

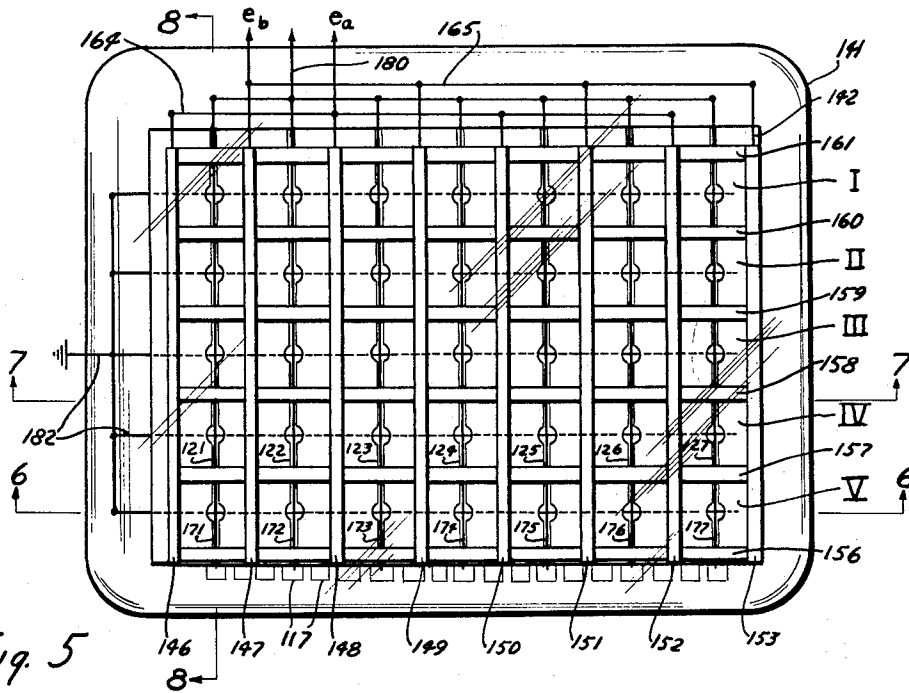
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LUMINOUS DISPLAY DEVICE

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2 Sheets-Sheet 2



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LUMINOUS DISPLAY DEVICE

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7 Claims. (Cl. 315-84.6)

The invention relates to visual character display devices, and, more particularly, to such devices of the serial shifting, multiple position, glow discharge type as disclosed in my copending applications:

Serial No.	Filed	For—
521,555	July 12, 1955	Electric Discharge Device.
588,021	May 29, 1956	Glow Discharge Device.
588,022	do	Do.
		Electric Controlled Information-bearing Device.
		Glow Discharge Device.
		Memory Device.

of which the present application is a continuation in part. Application Serial No. 588,021 is now U.S. Patent No. 2,869,036, issued January 13, 1959.

An object of the present invention is to provide a luminous display device, of the character described, having improved resolution and luminous intensity of the visual display.

Another object of the present invention is to provide a luminous display device, of the character above, in which a whole visual pattern may be fed into the device and then shifted en masse into view, and held, if desired, in view while another whole pattern is shifted into the device for similar subsequent showing.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawing accompanying and forming part of the specification. It is understood, however, that variations in the showing made by said drawing and description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawings:

Figure 1 is a plan view of a luminous display device constructed in accordance with the present invention.

Figure 2 is a cross-sectional view, on a somewhat enlarged scale, of the device and is taken substantially on the plane of line 2-2 of Figure 1.

Figure 3 is a cross-sectional view similar to Figure 2 but is taken on the plane of line 3-3 of Figure 1.

Figure 4 is a cross-sectional view, on the enlarged scale, taken substantially on the plane of line 4-4 of Figure 1.

Figure 5 is a plan view of a modified form of luminous display device.

Figure 6 is a cross-sectional view taken substantially on the plane of line 6-6 of Figure 5.

Figure 7 is a cross-sectional view, similar to Figure 6, taken substantially on the plane of line 7-7 of Figure 5.

Figure 8 is a cross-sectional view of the device taken substantially on the plane of line 8-8 of Figure 5.

