

PATENT SPECIFICATION

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(54) LIQUID CRYSTAL DISPLAY DEVICE

(71) We, KABUSHIKI KAISHA SUWA SEIKOSHA, a Japanese company, of 3-3, 4-chome, Ginza, Chuo-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to liquid crystal display devices.

A liquid crystal material is a material which generally performs the following phase changes:

solid phase $\longleftrightarrow$ liquid crystal phase $\longleftrightarrow$ isotropic liquid phase the phase depending upon the temperature. A particular type of liquid crystal phase is known as the nematic phase, in which the molecules of the liquid crystal material are linearly arranged. In the nematic phase, the liquid crystal material exhibits various phenomena one of which is that, when an electric field is applied thereto, the arrangement of the molecules is dynamically changed so that the liquid crystal material scatters or reflects light incident thereon. By using this effect, it is possible to construct a liquid crystal display device for displaying letters, numerals, gures, etc. Liquid crystal materials have a very high electrical resistance and so the electrical power required to drive a liquid crystal display device may be very small. Liquid display devices have uses in connection with portable desk-type electronic calculators, wrist watches, etc.

According to the present invention, there is provided a liquid crystal display device comprising two spaced apart electrode panels with a liquid crystal material retained therebetween, at least one terminal means on each electrode panel, and a respective resilient contact member in resilient engagement with the or each terminal means on at least one electrode panel, so that the or both the electrode panels may be electrically connected to an external circuit by the contact member or contact members.

The or each terminal means and/or the or

each contact member may be of, or coated with, a metal having a low electrical resistance to reduce contact resistance therebetween. The metal may be silver or gold.

In one embodiment, the or each terminal means on one electrode panel is in electrical connection with a respective further terminal means on the other electrode panel via a conducting member disposed between the electrode panels, a respective contact member being in resilient engagement with the or each terminal means on said other electrode panel and the or each further terminal means.

Preferably the terminal means of the electrode panels are on opposed surfaces thereof. The conducting member may be a metal leaf.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:

Figure 1 is a schematic sectional view of a conventional liquid crystal display device;

Figure 2 is a plan view of a conventional electrode panel for use in a liquid crystal display device and for displaying numerals;

Figure 3 is a schematic view of part of one embodiment of a liquid crystal display device according to the present invention;

Figure 4 shows a part of another embodiment of a liquid crystal display device according to the present invention; and

Figure 5 shows a yet further embodiment of part of a liquid crystal display device according to the present invention.

Referring to the drawings and, in particular, to Figure 1, there is shown a schematic sectional view of a conventional liquid crystal display device. A liquid crystal material 4 is disposed between a pair of glass plates 1 which are maintained in spaced apart relationship by sealing spacers 2. The opposed surfaces of plates 1 have transparent conductive electrodes 3 thereon. When the electrodes 3 are connected to a power source 5, an electric field is established across the liquid crystal material. As discussed above, the electric field excites the liquid crystal material to scatter or reflect light incident thereon.

Figure 2 is a plan view of a conventional electrode panel for use in a liquid crystal display device for displaying numerals. The electrode panel has an electrode 10, composed of seven segments *a* to *g* formed on a base plate 13. Each segment is connected to a respective terminal 12 by a conductive path 11. A liquid crystal material (not shown) is retained between the electrode panel and a second panel (not shown) having a common electrode. The liquid crystal material is excited when an electric field is applied between one or more of the segments and the common electrode. By suitably applying the electric field to different segments, different numerals can be displayed due to irregular scattering or reflecting of light by the liquid crystal material between the said different segments and the common electrode.

Conventionally, the electrode panel is connected to an external electric circuit (not shown) via the terminals 12 using conductive adhesives or soldering. However, since the electrode panel has seven terminals, short-circuits between adjacent terminals is likely, especially if the electrode panel is mass produced. Furthermore, it is difficult to replace the liquid crystal display device or the external circuit when necessary.

Referring to Figure 3, there is shown a schematic view of part of a liquid crystal display device according to the present invention. A liquid crystal material (not shown) is retained between electrode panels 51, 52 which are maintained in spaced apart relationship by a sealing spacer 53. The electrode panel 51 has a plurality (three shown) of terminals 54 by means of which a segmented electrode (not shown) thereof may be connected to an external electric circuit (also not shown). A plurality of leads 59 from the external circuit are connected to respective terminal members 58. Each terminal member 58 is in electrical contact with a post 56 which, in turn, is in electrical contact with the respective resilient contact portion 57. The terminal members 58, posts 56, and contact portions 57 form connecting devices which are rigidly retained in an electrically insulating support 55 so that each terminal 54 may come into electrical contact with a given contact portion 57 of one of the connecting devices. The terminal member 58, the post 56 and the contact portion 57 of each connecting device may be of integral construction and may be made of the same conducting material.

