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INDICATOR GAS TUBE

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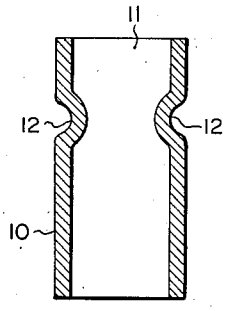


Fig. 1

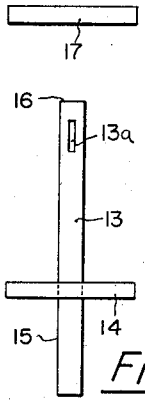


Fig. 2

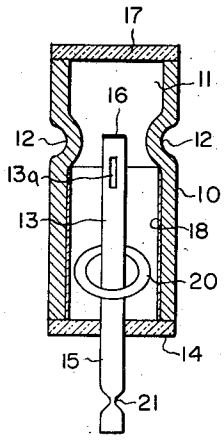


Fig. 3

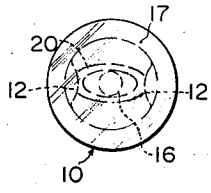


Fig. 4

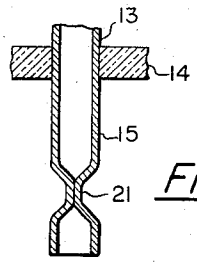


Fig. 5

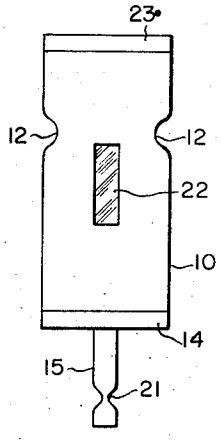


Fig. 6

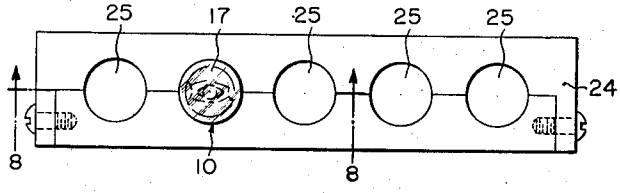


Fig. 7

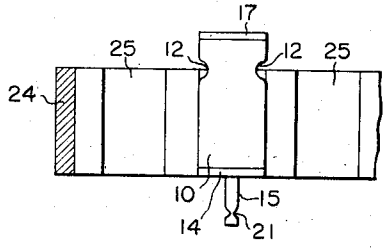


Fig. 8

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INDICATOR GAS TUBE

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6 Claims. (Cl. 313—110)

The present invention relates to indicating units and more particularly to a novel glow discharge unit diode cell.

In recent years the use of glow indicator tubes has steadily increased, keeping pace with the increasing demand of industry and business for automatic machinery. Especially has this been true in connection with computers wherein such tubes are used in large quantities to indicate the results of computations and/or various operating conditions of the machine. Unfortunately presently available glow tubes are so constructed as to somewhat limit their usefulness in such high speed machines.

The present practice in the manufacture of glow indicator tubes of the diode type is to provide the anode and cathode in the form of two wire or plate elements disposed in parallel relationship and sealed in a tubular transparent glass envelope. Usually the ends of the glass envelope are sealed by heating and pinching the glass together. Because of the parallel relationship of the anode and cathode the glow discharge often dances up and down the length of these elements when the tube is energized, resulting in an undesirable flickering of the glow discharge. Additionally, because of the particular type and configuration of the envelope the glow indication is so seriously impaired by internal reflection and distortion because of the pinched glass as to make the accurate reading of numbers or characters associated therewith quite difficult, a condition often leading to serious errors in the operation of the machine with which the tubes are associated. As one remedy for these unsatisfactory conditions the tubes were housed in frosted bulbs but the additional cost of fabrication and assembly became an item of considerable concern. Furthermore, such relatively cumbersome assemblies require a large area for mounting the tubes, thus limiting the number which can conveniently be used in associated apparatus of a compact nature.

It is, therefore, an important object of the present invention to provide a glow discharge indicating tube of the diode type wherein the foregoing disadvantages are overcome.

Another object is to provide an indicating tube or cell wherein it is unnecessary to house the tube in a supplemental envelope.

Still another object is to provide a glow indicating tube wherein undesirable flicker and reflection are eliminated.

A further object of the invention is to provide an envelope for a glow indicating tube wherein an internal substantially black body effect is obtained.

