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J. NORMAN ETAL
ELECTRON MULTIPLIER GATE

3,197,663

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2 Sheets-Sheet 1

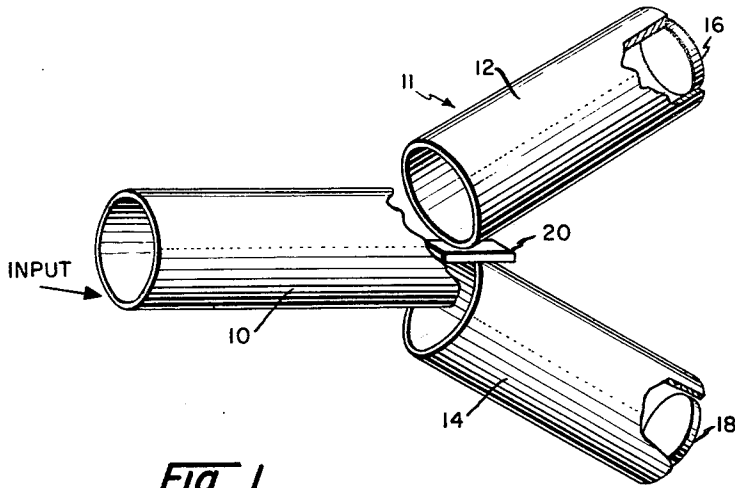


Fig. 1

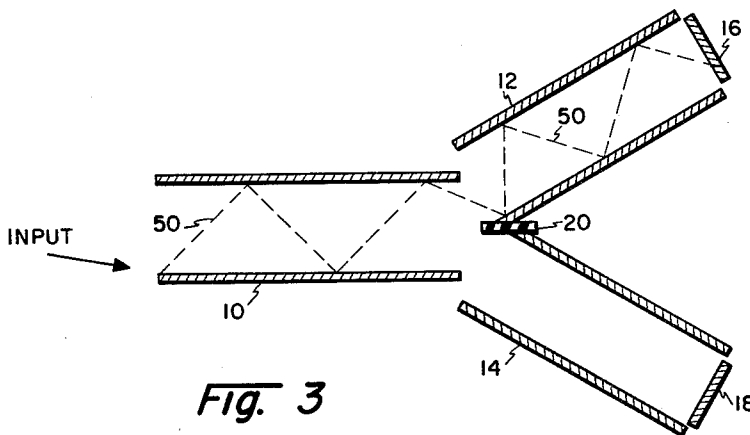


Fig. 3

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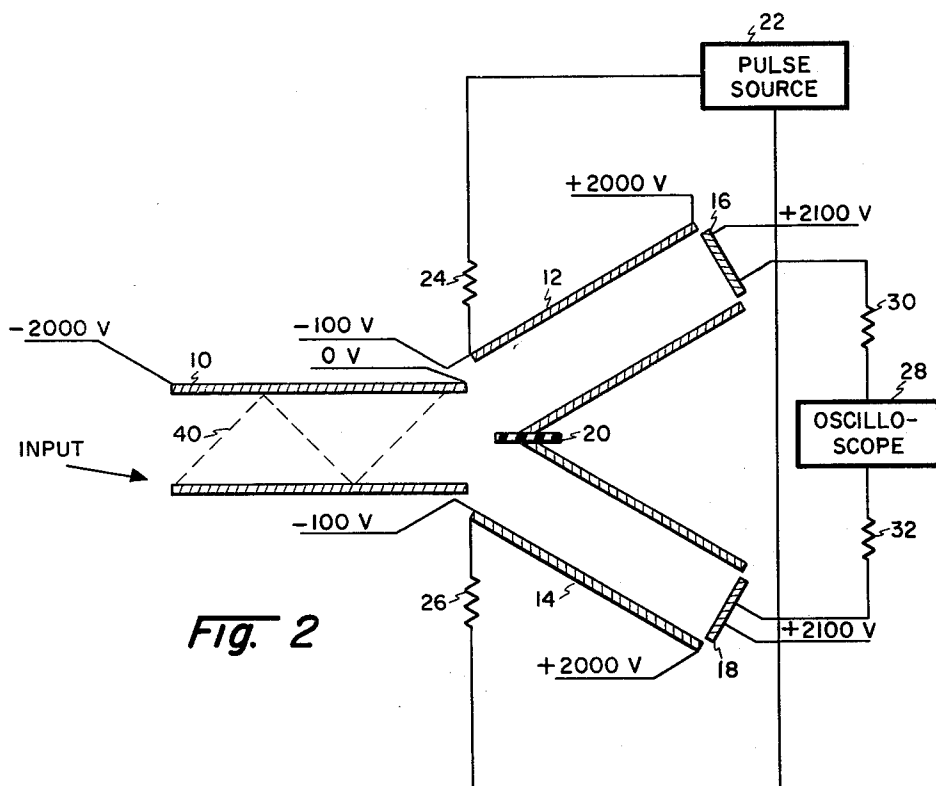


