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ELECTRON MULTIPLIER SPURIOUS NOISE BAFFLE

Filed May 7, 1959 2 Sheets-Sheet 1

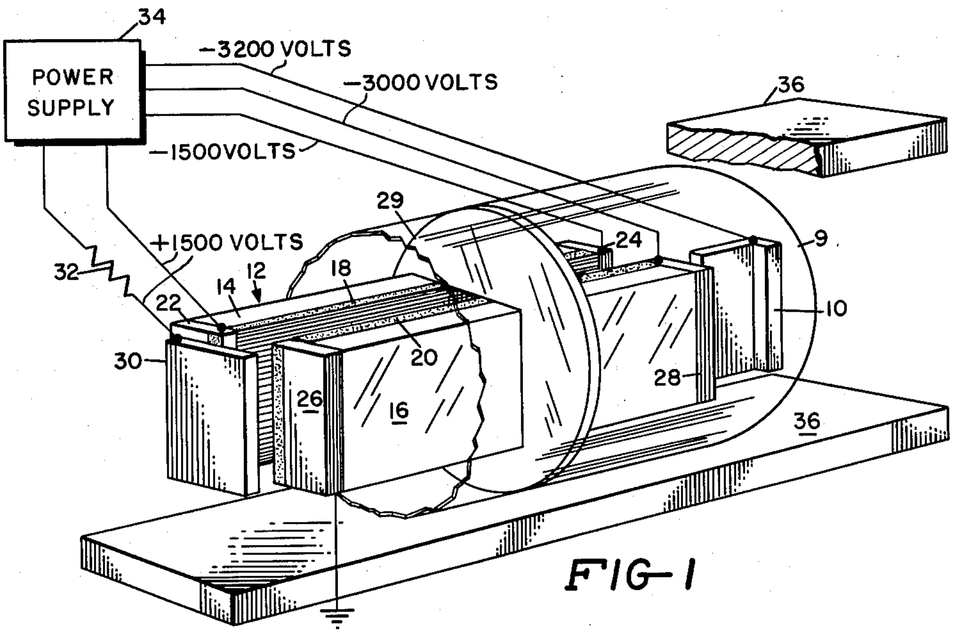

FIG-1

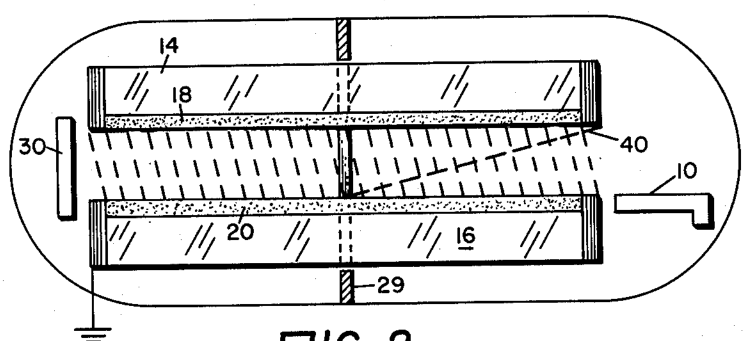

FIG-2

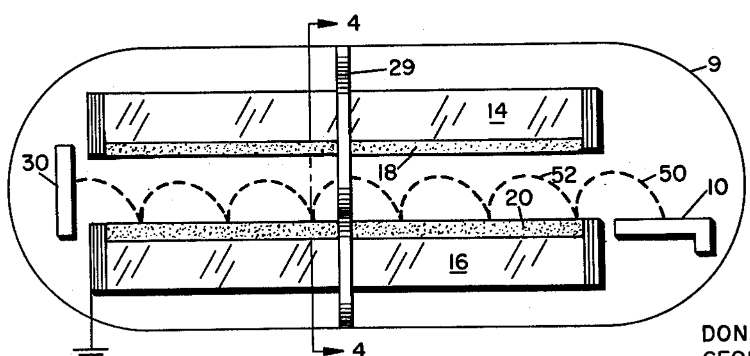

FIG-3

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ELECTRON MULTIPLIER SPURIOUS NOISE BAFFLE

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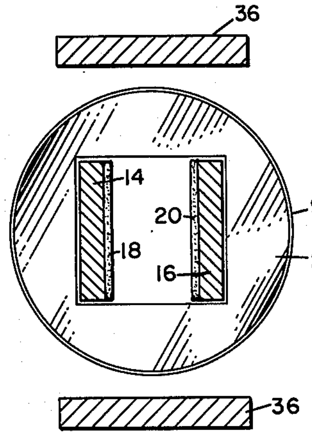

