June 5, 1934. C. T. ULREY 1,961,718

X-RAY TUBE

Filed Jan. 26, 1932

Fig. 1.

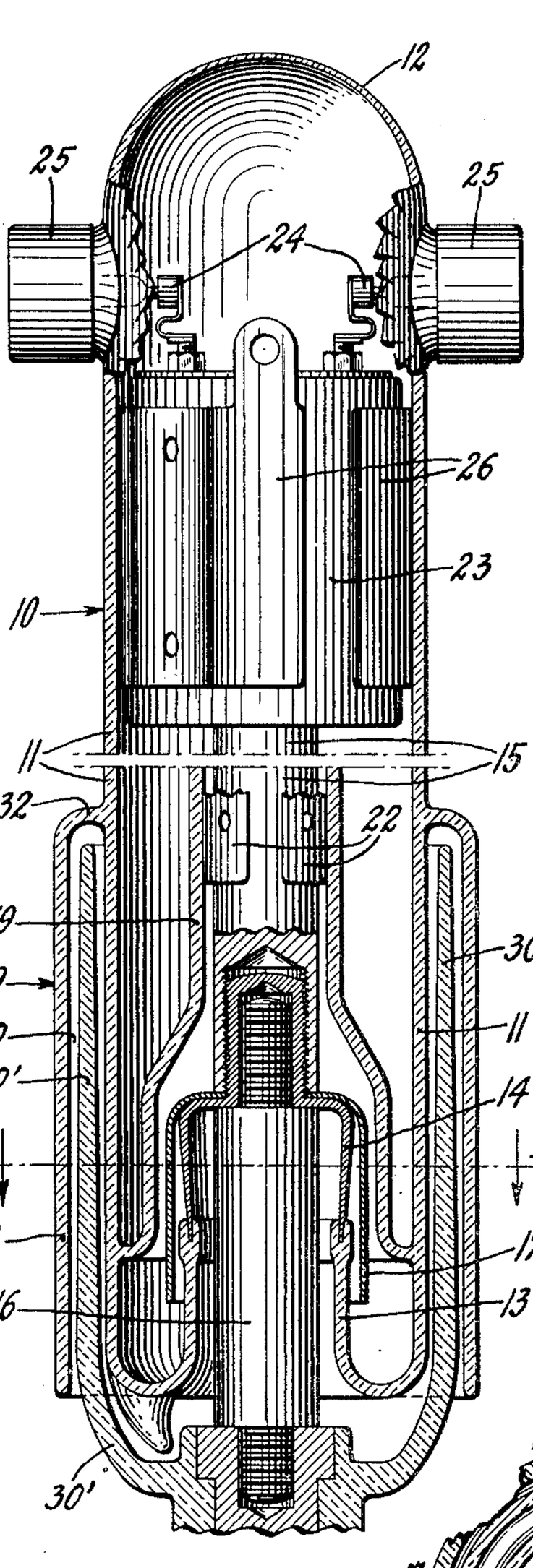


Fig. 3.

