

Internal distribution code:

- (A) Publication in OJ
(B) To Chairmen and Members
(C) To Chairmen
(D) No distribution

D E C I S I O N
of 22 March 2002

Case Number: T 0407/97 - 3.4.1

Application Number: 90202736.6

Publication Number: 0425014

IPC: H01S 3/06

Language of the proceedings: EN

Title of invention:

Amplifier for optical fiber telecommunication lines and optical fiber telecommunication lines incorporating said amplifier

Patentee:

Optical Technologies Italia S.p.A.

Opponent:

Bosch Telecom GmbH

Headword:

-

Relevant legal provisions:

EPC Art. 54(1)(2), 56, 100(a), 52(1)

Keyword:

"Novelty and inventive step (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 0407/97 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 22 March 2002

Appellant:
(Opponent)

Bosch Telecom GmbH
Abteilung ZG
Wernerstr. 1
D-70469 Stuttgart (DE)

Representative:

-

Respondent:
(Proprietor of the patent)

Optical Technologies Italia S.p.A.
Viale Sarca, 222
I-20126 Milano (IT)

Representative:

Marchi, Massimo, Dr.
Marchi & Partners
Via Pirelli, 19
I-20124 Milano (IT)

Decision under appeal:

Decision of the Opposition Division of the
European Patent Office posted 4 February 1997
rejecting the opposition filed against European
patent No. 0 425 014 pursuant to Article 102(2)
EPC.

Composition of the Board:

Chairman: G. Davies
Members: R. Q. Bekkering
M. G. L. Rognoni

Summary of Facts and Submissions

- I. The appellant (opponent) lodged an appeal against the decision of the opposition division, dispatched on 4 February 1997, rejecting the opposition against European patent No. 0 425 014. The notice of appeal was received on 10 April 1997, the appeal fee being paid on the same day, and the statement of grounds of appeal was received on 6 June 1997.
- II. Opposition had been filed against the patent as a whole, based on Article 100(a) EPC on the grounds of lack of novelty and inventive step (Articles 52(1), 54, 56 EPC).
- III. In the appeal proceedings reference was made to the following documents:
- D1: OCTIMA, 24-26 January 1989, Rome, Italy, pages 203-209 Payne et al.: "Erbium doped fibre amplifiers operating at 1.5 μm "
- D3: 14TH ECOC, 11th - 15th September 1988, pages 25-27; R.I. LAMING et al. : "Optimal pumping of erbium-doped-fibre optical amplifiers"
- D4: EP-A-0 293 289
- D4A: EP-A-0 234 326
- D5: EP-A-0 143 561
- D10: "Optical communication systems", John Gowar, Prentice/Hall International, 1984, page 140

D12: Applied Optics, Vol. 22, No. 3, 1 February 1983, pages 484-491, M. Dignonnet et al., "Wavelength multiplexing in single-mode fiber couplers"

IV. The appellant requested that the decision under appeal be set aside and the patent revoked.

V. The respondent requested that the appeal be dismissed. Alternatively, it was requested that the decision under appeal be set aside and the patent maintained in amended form on the basis of one of seven auxiliary requests.

VI. Oral proceedings were held on 22 March 2002.

VII. Independent claims 1 and 6 of the patent as granted read as follows:

"1. An amplifier (3) for signal-transmitting optical fiber telecommunication lines, which can be interposed between one portion (2) of the optical fiber of the line and a second portion (4) of the optical fiber of the line comprising an optical pumping radiation source (7), a dichroic coupler (6) adapted to be connected to said first optical fiber portion (2) of the line and connected to the optical pumping radiation source (7), and a length (8) of active-core optical fiber, single-mode to both optical signal radiation and optical pumping radiation, having one end connected to the dichroic coupler (6) and the other end susceptible of being connected to said second optical fiber portion (4) of the line, said amplifier (3) being characterized in that the dichroic coupler (6) is of the type comprising two lengths (9, 10) of nonactive-core optical fiber disposed in side by side relation over a portion (11) of their length

where they are optically coupled to each other by fusion of the respective claddings and substantial setting in common of the respective cores by stretching the lengths themselves, both said optical fiber lengths (9, 10) forming the dichroic coupler (6) being single-mode both for the optical signal radiation and optical pumping radiation.

