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NICKEL ANODE

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The present invention relates to nickel anodes for the electrodeposition of nickel and particularly to rolled nickel anodes containing carbon.

The art of nickel plating has been confronted with problems due to the physical, chemical, metallurgical and electrical properties of nickel anodes almost from the inception of the industry. Anodes of electrolytic nickel having a nickel content of 97% or better develop a passivity very shortly after the electrolysis has started. This passivity results in decreased anode current efficiency. As a means of eliminating this passivity the use of alloy anodes containing iron and carbon has been suggested. However, these have not been entirely successful since alloy anodes containing 6% iron tend to discolor the nickel plating deposited on the cathode. To obviate this difficulty anodes containing less than 1% iron and made of 95–97% nickel bearing carbon were introduced. Such anodes have many defects. Among the disabilities from which such cast nickel carbon bearing anodes suffer are cracks, blow-holes and other mechanical defects. In addition, the anode has a coarsely grained structure. To these imperfections may be ascribed the well-known characteristic of cast nickel carbon-bearing anodes to sluff off large quantities of undissolved nickel. In fact some experts attribute all the defects of cast nickel anodes to the presence of carbon. These anodes have tended to corrode very unevenly. The tendency to sluff off undissolved nickel may not seem to be of much importance but investigation has shown that as much as 2–7% of the nickel removed from the anodes in the course of an ordinary plating operation was undissolved nickel. This undissolved nickel has represented a loss of nickel which must be thrown away or recovered at an additional expense. Furthermore, this undissolved nickel frequently has been deposited on the cathode or article being plated to the detriment of the finish of the plated article. The imperfect or defective articles spoiled as described hereinbefore constitute a serious economic loss and a disturbance in a system of production. Such cast nickel anodes have been known to separate in service and to cause large portions to drop to the bottom of the tank and mix with the sludge. Naturally, such cast anodes cannot be readily worked to form shapes other than those in which they have been cast. Rolled carbon-bearing nickel anodes of good corroding quality have been offered to the industry but were unsuccessful since they suffer from an important drawback. Such anodes do not corrode satisfactorily at pH values above about 4.0 to about 4.5. Thus there has been a pressing need in the nickel plating industry for a highly soluble rolled anode containing carbon. Although many attempts and proposals have been made none, so far as we are aware, has been wholly successful when carried into practice on an industrial scale for commercial production.

We have discovered means of avoiding all of the aforesaid disabilities of carbon-bearing nickel anodes.

It is an object of the invention to provide a carbon-bearing nickel anode from which a negligible amount or a minimum amount of undissolved nickel sluffs off.

It is another object of the invention to provide a carbon-bearing nickel anode which operates satisfactorily at all pH values including those in excess of a pH of 4.0 and below a pH of 6.5.

It is a further object of the invention to provide a carbon-bearing nickel anode which operates at an acceptable current efficiency and does not become passive.

The invention also contemplates providing ductile carbon-bearing rolled nickel anodes.

Other objects and advantages of the invention will become apparent from the following description.

Generally stated, our invention provides for the casting of nickel anodes containing carbon, magnesium, titanium, silicon, iron, copper, cobalt and manganese in critical percentages. Such anodes can be rolled to produce a dense, fine grained structure substantially free from cracks, blow-holes and mechanical defects. Due to the ductility of these anodes, they may be bent and formed without breaking. Our improved, rolled or cast, carbon-bearing nickel anode corrodes evenly and well at pH values of the order of pH 6 in plating baths at temperatures ranging from ordinary room temperature to about 160° F. Our improved rolled anodes operate at a current density of from 1 to 100 amperes per square foot with an efficiency of slightly less than 100%. A distinguishing characteristic of our improved cast and/or rolled anodes is the formation of a gelatinous, adherent layer on the surface of the anode while in operation which traps substantially all the loose undissolved nickel particles and which acts as a strong, tenacious and permeable film.

Our improved nickel anode may contain carbon, magnesium, titanium, silicon in the following amounts:

Carbon	0.05–2.0%
Magnesium	0.05–1.0%
Titanium	0.05–1.0%
Silicon	0.05–1.0%
Cobalt	Up to 0.50%
Iron	Up to 0.25%
Copper	Up to 0.25%
Manganese	Up to 0.25%
Nickel	Balance

It is preferred that there is not more than a maximum of 0.50% cobalt nor more than a maxi-

mum of 0.25% of any of the group consisting of iron, copper and manganese. In practice, we prefer to use a carbon-bearing nickel anode having the following composition:

	Rolled	Cast
	Percent	*Percent*
Carbon	.15-.35	.25-1.25
Magnesium	.20-.30	.20-.30
Titanium	.15-.25	.15-.25
Silicon	.40-.60	.40-.70
Cobalt	.30-.40	.30-.40
Iron	.10-.20	.10-.20
Copper	.05-.15	.05-.15
Manganese	.05-.15	.05-.15
Nickel	Balance	Balance

The improved carbon-bearing nickel anodes operate in hot Watts plating solution at temperatures from about 110 to about 160° F. at pH values of from about pH 1.0 to 6.2 or at ordinary room temperature. A cold solution operates at from about 60 to about 100° F. at pH values up to about pH 6.3 to 6.5. Although the Watts solution has been used as typical of nickel plating solutions the anodes work equally well in the other commercial plating solutions.

For the purpose of giving those skilled in art a better understanding of the invention the following illustrative examples are given.

Our improved cast and/or rolled carbon-bearing nickel anode has the following composition:

	Rolled	Cast
	Percent	*Percent*
Carbon	0.30	1.00
Magnesium	0.31	0.28
Titanium	0.25	0.25
Silicon	0.53	0.53
Cobalt	0.35	0.35
Iron	0.14	0.14
Copper	0.08	0.10
Manganese	0.12	0.12
Nickel	Balance	Balance

Although the present invention has been described in connection with a preferred composition, it is to be understood that variations and modifications may be resorted to as those skilled in the art will readily understand. Such variations and modifications are considered to be within the purview and scope of the appended claims.

We claim:

1. A cast carbon bearing nickel anode comprising carbon about 1.00%, magnesium and titanium about 0.25 to 0.28% of each, silicon about 0.55%, cobalt about 0.35%, iron about 0.14%, copper about 0.10%, manganese about 0.12% and the balance nickel.

2. A cast carbon bearing nickel anode comprising carbon about 0.25 to about 1.25%, magnesium about 0.20 to about 0.30%, titanium about 0.15 to about 0.25%, silicon about 0.40 to 0.70%, cobalt about 0.30 to about 0.40%, iron about .10 to about 0.20%, copper about 0.05 to about 0.15%, manganese about 0.05 to about 0.15% and the balance nickel.

3. A cast and rolled carbon bearing nickel anode comprising carbon about 0.05 to about 2.00%, magnesium about 0.05 to about 1.0%, titanium about 0.05 to about 1.0%, silicon about 0.05 to about 1.0%, cobalt up to about 0.50%, iron up to about 0.25%, copper up to about 0.25%, manganese up to about 0.25% and the balance nickel.

4. A rolled carbon bearing nickel anode comprising carbon and magnesium about 0.30% of each, titanium about 0.25%, silicon about 0.55%, cobalt about 0.35%, iron about 0.14%, copper about 0.08%, manganese about 0.12% and the balance nickel.

5. A cast and rolled carbon bearing nickel anode comprising silicon, titanium and magnesium not more than about 1.0% of each, carbon not more than about twice the silicon content, cobalt not more than about 0.5%, iron, copper and manganese not more than 0.25% of each and the balance nickel.

6. A cast and rolled carbon bearing nickel anode comprising about 0.05 to about 2.00% carbon, about 0.05 to about 1.0% magnesium, about 0.05 to about 1.0% titanium, about 0.05 to about 1.0% silicon, upwards to 0.50% cobalt, iron, copper and manganese up to about 0.25% of each and the balance nickel.

7. A rolled carbon bearing nickel anode comprising carbon and silicon less than about 1.0% of each, magnesium, titanium and cobalt less than about 0.50% of each, iron, copper and manganese less than about 0.25% of each and the balance nickel.

8. A cast carbon bearing nickel anode comprising carbon and silicon not more than about 1.0% of each, magnesium, titanium and cobalt not more than about 0.50% of each, iron, copper and manganese not more than about 0.25% of each and the balance nickel.

9. A cast and rolled carbon bearing nickel anode comprising magnesium, titanium and silicon not more than about 1.0% of each, carbon not more than about 2.0%, not more than about 0.50% of cobalt, not more than about 0.25% of each of the group consisting of iron, copper and manganese and the balance nickel.

10. A nickel anode comprising carbon about 0.05 to about 2.0%, magnesium about 0.05 to about 1.0%, titanium about 0.05 to about 1.0%, silicon about 0.05 to about 1.0%, cobalt up to about 0.50%, iron up to about 0.25%, copper up to about 0.25%, manganese up to about 0.25% and the balance nickel.

11. A nickel anode comprising carbon about 0.15 to about 1.25%, magnesium about 0.20 to about 0.30%, titanium about 0.15 to about 0.25%, silicon about 0.40 to about 0.70%, cobalt about 0.30 to about 0.40%, iron about 0.10 to about 0.20%, copper about 0.05 to about 0.15%, manganese about 0.05 to about 0.15%, and the balance nickel.

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