United States Patent [19]

Purchase

[11] **3,812,486**

[45] **May 21, 1974**

[54] **DISPLAY HAVING A PHOTOCONDUCTOR GAS DISCHARGE CONTROL**

[75] Inventor: **F. Jack Purchase,** Kitchener, Ontario, Canada

[73] Assignee: **Antolelic Industries, Ltd.,** Fort Erie, Ontario, Canada

[22] Filed: **Apr. 18, 1972**

[21] Appl. No.: **245,099**

[52] **U.S. Cl.** .... **340/324 M,** 315/169 TV, 340/173 PL

[51] **Int. Cl.** **G09f 13/26**

[58] **Field of Search** .... 340/324 R, 324 M, 336, 340/173 PL; 315/169 R, 169 TV; 178/30

[56] **References Cited**

UNITED STATES PATENTS

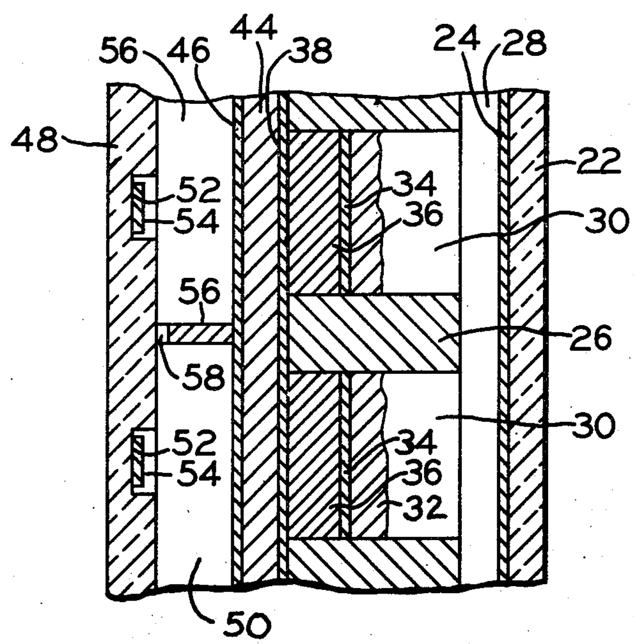
3,683,358	8/1972	Eichelberger	315/169 TV
3,122,734	2/1964	Rice	340/336
3,611,891	10/1971	McNaney	340/324 M
3,388,292	6/1968	Burns	340/324 M
3,689,910	9/1972	Glaser	340/324 M

Primary Examiner—John W. Caldwell
Assistant Examiner—Marshall M. Curtis
Attorney, Agent, or Firm—John A. Young, Esquire

[57] **ABSTRACT**

A display device of the plasma discharge type is provided with photoconductive control elements which are selectively illuminated by light bars extending angularly to electrodes which are connected to the photoconductive elements. Time related signals are employed for sequentially establishing the light bars and for supplying signals to the electrodes. Each photoconductive element is connected in controlling relation to a respective metallic member forming one signal emitting region of a basic display area which might comprise, for example, five adjacent columns of signal emitting regions with seven of the regions in each column and arranged in aligned rows.

