BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS | BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE | CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 15 October 1998

Case Number: T 0569/97 - 3.4.2

Application Number: 87117580.8

Publication Number: 0269122

IPC: G02B 27/00

Language of the proceedings: EN

Title of invention:
Laser optical system

Patentee:
Fuji Photo Film Co., Ltd.

Opponent:
Asahi Kogaku Kogyo K. K.

Headword:
-

Relevant legal provisions:
EPC Art. 56, 123(2), 84

Keyword:
"Inventive step (yes, after amendment)"

Decisions cited:
T 0536/88, T 0416/87

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0569/97 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 15 October 1998

Appellant: (Proprietor of the patent)
Fuji Photo Film Co., Ltd
210 Nakanuma
Minamiashigara-shi
Kanagawa-ken
250-01 (JP)

Representative:
Grünecker, Kinkeldey,
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

Respondent: (Opponent)
Asahi Kogaku Kogyo K. K.
36-9, Maenocho 2-chome
Itabashi-ku
Tokyo (JP)

Representative:
Schaumburg, Thoenes & Thurn
Mauerkircherstrasse 31
81679 München (DE)

Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 7 March 1997 revoking European patent No. 0 269 122 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: A. G. Klein
V. Di Cerbo

Summary of Facts and Submissions

I. European patent No. 0 269 122 (application No. 87 117 580.8) was revoked by decision of the Opposition Division.

Claim 1, the only independent claim of the set of claims as granted, reads as follows:

"1. A laser optical system comprising:

a semiconductor laser (1) of the direct analog modulation type;

a converging lens (4) for converging a laser beam emitted by said laser to a predetermined convergence position (Q); and

a density distribution filter (23) disposed in an optical path of said laser beam in front of said converging lens (4) and constituted such that the optical density at the centre portion is lower and the optical density at the peripheral portion is higher whereby only the low density portion substantially transmits the light beam, characterised in that the transmittance of the density distribution filter gradually decreases from its center portion to its peripheral portion."

The ground for the revocation was that the subject-matter of claim 1 lacked an inventive step because it resulted from the obvious replacement, in the nearest prior art laser optical system disclosed in document

D1: EP-A-0 100 242,

of an aperture by a varying density distribution filter as taught in either of documents

D4: Principles of Optics, 6th (Corrected) Edition, Born and Wolf, Pergamon Press 1984, Oxford, pages 414 to 418, or

D5: Progress in Optics, Volume 3, Edited by E. Wolf, North Holland Publishing Company, 1964, Amsterdam, pages 31 to 33 and 49 to 60.

The following document was also cited, amongst others, in the opposition procedure:

D2: REVIEW OF SCIENTIFIC INSTRUMENTS, vol. 45, No. 11, November 1974, pages 1344 to 1346, The American Institute of Physics, New York, US; B. J. PERNICK: "Irradiance uniformity and power loss with a spatially filtered laser beam".

II. The appellant (proprietor of the patent) lodged an appeal against the decision revoking the patent.

III. In the written appeal procedure the respondent (opponent) invoked still further citations, amongst which document:

D7: EP-A-0 019 778.

IV. Oral proceedings were held before the Board on 15 October 1998, at which the appellant as his main request requested that the decision under appeal be set aside and that the patent be maintained as granted.

As his auxiliary request, the appellant requested that the patent be maintained in amended form on the basis of a set of claims 1 to 3, of which the only independent claim reads as follows:

"1. A laser optical system comprising:

a semiconductor laser (1) of direct analog modulation type;

a driving means for driving the semiconductor laser (1) both in the ranges of natural light emission and laser light emission;

a converging lens (4) for converging a laser beam emitted by said laser to a predetermined convergence position (Q);

a density distribution filter (23) disposed in an optical path of said laser beam in front of said converging lens constituted such that the optical density at the center portion (23a) is lower, and the optical density at the peripheral portion (23b) is higher, whereby only the low density portion substantially transmits the light beam; and the high density portion substantially blocks the light beam such that the convergence spot of the light beam is prevented from increasing when the laser is driven in the region of natural light emission; and the transmittance gradually decreases from its center portion to its peripheral portion."

The respondent for his part requested that the appeal be dismissed.

The Board announced its decision at the end of the oral proceedings.

V. In support of his requests the appellant stressed in particular that the invention was distinguished from the laser optical system disclosed in Figures 7A and 7B of document D1, which constituted the nearest prior art, in that the aperture 79 was replaced by a density distribution filter. This filter did not only prevent the generation of side lobes when the diameter of the laser beam was adjusted through the aperture, as was assumed by the Opposition Division.

