United States Patent

[11] 3,611,019

[72] Inventor George M. Krembs
Hyde Park, N.Y.

[21] Appl. No. 785,210
[22] Filed Dec. 19, 1968
[45] Patented Oct. 5, 1971

[73] Assignee International Business Machines Corporation
Armonk, N.Y.

[54] GAS PANEL APPARATUS AND METHOD
14 Claims, 5 Drawing Figs.

[52] U.S. Cl. ..... 313/201, 313/220, 315/169 R, 316/19
[51] Int. Cl. H01j 65/00
[50] Field of Search ..... 313/201, 220; 315/169 R, 169 TV; 316/19

[56] References Cited
UNITED STATES PATENTS

2,991,394	7/1961	Archer et al.	315/169
3,499,167	3/1970	Baker et al.	315/169

Primary Examiner—Raymond F. Hossfeld
Attorneys—Edwin M. Thomas, Ralph L. Thomas and Thomas & Thomas

ABSTRACT: A gas panel display device having a micropanel disposed between first and second sets of electrical grid wires has one set of grid wires oriented orthogonally to the other set with the crossover points defining coordinate intersections. The micropanel is composed of a sealed envelope which is evacuated and filled with an illuminable gas under less than atmospheric pressure, and a nonmetallic spacer or mesh is enclosed within the envelope. The gas in the regions of the coordinate intersections define gas cells which may be selectively illuminated by electrical signals on the grid wires.

