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(54) AUTOMATIC AUXILIARY CRANE FOR MAINTAINING AN ELECTROLYSIS INSTALLATION

AUTOMATISCHER HILFSKRAN ZUR AUFRECHTERHALTUNG EINER ELEKTROLYSEANLAGE

GRUE AUXILIAIRE AUTOMATIQUE POUR LA MAINTENANCE D'UNE INSTALLATION D'ÉLECTROLYSE

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Description

TECHNICAL FIELD AND OBJECT OF THE INVENTION

[0001] Electrolysis installations include electrolysis cells with pairs of electrodes, cathode and anode, and a tank with a solution in which the electrodes are submerged subjected to a continuous electrical voltage difference in order to produce electrolysis. Electrolysis enables obtaining for example zinc, copper, nickel, cadmium or cobalt deposited in the cathode from the salts of the solution.

[0002] Unlike electrolysis processes through electrorefining, in electrowinning the anode is substantially insoluble during electrolysis, providing the surface for producing the anodic oxidation reaction. These processes conventionally use a lead anode but other types of alloys such as titanium can be used.

[0003] Conventionally, electrodes are plate-shaped, arranged in rows in the tank such that the anodes and cathodes alternate and the cells are connected electrically in series. For the electrical connection between the electrodes during electrolysis, an electrode head holds each electrode. The electrode head comprises an electrode rod of an electrically conductive material, usually copper, and during electrolysis, the electrode head holds the electrode in the tank, vertically and in the longitudinal direction of the rod. Likewise, each rod is arranged abutting in electrical contact on equipotential rails, usually made of copper, that extend to the sides of the tank and perpendicularly to the electrodes. An electrode unit comprises an assembly of the electrode and the electrode head. The electrode units are positioned in the tank as close as possible to each other in order to increase the productivity of the installation, but avoiding the risk of a short circuit. Optionally, the electrode head comprises handling means for facilitating the extraction or the insertion of the electrode in the tank, or the transport thereof by means of a crane or a bridge crane of the installation, for example in the form of hooks or gripping lugs. Patent EP 1492906 describes this type of arrangement in an electrolysis installation.

[0004] A document published by this Applicant on his website, namely on https://web.archive.org/web/20131006004738/http:/www.zincobre.com/eng/producto s.html, discloses a maintenance method of an electrolysis installation, comprising the stages of:

- identifying anomalies in the electrodes located in the tanks by means of a detection system having at least one sensor, namely cathodes surface quality analyzer, cathodes weighing devices;
- extracting, removing and replacing the anomalous electrodes moving them from the electrolytic tanks of the plant to the repair and replacement area; and
- repositioning new electrodes by inserting them in their operating positions.

[0005] The installation includes a main overhead crane and an auxiliary crane. The auxiliary crane is used for housekeeping cell house duties to warranty the exclusive permanent duty and preventive maintenance of the main crane.

[0006] However, said document does not specify whether the extraction, removal and replacement of the electrodes as well as the repositioning of new electrodes is carried out by means of the auxiliary crane. It does further not specify whether the at least one sensor remains static with respect to the electrolysis tank.

[0007] The document disclosed on the website https://web.archive.org/web/20140701173312/http://www.ontotec.com/en/Aboutus/O ur-technologies/Solutions-purification-and-metals-recovery/Electrolytic refining/#:rabid-6 discloses a process for the purification and metals recovery.

[0008] Patent document US4028211 discloses an apparatus for automatically replacing anodes and cathodes disposed alternately in an electrolytic cell used for the electrolytic refining of a metal. Document US2006049054 discloses a process for changing an anode of a cell for the production of aluminum by fused bath electrolysis including a plurality of anodes.

[0009] PCT application number WO2013160542 concerns a transfer apparatus configured to lift and lower anode plates and cathode plates moved to a position above an electrolytic cell to place the anode and cathode plates into the electrolytic cell and to remove the anode and cathode plates from the electrolytic cell. Another PCT application, in this case with number WO2014104896, describes a system and method for post-cleaning of electrolyte from a used carbon anode in aluminum production.

[0010] Patent document number CH592164 discloses an electrolytic installation for the production of primary aluminum that includes electrolytic cells assembled above ground level, equipment for the main productive operations arranged on guide rails in the floor, and auxiliary equipment for maintenance, cleaning, etc. suspended from overhead from cranes and/or beams, so that there is no interference between the two sets of equipment. Finally, Chinese patent document number CN203845728 provides an auxiliary device for mounting a cathode in an electrolytic cell.

[0011] The present invention relates to an electrolysis installation comprising a main crane for operating the installation and an automatic auxiliary crane for maintenance in an electrolytic cell house. The function of the Automatic Auxiliary Bridge Crane object of this invention for Handling, inspection and maintenance of Electrodes is that of identifying anomalies in the electrodes located in the tanks, such as increase in temperature, anomalous electrical contacts and faults in the morphology of the metal deposited in the electrodes, and enabling extraction, removal and replacement of the anomalous elec-

trodes from the electrolytic tanks of the plant to the repair and replacement area. Once these electrodes have been removed, the load of the tank will be incomplete and this crane will be in charge of repositioning new electrodes, inserting them in their operating positions.

[0012] The invention is particularly applicable in a zinc electrolysis installation.

BACKGROUND OF THE INVENTION

[0013] The electrode units of the electrolysis system can present and/or cause failures during electrolysis, such as short circuits, electrical contacts of the electrolysis rods with the anomalous equipotential rails or faults in the metal deposited in the electrodes especially on the surface of the cathodes in electrowinning processes. These failures can damage the electrodes, the electrode units and the electrolysis installation, ultimately reducing the productivity of the installation.

[0014] In order to prevent or solve these failures it is necessary to carry out maintenance methods of the electrolysis installation. These methods comprise detecting a faulty electrode unit in an electrolysis tank of the installation, either relocating the faulty electrode unit (when the failure is due to faulty electrical positioning or contact of the electrode unit) or removing the faulty electrode unit from the tank leaving a gap in the tank (when the failure is caused by the electrode unit itself) and inserting a spare electrode unit into the gap (if applicable). In order to remove, reposition and insert the spare units, a crane or a bridge crane intended for the normal operation of the installation is conventionally used to remove the electrolysis product. An operator is in charge of handling the crane or bridge crane for these maintenance operations.

[0015] This known maintenance method has the drawback that the use of the crane or bridge crane for the procedure implies the stoppage of normal operations and less preventive maintenance time of the crane of the installation during the time needed to resolve the failures, since the crane or bridge crane is no longer available, consequently implying a reduction in the productivity of the installation.

[0016] Therefore, the present invention aims to provide a maintenance method that enables increasing the productivity of the installation.

DESCRIPTION OF THE INVENTION

[0017] The present invention provides a maintenance method of an electrolysis installation as set forth in claim 1 and explained below. Furthermore, the dependent claims reflect advantageous embodiments as disclosed below.