The luminous display device of the present invention consists briefly of a serial shifting register of the glow discharge type, such as is more fully disclosed in my copending applications aforesaid, and which has a gaseous discharge channel, see the cross-sectional view, Figure 3, of the drawings, made up of a plurality of longitudinally spaced luminous station cells 11, 12, 13, 14, 15, 16 and 17, and intermediate shifting cells 21, 22, 23, 24, 25 and 26 arranged to shift glow discharges between the station cells 11-17, the arrangement being particularly characterized in the forming of the station cells 11-17 of substan-

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tially enlarged size in respect to, and in comparison with, the shifting cells 21-26, whereby the station, or display, cells are brought closer together and provide maximum luminosity for improved resolution and display effect. This is here accomplished by making the gas discharge channel, as seen in Figure 3, of undulating cross section with wide and deep portions of the channel forming the display cells 11-17 and shallow and narrow portions of the channel forming the shifting cells 21-26. Where a three-line serial shifting register is used, as here proposed, the intermediate shifting cells are each divided into two shifting cells lying between each adjacent pair of display cells, and an electrode is associated with each of these cells. Thus, a plurality of electrodes 31, 32, 33, 34, 35, 36 and 37 are associated with the display cells 11-17 and, when energized, will sustain a discrete glow discharge in the display cells; and a plurality of electrodes 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51 and 52 are associated with the glow shifting cells 21-26, and are effective, when sequentially energized, to shift discrete glow discharges from display cell 11 through the intermediate shifting passage 21 to cell 12, and then through the intermediate shifting passage 22 to cell 13, and similarly through intermediate shifting passage 23 to cell 14, shifting passage 24 to cell 15, shifting passage 25 to cell 16, and finally through shifting passage 26 to cell 17.

Electrodes 31-37 and 41-52 are here energized with respect to a plurality of ground electrodes 56, 57, 58, 59, 60, 61, 62 and 63 so as to sustain localized discrete glow discharges within the several cells, the amount of excitation being kept below the breakdown voltage of the gas in the cells and above the extinction voltage of glow discharge so that the excitation is sufficient to sustain a glow discharge once introduced into the cells. Another phenomenon used in the shifting register technique is that of priming one cell adjacent to a cell containing a glow discharge. The glow discharge in one cell will effect a partial ionization in an adjacent cell sufficient to enable the operating voltage to produce a glow discharge in the adjacent cell when the operating voltage is applied. This characteristic enables a transfer of the glow discharge from one cell to an adjacent cell.

The foregoing is illustrated in Figure 3 of the drawings by glow areas marked *a*, *b* and *c*. On energizing of electrode 31, a large glow area *a* is produced due to the electric field established by electrode 31 and ground electrodes 56 and 57. The glow discharge in the main large display area *a*, will prime, so to speak, the adjacent glow area *b* immediately adjacent to electrode 41 at the shift passage 21. Thus if the operating voltage is turned off from electrode 31 and has theretofore been, or is immediately thereafter, turned on at electrode 41, the large glow discharge *a* will decay and disappear and a smaller glow discharge *b*, due to the electric field between electrode 41 and ground electrode 57, will appear. In a similar manner, glow discharge *b* will prime the adjacent transfer cell, represented here by glow discharge area *c*, so that upon turning off the operating voltage from electrode 41 and turning it on at electrode 42 the glow discharge will decay at area *b* and be transferred to, and established in, area *c* which is here the localized electric field between electrode 42 and ground electrode 57. In this manner, the glow discharge may be successively shifted from display cell 11 through the shifting passage 21 through area *c* at electrode 42 in position to prime the glow discharge in the next display cell 12. For convenience, the electrodes 31-37 may be connected to a common conductor, here marked V_a , for joint excitation; electrodes 41, 43, 45, 47, 49 and 51 may be connected by a common conductor, here denoted V_b , for common excitation; and electrodes 42, 44, 46, 48, 50 and 52 may be connected to a common conductor, here denoted V_c .

for common excitation. If then, the voltages V_a , V_b and V_c are sequentially applied, the glow or no-glow condition in each of the display cells 11-17 will be successively shifted to the right, as seen in Figure 3, that is, the glow or no-glow condition in cell 11 will be shifted to cell 12 and, similarly, the glow or no-glow condition in cell 12 will be shifted to cell 13, etc.

