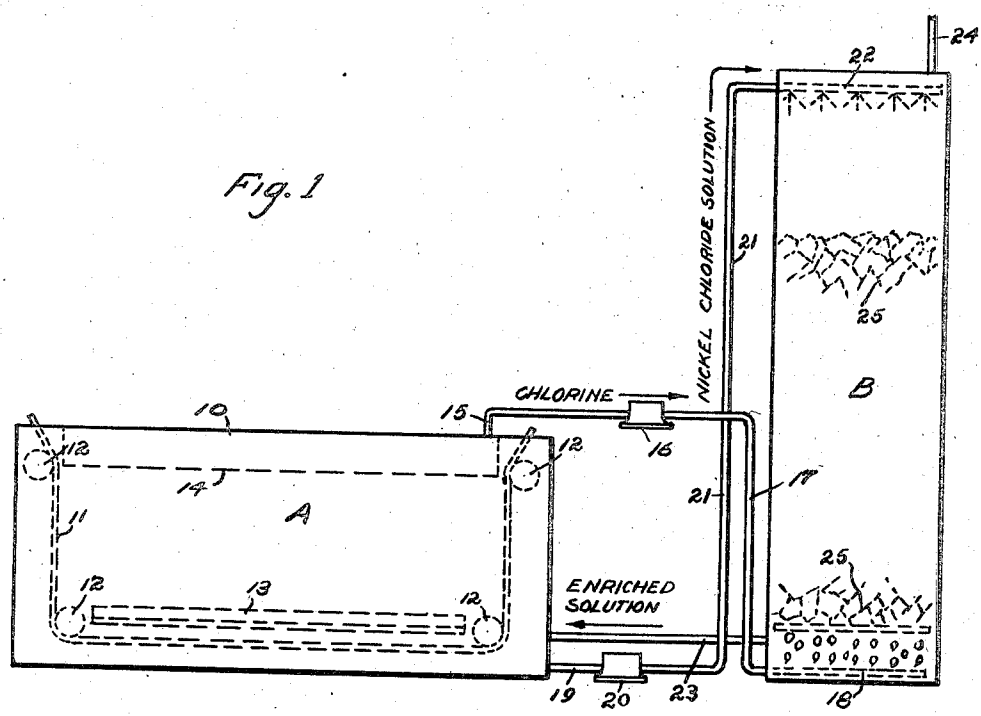
Sept. 14, 1948. L. N. SMITH 2,449,422

ELECTRODEPOSITION OF NICKEL

Filed April 15, 1944

Fig. 1



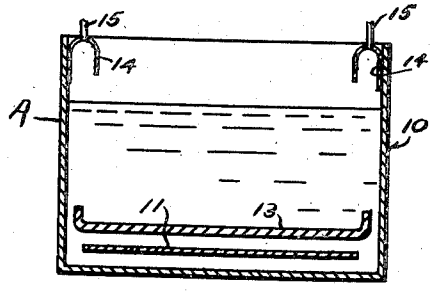


Fig. 2

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ELECTRODEPOSITION OF NICKEL

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2 Claims. (Cl. 204—49)

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This invention relates to electrodeposition of nickel and is also applicable to electrodeposition of cobalt. More specifically, the invention relates to an improved process for electrodepositing nickel or cobalt by the use of insoluble anodes, especially in electroplating on sheet steel in long strips.

One object of the invention is to secure the advantages which are inherent in the use of insoluble anodes while avoiding to a large extent the disadvantages which have attended such methods heretofore. More specifically, it is an object of the invention to provide a process whereby the concentration of the electrolyte with respect to nickel or cobalt can be maintained and a very high current density employed, utilizing a high chloride electrolyte and without excessive loss of chlorine. A further object is to provide for superior effectiveness in the solution of the metal whereby it becomes practical to use highly pure metal, such as electro-sheet nickel or other electrolytically deposited forms of nickel or cobalt, or mixtures thereof.

Still further objects of the invention will be in part apparent and in part pointed out hereinafter in connection with the accompanying drawings, wherein Fig. 1 is a diagrammatic elevation of an electroplating tank and dissolving tank and showing schematically the connections between them for circulating liquids and vapors, and Fig. 2 is a transverse section taken through the plating tank of Fig. 1, centrally thereof.

Referring now to the drawings, the reference character A indicates generally a plating tank, while the reference character B indicates generally a dissolving tank. The plating tank consists of a receptacle indicated generally by the numeral 10 through which may be led a continuous strip 11 of steel or other metal to be plated. This strip of steel may be guided through the tank by means of roller guides 12 or in any other suitable fashion. Adjacent to the horizontal reach of the steel strip 11 is an insoluble electrode 13 which may be composed of any conductive material which is not attacked by the solution, such for example as platinum-clad steel. The insoluble anode 13 will be suitably spaced from the strip to be plated and current will be passed between the anode and the strip by connecting a suitable source of current, one terminal to the insoluble anode and the other terminal to the roller guides 12. Adjacent to the side walls of the tank above the level of the plating solution are downwardly opening, channel shaped gas collectors 14 provided with outlet pipes 15 connected

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to a pump 16, which is adapted to place a suction on the gas collectors to draw in gases bubbling up through the solution along the sides of the tank and eject them through the pipe 17 into the bottom of the dissolving tank B through a suitable distributing outlet 18, which in its simplest form may be merely a continuation of the pipe 17 curved into a spiral in the bottom of the dissolving tank B and provided with small outlet openings in the top thereof.

Connected to the bottom of the plating tank A is a pipe 19 which leads to a pump 20. The pump 20 withdraws solution from the plating tank A and delivers the same through the pipe 21 to the spray head 22, which can be of construction similar to the outlet 18 just described. The solution is allowed to return from the dissolving tank B through a pipe 23. The dissolving tank B may be vented through a vent pipe 24 in order to dispose of any chlorine and other gases not absorbed. The dissolving tank B may be filled with pieces of nickel or cobalt indicated at 25, only the upper and lower portions of the metal pack in the dissolving tank being indicated. Such metal may rest on a suitable perforated plate or screen to prevent the interference of distribution of gas bubbles by the pieces of nickel or cobalt.

In operation, the dissolving tank is charged with nickel chloride or cobalt chloride, or a mixture of the chlorides of nickel and cobalt, or if desired, with a mixture of the sulfates and chlorides of nickel or cobalt or both, the chlorides however accounting for at least one-third of the nickel present. I preferably use chlorides only. The current is connected as above indicated and the strip 11 is caused to pass through the solution at a speed such as to apply the desired thickness of metal. In this process, chlorine will be evolved and will pass from beneath the insoluble anode 13 upwardly along the sides of the tank. This chlorine will keep the solution oxidized and prevent pitting. Plating under the conditions indicated also produces a degree of brightness of deposit beyond that of the normal Watts or gray nickel solutions. When the chlorine escapes from the solution, it is caught in the collectors 14 and by the action of the pump 16 is forced into the bottom of the dissolving tank and bubbles up through the solution therein, and then passes above the level of such solution over the pieces of metal 25 which are kept wet with solution through the spray head 22. The chlorine thus has an opportunity to be absorbed in the solution and react with the metal whereby metal chloride is formed and goes into solution thus enriching the solu-

tion with respect to metal. By circulating the solution at a suitable rate, the metal concentration can thus be maintained at the desired level. By the use of this process, I am able to dissolve electrolytic nickel and cobalt which are of such purity, for example, nickel electro-sheet, that they are not satisfactory for use as anodes in ordinary plating solutions. It is, of course, possible and indeed quite easy to dissolve those forms of nickel and cobalt which are easily dissolved, such for example as the regular nickel anodes now in general use.

A suitable solution for the realization of the invention might be termed an all-chloride solution and be of the following composition:

$NiCl_2 \cdot 6H_2O$	75–350 grams, suitably 175 grams
Formic acid	3–15 grams, suitably 5 grams
H_2O to make	1000 cc.
pH	1–5, suitably 3
Current density	100–2000 amps./sq. ft., suitably 1000 amps./sq. ft.
Temperature	120–200° F.

A suitable mixed chloride-sulfate bath may be composed as follows:

$NiCl_2 \cdot 6H_2O$	75–350 grams, suitably 150 grams
$NiSO_4 \cdot 6H_2O$	75–350 grams, suitably 150 grams
Formic acid	0–15 grams, suitably 6 grams
Boric acid	25–50 g./l., suitably 37.5 g./l.
H_2O to make	1000 cc.
pH	1–5, suitably 3
Current density	100–2000 amps./sq. ft., suitably 1000 amps./sq. ft.
Temperature	120–200° F.

What I claim is:

1. A plating process adapted for utilization of difficultly soluble masses of electrolytic nickel metal in electrodeposition of nickel comprising the steps of electrodepositing nickel from a body of acid nickel electrolyte containing nickel chloride whereby chlorine is evolved and the nickel chloride concentration of said electrolyte tends to be reduced and adding nickel chloride to said electrolyte to counteract the tendency to reduced concentration thereof by passing chlorine so evolved and electrolyte from said body of electrolyte containing nickel chloride equivalent to from 75 to 350 grams per liter of $NiCl_2 \cdot 6H_2O$ into simultaneous contact with masses of difficultly soluble electrolytic nickel whereby to dissolve nickel from such masses as nickel chloride and returning such electrolyte with its resulting increased nickel chloride content to said body of electrolyte.

2. A plating process adapted for utilization of difficultly soluble masses of electrolytic nickel metal in electrodeposition of nickel comprising the steps of electrodepositing nickel from a body of acid nickel electrolyte containing nickel chloride by passing current through said electrolyte from an insoluble anode to a cathode whereby chlorine is evolved and the nickel chloride concentration of said electrolyte tends to be reduced and adding nickel chloride to said electrolyte to counteract the tendency to reduced concentration thereof by passing chlorine so evolved and electrolyte from said body of electrolyte containing nickel chloride equivalent to from 75 to 350 grams per liter of $NiCl_2 \cdot 6H_2O$ into simultaneous contact with masses of difficultly soluble electrolytic nickel whereby to dissolve nickel from such masses as nickel chloride and returning such electrolyte with its resulting increased nickel chloride content to said body of electrolyte.

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