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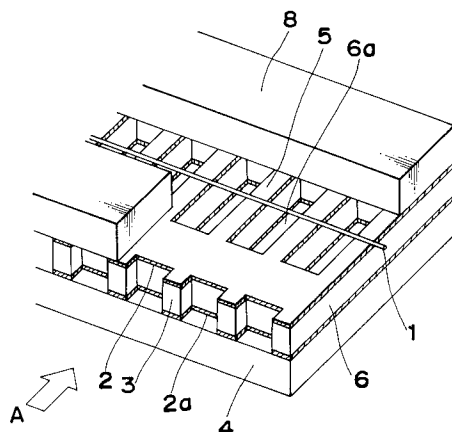
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W-2800 Bremen 1(DE)**(54) **Electron source drive device employing an improvement of an electron source unit.**

(57) In an electron source drive device, a cathode support member arranged in contact with a cathode is constructed by a conductive member and an insulation member interposed between the conductive member and a contacting portion of the cathode, and the insulation member is made of a material having a resistivity and a specific dielectric constant such that the electric discharge time constant of electrons on the surface of the insulation member depending on the insulation resistance and the electrostatic capacity between the surface of the insulation member and the conductive member is set in a visually permissible range of not too much in excess of one cycle of emission of the cyclical electron from the cathode without bringing forth intermittent electron emission.

Fig . 1 (a)

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to an electron source unit and electron source drive device of an image display unit for use in a television receiver, a computer terminal equipment and the like.

Description of the Prior Art

10 In recent years, there has been made much effort for studying and developing a flat type image display unit for displaying images, characters and the like thereon. The applicant of the present invention has already proposed such a flat type image display unit as disclosed in the U.S. Patent 4,955,681.

Fig. 9 shows the construction of internal electrodes of the image display unit disclosed in the above-mentioned U.S. Patent publication. The following describes the construction and operations of the electron source section of a flat type cathode ray tube in accordance with the above-mentioned conventional example.

The electron source of the cathode ray tube comprises a plurality of linear cathodes 51 arranged in a plane parallel to a back electrode 52 which is vertically disposed inside a back casing 62, and a flat plate electron beam drawing electrode 53 interposed between the linear cathodes 51 and a screen 59.

20 Each linear cathode 51 extends in a horizontal direction, and a plurality of such linear cathodes are appropriately provided in parallel to each other at certain intervals in a vertical plane direction, wherein the amount of the linear cathodes is assumed to be L in the description and only four of them are shown in Fig. 9.

Figs. 10 (a) and 10 (b) show an example of an arrangement of such linear cathodes employed in a conventional electron source as disclosed in the Japanese Patent Laid-open (unexamined) No. 1-30148 made by the same applicant of the present invention, wherein Fig. 10 (a) shows a perspective view of an entire part of the electron source and Fig. 10 (b) shows a partially sectional view of Fig. 10 (a). Each linear cathode 51 is extended as to be supported in contact with upper surfaces of cathode support sections 70a of cathode support member 70 which is constructed by covering a conductive member 71 with an insulation member 72.

Each cathode support section 70a is located in such a position that the cathode support section 70a does not confront an aperture 53a defined in the electron beam drawing electrode 53, while a cathode section 51a positioned above an opening section 70b confronts the aperture 53a thereby to emitting electrons from the cathode section 51a toward the aperture 53a. Spacers 75 and 76 are provided for holding the distance between the linear cathodes 51 and the electron beam drawing electrode 53 and the distance between the vertical scanning electrode 63 and the cathode support member 70 respectively.

Although the electron source shown in Figs. 10 (a) and 10 (b) has a construction somewhat different from that of the electron source of the U.S. Patent 4,955,681 shown in Fig. 9, it is assumable that the former has substantially the same construction as the latter for the reason that a linear cathode 51, an electron beam drawing electrode 53, and a rear electrode 52 (i.e., vertical scanning electrode 63) are combined. The cathode support member 70 has an advantageous function of preventing electron emission from being unstable due to the possible vibration of the linear cathode 51.

Then reference is made to the operations of the conventional electron source of Fig. 9 by taking an example in the case that 480 scanning lines are displayed in one frame according to the NTSC system (National Television System Committee color system) with reference to Fig. 11. Referring to Fig. 11, V.D represents a vertical synchronization signal, H.D represents a horizontal synchronization signal, and K_1 through K_L represent drive pulse signals for driving the linear cathodes in the amount of L.

Firstly, the period of drawing electrons from each cathode can be obtained by dividing the effective display period of 240H in one field (1V) represented by the vertical synchronization signal V.D by the cathode amount of L, wherein 1H means the period of scanning one horizontal scanning line represented by the horizontal synchronization signal H.D. Therefore, the period of electron emission from each cathode can be expressed by $(240/L)H$, and only in the electron emission period, the electric potential of the cathode is made lower than the electric potential of the electron beam drawing electrode 53 to thereby make the electric potential around the cathode 51 higher than that of the cathode 51 to allow electron emission. In the other period, the electric potential of the cathode is made higher than that of the electron beam drawing electrode 53 thereby to prevent the cathode from emitting electrons, and in this electron emission preventing period, the cathode 51 is heated. As a consequence, the cathode drive pulses K_1 through K_L are sequentially applied to the respective cathodes with time lapse shifted by $(240/L)H$.

A sheet-shaped electron beam drawn from the linear cathode 51 passes through the apertures 53a in the amount of M aligned in one line defined in the electron beam drawing electrode 53 to be diverged into thin beams in the amount of M, and then conducted to a beam modulating electrode 54. The amount of the electron beam passing through the aperture defined in the beam modulating electrode 54 is controlled according to an image signal, and then converged in the vertical and horizontal directions respectively by a vertical convergence electrode 55 and a horizontal convergence electrode 56. Thereafter, the converged electron beam is deflected horizontally by means of horizontal deflection electrodes 57 and 57a and further deflected vertically by means of vertical deflection electrodes 58 and 58a to be applied to a fluorescent material adhered onto the screen 59 to which a high voltage of approximately 10 kV is applied to eventually make the screen illuminate. The entire display picture is obtained by combining image display segments 60 in a matrix form which are illuminated by applying electron beams.

Referring back to the electron source shown in Figs. 10 (a) and 10 (b) where the cathode 51 concurrently serves as an electron beam modulating electrode, while in the rear side below the cathode 51, a vertical scanning electrode 63 is interposed between the spacer 76 and an insulation support member 73. Although the timing of drawing electrons from the cathode in this example is different from the example of Fig. 9, the principle thereof is common.

In this conventional example, a DC potential E_s is applied to the conductive member 71 of the cathode support member 70 serving as a vibration preventing plate. The above arrangement is adopted to make the cathode support member 70 have a shield effect in order to prevent possible entrance of an unnecessary signal into the cathode.

Although the DC potential E_s is applied to the conductive member 71 of the cathode support member 70 in the conventional construction, when a high voltage applied to the screen is discharged to any of the electrodes 71, 75, 76 and 77 having a low voltage applied, the electric potential of the conductive member 71 may be sometimes significantly changed by pulse noise voltage. The peak voltage sometimes reaches several tens to hundreds volts. The above-mentioned phenomenon takes place because neither the internal impedance of the power source supplying an electric potential to the conductive member 71 nor the inductance of the wire for supplying the electric potential is zero.

The pulse width of such a noise is usually smaller than the millisecond order, however, due to such a high-potential pulse discharged from the screen, a cathode 51 momentarily emits a great amount of electrons to the cathode support member 70, and the emitted electrons are charged in the surface of the insulation member 72 covering the conductive member 71.

Eventually, the electric potential at the surface of the insulation member 72, which is maintained at the electric potential in the period of drawing electrons from the cathode 74 in the normal operation time, is immediately driven and fixed at an electric potential lower than the electric potential in the normal operation time, which also makes the potential gradient around the cathode 51 hinder the electron emission, which disadvantageously results in no illuminating portion in the screen due to no electron emission from the cathode.

SUMMARY OF THE INVENTION

Accordingly, an essential object of the present invention is to provide an electron source unit and electron source drive device capable of exerting no hindering influence on the electron emission from the cathode or remarkably reducing the period of hindering the electron emission from the cathode even when a pulse noise is superimposed on the electric potential at the conductive member 71 of the cathode support member 70.

