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D E C I S I O N
of 25 February 1999

Case Number: T 0954/97 - 3.4.2

Application Number: 91903518.8

Publication Number: 0507882

IPC: G02F 1/01, G02F 1/125

Language of the proceedings: EN

Title of invention:
Variable optical fiber Bragg filter arrangement

Applicant:
United Technologies Corporation

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"
"Selection of the closest prior art

Decisions cited:
-

Catchword:
-

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Case Number: T 0954/97 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 25 February 1999

Appellant: United Technologies Corporation
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Representative: Klunker, Schnitt-Nilson, Hirsch
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 13 May 1997 refusing European patent application No. 91 903 518.8 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: A. G. Klein
M. Lewenton

Summary of Facts and Submissions

I. European patent application No. 91 903 518.8 (International publication No. WO 91/10 156) was refused by decision of the Examining Division.

The reason for the decision was that the subject-matter of claim 1 did not involve an inventive step within the meaning of Article 56 EPC in view of the following documents:

D1: Optical Fiber Sensors Topical Meeting, 1988, Technical Digest Series, New Orleans, Louisiana, 27-29 January 1988, vol. 2, part 1, Optical Society of America (Washington D.C., US), G. Meltz et al.: "In-fiber Bragg grating sensors", pages 163-166;

D3: Journal of Lightwave Technology, vol. 5, No. 9, September 1987, IEEE (New York, US), B.J. White et al.: "Optical fiber thermal modulator", pages 1169-1175, and

D5: Patent Abstracts of Japan, vol. 12, No. 394, (P-773), 20 October 1988, & JP-A-63 134 962 (Fujikura Ltd.) 7 June 1988.

The Examining Division in particular held that the nearest prior art was constituted by the arrangement disclosed in document D1 which, although used only as an optical fiber sensor, de facto formed a variable light filtering arrangement within the meaning of claim 1. The claimed arrangement differed from this

nearest prior art only by the explicit definition of means for controlledly modifying the reflected wavelength of the filter. However, means for applying temperature or strain to an optical fiber were generally well-known in the art, as was evidenced for instance by document D3 or D5. The skilled person would in an obvious way use such means to tune the wavelength of the in-fiber Bragg grating known from document D1.

The Examining Division in its decision also rejected the applicant's submission that the closest prior art was disclosed in either of documents:

D2: US-A-3 916 182, or

D7: EP-A-0 221 560

which in the applicant's view were the sole documents to describe controlledly tunable in-fiber Bragg grating devices.

II. The appellant (applicant) filed an appeal against the decision.

III. Oral proceedings were held on 25 February 1999, at the end of which the appellant requested that the decision under appeal be set aside, and that a patent be granted on the basis of amended documents filed at the oral proceedings, of which claim 1, the only independent claim, reads as follows:

"1. A variable optical fiber Bragg filter comprising:

a) at least one optical fiber section (11) including a waveguiding core (13);

b) at least one permanent Bragg grating region (12) in said optical fiber section (11) constituted by periodic refractive index variations of a predetermined initial periodicity and adapted for cumulatively redirecting of the light launched into said core (13) for guided propagation therein, that light having an axial wavelength within a narrow band around a central wavelength that is determined by the periodicity and refractive index variations of said grating region (12); and

c) wavelength tuning, scanning or modulating means (including 15; 15a; 15b; 15c; 15d; 15e; 15f; 15g) for controlledly modifying at least one of the periodicity and refractive index of said grating region (12), said modifying means (including 15; 15a; 15b; 15c; 15d; 15e; 15f; 15g) being controlled by a parameter other than structural strain or temperature, whereby an attendant change in said central wavelength within a predetermined wavelength range to an extent dependent on the magnitude of said parameter is performed."

IV. In support of his request, the appellant essentially contested the choice made by the Examining Division of document D1 as disclosing the closest prior art.

In his view, document D1 was directed to temperature and strain sensors as used, for example, for monitoring strain in aircraft wings or temperatures in aircraft engines. In contrast the invention was directed to variable light filters as used for instance as

controllable band-pass filters in electro optical communication systems, which was a very different technical environment.

Document D2 was dedicated to tunable optical band-pass filters for use in optical communication systems, which therefore came nearer to the invention than the sensor device of document D1.

Documents D2 and D7 consistently taught the expert to use a temporarily varying grating when the filter characteristic was to be modulated, and to use a permanent grating only when the filter characteristic was to remain constant. Producing the temporary grating of document D2 or D7 requires a complex and expensive equipment.

Against the consistent only teaching of the prior art, the invention now proposed using a permanent Bragg grating also as a variable optical filter arrangement, and to control it through a parameter other than strain or temperature.

