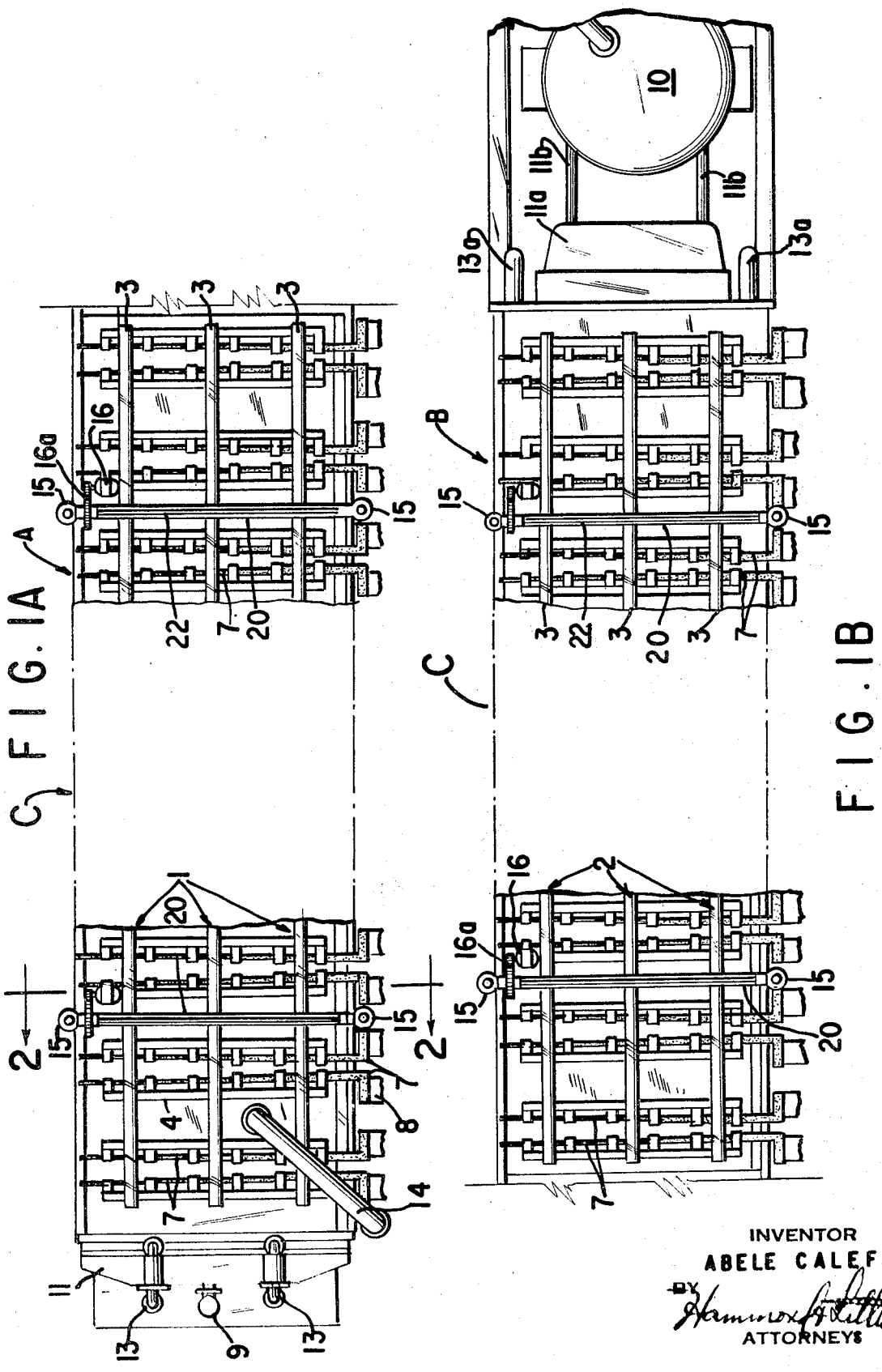
Sept. 5, 1972 A. CALEFFI 3,689,398

AUTOMATIC ANODE RAISING DEVICE

Filed Oct. 6, 1970 5 Sheets-Sheet 1

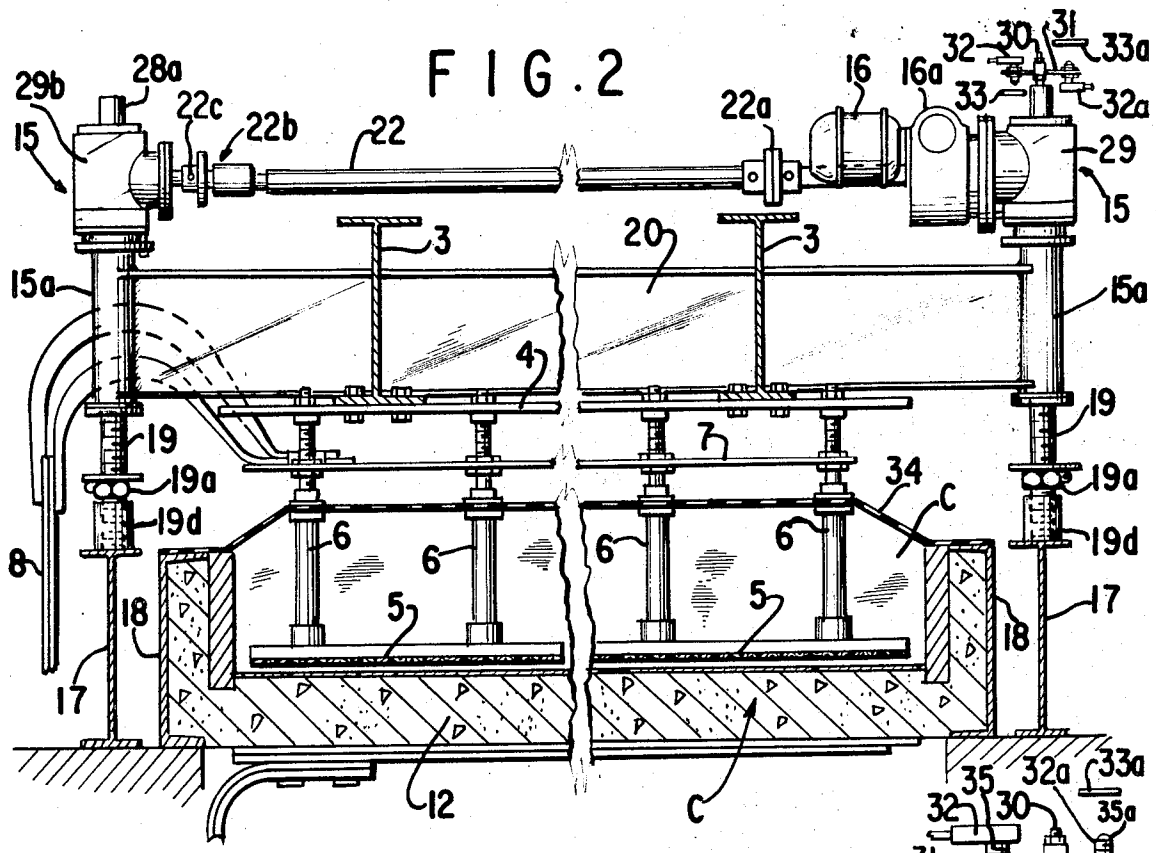


INVENTOR
ABELE CALEFFI
BY
ATTORNEYS

AUTOMATIC ANODE RAISING DEVICE

Filed Oct. 6, 1970 5 Sheets-Sheet 2

FIG. 2



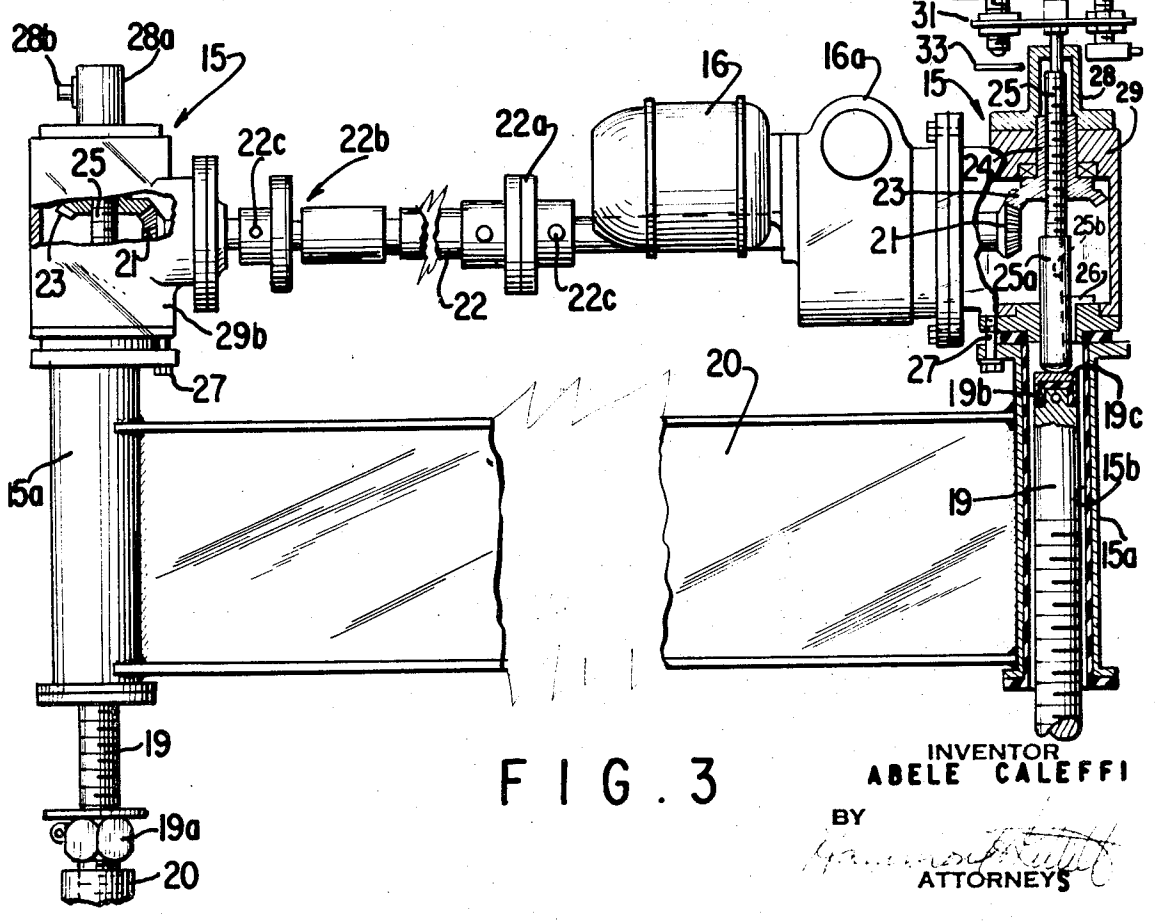


FIG. 3

INVENTOR
ABELE CALEFFI
BY
ATTORNEYS

AUTOMATIC ANODE RAISING DEVICE

Filed Oct. 6, 1970 5 Sheets-Sheet 3

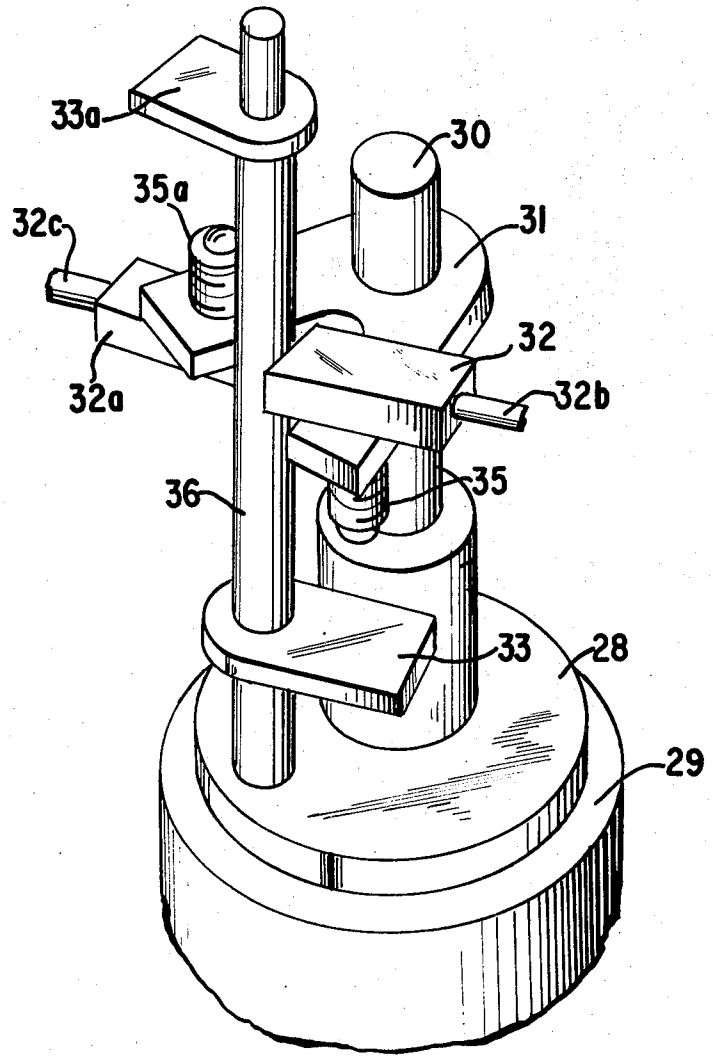


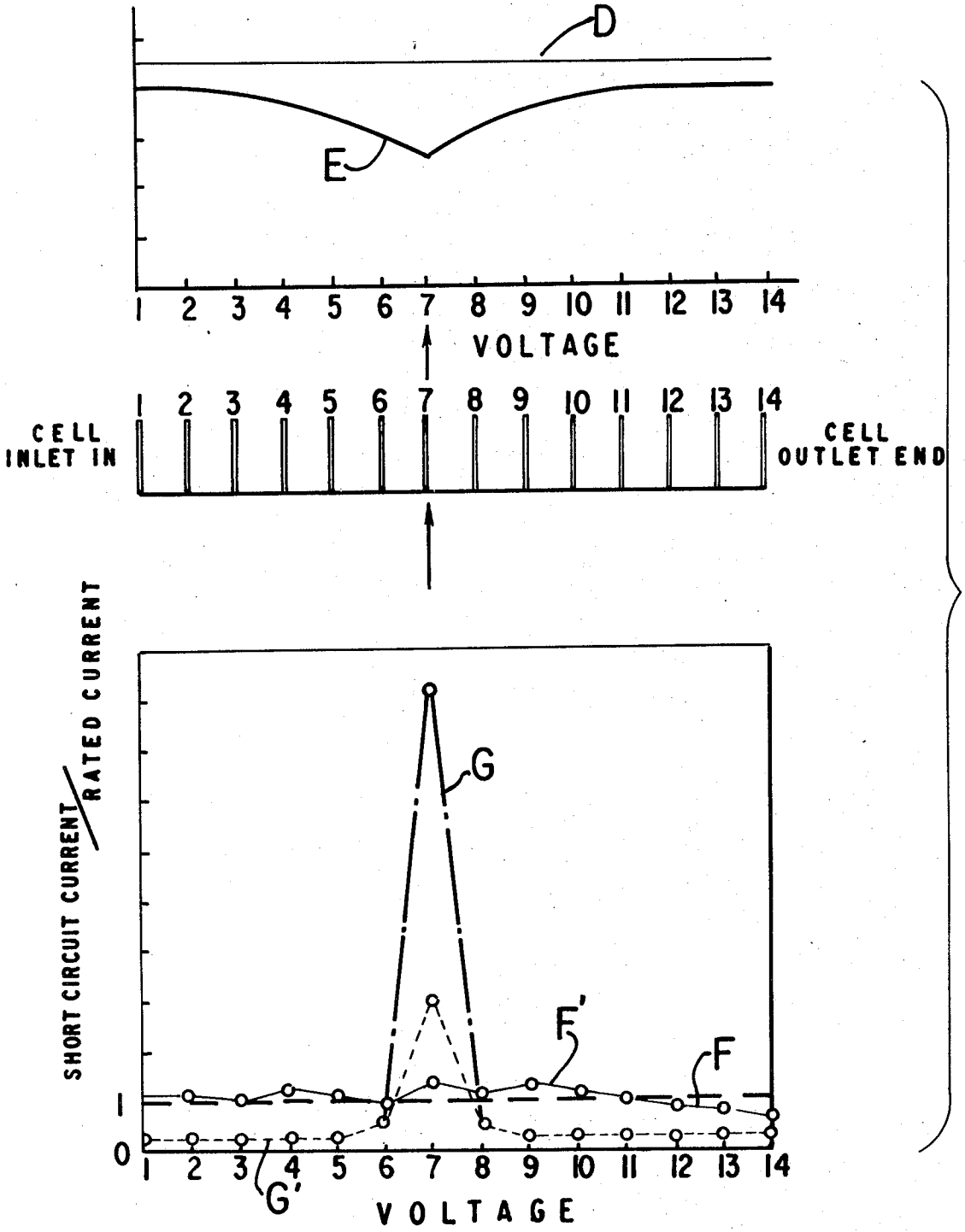
FIG. 4

INVENTOR
ABELE CALEFFI
BY
ATTORNEYS

AUTOMATIC ANODE RAISING DEVICE

Filed Oct. 6, 1970 5 Sheets-Sheet 4

FIG. 5



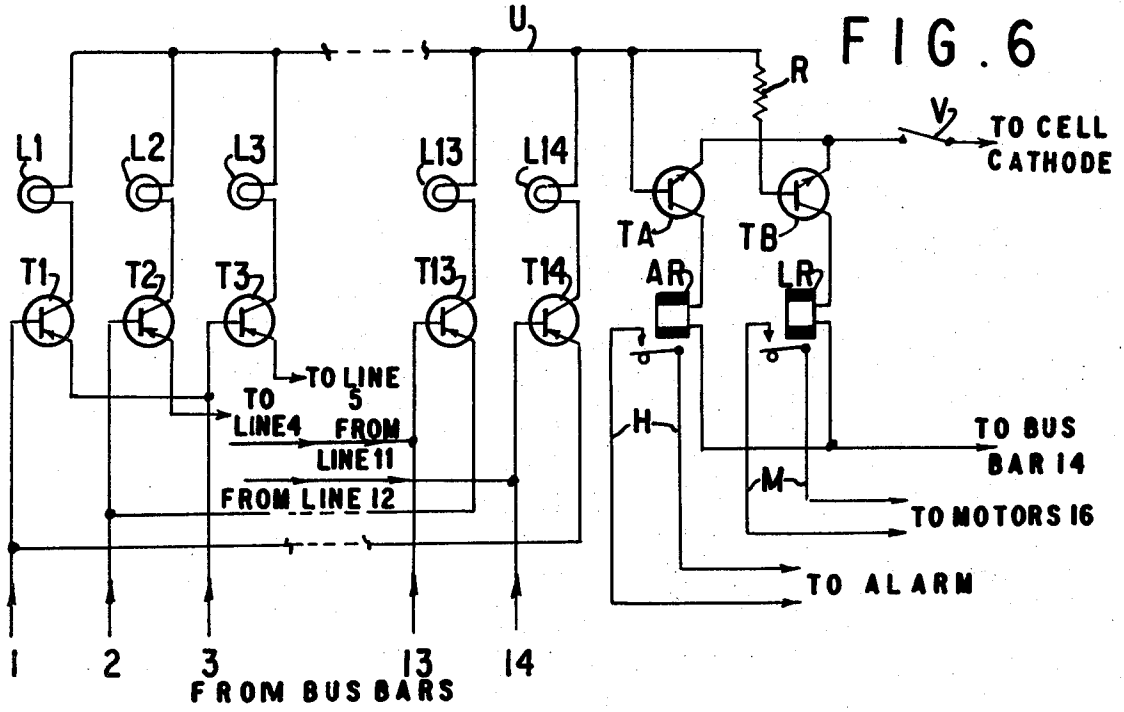
INVENTOR
ABELE CALEFFI
BY
ATTORNEYS

Sept. 5, 1972 A. CALEFFI 3,689,398

AUTOMATIC ANODE RAISING DEVICE

Filed Oct. 6, 1970 5 Sheets-Sheet 5

