

[54] **MICROCHANNEL PLATE GAS DISPLAY PANEL**

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[22] Filed: **Dec. 22, 1971**

[21] Appl. No.: **210,877**

[52] U.S. Cl. **340/324 R, 313/105, 315/169 TV**

[51] Int. Cl. **H05b 37/02**

[58] Field of Search **340/324 R, 324 M, 340/173 PL; 315/169 R, 169 TV, 12; 313/66, 67, 105, 217**

[56] **References Cited**

UNITED STATES PATENTS

3,408,532	10/1968	Hultberg et al.	313/105
3,619,700	11/1971	Kupsky	315/169 TV
3,263,120	7/1966	Aiken	340/324 M

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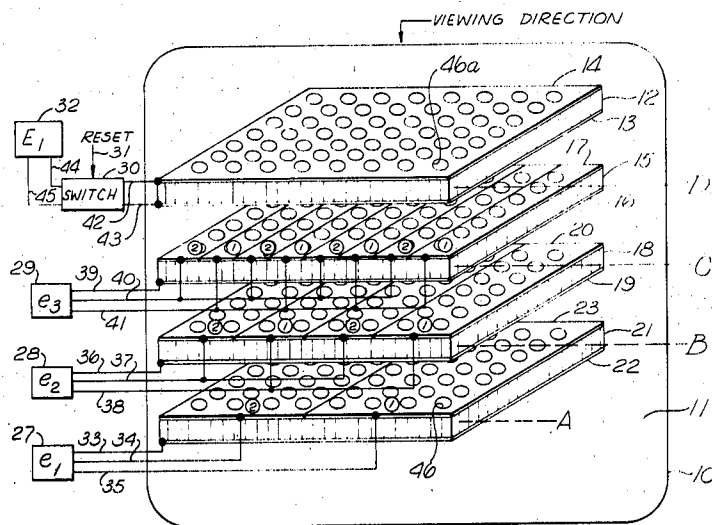
[57]

ABSTRACT

A randomly addressed neon glow display panel shown in linear form. The system is particularly adapted to the display of digitally presented information, and includes a channel plate corresponding to each digit of significance in a digital word to be presented. The least significant digit is applied to a channel plate divided into two electrode surface areas. Each succeeding more significant digit is supplied to a channel plate divided with the number of discrete surface electrodes areas increasing progressively according to a power (i.e., scale of two). These channel plates are stacked with insulating channel plates between them, all channels being aligned or in spatial registration throughout the "sandwich".

The entire assembly of channel plates is contained in a closed vessel containing neon gas in a quantity and pressure appropriate for obtaining glow discharge effect. Ignition transfer between plates is employed to obtain a discrete area of glow on a viewing channel plate arranged to respond to the glow stimulus from the aforementioned sandwich of plates.