FIG-4

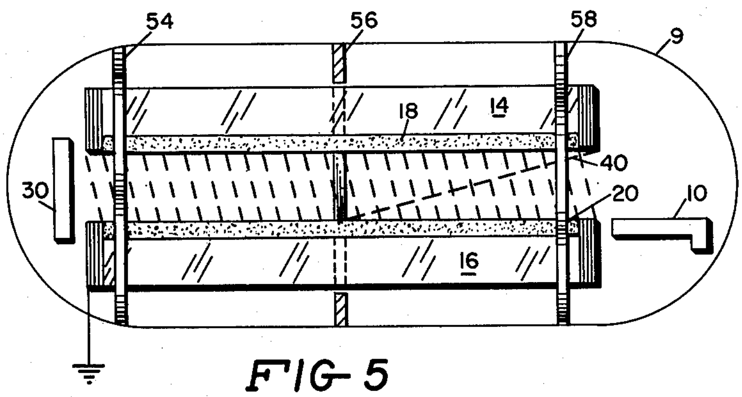

FIG-5

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ELECTRON MULTIPLIER SPURIOUS NOISE BAFFLE

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This invention pertains to an electron multiplier spurious noise baffle to reduce noise in an electron multiplier.

It is an essential object of this invention to provide a spurious noise baffle for reducing noise in an electron multiplier which is believed due to electron, ion, photon or other type feedback.

It is another object to provide in an electron multiplier having a secondary emissive surface and a related field surface spaced therefrom to define an electron path, a spurious noise baffle which surrounds such surfaces to block particles believed to have escaped from between the surfaces and to be traveling in a feedback path to a point of entry or re-entry between the surfaces and impingement on the emissive surface, and to block particle products believed on an entry or re-entry path.

It is a further object of this invention to provide in an electron multiplier having a pair of secondary electron emissive surfaces and electrical and magnetic fields aligned relative to said surfaces to urge charged particles in a cycloidal path between said surfaces, a spurious noise baffle comprising a section surrounding said surfaces in a plane substantially perpendicular to the surfaces, which section is closely spaced to the surfaces and is believed to intercept and prevent particle travel in a reverse or irregular manner outside of said surfaces.

These and other objects will become more apparent when preferred embodiments of the invention are considered in connection with the drawings in which:

Figure 1 is a perspective view, partly in block form, schematically illustrating a magnetic electron multiplier constituting one embodiment of this invention;

Figure 2 is a plan view illustrating the electrical field produced in the multiplier shown in Figure 1 and showing the baffle in section;

Figure 3 is a plan view illustrating electron travel in the multiplier of Figure 1;

Figure 4 is a section taken along 4—4 of Figure 3 showing the noise baffle; and

Figure 5 is a plan view of a second embodiment having a plurality of such baffles with the central baffle being sectioned.

A problem experienced in the art of designing and manufacturing electron multipliers and like instruments having a vacuum or gaseous path for electron flow, has been that of spurious or noise signals. It is believed that one of the sources of such spurious signals is that of particles and particle products, such as electrons which escape from the defined path between two secondary electron emissive surfaces, gas molecules ionized by electrons, photons generated by high energy particles, or other mass or energy particles which travel rearwardly or irregularly to re-enter or enter such defined path causing a spurious or false output signal. This invention overcomes the problem by constructing a baffle, or baffles, intermediate the ends of the secondary electron emissive surfaces to reduce the spurious or unwanted noise signals. It is believed that the baffle structure surrounding the secondary emissive surfaces in a plane perpendicular to the surfaces, blocks such particle and product travel outside the path defined by the secondary surfaces, so that particles escaping from between the surfaces and products of these particles cannot re-enter or enter the surfaces at an earlier or later point in the cycle to generate noise signals.

Referring now to the drawings, a first embodiment of this invention will be described. A vacuum tube 9 encloses a source for emitting electrons, such as a cathode 10, which is positioned to introduce electrons to a magnetic electron multiplier generally indicated at 12. The multiplier 12 includes a pair of substantially parallel plates 14 and 16 which are spaced from each other a distance such as ¼ inch. The plates 14 and 16 are made of an insulating material such as glass or Bakelite.

The plate 14 is provided with a conductive coating or strip 18 on its inner surface and a similar conductive strip 20 is provided on the inner surface of the plate 16. The conductive strips 18 and 20 are made of a secondary electron emissive material having a relatively high resistance such as a tin oxide or carbon compound. Since the secondary emissive properties of the strip 18 in this embodiment are not utilized, if manufacturing economies may be achieved thereby, the strip 18 may be made from a material which has a relatively high resistance but which does not have outstanding secondary emissive properties.

Terminals 22 and 24 are provided on the opposite ends of the plate 14 in contact with the conductive strip 18. Similarly, terminals 26 and 28 are provided on the opposite ends of the plate 16 in contact with the conductive strip 20. The terminals 22, 24, 26 and 28 are made of a conductive material having a very low resistance, such as silver.

A baffle 29, shown in section in Figure 2, and having a central opening through which pass the plates 14, 16, extends from the plates in a plane perpendicular to the plates. Satisfactory results have been obtained with the baffle 29 being made of an electrically conductive material (stainless steel) or an insulative material (polytetrafluoroethylene resin). It is believed any material sufficiently impenetrable to electron, ion, or photon travel is usable. The boundary of the central opening in the baffle is dimensioned as close to the outer surfaces of glass plates 14, 16 as possible without interfering with the normal multiplying action therebetween.

An anode plate 30 is disposed in substantially perpendicular relationship to the plates 14 and 16 to receive any electrons passed between the plates. The anode 30 is connected through a resistance 32 to a power supply 34 which applies a direct voltage such as +1500 volts to the anode.

Direct voltages, such as +1500 volts and −1500 volts are applied respectively to the terminals 22 and 24 from the power supply 34. A direct voltage, such as −3000 volts, is applied to the terminal 28 from the power supply and the terminal 26 is grounded. A direct voltage, such as −3200 volts, is also applied to the cathode 10 from the power supply.

A pair of pole pieces 36 are disposed above and below the plates 14 and 16 to provide a magnetic field in the region between the plates in a vertical direction and substantially parallel to the face of the plates. For example, a magnetic field of 300 gausses may be provided by the pole pieces.

The application of the direct voltages to the terminals 22 and 24 produces a flow of current through the conductive strip 18. The amount of current flow is relatively small because of the high resistance of the strip 18. For example, a current of one milliampere may be produced in the strip 18. This current flow results in a uniform voltage drop across the conductive strip 18 between the terminals **22** and **24**. A similar current flow and uniform voltage drop results across the conductive strip **20** between the terminals **26** and **28**.

Although the magnitude of the voltage drop across the strips **18** and **20** is substantially the same, the drop in each strip occurs between different potential levels. This causes the equipotential lines between the strips **18** and **20** to be slanting. For example, equipotential line —1500 volts is represented by the slanting line **40** (Figure 2) which is drawn between the terminal **24** and an intermediate position in the strip **20**. Since the electric field in a region is disposed in a direction perpendicular to the equipotential lines in the region, the electric field shown in Figure 2 is produced in the region between the strips **18** and **20** in a direction perpendicular to the equipotential line **40**. This field has a component substantially perpendicular to the plates **14** and **16** in a direction for causing any electrons in the region to move towards the plate **14**. The field also has a component substantially parallel to the plates **14** and **16** in a direction to cause any electrons in the region to acquire energy in their travel to the anode **22**. In this way the electrons acquire sufficient energy to cause secondary emission at a ratio greater than 1:1 when they impinge upon a surface of the plates.

Electrons emitted by the cathode **10** are subjected to the combined action of the magnetic field and electric field in the region between the plates **14** and **16**. This causes the electrons to travel in a cycloidal path **50** and to strike the surface of the strip **20** which emits a proportionately increased number of electrons. The electrons emitted by the strip **20** travel in a cycloidal path **52** and impinge upon another part of the strip **20** to again emit a proportionately increased number of electrons for cycloidal travel to another part of the strip **20**. In this way, successively emitted electrons travel across the surface of the strip **20** in successive cycloidal paths as shown in Figure 2 to multiply the number of electrons initially emitted by the cathode **10**. Finally, the electrons emitted by the strip **20** at its extreme left impinge upon the anode **30** for detection.

As mentioned, it is believed that in the operation of the disclosed multiplier, electrons generated by the multiplier escape from between plates **14, 16** and travel in an irregular or reverse manner outside the confines of the plates **14, 16**. These charged particles are believed to re-enter the area between plates **14, 16** striking an emissive surface **18, 20** to generate false signals on anode **30**. Also, some ions, photons, or other energy or mass particles formed or present in the multiplier envelope are believed to enter between the plates **14, 16** to generate false or spurious signals. Placement of baffle **29** approximately midway between the ends of plates **14** and **16** has effectively reduced the noise and it is believed the reason for this is that the stray particles and products are blocked before they can re-enter the multiplier path and strike one or the other of the emissive strips **18, 20** to generate a number of spurious or noise electrons which are, of course, amplified in the normal manner as they pass between plates **14** and **16** to cause a noticeable divergence from the true amplification.

A second embodiment is shown in Figure 5 and is similar to the embodiment shown in Figures 1 to 4 except that three baffles **54, 56** and **58** are placed, respectively, at the input end, at the center, and the output end of the plates **14** and **16**. The baffle may take forms other than a section in a perpendicular plane and may be of other suitable materials and locations.

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. An electron multiplier comprising means for producing primary electrons, secondary electron emissive means, means for establishing an electric field having a component perpendicular to said emissive means, means for establishing a magnetic field having a component substantially perpendicular to the electric field so that a charged particle in said fields will follow a cycloidal path, envelope means for enclosing the secondary emissive means, a baffle structure being in said envelope means and closely placed relative to said emissive means and having a surface component perpendicular to said emissive means to reduce noise and spurious signals.

2. The multiplier of claim 1 wherein said baffle structure comprises a section substantially encircling said secondary electron emissive means.

3. The multiplier of claim 2 wherein said section is in a plane substantially normal to the secondary electron emissive means and is centrally placed longitudinally of said emissive means.

4. The multiplier of claim 2 wherein said baffle section has an opening through which said secondary emissive means passes, the inner boundary of the baffle section opening being closely spaced relative the emissive means the outer boundary of said baffle fitting closely against said envelope and electric field means in order to reduce particle and product travel outside of said emissive and field means.

5. The multiplier of claim 1 which is further characterized by said baffle structure comprising a plurality of sections spaced longitudinally of said emissive means, each of said sections having a component extending in a plane perpendicular to the longitudinal direction of said emissive means.

6. The multiplier of claim 5 which is further characterized by a section being placed adjacent each end of said emissive means and centrally of said emissive means.

7. The multiplier of claim 6 where at least one of said baffle sections is close fitting against said envelope and is closely spaced to said emissive means.

8. The multiplier of claim 2 wherein said baffle section has an opening through which said secondary emissive means passes, the inner boundary of the baffle section opening being closely spaced relative the emissive means, the outer boundary of said baffle fitting closely against said envelope in order to reduce particle and product travel outside of said emissive means.

9. A charged particle multiplier comprising secondary emissive means for emitting a plurality of secondary charged particles upon impact of a primary charged particle, envelope means for enclosing the secondary emissive means, electric field means for establishing an electric field for accelerating said charged particles relative to said emissive means, a baffle structure being in said envelope means and closely placed relative to said emissive means, and having a surface component perpendicular to said emissive means to reduce noise and spurious signals.

10. The multiplier of claim 9 wherein said baffle structure comprises a section substantially encircling said secondary electron emissive means.

11. The multiplier of claim 10 wherein said baffle section has an opening through which said secondary emissive means passes, the inner boundary of the baffle section opening being closely spaced relative the emissive means, the outer boundary of said baffle fitting closely against said envelope and electric field means in order to reduce particle and product travel outside of said emissive and field means.

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