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ELECTRIC CONDUCTOR AND PROCESS OF MAKING SAME.

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This invention relates to improvements in electric conductors and process of making same; especially conductors designed to serve as electrodes in oscillating apparatus for communication by radio.

An object of the invention is to provide an electric conductor in the shape of a filament capable of thermionic emission in vacuum tubes; the filament being of novel composition, requiring relatively little power to cause it to become operative, and of relatively high efficiency and great durability.

A further object of the invention is to provide a filament of such a character that it will remain uniform and homogeneous in its molecular structure under all conditions of use, and in which the liability of the occurrence of defective portions with consequent deterioration and danger of burning out, is practically eliminated.

A further object of the invention is to provide a method by which an electrical conductor or filament of the nature above outlined can be produced in an easy and simple manner.

Other objects and advantages of this invention will be clear from the following description, and novel features of my invention will be defined in the appended claims; but I do not wish to be limited to the exact steps of procedure or other details herein set forth, since I may vary the specific process herein described for the sake of example, and to some extent the composition of the electrode or filament itself, without departing from the scope and spirit of the invention.

A conductor in the form of a filament according to my invention is particularly adapted for high power vacuum tubes, but by no means necessarily limited to such devices, as I may employ improved filaments made according to my invention, for ordinary vacuum tubes such as are generally mounted in radio receiving sets. Heretofore, vacuum tubes for radio communication have generally consisted of a bulb from which the air has been exhausted and containing a filament, a grid and a plate; the filament being made of some suitable conducting material and coated with a proper metallic oxide, so that it will emit electrons freely without consuming an unduly large quantity of current, supplied to the filament to heat the same and raise it to a temperature at which it will glow and become active. In high power tubes when a tube having a coated filament is employed in this way, the electric field generated by the anode or plate will often affect the filament or cathode in such a way that the outside coating of the filament will crack and flake off, with the result that after such deterioration of the oxide coating is continued for a certain period of time, the filament will become very thin in one or more places along its length, and when such thin places have developed to a material extent, current passing through the filament will cause the filament to flow more at such points than at others. Hence, the occurrence of so-called "brightspots" which are nothing more than the parts or sections of the filament which have become thinner than the rest of the filament, because the coating on such parts has been lost. Under such circumstances, current passing through a filament in this condition, will heat it to a higher temperature at all of the thin portions, and when the filament burns out, the burning out will take place at one of the points where the bright spots have been caused to appear.

In my invention, I aim to overcome this drawback by making a filament consisting of an alloy of certain rare metals such as platinum and iridium, with such substances as barium carbonate ($BaCO_3$) and strontium carbonate ($SrCO_3$), or instead of the carbonates the oxides of barium and strontium can be taken.

By my method, the mixture of platinum and iridium is so treated that the filament produced therefrom, instead of being merely covered with a coating, envelope or film of metallic oxide, is so treated that the barium and strontium, either in the form of metals or as oxides, are incorporated with the platinum and iridium and caused to permeate the entire mass thereof to such an extent as to be absolutely inseparable therefrom. In fact, I believe the filament to have a composition consisting of platinum and iridium or the like, and barium and strontium, present either as metals or as oxides in the body of the product.

I proceed by taking some sponge platinum,

grinding it into the form of powder, and then passing it through a sieve of sufficiently fine mesh. Next I take a quantity of iridium in sponge form and treat it the same way; then mixing the sponge platinum and the sponge iridium together in the portion of 95% platinum to 5% iridium. This mass can be pressed together to give it the form of a bar or ingot of convenient size for further working. The pressing of the powdered sponge platinum and iridium can be done in a small cylinder equipped with suitable means for exerting the necessary amount of force upon the mixture so as to cause the particles to move together until they cohere. In this state, the platinum and iridium are removed from the cylinder for the next step in my process; and, obviously, before compression is effected to produce the ingot, the particles of sponge platinum and sponge iridium must be intermingled as much as possible.

The ingot is then placed in an alundum crucible where it is covered with a mixture of barium carbonate and strontium carbonate or a mixture of the oxides of each of these two substances, to such an extent that the ingot is completely buried therein. The action of heat is then resorted to and for this purpose I may employ either an oxyhydrogen flame, playing directly upon the contents of the crucible, or I may place the crucible in a carbon furnace. Then as the platinum and iridium melt, they will take up some of the ingredients of the mixture of barium and strontium compounds. When this stage of the process has proceeded far enough, the mass of mixed platinum and iridium is removed from the remainder of the mixture of the barium and strontium compounds, and upon inspection will be found to have a heavy coating of the barium and strontium compounds upon its outside surface. This coating will not be uniform in thickness or hardness and if the product was drawn to wire in this condition, it would be of very inferior quality.

Hence in order to cause the barium and strontium in whatever form they occur in the mixture to be evenly distributed through the mixed mass of platinum and iridium, I take the ingot of platinum and iridium after heating and clean it thoroughly by scraping or otherwise, to remove as much of the coating as possible. The metal bar is then placed in a clean alundum crucible and remelted, being left to stand in its molten state for a number of minutes. To cause remelting, I can employ an oxyhydrogen flame as before and the force of this flame will so agitate the molten metal that currents will be set up in it, so that the barium and strontium will be thoroughly mixed with the iridium and platinum and pervade the mass thereof, the barium and strontium being distributed uniformly throughout the molten metal and when the metal is allowed to cool and harden it will be quite homogeneous in structure and composition. The mass of material which I have so selected and treated is then a novel and very useful product that can be drawn down to any desired size by the means ordinarily employed to transform platinum rods into wire. This operation can be performed by drawing through a perforated die. The conductor is at first quite brittle. It therefore has to be annealed after having been pulled through every five dies, as it is successively drawn down through intermediate stages to wire of the necessary thinness, for the filament.

In its final condition, when the filament has been reduced to the size desired, it will be found to have the same capacity for emission as that of the ordinary coated filament, but is much more stable and more durable and can be operated with about half the current which a coated filament requires. The filament so produced is of uniform composition throughout, as distinguished from filaments having a body of one substance and a coating thereon of another or others, and my filament, because it has no coating, cannot deteriorate and become thin at any point through the loss or breaking off of the coating, and consequently, bright spots never appear and the occurrence of thin sections giving rise to the danger of burning out thereat is made impossible.

In the course of the method by which the filament is produced, the utilization of heat when barium and strontium in the form of carbonates are employed to cover the platinum-iridium ingot is really the same in effect as the use of barium and strontium oxides; because heat causes the carbonates to break up very readily into the oxides, and the stage at which the strontium and barium are introduced and the subsequent stages cause the formation of a product consisting principally of the platinum and iridium, with the barium and strontium either as metals in the free state or as oxides of these metals. In any case, the filament when finished is of uniform molecular structure and of the same hardness and thickness throughout its entire length, so as to afford all of the advantages and possess all of the qualities which my invention aims to secure.

Having described my invention what I believe to be new and desire to secure and protect by Letters Patent of the United States is:—

1. A conductor comprising a mixture of finely divided and intermingled platinum and iridium, and containing barium and strontium evenly distributed through the mass of the conductor.

2. The process of making a conductor which consists in intermingling finely di-

vided platinum and iridium, causing said materials to unite in a single mass, heating said mass in contact with a mixture containing barium and strontium, whereby said mass becomes coated on its outer surface, fusing said mass and causing the barium and strontium to be distributed uniformly therethrough and permeate same, and then allowing said mass to solidify and drawing it into wire of the required thickness.

3. A conductive substance comprising a mixture of finely divided platinum and iridium, the mixture containing compounds of barium and strontium distributed throughout its mass.

4. A conductive substance comprising a mixture of finely divided platinum and iridium, the proportion of platinum being in excess of that of iridium, the mixture containing compounds of barium and strontium distributed throughout its mass.

In testimony whereof I affix my signature.

JAMES V. CAPICOTTO.