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ELECTRON WINDOW AND METHOD OF INCREASING THE MECHANICAL STRENGTH THEREOF
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FIG. 1

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ELECTRON WINDOW AND METHOD OF INCREASING THE MECHANICAL STRENGTH THEREOF

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11 Claims. (Cl. 313—74)

This invention relates to acceleration tubes in which electrons are accelerated to high energy and from which the high energy electrons are discharged in the form of a sheet. In particular, this invention relates to an electron window for the transmission of a high-energy stream of electrons in sheet form from a relatively low pressure region to a relatively high pressure region, and to a method of increasing the mechanical strength of such a window. More specifically stated, my invention relates to an elongated electron window including a thin metal foil so constructed and arranged that the stresses produced in said foil by the pressure exerted thereon are minimized, and to a method of forming said foil without appreciably reducing its tensile strength.

In the drawings:

Fig. 1 is a view, partly in perspective and partly in vertical central section, illustrating one form of acceleration tube provided with an elongated electron window;

- Fig. 2 is a top plan view of the elongated electron window illustrated in Fig. 1;

- Fig. 3 is a vertical section upon the line 3—3 of Fig. 2;

- Fig. 4 is a vertical section upon the line 4—4 of Fig. 2;

and

Fig. 5 is a perspective view of some of the component parts of the elongated electron window illustrated in Fig. 2, together with a similar view of a window sealing clamp, and illustrates the method, herein disclosed and claimed, of forming the thin metal foil of the electron window.

It is now becoming established that all types of living organisms are affected by gamma rays and high energy electrons and that lethal effects can be produced on unwanted organisms by doses which will raise the temperature of water only a few degrees centigrade. The growing availability of streams of high energy electrons makes possible the practical application of this knowledge to the sterilization of many important products, such as pharmaceuticals, surgical instruments, animal tissue for transplant purposes, as well as for the preservation of certain foods. Only high energy electron sources, as distinct from gamma ray sources, appear to possess enough total power output to handle economically the considerable amounts of material which may require sterilization.

A high energy electron source may be provided by accelerating electrons to high energy in an evacuated tube, and permitting the high energy electrons to issue from the tube through an appropriate electron window onto the product to be irradiated. In order to irradiate the entire surface area of the product, the high energy electrons may be caused to issue from the tube in the form of a sheet, and the product may be placed on a conveyor belt which moves the product through the electron sheet transversely thereto. For example, electrons may be accelerated as a beam within the evacuated tube, and then a rapid scanning movement may be imparted to the electron beam just before it issues from the tube, as disclosed in the U. S. patent to Robinson, No. 2,602,751, and assigned to the assignee of the present application. Alternatively, an electron beam may be focused into a sheet form within the tube by a system of cylindrical electron optics, as disclosed in a co-pending application belonging to the same assignee as does the present application.

The electron window through which the high energy electrons issue from the acceleration tube may include a supporting block hermetically sealed to the evacuated acceleration tube and having an aperture completely covered by a metal foil hermetically sealed to said supporting block. When the electron stream is thus formed into a sheet before issuance from the tube, the area of the aperture must conform to the cross-section of the electron sheet, and must be of elongated area. In addition, the metal foil must be thin, in order that the electrons may issue therefrom through the tube with minimum loss of energy. Each of these requirements reduces the mechanical strength of the electron window, which must be able to support atmospheric pressure on one side against a vacuum on the other.

My invention comprehends an electron window which is able to support a relatively high pressure on one side thereof against a relatively low pressure on the other side thereof, despite the elongated area of the aperture and the thinness of the metal foil, and also comprehends a method of increasing the mechanical strength of such an electron window. Such an electron window is advantageous whenever it is desired to propagate a sheet of high energy electrons from an evacuated acceleration tube into atmospheric air, and although my invention is in no wise limited to any particular use of such a sheet of high energy electrons, it has been used with particular advantage in electron sterilization.

Referring to Fig. 1 of the drawings, the electron window assembly 1 is attached to the lower end 2 of the acceleration tube 3 by means of screws 4. The junction 5 between the electron window assembly 1 and the lower end 2 of the acceleration tube 3 is made vacuum-tight by means of an appropriate gasket. The entire internal volume of the tube 3, from the cathode 6 to the electron window assembly 1, is evacuated until the pressure within the tube 3 is reduced to about 10⁻⁵ mm. of mercury. Electrons emitted from the cathode 6 are accelerated down the tube 3 so that they enter a scanning device 7 as a beam 8 of high energy electrons. The said scanning device 7 imparts a rapid scanning movement to the electron beam 8, so that the electrons issue through the electron window assembly 1 substantially in the form of a sheet, as indicated by the arrows 9. Alternatively, the scanning device may be replaced by means for focusing the electron beam into sheet form by a cylindrical electron optical system. A conveyor belt 10 is located below the electron window assembly 1 and in close proximity thereto moves the product 11 to be treated through the electron sheet 9 in a direction transverse to the plane of the said electron sheet 9.

The electron window assembly is illustrated in more detail in Figs. 2—4, and comprises essentially a supporting block 12 having an elongated aperture 13 which is covered by a thin sheet of metal foil 14. The shape of the aperture corresponds to the cross-section of the electron sheet which is to pass therethrough, and its size should be sufficient to allow clearance for the entire effective electron sheet, together with a safety margin. For example, if an electron beam of ¥1-inch diameter is scanned so that the length of scan at the electron window is 14 inches, the aperture should be about 15 inches long and about 1 inch wide.

A semicylindrical groove 15 is provided on the outer surface 16 of the supporting block. The longitudinal edges 17, 17 of the groove are substantially coincident
The sealing clamp 21 should be removed from the supporting block 12 after the foil 14 has been formed or, in the event that the foil is cemented to the block, after the foil has been so cemented. The entire electron window assembly 1 is then attached to the lower end 2 of the acceleration tube 3 by means of screws 4 which fit into the threaded holes 24 in the supporting block 12, as shown in Fig. 1, so that the threaded surface 16 is outermost. As stated, the joint 5 is made vacuum-tight by means of an appropriate gasket.

Having thus disclosed a preferred embodiment of the electron window of my invention, and the method of constructing an electron window to increase the mechanical strength thereof, it is to be understood that although specific terms are employed, they are used in a generic and descriptive sense and not for purposes of limitation, the scope of the invention being set forth in the following claims.

I claim:

2. That method of increasing the mechanical strength of an electron window the length thereof is markedly greater than the width thereof, which method comprises fabricating a supporting block having an elongated aperture of the shape and the size of the electron window desired, the width of said aperture being not less than one-quarter of an inch, and in so doing, forming said block with a semicylindrical groove in one surface thereof, and in so doing, causing the longitudinal edges of said groove to be substantially coincident with the longitudinal sides of said aperture; fitting a plane metal foil to said grooved surface by bending said foil about mutually parallel axes only, whereby said foil is formed into the proper shape without appreciably stretching or yield-forming said foil; and hermetically sealing said foil to said supporting block.

3. That method of increasing the mechanical strength of an electron window the length thereof is markedly greater than the width thereof, which method comprises fabricating a supporting block having an elongated aperture of the shape and the size of the electron window desired, the width of said aperture being not less than one-quarter of an inch, and in so doing, causing the longitudinal edges of said groove to be substantially coincident with the longitudinal sides of said aperture; fitting a plane metal foil to said grooved surface by bending said foil about mutually parallel axes only, whereby said foil is formed into the proper shape without appreciably stretching or yield-forming said foil; and hermetically sealing said foil to said supporting block.

4. An electron window for the transmission of a stream of high-energy electrons from a relatively low pressure region to a relatively high pressure region, said stream of electrons being substantially in the form of a sheet, comprising a supporting block having an elongated aperture adapted to transmit said stream of electrons in the form therethrough, the width of said aperture being not less than one-quarter of an inch, said supporting block having a
substantially semicylindrical groove on the surface thereof which faces the high pressure region, the longitudinal edges of said groove being substantially coincident with the longitudinal sides of said aperture, said groove extending beyond the extremities of said aperture, and a sheet of metal foil of low atomic number fitted into said groove so as to completely cover said aperture and contoured to and hermetically sealed to said surface, throughout extensive areas thereof at each side of said aperture and groove, said aperture and groove being narrow with respect to the much wider lateral extent of the supporting block at each side thereof, thereby providing wide areas on the surface of said block for receiving and having sealed thereto the portions of said foil that are laterally beyond said aperture and groove, the passage of said stream of electrons through said electron window being unobstructed except by said sheet of metal foil only.

5. An electron window for the transmission of a stream of high-energy electrons from an evacuated acceleration tube into atmospheric air, said stream of electrons issuing from said acceleration tube substantially in the form of a sheet, comprising a supporting block hermetically sealed to said acceleration tube, said supporting block having an elongated aperture adapted to transmit said stream of electrons in sheet form therethrough, the width of said aperture being not less than one-quarter of an inch, a sheet of metal foil of low atomic number hermetically sealed to the outer surface of said supporting block throughout extensive areas thereof at each side of said aperture, so as to cover said aperture completely, said aperture being narrow with respect to the much wider lateral extent of the supporting block at each side thereof, thereby providing wide areas on the surface of said block for receiving and having sealed thereto the portions of said foil that are laterally beyond said aperture and groove, the passage of said stream of electrons through said electron window being unobstructed except by said sheet of metal foil only, said foil having a substantially semicylindrical ridge formed therein so as to intrude into said aperture, the diameter of said ridge being substantially equal to the width of said aperture, said ridge extending the entire length of the foil, and a substantially semicylindrical groove in the said outer surface of said supporting block, the longitudinal edges of said groove constituting a prolongation of the longitudinal edges of said aperture, whereby said groove is adapted to receive said ridge, said ridge being fitted into said groove.

6. An electron window in accordance with claim 5, wherein said metal foil is cemented to the said outer surface of said supporting block.

7. An electron window in accordance with claim 5, wherein said metal foil is cemented to the said outer surface of said supporting block by a resilient plastic film bond.

8. An electron window in accordance with claim 5, wherein said metal foil comprises a thin sheet of aluminum.

9. An electron window in accordance with claim 5, wherein said metal foil comprises a sheet of aluminum the thickness of which is less than five thousandths of an inch.

10. An electron window for the transmission of a stream of high-energy electrons from an evacuated acceleration tube into atmospheric air, said stream of electrons issuing from said acceleration tube substantially in the form of a sheet, comprising a supporting block hermetically sealed to said acceleration tube, said supporting block having an elongated aperture adapted to transmit said stream of electrons in sheet form therethrough, the width of said aperture being not less than one-quarter of an inch, said supporting block having a substantially semicylindrical groove on the outer surface thereof, the longitudinal sides of said groove being substantially coincident with the longitudinal sides of said aperture, a sheet of metal foil of low atomic number hermetically sealed to said outer surface throughout extensive areas thereof at each side of said aperture and groove, so as to cover said aperture completely, said aperture and groove being narrow with respect to the much wider lateral extent of the supporting block at each side thereof, thereby providing wide areas on the surface of said block for receiving and having sealed thereto the portions of said foil that are laterally beyond said aperture and groove, the passage of said stream of electrons through said electron window being unobstructed except by said sheet of metal foil only, said foil having a substantially semicylindrical ridge formed therein and extending the entire length thereof so as to present a convex surface to said aperture whereby the mechanical strength of said foil is increased, said groove extending beyond the extremities of said aperture in order to receive said ridge, said ridge being fitted into said groove.

11. An electron window for the transmission of a stream of high-energy electrons from an evacuated acceleration tube into atmospheric air, said stream of electrons issuing from said acceleration tube substantially in the form of a sheet, comprising a supporting block hermetically sealed to said acceleration tube, said supporting block having an elongated aperture adapted to transmit said stream of electrons in sheet form therethrough, the width of said aperture being not less than one-quarter of an inch, said supporting block having a substantially semicylindrical groove on the outer surface thereof, the longitudinal sides of said groove being substantially coincident with the longitudinal sides of said aperture, said groove extending the entire length of said surface, and a sheet of metal foil of low atomic number fitted into said groove so as completely to cover said aperture and contoured to and hermetically sealed to said surface, throughout extensive areas thereof at each side of said aperture and groove, said aperture and groove being narrow with respect to the much wider lateral extent of the supporting block at each side thereof, thereby providing wide areas on the surface of said block for receiving and having sealed thereto the portions of said foil that are laterally beyond said aperture and groove, the passage of said stream of electrons through said electron window being unobstructed except by said sheet of metal foil only.

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