

**United States Patent** [19]

Nakamura et al.

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[54] **LIQUID CRYSTAL DISPLAY DEVICE  
BACKLIT BY LED'S COUPLED TO  
PRINTED CIRCUIT BOARD**

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5,184,888 2/1993 Sakuma et al. .... 362/136

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[21] Appl. No.: **164,373**

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[30] **Foreign Application Priority Data**

Dec. 15, 1992 [JP] Japan ..... 4-0353718  
Jun. 29, 1993 [JP] Japan ..... 5-40321 U  
Sep. 7, 1993 [JP] Japan ..... 5-246233

[51] **Int. Cl.<sup>6</sup>** ..... **G02F 1/1335; G02F 1/1333**

[52] **U.S. Cl.** ..... **359/49; 359/42; 359/48;**  
359/83

[58] **Field of Search** ..... 359/42, 48, 49,  
359/83; 362/31, 26, 800

[57] **ABSTRACT**

A liquid crystal display device with an illuminator installed in the back of a liquid crystal display panel. The illuminator is made of a shallow box-form holder having a reflective inner surface, a plurality of LED's installed in at least one side wall of the holder, a light-diffusing plate installed between the liquid crystal display panel and the holder, and a printed circuit board mounted on the outer surface of the bottom of the holder. The LED's are of different light directional angles and inclined toward the bottom surface of the holder so that the light from the LED's can be reflected by the reflective bottom surface towards the display panel.

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

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**10 Claims, 7 Drawing Sheets**

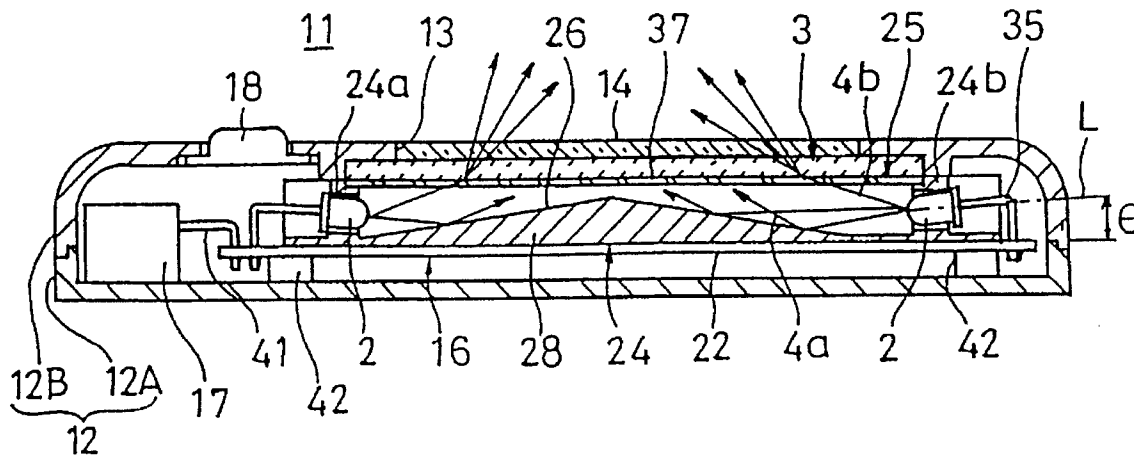


FIG. 1

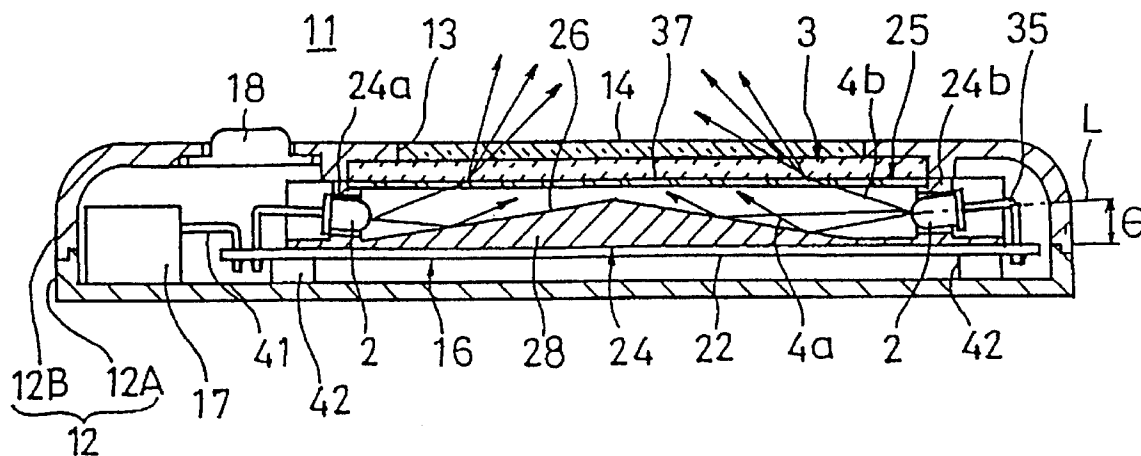


FIG. 3

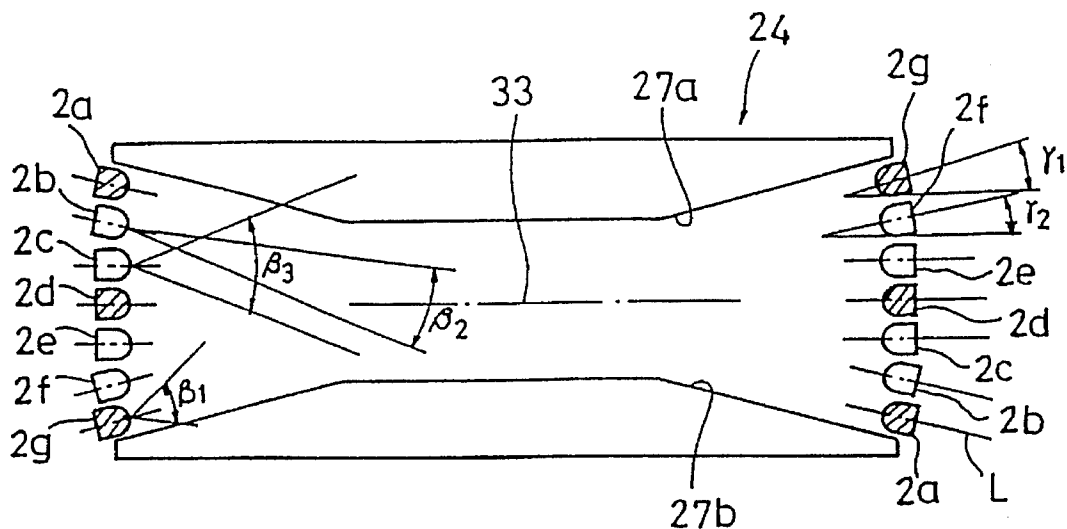


FIG. 2

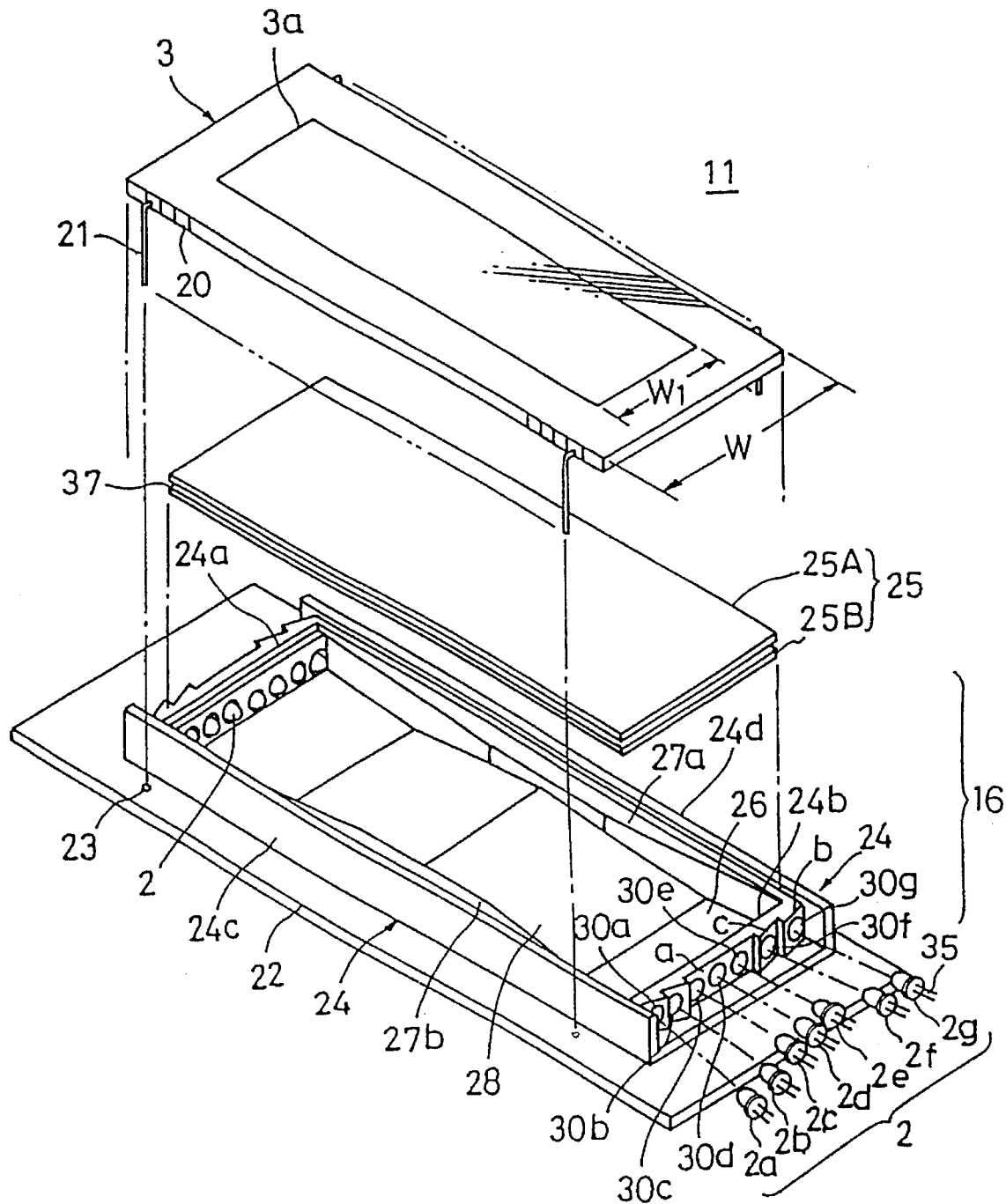


FIG. 4

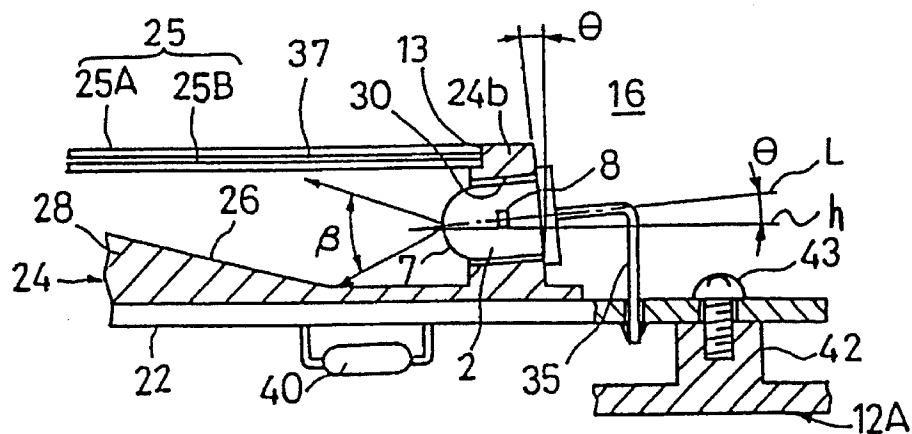


FIG. 5

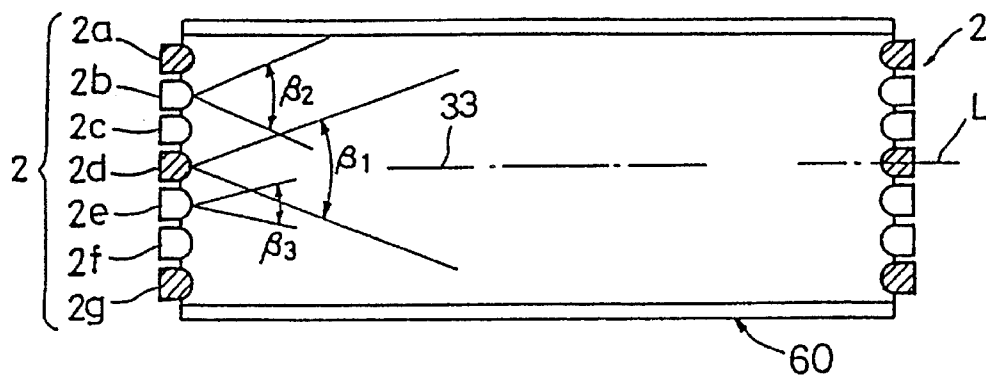
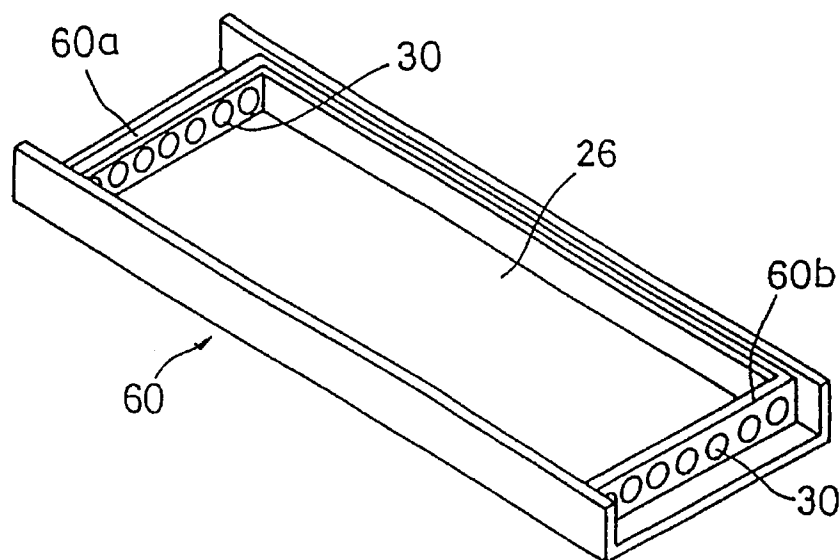
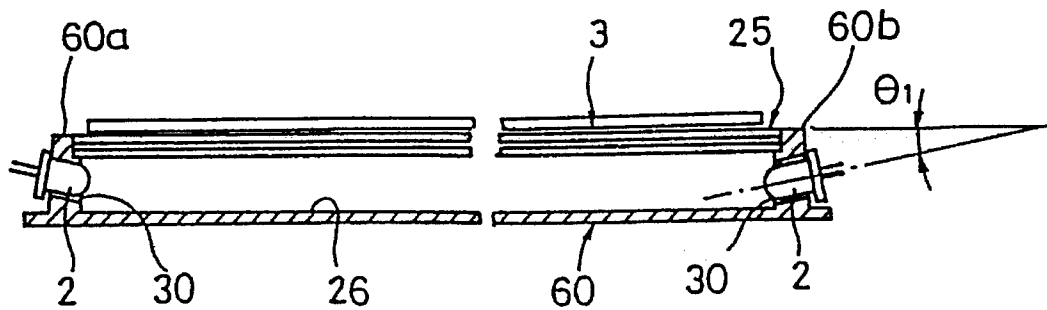
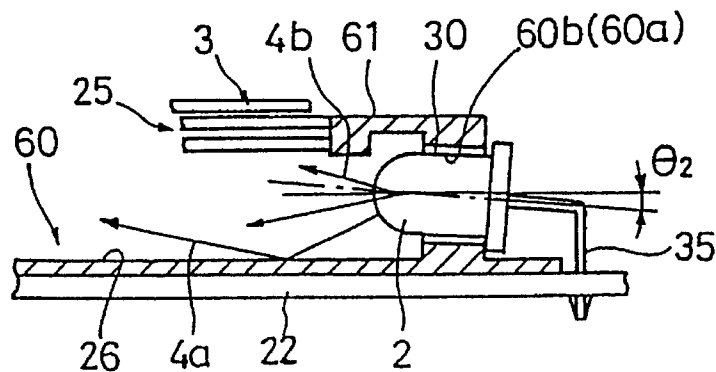
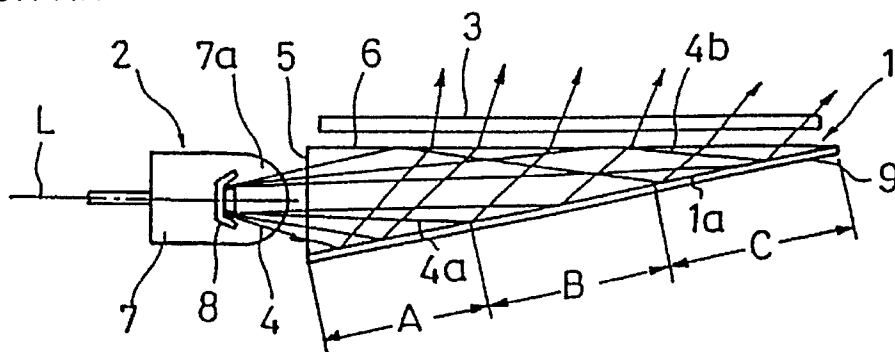


FIG. 6



**FIG. 7****FIG. 8****FIG. 12**  
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