Aug. 19, 1958 E. W. SMITH 2,848,638

MULTI-DISPLAY TUBE

Filed June 9, 1953 2 Sheets-Sheet 1

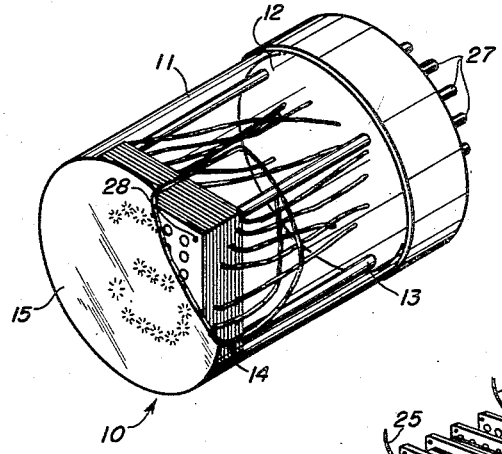

Fig. 1

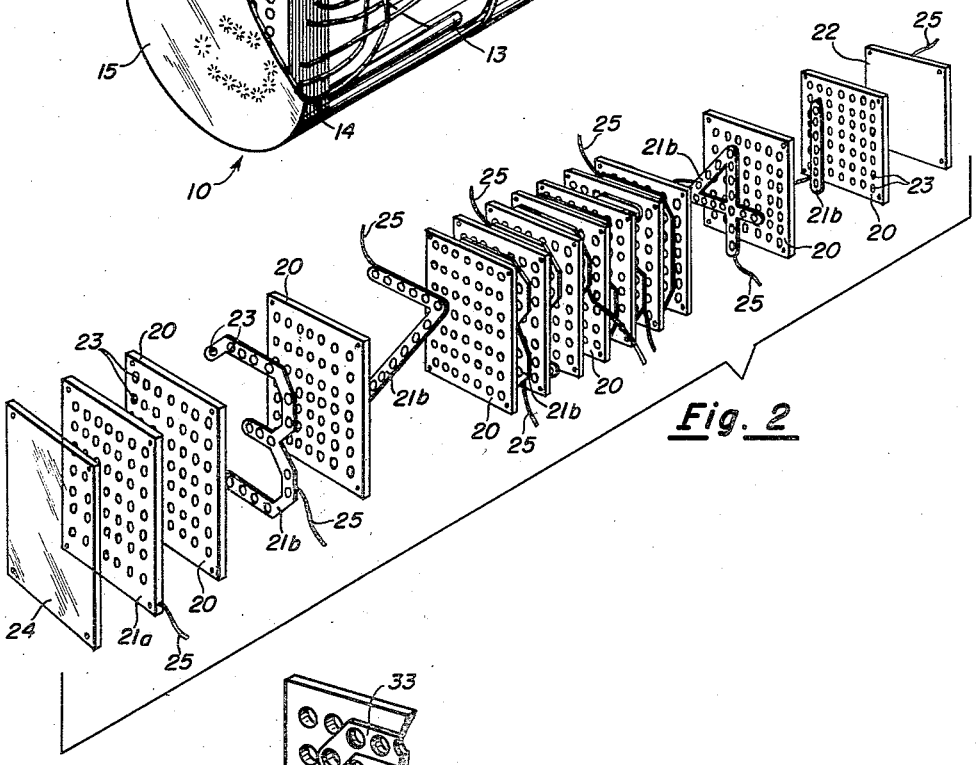

Fig. 2

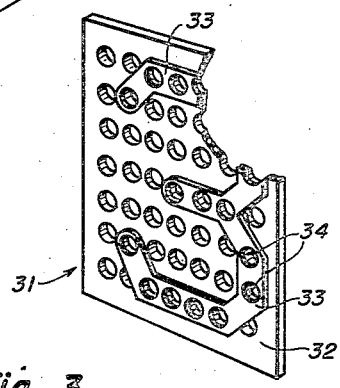

Fig. 3

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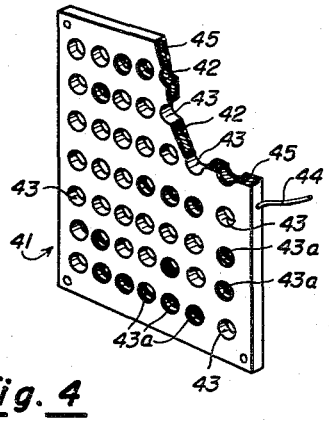

