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ALLOY AND ARTICLE COMPOSED OF SAME

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16 Claims. (Cl. 75—1)

This invention relates to metallic compositions for use in electron-emission devices and the like.

As cathodes for electron devices operated on direct current metallic filaments consisting of tungsten in which thorium oxide was embedded have been much used, but the advent of radio sets operating on alternating current made necessary a return to an older form of cathode consisting of a core of metal coated with a mixture of alkaline earths. Despite the manufacturing advantages of the thoriated tungsten, it was necessary to revert to the oxide-coated filament because it alone permitted of the use of short, stocky filaments, which, due to high thermal capacity, are relatively free from hum. The fact that the oxide-coated filaments emit at a temperature about half that of the thoriated filament was a further factor in the change.

The disadvantages of the oxide cathode type of filament are many. The high gas content of the carbonates or hydroxides, which, in the usual procedure are applied to the cathode and decomposed after mounting the latter in the tube, necessitates long periods of pumping during decomposition, resulting in the slowing up of production and therefore in significant increases in operating costs. Because of the impossibility of obtaining a perfectly uniform preliminary coating on the base metal, certain parts of the filament or heating unit are bound to rise in temperature over the remainder, and burnout frequently results. The coating is fragile and tends to flake off when the filament is handled.

A cathode with the low-temperature emission characteristic of the oxide-coated type, yet containing the emitting element as part of the cathode proper, rather than as a foreign coating on the surface only, is greatly to be desired, since it would thereby combine many of the advantages of the oxide-coated and thoriated tungsten types. It is obviously impossible, however, to alloy the alkaline earth metals with high melting point metals like tungsten or molybdenum; even if it were possible to form the alloys, fabrication of the tungsten or molybdenum into filament, in which fabrication high temperatures are essential, would result in the loss by vaporization of the alkaline earth metal.

For cathodes of the oxide-coated type it is not necessary, however, to use these high melting point metals. The intermediate melting point metals—iron, nickel, cobalt, and the like—are adequate for the purposes, and are regularly in use. Unfortunately, the alkaline earth metals do not alloy readily or to any great extent with metals of this sort; the best that can be done regularly with barium in nickel, as an example, is about 0.10%, though occasionally, under very special and exacting conditions, this may be raised slightly, to 0.15% barium content.

I have tested nickel alloys with the maximum content of barium which it is possible to incorporate and have found the electron emission to be much too low for satisfactory use. On the other hand, I have found that, contrary to previous belief, barium as well as the other alkaline earth metals will alloy in all proportions with copper. Using barium as an example, primarily because its emissive characteristics are the best of the alkaline earth metal family, though strontium is only slightly inferior in this respect, I have prepared copper alloys containing as high as 45% barium. Such alloys, however, are somewhat pyrophoric, lack stability under normal conditions, and are extremely brittle. It is doubtful, moreover, whether alloys of this type can be worked when the barium is present in the excess of 0.10%. What is even more vital to the situation, the melting point is much too low for the alloy to serve as an emission cathode.

By using, instead, ternary alloys composed of copper, nickel, and an alkaline earth metal (like barium), with the nickel in preponderance, I have found that much higher percentages of barium can be alloyed with the nickel than could be if no copper were present. The melting point of such ternary alloys is high—sufficiently high for use in electron devices—and their ductility and workability are retained as long as the barium is not raised to unduly high percentages. As an example, I may cite the alloy containing 30% of copper and 0.38% of barium with the balance nickel. This was drawn readily into wire and proved an effective emitter. Raising the barium content to 1.57% lowered the ductility and workability considerably, but under certain conditions of operation this disadvantage is compensated for by other qualities like increased emission. At least 0.25% of barium and at least 5% of copper should be present in the ternary alloy.

While the percentages cited represent alloys which have proven satisfactory, alloys containing up to 50% of copper can be used. As the copper content increases, the barium content can also be raised. However, for the purpose in question, 10% of barium represents the maximum needed.

These alloys can be made by first alloying the barium or similar alkaline earth metal with the copper, and then adding the alloy to the predominant metal, nickel. As indicated above,

other alkaline earth metals may be substituted for part or all of the barium.

This application contains subject matter in common with my prior application Serial No. 513,459, filed February 4, 1931 of which this application is a division.

I claim:

1. An alloy consisting of nickel, at least one alkaline earth metal, and copper; the alkaline earth metal being present in an amount between 0.25% and 10%, the copper being present in an amount between about 5% and 50%, the balance being nickel.

2. An alloy consisting of nickel, barium, and copper, in the proportions: 0.25% to 10% barium, 5% to 50% copper, the balance nickel.

3. An alloy consisting of nickel, at least one alkaline earth metal, and copper, in the proportions: 0.25% to 10%, alkaline earth metal, 30% to 50% copper, the balance nickel.

4. An alloy consisting of nickel, barium, and copper, in the proportions: 0.25% to 10% barium, 30% to 50% copper, the balance nickel.

5. A thermionic device comprising a cathode composed of an alloy consisting of nickel, at least one alkaline earth metal, and copper; the alkaline earth metal being present in an amount between 0.25% and 10%, the copper being present in an amount between about 5% and 50%, the balance being nickel.

6. A thermionic device comprising a cathode composed of an alloy consisting of nickel, barium, and copper, in the proportions: 0.25% to 10% barium, 5% to 50% copper, the balance nickel.

7. A thermionic device comprising a cathode composed of an alloy consisting of nickel, at least one alkaline earth metal, and copper, in the proportions: 0.25% to 10%, alkaline earth metal, 30% to 50% copper, the balance nickel.

8. A thermionic device comprising a cathode composed of an alloy consisting of nickel, barium, and copper, in the proportions: 0.25% to 10% barium, 30% to 50% copper, the balance nickel.

9. An alloy consisting of nickel, barium, and copper, in the proportions: .25% to 8.5% barium, 5% to 50% copper, the balance nickel.

10. A thermionic device comprising a cathode composed of an alloy consisting of nickel, barium, and copper, in the proportions: .25% to 8.5% barium, 5% to 50% copper, the balance nickel.

11. An alloy characterized by ready emission of electrons comprising from .25% to 10% barium, the balance consisting chiefly of nickel and copper.

12. An electron emitter made of an alloy consisting predominantly of nickel, copper and barium.

13. A method of forming alloys of alkaline earth metal and nickel which consists in employing a proportion of copper in the melt to hold the alkaline earth metal in solution.

14. A method of forming alloys containing nickel and barium which consists in employing a proportion of copper in the melt to hold the barium in solution.

15. An electron emitter made of an alloy consisting predominantly of nickel, copper and an alkaline earth metal.

16. An electron emitter made of an alloy comprising nickel as a base metal, an alkaline earth metal to impart high electron emissivity to the alloy, and copper to hold the alkaline earth metal in solution.

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