Fig. 2

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ELECTRON MULTIPLIER GATE

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4 Claims. (Cl. 313-103)

This invention relates to a gate for an electron multiplier and more particularly to a gate for a channel electron multiplier.

In copending patent application U.S. Serial No. 23,574, filed April 20, 1960, by George W. Goodrich and W. C. Wiley, now Patent No. 3,128,408, there is fully disclosed a tube type channel electron multiplier. In this type multiplier, the inside surface of the tube is conductive and has secondary emissive properties. Upon the application of a voltage difference between the ends of the tube, current flows through the tube and produces an electric field in an axial direction through the region defined by the tube. Electrons entering the input end of the tube are multiplied through secondary emission before they emerge from the output end of the tube.

This invention relates to gating apparatus for channel electron multipliers. In accordance with the invention, a first channel electron multiplier which is to be gated has positioned at its output second and third channel electron multipliers which comprise the gating apparatus. The electrons emerging from the first channel are gated into the second or third channel, depending upon the voltage applied to the inputs of these channels.

An object of this invention is to provide gating apparatus for the output of an electron multiplier.

Another object is to provide gating apparatus comprising a pair of channel electron multipliers positioned at the output of an electron multiplier to gate the output through one channel or the other upon application of a suitable voltage to the input of the appropriate channel.

Other objects and advantages will become apparent from the following detailed description and from the appended drawings and claims.

In the drawings:

FIGURE 1 is a perspective view, partly broken away, illustrating an embodiment of this invention.

FIGURE 2 is a schematic diagram partly in block form and partly in cross section, illustrating the embodiment in FIGURE 1 and showing the associated electrical circuitry.

FIGURE 3 is another schematic diagram similar to FIGURE 2 which shows the path followed by electrons when certain electrical conditions exist.

In FIGURE 1, a channel electron multiplier 10 is positioned to receive particles, such as ions or electrons, from a source (not shown). For example, the channel 10 may receive ions from a time-of-flight mass spectrometer of the type disclosed in U.S. Patent No. 2,685,035, issued to William C. Wiley and these ions would produce secondary emission of electrons upon striking the inside surface of the channel 10. Positioned at the output of the channel 10 is gating apparatus generally indicated at 11 which includes a pair of channel electron multipliers 12 and 14. The channels 12 and 14 are positioned to receive electrons emerging from the channel 10 and form a Y arrangement with the channel 10. Anodes 16 and 18 are disposed respectively at the output ends of the channels 12 and 14 to collect electrons passing through the channels. An insulator 20 provides insulation between the channels 12 and 14.

Direct voltages of suitable magnitude are applied to the elements disclosed above from a direct voltage source

(not shown). For example, as shown in FIGURE 2, direct voltages of -2,000 volts, 0 volts, -100 volts, +2,000 volts, and +2,100 volts may be applied respectively, to the input of the channel 10, the output of the channel 10, the inputs of the channels 12 and 14, the outputs of the channels 12 and 14 and the anodes 16 and 18. The inputs of the channels 12 and 14 at -100 volts, are normally maintained at a negative potential with respect to the output of the channel 10 at 0 volts.

A pulse source 22 is connected to the inputs of the channels 12 and 14 through resistances 24 and 26 respectively. The pulse source 22 is adapted to provide an input pulse, such as +200 volts, to either the channel 12 or the channel 14 to raise the input of the channel to a positive potential (+100 volts) with respect to the output of the channel 10 during application of the pulse. A detector, such as an oscilloscope 28, is connected to the anodes 16 and 18 through resistances 30 and 32, respectively, to detect the electrons striking the anodes.

