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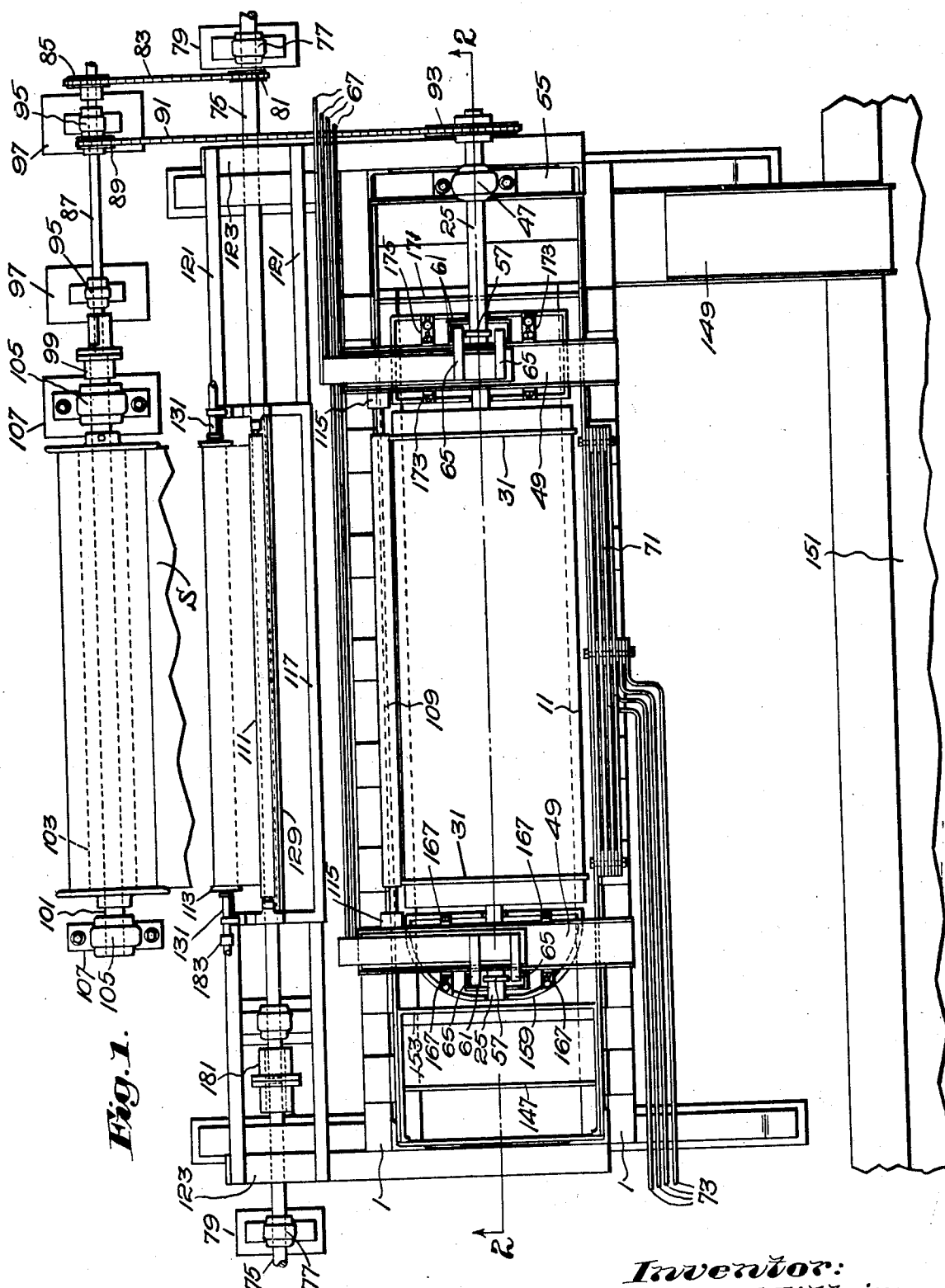
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1,993,726

