

June 24, 1952

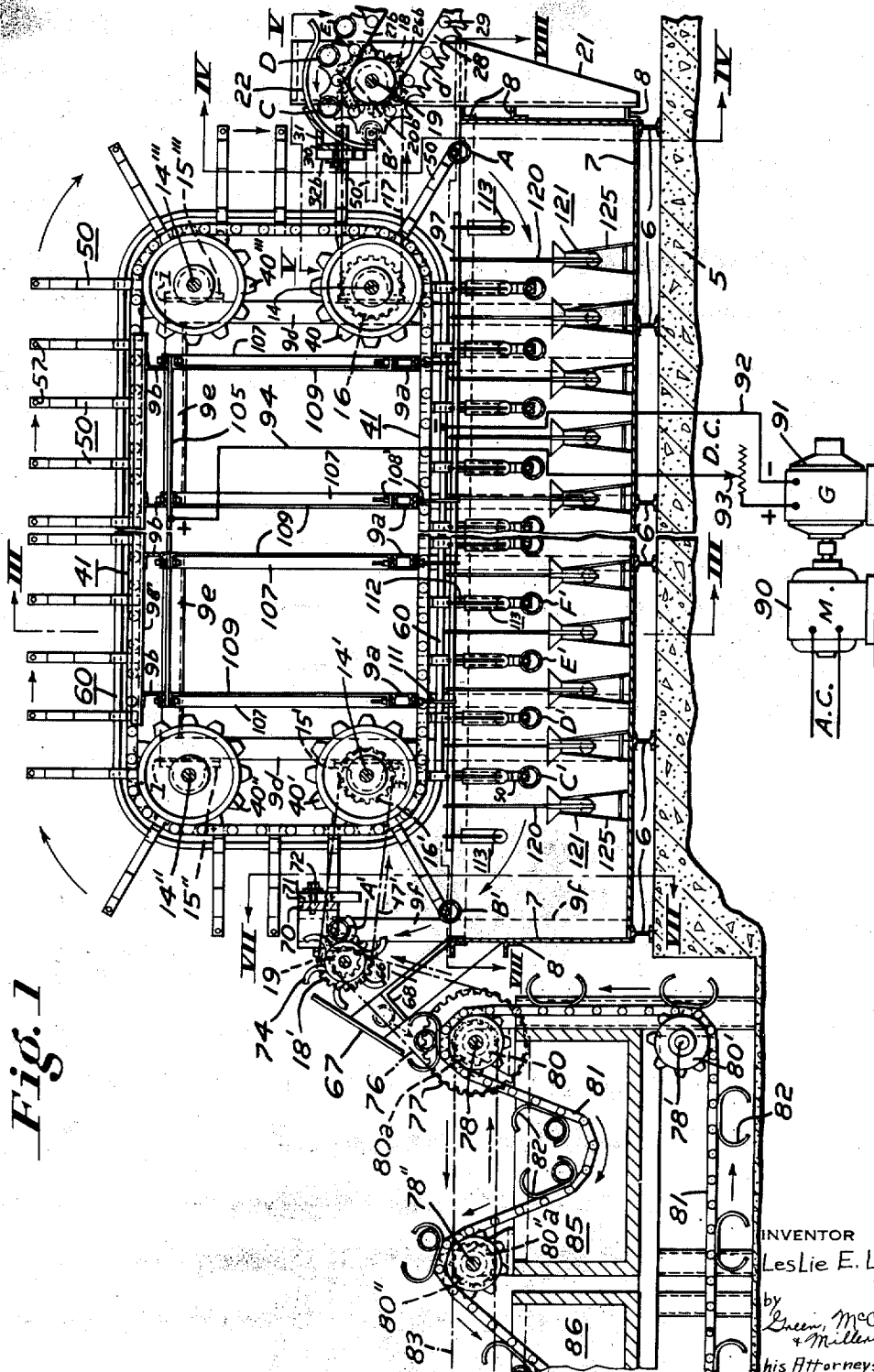
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ELECTROLYTIC TREATING APPARATUS