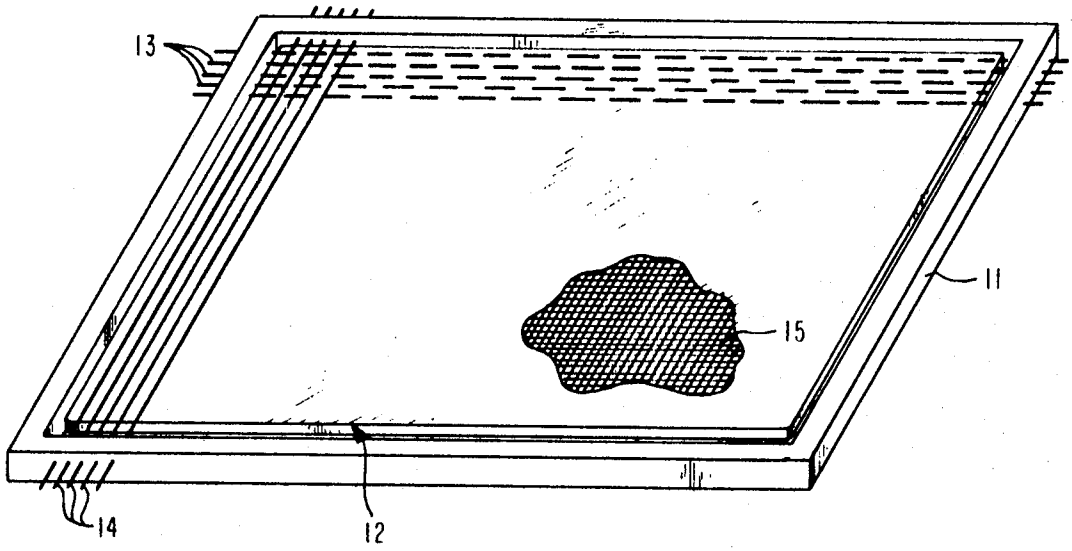


FIG. 1

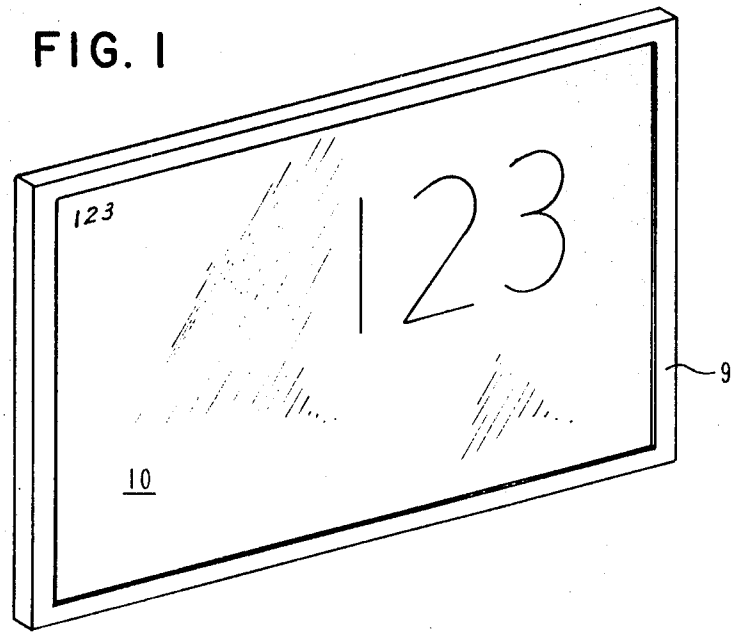
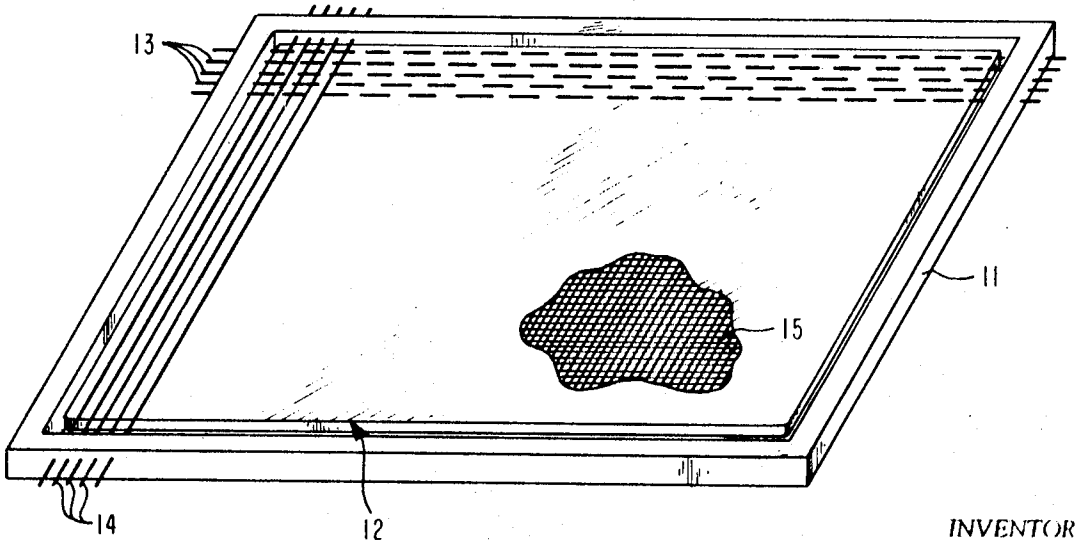


