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COUNTING CIRCUIT

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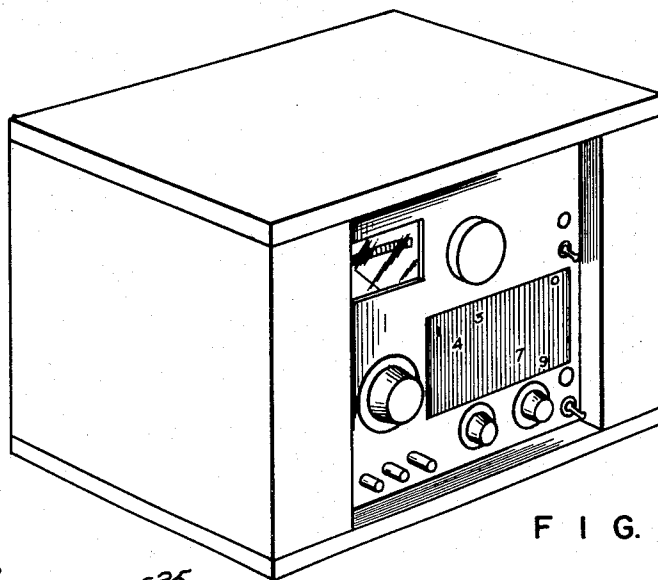


FIG. 1

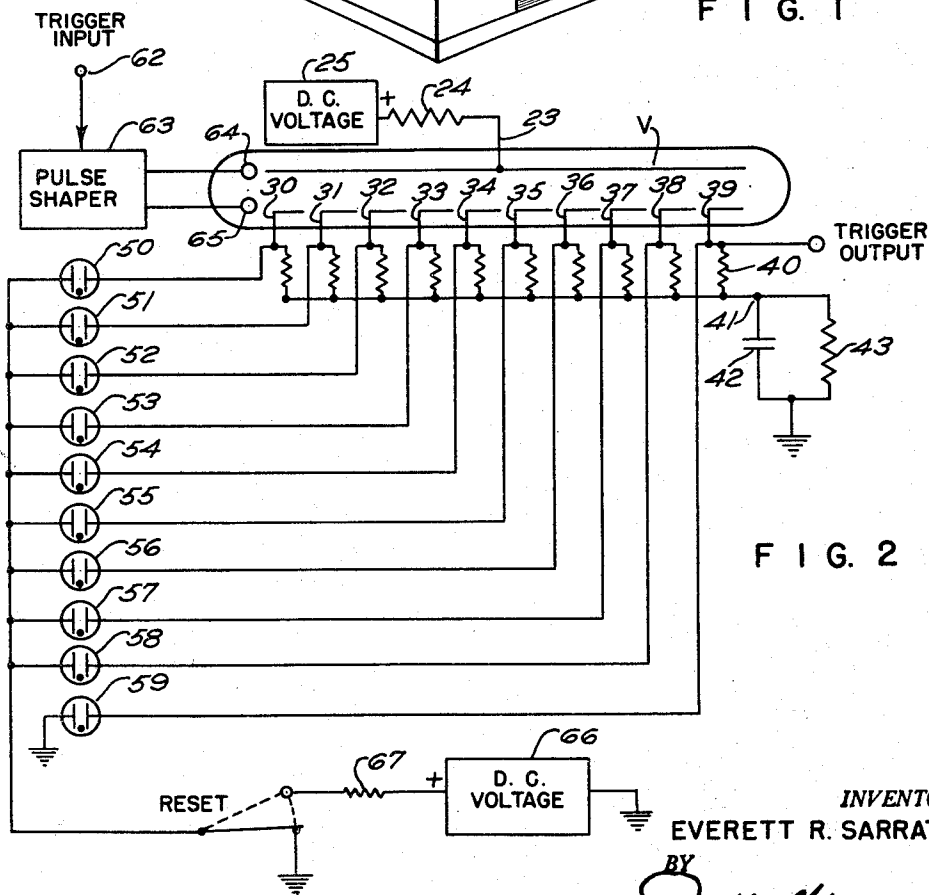


FIG. 2

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1

2,985,794

COUNTING CIRCUIT

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This invention relates in general to electronically controlled data displays and to means for actuating such displays from a glow transfer counting tube.

