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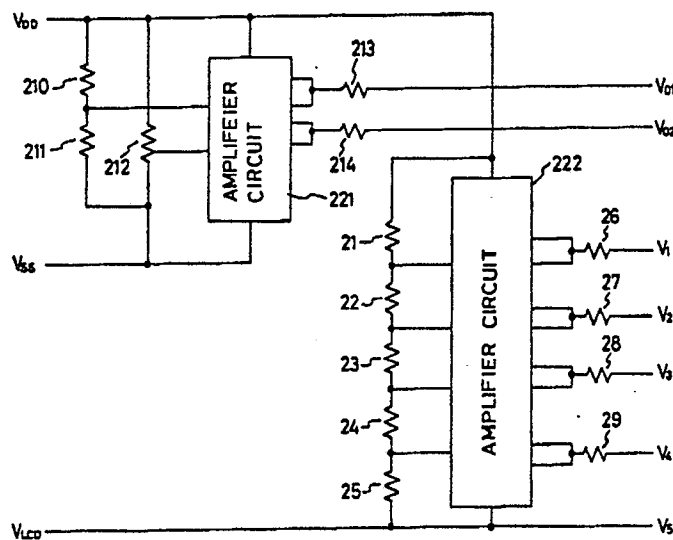
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Driving system for a display device.

A driving system for a liquid crystal display device having non-linear active elements. A voltage generating circuit for providing voltages to column electrode driver and row electrode driver comprises a bias voltage generating circuit and a selected voltage generating circuit.

The driving voltage applied to the column electrode driver is not equal value to the driving voltage applied to the row electrode driver to thereby electrically compensate the asymmetry of the active elements.

FIG. 2



DRIVING SYSTEM FOR A DISPLAY DEVICE

Background of the Invention

This invention relates to a driving method of a flat panel type display device with liquid crystal and the like. In particular, this invention is applied to the driving method of an active panel device having non-linear resistance elements therein.

Regarding an active panel device having 2-terminal active elements of non-linear resistance made of SiNx material and the like therein, it is not always true that the active elements themselves have symmetrical characteristics relative to the supplying voltage in the plus direction or in the minus direction. Namely, they have asymmetric characteristics in general. For example, when the voltage VS. current characteristics in case of applying the plus directional voltage is compared to said characteristics in case of applying the minus directional voltage, they are different from each other to be asymmetrical.

As shown in Fig. 3, voltage-averaging driving method is employed in the conventional matrix display device having liquid crystal. Referring to Fig. 3, dividing resistors 31, 32, 33, 34 and 35 are provided to divide an electric source voltage VDD and a liquid crystal driving voltage V_{LCD} . The divided voltages are amplified current by an operational amplifier circuit 40. The operational amplifier circuit 40 outputs voltages V1, V2, V3 and V4 via resistors 36, 37, 38 and 39. Furthermore, the electric source voltage V_{DD} becomes the highest positive driving voltage V_0 . The liquid crystal driving voltage V_{LCD} becomes the lowest negative voltage V_5 . The selected driving voltage V_0 and V_5 are inputted to a row electrode driving circuit and a column electrodes driving circuit. And also, the bias voltages V_1 and V_4 are inputted to the row electrode driving circuit, and V_2 and V_3 are inputted to the column electrode driving circuit. Thus, as the selected driving voltage V_0 , same magnitude of voltage is inputted to the row electrode driving circuit and the column electrode driving circuit. And therefore, when the non-linearity of the active elements is asymmetrical, the amount of electric charge charged into the liquid crystal differs depending on the polarity voltage in the plus direction or in the minus direction, and the discharging time of said electric charge also differs.

As described above, when turning on and turning off, some display pattern is switched repeatedly, because of the asymmetry of the active elements, and because of different amount of charged electric charge and the discharging time depending on the voltage of positive polarity or of negative polarity, it occurs the phenomenon of disappearing

display together with instant stripe shaped display. And so-called charging-up phenomenon occurs as follows; when some display of a static pattern is switched to another display of pattern, the previous static pattern is overlapped to the new pattern to be displayed for a few seconds.

