Nov. 1, 1960 J. L. REYNOLDS 2,958,641

ANODE FOR ALUMINA REDUCTION CELLS

Filed May 20, 1958 4 Sheets-Sheet 1

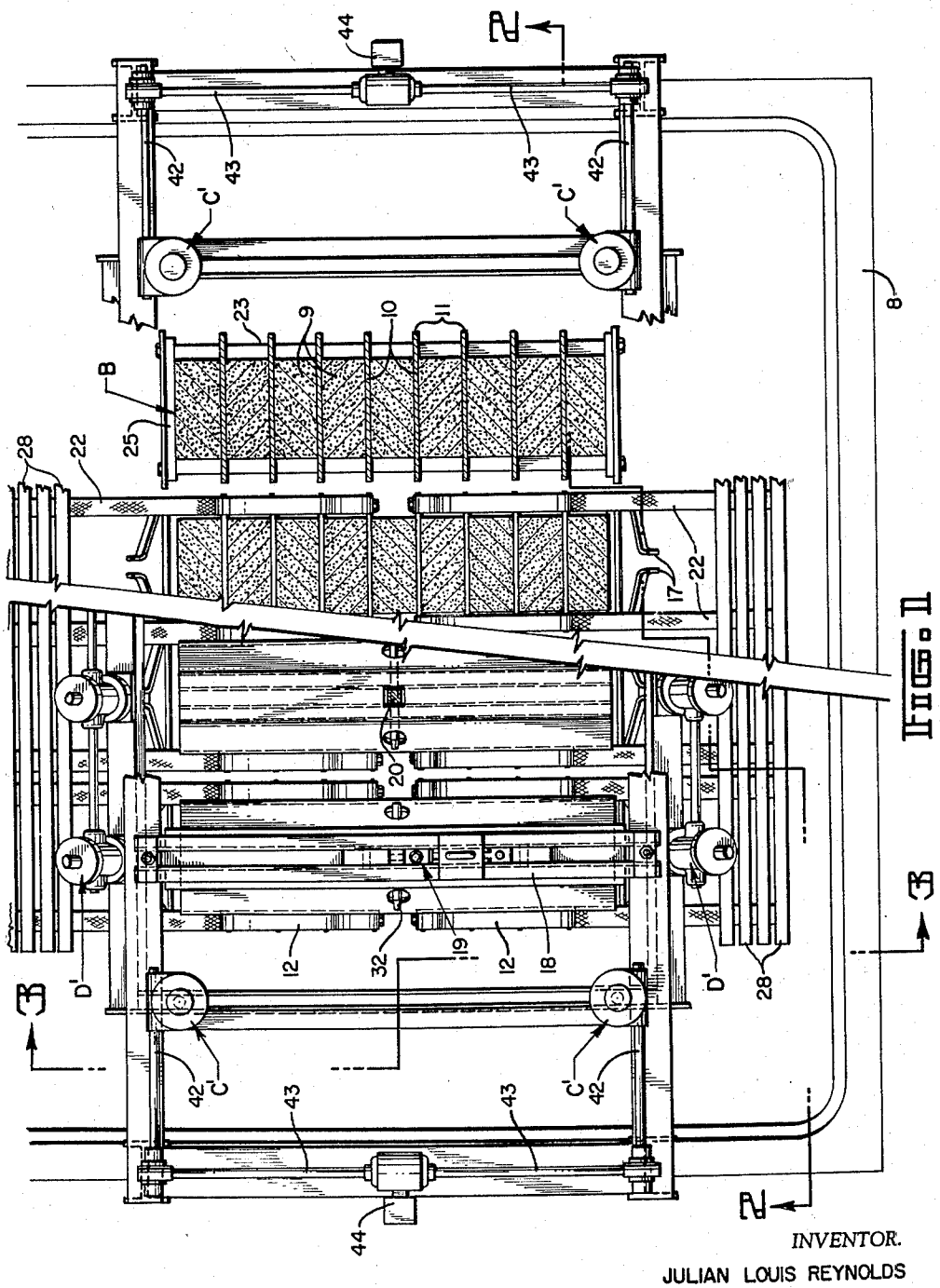


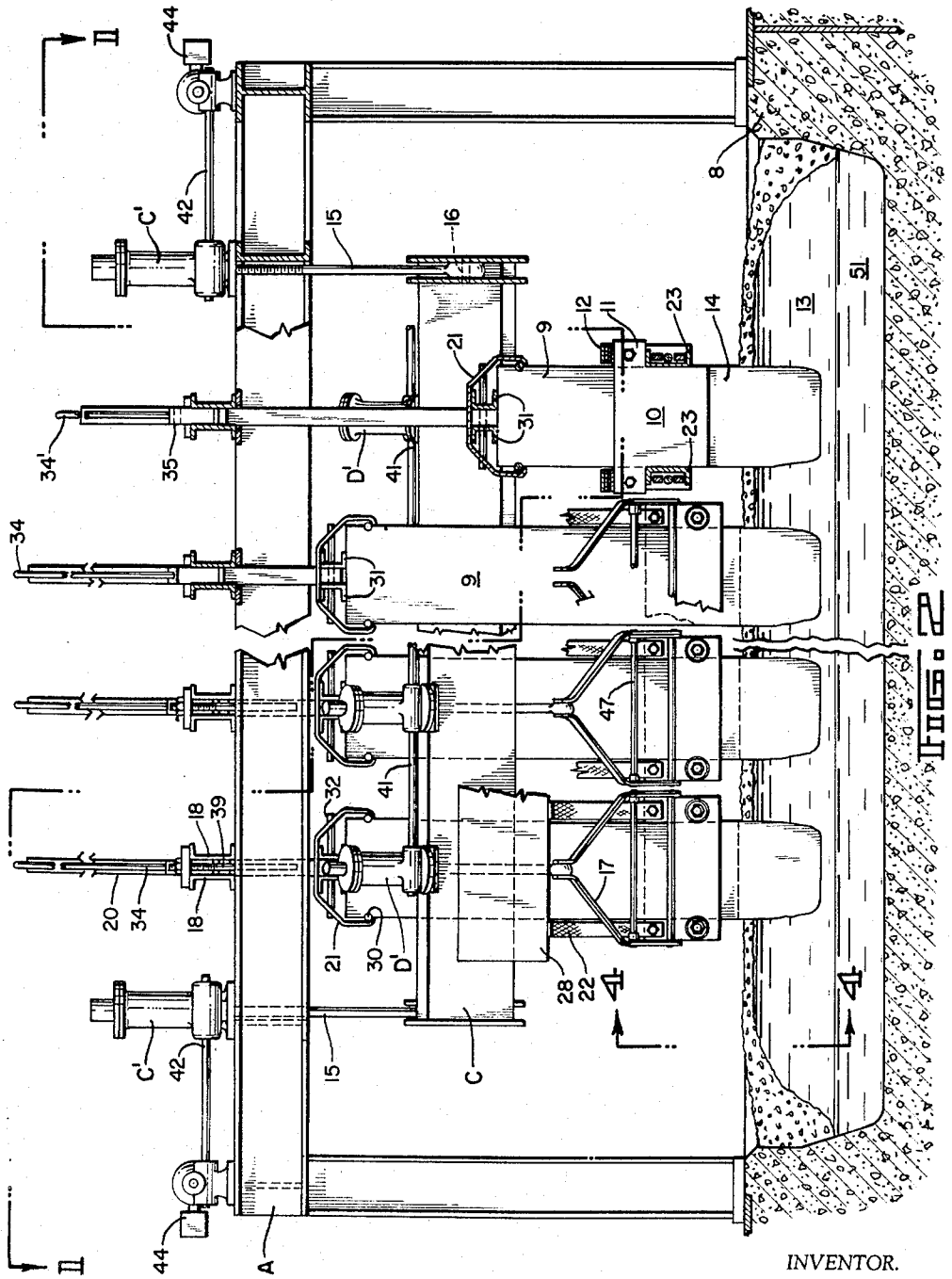

FIG. 1

INVENTOR.
JULIAN LOUIS REYNOLDS
BY
Pollard, Johnston, Longfellow & Robertson
