UNITED STATES PATENT OFFICE.

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ELECTROLYTICALLY REFINING ALLOYS.

987,947. Specification of Letters Patent. Patented Mar. 28, 1911.

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To all whom it may concern:

Be it known that I, ANSON GARDNER BETTS, a citizen of the United States, residing at Troy, in the county of Rensselaer and State of New York, have invented certain new and useful Improvements in Electrolytically Refining Alloys, of which the following is a specification.

This invention relates to the differentiation of alloys into two parts, one of which contains proportionately more of one ingredient and the other less of that ingredient, while at the same time impurities if present may be removed.

The object of my invention is to provide a method whereby an alloy which does not contain two principal metals in a desired proportion, may be separated into at least two other alloys, in one of which at least the ingredients are together in a more useful proportion.

To carry out my invention I dissolve the two principal metals of the alloy, by electrolysis as anode in a suitable solution, while many impurities may be left as an anode slime, and by varying the conditions of depositing I may alternately deposit at least two different alloys.

As examples of my process I may mention the refining of arsenic-antimony and nickel-iron alloys. The arsenic-antimony alloy is dissolved as anode by the electric current preferably in a solution containing antimony and arsenic trifluorids, an alkaline fluorid and hydrofluoric acid. When the solution is rapidly agitated, arsenic deposits out faster than antimony, in proportion to the amount in the solution, and the cathode metal may thus contain more arsenic in proportion, than is dissolved from the anode, until the solution becomes so impoverished in arsenic that equilibrium is reached and the proportionate amounts of antimony and arsenic deposited and dissolved are the same. At this stage of the process, or somewhat earlier for more practical results, if the solution is electrolyzed at rest an alloy containing a less proportion of arsenic than is dissolved from the anode, may be produced for a time, until arsenic has again accumulated to an extent great enough to hinder the further deposition of alloy lower in arsenic. Then the two steps of the process are repeated again in the same way. Practically there should be at least two refining tanks in use, through which the solution flows continually from one to the other, and in one of which the solution is well agitated, while in the other it is as nearly as may be at rest. The alloys deposited in the two tanks are different from each other and from the anode, and are generally also free of many impurities of the anode, as silver, lead, copper, sulfur, gold, bismuth, etc. About one-half of the arsenic in the anode remains in the anode slime.

As applied to the electrolytic refining of iron-nickel alloys which may contain also several other metals and impurities, the process may be used as follows. The anode of the iron-nickel alloy is dissolved by the current in a solution preferably of the sulfates, fluosilicates, or other usable salts of iron and nickel. If the conditions of the electrolysis were maintained substantially uniform, equilibrium of the solution and electrodes would soon result and the character of the cathode metal as regards iron and nickel contents would be determined by the proportion of iron and nickel dissolved from the anode. The most commercially desirable composition would depend on the market and not on the composition of the anode metal which latter would depend on the composition of the material smelted.

I have discovered that I can readily differentiate an alloy of iron and nickel into two products, one of which contains a less and the other a greater proportion of nickel compared to iron, by electrolyzing alternately at a diminished and an elevated temperature. At the same time I eliminate copper and other impurities of the crude alloy, as anode slime, or remaining in solution. With an anode containing say 6% of nickel, 6% of copper, 1% of manganese, about 3% of carbon, 1% of silicon and 1% of manganese, by electrolyzing at a temperature of about 40° to 50° centigrade I may deposit for a while cathode metal with 3% of nickel, more or less, while the percentage of nickel in the solution increases. Then by electrolyzing at a temperature of say 90° C., there deposits on the cathode an entirely different product which may contain 13% of nickel and nearly 87% of iron, while the percentage of nickel in the solution diminishes. When the percentage of nickel in the solution has gone down to a low figure, the solution may be cooled and the two steps repeated. Obvi-

ously as the two different products are not wanted on the same cathodes, the two steps should be performed in two or more separate electrolytic tanks, between which the solution is changed at the proper time, so that one step is always being carried out in one tank, and the other step in another tank.

Nickel steels containing 3 to 3.5% of nickel are at present the most popular. One of the above mentioned products of about this composition is directly convertible to an especially fine nickel steel nearly free from harmful impurities, containing this amount of nickel, by melting with the proper additions, while the other product may be melted with other relatively impure iron to produce a lower grade of nickel steel. If the entire product made from anode metal of the composition given, was of one kind, containing about 7% of nickel, it would require to be melted with outside non-electrolytic iron of lower grade to produce the very useful 3 to 3.5% nickel steel, and obviously would not be as good for making high-nickel steels as the 13% alloy for example. Also by my process with varying nickel content of anodes I may produce two standard products, but in varying proportionate amounts, while without my process the product would necessarily change with each change in anode composition.

Changing the current density may also be used in carrying out my invention or more than one change of conditions may be used. For example in the nickel-iron application of the process described above, I prefer to carry out the lower temperature deposition of the low nickel alloy with a quiet solution, and the higher temperature deposition of the high nickel alloy with a more rapidly circulating solution, to produce a more perfect result.

In these processes, the refining solution, or electrolyte is a reservoir of the metals, to which will be added in general a continuous supply of the alloying metals in practically a constant proportion, while by varying one or more physical conditions of the solution the electrolyte may be made to yield as cathode deposits alloys containing alternately a greater and a less proportion of one of the ingredients. The physical conditions of the solution most practicable to vary singly or in combination are temperature, rate of circulation, and rate of fall of electric potential from anode to cathode per unit of distance or concentration of salts at the electrode surfaces depending on current density. There are other physical conditions of the solution which it is perhaps less practicable to vary as concentration, viscosity, etc., and in some cases density and neutrality, for the heavy and frequently more neutral electrolyte running down the anode face may be electrolyzed separately from the lighter and frequently more acid solution rising at the cathode face with production of different alloy deposits.

In addition to the treatment of metallic alloys, my process contemplates the treatment of mattes in the same way.

What I claim as new and desire to secure by Letters Patent, is:

1. The process of treating alloy which consists of dissolving metals therefrom as anode by electrolysis in an electrolyte, depositing therefrom at a cathode an alloy, changing a condition of the solution and depositing a different alloy under the changed condition.

2. The process of treating alloy which consists in dissolving two metals therefrom, electrolyzing the solution, producing a cathode deposit of an alloy, changing a condition and depositing on a cathode a substantially different alloy.

3. The process of treating alloy which consists in dissolving metals therefrom as anode by electrolysis in an aqueous solution, and depositing therefrom in separate compartments two differently proportioned alloys, by maintaining in each of the said compartments a different condition of the solution.

4. The process of treating alloy which consists in dissolving metals therefrom by electrolysis in an aqueous electrolyte, and depositing therefrom in separate compartments two differently proportioned alloys by maintaining in each of the said compartments a different condition of the electrolyte, and interchanging the solutions in the said compartments.

5. The process of treating alloy which consists in dissolving therefrom iron and nickel, electrolyzing the solution producing a cathode deposit of an alloy containing iron and nickel, changing a condition of the solution, and depositing on a cathode a substantially different alloy containing iron and nickel.

6. The process of treating alloy which consists in dissolving therefrom, as anode, iron and nickel by electrolysis in a solution, and depositing in separate compartments differently proportioned iron-nickel alloys, by maintaining in each of the said compartments a different condition of the solution, and interchanging the solution in the said compartments.

7. The process of treating alloy which consists in dissolving therefrom, as anode, iron and nickel, by electrolysis in an aqueous solution, and depositing in separate compartments differently proportioned iron-nickel alloys, by maintaining in each of the said compartments a different temperature of the solution, interchanging the solutions and maintaining differing temperatures in the said two compartments.

8. The process of treating alloy which consists in dissolving therefrom, as anode, iron and nickel, by electrolysis in an aqueous solution, and depositing in separate compartments, in one at a lower temperature an iron-nickel alloy with less nickel, and in another compartment at a higher temperature an alloy with more nickel, and interchanging the solutions in the said compartments.

9. The process of treating alloy which consists in dissolving therefrom, as anode, iron and nickel, by electrolysis in an aqueous solution, and depositing in one compartment at a lower temperature an iron-nickel alloy with less than 9% nickel, and in another compartment at a higher temperature an alloy with more than 9% nickel, and interchanging the solutions and maintaining the temperatures of the said compartments.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ANSON GARDNER BETTS.

Witnesses:
JOHN N. PECK,
JOS. C. BEHAM.