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Document in this file	Readout Tube Patent 2769939 Inventor: C. R. Williams - Dated 1956-11-06
Display devices in this document	None. The shown tube in this patent looks like the GI-10 made by National Union in 1954

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C. R. WILLIAMS

2,769,939

READ-OUT TUBE CIRCUIT

Filed June 12, 1950

Fig. 1

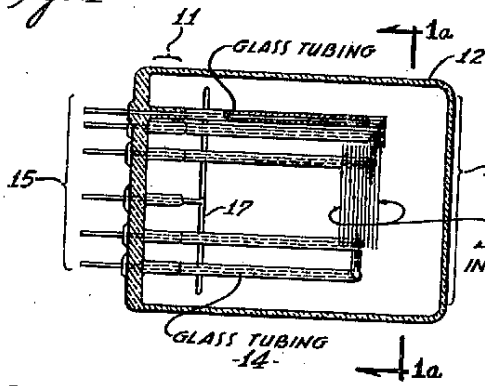


Fig. 1a

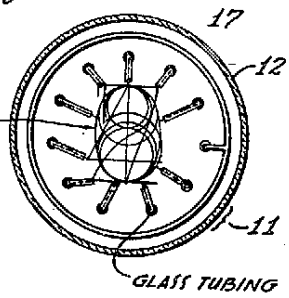


Fig. 2

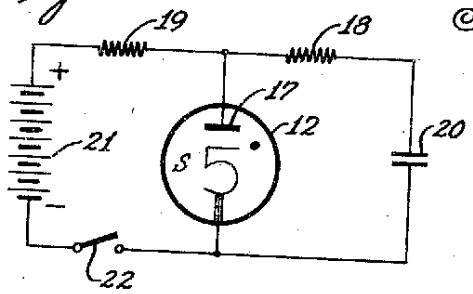


Fig. 3

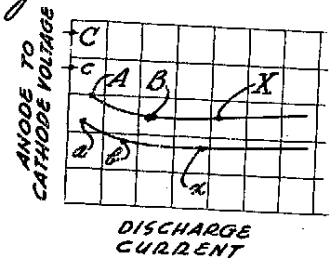


Fig. 4

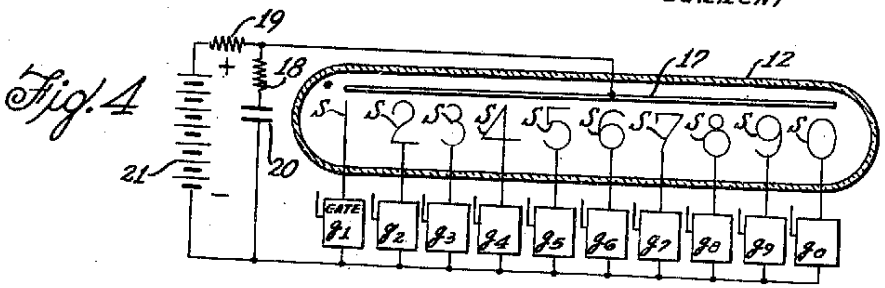
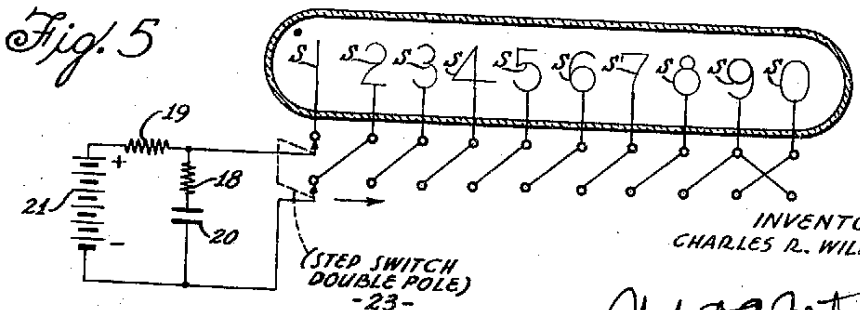


Fig. 5



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READ-OUT TUBE CIRCUIT

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Application June 12, 1950, Serial No. 167,571

1 Claim. (Cl. 315—233)

My invention relates to cold cathode glow tubes, and more particularly to a means and method of insuring that a cathode glow will cover the entire surface of an extended cathode representing an intelligible symbol in a numeral read-out tube, for example. A numeral read-out tube is herein defined as a tube having a plurality of cold cathodes each in the form of a different numeral such as used in mathematical counters and the like; a particular cathode being energized to glow to indicate a counting step as a visible number. Such read-out tubes are shown, described, and claimed in the copending application of Hagen, Serial No. 139,819, filed January 21, 1950, now abandoned.

