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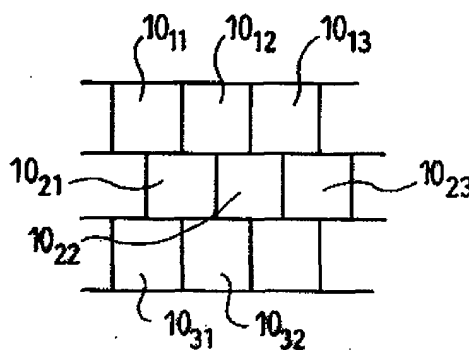
(54) **Magnetic particle display device**

(57) The invention relates to a magnetic particle or ball display device comprising a plurality of magnetic cells, each one presenting at least two display states, the switching from one state to another being obtained by the application of a magnetic field created by the addition of a magnetic field generated by a corresponding

line electrode and of a magnetic field generated by a corresponding column electrode,

According to the invention, the cells (10_{11} , 10_{12} , ..., 10_{21} , 10_{22}) are arranged in a delta configuration, the cells being arranged in lines and the projection of cells of neighboring lines overlapping two cells of the current line.

FIG.6a



Description

[0001] The invention relates to a magnetic particle display device.

[0002] One of the major features which is requested for a display device energized by electric signals is that its consumption of energy be minimal. A magnetic particle display presents this quality.

[0003] The principle of this kind of display is the following: each magnetic particle has a black face and a white face and according to the direction of the magnetic field a particle presents its white or black face. More generally a particle or ball may present several faces, each face having a given color and the face to be displayed (i.e. the color) depends on the direction of the magnetic field which is applied.

[0004] In such display the image remains after deenergization. In other words it is necessary to provide energy to write information with such a display but no energy is required for maintaining the image.

[0005] Instead of using magnetic particles having two, or more, different faces it is also possible to realize such a display by using cells containing magnetic particles which, in absence of magnetic field, are scattered in a liquid. Therefore, when no magnetic field is applied, the liquid is opaque. When a magnetic field is applied on a cell the small particles concentrate and, therefore, the liquid becomes transparent.

[0006] In order to write information on such magnetic display device, it is known to use a static addressing matrix comprising line electrodes and column electrodes. Each pixel is associated with the intersection of a given line and a given column. When both line and column electrodes of a given pixel are energized, the magnetic fields produced by those line and column electrodes impose a given direction to the magnetic particle. If it is only the line or the column electrode which is energized, the corresponding magnetic field is not sufficient to impose a given direction to the particle.

[0007] An other quality required for a display device is the density of the pixels: the greater will be the density, the better will be the resolution of the image.

[0008] The invention provides a magnetic particle display device having a high density of pixels.

[0009] For this purpose, each line (or column) electrode is associated to two lines (or columns) of magnetic particles and forms two sublines (or columns) of turns which are arranged in series, in such a way that the turns of the first subline (or column) associated to the first line (or column) of magnetic cells create, when excited, magnetic fields in one direction and the turns of the second subline (or column), associated to the magnetic cells of the second line (or column), create magnetic fields in the opposite direction,

and the column (or line) electrodes are energized by an electric current circulating in a direction selected in order to create a magnetic field having the same direction as the magnetic field created by the line (or col-

umn) electrode associated to the subline (or column) of cells to be energized.

[0010] In order to change the state of a given magnetic cell which is for instance associated to the second subline of the line electrode, covering the second subline of cells, this line electrode and the corresponding column electrode must be energized with a current having a direction which creates additive magnetic fields, i.e. having the same direction. The other cells keep their state because the magnetic fields created by the subline electrode is, by itself, insufficient to create a change of state. One cell of the first subline is submitted to magnetic fields created by the first subline electrode and by the column electrode; but these magnetic fields have opposite directions and, therefore, cannot change the state of this cell.

[0011] In order to maximize the density of cells, in each couple of lines of cells associated to one line electrode, the cells of the second line are shifted with respect to the cells of the first line, i.e. the projection of a cell of the second line on the first line is situated between two cells of this first line preferably in the middle. In that case the line electrodes have a sort of zigzag arrangement.

[0012] According to another aspect of the invention, which may be used independently from the previous aspect, the magnetic particle display device comprises a substrate, for instance an iron plate, which is such that, in absence of magnetic energization, it imposes a given direction to the magnetic cells, i.e. which provides a uniform luminance to the display in absence of energization. However the magnetization of the substrate is selected in such a way that before any magnetization of the cells it imposes a direction to said cells, but when the cells have been magnetized the magnetic field provided by substrate is too small to erase the display. Such a substrate may be also used to stabilize the magnetic cells when each cell contains a particle which may rotate freely in a liquid for instance.

[0013] According to an embodiment the magnetic substrate has several separate sections, some sections corresponding to a part(s) of the display which is (are) less energized than others. In fact if, for instance, the borders of the display are less energized than the central part of the display, the corresponding border sections of the substrate will be practically always submitted to the same magnetic field which will tend to have a greater amplitude than the amplitude of the magnetic field in other sections of the substrate, and this non uniformity of distribution of magnetic field on the substrate may disturb the operation of the display. But when such sections are separated from the others there is no more disturbance due to the non uniform energization of the different sections of the substrate, because the magnetic field of one section has practically no influence on the others.

[0014] In an embodiment a magnetic substrate is provided for each cell, this magnetic substrate being separated from the neighboring other substrates.

[0015] The invention relates generally to a magnetic particle or ball display device comprising a plurality of magnetic cells, each one presenting at least two display states, the switching from one state to another being obtained by the application of a magnetic field created by the addition of a magnetic field generated by a corresponding line electrode and of a magnetic field generated by a corresponding column electrode. According to the invention, the cells are arranged in a delta configuration, i.e. the cells are arranged in lines and the projection of cells of neighboring lines overlapping two cells of the current line.

[0016] In a preferred embodiment, each line (or column) electrode corresponds to two lines of cells and has the shape of a turn at the level of each cell,

the arrangement of each line electrode being such that turns corresponding to one line (or column) of cells are able to generate a magnetic field in one direction and turns corresponding to the second line (or column) of cells are able to generate a magnetic field in the opposite direction, column (or line) electrodes forming also turns corresponding to the cells, these turns being able to generate a magnetic field in one direction for a given direction of electric current in this column electrode

[0017] In that case, means may be provided to reverse the direction of the current in the column (or line) electrodes for selectively addressing the even or odd lines of cells.

[0018] Each cell may contain a magnetic ball able to rotate in a liquid, or in a gas, or in a vacuum.

[0019] According to another embodiment, each cell contains a liquid with magnetic particles, the liquid being opaque when the particles are scattered in the liquid and being transparent when the magnetic particles are concentrated under the effect of a magnetic field.

[0020] In one embodiment, line electrodes are on one side of the cells and column electrodes are on the other side of the cells.

[0021] The device may comprise a magnetic substrate wherein at least one part of this magnetic substrate is separate from the other parts of the substrate.

[0022] For instance, the borders of the magnetic substrate are separate from the rest of the magnetic substrate.

[0023] In another embodiment, the magnetic substrate is divided into a plurality of elements, each element corresponding to a cell.

[0024] Other features and advantages of the invention will appear with the description of certain of its embodiments, this description being made with reference to the drawings wherein :

figure 1 is a schematic drawing showing the principle of a magnetic particle display device, figures 2 and 2a show an other type of magnetic

particle display device, figure 3 shows the writing and erasing means in a magnetic particle display device, figure 4 and figure 5 show, in cross section, two embodiments, of a magnetic particle display device, figure 6 shows an arrangement of addressing electrodes of a magnetic particle display device according to the invention, and figure 7 shows a substrate of a magnetic particle display device according to the invention.

[0025] Figure 1 shows the principle of a conventional magnetic particle display device. This device comprises a plurality of cells 10 and each cell comprises a liquid, such as oil 12, and a magnetic ball 14 having a black face 16 and a white face 18. The base of the substrate comprises an iron plate 20 which retains a small magnetic field.

[0026] Each cell is a pixel of the display device.

[0027] Scanning means 22 are provided for writing information on the display. They impose a given direction to each ball. According to the magnetic field generated by the scanning means, each ball 14 presents an upper face (the visible face, at the opposite 24 of the iron plate 20) which is either black 16 or white 18.

[0028] In absence of magnetic field imposed by the scanning means 22, the magnetic field generated by the iron plate 20 provides a given orientation to each ball 14, for instance each ball presents its white face 18.

[0029] A grey point may be obtained through a selective choice of the position of the scanning means.

[0030] It is also known to have balls with different sectors, each sector having a given color. In this way it is possible to have a color display with the corresponding control means 22 able to select the orientation of each ball.

[0031] Instead of balls (figures 2 and 2a), it is possible to use magnetic particles scattered in a liquid 28. In absence of magnetic field the particles are uniformly scattered in the liquid of each cell and the liquid appears opaque. When a magnetic field of appropriate amplitude is applied, the particles 30 gather and form a point 30' which is practically not visible and the liquid 28 appears clear.

[0032] Figure 3 represents schematically scanning means 22. The scanning means comprise a matrix with line electrodes 32₁, 32₂, 32₃, etc, and column electrodes 34₁, 34₂, etc. In projection on the surface of the display a magnetic ball (or cell) is located at the intersection of each line electrode and each column electrode. The orientation of the magnetic ball changes when simultaneously the line electrode and the column electrode generate a magnetic field in the same direction.

[0033] In the embodiment represented on figure 4 the line electrodes 32_i and the column electrodes 34_j are on the same side of the display, i.e. in this example, between the iron plate substrate 20 and the cells 10, opposite to the transparent cover 24.

[0034] In the embodiment represented on figure 5 one set of electrodes, for instance the line electrodes 32'_i, is located on the side of the iron plate substrate and the other set of electrodes, for instance column electrodes 34'_j, are located on the transparent cover 24, or embedded in this transparent cover.

[0035] According to the invention, in order to maximize the density of cells of the display, the cells are arranged in a delta or zigzag arrangement, i.e. the cell 10₂₁ of line number 2 overlaps, in projection, the cells 10₁₁ and 10₁₂ of the line number one. In the same way the cell 10₂₁ overlaps, in projection, the cells 10₃₁ and 10₃₂ of the third line.

[0036] In order to energize this arrangement a wire 40 is associated to each couple of lines in the way represented on figure 6. In this wire 40 the current flows in a direction represented by arrow f and to each cell corresponds a turn of this wire.

[0037] The turns 40₁₁, 40₁₂, 40₁₃, etc., of the first line are such that the current circulates in one direction, for instance the clockwise direction and the turns of the second line 40₂₁, 40₂₂, 40₂₃, etc., are such that the current circulates in the other direction, i.e., in this example, counterclockwise. Therefore the magnetic field generated by each turn has one direction for line number 1 and the opposite direction for line number 2.

[0038] In order to impose a given direction to a given magnetic ball it is necessary to energize the corresponding column electrode with a current having a direction and an amplitude such that the corresponding magnetic field adds to the magnetic field generated by the corresponding turn of the line electrode.

[0039] Therefore the column electrode 42 is energized by a current flowing in the same direction than the current flowing in the turns of the first line (clockwise) in order to energize the magnetic balls of the first line. Reciprocally the current in the wire 42 flows in the reverse direction in order to energize the corresponding magnetic ball of the second line.

[0040] As shown on figure 6 the column electrodes 42 have a general direction which is slanted and the wire has, at the level of each cell, a shape of a half turn and all the turns generate a field having the same direction, for a given direction of the current in the wire 42.

[0041] Of course the arrangement of line and column electrode represented on figure 6 may be reversed, i.e. the column electrodes may be arranged like the line electrodes and the line electrodes may be arranged as the column electrodes of figure 6.

[0042] According to another embodiment of the invention, which may be used independently from the embodiment described with figures 6 and 6a, the iron plate 20' (fig 7 and 7a) is subdivided in a number of segments or sections equal to the number of cells. The segments 20'₁₁, 20'₁₂ ... 20'₂₁, 20'₂₂ ... etc. of substrate 20' are arranged conventionally as represented on figure 7, or arranged according to a delta arrangement as represented on figure 7a. Of course this arrangement of segments

20'_{ij} depends on the arrangement of cells.

[0043] The advantage of this segmented arrangement is the following :

The cells which are scarcely retained for displaying information receive always, or almost always, the same magnetic field. Therefore the magnetic substrate corresponding to these cells is always submitted to a magnetic field in a given direction, and this part may retain a magnetic field which is greater than the magnetic field of the neighboring parts which are submitted to magnetic fields of alternate directions. This increased magnetic field may disturb the neighboring cells and entail defects on the displayed information. For instance when the display device is used to display pages of a book the cells which are at the border are never addressed and may present this increased magnetic field for the substrate at the border. The fragmentation of the magnetic substrate eliminates these defects.

The fragmentation may be adapted to the use of the display. For instance with an electronic book only the part of the substrate which corresponds to the borders may be separated from the other parts.

Claims

1. A magnetic particle or ball display device comprising a plurality of magnetic cells, each one presenting at least two display states, the switching from one state to another being obtained by the application of a magnetic field created by the addition of a magnetic field generated by a corresponding line electrode and of a magnetic field generated by a corresponding column electrode,
wherein the cells (10₁₁, 10₁₂, ..., 10₂₁, 10₂₂) are arranged in a delta configuration, the cells being arranged in lines and the projection of cells of neighboring lines overlapping two cells of the current line.
2. A device according to claim 1 wherein each line (or column) electrode corresponds to two lines of cells and has the shape of a turn at the level of each cell,

the arrangement of each line electrode being such that turns (40₁₁, 40₁₂, ...) corresponding to one line (or column) of cells are able to generate a magnetic field in one direction and turns (40₂₁, 40₂₂, ...) corresponding to the second line (or column) of cells are able to generate a magnetic field in the opposite direction, column (or line) electrodes (42) forming also turns corresponding to the cells, these turns being able to generate a magnetic field in one direction for a given direction of electric current in this column (or line) electrode.

3. A device according to claim 2 wherein means are provided to reverse the direction of the current in the column (or line) electrodes (42) for selectively addressing the even or odd lines of cells. 5
4. A device according to any of claims 1, 2 or 3 wherein each cell contains a magnetic ball able to rotate in a liquid, or in a gas, or in vacuum.
5. A device according to any of claims 1, 2 or 3 wherein each cell contains a liquid with magnetic particles, the liquid being opaque when the particles are scattered in the liquid and being transparent when the magnetic particles are concentrated under the effect of a magnetic field. 10 15
6. A device according to any of claims 1-5 wherein line electrodes (32_i) are on one side of the cells and column electrodes (34_j) are on the other side of the cells. 20
7. A device according to any of the previous claims comprising a magnetic substrate wherein at least one part (20'₁₁, 20'₁₂, ...) of the magnetic substrate is separate from the other parts of the substrate. 25
8. A device according to claim 7 wherein the borders of the magnetic substrate are separate from the rest of the magnetic substrate. 30
9. A device according to claim 7 wherein the magnetic substrate is divided into a plurality of elements, each element corresponding to a cell. 35

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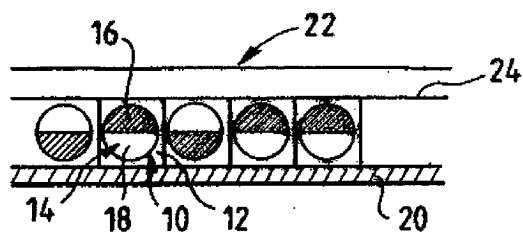


