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Datasheet for the decision of 10 June 2008

Case Number: T 0199/06 - 3.4.02

Application Number: 98934356.1

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Language of the proceedings: EN

Title of invention:
Multi-spectral two-dimensional imging spectrometer

Patentee:
Optical Insights LLC

Opponent:
-

Headword:
-

Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0199/06 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 10 June 2008

Appellant: Optical Insights LLC
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Representative: Roberts, Gwilym Vaughan
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 01 August 2005 refusing European application No. 98934356.1 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. Klein
Members: F. Maaswinkel
B. Müller

Summary of Facts and Submissions

I. The appellant lodged an appeal, received on 7 October 2005, against the decision of the examining division, dispatched on 1 August 2005, refusing the European patent application 989343546.1. The fee for the appeal was paid on 11 October 2005 and the statement setting out the grounds of appeal was received on 9 December 2005.

II. The examining division objected that the set of claims then on file was not allowable because their subject-matter did not involve an inventive step (Articles 52(1) and 56 EPC 1973) having regard to the disclosure in document D2 (US-A-5 729 011) and to customary practice of a person skilled in the art.

III. In the statement containing the grounds of appeal the appellant requested that the set of claims in the decision be considered by the Board and filed an auxiliary request for oral proceedings.

IV. In a Communication under Article 110(2) EPC 1973 the Board raised objections under Article 84 EPC 1973 since it appeared that the independent claims lacked essential features of the invention, indicating that provisionally a set of claims overcoming these deficiencies could possibly define patentable subject-matter.

V. With a letter dated and received 16 November 2007 the appellant filed a revised request supported by a new set of claims and revised description pages.

The documents comprising the request include:

Claims: 1 to 19, as received with the letter of 16 November 2007;
Description: pages 1, 2 and 4 to 19 as published; pages 3 and 3a as received with the letter of 16 November 2007;
Drawings: sheets 1/5 to 5/5 as published.

VI. The wording of independent claim 1 reads as follows:

"A multi-spectral two-dimensional imaging spectrometer (10, 40) comprising:

an image-collection sub-assembly (12) having a first optic (14) and a pupil relaying optic (16) arranged for producing an intermediate image (18) of an object along an optical axis at a plane substantially coincident with a field-stop aperture (20) of the spectrometer wherein the pupil relaying optic (16) is arranged to relay the exit pupil of the image collection sub-assembly;

a spectral separation sub-assembly (22) having:

means (24) arranged for collimating light from the intermediate image thereby providing a collimated space;

means (26, 42) arranged for dividing said collimated light from said intermediate image into multiple light channels wherein said means (26, 42) is positioned along said optical axis within the collimated space and substantially coincident with the exit pupil plane of the image-collection sub-assembly; and

means (28, 30, 42) arranged for modifying each channel to produce a predetermined optical state of the intermediate image; and

a re-imaging sub-assembly (32) having means (34) for imaging each channel on a single detector (36), thereby producing multiple two-dimensional images of the intermediate image".

The wording of independent claim 9 reads as follows:

"A method for generating multiple two-dimensional images using an optical system (10, 40) comprising the steps of:

allowing the optical system (10, 40) to receive an intermediate (18) image of an object from an image-collection sub-assembly along an optical axis at a plane substantially coincident with a field-stop (20);

relaying the exit pupil of the image-collection sub-assembly;

collimating the light from the intermediate image to provide a collimated space;

dividing light from the intermediate image into a plurality of optical channels by an optical separator (26) located in collimated space and substantially coincident with the pupil plane of the image-collection subassembly, the optical separator (26) placed symmetrically about the optical axis;

redirecting each optical channel using at least one optical reflector (28) in each channel located in collimated space;

modifying at least one optical channel (30) in the collimated space to produce a predetermined optical state of the intermediate image; and

imaging each optical channel (34, 38) on a detector (36)".

Claims 2 to 8 and 10 to 19 are dependent claims.

VII. The appellant's arguments may be summarised as follows:

In independent claim 1 the feature has been added "means (24) arranged for collimating light from the intermediate image thereby providing a collimated space" in order to provide antecedent for "within a collimating space" and to clearly recite the technical feature responsible for the collimating effect, see p.8, l. 18 - 20 of the description and Fig. 1, for example. Also the three groups of optics "image-collection sub-assembly", "spectral separation sub-assembly" and "re-imaging sub-assembly" are recited, see p. 7, l. 22; p. 8, l. 10 and p. 11, l. 11, respectively. Finally the feature has been added that the pupil relaying optic is arranged such that the collimated light dividing means (prism) (26, 42) is positioned at the exit pupil plane of the image-collection sub-assembly, hereby making it clear which exit pupil is in question and ensuring that the responsible technical features are indicated. Support for this feature is found on p. 8, l. 30 - 31. Independent claim 9 has been amended for consistency with the new claim 1. The claims have not been cast in the two-part form (Rule 29(1) EPC 1973), since this would give a distorted or misleading picture of the invention and the prior art, see Guidelines, Part C, Chapter III, 2.3. Instead, specific acknowledgement of the prior art has been given in the description to meet the requirements of Rule 27(1)(b) EPC 1973.

In its decision the examining division had based its objection of lack of inventive step on document D2. This document discloses in Fig. 3 a spectroscopic apparatus including a lens 301 for focussing an intermediate image onto a field stop 201. The diverging light from the image is refracted through a prism 202 having a plurality of facets each having a corresponding filter component 203 behind it. The spectral components are subsequently imaged via a lens 204 onto a detector 205. In the decision it was acknowledged that, contrary to the spectrometer defined in claim 1, in the apparatus known from D2 the prism is not positioned in a collimated space. Therefore, already by virtue of this feature, the spectrometer defined in claim 1 is novel. The examining division had argued that this feature was the only difference between the subject-matter of this claim and the apparatus known from D2, and that it would be customary practice for a skilled person to position the prism in a collimated space in order to solve the problem of reducing optical aberrations. However, D2 does not identify such a problem, let alone the solution provided by the present invention, therefore the suggestion that providing the claimed solution would be obvious is application of hindsight. Moreover, previous claim 1 also included the further feature that the means for dividing the incident light from the intermediate image into multiple light channels is positioned along the optical axis within a collimated space and substantially coincident with an exit pupil plane of preceding optics. In this context it is pointed out that the phrases "exit pupil" and "exit pupil plane" are well-known terms in the optical art.

Those of skill in the art know that each and every optical system has an inseparable and unique "exit pupil". They also recognise that the specific elements that comprise an optical system uniquely define the size and location of this exit pupil, see, e.g., the textbook "Modern Optical Engineering", Warren J. Smith, McGrawHill, 1990, §§ 6.2 and 6.4. In the present invention, for example, elements 14, 16 and 24 form an optical system which has the unique "exit pupil" associated with it, and thus, a unique "exit pupil plane". For the occurrence of the feature "exit pupil" in the apparatus of D2 the examining division referred in the decision to col. 4, l. 27 - 32 of that document, where it is stated that "...the prism 202 is situated near a pupil plane of the lens 204". However, this only implies that the prism is placed near the entrance pupil of succeeding optics rather than the exit pupil of preceding optics. By explicitly including in present claim 1 the relaying optic 16 which is arranged to relay the exit pupil of the image collection sub-assembly this difference over the apparatus of document D2 is even more pronounced.

In fact, the present invention solves various problems of which the system of D2 is suffering. Firstly, because the prism of that system is not placed in collimated light space, light from any point of the image is distributed non-linearly along a prism facet as a result of which the spectral component will not be uniformly distributed. In addition, optical aberrations can also affect the quality of the final image. Furthermore, because the prism is not placed at the exit pupil of the preceding optical system, less light is collected at the prism from points on the object

distant from the optical axis, once again providing a non-linear spectral response (vignetting). The present invention solves these problems by providing light in a collimated space, ensuring equal distribution of the light from a single point across the whole of the facet of the prism and by positioning the prism at the exit pupil of the preceding optics, reducing vignetting. The combination of both of these features requires careful optical design but results in a highly accurate, non-distorted separation of the object into spectral components. Therefore the apparatus defined in claim 1, and similarly the method of generating images as defined in claim 9 and involving corresponding technical features, involve an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

2.1 The board is satisfied that the amendments in the claims find support in the respective claims as originally filed as indicated by the appellant. Also the acknowledgement of the prior art is found to be admissible under Article 123(2) EPC.

2.2 The board concurs with the appellant that casting the claims in the two-part form (Rule 29 EPC 1973) would not add to a better understanding of the invention with respect to the closest prior art for the following reason. It is typical in complex optical systems (here: a spectrometer) that some of the elements (optical,

detector) may also be included in a prior art system. Often (as in the underlying case) it is not only the presence of such elements in the system as such, but also the proper sequence and positional relationship of such elements in the system which are responsible for the technical effect envisaged. In the present case casting the claim in the two-part form would have resulted in listing the known optical elements from D2 (prism, filter, detector) in the preamble of the claim, whereafter it still would have been necessary to enumerate the whole of present claim 1 in the characterising portion, because it is not just the presence of the known features as such, but their interrelationship with each other and with further optical parts, which reflects the features to be protected. Furthermore, since, in the opinion of the board, the prior art has been properly acknowledged on page 3 of the description, the requirements of Rule 27 EPC 1973 are equally met.

2.3 By including the essential features of the invention in the independent claims the Board is also satisfied that the claims fulfil the requirements of Article 84 EPC 1973.

3. *Patentability*

3.1 *Novelty - Claim 1*

3.1.1 In the decision under appeal there was no objection of lack of novelty. Rather, it was acknowledged that the subject-matter of the then-valid claim 1 differed from the disclosure in document D2 in the requirement that the means for dividing the incident light from the

intermediate image into multiple light channels is positioned within a collimated space. As will be discussed, present apparatus claim 1 (and corresponding method claim 9) is further distinguished from this disclosure.

The further documents in the proceedings are less relevant. Therefore the subject-matter of claims 1 and 9 is novel (Art. 52(1) EPC and 54 EPC 1973).

3.2 *Inventive step*

3.2.1 *Closest prior art*

In the decision document D2 was identified to disclose the closest prior art. This document (US-A-5 729 011) has the publication date of 17 March 1998, which is later than the valid priority date of the present patent application of 12 July 1997. However, document D2 is a family member of the Japanese patent application JP-A-08 233 658, which was published on 13 September 1996. Since the drawings of the Japanese priority document and the US-patent are identical it appears that also the respective spectroscopic apparatuses are the same and that the disclosure in the US family member may be validly used for discussing the patentability. It is added that the applicant/appellant did not raise any objections against the US document in this respect.

3.2.2 Document D2, see Figure 3, discloses a multi-spectral two-dimensional imaging spectrometer comprising:

- an image-collection sub-assembly having an optic (lens 301) for producing an intermediate image of an object along an optical axis at a plane substantially

coincident with a field stop aperture 201 of the spectrometer;
- a spectral-separation sub-assembly having means (prism 202) for dividing light from the intermediate image into multiple light channels and means (wavelength selection filter array 203 with filters 213) arranged for modifying each channel to produce a predetermined optical state of the intermediate image; and
- a re-imaging sub-assembly having means (lens 204) for imaging each channel on a single detector (imaging element 205) thereby producing multiple two-dimensional images of the intermediate image (col. 5, l. 27 - 32).

3.2.3 The subject-matter of claim 1 differs from the spectrometer shown in Figure 3 of document D2 in the following features:
i) the image-collection sub-assembly has, in addition to the first optic, a pupil-relaying optic which is arranged to relay the exit pupil of the image collection sub-assembly;
ii) it comprises means arranged for collimating light from the intermediate image thereby providing a collimated space; and
iii) the means arranged for dividing the collimated light from the intermediate image into multiple light channels is positioned along the optical axis within the collimated space and substantially coincident with the exit pupil of the image-collection sub-assembly.

3.2.4 According to the published patent application, see p. 10, starting on line 18 of the description, the inclusion of the pupil relaying optic 16 improves the optical performance of the system, since it provides

for the equal distribution of flux of the incident beam into the various channels. Furthermore the location of the exit pupil of the image-collection sub-assembly prevents parallax errors. Finally the provision of the optical separator in collimated space ensures that all the light from a particular point in the plane of the intermediate image sees the same spectral bandpass and prevents boresight/parallax errors (p. 12, l. 5 - 35).

3.2.5 Therefore, the objective problem addressed by the present patent application may be seen in a multi-spectral two-dimensional imaging spectrometer with improved optical and spectral performance over the prior art device (of document D2). Clearly, the skilled person in the field of optics will always try to improve an existing optical system, therefore the formulation of the technical problem as such does not yet include an inventive activity. Rather, it must be considered whether the skilled person would, on the basis of the disclosure in document D2, have understood the limitations of that optical system and whether he subsequently would have arrived at the claimed solution.

3.2.6 With respect to the issue of parallax problems, this is raised in document D2 in connection with the embodiment in its Figure 2 (see col. 5, l. 11 - 16) and Figure 6 (col. 7, l. 52). According to D2, the problem can be reduced by situating an object lens on the object side of the field stop, which is shown in the embodiment of Figure 3 and described in col. 5, l. 17 - 26. It is noted that with this solution the "influence of parallax is reduced" (col. 5, l. 25 - 26), therefore apparently no attempt is made to completely eliminate this effect.

3.2.7 The further problems of boresight errors and of possible wavelength bandpass errors being caused by the splitting element (prism 202 in the embodiment of Figure 3 of D2) being located in the diverging beam are not touched upon in D2, nor does this document hint at the technical features defined in claim 1 (i.e. pupil relaying optic 16 arranged to relay the exit pupil of the image collection sub-assembly at the plane of the dividing means 26, 42; and collimation means 24).

3.2.8 In its decision the examining division had referred to col. 4, l. 27 - 32 of document D2 from which paragraph it concluded that "the pupil plane of the lens is nothing else than the pupil plane of the optical system as a whole" and that, because the pupil of an optical system is re-imaged towards the object (resp. image) plane by the preceding (resp. subsequent) optical elements, this image becomes the "entrance pupil" (resp. "exit pupil") of the optical system. Therefore, in the opinion of the examining division, "The pupil of the optical system is therefore necessarily identical with the "exit pupil plane" of preceding optics". The Board does not concur with this interpretation of document D2. Rather, to the Board's understanding, the phrase in col. 4, l. 27 - 28 "...the prism 202 is so situated near a pupil plane of the lens 204 that the pupil plane of the lens is divided into four portions by the light refraction surfaces of the prism 202" implies that the prism is situated close to the lens surface, so that its active aperture (here: pupil) is divided into four sub-regions, acting as lenslets. This also follows from independent claim 1 (col. 12, l. 16) which specifies "dividing a pupil of an optical system". In no way is

this "pupil" related to or even equivalent to the concept of an "exit pupil" which, according to paragraph 6.2 of the textbook "Modern Optical Engineering" cited by the appellant, is "...the image of the aperture stop in image space". Furthermore, present claim 1 not only defines that the means for dividing incident light is positioned "substantially coincident with an exit pupil of preceding optics" as the former claim but requires explicitly the presence of a pupil relaying optic, with further restrictions to its performance. Such a pupil relaying optic is not disclosed in document D2, nor a means for collimating the light as defined in claim 1, and it is not imaginable why and how the skilled person would modify the optical system of D2 in this way, since this would require a rather substantial modification, if not a complete redesign, of that optical system.

3.2.9 The remaining citations referred to by the examining division are not more relevant.

3.2.10 Therefore, in the opinion of the Board, the subject-matter of claim 1 involves an inventive step (Art. 52(1) EPC and 56 EPC 1973).

3.3 Claim 9 defines a method for generating multiple two-dimensional images using an optical system, which method, *inter alia*, includes the corresponding method steps "relaying the exit pupil of the image-collection sub-assembly", "collimating the light from the intermediate image to provide a collimated space", and "dividing light ...by an optical separator located in collimated space and substantially coincident with the pupil plane of the image-collection sub-assembly". This

claim is novel and inventive for the same reasons as claim 1.

3.4 The further claims 2 - 8 and 10 to 19 are dependent claims and are therefore equally allowable.

4. For the above reasons, the Board finds that the appellant's request meets the requirements of the EPC and that a patent can be granted on the basis thereof.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

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

Claims:	1 to 19, as received with the letter of 16 November 2007;
Description:	pages 1,2 and 4 to 19 as published; pages 3 and 3a as received with the letter of 16 November 2007;
Drawings:	sheets 1/5 to 5/5 as published.

The Registrar: The Chairman:

N. Maslin A. G. Klein