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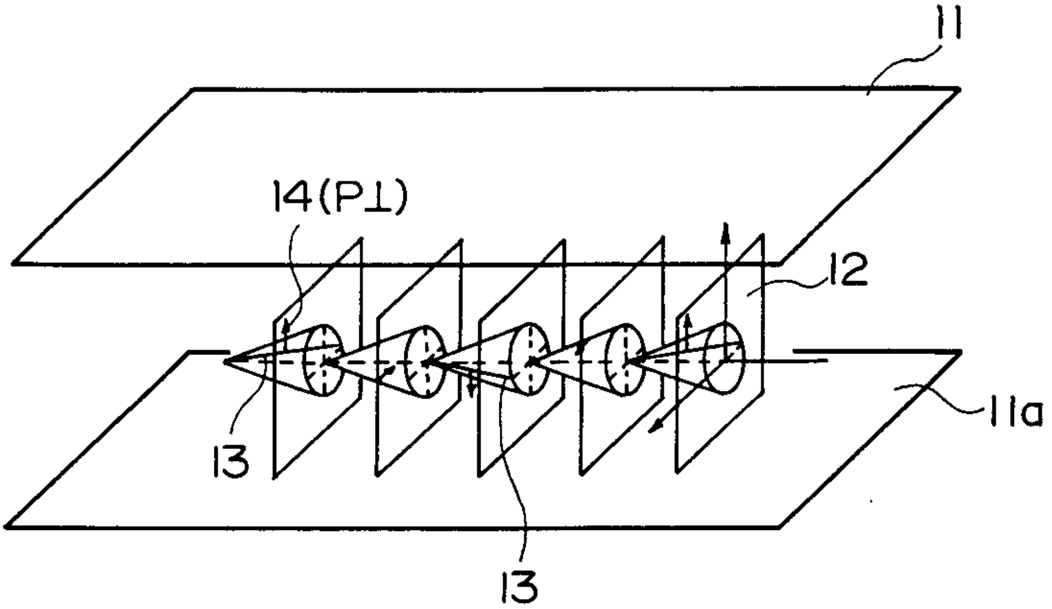

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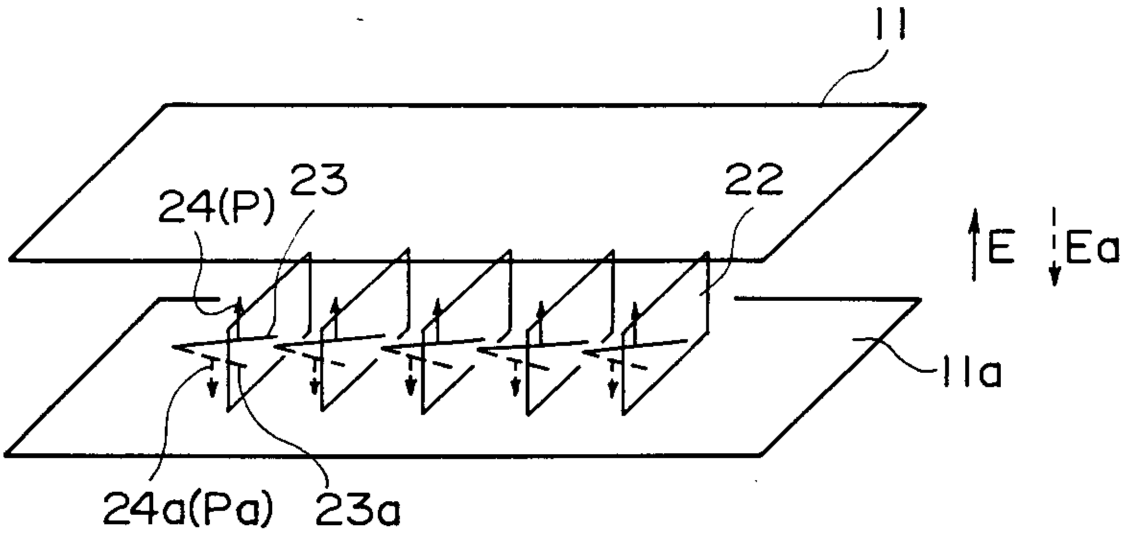

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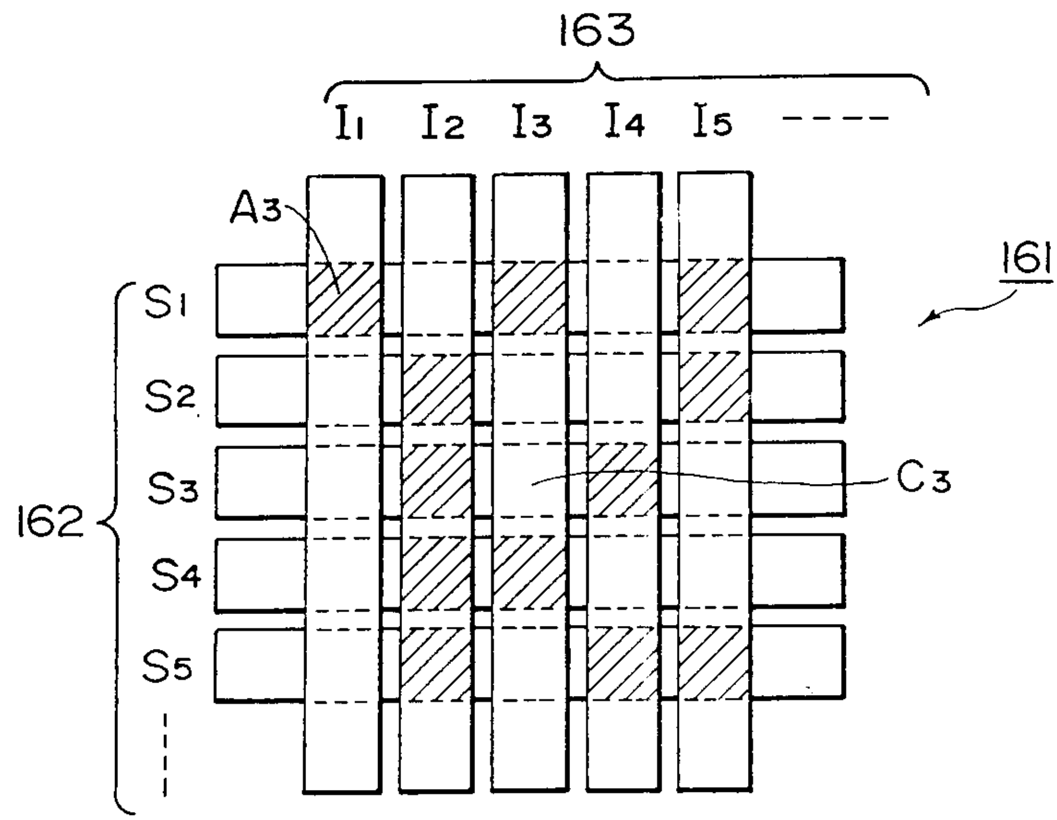


