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**Display device and driving system thereof.**

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## Description

The present invention relates to a display device, more particularly to a display device having such an incomplete memory characteristic as that of ferroelectric liquid crystal and which takes a specified time to rewrite the picture elements, and to a driving system of the display device.

Ferroelectric liquid crystal is a well-known element with incomplete memory characteristic. When a picture is to be displayed on a matrix type display panel that uses ferroelectric liquid crystal, video signals are sent from, say a personal computer to the display panel. Since the video signals from the personal computer are non-interlace signals, however, it is not possible to use all frames of the signals in displaying the picture on the panel because of the time restriction for rewriting by the ferroelectric liquid crystal. Conventionally, therefore, a picture is displayed by using, for instance, every other frame of video signals.

Assuming that the number of scanning lines M of a video signal sent from a personal computer is 200 and that the time required by the liquid crystal for rewriting the picture elements in one horizontal scanning period is 200  $\mu$ s, the frame frequency fF on the screen is calculated as:

$$fF = \frac{1}{f \times M} = \frac{1}{200 \times 10^{-6} \times 200} = 25 \text{ Hz}$$

If the memory characteristic of the liquid crystal is incomplete, when a figure "1" is kept written, the luminance of the image changes little by little after the figure is rewritten, as shown in Figs. 7(1), 7(2), 7(3) and 7(4). For instance, the luminance of the picture elements on the lines L<sub>1</sub>, L<sub>2</sub>, L<sub>3</sub> and L<sub>4</sub> changes as shown in Figs. 7(1), 7(2), 7(3) and 7(4), respectively. The combined luminance of the 4 (vertical)  $\times$  4 (horizontal) picture elements changes at 25 Hz as shown in Fig. 7(5). Since human eyes can sense the luminance variation at a frequency not higher than 60 Hz, the above luminance change is sensed as a flicker so that the picture quality is deteriorated.

An object of the present invention is to solve the above problem by providing a display device and its driving system which improves the display picture quality by controlling the operation of rewriting the picture elements.

The invention is defined by the claims.

To achieve the above object, according to an embodiment of the present invention, a display device, which provides an incomplete memory characteristic and takes "r" seconds to rewrite the picture elements in one horizontal scanning period, comprises "M" scanning lines divided into a plurality of groups each containing "K" scanning lines (K>1, M>1, K, M = positive integers), and means for sending scanning signals to the "M" scanning lines so as to rewrite a picture. The scanning signal sending means sends scan-

ning signals to the first scanning line in each scanning line group in the first frame, to the second scanning line in each scanning line group in the second frame, and to the "K"th scanning line in each scanning line group in the "K"th frame so that the picture elements on the "M" scanning lines are rewritten by "K" times of scanning.

The present invention is effective for the condition of  $60 > \frac{1}{r \times M}$  in which "r" is the time required for rewriting the picture elements in one horizontal scanning period.

The action of the present invention is described in the following, assuming K = 2, M = 200 and r = 200  $\mu$ s for simplification.

In the first frame, the scanning lines of odd number 1, 3, 5, ..., 199 are scanned, and in the second frame the scanning lines of even number 2, 4, 6, ..., 200 are scanned, thus completing an entire picture in two frames. Specifically, picture signals input to the display device contain 200 effective scanning lines in one frame. However, all of these 200 effective lines are not used for each frame. For the first frame, the signals for scanning lines of odd number alone are used while those for scanning lines of even number are discarded. For the second frame, the signals for scanning lines of even number alone are used while those for scanning lines of odd number are discarded. As a result, picture elements are written at 50 Hz on the display panel, compared with 25 Hz by the conventional device. This results in less conspicuous flicker of a picture.

The present invention will become more fully understood from the detailed description of preferred embodiments given hereinbelow and the accompanying drawings, which are given by way of illustration only and thus are not limitative of the present invention, and wherein:

Fig. 1 is a circuit diagram showing the construction of the display device of a first embodiment of the present invention;

Fig. 2 is a chart of signal waveform in each part thereof;

Fig. 3 is a circuit diagram showing the construction of the display device of a second embodiment of the invention;

Fig. 4 and 5 are charts of signal waveform in each part thereof;

Fig. 6 is a chart for explaining the effect of the present invention; and

Fig. 7 is a chart for explaining the conventional device.

According to an embodiment of the present invention, a display device such as an X-Y matrix type liquid crystal display panel contains a pair of insulating substrates with a liquid crystal layer sandwiched therebetween. "M" pcs. of scanning electrodes are provided on the inner side of one of the substrates,

and "N" pcs. of signal electrodes on the inner side of the other substrate, the scanning electrodes crossing the signal electrodes at a right angle. The display device of the present invention provides an incomplete memory characteristic and takes "r" seconds to re-write the picture elements in one horizontal scanning period. An example of a substrate with an incomplete memory characteristic is ferroelectric liquid crystal. The insulating substrate of the display device may include a conductive member with an insulating film formed thereon or a conductive member alone. The insulating substrates having scanning electrodes and signal electrodes respectively are covered with insulating films, respectively. An effective display region is realized by the "M" scanning electrodes and the "N" signal electrodes.

The present invention is characterised in the following features.

The "M" scanning electrodes are divided into "P" groups each containing "K" scanning electrodes ( $K > 1$ ,  $P > 1$ ,  $K, P = \text{integers}$ ). By the first frame, all the first scanning electrodes in all groups are scanned sequentially. Then by the second frame, all the second scanning electrodes in all groups are scanned sequentially. This process is repeated until all the "K"th scanning electrodes in all groups have been scanned by the "K"th frame. Namely, "P" scanning electrodes are scanned sequentially by each frame, and this scanning process is repeated "K" times to scan "M" scanning electrodes, thus rewriting the picture elements for one picture.

If "M" cannot be divided by "K", at least one of the "P" groups may contain fewer than "K" electrodes. But preferably every group should contain the same number of electrodes.

With  $K = 2$ , for instance, every other scanning line is rewritten by each frame. With  $K = 3$ , every third scanning line is rewritten by each frame.

The present invention is effective particularly for the condition of  $60 > \frac{1}{r \times M}$ .

In the following description, the display device is assumed to be an X-Y matrix type liquid crystal display panel in which the number of scanning electrodes "M" = 200, and the number of signal electrodes "N" = 640. It is not intended that the present invention is limited to the above; the number of electrodes "M" and "N" may be changed as desired.

In the X-Y matrix liquid crystal display panel 1 of the present embodiment, signal electrodes  $Y_1, Y_2, \dots, Y_{N=640}$  are provided on the first insulating substrate, and scanning electrodes  $L_1, L_2, \dots, L_{M=200}$  on the second insulating substrate. The signal electrodes and the scanning electrodes are covered with insulating films for insulation between the electrodes. A ferroelectric liquid crystal layer (such as CS-1014 by Chisso Corporation) is placed between the first and second insulating substrates.

Image data to be supplied to the signal electrodes  $Y_1, Y_2, \dots, Y_{640}$  is sent in form of input signals  $E_i$  through a terminal 3 to a shift register 6 which comprises D flip flops  $R_1, R_2, \dots, R_{640}$  corresponding to the signal electrodes respectively. The input signals  $E_i$  are applied to the data terminals of the D flip flops  $R_1, R_2, \dots, R_{640}$ . A basic clock pulse signal C is supplied from a converter circuit 2 to the clock terminals of the D flip flops  $R_1, R_2, \dots, R_{640}$  so that data signals are output sequentially from the D flip flops  $R_1, R_2, \dots, R_{640}$  in this order. The data signals thus output pass through D flip flops  $r_1, r_2, \dots, r_{640}$  and drivers  $d_1, d_2, \dots, d_{640}$  and are input to the signal electrodes  $Y_1, Y_2, \dots, Y_{640}$ . Horizontal clock pulse signals  $c^l$  are supplied as clock signals to the D flip flops  $r_1, r_2, \dots, r_{640}$ .

