

Feb. 3, 1942.

W. F. HALL

2,271,735

MACHINE FOR ELECTROPROCESSING METAL STRIP

Filed July 16, 1938

4 Sheets-Sheet 1

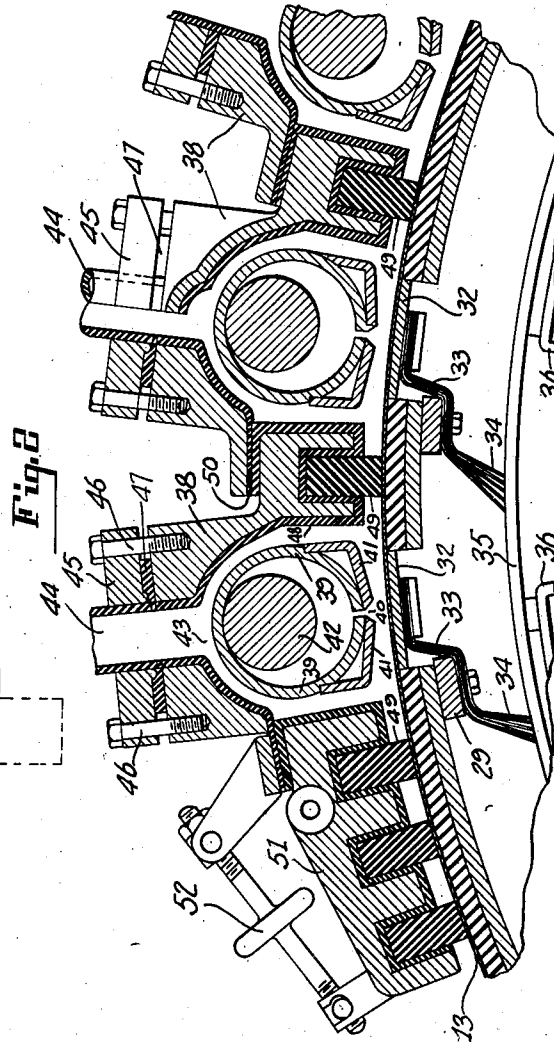
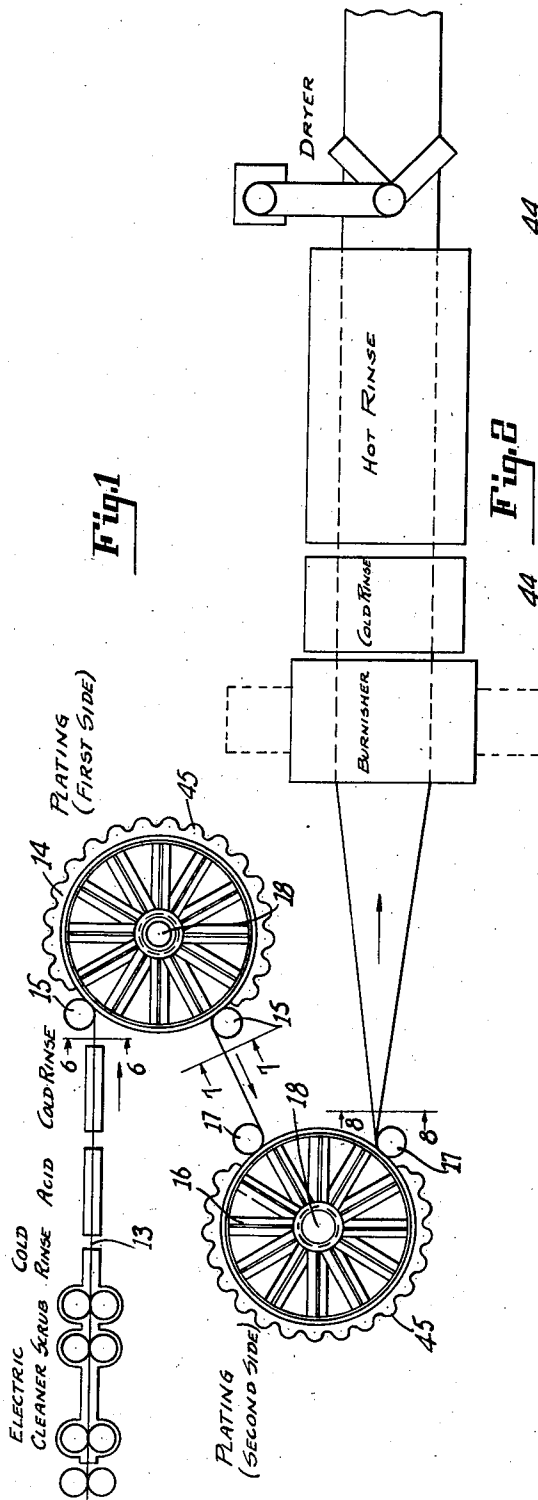
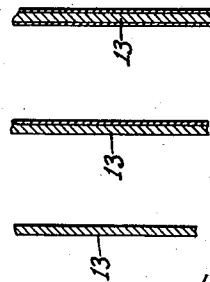


Fig. 6 Fig. 7 Fig. 8



INVENTOR
WESLEY F. HALL
BY *Toulmin & Toulmin*
ATTORNEYS

Feb. 3, 1942.

