

PATENT SPECIFICATION

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(54) DISPLAY DEVICE

(71) We, KABUSHIKI KAISHA DAINI SEIKOSHA a Japanese Company of 31-1 6-chome Kameido Koto-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.

This invention relates to display devices, and in particular although not so restricted, to display devices for timepieces.

According to the aspect of the present invention there is provided a display device comprising a liquid crystal cell disposed between a pair of polarising plates, at least one of the polarising plates having at least one portion whose polarising axis is different from the polarising axis of the remainder of the polarising plate.

Preferably, the polarising axis of the said at least one portion of one polarising plate is parallel to the polarising axis of at least a part of the other polarising plate.

In the preferred embodiment the or each said portion is hexagonal in plan.

The liquid crystal cell may consist of two glass plates between which is sandwiched the liquid crystal material.

The display device may include a reflecting plate disposed adjacent to one of the polarising plates.

According to a further aspect of the present invention there is provided a timepiece having a display device as recited above.

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

Figure 1 is a schematic representation of a conventional display device;

Figure 2 is a schematic representation of a display device according to the present invention;

Figure 3 is a plan view of part of a polaris-

ing plate of the display device of Figure 2 and

Figure 4 is a plan view of part of another form of polarising plate for the display device of Figure 2.

Throughout the drawings, like parts have been designated by the same reference numerals.

Referring first to Figure 1, there is shown a conventional display device comprising polarising plates BC between which is disposed a liquid crystal material or cell A. The polarising plate B has a uniform polarising axis B' and the polarising plate C has a uniform polarising axis C', the axes B', C' being at 90° to one another.

When an electric field is applied to electrodes, (not shown) of the liquid crystal cell A, those portions of the liquid crystal material to which the electric field is applied appear black in colour, the remainder of the liquid crystal material appearing transparent. Therefore, this conventional type of liquid crystal devices are limited to producing a display which is a combination of portions which appear black in colour and portions which appear transparent.

Referring now to Figure 2 there is illustrated one embodiment of a display device according to the present invention.

A liquid crystal panel cell consists of a first glass plate 3 and the second glass plate 4 between which is disposed the liquid crystal material 2. A polarising axis 5' of a first polarising plate 5 and a polarising axis 6' of a second polarising plate 6 are at 90° to one another. The liquid crystal cell 1 is disposed between the polarising plates 5, 6. The polarising plate 6 has a hexagonal portion 7 which has a polarising axis 7' which is not aligned with the polarising axis 6' of the polarising plate 6 but which is parallel to the polarising axis 5' of the polarising plate 5. A reflecting plate 8 is mounted adjacent to the polarising plate 6 on the opposite side to the

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liquid crystal cell 1. A digital electrode pattern (not shown) for displaying a time indication is formed on the glass plates 3, 4; and the polarising plates 5, 6, the liquid crystal cell 1, and the reflecting plate 8 are stacked on each other to form a compact display device.

Figure 3 illustrates one form of the hexagonal portion 7 for displaying a seconds indication. The hexagonal portion 7 has on the glass plates 3, 4, six transparent electrodes 9 to 14 each representing a ten-seconds time interval.

Referring now to the operation of the display device illustrated in Figures 2 and 3, digital numerals are selectively displayed by means of a digital electrode pattern (not shown) formed on the part of the glass plates 3, 4 away from the area of the hexagonal portion 7 and appear black in colour, under an electric field applied to the liquid crystal material 2. However, since the polarising axis 7' of the hexagonal portion 7 is parallel to the polarising axis 5' of the polarising plate 5, the liquid crystal material 2 between the electrodes 9 to 14 appears black in colour when no electric field is applied to the electrodes 9 to 14. When an electric field is sequentially applied to the electrodes 9 to 14 they appear transparent in sequence.

That is to say, in a conventional display device the electrodes appear transparent when no electric field is applied thereto, but appear black in colour when an electric field is applied thereto. However, with the display device illustrated in Figure 2 and 3, a part of the display device appears black in colour when no electric field is applied to the electrodes thereof and transparent if an electric field is applied thereto.

If the hexagonal portion 7 is as shown in Figure 3, the whole appears black in colour when no electric field is applied thereto. An electric field is sequentially applied to a further one of the electrodes 9 to 14 every 10 seconds so that they sequentially become transparent. After 60 seconds, the whole of the hexagonal portion 7 appears transparent.

Figure 4 illustrates another form of the hexagonal portion 7 in which the electrodes 9 to 14 have respective elongated portions 9a to 14a. In the condition (X), the areas of the

electrodes 9 to 14 appear black in colour and sequentially become transparent for a period of 10 seconds whilst the corresponding elongated portions 9a to 14a sequentially appear black in colour as indicated by conditions (H) and (Z). The display, therefore, is initially indicated by condition (X) which changes to condition (Z), 60 seconds lapses and then becomes as indicated by condition (X) again.

The display device of Figures 2 to 4 produces an interesting display effect. It will be appreciated that the hexagonal portion 7 can be provided additionally or alternatively on the polarising plate.

WHAT WE CLAIM IS:-

1. A display device comprising a liquid crystal cell disposed between a pair of polarising plates, at least one of the polarising plates having at least one portion whose polarising axis is different from the polarising axis of the remainder of the polarising plate.

2. A display device as claimed in claim 1 in which the polarising axis of the said at least one portion of one polarising plate is parallel to the polarising axis of at least a part of the other polarising plate.

3. A display device as claimed in claim 1 or 2 in which the or each said portion is hexagonal in plan.

4. A display device as claimed in any preceding claim in which the liquid crystal cell consists of two glass plates between which is sandwiched the liquid crystal material.

5. A display device as claimed in any preceding claim including a reflecting plate disposed adjacent to one of the polarising plates.

6. A display device substantially as herein described with reference to and as shown in Figures 2, to 4 of the accompanying drawings.

7. A timepiece having a display device as claimed in any preceding claim.

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2. A display device as claimed in claim 1 in which the polarising axis of the said at least one portion of one polarising plate is parallel to the polarising axis of at least a part of the other polarising plate.

3. A display device as claimed in claim 1 or 2 in which the or each said portion is hexagonal in plan.

4. A display device as claimed in any preceding claim in which the liquid crystal cell consists of two glass plates between which is sandwiched the liquid crystal material.

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