FIG. 6



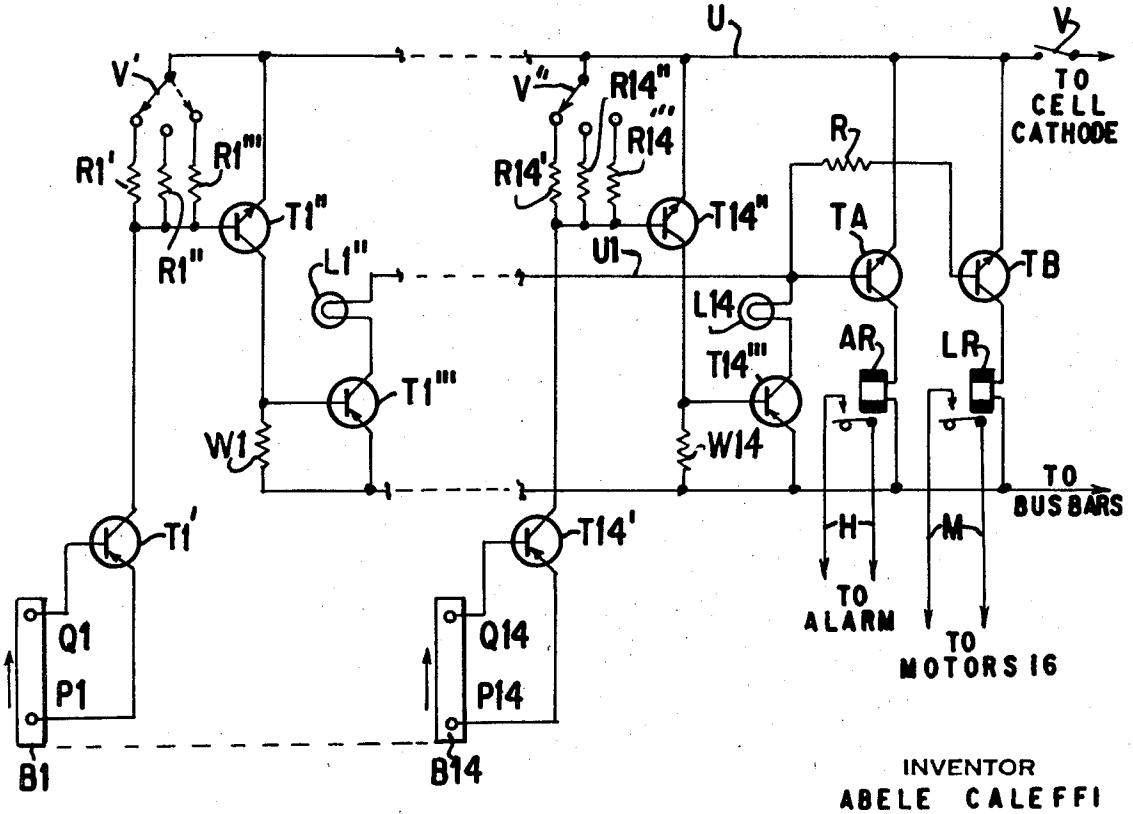


FIG. 7

INVENTOR
ABELE CALEFFI
BY
ATTORNEYS

United States Patent Office 3,689,398 Patented Sept. 5, 1972

3,689,398

AUTOMATIC ANODE RAISING DEVICE

Abele Caleffi, Milan, Italy, assignor to Nora International Company, Panama, Panama

Filed Oct. 6, 1970, Ser. No. 78,512
Int. Cl. B01k 3/00; C22d 1/04
U.S. Cl. 204—220 15 Claims

ABSTRACT OF THE DISCLOSURE

Describes a method and apparatus for protecting mercury cathode electrolysis cells against damage from internal short circuits in which the current flow through the cell is measured so as to detect any voltage unbalance through an anode bank and when a substantial increase in the current in an anode bank occurs, raising said anode bank to increase the gap between the anodes in said bank and the cathode.

This invention relates to a method and apparatus for protecting electrolysis cells against internal short circuits which might become established between the anode and cathode structures. The invention is particularly useful for the protection of electrolysis cells of the mercury cathode type, on account of the tendency of the mercury level to gradually rise in time; mainly as a consequence of progressive accumulation of foreign matter; especially iron particles, in the mercury stream, whereby the latter becomes sluggish with a tendency to pile up over the cell bottom and decrease the width of the anode gap. The phenomenon is aggravated by the influence of the strong magnetic field that is generated by the high intensity of electrolysis current and hinders the free movement of the bulk of mercury carrying the iron particles.

According to the present invention, means are provided to actuate a signal alarm system whenever the gap between the mercury cathode and the anode or group of anodes becomes so small as to increase the current intensity through a part of the anodes, above a pre-established safety limit. On actuation of the signal system, the cell operator may manually start a motorized anode lifting device which will raise the anodes to the desired distance above the cathode.

Another feature of the invention is to provide means whereby the anodes are automatically lifted, so as to break a short circuit, whenever the current intensity reaches such a dangerous level, at any local point within the cell, as to require a quicker action than could be provided by manual operation on signal notice. Later the gap width may be restored to a safe value by lowering the anode bank.

PRIOR ART

The normal horizontal mercury cell of the type described, for example, in U.S. Pat. No. 2,544,138, is in the form of a slightly inclined trough over which mercury, forming the cathode, flows beneath a plurality of anodes arranged in rows across the cell and spaced a short distance from the flowing mercury cathode. The anodes are submerged in an electrolyte, which when the cell is used, for example, to produce chlorine and caustic soda, is a sodium chloride brine. When an electrolysis current is applied to the cell, the brine is decomposed to sodium and chlorine. The sodium migrates through the electrolyte to the flowing mercury cathode where it is amalgamated with the mercury which flows out of the cell to a decomposer and the chlorine rises through the electrolyte, passes out of the cell through a chlorine outlet and is recovered in a chlorine recovery plant.

For efficient operation, the electrolyte gap between the lower face of the anodes and the flowing mercury cathode should be kept as small as possible, usually between 1.5

and 3.5 mm. However, ripples and other unevenness in the flowing mercury cathode, the accumulation of foreign matter in the mercury, etc., often cause a reduction in the width of the electrolyte gap and sometimes cause contacts between the mercury and one or more anodes which produce short circuits which may damage the anodes or may trigger explosions due to the formation of hydrogen gas which can damage the cell itself, if not quickly broken.

The anodes are usually made of graphite or of a valve metal such as titanium or tantalum or alloys thereof. When metal anodes are used, they provide dimensionally stable anodes, but when short circuits occur the metal itself may be burned by the short circuit and, in any event, the short circuits disrupt the uniform flow of current between the anodes and the cathode and throw the cell and often the entire plant, which may consist of many cells, out of balance.

OBJECTS OF THE INVENTION

One of the objects of this invention is to provide a method and apparatus for breaking short circuits in electrolytic cells promptly on their formation.

Another object of this invention is to provide a method and means for raising the anodes when the anode gap becomes too small for safety, so as to prevent a short circuit forming or so as to break a short circuit before any material damage is done to the anodes or the cell.

Another object of the invention is to provide a method and apparatus for automatically or manually raising the anodes to break a short circuit or to increase the width of the electrolyte gap to a safe limit if it becomes dangerously small.

Another object of the invention is to provide a method and apparatus for adjusting the spacing between the anodes and the flowing mercury cathode of an electrolysis cell whereby the anode gap may be uniformly adjusted.

Various other objects and advantages of this invention will appear as this description proceeds.

THE INVENTION

The invention comprises means to measure the current flow between the anodes and the cathode of a flowing mercury cathode electrolysis cell and means to raise or lower an anode bank manually or automatically in accordance with said current flow measurements. When this measurement indicates a substantial variation from normal voltages in a bank of anodes, means are provided to actuate an alarm signal whereby the operator may manually control the anode raising and lowering mechanism or if the variation in voltage is such as to indicate that a short circuit has been formed, means are provided to automatically raise the affected anode bank a sufficient distance to break the short circuit.

Referring now to the drawings which illustrate preferred embodiments of the invention and which are for illustrative purposes only:

FIGS. 1A and 1B are a plan view of a typical mercury cell in which the method and apparatus of this invention may be used; FIG. 1A represents the inlet end and FIG. 1B the outlet end of the same cell;

FIG. 2 is a cross sectional view substantially along the line 2—2 of FIG. 1, illustrating a typical horizontal mercury cell with the method and apparatus of the invention applied thereto;

FIG. 3 is a larger detail, partially in section, illustrating one construction of the anode raising and lowering means;

FIG. 4 is a perspective view of a limit switch for controlling the upper and lower limits of travel of the anode raising device;

FIG. 5 is a diagrammatic representation of voltage and current distribution, respectively, along an anode bank;

FIGS. 6 and 7 illustrate two different wiring schemes which may be used for operating the anode raising and lowering means.

THE HORIZONTAL MERCURY CELL

A typical horizontal mercury cell is illustrated in FIGS. 1A and 1B. The cell illustrated consists of 18 rows of anodes, mounted in two separated anode banks A and B and suspended in the cell trough C, so that each bank may be raised or lowered by means of two anode suspending frames, **1** and **2**, comprising three sets of anode suspending I-beams **3** connected to transverse anode suspending bars **4** (FIG. 2) from which the individual anodes **5** are suspended on adjustable copper lead-in rods **6** which also act as current lead-ins to the anodes. Copper bus bars **7** leading from positive bus bar connectors **8** extend across each row of anodes **5** and conduct current from a preceding cell in the series to the anodes **5** when the cell is in operation.

FIG. 1A illustrates the inlet end of a cell and FIG. 1B illustrates the outlet end. Mercury enters the inlet end through pipe **9** through which the denuded mercury from the decomposer **10** is returned to the cell. In the cell illustrated, the decomposer **10** is at the outlet end of the cell. In the inlet end box **11**, the mercury is spread over the entire width of the cell and flows in a substantially even layer over the cell base **12** (FIG. 2). Feed brine enters the inlet end of the cell through the pipes **13**. Wash water and other connections to and from the inlet end box are not illustrated as they would only complicate the drawings. Mercury-sodium amalgam flows from the outlet end box **11***a*, through conduits **11***b* to the decomposer **10**, from which mercury substantially stripped of sodium is pumped back through the pipe **9** to the inlet end box **11**. Caustic soda and hydrogen are recovered from the decomposer. Depleted brine containing some dissolved chlorine flows from the outlet end of the cell through conduits **13***a*. Chlorine is withdrawn above the brine level through the line **14** and sent to the chlorine recovery system.

All the above is standard construction for mercury cells and is more fully described, for example, in U.S. Pats. No. 2,958,635 and No. 3,042,602.

THE ANODE RAISING AND LOWERING MEANS

In the present invention, the anode banks A and B may be automatically or manually raised and lowered by means of motorized jacks **15** (FIG. 2), mounted in pairs on each side of the cell trough C, and driven by reversing motors **16** through suitable reduction gearing **16***a*. In the embodiment shown, there are two pairs of jacks **15** for each of the anode banks A and B, so that the anodes of a given bank are simultaneously raised or lowered while supported at four points along the cell. The jacks **15** are connected with depending cylinders **15***a*, provided with insulating liners **15***b*. The cylinders **15***a* move up and down on supporting posts **19**. The posts **19** may rest upon the cell side walls **18** or on fixed piers **17** mounted adjacent the cell walls **18**. The jacks are supported on posts **19** which are screwed into sockets **19***d* on piers **17** and adjustable lock nuts **19***a* are provided on posts **19** to facilitate levelling and adjustment of the anode raising means. Insulating fiber packings **19***b* covered by metal thimbles **19***c* are provided at the top of posts **19** and cylinders **15***a* are provided with insulating liners **15***b*, so that the anode raising and lowering means is electrically insulated from the supporting posts **19**. The cylinders **15***a* are connected by an I-beam **20**, welded to the cylinders **15***a* at each end, so that the cylinders **15***a* at each side of the cell will move up and down in unison. The anode I-beam supports **3**, which are connected to the transverse anode suspending bars **4** are welded or otherwise connected to the I-beams **20**.

The motors **16** through the reduction gearing **16***a* drive bevel pinions **21**, mounted at each end of a drive shaft **22**, extending to each side of the cell and provided with flexible couplings **22***a* and **22***b*, at each end of the shaft, and connected to the shaft **22** by pins or bolts **22***c*. The pinions **21** drive bevel gears **23**, which are connected with internally threaded collars **24** which move up and down on threaded posts **25**, one provided with right-hand threads and one with left-hand threads. The threaded posts **25** have an unthreaded portion **25***a*, having a slot **25***b* in which a key **26** extends to prevent turning of the posts **25** while still permitting up and down movement of the threaded collars **24** on the posts **25**. The posts **25** rest upon the top of posts **19**, but are not connected thereto. Bolts **27** connect the depending cylinders **15***a* with the anode raising and lowering means. Flanged covers **28** and **28***a* cover the top of the housings **29** and **29***b* for the gear trains **21–23** and plug closures **28***b* are provided to close oil holes in the covers **28** and **28***a*. One of the posts **25** is provided with an extension **30** which extends through one of the flanged covers **28** or **28***a* and on which a V-shaped limit switch carrier **31** is mounted. The post **30** is stationary and a stud **36** (FIG. 4) carrying stop plates **33** and **33***a* moves up and down with the movement of the flanged cover **28** or **28***a* to which it is connected to actuate the limit switches **32** and **32***a*, connected by flexible wiring **32***b* and **32***c* to the motor **16**, when the anode raising and lowering device has reached the upper or lower limit of travel for which it is adjusted. Adjustable contact members **35** and **35***a* are pushed into contact with the limit switches **32** or **32***a* by the stop plates **33** or **33***a* so as to open contacts mounted in the switches **32** or **32***a*, having connections to motor **16** and thus stop the movement of the anode raising and lowering device when it reaches the upper or lower limit of its travel. The adjustable contact members **35** and **35***a* extend above and below the V-shaped switch carrier **31** as shown in FIGS. 2 and 3. While I have shown and described a specific form of limit switch, any other type of limit switch suitable for the purpose may be used. A flexible cover **34** on the cell trough C, such as described in Pat. No. 2,958,635, permits raising and lowering of the anodes without opening the cell.

When current is supplied to motors **16**, the pinion gears **21** drive the bevel gears **23** to raise or lower the anode frames **2** and the anodes **5** of the affected bank with reference to the flowing mercury cathode in the cell trough C. As described later, wiring circuits are provided to give warning of a reduction in the width of the anode gap and which will activate means to automatically raise the anodes from the cathode in the event of a short circuit between any of the anodes and the cathode, to break the short circuit before any damage can be done to the cell. When the anodes are to be again restored to their operating position, the current through the motors **16** is manually reversed through a reversing switch (not shown) and the anode bank lowered to re-establish the desired anode to cathode surface gap.

WIRING CIRCUITS

FIG. 5 is a diagrammatic illustration of the flow of current in an electrolysis cell under normal and abnormal conditions. The upper diagram of FIG. 5 illustrates, by way of example, the typical voltage distribution between the cathode and the anodes of a mercury cell equipped with fourteen rows of anodes, each row being fed by a bus bar connection in parallel with the others. In general, each bus bar, which terminates at one end of the connectors with any one anode row in the cell, will establish electric continuity at its other end with the steel bottom, and consequently also with the flowing mercury cathode of the preceding cell in the circuit, as the current flows in series through all the cells. Whereas line D in the dia-

gram of FIG. 5 corresponds to the uniform voltage distribution prevailing under ideal operating conditions, line E indicates the local and abrupt voltage decrease that may take place in case of a short circuit being established between the cathode and any one of the anodes connected with a particular bus line. In FIG. 5, line E, the anodes subjected to a short circuit are those connected with the seventh bus line.

The lower diagram in FIG. 5 represents the current distribution among the several bus lines under several circumstances. Whereas the broken horizontal line F represents the ideal distribution, whereby all of the bus lines are passing the same amount of current, curve F' shows a typical distribution under normal operation conditions. On the other hand, if for any reason the anode-to-cathode gap becomes abnormally narrow under any one anode row, such as represented in the diagram for bus line No. 7, the current will sharply rise at this point, as indicated by the curve G, so as to reach a peak whose height gives a measure of the gravity of the emergency situation. At the same time, the magnitude of the current through the other bus lines, indicated by the curve G', will suffer a definite decrease from the normal value, on account of the fact that the rest of the circuit formed by the other cells connected in series will perform as a ballast and thus tend to keep the overall current at a constant value.

FIGS. 6 and 7 cover two particular embodiments of electrical circuitry for the practice of the present invention. Other circuits can obviously be used.

FIG. 6 represents a typical signal alarm and control circuit for a particular embodiment of the present invention, whereby the disturbance in current flow is detected by measuring the ensuing unbalance in voltage between any pair of bus lines.

FIG. 7 illustrates another embodiment of circuitry for practicing this invention, characterized in that each bus line is independently provided with a sensing device that can independently detect any rise in current above a safety limit.

Besides detecting and monitoring any abnormal conditions due to an undue decrease in the interelectrode gap which gives a signal or alarm, both circuits as represented in FIGS. 6 and 7 can automatically actuate an anode lifting device, such as illustrated in FIGS. 2 to 4, whenever the disturbance should reach such an extent that manual intervention, even though solicited by the alarm signal, could not be prompt enough to avert a sudden danger that the equipment might be damaged.

In the example illustrated in FIG. 6, the cell has fourteen rows of anodes, corresponding to as many bus bars **1** to **14** (shown in FIG. 5). Each bus bar is wired to the base of a PNP (positive, negative, positive) transistor **T1**, **T2**, **T3**, etc. to **T14**, so that there are as many such transistors serving one cell as there are bus lines.

In this particular wiring scheme, the emitter of transistor **T1** is connected with the base of transistor **T3**, and the emitter of transistor **T2** is connected with the base of transistor **T4** (not shown), and so on, so that the voltage unbalance between spaced anodes **1** and **3**, **2** and **4**, **3** and **5**, **4** and **6**, etc. is measured by this connection. The collector lines of PNP transistors **T1** to **T14** are provided with monitoring lamps **L1**, **L2** ,**L3**, etc. to **L14**; a common wire U joins these lamps directly to the base of NPN transistor TA as well as through a resistor R with the base of NPN transistor TB. The emitters of transistors TA and TB are connected with the cathode of the electrolysis cell, via a circuit breaker (switch) V, while their collector lines pass through the relay energizing coils AR and LR, respectively, and terminate on the anode bus bar **14**. Coil AR is the actuating element of the relay that switches in the alarm horn circuit H, while coil LR actuates the relay operating circuit M to the motors **16** of the anode lifting device, an embodiment of which is illustrated in FIGS. 2 to 4.

Under normal operating conditions, the current is uniformly distributed among the several anode rows **1** to **14**; accordingly, lines **1** to **14** of FIG. 6 are at approximately equipotential, as illustrated by line F in FIG. 5, so that no appreciable voltage exists between the base of each PNP transistor, **T1** to **T14**, and its emitter; accordingly, no current flows through the collector line U. However, should the gap between the mercury cathode and any one anode become by accident too small, the potential of the relevant anode line will sink underneath the potential of the adjacent lines, as illustrated for anode **7** of FIG. 5; consequently, the emitter base junction of the corresponding transistor would become forward biased and current would flow through the collector line U, thus, making the monitoring lamp **L7** (not shown), or the monitoring lamp of any other affected anode, glow and letting a forward biasing voltage be applied to both transistors TA and TB. The current flowing through coil AR is generally higher than through coil LR, on account of the impedance provided by resistor R in series with the coil LR; accordingly, the alarm circuit will be energized by coil AR for a voltage unbalance that is still too small for coil LR to energize the anode lifting circuit. This will permit the cell attendant to manually energize the circuit to motors **16** to raise the anode bank in which the alarm has been sounded, the necessary distance. However, should the unbalance exceed a certain limit, the anode lift relay LR will be actuated also and current will automatically flow to the motors **16** to raise the bank of anodes in which the short circuit occurs.

In the above described example, the emitter of each PNP transistor **T1** to **T14** is connected with the base of the second next transistor in numerical order. The purpose of this particular arrangement is to get a higher forward bias than would otherwise be obtainable if said interconnection were carried out between two immediately adjacent anode rows and if both rows were to be simultaneously affected by the disturbance involved in a local rise of mercury level. It should be clear, however, that in principle similar transistor interconnections, **T1–T3**, **T2–T4**, etc., could be established also between lines immediately following each other in the sequence, as well as between lines or anodes which are any distance apart, while still following the teachings of the present invention, it being necessary only to measure the difference in voltage between any two anodes or any two spaced points in the mercury cathode. Similar measurements can, for example, be taken between any two points in the mercury cathode.

Whereas the above described wiring scheme provides sufficient accuracy and safety for the case of cells equipped with graphite anodes, the recent inception of dimensionally stable anodes, such as illustrated by anodes **5** in FIG. 2, made of a metallic structure, such as titanium, has rendered the problem concerning accidental short circuits even more delicate, so as to require an even greater sensitivity of the detecting devices and a higher dependability of automatic anode raising means. This problem is also closely connected with another one that is known as the bubble effect, whereby the turbulence consequent to chlorine gas bubble accumulation within the space between anode and cathode tends to disturb the smooth flow of the mercury cathode and thus impairs the current efficiency. The bubble effect becomes in general more appreciable when the anode-to-cathode distance is made narrower; it imposes, therefore, a limitation in the minimum gap width that can be maintained so as to reduce the ohmic losses, such limitation being less stringent when dimensionally stable anodes are used instead of graphite, owing to the much thinner and more favorable foraminous or other open configuration into which the metallic structure of the dimensionally stable anodes can be worked out. Accordingly, although the chlorine bubbles are passed through the foraminous

anode structure and largely discharged from the top of the anodes, the tendency to make accidental contacts with mercury is more frequent when using dimensionally stable anodes, on account of the substantially smaller anode to mercury surface gap which can be maintained with dimensionally stable anodes; moreover, any such short circuit may have in general more severe consequences for a metallic structure than for graphite, on account of the local or complete burnouts which the metallic anode structure is liable to suffer in a relatively short time. Even though not necessarily limited in its scope, the embodiment as schematically shown in FIG. 7 and functioning according to the following description is particularly suited for use with dimensionally stable anodes.

For the sake of simplicity, only two bus bar segments B1 and B14 from the corresponding bus bars of the preceding cell are shown in FIG. 7. It will be understood, however, that the intervening bus bars, 2 to 13, inclusive, are similarly wired. More precisely, these segments are taken on two of the bus bars connecting the cathode of the preceding cell in the circuit with the corresponding anode rows that belong to the cell under consideration, so that the current will flow in the direction as shown in FIG. 7, from the cathode of the preceding cell in the electrolysis circuit to the anodes of the cell whose alarm and protective circuit is represented in the wiring diagram of FIG. 7. The following description will be limited to the circuitry connected with bus bar B1, it being understood that it represents all other bus bars in the system as well.

A point P1 on the bus bar and a downstream point Q1 on the same bus bar located a definite distance apart, are respectively connected with the emitter and the base of PNP transistor T1'. The collector of this transistor is, in turn, directly wired to the base of NPN transistor T1'', and through any one of resistors R1', R1'', R1''', to the emitter of the latter transistor as well as to the cathode of the electrolysis cell, with the interposition of a selector switch V'. Switch V' allows a resistor of suitable impedance to the preselected among resistors R1', R1'', R1''' in dependence on the sensitivity required from the response of the alarm and anode lifting device. The ohmic drop between P1 and Q1 provides a forward biasing voltage to transistor T1', which normally lets but a very weak current leak from the bus bar to the cell cathode, via the transistor's emitter and collector leads, as well as through the resistor shunting the transistor T1''. However, should the ohmic drop between P1 and Q1 exceed the normal value, because of an abnormally high current flowing along the bus bar B1, the biasing voltage of transistor T1', which is provided by the ohmic drop through the shunting resistor, becomes high enough to make this transistor conductive, so as to let a sizeable ohmic build up across resistor R1 on its collector line. Resistor W1 is shunted across the base and the emitter of transistor T1''', so that the forward bias provided by such ohmic drop will let a substantial current flow along the collector line U1 of T1''', and thus make the monitoring lamp L1'' glow and energize the relay AR which will send an alarm signal through the circuit to an alarm.

Just as already described in the circuit of FIG. 6, the resistor R branched on the base circuit of transistor TB, in parallel with TA, controls the current actuating the lift relay LR, which controls the flow of current through the circuit M to the motors 16, which will thus be energized only when the intensity of current flow through bus bar B1 becomes so high as to require instantaneous intervention by the automatic lifting device described in connection with FIGS. 2 to 4.

Similar wiring connections are shown for bus bar B14 which operates in the same was as the circuit just described, but for the sake of simplicity the similar wiring for bus bars B2 to B13 have been omitted from the wiring diagram of FIG. 7.

Each bus bar, B1 to B14, of each electrolysis cell is equipped with an equal set of transistors and resistors as the one described for bus bar B1, with the exception of the circuit formed by resistor R, transistors TA and TB, as well as relays AR and LR, which are combined in a single unit for each anode bank.

The energizing circuit for relays AR and LR, as shown in both diagrams of FIGS. 6 and 7, is powered by the cell voltage itself. It is, however, evident that this circuit can be energized by an independent power source, such as a battery, in which case it will no longer be necessary to establish electric continuity between the negative terminal of the energizing circuit with the cell cathode, or of the positive terminal with the bus bars.

On a panel board adjacent the cell, suitable switches are provided whereby the alarm circuits monitoring the cell may be disconnected from and reconnected to their source of power to stop the alarm, and switches are provided for manually controlling the current to motors 16 whereby they may be driven in forward or reverse direction, under manual control, to raise or lower an anode bank. When not under manual control, the motors 16 are automatically controlled by the circuits of FIG. 6 or 7 as described above. Various other wiring schemes may be used to control the operation of motors 16 in the event of a short circuit developing between any two points on an electrolysis cell.

In the automatic anode spacing adjustment of FIG. 6, a 50 mv. sensitivity corresponds approximately to a .5 mm. change in the anode-to-cathode gap and a change in the width of the anode gap of this order will actuate the alarm circuit and start operation of the elevating motors 16 connected to the affected anode bank. In the more sensitive embodiment of FIG. 7, which measures the current surge through each bus bar line, a 5 mv. sensitivity corresponds approximately to a .5 mm. change in the anode-to-cathode gap.

The wiring schemes and the anode raising mechanism shown and described herein are intended only as illustrative embodiments of the invention from which various changes and departures may be made within the spirit and scope of the invention.

What is claimed is:

1. An apparatus for protecting anodes in a horizontal mercury cell having a cell trough, anode banks and a flowing mercury cathode in the cell trough, means to feed an electrolyte into and out of the cell trough, input means to impress an electrolysis current from the anodes through the electrolyte to the cathode, and means to raise the anodes, said protective apparatus comprising a PNP transistor wired by its base to each input bus bar of the anode banks and by its emitter to the transistor of a non-adjacent anode to measure voltage unbalance between said anodes, the collector lines of said transistors being connected to individual warning systems, all of said warning systems being commonly connected to the base of a first NPN transistor and through a resistor means to the base of a second NPN transistor, the NPN transistors being connected in parallel and their emitters being connected to the mercury cathode and their collector lines being connected to anode bar through energizing means, the energizing means of the first NPN transistor activating an alarm and the energizing means of the second NPN transistor activating means to raise the anodes.

2. The apparatus of claim 1 wherein the anode raising means is comprised of support posts on the sides of the cell, an anode support frame on said support posts and motor means to raise and lower the anode support frame with the attached anodes on said support posts.

3. The electrolysis cell of claim 2, in which said support posts are provided with stationary elevating screws and said motor driven means drives internally threaded collars along said screws to raise and lower said anode support frame.

4. The electrolysis cell of claim 2, in which the cell is provided with a flexible cell cover to permit raising and lowering said anodes.

5. The electrolysis cell of claim 2, in which the anode support frame is electrically insulated from said support posts.

6. The electrolysis cell of claim 2, in which limit switches are provided to control the anode raising and lowering limits of travel of said motor driven means.

7. An apparatus for protecting anodes in a horizontal mercury cell having a cell trough, anode banks and a flowing mercury cathode in the cell trough, means to feed an electrolyte into and out of the cell trough, input means to impress an electrolysis current from the anodes through the electrolyte to the cathode, and means to raise the anodes, said protective apparatus comprising a PNP transistor for each anode bank connected to the input bus bar at two spaced points by its emitter and base and the collector of the said transistor connected to the base of a NPN transistor and through one of a series of resistors and a switch to the emitter thereof and the cell cathode. the collector of the NPN transistor being connected to a third transistor provided with a resistor shunted across its base and emitter and whose collector is connected to an alarm means, all the individual anode alarm means being connected to a pair of parallel connected transistors, the first transistor energizing an alarm means and the second transistor connected through a resistor activating the anode raising means.

8. The apparatus of claim 7 wherein the anode raising means is comprised of support posts on the sides of the cell, an anode support frame on said support posts and motor means to raise and lower the anode support frame with the attached anodes on said support posts.

9. The electrolysis cell of claim 8, in which said support posts are provided with stationary elevating screws and said motor driven means drives internally threaded collars along said screws to raise and lower said anode support frame.

10. The electrolysis cell of claim 8, in which the cell is provided with a flexible cell cover to permit raising and lowering said anodes.

11. The electrolysis cell of claim 8, in which the anode support frame is electrically insulated from said support posts.

12. The electrolysis cell of claim 8, in which limit switches are provided to control the anode raising and lower limits of travel of said motor driven means.

13. A method of preventing damage due to short circuits between the anodes and cathode of a flowing mercury electrolysis cell which comprises monitoring the electrical current flow through each anode bank by a transistor circuit connected to an alarm transistor to record current unbalances between spaced anode banks independent of the cell voltage between the anodes and cathodes and raising the anode bank when the voltage monitored exceeds a predetermined limit whereby the gap between the anode and cathode is increased to break short circuits.

14. The method of claim 13 wherein the current intensity is monitored between spaced points on the anode.

15. The method of claim 13, wherein the anodes are raised automatically when a predetermined voltage limit is exceeded.

References Cited

UNITED STATES PATENTS

3,574,073	4/1971	Ralston, Jr.	204—225
3,594,300	7/1971	Schafer	204—225
3,390,070	6/1968	Cooper et al.	204—225 X
3,450,621	6/1969	Anderson	204—219
3,531,392	9/1970	Schmeiser	204—225
3,476,660	11/1969	Selwa	204—219 X

FOREIGN PATENTS

1,804,259	5/1970	Germany	204—99

JOHN H. MACK, Primary Examiner

D. R. VALENTINE, Assistant Examiner

U.S. Cl. X.R.

204—225, 228, 250