United States Patent

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[54] **LIGHT OPERATED CHARACTER GENERATOR AND DISPLAY DRIVER**
20 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **315/153,** 250/208, 250/209, 250/220, 250/237
[51] **Int. Cl.** **H01j 39/12,** H05b 41/18, H05b 41/44
[50] **Field of Search** ..... 250/208, 209, 220, 237; 315/169 (TV), 152, 153, 154, 157, 159, 155

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ABSTRACT: A circuit for control of a segmented glow discharge tube is specifically disclosed, wherein each segment is triggered for glow discharge through a photoconductive element. The element, when illuminated, connects the respective segment to a voltage source. The illumination may be controlled through a BCD-decimal decoder and through a particular optical reencoder providing selective illumination to the photoconductive elements.

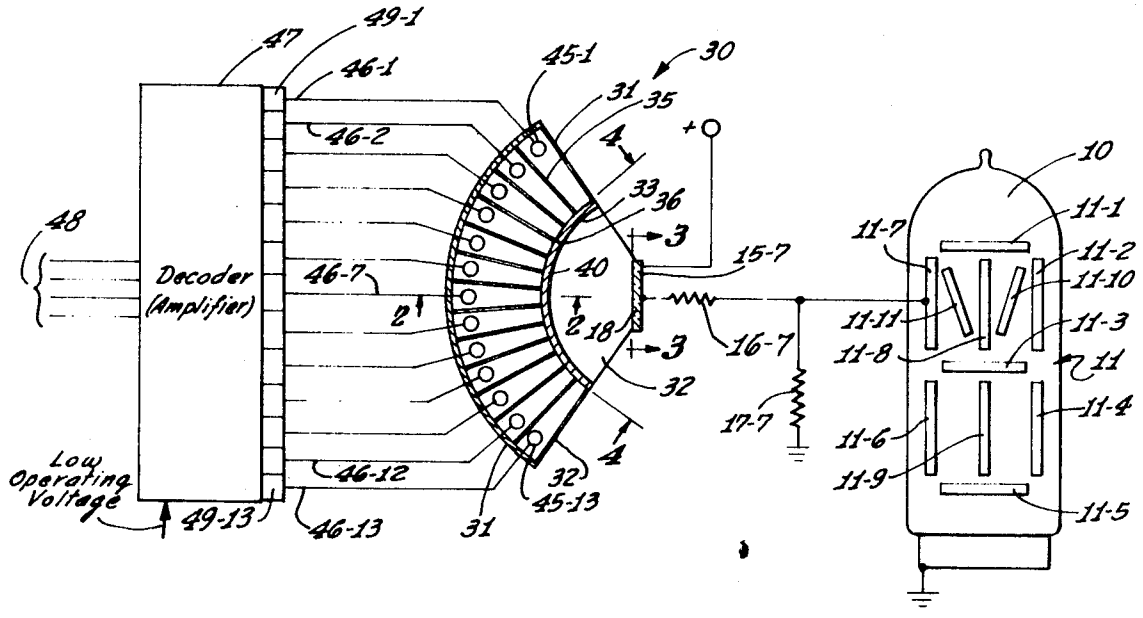


Fig. 1

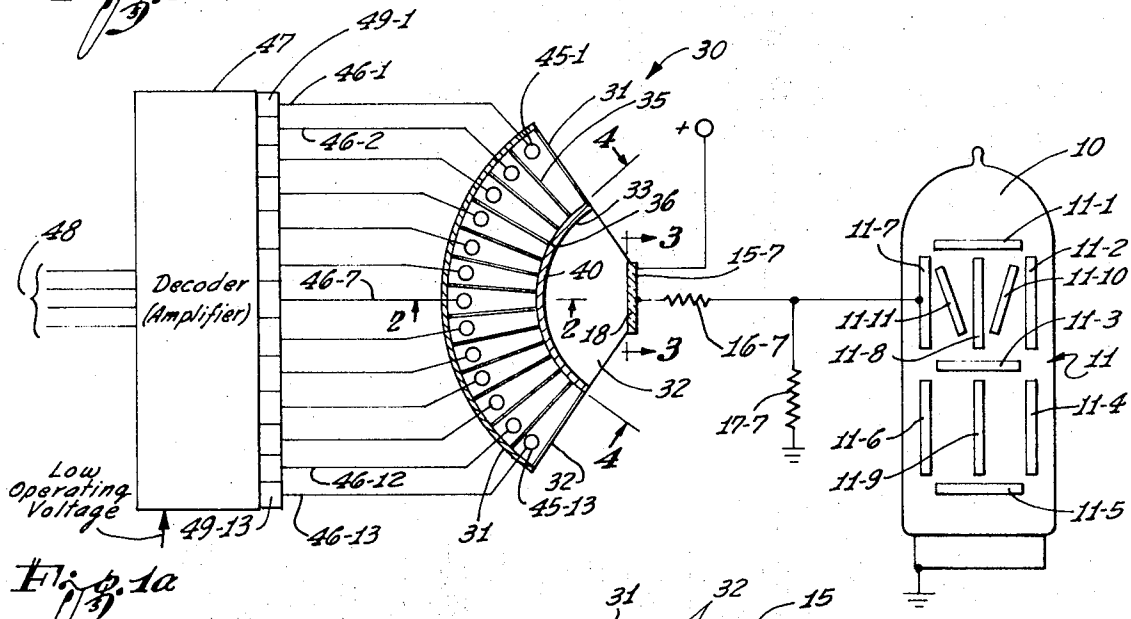
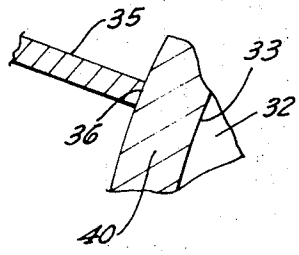