ELECTROLYTIC APPARATUS

Filed Aug. 30, 1930

4 Sheets-Sheet 1



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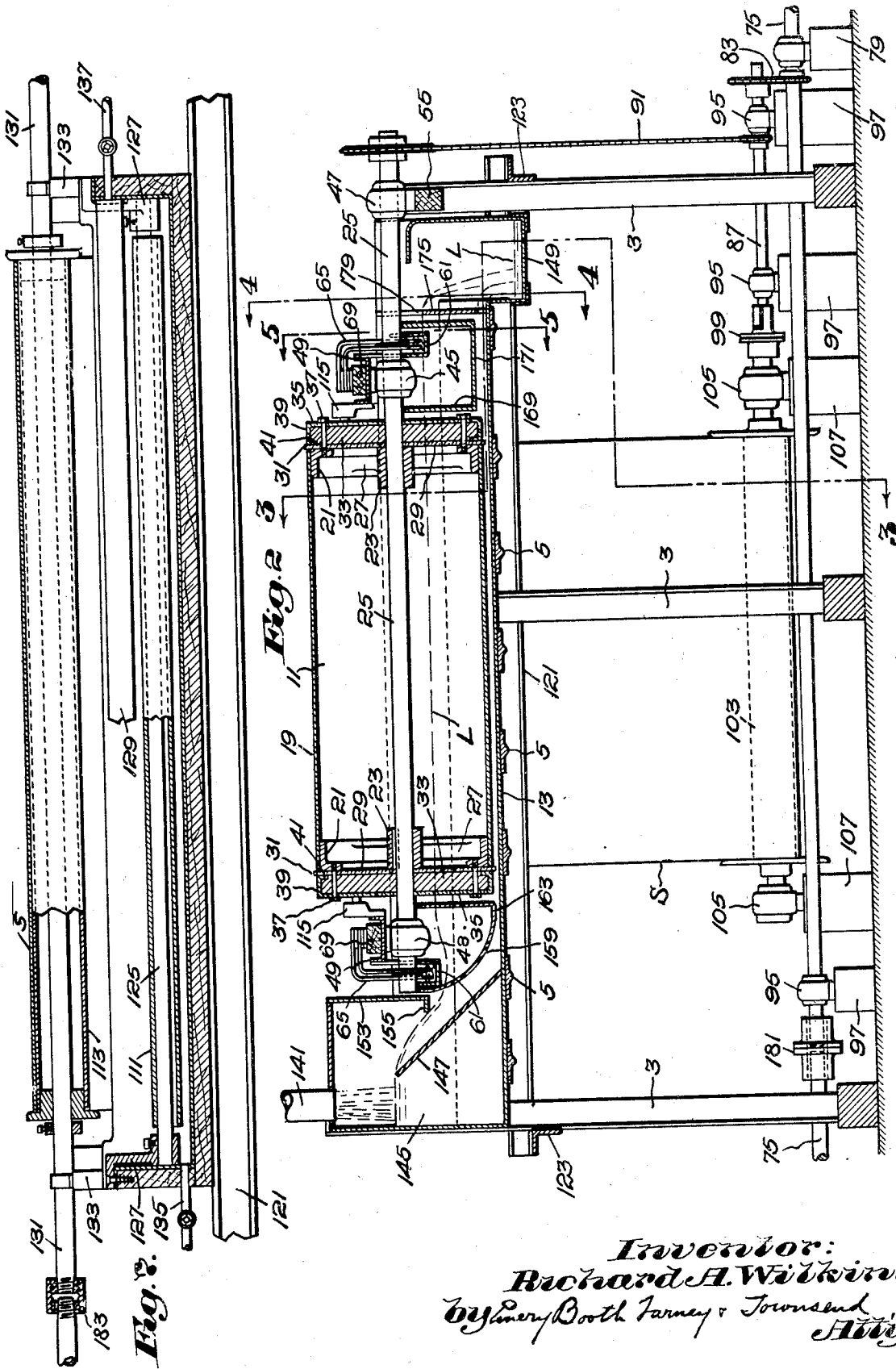
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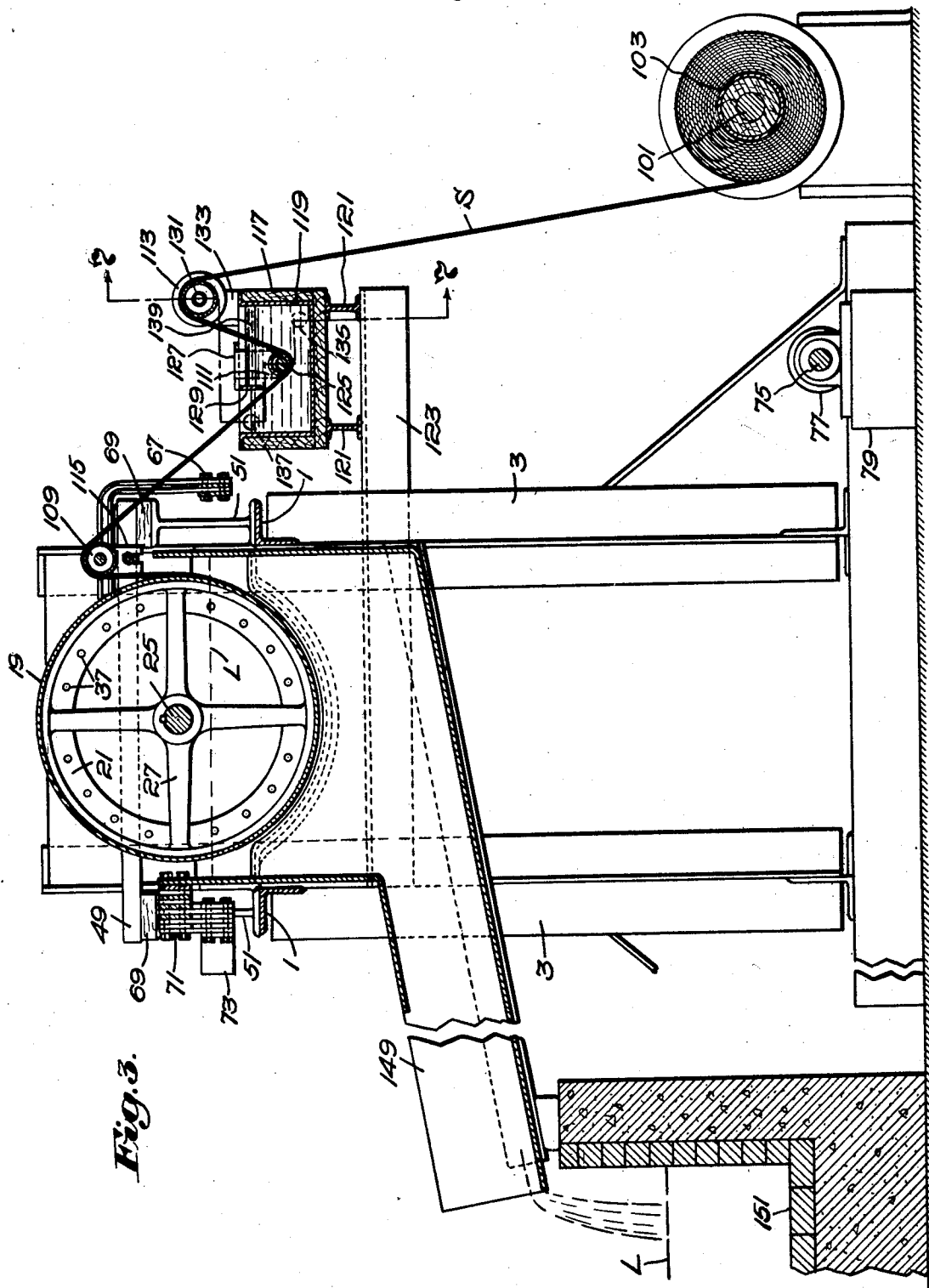