FIG. 2



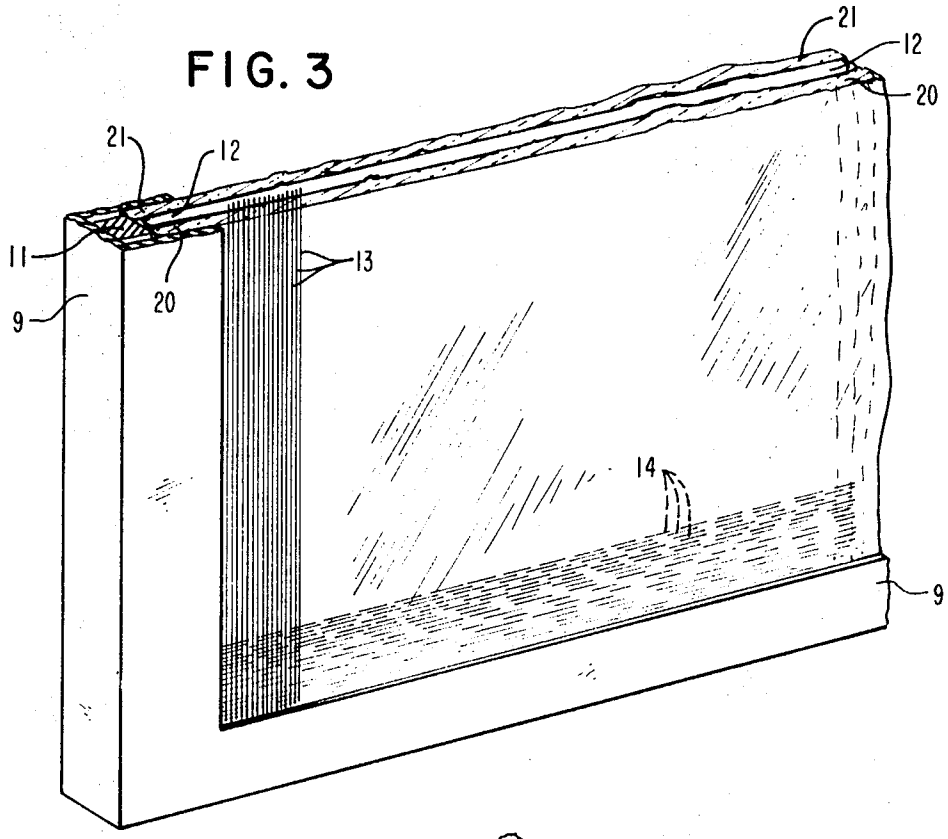
INVENTOR

GEORGE M. KREMBS

BY Thomas & Thomas

ATTORNEYS

FIG. 3



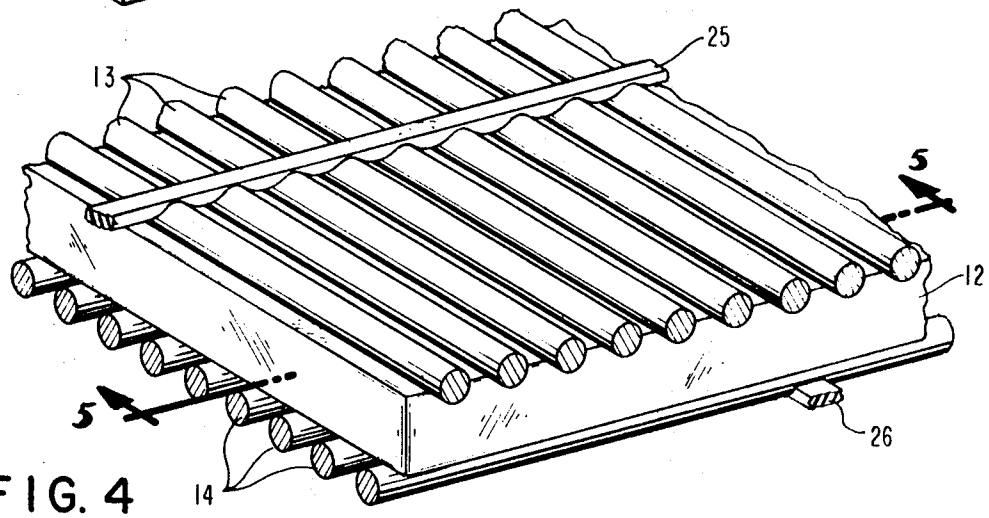


FIG. 4

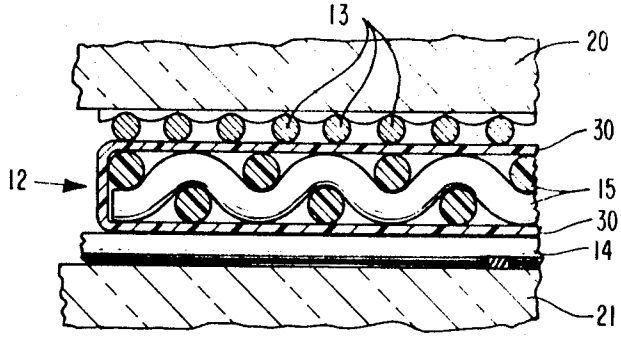


FIG. 5

GAS PANEL APPARATUS AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

Application Ser. No. 785,172 filed Dec. 19, 1968 for Display System by James C. Greeson et al.

BACKGROUND OF THE INVENTION

1. This invention relates to display devices and more particularly to gas panel display devices.

2. Earlier types of plasma display arrangements were constructed from thick glass plates on which were etched electrode patterns sandwiched together with an electrical insulation spacer on each side of a gas-filled envelope. However, when the size of the display surface of such devices approaches 2 square feet or larger, the deposition of large photoresist patterns becomes difficult, and the sealing technique heretofore used for uniform electrical insulation separation is not adequate. Furthermore, the electrical impedance drop varies with the length of a thin, semitransparent strip type of electrical line, and this causes a large variation in the required drive circuit voltage level for relatively long panels. It is a feature of this invention, therefore, to eliminate such problems by providing a novel panel construction and method which does not depend on evaporation or photoresist techniques, and yet provision is made for adequately sealing a display panel having a greater surface area than the 30-inch by 30-inch limit of viewing surface afforded by a cathode-ray tube display.

SUMMARY OF THE INVENTION

It is a feature of this invention to provide an improved gas display panel which is simple in construction, and consequently, is relatively inexpensive to manufacture and maintain.

It is a feature of this invention to provide a gas panel display arrangement which provides a high degree of flexibility for display purposes.

It is another feature of this invention to provide a novel method of making a gas display panel according to this invention.

In a preferred arrangement according to this invention a micropanel is disposed between a first set of grid wires and a second set of grid wires with one set of grid wires being oriented orthogonally to the other set. The micropanel consist of an envelope filled with an illuminable gas under a pressure less than atmospheric pressure, and a spacer, which is preferably in the form of a nonmetallic mesh, is enclosed within the sealed envelope to separate the sides of the envelope uniformly from each other. The envelope preferably is made from two sheets of microglass placed on either side of the spacer or nonmetallic mesh, and the edges are sealed with a high temperature process, epoxy being employed if desired. The envelope is then evacuated, filled with an illuminable gas having a pressure less than atmospheric. The grid wires are made from an electrically conductive material which is transparent or opaque, and covers disposed over the grid wires to press them against the envelope likewise are made of insulation material which is transparent or opaque.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a complete display panel.

FIG. 2 shows the display apparatus in FIG. 1 with the cover plates and outer frame removed.

FIG. 3 is a perspective view, partly in section, of a broken out portion of the apparatus in FIG. 1.

FIG. 4 is an exploded view in perspective showing a broken out portion of the apparatus in FIG. 2.

FIG. 5 is a cross-sectional view taken on the line 5—5 in FIG. 4 with the outer cover plates, partially broken away, shown in position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A complete display arrangement according to this invention is illustrated in FIG. 1. It includes an outer frame 9 which houses a display panel 10. Numbers, letters, characters and other symbols may be selectively displayed. The characters are light, and they are disposed on a dark background. Characters may be displayed in any part of the display panel, and they may be varied in size, as desired. For example, a display consisting of the numbers "1 2 3" may be displayed as small characters as shown in the upper left corner of the display panel 10, or they may be displayed larger in size as shown in the right half portion of the panel 10.

Referring next to FIG. 2, the display panel 10 includes an inner frame 11 within which is supported a micropanel 12 between two sets of electrical conductors 13 and 14. Enclosed within the micropanel 12 is a spacer or nonmetallic mesh 15. The electrical conductors 13 are disposed symmetrically along the length of the inner frame 11 forming a grid or network of parallel conductors. They are strung over the entire lower surface of the micropanel 12. A portion only of the electrical conductors 14 are disposed symmetrically across the width of the inner frame 11 forming a grid or network of parallel conductors. They are strung over the entire upper surface of the micropanel 12. A portion only of the electrical conductors 13 are shown in the interest of simplicity. The electrical conductors 14 are disposed symmetrically across the width of the inner frame 11 forming a grid or network of parallel conductors. They are strung over the entire upper surface of the micropanel 12. Likewise, a portion only of the electrical conductors 14 is shown in the interest of simplicity. The grid or network of parallel conductors 13 are disposed orthogonally with respect to the grid or network of conductors 14.

