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Datasheet for the decision of 21 April 2010

Case Number: T 0934/07 - 3.4.02

Application Number: 00310238.1

Publication Number: 1109036

IPC: G02B 5/20

Language of the proceedings: EN

Title of invention:
Optical low-pass filter, and image sensing unit and apparatus using the same

Applicant:
CANON KABUSHIKI KAISHA

Opponent:
-

Headword:
-

Relevant legal provisions:
-

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

Keyword:
"Inventive step - all requests (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0934/07 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 21 April 2010

Appellant: CANON KABUSHIKI KAISHA
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 24 November 2006 refusing European patent application No. 00310238.1 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. G. Klein
Members: M. Rayner
B. Müller

Summary of Facts and Submissions

I. The applicant appealed against the decision of the examining division refusing European patent application number 00 310 238.1 concerning image sensing and using birefringent plates. The following document has been referred to in the examination and appeal proceedings:-

D1 JP-A-11-218612 and PAJ Abstract thereof.

In the decision under appeal, the examining division substantiated its refusal with lack of novelty of the subject matter of claim 1 according to the main and first auxiliary requests before it and lack of inventive step of the subject matter of claim 1 according to the second auxiliary request.

II. Arguments of the examining division pertinent to the appeal can be summarised as follows.

Document Dl discloses an optical low pass filter comprising several plates including at least one birefringent plate. The plates are plane-parallel. The material for the birefringent plate is lithium niobate. This material has a refractive index difference of 0.02 or more for ordinary and extraordinary rays. Also disclosed is that the plurality of plates are adhered by an adhesive. Document Dl further discloses the well-known relationship linking material thickness, the angle θ between the optical axis of the material and the surface normal, and the ray separation caused by the birefringence of that material. For the typical case of a desired and therefore fixed ray separation for a particular application this equation identifies the

other two parameters as variables which have to be adapted. The variability of the angle θ which influences the ray separation is furthermore explicitly stated and the design mentioned is based upon a desired ray separation of 15 μm which is given by the CCD of the video camera for which the filter is intended. It is well known that trends in the development of video cameras are directed towards miniaturising and better resolution. The first trend concerns amongst others the size of the pixel elements in the CCD, the second implies the need for higher spatial frequencies. Hence both trends require increasingly smaller ray separation of the low pass filter. On the other hand the effort to miniaturise also requires the use of "as small as possible" optical elements. This evidently concerns the low pass filter, too. Highly birefringent material is therefore the best candidate for this requirement. Besides lithium niobate as birefringent material Dl also discloses the use of calcite, which has approximately double birefringence.

While these trends would suggest a low pass filter with an arbitrarily thin plate (in the micrometer range), an obvious limit is reached when the plate has become so brittle that cutting it from the crystal and handling it produces an unreasonable amount of waste. The skilled person working in this field is therefore met with the demand to effectively balance the quest for small sizes with the problem of lack of mechanical strength. The tool he needs to solve this problem is the understanding of the above mentioned well known relationship, which specifies that for a given ray separation the relationship between the plate thickness and the angle θ is fixed and varies over the entire

range of possible angles. No pronounced let alone surprising effect is linked to a particular choice of an angle or a range of angles θ. Therefore the skilled person will choose a parameter pair balancing the two contradicting requirements solely on the basis of the constraints of the problem without any inventive step.

III. The appellant requested that the decision under appeal be set aside and a patent granted on the basis of a set of claims filed with the statement of grounds for appeal or, in the alternative, on the basis of a first or second auxiliary request filed with the letter of 19.03.2010. Oral proceedings were requested on an auxiliary basis.

The appellant argued that any supposition that a person skilled in the art would have considered all manner of cut angles in pursuit of providing a more robust plate is based entirely upon hindsight knowledge of the invention. Document Dl, taken as closest prior art, discloses a cut angle taken assuredly to be 45 degrees, which certainly is well outside both ranges of cut angle specified in the main claims of the application. Moreover document Dl does not "raise the issue of mechanical strength" at all. The present invention has a feature that the angle of cut is chosen so as "daringly" to thicken the birefringence plate and achieve a robust filter. In a conventional optical low-pass filter such as disclosed in document Dl, the thickness of the birefringence plate can be reduced appropriately by changing the cut angle θ. Document D1 concludes that the setting of the cut angle θ to 45° degrees is the best, because, at this cut angle, the birefringence plate is the thinnest. The idea

"daringly" to thicken the birefringence plate cannot be derived from document Dl. There has been a bias in the prior art to produce thinner and thinner plates as filters and document Dl is evidence of this bias.

