

Nov. 18, 1947.

C. G. MILLER

2,431,065

CONTINUOUS WIRE AND STRIP ELECTROPROCESSING MACHINE

Filed Dec. 12, 1938

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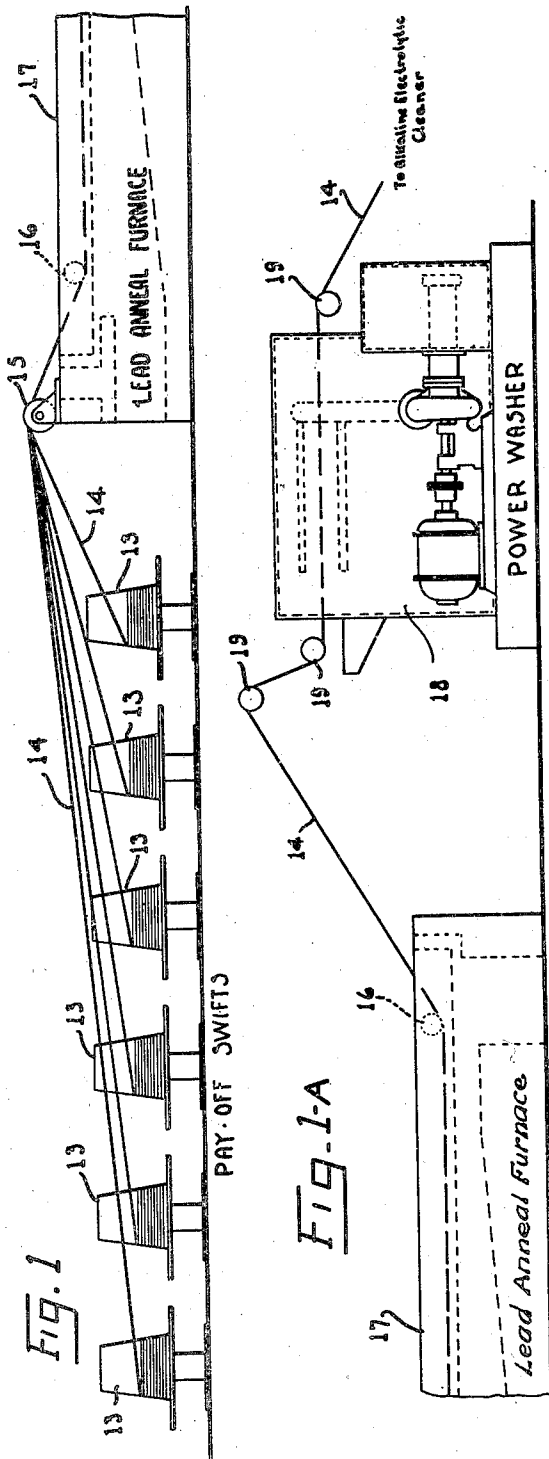
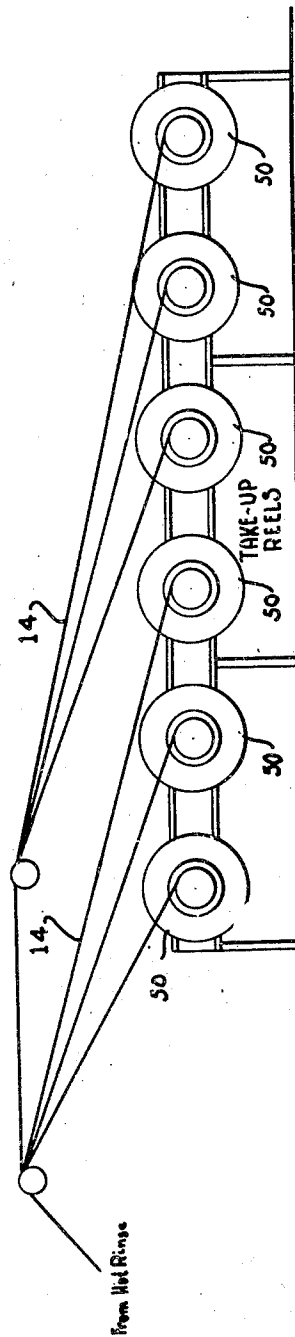