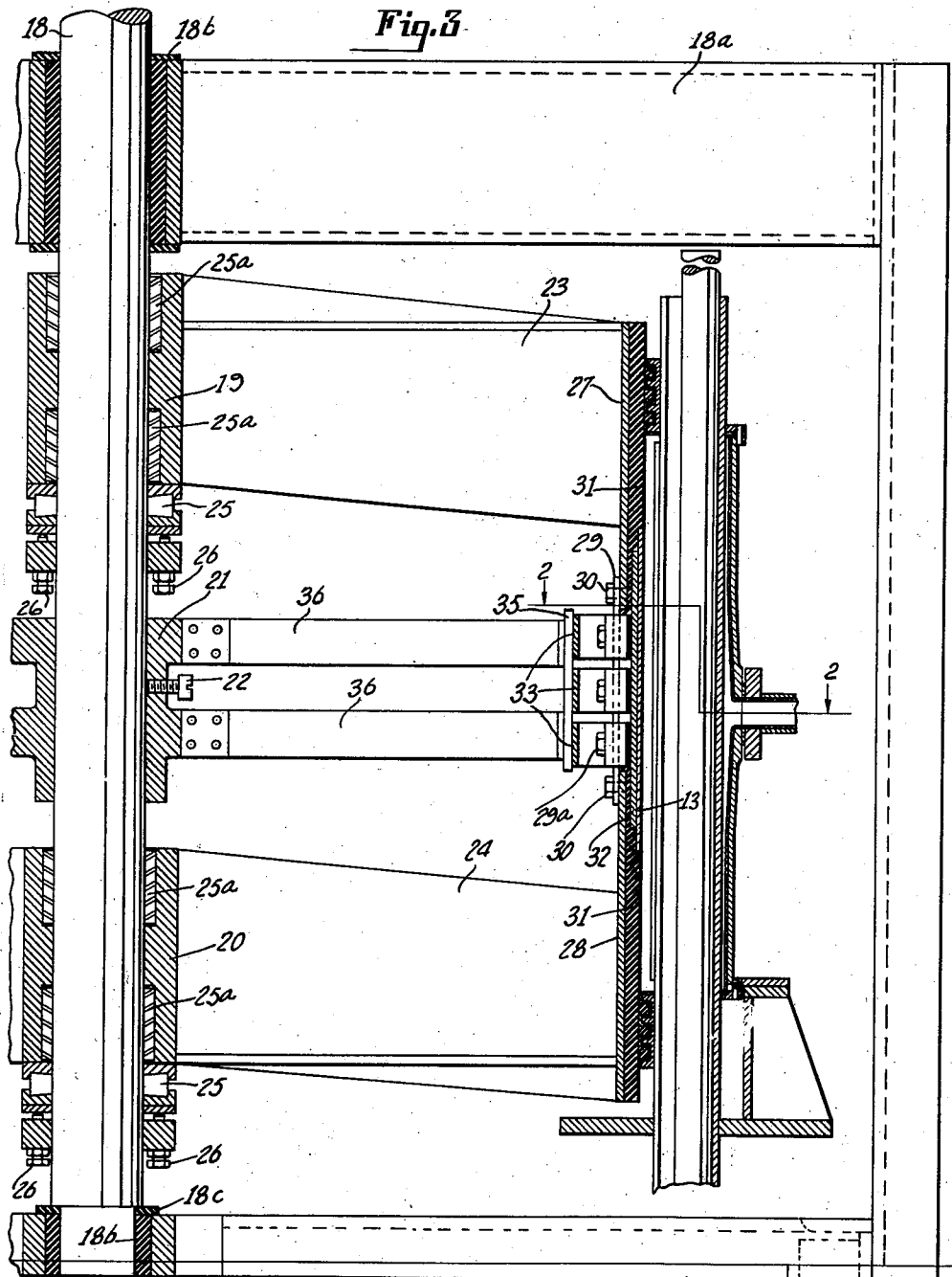
W. F. HALL

2,271,735

MACHINE FOR ELECTROPROCESSING METAL STRIP

Filed July 16, 1938

4 Sheets-Sheet 2



INVENTOR
WESLEY F. HALL
BY *Toulmin & Toulmin*
ATTORNEYS

Feb. 3, 1942.