[0018] The invention comprises both the maintenance method of an electrolysis installation and the electrolysis installation. Said electrolysis installation in turn comprises a main crane for operating the installation and an automatic auxiliary crane for maintenance of the electrolysis installation. The maintenance method of an electrolysis installation comprises the stages of:

Identifying anomalies in the electrodes located in the tanks, such as increase in temperature, anomalous electrical contacts and faults in the morphology of the metal deposited in the electrodes, by means of a detection system having at least one sensor;
Extracting, removing and replacing the anomalous electrodes, moving them from the electrolytic tanks of the plant to the repair and replacement area; and
Repositioning new electrodes by inserting them in their operating positions.

[0019] Unlike known state of the art, the maintenance method according to the invention comprises repositioning or removing the faulty electrode unit from the tank and/or inserting the spare electrode unit into the gap by means of an automatic auxiliary crane or bridge crane of the installation. Henceforth, the crane used conventionally for normal operations of the installation is called the main crane in order to distinguish it from the auxiliary crane.

[0020] This way, the use of the automatic auxiliary crane allows increasing productivity of the installation since it enables using the main crane for the normal operations of the installation while being able to proceed with the handling, repositioning or replacing of the faulty electrode units.

[0021] More specifically, the execution of the maintenance method of the installation enables eliminating any short circuits that may occur, inserting electrodes in the gaps of the tank due to the removal of those that were faulty, reducing the time needed to resolve the problems or anomalies that can occur frequently in the electrolysis installation, such as, for example, poor contact between the electrodes and the equipotential rail or a fault in the surface of the metal deposited in the electrode.

[0022] Advantageously, the stage of detecting the faulty electrode unit, repositioning or removing the same and/or inserting the spare electrode unit is carried out automatically, at least partially, that is, at least in some stages. This way, the productivity of the installation is further improved as the processing time for each stage can be reduced.

[0023] The invention anticipates the use of a detection system having at least one sensor for checking the status of the electrodes, such as electrode temperature sensors, electrode voltage drop sensors, display sensors of the metal deposited on the electrode and/or electrode weight sensors Thus, it is possible to detect whether the electrode units are faulty since short circuits in the installation or other anomalies during electrolysis can cause electrode temperature to rise, especially at the points of contact with the equipotential rails of the installation, irregularities in product deposition in the cathode detected by means of the morphology system of the deposited material or weight, and electrical voltage differences in

the electrodes.

[0024] This way, it is possible to identify the anomalies in the electrodes located in the tank, such as increases in temperature, anomalous electrical contacts and faults in the morphology of the metal deposited in the electrodes and subsequently reposition, remove or replace the anomalous electrodes from the electrolysis tanks of the installation moving them to a repair or replacement area. During maintenance, faulty electrode units can be detected, which cannot be reinstalled in the production process. Once these electrode units have been discarded, the electrode unit of the electrolysis tank will be incomplete, leaving gaps that have to be filled. The auxiliary crane enables repositioning the new electrode units inserting them into their corresponding positions in the tank.

[0025] Advantageously, in order to detect the faulty electrode unit, the detection system comprises at least one sensor that remains static with respect to the electrolysis tank. This enables saving processing time with regard to the configuration in which the sensors move with respect to the tank or are fixed with respect thereto, although this last configuration, alternative or complementary, allows reducing the number of sensors in the installation.

[0026] For the automatic execution of the method, a control unit of the installation can be used, programmed to receive information from the detection system, process said information and command the auxiliary crane to reposition or remove the faulty electrode unit and/or insert the spare electrode unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] As a complement to the description provided herein, and for the purpose of helping to make the characteristics of the invention more readily understandable, in accordance with a preferred practical embodiment thereof, said description is accompanied by a series of figures constituting an integral part of the same, which by way of illustration and not limitation represent the following:

Figure 1 shows an upper perspective view of the auxiliary crane of the invention.

Figure 2 shows an elevation view of the auxiliary crane of the invention.

Figure 3 shows a profile view of the same auxiliary crane of the previous figures.

Figure 4 shows a detail of the auxiliary end truck.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0028] In one embodiment, the electrolysis installation comprises a main crane for operating the installation and an automatic auxiliary crane used in the maintenance method according to the invention, for repositioning the faulty electrode unit (anode or cathode unit) in the tank or removing it from the tank leaving a gap therein, and/or inserting the spare electrode unit in the gap. Said automatic auxiliary crane comprises:

A Main Structure (1), made up of two box girders and two headwalls joined thereto, as well as a grid floor, gangway and railing for supporting and maintaining equipment.

[0029] A Longitudinal Translation System (2), made up of two motors and four wheels, that enable translation with respect to the electrolysis tanks of the installation, in a direction perpendicular to the longitudinal direction of the electrolysis rods on rails (8) abutting on rail beams (9)

A Main Lifting System (3) mainly made up of a lifting geared motor and two drums.

[0030] An Electrode Collection System (4), made up of A Load-bearing structure of the electrode collection trolley (4a) and a centering and guiding System (4b), centering the crane and guiding the load-bearing structure of the electrode collection trolley (4a).

An Anti-Oscillation System

A Contact Temperature Checking System

An Electrode Voltage Checking System

A Morphological Analysis System of the deposited metal

An Auxiliary Lifting Mechanism (5)

A Feeding System (6)

An Electrical Installation, a Control System and an Air Conditioning and Cabinet Pressurization System (7).

[0031] The supports (9) and rails (8) of the main bridge corresponding to the bridge crane of the main crane can be used, thus minimizing the cost of the auxiliary bridge and thereby the operational costs of the maintenance method. Furthermore, the automatic auxiliary crane can accommodate auxiliary means for the operation thereof in order to carry out the method, such as a control unit or PLC for controlling the movements of the auxiliary bridge, electrical systems, refrigeration equipment and pressurization equipment. The automatic auxiliary bridge can also have access platforms for maintenance and supervision of said means. Access to these platforms from the transit areas of the electrolysis installation can be carried out by means of a ladder (10).

[0032] The full extent of travel of the auxiliary crane is limited in one direction by the stops of the rails, while in the other direction it is limited by the proximity of the main crane.

[0033] The drive of the wheels (11) of the headwalls for moving the auxiliary bridge can be carried out by means of an independent electric motor for each drive wheel that acts through an appropriate reducer and is commanded by means of a converter that makes it possible to use the appropriate translation and approximation speeds. The motors can also incorporate brakes, preferably electrically driven brakes. The displacement system of the described auxiliary bridge enables ensuring a positioning with respect to the electrolysis cells that is sufficiently precise to carry out the maintenance method according to the invention. In order to control the prop-

er displacement of the different elements of the auxiliary crane, position detectors can be used on the parts of the crane with respect to which they move, such as markings. For collecting, extracting or inserting the electrode units, the electrode collection system (4) comprises:

A load-bearing structure of the electrode collection trolley (4a), and the centering and guiding system (4b). Both elements will have relative movements between them during the lifting and lowering strokes.

[0034] Once the Bridge has been placed in the approximate position thereof on the vertical of a cell, the following movements can be carried out:

Positioning the Bridge in the longitudinal direction of the plant.

[0035] Displacement inside the load-bearing structure of the electrode collection trolley (4a) up to the corresponding position of the Electrodes that are to be manipulated, and positioning the collection hooks in the opening or closing position, depending on the anodes or cathodes that are to be manipulated.