Fig. 1-E



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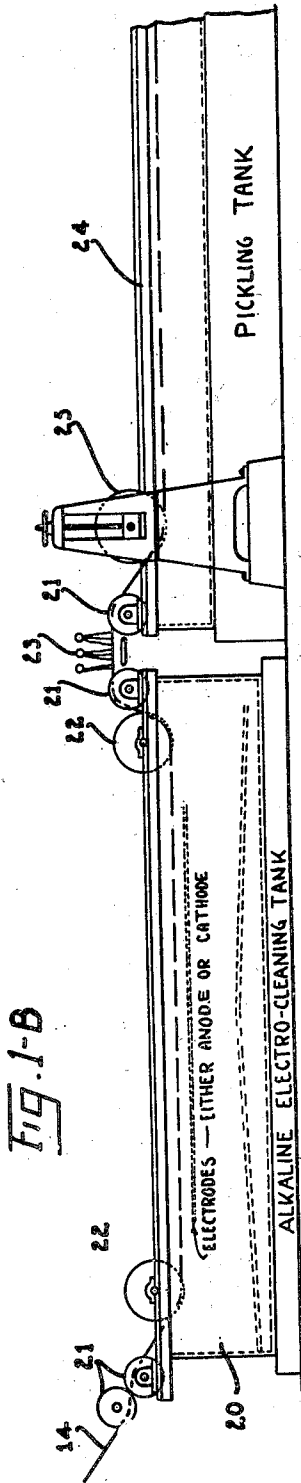
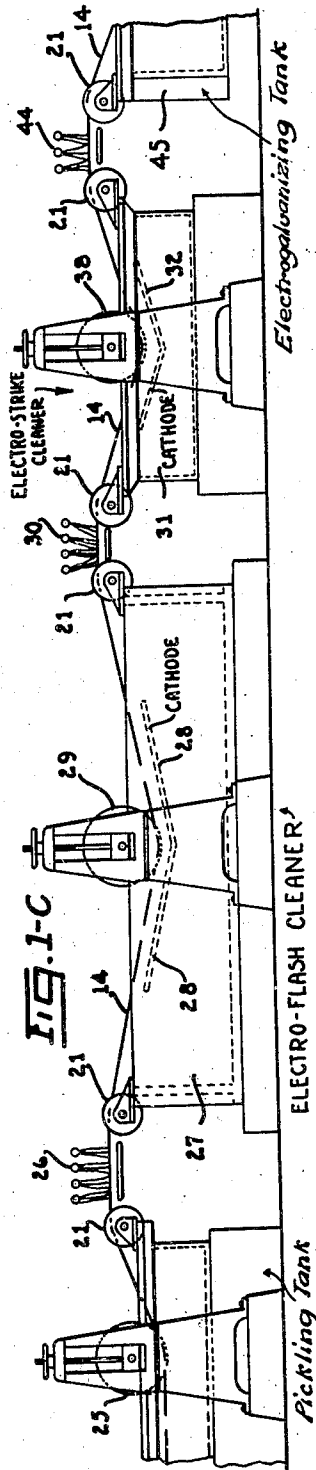
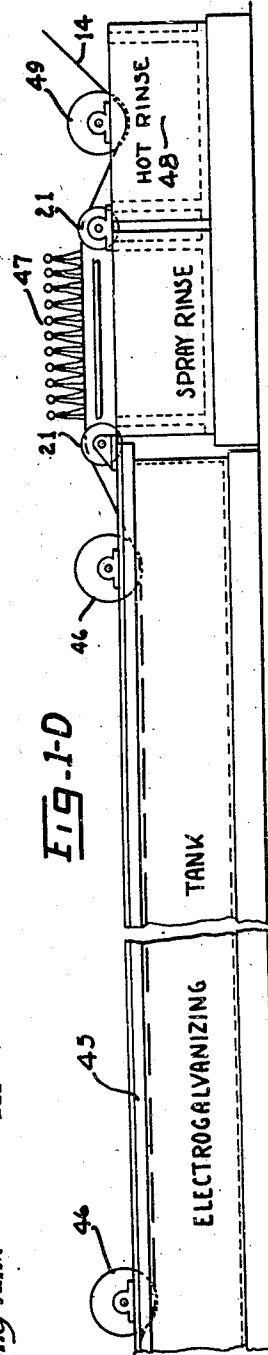
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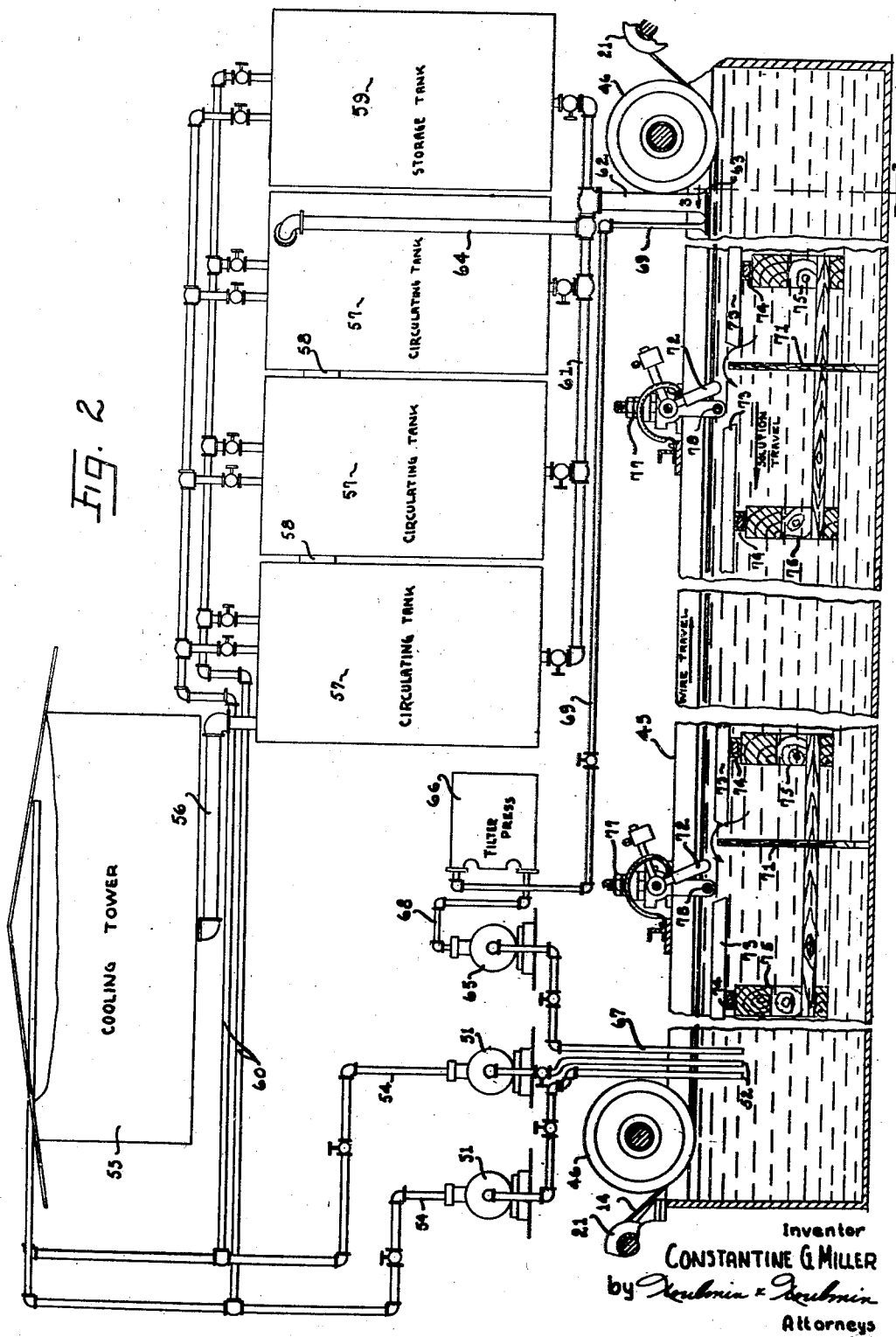
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Fig. 5

