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**Hirakata et al.**

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(54) **LIQUID CRYSTAL DISPLAY DEVICE AND DISPLAY DEVICE**

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Apr. 9, 1996 (JP) ..... 8-113166

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G02F 1/1333

(52) **U.S. Cl.** ..... **349/141**; 349/43; 349/110;  
349/138

(58) **Field of Search** ..... 349/42, 43, 110,  
349/111, 138, 141; 257/59, 72

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,774,989 A 11/1973 Takahashi ..... 350/160 LC  
5,055,899 A 10/1991 Wakai et al. .... 357/23.7  
5,339,181 A 8/1994 Kim et al. .... 359/59

5,521,107 A	5/1996	Yamazaki et al. ....	437/42
5,650,664 A	7/1997	Sakamoto .....	257/764
5,694,188 A	12/1997	Sano et al. ....	349/139
5,734,451 A *	3/1998	Yanagawa et al. ....	349/43
5,760,856 A *	6/1998	Yanagawa et al. ....	349/42
5,814,834 A *	9/1998	Yamazaki et al. ....	257/59
5,815,226 A *	9/1998	Yamazaki et al. ....	349/111
5,897,345 A	4/1999	Uochi .....	438/151
6,013,928 A	1/2000	Yamazaki et al. ....	257/347
6,133,620 A	10/2000	Uochi .....	257/649
6,160,600 A	12/2000	Yamazaki et al. ....	349/138

**FOREIGN PATENT DOCUMENTS**

JP	4-163528	*	6/1992
JP	07-036058		2/1995

\* cited by examiner

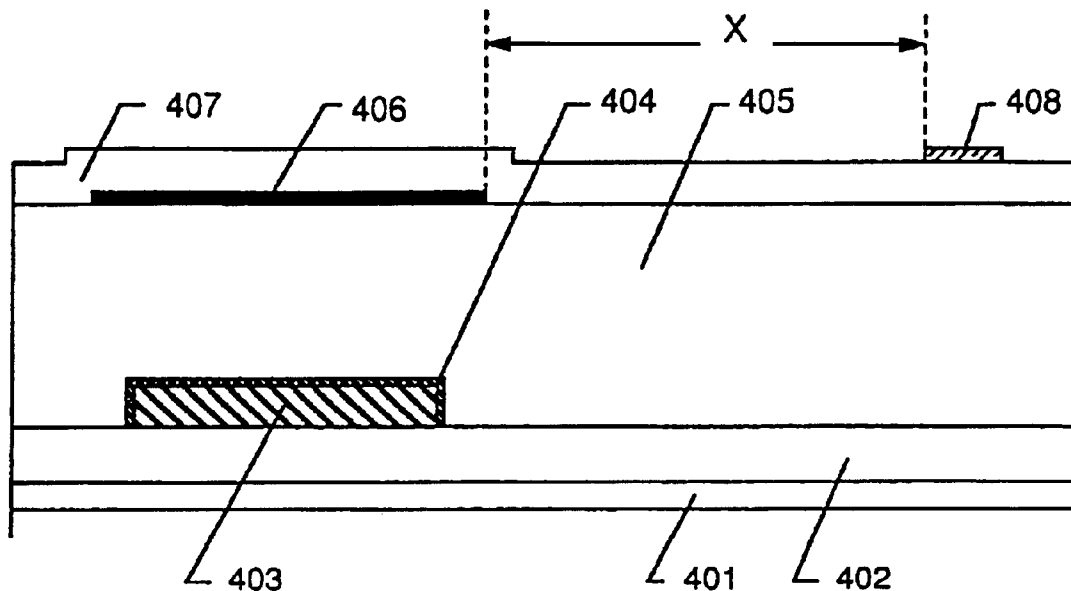
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(57) **ABSTRACT**

In a liquid crystal display device which performs image display by controlling a liquid crystal layer by a lateral electric field that is parallel with a substrate, the lateral electric field is formed by a black matrix and a pixel electrode. That is, a common electrode and a black matrix are commonized which are separately provided conventionally. Further, a storage capacitor is formed in an area where the black matrix and a pixel line coextend with a third interlayer insulating film interposed in between. Since the storage capacitor is formed by using all the area where a thin-film transistor is covered with the black matrix, sufficient capacitance can be secured even if the widths of electrodes wiring lines are reduced in the future.