High speed electronic scalars capable of totalizing and reading out up to 100,000 or 1 million counts are now well known in the art. While a variety of circuits have been used to provide the scaling mechanism, the basic counting unit itself is generally one of two types. The first type is a conventional vacuum tube cascaded flip flop circuit which in many cases is arranged with feedback to provide a scale of ten, while the second type is the more recently developed glow transfer tube. In the glow transfer tube ten cathode elements are arranged in a circle about a single anode, each cathode having interspersed grid elements. The circuitry is arranged such that a neon glow discharge occurs between the anode and one cathode. If a pulse is applied in proper sequence to the grid of the tube the glow discharge is transferred to the next adjacent cathode and hence for each pulse the discharge transfers one cathode, until after ten pulses it is again on the first cathode. Several such tubes are connected in sequence such that when the glow is transferred from the tenth cathode back to the first cathode, an electronic signal is applied to the input of the next glow transfer tube, thus cascading the decades. The general practice for reading out a scaler employing the glow transfer tube is to allow the end of the tubes to protrude through the front panel and to engrave on the front panel numbers in positions corresponding to the radial position of the glow to the cathode when that number of pulses has been entered into the decade. Since the cathodes are arranged in a circle, the readout for each decade is essentially rotary and when the scaler is stopped the total number of counts accumulated is read out by noting the position of the glow and reading the corresponding number for each decade. Thus to perform this readout, the viewer must ascertain where the glow is and what is the corresponding number for each decade of the scaler. Such a system is uncertain, subject to parallax, and very tedious to read. If six decades are employed another problem arises from the relatively large diameter of commercially available glow transfer tubes. If, using these tubes, a reasonable space is left on the diameter for engraving the numbers, a six decade readout may actually be twelve inches wide. Further, apart from the readout problem itself, the decade tubes in such a system must be in line and hence there must be at least an equivalent space across the front panel for the decade tubes alone, which places a severe limitation on panel design and tube layout.

In the vacuum tube flip flop decade, scale readout is generally accomplished by means of neon lamps mounted in a vertical column on each decade assembly. Thus each scale of ten can constitute a plug-in unit and a rectilinear readout is provided. However, in this system a resistor matrix is required in order to derive from the four stages of flip flops ten individual signals each capable of lighting one and only one neon lamp for each decade. Such a matrix generally operates on the basis of a three leg co-

2

incidence circuit such that the lamp must light when a potential is applied to each of the three leads, but not light when only one or two leads have a potential on them. This requires that there be a precise stable firing level and discrimination in the neon lamp matrix circuit and such a system is subject to "false" neon lamp lighting upon line surges and other transients.

Neither system then is entirely satisfactory since with the glow transfer tube the readout is rotary and subject to misinterpretation and a severe space limitation is present. With the conventional vacuum tube flip flop a critical matrix is required.

It is therefore a primary object of the present invention to provide an accurate, economical, compact, rectilinear readout for glow transfer scaling circuits.

It is another object to provide a circuit for providing individual neon lamp readout while maintaining the counting tube operative despite defective neon lamps.

Broadly speaking, the present invention provides a circuit for neon lamp readout of glow transfer scalars arranged such that a readout panel of the type described in copending application Ser. No. 827,344, filed July 15, 1959, can serve as the digital display. In this circuit the neon lamps are inserted between the cathodes of the glow transfer tube and ground and the lamp associated with any cathode is fired when the glow is located at that cathode in the glow transfer tube. Since the glow discharge to each individual cathode is itself a neon discharge, the surge of current to the cathode is more than sufficient to provide the requisite voltage swing to move the neon lamp from the unfired to the fired state. Thus the scale of ten counting tube and its neon indicators are essentially matched in characteristics and the firing is entirely uncritical. Since one side of each neon lamp is at ground and only one wire is required from each cathode to each lamp, a total of eleven leads to a bank of ten lamps is all that is required. This permits the lamps to be conveniently located at a reasonable distance from the counting tube itself and since the lamps are in the order of 1/4" diameter, it would be feasible to provide a six decade readout in less than two inches. The fact that there are only eleven leads per decade and that the neon lamps may be separately located from the counting tube itself allows them to be assembled on a printed circuit board as a complete five or six decade readout panel and mass production techniques such as dip soldering and the like can be applied, considerably reducing the cost of fabrication and assembly of the readout panel.

