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Janssen

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[54] **SUPPLY CIRCUIT FOR A GAS DISCHARGE CHARACTER DISPLAY TUBE**

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[52] **U.S. Cl.** ..... **315/84.6,** 315/169 R

[51] **Int. Cl.** **H01j 17/48**

[58] **Field of Search** ..... 315/169 R, 84.6; 313/109.5

[56] **References Cited**

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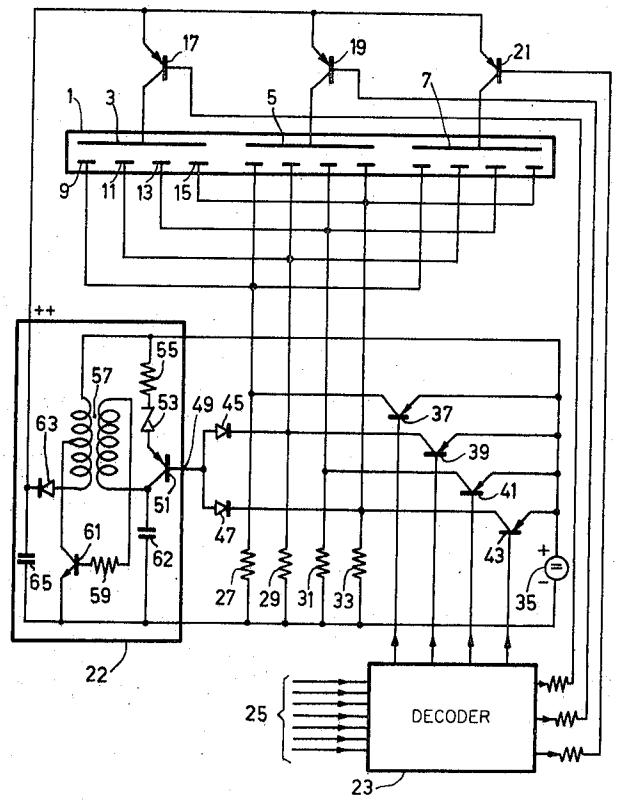
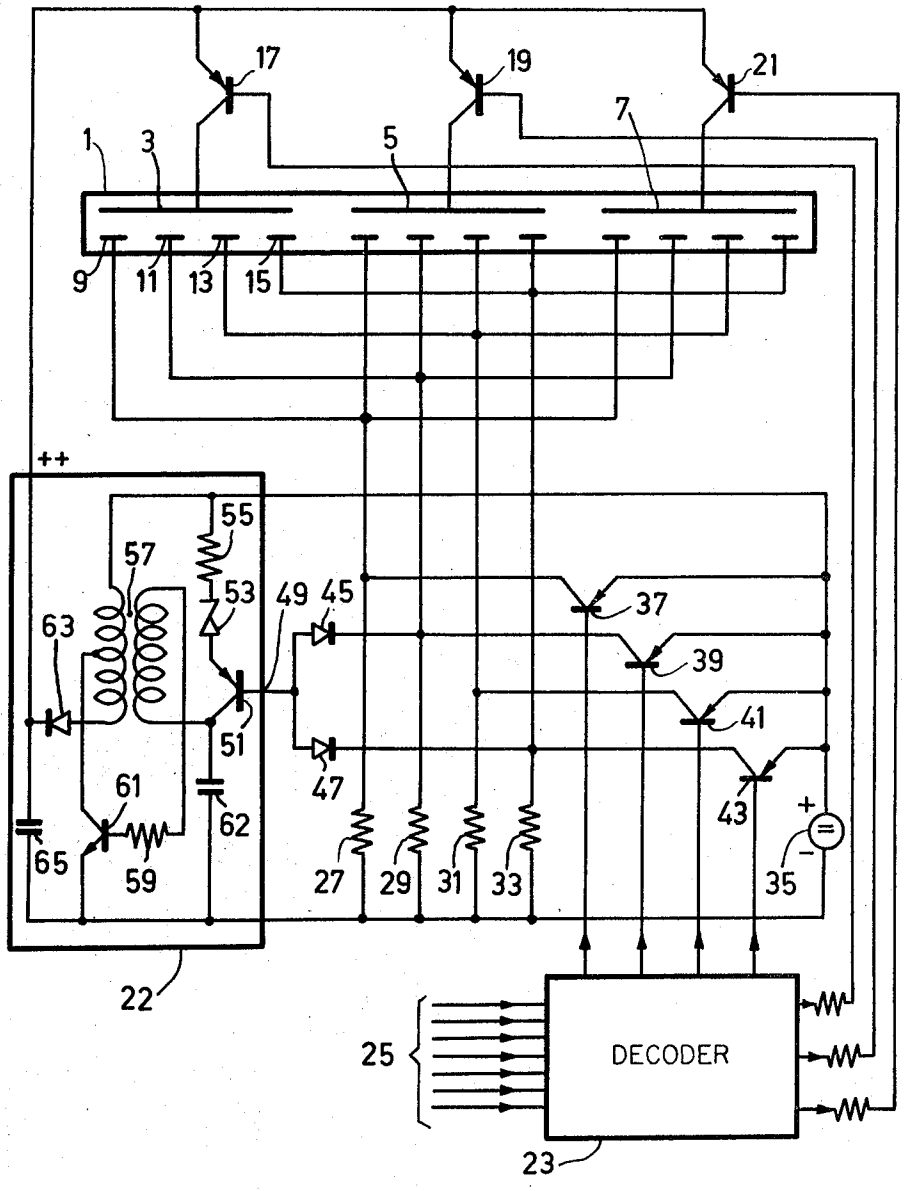
[57] **ABSTRACT**

A supply circuit for a gas discharge character segment display tube in which the cathode circuit of one or more cathodes luminescing upon the display of each character includes a measuring resistor from which a control voltage is derived for a supply voltage control.

10 Claims, 1 Drawing Figure

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SUPPLY CIRCUIT FOR A GAS DISCHARGE CHARACTER DISPLAY TUBE

The invention relates to a supply circuit for a gas discharge character display tube having at least one anode and at least two cathodes cooperating with said anode, said supply circuit including a stabilised current source circuit for supplying an electrode of the gas discharge character display tube with a substantially constant current, said stabilised current source circuit including a measuring resistor across which a voltage is maintained constant by the stabilised current source circuit by controlling an anode supply voltage.

A supply circuit of the kind described above is known from "Philips Application Information 334" for a gas discharge character display tube in which the cathodes in the area of contact with the gas in which the discharge takes place have the shape of a character to be displayed.

An object of the present invention is to provide a supply circuit for a different type of gas discharge display tube.

According to the invention a supply circuit of the kind described in the preamble is characterized in that the gas discharge character display tube is a character segment display tube with which segments of characters can be displayed by means of a plurality of cathodes while the measuring resistor is arranged in a cathode circuit of a cathode which is common to different characters, and which is, optionally, shielded from visual observation.

The applicant has found that character segment tubes exhibit a small spread in cathode current density at a given anode voltage. Stabilisation of the current of a cathode which for a plurality of characters to be displayed must luminesce as a section of these characters is found to be a surprisingly favourable replacement of the anode current stabilisation which for these types of tubes would produce a luminosity which is different from character to character.

In order that the invention may be readily carried into effect, an embodiment thereof will now be described in detail, by way of example, with reference to the accompanying diagrammatic drawing the sole FIGURE of which illustrates by means of a non-detailed circuit diagram a supply circuit according to the invention for a multiple character segment tube.

In the FIGURE a gas discharge multiple matrix character segment display tube **1** has a plurality of anodes **3, 5** and **7** and cathodes cooperating therewith in which only the cathodes facing anode **3** have reference numerals **9, 11, 13** and **15.** Corresponding cathodes facing the other anodes are interconnected to these cathodes.