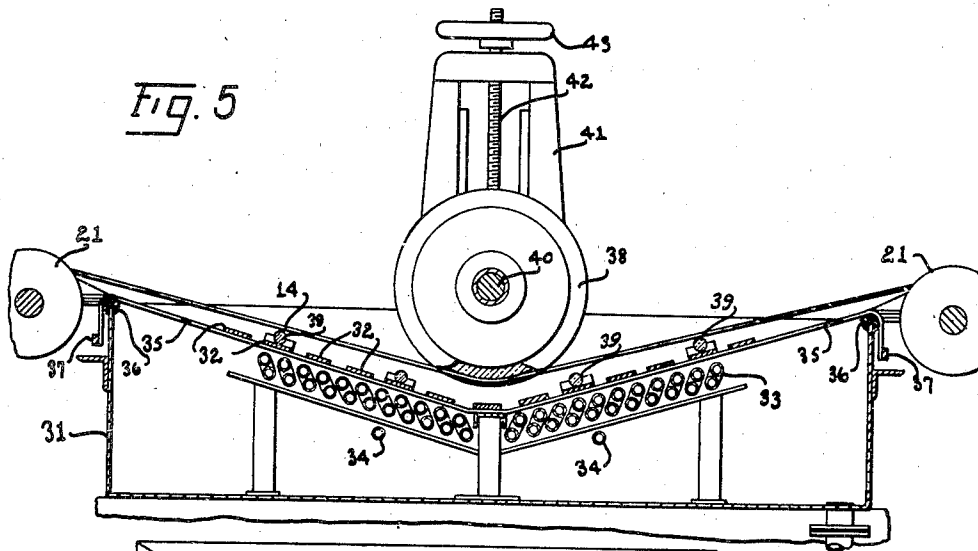
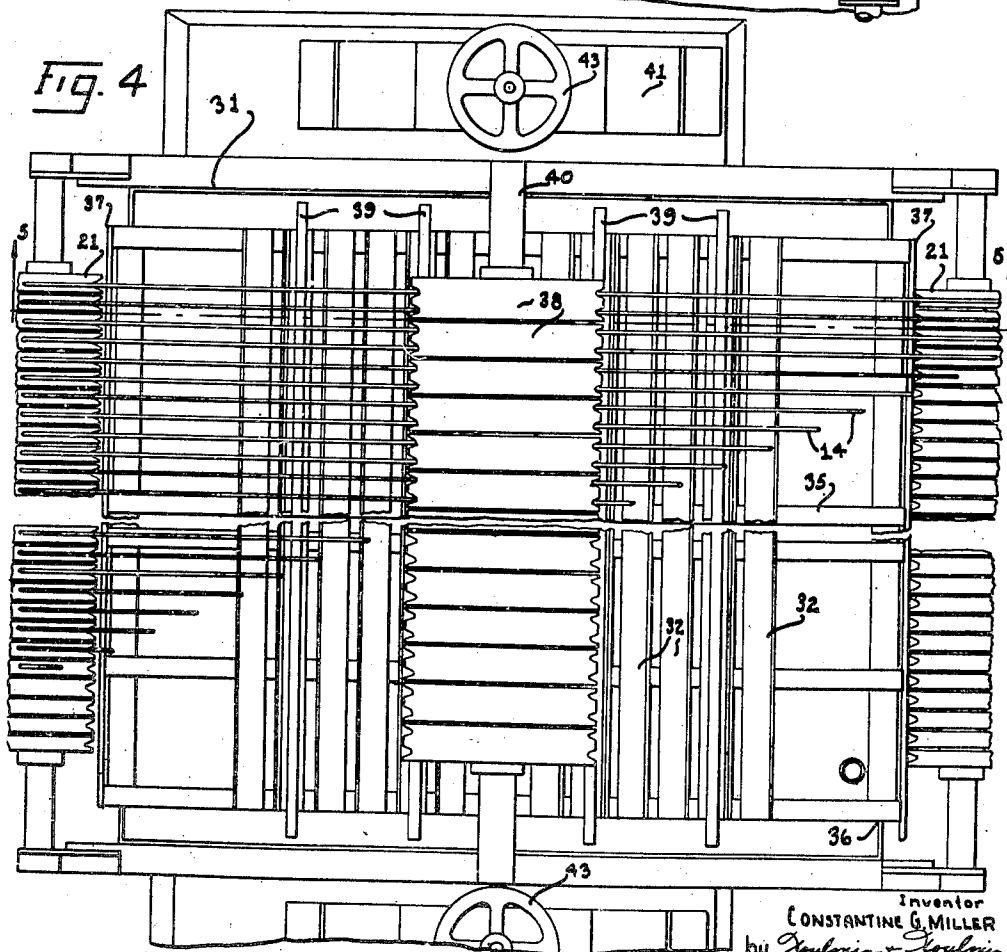


Fig. 4



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Fig. 6

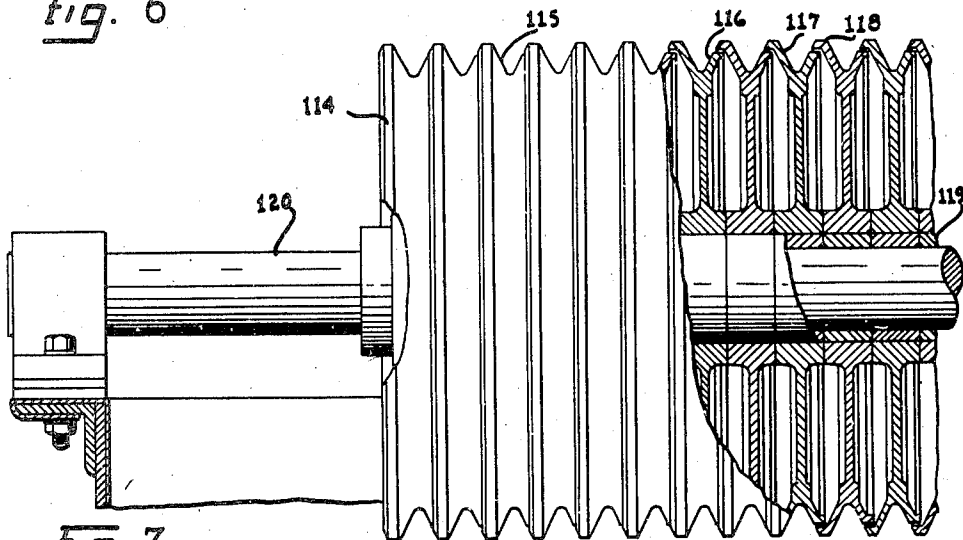


Fig. 7

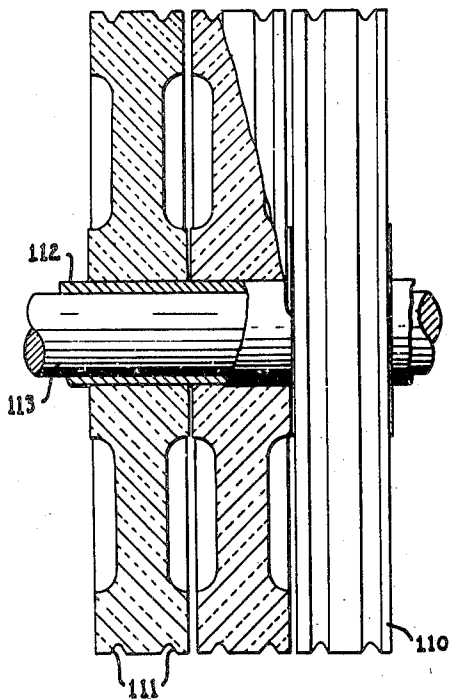
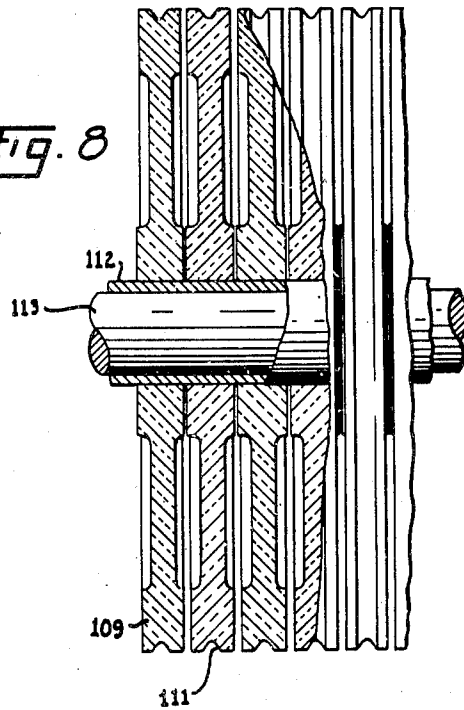