35 Claims, 13 Drawing Figures



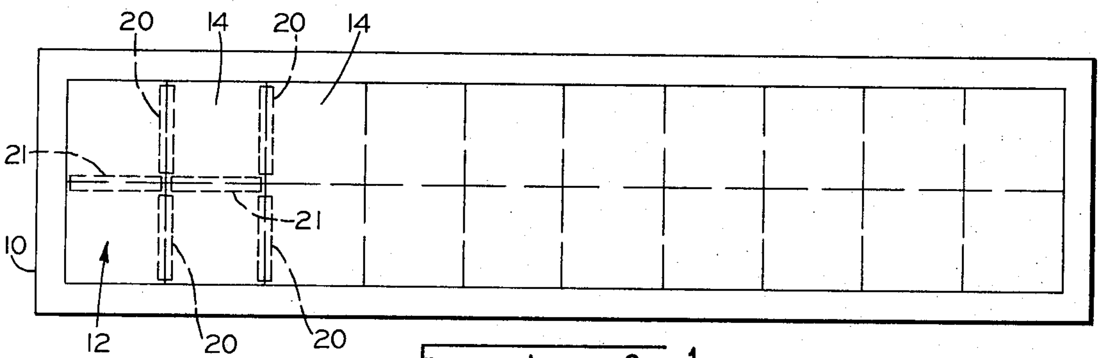


FIG. 1

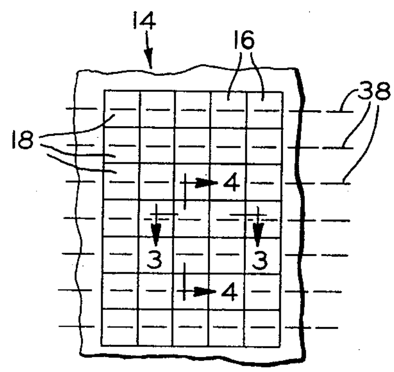


FIG. 2

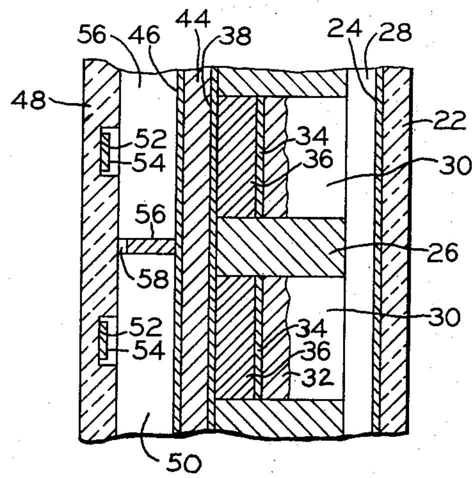


FIG. 3

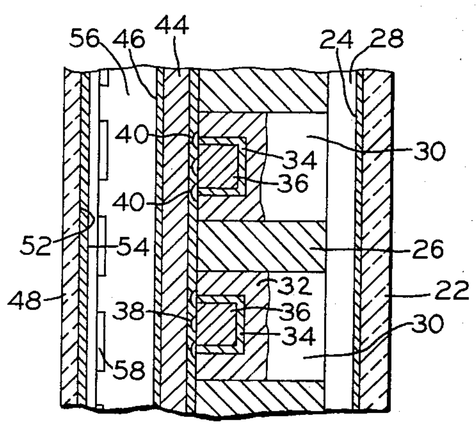


FIG. 4

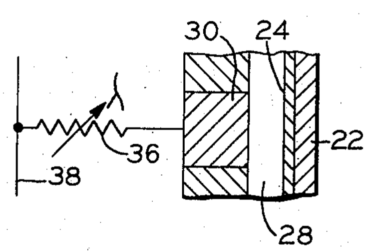


FIG. 5

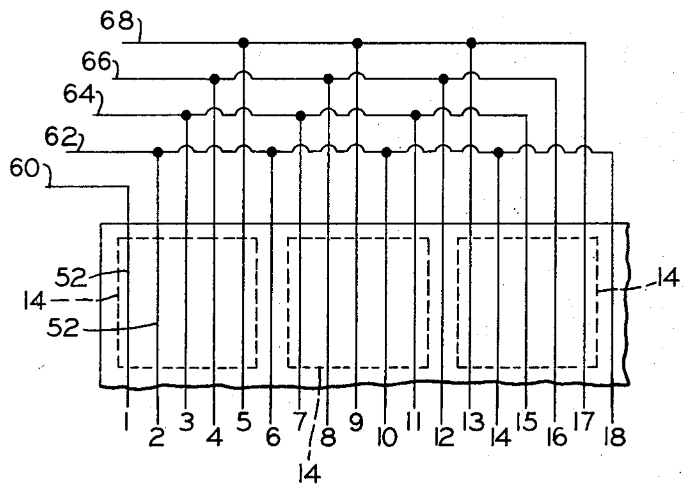


FIG. 6

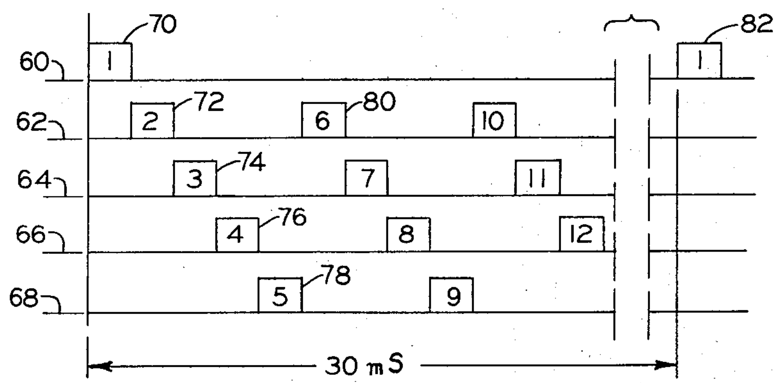


FIG. 7

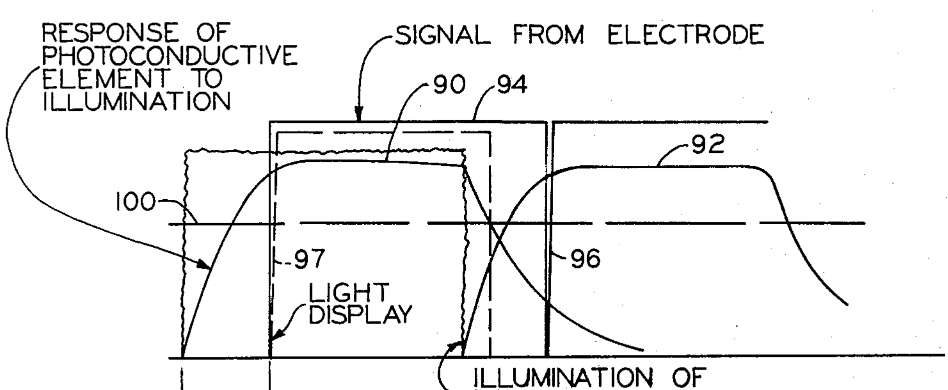


FIG. 8

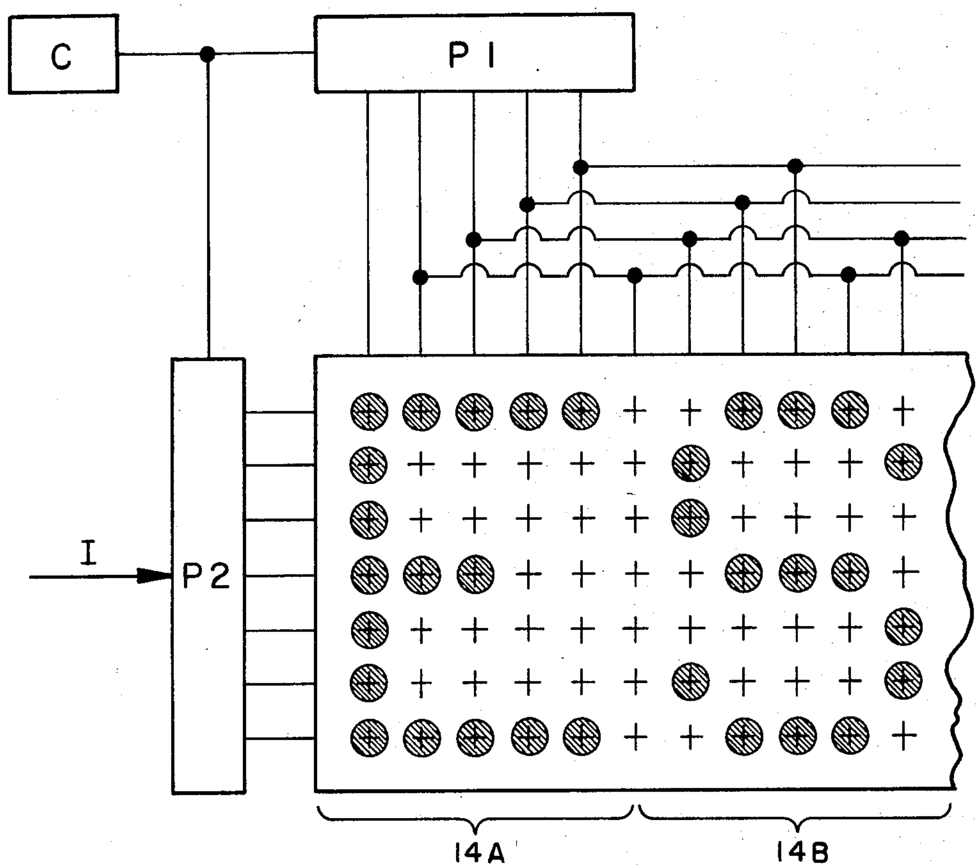
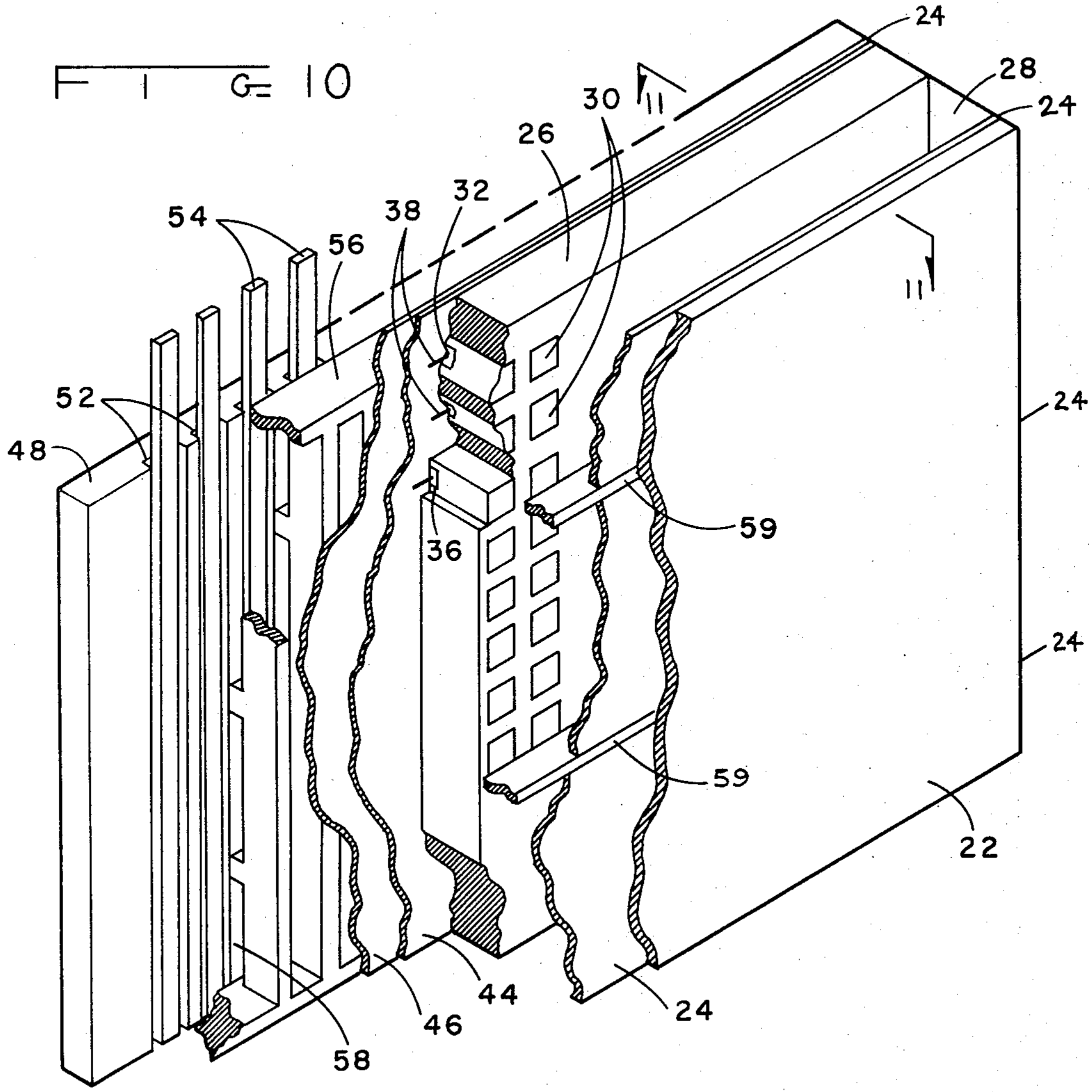


FIG. 9

FIG. 10


24
28
24
30
11
26
32
54
56
38
52
48
36
11
24
59
24
59
22
44
46
24
58

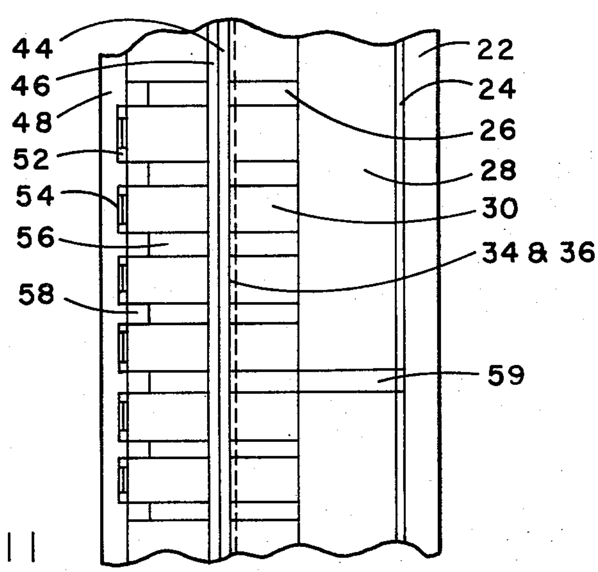

44
46
48
52
54
56
58
22
24
26
28
30
34 & 36
59

FIG. 11

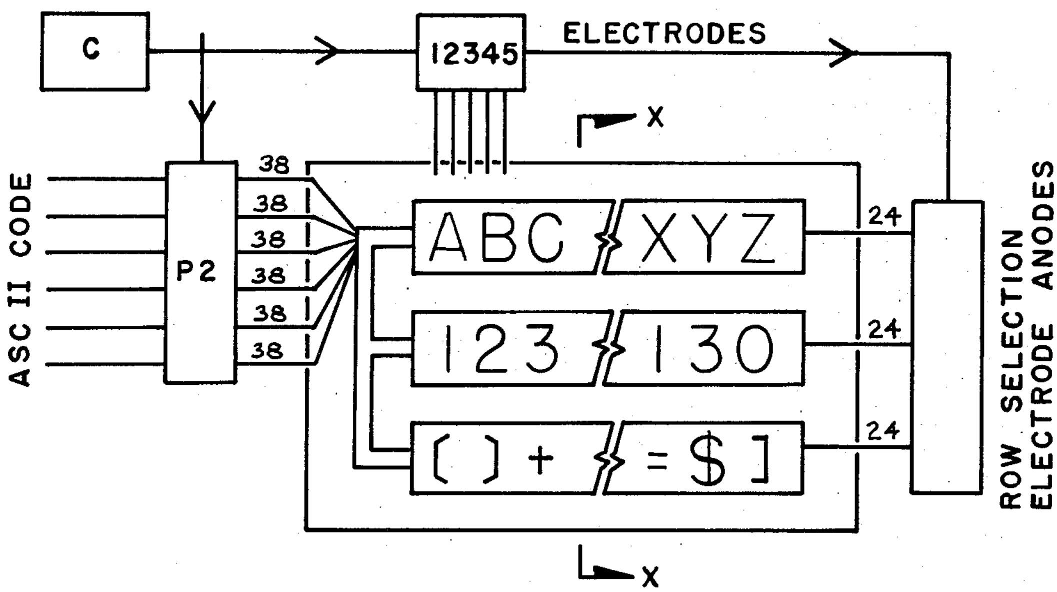

C
12345
ELECTRODES
X
ASC II CODE
P2
38
38
38
38
38
38
38
ABC
XYZ
123
130
[ ] +
= $]
24
24
24
ROW SELECTION ELECTRODE ANODES
X

