface area of the detector".

Claims 2 to 11 of this request are dependent claims.

VII. The arguments of the appellant may be summarised as follows.

Claim 1 according to the main request combines the features of original claims 1 and 8 and is, furthermore, now directed to a free-space optical information communications receiving system capable of carrying gigabit per second baud communication rates or greater.

Support for this feature can be found, for instance, in page 11, lines 1 to 4 of the original patent application. Hence it is clear that the invention is concerned with an alternative communication method to short-haul microwave radios that does not need governmental licensing, see page 1, lines 19 to 21. By virtue of the new wording the subject-matter of the claim is clearly distinguished from the disclosure of documents D2 and D2a, which deal with a curious form of remote control of a TV set. For this reason alone the subject-matter of claim 1 is novel over the disclosure in these documents which are also of no relevance for the issue of inventive step, because the data rates in TV systems are far below a gigabit per second. Rather document D4 is now considered to be the nearest prior art document. Claim 1 is drafted with the features common to those of D4 in its preamble.

The requirement of being capable of carrying gigabit per second baud communication rates or greater leads to two problems not considered in document D4:
- Sensors fast enough for such applications have very small sensor areas. Therefore the incident electromagnetic signal needs to be concentrated onto such a small area;
- There is a need to reduce the effect of multiple-path reception. Otherwise data received on a direct path have less delay than those received via reflections, which would cause the signal bits to merge with neighbouring bits.

Whereas it could perhaps be arguable whether the formulation of these problems as such is inventive, at least the solution defined in claim 1 is non-obvious

and therefore involves an inventive step. In the opinion of the appellant, the skilled person for the present case is an engineer working in the field of optical data communication. In order to find a solution to the above problems this skilled person would have to consult different fields of technology. The first problem of high concentration of the electromagnetic energy onto a small surface can be found in the field of solar energy. As a possible solution the use of a tapered concentrator may be found here. The second problem of reducing the effect of free-space multiple-path reception is known in the field of radio communications. Here one has normally only a few separate paths where the filtering out of each of the respective signals with subsequent delaying and superposition is possible and is indeed usually carried out. However, in case a tapered concentrator would be used there are not just a few separate paths but there may be many, and the filtering solution known from the radio communications field cannot be adopted. The person skilled in the art would only find the proper solution for these problems in yet another technical field, that of optical fibre data transmission, where fibres with transitions in the index of refraction profile are employed. Therefore, in order to arrive at the invention, information from three different technical fields would have to be combined. There appears to be no possibility that the skilled person would have arrived at the claimed solution in an obvious way by combining the teachings of the available documents with the disclosure in document D4. Therefore the solution defined in claim 1 of the main request is based on an inventive step.

Claim 1 according to the auxiliary request includes, in addition to the features of claim 1 of the main request, the features of original claim 4. These features relating to the size of the gap between the second surface of the concentrator and the sensing surface area of the detector address the further problem of reducing the loss at the transition between these elements. The solution to this further problem is not found in the available documents and therefore also involves an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 *Amendments*

The board is satisfied that the features of claim 1 are fairly supported by original claims 1 and 8 and the passage in the description referred to by the appellant. This applies similarly to the dependent claims.

2.2 *Novelty*

2.2.1 In the decision the patent application had been refused on the ground that the subject-matter of claim 1 then on file was not novel over the disclosure in document D2. Also in its Communication the board indicated that the subject-matter of this claim was anticipated by this document, in the form of its US-family member D2a. By amending claim 1 to a free-space optical communications receiving system capable of carrying

gigabit per second baud communications rates or greater the subject-matter of this claim is now clearly distinguished from the apparatus disclosed in D2 (D2a), because the receiving system of that document relates to data transfer at video TV-rates, which have typical transfer rates of some Megabits per second. Therefore, by virtue of the new features the subject-matter is novel over the disclosure in D2 or D2a.

2.2.2 The only further document of interest for the issue of novelty, document D4, discloses a free-space optical information communications receiving system as defined in the preamble of claim 1. In particular Figure 9 of D4 shows a lens system for use with the receiving system comprising a Fresnel lens 80 for receiving an optical communication signal carrying data (infrared signal, see column 5, line 1), a detector (photodiode 84), and a concentrator (immersion lens 82) arranged between the Fresnel lens and the detector. The subject-matter of claim 1 differs from the receiving system in Figure 9 of document D4 by the features of the characterising portion of this claim, i.e.

- the concentrator is a tapered concentrator; and
- the tapered concentrator has an inner core having a first index of refraction and an outer layer having a second index of refraction lower than the first index of refraction.

Therefore the subject-matter of claim 1 is novel.

2.3 *Inventive step*

2.3.1 At the oral proceedings the appellant argued that the features of claim 1 solve the problem of providing a sufficient concentration of the incident electromagnetic radiation onto a small detector surface and to provide a concentrator ensuring that the path differences of the various paths of the incident rays are not too large in order to avoid distortion and smearing of the signal bits. In this respect the following is noted.