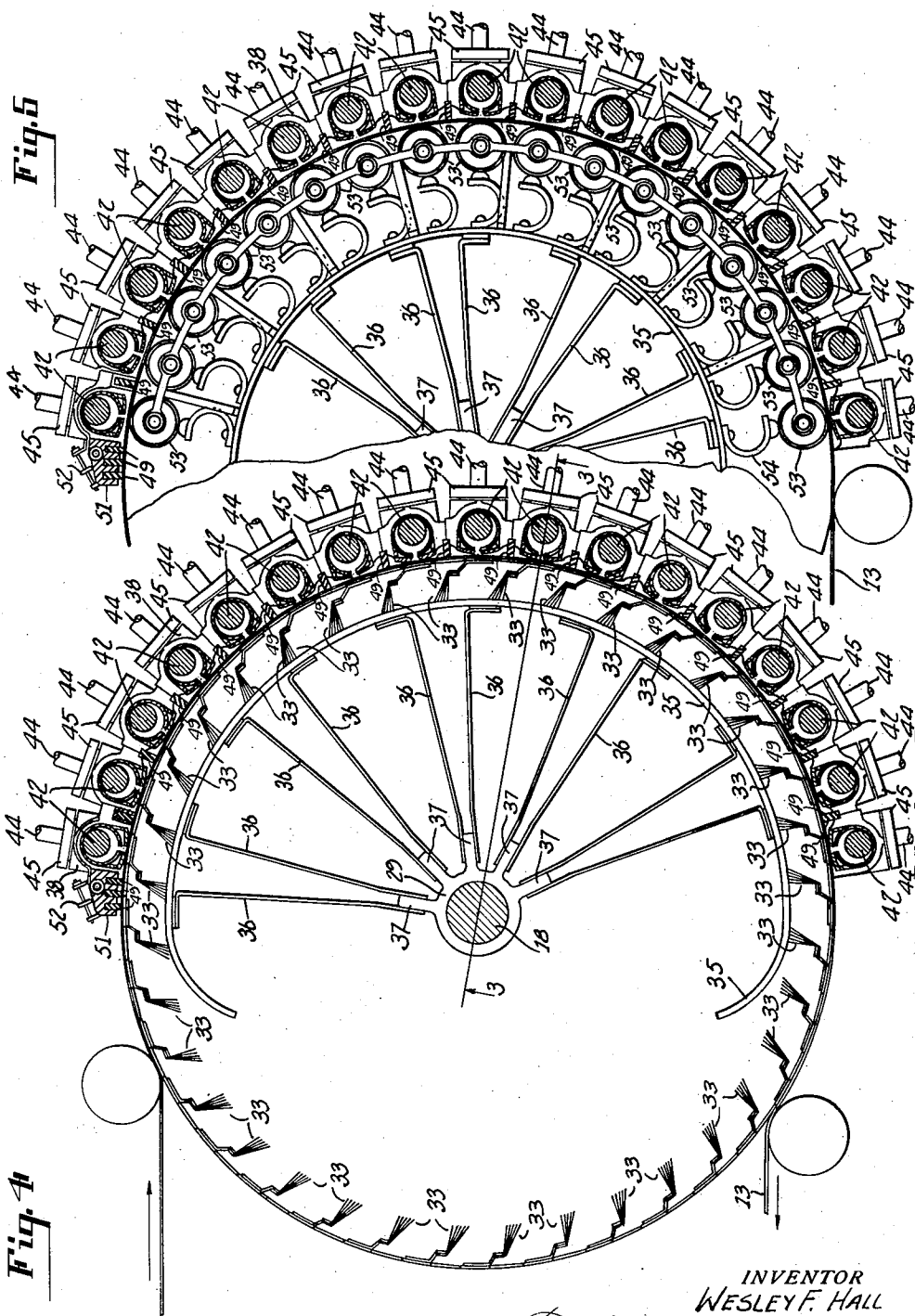
W. F. HALL

2,271,735

MACHINE FOR ELECTROPROCESSING METAL STRIP

Filed July 16, 1938

4 Sheets-Sheet 3



INVENTOR
WESLEY F. HALL
BY *Toulmin & Toulmin*
ATTORNEYS

Feb. 3, 1942.

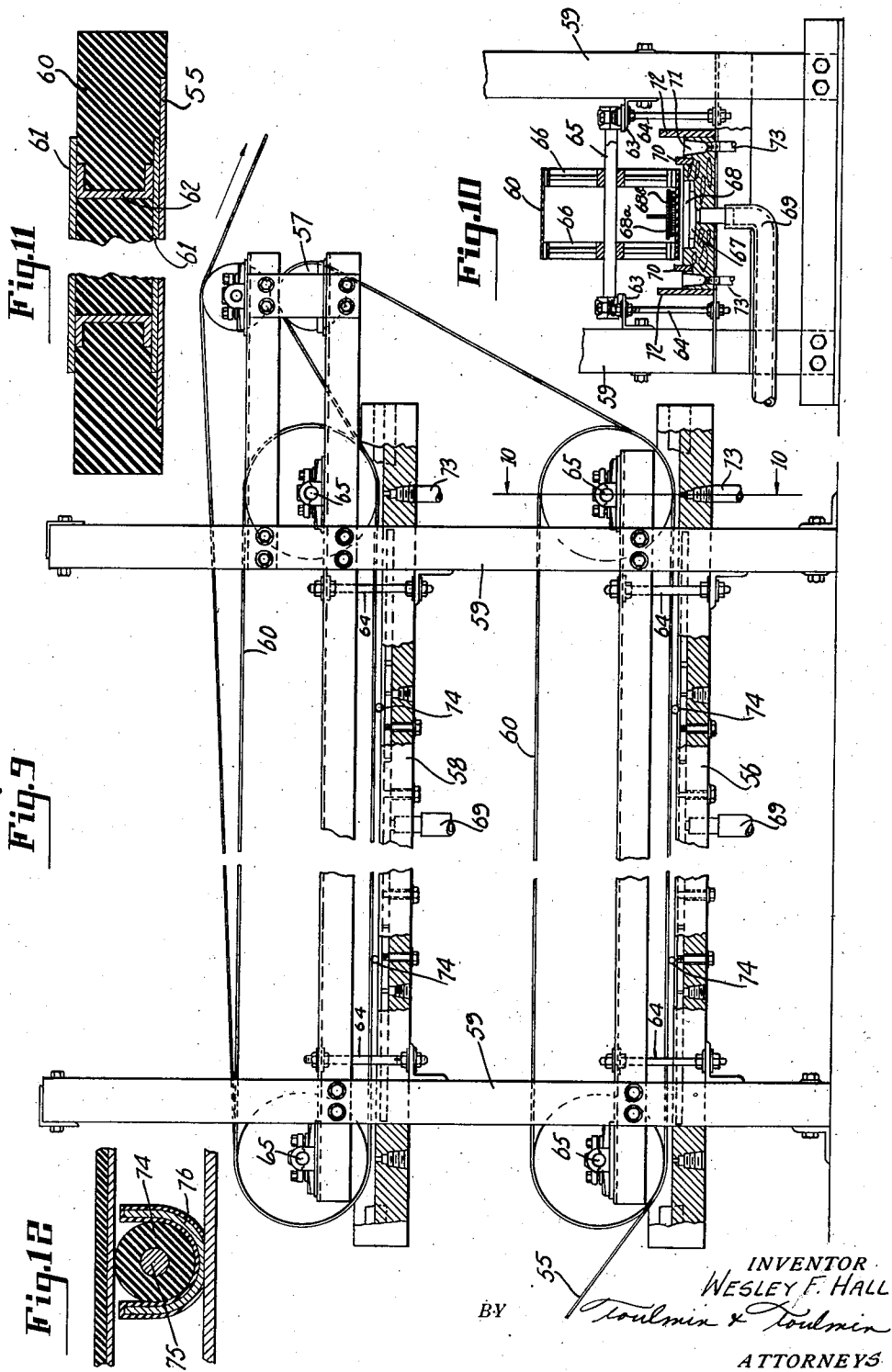
W. F. HALL

2,271,735

MACHINE FOR ELECTROPROCESSING METAL STRIP

Filed July 16, 1938

4 Sheets-Sheet 4



BY

INVENTOR
WESLEY F. HALL

Toulmin & Toulmin

ATTORNEYS

UNITED STATES PATENT OFFICE

2,271,735

MACHINE FOR ELECTROPROCESSING
METAL STRIP

Wesley F. Hall, Matawan, N. J., assignor to Han-
son-Van Winkle-Munning Company, Mata-
wan, N. J., a corporation of New Jersey

Application July 16, 1938, Serial No. 219,619

5 Claims. (Cl. 204—206)

This invention relates to a method and apparatus for electrolytic treatment of materials.

The invention is principally concerned with a process and mechanism for electrocleaning and electroplating relatively long lengths, strips or ribbons of metal. The process and apparatus of the invention are particularly adapted to electrolytic cleaning and tin plating of thin steel strips such as commonly used for making cans. It will be apparent, however, that this invention can be utilized for conducting various electrochemical treatments on different materials, both metallic and non-metallic of continuous or discontinuous lengths. Various electrolytes may also be used, depending upon the material being treated and the kind of treatment desired.

An important object of this invention is to provide an apparatus for electrocleaning, pickling or plating continuous strips of material at high current densities without the necessity of carrying the current through the strip for a long distance.

Another object is to provide a novel electrolytic cell for electroprocessing strip material on one side at a time while maintaining the opposite side free from contact with electrolyte by means of substantially non-wearing seals of rubber or equivalent resilient synthetic resinous material.

Another object of this invention is to provide an apparatus and method of treating strip material on one side at a time, the other side being held against electrical contacts spaced therealong and arranged so that they do not rub or slide against the strip, but roll or travel with it.

Another object of the invention is to provide an apparatus and method for electrocleaning and plating a continuous strip at high current densities while protecting the edges of the strip, preventing excessive concentration of current therealong.

Another object of this invention is to provide an apparatus for electroprocessing metal wherein the metal is electrochemically treated on one side with an electrolyte while current is supplied to the strip on the opposite side by means of spaced dry electrical contacts.

Another object is to provide an improved apparatus and method of electroplating continuous strip material while the strip is maintained either vertically on its edge or in a horizontal position.

Another object is to provide a method and apparatus for alternately electrochemically treating a moving metal strip or strips on one side

and then on the other while continuously moving both the strip material and the electrolyte.

Another object is to provide an apparatus for electrocleaning and plating continuous strips which is arranged to economize space to the maximum without lowering the efficiency of the machine.

Another object is to provide a novel wheel arrangement wherein each side of the strip is alternately treated as it passes therearound.

Another object is to provide an apparatus and method of electroprocessing strip material using high current densities, for instance on the order of 500 to 1000 amperes per square foot, whereby the marring or electric-spark marking of the surface of the strip being treated is avoided.

The construction and arrangement of this invention offers many advantages over the apparatus and the processes heretofore employed.

In the use of the apparatus and method for electrocleaning and plating strip material of this invention a product is obtained having a more uniform and superior coating than has heretofore been attained. Moreover the use of insulating coatings for protecting parts not to be plated, with their attendant removal, is eliminated.

Aside from the above mentioned improvements attained by this invention, very high current densities may be satisfactorily employed in electroprocessing materials by this invention. This is true whether the plating wheel arrangement is employed or the traveling belt substituted therefor. It will be understood, of course, that the wheel or belt apparatus may be arranged to handle the strip in a horizontal or vertical position during the treatment.

In the use of this invention the electrocleaning and plating of material can be effected in a much shorter time, increasing production with consequent lowering of electroprocessing costs.

Other objects and advantages of this invention will be apparent during the course of the following description.

Referring to the drawings:

Figure 1 is a diagrammatic plan view showing the complete electroprocessing apparatus of this invention. The arrangement shown is merely illustrative and is not intended to limit the disposition of the different treating compartments, electrolytes or the sequence of treating the strip material;

Figure 2 is a view in section taken on the line 2—2 of Figure 3 with certain parts broken away;

Figure 3 is a vertical section view taken on the line 3—3 of Figure 4;

Figure 4 is a longitudinal section view of the electroplating wheel construction;

Figure 5 is a similar longitudinal sectional view of a modified arrangement wherein rolling electrical contacts are employed;

Figures 6, 7 and 8 are detail cross section views of a portion of the strip, illustrating its thickness before and after plating; and taken on the line 6—6, 7—7 and 8—8 of Figure 1, respectively;

Figure 9 is a vertical longitudinal section view of a modification of the plating section, wherein a double deck traveling belt arrangement is provided for electrically contacting the strip while it is drawn through the horizontally disposed troughs;

Figure 10 is a vertical section view taken on the line 10—10 of Figure 9;

Figure 11 is a detail view in section of the endless belt and electrical contact means;

Figure 12 is a detail view in section of the bearing and roller supporting the strip in the arrangement illustrated in Figure 9.

Referring to the drawings in detail, wherein like references indicate similar parts throughout the drawings, Figure 1 shows the complete layout of the apparatus for electroprocessing continuous strips of material or pieces to be electroplated. As shown in Figure 1, the strip material 13 is drawn through the various electrocleaning compartments where it is cleaned, pickled and rinsed while the strip is maintained vertically on one edge. This is the preferred form, but it will be apparent that the strip material may be thus treated prior to plating while in the horizontal position if desired.

It will be also understood that either alkaline or acid electrolyte cleaners may be employed, and any one or more of the preliminary cleaning steps may be omitted prior to electroplating when such steps are unnecessary.

In some cases where the metal strips to be cleaned and plated are coated with oil, grease or the like fatty substance, they may be first subjected to a solvent degreasing treatment prior to being electrolytically cleaned and subsequently plated. Various solvents may be used in this treatment for dissolving and removing the oil and grease. Non-inflammable chlorinated hydrocarbons are preferable for this purpose, for example trichlorethylene and the like.

After the strip material is thoroughly cleaned it is guided around the plating wheel 14 by means of the guide rollers 15. One side of the strip is plated while it is moved around the periphery of the wheel. The strip is then conducted around another plating wheel 16 by the guide rollers 17 and the opposite side is electroplated. After leaving the plating wheel 17 the strip is turned to a horizontal position, and burnished, rinsed and dried as illustrated in Figure 1.

The strip material or the like to be treated is drawn through the apparatus from conventional uncoilers, and after being electroprocessed and plated is wound up on similar coilers at the delivery end. All of the treatments illustrated in Figure 1 may be performed on similar wheels as used for the plating, but it is not necessary to do so as the advantages of the wheels are mainly in connection with the plating or other electrochemical treatment wherein high current densities are employed.

Electroplating arrangement

The electroplating part of the preferred form of this apparatus comprises two wheels 14 and 16 which are of substantially the same construction, one wheel plating one side of the strip and the other plating the opposite side. Each wheel is made up of three sections which are connected to a vertical axle shaft 18 which is supported by the frame 18a. The frame is insulated from the axle shaft 18 by means of the rubber shackles 18b. At the bottom of the shaft 18 is an insulating collar or sleeve 18c, as illustrated in Figure 3. The upper and lower sections 19 and 20 respectively turn with the movement of the strip as it passes around the periphery of the wheel.

The central hub portion 21 is fixed to the shaft 18 by means of a key or pin 22. Steel spokes 23 and 24 of Z-shaped cross section make up the upper and lower sections of the wheel and which sections rotate about the axle shaft 18 on the thrust bearings 25 and roller bearings 25a. The thrust bearings are provided for adjustment by means of the bolts 26.

The extremities of the spokes are connected to steel or metal rib sections 27 and 28 which are in turn connected by a plate member 29 by means of the stud bolts 30. The rim parts are covered with rubber or the like, as indicated at 31. Electrical contact is made with the strip 13 by means of copper strips 32 spaced around the rim and held yieldably in place by the attached brush bars 33. These bars are suitably secured to the plate 29 by bolts 29a. The sliding brushes 34 contact the stationary rim 35. Split spokes 36 are bolted to the opposite sides of the stub spokes 37 which are integral with the central hub portion 21. In this manner electric current is carried to the middle fixed portion of the wheel and to the shaft 18.

A plurality of spaced electrolyte cells or compartments 38 is provided adjacent the outer surface of the strip 13. These cells are provided with hollow cylindrical anodes 39 spaced from the strip. The forward section of the anode adjacent the face of the strip is slit or open as at 40 to afford an entrance passageway for the electrolyte. On each side of the slit or opening are welded or otherwise fastened to and forming a part of the cylindrical anode 39, angle strips 41. The angle members 41 are attached to the tubular anode to extend the face of the anode along in conformity with the curved path of the strip being treated, so as to speed up the plating of the strip and maintain a high efficiency of the plating mechanism.

In the interior of the anode 39 along the back side may be placed an auxiliary soluble anode 42 which can be used to help replenish the metal content of the electrolyte as it is placed onto the material being electroplated. Electrolyte is conducted into the compartments or cells at the back through an opening 43 which is in communication with the pipe 44 of the head member 45. The head 45 is attached to the cell 38 by means of stud bolts 46 and between which a gasket member 47 is interposed to prevent leakage of electrolyte therearound. Each of the plating cells is lined with rubber as indicated at 48 in Figure 2.

The various plating cells are sealed off from each other by means of the rubber or synthetic resin sealing blocks 49 which extend therebetween and contact the strip material drawn therethrough. The rubber covered portions of

the cells are also provided with liquid sealing contacts as shown at 50. The entrance and exit to the plating wheel cells may likewise comprise multiple rubber sealing blocks arranged in a pivoted plate member 51. The pressure of the rubber sealing blocks disposed in the plate member 51 which bear against the strip 13 may be regulated by adjusting the jack screw 52 as illustrated in Figure 2.

In the modification of the plating wheel shown in Figure 5 electrical connections are made to the strip 13 by the rollers 53 and yieldable contact brush members 54 which are joined to the stationary rim 35.

For electroplating relatively narrow continuous strips of material the arrangement shown in Figure 9 may be employed. In this case the strip 55 lies flat and is conducted through the horizontally disposed trough 56 where one side is plated. The strip is then passed upward and over the idler roller 57 and backward through the plating trough 58 wherein the other side is plated. The troughs may be disposed one over the other in the manner shown in Figure 9 or they may be positioned on different floors or otherwise arranged.

In the construction shown in Figure 9 the two tanks or troughs are supported one above the other by means of frame 59. The troughs may be made of wood or rubber covered steel. Cathode contacts to the strip are made by means of the endless belt 60 which travels around the rollers at the end of the tank, as illustrated in Figure 9. The belt itself may be formed of current conducting material or preferably made of rubber or the like composition and provided with metal or electric current conducting bands 61 disposed on the outer surfaces of the belt as illustrated in Figure 11. The bands are electrically connected by means of the metal links 62 which extend through the belt at spaced intervals along the same.

Referring to Figure 10, the trough may be suspended from the angle irons 63 which are secured to the adjacent supporting frame 59 by means of the bolt 64. The angle irons 63 also afford a base for the shaft 65 and wheel 66 around which the belt 60 travels. The central part of the trough is provided with a shallow chamber 67 extending lengthwise of the trough. In this chamber is disposed an anode 68 which is preferably of carbon, and in use is maintained covered by electrolyte introduced through the rubber lined pipe 69.

The cathode electrode 68a is disposed between the wheel 66 and a roller 68b provides a rolling contact against the contact member 61 of the belt 60. In place of the roller it will be obvious that sliding brushes may be used, similar to that shown in Figure 4, for carrying the current to the back of the strip.

Electrolyte is flowed into the troughs near the center and after contacting the strip overflows the side wall 70 of the trough into the gutter 71 adjacent the outer wall 72. Waste electrolyte is conducted from the gutters by the return pipe 73.

Supporting rolls 74 are used when necessary to hold the strip up while plating the under side, as illustrated in Figures 9 and 12. The supporting rolls 74 are provided with graphite, rubber or other oilless bearings 75 which are designed to operate under water. The bearings 75

are disposed in rubber covered U-shaped metal sockets 76, as illustrated in Figure 12.

Electroplating procedure

In plating the strip on the plating wheels illustrated in Figures 4 and 5, the material is drawn through the plurality of electroplating cells disposed around the periphery of the wheel and one side of the strip is plated. Excessive electric current concentration at the edges of the strip is prevented by the cushion of soft rubber or resilient material against which the strip is held during its movement through the electroplating compartments. Further, electrical contact is made to the central portion of the strip as shown in Figure 3, which also tends to lessen the concentration of electric current around the edges of the strip. The back side of the strip being treated is maintained free from electrolyte since the outer edges of the strip are sealed by the rubber cushioning member 31, as shown in Figure 3.

The back side of the strip is directly connected to electric circuit at points closely adjacent to where the current enters the other side from the electrolyte. As shown in Figures 4 and 5, the electric circuit contact to the back of the strip is preferably made by means of sliding brushes or rollers, as shown in Figure 5. In each of these instances the series of contacts travel along with the strip and in contact with both the strip and a series of stationary current collectors, such as the member 35 on Figure 4 and members 35 and 54 on Figure 5. These contacts are arranged to move out of engagement with the collector while still in engagement with the strip. In this way the current is broken between the contact and the sliding brush or roller, and not between the contact and the strip. This eliminates the danger of scratching or marring the strip being treated and permits the breaking of the cathode connection to the strip without danger of burning or spark-marking the material.

In the plating arrangement shown in Figures 4 and 5 the electrolyte containing the salt of the metal to be plated on the strip is pumped or otherwise conducted from a storage tank or container to the various plating cells through the conduits 44, divides and flows around the anodes 39 and contacts the surface of the strip. After contacting the strip electrolyte flows back through the central opening 40 into the interior of the anode and out through the bottom thereof. The electrolyte is thereafter filtered, heated or cooled and replenished with the necessary chemical constituents and returned to the plating cells.

In operation the electrolyte fills the space between the anode and strip at all times. The anodes 39 are preferably formed of a material which is insoluble in the electrolyte, for example, carbon, lead or the like, whereas the auxiliary anodes 42 are preferably soluble in the electrolyte to replenish the metal plated out, as heretofore mentioned.

The anodes 39 are suitably connected with the positive electrode, and the stationary shaft 18 is connected to the negative or cathode electrode of a generator or source of electricity. In this manner the strip is made the cathode by means of the direct contacts made along the back of the strip. The strip is subjected to high current densities on the order of 500 to 1000 amperes per

square foot and the strip is rapidly and efficiently plated.