Here, the image data or video signals contains "M" pcs. of scanning electrodes or scanning lines in one frame. When a picture is to be rewritten by "K" frames, the same image signals are supplied "K" times.

Using horizontal synchronizing pulse HP and vertical synchronizing pulse VP that are input through terminals 4 and 5, a converter circuit 2 generates basic clock pulse signal C and horizontal clock  $c^l$ . The converter circuit 2 also generates selection signals  $U_1, U_2, \dots, U_K$  for selecting one of the 1st to the "K"th electrodes of each group. One of the selection signals  $U_1, U_2, \dots, U_K$  becomes high in each frame, the selection signal of high level changes in the order of  $U_1, U_2, \dots, U_K$  as a frame changes. Specifically, the selection signal  $U_1$  becomes high in the first frame, and the selection signal  $U_2$  becomes high in the second frame as shown in Fig. 2. And eventually, the selection signal  $U_K$  becomes high in the Kth frame (not shown).

Receiving the selection signal  $U_1$  and the horizontal clock pulse signal  $c^l$ , D flip flops  $b_1, b_{K+1}, \dots$  supply rewrite signals through drivers  $a_1, a_{K+1}, \dots$  to the scanning electrodes  $L_1, L_{K+1}, \dots$ . Similarly, receiving the selection signal  $U_2$  and the horizontal clock pulse signal  $c^l$ , D flip flops  $b_2, b_{K+2}, \dots$  supply rewrite signals through drivers  $a_2, a_{K+2}, \dots$  to the scanning electrodes  $L_2, L_{K+2}, \dots$ . With the selection signal  $U_K$  as well, rewrite signals are supplied to the specified scanning electrodes. Namely, on receiving the selection signal  $U_K$  and the horizontal clock pulse signal  $c^l$ , D flip flops  $b_K, b_{2K}, \dots, b_M$  supply rewrite signals through drivers  $a_K, a_{2K}, \dots, a_M$  to the scanning electrodes  $L_K, L_{2K}, \dots, L_M$ .

On receiving a selection signal and a horizontal clock pulse signal  $c^l$ , the D flip flop  $b_1$  supplies an output equivalent to the selection signal to the following D flip flop  $b_{K+1}$  simultaneously as it supplies rewrite signal to the scanning electrode  $L_1$ . The D flip flop  $b_{K+1}$ , on receiving the signal output from the D flip flop  $b_1$  and a horizontal clock pulse signal  $c^l$ , outputs rewrite signal to the scanning electrode  $L_{K+1}$  and simultaneously supplies an output equivalent to the selection signal to the following D flip flop. Through the rep-

etition of this operation, the scanning electrodes of the same order in all groups are rewritten sequentially in the same frame period.

As a result, the lines  $L_1, L_{K+1}, \dots$  are rewritten in the first frame, the lines  $L_2, L_{K+2}, \dots$  are rewritten in the second frame, and the lines  $L_K, L_{2K}, \dots$  are rewritten in the Kth frame so that all the effective scanning lines are rewritten in K frames, as indicated partly by the signal driver output D in Fig. 2. With  $K = 2$ , all the effective scanning lines are rewritten in two frames, the scanning lines of odd number being rewritten in the first frame and the scanning lines of even number being rewritten in the second frame.

Fig. 3 shows an example in which the present invention is applied to a split X-Y matrix type liquid crystal display panel 1. In this second embodiment, the display panel is divided into a first block 1A and a second block 1B. The first and second display block 1A and 1B are driven under the same condition as described later. The number of scanning electrodes in the effective display region is M, with  $M'$  pcs. in the first display block 1A and  $M'$  pcs. in the second display block 1B. The  $M'$  scanning electrodes in each of the first and second display blocks 1A and 1B are divided into  $P'$  groups each containing  $K'$  electrodes.

In the display device of this construction, the first scanning electrodes of the groups are scanned first, and the second scanning electrodes of the groups are scanned next. This process is repeated until the  $K'$ th electrode of the groups are scanned. In other words,  $2P'$  scanning electrodes are scanned in each time, and the scanning operation is conducted  $K'$  times to rewrite the picture on an entire display panel divided into the first and the second display blocks.

The action of the display device of the second embodiment shown in Fig. 3 is described assuming the number of scanning electrodes  $M = 200$ , the number of scanning electrodes in each of the first and second display blocks  $M' = 100$ , and the number of signal electrodes  $N = 640$ . In each of the first and second display blocks, the scanning electrodes are divided into groups each containing  $K'$  electrodes. In this example,  $K' = 2$ . Therefore, the scanning lines of even number and the scanning lines of odd number are scanned separately.

A hundred scanning electrodes  $L_1, L_2, \dots, L_{100}$  are arranged in the first display block 1A, and a hundred scanning electrodes  $L_{101}, L_{102}, \dots, L_{200}$  are arranged in the second display block 1B. Both the first and the second display blocks 1A and 1B have 640 signal electrodes  $Y_1, Y_2, \dots, Y_{640}$ . Ferroelectric liquid crystal is used as a liquid crystal layer for each of the display blocks 1A and 1B.

Signal electrode drivers  $d_1, d_2, \dots, d_{640}$  and D flip flops  $r_1, r_2, \dots, r_{640}$  and  $R_1, R_2, \dots, R_{640}$  for registers are basically the same as those for the first embodiment shown in Fig. 1. These elements are provided for the first and the second display blocks 1A and 1B inde-

pendently. Image input signals  $E_i$ , horizontal synchronizing pulses HP and vertical synchronizing pulses VP as shown in Fig. 4 are input from a personal computer to terminals 3, 4 and 5, respectively. On the basis of these signal inputs, a first converter circuit 2 outputs image data signals  $E_{i1}$  and  $E_{i2}$ , horizontal synchronizing pulses HP and basic selection pulses U shown in Fig. 5. The image data signals  $E_{i1}$  are supplied to the D flip flop  $R_1$  for the first display block 1A, and the image data signals  $E_{i2}$  are supplied to the D flip flop  $R_1$  for the second display block 1B.

On the basis of the horizontal synchronizing pulses HP and the basic selection pulses U, a second converter circuit 2' generates basic clock pulse signals c, horizontal clock pulse signals  $c^l$  and selection signals  $U_1$  and  $U_2$ . In the present embodiment, the first and second converter circuit 2 and 2' are provided separately. They may be combined in one circuit. Outputs from the first and second converter circuits 2 and 2' are shown in Fig. 5.

Referring to Fig. 3, the selection signals  $U_1$  are supplied to D flip flops  $b_1$  and  $b_{101}$ , and the selection signals  $U_2$  to D flip flops  $b_2$  and  $b_{102}$ . The output from the D flip flop  $b_1$  is given to the first scanning electrode  $L_1$  via a scanning electrode driver  $a_1$ . The output from the D flip flop  $b_{101}$  is given to the scanning electrode  $L_{101}$  in the second display block 1B via a scanning electrode driver  $a_{101}$ . D flip flops  $b_3, b_5, \dots, b_{99}$  are connected in series after the D flip flop  $b_1$ , but they are not shown in Fig. 3. The outputs from the D flip flops  $b_3, b_5, \dots, b_{99}$  are connected via scanning electrode drivers  $a_3, a_5, \dots, a_{99}$  to the scanning electrodes  $L_3, L_5, \dots, L_{99}$  in the first display block 1A. Similarly, D flip flops  $b_{103}, b_{105}, \dots, b_{199}$  are connected in series after the D flip flop  $b_{101}$ , although they are not shown. The outputs from the D flip flops  $b_{103}, b_{105}, \dots, b_{199}$  are connected via scanning electrode drivers  $a_{103}, a_{105}, \dots, a_{199}$  to the scanning electrodes  $L_{103}, L_{105}, \dots, L_{199}$  in the second display block 1B.