FIG. 3A

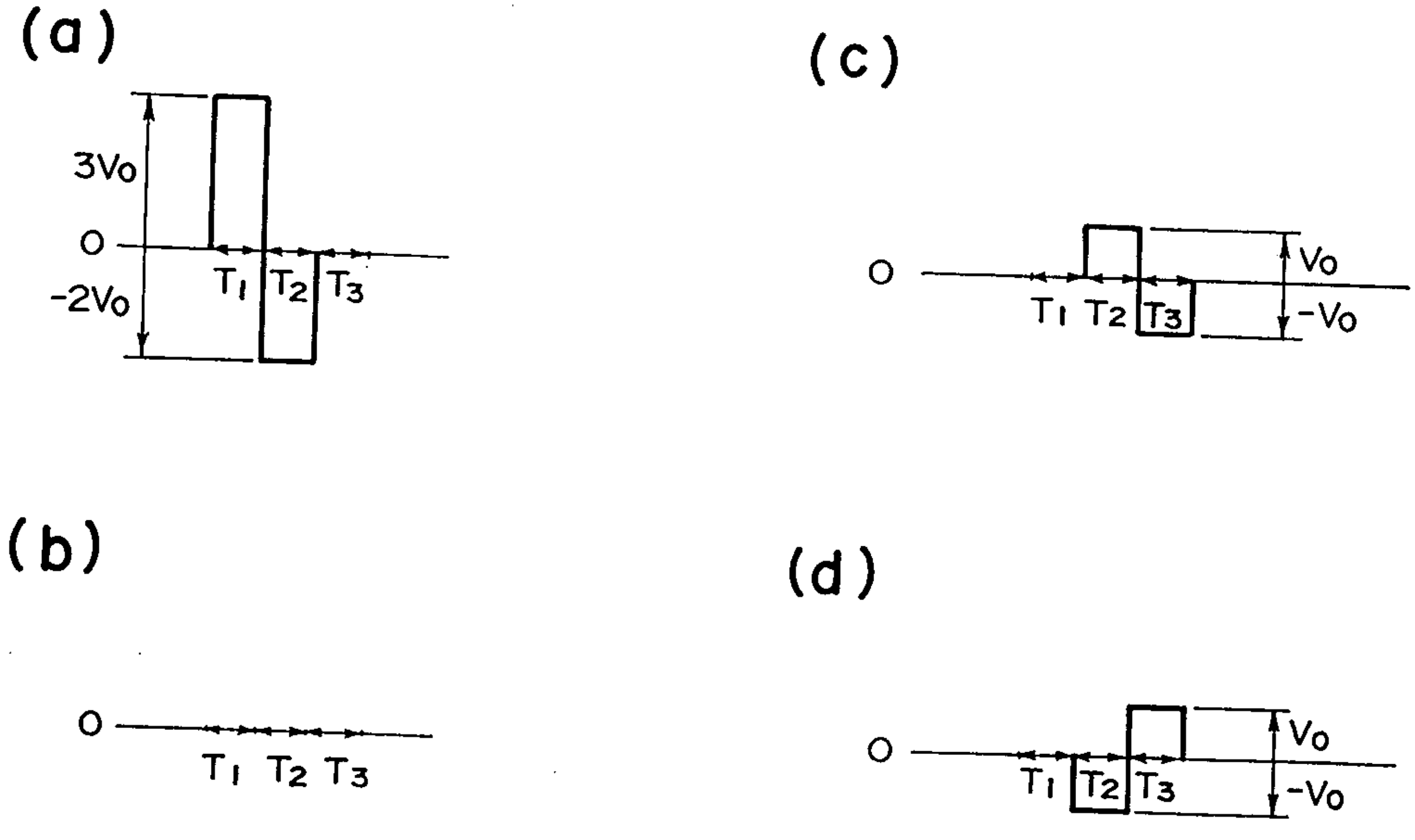
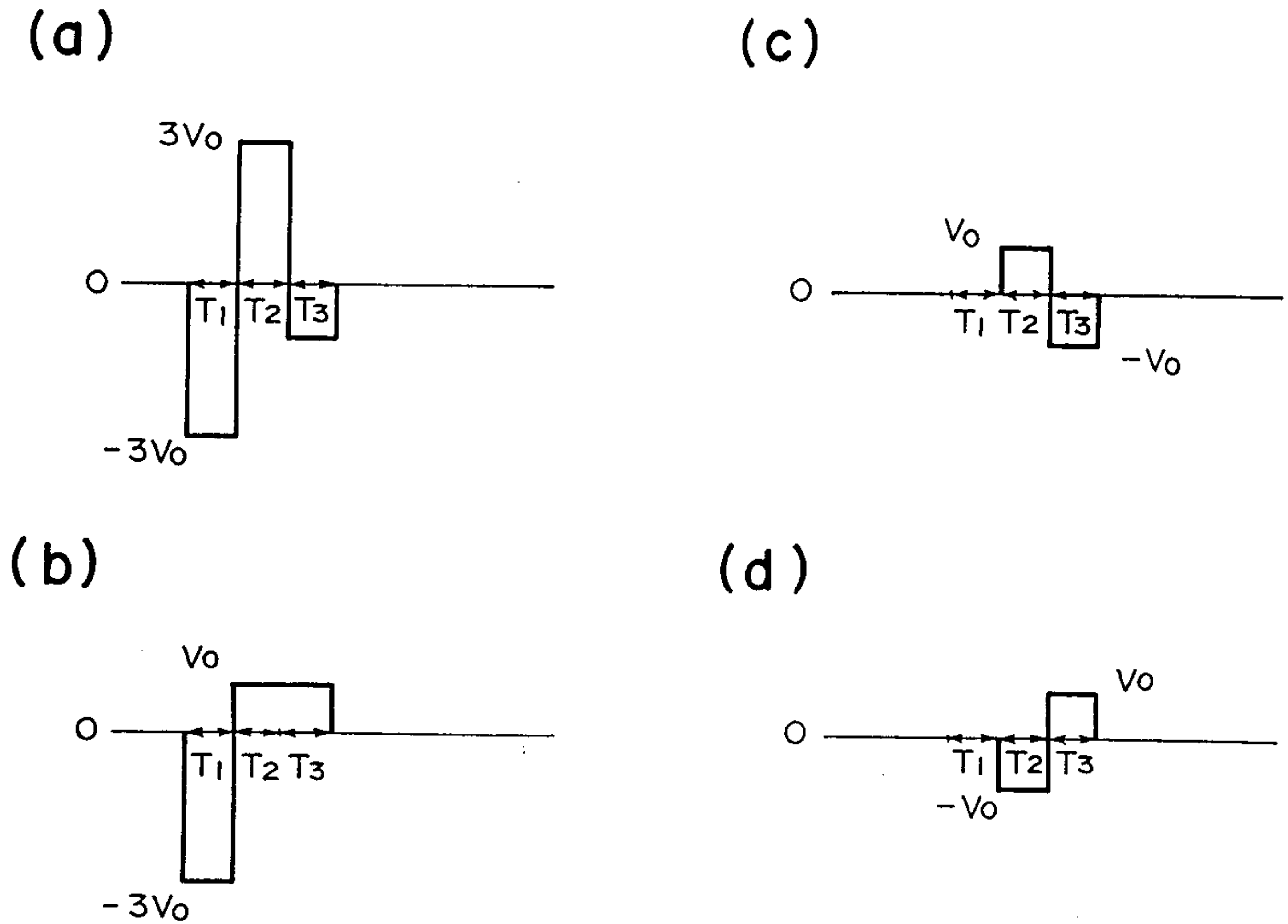


