Dec. 4, 1962 J. H. McCAULEY 3,067,355

INDICATOR TUBE

Filed March 16, 1960

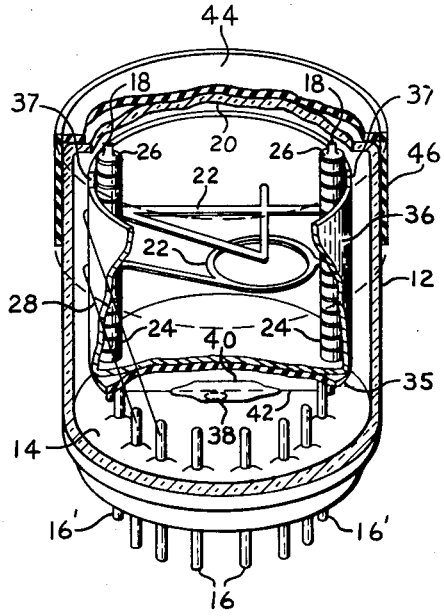

Fig. 1

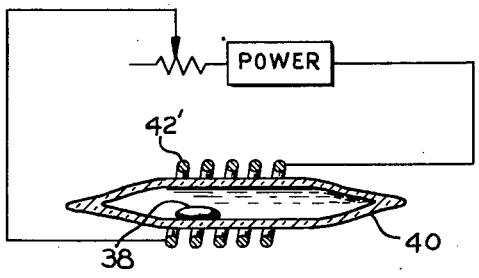

Fig. 2

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INDICATOR TUBE

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This invention relates to cold cathode gaseous indicator tubes and particularly to tubes of this type which may be constructed and operated to provide light output of different colors.

Cold cathode gaseous indicator tubes generally include a plurality of cathode electrodes in the form or indicator characters mounted in a suitable envelope filled with an ionizable gas such as neon, argon, or the like. Such tubes provide cathode glow having a characteristic color which is determined by the gas filling in the envelope. Presently available commercial devices of this type produce cathode glow which is generally pink, orange, or red. There are many applications in which, for example, blue light is desirable. However, at the present time, a cold cathode indicator or readout glow tube providing blue or other light output cannot be made simply and inexpensively and in commercial quantities.

Accordingly, the principles and objects of the present invention are concerned with the provision of an improved cold cathode gaseous indicator glow tube which may be adapted to provide different colors of light output.

Briefly, a gaseous cold cathode indicator glow tube, to which the principles of the invention are particularly applicable, includes an envelope in which is mounted a stack of cold cathode indicator glow electrodes in the form of numerals, letters, or other characters. Each cathode indicator electrode is adapted to glow when a voltage is applied between it and an anode electrode. The envelope is filled with an ionizable gas such as neon and a small quantity of mercury which, together, provide cathode glow which is light orange or light pink in color.

According to the invention, the characteristic light orange or pink cathode glow may be changed to an effective white light by raising the tube operating temperature above the typical normal level. With the tube thus operated to provide white light output, any desired color of glow may be obtained by means of a suitable light filter coupled to the tube.

The invention is described in greater detail by reference to the drawing wherein:

FIG. 1 is a perspective view, partly in section, of a cold cathode gaseous glow tube embodying the invention; and

FIG. 2 is a sectional, elevational view of a modification of a portion of the apparatus of FIG. 1.

Referring to the drawings, a typical gaseous indicator glow tube **10** useful in practicing the invention includes an envelope **12** which has been evacuated of air and filled with a gas suitable for supporting cold cathode glow. Such a gas may be argon, neon, or the like at a suitable pressure which may be in the range of about 30 to about 100 mm. of Hg. The envelope includes a base portion, or stem **14**, through which metal base pins **16** extend and by means of which electrical connection is made to suitable external electrical circuit elements. Two diametrically opposed pins **16'** are provided with insulated extension posts **18** within the envelope and are thus adapted to receive and support the various electrode elements of the tube. The envelope **12** also includes a transparent viewing window **20** through which glowing indicator cathode electrodes **22** are viewed.

The cathode glow indicator electrodes **22** of the tube **10** may take substantially any desired shape; for example, they may be numbers, letters, or the like, and they

may be as few in number as desired, or as many as is practical for the size of the tube. In one form of the tube **10** wherein the glow cathode indicator elements are numbers, ten of such elements are provided, including the numbers "0" to "9." Fewer than ten glow cathodes are shown in FIG. 1 for purposes of simplifying the drawing. The cathode indicator elements **22** are made of any suitable metal, for example, stainless steel, aluminum, Nichrome, molybdenum, or the like, and they may be made in any suitable fashion, for example, by etching, stamping, or the like.

The cathode elements are provided with diametrically opposed apertured end tabs (not shown) by means of which they are mounted and supported on the extension posts **18** of the pins **16'**. The cathode elements **22** are stacked on the posts **18** one above the other with their surfaces oriented parallel to each other and transverse to the vertical axis of the tube and facing the viewing window **20** of the envelope **12**. The cathode elements **22** are mounted with suitable insulating spacers **24** between them, the spacers having sufficient surface area to cover and insulate the cathode tabs to prevent them from glowing during operation of the tube. The stack of electrodes is locked on posts **18** by mica rings **26** or the like.

