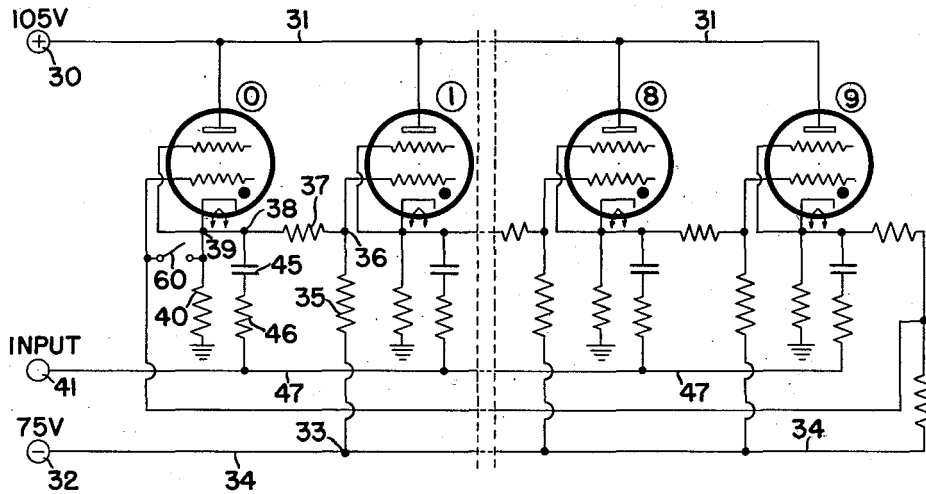


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ELECTRON TUBE COUNTING DEVICE

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ELECTRON TUBE COUNTING DEVICE

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1

2

This invention relates to a novel ring of electron discharge devices and in particular to a ring of gaseous electron discharge devices operable one after another in step-by-step fashion in response to input impulses which are applied to the extinguishing circuit of the ring.

In the embodiment of the novel ring which will be used to explain the invention, the gaseous electron discharge devices are so connected in the ring that conduction in a device will prime the next device for response to the next input impulse, and are further connected in an extinguishing circuit which enables conduction beginning in a device to cause any previously conducting device to be extinguished. The novel ring utilizes the extinguishing circuit also as an input circuit by which negative input impulses are applied to all the devices of the ring to cause the sequential operation of the devices.

It is an object of the invention to provide a ring or chain of gaseous electron discharge devices that are operable step by step in response to negative input impulses.

A further object of the invention is to provide a novel gaseous electron discharge device in which input impulses are applied to the ring through the usual extinguishing circuit for the ring.

A further object of the invention is to provide a gaseous electron tube ring in which an extinguishing circuit is provided for enabling the firing of a tube to extinguish a previously conducting tube and in which negative input impulses for causing the sequential operation of the tubes in the ring are applied to the extinguishing circuit, which also acts as a firing circuit.

A further object of the invention is to provide a gaseous electron tube ring in which the cathodes are electrostatically coupled in parallel to a common point for mutual extinguishing action and in which negative input impulses to fire the tubes in succession are impressed on the common point and thereby on the cathodes of all the tubes whereby to simplify the circuits of the ring and to enable the ring to be operated by negative impulses.

With these and incidental objects in view, the invention includes certain novel features of construction and combinations of parts, a preferred form or embodiment of which is hereinafter described with reference to the drawing which accompanies and forms a part of this specification.

The drawing shows the novel ring with certain of the tubes omitted from the drawing for clarity.

In this disclosure, the various potentials are given with reference to ground. It is not intended that the invention be limited to the use of the particular potentials and values of resistance and capacitance given in the following description, because the potentials applied to the various elements of the tubes are merely selected as convenient potentials for the disclosure, and the circuit elements of resistance and capacitance correspond in relative value to the potentials chosen. It is obvious that other tubes which are equivalent to the type to be specified and other potentials may be used and the values of the circuit elements adjusted accordingly to maintain the proper relation between the various parts of the circuit. Throughout the drawing, the cathode heater elements are shown conventionally.

The invention is shown embodied in a ten-tube ring, but, since the circuits to and between the tubes of the ring are the same, tubes "2" through "7" of the ring and their related circuits have been omitted in the circuit diagram, inasmuch as their operation and arrangement will be clear from the circuits which are shown for the remaining tubes, tubes "0," "1," "8," and "9."

The tubes "0" and "1" through "9" are connected in the novel ring for step-by-step sequential operation in response to negative impulses applied to the ring. The electron discharge devices used in the ring of the disclosed embodiment are gaseous tetrodes such as tubes sold by General Electric Company under the type designation GL5663.

Anode potential of +105 volts is applied from terminal 30 over positive potential supply conductor 31 to the anodes of the tubes of the ring.