The terminals 54 on the electrode panel 51 are brought into electrical contact with the contact portions 57 of the connecting devices merely by pressure on the liquid crystal display device as a whole and so electrical connection between the electrode panel 51 and the external circuit is effected.

An electrical connection with the electrode

panel 52 can be accomplished similarly. One such arrangement is shown in Figure 4 where part of another embodiment of a liquid crystal display device according to the present invention is shown. A first electrode panel 70 has a plurality of terminals 72 each of which is in engagement with a respective resilient contact portion 75 of a connecting device only part of which is shown. As seen in Figure 4 each terminal 72 is constructed on a surface of the first electrode panel, this surface being hidden in the assembled liquid crystal display device: that is to say the terminals 72 are located on a surface of the first electrode panel 70 nearer to a second electrode panel 71. This arrangement is similar to that illustrated in Figure 3. The second electrode 71 has a plurality of terminals 73 each of which is engaged with a resilient contact portion 74 of a further connecting device, again only part of which is shown. The terminals 73 are located on a surface of the second electrode panel 71 nearer to the first electrode panel 70. A liquid crystal material (not shown) is maintained between the electrode panels by a sealing spacer. It will be appreciated, therefore that since the contact portions engage the terminals on opposed surfaces of the electrode panels, their resiliency forms the necessary pressure to ensure good electrical contact between the terminals and the contact portions.

Figure 5 shows part of another embodiment of a liquid crystal display device according to the present invention. In this embodiment, only one set of connecting devices is used as distinct from the embodiment shown in Figure 4 which has two sets of connecting devices, namely, one set associated with each electrode panel. The liquid crystal display device has an electrode panel 125 of similar construction to that shown in Figure 2. The electrode panel 125 has two electrodes 126 each composed of seven segments *a* to *g* and *a'* to *g'*. Each segment is connected to a respective terminal 128 by a conductive path 127. A common electrode panel 121 has two electrodes 122 corresponding to the electrodes 126. Each electrode 122 is connected to a respective terminal 124 by a conductive portion 123. A liquid crystal material (not shown) is retained between the electrode panels which are maintained in spaced apart relationship by a sealing spacer (not shown).

Each terminal 124 is electrically connected to a terminal 131 provided on the electrode panel 125 via a metal leaf 130. Each terminal 131 is electrically connected with a respective terminal 132 on the electrode panel 125 by a conductive portion. The metal leaf 130 may be electrically connected to the respective terminals 124 and 131 by conductive adhesives etc.

Connecting devices, such as those illus-

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trated in Figure 4, are used so that the liquid crystal display device can be connected to an external electric circuit. Resilient contact portions in resilient engagement with the terminals 132 electrically connect electrode panel 121 to the external circuit while the resilient contact portions in resilient engagement with the terminals 128 electrically connect the electrode panel 125 to the electric circuit.

This arrangement enables the liquid crystal display device to be made simply with the contact members only in connection with one of the electrode panels.

If a metal, such as gold, or silver, is coated on the terminals of the electrode panels and/or on the contact portions of the connecting devices, the contact resistance can be reduced and reliability of operation can be increased. Alternatively, for the same purpose, the terminals and/or the contact portions may be made of gold or silver.

WHAT WE CLAIM IS:—

1. A liquid crystal display device comprising two spaced apart electrode panels with a liquid crystal material retained therebetween, at least one terminal means on each electrode panel, and a respective resilient contact member in resilient engagement with the or each terminal means on at least one electrode panel, so that the or both the electrode panels may be electrically connected to an external circuit by the contact member or contact members.

2. A liquid crystal display device as claimed

in claim 1 in which the or each terminal means and/or the or each contact member is of, or is coated with, a metal having a low electrical resistance to reduce contact resistance therebetween.

3. A liquid crystal display device as claimed in claim 2 in which the metal is silver or gold.

4. A liquid crystal display device as claimed in any preceding claim in which the or each terminal means on one electrode panel is in electrical connection with a respective further terminal means on the other electrode panel via a conducting member disposed between the electrode panels, a respective contact member being in resilient engagement with the or each terminal means on said other electrode panel and the or each further terminal means.

5. A liquid crystal display device as claimed in claim 4 in which the terminal means on the electrode panels are on opposed surfaces thereof.

6. A liquid crystal display device as claimed in claim 4 or claim 5 in which the conducting member is a metal leaf.

7. A liquid crystal display device substantially as herein described with reference to and as shown in any one of Figures 3 to 5 of the accompanying drawings.

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