Fig. 4

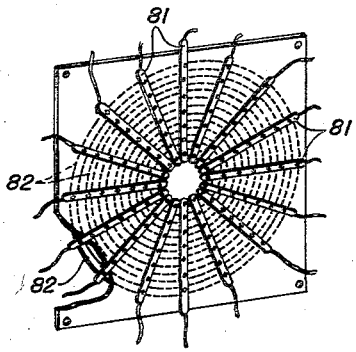

Fig. 8

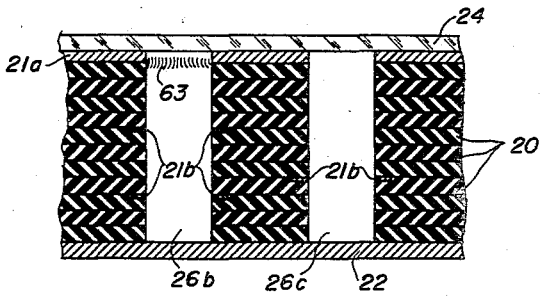

Fig. 6

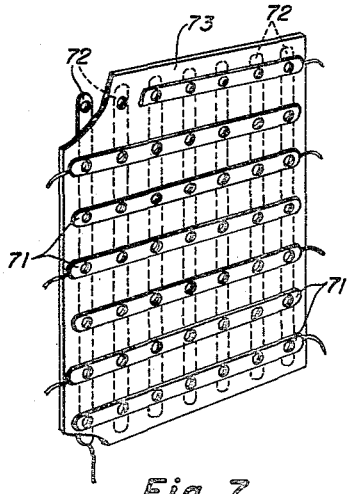

Fig. 7

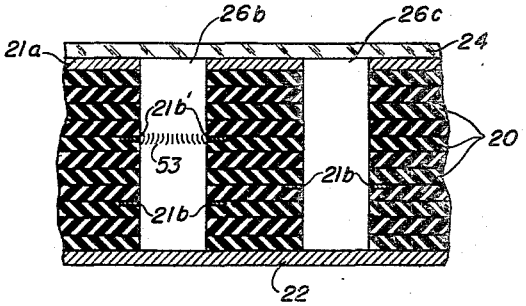

Fig. 5

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MULTI-DISPLAY TUBE

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6 Claims. (Cl. 313—109.5)

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This invention relates in general to display devices, and more specifically to a glow discharge tube for selectively displaying numerals, letters, or other characters, symbols or patterns.

It is an object of the present invention to provide a sensitive display device which is capable of selectively displaying any one of a plurality of characters or symbols in substantially the same display space.

A further object is to provide a display device wherein a plurality of component parts of characters may be selectively displayed simultaneously to form various characters consisting of combinations of such component parts.

Another object is to provide a multi-display device which basically is simple and rugged in construction and is adaptable to mass production processes.

Still a further object is the provision of a multi-display device which lends itself to a compact package construction such that space required on electronic equipment for its use is only slightly more than the area of the display itself.

Another object is to provide a display device which may readily be used side by side in an array or, if desired, may incorporate a number of display assemblies in a single envelope.

It is another object to provide a multi-display device which can provide both line and area displays.

Still another object is to provide a display device which may be utilized in pictorial or cartoon type presentations utilizing both line and area presentations.

A still further object of the invention is to provide a display device which will visually display range and bearing data on a coordinate system.

