# United States Patent [19]

## Kusunoki

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[45] Date of Patent: Feb. 23, 1993

[54] **MULTI-LAYER TYPE SEMICONDUCTOR DEVICE WITH SEMICONDUCTOR ELEMENT LAYERS STACKED IN OPPOSITE DIRECTIONS AND MANUFACTURING METHOD THEREOF**

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[21] Appl. No.: **585,462**

[22] Filed: **Sep. 20, 1990**

[30] **Foreign Application Priority Data**

Sep. 22, 1989 [JP] Japan ..................................... 1-247156

[51] Int. Cl.$^5$ ....................... H01L 27/14; H01L 31/00
[52] U.S. Cl. ......................................... 359/72; 359/48; 257/72; 257/84
[58] Field of Search ................. 357/30 D, 30 G, 30 H, 357/30 K, 49, 59 F, 71, 59 E, 23.7, 75, 49; 359/72

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*Assistant Examiner*—Sara W. Crane
*Attorney, Agent, or Firm*—Lowe, Price, LeBlanc & Becker

[57] **ABSTRACT**

A multi-layer type semiconductor device is disclosed, in which a plurality of semiconductor layers are formed in vertically opposite directions. The multi-layer type semiconductor device is obtained by forming a first semiconductor layer, an insulating layer and a second semiconductor layer in the mentioned order on a main surface of a first substrate, forming a semiconductor