

Sept. 21, 1943.

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2,329,792

ELECTRON DISCHARGE DEVICE CIRCUIT

Original Filed Oct. 23, 1941

2 Sheets-Sheet 1

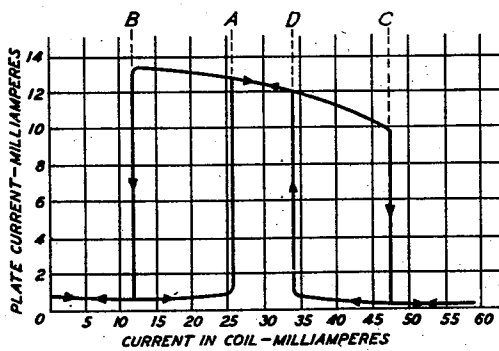
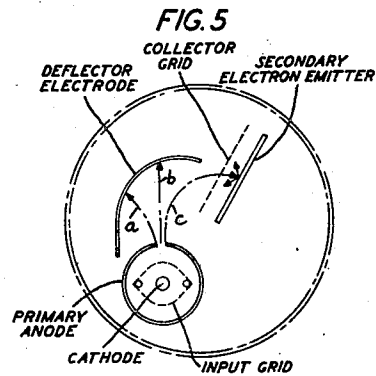
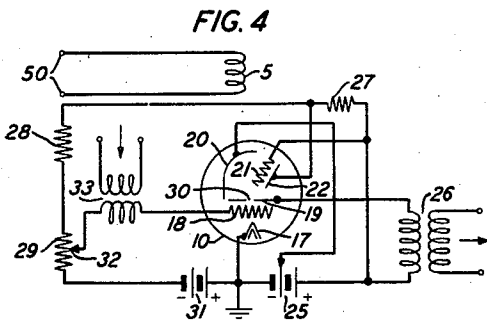
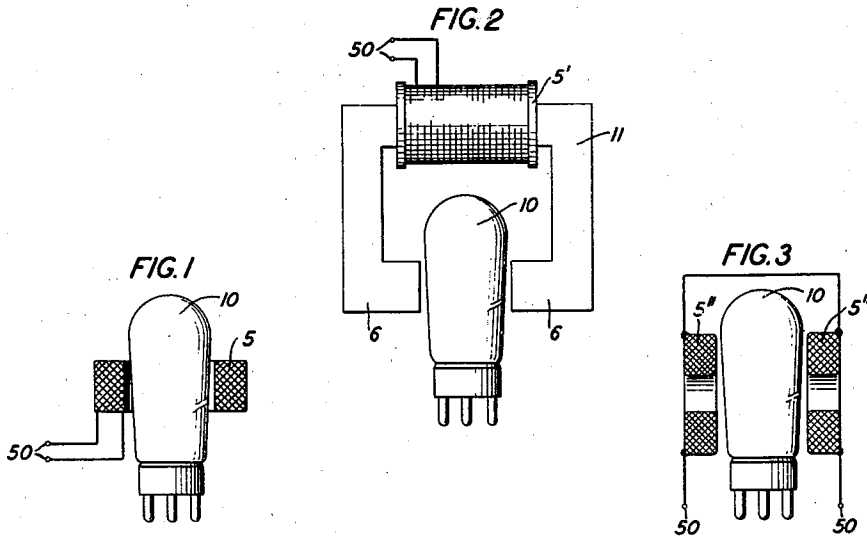