In order to give solution to the above-mentioned problems, an electron source and electron source drive device in accordance with the present invention comprises the means as follows.

According to a feature of the present invention, an electron source unit for emitting electrons comprises: at least a cathode member for cyclically emitting electrons; and a cathode support member for supporting said cathode member thereon in a contacting manner, said cathode support member further comprising a conductive member and an insulation member interposed between said conductive member and said cathode member, said insulation member made of a material having an electric discharge time constant of electrons charged in the surface thereof which is specified by an electric resistivity and a specific dielectric constant of said insulation member, wherein said electric resistivity and specific dielectric constant of said insulation member are selected in a visually permissible range that said insulation member has the electric discharge time constant of not too much in excess of one cycle of the cyclical electron emission from said cathode member without bringing forth intermittent electron emission.

According to another feature of the present invention, an electron source drive device for driving an

electron source unit comprises: a cathode member; a cathode support member for supporting said cathode member thereon in a contacting manner, said cathode support member further comprising a conductive member and an insulation member interposed between said conductive member and said cathode member; and electric potential applying means for yielding a variable electric potential to maintain a constant potential difference between the conductive member and the cathode member keeping a synchronization between a potential change at said conductive member and a potential change at said cathode member.

Otherwise, according to further another feature of the present invention, an electron source drive device is provided with a second conductive member located in the vicinity of the contacting portion between the cathode member and the first conductive member at such a position as not to hinder the electron beam travel axis; detection means for detecting entrance of external noise into said first conductive member of said cathode support member; and electric potential applying means for suppressing the electric potential at said second conductive member lower than the electric potential at said first conductive member of said cathode support member in a pulse form in synchronization with an output from said detection means, whereby the potential at the first conductive member is suppressed lower than the potential at the cathode.

The technical effective actions of present invention employing the above-mentioned means are as follows.

According to the first feature of the present invention, since the electric discharge time constant of electric charge in the surface of the insulation member depending on the insulation resistance and electrostatic capacity between the conductive member of the cathode support member and the surface of the insulation member covering the conductive member is selected in a visually permissible range which is not too much in excess of one cycle of the cyclical electron emission from the cathode, even if a great amount of electrons are temporarily charged in the surface of the insulation member by external noise thereby to decrease the potential at the surface, the charged electrons are rapidly discharged toward the conductive member according to the electric discharge time constant thereby to immediately restore the potential in the surface of the insulation member to a normal value, which results in solving the conventional problems mentioned above.

According to the second feature of the present invention, since the electric potential at the conductive member of the cathode support member is so varied as to maintain a constant potential difference in synchronization with the potential change at the cathode, therefore there occurs no emission of a great amount of electrons toward the insulation member covering the conductive member even when external noise is superimposed, which results in no abnormal electron charge in the surface of the insulation member.

According to the third feature of the present invention, since the electric potential at the second conductive member arranged in a vicinity of the contacting portion of the cathode in the electron emission period of the cathode is suppressed lower than the potential at the cathode in a pulse form in synchronization with the occurrence of external noise, and therefore the spatial potential gradient around the cathode is so changed as to hinder the electron emission from the cathode, thereby avoiding discharge of great amount of electrons toward the insulation member covering the conductive member of the cathode support member. Therefore, no abnormal electron charge takes place in the surface of the insulation member, which gives solution to the conventional problems.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings, in which:

Fig. 1 (a) is a perspective view for explaining a construction of an essential portion of an electron source in accordance with a first embodiment of the present invention;

Fig. 1 (b) is a section view showing a principle portion of a cathode support member used in the embodiment in Fig. 1 (a);

Fig. 1 (c) is a view of an equivalent circuit of the electron source for explaining electronic discharge in the embodiment in Fig. 1 (a);

Fig. 1 (d) is an explanatory view of the electronic discharge characteristic of the embodiment in Fig. 1 (a);

Fig. 2 (a) is a front view of a cathode support member of the first embodiment in Fig. 1 (a);

Fig. 2 (b) is a section view taken along the line A - A in Fig. 2 (a);

Fig. 3 is a view of an electron source and a drive circuit therefor in accordance with a second embodiment of the present invention;

Fig. 4 is a circuit diagram of a cathode drive circuit in accordance with the embodiment in Fig. 3;
 Fig. 5 (a) is a cathode drive pulse voltage waveform in the embodiment in Fig. 3;
 Fig. 5 (b) is another cathode drive pulse voltage waveform in the embodiment in Fig. 3;
 Fig. 5 (c) is a voltage waveform at a conductive member in the embodiment in Fig. 3;
 5 Fig. 6 is a view of an electron source and a drive circuit therefor in accordance with a third embodiment of the present invention;
 Fig. 7 is a circuit diagram of a control pulse generating circuit in the third embodiment in Fig. 6;
 Fig. 8 (a) is an external noise waveform in the embodiment in Fig. 6;
 Fig. 8 (b) is a voltage waveform at the electron charge control electrode in the embodiment in Fig. 6;
 10 Fig. 9 is a schematic view of the electrode construction of a conventional flat type cathode ray tube;
 Fig. 10 (a) is a schematic view of the construction of a conventional electron source;
 Fig. 10 (b) is a partial section view of Fig. 10 (a); and
 Fig. 11 shows drive waveforms in a conventional electron source.

15 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following describes in detail embodiments of the present invention.

Fig. 1 (a) shows a construction of an essential portion of an electron source in accordance with a first embodiment. A linear cathode 1 is disposed on a cathode support member 6, extending in contact with the
 20 upper surface of the cathode support member 6. The cathode support member 6 is composed of a conductive member 3 and insulation members 2 and 2a made of Al_2O_3 adhered onto the top and bottom surfaces of the conductive member 3 by melt-injection or the like means. The cathode support member 6 having an opening 6a formed, for example, by etching the conductive member 3 is superposed on a back electrode 4 and a spacer 8 is placed on the cathode support member 6 to define a space for extending the
 25 linear cathode 1.

Fig. 1 (b) shows a section view of the linear cathode 1 viewed from a direction A in Fig. 1 (a), wherein the insulation member 2 is interposed between the linear cathode 1 and the conductive member 3, and the insulation member 2a is interposed between the conductive member 3 and the back electrode 4. Electrically, there is applied a DC potential to the conductive member 3 from a power source 7.

30 In the present embodiment, it is considered that the insulation member 2 has electrically an insulation resistance R_z and an electrostatic capacity C_z between the conductive member 3 and the upper surface 5 of the insulation member 2. Therefore, the charge and discharge of electrons emitted from the linear cathode 1 into the surface 5 of the insulation member 2 can be explained using the values R_z and C_z .

Postulating now that a great amount of electrons is emitted from the cathode 1 to the insulation member
 35 2 to charge electrons in the electrostatic capacity C_z because a potential at the conductive member 3 is increased from a normal value approximately equal to a potential at the linear cathode 1 in an electron emission period to a large value temporarily exceeding the potential at the linear cathode 1 in the electron emission period to result in that a potential V_z at the surface 5 of the insulation member 2 with respect to the conductive member 3 is changed to $-V_{z0}$. Now the above-mentioned condition returns to the normal
 40 condition can be explained with a known equivalent circuit as shown in Fig. 1 (c) where the electric charge in the electrostatic capacity C_z is discharged through the insulation resistance R_z . In detail, assuming now that a switch SW is closed at the time the electric charge is completed, the potential V_z is increased according to a time constant $\tau = R_z C_z$ to the original potential as shown in Fig. 1 (d) to eliminate the electric charge accompanied by the abrupt electron emission from the cathode.

45 When the time constant τ is $\tau < T_f$ with respect to an electron emission cycle T_f of each electron source, no influence is exerted on the normal electron emission operation.

However, it has been conventionally considered that the insulation resistance R_z of the insulation member 2 is preferably higher for the reason of assuring a good insulation performance, and therefore a high-purity Al_2O_3 (99.5%) exhibiting an excellent insulation performance has been used. According to a
 50 reference document 1, page 650 of the 1984 version of "Fine Ceramics Handbook" issued from Asakura Bookstore, the high-purity Al_2O_3 (99.5%) has a volume resistivity greater than $10^{14} [\Omega\text{cm}]$ at a temperature of around 200 to 300 °C at which the insulation member 2 is used. Based on a postulation that the volume resistivity is typically $10^{14} [\Omega\text{cm}]$, the following describes a calculation example of the insulation resistance R_z of the insulation member 2 from the dimensions of a practical electron source.

55 Fig. 2 (a) shows a shape and size of the cathode support member 6 corresponding to one electron source viewed from the screen, while Fig. 2 (b) is a section view taken along a line A - A in Fig. 2 (a). Referring to Fig. 2 (a), the linear cathode 1 extends in a direction as shown by a broken line. Since the spacer 8 is interposed between the support member 6 and an electron beam drawing electrode 9 (not

shown) provided frontward of Fig. 2 (a) so as to hold the cathode 1 from both sides, the insulation member 2 is viewed like a hatched portion in Fig. 2 (a) when viewed in a direction from the linear cathode 1. Therefore, it is assumable that electrons are charged in the entire surface area of the hatched portion.

Postulating now that the surface area of the hatched portion is S_z , the volume resistivity is ρ_v , and the thickness of the insulation member is d_z , the following equations hold.

$$\begin{aligned} R_z &= \rho_v \cdot d_z / S_z \\ &= 10^{14} \times 0.003 / (0.16 \times 0.02) \\ &= 9.4 \times 10^{13} [\Omega] \end{aligned}$$

On the other hand, postulating that the electrostatic capacity is C_z and the specific dielectric constant is ϵ_z (9.8 in the reference document 1), the following equations hold.

$$\begin{aligned} C_z &= \epsilon_0 \cdot \epsilon_z \cdot S_z / d_z \\ &= 9.8 \times 8.854 \times 10^{-12} \times 1.6 \times 10^{-3} \times 0.2 \times \\ &\quad 10^{-3} / 0.03 \times 10^{-3} \\ &= 9.3 \times 10^{-13} [F] \end{aligned}$$

Accordingly, the electric discharge time constant τ can be derived as:

$$\tau = R_z \cdot C_z = 87.4 [s]$$

which indicates that the discharge time constant τ is much greater than the electron emission cycle $T_f = 16.7 [ms]$ of the field cycle according to the NTSC television system.

For the above reasons, according to the present embodiment, the insulation member 2 is made of a material having smaller volume resistivity and specific dielectric constant as compared with Al_2O_3 (99.5%). For example, a low-purity Al_2O_3 (92%) is selected. According to the reference document 1, the low-purity Al_2O_3 has a volume resistivity of 10^{10} to $10^{11} [\Omega cm]$ in a temperature range of 200 to 300 °C. Meanwhile the material has a specific dielectric constant of 8.5 in the same condition. Calculating R_z and C_z based on the above values, $R_z = 9.4 \times 10^{10} [\Omega]$ and $C_z = 8.0 \times 10^{-13} [F]$, while the time constant $\tau = 7.5$ to 75 [ms] which is remarkably smaller than the time constant $\tau = 87.4 [s]$ of the conventional device to result in exerting no influence on the electron emission from the cathode. Practically when the low-purity Al_2O_3 - (92%) is used, the actual time constant is approximately 10 [ms] which is substantially equal to the value of the calculation result.

It is noted that a time more than one hour is necessary to eliminate electron charge when Al_2O_3 - (99.5%) is used, which differs from the calculation result value. The reason of the above is presumed that the actual volume resistivity is higher than $10^{14} [\Omega cm]$ by an order of two digits.

The insulation member 2 is preferably made of a material having a volume resistivity of 10^7 to $10^{10} [\Omega cm]$ and a specific dielectric constant of 10 or less for the reason that, even when the period of stopping electron emission exceeds the electron emission cycle of the cathode by a small amount, it is visually permissible in an actual image display operation of a cathode ray tube and for the reason that an insulation between the cathode and the conductive member 3 must be ensured. As a material exhibiting the same characteristics as above, steatite ($MgO \cdot SiO_2$) and cordierite ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$) are known.

Accordingly by selecting the volume resistivity and the specific dielectric constant of the insulation member 2 to such values that the electric discharge time constant is in a visually permissible range of not too much in excess of the electron emission cycle, electron emission of the cathode in the normal operation time can be prevented from being hindered.

The following describes a second embodiment of the present invention. Fig. 3 shows the construction of the electron source and a drive method therefor of the second embodiment. The electrode construction

itself is the same as a conventional one where a linear cathode 1 extends in contact with a support member 6 laminated on a back electrode 4, while an electron beam drawing electrode 9 is provided in a position apart from the cathode 1, with which an electron beam 10 is drawn from the linear cathode 1 at the position corresponding to an opening 6a formed in the cathode support member 6 thereby to be conducted through an electron beam through hole 9a.

A cathode drive circuit 11 supplies pulse-shaped voltages K_1 through K_L to one end of each linear cathode 1, while a potential V_{Kc} is applied through a diode 13 to the other end of the cathode 1. A high potential of the pulse-shaped voltages K_1 through K_L are determined according to a voltage V_{Kh} superimposed on V_{Kc} , while a low potential is determined by the supply voltage V_{Ke} of a power source 12. In other words, the voltage V_{Kh} controls the heating current to be applied for heating the cathode 1, while the voltage V_{Ke} of the power source 12 controls the amount of electron emission from the cathode. On the other hand, a DC potential V_B is applied to the back electrode 4, while a DC potential V_{G1} is applied to the electron drawing electrode 9. These potentials are set in the present embodiment as follows: $V_{Ke} = 30$ V, $V_{Kc} = 55$ V, $V_{Kh} = 15$ V, $V_B = 28$ V, and $V_{G1} = 55$ V.

A feature of the present embodiment is that the electric potential at the conductive member 3 of the cathode support member 6 is supplied directly from the power source 12. With the above construction, the electric potential at the conductive member 3 is maintained approximately equal to the low potentials of the cathode drive pulse voltages K_1 through K_L , i.e., the electric potential at the cathode in the electron emission period of the cathode.

The above operation is described as follows with reference to Fig. 4 showing a practical example of the cathode drive circuit 11. Although Fig. 4 shows only one circuit for amplifying and outputting a cathode drive pulse, practically the same circuits are necessary in the amount corresponding to the amount of the linear cathodes.

Referring to Fig. 4, a TTL level pulse input to a terminal 20 is compared with an electric potential set up by V_{CC1} in a comparator circuit comprising transistors Q_3 , Q_4 and Q_5 to form an in-phase amplified output pulse at the collector of the transistor Q_3 and a reversed-phase amplified output pulse at the collector of the transistor Q_4 . The in-phase pulse is input to the base of a transistor Q_6 to be a reversed-phase pulse having its low level at the potential V_{Ke} supplied to a terminal 23 to be then input to the base of a transistor Q_{11} . Meanwhile an output pulse of the transistor Q_4 is input to the base of a transistor Q_8 to be an in-phase pulse having its high level at the potential V_{Kh} supplied to a terminal 21 to be then input to the base of a transistor Q_9 . The transistors Q_9 and Q_{11} constitute a totem pole circuit which produces at an output terminal 22 an amplified cathode drive pulse having a high level substantially equal to V_{Kh} and a low level substantially equal to V_{Ke} as in phase with the input. The reason why the term "substantially" is used is that a difference corresponding to the saturation voltage V_{CE} between the collector and the emitter of each of the transistors Q_9 and Q_{11} is included.

As described above, the low potential of the cathode drive pulse is determined by directly supplying the voltage V_{Ke} from the power source 12, and therefore, even when the voltage of the power source 12 fluctuates, the same electric potential can be achieved without delay. Since the electric potential at the conductive member 3 is also supplied from the power source 12, the potential difference between the potential level of the conductive member 3 and the low level of the cathode drive pulse is constantly maintained at V_{CE} so long as the amplitude V_N of external noise does not exceed the electric potential V_{Kh} .

When the amplitude V_N of the external noise exceeds the electric potential V_{Kh} , diodes D_5 and D_6 as shown in Fig. 4 turn on. Postulating that the potential difference at the time the diodes turn on is V_D , the electric potential at the conductive member 3 starts to increase from a time t_0 at which a noise pulse is input as shown in Fig. 5 (c) but it does not exceed the potential V_{Kh} by $2V_D$ or more. At the same time the electric potential of the cathode drive pulse also increases but it does not exceed the potential V_{Kh} by V_D or more as shown in Figs. 5 (a) and (b), and therefore the difference between the potential level of the conductive member 3 and that of the cathode drive pulse is maintained constant at V_D .

In each of periods t_0 to t_1 and t_2 to t_3 when the noise amplitude $V_N < V_{Kh} + 2V_D$, the potential difference between the two is maintained constant at V_{CE} . Practically, it is already confirmed that the potential difference in the above-mentioned degree causes no great amount of electron emission.

In the present embodiment, the resistance values of the resistors in the circuit in Fig. 4 are set as follows:

$R_1 = 3.5$ k Ω , $R_2 = 3$ k Ω , $R_3 = 820$ Ω , $R_4 = R_7 = 1$ k Ω , $R_5 = 4$ k Ω , $R_6 = 12$ k Ω , $R_8 = 100$ Ω , $R_9 = R_{12} = 6.8$ k Ω , $R_{10} = R_{13} = 560$ Ω , $R_{11} = R_{14} = R_{17} = 330$ Ω , $R_{15} = 220$ Ω , and $R_{16} = 470$ Ω .

As described above, by supplying a potential to the conductive member 3 from the power source 12, the electric potential at the conductive member 3 and the electric potential at the linear cathode 1 are maintained approximately same even when external noise enters. The above feature assures to avoid such

a great amount of electron emission from the cathode 1 toward the cathode support member 6, preventing reduction of the electric potential at the surface of the insulation member 2, which leads to no hindrance of electron emission from the cathode 1 in the normal operation.

The following describes a third embodiment in accordance with the present invention. Referring to the third embodiment in Fig. 6, an electron charge control electrode 30, i.e., an additional conductive member is provided opposite to a cathode support member 6 with interposition of a cathode 1 at a position very close to the linear cathode 1. To the electron charge control electrode 30, there is supplied an electric potential from a control pulse generating circuit 31. The electron charge control electrode 30 is arranged apart from the cathode 1 by a clearance of approximately 0.2 millimeters as having a width equal to that of the cathode support member 6 so as to confront the cathode support member 6 in position. The electron charge control electrode 30 may be arranged separately in contact with a back electrode 4 of the cathode support member 6, or the electrode 4 itself may serve as the electrode 30. In each of the above-mentioned cases, an electric potential is supplied from the control pulse generating circuit 31.

In the above-constructed electron source of the present embodiment, the control pulse generating circuit 31 detects a potential change at the conductive member 3 to supply a pulse-shaped electric potential synchronized with the potential change to the electron charge control electrode 30. To the other electrodes of the electron source, the same electric potentials as in the second embodiment of the present invention are applied.

Fig. 7 shows a concrete circuit construction of the control pulse generating circuit 31 to describe the operation of the circuit. A resistor R_s for detecting a potential change at the conductive member 3 is connected in series between the conductive member 3 and a power source 32 which supplies a potential to the conductive member 3. The emitter of a transistor Q_1 is connected via a detection terminal 33 to the conductive member 3, while the base of the transistor Q_1 is connected via a detection terminal 34 to the power source 32. Assuming now that pulse-shaped external noise enters into the conductive member 3 to increase the potential at the conductive member 3, the transistor Q_1 turns on to generate a pulse having its low level at the electric potential at GND in phase with the noise across a resistor R_2 connected to the collector of the transistor Q_1 . The resistor R_1 is to divide the pulse height value.

The thus-obtained pulse is input to an in-phase input terminal of a comparator 35 to be then output as an in-phase pulse having its high level at the potential at V_{CC1} and its low level at the potential at GND. The output pulse turns on the transistor Q_2 in the high-level status and turns off the transistor Q_2 in the low-level status, and therefore a reversed-phase pulse and an in-phase pulse appear across respectively the resistors R_3 and R_5 connected respectively to the collector and the emitter of the transistor Q_2 . The obtained pulses are input to transistors Q_3 and Q_4 to consequently output a pulse having its high level at $V_{CC2} - V_{CE3}$ and its low level at $V_{EE1} + V_{CE4}$ at an output terminal 39. It is noted here that V_{CE3} is the saturation voltage between the collector and the emitter of the transistor Q_3 , V_{CE4} is the same voltage of the transistor Q_4 .

Fig. 8 (a) shows an external noise waveform which enters into the conductive member 3, while Fig. 8 (b) shows an output waveform of a control pulse generating circuit 31 generated at the noise entrance time. When the operation sensitivity of the comparator 35 is increased, a pulse having a negative polarity is obtained at the output terminal 39 from the upraise time t_0 of the noise waveform to the time t_1 when the noise completely disappears. It is noted that the potential V_{CC2} is made equal to the potential V_s at the conductive member 3, while the potential V_{EE1} is made lower than the potential obtained by subtracting the external noise pulse height value V_N from the potential V_{CC2} . In the present embodiment, $V_{CC2} = 30$ V while $V_{EE1} = -50$ V. The circuit constants in the present embodiment are determined as follows: $R_s = 1$ k Ω , $R_1 = 5.6$ k Ω , $R_2 = 390$ Ω , $R_3 = R_5 = 560$ Ω , $R_4 = 15$ k Ω , and $V_{CC1} = 15$ V.

When supplying the thus-obtained pulse potential to the electron charge control electrode 30, no significant influence is exerted on the potential gradient around the cathode 1 in the normal operation time of the electron source because the potential at the electron charge control electrode 30 is substantially equal to the potential at the cathode 1. When the potential at the conductive member 3 is increased due to an influence of external noise, the potential around the cathode 1 is reduced lower than the potential at the cathode 1 to hinder electron emission from the cathode 1. Therefore, such a great amount of electron charge is prevented from taking place in the surface of the insulation member 2 provided on the conductive member 3 even when external noise enters.

According to the present invention as described above in detail, an electron source can be stably driven without being influenced by external noise, thereby increasing the quality of the displayed image.

Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted here that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention as defined by the appended claims, they should be construed as included therein.

Claims

1. An electron source unit for emitting electrons comprising:
 at least a cathode member for cyclically emitting electrons; and
 5 a cathode support member for supporting said cathode member thereon in a contacting manner, said cathode support member further comprising a conductive member and an insulation member interposed between said conductive member and said cathode member, said insulation member made of a material having an electric discharge time constant of electrons charged in the surface thereof which is specified by an electric resistivity and a specific dielectric constant of said insulation member,
 10 wherein said electric resistivity and specific dielectric constant of said insulation member are selected in a manner that said insulation member has the electric discharge time constant which is set in a visually permissible range of not too much in excess of one cycle of the cyclical electron emission from said cathode member.
- 15 2. The electron source unit as claimed in Claim 1, wherein said insulation member has a volume resistivity of 10^7 to 10^{10} Ωcm and a specific dielectric constant of not greater than 10.
3. An electron source drive device for driving an electron source unit comprising:
 a cathode member;
 20 a cathode support member for supporting said cathode member thereon in a contacting manner, said cathode support member further comprising a conductive member and an insulation member interposed between said conductive member and said cathode member; and
 electric potential applying means for yielding a variable electric potential to maintain a constant potential difference between the conductive member and the cathode member keeping a synchroniza-
 25 tion between a potential change at said conductive member and a potential change at said cathode member.
4. The electron source drive device as claimed in Claim 3, wherein said electric potential applying means and said cathode member in the period of the electron emission phase of said cathode member
 30 receive electric potentials from an identical power source.
5. An electron source drive device for driving an electron source unit comprising:
 a cathode member;
 a cathode support member for supporting said cathode member thereon in a contacting manner,
 35 said cathode support member further comprising a first conductive member and an insulation member interposed between said first conductive member and said cathode member;
 a second conductive member located in the vicinity of the contacting portion between the cathode member and the first conductive member at such a position as not to hinder the electron beam travel axis;
 40 detection means for detecting entrance of external noise into said first conductive member of said cathode support member; and
 electric potential applying means for suppressing the electric potential at said second conductive member lower than the electric potential at said first conductive member of said cathode support member in a pulse form in synchronization with an output from said detection means.
 45
6. The electron source drive device as claimed in Claim 5, wherein said second conductive member is arranged opposite to said first conductive member of said cathode support member with interposition of said cathode member.
- 50 7. The electron source drive device as claimed in Claim 5, wherein said second conductive member is arranged opposite to the portion in contact with the cathode member of said cathode support member, and a part or the entire body of said second conductive member is arranged opposite to said first conductive member.
- 55 8. The electron source drive device as claimed in Claim 5, wherein said detection means for detecting entrance of external noise is a resistor connected serially between said first conductive member and a power source for supplying an electric potential to said first conductive member.

Fig . 1 (a)

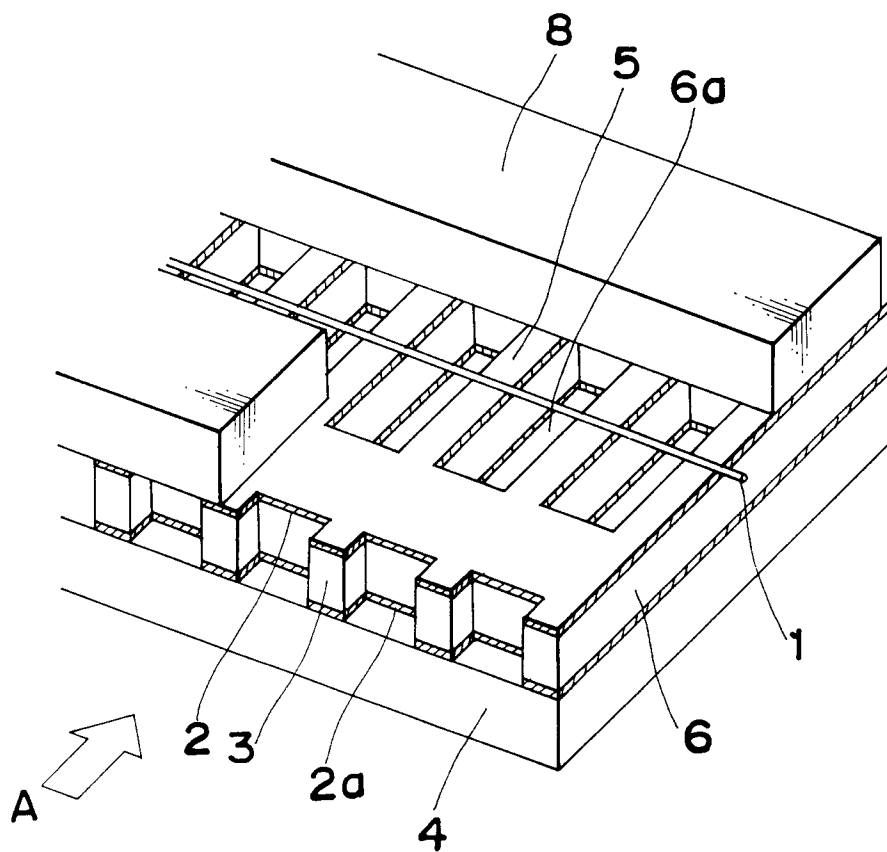


Fig. 1(b)

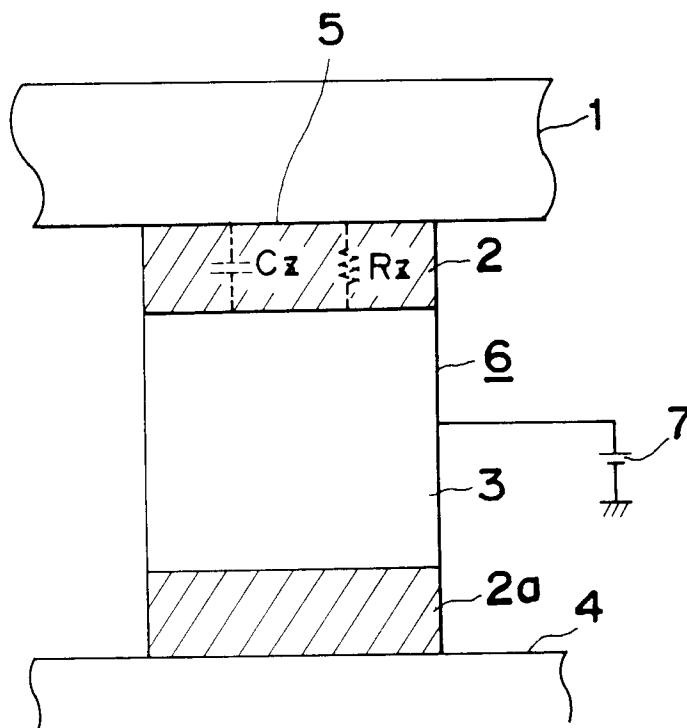


Fig. 1(c)

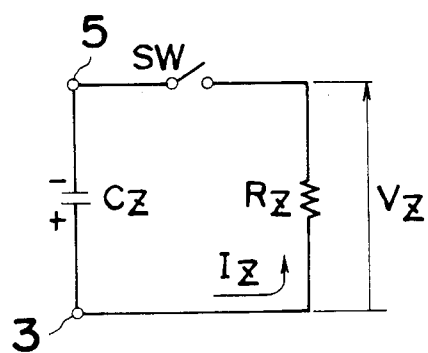


Fig. 1(d)

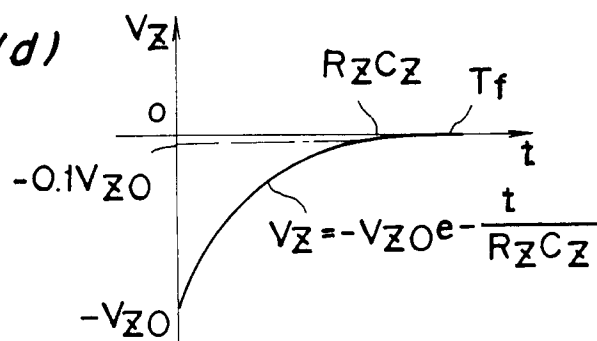


Fig . 2 (a)

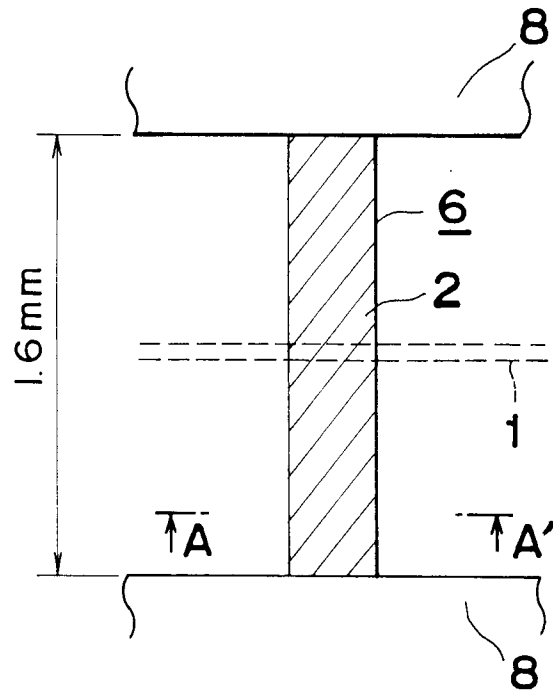


Fig . 2 (b)

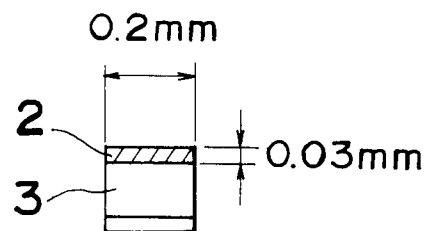


Fig. 3

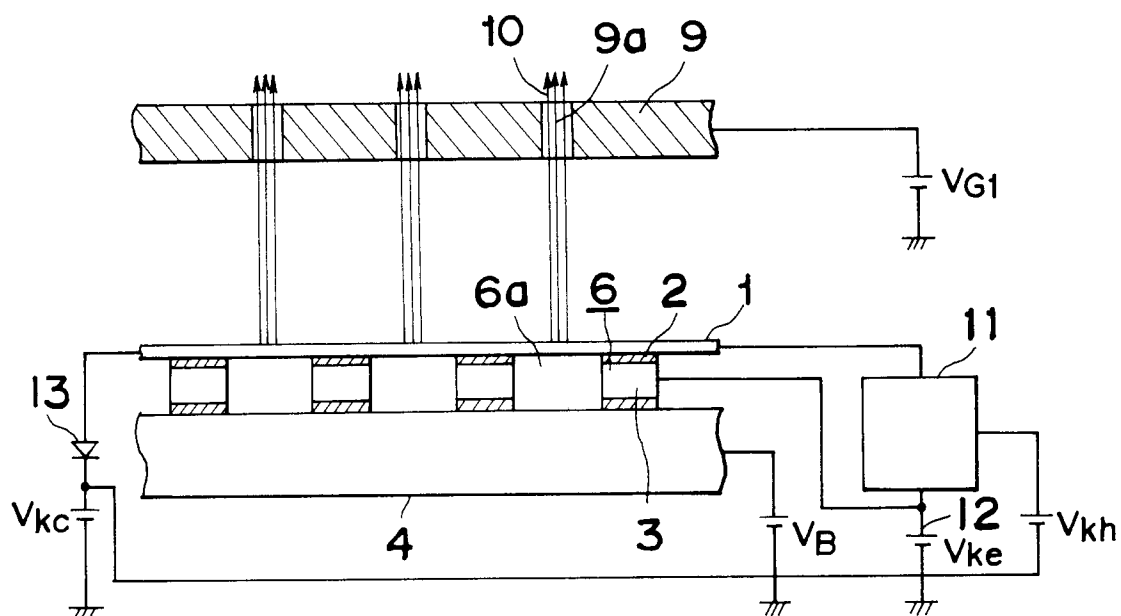


Fig. 4

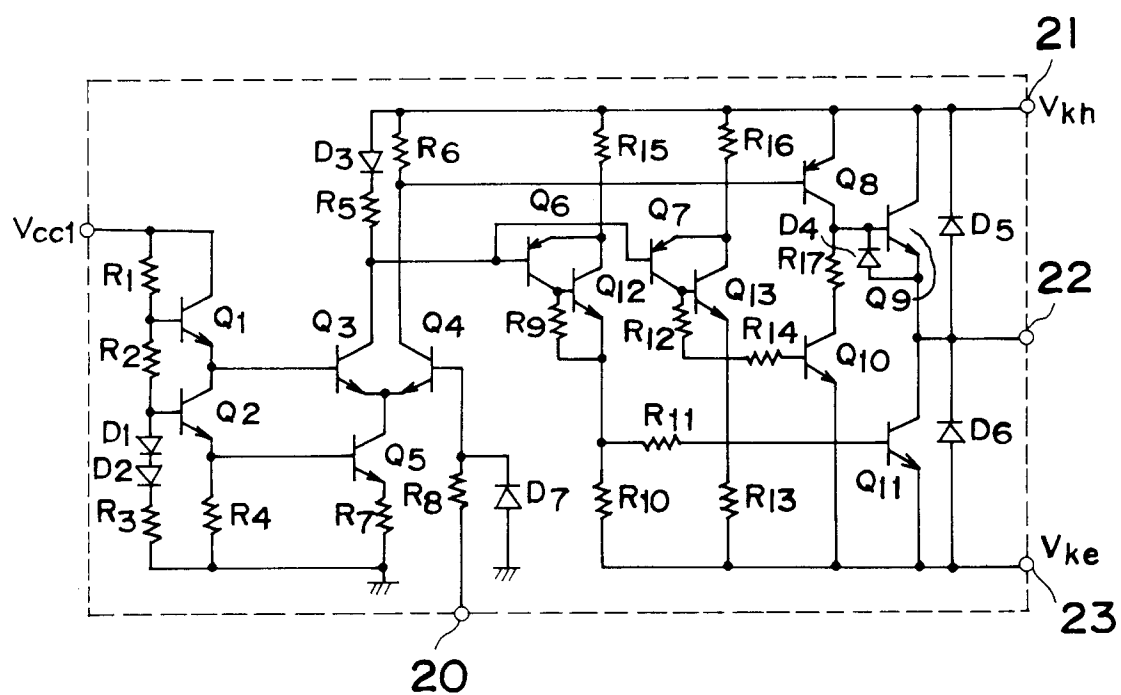


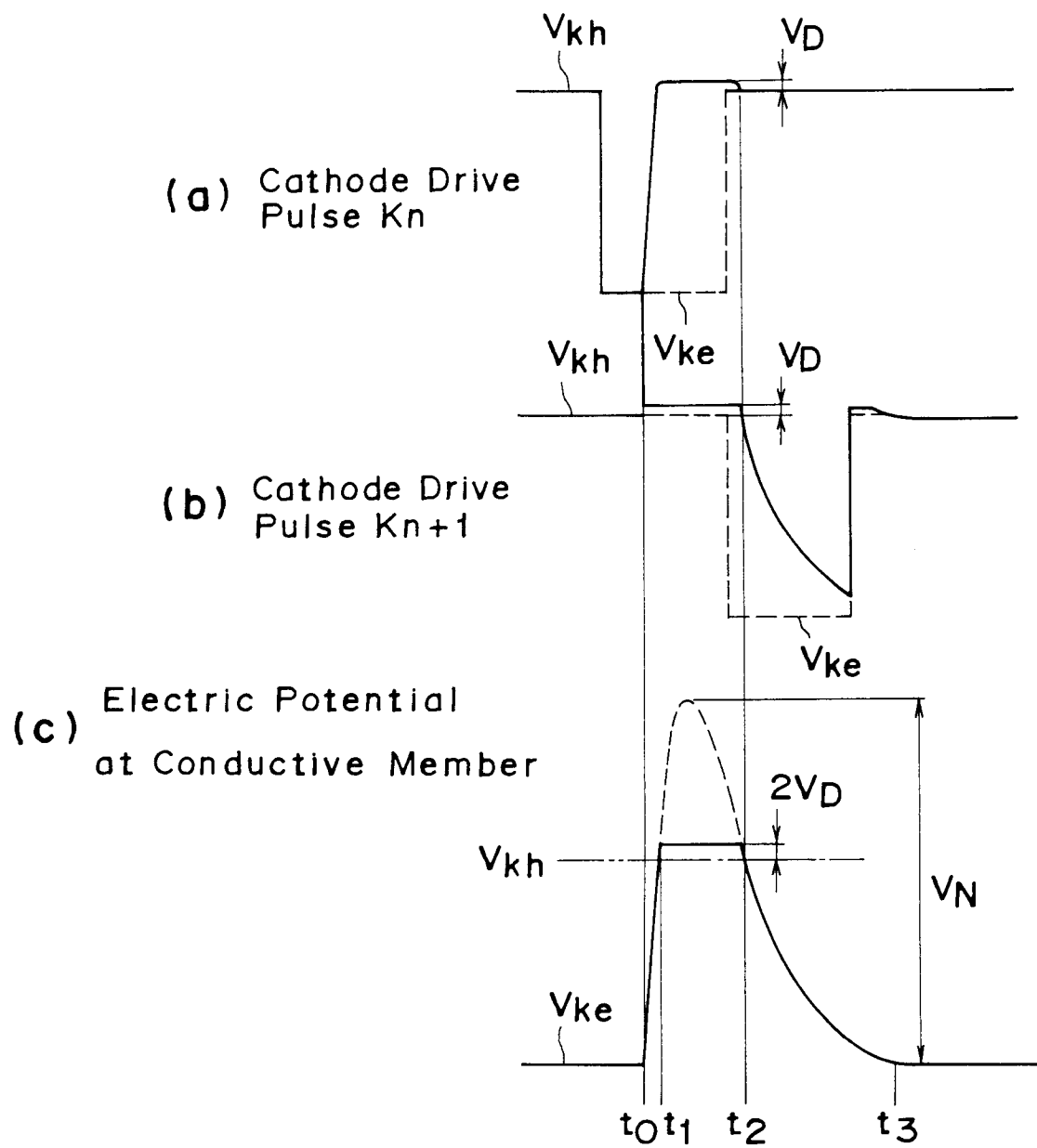
Fig . 5

Fig . 6

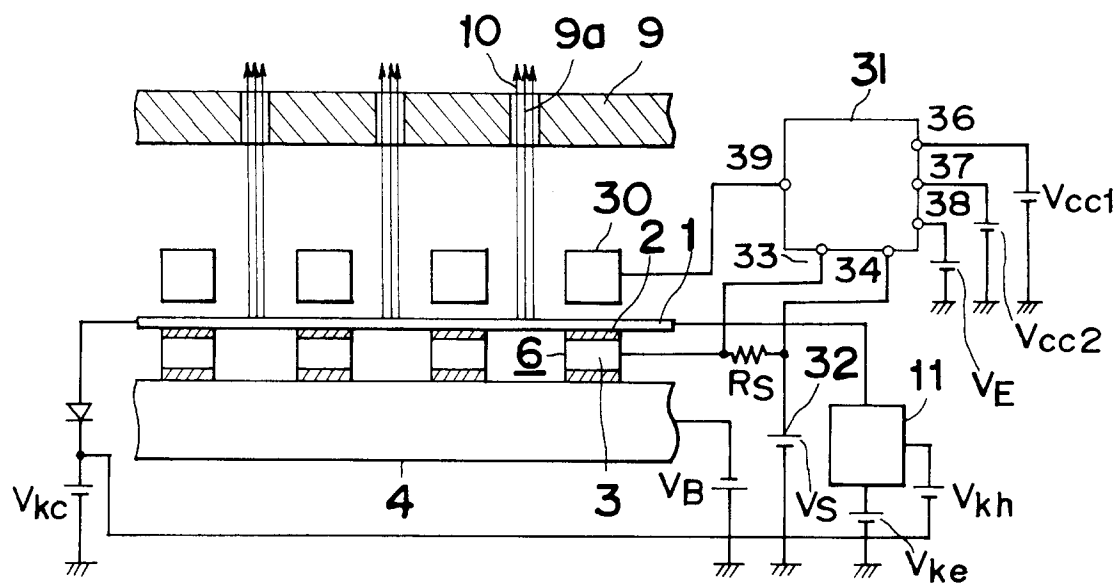


Fig . 7

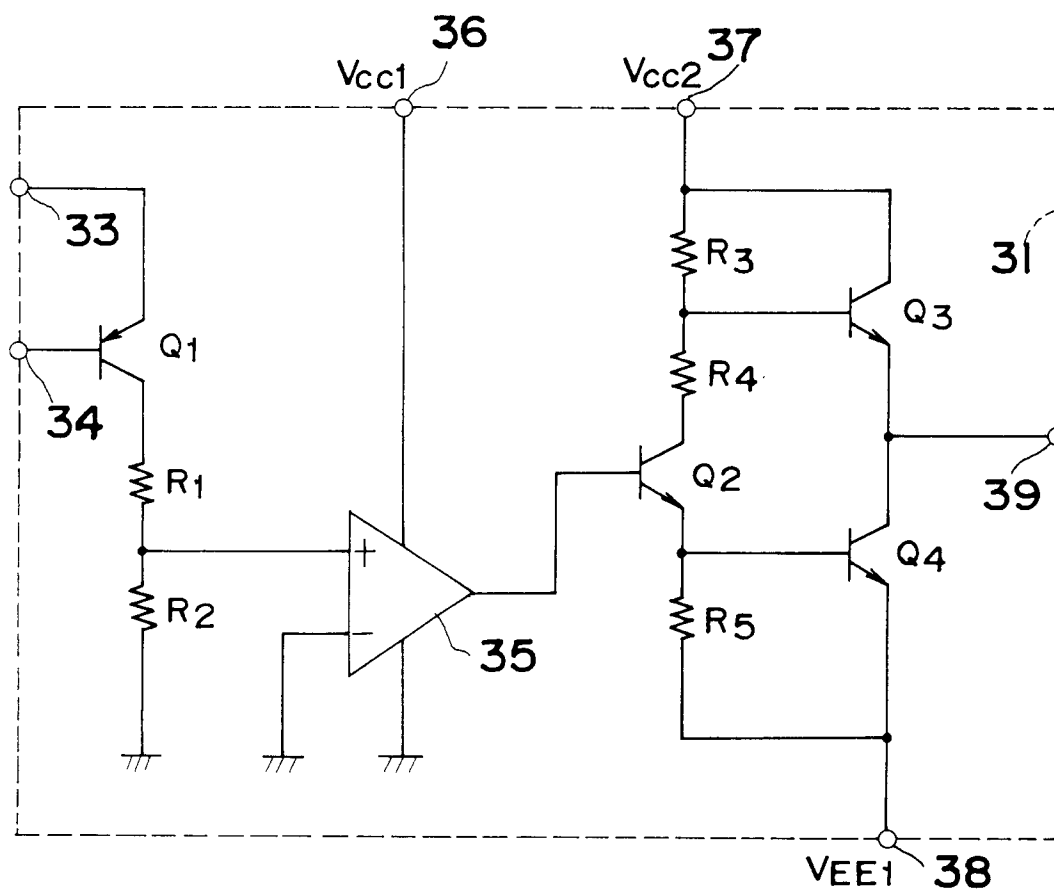


Fig . 8

(a) Electric Potential
at Conductive Member

(b) Electric Potential
of Charge Control
Electrode

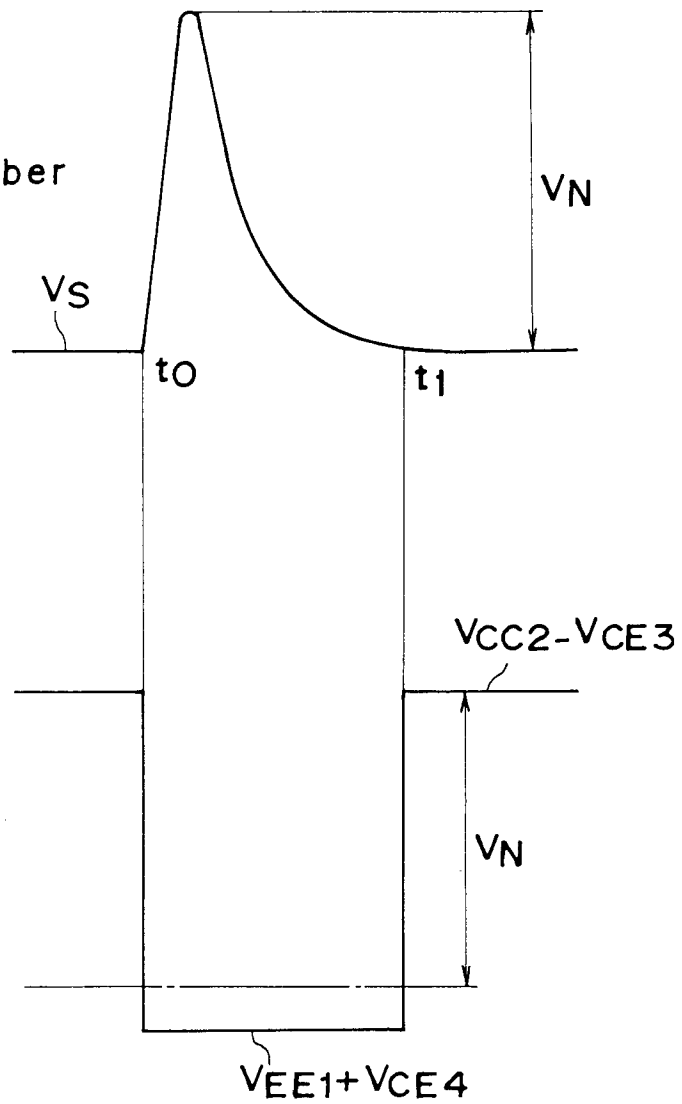


Fig . 9 (Prior Art)

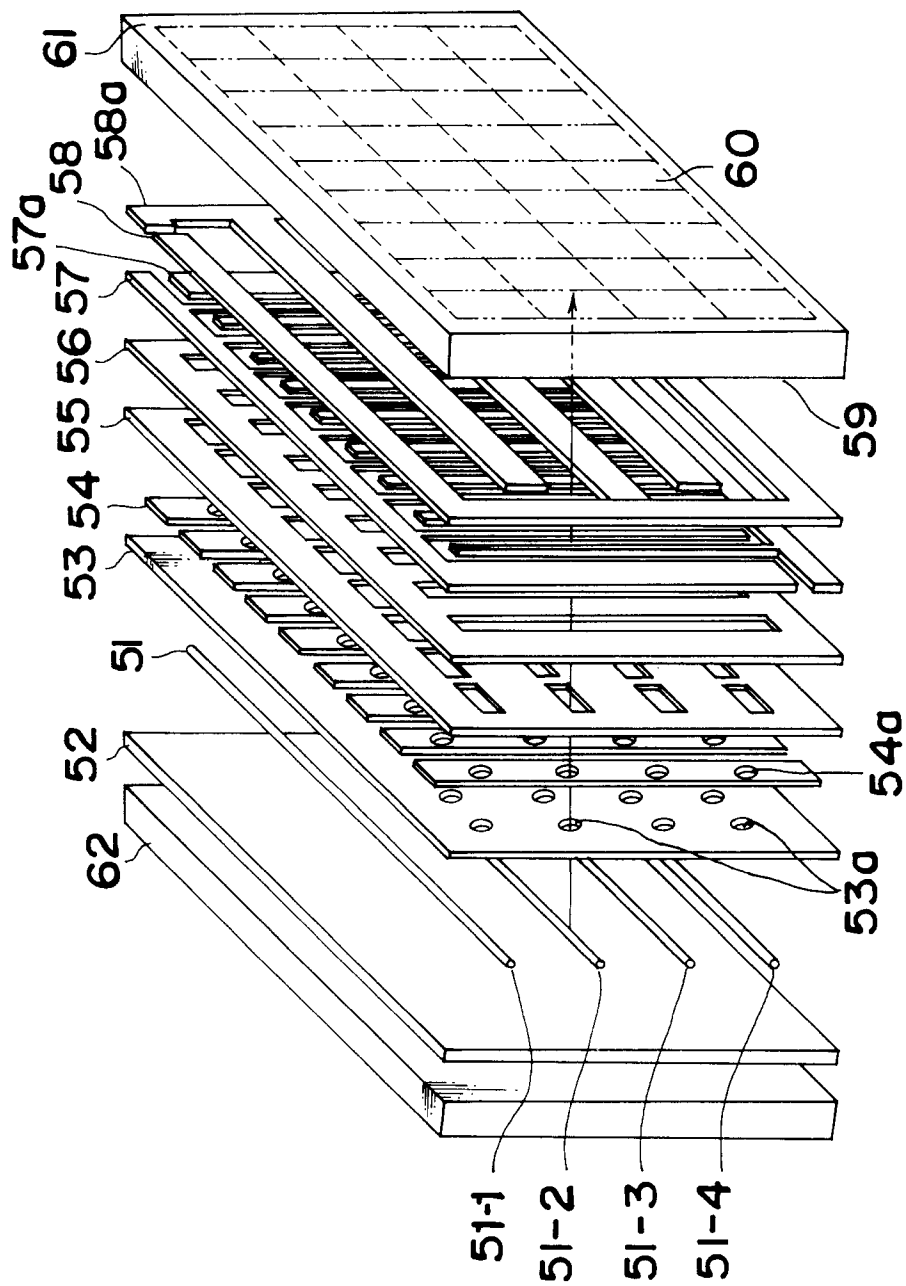


Fig. 10 (a) (Prior Art)

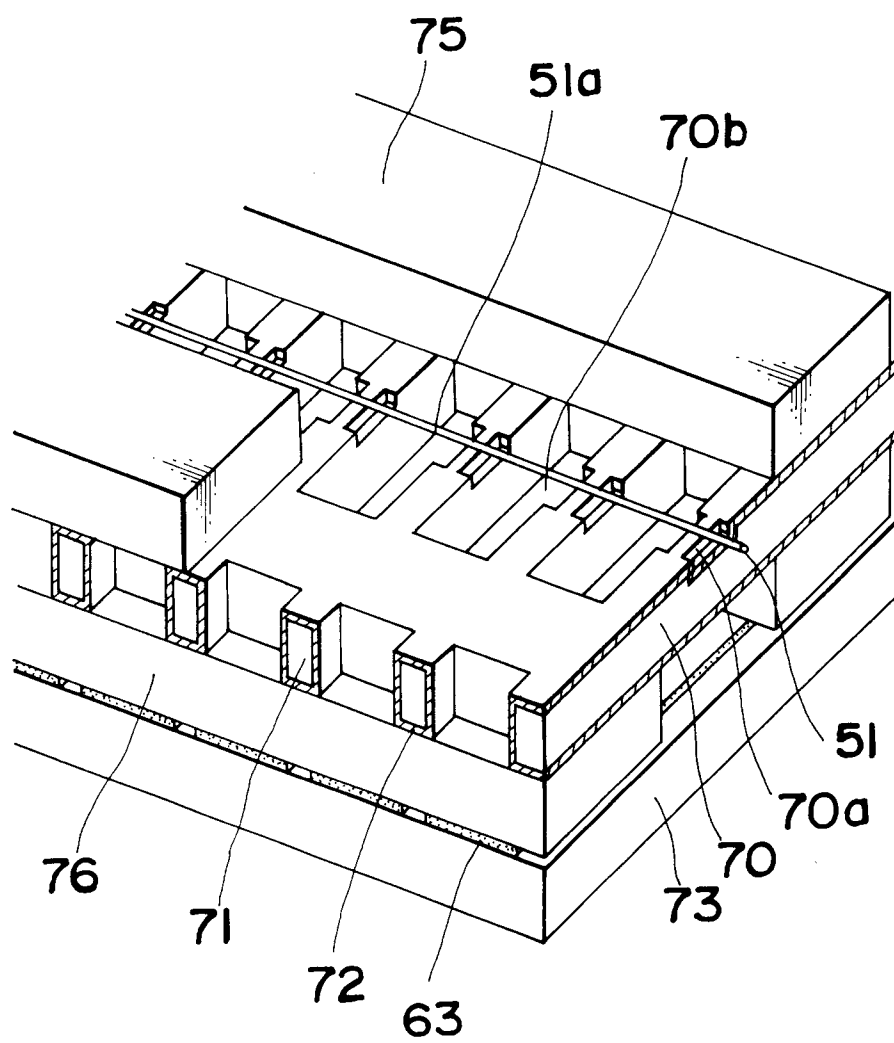


Fig. 10(b) (Prior Art)

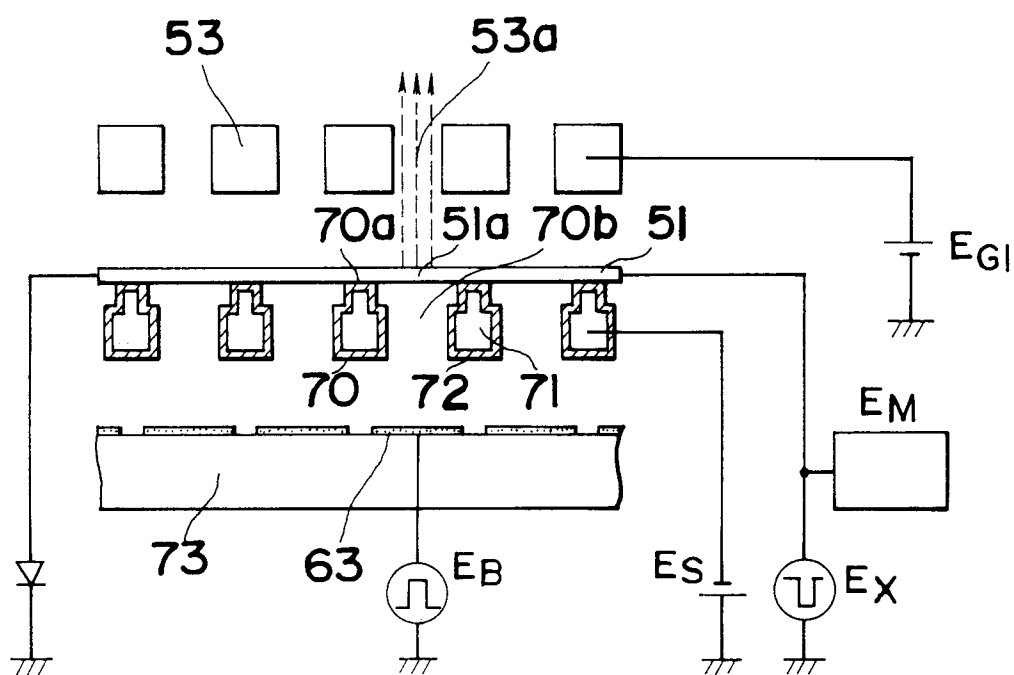


Fig. 11 (Prior Art)