ATTORNEYS.

Nov. 1, 1960 J. L. REYNOLDS 2,958,641

ANODE FOR ALUMINA REDUCTION CELLS

Filed May 20, 1958 4 Sheets-Sheet 2




INVENTOR.

JULIAN LOUIS REYNOLDS

BY

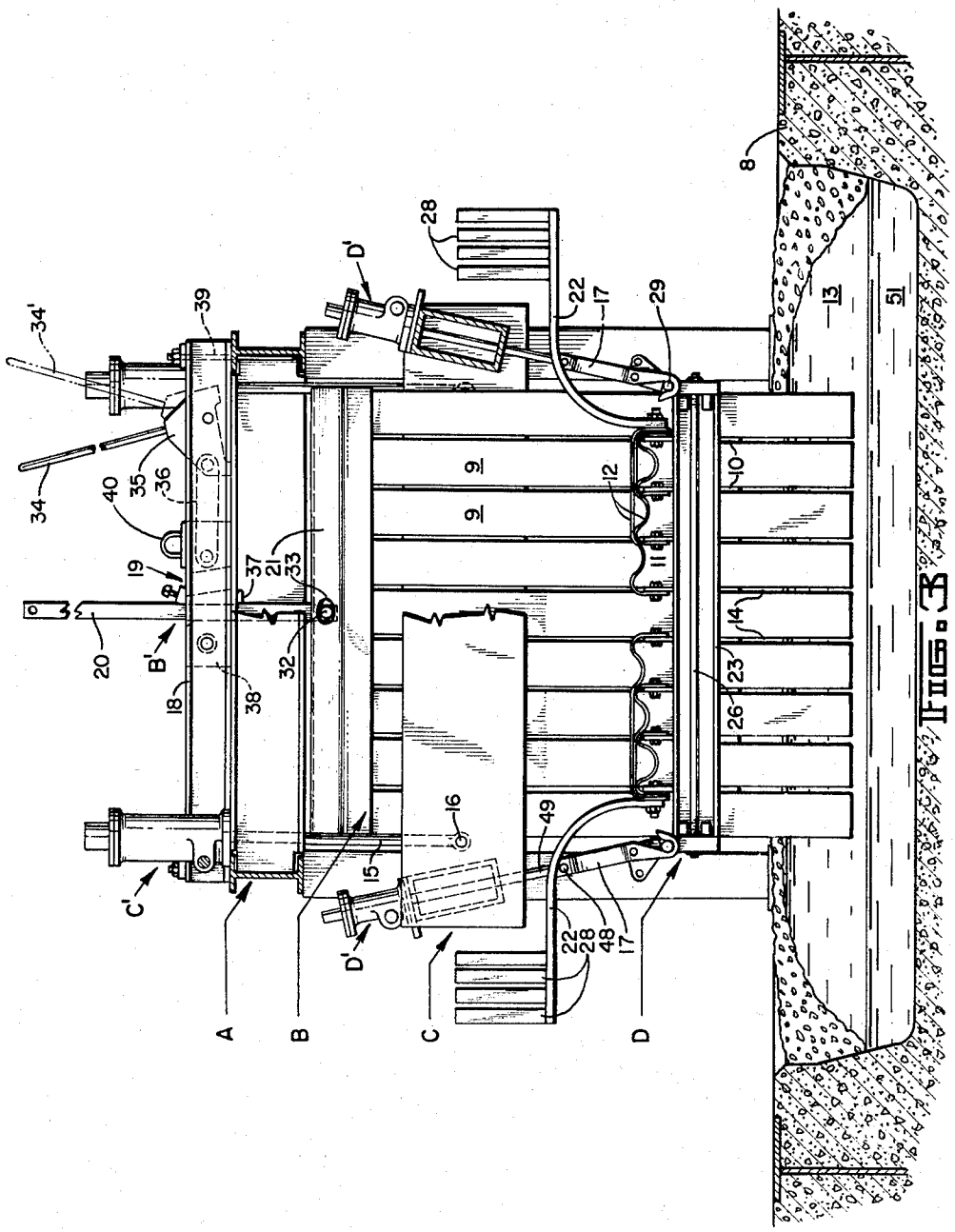
Pollard, Johnston, Smythe & Robertson

ATTORNEYS.

Nov. 1, 1960 J. L. REYNOLDS 2,958,641

ANODE FOR ALUMINA REDUCTION CELLS

Filed May 20, 1958 4 Sheets-Sheet 3




INVENTOR.
JULIAN LOUIS REYNOLDS
BY
Pollard, Johnston, Smythe & Robertson
ATTORNEYS.

Nov. 1, 1960 J. L. REYNOLDS 2,958,641

ANODE FOR ALUMINA REDUCTION CELLS

Filed May 20, 1958 4 Sheets-Sheet 4

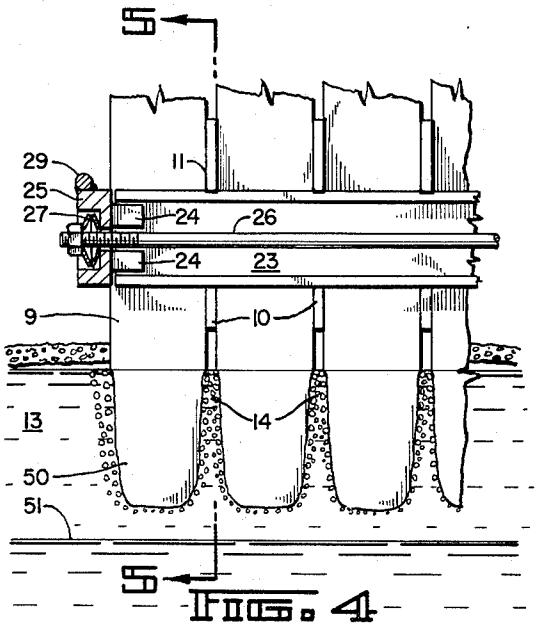



FIG. 4

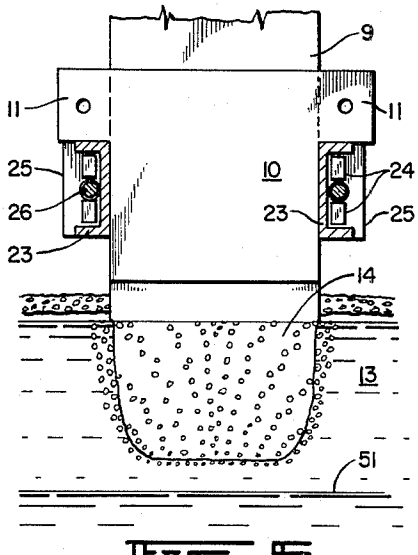



FIG. 5

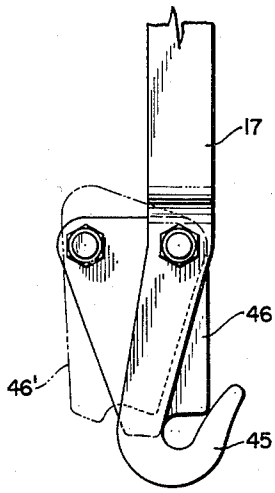



FIG. 6

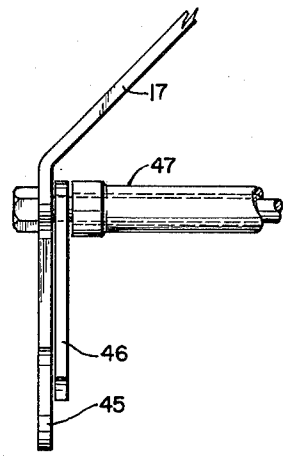



FIG. 7

INVENTOR.
JULIAN LOUIS REYNOLDS
BY
Pollard, Johnston, Smythe & Robertson
ATTORNEYS.

United States Patent Office

2,958,641

Patented Nov. 1, 1960



2,958,641

# ANODE FOR ALUMINA REDUCTION CELLS

Julian Louis Reynolds, Richmond, Va., assignor to Reynolds Metals Company, Richmond, Va., a corporation of Delaware

Filed May 20, 1958, Ser. No. 736,606

9 Claims. (Cl. 204—286)

The invention relates to anodes for electrolytic cells used in the production of aluminum.

## SUMMARY

According to my invention, an anode comprising a pack, or "bundle," of prebaked carbon slabs is arranged in the electrolytic cell with the lower ends of the slabs extending downwardly into the molten electrolyte, the opposed surfaces of the slabs in the bundle being spaced apart slightly over at least a substantial area of their lower portions to provide deep preformed channels extending upwardly from the bottom of the anode. These channels extend from side to side of the anode and are closed at the top to avoid a "chimney" effect. Gas bubbles produced at the lower active surfaces of the anode flow upwardly through the channels to be released at the sides of the anode at points removed from the electrolyzing area and thus relieve the active surfaces from the shrouding effect of the gas. As a result of this channeled construction, I have found that it is possible to accomplish a quieter and more uniform gas release than would otherwise be attained. Also, because the gas bubbles have a short path to traverse, there is less tendency to disturb the electrolyte bath and less chance for undesired contact between the gas and the metal produced.

The carbon slabs are interleaved with electrical contact plates which may be made of steel. These plates extend from side to side of the anode and are preferably located just a little above the surface of the bath so that their lower edges form the top of the channels described in the preceding paragraph. The contact plates are vertically adjustable relative to the slabs so that the anode can be lowered as it burns away while maintaining the depth of the preformed channels within predetermined limits and keeping the electrical contacts to the slabs close to the molten electrolyte at all times. This makes it possible to use preformed carbon slabs which are much longer than has heretofore been considered practicable, and by keeping the electrical contacts to the slabs close to the molten electrolyte the increased anode life resulting from use of the longer slabs is achieved without suffering excessive voltage loss in the anode and also without suffering excessive loss of anode material by atmospheric burning above the crust line.

My invention further comprises means for supporting the electrical contact plates and means for clamping the bundle of carbon slabs and interleaved contact plates so that the means for supporting the plates also supports the carbon slabs, and means are provided for lifting the plates upwardly relative to the carbon slabs when the clamping means is released. Also, means are provided to support the carbon slabs independently of the first supporting means so that the position of the slab is maintained against undesired vertical movement when the clamping means is released and during operation of the lifting means.

By virtue of the quieter and more uniform gas release, the arrangement for keeping the electrical contacts to the carbon slabs close to the surface of the molten electrolyte, and the particular clamping and adjusting means which facilitate adjustment and replacement of the anodes, a number of significant advantages accrue. Higher current densities can be used with resultant increase in aluminum production for a given size of cell, anode life is increased over that of conventional prebaked anodes with consequent reduction of labor needed to "change out" the electrodes in potroom operation. Other features of my construction which will be described contribute to these advantages and also yield other desirable results as will now be described in more detail.



## DESCRIPTION

For a complete understanding of the invention, it will be helpful to consider its relationship to the two common types of anodes which are in general use today. These are the prebaked anodes used in what is known as the Niagara cell, or pot, and the self-baking continuous anodes used in the Soderberg pot. Each of these principal commercial anode types has a number of recognized limitations and disadvantages well understood by those in the business of making aluminum. In the Niagara cell, according to the practice of the assignee of the present invention, the prebaked anode blocks are approximately 15½ inches by 20 inches in the horizontal cross section, approximately 13 inches high and weigh around 200 pounds each. At the time of their forming in a hydraulic press they are provided with a fluted hole in the top. Into this hole is placed a 3¾ inch round mild steel stub which is flattened on one end and drilled to receive a bolt. The stub is given mechanical and electrical connection to the block by pouring cast iron in the annular space between the stub and the hole. Copper rods approximately 2½ by ¾ inches are then bolted to the top of the stub at the flat surface. The entire assembly consisting of block, casting, stub, bolt and rod is known as the anode assembly. The anode assemblies are suspended from a movable frame which is part of the superstructure of the cell and are clamped to the anode bus which is a part of this movable frame. Individual adjustment of each anode with respect to the others is possible by loosening the clamp to the anode frame and adjusting the rod position relative to the frame with a hand jack. Adjustment of the carbons in unison is accomplished by raising or lowering the frame which supports all carbons.

An alternate arrangement currently found in practice is the "cluster" prebake pot in which the stubs of two anodes of the size mentioned above are clamped through a suitable arrangement to a single rod which in turn is clamped to the moving frame. Another alternate arrangement is the two-hole prebaked block which has a horizontal cross section approximately twice the size of the anode mentioned above, and which has two holes in which the stubs are secured by casting. The two stubs are then connected by suitable assemblies to a single rod which in turn is clamped to the moving frame.

These variations on the prebaked block were made primarily to overcome two difficulties. The first is the labor required to change out the single blocks. In practice a single block lasts approximately seven days and there are twenty-four of them operating in parallel. This means that slightly more than one block per shift must be taken out of each pot and replaced with a new assembly. This is very hard and hot labor, being probably the most difficult job remaining in potroom operation. The cluster pot overcomes this difficulty to some extent by allowing two blocks to be set with approximately the same amount of labor formerly required to set one block.

The second difficulty with the single block arrangement is that one runs into physical limitations as to the

size of pot than can be operated by present methods. These pots are normally oriented side by side with an aisle down the center between the carbons of each pot. This aisle is worked from the end of the pot by a potman using a poker. To double the capacity of a pot using single individually suspended carbons of the size now used one would have to make the pot twice as long which would be very difficult to operate and generally impractical. Furthermore it is not convenient from a carbon-setting standpoint to set single carbons which are on individual rods, two abreast on either side of the center aisle to keep the pot short. The cluster pot allows two carbons to be set abreast from a single suspension, keeping the pot short while allowing far greater area of anode per unit set in the pot. These are steps which have been made in the past in pursuit of higher capacity per pot while at the same time accomplishing reductions in labor per pound of metal produced. My invention offers a substantial advancement over even the cluster pot in this respect since it provides in a pot shell of reasonable size the added anode area required for high capacity and at the same time provides for long life anodes with consequently fewer changes of anodes.

Another disadvantage of the individual or cluster prebaked anodes is that they cannot be made much higher than 13 inches because if they were the voltage loss through new carbons would be excessive and unless they were protected by some coating they would air burn so badly above the crust line that the carbon would drop off the stub before the carbon had run its useful life. Attempts have been made at protecting carbons so that they would not air burn above the crust line; in particular, aluminum castings have been made around the top of the block. Certain inorganic chemicals have also been proposed as additives to the mix or coatings to give this protection. None of these protective means are in wide application, due undoubtedly to the added cost of providing them, so at the present time there has not been satisfactory progress toward making the individually suspended prebaked blocks long enough to substantially reduce the labor in changing. It is an object of this invention to overcome this difficulty by providing a segment of a total anode which can last in the pot between thirty and sixty days in contrast to the present life of seven days, and to accomplish this without excessive voltage loss in the longer anode and without excessive loss of anode material by atmospheric burning above the crust line.

The prebaked block assembly as described involves a physical and electrical connection obtained by pouring cast iron into the annular space between the supporting steel stub and the hole in the carbon block. This junction has the following disadvantages: (*a*) It involves the handling of molten cast iron under circumstances not easily controlled for the casting of iron. (*b*) It requires the cast iron to be broken away from the stub after the anode is used, which is a process requiring heavy equipment and considerable labor. (*c*) It involves cleaning and remelting the iron castings. (*d*) The contact pressure of the iron against the carbon is unknown, uncontrolled, and dependent on skill in the selection of the iron melt composition and pouring temperatures. In actual practice many factors enter into this, not the least of which is the character of the make-up of iron scrap which is not always easily controlled or even known. The junction of the copper anode rod to the steel stub is at a most unfortunate location since the temperatures frequently are hot enough to allow deformation of the copper by creep. This junction deteriorates rapidly and must actually be broken and recleaned each time a new anode block is prepared for use. This involves considerable labor. It is another object of this invention to eliminate many of the operations found necessary in connection with the present method of forming junctions to carbon, obtain controlled steel-to-carbon contact conditions, permit the elimination of the bolted connection in a practical manner and make the copper-to-steel connection where temperature conditions are more favorable.



Another disadvantage of the prebake junction from cast iron to carbon is that under the high temperatures encountered, the iron tends to migrate into the carbon and the sulfur tends to migrate to the stub, thereby forming a sulfide which causes a high resistance at the junction. With my invention this action is decreased by providing greater contact area and controlled pressures between the steel and the carbon and by distributing the junction over the carbon in such a manner that the current is not as highly concentrated in the carbon as it approaches the junction.

Another disadvantage of the prebake contact as now made is that when the carbon is partially consumed the assembly is removed from the pot and the remaining carbon left around the stub must be broken off with sledge hammers so that the remaining carbon may be returned to the carbon plant for reprocessing and the casting-stub-rod assembly may be returned to the rodding room for disassembling, clean-up, and re-use with new anodes. In the process of breaking the remaining carbon away from the stub with sledge hammers, many small pieces of iron are entrained with the carbon material and it requires additional equipment in the carbon plant to remove this iron. It frequently occurs that in spite of the best operating practices the iron content of new carbons builds up with consequent loss in quality of the aluminum produced. This iron build-up in the carbon is due, at least in part, to the entrainment of small pieces of the castings in the carbon material returned to the carbon plant. It is an object of this invention to overcome this difficulty by eliminating the need for castings while at the same time making it feasible to operate at a lower anode voltage loss than is experienced with prebaked blocks of the type now used.

The Soderberg pot has disadvanges which seriously limit capacity. The Soderberg anode is a large mass of carbon with relatively little periphery for heat dissipation compared to the volume of the mass and consequently, for the heat to be dissipated from the working surface of the anode, high temperatures are generated at the center of the pot. Current efficiency is known to be strongly influenced by temperature. It is a further object of this invention to dissipate the heat from the working surface of the anode more efficiently than can be done with the Soderberg anode so that higher current densities can be used.

For a given capacity of cell constructed according to my invention, the periphery of the carbon at the bath line is at least five times the periphery of a conventional Soderberg anode. With the Soderberg pot, the gas bubbles formed at the working surface have a great distance to travel before getting to the periphery for release; consequently large bubbles are formed and discharged over a relatively small periphery which results in heavy and erratic agitation of the bath. It is an important object of this invention to provide means for accomplishing a quieter and more uniform release of gas over a short path so that the disturbance of the bath is less and undesired contact between anode gas and metal produced is less.

A further disadvantage of the Soderberg pot is that, in the larger sizes, current must travel a considerable distance in the anode pin before making contact with the external bus system. This causes a high voltage drop in the anode, particularly at the current required to achieve the high capacity which is one of the objectives of the present invention. This difficulty in the present Soderberg pots cannot be entirely eliminated by introducing more pins to the anode because considerations of carbon strength prohibit increase in steel in proportion to the increase in current. It is an object of my invention to permit higher currents through the carbon without undesirable increase in anode voltage losses.

A further disadvantage of the Soderberg pot is that

two processing operations occur in the same piece of process equipment, namely the manufacture of aluminum and the baking of carbon. These two processes do not always, and in fact frequently do not, complement one another so that one process is usually being operated to the detriment of the other, with the net result that the total process is seldom at its maximum efficiency. According to my invention, prebaked electrodes can be used efficiently at high capacity in cell forms which permit use of the labor-saving devices developed for the Soderberg pot without suffering the disadvantage of the dual process operation of the Soderberg pot.

A further disadvantage of the Soderberg anode is that it is a single anode and not adjustable, to a practical degree, from one point on the anode to the next. This means that the operation is sensitive, and if one part of the anode must be raised to avoid grounding to the aluminum metal pad, the entire anode must be raised with consequent increase in over-all cell voltage and lower production efficiencies, merely for the sake of meeting a localized condition. It is an object of this invention to permit the use of multiple long life anodes combining the principal advantages of the Soderberg anode with certain advantages of the conventional prebake pot including provision for adjustment.

With reference to the drawings, I shall now describe the best mode contemplated by me for carrying out my invention.

Fig. 1 is a plan view, partly broken away in horizontal section as shown at **1—1** in Fig. 2, illustrating an electrolytic cell equipped with anodes constructed in accordance with the invention.

Fig. 2 is a vertical sectional view of the same, taken on line **2—2** of Fig. 1. [In Figs. 1 and 2, a central portion has been omitted to permit showing the remainder to a larger scale.]

Fig. 3 is an end elevational view of the anode structure, the cell and a portion of the superstructure in vertical transverse section. See **3—3** in Fig. 1.

Fig. 4 is a detail view taken as shown at **4—4** in Fig. 2.

Fig. 5 is a detail view taken as shown at **5—5** in Fig. 4.

Figs. 6 and 7 are detail views of the latch for an anode jack.

*The bundle anode*

The invention comprises, as to its general arrangement in an electrolytic cell **8** for the production of aluminum from alumina dissolved in florides, anode bundles B (Fig. 3) each comprising a pack of prebaked carbon slabs **9** interleaved above their lower ends with metal plates **10** extending from side to side of the anode and having tabs **11** to provide for attachment of electrical conductor straps **12** and to support the plates on the anode clamping assembly. The carbon slabs are arranged with their lower ends extending downwardly into the molten electrolyte solution **13** in the cell, the opposed surfaces of the slabs as separated by the electrical contact plates being spaced apart slightly over at least a substantial area of their lower portions to provide deep preformed channels **14** extending upwardly from the bottom of the anode between the slabs. These channels extend from side to side of the anode and are closed at the top by the lower edges of the plates **10** whereby gas produced at the lower active surfaces of the anode can flow upwardly through the channels to be released at the sides of the anode at points removed from the electrolyzing area and thus relieve the active surfaces from the shrouding effect of the gas. This produces a relatively quiet and uniform release of the gases, and, because the gas bubbles have a short path to traverse, there is little tendency to disturb the electrolyte bath and not too much chance for undesired contact between the anode gas and the metal produced.

*Anode adjustment and change out mechanism*

Before proceeding to a more detailed description of the anode construction, reference is made to Fig. 3 for a comprehensive understanding of the general arrangement of the anodes in relation to the clamping, supporting and adjusting devices, including the means for feeding the long anode slabs downwardly relative to the electrical contact plates. Within the superstructure of the cell, indicated generally at A, the anode bundles B are supported in the following manner: a vertically movable frame C is supported directly from the superstructure by rods **15** secured as at points **16** to the four corners of the frame. Suitable means, such as the jacks C', are provided for raising and lowering the frame C as desired. Each anode bundle made up of the carbon slabs **9** and electrical contact plates **10**, held together under predetermined pressure by a clamping assembly indicated generally at D, is in turn supported by the movable anode frame C, as by means of hangers **17** latched to the ends of the clamping assembly D. Suitable means such as the jacks D', mounted on frame C, serve to raise and lower the respective bundles relative to frame C, either individually or together as desired. Another means for supporting the carbon slabs **9** of each bundle independently of the means just described, is provided at B'. In my preferred construction this means comprises a removable bridge **18** carried by the superstructure on which is arranged a clamping mechanism **19** which engages a supporting rod **20** attached to the anode cap assembly **21** in which the upper ends of the slabs **9** are secured.

The slabs **9** of a new anode preferably are so adjusted in relation to the steel interleaved plates **10** that, when first installed with the active tips of the anode positioned within the desired distance (say 1½ to 2 inches) above the metal pad **51**, the lower edges of the plates, i.e. the upper edges of the channels **14**, will be between about 6 and 8 inches above the bath of molten electrolyte. As the active tips of the anodes burn away, the anodes are lowered by the jacks C' or D', or both, as desired. Jacks C' lower the frame C and with it all of the anode bundles B, it being understood that the supporting means B' of the several bundles are unclamped during operation of the jacks for the purpose stated. Jacks D' of the several anode bundles can be operated together or individually, it being understood that under conditions where one of the anode bundles has burned away more rapidly than another, such bundle can be lowered independently in order that the carbon tips of the several anode bundles be maintained at the same level or within the same distance from the cathode. Similarly, if one end of a bundle should burn away more rapidly than the other, it is possible to lower the one end more than the other in order to achieve a more uniform spacing from the cathode over the length of the bundle.

After a given anode bundle has been lowered to compensate for burning to the extent that the lower ends of the steel plates **10** come within, say, about two inches of the bath level, adjustment of the steel plates can be accomplished as follows (I shall refer now to adjustment of the plates of a single bundle):

(*a*) Clamping means **19** is actuated to grip bundle supporting rod **20** fixed in reference to bridge **18** and superstructure A, thus holding slabs **9** fixed in relation to the superstructure.

(*b*) Clamping assembly D is loosened to relieve the pressure compressing the slabs **9** against the plates **10**.

(*c*) Jacks D' are operated to raise clamping assembly D and with it the plates **10**.

(*d*) After the plates **10** have reached the desired elevation, clamping assembly D is tightened to press the slabs **9** against the plates **10** to provide support of the entire anode bundle assembly through the hangers **17**, to anode frame C, and thence through the supporting rods **15** to the superstructure A.

(*e*) Clamping means **19** is released so that the anode can move up or down as the movable frame C is raised or lowered.

Change out of an anode bundle is accomplished as follows:

(*a*) With the clamping means **19** released, bridge **18** is lifted off the superstructure, it being understood that such means as may be used to secure the bridge to the superstructure will also have been removed or released.

(*b*) Flexibles **22** are disconnected from the anode assembly.

(*c*) Potroom crane is secured to bundle supporting rod **20** through a suitable lifting device.

(*d*) Hangers **17** are unlatched from the bundle.

(*e*) The bundle is then lifted out of the pot.

(*f*) The new bundle is lowered in place, and hangers **17** latched to it.

(*g*) Flexible **22** are connected.

(*h*) Tension on the clamping assembly D is checked and adjusted.

(*i*) Current measurements are made at the flexibles to determine the loading on the anode.

(*j*) The anode is adjusted by means of the jacks D' to bring the tips to the desired distance from the cathode.

From the foregoing general description, it will be understood that I have provided an anode comprising a pack of prebaked carbon slabs **9** interleaved above their lower ends with steel plates **10**, the bundle of slabs and plates being secured by a clamping assembly D providing means for vertical adjustment of the plates **10** relative to the slabs **9** so that the slabs can be lowered to compensate for burning on their lower ends. Otherwise defined, we have means D for supporting the metal plates and clamping the pack of slabs and plates whereby the means for supporting the plates also supports the slabs, the clamping means being releasable, and means D' for lifting the plates upwardly relative to the slabs **9** when the clamping means D is released. Additionally, the means B' supports the slabs independently of the clamping assembly D whereby the position of the slabs is maintained against undesired vertical movement when the clamping means D is released and during operation of the lifting means D'. Through these means, the electrical contact plates **10** are vertically adjustable relative to the slabs, whereby the anode can be lowered as it burns away while maintaining the depth of the channels **14** within predetermined limits, while also keeping the electrical contacts to the slabs quite close to the molten electrolyte at all times. This construction makes it possible to use long slabs, giving greatly increased life to the anode and decreasing the frequency of needed change outs while also reducing voltage drop in the anode to a minimum.

Considering the assembly which includes the movable frame C, my construction may also be defined as comprising a pack of prebaked slabs interleaved above their lower ends with electrical contact plates, a clamping assembly D for the anode pack, this clamping assembly supporting the plates independently of the slabs when the clamping pressure is released, a vertically movable frame C, means **17** for suporting the clamping assembly D from the movable frame C, means B' for supporting the slabs **9** independently of the supporting means **17** when the clamping pressure is released, means D' for raising and lowering the clamping assembly relative to the movable frame C, and means C' for raising and lowering the movable frame C, by virtue of all of which the slabs and contact plates can be raised and lowered as a unit when clamping pressure is applied, and the contact plates can be raised independently of the slabs when the slabs are held by their independent supporting means B' and the clamping pressure is released.

*The anode clamping and operating assemblies*

The tabs **11** of the steel plates **10** overhang and engage channel members **23** extending along the sides of the anode. Members **23** are engaged and supported by lugs **24** projecting inwardly from end plates **25** (Figs. 4 and 5). Connecting tension rods **26** extend through openings in the end plates, and nuts threaded on either end of these rods, acting in conjunction with calibrated tensioning washers **27**, provide means for securing predetermined contact pressure between the carbon slabs and the electrical contact plates of the anode bundle. Current is taken from the bus bars **28** via the flexible connections **22** and conductor straps **12** to the plates **10**, thence to the contacting portions of the carbon slabs. The entire anode assembly is supported by the end plates **25** through hanger rods **29** fixed to the end plates. Hanger rods **29** are in turn supported by jack hangers **17** which are in turn supported by the individual anode jacks D'. Hangers **17** are suitably latched to the anode clamping assembly D as by means of the hook **45** and latch **46** with operating handle **47**, a detail of which is shown in Figs. 6 and 7. The retracted position of the latch is shown at **46'**. By lifting the handle **47**, the hooks **45** may be dropped free of the hanger rods **29** so as to hang vertically down below the pivot **48** by which the hanger is connected to the movable part **49** of the jack D'.

At times when the anode is not supported by the individual jack assemblies D', it is supported by the anode cap assembly **21** which preferably comprises rods **30** (Fig. 2) engaging grooves in the upper edges of the several slabs **9** and engaged by flanges at the lower edges of the cap **21**. Cap **21** is supported by strongback **31** comprising a pair of channel members coupled to anode supporting rod **20** as by means of a pin **32** extending through the strongback and lower end of rod **20**. Openings **33** are provided in cap **21** for convenient insertion of the connecting pin **32**.

An alternate clamping assembly is provided at B', consisting of the clamp **19** mounted in association with the bridge member **18**. In the construction shown, the bridge member consists of a pair of channels arranged back to back in spaced relation, and the clamp with its actuating mechanism is mounted between the channels. This clamp may, for example, comprise a toggle mechanism of a usual construction operated by handle **34**, comprising, for example, a bell-crank lever **35** and toggle link **36** for advancing and retracting the clamping member **37**, which in its clamping position grips the anode supporting rod **20** between member **37** and block **38** fixed to the bridge **18**. Bridge **18** may be bolted as at **39** to the superstructure A. For the purpose of lifting the bridge with its clamping mechanism out of the way when removing and replacing anodes, a lifting eye **40** is provided. The jacks D' are conveniently driven through a common shaft **41** connected to a suitable source of power (not shown). The jacks may incorporate individual clutches so as to permit selective operation of one or more of the jacks independently of the others or to permit all of them to be operated together according to need. Conventional clutches well known in the art may be used for this purpose and form no part of the present invention.

Suitable means also are provided for operation of the jacks C' used to raise and lower the movable frame C, such as the drive shafts **42**, **43** which may be geared together as shown in Fig. 1, for operation from a common power source at **44**.

At the right-hand end of Fig. 2, I have illustrated one of the steps in adjusting the plates **10** relative to the carbon slabs **9**, namely step (*c*), page 15, previously described, wherein after the anode slabs **9** have been clamped in fixed position by means of the bridge clamp **19** as indicated by the **34'** position of operating handle **34**, and the clamping assembly D has been loosened, the anode jacks D' are operated to elevate the plates. Here the plates are shown in such an elevated position, after which the clamping assembly D will again be tightened and bridge clamp **19** released by moving its operating handle to its original position **34**. It is assumed that the other anode bundles shown in Fig. 2 have been in use and that they have been lowered close to the point where it will be time to raise the plates **10** relative to

the carbon slabs 9. In Fig. 3 on the other hand, it has been assumed that the anode bundle shown is new and has just been placed in operation with the lower edges of the plates 10 located at some six to eight inches above the level of the bath.

During the operation of the cell, the tips of the electrode slabs take rather long tapers as can be seen at 50 in Fig. 4. This is in contradistinction to the Soderberg process wehre the edges merely round off. The long tapers demonstrate that current is leaving the sides of the anode slabs as well as their tips.

The terms and expressions which I have employed are used in a descriptive and not a limiting sense, and I have no intention of excluding such equivalents of the invention described as fall within the scope of the claims.

I claim:

1. An anode for electrolytic cells for the production of aluminum, comprising a pack of prebaked slabs interleaved near their lower ends with electrical contact plates, a clamping assembly for the anode pack, said clamping assembly supporting said plates independently of the slabs when the clamping pressure is released, a vertically movable frame, means for supporting the clamping assembly from said movable frame, means for supporting the slabs independently of the first-named supporting means when the clamping pressure is released, means for raising and lowering the clamping assembly relative to the movable frame, and means for raising and lowering the movable frame, by virtue of all of which the slabs and contact plates can be raised and lowered as a unit when clamping pressure is applied and the contact plates can be raised independently of the slabs when the slabs are held by their independent supporting means and the clamping pressure is released.

2. An anode for electrolytic cells for the production of aluminum, comprising a pack of prebaked slabs interleaved near their lower ends with electrical contact plates, a clamping assembly for the anode pack, said clamping assembly supporting said plates independently of the slabs when the clamping pressure is released, a vertically movable frame, means for supporting the clamping assembly from said movable frame, means for supporting the slabs independently of the first-named supporting means when the clamping pressure is released, means for raising and lowering the clamping assembly relative to the movable frame, and means for raising and lowering the movable frame, by virtue of all of which the slabs and contact plates can be raised and lowered as a unit when clamping pressure is applied and the contact plates can be raised independently of the slabs when the slabs are held by their independent supporting means and the clamping pressure is released, other anode packs each with its own clamping assembly and supporting means as described, the vertically movable frame being common to all of the packs whereby the several anode packs can be raised and lowered independently or all together, and any of the anode packs can be adjusted, or removed and replaced, without interfering with the operation of the others and while the electrolytic cell is in operation.

3. An anode for electrolytic cells for the production of aluminum, comprising a pack of prebaked slabs interleaved near their lower ends with electrical contact plates, a clamping assembly for the anode pack, said clamping assembly supporting said plates independently of the slabs when the clamping pressure is released, a vertically movable frame, means for supporting the clamping assembly from said movable frames, means for supporting the slabs independently of the first-named supporting means when the clamping pressure is released, means for raising and lowering the clamping assembly relative to the movable frame, and means for raising and lowering the movable frame, by virtue of all of which the slabs and contact plates can be raised and lowered as a unit when clamping pressure is applied and the contact plates can be raised independently of the slabs when the slabs are held by their independent supporting means and the clamping pressure is released, the means for independently supporting the slabs including a connection to the upper ends of the slabs and a clamp fixed with respect to the superstructure of the cell.

4. An anode for electrolytic cells for the production of aluminum, comprising a pack of prebaked slabs interleaved near their lower ends with electrical contact plates, a clamping assembly for the anode pack, said clamping assembly supporting said plates independently of the slabs when the clamping pressure is released, a vertically movable frame, means for supporting the clamping assembly from said movable frame, means for supporting the slabs independently of the first-named supporting means when the clamping pressure is released, means for raising and lowering the clamping assembly relative to the movable frame, and means for raising and lowering the movable frame, by virtue all of which the slabs and contact plates can be raised and lowered as a unit when clamping pressure is applied and the contact plates can be raised independently of the slabs when the slabs are held by their independent supporting means and the clamping pressure is released, the means for independently supporting the slabs including a connection to the upper ends of the slabs and a clamp fixed with respect to the superstructure of the cell, said clamp carried by a removable beam.

5. Anode construction comprising a number of anode packs each comprising a pack of prebaked carbon slabs interleaved with electrical contact plates and each including a releasable clamping assembly, a vertically movable frame, means for supporting the clamping assembly of each anode pack from the movable frame, and means for lifting said contact plates of any given anode pack upwardly relative to the carbon slabs of such pack when the respective clamping assembly is released and for raising and lowering the plates and slabs of said pack as a unit when the clamping assembly is tightened.

6. Anode construction comprising a number of anode packs each comprising a pack of prebaked carbon slabs interleaved with electrical contact plates and each including a releasable clamping assembly, a vertically movable frame, means for supporting the clamping assembly of each anode pack from the movable frame, and means for lifting said contact plates of any given anode pack upwardly relative to the carbon slabs of such pack when the respective clamping assembly is released and for raising and lowering the plates and slabs of said pack as a unit when the clamping assembly is tightened, means for raising and lowering the movable frame for adjustment of the position of the several anode packs together and means for separately supporting the slabs of any given anode pack while adjusting the contact plates of such pack relative to the slabs thereof.

7. In an electrolytic cell for the production of aluminum from alumina dissolved in fluorides, an anode comprising a pack of prebaked carbon slabs arranged with their lower ends extending downwardly into the molten electrolyte solution in the cell, said slabs being interleaved above their lower ends with metal electrical contact plates extending from side to side of the anode and projecting beyond the sides thereof to provide for attachment of electrical connections, the pack of slabs with the interleaved metal plates being secured by a clamping assembly including members extending along the sides of the anode, said member having supporting engagement with the projecting portions of the metal plates to hold the plates when the clamping assembly is loosened for raising the plates during adjustments to compensate for burning of the lower ends of the slabs.

8. An anode for electrolytic cells for the production of aluminum, comprising a pack of prebaked carbon slabs interleaved with metal plates, means for supporting the metal plates, and means for clamping the pack whereby the means for supporting the metal plates also supports

the carbon slabs, said clamping means being releasable, ments for lifting the plates upwardly relative to the carbon slabs when the clamping means is released, and means for supporting the carbon slabs independently of the first-named supporting means whereby the position of the slabs is maintained against undesired vertical movement when said clamping means is released and during operation of said lifting means.

9. Anode construction comprising a pack of prebaked carbon slabs interleaved with electrical contact plates, a releasable clamping assembly for the anode pack, projections extending from each plate beyond the sides of the pack, a vertically movable frame, means for supporting the anode pack from said movable frame, means for supporting the slabs independently of said anode pack supporting means when the clamping pressure is released, means for engaging said plate projections and adjusting the vertical position of the plates relative to the carbon slabs of the anode pack when the clamping pressure is released, and means for raising and lowering the movable frame.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 473,118 | Heroult | Apr. 19, 1892 |
| 776,490 | Briggs | Dec. 6, 1904 |
| 2,816,861 | Castex | Dec. 17, 1957 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 601,873 | Great Britain | May 13, 1948 |
| 1,132,770 | France | Nov. 5, 1956 |

UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 2,958,641 November 1, 1960

Julian Louis Reynolds

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 67, for "slab" read -- slabs --; column 7, line 15, for "Flexible" read -- Flexibles --; column 8, line 64, for "page 15," read -- column 6, line 65, --; column 9, line 9, for "wehre" read -- where --; line 67, for "frames" read -- frame --; column 10, line 18, after "virtue" insert -- of --; line 66, for "member" read -- members --; column 11, line 2, for "ments" read -- means --.

Signed and sealed this 25th day of April 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents