

Aug. 8, 1961

E. J. VAN BARNEVELD

2,995,681

COUNTER TUBE

Filed Dec. 26, 1957

3 Sheets-Sheet 1

FIG. 1

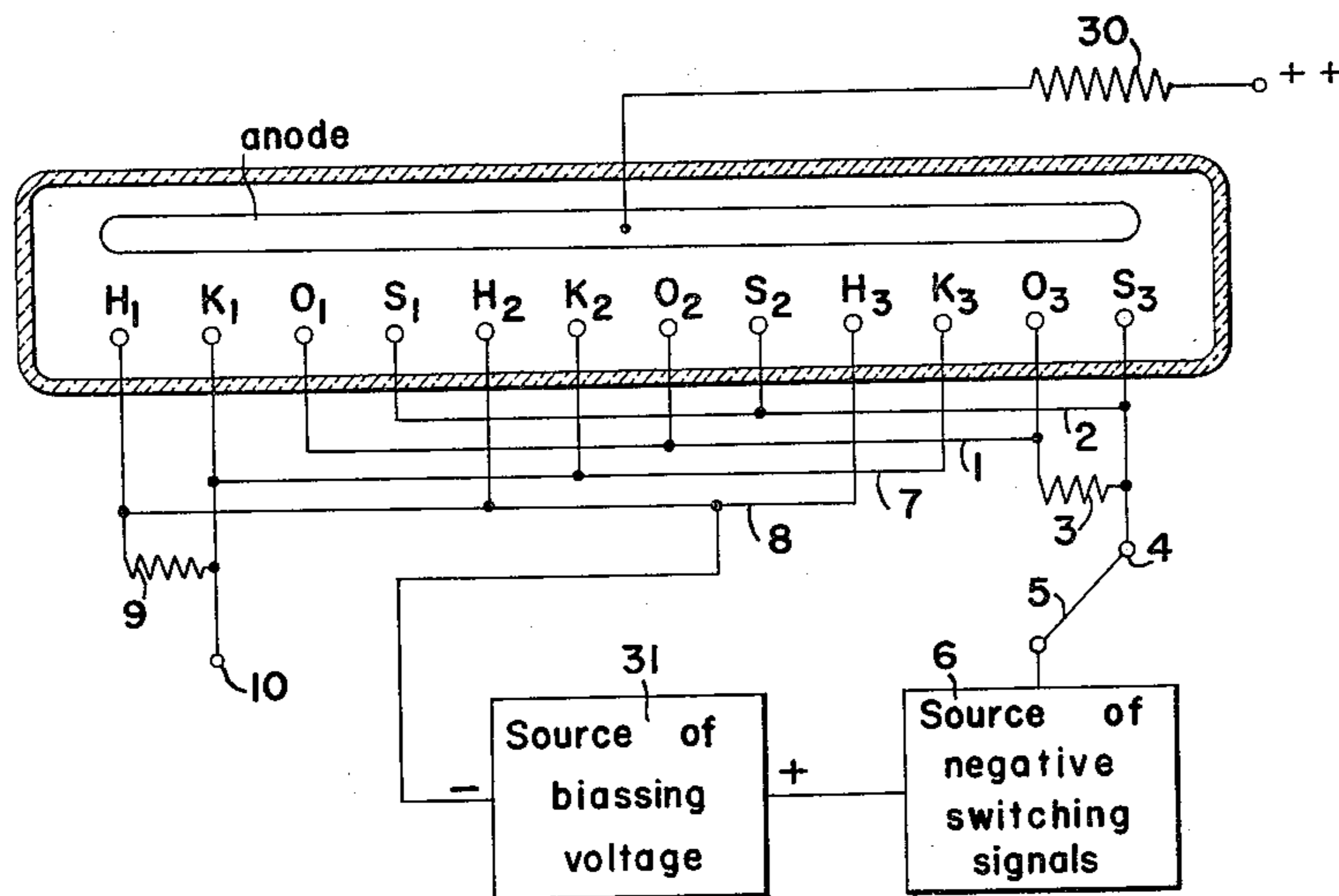
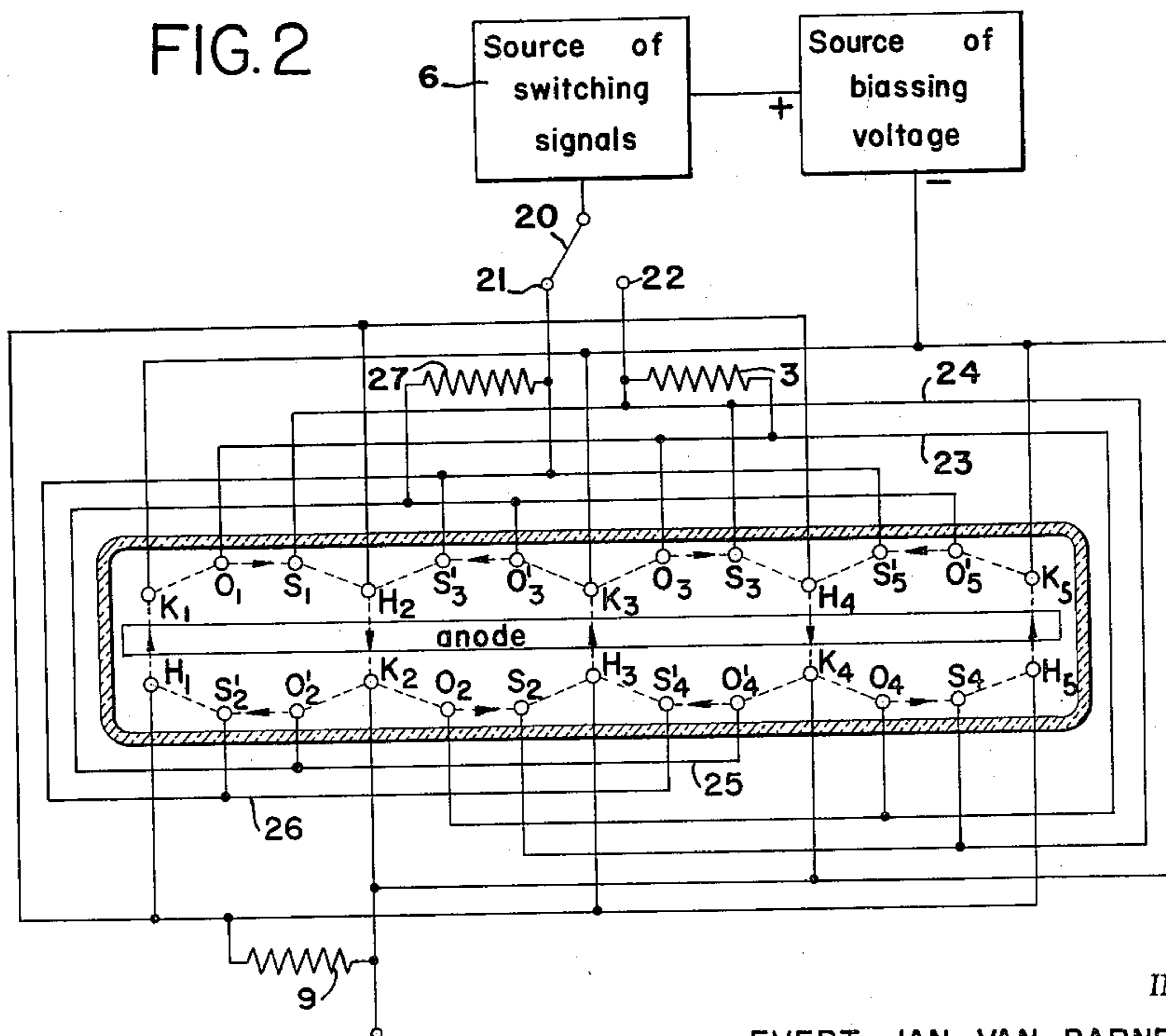


FIG. 2



INVENTOR

EVERT JAN VAN BARNEVELD

BY

Frank R. J. J. J.
AGENT

Aug. 8, 1961

E. J. VAN BARNEVELD

2,995,681

COUNTER TUBE

Filed Dec. 26, 1957

3 Sheets-Sheet 2

FIG. 3

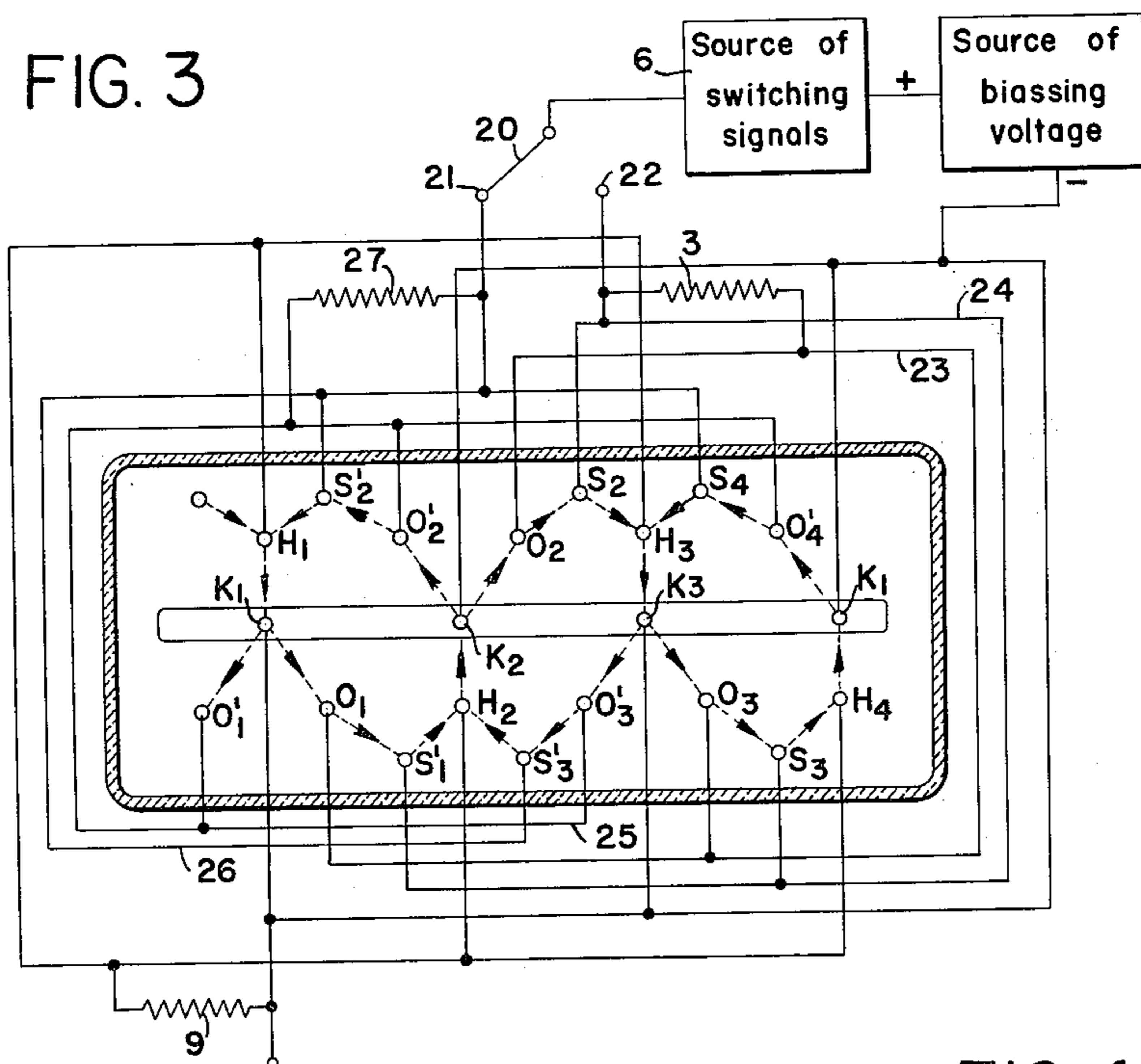
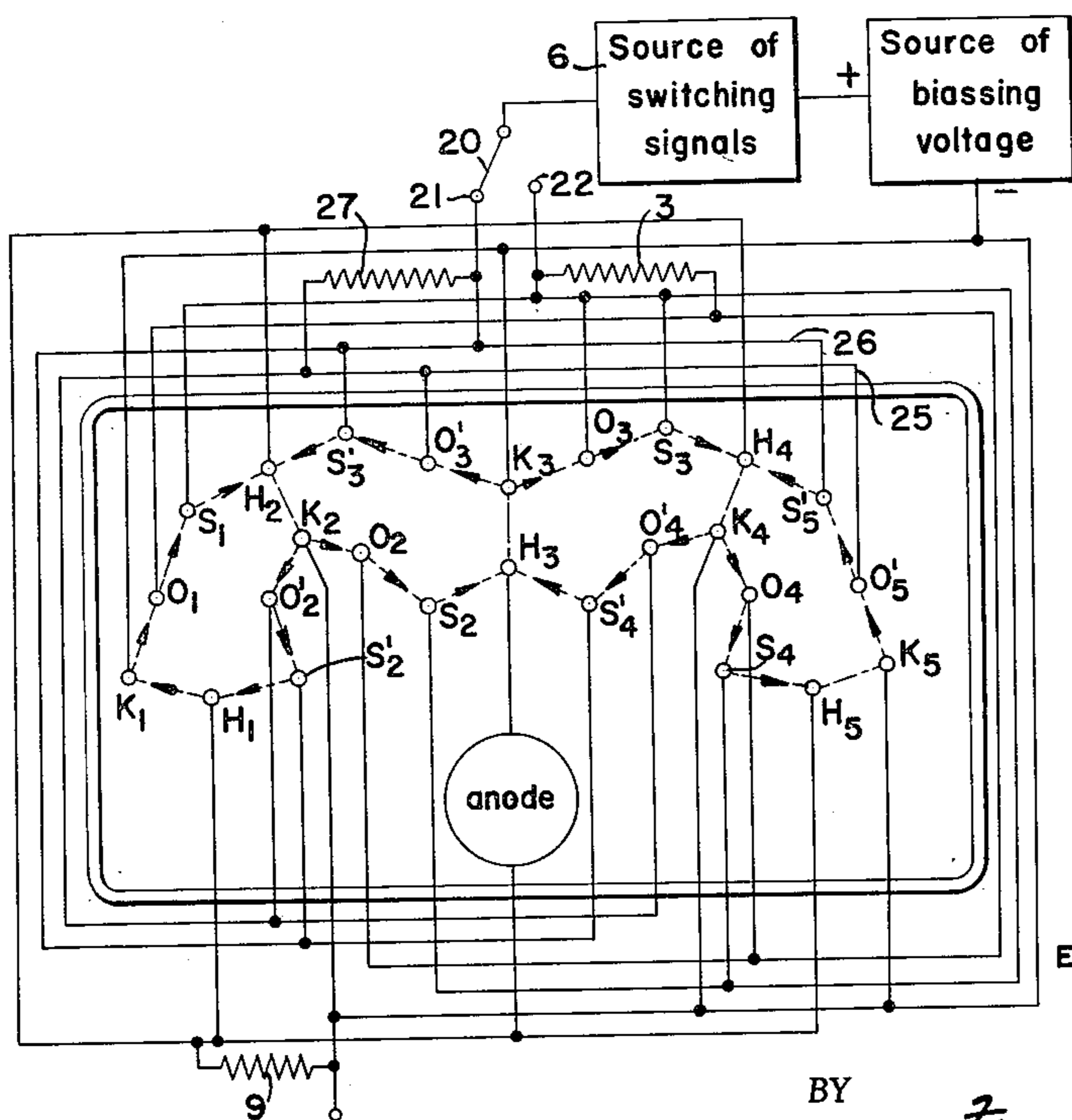


FIG. 4



INVENTOR

EVERT JAN VAN BARNEVELD

BY

Frank R. Juffer
AGENT

Aug. 8, 1961

E. J. VAN BARNEVELD

2,995,681

COUNTER TUBE

Filed Dec. 26, 1957

3 Sheets-Sheet 3

FIG.5

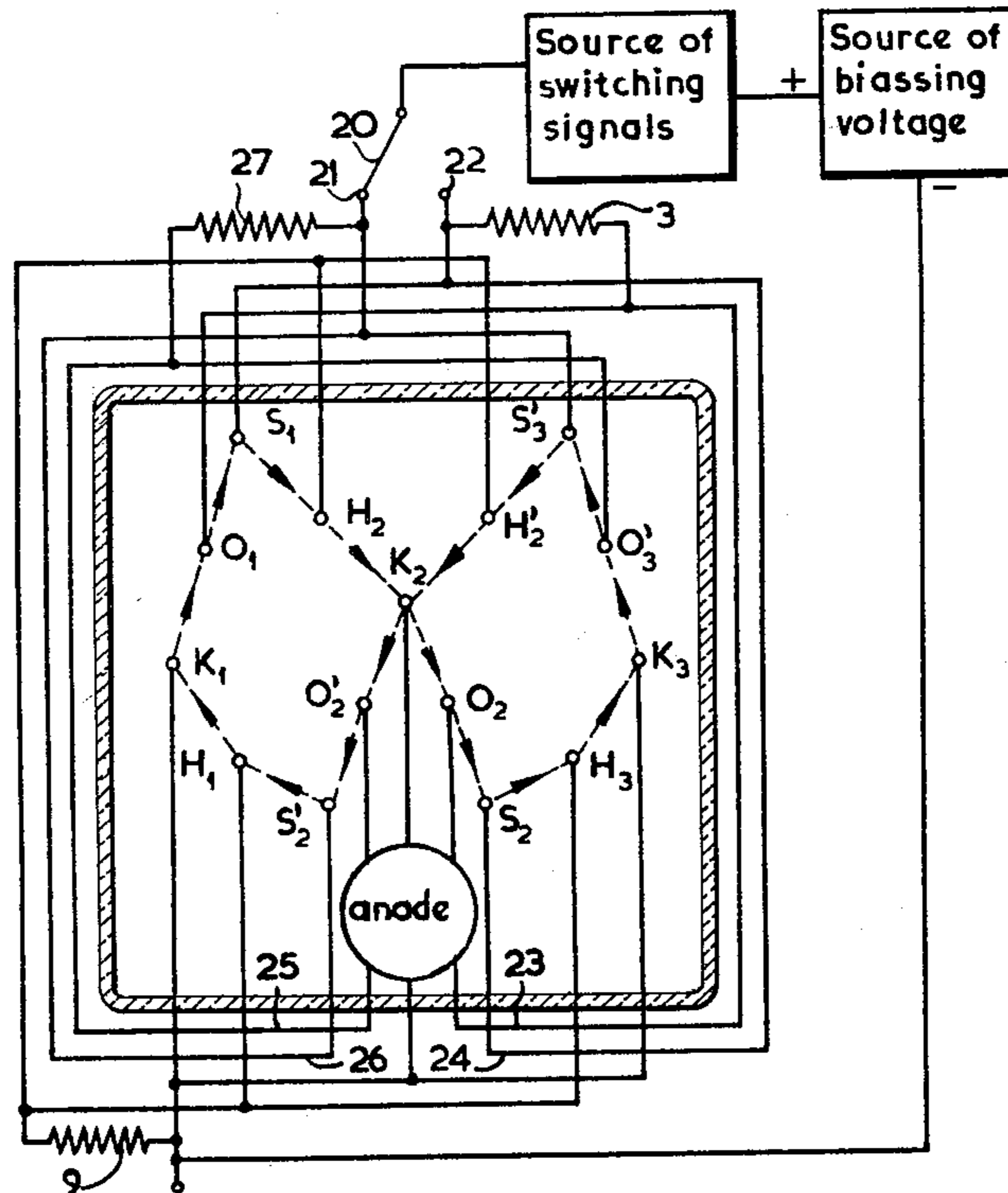
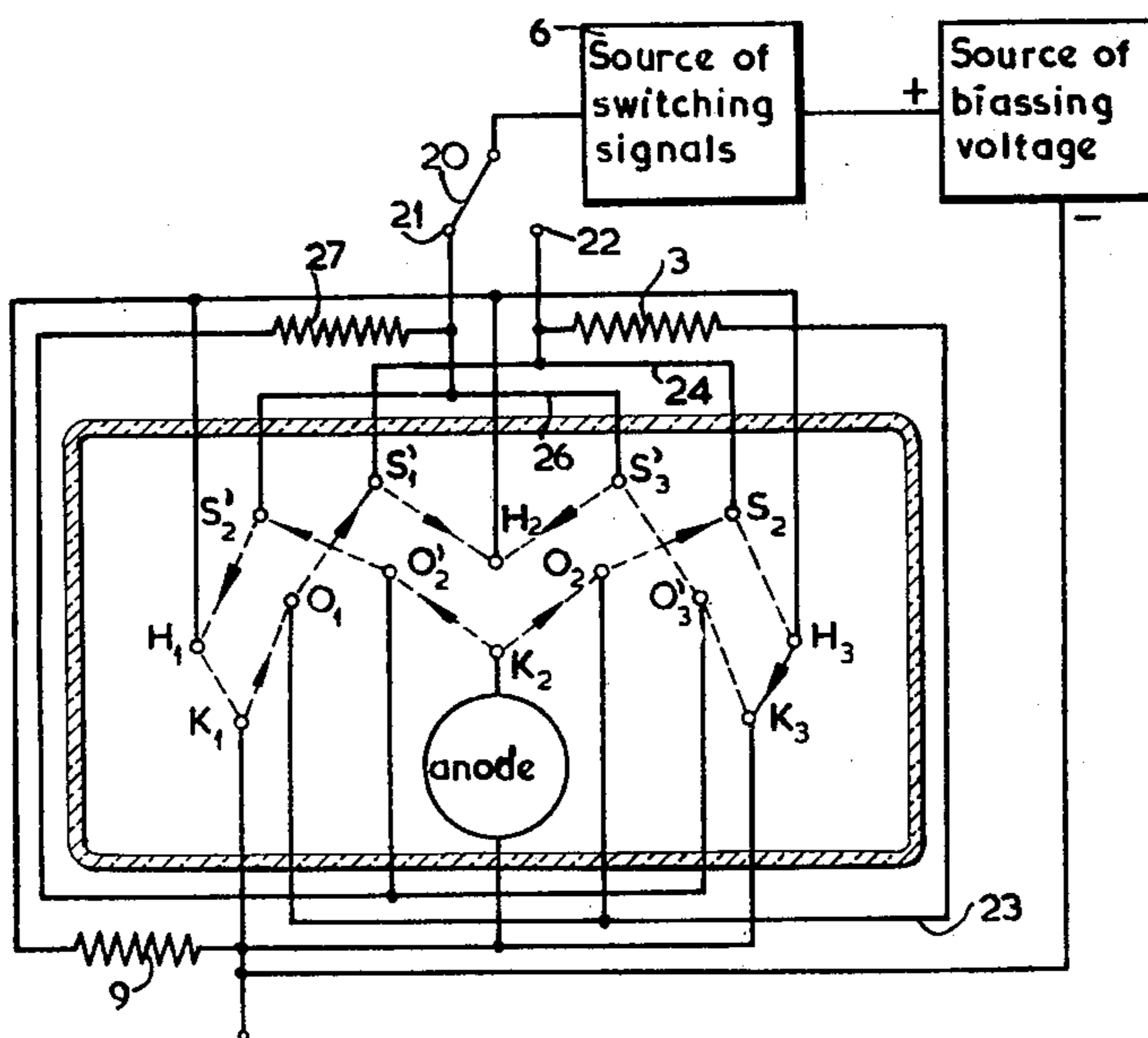


FIG.6



INVENTOR

EVERT JAN VAN BARNEVELD

BY

Frank R. Jaffari
AGENT

1

2,995,681

COUNTER TUBE

Evert Jan van Barneveld, Eindhoven, Netherlands, assignor to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Filed Dec. 26, 1957, Ser. No. 705,343

Claims priority, application Netherlands Jan. 3, 1957

8 Claims. (Cl. 315-84.6)

The present invention relates to a counter tube. More particularly, the invention relates to a counter tube of the glow discharge type having cold filamentary main cathodes and auxiliary electrodes which are arranged at right angles to a common anode. A discharge moves from a main cathode to a succeeding cathode through three intermediate auxiliary electrodes. Negative pulses are supplied to the switching electrode, which is the middle one of the auxiliary electrodes. The switching electrodes are connected through a resistor to another of the remaining two auxiliary electrodes. The auxiliary cathodes are connected through a resistor to the adjacent main cathodes.

Counter tubes of the aforementioned type have the advantage of a high permissible switching frequency and a comparatively cheap construction. They have, however, the limitation that without mechanical changeover the tube can operate, that is, the discharge can move, in one direction only.

Counter tubes are known which are able to operate in both directions, due to the fact that between each two main cathodes there are provided two auxiliary electrodes having a directional action, the main cathodes being the preferred discharge points. However, the preferred points and direction effect involve a prolonged deionization period so that the switching frequency is relatively slow.

It is an object of the present invention to provide a counter tube of the aforementioned type which is able to operate in two directions at a substantially high switching frequency.

In accordance with the present invention, in a tube of the aforementioned type, the discharge may pass from a main cathode to the adjacent main cathode in either of two directions due to the provision of two sets of auxiliary electrodes between each two adjacent main cathodes. The resistors are connected so that when negative pulses are supplied to the switching, or middle, electrode of a set of auxiliary electrodes, the discharge moves in one direction, and when negative pulses are supplied to the switching electrode of the other set of auxiliary electrodes, the discharge moves in the other, or opposite, direction. The auxiliary cathodes of two possible transitions to the same common cathode may be united to form a single auxiliary cathode. The auxiliary electrodes arranged on both sides of the main cathode, to which the negative pulses are applied, that is, the switching electrode and the transition electrode, are so positioned that the direction in which the discharge moves is clearly and directly determined.

Counter tubes provided in accordance with the present invention may be designed not only with electrode systems in which the electrodes are arranged in a substantially straight line, special precautions being taken against back ignition, but they may be designed with electrode systems in which the electrodes are arranged on a single or series of closed curves, such as, for example, circles.

