

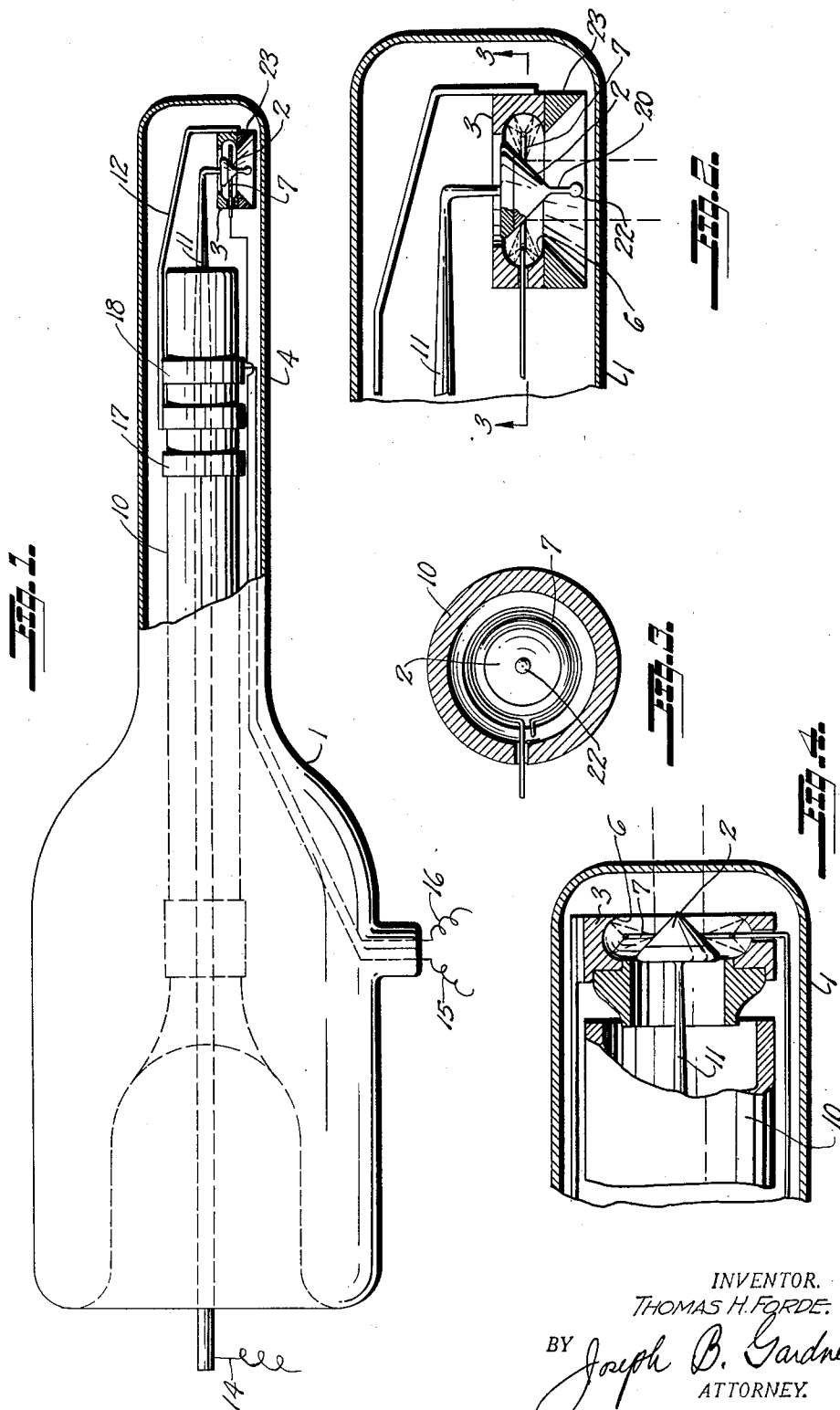
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X-RAY TUBE

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X-RAY TUBE

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4 Claims. (Cl. 250—35)

My invention relates to improvements in X-ray tubes, particularly the thermionic emission type.

5 An object of the invention is to provide an X-ray tube in which the projection of the cathode rays against the target or anode is such that practically all of the X-rays will be emitted from the tube in intimate parallel relation.

10 Another object of the invention is to provide an X-ray tube which will emit a highly concentrated beam of substantially parallel X-rays of practically uniform wave length with any potential of a large voltage range including voltages far below that necessary for the effective and
15 practical operation of tubes heretofore in use.

A further object is to provide an X-ray tube in which the cathode and anode are in such close proximity to each other and the volume of electrons passing from the one to the other is so
20 great and so controlled as to direction both with respect to each other and to the discharge end of the tube, that a large and effective amount of X-rays will be produced with comparatively low voltages.

25 Still another object is to provide an X-ray tube in which the cathode and anode are of an entirely new construction and relative arrangement so as to make possible the production under a wide range of voltages a comparatively great
30 volume of X-rays in a highly concentrated penetrative beam subject to directional control as to emission.

Further it is an object of my invention to provide an X-ray tube of the character described
35 in which the X-ray generating portion thereof is insertible into cavities or orifices of the human body.

Another object of my invention is to provide an X-ray tube which will produce X-rays on both
40 the negative and positive impulses of an alternately operating current.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention
45 which is illustrated in the drawing accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawing and description may be adopted within the scope of the invention as set forth in the claims.

Referring to the drawing,

Figure 1 represents a side view of the X-ray tube of my invention, partly in section.

55 Figure 2 represents an enlarged fragmentary longitudinal view through the X-ray generating elements of the tube.

Figure 3 represents a cross sectional view taken on the plane of line 3—3 of Figure 2.

60 Figure 4 is fragmentary longitudinal sectional

view of a somewhat modified form of the tube.

Briefly expressed, the tube of my invention comprises in a broad form, an arrangement wherein rays are emitted from around a cathode and concentrated on an annular focal spot
65 around the anode from whence is directed a concentrated stream of parallel X-rays.

One embodiment of my invention, as shown in detail in the accompanying drawing, comprises a glass bulb or tube 1 evacuated in the usual manner and preferably constructed so that the portion thereof containing the X-ray generating elements is comparatively small and may be inserted into cavities or orifices of the human body.
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My invention deals primarily with the construction and arrangement of the anode and cathode of the X-ray generating means, and in the present instance these elements, which are designated 2 and 7, are located in the smaller terminal 4 of the tube in position to cause a lateral
75 X-ray emission, although obviously these parts may be otherwise disposed and arranged if desired.

The anode or target 2, unlike such elements heretofore used, is constructed to provide an X-ray emitting surface which is of annular or other
85 perimetric form. This surface is also inclined in such manner or otherwise related to the cathode rays received thereby that the X-rays emitted therefrom will be substantially parallel and define a highly concentrated beam of annular cross section and comparatively small diameter. It will be apparent that a conical surface will meet the
90 aforementioned requirements, and the target is therefore preferably of this form and is disposed with its apex pointed in the direction of X-ray projection.
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The member 3 is arranged to produce a circumferential bombardment of cathode rays against the anode or target and as here shown is annular and positioned to surround the anode or target. The portion of the member opposed to the target, that is the inner annular surface of the member, is provided with a circular concavity 6 of substantially semi-circular form in cross section whereby the cathode rays will be so focused relative to the target that the resultant X-ray emission from the target will be longitudinally thereof to thereby provide a highly concentrated beam of substantially parallel X-rays. It will be seen that with this arrangement the focal point of the cathode rays on the target defines a narrow circumferential band thereon and this high concentration of cathode rays results in a correspondingly concentrated X-ray beam controlled as aforesaid, as to direction of emission to the extent that the X-rays are substantially parallel.
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As here shown, the tube of my invention utilizes a thermionic emission member as the cathode and to procure a source of electrons which serve in
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vehicular capacity in the cathode ray bombardment of the target. Accordingly I place a thermionic emission element, for example the annular filament 7 in such relation to the member 3 that the resultant "valve" action of these elements produces the desired rectification and cathode ray vehicle aforementioned. In the present instance the filament is located somewhat within the annular concavity of the member 3 but spaced therefrom.

Any suitable means of supporting the member 3, the anode and the cathode in the relative arrangement and position aforementioned may be employed. The means here shown comprises one way but as it forms no vital part of this invention a detailed description thereof is thought unnecessary save to point out that such means primarily comprises a porcelain rod 10 disposed in the tube and supporting the electrode 11 to which the target is affixed, also the bracket 12 which maintains the cathode in position.

The electrical connection of the X-ray generating elements may be effected in any manner suitable thereto and as here shown where an alternating current is used one conductor 14 is connected to the electrode 11, whereas the conductors 15 and 16 are connected with the filament 7 and the ring 18 on the rod 10, which in turn is connected to one end of the filament 7 and the bracket 12 serves as a conductor from the ring 18 to the member 3.

It will now be clear that the X-ray tube of my invention, constructed and arranged as shown in the accompanying drawing and as described herewith, will by reason of the annular member surrounding the conical target and the thermionic vehicular provision of the filament, produce a comparatively large volume of cathode rays which will bombard the target on a focal point extending completely around the latter. This highly concentrated bombardment of the comparatively great volume of cathode rays on the target circumferentially thereon, will obviously produce a large volume of X-rays which being projected in substantially parallel and intimate relation to one another provide a thin and highly concentrated beam. Owing to the high degree of concentration and directional control of the X-rays, a high degree of efficiency will be permitted by the use of the tube as the operator may concentrate practically all the rays on the object treated or operated upon. Furthermore by reason of such concentration and control of the X-rays I am able to produce X-rays of highly desirable characteristics on comparatively low voltages, and by merely varying the voltage a relatively small amount may produce soft, semihard and extremely hard rays. Therefore it will be apparent that the tube of my invention may have wide application, in intra body and extra body X-ray therapy, fluoroscopy and radiography.

I may construct the tube to utilize both negative and positive impulses of the alternating current, for generating X-rays. As here shown this is provided for by a pin-like axial extension 20 from the apex of the conical target, said extension having a small, substantially spherical head 22 preferably made of tungsten and of considerably less diameter than that portion of the target at which the cathode rays are focused. The head 22 becomes a cathode and the rays therefrom are arranged to be projected against an

annular extension 23 of the member 3 which is preferably tungsten and surrounds the head 22 and serves as the target. The inner face of the cathode extension 23 is beveled or otherwise formed in such manner that the X-ray emission therefrom will be substantially parallel with the X-rays from the target 2. A suitable gas vehicle is provided for the cathode rays which will be directed from the head 22 to the target 23. One way of providing the gas vehicle is to treat the porcelain post chemically in such manner that after evacuation of the tube, a suitable vehicular gas will generate in the tube, although any method known in the art of producing a vehicular gas in an "evacuated" tube may be employed.

It will now be clear that the tube equipped with this double X-ray generating means, as here shown, enables me to utilize the full wave or potential of the current in the production of X-rays inasmuch as each cycle is effective on one set of X-ray generators and therefore a more efficient tube is provided. It will also be clear that since both impulses of the alternating current are used for generation of the X-rays, the description of the heat of the unused current in the tube as entailed in tubes using but one impulse, is entirely eliminated and the tube of my invention will remain in a relatively cool condition even when in operation for long periods.

In the embodiment of the invention illustrated in Figure 4, the parts are so arranged as to cause the X-rays to be emitted longitudinally of the tube from the end thereof, instead of transversely of the tube as in the other embodiment. Also the tube is shown to operate merely on the single impulse, the cathode 22 and the anode 23 being omitted.

I claim:

1. In an X-ray tube, an envelope, a conical shaped anode, an annular member disposed about said anode and provided intermediate its ends with a recess portion opposed to and receding from said anode, and a cathode disposed about said anode and adjacent said recess portion.

2. An X-ray tube comprising, an envelope, an anode, an electron emissive element surrounding said anode, and a member surrounding said element and having a recess therein opposed to and receding from said anode, said recess being formed and disposed to direct the flow of electrons from said element to a relatively narrow band around said anode.

3. In an X-ray tube, comprising an envelope, an anode, an annular member about said anode, and having a recess therein opposed to and receding from said anode, said recess being so formed as to focus cathode rays on said anode, and an electron emissive cathode surrounding said anode and disposed within said recess.

4. An X-ray tube comprising, an envelope, an anode having a conical portion convergently extending toward said envelope, a member surrounding said anode and provided intermediate its ends with a circumferentially extending concavity opposed to and receding from said conical portion, and an electron emissive cathode surrounding said portion and disposed adjacent said concavity, said concavity being arranged to concentrate cathode rays from said cathode on a narrow band surrounding said conical anode portion.

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