device by using the second semiconductor layer as a base, with an exposed surface thereof directed upward, forming an insulating film on the semiconductor device, attaching a second substrate to the insulating film, thinning the first substrate to expose the first semiconductor layer, and forming a further semiconductor device by using the first semiconductor layer as a base, with an exposed surface of the first semiconductor layer directed upward. A single- chip type image forming system or sensing system may be provided by employing, as the semiconductor devices, a sensing device such as a photosensor, a pressure sensor or the like, a processing circuit for processing a signal received from the sensor, and a display device for displaying results of the processing. A large number of pads may be provided by arranging the pads on opposite surfaces of a chip.
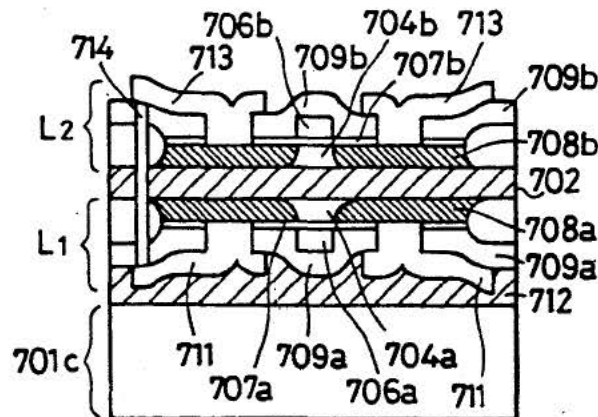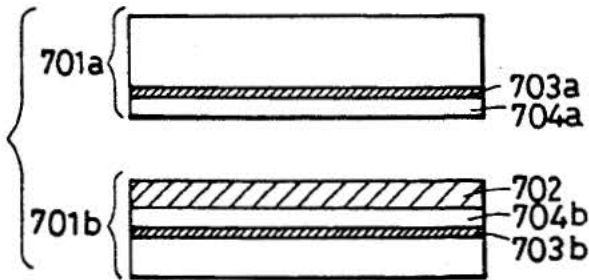
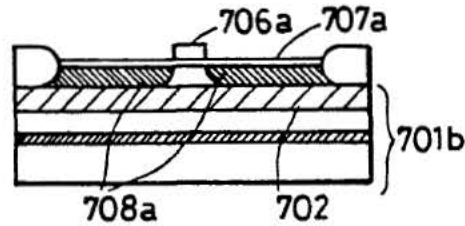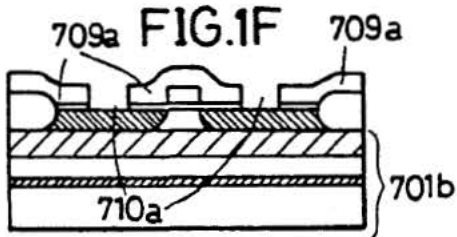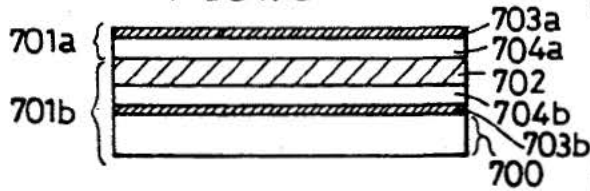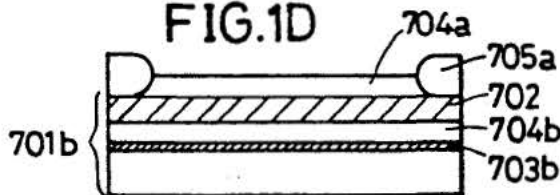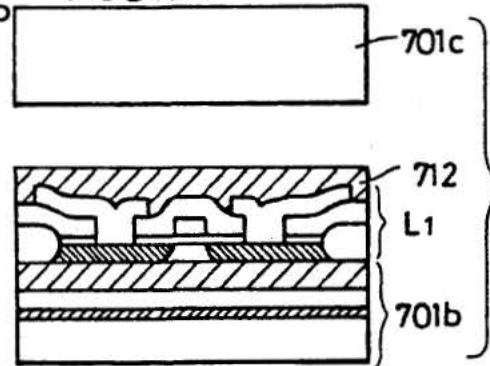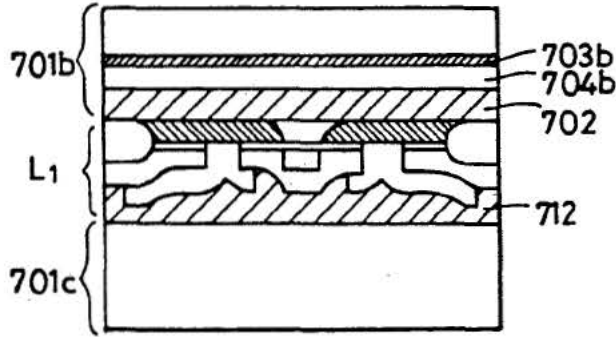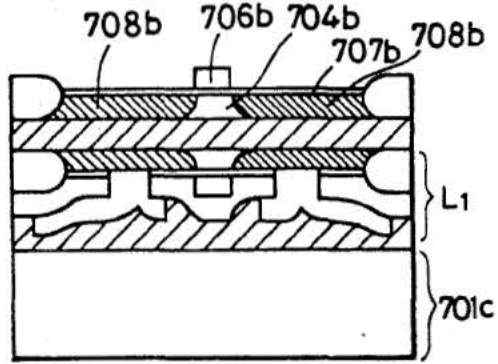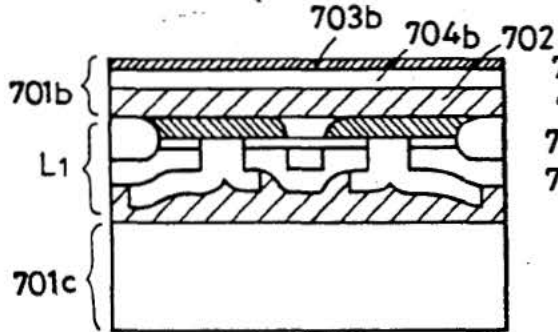**15 Claims, 24 Drawing Sheets**