The anodes **3, 5** and **7** are connected through pnp transistors **17, 19** and **21** to the positive terminal (++) of a controlled supply source **22** which serves as a stabilised current source circuit.

The bases of transistors **17, 19** and **21** are connected to a decoder circuit **23** having input lines **25** which receive signals that relate to a desired character to be displayed.

As regards the visible part of their surface of contact with the gas in the display tube **1,** the cathodes **9, 11, 13** and **15** have the shape of a section or segment of a character to be displayed and they are each connected through resistors **27, 29, 31** and **33,** respectively, to the negative terminal (−) of a supply source **35** which produces a voltage of, for example, 25 Volts.

The connections between cathodes **9, 11, 13** and **15** and resistors **27, 29, 31** and **33** are applied through pnp transistors **37, 39, 41** and **43,** respectively, to a positive terminal (+) of supply source **35.** The bases of these transistors are connected to the decoder circuit **23.** Of transistor **37, 39, 41** and **43** those transistors are cut off whenever the cathodes connected to their collectors must luminesce.

The area opposite the anode where the relevant cathode is to luminesce is determined by the conductance of one of the transistors **17, 19** or **21.**

The connections between cathodes **11** and **15** and resistors **29** and **33** are applied through diodes **45** and **47,** respectively, to a control input **49** of the controlled supply source **22.**

Cathodes **11** and **15** are cathodes which are common to a plurality of characters to be displayed. At least one of these two cathodes luminesces for all characters to be displayed. The voltage drop across resistor **29** or **33** is then low and one of the diodes **45** or **47** conducts.

The current then flowing through one of these diodes **45, 47** flows through a base of a pnp transistor **51** connected to the control input **49,** the emitter of said transistor being connected through a series arrangement of a zener diode **53** and a resistor **55** to the positive terminal (+) of supply source **35.** The difference between the emitter voltage and the voltage across the resistor **29** or **33** serving as a measuring resistor determines the base and collector currents of transistor **51.**

The collector of transistor **51** is connected through a winding of a transformer **57** and a resistor **59** to the base of an npn transistor **61.** The collector of transistor **51** is furthermore decoupled with respect to alternating voltage through a capacitor **62.**

Transistor **61** and transformer **57** constitute a voltage converter circuit which converts a direct voltage supplied by supply source **35** into an alternating voltage of a higher value which is rectified through a diode **63** and is smoothed by a capacitor **65** and which provides a high direct voltage for the (++) terminal of supply source **22.**

As a result of the collector current of transistor **51,** which current is dependent on the voltage across resistor **29** or **33,** the voltage at the (++) terminal is controlled in such a manner that the voltage across this resistor **29** or **33** is maintained substantially constant and hence the current flowing to the relevant cathode.

Resistors **27, 29, 31** and **33** are chosen to be preferably such that the current density for the relevant cathodes becomes substantially equal and they must then be chosen dependent on the surface of the relevant cathode.

The voltage drop across these resistors generally need not be larger than approximately 5V.

In the embodiment described a gas discharge character multiple section display tube is shown, i.e., a tube which is suitable for the substantially simultaneous display of a plurality of characters. Examples of this type of tube are illustrated in U.S. Pat. No. 3,418,509, 3,731,132 and 3,619,694. It is alternatively possible to use a separate tube for each character to be displayed. It is then recommended to choose the control time constant of the stabilisation circuit to be sufficiently short so as to compensate for a spread among the

tubes. The gas discharge character segment display tube may be of a type equipped with control grids.

Although a converter circuit is shown as the anode supply source, it will be evident that any suitable controllable supply circuit may be used.

The pnp transistors **37, 39, 41** and **43** may alternatively be p-channel MOS transistors which may be incorporated in an integrated circuit.

The various cathodes may be ignited with the aid of transistors arranged in series with the resistors **27, 29, 31** and **33** instead of the parallel arrangements of the transistors **37, 39, 41** and **43** used in this case. Furthermore it is possible to use a separate decoding circuit for each character position and to omit the anode transistor switches. The cathodes whose current is to be stabilised must then each be coupled to the control input through diodes.

