Aug. 15, 1961 G. F. KLEPP ET AL 2,996,635

COLD CATHODE CHARACTER DISPLAY TUBES

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FIG.1.

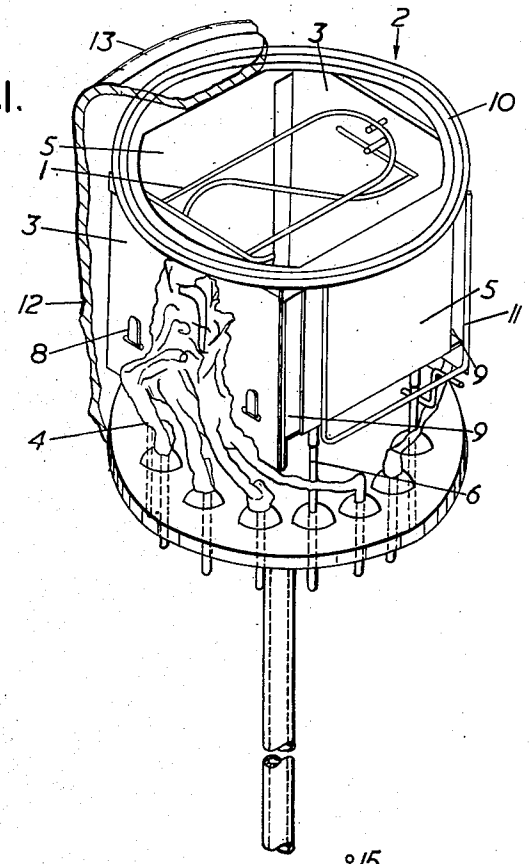

FIG.2.

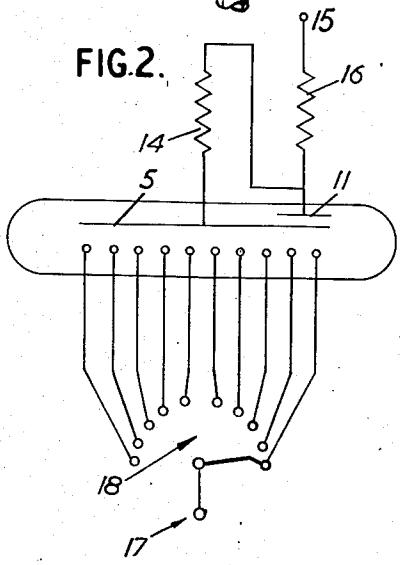

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FIG. 3.

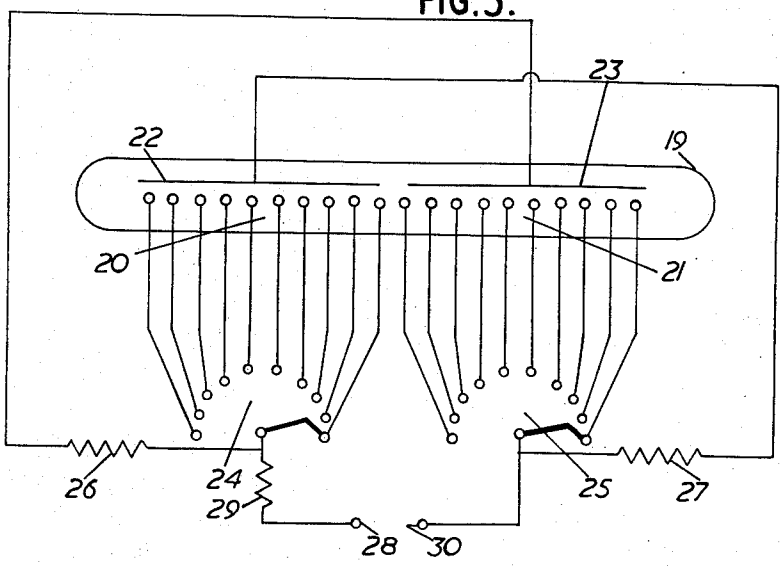
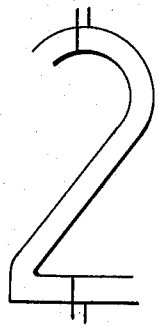


FIG. 4.



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COLD CATHODE CHARACTER DISPLAY TUBES

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1 Claim. (Cl. 313—109.5)

The present invention relates to cold cathode character display tubes and circuit arrangements therefor.

In known arrangements employing cold cathode character display tubes it is usual to operate the tube by applying direct voltages to two or more of the electrodes. These voltages must usually be obtained by rectifying an alternating supply voltage, which involves an increase in the number of components required. The circuitry is simplified if the need for rectification circuits is removed.

Accordingly the present invention provides a circuit arrangement which includes a cold cathode character display tube and means for applying alternating voltages to at least two of the electrodes in said tube, whereby at least one character is displayed.