FIG. 6

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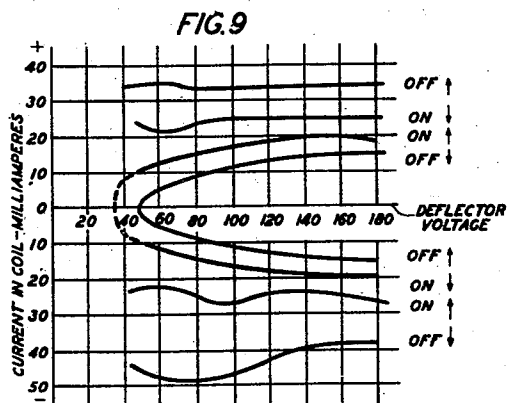
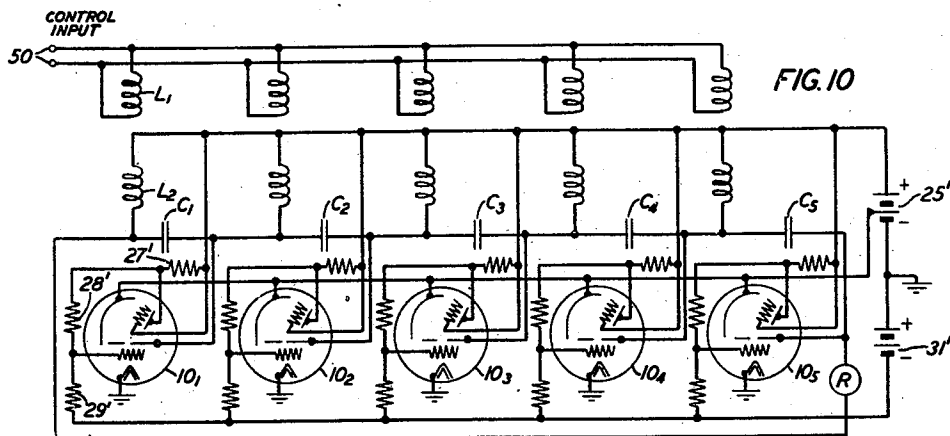
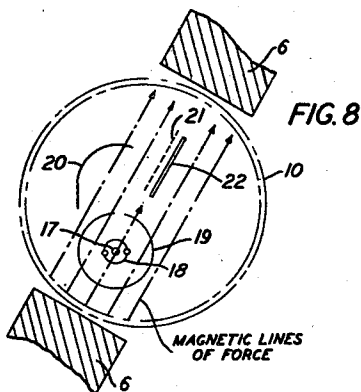
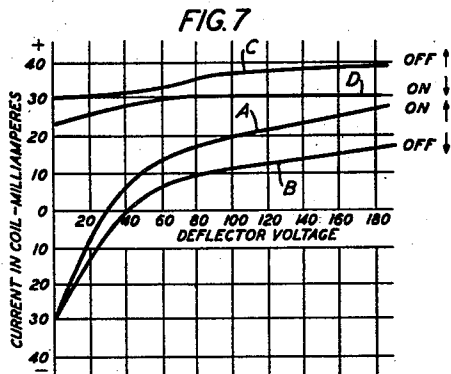
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2,329,792

ELECTRON DISCHARGE DEVICE CIRCUIT

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Original application October 23, 1941, Serial No.
416,155. Divided and this application Septem-
ber 1, 1942, Serial No. 456,875

28 Claims. (Cl. 250—27)

This application is a division of my applica-
tion Serial No. 416,155, filed October 23, 1941,
for Electron discharge device circuits, issued as
United States Patent No. 2,309,019 of January
19, 1943.

This invention relates to electron discharge
devices and, more particularly, to electronic
vacuum tubes of the secondary electron emission
type and circuits incorporating the same. More
specifically, the invention relates to modifica-
tions of the subject-matter of my United States
Patent 2,293,177 of August 18, 1942, for Electron
discharge device circuits.

An object of the invention is to improve the
means and method of regulating or controlling
the on and off properties or conditions of a trig-
ger device comprising a vacuum tube of the sec-
ondary electron emission type.

A feature of the invention comprises con-
trolling the operating condition of such a trig-
ger device by means of a magnetic field, the lines
of force of which may extend either parallel to
or perpendicular to the axis of the device.

A more complete understanding of the inven-
tion will be obtained from the detailed descrip-
tion that follows, read with reference to the
appended drawings, wherein:

Figs. 1, 2 and 3 illustrate arrangements for
associating a magnetic field with an electronic
device or vacuum tube;

Fig. 4 shows a circuit arrangement in accord-
ance with the invention in which a secondary
electron emission type vacuum tube has an
electromagnet associated with it, as in the ar-
rangement of Fig. 1, to provide a magnetic field
parallel to or along the axis of the tube;

Fig. 5 illustrates the electrode arrangement in
the tube of Fig. 4, and will be referred to in de-
scribing the action of the magnetic field on the
primary electrons emitted through the window
or aperture in the primary anode;

Fig. 6 is a typical operating characteristic of
the tube, being a plot of magnetizing current in
the magnetic field producing coil of Figs. 1 and 4
versus cathode-primary anode current, evidenc-
ing two critical primary anode current "off" and
two critical primary anode current "on" values
of magnetizing current for a given set of po-
tential conditions on the tube electrodes;

Fig. 7 shows a family of curves illustrating how
these critical "off" and "on" magnetizing cur-
rent values are affected by variation in deflector
electrode potential;

Fig. 8 is a schematic of a vacuum tube such as
shown in Fig. 4, but with the magnetic field pro-
ducing arrangement of Fig. 2 to provide a mag-
netic field perpendicular to the axis of the tube;

Fig. 9 shows a family of curves illustrating how
the critical "off" and "on" values of magnetizing
current in the coil vary with variation in de-

flector electrode potential, and with the direc-
tion of flow of the magnetizing current through
the coil or electromagnet of Figs. 2 and 5; and

Fig. 10 shows a closed ring pulse counting cir-
cuit embodying the magnetically controlled sec-
ondary electron emitter vacuum trigger tube of
this invention.

In my Patent 2,293,177, is disclosed a vacuum
tube having a trigger characteristic, i. e., it may
be substantially instantaneously energized or de-
energized dependent on its initial condition.
For a detailed description of the construction
and of circuit applications of this tube reference
may be had to Patent 2,293,177, but, in general,
the tube comprises a cathode; and input control
grid; a primary anode having an aperture or
window therein for the passage or escape there-
through of primary electrons originating at the
cathode; a secondary electron emitting electrode
or auxiliary anode having an emission ratio
greater than unity; a collector electrode or grid
for collecting secondary electrons released when
primary electrons bombard the auxiliary elec-
trode; and a deflector electrode for collecting
cathode particles that may be released from said
cathode, and for bending or deflecting from their
normal paths primary electrons that pass out-
wardly through the aperture in the primary
anode so that they may impinge on or bombard
the secondary electron emitting surface of the
auxiliary electrode; all of the electrodes being
supported in an evacuated envelope. The auxil-
iary anode has a floating characteristic, and as a
result of a suitable connection to the input grid
may be utilized with the latter to trigger the
tube on, subsequent to which the tube may be
used as a modulator, amplifier, oscillator or de-
tector.

Instead of utilizing a signal impulse to the in-
put grid and/or the auxiliary anode to trigger
the tube on or off as in Patent 2,293,177, the
trigger action, in accordance with this invention,
may be effected by magnetic or electro-magnetic
means, the presence or absence and the density
of magnetic flux parallel or perpendicular to
the axis of the tube determining whether the
primary electron stream is incident on the auxil-
iary anode and whether the latter is at its float-
ing potential and the input grid at a potential
substantially above cathode-primary anode cur-
rent cut-off.

Figs. 1, 2 and 3 illustrate how magnetic flux-
producing means may be associated with a vac-
uum tube 10 of the general type disclosed in my
aforementioned patent. In Fig. 1, an electro-
magnet 5, shown in cross section, surrounds the
tube, and when energizing current flows in the
electromagnet it produces magnetic flux in a
direction parallel to the axis of the tube. In Fig.
2, the electromagnet 5' surrounds a yoke 11 of

magnetic material between whose ends 6 the tube is located. In Fig. 3, the electro-magnet comprises a pair of coils 5'', each shown in cross section, between which the tube is positioned. With the arrangements of Figs. 2 and 3, magnetic flux may be produced that is perpendicular to the axis of the tube and at an azimuthal angle dependent on the location of the yoke ends or of the coils 5'' with respect to the tube.

