Nov. 15, 1960 J. V. DAVIS 2,960,456

ANODE SHIFTING DEVICE

Filed June 26, 1958 6 Sheets-Sheet 1

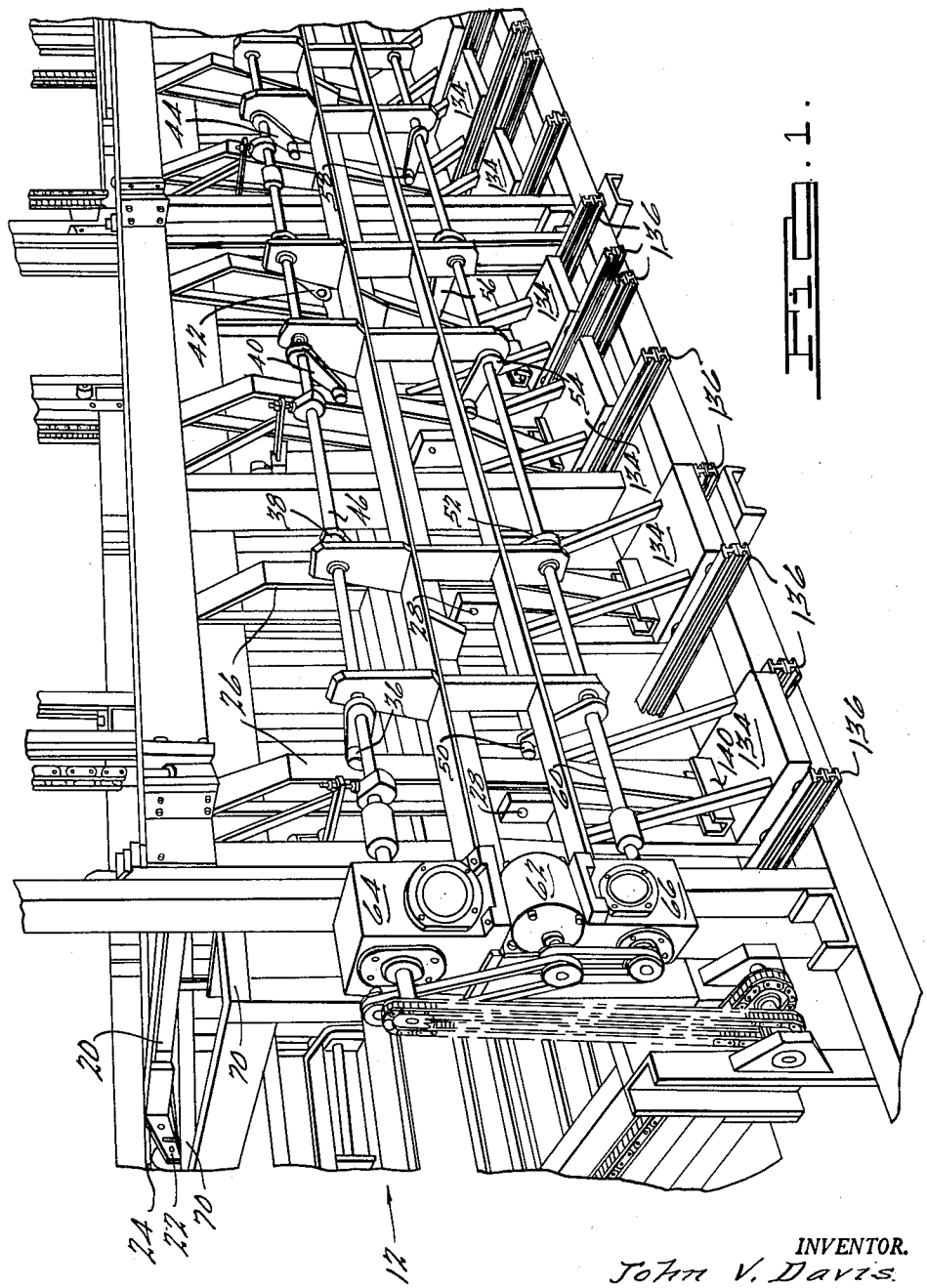


FIG. 1.

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ANODE SHIFTING DEVICE

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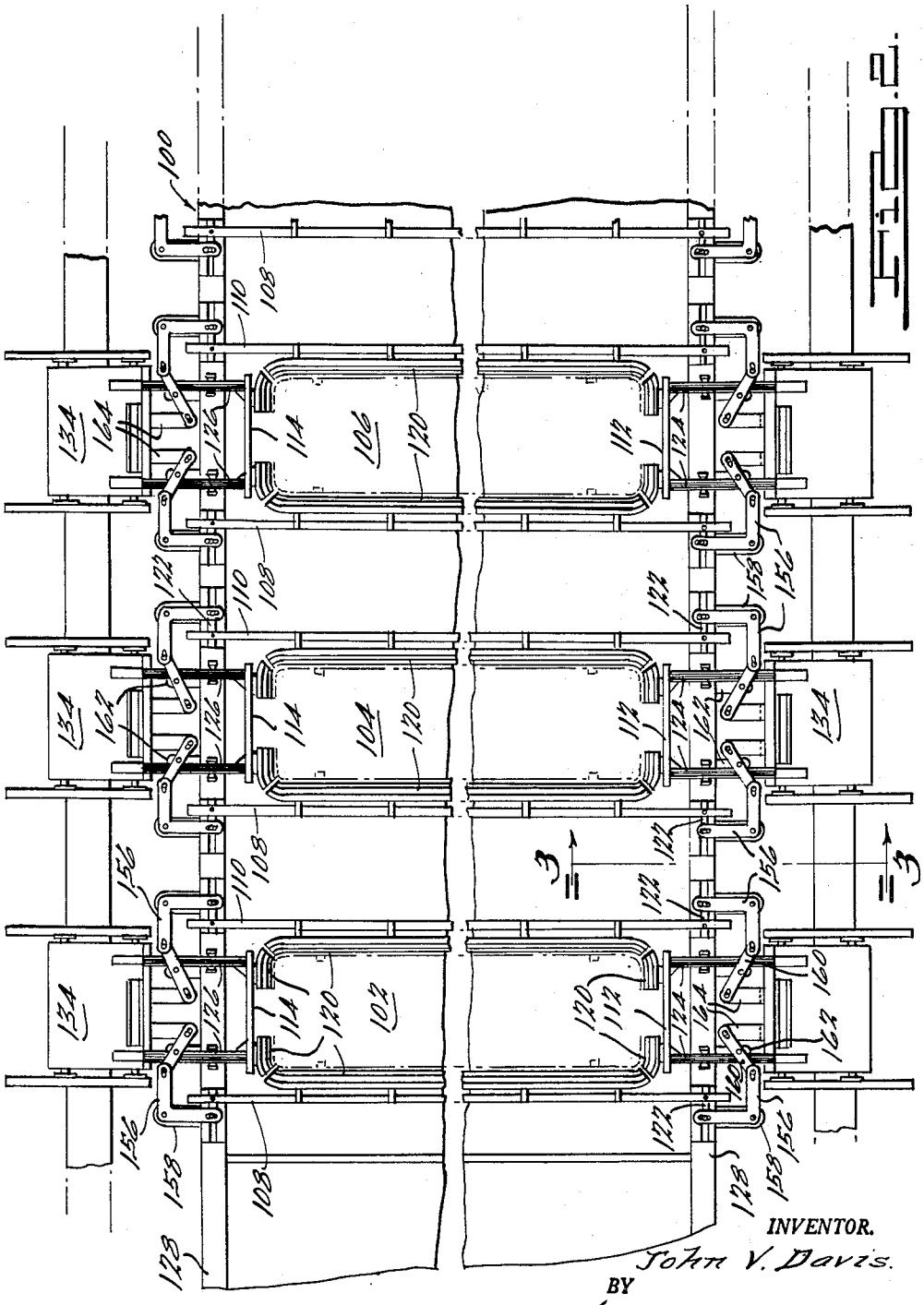


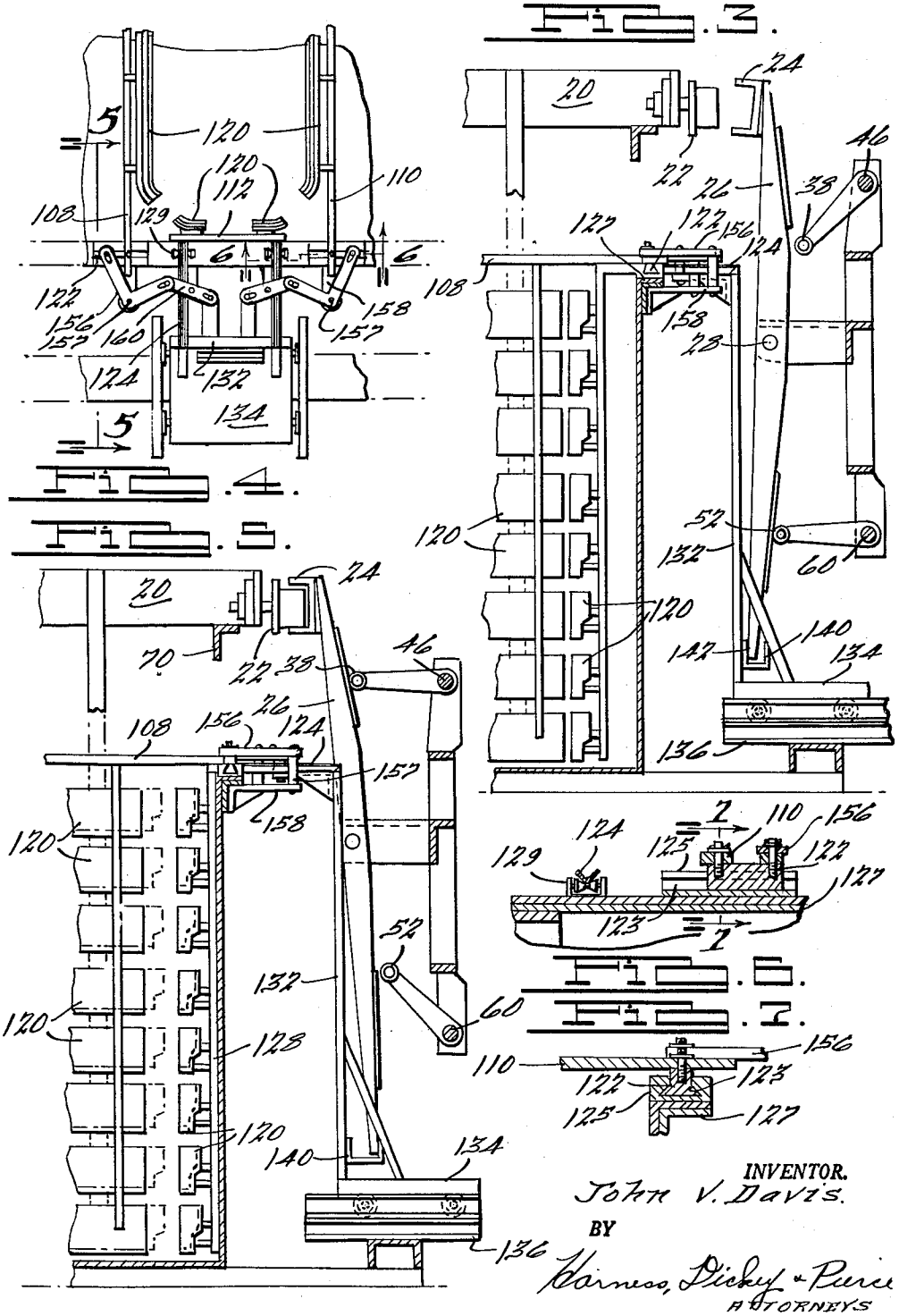
Fig. 2

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ANODE SHIFTING DEVICE

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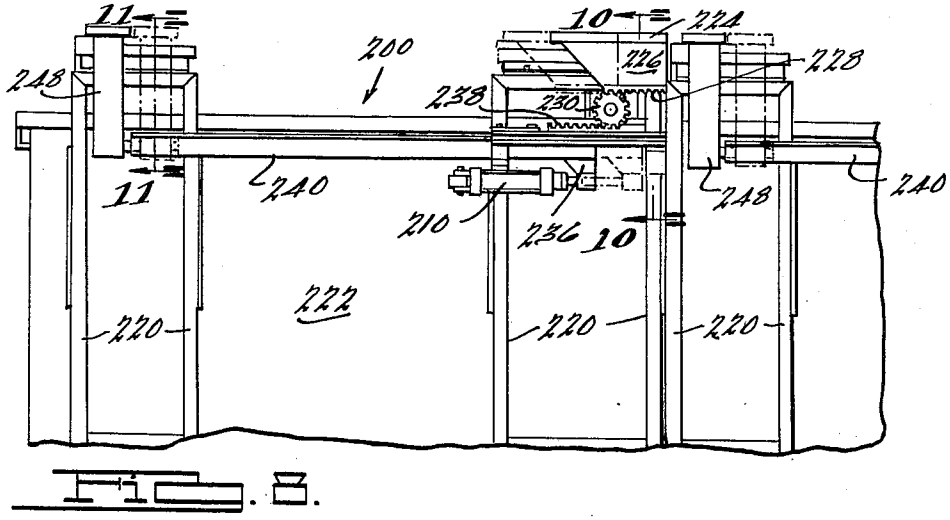


FIG. 8.

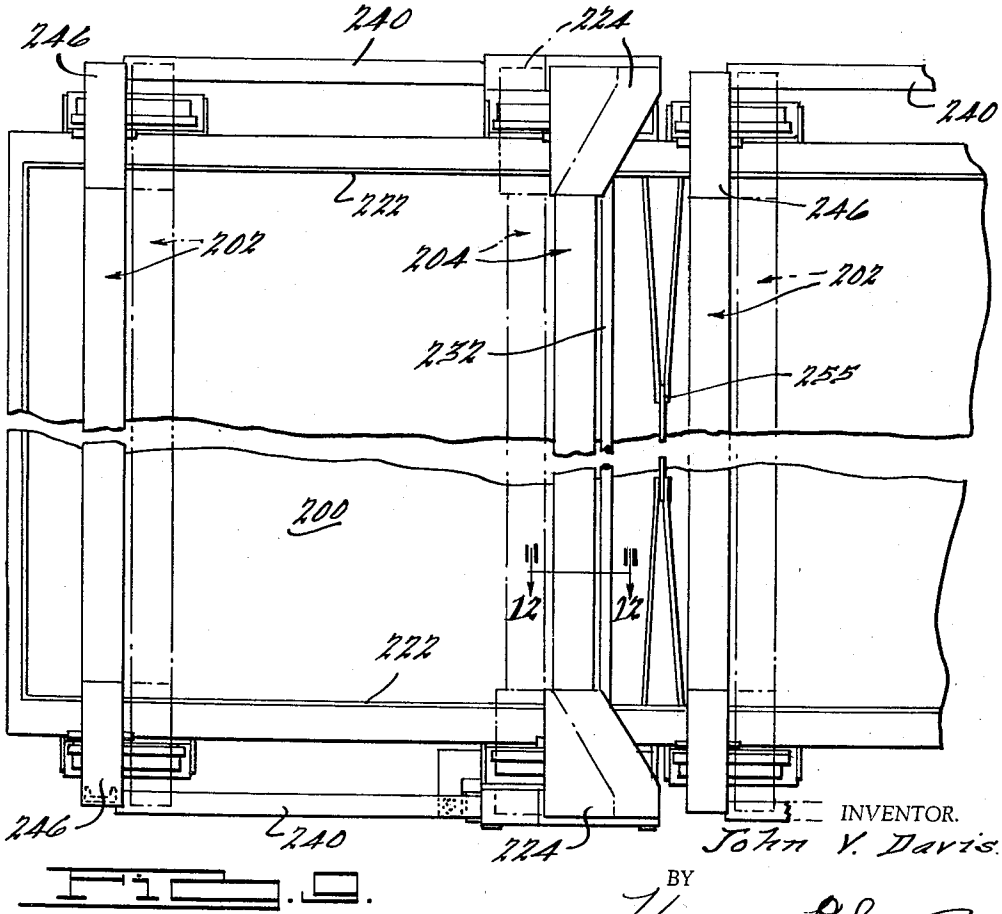


FIG. 9.

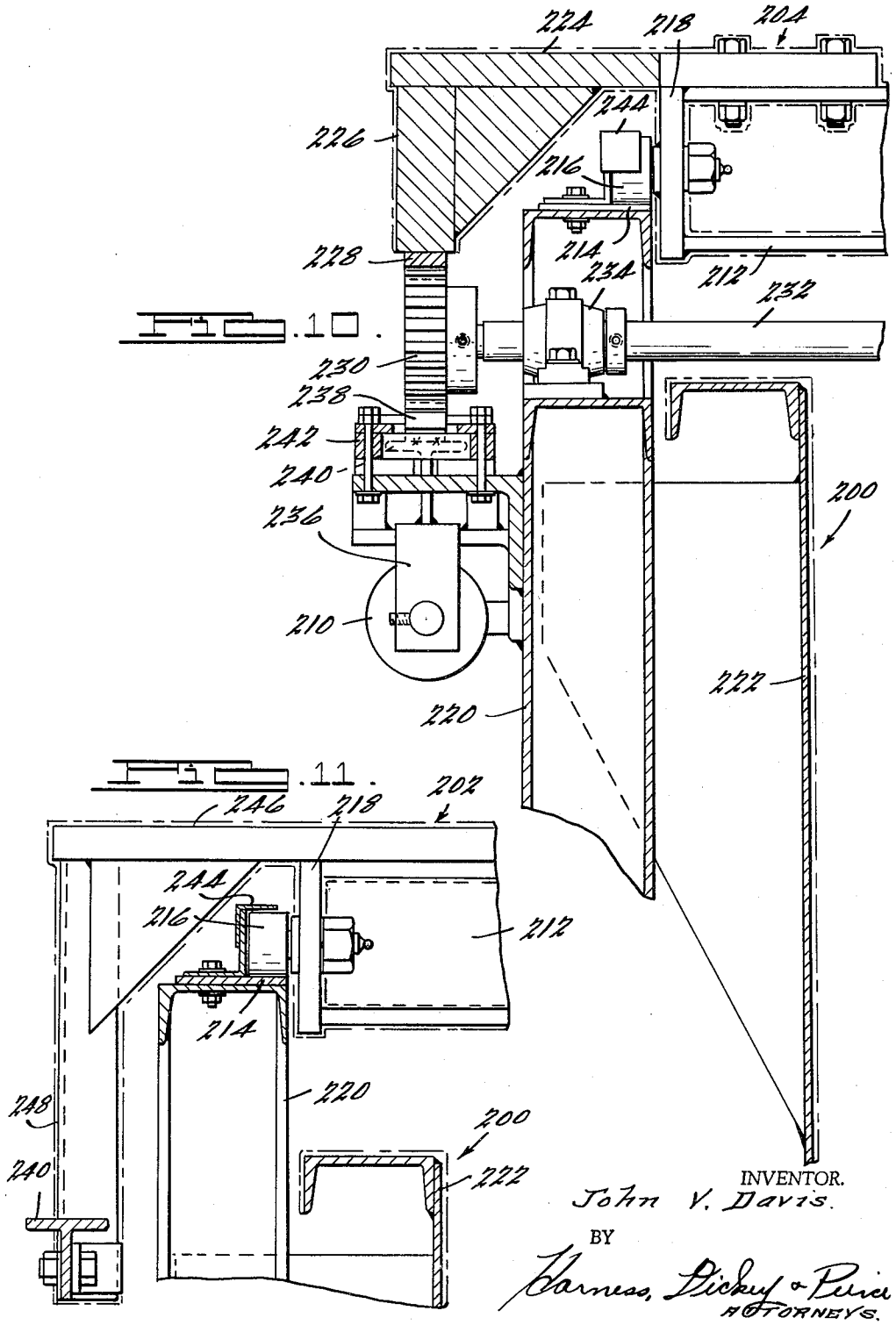
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ANODE SHIFTING DEVICE

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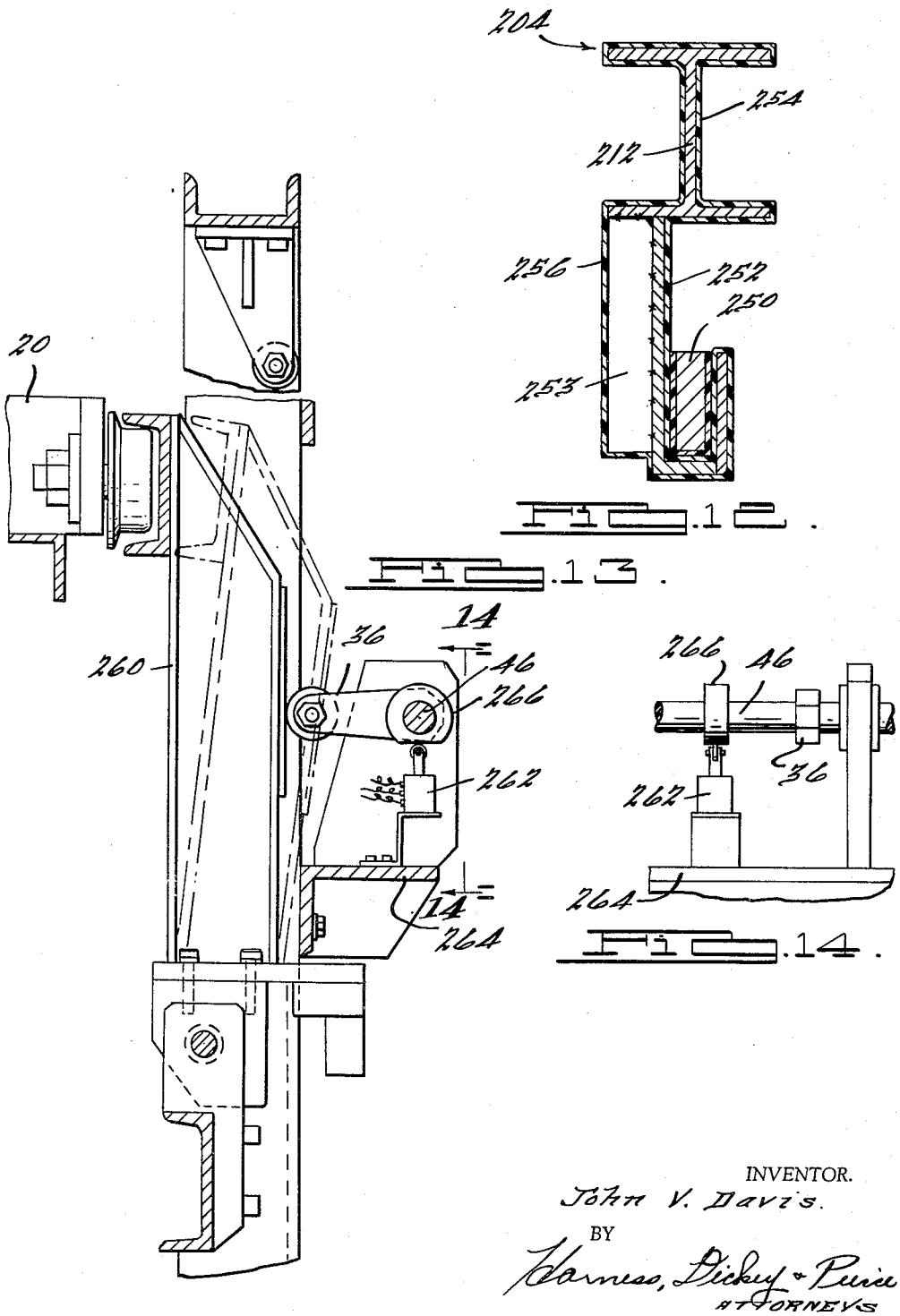


FIG. 12.

FIG. 13.

FIG. 14.

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United States Patent Office 2,960,456 Patented Nov. 15, 1960

2,960,456

ANODE SHIFTING DEVICE

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Filed June 26, 1958, Ser. No. 744,825

20 Claims. (Cl. 204—198)

This invention relates to improvements in plating machines, and more particularly to improved means for shifting anodes in plating machines.

It is well known in the art of plating that in many plating processes it is difficult to plate into a recess or cavity of a cathodic workpiece. Certain workpieces present shapes which require that the anodes be spaced closer to the workpiece than results from placing the anodes parallel to the side walls of the plating tank. In certain cases nesting the anodes around the workpiece is sufficient, while in others it is necessary to position the anodes even closer than can be obtained by conventional nesting practice.

The present invention relates generally to nested anode arrangements and provides improved means for shifting the separate portions comprising the anode nest toward and away from each other to vary their spacing from a cathodic workpiece disposed between them, and to means for automatically accomplishing this shifting synchronously with the normal operation of a plating machine.

Accordingly, one important object of the present invention is to provide improved electroplating apparatus.

Another object is to provide improved anode shifting means, particularly adapted for use with and actuatable by the workpiece transfer mechanism of electroplating apparatus.

These and other objects are accomplished by the present invention which provides means responsive to the operation of the workpiece transfer mechanism of a plating machine to reciprocate anode support bars longitudinally in an elongated tank. In one embodiment of the invention a plurality of anodes are mounted on four rectangularly disposed supporting bars. The individual bars are reciprocally movable toward and away from each other to vary the size of the rectangle defined by them, and are interconnected by linkages at the corners of the rectangle so that they may all be actuated by a force applied to only one pair of the bars.

In another embodiment of the invention, anode bars disposed transversely across an elongated plating tank are mounted and interconnected for synchronous reciprocating travel longitudinally with respect to the tank. Independently energized means are provided in this embodiment to drive the bars toward and away from each other in response to the operation of the workpiece transfer mechanism of the machine so that the bars are brought closer together when a workpiece is deposited in the tank between them and are driven apart when the workpiece is to be removed.

The invention will now be described in greater detail in connection with the accompanying drawings of which:

Figure 1 is a fragmentary, perspective view of a straight-line plating machine according to a first embodiment of the present invention, particularly showing mechanism for actuating the anode shifting device;

Fig. 2 is a partly schematic, plan view, with portions broken away, of the machine shown in Fig. 1;

Fig. 3 is a cross-sectional view of the machine shown in Fig. 2, taken along the section line 3—3 thereof;

Fig. 4 is a fragmentary, plan view of the machine shown in Fig. 1, the view being generally similar to the view of Fig. 2, but showing the anode shifting device in a different operative position from that shown in Fig. 2;

Fig. 5 is a cross-sectional view of the machine as shown in Fig. 4, taken along the section line 5—5 thereof;

Fig. 6 is a cross-sectional view of the machine as shown in Fig. 4, taken along the section line 6—6 thereof;

Fig. 7 is a cross-sectional view of the portion of the machine shown in Fig. 6, taken along the section line 7—7 thereof;

Fig. 8 is a fragmentary, side elevational view of a straight line plating machine incorporating a second embodiment of the invention, the elevator mechanism of the machine being stripped away to afford a better view of the anode shifting device;

Fig. 9 is a broken, plan view of the machine shown in Fig. 8;

Fig. 10 is a cross-sectional view of the machine as shown in Fig. 8, taken along the section line 10—10 thereof;

Fig. 11 is a cross-sectional view of the machine shown in Fig. 8, taken along the section line 11—11 thereof;

Fig. 12 is a cross-sectional view of the machine as shown in Fig. 9, taken along the section line 12—12 thereof;

Fig. 13 is an elevational view, partly in section showing a portion of the elevator and transfer mechanism of the machine, and more particularly showing details of the control means for synchronizing the operation of the anode shifting device with the operation of the elevator mechanism; and

Fig. 14 is a side elevational view of a portion of the machine shown in Fig. 13, taken generally along the line 14—14 thereof.

The practice of the invention is particularly advantageous for use in straight-line automatic plating machines of the type described and claimed in U.S. Patent No. 2,716,415. These machines contain, in at least one location, a multi-station tank comprising a plurality of cells formed by nested anodes disposed transversely of the tank. These multi-station tanks are provided with means for removing a work carrier from one or more of the cells, translating the work carrier from the multi-station tank to the next tank, and thereafter filling the vacated cell with a replacement work carrier and the machine includes control means for automatically effecting this cyclical operation.

The present invention will be described herein as embodied in apparatus particularly adapted for use in conjunction with a plating machine of this type. However, only so much of the machine as is necessary to a complete understanding of the present invention will be described in this specification, and reference may be had to U.S. Patent No. 2,716,415 for a complete description of the construction and mode of operation of the plating machine, if desired.

In Fig. 1 there is illustrated a portion 12 of a straight-line plating machine of the general type described in the above-identified patent and as modified according to a first embodiment of the present invention. The portion shown is the cell plating station (the plating tanks being removed) which is adapted to receive a series of sequentially arranged plating tanks or one large tank divided by an anode arrangement into separate cells, each cell representing a separate plating station. Workpieces (not shown) are supported upon transverse carriers 20 which

are moved to and from the work stations by means of an overhead track arrangement. The carriers **20** extend across the width of the machine and are supported for horizontal and vertical travel upon a pair of roller assemblies **22** which form the end portions of the carriers. Roller assemblies **22** are releasably engageable by channel members **24** which are inwardly open channels integrally forming the uppermost portion of arms **26**. The arms **26** are mounted upon pivots **28** fixed upon a vertically reciprocable lift frame (not separately designated but shown in its lower position), and a pair of arms **26** carrying an interconnecting channel **24** form a track section which can be selectively cammed about pivots **28** into engagement with roller assembly **22**. When oppositely disposed channels **24** are cammed inwardly, a carrier **20** moves upon vertical motion of the lift frame. Movement of arms **26** is controlled by a series of cams **36**, **38**, **40**, **42** and **44** mounted on a longitudinal shaft **46** adjacent to the arms **26** and above the lowered position of the pivot points **28**. Rotation of shaft **46** in the lowered position of the lift frame a predetermined extent moves one pair of arms **26** and the channel members **24** inwardly to engage at least one roller assembly **22** for lifting. While Figure 1 shows only three pairs of arms **26**, any desired number may be positioned on a lift frame or frames and by preliminarily setting the position of cam arms **36**, **38**, **40**, etc., rotation of shaft **46** can effect selection of a plurality of work carriers when desired. According to the present embodiment of the invention the arms **26** are extended downwardly from their pivot points **28** and a second series of cams **50**, **52**, **54**, **56**, **58**, etc. is mounted upon a second shaft **60** below the pivot points **28** to positively cam the lower ends of arms **26** inwardly and thus the channel members **24** outwardly to insure positive release of the roller assemblies **22** and for another purpose described in detail below. The two cam shafts **46** and **60** are driven in timed relationship and may be powered by separate motors or a single motor **62** through separate gear reduction assemblies **64** and **66**, respectively.

In operation of the machine, a workpiece, or a rack of workpieces (not shown) supported upon a carrier **20** is transported from a preparatory work station along an elevated track (not shown) to the cell plating station shown in Figure 1. With the lift frame carrying a plurality of opposed pairs of channel members **24** in its upper position a continuous track is in vertical alignment with the feed-in elevated tracks and motion along the track including channel members **24**, which extends the full length of the cell plating station, is continued until the work carrier reaches the cell to be filled. The frame carrying the pairs of arms **26** is then lowered to lower the workpiece into the cell. Cam shaft **60** is rotated with or slightly after cam shaft **46** is rotated to positively retract arms **26** from rollers **22** and thus position carrier **20** on supports **70**. Other cells are then emptied and re-filled by successively elevating and lowering the lift frame, with each cycle emptying and filling one or more cells depending upon the preliminary setting of cams **36**, **38**, etc. When a single cam actuating motor is used, cams **50**, **52**, etc. are positioned, relative to cams **36**, **38**, etc. so that the selection of the succeeding pair of arms **26** by cams **40**, **42** will concurrently cause the positive camming in of the arms **26** which deposited the carrier in the preceding adjacent cell on the descent of the lift frame.

According to the present embodiment of the invention, means actuatable by the arms **26** are provided to advance and to retract anodes of a plating cell toward and away from a workpiece placed in the cell between the anodes. Referring now to Fig. 2 in conjunction with Fig. 1, the general cell lay-out of a plating tank generally designated **100** may be seen. This tank **100** is of the type intended for use in the portion **12** of the plating machine shown in Fig. 1, and includes a series of adjacent work stations, or cells, three of which **102**, **104** and **106** are shown. Each cell includes a pair of transverse anode bars **108** and **110** extending across the width of the tank **100**, and a pair of longitudinal anode bars **112** and **114**. Each of the bars **108**, **110**, **112** and **114** supports a plurality of anodes **120** which are shaped to conform to the contours of the surfaces of workpieces to be treated. A suitable anode arrangement for plating objects such as automobile bumpers is illustrated in Figs. 2, 3 and 5 wherein the anodes **120** are arranged for electroplating a series of horizontally disposed automobile bumpers mounted in vertical array. The anode arrangement of Figs. 3 and 5 is illustrative only and in most commercial installations the anodes are vertically disposed and have their surface contoured as required. Electrical current is supplied to the anodes in conventional fashion. When the anodes are positioned sufficiently close to the work for good plating, the surface contour of the anodes, particularly vertically disposed anodes, is such that interference results when the work is attempted to be positioned in or removed from the anode nest.

In order to avoid this interference and to permit entry and egress of the workpieces, the transverse anode bars **108** and **110** are mounted upon longitudinally slidable shoes **122** and the longitudinal anode bars **112** and **114** are supported upon transversely movable arms **124** and **126**. The shoes **122** which support the transverse anode bars **108** and **110** are best shown in Figs. 6 and 7 and are of dovetail cross-section. They are slidably fitted in grooves **123** formed in mounting plates **125** which are rigidly supported upon the flange **127** of the tank **100**. The grooves **123** have a contour conforming to the shape of the shoes **122** so that the shoes **122** are rigidly supported against transverse and vertical escape, yet are freely slidable longitudinally along the tank. In order to minimize lubrication problems, the shoes **122** and the mounting plates **125** are preferably made of mutually different materials having low friction characteristics such as, for example, of brass and of steel, respectively.

The arms **124** and **126** that support the longitudinal anode bars **112** and **114**, respectively, may be simple angle irons as shown illustratively in Fig. 6. They extend over the side walls **128** of the tank and are rigidly secured to brackets **132** (Fig. 3) mounted upon carts, or dollies **134**. The dollies **134** roll upon fixed track sections **136** which extend outwardly in a transverse direction from the tank **100**. The track sections **136** are preferably of channel shaped or "I" cross-section and the rollers **135** of the dollies **134** are arranged to project into the channels to guide the dollies firmly and smoothly.

The brackets **132** are rigidly fixed to the dollies **134** and are preferably braced and reinforced to provide a rigid driving connection between the arms **124** and the dollies **134**. If the anodes **120** supported upon the longitudinal anode bars **112** and **114** are relatively heavy, rollers **129** (Fig. 6) may be mounted upon the tank flange **127** to provide additional support for the arms **124** and **126**.

Each dolly **134** is provided with a channel-shaped upwardly facing shoe member **140** adapted to receive the lower end **142** of one of the arms **26**. The dollies **134** are aligned along the sides of the tank **100** and positioned at the start of the operation of the machine directly beneath respective ones of the arms **26** with the lower ends **142** of the arms seated in respective ones of the shoe members **140**. When the arms **26** are pivoted back and forth, they drive the dollies **134** back and forth to advance and retract the anodes **120**.

The longitudinal anode bars **112** and **114**, being connected rigidly to the brackets **132**, move integrally with the dollies **134**. Advance and retraction of the transverse anode bars **108** and **110**, however, require movement at right angles to the travel of the dollies **134**. To actuate the transverse anode bars **108** and **110** the driving force transmitted to the longitudinal bars **112** and **114** is trans-

lated through an angle of 90° by a system of levers (not generally designated) connected between the transverse and longitudinal anode bars. Bell cranks **156** are pivoted about fixed pivots **157** mounted upon brackets **158** adjacent to the ends of the transverse anode bars **108** and **110**, and one end is pivotally connected to the shoes **122**. One bell crank **156** is provided at each end of each of the transverse anode bars **108** and **110**. The other end of each bell crank is pivotally connected to one end of a lever **160** which is fixedly pivoted at about its median point upon a bracket **162** fastened exteriorly upon the tank **100**. The end of the lever **160** opposite from the bell crank **156** is pivotally attached to an arm **164** mounted rigidly upon and extending from the dolly bracket **132**.

When the dolly **134** is moved inwardly to advance the longitudinal anode bar **112** or **114**, the end of levers **160** attached to bell cranks **156** move outwardly and this motion causes shoes **122** to move longitudinally toward each other to thus move the anodes close to the work. Similarly, when the dollies **134** are retracted to retract the longitudinal anode bars **112** and **114**, the levers and bell cranks function in the opposite manner to retract the transverse anode bars **108** and **110**. The apparatus is shown in Fig. 4 with the anode bars **108**, **110** and **112** retracted.

The pivot connections between the bell cranks **156** and the shoes **122**, as well as the connections between the bell cranks **156** and the levers **160**, and between the levers **160** and the arms **164** are all preferably of the pin-in-slot type, or otherwise adapted to facilitate translation of the arcuate motions of the linkage to the linear motions of the driving dollies **134** and the driven anode bars **108** and **110**.

The entire anode shifting device is disposed outside of the plating cell area, and all of the linkages between the longitudinal and transverse anode bars are disposed out of the tank area. Thus, corrosive drippings from the workpieces as they are raised from the cells do not fall on the mechanical parts, and these parts may be lubricated without danger of contaminating the plating bath. Moveover, there are no parts projecting into the path of the workpieces to obstruct them during operation of the machine.

The construction hereinabove described is particularly well adapted for use with straight-line plating machines of the type described herein, since the anodes are advanced and retracted automatically by the arms **26** which control the insertion and removal of workpieces from the cell stations. Note, with particular reference to Figs. 3 and 5, that when it is desired to lift a workpiece from a plating cell the arm **26** is swung to advance the channel member 24 into engagement with the roller assembly 22, and that this motion of the arm **26** also retracts the anodes 120 to permit unobstructed removal of the workpiece. After the workpiece is lowered into a cell, the arm **26** at the cell is swung in a clockwise direction as viewed in Figs. 3 and 5, simultaneously with the selection of a succeeding work carrier or carriers to be elevated and this motion simultaneously retracts the channel member 24 to disengage the roller assembly **22**, and advances the anodes **120**. This selection preferably occurs immediately after the lift frame reaches its lower position.

In normal operation of the machine illustrated in Fig. 1, the arms **26** are angularly driven only when they are in their lowered position. The shoes **140** are, therefore, always properly positioned to receive the lower ends of the respective arms 26 when the arms are lowered by the lift frame, since the arms **26** are always lowered in the same angular positions they were in when they were last raised.

In operation of the machine illustrated in Fig. 1, the first two arms **26** on the left may be actuated by the cams **36** and **38**, the remaining ones of the arms **26** being retracted and out of engagement with any of the carriers **20** that may be resting in the machine at their locations. The lift frame is then raised, carrying with it all of the arms **26**. As the arms **26** travel upwardly, and after the retracted ones clear the carriers **20**, they are all swung inwardly by cam members (not shown) mounted in fixed position on the machine frame. All of the channel sections **24** are thus aligned when the arms **26** are raised to form a continuous track above the entire plating station. The carrier **20** that is raised by the two left-hand arms **26** is then driven along this raised track over the succeeding plating cells to a post-treatment work station (not shown) and another carrier **20** is advanced to the raised track and positioned above the vacated cell or cells. The lift frame is then lowered to lower workpieces carried by the replacement carrier into the cells. When the lift frame is lowered, the two left-hand arms **26** are maintained in their inward angular position by the cams **36** and **38**, while the upper ends of the arms **26** fall outwardly because they are mounted and balanced to be normally open, as they are lowered below the fixed cam members. In the lower position, the cam shafts **46** and **60** are then rotated to drive the top portion of the two left-hand arms **26** outwardly, releasing the carriers **20** and advancing the dollies **134** to thus position the anodes in close relationship to the work to be plated.

On the next succeeding lift of the lift frame the cam shafts **46** and **60** are rotated to advance only the middle two of the arms **26**, leaving all others of the arms in their retracted positions. The positioning of the cams on the cam shafts **46** and **60** may be varied to control the operation of the machine for any desired loading and unloading sequence of the plating cells.

The anode shifting device according to this embodiment of the invention may be readily adapted for use in different types of plating machines from the specific machine described herein. For example, the anode bars **108**, **110**, **112** and **114** may be actuated by other means than the pivoted arms **26**, and such other means may be made responsive to any desired control signal. The longitudinal anode bars **112** and **114** may be mounted upon any desired, rigid, transversely movable support, and actuating power may be transmitted to them by any convenient means such as, for example, a pair of synchronized hydraulic cylinder assemblies or a pair of electric motors.

A second embodiment of the invention is illustrated in Figs. 8–14, Figs. 8–12 showing the anode shifting arrangement with the plating machine frame and transfer mechanism stripped away. This machine includes an elongated tank **200** which may be generally similar to the tank **100** hereinabove described, and is divided into a plurality of work stations, or cells by transverse anode bar assemblies **202** and **204**. Each of the assemblies **202** and **204** is mounted for smoothly controlled rolling or sliding travel longitudinally of the tank **200**. Each work station is bounded by one pair of bar assemblies **202** and **204**, which are interconnected as hereinafter described for synchronous reciprocating motion toward and away from each other. They are arranged to be driven by a pneumatic or hydraulic cylinder driving means **210** which is controlled by the workpiece transfer mechanism of the machine, so that when a workpiece, or a workpiece carrier is lowered into the work station and released by the transfer mechanism, the cylinder **210** is actuated to drive the anode bars **202** and **204** inwardly toward each other. Similarly, when the workpiece transfer mechanism is adjusted to engage a workpiece carrier previously placed in the cell, the cylinder **210** is energized to drive the anode bars outwardly away from each other to facilitate removal of workpieces from the cell.

Referring now to Fig. 10 and 11, in conjunction with Figs. 8 and 9, each of the anode bars **202** and **204** includes a supporting beam **212**, which spans the width of

the tank 200 and is supported upon ways 214 by means of rollers 216 journalled upon shafts (not separately designated) fixed in end plates 218 welded to the beams 212. The ways 214 are supported upon pillars, or stanchions 220 rigidly fixed adjacent to the side walls 222 of the tank. Brackets 224 are rigidly attached to opposite ends of one of the assemblies 204 and extend outwardly therefrom a short distance beyond the ways 214 and the stanchions 220. A depending plate 226 is rigidly secured at the outer end of each one of the brackets 224 and carries a downwardly facing rack 228 which is welded, or otherwise secured upon the lower face of the plate 226. The anode bar assembly 204 is driven longitudinally with respect to the tank 200 through this rack 228, the plate 226, and the bracket 224.

A pinion 230 is fixed upon a shaft 232 and meshes with the rack 228. The shaft is journalled within fixed bearings 234 mounted upon the stanchions 220, and extends across the width of the tank 200. One pinion 230 is fixed at each end of the shaft 232 so that the driving forces upon the racks 228 are equalized at both sides of the tank 200 through the shaft 232 to drive the anode bar assembly 204 evenly from both ends and to keep it positively aligned at all times. The shaft 232 is rotatively driven by the cylinder 210 which is mounted upon one of the stanchions 220. The movable element of the cylinder 210 is secured to a driving member 236 which in turn is fixed to a T-bar slide member 240 that carries an upwardly facing rack 238. This rack 238 is held in engagement with the lower teeth of the pinion 230, the slide member 240 being slidably supported within a guide assembly 242 for smoothly controlled longitudinal travel. The upper rack 228 is normally held in engagement with the pinion 230 by the weight of the anode bar assembly 204, and additional means such as the flange 244, which forms a part of the ways 214 and overhangs the rollers 216, are provided to prevent any possible upward escape of the rack 228 out of engagement with the pinion 230. The cylinder 210 may be a conventional pneumatic or hydraulic cylinder connected for bidirectional drive through a 4-way valve (not shown).

Thus, actuation of the cylinder 210 to drive the lower rack 238 in one direction rotates the pinion 230 and the shaft 232, and drives the anode bar assembly in the opposite direction, both ends of the assembly 204 being driven synchronously.

The other anode bar assembly 202, details of which are shown in Fig. 11, carries bracket extensions 246 projecting outwardly from both ends beyond the stanchions 220. An actuating arm 248 is rigidly attached to and extends downwardly from the outer end of each of the brackets 246. The previously mentioned slide member 240 is extended longitudinally to the arm 248 and is rigidly attached thereto. Thus, when the slide member 240 is driven by the cylinder 210 it directly actuates the one anode bar assembly 202 in the direction of travel of the movable element (not separately designated) of the cylinder, and through the rack and pinion arrangement drives the other anode bar assembly 204 in the opposite direction. The rack and pinion arrangement on the far side of the machine as viewed in Fig. 8, and the slide member 240 connections are identical to the connections shown on the near side, except that no cylinder 210 is provided on the far side. All of the energy required for reciprocating the assemblies 202 and 204 is provided by the single cylinder 210, a portion of the energy being transmitted through the shaft 232 to the far side of the machine.

The structure of the anode bar assembly itself is not critical in the practice of the invention. If, as in the example shown, the tank 200 is relatively wide, the assembly is preferably constructed as illustrated in Fig. 12. In this structure, the anode bar assembly 204 being shown by way of example, the assembly comprises a relatively rigid I-beam 212 from which is suspended an electrical conductor 250 upon which the anodes are directly hung. The conductor 250 is supported from the I-beam 212 upon spaced J-shaped bracket members 252 which may be welded or otherwise rigidly secured to the I-beam 212 and reinforced by gussets 253 to minimize bending strains. The I-beam 212 and the bracket 252 are preferably covered with a corrosion resistant electrical insulating material 254 as shown in Fig. 12 and indicated by broken lines in Figs. 10 and 11. The plating tank 200 itself may also be braced by providing bridge-like members 255 (Fig. 9) extending between and fixed to the opposite side walls of the tank at positions between the separate work stations.

When this anode bar driving mechanism is used in a plating machine of the type shown in U.S. Patent No. 2,716,415, the control of the cylinders 210 is preferably made responsive to the operation of the carrier selector arms 260, as shown, for example, in Figs. 13 and 14. These arms 260 need not be extended downwardly as in the previous embodiment, but may be in exactly the form shown in the patent referred to.

Synchronizing control between the arms 260 and the anode bar drive cylinder 210 may be effected by a double-throw limit switch 262 mounted on a fixed member 264 of the lift frame of the plating machine, and actuated by a cam 266 fixed upon the shaft 46 that drives the carrier selector arm cams 36. The cam is adjusted and shaped so that when the arms 260 are driven inwardly to engage a workpiece carrier 20 as hereinabove described, the limit switch 262 is driven to one position to retract the cylinder 210 to drive the assemblies 202 and 204 outwardly to facilitate removal of workpieces from the cell. The shape of the cam 266 is such that when the carrier selector cams 36 are retracted to permit the carrier selector arms 260 to fall away from the carrier 20, leaving workpieces in the cell for plating, the limit switch 262 is driven to its second position and maintained therein to extend the cylinder 210 to drive the assemblies 202 and 204 inwardly into closer proximity to the workpieces in the cell.

It will be understood, of course, that a complete shifting assembly including a pair of anode bar assemblies 202 and 204, a drive cylinder 210, and the connecting and synchronizing parts is provided at each work station, or cell in the tank 200, and that the controls such as the limit switch 262 for each such shifting assembly are separately actuatable in accordance with the actions of the carrier selector mechanism at each separate station. Preferably, a master control switch (not shown) is provided in the hydraulic or pneumatic supply line to which the cylinders 210 are connected. This master switch is preferably arranged to reduce the pressure in the supply line at all times except when it is desired to energize one of the cylinders. The individual limit switches 262 are thus effective only to control the direction of travel of the cylinders 210, and the master switch is effective to reduce the pressure in the cylinders after the anode bar assemblies have been moved either in or out.

This particular switching arrangement for controlling the energization of the drive cylinders 210 is illustrative only and it will be appreciated that many other switching arrangements may be substituted therefor to make the action of the cylinders responsive to the operation of the plating machine in any desired timed relationship. For example, if the dwell period of the machine, i.e., the time the lift frame remains in its lowered position is relatively long compared to the total plating time of the workpieces, it may be desirable to provide additional timing means or to change the sequence of operation of the machine so that the anode shifting takes place immediately after the workpieces are lowered into the work stations and immediately before they are raised. The desirability of providing such an arrangement will depend on technical aspects of the plating to be done.

There have thus been described improved anode shifting means especially suitable for use with plating machines wherein it is desired to advance and to retract anodes arranged transversely across or in a nest surrounding a plating machine work station, or cell, and to synchronize the anode movement with the operation of other functional parts of the machines.

What is claimed is:

1. Anode shifting device for a plurality of anode bars arranged in a generally rectangularly shaped anode nest, said device comprising means mounting said bars for reciprocating inward and outward movement with respect to said nest, and actuating means attached to said mounting means for causing said reciprocation.

2. Anode shifting device for advancing and retracting a plurality of anode bars arranged in a generally rectangularly shaped anode nest, said device comprising means mounting oppositely disposed bars of said plurality forming said nest for reciprocating inward and outward travel of said oppositely disposed bars with respect to said nest, and mechanical translating means connected to said means mounting said oppositely disposed bars for causing inward and outward movement thereof with respect to said nest.

3. Anode shifting device for advancing and retracting anode bars comprising a generally rectangularly shaped anode nest, said device comprising means to mount said bars for reciprocating inward and outward travel with respect to said nest, and translating means connecting adjacent ones of said bars together, said translating means including a lever pivoted upon a first fixed support and disposed completely outside of the rectangle defined by said anode bars, said lever being pivotally connected at one of its ends to one of said anode bars, and a bell crank pivoted upon a second fixed support and disposed completely outside of said rectangle, said bell crank being pivotally connected at one of its ends to said lever and at its other end to another one of said anode bars.

4. A work carrier selecting and anode shifting device comprising in combination a frame, a pair of arms carrying opposed track sections at the upper extremities thereof pivotally mounted on said frame at a point intermediate the ends of said arms, anode bar supports engaging the lower extensions of said arms, and movable thereby, each said anode bar support comprising an upright member carrying a plurality of anode supporting frames, and means associated with the upper portion of one of said pair of arms for moving said track sections toward each other and concurrently moving said anode bar supports away from each other, and means associated with the lower portion of one of said pair of arms for moving said anode bar supports toward each other and concurrently moving said track sections away from each other.

5. A device in accordance with claim 4 wherein said upright members support a first pair of opposed anode supporting frames disposed parallel to said track sections, and a second pair of anode supporting frames disposed between said first pair of frames, said two pairs of frames defining a generally rectangularly shaped anode nest, and means linking said second pair of frames to said first pair so that motion of said first pair of frames toward each other forces said second pair of frames to move toward each other, and vice versa.

6. A work carrier selecting and anode shifting device comprising in combination a support, at least one pair of anode supporting frames disposed parallel to each other and mounted on said support for motion toward and away from each other, a vertically reciprocable frame disposed on opposite exterior sides of said support and being laterally adjacent to said support when said frame is in its lowered position, a pair of opposed arms pivoted on said frame, the upper ends of said arms adapted to engage and support a work carrier therebetween, the upper ends of said arms being pivotal toward and away from each other, means for pivoting said arms, and means responsive to the motion of said arms effective to cause said each opposed one of said pair of anode supporting frames to move toward each other when the upper ends of said arms move away from each other, and vice versa.

7. A device in accordance with claim 6 wherein said anode supporting frames consist of one pair disposed transversely of said vertically reciprocable frame and another pair disposed parallel to the sides of said vertically reciprocable frame, said two pairs defining a generally rectangular shaped anode nest.

8. A device in accordance with claim 6 wherein said anode supporting frames consist of two frames disposed transversely of said vertically reciprocable frame.

9. A device in accordance with claim 8 wherein said means effecting movement of said anode supporting frames comprises a stationary toothed rack mounted on said support in contact with a pinion carried by the end of said anode frame, and a power-driven toothed rack disposed on the opposite side of said pinion from said stationary rack, said power-driven rack being energized when the upper end of said arm approaches the extreme limit positions of its pivotal movement.

10. Anode shifting device for advancing and retracting anode bars comprising a generally rectangularly shaped anode nest, said device comprising means mounting said bars for reciprocating inward and outward travel with respect to said nest, and translating means connecting adjacent ones of said bars together, said translating means including a lever centrally pivoted upon a first fixed support and disposed completely outside of the rectangle defined by said anode bars, said lever having a pin-in-slot connection at one of its ends to one of said anode bars, and a bell crank centrally pivoted upon a second fixed support spaced from said first fixed support, said bell crank being disposed completely outside of said rectangle and having at one of its ends a pin-in-slot connection to said lever and at its other end a pin-in-slot connection to another one of said anode bars, said lever and bell crank being arranged so that inward travel of said one anode bar produces inward travel of said other anode bar.

11. A straight line plating machine comprising an elongated plating tank, a plurality of generally vertical carrier selector arms arranged in two opposed rows along the sides of said tank, said arms being vertically movable and centrally pivoted for angular travel through a vertical angle between a carrier engaging and a carrier disengaging position, the upper ends of said arms being adapted to engage workpiece carriers when said arms are pivoted to said engaging position, rectangularly arranged anode bars supported above said tank for horizontal inward and outward travel with respect to the rectangle defined thereby, adjacent ones of said bars being linked together so that inward and outward driving forces applied to any one of said bars are translated to all of them to drive them all inwardly and outwardly respectively, one pair of said bars being disposed adjacent to and generally parallel with opposite sides of said tank, engaging shoes mounted exteriorly of said tank for guided travel toward and from said tank, said shoes being positioned to be engaged by the lower ends of said arms when said arms are lowered and to be driven toward and away from said tank by said arms when said arms are angularly reciprocated, said shoes being rigidly connected to respective ones of said one pair of bars, and positively actuated means to drive said arms in both angular directions between said engaging and said disengaging positions.

12. A straight-line plating machine comprising an elongated plating tank, a plurality of generally vertical carrier selector arms arranged in two opposed rows along the sides of said tank, said arms being vertically movable and centrally pivoted for angular travel through a vertical angle, means to drive said arms angularly

between a carrier engaging and a carrier disengaging position when said arms are lowered, the upper ends of said arms being adapted to engage workpiece carriers when said arms are in their carrier engaging position, rectangularly arranged anode bars supported above said tank and defining a generally rectangular work station therein, said bars being mounted for inward and outward travel with respect to said work station and being drivingly linked together so that inward and outward forces applied to one of said bars produce inward and outward forces respectively on all of said bars, drive members movably mounted exteriorly of said tank and positioned adjacent to the lower ends of said arms, said members being rigidly connected to opposite ones of said bars and being engageable by said arms when said arms are lowered for inward and outward drive upon angular reciprocation of said arms, said bars being driven inwardly when said arms are swung to their carrier disengaging position and being driven outwardly when said arms are swung to their carrier engaging position.

13. A straight line plating machine comprising carrier selector arms arranged in two opposed rows and mounted upon vertically movable horizontal pivots, said arms being vertically movable with said pivots and being selectively swingable through a vertical angle between first and second angular positions, said arms having carrier engaging means mounted thereon near the upper ends thereof, said engaging means being operative when said arms are in their first angular position and being inoperative when said arms are in their second angular position, rectangularly arranged anode supporting bars disposed between said rows, said bars being mounted for reciprocating inward and outward travel with respect to the rectangles defined by them and being drivingly linked together for synchronous movement, engaging means rigidly connected to opposite ones of said bars and positioned to be drivingly engaged by a pair of said arms for reciprocating said bars inwardly and outwardly through swinging movement of said arms.

14. Anode shifting device for advancing and retracting a pair of reciprocable anode bars arranged transversely across a plating machine and defining a work station therein, said plating machine being of the type having an elevator mechanism for raising and lowering workpieces out of and into said work station and including a selector mechanism to engage and disengage a workpiece carrier disposed at said work station for lifting and lowering of said carrier by said elevator mechanism, said device comprising means to mount said anode bars for smoothly guided reciprocating travel longitudinally with respect to said machine, interconnecting means cooperative with said bars to connect them for travel in mutually opposite directions, said interconnecting means also being effective to maintain said bars in spaced apart parallel relationship to each other, drive means to drive said bars controllably towards and away from each other, and control means responsive to the operation of said selector mechanism to control said drive means and effective to energize said drive means in a direction to drive said anode bars away from each other when said selector mechanism is positioned to engage a workpiece carrier disposed at said work station and to energize said drive means in the opposite direction when said selector mechanism is positioned to disengage a workpiece carrier at said work station.

15. Anode shifting device for advancing and retracting reciprocable anode bars arranged transversely across a plating machine work station, said plating machine being of the type having an elevator mechanism for raising and lowering workpieces out of and into said work station and having means for moving workpieces longitudinally when they are raised by said elevator mechanism, said device comprising fixed longitudinal ways poistioned at said work station adjacent to the ends of said anode bars, means to mount said anode bars upon said ways for smoothly guided reciprocating travel therealong, a shaft rotatably mounted adjacent to one of said anode bars and extending parallel thereto across said work station, a pair of pinions fixed on opposite ends of said shaft for rotation therewith, downwardly facing racks fixedly connected to the ends of said one anode bar and in engagement with said pinions, and means responsive to the operation of said elevator mechanism to drive said shaft selectively in opposite rotational directions, reciprocating rotational movement of said shaft being effective through said pinions and said racks to drive said one anode bar back and forth along said work station.

16. A plating apparatus comprising a tank, a plurality of anode nest locations spaced along said tank, anode supports on said tank at each said nest location, at least one pair of parallel spaced anode frames on said supports at each location, a vertically reciprocable frame disposed on either side of said tank and carrying a plurality of pairs of opposed track sections pivotally mounted thereon, means associated with each pair of said opposed track sections for pivoting said sections toward and away from each other and means associated with said anode frames responsive to the motion of said track sections for causing opposite ones of said spaced anode frames to move toward each other when said track sections separate, and vice versa.

17. A plating apparatus in accordance with claim 16 wherein said anode frames consist of one pair of frames disposed transversely of said vertically reciprocable frame.

18. A plating apparatus in accordance with claim 16 wherein said anode frames consist of a first pair of anode frames disposed parallel to the sides of said vertically reciprocable frame and a second pair of anode frames disposed transversely of said vertically reciprocable frame and said second pair are linked to said first pair whereby motion in one direction imparted to one of said frames disposed parallel to said vertically reciprocable frame causes opposite ones of said pairs to move toward each other, and vice versa.

19. Anode shifting device for advancing and retracting a plurality of anode bars arranged in a generally rectangularly shaped anode nest, said device comprising means mounting oppositely disposed bars of said plurality forming said nest for reciprocating inward and outward travel of said oppositely disposed bars with respect to said nest, actuating means connected to said means mounting said oppositely disposed bars so that said oppositely disposed bars move inwardly and outwardly with respect to said nest at the same time.

20. Device for shifting anode bars comprising a generally rectangularly shaped anode nest, said nest formed from separate anode bars constituting each of four sides thereof, means mounting said bars and means interconnecting said mounting means such that inward and outward movement of any one of said mounting means with respect to said nest causes the simultaneous inward and outward motion of the means mounting the anode bars constituting the other three sides of said nest.

References Cited in the file of this patent

UNITED STATES PATENTS

1,340,826	Greenwalt	May 18, 1920
1,427,877	Weeks	Sept. 5, 1922
2,588,910	Davis	Mar. 11, 1952

FOREIGN PATENTS

974,136	France	Feb. 19, 1951