Document D1 did not disclose anything other than a sensor for sensing temperature or strain, and there was no obvious motive why the expert in the field of optical filters who wanted to overcome the cost problems of the temporarily varying gratings of documents D2 and D7 should have considered combining the teachings of documents D2 (or D7) and D1.

Reasons for the Decision

1. The appeal is admissible.

2. *Allowability of the amendments*

2.1 As compared to the designation of the invention in claim 1 as originally filed ("a variable light filtering arrangement"), the designation of the invention in present claim 1 has been amended to "a variable optical fiber Bragg filter", in conformity with the presentation of the invention at the beginning of the description as originally filed (see page 1, lines 2 to 11).

The means for controlledly modifying at least one of the periodicity and refractive index of the grating region as set out in claim 1 as originally filed have been further specified to constitute "wavelength tuning, scanning or modulating means", as disclosed originally in page 6, lines 25 to 31 and page 7, lines 2 to 7 of the description.

Finally, the modifying means have been specified as being "controlled by a parameter other than structural strain or temperature, whereby an attendant change in said central wavelength within a predetermined wavelength range to an extent dependent on the magnitude of said parameter is performed". This limitation, introduced by the appellant during the examining procedure in an attempt to better distinguish his invention from the strain or temperature sensor of document D1, is supported in particular by the original disclosure of the various embodiments, which all involve controlling the wavelength tuning, scanning or modulating of a variable Bragg filter by directly

acting upon a parameter other than structural strain or temperature, such as electrical current (see Figure 1), optical radiation (see Figures 2 and 3), electrical voltage (see Figure 4), magnetic, electric or acoustic fields (see Figure 5) or electrical frequency (see Figure 6).

2.2 Dependent claims 2 to 19 were amended only for consistency with amended claim 1, and all claims were supplemented with reference signs.

2.3 The description was amended for consistency with the amended wording of claim 1, and supplemented with a short summary of the relevant content of documents D1, D2 and D7, in compliance with the requirements of Rule 27(1)(b) and (c) EPC.

A passage of the description which evoked the possibility of using the invention in a Fabry-Perot arrangement was deleted, and a few obvious clerical mistakes corrected.

2.4 Thus, the amended patent application does not in the Board's view contain subject-matter which extends beyond the content of the application as filed, in compliance with the requirement of Article 123(2) EPC.

3. *Novelty*

Document D1 discloses in-fiber Bragg grating sensors (see the title) which comprise an optical fiber section with a permanent Bragg grating region as set out in paragraphs a) and b) of claim 1 (see the paragraphs "INTRODUCTION" and "CONCLUSIONS").

Although document D1 in the above-mentioned passages explicitly states that the Bragg grating region in the fiber core acts as a very narrowband reflection filter, the line center of which shifts with temperature or applied strain (see page 165, lines 2 to 4), it only evokes their use as wavelength-selective, tandem temperature and strain sensing regions in a single fiber (see the last sentence of paragraph "INTRODUCTION").

Thus, document D1 does not disclose feature c) of claim 1, according to which wavelength tuning, scanning or modulating means controlled by a parameter above the structural strain or temperature are provided.

Document D2 discloses a variable Bragg filter comprising a Bragg grating region formed either in a planar waveguiding material or in an optical fiber section (see abstract and column 5, lines 63 to 68). Wavelength tuning, scanning or modulating means for controlledly modifying at least one of the periodicity and refractive index of the grating region, controlled by a parameter other than structural strain or temperature, consisting for instance of incident optical or ultrasonic energy, are also provided (see column 4, lines 36 to 55 and column 5, lines 13 to 26; Figures 1 and 5).

The grating region of this known variable optical fiber Bragg filter however consists of a temporary Bragg grating which results from controlled application of optical or ultrasonic radiation, and which disappears on interruption of the radiation.

Thus, the variable optical fiber Bragg filter defined in claim 1 is distinguished from the variable filter of document D2 essentially in that it comprises at least one **permanent** Bragg grating region.

Document D7 also discloses a variable optical fiber Bragg filter comprised of a temporary grating formed by exposing a region of the fiber to specially and temporarily varying radiation (see the paragraph bridging pages 16 and 17 and Figure 8). This document does not disclose a variable Bragg filter comprising a permanent Bragg grating region either.

The remaining citations on the file do not come closer to the subject-matter of claim 1. Documents D3 and D5 invoked by the Examining Division in the appealed decision neither relate to Bragg gratings nor to variable filters.

Accordingly, the subject-matter of claim 1 is novel within the meaning of Article 54 EPC, as was also acknowledged by the Examining Division.