Fig. 8



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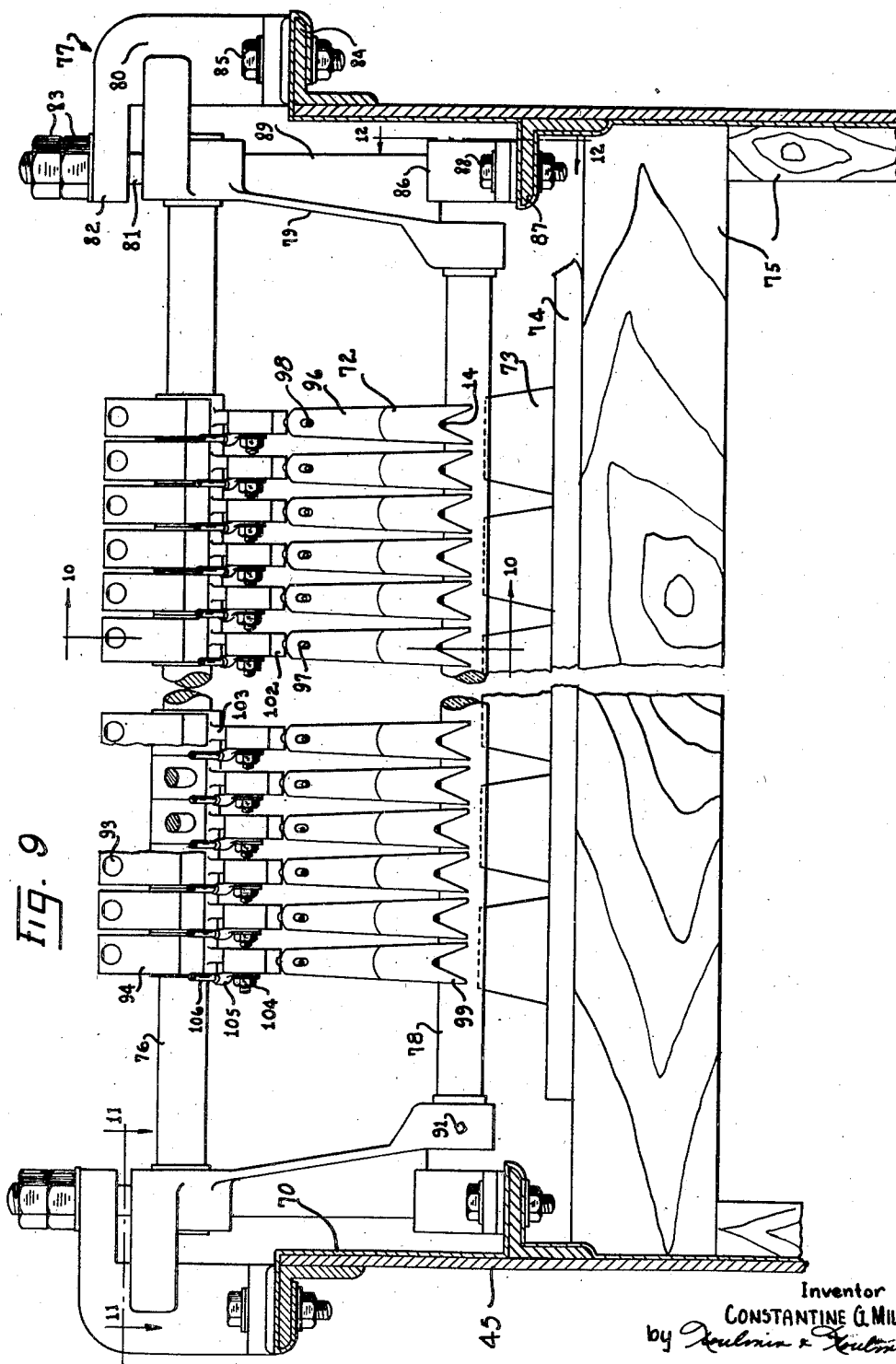
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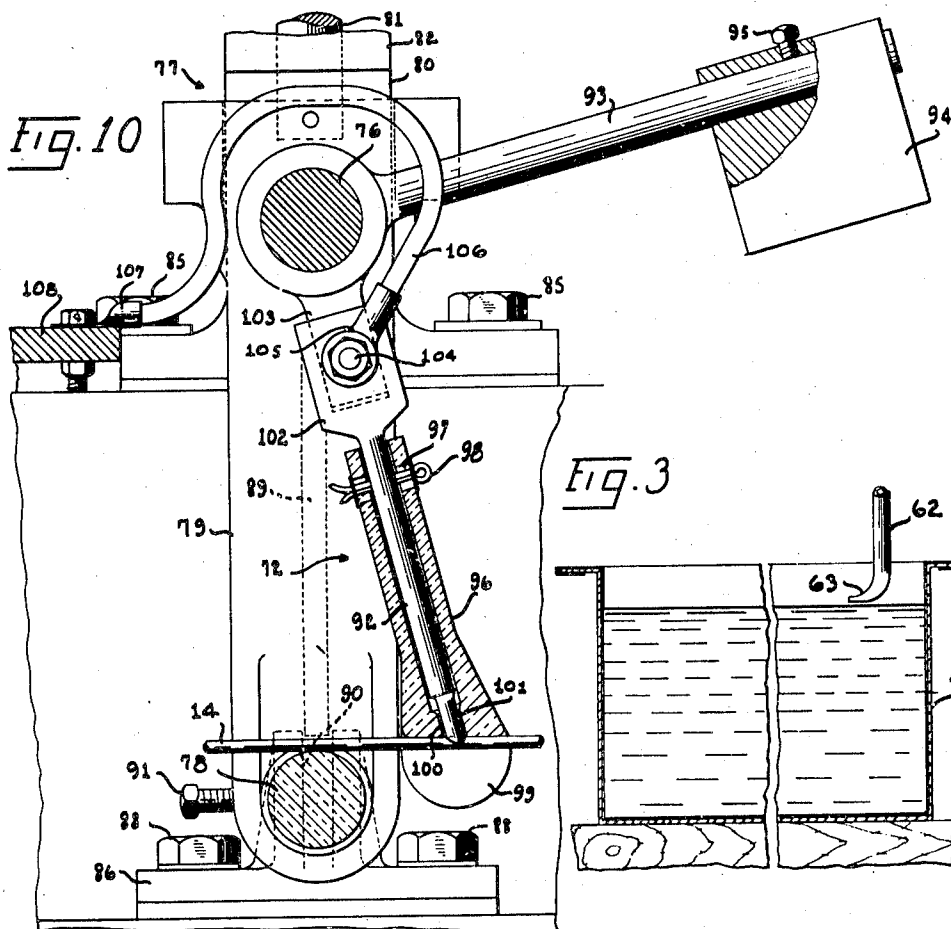
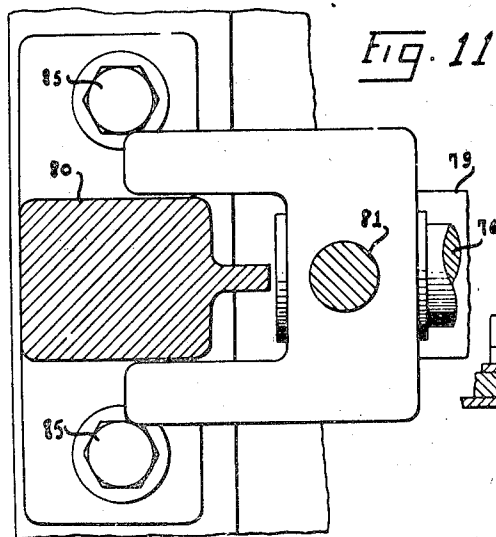
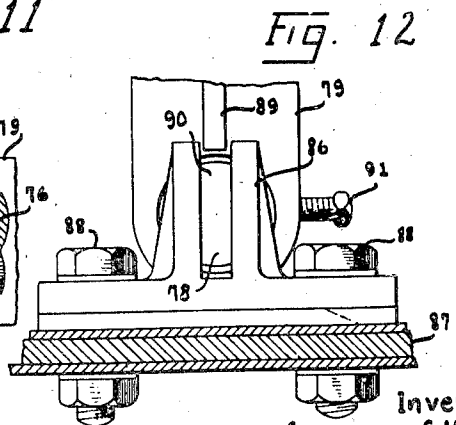
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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

