(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 461 657 A2**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **91109734.3**

(51) Int. Cl.[5]: **H01J 31/12**

(22) Date of filing: **13.06.91**

(30) Priority: **14.06.90 JP 156168/90**

(43) Date of publication of application:
18.12.91 Bulletin 91/51

(84) Designated Contracting States:
DE FR GB

(71) Applicant: **SONY CORPORATION**
7-35, Kitashinagawa 6-chome Shinagawa-ku Tokyo(JP)

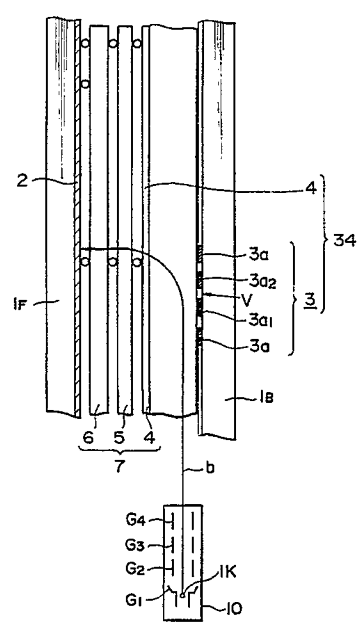
(72) Inventor: **Ohoshi, Toshio**
c/o SONY CORPORATION, 7-35, Kitashinagawa 6-chome Shinagawa-ku, Tokyo(JP)
Inventor: **Inoue, Junichi**
c/o SONY CORPORATION, 7-35, Kitashinagawa 6-chome Shinagawa-ku, Tokyo(JP)
Inventor: **Yamamoto, Masanobu**
c/o SONY CORPORATION, 7-35, Kitashinagawa 6-chome Shinagawa-ku, Tokyo(JP)

(74) Representative: **TER MEER - MÜLLER - STEINMEISTER & PARTNER**
Mauerkircherstrasse 45
W-8000 München 80(DE)

(54) Flat display.

(57) A flat display comprises a flat tube (1) having a front panel (1F) and a back panel (1B) facing the front panel (1), a fluorescent screen (2) formed on the inner surface of the front panel (1F) of the flat tube (1), an electron gun (10) disposed outside a region extending behind the fluorescent screen (2), a vertical deflecting electrode (3) disposed on the inner surface of the back panel (1B) and comprising a plurality of parallel electrode elements (3a) extending along the horizontal scanning direction, and an electrode structure (7) disposed between the vertical deflecting electrode (3) and the fluorescent screen (2), and comprising at least a counter electrode (4) constituting a vertical deflecting system together with the vertical deflecting electrode (3), a modulating electrode (5) and a horizontal deflecting electrode (6). The electron gun (10) has a back plate (41) and a cathode (1K) having a plurality of field emission cathode elements (K) arranged on a line on the inner surface of the back plate (41), and emits a flat electron beam (b) into the space between the vertical deflecting electrode (3) and the electrode structure (7). Since the flat electron beam (b) is produced by the plurality of field emission cathode elements (K) arranged on a line, the cathode (1K) of the electron gun (10) does not vibrate and hence the cathode (1K) can be formed in a large length suitable for a large display screen.

F I G. 3



EP 0 461 657 A2

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a flat display having a flat screen capable of displaying various pictures.

Description of the Prior Art

Various flat displays, namely, panel displays, have been proposed. Japanese Patent Laid-open (Kokai) No. 1-173555 discloses a flat cathode-ray tube of a secondary-electron multiplication type. It is desirable to apply the flat cathode-ray tube of a secondary-electron multiplication type to a flat display with a large screen, such as a 40 in. screen.

A flat display, like the flat cathode-ray tube disclosed in Japanese Patent Laid-open (Kokai) No. 1-173555, is provided with a plurality of cathodes or filaments, and makes sections of a fluorescent screen emit visible light for desired display by striking the fluorescent screen by thermions produced by the cathodes or the filaments and modulated according to display signals. The assignment of the plurality of cathodes or filaments to the sections of the fluorescent screen has a problem that the sections of the fluorescent screen are not uniform in brightness due to difference between the cathodes or filaments in their characteristics.

Japanese Patent Laid-open (Kokai) No. 60-115134 discloses a flat display employing a single cathode instead of a plurality of cathodes or filaments to obviate such a problem.

Single-cathode structures previously proposed by the applicant of the present patent application in Japanese Patent Application Nos. 1-331593 and 1-331594 are intended to avoid the variation of focusing conditions dependent on the position of a scanning spot on the screen and to enable displaying pictures on a large display screen. A single-cathode structure for a display having a large display screen, however, needs a linear cathode having a large length of about 100 mm or above with respect to the vertical scanning direction; and the linear cathode is liable to vibrate. The vibration of the linear cathode affect the path of the electron beam significantly to deteriorate the definition. Therefore, the linear cathode is provided with stays between the opposite ends thereof to suppress vibration.

Fig. 11 shows a conventional single-cathode structure having a single linear cathode 81. The linear cathode 81 is formed by coating a tungsten wire with a ternary salt and is stretched between anchors 82 fixed to an insulating base 80. Stays 83 provided between the anchors 82 supports the linear cathode 81 to prevent the vibration of the linear cathode 81. In Fig. 11, indicated at 84 is a back plate, and at G1 to G4 are first to fourth grids, respectively.

An electron beam of a desired acceleration can be obtained, for example, by applying voltages of 30 V, -5 V, 350 V and 110 V to the first grid G1, the second grid G2, the third grid G3 and the fourth grid G4, respectively, and a voltage of -10 V to the back plate 84.

In producing an electron beam, the linear cathode 81 is heated at a high temperature of 760°C or higher. However, heat flows from the linear cathode 81 through the stays 83 to the insulating base 80 to cause end cool, namely, local temperature drop in the linear cathode 81 in regions of about 10 mm about the stays 83, to deteriorate the thermion emission characteristics of the linear cathode 81. Thus, the stays 83 provided to prevent the vibration of the linear cathode 81 increases the ineffective region of the linear cathode 81 and deteriorates the thermion emission characteristics of the linear cathode 81.

Electrons emitted by the linear cathode 81 in a plane including the linear cathode 81 and traveling toward a fluorescent screen are divided into a plurality of groups by, for example, a counter electrode. However, many electrons collide against the counter electrode and become unavailable, and stray electrons produced by the collision of the electrons against the counter electrode charges the exposed surface of the insulating members, such as the surface of the tube entailing disturbance in the picture. To reduce the unavailable electrons, namely, to reduce reactive current, sections of the linear cathode 81 must be coated by the ternary salt so as to correspond respectively to the beam dividing sections of the counter electrode, which requires a troublesome work.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to improve the definition of pictures displayed on a flat display of such a type having a large display screen, and to improve the characteristics of the flat display by preventing the vibration of the cathode, reducing the power consumption, and reducing the reactive current to enhance the brightness and to reduce disturbance in the pictures.

In one aspect of the present invention, a flat display comprises a flat tube having a front panel and a back panel facing the front panel, a fluorescent screen formed on the inner surface of the front panel, an electron gun disposed outside a region extending behind the fluorescent screen, a vertical deflecting electrode provided on the inner surface of the back panel and comprising a plurality of parallel electrode elements extending along the horizontal scanning direction and disposed opposite to the fluorescent screen, and an electrode structure disposed between the vertical deflecting electrode and the fluorescent screen so as to construct a vertical deflecting system in combination with the vertical deflecting electrode and comprising at least a counter electrode provided with electron beam transmitting apertures, a modulating electrode and a horizontal deflecting electrode, wherein the electron gun has a cathode consisting of a plurality of field emission cathode elements arranged on a line, and the electron gun emits an electron beam into the space between the electrode structure and the vertical deflecting electrode.

In this specification, the horizontal and vertical scanning directions are not necessarily physically horizontal and vertical directions; they are two directions perpendicular to each other on a screen.

The electron gun emits an electron beam into the space between the electrode structure and the vertical deflecting electrode, and the cathode of the electron gun comprises the plurality of field emission cathode elements arranged on a line.

The electron beam is a generally planar or linear beam. Desired voltages are applied sequentially to the parallel electrode elements of the vertical deflecting electrode in synchronism with a vertical scanning period to create a deflecting electric field for deflecting the electron beam emitted by the electron gun toward the electrode structure for vertical scanning. The electron beam thus vertically deflected is directed toward the fluorescent screen by applying predetermined voltages to the counter electrode and the vertical deflecting electrode.

Thus, in the flat display in accordance with the present invention, the electron beam is produced by the plurality of field emission cathode elements. Therefore, the cathode of the electron gun does not vibrate and hence the cathode can be formed in a large length suitable for a large display screen without deteriorating its electron emitting characteristics.

Furthermore, since the cathode of the electron gun consists of the field emission cathode elements, the back plate and the accelerating electrode, which can be formed accurately in desired shapes, respectively, difference in characteristics between positions on the cathode is very small as compared with that on the conventional cathode consisting of a plurality of filaments. Accordingly, the flat display of the present invention is able to form pictures in uniform brightness.

The distribution of the field emission cathode elements according to the width and pitch of the electron transmitting slits of the electrode structure suppresses the emission of unavailable electrons and resultant charging up of the exposed insulating members by secondary electrons and stray electrons to avoid the disturbance of pictures. Reduction of reactive current enables the flat display to display pictures in high brightness without requiring much power.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a front view of a flat display in a preferred embodiment according to the present invention;

Figure 2 is atop plan view of the flat display of Fig. 1;

Figure 3 is a schematic sectional view of the flat display of Fig. 1 taken on a line parallel to the vertical scanning direction;

Figure 4 is a front view of patterns of electrodes;

Figure 5 is a schematic sectional view of an essential portion of an electrode structure;

Figure 6 is a schematic sectional view of an electron gun;

Figure s 7A t 7D are sectional views of assistance in explaining a process of fabricating a cathode having field emission cathode elements;

Figure 8 is an exploded perspective view of an essential portion of an electrode structure;

Figure 9 is a schematic sectional view of of a secondary-electron multiplier;

Figure 10 is a schematic sectional view of assistance in explaining the construction of a horizontal deflecting electrode and the arrangement of electron beam transmitting apertures; and

Figure 11 is a schematic sectional view of a conventional single-line cathode structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A flat display in a preferred embodiment according to the present invention employs a flat tube 1. The flat tube 1 has a light-transmissive front panel 1F, a back panel 1B and a circumferential wall 1S hermetically joined to the front panel 1F and the back panel 1B. The flat tube 1 is evacuated through a chip-off tube 21, and then the chip-off tube 21 is chipped off after hermetically sealing the flat tube 21. The front panel 1F, the back panel 1B and the circumferential wall 1S are formed of glass plates and are joined together by glass frit.

A fluorescent material is applied directly to the inner surface of the front panel 1F or a transparent plate coated with a fluorescent material is applied to the inner surface of the front panel 1F to form a fluorescent screen 2. The fluorescent screen 2 is a metal-backed fluorescent screen formed by coating a fluorescent film with a metal film, such as an aluminum film, by vapor deposition.

A vertical deflecting electrode 3 is attached directly to or through a substrate to the inner surface of the back panel 1B. An electrode structure 7 is disposed between the fluorescent screen 2 and the vertical deflecting electrode 3 with a predetermined interval between the vertical deflecting electrode 3 and the electrode structure 7. As shown in Figs. 3, 4 and 5, the vertical deflecting electrode 3 has a plurality of parallel electrode strips 3a having a predetermined width and arranged at predetermined intervals so as to extend in the horizontal scanning direction, the number of the parallel electrode strips 3a being, for example, in a range of 480 to 525 corresponding to the number of the vertical scanning lines. The electrode strips 3a are metal thin films formed by etching a thin film of 426 alloy or chromium, metal thin films formed by vapor deposition or carbon thin films formed by screen printing.

As shown in Figs. 1 and 3, an electron gun 10 is disposed outside a region extending behind the fluorescent screen 2, for example, at a position separated from the region extending behind the fluorescent screen 2 in the vertical scanning direction. As shown in Fig. 6, the electron gun 10 comprises a cathode 1K having a plurality of field emission cathode elements K arranged on a line, and four grid electrodes G1 to G4 disposed opposite to the cathode 1K and provided with slits extending along the horizontal scanning direction. The cathode 1K is, for example, a Spindt field emission cathode consisting of a back plate 41 to which a predetermined negative voltage is applied, the plurality of field emission cathode elements K arranged on a line on the inner surface of the back plate 41, an insulator 42, and an accelerating electrode 43 to which a predetermined positive voltage is applied to accelerate electrons. The back plate 41, the insulator 42 and the accelerating electrode 43 are stacked in layers. The back plate 41 has the shape of a band or strip having a predetermined width and a predetermined length.

A process of fabricating the cathode 1K will be described with reference to Figs. 7A to 7D. As shown in Fig. 7A, an insulating layer 42A having an appropriate thickness, for example, 1.5 µm, is formed over the entire surface of the back plate 41 by depositing an insulating material, such as SiO_2, by a CVD process (chemical vapor deposition process), and then the insulating layer 42A is coated with a metal layer 43A having an appropriate thickness, for example, 0.4 µm, by a vapor deposition process or the like.

Then, as shown in Fig. 7B, circular holes 44 of an appropriate diameter, for example, 1.2 µm, are formed at a longitudinal pitch p on the order of 5 µm in the metal layer 43A by anisotropic etching process, such as a RIE process (reactive ion etching process) to form the accelerating electrode 43. Holes 45 of a diameter greater than that of the circular holes 44 are formed in the insulating layer 42A by etching the insulating layer 42A through the circular holes 44 by an isotropic etching process.

Then, as shown in Fig. 7C, a metal layer 46, such as a Ni layer, is formed over the accelerating electrode 43 by an oblique vapor deposition process. During the oblique vapor deposition process, the back plate 41 is rotated to form holes 46A having the shape of a frustum of circular cone in the metal layer 46 over the circular holes 44, respectively. The oblique vapor deposition of the metal layer 46 is performed so that any metal layer is not deposited in the holes 45. Then, an electrode layer 47, such as a Mo layer, is formed over the metal layer 46 by a vapor deposition process. Even if the direction of vapor deposition is vertical to the back plate 41, holes each having a conical surface merging into the conical surface of the circular hole 44 are formed in the electrode layer 47, and the circular holes 44 are closed when the thickness of the electrode layer 47 exceeds a certain thickness. During the vapor deposition process for forming the electrode layer 47, the field emission cathode elements **K** are formed respectively in the holes 45. Each field emission cathode element **K** has the shape of a circular cone having a circular bottom of a diameter substantially equal to that of the lower circle of the hole formed in the metal layer 46.

Then, as shown in Fig. 7D, the metal layer 46 and the electrode layer 47 formed over the accelerating electrode 43 are removed to complete the cathode 1K of the electron gun 10. The pitch of the field emission cathode elements **K** is substantially equal to the pitch **p** of the circular holes 44, and the distance ℓ with respect to the longitudinal direction of the cathode 1K between the tip of the field emission element K and the edge of the corresponding circular hole 44 of the accelerating electrode 43 is on the order of 0.6 µm.

Electrons emitted by the minute field emission cathode elements **K** of a size in the range of 5 to 6 µm form an electron beam **b**. Since the field emission cathode elements **K** are fixed, the cathode 1K does not vibrate.

The field emission cathode elements **K** formed by the foregoing process are more uniform in characteristics than the plurality of filaments employed in the conventional flat display. Accordingly, the field emission cathode elements **K**, similarly to the single-line cathode, enables displaying pictures in uniform brightness.

A predetermined voltage is applied across the back plate 41 and accelerating electrode 43 of the electron gun 10 to make the field emission cathode elements **K** electrons having predetermined energy, and predetermined voltages are applied to the first grid electrode G1 comprising a meshed metal plate provided with circular through holes at positions corresponding respectively to the field emission cathode elements **K**, and the second grid electrode G2, the third electrode G3 and the fourth electrode G4 having a shape resembling a frame as shown in Fig. 6 to produce the electron beam **b** having the shape of a band or a strip.

As shown in Fig. 3, the electron beam **b** spreading in the horizontal scanning direction, namely a laminar flow of the electrons emitted by the field emission cathode elements **K**, is introduced into the space between the electrode structure 7 and the vertical deflecting electrode 3.

As shown in Figs. 4, 5 and 8, the counter electrode 4 comprises an electrode plate provided with a plurality of parallel slits SL extending along the vertical scanning direction and arranged at a predetermined pitch P_{SL}, for example, a pitch of 2 mm.

The modulating electrode 5 comprises an insulating plate S_M provided with electron beam transmission slits h_M corresponding respectively to the slits SL of the counter electrode 4, and conductive layers 5a formed along the edges of the electron beam transmitting slits h_M.

The horizontal deflecting electrode 6 comprises two superposed electrode plates 6a and 6b. The electrode plates 6a and 6b have insulating plates S_{H1} and S_{H2} provided with electron beam transmitting slits h_{H1} and h_{H2} corresponding to the slits SL of the counter electrode 4 and the electron beam transmitting slits h_M of the modulating electrode 5, respectively. Conductive layers $6a_1$ and $6a_2$ are formed on the edges of the electron beam transmitting slits h_{H1}, and conductive layers $6b_1$ and $6b_2$ are formed on the edges of the electron beam transmitting slits h_{H2}.

The insulating plates S_M of the modulating electrode 5, and the insulating plates S_{H1} and S_{H2} of the horizontal deflecting electrode 6 are formed of for example, a photosenstive glass, and the electron beam transmitting slits h_M, h_{H1} and h_{H2} are formed by an optical process, i.e., a photographic process. The conductive layers 5a, $6a_1$, $6a_2$, $6b_1$ and $6b_2$ are, for example, Ni layers formed by electroless plating or electroplating.

As shown in Fig. 5, if necessary, the electrode structure 7 may be provided with a shield electrode 12 disposed between the fluorescent screen 2 and the horizontal deflecting electrode 6 of the electrode structure 7. The shield electrode 12 comprises a plurality of metal plates, for example, four metal plates 12A, 12B, 12C and 12D provided with electron beam transmitting slits h_{SA}, h_{SB}, h_{SC} and h_{SD}, respectively, corresponding to the electron beam transmitting slits h_{H2}.

The adjacent electrodes, i.e., the counter electrode 4, the modulating electrode 5, the horizontal deflecting electrode 6, the electrode plates 12A, 12B, 12C and 12D of the shield electrode 12 are isolated from each other for insulation with insulating balls 11, such as glass beads. The electrode structure 7 is set apart from the front panel 1F by a predetermined interval with insulating balls 11.

Vertical fluorescent triplets each consisting of red, green and blue fluorescent stripes are formed on the fluorescent screen 2 so that a plurality of fluorescent triplets correspond to each electron beam transmitting slit h_{SD}.

Suppose that the distance ℓ between the tip of the field emission cathode element **K** and the edge of the corresponding circular hole 44 of the accelerating electrode 43 is 0.6 μm in the cathode 1K of the electron gun 10. Then, the field emission cathode elements **K** can be made to emit electrons of predetermined energy by applying a voltage of 0 V to the back plate 41 and applying a voltage of 80 V to the accelerating electrode 43. Voltages of 30 V, -5 V, 350 V and 100 V are applied respectively to the first grid electrode G1, the second grid electrode G2, the third grid electrode G3 and the fourth electrode grid G4. Predetermined voltages are applied to the counter electrode 4 and the parallel electrode stripes 3a. The vertical deflecting electrode 3 and the counter electrode 4 constitute a vertical deflecting system 34. The adjacent electrode strips $3a_1$ and $3a_2$ of the parallel electrode stripes 3 on the opposite sides of a predetermined vertical scanning position **V** are charged so that a potential difference is produced between the adjacent electrode strips $3a_1$ and $3a_2$, namely, a voltage of 100 V, which is equal to the voltage applied to the counter electrode 4, is applied to all the electrode strips 3a including the electrode strip $3a_1$ on the side of the electron gun 10 with respect to the predetermined vertical scanning position **V**, and a voltage of 0 V is applied to all the electrode strips 3a including the electrode strip $3a_2$ on the opposite side with respect to the predetermined vertical scanning position **V**, and then the predetermined vertical scanning position **V** is shifted in the vertical scanning direction in synchronism with the scanning speed and the scanning period. Consequently, the electron beam **b** is deflected in the vicinity of the electrode strips $3a_1$ and $3a_2$ toward the slits SL of the counter electrode 4 as shown in Fig. 3. Thus, the electron beam **b** are divided into a plurality of fractional electron beams. The number of the fractional electron beams is equal to that of the slits SL.

A voltage of 200 V, for instance, is applied to the modulating electrode 5 to focus the fractional electron beams, and a pulse width modulating voltage corresponding to a display signal is applied to the conductive layers 5a formed on the edges of the electron transmitting slits h_M.

A voltage of 300 V ± 100 V, for instance, is applied across a pair of conductive layers $6a_1$ and $6b_1$ and a pair of conductive layers $6a_2$ and $6b_2$ formed on the edges of each electron beam transmitting slit, in synchronism with the horizontal scanning action of the horizontal deflecting electrode 6, for the minute horizontal deflection of the fractional electron beams divided by the slits SL of the counter electrode 4 in areas on the fluorescent screen 2 corresponding to the electron beam transmitting slits, namely, in areas each including the plurality of vertical fluorescent triplets each of red, green and blue fluorescent stripes and corresponding to the electron beam transmitting slit.

A voltage of 10 kV, for instance is applied to the fluorescent screen 2, and voltages of 2 kV, 4 kV, 6 kV and 8 kV are applied respectively to the electrode plates 12A, 12B, 12C and 12D of the shield electrode 12 to shield the horizontal deflecting electrode 6 and the modulating electrode 5 from the influence of the high voltage applied to the fluorescent screen 2.

Thus, according to the present invention, the single laminar electron beam **b** activates the entire area of the fluorescent screen 2. If the density of the electron beam **b** is insufficient to produce a sufficient anode current, a secondary-electron multiplier 22 as shown in Fig. 9 may be provided between the modulating electrode 5 and the horizontal deflecting electrode 6.

Referring to Fig. 9, the secondary-electron multiplier 22 comprises electrode plates 22A, 22B and 22C arranged one after the other between the modulating electrode 5 and the horizontal deflecting electrode 6. The electrode plates 22A, 22B and 22C are provided respectively with electron beam transmitting slits h_{MA}, h_{MB} and h_{MC} corresponding to the slits SL. The inner surfaces of the electron beam transmitting slits h_{MA}, h_{MB} and h_{MC} are coated with a material having a high secondary-emission ratio, such as Mg, to emit a large number of secondary electrons for secondary emission upon the bombardment of the electrons thereon so that the electron beam traveling toward the fluorescent screen 2 builds up in strength. It is desirable to apply higher voltages to the electrode plates 22A, 22B and 22C nearer to the fluorescent screen 2. The electrode plates 22A, 22B and 22c, like the electrode plates of the electrode structure 7, may be isolated from each other with insulating balls 11, such as glass beads.

It is also possible to employ a horizontal deflecting electrode 6 comprising three electrically isolated electrode plates 6A, 6B and 6C provided respectively with electron beam transmitting slits h_{HA}, h_{HB} and h_{HC} as shown in Fig. 10. The slit h_{HB} of the electrode plate 6B is shifted in one direction relative to the corresponding slit h_{HA} of the electrode plate 6A, and the slit h_{HC} of the electrode plate 6C is shifted in the opposite direction relative to the corresponding slit h_{HA} of the electrode plate 6A to deflect a fractional electron beam b_S horizontally for minute horizontal deflection at a high definition.

The field emission cathode elements **K** may be disposed in an arrangement other than that shown in Fig. 6 in which the back plate 41 and the accelerating electrode 43 are common to all the field emission cathode elements **K**. A plurality of back plates and a plurality of accelerating electrodes may be provided respectively for the plurality of field emission cathode elements **K**.

In the foregoing embodiment, the field emission cathode elements **K** of the cathode 1K correspond respectively to the slits SL of the counter electrode 4. Each field emission cathode element **K** corresponding to each slit SL may be a multiple cathode element. The cathode 1K comprising the plurality of field emission cathode elements **K** or a plurality of multiple cathode elements corresponding respectively to the slits SL reduces the production of unavailable electrons resulting from the impingement of electrons on portions of the electrode structure 7 other than the slits SL, as compared with a cathode provided with the conventional cathode provided with a single cathode element having the shape of a band, so that reactive current can be reduced.

Although the invention has been described in its preferred forms with a certain degree of particularity, obviously many changes and variations are possible therein. It is therefore to be understood that the present invention may be practiced otherwise than as specifically described herein without departing from the scope and spirit thereof.

Claims

1. A flat display comprising:

a flat tube (1) having a front panel (1F) and a back panel (1B) facing the front panel;

a fluorescent screen (2) formed on the inner surface of the front panel;

an electron gun (10) disposed outside a region extending behind the fluorescent screen;

a vertical deflecting electrode (3) disposed opposite to the fluorescent screen (2) on the inner surface of the back panel facing the fluorescent screen, and comprising a plurality of parallel electrode elements (3a) extending along the horizontal scanning direction; and

an electrode structure (7) disposed between the vertical deflecting electrode (3) and the fluorescent screen (2), and comprising at least a counter electrode (4) disposed opposite to the vertical deflecting electrode (3) so as to constitute a vertical deflecting system together with the vertical deflecting electrode, a modulating electrode (5), and a horizontal deflecting electrode (6);

characterized in that the electron gun (10) emits an electron beam (b) into the space between the vertical deflecting electrode (3) and the electrode structure (7).

2. A flat display according to Claim 1, wherein said electron gun has a back plate (41), and a cathode (1K) having a plurality of field emission cathode elements (K) arranged on a line on the inner surface of the back plate.

FIG. 1

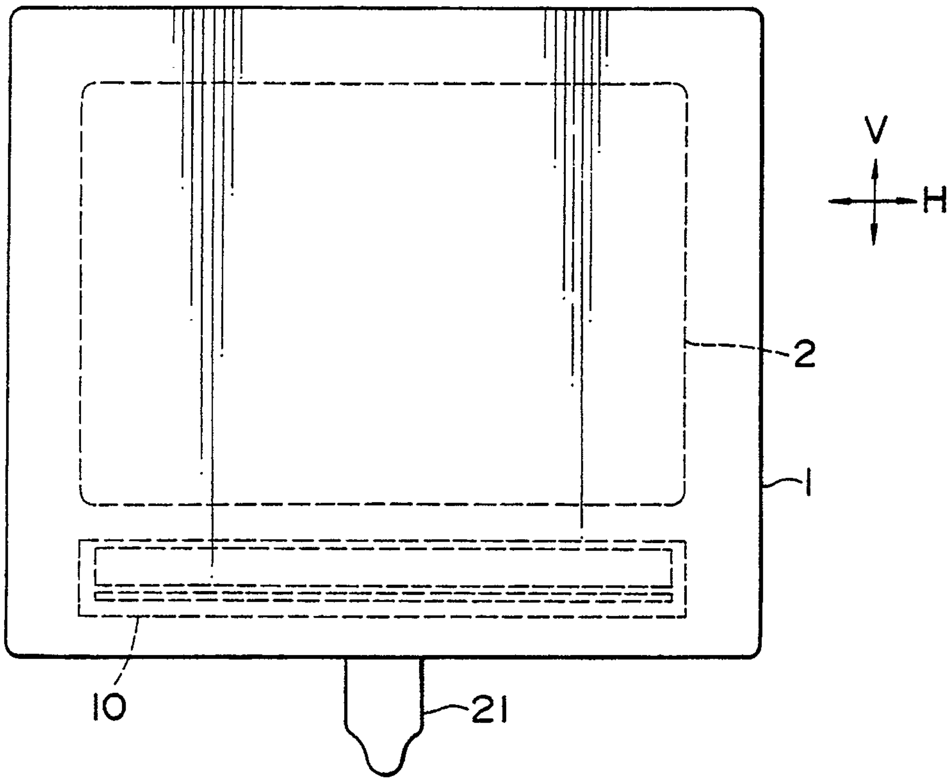
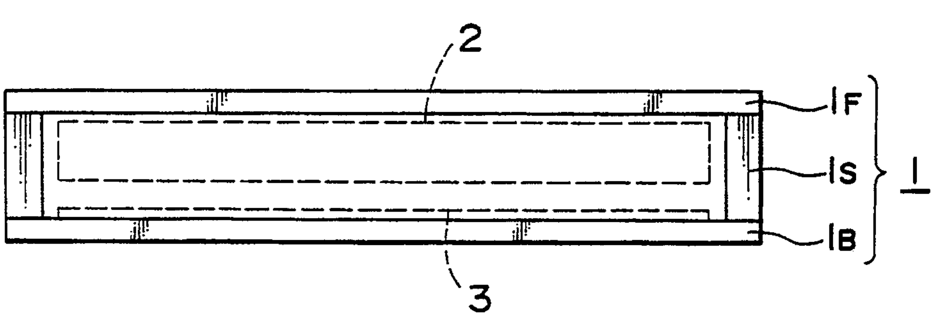
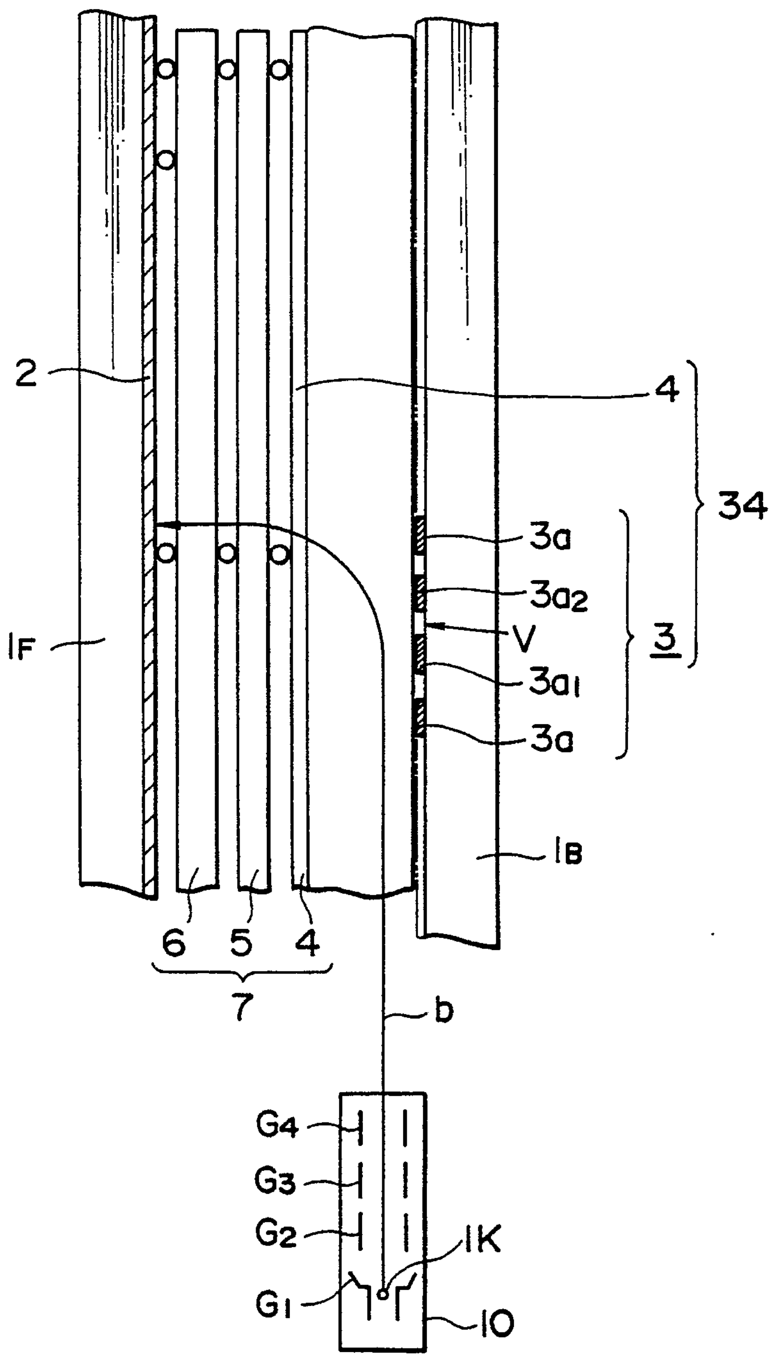


FIG. 2



F I G. 3



F I G. 4

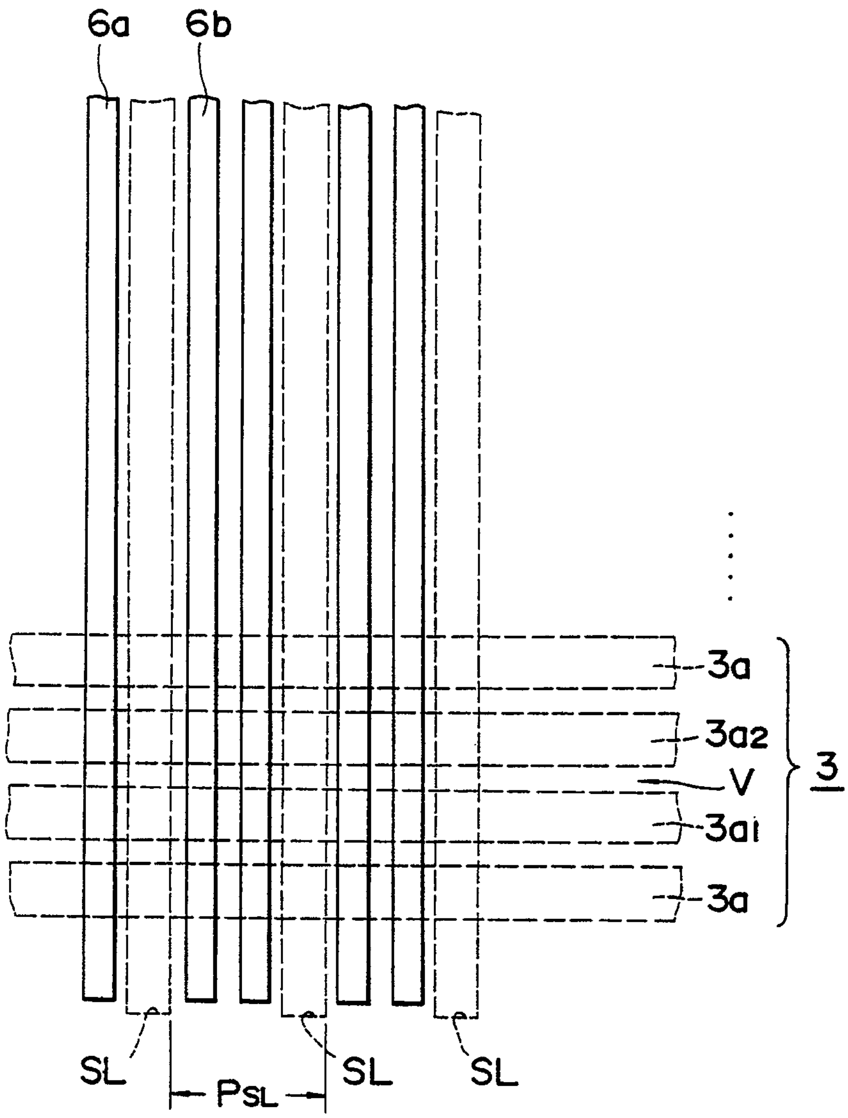


FIG. 5

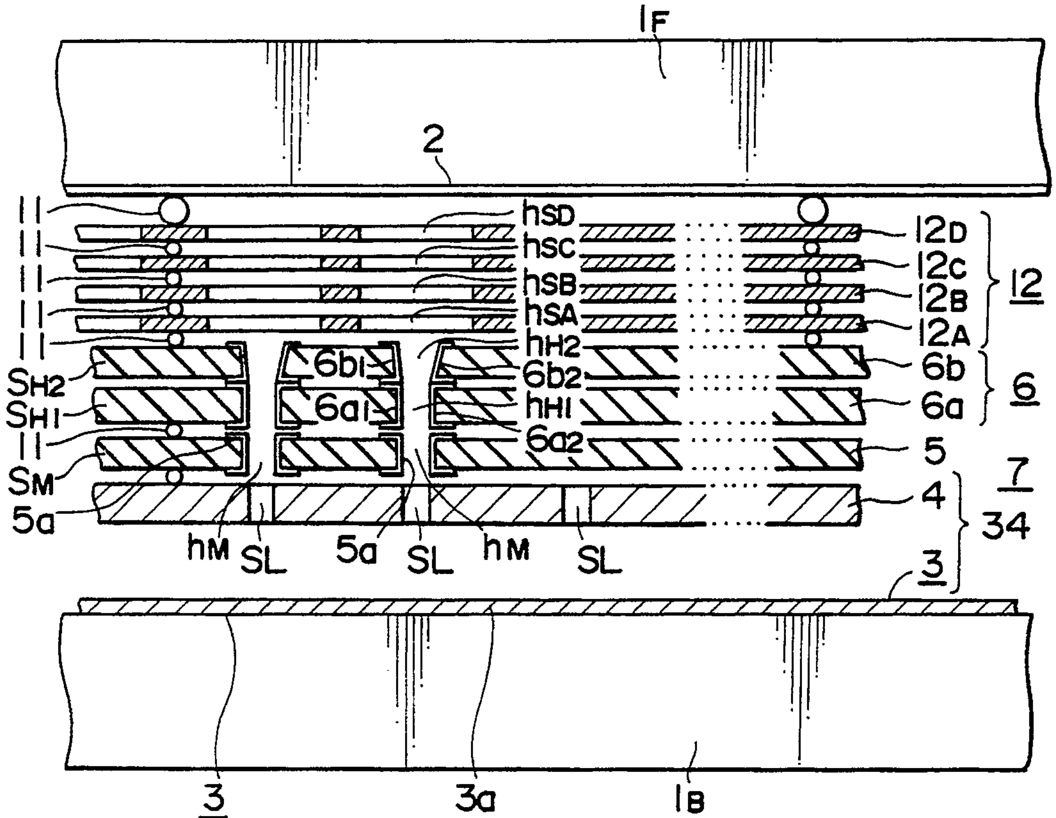

1F
2
11
hSD
hSC
hSB
hSA
hH2
12D
12C
12B
12A
12
6b1
6b2
6a1
hH1
6a2
6b
6a
6
SH2
SH1
SM
5
5a
4
7
34
hM
SL
3
3a
1B

FIG. 6

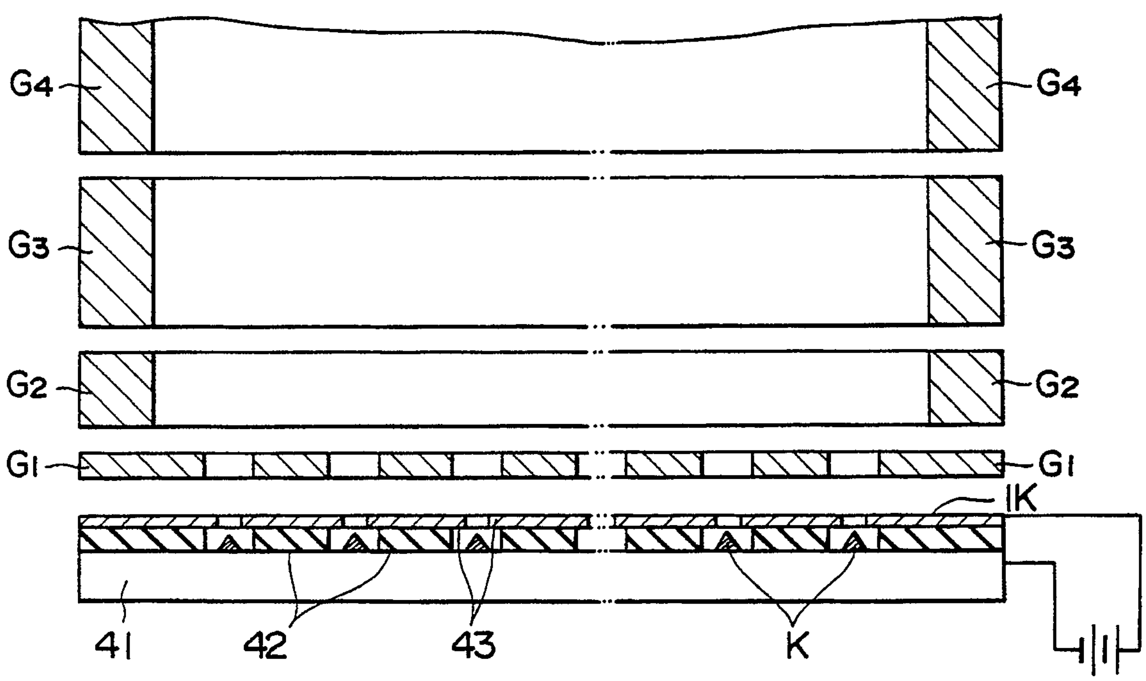

G4
G3
G2
G1
1K
41
42
43
K

FIG. 7A

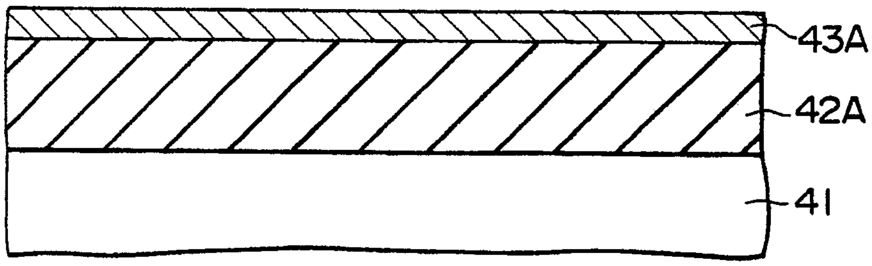


FIG. 7B

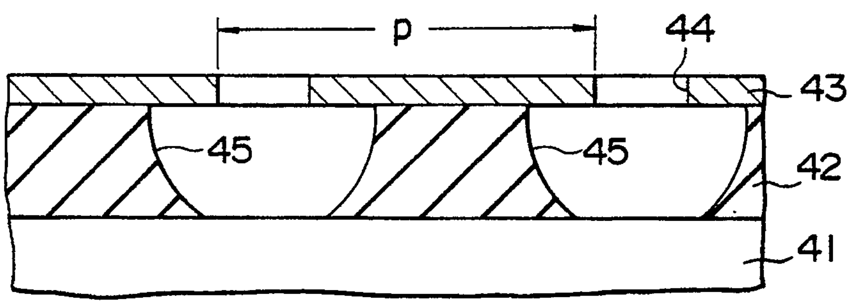


FIG. 7C

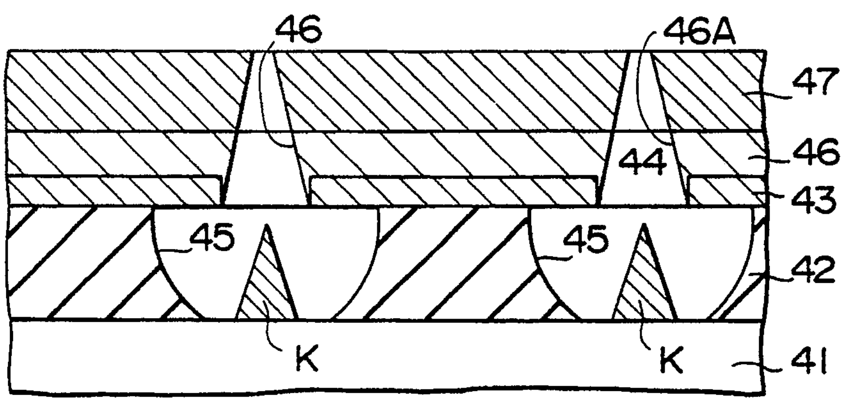


FIG. 7D

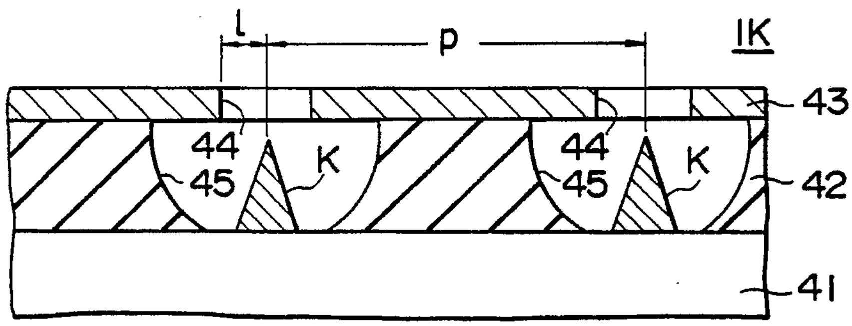


FIG. 8

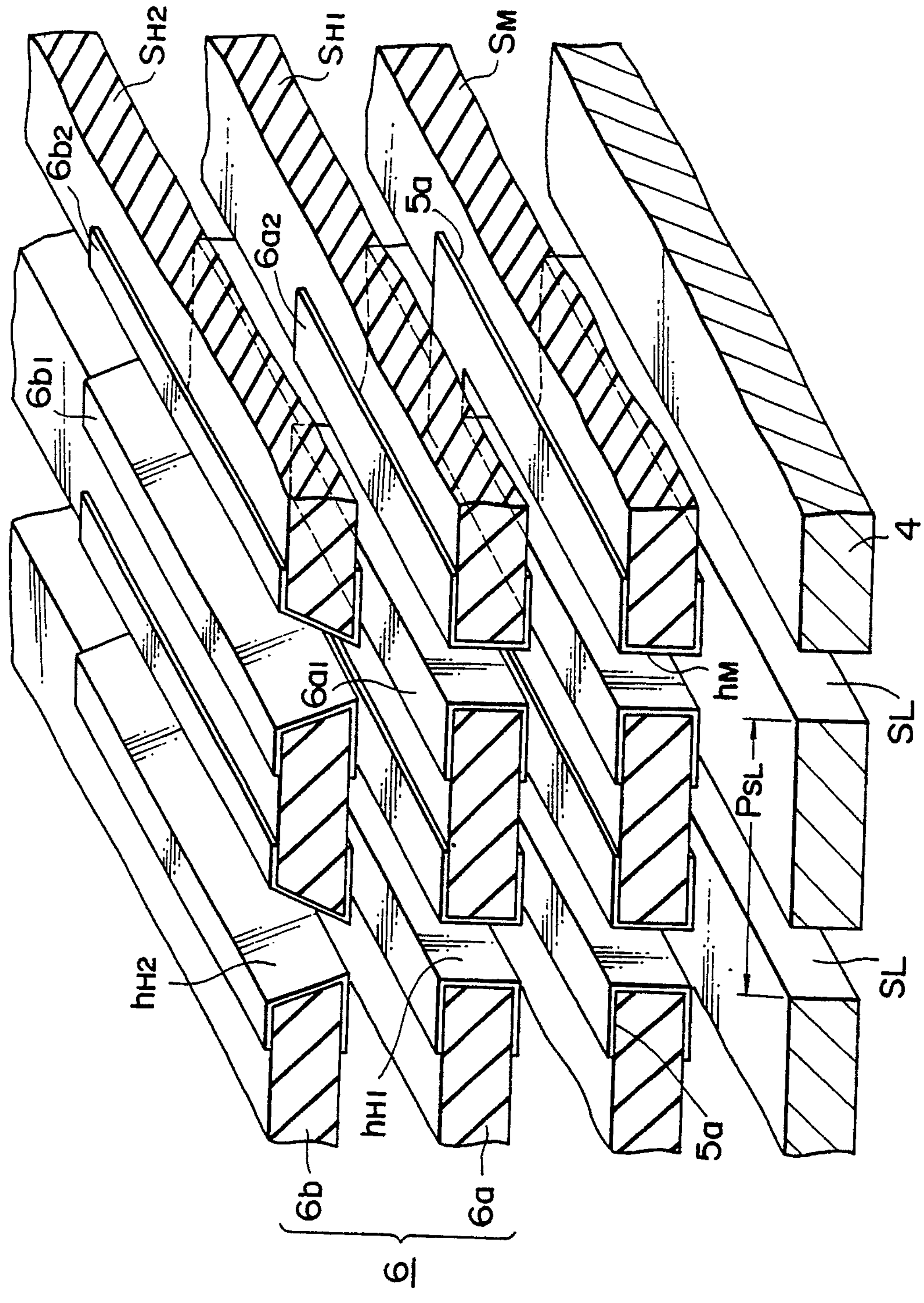


FIG. 9

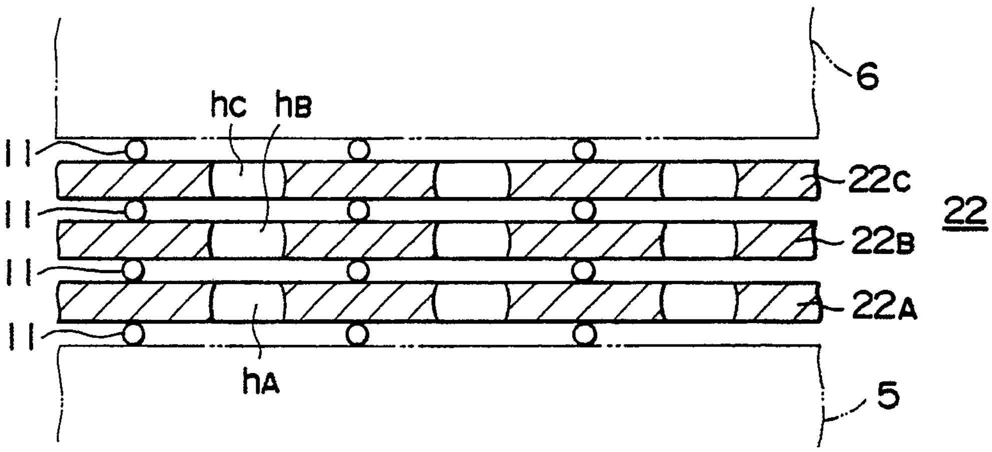
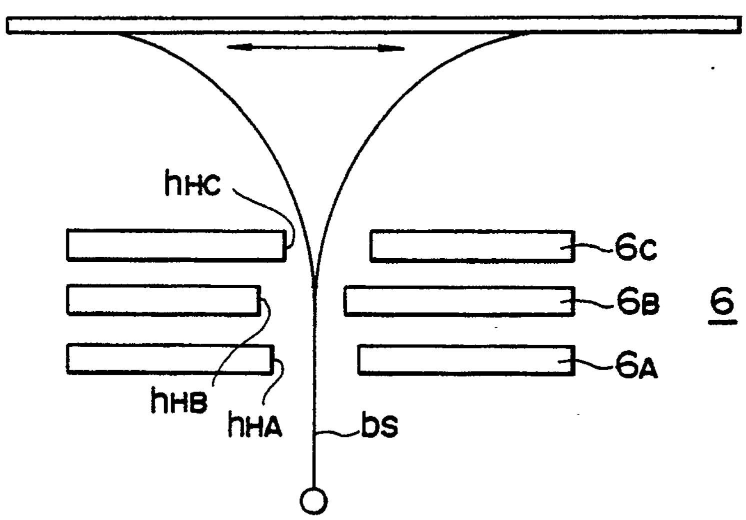


FIG. 10



F I G. 11