April 23, 1957 Z. J. ATLEE 2,790,102

X-RAY TUBE ANODE

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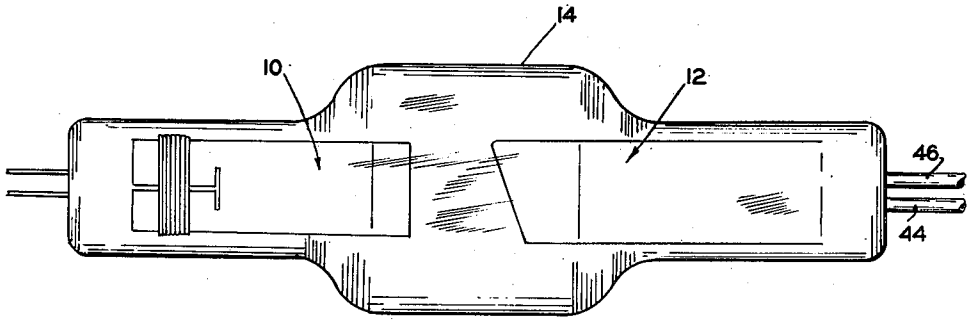

FIG. 1

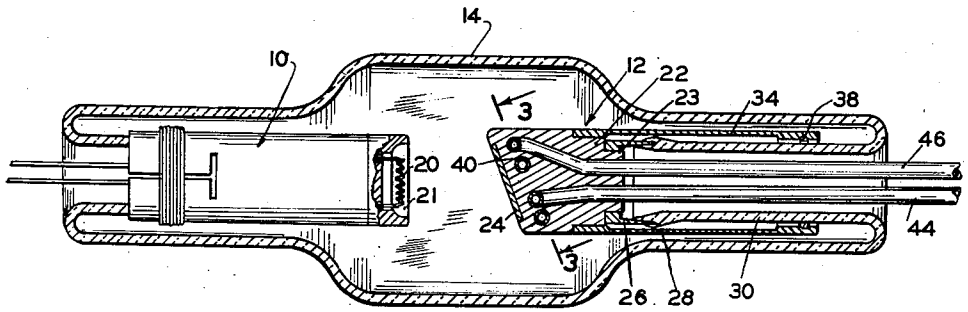

FIG. 2

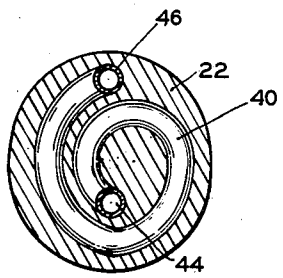

FIG. 3

INVENTOR.
ZED J. ATLEE
BY
Buckhorn and Cheatham
ATTORNEYS

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X-RAY TUBE ANODE

Zed J. Atlee, Chicago, Ill., assignor to Dunlee Corp., Chicago, Ill., a corporation of Illinois

Application October 4, 1955, Serial No. 538,324

1 Claim. (Cl. 313—32)

The present invention relates to X-ray tubes and more particularly to a new, improved X-ray tube anode.

During more or less continuous operation of an X-ray tube, the electrons impinging upon the anode generate considerable heat which must be dissipated to prevent overheating and destruction of the anode. In an effort to overcome the problem of overheating of the anode, various anode structures have been proposed and employed, including the use of a hollow copper anode body having a cooling coil mounted therein, through which a coolant can be circulated to extract heat from the anode body. Such prior structures have exhibited several disadvantages. The cooling coil has generally been fixed to the anode body by means of a solder which presents a layer of relatively low heat conductivity so that the heat transfer from the body to the coolant has been inefficient. Many of such proposed structures have had thin wall sections in the copper anode body through which air could leak into the evacuated tube, destroying the necessary vacuum therein. A general disadvantage of such prior structures has been the high cost of manufacturing the same.

It is an object of the present invention to provide a new and improved X-ray tube anode having a coolant coil incorporated therein which overcomes the disadvantages mentioned above.

It is a specific object of the invention to provide an X-ray tube anode having a coolant coil incorporated therein in such fashion that heat may be transferred efficiently from the anode to the coolant fluid.

Another specific object is to provide an anode of the type described in which the wall sections are sufficiently thick in all portions as to prevent leakage of air or other fluid therethrough.

Still another object is to provide an anode incorporating a coolant coil that may be manufactured at low cost.

Other objects and advantages of the invention will become more apparent hereinafter.

In accordance with the present invention, a coolant coil of gaseous impermeable metal is incorporated in an otherwise solid anode body of copper, as by casting the body about the coil so as to provide an inexpensively manufactured structure in which the coil and body are in intimate, efficient heat conducting contact.

For a more detailed description of the invention, reference is made to the accompanying drawings wherein:

Fig. 1 is a side elevational view of an X-ray tube embodying the invention;

Fig. 2 is a view of a longitudinal, medial section through the tube; and

Fig. 3 is an enlarged, sectional view through the anode taken substantially along line 3—3 of Fig. 2.

With reference to the views of the drawings, the X-ray tube of the invention is illustrated as comprising a cathode **10** and an anode **12** mounted and sealed within an evacuated envelope **14**. The envelope is illustrated as being formed of glass but the invention is not limited to

any particular form, construction or configuration of the envelope, and it will be apparent that it may be formed of other material.

The cathode **10** may be constructed in any suitable manner and is illustrated as including an electron generating filament **20** mounted in a cup **21** formed in the end of the cathode facing the anode whereby the electrons generated by the filament are focussed upon the adjacent end of the anode.

The invention is not necessarily limited to any particular anode shape, style, or configuration and the anode **12** may comprise a generally cylindrical body **22** of suitable cast metal into which is set an X-ray generating target **24** of tungsten or other suitable material on the end thereof facing the cathode **10**. The anode body **22** is formed with a shoulder **23** to which is secured, as by welding or brazing, one end of a mounting ring **26**, the other end of the ring being sealed by a glass-to-metal seal, indicated at **28**, to a re-entrant portion **30** of the envelope **14**. A tubular skirt **34** may also be mounted at one end upon the anode body, with the skirt extending between the outer wall of the envelope **10** and the re-entrant portion **30**, and supporting a getter ring **38** in a manner described and claimed in my prior Patent 2,502,070.

Because of the large amount of heat generated at the target **24**, the anode body **22** is preferably formed of a metal or alloy of high heat conductivity, such as copper, so as rapidly to conduct the heat away from the target.

In accordance with the present invention, a portion of a tubular element is embedded in the body **22** so as to be in direct, intimate contact therewith whereby heat may transfer readily from the body to a coolant fluid circulated through the element. In the illustrated embodiment of the invention, the tubular element includes a flat, coiled portion **40** positioned in the body immediately adjacent the anode target **24**. An inlet duct portion **44** leads to the coil and an outlet duct portion **46** leads from the coil portion, both the inlet and outlet ducts extending outwardly of the re-entrant portion of the envelope **14** for connection to a suitable coolant fluid circulating system. As indicated previously, the cooling coil may be incorporated in the body **22** by casting the body about the coil, though any other suitable process may be used.

Preferably, the tubular element or cooling coil is formed of a vacuum tight metal, such as molybdenum, so as to insure that the evacuated condition of the envelope **10** is not destroyed by leakage through the cooling coil and cast body **22** of the anode. Molybdenum has the further advantage that it is of higher melting point and insoluble in copper, therefore facilitating the casting of the anode.

It will be observed that the cooling coil and anode body **22** are in intimate contact, facilitating transfer of heat from the copper anode body to the coil. Also, it will be noted that the anode body **22** is of relatively small diameter, whereby the length of the glass-to-metal seal **28** and the seal or joint between the anode body **22** and mounting ring **26** are relatively short, facilitating the initial manufacture of the tube and also minimizing the possibility of subsequent failure at some point along one of the seals.

Having illustrated and described a preferred embodiment of the invention, it should be apparent to those skilled in the art that the invention permits of modification in arrangement and detail. I claim as my invention all such modifications as come within the true spirit and scope of the appended claim.

I claim:

An X-ray tube comprising an evacuated envelope, an

anode comprising a cylindrical body of cast, cuprous material extending within and without said envelope, means mounting said body in sealing relation to said envelope, an X-ray generating target mounted in the end of said body within said envelope, and means for conducting a coolant fluid through said body comprising a tube of molybdenum cast in said body and including a coiled portion positioned closely adjacent said body inner end and

an inlet duct portion and an outlet duct portion extending from said coil outwardly of the outer end of said body.

References Cited in the file of this patent

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