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D E C I S I O N
of 16 July 1999

Case Number: T 0635/98 - 3.4.2
Application Number: 83303373.1
Publication Number: 0098070
IPC: G02F 1/137, G02F 1/133
Language of the proceedings: EN

Title of invention:
Liquid crystal devices

Patentee:
The Secretary of the State for Defence in Her Britannic Majesty's Government of the United Kingdom of Great Britain and Northern Ireland

Opponent:
01: Asea Brown Boveri AG
02: Koninklijke Philips Electronics N.V.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 111(2), 123

Keyword:
"Decision re appeals - ratio decidendi"
"Inventive step (yes) after amendment: non-obvious optimisation"

Decisions cited:
T 0319/91, T 0609/94

Catchword:
-



Case Number: T 0635/98 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 16 July 1999

Appellant:
(Proprietor of the patent)

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Decision under appeal:

Decision of the Opposition Division of the
European Patent Office posted 9 June 1998
revoking European patent No. 0 098 070 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: S. V. Steinbrener
Members: A. G. Klein
V. Di Cerbo

Summary of Facts and Submissions

I. The appellant (proprietor of the patent) lodged an appeal against the decision of the Opposition Division revoking European patent No. 0 098 070 for the third time.

Two oppositions had been filed against the patent as a whole and based on the grounds of lack of novelty and/or inventive step (Article 100(a) EPC), insufficiency of disclosure (Article 100(b) EPC) and inadmissible amendments (Article 100(c) EPC).

The oppositions *inter alia* referred to the following documents (using the numbering of the opposition proceedings):

D1: Journal of Applied Physics, Vol. 49(7), July 1978, pages 4277 to 4279;

D2: Journal of Applied Physics, Vol. 48(4), April 1977, pages 1426 to 1431;

D3: JP-A-56-168 636 (and English translation thereof);

D4: JP-A-56-162 722 (and English translation thereof);

D5: A.R. Kmetz et al.(eds.): "Nonemissive Electro-optic Displays", Plenum Press, New York 1976, pages 261 to 289;

D6: F. Leenhouts et al: "Temperaturkompensierte Flüssigkristallanzeigen", 11. Freiburger Arbeitstagung Flüssigkristalle 8 to 10 April 1981, pages 1 to 3;

D7: US-A-4 143 947, and

D8: JP-A-55-146 416 (and English translation thereof).

II. In its first revocation of the patent in suit dated 12 March 1991, the Opposition Division held that the subject-matter of claim 1 as amended in accordance with a main and a subsidiary request, respectively, offended against Article 100(c) EPC.

At the end of first appeal proceedings, i.e. case No. T 319/91, the present Board found the subject-matter according to the appellant's seventh auxiliary request to be admissible under Article 123(2) EPC and remitted the case to the first instance for further prosecution.

In a second decision dated 8 July 1994, the patent in suit was again revoked by the Opposition Division since the main request and subsidiary requests I to III were not considered admissible by virtue of Article 111(2) EPC. Furthermore, in the Division's view, the subject-matter of subsidiary requests IV and V, although considered admissible, lacked the inventive step required by Article 56 EPC.

A second appeal was lodged by the patent proprietor against this further revocation. In its decision T 609/94, the Board *inter alia* ruled that the following point has been definitively decided by the earlier decision T 319/91:

A claim not including the feature that the liquid crystal display (LCD) incorporates a dye is not allowable under Article 123(2) EPC unless it comprises the features that the liquid crystal material has a high birefringence ($n \geq 0.15$), the thickness of the layer is at least 12 μm and the cell is disposed between two polarisers.

Therefore, in the Board's view the Opposition Division was entitled to reject the main request and the first subsidiary request, but was not entitled to reject the second and third subsidiary requests merely by reference to decision T 319/91. The case was once more remitted to the first instance for further prosecution on the basis of the existing (and possibly further) claims complying with the *ratio decidendi* of the first decision of the Board and Article 123 EPC.