A circuit arrangement in accordance with the invention is shown by Fig. 4. The vacuum tube 10 comprises a primary electron source or cathode 17, which may be indirectly heated; an input grid 18; a primary anode 19 having an aperture or window 30 for the passage therethrough of some primary electrons; a deflector electrode 20; a secondary electron collector electrode or grid 21; and a secondary electron emitting electrode or auxiliary anode 22, which may be similar to the correspondingly identified elements of Figs. 1, 2 and 3 of my Patent 2,293,177, but with the electrode arrangement of Fig. 3A of that patent. A source 25 of potential is connected between the grounded cathode and the primary anode, in circuit with the primary winding of an output transformer 26. The collector grid is connected directly to the high potential terminal of source 25, and the auxiliary anode is connected thereto through the resistor 27. The deflector electrode 20 is maintained at a positive potential which may be of the same order as that of the collector grid and primary anode, or less. The auxiliary anode is connected to the cathode through series-connected resistors 28, 29 and the source 31 of biasing potential for the grid 18, and to the latter through the tap or slide 32 engaging with resistor 29 and the secondary winding of input transformer 33. The resistors 27, 28, 29 are proportioned so that the auxiliary anode, in the absence of primary electrons incident thereon, is at a potential above its lower zero current potential.

With appropriate positive potential on the deflector electrode and no energizing or flux-producing current flowing in the coil 5, the primary electrons that are propelled from the cathode and through the window 30 in the primary anode are caused to follow the path b, Fig. 5, with none having access to the auxiliary anode. With current flow in one direction through the coil 5, the electrons are deflected to the left or caused to follow the path a, Fig. 5; with current flow in the opposite or reverse direction through the coil 5, the primary electrons are deflected to the right or caused to follow the path c, Fig. 5. If it is assumed that the input grid 18 is initially biased to such a value that the cathode-primary anode current is near cut-off, whereby the number of primary electrons reaching the primary anode is too small to provide an effective output current, and no current is being supplied to the coil 5, or only a current that produces a magnetic field that deflects to the left the electrons emitted through the window, the tube 10 is in its triggered-off condition, and signal impressed on the primary winding of the input transformer will not be transmitted through the tube. If, now, current is caused to flow in the coil in such direction as to produce a magnetic field that deflects the primary electron stream along path c, secondary electrons are caused to be emitted from the anode 22 and the latter rapidly rises in potential. As it increases to its stable floating potential, the bias on the grid 18 is decreased and the grid is driven sufficiently in the positive di-

rection so that substantial flow of electrons to the primary anode results. After the tube is thus triggered on, its cathode-input grid-primary anode structure may be utilized, for example, to amplify or to detect the signal wave impressed on the cathode-input grid circuit through the transformer 33. The tube may be triggered off by removing, or reversing the direction of, the magnetic field. The described combination of coil, tube and circuit has properties the equivalent of those of a polarized relay, as well as those of a conventional vacuum tube.

The magnitude of the magnetic field strength required to make the primary electrons follow the path c is given by

$$H = \frac{1.414}{R} \left(\frac{Vm}{e} \right)^{1/2}$$

where m and e are the mass and the charge of an electron, V is the voltage of the primary anode and the deflector and collector electrodes, and R is the radius of the path c.

Fig. 6 shows the cathode-primary anode current versus current in the electromagnet 5 for a complete cycle of operation in a circuit arrangement constructed in accordance with the invention, and in which resistors 27, 28, 29 were of 4.5 megohms, 2 megohms and 1 megohm, respectively, the input grid bias was of the order of -36 volts, the deflector potential was of the order of +135 volts, and that of the primary anode and the collector grid was about +150 volts. The coil 5 consisted of 13,750 turns of No. 36 wire, and had a resistance of 3000 ohms; 10 milliamperes produced a field of 34 gauss at its center. In the "off" condition of the tube, that is, with no current in the coil 5 to produce a magnetic field of correct polarity, the anode current is a fraction of a milliampere, in the specific instance, 0.65 milliampere. Increase of the coil current causes only a slight increase in the anode current until a critical coil current A (about 26 milliamperes) is reached at which the anode current jumps to 12.8 milliamperes. Decrease in the coil current to a second critical value B (about 12 milliamperes) causes the tube to trigger off with the primary anode current restored to its low value. It will be noted that the anode current rises slightly as the coil current is thus decreased between A and B, and that the coil current to trigger off the tube is substantially less than that required to trigger it on. When the tube triggers on, the potential of the auxiliary anode rises and this helps to hold the electrons over on to it. This insures a high order of stability to the tube in its off and in its on condition.