Fig. 1a



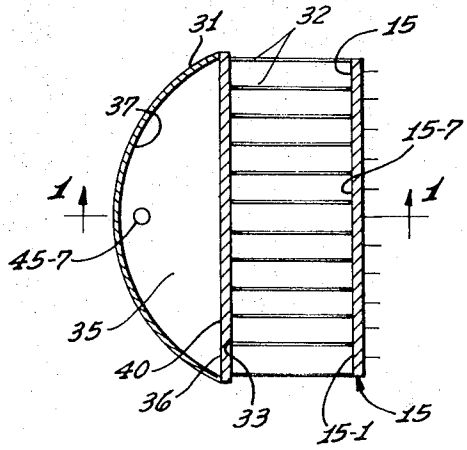
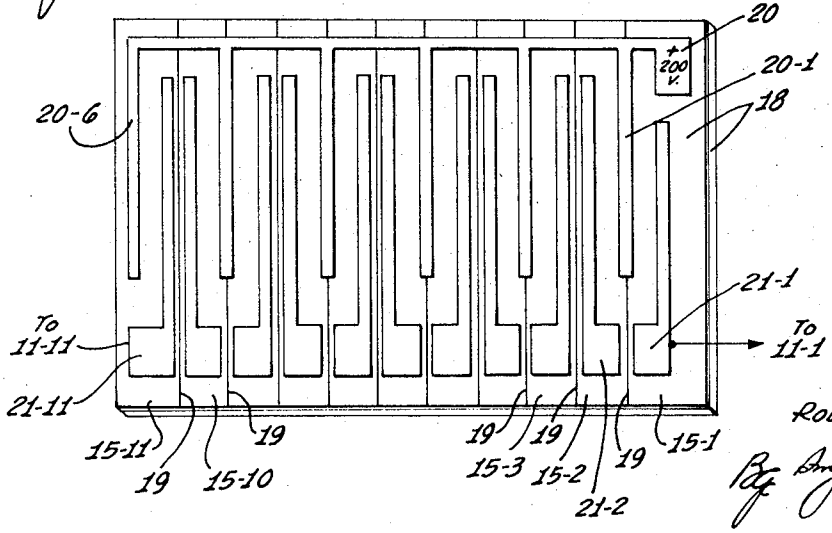


Fig. 2

Fig. 3



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Fig. 4

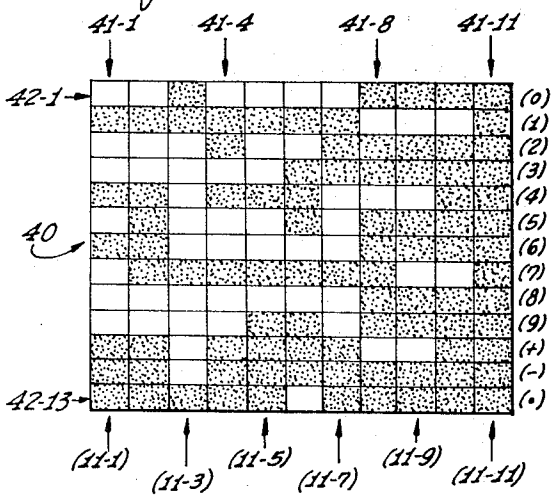


Fig. 5

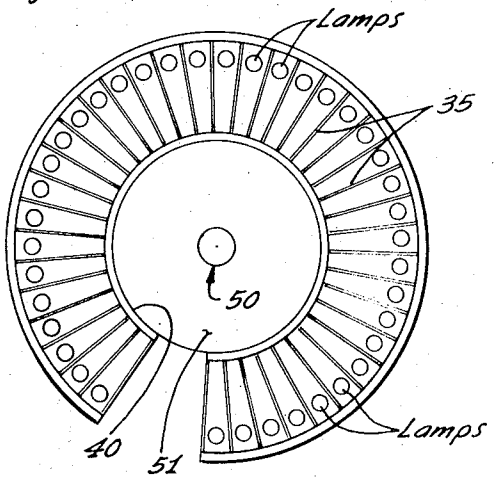
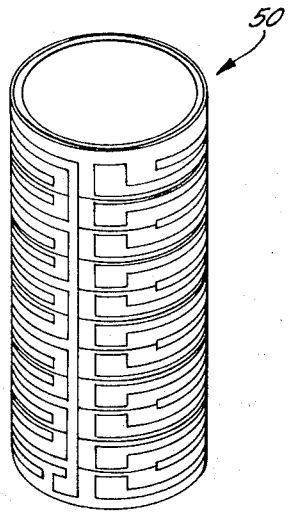


Fig. 6



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LIGHT OPERATED CHARACTER GENERATOR AND DISPLAY DRIVER

The present invention relates to a device, circuit and arrangement for the control of a glow discharge tube, particularly of the type serving as a means for visibly displaying symbols, such as legible characters, for example, alpha-numerical characters.

There are basically two types of display tubes known at this time; one defines a plurality of glow discharge paths each having configuration for outlining a particular character, such as a number. These particularly shaped discharge paths are arranged in different planes, whereby the one which is triggered provides visible glow in the shape of the character which is visible even if other glow discharge path means are positioned in front of the one which glows. The other type tube has glow discharge segments arranged in a particular pattern and in a single plane. The segments are individually controllable as to glow discharge, and by selecting particular ones of the segments for control of concurrent glow discharge therein, a character can be composed of glowing segments as character structure elements. It is obvious that a tube having a particular number of such suitably arranged segments has much more versatility than a nonsegmented, multicharacter tube. A tube having about 11 segments makes it possible to display all letters of the alphabet and all numbers, plus mathematical symbols. It would be extremely impractical to attempt the same with a nonsegmented type of tube having a separate discharge path for each character as was mentioned previously. Therefore, the invention has, as its preferred object, a system, device and arrangement for control of a segmented-type tube but many principles of the invention are applicable for both types of tubes.