The second selection signals  $U_2$  are provided to D flip flops  $b_2$  and  $b_{102}$ . Similarly, D flip flops  $b_4, b_6, \dots, b_{100}$  are connected in series after the D flip flop  $b_2$ , and D flip flops  $b_{104}, b_{106}, \dots, b_{200}$  after the D flip flop  $b_{102}$ . The D flip flops  $b_2, b_{100}, b_{102}$  and  $b_{200}$  drive the scanning electrodes  $L_2, L_{100}, L_{102}$  and  $L_{200}$  through the scanning electrode drivers  $a_2, a_{100}, a_{102}$  and  $a_{200}$ , respectively, as shown in Fig. 3. The D flip flops  $b_4, b_6, \dots, b_{98}$  and  $b_{104}, b_{106}, \dots, b_{198}$  drive the corresponding scanning electrodes in the same manner as the above but the description thereof is omitted here. The clock pulse signal inputs to the scanning electrodes from the D flip flops  $b_1, \dots, b_{200}$  are horizontal clock pulse signals  $c^l$  generated by the second converter circuit 2', and the clock pulse signal inputs to the signal electrodes from the D flip flops  $r_1, r_2, \dots, r_{640}$  are also the horizontal clock pulse signals  $c^l$ .

In the first frame, selection signals  $U_1$  are supplied to the data terminals of the D flip flops  $b_1$  and

$b_{101}$ . On the basis of the selection signals and the horizontal clock pulse signals  $c^l$  supplied as clock pulse signal inputs, the D flip flops  $b_1$  and  $b_{101}$  supply the scanning electrodes  $L_1$  and  $L_{101}$  with the output  $P_1$  shown in Fig. 5. The outputs  $P_1$  are also input to the data terminals of the following D flip flops  $b_3$  and  $b_{103}$  (not shown). On the basis of the signal input  $P_1$  and the horizontal clock pulse signals  $c^l$  supplied as clock pulse signal inputs, the D flip flops  $b_3$  and  $b_{103}$  output signals  $P_3$  of Fig. 5 to the scanning electrodes  $L_3$  and  $L_{103}$ . The similar pulses are output from the subsequent D flip flops to the corresponding scanning electrodes, and in the end of the first frame, the outputs from the D flip flops  $b_{97}$  and  $b_{197}$  are input to the data terminals and horizontal clock pulse signals to the clock terminals of the D flip flops  $b_{99}$  and  $b_{199}$ , which then supply the scanning electrodes  $L_{99}$  and  $L_{199}$  with signals  $P_{99}$  shown in Fig. 5. Thus, the first scanning electrodes of all groups are rewritten. In other words, rewrite signals are output sequentially to all the scanning electrodes of odd number in the first frame.

In the second frame, similar pulses are output from the D flip flops related to the second scanning electrodes of the groups, namely to the scanning electrodes of even number. The duration of the pulses  $P_1, P_3, \dots, P_{99}$  is set at "r" sec. (about 200  $\mu$ s in this embodiment) which is needed by liquid crystal to rewrite picture elements. "r/2" shown for the image data signal  $E_i$  in Fig. 5 is 100  $\mu$ s in this embodiment.

Referring to Fig. 5, in the duration of the pulse  $P_1$ , for example, the D flip flops  $r_1, r_2, \dots, r_{640}$  for the signal electrodes output signals to the first scanning line in the first display block 1A and to the 101st scanning line in the second display block 1B. Therefore, the scanning lines  $L_1$  and  $L_{101}$  are rewritten in the duration of the pulse  $P_1$ . Similarly, the scanning lines  $L_3$  and  $L_{103}$  are rewritten in the duration of the pulse  $P_3$ . Thus, the scanning lines of odd number  $L_1, L_3, \dots, L_{99}$ , and  $L_{101}, L_{103}, \dots, L_{199}$  are rewritten in the first frame, and the scanning lines of even number  $L_2, L_4, \dots, L_{100}$ , and  $L_{102}, L_{104}, \dots, L_{200}$  are rewritten in the second frame. In the third frame, the same scanning electrodes as in the first frame are rewritten.

In the second embodiment shown in Fig. 3, the number of scanning electrodes in each group  $K'$  is assumed to be 2 so that a picture is completed in two frames. It should be understood that the second embodiment shown in Fig. 3 can be modified easily to set  $K'$  to any desired value other than 2.

The effect of the present invention with  $K$  (or  $K'$ ) = 2 as shown in Figs. 1 and 3 is explained with reference to Fig. 6. When a figure "1" is kept written on the display screen, the luminance of the figure on the scanning electrodes  $L_1, L_2, L_3$  and  $L_4$  is shown in Figs. 6(1), 6(2), 6(3) and 6(4). The combined luminance of the 4 (vertical)  $\times$  4 (horizontal) picture elements is shown in Fig. 6(5). It means that the apparent frequency for rewriting the entire image is 50 Hz al-

though each scanning line is rewritten at 25 Hz. According to the present invention, therefore, flicker decreases and the picture quality improves compared with the picture by the conventional device in which an entire picture is rewritten at 25 Hz. With  $K = 2$ , every other scanning line is rewritten in each frame. With  $K = 3$ , every third line is rewritten in each frame.

According to the present invention, as mentioned above, the display device which provides an incomplete memory characteristic and takes a specified time to rewrite the picture elements in one horizontal scanning period decreases flicker by increasing the apparent speed of rewriting the picture elements. This results in improved picture quality.

In the above embodiments of the present invention, it is assumed that the number of effective scanning lines in the effective display region is  $M$ . The total number of scanning lines in the display device may be greater than  $M$ . For  $M = 200$ , for instance, the total number of scanning line may be, say, 262.

While only certain embodiments of the present invention have been described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the present invention as claimed.

## Claims

1. A display device (1) for receiving a non-interlaced image signal ( $E_i$ ) and displaying said received non-interlaced image signal ( $E_i$ ) by an interlaced scanning method, said device (1) comprising:

a matrix type liquid crystal display panel interposing a ferroelectric liquid crystal between plural scanning electrodes and plural signal electrodes, said scanning electrodes and said signal electrodes being arranged in directions intersecting each other, said ferroelectric liquid crystal constituting picture elements at intersections of said scanning electrodes and said signal electrodes, said picture elements having memory without utilising active-matrix driving elements; characterized by

$M$  scanning electrodes disposed on the display panel and divided into a plurality of groups, each group containing  $K$  scanning electrodes wherein  $K$  and  $M$  are integers and  $K$  is greater than 2; and

supplying means ( $2, b_1 - b_M$ ) for supplying scanning signals to drivers ( $a_1 - a_M$ ) connected to the  $M$  scanning electrodes in order to write data corresponding to said non-interlaced image signal ( $E_i$ ) to said picture elements, said supplying means including selecting means for successively selecting each of said  $K$  scanning electrodes of each of said groups, and means for successively applying a select voltage to a selected scanning

electrode and applying a non-select voltage to non-selected scanning electrodes,

said means for successively applying a select voltage being adapted such that said select voltage is applied to a first scanning electrode of each group in a first display device field period, to a second scanning electrode of each group in a second display device field period, and to a Kth scanning electrode of each group in a Kth display device field period so that picture elements on the M scanning electrodes are rewritten in a display device frame period which is K times longer than a display device field period, thereby displaying said received non-interlaced image signal ( $E_i$ ) on said display panel at a display device field frequency which is K times higher than a display device frame frequency.