The subject matter of claim 1, as amended, is therefore both novel and inventive and thus patentable.

IV. Consequent to the request of the appellant, oral proceedings were appointed by the board. In a communication attached to the summons, the board gave its preliminary opinion including matters summarised as follows.

Document D1 has been taken as closest prior art by the appellant and from the two part form of claim 1, it can be seen from the characterising part thereof that only the inequalities are deemed new by the appellant. A corresponding conclusion can be drawn for claim 16.

It is doubtful whether the problem addressed can be considered to be that of providing birefringent plates used according to document D1 of sufficient mechanical strength as those disclosed are already thicker than some of the plates used in the application, so that, by inference, the problem of mechanical strength is already solved.

Therefore, the problem actually addressed by what is claimed and novel over the disclosure of document D1, seems rather more to be simply that of changing the thickness of the plates for design purposes, a routine requirement for the skilled person. The solution, i.e. varying θ within the ranges defined by the inequalities,

does not appear patentable in view of the equation known from document D1 and referred to by the examining division, because ray separation is fixed so that changing thickness to fit the design can only be changed by varying θ. As indicated by the examining division, selection of the rather large angular ranges defined by the inequalities thus does not seem, per se, inventive.

V. Responsive to the communication of the board, the appellant filed the two auxiliary requests mentioned in section III above, pointing to Figure 1 of the original disclosure where their subject was to be seen. Further submissions concerning patentability were reserved for the oral proceedings.

VI. During the oral proceedings, the appellant made the following submissions.

It can be agreed that there was a trend towards miniaturisation and thus reducing pitch between elements and that the problem solved by the invention concerns this. While more expensive, it was, even at the priority date of the application, nevertheless possible to manufacture down to a 10 μm pitch and even smaller. However, in doing this, there was a prejudice against any angle other than the most effective value of 45°, the more so as crystal field defects outside 45° have an over proportionally more detrimental effect.

The trend was to decrease the thickness of the birefringent plate using the optimum angle of 45°, thus pitch reduction in the way argued by the examining division was not obvious from the relationship

disclosed in document D1, itself well known, because only the existence of the relationship is illustrated, i.e. only the opening of a possibility. The relationship is illustrated in Figure 1 of the application, but it is not this, but the range of angular values provided in the claim which is the basic solution to the problem.

In fact, the 15μm filter disclosed in document D1 itself prevents a smaller, for example 10μm, CCD being used. The skilled person would have been inhibited from using a smaller plate because of its low thickness and it was neither obvious to have used an angular value other than 45°, nor to have modified any of the filter, support or 15 μm CCD.

A skilled person attempting to achieve miniaturisation had, moreover, a number of possibilities available, such as changing the materials involved, changing the manufacturing process or providing a software solution. These are the options which would have been pursued.

The claims according to the auxiliary requests more precisely define the ranges concerned in that they specify not only inequalities for the angle shown in the graph of Figure 1 (abscissa axis), but also those for pitch over thickness (ordinate axis). Moreover, the claims are restricted to lithium niobate.

VII. The independent claims according to the requests of the appellant are worded as follows.

Main Request

"1. An image sensing unit comprising an image sensing element (3;95;97), and an optical low-pass filter (2;92;98) which is arranged on the light incidence side of said image sensing element, said optical low-pass filter (2;5) comprising at least one birefringence plate (21,22;Sl,52,53) which is made of a uniaxial single crystal that causes birefringence of incoming rays and has a refractive index difference of 0.02 or more for ordinary and extraordinary rays,
characterized in that:
said optical low-pass filter (2;5) satisfies one of the following conditions:

$10° < \theta < 27°$, . . . (1)

or $61° < 8 < 80°$ . . . (2)

where θ is the angle an optic axis (Zl,Zl;Z3,Z4,Z5) of said at least one birefringence plate (21,22;51,52,53) makes with a normal to a surface of said at least one birefringence plate.

