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GASEOUS COUNTING AND STORAGE DEVICE

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2 Sheets-Sheet 1

FIG. 1

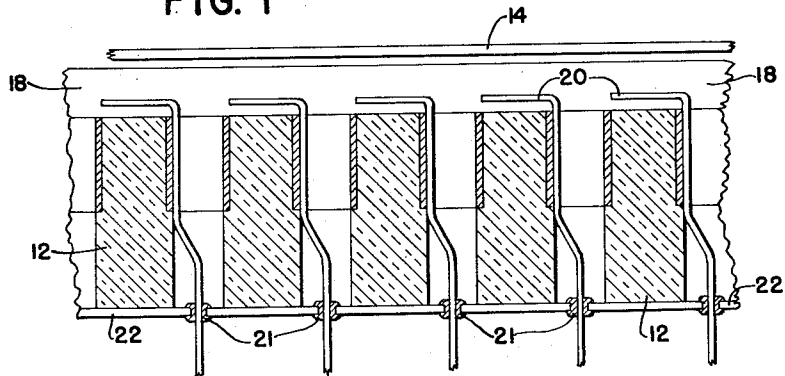


FIG. 2

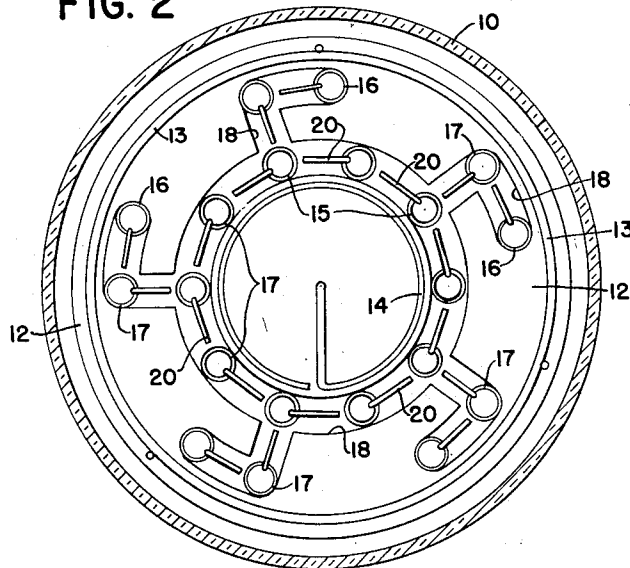
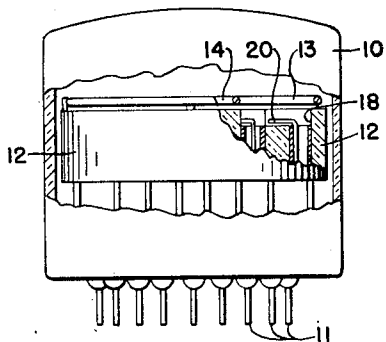