As will be observed from Figure 1, the device of the present invention is composed of a bank, or plurality, of shifting registers of the type above described, the particular arrangement, as here illustrated, being one having a bank of five parallel serial shifting registers, here denoted by numerals I, II, III, IV and V, each composed of seven display cells viz., cells 11-17 as above described.

As another feature of the present invention, the pattern of glows and no-glows to be introduced into the bank of shifting register I-V is here accomplished by the use of another serial shifting register of the glow discharge type having a glow servicing gaseous discharge channel 66 connected at longitudinally spaced positions to channels I-V, and which is provided with a plurality of electrodes 67 (see Fig. 3) arrayed along the servicing channel to sustain discrete glow discharges at, and for shifting such glow discharges between, the longitudinally spaced positions for establishing glow discharges in the channels I-V. A pair of glow starting electrodes 68 are provided at one end of the servicing channel 66 for initiating glow discharge therein, it being understood that glow discharges initiated by electrodes 68 may thereafter be shifted by the shifting register technique along channel 66 and into registration with the connecting ends of channels I-V for priming the first entrance cell, here identified as cell c, in a shifting passage 69 connecting the glow servicing channel 66 with the first display cell 11. As will be understood, a glow discharge may be set in display cell 11 by moving a glow discharge in channel 66 to passage 69 and then exciting electrode 70 associated with passage 69 at the cell 11 side of ground electrode 56. Electrode 70 is here connected to V_c so that the setting of the glow discharge c at electrode 70 will take place simultaneously with the transfer of the glow or no-glow discharge condition from the transfer passage 21 to glow area c associated with electrode 42. The foregoing arrangement thus provides for optionally shifting glow discharges from the glow servicing channel 66 through the several laterally extending channels 69 to the first cell of the bank of serial shifting registers I-V.

The several parts of the device are conveniently assembled within an envelope 72, preferably of glass, and containing an ionizable gas such as neon, at a pressure of approximately 15 mm. Hg. The several cells and channels are here formed by a grid composed of a plurality of elongated spaced metallic strips, heretofore denoted as ground electrodes 56-63, and a plurality of elongated spaced dielectric strips 73, 74, 75, 76, 77 and 78 which are mounted across the metallic strips and cooperate with one side 79 of the envelope to form a grid of luminous display cells as depicted by cells 11-17 in the several serial shifting registers I-V. The strips may be formed with interfitted recesses to afford an "egg-crate" type of assembly as here illustrated. The display electrodes 31-37 are here in the form of elongated metal strips which are mounted through aligned openings in the dielectric members 73-78 between and substantially parallel to the ground electrodes 56-63.

The several shifting passages 21-26 and 69 are here formed by openings through the metal strips 56-63 to thus establish the several rows of gaseous discharge channels I-V between the several dielectric strips 73-78. A base member 82 of dielectric material is here mounted under the metallic and dielectric strips to provide a support for the electrodes 41-52 and 70, as well as to assist in part in the definition of the glow servicing channel 66. The glow shifting electrodes for each of the cells in each of the bank of registers I-V, being electrodes 41, 43, 45,

47, 49, and 51 in each of the banks, are connected together by conductors 86, 87, 88, 89, 91 and 92 within the envelope to a common conductor brought out of the envelope and identified as V_b . In a similar manner all of the other glow shifting electrodes, being electrodes 42, 44, 46, 48, 50, 52 and 70, for all of the bank of registers I-V are connected by conductors 96, 97, 98, 99, 100, 101 and 102 within the envelope to a common conductor which is brought out of the envelope as conductor V_c as above explained.

The glow servicing channel 66 is here formed by the mounting within the envelope 72 between an end wall 106 and the ground electrode 56, an elongated member 107 of dielectric material which is spaced from the underlying portion 108 of the base member 82 so as to define the open channel 66 which is thus bounded by the end wall 106, member 107, electrode strip 56, and portion 108 of the base member. Communication between the glow servicing channel 66 and the first cell 11 of each of the bank of registers I-V is here effected by the series of openings 69 provided in longitudinally spaced relation in the elongated strip 56. The electrodes 67 for this auxiliary shifting register channel 66 may be mounted exteriorly of the envelope on the end wall 106, as here shown, and these electrodes may be connected by conductors 111, 112 and 113 to excitation voltages denoted as A, B and C in conformity with the three-line serial shifting register practice as above explained. The excitation voltages A, B and C and V_a , V_b , and V_c are derived from R.-F. generators, preferably having a frequency in the order of 20 to 25 megacycles per second and a magnitude of up to 150 volts R.M.S.

A modified form of the invention is illustrated in Figures 5 to 8 of the drawings wherein a whole display pattern may be fed into one or a plurality of shifting registers and then transferred en masse into a plurality of display cells, where the visual pattern may be held as long as desired, and while another whole pattern may be shifted into the device for similar subsequent showing. This device consists, briefly, of a serial shifting register, including gaseous discharge channel 116, as seen in Figure 6, and electrodes 117 arrayed along the channel to sustain and shift discrete glow discharges at and between longitudinally spaced cells in the channel opposite every third electrode, as obtained in a three-line serial shifting register, it being noted that electrodes 117 are here connected to operating voltages A, B and C as above explained. Means are provided at each of these cells for affording laterally extending gaseous discharge channels 121, 122, 123, 124, 125, 126 and 127 formed with luminous display cells 131, 132, 133, 134, 135, 136 and 137, and electrodes are associated with these laterally extending channels and display cells for optionally shifting glow discharges from channel 116 to the display cells 131-137, and vice versa.

The device illustrated in Figures 5 to 8 is here constructed, as in the preferred embodiment, to provide a bank or grid of display cells such as the 5 x 7 grid here depicted. This grid is mounted within an envelope 141 containing ionizable gas, as in the first embodiment, and is here supported on an internal dielectric partition member 142. The grid, similar to the first embodiment, is composed of a plurality of metallic strips 146, 147, 148, 149, 150, 151, 152 and 153 (see Fig. 7) and a plurality of elongated spaced dielectric strips 156, 157, 158, 159, 160 and 161 (see Fig. 8) mounted across the metallic strips to form rows I, II, III, IV and V of luminous display cells 131-137 (see Fig. 6), which are capable on excitation of the metallic strips 146-153 to sustain glow discharges. The under side of the partition 142 is formed with a plurality of gaseous discharge channels 116 which run parallel to the rows I-V, and the partition member is formed with openings (providing the lateral channels 121-127) at each of the display cells connecting the display cells in all of the rows I-V with

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the underlying shift register channels 116. As will be observed, the display cells are bounded on opposite sides by the metallic electrode strips 146-153 and excitation for the cells may be provided by connecting the strips 146-153 to two phase R.-F. voltage of the magnitude and frequency hereinabove noted. Every second strip 146, 148, 150 and 152 is connected within the envelope to a common conductor 164 which is brought out of the envelope for connection to an R.-F. voltage source, here denoted e_a . In a similar manner, electrodes 147, 149, 151 and 153 are connected within the envelope to a common conductor 165 which is brought out of the envelope for connection to R.-F. voltage source e_b . R.-F. voltages e_a and e_b thus energize all of the display cells 131-137 (Fig. 6) for sustaining glow discharges when introduced through transfer channels 121-127. To effect this transfer, a series of electrodes 171, 172, 173, 174, 175, 176 and 177 are mounted at each of the transfer openings of channels 121-127 for shifting glow discharges from the underlying shift register channels 116. All of the electrodes 171-177 may be connected together, as here illustrated, within the envelope 141, and brought out by way of conductor 180 for connection to an R.-F. generator supplying an operating voltage of the magnitude and frequency above discussed. Each of the shift register channels 116 is provided at one end with a glow setting electrode 181 which may be energized at a potential over breakdown voltage (with respect to ground electrode 182) for introducing glow discharges into the shift register channels.

The transfer electrodes 117 for the several channels 116 of the serial shifting registers may be mounted on the outside of the envelope opposite the channels, and since the channels are in spaced parallel relation, the electrodes 117 may be conveniently formed as elongated strips set perpendicular to the channels so that the several electrodes 117 extend across all of the channels 116. To cooperate with these electrodes in establishing localized electric fields to sustain and shift discrete glow discharges, there is provided in the partition member 142 at each of the channels 116 an elongated ground electrode 182.