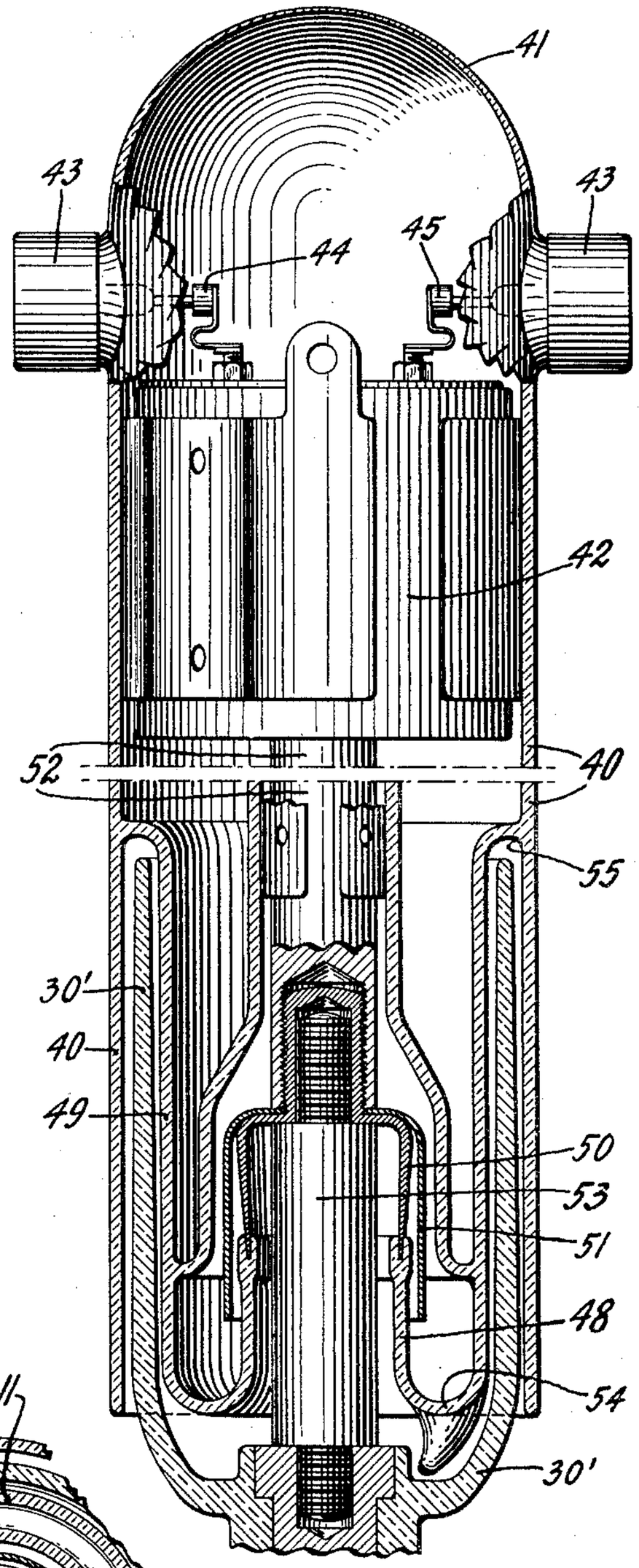
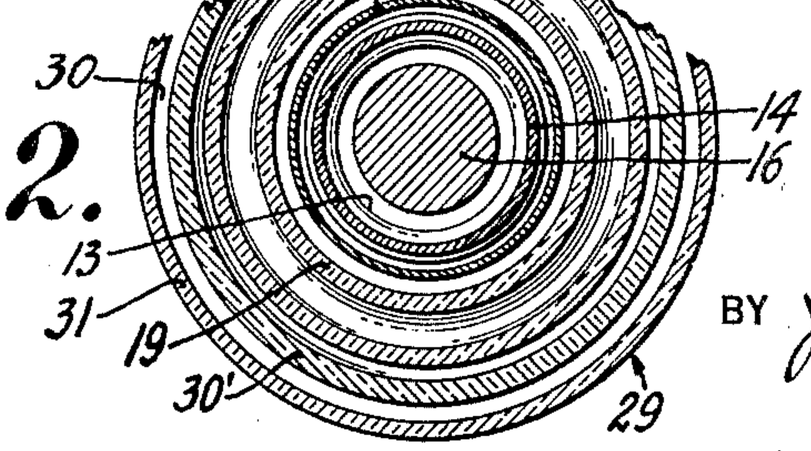


Fig. 2.



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1,961,718

X-RAY TUBE

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3 Claims. (Cl. 250—35)

This invention relates to electrical discharge devices, such as X-ray tubes, rectifying tubes and the like adapted to be employed in compact shock-proof X-ray apparatus, simple and compact rectifying apparatus and the like. In its more specific aspect the invention is directed to the provision of an electrical discharge device which is an improvement over that disclosed by William A. McKay in United States patent application Serial Number 572,785, filed November 3, 1931, and assigned to the same assignee as the present invention.

Heretofore, it has been proposed by McKay to provide a relatively compact electrical discharge device adapted to operate at its working voltages in an ambient medium such as air, or the like, without any danger of spark-over between its high tension electrode terminals. The tube as proposed by him consists essentially of an envelope comprising a body portion, a generally hemispherical upper end and a lower end in the form of a plurality of spaced sleeves, plaits or folds extending upwardly into said body portion. On the exterior and at the upper end of the body portion, adjacent the hemispherical portion are a plurality of cathode terminals. A tubular sleeve is secured to the upper end of the innermost plait or fold and supports an anode terminal and an anode located within the envelope. The tube is so designed that the shortest distance between the high tension anode and cathode terminals measured outside the tube is less than that necessary to prevent spark-over between these terminals at the maximum working voltage of the tube in a particular ambient medium. This tube is carried by or mounted in a dielectric cup having a plurality of concentric dielectric baffle members integral with the base thereof and extending upwardly into the spaces between the re-entrant plaits or folds.

In a simple relatively compact structure of this character the plaits or folds and the dielectric means are so dimensioned and designed that the spark-over distance between the high tension electrode terminals is great enough to prevent spark-over therebetween at the maximum working voltage of the tube in the particular medium.

A construction of this character has supplied a long-felt need. Like most electrical discharge devices, and all X-ray tubes, the tube per se requires a number of operations to complete the same. The manufacture of these tubes and especially the lower end thereof having three re-entrant folds to provide adjacent spaces to accommodate the two baffles of a dielectric cup, involves the utilization of three flared separate cylindrical sections composed generally of glass, a material of the same general composition as that of the body portion of the envelope. In order that these plaits or folds may be properly united with each other and with the body portion, it is necessary that three separate fusion or union operations be carried out, which operations are essentially hand operations and therefore costly.

In order that a tube of the same general character may be manufactured at less cost, I have developed the following invention.

One of the objects of my invention is to provide a relatively compact rugged X-ray tube which is relatively inexpensive to manufacture.

Another object of my invention is to provide an X-ray tube having relatively fewer dielectric parts than tubes of the same general character heretofore designed.

These as well as other objects and advantages of my invention will become apparent from the following specification and drawing wherein,

Figure 1 represents a cross-sectional view with some of the parts in elevation of an X-ray tube embodying my invention;

Figure 2 is a fragmentary cross-sectional view taken along line II—II of Figure 1 in the direction of the arrows;

Figure 3 is a modification of Figure 1.

As shown in Figure 1, one embodiment of my invention comprises a gas-tight envelope 10 of suitable glass or the like consisting of a body portion 11, a generally hemispherical upper end 12 and a re-entrant tube 13 at its lower end extending upwardly within and spaced from the body portion 11. The upper end of said re-entrant tube 13 has sealed thereto a metallic tubular sleeve member 14 which supports both an anode 15 and an anode extension 16. This anode extension 16 extends outside of the envelope, is surrounded by and spaced from the re-entrant tube 13 and is in axial alignment with the anode 15.

In the same manner as that disclosed in the United States patent application of Nelson H. Stewart, Serial Number 578,243, filed December 1, 1931, and assigned to the same assignee as the present invention there is a tubular metallic skirt 17 supported by the sleeve 14 and having a major portion thereof spaced therefrom and extending downwardly below the glass-metal seal. A second re-entrant tube 19 composed of a suitable dielectric has its lower end fusion ring sealed to the interior wall of the body portion 11 at a position slightly below the plane of the glass-

metal seal. This re-entrant tube 19 extends upwardly in the envelope and has a major portion thereof spaced from the inner wall thereof.

The anode 15 extending upwardly in the envelope and having a portion thereof surrounded by the re-entrant tube 19 has a target (not shown) embedded in its free end. Between the anode 15 and the inner wall of the re-entrant tube 19 is a spring sleeve 22 firmly secured to the anode and adapted to frictionally engage the inner wall of the re-entrant tube 19 to serve as a shock absorbing and distributing means therefor and also to assist in supporting the anode.

At the upper portion of the envelope 10 there may be provided a chrome-iron or other suitable X-ray screen 23 of appropriate thickness disposed around the target end of the anode, housing a filamentary cathode (not shown) and serving to screen out undesirable X-rays. The cathode is electrically connected by means of conductors 24 to a pair of terminal caps 25 located on the outside of the envelope. Secured to said X-ray screen 23 is a spring sleeve 26, the outer surface of which is in frictional contact with the inner wall of the envelope 10 to hold the screen in position.

In accordance with my invention, there is provided means 29 which may be directly fused to the outside of the envelope to provide an annular space 30 adapted to receive a cylindrical dielectric baffle plate 30' which co-operates with said means and said envelope to increase the length of the spark-over path between the high-tension electrode terminals. As shown, said means 29 may comprise a glass cylinder 31 having an inwardly directed glass flange 32 integral therewith. The inner limit of said flange 32 is in the form of a circle whose diameter is substantially the same as the diameter of the envelope 10.

This means 29 may be readily secured to the envelope by merely inserting the lower end of the envelope through the opening in the inverted cup-shaped means 29 until the flange is located an appropriate distance from the lower limit of the envelope. Generally, the distance between the flange 32 and the lower limit of the envelope is about one-half the length of the envelope. Thereafter, the inner periphery of the flange 32 is fusion ring sealed to the envelope at the adjacent area thereof.

In a construction of this character the shortest distance between the high tension cathode terminal 25 and the high tension anode terminal 16 measured outside the tube may be less than that equired to prevent spark-over therebetween when the maximum working voltage, as for example the operating and normal surge voltages, are applied therebetween in a particular ambient medium. Because of the unique construction of the tube which includes the envelope 10 and the inverted cup or skirt 29 fusion ring sealed thereto and including a cylindrical portion 31 spaced therefrom and extending downwardly to the lower end of the envelope, a dielectric cup with cylindrical dielectric baffle means may co-operate therewith to increase the length of the spark-over gap between the high tension electrode terminals so that the tube is capable of operating at its maximum working voltage without any danger of sparking therebetween.

In the manufacture of a construction of this character, it is apparent that at least one fusion operation is dispensed with and fewer parts are necessary in the manufacture of the envelope and its appended dielectric parts as compared with the structure heretofore proposed for the same purpose.

Another embodiment of my invention as shown in Figure 3 is a modification of the structure heretofore described. As shown the X-ray tube comprises a glass cylindrical member 40 having a generally hemispherical glass upper end 41. Located within said cylinder 40 and adjacent the upper end thereof is a metallic X-ray screen 42 composed of nickel-iron. This screen serves as a housing means for a cathode (not shown) and further to screen out undesirable X-rays produced therein. On the outside surface of the cylinder are secured a plurality of spaced terminal caps 43 electrically connected to the cathode by means of conductors 44 and 45.

Located within the lower open end of the cylinder 40 are a plurality of cylindrical glass plaits or folds 48 and 49. The innermost cylindrical plait or fold 48 may be of a diameter generally corresponding to that of the re-entrant tube 13 of Figure 1. This cylindrical plait or fold 48 has sealed thereto at the upper end thereof a metallic tubular sleeve 50 which supports both an anode 52 and an anode extension 53. Also supported by said sleeve 50 is an inverted cup shaped shield 51 which extends downwardly therefrom and spaced therearound. The anode extension 53 may extend outside of the cylinder 40, may be surrounded by and spaced from the cylinder 48 and may be in line with the anode 52.

The other cylindrical plait or fold 49 has a major portion thereof spaced from the plait or fold 48 and has the lower portion thereof integrally united with the lower portion of the cylinder 48 to form a bend 54. This cylindrical plait or fold 49 may be of a length about one half that of the cylinder 40 and of a diameter appreciably less than the diameter of said cylinder 40. Fusedly ring sealed as at 55 to said cylinder 40 on the inner wall thereof at about the middle length thereof is the upper end of said cylindrical plait or fold 49 which is in the form of an outwardly flared ring.

The length and diameter of the plait or fold 49 as well as the diameter of the flared portion thereof are of appropriate magnitudes so that the space between the lower end of said cylinder 40 and plait or fold 49 may readily accommodate cylindrical dielectric baffle means 30'.

Like the embodiment shown in Figure 1, the construction shown in Figure 3 is so designed that the shortest distance between the anode terminal 53 and the cathode terminal 43 measured outside the tube, is less than that necessary to prevent spark-over therebetween when the maximum working voltage of the tube is applied between these terminals in a particular ambient medium. The tube of this character including the envelope having a skirt portion depending therefrom and integral therewith and the cylindrical plaits or folds is so designed and dimensioned that a cup with cylindrical dielectric baffle means may co-operate therewith to so increase the length of the spark-over gap that no spark-over will occur between its high-tension terminals.

In the manufacture of either of these constructions heretofore described and embodying my invention it is apparent that at least one fusion sealing operation is dispensed with and fewer parts are necessary in the manufacture of the envelope and its appended parts as compared to the structure heretofore proposed for the same purpose.

What is claimed is:

1. An X-ray tube comprising an enclosing envelope, an anode and a cathode therein, a reentrant tube at one end of said envelope, means secured to one end of said reentrant tube and adapted to support said anode, and a sleeve integral with said envelope at a point on said envelope above the union of said means and said reentrant tube, said sleeve having a portion thereof spaced from and surrounding said envelope, said sleeve having a free end adjacent the other end of said reentrant tube, said sleeve being located outside the space enclosed by said envelope.

2. An X-ray tube comprising an envelope, an anode and a cathode therein, said envelope having a portion thereof in the form of a cylinder, another portion of said envelope being in the form of a plurality of spaced folds, another cylinder integral with said first mentioned cylinder and of approximately the same diameter as said first mentioned cylinder, said other cylinder surrounding and located exteriorly of said folds and having its lower limit adjacent the lower limit of said folds.

3. An X-ray tube comprising an elongated envelope, an anode and a cathode therein, said envelope having a reentrant tube, means secured to said tube and supporting said anode, an anode extension surrounded by said reentrant tube, a pair of contacts carried by said envelope and electrically connected to said cathode, a sleeve located exteriorly of the space enclosed by said envelope, said sleeve having a free end located adjacent the lower end of said reentrant tube, said sleeve having its other end integrally united with said envelope at a point above the union of said reentrant tube and said means.

CLAYTON T. ULREY.