In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic diagram of a top sectional view of an embodiment of a counter tube of a type known in the art;

FIG. 2 is a schematic diagram of a top sectional view

2

of an embodiment of a counter tube of the present invention;

FIG. 3 is a modification of the embodiment of FIG. 2;

FIG. 4 is a schematic diagram of a top sectional view of another embodiment of the counter tube of the present invention;

FIG. 5 is a modification of the embodiment of FIG. 4; and

FIG. 6 is another modification of the embodiment of FIG. 4.

In FIG. 1, the main cathodes are designated K_1 , K_2 , K_3 , etc.; the transition electrodes are designated O_1 , O_2 , O_3 , etc.; the switching electrodes are designated S_1 , S_2 , S_3 , etc., and the auxiliary cathodes are designated H_1 , H_2 , H_3 , etc. Each auxiliary electrode group comprises a transition electrode, a switching electrode and an auxiliary cathode interposed between adjacent main cathodes. The transition electrodes O are connected together by a common connecting lead 1. The switching electrodes S are connected together through a common connecting lead 2. The common connecting lead 1 is connected to the common connecting lead 2 through a resistor 3, the common connection point of the leads 1 and 2 being connected to an output terminal 4 of a switch 5. The switch 5 may comprise any suitable type of switching arrangement suitable for switching the output of a source of switching signals 6 to either one of a pair of terminals. A suitable type of switch may comprise, for example, a single pole, double throw switch. The source of switching signals 6 produces a negative pulse suitable for providing a discharge in the counter tube.

The main cathodes are connected together through a common connecting lead 7. The auxiliary cathodes are connected together through a common connecting lead 8. The common connecting lead 8 is connected to the common connecting lead 7 through a resistor 9, the common connection point of the leads 7 and 8 being connected to an output terminal 10 of the switch 5. The anode is biased positively with respect to the main cathodes over a resistor 30.

In the counter tube of FIG. 1, when a negative pulse is applied to the switching electrodes S and to the transition electrodes O , through the terminal 4 of the switch 5, a discharge is struck to the main cathode K_1 . The discharge passes from the main cathode K_1 to the transition electrode O_1 , and the voltage of said transition electrode, due to the resistor 3, is immediately increased to a value such that the discharge passes to the switching electrode S_1 . At the termination of the negative pulses, the discharge passes from the switching electrode S_1 to the auxiliary cathode H_2 because said auxiliary cathode is then the most negative electrode in the vicinity of said switching electrode. However, the voltage of the auxiliary cathode H_2 increases immediately, due to the resistor 9, so that the discharge passes to the main cathode K_2 , where it remains until the next pulse is applied.

If the resistors 3 and 9 were interchanged, the discharge would move in the opposite direction from that in which it moves in the preceding discussion. This changeover, however, can be performed only by means of mechanical switches, and these are unsuitable for use with counter tubes of the type described. Electronic changeover is also unsuitable due to the voltage losses involved.

FIG. 2 shows an embodiment of a counter tube of the present invention. In FIG. 2, the main cathodes K are alternately positioned on two parallel lines. The auxiliary cathodes H are alternately positioned opposite the main cathodes on the parallel lines, that is, one line will have alternate main cathodes and auxiliary cathodes and the other line will have alternate auxiliary cathodes and main cathodes, the main cathodes of one line being op-

posite the auxiliary cathodes of the other line. Between each main cathode K and the adjacent auxiliary cathode H on the same line is positioned a transition electrode O and a switching electrode S. Transition electrodes O₁, O₂, O₃, O₄, etc., and switching electrodes S₁, S₂, S₃, S₄, etc., shift the discharge to the main cathodes of the next higher order as shown by the arrows in FIG. 2. Thus, the discharge may be shifted from the main cathode K₁ to the transition electrode O₁ to the switching electrode S₁ to the auxiliary cathode H₂ to the main cathode K₂, as shown in FIG. 2. Transition electrodes O'₂, O'₃, O'₄, O'₅, etc., and switching electrodes S'₂, S'₃, S'₄, S'₅, etc., shift the discharge to the main cathode of next lower order. Thus, the discharge from main cathode K₃ is shifted to transition electrode O'₃ to switching electrode S'₃ to auxiliary cathode H₂ to main cathode K₂, as shown in FIG. 2. The source of switching signals 6 provides negative pulses suitable for shifting the discharge to the transition electrodes and switching electrodes on one side of the main cathodes to shift the discharge in one direction and to the transition electrodes and switching electrodes on the other side of the main cathodes to shift the discharge in the opposite direction. This is accomplished by the use of a single pole, double throw switch 20, the output terminals 21 and 22 of which are connected to common connecting leads 23, 24, 25 and 26 of the electrodes of the two differently directing sets of auxiliary electrodes. The transition electrodes O₁, O₂, O₃, O₄, etc., are connected together by the common connecting lead 23; the switching electrodes S₁, S₂, S₃, S₄, etc., are connected by the common connecting lead 24; the transition electrodes O'₂, O'₃, O'₄, O'₅, etc., are connected together by the common connecting lead 25; and the switching electrodes S'₂, S'₃, S'₄, S'₅, etc., are connected together by the common connecting lead 26. The common connecting lead 23 is connected to the common connecting lead 24 through the resistor 3 and the common connecting lead 25 is connected to the common connecting lead 26 through a resistor 27.

When the switch 20 is closed on the terminal 21, a negative pulse from the source of switching signals 6 is applied to the auxiliary electrodes O'₂, S'₂, etc., and the discharge is shifted to the left from the main cathodes, as shown in FIG. 2. When the switch 20 is closed on the terminal 22, a negative pulse from the source of switching signals 6 is applied to the auxiliary electrodes O₁, S₁, etc., and the discharge is shifted to the right from the main cathodes, as shown in FIG. 2.

If a negative pulse is applied to the auxiliary electrodes O'₂, S'₂, etc., the discharge struck to main cathode K₂, for example, shifts to the transition electrode O'₂ despite the fact that the auxiliary electrodes O'₃ and S'₃ have the same pulse applied to them; the auxiliary electrodes O'₃ and S'₃ being spaced further from the main cathode K₂ than the transition electrode O'₂.

The embodiment of FIG. 3 functions in a manner similar to that of FIG. 2, the distinction between the embodiments of FIGS. 2 and 3 being that in FIG. 3 the main cathodes K are positioned on a single line rather than in the two parallel lines of FIG. 2. The auxiliary cathodes H are so positioned alternately on both sides of the line that the auxiliary cathodes are opposite the main cathodes on alternate sides of the line and the transition paths of the discharges for both directions cross each other.

The corresponding similar components of FIGS. 1 to 6 are labeled by the same reference numerals.

The embodiment of FIG. 4 functions in a manner similar to those of FIGS. 2 and 3, the distinction between the embodiment of FIG. 4 and those of FIGS. 2 and 3 being that in FIG. 4 the main cathodes K are positioned on a circular curve rather than on one or a pair of lines as in FIGS. 2 and 3. In FIG. 4, half the auxiliary electrodes are positioned inside the circle of the main cathodes and half the auxiliary electrodes are positioned outside

the circle of the main cathodes. The auxiliary cathodes H are so positioned alternately inside and outside the circular curve that the auxiliary cathodes are radially opposite the main cathodes on alternate sides of the circular curve. In order that the counter tube shown in FIG. 4 functions in accordance with the present invention to provide a clear and direct direction of discharge, the distance K₃ to O'₃ must be smaller than the distances K₃ to O₂, K₃ to S₂, K₃ to O'₄ and K₃ to S'₄ and the distance from K₃ to O₃ must be smaller than the distances K₃ to O'₄, K₃ to S'₄, K₃ to S₂ and K₃ to O₂.

The embodiment of FIG. 5 functions in a manner similar to that of FIG. 4, the distinction between the embodiments of FIGS. 4 and 5 being that in FIG. 5 the auxiliary cathodes H for the transition paths located outside the circle of the main cathodes K are no longer common, as in FIG. 4, although they are positioned on both sides of the circle of the cathodes on circular curves. Although the auxiliary cathodes inside the circle are positioned radially opposite alternate main cathodes, the auxiliary cathodes outside the circle are positioned on either side of a radius line through each of the main cathodes interposed between the alternate main cathodes. This arrangement enables the remaining auxiliary electrodes to be positioned so that the counter tube functions in accordance with the present invention to provide a clear and definite direction of discharge. Thus, for example, in FIG. 5 the auxiliary cathodes H₂ and H'₂ are associated with the main cathode K₂.

The embodiment of FIG. 6 functions in a manner similar to those of FIGS. 4 and 5, the distinction between the embodiment of FIG. 6 and those of FIGS. 4 and 5 being that in FIG. 6 all the auxiliary electrodes are positioned outside the circle of the main cathodes. The transition electrodes O and the switching electrodes S are so positioned that the transition paths between two adjacent main electrodes cross each other. Thus, the main cathodes are positioned on a first circular curve, the auxiliary cathodes H and the transition electrodes O are positioned on a second circular curve having a larger radius than that of the first circular curve, and the switching electrodes are positioned on a third circular curve having a larger radius than that of the second circular curve.

The electrodes of the counter tubes of the present invention may be biased in any manner suitable for the desired operation. The transition electrodes O are preferably biased by a positive voltage which is larger than 40 volts with respect to the main cathodes over a resistor of about 100 kilohms to the switching electrodes S which are biased directly to the same positive voltage. The auxiliary cathodes H are connected over a resistor of about 100 kilohms to the main cathode.

A suitable value for the biasing voltage applied to the transition electrodes O and to the switching electrodes S may be, for example 60 volts. A suitable value for the negative pulses produced by the source of switching signals 6 may be, for example, 120 volts. A suitable value for the anode biasing voltage may be about 400 volts, for the anode series resistor about 350 kilohms, the tube current being about 0.7 milliamperes.

While the invention has been described by means of specific examples and in specific embodiments, I do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being

5

positioned in a manner whereby at least first and second groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connecting the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other.

2. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being positioned in a manner whereby at least first and second groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, said auxiliary cathodes being positioned in a manner whereby a single one of each of the said auxiliary cathodes is shared by adjacent first and second groups, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connecting the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other.

3. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being positioned in a manner whereby at least first and second

6

groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connecting the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other, said auxiliary electrodes being positioned in a manner whereby the transition electrode of a first group next preceding a main cathode is positioned at a relatively small distance from said main cathode and the transition electrode and switching electrode of a first group next succeeding the said main cathode are positioned at relatively larger distances from the said main cathode, the transition electrode and switching electrode of a second group next preceding the said main cathode being positioned at distances from the said main cathode which are relatively larger than the distance of the transition electrode of a second group next succeeding the said main cathode from the said main cathode.

4. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being positioned in a manner whereby at least first and second groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, said main cathodes and said auxiliary cathodes being alternately positioned in two parallel lines in a manner whereby the main cathodes in each of said lines are opposite the auxiliary cathodes of the other of said lines, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connecting the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said

tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other.

5. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being positioned in a manner whereby at least first and second groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, said main cathodes being positioned in a line and said auxiliary cathodes being positioned on both sides of said line in a manner whereby the said auxiliary cathodes are opposite adjacent main cathodes on opposite sides of the said line and none of the paths of the auxiliary electrodes of said first groups intersect any of the paths of the auxiliary electrodes of said second groups, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connecting the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other.

6. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being positioned in a manner whereby at least first and second groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, said main cathodes being positioned in a circular curve and said auxiliary cathodes being positioned inside and outside said circular curve in a manner whereby the said auxiliary cathodes are radially opposite adjacent main cathodes on opposite sides of the said circular curve, a first group of auxiliary electrodes between adjacent main cathodes being positioned inside said circular curve and a second group of auxiliary electrodes between adjacent main cathodes being positioned outside said circular curve, said auxiliary electrodes being positioned in a manner whereby the switching electrode of said first group is positioned at a shorter radial distance from the center of said circular curve than the transition electrode of the said first group and the switching electrode of said second group is positioned at a greater radial distance from the center

of said circular curve than the transition electrode of the said second group, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connecting the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other, said auxiliary electrodes being positioned in a manner whereby the transition electrode of a first group next preceding a main cathode and the transition electrode of a second group next succeeding said main cathode are positioned at relatively small distances from the said main cathode and the transition electrode and switching electrode of a second group next preceding the said main cathode and the transition electrode and switching electrode of a first group next succeeding the said main cathode are positioned at relatively larger distances from the said main cathode.

7. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being positioned in a manner whereby at least first and second groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, said main cathodes being positioned in a circular curve and said auxiliary cathodes being positioned inside and outside said circular curve in a manner whereby the said auxiliary cathodes positioned inside the said circular curve are radially opposite alternate main cathodes and the said auxiliary cathodes positioned outside the said circular curve are positioned on each side of a radial line through each main cathode interposed between said alternate main cathodes, a first group of auxiliary electrodes between adjacent main cathodes being positioned inside said circular curve and a second group of auxiliary electrodes between adjacent main cathodes being positioned outside said circular curve, said auxiliary electrodes being positioned in a manner whereby the switching electrode of said first group is positioned at a shorter radial distance from the center of said circular curve than the transition electrode of the said first group and the switching electrode of said second group is positioned at a greater radial distance from the center of said circular curve than the transition electrode of the said second group, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connect-

9

ing the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other, said auxiliary electrodes being positioned in a manner whereby the transition electrode of a first group next preceding a main cathode and the transition electrode of a second group next succeeding said main cathode are positioned at relatively small distances from the said main cathode and the transition electrode and switching electrode of a second group next preceding the said main cathode and the transition electrode and switching electrode of a first group next succeeding the said main cathode are positioned at relatively larger distances from the said main cathode.

8. An arrangement for a glow discharge counter tube comprising an anode, a plurality of main cathodes, a plurality of auxiliary electrodes comprising transition electrodes, switching electrodes and auxiliary cathodes, means electrically connecting said main cathodes to each other, means electrically connecting said auxiliary cathodes to each other, first resistance means connected between said main cathode connecting means and said auxiliary cathode connecting means, said auxiliary electrodes being positioned in a manner whereby at least first and second groups of the said auxiliary electrodes are positioned between adjacent main cathodes, each of said first and second groups comprising a transition electrode, a switching electrode and an auxiliary cathode, said main cath-

10

odes being positioned in a first circular curve and said auxiliary cathodes being positioned outside said first circular curve in a manner whereby the said auxiliary cathodes and said transition electrodes are positioned in a second circular curve having a radius larger than that of said first circular curve and said switching electrodes are positioned in a third circular curve having a radius larger than that of said second circular curve, the paths of the auxiliary electrodes of said first groups and the paths of the auxiliary electrodes of said second groups intersecting each other between adjacent main cathodes, means electrically connecting the transition electrodes of each of said first groups to each other, means electrically connecting the switching electrodes of each of said first groups to each other, second resistance means connected between said first group transition electrode connecting means and said first group switching electrode connecting means, means electrically connecting the transition electrodes of each of said second groups to each other, means electrically connecting the switching electrodes of each of said second groups to each other, third resistance means connected between said second group transition electrode connecting means and said second group switching electrode connecting means, and means for supplying a negative pulse to said first group switching electrode connecting means thereby to produce a discharge in said tube shifting through a first group of said auxiliary electrodes in a first direction and for supplying said negative pulse to said second group switching electrode connecting means thereby to produce a discharge in the said tube shifting through a second group of the said auxiliary electrodes in a second direction, said first and second directions being substantially opposite to each other.

References Cited in the file of this patent

UNITED STATES PATENTS

2,714,179	Thomas	July 26, 1955
2,783,415	Thomas	Feb. 26, 1957
2,823,336	Crowther	Feb. 11, 1958