

PATENT SPECIFICATION

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(54) DISPLAY DEVICE

(71) We, ASAHI KOGAKU KOGYO KABUSHIKI KAISHA, a Japanese Company of, No 36-9, Maeno-Cho, 2-chome, Itabashi-ku, Tokyo, Japan, do hereby

5 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:-

10 This invention relates to a display device and to a camera including such a display device. The display device is principally for use in displaying the output of an exposure meter circuit in a viewfinder of a single lens

15 reflex camera or the like.

The requirements of such a display device include the following:

- (1) it should be as thin as possible,
- (2) a light-emitting surface thereof

20 should be large, and its outline should be clear,

- (3) its light-emitting surface should have uniform brightness, and
- (4) electrodes and bonding wires for the

25 device should be inconspicuous.

A conventional arrangement which meets these requirements is shown in Figures 1(a) and 1(b), and comprises an array 1 of semiconductor light-emitting elements

30 arranged in a line, and encapsulated in a block 3 of moulded resin. An apertured mask 4 overlies the block 3, and the whole assembly is mounted in a single lens reflex camera so as to be viewable in the field of

35 viewfinder 5. If a light-scattering agent is mixed into the moulded resin so that the latter diffuses light passing therethrough, the aforementioned conditions can be satisfied to an acceptable extent.

40 In some cases, the semiconductor light-emitting elements 2 in the array 1 are arranged to emit a plurality of different colours (such as red for the end elements, green for the middle element and yellow for the remainder). In this case GaAsP, which

45 produces surface light emissions, is employed for the red light-emitting elements whereas GaP, which produces body light emissions, is employed for the yellow and

50 green light-emitting elements. Accordingly,

the light-emitting surfaces of these materials have different conditions of viewing or visibility, and in order to overcome such differences it is necessary to increase the light diffusion characteristics of the resin from

55 which the block 3 is moulded. This is difficult to accomplish in a thin display device, however. If the quantity of the light-scattering agent or the light-scattering characteristics of said agent are increased,

60 the bonding wires may be severed during moulding due to poor resin flow conditions and the thinness of the display device. Also, the production yield may decrease owing to difficulties in controlling the light-scattering

65 agent. Furthermore, the moulding resin is undesirably discoloured by the light-scattering agent.

It is an object of the present invention to obviate or mitigate the above disadvantages.

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According to one aspect of the present invention, there is provided a display device comprising a plurality of semiconductor light-emitting elements encapsulated in a block of moulded resin having a light-

75 scattering agent mixed therewith, a surface of the block through which the semiconductor light-emitting elements are to be viewed in use being roughened so as to impart light-diffusing properties to said surface.

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According to another aspect of the present invention, there is provided a camera including an exposure meter circuit, a viewfinder, and a display device as defined in the last preceding paragraph disposed so as to

85 be viewable through the viewfinder, the semiconductor light-emitting elements of the display device being electrically connected to the exposure meter circuit so as to be selectively energisable in accordance

90 with the output of said circuit.

In this way, differently coloured semiconductor light-emitting elements can be used in compatibility without having to increase the quantity or the characteristics of the

95 light-scattering agent. The roughening of the surface of the moulded resin block can also be used to preserve the thinness of the device as well as to obscure electrical leads and terminals which are associated with the

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device in use.

In the accompanying drawings:

Figure 1(a) is a plan view of a conventional display device and a camera viewfinder,

Figure 1(b) is a section taken through the display device shown in Figure 1(a), and

Figure 2 is a sectional view of a display device according to the present invention.

Referring to Figure 2 of the drawing, the display device comprises an array of light-emitting diodes 2 (only one shown) arranged in a line and encapsulated in a block 3 of moulded resin to which a light-scattering agent has been added. A surface of the block 3 through which the light-emitting diodes 2 are to be viewed (in this case, an upper surface of the block 3) is roughened so as to impart light-diffusing properties to that surface. With such roughening, satisfactory overall light-diffusion characteristics can be obtained even when only a relatively small quantity of light-scattering agent is mixed into the resin from which the block 3 is moulded, such that the ordinary manufacturing process will not be adversely affected. The surface of the block 3 may be roughened with No 600 sandpaper or thereabouts, or with an abrasive mixture of approximately No 1000 sand. Good results can be obtained by either technique, although the latter is somewhat lower in cost.

An odd number of at least five light-emitting diodes 2 are in fact used. The middle light-emitting diode is arranged to emit green light, the light-emitting diodes at the ends of the line are arranged to emit red light, and the remaining light-emitting diodes are arranged to emit yellow light. The different colours of light are sufficiently diffused at the surface of the block 3. Accordingly:

(I) the size of the apertures in a mask, not shown, but similar to the mask 4 in Figures 1(a) and 1(b) can be increased which makes the display more easily viewable,

(II) greater alignment tolerance can be accommodated between the mask and the light-emitting diodes, and the light-emitting diodes can be made smaller, and

(III) the bonding wires and electrodes are inconspicuous even though the display device is thin.

The display device described above can be incorporated into a camera (preferably a single lens reflex camera). The camera includes a viewfinder, the display device being positioned so as to be viewable there-through, and an exposure meter circuit to

which the light-emitting diodes are electrically connected. The light-emitting diodes are selectively energisable in accordance with the output of the exposure meter circuit.

WHAT WE CLAIM IS:-

1. A display device comprising a plurality of semiconductor light-emitting elements encapsulated in a block of moulded resin having a light-scattering agent mixed therewith, a surface of the block through which the semiconductor light-emitting elements are to be viewed in use being roughened so as to impart light-diffusing properties to said surface.

2. A display device as claimed in Claim 1, wherein the semiconductor light-emitting elements are arranged to emit light of at least two different colours in use.

3. A display device as claimed in Claim 2, wherein an odd number of at least five semiconductor light-emitting elements are provided and are disposed in a line, the middle semiconductor light-emitting element, the semiconductor light-emitting elements at the ends of said line, and the remaining semiconductor light-emitting elements being arranged in use to emit light of different colours, respectively.

4. A display device as claimed in Claim 3, wherein the middle semiconductor light-emitting element is arranged to emit green light in use, the semiconductor light-emitting elements at the ends of said line are arranged to emit red light in use, and the remaining semiconductor light-emitting elements are arranged to emit yellow light in use.

5. A camera including an exposure meter circuit, a viewfinder, and a display device as claimed in any preceding claim disposed so as to be viewable through the viewfinder, the semiconductor light-emitting elements of the display device being electrically connected to the exposure meter circuit so as to be selectively energisable in accordance with the output of said circuit.

6. A display device substantially as hereinbefore described with reference to Figure 2 of the accompanying drawing.

7. A camera substantially as hereinbefore described with reference to Figure 2 of the accompanying drawing.

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FIG. 1(a)
PRIOR ART

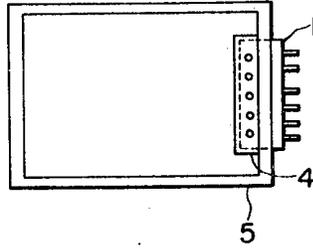


FIG. 1(b)
PRIOR ART

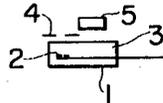


FIG. 2

