United States Patent

[11] 3,622,829

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Osaka, Japan
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[33] Japan
[31] 42/77143;
Nov. 28, 1967, Japan, No. 42/77144; Nov. 28, 1967, Japan, No. 42/77145; Nov. 28, 1967, Japan, No. 42/77147

[54] **FLUORESCENT SCREEN DISPLAY PANELS**
11 Claims, 8 Drawing Figs.

[52] U.S. Cl. 313/108 R, 315/169 R
[51] Int. Cl. H01j 1/62, H01j 63/04
[50] Field of Search 313/108, 109.5; 315/169, 169 TV; 178/7.5 D, 7.5

[56] **References Cited**
UNITED STATES PATENTS

2,848,638	8/1958	Smith	313/109.5
2,926,286	2/1960	Skellet	315/169
2,965,801	12/1960	Archer et al.	315/169
3,107,303	10/1963	Berkowitz	313/108 X
3,176,184	3/1965	Hopkins	315/169 X

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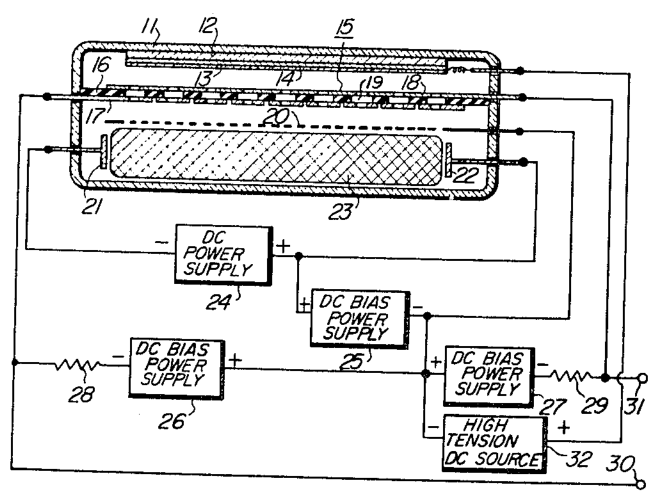
ABSTRACT: A display panel useful for realizing a very thin panel-shaped letter or figure display device or a panel-shaped TV set, wherein the small region of the fluorescent screen may be illuminated by the bombardment of charged particles; the control electrode, formed by providing a plurality of parallel metal electrode sheets on one principal surface of the insulating substrate, a plurality of parallel metal electrode sheets on the other principal surface orthogonal to the direction of arrangement of said former metal electrode sheets and holes penetrating through the insulating substrate at the part where said metal electrode sheets intersect across the insulating substrate, being made to contact the discharge plasma generated between the discharge electrodes; electrons or ions being taken out of the discharge plasma by applying a signal voltage to said metal electrodes of the control electrode and made to pass through the holes selectively, the transparent electrode comprising the fluorescent screen being provided on the side opposite to said discharge plasma with respect to said control electrode in parallel with said electrodes; and the electrons or ions passing through said holes being accelerated and made to collide with the fluorescent screen by the high voltage applied to said transparent electrode.