FIG. 3



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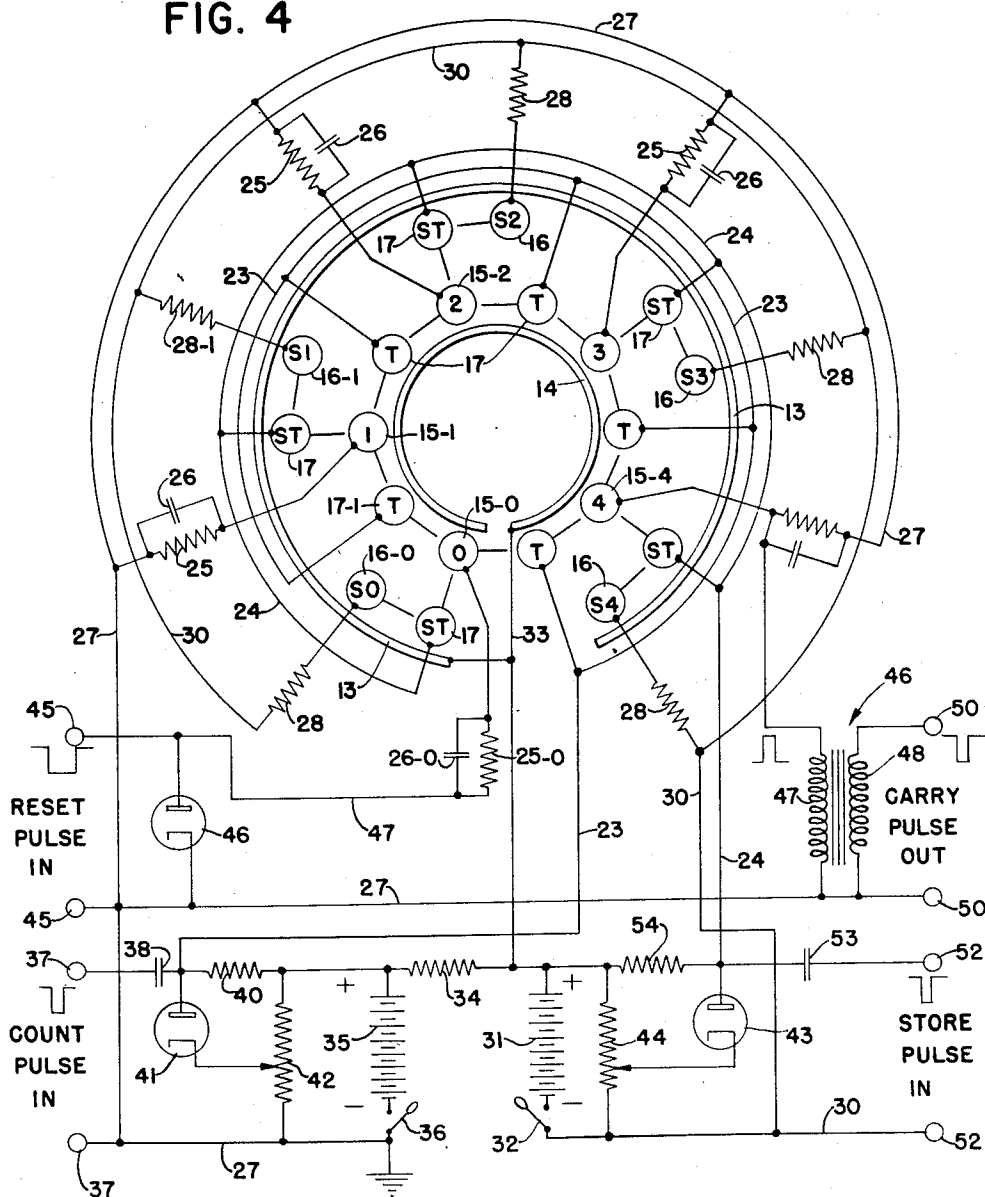
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FIG. 4



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GASEOUS COUNTING AND STORAGE DEVICE

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8 Claims. (Cl. 315—84.6)

This invention relates to a gaseous counting tube with means for storing or retaining a count in auxiliary storage electrodes. It has particular reference to a gaseous counting tube which is operated by electrical pulses to count and is also operated by electrical pulses to store a count by shifting a gaseous discharge to electrodes in series with recording means.

Many types of gaseous counting tubes have been developed which count electrical pulses but in order to record the value in the tube system it has been necessary to stop the counting operation and either photograph the discharge positions or make a visual note of the discharges in each tube. The present invention permits the storage and recording of the value in the counting system without stopping the counting action. When this system is in use a read-out operation can be effected every minute or every second to store the count value at the instant a storage pulse is received, and recording or printing means can be utilized to make a permanent record at the end of each selected time interval.

The present invention employs a series of storage electrodes adjacent to a series of counting electrodes. Transfer of a gaseous discharge is made by means of a transfer electrode mounted between the counting electrode and the storage electrode. The current taken by the storage electrode may be utilized to operate relays, counting storage devices, or printers which record the count value on paper.

One of the objects of this invention is to provide a Counting and Storage Device in one envelope which avoids some of the disadvantages and limitations of prior art arrangements.

Another object of the invention is to improve the reliability and accuracy of read-out storage devices so that a correct count value will be obtained even though the supply voltages may vary over a wide range of values.