Once the tube has been triggered on, increase of the coil current above the first trigger-on or first critical point A results in a slight decrease in the anode current until a third critical coil current C (about 46 milliamperes) is reached at which the tube triggers off. This results because the primary electron stream is deflected or bent to such an extent that the primary electrons no longer strike the auxiliary anode; the latter ceases to emit secondaries and decreases in potential to its original condition, and the effect on the grid 18 of the negative bias from source 31 is no longer compensated. After the tube has been triggered off in this manner, an appreciable reduction in the magnitude of the coil current below the upper trigger-off point C is necessary before the tube again triggers on at a fourth critical coil current D as a result of the primary electrons again

bombarding the auxiliary anode. In the particular case, this occurred at about 34 milliamperes, at which the anode current rose to about 12 milliamperes. Further reduction in the coil current causes the anode current to increase slightly until coil current B is again reached at which the tube triggers off.

The sensitivity of the trigger control may be varied by changing the potential on the deflector electrode. In general, the lower the positive potential of the deflector electrode the smaller the energizing current required in the coil 5. For example, for potential conditions otherwise the same as those under which the characteristic of Fig. 6 was obtained but with the deflector electrode at +45 volts, the tube was caused to trigger on initially with a current of only 9.5 milliamperes in the coil 5. Fig. 7 shows how the critical currents A, B, C, D for the coil current vary with variation in deflector electrode potential. These characteristic curves were obtained with the primary anode and the collector grid at +180 volts, and with the input grid biased to -22.5 volts. The positive (+) and negative (-) signs on the coil current scale indicate the direction of current flow through the coil, i. e., positive currents produce a magnetic field whose tendency is to deflect the primary electron stream toward the path c, negative currents produce a magnetic field of reversed polarity from that of the field produced by the positive currents and whose tendency is to deflect the primary electron stream toward path a.

The specific description hereinabove has been with respect to a control coil that produces a magnetic field substantially parallel to the axis of the tube. The arrangements of Figs. 2 and 3 enable magnetic control of the primary electron streams by means of a magnetic field extending perpendicular to the axis of the tube. Fig. 8 illustrates the relation to the electrodes of tube 10 of the magnetic lines of force provided by the magnetic yoke and coil 5' of Fig. 2. In a specific embodiment of the invention, the yoke was of iron, the coil consisted of 19,000 turns of No. 36 wire and had a resistance of 3,660 ohms. The gap between the faces of yoke ends 6 was about 1½ inches and 10 milliamperes of direct current in the coil 5' produced a field of 50 gauss at the center of the gap. The direction of the magnetic field with respect to the electrodes has been determined to be somewhat critical, best results being obtained when the direction of the field in the gap was set at an angle of 4.0 degrees with respect to the plane of the collector grid, although deviations of the order of a few degrees from this condition could be tolerated. A typical cycle of on and off operation for this arrangement would be similar to that shown in Fig. 6 for the control coil arrangement of Fig. 1. With the arrangement of Fig. 2 and Fig. 8, however, the direction of current flow in the coil 5' may be such as to produce magnetic lines of force in either direction across the gap between yoke ends 6, and yet enable substantially the same off and on cycle to be obtained. The arrangement of Fig. 2 provides the equivalent of an ordinary relay. As with the arrangement of Fig. 1, the sensitivity of the trigger control is dependent on the potential at which the deflector electrode is maintained. Fig. 9 shows a family of coil current-deflector potential curves for the arrangement of Fig. 2, in which the primary anode and collector grid of tube 10 were at +180 volts and the input grid was at a potential of -22.5 volts.

