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W. Y. SAKAMOTO ET AL
GLOW DISCHARGE DISPLAY TUBE

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2 Sheets-Sheet 1

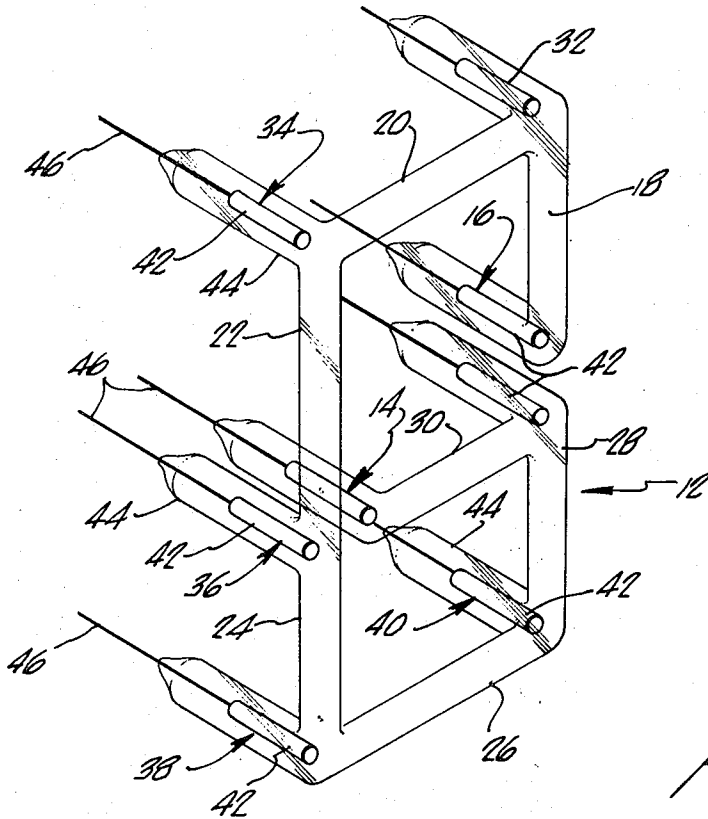


FIG. 1

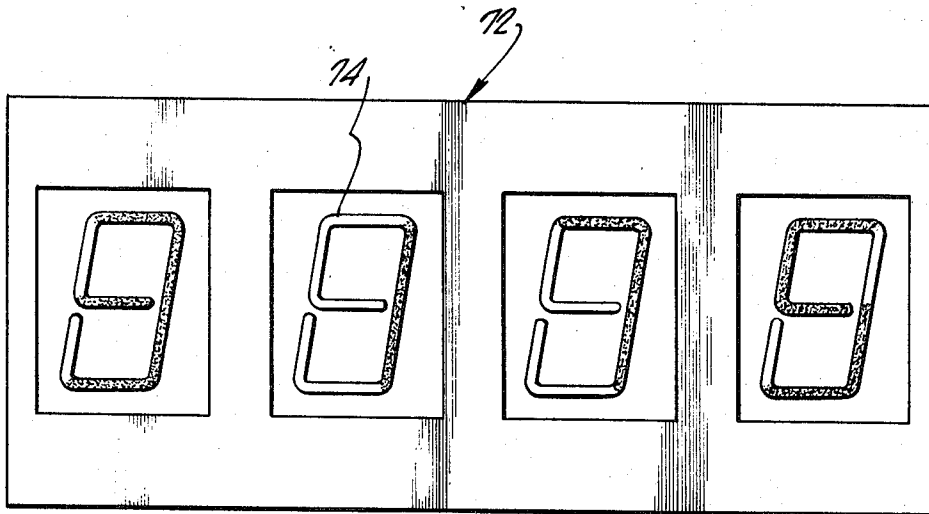


FIG. 3

INVENTOR.
WAYNE Y. SAKAMOTO
BY FRANKLIN I. FLETCHER
Christie, Parker & Hale
ATTORNEYS.

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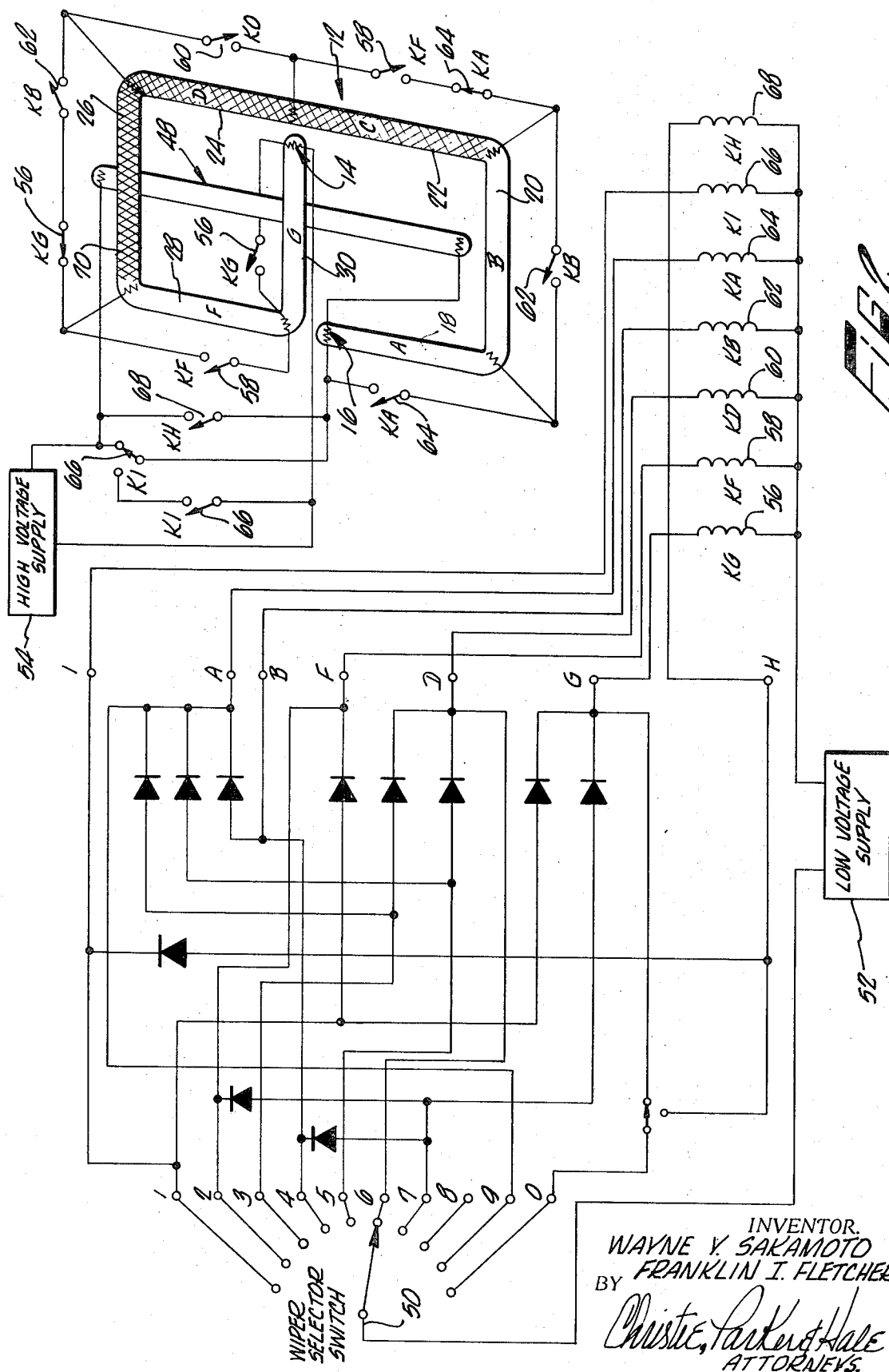
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GLOW DISCHARGE DISPLAY TUBE

Wayne Y. Sakamoto, Los Angeles, and Franklin I. Fletcher, Burbank, Calif., assignors to Card-Key Systems, Inc., Burbank, Calif., a corporation of California

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2 Claims

ABSTRACT OF THE DISCLOSURE

A shaped, glow discharge, display tube and supporting electrical circuitry for providing the display of one of a selection of characters. The tube is energized in the manner of a conventional glow discharge tube by applying a high voltage between the end electrodes of the tube. A number of auxiliary electrodes are provided along the length of the tube which divide it into segments. Electrical short circuits are applied to adjacent pairs of electrodes to blank or extinguish the display in the segment associated with the shorted electrodes, leaving only the segments forming the desired character illuminated.

BACKGROUND OF THE INVENTION

The present invention relates to display devices and in particular to multi-electrode glow discharge tubes for use in such display devices, the tubes being capable of producing a selection of characters to be displayed.

The presentation of statistical data and information is made in a variety of situations. Typical of such situations are travel terminals where changing schedules, departure and arrival information, etc. are presented on display panels located for easy viewing by people passing through the terminal. A second situation is stock brokerage offices where the changing quotations on a number of stocks and other securities and commodities are prominently displayed so that account executives and other visitors to the office can follow market trends and obtain latest quotes at a glance.

In these and other data presentation locations, the information displayed changes rapidly. In many instances electronic systems utilizing light powered displays are provided for presenting the readout. Frequently these light powered displays utilize incandescent lights, for example, backlighted display units such as shown in U.S. Pat. No. 3,041,600.

In addition to the examples outlined above, there are also many occasions where such displays are used in outdoor applications where the display is frequently presented in direct sunlight. Such applications include automobile parking lots, stadium scoreboards, automobile and pedestrian traffic control signs and the like. Where the display is provided by incandescent lights, presentation in direct sunlight is usually ineffective and often unreadable. To compensate, lights of this type are sometimes driven at higher voltage levels to brighten the glow of the filaments. Whether driven at conventional levels or higher, the service life of incandescent bulbs does not compare favorably with other types of electrically powered lamps such as

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neon glow discharge lamps. Statistics have shown that lamps of the latter type have a service life which is substantially longer than that of the incandescent bulb.

SUMMARY OF THE INVENTION

The present invention provides a glow discharge lamp for use in changing display applications. Because of the inherent brightness of the illumination provided by such a lamp, it is particularly suited for outdoor display applications. The lamp comprises a hollow, translucent, gas filled, tubular envelope having a first exciting electrode located within the envelope and a second exciting electrode located within the envelope at a distance spaced from the first electrode. Means for connecting a source of energizing electric power to the exciting electrodes is provided for producing a visible glow discharge between the exciting electrodes together with at least one auxiliary electrode located within the envelope intermediate the exciting electrodes. Means for connecting the auxiliary electrode and the exciting electrodes to external electric lamp display control circuitry is also provided whereby when the control circuitry is operated, the glow discharge in a portion of the lamp is extinguished.

The invention further contemplates a display apparatus utilizing the above-referred to display lamp and in this context provides a glow discharge tube formed in the shape of a plurality of characters to be displayed having a pair of primary electrodes, each one of the electrodes being located within the tube at opposite ends thereof. A plurality of auxiliary electrodes located within the tube are provided, the auxiliary electrodes being located along the length of the tube intermediate the primary electrodes with adjacent pairs of the auxiliary and exciting electrodes defining segments of the tube. A source of electric power is connected to the primary electrodes for energizing the tube and for producing a visible flow discharge between the primary electrodes and electrical control circuitry means are provided for producing an electric control circuit between selected adjacent pairs of electrodes for extinguishing the discharge in the tube segment associated with the electrode pairs to produce the display of a selected character.

In one aspect the present invention demonstrates the way in which glow discharge lamps such as neon tubes can be fabricated from a single length of tubing and made of a size which is to substantially reduced in comparison to tubes of this type currently available.

Moreover, by the present invention, a single length of tubing, appropriately shaped, can now be utilized to display a variety of alphanumeric characters. This is accomplished by electrically shorting certain segments along the length of tube. By virtue of the need for providing only one neon tube to selectively display a plurality of characters, e.g., the Arabic numerals 1 to 0, the supporting electrical circuitry and the number of high voltage power supplies required is reduced and simplified.

Whereas a separate neon tube has heretofore been provided, shaped in the form of one particular character to be displayed, by the present invention the number of tubes needed per number of characters to be displayed is substantially reduced. In place of a plurality of tubes, a single tube and a plurality of relays are provided hav-

ing contacts associated therewith, at least one of the contacts being arranged in parallel circuit relationship with each segment of the display tube. The tube generates light by means of a glow discharge when connected to a suitable electric power supply. In a neon lamp, the neon gas ionizes producing a characteristic red glow. By operating one or more of the relays associated with the tube and the relay contacts operatively associated therewith, one or more intermediate lengths or segments of the tube have connected in parallel circuit relationship with themselves, a connection which is essentially a short circuit. Because the impedance of the alternate short circuit path is lower than the impedance between the electrodes located at each end of the tube segment, the electric energy flowing through the tube is conducted around the segment through the alternate path causing the glow in each of the shorted segments to be extinguished. The combination of glowing and glow extinguished segments form the outline of the character which it is desired to display.

In certain strong radio interference areas it has been found that such interference has a tendency to cause the normally extinguished segments of the tube to blink. Where such a phenomenon is encountered, RFI shielding is provided in the housing for the display and where warranted shielding in the form of loosely braided cable is placed about the tube segments. The weaves of the cable is arranged such that when the segment glows substantially all of the illumination passes through the gaps in the weave to the exterior of the housing.

The high intensity of illumination provided by the tube of the present invention makes the tube particularly suited for outdoor applications. Thus the tube in combination with others of the same type is ideally suited for use in such locations as racetrack toteboards, sporting event scoreboards freeway and automobile traffic control signs. "WALK-WAIT" pedestrian traffic control signs can now be provided with a single tube rather than two separate ones. The physical size of the tubes is varied depending on the arena or location of the display presentation for ease of viewing even at the points in the area most remote the display location.

BRIEF DESCRIPTION OF THE FIGURES

These and other aspects of the invention will be better understood by reference to the following figures in which:

FIG. 1 is a perspective view of a display tube according to the present invention;

FIG. 2 is a schematic diagram illustrating the electrical circuitry for energizing the display tube; and

FIG. 3 is an elevational view of a fee indicator utilizing several display tubes.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, the display tube of the present invention is an elongated, continuous, translucent, hollow, tubular envelope 12 which is formed in the shape of two adjacent parallelograms having a common side such that the tube resembles the figure "eight." An electrode 14 is provided at one end of the tube and an electrode 16 is provided at the opposite end. For ease of reference the tube will be considered as being divided into a plurality of segments, seven in number, designated by reference numerals 18, 20, 22, 24, 26, 28 and 30. Located intermediate the ends of the tube at the ends of the various segments are auxiliary electrodes 32, 34, 36, 38, 40 and 42. Electrodes 14 and 16 will be referred to herein as exciting or primary electrodes. These exciting electrodes are connected to a high voltage electric power supply for establishing the necessary electric field within the tube between the electrodes to produce a glow dis-

charge and the visible radiations associated with such a discharge.

Electrodes 14 and 16, as well as electrodes 32 through 40, are cup-shaped devices 42 located within auxiliary tubes 44 which are joined to the main tube 12 with a pressure tight seal, for example, by means of conventional glass joining techniques such that the main tube and auxiliary tubes 44 form a sealed, continuous enclosure in which all compartments thereof are in fluid communication with the main tube. Extending from cup-shaped electrodes 42 are leads 46 which pass through glass seals at the end of the tubes 44 for connecting the various electrodes of the tube of the present invention to appropriate external, electrical, lamp display, control circuitry.

In a preferred embodiment cup-shaped electrodes 42 are spaced a short distance from the longitudinal axis of envelope 12. It has been found that the most satisfactory control of the operation of the tube and the glow within each of the segments of the tube is obtained when the cup-shaped electrodes are located close to this axis. This is especially true when the physical length of the segments of the tube become relatively small.

The display tube of the present invention is manufactured essentially according to standard neon tube fabricating methods. A continuous length of tube having electrodes 14 and 16 located at the ends thereof is shaped by a glass blower into the form of two adjacent parallelograms to produce the shape of the numeral eight (8). When so shaped the fabricator then attaches auxiliary electrodes located intermediate of electrodes 14 and 16 at the ends of the various segments of the tube. In the preferred embodiment the tube is filled with neon gas to provide the medium to be ionized producing the glow discharge. Other gases are also suitable for such an application including argon and neon-argon combinations.

An example of the circuitry used for energizing the display tube of the present invention is shown in FIG. 2. At the outset it should be understood that the tube is caused to provide a display of characters by first energizing the electrodes 14 and 16 located at the ends of the display tube and thereafter shorting the electrodes located at opposite ends of predetermined segments of the tube to extinguish the glow discharge in said segments leaving only those segments of the tube glowing which together present the display of the character desired by the operator of the tube.

As shown in FIG. 2, a second tube 48 is provided with tube 12. Tube 48 is a straight, cylindrical, hollow gas filled tube similar to tube 12 and is provided for displaying the numerical character "1." While it is possible to provide a readout of the character "1" by means of the main tube 12 by shorting segments 18, 20, 26, 28 and 30, it has been found that for purposes of symmetry and proportionality of display it is more desirable to provide a separate tube 48 located approximately in the center of the plane defined by display tube 12 for providing a readout of this character.

The circuitry for energizing the display tube comprises a selector switch 50 such as a Strowger step-by-step switch, or the like, capable of selectively making electrical contact with a plurality of contacts. Additionally, two power supplies are provided, a low voltage supply 52 and a high voltage supply 54, together with a series of relays 56, 58, 60, 62, 64, 66 and 68. For ease of reference herein, the relay coils and the relay contacts operated by that respective coil will be designated by the same reference numerals. The selector switch, power supplies and relays are connected to display tubes 12 and 48 by the interconnections and diodes shown in FIG. 2.

The operation of the tube is most efficiently illustrated by reference to the table set out immediately below. As indicated previously, various segments of tube 12 are electrically shorted to extinguish the glow in that segment leaving only certain segments lit to thereby provide a

particular character indication. The operating table is as follows:

Character to be displayed:	Relay(s) operated	Shorted segment
1-----	56, 58, 66	(1)
2-----	58	22, 28
3-----	58, 64	18, 28
4-----	62, 64	18, 20, 26
5-----	60, 64	18, 24
6-----		60
7-----	56, 58, 62, 64	18, 20, 28, 30
8-----	None	None
9-----	64	18
0-----	56	30

¹ Tube 48 only energized.

The low voltage supply 52 provides the power for operating relays 56 through 68. The high voltage supply 54 supplies the power for energizing display tubes 12 and 48. The selector switch 50 is operated by some external means such as a cash register used by a parking lot attendant to record the amount of money to be charged a customer who has parked his car in a lot utilizing the display tube of the present invention. The selector switch is driven to the contact corresponding to the number to be displayed by the tube. When the selector switch comes to rest, the appropriate relay or relays are energized, the associated relay contacts closed and the desired readout given.

When it is desired to produce a readout of the number "1," the circuitry is arranged such that display tube 12 is deenergized and display tube 48 energized. For all other characters 2 through 0 display tube 48 is deenergized and power supplied to electrodes 14 and 16 at the ends of display tube 12. In the case where none of the segments of display tube 12 are shorted such as in the case where the number "8" is to be displayed, the entire tube glows covering the length thereof from electrode 14 to electrode 16. For displaying any character other than the figure "8" one or more of the segments, in accordance with the preceding table, are electrically shorted. It has been found that by providing a short circuit between electrodes in parallel with a specific segment of the display tube that the glow discharge between the electrodes located at each end of such a segment is extinguished until such time as the selector on switch 50 is moved to another contact.

In certain instances to guard against interference from outside sources and to prevent the possibility of the glow discharged in any given segment from blinking on and off, a sleeve of a wire mesh 70 is provided around the exterior surface of the display tube. The wires used in the mesh are chosen of a sufficiently small diameter and woven into a mesh of spacing such that when the segment about which it is disposed glows no appreciable diminution of the radiation given off by the segment is experienced.

A fee indicator 72 is shown in FIG. 3 utilizing four (4) display tubes of the present invention. As indicated above, such an indicator is typically used in parking lots and is located adjacent the attendant's cash register or booth for providing a visible display of the charge to a patron of the lot for parking his car in that lot. In the display of FIG. 3 the charge is \$31.75. Display tube 74 in FIG. 3 illustrates the way in which a display tube of the present invention can be utilized to give a readout of the figure "1" as an alternate embodiment of the display tube combination shown in FIG. 2. In commercial installations it has been found that the preferred embodiment utilizes the two display tubes such as shown in FIG. 2.

It is contemplated that the display tube of the present invention has many applications and most especially applications where the display is to be presented in bright sunlight. In addition to the previously enumerated applications, these include time-temperature displays, outdoor advertising and other alpha-numeric display applications. Because the tube is a gas-filled, glow discharge

tube rather than an incandescent device, the readout is (1) substantially brighter than an incandescent display making it considerably easier to read and (2) the elimination of a filament type of lamp means a substantially increased life of the display tube with consequent savings in terms of replacement costs.

What is claimed is:

1. An improved character display device, comprising: a glow discharge tube having opposite ends; said tube being shaped in a configuration permitting selective representation of arabic numerals "1," "2," "3," "4," "5," "6," "7," "8," "9," and "0";

said tube configuration forming a pair of vertically adjacent parallelograms, having a common side;

a pair of end electrodes sealed in said tube adjacent said opposite ends thereof;

at least six intermediate electrodes sealed in said tube between said end electrodes; said intermediate electrodes being spaced from one another and from said end electrodes;

said tube including: a first section forming the common side of said vertically adjacent parallelograms; a second section substantially perpendicular to said first section; a third section substantially perpendicular to said second section and parallel to said first section; a fourth section substantially perpendicular to said first and third sections, and parallel to said second section; a fifth section coaxial with said fourth section, and substantially perpendicular to said first section; a sixth section substantially perpendicular to said fifth section, and parallel to said first and third sections; and a seventh section coaxial with said second section, substantially perpendicular to said first and sixth sections, and parallel to said fifth section;

at least one electrode being disposed at the intersection of each of said tube sections;

voltage supply means electrically connected between said end electrodes for illuminating said tube; and means for selectively shorting adjacent pairs of said electrodes to prevent illumination of the tube section therebetween.

2. An improved character display device, comprising: a glow discharge tube having opposite ends; said tube being shaped in a configuration permitting selective representation of a plurality of characters, including arabic numerals "1," "2," "3," "4," "5," "6," "7," "8," "9," and "0"; said tube configuration forming a pair of vertically adjacent parallelograms having a common side;

a first primary primary electrode sealed in said tube adjacent one end thereof;

a second primary electrode sealed in said tube adjacent the other end thereof;

at least six auxiliary electrodes sealed in said tube between said primary electrodes; said auxiliary electrodes being spaced from one another and from said primary electrodes;

said tube including: a first section forming the common side of said vertically adjacent parallelograms; a second section substantially perpendicular to said first section; a third section substantially perpendicular to said second section and parallel to said first section; a fourth section substantially perpendicular to said first and third sections, and parallel to said second section; a fifth section coaxial with said fourth section, and substantially perpendicular to said first section; a sixth section substantially perpendicular to said fifth section, and parallel to said first and third sections; and a seventh section coaxial with said second section, substantially perpendicular to said first and sixth sections, and parallel to said fifth section;

at least one of said electrodes being disposed at the intersection of each of said tube sections;

voltage supply means electrically connected between

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said first and second primary electrodes for illuminating said tube;
 electrical conductor means extending between pairs of said electrodes;
 relay switch means in said conductor means between pairs of said electrodes;
 a relay coil associated with each of said relay switch means;
 selector switch means for energizing selective relay coils to short selected pairs of said electrodes and prevent illumination of the tube sections therebetween; and
 second power supply means in series with said selector switch means for energizing said coils.

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DONALD J. YUSKO, Primary Examiner

D. L. TRAFTON, Assistant Examiner

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