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(54) **ELECTRONIC CIRCUIT,  
ELECTROLUMINESCENT DISPLAY  
DEVICE, ELECTRO-OPTICAL DEVICE,  
ELECTRONIC APPARATUS, METHOD OF  
CONTROLLING THE CURRENT SUPPLY TO  
AN ORGANIC ELECTROLUMINESCENT  
PIXEL, AND METHOD FOR DRIVING A  
CIRCUIT**

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(52) **U.S. Cl.** ..... **345/76**

**ABSTRACT**

The invention provides an electronic circuit that can include a programming path and a reproduction path. The circuit can further include a current driven element, a transistor in the production path arranged so as to operatively control a current supplied to the current driven element, a capacitor arranged for storing an operating voltage of the transistor, an additional transistor arranged in parallel to the transistor in the programming path for storing the capacitor and the operating voltage, and a switching device that controls the programming path and the reproduction path.

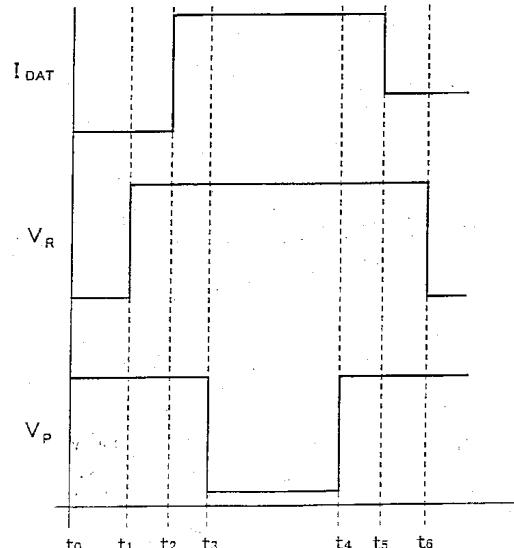
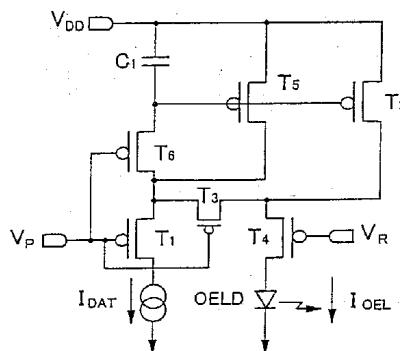


FIG.1

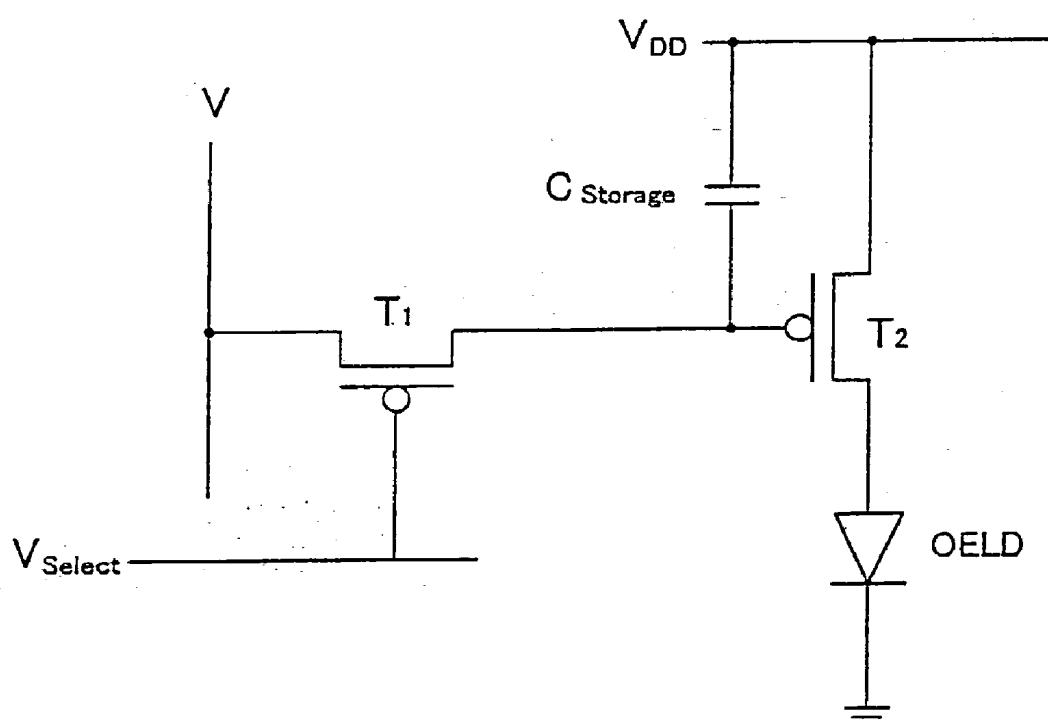


FIG.2

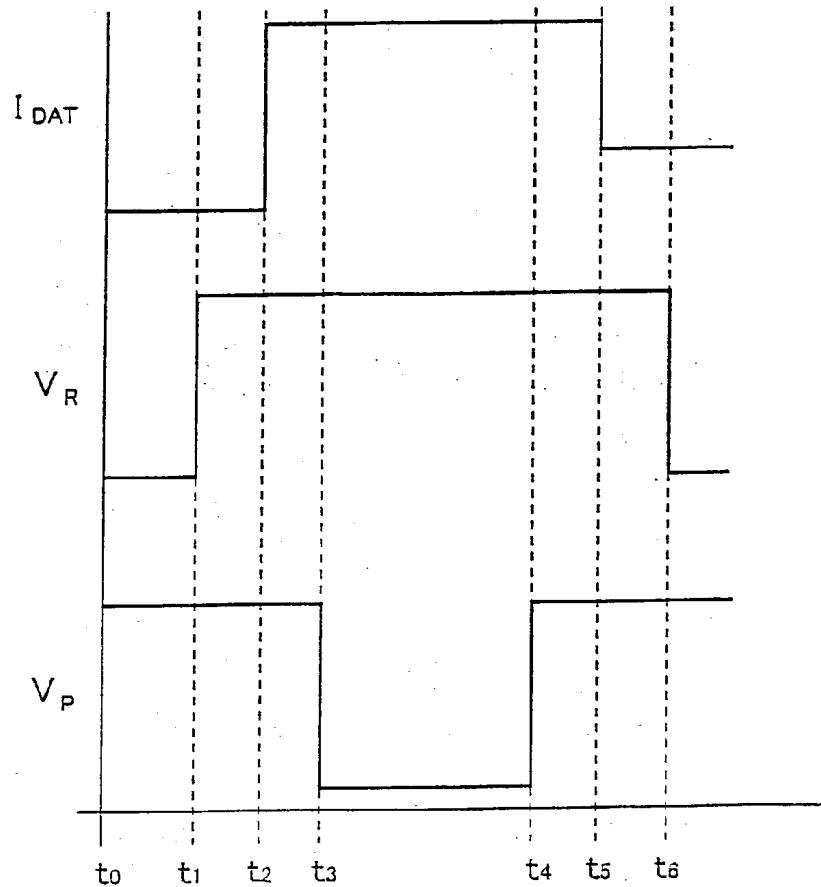
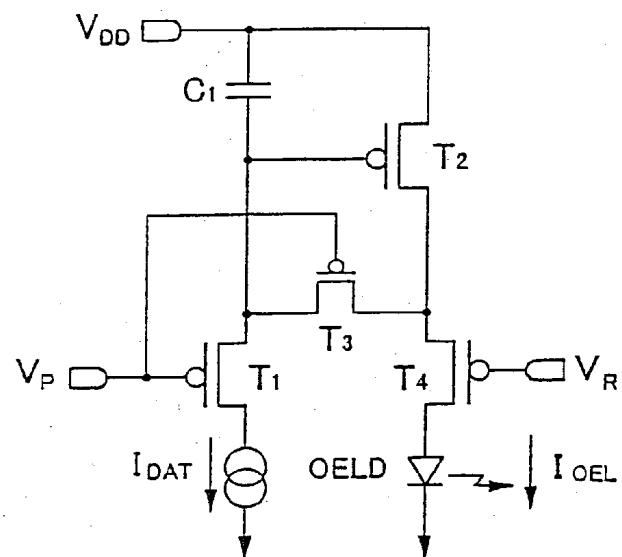


FIG.3

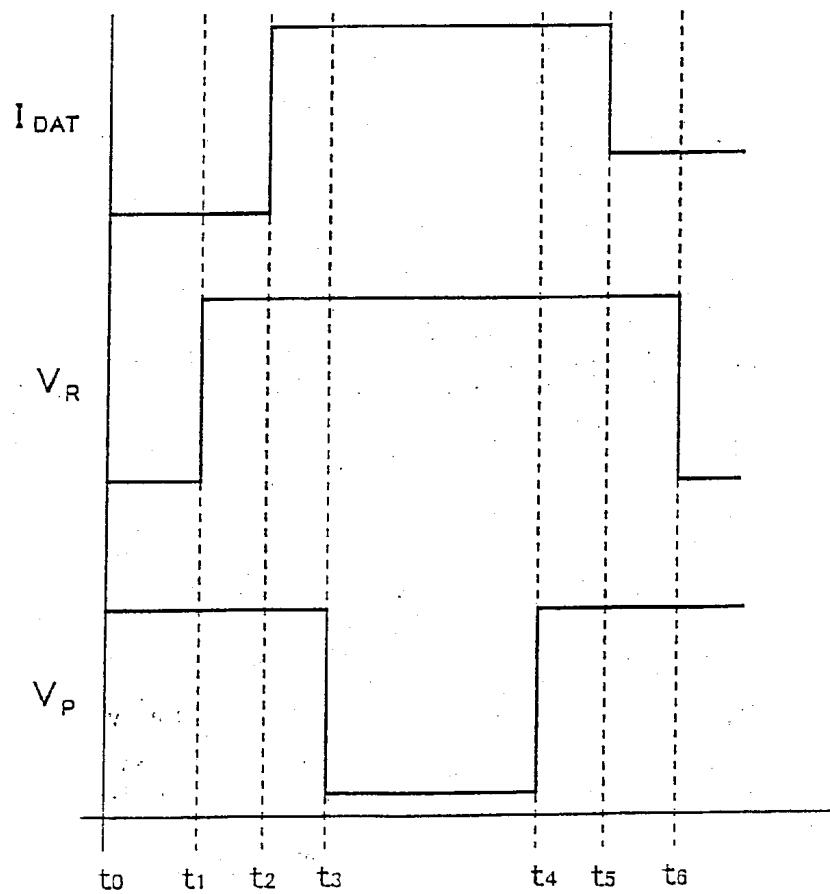
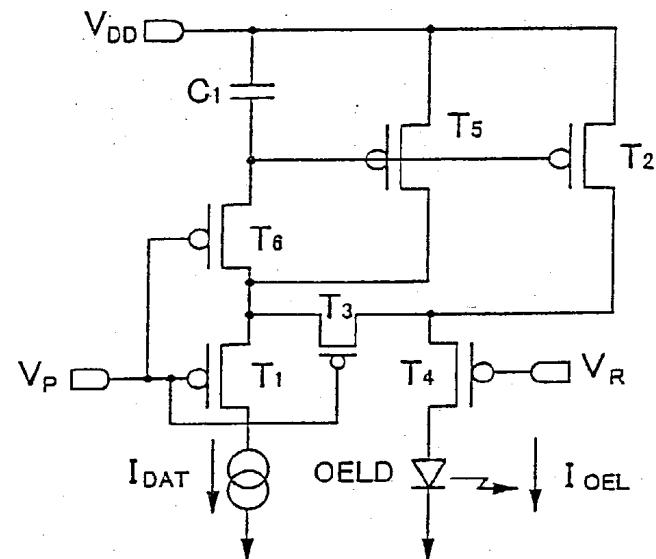