The cathodes and the control grids of the tubes of the ring are supplied with negative potential from potential dividers which are supplied with a potential of -75 volts from terminal 32. The potential divider for supplying the potential to the cathode of the "0" tube and the control grid of the "1" tube is representative and extends from point 33 on negative potential supply conductor 34, which is connected to terminal 32, thence over resistor 35 of 1.5 megohms, point 36, resistor 37 of 2.7 megohms, points 38 and 39, and resistor 40 of 22,000 ohms to ground. The cathode of the "0" tube is connected to this circuit at point 39, and the control grid of the "1" tube is connected at point 36, so that the control grid will normally have a more negative potential than the cathode. Since similar potential dividers are provided to supply cathode and con-

3

control grid potentials to the various other tubes, the control grid of each tube normally will be sufficiently negative with respect to its cathode to prevent conduction. The connection of the cathode of one tube of the ring and the control grid of the next tube in the ring to the same potential divider enables the tubes to be connected in a ring for sequential operation.

It is to be noted that, when a tube is not conducting, its cathode will be given a potential slightly negative with respect to ground; however, when the tube is conducting, the cathode will also be conductively coupled to the anode, which will cause the potential of the cathode to become highly positive. This potential change of the cathode of a conducting tube is reflected, through its potential divider, on the control grid of the next tube in the chain and will reduce the bias on that tube, or prime it, to make it more responsive than any other tube of the ring to an impulse applied to the ring. The shield grid of each of the tubes is directly connected to its cathode.

Due to the fact that the tubes of the ring are gaseous electron tubes, an extinguishing circuit is provided to enable conduction commencing in a tube to extinguish any previously-conducting tube. The extinguishing circuit consists of parallel capacitive couplings, as by capacitors, as 45, of 500 micro-microfarads, and over resistors, as 46, of 4,700 ohms, for each tube from its cathode to a common point or conductor 47. The extinguishing action in this circuit is as follows. When a tube is conducting, its cathode will be at a positive potential which is less than anode potential by the amount of drop across the conducting tube. This will cause the capacitor, as 45, associated with the cathode of the conducting tube to be charged so as to have a potential drop thereacross corresponding to the differences in the potential of the cathode and that of the common point or conductor 47, which is also coupled to the other cathodes having negative potential. As the next tube in the ring is fired, its cathode potential rise will be impressed as a positive impulse on the common conductor 47 through its coupling thereto, and this potential impulse on the common conductor will be impressed through the capacitive couplings to the cathodes of the other tubes of the ring. This positive pulse will have the effect of merely increasing the bias on the non-conducting tubes, but, in the case of the previously-conducting tube, whose cathode is already at a high positive potential, it will be effective to momentarily drive the cathode potential more positive than the anode potential and cause conduction to cease in this tube. Accordingly, the firing of any tube in the ring will be effective to impress a positive impulse on the extinguishing circuit and thereby extinguish any previously-conducting tube.

In the novel ring, the extinguishing circuit for the ring is also used as the input circuit through which impulses can be impressed on the ring to cause the step-by-step operation of the tubes therein.

Negative input impulses of steep wave front and of short duration are applied to the common point or conductor 47 from any suitable source of negative impulses 41 and are impressed on all the cathodes over the parallel couplings including the resistors as 46 and the capacitors as 45. These negative impulses on the cathodes will tend to cause the cathodes and the shield grids connected thereto to become more negative, but these

4

negative excursions will be ineffective to cause any but the primed tube to be fired. It will be recalled that in the case of the conducting tube, conduction in the tube will cause its cathode to become positive, which in turn reduces the bias on the control grid of the next tube of the ring and makes the control grid potential only slightly more negative than its related cathode. When the negative input impulse is applied to the cathodes through the extinguishing circuit, it will have very little effect on the cathode of the conducting tube, due to the conduction in the tube, and consequently will cause very little change in the potential of the control grid of the primed tube which is connected thereto. This negative impulse will have a greater effect on the cathodes of the non-conducting tubes and will make the cathode of the primed tube sufficiently more negative relative to its control grid that the bias on the control grid of this tube is overcome, and the tube will fire and become conducting.

The application of the negative input impulses to the extinguishing circuit will not affect the operation of the circuit to extinguish a previously-conducting tube upon the firing of another tube in the ring, because the negative impulse has little effect on the potential of the cathode of the conducting tube and because the amount of the positive potential rise which is applied to the cathode of the conducting tube as a subsequent tube is fired, when added to the already high positive potential of the cathode due to conduction in the tube, is much more than that necessary to overcome the drop across the previously-conducting tube and cause the cathode potential to become more positive than the anode potential, thereby extinguishing the conduction in the previously-conducting tube.

The ring can be set in its zero-representing condition initially, or at any time that it is desired to reset the ring to zero, merely by momentarily closing a reset key 60, which removes the bias from the control grid of the "0" tube by connecting the grid to its cathode.

While the disclosed embodiment shows the electron discharge devices connected in a ring for sequential operation, it is obvious that they may also be connected in a chain for operation one after another in sequence.

It is clear from the above description that, in the novel arrangement, the circuits of the chain or ring of tubes utilizes the same circuit to cause a previously-conducting tube to be extinguished when another tube is fired and also to apply input impulses to all the tubes to cause the firing of the tubes. With this arrangement, the circuits of the chain or ring are simplified by the elimination of a separate circuit for applying the input impulses to all the tubes and the utilization of the usual extinguishing circuit for this purpose.