7 Claims, 2 Drawing Figures



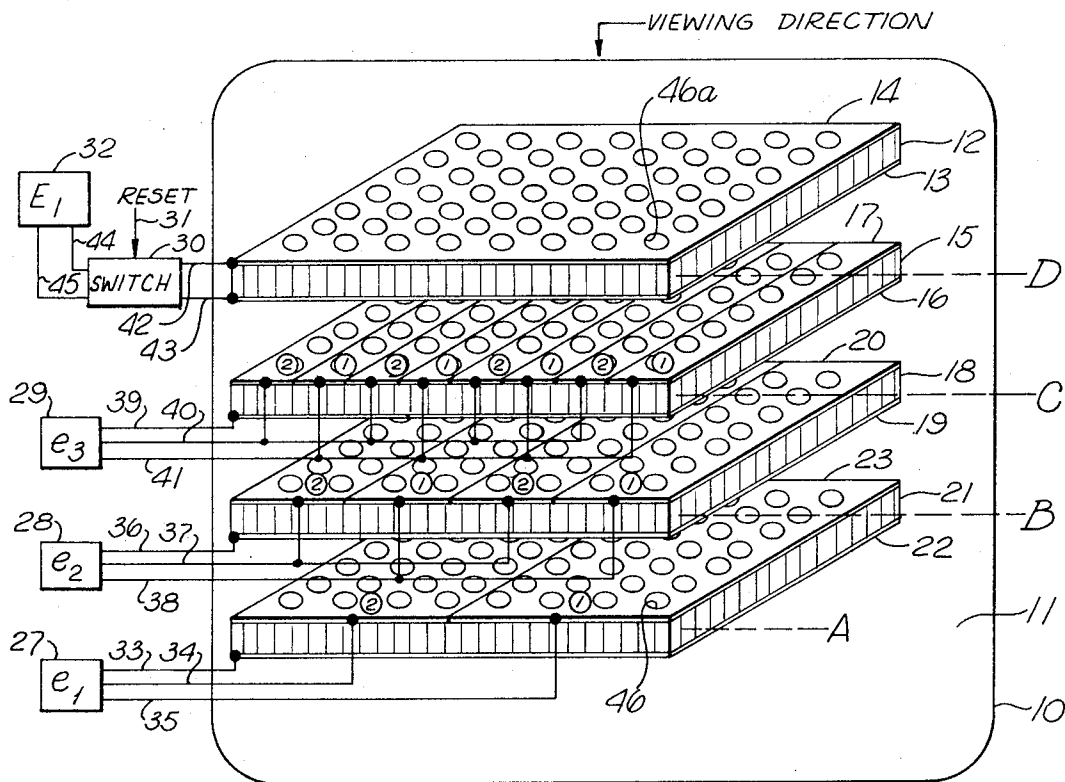


Fig. 1.

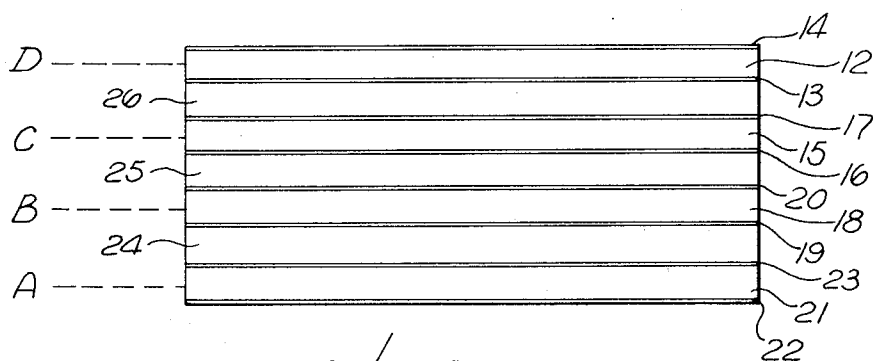


Fig. 2.

MICROCHANNEL PLATE GAS DISPLAY PANEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to electronic display panels, and more particularly, to neon glow discharge panels adapted for random access.

2. Description of the Prior Art

In the prior art various forms of matrix displays, some making use of glow discharge and others operating essentially as solid state devices, are extant. There are also various forms of randomly addressed matrix displays, for example, the so-called Northrop "Digiscanner" and the "Digisplay" devices.

In general, wherever a large number of discrete indicating positions, such as resulting from the display of a multibit digital word is involved, a correspondingly large number of external connections is frequently required.

Moreover, some prior art display arrangements do not provide for latching action whereby the last value displayed remains without continued electrical signal presence until erased or replaced by a new value. While, as indicated above, there have been a number of approaches to the general display problem to which the present invention relates, no one system has combined the features necessary to provide the simple operation and relatively simple structure of the present invention hereinafter described.

SUMMARY

The present invention makes use of a plurality of so-called channel plates, which are thin plates or discs of insulating material through which a large plurality of well ordered holes, or channels pass from face to face. The holes, or channels, are applied, for example, in rows and columns, in accordance with known processes and manufacturing techniques. In this art, ceramic and glass materials have been employed in the manufacture of microchannel plates such as are widely used in secondary emission electron multiplier applications. The term "channel plate" as used herein refers to the general class of devices including microchannel plates. Channel plates for this invention would normally have larger holes than those commonly called microchannel plates. One particular material widely known and used is widely identified and referred to as fotoceram.

The structure of the present invention may be thought of as comprising a number of channel plates stacked in a sandwich and arranged to be excited to produce glow of the neon gas within the channels. If the electric, or externally applied excitation in the form of a potential cross the face electrodes of any discrete part of one of the channel plates is momentarily excited with a sufficiently large potential, this glow discharge is initiated. The individual channel plates as viewed progressing through the sandwich are each divided into a larger number of areas than was the case with its predecessor. Each succeeding channel plate, for the ordinary digital display configuration, has (for example) twice as many discrete excitable areas as did the preceding plate. Moreover, a final channel plate is excited with only a sustaining potential, and depends for its registration over a discrete part of its overall area upon glow propagation to initiate a discharge which remains until the said sustaining voltage is interrupted.

A particular advantage of the present structure is the fact that each of the said channel plates in the sandwich is supplied with only three leads, one a common, and the other two corresponding to the two possible values of a digital bit in the binary system of values.

A detailed description of the structure of the invention and illucidation concerning the manner in which it operates, follows.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric expanded view of an assembly of channel plates electrically connected in accordance with the present invention.

FIG. 2 is a side view looking into the "sandwich" of channel plates assembled from FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, the essence of the present invention is illustrated in the form of four channel plates A, B, C, and D levels and specifically identified as 21, 18, 15 and 12. Each of these channel plates is to be understood to have the same number of holes or channels therethrough from face to face, corresponding holes in each level being aligned vertically overall.

In a manner very similar to the corresponding technique when microchannel plates are used for electron secondary emission multipliers, each of the plates 12, 15, 18 and 21 are provided with conductive face plates acting as energizing electrodes. The manner in which these conductive surface electrodes are applied has been described in the prior art including such references as U.S. Pat. No. 3,387,137 issued June 4, 1968, entitled "Multi-passage Electron Multiplier with Potential Differences Between Passage Ways".

Another reference pertinent to the state of the art in respect to the application of the electrodes to the microchannel plate faces, is U.S. Pat. No. 3,634,712, issued Jan. 11, 1972 entitled "Television Receiver or the like and Picture Tube Electron Multiplier Therefor". That patent is assigned to the assignee of the present invention. Although the two electrode top halves identified as 1 and 2 (encircled) of the channel plate 21 contain only four rows of holes per half, it is to be understood that this representation is illustrative only, and that in a practical case a much larger number of holes may, in fact, be used. For each channel plate there is a common electrode on one face, such as 13 for plate 12, 16 for plate 15, 19 for plate 18 and 22 for plate 21. These common electrodes extend entirely over the face of the corresponding channel plate, i.e., on the bottom surface as illustrated in FIG. 1. It is to be understood however, that these electrodes do not cover the channels or holes, but are in registration therewith. Stated otherwise, the electrode surfaces may be thought of a thin conductive films or plates with hole patterns congruent with the insulating body channels. Channel plate 12 has a top electrode coating 14 which like 13, extends fully over the surface of the plate between the holes, but on the upper side in that case, as viewed in FIG. 1. In the case of plates 15, 18, and 21; the corresponding top plates 17, 20, and 23, represent only the electrode plate segment farthest right in the illustration of FIG. 1. That is, they represent a plate area marked with the encircled FIG. 1 at each of the levels A, B and C. In the case of level A, that particular electrode is half of the surface, whereas at B is, is at

one-fourth of the surface and at C, one-eighth of the surface. This constitutes a digital progression of the subdivision factor of those electrode surfaces.

At levels A, B and C, it will be noted that the encircled FIGS. 1 and 2 alternate as they describe the individual segments of the conductor surface or electrode on each of the plates. It will further be noted that electrode segments of the same plate having the same encircled number are connected to common leads.

In the case of level A a common connection to the electrode 22 is made at 33 where as the number 1 segment is connected via lead 35 and the number 2 segment via lead 34 externally. In the case of level B, the encircled "1" segments are collected and come out at lead 38 and the encircled 2 segments are brought out at 37, whereas the common electrode 19 corresponds to lead 36. The same pattern follows in respect to level C, corresponding output terminals for the connection of common electrode 16 being 39, with leads 40 and 41 corresponding to segments 2 and 1 (encircled), respectively.

The non-segmented plate level D is uniformly excited between electrodes 13 and 14 by corresponding leads 43 and 42.

For clarity, the additional sections of channel plate separating the various levels have been omitted from FIG. 1 but are shown in FIG. 2. Accordingly, it is to be understood that the full complement of components as represented in FIG. 2 would be present within the enclosure 10 and included in the gas filling in the space 11. Although it is contemplated that neon gas at a pressure appropriate for glow discharge operation is present within enclosure 11, certain other elemental gasses or gaseous compounds can be considered appropriate generically.

Referring also now to FIG. 2, the channel plates 12, 15, 18 and 21 will be recognized as will the corresponding electrodes 13, 14, 16, 17, 19, 20, 22, and 23. Additionally channel plate sections 24, 25 and 26, without any additional electrode coatings on their faces, are aligned between the A, B, C and D levels depicted. A typical hole illustrated at 46 in FIG. 1 is to be understood to be in registration with all corresponding holes throughout the entire sandwich up through and including 46a through plate 12 and its top electrode 14.

Viewing of the device is identified by a directional arrow on FIG. 1. Operation and the additional external electrical control structure will be described contemporaneously.

Ignoring the switch 30 for the moment, i.e., assuming it is closed, the leads 42 and 43 and therefore the electrodes 14 and 13, will be energized by a sustaining potential applied via leads 45 and 44 from a potential source 32. The voltage E_1 of source 32 is preferably an AC voltage and is not of sufficient magnitude to cause discharge or glow within the gas filling the holes or channels in the plate 12 of itself. The set voltage E_1 is sufficient however, to maintain discharge wherever it may have otherwise been initiated. It is the purpose of the intervening channel plates 24, 25 and 26 between the various levels, to "guide" and "propagate" ionized gas, for example, from level C to a corresponding area of level D depending upon which particular segment of level C is glowing at any particular time.

Concerning now the mechanism by which the A, B and C levels are energized, it is pointed out that 27, 28 and 29 providing signals e_1 , e_2 and e_3 , respectively, are

pulse signals in a digital combination, i.e., either "1" or "2" with respect to the common lead in each case, so that the corresponding "1" or "2" electrode segments in each corresponding level are pulsed. Levels A, B and C, unlike level D, are not provided with sustaining potential and therefore, any glow discharge caused by application of e_1 , e_2 and/or e_3 is extinguished automatically at the end of the pulsing. Since leads 33, 36 and 39 are the said common leads respectively for e_1 , e_2 and e_3 , the pulse voltage is applied at each level through the corresponding one of said common leads and one of the two other leads from each of 27, 28 and 29.

At this point it should be pointed out that, if the switching code represented by e_1 , e_2 and e_3 is applied at relatively high frequencies, such that ionization times must be dealt with, then e_2 and e_3 may require the addition of pulse delay means, a one increment delay applying to e_2 and a two increment delay applying to e_3 .

Thus it will be seen that the pulse amplitude from e_1 must be sufficient of itself to ionize either the "1" or "2" electrode subpanel of the A level, depending upon whether the signal from e_1 is applied between 35 and 33 or 34 and 33, respectively. The resulting glow thus occurs in all or substantially all of the holes or channels in the A level in the area thus excited. The e_2 pulse, if applied between 38 and 36, results in the two "1" panels of level B being triggered. The e_2 signal will not be as large as e_1 , since the operation of the device inherently depends on the "propagation" of the glow discharge from the A level to reduce the pulse threshold which brings corresponding panels at the B level into glow discharge. It will be seen that one of the "1" electrode subpanels at level B is opposite the "1" subpanel at level A, whereas the other is not. Thus, the "1" panel at the B level farthest right as seen in FIG. 1, is the one which is "fertilized" from the glow propagated from the A level below, and is therefore placed in the glow discharge condition, whereas the other "1" subpanel of level B is not sufficiently pulsed to produce discharge or a glow condition. The voltage e_2 is not only less than that of E_1 , but is necessarily less than the threshold which would produce glow discharge without the propagation of ionized particles from the glow discharge of the adjacent level panel as just described. The aforementioned delays of e_2 and e_3 will now be understood in that they provide time for stabilization of the glow discharge in each level before the next higher level is pulsed.

From the foregoing description it will be apparent how the same type of glow or priming from level to level also applies between level B and C. Accordingly, if an A level pulse from e_1 is applied to the "1" subpanel (identified as an A1 pulse, etc.), and if the e_2 and e_3 pulses are described as B₂ and C₂, the fourth panel from the right in the D level is energized. An additional reference to FIG. 2 will remind the reader that additional channel plates fully aligned as hereinbefore described are shown at 24, 25 and 26. These plates have the capability of restricting and guiding the ionization "fertilization" or "priming" to the next plate level as hereinbefore described. Thus, the inadvertent energization of panels not intended to be energized, is avoided.

Finally, it will be seen that an area of the D level plate corresponding to the projection of the said fourth from the right D level subpanel will glow and be viewed.

To follow one more code example, consider pulsing of the levels corresponding to A₁, B₁ and C₁. In that instance, an area of D corresponding to the farthest right D level subpanel glows.

The sustaining voltage applied between 42 and 43 remains until interrupted by switch 30 in accordance with a reset pulse on 31. It is possible to retain one or more displays on the D level while additional displays are added. The sustaining voltage between 42 and 43 is sufficient to cause ionization at the level primed from the C level as hereinbefore described. The amplitude of the E₁ sustaining potential from 32 is not necessarily the same as the pulse amplitude e₁ or the amplitudes e₂ or e₃. The appropriate pulse voltages and optimum value for E₁ are dependent upon physical factors, gas pressure and pulse durations, however, the relationships are readily determined empirically.

While the foregoing description has been carried out in respect to a linear display, it will be evident that other types of displays involving other channel configurations are possible. For example, concentric circular electrode arrangements at the various levels could be employed resulting in a "radar-like" display. Various other modifications and applications of the principles of the present invention will suggest themselves to those skilled in this art, once the nature of the present invention is understood. Accordingly, it is not intended that the present invention should be restricted to the specific embodiment illustrated and described, this being intended to be typical and illustrative only.

What is claimed is:

1. An electronic display panel providing random access and information display, comprising the combination of:

a plurality of channel plates of insulating material including an end plate stacked with their channels aligned, the individual plates thereof having relatively thin conductive layers on opposite sides, said layers having holes congruent with said channels, adjacent conductive layers of adjacent channel plates being spaced apart;

means dividing a plurality of said conductive layers on one side of successive channel plates within said stack into discrete electrode areas, successive conductive layers on said one side of said plates being divided into a multiple number of smaller electrode areas aligned within a corresponding larger area of the preceding conductive layer, the other side of each of said channel plates having a continuous layer thereon;

means for applying a sustaining potential between the opposite side conductive layers on said plates facing said end plate of said stack to form an information display surface;

an enclosure containing a gas adapted for visible glow discharge in response to electrical stimulus, said enclosure being translucent at least in an area adjacent said display surface;

and means for selectively applying different electric signal potentials to predetermined discrete electrode areas of selected ones of said plates to produce glow discharge within the corresponding channels, said glow discharge acting as a priming influence propagating within said channels to corresponding areas of adjacent plates, said priming influence being sufficient to cause glow discharge over a corresponding area of said display surface.

2. Apparatus according to claim 1 including a plurality of intermediate channel plates interposed respectively between adjacent said channel plates and spacing apart said adjacent conductive layers.

3. An electronic display panel comprising:

a plurality of controlled channel plates of insulating material each having first and second faces arranged in a stack with the channels thereof in alignment throughout said stack; a plurality of conductive coatings, one over each face of each of said plates, said conductive coatings having holes congruent with the channels of said plates, said coatings further being subdivided along one face of each of said plates according to a predetermined spatial arrangement to form corresponding electrodes, successive conductive coatings on said one face of successive channel plates being divided into a multiple number of smaller electrode areas aligned within a corresponding larger area of the preceding conductive electrode coating, the other face of each of said channel plates having a continuous conductive electrode coating thereon;

a viewing channel plate having continuous electrodes substantially over both faces, said electrodes having holes congruent with the channels of said viewing plate;

an enclosure containing a gas capable of exhibiting visual glow discharge in response to excitation, said enclosure containing said channel plate stack and being transparent at least adjacent said viewing plate;

means for applying a sustaining potential between the electrodes on the two opposite faces of said viewing plate sufficient to maintain but not to initiate glow discharge therein;

and means for selectively applying different electric pulses to predetermined discrete electrode areas of said controlled channel plates to produce a glow discharge within the channels in the selected area of the face of the one of said controlled plates adjacent said viewing plate, whereby the channels of a corresponding area of said viewing plate are placed in a glow discharge condition by the priming action of the glow discharge of said selected area of said adjacent controlled plate acting with said sustaining potential.

4. Apparatus according to claim 3 in which said gas is neon.

5. Apparatus according to claim 2 in which said electrode areas are each controlled by a corresponding digit of a digital code, the first of said plates having its conductive coating on said one face divided into two discrete alternate electrode areas, each succeeding plate having its conductive coating on the same relative face divided into twice as many discrete alternating areas as the preceding plate and aligned within said corresponding larger areas of said preceding conductive coating, and said means for selectively applying different electric pulses to said electrode areas includes means for alternately applying two different electrical pulses each associated with respective alternate electrode areas of each channel plate.

6. Apparatus according to claim 3 in which said respective alternate discrete electrode areas of each plate are connected together electrically and are driven contemporaneously by the corresponding alternately applied electric pulse.

7. Apparatus according to claim 6 in which said interconnected discrete areas form first and second sets and whereby only three signal leads are required for each plate comprising one lead for each of said sets and one lead for said continuous conductive electrode coating on said other plate face.

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