Another object of the invention is to increase the current carrying capacity of the storage electrodes so that external current indicating devices may be operated directly from the device without recourse to intermediate circuits.

Another object of the invention is to provide circuit means for connecting two counting-storage devices so that the output of one device may apply a count pulse to a second tube.

The invention comprises an anode positioned within an envelope which is filled with ionizable gas at a reduced pressure. A plurality of counting cathodes are positioned in closely fitting cavities in an insulating block equally spaced from a portion of the anode. A plurality of storage cathodes are positioned in cavities in the insulating block equally spaced from another portion of the anode. A plurality of transfer cathodes are also positioned in cavities in the block positioned between each of the counting cathodes and between a counting cathode and its corresponding storage cathode. The counting cathodes and the storage cathodes are each connected to a

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separate lead-in conductor for application of voltages and counting pulses to and from circuits external to the envelope. Each cathode is provided with a probe which extends from the cathode body to a point just above the top edge of the adjacent cathode.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

Fig. 1 is a sectional view of a development of the electrodes encased in the insulating block.

Fig. 2 is a cross sectional drawing of a counting tube having five count cathodes, five storage cathodes, and ten transfer cathodes.

Fig. 3 is a side view of the counting-storage tube, with some parts in section, showing the insulator block and both portions of the anode.

Fig. 4 is a schematic diagram of connections showing the external circuitry employed with the tube for counting, storing, resetting, and carrying to another tube.

Referring now to Figs. 1, 2, and 3, the discharge device comprises an envelope 10 having a plurality of contact pins 11 secured in the base. Within the envelope an insulating block 12, having a generally cylindrical form, is employed to support all the cathodes in cavities within the block and also helps to support two portions of a single anode 13 and 14, both adjacent to the top surface of the block and spaced equidistant from the cathodes below it.

The tube shown in Fig. 2 contains five counting cathodes 15, five storage cathodes 16, and ten transfer cathodes, five of which (17) are alternately arranged between the counting cathodes 15 and five similar cathodes 17 each of which is positioned equidistant from a count cathode and a storage cathode. There is no structural difference between the cathodes except in their external connections. Each cathode is supported within a circular cavity in the block with the top edge of the cathode flush with the grooved surface of the block (see Fig. 1). For convenience in manufacture the cathodes are positioned within a groove 18 but this construction is not necessary for counting. On the inside of each cathode a wire probe 20 is conductively secured to the cathode surface, one end of which extends through the bottom of the block 12 where it is secured to an eyelet 21 set in a mica insulating sheet 22. The lower extremities of the probe 20 are used for connection to the lead-in wires and for other connections within the tube when desired. The upper ends of probes 17 are bent over so that they lie horizontally above the insulator block surface with their ends in close proximity to the next adjoining cathode. When a discharge has been started between the anode 14 and one of the count electrodes 15 a glow appears on the inside of the hollow cathode cylinder but is not visible elsewhere. However, the ionized gas molecules extend between the inside surface of the cylinder and the anode and the ionized region extends sufficiently to one side to include the end of the adjoining probe 20.

Fig. 4 shows the operating circuit in schematic form, each transfer cathode 17 between the count cathodes 15 being connected to a common conductor 23, and each transfer cathode 17 between a count cathode and a storage cathode being connected to a second common conductor 24. The count cathodes 15 are each connected to a resistor 25 which is shunted by a capacitor 26. The other ends of the resistors are connected to a common conductor 27 which is grounded. The storage cathodes are each connected to a resistor 28, the other ends of these resistors being connected to a common conductor 30 which is connected to the negative terminal of a source of potential 31 by means of switch 32. Both anodes 13 and 14 are connected together within the tube envelope

and their common conductor 33 is connected to a series resistor 34 and a source of potential 35, the negative terminal of which is connected to ground by means of switch 36. Conductor 33 is also connected to the positive terminal of source of potential 31.

