

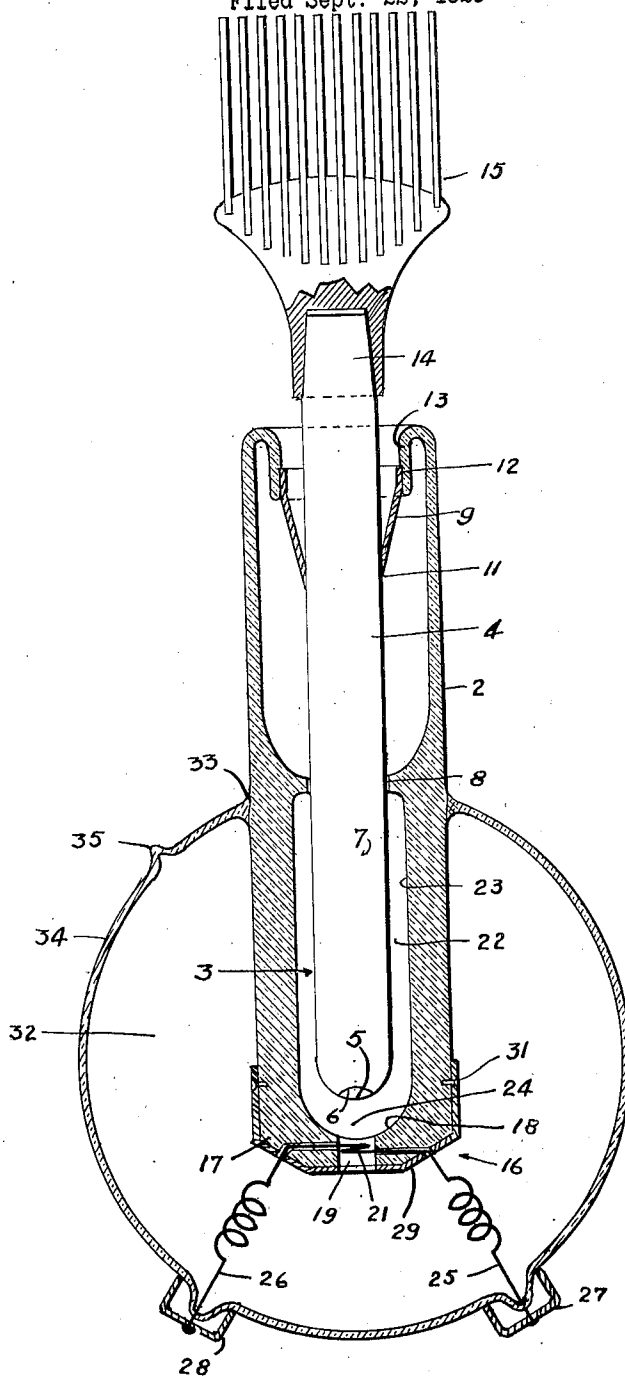
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M. MORRISON

X-RAY TUBE

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INVENTOR  
Montford Morrison

BY

*J. J. Herbert*  
ATTORNEY

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# UNITED STATES PATENT OFFICE.

MONTFORD MORRISON, OF CHICAGO, ILLINOIS.

## X-RAY TUBE.

Application filed September 22, 1925. Serial No. 57,835.

This invention relates to X-ray tubes and more particularly to such tubes adapted for radiographic purposes.

The present invention is an improvement upon the X-ray tubes described and claimed in my copending applications Serial No. 476,155 filed June 9, 1921 and Serial No. 684,336 filed January 4, 1924.

It is an object of my invention to provide an X-ray tube adapted for all kinds of radiography.

A further object is the provision of an X-ray tube which is simple in design and may be easily manufactured.

A further object of my invention is to provide an X-ray tube of such design that the liberation of gas during the operation of the tube will not increase the gas pressure within the same to such an extent as to materially affect the operation thereof.

A still further object of my invention is to provide an X-ray tube adapted to operate at substantial gas pressures but which is provided with a volumetric chamber whereby the operation of the tube is not impaired as a result of gas liberation.

A still further object of the invention is to provide an X-ray tube having a unitary support for the cathode and anode and which is also provided with a volumetric chamber surrounding these elements.

Further objects of the invention will become apparent as the description is read.

The invention will be better understood by reference to the accompanying drawing, in which a longitudinal sectional view of an X-ray tube embodying my invention is illustrated.

Referring to the drawing, the X-ray tube comprising my invention may consist of an insulating bushing or sleeve 2 made of any suitable material such as silica glass and the like. Disposed within the bushing is an anode 3 comprising a rod 4 of copper or other good heat conducting material having the target end 5 rounded. Centrally disposed within the rounded end is a target 6 of tungsten, thorium or other suitable ray-radiating material of high atomic weight. The intermediate portion 7 of the anode is engaged by an interiorly extending annular flange 8 secured to the bushing 2, the fit being such as to permit the rod to expand without placing any strain upon the glass bushing.

The rod 4 is firmly secured in position

within the bushing 2 by the platinum or chrome-iron collar 9 which may be welded or otherwise hermetically sealed at 11 to the rod and also sealed at 12 to a reentrant tube 13. The outer end 14 of the anode rod or shank may have a suitable radiator 15 secured thereto in any desirable manner.

The inner end 16 of the insulating bushing is substantially closed by a wall 17 having an inner concave surface 18 conforming substantially to the curvature of the rounded end 5 of the anode. An opening 19 in the wall 17 is arranged in axial alignment with the longitudinal axis of the anode, and within this opening is mounted a filamentary cathode 21 in the form of an open spiral. The center of the opening in the cathode lies in an extension of the longitudinal axis of the anode, so that electrons emitted by the cathode will strike the target 6 at substantially right angles to the surface thereof so that the X-rays generated thereby will pass along the longitudinal axis of the anode shank outwardly from the target and through the opening in the filamentary cathode 21.

It will be noted that the spacing 22 between the anode 3 and the inner wall 23 of the bushing 2 is very close and also that the space 24 between the end 5 of the anode and the filamentary cathode 21 is also very close. The purpose of such close spacing is to reduce to a minimum the amount of gas ionization which may arise through electronic impact of the gas molecules disposed within this space. Preferably this spacing should be such that it corresponds to the mean free path of the molecules of gas. In addition the surface of the wall 23 of the bushing should be of such order of magnitude that no leakage of current occurs between the cathode and the anode.

Suitable leading-in conductors 25 and 26 connected to the filamentary cathode 21 may be employed to conduct current thereto. These conductors may be secured to contact caps 27 and 28 for connection to a suitable source of power.

The end wall 17 of the bushing may be covered by a metal cap 29 for the purpose of screening out undesirable X-radiation, such cap being secured to the bushing by screws 31 or the like.

An important feature of the present invention is the provision of a volumetric chamber 32 surrounding the anode and cathode. This chamber may be formed by

sealing at 33 a spherical bulb of glass 34 to the insulating bushing 2. The size of the chamber 32 should be such that the liberation of gas during the operation of the tube will not change the total pressure sufficiently to materially affect the operation of the tube, it being appreciated that the present device is adapted to operate at substantial gas pressures of the order of 1 micron without detrimental gas ionization occurring.

However, if desired, the opening 19 may be provided with a window (not shown) transparent to X-rays and which is gas tight. Such a window may be made of glass sealed to the insulating bushing 2. The chamber 32 may be evacuated by suitable connection at 35 and a residual gas pressure of about 1 micron left remaining or if desired a pure inert gas such as hydrogen, helium, neon, may be introduced within the chamber before tipping-off.

The focussing of the electrons is accomplished by the insulating bushing 2, the curved surface 18 of which becoming negatively charged during the operation of the tube and thus causing the electron stream to concentrate upon the target 16. The wall 17 of the insulating bushing also functions to repress inverse electron flow from the anode 4 and to serve as a screen for undesirable X-radiation.

The operation of the device is obvious from the preceding description.

Modifications of my invention will suggest themselves to those skilled in the art, but such modifications are contemplated as coming within the spirit and scope of the appended claims.

What is claimed is:

1. An X-ray tube comprising a bulbous vessel, an insulating bushing sealed therethrough, an anode disposed within said bushing and spaced closely from the inner wall thereof and a cathode supported by said bushing and spaced closely from said anode.

2. An X-ray tube comprising an insulating sleeve, an anode having a target in one end disposed in said sleeve, means for hermetically sealing said anode within said sleeve, a cathode supported by said sleeve and disposed adjacent said anode, said sleeve being substantially closed at the end in which said cathode is supported but having an opening through which X-rays may be emitted.

3. An X-ray tube comprising an insulating sleeve having a wall with an opening therethrough at one end thereof, a cathode within said opening, an anode within said sleeve and having the target end thereof disposed adjacent the opening, means for sealing said anode to said sleeve, and means closing said opening from the atmosphere.

4. An X-ray tube comprising an insulat-

ing sleeve having its one end open and the other end substantially closed but having a passageway therethrough, a cathode adjacent the opening, an anode within said sleeve and having a target adjacent said cathode, means for sealing said anode to said sleeve, and a volumetric chamber enclosing the end of said sleeve in which the passageway is positioned.

5. An X-ray tube comprising an insulating sleeve, an anode and a cathode supported thereby, and a volumetric chamber enclosing one end of said sleeve.

6. An X-ray tube comprising an insulating sleeve, an anode and a cathode supported thereby, said anode having its target end positioned closely adjacent said cathode, the anode and cathode being in alignment with the longitudinal axis of said sleeve, said sleeve having an opening therein for the passage of X-rays, the opening also being in alignment with the longitudinal axis of said sleeve and means for hermetically sealing said sleeve from the atmosphere.

7. An X-ray tube comprising an insulating sleeve, a rod of good heat conducting material sealed to said sleeve at one end, the other end of said sleeve having a closure wall with an opening therethrough, a target disposed in the end of said rod and adjacent the opening, said rod being closely spaced from said sleeve, a cathode disposed in the opening, said rod, sleeve, target, opening and cathode being in longitudinal alignment, and means closing said opening from the atmosphere.

8. An X-ray tube comprising a spherical envelope, an insulating bushing sealed therein with one end projecting within said envelope and the other end extending without said envelope, an anode disposed within said bushing and sealed thereto, said anode extending to a point adjacent the inner end of said bushing, the inner end of said sleeve having an opening, a thermionic cathode within the opening, and an inert gas at a substantial pressure within said envelope, the size of said envelope being such that any liberation of gas during operation of the tube will not change the total pressure within the tube to such an extent as to materially affect the operation thereof.

9. An X-ray tube comprising an elongated rod of good heat conducting material, a sleeve of insulating material surrounding one end of said rod and sealed at one end thereto, the spacing of said rod from the walls of said sleeve being relatively close, said sleeve having a wall with an opening therein, a cathode mounted in the opening and spaced closely to the end of said rod, means for sealing said opening from the atmosphere, the space within said sleeve being filled with an inert gas at a substantial pressure, and a target mounted in the end

of said rod, whereby said tube may be operated at normal voltages and current without detrimental gas ionization.

10. An X-ray tube comprising a hollow  
5 elongated vessel of good insulating material, an anode sealed at one end of said vessel and concentrically disposed with respect thereto, the other end of said anode having  
a target of good ray radiating material  
10 mounted therein, a wall of insulating material closing one end of said vessel, said wall having an aperture therein, a cathode dis-

posed in the aperture, said anode, cathode and vessel being spaced in such relation as to permit the operation of said device at  
normal voltage and current in the presence  
of a substantial gas pressure but without  
detrimental gas ionization, and a filling of  
inert gas at about 1 micron pressure within  
said vessel.

In testimony whereof, I have hereunto  
subscribed my name this 18th day September, 1925.

MONTFORD MORRISON.