2. A display device (1) for receiving a non-interlaced image signal ( $E_i$ ) and displaying the received non-interlaced image signal ( $E_i$ ) by an interlaced scanning method, said device taking a specified period to rewrite the picture elements in one horizontal scanning period, said device (1) comprising:

a matrix type liquid crystal display panel containing a ferroelectric liquid crystal; characterized by

M scanning lines disposed on the display panel and divided into a plurality of groups, each containing K scanning lines, wherein K and M are integers and K is greater than 2; and

supplying means ( $2, b_1-b_M, a_1-a_M$ ) for supplying scanning signals to the M scanning lines to rewrite said non-interlaced image signal, said supplying means including selection means for sequentially outputting K select signals, delay means for successively delaying each of the K select signals, and means for successively applying each sequentially output select signal, successively delayed, to corresponding scanning lines of each of the plurality of groups,

said supplying means being adapted such that a scanning signal is outputted to the first scanning line of each group in a first display device field period, to the second scanning line of each group in a second display device field period, and to the Kth scanning line of each group in a Kth display device field period so that picture elements on the M scanning lines are rewritten by K times of scanning, thereby displaying said received non-interlaced image signal ( $E_i$ ) on said display panel at a display device field frequency which is K times higher than a display device frame frequency.

3. A liquid crystal display device including a ferroelectric liquid crystal display panel of matrix type

and a conversion means for converting a received non-interlaced image signal into a driving signal to be used for image writing in said display panel, characterized in that, when a period of time required for rewriting a picture element of said display panel is r, and a frame frequency and the number of horizontal scanning lines of said received non-interlaced image signal are S and N respectively, said conversion means generates a first field of said driving signal by extracting first, (K+1)th, (2K+1)th, (3K+1)th, ... horizontal scanning lines from a first frame of said received non-interlaced image signal, generates a second field of said driving signal by extracting second, (K+2)th, (2K+2)th, (3K+2)th ... horizontal scanning lines from a second frame of said received non-interlaced image signal, and generates subsequent fields in the same manner up to Kth frame, where K is an integer equal to or greater than 2 satisfying an inequality  $r \leq K/(N \cdot S)$ , so that one frame of said driving signal constituted by K fields is produced from K successive frames of said received non-interlaced image signal.

4. A method for converting a received non-interlaced image signal into a driving signal to be used for image writing in a liquid crystal display device including a ferroelectric liquid crystal display panel of matrix type characterized in that, when a period of time required for rewriting a picture element of said display panel is r, and a frame frequency and the number of horizontal scanning lines of said received non-interlaced image signal are S and N respectively, said method comprises the steps of generating a first field of said driving signal by extracting first, (K+1)th, (2K+1)th, (3K+1)th, ... horizontal scanning lines from a first frame of said received non-interlaced image signal, generating a second field of said driving signal by extracting second, (K+2)th, (2K+2)th, (3K+2)th, ... horizontal scanning lines from a second frame of said received non-interlaced image signal, and generating subsequent fields in the same manner up to Kth frame, where K is an integer equal to or greater than 2 satisfying an inequality  $r \leq K/(N \cdot S)$ , so that one frame of said driving signal constituted by K fields is produced from K successive frames of said received non-interlaced image signal.

## Patentansprüche

1. Anzeigevorrichtung zur Sichtdarstellung eines nichtverschachtelten Bildsignals ( $E_i$ ) mittels eines Zeilensprungverfahrens mit einem Matrix-Flüssigkristall-Anzeigepanel, bei dem ein ferroelektrischer Flüssigkristall zwischen mehreren

Abtastelektroden und mehreren Signalelektroden und die Abtastelektroden und die Signalelektroden in sich überkreuzenden Richtungen angeordnet sind, bei dem der ferroelektrische Flüssigkristall an Schnittpunkten der Abtastelektroden und Signalelektroden Bildpunkte darstellt und diese Bildpunkte ohne Verwendung von Aktiv-Matrix-Steuerungselementen einen Speicher bilden, **gekennzeichnet durch:**

- auf dem Anzeigepanel angebrachte und in eine Mehrzahl von Gruppen eingeteilte M Abtastelektroden, wobei jede Gruppe K Abtastelektroden umfaßt und K und M ganzzahlig sind und K größer als 2 ist; und
  - Schaltmittel ( $2, b_1 - b_M$ ), welche mit den M Abtastelektroden verbundene Treiber ( $a_1 - a_M$ ) durch Abtastsignale beaufschlagen, um entsprechend dem nichtverschachtelten Signal ( $E_i$ ) Daten an den Bildpunkten zu schreiben, wobei die Schaltmittel ein Auswahlmittel zum sukzessiven Auswählen jeder der K Abtastelektroden aus jeder der Gruppen und ein Mittel zum sukzessiven Anlegen einer Auswahlspannung an eine ausgewählte Abtastelektrode und zum Anlegen einer Nichtauswahl-Spannung an nichtausgewählte Abtastelektroden umfaßt, wobei das Mittel zum sukzessiven Anlegen der Auswahlspannung so ausgelegt ist, daß die Auswahlspannung an eine erste Abtastelektrode jeder Gruppe in einer ersten Teilbildperiode, an eine zweite Abtastelektrode jeder Gruppe in einer zweiten Teilbildperiode und an eine K-te Abtastelektrode jeder Gruppe in einer K-ten Teilbildperiode angelegt wird, so daß Bildpunkte auf den M Abtastelektroden in einer Vollbildperiode, die K-mal länger als eine Anzeigevorrichtungsteilbildperiode ist, wiedereingeschrieben werden, wodurch das empfangene nichtverschachtelte Signal ( $E_i$ ) auf dem Anzeigepanel mit einer Teilbildfrequenz angezeigt wird, die K-mal höher als die Vollbildfrequenz ist.
2. Anzeigevorrichtung für ein nichtverschachteltes Bildsignal ( $E_i$ ) mittels eines Zeilensprungverfahrens, welche eine bestimmte Zeitdauer zum Wiedereinschreiben der Bildpunkte in einer horizontalen Abtastperiode benötigt und ein Matrix-Flüssigkristall-Anzeigepanel mit ferroelektrischem Flüssigkristall aufweist, **gekennzeichnet durch:**
- auf dem Anzeigepanel angebrachte und in eine Mehrzahl von Gruppen eingeteilte M Abtastleitungen, wobei jede Gruppe K Abtastleitungen umfaßt, und K und M ganzzahlig sind und K größer als 2 ist; und
  - Schaltmittel ( $2, b_1 - b_M, a_1 - a_M$ ), welche die

M Abtastleitungen mit Abtastsignalen beaufschlagen, um das nichtverschachtelte Signal wiedereinzuschreiben, wobei das Schaltmittel ein Auswahlmittel zum sequentiellen Ausgeben von K Auswahlsignalen, eine Verzögerungseinrichtung zum sukzessiven Verzögern jedes der K Auswahlsignale und ein Mittel zum sukzessiven Anlegen jedes sequentiellen, sukzessive verzögerten Ausgabeauswahlsignals entsprechend den Abtastleitungen aus jeder der Mehrzahl von Gruppen umfaßt, wobei das Schaltmittel so ausgelegt ist, daß ein Abtastsignal an die erste Abtastzeile jeder Gruppe in einer ersten Teilbildperiode, an die zweite Abtastzeile jeder Gruppe in einer zweiten Teilbildperiode und an die K-te Abtastzeile jeder Gruppe in einer K-ten Teilbildperiode ausgegeben wird, so daß Bildpunkte auf den M Abtastleitungen durch K-maliges Abtasten wiedereingeschrieben werden, wodurch das empfangene nichtverschachtelte Signal ( $E_i$ ) auf dem Anzeigepanel mit einer Teilbildfrequenz angezeigt wird, die K-mal höher als die Vollbildfrequenz ist.