FIG. 3B


(a)
3Vo
0
T1 T2 T3
-3Vo
(b)
Vo
0
T1 T2 T3
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(c)
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-Vo
(d)
Vo
0
T1 T2 T3
-Vo

FIG. 3C

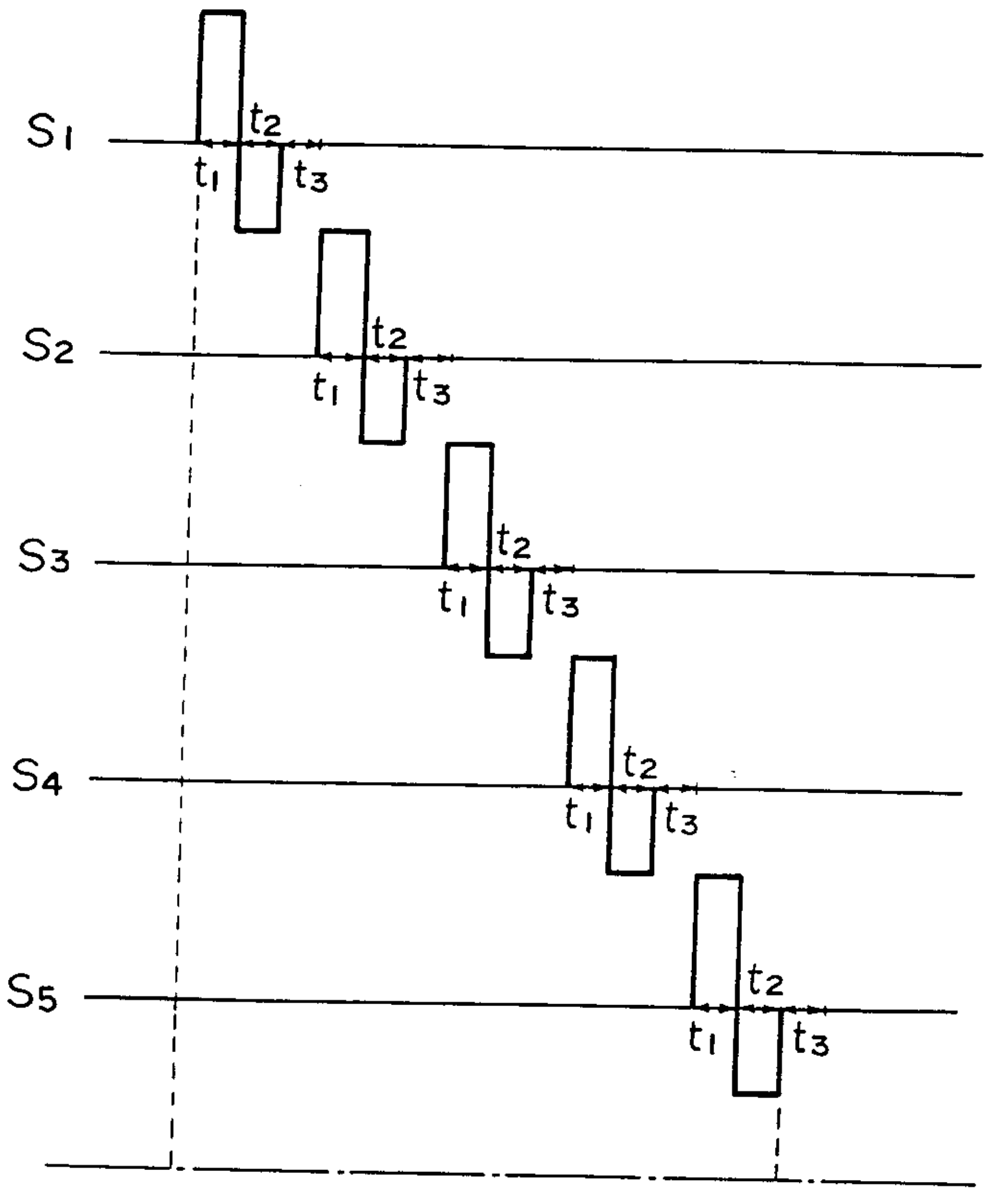

FIG. 4A

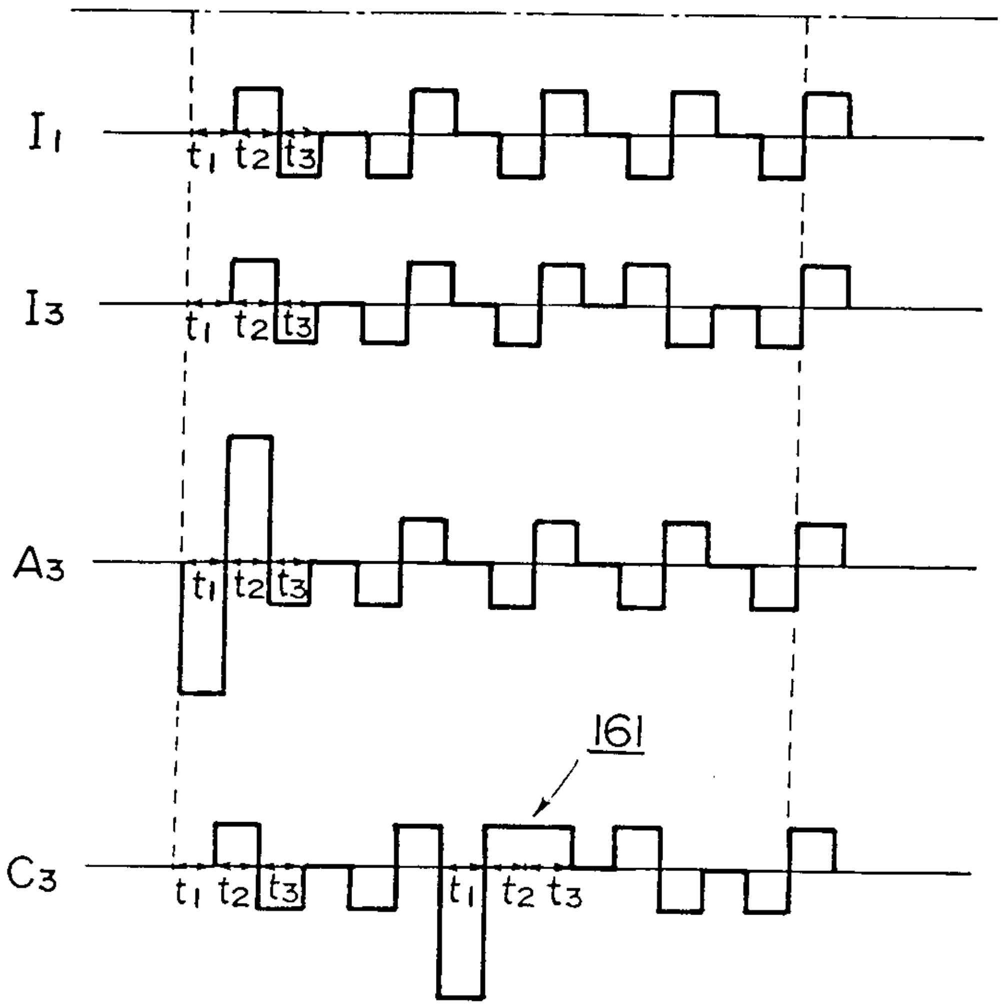

FIG. 4B

OPTICAL MODULATION DEVICE AND DRIVING METHOD THEREFOR

BACKGROUND OF THE INVENTION

The present invention relates to an optical modulation device, e.g., a display device, an optical shutter array, etc., and to a driving method therefor.

Hitherto, liquid crystal display devices are well known, which comprise scanning lines (or electrodes) and data lines (or electrodes) arranged in a matrix manner, and a liquid crystal compound is filled between the lines to form a plurality of picture elements thereby to display images or information. These display devices employ a time-sharing driving method which comprises the steps of selectively applying scanning selection signals sequentially and cyclically to the scanning lines, and, in parallel therewith selectively applying predetermined information signals to the group of signal electrodes in synchronism with the scanning selection signals. However, these display devices and the driving method therefor have a serious drawback as will be described below.

Namely, the drawback is that it is difficult to obtain a high density of picture elements or a large image area. Because of relatively high response speed and low power dissipation, among prior art liquid crystals, most of liquid crystals which have been put into practice as display devices are TN (twisted nematic) type liquid crystals, as shown in "Voltage-Dependent Optical Activity of a Twisted Nematic Liquid Crystal" by M. Schadt and W. Helfrich, Applied Physics Letters Vol. 18, No. 4 (Feb. 15, 1971) pp. 127-128. In the liquid crystals of this type, molecules of nematic liquid crystal which show positive dielectric anisotropy under no application of an electric field form a structure twisted in the thickness direction of liquid crystal layers (helical structure), and molecules of these liquid crystals are aligned or oriented parallel to each other in the surfaces of both electrodes. On the other hand, nematic liquid crystals which show positive dielectric anisotropy under application of an electric field are oriented or aligned in the direction of the electric field. Thus, they can cause optical modulation. When display devices of a matrix electrode arrangement are designed using liquid crystals of this type, a voltage higher than a threshold level required for aligning liquid crystal molecules in the direction perpendicular to electrode surfaces is applied to areas (selected points) where scanning lines and data lines are