Feb. 16, 1960 D. C. ENGELBART 2,925,530

LUMINOUS DISPLAY DEVICE

Filed Nov. 28, 1956 2 Sheets-Sheet 1

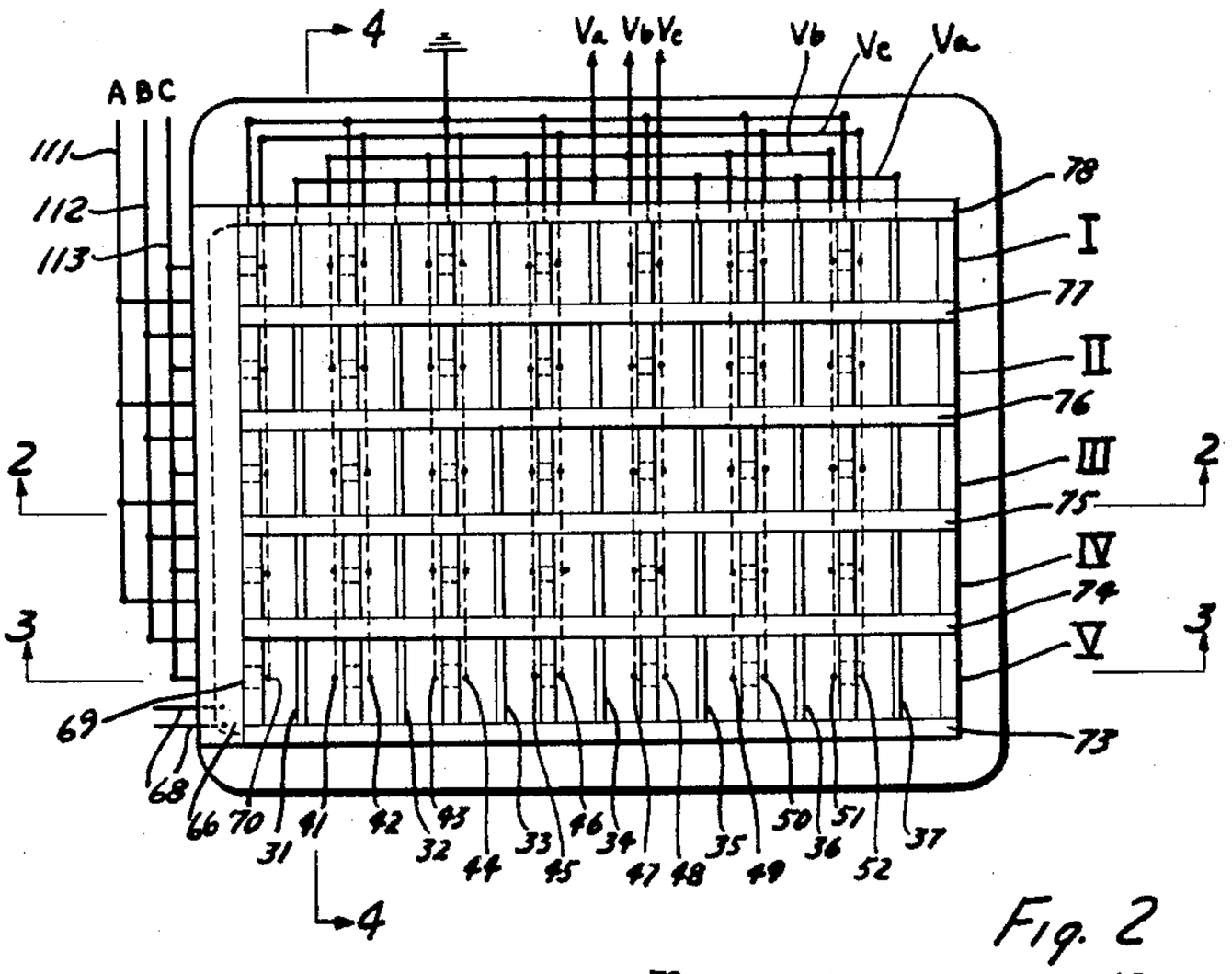
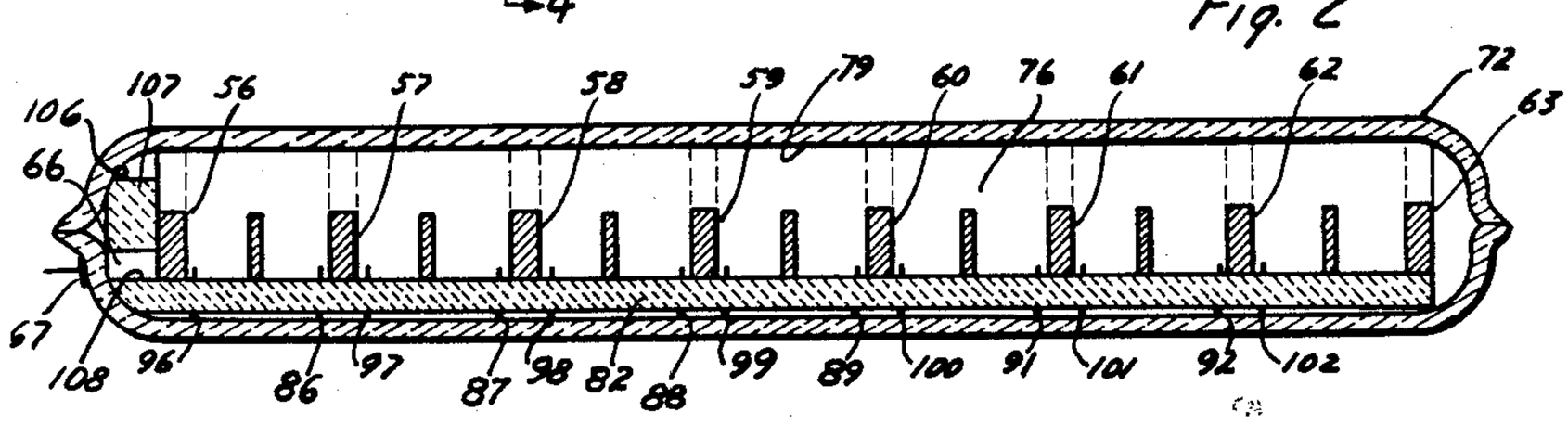


