

May 12, 1959

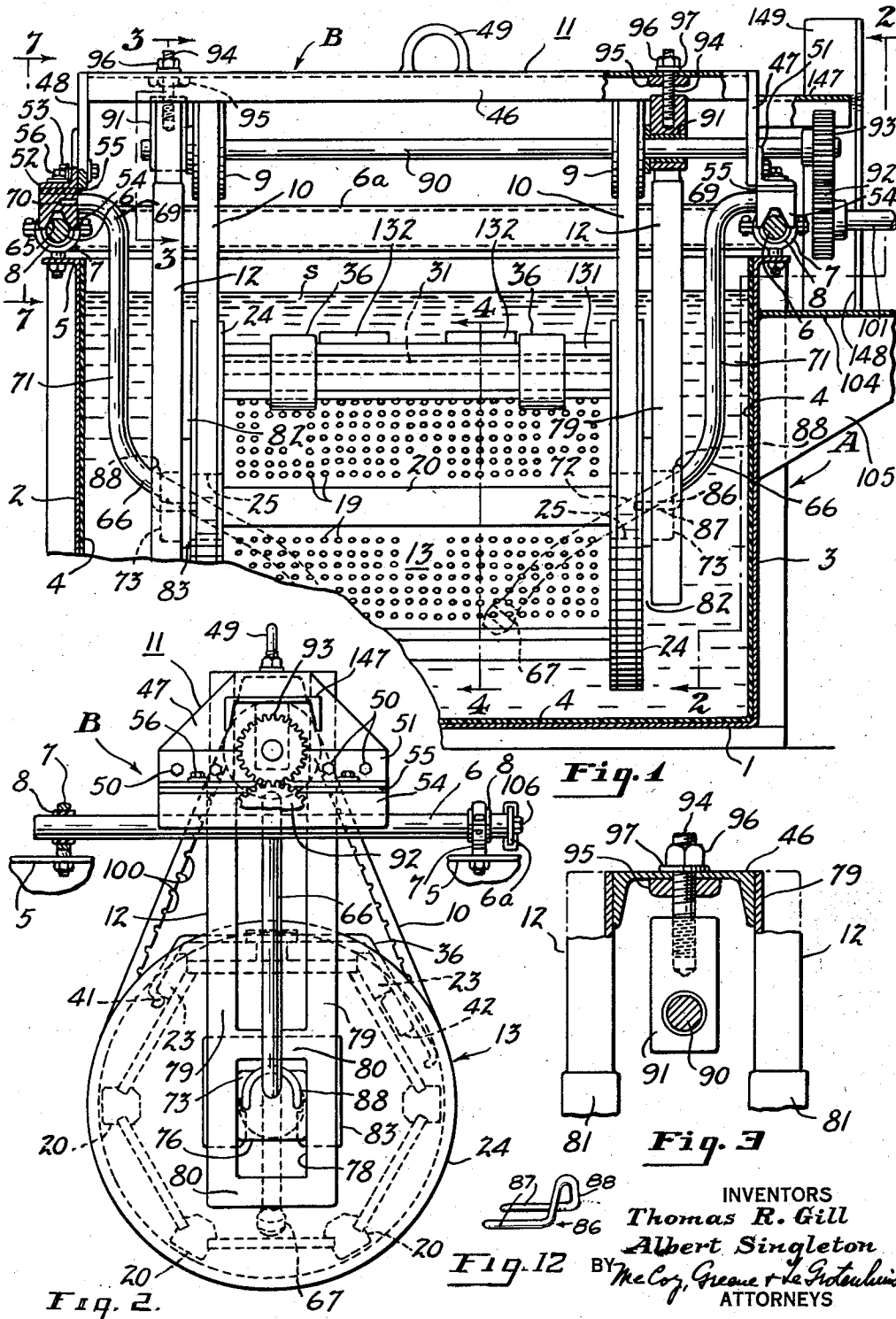
A. SINGLETON ET AL

2,886,505

PLATING APPARATUS

Filed April 20, 1956

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

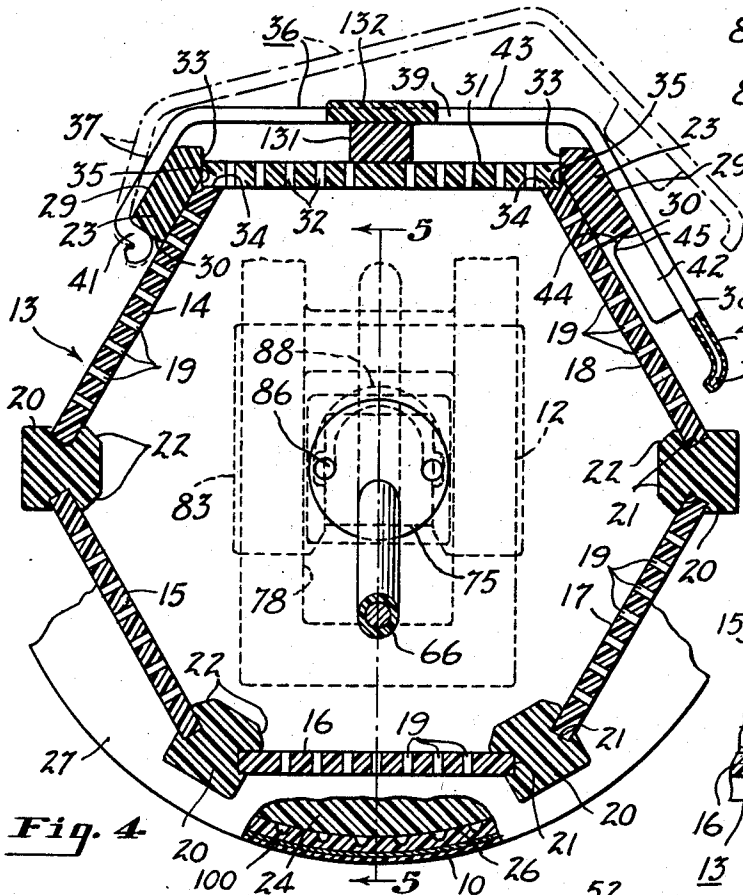


Fig. 4

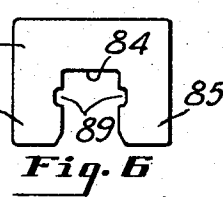


Fig. 6

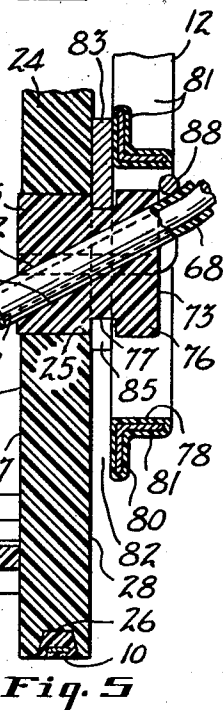


Fig. 5

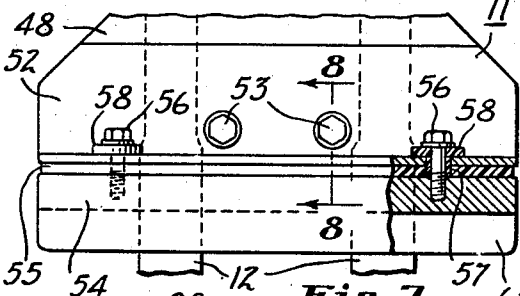


Fig. 7

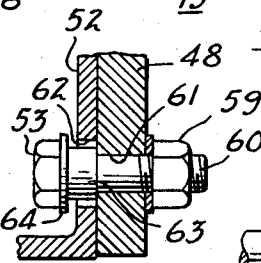


Fig. 8

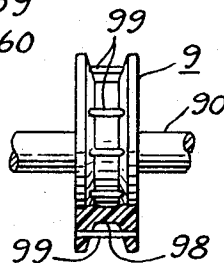


Fig. 9

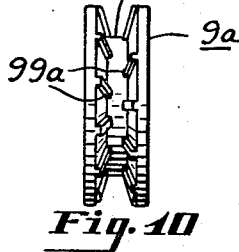


Fig. 10

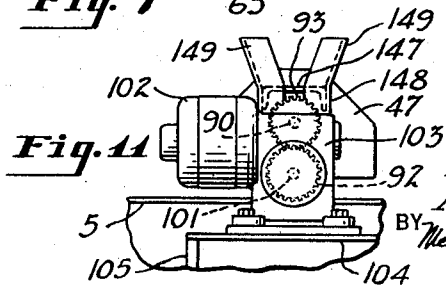


Fig. 11

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2,886,505

PLATING APPARATUS

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Application April 20, 1956, Serial No. 579,464

12 Claims. (Cl. 204—213)

The present invention relates to an improved apparatus for plating, cleaning or otherwise treating the exterior surface of small articles and more particularly to an improved plating barrel and novel means for mounting said barrel.

The barrel of this invention is of simple inexpensive construction and is rotatably supported from an overhead frame by a pair of endless belts at the opposite ends of the barrel. The frame may be moved to a position above a tank containing an electrolytic solution or the like and temporarily mounted on the end portions of the tank so that the barrel is submerged in the solution. Parts of the frame near one end of the tank may be pivotally mounted to prevent twisting or distortion of the frame due to irregularities in the shape of the tank and to allow for proper seating of the cathode contacts. The upper pulleys, which carry the endless belts are mounted on a horizontal shaft that is journaled in spaced bearing members carried by the frame, novel means being provided to permit ready adjustment of the height of each bearing member relative to the frame.

The barrel is held against movement laterally or axially relative to the frame by a pair of vertical guide members which extend downwardly from the frame to the opposite ends of the barrel. A stub shaft is provided at each end of the barrel which projects axially into the adjacent vertical guide member to prevent lateral movement of the barrel relative to the guide member. An electrical conduit extends through each shaft to the lower portion of the barrel to provide an electrode for the barrel. Novel means is provided for holding each stub shaft in place and for facilitating ready removal of the barrel from between the guide members including a removable locking member that fits between the end of the barrel and the adjacent vertical guide member and a removable retainer for holding the locking member in place.

