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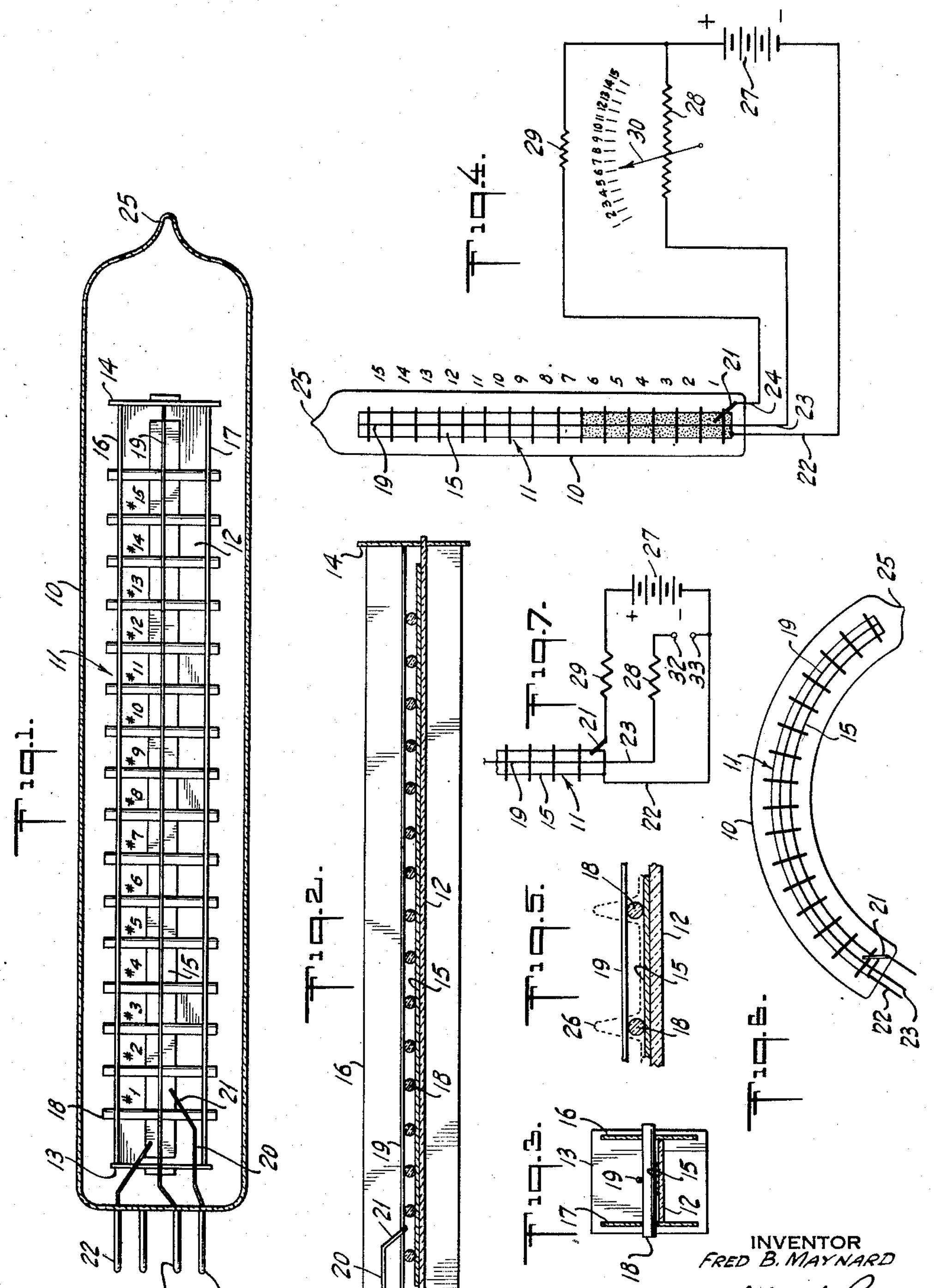


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# INCREMENTALLY EXTENSIBLE CATHODE GLOW INDICATOR TUBE

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This invention relates to indicator tubes, and more especially it relates to tubes of the gaseous content cathode glow discharge kind.