A still further object is to provide an indicating gas tube in which the tube envelope comprises an active element thereof.

A specific object of the invention is to provide a glow indicator tube characterized by its ease of accurate and precise assembly.

A more specific object is to provide an inexpensive glow indicating tube adapted for economical and rapid assembly with like tubes in the form of a matrix in which the tubes can be arranged in closely spaced relation, or even in contacting relationship side by side.

In accordance with the above objects and first briefly described the invention contemplates a tube construction including co-axially arranged inner and outer metallic cylinders, the outer of which is sealed at both ends and serves both as the envelope and anode of the tube, while the inner and somewhat smaller diameter cylinder serves as the cathode, the cathode lead, and provides the means for exhausting, gas charging, and sealing the tube. The seal at one end of the envelope comprises a transparent glass disc through which the glow discharge may be observed, while the seal at the other end carries the cathode and maintains the co-axial relationship of the cylinders. The inner end of the cathode terminates adjacent the viewing window between opposing depressions in the anode walls and because of the closer spacing of the anode and cathode produces a steady glow discharge in this area where it is easily seen or detected by a photocell or other pick-up device associated with the clear glass window at this end of the tube.

In the drawings:

Figure 1 is an enlarged medial sectional view of an anode forming a part of a glow cell embodying one form of the present invention;

Figure 2 is an exploded view of elements to be incorporated in the anode of Figure 1;

Figure 3 is a medial sectional view of an assembled cell;

Figure 4 is an end plan view of the cell of Figure 3;

Figure 5 is a detail view in section of a portion of the cathode;

Figure 6 is a side elevation of a modified form of the invention;

Figure 7 is a plan view of a holder for cell arrangement in matrix formation; and

Figure 8 is a sectional view taken on line **8—8** of Figure 7.

Referring to Figure 1 of the drawings, an anode **10** is shown in the form of a cylinder made of a metal or metal alloy having substantially the same coefficient of expansion as glass, such metal being illustrative of the type known in the trade as "Kovar," a cobalt, nickel, and iron alloy. Further and detailed information of such metal may be had by reference to Bulletin No. 145 published in 1955 by the Stupakof Ceramic and Manufacturing Co., of Latrobe, Pa. The cylinder **10** is formed with oppositely disposed indented depressions, dimples or inside beads **12** adjacent its viewing end **11**, the purpose of which will presently appear.

The cathode **13** of the cell, as seen in Figure 2, is cylindrical in form and made of a metal having the same coefficient of expansion as glass, such as "Kovar." The cathode is sealed axially of a circular glass disc or closure **14**, dimensioned to fit across the bottom end of the anode cylinder and be sealed thereto. The closure **14** is attached to the cathode **13** at such an intermediate location as will bring the glow end of the cathode into the plane of the beads **12** for concentrated effective glow discharge. Also it should be noted that the cathode tubing is mounted coincident with the axis of the anode and projects outwardly from the closure **14** as a circuit connecting lead **15**. Since the cathode **13** is in the form of tubing it also serves as a canal for exhausting the cylinder as well as a means to admit an atmosphere of gas at reduced pressure to allow a glow discharge to be visible when the cell has proper voltages impressed across it. While not necessary, it has been found that to achieve a more effective low-voltage breakdown, the annular inner end of the cathode tubing preferably has a low work surface coat-

ing such as barium fluoride applied thereto. In the preferred form of application the fluid is sprayed down the tube canal before assembly and collects on the annular end surface **16**, thus to act as a cathode in relatively close proximity to the cylinder beads **12**.

For closing the viewing end of the anode **10**, a thin glass window **17** is sealed in place, as shown in Figure 3, to complete an enclosed, sealed chamber, the construction of which affords a substantially "black body" effect whereby disturbing reflections are trapped inside and invisible at the viewing window **17**, and resulting in an apparent intensifying of the glow developed on the cathode end, which is juxtaposed to the window **17**.

Since metal in a vacuum outgasses, and such gas is deleterious to reliable gas-discharge operation, the lower inner surface of anode **10** preferably is provided with a gas trap material as a lining **18** which can be a sprayed frit or glass, but a ceramic sleeve is preferable because it will not charge-up and outgas. Such a cylinder lining **18** is inserted from the bottom end of the anode **10** beforethe cathode and its closure are sealed in place. The length of this lining **18**, whether in the form of a spraying or a cylinder, is dimensioned to terminate in close proximity to the beads **12** thereby to concentrate the discharge in the plane of the end **16** of cathode **13**. Preferably also a getter **20** is affixed to the internal wall of the anode **10**, or anywhere in the cathode anode space below the anode beads **12**.