**46 Claims, 11 Drawing Sheets**



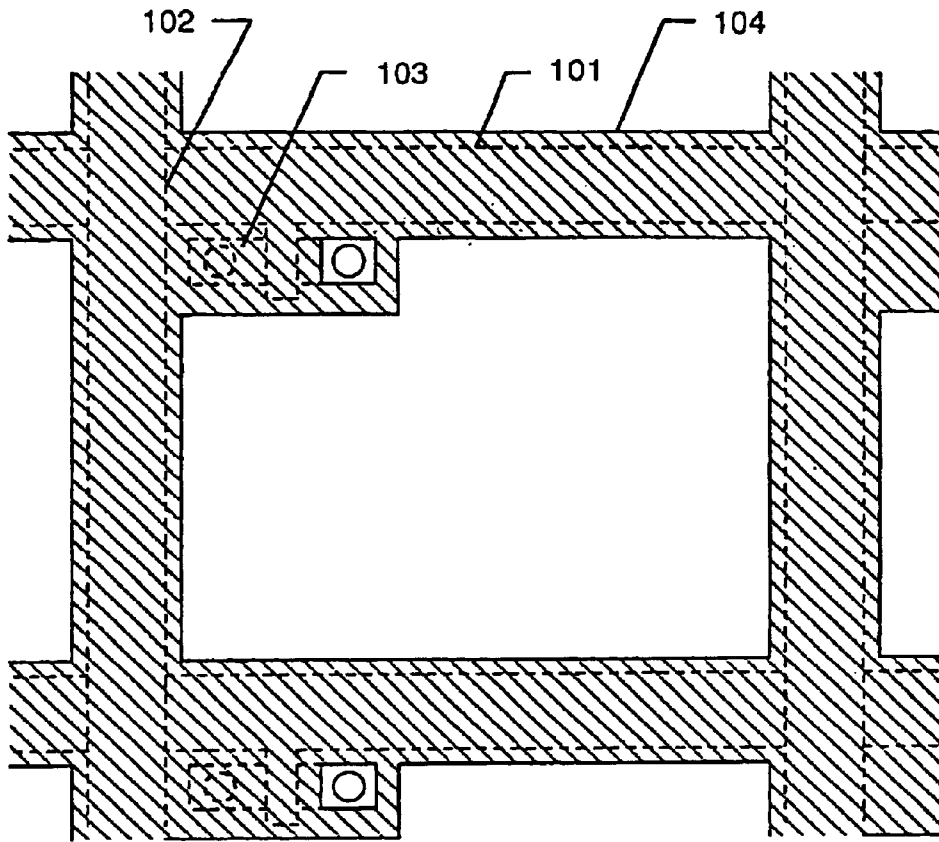


Fig. 1A

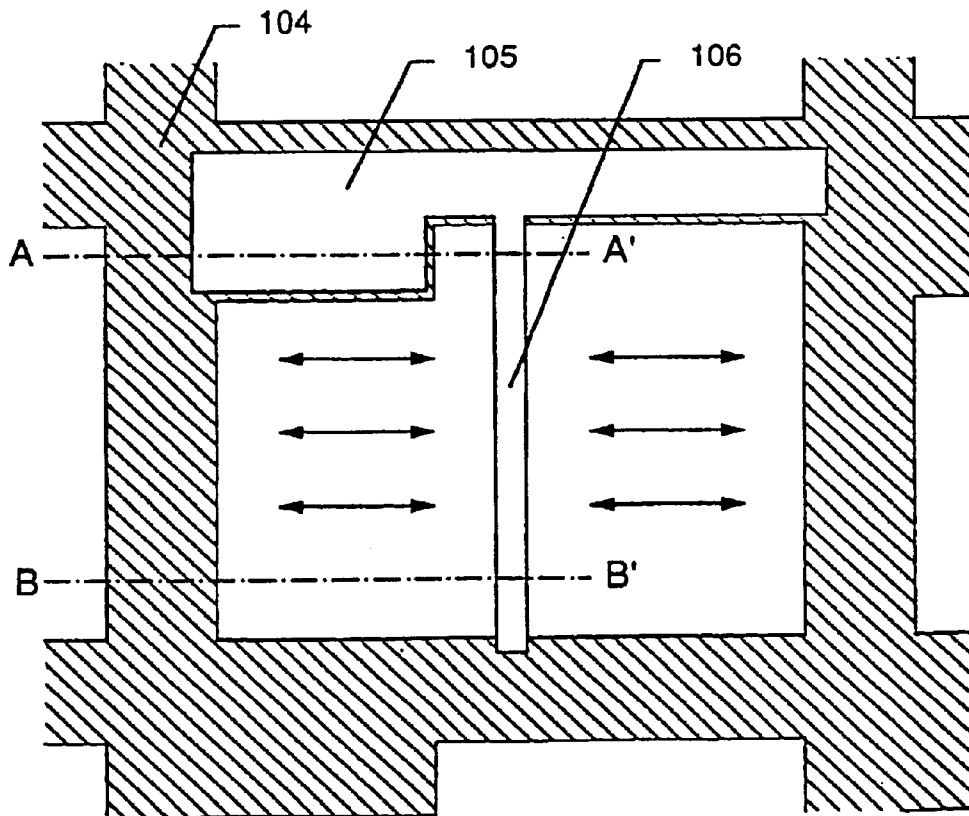


Fig. 1B

Fig. 2A

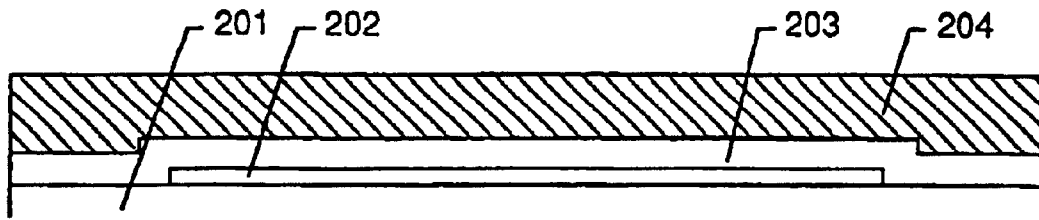