There is further provided a cold cathode character display tube having at least one electrode shaped to form a character, an additional electrode, and means for substantially screening said additional electrode from external view.

In the present specification an electrode is defined as "substantially screened from external view" if it is situated in such a position that when it is illuminated and the tube is viewed along the normal viewing direction then substantially all of the light from that electrode is masked from view.

The invention will be described with reference to the accompanying drawings in which:

FIG. 1 shows a cold cathode character display tube according to the invention;

FIG. 2 shows a circuit arrangement according to the invention;

FIG. 3 shows a further circuit arrangement according to the invention; and

FIG. 4 shows one of the electrodes of another type of cold cathode character display tube according to the invention.

The cold cathode character display tube illustrated in FIG. 1 can be operated from a D.C. supply, in the known manner, or from an A.C. supply, as is explained hereinafter. In either case any one of a series of suitably shaped electrodes making up an electrode stack 1 can be illuminated. The viewing direction is indicated by the arrow 2 in FIG. 1.

Each electrode in the electrode stack 1 is made from nickel wire which has been bent into the form of a character, those visible in FIG. 1 being shaped to form the numerals "0" and "2." They are mounted between two electrode support micas 3, each of which consists of two thin sheets of mica spaced apart. It is not possible to see the separate sheets making up each electrode support mica 3 in the view shown in FIG. 1. The electrodes are connected to the outer sheet of each electrode support mica 3 by means of connecting wires which pass through clearance holes in the inner sheets. The latter act as protective masks which reduce the possible occurrence of leakage paths on the outer sheets due to sputtered metal from the electrodes. Insulated leads 4 complete the connection of the electrodes to the pins of the tube.

A U-shaped box structure 5 is made from pure nickel, carbonised on the inside, and is connected to one of the pins of the valve by means of lead 6. The electrode stack 1 is thus enclosed within an open box formed by the two

electrode support micas 3 and the three sides of the box structure 5. As viewed along the direction 2 in FIG. 1 the bottom of the box structure 5 fits closely up against the electrode support micas 3 and is connected to them by bent-over portions 8. On the other hand there are gaps 9 between the sides of the box structure 5 and the electrode support micas 3. A front shield 10 is welded to the top of the box structure 5.

Mounted apart from the electrodes in the electrode stack 1 and shielded from them by the box structure 5 is an additional electrode 11. It consists of nickel wire bent into the form of the letter U, the two arms of the U running parallel to the gaps 9.

The whole assembly described above is enclosed inside a glass envelope 12 which is filled with an atmosphere of 99% neon plus 1% argon. A mask 13 which may be a layer of paint or a metallic film covers the whole of the sides of the glass envelope 12.

The box structure 5, front shield 10 and mask 13 are mounted in such positions that the additional electrode 11 is substantially screened from external view.

The cold cathode character display tube illustrated in FIG. 1 can be operated from a direct current supply by connecting the box structure 5 to the positive terminal and the appropriate electrode in electrode stack 1 to the negative terminal. With a supply voltage of approximately 200 volts and a limiting resistor of 12K in the box structure circuit the electrode connected to the negative terminal glows in the known manner.

For A.C. operation the circuit illustrated in FIG. 2 is used. The box structure 5 is connected to the additional electrode 11 by means of a resistor 14, and thence to a terminal 15 by a resistor 16. Any one of the electrodes in the electrode stack 1 can be connected to a terminal 17 through switch 18. With an A.C. supply voltage of 240 volts applied between terminals 15 and 17 suitable values for the resistors 14 and 16 are 100K and 18K, respectively.

The operation of the circuit arrangement is as follows: During those half cycles of the applied voltage when the box structure 5 and additional electrodes 11 are positive with respect to the electrode connected to switch 18 no current flows through the tube until the applied voltage reaches a certain value. At this value electrical breakdown occurs between the box structure 5 and the electrode connected to switch 18, and current begins to flow. The breakdown occurs between the box structure 5 and the electrode stack 1 rather than between the additional electrode 11 and the electrode stack 1 because the box structure 5 is much closer to the electrodes in electrode stack 1, and the voltage required for breakdown increases with distance. However, once a breakdown has occurred the current is thereafter carried almost wholly by the additional electrode 11, since the box structure 5 has the additional high-value resistor 14 in series with it. Although the additional electrode 11 is shielded from the electrodes in electrode stack 1 by the box structure 5 current can flow from one to the other through the gaps 9.

On the opposite half cycles of applied voltage, when the electrode in electrode stack 1 is positive with respect to the box structure 5 and the additional electrode 11, the additional electrode again carries substantially all of the current and, since it is now acting as a cathode, glows.

