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RADIOACTIVE UNIT AND METHOD OF
PRODUCING THE SAME

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My invention relates to improved radio-active units and to the method of producing the same.

My present invention also enables me to prepare radio-active units from metal powder and finely-divided radio-active substances which have a thickness less than the maximum depth of penetration of alpha rays in the metal which is used for mixing with the radio-active substance, so that the units will have the ability to emit alpha, as well as beta and gamma rays.

In Letters Patent No. 1,718,899 issued to me June 25, 1929, two methods of producing radio-active units are described, these methods comprising, briefly (a) the electrodeposition of radio-active substances on metal and (b) uniting the radio-active substances with the metal by heat treatment. These methods proved highly satisfactory when platinum or platinum-iridium was used as the carrier for the radio-active substances, but were not satisfactory if other metals, such as copper, steel, etc., were to be united with the radio-active substances.

It is a known fact that platinum, in comparison with certain other metals, is soft and experience has shown that in some cases radium needles or like units when made according to the above mentioned patent bend or break when inserted into tumors. Another disadvantage of prior art units is the lack of uniformity of distribution of the radio-active substance in the carrier and the consequent danger of non-uniform radiation of the unit when inserted.

The principal object of my invention is to provide an improved form of radio-active unit and a method of producing the same, whereby the inadequacies and disadvantages of the prior art are obviated. By means of my present invention I am enabled satisfactorily to unite the radio-active substances, such for example as radium, mesothorium, the salts thereof, or other natural or artificial radio-active substances with metals such as copper, stainless steel, nickel, aluminum, tungsten, silver, gold, etc., and to secure absolutely uniform distribution of the radio-active substance in the metal carrier.

Stated in general terms, the method of my invention comprises the steps of forming an intimate mixture of the metal powder and the radio-active substances, then subjecting the mixture to very high pressure to form a compact mass, thereafter subjecting the mass to heat treatment at temperatures below the melting point of the metal used as the carrier in any particular case. The pressure and heat treatment may be simultaneous or successive and, in some cases,

the sintered compact mass may again be pressed and heated and, if desired, may be hammered. The details of the procedure are governed to an extent, by the kind of metal powder used and the properties the final product is to have. The radio-active substances are preferably used in the form of their salts, for example radium sulphate with barium sulphate.

I have found in practice that I can obtain virtually perfect uniformity of distribution of radio-activity throughout the unit by employing a concentration of 98 to 99% of metal power and 2 to 1% of radio-active salt. Since, however, such high radio-activity is ordinarily not desired, I preferably blend radium salt and barium salt so that the two salts combined amount to about 1 to 2% in the unit. To obtain a uniform mixture of the salts, the calculated quantities thereof in the form of chlorides are dissolved in distilled water and precipitated by drops of sulphuric acid.

The heat treatment, referred to above, of the mixture of metal and radio-active substances, is effected under vacuum or under a protective atmosphere of a suitable gas such as hydrogen, nitrogen, argon or helium; hydrogen being preferred in order to eliminate the last traces of oxides. When operating at high temperatures, hydrogen reduces sulphates to sulphides, for example barium sulphate is reduced to barium sulphide between 900 and 1000° C. and consequently it is advantageous to reduce the radium-barium sulphate to sulphide before these substances are mixed with the metal powder.

When the heat treatment is carried out under vacuum, the heating furnace is first cleaned with a selected gas (hydrogen, nitrogen, etc.) before evacuation, the gas retained in the furnace until the temperature within the latter reaches 400° C., the furnace evacuated and maintained under vacuum as long as the interior temperature is above 400° C., and when the temperature drops below 400° C., gas is again introduced and retained in the furnace until the latter is perfectly cold.

In the practice of the method of my invention, any apparatus I employ is of standard construction and as it involves no special parts or arrangements I deem it unnecessary to illustrate the devices referred to in the course of the following description.

As a specific example of the forms of units which may be produced in accordance with my invention, very thin sheets or wires capable of

emitting alpha, beta and gamma rays are typical and are made by the following processes:

The metal powder and radio-active salts are thoroughly comminuted and ground together in an automatic grinding mortar and then passed through an agitating or shaking machine. Assuming that radium-barium sulphides are the radio-active salts employed and CO-reduced dry commercial copper is employed as the metal carrier, these components in the calculated amounts are reduced in a steady stream of commercial purified hydrogen at 300° C., for about two hours for the purpose of removing the last vestiges of oxides and water. The powder mixture is now consolidated by the application thereto of pressure of 25 tons per square inch and the consolidated or compacted mass is subjected to a sintering operation in an electric combustion furnace under the protective atmosphere of hydrogen.

During the sintering operating the temperature is increased very slowly, the preferred times and temperatures being: one hour at 400° C., one hour at 750° C., and 2 hours at 950° C., at which stage the material is white hot. The white hot block is removed from the furnace and subjected to the action of a heavy hammer to increase the density of the block to the maximum. The block is now in condition to be rolled into sheets of .0004 inch thickness or drawn into wires of a diameter similar to the thickness of the sheets. The small dimensions are necessary because the penetration power of alpha rays in copper is no greater than .018 mm. = .0007 inch. Whether rolled into sheets or drawn into wire, the thickness of the units should not exceed the maximum depth of penetration of alpha rays in the metal which is used for mixing with the radio-active substance.

Because of the extreme thinness of the sheet and the small diameter of the wires a backing therefor is often desirable and this may readily be supplied by soldering together a strip of cast copper, say 1 mm. thick, with a strip or wire of radio-active copper, say .01 mm. thick, and rolling the assembly down to about 0.1 mm. thickness. I may also form tubes of radio-active copper having a wall thickness of about .1 mm. and a diameter of 1 mm. and solder into the tube a cast copper wire having a diameter of about 1 mm. By drawing the assembly of tube and wire down to a thickness of .1 mm. the thickness of the radio-active part does not exceed .01 mm.

The units of my invention may take a great many different forms and are capable of use in many fields. The following cases illustrate a number of the uses in which my invention may be used.

In therapy radium needles, radium plaques, radium cells, radium pads, radio-active electrodes, tiny radio-active wires and sheets (the latter for the treatment of teeth) are used. These objects made of radio-active metals offer the advantage of emitting alpha, beta, and gamma rays contrary to the usual preparations, which give off gamma rays, occasionally also beta rays, but never alpha rays, while it must be borne in mind that about 90% of the total radium radiation consists of alpha rays. Furthermore, medical instruments like radium needles, for instance, made of radio-active stainless steel are much smaller in size and therefore cause smaller wounds than the ordinary needles and furthermore they are indestructible.

In physics there is need of a real alpha radiator. Polonium possesses the peculiarity of emitting alpha rays; its activity, however, is not permanent but decays with time, falling to half value in about 140 days. The half value period of the radium metal compound, however, is about 1650 years.

Due to their ability to emit alpha and beta rays the radium metal compound may be successfully used for various technical purposes. A web of radio-active wire ionizes the surrounding air and in this way discharges the electrical tension in the immediate neighborhood of explosives. Phosphorescent zinc sulphide subjected to alpha radiation will shine in the dark. Therefore zinc sulphide is mixed with radium salts. The phosphorescent power of zinc sulphide is exhausted after about two years. Together with the zinc sulphide the radium is lost. The radium metal compound, however, permits of keeping the radium incorporated in the metal and only the zinc sulphide has to be renewed. The radio-active metal is also of advantage in spark plugs. Ionization to a certain degree improves the formation of sparks. Equipping one or both electrodes of the spark plug with radio active metal would mean ionization of the gaseous mixture at the right spot. It is well known, that radium rays in small doses increase the growth of plants. A radio-active metal sheet put into a flower-pot would cause rapid and exuberant growth of flowers. Radium rays, especially alpha rays, are strong germicides. They also have the power of stimulating the formation of vitamins. Radio-active sheets brought in contact with milk, for instance, sterilize the milk and increase the vitamin contents. It may be assumed also that the radium metal compound emitting a continuous uniform stream of electrons will find its place in radio-technique, in long distance telephony and the like.

I claim:

1. As a new article of manufacture, a radio-active unit in the form of a solid compact mass capable of emitting alpha, beta and gamma rays and consisting of a highly compressed and sintered intimate mixture of a finely comminuted radio-active substance selected from the class consisting of radio-active salts and a finely comminuted non-cementitious metal carrier selected from the class consisting of copper, steel, nickel, tungsten, silver and gold.

2. As a new article of manufacture, a radio-active unit consisting of a highly compressed intimate mixture of finely comminuted radio-active salts amounting to about 1 to 2% of the unit and a finely comminuted metal carrier amounting to about 98 to 99% of the unit.

3. As a new article of manufacture, a radio-active unit consisting of a highly compressed intimate mixture of finely comminuted radium sulphate, barium sulphate and copper.

4. The herein described method of manufacturing radio-active units, which comprises comminuting a radio-active substance and a metal carrier to maximum fineness, forming an intimate mixture of said substances, compacting said mixture to obtain maximum homogeneity of the mixture and subjecting said compacted mixture to the action of heat at graduated temperatures.

5. The herein described method of manufacturing radio-active units, which comprises forming an intimate mixture of finely comminuted radio-active substance and metal carrier, subjecting said mixture to pressure sufficient to form

a compact mass of maximum homogeneity and subjecting said compacted mass to the action of heat at graduated temperatures in the presence of a protective atmosphere of gas.

6. The herein described method of manufacturing radio-active units, which comprises forming an intimate mixture of finely comminuted radio-active substances and metal carrier, subjecting said mixture to pressure sufficient to form a mass of maximum homogeneity, heating said mass in the presence of a protective gas atmosphere for one hour at about 400° C., another hour at about 750° C., and two hours at about 950° C., until said mass is white hot, subjecting the mass to pressure to achieve maximum density thereof and thereafter forming desired articles from the mass.

7. A thin elongated member that emits alpha rays and comprises a mechanically worked intimate mixture of metal powder and finely-divided radio-active substance sintered together, the thickness of the member being less than the maximum depth of penetration of alpha rays in such metal.

8. A thin elongated member that emits alpha rays and comprises an intimate mixture of particles of metal powder and finely-divided radio-active substances welded together by compression and sintering, the thickness of the member being

less than the maximum depth of penetration of alpha rays in such metal.

9. A mass of metal powder particles welded together by compression and sintering and having intimately dispersed therein a finely-divided radio-active substance, the thickness of the mass being less than the maximum depth of penetration of alpha rays in such metal.

10. In the manufacture of radio-active metallic members the improvement which comprises compressing and sintering to form a coherent relatively thick mass an intimate mixture of metal powder and a finely-divided radio-active substance, and reducing the thickness of the mass thus formed by mechanical working until its thickness is less than the maximum depth of the penetration of alpha rays in such metal.

11. In the manufacture of radio-active metallic members the improvement which comprises compressing and sintering to form a coherent relatively thick mass, an intimate mixture of metal powder and a finely-divided radio-active substance, reducing the thickness of the mass thus formed by mechanical working it in a hot condition, and thereafter subjecting the mass to mechanical working in a relatively cold condition until its thickness is less than the maximum depth of the penetration of alpha rays in such metal.

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