These and other objects and advantages will become apparent from the following detailed description when taken in conjunction with the accompanying drawing in which:

Fig. 1 is a perspective view of a typical scaler instrument employing the readout system of this invention;

Fig. 2 is a schematic diagram of the basic circuit of this invention.

With reference now specifically to Fig. 1, an instrument 22 employing the readout system of this invention, with the neon indicators grouped on the front face, is shown. It will be noted that in each digit column only that digit which is indicated appears, and hence no process of selection of which digit is illuminated is required; rather it is immediately obvious what the digit is.

Turning now to Fig. 2, a schematic representation of the circuit of a single decade is shown. A glow transfer tube V_1 has its single anode 23 coupled through resistor 24 to the positive terminal of the direct current voltage supply 25, the other terminal of which is grounded. The ten individual cathodes 30 through 39 of tube V_1 are coupled through individual cathode resistors 40 to junction 41. Also coupled to junction 41 is one side of bias resistor 43 and one side of bypass condenser 42, the

other side of both resistor 43 and condenser 42 being grounded. Each of the first nine cathodes 30 through 38 are individually coupled to one terminal of the corresponding neon lamp 50 through 58, while cathode 39 is coupled to one terminal of neon lamp 59. The other terminals of neon lamps 50 through 58 are coupled jointly to the pole of switch 61 which, in operation, electrically connects to ground. The other terminal of neon lamp 59 is coupled directly to ground. The pulses to be tabulated are applied to trigger input 62 of pulse shaper 63, which in turn provides a shaped pulse to electrodes 64 and 65, this pulse being appropriate to transfer the glow discharge in tube V_1 from one cathode to the next adjacent one in the conventional manner of operating these tubes. A trigger output is provided from the last cathode 39 when the glow switches back to it from the ninth cathode 38. When switch 61 is placed on the reset position, the positive terminal of D.C. voltage source 66 is coupled through resistor 67 to the previously grounded terminal of neon lamps 50 through 58.

Having described the interconnection of these circuit elements, the operation of the circuit will now be discussed. The characteristics of the glow transfer tube V_1 are such that if sufficient potential is applied to the anode 23, a glow discharge is produced between the anode and one of the cathodes. As will be described in more detail below, the reset mechanism is arranged to provide that after reset this glow discharge occurs between the anode and the tenth cathode, in this case cathode 39. Upon receipt of a pulse at the trigger input 62, pulse shaper 63 provides an output pulse to transfer electrodes 64 and 65 which operate to transfer the glow discharge from cathode 39 to cathode 30, since in physical layout the cathodes are in a circle and cathode 30 is adjacent to cathode 39. Subsequent pulses continue to transfer the discharge to the adjacent cathodes until the discharge is on cathode 38. When the discharge is on cathode 38, the next pulse transfers the discharge back to cathode 39. This pulse also provides an output through the trigger output in order to pass the pulse on to the next cascaded stage.

The individual neon lamps 50, which serve as indicators, are lit by the cathode circuit action. When the glow discharge is on, for example, cathode 30, all of the current in the glow transfer tube is being drawn through that cathode and, provided that resistors 40 and 43 are properly selected and the supply voltage 25 is sufficiently high, the neon lamp 50 associated with cathode 30 will be lit. Since resistors 40 and 43 are in series and this series combination is in parallel with neon lamp 50, the voltage drop across lamp 50 determines the current through these two resistors. This current multiplied by the resistance of resistor 43 places a cathode bias on the other nine cathodes and when the discharge is transferred to the next cathode it is only required that the cathode rise a sufficient potential above this bias to fire the associated neon lamp. Should the lamp be defective, the glow discharge will still be maintained on the appropriate cathode because the resistor series provides the closed circuit and the counting function of the glow transfer tube will not be impaired.