2.3.2 Concerning the first problem, concentration of the incident electromagnetic signal onto a small detector surface, it is observed that claim 1 does not define any numerical data or restrictions other than that the concentrator is a tapered concentrator comprising an inner core with a first index and an outer layer having a second index of refraction smaller than the first index of refraction. In any case, the requirement that the optical receiver system is designed in such a way that essentially all incident energy (through the Fresnel lens) reaches the detector is a self-evident requirement. Furthermore it appears that the optical receiver system in Figure 9 of document D4 meets the same requirement by using an alternative solution of the immersion lens 82. In fact, in column 5, lines 1 to 32 of D4 even explicitly discloses the importance of maximising the effective gain G, which can be optimised by maximising the optical gain (lines 6 to 8).

2.3.3 With respect to the second problem outlined by the appellant, the board was unable to find any disclosure of this problem in the application documents as

originally filed. It is true that in the description (see Section "Background Of The Invention") the phenomenon of scintillation is discussed which may lead to attenuation or refraction of the optical signal in the atmosphere (outside the receiver), but its deleterious effects are relieved by employing a (large size) Fresnel lens, just as in the optical receiver system of Figure 9 of D4. However, the problem of spatial dispersion of the propagating signals within the optical receiver system is not touched upon at all in the patent application, nor is a technical solution for such a problem offered. Rather, according to the second paragraph on page 7 of the original description, the electromagnetic field may propagate within the tapered concentrator under conditions of reflection or total internal refraction, and the concentrator may be constructed of glass, in agreement with the condition for the material index of refraction in claim 1. It goes without saying that neither a concentrator comprising a reflective conical inner surface, nor a concentrator being constructed of glass without special index of refraction profile can offer any compensation against spatial dispersion. Therefore, the board is not persuaded by the appellant's arguments in support of inventive step.

2.3.4 Rather, in order to assess a possible contribution to inventive step the board follows the well-known problem and solution approach. In point 2.2.2 supra the differences between the subject-mater of claim 1 and the embodiment in Figure 9 of document D4 have been reproduced. These differences reside entirely in the optical design of the optical receiver system, and the objective problem can therefore be seen in offering an

alternative solution for the beam combining system between the Fresnel lens and the detector.

2.3.5 In this respect the board does not accept the argument of the appellant that in the assessment of inventive step the skilled person is an optical data communication engineer. Rather, as discussed in the Case Law of the Boards of Appeal, 5th edition 2006, Section I.D.7.1 ("Definition of the skilled person"), if the problem prompts the skilled person to seek its solution in another technical field, the specialist in that field is the person qualified to solve the problem. Therefore in the present case, since the problem of designing an alternative beam combiner in the optical receiver system of Figure 9 of D4 is an optical problem, the skilled person seeking alternative solutions would consult an optical physicist or designer.

2.3.6 For an optical designer it is clear that the optical receiver system in Figure 9 of D4 is a system well-known in the field of non-imaging optics. Documents D5 and D6 are documents from this particular field. According to D5, see "Abstract", the lens-mirror combinations disclosed in this document are "useful whenever concentration rather than image formation is important, for example in radiation detectors and solar energy collectors". In Figure 3(b) of this document an optical system with a Fresnel lens and straight V-groove mirrors is shown as a simple example in 2-D geometry. On page 2677, left column, it is discussed that for 3-D geometries an acceptable response may be obtained by rotating the 2-D profile about an axis of revolution, which would result in a cone-shaped concentrator with an internally reflecting conical

surface, which is one of the possibilities disclosed in page 7 of the original description (see point 2.3.3. supra).

2.3.7 Also document D6 relates to the application of non-imaging optical concentrators to (infrared) electromagnetic energy, similarly to D4 which also addresses an infrared optical system (see Abstract). In Figure 3 of D6 a dielectric totally internal reflecting conical concentrator is shown, which is made out of germanium for concentrating the infrared radiation onto the detector. According to equation (4) on page 89 of D6, the maximum concentration ratio of the optical system is proportional to the square of the index of the refraction of the concentrator material. Therefore, following the recommendation in column 5 of document D4 to maximise the optical gain of the system, the skilled person would follow the teaching of document D5 to use a conical concentrator in combination with the Fresnel lens, wherein it would be advantageous to employ a conical concentrator out of dielectric material with an index of refraction within the material larger than the index of refraction at the outside of the material.

2.3.8 In finding this alternative solution for the optical receiver system of Figure 9 in document D4 he would automatically arrive at the subject-matter of claim 1. Therefore the subject-matter of this claim does not involve an inventive step.

3. *Auxiliary request*

3.1 *Amendments*

The additional features of claim 1 of this request had been disclosed in original claim 4. Therefore the provisions of Article 123(2) EPC are fulfilled.

3.2 *Novelty*

Since claim 1 of this request is more restricted than claim 1 according to the main request its subject-matter is novel for the reasons given in point 2.2. supra.

3.3 *Inventive step*

3.3.1 The minimisation of the gap between the output surface of the tapered concentrator and the detector surface solves the technical problem of maximising the energy transferred from the concentrator to the detector, as is also pointed out in document D6 on page 89, where it is disclosed that the concentration ratio is maximised if the output angle $\theta_2 = \pi/2$. On page 91, first paragraph of this document, it is therefore recommended to position the optical detector in optical contact with the concentrator, which can be achieved by using an optical cement. Furthermore it is noted that it is an intrinsic property of an immersion lens such as the one in the arrangement of Figure 9 of document D4 to be in optical contact with the detector, therefore the additional feature of this claim does not contribute to an inventive step.

4. Since the subject-matter of the independent claims of either request do not involve an inventive step, the appeal is not allowable.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Kiehl A. G. Klein