Fig. 4 is a matrix diagram illustrating the structure of a matrix-type display device having non-linear active elements therein. $X_1 \sim X_2$ are column electrododes, $Y_1 \sim Y_2$ are row electrododes, LA's are non-linear active elements, and LC's are liquid crystal display dots at the cross points. Fig. 5 shows the asymmetry of I-V characteristics of said non-linear active elements. As shown in the Fig. 5, when the case of supplying plus directional voltage to the non-linear active elements from the side of column electrodes is compared to the case of supplying minus directional voltage, it is necessary to make magnitude of the plus directional voltage larger in order to make flow same amount of current. Since the liquid crystal is displayed by means of holding the amount of electric charge charged by this current, it is important to make the plus directional voltage symmetrical with the minus directional voltage in case of driving the liquid crystal with non-linear active elements. When the plus directional voltage and the minus directional voltage the magnitude thereof being mutually equal are applied to the non-linear active elements, it will be understood by the fact that holding time of the electric charge amount differs depending on the plus directional voltage and the minus directional voltage, because impedance in the plus direction is different from that in the minus direction.

In order to solve the above noted problems of the conventional method, as object of the present invention is to provide a driving method for electrically compensating the asymmetry characteristics of the active elements.

Another object of the present invention is to provide a display device with high displaying quality.

According to the present invention there is provided a driving system which comprises column electrode driver for applying driving signals to column electrodes, row electrode driver for applying driving signals to row electrodes, and voltage generating circuit for providing driving voltage to the column electrode driver and the row electrode driver, and the driving voltage applied to the column electrode driver is not equal in absolute value to the driving voltage applied to the row electrode driver so as to compensate asymmetry characteristics between the plus direction and the minus direction of the non-linear active elements.

In a preferred form, the voltage generating circuit comprises bias voltage generating circuit and selected voltage generating circuit, and the output voltage from the selected voltage generating circuit to the column electrode driver is not equal to the output voltage from the selected voltage generating circuit to the row electrode driver. In such case, the selected voltage generating circuit comprises an adjusting means such as volume resistor which is capable of adjusting voltage at either one of the column electrodes and the row electrodes toward positive voltage or negative voltage.

Brief Description of the Drawings

Fig. 1 is a block diagram of the drive circuit of the matrix liquid crystal display device;

Fig. 2 is a circuit diagram illustrating one embodiment of this invention;

Fig. 3 is a diagram of a conventional drive voltage generator circuit;

Fig. 4 is a matrix diagram illustrating the structure of a matrix-type display device having non-linear active elements therein;

Fig. 5 is a diagram illustrating the asymmetry of I-V characteristics of the non-linear active elements;

Fig. 6 is a diagram illustrating conventional drive waves to drive the liquid crystal;

Fig. 7 is a diagram illustrating one embodiment of drive waves according to this invention;

Fig. 8 is a circuit diagram illustrating an alternate embodiment of this invention; and

Fig. 9 is a diagram illustrating an alternate embodiment of drive waves according to this invention.

Detailed Description of the Embodiments

Next, preferred embodiments are described in conjunction with the drawings according to the present invention.

Fig. 1 is a block diagram of the drive circuit for use in explaining driving method according to the present invention. In Fig. 1, reference number 11 indicates the liquid crystal display panel. Reference number 12 indicates a row electrode driver which outputs scan pulses to each electrode. Reference number 13 indicates a column electrode driver which converts video signals that arrive at each column in series into parallel signals and simultaneously outputs these to each column electrode. Reference number 14 indicates a voltage generating circuit for providing driving voltage to the row electrode driver 12 and the column electrode driver 13. As shown in Fig. 1, the voltage generating circuit 14 comprises a bias voltage generating circuit

15 and a selected voltage generating circuit 16.