Fig. 10 shows a closed ring pulse counting circuit comprising a plurality of stages of the magnetically controlled trigger vacuum tubes of this invention. Each tube 10₁—10₅ is similar to tube 10 of Fig. 4. The magnetic field producing coil for each tube comprises two separate windings L₁, L₂, the windings L₁ being connected in parallel across the terminals 50 on which are impressed the pulses to be counted, and each winding L₂ being connected in a primary anode potential lead from the high potential terminal of source 25', the winding L₂ of a particular tube being connected in the primary anode potential supply lead of the preceding tube in the ring. Biasing potential for the input grids of the tubes is provided by source 31'; the collector grid directly, and the auxiliary anode, through a resistor 27' are connected to the potential source 25', while the deflector electrodes are connected to an intermediate point on the source 25'. The resistors 27', 28', 29' are proportioned so that the auxiliary anode's normal potential, i. e., when the tube is in off condition, is at least above the lower zero current potential of the auxiliary anode. The primary anodes of succeeding tubes are connected through condensers C₁—C₅. The operation of this circuit is as follows: In order to "fire" or trigger on any one tube in the ring, both windings L₁, L₂ associated with that tube must be energized. If it is assumed that tube 10₁ has already been "fired" or is in its on condition, its cathode-primary anode current flows through the L₂ winding of tube 10₂, which produces a magnetic field in tube 10₂ of a strength substantially less than that required to trigger it on. When a current pulse is impressed on the terminals 50, each winding L₁ produces a magnetic field in its associated tube that is of strength substantially less than that required to trigger on the tube, but which, in the case of tube 10₂, supplements the field already provided by its winding L₂ sufficiently to cause tube 10₂ to trigger on. This primes the succeeding tube 10₃ since the primary anode current of tube 10₂ flows through the L₂ winding of tube 10₃ and provides the initial magnetic field for the latter. Simultaneously, the preceding tube 10₁ triggers off, each L₂ winding being of sufficient resistance to cause such change in the primary anode potential of a tube as it triggers on that, acting through the coupling condenser, in the present instance C₂, it momentarily reduces the primary anode potential of the preceding tube to such a value that insufficient primary electrons reach the auxiliary anode thereof to maintain the auxiliary anode at its floating potential. The fall of the auxiliary anode potential to its normal potential causes the input grid to reduce still further the flow of primary electrons in tube 10₁ and, in the absence of energizing current in both of the windings L₁, L₂ associated with tube 10₁ the latter remains triggered off. As successive current pulses are impressed through terminals 50, the tubes "fire" in succession around the ring, the register R in the primary anode lead for tube 10₅ registering every fifth pulse received.

Although this invention has been disclosed with reference to certain specific embodiments, it is to be understood that the invention is not limited thereto, but that such embodiments represent what are believed at this time to be the best mode of applying the invention.

What is claimed is:

1. In combination, an electronic device comprising a primary electron section and a second-

ary electron section, said primary section including a primary electron source and a primary anode, said primary anode containing an aperture for the escape of primary electrons therethrough, said secondary section comprising a secondary electron source for emitting electrons in ratio greater than unity when bombarded with primary electrons and a secondary electron collector electrode, said secondary source and collector electrode being positioned out of the direct path of escaped electrons, and an additional electrode; means for maintaining said additional electrode at a potential such that escaped electrons are attracted thereto; and means comprising a coil which, when traversed by current, produces magnetic flux perpendicular to the axis of the device, for deflecting the escaped electrons away from said additional electrode and onto said secondary source.

2. The combination of claim 1 in which the magnetic flux makes a relatively small angle with respect to the plane of the collector electrode.

3. The combination of claim 1 in which the magnetic flux makes an angle of approximately four degrees with respect to the plane of the collector electrode.

4. The combination of claim 1 in which current flow in either direction through the coil is effective to produce magnetic flux deflecting the escaped electrons onto the auxiliary anode.