FIG. 1

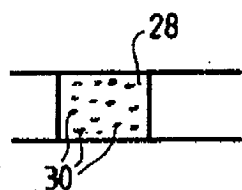


FIG. 2

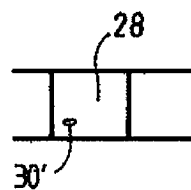


FIG. 2a

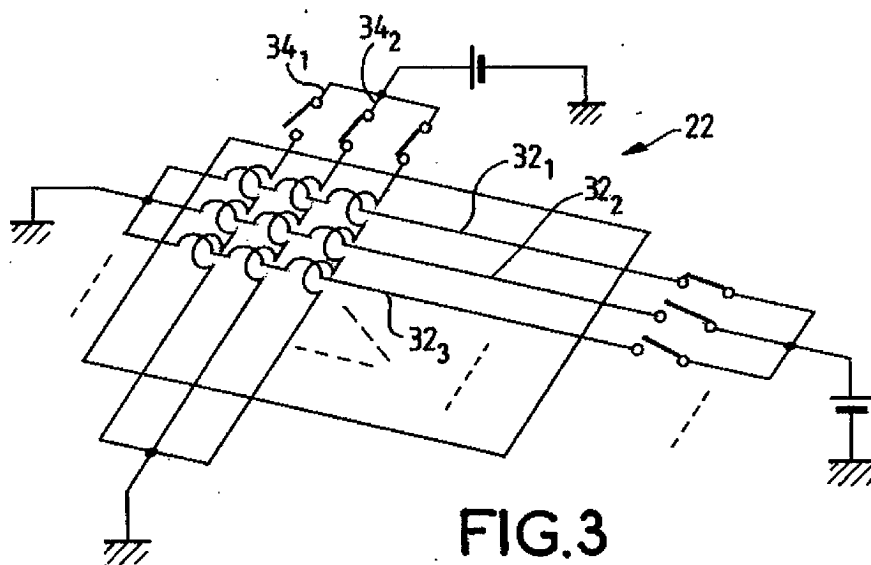


FIG. 3

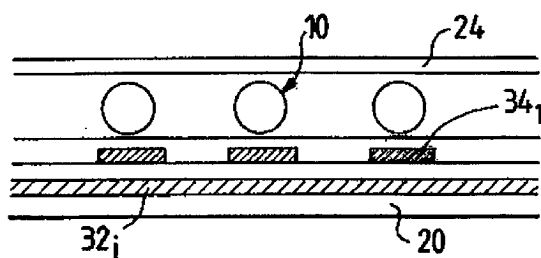


FIG. 4

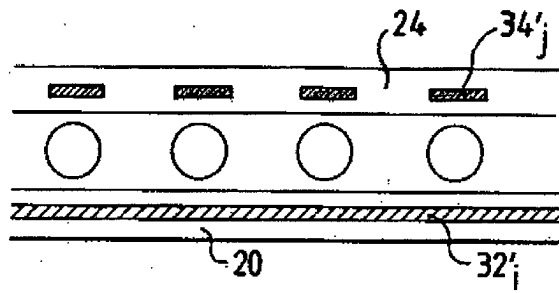


FIG. 5

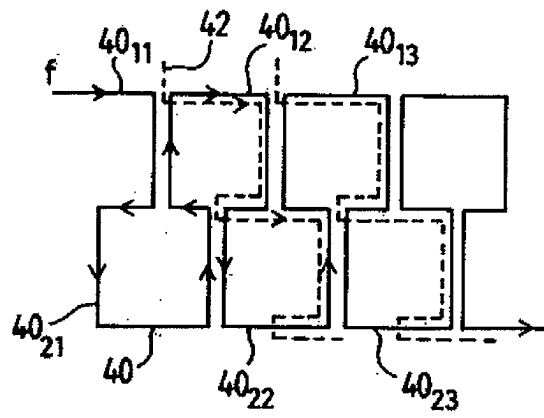


FIG. 6

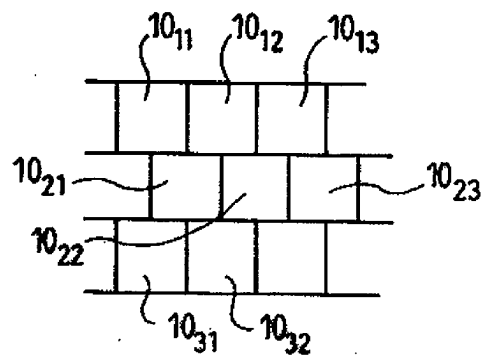
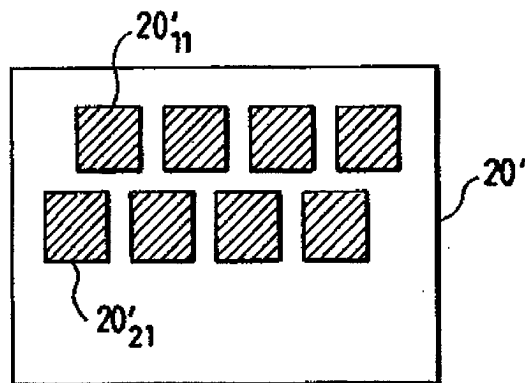
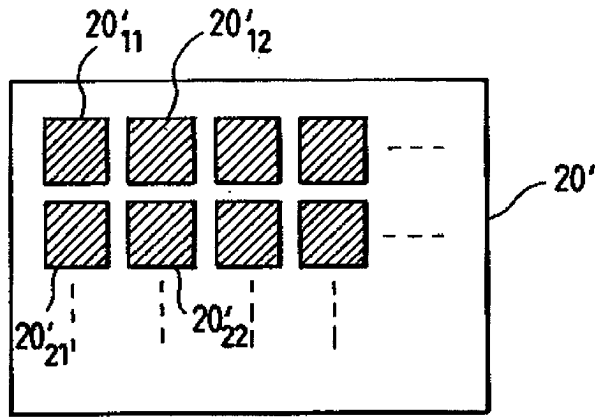


FIG. 6a





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 02 29 0315

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 633 488 A (KABUSHIKIGAISSYA KEIOU) 11 January 1995 (1995-01-11)	1,5,7-9	G09F9/37
Y	* column 4, line 1 - column 5, line 36; figures 1,2,4,5,17,22-24,33-35; examples 1-6 *	2,3,6	
X	--- PATENT ABSTRACTS OF JAPAN vol. 018, no. 376 (P-1770), 14 July 1994 (1994-07-14) -& JP 06 102830 A (HITACHI VLSI ENG CORP), 15 April 1994 (1994-04-15)	1,4	
Y	* abstract; figures 1,8-10,18,25 *	2,3,6	
Y	US 3 670 323 A (SOBEL ALAN ET AL) 13 June 1972 (1972-06-13)	2,3	
A	* column 1, line 50 - column 2, line 9 * * column 2, line 54 - line 71 * * column 5, line 60 - column 7, line 9 * * column 12, line 28 - line 67; figures 7,9,12 *	1,4-9	
Y	--- US 3 322 482 A (HARMON JAMES V) 30 May 1967 (1967-05-30)	6	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	* column 2, line 10 - column 5, line 20; figures 2-7 *	1-5,7-9	G09F
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 11 July 2002	Examiner Wahl, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 29 0315

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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11-07-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0633488 A	11-01-1995	JP 7146659 A	06-06-1995
		CN 1105127 A	12-07-1995
		EP 0633488 A1	11-01-1995
		CA 2126742 A1	06-01-1995
JP 06102830 A	15-04-1994	NONE	
US 3670323 A	13-06-1972	CA 947402 A1	14-05-1974
US 3322482 A	30-05-1967	NONE	