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X-RAY TUBE SHIELD

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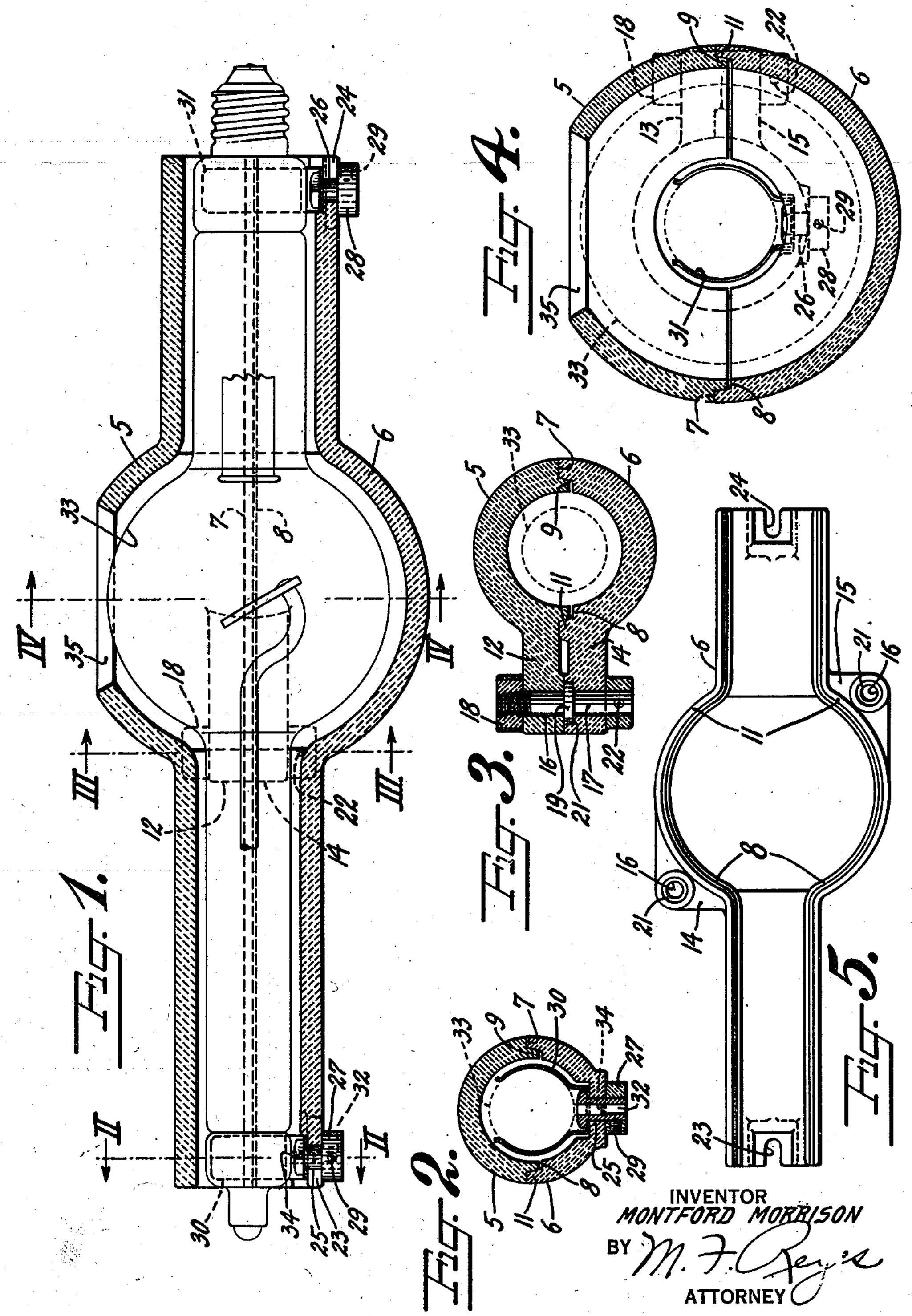

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X-RAY TUBE SHIELD

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4 Claims. (Cl. 250—34)

My invention relates to X-ray tube shields and particularly to such shields having high dielectric strength and heat resisting characteristics. These devices are usually employed with X-ray tubes for radiographic and fluoroscopic purposes and closely surround the tube during operation to protect the latter from breakage as well as to prevent stray radiation striking the operator or patient.

Shields of this general character are necessarily subjected to high temperature due to their proximity to the tube during operation and contain as an essential ingredient a material of high atomic weight capable of absorbing X-rays thus prohibiting passage of X-rays through the shield except at a designated part of the shield where a window pervious to X-rays is provided. As the shield is in most cases directly in contact with the tube at some points it must have a higher dielectric strength than air to prevent spark-over between the terminals of the X-ray tube during operation as the air-gap between the terminals is lessened by the shield. Moreover, it is highly desirable that the dielectric strength of the shield and its X-ray opaqueness should remain unaffected despite the extremely high rise in temperature of the shield attendant operation of the X-ray tube.