FIG.1A

FIG.1E

FIG.1B

FIG.1F

FIG.1C

FIG.1G
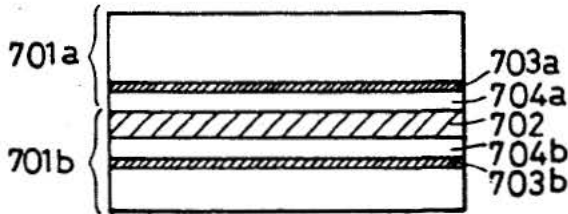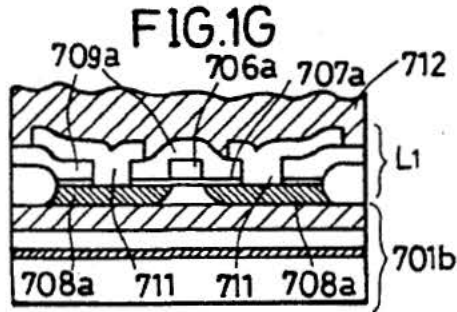
FIG.1D

FIG.1H

FIG.1I

FIG.1L

FIG.1J

FIG.1M

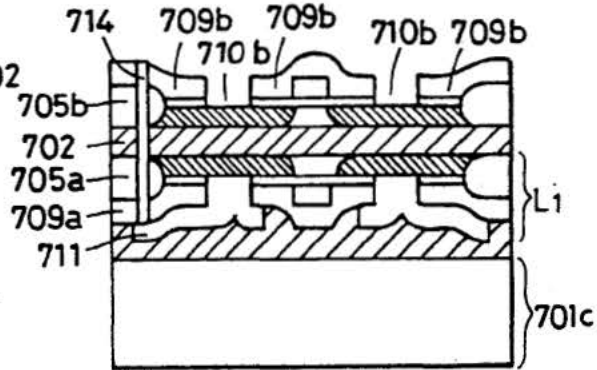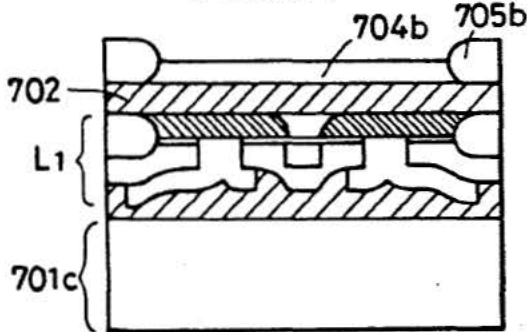FIG.1K

FIG.1N
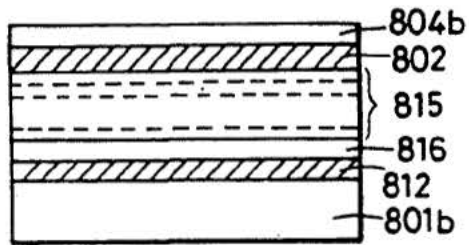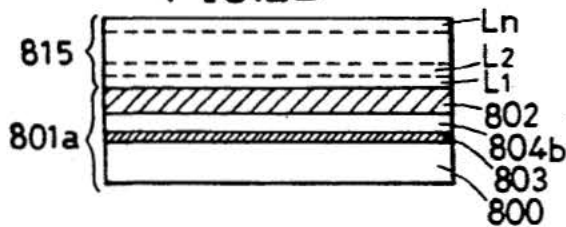
FIG.2A