The operation described above results in one of the electrodes in electrode stack 1 and the additional electrode 11 glowing during opposite half cycles of the supply voltage, and with a 50 cycle supply both give the appearance of continuous illumination. It is for this reason that the box structure 5, additional electrode 11, front shield 10 and mask 13 are shaped and positioned as illustrated in FIG. 1. The box structure 5 prevents substantially all of the light from the glow on the addi-

tional electrode **11** from entering the region of the electrode stack **1**, its inner, carbonised surface reducing any reflections to a minimum. The front shield **10** blocks out the additional electrode **11** as viewed along the direction of the arrow **2** in Fig. 1 and, finally, the mask **13** stops light from being transmitted through the sides of the glass envelope **12**.

The circuit illustrated in FIG. 3 employs a tube **19** which is shown diagrammatically only in FIG. 3 and which is of different construction from that shown in FIGS. 1 and 2 but which is likewise suitable for D.C. or A.C. operation. It enables two characters, for example, two numerals or a numeral and a plus sign, to be displayed simultaneously.

The tube itself contains two electrode stacks **20** and **21**, each of which is similar to that designated **1** in FIG. 1 and is likewise provided with an adjacent box structure, **22** and **23**, respectively. The two electrodes stacks are situated side by side as viewed along a direction corresponding to that of the arrow **2** in FIG. 1. There is no additional electrode corresponding to that in the tube illustrated in FIG. 1 and the tube can be operated from a D.C. supply by connecting the appropriate electrodes in the electrode stacks **20** and **21** to the negative pole and the box structures **22** and **23** to the positive pole.

For A.C. operation the circuit arrangement of FIG. 3 is used. Each electrode in the electrode stack **20** is connected to a different terminal on a switch **24** and each electrode in electrode stack **21** to a different terminal on a switch **25**. The movable arms of switches **24** and **25** are connected via resistors **26** and **27**, respectively, to the box structures **23** and **22**, respectively. The movable arm of the switch **24** is also connected to a terminal **28** by means of a resistor **29**, and that of the switch **25** is connected directly to a terminal **30**. With an A.C. supply of 240 volts applied across the terminals **28** and **30** the resistors **26** and **27** should be approximately 100K and the resistor **29** is approximately 18K.

The operation of the circuit arrangement is as follows: During one half cycle of the alternating voltage applied to the terminals **28** and **30** one of the electrodes in the electrode stack **20** is negative with respect to the box structure **22** and to one of the electrodes in the electrode stack **21**. Since the box structure **22** is situated very close to the electrode in electrode stack **20** the initial electrical breakdown takes place in the gap between them. Immediately afterwards, however, the main current flows from the electrode in electrode stack **20** to that in electrode stack **21**, since the resistor **27** limits the current which can flow to the box structure **22**. The electrode in electrode stack **20** is acting as a cathode during this half cycle of the applied voltage and is covered by a cathode glow. During the opposite half cycle it is the electrode in electrode stack **21** which is connected to the negative pole of the supply voltage and glows.

As a result of the above action one electrode in the electrode stack **20** and one in the electrode stack **21** are illuminated on alternate half cycles of the applied voltage, and if a 50 cycle supply is used both give the appearance of continuous illumination. The box structures **22** and **23** are responsible for the initial electrical breakdowns but are prevented from carrying sufficient current for them to glow by the resistors **26** and **27**.

If the electrodes in the electrode stack **1** in FIGS. 1 and 2 or electrode stacks **20** and **21** in FIG. 3 are made from .02" diameter nickel wire then the line width, or width of the glow, will appear disproportionately narrow for characters of 1" or more in height. One way of increasing the line width would be to make the electrodes from flat strip of greater width than the above wire. However, such strip would not only obscure other characters situated behind it in the stack but would also require treating by some inhibiting method to prevent the glow from spreading round to its back. Instead of this characters such as that shown in FIG. 4 are used. This figure shows a numeral "2" which is made from twin wires suitably spaced to give increased line width without unduly obscuring other electrodes in the stack. The character is 2" in height and is made from pure nickel wires of .02" diameter spaced .08" between centres. With a gas atmosphere of 99% neon plus 1% argon the diameter of the glow sheath is approximately .08" and the total width of any line in the character is approximately .16". The characters may also be constructed by blanking from suitable mesh.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What we claim is:

A character display tube comprising a gas-filled envelope containing an array of electrodes shaped in distinctive form, an additional electrode, shielding means having a portion thereof intermediate said array and said additional electrode, said shielding means disposed about said array, glow-reflection inhibiting means applied to the surface of said shielding means facing said array, at least one aspect of said array being visible through said envelope, whereby when an alternating voltage is applied between any given electrode of said array on the one hand and said additional electrode on the other, said given electrode and said additional electrode will alternately glow on receipt of negative portions of the cycle of said applied voltage, only the glow on said given electrode being visible through said envelope.

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