One of the problems posed by glow discharge tubes of this type is their relative high operating voltage. Nevertheless, the very clear and very bright display of alpha-numerical characters by means of flow discharge favors employment of such tubes at an increasing degree, whereby additionally the fast response of glow discharge tubes as to turning on and turning off is of considerable interest. Alpha-numerical characters often are to be displayed to establish a man-machine link necessary for useful operations of a data processing device or system, whereby the data processing system outputs data which should be displayed as man-recognizable characters.

Processing systems of this type are presently constructed entirely from semiconductor elements, for signal processing proper, and such semiconductor elements are operated at very low voltages, particularly when used in economical IC chips. Semiconductor devices such as transistors for switching high voltages (above 150 v) to be used to drive directly glow discharge tube systems are not readily available at economic prices, except that the discharge path can be permanently biased to below the sustaining voltage and the transistor switch handles only the difference. Nevertheless, such a switching device is expensive.

Price is an important consideration, as output devices of the type employing visible character display systems usually pertain to peripheral equipment of a computer, or the like. Moreover, such an input-output device often pertains to a large scale peripheral equipment system used by one of many multiusers, each of them being suitably connected to a computer system for using the computer on a time-sharing basis. Such input-output equipment has to be kept economical to make it economically feasible for an occasional computer user to access a computer system with his own input-output device linked to a centrally located computer through remote signal lines. In other words, the peripheral input-output equipment which a particular user uses at his establishment, for purposes of occasionally using the computer, must be inexpensive. Of course, reliability, etc., must not suffer because of the economic requirement. Therefore, for the particular problem at hand, there exists the need to provide an inexpensive but reliable way of controlling such character display tubes.

In accordance with the principal feature of the invention, it is suggested to connect a glow discharge path, such as a glow discharge segment needed for the display, to a photoconducting element, preferably of the semiconductor type, which, in turn, connects to a voltage source, providing a voltage which is sufficiently high to operate, i.e., to trigger, and to sustain glow discharges. The photoconduting element, when not illuminated, has resistance sufficiently high so that trigger voltage is not applied to the glow discharge tube or segment. When illuminated, the decrease in resistivity of the photoconductive element suffices, to apply high trigger voltage to the glow discharge tube for firing same, and for subsequently sustaining glow discharge therein. It has been found that ordinary ambient light is sufficient to provide the illumination for a photoconductor necessary to cause the glow discharge path to fire. In a more simple way, a mask can be used to selectively cover the photoconducting element in case glow discharge is to be inhibited or stopped. Removal of the mask initiates the discharge. A photoconductive element responding to comparably low intensity illumination has, for example, cadmium selenide as principal active element (to which, for example, cadmium sulfide, copper and chlorine are added as activators).

In case of a segmented tube, each glow discharge segment is connected to an individual photoconducting element, and individual illumination control for the latter provides control for the glow discharge of the individual segments. Therefore, selective control of illumination for the photoconducting elements permits selective control of the individual glow discharge segments, which as they glow concurrently to the exclusion of others, compose a character to be displayed. For adequate control, particularly for purposes of adaptation to systems of the type mentioned above, means are provided to receive digital control signals in representation of the characters to be displayed at any instant. In such a case it is more practical to employ auxiliary light sources which are turned on and off in accordance with the display requirements as represented by the control signals. In the preferred form of practicing the invention, it is suggested to provide lamps, for example, as many lamps as there are different characters to be displayed (a lesser number is possible as will be described later). A control circuit for turning the lamp selectively on and off, includes, for example, an electrical signal decoder responding to coded signals representing alpha-numerical characters.

A plurality of photoconducting elements corresponding, for example, to the number of segments of a segmented glow discharge tube, is connected in circuit, in that the elements individually connect the segments of the tube to a voltage source. The photoconducting elements are arranged so that there is a light path permitting each lamp to illuminate all semiconductor elements and permitting each semiconductor element to receive light from all lamps. Masking means are interposed between lamps and elements and being defined by a plurality of opaque and transparent sections or areas, so that a particular lamp, when turned on, causes illumination only of a particular plurality of photoconducting elements to the exclusion of the others. This particular plurality of elements is chosen so that the corresponding and associated particular plurality of glow discharge tube segments, when glowing, outlines a particular character in legible form.

The invention, as practiced in its preferred form, therefore, employs an optical encoder in which low voltage electrical signals of digital significance control lamp driving circuits. Different digital input signals cause different lamps to be turned on, and each lamp illuminates a different, particular plurality of light-conducting elements, which, in turn, individually control glow discharge segments to provide a display as a man-recognizable interpretation of the respective digital signal. Lamps, masks and photconductors are arranged in a particular spatial arrangement with a matrixlike mask interposed so that there are a plurality of light paths, each being essentially defined by walls or dividers which, in turn, are, for example, arranged in an orthogonal pattern corresponding to the matrix of the mask. Accordingly, each lamp illuminates a

particular plurality of photoconductive elements as selected by the mask, and each photoconductive element receives light from all those lamps where the particular glow tube segment serves as visible structure element for the characters as associated respectively with those lamps controlled through the electrical input decoder in response to the digital signals representing those characters.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. **1** includes a cross-sectional view into an optical encoder employed in accordance with the preferred embodiment of the invention; the FIG. furthermore includes a diagram for the input-output circuit of the optical re-encoder and for the control of a particular segmented glow discharge tube, shown schematically in front view;

FIG. **1***a* is an enlarged detail in the encoder shown in FIG. **1**;

FIG. **2** illustrates a modification of the optical encoder;

FIG. **3** illustrates a front view of a photoconductor element arrangement employed in the system shown in FIGS. **1** and **2**;

FIG. **4** illustrates a front view of a mask used in the electro-optical encoder, shown in FIGS. **1** and **2**;

FIG. **5** illustrates a different arrangement for a large number of the characters; and

Fig. **6** illustrates a portion of a cylindrical photoconductor arrangement to be used within the arrangement shown in FIG. **5**.

