Dec. 16, 1969 M. A. BOGANTES 3,484,856

ANODE ADJUSTING APPARATUS

Filed July 21, 1966 4 Sheets-Sheet 1

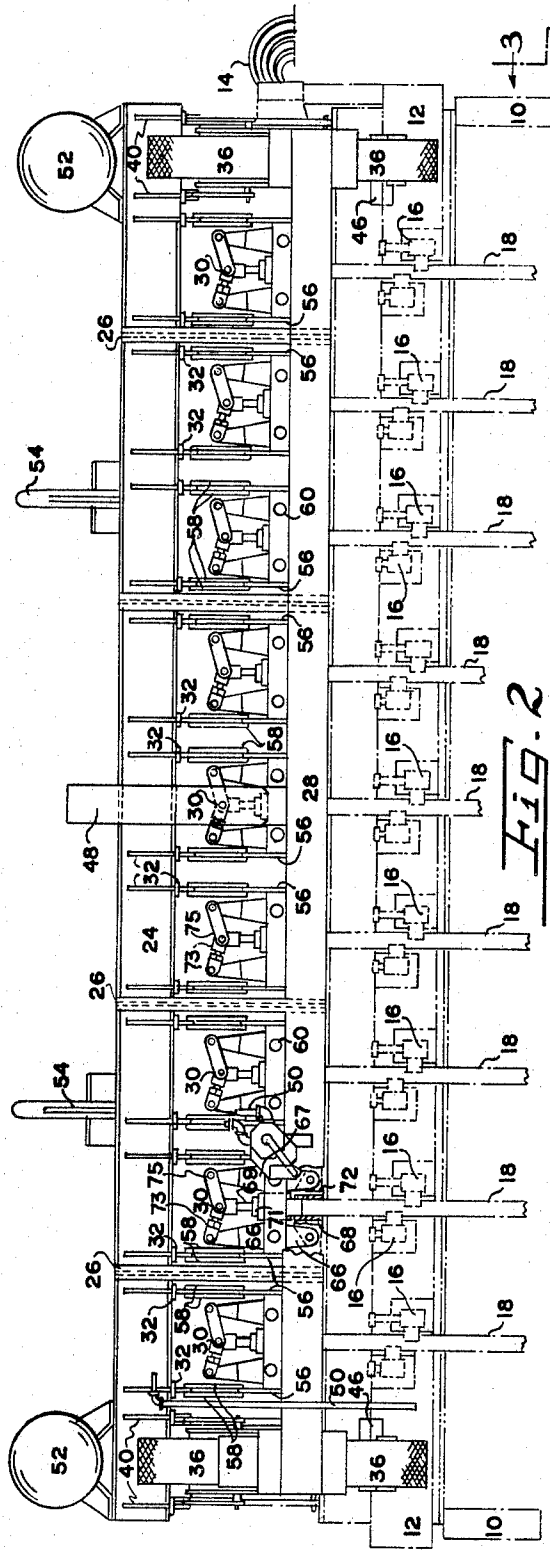

FIG. 2

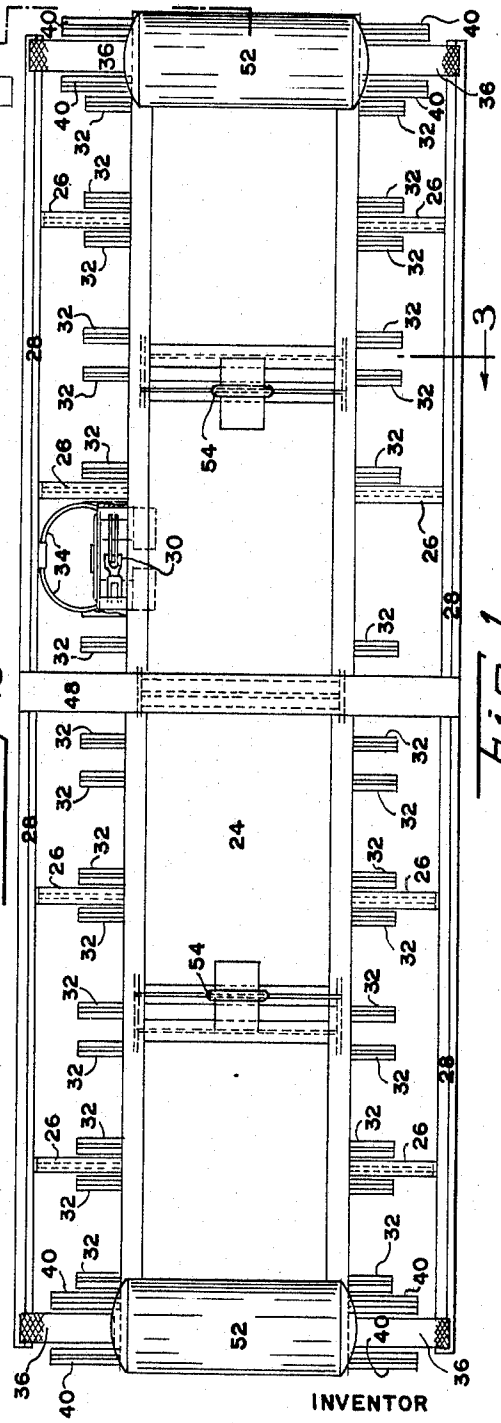

FIG. 1

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ANODE ADJUSTING APPARATUS