2,431,065

CONTINUOUS WIRE AND STRIP ELECTRO-
PROCESSING MACHINEConstantine G. Miller, Chicago, Ill., assignor to
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Application December 12, 1938, Serial No. 245,169

5 Claims. (Cl. 204—209)

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This invention relates generally to an apparatus for electroprocessing of metal, and more particularly to a machine for electrochemically cleaning and electrogalvanizing continuously moving articles and material such as wire. The invention disclosed and claimed in this application is an improvement over my copending application Serial No. 87,850, filed June 29, 1936.

The apparatus of this invention is especially adapted for electrogalvanizing round or flat wire, strip steel, metal ribbons, cables, tubing and the like.

It is an object of this invention to provide an improved electrogalvanizing machine which will rapidly and completely clean wire or metal strip material and apply a uniform adherent metal coating thereto while the wire is moved through the machine.

It is another object of this invention to provide an improved electroprocessing apparatus for treating multiple strands of wire or strips wherein electric current is conducted to the strands by means of contact finger members which are self-adjusting and self-protecting.

Another object of this invention is to provide an improved apparatus of this character which is capable of selectively treating a wire according to its requirement so as to render the same chemically and metallurgically clean prior to electrogalvanizing.

Another object is to provide a multiple wire or metal strand treating apparatus wherein the individual strands or different groups of wires can be continuously moved through the machine at the same or different speeds, as desired.

Another object is to provide an improved electroprocessing apparatus wherein the electrical contact members, which conduct electricity to or from the strip, are mounted in supporting frames which frames are made adjustable relative to the electrodes. This affords adjustment of the contact fingers so that the wire may be lowered toward the anodes as the anodes wear away, thus keeping the resistance between the anode and cathode more uniform, avoiding unnecessary power losses.

Another object is to provide an electrocleaning and galvanizing machine through which multiple wires or strands of metal may be continuously guided by individually rotatable grooved sheaves. These sheaves are made of stoneware, glass, or the like, and rotate on a supporting axle shaft. By this provision the use of multiple glass rod separators or equivalent means for maintaining the wires apart is eliminated. Further, by using

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sheaves complete through the machine it is possible to move one or more of the wires through the apparatus at a different speed than others without any difficulty.

Another object is to provide an apparatus for electrocleaning and electrogalvanizing of continuous moving articles wherein rinse tanks are substantially eliminated and sprays provided with drainboard means are employed. This conserves space and affords a more economical arrangement without sacrificing the efficiency of the rinsing treatment.

Another object of this invention is to provide in an apparatus of this nature an improved electrical contact member which will insure electrical contact with the moving wire or strip being treated at all times regardless of the smoothness or imperfections of the surfaces of the strip.

Another object of this invention is to provide an improved electrical contact member which is self-cleaning and requires the minimum of attention while assuring proper electrical contact with the moving wire.

Another object of this invention is to provide an electrogalvanizing machine having an improved arrangement of the elements wherein the metal strip being treated is subjected to an electrolytic flash cleaner followed by an electrolytic strike anodic treatment prior to electrogalvanizing. This sequence of treatment results in a highly improved, economical and efficiently operating machine.

Another object is to provide a rapid galvanizing machine in which the material to be electrogalvanized is moved continuously and at a high rate of speed through the electrolyte. The electrolyte is kept in motion in the direction reverse to that of the moving wire or strip so as to maintain a uniform distribution of the electrolyte over the surfaces of the wire being electrogalvanized.

In the drawings:

Figures 1, 1—A, 1—B, 1—C and 1—D illustrate the general layout of the electrogalvanizing machine of this invention. In the drawings the treatment of wires is illustrated but as heretofore mentioned, in place of wires, metal strips, ribbons and the like may be used.

Figures 1 and 1—A are side elevation views illustrating the arrangement of the pay-off reels or swifts, annealing furnace, and power washer;

Figures 1—B, 1—C and 1—D are similar side elevation views showing the general layout of the electrolytic cleaner, pickle, electro-flash, electro-strike, and electrogalvanizing tanks. Between the tanks the use of spray rinse and drainboard

means is shown. A hot rinse tank is stationed adjacent the end of the electrogalvanizing tank for rinsing the wires prior to winding them on the take-up reels;

Figure 1—E is a side elevation view of the take-up reels;

Figure 2 is a general view of the cooling, circulating and filtering system for maintaining the electrogalvanizing solution in proper working condition;

Figure 3 is a detail vertical sectional view taken on the line 3—3 of Figure 2, looking into the end of the galvanizing tank and showing the arrangement of the electrolyte return conduit means;

Figure 4 is a plan view of the electrolytic strike cleaner tank and wire guiding sheaves embodied in the apparatus of this invention;

Figure 5 is a vertical sectional view of the electrolytic strike cleaner taken on the line 5—5 of Figure 4;

Figure 6 is a detail view partly in section of the ducking sheaves showing the telescoping construction thereof and bushings provided therefor;

Figures 7 and 8 illustrative double and single grooved sheaves made of stoneware, glass, phenol-formaldehyde resin or the like electrical insulating material, certain parts being shown in section to more clearly illustrate the structural shape and mounting on the axle shafts;

Figure 9 is a vertical sectional view transverse of the galvanizing tank, with certain parts broken away, showing the adjustable contact finger frames and electrode adjacent thereto;

Figure 10 is a vertical sectional view taken on the line 10—10 of Figure 9, showing the particular construction of the adjustable contact fingers;

Figure 11 is a detail view of the adjustable contact finger frame taken on the line 11—11 of Figure 9, looking in the direction of the arrows;

Figure 12 is a detail view of the adjustable frame construction taken on the line 12—12 of Figure 9 and looking in the direction of the arrows.

