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Kupsky

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[54] **GASEOUS DISCHARGE DISPLAY DEVICE WITH IMPROVED CATHODE ELECTRODES**

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[52] **U.S. Cl.** **313/109.5**, 313/188, 313/217, 313/218

[51] **Int. Cl.**.....**H01j 61/08**, H01j 61/66

[58] **Field of Search**.....313/217, 218, 210, 313/311, 109.5, 188; 117/227

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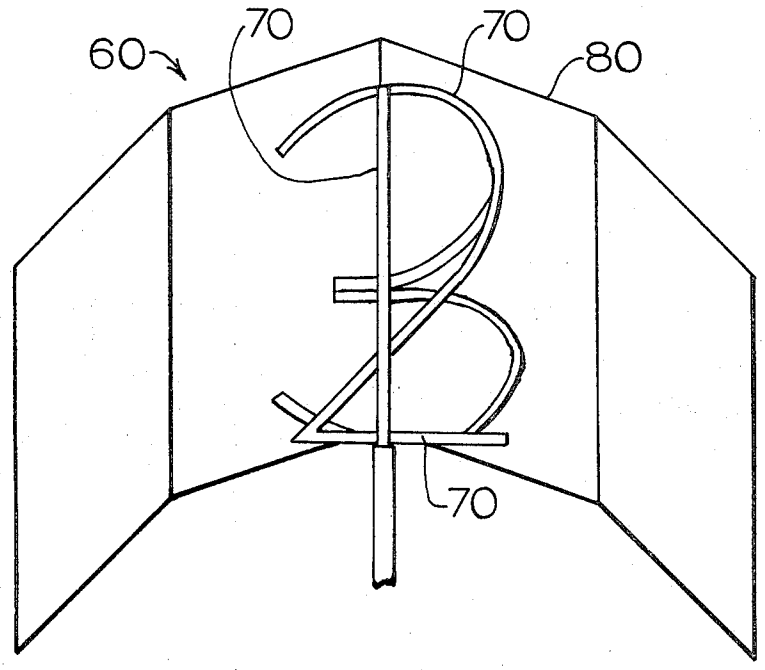
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[57] **ABSTRACT**

A display device includes an envelope having a gas filling, at least one anode electrode, and at least one cathode electrode for operation therewith. The cathode electrode comprises a metal plate having a conductive coating comprising pure metal particles in a glass carrier matrix.