PRIOR ART

FIG. 1

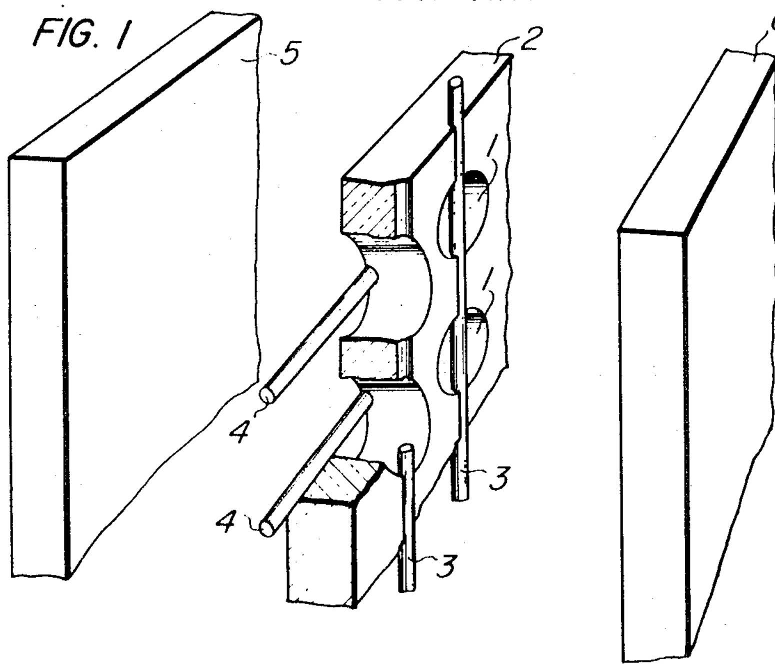


FIG. 2

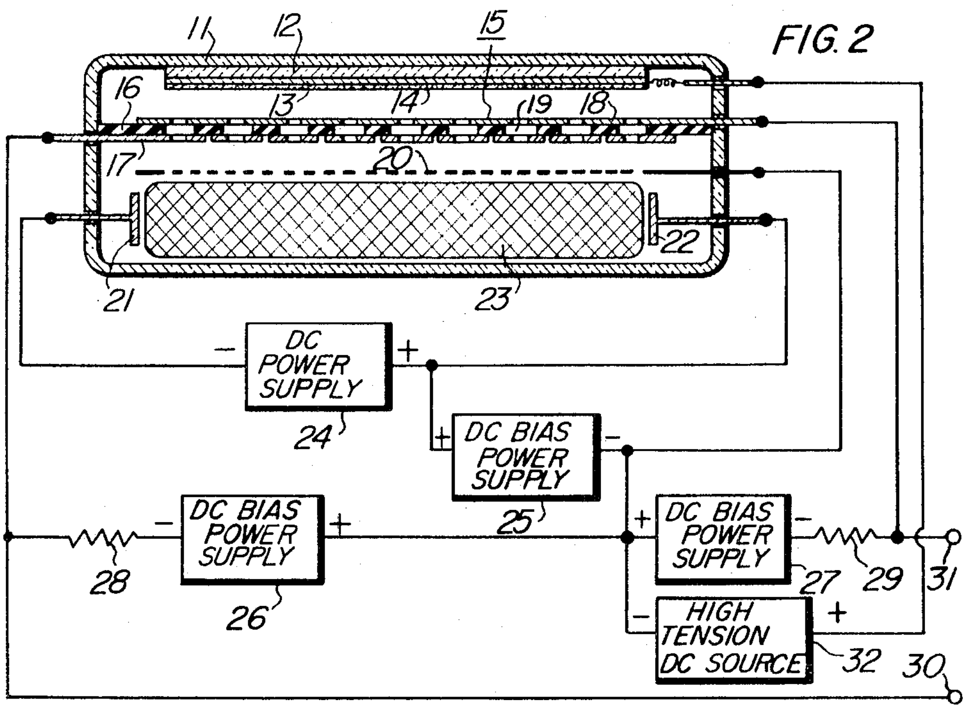


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FIG. 3

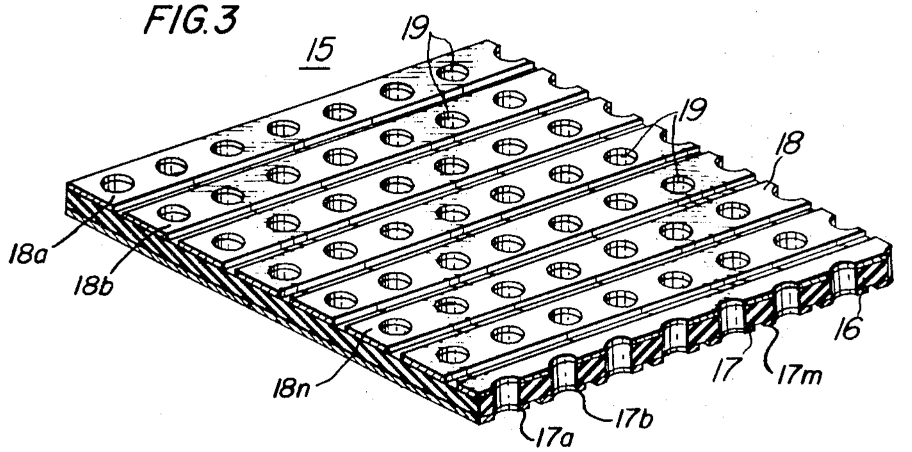

FIG. 4

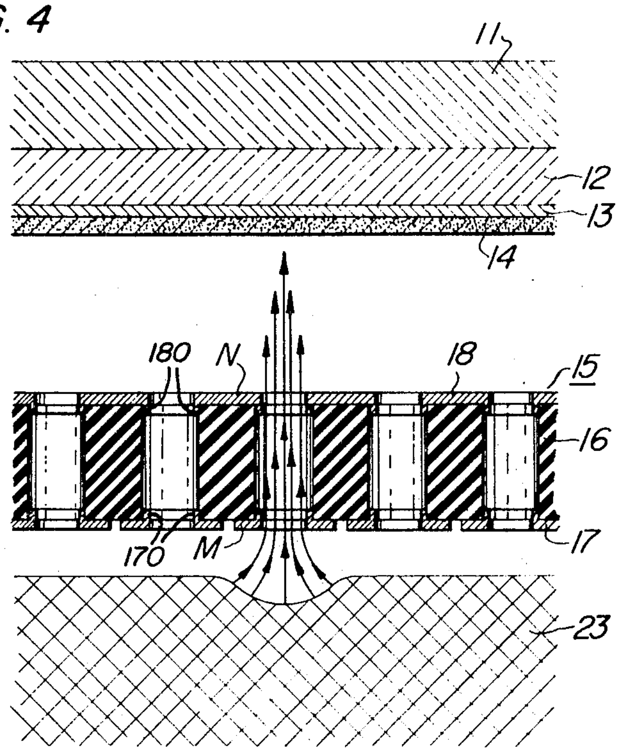

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FIG. 5

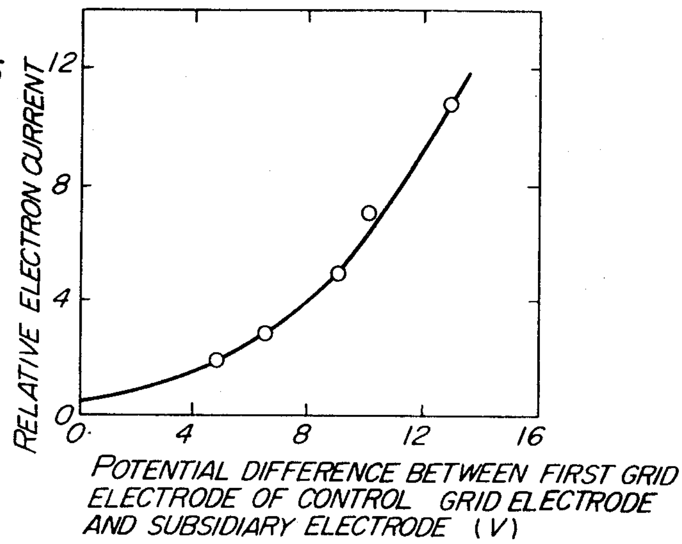

FIG. 6

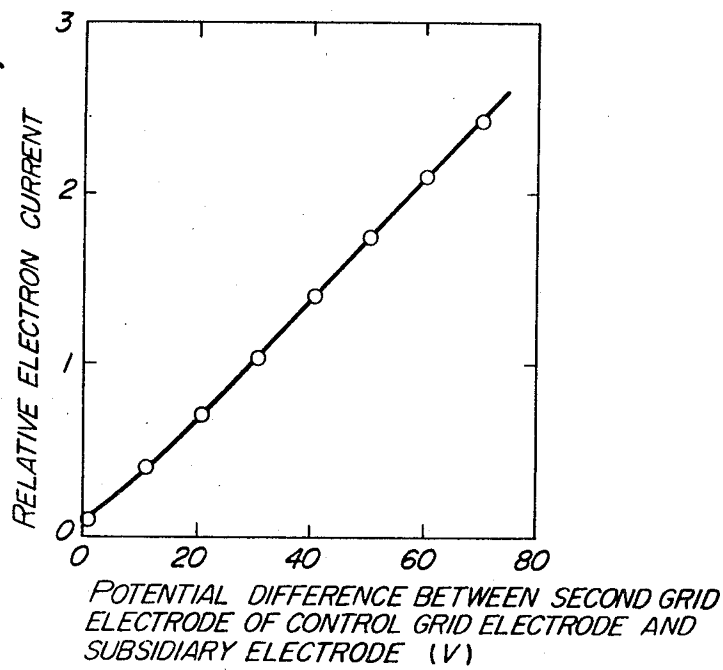

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FIG. 7

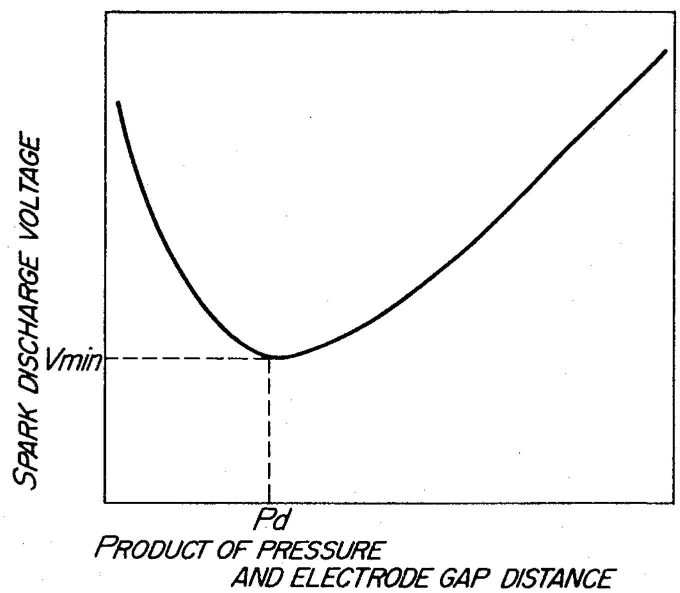
