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[54] **MATRIX PICTURE DISPLAY DEVICE USING LIQUID THAT IS REVERSIBLY REDUCIBLE AND OXIDISABLE BY ELECTRIC CURRENT**

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[51] **Int. Cl.** **G02f 1/28,** H01j 1/58
[58] **Field of Search** ..... 313/483, 188, 232, 307; 315/169 R, 169 TV; 340/166 R, 324 M, 166 EL; 350/160 R, 160 LC

[56] **References Cited**
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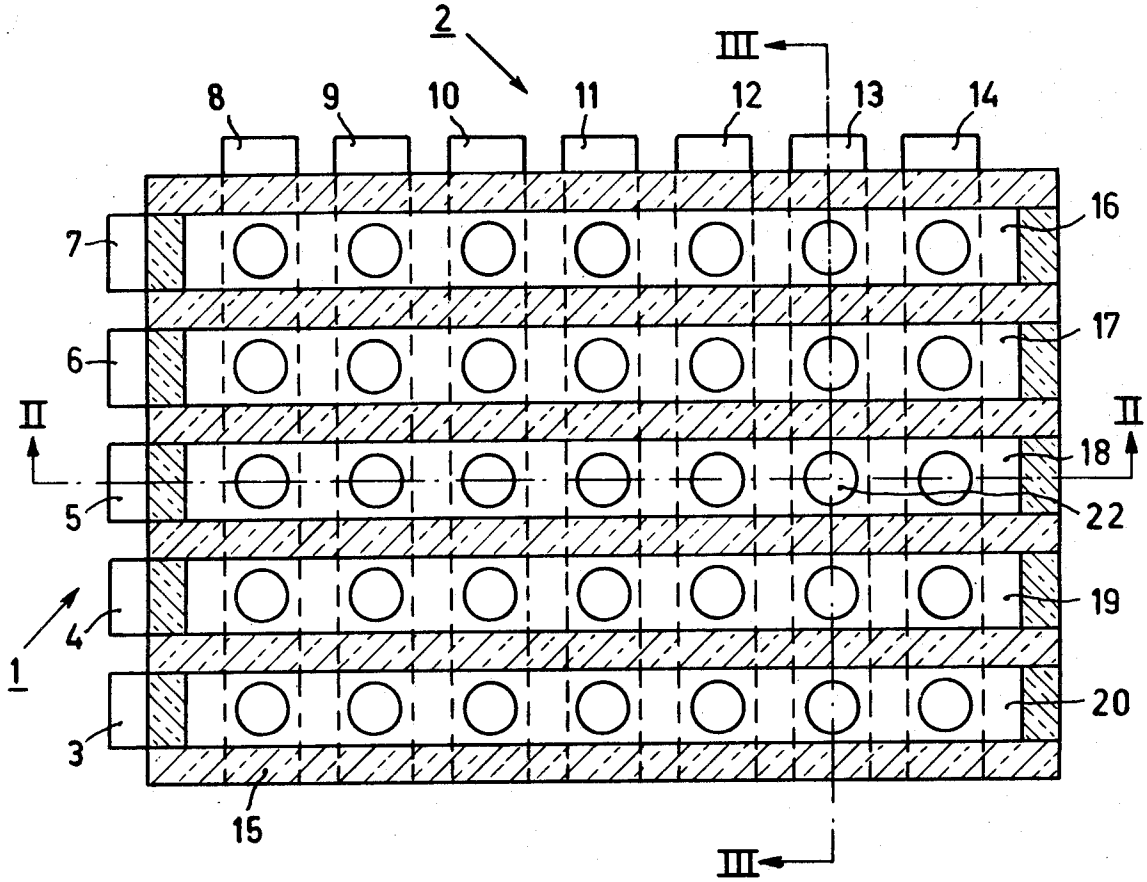
[57] **ABSTRACT**

A picture display device comprising a solution of a material which is reversibly reducible and oxidizable by means of an electric current. The electrodes constitute a cross-bar system. The device is divided into a number of non-communicating compartments which are filled with the solution. Each compartment comprises an electrode, which electrodes form a first set. Of a second set of electrodes, each electrode is in contact with the liquid in all the compartments.

4 Claims, 3 Drawing Figures



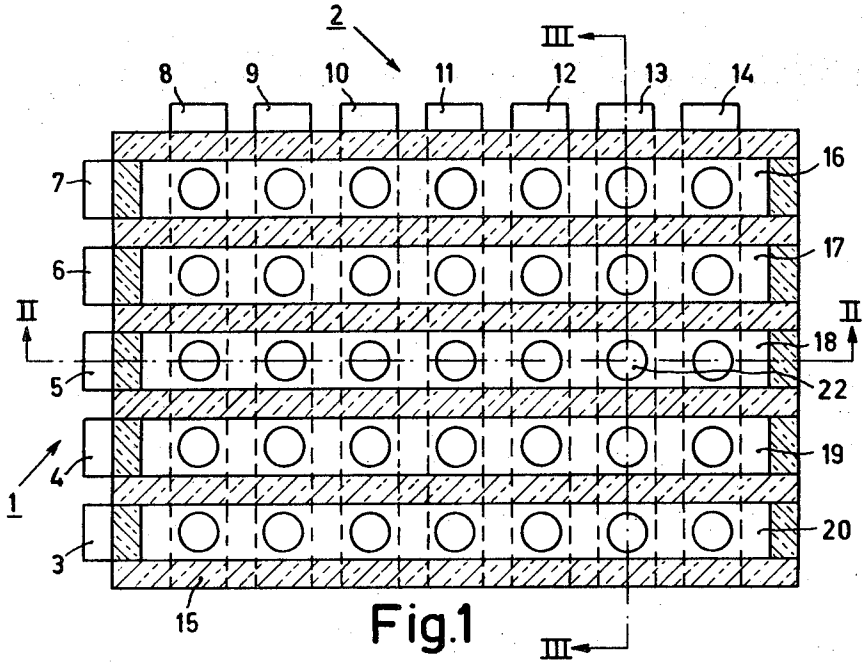


Fig.1

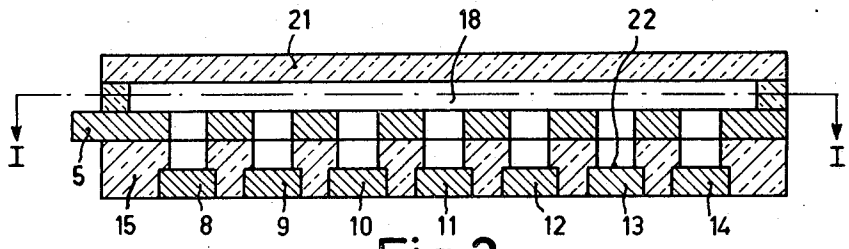


Fig.2

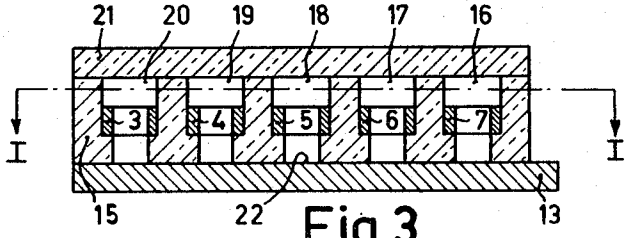


Fig.3

MATRIX PICTURE DISPLAY DEVICE USING LIQUID THAT IS REVERSIBLY REDUCIBLE AND OXIDISABLE BY ELECTRIC CURRENT

The invention relates to a picture display device comprising between two supporting plates of which at least one is transparent a solution of a material which is reversibly reducible and oxidisable by means of an electric current, which solution is in contact with at least two electrodes.

Such a picture display device is known from the published Dutch Pat. No. 7009521 and is furthermore described in the not yet published Dutch Pat. No. 7117713. A characteristic feature of such a picture display device is that the picture is formed by discolouring of the current-conveying surface of an energized electrode, in this case the cathode. This makes it impossible to manufacture such a display device with a matrix of picture elements which are energized by means of two sets of electrodes which cross each other and which form a so-called cross-bar system and which are all present in the same volume of the solution of the reversibly reducible and oxidisable material. The electrode in which the discolouring occurs would actually discolour throughout its length as a result of which it is impossible to activate one single picture point. It would be possible to construct a picture display device with a matrix of picture elements in such manner that each picture element comprises a separate cell which is filled with the solution and which is present between two electrodes of the cross-bar system crossing each other. However, this meets with great practical objections, inter alia when filling the display device with the solution.

It is the object of the invention to mitigate these drawbacks and to provide a construction for a picture display device with cross-bar electrodes.

According to the invention, a picture display device of the type mentioned in the first paragraph is characterized in that the space between the two supporting plates comprises a number of elongate non-communicating compartments which are filled with the said solution, that an elongate electrode extends in each of the said compartments and belongs to a first set of electrodes and is in contact with the liquid in the relevant compartment only, and that the device comprises a second set of elongate electrodes which are each in contact with the liquid in each of the said compartments.

In the case of current passage, the discolouring preferably occurs at the said second set of electrodes which are each in contact with the liquid in each of the said compartments.

As a result of this it is achieved that only that part of an electrode can discolour which is in contact with the liquid in a compartment in which an energized electrode of the first set is present.

A favourable construction which will be described with reference to the accompanying drawing is such that the electrode which discolours is viewed via apertures in the electrodes which do not discolour. In connection with the materials known from the said Dutch patent applications, the discolouring will generally occur at the cathode so that the said second set of electrodes will in general be cathodes. However, the invention may also be applied when other materials are used.

The invention will be described in greater detail with reference to the accompanying drawings of an embodiment of which

FIG. 1 shows a picture display tube according to the invention and

FIGS. 2 and 3 show two cross-sectional views mutually at right angles as denoted in FIG. 1.

The picture display device shown in the figures comprises a first set of electrodes **1** and a second set of electrodes **2** which together constitute a cross-bar system. The first set **1** comprises five electrodes **3, 4, 5, 6** and **7.** The second set comprises seven electrodes **8, 9, 10, 11, 12, 13** and **14.** The electrode sets **1** and **2** are embedded in a glass plate **15** which comprises five compartments **16, 17, 18, 19** and **20.** Said compartments are filled with liquid and do not communicate with each other. Each of the compartments comprises an electrode of the first set **1,** for example, compartment **18** comprises electrode **5.** The picture display device is sealed by means of a glass plate **21.** The cross-overs of the electrodes of the first set **1** and the second set **2** constitute $7 \times 5 = 35$ picture elements. The liquid in the compartment is a solution of ethylviologene borofluoride (0.1 molar) and tetrachlorohydroquinone (0.1 molar) in acetonitrile which contains 1½ percent by weight of acetic acid. A direct voltage of approximately 3V applied between an electrode of the first set **1** as anode and an electrode of the second set **2** as cathode colours the current conveying surface of the cathode blue. For example, when electrode **13** is cathode and electrode **5** is anode, the picture element **22** is coloured blue. The cross-overs of electrode **13** with the other electrodes **3, 4, 6** and **7** of the first set remain uncoloured because the quantities of liquid in the various compartments do not communicate with each other. Another liquid which may be used in the picture display device described is a solution of heptylviologene bromide (0.05 molar) and sodium bromide (3 molar) in water with which a blue violet colour at the cathode is obtained.

The material of the electrodes should be inert relative to the solutions used. Noble metals such as gold and platinum, provided in a thin layer of a conductor of, for example, copper, may be used. If transparent electrodes are desired, they may consist of a thin layer of tin oxide or indium oxide on a glass supporting plate. For example, the electrodes **8, 9, 10, 11, 12, 13** and **14** may be of tin oxide and be provided on a glass supporting plate. The picture display device can then be viewed from the side of the said last-mentioned supporting plate. If the electrodes **3, 4, 5, 6** and **7** are also manufactured from tin oxide and provided on the supporting plate **21,** the discolouring at said electrodes which occurs upon erasing the information and which would be visible via the transparent electrodes **8–14,** can be masked, for example by dispersing in the solution a white, chemically inert, insoluble compound, such as titanium oxide, which also increases the contrast.

What is claimed is:

1. A picture display device comprising between two supporting plates of which at least one is transparent a solution of a material which is reversibly reducible and oxidisable by means of an electric current, which solution is in contact with at least two electrodes, characterized in that the space between the two supporting plates comprises a number of elongate non-

communicating compartments which are filled with the said solution, that an elongate electrode extends in each of the said compartments and belongs to a first set of electrodes and is in contact with liquid in the relevant compartment only, and that the device comprises a second set of elongate electrodes which are each in contact with the liquid in each of the said compartments.

2. A picture display device as claimed in claim **1**, characterized in that in the case of current passage a local discolouring occurs at the surface of the electrodes of said second set.

3. A picture display device as claimed in claim **1**, characterized in that the electrodes of the said first set are present between a transparent supporting plate and the said second set of electrodes and comprise apertures through which the electrodes of the said second set are visible.

4. A picture display device as claimed in claim **3**, characterized in that the electrodes of the said first set are anodes and that the electrodes of the said second set are cathodes.

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