Each cathode indicator element is provided with a fine wire connecting lead **28** which is welded or otherwise secured at its free end to one of the pins **16** within the envelope **12**. The leads **28** may be of the same material as the numbers, or they may be of any other suitable material.

The tube **10** includes an anode which is preferably in the form of a cup **36** having a pair of diametrically opposed longitudinal slots **37** aligned with the support posts **18** and through which the cathode lead wires **28** extend to the pins **16**. The stack of cathode electrodes is, in effect, contained within the cup, with the cathode leads **28** and tube pins **16** lying outside the cup. The cup **36** rests on, but is insulated from, the pins **16** by an insulating disk **38** of mica or the like. The anode cup is also electrically connected to one of the pins **16** by a suitable lead (not shown).

The objects of the invention are accomplished by causing the tube **10** to generate substantially white light and coupling a selected filter to the tube to provide the desired color of light. The desired white light is obtained, according to the invention, by a combination of features in both tube construction and tube operation. Thus, a small quantity of mercury is added to the gas in the envelope, say neon, so that, under typical normal operating conditions, the cathode glow is light orange or light pink in color. The mercury may be added to the neon filling in any suitable manner during tube preparation which may follow well-known procedures. In one arrangement for carrying out this process, referring to FIG. 2, a small ball of mercury **38** is placed in an evacuated frangible capsule **40**, of glass or the like, through which a heating wire **42** extends. The capsule is sealed in the tube envelope, and at the desired time in the manufacturing process, heating current is passed through the wire, and the mercury is heated and caused to vaporize and crack the glass capsule. When the capsule cracks, the mercury escapes and condenses on the tube envelope. Alternatively (FIG. 2), a coil **42'** of heating wire surrounding the capsule may be used to crack the capsule and free the mercury.

According to the invention, the typical and normal light pink color of cathode glow of the tube **10** is converted to substantially white glow by operating the tube at an elevated temperature. The desired elevated temperature may be achieved by operating the tube at higher-than-normal cathode currents. Thus, with about 180 volts applied between the anode and the cathodes, a

cathode current of about eight milliamperes provides sufficient heat to cause substantially white cathode glow. Alternatively, elevated temperature may be achieved by passing heating current through the heating coil 42'. The heat generated by current in the coil 42' heats the gases in the tube 10 to the required temperature to provide white light cathode glow. With the latter method of operation, a normal cathode current level of about two milliamperes is maintained.

With the tube thus adapted to provide substantially white light, light of any desired color may be obtained by combining a suitable optical filter with the tube 10. Thus, for example, a sheet 44 of light filtering material is positioned in front of the viewing window 20 of the tube. Any suitable support means for the filter may be provided. For example, a hollow tube 46 may be secured to the tube envelope 12 and the filter sheet 44 may be suitably mounted in the tube.

What is claimed is:

1. A cold cathode gaseous indicator tube assembly comprising an envelope containing an anode and an indicator glow cathode adapted to exhibit cathode glow when an appropriate operating potential is applied between it and said anode, said cathode glow being provided by a glowing sheath of gas surrounding said cathode, said envelope containing a filling of an ionizable gas and a small quantity of mercury suitable for providing substantially white cathode glow when said tube is operated at an elevated temperature, and an optical filter in operative relation with said cathode.

2. The assembly defined in claim 1 and including circuit means for raising the temperature of the tube in operation.

3. The assembly defined in claim 1 and including auxiliary heating means inside the tube envelope for raising the temperature of the tube during its operation.

4. The assembly defined in claim 1 and including an auxiliary heating wire disposed within the tube envelope for raising the temperature of the tube during operation.

5. A cold cathode gaseous indicator tube assembly comprising an envelope having a viewing window and containing an anode and a stack of indicator glow cathodes facing said viewing window, each of said cathodes being adapted to exhibit cathode glow when an appropriate operating potential is applied between it and said anode, the cathode glow being provided by a glowing sheath of gas surrounding the cathode, said envelope containing a filling of an ionizable gas and a small quantity of mercury suitable for providing substantially white cathode glow when said tube is operated at an elevated temperature, and an optical filter coupled to said envelope in front of said viewing window, said optical filter being selected to provide a predetermined color of light output from said tube.

6. The assembly defined in claim 5 and including auxiliary heating means inside the tube envelope for raising the temperature of the tube during its operation.

7. The method of operating a cold cathode gaseous glow tube to provide light output of a selected color, said glow tube including a glow cathode and an anode and a gas filling of an ionizable gas and mercury, the method comprising the steps of applying an operating voltage between the cathode and the anode and thereby causing the cathode to glow with its characteristic color, heating said tube so that the cathode glow is substantially white, and optically filtering the desired color from the cathode glow.

8. The method of operating a cold cathode gaseous glow tube to provide light output of a selected color, said glow tube including a glow cathode and an anode and a gas filling of an ionizable gas and mercury, the method comprising the steps of applying an operating voltage between the cathode and anode to provide a level of current flow therebetween at which the cathode glows with its characteristic color, increasing the current flow to a higher level at which the temperature of the tube is elevated and the cathode glow is substantially white, and optically filtering a selected color from the cathode glow.

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