An object of the present invention is to provide a plating apparatus of simple and inexpensive construction which may be easily adjusted and readily assembled and disassembled.

A further object of the invention is to provide a simple inexpensive non-slip driving means for the barrel employing endless belts which are not easily damaged by corrosive liquids.

Another object of the invention is to provide an improved means for adjusting the position of the barrel-driving shaft that carries the upper pulleys.

A further object of the invention is to provide a supporting frame for a plating barrel which can be mounted properly when the tank has a slightly distorted shape or when the cathode supports have become worn or out of line.

Another object of the invention is to provide means for mounting the barrel which may be readily disassembled to permit removal of the barrel from its supporting frame.

Various other objects, uses and advantages of the present invention will become apparent from the following description and claims and from the drawings in which:

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Figure 1 is a fragmentary longitudinal elevational view of the plating apparatus of the present invention on a reduced scale with parts broken away and shown in cross section;

5 Figure 2 is an end elevational view with parts broken away taken substantially along the line 2—2 of Fig. 1 and drawn to the same scale;

10 Figure 3 is a fragmentary end elevational view with parts broken away and shown in cross section taken substantially along the line 3—3 of Fig. 1 and on a larger scale;

Figure 4 is a fragmentary transverse vertical sectional view with parts broken away and shown in section taken substantially along the line 4—4 of Fig. 1 and on a larger scale, the clamp used to fasten the lid of the barrel being shown in dash-dot lines in a released position;

Figure 5 is a fragmentary longitudinal vertical sectional view with parts broken away and shown in section taken substantially along the line 5—5 of Fig. 4 and on the same scale;

20 Figure 6 is a plan view of the U-shaped retaining plate on a reduced scale;

Figure 7 is a fragmentary end elevational view taken substantially along the line 7—7 of Fig. 1 and on a larger scale with parts broken away and shown in cross section;

25 Figure 8 is a fragmentary longitudinal vertical sectional view taken along the line 8—8 of Fig. 7 and on a larger scale;

Figure 9 is a fragmentary side elevational view showing one of the upper pulleys on a reduced scale with parts broken away and shown in section;

30 Figure 10 is an elevational view similar to Fig. 9 showing a modified form of upper pulley;

Figure 11 is a fragmentary end view of the apparatus 35 and

Figure 12 is a perspective view of the locking member shown in Figs. 1 and 2.

Referring more particularly to the drawings which are drawn substantially to scale and in which like parts are identified by the same numerals throughout the several views, Figs. 1 to 9 show a plating apparatus constructed according to the present invention including a conventional rectangular open-top tank A mounted in a fixed position on the floor and a removable plating assembly B mounted on the tank with portions submerged in the liquid in the tank.

As herein shown, the tank A comprises a flat rectangular horizontal bottom wall 1, flat parallel vertical side walls (not shown), and flat parallel vertical end walls 2 and 3 integrally joined to the bottom and side walls to form an impervious receptacle that contains an electroplating solution. The tank may be unlined where used with alkaline solutions or may be provided with a thin impervious lining 4 that completely covers the inside of the tank together with suitable anode bars to conduct current through the electrolytes. This lining may be of various corrosion-resistant rubber or plastic materials which will protect the outer metal shell of the tank from the corrosive action of acids in the tank.

40 Metal angles 5 are rigidly mounted on the top portions of the walls of the tank to provide horizontal edges at the top of the tank for supporting a pair of straight cylindrical low-resistance copper cathode rods 6 of circular cross section. The rods 6 are supported with their axes parallel and in substantially the same plane by two pairs of detachable clamping elements 7. Each of the clamping elements 7 includes a Y-shaped lower portion rigidly bolted to the angle 5 and an inverted U-shaped upper portion bolted to said lower portion, the interior surfaces of said portions being cylindrical and of a size to receive an annular insulator 8 of "Bakelite," "Melamine," or other non-conducting material. The insulators 8 have a tight

fit on the cathode rods 6 and are held tightly by the clamps 7 so that the rods are rigidly supported and held against rotation. However, the bolts of the clamps 7 may be loosened and retightened whenever desired to rotate and relocate the rods 6 whereby the wear on the rods may be distributed around its circumference.

An electrical connection is provided between the cathode rods 6 including a long copper bus bar 6a of rectangular cross section extending the full length of the tank A. The opposite end portions of said bus bar have circular openings therein of a size to receive hex-head machine screws 106, the ends of the cathode rods 6 being internally threaded to receive said screws. The bus bar 6a is connected to the negative terminal of an electrical source in a conventional manner, the positive terminal of said source being connected in a similar manner to the anode bars of the tank whereby a current can be conducted from the anodes to the cathodes in the usual manner.

The removable assembly B includes a steel frame 11 having end portions which may be mounted on top of the cathode rods 6 and having rigid longitudinally-alined vertical guide members 12 and includes a rotatable perforated barrel 13 which is suspended from the frame between the guide members and completely submerged in the liquid s when the frame rests on the end walls of the tank A.

The plating barrel 13 is of regular polygonal cross section and comprises a series of flat rectangular side walls 14 to 18 of uniform thickness and of substantially the same size located the same distance from the axis of the barrel and parallel to said axis. The side walls are provided with rows of perforations 19 and are held in fixed positions relative to each other by four parallel ribs or bars 20 equally spaced along the periphery of the barrel, each rib 20 having inclined grooves 21 therein of a size to receive the side edge portions of the adjacent side walls substantially as shown in Fig. 4. The ribs are shown herein as being substantially square in cross section with the corner edges 22 beveled so as not to interfere unduly with movement of the articles within the barrel. A pair of horizontally-alined reinforcing bars 23 of the same cross-sectional shape are rigidly mounted on the inclined upper side walls 14 and 18 along the upper edges of said side walls and parallel to the ribs 20. The ribs 20 and the bars 23 have a length corresponding to that of the side walls 14 to 18 and have a uniform cross section throughout their length substantially as shown in Fig. 4, which is drawn substantially to scale. As shown in that figure, the barrel is in the form of a regular hexagon in cross section, each flat side wall of the barrel being inclined relative to the adjacent side wall at an angle of about 120 degrees.

The opposite ends of the barrel are closed by a pair of coaxial vertical circular pulleys 24 which are rigidly attached to the ribs and bars 20 and 23 and the side walls 14 to 18 to support the barrel. The pulleys are provided with horizontally alined circular openings 25 and annular grooves 26 of uniform trapezoidal cross section having smooth side and bottom faces concentric to said openings so that the axis of the barrel passes through the center of each of said openings. Each pulley is of substantially uniform thickness and has flat parallel inner and outer vertical faces 27 and 28 which extend radially beyond the outer faces of the ribs 20.

The upper edges of the inclined side walls 14 and 18 are spaced apart to provide a rectangular opening directly above the lower side wall 16 to permit access to the inside of the barrel for insertion and removal of articles to be plated. A flat rectangular lid 31 of uniform thickness fits in said opening and serves as one of the side walls of the barrel during rotation of the barrel, a series of rows of perforations 32 being provided in the lid to permit the flow of liquid into and out of the barrel. The lid has a length corresponding to the distance between the inner

faces 27 of the pulleys 24 and a width corresponding to the distance between the flat vertical inner faces 33 of the bars 23. A pair of horizontal grooves are provided at the upper side edges of the side walls 14 and 18 to receive the lower side edge portions of the lid 36, each groove having a flat horizontal bottom face 34 in engagement with the flat inner face of the lid and a flat vertical side face 35 flush with the face 33 of the adjacent reinforcing bar. The lid is adapted to slide between the faces 33 and between the faces 35 into and out of its closed position parallel to the side wall 16. When in said closed position, the lid 31 is located the same distance from the axis of the barrel as the side walls 14 to 18 so that a generally uniform tumbling action is obtained when the barrel is rotated about said axis.

The lid 31 has a uniform thickness preferably not substantially greater than that of the side walls 14 to 18 and is reinforced by a central horizontal bar 131 of rectangular cross section. Said bar is welded to or otherwise rigidly connected to the lid and extends the full length of the lid midway between the bars 23. A pair of flat rectangular plates 132 may be welded to the top of the bar 131 as shown in Figs. 1 and 4 to provide handles to facilitate lifting the lid.

A pair of identical clamps 36 are provided for holding the lid in its closed position. Each clamp comprises a resilient metal strip of uniform width and thickness that is bent to form flat end portions 37 and 38 and a flat intermediate portion 39 integrally joining said end portions, said end portions being inclined at an angle of about 120 degrees relative to said intermediate portion so as to be parallel to the upper side walls 14 and 18 when in clamping position. Said strip is bent inwardly at its opposite ends to form a rounded end portion 40 at one end of the strip and a radial flange 41 at the opposite end of the strip. A rigid generally rectangular block 42 of suitable corrosion-resistant plastic material with a substantially uniform thickness greater than that of the side walls 14 to 19 and less than that of the bars 23 is rigidly connected to the end portion 3 near the center thereof for engaging the lower side portion of the adjacent bar 23. The metal portions of each clamp 36 are completely covered by a layer or coating 43 of generally uniform thickness. Said layer 43 may be made of the same material as the tank liner 4 or any other suitable corrosion-resistant material which will not be damaged by the strong acids which may be employed in the tank A.

As herein shown, each reinforcing bar 23 has a flat outer surface 29 extending between the pulleys 24 parallel to the adjacent side wall of the barrel 13 and a flat lower side surface 30 perpendicular to said side wall and extending substantially from the surface 29 to the side wall. The block 42 has a flat upper side surface that extends inwardly toward the adjacent side wall 18 a distance that is at least about two-thirds the thickness of the bar 23, said side surface being inclined at a small acute angle relative to the lower side surface 30 of said bar when the clamp 36 is in clamping position. When in said clamping position the intermediate portion of the clamp 36 is parallel to the lid 31 and engages the bar 131 substantially throughout the width thereof, and the end portions of the clamp are parallel to the side walls 14 and 18 and engage the surfaces 29 substantially throughout the width thereof as shown in Fig. 4.

Each block 42 is shaped so that the metal-reinforced clamp 36 must be sprung by moving the end portions 40 and 41 away from each other to permit assembly of the clamp on the barrel or removal therefrom. The inclined side surface 44 of the block is preferably inclined relative to the lower side surface 30 of the adjacent bar 23 at an angle of about 16 to 20 degrees, and the edge 45 of the block is preferably rounded to facilitate movement of the block over the outer side edge of the bar 23, which may also be rounded slightly. The edge 45 is a substantial distance nearer to the flange 41 than said outer side edge of the bar 23 so that the clamp must be sprung a

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substantial distance to permit removal of the lid 31 and can effectively hold the lid closed during rotation of the barrel 13. When the clamps 36 are in clamping position as shown in Fig. 4, the block 42 engages the bar 23 at said outer side edge so that the lid is held tightly in closed position against the surfaces 34 of the side walls. By springing each clamp to increase the distance between the flange 41 and the edge 45, the clamp may be moved away from the barrel to a released position, for example as shown in dot-dash lines in Fig. 4.

The barrel employed in the plating apparatus of the present invention may be made of any suitable material which may be protected against corrosion but is preferably made of a corrosion-resistant rubber or plastic material, such as "Plexiglas," "Lucite," "Tempron," polystyrene, "Crystallite" (a polymer of methylmethacrylate) or the like which can effectively resist the corrosive action of the liquids which are to be used in the tank A. The barrel 13 shown herein may be made entirely of pieces of polymethylmethacrylate in which case the side walls 14 to 18 may be cemented or welded to the ribs and bars 20 and 23, and the pulleys 24 may be cemented to said side walls and said ribs and bars to form a strong rigid structure.

The supporting frame 11 includes a horizontal steel beam or channel 46 of U-shaped cross section extending the length of the tank A, a pair of flat steel vertical end plates or end flanges 47 and 48 of substantially uniform thickness welded or otherwise rigidly connected to the beam 46 at the opposite ends thereof, and a short horizontally projecting metal channel 147 welded to the end plate 47, a lifting hook 49 being provided to facilitate raising and lowering of the assembly B into and out of the tank A.

The end plate 47 has a trapezoidal upper portion and a rectangular lower portion with a length materially greater than the width of the vertical guide members 12 but less than the diameter of the barrel 13 as shown in Fig. 2. Said lower portion is rigidly connected by a series of bolts 50 to a steel angle 51 having a uniform length equal to that of said lower portion.

The end plate 48 may be of the same shape as the plate 47 and may be connected to an angle 52 similar to the angle 51 by a pair of hex-head shoulder bolts 53, but a pivotal connection is provided between the plate 48 and the angle 52 rather than a rigid connection so that the beam 46 will not be twisted due to slight changes in the shape of the tank A and so that the frame 11 may be supported properly even though the cathode rods are worn or out of line.

The angles 51 and 52 are of the same length and are mounted in the same manner on aligned, horizontal, copper, electrical conduits or saddle blocks 54 of large cross-sectional area and low electrical resistance which extend the full length of said angles, a strip 55 of suitable electrical insulating material being inserted between each saddle 54 and the adjacent angle and extending the full length thereof to prevent the flow of electricity between the saddle and the angle. Each of the angles 51 and 52 is rigidly connected to the underlying bar 54 by a plurality of vertical hex-head bolts 56 which extend through the horizontal portion of that angle and the contiguous strip 55 and are screwed into said bar as best shown in Fig. 7. Where the bolts 56 are made of steel or other electrically conductive material, they may be insulated from the associated angle 51 or 52 by a cylindrical sleeve 57 and an annular washer 58 of suitable insulating material.

The pivotal connection between the vertical end portion 48 of the frame and the upright portion of the angle 52 may be of various types, but preferably comprises one or more generally horizontal shoulder bolts rigidly connected to one portion and extending longitudinally through a hole in the other portion which permits relative transverse movements between said portions, the head or

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shoulder of the bolt limiting longitudinal movements between said portions. As herein shown, a pair of shoulder bolts 53 are provided on opposite sides of the medial plane of the frame 11 and are rigidly connected to the plate 48 by hexagonal nuts 59 which are screwed on the threaded end portions 60 of the bolts. The plate 48 is provided with spaced, laterally aligned, circular holes 61 of a size to receive the end portions 60, and the vertical portion of the angle 52 is provided with circular holes 62 of materially larger diameter whose centers are spaced apart laterally the same distance as the centers of the holes 61 so that the holes 61 and 62 are in register to receive the bolts 53. Each shoulder bolt 53 has a cylindrical portion 63 with a diameter greater than that of the hole 61 and substantially less than that of the hole 62 and has an annular radially-outwardly-projecting flange 64 with a diameter slightly greater than that of the hole 62 providing a shoulder for engaging the angle 52. The flanges 64 of the bolts 53 limit longitudinal movements of the angle 52 and are preferably spaced from the plate 48 a distance slightly greater than the thickness of the vertical portion of the angle 52 as shown in Fig. 8 so as to permit a small amount of longitudinal movement which may be necessary where the end walls of the tank A are not exactly parallel.

The bolts 53 and the holes 62 are preferably so constructed that the angle 52 can be moved about one-quarter inch or so longitudinally and can be swung about one-half inch or so about a longitudinal axis. The hole 62 may therefore have a diameter 20 to 25 percent greater than that of the cylindrical bolt portion 63. By providing such a construction, it is easy to mount the assembly B on the cathode rods 6 of the tank A, and extreme accuracy is not required. This construction also insures a good contact between the saddle blocks 54 and the cathode rods 6 even though the rods are worn substantially and avoids rocking of the saddles on the rods which could cause arcing and damage to the rods.

A straight groove 65 of uniform trapezoidal cross section and of a size to receive the adjacent cathode rod 6 is formed in the lower portion of each bar 54 so that the latter bar may be mounted on the cathode rod. When the frame 11 is mounted with its saddles 54 on the vertical portions of the rods 6 as shown in Fig. 1, a low-resistance electrical connection is provided between each saddle 54 and the underlying cathode rod 6 so that electric current is free to flow therebetween.

Electrode means are provided for the rotatable barrel 13 including a pair of flexible low-resistance electrical conduits or cables 66 of large cross-sectional area having removable metal electrodes 67 near the bottom of the barrel, the metal portion of each conduit above the electrodes being completely covered by a tubular layer 68 of a suitable flexible corrosion-resistant rubber or plastic material. As shown in Figs. 1 and 2, each conduit 66 has a rounded upper portion 69 with a projecting end 70 of reduced diameter that fits tightly in the adjacent saddle 54 to provide a rigid electrical connection between the conduit and the saddle, a vertical portion 71 extending downwardly into the liquid *s* toward the barrel, and an inclined portion 72 extending from the portion 71 through the adjacent end of the barrel to the electrode 67.

A pair of coaxial, horizontally aligned, non-rotatable, stub shafts or hub members 73 of polystyrene, polymethylmethacrylate, or other suitable material are provided at the opposite ends of the barrel 13 to hold the conduits 66 in position during rotation of the barrel, each stub shaft having an inclined internally cylindrical passage 74 with a diameter substantially equal to that of the conduit portion 72 for receiving and gripping said conduit portion. Each stub shaft 73 has a cylindrical portion 75 at its inner end with a uniform diameter corresponding substantially to that of the internally cylindrical openings 25 and an axial thickness slightly greater

than that of the lower pulleys 24 that fits in one of said openings, a square guide portion 76 at its outer end with a length and width substantially equal to the diameter of the inner end portion 75 and an axial thickness less than that of the pulleys 24, and a groove 77 of uniform width between the inner and outer end portions 75 and 76 having flat vertical side surfaces and flat bottom surfaces. The portion of the shaft 73 within the bottom surfaces of the groove is of square vertical cross section.

Rotation of the stub shafts 73 during rotation of the barrel is prevented by the rigid vertical guide members 12 at the opposite ends of the plating barrel, each of said guide members having a vertically elongated rectangular opening or slot 78 formed therein with a width corresponding to that of portion 76 that is adapted to register with the adjacent opening 25 of the barrel. Each guide member 12 is formed by a pair of spaced, rigid, laterally aligned, parallel, vertical, metal angles 79 that are welded to or otherwise rigidly connected to the channel 46 with side portions thereof extending in a longitudinal direction as shown in Fig. 3 and a pair of spaced, rigid, vertically aligned, horizontal, metal angles 80 that are welded at their opposite ends of the angles 79. The submerged portions of the angles 79 and the angles 80 are completely covered by an impervious layer 81 of suitable corrosion-resistant material, such as that employed at 4 and 68. The vertical portions of the angles 79 and 80 of each vertical guide member 12 are spaced from and parallel to the outer pulley faces 28 to provide narrow spaces 82 at opposite ends of the barrel having a uniform axial height equal to or slightly less than the width of each groove 77 as best shown in Fig. 5.

A generally U-shaped locking member or retainer may be inserted in each space 82 to hold the adjacent stub shaft 73 against axial movement. As herein shown, a flat U-shaped locking plate 83 is provided at each end of the barrel having a uniform thickness slightly less than that of the space 82. Each plate is cut from a rectangular piece of polymethylmethacrylate or other suitable corrosion-resistant material and is provided with a substantially rectangular slot 84 having a width substantially equal to that of the square portion of the shaft 73 at the groove 77 so as to form parallel legs 85. The portions of the legs of each plate forming the margins of the slot 84 enter the groove 77 on opposite sides of the stub shaft 73 when the plate 83 is slid down to its locking position as shown in Fig. 5 to hold the stub shaft against axial movement, the upper portion of the plate projecting above the upper angle 80 and fitting between said angle and the adjacent pulley 24. Each locking plate may be slid upwardly in the space 82 out of the groove 77 of the associated stub shaft to release the stub shaft and its associated conduit 66 so that the electrode and the stub shaft may be removed through the rectangular opening 78.

It is preferable to provide a detachable U-shaped corrosion-resistant retainer for holding the locking member 83 in its locking position. In the plating apparatus shown herein, a rod of stainless steel or other corrosion-resistant material is bent to provide a locking member or retainer 86 of circular cross section for each stub shaft 73. Said retainer has a pair of parallel leg portions 87 joined by a U-shaped intermediate portion 88 that is perpendicular to said leg portions. Each plate 83 is provided with a pair of laterally aligned rectangular notches 89 which receive the leg portions 87 when said plate is in its locking position shown in Figs. 4 and 5, said leg portions being slidable axially in parallel aligned axial passages in the associated stub shaft 73 into and out of said notches to lock or release the plate 83. The intermediate portion 88 of each retainer 86 is of arcuate shape and extends over the inclined portion 72 of the flexible cable 66 as shown in Fig. 5 so as to be held

against the vertical outer face of the adjacent stub shaft 73 by the cable. When the assembly B is removed from the tank A, the cables 66 may be pulled out a short distance and held in a horizontal position in the vicinity of the stub shaft or removed to permit removal of the retainers 86 at the opposite ends of the barrel. The plate 83 may then be detached to permit removal of the stub shafts 73 from the barrel and removal of the barrel from the assembly B.

The barrel is supported from the frame 11 by means of a horizontal shaft 90 below the center of the channel 46, a pair of identical spaced circular upper pulleys 9 that are rigidly mounted on the shaft between the guide members 12 and in vertical alignment with the lower pulleys 24, and a pair of identical corrosion-resistant endless V-belts 10. The shaft 90 is journaled for rotation in a pair of longitudinally aligned, metal bearing blocks 91 of rectangular cross section and may be driven by means of a motor through suitable spur gears 92 and 93 positioned beyond the end of the frame below the channel 147 as shown in Figs. 1. The end portion of the shaft 90 projects through a circular opening in the end plate 47 and is rigidly connected to the gear 93, said opening having a diameter substantially greater than that of the shaft so as to permit adjustments in the position of the shaft relative to the frame.

The spur gear 92 is rigidly mounted on the end of a horizontal shaft 101 and is driven at a constant speed by means of an electric motor 102 and conventional reduction gearing 103. The motor and speed reducer are rigidly mounted on and supported by a rigid motor mount, including a flat horizontal plate 104 and a pair of vertical plates 105 at the ends of the horizontal plate, said plates being welded together and to the end wall 3 of the tank A.

A pair of upright metal angles 148 are welded to the top metal plate 104 of the motor mount to provide a guide for the superstructure B and a guard for the gears 92 and 93. The upper portions 149 of the angles are inclined to facilitate entry of the channel 147, and the vertical longitudinally extending flanges of the angles are spaced apart a distance only slightly greater than the width of the channel 147 so as to guide said channel vertically and to prevent rotation of the frame 11 relative to the tank A. Said flanges are located on opposite sides of the gear 92 far enough apart to allow entry of the gear 93 and serve to guide the gear 93 into engagement with the gear 92 and to guide the saddle blocks 54 into engagement with the cathode rods 6 when the assembly B is lowered.

Adjusting means is provided for the shaft 90 including a pair of vertical adjusting screws or studs 94 which may be adjusted to vary the heights of the bearing blocks 91. The threads at the lower end of each stud 94 fit into an internally threaded vertical hole in the bearing block 91 so as to provide a rigid connection between the stud and the bearing block. The upper end of each stud 94 is also threaded to receive an internally threaded adjustable hex-head nut 95 of large diameter that engages the bottom face of the horizontal beam 46 and a smaller hexagonal nut 96. The ends of the adjusting screws or studs 94 are inserted through a pair of longitudinally aligned circular openings located at the medial plane of the frame 11 directly above the shaft 90 and are rigidly mounted in adjusted positions on the beam 46 when the nuts 96 are tightened against their washers 97. The height of each bearing block 91 may be independently adjusted by unscrewing the nut 96, rotating the adjusting nut 95 to its desired position relative to said block, and tightening said nut 96. By adjusting the height of each bearing block 91 relative to the frame, the position of the shaft 90 may readily be adjusted so that the gears 92 and 93 mesh properly with each other.

Each circular upper pulley 9 is provided with an annular belt-receiving groove 98 of rectangular trapezoidal

cross section concentric to the shaft 90 and a series (usually at least 12) of circumferentially equally spaced transverse rods 99 extending across said groove parallel to the shaft 90 as shown in Fig. 1, each rod being located the same distance from the shaft 90. Each end-less V-belt 10 is of a trapezoidal cross section to fit in the grooves of the upper and lower pulleys and has a series of equally spaced notches 100 for receiving the rods 99. The rods 99 and the portion of the belt between the notches 100 provide teeth which mesh to provide a non-slip driving connection between each upper pulley 9 and its associated belt 10.

The belt receiving groove 26 of each lower pulley 24 has the same cross-sectional shape as the groove 98 throughout its circumference but is not provided with rods or other teeth for engaging in the notches 100 since the friction between the belts 10 and the lower pulleys 24 supported thereby is ample to eliminate slippage even where the side and bottom surfaces of the grooves 26 are extremely smooth.

Figure 10 shows a modified form of pulley 9a which may be used in place of the pulley 9. The pulley 9a has a circumferential groove 98a of trapezoidal cross section for receiving a V-belt and a series of circumferentially equally spaced ribs or teeth 99a of uniform height on the opposite side faces of the groove 98a for engaging the belt, the ribs on one side of the groove preferably being offset relative to the ribs on the opposite sides of the groove. A conventional V-belt may be provided in the groove 98a or a V-belt having notches in its tapered side faces to receive the teeth 99a. Where a conventional V-belt is employed having smooth side faces, the weight of the barrel acting on the belt causes the teeth to deform the tapered side faces of the belt slightly so as to prevent substantial slippage between the pulley and the belt.

It will be understood that, in accordance with the provisions of the patent statutes, variations and modifications of the specific devices disclosed herein may be made without departing from the spirit of the invention.

Having described our invention, we claim:

1. In an electroplating apparatus, a rigid support, a perforated barrel mounted for rotation about a horizontal axis and having end walls with flat vertical outer faces, said end walls having coaxial internally cylindrical central openings therein, a non-rotatable stub shaft at each end of said barrel having an inner cylindrical bearing portion that fits in the opening of the adjacent end wall and an outer non-circular end portion that projects axially from said end wall and away from the barrel, a vertical member mounted on said support adjacent each of said end walls and having an opening therein for receiving the end portion of said shaft, the margins of said opening engaging said end portion to prevent lateral and rotary movement of the shaft, said vertical member having an inner vertical face parallel to and spaced a short distance from the outer face of the adjacent end wall to provide a narrow space between the vertical member and the end wall, a circumferential recess in the shaft aligned with said space and having a width substantially equal to that of said space, a flat locking plate having a substantially uniform thickness substantially equal to the width of said space and having a slot therein for receiving a portion of the adjacent shaft, the margins of said slot fitting in the recess of the shaft to prevent relative axial movement between the shaft and the locking plate and having notches therein, longitudinal passages in the shaft aligned with said notches, and a retainer having generally parallel legs rigidly connected by a U-shaped intermediate portion, said legs fitting in said passages and engaging in said notches to prevent movement of said locking plate out of said circumferential recess, said legs being slidable out of said passages to permit removal of the locking plate from said shaft, said vertical member engaging

said locking plate to prevent axial outward movement of the shaft when the locking plate engages in said circumferential recess.

2. In a tank having upright end and side walls and containing a hollow polygonal barrel, a supporting frame comprising an intermediate horizontal beam portion and end portions resting on the upper edges of said end walls, a pair of laterally spaced horizontally aligned vertical guide members rigidly connected to said beam portion, and extending downwardly therefrom adjacent the opposite ends of the barrel, a horizontal shaft rotatably supported from said frame, a pair of coaxial axially spaced upper pulleys mounted on said shaft for rotation in unison therewith, said upper pulleys being located between said guide members and adjacent thereto, a pair of coaxial lower circular pulleys of relatively large diameter rigidly mounted on opposite ends of said barrel to close the ends thereof and vertically aligned with said upper pulleys, a pair of endless belts providing the sole support for said barrel, each of said belts connecting one of said upper pulleys with its aligned lower pulley, aligned circular openings at the centers of said lower pulleys, horizontally aligned vertically elongated slots of uniform width in said guide members that register with the circular openings of the barrel, a pair of coaxial non-rotatable hub members at opposite ends of the barrel, each hub member having a passage therein and having a cylindrical bearing portion fitting in one of the openings in said lower pulleys and an outer generally rectangular guide portion fitting in the slot of the adjacent guide member, a pair of rigid low-resistance electrical conduits of relatively large cross-sectional area mounted on opposite ends of the tank along the tops of each of said end walls and insulated from said tank and the end portions of the frame, electrode means for said barrel including a flexible electrical cable extending through the passage in each hub member to the lower interior region of the barrel, a pair of relatively flat retainers, each retainer being of a thickness so as to fit in the narrow space between the inner face of one guide member and the outer face of the adjacent lower pulley, a recess in each hub member for receiving a portion of one of said retainers, each retainer having a first position between a guide member and the adjacent lower pulley wherein a portion of said retainer fits in the recess of the adjacent hub member to prevent horizontal movement of that hub member and being movable to a second position clear of said recess wherein the hub member is released to permit removal of said hub member and the flexible cable therein from the barrel.

3. The apparatus defined in claim 2 wherein a locking member is provided for holding one of said retainers in its first position, said locking member having a pair of substantially parallel leg portions and a U-shaped intermediate portion extending between said leg portions, said last-named retainer and the adjacent hub member having openings therein which are aligned to receive the legs of said locking member when the retainer is in said first position, the U-shaped portion of the locking member extending over the adjacent cable and engaging the outer face of the hub when the legs are in said openings, said cable being inclined and engaging said U-shaped portion to resist movement of said legs away from said hub member.

4. In a plating apparatus, a supporting frame including a bearing block supported therefrom, a shaft having a horizontal axis and being rotatably mounted in said bearing block, a pair of axially spaced upper pulleys mounted on said shaft for rotation in unison therewith, a barrel, a pair of lower circular pulleys mounted on the ends of said barrel and aligned with said upper pulleys, a pair of endless belts providing the sole support for said barrel, each belt connecting one of the upper pulleys with its vertically aligned lower pulley, two

aligned and horizontally spaced vertical members rigidly connected to said frame and having lower end portions adjacent the ends of the barrel, aligned circular openings at the centers of said lower pulleys, openings in said vertical members that register with the circular openings of the barrel, a pair of coaxial non-rotatable hub members at opposite ends of the barrel, each hub member having a cylindrical bearing portion fitting in the circular opening of the adjacent lower pulley and having an outer portion that fits in the opening of the adjacent vertical member and that is held against rotation in said member, a pair of flexible electrical cables, each cable extending through an opening in one hub member into the lower interior regions of the barrel, means for preventing axial movement of the hub members with respect to the barrel including a pair of relatively flat retainers, each retainer being of a thickness so that it fits between the outer face of the adjacent lower pulley and the inner face of the adjacent vertical member, a recess in each hub member for receiving a portion of one retainer, said one retainer having a first position between said lower pulley and said vertical member wherein it fits in said recess and being movable to a second position wherein the hub member is released to permit removal of said hub member and the cable therein from the barrel.

5. The apparatus defined in claim 4 wherein a U-shaped locking member is provided for holding said one retainer in its first position, said member having a U-shaped intermediate portion and leg portions, said one retainer and the adjacent hub member having aligned openings therein to receive the legs of said locking member, the U-shaped portion of the locking member being held between the cable and the outer face of the hub when the retainer is in its first position.

6. In a tank having upright side and end walls, a supporting frame including a horizontal beam and upright flanges on each end of said beam, horizontally aligned bearing blocks mounted below said beam and supported thereby, a horizontal shaft rotatably supported by said bearing blocks, axially spaced upper pulleys mounted on said shaft for rotation in unison therewith, a barrel below said frame, a pair of circular lower pulleys rigidly mounted on opposite ends of said barrel in vertical alignment with said upper pulleys, a pair of endless belts connecting the lower pulleys to said upper pulleys and providing the sole support for said barrel, a low-resistance electrical conduit of relatively large cross-sectional area mounted on the top edge of each of said end walls, a pair of rigid angles detachably mounted above said end walls and supported by said conduits, each angle having a horizontal portion substantially parallel to the top of one of the end walls and having a vertical attaching portion that is adjacent the lower portion of one of said upright flanges, the attaching portion of one angle being pivotally connected to the lower portion of one of said flanges on one side of the tank and the attaching portion of the other angle being rigidly connected to the lower portion of the other of said flanges on the opposite side of the tank.

7. In a plating tank having upright end and side walls and containing a hollow barrel, a supporting frame having a horizontal beam portion and upright end portions, horizontally aligned bearing blocks connected to said beam at spaced points, a shaft rotatably mounted in said bearing blocks, two axially spaced upper pulleys mounted on said shaft for rotation in unison therewith, two lower pulleys of relatively large diameter rigidly mounted on opposite ends of the barrel in vertical alignment with said upper pulleys, endless belts connecting the upper and lower pulleys and providing the sole support for said barrel, a supporting member at each end of said tank resting on the upper edges of said end walls, each supporting member having an attaching portion near its upper end which is adjacent one of said end portions,

a rigid connection between one end portion and one of said supporting members, a pivotal connection between the opposite end portion and the attaching portion of the other of said supporting members, said pivotal connection including a pair of laterally spaced horizontal pins on one of said portions and a pair of laterally spaced openings in the other of said portions that receive said pins, said openings being larger than said pins so as to accommodate pivotal movement between said other supporting member and the end portion of the frame.

8. In a plating tank having upright end and side walls, and containing a hollow barrel, a supporting frame having a horizontal beam portion and upright end portions, horizontally aligned bearing blocks connected to said beam at spaced points, a shaft rotatably mounted in said bearing blocks, two axially spaced upper pulleys mounted on said shaft for rotation in unison therewith, two lower pulleys of relatively large diameter rigidly mounted on opposite ends of the barrel in vertical alignment with said upper pulleys, endless belts connecting said upper and lower pulleys and providing the sole support for said barrel, a supporting member on each end of said tank resting on the top of said end walls, said supporting member having an upright attaching portion near its upper end which is adjacent one of said end portions, one end portion of the frame being rigidly connected to one of the supporting members, a pivotal connection between the opposite end portion and the attaching portion of the other one of said supporting members, said pivotal connection including a hole in the attaching portion of one supporting member and a horizontal pin extending from the adjacent end portion of said frame through said hole, said pin having a head larger than said hole to limit separation of said supporting member and said frame, the portion of the pin within said hole being smaller than the hole to accommodate pivotal movement between said supporting member and the end portion of said frame.

9. In a plating apparatus, a tank with upright side and end walls, a rigid support extending the length of the tank and resting on upper end portions of said end walls, a shaft located below said support substantially parallel to said side walls, axially spaced bearing blocks for rotatably supporting said shaft, said shaft being supported solely by said blocks, adjustable means for supporting each bearing block below said rigid support including an adjusting screw extending through said support and connected to each bearing block, whereby the heights of the bearing blocks are independently adjustable, a pair of relatively small circular upper pulleys rigidly mounted on said shaft for rotation in unison therewith, a hollow barrel for receiving articles to be plated, a pair of coaxial circular lower pulleys of relatively large diameter rigidly mounted on opposite ends of said barrel, each of said lower pulleys being in vertical alignment with one of said upper pulleys, said upper pulleys and lower pulleys being connected by endless belts which provide the sole support for said barrel.

10. In an apparatus for plating articles, a hollow barrel having a longitudinal axis, a pair of coaxial circular pulleys of relatively large diameter rigidly mounted on opposite ends of the barrel for rotation about said axis, each pulley having a substantially smooth continuous circumferential belt-receiving groove, a substantially horizontal shaft parallel to said axis means for rotatably supporting said shaft above the barrel, means for adjusting the position of the shaft so that the shaft is in a horizontal position, a pair of coaxial circular upper pulleys of relatively small diameter rigidly mounted on said shaft for rotation in unison therewith, each upper pulley having a circumferential belt-receiving groove containing a multiplicity of teeth equally spaced throughout its circumference and being vertically aligned with one of said large pulleys, driving means for rotating said shaft, and an endless V-belt mounted in the grooves of each

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pair of vertically aligned pulleys to support one end of the barrel, said barrel being solely supported by said belts, said belts having equally spaced notches throughout its length of a size to receive the teeth of said upper pulleys, the portions of the belts between said notches meshing with the teeth of the upper pulleys and engaging the smooth belt-receiving grooves of said large pulleys so as to provide a friction drive for said barrel.

11. The apparatus defined in claim 10 wherein said teeth comprise transverse rods equally spaced along the belt-receiving grooves of said upper pulleys.

12. The apparatus defined in claim 10 wherein said teeth comprise a series of radially spaced ribs of substantially uniform height equally spaced throughout the circumference of the belt-receiving groove of each upper

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pulley, said ribs projecting axially from opposite side faces of said groove.

References Cited in the file of this patent

UNITED STATES PATENTS

682,973	Condict	Sept. 17, 1901
908,439	Backus	Jan. 5, 1909
1,095,328	Jordan	May 5, 1914
1,848,391	Simpson	Mar. 8, 1932
2,158,076	Lupo	May 16, 1939
2,249,609	Jackson	July 15, 1941
2,393,615	Davidson	Jan. 26, 1946
2,491,925	Lazaro	Dec. 20, 1949
2,498,128	Lang	Feb. 21, 1950
2,762,772	Jackson	Sept. 11, 1956