4. *Inventive step*

4.1 Closest prior art

Claim 1 is directed to a variable optical fiber Bragg filter which in particular comprises a Bragg grating region which can be so controlledly modified by varying a control parameter as to achieve wavelength tuning, scanning or modulating of the filter. This filter can for instance be used in optical communication or laser control systems (see page 3, lines 1 to 8 of the

description).

Variable optical fiber Bragg filters for use in communication systems are known from documents D2 and D7 (see point 3 above). The claimed variable filter is distinguished from these known arrangements mainly in that its Bragg grating region is of the permanent rather than of the temporary type.

The variable optical fiber Bragg filters disclosed in either document D2 or document D7 therefore in the Board's view represent the closest prior art.

The Board cannot in this respect endorse the Examining Division's selection of the devices disclosed in document D1 as constituting the closest prior art. These devices form mere passive sensors which indeed act as optical filters, the reflection characteristics of which depend on temperature or applied strain. These sensors do not however comprise any wavelength tuning, scanning or modulating means responsive to a parameter for controlledly modifying their filtering characteristics, as is required by claim 1.

Since the invention defined in claim 1 and described in the application is clearly directed to a variable optical filter for use for instance in optical communication systems, the skilled person in the Board's judgment would not have had any good reason to select a mere passive sensor as disclosed in document D1 as a starting point for further development of a variable optical filter.

4.2 Definition of the technical problem

The variable optical fiber Bragg filters of documents D2 or D7 use temporary Bragg gratings as filters the filter characteristics of which can be tuned or modulated by varying the grating pattern temporarily produced in a fiber material which is adapted to form a grating pattern only as long as it is exposed to radiation altering the index of refraction of the fiber material. Tuning or modulating the filter characteristics is obtained by varying the conditions of exposing the fiber material to the grating producing radiation. The Board has no reason to question the appellant's submission that temporary gratings impose narrow restrictions as to suitable fiber materials and that they require a relatively complex and costly exposing apparatus for each grating filter (see the prior art acknowledgement on page 3a of the description).

In contrast, the use of a permanent Bragg grating instead of the known temporary grating, which is the only feature to distinguish the subject-matter of claim 1 from the closest prior art, certainly allows for dispensing with the necessity of providing equipment specifically dedicated to the maintaining of a temporary grating pattern during operation of the filter.

Thus, the technical problem underlying the claimed invention is to reduce the complexity and cost of the variable optical fiber Bragg filters of the nearest prior art.

4.3 The claimed solution

Documents D2 and D7 each describe Bragg gratings both of the permanent type (see D2, the embodiment of Figure 1 and D7, the embodiment of Figure 1) and of the temporary type (see D2, the embodiments of Figures 4 and 5 and D7, the embodiment of Figure 8). In both documents, the permanent gratings are used in non-variable filters whilst the temporary gratings are always associated with variable filters. Document D2 explicitly states that permanent gratings may be produced by specified techniques, for applications where it is not necessary to vary the band-pass of the filter (see column 5, lines 28 to 33).

Documents D2 and D7 thus consistently teach that temporary gratings are required for forming tunable or variable Bragg filters, and they therefore teach away from the claimed solution, which consists in using a permanent grating in a variable filter too.

The only citation on the file to disclose permanent Bragg gratings is document D1, which however is specifically dedicated to sensors (see the title). This document indeed states that the permanent Bragg gratings disclosed there are sensitive to temperature and applied strain, and that they act as very narrowband reflection filters with a line center which shifts with temperature or applied strain (see the first paragraph on page 165).

In the Board's view, the skilled person striving generally to reduce the cost and complexity of the variable temporary Bragg filters of documents D2 and D7 and faced in particular with the consistent teaching in these documents that permanent gratings are only suitable for use with non-variable filters, had no obvious reason to contemplate the use of the permanent gratings disclosed in document D1 in connection only with passive sensors. Document D1 does not in any way suggest that the permanent gratings it describes could actually be associated with wavelength tuning, scanning or modulating means so as to form a variable Bragg filter which may in particular be controlled in a sufficiently reproducible way, and with the response times usually required in optical communication applications.

4.4 The subject-matter of claim 1 therefore in the Board's judgment involves an inventive step within the meaning of Article 56 EPC.

Dependent claims 2 to 19 also define inventive subject-matter, by virtue of their dependence on to claim 1.

5. Thus, the present patent application and the invention to which it relates in the Board's opinion meet the requirements of the Convention.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent on the basis of the followings documents:

Claims: 1 to 19,

Description: pages 1 to 14,

Figures: 1 to 8,

all documents filed during the oral proceedings of 25 February 1999.

The Registrar: The Chairman:

P. Martorana E. Turrini