FIG.4

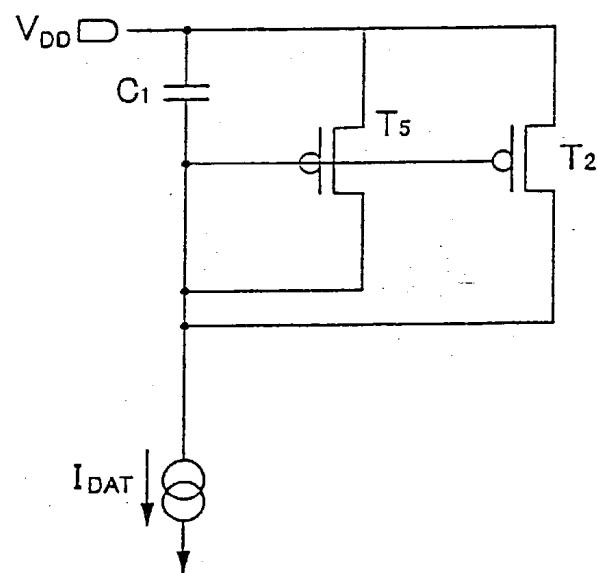


FIG.5

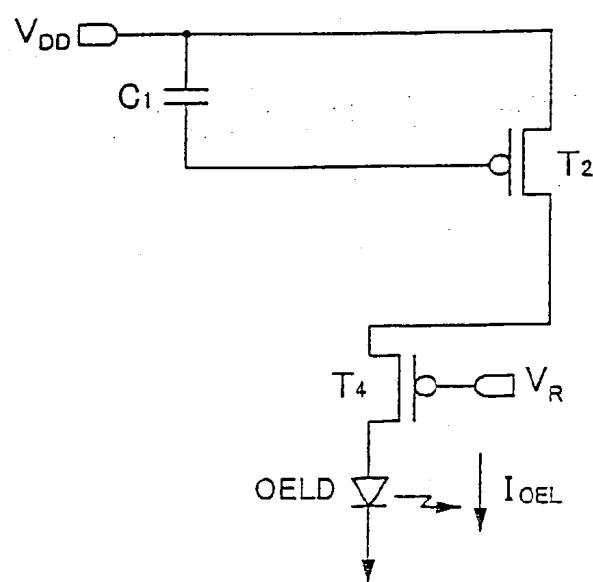


FIG. 6A

	$I_{DAT}$	$I_{QEL}$
the circuit in Fig.2	100 nA	100 nA
the invention	1 $\mu$ A	

FIG. 6B

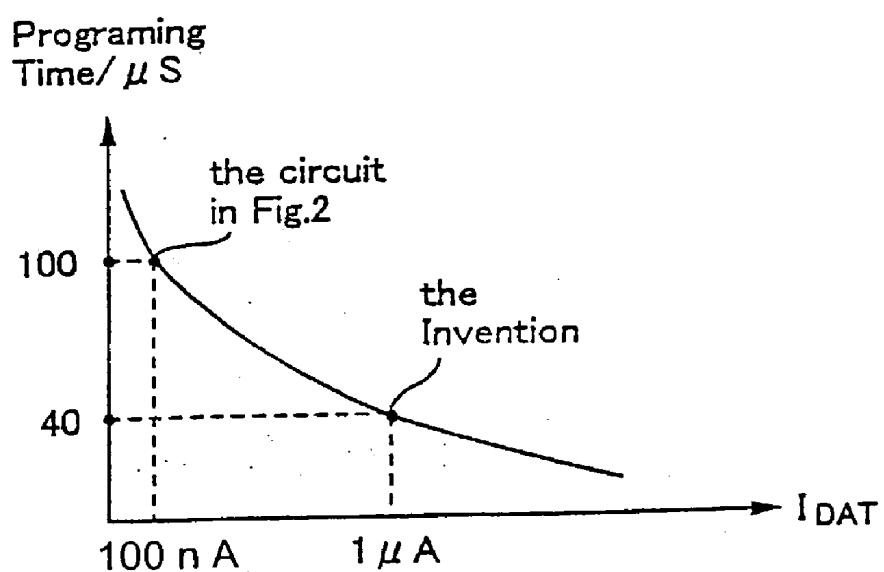


FIG. 7

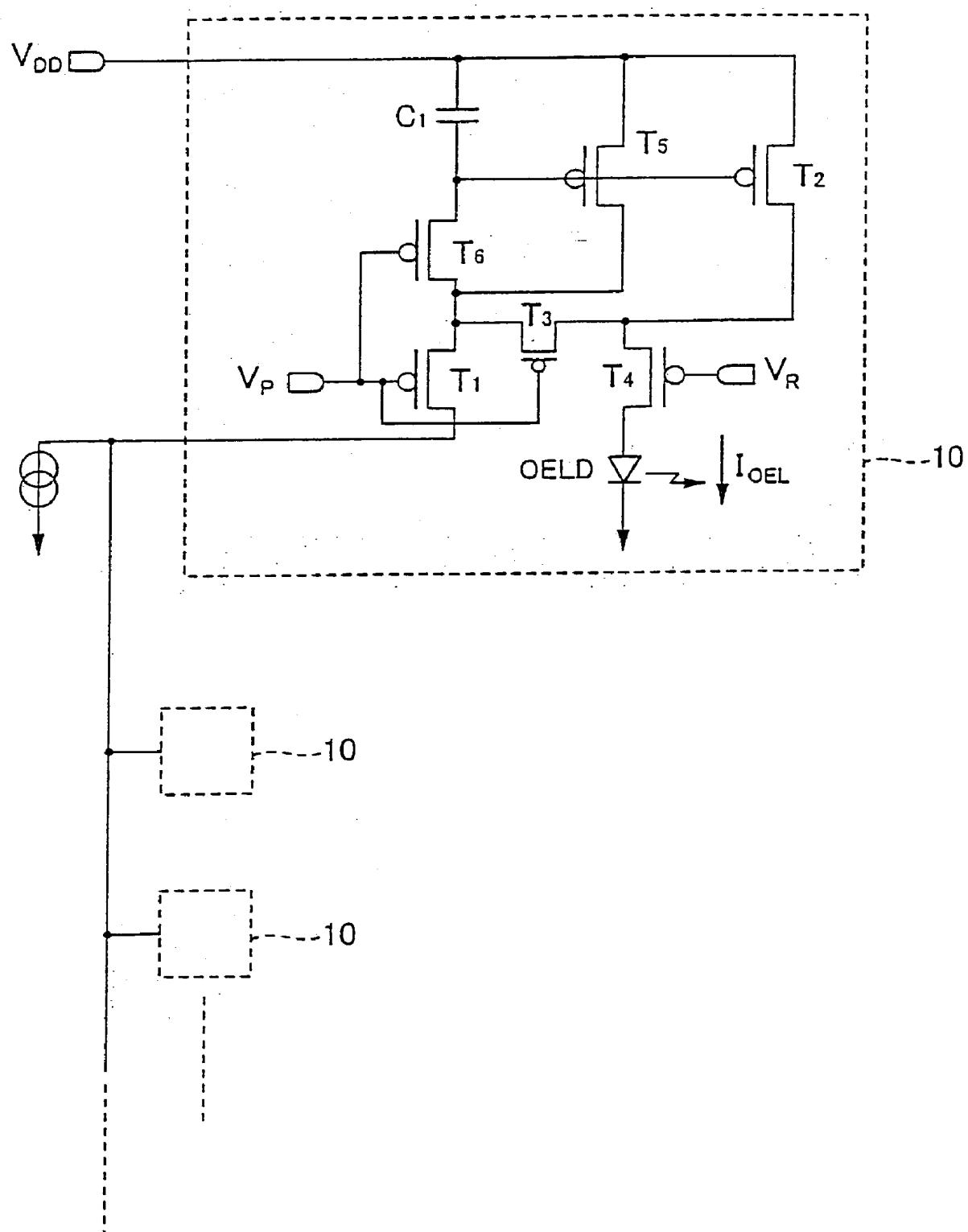


FIG.8

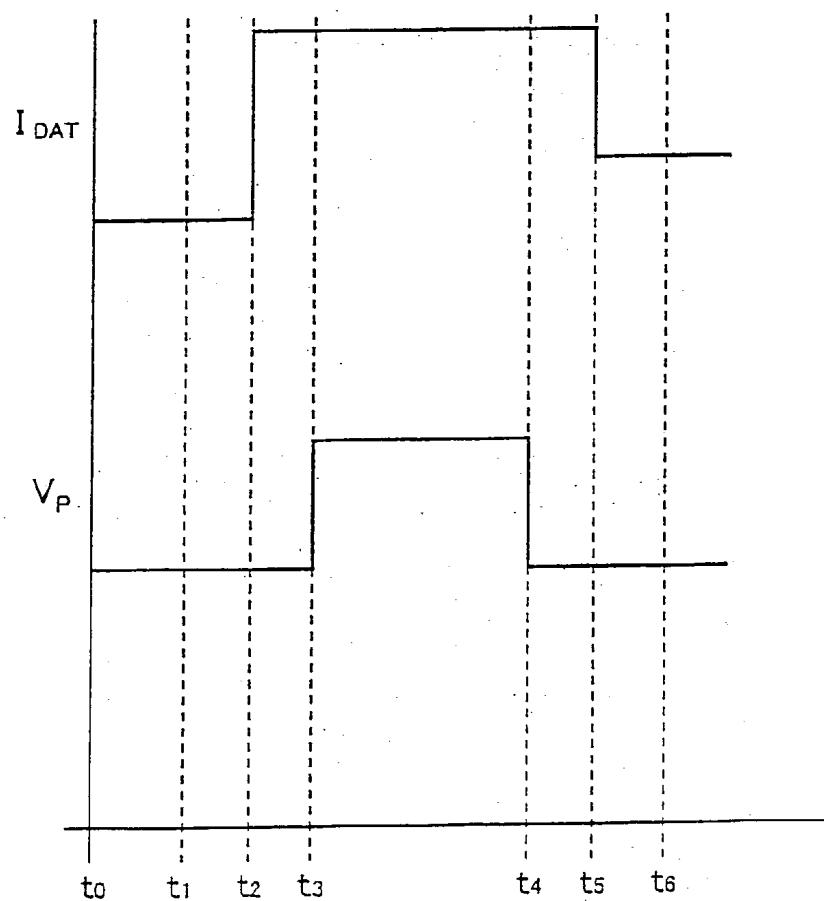
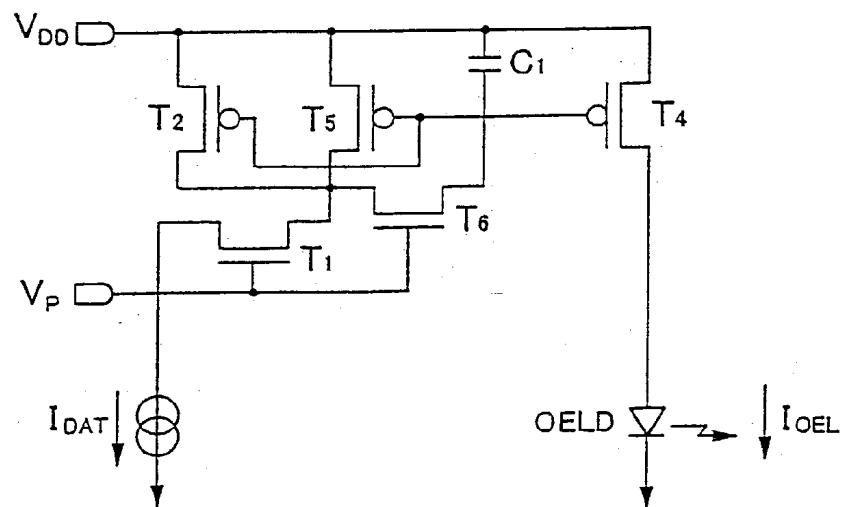