FIG. 12

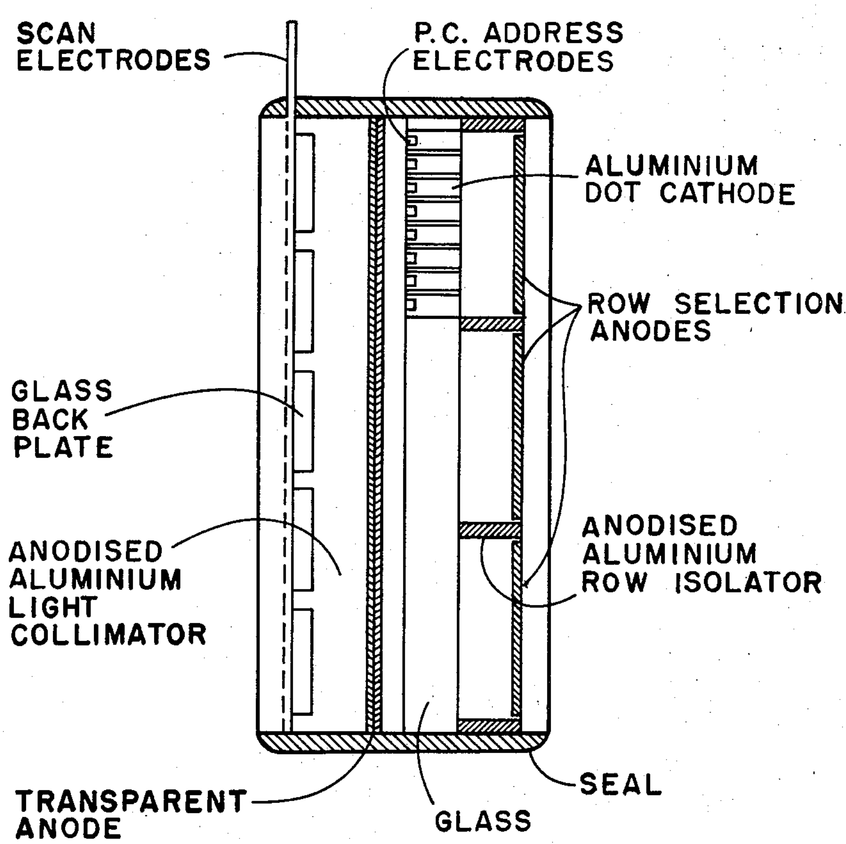

SCAN ELECTRODES
P.C. ADDRESS ELECTRODES
ALUMINIUM DOT CATHODE
ROW SELECTION ANODES
GLASS BACK PLATE
ANODISED ALUMINIUM LIGHT COLLIMATOR
ANODISED ALUMINIUM ROW ISOLATOR
TRANSPARENT ANODE
GLASS
SEAL

FIG. 13

DISPLAY HAVING A PHOTOCONDUCTOR GAS DISCHARGE CONTROL

The present invention relates to display devices and is particularly concerned with display devices which produce detectable signals, especially in the form of a luminous display in response to the supply of electrical signals to the device.

Display devices of the general nature with which the present invention is concerned are widely used in connection with displaying information, not only in the form of characters such as letters and numbers and symbols, but also in the form of graph lines and the like. Such devices, generally, are well known and are employed in many instances, such as in connection with advertising displays, information displays, computer readouts, calculator numerical displays, and in display devices, such as cathode ray tubes, which can display continuous functions. The display devices which display letters and numbers and symbols can operate in a digital mode while cathode ray tubes which display continuous functions operate in an analogue mode.

Heretofore, display devices have exhibited serious drawbacks in respect of cost, complexity, bulk, reliability, and/or weight. Furthermore, heretofore known display devices have sometimes been severely limited with regard to sharpness of the displayed information or in speed of response to applied signals or have required extremely extensive external circuitry in order to achieve the desired results.

With the foregoing in mind, a primary objective of the present invention is the provision of a display device of the nature referred to which will overcome the above enumerated deficiencies that have been present in heretofore known display devices.

Another object of the present invention is to make a display device which is quite light and which is not bulky.

Still another object of the present invention is the provision of a display device in which the external circuitry required for the operation of the device is kept at a minimum.

Still another object of the invention is the provision of a display device which has a wide range of application.

A particular object of the invention is the provision of a display device of the nature referred to which can be operated directly from a computer output with a minimum of intervening circuitry.

A still further object is the provision of a display device which requires a minimum of terminals for the display of information.

The foregoing objects as well as other objects and advantages of the present invention, will become more apparent upon reference to the following detailed description, taken in connection with the accompanying drawings, in which:

FIG. **1** is a schematic elevational view showing one form which a display device according to the present invention can take.

FIG. **2** is an elevational view of a portion of FIG. **1** and drawn at enlarged scale.

FIG. **3** is a plan sectional view taken on line III—III of FIG. **2** and drawn at an enlarged scale.

FIG. **4** is a vertical sectional view taken on line IV—IV of FIG. **2** and drawn at an enlarged scale.

FIG. **5** is a schematic view showing the electrical characteristics of a portion of the device.

FIG. **6** is a schematic view showing the electrical connections pertaining to a portion of the device.

FIG. **7** is a chart showing the sequence in which pulses are supplied to the terminals illustrated in FIG. **6.**

FIG. **8** is a schematic view showing correlation of signals in the device.

FIG. **9** is a schematic showing of a simple display.

FIG. **10** is an isometric view of the display device with portions broken away to illustrate the various matrix components.

FIG. **11** is an enlarged fragmentary sectional veiw taken on line **11—11** of FIG. **10.**

FIG. **12** illustrates a plurality of the display device shown interconnected by a multiplexing arrangement, wherein the economy of input wires is demonstrated.

FIG. **13** is a section view taken on line **13—13** of FIG. **12.**

BRIEF SUMMARY OF THE INVENTION

According to the present invention, a basic display area is provided consisting of a matrix of display regions, or dots, which is five dots wide and seven dots high and information is caused to be displayed thereon by controlling the illumination of the dots of the basic display area. The basic display areas can be combined in multiple with a single character being developed on each area or continuous functions can be displayed utilizing adjoining groups of areas.

Each dot is in the form of a metallic element spaced rearwardly from a glass panel having a transparent conductive coating, such as tin oxide, on the side facing the element. The space between the elements and the oxide coating contains a luminiscent gas, such as neon gas, with traces of ionizing material therein. When sufficient current flows between an element and the tin oxide film on the glass, the gas will glow at the end of the element facing the oxide coating.

As mentioned, the dots and, therefore, the metallic elements are arranged in vertical columns with seven elements in each column and with five columns in side by side relation to make up a basic display area.

Behind each column of elements is an arrangement for creating an image consisting of a bar of light which will impinge on the ends of the column of elements which face away from the aforementioned tin oxide film. Each arrangement for creating the bar of light consists of a metallic strip spaced from the column of elements. Immediately at the rear of the basic display area is another sheet of glass and on the side thereof facing away from the elements is a further transparent conductive coating which also consists of tin oxide.

The space between this last mentioned coating and the vertical metallic strips behind the column of elements is also filled with a gas which may be of the same nature as referred to above so that upon the development of a predetermined voltage between a metal strip and the last mentioned tin oxide film electrode, the gas in front of the strip will become luminescent and create vertically elongated beam-of-light which will impinge on the ends of the said elements facing the metallic strips.

Strips of opaque and electrically inert material, the as anodized aluminum, are arranged between adjacent ones of the metallic strips and extend forwardly there-from to said sheet of glass so that the beam of light pertaining to each strip falls on the ends of the elements of only a single column thereof.

According to the present invention, the ionized cloud of gas in the vicinity of a metal strip that has been energized is availed of for assisting in the ignition of the gas pertaining to the next adjacent metal strip by providing the shielding anodized aluminum strips with apertures or notches at the edges thereof nearest the metallic strips.