When a count is ended the glow discharge may, of course, be on any one of the cathodes and the reset function is intended to return this glow discharge to the initial cathode 39, usually labelled "zero" on the instrument panel. This is accomplished by momentarily switching the reset switch 61 to the reset position and then returning it to its original position. In the reset position switch 61 provides positive voltage from D.C. voltage source 66 to the normally grounded side of the first nine neon lamps. This voltage source 66 is made sufficiently high so that it not only fires the neon lamps in reverse but also provides sufficient positive potential on each of the nine cathodes so that the discharge is not sustained between the anode and any of them, but rather

moves to cathode 39 which is connected to one terminal of neon lamp 59, the other terminal of which is permanently grounded and hence not affected by the action of switch 61. While switch 61 is in the reset position, all ten neon lamps are lighted and the glow discharge is transferred to cathode 39. When switch 61 is released, all neon lamps except lamp 59 are extinguished and the glow discharge remains on cathode 39. An additional feature of this particular arrangement is that all neon lamps are in effect tested when reset action is initiated, thus providing a valuable means for checking those lamps which are seldom seen because of their occurrence far back in the ten and hundred thousands columns.

The table below lists typical values for the circuit elements and the voltage current characteristics of the glow transfer tube under these conditions:

Glow transfer tube type	Sylvania 6476.
Neon lamp type	G.E. Ne-2E.
Ne-2E firing voltage	90 volts firing (55 volts sustaining).
Resistors 40	150 thousand ohms.
Resistor 24	820 thousand ohms.
Resistor 43	220 thousand ohms.
Resistor 67	3.3 thousand ohms.
Condenser 42	0.1 μ f.
Supply voltage 25	+570 volts.
Supply voltage 66	+300 volts.
Amplitude of pulse from pulse shaper 63	-150 volts.

Characteristics when Ne-2E is fired:

Plate 23 voltage	240 volts.
Plate current	0.4 milliamp.
Plate to cathode (fired) potential	180 volts.
Cathode (fired) potential	60 volts.
Other cathodes potential	35 volts.
Current through resistor 43	0.16 milliamp.

Characteristics when Ne-2E does not fire due to Ne-2E defect:

Plate voltage	302 volts.
Plate current	0.33 milliamp.
Plate to cathode (fired) potential	180 volts.
Cathode (fired) potential	122 volts.
Other cathodes potential	70 volts.
Current through resistor 43	0.33 milliamp.

As indicated in the above table, the cathode voltage can rise as high as 120 volts, thus insuring that the neon lamp will in fact fire. If the neon lamp is defective the cathode resistors 40 and 43 provide a current path to ground, so that the glow transfer tube continues to scale properly. This is a precautionary measure and the system could be operated with the neon lamp in the cathode circuit as the only path to ground.

From the foregoing it is obvious that many alterations may now be made by those skilled in this art; the invention disclosed herein should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. Data display apparatus comprising a glow transfer tube having an anode element and a plurality of associated cathode elements, means for applying a succession of impulses to said glow transfer tube, circuit means cooperative with said glow transfer tube whereby each successive one of said applied impulses transfers a glow discharge from one of said cathode elements to the next successive cathode element in continuous ring fashion,

5

a like plurality of individual glow discharge lamps, a respective one of said lamps being electrically connected between each of said plurality of cathode elements and a first reference potential junction, whereby when said glow discharge occurs on one of said cathode elements, the respective glow discharge lamp is illuminated, means coupling each of said cathode elements to a second junction, and bias means for maintaining the potential of said second junction in excess of the potential at said first junction.

2. Data display apparatus in accordance with claim 1 wherein said means coupling each of said cathode elements to said second junction comprises a like plurality of resistors, each of said resistors having one end coupled to the respective cathode element and the other to said second junction, whereby the transfer of said glow discharge to said cathode elements in succession in response to said applied impulses continues notwithstanding failure of illumination of one or more of said glow discharge lamps.

3. Data display apparatus in accordance with claim 2 and including a reset potential source, switching means

6

for momentarily disconnecting all but one of said glow discharge lamps from said first reference potential junction and applying said reset potential thereto, whereby when said glow discharge lamps are reconnected to said first reference potential junction, said transfer tube glow discharge occurs at said cathode element connected to said glow discharge lamp not previously connected to said reset potential junction.

4. Data display apparatus in accordance with claim 3 wherein said reset potential value is sufficient to cause simultaneous illumination of said glow discharge lamps during application of said reset potential thereto upon operation of said switching means.

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