The novel arrangement has the further advantage that it enables a gaseous electron discharge tube chain or ring to be operated by negative input impulses.

While the form of apparatus herein shown and described is admirably adapted to fulfill the objects primarily stated, it is to be understood that it is not intended to confine the invention to the one form or embodiment herein disclosed, for it is susceptible of embodiment in various other forms.

What is claimed is:

1. In combination, a plurality of electronic devices; operating potential supply circuits and priming circuits connecting the devices in a chain

5

for sequential operation in response to input impulses; a further circuit interconnecting the devices and enabling conduction beginning in any device to cause any previously-conducting device to become extinguished; and means to impress input impulses on said further circuit and thereby on all of said devices to cause the sequential operation of the primed devices; said further circuit serving the dual function of enabling a previously-conducting device to be extinguished as a further device becomes conducting and also providing the medium through which input impulses are applied to the devices of the chain to cause the further devices to become conducting.

2. In combination, a plurality of electron discharge devices, each of said devices having at least a pair of electrodes and means to control conduction therebetween; operating potential supply circuits for said devices and priming circuits connecting an electrode of one device to the control means of another device for coupling the devices in a ring to be selectively primed one at a time in sequence for sequential operation in response to input impulses; an extinguishing circuit interconnecting similar electrodes in the various devices and enabling conduction beginning in any device to cause any previously-conducting device to become extinguished; and means to impress input impulses on the extinguishing circuit, said extinguishing circuit applying each impulse to all the electrodes to which it connects and acting as an input circuit to the ring to cause the sequential operation of the devices as they are primed.

3. In combination, a plurality of gaseous electron discharge devices, each of said devices having at least an anode, a cathode, and means to control conduction therebetween; potential supply circuits for supplying operating potential to said anodes and cathodes, and priming circuits connecting the several devices cathode-to-control means in a ring, said priming circuits providing normal bias potential to the control means and enabling conduction in a device to prepare the next device in the ring for sequential operation in response to an input impulse; an extinguishing circuit coupling the cathodes of the devices electrostatically in parallel to a common point and enabling conduction beginning in any device to cause any previously-conducting device to become extinguished; and means to impress negative potential input impulses on the common point in the extinguishing circuit and thereby on the cathodes of all the devices to cause the sequential operation of the primed devices.

4. In combination, a plurality of gaseous electron discharge devices, each of said devices having at least an anode, a cathode, and means to control conduction therebetween; potential supply circuits for supplying operating potential to said anodes and cathodes, and priming circuits connecting the devices cathode-to-control means in a ring, said priming circuits providing normal bias potential to the control means and enabling conduction in a device to prepare the next device in the ring for sequential operation in response to an input impulse; means to cause one of the devices of the ring to conduct; an extinguishing circuit interconnecting the cathodes of the devices and enabling conduction beginning in any device to cause any previously-conducting device to become extinguished; and means to impress negative potential input impulses on the

6

extinguishing circuit and thereby on the cathodes of all the devices to cause the sequential operation of the devices as they are primed in sequence.

5. In combination, a plurality of electron discharge devices, each device having at least a pair of main electrodes, and means to control conduction therebetween; means to supply operating potential to the devices, said potential supply including resistance which will cause the potential of one of the electrodes of a non-conducting device to change when the device conducts; connections for connecting the devices in a chain for sequential operation, said connections extending from said one electrode of a device to the control means of the next device of the chain and enabling conduction in a device to prime the next device in the ring for response to an input impulse; an extinguishing circuit for said devices and including parallel capacitative couplings between said one electrode of each device and a common conductor whereby the potential change of said one electrode as its device fires can be impressed on a corresponding electrode of each of the devices and cause any previously-conducting device to cease conducting; and means to impress input impulses on the common conductor of the extinguishing circuit and thereby on said one electrode of all the devices of the chain to cause any primed device to be fired, whereby the extinguishing circuit can also operate as the medium by which input impulses can be applied to all the devices of the chain.

6. In combination, a plurality of gaseous electron discharge tubes, each tube having an anode, a cathode, and means to control conduction therebetween; means to supply operating potential to the anodes and cathodes, said cathode potential supply including resistance which will cause the potential of the cathode of a non-conducting tube to change when the tube conducts; connections to supply controlling bias potential to the control means of one of said tubes from the cathode potential supply circuit of another of said tubes, said bias supply connections connecting the tubes in a ring for sequential operation and enabling conduction in a tube to prime the next tube in the ring for response to an input impulse; an extinguishing circuit for said tubes and including parallel capacitative couplings between the cathodes of all the tubes and a common conductor whereby the potential change of a cathode as its tube fires can be impressed on the cathodes of all the tubes and cause any previously-conducting tube to cease conducting; and means to impress negative potential input impulses on the common conductor of the extinguishing circuit and thereby on the cathodes of all the tubes of the ring to cause any primed tube to be fired, whereby the extinguishing circuit can also operate as the input circuit by which impulses can be applied to all the tubes of the ring.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,405,096	Mumma	July 30, 1946
2,422,583	Mumma	June 17, 1947
2,503,127	Mumma	Apr. 4, 1950