April 25, 1944. W. OWEN 2,347,608

COPPER PLATING OF MIRRORS

Filed March 8, 1941 4 Sheets-Sheet 1

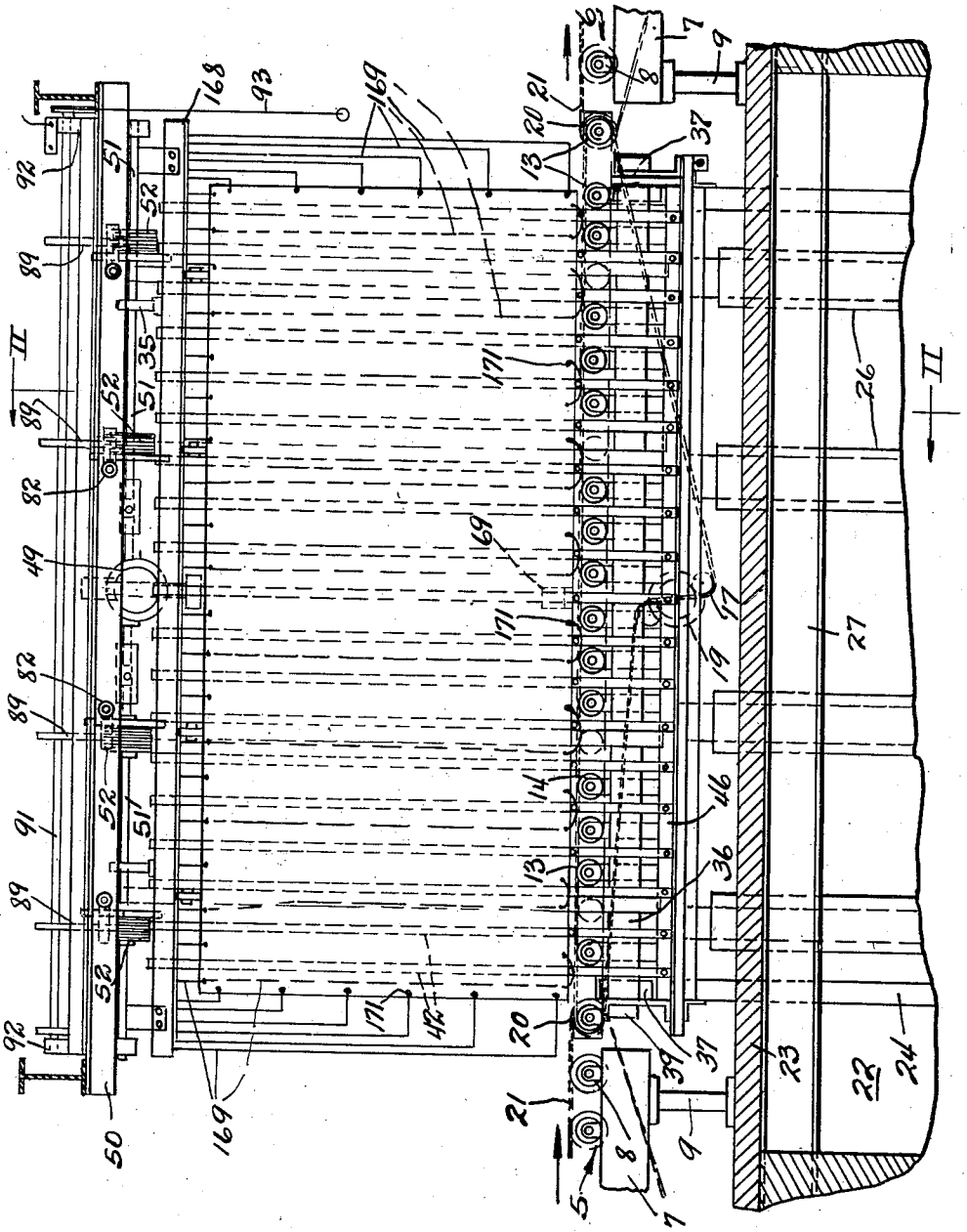


Fig. 1.

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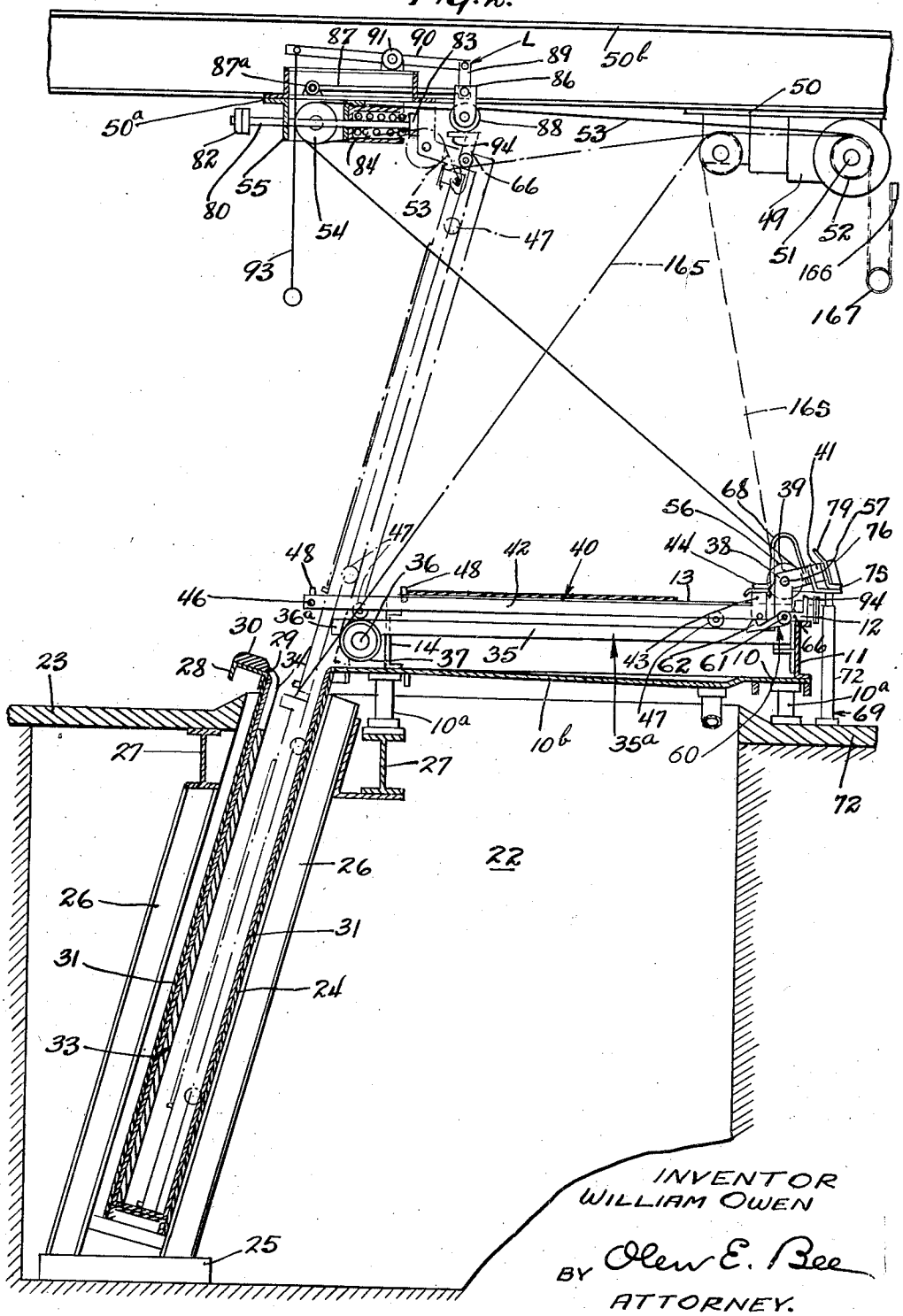
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COPPER PLATING OF MIRRORS

Filed March 8, 1941 4 Sheets-Sheet 2

Fig. 2.

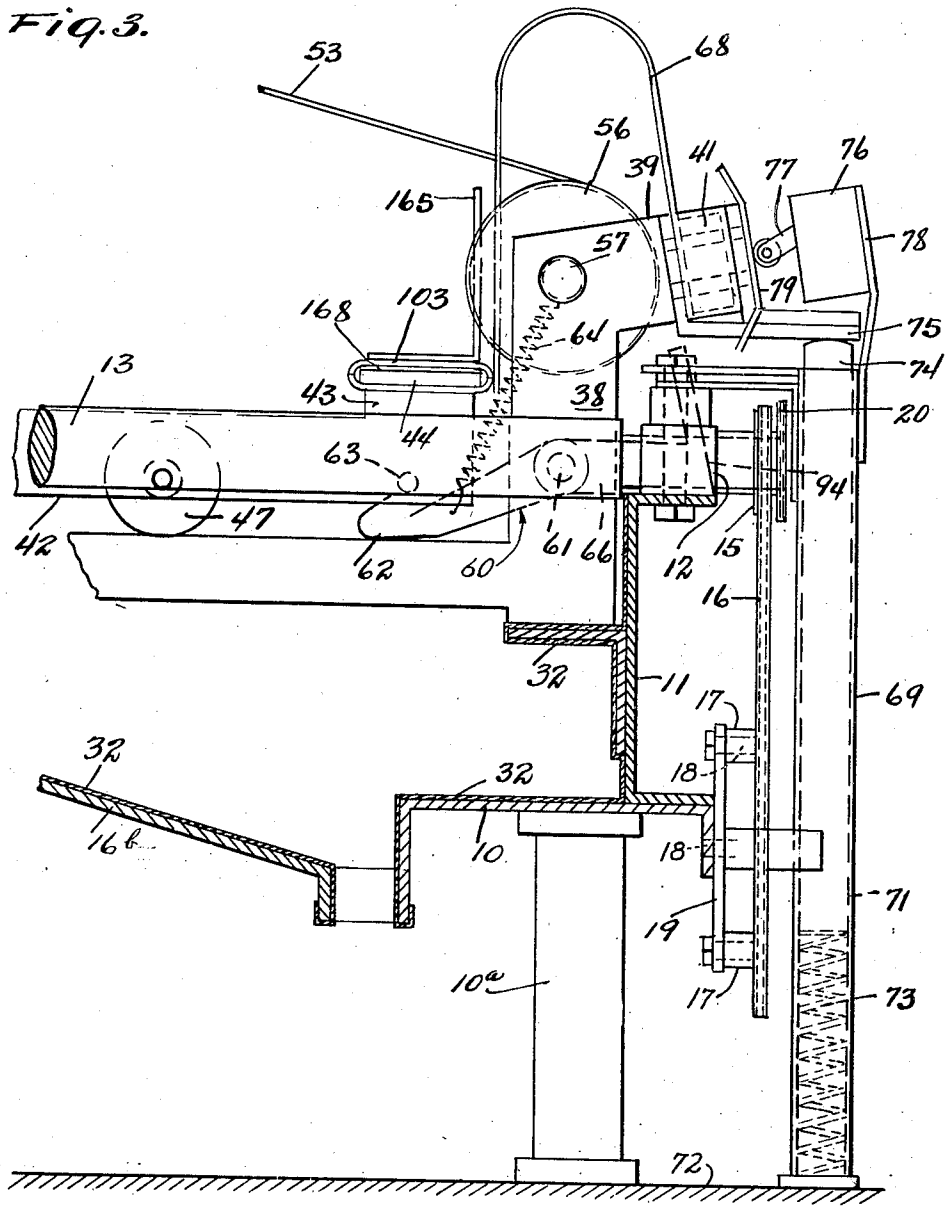


April 25, 1944. W. OWEN 2,347,608

COPPER PLATING OF MIRRORS

Filed March 8, 1941 4 Sheets-Sheet 3

Fig. 3.



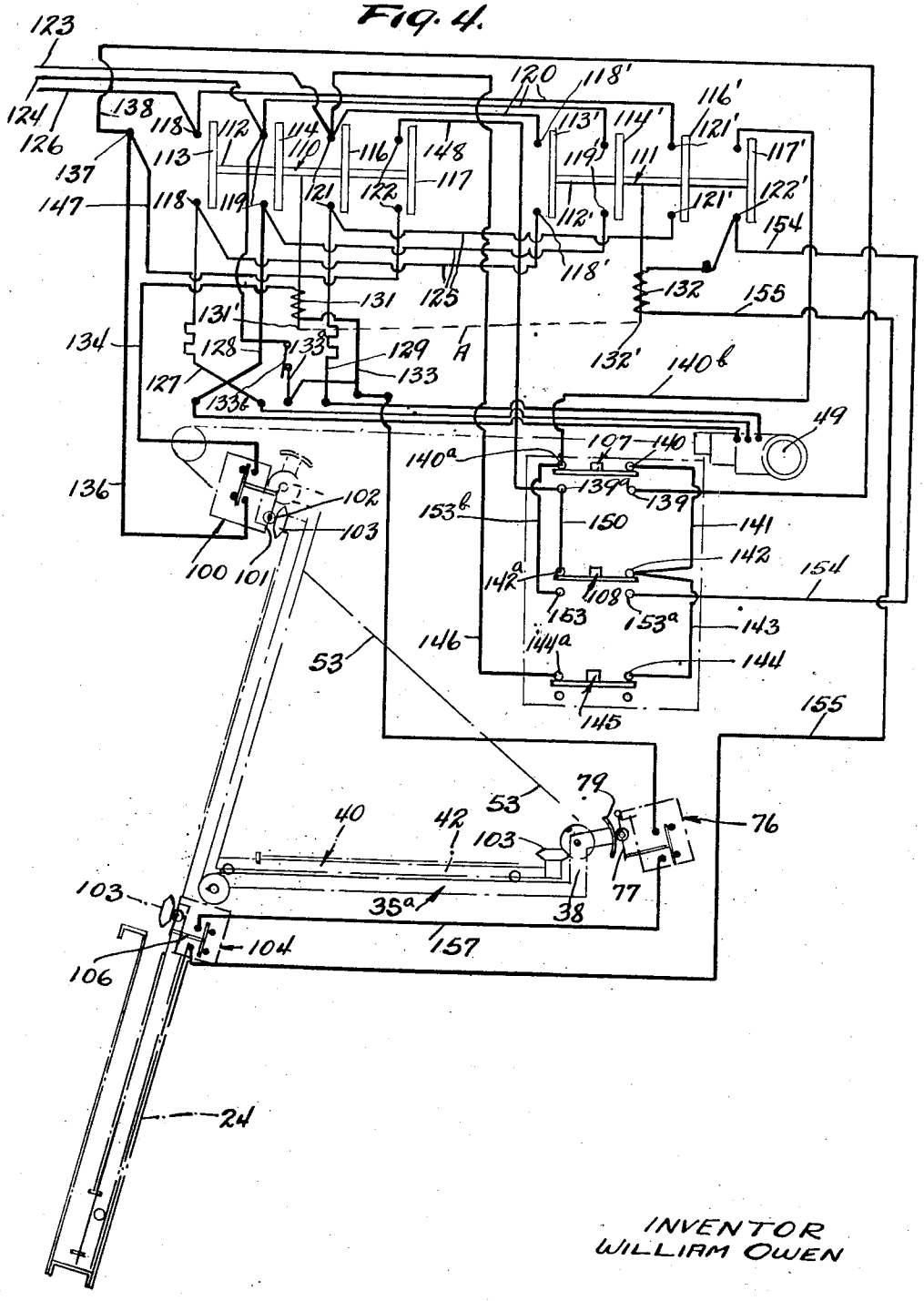
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April 25, 1944. W. OWEN 2,347,608

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Fig. 4.



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UNITED STATES PATENT OFFICE

2,347,608

COPPERPLATING OF MIRRORS

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Application March 8, 1941, Serial No. 382,377

7 Claims. (Cl. 204—225)

The present invention relates to an apparatus designed for applying coatings of copper or similar substance susceptible of deposition as protective films upon a surface of a plate-like object and it has particular relation to the provision of an apparatus for electrolytically coating the backs of silvered mirrors with a layer of metallic copper.

One object of the invention is to provide an apparatus for electrolytically coating mirrors with copper with a minimum amount of handling and minimum risk of mechanical injury to the silver film.

A second object of the invention is to provide an apparatus of the foregoing type by use of which uniform films of sludge free copper are deposited with a minimum expenditure of electrical energy.

These and other objects of the invention will be apparent from consideration of the following specification and the appended claims.

It is well recognized in the art that the silver films of mirrors are sensitive to moisture and chemically active fumes and the like which are often present in the atmosphere. In order to protect the films from the action of such agencies it is common practice to provide the silver film with a backing of relatively impermeable material, such as various paints, varnishes and the like. However, most satisfactory results have been obtained by electrolytically depositing a film of copper upon the silver.

Considerable difficulty has been encountered in the copper plating of mirrors and notably those of large size because they are difficult to pick up and transport without exposing the relatively delicate silver film to scratching or abrasion. Furthermore, in the conventional types of apparatus there is a tendency for copper sludge to settle upon the mirror undergoing copper plating and thus produces imperfections in the operation. In some types of apparatus heretofore available for the operation, the spacing of the anode employed to transfer electric current to the solution of copper compound is not uniformly spaced from the silver film and as a result considerable variation in the resistance offered to electrolytic currents passing to various parts of the plates is encountered and this results in variations in the thickness of the copper plating deposited.

In accordance with the provisions of the present invention, it is proposed to overcome the foregoing difficulties by provision of a conveyor system comprising rollers adapted to move plates of glass in horizontal position into proximity to the plating apparatus and a copper plating rack formed of members adapted to mesh between the rollers of the conveyor system. As a further feature the invention includes apparatus for tilting the rack to lift the plates of glass from the rollers to an almost vertical position and then to slide the rack into a plating bath, where the plating operation is performed with the glass disposed almost vertically and with the silver film in close and uniform proximity to the anode designed to conduct electricity into the bath.

For a better understanding of the invention reference may now be had to the accompanying drawings in which like numerals refer to like parts throughout.

In the drawings Figure 1 is a fragmentary view partially in elevation and partially in section of the apparatus employed in effecting a plating operation;

Figure 2 is a sectional view taken substantially upon the line II—II of Figure 1;

Figure 3 is a fragmentary sectional view showing on a larger scale a latching mechanism employed to hold the rack structure in elevated position;

Figure 4 is a diagrammatic view showing the wiring of the apparatus employed to effect movement of the rack and the rack transporting mechanism in its transit from one position to another.

As shown in Figure 1, the apparatus includes a conveyor system 5 for conducting mirrors to the plating apparatus and a system 6 for conducting it away. Each system includes supporting side rails 7 for rollers 8 and columns 9 supporting the rails at an appropriate height above the floor.

The plating apparatus may embody a conveyor system designed to bridge between systems 5 and 6 and comprising side rails 10 upon columns 10a of channel section and a drain pan 10b spanning the space between them. One rail bears a beam 11 supporting bearings 12 at the ends of rollers 13 of the system. At the opposite ends the rollers are journaled in bearing brackets 14. The first-mentioned ends, as shown in Figure 3, are provided with sprockets 15, which are engaged by and driven by a sprocket chain 16. The chain is looped about suitable idler sprockets 17, which function to take up the slack in the chain and are journaled upon shafts 18, upon a bracket 19, extending from one of the side bars 10. The end rollers are further provided with sprockets 20 about which are trained chains 21 that drive conveyor systems 5 and 6.

The conveyor system comprising rollers 13 is disposed above a pit 22 which is in part closed by a section of floor 23. Copper plating solu-

tion is contained in an open elongated tank or container 24, of rectangular section, which is disposed in position slightly inclined from the vertical and rests at its bottom upon suitable supports 25. The sides of the container are engaged by beams 26 which are designed to reinforce it against the hydraulic pressure exerted therein. The beams at their upper extremities are supported by longitudinally-extending I beams 27, which also function as supports for the floor 23. An inverted channel 28 secured along one edge of the tank supports a bus bar 29 insulated or covered by a bar 30 of wood, rubber or the like. The tank is lined throughout with a layer 31 of rubber or other non-conductive and relatively chemically-resistant material, and a similar coating 32 may be applied to pan 10b, beams 10, 11 and any other parts that are exposed to plating liquor. The anode for the tank comprises a sheet or layer 33 of copper, which preferably is of substantially the same dimensions as one face of the tank and is joined to bus bar 29.

Apparatus for transporting glass plates upon the conveyor system to the copper plating tank includes a tiltable platform or table 35a including spaced bars 35, which at one extremity are rigidly secured to a horizontal shaft 36, disposed contiguous to the ends of the rollers 13 and the corresponding edge of tank 24 and which rotates in suitable bearings 37 upon the side bars 10. These bars have projecting end portions 35a of such length and so disposed that the upper edges thereof align with the rear face of tank 24. When the platform is raised, thus providing a continuous trackway from the platform into the bath, each of the bars is designed to rest between a pair of contiguous rollers 13 at a slight distance below the upper portions of the latter. In order to interconnect the bars at their free extremities they are provided with upwardly-extending brackets 38 (best shown in Figs. 2 and 3), which further have angularly disposed portions 39 interconnected by a horizontal bar 41.

A rack 40 for supporting the glass during the plating operation includes bars 42 so spaced as to rest between the rollers 13 when they are in horizontal position and being provided at their extremities contiguous to brackets 38 with brackets 43 (best shown in Fig. 3), which are interconnected by a bar 44. The opposite extremities of the bars are interconnected by the transverse bar 46. Certain of the bars 42 are provided with rollers 47, designed to travel upon the bars 35 of the tiltable platform and the inner face of tank 24. The bars are also provided at appropriate points adjacent to the edge of the rack contiguous to the copper plating tank with removable vertical pins 48 designed to provide stops or rests for the lower edge of the glass plates during plating operations.

Hoisting mechanism for moving the tiltable platform and the rack thereupon to their elevated position includes a combination three phase reversible motor, speed-reducing mechanism and an automatic brake indicated as a unit at 49. This mechanism secured to a beam 50, which along with beam 50a is disposed transversely of beams 50b, includes driving shafts 51 upon which are keyed winding drums 52, about which are trained cables 53 that are further trained about drums 54 suitably journaled in brackets 55 upon the beam 50a. As many winding drums as may be desired are provided, for example, for purposes of illustration; four are included, as shown in Fig. 1 of the drawings. The cables, after passing around the drums 54, are also trained about drums 56, which are journaled upon a shaft 57 in the brackets 38. The extremities of the cables are attached as indicated in broken line in Fig. 2 to the upper extremity of the glass rack.

Latch mechanism shown in Fig. 3 for holding the glass rack or carriage 40 in position upon the tiltable platform 35a includes a dog or a plurality of dogs 60, pivoted as indicated at 61 upon one or a plurality of the brackets 38. Each dog is provided with a hooked portion 62 adapted to engage with a peg or rod 63 projecting from the sides of the bars 42 of the rack. A tension spring 64 interconnecting the dog and any convenient fixed point of attachment, such as the shaft 57 of pulley 56 urges the dog toward the pin 63. It is also to be noted that the dog has a projecting arm 66, which when the platform is in its lowermost position engages rail 11 of the conveyor system, thus to release the dog from the pin at the lowermost position of travel of the glass supporting platform.

A spring 68 of inverted U-shape is secured at one extremity, to the bar 41 and at the opposite extremity projects downwardly to engage bar 44 of the glass supporting rack. It will be apparent that with the dog engaging the pin 63 the spring is held slightly flexed. When the platform is horizontal the hook 62 is released and the glass rack is pushed by the spring transversely of the trackway or conveyor system. The pins engaging the edges of the glass are thus released from their contact with the glass, leaving the latter free to move under the urge of the rollers of the conveyor system.

Mechanism to check the downward movement of the glass supporting platform, without undue shock as it is lowered from its elevated to its horizontal position, includes a buffer device 69, best shown in Fig. 3. The device includes a vertically disposed tubular member 71, which at its lower extremity is secured to a support, such as a portion 72 of the building floor. This tubular member includes a helical spring 73, which at its upper extremity bears against a lower end of a plunger 74, that projects at its upper extremity from the tubular member, and is adapted to engage a lug or arm 75 upon bar 41.

It is further to be noted that a limit switch 76 having arm 77 is secured to any suitable support, e. g. bracket 78 upon member 71 in position to be engaged by a cam 79 carried by the bar 41. This switch is so connected into the circuit (to be later described) of the motor 49 as to stop the rotation of the latter when the platform has reached its lowermost or horizontal position.

A buffer to check the upward movement of the platform is shown in Fig. 2 and includes a horizontal rod 80, sliding horizontally in bracket 55 upon the beam 50a and being provided at one extremity with locked nuts 82 designed to prevent displacement of the rod from position. At the opposite extremity the rod is provided with a rigidly attached buffer-head 83, which is urged forwardly toward the bar 41 when the platform is in elevated position by means of a helical spring 84 coiled about the rod and engaging at one extremity with one side of the bracket 55, and at the opposite extremity engaging with the member 83.

A latch mechanism L for holding the platform in approximately vertical position includes spaced latching rods 86 rigidly secured upon arms 87, which are pivoted at 87a. At their

lower ends the rods are provided with rollers 88 designed to engage and hold the bar 41. At their upper extremities the rods are connected by links 89 pivoted to operating levers 90, which are rigidly secured upon a shaft 91 journaled in bearings 92 upon the beam 50a. The opposite extremity of one of the end levers is provided with a pull cord 93, by means of which the lever may be operated to raise the arms 86 and release bar 41. After release of the bar the platform may be lowered to its original horizontal position by reversal of the motor 49.

It is to be observed that the arm 66 of the latch dog 60 also includes an angularly directed portion 94 disposed to be engaged by the roller 88 when the platform approaches its upward limited travel. In this way the dog 60 is actuated to release the pin 63. With the pin released the glass rack or carriage may be lowered along the trackway provided by the arms of the platform, in order to introduce the rack and the glass carrier thereby into the bath in the plating tank.

The movement of the tiltable platform to its uppermost position also operates a limit switch 100 indicated diagrammatically in Fig. 4. This switch includes an operating arm 101 carrying a roller 102, which is engaged by a suitable cam-like shoe 103 upon the glass rack. The switch, like the switch 76, already described, is so connected into the circuit of the motor 49 that opening thereof is effective to open the circuit of the motor and thus to stop it.

A third limit switch 104 is disposed adjacent to the upper extremity of the plating tank and includes an operating arm 106 also engaged by the shoe 103. This switch, like the switch 100, is connected into the circuit of the motor 49 for purposes of stopping the latter when the glass-carrying rack 40 has been introduced into a plating bath. In order to start the motor after it has been stopped by operation of one of the switches 76, 100, or 104, suitable double circuit push-button switches 107 and 108 are provided.

The operating circuits in which switches 76, 100, 104 and the controlling switches 107 and 108 are connected will now be described. These circuits include an "up" switch mechanism 110 and a "down" switch mechanism 111. Switch 110 includes a movable member 112 carrying cross arms or connectors 113, 114, 116 and 117, which respectively bridge the gap between pairs of contact points 118, 119, 121 and 122. The "down" switch 111 is similar in all details and the parts thereof have been indicated by the same numerals, but with prime marks applied for purposes of identification. Conductors 120 connect upper points 118, 119 and 121 respectively to upper points 121', 119' and 118' of the down switch 111, and conductors 125 interconnect points 118–118', 119–119' and 121–121'. Bus lines 123, 124 and 126 are respectively connected to the upper of each of the pairs of points 121, 119 and 118 of switch 110, and lines 127, 128 and 129 from the corresponding lower points lead to the motor at 49.

It is to be observed that the two switches 110 and 111 are provided with holding coils 131 and 132, which are provided with armatures or plungers 131', 132', having suitable mechanical connections (indicated merely diagrammatically) with the elements 112 and 112'. They are further mechanically interlocked as indicated by broken lines A so that when one switch is closed the other must be open. In Figure 4 the interconnected elements 110 and 111 are shown in an intermediate or neutral position in which both switches are open. This position of course is held only momentarily while one switch is being opened and the other closed. The circuit of coil 131 includes conductors 133 and 133a, the latter of which is attached at one extremity to the point 119 connected to bus bar 124. It may, also, be provided with a normally closed switch 133b. At its opposite extremity the coil is connected by conductor 134, in series with the limit switch 100, which switch is provided with return lead 136, to a terminal 137. This terminal in turn is connected by a lead 138 to lower, normally free, contact point 139 of button switch 107. The upper point 140 of this switch is joined by line 141 to upper point 142 of switch 108 and the latter point is joined by line 143 to point 144, of double circuit push-button. The second upper point 144a of switch 145 in turn is connected by lead 146 to the upper contact point 121 and the power line 123, thus providing a complete circuit through the holding coil 131 when the button of the switch 107 is depressed.

In order to maintain the circuit in the holding coil after the button of switch 107 is released, a lead 147 from the point 137 is connected to the lower of the points 122 while the upper of the points 122 is connected by line 148 to point 139a of switch 107. Points 139a and 142a of switches 107 and 108 are interconnected by line 150.

A circuit from bus line 124, to energize the coil 131, is established when the button of switch 107 is depressed through lines 133a, 133, 134, switch 100, lines 136 and 138, switch points 139 and 139a, line 150, switch 108, line 143, switch 145 and line 146 to bus line 123. Thus when the coil is energized to close the switch 110 a circuit is established from line 123 through the line 146, switch 145, line 143, switch 108, line 150, line 148, arm 117, line 147, line 136, switch 100 and line 134 to the coil 131 and from the latter through line 133, 133a, to bus 124. The circuit is thus maintained by the holding coil and the motor unit 49 is actuated by current flowing through arms 113, 114 and 116 to line 127, 128 and 129 until the switch 100 is operated by the cam 102 to break the circuit. Downward movement of the tiltable platform from tilted to horizontal position and also of the glass carrying car into the plating bath is effected by means of the switch mechanism 111.

The lower pair of contact points 153 and 153a of switch 108 are connected by line 153b to upper point 140a of switch 107. Point 140a is further joined by line 140b to the upper of points 122' in switch 111. The point 153a is in series through line 154 with the holding coil 132, which in turn is further in series through line 155 with limit switch 104 connected by line 157 to limit switch 76. Switch 76 is also joined by lines 158 and 133 to contact point 119 and thus to bus line 124.

Assuming that the tiltable platform is in elevated position and the glass-carrying rack is retracted from the plating bath, both of the switches 76 and 106 will be closed and limit switch 100 will be open. If the button of switch 108 is pressed current will then flow from the bus line 123, through line 146, switch 145, line 143, line 141, switch 107, line 153b, lines 154, switch 104, line 157, switch 76, lines 158 and 133b to bus 124, to energize coil 132 and close switch 111.

When the button switch is released, a holding

circuit is established from bus 123 through line 146, switch 145, lines 143 and 141, through switch 107, line 140b, arm 117', coil 132, line 155, switch 104, line 151, switch 76, lines 158 and 133a to bus bar 124.

Assuming that the switch 110 is closed in order to wind up the cable 53, current from bus lines 123, 124 and 126 will flow through arms 116, 114, and 113 respectively, to lines 129, 128 and 127, to motor 49, to activate the latter. The platform 35a may thus be elevated from horizontal to inclined position. The rack 40, when in the bath, may also be lifted from the bath by the same winding operation, when the platform is in elevated position. If the "up" switch 110 is open and "down" switch 111 is closed current flows from bus lines 123, 124 and 126 through lines 120 respectively, through arms 113', 114' and 116' to lines 125 and through lines 127, 128 and 129, to cause motor 49 to run in the desired direction to unwind the cable 53.

Manifestly, during movement of the rack to or from the bath, the platform 35a must be held in tilted position by latch mechanism L. This latch is operated by hand pull 93 to permit the platform to be lowered to horizontal position.

Stoppage of unit 49 may be effected at any point in the cycle of operation merely by pressing switch 145 to open the circuit of lines 146 and 143.

An electrical conductor system for supplying current to the silver films upon mirrors to be plated includes a flexible strap 165, of superposed thin, flexible plates of copper or the like. This strap is joined at one end to a bus 166 of a source of current. It is also looped about a take-up roller 167 operating in guides (not shown). At its opposite end the strap is attached, as shown in Fig. 3, to bus bar 168 upon bar 44. The bus bar, in turn, is provided, as shown in Fig. 1, with spaced flexible connectors 169, which are equipped at their extremities with clips 171, designed to be clipped upon the edges of the glass to establish contact with the silver film.

In the operation of the apparatus, the mirrors, to be plated, are conveyed by the rollers of conveyor 5 to rollers 13 of the plating apparatus. It is to be understood that during this operation the bars 35 of platform 35a and bars 42 of rack 40 recline between rollers 13. When the blanks are above the rack, the rollers of the entire system are stopped and clips 171 are attached to the glass. The button switch 107 is then operated to close "up switch" 107, and operate motor 49 to take up cables 53 and lift platform 35a. When the platform reaches its uppermost position, latch L engages bar 41. Also, limit switch 100 is operated to stop unit 49, and hook 62 is disengaged from pin 63. Likewise, springs 84 are compressed and held so long as latches L operate. To lower rack 40 into the bath, button switch 108 is operated to close down switch 111, thus causing motor 49 to reverse and play out cable 53. Downward movement of the rack is stopped when the cam 103, on the rack, engages limit switch 104. The rack remains in the bath until the film of copper upon the mirror is sufficiently thick; then switch 107 is again operated to close "up" switch 110. The cable 53 winds up until cam 103 again engages switch 104 to stop the motor. Upon release of latches L the springs 84 initiate downward movement of the platform 35a, thus releasing cam 103 from the limit switch 100. Button switch may, subsequently be pressed to close "down" switch 111. The platform descends to horizontal position in which the copper-plated mirrors rest upon rollers 13. Dog 60 then engages rail 11 to release rack 40 and simultaneously limit switch 76 is opened to stop motor 49. The motor normally rotates for a moment after the switch opens. This overtravel is sufficient to create a slight slack in cable 53, so that when the rack is released, it is "kicked" transversely by spring 68 a sufficient distance to release pegs 48 from the edges of the mirrors. The conveyor rollers 13 and 8 may then be started to carry them away.

The form of the invention herein shown and described is merely exemplary. Numerous modifications may be made therein without departure from the spirit of the invention or the scope of the claims.

What I claim is:

1. In an apparatus for coating plates, a tank having an inclined side wall providing a track within the tank, said tank being adapted to contain a coating medium, a platform journaled to tilt from horizontal position to a position approximately aligning with said side wall about an axis contiguous to and parallel to an upper edge of the tank, a carriage mounted to move upon the platform and to rest upon it while it is in horizontal position, said carriage being designed to support the plates while they are being coated, means to tilt the platform about its axis from said reclining position to an inclined position and to move the carriage from the platform when the latter is tilted along said inclined side wall of the tank, then back to the platform, said apparatus including means to maintain the platform in inclined position while the carriage is being operated.

2. Apparatus as defined in claim 7 in which the connection for the plate is flexible, is joined to the carriage at one end and is provided with flexible leads having clips for engaging an edge of the plate.

3. In an apparatus for coating plates, a tank, a platform journaled to tilt upwardly from a reclining position about an axis contiguous to an upper edge of the tank, a carriage mounted to move upon the platform and being designed to carry a plate to be coated, a sheave upon the swinging edge of the platform, a cable attached to the carriage and being passed about the sheave and further being trained about a winding drum for tilting a platform from a reclining position to an angularly upwardly inclined position and then for lowering the carriage into the tank, guide means in the tank to direct the movements of the carriage while it is therein, said guide means being aligned with the platform when the latter is in inclined position and a latch for locking the platform in upwardly inclined position while the carriage is being lowered into the tank.

4. Apparatus for electroplating plate-like bodies with a metal, said apparatus comprising a tank for a plating bath, a platform journaled at one edge of the tank to swing from reclining position to a position in which its upper surface aligns with the adjacent surface of the tank, a movable carriage mounted to rest upon the platform in reclining position and to travel with the platform when the latter is raised, and then to travel upon the contiguous side of the tank into and from the bath, means to tilt the platform about its axis and to move the carriage into and from the bath, said apparatus being provided with means to hold the platform in tilted posi-

tion while the carriage is being manipulated, means to supply electrical current to a plate upon the carriage, the latter means comprising an anode of the metal with which the plates are to be coated, disposed within the tank in parallelism to a side of the plate to be coated, said anode being connected to one side of a source of plate current, a flexible conductor joined to said carriage and constituting the other conductor of said source of plate current, flexible conductors having clips adapted to engage an edge of the plate to be coated, joined to the latter conductor.

5. In an apparatus for electroplating the backs of mirror plates, a tank for an electroplating bath, a conveyor for plates comprising horizontal rollers disposed in parallelism to each other and being disposed to carry the plates alongside the tank, means to introduce the plates into the bath in an upwardly tilting position comprising a carriage constructed of bars adapted to nest between the rollers and to support a plate to be coated thereupon, means to tilt said carriage upwardly into an inclined position with the lower edge over the tank, means to slide the carriage while in inclined position downwardly into the tank and then to retract it to its starting position, a flexible electrical conductor secured to said carriage and providing means supplying electrical current thereto while it is in the tank and branch conductors secured to the first-mentioned conductor and having clips adapted to engage an edge of a plate upon said carriage, an anode in the tank contiguous to the face of the plate and the second conductor joined to said anode.

6. An apparatus for electrolytically applying coatings to plates, said apparatus comprising a tank adapted to contain a solution of an electrolyte for the coating operation, the tank having a downwardly-inclined trackway disposed therein and extending below the surface of the electrolyte, horizontal rollers adapted to support the plates to be coated preliminary to the coating operation, mounted along a side of but exterior of the tank contiguous to an upper edge thereof, a platform comprising bars adapted to nest between said rollers and being mounted to tilt upwardly from reclining position in which the bars are nested between the rollers to a position approximately aligning with said trackway and providing an upwardly-extending extension of the trackway, the tilting movement being about an axis contiguous to the upper end of said trackway, a carriage upon the platform for supporting the plates to be coated and comprising spaced bars corresponding to the bars of the platform to nest between said rollers when the platform is in reclining position and when so nested being below the plates upon the rollers, means to swing the platform from reclining position to an upwardly tilted position, to lower the carriage along the trackway with the plates thereon, into the tank while the platform is in tilted position and to return the carriage to the platform after the coating operation is completed, said apparatus including means to hold the platform in tilted position, the carriage being provided with a flexible electrical conductor for supplying electrical current, the conductor being connected to branches having contact with the plates to be coated.

7. Apparatus for electrolytically coating a mirror plate, comprising a deep upwardly-extending tank for a plating bath, an anode plate disposed in downwardly-inclined position within the tank and adapted to be covered by the bath, a carriage for supporting and moving a plate to be coated into the bath, said carriage being hingedly mounted to tilt about an axis contiguous to an edge thereof and contiguous to an edge of the tank, from a horizontal position, for receiving a horizontally-disposed plate to be coated to an upwardly-inclined position parallel to said anode, means extending parallel to said anode for guiding the carriage into the bath with said plate parallel to the anode and with the edge adjacent the axis disposed downwardly and actuating means for tilting the carriage about its axis from one extreme position to the other, then lowering the carriage along said guideway into the bath, then finally retracting the carriage and returning it to its initial position and electrical connections for supplying electrical current to the plate and the anode.

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