Proceeding now to a detailed description of the drawings, in FIG. **1** thereof, there is illustrated a multiple segment, cold cathode, gas discharge-type, display tube **10**. The tube has 11, particularly oriented, individually controllable segments **11**, individually identified by **11–1** through **11–11**; glow can be observed in and along each such segment, when a discharge therein has been triggered. These tubes are known, per se, so that a detailed description is not required. If, for example, segments **11–1**, **11–2**, **11–3**, **11–5** and **11–6** glow, the viewer has the impression of the number "2." If portions **11–1**, **11–2**, **11–3**, **11–4** and **11–5** glow, the impression is that of a "3", etc. The invention is concerned with the individual control of these glow discharge segments in order to permit triggering and maintaining of glow discharge in each segment and concurrently for a particular number of segments in each instant where any display is desired.

As a glow discharge tube has a firing voltage above 160 v., it is difficult to provide an all-semiconductor control circuit for such tube on an economic basis, particularly because 11 different control circuits are needed for the 11 segments of the tube. The circuit, in accordance with the present invention, provides control for the glow discharge tube using a sufficiently high voltage source **12**, having, for example, −200 v. taken here, for example, with reference to ground, assuming that ground serves as the positive supply potential. A photoconductive element is connected in series between voltage source **12** and the cathode of each glow discharge segment of the tube; the anodes of the tube are grounded. For the 11 cathodes of an 11-segment tube, 11 photoconductive elements are needed accordingly,

The photoelectric device is collectively denoted with reference numeral **15**. There are accordingly 11 photoconductive elements **15–1** through **15–11** (see FIG. **3** to be discussed below) in that device, respectively connected to the glow discharge segments **11–1** through **11–11**. FIG. **1** shows one such connection as between photoconductive element **15–7** and segment **11–7**. A resistor **16–7** may be included in the particular connection circuit illustrated (there being one per ignition circuit), to match the sum of the voltage drops from source **12** across photoconducting element **15–7** when conducting and across resistor **16–7**, to the sustaining voltage at glow discharge load current for glow discharge of segment **11–7**.

A second resistor **17–7** may provide bias to segment **11–7**, there being a corresponding number of such biasing resistors for the other segments. The resistor **17–7** (and the others) may not be needed, if the voltage drop due to leakage current through the photoconductive element **15–7** (and the others) is sufficiently large to prevent the cathode of the segment from reaching firing potential. As illuminating radiation reaches photocell **15–7** (and/or the others) the element becomes conductive, the cathode potential of segment **11–7** drops to below the firing level of, for example, 165 v. After firing, the glow discharge establishes a particular voltage cross the segment, and the load current across element **15–7** and resistor **16–7** adjusts so that the voltage drop equals the glow discharge path drop minus the supply source voltage. As the illumination of element **15–7** ceases, the voltage drop across elements **15–7** and resistor **16–7** increases so that the voltage across cathode and anode of segment **11–7** drops below the glow discharge sustaining level, and the glow terminates.

FIG. **3** illustrates by way of example, a particular photoresistor arrangement **15**, having a base on which is provided photoconductive layer **18**. In general, all photoconductive devices are applicable for practicing the present invention, provided they can sustain the high operating voltage needed for such glow discharge. Nevertheless, a layer having, for example, cadmium selenide as principal active ingredient is preferred. Layer **18** is divided into 11 strips by means of, for example, insulating grooves or other dividing means **19** to establish the 11 photoconducting resistance elements, **15–1** through **15–11** as individual cells. A surface lamina **20** analogous to a printed circuit contact element has branches **20–1** through **20–6** as power input leads to each of the cells, with five out of six branches each serving two of the cells. Lamina **20** with branches is an electrode common to all cells for connection to the voltage source **12**. Each cell, additionally, is provided with an electrode lamina denoted **21–1** through **21–11** respectively, and each serving as the individual output electrode of the particular photoconductor cell. These electrode lamina are individually connected to the tube segment **11–1** through **11–7**.

The photocell arrangement of FIG. **3** pertains to a particular control and optical encoder unit **30** in FIGS. **1** and **2**, to be described next in greater detail. The control unit **30** is enclosed in a lighttight housing **31**. The photocell arrangement **15** is positioned in housing **31** to expose the photoconductive surfaces of the eleven cells to the interior thereof. There is provided a plurality of altogether 10 light duct defining walls **32**. These 10 walls together with outer walls of housing **31** define 11 light ducts, in the following also called receiving light ducts. The 10 walls **32** respectively terminate in the 10 dividers **19** to provide the individual receiving light ducts for confining respective ray paths as leading toward the 11 photocells. Thus, the first one of the 10 dividers **32** separates the receiving light duct leading to cell **15–1** from the light duct leading to cell **15–2**; the next wall separates the latter cell from cell **15–3**, etc.

The front edges **33** of each of these walls is convexly curved, and the curvatures of the edges together define a cylinder or, more precisely, a portion of a cylindrical surface. Accordingly, each receiving light duct has a cylindrically curved entrance opening. A mask such as mask **40** is placed in that cylindrical surface. Therefore, the entrance of the 11 receiving light ducts is controlled by the mask **40**.

The mask **40** (FIG. **4**) is established by a particular pattern of opaque and translucent or transparent areas arranged in a matrixlike array. The transparent and opaque mask areas or elements of this array are organized in rows and columns. In the particular mask illustrated, there are 11 columns respectively denoted as **41–1** through **41–11** and 13 rows respectively denoted **42–1** through **42–13**. Accordingly, then, each column of the matrix has 13 masking elements, whereas each row of the matrix has 11 masking elements.

The mask **40** is positioned in the cylindrical surface as defined by the several front edges **33** of dividers **32**, in that all defining the 13 masking elements of one column control the

entrance to a receiving light duct and face one photoconductor element which is the optical receiving element at the end of that individual duct. Conversely the 11 masking elements of one row face respectively one each of the 11 photocells. Therefore, each photoconductive element or cell can receive light through some of the masking elements along the particular column of masking elements facing that particular photocell. The resulting mask column tube segment association is schematically shown in FIG. **4** through labeling along the bottom row.

On the other side of mask **40**, when positioned in housing **30** as defined, there is provided a plurality of concentrically arranged light duct defining walls **35**. Walls **35** each have a concavely shaped edge adjacent mask **40**, and all edges **36** of the 12 walls **35**, therefore, delineate also a cylindrical surface. That cylindrical surface has radius equal to the radius of the cylindrical surface delineated by edges **33** plus the thickness of mask **40**. Walls **35** are orthogonally arranged to walls **32** so that edges **36** terminate at mask **40** respectively along the borderlines between two adjacent rows masking elements of mask **40**. Therefore, the first dividing wall **35** has an edge which extends along the dividing line between rows **41–1** and **41–2**. The next wall terminates along the dividing line between rows **41–2** and **41–3**, etc. There are accordingly 12 walls for defining 13 light ducts. As these light ducts include light source means **45** to be described shortly, they will be called illuminating light ducts. Each illuminating light duct as defined by walls **35** thus faces all of the 11 masking elements of one row of masking elements, and through the transparent ones of the 11 masking elements, each illuminating duct faces the corresponding ones of the 11 photocells not covered opaque masking elements of that row.

Each dividing wall of walls **35** terminates at the respectively other side in a doubly curved surface which is preferably a mirror surface **37**. Neglecting for each light duct the curvature of mirror **37** in a plane transverse to the respective light duct wall **36**, which is the plane of FIG. **1**, one can see from FIG. **2** that the portion mirror surface **37** are effective individually in each light duct defines essentially a cylindrical mirror. A lamp is positioned in or near the focal point of each such mirror, pertaining to a set of lamps **45**; these 13 lamps are individually denoted as **45–1** through **45–13**. Therefore, an even illumination field is provided in each illuminating duct toward all photocells at essentially similar intensities for each of them. The curvature of mirror **37** in the plane transverse to the plane of focusing in each individual light duct, is actually the result of radially arranging the light ducts for each to direct light toward the photocell arrangement **15**.

It appears from the foregoing that there are 13 radially oriented illuminating light ducts each having a collimating mirror and a lamp in the focal area thereof. Each illuminating duct directs a collimating beam toward the 11 different masking elements which pertain to one row of mask **40**. Each masking element of that row pertains to a different column and is, therefore, an entrance element to a particular receiving duct at the end of which is a photocell. Each lamp, therefore, is capable of illuminating all of the photoconductive cells **15–1** through **15–11** evenly. However, some of the masking elements of the particular row and as controlling the entrance to a particular receiving duct may be opaque. Such an opaque element prevents the light from being received by the particular photoconducting element positioned at the end of the receiving light duct having an entrance column of masking elements of which the opaque one considered is an element. In other words, each lamp is potentially coupled to each photocell through a single masking element of the row-column matrix and defined by a particular row and by a particular column. The lamp pertains to the illuminating duct facing that row. The photocell is at the end of the receiving duct having that column of masking elements at its entrance. If that masking element is opaque, lamp and cell associated in that manner by a mask matrix position are effectively decoupled, if that masking element is transparent, lamp and cell are operatively coupled when the lamp is turned on, for the lamp to activate the cell.

As a lamp of set **45** is turned on, those of the photocells coupled to that cell through transparent masking elements of a row will become conductive. The other cells will not conduct current. Photocells optically energized and rendered conductive in this manner will provide a glow discharge trigger voltage to the respective glow discharge tube segment connected to that cell causing a glow to appear along the segment. As long as the lamp is on, all those energized photocells will continue to provide sustaining voltage and current to these tube segments.

It is apparent that the distribution of opaque and transparent masking elements along a row is such that when the respectively associated lamp is turned on, it will illuminate those photocells of the photocell arrangement **15** so that a plurality of thusly triggered glow discharge segments establish and, therefore, display a particular symbol or character, such as a number or a letter. Along the right margin of FIG. **4** there are written the numbers and symbols that will be displayed as the particular transparent masking elements along the respective rows permit passage of light to those cells associated with segments which, when glowing, outline the particular number. For example, the first row shows opaque masking elements in columns **41–8**. **41–9**, **41–10** and **41–11**, the other restricted transparent, so that accordingly, all glow discharge segments **11–1** through **11–7** are triggered to display an "0."

The system as described, therefore, is capable of providing a control for the display of 13 different symbols as each row of masking elements indirectly defines one symbol. This establishes a general rule as to the overall configuration of mask **40**. The mask will have as many rows as there are different characters to be displayed by an individual tube. The mask has as many columns as the display tube has different segments. The number of segments is, of course, given by the particular configuration of the tube. The illustrated 11 segment-type configurations has been found suitable to display the letters of the alphabet or numbers in a satisfactory manner as far as visibility and visual character recognition are concerned. In the particular control configuration shown, display is restricted to the 10 numbers 0 through 9, the decimal point and the plus and minus signs, to fully provide display for all numbers and for those arithmetic symbols commonly used for display.

The particular display capabilities, of course, are given by the structure of the masking elements of mask **40**, each character having available 11 structure elements (segments of the tube) and the nontriggering of some due to masking in particular column positions establishes the particular display. What characters can be displayed in basically arbitrary, i.e., each row of the mask is independently encodable. It should be mentioned further, that segment **11–11** is not needed as structure element for any of the 10 numbers and three symbols as encoded by the particular mask, so that in this particular case, cell **15–11** is completely shaded from all 13 photocells. Of course, that particular segment is needed for letter display, for which case a different mask would be used.

Completing now the description, particularly of FIG. **1**, one can see that the optical encoder system has altogether 13 different electric inputs which lead to the 13 different lamps **45–1** through **45–13**. These input channels are schematically denoted as **46–1** through **46–13**, and it is, of course, apparent that at any instant only one of these input channels should provide energizing voltage to the respectively associated lamps. This, however, is a restriction only as to the construction of the mask in that the transparent masking elements of a row face all those photocells to be illuminated so that collectively the thus associated display tube segments, when glowing, display a complete character. It is, however, conceivable that the association of the masking elements along one row of the mask matrix is such so as to cause, in some cases the triggering of display segments without establishing a complete character but only a certain basic structure group thereof so that two or

more lamps have to be turned on to cause display of a complete character. This, however, is a matter of control and of processing input signals for the system, as will be understood shortly. Moreover, this is mentioned here only for purpose of completion and in order to point to the general case. It is not necessary, in principle, that only one lamp at a time be turned on to the exclusion of all others. The system, however, has been described with reference to a mask constructed in that all masking elements of any of the mask rows define display of one character, so that for such particular mask construction only one lamp should be turned on at a time. Were the mask constructed differently, more lamps could be on at the same time.

The 13 electrical signal input channels **14–1** through **14–13** constitute the individual output channels of 13 lamp drivers **49–1** through **49–13**, which, in turn, are connected respectively to 13 output channels of a decoder **47**. Decoder and lamp drivers are electronic, preferably semiconductor circuit devices. The decoder may include power amplifiers for the lamp driver circuits, all of which are known, per se, and do not require elaboration. It follows from the foregoing that the control for the display tube includes low voltage operated electrical decoders and stages for driving lamps which, in turn, pertain to an optical encoder having as its output high voltage signals as can be handled by photoconductive resistance elements which, in turn, control the segments of a segmented glow discharge tube for selective character display.

The decoder **47** is connected, for example, to an input channel **48** having four signal lines which extend, for example, from a data processing device (not shown) as output channel thereof. Channel **48** receives, for example, digital signals in BCD format, as well as codes associated with decimal point and plus and minus symbols. The signal level in channel **48** is expected to be commensurate with the signal levels with which the digital data processing unit operates as a whole. The decoder **47** operates as a BCD-to-decimal decoder, using similar voltages for input and output so that inexpensive diode decoder matrix and inexpensive transistor current amplifiers can be employed.

The decoder, as well as the lamp drivers, operate with input and output signals of a few volts, and such low voltage signal level suffices to drive lamps **45–1** through **45–13** through inexpensive transistor drivers **39–1**, etc. Essential is that the lamp driver stages **49–1** through **49–13** can be low voltage semiconductor devices. Moreover, the sensitivity of the photoconductive cells is such in cooperation with mirror **37**, lamps **45** need to glow only rather dimly, so that they can be driven at low voltages and with little power consumption which is beneficial as to the life time of the lamps and economical as far as layout of the lamp driver stages **49** and of the power amplification in decoder **47** is concerned.

The radiation sources **45** have been generally designated as lamps and it is, of course, understood that the radiation sources must be such that they emit radiation to which photocells **15** are responsive. If simple incandescent lamps are employed, additional advantages are obtained, aside from the fact that ordinary light bulbs are both suitable and economical. In some cases there is a delay between the decay of a particular digital signal in input channels **48** and the providing of a new one. Incandescent lamps, when used as radiation source for the photocells, continue for several milliseconds to provide radiation, particularly, infrared radiation, after current supply has been turned off. A cadmium selenide cell is sensitive also to infrared radiation so that for several milliseconds after decay of the input control signals at channels **48**, the respective photocells remain conductive under the influence of the gradually decaying total radiation output of the lamp, which has already been turned off. In other words, there is an inherent delay between the removal or decay of the digital input signal and cessation of display. Some control over this delay is available as lamps **45** can be readily overdriven over a wide range as far as radiation input requirement for the photocells is concerned. Accordingly, the period between lamp current turnoff and dropping of the radiation output beyond the effective response level of the photocells is variable. This is a simple expedient to adjust the delay between turnoff of a lamp as to input current, and turnoff of the glow segments.

The response delay as described is of great advantage as it overbridges the period between the sequential display of two numbers. In case of an undelayed response of the glow discharge to turning off and on, to turning on of the control signals in the input channel **48**, a very annoying flicker would be observed, as is the case with other types of glow discharge tube drivers. Even if two digital signals follow without appreciable delay, the display will be such that there is a smooth merging of one character in the other during changeover without annoying complete turnoff flicker.

It will be appreciated that the response delay, as between turning off of the respective lamp current and cessation of glow of the respective glow discharge segments, can be avoided if desired, particularly in cases when there is no delay between the digital signals and when the digital signals each are provided for a rather short period only. In this case different photocells, i.e., one which is not sensitive to infrared, can be employed, and/or an infrared filter could be interposed, e.g., as part of the transparent masking elements. This is mentioned here only to show that a response delay is not a principal and unavoidable characteristic of the system.

