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(54) **METHOD OF ADDRESSING A MATRIX-ARRAY TYPE LIQUID CRYSTAL CELL**
VERFAHREN ZUM STEUERN EINER FLÜSSIGKRISTALLANSEIGEMATRIX
PROCEDE D'ADRESSAGE D'UNE CELLULE A CRISTAUX LIQUIDES DU TYPE A MATRICE

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(56) References cited:
DE-A- 3 501 982
GB-A- 2 173 336

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Description

The present invention relates to a method for addressing a matrix-type liquid crystal cell and the method has particular, although not exclusive, relevance to such cells as are employed within visual displays and the like.

One known method of addressing a matrix-array type liquid crystal cell is that disclosed in UK Patent Number GB 2,173,336B. In this method, the cell is treated as a matrix of orthogonal row and column electrodes. Waveforms are applied to both the rows and columns in order to selectively switch the individual elements into either the dark (non-light transmitting) state, or the light transmitting state.

To the column electrodes may be applied two types of data waveform: "on" or "unchanged". Synchronised to these waveforms are those waveforms which are applied to the row electrodes, these are termed "select", "non-select" and "blank". At any one time, only one row electrode has the "select" waveform applied to it, and at least one other row electrode has the "blank" waveform applied to it. All the remaining row electrodes have the "non-select" waveform applied thereto.

The scheme mentioned above operates in the following manner: Data waveforms are applied to the column electrodes in order to create the desired pattern on the row electrode to which the select waveform is applied. The arrangement is such that this electrode will previously have been blanked by application thereto of the blanking waveform. This has the effect of setting that row into the dark (or "off") state, regardless of whether it combines with an "on" or "unchanged" data waveform all of the elements of the display common to that electrode will be switched into the dark state, prior to the application to that row, of the select waveform.

Contemporaneously with the application of the data waveform, a row electrode has the blank waveform applied to it. It will be apparent to those skilled in the art that with any such system it is a requirement to maintain dc compensation, or charge balancing, that is both the "on" and "unchanged" data waveforms must have no dc component.

The system exemplified in GB 2,173,336B however suffers from the shortcomings that the response time of the liquid crystal material is slowed down if the blanking waveform is applied to a row electrode only shortly before the application of the select waveform to that same row electrode. This is because the magnitude of the blanking waveform is greater than that required to set the liquid crystal material into its dark state and therefore a degree of relaxation must ensue before the electrode addressing activity may occur. The disclosure in GB 2,173,336B does indicate generally that the duration and amplitude of blanking pulses can be concomitantly changed to suit specific requirements, but there is no indication that the expedient could have value in addressing the shortcomings identified above. Indeed, where the adverse effects on switching performance resulting from the occurrence of reverse voltage stimuli either immediately following or immediately preceding the switching stimulus are considered in GB 2,173,336B, the solution advocated involves the introduction of one or more gaps into the data pulse waveforms. The introduction of gaps into the data pulse waveforms is undesirable because (being of extremely short duration) they require the switching circuits and associated components to have extremely high reaction speed.

DE 3,501,982 describes another addressing technique, in which blanking pulses are applied simultaneously to both sets of electrodes; each individual blanking pulse being of smaller amplitude than the strobing (or select) pulse, but the combined effect of the two synchronised blanking pulses being such as to create, at the pixels, a voltage which exceeds that of the strobing (select) pulse.

It is thus an object of the present invention to provide an addressing scheme in which the slowing down of the liquid crystal response time is at least alleviated.

Thus according to the present invention there is provided a method of addressing a matrix-array type liquid crystal cell including ferroelectric liquid crystal material, the cell comprising a plurality of pixels which are defined by areas of overlap between members of a first set of electrodes on one side of the material and members of a second set of electrodes, oriented orthogonal to the first set, on the other side of the material; in which method the pixels of the array are addressed on a line-by-line basis after blanking, wherein unipolar blanking pulses are applied exclusively to the members of the first set of electrodes to effect blanking and wherein for selective addressing of the pixels, unipolar select pulses are applied serially and exclusively to the members of the first set of electrodes while charge-balanced bipolar data pulses are applied exclusively and in parallel to the members of the second set, the positive going parts of the data pulses being synchronised with the select pulses for one data significance and the negative going parts of the data pulses being synchronised with the select pulses for the other data significance, wherein the polarities of the select and blanking pulses are opposite and invariable and characterised in that reductions in the response time of said liquid crystal material to said selective addressing of the pixels when blanking pulses and select pulses are applied temporally adjacent one another are mitigated by the use of blanking pulses of magnitude Vs/n and duration mT, where V_s is the select pulse and n and m are arbitrary values where m is greater than or equal to n such that the amplitude of any given blanking pulse is less than that of any given select pulse.