3. Flüssigkristall-Anzeigevorrichtung mit ferroelektrischem Flüssigkristall-Anzeigepanel des Matrix-Typs und einer Umsetzerschaltung zum Umwandeln eines empfangenen nichtverschachtelten Signals in ein Treiber-Bildsignal für das Anzeigepanel, **dadurch gekennzeichnet**, daß die Umsetzerschaltung, sofern die Zeitdauer zum Wiedereinschreiben eines Bildpunktes  $r$  ist, während die Vollbildfrequenz und die Anzahl der horizontalen Abtastzeilen des empfangenen nichtverschachtelten Signals  $S$  bzw.  $N$  sind, ein erstes Teilbild des Treibersignals durch Abfragen von ersten,  $(K+1)$ -ten,  $(2K+1)$ -ten,  $(3K+1)$ -ten, ... horizontalen Abtastzeilen aus einem ersten Vollbild des empfangenen nichtverschachtelten Signals erzeugt, ein zweites Teilbild des Treibersignals durch Abfragen von zweiten,  $(K+2)$ -ten,  $(2K+2)$ -ten,  $(3K-2)$ -ten, ... horizontalen Abtastzeilen aus einem zweiten Vollbild des empfangenen nichtverschachtelten Signals erzeugt und weitere Teilbilder auf die gleiche Weise bis zu dem K-ten Vollbild erzeugt werden, wobei K eine ganze Zahl und größer gleich 2 ist, welche die Ungleichung  $r \leq K/(N-S)$  erfüllt, so daß ein Vollbild des Treibersignals bestehend aus K Teilbildern aus K aufeinanderfolgenden Vollbildern des empfangenen nichtverschachtelten Signals generiert wird.
4. Verfahren zum Umwandeln eines empfangenen nichtverschachtelten Signals in ein Treibersignal zur Bilddarstellung auf einer Flüssigkristall-An-

zeigevorrichtung mit ferroelektrischem Flüssigkristallpanel des Matrix-Typs, **dadurch gekennzeichnet**, daß das Verfahren, wenn die Zeitdauer zum Wiedereinschreiben eines Bildpunktes des Anzeigepanels  $r$  ist, während die Vollbildfrequenz und die Anzahl der horizontalen Abtastzeilen des empfangenen nichtverschachtelten Signals  $S$  bzw.  $N$  sind, folgende Schritte aufweist:

- Erzeugen eines ersten Teilbildes des Treibersignals durch Abfragen von ersten,  $(K+1)$ -ten,  $(2K+1)$ -ten,  $(3K+1)$ -ten, ... horizontalen Abtastzeilen eines ersten Vollbildes des empfangenen nichtverschachtelten Signals,
- Erzeugen eines zweiten Teilbildes des Treibersignals durch Abfragen von zweiten,  $(K+2)$ -ten,  $(2K+2)$ -ten,  $(3K+2)$ -ten, ... horizontalen Abtastzeilen eines zweiten Vollbildes des empfangenen nichtverschachtelten Signals und
- Erzeugen weiterer Teilbilder auf die gleiche Weise bis zu dem  $K$ -ten Vollbild, wobei  $K$  eine ganze Zahl größer gleich 2 ist, welche die Ungleichung  $r \leq K/(N-S)$  erfüllt, so daß ein Vollbild des Treibersignals bestehend aus  $K$  Teilbildern aus  $K$  aufeinanderfolgenden Vollbildern des empfangenen nichtverschachtelten Signals generiert wird.

## Revendications

1. Dispositif d'affichage (1) destiné à recevoir un signal d'image non entrelacé ( $E_i$ ) et à afficher ledit signal d'image non entrelacé reçu ( $E_i$ ) selon un procédé de balayage entrelacé, ledit dispositif (1) comprenant:

un panneau d'affichage à cristaux liquides du type à matrice comportant des cristaux liquides ferroélectriques interposés entre plusieurs électrodes de balayage et plusieurs électrodes de signal, lesdites électrodes de balayage et lesdites électrodes de signal étant disposées dans des directions qui se coupent l'une l'autre, lesdits cristaux liquides ferroélectriques constituant des éléments d'image aux intersections desdites électrodes de balayage et desdites électrodes de signal, lesdits éléments d'image ayant une mémoire sans l'utilisation d'éléments d'attaque à matrice active; caractérisé par

$M$  électrodes de balayage placées sur le panneau d'affichage et réparties en plusieurs groupes, chaque groupe renfermant  $K$  électrodes de balayage,  $K$  et  $M$  étant des nombres entiers et  $K$  étant supérieur à 2; et

des moyens de fourniture ( $2, b_1$  à  $b_M, a_1$  à  $a_M$ ) destinés à fournir des signaux de balayage à des circuits d'attaque ( $a_1$  à  $a_M$ ) reliés aux  $M$  électrodes

de balayage, afin d'inscrire des données correspondant audit signal d'image non entrelacé ( $E_i$ ) sur lesdits éléments d'image, lesdits moyens de fourniture comprenant des moyens de sélection pour sélectionner successivement chacune desdites  $K$  électrodes de balayage de chacun desdits groupes, et des moyens pour successivement appliquer une tension de sélection à une électrode de balayage sélectionnée et appliquer une tension de non sélection à des électrodes de balayage non sélectionnées,

lesdits moyens pour successivement appliquer une tension de sélection étant conçus de telle façon que ladite tension de sélection soit appliquée à une première électrode de balayage de chaque groupe dans une première période de trame du dispositif d'affichage, à une deuxième électrode de balayage de chaque groupe dans une deuxième période de trame du dispositif d'affichage, et à une  $K$ ième électrode de balayage de chaque groupe dans une  $K$ ième période de trame du dispositif d'affichage, afin que des éléments d'image situés sur les  $M$  électrodes de balayage soient réécrits dans une période d'image du dispositif d'affichage qui est  $K$  fois plus longue qu'une période de trame du dispositif d'affichage, ledit signal d'image non entrelacé reçu ( $E_i$ ) étant ainsi affiché sur ledit panneau d'affichage à une fréquence de trame du dispositif d'affichage qui est  $K$  fois plus élevée qu'une fréquence d'image du dispositif d'affichage.

2. Dispositif d'affichage (1) destiné à recevoir un signal d'image non entrelacé ( $E_i$ ) et à afficher le signal d'image non entrelacé reçu ( $E_i$ ) selon un procédé de balayage entrelacé, ledit dispositif prenant une période définie pour réécrire les éléments d'image dans une période de balayage horizontal, ledit dispositif (1) comprenant:

un panneau d'affichage à cristaux liquides du type à matrice contenant des cristaux liquides ferroélectriques; caractérisé par

$M$  lignes de balayage placées sur le panneau d'affichage et réparties en plusieurs groupes renfermant chacun  $K$  lignes de balayage,  $K$  et  $M$  étant des nombres entiers et  $K$  étant supérieur à 2; et

des moyens de fourniture ( $2, b_1$  à  $b_M, a_1$  à  $a_M$ ) pour fournir des signaux de balayage aux  $M$  lignes de balayage afin de réécrire ledit signal d'image non entrelacé, lesdits moyens de fourniture comprenant des moyens de sélection pour délivrer séquentiellement  $K$  signaux de sélection, des moyens de retardement pour retarder successivement chacun des  $K$  signaux de sélection, et des moyens pour appliquer successivement chacun des signaux de sélection délivrés séquentiellement, successivement retardés, à des

lignes de balayage correspondantes de chacun des groupes;

lesdits moyens de fourniture étant conçus de telle façon qu'un signal de balayage soit délivré à la première ligne de balayage de chaque groupe dans une première période de trame du dispositif d'affichage, à la deuxième ligne de balayage de chaque groupe dans une deuxième période de trame du dispositif d'affichage, et à la Kième ligne de balayage de chaque groupe dans une Kième période de trame du dispositif d'affichage, afin que des éléments d'image situés sur les M lignes de balayage soient réécrits en réalisant K fois un balayage, ledit signal d'image non entrelacé reçu ( $E_i$ ) étant ainsi affiché sur ledit panneau d'affichage à une fréquence de trame du dispositif d'affichage qui est K fois plus élevée qu'une fréquence d'image du dispositif d'affichage.