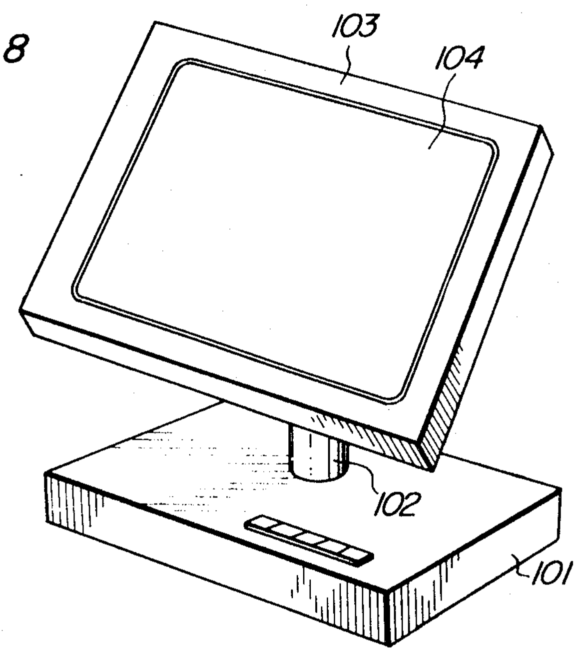


FIG. 8



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IMPROVEMENTS IN FLUORESCENT SCREEN DISPLAY PANELS

This invention relates to a plasma display panel in which electrons or ions emitted from the surface of the discharge plasma, which is the source of the charged particles, are accelerated and made to bombard the fluorescent material to illuminate the panel selectively, and more particularly to a TV set or a letter display device.