selected at a time, whereas a voltage is not applied to areas (non-selected points) where scanning lines and data lines are not selected and, accordingly, the liquid crystal molecules are stably aligned parallel to the electrode surfaces. When linear polarizers arranged in a cross-nicol relationship, i.e., with their polarizing axes being substantially perpendicular to each other, are arranged on the upper and lower sides of a liquid crystal cell thus formed, a light does not transmit at selected points while it transmits at non-selected points. Thus, the liquid crystal cell can function as an image device.

However, when a matrix electrode structure is constituted, a certain electric field is applied to regions where scanning lines are selected and data lines are not selected or regions where scanning lines are not selected and data lines are selected (which regions are so called "half-selected points"). If the difference between a voltage applied to the selected points and a voltage applied to the half-selected points is sufficiently large, and a voltage threshold level required for allowing liquid crystal molecules to be aligned or oriented perpendicular to an electric field is set to a value therebetween, the display device normally operates. However, in fact, according as the number (N) of scanning lines increases, a time (duty ratio) during which an effective electric field is applied to one selected point when a whole image area (corresponding to one frame) is scanned decreases with a ratio of 1/N. For this reason, the larger the number of scanning lines are, the smaller is the voltage difference as an effective value applied to a selected point and non-selected points when scanning is repeatedly effected. As a result, this leads to unavoidable drawbacks of lowering of image contrast or occurrence of crosstalk. These phenomena result in problems that cannot be essentially avoided, which apepar when a liquid crystal not having bistability (which shows a stable state where liquid crystal molecules are oriented or aligned in a horizontal direction with respect to electrode surfaces, but are oriented in a vertical direction only when an electric field is effectively applied) is driven, i.e., repeatedly scanned, by making use of time storage effect. To overcome these drawbacks, the voltage averaging method, the two-frequency driving method, the multiple matrix method, etc., has already been proposed. However, any method is not sufficient to overcome the above-mentioned drawbacks. As a result, it is the present state that the development of large image area or high packaging density in respect to display elements is delayed because of the fact that it is difficult to sufficiently increase the number of scanning lines.