The burnishing or polishing section is provided with brushes having fine wire, mineral wool or the like bristles, to thoroughly burnish and polish the plating. Instead of burnishing rolls the plating may be followed by fluxing or heating medium for improving the physical characteristics of the deposit, according to the particular metal or alloy forming the plating coating.

In the modified plating mechanism shown Figures 9 and 10, it will be understood that the wheel members 66 may be connected to the negative or cathode side of a source of electricity and current supplied through the belt contact members 61 and 62 which contact the back of the strip. Preferably this cathode contact is made to the back of the strip by means of rollers 68b which contact the cathode electrode 68a and transfer current to the endless belt 60 and thence to the back of the strip material, as shown in Figure 10.

It will be obvious that the details of this apparatus and the method of electroprocessing strips may be widely varied while preserving the principles of this invention, and it will be understood that such modifications as come within the scope of the disclosure and claims are comprehended to be within this invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an electroprocessing machine for processing long metal strips, a wheel member disposed and rotatable on a vertical axis for supporting and guiding said long metal strips around the periphery thereof, a plurality of cells having an open face juxtaposed along at least a portion of the periphery of said wheel member, each of said cells being interlocked with its adjacent cell and separated from it by a common sealing means, each of said cells including hollow insoluble electrodes, auxiliary soluble electrodes within said hollow electrodes, said strip forming a closure for the open faces of each of said cells while the strip is moved along, means for flowing electrolyte through said cells and in contact with said strip, and means for electrically connecting the back of said strip to a source of electrical voltage to electrochemically treat said strip as the same is moved along through the open faces of said cells.

2. In an electroprocessing machine, a plurality of arcuate cells having one face open, a wheel member disposed and rotatable on a vertical axis having a periphery surface for supporting and moving a metal strip across the open faces of said cells, said strip forming a closure for the open faces of said cells while the strip is moved along supported on the surface of said wheel member, each of said cells being interengaged with its adjacent cell and separated from it by a common wall, each of said cells including hollow insoluble electrodes, auxiliary soluble electrodes within said hollow electrodes, means for flowing electrolyte through said cells and against said strip, and means for electrolytically connecting the back of said strip to a source of electrical voltage to electrochemically treat said strip as the same is moved along while supported on the periphery of said wheel member.

3. In an electroprocessing machine, means for

supporting long metal strip material to be treated, said means comprising a wheel disposed and rotatable on a vertical axis, a plurality of cells having an open face juxtaposed adjacent the periphery of said wheel member, each of said cells being interengaged with its adjacent cell and separated from it by a common wall, said strip material forming a closure for the open faces of said cells while the strip is moved along supported on the periphery wheel surface, means for flowing electrolyte through said cells and in contact with the outer surface of said strip, each of said cells comprising tubular insoluble electrodes disposed therein, auxiliary soluble electrodes arranged in said tubular electrodes, and means for electrically connecting the back of said strip to a source of electrical voltage to electrochemically treat said strip as the same is moved along through the open faces of said cells.

4. In an electroprocessing machine, means comprising a wheel member disposed and rotatable on a vertical axis for supporting metal strip material to be treated, a plurality of cells having an open face arranged in juxtaposed position around the periphery of said wheel member, said strip material forming a closure for the open faces of said cells while the strip is moved along supported on the periphery of said wheel member, each of said cells being interlocked with its adjacent cell and separated from it by a common sealing wall, each of said cells including insoluble electrodes which are arranged adjacent to the open face of said cells and shaped to substantially conform with the curved path of the strip being treated, auxiliary soluble electrodes in said cells, said auxiliary electrodes being substantially surrounded by said first mentioned electrodes, means for flowing electrolyte through said cells and against the surface of said strip, and means for electrically connecting the back of said strip to a source of electrical voltage to electrochemically treat said strip as the same is moved along through the open faces of said cells.

5. In an electroprocessing machine for treating long continuous strips of material comprising a circular member disposed and rotatable on a vertical axis, said strip being supported on the periphery surface of said circular member and guided simultaneously therealong by the rotary movement of said member, a plurality of cells for containing electrolyte arranged adjacent the periphery of said member and having an open face juxtaposed thereto, each of said cells being interengaged with its adjacent cell and separated from it by a common sealing means, said cells having insoluble electrodes arranged therein, auxiliary soluble electrodes in said cells, said auxiliary electrodes being substantially surrounded by said first mentioned electrodes, said strip forming a closure for the open faces of said cells as the strip is moved along while supported on the periphery of said circular member, means for flowing electrolyte through said cells and in contact with said strip, and means for electrically connecting the back of said strip and said electrolyte in circuit to electrochemically treat said strip with high density current as the strip is moved along through the open faces of said cells.

WESLEY F. HALL.