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METHOD OF NICKEL PLATING

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2 Claims. (Cl. 204—49)

This invention relates to a method of nickel plating and more particularly to the electrodeposition of nickel from a bath containing the usual nickel planting salts and sodium formate.

It has heretofore been proposed, as in the Haas Patent No. 230,872, to employ a nickel formate bath for the electrodeposition of nickel. In the Haas bath, however, the concentration of nickel salts is so low that it is not practicable to use a relatively high current density. The Haas bath is therefore not suitable for use in accordance with present day nickel plating practices.

The Weisberg and Stoddard Patent No. 2,026,-718, dated January 7, 1936, also discloses the use of a formate in a nickel, or nickel and cobalt, plating bath. According to that patent, the formate has a twofold effect, in that it acts as a buffer for the control of the hydrogen ion concentration near the optimum point and also has a brightening effect in combination with certain of the other ingredients of the solution. In the Weisberg and Stoddard bath the other ingredients of the solution that are essential are ammonium sulfate and formaldehyde. Neither of these latter two ingredients is essential to the operation of my bath. In fact any compound furnishing ammonium radicals is to be avoided, if best results are to be obtained.

I have now found that a very superior nickel electrodeposit can be obtained by the use of a nickel plating bath containing sodium formate, without employing a cobalt anode or a cobalt salt, an ammonium salt or formaldehyde. Preferably, my bath also contains a wetting agent, since the combined action of sodium formate and a wetting agent results in a plate that is more lustrous and freer from pits than a plate produced from a bath containing sodium formate only.

By the use of my bath, a nickel deposit is obtained which, before being subjected to any buffing operation, is more lustrous than ordinary gray nickel, varying from a milky lustre having limited image reflectability to a bright lustre. While not a "bright nickel" plate within the present acceptance of the term as signifying a nickel crystal size of less than $\frac{1}{10000}$ of a millimeter, the nickel plate so produced from my bath can nevertheless be buffed very easily and at but little greater cost than "bright nickel" to give a brilliantly lustrous, mirror like surface.

As compared with the ordinary gray nickel, obtainable by the use of the Watt bath, the nickel plate resulting from the use of my method can be much more readily buffed and polished, with consequent saving in labor and material cost. Also, while the relatively small cost of buffing my nickel plate represents an item that may not be present in the case of "bright nickel" plating, the superior ductility and adherence of my nickel plate over a "bright nickel" plate far outweights the added slight cost of buffing.

With respect to its properties, nickel deposited from my bath is equally as ductile and adherent as ordinary gray nickel deposited from a Watt bath and much more so than "bright nickel." My nickel plate, furthermore, exhibits excellent adherence when deposited in a thickness up to 0.001 inch or more directly upon plain carbon steels, either low carbon or heat treated high carbon steel, or upon low alloy steels. For instance, if a sheet of plain carbon steel plated directly with nickel from my bath be held edgewise against an emery wheel, there is no separation of the plate whatsoever, whereas, if similarly tested, a "bright nickel" plate would show some separation from the steel. Furthermore, "bright nickel" plate could easily be stripped entirely from the steel by manually completing the separation started by the emery wheel.

My nickel plate adheres to steel more firmly than does a composite plate of copper and bright nickel, with the copper deposited from a copper cyanide plating solution. I also find that my nickel plate is at least as firmly adherent to steel as is a composite plate of gray nickel plate followed by bright nickel plate, such as is described in the Hogaboom Patent No. 1,991,747.

With respect to hardness, nickel plate deposited by my method is of the same order of hardness as ordinary gray nickel and considerably softer than "bright nickel."

It is therefore an important object of this invention to provide a method for the electrodeposition of nickel, whereby a fairly lustrous deposit may be obtained approaching "bright nickel" plate in lustre, but having a much higher degree of ductility and a much better adherence to the foundation metal.

It is a further important object of this invention to provide a nickel plating bath containing sodium formate for use in the plating of nickel at relatively high current densities and high temperatures and low pH value, for obtaining directly a lustrous nickel plate that requires very little buffing and that has such excellent adherence to a ferrous foundation metal that it may be plated directly over a ferrous metal and form an adherent undercoating for a subsequent deposit of chromium.

It is a further important object of my invention to provide a nickel plating bath containing sodium formate and a wetting agent adapted to increase the lustre of the nickel electrodeposit obtained therefrom, while retaining the softness and ductility of ordinary gray nickel.

Other and further important objects of this invention will become apparent from the following description and appended claims.

The following illustrates the preferred range

of bath compositions and conditions for use with the method of my invention:

Nickel sulfate, hydrated ----------	grams per liter	240–300
Nickel chloride, $NiCl_2.6H_2O$	do	35– 50
Sodium formate	do	25– 40
Boric acid	do	25– 40
pH	do	3.6– 4.0
Temperature	°F.	135–145
Current density	amperes per sq. ft.	40– 60

In the foregoing bath the concentrations of nickel sulfate, nickel chloride and boric acid are not critical but may be varied within the usual ranges known to those skilled in the art. In fact, the boric acid may be omitted entirely and good results still obtained, although boric acid is an aid in the obtaining of smooth plates of more or less uniform quality, as measured by surface lustre, on objects of irregular shape. Likewise, the concentration of sodium formate may be varied from as little as 1 gram per liter up to its saturation point of around 50 to 60 grams per liter. Baths containing 35 to 40 grams per liter of sodium formate exhibit greater throwing power than those containing a lower sodium formate content. I prefer to add sodium formate, as such, to the bath, but the sodium formate may, instead, be formed in the bath by the addition thereto of its constituent radicals in reacting proportions, as by the addition of formic acid and caustic soda, or by any suitable method. Other metal formates, such as nickel formate, or ammonium formate, are not the equivalent of sodium formate.

In general, the hydrogen ion concentration of the nickel plating bath may be varied between the pH values of 5.5 and 2.5 and the temperature within the range of 90° to 190° F., the higher temperatures being used with the numerically lower pH values. With proper control of the pH of the bath, the bath may be operated at a temperature as low as room temperature. Nickel carbonate, sulfuric acid, or formic acid may be conveniently used for the adjustment of the pH value of the bath.

In order to obtain best results, the cathode rod should be agitated. An agitation equivalent to 30 cycles of strokes per minute with a minimum travel of 2½ inches has been found to give very satisfactory results. More rapid agitation gives a brighter plate. Other equivalent means of agitation may be employed, such as circulation of the electrolyte over the cathode.

The usual types of nickel anodes may be used, the same as in ordinary gray nickel plating. During continued use of the bath, its composition and pH should be maintained within the preferred ranges given above. The use of wetting agents in my bath is highly desirable in order to prevent pitting troubles. Wetting agents that have been found suitable include those known under the trade names "Tergitols," which are sulfated branch chain alcohols and their sodium salts; "Duponols," which are sulfated straight chain alcohols, such as lauryl alcohol, and their sodium salts; and "Nekals BX," which are sodium salts of alkylated naphthalene sulfonic acids.

The wetting agent may be added in amounts varying between 0.01 and 2%, but should be added in a sufficient quantity to lower the surface tension of the bath to below 50 dynes per cm. In the case of lauryl sulfate, commercially available as "Duponol M. E. dry," as little as 0.2 g./l. is sufficient to lower the surface tension of the bath to 30 dynes per cm., satisfactorily prevent pitting and, in combination with the action of sodium formate, impart the desired lustre to the nickel plate.

With respect to the nickel plate that is obtained by electrodeposition from the foregoing bath, the plate does not have a brilliant lustre but is rather characterized as varying from a milky brightness, having a limited image reflecting ability, to a bright lustre approaching that of unbuffed "bright nickel." The plate is quite smooth and buffs very readily to give a mirror-like surface, very suitable for the reception of chromium plate. The nickel deposit, furthermore, is very ductile and has a hardness about the same as that of gray nickel deposited from the regular Watt bath. In fact, the deposit may even be somewhat softer, and is just as adherent if not more so than gray nickel. In this respect, of course, the nickel deposited in accordance with my method is much superior to "bright nickel," which is ordinarily rather brittle and not nearly so firmly adherent as gray nickel.

While the plating of ferrous metals has been emphasized herein, it should be understood that my nickel plate can be satisfactorily applied to non-ferrous metals as well. Because of the ease with which my nickel plate may be electrobuffed to a high lustre, it has especial advantages when applied to irregularly shaped articles. The method of electrobuffing nickel plate deposited from a bath such as herein described forms the subject matter of a copending application of Walter L. Pinner and myself Serial No. 277,443, filed June 5, 1939.

I am aware that numerous details of the process may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than necessitated by the appended claims.

I claim as my invention:

1. The method of electrodepositing a ductile, adherent, lustrous nickel, which comprises passing an electric current to the work to be plated as a cathode through a solution having a pH between 2.5 and 5.5 and consisting essentially of from 240 to 300 g./l. of nickel sulfate and from 35 to 50 g./l. of nickel chloride as the nickel plating salts and of sodium formate, said sodium formate being present in an amount equal to between 1 g./l. and the saturation point of sodium formate in said solution, maintaining said solution at a temperature between 90° and 190° F., the temperature being higher as the pH is numerically lower, and maintaining the composition and pH of said solution within the ranges given above.

2. The method of electrodepositing a ductile, adherent, lustrous nickel, which comprises passing an electric current to the work to be plated as a cathode through a solution having a pH between 3.6 and 4.0 and consisting essentially of nickel sulfate and nickel chloride plating salts and from 25 to 40 g./l. of sodium formate.

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