Today, cathode-ray tubes are widely used in display devices including TV sets. The characteristics of the cathode-ray tube include easiness in obtaining high brightness, possibility of changing from low to high brightness continuously and obtain a so-called halftone, possibility of obtaining high resolution and so forth.

However, since in a cathode-ray tube the cathode ray is accelerated, deflected and made to bombard the fluorescent screen for illumination, the electron gun, the deflection yoke, etc. must be arranged in sequence on or around the same axis. Accordingly, the device necessarily becomes large in length and large in volume. Further, even if the cathode-ray tube is constructed in a panel form, the construction is limited by the presence of the electron gun and the deflection means.

Recently, the need for a display pane wherein said deficiencies are obviated has become great. As such a display panel, many devices utilizing the electroluminescence or gas discharge phenomena have been studied and proposed. The device utilizing electroluminescence is still in the developmental stage since sufficient brightness for practical use has not yet been obtained. A study on the device utilizing gas discharge has been reported in Th. J. de Boer: Ninth National Symposium on Information Display: p. 193 (1968), B. M. Arora, D. L. Bitzer, H. G. Slottow and R. H. Wilson: Eighth National Symposium on Information Display: p. 1 (1967).

The report of Boer will be described briefly with reference to FIG. 1. Platinum wires 3, 4 are set on both sides of the insulating substrate 2 comprising a large number of regularly arranged holes 1 in a way that the wires may pass the center of said holes 1 and the periphery is sealed airtight by closely adhering the glass plates 5, 6 on both sides. Here, the directions of the platinum wires 3, 4 are orthogonal to each other. The inside of the device is filled with an inert gas like neon, argon, etc. with appropriate pressure. When the DC voltage is applied selectively to the mutually orthogonal platinum wires 3, 4, the gas in the cell at the intersection is ionized and made to illuminate.

The device reported by M. B. Arora et al. is almost the same in structure and principle of operation as the one by Boer.

The deficiencies of said display devices include the spread of the order of several hundred microseconds present in the time lag between the application of the discharge voltage with the initiation of discharge. For example, since according to the American TV standard system, the frame number is 30 per second, the number of scanning lines is 525 per frame and the number of the effective scanning lines is 491 per frame, the linear scanning time is 63.5 microseconds and the effective linear scanning time is 52.7 microseconds. According to the British TV standard system, the number of frames is 25 per second, the number of scanning lines is 405 per frame, the number of effective scanning lines is 379 per frame. Thus, the linear scanning time is 98.8 microseconds and the effective linear scanning time is 82.0 microseconds. Further, according to the European TV standard system, since the number of frames is 25 per second, the number of scanning lines is 625 per frame and the number of effective scanning lines is 584 per frame, the linear scanning time is 64.0 microseconds and the effective linear scanning time is 53.0 microseconds. Accordingly, since in either one of these TV standard systems, the effective linear scanning time is less than 100 microseconds, a several hundred microsecond time lag is too large for effective use in any of the above TV systems. Further, since the brightness depends on the discharge time, it is technically difficult to realize brightness modulation due to the large jitter.

An object of this invention is to provide a panel form or thin display device.

Another object of the invention is to provide a device having a short response time, i.e. a device having good response characteristics comparable to or better than those of conventional TV sets.

A further object of the invention is to provide a device in which brightness comparable to that of conventional TV sets is obtained and the brightness can be changed by a signal.

A yet further object of the invention is to provide a thin TV set which can be hung on the wall.

A yet further object of the invention is to provide a light TV set having a large panel or image display screen.

Other objects, features and advantages of the present invention will be readily apparent from the following detailed description of certain preferred embodiments taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagram for illustrating the main parts of the display panel utilizing gas discharge as present by Th. J. de Boer;

FIG. 2 is a diagram illustrating the structure of an embodiment of this invention;

FIG. 3 is a diagram illustrating the control electrode of the device shown in FIG. 2;

FIG. 4 illustrates the operation of the device shown in FIG. 2;

FIGS. 5 and 6 show the characteristics of the control electrode shown in FIG. 3;

FIG. 7 is a diagram for explaining Paschen's law; and

FIG. 8 shows a perspective view of an embodiment of this invention.

Referring to FIG. 2, the structure of a panel-shaped display device according to this invention will be described. In the figure, **11** is the panel-shaped discharge tube, at least one principal wall of which is made of a transparent insulating material like glass, **12** is a glass plate mount against the inner wall of said principal wall of the discharge tube **11**, **13** is a transparent electrode formed of conductive filmlike tin oxide film adhered to the surface of said glass plate **12**, **14** is a fluorescent screen formed by applying fluorescent material like zinc sulfide on the transparent electrode **13**, and **15** is a control electrode arranged adjacently to the fluorescent film **14** in parallel with the glass plate **12**. As shown in FIG. 3 which shows a magnified part of the control electrode, the control grid **15** comprises the first grid electrode **17** on one surface of the insulating substrate **16** and the second grid electrode **18** on the other surface; both grid electrodes being formed by arranging a plurality of metal electrode sheets in parallel with each other. The direction of the array of the second set of grid elements **18***a*, **18***b*,... **18***n*,... is orthogonal to that of the first set of grid elements **17***a*, **17***b*,... **17***m*,... At the part where the metal electrode sheets **17***a*, **17***b*,... **17***m*,... and **18***a*, **18***b*,... **18***n*,... composing the first and second grid electrodes **17** and **18**, respectively, intersect, small holes **19** penetrating through the electrodes and the insulating substrate **16** are provided. As material for the insulating substrate **16**, glass is preferable. The reference numeral **20** indicates the grid or mesh subsidiary electrode placed adjacently to the control electrode **15** in parallel therewith on the side opposite to the transparent electrode **13** of the control electrode **15**. The numerals **21** and **22** indicate discharge electrodes. When DC or AC voltage is applied between the two, a glow discharge is generated and plasma **23** results. The discharge tube **11** is filled with inert gas or a mixture of such gas and other kinds of gas of the order of 10'7E'2 Torr in pressure.