A principal object of the invention is to provide an improved cathode glow indicator tube wherein the glowing area can be extended and contracted in precise incremental or decremental steps in proportion to the successive levels of an input control voltage.

Another object is to provide an improved cathode glow discharge tube wherein the glow can be accurately extended along the length of a cathode in well-defined incremental areas.

Heretofore it has been proposed to manufacture so-called extended area glow discharge tubes wherein a cathode is arranged to have a glow produced thereon of variable area. While there has been a considerable commercial demand for that general kind of tube, such demand has not been met for a variety of reasons. Amongst these reasons are, first, the difficulty of accurately incrementing and decrementing the glow area in response to incremental and decremental applied voltages; second, the difficulty of producing such tubes in mass production with uniformity of incremental glow area characteristics as between various tubes.

Accordingly, one of the features of this invention is the novel construction and design of an extended cathode glow area tube wherein uniformity and precisional accuracy of incremental glow areas can be obtained during the mass production of such tubes.

Other features and advantages not particularly enumerated will become apparent after a consideration of the following detailed descriptions, the appended claims and the attached drawing.

In the drawing, which shows by way of example certain preferred embodiments,

Fig. 1 is a plan view of an indicator tube according to the invention;

Fig. 2 is a sectional view of Fig. 1 taken along the line 2—2 thereof;

Fig. 3 is a sectional view of Fig. 2 taken along the line 3—3 thereof;

Fig. 4 is a schematic diagram showing one manner of using the tube of Figs. 1 to 3 as a numerical indicator;

Fig. 5 is a magnified cross-sectional view of part of the tube of Fig. 1 and used in explaining its operation;

Fig. 6 is a modification of the tube of Figs. 1 to 3;

Fig. 7 is a schematic diagram showing the device used as a voltmeter.

The tube according to this invention provides a gaseous discharge device which has the function of exhibiting a visual bar, line or similar precisely defined area of light whose length is a specific function of or proportional to the instantaneous values of an input signal voltage. Specifically the bar or line of light is in the form of a cathodic glow, the length of which may start from zero or some minimum magnitude corresponding to the minimum of the input signal, and rising to some other maximum value corresponding to the maximum value of the input signal,

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the intervening variable lengths of the bar or line of light then corresponding to the intervening values of applied signal input. Furthermore, the device according to the present invention instead of expanding progressively smoothly with increasing values of the input signal, is expanded or contracted in length in discrete steps. The number of these steps for any given range of input signal values or for any given physical length of the indication desired may be made any convenient value. As a result the device is capable of acting as a digitalizing device, in that the value of the input signal or function can be expressed as a discrete number of equal steps, if desired.

Referring to Figs. 1 to 3 of the drawing, the device comprises an enclosing glass envelope or bulb **10** within which is enclosed the novel electrode mount **11** according to the invention. This mount consists of a flat strip **12** of mica or similar insulating material which can be interlocked at its opposite ends with two end mica plates **13, 14.** Attached to the upper face of strip **12** is a metallic strip **15** which may be made of any suitable metal, such for example as aluminum foil. This metallic layer **15** may be attached to the mica strip **12** in any convenient manner so that it lies flat thereagainst. If desired, the metallic strip **15** may be in the form of a metallic coating applied in any well known manner to the surface of mica **12.** The metallic strip **15** constitutes the cathode of the device on which incremental step by step glow discharge is produced. Merely by way of example, the strip **15** may have a width of approximately two to three millimeters and a thickness of the order of 0.001 inch.

Also extending between and suitably interlocked with the end micas **13** and **14** are two lateral mica strips **16, 17.** Each of these strips **16, 17** has sets of aligned openings through which pass a series of insulating barriers **18** which may be of ceramic, glass or other similar refractory insulating material. Preferably, although not necessarily, the ceramic rods **18** are of round cross-section, for example of 0.050 inch in diameter. In accordance with the invention, the barrier rods **18** are mounted in micas **16, 17** so that each of the said barrier rods engages the surface of the cathode strip **15.** Preferably the rods **18** are spaced apart equally along the length of the cathode **15,** this spacing depending upon the size of the cathode stepped areas to be illuminated. Preferably also, although not necessarily, the barriers **18** are mounted at right angles to the length of strip **15** so that the area defined between each adjacent pair of barriers **18** and the intervening edges of the cathode strip **15** are square or rectangular in shape.

Extending centrally along the cathode strip **15** and engaging the upper periphery of all the barrier members **18,** is a thin wire **19** which at its opposite ends is interlocked in any suitable manner with the end micas **13, 14.** It will thus be seen that the anode wire **19** extends along the full length of the cathode strip **15.** The wire **19** should be of sufficient thinness in cross-section consistent with its necessary rigidity so as not to materially obscure the light emitted from any controlled glowing area or cell of the cathode strip **15.** If desired, the fine wire anode **19** can take the form of a fine wire mesh strip, the plane of which extends substantially parallel to the cathode **15.** Another anode element in the form of a fine wire **20** passes through the mica **13** and has its forward tip **21** bent downwardly so as to be in close proximity to the cathode strip **15** between the first pair of barrier members **18.**

Suitably sealed in a vacuum tight manner through the header of the bulb **10** are lead-in wires or contact prongs **22, 23, 24** connected, respectively, to the cathode strip **15,** the main anode **19** and the auxiliary anode **21.** When the above-described mount has been assembled within the bulb 10 the latter can be exhausted in the conventional way to the exhaust tubulation 25 and filled with a rare gas to the appropriate pressure. The pressure of the rare gas determines to some extent the sensitivity of the device. By sensitivity here is meant the incremental current required per complete step or cell of illumination. This pressure can be as low as two millimeters of neon, with as little as 20 microamperes per square millimeter of cathode surface, up to pressures as high as 40 millimeters and approximately 100 microamperes per square millimeter of cathode surface to be illuminated. In either case the important feature achieved is that this incremental current is the same for every cell in the strip. By the term "cell" is meant the cathode area between 2 successive barrier members 18.

The function of the auxiliary anode 21 is to maintain a cathode glow at all times for a given minimum level of signal voltage with which the device is to be used. With this minimum signal level only the cell defined by the first two barrier members 18 and the corresponding rectangular area of cathode 15 with which the auxiliary anode 24 cooperates, is illuminated. The remaining cells under this minimum input signal condition remain unilluminated. As the input signal level is increased, one or more of the succeeding cells become cathode luminescent, the luminescence spreading evenly over the cathode surface of each cell and having a well-defined boundary determined precisely by the width of the cathode 15 and the spacing between adjacent barriers 18.

While I do not wish to be confined to any theory as to why the cathode glow in each cell is confined to the sharply defined boundary of each cell and does not extend beyond any given cell for a given input signal voltage, it is possible that the barrier bars 18 accumulate a negative electrostatic charge as a result of the ionizing of the gas as long as the cell area of each cathode between adjacent barrier bars is sustaining a cathode glow and the number of successive cells that are illuminated will vary with the level of the input voltage applied to anode 19. Thus, as illustrated in Fig. 5, the electrostatic charge on each barrier bar may result in a building up of a barrier field above each such bar as represented by the dotted line 26, thus effectively preventing the extension of an ionizing discharge between the anode wire 19 and the next successive cell. I have found, however, that when the input signal voltage is increased beyond a certain critical value, the barrier 26 apparently is insufficient to prevent spreading of the cathode discharge to the next adjacent cell. In fact it has been found that by correlating the input signal level with the number of cells, it is possible to extend the cathode glow in precisely dimensional incremental spaces along the cathode 15. For example, for the minimum input signal level, the number 1 cell only is illuminated, for the next value of input signal level cells numbers 1 and 2 only are illuminated, and so on, so that for the maximum value of input signal level the entire group of cells, numbers 1–15 are illuminated.

Referring to Fig. 4 there is shown a typical electrical circuit in which the device of Figs. 1–3 may be used. In Fig. 4 the numeral 27 represents a source of direct current voltage, the negative terminal of which is connected to the cathode strip 15 and the positive terminal of which is connected through an adjustable signal-controlled resistor 28 to the anode 19. The positive terminal of the source 27 is also connected through a fixed resistor 29 to the auxiliary anode 21. It will be understood, of course, that the source 27 and the signal-controlled resistor 28 are merely typical of a suitable source of variable input signal level voltage. This source may be either a battery, a power supply, or any other direct current pulse type input signal supply. The potential of source 27 in one arrangement that was found to produce the desired results had a potential of approximately 250 volts, the resistance 29 was of relatively high value, for example one or two megohms, which established a sufficient potential on the auxiliary anode 21 to keep the number 1 cell luminous by cathode glow. This cell, as pointed out above, is maintained in glowing condition at all operating times regardless of any other input condition. This illumination of cell number 1 furnishes the ionization which makes the next successive cell, cell number 2, more sensitive to ignition for the next increment of signal voltage applied to anode 19, as compared with the sensitivity of succeeding cells numbers 3 through 15.

It should be observed that in the absence of auxiliary anode 21 and the maintenance of the cathode glow in cell number 1, as above mentioned, a potential applied between cathode 15 and anode 19 would cause a glow to start somewhere on cathode 15, but the location of this glow would be absolutely unpredictable. However, by maintaining the number 1 cell luminous at all times by a suitable minimum voltage applied through resistor 29 or otherwise, any further increment of potential between the cathode 15 will cause the glow to extend to the next succeeding cell. In other words, once the glow is established in cell number 1, as above described, the glow will be extended to the next adjacent cell and so on to succeeding cells in accordance with the successive levels of the input signal voltage applied to anode 19. In other words, the illumination of cell number 1 predisposes the number 2 cell to sensitivity of glow resulting probably from the spilling over of ions from the number 1 cell to number 2, but of insufficient velocity to cause the number 2 cell to become luminous until the next level of incremental voltage is applied to anode 19. Likewise, when cell number 2 becomes luminous it predisposes the next cell, number 3, so that cell number 3 becomes luminous only when the next incremental level of voltage is applied to anode 19.

The resistor 28 may be of any variable kind which changes its resistance value with the input signal function to be measured or portrayed on the successive cells. For example, resistor 28 can be a mechanically controlled rheostat, a heat-sensitive resistor or thermistor, a variable voltage or current supply, and in the event that the power supply 27 is of the pulsating kind, the resistor 28 may take the form of a capacitive or inductive reactance. Whatever form the control device 28 assumes, it must have minimum and maximum effective values so that the presented glowing bar along the cathode 15 will be minimum at one extreme of the setting of device 28, and at the opposite extreme of the setting of said device 28, the glow will be extended to the last cell of the device.

By utilizing various gas pressures and mixtures of gases, a wide variety of sensitivity can be obtained in the incremental extension of the glow in step fashion to successive cells, with the result that for a given total number of luminous cells any length of luminous column can be obtained, for either quite small or quite large changes in the effective value of the resistance 28.

If desired, the movable adjustable element 36 of rheostat 28 can be provided with a graduated scale 31 having graduated markings corresponding to the number of luminous cells within the indicator tube 10. Thus in the particular setting shown in Fig. 4, the arm 30 is shown in position number 6, wherein the resistance 28 is adjusted so that the voltage applied between the cathode 15 and the anode 19 is such as to cause cells numbers 1–6 to be illuminated. If the member 30 is moved to position number 5, for example, only cells numbered 1 to 5 are illuminated. On the other hand, if the member 30 is moved to a higher position, for example position number 7, the first seven cells are illuminated so that by this means the column of light in the indicator tube is increased or decreased in precise uniform steps, counting from cell number 1 toward cell number 15 in accordance with the setting of member 30.

While the drawing shows the device in the form of a straight cylindrical tube 10 and with the mount 11 likewise linear in extent, it will be understood that the tube 10 can be bent in any desired shape, such for example as semi-circular, as shown in Fig. 6, and the mount 11 likewise is formed with a semicircular configuration. Any other desired configuration of the bulb and mount can be employed.

From the foregoing it will be seen that the device is capable of wide application in the measuring and indicating arts. For example, if the member **28** is a thermistor of any well-known kind, the device can be used as a thermometer, the number of successive cells that are illuminated indicating the temperature to be measured. Likewise the device may be used as a speedometer, in which the resistor **28** instead of being manually operated, can be operated by any speed responsive mechanism such as the flying ball of any well known governor which is coupled to the member **30**. Likewise the device may be used as a liquid level indicator, in which case the element **28** can take the form of the moving core of a reactance, the core being raised and lowered in accordance with the level of the liquid. In the event that the device is to be used as a voltmeter, the rheostat **28** may be of fixed resistance value and the voltage to be measured can be applied between the terminals **32** and **33**, as shown in Fig. 7.

Various changes and modifications may be made in the disclosed embodiments without departing from the spirit and scope of the invention.

What is claimed is:

1. A cathodic glow discharge indicator tube comprising an enclosing envelope containing a filling of an ionizable medium, an electrode mount within said envelope and including a cathode, a corresponding anode extending along and in spaced relation to said cathode, and a series of spaced insulator discharge barrier members each extending across the cathode and located between the cathode and anode to form therewith a series of discrete cells to confine the cathodic glow to one or more cells in accordance with the respective levels of signal control voltage applied across said cathode and anode.

2. A cathodic glow discharge indicator tube comprising an enclosing glass bulb containing a filling of an inert gas, an electrode mount within said bulb comprising an elongated flat cathode, an elongated anode mounted in spaced relation to and extending along the length of said cathode, a series of insulating barrier members arranged in spaced relation along said cathode to define therewith a series of discrete cathodic glow cells, and an auxiliary anode mounted in spaced relation to the cathode in a particular one of said cells.

3. A cathodic flow discharge indicator tube according to claim 2, in which said auxiliary anode is in the form of a fine wire having a tip which is located in spaced relation to the cathode surface in one of said cells.

4. A cathodic glow discharge indicator tube according to claim 2, in which said auxiliary anode is mounted in spaced relation to the first one of said cells located at one end of said cathode.

5. A cathodic glow discharge indicator tube according to claim 2, in which said anode is in the form of a single fine wire extending parallel to said cathode, and spaced therefrom by said barrier members.

6. A cathodic glow discharge indicator tube according to claim 2, in which said anode is in the form of a



fine wire mesh extending parallel to said cathode and spaced therefrom by said barrier members.

7. A cathodic glow discharge indicator device for producing a cathodic glow whose length is accurately controlled in incremental steps by corresponding applied signal voltages, comprising an enclosing envelope containing an ionizable medium, an electrode mount within said envelope, said mount comprising an elongated narrow metal strip cathode, an elongated fine wire anode, insulator members at opposite ends of said cathode for supporting said cathode and anode in spaced parallelism, a series of spaced insulator barrier members between the cathode and anode, each extending across the width of the cathode strip and in contact therewith to define a corresponding series of discrete cathode glow discharge cells, and an auxiliary anode located adjacent only one of said cells to maintain said one of said cells with a cathodic glow and thereby to form a priming source for the step by step spread of the cathodic glow in successively controlled steps to the succeeding cells.

8. A cathodic glow discharge indicator device according to claim 7, in which said insulating members at the opposite ends of the mount are interlocked with a corresponding pair of insulator strips extending along the mount, said barrier members being anchored to and extending between the last-mentioned insulator strips.

9. A cathodic glow discharge indicator device according to claim 7, in which said cathode strip is attached to one surface of a flat insulator strip which is interlocked with said pair of insulators at the ends of the mount.

10. A cathodic glow discharge indicator device according to claim 7, in which said auxiliary anode is in the form of a fine wire having a tip portion which is mounted in spaced relation to the cathode surface of the first one of said cells.

11. Visual indicating apparatus of the cathodic glow kind, comprising a gaseous discharge tube having a glass enclosing envelope containing a filling of an ionizable medium, an elongated cathode, an elongated anode, means supporting said cathode and anode in spaced relation throughout their lengths, and means to cause said cathode to be illuminated by cathodic glow in discrete well-defined successive areas, the last-mentioned means including a series of spaced insulating barrier members located in spaced relation along and in contact with the surface of said cathode to define a series of discrete cathodic glow cells.

12. Visual indicating apparatus according to claim 11, in which an auxiliary anode is mounted in spaced relation to the cathode in one of said cells, means for applying a steady potential between said auxiliary anode and said cathode to maintain said one of said cells illuminated by cathodic glow, and means to apply a signal control voltage between said elongated anode and said cathode to cause successive cells to be illuminated by cathodic glow in step by step succession in accordance with the successive increments in level of said signal voltages.

No references cited.