ANODE CLEANING MACHINE

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Filed Mar. 4, 1968, Ser. No. 710,178
Int. Cl. A46B 15/04

15 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for removing manganese deposits and other matter from anode assemblies used in electrolytic metal recovery processes. The anodes are handled on a moveable truck with the individual anodes in parallel transverse positions along a longitudinal line. The truck carrying the anodes is moved by a horizontal conveyor across the machine framework while a vertical conveyor simultaneously lifts each anode assembly from the truck and carries it through hydraulicsprays and powered brush cleaning assemblies. The individual anodes are returned to their original positions on the truck in the timed operation of the horizontal and vertical conveyor components.

BACKGROUND OF THE INVENTION

The cleaning machine for anode assemblies described herein was developed as part of a program to mechanize the handling of electrolytic cell components in a metals recovery operation such as used in the recovery of zinc. Such an operation requires the utilization of lead anodes interspersed between adjacent cathodes on which the zinc is deposited. During the deposition of zinc on the cathodes, manganese is deposited on the anodes and must be periodically removed.

Current machines for removing the manganese generally operate in a horizontal fashion and require that individual anodes be manually loaded onto a conveyor which carries the anodes through cleaning assemblies in an in-line arrangement. Such an apparatus requires considerable floor space and several men to supply anodes, feed them onto the conveyor, and remove them from the conveyor after being cleaned.

SUMMARY OF THE INVENTION

The basic concept of the invention set out herein is the combination of a first conveyor for moving grouped parallel anode assemblies across the machine framework in a line and a second conveyor assembly that overlaps the path of the anode assemblies. The second conveyor assembly lifts individual anode assemblies in an upright direction through cleaning devices such as hydraulic nozzles and returns each anode assembly to its original position. In the apparatus, the first conveyor is a horizontal conveyor for moving trucks that carry the anode assemblies in equally spaced parallel positions. The upright conveyor is operated in a timed relation to the horizontal conveyor so as to remove and return the anode assemblies in a continuous pattern whereby each anode assembly is returned to its original position on the truck. Mechanical means is provided to insure the proper pickup of each anode assembly. A binning roller is provided to tilt each anode rearward and insure that it is returned to its proper location on the truck. The combination of the horizontal truck conveyor and the vertical cleaning conveyor greatly reduces the required floor space for this assembly.

The object of this invention is to mechanize as much as possible the handling and cleaning of anode assemblies. The only manual effort required is the periodic positioning of a truck at the apparatus and the subsequent removal of the truck at the completion of the cleaning operation.

No manual handling of individual anode assemblies is required.

Another object of the invention is to provide a cleaning apparatus for handling anode assemblies spaced along a truck wherein the anode assemblies are removed from the truck individually, processed for cleaning, and returned to their original positions on the truck. Anode assemblies are returned to their original positions on the truck.

Another object of the invention is to provide an effective cleaning and brushing mechanism for removing the deposited matter from the anodes during periodic maintenance procedures. The present apparatus utilizes hydraulic jets and also gravity force on the brushes that clean the two sides of the anode to insure removal of solid material not freed by hydraulic pressure.

Another object of the invention is to provide a rather compact cleaning assembly as compared to horizontal conveyor devices presently in use.

These and further objects will be evident from the following disclosure, particularly in view of the detailed apparatus illustrated in the drawings. However, the details of this structure are not intended to limit or encompass the full extent of the invention, which is set out in the claims at the conclusion of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of the cleaning machine;
FIG. 2 is a rear elevation view of the apparatus;
FIG. 3 is a front elevation view of the apparatus;
FIG. 4 is a vertical sectional view taken through the apparatus along line 4--4 in FIG. 2, further illustrating the truck structure utilized in conjunction with the apparatus;
FIG. 5 is an enlarged plan view of the apparatus shown in FIG. 1;
FIG. 6 is a schematic plan view of the manifold and nozzle arrangement;
FIG. 7 is a schematic elevation view of the manifold and nozzle arrangement shown in FIG. 6;
FIG. 8 is an enlarged vertical sectional view through the center portion of the apparatus as seen along line 8--8 in FIG. 2;
FIG. 9 is a further enlargement of a fragmentary sectional view taken generally along line 9--9 of FIG. 8 illustrating the handling of an anode assembly;
FIG. 10 is a fragmentary view taken along line 10--10 in FIG. 9, illustrating the manner in which the anode assemblies are picked up by the upright conveyor mechanism;
FIG. 11 is a view similar to FIG. 10, illustrating the return of the anode assemblies to the rails of the storage truck; and
FIG. 12 is a somewhat schematic perspective view of the cleaning apparatus, illustrating the handling of the anode assemblies and showing the basic structural components of the machinery with some of the protective housing not being illustrated.

PREFERRED EMBODIMENT OF INVENTION

The machine disclosed herein is designed for the automated cleaning of anode assemblies such as are used in electrolytic metal recovery processes. In the recovery of zinc, for example, plate-shaped aluminum cathodes are interspersed in an electrolytic cell between lead grids that act as anodes in the electrical circuit. The zinc is deposited on the cathodes by the electrolytic reaction process and manganese is deposited in the anode grid. The zinc is removed from the cathodes in a daily process and the anode grids must be cleaned of deposited matter about once a week. The frequency of anode cleaning is dependent upon the operation characteristics and the size of the cell arrangement. While a particular anode assembly designed
for mechanized cells is illustrated in this case, any conventional anode structure can be cleaned with equal efficiency by the machine described herein.

The peculiar anode assembly of this disclosure can be understood from viewing FIGS. 9, 10, and 11. The anode assembly includes a plate-like grid 10 apertureed across its face to permit circulation of electrolyte through the anode in the electrolytic cell. A bar 12 extends transversely across the full width of the anode grid 10 and serves as a structural support and electrical conductor in the cell assembly. Both the plates-shaped grid 10 and the header bar 11 are generally cast of lead, the header bar 11 being provided with structural reinforcement. The header bar 11 extends outwardly beyond each side of the anode grid 10, the extension to one side being longer than the other in order to provide contact with a bus bar in the cell assembly.

One peculiar feature of the present anode assembly is the provision of insulating guides 12 at each side of the anode grid 10. Each guide 12, preferably molded of a suitable structural resin, is fastened along the side of the grid 10 and encloses the header bar 11. The upper portion of each guide 12 converges toward the center of the anode assembly and provides an insulating guide for the cathode chain 21, the cathode chain being transversely interspersed between the anode assemblies in the cell structure. One feature of the present machine is the provision of a cleaning apparatus for the anode assemblies that does not require the removal of the vertical guides 12. The utilization of a vertical cleaning apparatus permits matter to be removed from the anode assembly without being obstructed by the continued presence of the projecting guides 12.

According to the structure shown, the anode assemblies are delivered to the cleaning machine on truck assemblies that can be generally understood from FIGS. 4, 9, and 12. Each truck includes a wheeled supporting carriage 13 guided by front and rear sets of four wheels each, the wheels being designated by the numeral 14. At the front of each carriage 13 is a guiding handle 15 used for manual or machine pulling of the carriage and basically inoperative during the operation of the cleaning machine.

Placed on the wheeled carriage 13 is an anode tray 16 including longitudinally anode support rails 17 spaced transversely from one another by a distance slightly greater than the width of the anode grids 10 which hang between them. The upper edge of each rail 17 is provided with transversely aligned pairs of notches that are equally spaced along the length thereof. The rails 17 are rigidly supported by posts 18 that extend upwardly from the base of the tray 16. Rails 17 support the anodes in parallel transverse positions.

The spacing of the notches and supported header bars 11 along the rails 17 is preferably equal to the spacing of the anode assemblies in the cell structure in which they are used. This facilitates mechanized removal of the anodes from the cells and the return of the anodes to the cells. In a typical installation, the center to center spacing between the anode assemblies is three inches.

The truck assembly is guided longitudinally through the cleaning machine by guiding tracks 20 provided along the floor of the supporting framework structure. The four tracks 20 provide transversely positioning of the truck assembly during movement through the machine. At the rear of the machine in the direction of travel of the truck assemblies, the two tracks at each side of the apparatus converge inwardly to assist in properly aligning the wheeled carriage 13.

Mounted along the center of the tracks 20 is a first conveyor mechanism, this first conveyor mechanism being a horizontal conveyor designed to move the truck assembly across the machine framework. It includes a floor conveyor chain 21 having an upper horizontal flight approximately flush with the supporting floor level. The chain 21 is wrapped about a forward drive sprocket 22 fixed to a front transverse shaft 23 on the support frame and about a movable mounted rear sprocket 24 that can be adjustably positioned by conventional supports in order to properly tension the chain 21. Outwardly protruding lugs 25 are spaced along the length of the continuous chain 21, each lug 25 projecting outwardly a distance adequate to contact the front axle of the wheeled carriage 13, the front axle being provided with a suitable depending bracket to be pushed by a lug 25. The spacing of lugs 25 is such as to provide the required minimal spacing between successive truck assemblies while being moved across the machine. The horizontal conveyor mechanism can be of an desired length to accommodate the number of trucks required in a particular installation.

At the center of the horizontal conveyor as shown in the drawings, there is provided an upright frame 26 including vertical side channels 27. The side channels 27 serve as the basic support for the individual anode lifting mechanism and the associated cleaning devices.

An upright conveyor is mounted on the upright frame 26, the conveyor being composed of drive sprockets 28, a pair of endless conveyor chains 30 and idle upper sprockets 31 at each side of the apparatus. It overlaps the horizontal conveyor across the rails 17. The separation between the chains 30 is greater than the outside width across the anode support rails of a truck assembly but less than the width of a header bar 11 of a single anode assembly. The grid 10 of an anode assembly is therefore free to pass between the chains 30 and supporting sprockets 28, 31.

Mounted in transversely aligned positions on the two chains 30, which are driven in an identical fashion as will be described below, are a series of hooks 32 spaced equally along the length of chain 30. Each hook 32 is pivotally supported by a transverse pin 34 on special support links 33 in the chain 30. Each link 33 has a portion protruding outwardly from the remainder of the chain structure. Each hook 32 has two upwardly directed spaced members between which the header bars 11 can be received. The lower portion of each hook below the pivot pin 34 is preferably weighted to normally maintain the hook in a vertical position with the open end thereof directed upwardly.

Located along the length of the chain 30 are cleaning devices which are only exemplary of the type of apparatus which can be used. As shown, two manifolds 35 are positioned at opposite sides of the upwardly moving rear flights of chains 30, the manifolds 35 being provided with a series of transversely spaced nozzles 36. The angular relation and spray pattern of the jets produced by nozzles 36 can be seen in the schematic view of FIGS. 6 and 7. A downwardly converging spray shield 37 is provided at the rear of the apparatus. An upright spray shield 39 is provided forwardly of the nozzles, the shields 37 and 39 serving to prevent the spray from the nozzles 36 from being directed to the remainder of the machinery. The lower ends of the shields 37, 39 are open so as to not restrict movement of the anodes along the upright conveyor mechanism.

At the lower end of the chains 30 are a pair of arcuate fixed guides 38 spaced from the portions of the chains 30 passing beneath the drive sprockets 28. The guides 38 are in the path of movement of the hooks 32 and are adapted to engage hooks 32 to tilt the hooks rearwardly (FIG. 10) and insure the proper angular relationship of hooks 32 as they engage the header bar 11 of a particular anode 10. The guides 38 insure that the hooks 32 will not be angularly displaced at this critical point.

Mounted above the manifolds 35 at both the front and rear of the upright frame 26 are two identical brush mechanisms for respectively brushing the root and top surfaces of each anode 10. Each brush unit 40 is suspended from frame 26 by a pair of fixed support ears 41. Pivotally mounted on pins 42 are brush frames 43, which are freely pivotable about the respective axes of the pins 42.
Each frame 43 supports a motor 44 that rotates a transverse brush 45 at the inner portion of the frame 43. Each brush 45 is powered by the respective motor 44 through a chain 46. Rotatably mounted on the frame 21 in opposition to the brush units 40 is a backup roll 47. The width of each backup roll 47 preferably approximates the width across the anode grid 10 between the guides 12, so that the roll 47 is in contact with the flat metal structure. The brushes 45, which can be provided with metal or fiber bristles can extend across the full width of the anode grid 10 and guides 12, being suitably resilient so as to accommodate variations in the thickness of the structure.

The guides and metal portions of the anode assemblies will be effectively cleaned by the two brushes 45. The rear brush 45 will contact the rear surface of each anode assembly as it is travelling upward along the rear flight on the upright conveyor mechanism. As the anode assemblies pass over the upper end of the upright conveyor mechanism, the lower end of each anode assembly will then pass between the forward brush 45 and its backup roll 47 and the forward facing surface of each anode grid 10 will be cleaned by the second brush. The anode assembly will remain in a vertical position due to its own weight and the free pivotal support provided by the hooks 32.

To insure proper repositioning of each anode assembly on the rails 17 of the truck assembly, it has been found advisable to positively bias the anode assemblies in a rearward direction as the hooks 32 approach the lower end of the return flight of the upright conveyor. A forwardly positioned biasing roll 48 extends transversely across the apparatus, again having a width that fits between the anode guides 12 so as to contact the anode grid 10 as shown in FIG. 11. The biasing roll 48 is rotatably carried by bearings supported by longitudinally movable mounting rods 50 slidably positioned by fixed mounts 51. Compression springs 52 mounted about the rods 50 serve to bias the roll 48 in a rearward direction permitting forward movement when necessary.

The roll 48 remains in contact with each anode assembly during the crucial time at which the anode assembly is being positioned rearward of the anode assembly immediately forward of it on the truck rails 17. Placement of each anode assembly is continued by the advancing downward movement of the supporting hooks 32, which release the anode when the anode header bar 11 is again supported on the rails 17.

In the apparatus shown, the truck assembly is continuously driven by the floor conveyor chain 21 and the individual anodes are continuously handled by the upright chains 30. Both chains 21 and 30 are driven from a common source, illustrated as being a motor 53 located at the forward end of the apparatus. Motor 53 drives the drive sprocket 22 for the chain 21 through a chain 54 and driven sprocket 55 on the front supporting shaft 23 (FIG. 1). The motor 53 also drives the two chains 30 simultaneously through a jack shaft 57 on the framework that extends transversely across the upright frame 26 clear of the area in which the anodes are lifted. The jack shaft 57 is powered by means of a chain 56 from the motor 53 and countershafts on the supporting drive shafts for the chain drive sprockets 28 by means of connecting drive chains 58.

At the bottom of the apparatus and extending across the washing area is a recovery chute that is preferably screened to recover the manganese deposits. The recovery chute is used for recirculation of water from the wash water. Also, the center portion of the apparatus about the moving truck assemblies is shielded by a housing generally shown as 61 (FIG. 11), this housing being for protective purposes to prevent the deposited matter and water from spraying about the environment of the machine. The housing 61 is not illustrated in FIG. 12 in order to better show the basic structural features of the apparatus. In addition, spray nozzles for a low pressure stream of water might be provided within the housing 61 at the forward end to rinse the truck assembly and the anodes supported thereby and remove any loose residue of material after the cleaning operation. These spray nozzles are not illustrated, but can be located at any forward portion of the apparatus or, in the alternative, the truck might be rinsed at another location.

The operation of the apparatus is continuous and requires only the manual positioning of the individual wheeled carriages 13 so as to be engaged at the rear end of chain 21 by one of the lugs 25. The supported truck and anodes then pass in a continual movement across the machine from left to right as shown in FIG. 4. The chains 21 and 30 are timed directly due to the common connection to the motor 53, so that each anode header bar 11 will be engaged by hooks 32 at each of its ends in the manner shown in FIG. 10. Each anode grid is first subjected to the high pressure spray from the nozzles 36 at each side of the anode, which removes substantially all solid material from the metal grid and the attached guides 12. More stubborn deposits are then removed from the two faces of the anode, first the forward facing brush 45 and then by the forward rotating brush 45 following movement of the anode across the top ends of the chains 30.

As each anode continues downwardly along the front flight of the upright conveyor mechanism, its forward surface is engaged and pushed slightly rearward by the biasing roll 48 to insure the proper placement rearward of the immediately preceding anode on the truck assembly as shown in FIG. 11. The timing of the two conveyors is such that each anode will be redeposited on the truck assembly in the position initially filled by it.

As an example of the operation of the apparatus, assuming a three inch center to center spacing of the anodes on the truck and a forty-eight inch spacing between the hooks 32 to accommodate normal anode height, the apparatus is designed using sprocket sizes and dimensions across the front and rear hooks 32 so that each anode moves twelve inches horizontally while making the vertical loop on the upright conveyor mechanism. With four anode-engaging pairs of hooks 32 on the upright conveyor mechanism, the truck assembly is operated to move approximately twelve inches horizontally during the complete path of travel of each anode from the truck and back. This requires a simple 4:1 speed reduction from the motor to the shaft 23 and a 4:1 speed increase from the motor 53 to the shafts that carry the drive sprockets 28. This yields a 16:1 speed ratio between the upright conveyor mechanism and the horizontal conveyor mechanism, resulting in three inches of horizontal truck travel for every forty-eight inches of anode travel. For indexing purposes, a phase variator can be provided between the motor and one of the conveyors to provide adjustment of the synchronization of the two conveyor mechanisms.

The nozzles 36 and manifolds 35 are preferably provided with high pressure water at approximately 4500 to 6000 p.s.i. A flat spray is directed across the full width or each anode. The shields 37 confine the spray to the cleaning area.

Other rollers for straightening the anodes can also be provided in the apparatus if warping of the anodes is a problem in a particular installation.

The apparatus provides effective cleaning of the anode assemblies, including the anode grids as well as the flat metal surfaces. With adequate impact of the water pressure, nearly instant adjustment of the degree of cleaning of the anode surfaces is obtainable. The apparatus is operable to clean conventional anode areas in a time of approximately 2.5 to 3 seconds per anode.
The apparatus has a great advantage in eliminating the manual handling of the anodes. Besides being impractical in the case of large heavy anodes, such manual handling can result in abusive treatment and damage to the anodes. The mechanical handling by the present mechanism reduces labor costs and possible damage to the anodes and permits automatic spacing of each anode to facilitate handling of the anodes at the cell room.

Having thus described my invention, I claim:

1. An apparatus for removing deposited matter from anode assemblies used in electrolytic metals recovery processes wherein each anode assembly comprises a plate-like grid suspended from a header bar which projects outwardly beyond each side of the grid, comprising:
   a rigid framework;
   first conveyor means on said framework for moving a plurality of anode assemblies across said framework in a line, the anode assemblies being parallel to one another;
   second conveyor means on said framework engageable with individual anode assemblies, said second conveyor means including an upright flight for lifting the anode assemblies individually clear of the first conveyor means;
   and cleaning means on said framework adjacent said second conveyor means for removing deposited matter from the individual anode assemblies;
   said second conveyor means comprising a pair of laterally spaced conveyor elements having hooks projecting therefrom to engage the respective ends of a header bar from beneath.

2. An apparatus as set out in claim 1 wherein said hooks are freely pivoted on said conveyor elements about a transverse axis.

3. An apparatus as set out in claim 2 further comprising:
   guide means on said framework in the path of said hooks and engageable therewith to angularly position said hooks about their axes so as to prepare said hooks for engagement with a header bar.

4. An apparatus as set out in claim 1 wherein said cleaning means comprises:
   high pressure water nozzles on said framework directed toward the transverse center line of said upright flight of said second conveyor means from opposite sides thereof.

5. An apparatus as set out in claim 1 wherein said cleaning means comprises:
   a transverse rotary brush supported on said framework tangential to said second conveyor means;
   power means operatively connected to said brush to rotate said brush about the transverse axis thereof; and
   mounting means on said framework rotatably mounting said brush, including means to bias the brush toward said second conveyor means.

6. An apparatus for removing deposited matter from anode assemblies used in electrolytic metals recovery processes wherein each anode assembly comprises a plate-like grid suspended from a header bar which projects outwardly beyond each side of the grid, comprising:
   a rigid framework;
   horizontal conveyor means on said framework including longitudinal movable rails for supporting the header bars of a plurality of anode assemblies spaced in parallel transverse positions along the rails;
   upright conveyor means having a receiving flight thereof perpendicular to and overlapping said horizontal conveyor means, said upright conveyor means including movable hooks for engaging and supporting the header bars of individual anode assemblies on said rails and for lifting anode assemblies so engaged clear of the horizontal conveyor means; and
   cleaning means on said framework adjacent to the receiving flight of said upright conveyor means for removing deposited matter from the individual anode assemblies.

7. An apparatus as set out in claim 6 wherein said upright conveyor means is an endless conveyor further comprising a return flight integral with said receiving flight for depositing individual anode assemblies on said rails of said horizontal conveyor means after traversing said receiving flight.

8. An apparatus as set out in claim 7 wherein said horizontal and upright conveyor means are each operated continuously in a timed relationship such that an individual anode assembly is removed from the rails of said horizontal conveyor means by said upright conveyor means and is subsequently redeposited at its original position on said rails after completing said return flight.

9. An apparatus as set out in claim 6 wherein said receiving flight and said return flight of said upright conveyor means are in parallel vertical planes;

10. An apparatus for removing deposited matter from anode assemblies used in electrolytic metals recovery processes wherein each anode assembly comprises a plate-like grid suspended from a header bar which projects outwardly from each side of the grid;
    said anode assemblies being grouped on a movable truck having parallel longitudinal side rails on which the anode header bars rest with the anode assemblies hanging freely downward in parallel transverse positions;
    said apparatus comprising:
    a rigid framework;
    first conveyor means on said framework for moving said truck longitudinally in a horizontal path across said framework;
    second conveyor means on said framework overlapping the path of movement of said truck and including an upwardly moving flight of header bar engaging elements for engaging individual anode assemblies and lifting each anode assembly so engaged from the truck; and
    cleaning means on said framework adjacent to the second conveyor means for removing deposited matter from the individual anode assemblies.

11. An apparatus as set out in claim 10 wherein said second conveyor means is an endless conveyor structure including a return flight for returning individual anode assemblies on the truck; and
    common drive means on said framework operatively connected to said first and second conveyor means for driving them in unison in such manner that each anode assembly is returned by said second conveyor means to its original position on the truck side rails from which it was lifted.

12. An apparatus as set out in claim 11 further comprising:
    biasing means on said framework adjacent the lower end of said return flight of said second conveyor for engaging anode assemblies thereon prior to return of the anode assemblies to the truck to shift the lower end of each anode assembly rearward relative to the direction of travel of said first conveyor means.

13. An apparatus as set out in claim 10 wherein said second conveyor means comprises:
    a pair of laterally spaced conveyor elements having hooks projecting therefrom to engage the respective ends of a header bar from beneath.
14. An apparatus as set out in claim 13 wherein said hooks are freely pivoted on said conveyor elements about a transverse axis.

15. An apparatus as set out in claim 14 further comprising:

guide means on said framework in the path of said hooks and engageable therewith to angularly position said hooks about their axes so as to prepare said hooks for engagement with a header bar.

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U.S. Cl. X.R.