[0036] Lowering of both the load-bearing structure of the electrode collection trolley (4a) and the centering and guiding system (4b) until the latter fits into the positioning elements.

[0037] Lowering of the electrode collection trolley (4c) up to the position where it will engage or disengage the corresponding electrode bundle.

[0038] Lifting of the electrode collection trolley (4c) up to the position where it will abut with the Guiding Structure.

[0039] Lifting of both the electrode collection trolley (4c) and the centering and guiding system (4b) up to the starting position. During the lifting stroke thereof, the Electrode Collection Trolley (4c) will drag the Guiding Structure against which it had abutted.

[0040] In turn, the load-bearing structure of the electrode collection trolley (4a), which is in charge of handling the electrodes, comprises:

A frame that supports both the electrode collection trolley (4c) itself and the guide frame when it is lifted. This Frame incorporates four guide elements at the ends thereof that will enable the relative vertical movement of the Electrode Collection Trolley along the guides that the Guiding Structure will be equipped with.

[0041] Four pulleys through which the Main Lifting System will pass.

[0042] The electrode collection trolley (4c) in charge of handling the electrodes consisting of a frame on four wheels, two of which are motorized, which has four sets of opening and closing mechanisms of the electrode collection lugs.

[0043] A centering and guiding system (4b), comprising a mobile structure equipped with guide rails on which the Electrode Collection Trolley will slide.

[0044] The centering and guiding system (4b) is positioned on the upper part of the tank, ensuring the correct position of the Electrode Collection Trolley with respect to the electrodes for their handling.

[0045] The load-bearing structure of the electrode collection trolley (4a) will be in charge of the vertical movements of the centering and guiding system (4b) when dragging it in the vertical movements thereof, when abutting with it.

[0046] In the Main Structure of the automatic auxiliary crane object of this invention (1), two columns with guide rails will be located and on these, the Guiding Structure will abut and slide by means of mounted wheels. This way, the Guiding Structure will be referenced at all times with respect to the Main Structure.

Vertically: through the Main Lifting System

Horizontally: through the guiding in the columns provided for this purpose.

[0047] The electrode collection trolley (4c), as shown in detail in Figure 4, is configured for managing the electrode units, comprising a frame (17) on four wheels (18), two of which are motorized, which has opening and closing means (14) of the tilting gripping arms (21) with electrode collection lugs (15). These lugs have a coupling hole (16) adapted to engage with the gripping means (19) provided in electrode heads (20) of the installation, thus enabling management and handling thereof. The tilting gripping arms (21) can be built with two rotating arms that support the collection lugs (15), for example, driven in a coordinated manner by a single linear actuator that make up the opening and closing means (14). The use of two types of collection lugs (15) is anticipated, some for anodes and others for cathodes. In order to identify the presence of an electrode or a gap in the electrolysis tank, the electrode collection trolley (4c) can incorporate laser detectors, each corresponding to the position of a collection lug, which enable identifying the presence of the electrode in the support thereof on the electrolysis rod, identifying both the number of electrodes present and the correct polarity thereof.

[0048] In order to control the lowering of the load-bearing structure of the electrode collection trolley (4a) including the electrode collection trolley (4c) and the centering and guiding system toward the electrolysis cell, a suitable detector system can be incorporated.

[0049] Other means of protection, such as anti-oscillation, can also be incorporated to prevent the electrode units from oscillating or moving with respect to the collection trolley during the lifting and lowering motions.

[0050] The different elements of the auxiliary crane must be adequately protected against acid mist corrosion, especially found in zinc electrolysis installations, for example, by means of specific acid-proof paint.

[0051] The detection system for detecting faulty electrode units may include a detection system with an electrode temperature sensor system, an electrode voltage drop checking system, a system for analyzing the morphology of the metal deposited on the electrodes and/or a system for balancing or checking the weight of the electrodes.

[0052] The temperature sensor system may include as many sensors as electrodes in the tank.

[0053] The electrode voltage drop checking system includes voltage drop sensors, which can include as many voltage probes as the number of cathodes plus a probe, for measuring the voltage between the electrode rod and the electrolysis rail on which it abuts.

[0054] The system for analyzing the morphology of the metal can comprise fixed cameras intended to take pictures of the surface of the metal deposited on the electrode. These pictures can be analyzed manually by an operator in order to assess possible faults in the deposition or automatically by means of image analysis systems. The pictures have sufficient resolution to enable a global analysis of the electrode and the processing thereof so that they can serve as a basis for comparative and statistical analyses.

[0055] In order to carry out automatically the method according to the invention, a control unit can be used programmed to detect information from the sensors on the state of the electrode units, process said information and command the auxiliary crane through displacements of the crane and the components thereof, such as translation of the automatic auxiliary crane, lifting and lowering of the electrode collection system, the auxiliary hoist, the electrode collection trolley or the electrode collection lugs.

[0056] The control unit can also enable partially automatic or semi-automatic control, allowing one or several of the stages of the method to be carried out manually by an operator.

Claims

1. A MAINTENANCE METHOD OF AN ELECTROLYSIS INSTALLATION, comprising the stages of:

   - identifying anomalies in the electrodes located in the tanks, such as increase in temperature, anomalous electrical contacts and faults in the morphology of the metal deposited in the electrodes by means of a detection system having at least one sensor;
   - extracting, removing and replacing the anomalous electrodes moving them from the electrolytic tanks of the plant to the repair and replacement area; and
   - repositioning new electrodes by inserting them in their operating positions, **characterized in that** the stages of extraction, removal, replacement and repositioning are being carried out by means of an auxiliary crane, different from the main crane used for operating the installation, and where said at least one sensor remains static with respect to the electrolysis tank.

2. MAINTENANCE METHOD OF AN ELECTROLYSIS INSTALLATION according to claim 1, **characterized in that** the stage of identifying anomalies in the electrodes, extracting, removing and replacing the electrodes as well as repositioning new electrodes is carried out automatically.

3. MAINTENANCE METHOD OF AN ELECTROLYSIS INSTALLATION according to one of claims 1 or 2, **characterized in that** the at least one sensor is selected from the group consisting of an electrode temperature sensor, an electrode voltage drop sensor, a system for analyzing the morphology of the metal deposited on the electrodes, an electrode weight sensor, and a combination of the above.

4. MAINTENANCE METHOD OF AN ELECTROLYSIS INSTALLATION according to claim 3, **characterized in that** it comprises the use of a control unit programmed to automatically receive information from the detection system, process said information and command the auxiliary crane to relocate or remove the faulty electrode unit and/or insert the spare electrode unit.

5. MAINTENANCE METHOD OF AN ELECTROLYSIS INSTALLATION according to claim 4, **characterized in that** in order to relocate or remove the faulty electrode unit and insert the spare electrode unit into the gap, the bridge crane of the auxiliary crane comprises an electrode unit collection system comprising an electrode unit collection trolley.

6. An electrolysis installation comprising a main crane for operating the installation and an automatic auxiliary crane for maintenance thereof, **characterized in that** the automatic auxiliary crane comprises:

   - a Main Structure (1), made up of two box girders and two headwalls joined thereto, as well as a grid floor, gangway and railing for supporting and maintaining equipment;
   - a Longitudinal Translation System (2), made up of two motors that actuate on wheels, enabling translation with respect to electrolysis tanks of the installation, in a direction perpendicular to the longitudinal direction of the electrolysis rods on rails (8) abutting on rail beams (9);
   - a Main Lifting System (3) mainly made up of a lifting geared motor and two drums; and
   - an Electrode Collection System (4) comprising a load-bearing structure of the electrode collection trolley (4a) and a centering and guiding system (4b), wherein both elements have relative movements between them during the lifting and lowering strokes.

7. An electrolysis installation according to claim 6, **characterized in that** an electrode collection trolley (4c) handles the electrode units and comprises a

frame (17) on four wheels (18), two of which are motorized, having opening and closing means (14) of a tilting gripping arms (21) with electrode collection lugs (15), these lugs being provided with a coupling hole (16) adapted to engage with gripping means (19) provided in electrode heads (20) of the installation, thus enabling management and handling thereof.

8. An electrolysis installation according to claim 7, **characterized in that** the tilting gripping arms (21) are built with two rotating arms that support the collection lugs (15), driven in a coordinated manner by a single linear actuator, that make up the opening and closing means (14).

9. An electrolysis installation according to claims 6 to 8, **characterized in that** two types of collection lugs (15) are used, one for anodes and the other for cathodes.

10. An electrolysis installation according to claims 6 to 9, **characterized in that** the presence of an electrode or a gap in the electrolysis tank is identified by means of laser detectors, each corresponding to the position of a collection lug, which enable identifying the presence of an electrode in the support thereof on the electrolysis rod, identifying both the number of electrodes present and the correct polarity thereof, these elements being located in the electrode collection trolley (4c).

11. An electrolysis installation according to claims 6 to 10, **characterized in that** in order to control the lowering of the electrode collection system (4) towards the electrolysis cell, it incorporates a detector system, further incorporating other protection means , such as anti-oscillation means to prevent the electrode units from oscillating or moving with respect to the collection trolley during the lifting and lowering motions.

12. An electrolysis installation according to claims 6 to 11, **characterized in that** it further comprises:

- a detection system for detecting faulty electrode units with an electrode temperature sensor system,
- an electrode voltage drop checking system,
- a system for analyzing the metal deposited on the electrodes and/or
- a system for balancing or checking the weight of the electrodes.

13. An electrolysis installation according to claim 12, **characterized in that** the temperature sensor system may include as many sensors as electrodes in the electrolysis tank.

14. An electrolysis installation according to claim 12, **characterized in that** the electrode voltage drop checking system comprises voltage drop sensors, which can include as many voltage probes as the number of cathodes plus a probe, for measuring the voltage between the electrode rod and the electrolysis rail on which it abuts.

15. An electrolysis installation according to claim 12, **characterized in that** the system for analyzing the deposited metal comprises fixed cameras intended to take pictures of the surface of the metal deposited on the electrode, which are analyzed manually by an operator or automatically by means of image analysis systems in order to assess possible faults in the deposition.

16. An electrolysis installation according to claims 6 to 15, **characterized in that** it has a control unit programmed to detect information from sensors on the state of the electrode units, process said information and command the auxiliary crane through displacements of the crane and of each of the components of the auxiliary crane, such as the translation of the entire crane, that of the lifting of the electrode collection system (4) made up of the load-bearing structure of the electrode collection trolley (4a), the centering and guiding system (4b) the electrode collection trolley (4c), and an auxiliary lifting mechanism (5).

Patentansprüche

1. Wartungsmethode einer Elektrolyseanlage, die die folgenden Schritte umfasst:

- Identifizierung von Anomalien in den Elektroden, die in den Behältern angeordnet sind, wie zum Beispiel einen Temperaturanstieg, anomale elektrische Kontakte und Fehler in der Morphologie des in den Elektroden abgeschiedenen Metalls mittels eines Detektionssystems mit mindestens einem Sensor;
- Herausstrennen, Entfernen und Ersetzen der anomalen Elektroden, indem diese aus den Elektrolysebehältern der Einrichtung in den Reparatur- und Ersatzbereich gebracht werden; und
- Repositionierung neuer Elektroden durch Einsetzen in ihre Betriebspositionen, **dadurch gekennzeichnet, dass** die Schritte des Heraustrennens, Entfernens, Ersetzens und der Repositionierung mittels eines Hilfskrans durchgeführt werden, der sich von dem Hauptkran unterscheidet, der für den Betrieb der Anlage verwendet wird, und wobei der mindestens eine Sensor in Bezug auf den Elektrolysetank sta-

tisch bleibt.

2. Wartungsmethode einer Elektrolyseanlage nach Anspruch 1, **dadurch gekennzeichnet, dass** der Schritt des Erkennens von Anomalien in den Elektroden, des Heraustrennens, Entfernens und Ersetzens der Elektroden sowie des Repositionierens neuer Elektroden automatisch durchgeführt wird.

3. Wartungsmethode einer Elektrolyseanlage nach einem der Ansprüche 1 oder 2, **dadurch gekennzeichnet, dass** der mindestens eine Sensor aus der Gruppe die aus einem Elektroden-Temperatursensor, einem Elektroden-Spannungsabfallsensor, einem System zur Analyse der Morphologie des auf den Elektroden abgeschiedenen Metalls, einem Elektroden-Gewichtssensor und einer Kombination der genannten, besteht, ausgewählt ist.

4. Wartungsmethode einer Elektrolyseanlage nach Anspruch 3, **dadurch gekennzeichnet, dass** es die Verwendung einer Steuereinheit umfasst, die programmiert ist, um automatisch Informationen von dem Detektionssystem zu empfangen, diese Informationen verarbeiten und dem Hilfskran zu befehlen, die fehlerhafte Elektrodeneinheit zu versetzen oder zu entfernen und/oder die Ersatzelektrodeneinheit einzusetzen.

5. Wartungsmethode einer Elektrolyseanlage nach Anspruch 4, **dadurch gekennzeichnet, dass** der Brückenkran des Hilfskrans zum Versetzen oder Entfernen der fehlerhaften Elektrodeneinheit und zum Einsetzen der Ersatzelektrodeneinheit in die Lücke ein Elektrodeneinheitensammelsystem mit einem Elektrodeneinheitensammelwagen umfasst.

6. Elektrolyseanlage mit einem Hauptkran zum Betreiben der Anlage und einem automatischen Hilfskran zu deren Wartung, **dadurch gekennzeichnet, dass** der automatische Hilfskran Folgendes umfasst:

- eine Hauptstruktur (1), die aus zwei Kastenträgern und zwei damit verbundenen Stirnwänden sowie einem Gitterboden, einem Laufsteg und einem Geländer zum Tragen und Warten von Ausrüstung besteht;
- einem Längsverschiebungssystem (2), das aus zwei Motoren besteht, die auf Rädern angetrieben sind und eine Verschiebung in Bezug auf die Elektrolysebehälter der Anlage in einer Richtung senkrecht zur Längsrichtung der Elektrolyse-Stäbe auf Schienen (8) ermöglichen, die auf Schienenträgern (9) aufliegen;
- ein Haupthubsystem (3), das im Wesentlichen aus einem Hubgetriebemotor und zwei Trommeln besteht; und
- ein Elektrodensammelsystem (4), das eine lasttragende Struktur des Elektrodensammelwagens (4a) und ein Zentrier- und Führungssystem (4b) umfasst, wobei beide Elemente während der Hub- und Senkhübe Relativbewegungen zueinander aufweisen.