The illumination of the ends of the metallic elements which face the metallic strips is availed of for obtaining a highly desirable end result, especially with regard to the sharpness of the display and to the simplicity of control of the device. More specifically, the end of each element facing the metallic strip, namely, the back end of each element, is provided with a recess and mounted in the recess is a body of photoconductive material. The photoconductive material is fully insulated from the confining walls of the recess in which it is mounted and is connected at the side edges to the rear end of the respective element.

Electrodes extending transversely of the display area extend over the photoconductive members pertaining to the corresponding elements in each column thereof and are connected to the pertaining horizontal row of photoconductive members in about the center of the face of the photoconductive member which faces the above mentioned metal strips.

It is between the last mentioned electrodes and the tin oxide film on the back of the first mentioned glass that the voltage is developed which will cause the front end of a metal element to glow due to ionization of the gas adjacent thereto. However, if the photoconductive member pertaining to a respective metal element is dark, there is a high resistance interposed between the electrode and the metal element and there will not be sufficient voltage gradient between the front end of the element and the opposed tin oxide coating to cause the gas to ionize. If, on the other hand, the photoconductive member is illuminated, the resistance interposed between the electrode and the metal element, is sharply reduced and the front end of the element will be able to cause ionization of the gas and the development of a dot of light.

From the foregoing, it will be perceived that with the light beam creating metal strips disposed behind vertical columns of the metal elements making up the dots, and with the electrodes extending horizontally between the metallic elements making up the dots, a matrix arrangement is established which permits selective illumination, or activation, of the dots by the supply of a minimal number of time related signals.

It has been mentioned that the device provides an illuminated display, but it will be apparent that the front ends of the metal elements forming the dots of the device can themselves form signal emitters rather than ionizing a gas for display purposes.

The glass panel referred to disposed forwardly of the vertical metallic strips can be dispensed with by forming on the back of the panel which carries the metallic elements an insulating layer and an anode layer for cooperation with the metallic strips.

Also, while a basic display area is made up of five columns of display regions with seven regions in each column, whenever a group of basic display areas are combined in a display device, an extra column of regions is provided beween each pair of display areas in side by side relation and an extra row of regions is provided between each pair of display areas which are in adjacent vertical alignment. Such exta regions are not employed when displaying characters, such as letters or numbers, but are used when displaying continuous functions.

DETAILED DESCRIPTION OF THE INVENTION:

Referring to the drawings somewhat more in detail, FIG. 1 schematically indicates a device according to the present invention consisting of a frame **10** having an overall, or basic, display area **12** divided into a plurality of individual areas **14**. Each basic display area is adapted to develop a respective character, such as a letter, or number, or symbol. Each of the areas **14** will be seen in FIG. 2 to consist of a field of dots, or regions, consisting of five adjacent vertical rows **16** with the dots in the vertical rows laterally aligned and making up seven horizontal rows **18**.

In actual practice, adjacent ones of the areas **14** are separated from each other by spaces **20** and **21** which consists of columns and rows of dots but which remain idle during the formation of individual characters in the areas **14**. The spaces **20** and **21** are employed for continuous displays such as for displaying graph lines extending over more than one of the basic display areas **14**.

The construction of representative dots of a respective display area is disclosed more in detail in FIGS. 3 and 4 which are horizontal and vertical sections respectively taken through a pair of adjacent dots of a display area.

As will be seen in FIG. 4, the front side of the device and which is the side of the device which is viewed, comprises a glass panel **22** having on the back thereof a thin coating **24** which is transparent and which is also electrically conductive. Such a coating could, for example, be formed of tin oxide.

Spaced from panel **22** on the coated side is a plate **26** which may be of glass or a plastic material and which is nonconductive and opaque and which has the character of minimum gasing and decomposition in the presence of high velocity gas ions. The space between plate **26** and tin oxide coating **24** is filled with a gas **28** which advantageously contains, according to known practices, neon and at least a trace of an ionizing agent so that upon the development of a predetermined voltage gradient in the gas, the gas will ionize and glow.

Sealing mounted in plate **26** in distributed relation are metal elements or plugs **30** forming the dots of the respective display area. An end of each metal element is exposed on each side of plate **26**. Each of the metal elements **30** has a recess **32** formed in the rear end thereof and which is lined with insulating material **34**. If metal elements **30** are formed of aluminum, insulation **34** can take the form of anodizing.

Mounted in each recess **32**, and insulated from the respective metal elements by electrical insulating layer **34**, is a photoconductive member **36**. Extending laterally across the backs of elements **30**, and indicated by dashed lines in FIG. 2 are electrodes **38** which are connected to the photoconductive members in a respective horizontal row about the centers thereof.

As will be seen in FIG. 5, each photoconductive member **36** is also connected to the rearwardly facing end of the respective element **30** as by the connections **40** located at the side edges of the photoconductive member. Both electrodes **38** and connections **40** can be vapor deposited, or plated on.

Immediately behind panel **26** is another glass plate **44** having a transparent electrical conductive film, such as tin oxide, thereon as indicated at **46.** Spaced rearwardly from plate **46** is a back panel **48,** glass, for example, and contained in space **50** between plates **44** and **48** is an ionizable gas, such as neon, as referred to previously in connection with space **28.**

Plate **48** is provided with vertically extending grooves **52** in fore and aft alignment with each column **16.** Disposed in each groove is a metallic strip **54,** preferably of stainless steel.

Extending between plates **44** and **48** between adjacent columns of the elements **30** are the opaque electrically inert divider strips **56** which may consist of anodized aluminum and which are provided with notches **58** along the edges nearest plate **48.**

The material from which the photoconductive bodies **36** is formed is a highly sensitive photoconductive material of a novel nature. This is a polycrystalline material with the crystals suspended in a transparent plastic matrix in sufficient density to form a continuous phase in the body so that upon illumination of the body the crystals will conduct. The individual crystals are formed of cadmium and selenium with a doping agent, for example, in the form of copper or chlorine included. The reference to cadmium selenide is for purposes of illustration only and is not intended to be limitative of the invention. The invention further contemplates usage of a thin film material, either polycrystalline or monocrystalline and the thin film can be sputter deposited. All of these variations are within the scope of the present invention. The film can be also epitaxially grown on a substrate. These additional embodiments will contribute to the speed of response of the conductors thus making either an increase in resolution or size of the display. The material is prepared in a careful manner in a controlled atmosphere to control the antidoping action of hydrogen and oxygen.

The photoconductive material described above is extremely sensitive to light and is quite rapid in respect of reaction to illumination, and can have a ratio of 200:1 in conductivity between illuminated and dark conditions. The material is readily machinable and the transparent plastic as for example an epoxy resin, matrix forms a sealant so that no particular precautions are required in establishing the environment in which the material is to operate.

The function of the photoconductive material is to permit selective actuation of the elements **30.** FIG. **5** schematically illustrates the manner in which each photoconductive member **36** cooperates with the respective metal element **30** during operation of the device. In FIG. **5,** if a potential is developed between an electrode **38** and tin oxide layer **24** on the back of the front glass panel **22,** if the photoconductive member **36** is dark and the resistance is extremely high, there will be no glow at the forward end of the respective element **30.**

However, under the same conditions of applied potential, if photoconductive element **36** is illuminated, the resistance between electrode **38** and element **30** drops sharply and sufficient power can be supplied to element **30** to create ionization of gas at the front end thereof which will create the desired glow.