The input circuit which receives negative counting pulses comprises two input terminals 37, one of which is connected to the ground conductor 27 and the other of which is connected in series with a blocking capacitor 38 and the conductor 23. The transfer conductor 23 is also connected through resistor 40 to the positive terminal of the source of potential 35. In order to give conductor 23 its proper positive potential and to keep the negative input pulses from the adjustable circuit a diode 41 is connected between the conductor 23 and an adjustable point on a voltage divider 42. Conductor 24 is also held at a nominal potential by a similar network which includes a diode 43 connected to the conductor and an adjustable point on a bleeder resistor 44 across battery 31.

When the tube is first switched into operating condition by the closure of switches 36 and 32 any one of the count cathodes may be lighted. To transfer the discharge to the zero cathode 15-0 a reset circuit is provided which includes a pair of reset terminals 45-45, a diode 46, and a conductor 47 which connects one of the input terminals to the time constant circuit 25-26.

In the usual counting operation, using the denary or decimal system, the counting tube shown in Fig. 4 will have ten counting cathodes instead of five and there will be a plurality of counting tubes, one for each denominational order, to record the number of input pulses received. In order to "carry" from one denominational order to another a coupling circuit is used which includes a transformer 46 which has a primary winding 47 connected between ground and cathode 15-4. The secondary winding 48 is connected to output terminals 50-50 so that a negative pulse will be produced when the primary winding receives a positive pulse. Other suitable coupling networks may be used instead of a transformer.

The operation of this circuit may be described by reference to Fig. 4. In order to count, switches 36 and 32 are closed. This supplies anodes 14 and 13 with positive potential and one of the count cathodes will start the discharge, its position in the tube determined by chance or by stray ionizing influence. The discharge is reset to zero by applying a negative pulse to the reset terminals 45-45 making cathode 15-0 considerably more negative than any other cathode and moving the discharge to that electrode.

When it is desired to count, negative pulses are applied to terminals 37-37, each negative pulse sent over conductor 23 makes all the transfer electrodes 17 more negative than their normal potential and provides a large voltage drop between each transfer electrode and the inner anode 14. This voltage drop is greater than the normal voltage difference between the anode and a lighted count cathode and the electric discharge from any count cathode (such as the zero one) is transferred to the transfer cathode whose probe 17 lies adjacent to the discharge. The presence of ionized gas between the anode 14 and a count cathode 15 produces an ionized gas path between the anode and the adjacent probe of the next transfer cathode 17-1 and the discharge transfers to the transfer cathode as soon as the voltage drop between the transfer cathode and anode has exceeded the primed breakdown potential. The discharge between the anode and the transfer cathode lasts at most only as long as the duration of the input counting pulse. When the input terminals 37 and conductor 23 are returned to their normal voltage value, the transfer cathodes are all returned to their normal voltage which is less than the maintaining voltage for a discharge and the glow discharge then transfers to the next higher count cathode 15-1 be-

cause its probe extends into the ionized region of the transfer electrode.

The voltage variations caused by the negative input pulse can be explained in detail as follows: when the glow discharge is between the zero count cathode and the anode, the voltage furnished by the source of potential 35 (Fig. 4) is divided between resistor 34, the voltage drop across the glow discharge, resistor 25, and the diode 46. The voltage across resistor 25 keeps the zero cathode at some positive potential above ground. When the negative count pulse is received and applied to all the transfer cathodes, they are all lowered in potential making the voltage drop between the transfer cathodes and the anode greater than the primed breakdown voltage. The input pulse being negative cannot pass through the diode 41 and the lower part of resistor 42, therefore very little current must be supplied.

Since the transfer cathodes are arranged so that only one cathode in the inner ring has its probe wire in the region of the discharge, only that one will be lighted and take the discharge. When the count pulse is applied the additional current causes the voltage drop across resistor 34 to increase and the anode potential is lowered until the discharge between the count cathode 15-0 is eliminated. However, the zero count cathode is still biased at some potential above ground due to the charge on capacitor 26-0. This capacitor discharges through its parallel connected resistor 25 at a rate governed by the time constant of the circuit and the component values are adjusted so that this time constant is several times the duration of the count pulse.