7. Elektrolyseanlage nach Anspruch 6, **dadurch gekennzeichnet, dass** ein Elektrodensammelwagen (4c) die Elektrodeneinheiten handhabt und einen Rahmen (17) auf vier Rädern (18), von denen zwei motorisiert sind, umfasst, der Öffnungs- und Schließmitteln (14) eines kippbaren Greifarms (21) mit Elektrodensammellaschen (15) aufweist, wobei diese Laschen mit einem Kupplungsloch (16) versehen sind, das geeignet ist, in Greifmittel (19) einzugreifen, die in Elektrodenköpfen (20) der Anlage vorgesehen sind, wodurch deren Verwaltung und Handhabung ermöglicht wird.

8. Elektrolyseanlage nach Anspruch 7, **dadurch gekennzeichnet, dass** die kippbaren Greifarme (21) mit zwei drehbaren Armen ausgeführt sind, die die Sammellaschen (15) tragen und die koordiniert von einem einzigen Linearantrieb angetrieben werden und die Öffnungs- und Schließmittel (14) bilden.

9. Elektrolyseanlage nach einem der Ansprüche 6 bis 8, **dadurch gekennzeichnet, dass** zwei Arten von Sammellaschen (15) verwendet werden, eine für Anoden und die andere für Kathoden.

10. Elektrolyseanlage nach einem der Ansprüche 6 bis 9, **dadurch gekennzeichnet, dass** das Vorhandensein einer Elektrode oder einer Lücke in dem Elektrolysebehälter mittels Laserdetektoren erkannt wird, die jeweils mit der Position einer Sammelasche korrespondieren und es ermöglichen, das Vorhandensein einer Elektrode in deren Halterung an dem Elektrolysestab zu erkennen, wobei sowohl die Anzahl der vorhandenen Elektroden als auch deren korrekte Polarität erkannt werden, wobei diese Elemente in dem Elektrodensammelwagen (4c) angeordnet sind.

11. Elektrolyseanlage nach einem der Ansprüche 6 bis 10, **dadurch gekennzeichnet, dass** sie zur Steuerung des Absenkens des Elektrodensammelsystems (4) in Richtung der Elektrolysezelle ein Detektorsystem enthält, wobei sie ferner weitere Schutzvorrichtungen, wie z. B. Antischwingungsvorrichtungen, enthält, um ein Schwingen oder Bewegen, der Elektrodeneinheiten während der Hebe- und Senkbewegungen in Bezug auf den Sammelwagen zu verhindern.

12. Elektrolyseanlage nach einem der Ansprüche 6 bis 11, **dadurch gekennzeichnet, dass** sie weiterhin Folgendes umfasst:

- ein Erkennungssystem zum Erkennen fehlerhafter Elektrodeneinheiten mit einem Elektroden-Temperatursensorsystem,
- ein Elektroden-Spannungsabfall-Kontrollsystem
- ein System zum Analysieren des auf den Elektroden abgeschiedenen Metalls und/oder
- ein System zum Ausgleichen oder Überprüfen des Gewichts der Elektroden.

13. Elektrolyseanlage nach Anspruch 12, **dadurch gekennzeichnet, dass** das Temperatursensorsystem so viele Sensoren wie Elektroden im Elektrolysebehälter umfassen kann.

14. Elektrolyseanlage nach Anspruch 12, **dadurch gekennzeichnet, dass** das Elektroden-Spannungsabfall-Kontrollsystem Spannungsabfallsensoren umfasst, die so viele Spannungssonden wie die Anzahl der Kathoden plus eine Sonde umfassen können, um die Spannung zwischen dem Elektrodenstab und der Elektrolyseschiene, an der er anliegt, zu messen.

15. Elektrolyseanlage nach Anspruch 12, **dadurch gekennzeichnet, dass** das System zur Analyse des abgeschiedenen Metalls feststehende Kameras umfasst, die dazu bestimmt sind, Bilder von der Oberfläche des auf der Elektrode abgeschiedenen Metalls aufzunehmen, die manuell von einem Bediener oder automatisch mit Hilfe von Bildanalysesystemen analysiert werden, um mögliche Fehler in der Abscheidung zu beurteilen.

16. Elektrolyseanlage nach einem der Ansprüche 6 bis 15, **dadurch gekennzeichnet, dass** sie eine Steuereinheit aufweist, die programmiert ist, um Informationen von Sensoren über den Zustand der Elektrodeneinheiten zu erfassen, diese Informationen zu verarbeiten und den Hilfskran durch Verschiebungen des Krans und jeder der Komponenten des Hilfskrans, wie zum Beispiels die Verschiebung des gesamten Krans, das Anheben des Elektrodensammelsystems (4), das aus der lasttragenden Struktur des Elektrodensammelwagens (4a), dem Zentrier- und Führungssystem (4b), dem Elektrodensammelwagen (4c) und einem Hilfshubmechanismus (5) besteht, zu steuern.

Revendications

1. Procédé de maintenance d'une installation d'électrolyse, comprenant les étapes suivantes :

identifier des anomalies dans les électrodes situées dans les cuves, telles que l'augmentation de température, des contacts électriques anormaux et des défauts dans la morphologie du métal déposé dans les électrodes au moyen d'un système de détection ayant au moins un capteur ;
extraire, retirer et remplacer les électrodes anormales en les déplaçant des cuves électrolytiques de l'installation jusqu'à la zone de réparation et de remplacement ; et
repositionner les nouvelles électrodes en les insérant dans leurs positions opérationnelles,
caractérisé en ce que les étapes d'extraction, de retrait, de remplacement et de repositionnement sont réalisées au moyen d'une grue auxiliaire, différente de la grue principale utilisée pour actionner l'installation, et où ledit au moins un capteur reste statique par rapport à la cuve d'électrolyse.

2. Procédé de maintenance d'une installation d'électrolyse selon la revendication 1, **caractérisé en ce que** l'étape pour identifier des anomalies dans les électrodes, extraire, retirer et remplacer les électrodes ainsi que repositionner de nouvelles électrodes est réalisée automatiquement.

3. Procédé de maintenance d'une installation d'électrolyse selon l'une des revendications 1 ou 2, **caractérisé en ce que** le au moins un capteur est sélectionné dans le groupe comprenant un capteur de température d'électrode, un capteur de chute de tension d'électrode, un système pour analyser la morphologie du métal déposé sur les électrodes, un capteur de poids d'électrode et une combinaison des éléments ci-dessus.

4. Procédé de maintenance d'une installation d'électrolyse selon la revendication 3, **caractérisé en ce qu'**il comprend l'utilisation d'une unité de commande programmée pour recevoir automatiquement une information du système de détection, traiter ladite information et commander la grue auxiliaire pour repositionner ou retirer l'unité d'électrode défectueuse et/ou insérer l'unité d'électrode de rechange.

5. Procédé de maintenance d'une installation d'électrolyse selon la revendication 4, **caractérisé en ce qu'**afin de repositionner ou de retirer l'unité d'électrode défectueuse et insérer l'unité d'électrode de rechange dans l'espace, la grue à portique de la grue auxiliaire comprend un système de collecte d'unité d'électrode comprenant un chariot de collecte d'unité d'électrode.

6. Installation d'électrolyse comprenant une grue principale pour actionner l'installation et une grue auxiliaire automatique pour sa maintenance, **caractérisée en ce que** la grue auxiliaire automatique comprend :

une structure principale (1) composée de deux poutres à caisson et deux murs de tête assemblés à cette dernière, ainsi qu'un plancher grillagé, une passerelle et un garde-corps pour supporter et maintenir l'équipement ;
un système de translation longitudinal (2) composé de deux moteurs qui actionnent des roues, permettant la translation par rapport aux cuves d'électrolyse de l'installation, dans une direction perpendiculaire à la direction longitudinale des tiges d'électrolyse sur des rails (8) venant en butée sur des poutres de rail (9) ;
un système de levage principal (3) principalement composé d'un moteur à train d'engrenages de levage et de deux tambours ; et
un système de collecte d'électrodes (4) comprenant une structure de support de charge du chariot de collecte d'électrodes (4a) et un système de centrage et de guidage (4b), dans lequel les deux éléments ont des mouvements relatifs entre eux pendant les courses de levage et d'abaissement.

7. Installation d'électrolyse selon la revendication 6, **caractérisée en ce qu'**un chariot de collecte d'électrode (4c) manipule les unités d'électrode et comprend un bâti (17) sur quatre roues (18), dont deux sont motorisées, ayant des moyens d'ouverture et de fermeture (14) d'un bras de préhension incliné (21) avec des pattes de collecte d'électrodes (15), ces pattes étant prévues avec un trou de couplage (16) adapté pour se mettre en prise avec un moyen de préhension (19) prévu dans les têtes d'électrode (20) de l'installation, permettant ainsi sa gestion et sa manipulation.

8. Installation d'électrolyse selon la revendication 7, **caractérisée en ce que** les bras de préhension inclinés (21) sont construits avec deux bras rotatifs qui supportent les pattes de collecte (15), entraînés d'une manière coordonnée par un seul actionneur linéaire, qui composent les moyens d'ouverture et de fermeture (14).

9. Installation d'électrolyse selon les revendications 6 à 8, **caractérisée en ce que** deux types de pattes de collecte (15) sont utilisées, l'une pour les anodes et l'autre pour les cathodes.

10. Installation d'électrolyse selon les revendications 6 à 9, **caractérisée en ce que** la présence d'une électrode ou d'un espace dans la cuve d'électrolyse est identifiée au moyen de détecteurs laser, chacun correspondant à la position d'une patte de collecte, qui permettent d'identifier la présence d'une électrode dans son support sur la tige d'électrolyse, identifier à la fois le nombre d'électrodes présentes et leur bonne polarité, ces éléments étant positionnés dans le chariot de collecte d'électrodes (4c).

11. Installation d'électrolyse selon les revendications 6 à 10, **caractérisée en ce qu'**afin de commander l'abaissement du système de collecte d'électrodes (4) vers la cellule d'électrolyse, elle comprend un système de détecteur, comprenant en outre d'autres moyens de protection, tels que des moyens anti-oscillation pour empêcher les unités d'électrodes d'osciller ou de se déplacer par rapport au chariot de collecte pendant les mouvements de levage et d'abaissement.

12. Installation d'électrolyse selon les revendications 6 à 11, **caractérisée en ce qu'**elle comprend en outre :

un système de détection pour détecter des unités d'électrodes défectueuses avec un système de capteur de température d'électrode,
un système de vérification de chute de tension d'électrode,
un système pour analyser le métal déposé sur les électrodes, et/ou
un système pour équilibrer ou vérifier le poids des électrodes.

13. Installation d'électrolyse selon la revendication 12, **caractérisée en ce que** le système de capteur de température peut comprendre autant de capteurs que d'électrodes dans la cuve d'électrolyse.

14. Installation d'électrolyse selon la revendication 12, **caractérisée en ce que** le système de vérification de chute de tension d'électrode comprend des capteurs de chute de tension qui peuvent comprendre autant de sondes de tension que le nombre de cathodes plus une sonde, pour mesurer la tension entre la tige d'électrode et le rail d'électrolyse sur lequel il vient en butée.

15. Installation d'électrolyse selon la revendication 12, **caractérisée en ce que** le système pour analyser le métal déposé comprend des caméras fixes prévues pour prendre des photos de la surface du métal déposé sur l'électrode, qui sont analysées manuellement par un opérateur ou automatiquement au moyen de systèmes d'analyse d'image afin d'évaluer des défauts éventuels dans le dépôt.

16. Installation d'électrolyse selon les revendications 6 à 15, **caractérisée en ce qu'**elle a une unité de commande programmée pour détecter une information des capteurs concernant l'état des unités d'électrode, traiter ladite information et commander la grue auxiliaire par le biais des déplacements de la grue et de chacun des composants de la grue auxiliaire, comme la translation de toute la grue, celui du levage

du système de collecte d'électrodes (4) composé de la structure de support de charge du chariot de collecte d'électrodes (4a), le système de centrage et de guidage (4b), le chariot de collecte d'électrodes (4c) et un mécanisme de levage auxiliaire (5).

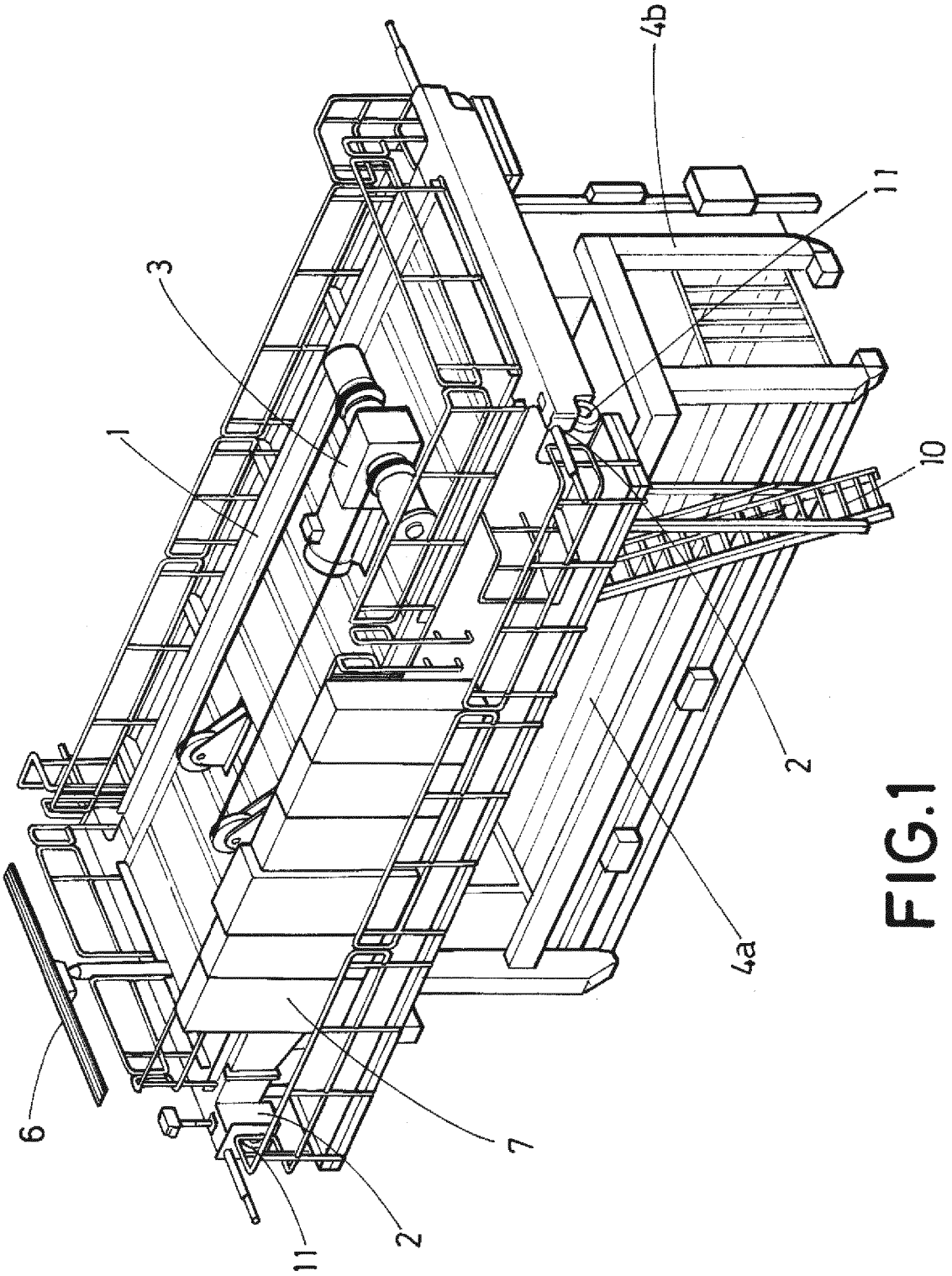

FIG.1

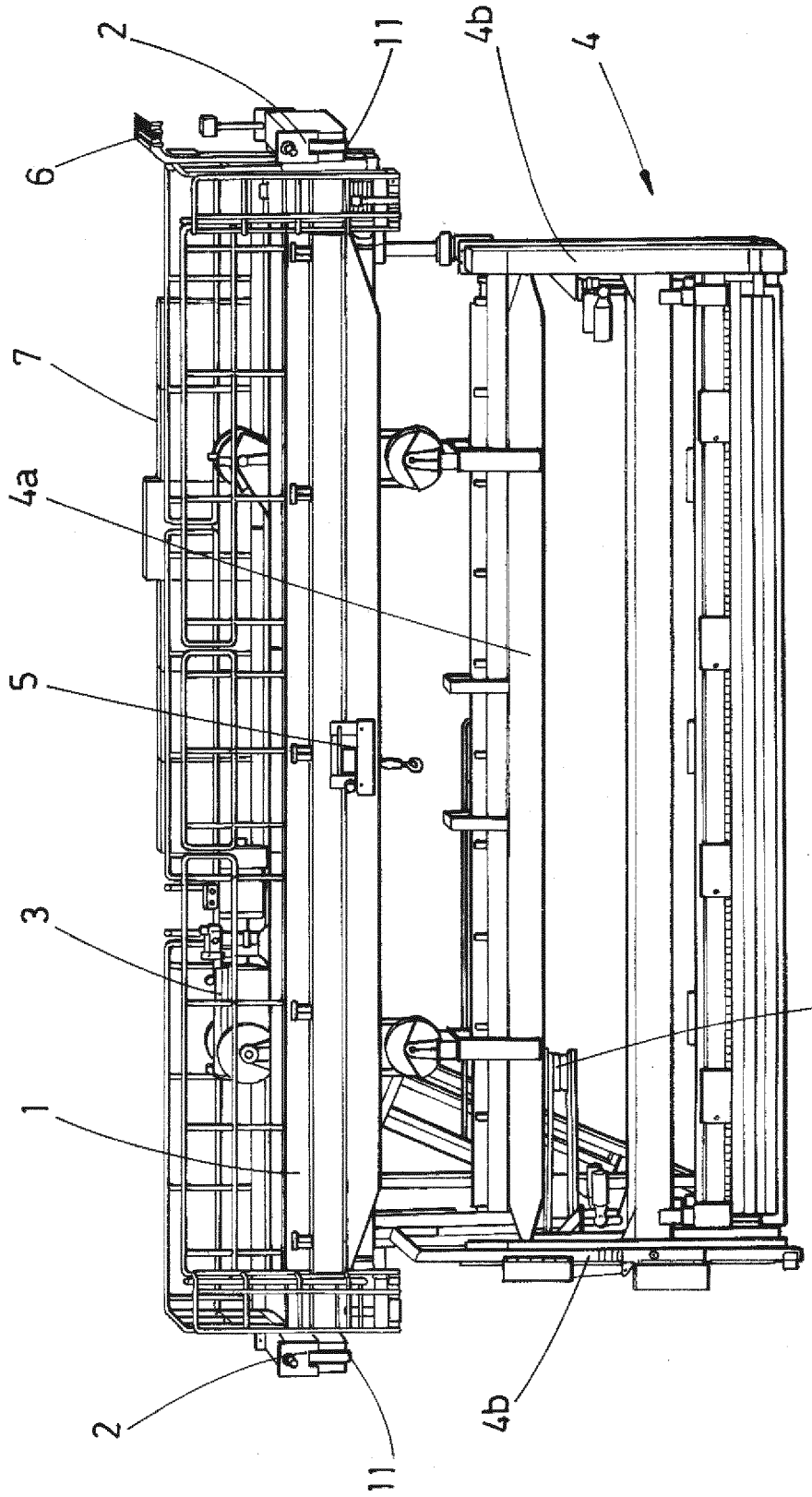

FIG.2

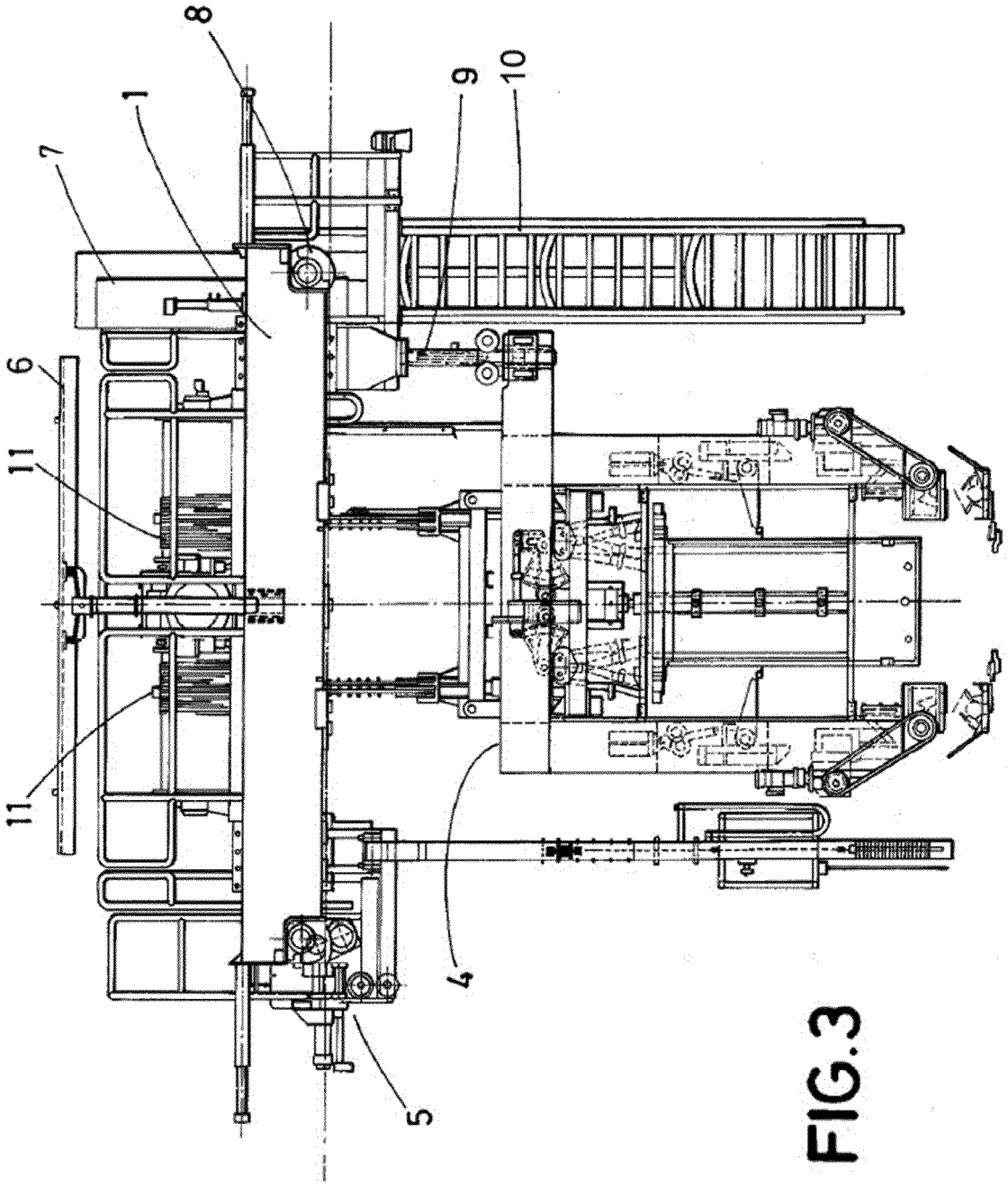

FIG.3

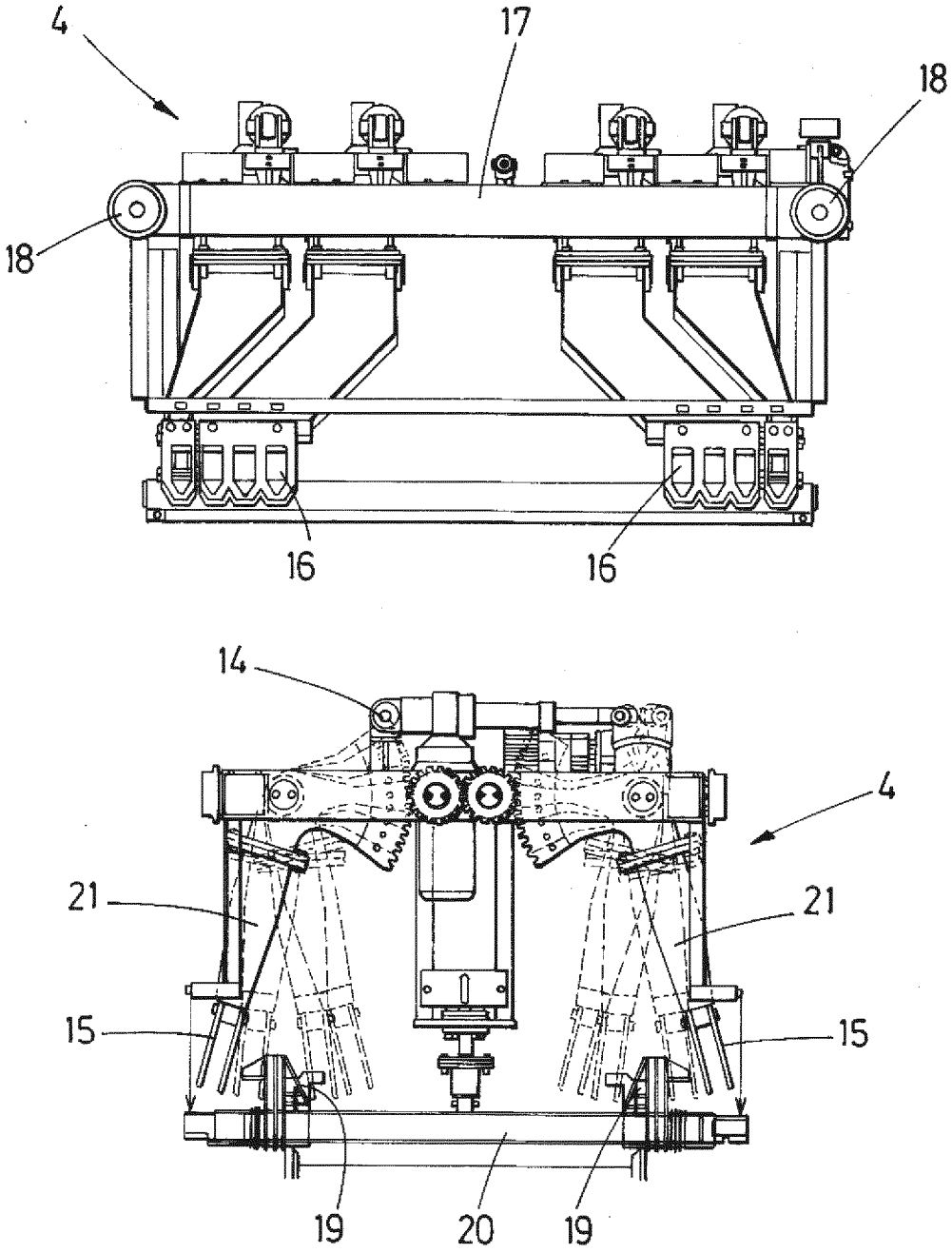

FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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