APPARATUS FOR OBTAINING SUBSTANTIALLY UNIFORM IRRADIATION FROM A NONUNIFORM SOURCE

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The present invention relates to a method and apparatus for obtaining substantially uniform dosage in the irradiation of a product from a nonuniform source, as for example a beam of electrons from a cathode ray tube. With the usual cathode ray tube operating at relatively high powers, there is an inherent focusing of the electrons emitted from the window at the end of the tube. This produces a beam of electrons that has a core, in which the electrons are highly concentrated, surrounded by areas of increasingly less density. When such a beam is used to irradiate product, the areas of high concentrations obviously receive a much heavier dosage than do the areas where there is a lesser concentration of electrons.

Various expedients have been tried in an effort to obtain a more uniform beam. One of these has been to pass the beam through something that would diffuse it so as to scatter the electrons and thus produce a more even concentration throughout the area covered by the beam. Another expedient has been to rapidly sweep the beam back and forth much in the manner in which a beam of electrons is swept across the face of a cathode ray tube in a television set. With high energy electrons this requires substantial amounts of power. It also is somewhat difficult to obtain a sweeping rate that will produce relatively uniform dosages throughout the area covered.

The principal object of the present invention is to provide a relatively simple method and apparatus for obtaining such uniform dosages. In most installations the only additional piece of equipment required is a shield that is simple to make and which does not require repair and replacement. A conveyor is also used, but normally this conveyor would be required anyhow because of the danger in permitting employees to be around the area covered by a cathode ray tube when it is operating. Continued exposure to the electrons and to the X-rays produced by the electrons striking various substances can be dangerous. As a result, where there is any amount of operation at all a conveyor is used to carry the product past the window of the tube for irradiation. Such a conveyor continually operated is utilized as a part of the invention.

Other objects and advantages will become apparent from the following description taken in conjunction with the drawings, in which:

Figure 1 is a schematic elevational view of a part of an apparatus embodying the present invention, and

Figure 2 is a schematic plan view taken at line 2—2 of Figure 1.

The method for obtaining the substantially uniform coverage in accordance with the present invention is first to determine the variations in intensity of the concentration of the electrons in a given area in a plane spaced from the electron window. If other sources of irradiation equipment are used a similar procedure is followed. In most electron irradiation equipment it will be found that the distribution of the electrons in the beam is that of a probability curve centered about the axis of the beam.

For practical purposes this can be approximated by a cosine curve. A line of movement of the product through the beam is chosen and parts of the area of the beam are shadowed with the shadowing being such that the dimensions of the unshadowed areas as measured along lines parallel to the path of travel through the beam are inversely proportional to the average intensity along the line of each dimension. In the case of an electron beam having a distribution corresponding to a probability curve, the lengths of these dimensions of the unshadowed area as measured along lines parallel to the path of movement vary as a probability curve with the shortest dimension intersecting the axis of the beam and the longer dimension spaced to each side thereof.

Referring to Figure 1, an electron tube generally 10 has a window 11 from which a cathode ray beam 12 is emitted. Such an electron generator is conventional and forms no part of the present invention. Other details as described in the article "Radiation Sterilization III" by J. A. Knowlton, G. R. Mahn and J. W. Ranftl, published in Nucleonics, volume 11, Number 11, dated November 1953, at pages 64 et seq. The products to be irradiated in the illustrated embodiment are a plurality of units 14 which are passed through the beam in a given direction at a uniform rate of speed by a belt conveyor 15. A shield 16 is positioned between the window 11 and the product 14 to shadow portions of the area traversed by the units of product 14. The shield has a cut out 17 to provide unshadowed areas. The cut out is shaped so that all of the dimensions as measured parallel to the path of travel of the product along conveyor 15 vary in the nature of a probability curve (or for most purposes a cosine curve will suffice). In the illustrated embodiment this is achieved by having the two opposite edges 18 and 19 of the cut out, which two edges are transverse to the path of movement, shaped in the form of probability curves.

In a specific embodiment constructed for use with an electron generator having a peak output of 800,000 electron volts, the shield was made of one-eighth inch aluminum sheet. The distance between the two peaks of the edges 18 and 19, which dimension was designed to intersect the axis of the beam, was three and five-sixteenths inches. The edges 18 and 19 are cut to correspond to probability curves. The amount of the probability curve employed was such that at the ends the Y axis dimension of the curve was ten percent of the maximum Y axis dimension at the center of the curve. The distance from the window 11 to the product was four inches and the shield 16 was positioned one-half inch from the product. The maximum width of the cut out 17 was three inches and the maximum length as measured parallel to the line of movement was seven inches. With such a set up the maximum width of the product 14 as measured transverse to the path of movement of the product was three and one-eighth inches.

In another embodiment the shield was positioned one-half inch above the product and eight inches from the window 11. The distance between the two peaks of edges 18 and 19 was four and three-quarters inches, while the maximum width of the cut out was seven and five-eighths inches. The maximum length of the cut out parallel to the line of movement was twelve and three-quarters inches and the maximum width of the product 14 was seven and three-quarters inches.

The foregoing description of a specific embodiment is for the purpose of compliance with 35 U.S.C. 112, and I do not desire to be limited to the exact details shown and described, for obvious modifications will occur to a person skilled in the art.
I claim:

1. A device for obtaining substantially uniform coverage in the irradiation of a product, said device including a nonuniform source of irradiation, means for moving said product along a given path in a given direction through an area subjected to a beam of irradiation from said source, and a mask interposed between said path and said source, said mask having an opening therein positioned in said beam, the dimensions of the opening, as measured along lines parallel to said path, being inversely proportional to the average intensity of irradiation along said lines.

2. A device for obtaining substantially uniform coverage in the irradiation of a product from a nonuniform source of irradiation, said device including means for moving said product along a given path in a given direction through an area subjected to a beam of irradiation from said source, and a mask interposed between said path and said source, said mask having an opening therein positioned in said beam, the dimensions of the opening, as measured along lines parallel to said path, being inversely proportional to the average intensity of irradiation along said lines.

3. A device for obtaining substantially uniform coverage in the irradiation, from a nonuniform source, of a product moving along a given path in a given direction through an area subjected to a beam of irradiation from said source, said device including a mask interposed between said path and said source, said mask having an opening therein positioned in said beam, the dimensions of the opening, as measured along lines parallel to said path, being inversely proportional to the average intensity of irradiation along said lines.