5. In combination, an electronic device comprising a primary electron section and a secondary electron section, said primary section including a primary electron source and a primary anode, said primary anode containing an aperture for the escape of primary electrons therethrough, said secondary section comprising a secondary electron source for emitting electrons in ratio greater than unity when bombarded with primary electrons and a secondary electron collector electrode, said secondary source and collector electrode being positioned out of the direct path of escaped electrons, and an additional electrode; means for maintaining said additional electrode at a potential such that escaped electrons are attracted thereto; means comprising a coil which, when traversed by current, produces magnetic flux perpendicular to the axis of the device, for deflecting the escaped electrons away from said additional electrode and onto said secondary source; and means interconnecting the secondary section and the primary section such that changes in potential in the secondary section upon secondary electron emission by said secondary source when the escaped electrons are deflected thereonto sharply increases the magnitude of primary electron flow in said primary section.

6. The combination of claim 5 in which current flow in either direction through the coil is effective to produce magnetic flux deflecting the escaped electrons onto the auxiliary anode.

7. In combination, an electronic device comprising a primary electron section and a secondary electron section, said primary section including a primary electron source and a primary anode, said primary anode containing an aperture for the escape of primary electrons therethrough, said secondary section comprising a secondary electron source for emitting electrons in ratio greater than unity when bombarded with primary electrons and a secondary electron collector electrode, said secondary source and collector electrode being positioned out of the direct path of escaped electrons, and an additional elec-

trode; means to limit primary electron flow to a low value between said primary source and primary anode; means for maintaining said additional electrode at a potential such that escaped electrons are attracted thereto; means comprising a coil which, when traversed by current, produces magnetic flux perpendicular to the axis of the device, for deflecting the escaped electrons away from said additional electrode and onto said secondary source; and means interconnecting the secondary section and said primary electron flow limiting means such that changes in potential in the secondary section upon secondary electron emission by said secondary source when escaped electrons are deflected thereonto, compensates said limiting means whereby the magnitude of the primary electron flow increases sharply.

8. The combination of claim 7, in which the current flow in either direction through the coil is effective to produce magnetic flux deflecting the escaped electrons onto the secondary source.

9. A pulse counting circuit comprising a plurality of interconnected vacuum electronic devices, each of said devices including a primary electron source and a primary anode between which an electron stream may be established and a secondary electron emission electrode; means for establishing secondary electron emission in one of said devices and for priming a second of said devices for establishment of secondary electron emission in said second device; and means, including a connection between the primary anodes of said devices, for establishing secondary electron emission in said second device and for simultaneously disestablishing the secondary electron emission in said first device.

10. The circuit of claim 9 in which the connection between the primary anodes includes a reactance.

11. The circuit of claim 9 in which the connection between the primary anodes includes a negative reactance.

12. In combination, a plurality of vacuum electronic devices, each device comprising a primary electron section and a secondary electron section, said primary electron section comprising a primary electron source and a primary anode, and said secondary electron section comprising a secondary electron source and a secondary electron collecting electrode; means for establishing secondary electron emission in the secondary section of one device and for increasing the magnitude of primary electron flow in the primary section of said one device; means for priming a second of said devices for secondary electron emission, said priming means including a coil connected to the primary electron section of said first-mentioned device for producing a magnetic field in said second-mentioned device; and means for increasing the strength of said magnetic field sufficiently to establish secondary electron emission in the secondary section of said second-mentioned device, to increase the magnitude of primary electron flow in the primary section of said second-mentioned device and to disestablish secondary electron emission in said first-mentioned device.

13. The combination of claim 12 in which the last-mentioned means includes a second coil for producing a magnetic field aiding that of the first-mentioned coil.

14. The combination of claim 12 in which the last-mentioned means includes an interconnection between the primary section of said first and

second-mentioned devices whereby change in potential on the primary anode of the primary section of the second-mentioned device on increase of primary electron flow in the latter, reduces the potential on the primary anode of the primary section of the first-mentioned device to a value below that required to sustain secondary electron emission in the first-mentioned device.

15. In combination, a plurality of vacuum electronic devices, each device comprising a primary electron section and a secondary electron section; means for establishing secondary electron emission in the secondary section of one device and for increasing the magnitude of primary electron flow in the primary section of said one device; means for priming a second of said devices for secondary electron emission, said priming means including a coil connected to the primary section of said first-mentioned device for producing a magnetic field in said second-mentioned device; and means for increasing the strength of said magnetic field sufficiently to establish secondary electron emission in the secondary section of said second-mentioned device to increase the magnitude of primary electron flow in the primary section of said second-mentioned device and to disestablish secondary electron emission in said first-mentioned device.

16. The combination of claim 15 in which said last-mentioned means includes a second coil for producing a magnetic field aiding that of the first-mentioned coil.

17. The combination of claim 15 in which said last-mentioned means includes an interconnection between the primary sections of said first and second-mentioned devices.

18. The combination of claim 15 in which said last-mentioned means includes a reactive interconnection between the primary sections of said first and second-mentioned devices.

19. The combination of claim 15 in which said last-mentioned means includes a negative reactance interconnection between the primary sections of said first and second-mentioned devices.

20. A pulse counting circuit comprising a plurality of vacuum electronic devices, each device comprising a primary electron section and a secondary electron section, said primary section including a primary electron source and a primary anode, and said secondary section comprising a secondary electron source and a secondary electron collecting electrode; pulse responsive means for establishing secondary electron emission in the secondary section of one of said devices and for increasing the magnitude of primary electron flow in the primary section thereof; means for priming a second of said devices for secondary electron emission; pulse responsive means for establishing secondary electron emission in the secondary section of said second-mentioned device and for increasing the magnitude of primary electron flow in the primary section of said second-mentioned device; and means interconnecting the primary anodes of the primary sections of said devices for disestablishing secondary electron emission in the first-mentioned device upon the increasing in the primary electron flow in said second-mentioned device.

21. The circuit of claim 20 in which said last-mentioned means disestablishes secondary electron emission in the first-mentioned device by sharply reducing the potential on the primary

anode of the primary section of said first-mentioned device.

22. The circuit of claim 20 in which the interconnecting means comprises a reactance.

23. The circuit of claim 20 in which the interconnecting means comprises a negative reactance.

24. The circuit of claim 20 in which the interconnecting means comprises a condenser.

25. A pulse counting circuit comprising a plurality of vacuum electronic devices, each device comprising a primary electron section and a secondary electron section; pulse responsive means for establishing secondary electron emission in the secondary section of one of said devices and for increasing the magnitude of primary electron flow in the primary section thereof; means for priming a second of said devices for secondary electron emission therein, said means comprising a magnetic field producing coil connected to the primary section of said first-mentioned device; pulse responsive means for establishing secondary electron emission in the secondary section of said second-mentioned device and for increasing the magnitude of primary electron flow in the primary section of said second-mentioned device, said second-mentioned pulse responsive means including a second coil for producing a magnetic field aiding the field of the first-mentioned coil; and means interconnecting the primary sections of said devices for disestablishing secondary electron emission in the first-mentioned device upon the increase in the magnitude of primary electron flow in said second-mentioned device.

26. A pulse counting circuit comprising a plurality of electronic devices, each device comprising a primary electron source, a primary anode, a first control electrode, a secondary electron source, a secondary electron collector electrode and an auxiliary control electrode, said primary anode being apertured for the escape of some primary electrons therethrough, said auxiliary control electrode being in the normal path of said escaped electrons and said secondary source being out of the normal path of said escaped electrons; means for initially biasing each control electrode so that a low value of primary electron flow exists between said primary source and said primary anode of the respective device; means to maintain each auxiliary control electrode at a potential positive with respect to the primary source such that the escaped electrons are normally attracted to the auxiliary control electrode; means interconnecting said secondary source and said first control electrode of the respective device; a common source of potential for the primary anodes of the devices; a coil connected between each primary anode and said source of potential; a condenser connected between the primary anodes of said devices; and a second coil for each device adapted to have impressed thereon the pulses to be counted.

27. The circuit of claim 26 in which each of said first-mentioned coils is associated with a device other than the one containing the primary anode with which the coil is connected.

28. The circuit of claim 26 in which each of said first-mentioned coils when traversed by current flow therethrough primes its associated device for establishment of secondary electron emission therein.

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