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F. F. CRAWFORD ETAL

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HIGH VACUUM DISPLAY DEVICE

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FIG. 1

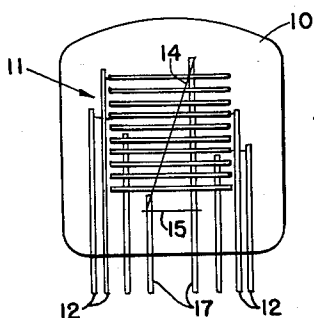


FIG. 2

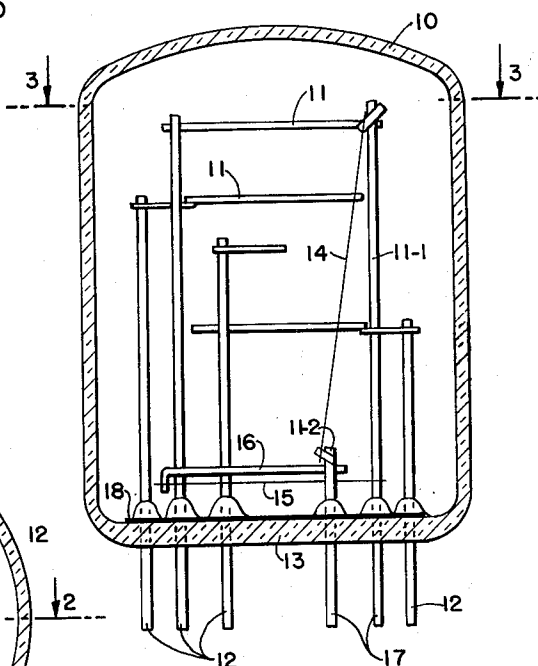


FIG. 3

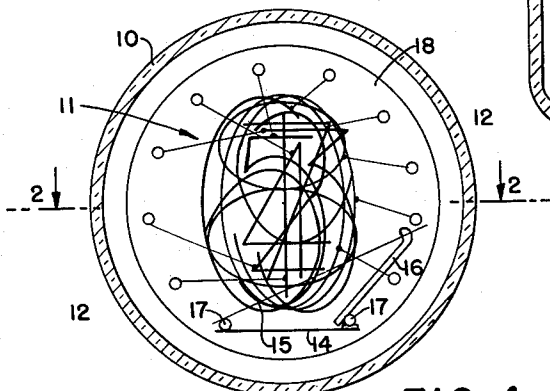
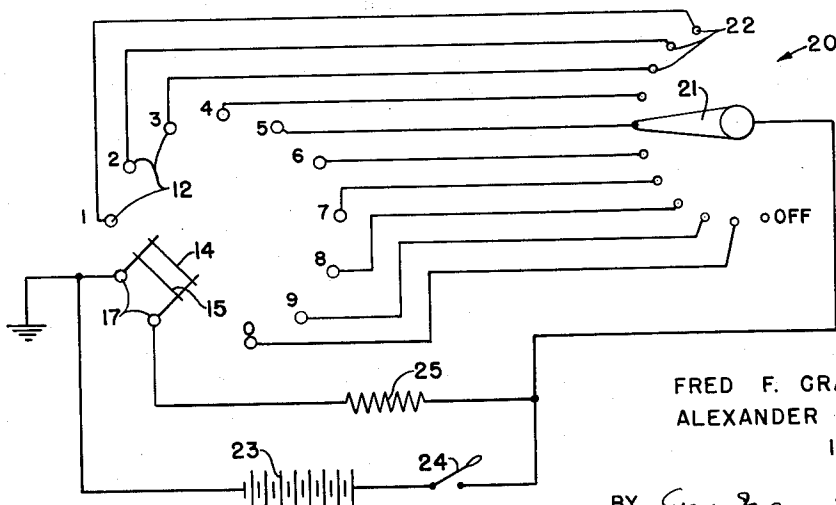


FIG. 4



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HIGH VACUUM DISPLAY DEVICE

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3 Claims. (Cl. 313-108)

This invention relates to a display device in which the characters displayed are anodes and the common electrode is the cathode. The envelope is pumped to produce a high vacuum and a chemical getter is included within the tube to maintain a vacuum which does not have enough gas for the glow-type of conduction.