The density distribution filter also limited the beam diameter in the natural light emission mode, so as to prevent the convergence spot from increasing.

Admittedly, the latter feature was not set out in claim 1 of the main request. It was however specified in the description to be an overriding feature of the invention. Accordingly, following the ruling in decision T 416/87 (OJ EPO 1990, 415), the claim should be read as requiring this essential feature as well.

Documents D4 and D5 did not disclose the replacement of an aperture with a variable density filter, but only the addition of such filter behind the entrance aperture of an optical system. Neither did they address the technical problem consisting in preventing the convergence spot in a laser system from increasing when the laser was driven in the region of natural light emission.

Document D7 had not been invoked in the opposition procedure, and it should not therefore be admitted in the appeal procedure either.

This late citation did not disclose any semiconductor laser of the direct analog modulation type, which could be driven in the natural light emission mode, nor the provision of a density distribution filter.

VI. The respondent denied that limitation of the beam diameter in the natural emission mode so as to prevent the convergence spot from increasing was an overriding requirement of the description, and that claim 1 of the main request could be construed as comprising such limitation, accordingly.

He also questioned whether the wording of claim 1 of the auxiliary request, in particular the expression "such that the convergence spot of the light beam is prevented from increasing when the laser is driven in the region of natural light emission" clearly attributed the stated effect to the presence of the high density portion of the density distribution filter, or whether this expression was merely intended to explain to which extent said high density portion should substantially block the light beam.

The respondent further submitted that the provision of a driving means for driving the semiconductor laser both in the ranges of natural light emission and of laser light emission as set out in amended claim 1 of the auxiliary request had not been adequately disclosed in the application as filed, as was required under Article 123(2) EPC. Such means had been disclosed in the application documents as filed by reference only to the state of the art, but not in the portion of the description which actually described the invention.

Concerning inventive step, documents D4 and D5 were excerpts from textbooks which illustrated the basic knowledge of the skilled person.

Since the optical system of document D1 also comprised entrance and exit pupils, the teaching of documents D4 and D5 could easily be applied to it. The present patent itself stressed the capacity of the claimed filter to operate in the range of natural light, which was the range addressed also by documents D4 and D5. These documents also very explicitly disclosed the apodisation technique as a means of improving the resolving power of optical systems, which was a main concern in, and the actual technical problem addressed by, the laser optical systems of documents D1 and D7, and of the patent.

Reasons for the Decision

1. The appeal meets the requirements of Articles 106 to 108 and of Rule 64 EPC. It is admissible, accordingly.

2. *Admissibility of document D7 into the procedure*

Document D7 was invoked by the respondent for the first time in his response dated 3 November 1997 to appellant's statement of the grounds of appeal, and its admissibility into the appeal procedure at this late stage was contested by the appellant.

Document D7, however, corresponds to the Japanese patent application JP-A-58 20 015 as cited in the introduction of the patent in suit (see column 1, lines 36 to 40). It is therefore automatically part of the procedure, by virtue of its reference in the patent at the starting point of the invention; see decision T 536/88 (JO EPO 1992, 638).

3. *Main request*

3.1 Novelty

Document D1 discloses a laser optical system comprising a semiconductor laser 70 (see Figures 7A and 7B) of the direct analog modulation type (see the curves of Figure 11 showing the power of the emitted laser beam as a function of the driving current), and a converging lens 78 for converging a laser beam emitted by said laser to a predetermined convergence position 82. The optical system also comprises a number of lenses and apertures in front of the converging lens, but no density distribution filter.

Accordingly, the subject-matter of claim 1 is distinguished from the laser optical system of document D1 in that it comprises a density distribution filter disposed in front of the converging lens and constituted such that the optical density at the centre portion is lower and the optical density at the peripheral portion is higher whereby only the low density portion substantially transmits the light beam, the transmittance of the density distribution filter gradually decreasing from its center portion to its peripheral portion.

Document D2 is dedicated to the improving of the irradiance profile uniformity of a laser beam by selecting only a limited, central region of the beam (see abstract). The document in this respect *inter alia* discloses the achieving of an improved beam uniformity with a radially variable density filter placed in an expanded Gaussian beam (see page 1344, left hand column, lines 13 to 16). The document does not however specify the specific type of the laser source, nor does it disclose converging of the uniformised laser beam.