The unit which has been described above is sealed about the entire periphery and the gas spaces **56** and **28** are preferably sealed off from each other. The terminals extending sealingly into the device are connected to the electrodes **38** and to the metal strips **54** and to the conductive films **24** and **46** which form the anode sides of the respective gas ionizing arrangements.

The films **24** and **46** can be continuous over the entire area of the device or can be subdivided in conformity with the respective display areas and can even be subdivided within the display areas, all depending upon the type of display desired and the degree of complexity of the external circuitry to be connected to the device.

When film **24** is divided into discrete areas, these areas will conform to rows or columns of the basic display areas, or to the basic display areas, or to rows or groups of the display areas. When the film **24** is so divided, opaque, electrically inert, non-light-reflective divider strips are interposed between panel **22** and plate **26** and divide the space therebetween into discrete chambers in conformity with the discrete areas of anode surface formed by dividing of film **24.**

The vertically elongated light beams, or light bars, created by the metal strips **54** are developed in a manner illustrated schematically in FIG. **6.** FIG. **6** is a view looking in the front of the device and showing three adjacent basic display areas **14.** Each of these display areas has six vertically extending metal strips **52** associated therewith.

In operation, the metal strip at the extreme left side of FIG. **6,** and which may be referred to as a trigger strip, receives a single trigger pulse from terminal **60** and the cloud of ions created thereby will influence the next adjacent strip **52** so that when a pulse is supplied thereto via terminal **62** it also will cause gas ionization. Terminal **62,** commencing with the first strip to which it is connected, is thereafter connected with every fourth one of strips **52.**

The pulse supplied to terminal **62** immediately following the pulse to terminal **60** will, however, effectively energize only the first one of the strips to which it is connected because of the ionized gas supplied thereto from the next adjacent chamber in which strip connected to terminal **60** is disposed. For simplicity, the strips are numbered along the bottom from one to **18** and the strips to which terminal **62** is connected are numbers two, six, 10, 14 and 18.

A third terminal **64** is connected to the strips numbered three, seven, 11 and 15. A further terminal **66** is connected to strips numbered eight, 12 and 16.

Still another terminal **68** is connected to the strips numbered five, nine, 13 and 17.

Pulses are supplied sequentially to the terminals **60** to **68** according to the chart of FIG. **7,** wherein the first pulse supplied to terminal **60** is indicated at **70.** Immediately following pulse **70,** a pulse **72** is supplied to electrode **62** which effectively energizes the strip in position two. The next pulse **74** to electrode **64** effectively energizes the strip in position three.

The next pulse **76** to electrode **66** effectively energizes the strip in position four. The next pulse **78** supplied to terminal **68** effectively energizes the strip in position five. The next pulse is again supplied to terminal **62** and will now effectively energize the strip in position six and which is next adjacent to the strip in position five which was the last energized strip. This pulse is indicated at **80.** This pattern repeats completely across the display device to the right side. At this time another trigger pulse at **82** is supplied to terminal **60,** thus resetting the device back to the left end thereof and starting the cycle over again.

The photosensitive elements pertaining to the strips numbered six, twelve and eighteen can be left idle to provide for the space between adjacent display areas **14,** if so desired.

The pulses **70** and **82** are advantageously about **30** milliseconds apart with the number of pulses supplied to electrodes **62** to **68** depending upon the length of the display unit. The 30 milliseconds between successive trigger pulses in FIG. **7** is short enough that substantially no flicker can be perceived in the display and the display is sharply defined and of high density.

The pulses supplied to strips **52** create the vertical bars of light previously referred to and these flashes of light are coordinated with the supply of signals to the horizontal electrodes **38.**

In order to obtain maximum illuminaton of a given dot without any interference from an adjacent dot which is actuated immediately prior to or immediately following the energization of the said given dot, the period of energization of the horizontal electrode **38** is carefully selected as shown in FIG. **8.**

In FIG. **8,** line **90** pertains to the response of a photoconductive member to the energization of the respective vertical bar of light and line **92** pertains to the photoconductive member next adjacent thereto. The line **92** pertains to the period of energization and of the horizontal electrode pertaining to the photoconductive members, and vertical notch **96** indicates the separation of successive pulses on the electrode.

By setting the starting time for energization of electrode **38** a predetermined time T1 after the instant that the pulse is supplied to the metal strip **52,** sharp selective actuation of the dots without interference can be obtained. The delay time T1 thus provides for improved definition of the display. Line **97** shows the period of display of light at the viewing side.

Taking the horizontal line at **100** to represent the ignition level for the displayed dots, it will be apparent that the light display will commence simultaneously with each pulse on the electrode and will extinguish as soon as the respective line **90, 92** drops below line **100.** The dots are thus sharp and do not influence one another.

A particular feature of the present invention is to be found in the possibility of subdividing the anode surface **24** on the display panel **22** in order to provide for various control modes. For example, the anode surface **24** on the front of the display panel in FIG. **1** could comprise a single anode surface covering all of the basic display areas with a single terminal leading from the anode surface.

However, the anode surface could be divided to provide one discrete part covering the upper row of display areas and another discrete part covering the lower row of display areas with, of course, an individual terminal leading from each discrete anode surface. With the anode so divided, it is preferable to insert an electrically inert divider strip, such as an anodized aluminum strip, between the display panel and the matrix panel so that the ionized gas pertaining to one anode region does not influence the other anode region.

Still further, the anode area could be subdivided to provide an individual anode area for each basic display area. Each such anode area would have an individual control terminal connected thereto and electrically inert divider strips, such as anodized aluminum, would be provided to isolate each gas space pertaining to a respective display area from the others thereof. It is also possible to subdivide the anode area to provide an individual anode area for each column of each display area, divider strips being disposed between adjacent columns and each such anode area having a respective terminal.

FIG. **9** shows a display device with two basic display areas **14*a*** and **14*b*** with the letter E displayed in area **14*a*** and the letter S displayed in area **14*b*.** **P1** is the source of signals for developing the light bars which are illuminated in succession, and repetitively, from left to right. **P2** is the source of signals for the horizontal electrodes. This source may be altered by input line **I. C** indicates a clock pulse source which is in controlling relation to **P1** and **P2.**

It will be seen that for a display using a plurality of display areas, only a few terminals are required, namely, five connections to the electrodes for the light bars, eight connections to the signal electrodes, and two anode connections. The external circuitry is simple and the entire device is, thus, simple and inexpensive.

