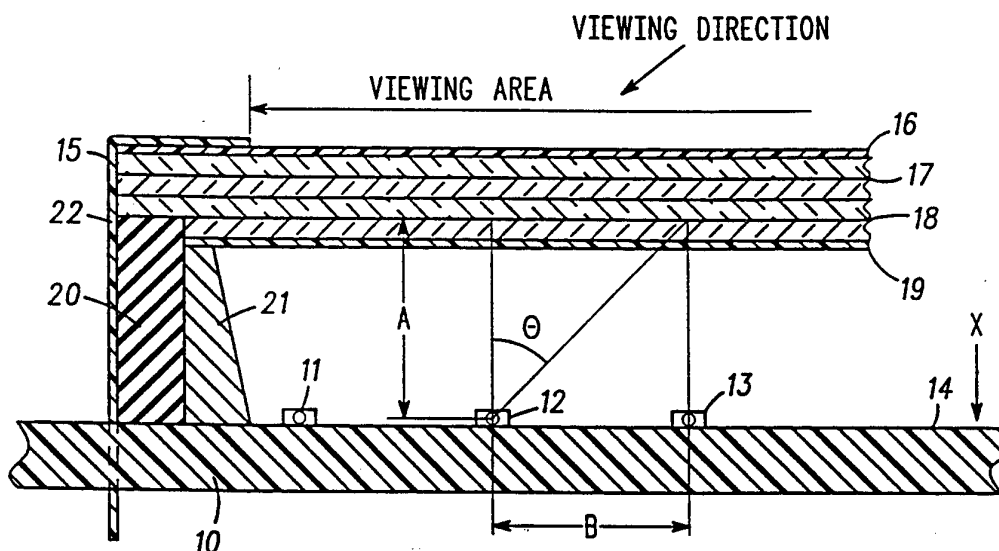




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>(51) International Patent Classification <sup>5</sup> :</b><br><br><b>G02F 1/1335, 1/1347</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>A1</b> | <b>(11) International Publication Number:</b> <b>WO 94/00793</b><br><br><b>(43) International Publication Date:</b> 6 January 1994 (06.01.94)                                                |
| <b>(21) International Application Number:</b> PCT/EP93/01398<br><b>(22) International Filing Date:</b> 3 June 1993 (03.06.93)<br><br><b>(30) Priority data:</b><br>9213646.4                      26 June 1992 (26.06.92)                      GB<br><br><b>(71) Applicant (for all designated States except US):</b> MOTOROLA A/S [DK/DK]; Artillerivej 126, DK-2300 Copenhagen (DK).<br><br><b>(72) Inventor; and</b><br><b>(75) Inventor/Applicant (for US only) :</b> HANSEN, Ingolf, G [DK/DK]; Tølløse 59, DK-4340 Tølløse (DK).<br><br><b>(74) Agents:</b> DUNLOP, Hugh, Christopher et al.; Motorola, European Intellectual Property Operations, Jays Close, Viabes Industrial Estate, Basingstoke, Hants RG22 4PD (GB). |           | <b>(81) Designated States:</b> JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).<br><br><b>Published</b><br><i>With international search report.</i> |

**(54) Title:** A DISPLAY**(57) Abstract**

A display is provided comprising a semi-transparent display element (16, 17, 18, 19), such as double supertwisted nematic (DSTN) liquid crystal display (LCD) glass, a sub-assembly having backlight elements (11, 12, 13) mounted thereon, and mounting means (20) mounting the display element over the sub-assembly with the display element adjacent to the backlight elements, with no diffuser between the backlight elements and the display element. The backlight elements are an array of light emitting diodes (LEDs) of sufficiently wide angle and spaced sufficiently close together that, when viewed from the front of the display element, the display has substantially evenly dispersed brightness across the array.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

|    |                          |    |                                          |    |                          |
|----|--------------------------|----|------------------------------------------|----|--------------------------|
| AT | Austria                  | FR | France                                   | MR | Mauritania               |
| AU | Australia                | GA | Gabon                                    | MW | Malawi                   |
| BB | Barbados                 | GB | United Kingdom                           | NE | Niger                    |
| BE | Belgium                  | GN | Guinea                                   | NL | Netherlands              |
| BF | Burkina Faso             | GR | Greece                                   | NO | Norway                   |
| BG | Bulgaria                 | HU | Hungary                                  | NZ | New Zealand              |
| BJ | Benin                    | IE | Ireland                                  | PL | Poland                   |
| BR | Brazil                   | IT | Italy                                    | PT | Portugal                 |
| BY | Belarus                  | JP | Japan                                    | RO | Romania                  |
| CA | Canada                   | KP | Democratic People's Republic<br>of Korea | RU | Russian Federation       |
| CF | Central African Republic | KR | Republic of Korea                        | SD | Sudan                    |
| CG | Congo                    | KZ | Kazakhstan                               | SE | Sweden                   |
| CH | Switzerland              | LJ | Liechtenstein                            | SI | Slovenia                 |
| CI | Côte d'Ivoire            | LK | Sri Lanka                                | SK | Slovak Republic          |
| CM | Cameroon                 | LU | Luxembourg                               | SN | Senegal                  |
| CN | China                    | LV | Latvia                                   | TD | Chad                     |
| CS | Czechoslovakia           | MC | Monaco                                   | TG | Togo                     |
| CZ | Czech Republic           | MG | Madagascar                               | UA | Ukraine                  |
| DE | Germany                  | ML | Mali                                     | US | United States of America |
| DK | Denmark                  | MN | Mongolia                                 | UZ | Uzbekistan               |
| ES | Spain                    |    |                                          | VN | Viet Nam                 |
| FI | Finland                  |    |                                          |    |                          |

- 1 -

## A DISPLAY

Field of the Invention

5           This invention relates to semi-transparent displays, such as liquid crystal displays (LCDs).

Background of the Invention

10           Solid state displays are finding wider and wider applications in the electronics and consumer industries. Liquid crystal displays have largely superseded earlier light emitting diode displays, on account of factors such as low current drain, reliability, readability and aesthetic appearance.

15           LCDs operate in either reflective mode, transmissive mode or transflective mode. A reflective mode LCD requires ambient light to be reflected from the display to show the contrasting segments. A transmissive mode LCD has a backlight and passes the light through the display. A transflective mode LCD has a  
20 low backlight and a thin reflective layer in the back polarizer. Transflective mode LCDs are usable in all conditions of ambient light. The ruggedness of such devices is in part dependent on the reliability of the backlights.

25           Positive transmissive or Transflective mode LCDs are displays in which the characters appear dark in contrast to a light background. Negative transmissive or transflective mode LCDs allow light to pass through the characters and block the passage of light through the background.

30           LCDs are made from a sandwich of two layers of glass with polarizable liquid between them. The liquid selectively rotates the light passing through. Front and back polarizers polarize the light and filter out light that has been rotated by the liquid, or has not been rotated, depending on the transmissive mode of the display. The glass sandwich is typically known as twisted  
35 neumatic glass and typically rotates the light through 180°. Super twisted neumatic glass is similar but has a liquid that imparts about 270° rotation. Double super twisted neumatic (DSTN) glass is a double sandwich of super twisted neumatic

- 2 -

glass where the extra sandwich is a compensation cell and gives a wider viewing angle. Normal super twisted neumatic displays tend to change colour with temperature. In a DSTN display, the compensation cell also gives colour compensation. DSTN displays  
5 are neutral regarding colour.

It is known to provide negative transmission mode LCD displays using DSTN glass with a cold cathode tube to provide the backlighting, generally provided via a light pipe from outside the display. Such an arrangement is only possible in such  
10 applications as aviation displays where there is adequate room for the bulky cold cathode tube and the light pipe. Cold cathode tubes are not suitable for mobile radios because of the need for a high voltage transformer, shielding and because of r.f. noise generated. A further problem with cold cathode tubes is that  
15 they cannot start below about  $-10^{\circ}\text{C}$ . This is acceptable in aircraft cockpits and some motor vehicle dashboards, but is not acceptable for radios which need to be operated outdoors. Ordinary filament bulbs can be used, but these have a very short lifetime.

20 It is also known, for transreflective mode LCDs, to provide a module of LEDs to provide backlighting. Such a module comprises an array of chip LEDs mounted on a printed circuit board (PCB) and covered by a diffuser. The diffuser diffuses the light from the array of LEDs and provides uniform distribution of  
25 light across the module. The diffuser reduces the light from the LEDs by about 20%. A problem when attempting to use a module of LEDs and a diffuser as a backlight for a transmission mode LCD is that the overall display has a very thick profile. This is unacceptable in many applications, creating the same  
30 problem as the cold cathode tube arrangement.

There is currently no low-profile display that meets all the customer requirements of viewing angle, character definition, temperature range, durability, operating life and aesthetic appearance (including colour stability).

35 There is a need for an improved low profile display.

Summary of the Invention

According to the present invention, a display is provided comprising: a semi-transparent display element; a sub-assembly  
5 having backlight elements mounted thereon, and mounting means mounting the display element over the sub-assembly with the display element adjacent to the back light elements, with no diffuser between the backlight elements and the display element. The backlight elements are an array of light  
10 emitting diodes of sufficiently wide angle and spaced sufficiently close together that, when viewed from the front of the display element, the display has substantially evenly dispersed brightness across the array.

It is preferred that the semi-transparent display element  
15 is a transmissive or transfective mode liquid crystal assembly having a front polarizer, a back polarizer and a display cell element and a compensation cell element sandwiched between the front and back polarizers.

The inventor has discovered that a display cell element of  
20 double super twisted neumatic (DSTN) glass gives a degree of diffusion in the glass and thereby obviates the need for a diffuser. This substantially reduces the profile of the display. It is therefore preferred that the display cell element and the compensation cell element are of DSTN glass.

25 The LCD is preferably negative transmission mode.

It is a further significant problem that an array of LEDs generates a substantial amount of heat. Moreover, a semi-transparent display element such as DSTN glass absorbs light from the LEDs. This has the effect of heating the LCD glass  
30 outside its specified range and if not dissipated, harms glue joints used for assembly of the front and back polarizers. The problem is made worse by the proximity of the LEDs to the display element.

It has been found that if the LED devices are directly  
35 mounted on copper conductive strips of a PCB, rather than through using a module of LEDs, the two-fold advantages of good heat conduction through the LED leads to the PCB and low overall profile are achieved.

The LEDs are preferably surface-mounted on the PCB.

It has been mentioned that DSTN glass is the preferred material for the LCD display. Other glasses may be available, but it is preferred that glass having fifty per cent, and more  
5 preferably eighty per cent light reduction (measured through the display) is used. Some of the non-transmitted light is diffused in the glass and contributes to the uniform brightness.

The surface of the PCB may be lightly coloured or silvered, but is most preferably white (e.g. paper white) so as to reflect as  
10 much as possible of the light from the LEDs within the space between the PCB and the LCD backplane. Preferably still, all the surfaces behind and around the LEDs are substantially white.

Instead of white surfaces, the surface of the PCB and/or the other surfaces around the LEDs may be selected to reflect the  
15 colour of light of the selected LEDs.

#### Brief Description of the Drawings

A preferred embodiment of the invention is described, by  
20 way of example, with reference to the drawings, in which:

Fig. 1 is a cross section through the complete display of the preferred embodiment of the invention,

Fig. 2 is a view in the direction of the arrow X on Fig. 1;  
and

25 Fig. 3 is a circuit diagram of the electrical connections of the LEDs of Fig. 1.

#### Detailed Description of the Preferred Embodiment

30 Referring to Fig. 1, there is shown a printed circuit board (PCB) 10 having mounted thereon an array of LEDs 11, 12, 13. The PCB 10 has a top solder mask 14 which has a white surface. (NB a green surface is more usual).

Mounted over the PCB 10 is a liquid crystal display 15  
35 comprising a front polarizer 16, a compensation cell 17, a display cell 18 and a back polarizer 19, including a reflector sheet. The LCD display 15 is separated from the PCB 10 by means of a silicone rubber zebra connector 20 which provides electrical

connections between the board 10 and terminals of the display cell (the compensation cell has no terminals). A reflector 21 is provided inside the zebra connector. A bezel 22 covers the zebra 20 and the edges of the display 15, fixing the display in position.

The display is viewed from the top, at an angle between the perpendicular and the angle shown by the arrow labelled "viewing direction". The total viewing area of the display is the area within the bezel 15 as marked.

A significant feature of the arrangement is the compensation cell 17 and the display cell 18. These are, in the preferred embodiment, double super twisted neumatic glass, available from Optrex Europe GmbH of Sodener Strasse 9, W-6231 Schwalbach/Taunus., Germany. The area of the display is predominantly black and the characters appear transparent. Light transmission through the "open" LCD glass is reduced by at least 50% and preferably by about 80% - i.e. a back light source of 100 Cd/m<sup>2</sup> is reduced to 20 Cd/m<sup>2</sup> at the front (viewing side). The functional temperature range of the DSTN LCD glass is from -30° C to +80° C. Critical to the high temperature is the attachment/gluing of the LCD polarizer, which affects the stability and lifetime of the display. Local heating up of the LCD glass also affects the temperature coefficient of the liquid material.

The LEDs 11, 12, 13 are mounted on the PCB 10 with a brilliant white surface 14 and are surrounded by a white plastic retainer 21 with slanted edges. The LCD glass terminals are connected to the PCB on two sides by the conducting zebra strips 20. These have the function of maintaining the spacing between the PCB surface and the display 15.

The negative transmission DSTN LCD needs a constant, evenly dispersed and high intensity back light to emit light through the "open" transparent display areas. The light source is provided by the LEDs 11, 12, 13, which are also shown in Fig. 2. These LEDs have fifty-degree polar lighting angle for 100% intensity (35-40 mCd/m<sup>2</sup>/20mA). They have a spectral wave length of typically 570nm (yellow-green) and each is mounted

on a ceramic chip carrier substrate 0.7mm above the mounting plane. Each LED has a rating of 50mW and consumes 21mW.

The LEDs are mounted on the surface of a multi-layer PCB. The next layer below is a solid ground plane which absorbs and distributes heat from the top layer. The arrangement provides very low thermal resistance.

It has been found that a distance between the lighting point and the liquid layer of the display element 18 (distance "A" in Fig. 1) of 6mm can be achieved with uniform distribution of light across the display by using 100% overlapping of light from one LED to another, as shown in Fig. 1. This is achieved by having a maximum distance between the LEDs of about 7mm. Note that this figure is derived from the formula:

$$B = A \tan \Theta$$

Using the dimensions given:

$$6 \tan 50 = 7.15\text{mm.}$$

With these dimensions, the light from one LED is completely overlapped by light from adjacent LEDs (at least in the direction of the rows and columns of the array of LEDs). This arrangement is reached empirically. Slightly wider spacing could be acceptable. Narrower spacing will increase the cost and increase the heat generation and power drain.

The slanting edges of the plastic retainer reflect light upwards through the display. The plastic retainer has a hole in each end for air circulation.

Fig. 3 shows an electrical schematic diagram for the LED connections. It is seen that they are connected in parallel. This arrangement will distribute the supply current evenly. The voltage drop across the LED assembly is  $8 \pm 1.4\text{V}$  - i.e. the total supply current is 125mA for 1W power dissipation and the single LED current is 10.5mA. To achieve an acceptable lifetime for the LED backlight (100,000 hours) the supply current is reduced to 10mA at  $60^\circ\text{C}$  and reduced linearly with temperature until it is switched off above  $80^\circ\text{C}$ .

It is found that no further light diffusion is necessary than takes place in the glass and the material of the back polarizer.

The light intensity has been increased by about 25% in comparison with the diffusion loss of standard LED backlight

- 7 -

modules with constant LED current.

- 8 -

## Claims

1. A display comprising:  
a semi-transparent display element;  
5 a sub-assembly having backlight elements mounted thereon, and  
mounting means mounting the display element over the sub-assembly with the display element adjacent to the back light elements, with no diffuser between the backlight elements  
10 and the display element, wherein  
the backlight elements are an array of light emitting diodes of sufficiently wide angle and spaced sufficiently close together that, when viewed from the front of the display element, the display has substantially evenly dispersed  
15 brightness across the array.
2. A display according to claim 1, wherein the display element is a transmissive or transflective mode liquid crystal assembly having a front polarizer, a back polarizer and a display  
20 cell element and a compensation cell element sandwiched between the front and back polarizers.
3. A display according to claim 1 or 2, wherein the display element is a negative transmissive or transflective mode liquid  
25 crystal assembly.
4. A display according to any one of the preceding claims, wherein the display element comprises double super twisted  
30 neumatic glass.
5. A display according to any one of the preceding claims wherein the display element has a layer of reflective material on the back side thereof, making it a transflective display element.
- 35 6. A display comprising:  
a double super twisted neumatic glass display element;

- 9 -

a printed circuit board having backlight elements mounted directly thereon and a reflective surface around and between the backlight elements, and

5 mounting means mounting the display element over the sub-assembly with the display element adjacent to the backlight elements, with no diffuser between the backlight elements and the display element, wherein

10 the backlight elements are an array of light emitting diodes of sufficiently wide angle and spaced sufficiently close together that, when viewed from the front of the display element, the display has substantially evenly dispersed brightness across the array

7. A display according to claim 6 wherein holes are provided  
15 in the mounting means for circulation of air.

8. A display according to any one of the preceding claims comprising temperature measuring means, supply current means and means for controlling the supply current to the  
20 backlight to reduce the current when the temperature exceeds a threshold.



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 93/01398

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                      |                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| <b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                      |                                     |
| According to International Patent Classification (IPC) or to both National Classification and IPC<br>Int.Cl. 5 G02F1/1335; G02F1/1347                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                      |                                     |
| <b>II. FIELDS SEARCHED</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                      |                                     |
| Minimum Documentation Searched <sup>7</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                      |                                     |
| Classification System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Classification Symbols                                                                                                                                                                               |                                     |
| Int.Cl. 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | G02F                                                                                                                                                                                                 |                                     |
| Documentation Searched other than Minimum Documentation<br>to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                      |                                     |
| <b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                      |                                     |
| Category <sup>10</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>                                                                                       | Relevant to Claim No. <sup>13</sup> |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | EP,A,0 363 700 (LIC-LANGMATZ GMBH)<br>18 April 1990<br>see column 2, line 24 - line 46<br>see column 3, line 42 - column 4, line 17<br>see claims 1-4; figures 2-3                                   | 1,3,5                               |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | idem<br>---                                                                                                                                                                                          | 2,4,6-8                             |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ELEKTRONIK<br>vol. 40, no. 19, September 1991, MUNCHEN<br>DE<br>pages 96 - 99 , XP000262963<br>G. WAITL ET AL. 'Hintergrund-Beleuchtung<br>mit LEDs'<br>see abstract; figures 2,6; tables 1-2<br>--- | 1,3,5                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | -/--                                                                                                                                                                                                 |                                     |
| <sup>10</sup> Special categories of cited documents :<br>"A" document defining the general state of the art which is not considered to be of particular relevance<br>"E" earlier document but published on or after the international filing date<br>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br>"O" document referring to an oral disclosure, use, exhibition or other means<br>"P" document published prior to the international filing date but later than the priority date claimed<br>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention<br>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step<br>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.<br>"&" document member of the same patent family |                                                                                                                                                                                                      |                                     |
| <b>IV. CERTIFICATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                      |                                     |
| Date of the Actual Completion of the International Search<br><br>03 SEPTEMBER 1993                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Date of Mailing of this International Search Report<br><br>15. 09. 93                                                                                                                                |                                     |
| International Searching Authority<br><br>EUROPEAN PATENT OFFICE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Signature of Authorized Officer<br><br>IASEVOLI R.                                                                                                                                                   |                                     |

| III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET) |                                                                                                                                                                                                                                                                                                                                         |                       |
|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Category °                                                                 | Citation of Document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                                      | Relevant to Claim No. |
| Y                                                                          | <p>TRANSACTIONS OF THE INSTITUTE OF<br/>ELECTRONICS AND COMMUNICATION ENGINEERS OF<br/>JAPAN, SECTION E<br/>vol. 71, no. 11, November 1988, TOKYO JP<br/>pages 1080 - 1085 , XP000001489<br/>M. NAGATA ET AL. 'Neutralized Supertwisted<br/>Nematic LCD : Principle and<br/>Characteristics'<br/>see abstract; figure 10</p> <p>---</p> | 2,4,6                 |
| Y                                                                          | <p>PATENT ABSTRACTS OF JAPAN<br/>vol. 13, no. 345 (P-909)3 August 1989<br/>&amp; JP,A,01 105 216 ( THOSHIBA ) 21 April<br/>1989<br/>see abstract</p> <p>---</p>                                                                                                                                                                         | 7                     |
| Y                                                                          | <p>PATENT ABSTRACTS OF JAPAN<br/>vol. 12, no. 71 (P-673)5 March 1988<br/>&amp; JP,A,62 210 428 ( SATO TSUTOMU ) 16<br/>September 1987<br/>see abstract</p> <p>---</p>                                                                                                                                                                   | 8                     |
| A                                                                          | <p>TECHNICAL DIGEST - WESTERN ELECTRIC<br/>no. 67, July 1982, NEW YORK US<br/>pages 1 - 2<br/>W.D. APGAR 'Back Lighting Liquid Crystal<br/>Displays with Light Emitting Diodes'<br/>see the whole document</p> <p>---</p>                                                                                                               | 1,6                   |
| A                                                                          | <p>DE,A,2 655 866 (THE GEC MARCONI CO)<br/>23 June 1977<br/>see page 3, paragraph 5 - page 5,<br/>paragraph 1<br/>see claims 1-2,4; figures</p> <p>-----</p>                                                                                                                                                                            | 1,3,6                 |

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

EP 9301398  
SA 74598

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

03/09/93

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| EP-A-0363700                              | 18-04-90            | DE-A- 3834492              | 12-04-90            |
| DE-A-2655866                              | 23-06-77            | GB-A- 1502330              | 01-03-78            |