Fig. 2B

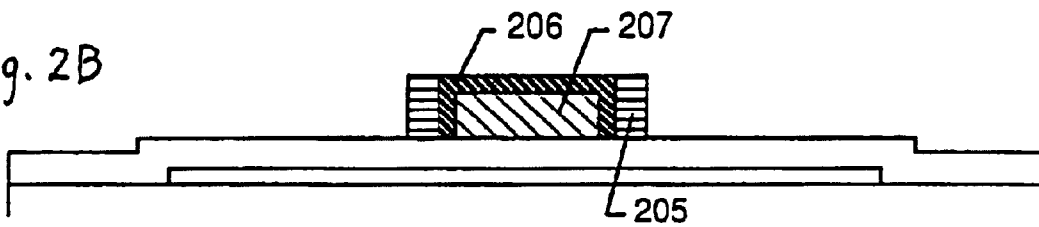


Fig. 2C P+ OR B+ DOPING

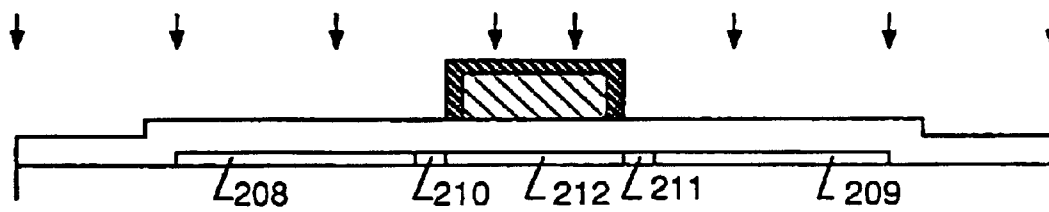


Fig. 2D

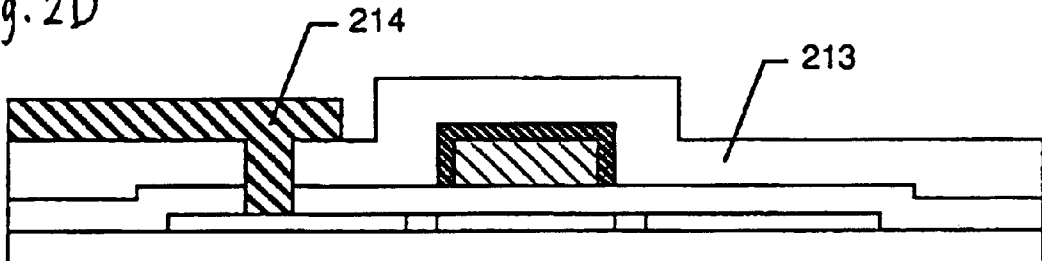


Fig. 3A