16. Use of at least one birefringence plate (21,22;51,52,53) which is made of a uniaxial single crystal that causes birefringence of incoming rays and has a refractive index difference of 0.02 or more for ordinary and extraordinary rays, which at least one birefringence plate satisfies one of the following conditions:

$10° < \theta < 27°$, . . . (1)

or $61° < 8 < 80°$ . . . (2)

where θ is the angle an optic axis (Zl,Zl;Z3,Z4,Z5) of said at least one birefringence plate (21,22;51,52,53) makes with a normal to a surface of said at least one

birefringence plate, as an optical low-pass filter, in an image sensing apparatus."

First Auxiliary Request

"1. An image sensing unit comprising an image sensing element (3; 95; 97), and an optical low-pass filter (2; 92; 98) which is arranged on the light incidence side of said image sensing element, said optical low-pass filter (2; 5) comprising at least one birefringence plate (21, 22; 51, 52, 53) which is made of a uniaxial single crystal that causes birefringence of incoming rays and has a refractive index difference of 0.02 or more for ordinary and extraordinary rays,
characterised in that:
said optical low-pass filter (2; 5) satisfies one of the following conditions:

$10° < \theta < 27°$, . . . (1)

or $61° < \theta < 80°$ . . . (2)

where θ is the angle an optic axis (Zl, Z1; Z3, Z4, Z5) of said at least one birefringence plate (21, 22; 51, 52, 53) makes with a normal to a surface of said at least one birefringence plate, wherein said image sensing element has a rectangular image sensing surface, and said unit satisfies:

$0.015 < p/d < 0.031$ (3)

where d is the thickness of the at least one birefringence plate, and p is the pixel pitch of the image sensing surface in a long side direction, wherein the at least one birefringence plate is made of lithium niobate.

15. Use of at least one birefringence plate (21, 22; 51, 52, 53) which is made of a uniaxial single crystal that

causes birefringence of incoming rays and has a refractive index difference of 0.02 or more for ordinary and extraordinary rays, which at least one birefringence plate satisfies one of the following conditions:

$10° < \theta < 27°$ ... (1),

or $61 < \theta < 80$ ... (2)

where θ is the angle an optic axis (Zl, Zl; Z3, Z4, Z5) of said at least one birefringence plate (21, 22; 51, 52, 53) makes with a normal to a surface of said at least one birefringence plate, wherein said image sensing element has a rectangular image sensing surface, and said unit satisfies:

$0.015 < p/d < 0.031$ ... (3)

where d is the thickness of the at least one birefringence plate, and p is the pixel pitch of the image sensing surface in a long side direction as an optical low-pass filter, in an image sensing apparatus, wherein the at least one birefringence plate is made of lithium niobate."

Second Auxiliary Request

The second auxiliary request differs from the first auxiliary request in that in both of claims 1 and 15, the lower value in inequality 3 is changed from 0.012 to 0.015, i.e. the inequality reads

"$0.015 < p/d < 0.031$ ... (3)"

VIII. At the end of the oral proceedings, the board gave its decision.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request - Claim 1*

3. *Novelty*

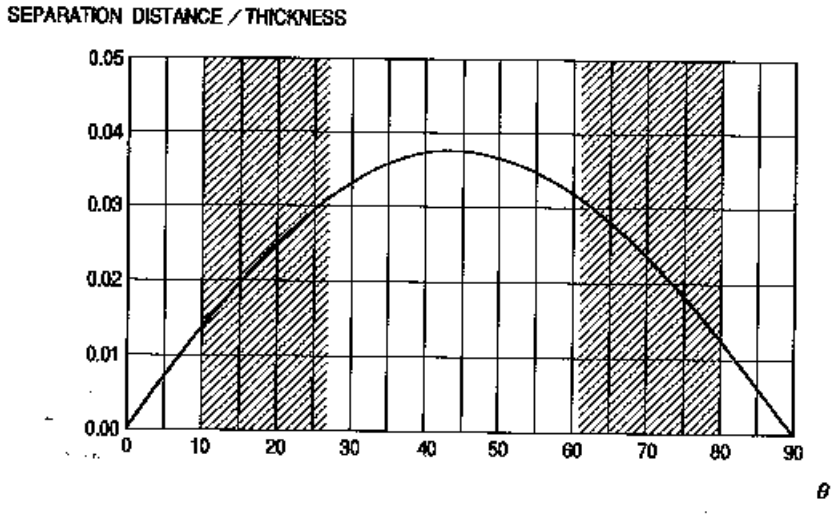
3.1 Document D1 can be considered to represent the closest prior art to the subject matter claimed in claim 1. As can be seen from the PAJ abstract of document D1, this document discloses a low pass filter 5 for attenuating a pseudo signal occurring at the time of converting a signal formed by a lens with a solid state imaging pickup element. The filter comprises a plate of lithium niobate and thus has a refractive index difference of 0.002 or more for ordinary and extraordinary rays. Accordingly, in agreement with the two part form of claim presented by the appellant, the features of the pre-characterising part of claim 1 are known from document D1. In the example disclosed in document D1 a design condition of ordinary/extraordinary ray separation of 15 μm and an angle θ of 45° for the plate of lithium niobate is mentioned.

