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[54] **APPARATUS AND METHOD FOR CATHODE STRIPPING**

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[51] **Int. Cl.** **C23b 7/02;** B01k 1/00

[58] **Field of Search** 204/3, 4, 12, 281

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[57] **ABSTRACT**

Disclosed is apparatus and a method for stripping electrodeposits from cathode blanks which apparatus comprises a conveyor for conveying cathodes to a stripping station, a stripping mechanism for stripping electrodeposits from the cathode blanks, quenching devices in the stripping station, a control device for controlling the quenching device so that quenching commences after the stripping mechanism engages the electrodeposit but before the stripping mechanism is activated, and conveyors for conveying stripped electrodeposits and cathode blanks from the stripping station.

14 Claims, 3 Drawing Figures

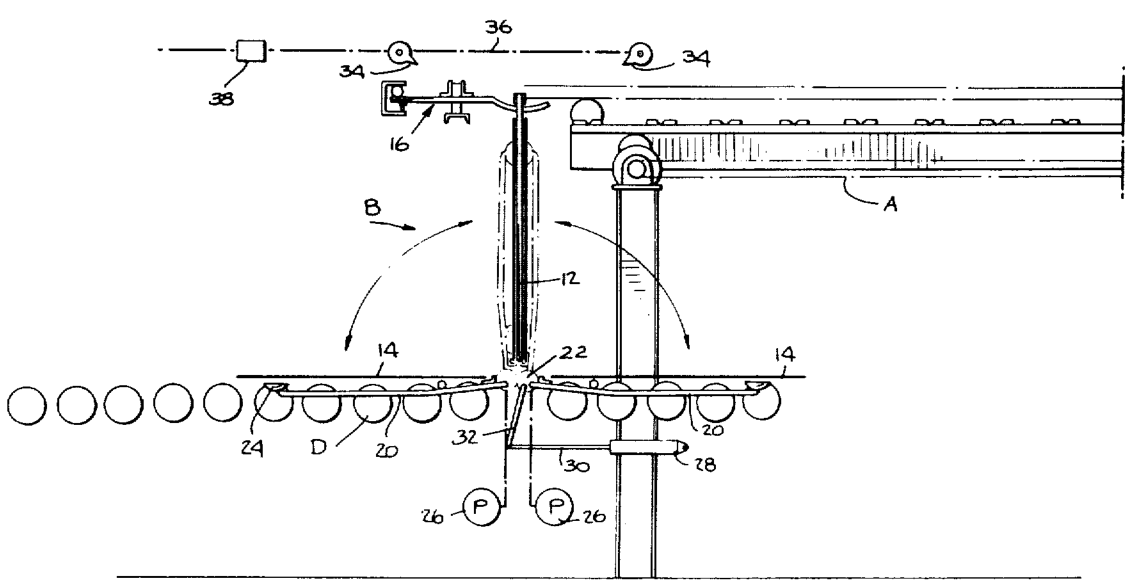
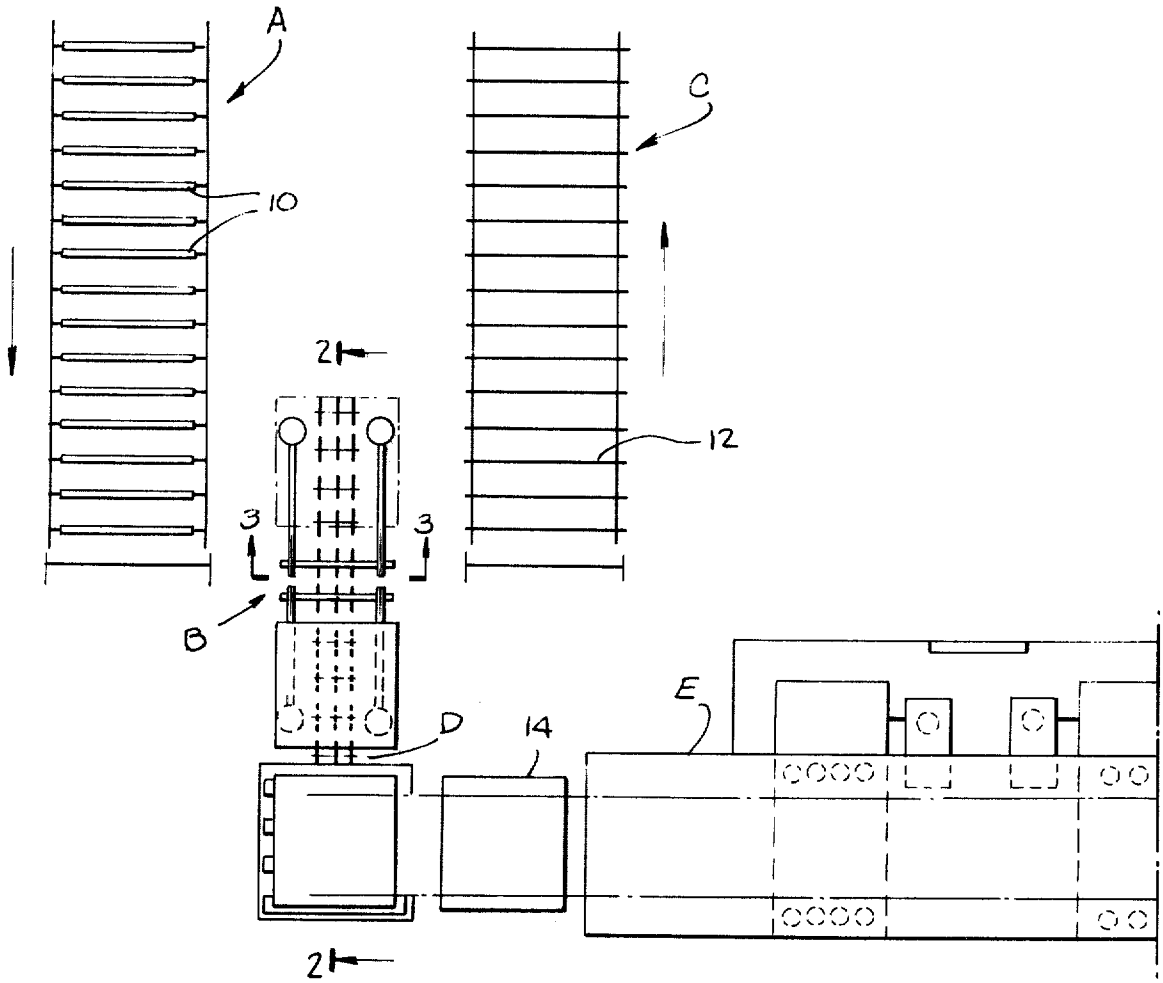


Fig. 1.



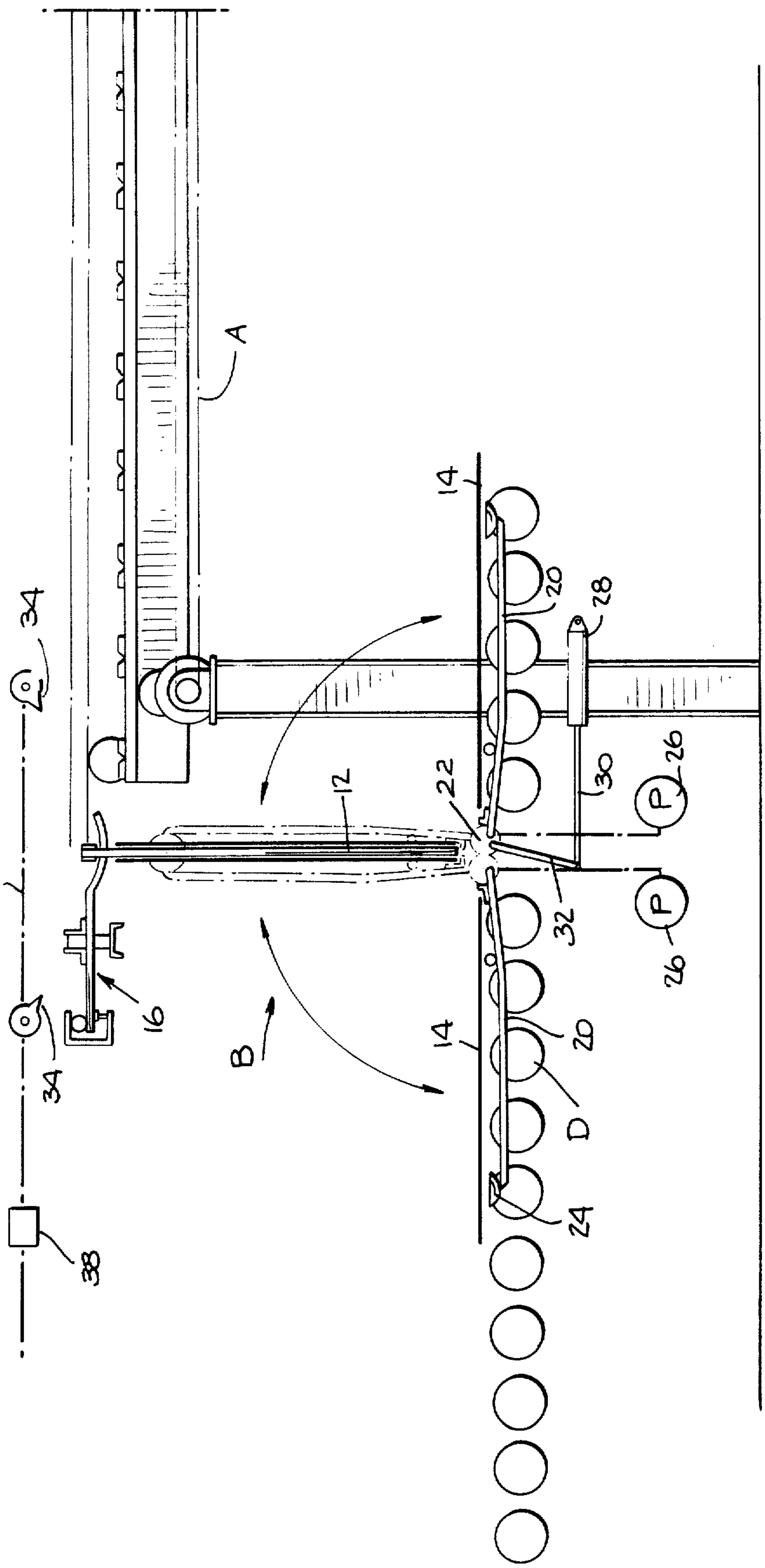
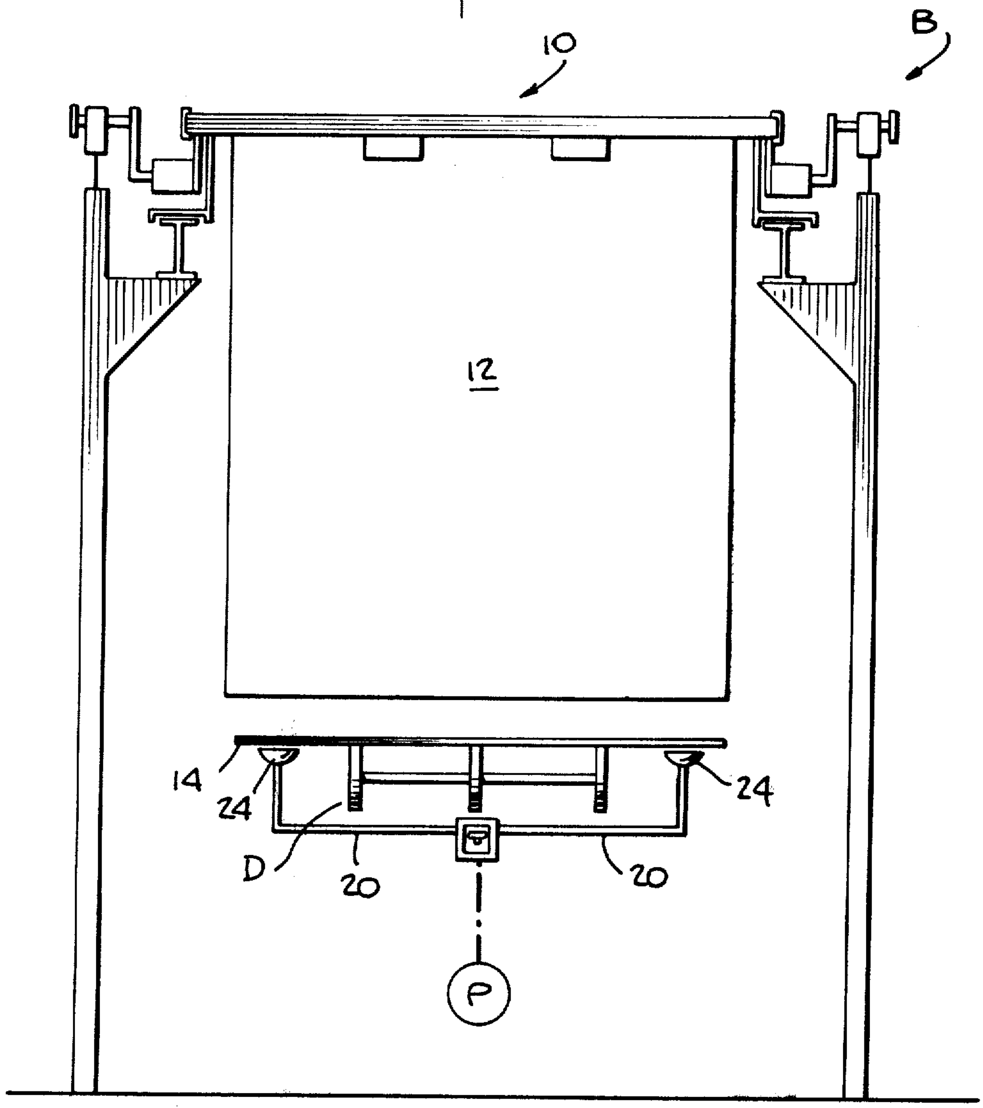


Fig. 2.

Fig. 3.



APPARATUS AND METHOD FOR CATHODE STRIPPING

The present invention pertains to apparatus and a method for stripping metallic electrodeposits from cathode blanks.

Electrorefining and electrowinning processes, particularly the electrorefining of nickel and copper, conventionally involve the use of a starting sheet upon which the metal being refined or recovered is electrodeposited, which processes are known as "multiple processes." The "multiple process" includes, using copper as an example, electrodeposition of copper on a rigid mother blank that is coated with a parting compound, stripping the electrodeposit from the mother blank, straightening the electrodeposit and attaching copper loops, which are cut up electrodeposits, to the straightened electrodeposit to form starting sheets. The frail nature of these starting sheets can create problems during electrorefining by warping, thereby causing short circuiting. Warped sheets must be withdrawn from the electro-refining tank and straightened before being reintroduced into the electrolytic tank. All of these operations involve a great deal of manual labor and are not readily automated.

It has frequently been suggested to employ robust cathode blanks upon which a heavy electrodeposit product, that can be mechanically stripped from the cathode blank, is directly formed. The working surface, i.e., the surface upon which the electrodeposit is formed, can be made of stainless steel, titanium or any other metal or alloy that is corrosion resistant under the electrolyte condition employed and that can be readily surface finished to facilitate stripping of electrodeposits.

One of the major problems encountered in commercially implementing direct electrodeposition is that mechanical stripping, whether or not a parting compound is employed, frequently involves rolling, hammering, chipping or chiseling to part the electrodeposit from the cathode blank so that the electrodeposit can be stripped from the blank by pulling with mechanical means. Parting by rolling, hammering, chipping or chiseling damages the working surface, making subsequent parting even more difficult. When such mechanical parting is employed, the working surfaces must be frequently refinished thereby reducing some of the savings provided by the direct process.

Generally speaking, the present invention contemplates an improved method and apparatus for stripping cathodes, which comprise a cathode blank and an electrodeposit on the cathode blank. The apparatus includes a stripping station, a conveyor for conveying cathodes to the stripping station, an indexing device for placing the cathode into position in the stripping station, a conveyor for conveying the cathode blank from the stripping station and a conveyor for conveying stripped electrodeposit from the stripping station. The improvement comprises equipping the stripping station with support means for supporting a cathode, gripping means for gripping the electrodeposit, thermal means for rapidly altering the temperature of the electrodeposit to thermally part the electrodeposit from the cathode blank, control means for activating the thermal means only after the gripping means have engaged the electrodeposit and for deactivating the thermal means after the electrodeposit is at least partially parted from the cathode blank and stripping means affixed to the gripping means for stripping the parted electrodeposit from the cathode blank.

FIG. 1 is a schematic top view of automatic cathode stripping apparatus showing portions of conveyor assemblies and a washing station and a stripping station that includes the improvements in accordance with the present invention;

FIG. 2 is a vertical section of the stripping station taken along the line 2—2 in FIG. 1; and

FIG. 3 is a vertical section of the stripping station taken along the line 3—3 in FIG. 1.

Referring now to the drawings, there is depicted in the Figures apparatus for stripping cathodes including a conveyor A, stripping station B, conveyor C, conveyor D and washing station E.

The cathodes comprise a cathode blank **12** and an electrodeposit **14** on the cathode blank. Electrodeposit **14** is sufficiently heavy, e.g., at least about one-sixteenth inch, and advantageously between about one-eighth inch and one-half inch, to withstand the forces it is subjected to during the stripping operation. The cathode blank **12** comprises a plate of a metal selected from the group consisting of wrought copper, aluminum, stainless steel and titanium having a working surface roughness of from about 5 to 250 microinches RMS, e.g., between about 50 and 200 microinches RMS, and having electrically insulating masking means at at least the side edges thereof to minimize electrodeposits at and envelopment around the edges. The working surface of the cathode blank can be coated or provided with a film of a parting compound to facilitate parting. Examples of parting compounds are oil, metallic soaps, grease, stearates and resins, such as sodium resinate.

Stripping of electrodeposits from cathode blanks can be improved by employing cathode blank materials that have a substantially different coefficient of thermal expansion than the material being electrodeposited. For example, when electrodepositing copper, which has a coefficient of thermal expansion of 16.8×10^{-6} (defined as change in linear dimension per unit length per degree Celsius), a titanium cathode blank, which has a coefficient of thermal expansion of 9.0×10^{-6}, is employed. In most instances, it is advantageous for the cathode blank and the electrodeposit to have a minimum difference in their coefficient of thermal expansion of at least about 10 percent, e.g., preferably at least about 25 percent. When cathode blanks and electrodeposits having such minimum differences in coefficients of thermal expansion are cooled or heated from electrodeposition temperatures, stresses are induced at the electrodeposit-cathode blank interface which promote parting.

Partial parting of the electrodeposit from the cathode blank can also be promoted by adding a stress inducing reagent to the electrolyte which contains soluble salts of the non-ferrous metal being deposited. For example, when electrodepositing copper, small but effective amounts of at least one stress-inducing reagent selected from the group consisting of guar gum, gelatine, benzotriazole, thiourea, animal glue, and polyacrylamide are added to the electrolyte. When electrodepositing nickel, stress-changing reagents including ethylenecyanohydrine, chloride ion, butynediol, naphthalene sulfonic acids, and saccharin are added to the nickel-containing electrolyte in small but effective amounts to change internal stresses in the electrodeposit so that upon cooling or heating from the electrodeposition temperature parting from the cathode blank is promoted. In most instances, stress-inducing reagents are added to the electrolyte in amounts of at least about 0.01 parts per million (ppm), and advantageously in amounts between about 0.1 ppm and 50 ppm (in some instances amounts up to about 100 ppm can be used), in order to insure the imparting of internal stresses to the electrodeposit while minimizing contamination of the electrodeposit by the additive.

Cathodes are removed from the electrolytic cell, not shown on the drawings, and are conveyed by conveyor A to stripping station B where individual cathodes are placed in stripping position by indexing mechanism **16**. Conveyor A can be equipped with heating means, such as a hot air blower or hot water spray, to maintain cathodes held therein at predetermined temperatures to minimize the problems associated with premature parting and possible stripping within the conveyor.

Stripping station B comprises links **20** pivotally mounted on crankshaft **22** and equipped with suction pads **24** for gripping electrodeposit **14**. Links **20** can be hollow so that pumps **26** can evacuate suction pads **24**. Suction pads **24** are sufficiently large so that the pressure differential between atmospheric pressure and the subatmospheric pressure within the pads multiplied by the total area of all the cups engaging one side of the cathode is greater than the forces required to pull electrodeposit **14** from cathode blank **12**. Links **20** are moved from the starting position, as shown by the solid lines in FIG. **2** to the electrodeposit engaging position, as shown by the phantom lines in FIG. **2**, by air motors **28**, only one being shown in FIG. **2** for the sake of clarity, via linkages **30** and **32**. Stripping station B is also equipped with a plurality of nozzles **34** for rapidly quenching or heating electrodeposits **14** for thermally parting the electrodeposit from cathode blank **12**. Water or other quenchants are led to nozzles **34** via pipes **36** and the flow of water or other quenchant to and through pipes **36** and nozzles **34** is controlled by control mechanism **38** which can be a relay-operated valve. Once suction pads **24** have engaged and gripped electrodeposit **14**, control mechanism **38** is activated and water flows through pipe **36** and nozzles **34** to rapidly quench and thermally part the electrodeposit from cathode blank **12**. After electrodeposit **14** is parted from at least the tip of the cathode blank **12**, air motor **28** is actuated to rotate linkages **20** from the vertical to the horizontal position thereby stripping the electrodeposit from the cathode blank.

Stripped cathode blanks **12** are removed from stripping station B by indexing mechanism **16** to conveyor C which conveys the cathode blanks back to the electrolytic tanks or to a reconditioning area to be prepared for further use.

Stripped electrodeposits **14** are transferred to washing station E by conveyor C. Upon exiting the washing station, the stripped electrodeposits can be melted or otherwise formed into commercial shapes.

In operation, cathode blanks having a copper electrodeposit **14** thereon are removed from an electrolytic tank at a temperature between about 60° and 70°C., dipped in a tank of hot water at a temperature about 60°C. and placed on conveyor A. The hot cathodes are conveyed by conveyor A to stripping station B without substantially altering their temperatures and are placed therein by indexing mechanism **16** at temperatures between about 50° and 65°C. Suction pads **24** engage electrodeposit **14**, and only then is control mechanism **38**, which can be a relay actuated by a timer or by means for sensing that a vacuum has been established within the suction pads, activated to commence quenching to lower the temperature of the electrodeposit **14** to less than about 40°C. When the cathode is quenched, electrodeposit **14** parts from cathode blank **12** and links **20** are actuated to pull the parted electrodeposit from the cathode blank. The stripped electrodeposits are placed on conveyor C by links **20** and are conveyed thereby to working station E. The stripped cathode blank is placed on conveyor D by indexing mechanism **16** and is conveyed back to the electrolytic tank.

If for any reason the automatic stripping operation must be temporarily stopped, cathodes on conveyor A should be maintained at a temperature not materially different from the cathodes emerging from the electrolytic tanks, e.g., above 50°C., in order to prevent premature stripping, either on conveyor A or in stripping station B, or should be removed from conveyor A. The cathodes can be maintained at temperature during such temporary stoppages by contacting the cathodes with either hot air, water or steam or placing them into the hot water tank.

In order to give those skilled in the art a better appreciation of the present invention the following illustrative example is given:

A cathode comprising a cathode blank of titanium polished to 60 microinches RMS and an electrodeposit of copper of 0.3 inch while wet and at a temperature of 55°C. was placed into position in the stripping station by an indexing mechanism as shown in FIG. **2**. Rectangular vacuum cups having interior cavities measuring 3.5 inches by 7 inches were moved into engaging position by air motor drawn linkages and the cavities were evacuated to 2.4 psi to grip the electrodeposits with a force of 300 pounds. Once the vacuum cups were gripping the electrodeposits, quenching means were activated to lower the temperature to 28°C., at which point separation of the upper part of the electrodeposit from the titanium blank was visible and the quenching was then terminated. The linkages holding the vacuum cups were then moved to the horizontal from the vertical position to strip the electrodeposit from the cathode blank. After stripping, the vacuum was released and the stripped electrodeposits were conveyed to a washing station. The stripped cathode blank was removed from the stripping station to a conveyor to be returned to the electrolytic cell, and the stripping station was ready to receive another cathode for stripping.

Although the invention has been described primarily by reference to the apparatus, it will be observed that the invention also includes a method for electrodepositing a non-ferrous metal, e.g., copper, nickel, cobalt, zinc and manganese, on a cathode blank and subsequently stripping the electrodeposit from the cathode blank. The method comprises electrodepositing a non-ferrous metal on a cathode blank in an electrolytic cell containing an electrolyte that is maintained at a predetermined temperature to form a cathode comprising the cathode blank and an electrodeposit of a preselected thickness thereon, removing the cathode from the electrolytic cell, conveying the cathode to a stripping station while maintaining the temperature of the cathode at substantially the predetermined temperature to minimize premature parting, engaging the electrodeposit in the stripping station with gripping means affixed to stripping means, rapidly altering the temperature of the engaged electrodeposit to part at least partially the electrodeposit from the cathode blank and then actuating the stripping means to strip the parted electrodeposit from the cathode blank.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

We claim:

1. In an apparatus for stripping cathodes, the cathode comprising a cathode blank and a metallic electrodeposit on the cathode blank, said electrodeposit having been applied at an electrodeposit bath temperature, which apparatus includes a stripping station, means for conveying cathodes to the stripping station, means for indexing the cathode in and for removing the cathode blank from the stripping station, means for conveying the cathode blank from the stripping station and means for conveying stripped electrodeposit from the stripping station, the improvement which comprises support means in the stripping station for supporting the cathode, gripping means in the stripping station for gripping the electrodeposit, thermal means for maintaining the temperature of the electrodeposit substantially at the bath temperature until the gripping means have engaged the cathode in the stripping station, thermal means for rapidly altering the temperature of the electrodeposit after the gripping means have engaged the electrodeposit to thermally part the electrodeposit from the cathode blank, control means for activating the thermal means only after the gripping means have engaged the electrodeposit and for deactivating the thermal means after the electrodeposit is parted from the cathode blank and stripping means affixed to the gripping means for stripping the parted electrodeposit from the cathode blank.

2. The apparatus described in claim **1** wherein the gripping means are suction pads.

3. The apparatus described in claim **1** wherein the thermal means includes at least one nozzle directed at the electrodeposit, a quenchant source and means for conveying quenchant from the source to the nozzle for rapidly lowering the temperature of the electrodeposit.

4. A process for electrodepositing a non-ferrous metal on a cathode blank and subsequently stripping the electrodeposit from the cathode blank which comprises electrodepositing a non-ferrous metal on a cathode blank in an electrolytic cell, said cathode blank and electrodeposit having different coefficients of thermal expansion, and said electrolytic cell containing an electrolyte that is maintained at a predetermined temperature, to form a cathode comprising the cathode blank and an electrodeposit of a preselected thickness thereon of at least about one-sixteenth inch thickness, removing the cathode from the electrolytic cell, conveying the cathode to a stripping station while maintaining the temperature of the cathode at substantially the predetermined temperature to minimize premature parting, engaging the electrodeposit in the stripping station with gripping means affixed to mechanical stripping means, rapidly altering the temperature of the engaged electrodeposit to part at least partially the electrodeposit from the cathode blank at an edge and then actuating the stripping means to strip the parted electrodeposit from the cathode blank.

5. The process described in claim **4** wherein the non-ferrous metal is at least one member selected from the group consisting of copper, nickel, cobalt, zinc and manganese.

6. The process as described in claim **4** wherein the cathode blank and the electrodeposit have a minimum difference in their coefficients of thermal expansion of at least about 10 percent.

7. The process as described in claim **6** wherein the cathode blank is made of a metal selected from the group consisting of wrought copper, aluminum, stainless steel, or titanium.

8. The process as described in claim **6** wherein the working surface of the cathode blank is coated with a parting compound.

9. The process as described in claim **6** wherein the parting compound is at least one member selected from the group consisting of oil, metallic soaps, grease, stearates and resins.

10. The process as described in claim **4** wherein the electrolyte contains a stress-inducing reagent in small but effective amounts to induce internal stresses in the electrodeposit to promote parting.

11. The process as described in claim **4** wherein the non-ferrous metal is copper, the electrolyte contains copper salts and a stress-inducing reagent in small but effective amounts to induce internal stresses in the electrodeposit and heated to a temperature between about 60° and 70°C., the cathode blank is made of a metal selected from the group consisting of wrought copper, stainless steel and titanium and its working surface is coated with a parting compound and the electrodeposit is quenched with water to lower its temperature to less than about 40°C. to promote parting.

12. The process as described in claim **4** wherein the non-ferrous metal is nickel, the electrolyte contains nickel salts and a stress-inducing reagent in small but effective amounts to induce internal stresses in the electrodeposit and heated to a temperature between about 60° and 70°C., the cathode blank is made of a metal selected from the group consisting of wrought nickel, aluminum, stainless steel and titanium and its working surface is coated with a parting compound and the electrodeposit is quenched with water to lower its temperature to less than about 40°C. to promote parting.

13. The process as described in claim **4** wherein the non-ferrous metal is nickel, the electrolyte contains nickel salts and is heated to a temperature between about 60° and 70°C., the cathode blank is made of a metal selected from the group consisting of wrought nickel, aluminum, stainless steel and titanium and the electrodeposit is quenched with water to lower its temperature to less than about 40°C. to promote parting.

14. The process described in claim **7** wherein the cathode blank has a working surface roughness of from about 5 to about 250 microinches RMS.

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