Fig. 2 is a circuit diagram illustrating one embodiment of a drive voltage generator circuit according to this invention. In Fig. 2, 21, 22, 23, 24, and 25 are dividing resistors to divide voltage between electric source voltage V_{DD} and liquid crystal drive voltage V_{LCD} . An operational amplifier circuit 222 amplifies the divided voltage to provide bias drive voltages V_1 , V_2 , V_3 and V_4 . Dividing resistors 210 and 211 divide voltage between electric source voltage V_{DD} and liquid crystal driving voltage V_{LCD} . And also, a variable resistor 212 divides voltage between V_{DD} and V_{SS} to output adjustable voltage. An operational amplifier circuit 221 amplifies said divided voltage and adjustable voltage to output selected drive voltages V_{01} and V_{02} of positive polarity.

Here, the selected drive voltage V_{01} of positive polarity is supplied to the column electrodes driving circuit, and the other selected drive voltage V_{02} is supplied to the row electrodes driving circuit, or vice versa. And also, the bias drive voltages V_1 , V_4 and the selected drive voltage V_5 of negative polarity are supplied to the row electrodes driving circuit. The bias drive voltages V_2 , V_3 and the selected drive voltage V_5 of negative polarity are supplied to the column electrodes driving circuit. According to the structure described above, when the selected drive voltage V_{01} of positive polarity is set between the electric source voltage V_{DD} and the grounded voltage V_{SS} , magnitude of the other selected drive voltage V_{02} of positive polarity may be made to be larger or smaller than that of said selected drive voltage V_{01} of positive polarity by means of adjusting the variable resistor 212.

Fig. 6 is a diagram illustrating a drive voltage wave applied to liquid crystal elements in case that a conventional drive voltage generator circuit is driven by means of a conventional driving method. Fig. 7 is a diagram illustrating a drive voltage wave with a drive voltage generator circuit according to this invention. As seen from Fig. 7, magnitude of the selected drive voltage of positive polarity is set to be larger than that of the selected drive voltage of negative polarity. On the other hand, it is also possible to set magnitude of the selected drive voltage of negative polarity larger than that of the selected drive voltage of positive polarity. As described above, magnitude of the drive voltage of one polarity is made to be larger than that of the drive voltage of the other polarity in order to compensate the asymmetry of the active elements.

According to the present embodiment asymmetry of the active elements is adjusted to be symmetrical depending on magnitude of the drive voltages, and therefore, the amount of electric charge charged into the liquid crystal display ele-

ments and the discharging time can be made to be equal irrespective of whether positive polarity or negative polarity.

Therefore, asymmetry of active elements is able to be compensated by means of making magnitude of one side of selected drive voltage larger or smaller than that of the other side, even if the asymmetry of active elements is in the plus direction or in its reverse direction. Accordingly, the problems of striping phenomenon, charging-up phenomenon and the like can be solved to provide a flat panel type display device with high displaying quality.

Fig. 8 illustrates a bias voltage generating circuit as modified embodiment of a drive system according to this invention. In Fig. 86-90 show resistors for dividing bias voltage. 81-85 show operational amplifier circuits. The value of V_{DD} is +5V, and V_{LC} is a negative voltage source for driving liquid crystals. V_{01} , V_{02} are respectively selected voltages in the plus direction for X electrode and for Y electrode. In here, X electrode means column electrode and Y electrode means row electrode. V_5 shows a selected voltage in the minus direction. $V_1 \sim V_4$ show bias voltage in case of not selected state. When the resistance value of resistor is $1.0R$, then each resistance value of resistors 86, 87, 89, 90 is $1.5R$, $0.5R$, $1.5R$ and $0.5R$. Also, 86 is composed of a variable resistor, and its central point voltage is amplified by the operational amplifier circuit 81. Accordingly, it is understood that magnitude of the selected voltage v_{02} is the plus direction applied to said Y electrode is made lower than that of the selected voltage V_{01} in the plus direction applied to said X electrode. And also, on one hand, difference of voltage between V_{01} and V_1 and that between V_3 and V_4 become larger depending on difference of voltage between V_2 and V_3 , and on the other hand, difference of voltage between V_1 and V_2 and that between V_4 and V_5 become smaller than the difference between V_2 and V_3 . Namely, the bias voltage is not equally divided, but it is featured by being unequally divided. Thus, said asymmetry of the non-linear active elements is compensated by this feature.