6. An optical fiber telecommunication line comprising at least one portion (2) of signal transmitting optical fiber and at least a second portion (4) of signal transmitting optical fiber optically connected to each other through an optical amplifier (3) interposed therebetween, said optical amplifier (3) comprising an optical pumping radiation source (7), a dichroic coupler (6) optically associated with said optical pumping radiation source (7) and to the first optical fiber transmission portion (2) of the line, one length (8) of active-core optical fiber, single-mode to both optical signal and pumping radiations downstream of the dichroic coupler (6) and optically connected thereto, said length (8) of active-core optical fiber being also optically connected to the second portion (4) of the signal transmitting optical fiber of the line, said line being characterized in that the dichroic coupler (6) is of the type comprising two lengths (9, 10) of nonactive-core optical fiber disposed in side by side relation over a portion (11) of their length where they are optically coupled to each other by fusion of the respective claddings and substantial setting in common of the respective cores by stretching the lengths themselves, both optical fiber lengths (9, 10) of the dichroic coupler (6) being single-mode to both optical signal and pumping radiations."

VIII. The appellant argued that the subject-matter of independent claims 1 and 6 was rendered obvious by the teachings of any one of documents D1, D3 or D5 in combination with the teaching of any one of documents D4, D4A or D11. In particular, the substantial setting in common of the respective cores of the coupler by stretching the lengths themselves [sic] had to be interpreted as meaning that the cores were brought close together, but without merging of the cores. Since a merging of the cores would be physically impossible with the process as disclosed in the patent in suit, any other interpretation necessarily implied that the patent did not disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (cf Articles 83, 100(b) EPC). However, bringing the cores close together without merging was considered to be rendered obvious by any one of documents D4, D4A or D11. In particular, starting from document D1 as the closest prior art and wishing to optimise the coupler, the skilled person would have considered the single mode fused fiber coupler disclosed in document D4A. The instructions for obtaining the desired coupler characteristics by controlling the degree of fusing and stretching of the fibers contained in this document (cf page 6, second paragraph; page 10, first paragraph) were considered to be sufficient to enable the skilled person to arrive at a coupler optimised for use in an amplifier according to document D1. Furthermore, it would have been obvious to the skilled person to use fibers for the coupler which were single-mode both for the optical signal radiation and for the optical pumping radiation, as this would have been consistent with the active core fiber in document D1 being single mode to both, and would have provided for an easy and low loss splicing into the overall arrangement of document D1.

Furthermore, in the light of the above interpretation, the subject-matter of claim 1 was considered to lack novelty with respect to document D5.

IX. The respondent submitted that the proper interpretation of the substantial setting in common of the cores referred to in claims 1 and 6 was that the cores were so thin and so close together that presumably the coupling between the cores no longer took place by evanescent field coupling but rather by cladding mode coupling.

Furthermore, the respondent disputed the appellant's view, relying essentially on the following arguments:

Document D5 did not disclose an active core optical fiber single mode to both the optical signal and pumping radiation, but rather a Nd:YAG crystal which lacked the core and cladding of a fiber and which was multimode. Furthermore, the coupler was made by removing part of the claddings by polishing, and not by fusing, and was not single mode to both the optical signal and pumping radiations. Accordingly document D5 was neither prejudicial to the novelty of the subject-matter of claims 1 and 6, nor did it provide the closest prior art for assessing the presence of an inventive step.

Document D1 was concerned with the optimisation of the gain of the optical amplifier and did not contain any indication as to the optimisation of the coupler.

Furthermore, document D4 and D4A did not concern dichroic couplers and thus the skilled person wishing to optimise the coupler of document D1 would not have considered their teachings. Moreover, the coupler of documents D4 and D4A would have required further modifications in order to render the cores single-mode

to both signal and pumping radiations, to make the cores thinner, and to bring the cores closer together as specified in claims 1 and 6. In the absence of any prospect of success, the skilled person would not have considered such modifications. Therefore the appellant's arguments were based on an ex post facto analysis. Furthermore, in support of the presence of an inventive step, the combinations of features of claims 1 and 6 achieved a surprising increase of the amplifier yield to 4.1 dB/mW.