If the gas discharge character section display tube includes an auxiliary cathode arranged in an invisible position and being comparable with the normal visibly arranged cathode, which auxiliary cathode would convey current upon display of each character, control input **49** may be coupled permanently, for example, through a resistor to this auxiliary cathode. In that case the measuring resistor of the stabilisation circuit must be arranged in the auxiliary cathode circuit.

What is claimed is:

1. A display system comprising a gas discharge character segment display tube in which segments of characters can be displayed by means of a plurality of cathodes, said display tube comprising a plurality of electrodes including at least one anode electrode and at least two cathode electrodes cooperating with said anode, at least one of the tube cathodes being common to different characters to be displayed, and a stabilised current source circuit for supplying the tube anode voltage and one of said cathodes of the gas discharge character display tube with a substantially constant current and including a measuring resistor connected in the cathode circuit of said common cathode, said current source circuit being responsive to a voltage developed across said resistor for controlling the tube anode supply voltage so as to maintain the voltage across the resistor constant.

2. A display system as claimed in claim **1,** further comprising a plurality of resistors each connected individually in a different cathode circuit of the display tube, at least one other tube cathode being common to different characters to be displayed, and means for coupling said one common cathode and said one other common cathode through a gating circuit of the OR-type to a control input of the stabilised current source circuit.

3. A display system as claimed in claim **2,** characterized in that the resistors in the cathode circuits each have a value which varies with the active surface of the corresponding cathodes.

4. A display system as claimed in claim **1** wherein the gas discharge character segment display tube is of the multiple matrix type for the substantially simultaneous display of a plurality of characters and having a common cathode for each character, and means for coupling the common cathodes through a gating circuit to a control input of the stabilised current source circuit.

5. A display system as claimed in claim **1** wherein the display tube includes an auxiliary cathode shielded from visual observation, and means connecting the measuring resistor in the cathode circuit of said auxiliary cathode.

6. A display system comprising a gas discharge character segment display tube, said tube comprising a plurality of electrodes including at least one anode electrode and a plurality of cathode electrodes cooperatively disposed to said anode, at least one of the tube cathodes being common to different characters to be displayed, a regulated source of current having output terminals coupled to the tube electrodes to supply operating voltages across the tube anode-cathode circuits, a measuring resistor connected in the cathode circuit of said common cathode across which a control voltage is derived from the current supplied by said regulated current source, and means for applying said control voltage to a control input terminal of the regulated current source, said regulated current source including means responsive to said control voltage for controlling the tube operating voltage in a manner to maintain the voltage across said resistor substantially constant whereby at least one electrode of the display tube draws a substantially constant current from the regulated current source.

7. A display system as claimed in claim **6** further comprising a plurality of resistors each individually connected to a given one of the cathodes of said display tube, at least one other of said tube cathodes being common to the different characters to be displayed, and a diode gate circuit for coupling the common cathodes to the control input terminal of the regulated current source.

8. A display system as claimed in claim **6** wherein the display tube includes a second anode and a second plurality of cathodes cooperatively disposed therewith, means for connecting cathodes of the first group of cathodes to the corresponding cathodes of the second group of cathodes, first and second switching devices for coupling the first and second anodes, respectively, to one output terminal of the current source, a plurality of other switching devices each coupled individually to a pair of corresponding cathodes of the first and second group of cathodes to selectively control cathode current, and a decoding circuit having output terminals coupled to said switching devices for switching same in accordance with the characters to be displayed.

9. A display system as claimed in claim **8** wherein at least one cathode of the second group of cathodes is common to the different characters to be displayed and includes a measuring resistor in the cathode circuit thereof for deriving a control voltage, and a gating circuit for coupling all of said common cathodes to the control input of the regulated current source.

10. A display system as claimed in claim **6** wherein the display tube includes an auxiliary cathode shielded from view and common to the different characters to be displayed, and wherein said measuring resistor is connected in the cathode circuit of said auxiliary cathode.

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