With the cathode **13** in place within the anode, and with closure **14** and lining **18** sealed in place, the enclosed chamber is exhausted by way of the cathode tubing, and a gas, such as neon, is introduced by way of the cathode tubing, after which the tubing is sealed off by a crimped pinch as indicated at **21** to make a vacuum tight seal. The getter is then fired to provide insurance against gas contamination.

From the foregoing it will be seen that the anode **10**, with its vacuum sealing closure, forms an evacuated envelope housing the cathode and containing a suitable gas, such as neon.

In some instances or special locations it may be desirable to view the cell from a side, in which case a longitudinal slot is cut in the wall of anode **10** and closed by a sealed-in glass window **22** as shown in the modification of Figure 6. In this form of the invention the window **17** may, if desired, be replaced by an opaque disc **23**, sealed in place to hold the vacuum as will be understood.

In a tube constructed as described above, that is, wherein the barium fluoride is coated only around the peripery of the inner end of cathode **13**, a "ring-like" glow will be observed. If on the other hand, a "dot" glow is preferred, the coating would be applied in a manner to cover and close the inner end, in which case a slot **13*a*** is provided in the side wall of cathode tube **13**, for exhausting and charging the tube.

Cells manufactured in accordance with this invention are particularly well suited for matrix assembly wherein a holder **24** is provided having cell receiving holes **25**, here shown as an aligned row, but which can be arranged in any desired pattern as will be understood. These holes **25** are dimensioned to snugly receive and mount the respective cells with their viewing ends outwardly disposed for ready inspection of glow discharge. The holder may be metal thus to provide a common circuit connector for all tubes so assembled. If desired, a plurality of cells may be bound together in a group with adjacent anodes contacting each other, thus forming the common anode connection from one to the other.

It will now be apparent that a complete unitary glow cell has been devised wherein the glow is concentrated at the inner or free end of the cathode tubing, and wherein viewing is further enhanced by the "black body" effect afforded by the non-reflective structure, resulting in a glow discharge which is sharp and discrete with no wandering. This is a wide departure from ordinary gas discharge diodes where a flickering glow appears between two parallel plates or rods housed in a pinched end glass envelope making end viewing difficult because of the obstruction between the viewer and the glow.

While the cell of the invention is primarily for glow indication, it is also useful as a reliable gas diode since the coaxial construction of the cell; the accurate spacing between the cathode and the anode so obtained; the use of a getter; the ceramic liner; and the resultant small glass area all combine to reduce the unreliability factors found in prior gas diodes.

From the above description it will be understood that the invention provides a novel diode type glow indicator tube overcoming the objectional features of prior tubes of this type and which is further characterized by its adaptability for precise manufacture by mass production technique, its stable, easily observed glow discharge, and its usefulness in compact matrix assemblies.

What is claimed is:

1. An indicating gas tube comprising a tubular anode forming a chambered envelope, a gas in said envelope, a transparent viewing window sealed in one end of said anode, a closure sealing the other anode end, and a cathode sealed in said closure coaxially of said anode to terminate in juxtaposed relation to said window and projecting exteriorly from said closure as a circuit lead, said anode having an internally projecting bead adjacent to the internal cathode end.

2. An indicating gas tube according to claim 1 wherein the cathode end adjacent the bead has a low work breakdown coating thereon.

3. An indicating glow tube according to claim 2 wherein said cathode comprises a tubular member with a slot in that portion within said anode tube and wherein said coating covers the inner end of said tubular cathode.

4. An indicating gas tube according to claim 1 wherein the anode has a lining between said closure and said bead to prevent outgassing of said anode.

5. An indicating gas tube according to claim 1 wherein said anode comprises an opaque tubular member having a transparent viewing window sealed in the side wall thereof.

6. A diode type indicator glow tube comprising, a cylindrical anode forming the tube envelope, a transparent window sealing one end of said envelope, an electrically insulating closure member sealing the other end thereof, a low pressure gas filling said envelope, and a cathode, said cathode being sealed to said closure member in a manner extending interiorly and exteriorly of and coaxial with said envelope, the inner cathode end terminating adjacent to said window, said envelope being provided with an internally projecting bead in the plane of said internal cathode end whereby when the tube is energized a stable glow discharge will occur only at the said inner cathode end where easily visible through said window.

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