PRODUCTION OF COBALT
Filed June 29, 1933

June 23, 1936.

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2,045,212

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--- Diagram of production process ---
The present invention relates to the recovery of cobalt from material containing iron and cobalt, and more particularly from material containing copper, iron and cobalt. An instance of such material is a copper-cobalt ore or concentrate or furnace product containing iron, which is roasted and leached to produce a solution of the metals. Another instance is an alloy or mixture of copper, iron and cobalt such as may be obtained by reducing slag resulting from the smelting of copper ore containing iron and notable quantities of cobalt.

The object of the invention is to provide an effective electrolytic process whereby commercially pure cobalt may be cheaply obtained from a material containing iron and cobalt with or without copper or other metal which is lower in the electrochemical series than copper.

According to the invention, a solution of iron and cobalt is obtained, from which the iron is removed. The resulting purified cobalt solution is supplied as katholyte to an electrolytic cell in which positive ions from the anode are excluded from the neighbourhood of the kathode. Such cell may be of the known kind in which the anode and kathode are separated by a partition which is porous to the extent of permitting flow of electrolyte. In said cell, also in the known manner, an outward flow of katholyte is maintained from the kathode compartment of sufficient velocity to prevent the migration or diffusion of positive ions from the anode compartment into the kathode compartment. The katholyte is maintained at approximate neutrality, but with sufficient free acid to enable control to be maintained so that it does not pass over to basicity, which would cause cobalt hydrates to appear at the kathode.

The acid released by the electrolytic deposition of the cobalt is available for the dissolution of further quantities of the raw material. When such material is in metallic form, the dissolution is preferably effected anodically. Moreover in order to conserve electrical energy, the anodic dissolution of the metals is preferably effected in the same cell as the electro-deposition of the cobalt. This is rendered feasible by the aforesaid exclusion from the kathode of positive ions liberated at the anode, which prevents the metals, as they go into solution, from plating directly onto the kathode.

The anolyte produced by thus dissolving the mixed metals is continuously displaced from the cell and subjected to the selected treatment for the removal of its iron content; being then acidified as far as may be necessary and returned to the cell as katholyte as above described.

Since all the metal thus anodically dissolved is not electro-deposited on the kathode owing to the removal from the solution of iron as above described and copper or other metal as described hereafter, and since also the metal which can be anodically dissolved is measured by that which is actually electro-deposited, it is necessary to dissolve additional metal to make up the deficiency. This constitutes an "electro-chemical balance", which term is employed in the claim.

This may conveniently be effected by providing make-up cells in which the electrolyte has a free acid content such that the dissolved iron and cobalt will not electro deposit from it, such as three to five grams per litre or over reckoned as sulphuric acid. The solution thus obtained is added to the anolyte effluent from the deposition cell first described, so that its iron content is removed before it enters the kathode compartment of such deposition cell.

When the raw material is metallic and contains copper or another metal lower than copper in the electro-chemical series, such copper or other metal is left to a large extent undissolved by the anodic dissolution above described, owing to the low acidity of the electrolytes employed and to the presence of iron and cobalt, which are precipitants of it. In any event so much of the copper or equivalent other metal as enters the solution is precipitated with the iron at the iron precipitation stage.

A practical method of carrying out the invention will be described with reference to the accompanying diagrammatic drawing.

When a copper ore contains both iron and cobalt the latter proceeds through the smelting operations with the iron and becomes automatically concentrated in the converter slag and also in the reverberatory slag in case the converter slag is returned to the reverberatory furnace. Either slag may accordingly be taken and reduced to an alloy or mixture of metallic iron, cobalt and copper. It is desirable to keep the iron content of the mixed metal low in order to diminish the cost of dissolving and precipitating it. The same consideration does not apply to the copper content since it is for the most part not dissolved by the process of the invention. A composition well adapted for the purpose of the invention consists of:

<table>
<thead>
<tr>
<th>Percent</th>
<th>Copper</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>Iron</td>
<td>10</td>
</tr>
<tr>
<td>Percent</td>
<td>Cobalt</td>
<td>65</td>
</tr>
<tr>
<td>Percent</td>
<td>Impurities</td>
<td>5</td>
</tr>
</tbody>
</table>

This metal is cast as anode plates which are suspended in the electrolytic cell and connected to the positive pole of a direct electric current supply system. The kathode plates may be of various materials such as rolled cobalt, iron, copper or stainless steel. The kathodes are enclosed in boxes the sides of which are of filter cloth. Cobalt sulphate is fed into these boxes.
from a storage tank 8 by means of pipes 9 having valves 10 for controlling the rate of flow, whereby the liquid in the boxes may be kept at a higher level than the liquid outside them. It is desirable thus to maintain a hydraulic head in the box sufficient to cause flow through the filter sides equal to about ½ litre per sq. foot of filter surface per hour. Flow at this rate substantially prevents the access of positive ions from the anolyte to the katholyte. 11 indicates a circulating system by which the liquid in the box 7 is kept in movement, with the object of maintaining the katholyte of uniform composition and assisting deposition.

No acid need be added to the cell, the acid radicle liberated in the kathode compartment being carried through the walls 1 by the flowing electrolyte and effecting the corrosion of the anodes 2. A low current density is desirable from the point of view of limiting the tendency of positive ions to migrate or diffuse into the katholyte, and about 10 amps. per square foot may be employed. Under such conditions the anodes 2 are corroded; and their iron and cobalt contents go into solution. A small quantity of their copper content also goes into solution; but the bulk of it falls, as sludge, to the bottom of the cell 3. It is desirable to brush or scrape the anodes 2 from time to time to prevent accumulation of copper thereon, which would result in its going excessively into solution.

The liquid in the cell 3 flows to an outlet 12 whence it is conducted to the make-up cell 13. In this cell the anodes 14 are made of the mixed metal under treatment. The kathodes 15 are required only to act as conductors of electricity and may be copper plates. An essential feature of this cell is that the electrolyte 16 is too high in free acid to permit electro-deposition of the iron or cobalt dissolved from the anodes 14; and for this purpose an acidity equivalent to more than three grams per litre of free acid reckoned as sulphuric acid, is necessary. This is maintained by additions of fresh acid as indicated at 17. The current density in this cell may be the same as that in the cell 3.

The dissolving capacity of the make-up cell 13 is such as to add to the solution as much cobalt as is necessary to maintain the balance between deposition of cobalt in cell 3 and its dissolution in cells 3 and 13. The reinforced solution passes to a storage tank 18, whence it is delivered in batches to the agitation tank 19. To the latter are also supplied oxidizing material, such as manganese di-oxide and acid; and basic material such as limework. These contents of the tank are agitated by means indicated by 20 and maintained at an elevated temperature by steam coils 21 or the like.

By these means iron is precipitated in filterable form and the cobalt solution is thereafter separated from it in a filter 22; being then returned to the storage tank 8.

Here acid is added to it in just sufficient amount to ensure that the solution does not go basic in the cell 3, and the solution is allowed to flow into the boxes 6. There it becomes katholyte from which cobalt is electro-deposited onto the kathodes 5; the deposit usually taking a form which is easily detached after removal of the kathodes from the cell. The detached cobalt is washed and dried in stage 23 and melted in stage 24 to produce marketable metal.

I claim:

The process of electro-depositing cobalt from anode material containing iron, cobalt and copper, which consists in anodically corroding the anode material under conditions such that cobalt and iron go into solution in the electrolyte whilst copper is deposited mainly as sludge.