FIG. 9

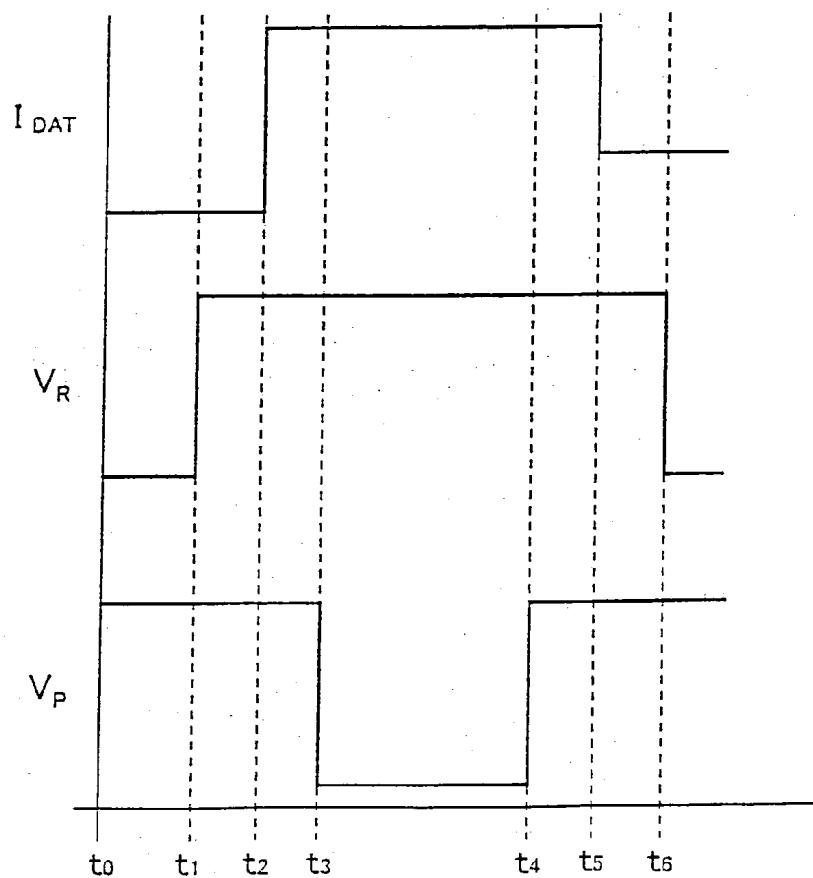
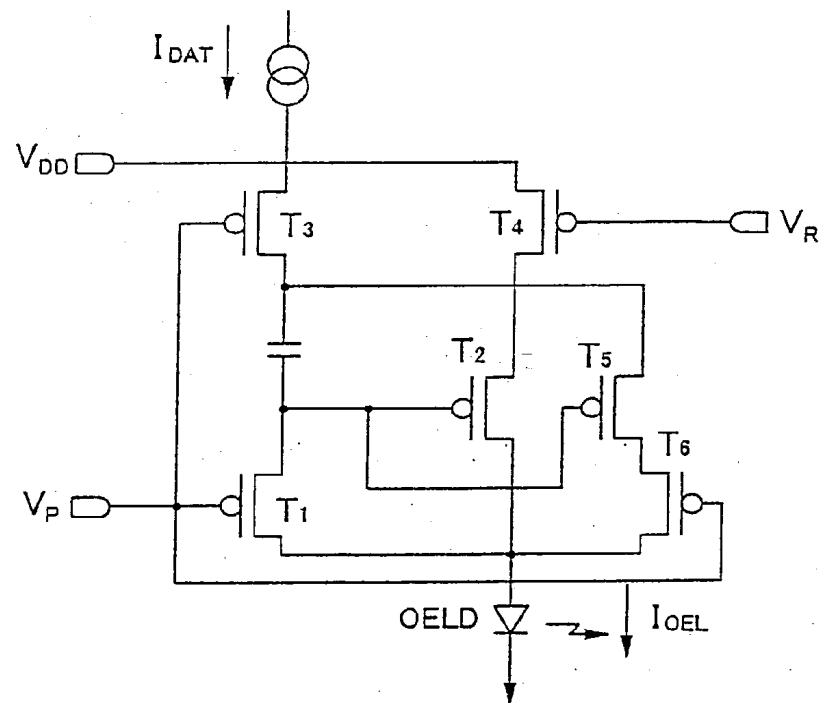


FIG.10

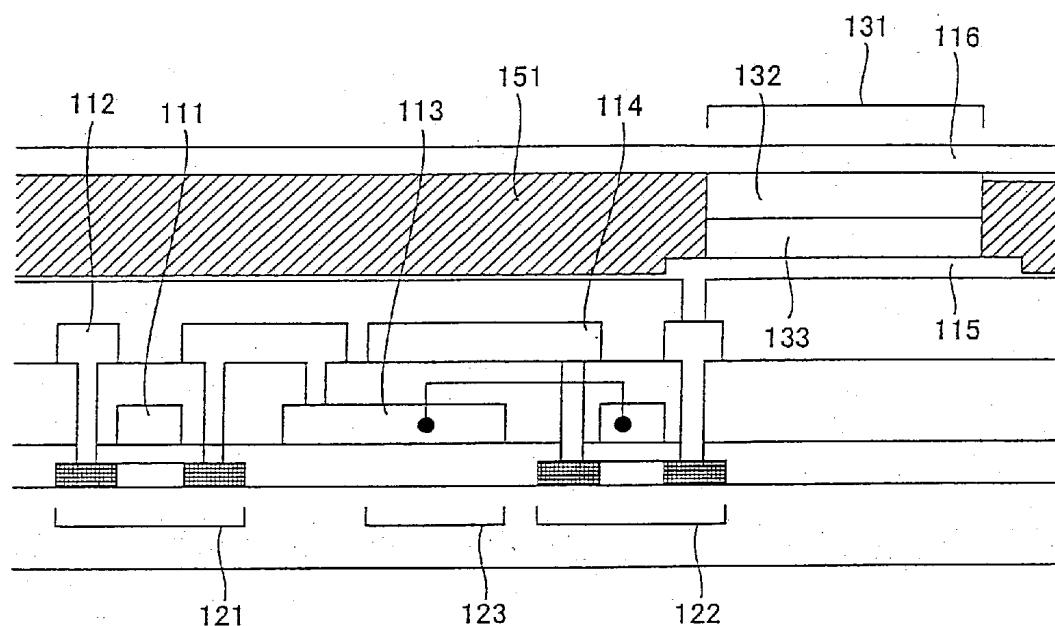


FIG.11

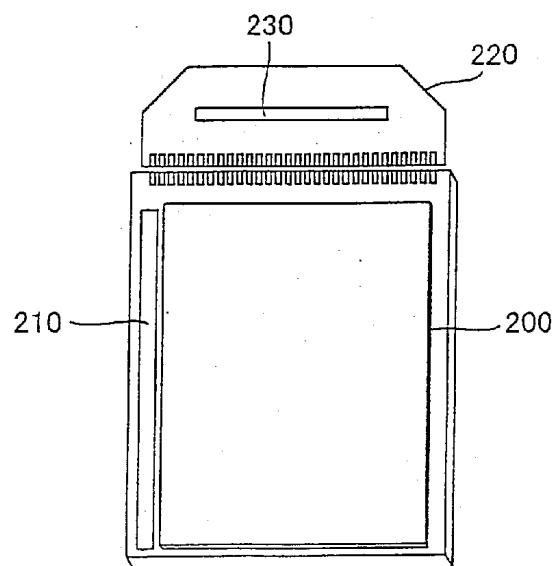


FIG.12

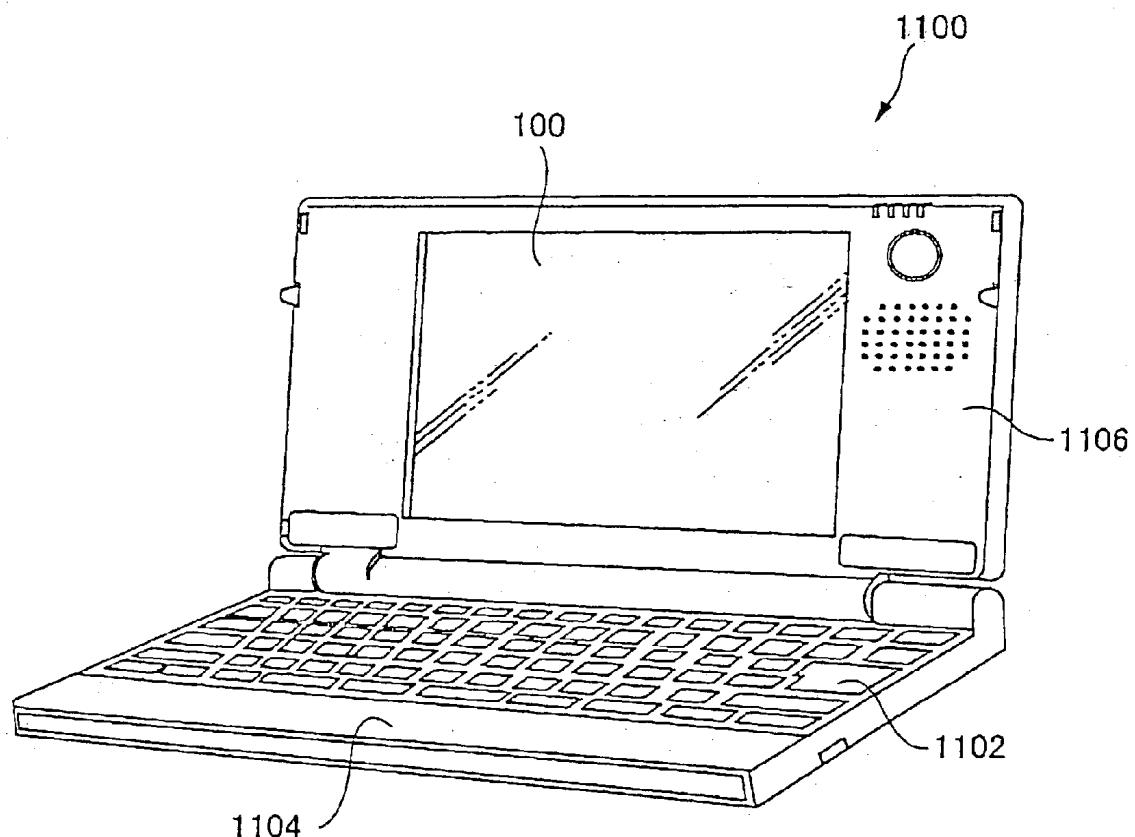


FIG.13

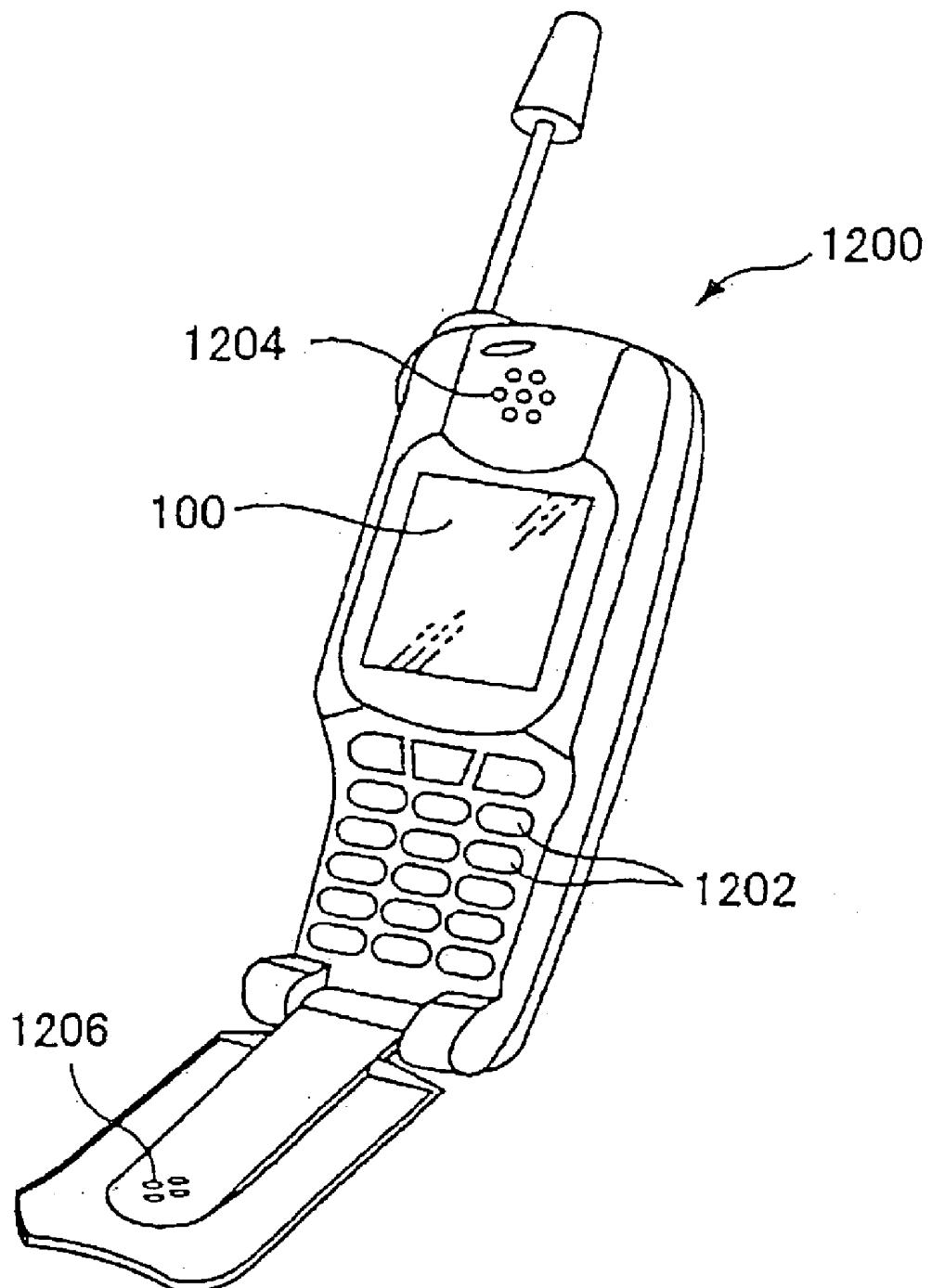


FIG.14

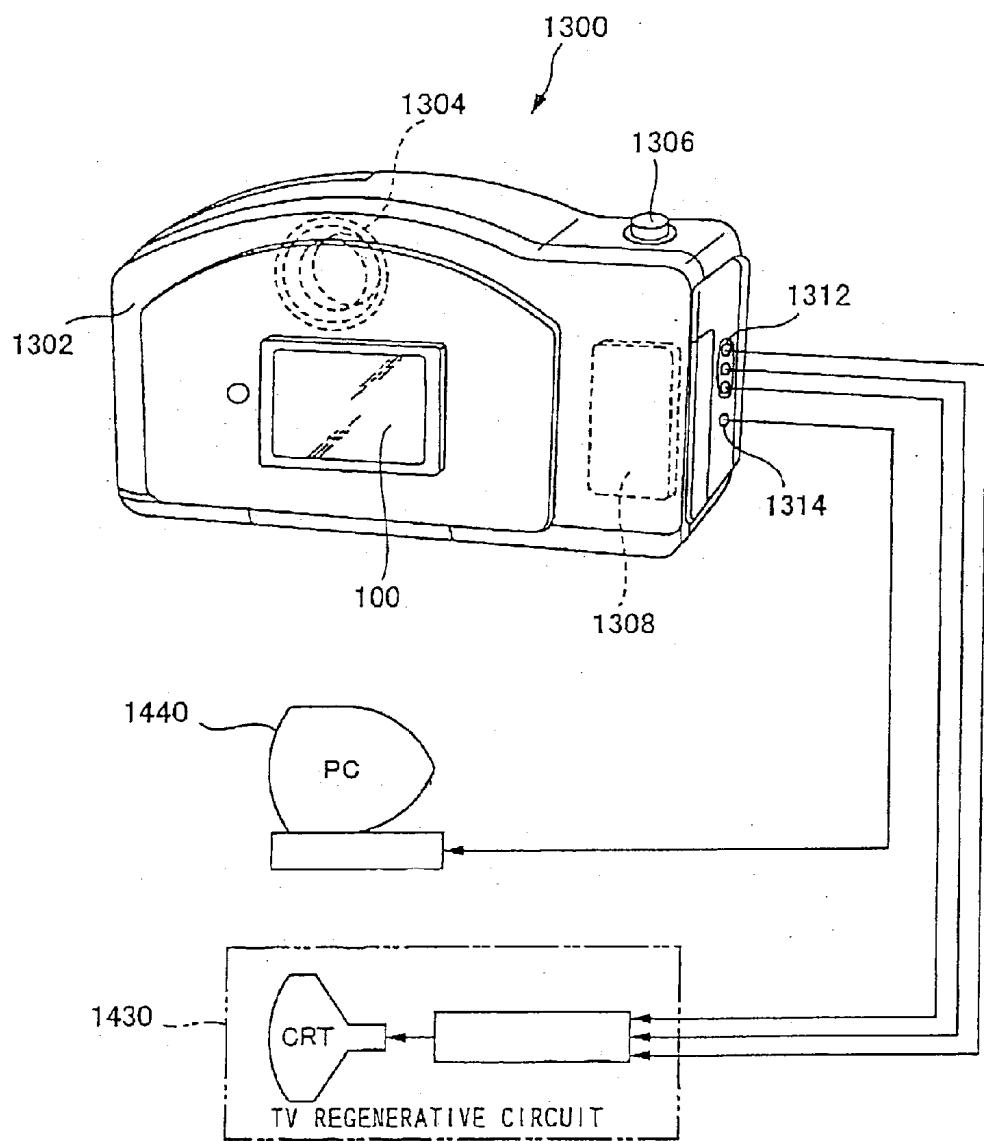


FIG.15

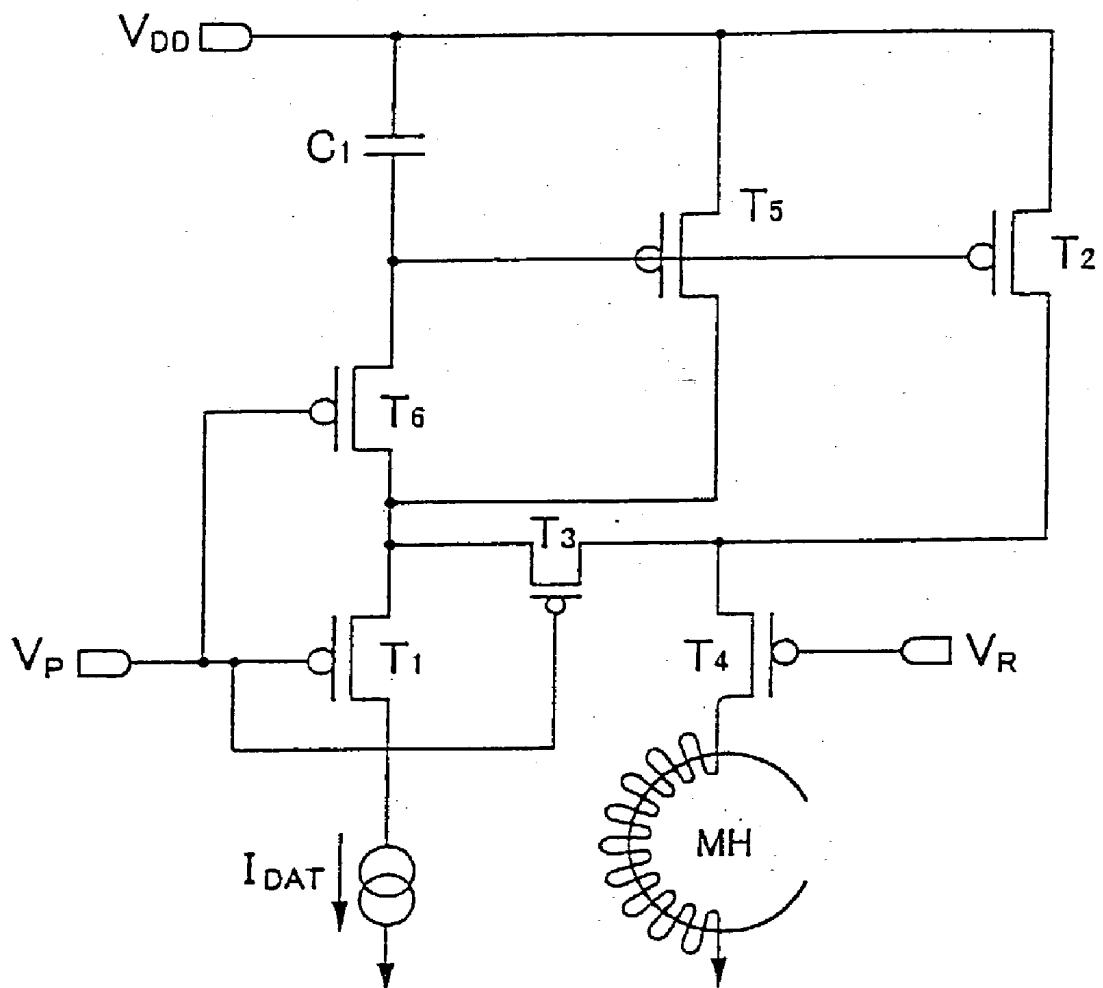


FIG.16

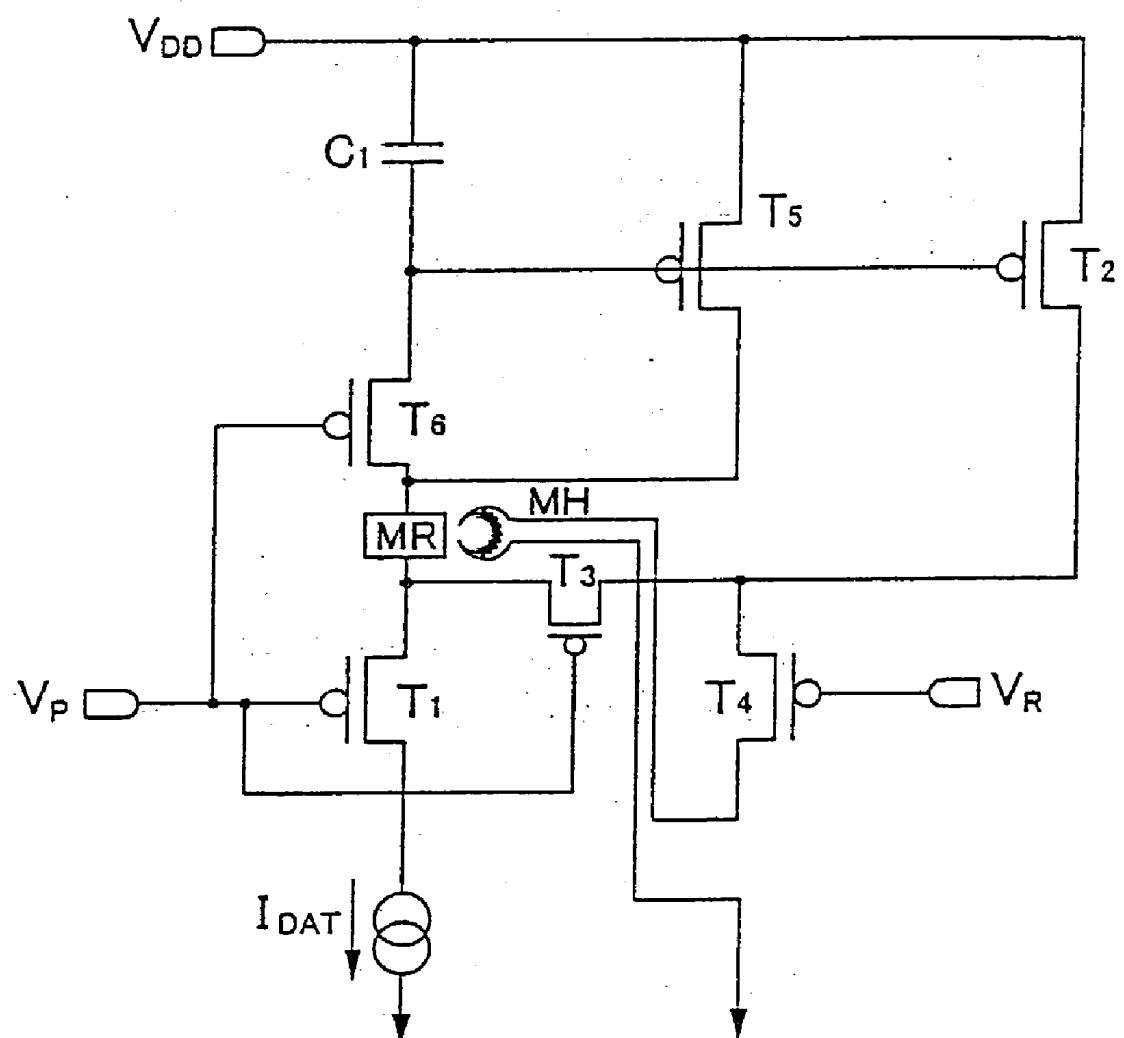


FIG. 17

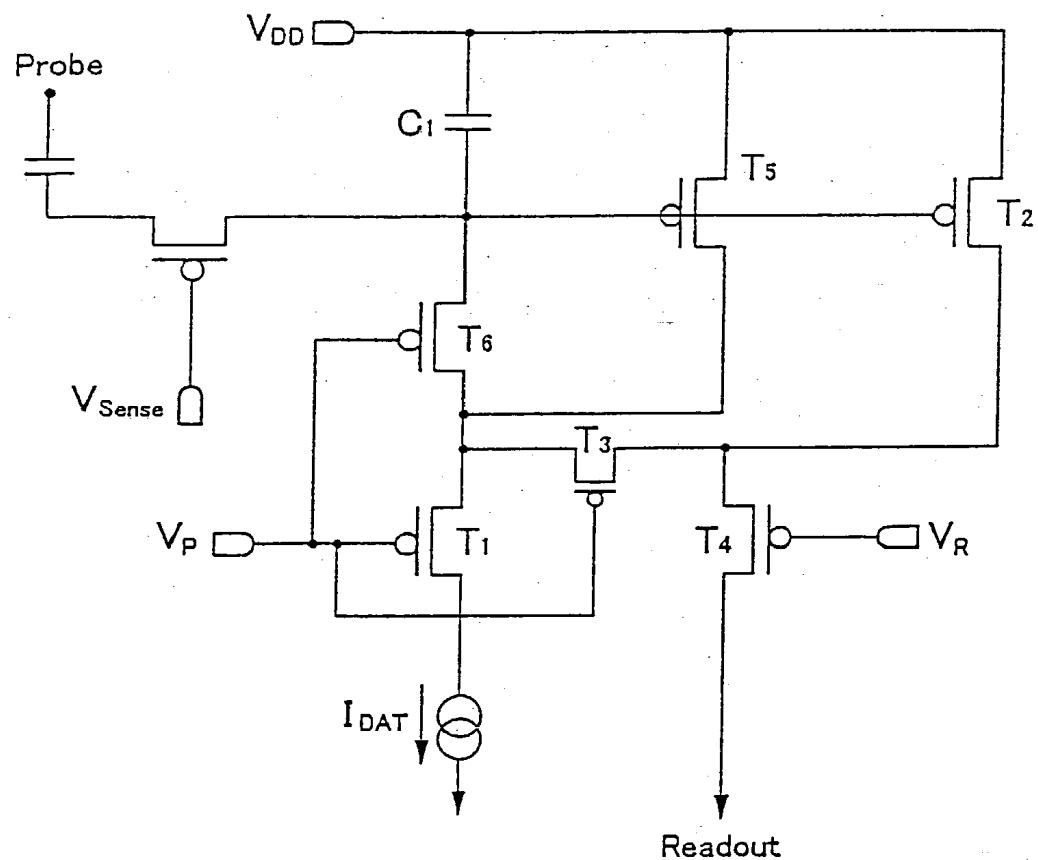
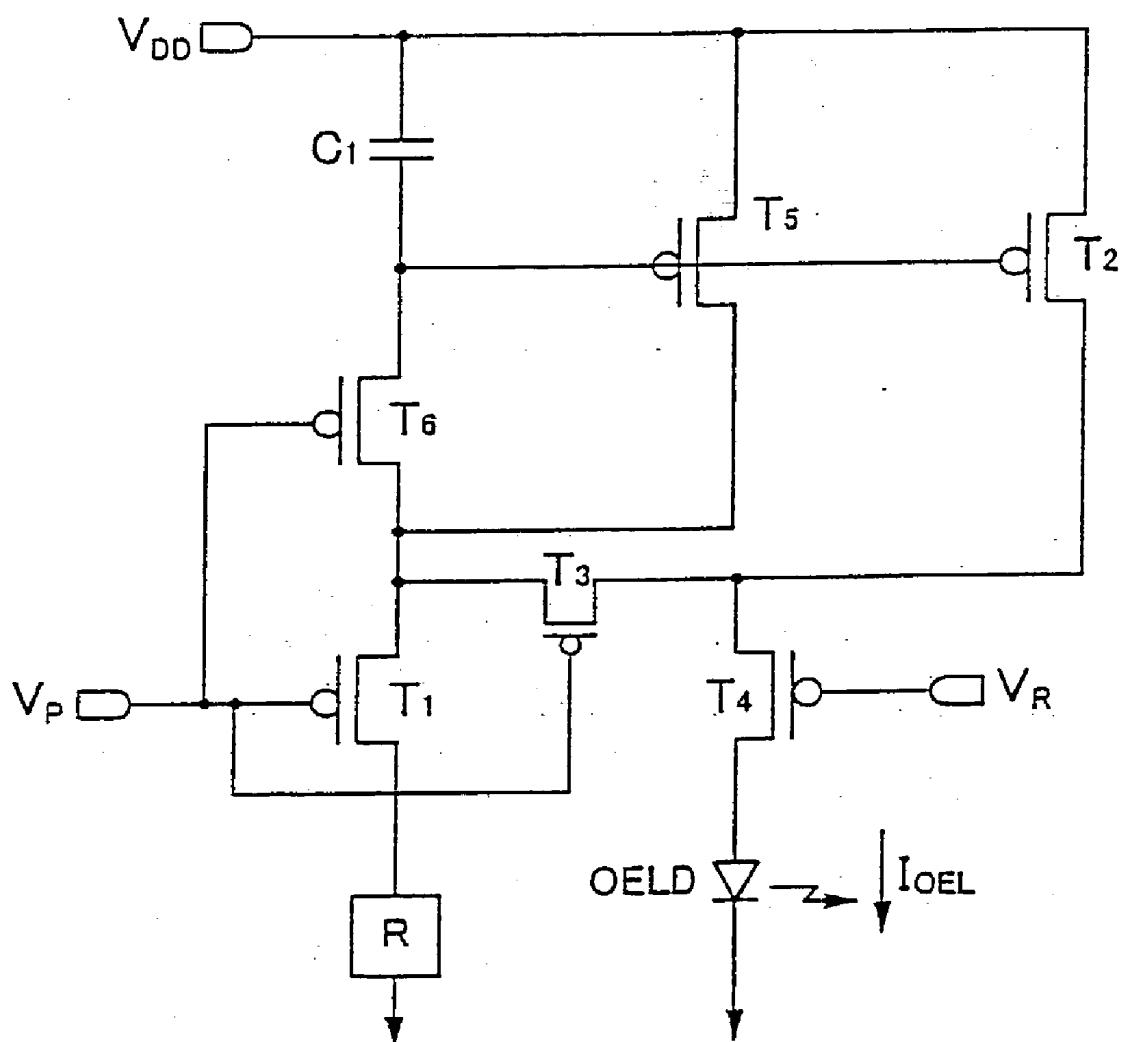


FIG.18



**ELECTRONIC CIRCUIT,  
ELECTROLUMINESCENT DISPLAY DEVICE,  
ELECTRO-OPTICAL DEVICE, ELECTRONIC  
APPARATUS, METHOD OF CONTROLLING THE  
CURRENT SUPPLY TO AN ORGANIC  
ELECTROLUMINESCENT PIXEL, AND METHOD  
FOR DRIVING A CIRCUIT**

**BACKGROUND OF THE INVENTION**

**[0001]** 1. Field of Invention

**[0002]** The present invention relates to an electronic circuit with one particular application of such an electronic circuit being as a circuit for driving a pixel of an organic electroluminescent device.

**[0003]** 2. Description of Related Art

**[0004]** An organic electroluminescent (OEL) element can include a light emitting material layer sandwiched between an anode layer and a cathode layer. Electrically, this element operates like a diode. Optically, it emits light when forward biased, and the intensity of the emission increases with the forward bias current. It is possible to construct a display panel with a matrix of OEL elements fabricated on a transparent substrate and with at least one of the transparent electrode layers, one can also integrate the driving circuit on the same panel by using low temperature polysilicon thin film transistor (TFT) technology.

**[0005]** In a basic analog driving scheme for an active matrix OEL display, a minimum of two transistors are required per pixel (**FIG. 1**).  $T_1$  is for addressing the pixel and  $T_2$  is for converting the data voltage signal, to a driver current for an OELD to emit light at a designated brightness. This data signal is stored by the storage capacitor,  $C_{\text{storage}}$ , when the pixel is not addressed. Although p-channel TFTs are shown in the figures, the same principle can also be applied for a circuit with n-channel TFTs.

**SUMMARY OF THE INVENTION**

**[0006]** The pixel driver circuit (electronic circuit), as shown in **FIG. 2**, can include a transistor  $T_2$  that operates as an analog current controller to provide the driving current to the OELD. Further, the storage capacitor  $C_1$  is connected between the gate and source terminals of  $T_2$ . In a circuit shown in **FIG. 2**, the drain of the transistor  $T_2$  is connected to the source of the transistor  $T_1$  via the source-drain path of the transistor  $T_3$ . The source of the transistor  $T_1$  is connected to the gate of the transistor  $T_2$  and the gates of the  $T_1$  and  $T_3$  are connected to each other. The gates of the  $T_1$  and  $T_3$  are applied with a programming voltage  $V_p$ . The transistor  $T_4$  which is turned off during a programming stage, connects the drain of the  $T_2$  and the source of the  $T_3$  to the OELD. During the programming stage, the transistor  $T_1$  connects the  $T_2$  to a current sink which is grounded or which is connected to a reference voltage. At this stage, the current which flows into the OEL element via the transistor  $T_2$  is 0.

**[0007]** In the circuit of **FIG. 2**,  $T_4$  is OFF, and  $T_1$  and  $T_3$  are ON in the programming stage. The  $T_3$  which is ON has an effect of operating the  $T_2$  as a diode. Further, the  $T_1$  connects this diode to the data current sink. As a result, the storage capacitor  $C_1$  stores (stores the charge) (or discharges, depending on the voltage stored during the previous frame). Storage capacitor  $C_1$  charges to the gate/source voltage of

transistor  $T_2$ , and thus stores the voltage ( $V_{GS2}$ , corresponding to the data current  $I_{\text{DAT}}$ ), which will control the current supply to the OEL element during the reproduction stage. At the end of the programming stage,  $T_1$  and  $T_3$  are switched off. The voltage  $V_{GS2}$  is noted on  $C_1$  for the remainder of the frame period (that is, in the reproduction stage).

**[0008]** The off resistance of  $T_3$  can be important, because after  $C_1$  has been charged and  $T_3$  is switched off, the off resistance of  $T_3$  can affect the voltage across  $C_1$  for the rest of the frame period. Thus, the gate/source capacitance of  $T_3$  should preferably be small compared with  $C_1$ .

**[0009]** The reproduction voltage  $V_R$  is applied to the gate of transistor  $T_4$ . At the beginning of the reproduction stage, in the circuit of **FIG. 2**,  $T_4$  is switched on and  $T_1$  and  $T_3$  remain switched off. As a result,  $T_2$  acts as a current source with  $V_{GS2}$  biased by  $C_1$ , thus supplying current to the OEL element. At the end of the reproduction stage  $T_4$  is switched off, and  $T_1$  and  $T_3$  remain switched off. This completes one cycle. The driving waveform is indicated in **FIG. 2**.

**[0010]** It will be noted that according to the circuit shown in **FIG. 2**, no current is supplied to the current driven element by the current controlling transistor during the programming stage. In accordance with the present invention in an electroluminescent device a pixel driver circuit can be implemented without degrading the perceived image presented by the electroluminescent device. In effect, the present invention provides for separation of the programming and the reproduction current paths. This enables a number of advantages to be achieved. For example, if there is no current flow through the OEL element during the programming stage then the programming stage operates more quickly since the arrangement avoids the slow down caused by the parasitic capacitance of the OEL element.

**[0011]** The circuit of **FIG. 2** is effective, but there is still a need to lower the consumption electric power. Therefore, with the improvement of the materials of the recent OEL element, the circuit may be driven even with a small current.

**[0012]** However, particularly, when expressing a low gradient, it is necessary for the data current  $I_{\text{DAT}}$  to be made extremely small in the programming stage, and there are problems, such as the charging speed to the storage capacitor  $C_1$  becoming slow. In addition when programming is performed by a small data current  $I_{\text{DAT}}$ , due to a variation in manufacture of the storage capacitor  $C_1$  and a data line, the charging speed and the stored charge to the storage capacitor  $C_1$  may be seen.

**[0013]** According to a first aspect of the present invention there is provided an electronic circuit having both a programming path and a reproduction path, the circuit can include a current driven element, a transistor in the production path arranged so as operatively to control a current supplied to the current driven element, a capacitor arranged for storing an operating voltage of the transistor, an additional transistor arranged so as to be in parallel to the transistor in the production path, for storing the operating voltage in the capacitor, and a switching device for controlling the programming path and the reproduction path.

**[0014]** According to a second aspect of the present invention there is provided an electronic circuit for driving a pixel of an electroluminescent device. The pixel can include an electroluminescent element. The circuit can include a trans-

sistor arranged so as operatively to control the current supplied to the electroluminescent element, a capacitor arranged for storing an operating voltage of the transistor during a programming stage, an additional transistor arranged in parallel to the transistor for storing the operating voltage to the capacitor, a first switching device that is connected so as operatively to establish a current path through the transistor and the additional transistor during the programming stage, and a second switching device that is connected so as to operatively establish a current path through the transistor and the electroluminescent element during a reproduction stage.

[0015] According to a third aspect of the present invention, there is provided an electronic circuit for driving a pixel of an electroluminescent device. The pixel can include an electroluminescent element. The circuit can include a transistor connected so as operatively to control the current supplied to the electroluminescent element, a capacitor connected for storing an operating voltage of the transistor during a programming stage, an additional transistor connected in parallel with the transistor for storing the operating voltage in the capacitor, a first switching device that is connected so as to establish a current path through the transistor and the additional transistor during the programming stage, a second switching device that is connected so as to establish when operative a current path through the transistor and the electroluminescent element during a reproduction stage, and a current sink, and the first switching device that is arranged such that the current path in the programming stage is connected to the current sink via the transistor and the additional transistor.

[0016] According to a fourth aspect of the present invention, there is provided an electronic circuit having a current driven element, a data line for outputting a current as a data signal, a capacitor for storing charge based on current output via the data line, a plurality of transistors arranged in parallel to each other as well as the capacitor being connected to the gate, and a driver transistor arranged in series to the current driven element. The electronic circuit can supply current according to the charge stored in the capacitor based on the current amount flowing in the current path including the plurality of transistors in a state the plurality of transistors are connected to the data line via the driven transistor.

[0017] According to a fifth aspect of the present invention there is provided an electronic circuit for driving the pixel of the electroluminescent device, the pixel can include the electroluminescent element. The circuit can include a current driven element, a data line for outputting a current as a data signal, a capacitor for storing charge based on the current output via the data line, a plurality of transistors with the capacitor being connected to a gate, and a driven transistor arranged in series to the current driven element. The electronic circuit can supply a current according to the charge stored in the capacitor based on the current amount flowing in the current path including the plurality of transistors in a state where the plurality of transistors are connected to the data line via the driven transistor ( $T_4$ ) to the current driven element. The circuit can further include a switching device for forming a programming path through the plurality of transistors, and a current sink, and the switching device is arranged to connect to the current sink via the plurality of transistors in the programming path.

[0018] According to a sixth aspect of the present invention there is provided an electronic circuit having a current driven element, a data line for outputting a current as a data signal, a capacitor for storing charge based on a current output via the data line, a plurality of transistors arranged in parallel to each other as well as the capacitor being connected with a gate, and a driver transistor arranged in series to the current driven element. The electronic circuit supplies current according to the charge stored in the capacitor based on the current amount flowing in the current path including the plurality of transistors in a state the plurality of transistors are connected to the data line via at least one of the plurality of transistors.

[0019] According to a seventh aspect of the present invention there is provided an electronic circuit for driving a pixel of the electroluminescent device, the pixel can include the electroluminescent element. The circuit can further include a current driven element, a data line for outputting a current as a data signal, a capacitor for storing charge based on current output via the data line in the programming stage, and a plurality of transistors with the capacitor being connected to the gate. The electronic circuit supplies current according to the charge stored in the capacitor based on the current amount flowing in the current path including the plurality of transistors in a state the plurality of transistors are connected to the data line via the driven transistor to the current driven element. Additionally, the circuit can include a first switching device for operatively generating a current path through the plurality of transistors in the programming stage, and a second switching device for operatively generating a current path through at least one of the plurality of transistors and the electroluminescent element in the reproduction stage.

[0020] According to an eighth aspect of the present invention there is provided an electroluminescent display device having one or more electronic circuit.

[0021] According to a ninth aspect of the present invention there is provided an electronic apparatus incorporating an electroluminescent display device.

[0022] According to a tenth aspect of the present invention there is provided a method of controlling a current supply to an electroluminescent element including the steps of providing a programming path including a plurality of auxiliary (or sub-) current paths, and providing a reproduction path which passes through the electroluminescent element.

[0023] According to an eleventh aspect of the present invention there is provided a method of controlling a current supply to an electroluminescent element including the steps of providing a programming path including a plurality of auxiliary (or sub-) current paths which connects to a current sink and providing a reproduction path which passes through the electroluminescent element.

[0024] According to this invention, since data current may be large, the programming operation may be performed more quickly.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The invention will be described with reference to the accompanying drawings, wherein like numerals refer to like elements, and wherein:

[0026] FIG. 1 shows a conventional OEL element pixel driver circuit using two transistors;

[0027] FIGS. 2A and 2B show a known current programmed OEL element driver circuit and corresponding driving waveform;

[0028] FIGS. 3A and 3B show a pixel driver circuit according to a first embodiment of the present invention and corresponding driving waveform;

[0029] FIG. 4 shows an equivalent circuit in a programming stage of a pixel driver circuit according to an embodiment of the present invention;

[0030] FIG. 5 shows an equivalent circuit in a reproduction stage of a pixel driver circuit according to an embodiment of the present invention;

[0031] FIGS. 6A and 6B are a table and a diagram related to a data current value and a programming stage operation speed, and compares a pixel driver circuit of an embodiment according to the present invention and a pixel driver circuit of FIG. 2;

[0032] FIG. 7 is an example of a circuit diagram applying an OEL element and a pixel driver circuit to a display in an embodiment of the present invention;

[0033] FIGS. 8A and 8B show another embodiment of a pixel driver circuit according to the present invention and corresponding driving waveform;

[0034] FIGS. 9A and 9B show further another embodiment of a pixel driver circuit according to the present invention and corresponding driving waveform;

[0035] FIG. 10 is a schematic sectional view showing an OEL element device mounted with a pixel driver circuit according to the present invention;

[0036] FIG. 11 is a schematic plan view of an OEL display panel according to the present invention;

[0037] FIG. 12 is a schematic view of a mobile personal computer incorporating a display device having a pixel driver circuit according to the present invention;

[0038] FIG. 13 is a schematic view of a mobile telephone incorporating a display device having a pixel driver circuit according to the present invention;

[0039] FIG. 14 is a schematic view of a digital camera incorporating a display device having a pixel driver circuit according to the present invention;

[0040] FIG. 15 illustrates an application of a driver circuit of the present invention to a magnetic RAM;

[0041] FIG. 16 illustrates an application of a driver circuit of the present invention to a magneto resistive element;

[0042] FIG. 17 illustrates an application of a driver circuit of the present invention to a capacitance sensor or a charge sensor; and

[0043] FIG. 18 illustrates an application of a driver circuit of the present invention to a night vision camera.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0044] The embodiments of the present invention are described referring to the attached drawings with further

examples. These are of course only examples. In this embodiment, in respect to the circuit shown in the above described FIG. 2, common portions regarding the structure, operation and operating effects are as described above, and the differing portions are mainly described.

[0045] As shown in FIG. 3, the circuit of this embodiment can include, first, in addition to the circuit shown in FIG. 2 described above, an additional transistor  $T_5$  and an additional switching transistor  $T_6$ . These  $T_5$  and  $T_6$  are p-type transistors. The source of the switching transistor  $T_6$  is connected to the storage capacitor  $C_1$ , and the drain thereof is connected to the source of the p-type transistor  $T_1$ . The gates of the additional switching transistor  $T_6$ ,  $T_1$ , and the p-type transistor  $T_3$  are connected to each other. The gates of  $T_1$ ,  $T_3$ , and  $T_6$  are applied with a programming voltage  $V_p$ . The  $T_1$  is connected to  $C_1$  via the drain and source of the  $T_6$ .

[0046] The source of the additional  $T_5$  is connected to  $V_{DD}$  and its gate is connected to the storage capacitor  $C_1$ , and is applied with the same driver voltage signal as the gate of the transistor  $T_2$ . The drain of transistor  $T_5$  is connected to the common point of connection of to the transistors  $T_1$ ,  $T_3$ , and  $T_6$ . That is, the storage capacitor  $C_1$  is also connected between the gate and source of the additional transistor  $T_5$ .

[0047] In the circuit of FIG. 3, the programming voltage  $V_p$  is applied to the gates of transistors  $T_1$  and  $T_3$ , and  $T_6$ . The p-type transistor  $T_4$  which is switched off during the programming stage, connects the drain of the p-type transistor  $T_2$  and the source of  $T_3$  to the OEL element. During the programming stage, the transistor  $T_1$  operatively connects transistor  $T_2$ ,  $T_5$  to a current sink, which is tied to ground or to a reference voltage.

[0048] The circuit of FIG. 3 operates in the programming stage with  $T_4$  switched off and  $T_1$ ,  $T_3$  and  $T_6$  switched on.  $T_3$  and  $T_6$  being switched on have the effect of making  $T_2$  and  $T_5$  act as diodes. Further,  $T_1$  connects this diode  $T_2$  and  $T_5$  to the data current sink. As a result, the storage capacitor  $C_1$  charges (or discharges, depending on the voltage stored during the previous frame). Storage capacitor  $C_1$  charges to the gate/source voltage of transistor  $T_2$  and  $T_5$ , thus stores the voltage ( $V_{GS2}$ , corresponding to the data current  $I_{DAT}$ ), which will control the current supply to the OEL element during the reproduction stage. Here, the data current  $I_{DAT}$  is a data signal output by the data line. At the end of the programming stage,  $T_1$ ,  $T_3$  and  $T_6$  are switched off. The voltage  $V_{GS2}$  is stored on  $C_1$  for the remainder of the frame period, that is for the reproduction stage.

[0049] More specifically, the circuit in FIG. 3 in the programming stage, operates as the circuit shown in FIG. 4. That is, in FIG. 4, the programming paths from the two auxiliary (or sub-) current paths including the two transistors  $T_2$  and  $T_5$  which operate as diodes are formed.

[0050] The reproduction voltage  $V_R$  is applied to the gate of transistor  $T_4$ . At the beginning of the reproduction stage, in the circuit of FIG. 3,  $T_4$  is switched on and  $T_1$ ,  $T_3$  and  $T_6$  remain switched off. As a result, the reproduction path as shown in FIG. 5 is formed,  $T_2$  acts as a current source with  $V_{GS2}$  biased by  $C_1$ , thus supplying current to the OEL element. At the end of the reproduction stage  $T_4$  is switched off,  $T_1$ ,  $T_3$  and  $T_6$  remain switched off. This completes one cycle. This driving waveform is indicated in FIG. 3.

[0051] As described above and shown in FIG. 4, during the programming stage, two auxiliary (or sub-) current paths

including the two transistors  $T_2$  and  $T_5$  which operate as diodes are formed. Accordingly, for example, if the ratio of the current supply power of the  $T_2$  and  $T_5$  are set as 1:9, as in **FIG. 6**, if the current  $I_{OEL}$  supplied to the electroluminescent element in the production stage is the same 100[nA], as compared to the circuit shown in **FIG. 2** in which the data current  $I_{DAT}$  is 100[nA], this embodiment may be increased 10 times to 1[ $\mu$ A]. As a result, as shown in **FIG. 6**, the programming stage period (programming time) in which the data current  $I_{DAT}$  flows, may be made extremely short as 40[ $\mu$ s] compared to the 100[ $\mu$ s] in the circuit as shown in **FIG. 2**. Therefore, a big increase in speed of the programming operation can be achieved. The comparison shown in **FIG. 6** is of course only one example.

[0052] In the organic electroluminescent element device, an example of mounting the driver circuit of **FIG. 3** is shown in **FIG. 7**. In the circuit of **FIG. 7**, a plurality of circuit blocks **10** are connected to a common current sink.

[0053] As other embodiments, circuit examples are shown in **FIGS. 8 and 9**. In the circuit of **FIG. 8**, transistors  $T_1$  and  $T_6$  are turned on, and the two auxiliary (or sub-) current paths including the two transistors  $T_2$  and  $T_5$  which operate as diodes are formed. Then, at the start of the reproduction stage,  $T_4$  is turned on and  $T_1$  and  $T_6$  remain turned off. As a result, as shown in **FIG. 8**,  $T_4$  acts as a current source with  $V_{GS2}$  biased by  $C_1$ , thus supplying current to the OEL element. At the end of the reproduction stage  $T_4$  is switched off,  $T_1$  and  $T_6$  remain switched off. This completes one cycle. This driving waveform is indicated in **FIG. 8**. As in the embodiment of **FIG. 8**, similarly to the circuit of **FIG. 3** described above, the data current  $I_{DAT}$  may be increased, and the programming operation may be made quicker. For example, if  $T_2$ ,  $T_4$  and  $T_5$  are structured as a same characteristic transistor, the characteristics of the transistors may be easily matched, and also a state of  $I_{DAT}:I_{OEL}=2:1$  may be realized.

[0054] As shown in **FIG. 9**, during the programming stage, transistors  $T_1$ ,  $T_3$  and  $T_6$  are turned on, and two auxiliary (or sub-) current paths including the two transistors  $T_2$  and  $T_5$  which operate as diodes are formed. Accordingly, at the start of the reproduction stage,  $T_4$  is turned on and  $T_1$ ,  $T_3$  and  $T_6$  remain turned off. As a result, as shown in **FIG. 9**,  $T_4$  acts as a current source with  $V_{GS2}$  biased by  $C_1$ , thus supplying current to the OEL element. At the end of the reproduction stage  $T_4$  is switched off, and  $T_1$ ,  $T_3$  and  $T_6$  remain switched off. This completes one cycle. The driving waveform is indicated in **FIG. 9**. As in the embodiment of **FIG. 9**, similarly to the circuit of **FIG. 3** described above, the data current  $I_{DAT}$  may be increased, and the programming operation may be made quicker. For example, if  $T_2$  and  $T_5$  are structured as a same characteristic transistor, the characteristics of the transistors may be easily matched, and also a state of  $I_{DAT}:I_{OEL}=2:1$  may be realized.

[0055] **FIG. 10** is a schematic cross-sectional view of a certain OEL element device. In **FIG. 10**, numeral **132** indicates a hole injection layer, numeral **133** indicates an organic EL layer, and numeral **151** indicates a resistor or a separating structure formed by an insulating film. The switching thin-film transistor **121** and the p-channel type current thin-film transistor **122** adopt the structure and the process ordinarily used for a low temperature polysilicon thin-film transistor liquid crystal display devices, such as a

top-gate structure and a fabrication process, wherein the maximum temperature is 600°C or less. However, other structures and processes are applicable.

[0056] The organic EL display element **131** is formed by the cathode **116** formed of Al, the anode **115** formed of ITO, the hole injection layer **132**, and the organic EL layer **133**.

[0057] The hole injection layer **132** and the organic EL layer may be formed by a technique, such as an ink-jet printing method or a mask evaporation method, employing the resist **151** as a separating structure between the pixels. The opposite anode **115** formed of ITO may be formed using a sputtering method. However, other methods may also be used for forming all of these components. For example, an electron transporting layer may be arranged in between the light emitting layer and the cathode.

[0058] The typical layout of a full display panel employing the present invention is shown schematically in **FIG. 11**. The panel can include an active matrix OEL element **200** with analogue current program pixels, an integrated TFT scanning driver **210** with level shifter, a flexible TAB tape **220**, and an external analogue driver LSI **230** with an integrated RAM/controller. Of course, this is only one example of the possible panel arrangements in which the present invention can be used.

[0059] It should be understood that the structure of the organic EL display device is not limited to the one described here. Other structures are also applicable without departing from the spirit and scope of the present invention.

[0060] Preferably the circuits shown in **FIGS. 3 to 11** are implemented using thin film transistor (TFT) technology, most preferably in polysilicon TFT.

[0061] The present invention is particularly advantageous for use in small, mobile electronic products such as mobile phones, computers, CD players, DVD players and the like, although it is not limited thereto.

[0062] For example, several electronic apparatuses using the above organic electroluminescent display device will now be described.

[0063] An example in which the display device according to one of the above embodiments is applied to a mobile personal computer will now be described. **FIG. 12** is an isometric view illustrating the configuration of the personal computer. In the drawing, the personal computer **1100** is provided with a body **1104** including a keyboard **1102** and a display unit **1106**. The display unit **1106** is implemented using a display panel fabricated according to the present invention, as described above.

[0064] Next, an example in which the display device of the present invention is applied to a display section of a portable phone will be described. **FIG. 13** is an isometric view illustrating the configuration of the portable phone. In the drawing, the portable phone **1200** is provided with a plurality of operation keys **1202**, a speaker **1204**, a mouthpiece **1206**, and a display panel **100**. This display panel **100** is implemented using a display panel fabricated according to the present invention, as described above.

[0065] Next, a digital still camera using an OEL display device as a finder will be described. **FIG. 14** is an isometric

view illustrating the configuration of the digital still camera and the connection to external devices in brief.

[0066] Typical cameras sensitize films based on optical images from objects, whereas the digital still camera **1300** generates imaging signals from the optical image of an object by photoelectric conversion using, for example, a charge coupled device (CCD). The digital still camera **1300** is provided with an OEL element **100** at the back face of case **1302** to perform display based on the imaging signals from the CCD. Thus, the display panel **100** functions as a finder for displaying the object. A photo acceptance unit **1304** including optical lenses and the CCD is provided at the front side (behind in the drawing) of the case **1302**.

[0067] When a cameraman determines the object image displayed in the OEL element panel **100** and releases the shutter, the image signals from the CCD are transmitted and stored to memories in a circuit board **1308**. In the digital still camera **1300**, video signal output terminals **1312** and the input/output terminals **1314** for data communication are provided on a side of the case **1302**. As shown in the drawing, a television monitor **1430** and a personal computer **1440** are connected to the video signal terminals **1312** and the input/output terminals **1314**, respectively, if necessary. The imaging signals stored in the memories of the circuit board **1308** is output to the television monitor **1430** and the personal computer **1440**, by a given operation.

[0068] Examples of electronic apparatuses, other than the personal computer shown in **FIG. 12**, the portable phone shown in **FIG. 13**, and the digital still camera shown in **FIG. 14**, can include OEL element television sets, view-finder-type and monitoring-type video tape recorders, car navigation systems, pagers, electronic notebooks, portable calculators, word processors, workstations, TV telephones, point-of sales system (POS) terminals, devices provided with touch panels, and the like. Of course, the above OEL device can be applied to display sections of these electronic apparatuses.

[0069] The driver circuit of the present invention can be disposed not only in a pixel of a display unit but also outside a display unit.

[0070] In the above description, the driver circuit of the present invention has been described with reference to various display devices. However, it should be understood that the applications of the driver circuit of the present invention are much broader than just display devices and include, for example, its use with a magneto resistive RAM, a capacitance sensor, a charge sensor, a DNA sensor, a night version camera and many other devices.

[0071] **FIG. 15** illustrates the application of the driver circuit of the present invention to a magnetic RAM. In **FIG. 15** a magnetic head is indicated by the reference **MH**.

[0072] **FIG. 16** illustrates an alternative application of the driver circuit of the present invention to a magnetic resistance element. In **FIG. 16** a magnetic head is indicated by the reference **MH**, and a magnetic resistor is indicated by the reference **MR**.

[0073] **FIG. 17** illustrates the application of the driver circuit of the present invention to a capacitance sensor or a charge sensor. In **FIG. 17** a sense capacitor is indicated by

the reference  $C_{sense}$ . The circuit of **FIG. 17** is also applicable to other applications, such as a fingerprint sensor and a DNA sensor.

[0074] **FIG. 18** illustrates the application of the driver circuit of the present invention to a night vision camera. In **FIG. 18** a photoconductor is indicated by reference **R**.

[0075] In the embodiments illustrated with reference to the above specific description the transistors have been shown as p-channel transistors. This is not limiting of the present invention. For example, n-channel transistors may be used throughout the circuit, except for the drive transistor, which is retained as a p-channel transistor.

[0076] It will be apparent to persons skilled in the art that other variations and modifications can be made to the arrangements described with respect to FIGS. **3** to **18** without departing from the spirit and scope of the present invention.

What is claimed is:

1. An electronic circuit having a programming path and a reproduction path, the circuit comprising:

a current driven element;

a first transistor in the reproduction path arranged so as operatively to control a current supplied to the current driven element;

a capacitor arranged that stores an operating voltage of the first transistor;

a second transistor arranged so as to be in parallel to the first transistor in the reproduction path, that stores the operating voltage in the capacitor; and

a switching device that controls the programming path and the reproduction path.

2. An electronic circuit that drives a pixel of an electroluminescent device, the pixel including an electroluminescent element, the circuit comprising:

a first transistor arranged so as operatively to control a current supplied to the electroluminescent element;

a capacitor arranged that stores an operating voltage of the first transistor during a programming stage;

a second transistor arranged in parallel to the transistor that stores the operating voltage to the capacitor;

a first switching device connected so as operatively to establish a current path through the first transistor and the second transistor during the programming stage; and

a second switching device connected so as to operatively establish a current path through the first transistor and the electroluminescent element during a reproduction stage.

3. An electronic circuit that drives a pixel of an electroluminescent device, the pixel including an electroluminescent element, the circuit comprising:

a first transistor connected so as operatively to control a current supplied to the electroluminescent element;

a capacitor connected that stores an operating voltage of the first transistor during a programming stage;

- a second transistor connected in parallel with the first transistor that stores the operating voltage in the capacitor;
- a first switching device connected so as to establish a current path through the first transistor and the second transistor during the programming stage;
- a second switching device connected so as to establish when operative a current path through the first transistor and the electroluminescent element during a reproduction stage; and
- a current sink, the first switching device being arranged such that the current path in the programming stage is connected to the current sink via the first transistor and the second transistor.

**4.** An electronic circuit as claimed in claim 2, the first and second switching controlled by respective control signals separate from each other.

**5.** An electronic circuit as claimed in claim 2, further comprising a third switching device arranged so the first transistor acts as a diode when it is turned on during the programming stage.

**6.** An electronic circuit as claimed in claim 5, the third switching device connecting the first switching device to the source/drain current path of the first transistor.

**7.** An electronic circuit as claimed in claim 2, further comprising an additional switching device arranged to be connected so the second transistor acts as a diode when turned on during the programming stage.

**8.** An electronic circuit as claimed in claim 7, the additional switching device being arranged between the capacitor and the first switching device.

**9.** An electronic circuit as claimed in claim 7, the additional switching device connecting the first switching device to the gates of the first transistor and the second transistor.

**10.** An electronic circuit as claimed in claim 5, a third switching device interconnecting drains of the first transistor and the second transistor, and a gate of the second transistor being connected to a gate of the first transistor.

**11.** An electronic circuit as claimed in claim 9, comprising a plurality of second transistors each with a respective additional switching device, each additional switching device being arranged in series with each other.

**12.** An electronic circuit, comprising:
 

- a current driven element;
- a data line that outputs a current as a data signal;
- a capacitor that stores charge based on current output via the data line;
- a plurality of transistors arranged in parallel to each other as well as having the capacitor being connected to a gate;
- and a driven transistor arranged in series to the current driven element, the electronic circuit supplying current according to a charge stored in the capacitor based on a current amount flowing in a current path including the plurality of transistors in a state where the plurality of transistors are connected to the data line via the driven transistor.

**13.** An electronic circuit that drives a pixel of an electroluminescent device, the pixel comprising an electroluminescent element, the circuit comprising:
 

- a current driven element;
- a data line that outputs a current as a data signal;
- a capacitor that stores charge based on current output via the data line in a programming stage; and
- a plurality of transistors with the capacitor being connected to the gate, the electronic circuit supplying current according to the charge stored in the capacitor based on a current amount flowing in a current path

including the plurality of transistors in a state where the plurality of transistors are connected to the data line via a driven transistor to the current driven element;

the circuit further including a first switching device that operatively generates a current path through the plurality of transistors in the programming stage; and

the second switching device that operatively generates a current path through at least one of the plurality of transistors and the electroluminescent element in a reproduction stage.

**20.** An electronic circuit as claimed in claim 19, the first and second switching devices being controlled by respective control signals that are separated from each other.

**21.** An electronic circuit as claimed in claim 19, further comprising a third switching device arranged to be connected so the plurality of transistors act as diodes when turned on during the programming stage.

**22.** An electronic circuit as claimed in claim 21, the third switching device connecting at least one of the plurality of transistors to an electroluminescent element in the programming stage.

**23.** An electronic circuit as claimed in claim 19, further comprising an additional switching device arranged to be connected so the plurality of transistors act as diodes when turned on during the programming stage.

**24.** An electronic circuit as claimed in claim 23, the additional switching device is disposed between the capacitor and the electroluminescent element.

**25.** An electronic circuit as claimed in claim 21, a third switching device interconnecting drains of the plurality of transistors, the drains being connected to the electroluminescent element, and gates of the plurality of transistors being connected to each other.

**26.** An electronic circuit as claimed in claim 1, the first transistor being a p-channel thin film transistor.

**27.** An electronic circuit as claimed in claim 12, at least one of the plurality of transistors being a p-channel thin film transistor.

**28.** An electronic circuit as claimed in claim 5, the first, the second, and the third switching devices being formed respectively of p-channel thin film transistors.

**29.** An electronic circuit as claimed in claim 14, the switching device and the second switching device being respectively, p-channel thin film transistors.

**30.** An electroluminescent display device comprising one or more electronic circuit as claimed in claim 1.

**31.** An electronic apparatus incorporating the electroluminescent display device as claimed in claim 30.

**32.** A method of controlling a current supply to an electroluminescent element, comprising the steps of:

providing a programming path including a plurality of auxiliary current paths; and

providing a reproduction path which passes through the electroluminescent element.

**33.** A method of controlling a current supply to an electroluminescent element, comprising the steps of:

providing a programming path including a plurality of auxiliary current paths which connect to a current sink; and

providing a reproduction path which passes through the electroluminescent element.

**34.** A method for driving a circuit including a current driven element and a transistor that controls a current supplied to the current driven element, comprising a step of determining a gate voltage of the transistor based on a predetermined current, the predetermined current being larger than the current supplied to the current driven element.

**35.** An electronic circuit as claimed in claim 3, the first and second switching controlled by respective control signals separate from each other.

**36.** An electronic circuit as claimed in claim 3, further comprising a third switching device arranged so the transistor acts as a diode when it is turned on during the programming stage.

**37.** An electronic circuit as claimed in claim 36, the third switching device connecting the first switching device to the source/drain current path of the transistor.

**38.** An electronic circuit as claimed in any of claims 3, further comprising an additional switching device arranged to be connected so the second transistor acts as a diode when turned on during the programming stage.

**39.** An electronic circuit as claimed in claim 2, the first transistor being a p-channel thin film transistor.

**40.** An electronic circuit as claimed in claim 3, the first transistor being a p-channel thin film transistor.

**41.** An electronic circuit as claimed in claim 13, at least one of the plurality of transistors being a p-channel thin film transistor.

**42.** An electroluminescent display device comprising one or more electronic circuit as claimed in claim 2.

**43.** An electroluminescent display device comprising one or more electronic circuit as claimed in claim 3.

\* \* \* \* \*

专利名称(译) 电子电路，电致发光显示装置，电光装置，电子设备，控制向有机电致发光像素的电流供应的方法，以及用于驱动电路的方法

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#### 摘要(译)

本发明提供一种电子电路，其可包括编程路径和再现路径。该电路还可包括电流驱动元件，生产路径中的晶体管，其布置成可操作地控制提供给电流驱动元件的电流，电容器，用于存储晶体管的工作电压，附加晶体管，并联设置。用于存储电容器和工作电压的编程路径中的晶体管，以及控制编程路径和再现路径的开关器件。