12 Claims, 8 Drawing Figures



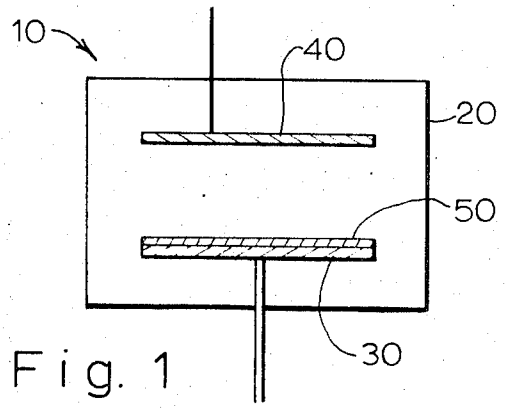


Fig. 1

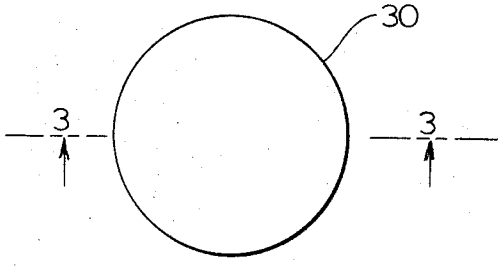


Fig. 2

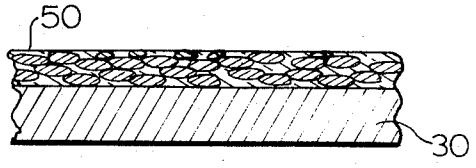


Fig. 3

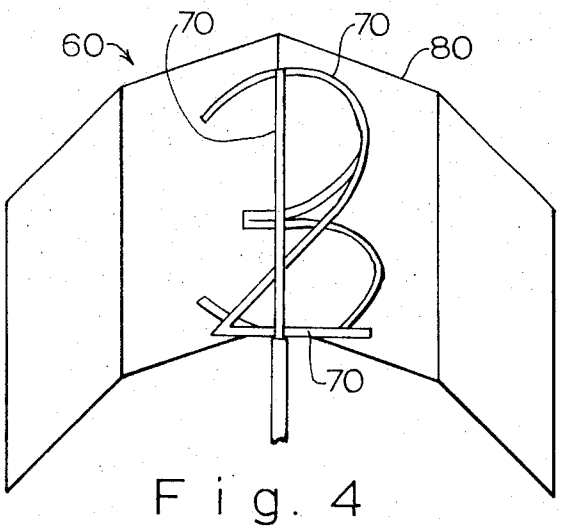


Fig. 4

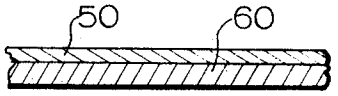


Fig. 5

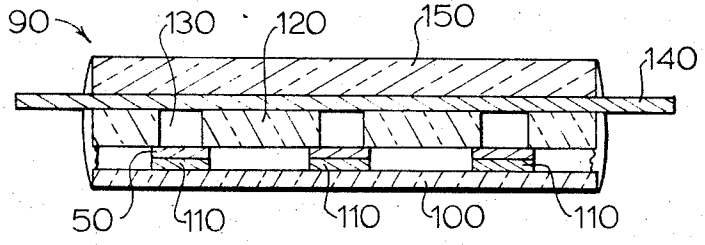
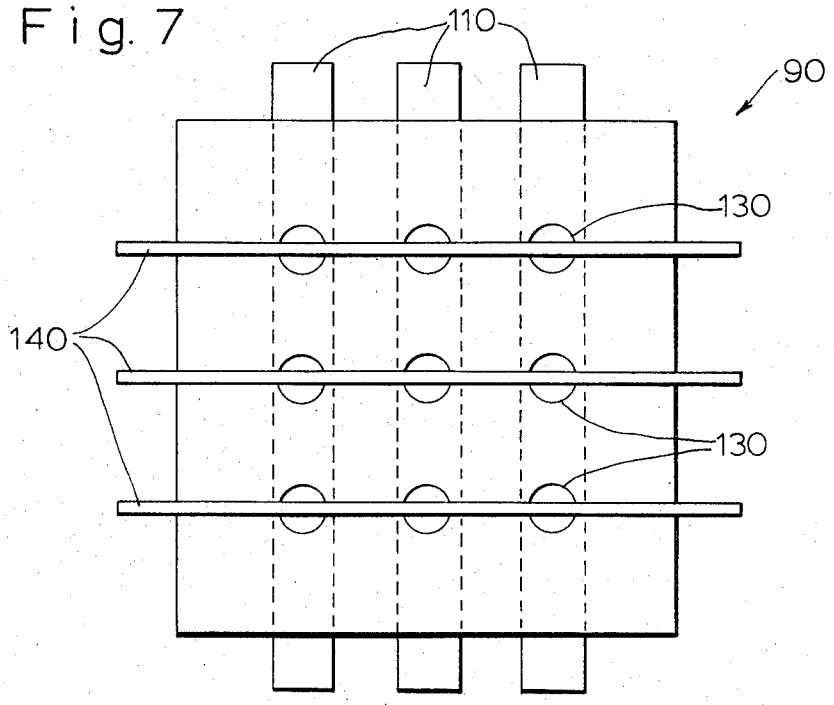


Fig. 6

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Fig. 7



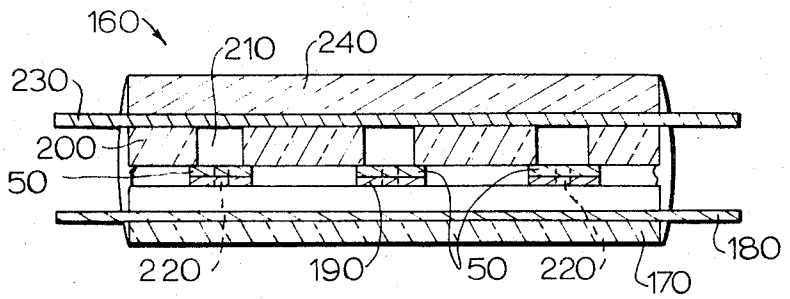


Fig. 8

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GASEOUS DISCHARGE DISPLAY DEVICE WITH IMPROVED CATHODE ELECTRODES

BACKGROUND OF THE INVENTION

Display devices of the type which utilize the phenomenon of cathode glow and operate with at least one anode electrode and one cathode electrode in a gas atmosphere have been known for many years. Generally, such devices utilize cathode electrodes which comprise strips of a suitable metal. When a potential is applied between the anode and the cathode, the cathode appears to glow due to the presence of a sheath of glowing gas which surrounds the cathode. When a potential is applied between the anode and cathode and it is slowly and gradually increased, cathode glow starts at a point on the cathode, and, as the potential is increased, the glow gradually spreads over the entire surface of the cathode until full cathode glow is achieved at some potential difference. This potential difference is determined by a number of mechanical, metallurgical, and electrical parameters, as is well known to those skilled in the art. However, the phenomenon whereby cathode glow begins at a point on the surface of the cathode and then spreads over the entire surface of the cathode is apparently due to the fact that the surface of the cathode is not completely uniform from the standpoint of ionization potential due to surface impurities which are formed in the processes by which the cathode is manufactured. Generally, such processes include stamping or rolling steps or the like, which force, into the metal, impurities which cannot be completely removed. These localized impurity areas have different ionization potentials, and, in general, a larger voltage must be applied to achieve full glow than if the cathode metal were pure and contained no impurities. In general, this is not a serious problem; however, it is always desirable to be able to operate display devices with optimum cathode uniformity whereby cathode glow would appear quickly and, apparently, instantaneously over the entire surface of a cathode.