Thus the present invention provides a method for addressing a matrix-array type liquid crystal cell whereby the potential for the response time of the liquid crystal material being slowed down is reduced by providing a blanking pulse whose amplitude and duration may be modified as desired, within working limits.

One embodiment of the present invention will now be described, by way of example only, with reference to the following drawings, of which,

Figure 1 illustrates schematically a conventional matrix-array type cell;
Figure 2 illustrates graphically the various waveforms which may be applied to row and column electrodes for both the prior art and the present invention:
Figure 3 illustrates schematically a comparison between the general form of a blanking waveform and a select waveform;
Figures 4 is a schematic illustration of the modified blanking waveform occurring at the cell in accordance with the present invention, and
Figure 5 illustrates a graph of applied voltage against time for a selected pixel.

By reference firstly to figure 1, it will be seen that a matrix-array type liquid crystal cell, shown generally as 2 comprises an array of overlapping orthogonal row 4 and column 6 electrodes between which is disposed liquid crystal material (not shown).

Referring now also to figure 2, the operation in terms of the addressing of the cell 2 will be described. It will be appreciated that the general principles of operation applicable to known liquid crystal displays will also be applicable to the display described in the present example. Therefore, the data signals which may be applied to the column electrodes 6 are the "unchanged" waveform 8 and the "on" waveform 10. The row electrode 4 waveforms, which are applied synchronous with the column electrode waveforms 8,10 are the "select" 12, "non-select" 14 and "blank" 16 waveforms. Figures 2(a), (b), (c) and (d) illustrate the resultant waveforms at the intersections of row and column electrodes 4,6 as a result of combining the selected waveforms applied thereto.

The method of addressing one particular pixel 3 within cell 2, which is defined by an area of overlap between a row electrode 4 and a column electrode 6 is as follows: Before any addressing of the cell 2 with display data may take place, the row 4 of which the one particular pixel 3 forms a part must first be set into the dark state state. This is achieved by applying a blanking waveform 16 thereto. This is necessary to ensure that the whole row 4 is set into a predetermined state from which display data addressing may take place.

The desired display data waveform 8 or 10, say 8, is applied to the desired column electrode 6 which intersects or overlies pixel 3. Simultaneously, the corresponding electrode 4 which overlies pixel 3 has applied thereto the select waveform 12. By reference particularly to figure 2(a) it will be seen that the combination of unchanged waveform 8 and select waveform 12 at pixel 3 creates a specific combined waveform. Similarly, if the on waveform 10 had been selected instead of the unchanged waveform 8, then the resulting waveform at pixel 3 would have been that which is shown in figure 2 (b).

In any event, at the same time as the row electrode 4 overlying pixel 3 is addressed as described above, the electrode for the next row which it is desired to address (although not necessarily the next row in the array) will receive blanking waveform 16 ready for addressing, as above.

It will be understood that the amplitude of the voltages shown in figure 2 as defined as follows: V_d is the voltage of the data waveform 8,10 and T is the time duration of a waveform having this voltage amplitude. Similarly V_s is the amplitude of the select waveform 12; V_b is the amplitude of the blanking waveform 16.

Whereas with the prior art displays a disadvantage results when the blanking waveform is applied to the electrodes for the next row only a few row addressing periods ahead of the select waveform because the response time of the liquid crystal is slowed down, and the temporal width, T, of the waveform must necessarily be increased to allow the display to function; by reference now also to figure 3; it will be seen that the present invention, as exemplified by the present embodiment, alleviates this problem by providing for the blanking waveform 16 to be applied as temporally adjacent to the select waveform 12 as desired, without slowing the response time of the liquid crystal.

This is achieved by modifying the shape of blanking pulse 16. This modification is achieved by a reduction in the amplitude of the blanking pulse 16 such that it is less than the amplitude, V_s, of the following select pulse 12. However, there is then preferably an extension of the duration of the blanking pulse 16 as compared with the duration, T, of this select pulse 12.