3. Dispositif d'affichage à cristaux liquides comprenant un panneau d'affichage à cristaux liquides ferroélectriques du type à matrice et un moyen de conversion pour convertir un signal d'image non entrelacé reçu en un signal d'attaque appelé à être utilisé pour inscrire une image dans ledit panneau d'affichage, caractérisé en ce que, quand une période de temps requise pour réécrire un élément d'image dudit panneau d'affichage est r, et qu'une fréquence d'image et le nombre de lignes de balayage horizontal dudit signal d'image non entrelacé reçu sont respectivement S et N, ledit moyen de conversion engendre une première trame dudit signal d'attaque en extrayant les première, (K+1)ième, (2K+1)ième, (3K+1)ième, ... lignes de balayage horizontal d'une première image dudit signal d'image non entrelacé reçu, engendre une deuxième trame dudit signal d'attaque en extrayant les deuxième, (K+2)ième, (2K+2)ième, (3K+2)ième ... lignes de balayage horizontal d'une deuxième image dudit signal d'image non entrelacé reçu, et engendre des trames consécutives de la même manière jusqu'à la Kième image, K étant un nombre entier égal ou supérieur à 2 satisfaisant l'inégalité  $r \leq K/(N-S)$ , de sorte qu'une image dudit signal d'attaque constituée par K trames est produite à partir de K images successives dudit signal d'image non entrelacé reçu.

4. Procédé pour convertir un signal d'image non entrelacé reçu en un signal d'attaque appelé à être utilisé pour inscrire une image dans un dispositif d'affichage à cristaux liquides comprenant un panneau d'affichage à cristaux liquides ferroélectriques du type à matrice, caractérisé en ce que, quand une période de temps requise pour réécrire un élément d'image dudit panneau d'af-

fichage est r, et qu'une fréquence d'image et le nombre de lignes de balayage horizontal dudit signal d'image non entrelacé reçu sont respectivement S et N, ledit procédé comprend les étapes consistant à engendrer une première trame dudit signal d'attaque en extrayant les première, (K+1)ième, (2K+1)ième, (3K+1)ième, ... lignes de balayage horizontal d'une première image dudit signal d'image non entrelacé reçu, à engendrer une deuxième trame dudit signal d'attaque en extrayant les deuxième, (K+2)ième, (2K+2)ième, (3K+2)ième, ... lignes de balayage horizontal d'une deuxième image dudit signal d'image non entrelacé reçu, et à engendrer des trames consécutives de la même manière jusqu'à la Kième image, K étant un nombre entier égal ou supérieur à 2 qui satisfait l'inégalité  $r \leq K/(N-S)$ , de sorte qu'une image dudit signal d'attaque constituée de K trames est produite à partir de K images successives dudit signal d'image non entrelacé reçu.

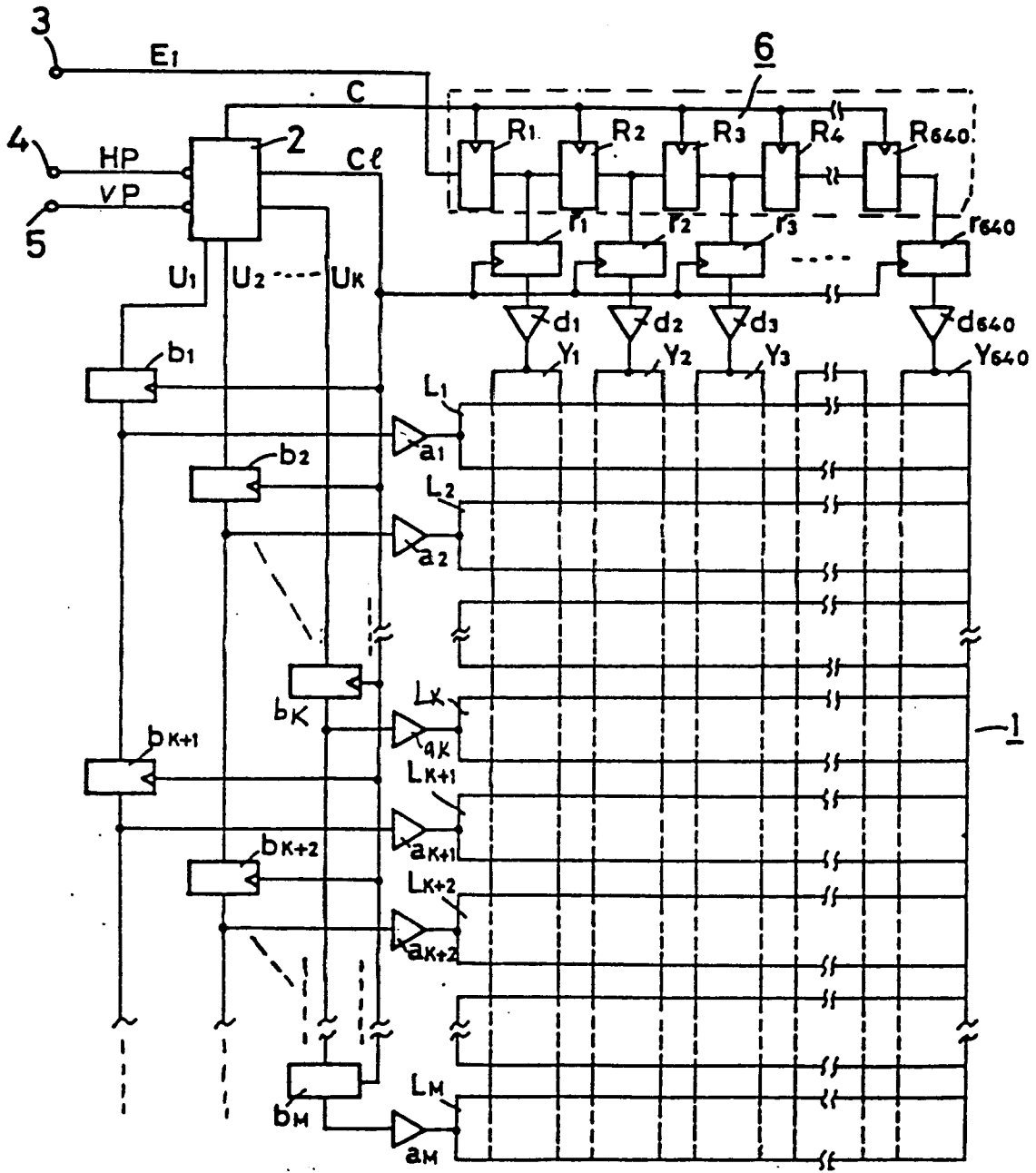


Fig. 1

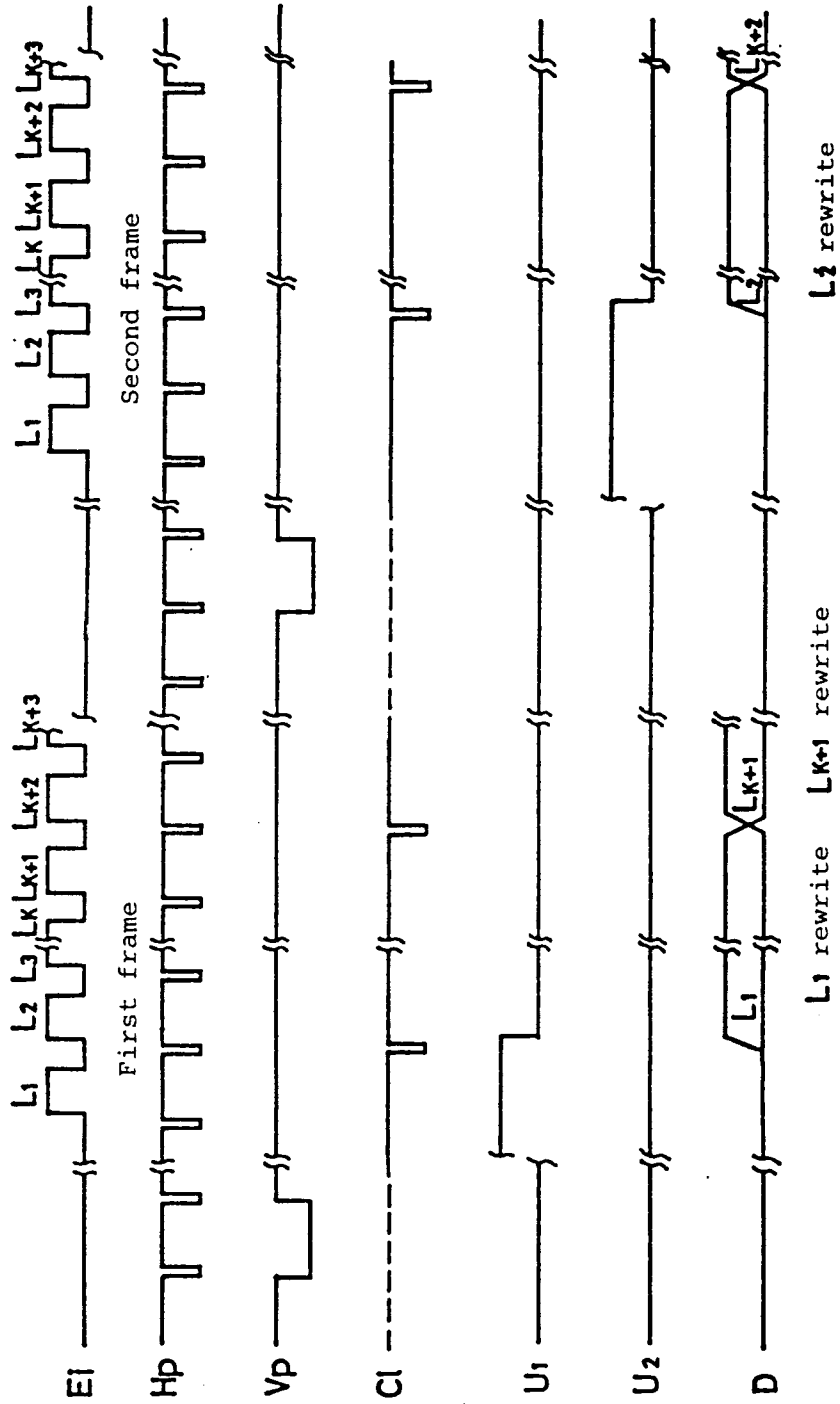


Fig. 2

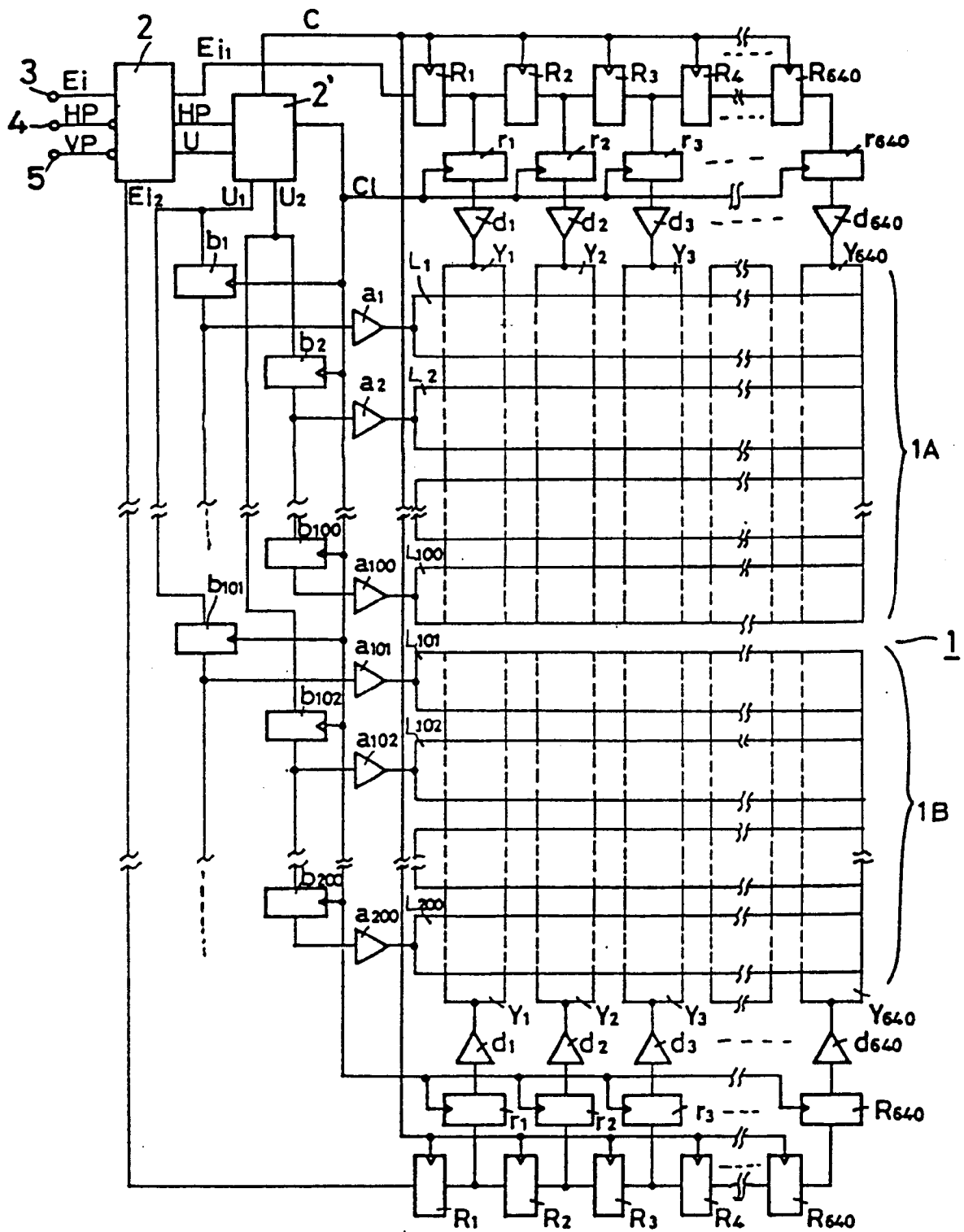


Fig. 3

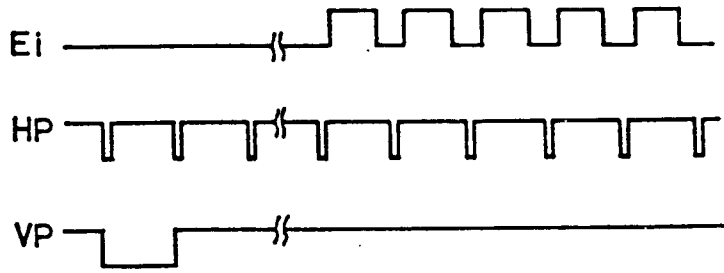


Fig. 4

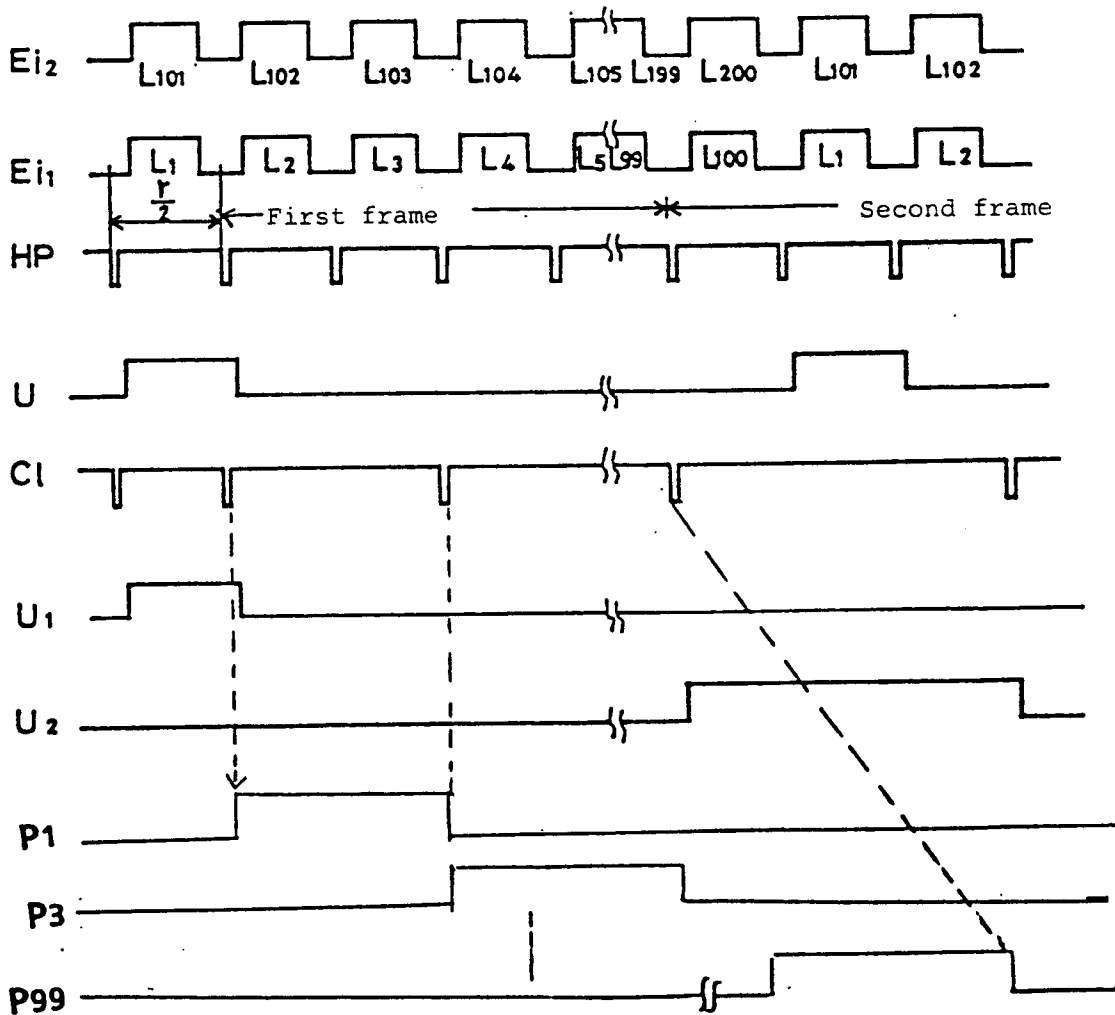


Fig. 5

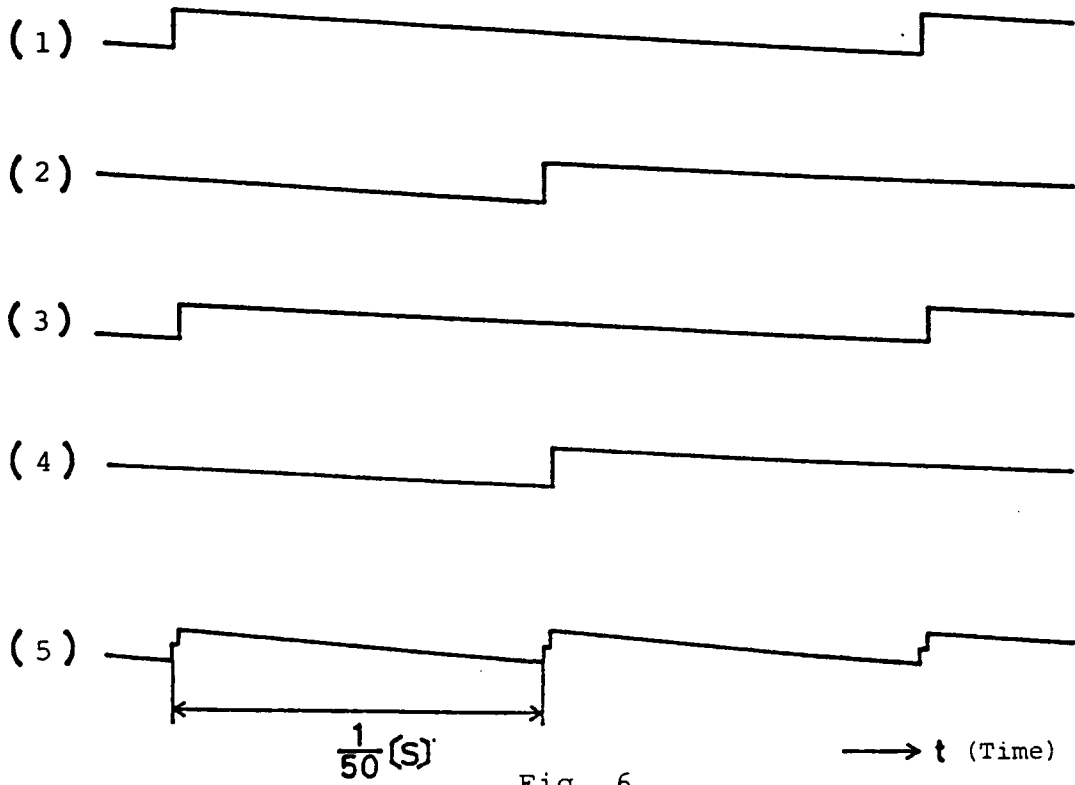


Fig. 6

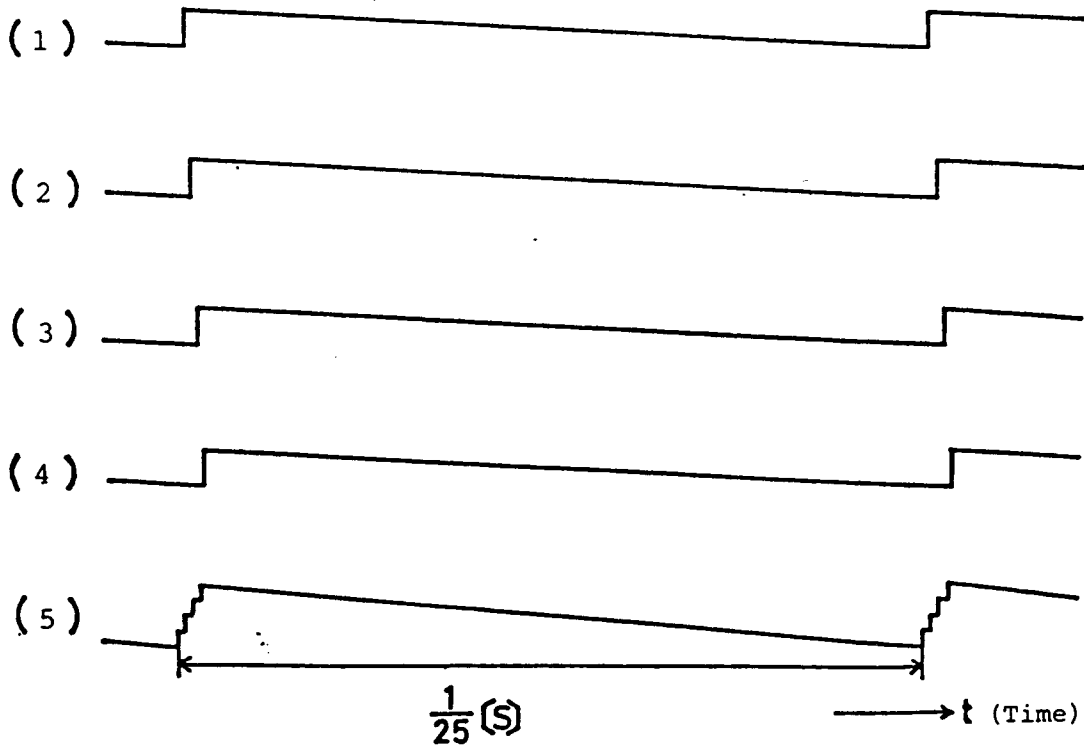


Fig. 7