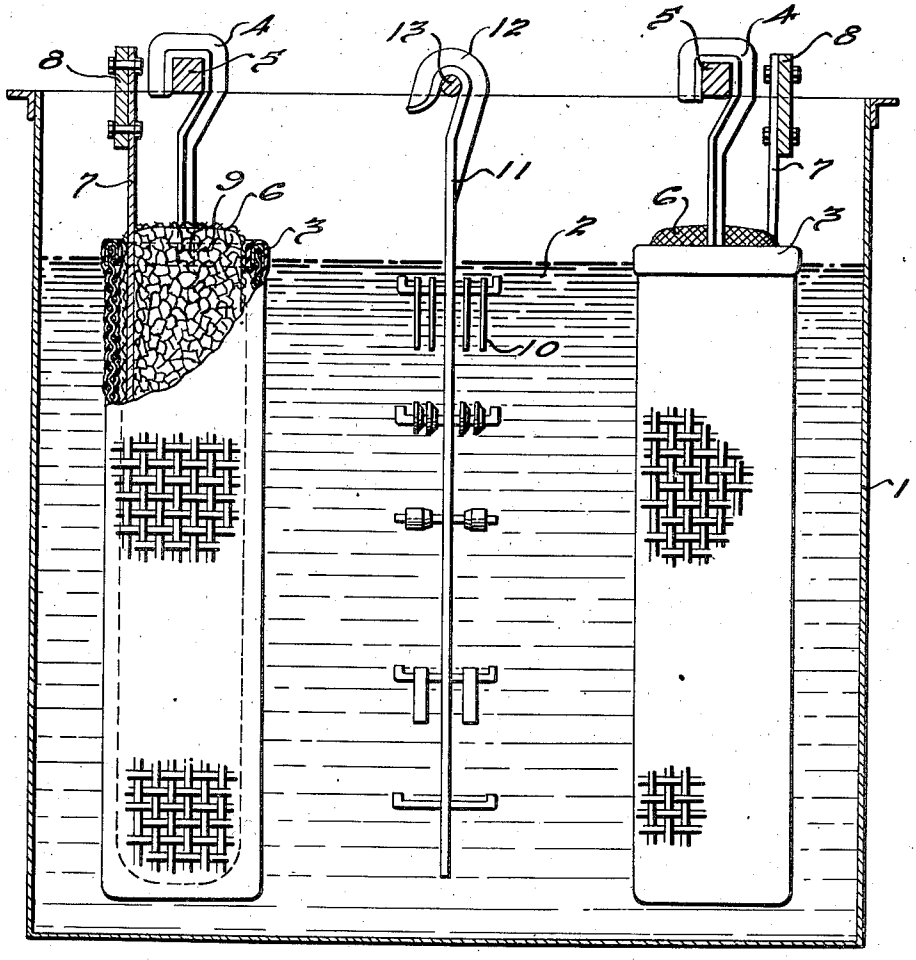
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ELECTROLYTIC DEPOSITION OF NICKEL

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ELECTROLYTIC DEPOSITION OF NICKEL

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This invention relates to a method of nickel plating, and more particularly relates to a method of electrolytically depositing nickel at relatively high current densities which makes possible the utilization of an anode structure of electrolytic nickel.

Numerous attempts have been made in the past to electrolytically deposit nickel employing an anode of electrolytic nickel. Electrolytic nickel is considerably freer from impurities than cast nickel such as is commonly employed as an anode and it is also very much cheaper. Consequently, in plating operations where substantial amounts of nickel are consumed, material savings may be effected by use of electrolytic nickel as an anode if such anode were wholly satisfactory in all other respects.

Electrolytic nickel has heretofore proven highly unsatisfactory when employed as an anode in an electro-plating bath and the unsatisfactory nature of the results normally obtained is materially increased as the current density at which the plating operation is conducted is increased.

Obviously large scale plating operations, where very substantial quantities of nickel are used, are usually carried on at very high current densities, and, consequently, in the particular plating operations where large amounts of nickel are being consumed, and where the savings by the use of electrolytic nickel are most important, electrolytic nickel anodes may be expected to corrode in a most unsatisfactory manner.

When electrolytic nickel is employed as an anode at relatively high current density, that is in excess of 20 amperes per square foot of anode surface, the surface of electrolytic nickel corrodes unevenly creating a sponge-like structure which results in the release of relatively large fragments or particles of loose nickel. Some of these particles drop to the bottom of the plating tank forming a sludge and resulting in considerable loss of nickel. Other particles are carried over bodily to the cathode and produce a roughness of the electrolytic deposit on the article being plated. This latter effect is particularly undesirable in decorative plating operations and particularly so in plating operations employing addition agents intended to produce a bright, lustrous cathode deposit.

The undesirable effects of this type of corrosion may in some cases be partially reduced by placing the anodes in bags or by the employment of other filtering devices disposed in the bath between the anode and the cathode. However, such filtering devices are not only expensive but many of them have an extremely short life when used in extremely acid solutions.

Cast nickel, such as is conventionally used for nickel anodes, corrodes far better than sheets of electrolytic nickel under ordinary plating conditions, but the corrosion of even the best anodes is far from satisfactory and it is quite conventional to use bags surrounding each of the anodes in order to prevent as far as possible the deleterious effects resulting from the release of loose nickel from the anode during a plating operation.

The present invention has for its object the provision of a method of electrolytically depositing nickel employing a bath which may, if desired, be extremely acid having a cathode current density which, if desired, may be extremely high and at the same time employing an anode of electrolytic nickel without at the same time encountering the deleterious effects of unsatisfactory corrosion mentioned above.

Still further, the invention contemplates a method of electrolytically depositing nickel which inherently results not only in a substantial saving in the cost of the anode nickel, but one which results in a cathode deposit which is more nearly pure, less porous and, therefore, more corrosion resistant, than deposits obtained by methods of electrolytically depositing nickel heretofore known.

While it will be readily understood by reference to the following description and the accompanying drawing that substantial departures and variations may be made in the selection of apparatus to practice the method, the apparatus and description of the method following are herein specifically described as merely illustrative of one embodiment of the invention which has been found particularly satisfactory for commercial plating operations.

Referring to the drawing, the figure shown is a more or less diagrammatic sectional view taken transversely through a conventional plating tank illustrating suitable apparatus for practicing the novel method described below.

In order to simplify the description of the present invention, the term "electrolytic nickel" as used in the specification and claims herein is intended to refer to substantially pure nickel which has been electrolytically refined and which, after electrodeposition, has not been subject to any thermal treatment, that is, has not been melted.

The tank 1 is of conventional construction and is substantially filled with a solution 2 described

in detail below. The anodes employed comprise baskets or containers 3 of conventional construction which may be formed of wire mesh in which the wire members making up the baskets are coated with rubber in order to prevent their dissolution. These baskets are hung by means of hooks 4 on suitable supports 5. Bags 6, formed of cloth or other suitable material, are disposed interiorly of the baskets 3 and adjacent one side interiorly of each bag is mounted a sheet or plate 7 of electrolytic nickel, the upper end of which is secured in electrical contact with bus bar 8 in order to provide a supply of current to the anode structure as a whole.

The bags 6 are substantially filled with small sections of electrolytic sheet nickel 9 which are packed against the surface of the sheet 7 and completely surrounded by the bag 6. The work 10 to be plated is hung on conventional plating racks 11 which are supported by means of a hook 12 on a rod 13 which rod forms the opposite side of the plating circuit.

Conventional commercial nickel plating operations are generally carried on at cathode current densities of less than 80 to 90 amperes per square foot. It is obvious that in commercial plating operations, it is extremely desirable to maintain relatively high cathode current densities in order to reduce as far as is reasonably possible the plating time, that is, to deposit as much nickel on the work as is reasonably possible within as short a time as possible. Consequently, many commercial nickel plating operations are carried on at current densities in excess of 50 amperes per square foot and it is generally understood that it is desirable to maintain the current density in excess of 20 amperes per square foot on the work being plated.

It will be obvious that in the event the aggregate area of the anode which is exposed to the solution is substantially equal to the aggregate area of the work to which the plating is applied, the anode current density will be substantially equal to the cathode current density and in the event it is necessary to maintain a current density of 20 amperes per square foot or higher on the work being plated, the anode current density will also be in excess of 20 amperes per square foot.

In the past it has been appreciated that electrolytic nickel does not corrode satisfactorily and knowledge of this fact has resulted in the development of cast nickel anode structures which contain appreciable amounts of impurities such as sulphur, silicon carbon, etc., which impurities it is believed result in more satisfactory corrosion. Electrolytic nickel, when corroded in a conventional nickel plating bath under normal conditions, corrodes very unevenly to provide a sponge-like surface structure resulting in the release of considerable amounts of loose nickel, some of which drops into the bottom of the tank to form a sludge and some of which is carried to the cathode causing roughness in the finished deposit.

It has been found, however, that extremely satisfactory corrosion of electrolytic nickel may be obtained if the current density at which the corrosion takes place is extremely low, preferably less than three amperes per square foot.

In general, it may be stated that it has been found that the lower the current density at which electrolytic nickel is corroded, the more satisfactory is the nature of the corrosion. The present invention, therefore, contemplates the provision of an electrolytic anode structure having an extremely large surface area with respect to the area of the cathode employed in the plating operation whereby commercial plating operations can be carried on employing relatively high cathode current densities and at the same time maintaining the average current density on the anode sufficiently low to produce extremely satisfactory corrosion of the anode.

As is illustrated in the drawing, the anodes comprise a sheet of electrolytic nickel 7 extending from top to bottom of the basket 3 and extending throughout substantially the entire transverse width of the basket. This sheet of nickel is preferably placed on the side of the basket away from the cathode in order that the sheet itself will be exposed to current density even lower than the current density to which the fragments of nickel 9 are exposed. The bag 6 is filled with fragments of electrolytic nickel, satisfactory results having been obtained by utilization of conventional nickel squares. These nickel squares are furnished to the trade in suitable sizes and thicknesses and extremely satisfactory results have been obtained by employing squares approximately one inch square and about one-quarter inch thick. In any event, however, the fragments of nickel making up the bulk of the anode should be sufficiently small and numerous so that the aggregate surface area of the anode structure as a whole exposed to the electrolyte will be many times the aggregate surface area of the work being plated.

Manifestly, it is not absolutely essential that the rubber covered baskets 3 be employed in order to practice the method herein described. The nickel fragments might obviously be piled in a heap either dircctly on the bottom of the tank or in any other suitable receptacle so long as these fragments collectively serve to constitute an anode structure having an aggregate effective area many times the area of the cathode.

In the above description, and in the description that follows, numerous references are made to the cathode current density to which the work being plated is exposed and also reference is made to the anode current density, that is, the current density to which the surface of the anode structure is exposed. It will be readily appreciated that in both the case of the anode and the cathode, the current density will not be absolutely uniform throughout the entire exposed surface of each member but, on the other hand, the current density will be relatively high on some portions and relatively low on other portions and for the purposes of the present description, the terms "anode current density" and "cathode current density" are intended to define the average anode current density or the average cathode current density as the case may be. It will be further appreciated that in this connection that good plating practice dictates that the anode and the cathode be formed and disposed to each other in such a way as to maintain the current density on the various portions of each member as near the average current density as is possible within reasonable limitations.

The particular solution of the bath 2 may be varied within relatively wide limits and it has been found that practically any solution which is generally satisfactory for conventional plating operations will serve the purpose except that it has been found to be essential to maintain a concentration of nickel chloride in the bath of at least one-tenth normal and preferably between

one-third and one-half normal. One form of bath which has been found satisfactory for use in practicing the present method may be constituted as follows:

	Grams per liter
Nickel chloride	40
Nickel sulphate	300
Boric acid	30

To the above may be added any suitable organic or inorganic brightening agents as may be desired in order to improve the luster of the cathode deposit.

The pH of the bath may be regulated within any reasonable limits and, similarly, the temperature at which the plating operation is conducted may be varied.

It has been observed that nascent chlorine is formed during corrosion in accordance with the methods described above and that this nascent chlorine to a large extent dissolves in the bath. It is recognized that chlorine acts as an effective anti-pitting and purifying agent in nickel plating solutions and, therefore, it is believed that the presence of this chlorine adjacent the anode structure contributes materially to the beneficial results obtained by use of the method herein described.

In supplying current to the bath, sufficient current is preferably supplied in order that the cathode current density will be maintained above twenty amperes per square foot and preferably fifty to eighty amperes per square foot. As has been described above, the anode structure employed is so constructed and arranged with respect to the cathode that the anode current density employed when plating even at a cathode current density of eighty amperes per square foot will under no circumstances exceed three amperes per foot and preferably be maintained in the neighborhood of one ampere per square foot or less.

It will be readily appreciated that the specific embodiment of the invention described above is merely illustrative of one form which the invention may take and substantial departures from the above described specific method may be made falling within the scope of the invention as set forth in the following claims.

What is claimed is:

1. The method of electrodepositing nickel at a cathode current density in excess of twenty amperes per square foot which comprises passing an electric current from an anode to a cathode in an aqueous bath containing nickel salts in solution therein, said bath containing nickel chloride in a concentration in excess of one-tenth normal, said current being of sufficient strength to produce an average current density on said cathode of not less than twenty amperes per square foot, said anode comprising electrolytic nickel having sufficient surface area to reduce the average current density thereon to below about three amperes per square foot.

2. The method of electrolytically depositing nickel which comprises passing sufficient electric current fron an anode to a cathode in an aqueous bath to produce an average cathode current density in excess of twenty amperes per square foot, maintaining in solution in said bath a concentration of nickel chloride of at least one-tenth normal, said bath comprising essentially nickel sulphate and boric acid in addition to said nickel chloride, and maintaining in said bath an anode of electrolytic nickel in divided form of sufficient effective surface area many times the area of the cathode to produce thereon an anode current density of not more than about three amperes per square foot.

3. The method of electrolytically depositing nickel which comprises passing electric current from an anode to a cathode in an aqueous bath containing in solution therein nickel chloride in a concentration in excess of one-tenth normal, said electric current being sufficiently strong to create upon said cathode an average current density of at least twenty amperes per square foot, maintaining in said bath an anode structure of electrolytic nickel having a surface area at least ten times the area of the cathode in said bath.

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