Referring now to FIGS. **12** and **13** there is shown the structure illustrating the method whereby a plurality of sets of the photoconductor controlled gas discharge elements arranged in horizontal rows are interconnected by a clock-controlled stepping mechanism labelled "Row Selection Electrodes" and multiplexing of **P2** which is the electrical address used in addressing the photoconductive elements. The successive sets are addressed by the same illuminating means **P1** and electrical address **P2.** The added sets are accomplished with only a single input wire enabling a total economy of input wires. In referring to FIG. **12,** all that is required for each additional display set is simply to add a further conductor to the bank of anodes at the right hand side of the drawing. In the device illustrated a row **12** is shown with a seven wire input from **P2,** and the arrangement is such that the clock pulse source C is connected both to P2 and through the scan electrodes to a row of selection electrode anodes having a single conductor connection with the respective row set. Thus, it is possible to add any number of additional sets by merely adding a single conductor connection with the Row Selection Electrode Anodes FIG. **12.** Clock C then serves as the timer for the multiplexing function of **P2** which, together with the associated "Row Selection Electrodes" will effect an illumination of the particular PC elements in each row set. The only limiting factor is the speed of the photoconductor and, as previously stated, it is possible to increase the rate of response of the photoconductor appreciably, depending upon the particular composition, construction and method of formation of the photoconductor. In this way, one of the principal advantages of the present invention can be secured which is, to make it possible with, for example, a 275 character display having five horizontal rows, to achieve the entire functions with only 19 conductors, of which eight are horizontal address conductors, five vertical scan electrodes, five row selector anodes, and one conductor connected to the anode used in association with the scanning cathodes.

This number of character displays using this small number of conductors is far in advance of that found in the present state of the art in which there is in the order of five times the number of conductors to obtain this order of character displays. In other words, one of the principal advantages of the present invention is the ability to connect successive rows or sets with a single anode conductor by the unique multiplexing and stepping functions described in FIGS. **12** and **13.** Prior art devices are limited in the ability in which they can obtain either a comparable number of display characters with a comparable number of conductors before they are inherently limited in the number of rows or sets of character displays by reason of their inability to select the row by a secondary means such as provided in the present invention through the multiplexing function in the connection with row selection anodes. All prior devices in contrast with the present invention secure addressing functions by means of a primary address which is to say addressing in the X direction and the Y direction whereas in the present invention each successive row is individually addressed and then effects its display through a stepping row selection anode. In other words, the present invention has common X and Y address electrodes for each row set, with the row set selected by means of a row selection electrode on a row-by-row basis. This, in effect, represents one of the substantial advantages of the present invention and is the advance in the state of the art.

In a further embodiment of the invention, which will be described in connection with FIG. **12,** it is possible to obtain within a 30 millisecond scan period, as many as 50 characters per row with as many as 25 rows, or in excess of 1,000 characters with a 39 conductor display device. This is accomplished by stepping with the row selection electrode amode from the uppermost row to the lowermost row and multiplexing the display data at each row select by unit **P2.** Thus, the clock C during a scan will cause a stepping from one row to the next and multiplexing through **P2** at each vertical column step. This sequence occurs at each scan increment from left to right in FIG. **12.** The speed of multiplexing and stepping by **P2** and the row selection electrode anode as dictated by the clock C is of such speed characteristics that it is possible during a scan period of 30 milliseconds to obtain a display with as many as 25 rows each having 50 characters per row. Information is accessible from the multiplexing device **P2** and the stepping row selection electrode (FIG. **12**) so that even taking into account the response time of a photoconductor element of cadium selenide it is possible to obtain 25 rows with as many as 50 characters per row and still be well within the response time, access time, and information-receiving capabilities of the display device. Starting from the left hand side of the device to the right hand side of the device stepping occurs for each row in a vertical sense and multiplexing occurs vertically at each row so that the total display develops from left to right in the device and the display is continuously refreshed without apparent flicker.

Although the present invention has been illustrated and described in connection with a few selected example embodiments it will be understood that these are illustrative of the invention and are by no means restrictive thereof. It is reasonably to be expected that those skilled in the art can make numerous revisions and adaptations of the invention and it is intemded that such revisions and adaptations will be included within the scope of the following claims as equivalents of the invention.

What is claimed is:

1. In a display device, display area means comprising at least one basic display area consisting of a plurality of individual regions distributed in an array, a conductive member in each region, a plate supporting said conductive members and electrically isolating the members from each other and exposing both ends of said members, means including impedance means connected at one end of each member responsive to the supply of a predetermined amount of electrical power and illumination of the area corresponding to the said member to produce an electric field in the respective regions, an electrode extending across and spaced from a set of ends of members at selected array portions, each impedance means having high impedance and actuatable into a low impedance condition, illumination means for respective array sections sensitive to voltage signals for actuating all of the impedance means of a respective portion of the array into a low impedance condition, means for supplying said voltage signals to said illumination means, and means for applying said predetermined amount of electrical power to said impedance means and said conductor members.

2. A display device according to claim **1** in which each said impedance means comprises photosensitive resistor means.

3. A display device according to claim **1** in which each said impedance means comprises a photosensitive resistor, and each said control means comprises means for generating a light beam which is bar-like in cross section and which simultaneously illuminates all of the said photosensitive resistors pertaining to the respective column simultaneously.

4. A display device according to claim **1** in which said means for supplying voltage signals to said control means and to said electrodes comprises means for supplying actuating voltage signals to said control means and to said electrodes sequentially.

5. A display device according to claim **1** in which said means for supplying voltage signals to said control means and to said electrodes comprises a first source of signals connected to said control means and supplying actuating signals thereto sequentially, a second source of signals connected to said electrodes and supplying signals thereto according to controllable patterns, and means maintaining the signals from the respective sources in a condition of predetermined timed relation.

6. A display device according to claim **1** which includes a transparent electrically nonconductive panel adjacent to but spaced from said plate and facing the said one end of said members, conductive means distributed on the side of said panel facing said members, a gas in the space between said panel and said members which luminesces in the presence of an electric discharge, and each said detectable signal comprising light rays emanating from the gas adjacent the said one end of each member when the said member is supplied with said predetermined amount of electric power.

7. A display device according to claim **6** in which said conductive means is a substantially transparent film of electrically conductive material.

8. A display device according to claim 7 in which said film is a film of tin oxide.

9. A display device according to claim 3 which includes a back panel spaced from said plate and facing said other end of said members, a gas in the space between said plate and back panel which luminesces in the presence of an electric discharge, conductive strips parallel to the said columns and mounted on the side of said back panel facing said plate, electrically conductive means distributed on the side of said plate facing said back panel, and electrically inert opaque divider strips extending between said back panel plate and parallel to said columns and located between said columns and also between said strips whereby the space between said plate and back panel is divided into a plurality of bar-like chambers with one thereof pertaining to each column.

10. A display device according to claim 9 in which said back panel has grooves therein on the side facing said plate parallel to and coplanar with said columns, said strips being mounted in said grooves.

11. A display device according to claim 9 which includes means providing communication between adjacent ones of said chambers for the exchange of gas ions therebetween.

12. A display device according to claim 11 in which said means includes notch means in the edges of said divider strips nearest said back panel.

13. A display device according to claim 6 which includes a plurality of electrically inert opaque divider strips perpendicular to said plate and panel and disposed therebetween and dividing the space between said plate and panel into discrete chambers, said conductive means on said panel being electrically divided to provide for a discrete area for each said chamber.

14. A display device according to claim 13 in which said divider strips are disposed between adjacent ones of said regions.

15. A display device according to claim 13 in which said divider strips are non light reflective.

16. A display device according to claim 1 which includes a transparent electrically nonconductive panel adjacent to but spaced from said plate and facing the said one end of said members, conductive means distributed on the side of said panel facing said members, a gas in the space between said panel and said members which luminesces in the presence of an electric discharge, each said detectable signal comprising light rays emanating from the gas adjacent the said one end of each member when the said member is supplied with said predetermined amount of electric power, a back panel spaced from said plate and facing said other end of said members, a gas in the space between said plate and back panel which luminesces in the presence of an electric discharge, conductive strips parallel to the said columns and mounted on the side of said back panel facing said plate, electrically conductive means distributed on the side of said plate facing said back panel, and electrically inert opaque divider strips extending between said back panel plate and parallel to said columns and located between said columns and also between said strips whereby the space between said plate and back panel is divided into a plurality of bar-like chambers with one thereof pertaining to each column.

17. A display device according to claim 16 which includes means providing communication between adjacent ones of said chambers for the exchange of gas ions therebetween.

18. In a device for creating bar-like beams of light; first and second plate members in a spaced parallel relation defining a space therebetween to receive a gas which will luminesce in the presence of an electric discharge, spaced parallel opaque nonreflective divider strips perpendicular to said plate members and disposed therebetween to divide said space into a plurality of elongated chambers to confine the light emitted from said discharge anode means formed on the side of said first plate member which faces said second plate member, an elongated electrode extending in each chamber on the side of said second plate member which faces said first plate member, means for generating bar-like beams of light extending from one side to the other of said first and second plate members and having a narrowly defined width of predetermined proportions, and means providing communication between at least adjacent chambers for the flow of gas ions therebetween, and signal supply means connected to said electrodes and operable for addressing electric signals to said electrodes operable to create a luminous condition in the respective chamber in sequence from an end one of said chambers across the series of chambers to the other end chamber.

19. A device according to claim 18 in which said electrodes comprise a first electrode in said one end chamber and successive equal groups of electrodes, a first terminal connected to said first electrode and a plurality of further terminals connected to respective electrodes of the group thereof adjacent said first electrode, connectors electrically connecting the corresponding electrodes of said groups together, said signal supply means supplying a first signal to said first terminal and then supplying further signals in succession to said further terminals in the order of remoteness of the respective electrodes from said first electrode, the number of said further signals so supplied being equal to the number of electrodes in a said group times the number of the said groups.

20. A device according to claim 18 in which said signal supply means addresses a first signal to a first electrode in an end one of said chambers at intervals of about thirty microseconds and addresses a further signal to each of the other electrodes in succession commencing with the electrode adjacent said first electrode during each said interval.

21. A device according to claim 20 in which said other electrodes are divided into equal groups of adjacent electrodes, and means interconnecting corresponding electrodes of said groups whereby following the said first signal addressed to said first electrode a series of said further signals are addressed in succession to the electrodes of the group adjacent said first electrode commencing with the other electrode which is nearest to said first electrode and said series of further signals in repeated as many times as there are groups of electrodes thereby to cause the chambers to become successively luminous in one direction of progression along the chambers.

22. A device according to claim 18 in which said means providing communication between adjacent chambers comprise notch means in the edges of said divider strips adjacent said second plate member.

23. A device according to claim **18** in which said divider strips are electrically inert in respect of the environment thereof.

24. A device according to claim **18** in which said divider strips are substantially non reflective in respect of light.

25. In a pair of optically coupled gas discharge panels, the method for creating information bearing patterns of detectable signals in the second of two panels by controlling said second discharge panel which has transmitting elements in an array corresponding to discharge regions on the first of said panels with each of said elements having a signal emitting region and a signal receiving region, the steps of selectively illuminating the respective array portions of the signal receiving regions with radiation produced by said first panel, electronically addressing said transmitting elements to render them effective for transmitting signals from the said signal receiving regions thereof to the said signal emitting regions thereof, said signal emitting regions of said elements developing the said pattern of detectable signals.

26. The method according to claim **25** in which a photosensitive resistor is interposed between each signal receiving region and the supply of signals, and said columns of elements are made effective by illumination of all of the resistors pertaining to a column of said elements simultaneously.

27. The method according to claim **26** which includes creating said illumination by plasma discharge.

28. The method according to claim **26** which includes disposing a respective plasma discharge chamber adjacent the resistors of each column of elements, and actuating said chambers in succession.

29. The method according to claim **28** which includes arranging said chambers in adjacent relation, providing for limited communication between adjacent chambers for the flow of gas ions therebetween, addressing a first signal to an end one of said chambers to create plasma discharge therein with simultaneous flow of gas ions into the next adjacent chamber, and addressing further signals to each chamber in succession following said one chamber.

30. The method according to claim **29** which includes addressing each said further signal to uniformly spaces ones of said chambers simultaneously whereby each said further signal will create plasma discharge only in the one of said chambers next adjacent the chamber last to have a discharge created therein.

31. The method according to claim **30** which includes supplying said first signals at intervals such that no substantial flicker is observable at said one chamber, and uniformly distributing said further signals during said intervals.

32. In a combination with first and second optically coupled gas discharge panels, a second panel forming a display device and including photoconductor controlled gas discharge elements arranged in a set, said first panel including illuminating means for addressing a group of said photoconductors, corresponding to selected elements of the set, means in combination with said second panel for electrically addressing one or more groups of selected elements of the same set, input means including synchronous means for determining which of the elements are simultaneously addressed by said illuminating means and said electrical addressing means whereby an emission of light will produce a desired display on said second panel.

33. The display device in accordance with claim **32** including a plurality of said sets, a second mechanism responsive to said clocking means for determining which of the sets is operative, and multiplexing means whereby a combination of the same illuminating means and electrical means is utilizable for effecting discharge of the elements of the set controlled by said clocking means of a given one of the said elements of said respective sets by simultaneous energization through a combination of said illuminating means and electrical means.

34. A process for producing a display from a combination of optically coupled first and second gas discharge panels, said second panel having a plurality of gas discharge cells each controlled by photoconductors and arranged in a set, comprising the steps of optically scanning the said photoconductor with said first panel means, and simultaneously imposing an electrical voltage on selected ones of said photoconductors to produce a discharge on said cells and thereby effecting a display by the total number of gas discharging cells on said second panel.

35. The process in accordance with claim **34** wherein a plurality of such sets are provided in combination and including the steps of stepping by a clocking function from one set of elements to a successive set, and simultaneously repeating by a multiplexing function the electrical energization of selected ones of said elements of a respective set determined by said clocking function and multiplexing function.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,812,486 Dated May 21, 1974

Inventor(s) F. Jack Purchase

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

Column 1, lines 56 and 57, "description" should read -- specification --. Column 2, line 65, "the" should read -- such --. Column 7, line 31, "92" should read -- 94 --. Column 10, line 2, "intemded" should read -- intended --.

Signed and sealed this 24th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents