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**Datasheet for the decision
of 08 February 2011**

Case Number: T 1564/07 - 3.4.02
Application Number: 02738809.9
Publication Number: 1400837
IPC: G02F1/1335, G02F1/13,
G02F1/1362, G02F1/139
Language of the proceedings: EN

Title of invention:

REFLECTION TYPE LIQUID CRYSTAL DISPLAY ELEMENT, DISPLAY UNIT,
PROJECTION OPTICAL SYSTEM, AND PROJECTION DISPLAYSYSTEM

Applicant:

Sony Corporation

Headword:

Relevant legal provisions:

EPC Art. 56

Keyword:

Decisions cited:

Catchword:

Inventive Step - Main and auxiliary requests (no)



Case Number: T 1564/07 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 08 February 2011

Appellant:
(Applicant)

Sony Corporation
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Tokyo 141-0001 (JP)

Representative:

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Decision under appeal:

**Decision of the Examining Division of the
European Patent Office posted 16.03.07 refusing
European patent application No. 02738809.9
pursuant to Article 97(1)**

Composition of the Board:

Chairman: A. Klein
Members: M. Rayner
L. Bühler

Summary of Facts and Submissions

I. The applicant has appealed against the decision of the examining division refusing European patent application number 02 738 809.9 (publication no. WO 2003/001285) concerning liquid crystal display device and projection devices for lack of inventive step or inadmissible amendment. Reference has been made to the following document in the examination and/or appeal proceedings:-

D1 EP-A-0 294 900.

II. In the decision under appeal, the reasoning of the examining division included the following.

a) Pixel Size

Document D1 concerns publication of an invention made in 1987, i.e. 14 years before the patent application, at which time the resolution used was much worse. A pixel resolution of 50x50m was then a realistic value compatible with manufacturing processes available. In view of subsequent progress in resolution, 10x10m can be considered standard at the application filing date.

b) Pretilt

Use of pretilt angles in vertically aligned displays was also standard. The reason is that the tilt direction of the molecules has to be unambiguously set in order to avoid formation of disclination lines when an electrical field is applied to the liquid crystal. Therefore, when realising the display of document D1, the skilled person would, as suggested in D1, have given a preferred direction to the liquid crystal molecules, a pretilt. Values of a few degrees, in

particular between 1 to 5 degrees, would be first choice, as they are the most commonly used values.

c) Refractive Index Anisotropy

In the original application, the only range disclosed for the value of n is that it should be larger than 0.1 and smaller than 0.25. Values of n disclosed in the table on page 32 are 0.103, 0.114 and 0.13. The value 0.13 was not disclosed as being an upper limit of a possible range of values for the refractive index anisotropy. Regarding the precise value 0.13, the applicant even emphasizes using this value leads to an excellent reflex display. When reading the application, the skilled person would therefore have no reason to consider a possible limitation of the value to 0.13. Hence, a range of values of the refractive index anisotropy having an excluded upper value of 0.13 is neither explicitly nor implicitly disclosed in the application as filed.

d) Saturation Voltage

Document D1 does not specify the saturation voltage of the disclosed display. However, the choice of both the thickness of 1.1 μ m and the refractive index anisotropy of 0.13 of the liquid crystal should automatically, as in the present application, lead to a saturation voltage in the claimed range. Furthermore, the display disclosed in D1 uses MOS transistors as driving devices for the pixels. This would give a hint to the skilled person that the saturation voltage has a low value. Thus, as in the case of the pretilt angle value and of the pixel size, the claimed range of saturation voltage is a standard in the art.

e) Thickness

Document D1 discloses thickness of a vertically aligned liquid crystal layer of less than 2m (see column 4, lines 49-56).

III. In a communication dated 06.06.2005 (point 4.3 et seq.), the examining division had considered claims pertaining to

f) different types of apparatus.

The division referred to a display apparatus, a projection apparatus and a projection display. It considered use of reflective display devices on silicon substrate in such kind of apparatus to be well known, citing document D1, column 1, lines 1 to 17. The use of optical means to illuminate the display and to collect light reflected from the display, as, for example, polarisation beam splitters or lenses are standard. Furthermore the illumination with a light source, the subsequent separation of the three colours red, green and blue onto three different displays and the recombination of the different beams using for example a prism are commonly used techniques which can not serve as a basis for an inventive step. Moreover a reflective display used in projection systems having, for example, F-numbers of 2.0 and 2.8 is also known. Such subject-matter can therefore not be considered as being inventive.