Referring to the drawings in detail, the numeral 13 designates the pay-off reels or swifts employed for feeding the wires 14 as work pieces through the apparatus. These wires are passed over the guide sheaves 15 and beneath the sheaves 16 while being passed through the lead annealing furnace 17.

The wires then pass to the power washer 18. The sheaves 19 guide the wires therethrough from whence they pass to the alkaline electrolytic cleaner 20. The wires are guided over the sheaves 21 and under the ducking sheaves 22, which are made of suitable alkaline resisting material. After passing through the cleaner the wires are moved over other guide sheaves 21 and under the spray rinse 23. Following the spray rinse the wires are drawn through a pickle tank 24 comprising sulphuric or other suitable mineral acid. Ducking sheaves 25 are used for maintaining the wires submerged while passing through the pickling solution. These sheaves are mounted on vertically adjustable shafts as illustrated in Figure 1—B and they are preferably made of acid resistant material and are individually rotatable relative to the common axle shafts, as shown in Figures 7 and 8.

When desired the power washer, alkaline cleaner and spray rinse treatment of the wires prior to pickling may be omitted and the wires passed through the annealing furnace, then cooled and passed directly into the pickling tank.

After passing through the pickling solution the wires are drawn over the opposed sheaves 21, under the spray rinse 26 and thence to the electrolytic flash cleaner tank 27. Nitric acid is preferably employed as the cleaning solution for this treatment. The cleaning is anodic, that is, the electric current flows from the wires through the electrolyte to the cathode electrode grids 28. The cathode grids 28 are submerged in the electrolyte, positioned in the tank, and are arranged parallel with the surface of the wires being treated.

The wires are made the anode by electric current which is supplied to the wires through the guide sheaves 21 positioned at the end of the tank. These sheaves preferably are of the telescoping type and are made of metal. Each sheave is independently rotatable on the axle shaft, as shown in Figure 6. The shaft is directly connected with the copper bus bars leading to the electric current supply means.

Vertical adjustable ducking sheaves 29 are centrally positioned in the tank 27 to maintain the wire submerged in the electrolyte while being drawn therethrough. These sheaves preferably are of double grooved stoneware construction, as shown in Figure 7. Where the ceramic material is of sufficient strength single grooved sheaves may be used similar to that illustrated in Figure 8.

Passing from the electrolytic flash treatment the wires are moved through the spray rinse 30 over the sheaves 21 and thence into the electrolytic strike tank 31. This is an anodic cleaning treatment similar to that employed in tank 27. The construction of the electrolytic strike tank is illustrated in Figures 4 and 5. Electric current flows from the wire to the cathode grid electrodes 32. The electrodes may be made of lead or other suitable material insoluble in the electrolyte. The electrolyte employed in this strike cleaning tank is preferably strong sulphuric acid which is kept cool by the lead coils 33 installed in the tank. Cold water is circulated through these coils. The electrolyte is kept agitated by means of air forced through the perforated pipes 34 positioned below the cooling coils 33, as shown in Figure 5. Electric current is supplied to the wires through the guide sheaves 21 disposed at opposite ends of the tank in a similar manner as provided in the electro-flash treatment.

The electrode grid members 32 are suitably supported on the member 35 which extends over the walls of the tank as at 36 and are connected with the bus bars 37, which in turn are connected to the negative side of an electric current supply means. A vertical adjustable ducking sheave 38 is positioned centrally of the electro-strike tank 31 under which the wires 14 pass. The shaft 40 upon which the sheaves are rotatably mounted is adjustable vertically in the yoke 41 by means of the screw threaded shaft 42. Vertical movement of the screw threaded member 42 is provided by turning of the handwheel 43. Sheave 38 is made of similar material to sheave 29 and maintains the wire submerged in the electrolyte while passing through the tank 31. Glass or other equivalent insulating rod means 39 are suitably positioned between the wires and the cathode grid electrodes 32 to prevent the wires from directly contacting the electrode while passing through the electrolytic strike cleaner.

The wires may be made either the cathode or the anode while passing through the electrolytic flash and strike cleaning tanks, depending upon the individual cleaning requirement of the material being processed. Likewise, one or more

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electrolytic flash or strike tanks may be used as desired; however, in general, only one electro-flash and strike tank will be used. The tanks will be made of sufficient length to give the proper cleaning of the wires or strip material being electrogalvanized.

The wires, after leaving the electrolytic strike tank 31, pass over the sheaves 21 and are subjected to the spray rinse 44 and thence they are conducted through the electrogalvanizing tank 45 under the ducking sheaves 46. In the galvanizing tank 45 the wires are made cathodic and electroplated. Thereafter the wires are conducted out of the galvanizing tank over the sheaves 21 at the ends of the tank and subjected to the spray rinse 47. Thereafter the wires are drawn through a hot rinse solution contained in tank 48 being submerged therein by means of the ducking sheave 49. From the hot rinse the wires are wound on the take-up reels 50, as shown in Figure 1—E. These take-up reels may be driven at the same or different speeds so as to move the wires or strands of metal through the electrogalvanizing machine at any desired speed.

Electrolyte cooling, circulating and filtering system

The electrogalvanizing electrolyte as used in the galvanizing tank 45 is constantly removed from the galvanizing tank, cooled and otherwise treated to replenish the metal, and returned to the galvanizing tank, as illustrated in Figure 2. In this arrangement the circulating pumps 51 have their suction inlet pipes 52 positioned in the forward end of the electrogalvanizing tank so as to withdraw electrolyte and discharge it through the pipes 54 into the cooling tower 55. From the cooling tower 55 the electrolyte flows by gravity through the pipe or conduit 56 into the circulating tanks 57 which are interconnected by the pipe 58.

Provision is made for storing a certain amount of the electrolyte in one of the circulating tanks 59. Entrance and exit of electrolyte from the tanks is valve controlled through the pipes 60 and 61 so that the electrolyte may be permitted to flow directly into the circulating tanks and/or storage receptacle 59 as required. Conduit 61 provides a common exit from the tanks of the electrolyte through the pipe 62 which forms a return inlet means for admitting electrolyte to the electrogalvanizing tank 45. The inlet pipe 62 is positioned at the opposite end of the tank from which the electrolyte is withdrawn and adjacent the side thereof, as illustrated in Figures 2 and 3.