Fig. 3.

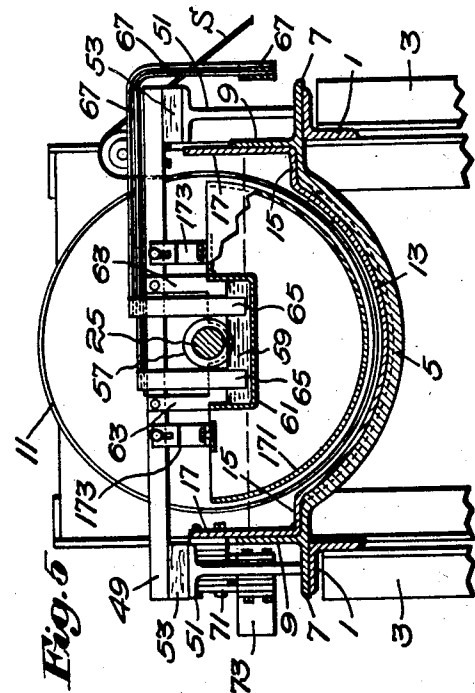
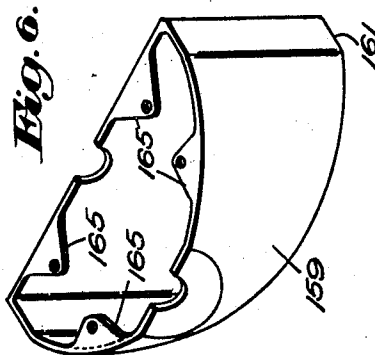
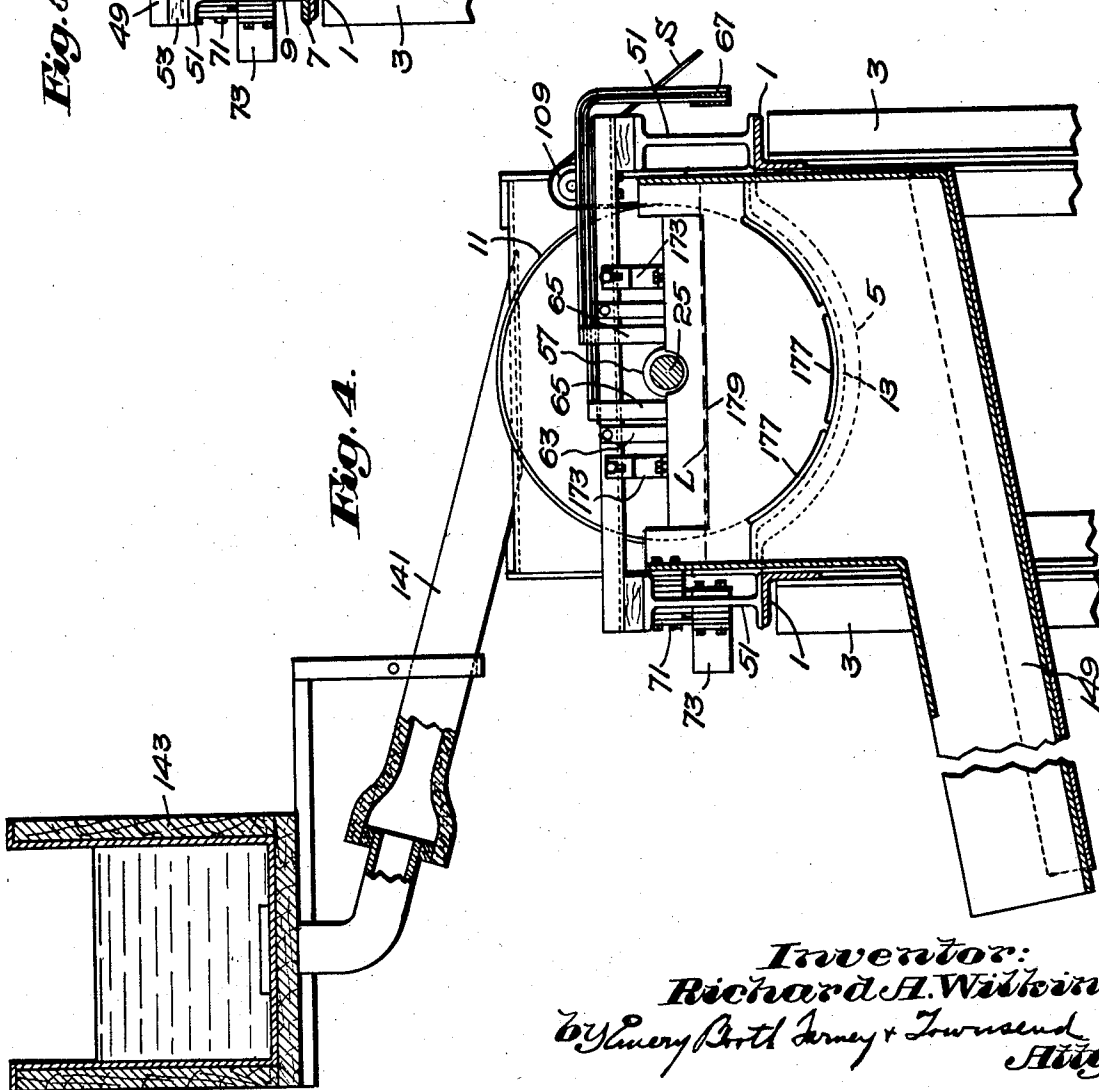
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

1,993,726

ELECTROLYTIC APPARATUS

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Application August 30, 1930, Serial No. 478,905

20 Claims. (Cl. 204—6)

My invention relates to electrolytic apparatus and methods, particularly but not exclusively adapted for forming sheet metal, as for example, sheet copper.

5 The invention will be best understood from the following description when read in the light of the accompanying drawings of one embodiment of the invention, the scope of which latter will be more particularly pointed out in the appended
10 claims.

In the drawings:—

Fig. 1 is a plan of apparatus constructed according to the invention for electro-depositing sheet metal;

15 Fig. 2 is a section on the line 2—2 of Fig. 1; Figs. 3, 4 and 5 are respectively sections on the lines 3—3, 4—4 and 5—5 of Fig. 2;

Fig. 6 is a perspective of the entering stream guide; and

20 Fig. 7 is a section on the line 7—7 of Fig. 3.

The present invention is more particularly concerned with an electro-depositing unit, a plant employing a plurality of such units being more fully described in my copending application Serial
25 No. 478,903, filed herewith.

Referring to the drawings, the unit illustrated comprises a frame having the longitudinally arranged angle-irons 1 supported on suitable legs 3. Carried by the angle-irons 1 are a plurality
30 of spaced bracket members having the arcuate portions 5 between the angle-irons, at opposite sides of which arcuate portions are extensions 7 resting upon the upper webs of the angle-irons, each extension carrying a vertically extending
35 portion 9. Supported by the bracket members is a trough, preferably formed of relatively thin sheet lead or other conductive material inert with respect to the electrolyte employed, this trough herein constituting an insoluble anode cooperating
40 with a rotating cylindrical cathode 11. The trough comprises a lower portion 13 conforming to the arcuate portions 5 of the brackets so as to form a surface conforming to a cylinder concentric with the axis of the cathode, the trough
45 also having at each side of the portion 13 thereof horizontal portions 15 and vertical portions 17 conforming to the adjacent inner sides of the portions 7 and 9 of the bracket.