In its third revocation, against which the present appeal lies, the Opposition Division considered the subject-matter of the main request inadmissible under Articles 111(2) and 123(2) EPC. Furthermore, the Division held that the grounds for opposition mentioned in Article 100(a) EPC prejudiced the maintenance of the contested patent in that the subject-matter of the independent claims according to subsidiary requests 1 to 3 did not involve an inventive step when taking account of documents D1 or D3 with respect to the claimed LCD embodiment of guest-host type, and documents D2, D7 and D8 with respect to the claimed LCD embodiment of twisted-nematic type.

- III. In the communication of 29 April 1999 pursuant to Article 11(2) of the Rules of Procedure of the Boards of Appeal, the Board expressed its provisional non-binding opinion that in order to comply with the preceding appeal decisions the wording of claim 1 should unambiguously postulate the incorporation of a dye in the liquid crystal material.
- IV. Oral proceedings, which were appointed at the respective requests of the parties, took place on 16 July 1999. At the end of the oral proceedings, the Board's decision was given.
- V. The appellant requested that the decision under appeal be set aside and that the patent be maintained with claims 1 to 9, amended description and drawings as filed at the oral proceedings.
- VI. The respondents requested that the appeal be dismissed.
- VII. The wording of amended claim 1 on which the present decision is based, reads as follows:

"1. A liquid crystal device incorporating an amount of a pleochroic dye to distinguish between switched states of the device, having

a layer (2) of a long pitch cholesteric liquid crystal material of thickness (d) less than $20\mu\text{m}$ and positive dielectric anisotropy which contains the pleochroic dye, the ratio of the layer thickness (d) divided by the pitch (p) of the liquid crystal material (2) being more than 0.5 and less than 0.75,

two cell walls (3, 4) bearing electrode structures (6, 7) which are arranged as a first series of m separate electrodes ($6; 6_1$ to 6_m) on one wall (3) and a second series of n separate electrodes ($7; 7_1$ to 7_n) on

the other wall (4), forming an $m \times n$ matrix of separate addressable elements, the cell walls being surface treated to align the liquid crystal molecules (23) at the cell wall surface along an alignment direction (R) and with a substantially equal tilt angle to the surface on both cell walls in a tilted homogeneous structure,

the surface alignment and the natural pitch of the liquid crystal material (2) being arranged to provide a progressive molecular twist of greater than π and equal to or less than $3\pi/2$ radians across layer (2), with a uniform tilt direction,

the elastic and dielectric constants of the material (2) together with the surface alignment and natural pitch of the material (2) being arranged to provide a sharp transmission voltage characteristic in combination with substantially zero hysteresis,

driver circuits (8, 9) for repetitively applying voltages from a voltage source (11) to the electrodes (6, 7) to RMS multiplex address each addressable element, and a

logic circuit (10) controlling the driver circuits (8, 9),

and being switchable directly between a light transmissive ON state and a light absorbing non transmissive OFF state in which the ratio of the RMS ON voltage V_2 to OFF voltage V_1 is 1.165 or less at 20°C, and is highly multiplexible with $n \geq 40$."

In the wording of the above claim, two minor errors have been corrected by the Board (clerical error at the beginning of the last paragraph "and it is switchable" into "and **being** switchable", and unit "C" into "°C" according to SI convention).

Claims 2 to 9 are dependent on claim 1.

VIII. The appellant's arguments in support of its request may be summarised as follows:

The wording of amended claim 1 now makes it perfectly clear that the dye is incorporated in the liquid crystal material. Furthermore, the claimed subject-matter has been restricted in several respects, in particular to

- d/p ratios of more than 0.5 and less than 0.75,
- substantially equal tilt angles on both cell walls,
- a molecular twist of greater than π and equal to or less than $3\pi/2$, and
- V_2/V_1 ratios of 1.165 or less.

The patent in suit relates to achieving high multiplexibility of a guest-host device by carefully and very specifically optimising the relevant device parameters including the elastic and dielectric properties of the liquid crystal material. For instance, Figure 9 of the contested patent shows a remarkable increase of the V_2 value at $d/p = 0.75$ for low tilt cells, thus reducing the level of multiplexibility considerably in accordance with the Alt and Pleschko formula. This specific effect is nowhere disclosed in the prior art.

Although the cited documents, in particular documents D1 and D3, admittedly consider broad ranges of such device parameters, attempts of optimisation went in the wrong direction so that only a few lines could be multiplexed. For what reasons these earlier attempts missed the point, is a matter of mere speculation. However, it is a fact recognised in scientific literature that a breakthrough in this respect was for the first time achieved by the patent in suit. A piecemeal combination of individual features disclosed at various places in the prior art - as was done in the impugned decision - suffers from hindsight. In this context, it must be acknowledged that at the priority date of the patent in suit LCD technology was more an art than a science, and even the actual result of such piecemeal combinations could not be predicted.

IX. Both respondents substantially advanced the following counter-arguments:

Although it is admitted that the teaching of claim 1 is sufficiently complete for attaining the alleged effect of low hysteresis, the claimed structure is nevertheless in substance anticipated by documents D1 and D3. This is also the case for most of the limitations of parameter ranges figuring in claim 1. Novelty of the claimed subject-matter may only be accepted in view of the very specific upper limit for the V_2/V_1 ratio.

Taking account of the identical structures, similar multiplexing results should already be expected for the devices of D1 or D3. The failure of the prior art to disclose low hysteresis in the transmission characteristics, and hence high multiplexibility, may be due to the fact that a different parameter for describing the transmission characteristics was used in document D1, i.e. the so-called "threshold sharpness"

possibly leading to less favourable predictions for multiplexibility. Moreover, according to the patent in suit, for the existence or non-existence of hysteresis it makes a big difference whether the voltage is rapidly increased or not. Thus, the hysteresis phenomena expressly observed in D3 and derivable from Figure 1 of D1 might simply be due to slow voltage variation.

Since all of the relevant structural elements and parameter ranges were available from the prior art, a skilled person would have more or less automatically received the desired result of high multiplexibility if he had ever tried the known devices in this respect. Therefore, the teaching of the patent in suit can at best be regarded as some kind of overdue discovery.

Reasons for the Decision

1. *Admissibility of Appeal*

The appeal meets the requirements of Rule 65 EPC and is therefore admissible.

2. *Articles 111(2), 123 and 84 EPC*

The Board considers the amended version of claims to be admissible and sufficiently clear to meet the requirements of Articles 111(2), 123 and 84 EPC, respectively.

In particular, the subject-matter of claim 1 complies with the *ratio decidendi* of the Board's earlier decisions T 319/91 and T 609/94 in that a pleochroic dye is incorporated in the liquid crystal material.

The further limitations are, e.g., disclosed at

- Figure 9, column 7, lines 22 to 34 of the patent specification (corresponding to Figure 9 and associated text of the patent application as filed) for the d/p ratio;
- column 6, lines 42 to 45, column 7, lines 35 to 47 and Examples 1 to 10 of the patent specification (corresponding to page 10, lines 1 to 3, page 11, lines 21 to 30 and Examples 1 to 10 of the patent application as filed) for an equal tilt angle on both cell walls;
- claim 1 (corresponding to original claim 1 in this respect) as granted in combination with the above-cited passage at column 7, lines 22 to 34 of the patent specification for the molecular twist; and
- Examples 1 to 10 of the patent specification for the V_2/V_1 ratio.

Admissibility of present claims 1 to 9 was, in fact, no longer contested by the respondents.

3. Article 54 EPC

The Board holds the view that the claimed subject-matter is novel with respect to the prior art identified.

In particular, a V_2/V_1 ratio of 1.165 or less is neither disclosed in document D1 nor in document D4. Document D3 does not disclose a guest-host cell having equal tilt angle on both cell walls and a d/p ratio less than 0.75 (see D3, Table 1 and associated text of the English translation).

Documents D5 and D6 specifically relate to the aspects of temperature compensation and matrix addressing, respectively, and only mention LCDs of guest-host type without giving any structural details. The remaining documents D2, D7 and D8 do not refer to guest-host cells at all.

4. *Article 56 EPC*

4.1 Closest prior art

In the Board's view, the guest-host cell of document D1 comes closest to the subject-matter of claim 1. This publication in substance anticipates the claimed details with respect to cell structure, liquid crystal/dye composition, layer thickness, equal (low) tilt angle, electrode structure and drive and control circuits, some of these features may be considered implicit from what has been explicitly described in D1 (see in particular, page 4277, left-hand column).

Furthermore, theoretically possible ranges of $0.25 < d/p < 0.75$ for π twist textures, of $0 < d/p < 0.5$ for $\pi/2$ twist cells and of $0.5 < d/p < 1$ for cells having $3\pi/2$ twist are indicated in D1 (see the arrows in Figure 1 and page 4277, right-hand column, middle of first paragraph; the d/p values of the prior art have to be divided by two if they are to be compared to the values claimed in the contested patent since D1 uses a 180° pitch definition).

However, apart from the above-mentioned fact that document D1 does not disclose a V_2/V_1 ratio of 1.165 or less leading to a multiplexibility of at least 40 lines, the prior art is also silent with respect to any

adaptation of the elastic and dielectric properties of the liquid crystal material with a view of hysteresis suppression. From Figure 3 of D1, it must be concluded that the number of actually scanned lines was up to eight.

4.2 Technical problem

The technical problem solved by the claimed subject-matter with respect to the closest prior art may therefore be seen in an improvement of the multiplexibility which at the priority date of the patent in suit seemed to have been an important, much sought after objective (see e.g. document D1, page 4277, left-hand column, first paragraph).

4.3 Assessment of inventive step

- 4.3.1 Although document D1 shows a decreasing tendency of the threshold sharpness value with increasing d/p (which means increasing multiplexed performance with higher d/p values; see D1, Figure 2) and although the authors of D1 take account of the results of Aftergut and Cole (see D1, page 4277, middle of right-hand column) according to which the decay times for twisted nematic LCDs decrease with the increase of d/p and a twist angle of $3\pi/2$ is preferred (see D7, column 6, lines 43 to 52 and claim 5), they conclude from their own measurements of rise and decay times for guest-host LCDs that the response characteristics were best for d/p ~ 0.3, both for parallel and twist samples (see D1, page 4277, right-hand column, first paragraph and Figure 1). At d/p values more than 0.3, in particular between 0.5 and 1.0, the somewhat erratically behaving rise times were found to become rather long. From Figure 1 of D1, it may be concluded that a considerable hysteresis exists in the range $0.5 \leq d/p \leq 1.0$.

The results for multiplexed performance reported in D1 for $d/p = 0.3$ corresponding to a natural twist angle of 108° , i.e. a 90° twist between orthogonal base and top cell walls and a 180° twist between parallel base and top cell walls, respectively, are nevertheless disappointing since the threshold sharpness values are inferior to that of the twisted nematic display (see D1, page 4278, left-hand column, first paragraph), and the number of scanned lines remains low (see D1, Figure 3). Moreover, with respect to buildup lag time (see D1, Figure 4), the parallel cell arrangement is generally preferred in D1 over the twist arrangement (see page 4278, right-hand column, last paragraph; page 4279, left-hand column, second paragraph; and the abstract).

In the Board's view, there is no incentive in D1 to select a d/p value of more than 0.5 and less than 0.75 and a molecular twist of greater than π and equal to or less than $3\pi/2$ since the optimum multiplexed performance has been clearly localised elsewhere in D1 and the claimed values are not promising at all in the light of the prior art.

On the other hand, the respondents have expressly confirmed in the oral proceedings that by selecting the claimed parameter ranges for an LCD of the type investigated in D1 the above technical problem is indeed solved and high multiplexibilities with 40 or more lines are achieved. The reason why the prior art failed to find out the claimed solution is unclear and must be left to speculation.

In consequence, be it due to the perseverance of convinced or simply painstaking scientists or be it due to a lucky strike, the claimed solution cannot be considered obvious from D1. The Board would like to add that such a lucky strike could not be equated with a

discovery excluded from patentability under Article 52(2)(a) EPC since it does not relate to the finding of new surprising properties of a known liquid crystal material but to its optimised application for a practical purpose, i.e. a highly multiplexed liquid crystal device.