3.2 While there are some obvious errors in document D1 and the application, e.g. 2θ instead of θ and mixing up of + and -, the relationship disclosed, for example, at the end of page 5 of document D1 corresponds to equation 4 in the present application, and, as agreed by the appellant during the oral proceedings, represents the well known relationship linking material thickness t, the angle θ between the optical axis of the material and the surface normal, and the ray separation d caused by

the material, with n_o and n_e being the ordinary and extraordinary refractive index, respectively. This well known relationship (A) is as follows

$$d/t=((n_e^2-n_o^2)\sin\theta\cos\theta)/(n_o^2\sin^2\theta+n_e^2\cos^2\theta) \text{ ---- (A)},$$

which is more easily comprehensible when shown graphically as, for the example of lithium niobate, in Figure 1 of the application as follows:-



3.3 The subject matter of claim 1 can be considered novel by virtue of the inequalities in the characterising features of the claim, i.e. selecting θ in the hatched area in the graph above.

4. *Inventive step*

4.1 The objective problem addressed by the novel features of claim 1 was meeting the miniaturisation/resolution trend, which calls for reducing size. This corresponds to a trend identified by the examining division and also acknowledged, in the board's view correctly, by

the appellant during the oral proceedings. The board concurs with the examining division that highly birefringent material and use of "as small as possible" optical elements are obviously sought to meet this trend.

4.2 The appellant offered a first line of argument that it would have been possible to miniaturise the device of document D1 with a 45° angle of θ down to a 10 μm pitch, but that this was too expensive and thus not an obvious route for the skilled person. While this line of argument was not documented in any way, the board considers a plausible reason for this expense to be cutting and handling causing an unreasonable amount of waste as referred to by the examining division. However, whatever the reason for the expense was, the obvious counter argument is that the expense would have caused the skilled person to have sought another way to achieve the miniaturisation. The first line of argument is thus not very convincing as it tends rather more to support the position of the examining division than challenge it.

4.3 A second line of argument is essentially in the direction that the skilled person starting from document D1 would, in fact, have rejected the trend towards miniaturisation, essentially because of sizing incompatibility of the filter with the existing components. This line of argument is also not very convincing because the skilled person obviously knew that miniaturisation means that the other components are also made smaller. In other words, the filter has to be sized with smaller components, not the existing ones.

4.4 A third line of argument is that there are a number of solutions to the problem, such as changing materials, changing and improving the software or changing the manufacturing process. Since consideration of inventive step is starting from document D1, it is appropriate first to consider what is there disclosed, which leads to the conclusion that there is nothing relating to software, nor is there any indication of what to change in the manufacturing process. Document D1 does mention a possible change to other highly birefingent materials, such as calcite, and doing this would be in agreement with the analysis of the examining division. So far as this line of argument is persuasive, it again, therefore, tends to support the position of the examining division.

4.5 While it is true, as the board pointed out in the summons, the problem is not that of providing sufficient mechanical strength for the birefringent plates as disclosed in document D1, as at that size they are already strong enough, it is also true that consequent to miniaturisation to "as small as possible", which is the problem really addressed, the skilled person knows there comes a point when, as pointed out by the examining division, the plate has become so brittle that cutting it from the crystal and handling it produces an unreasonable amount of waste. At this point, as the board pointed out in the summons, the thickness of the plates has to be changed to meet the design thickness. Since document D1 discloses relationship (A), varying θ to make this change is obvious because as ray separation is fixed, changing thickness to fit the design can only be changed by

varying θ. In other words, selection of another appropriate angle including one in the rather large angular ranges defined by the inequalities claimed is obvious.

4.6 A fourth line of argument is that there was a prejudice against any angle other than that giving the highest separation per unit thickness, namely 45°, in general and, in particular, because this was chosen in the example in document D1 and also, moreover, because the effect of crystal defects away from 45° would be greater. The problem with this line of argument is that increasing difficulty of working the crystal with decreasing thickness is ignored, in other words the obvious limit referred to by the examining division is not recognised. Simply declaring that document Dl does not "raise the issue of mechanical strength" and the angle of cut is chosen so as "daringly" to thicken the birefringence plate and achieve a robust filter as done by the appellant just concerns thickening the document D1 plate and is not relevant to the knowledge of the skilled person in relation to the miniaturisation problem as set out in point 4.5. Of course a thicker plate is more affected by defects, but this has to be accepted if a thinner one cannot be used. Accordingly, this line of argument did not persuade the board for lack of relevance to the problem addressed.

4.7 Finally, the appellant alleged that hindsight in the knowledge of the application was involved in the analysis of inventive step when starting from document D1. The board takes this allegation seriously, but in the end, it boils down to whether the skilled person knew or did not know that plates worked down to the

smallest possible thickness would reach a point where cutting them from the crystal and their handling produce an unreasonable amount of waste. The board is convinced, for example for reasons of expense as mentioned in point 4.2 above, that the examining division was correct that this was part of the knowledge of the skilled person and that therefore no hindsight was involved in the analysis concerned. Moreover, as claim 1 of the main request is not even restricted to any particular birefringent material, an allegation that the skilled person would not have known that any very birefringent material would become too thin when highly miniaturised is not credible.

4.8 In view of the foregoing, the board had to conclude that selecting the ranges of angle specified in claim 1 is obvious and that, therefore, the subject matter of claim 1 of the main request cannot be considered to involve an inventive step.

5. Main Request - Claim 16

This claim concerns use of at least one birefringent plate as an optical filter in an image sensing apparatus. While the form of claim is different to claim 1 in being directed to a use, the features claimed do not contain any technical substance differing from that dealt with in sections 4.x above. Consequently, the subject matter of claim 16 cannot be considered to involve an inventive step for corresponding reasons.

6. In view of the foregoing, the main request failed.

7. *First auxiliary request*

7.1 Independent claims 1 and 15 are limited to lithium niobate, so the question is if the skilled person, knowing that consequent to miniaturisation highly birefringent materials would have an unreasonable amount of waste if worked very thin consequent to miniaturisation, would have considered lithium niobate to be in this category. The board has been offered no reason to consider this not to be the case, nor does it consider anything other than a positive answer to be correct. Accordingly, this feature does not contribute towards an inventive step.

7.2 The other difference between independent claims 1 and 15 of this request and the corresponding claims 1 and 16 of the main request is the recitation of the inequalities for pitch over thickness. Reference has been made to Figure 1 in connection with the inequalities, and, leaving aside discussion of the amendments in the contexts of Articles 84 and 123(2), it can be considered that they more or less correspond to the values for θ in Figure 1. In other words, a portion of the curve is defined not only by the axis of abscissae but also by the axis of ordinates. Consequently, no more than the same item is selected and as the selection of the range using θ is obvious, the selection defined by pitch over thickness is also obvious.

7.3 Therefore, the subject matter of independent claims 1 and 15 of the first auxiliary request cannot be considered to involve an inventive step.

7.4 In view of the foregoing, the first auxiliary request also failed.

8. *Second auxiliary request*

8.1 The difference between independent claims 1 and 15 of this request and the corresponding claims of the first auxiliary request resides in the change of lower limit for pitch over thickness from 0.12 to 0.15. Leaving again aside discussion of the amendments in the context of Articles 84 and 123(2), this amendment narrows the pitch over thickness range somewhat, but the effective consequential change of a few degrees to the lower limit of θ does not affect the conclusion reached in respect of the claims of the first auxiliary request concerning selection of the remaining still rather large angular ranges defined by the inequalities claimed being obvious.

8.2 In view of the foregoing, the second auxiliary request too failed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar | The Chairman

A. Counillon | A. G. Klein