The cathode 11, as illustrated, comprises a sleeve 19 of copper or other conductive material, preferably coated with a thin layer of silver, said sleeve at opposite ends thereof receiving and being sweated to the rim portions 21 of spiders
50 the hub portions 23 of which are secured in non-rotatable relation to the shaft 25. As shown, the

rim and hub portions of the spiders are connected by spokes 27, the spider preferably being formed of an integral casting of conductive material such as bronze. As shown, at the ends of the cathode sleeve 19 are provided gaskets 29 of
5 non-conductive material inert with respect to the electrolyte, as for example, rubber, these gaskets providing portions 31 forming radially extending flanges about the cathode, which flanges in practice act to give a cleanly formed
10 edge to the electro-deposited sheet which is stripped from the cathode as hereinafter described. Herein, for closing the ends of the sleeve 19, and for securing the gaskets, the cathode at the ends thereof is provided with
15 disks 33 of non-conductive material, preferably wood, fiber, or the like, coated on its exterior with a layer 35 of rubber for protecting it from the action of the electrolyte, the disks being secured to the spiders by means of studs 37 screw
20 threadedly secured to the rim portions 21 thereof. Conveniently, each rubber layer 35 may be molded separately as a disk having the annular portion 39 and radial flange 41, and after vulcanization may be sprung over the disk 33.

As shown, the shaft 25 for the cathode is supported in bearings 43, 45 and 47, the bearings 43 and 45 being carried at the under sides of channel-irons 49 supported on brackets 51, the latter resting upon the upper webs of the angle-irons 1, the channel-irons 49 being insulated from
30 the frame of the machine by blocks 53 of insulating material inserted between the opposed faces of said channel-irons and brackets. As shown, the bearing 47 is supported on a beam 55 of wood, or other insulating material, carried by the adjacent legs 3 of the frame.

Herein, the shaft 25 adjacent each bearing 43 and 45 has secured thereto a ring 57 of conductive material in conductive relation with the shaft. Each ring, at its lower side, is partially
40 immersed in a body 59 of mercury contained in a cup 61, the latter supported by brackets 63 from the adjacent channel-irons 49 which carry the bearings. As shown, a pair of bars 65 of conductive material, respectively positioned at opposite sides of the shaft, extend into each body of mercury, these bars being continuations of the
45 strips 67 forming a bus-bar connected to the negative terminal of a source of electromotive force, the positive terminal of which is connected to the lead trough constituting the insoluble anode cooperating with the cathode. As shown, the strips 67 are insulated from the frame of the machine by strips 69 of wood, or other in-
55

insulating material, carried at the open sides of the channel-irons 49.

As illustrated, one of the vertical portions 17 of the lead trough has bolted thereto in conductive relation therewith a plurality of bars 71 co-extensive in length with the active portion of the cathode, the bus-bar so formed being connected to the positive terminal of the above mentioned source of electromotive force by the conductive strips 73. As more fully described in the above mentioned copending application, the strips 67 connected to the cathode may be part of the strips 73 connected to the insoluble anode of an associated unit, permitting said units to be connected in series.

As shown, the shaft 25 supporting the cylindrical cathode is driven from a longitudinal extending drive shaft 75 supported in bearings 77 carried by piers 79, the latter preferably being of concrete, wood, or other insulating material. As shown, the drive shaft is provided with a sprocket wheel 81 around which passes a chain 83 for driving the sprocket wheel 85 on the lay shaft 87, the latter having thereon a chain sprocket wheel 89 around which passes a chain 91 cooperating with a chain sprocket wheel 93 on the end of the shaft 25.

Referring to Figs. 1 and 2 the lay shaft 87 is shown as mounted in bearings 95 carried by piers 97, preferably of wood, concrete, or other insulating material. Secured to the lay shaft in driving relation thereto by a detachable coupling 99 is the shaft 101 of a winding roll 103 for stripping the sheet S of electro-deposited material from the cathode, said roll preferably formed of wood or other insulating material so as to insulate it from the shaft 101. The shaft 101 is shown as mounted in bearings 105 carried by piers 107 of material like that of the hereinbefore mentioned piers. In operation the winding roll 103 is rotated in definite relation to the cathode so that the electro-deposited sheet is stripped from the latter as it is rotated.

For guiding the sheet of deposited material from the cathode to the winding roll 103, the machine herein is provided with the guide rolls 109, 111 and 113, the guide roll 109 being carried by vertically adjustable brackets 115 secured to the vertical sides of the channel-irons 49. By making the brackets 115 vertically adjustable relative to the channel-irons the sheet may be suitably tensioned. The guide rolls 111 and 113 are carried by the tank 117 which, as hereinafter described, is insulated from the frame of the machine.

It will be understood that the construction above described prevents the sheet of electro-deposited material and its associated guide and winding rolls, and the driving mechanism for the cathode drum, from short circuiting the cathode and anode.

Preferably, the tank 117 is of wood, or the like, having a lining 119 of lead or other material inert with respect to the electrolyte, the trough being mounted on a pair of I-beams 121 which at opposite ends are carried by beams 123 supported on the legs 3. The guide roll 111 herein is tubular, and is loosely mounted on a bar 125 of circular cross-section carried by the brackets 127 at the ends of the trough. The interior of the tank is divided into two compartments by a partition 129 extending downward a slight distance from the top of the tank. The guide roll 113 is rotatably supported on a steam pipe 131 carried by the brackets 133 fixed to the tank 117. In this way the roll 113 serves as a drying roll.

In practice, the tank 117 may contain water, or other suitable liquid, for washing the residual electrolyte from the sheet of electro-deposited material. The water may be supplied to the tank 117 through an inlet indicated at 135 (Fig. 3) and be discharged therefrom through an outlet indicated at 137. As shown, on the surface of the water at the right of the partition 129 is placed a layer of oil 139 for coating the sheet to prevent corrosion thereof. The oil preferably is a hydrocarbon oil, preferably one having a paraffin base, such as lard oil, so called "whale oil soap emulsion", or the light or medium body oils of this nature commonly employed for lubricating machinery, known to the arts as "light" or "medium" machine oil. Preferably lard oil is employed as it does not interfere with soldering of the sheet material in subsequent operations. Drying the roll 113 will render the oil somewhat gummy. For usual conditions a temperature of 30 degrees C. for the roll will give satisfactory results. It has been found that in the absence of washing the strip, to remove the traces of the electrolyte and stripping agent, the latter, for example, selenious acid applied from time to time to the exposed portion of the cathode, and applying a film of oil to the sheet, particularly when it is of copper, is subject to oxidization.

Referring particularly to Figs. 1, 2 and 4, the electrolyte is discharged into the left hand end of the trough, as viewed in Fig. 2, through a conduit 141, which is preferably of ceramic or other insulating material, to prevent the possibility of short circuits, and leads from a distributing trough 143 which may be utilized to supply the electrolyte to a number of units, as set forth in the above mentioned copending application. The electrolyte is received in the trough in a chamber 145 formed by an inclined dam 147, the stream of electrolyte flowing over the dam and down the inclined breast thereof into the body of the trough, whence it passes through the latter in a swiftly flowing stream and discharges through a chute 149 into a suitable collecting trough 151 (Fig. 3). From the collecting trough, the electrolyte may be pumped through apparatus for replenishing its metal content, and returned to the trough for reuse. As shown, in front of the breast of the dam 147 is a vertical splash plate 153 having the horizontal flange portion 155 directed toward the breast of the dam, the electrolyte contacting with the edge of the flange, as illustrated in Fig. 2, so as to insure a smooth flow of the electrolyte toward the cathode. Between the plate 153 and the cathode drum is shown a stream guide 159, the under surface of which, as illustrated, (see Figs. 2 and 6) approximately conforms to the surface of a sphere except at its portion 161, which latter portion conforms to the surface of the cylinder spaced from the arcuate portion of the walls of the trough about the same distance as the cathode surface is spaced therefrom, thus affording an orifice 163 for discharging and guiding the electrolyte into the space between the cathode drum and the insoluble anode trough. As shown, the stream guide 159 is in the form of a hollow tank open at the top, the upper edges being provided with perforated lugs 165 for attachment of brackets 167 for suspending the stream guide from the adjacent channel-iron 49. The stream guide also serves to house the bearing 43 and the adjacent mercury cup 61, thus protecting the latter from the electrolyte.

At the right hand end of the cathode drum, 75

as viewed in Fig. 2, is a member 169 similar to the stream guide 159 except that its lower wall 171 conforms to the surface of the cylinder slightly spaced from the wall of the insoluble anode trough. The member 169 serves to house the bearing 145 and adjacent mercury container 61 and to protect them from the electrolyte. As shown (Fig. 5), the member 169 is suspended by means of brackets 173 from the adjacent channel-iron 49, the brackets 173 being similar to the brackets 167.

Adjacent the discharge chute 149 the insoluble anode trough is provided with a dam or weir 175 which, as indicated in Fig. 4, is slightly spaced from the arcuate portions of the trough so as to form orifices 177 through which the major portion of the electrolyte discharges into the discharge chute. A small portion of the electrolyte flows over the upper edge 179 of the weir, as a result of which the upper surface of the stream of electrolyte is maintained horizontal, thereby causing the cathode drum to be immersed to the same depth throughout its length for insuring that the thickness of the electro-deposited sheet will be uniform throughout the width of said sheet. Preferably the dams, weirs and stream guides are formed of sheet lead or other material inert with respect to the electrolyte.

As illustrated, the depth of the stream of electrolyte flowing in the space between the cathode and insoluble anode is such that the level of the electrolyte, indicated by the line L, is slightly above the horizontal portions 15 of the trough, the part of the electrolyte above said portions 15 therefore flowing through a channel of increased width as compared to the channel afforded by the space between the cathode and trough. As a result of this construction waves along the upper surface of the electrolyte are dampened, which prevents splashing, and a sudden rush of electrolyte is ineffective to increase to any appreciable degree the extent of immersion of the cathode in the electrolyte. The construction also provides that where a series of units are employed, and are supplied with electrolyte from a common source of electrolyte supply, any small variations in the amount of electrolyte supplied the several units will not to any appreciable degree cause a variation in the extent of immersion of the several cathodes in the electrolyte. The construction further provides a large upper surface for the electrolyte, permitting ready escape of gases, and still further provides a shallow depth for any foam or bubbles which may collect on the surface of the electrolyte as it passes the cathode, and, in this respect, the construction permits an increased current density with consequent increase in the rate of deposition.

The provision of the channels of increased width for the electrolyte flowing above the horizontal portions 15 of the insoluble anode troughs 3, causes the electrical resistance between said anode and the cathode at that point to be much higher than between the arcuate portion 13 of said anode and the cathode. As a result of this construction, the current density between the arcuate portion of the insoluble anode and cathode is much greater than between the portions of said anode above the horizontal walls 15 thereof and the cathode. Consequently, practically all the deposition of metal on the cathode occurs at the portion thereof opposite the arcuate portion of the insoluble anode. Further, changes in the amount of current flowing, and the potential

drop between the insoluble anode and cathode, and the rate of deposition of metal on the cathode are not materially affected by variations in the amount of electrolyte flowing.

As more fully set forth in the above mentioned copending application, the drive shaft 75 may be utilized to drive a plurality of machines, and the steam pipe 133 on which the drying roll 113 is mounted may be common to a number of machines, said machines electrically connected in series. For preventing short circuits of the machines by the drive shaft and steam pipe, these elements respectively may be provided with couplings 181 and 183 respectively, said couplings formed of insulating material.

It will be understood that within the scope of the invention wide deviations may be made from the embodiment thereof herein described without departing from the spirit of the invention.

What is claimed is:

1. Electrolytic apparatus having, in combination, an electrolytic cell having a cathode and a cooperating insoluble anode, the latter formed to guide a stream of electrolyte past said cathode in contact therewith, means for passing a metal bearing electrolyte through said cell and causing a stream of the electrolyte to flow through the space between said cathode and anode, said anode being so shaped and disposed relative to said cathode as to maintain the ohmic resistance of said cell substantially constant for variations in the amount of electrolyte passed through said cell.

2. An electrolytic cell having, in combination, a cathode, means constituting an anode for guiding a stream of electrolyte past said cathode in contact therewith, and means for providing flow space for excess electrolyte acting to maintain the ohmic resistance between said anode and cathode substantially constant for variations in the amount of electrolyte passed through said cell.

3. Electrolytic apparatus having, in combination, an electrolytic cell having means providing a cathode surface and means providing an anode cooperating with said surface; means for passing a stream of electrolyte through said cell, said anode formed to provide a guide for the stream of electrolyte, in which latter said cathode is partially immersed, and having surface portions opposed to said cathode surface in relatively close spaced relation thereto, and other portions relatively widely spaced from said cathode surface adjacent the surface level of the electrolyte.

4. Electrolytic apparatus having, in combination, a cathode, means constituting an anode for guiding a stream of electrolyte past said cathode in contact therewith, said means having provision for dampening wave effects at the surface of the electrolyte.

5. Electrolytic apparatus having, in combination, an electrolytic cell having a cathode, means for passing a stream of electrolyte through said cell, means constituting an anode for guiding the stream of electrolyte past said cathode in contact therewith, said means so shaped and disposed relative to the cathode surface as to maintain the ohmic resistance between said cathode and anode substantially constant for variations in the depth of said stream caused by variations in the amount of electrolyte passed through said cell.

6. Electrolytic apparatus having, in combination, an electrolytic cell having a rotary cylindrical cathode, means for passing a stream of electrolyte through said cell, an electrolyte trough

for guiding said stream constituting an anode cooperating with said cathode, said trough so shaped and disposed relative to the surface of said cathode as to maintain the ohmic resistance between said cathode and anode substantially constant for variations in the depth of electrolyte in said trough caused by variations in the amount of electrolyte passed through said cell.

7. Electrolytic apparatus having, in combination, a trough for electrolyte constituting an anode, a cylindrical cathode partially immersed in said electrolyte, said trough having a portion forming an arcuate wall in proximity to the surface of said cathode, and at the surface portion of the electrolyte having an adjoining portion the walls of which are relatively distant from said cathode.

8. Electrolytic apparatus having, in combination, a cylindrical cathode, means providing a trough having an arcuate portion in close proximity to said cathode constituting an insoluble anode, said arcuate portion guiding the electrolyte in a swiftly flowing stream past said cathode in contact therewith, and means providing conduits at opposite sides of said arcuate portion for receiving the excess of electrolyte over that necessary to fill the space between the walls of said cathode and said arcuate portion.

9. Electrolytic apparatus having, in combination, an electrolytic cell, means for passing a stream of electrolyte through said cell, the latter comprising means constituting an anode formed for guiding said stream, a cathode partially immersed in said stream in closely spaced relation to the opposed surface of said anode, and means associated with said cell for maintaining the effective degree of submergence of said cathode substantially constant comprising means operatively acting to by-pass excess electrolyte around the space between the closely spaced surfaces of said anode and cathode.

10. Electrolytic apparatus having, in combination, a plurality of electrolytic cells, means for flowing separate streams of metal bearing electrolyte through said cells from a common source of electrolyte supply, and means associated with each cell acting to maintain the ohmic resistance thereof substantially constant for variations in the amount of electrolyte flowing through that cell.

11. Electrolytic apparatus having, in combination, spaced longitudinally extending members, spaced rigid transverse members bridging said longitudinally extending members, a sheet lead trough constituting an insoluble anode conforming to said transverse members and supported thereby, and a cathode drum rotatably supported on bearings operatively carried by said longitudinally extending members.

12. Electrolytic apparatus having, in combination, a rotary cylindrical cathode, a trough for guiding a stream of electrolyte past said cathode lengthwise thereof and in contact therewith, the cylindrical wall of said cathode being in relatively close proximity to said trough, and means stationary relative to said cathode providing a tapering arcuate orifice for distributing the stream of electrolyte about the surface of said cathode.

13. Electrolytic apparatus having, in combination, a rotary cylindrical cathode, a trough having an arcuate portion concentric with said cathode in proximity thereto for guiding a stream of electrolyte past said cathode lengthwise there-

of and in contact therewith, and means stationary relative to said cathode providing a tapering orifice for distributing the electrolyte into the form of an arcuate sheet conforming to the arcuate space between said cathode and said arcuate portion of said trough.

14. Electrolytic apparatus having, in combination, a rotary cylindrical cathode, a trough having an arcuate portion concentric with said cathode in proximity thereto for guiding a stream of electrolyte past said cathode lengthwise thereof and in contact therewith, and a member in said trough having a longitudinally and transversely tapered surface opposed to the surface of said trough for distributing the electrolyte about the surface of said cathode.

15. Electrolytic apparatus having, in combination, a longitudinally extending trough for conducting a stream of electrolyte, a cylindrical cathode partially immersed in said stream, a shaft for said cathode extending longitudinally of said trough, a bearing for rotatably supporting said shaft, and a can-like member immersed in said stream near one end of the cathode for protecting said bearing from said electrolyte.

16. Electrolytic apparatus having, in combination, a longitudinally extending trough for conducting a stream of electrolyte, a cylindrical cathode partially immersed in said stream, a shaft for said cathode extending longitudinally of said trough, a bearing for rotatably supporting said shaft, a can-like member in said stream for protecting said bearing from said electrolyte, said can-like member having an immersed surface for guiding the electrolyte toward that surface of said cathode which is opposed to said anode.

17. Electrolytic apparatus having, in combination, a trough for the electrolyte, a rotary cathode suspended in said trough in insulated relation thereto, a support for said trough, and means for stripping an electro-deposited sheet from said cathode, and a tank for liquor for treating said sheet carried by said support in insulated relation thereto.

18. A cathode comprising an open ended sleeve of conductive material, closures of non-conductive material for said sleeve, and means forming annular radial flanges of non-conductive material projecting from said sleeve at the ends thereof, said means comprising rubber sheets of greater diameter than both said sleeve and closures clamped between said closures and the ends of said sleeve.

19. Apparatus for making sheet material having, in combination, a cathode comprising an open ended sleeve of conductive material adapted to be immersed in the electrolyte, and end closures for said sleeve exteriorly covered with a protective layer of rubber.

20. Electrolytic apparatus having, in combination, a cathode, means constituting an insoluble anode relatively closely spaced from said cathode for guiding a stream of electrolyte past said cathode lengthwise thereof and in contact therewith with said cathode partially submerged in said stream, said means adjacent the surface level of the electrolyte providing a channel lengthwise of the cathode of sufficient width to accommodate relatively large excess amounts of electrolyte without materially increasing the depth of submergence of said cathode.

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