On the other hand, a conventional matrix-type display device with liquid crystal employs a drive bias circuit by means of voltage averaging method. That is, the portion between V_{DD} and V_{LC} is equally divided with resistors of mutually equal resistance so as to make the drive voltage applied in the plus direction of the liquid crystal to be equal to that applied in the minus direction thereof, whereby DC voltage is not applied to the liquid crystal.

Fig. 9 illustrates various driving waves for the embodiment of this invention. In Fig. 3, the driving waves are illustrated the case of 1 dot-display and non-display being repeated at every line. M is a

polarity inverted signal at every frame, and DFM shows a polarity inverted signal at every 2 lines. Y_1 , X_1 are respectively driving waves applied to row electrode and column electrode. And also, $Y_1 - X_1$ is a driving voltage wave to be applied to the liquid crystal at the cross point of $Y_1 - X_1$. As shown in Fig. 9, it is understood that the driving wave between $Y_1 - X_1$ is wholly shifted to the side of column electrode, and the minus directional voltage is applied to the plus directional voltage at the side of column electrode so that larger voltage can be applied to the side of column electrode. Accordingly, larger voltage is applied to the side of column electrode in order to compensate the asymmetry of said non-linear active elements, and thus same amount of charging current can be supplied for the voltage driving operation both in the plus direction and in the minus direction, thereby the compensating operation becomes capable to hold the same charged electric charge.

As described above, according to this embodiment, the asymmetry of non-linear active elements is compensated by the drive voltage. Accordingly, the problem of striping phenomenon as the conventional problem could be solved by means of obtaining uniform going down time by changing said resistance values and by adjusting the variable resistance value. Said problem was presented as follows: while the display operation is performed by the drive voltage in the plus direction or in the minus direction, the time difference (about 2 - 10 ms) of going down response in case of the non-display phenomenon being occurred is the cause of said problem of striping phenomenon. And also, the problem of charging-up could be solved. Said problem was presented as follows: because of over stored electric charge, the off-time is lengthened and the display state is continued for a relatively long time. Furthermore, since the liquid crystal at the cross points of X abscissa and Y ordinate is substantially AC driven without having DC component, life of the liquid crystal may be lengthened compared to the conventional art.

Claims

1. A driving system for a display device including a group of column electrodes and another group of row electrodes which intersect with the column electrodes to define intersections therebetween, and a plurality of matrix picture elements, each matrix picture element having non-linear active element, the system comprising:
 - column drive means for applying driving signals to column electrodes;
 - row drive means for applying driving signals to row electrodes; and

voltage generating means for providing driving voltages to the column drive means and the row drive means, and the driving voltage applied to the column drive means being not equal in absolute value to the driving voltage applied to the row drive means so as to compensate asymmetry characteristics between the plus direction and the minus direction of the non-linear active elements.

2. A driving system as claimed in claim 1; wherein the voltage generating means comprises bias voltage generating means and selected voltage generating means.

3. A driving system as claimed in claim 2; wherein the output voltage from the bias voltage generating means is not equally divided.

4. Wherein the bias voltage in the plus direction is not equal to the bias voltage in the minus direction the bias voltage being a voltage applied between the column and row drive means.

5. A driving system as claimed in claim 4; wherein the output voltage from the bias voltage generating means is not equally divided.

6. A liquid crystal display device comprising: a group of column electrodes and another group of row electrodes which intersect with the column electrodes to define intersections therebetween; a plurality of matrix picture elements disposed at the respective intersections, each matrix picture element including a non-linear element and a liquid crystal connected in series to the non-linear element between the corresponding column and row electrodes;

column drive means for applying driving signals to column electrodes;

row drive means for applying driving signals to row electrodes; and

voltage generating means for providing driving voltages to the column drive means and the row drive means, and the driving voltage applied to the column drive means being not equal in absolute value to the driving voltage applied to the row drive means so as to compensate asymmetry characteristics between the plus direction and the minus direction of the non-linear elements.

7. A liquid crystal display device as claimed in claim 6; wherein the voltage generating means comprises bias voltage generating means and selected voltage generating means.

