United States Patent [19]

Ohno

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[54] **DISPLAY PANEL HAVING CONDUCTIVE CONTACT MEDIA**

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[30] **Foreign Application Priority Data**

Apr. 20, 1982 [JP] Japan 57-65698

[51] **Int. Cl.**[4] **G02F 1/13**

[52] **U.S. Cl.** **350/336**; 350/343; 350/344

[58] **Field of Search** 350/336, 344, 343

[56] **References Cited**

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[57] **ABSTRACT**

A liquid crystal display panel comprising opposed substrates, electrodes on the inside opposed surfaces of said substrates and arranged opposite to each other to sandwich a display layer, a contact media for electrically connecting an electrode on one substrate with an electrode on the other substrate and disposed between said electrodes of said substrates, and a binder between said substrates and fixably engaging said contact media with said electrodes, the diameter of said contact media selected to be substantially the same as the thickness of a liquid crystal cell layer. The contact media comprises a non-conductive core electroless plated with a conducting metal.

15 Claims, 8 Drawing Figures

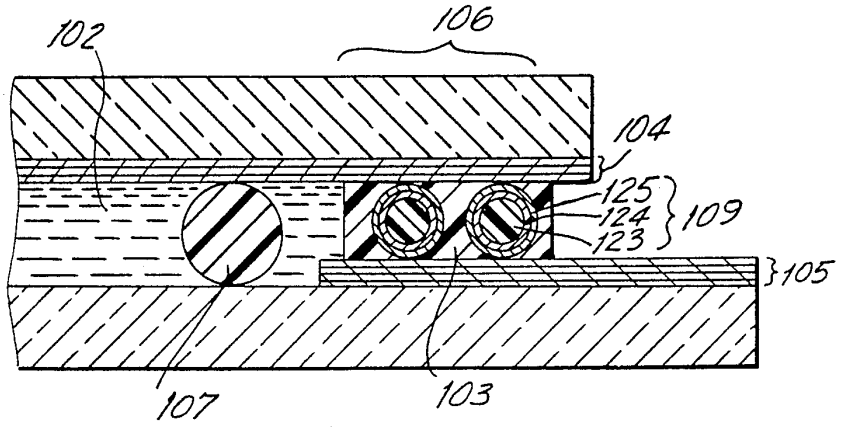


FIG. 1

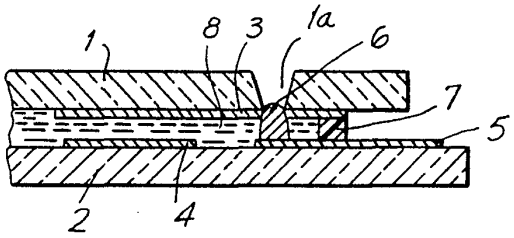


FIG. 2

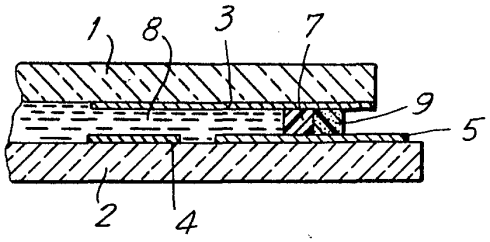


FIG. 3

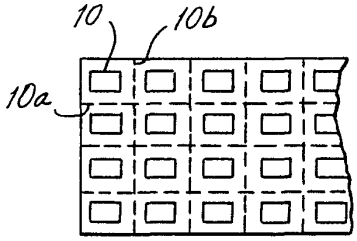


FIG. 4

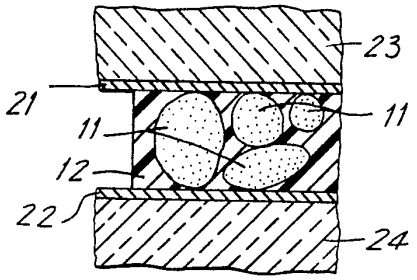


FIG. 5

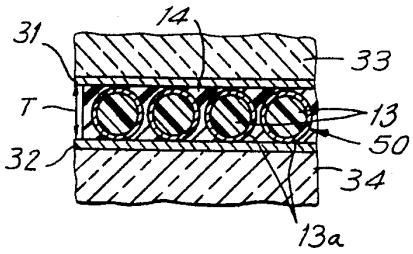


FIG. 6

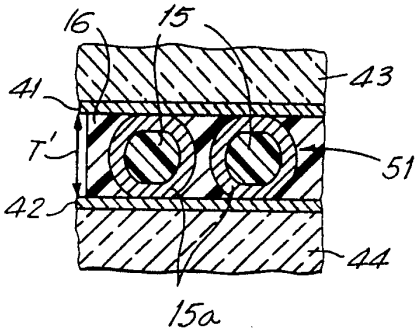
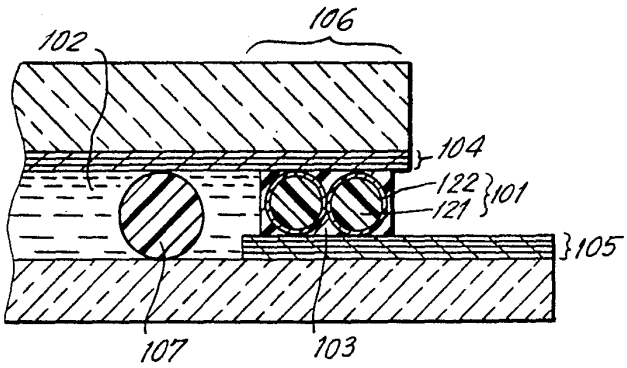


FIG. 7



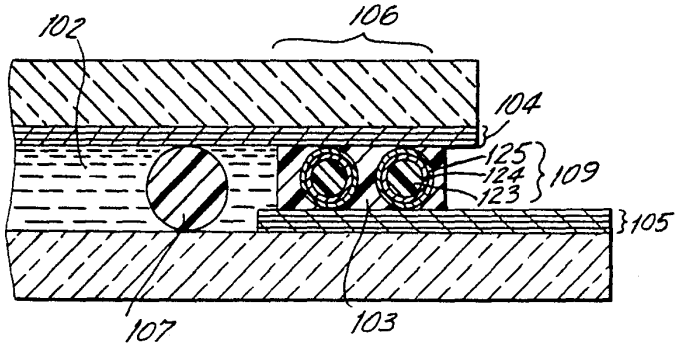


FIG. 8

DISPLAY PANEL HAVING CONDUCTIVE CONTACT MEDIA

BACKGROUND OF THE INVENTION

This invention relates to a display panel having conductive contact media disposed between upper and lower electrodes which function as the gap material between the electrodes and more particularly to a liquid crystal display panel having improved electrical contacts between the upper and lower electrodes, and improved display quality, speed and color.