SUMMARY OF THE INVENTION

Briefly, principles of the invention are directed to a gas-filled display device which utilizes a cathode electrode comprising a mass of finely divided pure metallic particles on a metallic support surface.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional elevational view of a gas tube embodying the invention;

FIG. 2 is a plan view of the cathode electrode in the device of FIG. 1;

FIG. 3 is a sectional view, along the lines 3—3, in FIG. 2;

FIG. 4 is a perspective view of portions of a gaseous display tube;

FIG. 5 is a sectional view of a cathode electrode of the device of FIG. 4;

FIG. 6 is a sectional elevational view of another type of display device embodying the invention;

FIG. 7 is a plan view of the device shown in FIG. 6; and

FIG. 8 is a sectional view of still another type of display device embodying the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The principles of the invention are applicable to substantially any type of gas-filled, cold cathode display device, of which there are many at the present time. Such display devices include NIXIE tubes, SELF-SCAN panel displays, PANAPLEX panel displays, and the like. For purposes of initially describing the invention, reference is made to FIGS. 1 and 2 which show a relatively simple display device 10 comprising an envelope 20 filled with a gas such as neon, argon, or the like and including a cathode 30 in the form of a metal disk and an anode 40 in the form of a plate or screen or the like spaced from the cathode a suitable distance. In device 10, when a suitable potential is applied between cathode 30 and anode 40, the cathode 30 glows, or, more correctly, a thin sheath of gas adjacent to the cathode glows.

It is difficult to obtain a cathode of any size which is perfectly clean and has such uniform surface characteristics that cathode glow forms relatively quickly and evenly over its entire surface and at a desirably low potential. In order to overcome this problem, according to the invention, the cathode 30 shown in device 10 is coated with a film or coating 50 which comprises finely divided pure metal particles in a carrier or matrix of glass powder, and, if desired, a vehicle such as pine oil. Also, if desired, a binder such as nitrocellulose, polyvinyl chloride, or the like may be included. The metal particles may be of nickel, molybdenum, tungsten, or the like, and it may also be a semiconductor material such as silicon, gallium arsenide, or the like. It is known that very pure particles of a metal can be obtained, whereas similar purity cannot be obtained in large pieces of metal. The metal particles are preferably of the order of 1 to 4 microns in dimension, for example diameter, and they are preferably in flat platelet form. In layer 50, the metal particles are all in contact with each other to provide the desired conductivity. This is illustrated in FIG. 3. With a cathode of this type, when a potential is applied between the cathode and the anode, cathode glow is initiated quickly when the necessary potential is applied, and it forms uniformly over the entire surface. This potential is smaller than that required with an uncoated cathode, that is, just cathode disk 30.

The principles of the invention may also be practiced, as noted above, in a NIXIE tube of the type which is shown schematically in FIG. 4. A NIXIE tube 60 includes a stack of cathode electrodes 70 which comprise metal strips shaped in the form of characters mounted in a gas-filled envelope and having an anode electrode 80 in operative relation therewith. In accordance with the invention, each of the metal cathode strips 70 in a tube of this type is coated with a layer 50 of the type described above (FIG. 5) and comprising metal particles in a suitable carrier.

The principles of the invention are also applicable to a display device of the type known as a dot matrix panel. Such a panel 90 is shown in FIGS. 6 and 7 and comprises an insulating base plate 100, on the top surface of which are disposed a plurality of parallel, flat, strip-like, metal cathodes 110, each of which is coated with a conductive layer 50. On the cathode is seated an insulating plate 120 having a plurality of apertures or

cells **130** arrayed in rows and columns, with the columns of cells being disposed along the cathodes **110**. Thus, a circular portion of a cathode is exposed in each cell. On the top surface of the insulating plate **120** are disposed anode wires **140**, each of which is aligned with a row of cells, and each is thus oriented at 90° to the cathodes **110**. A glass face plate **150** completes the panel assembly, and, of course, the panel is filled with gas in conventional fashion.

In operating panel **90**, when a suitable potential is applied between a cathode **110** and an anode **140**, the gas-filled cell at the junction of the two electrodes is ionized and glows. The coating **50** on each of the cathodes provides uniform turn-on and cathode glow, as described above.