8. A liquid crystal display device as claimed in claim 7; where in the output voltage from the selected voltage generating means to the column drive means is not equal in absolute value to the output voltage from the selected voltage generating means to the row drive means.

9. A liquid crystal display device as claimed in claim 8;

wherein the bias voltage in the plus direction is not equal in value to the bias voltage in the minus direction, the bias voltage being a voltage applied between the column and row drive means.

FIG. 1

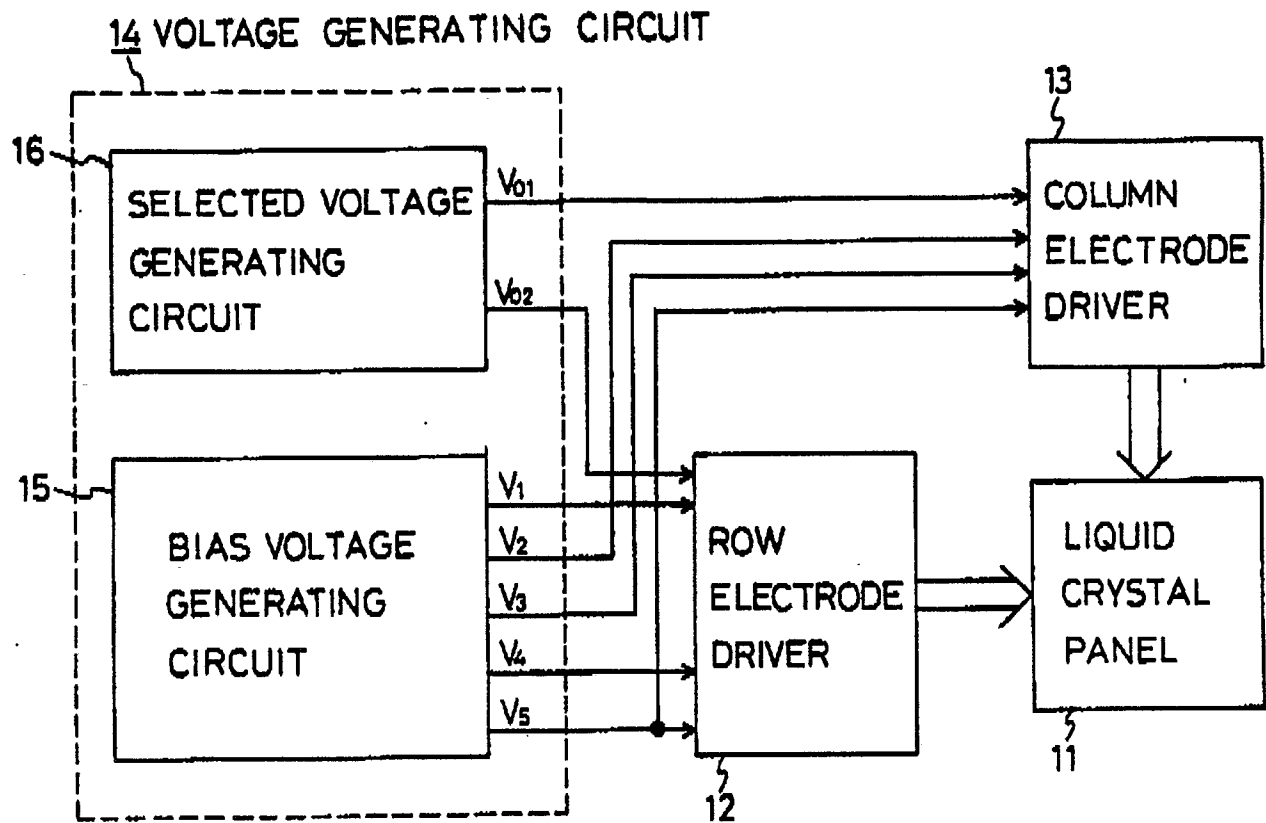


FIG. 2

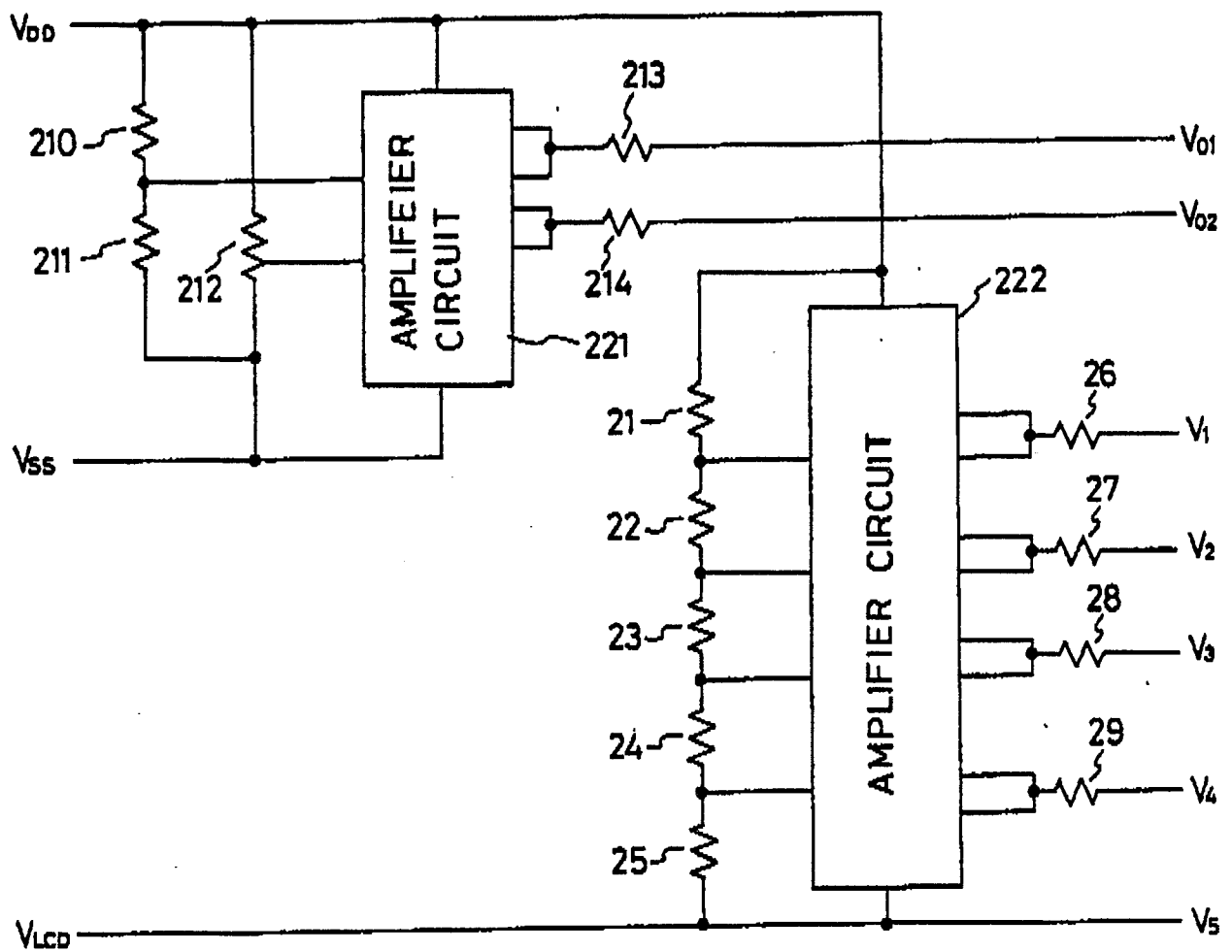


FIG. 3 PRIOR ART

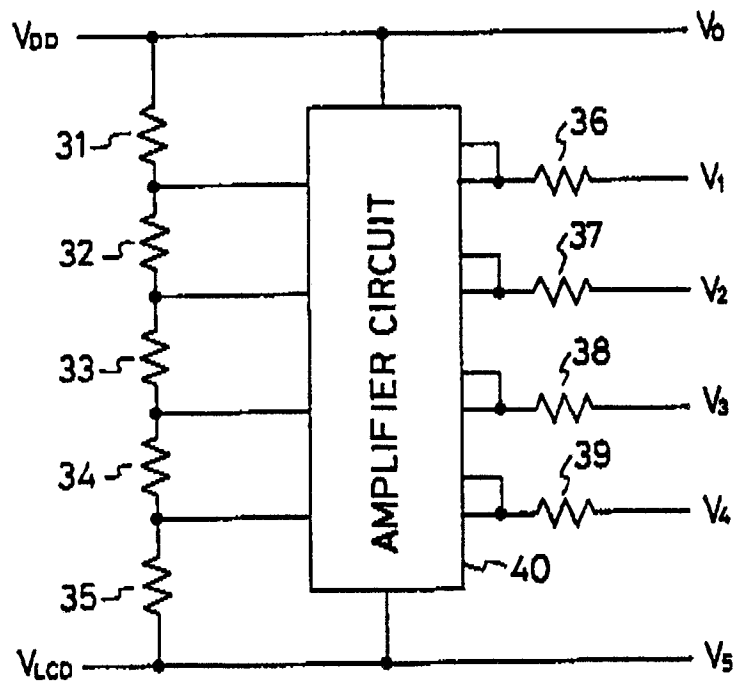


FIG. 4

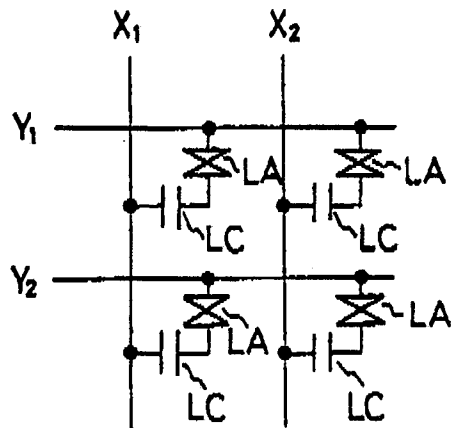