Thus, the subject-matter of claim 1 is distinguished from the device referred to in document D2 in that it comprises a semiconductor laser of the direct analog modulation type and in that a converging lens is provided for converging the laser beam emitted by said laser to a predetermined convergence position.

Document D4 is dedicated to the improving of the resolving power of image-forming systems by altering their pupil function. The document in this respect states that a general method for modifying a pupil function consists in depositing on one or more surfaces of the system a thin, partially transmitting film of suitable substance. The same effect may be achieved by means of a specially constructed filter, for example, a hollow lens of appropriate form filled with an absorbing liquid (see page 416, last paragraph). The only practical applications evoked in the document are the improving of the resolution of telescopes and of spectroscopic analysers (see page 417, last paragraph), and the only example given for a modified pupil function is the annular aperture which results from the obstruction of the central part of a circular aperture (see page 416, last paragraph and page 417, Figure 8.30).

Thus, the subject-matter of claim 1 is distinguished from the disclosure in document D4 in that it comprises a laser optical system with a semiconductor laser of the direct analog modulation type and a converging lens for converging a laser beam emitted by said laser to a predetermined convergence position, and in that the density distribution filter has the constitution set out in detail in the claim, with a low optical density portion at the centre, a higher optical density portion at the periphery and a transmittance which gradually decreases from the centre portion to the peripheral portion.

The disclosure in document D5 is similar to that in document D4. Document D5 further evokes the interest of the apodisation technique it describes in microscopy (see page 31, point 2, last sentence). The pupil function shown on Figure 3.6.a on page 55 in substance corresponds to a density distribution with a transmittance gradually decreasing from the centre portion to the peripheral portion as is set out in claim 1.

Thus, the subject-matter of claim 1 is distinguished from the disclosure in document D5 essentially in that it comprises a semiconductor laser of the direct analog modulation type and a converging lens for converging the laser beam emitted by said laser to a predetermined convergence position.

Document D7 describes a laser optical system comprising a laser 12 (see Figure 2) of a non-specified type and a converging lens 14 for converging the laser beam emitted from said laser to a predetermined convergence position. In front of the converging lens is disposed an optical stop 20 comprising an aperture (see page 3, first paragraph).

In contrast with the subject-matter of claim 1, the system of document D7 does not comprise a density distribution filter.

The remaining documents on the file do not come closer to the claimed laser optical system.

For these reasons, the subject-matter of claim 1 is novel in the sense of Article 54 EPC.

3.2 Inventive step

3.2.1 Document D1 is the sole citation on the file to disclose a laser optical system comprising a semiconductor laser of the direct analog modulation type and a converging lens for converging the laser beam emitted by said laser to a predetermined convergence position. The optical system shown in Figures 7A and 7B of document D1 can therefore be considered to represent the nearest prior art, as was agreed by the parties.

The optical system set out in claim 1 is distinguished from this nearest prior art in that a density distribution filter constituted as indicated in the last paragraph of the claim is disposed in the optical path of the laser beam in front of the converging lens.

3.2.2 In the specific embodiment disclosed in the description of the present patent, the density distribution filter is used for decreasing the diameter of the convergence spot of the laser beam in the low output region, wherein the natural emission light is predominant, to a value close to the diameter of the convergence spot of the laser oscillation light (see column 5, lines 7 to 12). Claim 1 is however not restricted to an arrangement in which the density distribution filter achieves such effect, nor even to an optical system comprising a semiconductor laser which, in use, actually operates both in the natural light emission and in the laser light emission regions. The end of the description indeed explicitly states that "the laser optical system in accordance with the present invention is also applicable to the other laser optical systems wherein the beam diameter is to be restricted **for the purpose of increasing the focal depth** or for other purposes" (see column 9, lines 12 to 20).

Accordingly, the technical problem solved by the provision of the density distribution filter specified in claim 1 can be seen *inter alia* in improving the laser optical system of document D1 in such a way as to achieve an increased focal depth.

3.2.3 Document D7 is dedicated to the increasing of the focal depth in a focussed laser beam optical system. To this effect it teaches to first expand the beam emitted by a laser source, and then to reduce the cross-section of the expanded beam by way of an aperture (see page 1, third paragraph, claim 1 and Figure 2).

Document D2 is also dedicated to the achievement of improved profile characteristics by operating with the centre and relatively flat portion of an expanded Gaussian beam and discarding the outer edge region (see page 1344, lines 8 to 13). According to document D2, improved beam uniformity can alternatively be achieved with a radially variable density filter placed in the expanded Gaussian beam (see page 1344, left-hand column, lines 13 to 16).