When the count pulse ends the current through the resistor 34 decreases and the anode voltage again rises so that the potential difference between all count cathodes 15 is greater than the breakdown voltage. Cathode 15-1 takes the discharge because it is primed by having its probe in the ionized region of the previously lighted transfer electrode. The zero count cathode does not take the discharge because its capacitor 26-0 maintains a potential above ground of sufficient value so that the primed cathode 15-1 breaks down first.

After a counting sequence of operation the value of the count may be determined visually by noting the position of the lighted cathodes if there is a time interval between counts to do so. However, if the count proceeds at a fast rate visual inspection cannot be relied upon and some other means must be used. The storage transfer cathodes and storage cathodes 16 have been devised for such a read-out operation.

Let it be assumed that the discharge is between the anode 14 and the count cathode 15-1. At this time a negative pulse is applied to terminals 52-52 and this pulse is transmitted through capacitor 53 to conductor 24 and all the storage transfer cathodes in the outer ring adjacent to anode 13. A discharge will be transferred to the storage transfer cathode whose probe is adjacent to the count cathode having the discharge but the discharge is retained by the count cathode because there have been no voltage changes in the count system. The source of potential 35 which supplies the count cathodes and the transfer cathodes between them is different and segregated from the source of potential 31 which supplies the storage cathodes and their transfer electrodes. Also, the series resistors 34 and 54 do not carry the same current and a variation of current through the count system causes no effect in the storage system.

When the storage pulse ends the potential between the anode 13 and the storage transfer cathode drops to a value which is below the maintaining voltage and the discharge is then moved to the storage cathode 16-1 where it remains until switch 32 is opened. When the discharge exists between anode 13 and storage cathode 16-1 current flows through resistor 28-1. These resistors 28 represent the output loads of the storage system and may consist of relays, printing solenoids, or control

magnets which operate to cause mechanical indicators to show the count as it existed when the storage pulse was applied. Since the storage discharge remains at the storage electrode for an indefinite time, slow moving printing or recording apparatus may be employed to retain the count information regardless of the subsequent counting operations in the inner ring of electrodes.

After the count has been properly recorded switch 32 is opened, thereby eliminating the storage discharge. Then switch 32 is closed and the storage-recording system is ready for another storage pulse.

The above described storage system can be used to record the number of events, such as counts received from a Geiger counter, and read-out the total at the end of a predetermined time interval, such as every 30 seconds. For such a system, the storage pulse must be supplied every 30 seconds and automatic means must be provided for opening and closing the switch 32 after each recording operation. It will be obvious from the above description that the inner ring of count cathodes and transfer cathodes can continue to count the input pulses regardless of the operation of the storage cathodes. An indefinite number of tubes, each representing a denominational order, can be coupled to each other so that each counting tube "carries" to the tube in the next higher denominational order when a complete count has been made in the first tube.

While there have been described and illustrated specific embodiments of the invention, it will be obvious that various changes and modifications can be made therein without departing from the field of the invention which should be limited only by the scope of the appended claims.

We claim:

1. A gaseous storage device for storing a count made by a gaseous counting system comprising; a counting system which includes a plurality of count cathodes, each of which comprises the terminal of a glow discharge to denote a count value; a plurality of storage cathodes, each corresponding to a count cathode and positioned adjacent thereto; a plurality of storage transfer cathodes positioned between a count cathode and its corresponding storage cathode; each of said cathodes comprising a hollow cylinder which is partially enclosed in a block of insulating material; and a transfer probe for each of said cathodes, said probes each comprising an elongated conductor with one end secured to said cathode and the other end extending therefrom to an open end of one other preselected cathode to establish a preferential path for transferring the glow discharge.

2. A gaseous storage device for storing a count made by a gaseous counting system comprising; a counting system which includes a plurality of count cathodes, each of which comprises the terminal of a glow discharge to denote a count value; a plurality of storage cathodes, each corresponding to a count cathode and positioned adjacent thereto; a plurality of storage transfer cathodes positioned between a count cathode and its corresponding storage cathode; each of said cathodes comprising a hollow cylinder which is partially enclosed in a block of insulating material; a transfer probe for each of said cathodes, said probes each comprising an elongated conductor with one end secured to said cathode and the other end extending therefrom to an open end of one other preselected cathode to establish a preferential path for transferring the glow discharge; and a common electrode which is equally spaced from all the storage cathodes to comprise a common terminal for the storage discharges.

3. A gaseous storage device for storing a count made by a gaseous counting system comprising; a system for counting applied electrical pulses by the movement of a glow discharge from one set of counting electrodes to another; a plurality of storage cathodes, each corresponding to a count set of electrodes and positioned adjacent thereto; a plurality of storage transfer cathodes positioned be-

tween a counting position and its corresponding storage cathode; each of said storage cathodes and storage transfer cathodes comprising a hollow cylinder which is enclosed in a common block of insulating material with the cylinder ends mounted flush with a surface of the block; means for establishing a preferential path for transferring the discharge from a counting position to a storage cathode; and a common anode which is equally spaced from all the storage cathodes to comprise a common terminal for the storage discharges.

4. A gaseous storage device for storing a count made by a gaseous counting system comprising; a system for counting applied electrical pulses by the movement of a glow discharge from one set of counting electrodes to another; a first source of potential in series with a common resistor for supplying the current necessary for the counting glow discharge; a plurality of storage cathodes, each corresponding to a set of counting electrodes and positioned adjacent thereto; a plurality of storage transfer cathodes positioned between said counting electrodes and the corresponding storage cathodes; each of said storage cathodes and storage transfer cathodes comprising a hollow cylinder enclosed in a common block of insulating material with an open end of a cylinder mounted adjacent to the surface of the block; a second source of potential for supplying the current for a glow discharge for a storage cathode; means for establishing a preferential path for transferring the discharge from a counting position to a storage cathode; and a common anode which is equally spaced from all the storage cathodes to comprise a common terminal for the storage discharges.

5. A gaseous storage device for storing a count made by a gaseous counting system comprising; a system for counting applied electrical pulses by the movement of a glow discharge from one set of counting electrodes to another; a first source of potential in series with a common resistor for supplying the current necessary for the counting glow discharge; a plurality of storage cathodes, each corresponding to a set of counting electrodes and positioned adjacent thereto; a plurality of storage transfer cathodes positioned between said counting electrodes and the corresponding storage cathodes; each of said storage cathodes and storage transfer cathodes comprising a hollow cylinder enclosed in a common block of insulating material with an open end of a cylinder mounted adjacent to the surface of the block; a second source of potential for supplying the current for a glow discharge for a storage cathode; means for electrically connecting all of the storage transfer cathodes to a common conductor which is connected to a circuit which receives an electrical storage pulse when a storage operation is desired; means for establishing a preferential path for transferring the discharge from a counting position to a storage cathode; and a common anode which is equally spaced from all the storage cathodes to comprise a common terminal for the storage discharges.

6. A gaseous storage device for storing a count made by a gaseous counting system comprising; an envelope filled with a gas at reduced pressure; a system for counting applied electrical pulses by the movement of a glow discharge positioned within the envelope; a first source of potential external of the envelope for supplying the current for said glow discharge; a plurality of storage cathodes within the envelope, each corresponding to a counting position within the counting system and positioned adjacent to a counting glow discharge; a plurality of storage transfer cathodes positioned between said counting glow discharges and the corresponding storage cathodes; each of said storage cathodes and storage transfer cathodes comprising a hollow cylinder enclosed in a common block of insulating material with an open end of a cylinder mounted adjacent to the surface of the block; a second source of potential external of the envelope for supplying the current for a glow discharge for a storage cathode; conductive means within the envelope which

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connects all of the storage transfer cathodes to a common lead-in conductor which is connected to an external circuit for receiving an electrical storage pulse; means for establishing a preferential path for transferring the discharge from a counting glow discharge to a storage cathode when an electrical storage pulse is received; and a common anode which is equally spaced from all the storage cathodes to comprise a common terminal for the storage discharges.

7. A gaseous storage device as set forth in claim 6 10 which includes a lead-in conductor for each storage cathode for connection to an external recording mechanism.

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8. A gaseous storage device as set forth in claim 6 which includes a switching means for disconnecting said second source of potential and thereby disabling the storage glow discharge system after a record of the count 5 has been made.

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