It is a further object to provide a display device which visually will indicate points on a rectangular, polar, or other coordinate system.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a perspective view in partial fragmentary section of a physical embodiment constructed in accordance with my invention;

Fig. 2 is an exploded view of the display assembly shown in Fig. 1;

Fig. 3 is a perspective view in fregmentary section of a modification of a pattern component of the display assembly;

Fig. 4 is a perspective view in fragmentary section of a second modification of a pattern component of the display assembly;

Fig. 5 is a schematic fragmentary sectional view of a display assembly illustrating one mode of operation;

Fig. 6 is a schematic view similar to Fig. 5 illustrating a second mode of operation;

Fig. 7 is a further modified form of the invention; and

Fig. 8 is still another modified form of the invention.

In the well-known space discharge devices or glow lamps a pair of metallic electrodes are sealed within a glass bulb filled with neon, argon, or other suitable gas at a suitable low pressure. When a unidirectional (direct current) potential of sufficient amplitude is applied to the electrodes a glow discharge will be initiated in the space between the two electrodes. The luminous glow discharge is produced by negative electrons and positive gas ions and takes place in the space between the two electrodes within a certain small distance from the exposed surface of the cathode or negative electrode.

A number of previous glow lamp display devices have made use of this luminous discharge adjacent to the cathode by providing a multiplicity of cathodes shaped in the form of the desired characters. The luminous discharge adjacent to the actuated cathode then produces a luminous outline of the character desired. In such previous devices alternative displays are made possible by mounting formed cathodes (such as small wires shaped in the characters desired) one behind the other or by displacing the separate cathodes laterally across the face of the tube. In the first type of construction there are several disadvantages: (1) front cathodes tend to obscure those at the rear; (2) construction is difficult; and (3) there may be difficulty in getting the glow discharge to cover the wire uniformly. In the second type of construction wherein successive images are displayed laterally, one of the principal objectives of the present invention is not achieved; i. e., alternative display of characters in essentially the same display space.

The present invention utilizes a basic principle for multi-display different from that utilized by the tubes just described. Rather than employing several discrete cathodes shaped in the form of the desired characters the present invention employs a display area composed of many glow discharge holes or cells. These cells are selectively fired in appropriate groups, to display the characters or patterns desired.

In wire or similar type display tubes, as has been mentioned supra, difficulty may be experienced in getting all of the exposed electrode area to glow. Increasing voltage may merely cause an increase in intensity of the parts already glowing, without causing the remainder of the surface to glow. In the present invention, each cell is partially if not entirely independent of ionization or lack of ionization of its neighbor. This is an important advantage, since an increase of voltage will cause the selected cells to ionize and thus glow.

One embodiment of the invention is shown in Figs. 1 and 2, wherein a tube 10 is provided having a glass envelope 11 which is filled with a suitable gas, such as neon, at the required pressure for such gas. The glass stem 12 of the tube 10 has fused into it a plurality of supports 13 which hold a display assembly 14 adjacent the glass viewing surface 15 of the envelope 11.

The display assembly 14 is comprised of a sandwich of alternately insulating laminations 20 and conductive electrodes 21 and 22. The assembly 14 may be held together as with riveted pins 28, clips, and/or suitable cement having good insulating qualities, or by other suitable means. These insulating laminations 20 and electrodes 21 have formed therein a plurality of holes 23 which, when the insulating laminations and electrodes are assembled, are in alignment. These aligned holes 23 are loosely sealed at the front of the assembly 14 by a transparent cover plate 24 and at the back by a rear cover plate 22, and thus form a plurality of cells 26 corresponding in number to the number of holes 23 in one

of the laminations 20. The electrodes consist of a front electrode plate 21*a*, a plurality of pattern electrodes 21*b*, and a rear electrode, which may be the rear cover plate 22, as shown in Fig. 2. The front electrode plate 21*a* has holes 23 therein corresponding to and aligned with those in the insulating laminations 20. During filling and sealing off of the tube 10, the gas with which the tube is filled penetrates into and fills the cells 26.