Conventional liquid crystal display panels have a spacing, or gap, between upper and lower electrode bearing substrates. A common electrode, generally of a metal, is in electrical contact with the electrodes of each substrate. In general, a soft metal, e.g. indium, is utilized as the electrical connection between the upper and lower substrates. In order to provide this connection, the soft metal is placed into a gap created in one substrate and then the two substrates are forced into parallel, opposed alignment, spaced apart by the soft metal. One disadvantage of this structure and method is the tendency toward contact failure between the soft metal and the electrodes. To overcome this defect resinous adhesive agent including a conductive metal, e.g. silver, has been printed on either the upper or lower substrate prior to construction of the panel. This resinous agent is generally applied in the form of a paste. However, unacceptably high proportions of electrical contact failure between the upper and lower electrodes when using such pastes are known. These failures occur during the necessary steps undertaken in the process of manufacturing a liquid crystal panel. To manufacture a panel, a matrix of panel substrates is formed on a master substrate and then each panel substrate is separated by mechanical means. In a conventional construction, a conductive resinous adhesive silver paste is positioned on each individual substrate panel prior to the separation step. When the force necessary to separate each individual panel is applied, the silver paste in the adhesive material tends to disassociate itself therefrom. As a result, when the individual substrates are brought into opposition, contact failure sometimes occurs between the upper and lower substrates. The contact failure can be adhesive or electrical in nature. When the adhesive resin content of the silver paste is increased, it becomes difficult to maintain the silver particles in electrical contact with each other. This results in unacceptable levels of contact failure between the upper and lower electrodes. Conversely, if the concentration of the silver particles in the silver paste is increased to overcome this drawback, the adhesive properties of the paste are diminished, thereby also causing unacceptable rates of contact failure. Optimum ratios of resins and silver particles, even when mixed properly, do not exist, since variations in conditions such as humidity and temperature of manufacture, as well as drying temperature, all cause variations in the properties of the silver paste product. Furthermore, the average particle diameter of the silver particles in the silver paste varies. It is generally more than about seven microns, although particles smaller than this size do regularly appear. Additionally, the shape of the particles also varies. Thus, two particles can be generally of the same size, but differ enough in shape to effect the alignment of the opposed display panels. This variation in particle sizes and shapes causes great difficulty in aligning in parallel the opposed substrate plates.

SUMMARY OF THE INVENTION

The disadvantages of the art can be overcome by providing a contact media which generally comprises a non-conductive core material disposed between the upper and lower electrodes of the display panel. The core material is made conductive by electroless plating thereon of one or more conductive materials. The diameter of the coated core materials is selected to be almost the same as, or slightly larger than, the gap between the upper and lower liquid crystal panel electrodes of the display. The non-conductive core particles, such as glass beads, glass fibers, or plastic balls, can be formed by injection-molding or by cooling after they are melted and passed through an orifice, having a fixed diameter. It is, therefore, possible to mass-produce particles having a uniform diameter. As a result, cell thickness can be made uniform and the cost of manufacture can be reduced.

In accordance with the invention, a conductive contact media is disposed between the upper and lower electrodes to provide electrical contact and consistent spacing between the electrodes on the upper and lower panels. The media has a relatively uniform, predetermined thickness. The contact media acts as a gap material, providing uniformity to the thickness of the display cell. It also imparts effective, reliable electrical contact between the upper and lower electrodes. The contact media includes a non-conductive core material, such as glass fiber, glass beads, inorganic glass beads or plastic fiber or beads. These core materials are electroless plated with a conductive metal. The contact media also includes alumina fiber and beads. They are then disposed in a resinous adhesive material. The material is sandwiched between the electrodes on the upper and lower substrate panels.

The adhesive containing the metallized cores (contact media) is placed on the contact portion between the upper and lower electrodes of the liquid crystal panel by printing or dropping onto an electrode before it is incorporated into the liquid crystal panel

Generally, glass is utilized as the substrate of the liquid crystal panel. However, it is possible to use a plastic film wherein a transparent electrode (SnO_2, In_2O_3, etc.) is patterned. When using plastic film, the contact portion of the contact media between the upper and lower electrodes is depressed by pressure when the liquid crystal panel is assembled. The contact area of the electrodes with the contact media between upper and lower electrodes increases, which results in increased adhesion.

When the non-conductive core comprises a relatively hard material, such as glass fibers, glass beads or hard plastic fibers or beads, its diameter should be about that of the cell thickness. When the core comprises a soft plastic its diameter should be no more than about 1.0 to about 1.3 times the thickness of the cell.

Accordingly, it is an object of the invention to provide an improved liquid crystal panel.

Another object of the invention is to provide an improved contact media between the upper and lower electrodes of a liquid crystal panel.

A further object of the invention is to provide contact media between the upper and lower electrodes which are made conductive by providing a non-conductive core and thereupon electroless plating to the core a

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