

- [54] **DISPLAY DEVICE**
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[58] Field of Search..... 340/336, 343, 344, 340/324 R; 235/92 SH, 92 EA; 315/169 R, 315/335; 313/109.5

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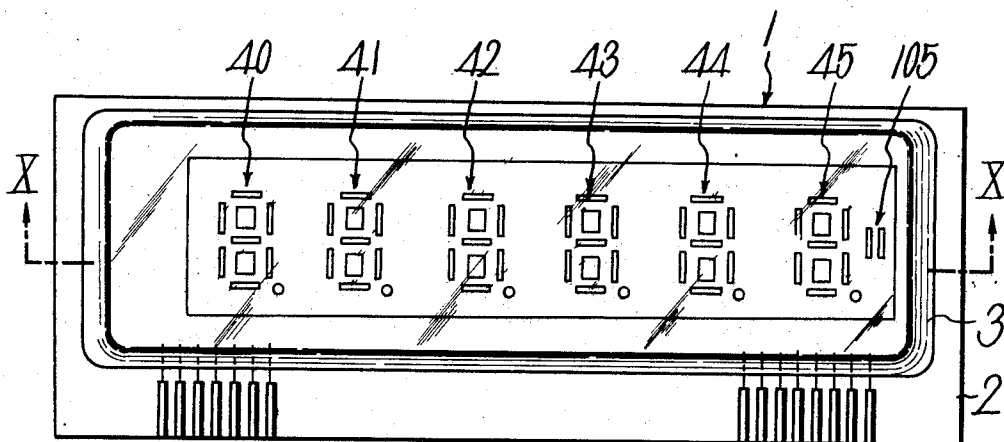
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Primary Examiner—David L. Trafton
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[57] **ABSTRACT**

A display device for electronic computers, calculators and the like in which indicator electrode units, each comprising anode and cathode segments lying in the same plane in an envelope and in which all of the cathode segments are simultaneously energized for a predetermined desired configuration and the anode electrodes are energized on a time sequential basis in such a manner that only the cathode segments of the indicator electrode unit having its anodes energized will glow at a particular time. The individual respective cathode segments of each indicator unit are connected in parallel, and accordingly the number of leads to the display device is substantially reduced, as compared with conventional indicators which require separate leads for energizing the cathode segments respectively. The display device is provided with means for producing charged particles within the envelope to facilitate glow discharge of a particular indicator unit.

15 Claims, 13 Drawing Figures



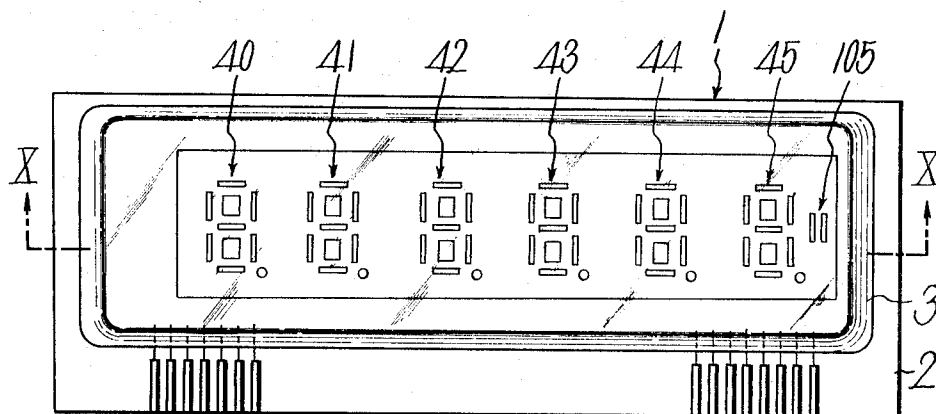


Fig. 1

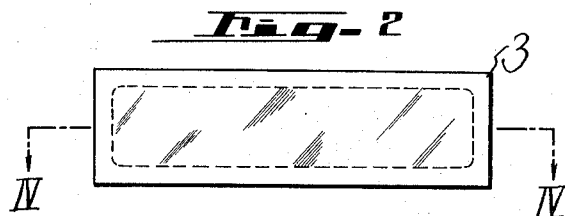


Fig. 2

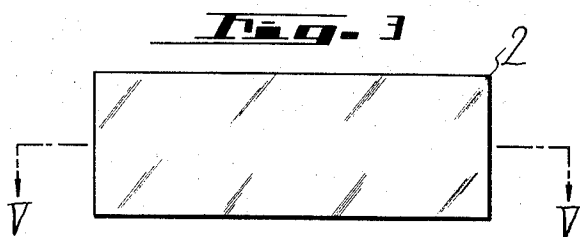


Fig. 3



Fig. 4



Fig. 5

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Fig. 6

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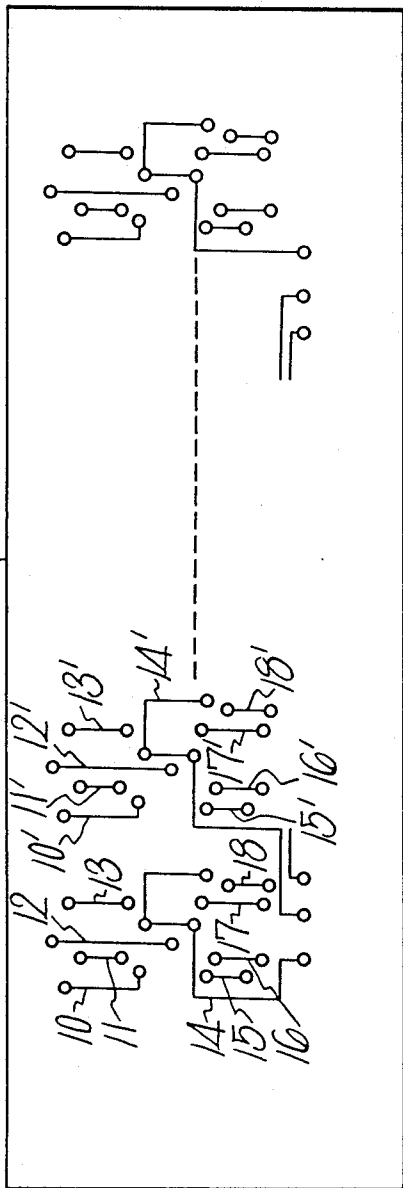
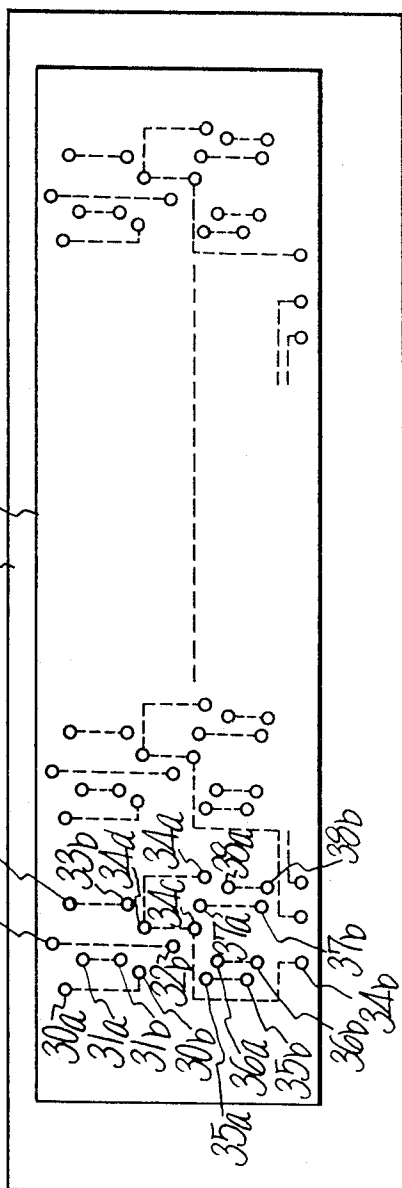


Fig. 7

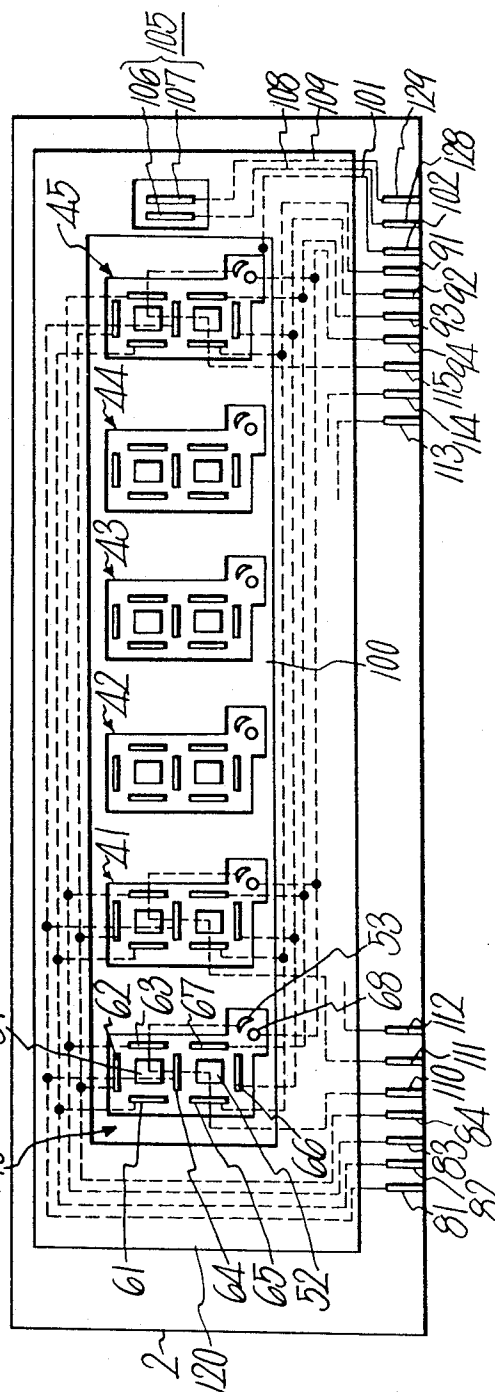
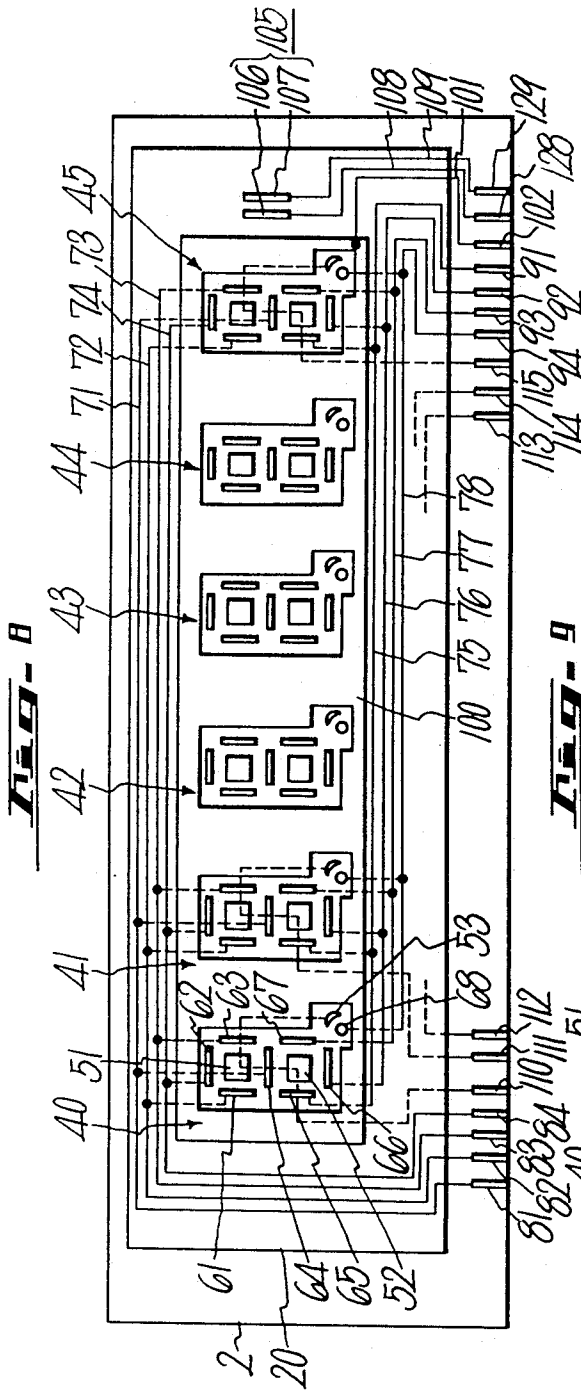
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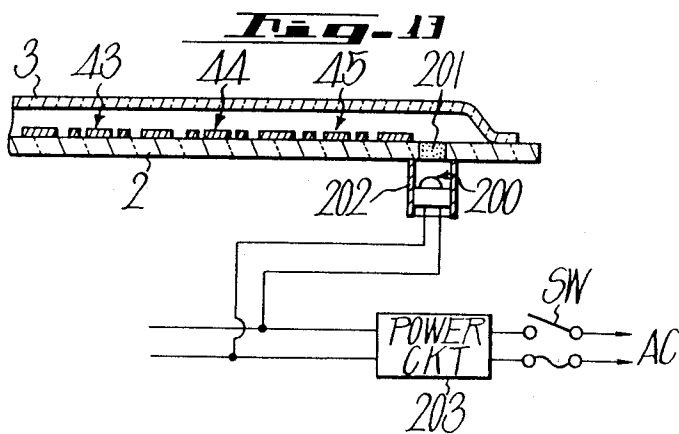
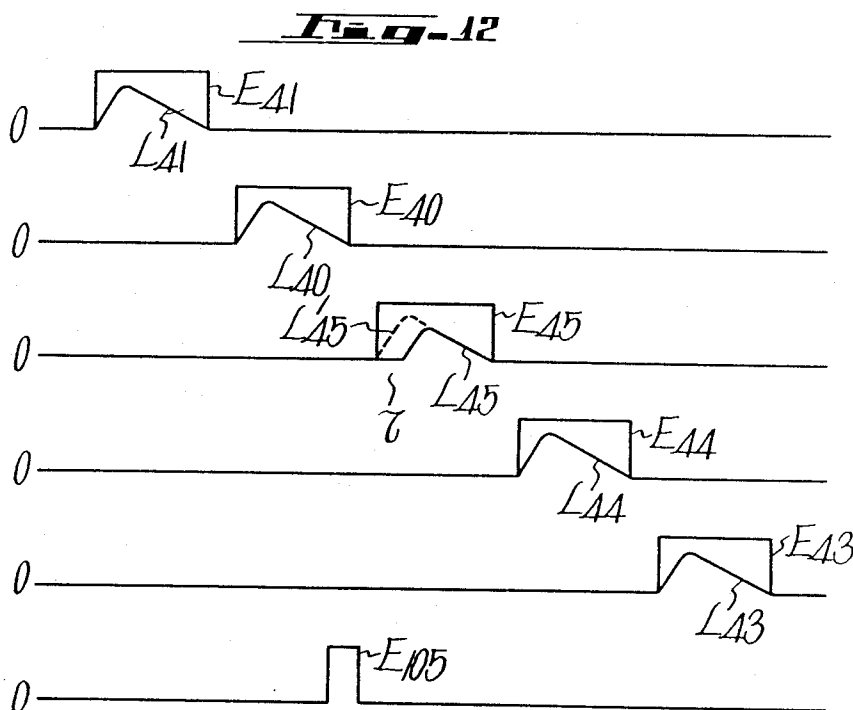
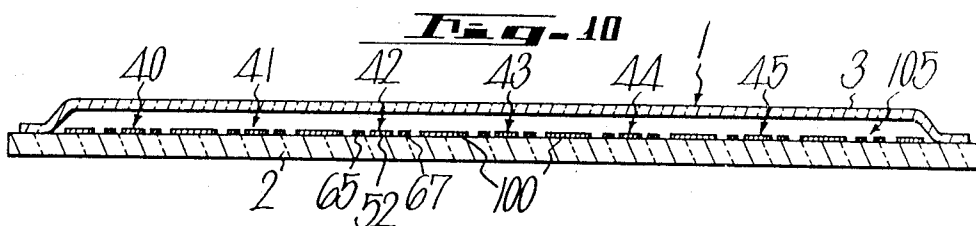


