

United States Patent [19]

[11] Patent Number: **5,453,855**

Nakamura et al.

[45] Date of Patent: **Sep. 26, 1995**

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

5,064,276 11/1991 Endo et al. 359/49
5,184,888 2/1993 Sakuma et al. 362/136

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

[57] **ABSTRACT**

[22] Filed: **Dec. 9, 1993**

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.

[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.⁶** **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**

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,791,540 12/1988 Dreyer, Jr. et al. 362/331

10 Claims, 7 Drawing Sheets

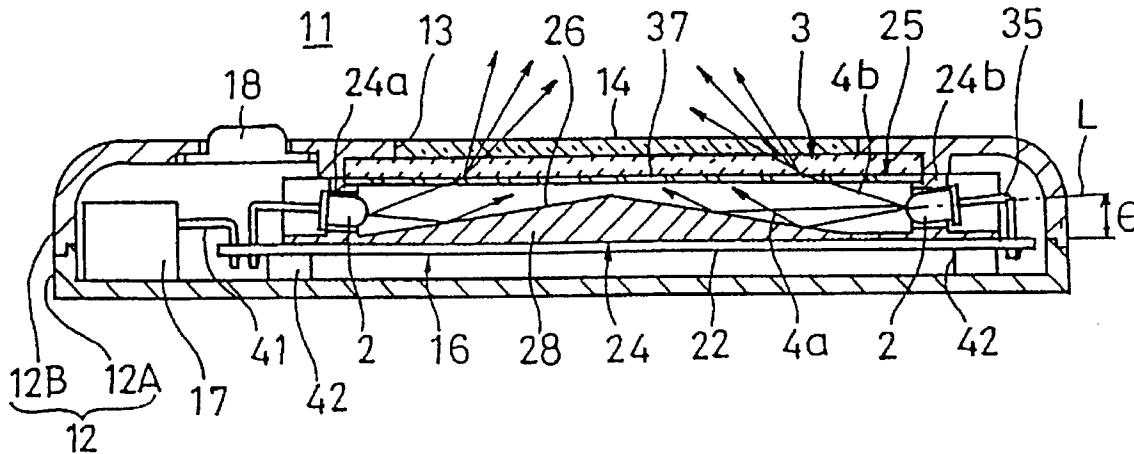


FIG. 7

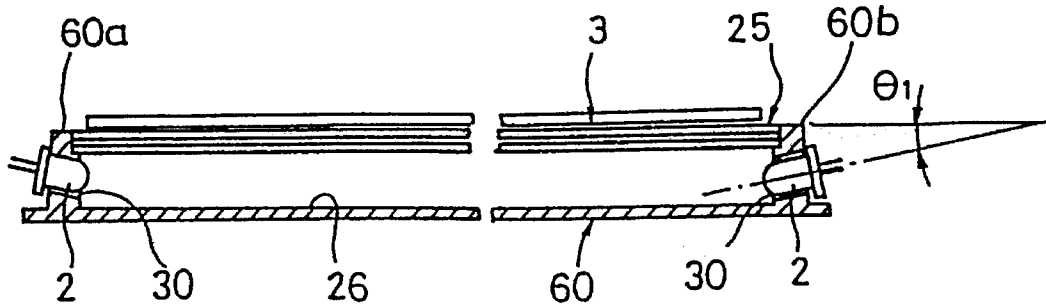


FIG. 8

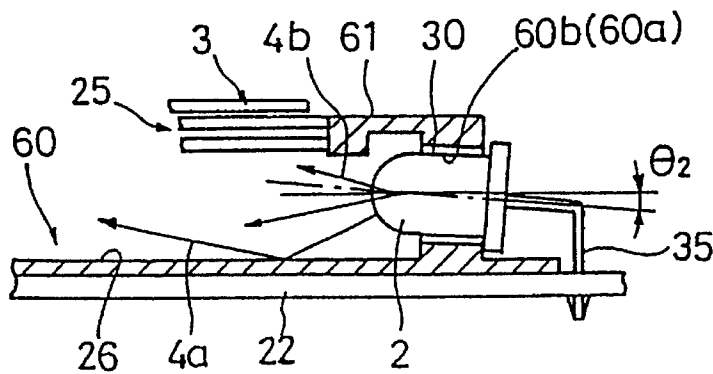
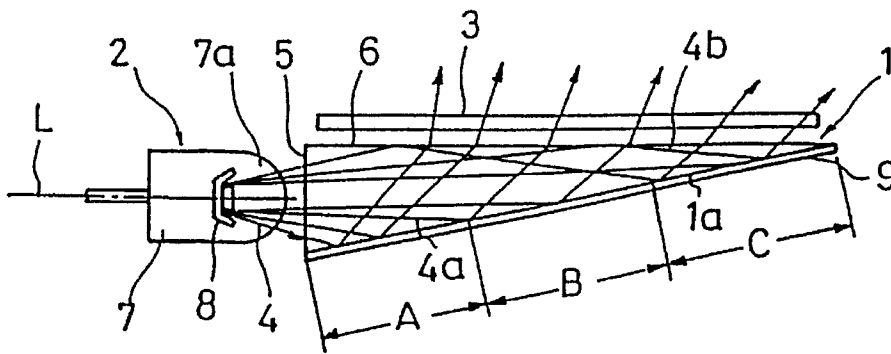


FIG. 12
PRIOR ART



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