The micropanel 12 is filled with an illuminable gas which may be ignited or illuminated by the application of a sufficient electrical potential difference. The gas may be an inert gas such as Neon, Argon, or the like. It may be a mixture of such gases or a mixture of such gases with other gases. One suitable combination, for example, is a gas which includes 90 percent Neon and 10 percent Nitrogen. The pressure of such gas within the micropanel 12 is less than atmospheric pressure, for reasons pointed out more fully hereinafter, and the pressure may be 200 millimeters of Mercury, for example.

The two sets of electrical conductors 13 and 14 in FIG. 2 may be designated X and Y drive lines. The X and Y drive lines cross over each other at numerous points, and such crossover points may be designated coordinate intersections. The gas in the micropanel 12 between the crossover points or coordinate intersections may be defined as a gas cell. When a given X line and a given Y line are energized with a potential difference sufficient to exceed the ignition potential of the gas involved, the gas in the region, and not elsewhere, of the coordinate intersection is ignited or illuminated. Once ignited, the gas at a coordinate intersection may be maintained in the illuminated state by a holding potential. The firing potential is relatively much higher than the holding potential. Whenever a display is to be maintained in the illuminated state, a holding potential may be constantly applied to all X and Y lines for the duration of the period such display is to be maintained. Reference is made to copending application Ser. No. 785,172 filed Dec. 19, 1968 by James C. Greeson, Jr. et al., for a description of one suitable electrical arrangement for generating and maintaining a display on a gas panel of the type herein described. The arrangement described in such application provides for selectively energizing the X and Y lines with a firing potential when generating a display while simultaneously energizing the X and Y lines with the holding potential as long as the display is to be maintained.

The complete gas panel 10 in FIG. 1 includes a transparent cover plate 20 which, as better seen in FIG. 3, is disposed on the front face of the micropanel 12. A transparent cover plate 21 disposed on the rear face of the micropanel 12. The transparent cover plates 20 and 21 are made of an electrical insulation material such as glass or plastic. The cover plate 20

presses the set of electrical conductors 14 against the front face of the micropanel 12, and the cover plate 21 presses the set of electrical conductors 13 against the rear face of the micropanel 12. Further, the cover plates 20 and 21 lend structural rigidity to the gas panel assembly, and since they are constructed of electrical insulation material, they protect personnel from contacting the conductors 13 and 14. The cover plates 20 and 21 are secured to the display panel assembly by a frame 9, as seen more clearly in FIG. 3. However, the cover plates 20 and 21 may be secured to the display panel assembly by other techniques such as by an adhesive, for example, in place of the frame 9.

Reference is made next to FIG. 4 which is a perspective view of a partial section which is exploded to show the relationship of the grids or sets of electrical conductors 13 and 14 with the micropanel 12. The set of electrical conductors 13 is shown in FIG. 4 disposed on the top of the micropanel 12, and the set of electrical conductors 14 is shown disposed on the lower side of the micropanel 12. Both sets of electrical conductors are pressed against the micropanel 12 by the glass cover plates 20 and 21, as shown in FIGS. 3 and 5. A comb or spacer 25 in FIG. 4 maintains proper spacing and hence alignment of the electrical conductors 13 in parallel, and a similar comb or spacer 26 maintains proper spacing and alignment of the electrical conductors 14 in parallel. Additional combs or spacers may be employed on each side of the micropanel 12 as may be needed to maintain proper spacing and alignment of the electrical conductors and insure parallelism.