Thus, the skilled person striving to increase the focal depth in the laser optical system of document D1, which itself is a common desire in many optical applications as evidenced for instance by document D7 (see page 1, second and third paragraphs), would find in the latter document the teaching that an increase of the focal depth can be obtained by expanding the laser beam and passing it through an aperture. Using instead of the aperture the radially variable density filter explicitly disclosed in document D2 as an alternative to the aperture, immediately leads to the laser optical system set out in claim 1.

3.2.4 In this respect, the appellant essentially submitted that claim 1 implicitly comprised the limitation of the density distribution filter actually decreasing the diameter of the convergence spot of the laser beam in the low output region to a value close to its diameter in the laser oscillation region. This feature in his view was specified in the description to be an overriding requirement of the invention and claim 1 should therefore be interpreted as requiring it as an essential feature, even though the wording of the claim when read in isolation did not specifically require such feature, pointing in this respect to the ruling in decision T 416/87 (OJ EPO 1990, 415).

As indicated under point 3.2.2 above, the description of the patent in suit however explicitly allows for the density distribution filter being used for other purposes, in particular for increasing the focal depth of the optical system. The narrow interpretation of claim 1 proposed by the appellant would therefore certainly not be consistent with the description, in contrast with the situation on which decision T 416/87 was based.

3.2.5 For these reasons, the subject-matter of claim 1 of the main request does not in the Board's opinion involve an inventive step in the sense of Article 56 EPC, and the main request must therefore be rejected.

4. *Appellant's auxiliary request*

4.1 The amendments brought to claim 1 and to the description of the patent in accordance with appellant's auxiliary request comply with the requirements of Article 123(2) and (3) EPC.

Claim 1 in particular was supplemented with an additional feature directed to the provision of a driving means for driving the semiconductor laser both in the ranges of natural light emission and of laser light emission. The application documents as originally filed admittedly did not explicitly refer to "driving means". Claim 2 as originally filed however explicitly specified that the semiconductor laser emits both natural light and laser oscillation light in accordance with the level of an applied current, which clearly requires that such driving means be provided.

Claim 1 was further supplemented with the statement that the high density portion of the density distribution filter substantially blocks the light beam such that the convergence spot of the light beam is prevented from increasing when the laser is driven in the region of natural light emission. This feature was disclosed originally in the second paragraph of page 20 of the description as filed, which explicitly states that the density distribution filter is used for decreasing the diameter of the convergence spot of the laser beam in the low output region to a value close to the diameter of the convergence spot of the laser oscillation light by decreasing the diameter of the beam as it passes through the low density portion of the filter formed inward from a high density portion which substantially intercepts light (see lines 6 to 18).

The above additional features also clearly limit the scope of the claim.

The description was only amended for consistency with the wording of amended claim 1, by deletion of the general statements in column 9, lines 12 to 20 of the specification as granted, which stated that the invention was also applicable to other laser optical

systems wherein the beam diameter was to be restricted for the purpose of increasing the focal depth or for other purposes, and that the laser source was not limited to the semiconductor laser type.

4.2 The Board does not share the respondent's view that claim 1 of the auxiliary request does not meet the clarity requirement of Article 84 EPC with respect of the definition of the density distribution filter.

As a matter of fact, the last paragraph of the claim explicitly expresses that the density distribution filter comprises three portions, namely a center portion of lower density which substantially transmits the light beam, a peripheral portion of higher density and an intermediate portion with a transmittance gradually decreasing from the center portion to the peripheral portion.

The last paragraph of the claim further specifies that the high density portion substantially blocks the light beam, and that it blocks the light beam such that the convergence spot of the light beam is prevented from increasing when the laser is driven in the region of natural light emission. These indications unambiguously express that the peripheral high density portion is so located with respect to the beam emitted by the semiconductor laser that it actually reduces the natural light beam diameter to such an extent that there is no increasing of the convergence spot in the natural light emission mode of the laser.

4.3 Novelty

The subject-matter of claim 1 of the auxiliary request is novel for the reasons already set out in point 3.1 above in relation to the subject-matter of claim 1 of the main request, of an even broader scope.

4.4 Inventive step

4.4.1 Besides the features of the density distribution filter which were already set out in claim 1 of the main request, the subject-matter of claim 1 of the auxiliary request is further distinguished from the arrangement of document D1 by the provision of driving means for driving the semiconductor laser both in the ranges of natural light emission and of laser light emission, and by the specific arrangement of the high density portion substantially blocking the light beam such that the convergence spot of the light beam is prevented from increasing when the laser is driven in the region of natural light emission.

