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RADIOACTIVE METALLIC FOIL PRODUCT

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FIG. 1

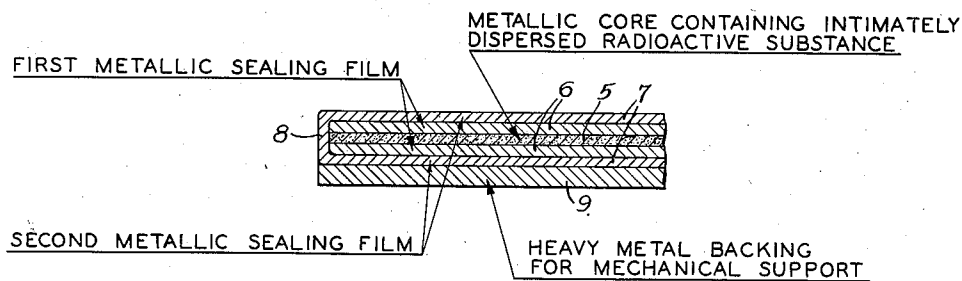
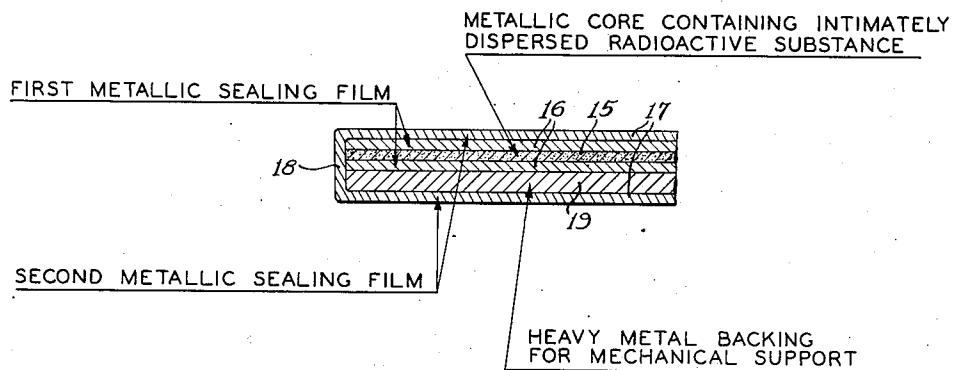


FIG. 2



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RADIOACTIVE METALLIC FOIL PRODUCTS

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Application September 27, 1947, Serial No. 776,542

8 Claims. (Cl. 250—106)

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In our copending application Serial No. 654,460, filed March 14, 1946, of which this application is a continuation-in-part, we have described a radioactive metal foil comprising a thin metallic core in which a radioactive alpha-particle-emitter is intimately dispersed, to which a thin sealing film, substantially free of radioactive material, is applied. The sealing film largely prevents the escape of radon or other gaseous radioactive disintegration product of the radioactive material (e. g. radium sulphate). The sealing film, however, is thin enough to be penetrable by alpha particles emitted by the radioactive substance, and this means that it is usually only about $\frac{1}{2}$ to $1\frac{1}{2}$ microns thick.

The present invention provides an improved radioactive foil of this character, having a second thin sealing film applied by electrodeposition or otherwise to the outer surface of the first sealing film. The second sealing film minimizes escape of the gaseous radioactive disintegration products, and is preferably of such character as to provide a hard surface on the product.

Extensive experience with radioactive foils of the character described in our above-mentioned application has shown that, while the sealing film prepared as described in our aforementioned application reduces the escape of radon or other radioactive gas to a very small fraction of that produced by disintegration of the radioactive ingredient of the core, the sealing efficiency of the film is not perfect. We have found that two factors seemingly contribute to the escape of a small proportion of the radioactive gas. One of these factors is the presence of minute fissures in the sealing film, or thin spots therein that are not wholly impervious to penetration by gas molecules, which evidently are formed in rolling the metal product to the required thinness. The other factor results from the need of cutting the rolled foil to the size and shape required for use. The cut side or end edges expose minute areas of the core in which the radioactive material is dispersed, and a small proportion of the radioactive gaseous disintegration product evidently escapes at these exposed areas.

While only a small amount of radon or other radioactive gas escapes from a cut foil prepared as described in our above-mentioned application (the amount that escapes is in the neighborhood

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of 1%, more or less, of the amount formed, depending on the average thickness of the sealing film and the area of the cut edges relative to the total area of the foil), it is generally desirable to reduce its escape to the smallest extent practicable.

We have found that if a second thin metallic sealing film is applied over the first sealing film, preferably so that it covers any cut edges of the coil as well as the broad surface areas thereof, the amount of radon or other radioactive gaseous disintegration product that escapes from the foil may be reduced to one one-hundredth of one per cent, or less, of the amount formed in the foil by disintegration of the radioactive substance. Fissures and excessively thin spots in the first sealing film, and areas of the core that are exposed at cut edges of the foil may be effectively sealed by the second sealing film. There is very little chance that defects in the second sealing film will coincide in location with defects in the first sealing film, so minute fissures or the like in the second sealing film do not in general impair its efficacy.

Gold is generally the most satisfactory material to employ in the manufacture of both the core and the sealing film of the radioactive foil described in our aforementioned application, because it is highly resistant to oxidation, is unaffected by the radioactive component of the product, and is more easily rolled to the required thinness than any other metal. Gold, however, is a soft metal and is quite easily abraded by mechanical handling of the product in use. Because of the necessary extreme thinness of the gold sealing film, such abrasion can seriously shorten the safe service life of the product. By suitably selecting the material of which the second sealing film is composed, a product having the advantages of a first sealing film of gold combined with a coating or surface film that is wear-resistant and hence longer-lived, or that possesses other desired properties, may be produced.

The combined thickness of the first and second sealing films together is preferably no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by the radioactive substance. We have found that the advantages of greatly reduced escape of radon or other radioactive gas, and of improved

foil surface characteristics, are effectively provided even when the combined thickness of the two sealing films is no more than 1 to 2 microns; and yet sealing films having this combined thickness generally are quite readily penetrated by the alpha particles emitted by such radioactive substances as radium compounds, thorium compounds, polonium compounds, etc.

Based on the foregoing, our present invention provides a radioactive metallic product that emits alpha particles comprising a thin metallic core having a radioactive alpha-particle-emitting substance intimately dispersed therein, a thin metallic film substantially free of radioactive material bonded to a surface of said core, and a second thin metallic film also substantially free of radioactive material separately applied to the outer surface of said first-mentioned film, the combined thickness of said films being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by the radioactive substance.

Successful embodiments of the invention are shown in the accompanying drawings, in which

Fig. 1 is a cross-section, on a greatly magnified scale, through a radioactive foil of the type provided by the invention, and

Fig. 2 is a cross-section, also on a greatly magnified scale, through an alternative type of foil.

The foil shown in Fig. 1 comprises a core 5 of a metal such as gold in which a radioactive substance such as radium sulphate is intimately dispersed. A first sealing film 6, free of any radioactive material and advantageously of pure gold, covers both sides of the core. The core 5 is most conveniently prepared by compressing and sintering a mixture of gold powder and finely divided radium sulphate or other radioactive substance. The metal forming the first sealing film 6 may be welded to the core after the former has been compressed and sintered, and the composite of core and first sealing film may be reduced by rolling to the desired total thickness, say about 5 microns or less. Thus the core of the rolled product may be about 0.3 to 3 microns in thickness and the first sealing film may be about $\frac{1}{2}$ to $1\frac{1}{2}$ microns in thickness on each side of the core. The core and first sealing film are, of course, coextensive in length and breadth. The manner in which the core and the first sealing film bonded thereto is prepared is not a part of the present invention; we prefer, however, to prepare it as described in our aforementioned copending application Serial No. 654,460.

In accordance with the invention and as shown in Fig. 1, a second metallic sealing film 7 is applied over the outer surfaces of the first sealing film 6. The second sealing film may be applied in various ways, as by sputtering in vacuum or by dipping the composite of core and first sealing film in a molten coating metal and wiping off the excess, but in general we find it most satisfactory to apply it by electrodeposition. It is highly desirable to apply the second sealing film after the composite of core and first sealing film have been reduced to final thickness and cut to desired size, so that the exposed end or edge surfaces of the core are covered by the second sealing film, as indicated at 8.

A backing 9 of relatively very heavy gauge metal is bonded to one surface of the sealed foil to provide mechanical support for the very thin core and sealing films, and to facilitate handling and mounting it. Silver about 0.020

inch in thickness is a very satisfactory backing metal, but copper, brass, nickel, aluminum, or other metal, or a non-metal such as glass, may be used for the backing if desired. In some cases, the backing may be omitted altogether, but then extreme care must be used in handling the thin and delicate foil.

In the alternative foil construction shown in Fig. 2, the radioactive metallic core 15 and the first sealing film 16 (both preferably being of gold) are substantially the same as the corresponding parts of the foil shown in Fig. 1. However, in the foil of Fig. 2, the heavy backing 19 of silver or other desired material (preferably a metal in this case) is bonded directly to a surface of the first sealing film 16. The second sealing film 17 then is applied, by electrodeposition or otherwise, over the already backed and once-sealed radioactive film. Here again it is highly desirable that the second sealing film extend around and cover the cut edges of the radioactive core, as indicated at 18.

The second sealing film 17, where it extends over the surface of the backing 19 on the side opposite the radioactive core 15, serves no necessary purpose, but it is generally easier and less expensive to apply it to both sides of the product than to seek to avoid applying it to the places where it is not particularly necessary. The same generally is true of any sealing films interposed between the radioactive core and the backing (such as the first and second sealing films of Fig. 1 when they lie between the core 5 and the backing 9, and the first sealing film of Fig. 2 when it lies between the core 15 and the backing 19) sealing films at these places add nothing to the effectiveness of the backing itself as a sealing layer, but it is generally easier and less expensive to apply them all around the core than only on the sides (i. e. the otherwise exposed face or faces of the core) where they are really advantageous.

Any metal having physical properties suited to the ultimate use of the foil may be used as a second sealing film 7 or 17 in accordance with the present invention. Nickel, cobalt, chromium, cadmium, copper, tin, silver, gold, rhodium, platinum, iridium, and alloys such as brass or cupronickel are examples of metals that can be so used, and that may be electroplated on the once-sealed foil before or after bonding it to the backing. For most purposes, we find nickel and chromium to be particularly desirable metals of which to make the second sealing film. Electroplating procedures are available for applying both nickel and chromium as a bright deposit that does not require buffing to form a smooth surface of uniform thickness. Electrodeposited films of both nickel and chromium electroplates are hard and resistant to corrosion, and impart to the foil a wear-resistant non-corrosive surface. Both nickel and chromium also have the advantage of being of intermediate atomic weight, so that a film of given thickness of either of these metals is more readily penetrable by alpha particles of given energy than is a film of a metal of considerably higher atomic weight, such as silver, tin, gold, or the platinum group metals.

No particular difficulty is encountered in applying the second sealing film by well-known electroplating procedures. It is only necessary to be sure that the foil to which the electroplate is applied is clean, and that the electroplating process chosen be carried out under conditions appropriate to formation of a thin, adherent

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deposit of good quality. It is generally advantageous to apply the electroplate at as low a current density as is practical for the particular plating procedure used, to insure formation of a dense, uniform and firmly adherent second sealing film.

As pointed out above, the second sealing film should be sufficiently thin so that the combined thickness of both the first and second sealing films will be no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by the radioactive substance. Generally speaking the second sealing film should be from $\frac{1}{2}$ to $1\frac{1}{2}$ microns in thickness, and related to the thickness of the first sealing film so that the combined thickness of both sealing films will be not greater than about 2 microns in the direction of desired radiation. If the thickness of the first sealing film is in the lower portion of its thickness range as given above, then the thickness of the second sealing film may be in the upper portion of its thickness range; but if the first sealing film is thick enough so as to have a thickness in the upper portion of the range given, the second sealing film need be and should be of a thickness that lies in the lower portion of its thickness range. If possible, the combined thickness of the two films should be less than about $1\frac{1}{2}$ microns in order to combine maximum sealing effect against the escape of radon or other radioactive gas, with maximum penetrability by alpha particles.

Certain of the appended claims refer specifically to a foil having a nickel electroplate overlying the first sealing film. A chromium electroplate is to be regarded as among the equivalents of the nickel electroplate specifically mentioned in such claims, because it, like nickel, forms a hard surface layer that is resistant to corrosion, and because the atomic weight of chromium is sufficiently low so that a thin electroplate thereof is penetrated by alpha particles from radium, for example, more readily than is a gold film of equal thickness.

We claim:

1. A radioactive metal product that emits alpha particles comprising a thin metallic core having a radioactive alpha-particle-emitting substance intimately dispersed therein, a thin metallic film substantially free of radioactive material bonded to a surface of said core, and a second thin metallic film also substantially free of radioactive material separately applied to the outer surface of said first-mentioned film, the combined thickness of said films being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

2. A radioactive metal product that emits alpha particles comprising a thin metallic core having a radioactive alpha-particle-emitting substance intimately dispersed therein, a thin gold film substantially free of radioactive material bonded to a surface of said core, and a second thin metallic film also substantially free of radioactive material separately applied to the outer surface of said gold film, the combined thickness of said films being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

3. A radioactive metal product that emits alpha particles comprising a thin metallic core having a radioactive alpha-particle-emitting substance intimately dispersed therein, a thin me-

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tallic film substantially free of radioactive material bonded to a surface of said core, and a nickel film also substantially free of radioactive material separately applied to the outer surface of said films, the combined thickness of said film being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

4. A radioactive metal product that emits alpha particles comprising a thin metallic core having a radioactive alpha-particle-emitting substance intimately dispersed therein, a thin gold film substantially free of radioactive material bonded to a surface of said core, and a nickel film also substantially free of radioactive material separately applied to the outer surface of said gold film, the combined thickness of said films being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

5. A radioactive metal product that emits alpha particles comprising a thin core film of pressed gold powder intimately mixed with a finely divided alpha-particle-emitting substance, a thin gold sealing film substantially free of radioactive material bonded to a surface of said core film, and a thin nickel film applied to the outer surface of said sealing film, the combined thickness of said films being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

6. A radioactive metal product that emits alpha particles comprising a thin metallic core strip having a radioactive alpha-particle-emitting substance intimately dispersed therein, thin metallic sealing films substantially free of radioactive material bonded to both surfaces of said core strip and coextensive in length therewith, and a thin metallic coating covering the outer surfaces of said films and the side and end edges of the assembled core strip and sealing films, the combined thickness of the sealing film and coating on at least one side of the strip being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

7. A radioactive metal product that emits alpha particles comprising a thin metallic core strip having a radioactive alpha-particle-emitting substance intimately dispersed therein, a thin gold sealing film substantially free of radioactive material bonded to at least one surface of said core strip and coextensive in length therewith, and a thin nickel coating covering the outer surface of said film and the side and end edges of the assembled core strip and sealing film, said sealing film and coating covering all areas of the foil where radioactive gaseous disintegration products might escape from the core to the atmosphere, the combined thickness of the sealing film and coating on at least one side of the strip being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

8. A radioactive metal product that emits alpha particles comprising a thin metallic core strip having a radioactive alpha-particle-emitting substance intimately dispersed therein, said core strip being mounted on and supported mechanically by a relatively heavy backing, a first thin metallic sealing film bonded to the face of said core opposite said backing, and a second thin metallic sealing film applied over said first-sealing

film, said second sealing film extending around and sealing the edges of the core, the total combined thickness of said first and second sealing films being no greater than can be penetrated by alpha particles having the maximum energy with which they are emitted by said radioactive substance.

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The following references are of record in the file of this patent:

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