Reference is made next to FIG. 5 which is a cross-sectional view taken on the line 5—5 in FIG. 4 with the cover plates 20 and 21 partially broken away and shown in position. The micropanel 12 is a subassembly which includes (1) a sealed envelope 30 which is evacuated and filled with a suitable gas under less than atmospheric pressure and (2) a nonmetallic mesh enclosed within the envelope 30. The envelope 30 is made of an electrical insulation material which is transparent and can be made gastight. It is preferably made of microglass, but it may be made of plastic material. Microglass is a very thin, flexible material made of glass. The nonmetallic mesh 15 disposed within the envelope 30 may be made of plastic material, for example.

The novel plasma display panel provided according to this invention is relatively simple in construction, and consequently, is relatively inexpensive to manufacture and maintain the display panel provides a high degree of flexibility for display panel 10, and the size of the display may be increased or diminished, as desired. Moreover, the number of cells or coordinate intersections of the lines 13 and 14 per linear inch across the width and length of the display panel 10 may be made sufficiently large to provide any degree of resolution desired. More specifically, characters generated by igniting numerous gas cells compactly arranged, each cell being small and separated a minute distance from adjacent cells, has an outline which appears to be continuous, not a broken-line outline as in many earlier types of plasma display devices. The high degree of resolution obtained by providing an increased number of gas cells per square inch permits characters to be made as thin or as wide as desired.

It is a further feature of this invention to provide a novel process for fabricating large-area gas panels. Earlier types of plasma display arrangements were constructed from thick glass plates on which were etched electrode patterns sandwiched together with an electrical insulator spaced on each side of a gas-filled envelope. However, when such displays approach a size with a display surface of approximately 2 square feet or larger, the deposition of large area electrical conductors by the evaporation technique loses uniformity, the exposure of large photoresist patterns becomes difficult, and the sealing technique heretofore used for uniform electrical insulator separation is not adequate. Furthermore, the electrical impedance drop varies along a thin, semitransparent strip type of electrical line, and this causes a large variation in the required drive circuit voltage level over the relatively long panel. It is a feature of this invention, therefore, to eliminate such problems by providing a novel panel construction and method which does not depend on evaporation or photoresist techniques, and yet provision is made for adequately sealing a display panel having a greater surface area than the 30-inch by 30-inch limit of viewing surface provided by a cathode-ray tube display.

Next, the novel method of construction is described. The frame 11 in FIG. 2 may be strung with electrical wires by using machines now employed in FIG. 2 may be strung with electrical wires by using machines now employed to wire the frames of a magnetic core memory. When such equipment is used, magnetic cores are not employed, and no sense winding is included. When such equipment is used to wire the frame 11 in FIG. 2, the electrical conductors 13 and 14 are made taut enough not to become tangled, but they are loose enough to permit insertion of the sealed microglass panel 12 therebetween in a subsequent assembly step. Present day wiring machines are able to string wires on the frame 11 in FIG. 2 spaced 36 mils apart in frames which are at least 2 feet by 4 feet in size. The spacing between wires may be reduced to 25 mils or less, if desired. The wire used is preferably round copper wire with a diameter of approximately 1½ mils.

The constructing of the micropanel 12 is described next. The envelope 12 preferably is made from two sheets of microglass which have a uniform thickness. The thickness may be between 0.6 and 1.7 mils for example. The two sheets of microglass are placed on either side of the spacer or nonmetallic mesh 15, and the edges of the microsheets are sealed with a high temperature process. If desirable, an epoxy may be used to seal the edges. The envelope is then evacuated or exhausted, filled with a gas having a pressure less than atmospheric, and the envelope 12 is then tipped off. The gas may be a mixture consisting of 90 percent Neon and 10 percent Nitrogen with a pressure of 200 millimeters of Mercury. The size of the nonmetallic mesh is sufficient to prevent the two microsheets from implosion during the evacuation process and refill with a gas at a pressure less than atmospheric pressure. The nonmetallic mesh 15 also serves the function of preventing the front and back sides of the envelope 30 from collapsing together in one or more places in response to atmospheric pressure which exceeds the internal pressure of the gas. It is pointed out that if the two sides of the envelope 12 should collapse and engage each other in a given area, the gas panel could not be illuminated in such areas because of the absence of the gas mixture, thereby rendering the gas panel unreliable as a display device. This is prevented by the presence of the nonmetallic spacer or mesh 15. Furthermore, the nonmetallic mesh has a uniform thickness, and in response to atmospheric pressure and any pressure from the cover plates 20 and 21, the front and back faces of the envelope 12 are pressed against both the front and back surfaces of the nonmetallic mesh 15. The nonmetallic mesh, therefore, serves as a spacer to maintain the front and back faces of the gas envelope 12 a fixed distance apart throughout their entirety. It is essential to maintain a uniform thickness throughout all regions of the gas envelope 12 because this insures that the magnitude of the firing potential is likewise uniform for each cell throughout all regions of the gas envelope 12. The thickness of the mesh 15 is preferably in the range of 7 to 9 mils. The subassembly including the gas envelope 12, the gas therein, and the nonmetallic mesh enclosed therein is referred to as the micropanel 12, as pointed out above.

