May 3, 1932. F. S. SMITH 1,856,084

METHOD AND APPARATUS FOR SUBJECTING ARTICLES TO X-RAYS

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Fig. 1.

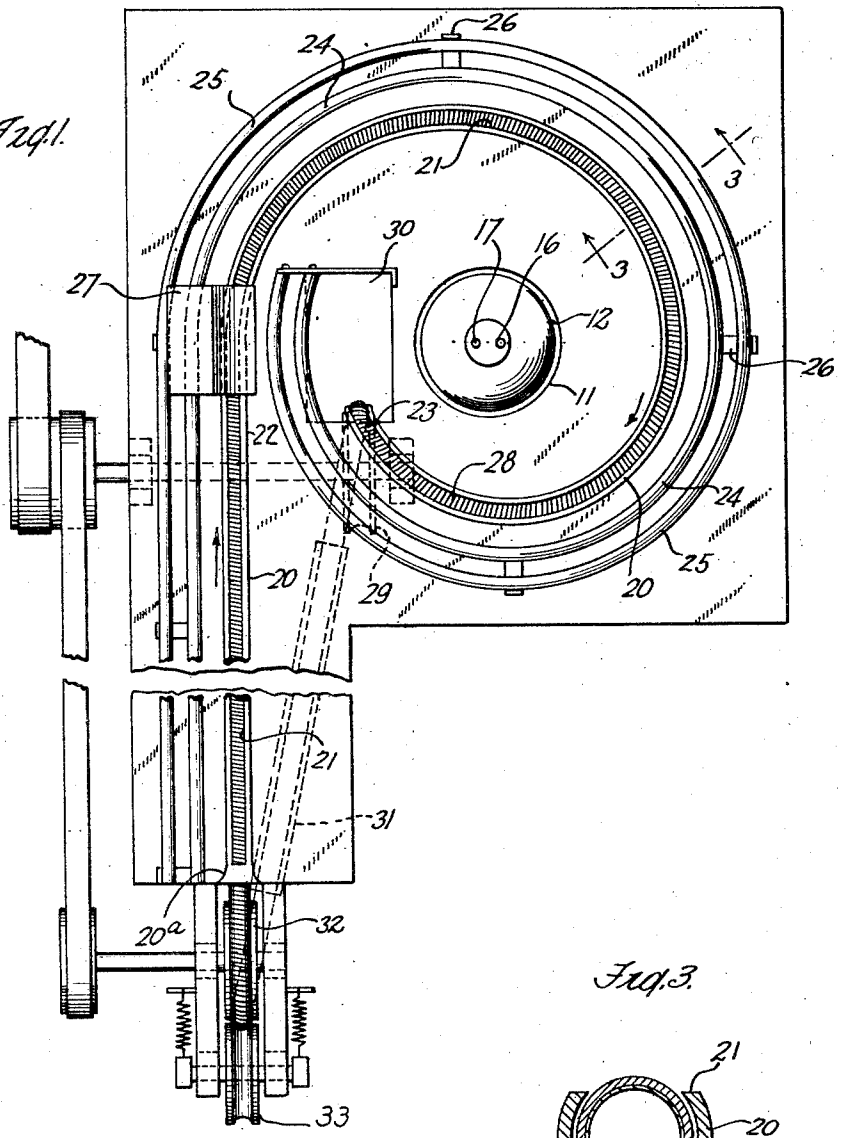

Fig. 3.

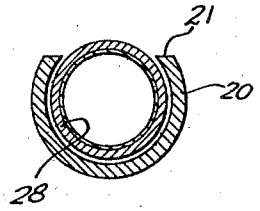

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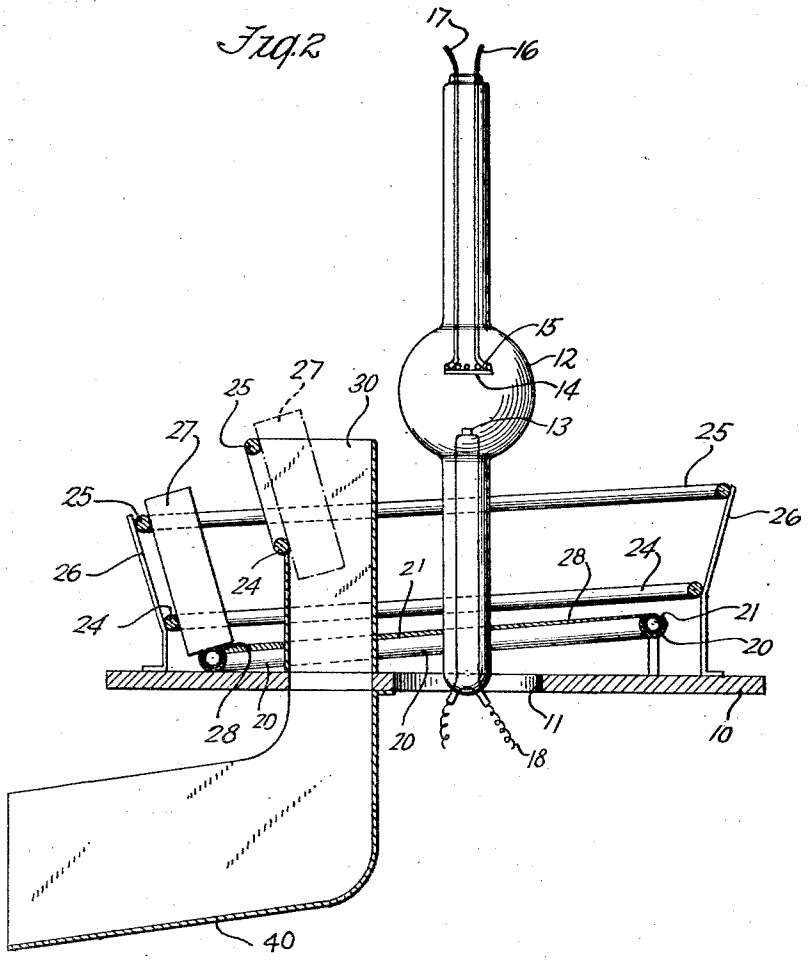
Fig. 2



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR SUBJECTING ARTICLES TO X-RAYS

Application filed August 2, 1928. Serial No. 296,980.

This invention relates to an art and apparatus for subjecting articles to X-rays in order to sterilize such articles by effecting a destruction of the eggs, larvæ and pupæ of insects or bugs or by destroying the insects or bugs themselves, by the action of the X-rays from an appropriate X-ray tube.

One of the objects of this invention is to provide a simple and thoroughly practical method for subjecting articles, such as packaged goods like tobacco, food products, and the like, to X-rays and which will be highly efficient in practice, capable of being inexpensively and rapidly carried on, and well adapted for treatment of articles on a large scale. Another object is to provide an art of the above-mentioned nature whereby a highly efficient use is made of the energy dissipated in the X-ray tube in the production of X-rays. Another object is to provide a simple and thoroughly practical X-ray sterilizing apparatus of inexpensive and durable construction, highly efficient action, and capable of operating at high speed. Another object is to provide an apparatus of the above-mentioned nature in which waste of X-ray energy is minimized and in which the articles to be treated are subjected to the X-rays in a manner which will insure positive results. Another object is to provide an apparatus of the above nature well adapted to meet the varying conditions of hard practical use. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which a preferred embodiment of the mechanical features of my invention are illustratively shown,

Figure 1 is a plan view of the apparatus;

Figure 2 is a front elevation partly in vertical section, and

Figure 3 is an enlarged sectional view taken on the line 3—3 of Figure 1.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings and more particularly to Figures 1 and 2, there is shown at 10 an appropriate base or table, adapted to be supported by any suitable standards (not shown) and provided with a substantially centrally positioned opening 11. An X-ray tube 12, preferably of the hot cathode type, is mounted and insulatingly supported in any suitable manner so that its longitudinal axis extends substantially vertically and centrally through the opening 11 in the base 10; the X-ray tube 12 is provided with a filament cathode 13 adapted to be energized from any suitable source of filament heating energy. The X-ray tube 12 has an anode 14 positioned preferably so that its active face extends substantially transversely to the longitudinal axis of the X-ray tube 12; accordingly, when the X-ray tube 12 is mounted with its axis extending vertically, as is clearly shown in Figure 2, the active face of the anode 14 extends substantially horizontally and the X-ray beam emanating therefrom will be directed in a general downward direction but throughout a scope including substantially 90° to either side of the vertical axis as seen in Figure 1. The anode 14 may be of the water cooled type, the cooling coils being indicated at 15 and the entry and exit tubes or conduits for the cooling liquid being indicated at 16 and 17. Any suitable source of high potential energy may be connected across the anode 14 and cathode 13 as by the conductors 16 and 18, for example.

Supported upon the base or table 10 is a guideway, the base member of which comprises a tubular member 20 cut away or slotted at its upper portion as indicated at 21 (see also Figure 3), this slot 21 extending preferably throughout the entire length of the tubular member 20. The tubular member 20 is curved about the X-ray tube 12, the curve thereof being given, as is clearly seen in Figure 1, the form of a spiral. Accord-

ingly, the tube 20 extends from a point 22 (see Figure 1) remote from the vertical axis of the beam of X-rays emanating from the anode 14 to a point 23 (see Figure 2) in greater proximity to the vertical axis of the X-ray beam than the point 22. Preferably, the tubular member 20, thus curved spirally, is given about one complete spiral turn, but it is to be understood that the substantially spiral curvature given the tubular member 20 and its coacting parts may be inclusive of more than one complete turn or may be even less than one turn in extent. Points in the tubular member 20 intermediate of the above-mentioned points 22 and 23 will thus be seen to be of progressively varying distances from the vertical axis of the X-ray beam.

In addition to the above-described spiral curvature of the tubular member 20, the latter is preferably also curved in the form of a helix, as is more clearly shown in Figure 2, and this helical curvature is preferably such that the point 23 is at a higher elevation than the point 22. Aside, therefore, of the progressively closer approach of the tubular member 20 to the vertical axis of the X-ray beam as the path of travel along the member 20 from the point 22 to the point 23 is traversed, there is thus brought about a progressive decrease in the vertical distance between the tubular member 20 and the anode 14 of the X-ray tube. This latter relation is clearly indicated in Figure 1.

As hereinabove noted, the tubular member 20 forms preferably the bottom member of an appropriate guideway; coacting with the tubular member 20 and adapted to form lateral guides is a plurality of members spaced laterally and vertically from the tubular member 20. Thus, there are provided two guide members 24 and 25 (see Figure 2) preferably made of a suitable insulating material and supported in vertically spaced relation from each other and from the tubular member 20 and in laterally spaced relation from the tubular member 20 by suitable brackets 26, and appropriate in number. The members 24 and 25 are given a spiral curvature (see Figure 1) and preferably also a helical curvature commensurate with the curvatures given the tubular member 20, and preferably the upper guide member 25 is of slightly greater radius than is the lower guide member 24, as is clearly shown in Figure 2. The lateral guide members 24 and 25, together with the tubular member 20, thus form a substantially L-shaped guideway within which may be supported a succession of articles or packages, one of which is indicated at 27 in Figure 2. The relation of the lateral guides 24 and 25 with respect to the tubular member 20 will be seen to be such that the tubular member 20 may sustain the weight of the package or packages 27, the latter leaning against the guide members 24 and 25 to any appropriate degree. This degree of leaning of the packages 27 is preferably such that the major plane of the packages 27 approximates a relation that is substantially normal to the X-rays emanating from the anode 14.

Resting within the tubular member 20 and held therein by reason of the fact that the slot cut into the member 20 is less than 180° in extent is a flexible conveyor member 28. This conveyor member 28 may be in the form of a flexible metal tube or may consist of any appropriate flexible material which may also be non-conducting, if desired. By reason of the cut away or slotted portion of the tubular member 20, the flexible member 28 is exposed throughout the upper portion of the tubular member 20 so that the packages 27 rest directly upon the flexible member 28.

The flexible member 28 is preferably endless and suitably mounted on the underside of the base or table 10 and adjacent the inner end of the tubular member 20 is a pulley 29 over which the flexible member is adapted to pass downwardly through an opening 30 in the table 10. This opening 30, moreover, is of such a size that the packages can drop therethrough. From the pulley 29 there extends a tube 31 in a forward direction in order to receive therethrough and guide the flexible member 28 to a pulley 32 suitably mounted at the forward portion of the apparatus. The flexible member 28 passes upwardly over the pulley 32 (as viewed in Figure 1) and then passes into the other end 20*a* of the tubular member 20; the latter, as will be clearly seen from Figure 1, is extended substantially tangentially in a forward direction from the point 22 hereinbefore mentioned.

Either or both pulleys 29 and 32 may be positively driven from any suitable source of power; preferably both these pulleys are driven as is diagrammatically indicated in Figure 1, and the direction of drive is preferably such that the flexible member 28 is withdrawn from the inner end of the tubular member 20 and enters the outer end 20*a* of the tubular member 20, the direction of drive being indicated by the arrow shown in Figure 1. Preferably there is juxtaposed with respect to the pulley 32 and spring pressed toward the latter, another pulley 33 in order that the endless flexible member 28 may be securely gripped by the pulley 32. Accordingly, as the flexible member 28 leaves the pulley 32, it is in effect positively pushed into the end 20*a* of the tubular member 20, while the action of the driven pulley 29 at the inner end of the tubular member 20 is in effect to pull the flexible member 28 out of the inner end of the tubular member 20. In this manner, a positive drive of the flexible member 28 is insured and friction between the relatively moving parts minimized.

In the operation of the apparatus, the packages 27 are placed upon the tangential portion 20*a* in the tubular member 20 either by hand or by any suitable mechanical means. The packages thus rest upon the flexible moving member 28 and lean against the lateral guides 24 and 25. The flexible conveyor member 28, being in movement at an appropriate rate of speed, effects a movement of the succession of packages along the hereinbefore described path provided by the guideway. The leaning over of the packages insures their being exposed substantially normally to the X-rays emanating from the anode 14 while the path of movement to which the packages are subjected is such that they are progressively carried inwardly toward the vertical axis of the X-ray beam, due to the substantial spiral curvature of the guideway, and simultaneously, due to the helical curvature of the guideway, the vertical distance between the packages and the anode is progressively decreased. As the package or packages reach the point 23, they drop through the opening 30 in the base 10 and may be guided or carried away from the apparatus by any suitable mechanism, such as a chute 40 diagrammatically shown in Figure 2.

As a single package is thus transported through the apparatus, it will be seen to be subjected to the varying intensities of the X-ray beam, it being understood that the intensity of the X-ray beam is not uniform throughout its scope, and that at the same time the package is brought into such close proximity to the anode that such an intense "dose" of X-rays is directed through the article or material in the package that sterilization thereof is positively assured. Moreover, the path of travel to which the package or the succession of packages is subjected is such that a maximum number of packages may be simultaneously subjected to the available beam of X-rays emanating from the anode, whereby the rate at which the packages or articles are treated is greatly increased over the rate which has heretofore been possible to achieve. In spite, however, of the high rate of treatment thus made possible by the method and apparatus provided by my invention, it will be seen that the articles are subjected to the X-rays for a sufficiently great period of time and throughout such intensities of the X-ray beam that positive results are assured.

It will thus be seen that there has been provided in this invention an art and apparatus in which the several objects as well as many thoroughly practical advantages are successfully achieved.

As many possible embodiments may be made of the mechanical features of the above invention, and as the art herein described might be varied in various parts all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In apparatus of the character described, in combination, an X-ray tube mounted with its axis substantially vertical and having an anode whose active face extends substantially transversely to said axis, means forming a substantially spiral and helical guideway about the substantially vertical axis of said tube and adapted to guide a plurality of articles simultaneously into the beam of X-rays emanating from said anode and to distribute said articles throughout varying focal distances from said anode, and means for predetermining the rate of movement of the articles along said guideway.

2. In apparatus of the character described, in combination, an X-ray tube mounted with its axis substantially vertical and having an anode whose active face extends substantially transversely to said axis, means forming a substantially spiral guideway about the substantially vertical axis of said tube and adapted to guide a plurality of articles simultaneously into the beam of X-rays emanating from said anode and to distribute said articles throughout varying focal distances from said anode, and means for predetermining the rate of movement of the articles along said guideway.

3. In apparatus of the character described, in combination, an X-ray tube having the plane of its anode substantially horizontal so as to provide an X-ray beam emanating from said anode of substantially 90° in scope about each side of the substantially vertical axis of said beam, and a traveling conveyor for carrying articles into said X-ray beam and having a path of travel that is substantially spiral about the substantially vertical axis of the X-ray beam.

4. In apparatus of the character described, in combination, an X-ray tube having the plane of its anode substantially horizontal so as to provide an X-ray beam emanating from said anode of substantially 90° in scope about each side of the substantially vertical axis of said beam, and a traveling conveyor for carrying articles into said X-ray beam and having a path of travel that is substantially helical about the substantially vertical axis of the X-ray beam.

5. In apparatus of the character described, in combination, an X-ray tube having the plane of its anode substantially horizontal so as to provide an X-ray beam emanating from said anode of substantially 90° in scope about each side of the substantially vertical axis of said beam, and a traveling conveyor for carrying articles into said X-ray beam and having a path of travel that is substantially spiral and helical about the substantially vertical axis of the X-ray beam.

6. In apparatus of the character described, in combination, an X-ray tube mounted with its axis substantially vertical and having an anode whose active face extends substantially transversely to said axis, and means for moving an article into the beam of X-rays, said means being adapted to give said article a movement having a component in a direction substantially about the vertical axis of the beam and having a component in a direction toward the axis of the beam, thereby to vary substantially progressively the distance of the article from said anode.

7. In apparatus of the character described, in combination, an X-ray tube mounted to have the plane of its anode substantially horizontal so as to provide an X-ray beam directed downwardly and laterally, a guideway associated with said X-ray tube and curved about the vertical axis of the X-ray beam, said guideway including a curved tubular member having a slot extending substantially throughout its length, and movable flexible means in said tubular member, exposed through said slot, and adapted to engage and move an article along said guideway.

8. In apparatus of the character described, in combination, an X-ray tube mounted to have the plane of its anode substantially horizontal so as to provide an X-ray beam directed downwardly and laterally, a guideway for guiding an article into the X-ray beam, said guideway including a tubular member curved spirally about substantially the vertical axis of the X-ray beam, said tubular member having a slot therein substantially throughout its length, and movable flexible means in said tubular member and exposed through said slot for engaging and moving an article along said guideway.

9. In apparatus of the character described, in combination, an X-ray tube mounted to have the plane of its anode substantially horizontal so as to provide an X-ray beam directed downwardly and laterally, a guideway for guiding an article into the X-ray beam, said guideway including a tubular member curved helically about substantially the vertical axis of the X-ray beam, said tubular member having a slot therein substantially throughout its length, and movable flexible means in said tubular member and exposed through said slot for engaging and moving an article along said guideway.

10. In apparatus of the character described, in combination, an X-ray tube mounted to have the plane of its anode substantially horizontal so as to provide an X-ray beam directed downwardly and laterally, a guideway for guiding an article into the X-ray beam, said guideway including a tubular member curved spirally and helically about substantially the vertical axis of the X-ray beam, said tubular member having a slot therein substantially throughout its length, and movable flexible means in said tubular member and exposed through said slot for engaging and moving an article along said guideway.

11. In apparatus of the character described, in combination, an X-ray tube mounted to have the plane of its anode substantially horizontal so as to provide an X-ray beam directed downwardly and laterally, a guideway for guiding an article into the X-ray beam, said guideway including a tubular member substantially curved about the vertical axis of said beam, said tubular member having a slot therein substantially throughout its length, an endless flexible member in said tubular member and exposed through the slot therein for engaging and moving an article along said guideway, and means for effecting movement of said endless flexible member along said tubular member.

12. In apparatus of the character described, in combination, an X-ray tube mounted to have the plane of its anode substantially horizontal so as to provide an X-ray beam directed downwardly and laterally, a guideway for guiding an article into the X-ray beam, said guideway including a tubular member substantially curved about the vertical axis of said beam, said tubular member having a slot therein substantially throughout its length, an endless flexible member in said tubular member and exposed through the slot therein for engaging and moving an article along said guideway, and driving means for said endless flexible member adapted to pull said flexible member lengthwise along said tubular member.

13. In apparatus of the character described, in combination, an X-ray tube mounted to have the plane of its anode substantially horizontal so as to provide an X-ray beam directed downwardly and laterally, a guideway for guiding an article into the X-ray beam, said guideway including a tubular member substantially curved about the vertical axis of said beam, said tubular member having a slot therein substantially throughout its length, an endless flexible member in said tubular member and exposed through the slot therein for engaging and moving an article along said guideway, and driving means for said endless flexible member adapted to pull the latter out of one end of said tubular member and to push said flexible member into the other end of said tubular member.

14. The herein described method of subjecting articles to X-rays which consists in effecting a movement of articles into the beam of X-rays from an X-ray tube and in the same fixed path, said path extending substantially about the axis of the X-ray beam and of progressively varying distance from the anode of the X-ray tube.

15. The herein described method of subjecting articles to X-rays which consists in moving articles in the same fixed path curved

substantially spirally about the axis of the X-ray beam from an X-ray tube, thereby to progressively vary the distance of the articles from the anode of the X-ray tube as the articles are moved along said path.

16. The herein described method of subjecting articles to X-rays which consists in moving the articles throughout the X-ray beam emanating from an X-ray tube in the same fixed path which is substantially spiral and helical about the axis of the X-ray beam.

17. The herein described method of subjecting a plurality of articles to X-rays which consists in passing a succession of articles through the X-ray beam emanating from an X-ray tube but in the same fixed path curved about the axis of the X-ray beam and adapted at successive increments of movement of each article to change the distance of the article from the anode of the X-ray tube.

In testimony whereof, I have signed my name to this specification this 10th day of July, 1928.

FRANKLIN S. SMITH.