Reasons for the Decision

1. The appeal is admissible.
2. *Novelty*
 - 2.1 Document D5 discloses a Nd:YAG crystal fiber amplifier (cf page 4, second paragraph; page 5, last paragraph; page 18, lines 18 to 29) with a wavelength multiplexing (ie dichroic) fiber coupler consisting of two lengths of optical fiber, single-mode at the signal and pumping frequencies to be used (cf page 9, second paragraph), optically coupled to each other by having part of the claddings removed by mechanical polishing (cf page 10, second paragraph).

The Nd:YAG crystal is not disclosed to be single mode at both the optical signal and pumping radiations. In fact, its rather large diameters (cf page 18, lines 21 to 24) would result in a multimode structure at the wavelengths used. Furthermore, the fibers of the coupler are not optically coupled to each other by fusion of the claddings but rather by placing the polished surfaces in facing relationship.

Accordingly the subject-matter of claim 1 of the patent as granted has to be considered as being novel with respect to document D5.

2.2 For the same reasons, the subject-matter of independent claim 6 of the patent as granted, which is directed to an optical fiber telecommunication line comprising an optical amplifier according to claim 1, has to be considered as being novel with respect to document D5.

2.3 The novelty of the subject-matter of claims 1 and 6 of the patent as granted with respect to the remaining prior art referred to in the appeal proceedings has not been disputed by the appellant.

3. *Inventive step*

3.1 The closest prior art for an amplifier according to claim 1 is considered to be provided by document D1, rather than by document D5 which relates to a multimode Nd:YAG crystal, as discussed above.

Document D1 (cf Figure 1 and corresponding description) discloses an amplifier for signal-transmitting optical fiber telecommunication lines, which can be interposed between two portions of the optical fiber of the line, in accordance with the preamble of claim 1 under consideration. The amplifier comprises an optical pumping radiation source ("Pump laser"), a dichroic coupler (" λ -MUX 4-port coupler") adapted to be connected to said first optical fiber portion of the telecommunication line and connected to the optical pumping radiation source, and a length of active-core optical fiber ("Rare-earth doped fibre"), single-mode to both optical signal radiation and optical pumping radiation (cf page 207, second paragraph, last

sentence), having one end connected to the dichroic coupler and the other end susceptible of being connected to said second optical fiber portion of the telecommunication line.

The coupler in document D1 is depicted in Figure 1 as comprising two lengths of optical fiber disposed in side by side relation over a portion of their length where they are optically coupled to each other, with the first length of optical fiber being connected at the input side to the incoming line and at the output side to the active-core optical fiber, and with the second length of optical fiber being connected at the input side to the pump laser and being unconnected at the output side. The coupler is a wavelength multiplexing coupler for combining the signal at a first wavelength (eg 1536 nm) at the input of the first length of optical fiber and the pumping radiation at a second wavelength (eg 980 nm) at the input of the second length of optical fiber into the output of the first length of optical fiber. The coupler is thus a dichroic coupler within the meaning of the patent in suit (cf description, column 1, line 51 to column 2, line 4; column 6, lines 12 to 30; respondent's submission dated 22 February 2002, page 8, lines 6 to 10; document D12, Section III).

- 3.2 The subject-matter of claim 1 differs from the amplifier known from document D1 in that the dichroic coupler is of a type in which the two lengths of nonactive-core optical fiber are optically coupled to each other by fusion of the respective claddings and substantial setting in common of the respective cores by stretching the lengths themselves [sic], whereby both said optical fiber lengths are single-mode for both the optical signal radiation and the optical pumping radiation.

Since document D1 does not further specify the fiber coupler to be used, it is left to the skilled reader to select a suitable coupler. It would thereby be readily apparent to him that the ideal coupler should fully couple the pumping radiation into the signal fiber, and thus in the active core, and not couple any of the signal radiation into the pump fiber, so as to avoid any signal loss, thereby optimising the gain of the amplifier.

- 3.3 The appellant argued that the skilled person looking for a suitable coupler would refer to document D4A.

Document D4A (cf abstract) discloses a single mode fiber coupler fabricated by fusing and stretching two lengths of single mode optical fiber. The coupler is used for distributing the power of the radiation fed into one input end between the output ends according to a predetermined splitting ratio, and thus is what is commonly referred to as a power splitter. Coupling between the cores is believed to occur primarily by evanescent wave coupling (cf page 5, lines 16 to 20). This form of coupling is known to show a wavelength dependency, which makes it suitable for use in wavelength (de-) multiplexing or dichroic couplers (cf for example document D12, Figures 4 to 6, 8 and corresponding description; document D5, page 12, line 19 to page 17, line 30).

However, in the absence of any hint in document D4A as to the possibility of using the disclosed coupler as a wavelength multiplexing or dichroic coupler, the skilled person would not have referred to this document in his search for a suitable dichroic coupler, since this document did not offer any reasonable prospect of providing a solution to the problem to be solved.

This is all the more true since, in order to be usable as a dichroic coupler in the amplifier of document D1, the coupler of document D4A would have required further modifications, leading away from the typical characteristics of power splitters. In particular, for use as a dichroic coupler, the coupler should be adapted to fully couple the two input radiations with different well-defined wavelengths into only one output, whereas for use as a power splitter a distribution of the power fed into one input between the two outputs is required. Though document D4A provides some instructions for adjusting the energy distribution at the outputs by varying the degree of fusing and stretching (cf page 10, first paragraph), it does not give the skilled person any clear teaching as to how to adapt the coupler for use as a dichroic coupler. In this respect, it is noted that the preferred embodiment of document D4A (cf paragraph bridging pages 6 and 7) with cores having a diameter of 2-6 μm separated by 15-30 μm , is indeed very different from the coupler of claim 1, which requires that the cores be very close together.

Finally, since power splitters are operated with a single input radiation, document D4A does not suggest to select both fiber lengths of the coupler to be single mode for two input radiation wavelengths.

- 3.4 The appellant's reasoning, according to which the skilled person would have at least tried the fusing process suggested in document D4A and, using the instructions provided (cf page 10, first paragraph), would have arrived with simple tests at a coupler as claimed, must, in the absence of any hint in document D4A as to the fact that the disclosed coupler would in principle be usable as a dichroic coupler, or as to how it should be adapted for use as a dichroic coupler, be dismissed as being based on an ex post facto analysis.

3.5 Hence the subject-matter of claim 1, and for the same reasons that of independent claim 6, of the patent as granted must be considered to involve an inventive step having regard to the teachings of documents D1 and D4A.

4. The remaining documents referred to in the appeal proceedings are less relevant:

4.1 Document D4 (cf column 2, lines 4 to 46) discloses a single mode fiber coupler to be used as a power splitter, fabricated by fusing and stretching two lengths of single mode optical fiber, similar to document D4A. However, the object of this document is to obtain a splitting ratio which is independent of the wavelength. To this end, the coupler of document D4 comprises cores with different indexes of refraction, providing for a coupling between the two cores which is substantially wavelength independent over a predetermined wavelength range. Hence, the teaching of this document is not relevant to dichroic couplers.

4.2 Document D3 shows an erbium doped fiber amplifier similar to the one of document D1. In this document it is merely specified that the coupler is dichroic (cf page 25, penultimate paragraph), but no details concerning its structure are given.

4.3 Document D12 discloses a wavelength multiplexing (ie dichroic) single-mode fiber coupler fabricated by removing the claddings by polishing, similar to the coupler according to document D5.

5. Consequently the Board is satisfied that the subject-matter of independent claims 1 and 6 of the patent as granted is novel and involves an inventive step, having regard to the prior art referred to in the appeal proceedings.

6. In view of the above, none of the grounds of opposition invoked by the appellant prejudice the maintenance of the patent as granted, in accordance with the respondent's main request.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

R. Schumacher

G. Davies