It is characteristic of a steady current cathode glow that the area of cathode surface covered by the glow is directly proportional to the glow current and is inversely proportional to the gas pressure. It is also characteristic of a steady cathode glow that the thickness of the glow, that is, the distance to which the glow volume extends away from the cathode surface, is inversely proportional to the gas pressure. Hence, if a symbol is to be a cathode formed from a thin conductor such as a metal wire, the gas pressure must be sufficient to restrict the thickness of the glow to give adequate line definition to the symbol consistent with its size. Having determined a preferred gas pressure, then sufficient current must flow to the cathode to cause the glow to extend along the entire length of the wire forming the symbol. In compact read-out tube assemblies sufficient steady current to cover the cathode with glow may result in power expenditure so great as to cause overheating and failure of the tube.

It is an object of the present invention to provide a means and method of greatly reducing, by a factor of from $\frac{1}{10}$ to $\frac{1}{100}$ for example, the current drain required to completely cover an extended area cathode with glow.

It is another object to provide a method and means of glowing an extended area cathode with a thin glow sheath affording greater visual definition of the cathode shape.

It is still another object to provide a means of supporting a plurality of fine wire extended area electrodes in a common envelope.

It is a further object to provide a suitable gas filling for cold cathode glow discharge tubes to promote the oscillatory tendencies of said glow discharge current.

It is a further object to provide a novel circuit for the indication of a particular symbol electrode in a multi-electrode glow tube or a particular cathode in a series of cathode glow tubes by causing a cathode glow to form thereon.

It is a still further object to provide a means and method of causing an extended area cathode to glow intermittently to produce a visible rate flicker.

In brief, the present invention includes the use of a glow tube having an anode and an extended area cold cathode in a circuit whereby the tube is operated on the negative slope of its characteristic curve to cause the tube

to self-oscillate when energized from a D. C. source. An oscillatory circuit of this type has the following advantages over a steady cathode glow current circuit when used for read-out tubes, for example:

A. A smaller supply current can be used to cover a given sized cathode figure with glow.

B. The cathode glow coverage is less dependent upon supply current. Figures having different sizes and area can be covered by the same value of current; hence, one common current supply circuit can be used for all figures in a series.

C. A thinner cathode glow sheath is obtained by self oscillation, which permits the construction of smaller figures for a given gas pressure.

Other objects and advantages of the present invention will be apparent from the perusal of the following description of the figures of the drawings in which:

Figure 1 is a longitudinal sectional view of a preferred form of construction of a multi-symbol cathode glow read-out tube.

Figure 1*a* is a cross sectional view taken as indicated by line 1*a*—1*a* in Figure 1.

Figure 2 is a circuit diagram of a read-out glow tube in an oscillation circuit.

Figure 3 is a chart showing typical voltage-current curves for a glow tube of the read-out type.

Figure 4 is a circuit diagram showing how a read-out tube having a plurality of symbol shaped electrodes can be supplied to form the read-out indication of one stage of a decade counter.

Figure 5 is a circuit diagram showing how adjacent symbol shaped electrodes may be used as anodes in a read-out tube having a plurality of symbol shaped electrodes.

A read-out tube **11** is shown in Figures 1 and 1*a* having an envelope **12** with a visually transparent window **13**. The envelope **12** supports insulating tubes **14** of glass or ceramic for example, which in turn support the symbol electrodes S_1, S_2, S_3, etc. The electrodes are symbol shaped, formed of fine conducting wire, and each symbol electrode S lies in a separate plane parallel to and sufficiently spaced from adjacent symbol electrodes for proper operation. The supporting wires connect each electrode through a seal in envelope **12** to a corresponding external lead **15**. The envelope is filled with a gas mixture such as neon 90%, hydrogen 10% for example, at a glow discharge pressure such as 50 mm. Hg. The neon is used for its characteristic bright orange glow, and the hydrogen is included to promote oscillatory characteristics. In addition to the symbol shaped electrodes S the tube may or may not contain an additional electrode **17** to be used as an anode. Normally only one symbol electrode is to be glowed at one time, hence any other symbol electrode in the tube can be used as an anode. Figure 5 shows a circuit in which the adjacent symbol electrode is used as an anode and will be referred to later.

Figure 2 shows the fundamental oscillatory read-out circuit diagram in which anode **17** and cathode S_5, for example, of a tube such as tube **11** are connected by switch **22** to a voltage source **21** sufficient to quickly ignite the tube. A resistor **19** is connected in series with source **21** to limit the supply current drain to a value within the oscillatory range of the tube. A capacitor **20** is connected across the tube to promote oscillation and to provide sufficient peak current to cause the glow to flash over the entire cathode surface. A small value resistor **18** is placed in series with capacitor **20** to limit peak amplitudes of tube current and reduce the tendency to form hot spots and consequent arcing.