It is preferable, but not imperative that the areas defined by the select 12 and blanking pulses 16 are equal, although the area defined by the select pulse may never be less than that of the preceding blanking pulse.

The above is illustrated in figure 3 in where it will be seen that the blanking pulse 16 has an implitude V_s/n and duration mT as compared with select pulse 12 which has amplitude V_s and duration T. In this example m=n=2.

The reason for a reduction in blanking waveform 16 amplitude providing the advantage stated herebefore may be explained by reference also to figure 5. Figure 5 illustrates the switching characteristics of the cell 2 by plotting the voltage applied thereto against the time for which this voltage is applied. It is known to those skilled in the art that generally, the magnitude of the blanking pulse 16 is greater than is actually required in order to set each pixel 3 into the "dark" state. Because of this, then some relaxation period immediately subsequent to the application of the blanking pulse will be necessary before addressing takes place. Thus, by reducing the amplitude of the blanking waveform 16 in accordance with the present invention, yet still remaining within the switching boundary of figure 5, the need for a relaxation period may be obviated.

It will be understood that the limit of reduction of the blanking waveform 16 amplitude and temporal extension will be governed by the requirement that $V_s/n > V_d$.

In principle any values of n and m may be used, although integer values have been found convenient. There is no necessity for n and m to be equal but m must be greater than or equal to n.

If however n and m are chosen to be equal, it is preferable that values of greater than or equal to 2 are chosen; this is because a value of less than 2 would lead to the blanking waveform 16 amplitude and duration being such that it approaches that of Figure 1(a), which causes no switching. In this case the blanking waveform 16 would be ineffective.

Referring finally also to figure 4, an illustration is given of the general waveform which appears at pixel 3 when it is addressed with a blanking pulse 16 in accordance with the present invention. This figure illustrates the requirement $V_s/n>V_d$, because it can be seen that if the amplitude of the blanking pulse 16, V_s/n falls below V_d, then there will be some time during the blanking period when the voltage changes polarity, and this change in polarity may promote switching in the opposite direction away from the desired blank (or dark) state. Hence the limit $V_s/n > V_d$.

It will be appreciated that the amplitude of the blanking pulse 16 must be greater than or equal to that of the data pulses 8,10. This is so that during application of the blanking pulse 16 there is no excursion of the difference between blanking pulse 16 and either data pulse 8 or 10 to a polarity opposite that of blanking pulse 16.

Thus the present invention provides a method of addressing a matrix-array type liquid crystal cell having a modified blanking waveform whereby the response time of the liquid is maintained.

With the present invention, the number of lines of pixels between the application of the blanking pulse 16 and the select pulse 12 may be reduced to 8 or less.

It will be apparent to those skilled in the art that modifications and alterations may be afforded to the embodiment hereinbefore described whilst still remaining within the scope of the invention, such as the possibility of the blanking occurring in order to set elements into the light, rather than dark state.

Claims

1. A method of addressing a matrix-array type liquid crystal cell (2) including ferro electric liquid crystal material, the cell comprising a plurality of pixels (3) which are defined by areas of overlap between members of a first (4) set of electrodes on one side of the material and members of a second set (6) of electrodes, oriented orthogonal to the first set, on the other side of the material; in which method the pixels of the array are addressed on a line-by-line basis after blanking, wherein unipolar blanking pulses (16) are applied exclusively to the members of the first set (4) of electrodes to effect blanking and wherein for selective addressing of the pixels, unipolar select pulses (12) are applied serially and exclusively to the members of the first set (4) of electrodes while charge-balanced bipolar data pulses (8, 10) are applied exclusively and in parallel to the members of the second set, (6) the positive going parts of the data pulses being synchronised with the select pulses for one data significance and the negative going parts of the data pulses (8, 10) being synchronised with the select pulses (12) for the other data significance, wherein the polarities of the select (12) and blanking (16) pulses are opposite and invariable and characterised in that reductions in the response time of said liquid crystal material to said selective addressing of the pixels (3) when blanking pulses (16) and select pulses (12) are applied temporally adjacent one another are mitigated by the use of blanking pulses (16) of magnitude V_s/n and duration mT, where V_s is the select pulse (12) voltage, T is the duration of the select pulse (12) and n and m are arbitrary values where m is greater than or equal to n such that the amplitude of any given blanking pulse (16) is less than that of any given select pulse (12).

2. A method according to claim 1 wherein n and m are equal values such that charge balancing is maintained for the individual members of the first set (4) of electrodes by the areas defined by the select (12) and blanking (16) pulses being equal.

3. A method according to claim 1 or claim 2 wherein n and m are integer values.

4. A method according to claim 3 where n and m have value 2.

5. A method according to claim 1 wherein m is greater than n.

6. A method according to claim 5 wherein n and m are integer values.

7. A method according to any one of the proceeding claims wherein, for any given line of pixels (3) within the array, the blanking pulse (16) is applied thereto prior to the application of the select pulse (12), the number of lines between the blanking (16) and select (12) pulses being less than or equal to 8.

Patentansprüche

1. Verfahren zum Adressieren einer Flüssigkristallzel-

le (2) vom Matrix-Gruppen-Typ, die ferroelektrisches Flüssigkristallmaterial enthält, wobei die Zelle eine Vielzahl von Pixeln (3) umfaßt, die durch sich überlappende Bereiche zwischen Elementen einer ersten Gruppe (4) von Elektroden auf einer Seite des Materials und Elementen einer zweiten Gruppe (6) von Elektroden, die orthogonal zu der ersten Gruppe auf der anderen Seite des Materials orientiert sind, definiert werden; wobei die Pixel der Gruppe auf einer Zeile-für-Zeile-Basis nach Austastung adressiert werden, wobei unipolare Austastimpulse (16) ausschließlich den Elementen der ersten Gruppe (4) von Elektroden zugeführt werden, um eine Austastung zu bewirken, und wobei zum wahlweisen Adressieren der Pixel unipolare Auswahlimpulse (12) seriell und ausschließlich den Elementen der ersten Gruppe (4) von Elektroden zugeführt werden, während in der Ladung ausgeglichene bipolare Datenimpulse (8, 10) ausschließlich und parallel den Elementen der zweiten Gruppe (6) zugeführt werden, wobei die positiv verlaufenden Teile der Datenimpulse mit den Auswahl impulsen für eine Datensignifikanz synchronisiert und die negativ verlaufenden Teile der Datenimpulse (8, 10) mit den Auswahlimpulsen (12) für die andere Datensignifikanz synchronisiert werden, wobei die Polaritäten der Auswahlimpulse (12) und der Austastimpulse (16) entgegengesetzt und unveränderbar sind, dadurch gekennzeichnet, daß Verminderungen in der Ansprechzeit des Flüssigkristallmaterials auf die wahlweise Adressierung der Pixel (3), wenn Austastimpulse (16) und Auswahl impulse (12) einander zeitlich benachbart zugeführt werden, durch die Verwendung von Austastimpulsen (16) mit der Größe V_s/n und der Dauer mT abgeschwächt werden, worin V_s die Spannung des Auswahlimpulses (12), T die Dauer des Auswahlimpulses (12) und m willkürliche Werte sind, und worin m größer oder gleich n ist, so daß die Amplitude eines gegebenen Austastimpulses (16) kleiner als die eines gegebenen Auswahlimpulses (12) ist.

2. Verfahren nach Anspruch 1, bei dem n und m gleiche Werte haben, so daß der Ladungsausgleich für die einzelnen Elemente der ersten Gruppe (4) von Elektroden durch die Bereiche aufrechterhalten wird, die durch die Auswahlimpulse (12) und die Austastimpulse (16) definiert werden, die gleich sind.

3. Verfahren nach Anspruch 1 oder 2, bei dem n und m ganzzahlige Werte sind.

4. Verfahren nach Anspruch 3, bei dem n und m den Wert 2 haben.

5. Verfahren nach Anspruch 1, bei dem m größer als n ist.

6. Verfahren nach Anspruch 5, bei dem n und m ganzzahlige Werte sind.

7. Verfahren nach einem der vorhergehenden Ansprüche, bei dem für eine gegebene Zeile von Pixeln (3) innerhalb der Gruppe der Austastimpuls (16) vor der Zuführung des Auswahlimpulses (18) zugeführt wird, wobei die Zahl der Zeilen zwischen dem Austastimpuls (16) und dem Auswahlimpuls (12) kleiner als oder gleich 8 ist.

Revendications

1. Un procédé d'adressage d'une cellule (2) à cristaux liquides du type à réseau matriciel incluant une matière à cristaux liquide ferroélectrique, la cellule comprenant une série de pixels (3) qui sont définis par des zones de recouvrement entre des éléments d'un premier ensemble (4) d'électrodes agencé sur un premier côté de la matière et des éléments d'un deuxième ensemble (6) d'électrodes, orienté orthogonalement au premier ensemble et agencé sur l'autre côté de la matière; procédé dans lequel les pixels du réseau sont adressés sur une base ligne par ligne après effacement, des impulsions unipolaires (16) d'effacement étant appliquées exclusivement aux éléments du premier ensemble (4) d'électrodes pour effectuer un effacement et des impulsions unipolaires (12) de sélection étant appliquées sériellement et exclusivement, pour un adressage sélectif des pixels, aux éléments du premier ensemble (4) d'électrodes tandis que des impulsions bipolaires, équilibrées en charge (8, 10), de données sont appliquées exclusivement et en parallèle aux éléments du deuxième ensemble (6), les parties devenant positives des impulsions de données étant synchronisées avec les impulsions de sélection pour une première signification de données et les parties devenant négatives des impulsions (8, 10) de données étant synchronisées avec les impulsions de sélection (12) pour l'autre signification de données, les polarités des impulsions de sélection (12) et d'effacement (16) étant opposées et invariables, et caractérisé en ce que des réductions du temps de réponse de ladite matière cristalline liquide audit adressage sélectif des pixels (3) lorsque des impulsions d'effacement (16) et des impulsions de sélection (12) sont appliquées temporairement l'une près de l'autre sont atténuées en utilisant des impulsions d'effacement (16) d'une amplitude V_s/n et d'une durée mT, où V_s est la tension d'impulsion (12) de sélection, T est la durée de l'impulsion (12) de sélection, et n et m sont des valeurs arbitraires, m étant supérieur ou égal à n de sorte que l'amplitude d'une impulsion donnée quelconque (16) d'effacement est inférieure à celle d'une impulsion donnée quelconque (12) de sélection.

2. Un procédé selon la revendication 1 dans lequel n et m sont des valeurs égales de façon que l'équilibrage de charge soit maintenu pour les éléments individuels du premier ensemble (4) d'électrodes dès lors que les zones définies par les impulsions de sélection (12) et d'effacement (16) sont égales.

3. Un procédé selon la revendication 1 ou la revendication 2 dans lequel n et m sont des valeurs entières.

4. Un procédé selon la revendication 3 dans lequel la valeur de n et de m est de 2.

5. Un procédé selon la revendication dans lequel m est supérieur à n.

6. Un procédé selon la revendication 5 dans lequel n et m sont des valeurs entières.

7. Un procédé selon l'une quelconque des revendications précédentes dans lequel l'impulsion d'effacement (16) est appliquée, à une ligne donnée quelconque de pixels (3) du réseau, avant que l'impulsion (12) de sélection n'y soit appliquée, le nombre de lignes comprises entre les impulsions d'effacement (16) et les impulsions de sélection (12) étant inférieur ou égal à 8.

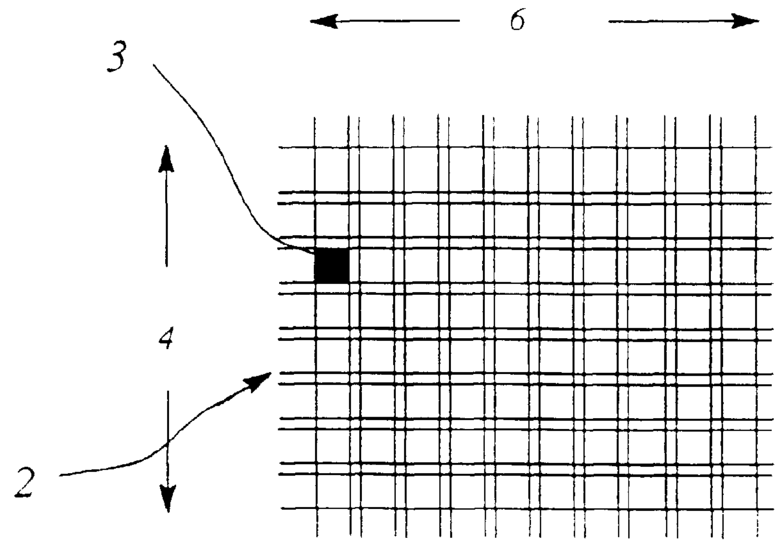
6
3
4
2

Fig.1.

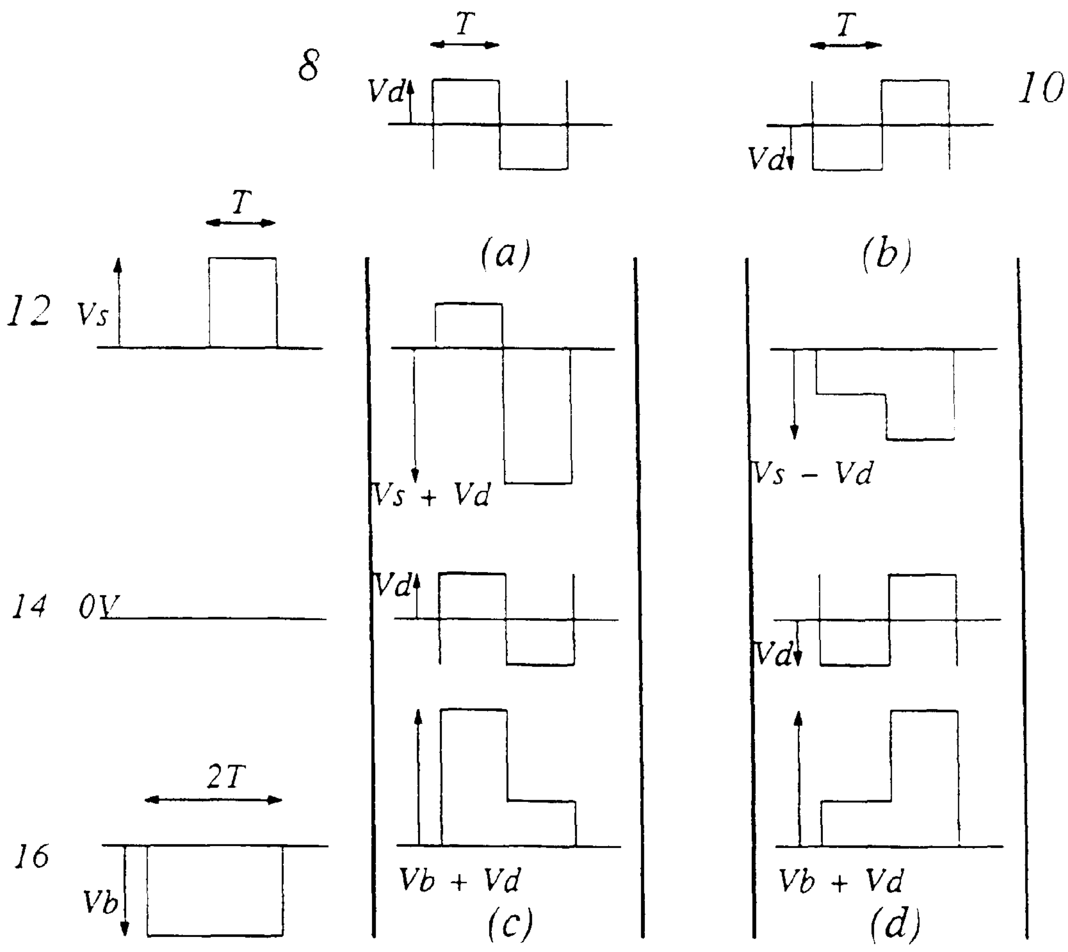
8
T
Vd
T
10
Vd
T
(a)
(b)
12 Vs
Vs + Vd
Vs − Vd
14 0V
Vd
Vd
2T
16
Vb
Vb + Vd
(c)
Vb + Vd
(d)

Fig.2.

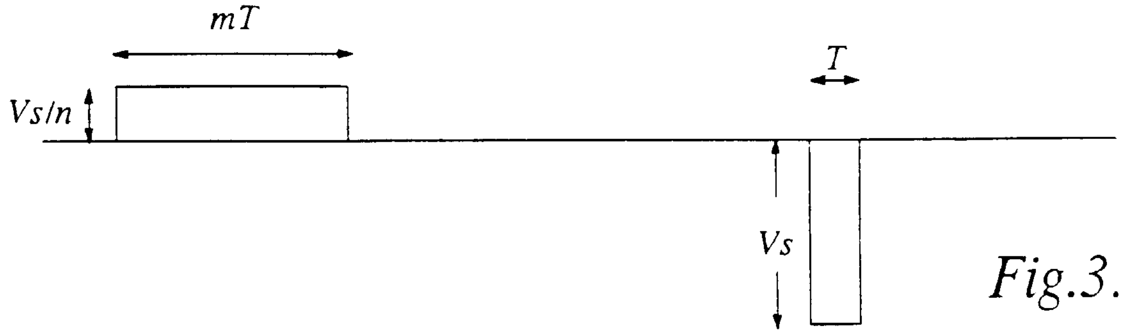

Fig.3.

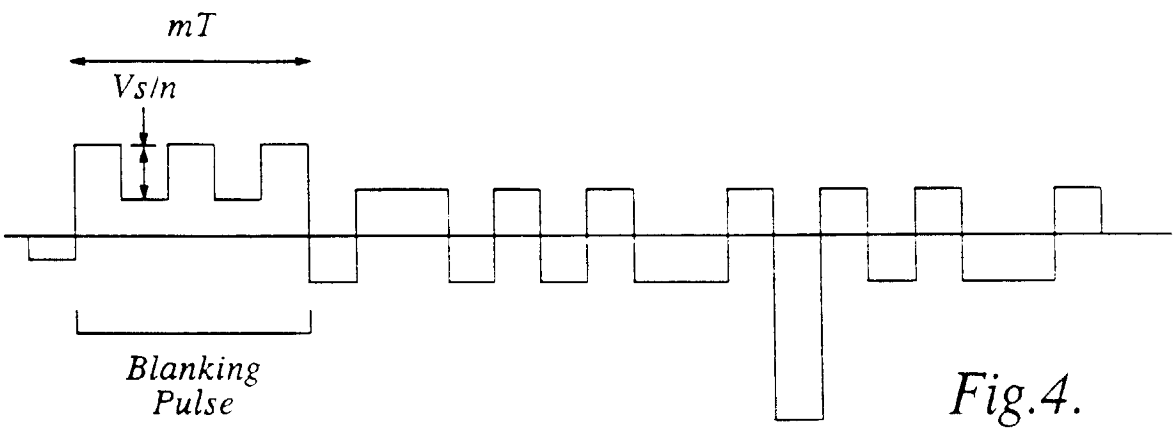

Fig.4.

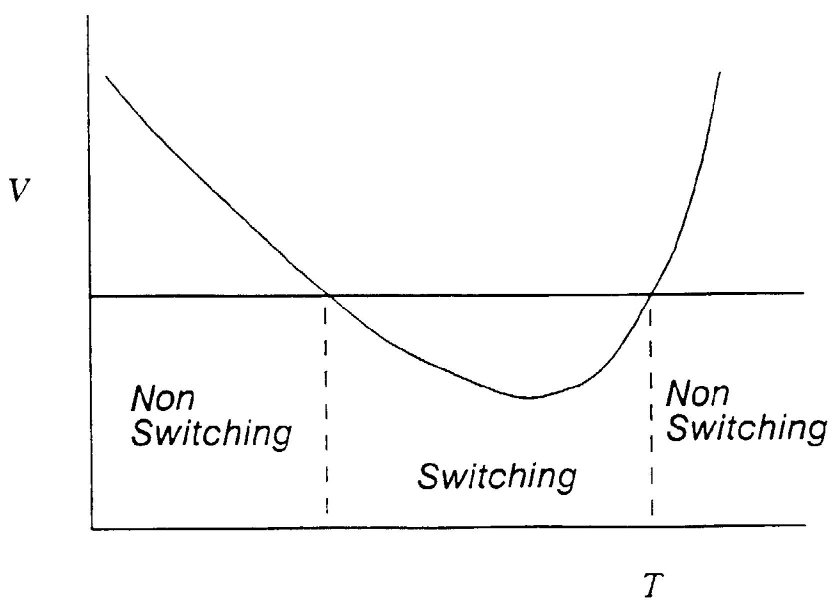

Fig.5.