The next step in the novel method according to this invention is to insert the micropanel 12 between the two sets of grid wires 13 and 14. As pointed out above, the wires strung on the frame 11 are sufficiently taut not to become tangled, but sufficient slackness is provided to permit insertion of the micropanel 12 therebetween. The micropanel 12 in FIG. 5 has a cross-sectional thickness which is approximately 10 mils from the top side of the upper surface to the lower side of the bottom surface. The spacing between the electrical conductors is approximately 25 to 35 mils. Hence, the micropanel 12

may be inserted between a pair of conductors 14 at the left side of the frame 11 in FIG. 2, and the micropanel 12 may be worked along toward the right between the two sets of conductors 13 and 14 until completely inserted Alternatively, the micropanel 12 may be inserted from the bottom between two of the conductors 13 near the top of the frame 11 in FIG. 2. It is then worked slowly down between the conductors 13 and 14 toward the bottom of the frame 11 in FIG. 2 until it is completely inserted. In either case the micropanel 12 must be properly oriented for insertion. It is inserted lengthwise when inserted from the left in the frame 11 of FIG. 2, or it is inserted sidewise when inserted through the tip of the frame 11 in FIG. 2.

The next step involves placing the combs or spacers 25 and 26 on respective sets of conductors 13 and 14 as shown in FIG. 4. As many such combs may be employed as required to maintain proper spacing and alignment of the electrical conductors. Then the transparent protective plates 20 and 21 are mounted against the respective front and back faces of the micropanel 12, pressing the respective sets of electrical conductors 13 and 14 against the micropanel, as shown in FIG. 3. The cover plates 20 and 21 may be secured to the assembly by any suitable technique, such as by placing the display panel within a frame 9 as shown in FIGS. 1 and 3. Alternatively, the cover plates may be secured to the inner frame 11 by an adhesive.

A novel process is thus provided for constructing a plasma display arrangement according to this invention. It is readily apparent that the sequence of some of the steps may be varied without departing from the novel process. Mass production techniques may be utilized, in whole or in part, in each of the method steps although the micropanel 12 may have to be inserted manually into the frame 11.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A display panel comprising:
- a frame, a first set of transparent, parallel electrical conductors disposed on said frame, a second set of transparent, parallel conductors on said frame displaced from and oriented orthogonally to said first set of parallel electrical conductors,
- a micropanel disposed between said first and second sets of transparent, parallel electrical conductors, said micropanel including a sealed envelope filled with an illuminable gas under less than atmospheric pressure, and a nonmetallic mesh enclosed in said envelope.

2. The apparatus of claim 1 further including transparent cover plates mounted against the front and back faces of said micropanel and said cover plates being made of an electrical insulation material.

3. A display panel comprising:
- a sealed envelope made of a transparent electrical insulation material filled with a gas under less than atmospheric pressure, said gas being illuminated when sufficient electrical potential difference is applied thereacross,
- a nonmetallic mesh disposed in said sealed envelope,
- a frame having a first set of transparent electrical conductors aligned in parallel, said second set of transparent electrical conductors being displaced from and arranged orthogonally to said first set of transparent electrical conductors, and
- said sealed envelope being located between said first and second sets of transparent electrical conductors.