FIG.2B

FIG.2C

FIG.2D

FIG.2E

FIG.2F

FIG.3

## FIG.4A



- 801b
- 816
- 815a
- 815b
- 815c
- 815d
- 818
- 819
- 821

## FIG.4B



THE PHOTOSENSOR LAYER
DETECTS THE LIGHT ENTERING
THE TRANSPARENT SUBSTRATE

ELECTRIC SIGNAL IS
DIGITALIZED BY AN
A/D CONVERTER

LOGIC OPERATIONS
ARE PERFORMED

THE SIGNAL OBTAINED BY
LOGIC OPERATIONS ARE
CONVERTED INTO AN
ANALOG SIGNAL

THE LIQUID CRYSTAL DISPLAY
DISPLAYS AN IMAGE BASED
ON THE SIGNAL
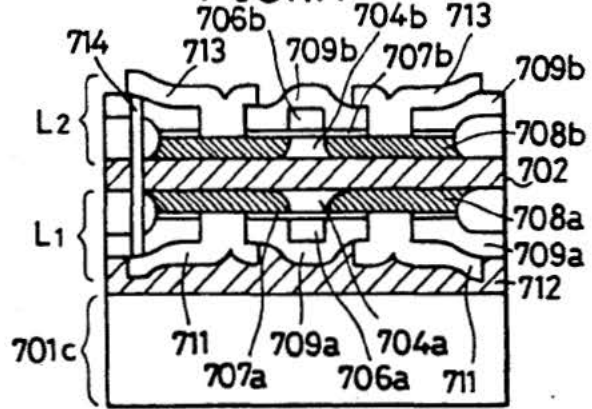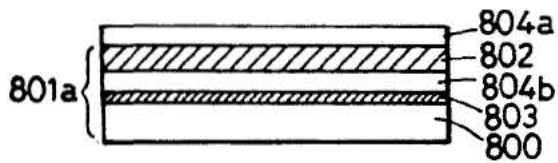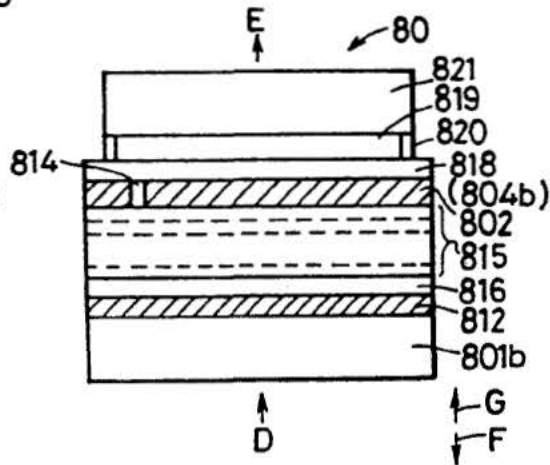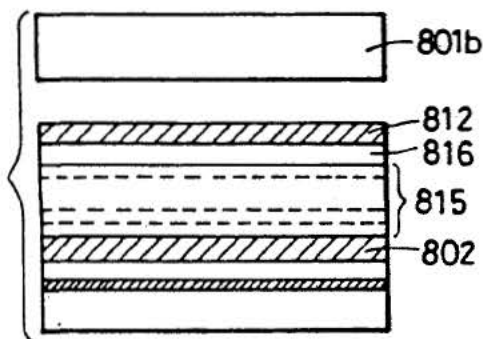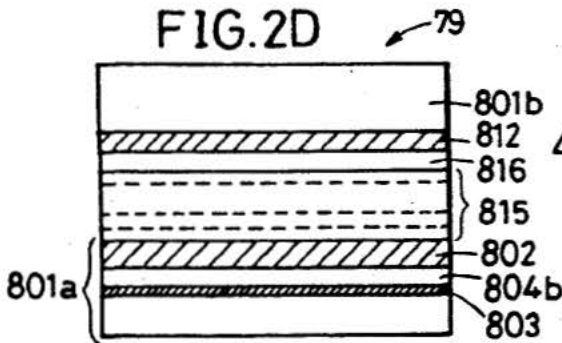
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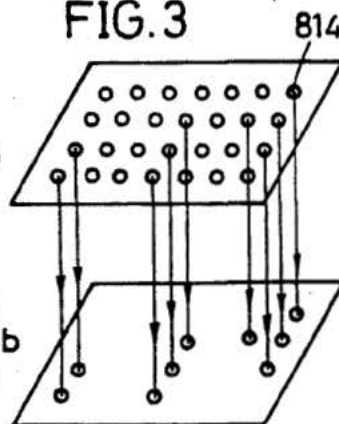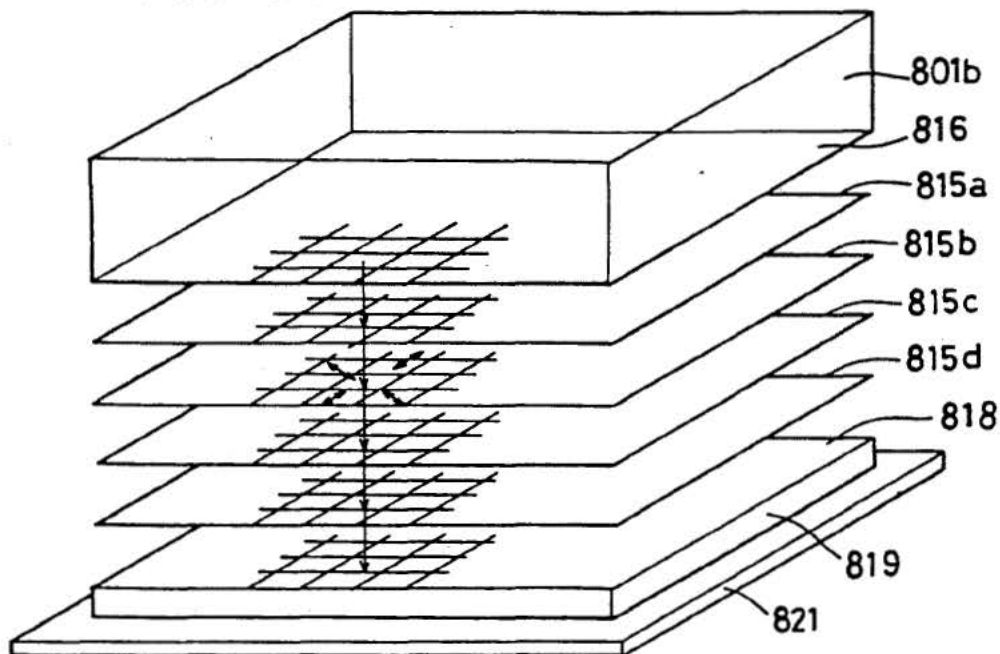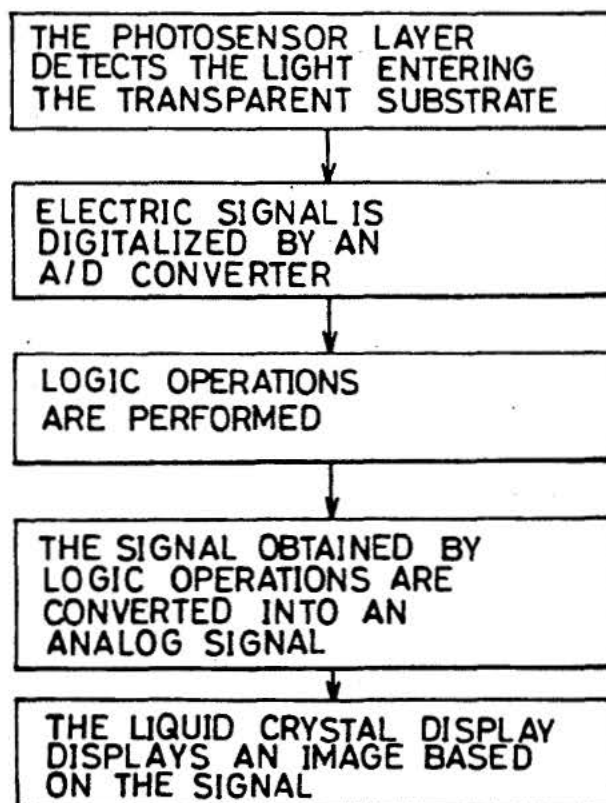
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