The thin conductive pattern electrodes 21*b* embedded between the insulating laminations 20 are each connected to a pattern lead-out wire 25. The lead-out wires 25 are connected each to a separate external electrical connecting post, such as a base prong 27. In order to prevent firing between the lead-out wires 25, it is desirable in most cases to have the exposed portions of these conductors insulated, as with a suitable ceramic insulating material. In some modes of operation (as described infra), such as where either the front plate 21*a* or rear plate 22 is to be used as the cathode, it may only be necessary to insulate the lead-out wire connected to this electrode.

When sufficient voltage is applied (i. e. equal to the ionization potential or firing point) between any character electrode 21*b* and either the front or back electrode plates, 21*a* or 22, a glow discharge is set up in all cells 26 connected with the energized pattern electrode 21*b*. Cells not connected to that or a similarly energized pattern electrode are not fired. If another pattern electrode 21*b* is energized with an ionization potential, the glow cells 26 associated with this pattern electrode are fired producing an alternative pattern. In other words, a pattern of glow cells 26 is selectively fired, depending upon which pattern electrode or electrodes 21*b* are energized. If desired, two or more pattern electrodes 21*b* might be energized at the same time, in combination with either the front or back electrode plate, thus producing a composite display of the two or more patterns.

The viewing surface 15 of the tube may be either transparent or translucent. It may be made translucent as by using ground glass for the viewing surface or by securing mica thereon. By using a translucent viewing surface 15, as shown in Fig. 1, glow patterns produced in the cells 26 will appear as projected images on this viewing surface 15, thus providing extremely wide-angle viewing. The various displays thus provided are not only in the same area but on the same surface. It will be apparent that in lieu of using a translucent surface 15, the front cover plate 24 might be made translucent if desired.

In Fig. 3 there is shown an alternative construction for the assembly components. In this modification the display assembly (not shown) may be made up of a plurality of unitary pattern components generally designated 31, together with front and rear electrode and/or cover plates as in the first described embodiment. The thickness of the component 31 is exaggerated in order to clearly show the details thereof. Each of the pattern components has a perforated insulating sheet 32 with a thin layer 33 of conductive material connecting a desired pattern of holes 34. A lead-out wire may readily be secured to the conductive coating or layer 33. The holes 34 in each of the perforated sheets 32 are formed for alignment upon assembly of the various desired pattern components 31. It will readily be seen that such a construction is quite adaptable to mass production techniques and provides for ease of assembly. This embodiment, as well as the next following embodiment, lends itself to printed circuit techniques.

As a further alternative to the use of separate insulating laminations 20 and pattern electrodes 21, Fig. 4 shows a modification in which each pattern component 41 has a perforated conductive sheet 42 which is covered with a thin layer or coating of insulating material 45. The thickness of the component 42 as shown is exaggerated in order to clearly show the details thereof. The coating covers the entire sheet 42 including all holes 43 except those holes 43*a* forming the desired pattern or configuration. A lead-out wire 44 is attached to the conductive sheet 42 and provides for energization thereof. As in the first modification, described supra, this modification readily lends itself to printed circuit or other mass production techniques and enables one to assemble readily and easily a complete sandwich assembly by selecting the desired pattern components 41.

It will thus be apparent that practical construction of the display assembly may be accomplished by any of several different approaches which might include depositing conductive layers on thin perforated insulating sheets, such as mica or glass; utilization of conductive perforated sheets, the desired inactive portions of which may be coated with suitable insulating enamel or porcelain, leaving the edges of only the desired active holes exposed; or assembly of perforated metallic laminations cut to connect with the desired holes, insulating one from the other as by perforated mica, glass, or other suitable insulating material.

Among the various modes of operation possible with the type of construction described are:

a. Mode 1.—The internal pattern electrodes 21*b* may be operated as cathodes and either the front electrode plate 21*a* or the rear electrode plate 22 as an anode, in which case the glow will be produced internally in the cells in an area close to the internal electrodes actuated, as shown schematically for example in Fig. 5. In Fig. 5 there is shown schematically in fragmentary cross section a pair of cells, one 26*b* energized, and the other 26*c* not energized. The pattern electrodes as shown in this figure as well as Fig. 6 are inlaid on the surface of the various insulating laminations 20. The glow is indicated at 53, near the energized pattern electrode 21*b'*. With this mode of operation front cover plate 24 or other similar arrangement to prevent cross-firing is not necessarily required.

b. Mode 2.—The internal pattern electrodes 21*b* may be operated as anodes and the front electrode plate 21*a* operated as the cathode in which instance the glow patterns will be produced close to the front electrode 21*a*, near the front surface, as shown schematically at 63 in Fig. 6, regardless of which pattern electrode 21*b* is actuated. For most displays this mode of operation would provide the more desirable display for wide-angle viewing. However, a tighter type of construction of the cells is required, in order to prevent cross firing of cells on the front surface. With this mode of operation the cathode, where most of the deterioration takes place, may if desired be made a relatively heavy electrode, as shown in Fig. 2, while each inner pattern electrode 21*b* with its adjacent insulation need have a thickness of only a few mils, so that all the letters of the alphabet can be provided by an assembly of practical proportions. For example, in one tube which has been constructed, a display assembly having pattern electrodes for ten digits has a "sandwich" thickness of less than ⅛ inch.

c. Mode 3.—Alternating voltage may be applied between the front and back plates 21*a* and 22. The pattern electrodes 21*b* may then be employed as control grids to control the onset of ionization in the pattern holes between the front and back electrodes by varying the ionization potential which is required across the front and back electrodes to fire the various pattern holes.

Many variations in operation are possible in order to obtain various desired effects. By energizing the external leads applicable to two or more groups of cells simultaneously, the composite pattern appropriate to the actuated groups can be produced. Thus a "growing" or a "diminishing" composite pattern can be produced. Or, for advertising or novelty purposes, the effect of motion can be produced through the energization of successive patterns. Or if multiple anode/cathodes as well as multiple cathode/anodes are provided in patterns, the dis-

play can be made a function of two variables, one set applied to the anodes and one set to the cathodes.

Depending upon the voltage and current characteristics, gas pressure, materials employed, and details of construction, there is always more or less atomization of the cathode in a glow tube due to ion bombardment of the cathode. Particles of metal bombarded off may settle on the viewing window, tending to obscure the glow pattern. Operation of the tube at minimum current will minimize this effect. Treatment of the cathode by one of many processes common to the neon tube and gas tube art will also help to prevent this possible difficulty. If Mode 2 operation is employed, undercutting of the cathode between two insulating wafers will tend to confine the particles to the immediate vicinity of the cathode.

Fig. 7 illustrates a further modification of the invention in which the anode and cathode group connections are arranged in spaced apart lines 71 and 72 at right angles to each other and on opposite sides of a perforated insulating sheet 73. Either one or both of the groups of electrodes 71, 72 may be perforated. In this embodiment the position of the illuminated spot (i. e., energized cell) will correspond to the x-coordinate and y-coordinate circuit actuated. Obviously, in lieu of using a single sheet 73, a plurality of perforated sheets could be used with one or more electrodes 71 or 72 arranged between each pair of sheets.

As a further modification the electrode group connections may be arranged, one group (either anode or cathode) in conductive radial lines 81 and the other group (either cathode or anode) in concentric circular lines 82, as shown in Fig. 8. A single perforated insulating sheet is sandwiched between the radial and circular electrodes 81 and 82. In this embodiment the position of the illuminated spot (i. e., energized cell) will be dependent upon the radius (or range) and the bearing (or angle) circuits actuated, and may thus reflect range and bearing, or other similar data.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced other than as specifically described.