FIG. 5

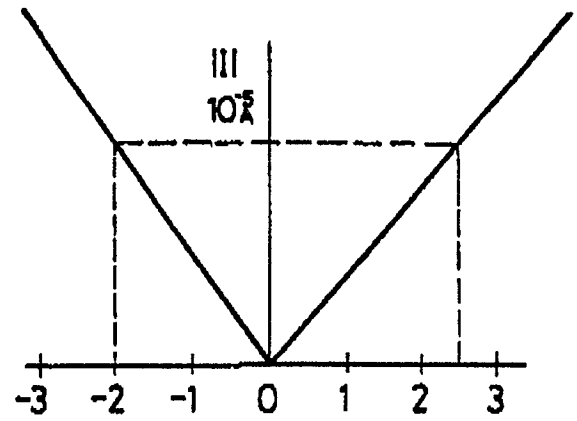


FIG. 6 PRIOR ART

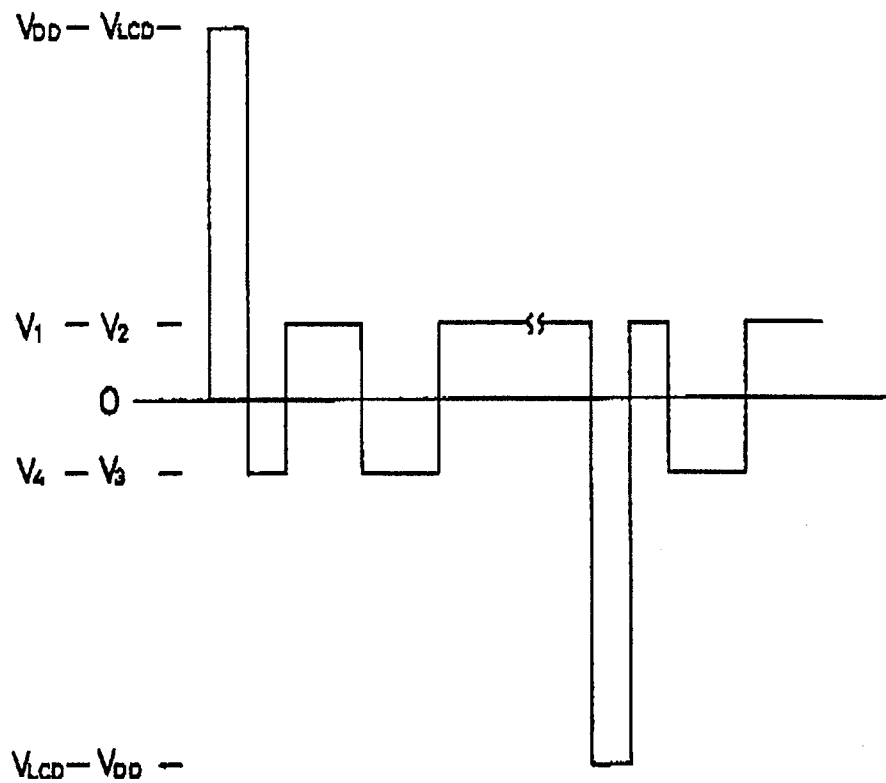


FIG. 7

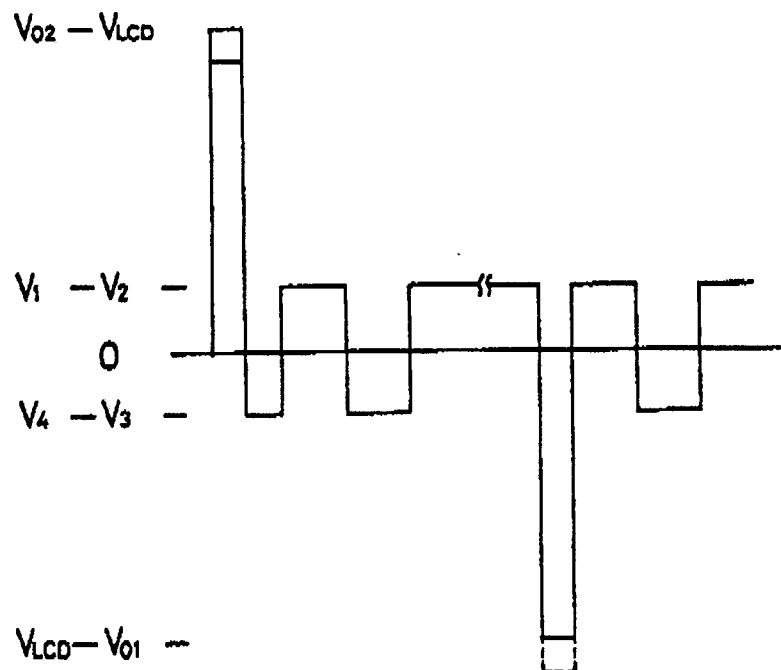


FIG. 8

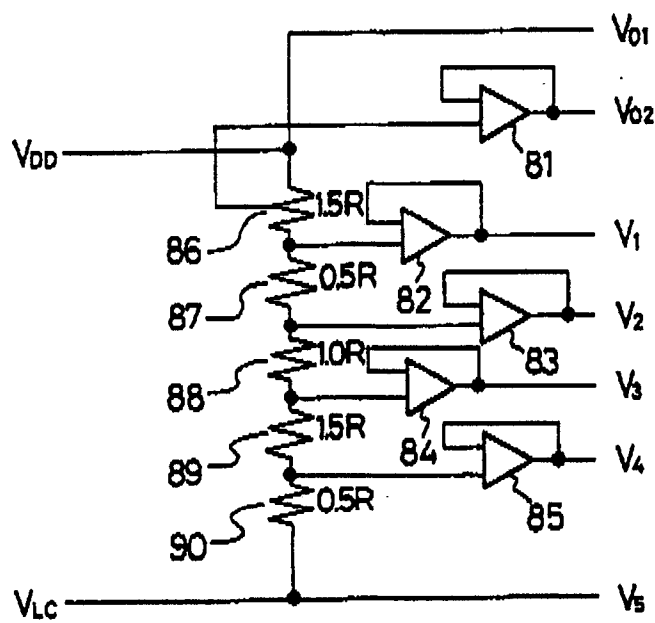


FIG. 9