The principles of the invention can also be practiced with advantage in a SELF-SCAN display panel **160** (FIG. **8**) which is a modification of panel **90** and includes a slotted base plate carrying an anode electrode **180** in each slot. A plurality of cathode electrode strips **190** carrying coatings **50** are seated on the top surface of the base plate, and an apertured insulating plate **200** having a plurality of apertures or cells **210** arrayed in rows and columns is seated on the cathodes. The columns of cells **210** in plate **200** are aligned with the cathodes, and the cathodes have small apertures **220** at each such cell. Anode wires **230** are seated on the insulating plate, and each is aligned with a row of cells **210**, and a glass cover plate **240** completes the panel. The usual gas filling is also provided.

In panel **160**, the bottom surface of each cathode **190** operates with the anode electrode **180** beneath it to comprise a scanning cell, and the top surface of each cathode electrode operates with the anode electrode **230** and the gas in a cell **210** as a display cell. Characters are displayed by firing groups of display cells. According to the invention, the top surface of each cathode electrode which is coated with layer **50** provides improved cathode glow in the cells **210**.

In practicing the invention, a suitable mixture of pure metallic particles in a glass carrier (and having a suitable vehicle and/or binder, if desired) is prepared and applied to the cathodes by spraying, by a silk-screen process, or the like. The screened cathodes are suitably baked to fuse the glass carrier to insure adherence of the cathode substrate beneath it and to remove the binder if such is used.

It is noted that the glass matrix in which the metal particles are embedded occupies some of the free surface of layer **50**. Thus, with less metal exposed than the entire surface, there is a lower current requirement for full glow than if the entire surface were of metal. The individual particle glows blend to give full surface glow.

The advantages of the invention are illustrated by the fact that, whereas an uncoated metal cathode might provide full glow at a cathode-anode potential of approximately 170 volts, cathodes embodying the invention can be operated at a potential of about 140 volts. However, another important advantages of the invention is that the metal substrate which supports layer **50** can be of an inexpensive metal.

What is claimed is:

1. A cold cathode gas display device comprising

a gas-filled envelope having a portion through which a glowing character in said envelope can be seen,

a cathode electrode and an anode electrode mounted in operative relation with each other within said envelope,

said cathode electrode having a shape which can represent a character,

said cathode including a metal substrate and a coating thereon comprising particles of a conductive material disposed in an insulating carrier, the particles being in electrical contact with each other to provide a conductive electrode.

2. The device defined in claim **1**, wherein said particles consist of a material selected from the group consisting of nickel, molybdenum, tungsten, silicon and gallium arsenide.

3. The device defined in claim **1** wherein said particles are of the order of one to four microns in their longest dimension.

4. The device defined in claim **1** wherein said particles are in the form of generally flat platelets.

5. The device defined in claim **1** wherein said particles comprise pure, clean metal bodies.

6. A display device comprising

a gas-filled, thin, flat, panel-like envelope having a viewing

window and containing

a matrix of gas-filled cells arrayed in rows and columns,

a strip-like cathode electrode aligned with each column of cells and having a portion communicating with each cell,

a coating on each said portion of each cathode electrode comprising particles of a relatively pure, clean, conductive material disposed in an insulating carrier, the particles being in electrical contact with each other to provide a conductive electrode, and

an anode electrode in operative relation with each of said cells.

7. The device defined in claim **6** wherein said particles consist of a material selected from the group consisting of nickel, molybdenum, tungsten, silicon and gallium arsenide.

8. The device defined in claim **6** wherein said particles are of the order of one to four microns in their longest dimension.

9. The device defined in claim **6** wherein said particles are in the form of generally flat platelets.

10. The device defined in claim **6** wherein each said anode electrode is disposed in operative relation with a row of said cells.

11. The device defined in claim **6** wherein said cells have lower ends and upper ends and said cathode strips are disposed adjacent to the lower ends of said cells and said anode electrodes are disposed adjacent to the upper ends of said cells.

12. A display device comprising

a gas-filled, thin, flat, panel-like envelope having a viewing window

and containing

a matrix of first gas-filled cells arrayed in rows and columns, said first cells having lower ends and upper ends,

a wire-like anode electrode aligned with each row of said first cells and disposed adjacent to the lower ends of said cells,

a strip-like cathode electrode aligned with each column of said first cells and having a portion communicating with each cell,

a coating on each said portion of each cathode electrode comprising particles of a relatively pure, clean, conductive material disposed in an insulating carrier, the particles being in electrical contact with each other to provide a conductive electrode,

a matrix of second gas-filled cells overlaying said matrix of first cells, with each second cell aligned with a first cell, with a said portion of a cathode electrode between them, and

a wire-like anode electrode in operative relation with each row of said second cells and spaced from said cathode electrodes.

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