What is claimed is:

1. A display device comprising a gas-filled light-passing envelope, a sandwich of alternately conducting and non-conducting layers, said sandwich being mounted in said envelope and having one of its faces positioned in close proximity with said envelope, said layers having a plurality of holes formed therein and comprising a plurality of cells each having a quantity of gas under pressure therein, each said cell having at least one conducting hole comprising a cathode therefor and at least one conducting hole comprising an anode therefor, said conducting layers being each electrically connected to selected ones of said holes corresponding to a configuration resembling the predetermined indicia whereby the cells individual thereto may be simultaneously fired, and means for connecting a source of power across selected pairs of said conductors to fire the gas in the cells connected to the thus energized conductors, said fired cells each being lighted by the luminous glow produced adjacent its cathode and said glow being visible through said envelope.

2. A display device comprising a gas filled envelope, and a display assembly mounted in said envelope, said assembly comprising a plurality of perforated conducting laminations, selected perforations in said laminations having a non-conductive coating thereon, and an insulating layer between each of said conducting laminations, said perforations being in alignment to form a plurality of discrete cells each having a quantity of gas under pressure therein, each said cell having at least one conducting perforation comprising a cathode therefor and at least one conducting perforation comprising an anode therefor, and means for connecting a source of power across selected pairs of said conducting laminations to fire the gas in the cells conductively connected to the thus energized laminations, said fired cells each being lighted by the luminous glow produced in the perforation of its cathode.

3. A gas-filled light-passing tube having a display assembly mounted therein, said assembly comprising a plurality of glow cells each having a quantity of gas under pressure therein, each cell having at least three electrodes connected thereto for control thereof, one of said electrodes comprising a cathode, a second an anode, and a third a control grid electrode positioned between said first and second electrodes, each said cell being lighted by the luminous glow produced adjacent its cathode upon application of ionization potential between its cathode and anode sufficient to overcome bias potential applied to its grid.

4. A display device comprising a gas-filled light-passing envelope, a display assembly positioned within said envelope, said display assembly comprising layers of alternately conducting and non-conducting members, said layers having a plurality of mutually cooperating groups of holes therein forming a plurality of cells, each of said conducting layers having conducting members individual to preselected cells therein for simultaneously firing one of said groups of cells, said cells containing a quantity of gas under pressure therein, predetermined members of said conducting members being a cathode and an anode in said cells, each of said cells being lighted by the luminous glow produced adjacent its cathode upon application of ionization potential between its cathode and anode.

5. A display device comprising a gas-filled light-passing envelope, a display assembly mounted in said envelope, said assembly comprising a plurality of conducting and non-conducting layers, a majority of said individual conducting layers having a configuration resembling predetermined indicia, said layers having a plurality of holes formed therein and comprising a plurality of cells each having a quantity of gas under pressure therein, each said cell having at least one conducting hole comprising a cathode therefor and at least one conducting hole comprising an anode therefor, said conducting layers being each connected to selected ones of said holes, and means for connecting a source of power across selected pair of said conductors to fire the gas in the cells connected to the thus energized conductors, said fired cells each being lighted by the luminous glow produced adjacent its cathode and said glow being visible through said envelope.

6. A display device comprising a gas-filled light-passing envelope, a display assembly mounted in said envelope, said assembly comprising a plurality of conducting and non-conducting layers, said layers having a plurality of holes formed therein and comprising a plurality of cells each having a quantity of gas under pressure therein, each said cell having at least one conducting hole comprising a cathode therefor and at least one conducting hole comprising an anode therefor, each of said conducting layers being each electrically connected to selected ones of said conducting holes therein forming a configuration resembling predetermined indicia, and means for connecting a source of power across selected pairs of said conductors to fire the gas in the cells connected to the thus energized conductors, said fired cells each being lighted by the luminous glow produced adjacent its cathode and said glow being visible through said envelope.

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