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B. G. E. STIFF

2,820,168

ELECTRON WINDOW

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FIG. 1

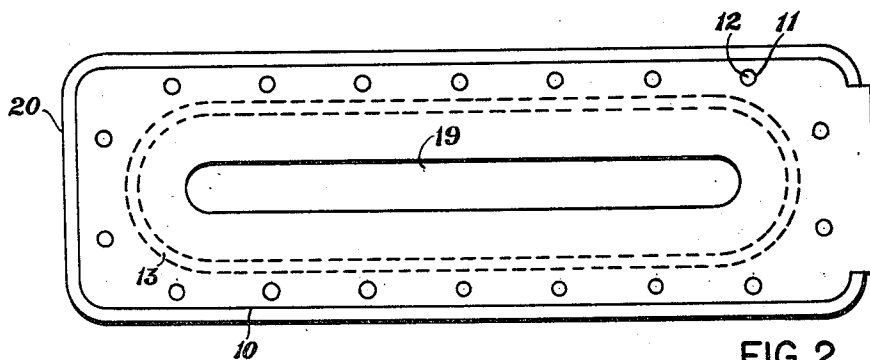
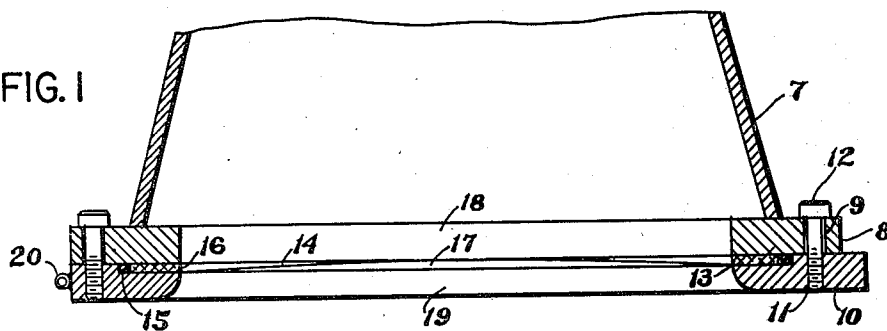


FIG. 2

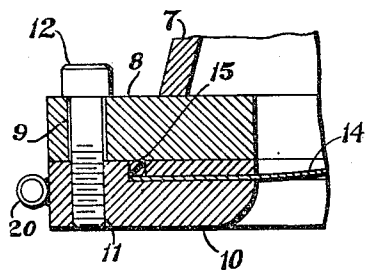


FIG. 3

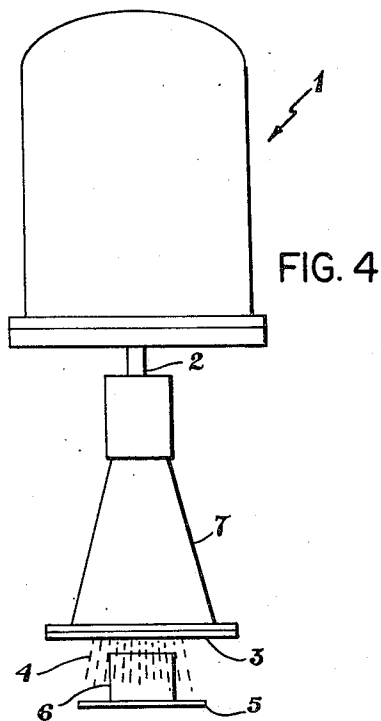


FIG. 4

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ELECTRON WINDOW

Bernard G. E. Stiff, North Reading, Mass., assignor to High Voltage Engineering Corporation, Cambridge, Mass., a corporation of Massachusetts

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4 Claims. (Cl. 313—74)

This invention relates to evacuated acceleration tubes in which electrons are accelerated to high energy and from which the high-energy electrons are discharged onto matter to be irradiated thereby. In particular, this invention relates to an electron window for such an acceleration tube, through which such electrons may be discharged onto such matter.

High-energy electrons are an important form of ionizing energy, and high-energy electron sources are finding increasing application in radiation chemistry, sterilization and preservation of food and drugs, and similar fields. 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 matter to be irradiated. Frequently the high-energy electrons are caused to issue from the tube in the form of a sheet, and the matter to be irradiated is placed on a conveyor belt which moves the matter 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 sheet form within the tube by a system of cylindrical electron optics, as disclosed in the U. S. patent to Robinson, No. 2,680,814, and assigned to the assignee of the present application.

The electron window through which the high-energy electrons issue from the acceleration tube must be as thin as possible in order that the electrons may issue therethrough from the tube with minimum loss of energy, and usually comprises a thin sheet of aluminum foil. Moreover, the area of the electron window must be large enough to permit the passage therethrough of the entire electron sheet. A representative electron window might be one-half inch wide and six inches long. On the other hand, the electron window must have sufficient mechanical strength to be able to support atmospheric pressure on one side against a vacuum on the other. In addition, the metal foil must be secured to the evacuated acceleration tube in such a manner that the junction is not only vacuum-tight but also of good thermal conductivity, in order to carry away the heat generated in the foil by the passage of the high-energy electrons therethrough.

It has been difficult to construct electron windows which satisfy all the foregoing requirements, and failure of electron windows has been frequent. The principal causes of such failure have been: (1) electron bombardment of end gaskets with resulting embrittlement of the rubber; (2) softening of the vinyl acetate seal, between the foil and its support, under intense heat from local product fires; and (3) insufficient heat dissipation because of heat insulating properties of the plastic bond between the foil and its support.

The electron window of my invention, described and

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claimed herein, has been tested for several months with great success. To date, under full beam and punishing operation, no window failures have been reported, except for those caused by puncturing of the foil by product fragments.

A principal feature of the window of my invention other than its ruggedness is the ease with which foils can be replaced. If a foil is punctured, the foil itself is the only replacement necessary.

My invention may best be understood from the following detailed description thereof, having reference to the accompanying drawing, in which:

Fig. 1 is a vertical central section illustrating an electron window constructed in accordance with my invention;

Fig. 2 is a bottom plan view of the electron window of Fig. 1;

Fig. 3 is a detail in vertical section of a portion of the electron window of Fig. 1; and

Fig. 4 is a diagrammatic view illustrating a complete electron accelerator having an electron window constructed in accordance with my invention.

Referring to the drawing, and first to Fig. 4 thereof, the electron accelerator shown at 1 in Fig. 4 is provided with an evacuated acceleration tube 2 which terminates in an electron window 3 through which electrons issue in the form of a sheet 4. A conveyor belt 5 travels in a direction perpendicular to the plane of the drawing and conveys the product 6, which is to be irradiated, through the electron sheet 4, so that the ionizing energy of the high-energy electrons is delivered to the product 6.

Referring now to Figs. 1, 2 and 3, the lateral wall 7 of the lower extremity of the evacuated acceleration tube 2 terminates in a flange 8 which is provided with a series of holes 9. A flat plate 10, whose outer circumference may be similar to that of the flange 8, is provided with a series of tapped holes 11 corresponding to the holes 9 in the flange 8, so that the flat plate 10 may be secured to the flange 8 by means of suitable bolts 12.

A nest or cavity 13 is provided in the upper surface of the plate 10 by means of a counterbore or shell end-mill. A metal foil 14, whose area is approximately the same as, and preferably slightly greater than, that of the cavity 13, is placed in the cavity 13. An O-ring or gasket 15 is then fitted in the cavity 13 on top of the foil 14, and an apertured disk 16 is laid on top of the foil 14 inside the O-ring or gasket 15, so that an annular space is provided to receive the O-ring 15 between the outer periphery of the apertured disk 16 and the inner periphery of the cavity 13 in the plate 10. The metal foil 14 must extend outward beyond the O-ring 15, as shown in detail in Fig. 3, in order to provide the necessary vacuum-tight seal.

The aperture 17 in the apertured disk 16 forms the boundary of the electron-permeable area of the electron window 3, and so conforms generally to the cross-section of the electron stream 4. In the drawing, the electron stream 4 is in sheet form (Fig. 4), so that the aperture 17 is elongated, as shown in Fig. 2. The aperture 18 in the flange 8, as well as the aperture 19 in the plate 10, are similar to the aperture 17 in the apertured disk 16, but the apertures 18 and 19 in the flange 8 and plate 10, respectively, may be and preferably are larger than the aperture 17 in the disk 16. Of course, the boundary of apertures 18 and 19 must lie within the outer periphery of the apertured disk 16, in order to hold the disk 16 in place. The O-ring 15 is thus completely surrounded and is compressed tightly when the plate 10 is bolted to the flange 8.

The flange 8, plate 10, and apertured disk 16 are preferably made out of a material, such as aluminum or brass, which has good thermal conductivity, in order to assist in dissipating the heat which is generated by the

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passage of electrons through the metal foil 14. The plate 10 should be as thin as is consistent with adequate rigidity and strength, in order that the product 6 may pass close to the foil 14, thereby minimizing the amount of air intervening between the foil 14 and the product 6.

Any suitable compressible annulus may serve as the O-ring or gasket 15.

The apertured disk 16 is in contact with the foil 14 over an extended area, and thus effectively transfers the heat generated in the foil 14 to the plate 10. Generally it will be desirable to provide a water line 20 in the plate 10, in order to carry this heat away from the window assembly 3 entirely.

The apertured disk 16 also serves to shield the O-ring 15 from electron bombardment and thus prevents embrittlement and deterioration of the O-ring 15.

Various modifications may be made in the apparatus described herein in detail without departing from the spirit and scope of my invention. Since such modifications will be apparent to those skilled in the art, it is not necessary to discuss them here in any detail. For example, the electron window 3 shown in the drawing may be inverted, so that the cavity 13 is provided in the lower surface of the flange 8 rather than in the upper surface of the plate 10, the foil 14 being positioned above rather than below the O-ring 15 and the apertured disk 16.

Having thus described my invention, together with an illustrative embodiment 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:

1. An electron window for the transmission of high-energy electrons from an evacuated acceleration tube, said high-energy electrons issuing from said acceleration tube as a stream at least one of whose lateral dimensions is at least of the order of several inches, comprising a plate adapted to be secured to the lower end of said acceleration tube, said plate having a cavity in that surface thereof which faces said acceleration tube and having an aperture in the bottom of said cavity, a metal foil lining the surface of said cavity and covering said aperture in said cavity, a compressible annulus in said cavity along the periphery thereof, an apertured disk inside said compressible annulus and cooperating with the periphery of said cavity to form a channel for said compressible annulus, and means for securing said plate to the lower end of said acceleration tube so as to compress said compressible annulus against the surfaces bounding said channel sufficiently to form a vacuum-tight seal and so as to compress said metal foil between said plate on one side and said compressible annulus and said apertured disk on the other side sufficiently to hold said metal foil in place.

2. An electron window for the transmission of high-energy electrons from an evacuated acceleration tube, said high-energy electrons issuing from said acceleration tube as a stream at least one of whose lateral dimensions is at least of the order of several inches, comprising a supporting flange hermetically sealed to said acceleration tube, a plate removably securable to said flange, said plate having a cavity in that surface thereof which faces said flange and having an aperture in the bottom of said cavity, a metal foil lining the surface of said cavity and covering said aperture in said cavity, a compressible annulus in

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said cavity along the periphery thereof, an apertured disk inside said compressible annulus and cooperating with the periphery of said cavity to form a channel for said compressible annulus, and means for securing said plate to said flange so as to compress said compressible annulus against the surfaces bounding said channel sufficiently to form a vacuum-tight seal and so as to compress said metal foil between said plate on one side and said compressible annulus and said apertured disk on the other side sufficiently to hold said metal foil in place.

3. An electron window for the transmission of high-energy electrons from an evacuated acceleration tube, said high-energy electrons issuing from said acceleration tube as a stream at least one of whose lateral dimensions is at least of the order of several inches, comprising a supporting flange hermetically sealed to said acceleration tube, a plate removably securable to said flange, said flange having a cavity in that surface thereof which faces said plate and having an aperture in the bottom of said cavity, a metal foil lining the surface of said cavity and covering said aperture in said cavity, a compressible annulus in said cavity along the periphery thereof, an apertured disk inside said compressible annulus and cooperating with the periphery of said cavity to form a channel for said compressible annulus, and means for securing said plate to said flange so as to compress said compressible annulus against the surfaces bounding said channel sufficiently to form a vacuum-tight seal and so as to compress said metal foil between said plate on one side and said compressible annulus and said apertured disk on the other side sufficiently to hold said metal foil in place.

4. An electron window for the transmission of high-energy electrons from an evacuated acceleration tube, said high-energy electrons issuing from said acceleration tube as a stream at least one of whose lateral dimensions is at least of the order of several inches, comprising an apertured plate adapted to be secured to the lower end of said acceleration tube, said plate having a cavity in that surface thereof which faces said acceleration tube, an apertured disk nesting in said cavity and cooperating with the periphery of said cavity to form an annular channel, the aperture in said disk being in alignment with the aperture in said plate, a compressible annulus in said annular channel, a metal foil between said disk and said plate, covering the apertures in both said disk and said plate and extending outward sufficiently so as to separate said compressible annulus from said plate, and means for securing said plate to the lower end of said acceleration tube so as to compress said compressible annulus against the surfaces bounding said channel sufficiently to form a vacuum-tight seal and so as to compress said metal foil between said plate on one side and said compressible annulus and said apertured disk on the other side sufficiently to hold said metal foil in place.

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