Many types of indicator tubes and display devices have been manufactured using gas at reduced pressure within an envelope. These types have a common anode and a plurality of cathodes formed with distinctive shapes to indicate digital values. Such tubes are generally of short life and the envelope discolors easily because of the material sputtered from the wire cathodes. Applicant's tube, hereinafter described, uses a high vacuum and two electron emitting cathodes which are heated by external means to produce a large number of electrons and make these electrons available to any one of a number of anodes which are coated with a fluorescent substance. When an anode is switched into the circuit by connecting it to a positive potential, it shines with a distinctive color to indicate a number or a letter. One of the faults of gas indicator tubes is the large amount of sputtering by the digital cathodes. In the present tube, the indicators are anodes surrounded by a fluorescent coating and these anodes are not subject to the usual sputtering operation and therefore the interior of the glass envelope does not become dark with continuous use.

One of the objects of this invention is to provide a display device having a long life.

Another object of the invention is to increase the luminosity of the characters displayed.

Another object of the invention is to provide a display device wherein the light provided by each display unit is equally spread over each unit, thereby eliminating hot spots and portions of the electrode which may form an arc discharge.

Another object of the invention is to provide a display device which can be designed to show characters in many different colors.

Another object of the invention is to provide a display device having a transparent envelope which does not darken with continued use.

The invention comprises a high vacuum display device comprising an evacuated transparent envelope containing a plurality of anodes and two cathodes. Each of the anodes are connected to lead-in conductors and each are formed in a distinctive symbolic manner. Each anode is formed with a central conductor which is surrounded by a fluorescent coating which gives off a distinctive light when bombarded by high speed electrons. One of the cathodes is an elongated electron emitting conductor which is mounted at right angles to the axis of the envelope. The other cathode is a similar arrangement but is mounted substantially parallel to the envelope axis. Both cathodes are connected to lead-in conductors so that they may be heated by a source of external electrical power.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

FIG. 1 is a side view of the display device showing the pins, the supporting conductors, the two cathodes, and the display anodes.

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FIG. 2 is a cross sectional view of the display device taken along line 2-2 of FIG. 3 and showing six of the lead-in conductors with the two cathodes and some of the anodes.

FIG. 3 is a cross sectional view of the display device shown in FIG. 2 and is taken along line 3-3 of that figure.

FIG. 4 is a schematic diagram of connections showing an external power supply and switching circuit connected to the lead-in conductors for operating the device.

FIG. 1 shows a transparent envelope 10, a plurality of anode display wires 11, and a plurality of external pin connectors 12 which can be fitted into a socket for connection to a suitable power supply and switching circuit. The details of construction of the display device are indicated in greater detail in FIGS. 2 and 3 where the pins 12 are sealed within a base portion 13 and extend in a direction parallel to the axis of the tube and thereby form supporting rods to which the display characters 11 can be welded. It is to be understood that in case of the larger sizes of indicator devices, other means of support will be necessary and these supports may include conventional glass insulator rods similar to those used as supporting means for the electron guns in cathode ray picture tubes.

One of the rod conductors 11-1 forms a supporting means for the upper end of a vertical cathode 14, the lower end of which is connected to a similar support 11-2. The cathode 14 may be a tungsten or alloy wire coated with the usual electron emitting film or the cathode could be a hollow cylindrical conductor with electron emissive material on its outer surface and with a heater wire inside. A second similar cathode 15 is mounted horizontally as shown in FIG. 2 having one end connected to support rod 11-1 and the other end connected to a horizontal conductor 16 which is welded to support rod 11-2. This arrangement connects the two cathodes in parallel so that a single source of potential applied to pins 17 will cause current to flow through both wires and raise the cathode temperature to a point where electrons will be emitted. It has been found by experiment that the combination of two cathodes, one horizontal and one vertical, provides a sufficiently even distribution of electrons within the discharge space so that a positive voltage applied to any one of the anodes 11 draws electrons to all parts of the anode surface and provides illumination of the entire anode area.