4. The apparatus of claim 3 further including a pair of transparent cover plates of electrical insulation material mounted against opposite sides of said sealed envelope.

5. A plasma display panel having
- a flat flexible envelope,
- an illuminable gas under less than atmospheric pressure sealed in said envelope,
- a nonmetallic mesh enclosed in said flat envelope and extending throughout the surface area of said flat flexible envelope, and
- electrically conductive grid wires disposed on opposite sides of said flat flexible envelope for applying an electrical firing potential to selected areas of said envelope.

6. A gas panel display device having:
- a flat envelope made of a thin, flexible material which is an electrical insulator,
- an illuminable gas under less than atmospheric pressure sealed in said flat envelope,
- a nonmetallic mesh disposed in said flat envelope,
- a plurality of electrical conductors mounted adjacent to each side of the flat envelope, and
- means made of transparent electrical insulation material disposed adjacent each side of the flat envelope which presses the electrical conductors against said flat envelope.

7. A method of constructing a plasma display panel comprising the steps of:
1. stringing a first set of electrical grid wires on a frame and stringing a second set of electrical grid wires on said frame displaced from and disposed orthogonally to said first set of electrical grid wires;
2. making a micropanel by placing two sheets of thin, flexible material over a nonmetallic mesh, sealing the edges of said two thin sheets to form a sealed envelope, evacuating the sealed envelope, and filling it with an illuminable gas having pressure less than atmospheric;
3. inserting the micropanel in said frame between said first and second sets of electrical grid wires, and
4. mounting transparent electrical insulator means against the first and second sets of electrical grid wires to press the said grid wires against the micropanel.

8. The method of claim 7 wherein the order of method steps 1 and 2 is reversed.

9. A method of constructing a gas display panel comprising the steps of:
1. attaching first and second sets of parallel wires on a frame with one set of parallel wires being displaced from and orthogonally oriented with respect to the other set,
2. making a micropanel by placing two sheets of thin, flexible material over a nonmetallic spacer, sealing the edges of said two thin sheets to form a sealed envelope, evacuating the sealed envelope, and filling it with an illuminable gas having pressure less than atmospheric;
3. inserting the micropanel in said frame between said first and second sets of parallel wires.
4. placing one or more transparent combs or spacers on each set of parallel wires to maintain proper alignment, and
5. mounting a first transparent electrical insulator against said first set of parallel wires and mounting a second transparent electrical insulator against said second set of parallel wires in order to hold said first and second sets of parallel wires against said micropanel.

10. The method of claim 9 wherein the order of method steps 1 and 2 is reversed.

11. A plasma display panel comprising:
- a sealed flat envelope filled with an illuminable gas having a pressure less than atmospheric,
- a spacer means in the form of a mesh enclosed in said envelope to prevent said envelope from collapsing on itself, and
- electrical wires disposed on each side of said sealed envelope to carry electrical signals for energizing said gas.

12. The apparatus of claim 11 wherein the electrical wires are round.

13. The apparatus of claim 12 wherein the electrical wires are disposed in grid patterns, the wires in the grid pattern on one side of the sealed envelope being orthogonally disposed with respect to the wires in the grid pattern on the other side of the sealed envelope.

14. A plasma display panel comprising:

a sealed flat envelope filled with an illuminable gas having a pressure less than atmospheric pressure,

spacer means in the form of a mesh disposed throughout the interior of said envelope to prevent said envelope from collapsing on itself, said spacer means having a plurality of openings therein to disburse said illuminable gas, and

electrical conductors disposed on each side of said sealed flat envelope to carry electrical signals for energizing said gas.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,611,019 Dated October 5, 1971

Inventor(s) George M. Krembs

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 63, after "parallel" insert -- and a second set of transparent electrical conductors aligned in parallel -- Column 6, line 49, "wires." should read -- wires, --; line 63, cancel "a", first occurrence.

Signed and sealed this 29th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE: 1969 O—366-334