The operation of the form of device illustrated in Figures 5 to 8 may be briefly summarized as follows. A glow, no-glow, discharge pattern is fed into the channels 116 of each of the serial shifting registers I-V by conventional shift-register practice, thus disposing a desired glow or no-glow at each of the transfer channels 121-127 at each of the display cells 131-137 of each of the row or bank of cells I-V. R.-F. excitation is then applied to metallic electrode strips 146-153. The glow or no-glow pattern then in the shift registers may be transferred en masse to the display cells by momentarily energizing the transfer electrodes 171-177. The visual pattern thus brought into view may then be held while another full visual pattern is fed into the serial shifting registers for subsequent transfer to the display cells, or the pattern in the display cells may be transferred back to the underlying serial shifting registers as may be desired.

A phosphor coating may be applied to the under side of the glass envelope at the display cells in both of the above described embodiments to intensify the luminosity and afford a more uniform appearance.

I claim:

1. A luminous display device comprising, an envelope, an ionizable gas therein, a plurality of elongated spaced metallic strips mounted in said envelope, a plurality of elongated spaced dielectric strips mounted across said metallic strips to form a grid of luminous display cells, certain of said metallic strips being formed with openings connecting adjacent cells, and electrodes mounted at said openings for shifting glow discharges from one to another of said cells.

2. A luminous display device comprising, an envelope,

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an ionizable gas therein, a plurality of elongated spaced metallic strips mounted in said envelope, a plurality of elongated spaced dielectric strips mounted across said metallic strips to form a grid of luminous display cells, said metallic strips being formed with openings connecting said cells in rows of gaseous discharge channels between said dielectric strips, and electrodes mounted at said openings for shifting glow discharges along said channels from one to another of said cells.

3. A luminous display device as characterized in claim 2 and including a serial shifting register of the multiple position glow discharge type having a glow servicing gaseous discharge channel connected at longitudinally spaced positions to said first named discharge channels for introducing glow discharges therein.

4. A luminous display device comprising, an envelope having a light transmitting side, an ionizable gas therein, a grid mounted in said envelope at said side and composed of a plurality of elongated spaced metallic strips and a plurality of elongated spaced dielectric strips mounted across said metallic strips and cooperating with said side to form a grid of luminous display cells, electrodes mounted within said cells cooperating with said metallic strips when energized to sustain a glow discharge in said cells, said metallic strips being formed with openings connecting cells in rows of gaseous discharge channels between said dielectric strips, and electrodes mounted at said openings and cooperating with said metallic strips when energized for shifting glow discharges along said channels from one to another of said cells.

5. A luminous display device as characterized in claim 4, including a member mounted in spaced substantially parallel relation to one of said metallic strips to define a glow servicing channel, and electrodes arrayed along said servicing channels to sustain and shift discrete glow discharges at and between longitudinally spaced positions generally registering with the openings in said last mentioned metallic strip for introducing glow discharges into said first named channels.

6. In a device of the character described, a serial shifting register of the multiple position glow discharge type and including a gaseous discharge channel and electrodes arrayed therealong to sustain and shift discrete glow discharges at and between longitudinally spaced cells in said channel, means at said cells providing connecting and laterally extending gaseous discharge channels formed with luminous display cells, and electrodes associated with said laterally extending channels and display cells for optionally shifting glow discharges from said first named cells to said display cells.

7. A luminous display device comprising, an envelope, an ionizable gas therein, a dielectric partition in said envelope, a grid mounted in said envelope on one side of said partition and composed of a plurality of elongated spaced dielectric strips mounted across a plurality of elongated spaced metallic strips to form rows of luminous display cells arranged on excitation of said metallic strips to sustain glow discharges, means at the opposite side of said partition providing gaseous discharge channels parallel to said rows, said partition being formed with openings connecting said channels and cells, electrodes arrayed along said channels to sustain and shift discrete glow discharges at and between longitudinally spaced positions at said openings, and electrodes at said openings for shifting glow discharges from said channels to cells.

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