The outlet opening of the pipe 62 is flattened and flared outward, as at 63, so as to distribute the electrolyte over the surface level of the solution. An overflow pipe 64 communicates with the pipe 62 and the top of one of the intercommunicating circulating tanks 57 to prevent overflowing of the circulating tanks should they become filled for any reason.

Filtering of the electrolyte is provided for by means of the pump 65 and filter press 66. Electrolyte is withdrawn from the galvanizing tank and forced through the filter press by the pump 65, the suction side of which is connected to the pipe 67. This pipe extends into the galvanizing tank 45 below the surface of the electrolyte, as shown in Figure 2. The outlet side of the filter press pump 65 is connected by the pipe 68 to the filter press or other suitable filtering means. Filtered electrolyte returns to the other end of the

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tank through the conduit 69 which has a flared discharge outlet similar to the outlet pipe 62.

It will be seen that the electrolyte in the galvanizing tank is kept flowing from one end of the tank to the other by means of the circulating system illustrated in Figure 2. The suction lines of the pumps are located at one end of the galvanizing tank where the wire enters, while the discharge lines are located at the opposite end. In this way the electrolyte in the galvanizing tank is circulated countercurrent to the directional movement of the wires through the electrogalvanizing tank.

The purpose of the several circulating tanks is to insure a thorough remixing and cooling of the electrolyte. It will be appreciated that when cooling of the electrolyte is unnecessary, the cooling tower may be omitted or electrolyte shunted directly into the circulating tanks and returned to the galvanizing tank, as illustrated in Figure 2.

Electrogalvanizing tank

The electrogalvanizing tank 45 may be constructed of wood or metal, and when of metal is rubber lined, as indicated at reference numeral 70 in Figure 9. Lead lined metal tanks may also be used.

In the galvanizing tank construction there is positioned a series of vertically arranged spaced dams 71. These dams may be made of wood, phenol-formaldehyde resin, or any other suitable material which is resistant to the action of the electrolyte employed. The electrolyte is forced to flow over each successive dam which dams are placed adjacent the point of engagement of the electrical contact fingers 72 with the wires and between the opposed ends of the anode electrodes 73. In this way the electrolyte is circulated above the bottom of the tank and is kept in constant movement over the electrodes and the wires.

The anodes 73 extend lengthwise of the tank and parallel to the wires passing therethrough and rest on the electrical conducting members 74. The latter are in turn supported on the framework 75 resting on the bottom of the tank, as illustrated in Figures 2 and 9. Electrical conducting members 74 are preferably made of copper bars which are lead coated to prevent being attacked by the electrolyte.

The members 74 extend transverse of the tank and are electrically connected to bus bars running along the side of the tank for supplying electric current to the anodes. The current density employed may be upwards of 3000 amperes per square foot. It will be appreciated that the electrical current carrying parts will be insulated from the tank, when made of metal, and be spaced from the opposite electrode.

Referring to Figure 9, it will be observed the electrical contact finger members 72 are mounted on the shaft 76 of the carrier frame generally designated 77. This carrier comprises the contact finger shaft 76 and glass rod 78 which are positioned transverse of the tank and are retained in the flanged end supporting member 79. The glass rod 78 positions the wires with respect to the fingers 72 so that proper contact can be made with the wires by the fingers 72.

The entire unit is vertically adjustable in the brackets 80 by means of the threaded rod members 81. The latter extends through apertures in the overhanging bracket portion 82, and are retained thereto by the nuts 83 threaded onto the ends of the rods, as shown in Figure 9. By ad-

vancing or retracting the members 83 on the rods 81, vertical adjustment of the shaft 76 and glass rod 78 is obtained. The brackets 80 are fastened to the angle irons 84, forming the ledge at the sides of the galvanizing tank, by means of the bolts 85.

Guide members 86 are positioned on the angle iron supports 87 by the bolts 88. The guides are supported below the laterally extending flange 89 on the member 79. These guides are provided with a slot 90 for accommodating the vertical movement of the member 79 and integral flange portion 89, as shown in Figures 11 and 12. The angle iron supports 87 are suitably anchored to the inner walls of the galvanizing tank, as shown in Figure 9. The metal parts are rubber covered or otherwise insulated against contact with the electrolyte. Adjacent the ends of the glass rod 78 are provided screw locking members 91.

The purpose of this adjustability of the contact finger frame 77 is to maintain the constant distance of the wire from the surface of the anodes which are positioned below the wire. As the anodes wear away, that is, decrease in thickness, this frame can be lowered so that the wire and contact finger can be correspondingly lowered. In this manner a uniform distance can be maintained at all times between the wires and the anode. This saves current and keeps the resistance between the anode and cathode more uniform. In this connection it will be appreciated that means may be provided for adjusting the positioning of the anode relative to the wire to achieve the same effect. All that is necessary is to have the contact fingers, wires and anodes mutually adjustable so that their relative positions may be varied to provide a predetermined distance between the anodes and the wire.

Electrical contact finger construction

The improved construction of the electrical contact fingers 12 is shown in Figure 10. This member comprises a weight pressed finger or stem 92. The contact member may be made of brass or copper alloy or other suitable electrical conducting material having the required strength and hardness. The finger member is rotatably mounted on the shaft 76 which is vertically adjustable in the frame 77, as shown in Figure 9. Integral with or attached to the contact finger 72 is an arm 93 slidable on which is a weight 94. This weight may be positioned on the arm 93 by means of the stud bolt 95 threaded into the weight and contacting the arm 93, as shown in Figure 10.

Positioned around the finger member 92 is a loosely fitted porcelain insulator covering 96. The porcelain cover is provided with a slot 97 through which is placed a retaining pin 98 which passes through the contact finger, as clearly illustrated in Figure 10. This mounting permits the reciprocation of the porcelain cover relative to the finger. At the lower end of the porcelain cover 96 are overhanging ear portions 99 between which the wire or strip being treated passes. An opening 100 in the bottom of the porcelain covering allows the end portion 101 of the contact finger member to protrude and contact the wire or strip 14. The end of the finger portion 101 will be grooved or shaped to fit the surface of the strip or wire being contacted.

The upper part of the finger member 92 comprises an enlarged portion 102 which is provided with a socket for receiving the member 103. The

portion 103 forms a bell crank with the member 93 and rotates about the shaft 76. It will be understood that the finger part 102 and member 103 may be integral if desired. The members 102 and 103 are bolted or secured together by means of the bolt 104, to which is also secured the electrical terminal 105. A flexible electrical conductor 106 connects the terminal 105 with the other terminal 107 which is in turn secured to the bus bar 108. The electrical connections will be made in this manner to the negative side of the electric current generator so as to make the wire the cathode in the electroplating solution. The finger or stem 92 is accurately grooved from the center of the bolt 104 so that the wear in the groove on the end of the finger portion 101 will be uniform.