It should be understood that the channels 10, 12 and 14, and the anodes 16 and 18 operate in a vacuum tube at a pressure of approximately 10^{-6} mm. Hg.

When electrons are introduced to the input end of the multiplier 10, they successively strike the surface of the channel 10 as shown by the path 40 in FIGURE 2 and are multiplied through secondary emission. Since the inputs of channels 12 and 14 are normally maintained at a negative potential with respect to the output of the channel 10, the electrons passing through the channel 10 cannot enter the channels 12 or 14. The electrons reach the end of the channel 10 are eventually lost to the inner surface of the channel.

When it is desired to gate the electrons through the channel 12 or the channel 14, a positive voltage pulse is applied to the input of the appropriate channel from the pulse source 22. If the pulse is applied to channel 12, the electrons emerging from the channel 10 are permitted to enter the channel 12 where they successively strike the surface of the channel and are further multiplied before they impinge upon the anode 16. The path followed by the electrons is shown by the path 50 in FIGURE 3. The electrons striking anode 16 are indicated on the oscilloscope 28. The electrons would follow a similar path through the channel 14 if the pulse is applied to that channel. Thus, by applying a positive pulse to the channel 12 or to the channel 14, gating action results to direct the electrons at the output of the channel 10 through either the channel 12 or the channel 14.

The above gating apparatus would be particularly useful in connection with the time-of-flight mass spectrometer such as disclosed in the aforesaid U.S. Patent No. 2,685,035. From the mass spectrometer, ions of different mass would arrive at the input of the channel 10 at different times. Accordingly, the electrons produced through secondary emission by the ions of different mass would also arrive at the output of the channel 10 at correspondingly different times. At the times that electrons produced by the ions of a particular mass are expected at the output of the channel, the channel 12 may be pulsed to gate the electrons through the channel for collection by the anode 16 and detection by the oscilloscope 28. Similarly, electrons produced by ions of a different mass would be gated through channel 14 upon the application of a pulse to that channel at the proper time.

Although only two channels (12 and 14) have been used in describing this invention, it will be recognized that additional channels can be provided at the output of the channel 10 and the electrons gated through the one to which a pulse is applied. If desired, the electrons could be gated through more than one channel by applying pulses simultaneously to the inputs of two or more channels.

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Although this invention has been disclosed and illustrated with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is therefore to be limited only as indicated by the scope of the appended claims.

Having thus described our invention, we claim:

1. A gate for a first channel electron multiplier comprising
 - a plurality of channel electron multipliers positioned relative to the output of the first channel to receive electrons emerging from the first channel,
 - and means for changing the potential of at least one of the channels in the plurality to cause the electrons emerging from the first channel to enter only said channel in the plurality.
2. A gate for a first channel electron multiplier comprising
 - a plurality of channel electron multipliers having their inputs positioned relative to the output of the first channel to receive electrons emerging from the first channel,
 - means for applying biasing voltages to the inputs of each of the plurality of channels to prevent the entrance of electrons emerging from the first channel,
 - and means for applying a voltage pulse to at least one of the inputs of the plurality of channels to cause the electrons emerging from the first channel to enter the pulsed channel during application of the pulse.
3. A gate for a first channel electron multiplier comprising
 - second and third channel electron multipliers having

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their inputs positioned relative to the output of the first channel to receive electrons emerging from the first channel,

means for applying a biasing voltage to the inputs of the second and third channels to prevent the entrance of electrons emerging from the first channel,

and means for applying a voltage pulse to the input of the second or third channel to cause the electrons emerging from the first channel to enter the pulsed channel during application of the pulse.

4. A gate for a first channel electron multiplier comprising
 - a plurality of multiplier units positioned relative to the output of the first channel to receive electrons emerging from the first channel,
 - each multiplier unit including a channel electron multiplier and collecting means positioned at the output of the channel,
 - and means for changing the potential of at least one of the multiplier units in the plurality to cause the electrons emerging from the first channel to enter only the channel in said one multiplier unit and to reach the collecting means positioned at its output.

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DAVID J. GALVIN, *Primary Examiner.*