The numeral **24** indicates a power supply, e.g. a DC power supply, whose cathode and anode are connected to the electrodes **21** and **22**, respectively, and **25** is a DC bias power supply whose cathode is connected to the subsidiary electrode **20** and whose anode is connected to the electrode **22** or the anode of the DC power supply **24**. By said DC bias power supply **25**, a potential lower than that of the electrode **22** is given. The reference numerals **26** and **27** indicate DC bias power supplies whose anodes are both connected to the subsidiary electrode **20** or the cathode of the DC bias power supply **25**. The cathode of the DC bias power supply **26** is connected to the first grid electrode **17** of the control electrode by way of the resistor 28. The other DC bias power supply 27 is connected to the second grid electrode 18 of the control electrode 15 through the resistor 29. The numerals 30, 31 designate signal input terminals. Pulsed signals are fed from the terminal 30 to the first grid electrode 17 of the control electrode 15 and from the terminal 31 to the second grid electrode 18 of the control electrode 15. The sheets of electrodes elements composing the first and second electrodes 17 and 18 comprise individual input terminals, but they are represented by said signal input terminals 30, 31 in FIG. 2. The numeral 32 indicates a high-tension DC power supply the cathode thereof being connected to the subsidiary electrode 20 and the anode being connected to the transparent electrode 13.

In another embodiment, shown in FIG. 4, a portion 170 of each element of the grid electrode 17 and a portion 180 of each element of the grid electrode 18 extends into the holes 19. This feature improves the control of the electron flow by reducing the surface charge caused by electrons adhering to the surface of the insulating substrate 16 defining the hole 19.

Now, the operation of said device when the fluorescent film is bombarded with electrons will be explained.

Since the discharge voltage is applied between the electrodes 21 and 22 by the DC power supply 24, a glow discharge is generated and the gas present between said electrodes 21 and 22 is ionized to form the plasma 23. If the electrode 21 to which the cathode of the DC power supply 24 is connected is a thermionic cathode, the plasma 23 can be formed with a voltage between less than 100 volts and about several tens of volts.

The plasma 23 fills the space surrounded by the walls of the discharge tube 11 and the subsidiary electrode 20 and electrons and ions distribute with substantially uniform density. The subsidiary electrode 20 is maintained by the DC bias source 25 at a potential slightly lower than than of the electrode 22 to which the anode of the DC power supply 24 is connected. At the same time, part of the plasma 23 flows into the side of the control electrode 15 through the gaps or meshes of the subsidiary electrode 20. By suitably selecting the gap width when the subsidiary electrode 20 is grid-shaped, and the size of the mesh when it is mesh-shaped, the potential, the density and the electron temperature of the plasma passing through the electrode 20 can easily be made more uniform than these of the plasma 23 located between the electrodes 21 and 22.

The first grid electrode 17 of the control electrode 15 is supplied by the DC bias source 26 with a potential lower than that of the subsidiary electrode 20. Since the potential of the plasma passing through the subsidiary electrode 20 is nearly equal to that of the electrode 20, there will occur no constant flow of electron current onto grid electrode 17. Similarly, since the second grid electrode 18 is supplied with a potential lower than that of the subsidiary electrode 20 by the DC bias source 27, the electron current does not flow into the electrode 18 either. Therefore, in the quiescent state electrons will not flow into the side of the fluorescent screen 14 through the holes 19 provided in the control electrode 15.

To obtain an image on screen 14, a pulse signal with positive polarity is applied from the input signal terminal 30 to the M electrode of the metal electrode sheets composing the first grid electrode 17 of the control electrode 15. The potential of the M electrode will instantaneously become higher than that of the subsidiary electrode 20 due to the pulse signal. This state is shown in FIG. 4.

Then, the electrons in the plasma 23, particularly the electrons which passed through the subsidiary electrode 20, are attracted to the M electrode and the electron current flows in. Since a large number of holes 19 are provided at the M electrode, part of the electrons enter the holes 19.

The, the semicylindrical electron sheath is formed around the M electrode, and a self-convergent electron current flows. A unique relation holds among the plasma density, the thickness of the electron sheath and the potential difference between the electrode and the plasma. According to the theory of plasma technology, the relation

$$d^2=\frac{4}{9\pi}\sqrt{\frac{2e}{m_e}}\frac{V^{\frac{3}{2}}}{v_e n}$$

holds, where n denotes the plasma density, d denotes the thickness of the electron sheath, V denotes the potential difference between the electrode and the plasma, m_e indicates the electron mass, e the elementary charge and v_e the mean velocity of the electron. The electrons at the plasma surface move in a way to satisfy the above equation, and the electron sheath is formed around the electrodes to which the signal is applied.

Since the potential of the second grid electrode 18 is maintained lower than that of the subsidiary electrode 20 by the DC bias source 27, the electron current flowing into the holes 19 of said M electrode is reflected by the electric field formed by said electrode 18 and never enters into the fluorescent screen 14. In such a state, a pulse signal of positive polarity is applied from the signal input terminal 31 to the N electrode of the metal electrode sheets composing the second grid electrode 18. The potential of the N electrode becomes instantaneously higher than that of the subsidiary electrode 20 while the pulse is present. Since the first and second grid electrodes 17 and 18 are arranged orthogonally to each other, the electron current flows through the common hole (M, N) of the M and N electrodes, whose potential is higher than that of the subsidiary electrode 20, from the side of the subsidiary electrode 20 to the side of the fluorescent screen 14.

A high potential is applied to the transparent electrode 13 by the DC high-tension power supply 32. The electric field formed by the transparent electrode 13 acts as an accelerating electric field for electrons. Therefore, the electric current which passed through said hole (M, N) travels while being accelerated in a beam form and finally collides with the fluorescent screen 14. The atoms in the small region of the fluorescent screen 14 where the electron current hits are excited and emit light in the form of a spot.

Then, if a pulse signal is fed to the (N+1) electrode of the second grid electrode 18 while maintaining the potential of the M metal electrode sheet of the first grid electrode 17 above that of the subsidiary electrode 20, the electron current passes through the common hole (M, N+1) only while the pulse is present, and the small region of the fluorescent screen 14 at a position corresponding to the hole (M, N+1) is illuminated. Thus, if a pulse signal is fed to the metal electrode sheets composing the first and second grid electrodes 17 and 18, the fluorescent screen 14 can be scanned by the electric current.

If the amplitude of the pulse signal is controlled, the quantity of the electron current, which passes selectively through the holes 19 of the control electrode 15 while the pulse signal is applied, is controlled. The relation between the signal voltage and the electron current in this state is shown in FIGS. 5 and 6. FIG. 5 shows an example of the relation when the potential of the second grid electrode 18 of the control electrode 15 is maintained equal to that of the subsidiary electrode 20 and a signal voltage is applied to the first grid electrode 17. The abscissa shows the potential difference between the first grid electrode 17 and the subsidiary electrode 20 when a signal voltage is applied to the electrode 17. The ordinate shows the relative value of the electron current corresponding to the potential difference. FIG. 6 shows an example of the relation when a signal voltage is applied to the second grid electrode 18 while maintaining the potential of the first grid electrode 17 of the control electrode 15 equal to that of the subsidiary electrode 20. The abscissa shows the potential difference between the second grid electrode 18 and the subsidiary electrode 20 and the ordinate shows the relative value of the electron current. As is evident from the figure, the electron current flows in correspondence to the signal voltage fed to the control electrode 15. In particular, a linear relation holds between the signal voltage fed to the second grid electrode 18 of the control electrode 15 and the electron current passing through the holes 19 of the control electrode.

Accordingly, the fluorescent screen **14** emits light with a brightness corresponding to the amplitude of the pulse signal. If the pulse signal is changed with time, the brightness of the fluorescent screen **14** changes with position, and letters or figures can be displayed.

In this embodiment the wall of the discharge tube **11** is made transparent only at its area mounting the glass plate **12**, the transparent electrode **13** and the fluorescent screen **14** and may be made of opaque at the other area thereof. Further, another embodiment of the present display panel arrangement may be made in the form of the fluorescent screen **14** and the transparent electrode **13** which are mounted onto the tube **11** without such an intermediate glass plate **12**.

If the transparent electrode **13** is provided on the face of the discharge tube **11** and the luminescent screen **14** is applied on the opposite side of the electrode **13**, the luminescent efficiency increases since the electrons or ions hit the luminescent screen **14** directly. Conversely, if the luminescent screen is adhered directly to the face of the discharge tube **11** and the transparent electrode is provided thereon, the electrons can pass through the transparent electrode to make the screen illuminate, but ions cannot. In the method of bombarding the luminescent screen **14** with ions, the luminescent screen **14** may be damaged (so-called ion spot) due to the large mass of ions. Therefore, it may be said that the method of using electrons is more preferable because of the easiness of acceleration and the lace of danger of damaging the luminescent screen **14**.

A particular construction of the discharge tube **11** is as follows: the insulating substrate **16** of the control electrode **15** is a glass plate of 1–2 mm. in thickness, the first grid electrode **17** and the second grid electrode **18** are formed of low-resistivity material like Cu, Al, Au, Ag, etc. of 0.005–0.1 mm. in thickness, the hole provided at the insulating substrate **16** is 0.25–1 mm. in diameter, the holes provided at the first and second grid electrodes **17** and **18** are 0.2–0.8 mm. in diameter, the thickness of the transparent electrode **13** is of the order of $m\mu-\mu$, and the gap between the transparent electrode **13** and the control electrode **15** is 1–2 mm., the potential difference between the two electrodes **13** and **15** is 2–5 kv., and the thickness of the discharge tube **11** is 10 to several tens of millimeters.

Though a high-tension voltage is applied between the transparent electrode **13** and the subsidiary electrode **20**, discharge will never occur between the transparent electrode **13** and the subsidiary electrode **20** or the control electrode **15**. This is because the property of such gas discharge is expressed by Paschen's law. Namely, the spark voltage V*s* of the uniform electric field becomes a function of the product of the gas pressure P and the electrode gap distance *d*. The spark voltage V*s* decreases as said product P*d* increases and assumes a minimum value at a certain value. As the product P*d* increases further, the spark voltage V*s* increases. Such relation holds true over the wide range of the product P*d* of gas pressure P $10^{-2}-2{,}400$ mm. Hg, electrode gap distance d $5\times10^{-4}-20$ cm. and gas temperature −15°–860° C. Some examples of the minimum spark voltage V*s min* and the product P*d* of the gas pressure and the electrode gap distance will be shown in the following table.

Gas	Helium (He)	Neon (Ne)	Argon (Ar)	Mercury vapor (Hg)	Air	Hydrogen (H_2)	Nitrogen (N_2)
Vsmin (V)	147	168	192	400	330	270	250
Pd (mm. Hg·mm.)	35	38	12	6.6	5.67	11.5	6.7

The above table is derived from the "Electric Engineering Handbook" published by the Institute of Electrical Engineers of Japan. In the table, the values in the case of helium, neon and argon are shown with respect to the use of the cathode of aluminum.

According to the above fact, when the gas pressure P and the electrode gap distance *d* between the discharge electrodes **21**, **22** are determined so as to ensure the minimum spark voltage V*s* of the Paschen's law, the transparent electrode **13**, the control electrode **15** and the subsidiary electrode **20** are arranged very close to each other without causing electrical discharge therebetween even if a certain large potential difference is produced therebetween. For example, in the case of argon gas, providing a gas pressure of 10'7E'2 mm. Hg and the discharge electrode distance 100 mm. (between the electrodes **21**, **22**), the product P*d* is equal to 1 mm. Hg· mm. Although this product value differs from that of the table (12 mm. Hg·mm.), the electrical discharge is easily occurrable with a thermionic cathode as the discharge electrode **21**. As to the control electrode **15** and the accelerating electrode **13**, the electrode distance is set to be 1–2 mm., so that the product P*d* is equal to 1–2 mm. Hg·mm. which remarkably differs from the table value, and the spark initiation voltage also becomes very high.

If a pulse signal of positive polarity lasting for a time interval equal to one level scanning period of the TV signal is applied in sequence to each metal electrode sheet of the first grid electrode **17** composing the control electrode and the video signal of one level scanning period is divided and distributed to the metal electrode sheet composing the second grid electrode **18**, the transmitted image is reproduced.

Since the electrons are taken out of the plasma **23** by the electric field formed by selectively applying the pulse signal of positive polarity to the first and second grid electrodes **17** and **18** of the control electrode **15**, the response time is quite short. Since the electrons which passed through the holes **19** of the control electrode **15** are accelerated by the electric field formed by the transparent electrode **13**, the time lag between the arrival of the signal and the illumination of the small region of the luminescent screen **14** at the corresponding position is hardly noticeable. When a signal, such as a TV signal, whose amplitude changes constantly is applied to the device, the device operates in a proper manner.

FIG. 8 shows an example of the completed device. The electronic device of the TV set is installed into the base **101** or the column **102** and the image-reproducing discharge tube **104** is installed in the panel-shaped case **103**.

What is claimed is:

1. A display panel comprising a panel-shaped discharge tube filled with low-pressure inert gas; a transparent electrode provided on one inner surface of said tube; a fluorescent screen applied on said transparent electrode; control electrode means spaced in parallel with said one inner surface of said discharge tube; and a pair of spaced discharge electrodes for producing a plasma by ionizing said inert gas, said discharge electrodes being placed in a space opposite to said fluorescent screen, said space being defined by said control electrode means and the opposite inner surface of said discharge tube; said control electrode means comprising an insulating substrate having a plurality of holes formed therein, a plurality of first parallel metal electrode sheets on one surface of said insulating substrate and a plurality of second parallel metal electrode sheets on the opposite surface of said substrate which are orthogonal to said first metal electrode sheets, said holes being formed in and through said insulating substrate at the intersections of said first and second metal electrode sheets, both sheets having apertures in correspondence with said holes in said insulating substrate; and further comprising means applying a signal voltage in sequence to said metal electrode sheets of said control electrode means while applying a high voltage between said transparent electrode and each of said discharge electrodes.

2. A display panel according to claim **1** further comprising a subsidiary electrode disposed in parallel with and between said control electrode means and said opposite inner surface of said discharge tube.

3. A display panel according to claim **1**, wherein one of said discharge electrodes is a thermionic cathode.

4. A display panel comprising a panel-shaped discharge tube filled with low-pressure inert gas; a transparent electrode provided on one inner surface of said tube; a fluorescent screen applied on said transparent electrode; control electrode means spaced in parallel with said one inner surface of said discharge tube; and a pair of spaced discharge electrodes for producing a plasma by ionizing said inert gas, said discharge electrodes being placed in a space opposite to said fluorescent screen, said space being defined by said control electrode means and the opposite inner surface of said discharge tube; said control electrode means comprising an insulating substrate having a plurality of holes formed therein, a plurality of first parallel metal electrode sheets on one surface of said insulating substrate and a plurality of second parallel metal electrode sheets on the opposite surface of said substrate which are orthogonal to said first metal electrode sheets, said holes being formed in and through said insulating substrate at the intersections of said first and second metal electrode sheets, both sheets having apertures in correspondence with said holes in said insulating substrate, wherein a portion of each of said first and second electrode sheets extends into said holes in said insulating substrate; and further comprising means applying a signal voltage in sequence to said metal electrode sheets of said control electrode means while applying a high voltage between said transparent electrode and each of said discharge electrodes.

5. A display panel comprising a panel-shaped discharge tube filled with low-pressure inert gas; a fluorescent screen applied on one inner surface of said discharge tube; an electrode provided on said fluorescent screen; control electrode means spaced in parallel with said one inner surface of said discharge tube; and a pair of spaced discharge electrodes for producing a plasma by ionizing said inert gas, said discharge electrodes being placed in a space opposite to said fluorescent screen, said space being defined by said control electrode means and the opposite inner surface of said discharge tube; said control electrode means comprising an insulating substrate having a plurality of holes formed therein, a plurality of first parallel metal electrode sheets on one surface of said insulating substrate and a plurality of second parallel metal electrode sheets on the opposite surface of said substrate which are orthogonal to said first metal electrode sheets, said holes being formed in and through said insulating substrate at the intersections of said first and second metal electrode sheets, both sheets having apertures in correspondence with said holes in said insulating substrate; and further comprising means applying a signal voltage in sequence to said metal electrode sheets of said control electrode means while applying a high voltage between said electrode provided on said fluorescent screen and each of said discharge electrodes.

6. A display panel according to claim **5**, further comprising a subsidiary electrode disposed in parallel with and between said control electrode means and said opposite inner surface of said discharge tube.

7. A display panel according to claim **5**, wherein one of said discharge electrodes is a thermionic cathode.

8. A display panel comprising a panel-shaped discharge tube filled with low-pressure inert gas; a fluorescent screen applied on one inner surface of said discharge tube; an electrode provided on said fluorescent screen; control electrode means spaced in parallel with said one inner surface of said discharge tube; and a pair of spaced discharge electrodes for producing a plasma by ionizing said inert gas, said discharge electrodes being placed in a space opposite to said fluorescent screen, said space being defined by said control electrode means and the opposite inner surface of said discharge tube; said control electrode means comprising an insulating substrate having a plurality of holes formed therein, a plurality of first parallel metal electrode sheets on one surface of said insulating substrate and a plurality of second parallel metal electrode sheets on the opposite surface of said substrate which are orthogonal to said first metal electrode sheets, said holes being formed in and through said insulating substrate at the intersections of said first and second metal electrode sheets, both sheets having apertures in correspondence with said holes in said insulating substrate, wherein a portion of each of said first and second electrode sheets extends into said holes in said insulating substrate; and further comprising means applying a signal voltage in sequence to said metal electrode sheets of said control electrode means while applying a high voltage between said electrode provided on said fluorescent screen and each of said discharge electrodes.

9. A display panel comprising a flat panel-shaped discharge tube filled with low-pressure inert gas; a transparent sheet electrode provided on one longitudinal inner surface of said tube; a fluorescent screen coated on said transparent electrode; control electrode means parallel spaced from said inner surface and said screen; a mesh-type subsidiary electrode spaced from said control electrode means; opposed cathode and anode discharge electrodes; and a plasma space for ionized inert gas opposite to said screen and defined by said subsidiary electrode, said discharge electrodes and a second longitudinal inner surface of said tube; said control electrode means comprising an insulating substrate having a plurality of holes formed therein, a plurality of first parallel metal electrode sheets on one surface of said substrate, and a plurality of second parallel metal electrode sheets on the opposite surface of said substrate which are arranged orthogonally to said first sheets, said holes being arranged in a matrix penetrating through said substrate at the intersections of said first and second sheets, both sheets having apertures therein in correspondence with said holes; and wherein said display panel is further provided with means for biasing the potential of said subsidiary electrode below the potential of said anode discharge electrode, means for biasing the potentials of said control electrode sheets below the potential of said subsidiary electrode, and a high-voltage supply connected between said transparent sheet electrode and said cathode and anode electrodes.

10. A display panel comprising a flat panel-shaped discharge tube filled with low-pressure inert gas; a transparent sheet electrode provided on one longitudinal inner surface of said tube; a fluorescent screen coated on said transparent electrode; control electrode means parallel spaced from said inner surface and said screen; a mesh-type subsidiary electrode spaced from said control electrode means; opposed cathode and anode discharge electrodes; and a plasma space for ionized inert gas opposite to said screen and defined by said subsidiary electrode, said discharge electrodes and a second longitudinal inner surface of said tube; said control electrode means comprising an insulating substrate having a plurality of holes formed therein, a plurality of first parallel metal electrode sheets on one surface of said substrate, and a plurality of second parallel metal electrode sheets on the opposite surface of said substrate which are arranged orthogonally to said first sheets, said holes being arranged in a matrix penetrating through said substrate at the intersections of said first and second sheets, both sheets having apertures therein in correspondence with said holes, wherein a portion of each of said first and second electrode sheets extend into said holes in said insulating substrate; and wherein said display panel is further provided with means for biasing the potential of said subsidiary electrode below the potential of said anode discharge electrode, means for biasing the potentials of said control electrode sheets below the potential of said subsidiary electrode, and a high-voltage supply connected between said transparent sheet electrode and said cathode and anode electrodes.

11. A display panel according to claim **10**, further provided with scanning means for supplying information signals to said first and second electrode sheets.

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