As schematically indicated in FIG. **5**, the system, particularly the discharge tube segment control device, can be supplemented and modified. The light ducts for the lamps in unit **30** are arranged in FIG. **1** along an arc of 110° as far as concentric arrangement of the illuminating light ducts with lamps is concerned. The arrangement shown in FIG. **5** provides three times as many of such illuminating ducts, i.e., there are 39 lamp channels, arranged almost in a full circle, but leaving some space for the leading in of conductors. The photoconductor arrangement is modified in FIG. **5** in that a photoconductive surface layer, such as shown in FIG. **3**, appears to be wrapped around an axis, which in FIG. **3** would be a horizontal axis, to form a cylindrical "rod" **50**, such as shown in FIG. **6**. Each of the individual photocells extend completely around the periphery of the cylinder along an axial segment thereof, i.e., the several cells are axially spaced along that cylinder. This way, each photocell can be reached from any of the 39 concentrically arranged illuminating light ducts. Such an optical reencoder can thusly optically process 39 different characters such as all 10 numbers, all letters of the alphabet, and additional symbols. The mask **40'** in this case has 39 rows commensurate with 39 lamps and illuminating ducts. Of course, the mask has still 11 columns in accordance with the 11 segments of the particular tube. Thus, there are still only 11 receiving ducts and 11 photocells, as can be seen from FIG. **50**.

The decoder operating the 39 lamps has, of course, 39 output channels requiring six input channels, if the data processor provides signals in bivalued code. The column dividers in this arrangement, i.e., the means defining the receiving channels are discs such as **51** which are axially stacked along the axis of the cylindrical photoconductor arrangement **50**, each having a centrical opening to receive that cylinder and abutting mask **40'** along the periphery between two columns of the mask.

Other modifications of the system are readily deducible from the drawings. If the tube has individual discharge paths outlining individually a character completely, then each photoconductive element is associated with one lamp only and optical encoding in not needed. One can think of the photoconductive elements then as arranged in the plane of matrix **40** in FIG. **1**, each cell forming one end of a light duct having a lamp on the other end; i.e., optical encoding is not required in such case. Another modification is conceivable, also using discharge paths contoured to outline individually a complete character and a photo element for control thereof. Optical, in lieu of electrical, decoding could then be provided, by providing, for example, four lamps and causing them to be controlled directly from the digital signal in channel **48**. The

mask then provides BCD-to-decimal decoding. Such an optical decoder could be constructed essentially as shown at **30** in FIGS. **1** and **2**, except that for a 13 character tube there would be 13 photoconductive elements, and only four lamps would need to be connected directly to channel **48**.

The invention is not limited to the embodiments described above but all changes and modifications thereof not constituting departures from the spirit and scope of the invention are intended to be covered by the following claims.

I claim:

1. A circuit for the control of a multidischarge path, glow discharge display tube for the display of characters and having individually controllable glow discharge paths, a voltage source providing voltage sufficiently high to trigger glow discharge in such discharge paths; and circuit means including a plurality of photoconducting elements respectively connecting the voltage source to the discharge paths in DC circuit connection for providing thereto glow discharge trigger voltage when conducting, a conductive photoconducting element having resistance to lower the effective voltage as derived from the source to glow discharge sustaining level, the photoconducting elements positioned to be individually selectively exposed element conductive to provide the trigger and glow sustaining voltage to the respective discharge path.

2. A circuit for the control of a segmented glow discharge display tube for the display of alpha-numerical characters or the like, having individually controllable glow discharge segments comprising:

means defining a voltage source providing voltage sufficiently high to trigger discharge in glow discharge segments;

a plurality of photoconducting elements respectively connecting the voltage source means to the segments of the plurality in DC circuit connection for individually providing thereto glow discharge trigger voltages when conducting;

resistance means individually connecting respectively the photoconductive elements in circuit with the glow discharge paths of the segments and with the voltage source, so that the voltage drop across a photoconductive element when conducting in cooperation with the voltage drop across the respective resistance means lowers the effective voltage for the segment to a discharge sustaining level; and

means for individually selectively causing the photoconducting elements to be exposed to radiation sufficient to individually render the elements conductive, to provide trigger voltage to the segment of the plurality to which an element of the plurality if connected.

3. A circuit for the control of a glow discharge path, comprising:

a voltage source providing voltage sufficiently high to trigger glow discharge in the discharge path;

circuit means including resistance means and a photoconductive resistance element connecting the voltage source to the discharge path in DC circuit connection for providing thereto relatively high discharge trigger voltage the subsequent voltage drop across the photoconductive resistance element when conducting and across the resistance means adjusted to provide relatively low discharge sustaining voltage to the discharge path; and

means for selectively providing exposure and nonexposure of the photoconductive resistance element to illuminating radiation for selectively triggering and inhibiting glow discharge in the discharge path.

4. The circuit for the control of a segmented glow discharge display tube for the display of alpha-numerical characters of the like, having:

individually controllable glow segments, a voltage source means providing voltage sufficiently high to trigger glow discharge display tube segments;

a plurality of photoconducting elements respectively connecting the voltage source means to the segments of the plurality for individually providing thereto glow discharge trigger voltages when conducting;

a plurality of lamps, each positioned for illuminating all of the photo elements of the plurality to render an element of the plurality conductive to respectively provide trigger voltage to the segment to which it is connected;

masking means positioned between the plurality of photoconducting elements and the plurality of lamps to cause each lamp when turned on to illuminate a particular plurality of photoconducting elements of the plurality; and

control means connected to the lamps of the plurality for selectively turning the lamp individually on and off to thereby cause photoconductive elements of the plurality receiving light from a lamp of the plurality when turned on and through the masking means to cause the glow discharge segments to which the light-receiving elements are respectively connected, to be triggered.

5. A circuit for the control of a glow discharge path, comprising:

a voltage source providing voltage sufficiently high to trigger glow discharge in the discharge path;

circuit means including a photoconductive resistance element connecting the voltage source to the discharge path for providing thereto discharge trigger and sustaining voltages when conducting;

a lamp positioned to illuminate the element;

low voltage operated lamp driver means connected to the lamp for providing current thereto; and

control means connected to the lamp driver for selectively turning the lamp on and off so as to respectively initiate and terminate glow discharge.

