

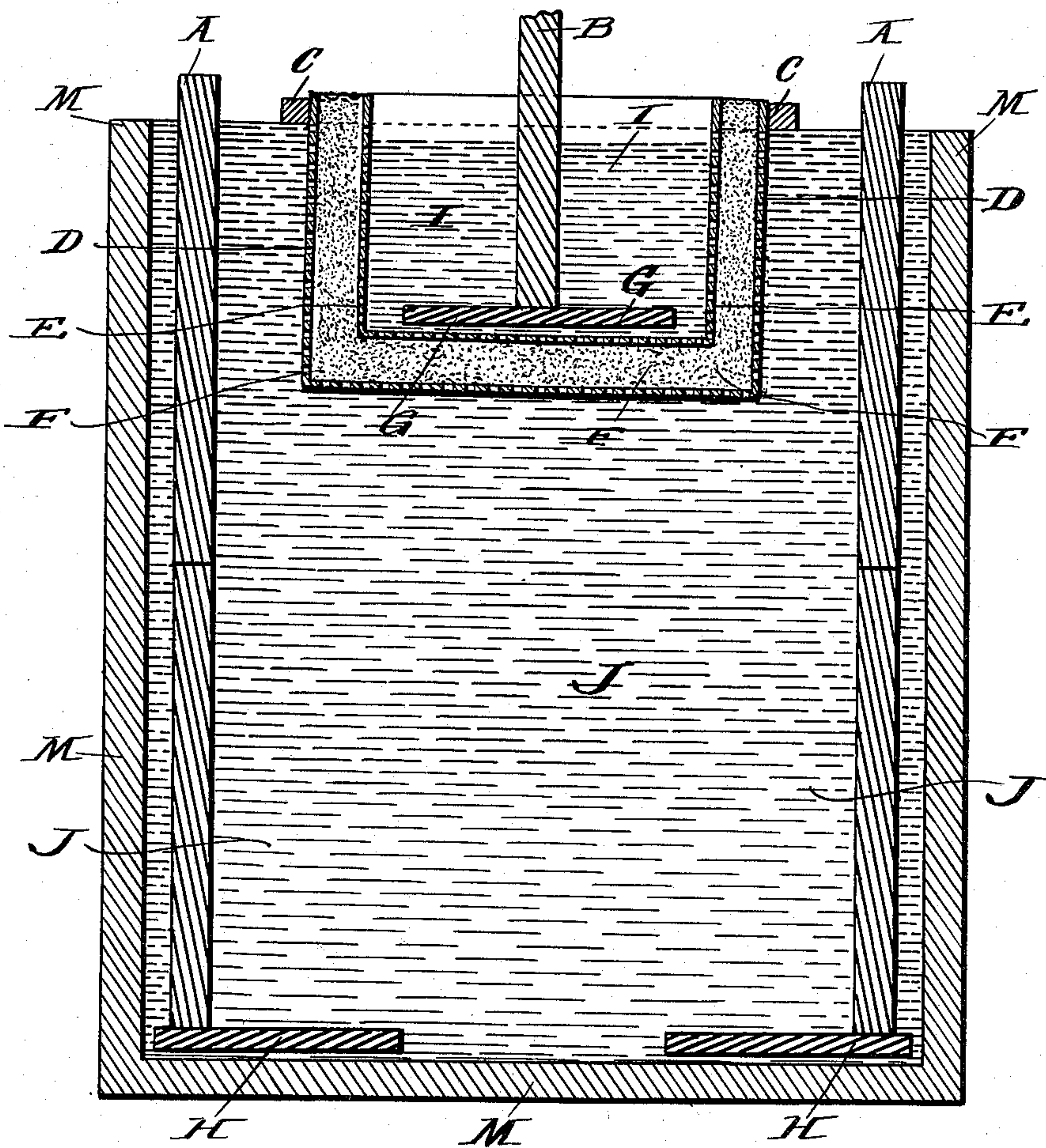
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E. E. ARMSTRONG.

PROCESS FOR TREATING COMPLEX COBALT ORES AND FOR REFINING  
COBALT FROM NICKEL, ARSENICAL, AND SILVER BEARING ORES.

APPLICATION FILED MAY 1, 1906.



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# UNITED STATES PATENT OFFICE.

ERNEST E. ARMSTRONG, OF NIAGARA FALLS, NEW YORK.

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No. 881,527.

Specification of Letters Patent.

Patented March 10, 1908.

Application filed May 1, 1906. Serial No. 314,624.

*To all whom it may concern:*

Be it known that I, ERNEST E. ARMSTRONG, a citizen of Canada, and a resident of Niagara Falls, county of Niagara, and State of New York, have invented a new and useful Process for Treating Complex Cobalt Ores and for Refining Cobalt from Nickel, Arsenical, and Silver-Bearing Ores, of which the following is a specification.

This process is particularly useful for treating the mixed ores of the Temiskaming or Cobalt Lake district, and in describing my process I will take of the typical mixed ore of that district the average run of material that would be supplied to a smelter as an example. It will be apparent, however, that the process involved may be applied broadly to many ores of more or less similar character by such slight modifications to meet the particular ore as will suggest themselves. Certain portions of my process may also be applied broadly to the refining of cobalt from impure cobalt solutions of whatever source.

The ore that will be taken as an example of the preferred treatment contains silver cobalt, usually nickel, arsenic, sulfur and more or less iron and sometimes antimony. The economic problem is to extract the silver and noble metals, nickel and cobalt, economically on a large scale and incidentally to extract also the arsenic, either as metal or a useful salt.

In the accompanying drawing, I have shown in vertical section the cell that I prefer to use for the electrolysis of the cobalt solution.

The following is a description in three steps of the preferred form of my process. It is to be understood, however, that I do not limit myself to the details of these steps nor to the use of all of the steps since I am aware that certain of the steps may be usefully applied to certain materials without the others and with considerable modification in details.

The first step consists in making a solution of the cobalt attended with such iron and nickel, if any, as may be present in the ore. I first roast the ore and thereby remove a large portion of the arsenic which can be collected in a suitable apparatus, as a white oxid of arsenic  $As_2O_3$  and saved. During the roasting, a large part of the sulfur, if present, is converted into sulfur

dioxid  $SO_2$  which, if desired, can be further converted into sulfuric acid. I next smelt the calcined ore with proper fluxes in a cupola or reverberatory furnace and bessemerize the resulting matte to remove the excess of iron. I next grind and calcine the matte preferably with nitrate or carbonate of soda, to further remove the arsenic and sulfur. I next mix the calcined product with charcoal, retort coke, or other form of carbon and smelt it in a crucible or reverberatory furnace, and cast it into anodes. I next electrolyze these anodes in an acid bath and continue the operation till the acid of the bath is saturated with the iron, cobalt and nickel. During this electrolysis, silver, gold, platinum and other precious metals separate from the anodes as slimes and fall to the bottom of the vat and can be collected and refined by any of the well known methods used for that purpose. The acid of this bath is preferably sulfuric or hydrochloric but may be sulfate of soda or an organic acid, such as acetic, citric, tartaric or oxalic.

The second step is to separate the iron from the solution produced in the first step. For this purpose, said solution is placed as the electrolyte in the cell shown in the accompanying drawing, which will be more particularly described below. This cell has insoluble electrodes preferably of graphite; the positive electrode or anode being placed near the bottom of the cell and the negative or cathode above, as near as possible to the top of the electrolyte. The cathode is incased in a porous inclosure or other form of diaphragm, to prevent the hydrogen from combining with the electrolyte and neutralizing the oxidizing effect of the gases liberated at the anode.

Before or during this electrolysis, I add to the said solution forming the electrolyte, a chlorid of an alkali or alkaline earth, preferably chlorid of sodium. The nascent chlorine generated in the electrolyte at the anode oxidizes the iron in the solution to the ferric condition. In lieu of the chlorid, another halogen salt of a metal, such as a bromid, a fluorid or an iodid, may be employed. The complete oxidation of the iron can be determined by testing a sample of the solution with potassium ferro cyanid and potassium ferri cyanid. The electrolysis is then stopped and the solution



drawn off into precipitating tanks. Milk of lime or the caustic soda from the cathode compartment is then added and the iron and arsenic precipitated as hydrate and arsenid  
5 of iron, which precipitate is removed by filtering or settling leaving a solution containing the cobalt and nickel.

The third step is to separate the cobalt (or cobalt and nickel) from the solution.  
10 For this purpose, the solution resulting from the second step is returned to the cell shown in the accompanying drawing and the electrolysis is continued until the cobalt is precipitated as oxid of cobalt which can then  
15 be removed by settling or filtering and the nickel can then be precipitated and separated in the same manner. Or the cobalt and nickel can be simultaneously precipitated as sesquioxids, the caustic soda generated in the cathode compartment being  
20 used to assist in the precipitation.

The electrolytic cell shown in the accompanying drawing, may be described as follows: M is a wooden tank lined with  
25 asphalt or other acid resisting paint. A, A, are graphite conductors carrying the current to the positive electrodes H, H, situated at the bottom of the tank. B is a graphite conductor carrying the current from the  
30 negative electrode G. C is a frame supporting the diaphragm which incloses the negative electrode. D and E are two perforated hard rubber baskets; the basket E being placed within the larger basket D and the  
35 space between the two baskets being filled with asbestos fiber F or ground graphite or other suitable material to form a porous medium between the walls of the perforated baskets to act as a porous diaphragm. In  
40 order to prevent the hydrogen from the cathode passing through the porous cell into the anode compartment I, the solution in the anode compartment is maintained slightly  
45 higher than the solution in the cathode compartment J causing a slight flow of the liquid through the diaphragm toward the cathode.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

50 1. The process of separating cobalt which consists in electro chemically precipitating the cobalt as oxid by treating a solution of the same to electrolysis in the presence of a halogen salt of a metal.

55 2. The process of separating cobalt which consists in electro chemically precipitating the cobalt as oxid by treating a solution of

the same to electrolysis in the presence of a chlorid.

3. The process of separating cobalt which consists in electro chemically precipitating  
60 the cobalt as oxid by treating a solution of the same to electrolysis by an electrode which is not soluble in the electrolyte in the presence of a halogen salt of a metal. 65

4. In the process of refining cobalt solution containing iron, the steps which consist in treating a solution of the same to electrolysis in the presence of a halogen salt of a metal  
70 until the iron is converted into the ferric state and precipitating the iron compound. 70

5. The process of separating cobalt which consists in electro chemically precipitating the cobalt as oxid by treating the same to electrolysis in the presence of a halogen salt  
75 of a metal until the iron is converted into the ferric state, interrupting the electrolysis, precipitating the iron compound, and then continuing the electrolysis until the cobalt is electro chemically precipitated as oxid. 80

6. The process of separating cobalt which consists in the electrolysis of a solution of the same in the presence of a halogen salt of a metal until the iron is converted to the ferric state, interrupting the electrolysis, precipi-  
85 tating the iron compound and continuing the electrolysis until the cobalt and nickel are precipitated. 85

7. The process of treating complex cobalt ore which consists in removing the bulk of  
90 such arsenic and sulfur as may be present by calcining and smelting, forming into an anode, dissolving the anode thus produced in an acid electrolyte, electrolyzing the solution in the presence of a halogen salt of a metal  
95 until the iron is separated and further electrolyzing the solution until the cobalt is precipitated. 95

8. The process of treating cobalt ores which consists in forming the same into an  
100 anode, dissolving the anode thus produced in an acid electrolyte, electrolyzing the solution in the presence of a halogen salt of a metal until the iron is converted to the ferric state, separating the iron, and further electrolyzing  
105 the solution until the cobalt is precipitated. 105

In testimony whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

ERNEST E. ARMSTRONG.

Witnesses:

WM. J. SIRDEVAN,  
ARTHUR KILLIAN.