When the wire or strip 14 is not passing through the jaws of the insulator, the insulator part 90 drops down and protects the end of the contact finger portion 101 from acquiring a plate. This avoids interference with the function of the contact finger when a wire or strip is passing through the electrogalvanizing tank. When the contact finger is in place, as shown in Figure 10, and riding on the wire, the wire holds up the porcelain cover 96 and allows the brass or contact finger portion 101 to ride directly on the wire. In this position the tip of the contact finger will become coated with metal which is being plated on the wire, but as the splices and imperfections on the wire pass along, the porcelain cover is moved up and down knocking off the loose, spongy metal maintaining a clean electrical contact. There is thus provided a novel self-cleaning and self-protecting electrical contact finger mechanism. The tension on the wire is gauged by the counterweight 94 which is adjustably attached to the arm 93 of the finger member.

Sheaves

The sheaves used for ducking the wires into the various acid, alkali and chemical treating solutions are preferably made of stoneware, glass or equivalent ceramic material which is resistant to attack by the chemical solutions used.

Stoneware sheaves are constructed as illustrated in Figures 7 and 8 and are of the single or double grooved wheel type and designated 109 and 110, respectively. Generally the double grooved sheave construction is used in order to provide a sheave of sufficient thickness to have the required strength. If, however, the selected material possesses the required strength, single grooved sheaves, such as illustrated in Figure 8, may be employed.

Around the circumference of the sheaves are formed the grooves 111. The sheaves are also provided with a chemical resistant bushing 112 fitted on the axle shaft 113. The bushings may be made of stainless steel or other chemical resistant metal or non-metal materials.

Metal ducking sheaves of the telescoping type, such as illustrated in Figure 6, may be used where it is desired to provide electrical connection to the material being treated from the axle shaft. These sheaves may be made of chemical resistant metal alloys such as chromium-iron-nickel alloys, stainless steels or high silicon alloy steels. This permits their use in contact with corrosive chemical solutions.

The construction of the telescoping sheaves, as shown in Figure 6, comprises the individual wheels 114 of disk shape having grooves 115 formed around the periphery. The walls of each sheave which form the grooves comprise a short leg por-

tion 116 of less diameter than the opposite groove wall portion 117. The latter is formed with a lateral flange part 118 which is designed to overlap the adjacent short leg sheave portion, when assembled, so as to make the length of the walls forming the grooves equal as illustrated in Figure 6. The sheaves are assembled in the manner indicated in Figure 6 and permit the handling of a large number of wires or strips of material for treatment in a minimum width of space. The sheaves are provided with bushings 119 of suitable corrosive resistant material and rotate on the axle shaft 120.

When wide tanks are used having upwards of forty or more wires in line passing there-through, the shafts for the sheaves have to be supported in the center to prevent bending. Where a bearing is necessitated, sheave separator members are inserted to separate the two center wires further apart, to provide space for the bearing installation.

The operation of the electrogalvanizing machine is readily understood from the foregoing description and further explanation is deemed unnecessary.

It will be understood, of course, that this invention is not limited to the exact details of construction and operation since obvious modifications may be made, by those skilled in the art, without departing from the spirit and scope of the description and claims.

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

1. In an electrogalvanizing machine for continuously electrogalvanizing multiple metal strands, means for moving said metal strands through said machine comprising guiding sheaves of inert material which are independently rotatable on a common axle, said sheaves having grooves with overlapping leg portions so as to be in telescoping engagement with each other.

2. A guiding wheel member for moving strands of metal lengths in spaced relationship through an electroprocessing machine comprising multiple sheave members which are independently rotatable on a common shaft, said sheaves having grooves with overlapping leg portions so as to be in telescoping engagement with each other to provide a compact multiple strand handling unit.

3. In apparatus for the electrochemical processing of a moving wire, including a tank adapted to contain electrolyte, and means for guiding the wire substantially horizontally through said tank below the level of the electrolyte; the combination therewith of an electrical contactor pivoted about a point above said wire and including a sleeve of insulating material having a grooved lower end straddling said wire, and a rod of conducting material loosely extending through said sleeve, the lower end of said rod being exposed in the groove to contact the wire, the upper end of said rod being connected to a source of electrical power, and the point of contact with said wire being vertically offset from the pivot point so that a gravitational force yieldingly presses said rod against the wire.

4. In apparatus for the electromechanical processing of a moving wire, including a tank adapted to contain electrolyte, and means for guiding the wire substantially horizontally through said tank below the level of the electrolyte; the combination therewith of an electric contactor pivoted about a point above said wire and includ-

ing a sleeve of insulating material having a grooved lower end straddling said wire, a rod of conducting material loosely extending through the sleeve, said sleeve being secured to said rod at an intermediate position and with a connection that is adapted to yield in the longitudinal direction to permit movement of the sleeve with respect to the rod in said direction, the lower end of said rod being exposed in the groove to contact the wire, the upper end of said rod being connected to a source of electrical power, and the point of contact with said wire being vertically offset from the pivot point so that a gravitational force yieldingly presses said rod against the wire.

5. In apparatus for the electrolytic mechanical processing of a moving wire, including a tank adapted to contain electrolyte, and means for guiding the wire substantially horizontally through said tank below the level of the electrolyte; the combination therewith of an electric contactor rod pivoted about a point above said wire the end of said rod being in contact with said wire and including a covering of insulating material loosely mounted on said rod and having a grooved lower end straddling said wire, the lower end of said rod being exposed in the groove to contact the wire, the upper end of said rod being connected to a source of electric power, and the point of contact with said wire being vertically offset from the pivot point so that a gravitational force yieldingly presses said rod against the wire, said covering of insulating material having means connecting the same to said rod, said last-named means including means for allowing some but preventing unlimited sliding movement of said covering on said rod.

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1,322,494	Merritt	Nov. 18, 1919
1,191,386	Battle	July 18, 1916
954,833	Wallace	Apr. 12, 1910
541,986	Sanders	July 2, 1895
1,515,092	Cowper-Coles	Nov. 11, 1924
2,053,279	Fosburg	Sept. 8, 1936
2,146,488	Sykes	Feb. 7, 1939
1,115,671	Herrmann	Nov. 3, 1914
1,275,887	Finnell	Aug. 13, 1918
1,917,657	MacChesney	July 11, 1933
2,093,238	Domm	Sept. 14, 1937
2,203,062	Schueler	June 4, 1940
1,425,184	Edison	Aug. 8, 1922
1,804,486	Wright	May 12, 1931

FOREIGN PATENTS

Number	Country	Date
63,030	Germany	Oct. 9, 1891
412,582	Great Britain	June 25, 1934
19,586	Great Britain	1890
479,869	Great Britain	Feb. 14, 1938
21,081	Great Britain	1906