

## UNITED STATES PATENT OFFICE

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## ELECTROLYTIC RECOVERY OF METALS

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This invention relates to the electro-deposition of nickel from a solution of nickel sulphate when insoluble anodes are used. During the electrolysis free acid is formed; in other words, the hydrogen ion concentration increases in the electrolyte as the nickel ion concentration decreases. Roughly speaking, when these concentrations are substantially equivalent, practically hydrogen alone is produced at the cathodes, deposition of nickel having substantially ceased. It follows that the deposition of nickel is very incomplete.

By this invention the free sulphuric acid developed by the electrolysis is converted into ammonium sulphate, as far as possible pari passu with its development; for instance, ammonia may be added intermittently or continuously to the depositing bath so as to keep the liquor substantially neutral pH values of 3.5-6.5 may be given as representing the best condition of the liquor, but an acidity a little in excess of pH=3.5 is not injurious.

A feature of the invention is the high degree of exhaustion of nickel from the bath, and in order that this may be attained with success it is important that as the content of nickel in the bath diminishes, the current density should be reduced; for instance, the current density should be halved when the content of nickel has fallen to, say, 1 per cent.

A further feature of the invention is the use of aluminium or aluminium alloy cathodes in the electrolysis of nickel sulphate solution. It has been found that the difficulties met with in the use of other metals as cathodes for winning nickel by electrolysis, are avoided by the use of aluminium; from this metal the deposited nickel can be stripped readily.

As a specific example of the invention the following may be given:—

A solution of nickel sulphate containing 5.0 per cent. of nickel was electrolyzed in a lead lined tank using aluminium cathodes and lead anodes. The current was maintained at about 17 amps. per sq. ft. of cathode area and under the prevailing conditions the

voltage registered across the electrodes was about 3 volts. During the electrolysis mechanical agitation was used and the acidity maintained as nearly as possible between pH4.5 and pH5.5 by the continuous addition of aqueous ammonia. When the content of nickel in the liquor had fallen to 1 per cent. the current density was reduced to about 8.5 amps. per sq. ft.

During the electrolysis the temperature of the bath was maintained at 48-50° C. in order to avoid crystallization of nickel ammonium sulphate.

The electrolysis was stopped when the nickel content of the liquor was reduced to 0.05 per cent. when the liquor was run off for further treatment for the recovery of ammonium sulphate contents. The nickel recovered was obtained at a power expenditure of approximately 3,000 K. W. hrs. per ton.

The main advantage of the invention resides in the possibility of stripping the bath of some 99 per cent. of the nickel contained in it with an average current efficiency of over 90 per cent.

The liquor which has been stripped of nickel as far as is economical may be treated to recover residual nickel and also ammonium sulphate. One method consists in concentrating the liquor until it shows a tendency to crystallize on cooling and then allowing it to cool, whereby the nickel will separate in the form of nickel-ammonium sulphate which is substantially insoluble in saturated ammonium sulphate solution. After separation from the crystals the mother liquor may be concentrated to yield ammonium sulphate crystals. Another method consists in precipitating the residual nickel in the electrolyzed liquor in the form of sulphide by adding ammonium sulphide; after separation of the nickel sulphide, the liquor may be concentrated to crystallize ammonium sulphate.

Having thus described the nature of my said invention and the best means I know for carrying the same into practical effect, I claim:—

A process for substantially completely exhausting the nickel by electro-deposition

from nickel sulphate solutions of low acidity, which process comprises passing an electric current through the solution at a current density of approximately 17 amperes per square foot of cathode area between an insoluble anode and a cathode, continuing the operation until the solution has become substantially free from nickel, meanwhile converting the sulphuric acid thereby produced in the solution into ammonium sulphate substantially simultaneously with its production, whereby the low acidity is constantly maintained during the entire process, and reducing the current density to approximately 8.5 amperes per square foot when the nickel concentration reaches approximately one per cent.

In testimony whereof I have signed my name to this specification.

STANLEY COCHRAN SMITH.

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