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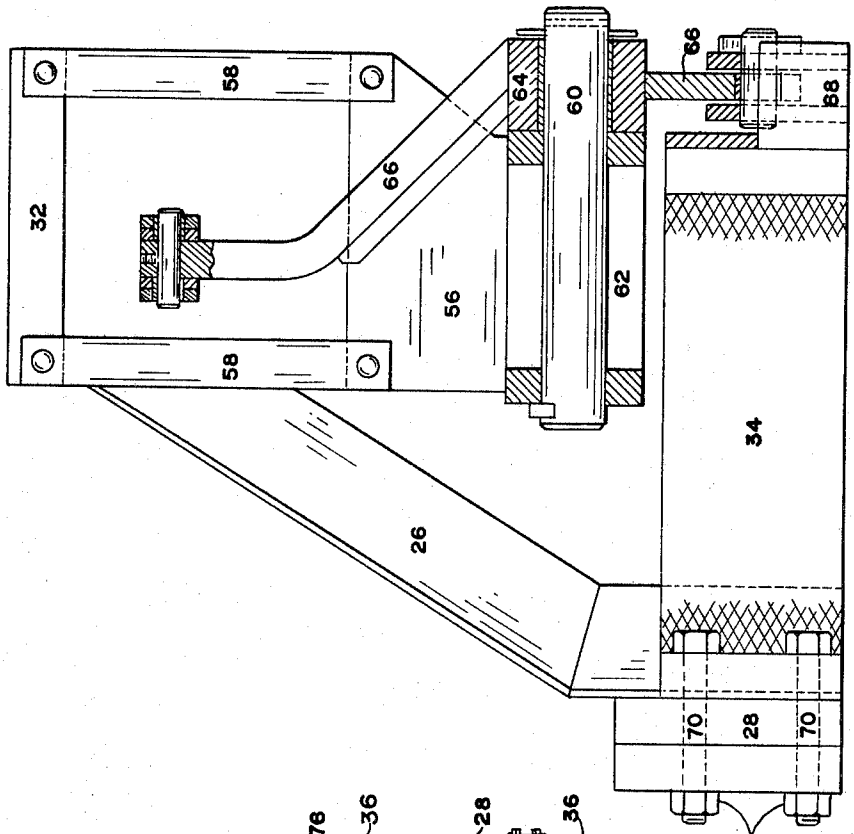

Fig. 4

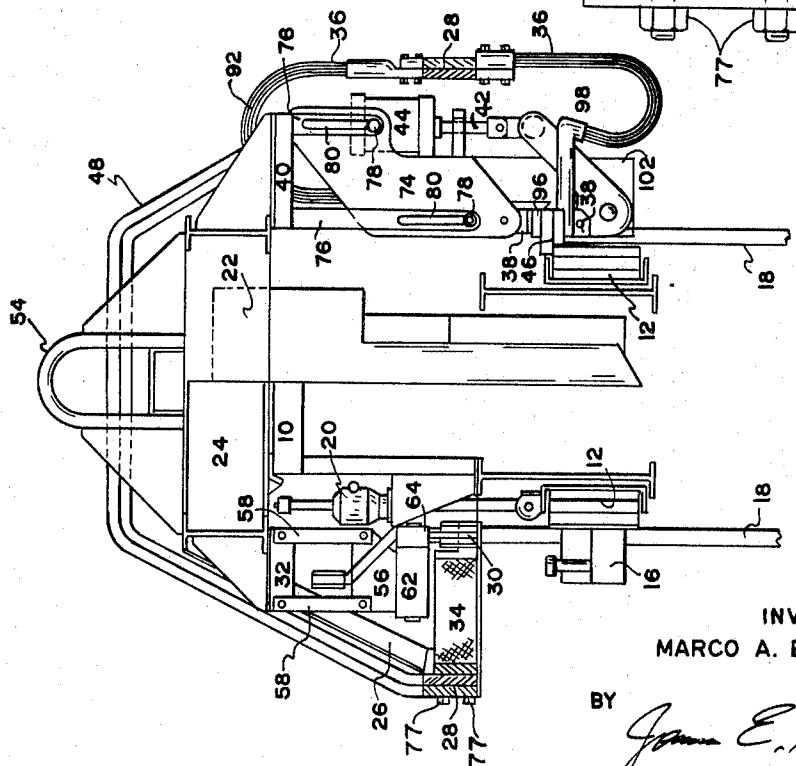

Fig. 3

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ANODE ADJUSTING APPARATUS

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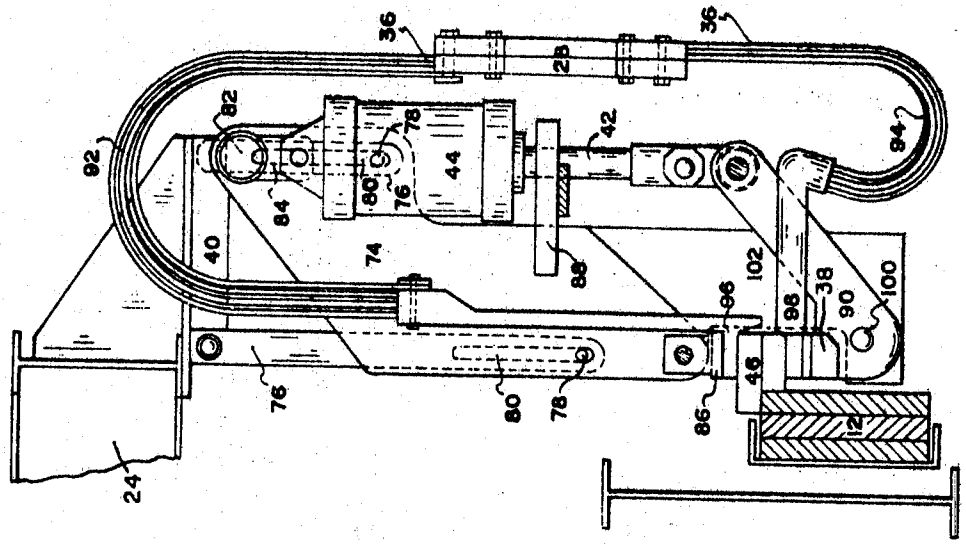

Fig. 6

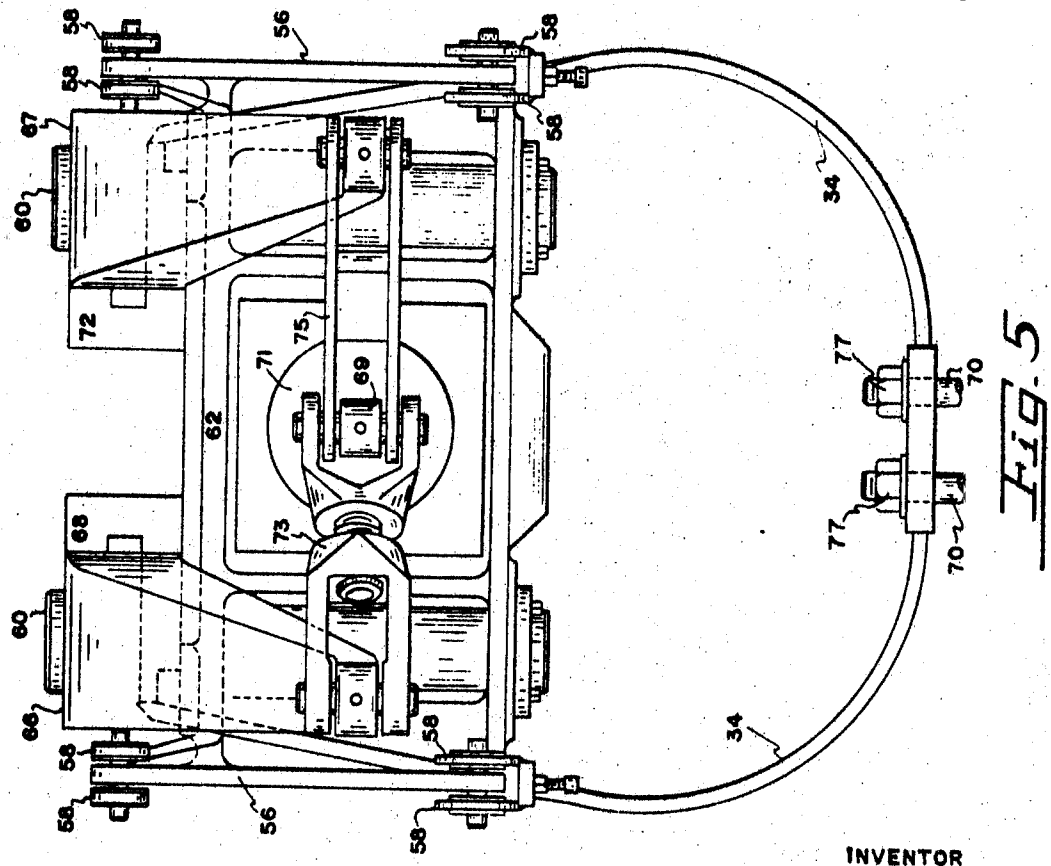

Fig. 5

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ANODE ADJUSTING APPARATUS

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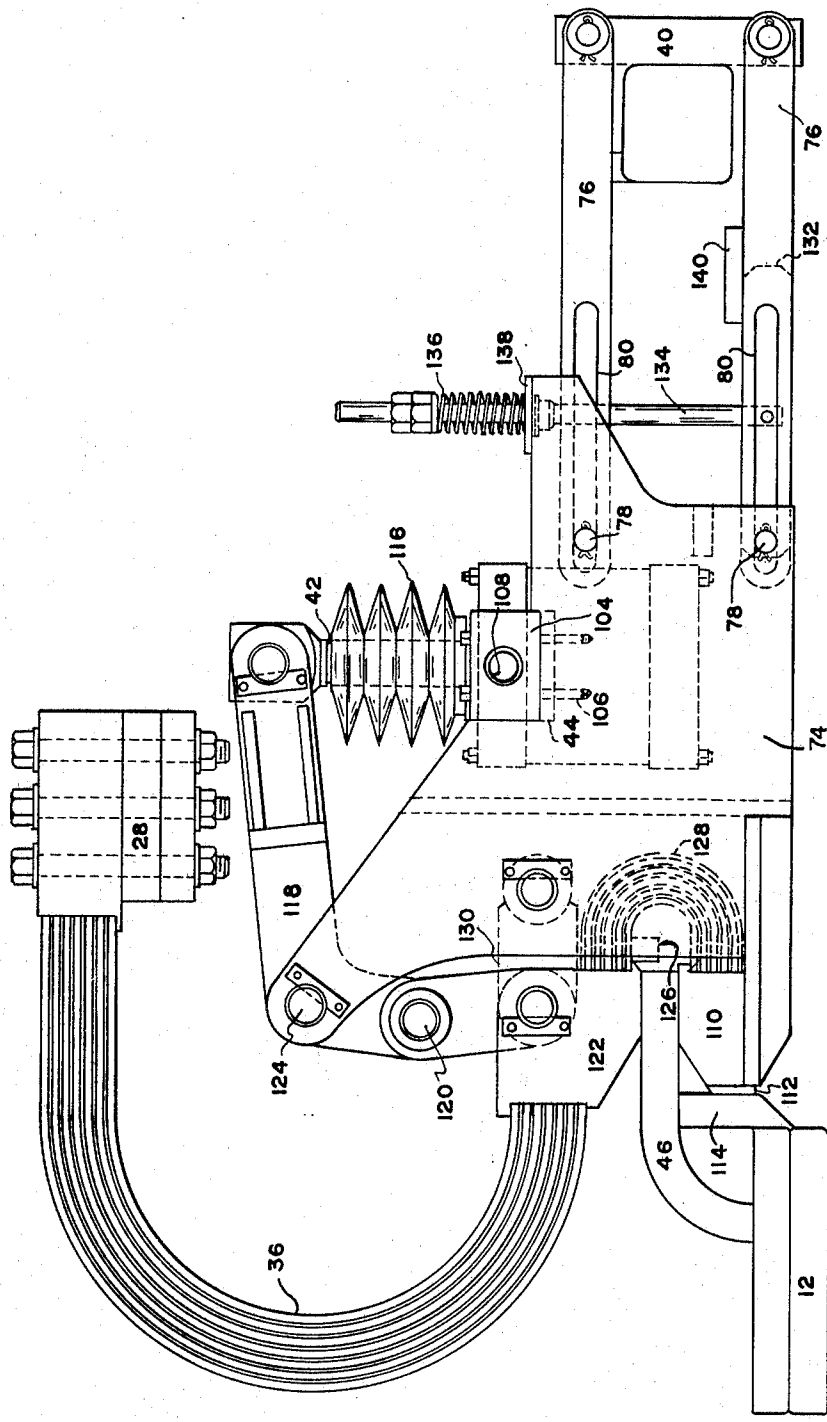

Fig. 7

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3,484,856

ANODE ADJUSTING APPARATUS

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Int. Cl. C23b 5/70
U.S. Cl. 204—297 12 Claims

ABSTRACT OF THE DISCLOSURE

An auxiliary apparatus for supporting the anodes of an electrolytic cell for the production of aluminum and maintaining current flow therein during the position adjustment of the cell anode bus bar mounted on the anode supporting superstructure of the cell.

This invention relates to electrolytic cells employing electrodes supported by individual bars or rods of conductor material suspended from one or more cell anode bus bars. More particularly, this invention concerns a novel system for supporting the anodes of an electrolytic cell for the production of aluminum and maintaining current flow therein during position adjustments of the cell anode bus bar mounted on the anode-supporting superstructure of the cell.

In the prebaked type of electrolytic cell used in the aluminum industry, a plurality of anodes are individually suspended from metal anode rods or conductor bars, for example of copper or aluminum, which in turn are suitably affixed to supporting conductors or cell anode bus bars which are positioned substantially horizontally above the cavity of the electrolytic cell. During operation of the cell, the lower portion of the anodes is consumed or burned off, and the anodes must be lowered in order to have the lower surface thereof in the proper position in the electroylte. Accordingly, a suitable jacking mechanism must be provided for lowering and raising the supporting cell anode bus bars. In order to avoid the necessity of removing and replacing all of the anodes at once, they are staggered in their vertical position such that only one or two require replacing at a given time. In view of such staggering, it is necessary, when the supporting cell anode bus bars have reached their lowest position, to be able to maintain the anodes in a fixed position relative to the electrolyte while the supporting cell anode bus bars are raised to their highest position. After the supporting cell anode bus bars are raised to their highest position, the anodes may be lowered further by lowering the supporting cell anode bus bars. Accordingly, suitable structural members or auxiliary anode bus bars are provided above and parallel to the supporting cell anode bus bars. The metal anode rods are of sufficient length that the ends of the rods extend to a position above the structural auxiliary anode bus bars when the electrode is at its lowest position. Thus, when the supporting cell anode bus bars reach their lowest position, the rods may be affixed to the structural auxiliary anode bus bars to maintain them in position. The rods may then be disengaged from the supporting cell anode bus bars and the supporting cell anode bus bars moved to the uppermost position. The rods may be again affixed to the supporting cell anode bus bars and disengaged from the structural auxiliary anode bus bars. Lowering of the rods and electrodes may then be resumed by lowering the supporting conductors or anode bus bars.

When an anode has been consumed to a point where it needs to be replaced, the replacement is done with the aid of a suitable lifting device such as a crane. To facilitate such lifting, an opening is generally provided in the upper end of the metal anode rod for engagement by a hook of the crane. Accordingly, the metal anode rods must be sufficiently long to extend to the structural auxiliary anode bus bars and also extend somewhat beyond to make possible engaging the crane hook in the opening.

This conventional system has several disadvantages. Current flows into the anode rod during the position adjustment of the cell anode bus bar either through current connection to the auxiliary anode bus bar or by a sliding or scraping electrical contact obtained between the anode rod and the cell anode bus bar as the bus bar is jacked upwards. This gives undesirable sparking with consequent surface disintegration of the cell anode bus bar and of the anode rod. The anode rods must be long enough to be clamped to either bus and the superstructure of the cell must be strong enough to support the auxiliary anode bus bar and all its related appendages. This means the superstructure of the cell must be much stronger than it would otherwise have to be. Since the resultant superstructure is taller than it otherwise need be, the building must also be taller than it otherwise need be. It takes as much as forty-five minutes per cell to raise the main bus and reclamp the anodes by this conventional procedure.

Accordingly, the instant invention is concerned with providing a novel system for supporting the anode of an electrolytic cell for the production of aluminum and maintaining current flow therein during position adjustment of the cell anode bus bar mounted on the anode supporting superstructure of the cell.

Advantageously, the novel system of this invention is independent of the superstructure of the cell. Consequently, a lighter superstructure may be utilized in the design and construction of the cell. This makes possible a substantial reduction in the cost of the cell. Whereas the conventional procedure can require as much as forty-five minutes per cell to raise the main bus and reclamp the anodes, the task, using the instant system, can be accomplished in approximately ten minutes.

Also, the novel system of this invention is advantageous in that shorter anode rods can be used which result in additional cost saving since the anode rods are made of relatively costly materials such as aluminum or copper. There is less wear and tear on the anode rods which results in a further savings.

A further advantage of the novel system of this invention is that there is no sparking with consequent deterioration of the electrical connection of the main anode bus and anode rod during position adjustment of the cell anode bus bar. This greatly increases the life of both the cell anode bus bar and the anode rod.

These and other purposes and advantages of this invention will become more apparent from the following description taken in conjunction with the accompanying drawings.

This invention relates to auxiliary apparatus for supporting the anodes of an electrolytic cell for the production of aluminum and maintaining current flow therein during position adjustment of the cell anode bus bar mounted on the anode supporting superstructure of the cell. The apparatus includes an elongated frame member and means for positioning the frame member in juxtaposition with the superstructure of the cell. An Auxiliary anode bus bar is mounted on the frame and is adapted to be positioned substantially parallel to an anode bus bar of the cell. Means are associated with the frame and auxiliary anode bus bar for clamping the anode rods supporting the cell anodes to the auxiliary anode bus bar in current conducting engagement. Flexible leads are attached to each end of the auxiliary anode bus bar and a clamp is attached to the free end of each flexible

lead. Means are provided for attaching the clamps to the ends of the cell anode bus bar in current conducting engagement so that the current bypasses the cell anode bus bar and flows into the cell via the axiliary anode bus bar and the anode rods clamped in current conducting engagement therewith. The elongated frame member may be suspended from overhead rails for positional movement, or it may be mounted on wheels therefor, or in any other appropriate manner. Although the elongated frame member may extend only along one side of the superstructure of the cell, it may also be constructed so as to resemble an inverted "U" in cross-section whereby it envelops the superstructure of the cell when positioned in juxtaposition therewith. When the inverted U-shaped cross-sectional construction is used, then of course, an auxiliary anode bus bar and the related appendages may be provided on each leg of the U. This means that the main anode bus bars on both sides of the superstructure of the cell may be adjusted without having to change the position of the auxiliary apparatus of the instant invention.

In addition, although the invention contemplates clamping the anode rods supporting the cell anodes to the auxiliary anode bus bar in current conducting engagement, in some instances, it may be desirable to provide a flexible current conducting connector between each clamp and the auxiliary anode bus bar to compensate for warpage of the anode rods. When this is done, then, of course, the clamps may be associated with the frame so as to grip the anode rods supporting the cell anodes in weight supporting current conducting engagement with the flexible current conducting connectors completing the circuit to the auxiliary anode bus bar.

The accompanying drawings are illustrative of some embodiments of this invention.

FIG. 1 is a top plan view of one embodiment of the apparatus of this invention with parts removed for purposes of clarity.

FIG. 2 is a front view of the embodiment shown in FIG. 1 with parts removed for purposes of clarity and with a portion cut away to more clearly show one of the anode clamps.

FIG. 3 is a side elevation view partly in section taken substantially along line 3—3 of FIG. 1 with parts removed for purposes of clarity.

FIG. 4 is a side elevation view partly in section of the anode rod clamping means and flexible connection shown in FIG. 3 with parts removed for purposes of clarity.

FIG. 5 is a top plan view partly in section of the anode rod clamping means and flexible connection shown in FIG. 4 with parts removed for purposes of clarity.

FIG. 6 is a side elevation view partly in section of the flexible lead and clamp for attachment to the ends of the cell anode bus bar in current conducting engagement therewith shown in FIG. 3 with parts removed for purposes of clarity.

FIG. 7 is a side elevation view partly in section with parts removed for purposes of clarity of another form of flexible lead and clamp for attachment to the ends of the cell anode bus bar in current conducting engagement therewith.

Referring now more particularly to the drawings, in which the same reference numerals have been applied to corresponding parts, and with particular reference to FIGS. 1, 2 and 3, the superstructure of an electrolytic cell for the production of aluminum is indicated generally at **10**. Supported by the cell superstructure **10** are cell anode bus bars **12**. Current is supplied to the cell anode bus bars **12** via electrical conductor **14**. Attached to each cell anode bus bar **12** are anode rod clamps **16**. Anode rod clamps **16** engage the anode rods **18** which support the cell anodes (not shown) in current conducting engagement with the cell anode bus bar. As shown in FIG. 3, suitable jacking means **20** are also mounted on

cell superstructure **10** for adjusting the position of the cell anode bus bar **12**. An ore hopper **22** is attached to the superstructure of the cell for supplying makeup feed to the cell.

In accordance with the instant invention, the apparatus for supporting the anodes of the electrolytic cell during position adjustment of cell anode bus bar **12** mounted on the anode supporting superstructure **10** of the cell comprises an elongated frame member **24** which in the embodiment shown here resembles an inverted U in cross-section so as to envelop the superstructure **10** of the cell when positioned in juxtaposition therewith. Each leg **26** of the U is provided with an auxiliary anode bus bar **28** mounted thereon and which is adapted to be positioned as shown, substantially parallel to an anode bus bar **12** of the cell. Suitable clamps **30** are associated with and suspended from the frame by braces **32** for gripping the anode rods **18** in weight supporting current conducting engagement. As shown in FIG. 2, the clamp **30** may be of a toggle type but other suitable clamping means may, of course, be used.

As shown in FIGS. 1 and 3, a flexible current conducting connector **34** is connected at its opposite ends to both a clamp **30** and the auxiliary anode bus bar **28**. This provides the path of travel of the electrical current from the auxiliary anode bus bar **28** to the anode rod **18** via the clamp **30**. Flexible leads **36** are attached to each end of each auxiliary anode bus bar **28**. A clamp **38** is attached to the free end of each flexible lead. Each clamp **38** is suspended from frame member **24** in a suitable manner as by brace **40**. Suitable means such as piston **42** and cylinder **44** are provided for attaching the clamps **38** to the end of the cell anode bus bar **12** in current conducting engagement. To facilitate this connection, a pad **46** may be attached to the end of the cell anode bus bar **12** in a suitable manner as by welding. When such a pad **46** is provided then clamp **38** will grip pad **46** in current conducting engagement.

In the embodiment shown in these figures, an equalizer bus **48** is provided between the two auxiliary anode bus bars **28** so as to ensure even current distribution therebetween. The equilizer bus **48** may be so constructed as to provide additional strength to the elongated frame member **24**, as shown here. If, as is shown in this embodiment, fluid pressure is utilized to operate the various clamps on the apparatus, then suitable fluid supply lines **50** (segments only shown), are provided on the frame member **24**. Fluid storage tanks **52** may be mounted on frame member **24** as a reserve source of fluid pressure should the main source of fluid pressure through fluid supply lines **50** fail for some reason. Pad eyes **54** are attached to the top of elongated frame member **24**. The pad eyes **54** are adapted to be engaged by suitable hooks so that the elongated frame member **24** and the apparatus of the instant invention may be suspended from overhead rails for positional movement.

The manner in which clamp **30**, flexible connector **34**, and auxiliary anode bus bar **28** and brace **32** are interrelated shall be explained in greater detail with reference to FIGS. 2, 3, 4 and 5. As shown in FIGS. 3 and 4 support plate **56** is suspended from brace **32** by a plurality of parallel legs **58** each of which is connected pivotally at its opposite ends to both the support plate **56** and brace **32** so as to permit reciprocating movement of the support plate **56** with respect to brace **32**. Cylindrical bearings **60** are mounted on the lower end of support plate **56** in journal housing **62**. Pivotally mounted on cylindrical bearings **60** by sleeves **64** are clamp pivot linkages **66** and **67**. Pivotally mounted on the lower end of clamp pivot linkages **66** is a jaw **68** of clamp **30**. Attached to the rear of jaw **68** is flexible connector **34** in any suitable manner as by welding. The opposite end of flexible connector **34** is attached to auxiliary anode bus bar **28** in any suitable manner as by nuts **77** and bolts **70**. It is desirable although not absolutely essential that flexible connector **34**

be divided into two sections, one section extending between one jaw **68** of clamp **30** and auxiliary anode bus bar **28** and the other section extending between the other jaw **72** of clamp **30** and auxiliary anode bus bar **28**. The pivotal mounting of support plate **56** on brace **32** by means of legs **58** permits the clamp **30** and flexible connector **34** assembly to move horizontally as necessary to compensate for warpage, distortion, etc. of anode rod **18**. Clamp pivot linkages **66** and **67** are operated by the movement of piston **69** in cylinder **71** under fluid pressure, piston **69** being linked to clamp pivot linkages **66** and **67** by arms **73** and **75**.

With reference now to FIGS. 3 and 6, the connection between the auxiliary anode bus bar **28** and the cell anode bus bar **12** shall be described in greater detail. Suspended from brace **40** is support plate **74** by means of a plurality of parallel legs **76**, each of which is connected pivotally at its opposite ends to both support plate **74** and brace **40** so as to permit reciprocating movement of support plate **74** with respect to brace **40**. The attachment of each leg **76** to support plate **74** is by means of a pin **78** riding in elongated slot **80** to permit vertical movement of support plate **74** with respect to brace **40**. Cylindrical bearing **82** extends horizontally from one plate **74** to another plate **74** suspended on the opposite side of flexible lead **36** from a second brace **40**. Suspended from bearing **82** by leg **84** is cylinder **44**. Leg **84** is connected pivotally at its opposite ends to both bearing **82** and cylinder **44** so as to permit pivotal movement of the cylinder **44** with respect to bearing **82**. Attached to support plate **74** is upper jaw **86** of clamp **38**. Extending from cylinder **44** is piston **42** passing through sleeve guide **88** attached to support plate **74**. Attached to the lower end of piston **42** is lower jaw **90** of clamp **38**. As shown, flexible lead **36** is divided into two sections, the free end of upper section **92** being attached to upper jaw **86** of clamp **38** by means of rigid lead **96**. Similarly, lower section **94** of flexible lead **36** is attached to lower jaw **90** of clamp **38** by means of rigid lead **98**. As shown in FIG. 6, lower jaw **90** of clamp **38** is pivotally mounted by means of pin bearing **100** to extension plate **102** attached to support plate **74**.

An alternate form of connection between the auxiliary anode bus bar **28** and the cell anode bus bar **12** is shown in FIG. 7 wherein like numerals have been used for like parts. Suspended from brace **40** is support plate **74** by means of a plurality of parallel legs **76**, each of which is connected pivotally, at its opposite ends to both support plate **74** and brace **40** so as to permit reciprocating movement of support plate **74** with respect to brace **40**. The attachment of each leg **76** to support plate **74** is by means of a pin **78** riding in elongated slot **80** to permit vertical movement of support plate **74** with respect to brace **40**. A journal bearing **104** is attached to each support plate **74**, as by bolts **106** to support shaft **108** attached to cylinder **44** so as to permit some pivotal movement of cylinder **44**. Attached to support plate **74** is jaw **110** provided at its lower end with stop **112** adapted to contact buffer **114** on pad **46** and cell anode bus bar **12**. Extending from cylinder **44** is piston **42** in bellows cover **116**. Attached to the free end of piston **42** by arm **118** through linkage **120** is jaw **122**. Arm **118** is pivotally mounted by means of a pin bearing **124** to support plate **74**. Jaw **122** is provided with pad limit stop **126**. As shown, the free end of flexible lead **36** is attached to jaw **122**, as by welding, in current conducting engagement therewith. A second flexible lead **128** connected at its opposite ends as by welding in current conducting engagement with jaws **122** and **110** provides a path for current travel between jaws **122** and **110**. Jaw **122** is suspended from support plate **74** by leg **130** connected pivotally at its opposite ends to both support plate **74** and jaw **122** so as to permit reciprocating movement of jaw **122** with respect to support plate **74**. Mounted behind a leg **76** on a pin **78** is plate **132**. Pinned to plate **132** is shaft **134** loaded by spring **136** pressing against seat **138** on support plate **74**. A bearing plate **140** is provided on a leg **76** for plate **132** to ride against as support plate **74** moves vertically with respect to brace **40**, for example during position adjustment of cell anode bus bar **12**. This arrangement tends to keep support plate **74** and its related appendages in proper upright alignment as support plate **74** moves vertically with respect to brace **40**.

The operation of this apparatus embodying the principle of the instant invention shall now be described with reference to FIGS. 1–6 inclusive. When the cell anode bus bar **12** has reached its lowest position, the elongated frame member **24** suspended for example from an overhead crane by means of hooks engaging pad eyes **54** is brought into position and lowered over the superstructure **10** of the cell so as to envelop the superstructure **10** of the cell when positioned in juxtaposition therewith. During the positioning operation, the auxiliary anode bus bars **28** are positioned substantially parallel to the cell anode bus bars **12**. By means of suitable control devices, either automatic or manual, the clamps **30** are actuated so as to grasp the anode rods **18**. At the same time, clamps **38** attached to flexible leads **36** are also actuated so as to grasp the ends of the cell anode bus bar **12**, for example at pad **46**, in current conducting engagement therewith. By so doing the current is bypassed from the cell anode bus bar **12** to the auxiliary bus bar **28**. The anode rod clamps **16** holding the anode rods **18** to the cell anode bus bar **12** are then released and the cell anode bus bar **12** is raised to its uppermost position for example by jacking means **20**. The anode rod clamps **16** on the cell anode bus bar **12** are then actuated again, clamping the anode rods **18** to the cell anode bus bar **12**. Clamps **30** and **38** on the auxiliary bus bar **28** are then released so that the anode rods **18** are again supported by the cell anode bus bar in current conducting engagement and current is again flowing to the cell anode via the cell anode bus bar **12**. The auxiliary apparatus of the instant invention may then be moved onto the next cell wherein a position adjustment of the cell anode bus bar is due.

It can be seen that the novel auxiliary apparatus of this invention makes possible a substantial reduction in the cost of the electrolytic cell due to a much lighter and smaller superstructure. Since one apparatus embodying the principles of this invention may service many reduction cells, a substantial savings in the cost of equipment may also be realized. Since the operation of the auxiliary apparatus of this invention may be fully automatic, a substantial time saving may also be realized. Shorter anode rods can be used to support the cell anodes which results in additional cost saving. Since the flow of current bypasses the cell anode bus bar during the position adjustment operation, sparking of the main anode bus bar against the anode rod as the main cell anode bus bar moves upwardly with consequent surface deterioration of the electrical connection of both the bus and the rod is eliminated.

While there has been shown and described hereinabove one embodiment of this invention, it is to be understood that the invention is not limited thereto and that various changes, alterations, and modifications can be made thereto without departing from the spirit and scope thereof as defined in the appended claims. For example, the elongated frame member may be such that only one auxiliary anode bus bar is attached thereto and thus the cell anode bus bar on one side of the cell only can be adjusted utilizing the apparatus. Similarly, although the apparatus is of inverted U-shaped cross-section, only one auxiliary anode bus bar may be provided thereon. Further, the instant invention is not to be construed as limited to any particular form of clamp or clamp actuating means. Only the presently preferred types of clamps and clamp actuating means have been described hereinabove. Although the apparatus has been described as suspended from overhead for example from a crane travelling on overhead rails for positional movement, the elongated frame mem-

ber could also be mounted on wheels for positional movement. The wheels, of course, could rotate either on the floor or on an elevated track for movement. The flexible connectors and flexible leads do not necessarily have to be divided into two sections for attachment to their respective clamps, but could be of unitary construction attached to their respective clamps in an appropriate manner. Similarly, the anode rods could be clamped in current conducting engagement directly to the auxiliary anode bus bar without the use of a flexible connector.

What is claimed is:

1. Auxiliary apparatus for supporting the anodes of an electrolytic cell for the production of aluminum and maintaining current flow therein during position adjustment of the cell anode bus bar mounted on the anode-supporting superstructure of the cell which comprises:

(a) an elongated frame member;

(b) means for positioning the frame member in juxtaposition with the superstructure of the cell;

(c) an auxiliary anode bus bar mounted on the frame and adapted to be positioned substantially parallel to an anode bus bar of a cell;

(d) means associated with the frame and auxiliary anode bus bar for clamping anode rods supporting the cell anodes to the auxiliary anode bus bar in current conducting engagement;

(e) flexible leads attached to each end of the auxiliary anode bus bar;

(f) a clamp attached to the free end of each flexible lead;

(g) means for attaching the clamps to the ends of the cell anode bus bar in current conducting engagement so that the current bypasses the cell anode bus bar and flows into the cell via the auxiliary anode bus bar and the anode rods clamped in current conducting engagement therewith.

2. The apparatus of claim 1 wherein the elongated frame member resembles an inverted U in cross-section whereby it envelops the superstructure of the cell when positioned in juxtaposition therewith.

3. The apparatus of claim 1 wherein the means for clamping the anode rods supporting the cell anodes to the auxiliary anode bus bar in current conducting engagement is provided with a flexible, current conducting connector between each clamp and the auxiliary anode bus bar.

4. The apparatus of claim 3 wherein the clamping means comprises two jaws and wherein the flexible current conducting connectors are each divided into two sections, one section extending between one jaw of the clamping means and the auxiliary anode bus bar and the other section extending between the other jaw of the clamping means and the auxiliary anode bus bar.

5. The apparatus of claim 1 wherein the clamp attached to the free end of each flexible lead attached to each end of the auxiliary anode bus bar comprises two jaws and wherein the flexible leads are each divided into two sections, the free end of one section being attached to one jaw of the clamp and the free end of the other section being attached to the other jaw of the clamp.

6. The apparatus of claim 5 wherein a second flexible lead is provided between and in current conducting engagement with the jaws of the clamp so as to provide a path of current travel between the jaws of the clamp.

7. Auxiliary apparatus for supporting the anodes of an electrolytic cell for the production of aluminum and maintaining current flow therein during position adjustment of the cell anode bus bar mounted on the anode-supporting superstructure of the cell which comprises:

(a) an elongated frame member of inverted U shaped cross-section, each leg of the U being provided with:

(i) an auxiliary anode bus bar mounted on the frame and adapted to be positioned substantially parallel to an anode bus bar of a cell;

(ii) means associated with the frame and auxiliary anode bus bar for clamping anode rods supporting the cell anodes to the auxiliary anode bus bar in current conducting engagement;

(iii) flexible leads attached to each end of the auxiliary anode bus bar;

(iv) a clamp attached to the free end of each flexible lead;

(v) means for attaching the clamps to the ends of the cell anode bus bar in current conducting engagement so that the current bypasses the cell anode bus bar and flows into the cell via the auxiliary anode bus bar and the anode rods clamped in current conducting engagement therewith; and

(b) means for positioning the frame member in juxtaposition with and enveloping the superstructure of the cell.

8. The apparatus of claim 7 wherein the means for clamping the anode rods supporting the cell anodes to the auxiliary anode bus bar in current conducting engagement is provided with a flexible, current conducting connector between each clamp and the auxiliary anode bus bar.

9. The apparatus of claim 8 wherein the clamping means comprises two jaws and wherein the flexible current conducting connectors are each divided into two sections, one section extending between one jaw of the clamping means and the auxiliary anode bus bar and the other section extending between the other jaw of the clamping means and the auxiliary anode bus bar.

10. The apparatus of claim 7 wherein an equalizer bus bar connects the two auxiliary anode bus bars so as to ensure even current distribution therebetween.

11. The apparatus of claim 7 wherein the clamp attached to the free end of each flexible lead attached to each end of the auxiliary anode bus bar comprises two jaws and wherein the flexible leads are each divided into two sections, the free end of one section being attached to the other jaw of the clamp.

12. The apparatus of claim 11 wherein a second flexible lead is provided between and in current conducting engagement with the jaws of the clamp so as to provide a path of current travel between the jaws of the clamp.

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