Filed Aug. 9, 1948

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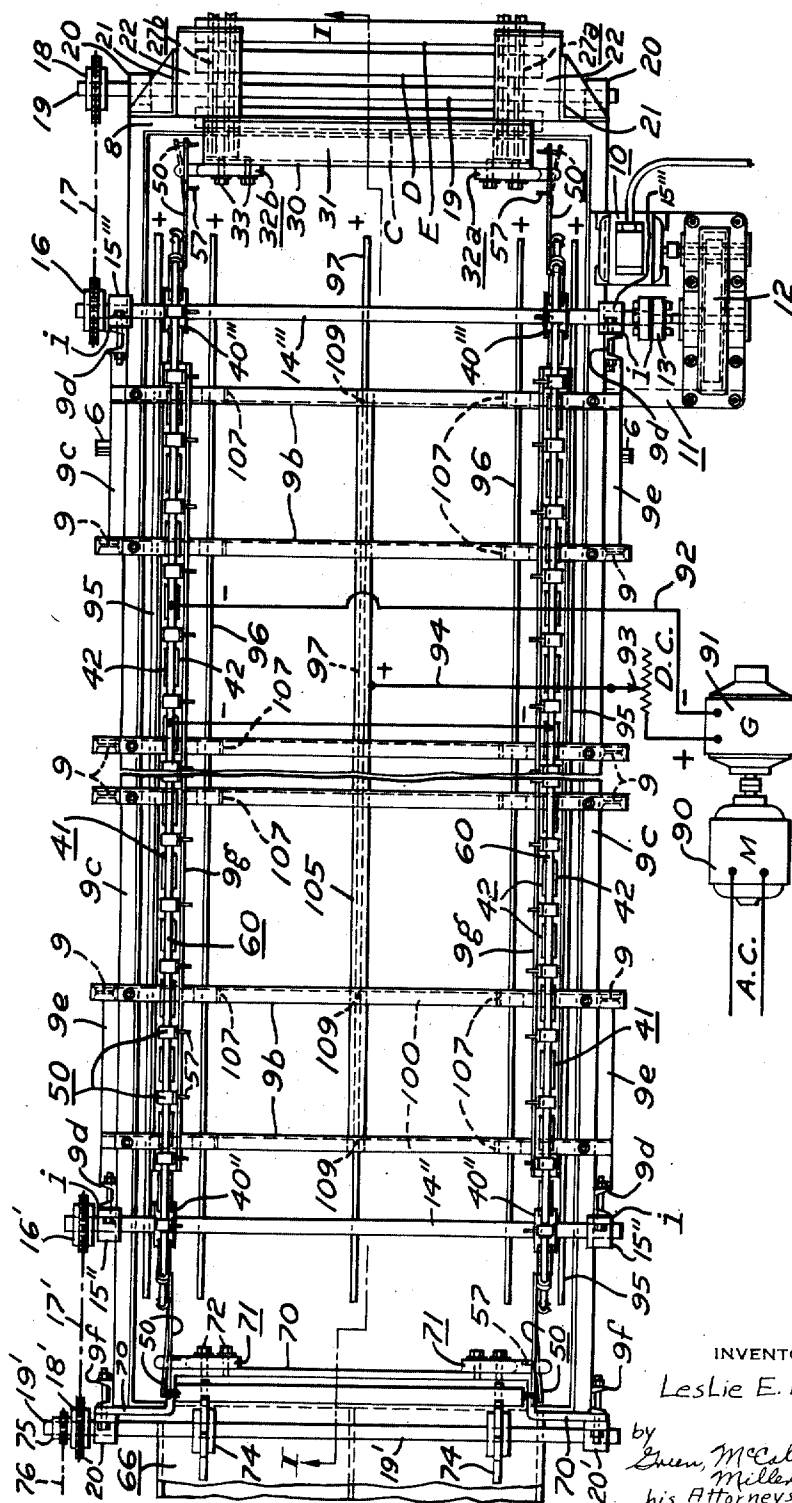
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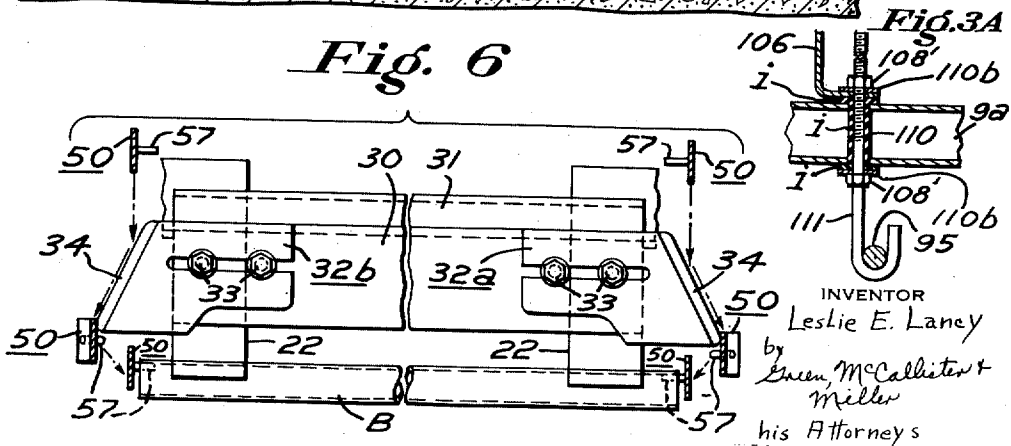
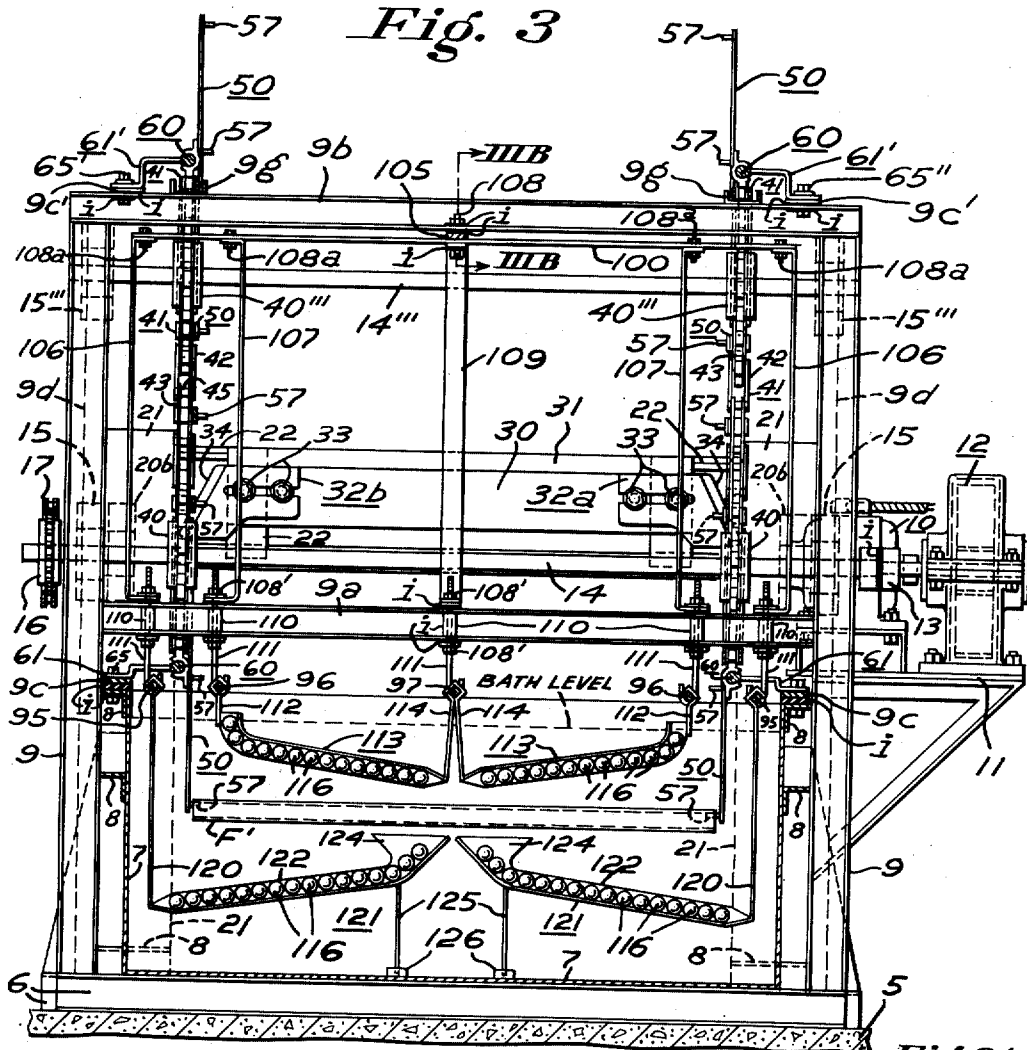
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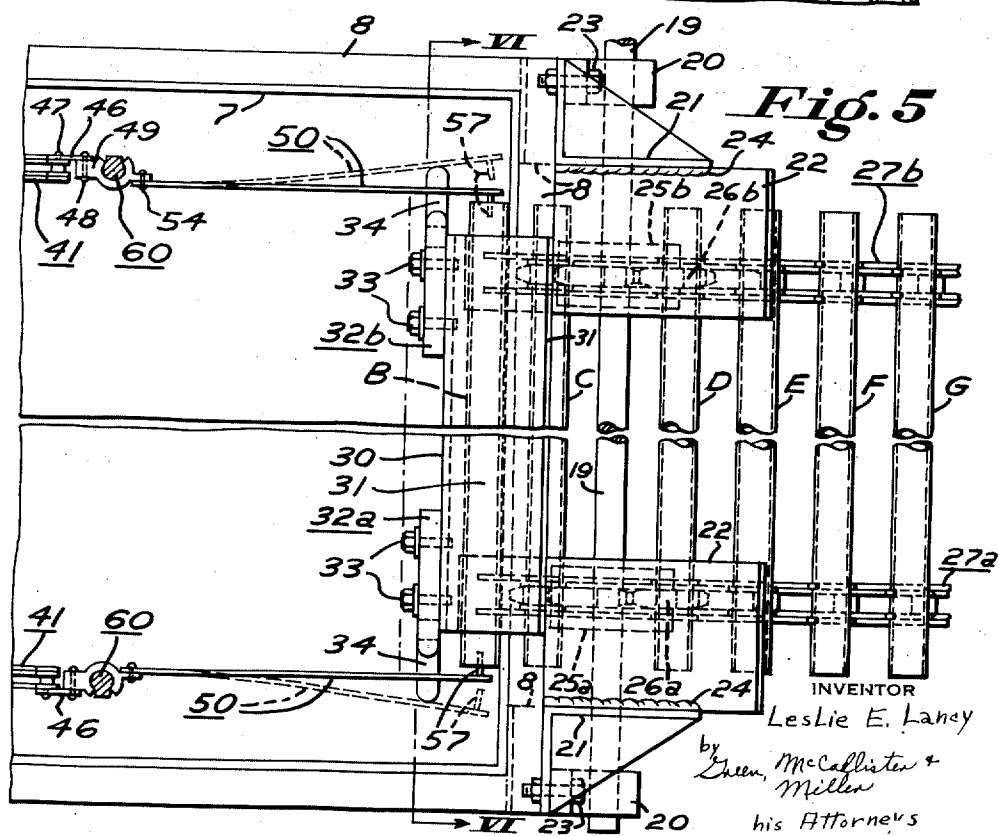
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Fig. 7

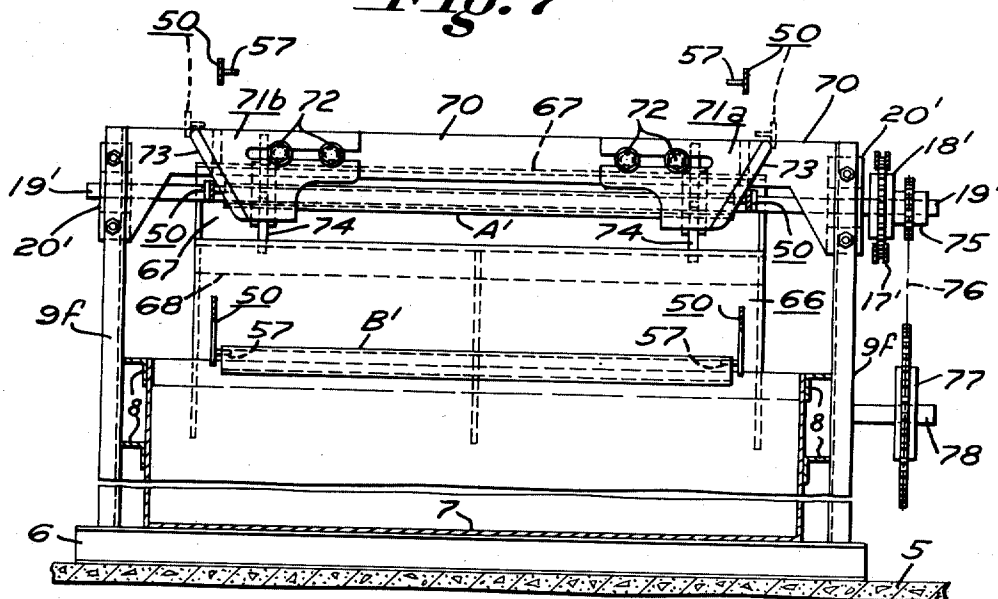
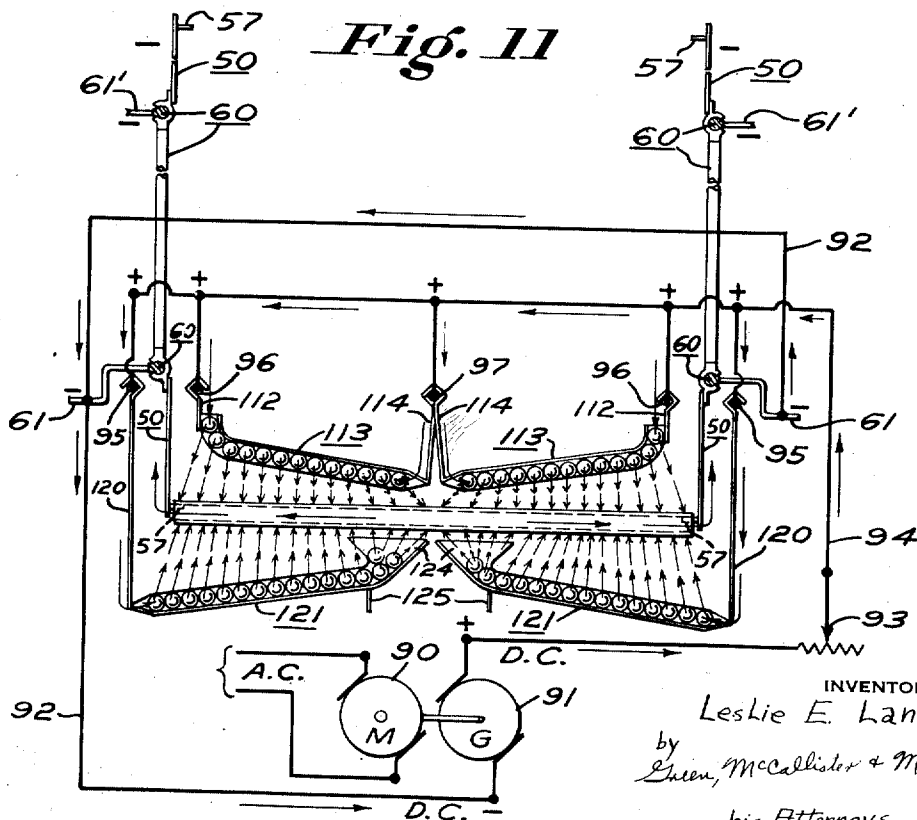


Fig. 11



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Fig. 8

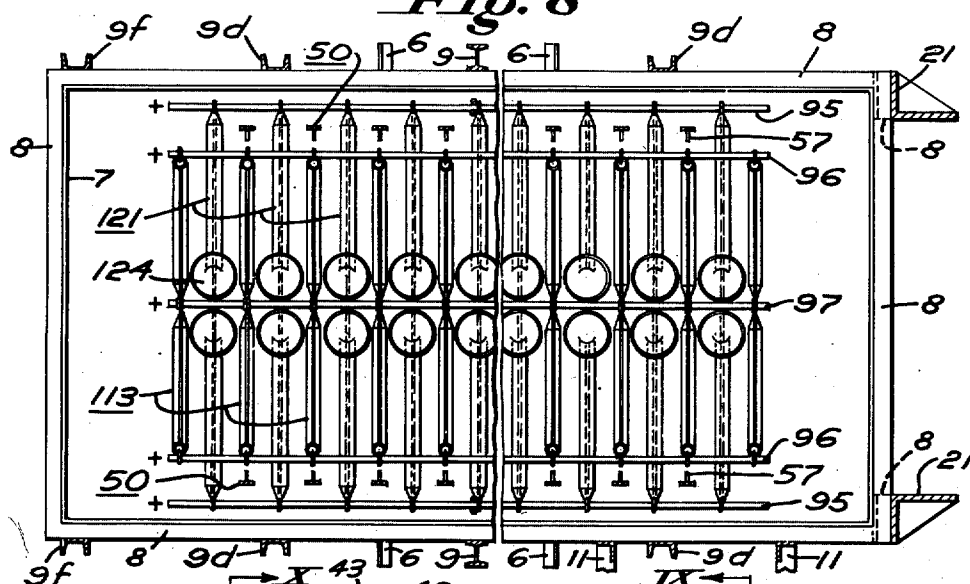


Fig. 9

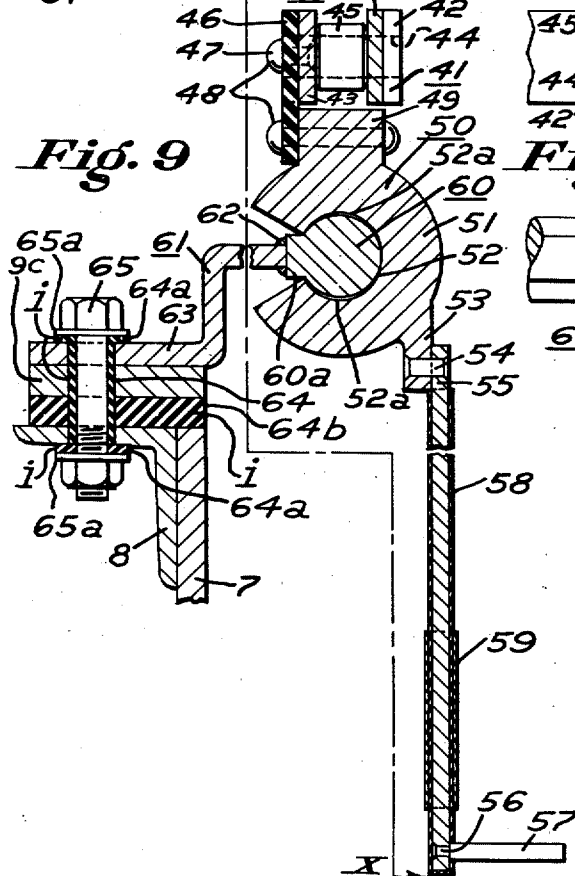
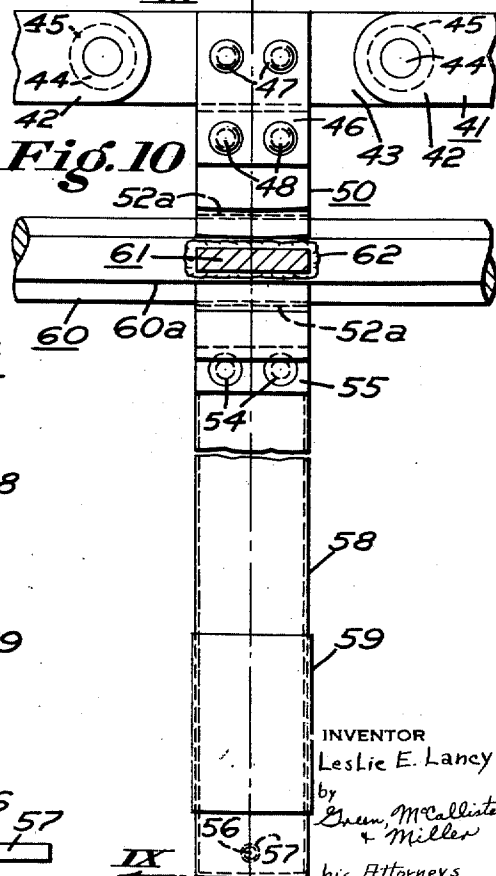


Fig. 10



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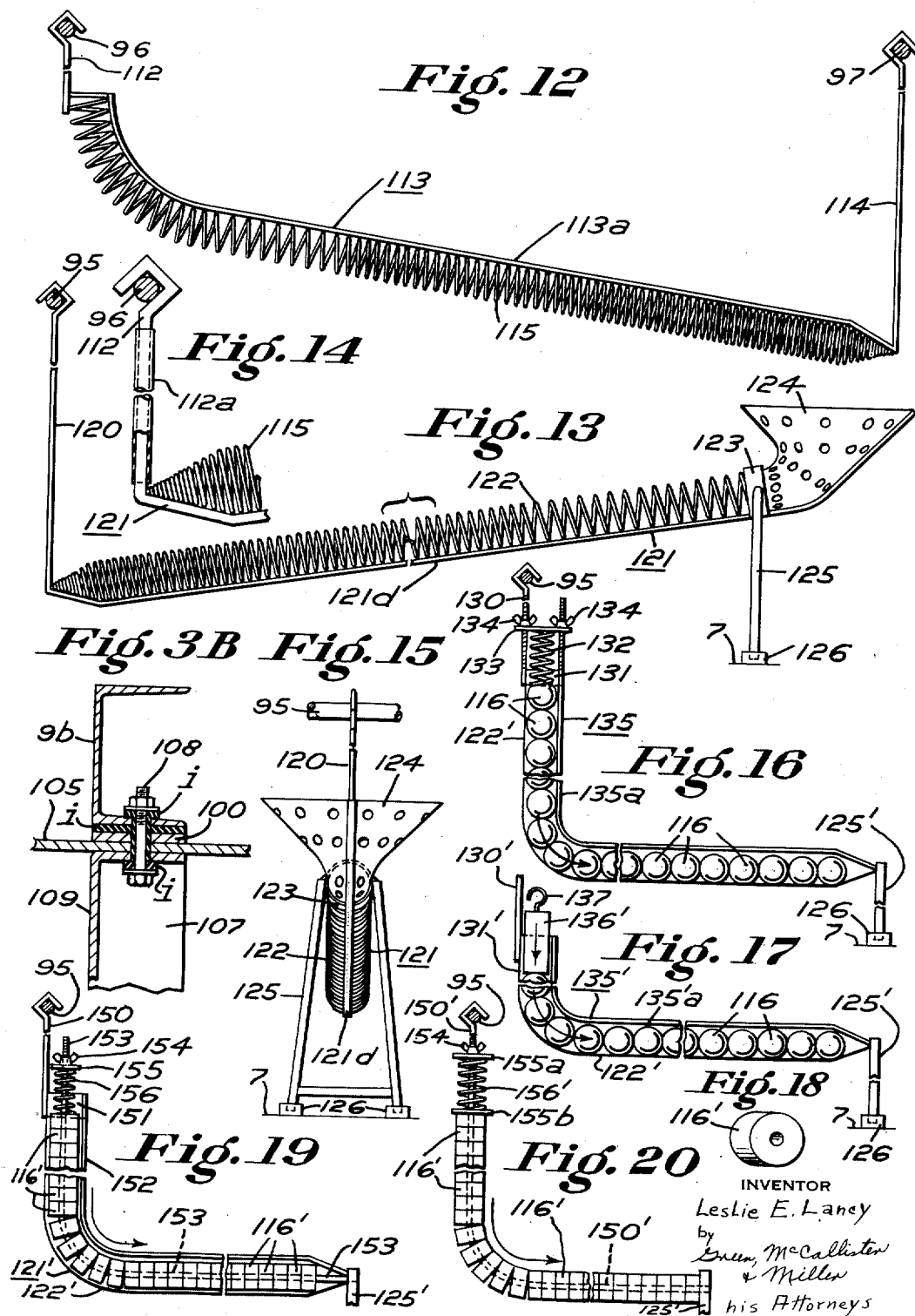
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ELECTROLYTIC TREATING APPARATUS

