Sept. 7, 1937. M. J. GROSS 2,091,978

TUBE CASING

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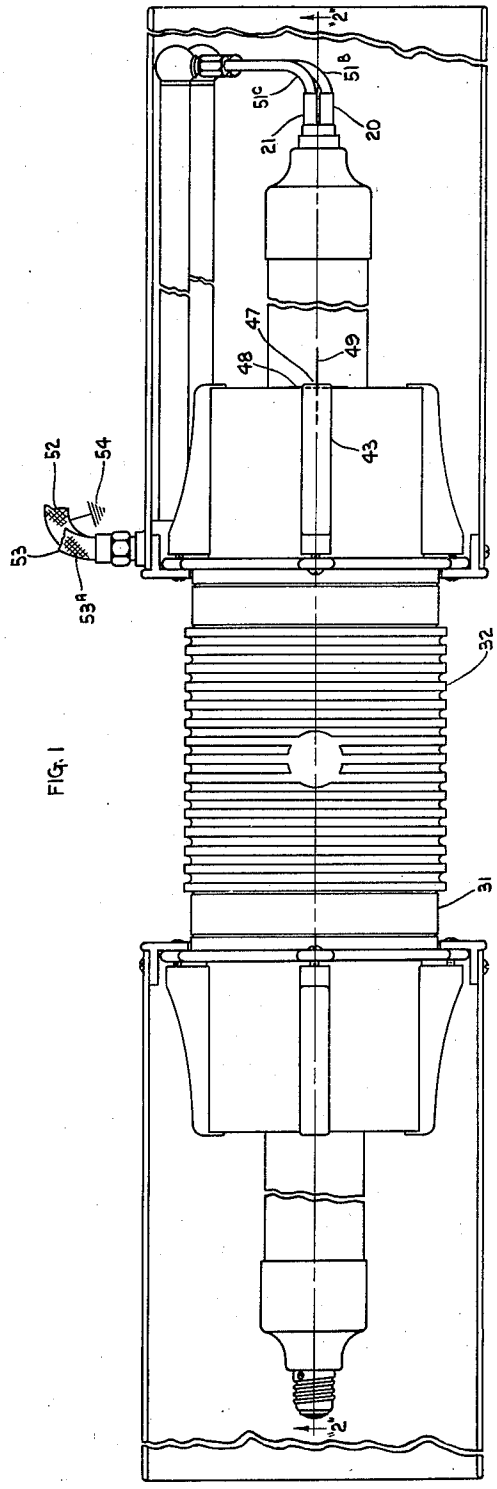

FIG. 1

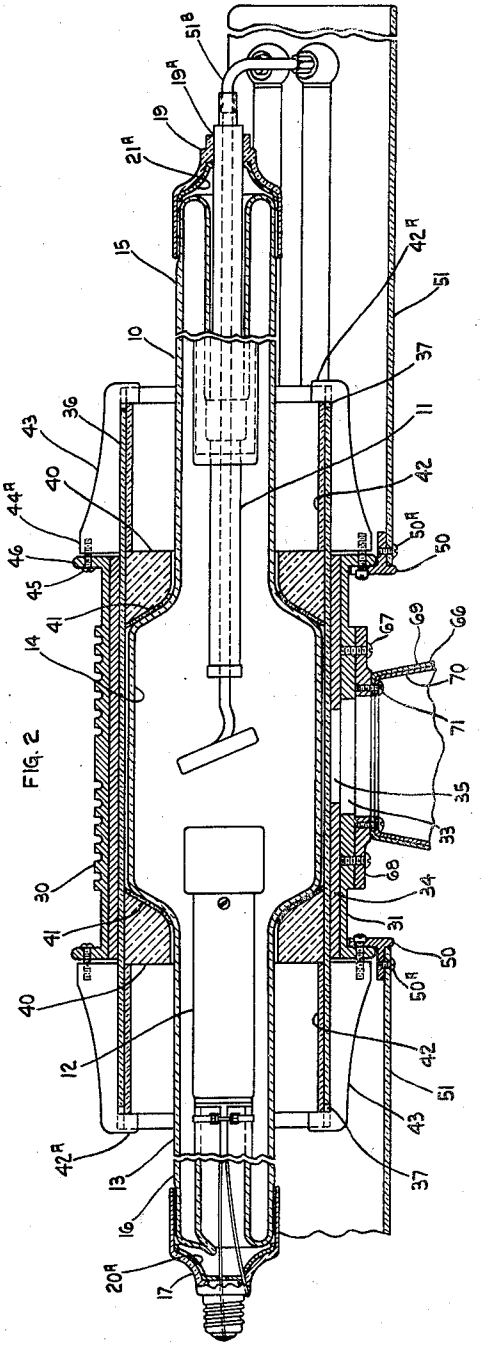

FIG. 2

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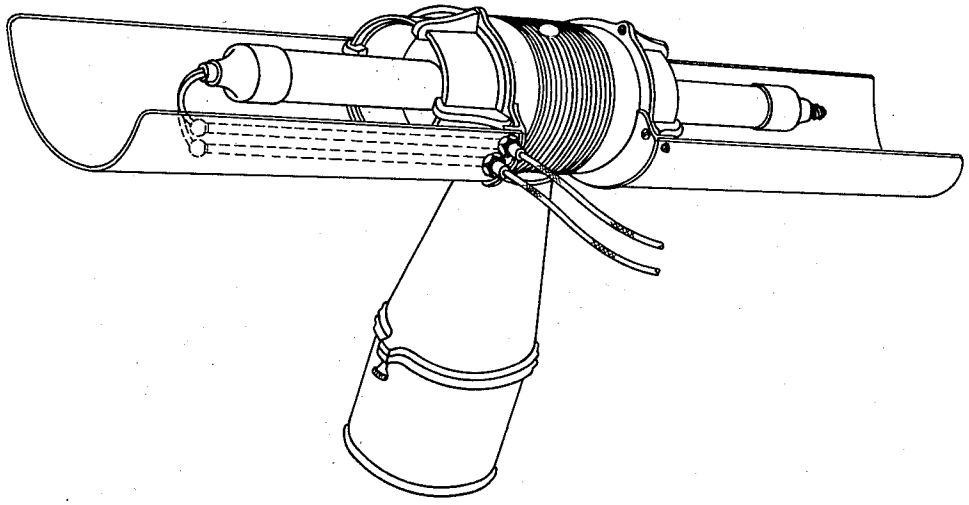
FIG. 6



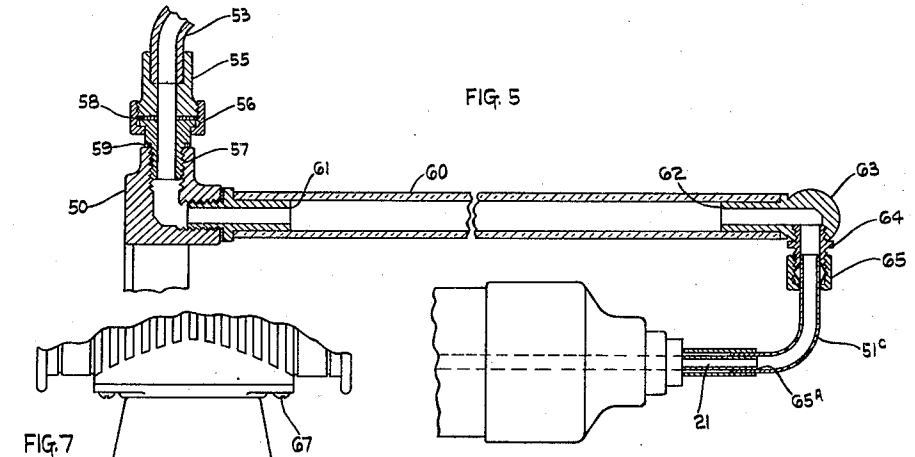



FIG. 5




FIG. 7

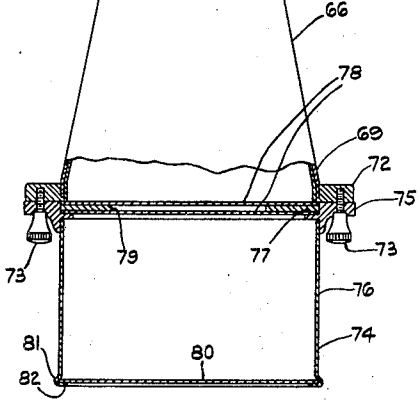



FIG. 4

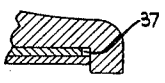
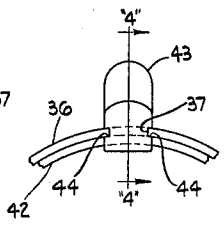



FIG. 3

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# UNITED STATES PATENT OFFICE

2,091,978

## TUBE CASING

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Application August 19, 1933, Serial No. 685,867

7 Claims. (Cl. 250—34)

The present invention has to do with an improved form of insulation for an X-ray tube and relates particularly to the construction of a casing for such tube.

The construction of the tube includes a novel glass envelope having a cylindrical mid-section with extensions of reduced diameter projecting axially thereof. Such construction makes possible a new type of X-ray tube casing, precluding radiation of vagrant X-light from the tube. Such casing may have a novel insulatory sleeve that allows a shortened length of tube and which can be removably and adjustably assembled with respect to the tube.

Another object of the invention is the provision of an X-ray tube having an envelope with shoulders and a casing therefor comprising a sheet of X-ray opaque material covering the main portion of the tube and fastening upon the shoulders of such tube.

Still another object of the invention is an improved form of casing for an X-ray tube which includes a sheet of material impervious to X-rays and having an aperture coinciding with the path to be traversed by a beam of useful X-light from the tube, the casing being employed with a cone confining such beam of useful X-light and precluding secondary radiation therefrom.

Another object of the invention is the provision of an improved circulatory system for cooling an X-ray tube and comprising flexible grounded conduits.

An additional object of the invention is an improved system for conducting an insulating cooling fluid to the anode of an X-ray tube and in which a link of material insulates the anode of the tube from the tube casing.

A still further object of the invention is the provision of a unique X-ray tube having a glass envelope with electrodes at its ends and having material impervious to X-rays about such electrodes where they enter the envelope.

Another object of the invention is a casing for an X-ray tube having depending shields of electrical insulating material for the protection of a patient.

Still another object of the invention is a casing for an X-ray tube, the casing having a hollow coniform member for enclosing a beam of useful X-light emitted from the tube, the coniform member having walls impervious to X-rays and a diaphragm therein for resisting the passage of such beam.

Further objects of the invention include the provision of a coniform member of the type mentioned having means associated therewith for measurably spacing a patient from the anode of an X-ray tube, such a coniform member having an apertured transverse diaphragm impervious to the passage of X-rays for regulating the cross section of a beam of X-rays; a grounded casing for an X-ray tube cooled by a circulating medium having means for electrically connecting to said casing the conduits conveying the fluid to such tube; and an improved structure and arrangement for a conduit used to conduct a cooling medium to and from an X-ray tube, such conduit comprising a metallic covering grounded to a metallic casing of the tube.

The above, and other desirable objects, are obtained by means of the novel combination, unique structure, and the improved combination of the various elements comprising the new combination or invention, one form of which is illustrated in the accompanying two sheets of drawings hereby made a part of this specification, and in which:

Figure 1 is an orthographic projection of an X-ray tube and a casing illustrative of one form of the present invention;

Figure 2 is a longitudinal cross section of the device shown in Figure 1 taken on the line 2—2 of Figure 1;

Figure 3 is a detail of parts for holding casing shown in Figures 1 and 2 in adjustable assembly with an X-ray tube;

Figure 4 is a sectional view taken at the line 4—4 of Figure 3;

Figure 5 is a fragmentary view of a circulatory system for conducting cooling fluid to or from the X-ray tube forming a part of the present invention;

Figure 6 is a perspective view of the device shown in Figure 1; and

Figure 7 is a side view of a cone depending from the tube casing shown in Figures 1 and 2.

Like reference characters are used in the various figures of the drawings and throughout the following description for designating similar parts of the device illustrated.

Reference will now be had more particularly to Figures 1 and 2 wherein the ordinal 10 indicates generally an X-ray tube constructed in accordance with the invention. The tube 10 includes an anode 11 and a cathode 12. An envelope 13 surrounds the electrodes 11 and 12 and consists of a central cylindrical section 14 and two cylindrical arms 15 and 16 of smaller diameter than section 14 and extending oppositely to one another and axially of the central section 14. The

tube is designed for operation from a source of electrical energy reaching peak potentials well in excess of one hundred fifty kilovolts. A hard glass, such as pyrex, suited to withstand high temperatures, may be used for forming the envelope, the walls of which may be from one-eighth to three-eighths of an inch in thickness to avoid puncture as a result of the stresses therein by electrostatic charges of different potentials upon the outer and inner surfaces thereof.

At the free ends of the arms 15 and 16 are terminal caps. The arm 16 is supplied with a cap 17, which may comprise a body of a phenol condensation product such as "bakelite" with an Edison base at its outer end. The Edison base is for attaching to a source of energy the filament associated with the cathode. The cap 19 for the anode end of the tube may also be of a phenol condensation product such as "bakelite" and has a central opening 19A, through which conduits 20 and 21 extend. Conduits 20 and 21 provide means for conducting a cooling medium to and from the tube. The caps 17 and 19 have lead caps 20A and 21A for blocking off X-rays projected longitudinally of the arms 15 and 16.

The tube 10 is disposed within a casing 30. Casing 30 consists of an outer sleeve member 31 generally cast and suitably ribbed, as indicated at 32, to increase the surface thereof to facilitate heat radiation. An aperture 33 is provided in outer sleeve member 31 for the passage of a cone of useful X-light projected from the target upon anode 11.

Supported within the outer sleeve member 31 is a sleeve 34 of lead or other X-ray absorbing material impeding the passage of X-light. Sleeve 34 is preferably made of a single strip of lead wound about a mandrel. In the particular structure illustrated, the wall thickness of the completed cylinder 34 is three-sixteenths of an inch. The cylinder comprises a strip of sheet lead one-thirty-second of an inch in thickness, wrapped six full revolutions about a mandrel and held in cylindrical assembly by solder or by other means. It is highly desirable to make the cylinder 34 by wrapping a lead strip in the manner described in order to obviate the formation of a joint extending axially of the sleeve and whose X-ray opacity would be lower than that of the main body of the cylinder. The lead cylinder just described has an aperture 35 registering with the aperture 33 in the outer sleeve member 31. A suitable cement or adhesive may be applied between the opposed surfaces of outer sleeve member 31 and sleeve 34 to maintain them with the windows 33 and 35 in registry.

Within the lead cylinder 34 is a cylinder 36 of dielectric material. In the particular construction illustrated, the cylinder 36 is of laminated paper held together by some insulating and binding material such as a phenol condensation product. Such products combine high dielectric strength with relatively low X-ray absorption, hence are ideal for the purposes of the present device. The cylinder 36 effectively insulates the metallic outer sleeve member 31 and the sleeve 34 from the tube envelope while permitting X-light to pass substantially unobstructedly through the registered windows 33 and 35. When desired, the dielectric cylinder 36 may be secured to the inner wall of the lead sleeve 34 by a suitable cement material. Each end of the cylinder 36 may be provided with notches 37 which are shown in detail in Figures 2, 3 and 4. The purpose of notches 37 will be made apparent later.

Because cylinder 36 is insulatory and longer than conducting outer sleeve member 31 and lead sleeve 34, the leakage path from end to end of the tube is maintained as great as it would be without the tube casing. The leakage path around the two ends of dielectric cylinder 36 to the conducting outer sleeve 31 and lead sleeve 34 is greater than across the glass in contact with cylinder 36. Hence the overall length of the tube does not have to be increased because of the cover, which would be the case with other metallic casings.

The X-ray tube 10 is held within the casing 30 by means of the shaped rings 40. Felt washer 41 or a washer of another yelding material may be placed between rings 40 and the shoulders determining the ends of the central cylindrical section 14 of the tube envelope. Two thrust collars 42 are contained within the dielectric cylinder 36 at the opposite ends thereof. The inner ends of collars 42 engage the rings 40 with their outer ends against inturned lugs 42A of clamping fingers 43.

Clamping fingers 43 have a pair of opposed slots 44 for slidingly receiving the opposed edges of their respective notches 37 in the insulatory cylinder 36 (see Figure 3). By this arrangement, the fingers 43 are keyed against circumferential displacement with respect to the cylinder 36. At their inner ends, the fingers 43 are each provided with a tapped recess 44A into which screws 45, which pass through apertured ears 46 at the ends of the outer sleeve member 31, may be inserted. By tightening the screws 45, the fingers 43 may be drawn toward the center of the casing forcing the thrust collars 42 against the rings 40 to dispose the latter snugly against the felt washers 41 and the shoulders defining the ends of the cylindrical section 14 of the tube.

When pressure is applied at the ends of the cylindrical section of the tube in the manner described, the casing will be maintained firmly in place upon the tube. By manipulation of the screws 45, the relative position of the tube and casing may be modified. The tube may be held securely in the tube casing in any desired position within definite limits. For example, if the set of screws 45 at one end of outer sleeve member 31 are loosened and the set of screws 45 at the opposite end are tightened, the center of the tube will be moved lengthwise of the casing. By suitable adjustments, the target upon the anode of the tube may be alined accurately with the registered openings 33 and 35 in the several casings.

A cross mark 47 in Figure 1 is used for alining the target of the anode and the registered casing apertures. The transverse line 48 of the cross 47 is alined with the outer edge of the dielectric cylinder 36 for positioning the anode lengthwise of the casing. The longitudinal line 49 of the cross mark 47 is centered upon finger 43 to bring about the proper radial adjustment of the tube and the casing therefor.

Means thus are provided for accurately fitting casing to tubes of different size. Each tube may be accurately marked by cross 47, such cross having a transverse line a fixed distance from the target and a longitudinal line, if extended, accurately splitting the target face. This feature is important for with it it is possible for any one to accurately interchange tubes in the casing. The adjustability of the casing compensates for

any differences in the lengths of the interchanged tubes.

The rings **40** generally are made of insulating material opaque to X-rays. Such material may be a phenol condensation product loaded with lead oxide or another salt of relatively high atomic weight impeding the passage of X-rays. Attached to the outer sleeve member **31** are two semi-circular castings **50**, which may be secured thereto by means of several of the screws **45** serving to hold the clamping fingers **43**. Attached to the castings **50** in any desired fashion, as by standard means **50A**, are two half cylinders **51** of an insulating material which is preferably opaque to X-rays. The primary purpose of the half cylinder members **51** is to barricade the passage of electrical discharges from the terminals of the tube to the patient. If the half cylinders **51** are made of material opaque to X-rays, they will also prevent the patient from being exposed to any diffused radiation of X-rays emanating from the open ends of the X-ray tube.

The casing herein described may be used with a tube whose anode is cooled by a fluid medium, such as water or oil. If water is used as the cooling medium, the conduits **51B** and **51C**, which form the outer terminals of the tube cooling circuit, may be connected directly to water lines from an insulated cooling system in accordance with common practice in the art. Because of the fact that water is a relatively good conductor of electricity, all parts of a water circuit are at anode potential which is above that of ground.

In the particular embodiment of the invention illustrated herein, the anode is cooled by the circulation of an insulating fluid, such as oil. When an insulating fluid is used as a cooling agent, the circulatory system therefor under certain conditions may be at ground potential for the anode potential is not carried through the system by means of the cooling fluid.

The insulatory cooling fluid may be conducted to the casing in the illustrated device by means of the two flexible or hose conduits **52** and **53**. The hose conduits **52** and **53** are illustrated as being covered by a metallic braid **53A**, which is connected to ground as indicated schematically at **54**. Reference should now be had to Figure 5, an illustration of part of the cooling system in detail. The numeral **55** indicates a fitting connected to the hose **53** and which forms one part of a union indicated generally by the numeral **56**. Union **56** is threaded into hole **57** in one of the castings **50**, leakage between the portions of the union being prevented by means of a gasket **58**, and leakage between the union and the elbow-like section of the semi-circular piece **50** to which it is coupled being prevented by means of a gasket **59**. Tube **60**, which may be made of a phenol condensation product or other insulating material is provided at one end with a terminal member **61** which screws into its respective casting member **50** as shown. The other end of the tube **60** is provided with a terminal **62** which comprises an elbow section **63** to which bent conduit **51C** is secured by means of a coupling member **64** and a free running nut **65**. The other end of the curved conduit **51C** is secured to the conduit **21** in any desired fashion, as by soldering, as shown at **65A**. A section of the fluid circulatory system comprising parts similar to those just described for connecting the conduit **21** to the hose **53** is employed between the conduit **20** and the hose **52**.

The cooling fluid may be caused to flow from the hose **53** through the parts just described to and through the anode and back to hose **52**. The insulating sections or tubes **60** isolate, electrically, the anode terminal from the metallic outer sleeve member **31** of the casing. Because of the ground connection **54** (which is electrically connected to the outer sleeve member **31**), the tube casing **30** is maintained at ground potential, and charges that may leak back thereto from the anode over the walls of the glass envelope and about or through the dielectric cylinder **36** are immediately dissipated so that the casing may be handled at all times without danger of electrical shock.

Attached to the outer sleeve member **31** coaxially with the openings **33** and **35** is a master radiation cone **66**. Cone **66** may be secured to the outer sleeve member **31** by means of screws **67**. The cone **66** consists of a top casting **68** to which a copper coniform member **69** having a lining **70** of lead is attached by means of screws **71**. A ring **72** may be attached to the copper cone **69** in any desired fashion, as for instance, by solder. The ring **72** carries a pair of thumb screws **73** for the purpose of singly securing auxiliary extension members to the bottom of the cone. One of such extensions is indicated **74**. Extension members **74** may be of various lengths. The extended end of the outermost member **74** is placed against a patient to measurably space the target of the anode from such patient. In this manner, the desired "anode to skin" distance for particular kinds of X-ray treatment may be most accurately had.

Each of the extension units **74** consists of an upper ring **75** suitably secured to an outer cylinder **76**, which may be of copper. Ring **75**, within its upper surface has a recess **77** into which filters **78** or lead diaphragming washers **79** may be placed. Both filters and washers may be placed transversely of the cone member **66** and into the recess **77** when desired. The bottom end of the cylinder **74** may be closed by a disc **80** of a phenol condensation product, which may be held in assembly by means of bead **81** and an inturned flange **82**.

Usually the apparatus illustrated will be supported upon a tube stand or standard (not shown) having adjustable clamping members (not shown) for engaging the sleeve **31** at its ends adjacent to the ribbed area thereof.

What is claimed as new and is desired to be secured by Letters Patent of the United States is:

1. The combination with an X-ray tube comprising a glass envelope having a central enlarged cylindrical section, and extensions of smaller diameter extending axially from opposite ends of said cylindrical section and separated therefrom by sharply defined transverse shoulders, of a casing including annular members resistant to the passage of X-light disposed about the tube at said shoulders, a cylinder of dielectric material about said members and the cylindrical section of said tube, a sleeve of lead disposed about said dielectric cylinder, an outer sleeve member about said lead sleeve, fingers extending londitudinally from the ends of said outer sleeve member, means between said fingers and said annular members, and means for moving said fingers relatively to said outer sleeve member, the movement of said fingers being imparted to the means between said fingers and said annular members whereby said annular members are compressed oppositely against said shoulders relatively to said tube.

2. An X-ray tube comprising a cylindrical cen-

tral section, and axially disposed tubular extensions, in combination with annular shielding members at the ends of said cylindrical section, a cylinder of insulatory material transparent to X-light arranged about said cylindrical section and said shielding members, an outer sleeve member about said insulatory cylinder, thrust collars intermediate said shielding members and the ends of said outer sleeve member, and means upon said outer sleeve member engaging said thrust collars to move said outer sleeve member relatively to said thrust collars.

3. The combination with an X-ray tube having a central cylindrical section, of a casing comprising an imperforate dielectric cylinder pervious to X-rays and snugly surrounding said cylindrical section, an outer sleeve member about said cylinder, said outer sleeve member being formed of material impervious to X-light and having a window portion pervious to X-light, and means adjustably connecting said outer sleeve member to said X-ray tube whereby to relatively shift said X-ray tube and outer sleeve member in order to position said window adjustably with respect to the X-ray tube.

4. A housing comprising tubular means of material impervious to X-light, said housing having a lateral window portion pervious to X-light, clamp means for engaging an X-ray tube within said housing, and means on the housing and operable to relatively shift the clamp means on the housing whereby to adjust the tube longitudinally in the housing and align the source of X-light with said window portion.

5. A housing for an X-ray tube comprising a source of X-light, said housing comprising tubular means of material impervious to X-light, said housing having a lateral window portion pervious to X-light, clamp means for engaging an X-ray tube within said housing, and means on the housing and operable to relatively shift the clamp means on the housing whereby to adjust the tube longitudinally in the housing and align the source of X-light with said window portion, and cooperating means on the X-ray tube and said housing and adapted to be aligned by adjustment of the tube in the housing to indicate a desired relative positioning of the tube and housing.

6. A housing for an X-ray tube having a central enlarged portion defined between a pair of oppositely facing shoulders, said housing comprising tubular means surrounding the enlarged portion of an X-ray tube and mounting means for supporting the tube within the housing, said mounting means comprising bearing blocks carried within and by said tubular means in position to engage said opposed shoulders whereby to secure the tube against longitudinal movement on said housing, and clamp means, including spaced clamping fingers, on said housing for pressing said blocks on said shoulders, the tubular means of said housing comprising an inner sleeve surrounding the tube and enclosing said blocks and an outer sleeve enclosing the inner sleeve and carrying the clamping fingers, said clamping fingers having interlocking relationship with the inner sleeve to prevent relative angular movement between the sleeves.

7. An X-ray tube housing comprising an inner and an outer sleeve and clamp means operatively associated with said sleeves and with an X-ray tube to clamp the tube against longitudinal movement in the housing, said clamp means comprising clamp blocks within the inner sleeve and engaging oppositely facing shoulders of the tube, clamping elements engaging said blocks and extending thence to the end of the inner sleeve, and clamping members carried at opposed ends of the outer sleeve and extending thence to the ends of the inner sleeve in position to engage the outer ends of the clamping elements to hold same in position securing said blocks against the opposed shoulders of the tube.

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