Such devices are well known to the art but heretofore the useful life thereof has been of considerably short duration. The most common form of X-ray tube shield has consisted mainly of glass having incorporated therewith a considerable quantity of ray opaque material, such as lead, for absorbing stray radiation. Although the dielectric strength of this type of shield remains substantially constant its useful life is generally very limited due to its fragility. This latter characteristic being inherent the possibility of destruction by accidentally striking the shield is always present and requires considerable care on the part of the operator. Moreover, the considerable rises in temperature to which the shield is subjected during operation of the tube too frequently causes destruction thereof and results not only in annoyance to the operator but may also be attendant with danger to a patient.

A further type of X-ray tube shield which is well known to the art consists mainly of a phenolic condensation product having incorporated therewith a ray opaque material for preventing the passage therethrough of X-rays. While the fragility of this latter type of shield is considerably less than the aforementioned lead glass shield it nevertheless has an objectionable feature in that its useful life is limited. The rise in temperature of the shield during operation of the tube will, in a comparatively short time, cause the shield to become softened thus losing its configuration and ray opaqueness or it will carbonize allowing spark-over across the carbonized path, formed on the surface of the shield, between the electrodes of the X-ray tube as well as lose its opaqueness due to carbonization.

It is accordingly an object of my present invention to provide an X-ray tube shield having high dielectric strength and heat resisting characteristics and a long useful life.

Another object of my invention is to provide a substantially non-fragile X-ray tube shield having high dielectric strength and heat resisting characteristics in which the dielectric strength remains constant throughout the entire life thereof.

Another object of my invention is to provide a simplified method of producing a substantially non-fragile X-ray tube shield having high dielectric strength and heat resisting characteristics.

Still further objects of my invention will become obvious to those skilled in the art by reference to the accompanying drawing illustrating one form of my invention may take and in which,

Figure 1 is a longitudinal view in cross-section of one embodiment of my X-ray tube shield;

Figure 2 is a transverse sectional view of one end of my tube shield taken on the line II—II of Figure 1;

Figure 3 is still another transverse sectional view of my shield taken on the line III—III of Figure 1 looking in the direction indicated by the arrows;

Figure 4 is a still further transverse sectional view of my shield taken at substantially the center thereof on the line IV—IV of Figure 1, and

Figure 5 is an interior plan view of the lower section of my tube shield.

Referring now to the drawing in detail I have shown an X-ray tube shield consisting of an upper section **5** and a similar complementary lower section **6**. The upper section **5** is provided with a longitudinal groove **7** disposed around its outer edge while the lower section **6** is provided with a similar groove **8**, but disposed around the inner edge. These respective grooves extending longitudinally at each side of the sections accordingly form a ridge **9** in the upper section **5** and a corresponding ridge **11** in the lower section **6**.

The grooves of each section being opposed to each other enable the ridge 9 of the upper section to engage the groove 8 of the lower section and similarly the ridge 11 of the lower section to engage the groove 7 of the upper section thus forming a dovetail joint between the sections to prevent lateral movement and emission of light or X-rays from the interior of the shield when the sections are joined together.

The upper section 5 is provided with a pair of laterally extending portions 12 and 13 and the lower section is likewise provided with similar portions 14 and 15 which align with the portions of the upper section when the sections are placed in engagement with each other. These laterally extending portions are provided with openings 16 and suitable fastening means, such as a bolt 17 passing through these openings and held in place by a nut 18, is provided for rigidly holding the sections together to form a composite shield conforming substantially to the contour of the X-ray tube.

The bolts 17 are rigidly secured to the lower section of the shield by means of a shoulder 19 which fits into a recess 21 provided in the laterally extending portions 14 and 15 to allow the disengagement of the sections by removal of the nuts 18 without removal of the bolts. This shoulder may be a threaded washer run down upon the bolt in which latter event the bolts with the shoulder 19 are inserted in the openings 16 and a nut screwed thereon and rigidly held in place by means of a pin 22 to form a head for the bolts 17.

The lower section 6 is provided at its extremities with longitudinally extending slots 23 and 24 and short bolts 25 and 26, provided with collars 27 and 28 rigidly secured thereto by means, such as set screws 29, fit into these slots.

Spring clips 30 and 31 are carried by these bolts 25 and 26 which are positioned interiorly of the lower section 6 of the shield and one of these bolts 25 is provided with an opening 32 extending therethrough for a purpose to be hereinafter more fully described.

An X-ray tube 33 is secured at its respective ends to the spring clips 30 and 31 in spaced relation with the shield to allow a slight circulation of air therebetween to assist in cooling the X-ray tube during operation of the latter. The X-ray tube is provided with a pin 34 extending in a lateral direction from one of its ends which fits into the opening 32 provided in the bolt 25 for the purpose of preventing longitudinal or rotary movement of the tube in order to align the anode of the tube with a window 35 pervious to X-rays provided in the upper section 5 of the shield.

From the foregoing description it becomes obvious that the lower section of the shield carries substantially all the necessary support for the X-ray tube and upon loosening of the nuts 18 this lower section carrying the tube and the bolts 17 readily becomes disengaged from the upper section.

My shield is formed of ceramic material having high dielectric strength and heat resisting characteristics and is of a substantially nonfragile composition. I have found that certain refractory oxides are particularly adaptable for this purpose, such for example as the oxides of silicon, aluminum, zirconium, boron, calcium, sodium and magnesium in composition.

Although I have found that the oxides of these elements are very satisfactory it is equally true that other compounds, such for example as the carbonates of these elements, operate just as efficiently.

In its broadest aspect my invention contemplates selecting a ceramic material having a composition the characteristics of which are that it has high dielectric strength and heat resisting qualities. To this ceramic composition I add a high atomic weight material that is opaque to X-rays and which composition when fired in a furnace may be formed into any desired configuration. However, the ceramic material selected as well as the particular high atomic weight material incorporated therewith must be such that in the firing of the admixture fusion of the ray opaque material will readily take place and the same flux with the ceremic material and be equally distributed throughout the product. It must be appreciated that, as the product, when fired in a mold, is subjected to comparatively high temperature this latter is a controlling factor in the selection of both the particular ceramic composition and the ray opaque material. Accordingly the high atomic weight material itself must be such that fusion thereof will not occur too readily during the firing process, which would cause a concentration at some portion of the product, or a fluxing material may be utilized to increase the fusion temperature to prevent this latter occurrence.

In the actual embodiment of the shield constructed by me I combined the oxides of some of the above noted elements to form a desired ceramic material and incorporated therewith a high atomic weight material, such as the oxide of lead. The following proportions by weight of these oxides I found met all necessary requirements:

SiO_2	30.9
Al_2O_3	13.8
ZrO_2	14.6
PbO	39.3
Na_2O	0.4
B_2O_3	0.8

Any one of several methods may be employed to form my shield from the composition of the above proportions. I may first mix all of the above mentioned oxides in the form of a plastic admixture then pour this plastic mass into a mold of the required configuration and fire in a suitable furnace until a ceramic shield is formed after which it is allowed to cool and removed from the mold.

Two further methods which produce an equally efficient shield are in both instances to omit the lead oxide from the plastic mixture until after the firing process. Then the high atomic weight material may be impregnated in the ceramic shield in one instance or, the ceramic shield may be coated with the ray opaque material and refired to produce a glazed surface thereon.

I found that in the absence of the oxide of zirconium, when the mold was fired with the ray opaque material either in the admixture or incorporated therewith by the other above noted methods, there was a tendency for the shield to become distorted and the ray opaque material to have too low a fusion point. This caused the latter material to become concentrated at portions of the shield rather than evenly distributed throughout the latter.

By adding this other oxide of zirconium, which incidentally has an atomic weight approximately half that of lead but a melting point a little greater than seven times the latter, the fusion point of the lead oxide was materially increased. This resulted in the ray opaque material remaining evenly distributed throughout the admixture after completion of the firing process and a shield, which was opaque to X-rays having high dielectric strength and heat resisting characteristics. Moreover, my ceramic shield is substantially non-fragile in character being of relatively strong composition and capable of withstanding considerably high degrees of temperature without cracking.

Although I have described one embodiment of my invention and several methods by which the same may be constructed I do not desire to be limited thereto as various other modifications thereof may be made without departing from the spirit and scope of the appended claims.

What is claimed:

1. An X-ray tube protective shield having high dielectric strength and heat resisting characteristics comprising paired members joined together and formed of a plurality of refractory oxides including those of silicon, aluminum and zirconium with the proportion by weight of the silicon oxide being slightly greater than the sum of the proportions by weight of the oxides of aluminum and zirconium, and an X-ray opaque material combined with said aforementioned oxides comprising the oxide of a high atomic weight material, the proportion by weight thereof being greater than the proportion by weight of any other of said oxides.

2. An X-ray tube protective shield having high dielectric strength and heat resisting characteristics comprising paired members joined together and formed of a plurality of refractory oxides including those of silicon, aluminum, and zirconium, with the proportion of weight of the oxide of silicon being slightly greater than the sum of the proportions by weight of the oxides of aluminum and zirconium, and an X-ray opaque material combined with said aforementioned oxides comprising the oxide of lead, the proportion by weight thereof being greater than the proportion of the oxide of silicon, but less than the sum of the oxides of silicon and aluminum.

3. An X-ray tube protective shield having high dielectric strength and heat resisting characteristics comprising paired members joined together and formed of a plurality of refractory oxides including those of silicon, aluminum, and zirconium, with the proportion by weight of the oxide of silicon being slightly greater than the sum of the proportons by weight of the oxides of aluminum and zirconium, an X-ray opaque material combined with said aforementioned oxides comprising the oxide of lead, the proportion by weight thereof being greater than the proportion of the oxide of silicon, but less than the sum of the oxides of silicon and aluminum, said oxide of zirconium being incorporated in said shield to cause the oxide of lead to remain uniformly distributed throughout said shield during the molding and firing thereof.

4. An X-ray tube protective shield having high dielectric strength and heat resisting characteristics comprising paired members joined together and formed of a plurality of refractory oxides including the following in proportions by weight

SiO_2	30.9
Al_2O_3	13.8
ZrO_2	14.6
PbO	39.3
Na_2O	0.4
B_2O_3	0.8

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