Fig. 1

Fig. 2



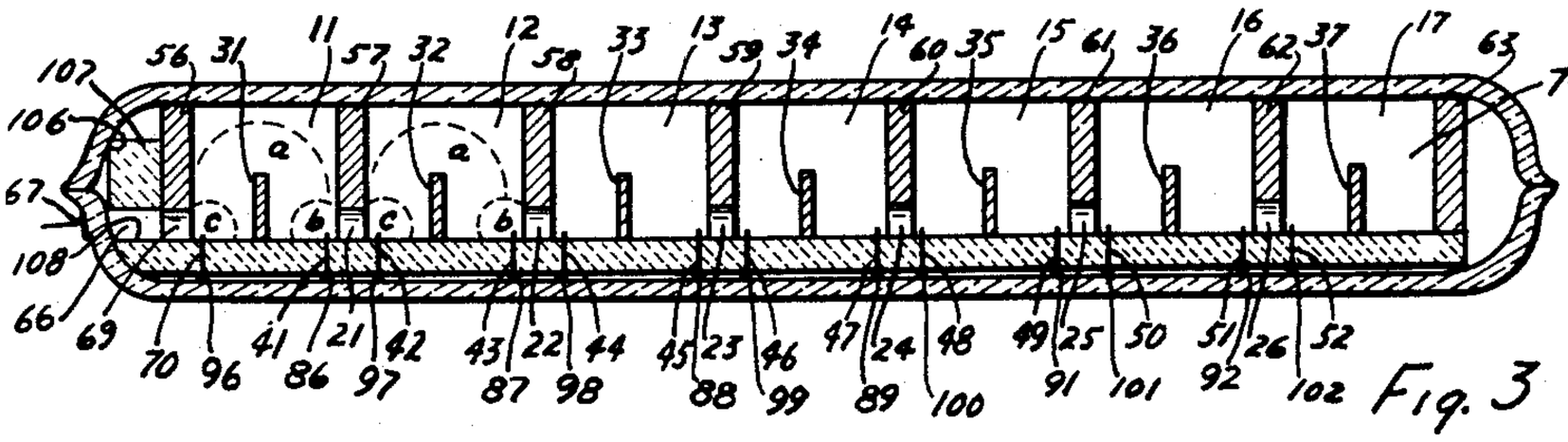


Fig. 3

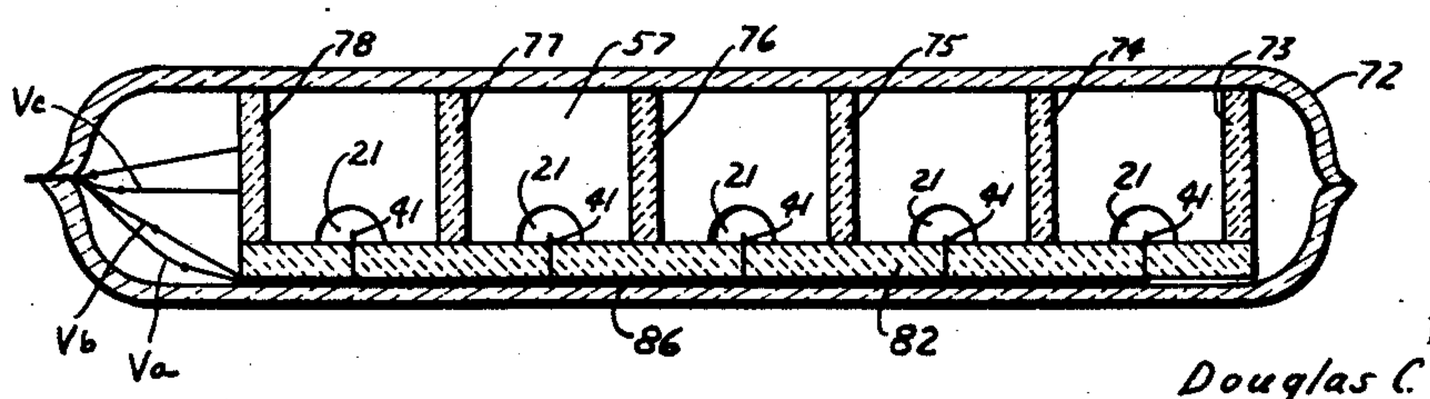


Fig. 4

INVENTOR.
Douglas C. Engelbart
BY Manfred M. Warren
His attorney

Feb. 16, 1960 D. C. ENGELBART 2,925,530

LUMINOUS DISPLAY DEVICE

Filed Nov. 28, 1956 2 Sheets-Sheet 2

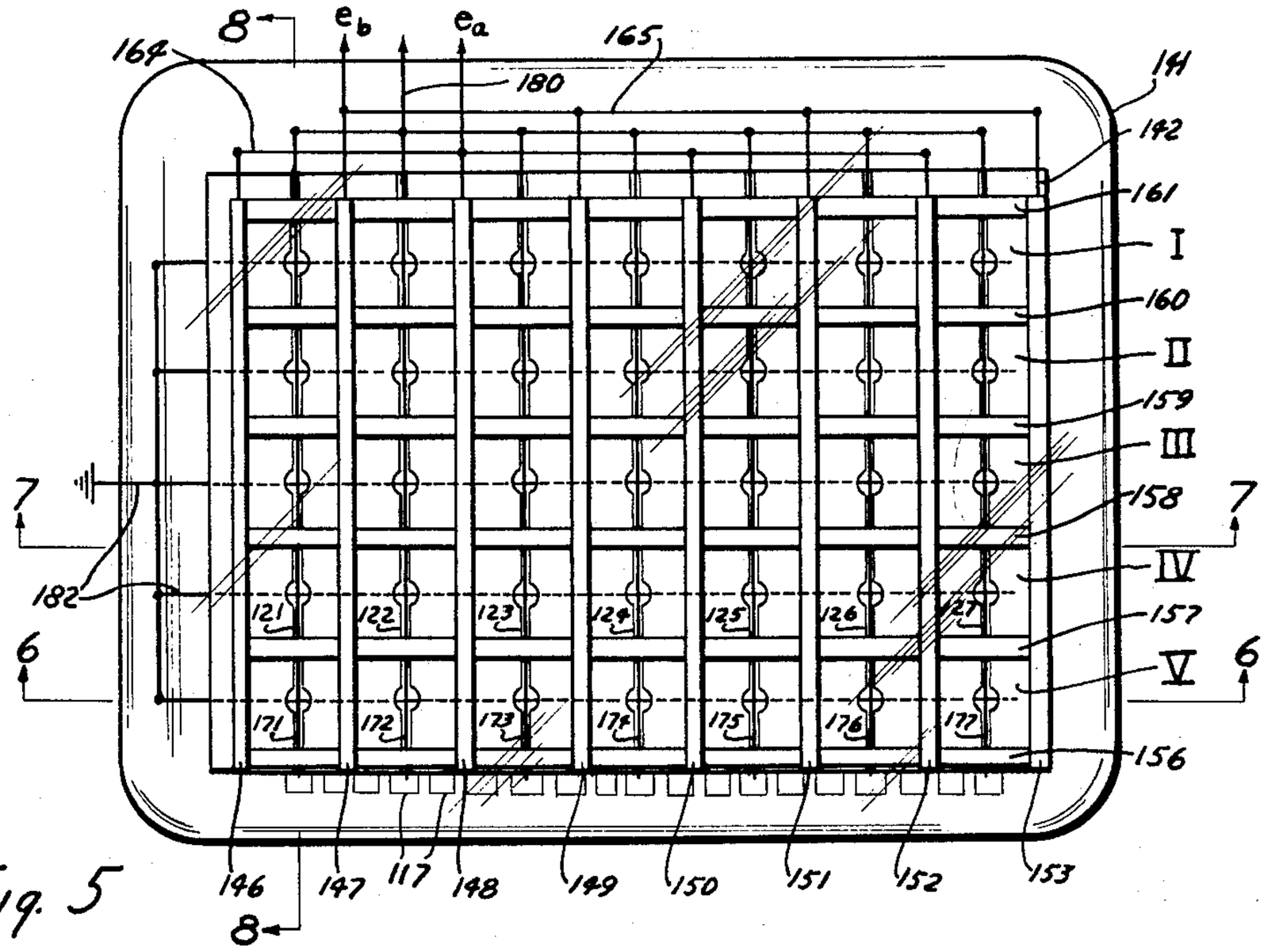


Fig. 5

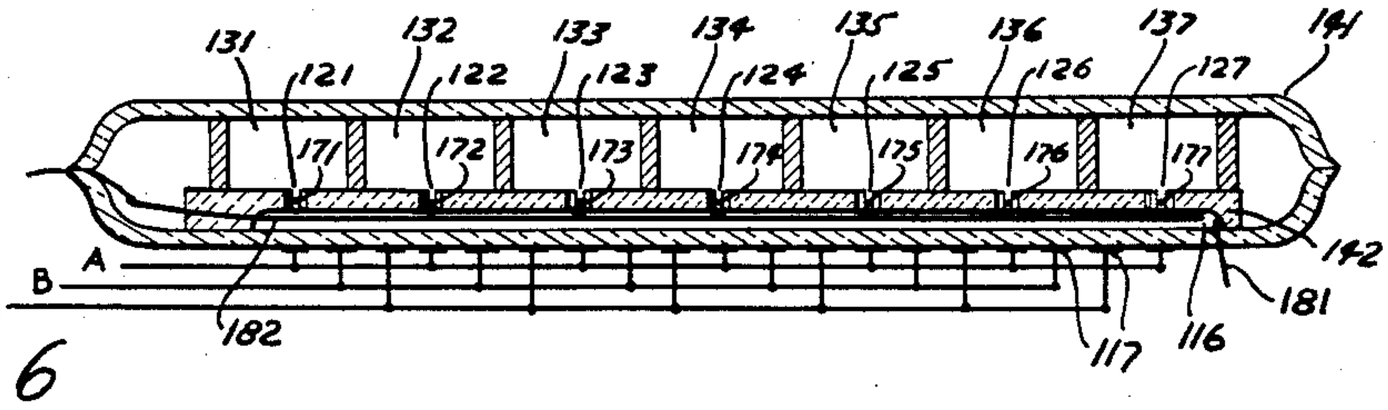


Fig. 6

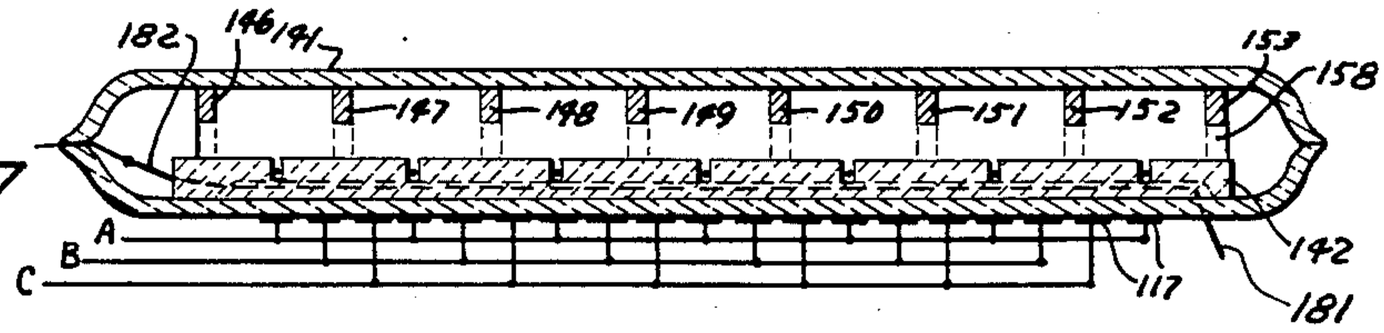


Fig. 7

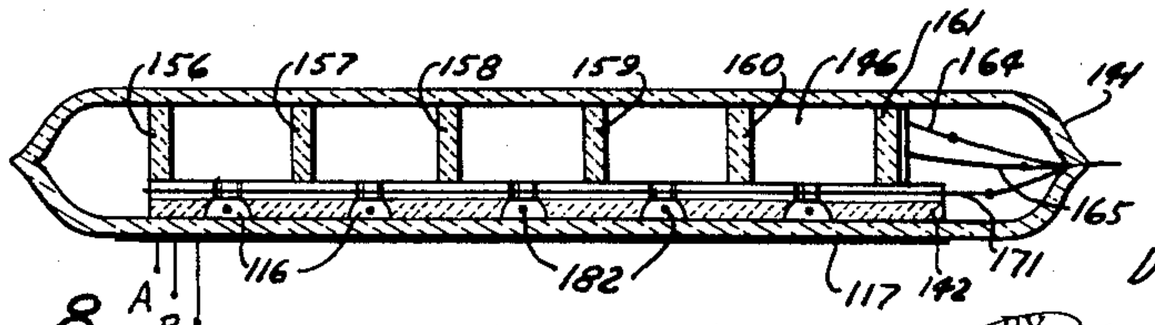


Fig. 8

INVENTOR.
Douglas C. Engelbart
BY Manfred M. Warren
His Attorney

United States Patent Office

2,925,530

Patented Feb. 16, 1960

2,925,530

LUMINOUS DISPLAY DEVICE

Douglas C. Engelbart, Oakland, Calif., assignor to Digital Techniques, Inc., Berkeley, Calif., a corporation of California

Application November 28, 1956, Serial No. 624,799

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 Dicharge 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 substantially 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 interfitting 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

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 connecton 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 underyling 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 relat'on, 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, 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 arraved 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.

References Cited in the file of this patent

UNITED STATES PATENTS

2,500,929	Chilowsky	Mar. 21, 1950
2,558,019	Toulon	June 26, 1951
2,749,480	Ruderfer	June 5, 1956
2,760,119	Toulon	Aug. 21, 1956