Meanwhile, turning to the field of a printer, as means for obtaining a hard copy in response to input electric signals, a Laser Beam Printer (LBP) providing electric image signals to electrophotographic charging member in the form of lights is the most excellent in view of density of a picture element and a printing speed.

However, the LBP has drawbacks as follows:

1) It becomes large in apparatus size.

2) It has high speed mechanically movable parts such as a polygon scanner, resulting in noise and requirement for strict mechanical precision, etc.

In order to eliminate drawbacks stated above, a liquid crystal shutter-array is proposed as a device for changing electric signals to optical signals. When picture element signals are provided with a liquid crystal shutter-array, however, 2000 signal generators are required, for instance, for writing picture element signals into a length of 200 mm in a ratio of 10 dots/mm. Accordingly, in order to independently feed signals to respective signal generators, lead lines for feeding electric signals are required to be provided to all the respective signal generators, and the production has become difficult.

In view of the above, another attempt is made to apply one line of image signals in a time-sharing manner with signal generators divided into a plurality of lines.

With this attempt, signal feeding electrodes can be common to the plurality of signal generators, thereby enabling to remarkably decrease the number of lead wires. However, if the number (N) of lines is increased while using a liquid crystal showing no bistability as usually practiced, a signal "ON" time is substantially reduced to 1/N. This results in difficulties that light quantity obtained on a photoconductive member is decreased, and a crosstalk occurs.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, there is provided a driving method for an optical modulation device having a plurality of electro-optical elements arranged in a matrix and comprising scanning lines, data lines spaced apart from and intersecting with the scanning lines, and a ferroelectric liquid crystal, assuming a first orientation state or a second orientation state depending on the direction of an electric field applied thereto, interposed between the scanning lines and the data lines, each of the intersections between the scanning lines and the data lines forming one of said plurality of electro-optical elements; said driving method comprising:

applying a scanning selection signal to the scanning lines sequentially, said scanning selection signal comprising a voltage of one polarity and a voltage of the other polarity respectively with respect to a voltage applied to a non-selected scanning line; and

applying information signals to the data lines, said information signals comprising a voltage signal providing in combination with said scanning voltage of said one polarity a voltage exceeding a first threshold voltage of the ferroelectric liquid crystal applied to the electro-optical elements on the selected scanning line, a voltage signal providing in combination with said scanning voltage of said other polarity a voltage exceeding a second threshold voltage of the ferroelectric liquid crystal applied to a selected electro-optical element on the selected scanning line, and a voltage not exceeding the first or second threshold voltages at a non-selected electro-optical element on the same scanning line, and an auxiliary signal applied to the data lines in between the application of information signals to the data lines;

said auxiliary signal providing an inversion preventing voltage in combination with the voltage applied to the non-selected scanning line before the application period of a voltage of a particular polarity reaches a period beyond which the first or second orientation state of an electro-optical element on the non-selected scanning line is unintentionally inverted due to said voltage of said particular polarity and less than the relevant threshold voltage, the inversion preventing voltage being a zero voltage or having a polarity opposite to said particular polarity.

In accordance with another aspect of the invention, there is provided an optical modulation device having a plurality of electro-optical elements arranged in a matrix and comprising scanning lines, data lines spaced apart from and intersecting with the scanning lines, and a ferroelectric liquid crystal, assuming a first orientation state or a second orientation state depending on the direction of an electric field applied thereto, interposed between the scanning lines and the data lines, each of the intersections between the scanning lines and the data lines forming one of said plurality of electro-optical elements; said optical modulation device comprising means for:

applying a scanning selection signal to the scanning lines sequentially, said scanning selection signal comprising a voltage of one polarity and a voltage of the other polarity respectively with respect to a voltage applied to a non-selected scanning line; and

applying information signals to the data lines; said information signals comprising a voltage signal providing in combination with said scanning voltage signal of said one polarity a voltage exceeding a first threshold voltage of the ferroelectric liquid crystal applied to the electro-optical elements on the selected scanning line, a voltage signal providing in combination with said scanning voltage of said other polarity a voltage exceeding a second threshold voltage of the ferroelectric liquid crystal applied to a selected electro-optical element on the selected scanning line, and a voltage not exceeding the first or second threshold voltages at a non-selected electro-optical element on the same scanning line, and an auxiliary signal applied to the data lines in between the application of information signals to the data lines;

said auxiliary signal providing an inversion preventing voltage in combination with the voltage applied to the non-selected scanning line before the application period of a voltage of a particular polarity reaches a period beyond which the first or second orientation state of an electro-optical element on the non-selected scanning line is unintentionally inverted due to said voltage of said particular polarity and less than the relevant threshold voltage, the inversion preventing voltage being a zero voltage or having a polarity opposite to said particular polarity.

A specific embodiment of the invention will now be described by way of example with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 are schematic perspective views illustrating the basic operation principle of a liquid crystal device used in the present invention,

Figure 3A is a plan view of an electrode arrangement used in an embodiment of the present invention.

Figures 3B (a) - (d) illustrate waveforms of electric signals applied to electrodes,

Figures 3C (a) - (d) illustrate voltage wave-forms applied across the liquid crystal, and

Figures 4A and 4B in combination show voltage waveforms applied in time series.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As an optical modulation material used in a driving method according to the present invention, a (ferro-electric liquid crystal) material which shows either a first optically stable state or a second optically stable state depending upon an electric field applied thereto, i.e., has bistability with respect to the applied electric field,

[~~particularly a liquid crystal having the above-mentioned property, may be~~] is used.

Preferable liquid crystals having bistability which can be used in the driving method according to the present invention are chiral smectic C (SmC*)- or H (SmH*)-phase liquid crystals having ferroelectricity. In addition, liquid crystals showing chiral smectic I phase (SmI*), J phase (SmJ*), G phase (SmG*), F phase (SmF*) or K phase (SmK*) may also be used. These ferroelectric liquid crystals are described in, e.g., "LE JOURNAL DE PHYSIQUE LETTERS" 36 (L-69), 1975 "Ferroelectric Liquid Crystals"; "Applied Physics Letters" 36 (11) 1980, "Submicro Second Bistable Electrooptic Switching in Liquid Crystals", "Solid State Physics" 16 (141), 1981 "Liquid Crystal", etc. Ferroelectric liquid crystals disclosed in these publications may be used in the present invention.

More particularly, examples of ferroelectric liquid crystal compound usable in the method according to the present invention include decyloxybenzylidene-p'-amino-2-methylbutyl cinnamate (DOBAMBC), hexyloxybenzylidene-p'-amino-2-chloropropyl cinnamate (HOBACPC), 4-o-(2-methyl)-butylresorcilidene-4'-octylaniline (MBRA8), etc.

When a device is constituted using these materials, the device may be supported with a block of copper, etc., in which a heater is embedded in order to realize a temperature condition where the liquid crystal compounds assume a smectic phase.

Referring to Figure 1, there is schematically shown an example of a ferroelectric liquid crystal cell for explanation of the operation thereof. Reference numerals 11 and 11a denote base plates (glass plates) on which a transparent electrode of, e.g., In_2O_3, SnO_2, ITO (Indium-Tin Oxide), etc., is disposed, respectively. A liquid crystal of an SmC*- or SmH*-phase in which liquid crystal molecular layers 12 are oriented perpendicular to surfaces of the glass plates is hermetically disposed therebetween. A full line 13 shows liquid crystal molecules. Each liquid crystal molecule 13 has a dipole moment ($P\perp$) 14 in a direction perpendicular to the axis thereof. When a voltage higher than a certain threshold level is applied between electrodes formed on the base plates 11 and 11a, a helical structure of the liquid crystal molecule 13 is loosened a unwound to change the alignment direction of respective liquid crystal molecules 13 so that the dipole moments ($P\perp$) 14 are all directed in the direction of the electric field. The liquid crystal molecules 13 have an elongated shape and show refractive anisotropy between the long axis and the short axis thereof. Accordingly, it is easily understood that when, for instance, polarizers arranged in a cross nicol relationship, i.e., with their polarizing directions crossing each other, are disposed on the upper and the lower surfaces of the glass plates, the liquid crystal cell thus arranged functions as a liquid crystal optical modulation device, of which optical characteristics vary depending upon the polarity of an applied voltage. Further, when the thickness of the liquid crystal cell is sufficiently thin (e.g., 1 μ), the helical structure of the liquid crystal molecules is loosened even in the absence of an electric field whereby the dipole moment assumes either of the two states, i.e., P in an upper direction 24 or Pa in a lower direction 24a as shown in Figure 2. When electric field E or Ea higher than a certain threshold level and different from each other in polarity as shown in Figure 2 is applied to a cell having the above-mentioned characteristics, the dipole moment is directed either in the upper direction 24 or in the lower direction 24a depending on the vector of the electric field E or Ea. In correspondence with this, the liquid crystal molecules are oriented in either of a first stable state 23 and a second stable state 23a.

When the above-mentioned ferroelectric liquid crystal is used as an optical modulation element, it is possible to obtain two advantages. First is that the response speed is quite fast. Second is that the orientation of the liquid crystal shows bistability.

The second advantage will be further explained, e.g., with reference to Figure 2. When the electric field E is applied to the liquid crystal molecules, they are oriented in the first stable state 23. This state is kept stable even if the electric field is removed. On the other hand, when the electric field Ea of which direction is opposite to that of the electric field E is applied thereto, the liquid crystal molecules are oriented to the second stable state 23a, whereby the directions of molecules are changed. This state is also kept stable even if the electric field is removed. Further, as long as the magnitude of the electric field E being applied is not above a certain threshold value, the liquid crystal molecules are placed in the respective orientation states. In order to effectively realize high response speed and bistability, it is preferable that the thickness of the cell is as thin as possible and generally 0.5 to 20 μ, particularly 1 to 5 μ. A liquid crystal-electrooptical device having a matrix electrode structure in which the ferroelectric liquid crystal of this kind is used is proposed, e.g., in the specification of U.S. Patent No. 4367924 by Clark and Lagerwall.

Microscopic mechanism of switching due to electric field of a ferroelectric liquid crystal having bistability has not been fully clarified. Generally speaking, however, the ferroelectric liquid crystal can retain its stable state semi-permanently, if it has been switched or oriented to the stable state by application of a strong electric field for a predetermined time and is left standing under absolutely no electric field. However, when a reverse polarity of an electric field is applied to the liquid crystal for a long period of time, even if the electric field is such a weak field (corresponding to a voltage below V_{th} in the previous example) that the stable state of the liquid crystal is not switched in a predetermined time for writing, the liquid crystal can change its stable state to the other one, whereby correct display or modulation of information cannot be accomplished. We have recognized that the liability of such switching or reversal of oriented states under a long term application of a weak electric field is affected by a material and roughness of a base plate contacting the liquid crystal and the kind of the liquid crystal, but have not clarified the effects quantitatively. We have confirmed a tendency that a monoaxial treatment of the base plate such as rubbing or oblique or tilt vapor deposition of SiO, etc., increases the liability of the above-mentioned reversal of oriented states. The tendency is manifested at a higher temperature compared to a lower temperature.

Anyway, in order to accomplish correct display or modulation of information, it is advisable that one direction of electric field is prevented from being applied to the liquid crystal for a long time.

Figure 3 (inclusive of Figures 3A, 3B and 3C) and Figure 4 (combination of Figures 4A and 4B) illustrate a driving mode for an optical modulation device comprising: a writing step comprising a first phase wherein a voltage orienting the bistable optical modulation material to the first stable state is applied to picture elements on selected scanning lines among said plurality of picture elements, and a second phase wherein a voltage orienting the bistable optical modulation material to the second stable state is applied to a selected picture element among the picture elements on the selected scanning lines to write in the selected picture element, and a step of applying an alternating current to the written selected picture element.

A further preferred example of this driving mode is used for driving a liquid crystal device which comprises scanning lines sequentially and periodically selected based on scanning signals, data lines facing the scanning lines and selected based on predetermined information signals, and a bistable liquid crystal assuming a first stable state or a second stable state depending on an electric field applied thereto interposed between the scanning lines and data lines. The liquid crystal device is driven by applying to a selected scanning line an electric signal comprising a first phase t_1 providing one direction of an electric field by which the liquid crystal is oriented to the first stable state regardless of an electric signal applied to signal electrodes and a second phase t_1 having an auxiliary voltage assisting reorientation to the second stable state of the liquid crystal corresponding to electric signals applied to data lines, and a third step or phase t_3 of applying to data lines an electric signal having a voltage polarity opposite to that of the electric signal applied at the phase t_2 based on predetermined information.