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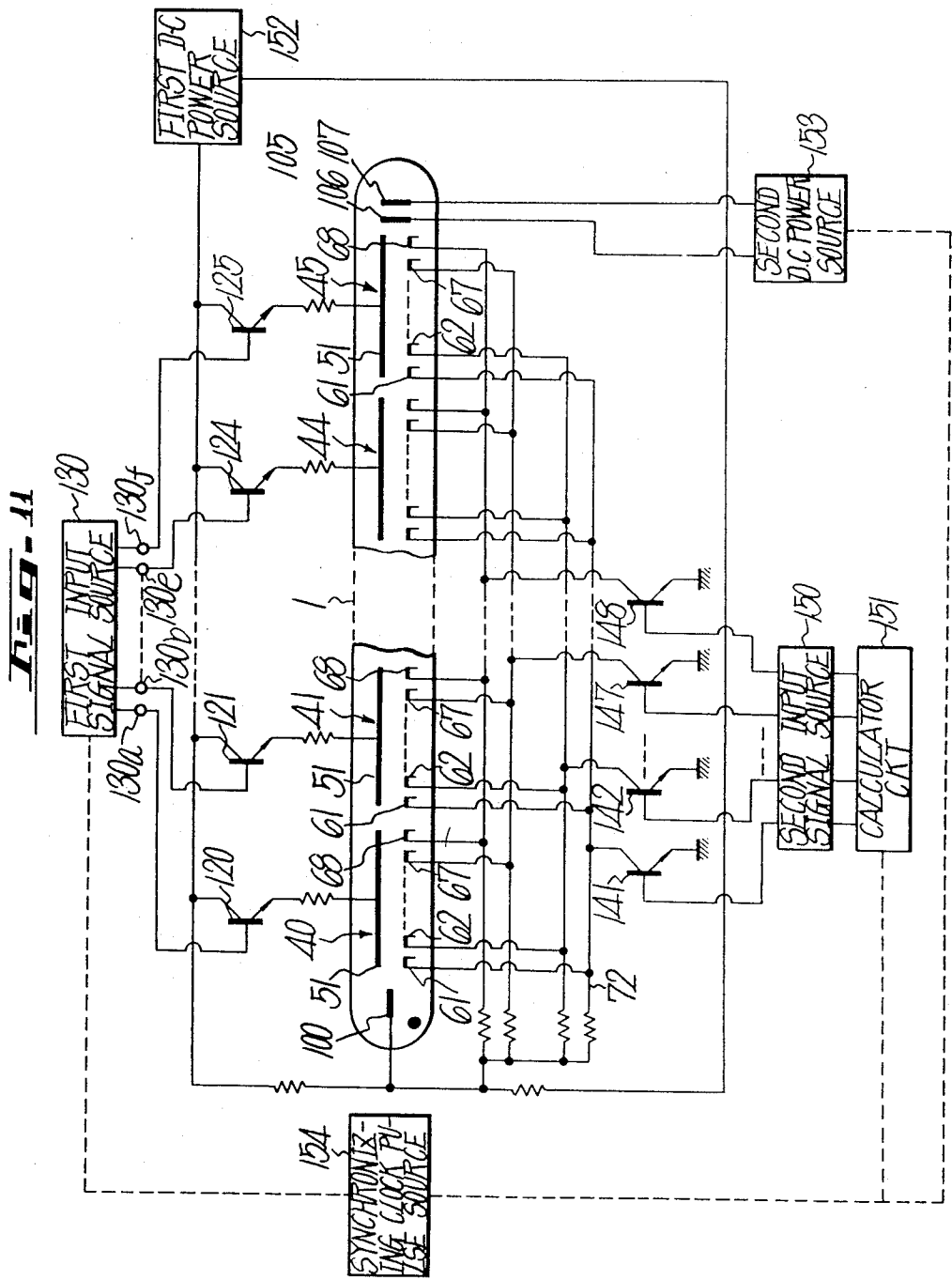
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DISPLAY DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

The present invention is an improvement over the invention disclosed in pending applications, Ser. No. 128,888, filed Mar. 29, 1971; Ser. No. 155,555, filed June 22, 1971; Ser. No. 172,855, filed Aug. 18, 1971, Ser. No. 177,990 filed Sept. 7, 1971; and Ser. No. 180,727 filed Sept. 15, 1971, all of which are assigned to the same assignee as the present invention.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates generally to a display device, and more particularly to a display device which is of particular utility when employed in electronic computers, calculators and so on.

2. Description of the Prior Art:

Generally, display devices, which are of the type including a plurality of indicator units mounted inside a transparent envelope for displaying numerals, symbols, letters or the like, have been used with electronic counters and other various indicating devices. One example of such display device is the so-called "Nixie" tube in which an anode and a plurality of cathodes are aligned in a stack one above another and the cathodes are selectively energized to provide a display of a desired numeral or letter. Another type of indicator display tube utilizes cathode segments mounted in a common plane and an anode in the form of a wire screen or mesh mounted in a second plane.

For displaying a number containing a plurality of figures with the Nixie tube, it is necessary to employ the same number of Nixie tubes as that of the figures, which inevitably leads to bulkiness of an indicator display device. Another display device is small and thin but requires the same number of leads as that involved in the case of the Nixie tube for a number display. This introduces difficulty in the formation of leads coming from the envelope and also complexity in external wiring.

U. S. Pat. No. 3,588,571, which is not prior art, discloses an indicator display tube of the type in which many indicator electrode units, each consisting of an anode and a plurality of cathode segments are formed on an insulating plate with the cathode segments of each unit common to those in the other units and connected together by common leads, but the anodes are separately led out from the envelope. This indicator display tube is advantageous in that the number of the leads required is smaller than that of the Nixie tube. The indicator units of such a display device are selectively energized to glow on a time sequential basis as disclosed in the U. S. Pat. No. 3,414,764. In a display device having, for example, twelve indicator units, the indicator units are sequentially supplied with a predetermined voltage in the order from the least significant unit to more significant ones to provide a display. In this case, gas in the vicinity of the indicator unit energized is ionized and one part of charged particles flows in neighboring indicator units, by which, in the unit to be subsequently energized, there is produced an atmosphere in which the unit is ready to glow. In general, the indicator units of the most and least significant units are spaced apart from each other, so that the charged

particles generated in the vicinity of the unit of the most significant unit do not momentarily flow in the region of the least significant unit. Accordingly, in a display device of the type in which the indicator units are sequentially energized from the most significant unit to the least significant one on a time sequential basis to provide a display, there is the possibility that glow of the indicator unit of the least significant unit incurs a slight delay which results in its glow brightness becoming lower. This phenomenon occurs not only in the above display device but also in a display device in which every second or fourth indicator unit is energized. Also at the start of operation of the display device, no charged particles exist, so that lighting of the indicator unit of a first unit is likely to be delayed.

SUMMARY OF THE INVENTION

The present invention is directed to a display device of the type having a number of indicator electrode units with their anode and cathode segments formed in a common plane in which there is provided means within an envelope to produce ionized ions therein. In such an arrangement, the cathode segments of each electrode unit common to those of the other units are electrically interconnected and simultaneously energized and the anodes are energized time-sequentially in such a manner that a particular electrode unit with its anodes energized provides a display.

One object of this invention is to provide an improved display device which is provided with many indicator electrode units and which has means for insuring uniformity of brightness of all units.

Another object of this invention is to provide a display device which is driven on a time sequential basis and in which the indicator units are caused to glow with uniform brightness.

Another object of this invention is to provide a display device which is driven on a time sequential basis and is arranged to eliminate substantially any delay in lighting indicator units.

Still another object of this invention is to provide a display device which uses a power source pilot device of a computer, a calculator or the like as a means for preventing a delay in lighting a particular indicator unit.

Other objects, features and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view schematically illustrating one example of a display device of this invention;

FIG. 2 is a plan view of a cover plate of the display device of this invention;

FIG. 3 is a plan view of the glass backing plate of the invention;

FIG. 4 is a sectional view taken on line IV—IV of FIG. 2;

FIG. 5 is a sectional view taken on line V—V of FIG. 3;

FIG. 6 is a plan view of the backing plate illustrated in FIG. 3 with a plurality of interconnecting leads formed thereon;

FIG. 7 is a plan view of the backing plate of FIG. 6 with an insulating layer formed over the interconnecting leads;

FIG. 8 is a plan view of the backing plate of FIG. 7 with a plurality of indicating units and selecting leads formed over the insulating layer;

FIG. 9 is a plan view of the backing plate of FIG. 8 with an insulating layer formed thereon;

FIG. 10 is a sectional view taken on line X—X of FIG. 1;

FIG. 11 is a circuit diagram showing a schematic indicator assembly together with a drive circuit therefor;

FIG. 12 is a graph, for explaining this invention; and
FIG. 13 is a sectional view schematically showing another example of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 there is illustrated generally one example of a gaseous glow type display device 1 produced according to this invention. The display device 1 is made up of a base plate 2 of an insulating material such as, for example, glass. A plurality of indicator units 40, 41, 42, 43, 44 and 45 of the same pattern are formed by printing techniques on the base plate 2 in alignment with one another and a transparent cover plate 3, as of glass, is attached at its periphery in an air-tight manner to the base plate 2 and its center is spaced a predetermined distance from the indicator units.

The display device 1 is constructed in the following manner: The insulating base plate 2 such as illustrated in FIG. 3 has the indicator units and the interconnecting leads formed thereon. The transparent cover plate 3 is attached to the base plate 2 after the indicator units are formed. The cover plate 3 is formed with a depression or hollow portion 4 in which the indicator units are received as shown in FIG. 4.

Both of the plates 2 and 3 may be made of glass and generally the base plate 2 is larger in area than the cover plate 3 as may be observed by comparing FIGS. 2 and 3.

FIG. 4 is a sectional view taken on line IV—IV of FIG. 2 and illustrates the depression 4 in the cover plate 3.

FIG. 5 is a sectional view taken on line V—V of FIG. 3.

FIG. 6 is an enlarged plan view of the base plate 2 and illustrates a plurality of interconnecting leads 10 to 18 which are formed on the insulating base plate 2 by suitable thin film techniques such as, for example, by printing. It is to be particularly noted that the interconnecting leads 10 to 18 are grouped so that they will align with indicator units to be formed above a particular group. Thus, the interconnecting leads for the first indicator unit are designated by numerals 10 to 18 and the interconnected leads for the second unit are designated by numerals 10' to 18'. The interconnecting leads are formed of silver paste which adheres well to the glass base plate 2.

After the interconnecting leads are formed by printed circuit techniques on the base plate 2, the plate and leads are baked to provide suitable bonding.

It is to be realized that the lengths of the interconnecting leads 10 to 18 are such that they will be capable of interconnecting the cathode and anode elements of the indicator units to suitable selecting leads as will become more apparent in the description.

FIG. 7 is a plan view of the base plate 2 in which a glass insulating layer 20 has been deposited on the base plate 2 so as to cover a substantial portion of the inter-

connecting leads 10 to 18. The insulating layer 20 may be formed by a glass coating method by spraying two or three times and then by drying it to provide it with a suitable insulation coating 20 over the interconnecting leads.

Windows are formed in the insulating layer 20 at opposite ends at each of the interconnecting leads 10 to 18 so as to allow electrical conducting paths to be formed through the insulating layer 20 to the interconnecting leads 10 to 18. For example, windows 30a and 30b are formed through the insulating layer 20 at opposite ends of the interconnecting lead 10. Windows 31a and 31b are formed at opposite ends of the interconnecting lead 11 and additional windows 32a and 32b through 38a and 38b are respectively formed at opposite ends of leads 12 to 18. Additional windows intermediate the ends of lead 14 are formed and are designated 34c and 34d.

It is to be realized, of course, that the windows formed through the layer 20 are formed for each of the indicator units although they are only particularly numbered in FIG. 7 for the first indicator unit.

FIG. 8 illustrates the next step of the method of making the indicator unit and illustrates a plurality of indicating units 40 to 45 which are formed on the top of the insulating layer 20.

In the next step the plurality of indicator units 40 to 45 (the number depending upon the desired number) are formed on the insulating layer 20 and aligned with the windows through the layer 20 so that electrical contact will be made with the interconnecting leads. Each of the indicator units comprises electrically conducting anode segments 51, 52 and 53 as well as an associated plurality of cathode elements 61 to 68. At the same time, a plurality of selecting leads 71 to 78 are formed on the insulating layer 20 with the leads 71 to 74 extending along the top of the indicator units 40 to 45 as shown in FIG. 8 and the selecting leads 75 to 78 extending along the bottom of the indicator units 40 to 45 as shown in FIG. 8. The anode and cathode segments and selecting leads are formed by suitable thin film techniques and are formed so as to align with the windows 30a to 38a and 30b to 38b so that electrical connections will be made between the selecting leads 71 to 78 and the anode and cathode segments.

A plurality of external leads 81 to 84 are formed on the insulating plate 2 adjacent the lower edge relative to FIG. 8 and are respectively connected to the selecting leads 71 to 74. A plurality of external leads 91 to 94 are respectively connected to the selecting leads 75 to 78 and are formed on the insulating plate 2 along the bottom edge as shown in FIG. 8.

It is to be realized that the indicator units 40 to 45, the selecting leads 71 to 78 and the external leads 81 to 84 and 91 to 94 are formed at the same time by a silk screen process and when the indicator units 40 to 45 and selecting leads 71 to 78 are printed on the insulating layer 20, each of the cathode elements 71 to 68 and anode elements 51 to 53 are respectively connected to the associated selecting leads through the windows 30a to 38d formed in the insulating layer 20. For example, the cathode element 62 is formed so that it aligns with window 31b which connects it to one end of the interconnecting lead 11 and the selecting lead 74 is formed over the window 31a so that the selecting lead 74 is connected to the cathode segment 62 through the interconnecting lead 11. Simultaneously, all of the corre-

sponding cathode segments 62 of all of the indicator units 40 to 45 are connected to lead 74 through associated windows and thus all of the segments 62 of all of the indicator units are electrically connected together and to the external lead 84. Similarly, all of the cathode segments 61 are connected by interconnecting lead 10 to selecting lead 72 and to external lead 82. All of the cathode segments 63 are connected by interconnecting leads 13 to selecting lead 73 which is connected to external lead 83. Each of the cathode segments 64 is connected by interconnecting lead 12 to selecting lead 71 which is connected to external lead 81. Each of the cathode segments 65 is connected by interconnecting lead 15 to selecting lead 75 and to external lead 91. Each of the cathode segments 66 is connected by interconnecting lead 16 to selecting lead 76 which is connected to external lead 92. Each of the cathode segments 67 is connected by interconnecting lead 17 to selecting lead 77 which is connected to external lead 93. Each of the cathode segments 68 is connected by interconnecting lead 18 to selecting lead 78 which is connected to the external lead 94.

Thus, in the structure defined thus far, the associated cathode segments of all of the indicator units 40 to 45 are electrically connected together and thus can be electrically energized by the eight cathode selecting leads 81 to 84 and 91 to 94. The three anode segments 51, 52 and 53 of each of the indicator units 40 to 45 are interconnected together by the interconnecting lead 14 and a separate external lead is formed along the lower edge of the insulating plate 2 so that the anode segments of each of the indicator units can be individually energized. For example, an external lead 110 is connected to interconnecting lead 14 of the indicator unit 40 which is connected to the anode segments 51, 52 and 53 of the indicator unit 40 but not to the anode leads of any other indicator unit and the indicator unit 40 alone will be energized when the external lead 110 is energized with a selective pattern of the cathode segments.

Likewise, the anode segments of the indicator unit 41 are connected through an interconnecting lead to the external anode lead 111 for the indicator unit 41. An external lead 112 is connected to the associated anode segments of the indicator unit 42 in a similar manner. An external lead 113 is connected to the anode segments of the indicator unit 43 and an external lead 114 is connected to the anode segments of the indicator unit 44. An external lead 115 is connected to the anode segments of the indicator unit 45.

The display device is adapted to prevent an incorrect message display which is caused by accidental discharge of the indicator units. For this purpose, in the illustrated example an auxiliary electrode or barrier electrode designated at 100 is utilized. The barrier electrode 100 may be formed around the indicator units 40 to 45 on the insulating layer 20 at the same time as the indicator units and leads and has suitable windows for the indicator units as shown. A lead 101 is also formed on the insulating layer 20 and extends from the barrier electrode 100 to an external lead 102 so that a suitable voltage may be applied. The leads 101 and 102 are formed at the same time that the barrier electrode 100 is formed. The leads, cathode and anode segments and barrier electrode are all formed of silver paste which adheres well to the glass insulating layer 20.

Further, in this step a keep-alive means 105 for producing charged particles is provided adjacent the indicator unit 45 of the least significant unit. The keep-alive means 105 comprises cathode and anode electrodes which are formed on the insulating layer 20. A pair of leads 108 and 109 are also formed on the insulating layer 20 to extend from the electrodes 106 and 107 to a pair of external leads 128 and 129, respectively, so that a suitable voltage may be applied therebetween.

In the next step, as shown in FIG. 9, a second insulating layer 20 of glass is deposited over the selecting leads 71 to 78 and 101 but the indicator units and the keep-alive means 105 are left uncovered by this second insulating layer 120. In other words, the cathode segments 61 to 68 and the anode segments 51 to 53 of each of the indicator units and at least the cathode and anode electrodes 106 and 107 of the keep-alive means 105 are left uncovered by the second insulating layer 120. The external leads are also left uncovered by the second insulating layer 120.

Since the cathode segments of each indicator unit are bombarded by ionized ions emitted from the space discharge layer which can cause them to sputter, it is necessary to form the cathode segments of a metal which resists sputtering and which has a low work function.

For accomplishing this, a thin nickel layer is formed on the various elements of the plurality of indicator units 40 to 45, over the barrier electrode 100 and over the electrodes 106 and 107 by electroplating in a suitable plating bath.

After the indicator units are formed on the base plate 2, the cover plate 3 is attached to the base plate 2 as shown in FIG. 10 by suitable cement or other means so as to form a sealed chamber between the base plate 2 and cover plate 3 which encloses the indicator units. The external leads have portions which extend beyond the cover plate 3 on the base plate 2 so that electrical connection can be made.

The base plate 2 is formed with an opening to which an exhaust tube (not shown) may be connected so as to evacuate the space between the cover plate 3 and the base plate 2 and a suitable ionizing gas may be inserted into the space between the cover plate 3 and the base plate 2.

FIG. 11 is a schematic circuit diagram showing a drive circuit for the display device according to this invention. In the figure the anode electrodes of each indicator unit of the display device 1 are designated by 51. The anode electrodes 51 are respectively connected to a first signal input source 130 through first switching means, for example, transistors 120 to 125. While, the corresponding cathode segments 61 of the indicator units are connected through a lead 72 to a second switching means, for example, a transistor 141 and, similarly, the corresponding cathode segments 62 to 68 of the indicator units are connected to transistors 142 to 148 through leads respectively. The second switching means are connected to, for example, a calculator circuit 151 through a second input signal source 150. Further, a first DC power source 152 is provided for applying a predetermined DC potential to the anodes 51 and the cathode segments of the respective indicator units and the barrier electrode 100 through a resistor. Further, a second DC power source 153 is provided for impressing a predetermined DC voltage between the anode and cathode electrodes 107 and 106

of the keep-alive means 105. The voltage to the keep-alive means 105 may be supplied from the first power source 152 without providing the second power source 153.

The first input signal source 130 serves to determine which indicator unit becomes energized. The source 130 may take the form of a counter so that its output terminals 130a to 130f are energized in a predetermined sequence.

The first and second input signal sources 130 and 150 are synchronously energized in such a manner that when their associated first and second switching means are individually closed at predetermined intervals, particular indicator units are activated to indicate particular numbers in a particular sequence. This sequence of numbers corresponds to the relationship between the outputs of the first and second signal sources 130 and 150. As shown, there may be provided a synchronizing clock pulse source 154 to supply synchronizing signals to the first and second input signal sources 130 and 150.

With the above described arrangement, since the first and second signal sources 130 and 150 sequentially drive the switching means 121 to 125 and 141 to 148 in synchronism as by means of clock pulses, a particular indicator unit is ignited which is simultaneously energized by both the first and second input signal sources. That is, the cathode segments of each indicator unit can sequentially be caused to glow in a time divisional manner.

With such a display device, the indicator units are sequentially energized to glow on a time sequential basis in an order of, for example, 45, 44, . . . 40, thereby to display a number containing a plurality of figures. In such a case, when the first indicator unit 45 is energized again after the indicator unit 40 has been driven, charged particles produced by previous discharge of the first indicator unit 45 have already become extinct in its vicinity and charged particles produced by discharge of the indicator unit 40 do not flow to the indicator unit 45 because the both indicator units are not close to each other, so that initiation of glow of the indicator 45 is delayed, which lowers its glow intensity as compared with that of the other indicator units 44 to 40. This is illustrated in FIG. 12. Namely, in the event that predetermined positive voltages E_{41} , E_{40} , E_{45} , E_{44} , E_{43} , . . . are sequentially applied to the indicator units in an order of 41, 40, 45, 44, 43, . . . , the indicator unit 45 starts to discharge at a time delayed by τ behind that when supplied with the voltage E_{45} . Accordingly, the glow intensity of the indicator units except that 45 varies with time as indicated by curves L_{41} , L_{40} , . . . , respectively, but the glow intensity of the indicator unit 45 varies as indicated by a curve L_{45} , so that the maximum value of glow intensity is smaller and the time for glow discharge is shorter, as compared with those of the other indicator units. As a result of this, the glow intensity of the indicator unit 45 becomes lower which makes it impossible to provide a display of uniform intensity. Especially in the case where the glass envelope is extremely flat as depicted in FIG. 10, the atmosphere in the envelope is not fluid, so that while an erroneous display may well be avoided, the phenomenon such as above described is likely to occur.

With the present invention, however, the keep-alive means 105 consisting of the anode and cathode electrodes 107 and 106 is disposed adjacent the indicator

unit 45 as previously described. The keep-alive means 105 is driven by the DC power source 153 as will hereinafter be described in detail. That is, the DC power source 153 includes switching means (not shown), which is controlled by a pulse from the clock pulse source 154 in such a manner as to be closed immediately before or after termination of glow discharge of the indicator unit 40. When the DC power source 153 is driven under the control of the clock pulse source 154, a predetermined voltage indicated by E_{105} in FIG. 12 is applied between the anode and cathode electrodes 107 and 106 of the keep-alive means 105 to cause glow discharge therebetween, so that gas in the vicinity of the means 105 is ionized, namely particles are charged positive or negative.

With such an arrangement as above described, the keep-alive means 105 is driven immediately before the indicator unit 45 is energized, so that the indicator unit 45 is made ready for glow discharge by the residual ionization of the keep-alive means 105, that is, charged particles produced by the means 105. This ensures that the indicator unit 45 also initiates discharge immediately when supplied with the predetermined voltage, as is the case with the other indicator units 44 to 40. Accordingly, the maximum value of glow intensity of the indicator unit 45 and the time for the glow discharge thereof are equal to those of the other indicator units 44 to 40 as indicated by a curve L'_{45} in FIG. 12, thus providing a display with uniform glow intensity as a whole.

In the case where the indicator units are driven in an order of 45, 43, 41, . . . D_{n-1} and then in an order of 44, 42, . . . D_n , a keep-alive means may be provided adjacent the indicator unit 44, for example, between the indicator units 44 and 45, in which case the keep-alive means is driven after driving of the indicator unit D_{n-1} and then the indicator unit 44 is driven. Further, when the indicator units 45, 44 and 43 are sequentially driven and then the indicator unit D_n is driven without driving the preceding ones 42 to D_{n-1} , a similar keep-alive means is provided adjacent the indicator unit D_n , in which case the keep-alive means is driven first and then the indicator unit D_n is driven. In the case where glow of the keep-alive means 105 is a nuisance or cannot readily be distinguished from that of the indicator units 40 to 45, a black film or the like may be coated on the surface of the cover 3 at an area overlying the keep-alive means 105. Further, the keep-alive means 105 may be driven at all times or in association with closing of a power source switch so as to avoid a time lag in initial ignition of the indicator units. It is also possible to coat the cathode and anode electrodes of the keep-alive means with a radioactive material.

In FIG. 13 there is illustrated another example of this invention. In this figure elements corresponding to those in FIGS. 1 and 2 are identified by the same reference numerals and no detailed description thereon will be repeated. In the present example, the indicator units are sequentially energized in repeating cyclic order of 45, 44, . . . D_n , in which case a charged particle producing means, for example, a luminescent element 200 is provided in the proximity of the first indicator unit 45, for example, immediately on the right thereof. The luminescent element 200 may be, for example, a luminescent diode, an incandescent bulb, a neon tube or the like. In the illustrated example, a light transparent portion (a transparent member or an aperture) 201 is pro-

vided in the glass plate 2 near the indicator unit 45 and a luminescent diode 200 serving as the luminescent member is disposed on the plate below the light transparent portion 201. Reference numeral 202 designates a case for holding the luminescent element 200 in position on the plate 2.

The luminescent member 200 is associated with the power source for the display device. In practice, when the display device is incorporated in an electronic instrument such as an electronic desk computer, the luminescent member is associated with the power source of the electronic instrument. In the present example, an AC voltage from an AC power source AC is converted by a power source 203 into a desired DC voltage and then supplied to the display device and other parts of the electronic instrument but, at the same time, the DC voltage from the power source circuit 203 is directly applied to the luminescent diode 200 acting as the luminescent element. Reference character SW indicates a power source switch, through which the AC power source AC is connected to the power source circuit 203. Where the luminescent element 200 is, for example, an incandescent bulb, a neon lamp or the like, it is also possible to connect it between the power source switch SW and the power source circuit 203 and supply the AC voltage thereto.

Turning on the power source switch SW, the DC voltage is applied from the power source circuit 203 to the luminescent diode 200 as well as the display device and the other parts of the electronic instrument to light the diode 200. Thus, photoelectrons, that is, charged particles are always produced by stimulation with light emitted from the luminescent diode 200 in the vicinity of the indicator unit 45. Further, by lighting of the luminescent diode 200, it is known visually that the power source of the display device or that of the electronic instrument provided with the display device has been turned on.

In the case where the indicator units are sequentially driven in an order from 45 to D_n as previously described in connection with the foregoing example, the indicator unit 45 immediately initiates discharge when a voltage is applied between its anode and desired cathode segments because charged particles are always produced in the neighborhood of the indicator unit 45. Accordingly, the maximum value of glow intensity of the indicator unit 45 and the time for glow discharge thereof are equal to those of the other indicator units, thus ensuring to produce a display with uniform glow intensity as a whole.

Such a luminescent element also serves as a pilot lamp of the power source, so that a special indicator therefor need not be provided and the luminescent element does not disturb the display produced by the display device.

The production efficiency of the charged particles becomes higher as the wavelength of light from the luminescent element 200 becomes shorter.

It is preferred for the function of the power source pilot lamp that the light of the luminescent element is selected to be different in color from that of the indicator units or that the luminous portion of the luminescent element is formed in a peculiar configuration.

Of course, the luminescent element 200 may be disposed on the inside of the envelope formed with the plate 2 and the glass cover 3.

The power source associated with the luminescent element 200 may be a battery or the like.

Further, the relative arrangement of the cathode and anode segments making up each indicator unit is not limited specifically to the above described one but may be selected at will.

Needless to say, the present invention is also applicable to a display device in which indicator units for displaying letters, symbols or the like are sequentially arranged.

The display device of this invention may be used with not only the electronic desk computer but also a telephone, a measuring instrument, a vending machine and so on.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of this invention.

I claim as my invention:

1. A display device comprising: an indicator tube having

a base plate of insulating material;

a plurality of indicator units aligned on one side of said plate, each of said indicator units comprising a plurality of cathode segments arranged in a predetermined configuration on said base plate and at least one anode electrode forming a part of each indicator unit disposed on said base plate;

a transparent cover sealed to said base plate and spaced above said cathode segments and said anode electrodes thereby forming a closed chamber with said cathode segments and anode electrodes therein;

an ionizable gas in said chamber;

means for applying a bias potential to each of said indicator units between the anodes and selected ones of said cathode segments thereof on a time sequential basis beginning with a first one of said indicator units and continuing through a last one of said indicator units; and

means for locally ionizing said gas adjacent said first indicator unit,

means for energizing said last means immediately prior to the time when said first indicator unit is energized, whereby the time for causing said first indicator unit to glow is substantially the same as for said remaining indicator units.

2. A display device according to claim 1, wherein said means for locally ionizing said gas includes a cathode electrode and an anode electrode.

3. A display device according to claim 1, wherein said means for locally ionizing said gas includes a luminescent element disposed in proximity to said first indicator unit on said base plate.

4. A device according to claim 1 in which each of said cathode segments and each of said anode segments have a thin nickel coating thereon.

5. An indicator unit comprising:

a base plate of insulating material;

a plurality of indicator units on one side of the base plate;

a transparent cover sealed to said base plate and forming a chamber therewith enclosing said indicator units;

an ionizable gas within said chamber;

each of said indicator units including a plurality of cathode segments in a discrete pattern located in a single plane; and at least one anode segment for

each of said indicator units in the plane of said cathode segments;
 an electrode for each indicator unit having portions which surrounds the cathode segments of that indicator unit and located in the same plane as said cathode segments;
 the cathode segments of each indicator unit being connected through leads to similarly positioned cathode segments of all indicator units;
 means during each indicating cycle for time sequentially applying a bias potential to each of said anode segments sufficient to cause ionization of gas adjacent those cathode segments of each indicator unit whose anode segment is so biased when such cathode segments are given a decoding potential negative with respect to said anode segment;
 means for sequentially connecting a decoding potential to those cathode segments of each indicator tube to form the desired pattern;
 means for applying a biasing potential to said electrode with a potential insufficient to cause ionization but sufficient to act as an ion barrier;
 keep-alive electrode means adjacent said indicator unit which is first to be energized during each indicating cycle; and
 means for energizing said keep-alive electrode means each cycle just prior to the energization of the first of said indicator units in said cycle.

6. A device according to claim 5 in which each of said indicator units and each of said barrier electrodes have an electro-plated coating of nickel thereon.

7. A display device comprising:
 A plurality of indicator units formed on a plate of an insulating material for sequential energization, each of said plurality of indicator units consisting of a plurality of first electrode segments lying in a single plane arranged in a predetermined configuration and at least one second electrode in proximity to each indicator unit group of said first electrode segments also lying in said single plane;
 a plurality of first leads each connected to corresponding ones of said first electrode segments of said indicator units;
 a plurality of second leads each connected to a different one of said second electrodes of said indicator units;
 a transparent cover of an insulating material covering at least one side of said insulating plate to form an envelope;
 an ionizable gas sealed in said envelope; and
 means for producing ionized charged particles within said envelope adjacent at least one of said indicator units prior to activation of said one indicating unit.

8. A display device as claimed in claim 7, wherein said indicator units lie on said insulating plate in alignment with one another and said transparent cover is mounted on said plate so as to accommodate all of the said indicator units and ionized charged particle producing means.

9. A display device as claimed in claim 8, wherein said charged particle producing means comprises an anode electrode and a cathode electrode to be supplied with a predetermined voltage therebetween.

10. A display device as claimed in claim 9 wherein said cathode and anode electrodes of said charged particle producing means are formed on said insulating plate.

11. A display device as claimed in claim 8, wherein said particle producing means lies in alignment with said indicator units.

12. A display device as claimed in claim 7, wherein said particle producing means is an electric-to-light conversion element.

13. A display device as claimed in claim 12, wherein said electric-to-light conversion element is disposed on said insulating plate.

14. A display device as claimed in claim 12, wherein said electric-to-light conversion element is energized by turning on a power source switch.

15. A display device comprising an indicator tube having:
 a base plate of insulating material;
 a plurality of indicator units aligned on one side of said plate, each of said indicator units comprising a plurality of cathode segments arranged in a predetermined configuration on said base plate and at least one anode electrode forming a part of each indicator unit disposed on said base plate;
 a transparent cover sealed to said base plate and spaced above said cathode segments and said anode electrodes thereby forming a closed chamber with said cathode segments and anode electrodes therein;
 an ionizable gas in said chamber;
 means for applying a bias potential to each of said indicator units between the anodes and selected ones of said cathode segments thereof on a time sequential basis beginning with a first one of said indicator units and continuing through a last one of said indicator units; and
 means for locally ionizing said gas adjacent said first indicator unit,
 means for energizing said last means immediately prior to the time when said first indicator unit is energized, whereby the time for causing said first indicator unit to glow is substantially the same as for said remaining indicator units,
 said base plate having a transparent portion there-through adjacent said first indicator unit, and wherein said means for locally ionizing said gas includes a light producing source below said transparent portion for ionizing the gas adjacent said first indicator unit just prior to energization of said first indicator unit.

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