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Case Number: T 1362/09 - 3.4.03

Application Number: 97310370.8

Publication Number: 848463

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Language of the proceedings: EN

Title of invention:
Optical fibre amplifier and optical amplification method

Applicant:
NIPPON TELEGRAPH AND TELEPHONE CORPORATION

Headword:
-

Relevant legal provisions (EPC 1973):
EPC Art. 54, 56, 87(1)

Keyword:
"Novelty (no) - all requests"
"Priority (not valid) - third to sixth auxiliary requests"

Decisions cited:
-

Catchword:
-

Case Number: T 1362/09 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 10 May 2012

Appellant: (Applicant)
NIPPON TELEGRAPH AND TELEPHONE CORPORATION
19-2 Nishi-Shinjuku 2-chome
Shinjuku-ku
Tokyo 163-19 (JP)

Representative:
Lunt, Mark George Francis
Harrison Goddard Foote
Fountain Precinct
Balm Green
Sheffield
S1 SJA (GB)

Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 6 February 2009 refusing European patent application No. 97310370.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: G. Eliasson
Members: T. Häusser
T. Bokor

Summary of Facts and Submissions

I. The appeal concerns the decision of the examining division to refuse European patent application No. 97 310 370 for lack of clarity and inventive step (main request, first and second auxiliary request) and for lack of novelty (main and first auxiliary request).

II. Reference is made to the following documents:

D1: MASSICOTT J F ET AL: "Low noise operation of Er^{3+} doped silica fibre amplifier around 1.6µm", ELECTRONICS LETTERS, 24 September 1992, vol. 28, no. 20, pages 1924-1925, XP 315929,

D5: ONO H ET AL: "Gain-flattened Er^{3+}-doped fiber amplifier for a WDM signal in the 1.57-1.60µm wavelength region", IEEE PHOTONICS TECHNOLOGY LETTERS, May 1997, vol. 9, no. 5, pages 596-598, XP 677335,

D7: ONO H ET AL: "Er^{3+}-doped fluorophosphate glass fibre amplifier for WDM systems", ELECTRONICS LETTERS, 15 August 1996, vol. 32, no. 17, pages 1586-1587, XP 6005548.

III. At oral proceedings before the board the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the Claims 1-20 of the Main Request, or Claims 1-18 of the First Auxiliary Request, both filed with the grounds of appeal dated 5 June 2009, or alternatively on the basis of Claim 1 of the Third Auxiliary Request, or Claim 1 of the Fourth Auxiliary Request, both filed with letter dated 17 August 2011, or further alternatively on the basis of Claim 1 of the Fifth Auxiliary Request or

Claim 1 of the Sixth Auxiliary Request, both filed with letter dated 1 May 2012. Second Auxiliary Request filed with the grounds of appeal was earlier withdrawn.

IV. The wording of claim 1 of the main request, claim 7 of the first auxiliary request, and claim 1 of the third to sixth auxiliary requests is as follows (labelling $(i)_0$, $(ii)_0$, …, $(iii)_5$ by the board):

Main request:

"1. An optical amplifier comprising an erbium doped fiber having a core part and a clad part, at least one of the core part and the clad part being doped with erbium, an excitation light source for exciting said Er-doped fiber, optical means for inputting excitation light from said excitation light source and signal light in a wavelength region of 1.58µm band to said Er-doped fiber, and an optical isolator, characterized in that:

$(i)_0$ said excitation light source is any one of a 0.97µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, a 0.98µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, or a 1.48µm band excitation light source for exciting a $^4I_{13/2}$ level of Er,

$(ii)_0$ said Er-doped fiber has an equivalent fiber length, as a product of a fiber length (m) and an erbium doping concentration (ppm by weight), providing a signal gain of more than 15dB obtained at 1.58µm band,

$(iii)_0$ said excitation light source generates excitation light with a predetermined intensity according to said equivalent fiber length, whereby a difference between the signal gain of wavelength division multiple signal lights in the 1.58μm band is less than 2dB."

First auxiliary request:

"7. An optical amplifier comprising an erbium doped fiber having a core part and a clad part, at least one of the core part and the clad part being doped with erbium, an excitation light source for exciting said Er-doped fiber, optical means for inputting excitation light from said excitation light source and signal light in a wavelength region of 1570-1600nm band to said Er-doped fiber, and an optical isolator, characterized in that:

said excitation light source is a 1.48μm band excitation light source for exciting a $^4I_{13/2}$ level of Er,

said Er-doped fiber has an equivalent fiber length, as a product of a fiber length (m) and an erbium doping concentration (ppm by weight), providing a signal gain of more than 15dB obtained at 1570-1600nm band,

said excitation light source generates excitation light with an intensity according to said equivalent fiber length, whereby a difference between the signal gain of wavelength division multiple signal lights in 1570-1600nm band is less than 2dB."

Third auxiliary request:

"1. An optical amplifier comprising an erbium doped fiber having a core part and a clad part, at least one of the core part and the clad part being doped with erbium, an excitation light source for exciting said

Er-doped fiber, optical means for inputting excitation light from said excitation light source and signal light in a wavelength region of 1570-1600nm band to said Er-doped fiber, and an optical isolator, characterized in that:

(ii)$_3$ said Er-doped fiber has an equivalent fiber length, as a product of a fiber length (m) and an erbium doping concentration (ppm by weight), providing a signal gain of more than 15dB obtained at 1570-1600nm band,

a combination of said excitation light source and said Er-doped fiber is any one of following combinations:

a) said excitation light source is a 0.98µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, said Er-doped fiber is an Er-doped silica fiber having an equivalent fiber length of greater than 0.3 x 10^5 (m x ppm by weight);

b) said excitation light source is a 1.48µm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped silica fiber having an equivalent fiber length of greater than 0.6 x 10^5 (m x ppm by weight);

c) said excitation light source is a 0.98µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, said Er-doped fiber is an Er-doped tellurite glass fiber having an equivalent fiber length of greater than 0.005 x 10^5 (m x ppm by weight);

d) said excitation light source is a 1.48µm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped tellurite glass fiber having an equivalent fiber length of greater than 0.01 x 10^5 (m x ppm by weight);

e) said excitation light source is a 0.98μm band excitation light source for exciting a $^4I_{11/2}$ level of Er, said Er-doped fiber is an Er-doped multi-component oxide glass fiber having an equivalent fiber length of greater than 0.008 x 10^5 (m x ppm by weight);

f) said excitation light source is a 1.48μm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped multi-component oxide glass fiber having an equivalent fiber length of greater than 0.015 x 10^5 (m x ppm by weight);

g) said excitation light source is a 0.98μm band excitation light source for exciting a $^4I_{11/2}$ level of Er, said Er-doped fiber is an Er-doped chalcogenide glass fiber having an equivalent fiber length of greater than 0.01 x 10^5 (m x ppm by weight);

h) said excitation light source is a 1.48μm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped chalcogenide glass fiber having an equivalent fiber length of greater than 0.02 x 10^5 (m x ppm by weight);

i) said excitation light source is a 0.98μm band excitation light source for exciting a $^4I_{11/2}$ level of Er, said Er-doped fiber is an Er-doped fluorophosphate glass fiber having an equivalent fiber length of greater than 0.008 x 10^5 (m x ppm by weight);

j) said excitation light source is a 1.48μm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped fluorophosphate glass fiber having an equivalent fiber length of greater than 0.015 x 10^5 (m x ppm by weight);

k) said excitation light source is a 0.98μm band excitation light source for exciting a $^4I_{11/2}$ level of Er, and a 1.48μm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an

Er-doped silica fiber having an equivalent fiber length of greater than 0.3×10^5 (m x ppm by weight);

l) said excitation light source is a 0.98µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, and a 1.48µm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped tellurite glass fiber having an equivalent fiber length of greater than 0.005×10^5 (m x ppm by weight);

m) said excitation light source is a 0.98µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, and a 1.48µm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped multi-component oxide glass fiber having an equivalent fiber length of greater than 0.008×10^5 (m x ppm by weight);

n) said excitation light source is a 0.98µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, and a 1.48µm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped chalcogenide glass fiber having an equivalent fiber length of greater than 0.01×10^5 (m x ppm by weight);

o) said excitation light source is a 0.98µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, and a 1.48µm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped fluorophosphate glass fiber having an equivalent fiber length of greater than 0.008×10^5 (m x ppm by weight);

p) said excitation light source is a 0.97µm band excitation light source for exciting a $^4I_{11/2}$ level of Er, said Er-doped fiber is an Er-doped fluoride fiber having an equivalent fiber length of greater than 0.1×10^5 (m x ppm by weight);

q) said excitation light source is a 1.48μm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped fluoride fiber having an equivalent fiber length of greater than 0.2×10^5 (m x ppm by weight);

r) said excitation light source is a 0.97μm band excitation light source for exciting a $^4I_{11/2}$ level of Er, and a 1.48μm band excitation light source for exciting a $^4I_{13/2}$ level of Er, said Er-doped fiber is an Er-doped fluoride fiber having an equivalent fiber length of greater than 0.1×10^5 (m x ppm by weight); and

$(iii)_3$ said excitation light source generates excitation light with an intensity according to said equivalent fiber length, whereby a difference between the signal gain of wavelength division multiple signal lights in 1570-1600 nm band is less than 2 dB."

Fourth auxiliary request:

Claim 1 of the fourth auxiliary request differs from claim 1 of the third auxiliary request in that feature $(iii)_3$ is replaced by the following feature:

$(iii)_4$ "said excitation light source generates excitation light with an intensity according to said equivalent fiber length, whereby a difference between the signal gain of the maximum wavelength and the signal gain of the minimum wavelength in wavelength division multiple signal lights in 1570-1600nm band is less than 1dB resulting in a difference between the maximum signal gain and the minimum signal gain in wavelength division multiple signal lights in 1570-1600nm band of less than 2dB".

Fifth auxiliary request:

Claim 1 of the fifth auxiliary request differs from claim 1 of the third auxiliary request in that feature $(iii)_3$ is replaced by the following feature:

$(iii)_5$ "said excitation light source generates excitation light with an intensity such that a difference between the signal gain of the maximum wavelength and the signal gain of the minimum wavelength in wavelength division multiple signal lights in 1570-1600nm band is less than 1dB resulting in a difference between the maximum signal gain and the minimum signal gain in wavelength division multiple signal lights in 1570-1600nm band of less than 2dB".

Sixth auxiliary request:

Claim 1 of the sixth auxiliary request differs from claim 1 of the fifth auxiliary request in that the alternatives a), b), k), and r) are deleted and the remaining alternatives are relabelled as a) to n). In particular, alternative f) is relabelled as d).

V. The appellant argued essentially as follows:

(a) Main and first auxiliary request

The appellant argued that in document D1 there was no disclosure of determining an equivalent fibre length in order to provide a signal gain of more than 15dB in the 1.58µm band. Furthermore, in claim 1 of the main request it was recited that the excitation light source was any ***one*** of three light sources. By contrast, two light sources were used in the apparatus of document D1.

Moreover, in document D1 the auxiliary pump laser operating at a wavelength of 1.55µm was adjusted in order to achieve a flat gain spectrum, whereas the last feature of claim 1 of the main request implied that the recited pump laser, which operates at a wavelength of 0.97µm, 0.98µm or 1.48µm was adjusted to achieve the flat gain spectrum.

Accordingly, the subject-matter of claim 1 and, for the same reasons, also that of claim 7 of the first auxiliary request was new over document D1.

(b) Third to sixth auxiliary requests

Concerning alternative f) of claim 1 according to the third to fifth auxiliary request and alternative d) of claim 1 according to the sixth auxiliary request the appellant argued as follows:

It was disclosed in the priority document 333923/1996 of 13.12.1996 that the amplification unit could be implemented with any of the fibre types described in Table 2 of that priority document. As Table 2 covered all the fibre types recited in claim 1, all alternatives in claim 1 of the third to sixth auxiliary request validly claimed priority. Document D5 could therefore not be used as state of the art.

Furthermore, in document D5 it was merely indicated that a "silica-based" fibre was used. There is no teaching in that document that other fibres would yield the same results as the employed fibre.

Therefore, the subject-matter of alternative f) of claim 1 according to the third to fifth auxiliary request and of alternative d) of claim 1 according to the sixth auxiliary request was new and involved an inventive step.

Reasons for the Decision

1. Admissibility

The appeal is admissible.

2. Main request and first auxiliary request

2.1 Document D1

Document D1 discloses (see page 1924, right-hand column – page 1925, left-hand column) a 1.6µm fibre amplifier using two co-propagating pump sources. The majority of the pump power is provided at 1.48µm and an auxiliary pump is provided at 1.555µm. The fibre has a core of diameter 5.5µm, $\Delta n=0.015$, and is doped with Er^{3+} ions to a level corresponding to an absorption of 5.5dB/m at the 1.53µm absorption peak. The output of the signal source and the two pump sources are passed through an optical isolator and into the fibre. Gain spectra are measured with 82mW pumping at 1.48µm and auxiliary power levels of +1, -8, -17, and -21dbm at 1.555µm. For an auxiliary input power of -17dBm a gain of 24dB and a particularly flat gain spectrum is obtained, which shows less than 1dB gain variation between 1.57µm and 1.6µm.

2.2 Novelty – claim 1 of the main request

2.2.1 The expression "1.58µm band" used in claim 1 of the main request is interpreted to mean, in view of the description of the application (page 16, lines 35-36), a wavelength region from 1.57µm to 1.6µm.

2.2.2 Using the wording of claim 1 of the main request, document D1 discloses an optical amplifier comprising an erbium doped fibre (fibre doped with Er^{3+} ions) having a core part and a clad part (core of diameter 5.5µm, $\Delta n=0.015$), at least one of the core part and the clad part being doped with erbium (Er^{3+} ions), an excitation light source (1.48µm pump) for exciting said Er-doped fibre, optical means for inputting excitation light from said excitation light source and signal light in a wavelength region of 1.58µm band (the signal light used when the flat gain spectrum is obtained) to said Er-doped fibre, and an optical isolator.

In claim 1 of the main request an optical amplifier is defined "comprising" an excitation light source and that the excitation light source is one of a 0.97µm band source, a 0.98µm band source or a 1.48µm band source as defined in feature $(i)_0$.

The board agrees with the examining division that the wording of claim 1, in particular the use of the term 'comprising', does not exclude the presence of further excitation light sources. Since D1 discloses that one of the two excitation light sources is a 1.48µm pump source, which necessarily excites a $^4I_{13/2}$ level of the Er^{3+} ions, the third alternative of feature $(i)_0$ is regarded to be disclosed in D1.

2.2.3 The fibre length used in the amplifier of D1 is reported to be 120m long (page 1924, right-hand column, third-to-last paragraph). Furthermore, it is disclosed in D1 (page 1925, left-hand column, second paragraph and right-hand column, first paragraph) that with 82mW pumping at 1.48µm and an auxiliary power level of -17dBm at 1.555µm a gain of 24dB is achieved between 1.57µm and 1.6µm. The concentration of the Er^{3+} ions is therefore high enough that the amplifier achieves – with the 120m long doped fibre – a gain of 24dB in the stated wavelength region. Hence, the board regards – like the examining division - feature $(ii)_0$ to be implicitly disclosed in D1.

2.2.4 In view of the description (page 27, line 28 – page 28, line 26) the expression 'difference between the signal gain of wavelength division multiple signal lights in the 1.58µm band is less than 2dB' in feature $(iii)_0$ is interpreted to mean that the difference between the maximum signal gain and the minimum signal gain in wavelength division multiple signals in the 1.58µm band is less than 2dB.

The power levels of the pump sources referred to above under point 2.2.3 leading to a gain of 24dB between 1.57µm and 1.6µm are also described in D1 (page 1925, left-hand column, second paragraph) to lead to a gain spectrum showing less than 1dB variation in that wavelength region.

For the purposes of the novelty assessment of apparatus claim 1 of the main request, it is not relevant how the power levels of the pump sources leading to the particularly flat gain spectrum were found. In particular, it is not relevant which power level was kept fixed and which was adjusted to find the power levels yielding the desired gain spectrum.

Furthermore, in the board's view, the two pump sources used in the apparatus of D1, which operate at 1.48µm and 1.555µm, co-operate to achieve the flat gain spectrum referred to above. It cannot be said that the 1.48µm pump source was responsible for the level of the gain while the 1.555µm pump source was responsible for the flatness of the gain spectrum since both sources contribute to the signal gain. Similarly, the excitation light sources according to the invention co-operate to achieve the flat gain spectrum. Moreover, as pointed out under point 2.2.2 above the wording of claim 1 allows for the presence of further excitation light sources. Feature $(iii)_0$ is therefore not regarded to imply that it is exclusively the excitation light source mentioned in feature $(iii)_0$ which is responsible for the flatness of the gain spectrum.

The expression 'predetermined intensity' in feature $(iii)_0$ is interpreted to mean that the intensity is determined beforehand. The power level of the 1.48µm pump source referred to above, namely 82mW, can be assumed to be so determined.

Accordingly, feature $(iii)_0$ is regarded to have been disclosed in document D1.

2.2.5 The subject-matter of claim 1 according to the main request is therefore not new over document D1 (Article 52(1) EPC and Article 54(1) EPC 1973).

2.3 Novelty – claim 7 of the first auxiliary request

Claim 7 of the first auxiliary request differs from claim 1 of the main request in that:

- "1.58µm band" is replaced by "1570-1600nm band",
- only the third alternative in feature $(i)_0$ is retained, the other two alternatives being deleted,
- in feature $(iii)_0$ it is furthermore deleted that the intensity is "predetermined".

In the above novelty assessment of claim 1 according to the main request

- the expression '1.58µm band' is interpreted in a way corresponding exactly to the first difference, namely to mean a wavelength region from 1.57µm to 1.6µm (see point 2.2.1 above), and
- it is the third alternative of feature $(i)_0$, which is the only alternative retained according to the second difference, which is regarded to be disclosed in D1.

Furthermore, the omission of the term 'predetermined' clearly has no limiting effect on the claim.

Consequently, in view of the reasons provided in relation to claim 1 according to the main request (point 2.2 above), the subject-matter of claim 7 according to the first auxiliary request is also not new over document D1 (Article 52(1) EPC and Article 54(1) EPC 1973).

3. Third to sixth auxiliary request

3.1 Document D5

Document D5 discloses (see page 596, left-hand column, second-to-last paragraph – right-hand column, second paragraph, Figure 1; page 597, left-hand column, second-to-last paragraph – right-hand column, second paragraph, Figure 5) a gain-flattened Er^{3+}-doped fibre amplifier using a silica-based fibre having a refractive index difference of 1.8% and Er^{3+}, Al, and Ge concentrations of 1310ppm, 4.2, and 18 wt%, respectively. The fibre is pumped by a bi-directional pump scheme with two 1.48µm pump laser diodes. A gain-flattened amplification band for an input signal power of -30dBm is obtained from 1570-1600nm for various fibre lengths, e.g. for a 200m long fibre, and is shown in Figure 1. For a 200m long fibre and an input signal power of -30dBm it is also reported in relation to Figure 5 that an average signal gain of 29.5dB and a gain excursion of less than 0.9dB is obtained from 1573-1600nm.

3.2 Novelty – claim 1, alternative f), of the third auxiliary request

3.2.1 Alternative f) of claim 1 according to the third auxiliary request relates to a 1.48µm band excitation light source in combination with an Er-doped multi-component oxide glass fibre having an equivalent fibre length of greater than 0.015 x 10^5 (m x ppm by weight).

In the priority document JP 331199/96 of 11 December 1996 it is merely disclosed to use a 1.48µm band excitation light source in combination with either

- an erbium-doped silica-based fibre having an equivalent fibre length of not less than 0.6 x 10^5 (m x ppm by weight) (see claim 2), or
- an erbium-doped fluoride-based fibre having an equivalent fibre length of not less than 0.2 x 10^5 (m x ppm by weight) (see claim 5).

In the priority document JP 333923/96 of 13 December 1996 two examples of multi-component oxide glass fibres are mentioned. However, the concept of an equivalent fibre length is not described in that document, let alone a value for the equivalent fibre length corresponding to these examples of multi-component oxide glass fibres.

The above feature of alternative f) of claim 1 according to the third auxiliary request is therefore not directly and unambiguously derivable from any one of the priority documents. The appellant does therefore not enjoy a right of priority under Article 87(1) EPC 1973 as far as this alternative is concerned. The effective date of the subject-matter of this alternative is therefore the filing date of the application, i.e. 10 December 1997. Document D5 is published in May 1997, i.e. before this effective date, and is therefore state of the art within the meaning of Article 54(2) EPC 1973 as far as the subject-matter of alternative f) of claim 1 according to the third auxiliary request is concerned.

3.2.2 Using the wording of claim 1 of the third auxiliary request, document D5 discloses an optical amplifier comprising an erbium doped fibre (Er^{3+}-doped fibre) having a core part and a clad part (refractive index difference of 1.8%), at least one of the core part and the clad part being doped with erbium (Er^{3+}), an excitation light source (one of the 1.48µm pump laser diodes) for exciting said Er-doped fibre, optical means (implicit) for inputting excitation light from said excitation light source and signal light in a wavelength region of 1570-1600nm band (the input signal in the 1570-1600nm region used for obtaining the data of Figure 1) to said Er-doped fibre, and an optical isolator (implicit – to suppress oscillations).

3.2.3 Document D5 discloses an amplifier which uses – in a bidirectional scheme - two 1.48µm pump laser diodes, which thus necessarily excite a $^4I_{13/2}$ level of the Er^{3+} ions. The fibre used in the amplifier is based on silica and has Er^{3+}, Al, and Ge concentrations of 1310ppm, 4.2 and 18wt%. Silica is well-known to be an oxide of silicon with the formula SiO_2. The fibre can therefore be regarded as a multi-component oxide glass fibre.

Even though it is not explicitly indicated in D5 that 'ppm' is measured by weight, the concentrations of Al and Ge are measured by weight and it is natural to measure concentrations this way for the purposes of mixing the components in order to manufacture the fibre. The board is therefore satisfied that 'ppm' in D5 is indeed measured by weight.

Furthermore, a 200m long fibre is used for obtaining the data of Figure 5. The equivalent fibre length for that fibre is therefore 200 x 1310 (m x ppm by weight) = 2.6 x 10^5 (m x ppm by weight). In relation to that figure it is also disclosed that the average signal gain in the wavelength region from 1573nm to 1600nm is 29.5dB. Moreover, it can be read off from Figure 1, which shows the signal gain for a 200m long fibre in the wavelength region from 1570nm to 1600nm, that the signal gain is essentially flat between 1570nm and 1573nm.

Feature $(ii)_3$ and the features of alternative f) of claim 1 according to the third auxiliary request are therefore disclosed in document D5.

3.2.4 The expression 'difference between the signal gain of wavelength division multiple signal lights in 1570-1600 nm band is less than 2 dB' in feature $(iii)_3$ is interpreted to mean – similar to point 2.2.4 above - that the difference between the maximum signal gain and the minimum signal gain in wavelength division multiple signals in the 1570-1600nm band is less than 2dB. In relation to Figure 5 of D5 it is disclosed that a gain excursion of less than 0.9dB is achieved in the wavelength region from 1573nm to 1600nm. Moreover, it can be read off from Figure 1 that the signal gain is essentially flat between 1570nm and 1573nm. The board is therefore satisfied that feature $(iii)_3$ is disclosed in document D5.

3.2.5 The subject-matter of claim 1 according to the third auxiliary request (alternative f)) is therefore not new over document D5 (Article 52(1) EPC and Article 54(1) EPC 1973).

3.3 Novelty – claim 1, alternative f), of the fourth and fifth auxiliary requests

Claim 1 of the fourth and fifth auxiliary requests differs from claim 1 of the third auxiliary request in that feature $(iii)_3$ is replaced by features $(iii)_4$ and $(iii)_5$, respectively. From the remarks presented above under point 3.2.4 it follows that the difference of the signal gain at 1600nm and the signal gain at 1570nm is less than 1dB. Features $(iii)_4$ and $(iii)_5$ are therefore also disclosed in document D5.

Consequently, in view of the reasons provided in relation to claim 1 according to the third auxiliary request (point 3.2 above), the subject-matter of claim 1 according to the fourth auxiliary request (alternative f)) and of claim 1 according to the fifth auxiliary request (alternative f)) is not new over document D5 (Article 52(1) EPC and Article 54(1) EPC 1973).

3.4 Novelty – claim 1, alternative d), of the sixth auxiliary request

The subject-matter of alternative d) of claim 1 according to the sixth auxiliary is the same as the subject-matter of alternative f) of claim 1 according to the fifth auxiliary request.

Consequently, in view of the reasons provided under points 3.2 and 3.3 above, the subject-matter of claim 1 according to the sixth auxiliary request (alternative d)) is not new over document D5 (Article 52(1) EPC and Article 54(1) EPC 1973).

3.5 Inventive step – other alternatives of claim 1 according to the third to sixth auxiliary request

3.5.1 The combination of the excitation band, fibre composition and lower endpoint of the half-bounded interval for the equivalent fibre length claimed in alternative f) of claim 1 according to the third auxiliary request has been treated in point 3.2 above. The other alternatives a) to e) and g) to r) of that claim relate to various other such combinations. For reasons corresponding to those of point 3.2.1 above the appellant does not enjoy a right of priority under Article 87(1) EPC 1973 as far as many of these alternatives are concerned, for example those relating to tellurite, chalcogenide, fluorophosphate, and multi-component oxide glass fibres. As far as these alternatives are concerned document D5 is therefore state of the art within the meaning of Article 54(2) EPC 1973.

3.5.2 As shown in point 3.2.3 above, it is known from document D5 to use a fibre having an equivalent fibre length of 2.6×10^5 (m x ppm by weight). That value is well within the half-bounded interval claimed for that quantity in any of the alternatives of claim 1 according to the third auxiliary request, the ***maximum*** value of the lower endpoints being 0.6×10^5 (m x ppm by weight). It is also known from D5 to use a 1.48µm excitation light source and to adjust the pump conditions to obtain a flattened gain spectrum in the 1570-1600nm band.

Furthermore, it was known at the filing date of the application to use other fibre materials in the manufacture of erbium-doped fibre amplifiers. For example, in document D7 it is mentioned (see the sections "Introduction" and "Experimental procedures") to use for that purpose fluorophosphate glass fibre, fluoride fibre, phosphate fibre, germinate glass fibre and aluminosilicate fibre.

3.5.3 For example, alternative j) of claim 1 according to the third auxiliary request relates to a 1.48µm band excitation light source in combination with an Er-doped fluorophosphate glass fibre having an equivalent fibre length of greater than 0.015×10^5 (m x ppm by weight).

In view of document D7 it would be obvious for the skilled person to consider a fluorophosphate glass fibre as an alternative fibre material.

By way of example the board considers thus the subject-matter of claim 1 according to the third auxiliary request (alternative j)) to lack inventive step over document D5 in combination with document D7 (Article 52(1) EPC and Article 56 EPC 1973).

3.5.4 The remarks in points 3.5.1 to 3.5.3 also concern the corresponding alternatives of claim 1 according to the fourth to sixth auxiliary request. In particular, by way of example the board considers the subject-matter of claim 1 according to the fourth auxiliary request (alternative j)), claim 1 according to the fifth auxiliary request (alternative j)), and claim 1 according to the sixth auxiliary request (alternative h)) to lack inventive step over document D5 in combination with document D7 (Article 52(1) EPC and Article 56 EPC 1973).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson