APPARATUS FOR STRIPPING CATHODE STARTING PLATES

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UNITED STATES PATENTS
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ABSTRACT

Apparatus for stripping electrolytically deposited layers of metal, such as copper, from cathode starter plates comprising a forwarding conveyor for delivery of a cathode starter plate to a take-away station, transfer means for gripping a cathode at the take-away station, lifting and swinging it first to a stripping station and then to a receiving station on take-away conveyor. At the stripping station, a pair of arms, each carrying a vacuum gripping head swing into gripping engagement with opposite faces of the metal layers on the cathode and then swing away from the cathode to strip the metal layers from the cathode starter plate with the transfer means positively holding the cathode starter plate as the metal layers are stripped from the sides thereof.

12 Claims, 13 Drawing Figures
APPARATUS FOR STRIPPING CATHODE STARTING PLATES

BACKGROUND OF THE INVENTION

This invention relates to apparatus for stripping cathode starter plates, and more particularly for stripping from such plates electrolytically deposited layers of metal, such as copper.

In the electrolytic refining of copper, copper-bearing anodes are placed with so-called cathode starter plates, which may be titanium plates, in an electrolytic bath and electrolyzed with resultant deposition of copper from the anodes on the the starter plates. There is then the problem of removing the copper from the starter plates, and this invention is directed toward that problem.

Reference may be made to U.S. Pat. No. 3,636,677 showing apparatus in the same general field as the apparatus of this invention.

SUMMARY OF THE INVENTION

Among the several objects of this invention may be noted the provision of apparatus such as above described especially useful in stripping layers of copper electrolytically deposited on titanium cathode starter plates from the starter plates; the provision of such apparatus which securely holds a starter plate while the layers of copper are stripped from both sides thereof; the provision of such apparatus in which the layers of metal are stripped from cathode starter plates without damage to the starter plates; the provision of such apparatus which permits a series of reject cathode starter plates to accumulate on a reject starter plate conveyor before this reject conveyor must be unloaded; and the provision of such apparatus which is of rugged construction and reliable in operation.

In general, apparatus of this invention is adapted to strip layers of metal electrolytically deposited on cathodes, each of which comprises a cathode starter plate having a bar at the top extending laterally beyond the sides of the cathode enabling the plate to be suspended by means of the end of the bar with the plate having layers of metal on opposite faces thereof. It comprises a cathode forwarding conveyor having a pair of space-apart elevated support members adapted to hold a series of cathodes suspended therefrom by means of the ends of the starter plate top bars bearing on the support members, with the cathodes extending transversely of the forwarding conveyor below and between the support members and spaced at generally equal intervals along its length, and means for advancing the entire series of cathodes one interval successively to bring the cathodes to a take-off station at one end constituting the forward end of the forwarding conveyor. The apparatus further comprises a started plate take-away conveyor extending alongside and spaced from the forwarding conveyor comprising a pair of space-apart elevated support members adapted to hold a series of starter plates by means of the ends of the starter plate top bars bearing on the support members, with the starter plates extending transversely of the take-away conveyor below and between its support members and spaced at generally equal intervals along its length. One end of the take-away conveyor constituting its starter plate receiving end is adjacent the forward end of the cathode forwarding conveyor. Means is provided for moving the entire series of starter plates one interval in the direction away from the receiving end of the take-away conveyor. Transfer means is provided for gripping the cathode at the take-off station of the forwarding conveyor at the top of the cathode, lifting it and swinging it forward to a stripping position wherein both faces of the cathode are accessible. The apparatus further comprises vacuum means at the stripping position movable from a retracted position into vacuum gripping engagement with the opposite faces of the cathode at the stripping position and back to said retracted position to strip the metal layers from both faces of the starter plate of the cathode. The transfer means is further swingable after stripping of the metal layers to deposit the stripped starter plate on the support members of the take-away conveyor at a take-away station at its receiving end.

Other objects and features of this invention will be in part apparent and in part pointed out hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of apparatus of this invention showing a rinse station at which a series of cathodes is washed, a plurality of cathode conveyors, a stripping station at which layers of metal on the cathode starter plate are stripped therefrom, cathode transfer means for lifting and transferring a cathode from one conveyor to the stripping position and thence to another conveyor, and an operator's console;

FIG. 2 is a vertical section taken on line 2—2 of FIG. 1 illustrating a cathode forwarding conveyor and a cathode at the stripping station for having layers of metal stripped therefrom by vacuum gripping means of the apparatus;

FIG. 3 is an enlarged horizontal view taken on line 3—3 of FIG. 2 showing details of the stripping station;

FIG. 4 is a view in elevation on line 4—4 of FIG. 3;

FIG. 5 is a right side elevation of FIG. 4;

FIG. 6 is an enlarged plan on line 6—6 of FIG. 2 showing details of the cathode transfer means;

FIG. 7 is a side elevation view of FIG. 6;

FIG. 8 is a longitudinal vertical section on line 8—8 of FIG. 1 illustrating details typical of all the cathode conveyors;

FIG. 9 is an enlarged vertical section on line 9—9 of FIG. 8;

FIG. 10 is a front elevation of a cathode with a portion of the metal layers deposited thereon broken away showing the cathode starting plate;

FIG. 11 is an enlarged vertical section on line 11—11 of FIG. 1 showing means for rinsing each cathode as it advances toward its take-away position;

FIG. 12 (sheet 4) is an enlarged view in elevation taken on line 11-11 of FIG. 7; and

FIG. 13 is a view similar to FIG. 4 illustrating the vacuum gripping means at an intermediate position.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is generally indicated at 1 apparatus of this invention for stripping electrolytically deposited layers of metal M, such as cop-
per, from cathode starter plates 3. As shown in FIG. 10 (see sheet 6), each starter plate comprises a generally rectangular plate 5 of titanium, or other suitable metal resistant to chemical attack by electrolyte solutions, having a bar 7 of copper or other suitable electrically conductive material secured as by rivets 9 to its top, with the ends of this top bar 7 extending beyond the sides of the plate thus enabling the starter plate to be suspended by means of the ends of the bar. A series of starter plates (e.g., 22 or 23 starter plates) may be suspended in a plating tank or cell (not shown) immersed in an electrolyte solution and electrically connected in an appropriate electrical circuit to serve as cathodes on which metal ions in the solution are electrically deposited on the plate. The starter plates with the layers of metal M deposited thereon are generally referred to as cathodes C. As appears in FIG. 1, the apparatus comprises a cathode forwarding conveyor 11, a starter plate take-away conveyor 13 and a reject starter plate conveyor 15, each for moving a series of cathodes or starter plates supported thereby in the directions as indicated by the arrows shown in FIG. 1. These conveyors are arranged parallel and adjacent to one another for purposes as will appear.

The forwarding conveyor 11 has a pair of spaced-apart, elevated, stationary support members 17 adapted to hold a series of cathodes C by means of the ends of the starter plate top bars 7 bearing on the support members, with the cathodes extending transversely of the conveyor below and between the support members spaced at generally equal intervals along the support members. Means generally indicated at 19 is provided for advancing the entire series of cathodes supported from supports 17 one interval successively to bring the cathodes to a take-off station 21 at the forward end (the left end as viewed in FIG. 1) of the forwarding conveyor.

Take-away conveyor 13 is generally similar to forwarding conveyor 11 but for the direction of movement of the cathodes. The take-away conveyor has a pair of spaced-apart elevated support members 23 for receiving a series of cathode plates after the layers of metal M have been stripped therefrom, and means generally indicated at 25 for moving the series of starter plates supported by the support members one interval successively to move each starter plate from a receiving station 27 at the end of the conveyor adjacent take-away station 21 of the forwarding conveyor.

As indicated at 29, transfer means is provided between the take-off station 21 of the forwarding conveyor 11 and the receiving station 27 of the take-away conveyor 13 for gripping a cathode C at the take-off station, lifting it, and swinging it forward to a stripping station generally indicated at 31. At the stripping station the cathode is positioned in a stripping position (see FIGS. 3-5) wherein both faces of the cathode are accessible for stripping the layers of metal M therefrom. Vacuum gripping means generally indicated at 33 is provided at the stripping station. This means includes a pair of vacuum heads movable from a retracted position (see FIG. 1) to a gripping position (see FIGS. 2-5) in which they are in gripping engagement with the opposite faces of metal layers M of the cathode and thence movable back down to their retracted positions forcefully to strip the metal layers M from plate 5 of cathode C. After stripping is complete, transfer means 29 is further swingable to deposit the stripped starter plate 3 (for re-use) on support members 23 of take-away conveyor 13 at take-away station 27.

In the event a starter plate 3 is not suitable for re-use (any such plate being referred to as a reject starter plate), provision is made for removing a reject from take-away conveyor 13 and depositing it on reject conveyor 15. This reject conveyor is positioned adjacent and parallel to the take-away conveyor and has a pair of stationary spaced-apart elevated support members 35 adapted to support reject starter plates by means of the ends of their top bars 7 in a manner similar to the other conveyors. The reject starter plates are deposited on one end of the reject conveyor constituting its receiving end, as indicated at 37, adjacent take-away station 27 of the take-away conveyor. Selectively operable means 39 is provided for moving a series of rejected starter plates supported by support members 35 one interval in the direction away from its receiving end (as shown by the arrow). A second transfer means 41 is provided between the forward ends of the take-away and reject conveyors for gripping a rejected starter plate at the receiving end of the take-away conveyor, lifting it, swinging it to the receiving end of the reject conveyor and depositing it on support members 35. This second transfer means 41 is generally similar to the first transfer means 29 (to be described in detail hereinafter).

A rinse tank 43 is provided adjacent the forwarding conveyor 11 for washing excess electrolyte from a series of cathodes C removed from a plating tank or cell (not shown). An operator's control console generally indicated at 45 is provided adjacent stripping station 31 equipped with suitable controls for controlling operation of the apparatus in a manner that will appear.

Conveyors 11, 13 and 15 are of generally similar construction, hence only the forwarding conveyor 11 will be described in detail with differences between the other conveyors particularly pointed out. As shown in FIG. 2, conveyor 11 is supported in elevated position above floor F by a rigid framework generally indicated at 47 of steel beams or the like. This framework includes a pair of spaced-apart horizontal I-beams 49 carrying rails constituting the support members 17 on opposite sides of the conveyor (see FIG. 11).

As previously noted, means 19 is adapted to advance the entire series of cathodes C supported by support members or rails 17 one interval, and this interval is determined by a series of equally spaced notches 51 in the upper edge of the rails for receiving the ends of top bar 7 of cathodes. Means 19 comprises a pair of walking beams 53 extending parallel to rails 17 on the outside thereof. These walking beams each have a series of equally spaced notches 55 in their upper edges corresponding to notching 51 in the support members, and are operable by a lifting linkage arrangement 57 actuable by a hydraulic cylinder unit 59 (referred to as a lifting cylinder) and by a translating linkage arrangement 61 actuable by a hydraulic cylinder unit 63 (referred to as a translating cylinder). Upon actuation of the lifting cylinder, the walking beams are raised to lift the cathodes C clear of rails 17, and upon actuation of the translating cylinder the entire series of cathodes (now supported by the walking beams 53) is shifted toward the take-away station 21 an interval equal to the spacing of the notches 51 in support 17. The lifting and translating cylinders are then reversely actuated
thereby respectively to lower the walking beams to lower the cathodes into the notches 51 in support 17 and to return the walking beams to their starting positions. It will be understood that the construction of means 25 and 39 for moving starter plates 3 on conveyors 13 and 17, respectively, is substantially similar to the construction of the advancing means 19 herein described with the exception that when the translating cylinders of these conveyors are actuated, walking beams 53 are moved away from their respective receiving ends to advance the series of starter plates supported thereby in the direction of the arrows shown in FIG. 1.

More particularly, each walking beam 53 is swingably mounted on a respective I-beam 49 by means of a plurality of cranks 65, each crank being fixed to a shaft 67 carried by I-beam 49 for rotation about a horizontal axis and having a crank pin 69 at its upper end (see FIG. 9). This crank pin carries a pair of rollers 71 engageable with the bottom face of the walking beam 53 so that upon rotation of the crank on shaft 67, the walking beam 53 is lifted by the rollers from a lowered retracted position in which it lies below and clear of top bars 7 of cathodes C to a raised lifting position (shown in FIGS. 8 and 9) in which the top bars 7 of the series of cathodes C are lifted clear of rail 17. Each crank further includes a brace 73 between rollers 71 secured to and rotatable with shaft 67 for brushing the crank pin 69. The cranks for each walking beam 53 are simultaneously rotated to effect movement of beams 53 between their lowered retracted and raised lifting positions by an elongate actuating member 75 rotateably connected to each crank pin 69. Each actuating member (shown in dotted lines in FIG. 8) is pivotally connected, as indicated at 77, to a U-shaped lifting yoke 79 pivotally carried between I-beams 49 for swinging movement about a horizontal axis, as indicated at 81. This yoke has a pair of spaced-apart vertical arms 79a and a horizontal beam 79b extending between the lower ends of the vertical arms. Lifting cylinder 59 has its piston rod 83 pivotally connected to beam 79b intermediate its ends, as indicated at 85. The lifting cylinder is pivotally carried by frame 47 by means of transverse beam 120 which extension of its piston rod 83 effects swinging of yoke 79 clockwise (as viewed in FIG. 8) in a vertical plane about pivots 81 thereby to effect rotation of cranks 65 about their respective shafts 67 so as to effect movement of walking beams 53 from their lowered retracted positions to their raised lifting positions (shown in FIGS. 8 and 9). Retraction of piston rod 83 reversely rotates the cranks and lowers the walking beams to their lowered retracted positions. The actuating members 75, yoke 79 and lifting cylinder 59 together constitute the lifting linkage arrangement 57.

The translating linkage arrangement 61 includes a crossbeam 89 interconnecting the rear ends (right ends as viewed in FIG. 8) of the two walking beams 53. Translating cylinder 63 is pivotally mounted on frame 47 by trunnions 91 and has a piston rod 93 extending therefrom with its free end pivotally connected to the crossbeam 89 as indicated at 95. Thus, with movable walking beams 53 in their raised lifting positions, extension of piston rod 93 a distance corresponding to the spacing of notches 51 in rails 17 translates the walking beams forwardly on rollers 71 thereby to advance the series of cathodes C supported by the walking beams one interval to bring the cathodes successively to take-off station 21. With the walking beams in their lowered retracted position, retraction of piston rod 93 returns the walking beams 53 to their starting positions. It will be understood that the translating cylinders for means 25 and 39 for conveyors 13 and 15, respectively, have their piston rods initially extended such that with their walking beams 53 in their raised lifting positions, retraction of the translating cylinder piston rods translates the lifting bars and the starter plates supported thereby in the direction of the arrows shown in FIG. 1.

A rinsing station (see FIG. 1) generally indicated at 97, is provided along forwarding conveyor 11 adjacent take-away station 21 at the forward end thereof. As shown in FIG. 11, a spray head 99 including a plurality of spray outlets 101 is guided by guides 103 for vertical movement between two adjacent cathodes C suspended from rails 17. The guides have upper and lower portions separated by gaps 104 for passage of bars 7. The spray head is supplied with water under pressure by a flexible hose 105 and is movable between a raised retracted position (shown in solid lines in FIG. 11) above the top bars 7 of cathodes C, and a lowered position (shown in phantom) adjacent the lower ends of the cathodes. The spray head comprises a plate 107 somewhat wider than the cathodes with its ends in engagement with guides 103. The spray head is suspended by a cable 109 trained around pulleys 111 and 113 and attached to the free end of a piston rod 115 of a hydraulic cylinder unit 117 actuable to raise and lower the spray head.

Transfer means 29 and transfer means 41 are substantially identical (with such exceptions as will be particularly pointed out), and for that reason, only the construction and operation of the first transfer means 29 will be described in detail. As shown in FIGS. 2, 6 and 7, the transfer means 29 comprises a stationary, rigid mounting structure 117 supported by frame 47 between forwarding conveyor 11 and take-away conveyor 13 (adjacent their left ends as viewed in FIG. 1). The mounting structure includes a vertical cylinder 130, a horizontal beam 131, a vertical brace 123. Upper and lower mounting brackets 125 and 127, respectively, are secured to the front face of post 119 for pivotally mounting a boom generally indicated at 129 for swinging movement about a generally vertical axis. The boom structure may generally be described as a parallelogram linkage including an inner vertical post 131 journaled in bearings 133 and 135 carried by the upper and lower mounting brackets 125 and 127, respectively, an outer vertical post 137, a pair of upper horizontal spaced-apart boom members 139a, 139b pivotally connected to the upper ends of vertical members 131 and 137 as indicated at 141 and 143, respectively, and a pair of lower spaced-apart horizontal boom members 145a, 145b pivotally connected to the lower ends of the vertical members as indicated at 147 and 149. A rigid bracket 151 is secured to the inner face of inner vertical member 131 and a rigid crossbeam 153 extends between the lower spaced-apart boom members 145a, 145b intermediate pivots 147 and 149. A hydraulic cylinder unit 155 (referred to as a boom lift cylinder) having a piston rod 157 is pivotally secured to crossbeam 153, as indicated at 159, and its piston rod is pivotally secured to bracket 151, as indicated at 161. Actuation of the boom lift cylinder effects swinging of
the boom members in a vertical plane about pivot connections 141 and 147 between a raised position (shown in FIG. 7, with piston rod 157 retracted into the boom lift cylinder) and a lowered position (not shown) in which the piston rod is extended (and the cylinder 155 lowered).

Boom 129 carries means generally indicated at 163 for clamping or gripping the top bar 7 of a cathode C (or of a starter plate 3). This enables the boom to lift and move a cathode from forwarding conveyor 11 to the stripping station 31, and thence to take-away conveyor 13, and securely to hold it at the stripping station as the layers of metal M are stripped therefrom. As shown in FIGS. 6, 7 and 12, this clamping means includes a pair of opposed jaws 165a, 165b each having mounting lugs 166a, 166b, respectively, secured thereto. Each lug is rotatably journalled on a horizontal shaft 167 rigidly secured to the bottom end of the outer vertical post 137 of the boom. Each jaw is channel-shaped in cross section, with the webs of the channels being back-to-back, and each jaw carries a second lug 169a, 169b on its upper flange. Hydraulic cylinder units 171a, 171b are pivotedally carried by brackets 172a, 172b, respectively, on opposite sides of vertical member 137. These cylinder units may be referred to as gripper cylinders and each has a piston rod 175a, 175b, respectively, which is pin-connected to the respective lug 169a or 169b. Upon simultaneous extension of piston rods 175a, 175b, the jaws are rotated on shaft 167 to a closed or gripping position (see FIG. 12) in which the webs of the jaws may be brought into gripping engagement with top bar 7 of a cathode, and upon retraction of the piston rods, the jaws are swung away from one another to an open position in which the jaws are clear of the cathode top bar.

Transfer means 29 further includes means generally indicated at 177 for swinging boom 129 about the vertical axis of the bearings 133 and 135 from a pick-up position (not shown) in which clamping means 163 is in position above a cathode C at take-off station 21 on the forwarding conveyor 11, to a stripping position (see FIG. 1) in which a cathode gripped by clamping means 163 is in its stripping position at stripping station 31, thence to a deposition position (not shown) at the receiving end 27 of take-away conveyor 13 in which the starter plate gripped by the clamping means may be deposited on the take-away conveyor, thence returning to its pick-up position for gripping the next successive cathode on conveyor 11. Boom swinging means 177 comprises a pinion 179 secured to the bottom end of vertical post 131 in mesh with a reciprocable rack 181.

In transfer means 29, the rack 181 is reciprocated by means of a compound hydraulic cylinder assembly 183 including a pair of hydraulic cylinder units 185a, 185b each having their back or capped ends secured together, with their respective piston rods 187a, 187b extending endwise therefrom in opposite directions. The free end of piston rod 187a carries rack 181 and the free end of piston rod 187b is pin-connected at 188 to vertical brace 123 of mounting structure 117. Rack 181 is guided by a guide 189 (see FIG. 6) to retain the rack in mesh with pinion 179. The arc through which boom structure 129 is swung is dependent upon the stroke of cylinders 185a, 185b. With the transfer means 29 supported midway between conveyors 11 and 13 and on a transverse line between take-away station 21 and receiving end 27, the boom structure must be swung through arcs of approximately 90° to move it from its pick-up position to its stripping position, and from its stripping position to its depositing position, and through an arc of approximately 180° to return it from its depositing position to its pick-up position. Thus, rack 181 must be of sufficient length to move pinion 179 through at least 180° of rotation and the stroke of cylinder units 185a, 185b each must be sufficient to rotate the boom through an arc of 90° with cylinder unit 185b being actuable to swing the boom 90° from its pick-up position to its stripping position, with unit 185a being actuable to swing the boom a further 90° from its stripping position to its depositing position and with both the cylinder units 185a and 185b being reversibly actuable to swing the boom 180° from its depositing position to its pick-up position.

In transfer means 41, the hydraulic cylinder assembly reciprocating rack 181 has only one hydraulic cylinder unit (see FIG. 1) which is actuable to swing its boom through an arc of at least 180° to transfer a rejected starter plate from receiving end 21 of conveyor 13 to the receiving end 37 of conveyor 15. This cylinder unit is partially actuated to move the boom structure to its starting position (shown in FIG. 1) adjacent receiving end 37 clear of receiving end 27.

Referring to FIGS. 3–5, stripping station 31 comprises a frame 191 mounted on the floor forward of and midway between conveyors 11 and 13 (see FIG. 1) and a pair of splicing arms 193 each carrying a vacuum head generally indicated at 194 to constitute the vacuum gripping means 33. These gripping arms are pivotally mounted on the frame for movement between a retracted (open) position (see FIG. 1) in which a cathode C gripped by transfer means 29 may be swung to and from its stripping position to a gripping (closed) position (see FIGS. 2–5) in which vacuum heads 194 are in gripping engagement with the layers of metal M on both faces of a cathode C at its stripping position. Each of these gripping arms has a crossbar 195 at its lower end journaled in bearings 197 for rotation about a horizontal axis 199 (this axis being common to the two crossbars). Each arm 193 carries a resilient snubber 200 adjacent its lower end engageable with a respective face of a cathode C at its stripping position as the arms are swung from their open to their closed positions (see FIG. 13) thereby to limit swinging of the cathode as it is suspended from clamping jaws 165a, 165b. These snubbers 200 have sufficient give to permit vacuum heads 194 freely to strip layers of metal M from the starter plate as the arms 193 are forcefully moved to their open position. As shown in FIG. 5, guides 201 are provided at the stripping station to receive the ends of top bar 7 of the gripped cathode C thereby to locate the cathode laterally with respect to axis 199 so as to position the cathode for being gripped by vacuum heads 194 as arms 193 are moved to their closed gripping positions. These guides each comprise a post 202 secured to and extending vertically from a respective bearing 197. Each post carries a pair of spaced-apart plates 204 having their upper end portions flared outwardly for receiving top bar 7. These guide plates are spaced apart a distance somewhat wider than the thickness of top bar 7 thereby to permit the cathode to be lowered to its stripping position (see FIGS. 5 and 13).

Arms 193 are movable between their gripping (closed) and retracted (open) positions by a hydraulic
cylinder unit 205 and a bell crank linkage 207 (see FIG. 5). This bell crank linkage includes a bell crank 209 journaled on a horizontal shaft 211. This bell crank is disposed below bars 195 and rotates in a vertical plane generally in line with axis 199. Bell crank 209 has two arms, as indicated at 213 and 215, at substantially right angles to one another with arm 213 pivotally connected to the end of a piston rod 217 of cylinder unit 205 and with the other arm carrying spaced-apart crank pins 219 (see FIG. 4). Rigid, adjustable turn-buckle links 221 interconnect each bar 195 and a respective crank pin 219. These links have universal or spherical bearings 223 at their lower ends for connection to crank pins 219 thereby to permit limited rotation of the links relative to their respective crank pins about any axis as the bell crank is rotated to effect raising and lowering of arms 193. The upper end of each link is pivotally connected to a respective bar 195, as indicated at 224. Thus, retraction of piston rod 217 into cylinder unit 205 causes clockwise rotation (as viewed in FIG. 5) of bell crank 207 about shaft 211 so as to rotate the arms 193 of both bars 195 about horizontal axis 199 from their lowered retracted position (see FIG. 1) to their raised gripping position (see FIGS. 2-5) with vacuum gripping means 33 in gripping engagement with the metal layers M on both faces of a cathode C at stripping station 31. Extension of piston rod 217 effects rotation of arms 193 from their raised gripping positions back down to their lowered retracted or supporting positions thereby forcefully to strip the layers of metal M from plate 5 of the cathode starter plate 3.

As shown, each of the vacuum heads 194 comprises a back plate 225 secured to the respective arms 193 at their outer (free) ends. On the face of the back plate is secured a pair of open rectangular frame members each designated 227, made of rubber or other suitable material, providing two rectangular vacuum cups 229 and 231 (see FIG. 1). Each of these cups is suitably connected to a vacuum source so that, as the vacuum heads engage the metal layers M on the cathode, vacuum may be applied to each cup thereby to effect gripping of the metal layers.

A flipped arm assembly 233 (see FIGS. 3 and 4) is provided adjacent each of the stripper arms 193 to receive the layers of metal M stripped from a cathode C at stripping station 31. Each flipper arm assembly comprises a bar 235 having trunnions at its ends journaled for rotation in bearings 237, and having a pair of arms 238 extending radially therefrom generally of angle shape in cross section and spaced a distance somewhat greater than the width of a layer M for cradling a layer M received from a vacuum head 194 as the latter swings downward toward its open position. Each pair of arms 238 is adapted to occupy a layer M receiving position shown in FIGS. 3 and 4 and wherein the arms extend generally horizontal and inward toward the crossed 195 for engagement thereof by the side margins of a stripped layer M swinging downward with a respective vacuum head. As the side margins of the layer M engage the arms, the vacuum in cups 229 and 231 is not only cut off but also compressed air may be delivered to the cups (by suitable means, not shown) to free the layer from the vacuum grip and positively discharge it from the cups to rest on the arms (confined laterally between the side flanges of the arms). Subsequently, the arms 238 may be swung upwardly to an up-right position (not shown) for flipping the layer over and delivering it to a rack 239 (see FIG. 1) on which the layers are stacked. Each assembly 233 is actuated by a hydraulic cylinder unit 241 (which may be referred to as a flipper cylinder). After a number of stripped layers of metal M have been stacked, the layers may be conveniently removed from the racks by means of a conventional fork-lift truck.

Operation is as follows:

Under control of the operator at the console 45, and starting with each of the conveyors 11, 13 and 15 and with stripper station 31 empty of cathodes C or starter plates 3, an overhead crane (not shown) is brought over rinse tank 43 to lift an entire series of cathodes C (e.g., 22 or 23 cathodes) therefrom and to deposit them on rails 17 of forwarding conveyor 11. The operator then repeatedly actuates means 19 of the forwarding conveyor (i.e., the walking beams 53 of means 19) to advance the series of cathodes one interval at a time toward the forward end of the conveyor until the forwardmost cathode is at take-off station 21. Each time the advancing means 19 is actuated, sprayer head 99 is automatically moved up and down between the two cathodes on opposite sides thereof to rinse the adjacent faces of these two cathodes.

With a cathode C at take-away station 21, the operator actuates swing cylinder assembly 183 to swing the boom 129 of transfer means 29 to its pick-up position at the take-away station 21, then actuates cylinder 171a and 171b to open jaws 165a and 165b, and then actuates the boom lift cylinder 155 to lower the boom to bring the jaws down into position for engagement with top bar 7 of the cathode at the take-away station. The jaws are then closed to grip the cathode top bar 7, and the boom is then raised (via cylinder 155) to lift the cathode clear of rails 17 of the forwarding conveyor. In being lowered and lifted, the jaws remain generally horizontal. Swing cylinder assembly 183 is then actuated to swing the gripped cathode to a position between guides 201 with the ends of its top bar 7 above the flared ends of guide plates 204. Lift cylinder 155 is then actuated to lower the cathode to its stripping position (see FIG. 5). Here the cathode is in a vertical plane parallel to and generally midway between conveyors 11 and 13. Upon removing the cathode from the take-away position, advancing means 19 is immediately actuated (this may be automatic) to advance the series of cathodes on the forwarding conveyor one interval and bring the next cathode to the take-away station 21.

The operator then actuates cylinder 205 to raise stripping arms 193 from their lowered retracted positions to an intermediate position (see FIG. 13) at about 70° to the horizontal. Snubbers 200 confine the cathode gripped by the clamping jaws 165a, 165b against swinging and hold it in its stripping position for engagement by vacuum cups 229 and 231. Arms 193 are then moved to their gripping positions (FIGS. 3-5) in which vacuum heads 194 are in engagement with the outer faces of the layers of metal M on the cathode. Vacuum is applied (this may be automatic) to the vacuum cups 229 and 231 of both heads 194 to cause the metal layers to become securely gripped thereby. Cylinder 205 is then reversely actuated to swing arms 193 down from their gripping positions to their intermediate positions thereby forcefully stripping the layers of metal M from plate 5 of the cathode. It is to be noted that during cooling of the cathodes in rinse tank 43, the differences in
the coefficients of thermal expansion between the layers of copper and the titanium starter plate cause thermal stresses therebetween of sufficient magnitude at least partially to loosen the copper from the titanium starter plate. The copper layers may then readily be stripped from the starter plate by the vacuum heads.

The operator then visually inspects the cathode at the stripping station to insure that the layers M have been stripped from both faces of the plate. If the cathode has not been properly stripped, arms 193 are again moved to their gripping positions to again grip the metal. If the metal has been properly stripped from the plate, the arms along with the metal layers stripped from the cathode are moved to their lowered retracted positions. It should also be noted that jaws 165a and 165b securely grip the cathode by its top bar 7 so that in the event it requires more force to strip one layer M from one face of the cathode than the other, the cathode is positively held in its stripping position.

As the arms move toward their lowered retracted positions, the vacuum to vacuum cups 229 and 231 is cut off and compressed air is supplied thereto, thus effecting the release of the metal layers therefrom. As the arms 193 move toward their retracted positions, the marginal portions of the metal layers M engage flipper arms 233 and the metal layers are thereby deposited on the flipper arms. Flipper cylinders 241 are then actuated to swing flipper arms 233 up for flipping over and stacking the metal layers on racks 239, and the flipper arms are then returned to their starting or lowered positions.

Lift cylinder 155 is then actuated to raise boom 129 and the stripped starter plate 3 at stripping station 31 (still in the grip of jaws 164a, 165b) from its stripping position clear of guides 201, and swing cylinder assembly 183 is actuated to swing boom 129 and the stripped starter plate gripped by the jaws from the stripping station to receiving end 27 of take-away conveyor 13. The starter plate is then lowered onto rails 23 of convor 13 and jaws 165a and 165b are opened to release the starter plate and deposit it on these rails 23. Lift cylinder 155 is then actuated to raise the boom clear of the starter plate, and the swing cylinder assembly is actuated to return the boom to its pick-up position.

If, on visual inspection, the operator finds a starter plate delivered to receiving station 27 of conveyor 13 to appear to be unsuitable for reuse without repair, he may cause it to be removed from receiving station 27 and deposited on receiving end 37 of reject conveyor 15. In order to accomplish this, the operator effects swinging of the boom of transfer means 41 from its starting position (such as shown in FIG. 13) in which it is clear of the path of transfer means 29 as the latter swings between its pick-up and deposit positions to the receiving end 27 of conveyor 13. The boom of transfer means 41 is then lowered and its clamping jaws are actuated to grip the top bar of the reject starter plate at said receiving station 27. The reject plate is then lifted clear of the rails 23 of the take-away conveyor 13 and swung to and deposited on rails 35 at the receiving end of the reject conveyor 15. Means 39 of the reject conveyor is then selectively actuated to move the reject starter plate in the direction of the arrow shown in FIG. 1: away from receiving end 37 to make room for the next plate. It will be recognized that means 39 of the reject conveyor is selectively actuated only after a reject cathode starter plate has been deposited on its support members 35. This enables a complete series of rejected starter plates to be accumulated on the reject conveyor before these rejected cathode starter plates must be removed therefrom.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for stripping layers of metal electrolytically deposited on cathodes each of which comprises a cathode starter plate having a bar at the top extending laterally beyond the sides of the plate enabling the plate to be suspended by means of the ends of the bar, the plate having said layers of metal on opposite faces thereof, said apparatus comprising a cathode forwarding conveyor comprising a pair of spaced-apart elevated support members adapted to hold a series of cathodes suspended from by means of the ends of the starter plate top bars bearing on the support members, with the cathodes extending transversely of the forwarding conveyor below and between the support members and spaced at generally equal intervals along its length, and means for advancing the entire series of cathodes one interval successively to bring the cathodes to a take-off station at one end constituting the forward end of the forwarding conveyor, a starter plate take-away conveyor extending alongside and spaced from the forwarding conveyor comprising a pair of spaced-apart elevated support members adapted to hold a series of starter plates by means of the ends of the starter plate top bars bearing on the support members, with the starter plates extending transversely of the take-away conveyor below and between its support members and spaced at generally equal intervals along its length, one end of the take-away conveyor constituting its starter plate receiving end being adjacent the forward end of the cathode forwarding conveyor, and means for moving the entire series of starter plates one interval in the direction away from said receiving end of the take-away conveyor, transfer means operable to grip the cathode at said take-off station at the top of said cathode, lift it, and swing it forward to a stripping position wherein both faces of the cathode are accessible, and vacuum means movable from a retracted position into vacuum gripping engagement with the faces of the cathode in said stripping position and back to said retracted position to strip the metal from both faces of the starter plate of said cathode, said transfer means being swingable farther after stripping of the metal to deposit the stripped starter plate on the support members of said take-away conveyor at a take-away station at its said receiving end.

2. Apparatus as set forth in claim 1 wherein said transfer means comprises a boom swingable about a generally vertical axis located between said forward end of said forwarding conveyor and said receiving end of said take-away conveyor, means carried by the boom for gripping said cathode, means for raising and lowering said boom to raise and lower a gripped cathode, means for rotating said boom about said axis for swinging a gripped cathode from said take-off station on said
forwarding conveyor to said stripping position, thence from said stripping position to said take-away station on said take-away conveyor, and thence back to said take-off station of said forwarding conveyor for gripping the next successive cathode on the forwarding conveyor.

3. Apparatus as set forth in claim 2 wherein said boom comprises a vertically disposed post rotatable about said vertical axis to effect swinging of the boom, and boom members pivotally connected to said post for swinging relative to the post in a vertical plane, and wherein said boom raising and lowering means comprises a hydraulic cylinder unit interconnected between said post and said boom members operable to effect swinging of said boom members in said vertical plane for raising and lowering said boom.

4. Apparatus as set forth in claim 3 wherein said post and said boom members together constitute a parallelogram boom linkage, and wherein said gripping means comprises a pair of clamping jaws carried by said parallelogram linkage for movement relative to said linkage between an open position and a closed clamping position in which the jaws are adapted to grip the top bar of a cathode starter plate, with said gripped top bar remaining substantially horizontal as said boom is raised and lowered.

5. Apparatus as set forth in claim 1 further comprising a reject starter plate take-away conveyor extending alongside and spaced from the starter plate take-away conveyor comprising a pair of spaced-apart elevated support members adapted to hold a series of rejected starter plates by means of the ends of the top bars thereof bearing on the support members, with the rejected starter plates extending transversely of the reject conveyor below and adjacent its support members and spaced at generally equal intervals along its length, one end of the reject conveyor constituting a receiving end for said rejected starter plates, said reject conveyor receiving end being adjacent the receiving end of said take-away conveyor, and means for moving the series of rejected starter plates supported by said support members of the reject take-away conveyor one interval in the direction away from said receiving end of the reject conveyor.

6. Apparatus as set forth in claim 5 wherein said apparatus further comprises second transfer means selectively operable for gripping a rejected starter plate at said receiving end of said take-away conveyor, lifting it, swinging it to said receiving end of said reject conveyor, and lowering it onto said support members of said reject conveyor.

7. Apparatus as set forth in claim 6 wherein said second transfer means comprises a boom swingable about a generally vertical axis located between said receiving ends of said take-away conveyor and said reject conveyor, means carried by said boom for gripping a rejected starter plate, means for raising and lowering said boom to raise and lower a gripped reject starter plate, and means for rotating said boom about said axis for swinging a gripped starter plate from said receiving end of said take-away conveyor to said receiving end of said reject conveyor.

8. Apparatus as set forth in claim 1 wherein said vacuum means comprises a pair of vacuum gripping heads, means mounting said heads for movement between a lowered retracted position and a raised operative position in which each head is in vacuum gripping engagement with the layer of metal on a respective face of said cathode at said stripping position, said heads when in their lowered retracted position enabling swinging of a cathode gripped by said transfer means to and from said stripping position, and power operated means for effecting movement of the heads from their retracted positions to their gripping positions and from their gripping positions to their retracted positions thereby to strip the layers of metal from the faces of the starter plate.

9. Apparatus as set forth in claim 8 further comprising means for receiving said layers of metal stripped from the starter plate as said heads return to their retracted positions, said receiving means comprising a member adjacent each said head engageable by a respective metal layer stripped from the starter plate as said head returns to its retracted position, each said member being rotatable about a respective horizontal axis to move the metal of metal received thereby clear of its respective head and to stack it for removal from the apparatus.

10. Apparatus as set forth in claim 1 further comprising means associated with said forwarding conveyor for rinsing each cathode, said rinsing means comprising a spray head movable between two adjacent cathodes of said series of said cathodes for spraying water on the adjacent faces of said adjacent cathodes.

11. Apparatus as set forth in claim 9 wherein said spray head is mounted for vertical movement between said adjacent cathodes, said spray head being movable between a raised retracted position in which it is clear of said cathode permitting movement of said series of cathodes along said support members of said forwarding conveyor and a lowered position in which the spray from said spray head rises the bottom portion of the cathodes.

12. Apparatus for stripping layers of metal electrolytically deposited on cathodes each of which comprises a cathode starter plate having a bar at the top extending laterally beyond the sides of the plate enabling the plate to be suspended by means of the ends of the bar, the plate having said layers of metal on opposite faces thereof, said apparatus comprising a cathode forwarding conveyor comprising a pair of spaced-apart elevated support members adapted to hold a series of cathodes suspended therefrom by means of the ends of the starter plate top bars bearing on the support members, with the cathodes extending transversely of the forwarding conveyor below and between the support members and spaced at generally equal intervals along its length, and means for moving the entire series of cathodes one interval successively to bring the cathodes to a take-off station at one end constituting the forward end of the forwarding conveyor, a starter plate take-away conveyor extending alongside and spaced from the forwarding conveyor comprising a pair of spaced-apart elevated support members adapted to hold a series of starter plates by means of the ends of the starter plate top bars bearing on the support members, with the starter plates extending transversely of the take-away conveyor below and between its support members and spaced at generally equal intervals along its length, one end of the take-away conveyor constituting its starter plate receiving end being adjacent the forward end of the cathode forwarding conveyor, and means for moving the entire series of starter plates one interval in the direction away from said receiving end.
of the take-away conveyor, said forwarding conveyor moving means and said take-away conveyor moving means each comprising a pair of spaced-apart walking beams engageable with the ends of the top bars of a respective series of cathodes or cathode starter plates, each said walking beam being disposed adjacent a respective support member, means for lifting said walking beams for engagement with said top bars to lift the series of cathodes clear of said support members and means for translating said walking beams with said cathodes supported therefrom one interval in the desired direction, transfer means operable to grip the cathode at said take-off station at the top of said cathode, lift it, and swing it forward to a stripping position wherein both faces of the cathode are accessible, and means at said stripping position for stripping the metal from both faces of the starter plate of said cathode, said transfer means being swingable farther after stripping of the metal to deposit the stripped starter plate on the support members of said take-away conveyor at a take-away station at its said receiving end.

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