4.3.2 A similar result is achieved if document D3 were used as a starting point for assessing inventive step. In this document, the emphasis is put on different tilt angles on both cell walls of a guest-host cell (see D3, claim 1 of the English translation). Guest-host cells having equal tilt angles are only referred to as prior art in D3 (see Table 1). The d/p ratio of these cells is greater or equal to 1.0.

Document D3 is concerned with the problem of suppressing different memory effects, which problem in accordance with D3 is solved by the above-mentioned low/high tilt angles (see D3, page 3 of the English translation, third paragraph).

In this context, parallel arrangements (180°) are preferred in D3 (see claim 2 and page 3, last paragraph of the English translation). Furthermore, although D3 discloses a broad d/p range of $0.5 \leq d/p \leq 2.0$ (see claim 3 of the English translation), the actual d/p values in Table 2 of D3 describing embodiments of the invention are about 0.87 or greater.

Moreover, document D3 shows a marked hysteresis in the transmission-voltage curve (see Figure 3), without however indicating the cell type (parallel or twist arrangement) and the voltage ramping conditions (slow or fast) used for the measurement. Although the hysteresis $V_s - V_{down}$ is considered small by the authors of D3 so that it lends itself to multiplex driving, no numerical values are given (see page 3, penultimate

paragraph of the English translation). From Figure 3 of D3, a value of between 1.3 and 1.4 can be derived for V_s/V_{down} (using voltages corresponding to the position of the respective arrows for V_s and V_{down} in Figure 3), this value being much higher than the claimed value of 1.165 or less, and leading to only about 13 multiplexible lines in accordance with the Alt and Pleschko formula.

Therefore, although examining the same field as the patent in suit, document D3 does not give any hint for the claimed optimisations, nor does it seem to have solved the multiplexibility problem. In the Board's view, the teaching of D3 must be considered as another earlier attempt, similar to that of D1, which did not bring about the great breakthrough.

Nor would a combination of the different parameter selections in accordance with documents D1 and D3, respectively, lead to the claimed invention, as can be seen from the discussion above, even if such combination were considered at all by a skilled person in view of mutually exclusive selections in the prior art.

4.3.3 The remaining documents are less relevant. The only further prior art concerned with response time and dynamic driving of guest-host LCDs, i.e. document D4 (see claim 3 and page 5, penultimate paragraph of the English translation), makes completely different parameter selections in that

- the twist angle ϕ is less than 3π (see claim 1 of the English translation),
- a different tilt angle exists on both cell walls (see claims 1 and 2, first half of page 3 of the English translation and Tables 2 to 4), and

- the d/p values lie within the range $\varphi/2\pi \leq d/p \leq \varphi/2\pi + 1/4$ which leads to $0.75 \leq d/p \leq 1.0$ for $\varphi = 3\pi/2$.

Table 1 of D4 relating to the only embodiments with equal (low) tilt angles clearly shows bad dynamic driving for a $3\pi/2$ twist in the range of $0.5 \leq d/p \leq 0.75$.

Moreover, as has already been mentioned above (see point 3.), no concrete multiplexing achievements are reported in D4. A skilled person would therefore not be able to derive any indication about how to successfully solve the multiplexibility problem from that document.

- 4.3.4 In consequence, the Board does not consider the subject-matter of amended claim 1 to be obvious from the prior art identified (Article 56 EPC), and claim 1 is thus allowable.

5. *Dependent claims and description*

Dependent claims 2 to 9 concern particular embodiments of the claimed subject-matter and are therefore also allowable.

The description has been adapted to the amended version of claims and meets the requirements of Rule 27 EPC. On page 2A, a linguistic error in line 27 ("and it is switchable") is to be corrected to read "and is switchable" and the unit "C" in line 30 needs correction into "°C".

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent with claims 1 to 9, amended description and drawings as filed at the oral proceedings, whereby the following corrections are to be made:
 - claim 1, line 27: "and it is switchable" to read "and being switchable";
 - claim 1, line 30: "C" to read "°C";
 - page 2A, line 27 of the description: "and it is switchable" to read "and is switchable"; and
 - page 2A, line 30 of the description: "C" to read "°C".

The Registrar:

The Chairman:

P. Martorana

S. Steinbrener