In Figure 3, x is a typical voltage vs. steady current characteristic obtained with a neon gas filled tube. A

point *a* on this curve indicates the minimum current value with which the tube will conduct stably without shunt capacitance other than inter-electrode capacitance. The addition of a shunt capacitor, such as capacitor 20 in Figure 2, will increase the range of oscillation to a value indicated by point *b*. Since the brightness of the cathode glow is proportional to the average current drain, it may be desirable to increase the current drain beyond point *b*. This can be accomplished by the addition of a small percentage of hydrogen or other suitable gas which shifts the characteristic to a curve X with maximum unstable current points A and B corresponding to points *a* and *b* respectively. In addition to increasing the range of oscillation current, the use of hydrogen also increases the firing potential from a value *c* to a value C for example. This permits greater discharge energies to be obtained from a given size shunt capacitor 20 and thus extends the range of cathode area which can be covered with glow.

The action of the type of oscillation referred to herein is that glow current in the unstable range will automatically extinguish, whereupon the anode 17 potential rises toward the potential of source 21 thus charging capacitor 20. When the firing potential is reached, the tube restrikes; the anode potential drops sharply permitting capacitor 20 to discharge a high amplitude current pulse through the tube causing a flash of glow over the cathode surface. When the capacitor has discharged, the current falls back into the unstable range and the glow again extinguishes, thus completing the cycle. If the repetition rate of these pulses is sufficiently high, the glow will appear to the eye to be continuous. The repetition rate of the flashes can be controlled by the value of capacitor 20. A sufficiently large capacitance can cause the glow flashes to be individually distinguishable by the eye thus causing the symbol to appear with a flicker which may be desirable, as in an advertising sign for example.

Figure 4 shows a decade read-out tube circuit which may be employed to indicate the state of a counter decade. The ten symbol cathodes S_1 to S_0 are connected in series with ten corresponding switches or gates g_1 to g_0. The gates are normally closed and are controlled by the counter such that only one gate corresponding to the state of the counter is open at a given time. A single supply circuit similar to the circuit of Figure 2 can be used to supply all symbol cathodes regardless of the considerable differences in surface area of the individual symbol electrodes.

Figure 5 shows a circuit in which a decimal read-out tube is used to indicate the position of a ten position step switch or stepping relay 23. With this circuit the anode used in Figure 4 is unnecessary, thus an economy of tube components is obtained. The supply circuit is the same as that of Figures 2 and 4. In switching the two poles of switch 23, adjacent symbols are connected to form the anode and cathode of a glow discharge circuit. It is not necessary to use the immediately adjacent electrode as an anode, as a more distant electrode can be chosen for the purpose of obtaining a better firing to burning voltage differential and a resulting better distribution of glow over the cathode. However, if the anode to cathode spacing is too great, an undesirably high potential source 21 will be required so the optimum anode to cathode distance may be the equivalent of two or three symbol electrode spacings. Anode area is not critical; however, it is desirable to have the anode approximately equi-distant from all parts of the cathode to obtain uniform intensity of glow over all parts of the cathode. This requirement is quite well satisfied by the use of a parallel symbol electrode as an anode. Frequently small glow spots appear on the anode surface and conducting paths from anode to cathode are somewhat luminous, therefore, it is sometimes desirable to have the anode behind the cathode as viewed by the observer so that these undesirable sources of glow will have less prominence.

While the invention has been described as using cathodes in the shape of numerals, the invention is equally applicable to the use of multiple cathodes in the form of letters, for example. In this latter case, gates *g* can be used to cause the letter cathodes to spell words for example, suitable for advertising and similar purposes.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute, the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise a preferred form of putting the invention into effect, and the invention is, therefore, claimed in any of its forms or modifications within the legitimate and valid scope of the appended claim.

What is claimed is:

In combination, a tube having a light transmitting portion, an ionizable gas disposed in the tube at a pressure for producing a glow discharge upon ionization, a plurality of cathodes disposed within the tube, the cathodes being shaped to represent different symbols and being superimposed in substantially parallel relationship to one another adjacent to the light transmitting portion of the tube, an anode disposed in the tube, a plurality of switches each associated with a different cathode, a source of direct voltage, a resistance, and a capacitance, the voltage source, the resistance and the switches being connected in series with the capacitance to provide for a charging of the capacitance upon the closure of one of the switches, the voltage source, the resistance and the switches also being connected in series with the anode and cathodes to provide for an initial flow of current from the voltage source through the anode and a particular one of the cathodes dependent upon the operation of the associated switches, the capacitance being connected across the anode and cathodes to provide at least one discharge between the anode and the particular cathode upon the initial flow of current from the voltage source through these members.

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