A preferred embodiment according to this mode is explained with reference to Figure 3.

Figure 3A schematically shows a cell 16 having picture elements arranged in a matrix which comprise scanning lines (scanning electrodes), data lines (signal electrodes) and a ferroelectric liquid crystal interposed therebetween. Reference numeral 162 denotes data lines. For the brevity of explanation, a case where two state signals of "white" and "black" are displayed is explained. It is assumed that hatched picture elements correspond to "black" and the other picture elements correspond to "white" in Figure 3A.

Figures 3B (a) and 3B (b) show an electric signal (scanning selection signal) applied to a selected scanning line and an electric signal (scanning non-selection signal) applied to the other scanning lines (nonselected scanning lines), respectively. Figures 3B (c) and 3B (d) show an electric signal (information selection signal) applied to a selected (referred to as "black") data line and an electric signal (information non-selection signal) applied to a non-selected (referred to as "white") data line, respectively. In the Figures 3B (a) - 3B (d), the abscissa represents time, and the ordinate a voltage, respectively. T_1, T_2 and T_3 in the writing step represent first, second and third phases, respectively. This example shows a case where $T_1 = T_2 = T_3$.

It is assumed herein that a threshold voltage for providing the first stable state (white) of the bistable liquid crystal for an application time of Δt be $-V_{th2}$, and a threshold voltage for providing the second stable state for an application time of Δt be V_{th1}. Then, the electric signal applied to the selected scanning line comprises voltages of $3V_0$ at phase (time) T_1, $-2V_0$ at phase (time) T_2 and 0 at phase (time) T_3 as shown in Figure 3B (a). The other scanning lines are placed in grounded condition as shown in Figure 3B (b) and the electric signal is 0. On the other hand, the electric signal applied to the selected data line comprises 0 at phase T_1, V_0 at phase T_2 and $-V_0$ at phase T_2 as shown in Figure 3B (c), and the electric signal applied to the nonselected data line comprises 0 at phase T_1, $-V_0$ at phase T_2 and $+V_0$ at phase T_3 as shown in Figure 3B (d). In this instance, the voltage V_0 is set to a desired value which satisfies $V_0 < V_{th1} < 3V_0$ and $-V_0 > -V_{th2} > -3V_0$.

Voltage waveforms applied to respective picture elements when the above mentioned electric signals are given are shown in Figures 3C. Figures 3 C(a) and 3 C(b) show voltage waveforms applied to picture elements where "black" and "white" are displayed, respectively, on the selected scanning line. Figures 3C (c) and 3C (d) respectively show voltage waveforms applied to picture elements on the nonselected scanning lines.

As shown in Figure 3C, a voltage $-3V_0$ exceeding the threshold voltage $-V_{th2}$ is applied to all the picture elements on the selected scanning line at phase T_1, whereby these picture elements are once rendered white. In the second phase T_2, a voltage $3V_0$ exceeding the threshold voltage V_{th1} is applied to the picture elements which are to be displayed as "black", whereby the other optically stable state ("black") is attained. Further, the voltage applied to the picture elements which are to be displayed as "white" is V_0 not exceeding the threshold voltage, whreby the same optically stable state is maintained.

On the other hand, on the nonselected scanning lines, the voltage applied to all the picture elements is $\pm V$ or 0, each not exceeding the threshold voltage. Accordingly the liquid crystal at the respective picture elements retains its orientation which has been obtained when the picture elements have been last scanned. In other words, when a scanning line is selected, all the picture elements on the scanning line is uniformly oriented to one optically stable state ("white") at phase T_1 and selected picture elements are transformed into the other optically stable state ("black"), whereby one line is written. The thus obtained signal or display state is retained even after writing steps for one frame is finished and until subsequent scanning.

Figure 4 (combination of Figures 4A and 4B) shows an example of the above mentioned driving signals in time series. S_1 to S_5 represent electric signals applied to scanning lines; I_1 amd I_3 represent electric signals applied to data lines; and A_3 and C_3 represent voltage waveforms applied to picture elements A_3 and C_3, respectively, shown in Figure 3A.

As has been described above, a reversal of orientation states (cross talk) can occur due to application of a weak electric field for a long period. In a the embodiment, however, the reversal of orientation states can be prevented by applying a signal capable of preventing continual application of a weak electric field in one direction.

Figures 3B (c) and 3B (d) illustrate the embodiment for the above purpose wherein a signal having a polarity opposite to that of an information signal ("black" in Figure 3B (c) and "white" in Figure 3B (d)) applied to a data line at phase T_2 is applied to the data line at phase T_3. In a case where a pattern shown in Figure 3A is intended to be displayed, for example, by a driving method not having such phase T_3, picture element A_3 is made "black" on scanning of the scanning line S_1, but it is highly possible that the picture element A_3 will be switched sometime to "white" because an electric signal or voltage of $-V_0$ is continuously applied to the signal electrode I_1 during the steps for scanning of the scanning electrode S_2 and so on and the voltage is continuously applied to the picture element A_3 as it is.

The picture elements on the selected scanning line are uniformly rendered "white" at the first phase T_1, and then "black" is written into picture elements corresponding to information at the second phase T_2 in the scanning. In this example, the voltage for providing "white" at phase T_1 is $-3V_0$ and the application time is Δt. Further, the voltage for writing "black" at phase T_2 is $3V_0$ and the application time is also Δt. The voltage applied to the respective picture elements except at the scanning time is $|\pm V_0|$ to the maximum, and the longest time during which the maximum voltage is $2\Delta t$ as shown at part 161 in Figure 4 . Thus cross talk does not occur at all, whereby a displayed information is retained semipermanently after the scanning of the whole picture is once completed. For this reason, a refreshing step as required in a display device using a TN liquid crystal having no bistability is not required at all.

The optimum length of the third phase T_3 depends on the magnitude of the voltage applied to the data line at this phase. When a voltage having a polarity opposite to that of the information signal is applied, it is preferred that the time length is shorter for a larger voltage and longer for a shorter voltage. When the time is longer, it follows that a longer time is required for scanning the whole picture. Therefore, T_3 is preferably set to satisfy $T_3 \leqq T_2$.

The driving method according to the present invention can be widely applied in the field of optical shutters and display such as liquid crystal-optical shutters and liquid crystal TV sets.

Hereinbelow, the embodiment will be explained with reference to a working example.

<u>Example</u>

A pair of electrode plates each comprising a glass substrate and a transparent electrode pattern of ITO (Indium-Tin-Oxide) formed thereon were provided. These electrodes were capable of giving a 500 x 500 matrix electrode structure. On the electrode pattern of one of the electrode plates was formed a polyimide film of about 300Å in thickness by spin coating. The polyimide face of the electrode plate was rubbed with a roller about which a suede cloth was wound. The electrode plate was bonded to the other electrode plate which was not coated with a polyimide film, thereby to form a cell having a gap of about 1.6μ. Into the cell was injected a ferroelectric crystal of decyloxybenzylidene-p'-amino-2-methylbutyl cinnamate (DOBAMBC) under hot-melting state, which was then gradually cooled to form a uniform monodomain of SmC phase .

The thus formed cell was held at a controlled temperature of 70°C and driven by the waveforms shown in Figures 3 and 4 under the conditions of V_0 = 10 volt, and $T_1=T_2=T_3=$ t=50 μsec, whereby extremely good image was formed.

Reference is directed to United Kingdom patent application No GB 2156131 A (8501718) from which this application is divided.

CLAIMS

1. A driving method for an optical modulation device having a plurality of electro-optical elements arranged in a matrix and comprising scanning lines, data lines spaced apart from and intersecting with the scanning lines, and a ferroelectric liquid crystal, assuming a first orientation state or a second orientation state depending on the direction of an electric field applied thereto, interposed between the scanning lines and the data lines, each of the intersections between the scanning lines and the data lines forming one of said plurality of electro-optical elements; said driving method comprising:

applying a scanning selection signal to the scanning lines sequentially, said scanning selection signal comprising a voltage of one polarity and a voltage of the other polarity respectively with respect to a voltage applied to a non-selected scanning line; and

applying information signals to the data lines, said information signals comprising a voltage signal providing in combination with said scanning voltage of said one polarity a voltage exceeding a first threshold voltage of the ferroelectric liquid crystal applied to the electro-optical elements on the selected scanning line, a voltage signal providing in combination with said scanning voltage of said other polarity a voltage exceeding a second threshold voltage of the ferroelectric liquid crystal applied to a selected electro-optical element on the selected scanning line, and a voltage not exceeding the first or second threshold voltages at a non-selected electro-optical element on the same scanning line, and an auxiliary signal applied to the data lines in between the application of information signals to the data lines;

said auxiliary signal providing an inversion preventing voltage in combination with the voltage applied to the non-selected scanning line before the application period of a voltage of a particular polarity reaches a period beyond which the first or second orientation state of an electro-optical element on the non-selected scanning line is unintentionally inverted due to said voltage of said particular polarity and less than the relevant threshold voltage, the inversion preventing voltage being a zero voltage or having a polarity opposite to said particular polarity.

2. The driving method according to Claim 1, wherein one period for applying a voltage to the electro-optical elements on the selected scanning line

comprises: a first phase for applying to all or a prescribed number of the electro-optical elements on the selected scanning line a voltage exceeding the first threshold voltage for causing the first orientation state of the ferroelectric liquid crystal; a second phase for applying to a selected electro-optical element among said all or a prescribed number of the electro-optical elements a voltage exceeding the second threshold voltage for causing the second orientation state of the ferroelectric liquid crystal; and a third phase for applying an auxiliary signal to data lines thereby to apply a voltage between the first and second threshold voltages to said all or prescribed number of the electro-optical elements.

3. The driving method according to Claim 2, wherein said auxiliary signal applied to data lines in the third phase has a voltage polarity opposite to that of the voltage applied to the data lines in the second phase, with respect to the voltage applied to the non-selected scanning lines.

4. The driving method according to Claim 2 or 3, wherein said third phase has a period of t_3 and said

second phase has a period of t_2, said t_3 and t_2 satisfying the relationship $t_3 < t_2$ or $t_3 = t_2$.

5. The driving method according to any of claims 2 to 4, wherein, in the second phase, an information selection signal is applied to a selected data line and an information non-selected signal is applied to a non-selected data line, said information selection signal and information non-selection signal having different voltage polarities with respect to the voltage applied to the non-selected scanning lines.

6. The driving method according to any preceding claim, which comprises applying an alternating voltage below the threshold voltages to the electro-optical elements on the non-selected scanning line.

7. An optical modulation device having a plurality of electro-optical elements arranged in a matrix and comprising scanning lines, data lines spaced apart from and intersecting with the scanning lines, and a ferroelectric liquid crystal, assuming a first orientation state or a second orientation state depending on the direction of an electric field applied thereto, interposed between the scanning lines

and the data lines, each of the intersections between the scanning lines and the data lines forming one of said plurality of electro-optical elements; said optical modulation device comprising means for:

applying a scanning selection signal to the scanning lines sequentially, said scanning selection signal comprising a voltage of one polarity and a voltage of the other polarity respectively with respect to a voltage applied to a non-selected scanning line; and

applying information signals to the data lines; said information signals comprising a voltage signal providing in combination with said scanning voltage signal of said one polarity a voltage exceeding a first threshold voltage of the ferroelectric liquid crystal applied to the electro-optical elements on the selected scanning line, a voltage signal providing in combination with said scanning voltage of said other polarity a voltage exceeding a second threshold voltage of the ferroelectric liquid crystal applied to a selected electro-optical element on the selected scanning line, and a voltage not exceeding the first or second threshold voltages at a non-selected electro-optical element on the same scanning line, and an auxiliary signal applied to the data lines in between the application of information signals to the data lines;

said auxiliary signal providing an inversion preventing voltage in combination with the voltage applied to the non-selected scanning line before the application period of a voltage of a particular polarity reaches a period beyond which the first or second orientation state of an electro-optical element on the non-selected scanning line is unintentionally inverted due to said voltage of said particular polarity and less than the relevant threshold voltage, the inversion preventing voltage being a zero voltage or having a polarity opposite to said particular polarity.

8. The optical modulation device according to Claim 7, which comprises means for applying an alternating voltage below the threshold voltages to the electro-optical elements on the non-selected scanning line.

9. An optical modulation device or driving method therefor substantially as described in the description with reference to the drawings.

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