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UNITED STATES PATENT OFFICE

2,601,535

ELECTROLYTIC TREATING APPARATUS

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Application August 9, 1948, Serial No. 43,193

5 Claims. (Cl. 204-202)

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This invention relates to the electrolytic treating of articles such as tubes, tubular or formed shapes, rods, extrusions, sheets, wire, screen, etc., and particularly, to the treating of articles having a length or extent such that they cannot be readily treated in a conventional manner. My invention is of a special importance in connection with the treatment of tubular lengths.

Previous to my present invention, one method has been to advance articles through a treatment bath by a series of sweeping devices that employ moving fingers and guide channels. In accordance with this procedure, the articles rest loosely on the guide channels and are advanced therealong by a progressive series of rotating sweep-fingers.

In accordance with another method, a current-carrying conveyor is used for moving detachable, article-holding, rectangular metal racks through a treatment bath. A plurality of such independent racks are provided and work articles are manually mounted within the periphery of the rectangular framework of the racks. The racks are then manually hung from the carrier. At the completion of the treating operation, the racks are manually removed from the carrier and the treated articles manually removed from the racks. Thus, at least two men are needed at each end of the treatment bath. It will be appreciated that this is a time and labor consuming procedure. Also, such a procedure is disadvantageous from an electrical efficiency standpoint. That is, the portions of a rack or other supporting structure for the work articles that are submerged in the bath during the treatment operation will, themselves, be acted upon by or will influence the action of the treating bath. The rack extends along a lower side of the work article in the bath and portions of the rack below the article tend to mask or prevent a free flow of electrical charges about peripheral sides of the article. If the operation is a cleaning operation, then the submerged portions of the rack will be gradually eaten away, and if the operation is a plating operation, the submerged portions of the rack will take up coating material. Even if such a rack could be made of dielectric material, I have determined that its lower vertical portions and its transverse connection portion would tend to shade the treatment of the work article.

Basket as well as slab types of electrodes have been used by those skilled in the art. Slab electrodes must be cast into a certain shape and at least portions of the structure must be then torn down and the solution removed from the bath

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container to replace them. Heretofore, a basket type of electrode has only been used where a gravity flow of its ball elements has been possible and its feed end can be located above the bath level. Thus, when a horizontal electrode is required, it has been customary to use a slab type.

In accordance with my procedure, the articles are carried by a pair of transversely-aligned, electrical-current-carrying arms which hold the articles adjacent their opposite ends. Such arms are rigidly or integrally mounted upon a conveyor apparatus which includes a pair of transversely-spaced-apart conveyors. Such conveyors are synchronized for simultaneous operation, in order that the arms of one conveyor may be aligned and kept in alignment with transversely-opposite arms of the other conveyor during the movement of the apparatus. The article-carrying arms may be an integral or rigid part of the pair of conveyors. Such conveyor apparatus is insulated electrically from the arms. Each arm of a pair of cooperating arms extends or projects adjacent opposite sides of the apparatus, and is in substantial alignment with an end portion of a work article being carried. There is no masking of current flow through the treating solution to the work article below its point of support, or as to its outer side periphery.

In accordance with my invention, masking is practically eliminated, both from the standpoint of support arms interposed in the path of movement of current through the bath to surface portions of the work articles that are to be treated, as well as from the standpoint of electrolytic action upon such support arms.

These and other conventional procedures have a number of disadvantageous features which limit their application and use, which complicate the apparatus employed, which are inefficient or wasteful in the transmission of electric energy, which limit sizes and shapes that may be treated, which tend to mask or cover at least a portion of the surface of the articles that are to be coated or treated, and which make it difficult and expensive to replace or renew the electrodes that are located in the treatment bath.

I have been able to, in accordance with my invention, eliminate the disadvantageous features of prior procedure and apparatus by an entirely new approach to the problems involved. I have been able to solve the problems heretofore presented by the art in question, to overcome the limitations as to the size and shape or articles to be treated, and to simplify the overall construction and operation of the apparatus and to

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provide an improved efficiency of electrolytic treatment. Although for the purpose of describing my invention, I will particularly show apparatus and procedure as applied to members having a relatively long, tubular extent, it will be apparent that the principles of my invention may be applied to any suitable shape or size of article which is to be conditioned or treated. The arrangement of apparatus is now such that shading of current flow to the articles being treated is substantially eliminated, a more efficient and practical, as well as a simplified construction and maintenance of the equipment may be effected, and the overall treatment procedure is materially speeded-up.

In accordance with my invention, the work objects, pieces, or articles may be continuously subjected to treatment while they are being carried through a treatment cycle or zone in a substantially horizontal position.

Optimum electrode spacing and ease of handling through a number of treatment cycles follows as a result of my invention. That is, it is now possible to treat a continuous succession of work objects or articles at a high current density and in such a manner that the treating solution is concentrated over the full desired surface area of the work articles and that losses in transmitting current from bus bars to the articles are greatly minimized. Relatively large amounts of current can be delivered directly to the articles, due in part at least, to relatively large contact surfaces and to more direct and intimate contacts between the current-carrying bus bars and the work articles. The lack of obstructions, like guides, tracks, etc., provides complete freedom in effecting the most suitable location and replenishment of the bath electrodes. The apparatus employed lends itself perfectly to automatic loading and unloading systems and can be incorporated as a unit of a material handling system to receive the work articles for treatment and to deliver them as processed. One or more electrolytic and processing treatment units can also be readily connected in series by continuous conveying mechanism.

Briefly summarized, the articles to be treated are picked up by a continuously moving conveyor apparatus which, itself, need not be current-carrying. This conveyor apparatus is provided with a pair of transversely spaced-apart continuous conveyors and each conveyor is provided with a series of outwardly-projecting and longitudinally spaced-apart arms. This arrangement provides a plurality of pairs of substantially horizontally or transversely-spaced-apart and substantially aligned arms which are moved by the conveyor apparatus along current-carrying bus bars, and are provided with fingers, hooks, etc., constructed and arranged to pick up a work article or a plurality of articles at one end of the treatment apparatus, for example, from a conveying mechanism. The article is positively carried through the treatment bath, is supplied with current during such movement, and is discharged at the other end of the treatment bath on a conveying mechanism, for example. The fingers, contactors, hooks, or work article-carrying elements of the arms are preferably positioned to engage the article adjacent opposite ends thereof. The engagement is effected in such a manner that current is efficiently carried to the work articles and without materially masking or shading surface areas of the articles which are to be treated. For example, in the illustrated

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embodiments, the article-holding elements which are also electric contactor elements, engage opposite ends of the article and extend into the interior thereof.

Cam mechanism is provided for periodically separating the article-holding or contactor elements in accordance with the position of the conveying system, in order to, as previously pointed out, automatically pick up the articles and automatically deliver them after treatment.

In accordance with my invention, I also provide a longitudinally extending, current-carrying common or main bus bar for the bath electrodes and mount a spaced series of drop frames on such main bus bar which are directly connected to the bath electrodes. The main bus bar, as well as the drop frames and the various connections may be of a highly conductive metal such as copper. The drop frames are longitudinally spaced-apart, and each frame has a transversely-extending bus bar and a plurality of transversely-spaced-apart, vertically-extending bus bars secured thereto and to the electrodes. The number of individual frames may correspond substantially to the number of electrodes and in spacing to the spacing of such electrodes. In this connection, in an ordinary galvanizing procedure, I have successfully employed a frame spacing of about 5 feet. Line drop of current being carried is practically nil. Although, I prefer to employ a plurality of suitably positioned electrodes, my conveyor apparatus can also be employed where the container, itself, is an electrode.

I have also provided an improved type of electrode having replaceable elements which may be utilized where both of its end portions are under the level of the treating fluid or liquid and where full gravity movement of electrode elements is not possible or practical. Contrary to belief of those skilled in the art, a flexible type of electrode can be successfully used, even where the electrode support or housing must be fed through a portion of the depth of the fluid level of the treatment bath and even where full gravity movement of its elements is not practical. I am able to use a flexible or a basket type of electrode of a suitable shape and to locate it in any suitable location for most efficient treating action within the treatment bath.

Another important feature of my invention rests upon the fact that conveyor apparatus for moving work articles through the treatment zone or bath is not, itself, current conducting. The conveyor apparatus carries a minimum arm structure for supporting the work articles and such structure is, itself, secured to the conveyor apparatus for movement thereby. The arm structure cooperates with or slides along electrical bus bars which are insulated from other parts of the apparatus, including the conveyor apparatus. It is no longer necessary to conduct current through steel chains or relatively poor conductors, in that the current may be directly carried by short lead members which are of highly conductive material, such as copper, aluminum, etc. Metal parts used for supporting and conducting current to the work articles can be insulated from the bath by suitable dielectric sleeves. The efficiency of the overall plating operation is increased, current is conserved, and wear and tear on the article-handling and current-conducting portions of the apparatus is minimized.

I have also provided an improved electrode

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arrangement wherein the work articles are carried through the treatment bath between suitably spaced electrodes that are located on opposite sides thereof. Such reverse electrodes are so located and constructed that they can be readily replaced or recharged as they are used up by treating or processing operations. That is, the reverse electrodes can be provided with additional plating metal or electrode elements, without shutting down the apparatus and without partially dismantling it.

I have provided force-generating means for feeding electrode shapes, elements, portions, or segments and for holding them in close abutment, either by gravity or by kinetic energy. Thus, the feeding or replenishing operation as to the electrode elements may be effected by positioning the electrodes on an inclined horizontal plane or by employing pneumatic, hydraulic, spring, or other suitable force-applying means to advance and hold their segments or elements in a proper position with respect to each other. That is, the electrode support or housing can be shaped and positioned in a manner most suitable for effective current distribution. In this connection, suitable discs, balls, quoits, flat-tops, dumbbells, cone shapes, or suitable anode plating material can be supplied to the electrode as the need arises, and thus, as they are used up by the electrolytic treating operation. Although conventional slab electrodes can be used, I prefer to employ somewhat flexible electrodes for this purpose. Such shapes can, in accordance with my invention, also be employed for electrodes that are located underneath the work articles or pieces. The feeding of new pieces of fresh metal may be effected and a positive contact between the shapes may be maintained, regardless of whether the electrodes are positioned on a horizontal, vertical, or an inclined plane. The electrode shapes can be dropped into an electrode housing or container from above the level of the bath solution, regardless of whether a feed end of the electrode is mounted above or below the level of the bath. They are then forced along the support member or housing by their own gravitational force alone, or by an added weight, by spring tension, hydraulic or pneumatic pressure alone, or in combination with gravitational force.

The electrode or anode housing, container or support provides a continuous line of electrode or anode shapes along the desired length of the electrode which can be readily placed at a suitable location for most efficient electrolytic action and, as previously pointed out, can be kept in a fully charged relationship by adding additional shapes thereto, as needed.

It has thus been an object of my invention to provide new and improved procedure for electrolytically treating work articles;

Another object has been to eliminate the disadvantages of prior art procedures and constructions by finding a practical solution to the problems involved;

A further object of my invention has been to broaden the scope of efficient utilization of electrolytic treating procedure, and particularly, from the standpoint of shapes having a greater length or extent;

A still further object has been to devise improved apparatus for handling or advancing articles through a treatment bath;

A still further object has been to provide new and improved forms of electrode constructions

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and arrangements for electrolytically treating articles during their movement through a bath; These and many other objects of my invention will be apparent to those skilled in the art from the illustrated embodiments thereof.

In the drawings:

Figure 1 is a longitudinal section taken on the line I—I of Figure 2; upper and lower electrodes are shown diagrammatically in outline;

Figure 2 is a top plan view of the apparatus of Figure 1; in this view, the bath electrodes have been omitted;

Figure 3 is a transverse section looking towards a front end of the apparatus and taken along the line III—III of Figure 1;

Figure 3A is an enlarged detail showing a method of insulating and mounting bus bar hangers on structural support members, see the embodiment of my invention shown for example in Figure 3;

Figure 3B is an enlarged sectional detail taken on the line IIIB—IIIB of Figure 3;

Figure 4 is a front end sectional detail in elevation showing means for opening the work article contactors or holding fingers to pick up an article at the front end of the treating apparatus and is taken along the line IV—IV of Figure 1;

Figure 5 is a top sectional detail taken at the front end of the apparatus arrangement of Figure 1 and along the line V—V of Figure 1;

Figure 6 is a vertical end sectional detail along the line VI—VI of Figure 5; the view shows the movement of work article-carrying arms in conjunction with cam members and an article B;

Figure 7 is a back end vertical section showing means for releasing the articles being treated at the delivery or back end of the apparatus and is taken along the line VII—VII of Figure 1;

Figure 8 is a horizontal plan section taken below the conveyor apparatus of Figure 1 and along the line VIII—VIII of Figure 1;

Figure 9 is an enlarged vertical sectional detail showing how pairs of article carrying arms are electrically connected to the bus bars for providing an efficient and continuous flow of current to the arms, while they are being advanced through the treatment bath by the conveyor; this figure is taken along the line IX—IX of Figure 10;

Figure 10 is an enlarged sectional detail taken along the line X—X of Figure 9;

Figure 11 is a somewhat diagrammatic end view in elevation showing electrical features or connections for the apparatus of Figure 1;

Figure 12 is an enlarged view in elevation, taken endwise of the apparatus of Figure 1 and illustrating a form of upper electrode or electrode holder;

Figure 13 is an enlarged side view in elevation of a lower electrode or electrode holder, taken endwise of the apparatus of Figure 1;

Figure 14 is a still more enlarged fragmental detail, taken from one end of the electrodes of Figures 12 and 13 and illustrating a dielectric sleeve for protecting drop supports or connections from the electrolytic bath;

Figure 15 is an enlarged end view taken from the right hand side of the electrode or holder of Figure 13;

Figure 16 is an enlarged side view similar to Figure 12 and illustrating a modified form of electrode;

Figure 17 is a view similar to Figure 12, but illustrating another form of electrode;

Figure 18 is a greatly enlarged perspective view

showing a doughnut or flat disc type of electrode shape which may be employed in connection with the electrode embodiments shown in Figures 19 and 20;

And, Figures 19 and 20 are enlarged side views in elevation of further forms of electrode constructions that may be utilized in accordance with my invention.

Referring particularly to Figures 1 and 2 of the drawings, I have shown an apparatus arrangement and suitable electrical connections for electrolytically treating work articles, such as metal tubing. The work articles to be treated are represented by capitalized, alphabetical designations. I have shown a series of work articles designated A, B, C, E, etc., being fed to a front end of a conveyor of the treating apparatus by means of a pair of transversely-spaced-apart, article-holding chains 27a and 27b of a delivery conveyor mechanism. After the treatment operation, the articles indicated A', B', C', etc., are progressively discharged upon a delivery guide table 66, and thence, to a conveyor mechanism which may be employed to move the articles progressively through suitable washing, rinsing, or other processing baths 85 and 86. The entire layout may be driven in synchronism, for example, by a single motor 10, see Figure 2.

Referring particularly to Figure 1, the apparatus layout is mounted on a suitable foundation 5. Transversely-extending I-beams 6 are mounted on the foundation 5 and are secured or welded to the bottom of a tank enclosure or container 7 that may be employed to receive the treating bath or liquid. At the front end of the apparatus, to the right of Figure 1, a work article feeding mechanism or system is mounted on a front end of the container structure by means of transversely-extending angle pieces or members 8. The delivery mechanism is provided, as shown particularly in Figures 1, 2, and 5, with a pair of oppositely-spaced-apart, upright support members 21 of angular shape. Back flange portions of the upright members 21 are welded or secured to the transverse angle members 8, and side flange portions thereof are welded at 24 to a pair of oppositely-positioned, longitudinally-extending, curved, retaining guide members 22, see Figures 1 and 5.

Referring particularly to Figure 2, a motor 10 is mounted on an extending support member 11 which is secured to the structure of the container 7 and additionally mounts a speed reduction unit 12. The speed reduction unit 12 is driven by the motor 10, and in turn, actuates a primary drive shaft 14 through an insulating drive coupling 13. The letter *i* indicates insulating material where used in the drawings. The shaft 14 is journaled at its opposite ends within bearings 15 which are mounted upon vertical upright channels 9d of the outer frame structure of the container or tank 7, and which are also insulated from the channels 9d. A chain-sprocket 16 is secured on the other end of the shaft 14 to drive a sprocket wheel 18 through a chain 17. The sprocket wheel 18 is secured on a delivery conveyor driving shaft 19. The shaft 19 is journaled adjacent its opposite ends within bearings 20 which are mounted on the upright members 21.

As shown particularly in Figures 1 and 5, a pair of spaced-apart conveyor-chain-mounting wheels 25a and 25b which carry chain sprockets 26a and 26b, are secured on the drive shaft 19 for actuation thereby. It will thus be apparent

that work articles A, B, C, etc., will be advanced progressively towards the front end of the treating bath by apparatus link chains 27a and 27b and under the retaining guide members 22. As shown in Figure 1, the work articles rest in outwardly-concave, slotted members of the chains 27a and 27b and extend thereacross, see particularly Figure 5.

After a work article has reached the position indicated by the article B of Figure 1, then means is provided for gripping the article adjacent its opposite ends to advance it along the inside of the bath container 7. As shown particularly in Figures 4 and 5, a continuous conveyor apparatus is positioned above the container 7 for progressively advancing the articles longitudinally therealong. In this connection, it will be seen particularly from Figures 2 and 3, that there are two transversely-spaced-apart conveyors which are connected together for simultaneous operation and which extend along opposite sides of the container 7. Due to the similarity of these two conveyors I have used the same numbers to designate them. The pair of conveyors are driven by the primary drive shaft 14 through the agency of a pair of oppositely-positioned, chain sprocket wheels 40 which are secured on the shaft 14 for rotation therewith.

I have shown, see Figure 1, three secondary drive shafts 14', 14'', and 14''' located in a somewhat rectangular relationship with respect to primary drive shaft 14 which with the shaft 14 support and drive a pair of transversely-spaced-apart conveyor chains 41. Each of these three shafts is provided with a pair of sprocket wheels which are shown positioned on common vertical planes taken along opposite sides of the conveyor. That is, the sprocket wheel pairs 40', 40'', and 40''', like the sprocket wheel 40, are secured to their respective shafts 14', 14'' and 14''' for rotation therewith and for common actuation by the primary drive shaft 14, its sprocket wheel 40 and the pair of chains 41. As disclosed in Figures 1, 2, 3, 9, and 10, each chain 41 has interfitting connector links 42 and 43 that are pivotally connected by pins 44. As shown particularly in Figures 9 and 10, the pivot pins 44 carry chain rollers 45 that also hold the container links 42 and 43 in a suitably spaced relationship with respect to each other. Spaced links 43 carry article-carrying arms 50 that are securely mounted thereon to extend therefrom by dielectric connector pieces 46 which insulate the current carrying arms 50 from the conveyor apparatus. Each piece 46 is secured adjacent one end to the link 43 by dowel or rivet pins 47 and adjacent its other end upon a mount portion 49 of the arm member 50 by dowel or rivet pins 48.

The arms 50, as shown particularly in Figure 9, are provided with a central body portion 51 having a somewhat circular bore 52 to slidably receive a continuous bus bar 60, principally of circular cross section and having a rib, track, or guide portion 60a of rectangular section, see Figure 1 for longitudinal elevation of complete bus bar. It will be noted that the surface of the bore 52 is offset at 52a along a major portion of its length with respect to portions of the circular cross section of the bus bar 60. As a result, the electrical contact between the central body portion 51 and the bus bar 60 is a wedging contact between substantially-opposite, front and back sides of the bus bar. Thus, the slide area is minimized and an efficient electrical contact is maintained. The track or rib 60a also

holds the arms 50 against lateral movement. That is, arms 50 can not rotate on bus bar 60. The work article carrying arms 50 are adapted to be moved by chains 41 along the pair of bus bars 60 with a wiping joint action. The clearance provided at 52 prevents binding when member 51 passes along a curved part of bus bar 60.

The body portion 51 of each arm member 50 is provided with an outwardly-projecting portion 53 integral therewith upon which an extension arm member 55 is securely and rigidly mounted by dowel or rivet pins 54, see Figures 9 and 10. The extension arm members 55, as shown particularly in Figure 3, are adapted to extend below the level of the bath, as indicated by a transverse, horizontal, dotted line of the figure. Thus, it may be desirable, as shown in Figure 9, to provide each of the extension arm members 55 with a dielectric sleeve, insulation, or plastic coating 58 along its length. I also prefer to provide a hard, wear-resistant sleeve 59 which is contacted by cams 32 and 71 for spreading or flexing the extension arms 55 adjacent front and back ends of the apparatus to progressively pick up work articles at the front end and to progressively discharge work articles at the back or delivery end thereof. The sleeve 59 may be of metal if the dielectric sleeve 58 is used, or if desired, may be of a hard, wear resistant dielectric material, such as hard rubber or plastic. A suitable transversely-extending finger 57 is rigidly secured to extend from an end portion of each arm extension member 55 as by a pin or rivet portion 56 which is integral with the finger 57 and which provides a secure and rigid electrical contact with the metal of the arm 55, and thus with one of the pair of electrical bus bars 60.

Each work article, A, B, etc., rests upon an oppositely-aligned pairs of fingers 57, adjacent opposite ends of its length, while it is being moved in a transverse position longitudinally along the container 7 by the pair of spaced-apart, side-positioned, continuous chains 41. Regardless of whether or not a dielectric sleeve 58 is used, I prefer to provide a contact sleeve 59, not only to serve as a wear-resistant surface, but also, as a dielectric sleeve to insulate each current carrying extension arm member 55 from the other metallic parts including the opening cams 32 and 71.

In Figures 4, 5, and 6, I have shown mechanisms for spreading apart or flexing the arm members 55 which are preferably of spring-metal construction. When as shown in Figure 1, a particular work article is delivered to the position of the article C by the conveying chains 27a and 27b, the movement of the bath conveyor causes one pair of arm extension members 55 to be flexed outwardly by a stationary cam mechanism. The mechanism has a front, transversely-extending, face plate portion 30 which has a somewhat angular-shaped top portion 31 (see Figure 1) which may in turn be welded to the retaining guide members 22 of the chain conveying system 27a and 27b. The members 30-31 may be formed by bending a plate or angle. As shown particularly in Figures 4 and 6, cams 32a and 32b are mounted on the face plate member 30 by threaded adjustment bolts 33. The cam members 32 are bifurcated or slotted to receive the bolts 33 and to permit their horizontal adjustment along the face plate member 30. Once a proper adjustment has been made, the oppositely-spaced-apart cams 32a and 32b are secured by tightening the bolts 33. Each

of the cams is provided with a downwardly and outwardly projecting cam surface 34, when the movement of the conveyor 41 is in a clockwise direction, as shown in Figure 1.

It will be apparent from a comparison of Figures 1, 5, and 6, that the cam surfaces 34 spread or flex the extending arm members 55 to positions indicated by the dotted lines of Figure 5 (see also the diagrammatic view of Figure 6) to open them to receive a work article, such as B of Figure 1. The extending arm members 55 are automatically closed or returned to their original full-line positions of Figure 5 after the cam contact portions 59 have ridden over the full extent of the cam surfaces 34. The work article, such as A of Figure 1, then falls upon the fingers or contactor pins 57 and rests thereupon during movement through the container 7.

To deliver work articles, such as A' of Figure 1 at the back or delivery end of the apparatus and after the treating operation, a somewhat similar form of cam mechanism is provided to again spread the extending arm members 55 apart to release a treated work article as it is being raised from the container 7 by its conveyor. Referring particularly to Figures 1 and 7, a face plate member 70 is bolted at its opposite ends to a pair of vertically-extending structural channel members 9f that are secured to the container member 7 by the transverse angle members 8. A pair of cams 71a and 71b are adjustably mounted adjacent opposite ends of the member 70 and are bifurcated or slotted to receive threaded bolts 72 in a manner similar to the cams 32a and 32b of the front mechanism. Also in a like manner, the cams 71a and 71b are provided with cam faces 73 which by reason of the direction of rotation of the conveyor 41, incline upwardly and outwardly, as shown in Figure 7, to engage the contacting wear portions 59 of the extending arm members 55 and to move their fingers 57 out of engagement with the work article A' which is to be discharged to a suitable conveying mechanism or system which will be herein described.

As shown particularly in Figures 1 and 2, a drive shaft 19' for the delivery conveying mechanism is journaled in bearings 20' which are bolted to the upright channels 9f and to the face plate member 70 of the cam mechanism. A sprocket wheel 18' secured on one end of the shaft 19' for rotation therewith is driven by a chain 17' and a chain sprocket 16' which is secured on the end of one of the secondary drive shafts 14'. The shaft 19' also carries a pair of spaced-apart finger wheels 74, see Figures 1 and 2, which are secured thereon in a transversely spaced-apart relationship to periodically receive an article, such as A' or B', etc., from the conveyor of the treating bath apparatus after a pair of conveyor arms 50 and their fingers 57 have released the work article. A backwardly-extending guide bracket member 65 is secured upon a back wall of the container 7 and is provided with a top guide plate 67 and a lower guide plate 68 (see Figure 1), to guide a work article when it is discharged from the finger wheels 74 upon a delivery conveying mechanism. In this connection, see the tubular work article shown between the guide plates 67 and 68 by dot and dash lines, and the dotted arrow showing the direction of the travel of the work article.

By way of illustration, I have shown processing bath containers 85 and 86 through which the delivery conveying system or mechanism may move the treated work articles. This conveying

system is driven by a small chain sprocket wheel 75 (see Figure 2) that is secured on the end of the shaft 19', by a chain 76; and by a large sprocket wheel 77, see Figure 1. The sprocket wheel 77 is secured on a transverse shaft 78 which is journaled on the container 85 and which carries a pair of spaced-apart conveyor chain sprockets 80 secured thereon. Transversely-opposite endless link chains 81 mesh with the sprocket wheels 80, 80', 80'', etc., that are secured in pairs on shafts such as 78' and 78'', etc. Any suitable number of sprockets and shafts may be employed to provide a continuous conveying system. The pair of endless conveyor chains 81 are provided with a series of outwardly-projecting work-article-receiving loop elements or carriers 82 into which a work article is delivered from the guide member 66. The work articles may be carried from the bath 85 to the bath 86 and delivered to a stock pile or to further treating apparatus. In Figure 1, the conveyor chains 81 are constructed and arranged to rotate in a counter-clockwise direction. The upper sprocket pairs 80, 80'', etc., are provided with secondary sprocket pairs 80a and 80'a for receiving an endless drive chain 83 which permits a sag of the conveyor chains 81 into the containers 85 and 86.

Referring particularly to Figures 1 and 2, the treatment bath conveyor chain sprocket wheels 40, 40', 40'' and 40''' are positioned by a substantially rectangular support frame which comprises, upright channel members 9d on opposite sides of the apparatus and longitudinally-extending channel members 9e which are welded or secured to the upper ends of the spaced-apart channel members 9d and to I-beam columns 9 to extend along each side of the apparatus. Transversely-extending channel members 9b are secured to the column members 9 and some are, as shown in Figure 2, secured to the members 9e to support or carry a pair of upper channel or guide members 9g which prevent sagging of the conveyor chains 41 during the upper phase of their movement between the upper sprockets 40'' and 40''', see Figure 3.

As shown particularly in Figures 1, 3, 8 and 11, the treating apparatus is provided with electrodes such as anodes, which are electrically connected to bus bars 95, 96, and 97 of opposite potential to the bus bars 60 for the work articles. Upper electrodes 113 are mounted to extend transversely of the container 7 and in a longitudinally-spaced-apart relationship with respect to each other above a work article, such as F' of Figure 3, which is being moved through the treatment bath. A series of lower electrodes 121 are also positioned to extend transversely of the container 7 and in a longitudinally-spaced-apart relationship with respect to each other within a lower portion of the treatment bath and in a staggered relationship with respect to the upper electrodes 113, see Figure 8. It will be apparent that the upper and lower electrodes are positioned on opposite sides of the work articles that are being processed to, as shown in Figure 11, provide a highly efficient electrolytic action.

As shown particularly in Figures 1, 2, and 11, A. C. current may be employed to drive a motor generator 90 and 91 to provide D. C. current for the electrolytic bath. A rheostat 93 may be employed to adjust the current value and is shown connected in a positive potential line 94. A negative potential line 92 from the generator 91 is

connected to the pair of oppositely-positioned bus bars 60 which supply current to the article-carrying-arms 50 of the treatment bath conveyor.

As shown particularly in Figures 9 and 10, each bus bar 60 is mounted by angle members 61 at suitably spaced locations therealong. Each angle member 61 is brazed at its upper end portion 62 to one of the pair of bus bars 60. Each angle member 61 has an integral foot or lower end portion 63 that is drilled out to receive a mounting bolt 65. This mounting bolt 65 is provided with washers 65a and extends through the portion 63 of the bus bar mounting element 61, through a feeder bus-bar such as 9c, through an insulator block 64b, and through an upper flange portion of an upper angle member 8 of the container 7, see also Figure 3. A dielectric sleeve 64 mounted on the bolt 65 and provided with dielectric washers 64a, serves to insulate the bolt from the metal structure of the apparatus including the container 7. The mounts 61 are spaced along the lower extent of the pair of bus bars 60 and a similar mounting 61' is spaced along the upper extent of the pair to secure them on the transversely-extending structural members 9b, see Figure 3.

Referring to Figures 1, 2, 3, 8, and 11, I have also shown a frame for supporting the bus bars 95, 96, and 97 for the upper and lower electrodes 113 and 121. The line 93 from the motor generator 91 or the D. C. source is connected to the bus bars 95, 96, and 97 which supply current to such electrodes. The electrical distribution to bus bars 95, 96, and 97 is effected by main bus bar 105 (see particularly Figure 3), transversely-extending, strap-like top members 100 and vertically-extending and transversely spaced-apart side strap-like drop members 106 and 107, as well as an intermediate vertical, strap-like drop member 109. A plurality of these members are spaced longitudinally along the apparatus, see Figure 1. It will be noted that these members are located inside of the spacing defined by the conveyor chains 41 and do not interfere in any way with the operation of carrying the articles through the treatment bath, see Figures 1 and 8, or with the operation of filling or refilling the electrodes 113 and 121.

The bus bar 105, see Figure 3, is centrally secured or suspended from a lower flange of the transverse structural members 9b, and to effect this result, bolts 108 and an insulating connection is employed, see Figure 3B. The insulation of the mounting is similar to that shown in Figure 9 for the bus bar 60.

The upper ends of the side conducting member pairs 106 and 107 are secured by bolts 108a to strap member 100; and, the lower ends of the strap members 106 and 107 are secured to lower transverse structural members 9a of the structural framework by mounts illustrated in Figure 3A. Hangers 111 for the bus bars 95, 96, and 97, see Figure 3A, are provided with a threaded upper end which is adapted to receive mounting nuts 108' to secure the vertical strap members, such as 106, 107 and 109, and to electrically connect them to the hangers 111. It will be noted that dielectric sleeves 110, similar to the sleeve 64 described in connection with the arrangement of Figure 9, insulates these current-carrying members from the structural members 9a. The lower or hook end portions of each hanger 111 may be secured or brazed to provide a suitable

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electrical connection with the bus bars 95, 96, or 97.

Referring particularly to Figure 12, it will be seen that the upper electrodes 113 are secured at their opposite ends on bus bars 96 and 97 by vertical extension hangers 112 and 114 which are integral with a substantially transversely-extending support piece or member 113a. A convoluted, open-network, spring-like member 115 is secured or welded on one side to the member 113a to form a housing for electrode elements, such as balls 116, see Figure 3. It will be noted in Figures 3 and 11 that the balls 116 which may be of anode metal for an electroplating operation, extend along their housing in a closely abutting and contacting relationship with respect to the housing and respect to each other. The outer open ends of the housing of the electrode 113 preferably extends slightly above the fluid level of the bath, see the dotted line of Figure 3, so that the additional electrode elements 116 may be added as needed, see Figure 8, from above the bath. The opposite or lower end of the electrode 113 converges or is provided with a stop portion for the shapes or elements, such as 116.

Referring particularly to Figures 13, 14, and 15, the lower electrodes 121 are hung by vertical extension hangers 120 from the bus bars 95. The hanger 120 is integral with a transversely-extending support member 121d which is shown provided with a collar 123 at its other end and a perforated funnel 124 secured thereto or formed as an integral part thereof. An open-network, spring-like portion or housing member 122 converges or is closed by a stop portion adjacent the hanger 120 at its lower end and is open at its upper end adjacent the collar 123 to receive electrode elements introduced into the funnel-like, perforated portion or member 124. The higher end of the electrode 121 is supported from the floor of the container 7 by a vertical framework 125, see particularly Figure 15, which at its upper end is welded or secured to the collar 123 and at its lower end is secured in dielectric mounts 126 that extend from the bottom of the container 7. Although the perforated funnel-shaped portion or member 124 of the lower electrode 121 is shown positioned below the level of the bath, additional or replacement electrode elements such as 116, may be dropped into it through and from the top of the bath, as indicated particularly in Figure 8.

In Figures 16, 17, 18, 19 and 20, I have shown modified forms of electrodes. In figure 16, an electrode 135 (which may be a lower electrode) is of a somewhat similar construction to the electrode 121 of Figure 14, except that its hanger 130 is threaded along its length to receive a wing nut 134 and is secured to a collar 131 which forms a housing for a tension spring 132. The extending support portion or member 135a is of rod-like form and is threaded at its upper end to also receive a wing nut 134. Wing nuts 134 are employed to hold down a positioning plate 133 which may be adjusted to provide a desired degree of tension or spring force upon the balls 116. To add additional balls 116, the wing nut 134 on the member or portion 135a is removed and the plate 133 is swung about the hanger 130, in order that the spring 132 may be removed.

In Figure 17, I have shown a modified form of electrode 135' whose collar or sleeve 131' is provided with a slide weight 136 for forcing the

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balls 116 along the horizontal extent of the electrode housing. The weight 136 is provided with a hook 137, in order that it can be lifted out of the collar 131' to insert additional electrode elements 116 therein. In the embodiment of Figures 16 and 17, the upper ends of the electrodes preferably extend above the level of the fluid in the container and their housings 122' may be of similar construction to the housing 122 of the embodiment of Figure 13.

In Figures 19 and 20, I have shown modified forms of electrodes for utilizing a different type of electrode element, such as 116' of Figure 18. The elements 116' are of a somewhat doughnut or flat-circular shape, and thus, can be slidably mounted on rod members.

In Figure 19, I have shown the electrode 121' as being hung at one end by a hanger 150 that is secured to a collar 151. The support 125' for the other end of the electrode has a rod-like member 153 secured thereto and extending substantially centrally along the inside of the housing 122' of the electrode. The upper end of the rod 153 is threaded to receive a wing nut 154, and also receives a plate 155 and a tension spring 156. The wing nut, plate 155, and spring 156 are removed to add additional electrode elements 116'.

The embodiment of Figure 20 is constructed somewhat similar to that of figure 19, except that the housing 122' is omitted and the electrodes are carried entirely by a hanger rod 150'. The hanger rod 150' is threaded intermediate its ends to receive a wing nut 154, and also receives positioning plates 155a and 155b and a tension spring 156'. The hanger rod 150' extends the full length of the electrode and is securely mounted upon the member 125' that also provides an abutment end or stop for the electrode elements 116'.

What I claim is:

1. In an apparatus for electrolytically treating and advancing a series of work articles in a transversely-horizontally extending relationship longitudinally along and within a longitudinal tank having a treatment solution therein, wherein a frame structure is positioned to extend longitudinally along and above the tank, an upper set and a lower set of transversely-horizontally extending electrodes are positioned within and along the tank, and the upper and lower sets of electrodes are in a vertically spaced-apart relationship to define a longitudinal path of movement for the work articles therebetween along the tank, the combination of a pair of vertically spaced-apart upper and lower shafts operatively mounted on one longitudinal end of the frame structure to extend transversely thereacross, a second pair of vertically spaced-apart upper and lower shafts operatively mounted on an opposite longitudinal end of the frame structure to extend transversely thereacross, the lower shafts of said pairs being mounted adjacent a top portion of the tank and above the treatment solution therein; a pair of inner and outer longitudinally-extending bus bars along one longitudinal side of the tank and a similar pair along an opposite longitudinal side of the tank, means suspending the outer bus bars of said pairs from the frame structure closely adjacent to and transversely between vertical planes representing longitudinal side walls of the tank, means suspending the inner bus bar of each of said pairs in a transversely-inwardly spaced relationship with respect to the outer bus bar of the

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same pair, outer hangers projecting downwardly from said outer bus bars and connected to outer ends of the lower set of electrodes, inner hangers spaced transversely inwardly from said outer hangers and projecting downwardly from said inner bus bars and connected to outer ends of the upper set of electrodes; a pair of chain sprockets mounted in a transversely spaced-apart relationship on each of said shafts, one sprocket of each of said pairs being positioned in a vertical plane that represents transverse spacing between said inner and outer hangers and between the inner and outer bus bars of one of said pairs, the other sprocket of each of said pairs being positioned in a vertical plane that represents transverse spacing between said inner and outer hangers and between the inner and outer bus bars of the other of said pairs; a conveyor chain meshing with one chain sprocket of each of said pairs and a second conveyor chain meshing with the other chain sprocket of each of said pairs; said lower shafts and their associated sprockets defining a lower flight of said conveyor chains and said upper shafts and their associated sprocket pairs defining an upper flight of said conveyor chains; the upper and lower shafts of each of said pairs and their associated sprocket pairs defining vertical flights of said conveyor chains; means for actuating at least one of said chain sprocket pairs; a pair of continuous bus bar loops, means positioning one of said bus bar loops along one longitudinal side of the frame structure and about one of said conveyor chains, means positioning the other of said bus bar loops along an opposite longitudinal side of the frame structure and about the other of said conveyor chains; a series of work-holding arm pairs, one arm of each of said arm pairs being carried by one of said conveyor chains to project vertically-outwardly therefrom, the other arm of each of said arm pairs being carried by the other of said conveyor chains to project vertically-outwardly therefrom in transverse alignment with the other arm of the same pair and carry a transversely-extending work article therewith, a slide bore portion on each of said work-holding arms, the slide bore portion of one work-holding arm of each of said pairs being slidably clamped on one bus bar loop of said pair of bus bar loops for movement therealong and the slide bore portion of the other work-holding arm of each of said pairs being slidably clamped on the other bus bar loop of said pair of bus bar loops for movement therealong, and the arms of said arm pairs carried by the lower flight of said conveyor chains projecting downwardly into the tank along the vertical planes that represent transverse spacing between said inner and outer hangers and between said pairs of inner and outer bus bars to support and move the work articles in and along the longitudinal path defined by the upper and lower sets of electrodes.

2. An apparatus as defined in claim 1 wherein, the combination also comprises, an article conveyor mechanism at one longitudinal end of the frame structure operatively positioned to deliver a work article in a transversely-extending relationship to each of said pair of work-holding arms along one vertical flight of said conveyor chains; an article conveyor mechanism at an opposite longitudinal end of the frame structure operatively positioned to receive work articles from each said pair of work-

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holding arms along the other vertical flight of said conveyor chains; said actuating means being connected to move said first and second mentioned conveyor mechanisms in synchronism with said conveyor chains; a pair of transversely spaced-apart cams mounted on the one longitudinal end of the frame structure in the path of movement of the work-holding arm pairs carried by the one vertical flight of said conveyor chains to flex said arm pairs outwardly to receive a work article from said first-mentioned conveyor mechanism, and a similar pair of cams mounted on the opposite longitudinal end of the frame structure in the path of movement of the work-holding arm pairs carried by the other vertical flight of said conveyor chains to flex each of said arm pairs outwardly and discharge a work article to said second-mentioned conveyor mechanism.

3. In an apparatus for electrolytically treating and advancing a series of work articles in a transversely-horizontally extending relationship longitudinally along and within a longitudinal tank having a treatment solution therein, wherein a frame structure is positioned to extend longitudinally along and above the tank and electrodes are positioned within and along the tank to define a longitudinal path of movement for the work articles along the tank, the combination of a pair of continuous conveyor chains operatively mounted for movement along opposite longitudinal sides of the frame structure; a series of longitudinally spaced-apart work-holding arm pairs carried by said conveyor chains, each of said arm pairs having one arm mounted on one conveyor chain and the other arm mounted on the other conveyor chain in a transversely-horizontally spaced-apart and aligned relationship with respect to each other, each arm of each of said arm pairs having a vertically-outwardly extending flexible portion, each of said extending flexible portions of each arm pair having a pin to engage an end portion of a work article and support the work article transversely-horizontally between the arms of said arm pair; a continuous bus bar loop carried by the frame structure along a longitudinal side thereof and extending about one of said conveyor chains and a second continuous bus bar loop carried by the frame structure along an opposite longitudinal side thereof and extending about the other of said conveyor chains; one arm of each of said work-holding arm pairs having a slotted clamping contact portion operatively mounted for continuous sliding contacting movement along one of said bus bar loops and the other arm of each of said arm pairs having a slotted clamping contact portion operatively mounted for sliding contact movement along the other of said bus bar loops; and actuating means operatively connected to said conveyor chains for moving them in synchronism with each other.

4. In an apparatus for electrolytically treating and advancing a series of work articles in a transversely-horizontally extending relationship longitudinally along and within a longitudinal tank having a treatment solution therein, wherein a frame structure is positioned to extend longitudinally along and above the tank and electrodes are positioned within and along the tank to define a longitudinal path of movement for the work articles along the tank, the combination of a continuous conveyor mechanism operatively positioned above and longi-

itudinally along the tank; pairs of work-holding arms carried by said conveyor apparatus in a longitudinally spaced-apart progression therealong and extending vertically outwardly from said conveyor mechanism, the work-holding arms of each of said pairs being in a transversely-horizontally spaced-apart relationship with respect to each other to carry a work article therebetween, said conveyor mechanism having a lower flight adjacent to and longitudinally along an upper portion of the tank, the work holding arm pairs of said lower flight projecting downwardly into the tank; at least one continuous bus bar loop mounted on the frame structure and extending about said conveyor mechanism; and a work-holding arm of each of said pairs having a slotted clamping-contact portion slidably mounted on said bus bar loop for continuous contacting movement therealong during the continuous movement of said conveyor mechanism.

5. In an apparatus for electrolytically treating and advancing a series of work articles in a transversely-horizontally extending relationship longitudinally along and within a longitudinal tank having a treatment solution therein, wherein a frame structure is positioned to extend longitudinally along and above the tank, an upper and lower series of transversely-horizontally extending electrodes are positioned within and along the tank, and the upper and lower series of electrodes are in a vertically spaced-apart relationship to define a longitudinal path of movement for the work articles along the tank, the combination of a pair of vertically-outwardly projecting supporting arm pairs for each work article, the arms of each of said arm pairs being in a transversely-horizontally opposed and spaced-apart relationship with respect to each other to support ends of a work article therebetween, a continuous chain mechanism operatively carried by the frame structure above the tank and having a lower flight carrying said arm pairs and the work articles supported thereby in series progression within

the tank and along the longitudinal path of movement between the upper and lower series of electrodes, means protecting said arm pairs from the treating solution of the tank, means continuously applying electric current of one potential through the arms of said arm pairs internally within the supported ends of each work article, outer hangers extending vertically-downwardly from the frame structure in a transversely-outwardly spaced-apart relationship with respect to the arms of said arm pairs and into the tank, said outer hangers being connected to the lower series of electrodes to supply electric current of opposite potential thereto; inner hangers extending vertically-downwardly from the frame structure in a transversely-inwardly spaced-apart relationship with respect to the arms of said arm pairs and into the tank, said inner hangers being connected to the upper series of electrodes to supply the current of opposite potential thereto; the transversely spaced-apart relationship of said outer and inner hangers with the arms of said arm pairs providing an unobstructed vertical path for movement of said arm pairs.

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