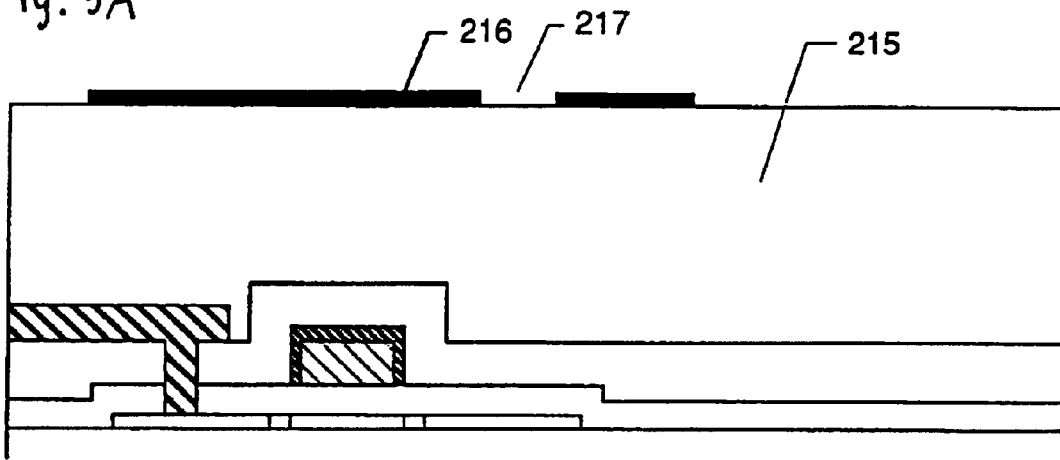


Fig. 3B

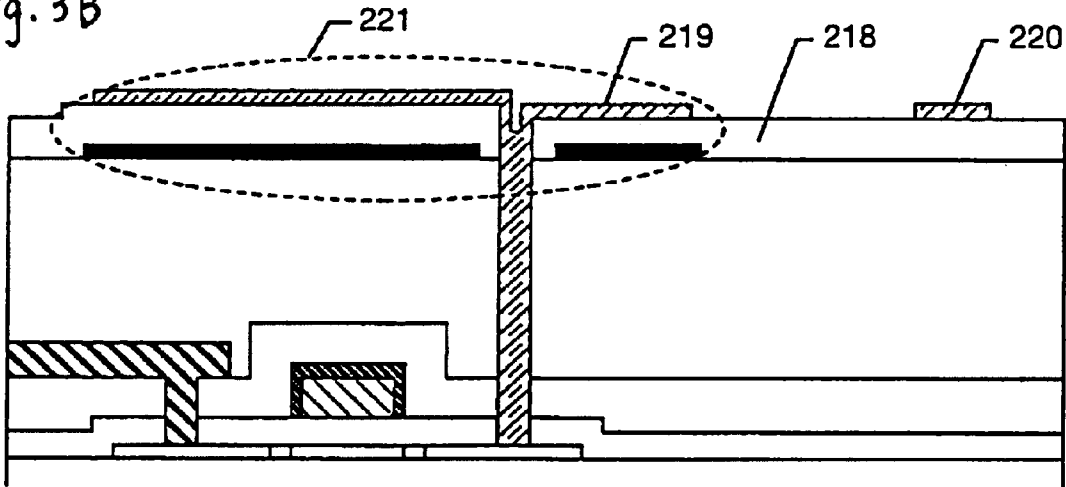
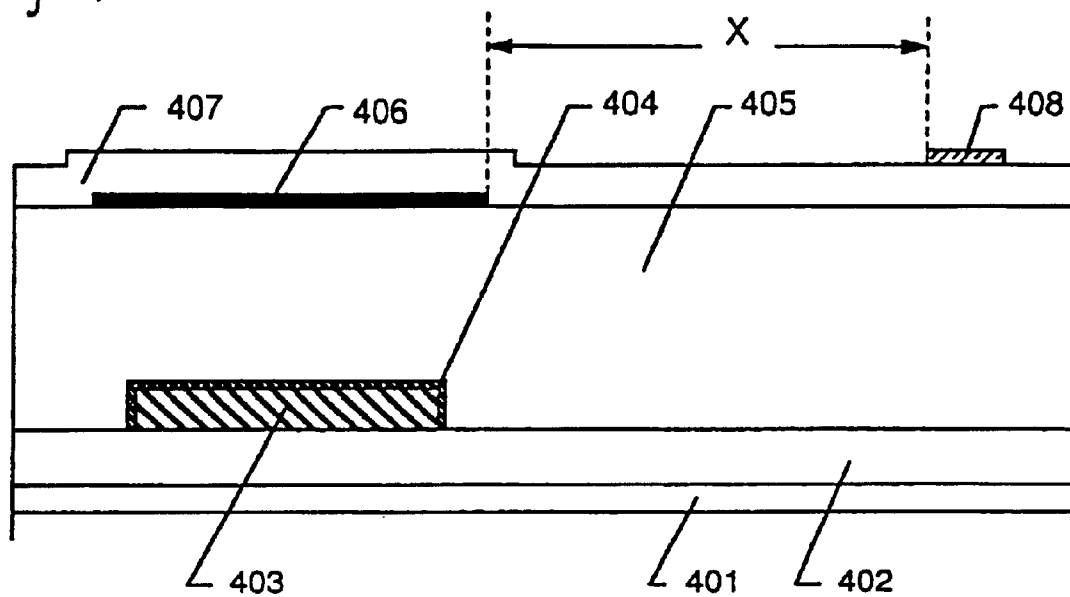


Fig. 4



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