6. An arrangement for the control of a multicharge path, glow discharge display tube for the display of characters such as alpha-numerical characters or the like, having a plurality of individually controllable glow discharge paths, the combination comprising:

a plurality of lamps;

first means positioned in relation to the lamps of the plurality to respectively define a first plurality of individual light paths;

means connected to the lamp of the plurality for individually turning the lamps on and off to provide radiation in the respectively associated light paths to the exclusion of the remaining off the light paths of the first plurality;

a plurality of photoconducting elements including means for defining a second plurality of light paths respectively to the photoconducting elements, the light paths of the first plurality positioned in relation to the light paths of the second plurality so that each photoconducting element can receive light from all the lamps, and each lamp can illuminate all photoconducting elements;

masking means interposed between the light paths of the first plurality and the light paths of the second plurality so that a lamp of the plurality illuminates a particular plurality of elements of the plurality to the exclusion of the remaining element of the plurality;

voltage source means providing voltage sufficiently high to control glow discharge display tube segments; and

circuit means respectively connecting the elements of the plurality to the discharge paths of the plurality and to the voltage source so that a discharge path of the plurality connected to an element of the plurality which receives light from a lamp of the plurality is controlled for glow discharge.

7. A device, as set forth in claim **6**, the first means including cylindrical mirror means for collimating light in the direction toward the elements of the plurality and individually for each of the light paths of the first plurality.

8. A device as set forth in claim **6**, the first means being arranged for defining the light paths of the first plurality in a radial pattern for directing light at different angles toward the elements of the plurality.

9. A device as set forth in claim 6, the masking means comprising an array of opaque and translucent or transparent masking elements.

10. A device as set forth in claim 9, the array being arranged in a matrixlike row and column arrangement of the masking elements, the first means providing the respective light paths toward the columns of the matrix, the light paths of the second plurality each facing the masking elements of a row of the matrix.

11. A device as set forth in claim 6, the means for defining the light paths of the second plurality including a plurality of ring sector dividers having a common cylindrical surface at their respective edges, the masking means extending in said cylindrical surface adjacent the edges, the light paths of the first plurality arranged to terminate on the cylindrical surface.

12. A device as set forth in claim 6, the photoconducting elements of the plurality being arranged on the surface of the cylinder, the elements of the plurality being axially spaced on the cylinder, the means defining the light paths of the second plurality including a plurality of parallel discs axially spaced along the cylinder defining the plurality of photoconducting elements, the lamps being circularly arranged around the cylinder, the first means including the plurality of radially arranged walls terminating on the cylinder mantle as defined by said discs.

13. A device for the control of a segmented glow discharge display tube for the display of alpha-numerical characters having individually controllable glow segments, the combination comprising:

a plurality of lamps;

a plurality of photoconducting elements positioned in relation to the plurality of lamps so that each lamp of the plurality can illuminate all elements of the plurality and each element of the plurality can receive light from each of the lamps of the plurality;

masking means interposed between the lamps of the plurality and the elements of the plurality so that each lamp can illuminate only a particular plurality of elements of the plurality to the exclusion of the remaining elements of the plurality;

voltage source means providing voltage sufficiently high to trigger glow discharge display tube segments;

circuit means respectively connecting the elements of the plurality to the segments of the plurality and to the voltage source so that a segment connected to an element of a plurality which receives light from the lamps of the plurality is controlled for glow discharge; and

control means connected to the lamps of the plurality for individually turning the lamps on and off so as to cause a lamp when on to provide an illuminating radiation to particular ones of the elements to the extent permitted by the masking means.

14. In a circuit for the control of a multidischarge path glow discharge display tube for the display of characters such as alpha-numerical characters or the like, having a plurality of individually controllable glow discharge paths, the combination comprising:

first means connected for receiving signals representing such characters;

a plurality of lamps connected to the first means and being controlled by the signals as lamp driver signals to turn the respective lamp on;

a plurality of photoconducting elements positioned so that each element can receive light from any lamp of the plurality;

optical coding means defining selective light paths between the lamps of the plurality and the elements of the plurality so that a lamp of the plurality when on illuminates less than all elements of the plurality to the respective exclusion of the remaining elements of the plurality;

voltage source means providing voltage sufficiently high to control the glow discharge; and

circuit means connecting the elements of the plurality to the discharge paths and to the voltage source means so that an element of the plurality when receiving light from a lamp of the plurality, causes the respective discharge path to be triggered and to sustain glow therein.

15. A circuit as set forth in claim 14, including second means connected to the first means and receiving externally provided signals of digital and control significance and decoding them to provide the decoded signals at the signals received by the first means.

16. A circuit as set forth in claim 14, the lamps being incandescent lamps, the photoconductive elements being responsive to visible as well as infrared radiation.

17. A circuit as set forth in claim 14, the first means receiving signals at particular delays between the lamps and the photoconductive elements, having characteristics that an element remains energized after a lamp having energized that element is turned off and for a period comparable with that delay.

18. A circuit for the control of a multidischarge path display tube for the display of characters, such as alpha-numerical characters or the like, having:

individually controllable glow discharge paths, a voltage source providing voltage sufficiently high to trigger glow discharge in the paths of the display tube;

resistance means including a photoconducting element connecting the voltage source to a discharge path in DC circuit connection for providing thereto a glow discharge trigger voltage when conducting and providing a reduced discharge sustaining voltage subsequent to discharge triggering as a consequence of resulting change in resistance ratio as directly effective across the discharge path;

a lamp positioned for illuminating the photoconductive elements to render the element conductive to provide trigger voltage to the discharge path; and

control means connected to the lamp for selectively turning the lamp on and off.

19. A circuit as set forth in claim 18, the lamp having characteristics of providing output radiation decaying slower than a current decay in case of lamp turnoff by operation of the control means.

20. A circuit as set forth in claim 19, the lamp being an incandescent lamp, the photoconductive element being sensitive to infrared radiation.