IV. The appellant requests that the decision under appeal be set aside and a patent granted on the basis of a main request or six auxiliary requests according to the statement of grounds for appeal, or according to a

seventh or eighth auxiliary request filed on 08 February 2011.

1. Main Request:

- claim 1 (Main Request),
- claims 2 to 29 as of December 15, 2005,
- original description,
- original Figures 1 to 17 on drawing sheets 1/16 to 16/16.

2. First Auxiliary Request (AR1):

- claim 1 (1st Auxiliary Request),
- claims 2 to 29 as of December 15, 2005,
- original description,
- original Figures 1 to 17 on drawing sheets 1/16 to 16/16.

3. Second Auxiliary Request (AR2):

- claim 1 (2nd Auxiliary Request),
- claims 2 to 29 as of December 15, 2005,
- original description,
- original Figures 1 to 17 on drawing sheets 1/16 to 16/16.

4. Third Auxiliary Request (AR3):

- claim 1 (3rd Auxiliary Request),
- claims 2 to 29 as of December 15, 2005,
- original description,
- original Figures 1 to 17 on drawing sheets 1/16 to 16/16.

5. Fourth Auxiliary Request (AR4):

- claim 1 (4th Auxiliary Request),
- claims 2 to 29 as of December 15, 2005,
- original description,
- original Figures 1 to 17 on drawing sheets 1/16 to 16/16.

6. Fifth Auxiliary Request (AR5):

- claim 1 (5th Auxiliary Request),
- claims 2 to 29 as of December 15, 2005,

- original description,
 - original Figures 1 to 17 on drawing sheets 1/16 to 16/16.
7. Sixth Auxiliary Request (AR6):
- claims 1 to 20 (6th Auxiliary Request),
 - original description,
 - original Figures 1 to 17 on drawing sheets 1/16 to 16/16.
8. Seventh Auxiliary Request (AR7):
- claim 1 (7th Auxiliary Request),
 - original description,
 - original Figures 1 to 17 on drawing sheets 1/16 to 16/16.
9. Eighth Auxiliary Request (AR8):
- claim 1 (8th Auxiliary Request),
 - original description,
 - original Figures 1 to 17 on drawing sheets 1/16 to 16/16.

Oral proceedings were requested on an auxiliary basis.

V. The case of the appellant can be summarised as follows.

a) Pixel Size

In essence, document D1 specifies a method making use of a spacer layer and then under etching the spacer layer via openings within the pixel. The reflectivity of the remaining spacers is very different from the reflectivity of the rest of the pixel areas. For this reason the technique proposed by document D1 was not successful and was not considered any further in the difficult technique of liquid crystal displays manufacturing. Additionally an opening with a diameter of 2 μ m also significantly deteriorates the optical properties of the liquid crystal display itself. When

reducing the pixel size to 10m, an opening with a diameter of 2m would deteriorate the function of the liquid crystal device even more, since liquid crystal material is not driven at the opening. Furthermore, any reducing of the diameter of the holes corresponding to the pixel size would result in the problem of how successfully to under etch and fill the liquid crystal material via tiny 400 nm holes. Thus, a person skilled at the art would not have adapted the teaching of document D1 about the liquid crystal device towards pixel sizes of 10m. Accordingly, it would be fair to say that the jump from document D1 was the result of an inventive step.

b) Pretilt

The pretilt angle is a parameter leading to the saturation voltage values as claimed.

c) Refractive Index Anisotropy

The invention discloses for the first time a certain range of refractive index anisotropies n for providing improvements of vertically-aligned liquid crystal display devices. Such remarkable improvements are a high response speed, and the liquid crystal transmissivity reaches saturation at a low voltage level despite a small thickness of the liquid crystal layer. This new display device can be driven easily by a driving circuit manufactured by an ordinary rather cheap process even for small pixel sizes. The n range is between 0.1 and 0.25. Several special values have been recommended (0.103, 0.114, 0.13) for further investigations, the results being shown e.g. by the Figures. It is also emphasised that the object can be achieved by any intermediate value. It would be

unjustified not to allow claiming any range at all if only one known value coincidentally falls within the total range. A knowledgeable reader could easily understand from the original disclosure that the liquid crystal device works in a range of refractive index anisotropy between 0.1 and 0.13. Moreover, in the original disclosure a lower limit of 0.1 for the refractive index anisotropy n has been disclosed as having specific values of 0.103 and 0.114. It is thus unambiguously derivable from the original documents that a region between 0.1 and 0.114 is disclosed. Since none of the documents gives any even remote hint to use any value for the refractive index anisotropy in the claimed ranges, a person of ordinary skill had no incentive towards the claimed subject matter, which is considered to be based on an inventive step.

d) Saturation Voltage

The saturation voltage is different to the disclosure of document D1 even if the condition of the optical path is approximately the same. While the saturation voltage is a function of the geometry, it is required to be less than the withstand-voltage of the transistor in order to drive the liquid crystal layer. The saturation voltage is not determined by one parameter only. Thus, the choice of the corresponding saturation voltage in relation to a withstand-voltage of the appropriate dimensions of the transistor should be carefully evaluated when discussing the inventive step. Within document D1 there is no disclosure of any saturation voltages, nor how exactly the transistors are built. Also, there is no disclosure whether the voltage range to be chosen follows any standard or how this voltage should automatically be selected. It would simply be inadmissible to conclude that an average

skilled person would arrive at the voltage values of claim 1 when transferring the teaching of D1 to smaller pixel sizes. Therefore, this subject-matter is based on an inventive step.

e) Thickness

In Figures 1, 2 and 5 of the application, there is shown that a high transmissivity as well as saturation voltages up to 6V can be attained when using thicknesses of the liquid crystal layer of 2m or 1.5m. Regarding this thickness selection, a thickness of 1.0m results in a lower transmissivity. Accordingly, a person skilled at the art would use values for layer thicknesses between the disclosed values in order to obtain good transmissivity and low saturation voltages. The technical effect achieved is the possibility of designing the device for more than one wavelength. The person skilled at the art had no incentive to realise and make use of this subject-matter by combining the teaching of D1 with any other document on file. The degradation of the saturation voltage with increasing thickness is a new phenomenon which has been found by the inventors. None of the prior art documents disclose or suggest that the saturation voltage will increase when the thickness of liquid crystal layers is decreased. The conclusion must be that the subject-matter is the result of an inventive step.

f) Sixth Auxiliary Request - Independent Claims

The independent claims concern a projection or optical system with a plurality of liquid crystals. Document D1 does not disclose a display device with liquid crystal devices for different colours. An average skilled

person who takes into account the teaching of document D1 might arrive at a display apparatus or projection optical system for different colours, but would choose different parameters for the layer thicknesses for different colours. Therefore the subject-matter of the independent claims is also based on an inventive step.

g) Oblique Evaporation

Oblique evaporation according to the invention has the advantage that even in varying illumination conditions the pretilt angle remains in the range which is needed for ensuring a low saturation voltage. None of the documents currently on file discloses such orientation layers formed by oblique evaporation. Thus an average skilled person gets no hint to adapt the teaching of D1 in a corresponding way. Accordingly, this subject matter is based on an inventive step.

VI. Consequent to the request of the appellant, oral proceedings were appointed for the date set by the summons.

In a communication attached to the summons included observations which can be summarised as follows.

A general problem with the present case is that features claimed as novel over document D1 are mostly not structural features but, in essence, desiderata. This situation leads to problems with clarity because any inventive difference is not reflected in the claimed subject matter. Even where a feature might be regarded as structural, what exactly was disclosed in the documents as filed is doubtful.

Specific points mentioned were:-

a) Pixel Size

The key feature of the main request, pixel size <10m is more or less admitted to derive from the better resolution for the display of document D1 which the skilled person would have wanted. At that point, there is a lack of inventive step. The board can accept that the skilled person might have had doubts about a "holed" pixel and the undercut and filling process, yet this is not a complete picture of that disclosure of document D1. For instance, the undercut/fill holes taught by document D1 need not be in the pixel region, but can be between the electrodes, i.e. 29 not 29' in Figure 5. Quite apart from the foregoing point, there is no feature in the claim pertaining to the LCD which actually excludes undercutting, i.e. the device of document D1 with the obvious wish to reduce pixel size.

b) Pretilt

The pretilt values amount to desiderata and standard target values and would not therefore seem suitable for supporting inventive step.

c) Refractive Index Anisotropy

The examining division does not seem to be wrong about the original disclosure of the n ranges. It seems the appellant is now trying to make a case for inventive step by selecting part of the original range.

d) Saturation Voltage

The saturation voltages amount to desiderata and standard target values and would not therefore seem suitable for supporting inventive step.

e) Thickness

On the question of cell thickness, it is questionable whether the range claimed was originally disclosed. Supposing this hurdle were taken, the main substance in support of inventive step seems to be the negative gradient shown between 1.5 and 2 in the figure furnished with the statement of appeal. This does not seem that convincing for a value for n of 1.3, which the appellant decided not to show in the figure.

e) Sixth Auxiliary Request - Independent Claims

The various devices claimed in auxiliary request 6 are standard.

f) Oblique Evaporation

An oblique evaporation has little to do with the remaining features and is a standard choice.

VII. During the oral proceedings, the arguments on file were discussed and the following further points added.

In the appellant's view, figure 5 of document of document D1 concerns operation in a transmissive mode and so would not have been considered by the skilled person for reflective mode operation. Starting from document D1 to address a problem of higher resolution, the skilled person could not have gone forward because the undercutting manufacturing process involved gave no incentive therefor. Thus the whole control might have

to be different, any holes used would be much more difficult in which to inject so that document D1 cannot be considered an appropriate starting point.

The chairman observed that a problem addressed in the teaching of document D1 was to improve parallelism of the supporting and cover plates of a liquid crystal device using the undercutting process in place of spacers, which are used in the present application. Conceding an obvious disadvantage of the prior art was not, however, inventive. According to document D1, the small thickness was chosen to improve response, as is also the case in the present application.

The appellant explained that a range of thickness was claimed, which resulted from carrying out comprehensive experiments as can be seen from Figure 5. Document D1 on the other hand only disclosed 1.1m with reference to the formula in column 5, there was no mention of any other values such as those in the range 1.5m to 2m.

VIII. The independent claims of the requests of the appellant are worded as follows.

Main Request

"1. Reflex liquid crystal display device, comprising:
- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33)

and said light reflective electrode (30) are opposed mutually defining a pixel structure,
(a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m,
(b) wherein the refractive index anisotropy n of said liquid crystal material is more than 0.1, and
(c) wherein the pixel size is less than 10m."

First Auxiliary Request

"1. Reflex liquid crystal display device,
comprising:
- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually defining a pixel structure,
(a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m and more than or equal to 1.5m,
(b) wherein the refractive index anisotropy n of said liquid crystal material is more than 0.1,
(c) wherein the pixel size is less than 10m."

Second Auxiliary Request

"1. Reflex liquid crystal display device,
comprising:
- a first substrate (33) with a light transmissive electrode (32),

- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually defining a pixel structure,
 - (a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m,
 - (b) wherein the refractive index anisotropy n of said liquid crystal material is more than 0.1, and less than 0.13, and
 - (c) wherein the pixel size is less than 10m."

Third Auxiliary Request

"1. Reflex liquid crystal display device,
comprising:

- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually defining a pixel structure,
 - (a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m,
 - (b) wherein the refractive index anisotropy n of said liquid crystal material is more than 0.1 and less than or equal to 0.114, and
 - (c) wherein the pixel size is less than 10m."

Fourth Auxiliary Request

"1. Reflex liquid crystal display device, comprising:

- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually defining a pixel structure,
 - (a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2 μ m,
 - (b) wherein the refractive index anisotropy n of said liquid crystal material is more than 0.1 and less than 0.25,
 - (c) wherein the pixel size is less than 10 μ m,
 - (d) wherein a pretilt angle of liquid crystal molecules of said liquid crystal material (36) is in a range of 1 to 5 degrees, and
 - (e) wherein a voltage of saturating a light output with respect to a light input to said layer of vertically-aligned liquid crystal material is between 4V and 6V, said voltage being applied between said light transmissive electrode (32) and said light reflective electrode (30)."

{N.B. Reference letter of the last feature should obviously be (e)}

Fifth Auxiliary Request

"1. Reflex liquid crystal display device,

comprising:

- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually defining a pixel structure,
 - (a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2 μ m,
 - (b) wherein the refractive index anisotropy n of said liquid crystal material is more than 0.1,
 - (c) wherein the pixel size is less than 10 μ m,
 - (d) wherein a pretilt angle of liquid crystal molecules of said liquid crystal material (36) is in a range of 1 to 5 degrees."

Sixth Auxiliary Request

"1. Display apparatus, comprising:

- a light source
- a plurality of reflex liquid crystal display devices,
- an optical unit for enabling incidence of the emitted light from the light source on the plurality of reflex liquid crystal display devices, separated by color, and an optical unit for introducing the reflected light from each of said plurality of reflex liquid crystal devices, wherein all of the components are disposed in an optical path of said apparatus, wherein each of said reflex liquid crystal devices includes:
 - a first substrate (33) with a light transmissive electrode (32),

- a second substrate (31) with a light reflective electrode (30),
 - a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually,
 - (a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2 μ m,
 - (b) wherein the refractive index anisotropy of said liquid crystal material is more than 0.1,
 - (c) wherein the pixel size is less than 10 μ m,
- and wherein said thickness and said refractive index anisotropy n are the same for all reflex liquid crystal devices of said plurality of reflex liquid crystal devices.

5. A projection optical system, comprising:

- a light source
 - a plurality of reflex liquid crystal display devices,
 - an optical unit for enabling incidence of the emitted light from the light source on the plurality of reflex liquid crystal display devices, separated by color, and an optical unit for introducing the reflected light from each of said plurality of reflex liquid crystal devices, wherein all of the components are disposed in an optical path of said system,
- wherein each of said reflex liquid crystal devices includes:
- a first substrate (33) with a light transmissive electrode (32),
 - a second substrate (31) with a light reflective electrode (30),
 - a layer (36) of vertically-aligned liquid crystal material interposed between said first and second

substrates (33,31) positioned opposite to each other in a state where said light transmissive electrodes (33) and said light reflective electrodes (30) are opposed mutually,

(a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m,

(b) wherein the refractive index anisotropy of said liquid crystal material is more than 0.1,

(c) wherein the pixel size is less than 10m,

and wherein said thickness and said refractive index anisotropy n are the same for all reflex liquid crystal devices of said plurality of reflex liquid crystal devices.

9. A projection display system, comprising:

- a light source
- a plurality of reflex liquid crystal display devices,
- an optical unit for enabling incidence of the emitted light from the light source on the plurality of reflex liquid crystal display devices, separated by color, and an optical unit for introducing the reflected light from each of said plurality of reflex liquid crystal devices, wherein all of the components are disposed in an optical path of said system,

wherein each of said reflex liquid crystal devices includes:

- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30),
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually,

(a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m,
(b) wherein the refractive index anisotropy of said liquid crystal material is more than 0.1,
(c) wherein the pixel size is less than 10m,
and wherein said thickness and said refractive index anisotropy n are the same for all reflex liquid crystal devices of said plurality of reflex liquid crystal devices.

13. A projection optical system, comprising:

- a light source
- a plurality of reflex liquid crystal display devices,
- an optical unit for enabling incidence of the emitted light from the light source on the plurality of reflex liquid crystal display devices, separated by color, and
- an optical unit for introducing the reflected light from each of said plurality of reflex liquid crystal devices, wherein all of the components are disposed in an optical path of said system,

wherein each of said reflex liquid crystal devices includes:

- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30),
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually,

(a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m,
(b) wherein the refractive index anisotropy of said liquid crystal material is more than 0.1,

(c) wherein the pixel size is less than 10 μ m, wherein said thickness and said refractive index anisotropy n are the same for all reflex liquid crystal devices of said plurality of reflex liquid crystal devices and wherein said optical units have an F number under 3.

17. A projection display system, comprising:

- a light source
 - a plurality of reflex liquid crystal display devices,
 - an optical unit for enabling incidence of the emitted light from the light source on the plurality of reflex liquid crystal display devices, separated by color, and an optical unit for introducing the reflected light from each of said plurality of reflex liquid crystal devices, wherein all of the components are disposed in an optical path of said system, wherein each of said reflex liquid crystal devices includes:
 - a first substrate (33) with a light transmissive electrode (32),
 - a second substrate (31) with a light reflective electrode (30),
 - a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually,
- (a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2 μ m,
- (b) wherein the refractive index anisotropy of said liquid crystal material is more than 0.1,
- wherein said thickness and said refractive Index anisotropy n are the same for all reflex liquid crystal devices of said plurality of reflex liquid

crystal devices and wherein said optical units have an F number under 3."

Seventh Auxiliary Request

"1. Reflex liquid crystal display device, comprising:
- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually defining a pixel structure,
(a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m and more than or equal to 1.5m,
(b) wherein the refractive index anisotropy n of said liquid crystal material is more than 0.1 and less than 0.13,
(c) wherein the pixel size is less than 10m."

Eighth Auxiliary Request

1. Reflex liquid crystal display device, comprising:
- a first substrate (33) with a light transmissive electrode (32),
- a second substrate (31) with a light reflective electrode (30), and
- a layer (36) of vertically-aligned liquid crystal material interposed between said first and second substrates (33,31) positioned opposite to each other in

a state where said light transmissive electrode (33) and said light reflective electrode (30) are opposed mutually defining a pixel structure,

(a) wherein the thickness of said vertically-aligned liquid crystal layer (36) is less than 2m and more than or equal to 1.5um,

(b) wherein the refractive Index anisotropy n of said liquid crystal material is more than 0.1 and less than or equal to 0.114,

(c) wherein the pixel size is less than 10m."

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

Reasons for the Decision

1. The appeal is admissible.
2. Document D1
 - 2.1 Pertinent disclosure of document D1 can be summarised as follows.
 - 2.2 The display devices are used, for example, in colour television or in (colour) monitors for data display and in, for example, display devices in dashboards, etc., but they may also be used as light switches in optical equipment or other optical applications. In addition such devices are increasingly being used in projection television (see column 1, lines 11 to 17).
 - 2.3 A liquid crystal display device comprising a liquid crystalline medium between a supporting plate and a cover plate at least one of which is transparent and each of which is at least provided with a layer comprising a conducting material (see column 1, lines 1

to 6). The supporting plate and the cover plate are generally in the form of two glass substrates on which electrodes (metal patterns) are provided (see column 1, lines 18 to 20). Usually fibres or spheres of the desired dimensions which are deposited in advance on one of the plates are chosen for spacers (see column 1, lines 27 to 28). An object is to provide a liquid crystal display device in which variation in thickness is at most 4%, notably in thin liquid crystal layers, by means of under etching techniques in which various openings are used as etching holes (see column 2, lines 10 to 14).

- 2.4 One embodiment of a device operating in the reflection mode distances the supporting plate and the cover plate by approximately 1m with a tolerance of less than 2% (see column 4, lines 49 to 50), the space between the supporting plate and the cover plate being filled with a homeotropic liquid crystal material (column 4, lines 27 to 32). An advantage of such a small thickness is the shorter relaxation time of a plurality of liquid crystal effects which are inversely proportional to the square value of the thickness (column 4, lines 50 to 55). Consequently fast switch-off times are possible. The device may be manufactured with picture electrodes of dimension $50 \times 50\text{m}^2$ and a thickness d of 1.1m . The thickness d is determined using a formula involving wavelength and refractive index anisotropy n of 0.13 (paragraph bridging columns 5 and 6).

3. Main Request

- 3.1 The subject matter of claim 1 of the main request differs from the disclosure of document D1 by virtue of the pixel size being less than 10m as opposed to 50m. The board concurs with the examination division that

the problem solved by reducing pixel size is increasing display resolution. Moreover, the board also agrees with the examining division that a 10m size was standard at the date of filing of the application. Therefore, in reducing the pixel size commensurate with increasing resolution to values normal at the application date of the application, the subject matter of claim 1 is reached. Consequently, the board reached the view that the subject matter of claim 1 cannot be considered to involve an inventive step.

3.2 Although not explicitly recited in relation to embodiments in the application, yet nevertheless consequent to the same method used as for the comparative example, it can be deduced that, according to the application, spacing between substrates is provided by an adequate number of glass beads sprinkled between the two substrates (see paragraphs [0071] and [0074] of the "A" publication). In other words, the usual method, i.e. as also mentioned as such, in document D1 is used.

3.3 The appellant's position is that document D1 is not an appropriate starting point for the problem addressed by the application because of its focus on under etching techniques to provide more accurate spacing between the supporting and cover plates, i.e. parallelism. However, this approach is not persuasive because the claim's wording does not exclude under etching and, importantly, advantages in liquid crystal response common to document D1 and the application result from the spacing as such, not how this spacing is achieved. As was discussed in the oral proceedings, dispensing with advantages associated with improved parallelism by under etching, in other words accepting a known

disadvantage of the usual spacers cannot be considered to involve an inventive step.

3.4 Moreover document D1 discloses openings between as well as through pixels, so that the board was not, in any case, convinced that under etching techniques would have impacted negatively on reducing pixel size. While Figure 5 (holes between pixels) shows a transmissive cell so that a reflex cell is novel over this disclosure, a reflex cell is shown in the preceding embodiment and application of the teaching concerned to a reflex cell amounts to no more than an obvious variation.

3.5 The appellant stressed that comprehensive experimental work was involved in reaching the subject matter claimed and that a range of thicknesses was found to be satisfactory. The liquid crystal display devices concerned are successful and the work done has merit and should be considered to involve an inventive step over the single disclosure of document D1. The board accepts that significant experimental work was performed by the appellant, but the prior art disclosure exists and cannot be ignored in assessing patentability. The disclosure of thickness meets what is claimed and, even accepting the unproven commercial success, the board has no room for reading the recitation of a broader range as inventive.

4. Auxiliary Requests

Having lost the main request, the appellant has fallen back on selecting other features of the device which are not specifically mentioned in document D1. The appellant's position is basically that because these features, mostly parameter ranges or applications of

the device, are not mentioned, the skilled person had no reason to use them. This amounts to a rather artificial approach, largely calling for per se well known features and even leading in some cases to dispensing with what is disclosed as the best performer.

5. First Auxiliary Request

The difference to the main request is provided by the recitation of a lower limit of thickness of $1.5\mu\text{m}$. While, from the appellant's point of view, there is a certain logic in excluding lower values to move the subject matter claimed away from the disclosure of document D1 ($=1.3\mu\text{m}$), the board considers that from the point of view of inventive step, it does not help. The reason for this is that the application teaches in paragraph [0050].

"Particularly due to the use of a selected liquid crystal material having a high value of n of 0.13, it is possible to realize, even with a thickness of $1\mu\text{m}$, an excellent reflex display device which uses vertically-aligned liquid crystal of silicon and indicates a sufficient transmissivity with superior driving characteristic."

The content of this paragraph is borne out by Figure 5, referred to by the appellant, in that example 12 (n of 0.13) has the best transmissivity at $1.5\mu\text{m}$ and even at $1\mu\text{m}$ has a transmissivity of 80%. Moreover, a negative slope of saturation voltage to thickness exists in the region from 1 to $2\mu\text{m}$ both for n equals 0.114 and 0.13, only n values 0.082 and 0.103 do not have a negative slope for the whole of this region. This situation led the board to conclude that there is no inventive step

in excluding thicknesses below 1.5 μ m. Such exclusion would be to run against the teaching of high n both in document D1 and the Figures relied on in the appellant's own arguments and the application.

6. Second Auxiliary Request

The subject matter of claim 1 of this request differs from that of the main request in imposing an upper limit of less than 0.13 on refractive index anisotropy. With reference to the passages referred to in the preceding section it can be seen that this is not what is taught in the application, where a n of 0.13 - not less than 0.13 - is best. Exclusion of 0.13 is therefore a surprise for the skilled person, which as the examining division found, amounts to adding subject matter by selection. Deliberately taking second best and dispensing with the best value would not, even leaving aside the question of added subject matter, solve any problem and cannot therefore be considered to involve any inventive step.

7. Third Auxiliary Request

The subject matter of claim 1 of this request differs to that of the main request in imposing an upper limit of 0.114 on refractive index anisotropy. The value has been plucked out from the examples used in Figure 5, presumably to move even further away from document D1. The appellant argues that there was no reason for the skilled person to choose this value, but has not offered any argument, for example based on a problem solution approach, which might justify recognition of an inventive step in relation to this value as opposed to the known value of 0.13. Even leaving aside the question of admissibility of the selection, the subject

matter of claim 1 of this request cannot therefore be considered to involve an inventive step.

8. Fourth Auxiliary Request

The subject matter of claim 1 of this request differs from that of the main request firstly by imposing an upper limit of 0.25 on refractive index anisotropy. This value is given in paragraph [0032] of the published specification. However, since a value of 0.13 is known from document D1, no novelty is provided by this feature. A second difference is provided by the recitation of a pretilt of 1° to 5°, but this is a standard range of values for pretilt which is set to avoid disclination arising from varying pretilts across the crystal area. Finally, there is a recitation of range of saturation voltage, but this is, as the examining division explained, given a common n of 0.13 also produced by the display of document D1 because use of a thickness of 1.1µm would lead to a slightly lower value of the saturation voltage certainly still in the region of 4-6 Volts. Although the case of n being 0.082 referred to in the appeal arguments concerns a value which is per se not relevant to the known value of n of 0.13, the division's view is confirmed thereby because even for n of 0.082, the saturation voltage falls with increasing thickness. The board therefore concurs with the examining division and is not convinced by the appeal argument. Accordingly, the subject matter of claim 1 of this request cannot be considered to involve an inventive step.

9. Fifth Auxiliary Request

The subject matter of claim 1 of this request differs from that of the main request by virtue of the pretilt

of 1° to 5° already dealt with in connection with the fourth auxiliary request. In addition, there is a recitation of orientation layers formed by oblique deposition. However, as the board pointed out in the summons to oral proceedings, an oblique evaporation is also standard choice for an orientation layer and cannot therefore be considered inventive. Accordingly, the subject matter of claim 1 of this request cannot be considered to involve an inventive step.

10. Sixth Auxiliary Request

This request is subject to the general problem referred to by the board in the communication attached to the summons to oral proceedings. The subject matter of claim 1 of this request differs from that of the main request in that it refers to a display apparatus with plurality of reflex LCD devices for separate incident colour. There has been no dispute against the position of the examining division that separation of the three colours red, green and blue onto three different displays and the recombination of the different beams using for example a prism are commonly used techniques which cannot serve as a basis for an inventive step. However, the appellant sees an invention in an allegedly implicitly disclosed feature of using the same product of refractive index anisotropy and thickness for all wavelengths because document D1 refers to determining thickness by the wavelength used, the appellant then glitching to the perceived manufacturing advantage of common thickness, not product of thickness and refractive anisotropy. However, it is doubtful what was really disclosed in the application as filed. Are different thicknesses for different colours disclosed by the range of thickness claimed, i.e. designing the device for different

wavelengths, an advantage praised by the appellant in its thickness submissions, yet counting against the implicit disclosure of the same thickness now argued? Leaving aside the question of admissibility and clarity, the board is not persuaded on inventive step by this argument because as the examining division pointed out document D1 discloses the use of the devices in projection apparatus (see column 1, lines 11 to 14) and setting off simplification of the apparatus at the cost of paying less attention to the individual colours or vice versa amounts, either one way or the other, to no more than routine and therefore not inventive optimisation.

Independent claims 5 and 9 differ from claim 1 by being directed to a projection optical system and a projection display system as opposed to a display apparatus. However, the content of the claims does not otherwise differ and the changes concerned, as they involve routine systems, are not inventive. Claims 13 and 17 differ from claims 5 and 9, respectively by the recitation that the optical units have an F number under 3. The claims are subject to the general problem mentioned by the board because a low F number is a desideratum. Achieving this desideratum is, as the examining division said, known. The board therefore sees no inventive step in intending to optimise the LC parameters, the exact values not being recited, to achieve the desideratum.

Accordingly, the subject matter of the independent claims of these requests cannot be considered to involve an inventive step.

11. Seventh Auxiliary Request

The subject matter of claim 1 of this request differs from that of the main request in that it recites a combination of the differing features of auxiliary requests 1 and 2. Simply combining these features does not defeat the considerations leading the board to a negative view thereof. Therefore this request fails for reasons corresponding to those given for auxiliary requests 1 and 2.

12. Eighth Auxiliary Request

The subject matter of claim 1 of this request differs from that of the main request in that it recites a combination of the differing features of auxiliary requests 1 and 3. Therefore this request fails for reasons corresponding to those given for auxiliary requests 1 and 3.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Kiehl

A. Klein