It has been found that the illuminated portions of the anode can be made more readily visible and distinctive by applying a black insulating coating 18 to the base of the tube. This coating may be incorporated in the glass base 13 or it may be a deposit on the inside surface of the base.

The anode wires 11 are conductive and can be made of copper or nickel or any other suitable substance. They are coated with a fluorescent material similar to the type used in the picture screens of cathode ray receiving tubes. It is obvious that a wide range of colors is available to the tube designer and also different colors may be used in the same tube. For example, all the digit figures from one to nine may have a coating which produces a white light when connected in the circuit while the zero character may show red when it is connected. Other combinations of colors, depending upon the practical application desired, may be used. FIG. 3 shows all the digits from zero to nine, inclusive, as they appear when not illuminated. When one of the anodes is connected in the circuit, the light it produces is sufficiently intense to shine through the unlighted display wires positioned between the lighted anode and the upper end of the tube so that the intervening wires can not be seen if the viewing distance is greater than one foot.

The schematic diagram of connections shown in FIG.

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4 is illustrative of one method of lighting the various digital displays under control of a dial switch 20 having a rotatable contact arm 21 and a plurality of contact points 22 which are connected directly to the contact pins 12. In this example, the display device is operated by a source of direct current which may be a battery 23 having its negative terminal connected to one of the cathode conductors 17 and its positive terminal connected through a switch 24 to the contact arm 21. This same source of potential may be employed to heat the cathodes 14 and 15 and for this purpose the other conductor 17 is connected in series with a dropping resistor 25 to the positive side of the battery 23. It will be obvious that other sources of potential can be used, if desired, a separate source of current may be applied to the cathodes 14 and 15.

In the drawings, only cathodes and anodes have been shown without grids or accelerating electrodes. It is well known that many types of accelerating electrodes can be used, adjacent to a cathode, to speed up the electron stream and provide the electrons with more energy. Experiments have indicated that, in general, accelerating electrodes are not necessary and the display devices work quite well without them. However, there may be times when such electrodes increase the luminosity of the characters, and it is to be understood that the invention may include these additional components when necessary.

In the drawings only digit displays have been shown. It is obvious that letters, signs, and other indicia can be used. Also, any number of cathodes may be used, distributed throughout the envelope.

The foregoing disclosure and drawings are merely il-

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lustrative of the principles of this invention and are not to be interpreted in a limiting sense. The only limitations are to be determined from the scope of the appended claims.

5 We claim:

1. A high vacuum display device comprising, a cylindrical evacuated transparent envelope containing a plurality of anodes and two cathodes, each of said anodes connected to a lead-in conductor and each formed in a distinctive symbolic manner, each of said anodes including a conductor surrounded by a fluorescent coating, one of said cathodes including an elongated electron emitting surface mounted at right angles to the axis of the envelope, the other of said cathodes including an elongated electron emitting surface mounted substantially parallel to the tube axis, and electrical means for heating both cathodes.

2. A high vacuum display device as claimed in claim 1 wherein said electrical means includes two lead-in conductors sealed in the envelope with their inside ends connected to the two cathodes and their outside ends available for connection to an external source of electrical power.

3. A high vacuum display device as claimed in claim 1 wherein the interior surface of a portion of the envelope is coated with a non-reflecting film.

References Cited in the file of this patent

UNITED STATES PATENTS

2,891,184	Haddad	June 16, 1959
2,957,098	Bernstein	Oct. 18, 1960