

May 12, 1959

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2,886,723

X-RAY TUBES

Filed Sept. 4, 1956

2 Sheets-Sheet 1

FIG. 1

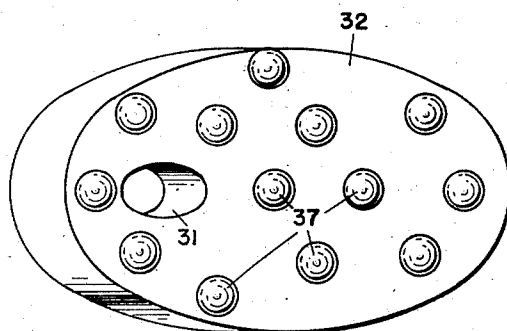
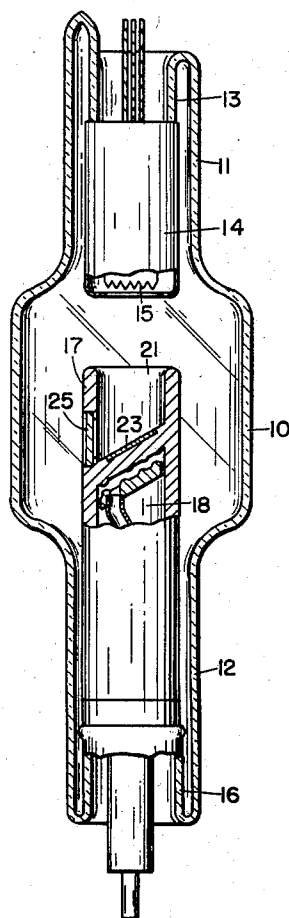


FIG. 3

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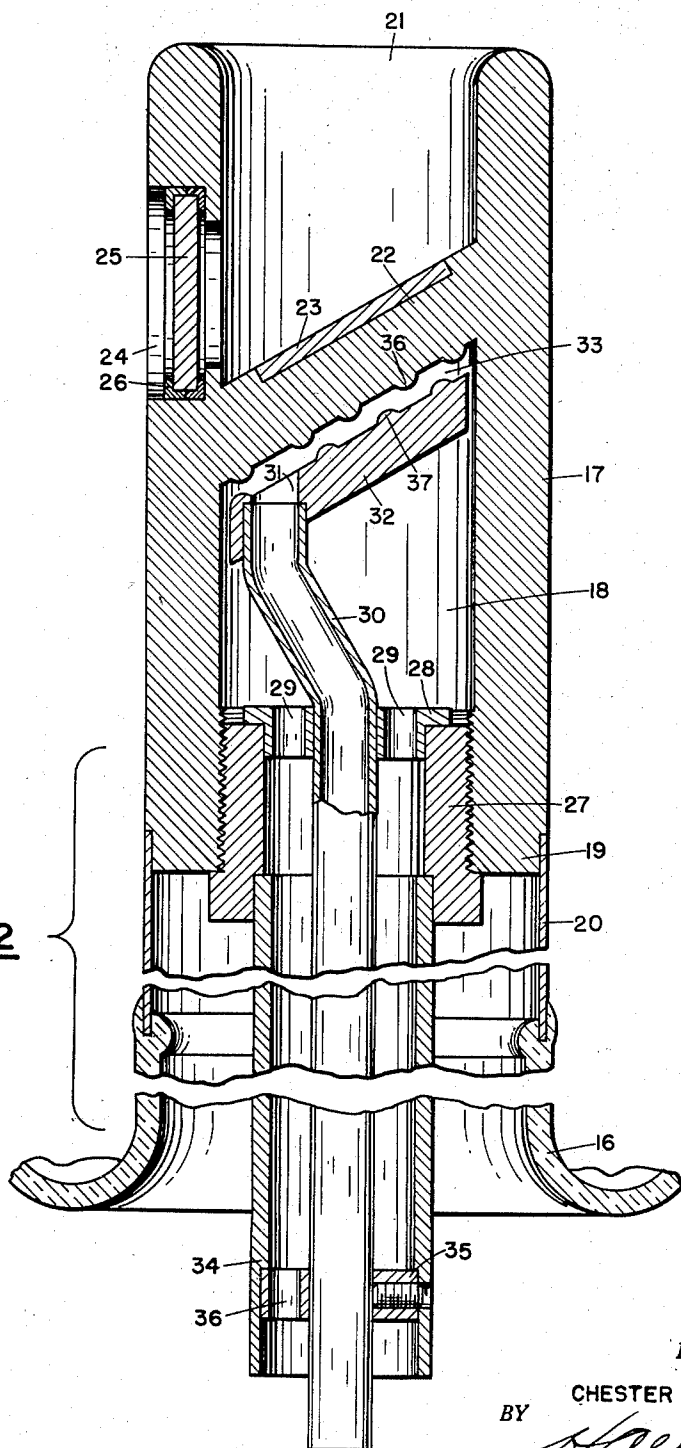
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FIG. 2



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X-RAY TUBES

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Application September 4, 1956, Serial No. 607,741

3 Claims. (Cl. 313—32)

This invention relates to improvements in X-ray tubes and has particular reference to novel means for aiding in the dissipation of heat from anodes of X-ray tubes.

More specifically this invention relates to the provision of a plurality of nodules on the walls of a chamber formed in the anode of an X-ray tube behind the target, for the purpose of creating turbulence in the flow of a coolant through the chamber such as will result in substantially uniform heat distribution throughout the coolant.

In the manufacture of X-ray tubes of the presently described type, an elongated anode is provided within a dielectric envelope and carries at one end a target which is adapted to be bombarded by electrons from a suitable cathode for the production of X-radiation. Such bombardment causes the anode, particularly at the target end, to attain a temperature high enough to require means for dissipating the heat to prevent destruction of or even damage to the anode.

Cooling has been provided, as taught by the prior art, through the introduction of a fluid coolant into a chamber formed interiorly of the anode and behind the target. Various means have been provided for controlling the distribution of the coolant over the surfaces of the chamber and for creating the desired turbulence in the flow of the coolant. Some of the prior art devices embodied fins attached to the wall of the chamber on the surface thereof immediately behind the target and extending therefrom toward the fluid inlet. Other prior art devices embodied an axially located inlet which expelled coolant onto a central cone which caused the coolant to flow in all directions over the surface of the chamber.

To prevent the formation of deposits on surfaces of the chamber, some prior art devices embody coatings of various materials disposed on the surfaces and to which the coolant would not adhere. Other devices utilized movable members such as small vanes or brushes which functioned to sweep the surfaces and to thereby remove undesired deposits.

Such known means and methods of controlling the flow of fluid through a chamber have not, however, been entirely satisfactory since many did not create the desired turbulence, while others which created sufficient turbulence were generally relatively complicated and consequently expensive.

Accordingly, it is an object of this invention to provide an anode of an X-ray tube with improved means for creating the desired turbulence in the flow of a fluid coolant therethrough.

Another object is to provide anodes of X-ray tubes with efficient cooling means which are relatively simple and inexpensive to manufacture.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings wherein

Fig. 1 is an axial sectional view of an X-ray tube embodying the invention;

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Fig. 2 is an enlarged axial sectional view of the anode portion of the tube shown in Fig. 1; and

Fig. 3 is a plan view of the baffle in the chamber behind the target.

Referring more particularly to Fig. 1, there is shown a conventional X-ray tube which embodies a cylindrical dielectric envelope 10 having end portions 11 and 12 of reduced diameter. End portion 11 has a reentrant part 13 which carries a conventional cathode structure 14 embodying an electron emitting filament 15.

The opposed end portion 12 is formed with a reentrant part 16 which carries the anode 17. Anode 17 is a block of copper or the like which is formed with a chamber 18 in the end thereof nearest the reentrant part 16 (see Fig. 2), the annular end 19, thus formed, being vacuum sealed to one end of a metal ring 20 of Kovar or like material which in turn is sealed to the inner end of reentrant part 16 by any suitable glass-to-metal seal.

The opposite end of the anode 17 is recessed as indicated at 21 and the base of the recess is an inclined wall 22 in which is embedded a target 23, preferably formed of tungsten or other hard metal having a relatively high melting point. The exposed surface of the target 23 is flush with the surface of wall 22 and is inclined so that when it is bombarded by electrons which enter recess 21 from filament 15, in the normal operation of the tube, X-radiation emanating therefrom will be directed outwardly of the recess 21 through an opening 24 in the adjacent wall of the anode and through a beryllium window 25 mounted by bezel 26 in the opening 24.

During operation of the X-ray tube, the electron bombardment of the target creates considerable heat which must be dissipated to prevent destruction of or damage to the target or tungsten-to-copper bond. Copper is preferred as the material from which the anode 17 is formed because it possesses the ability to conduct away such heat at a greater rate than most other metals suitable for this use. To still further aid in the dissipation of heat, the chamber 18 is provided for the purpose of receiving a flow of selected fluid coolant, such as oil or water, which coolant picks up heat from the anode and carries it away.

Within the supported end 19 of the anode 17 is threadedly mounted a supporting ring 27 which carries a supporting disc 28 having a series of apertures 29 therein arranged preferably, but not necessarily, in a circular configuration and a central aperture in which is supported an inlet pipe 30. The major portion of pipe 30 extends substantially along the axis of the anode. The inner end portion of pipe 30, however, is directed toward one side of the chamber 18 as shown in Fig. 2, and the end thereof is secured in an opening 31 in a baffle 32.

Baffle 32 is supported by pipe 30 parallel with and spaced a predetermined distance from the inner surface of the inclined wall 22 of the anode and is of a diameter such that a clearance is provided between its periphery and the adjacent side walls of chamber 18.

The other end of pipe 30 may be connected by any suitable means to a source of fluid coolant, the coolant being preferably injected under pressure through pipe 30 into the space 33 between wall 22 and baffle 32. The coolant will then flow over the heated surfaces of the anode, passing outwardly of space 33 around the edges of baffle 32 into the main chamber 18, from which it passes through apertures 29 into the interior of supporting ring 27 exteriorly of pipe 30. From ring 27 the coolant passes out of the tube through an outlet pipe 34 which is supported at its inner end by the supporting ring 27. Suitable means such as plug 35 may be provided in pipe 34 for directing the exiting coolant into a suitable vent 36 from which it can be collected by any suitable means.

During passage of the coolant through the anode in conventional anode structures, the natural tendency of the coolant to adhere to the surfaces of the anode has proved to be detrimental since undesired deposits are sometimes formed on the surfaces, which deposits retard the heat dissipating action. Also, the portions of coolant which flow uninterruptedly nearest the heated surfaces of the anode become heated to a greater extent than other portions. This unequal distribution of heat within the coolant also results in inefficient cooling. To overcome both of these objections, the adjacent surfaces of the wall 22 and baffle 32 are provided with a plurality of discrete nodules for creating turbulence in the flow of coolant. Wall 22 is provided with nodules 36 and baffle 32 with similar nodules 37 which are unsymmetrically arranged but are preferably of substantially uniform size, the nodules being either secured to or cast integrally into their supports. The nodules 36 and 37 are not arranged opposite each other, but the entire arrangement is such as to interrupt the continuous flow of coolant through space 33 sufficiently to agitate the coolant to an extent where no sluggish or relatively immovable pools of coolant will be formed and where the entire body of coolant will engage heated surfaces and will substantially uniformly acquire heat from the anode. The distance between any two nodules on a single surface is always as great or greater than the diameter of the nodules, since lesser distances tend to allow pools to form.

In such a construction, heat dissipation from anodes is greatly improved, resulting in longer life of X-ray tubes embodying the construction, by the provision of improved, simple and inexpensive means for creating turbulence in the flow of a coolant through the anodes in accordance with the objects of this invention.

It is apparent, however, that one skilled in the art may conceive of changes and modifications in the construc-

tion shown and described which will come within the scope of this invention. The matter shown and described herein is, therefore, to be considered as illustrative.

I claim:

- 5 1. In an X-ray tube, an anode structure comprising an anode block having a chamber therein, a target on one side of the anode block, a wall separating the target from the chamber, a disclike baffle within the chamber having a side surface substantially parallel with and
- 10 spaced from said wall, and means for directing coolant into the space between the baffle and wall, the adjacent surfaces of the wall and baffle being provided with a plurality of nodules thereon for creating turbulence in the coolant as it passes between said surfaces, said nodules
- 15 on each of the respective surfaces projecting toward the opposing surface and terminating in spaced relation thereto whereby coolant may flow over the entire surface of each nodule.
- 20 2. In an X-ray tube, an anode structure substantially as set forth in claim 1 wherein the nodules on the surfaces are all spaced apart from one another a distance which is at least as great as the diameter of the nodules.
- 25 3. In an X-ray tube, an anode structure substantially as set forth in claim 1 wherein the nodules are unsymmetrically arranged, are of substantially uniform size, and are located on the respective surfaces opposite inter-

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