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X-RAY SCREENING DIAPHRAGM

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Fig. 1

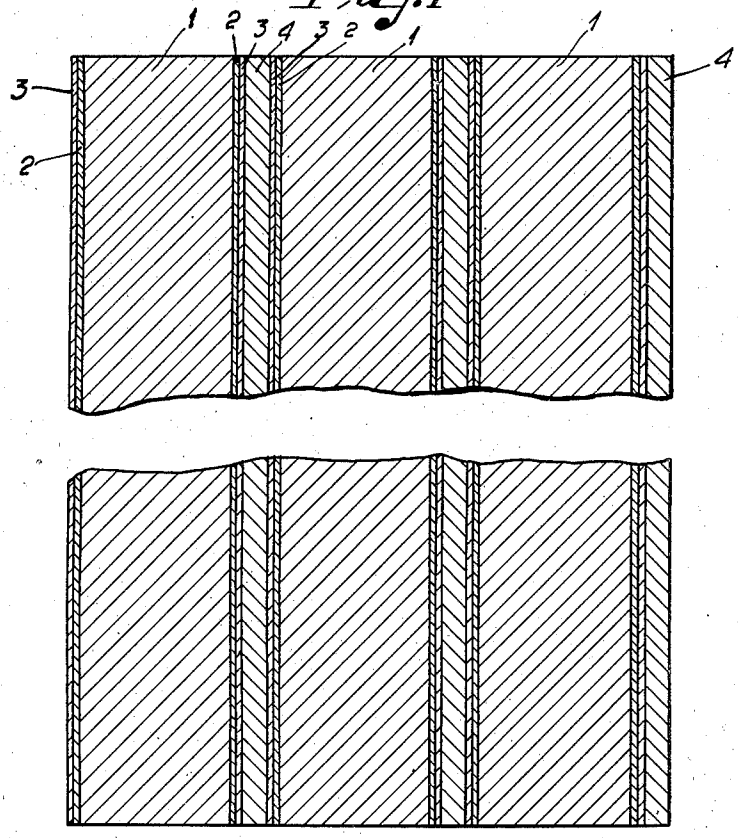


Fig. 2

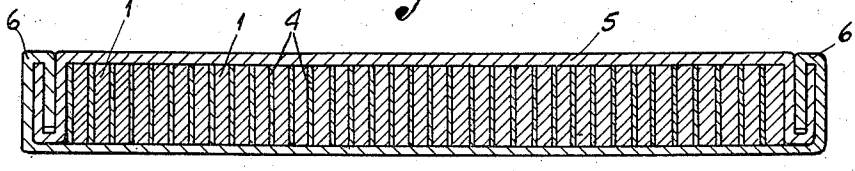
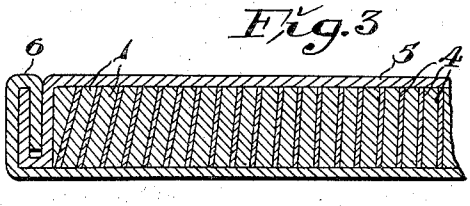


Fig. 3



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X-RAY SCREENING DIAPHRAGM

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8 Claims. (Cl. 250—63)

In order to absorb in fluoroscopy and X-ray photography undesirable secondary rays emanating from the body to be examined, diaphragms for screening or shutting out the secondary radiation are utilized. These diaphragms substantially consist of thin leaves standing upright and made of a metal or a metal alloy opaque to the X-rays alternating with leaves of a material more transparent to the X-rays. These last-named leaves may also consist of metal or a metal alloy, preferably of a light metal, such as for instance aluminium or magnesium or an alloy containing these metals. The leaves opaque to the X-rays may be made for instance of lead, bismuth, gold, tungsten, tantalum, antimony, tin, silver, heavy platinum metals or of alloys which substantially consist of heavy metals. When in the following description the short expressions heavy metal and light metal, respectively, are used, they are understood to mean a metal or an alloy which permits X-rays to pass with difficulty or more easily.

This invention relates to, and it is the principal object thereof to provide, an improved X-ray screening diaphragm of the character described.

In the construction of diaphragms of this type, the light metal leaves and the heavy metal leaves preferably are metallically united with each other to form a coherent body. Several methods of making such screening diaphragms are already known. It has, for instance, been proposed to provide both sides of a light metal plate with a layer of a metal (soldering metal) having low melting point, whereafter one side of this plate is provided with a layer of heavy metal. This plate is then cut into strips which are laid one upon the other and the packet thus formed is subjected to pressure and heat, so that the heavy metal is metallically united with the light metal through the intermediary of the soldering metal. It has also been attempted to dispense with the soldering metal and to unite the light metal directly with the heavy metal.

These known methods, however, have certain drawbacks. As is well known, it is very difficult on account of the oxide layer, to solder light metals, especially aluminium. The joint between light metal and soldering metal and between light metal and heavy metal, respectively, has comparatively feeble strength, so that diaphragms made according to the methods hitherto practiced may easily break to pieces.

The aforesaid drawbacks are eliminated according to the present invention by providing a new diaphragm construction and applying a new method of manufacture involving the following features:—Light metal plates or light metal ribbons are first provided with a metal coating, a so-called auxiliary coating, having a surface which is solderable more easily than the light metal without consisting itself of easily meltable metal (soldering metal), whereupon the plates or ribbons or strips cut therefrom are metallically united with each other after first having inserted between them a layer or leaf of heavy metal and, if considered necessary or desirable, some soldering metal. Preferably, the melting point of the auxiliary coating metal is higher than that of the heavy metal. Further features of the invention will become apparent upon a consideration of the detailed description of the various embodiments thereof which follows.

In general, it will be preferable to cut the plates or ribbons into strips which are metallically united with each other. It is, however, also possible to unite the whole plates to a block which then is divided, for instance by sawing, into a plurality of screening diaphragms. Another method of making a diaphragm consists in winding a ribbon of said combined metals into spiral form, so that the diaphragm receives a circular form.

The advantage of the method according to the present invention is twofold. In the first instance, in making the diaphragm, one has no longer to do with such a surface of the light metal, which is soldered or welded with difficulty, but with the surface of a covering layer, the properties with respect to easy soldering or welding of which may be chosen at will and favourably. In the second instance, it is possible to choose the coating metal in such manner that the joint between light metal and auxiliary layer on one hand and between the auxiliary layer and the heavy metal on the other hand has a considerably greater strength than a joint which is carried out directly between light metal and heavy metal or between light metal and soldering metal.

The auxiliary metal coating may be applied to the underlying metal by any suitable method which will assure an intimate adhesion of the auxiliary coating to the base metal, for instance by a mechanical process, such as rolling, by an electro-galvanic process, or by squirting molten metal onto the surface of the light metal.

In carrying out the electro-galvanic process for covering the light metal plate with an auxiliary metal layer, the plate is carefully cleaned of all grease, after which it may also be pickled or dipped in order to effect a rough surface. In this manner, strongly adhering galvanic deposits may

be obtained, from all metals generally utilized in electro-plating, such as from copper, zinc, cadmium, iron, silver, etc. Especially, suitable for this purpose is nickel. The thickness of the nickel deposit should preferably be approximately 0.01 mm.

As is well known, pickling may be carried out in an alkaline bath or in an acid bath, for instance hydrochloric acid with metal salts. A crystalline surface which is very favourable for the adhesion of the auxiliary metal coating is obtained by pickling the plates or ribbons several times, alternating in the alkaline bath and in the acid bath.

In some cases it may be of advantage to apply two auxiliary metal coatings one on top of the other in order to assure the best possible adhesion of the auxiliary coating to the light metal as well as to the heavy metal and to the soldering metal. When in the following description mention is made of the melting point of the metal coating, always the melting point is meant of that partial coating which melts easiest.

In case the heavy metal employed is a metal having a low melting point, such as for instance lead or a lead alloy, the plates or ribbons of light metal which are provided with an auxiliary coating may be coated with the desired layer of heavy metal directly, for instance by dipping the same into a bath of molten heavy metal. The diaphragm is then made by joining strips coated with a layer of heavy metal alternately with strips of light metal having one auxiliary coating only, and, if desired, soldering metal may be employed for fastening the strips to each other. In this case, however, the thickness of the leaves of heavy metal will always be relatively small, and therefore, the method just mentioned will be applied substantially in such instances only where very thin heavy metal leaves are desired.

In general, however, methods will be preferred in which the heavy metal is introduced in the form of metal foils. According to one proposal, for instance, light metal strips having an auxiliary metal coating alternating with heavy metal strips may be laid one on top of the other, whereupon the pile of strips is compressed while simultaneously applying heat and adding soldering metal to the edges of the strips. This process, however, has the disadvantage that the soldering metal, having been added in a surplus quantity, forms, to a very extensive degree, an alloy with the heavy metal, for instance lead, so that the heavy metal partly melts away or by mixing itself with the soldering metal does not effectively screen the secondary rays.

For this reason, it is preferred to apply the soldering meal before the heating process in a limited quantity between the strips to be united. This introduction of the soldering metal may be carried out by laying a soldering metal foil between two alternating strips of light metal and heavy metal. The best method, however, is to apply a soldering metal layer on one or both sides of the light metal strips or of the heavy metal strips or of all strips. It is not necessary to apply more soldering metal than is absolutely required for effecting a reliable joint nor to heat the compressed strips at a temperature which is higher than the melting point of the soldering metal; it may even be sufficient to apply heat which is somewhat lower than said melting point.

As solding metal, all metals or alloys may be employed which will adhere to the auxiliary coating as well as to the heavy metal, and the melting point of which lies under that of the auxiliary coating and that of the heavy metal. In many cases, it is recommended to use tin or an alloy of tin and lead as the soldering metal.

In this latter case, the soldering metal layer is produced in the following manner:—The light metal plate or ribbon having been coated with an auxiliary layer is either dipped into flux, such as zinc chloride, and thereafter into a tin melt or a tin-lead melt, or tin is deposited thereon by a plating process, or a tin foil or a tin-lead foil is applied or pasted to both sides of the coated light metal plate.

It is within the scope of the invention to apply the soldering metal by any other process than those suggested above.

According to a preferred method, the light metal plates or ribbons, having first been provided on both sides with an auxiliary coating and then with a soldering metal layer on top of said coating, are provided on one or both sides with a heavy metal coating. This last-named coating may be produced in any convenient manner, for instance electrolytically or by squirting. A very effective and reliable method, however, is to produce the heavy metal layer by pasting a heavy metal foil onto the prepared light metal strip. As adhesive, one preferably uses a soldering or flux means, such as resin or stearin. To ensure good adhesion of the heavy metal foil, the plates or ribbons together with the metal foil between them are rolled.

If the prepared light metal plates have a coating of heavy metal on both sides, it is recommended, when joining together strips thereof, to insert between two such strips a strip of light metal which also has an auxiliary metal coating on both sides and a soldering metal layer but no heavy metal coating.

The light metal strips have a thickness of about 0.2–0.4 mm.; the auxiliary metal and the soldering metal layers have each a thickness of about 0.01–0.02 mm.; and the heavy metal layers a thickness of about 0.04–0.06 mm. In special cases other dimensions may be employed.

Referring now to the accompanying drawing, which for the sake of clearness shows a diaphragm in exaggerated manner and not to scale, a preferred method of manufacture will be described by way of example. Fig. 1 is an interrupted section of three elements of a diaphragm according to the invention. Fig. 2 is a section through an entire diaphragm, but only light metal strips alternating with heavy metal strips have been shown, the auxiliary coatings and the soldering metal layers having been left out for the sake of clearness. Fig. 3 is a fragmentary section similar to that of Fig. 2 but differing from the latter in that the light metal strips alternating with the heavy metal strips are arrranged in converging relationship with respect to one another.

In carrying out the method, a plate of aluminium 1 having a thickness of about 0.3 mm. is degreased, pickled and scratched, then plated with a layer of nickel 2 of about 0.01–0.015 mm. thickness, and washed. Thereafter it is plated with a layer of tin 3 with a thickness of about 0.01 mm., and again washed and dried. Upon one side of this prepared light metal plate some adhesive is then squirted and on top of this a lead foil 4 of about 0.05 mm. thickness is laid and rolled. Both sides are thereafter oiled with

stearin and the plate is cut into strips which are formed into a pile. This pile is packed into a press cassette of aluminium, compressed and heated to a temperature just above the eutetic point of the alloy between lead and the soldering metal. After finishing the edges of this pile and cutting it to the desired size it is surrounded by a protective cover **5**, Fig. 2, of aluminium. This cover may conveniently be made of two thin aluminium sheets which are twice folded together at the edges **6**.

In the examples shown in Figs. 1 and 2, the leaves are arranged in parallel relationship. It is, however, possible and within the scope of the present invention to arrange the leaves opaque to X-rays in planes which converge relatively to each other so as to coincide with the directions of radiation from the focal point of the Roentgen tube as is indicated in Fig. 3. In other words, when utilizing a diaphragm according to the present invention in a Roentgen apparatus, the screening elements have the main extension of their section directed towards the focus of the Roentgen tube.

What we claim is:—

1. An X-ray screening diaphragm consisting of strips of light metal coated with a metallic layer having a surface which is more easily solderable than the surface of the light metal, alternating with strips of heavy metal.

2. An X-ray screening diaphragm consisting of strips of heavy metal alternating with strips of light metal coated with a metallic layer having a surface which is more easily solderable than that of the light metal and the melting point of which is higher than that of the heavy metal.

3. An X-ray screening diaphragm consisting of strips of heavy metal alternating with strips of light metal coated with a metallic layer having an easily solderable surface, and having a layer of soldering metal applied to said surface.

4. An X-ray screening diaphragm consisting of leaves of lead alternating with leaves of aluminium which is coated with nickel and with tin on top of the nickel.

5. An X-ray screening diaphragm consisting of leaves of heavy metal alternating with leaves of light metal coated with a metallic layer having an easily solderable surface, said leaves being arranged in converging relationship with respect to each other.

6. An X-ray screening diaphragm consisting of elements of heavy metal alternating with elements of light metal coated with a metallic layer having an easily solderable surface and having a higher melting point than said elements of heavy metal.

7. An X-ray screening diaphragm as claimed in claim 6, in which the elements of heavy metal and the elements of light metal are arranged in converging relationship with respect to each other.

8. An X-ray screening diaphragm consisting of leaves of heavy metal standing upright alternating with leaves of light metal also standing upright, and a plate of light metal mounted on either side of the diaphragm covering the short edges of the upright standing leaves.

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