As a matter of fact, there is no suggestion in document D1 that the laser system it discloses is intended for operation also in the range of natural light emission. On the contrary, the various power outputs at 11, 110 and 50 mW referred to in document D1 all correspond to operation of the laser in the laser light emission range (see page 7, first paragraph in conjunction with Figure 11).

4.4.2 The technical problem underlying the invention defined in claim 1 of the auxiliary request, as objectively assessed in view of the contents of document D1, thus essentially consists in improving the known laser system in such a way that it be operable also in the range of natural light emission, whilst preventing the convergence spot of the light beam from increasing when the laser is driven in this range of operation.

4.4.3 The Board notices that none of the prior art citations on the file addresses the problem of avoiding an increase of the convergence spot of the light beam of a laser source driven in the natural light emission region, and none of them even discloses a laser system

which is actually intended for operating both in the natural and in the laser light emission regions. The only document to disclose such system, namely Japanese patent application No. 61-196 352 as referred to in the introductory portion of the description of the present patent (see column 2, lines 35 to 45), was published under publication No. 63-051 687 on 4 March 1988, which is later than the filing date of the present patent.

In addition, the only prior art citation to disclose the use of a density distribution filter in conjunction with a laser beam is document D2. The density distribution filter disclosed there is however used only as a means for compensating non-uniformity of the beam profile, and there is no indication in the document that the density distribution filter could have any benefical effect in avoiding the formation of deleterious side lobes when a laser beam passes an aperture. Quite on the contrary, with reference to the arrangement of Figure 1 in which the laser beam passes a spatial filter pinhole structure, the document explicitly states that "Truncation or self limiting of the laser beam diameter and associated diffraction effects can be neglected. Deviations in the Gaussians beam geometry and truncation-induced side lobe levels in the focal plane of the spatial filter lens are extremely low for typical laser beam profiles" (see page 1344, left-hand column, lines 39 to 44).

This statment is consistent also with the fact that document D1, which is specifically dedicated to improving the focusing capability of a laser system, still recommends the use of mere apertures "to block undesirable side or lower power interference lobes or diffraction orders that may be present in the far field pattern" (see page 9, lines 6 to 10).

Thus, from an objective assessment of the citations available on the file, it emerges that the formation of side lobes as the result of diffraction of a laser beam when it passes through an aperture had not been recognised in the prior art as a cause of substantial difficulties with respect of the convergence of laser beams.

Documents D4 and D5 indeed teach the use of a density distribution filter to mitigate the effect of side lobe generation by diffraction effects, but only through the entrance pupil of image forming devices like telescopes, microscopes or spectroscopes.

In the apparent absence of any awareness by the skilled person that in laser systems involving the direct analog modulation of a semiconductor laser driven both in the ranges of natural light emission and of laser light emission as used for instance in scanning or recording apparatuses, diffraction effects as occurring when the natural light beam is passed through an aperature could substantially affect the size of the convergence spot, the skilled person in the Board's opinion had no obvious reason to resort to the technique disclosed in documents D4 and D5 in a very different context.

Neither is there any evidence in the file that the convergence or resolution requirements in a laser optical system of the type addressed in the patent are in any way comparable to the extreme resolution requirements of the imaging systems addressed in documents D4 and D5, the resolving power of which should be such as to allow for instance observation of the companion of Sirius in astronomy, or of faint satellite lines or of lines of rare isotopes in spectroscopy (see document D5, page 31, third paragraph,last sentence).

The Board also agrees to appellant's submission that in the specific applications disclosed in documents D4 and D5, the density distribution filter constitutes a separate optical element provided in addition to the entrance pupil, of which it mitigates the side lobe generation effect, whilst in the claimed arrangement its peripheral high density portion **simultaneously** forms the beam diameter limiting element.

For the above reasons, the subject-matter of claim 1 of the auxiliary request in the Board's view does not in an obvious way result from the state of the art available on the file. It therefore involves an inventive step in the sense of Article 56 EPC.

4.5 The same conclusion applies to the subject-matter of claims 2 and 3 by virtue of their appendency to claim 1.

Since, taking into consideration the amendments made by the appellant, the patent and the invention to which it relates meet the requirements of the Convention, the patent can be maintained as amended (see Article 102(3) EPC).

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 maintain the patent in amended form as follows:

   Claims, description and drawings as presented at the oral proceedings.

The Registrar: The Chairman:

P. Martorana E. Turrini