Oct. 31, 1939. A. H. HANNON 2,177,982

BARREL ELECTROPLATING MACHINE

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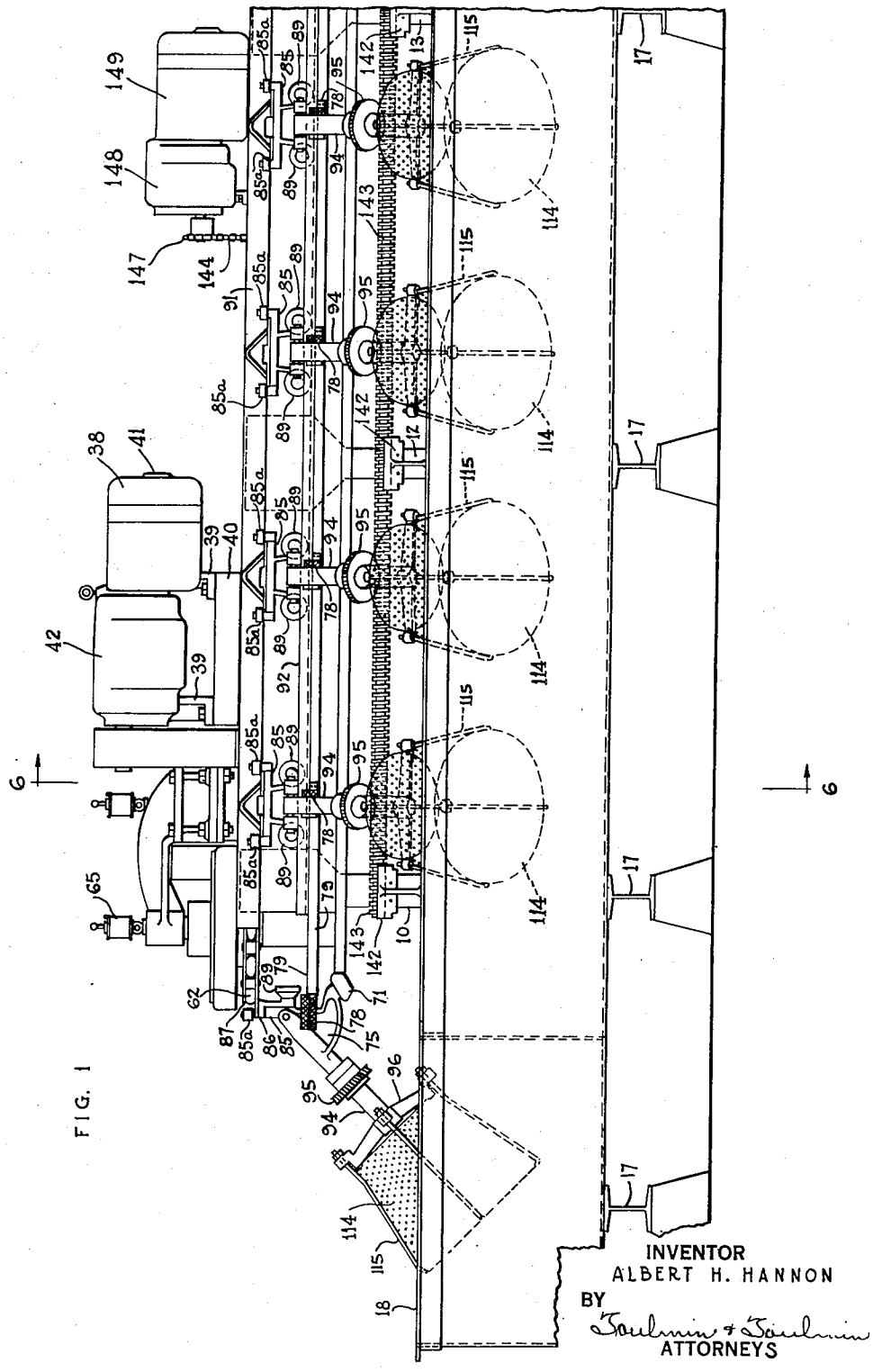


FIG. 1

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BARREL ELECTROPLATING MACHINE

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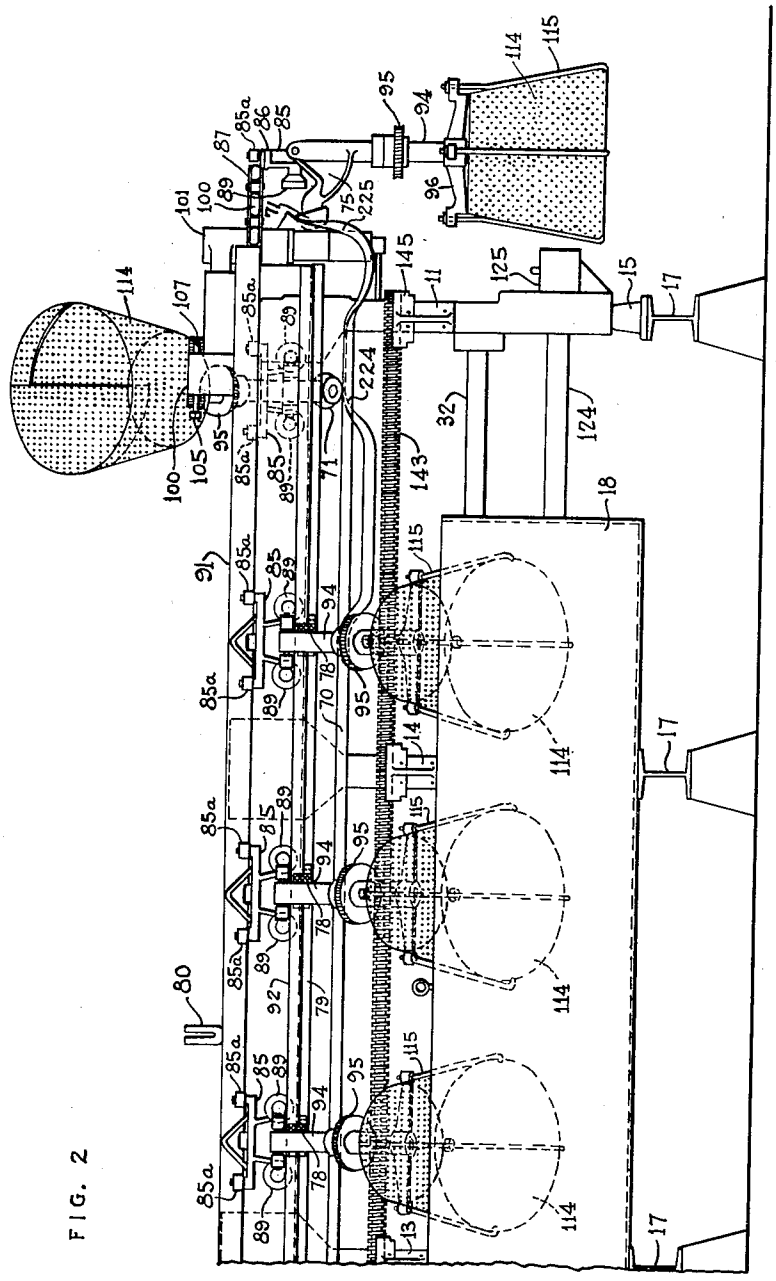


FIG. 2

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BARREL ELECTROPLATING MACHINE

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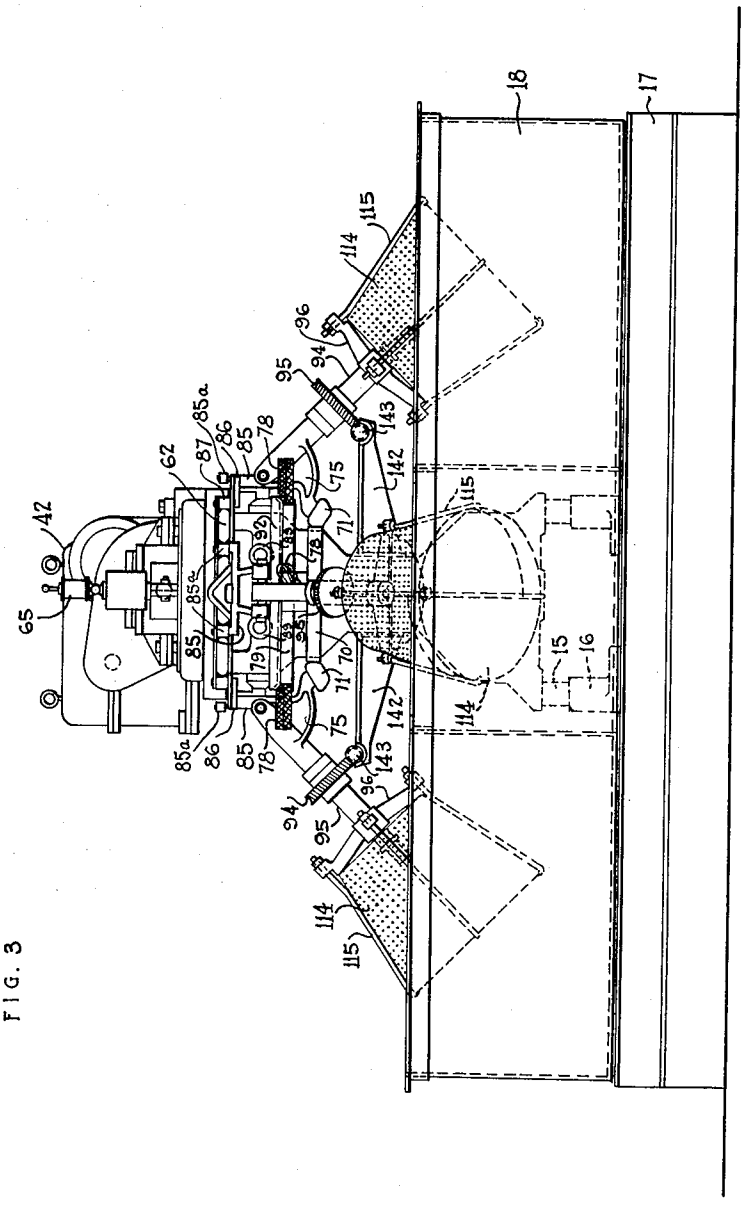


FIG. 3

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BARREL ELECTROPLATING MACHINE

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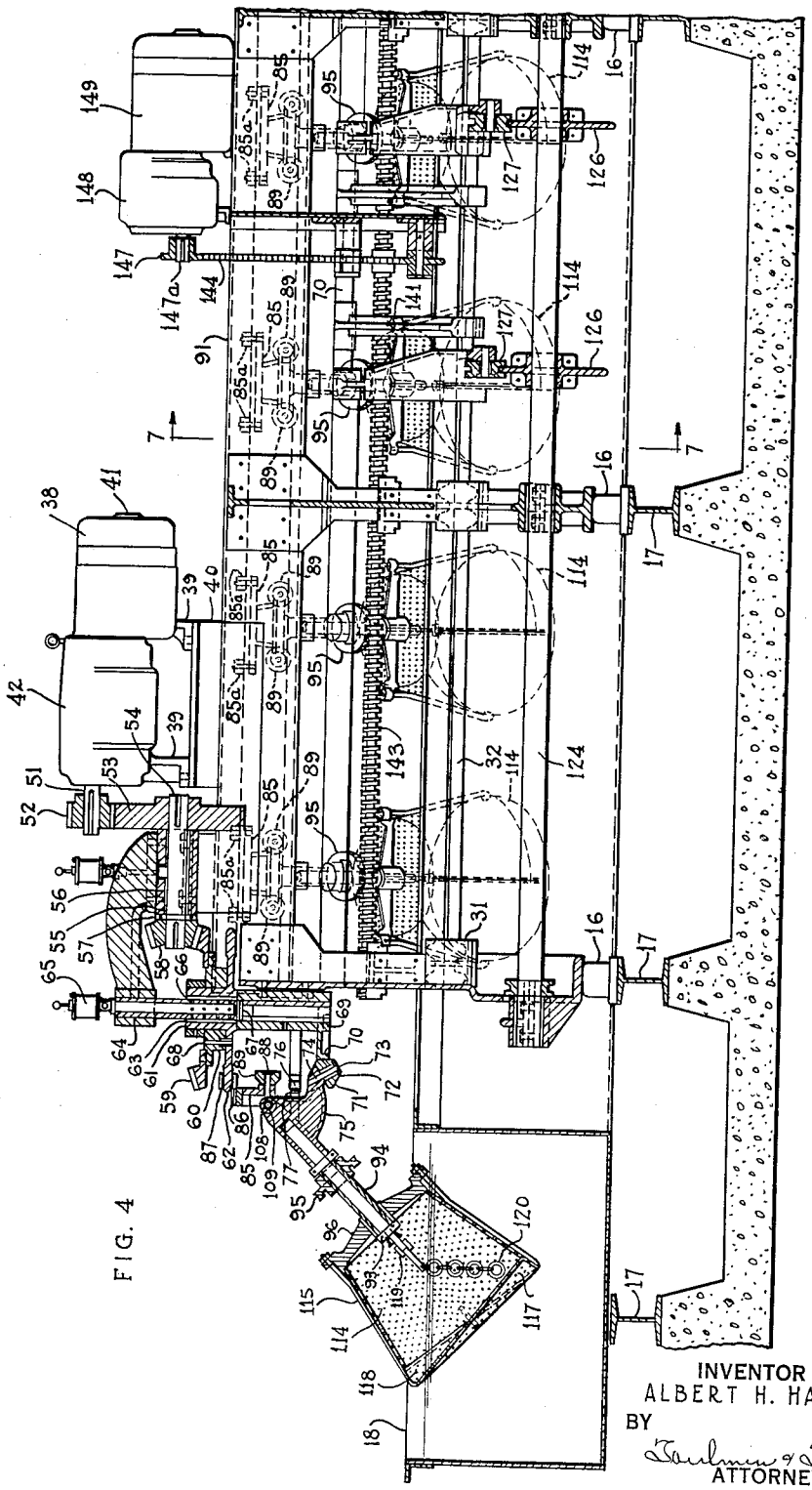


FIG. 4

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BARREL ELECTROPLATING MACHINE

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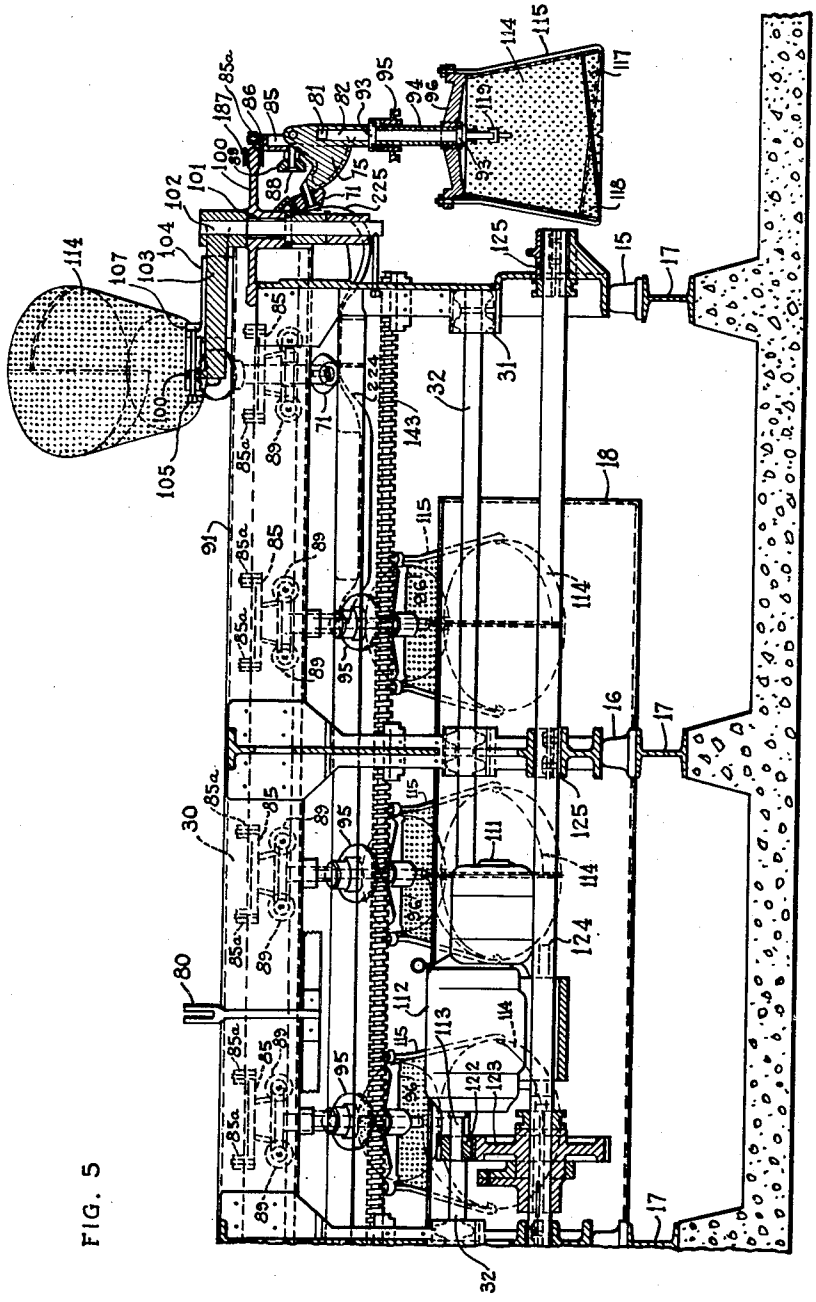


FIG. 5

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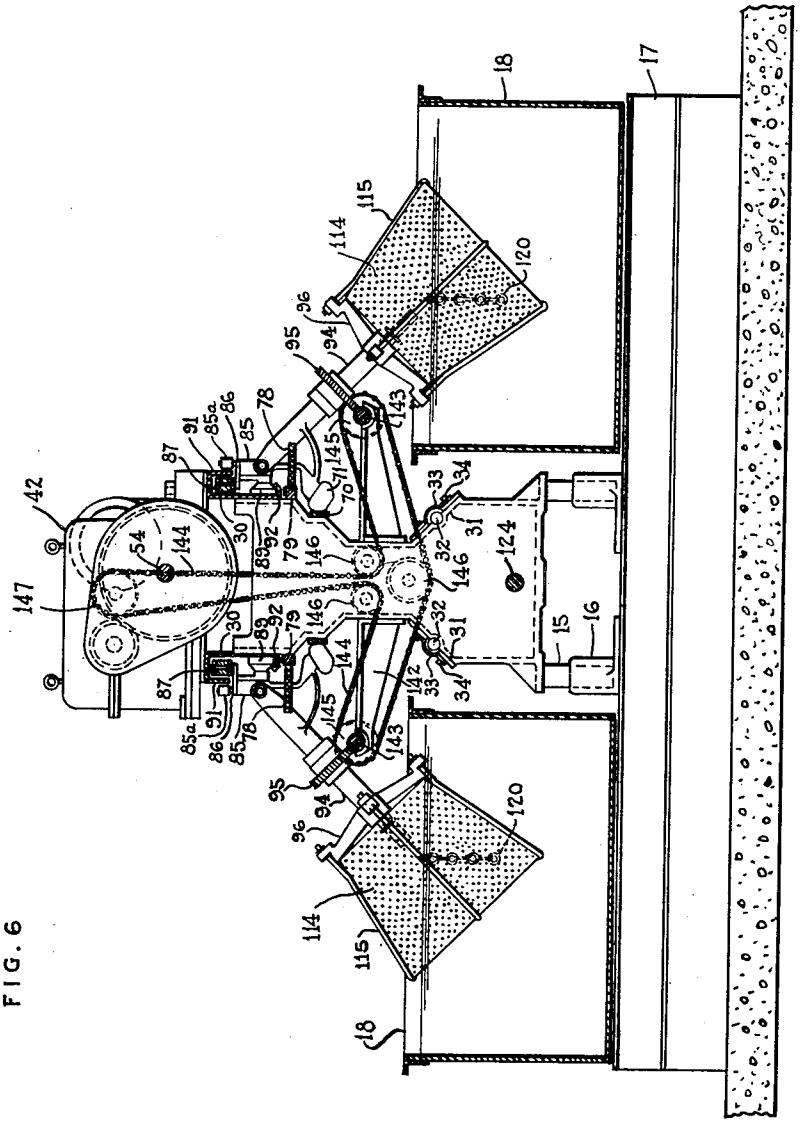


FIG. 6

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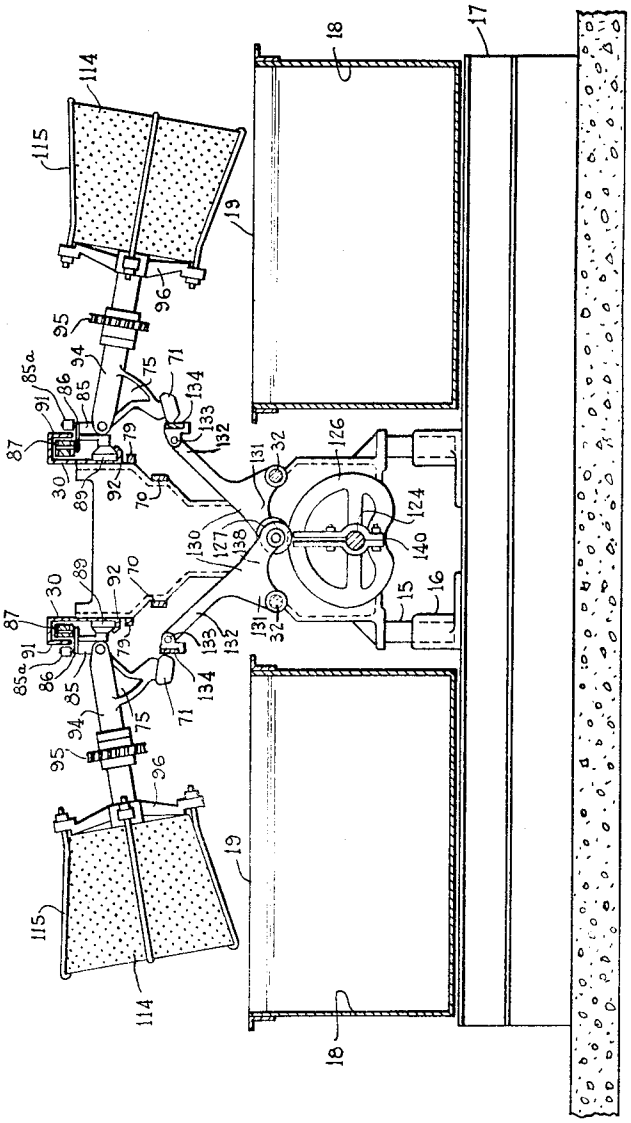


FIG. 7

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FIG. 8

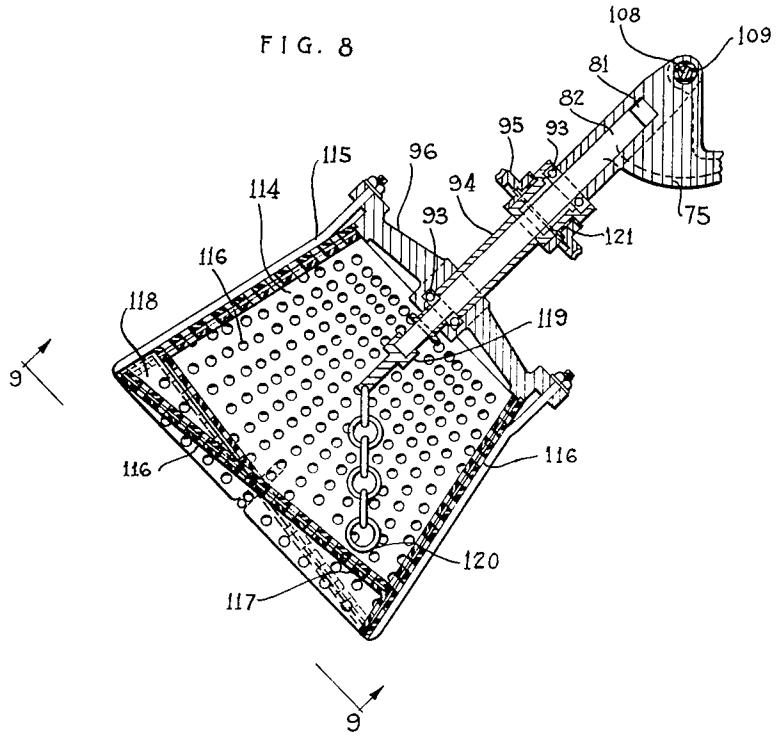
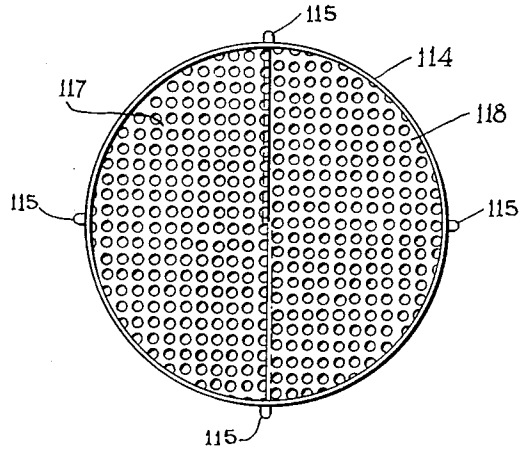


FIG. 9



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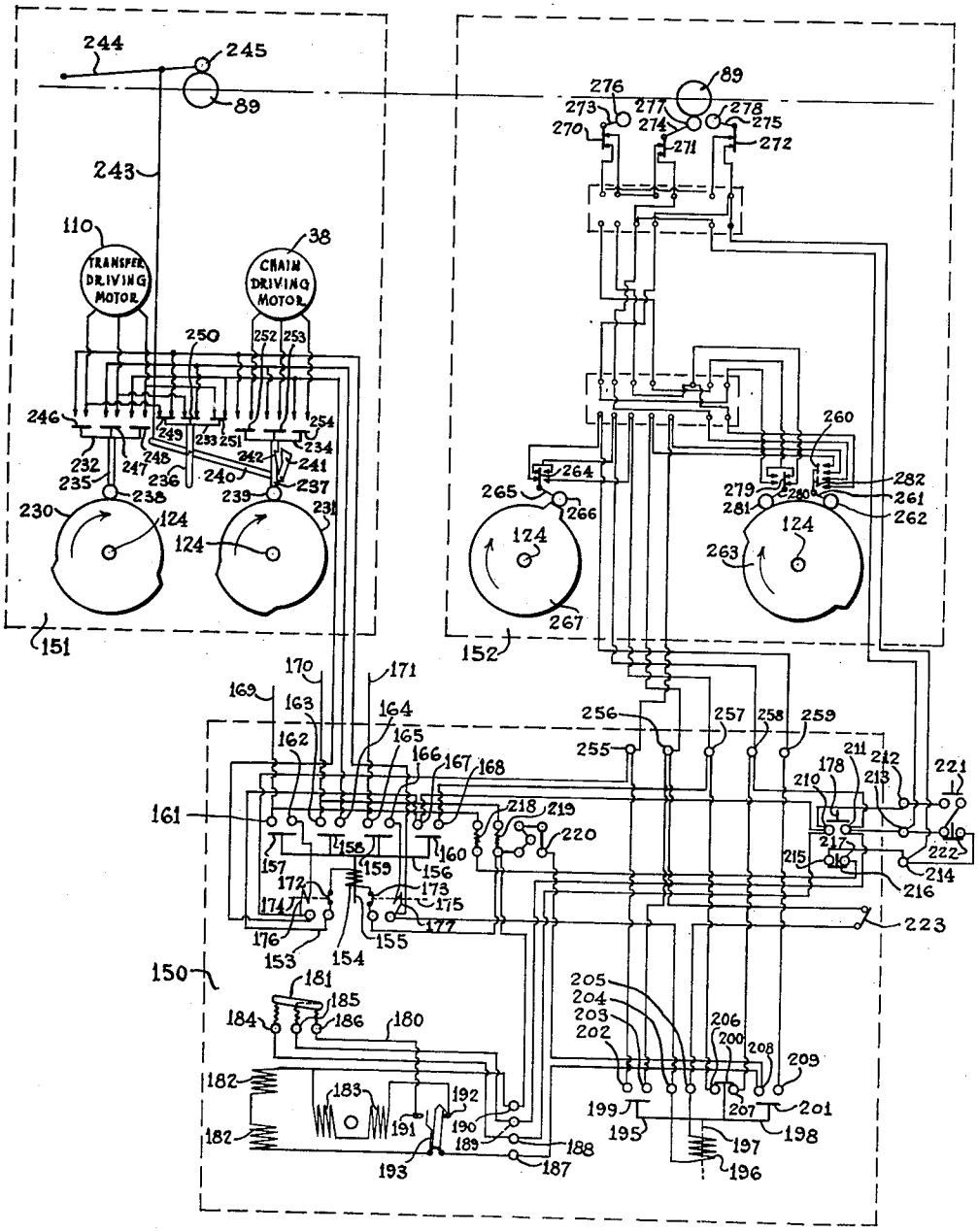
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BARREL ELECTROPLATING MACHINE

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FIG. 10



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Patented Oct. 31, 1939

2,177,982

UNITED STATES PATENT OFFICE

2,177,982

BARREL ELECTROPLATING MACHINE

Albert H. Hannon, Springfield, Ohio

Application July 17, 1936, Serial No. 91,170

16 Claims. (Cl. 214—17)

This invention relates to electroprocessing machines, and in particular, to automatic machines having rotatable barrels in which the work-pieces are tumbled as they are carried through the various treatment baths.

One object of this invention is to provide an electroprocessing machine wherein a plurality of perforated barrels is arranged on tilting shafts supported in brackets at intervals along a conveyor chain, together with apparatus for tilting these brackets so as to carry the barrels over the partitions between the various tanks.

Another object is to provide electroprocessing apparatus having work-holding barrels with perforated walls, the bottom of each barrel being formed in such a manner as to impart an additional tumbling motion to the work-pieces as the barrel is rotated, the rotating means consisting preferably of rotatable screws extending along the sides of the machine and engaging worm gears mounted on the barrel shafts.

Another object is to provide such a machine wherein the brackets for supporting the barrels are provided with a plurality of rollers adapted to travel in a supporting guideway, thereby supporting the conveyor chain which is attached to the bracket, this bracket also preferably having rollers at its upper part engaging the chain guide on the outside wall thereof, immediately adjacent the conveyor chain.

Another object is to provide an electroprocessing machine including a plurality of perforated barrels mounted on shafts rotatably and tiltably supported by brackets arranged at intervals along the conveyor chain, the machine being provided with movable transfer members adapted to engage the work carriers upon which the barrels are mounted and force them outwardly, thereby lifting the barrels over the partitions between the various tanks, the tanks at their unloading and loading ends being preferably provided with guide rails which engage the carrier arms and force them and their barrels upwardly into the unloading position of the barrels, and then downwardly into the loading position thereof.

Another object is to provide a container for objects to be plated consisting of a perforated barrel, preferably of frusto-conical form, having a bottom which is given a special form arranged to impart an additional turning and tumbling motion to the work-pieces as the barrel rotates while it is being carried forwardly through the solutions, and also to keep the solutions stirred up so as to bring about a uniform plating action.

In the drawings:

Figure 1 is a side elevation of the left-hand end of the electroprocessing machine of this invention.

Figure 2 is a side elevation, similar to Figure 1, but of the right-hand end of the machine.

Figure 3 is a left-hand end elevation of the machine shown in Figures 1 and 2.

Figure 4 is a vertical longitudinal section through the left-hand end of the machine shown in Figure 1.

Figure 5 is a vertical longitudinal section, similar to Figure 4, but through the right-hand end of the machine as shown in Figure 2.

Figure 6 is a vertical cross section along the line 6—6 of Figure 1.

Figure 7 is a vertical cross section through the machine, taken along the line 7—7 of Figure 4, showing the lifting mechanism for lifting the work carriers and their barrels over the partitions between the tanks.

Figure 8 is an enlarged vertical section through one of the work carrier barrels and its supporting structure.

Figure 9 is a bottom plan view of the work carrier barrel shown in Figure 8.

Figure 10 is a wiring diagram of the electrical control circuit employed in the electroprocessing machine of this invention.

General construction

Referring to the drawings in detail, Figures 1 and 2 show the electroprocessing machine of this invention as mounted upon end posts 10 and 11 and intermediate posts 12, 13 and 14. These posts are mounted upon stanchions 15, which in turn, rest in sockets 16 secured to the bottom cross members 17. The latter are preferably of channel cross section and rest upon the floor of the building in which the machine is located. The bottom cross members 17 also serve to support the tank assembly, generally designated 18.

The tank assembly 18 consists of a series of tanks or a single tank with a series of partitions, the assembly being in approximate U-shape form. The mechanism supported by the stanchions 15 and posts 10 to 14 is arranged within the arms of the tank assembly 18, the circular portion of the tank passing around one end of the machine. The open end of the U-shaped tank is employed, respectively, for loading the work-pieces and for unloading the processed work-pieces. The tank assembly 18 is divided transversely at various points by partitions 19, transfer mechanism being provded, as hereinafter explained, for transferring the work-pieces over

these partitions from one portion of the tank to the other.

The vertical posts 10 to 14, inclusive, are secured to and interconnected by horizontal top members 30, constituting chain guides, as will subsequently appear. The chain guides 30 form a frame upon which the operating mechanism of the machine is supported. The posts are also provided at their lower portions (Figure 6) with laterally extended portions 31, within which are secured longitudinal shafts 32, held rigidly in place by the clamping members 33. The shafts 32 serve not only as frame members but also to support certain parts of the transfer and lifting mechanism, as hereinafter explained. The clamping members 33 are secured to the lateral extensions 31 in any suitable manner, as by the cap screws 34.

Horizontal conveyor and carrier arm construction

The horizontal conveying mechanism of the machine is driven by a motor 35 (Figure 1) mounted upon the brackets 39, which in turn, is supported upon the base plate 40 secured to the chain guides 30. The motor shaft 41 enters a geared reduction unit, generally designated 42, a train of gears therein reducing the speed of the motor. The output shaft 51 carries a pinion 52 which drives a gear 53 upon the shaft 54, the latter being rotatably mounted in the bearing bushing 55 mounted in the bearing support 56.

A thrust bearing 57 sustains longitudinal thrusts along the shaft 54, and immediately adjacent thereto is a bevel pinion 58. The latter drives a bevel gear 59 attached to the shear pin hub 60, within which is the hub 61 of the sprocket 62. Within the hub 61 is a bearing bushing 63, supported upon a tubular shaft 64 having an oiling reservoir 65 for supplying oil to the bushing 63 by way of the apertures 66. The thrust bearing 67 is arranged to sustain vertical thrusts and the weight of the bevel gear 59 and sprocket 62. Shear pins 68 drivingly interconnect the shear pin hub 60 of the bevel gear 59 and the sprocket 62, these pins 68 being adapted to be sheared off in case of a jamming of the mechanism, thereby severing the driving connection and preventing damage to the machinery.

Below the thrust bearing 67 is a bracket 69 (Figure 4), having an arcuate rail 70 passing around the end of the machine. Engaging this rail 70 is a roller 71 surrounding an insulating sleeve 72 within which is a pin 73 seated in a bore 74 in the inner end of the carrier arm 75. The carrier arm 75 is likewise provided with a bronze contact pad 76 universally mounted thereon, as at 77, and connected thereto by the flexible cable 78. The contact pad 76 serves to engage the cathode rail 79 (Figure 1), the latter being connected at the connection 80 to the line running to the negative pole of the generator. In this manner current is conveyed from the cathode rail 79 to the carrier arm 75.

The work carrier arm 75 is pivotally mounted upon the rod 84 (Figure 3), supported in the chain bracket 85. The latter is connected by a link 86 to the side plates of the conveyor chain 87, driven by the sprocket 62. The chain bracket 85 is provided with upper rollers 85*a* and also provided at its lower portion with a pair of pins 88 which carry rollers 89. Each chain guide 30 (Figure 6) has an upper portion 91, partially surrounding the conveyor chain 87, and a lower portion 92 bent to form a channel-like rail in which the roller 89 is adapted to travel. In this manner the chain guide 30 serves to guide the chain 87 as well as to support the weight thereof by way of the chain bracket 85 and its associated roller 89 (Figures 6 and 7).

The conveyor chain 87 pursues an orbital path around the central portion of the machine, and at the end opposite the sprocket 62 is supported by an idler sprocket 100. The latter is provided with a bearing bushing 101 by which it is rotatably supported upon a vertical shaft 102. This shaft is mounted at the end of a slide 103, which is adapted to reciprocate in guideways 104 for the purpose of tightening or loosening the conveyor chain 87. This adjustment is obtained by rotating a screw 105 which passes through threaded projections 106 and 107 on the slide 103 and guideways 104, respectively.

The lifting mechanism whereby the carrier arms 75 are elevated to lift the work-piece racks over the partitions between tanks is driven by the cam-driving motor 110 (Figure 5), the drive shaft 111 of which enters the geared reduction unit 112 and drives the output shaft 113 thereof through a train of gears. The output shaft 113 carries a pinion 122 which meshes with a gear 123 upon the cam shaft 124, this being journalled, as at 125, in the various vertical posts 10 to 14. The cam shaft 124 is provided with a plurality of cams 126 at intervals along the shaft, these cams being formed in halves and bolted together around the cam shaft 124.

The cams 126 are roughly heart-shaped and are engaged by grooved rollers 127 mounted on pins 128. Each pin 128 is mounted in one arm 129 of a Y-shaped lever 130, another arm 131 of which (Figures 7, 8 and 9) is pivotally mounted upon the shaft 32. A pad 134 is secured, as at 133, to the remaining arm 132 of the Y-shaped lever 130.

As the cams 126 are rotated by the rotation of the cam shaft 124, the rollers 127 move upwardly and cause the Y-shaped levers 130 to move outwardly, and with them the pads 134. In this manner the rollers 71 are engaged and pushed upwardly by the pads 134, thereby raising the carrier arms 75 and the work-pieces supported by them. As the cam 126 continues to rotate, the rollers 127 move into the indented portion 140 thereof, causing the U-shaped arms 130 to recede, thereby lowering the work carrier arms 75. Between the transfer positions the rollers 71 roll along against the rails or roller tracks 70, these being supported along the sides of the machine by the brackets 141 secured thereto (Figure 4) and having their opposite ends resting upon the stationary shafts 32.

The work carrier arm 75 is pivotally mounted upon the rod 108 supported by the chain bracket 85. The work carrier arm 75, however, is insulated from its pivot rod 108 by means of the insulating bushing 109 surrounding the pivot rod 108. Mounted in the bore 81 of the work carrier arm 75 is a shaft 82 having anti-friction bearings 93, arranged to rotatably support a sleeve 94 having a worm gear 95 mounted thereon. Mounted on the sleeve 94 is the head 96 of a work-carrying barrel, generally designated 114, and having retaining rods 115 for holding the frusto-conical perforated body portions 116 in engagement with the barrel head 96. The barrel 114 is provided with a bottom consisting of two portions 117 and 118, tilted at an angle to one another. By this tilted construction the work-pieces within the barrel 114 are given an additional tumbling effect, resulting in a screw-like

motion as the barrel is rotated while it is being carried forwardly through the various tanks.

The sides 116 and the bottom portions 117 and 118 of the barrel 114 are of heavy perforated metal, and rubber-covered so as to permit the solution to pass through the perforations without injuring the material of which the barrel is constructed. To the lower end of the shaft 82 is attached a holder 119 for a chain-like flexible member 120. In this manner the chain-like member 120 conducts electricity from the work carrier 75, by way of the shaft 82, to the articles in the barrel 114. To prevent the escape of electricity through the worm gears 95 the hubs thereof are provided with an insulating bushing 121 between the hub and the sleeve 94 upon which the hub is mounted.

Rotatably supported upon brackets 142 extending laterally from the vertical posts 10 to 14 are screw shafts 143, driven by a sprocket chain 144 engaging sprockets 145 upon the screw shafts 143 (Figure 6). The sprocket chain 144 passes over idler sprockets 146 and around a drive sprocket 147 mounted on the output shaft 147a of a reduction gear box 148, to which is connected the driving motor 149 (Figures 1 and 4). At its right-hand end the rail 70 (Figure 2) is bent upwardly, as at 224, so that it causes the work carrier arm 75 and its barrel to be elevated into the unloading position. At the very ends of the machine the rail 70 is brought inwardly, as at 225, so that the work carrier is permitted to assume a vertical position for loading. Elsewhere than at its ends the barrels and their work carrier arms are elevated by the positive lifter pads 134 actuated by the cams 140.

Electrical circuit and electrical elements

The electrical circuit in the present machine is arranged to control the operation of the chain driving motor 38 and cam shaft driving motor 110 so as to cause the chain 87 to move the carrier arms 75 until they approach a partition between the various tanks. At this point the electrical control system comes into operation to halt the chain driving motor 38 and chain 87, bringing the carrier arm 75 to rest. When this occurs the electrical control system brings the cam driving motor 110 into operation to move the lifting arms 130 and lift the carrier arms 75 vertically until the work baskets are safely clear of the partitions.

The control system then comes into action to re-start the chain driving motor 38 and operate the chain 87 to move the elevated carrier arms 75 by such a distance as will carry them beyond the partitions, whereupon the control circuit again comes into play to halt the horizontal motion of the chain 87. The control circuit then operates the cam driving motor 110 to retract the lifting arms 130 and lower the work carriers 75 and their contents into the next tank or tank section. The control system finally comes into play again when the lowering has been accomplished, causing the chain driving motor 38 and chain 87 to re-start and move the work carrier arms 75 horizontally until they arrive at the next partition, whereupon this cycle of operations is repeated.

The electrical circuit required to accomplish this operation is shown in Figure 10. This circuit consists primarily of three main assemblies or subcircuits, namely, an intermittent control circuit, generally designated 150, a synchronizing circuit, generally designated 151, and a safety circuit, generally designated 152. As will be subsequently pointed out, certain switches in the intermittent control circuit are located within the dotted lines inclosing the safety circuit 152, these switches being located therewithin for purposes of convenience because they are operated by the same cams which operate the safety circuit switches.

The intermittent control circuit 150 provides control of the duration of the stopping period of the machine, together with overload and no-voltage relays for the chain driving motor 38 and the cam driving motor 110. The synchronizing circuit 151 maintains the two motors 38 and 110 in proper relationship with each other. The safety circuit 152 is normally dormant and comes into play only when the various elements of the machine get out of step, or an accident occurs which throws the elements out of their proper timing. When such an abnormal situation arises the safety circuit 152 comes into play to stop the chain driving motor 38 and the cam driving motor 110 to prevent damage to the mechanism, such as might occur by a collision between the work carrier arms 75 and the lifting arms 130 if the latter had not returned to their positions before they approach the former.

The intermittent control circuit 150 contains a standard type magnetic motor starter, generally designated 153, having an operating coil 154 which operates an armature 155 having a cross bar 156 with switch bars 157, 158, 159 and 160, arranged to bridge four pairs of contacts 161 to 168, inclusive. To the contacts 161, 163 and 165 are joined the main lines 169, 170 and 171, respectively. These main lines convey the current from the current mains to the control circuit, and a manual line switch (not shown), with the usual fuses, may be inserted for rendering the entire circuit manually inoperative.

The motor starter 153 is also provided with overload thermo-relays 172 and 173, having armatures 174 and 175, operated by the coils 176 and 177. Upon an excessive load being maintained for any considerable period of time, these thermo-relays come into operation to break the circuit in the holding coil 154 and cause the member 153 to fall out, stopping the motors. The thermo-relays 172 and 173 may be of any suitable type, such relays being known to those skilled in the art. These relays may be re-set manually a few minutes after the motors have stopped. As will be subsequently seen, the contacts 167 and 168 operate a holding circuit for maintaining the energization of the operating coil 154 when the starting button 178 is released by the operator.

Associated with the motor starter 153 in the intermittent control circuit 150 is a timing relay, generally designated 180, of any suitable type, such as known to those sikIled in the art. This timing relay is provided with a three-pole mercury switch 181 adapted to be tilted to and fro by a timing motor (not shown) at the end of its operating period. When current is supplied to the holding coils 182 and motor coils 183, these operate an armature to bring the timing motor into operative engagement with the timing mechanism, such as a train of gears, which after a predetermined time, tips the mercury switch 181. In the meantime, in the present invention, a pawl is operated by the armature of the holding coils to engage the train of gears so that the motor which is connected in multiple with these holding coils, drives the train of gears, and after

a predetermined time tips the mercury switch. The details of this timing relay in themselves form no part of the present invention, and any suitable timing device may be used.

The mercury switch 181 is provided with three poles 184, 185 and 186, and so constructed that the contacts 185 and 184 must "make" before contacts 185 and 186 "break". One side of the holding coils 182 is connected to the terminal 187. The poles 184 and 185 are connected, respectively, to the terminals 188 and 189, whereas the remaining side of the holding coils 182 is connected to the terminal 190. The pole 186 is connected to a contact 191 arranged opposite a contact 192, connected to one side of the holding coils 183. Upon the energization of the holding coils 182 and 183, the switch blade 193 is operated to contact the mercury switch pole 186 to the terminal 187, the latter being otherwise connected to the motor coils 183.

Likewise associated with the motor starter 153 and the timing relay 180 in the intermittent control circuit 150 is a magnetic contactor 195, having an operating coil 196 arranged, when energized, to operate an armature 197 and move a cross bar 198 having switch blades 199, 200 and 201. The magnetic contactor 195 is provided with eight contacts, 202 to 209, inclusive. The energization of the holding coil 196 causes the switch blades 199 and 201 to interconnect the contacts 202 and 203, also 208 and 209, respectively, whereas the same motion breaks the connection between the contacts 206 and 207 by the separation therefrom of the switch blade 200.

The starting button 178 is provided with contacts 210 and 211, these being led out to terminals 212 and 213, respectively. A terminal 214 is connected to one contact 215 of a stop switch 216, the opposite contact 217 of which is connected, through a fuse 218, to the contact 161 of the motor starter 153. Another fuse 219 is interposed in the line interconnecting the motor starter switch contact 163 and the timing relay terminal 190. A plurality of incandescent light bulbs 220 is likewise interposed in series in the line running from the fuse 219 to the contact 208 of the magnetic contactor 195. The lighting of these bulbs 220 indicates when the circuit is in operation. Additional starting and stopping switches 221 and 222, respectively, may be connected to the terminals 212, 213 and 214 for the purpose of controlling the machine from a remote point. A manual switch 223 is likewise interposed in series with the operating coil 196 of the magnetic contactor 195 in order to disable the latter when it is desired to cut out the operation of the timing relay 180 and run the machine continuously.

For purposes of convenience certain of the external connections of the magnetic contactor 195 are brought out to terminals 255, 256, 257, 258 and 259. The terminals 255 and 256 are connected to a single-throw mercury switch 260 operated by a member 261 having an operating roller 262, adapted to engage a cam 263. Similarly, the terminals 257, 258 and 259 are connected to a double-throw mercury switch 264, so arranged as to close one pair of its contacts before opening the other pair, and operated by a member 265 having a roller 266 engaging a cam 267. The cams 263 and 267 are mounted upon a cam shaft 124, and are shown in Figure 10 as separated from one another, although in practice they are preferably mounted side-by-side or combined with one another in an integral cam. The mercury switches 260 and 264 are shown as included within the safety circuit 152 for the sake of convenience, because the switch 260 is operated by the same cam which operates other switches used in connection with the safety circuit. These other switches will be described later.

The synchronizing circuit 151 consists of a mechanically operated switch assembly actuated by cams 230 and 231, mounted upon the cam shaft 124 and associated with a tripping mechanism operated by a cam or the chain bracket roller 89. The cams 230 and 231 (Figure 10) are shown for convenience as separated from one another, whereas in the actual machine they are preferably placed side-by-side or made integral with one another. The mechanical switch assembly operated by these elements consists of three three-pole switches 232, 233 and 234, having push rods 235, 236 and 237. The push rods 235 and 237 are provided with rollers 238 and 239 for engaging the cams 230 and 231, respectively. To the push rod 236 is pivoted a lever 240, having a tripping member 241 adapted to engage a notch 242 in the push rod 237. Connecting means, shown diagrammatically by the line 243, mechanically connects the lever 240 with the arm 244, having a roller 245 adapted to be engaged by the chain bracket roller 89 as the latter passes underneath the former during its horizontal motion around its orbital path. The switches 232, 233 and 234 are provided with switch blades 246 to 254, inclusive, adapted to bridge pairs of lines when they engage the latter.

One switch 234 governs the connection of the current to the chain driving motor 38, whereas the other two switches 232 and 233 are connected in multiple and govern the distribution of current to the cam driving motor 110. Current to these switches is supplied from lines running to the motor starter 153. The switches 232, 233 and 234 are shown in a position of rest, with one of the cam motor switches 233 closed and the other switch 232 open. The chain motor switch 234 is also open.

The safety circuit 152 (Figure 10) is shown as including the switches 260 and 264. These switches, however, as previously stated, are associated with the intermittent control circuit 150 and are shown in the safety circuit 152 because they are actuated by the same cams which actuate the safety circuit switches. The safety circuit 152 is provided with three single-throw mercury switches 270, 271 and 272, actuated by the members 273, 274 and 275, having rollers 276, 277 and 278 arranged to be engaged by the chain bracket roller 89 as it moves in its orbital path around the machine.

Associated with the chain-operated mercury switches 270, 271 and 272 are the mercury switches operated by the cam 263. One mercury switch 279 is a double-throw switch operated by the member 280, having the roller 281, whereas the other mercury switch 282 is a single-throw switch operated by the same member 261 which operates the mercury switch 260, previously described in connection with the intermittent control circuit. The safety circuit is a normally closed circuit and is connected to the intermittent control circuit at the terminals 213 and 214 on the right-hand side of Figure 10, between the starting button 178 and stopping button 216.

The switch 270 is operated by the member 273 and roller 276 to insure the return of the lifter arm 130 and its pad 134 to their retracted positions, ready for the arrival of the next carrier

arm 75. It will stop the machine in case the cam shaft motor should fail after the conveyor chain 87 has started forward, and before the lifter arm 130 and lifter pad 134 have returned to their retracted position, thereby stopping the machine before the following carrier arm runs in under the unretracted lifter pad 134. The switch 271, on the other hand, is provided to insure that all of the carrier arms 75 are in their proper positions to set down or lower their work-pieces so that the cam shaft 124 cannot revolve to lower the carrier arms without opening the circuit at the switch 282. The switch 271, operated by the member 274 and roller 277, therefore insures that the carrier arms 75 shall be in their proper positions before they can be lowered. The switch 272 provides against an overrun of the chain bracket roller 85. In this event the opening of its associated switch 279 will open the safety circuit 152 and stop the machine unless the cam shaft 124 and cam 263 are in their proper positions, and the left-hand contacts of the switch 279 closed. The arrangement of the switches 270, 271, 272, 279 and 282 is such that if the chain bracket roller 89 opens one of the chain-operated switches 270, 271 or 272, the cam 263 maintains either of the switches 279 or 282 closed, each of the switches 271 and 272 having a cam-operated switch connected in multiple with it.

Should the machine cams be out of time, or the chain and carrier arms in incorrect position, such as might occur by the failure of either of the motors 38 or 110, or other associated apparatus either mechanical or electrical, one of the switches 270, 271 or 272 will be opened without its corresponding switch 279 or 282 being simultaneously closed. As each pair of switches is connected in series the circuit supplying current to the motor starter coil 154, under such circumstances, would be opened, thereby preventing the operation of the motor starter 153 and shutting off all current to both motors 38 and 110. As the safety circuit 152 is in series with the stopping push button switch 216, the motor cannot again be started by merely pushing the starting push button. Before this can be done it is necessary to correct the source of the trouble by readjusting the timing mechanism or resetting the cams until the machine parts are again in properly timed and positioned relationships.

It will be understood that the machine of this invention will operate without the safety circuit 152, and the latter can be rendered inoperative merely by shortcircuiting the terminals 213 and 214. The safety circuit 152, however, provides the valuable feature of preventing the operation of the machine when the parts are out of their proper relationships with each other. Otherwise, the safety circuit 152 remains inactive because none of its switch contacts normally ever breaks a circuit unless the machine is thrown out of properly timed relationship for some reason.

Operation

The mechanical operation of the machine has been described to some extent in connection with the construction of the various parts. The chain driving motor 38 is started by closing the motor starting switch 153, whereupon the cam shaft 124 revolves and the chain 87 starts moving in an orbital path, carrying with it the carrier arms 75. At the same time the revolving screw shafts 143 cause the barrels 114 to rotate as they move horizontally. As the carrier arms 75 arrive next to a partition the chain driving motor 38 will cease operating, and the chain 87 will come to a halt. By this time the carrier arm rollers 71 have arrived over the lifter pads 134. The electrical circuit now comes into operation to start the cam driving motor 110 to rotate the cam shaft 124 and the cams 126 so that the lifter arms 130 are actuated to push the lifter pads 134 outwardly and lift the carrier arms 75. When the carrier arms 75 reach the tops of their positions, the chain driving motor 38 is again operated to move the chain 87 and the carrier arms 75 horizontally over the partition. The chain driving motor 38 then stops and the cam driving motor 110 is operated to lower the carrier arms 75 and their work-pieces into the next tank. When the lowering has been completed the cam driving motor 110 stops, and the chain driving motor 38 restarts to move the chain 37 and the carrier arms 75 through the tanks toward the next partitions.

The operation of the electrical circuit for bringing about this mechanical operation has been partly described in connection with the description of the circuits. When the starting switch button 178 is depressed, closing the circuit between the terminals 210 and 213 (Figure 10), current is supplied from the lines 169 and 170 leading to the switch contacts 161 and 163, through the fuses 218 and 219 to the actuating coil 154 of the motor starter 153, closing its switch blades 157, 158, 159 and 160. The switch blade 160 interconnects the contacts 167 and 168, which are in series, with the terminals 257 and 258 connected to the double-throw mercury switch 264 operated by the cam 267. These elements, the stop switch 215 and contacts 206 and 207 form a holding circuit to keep the starter operating coil 154 energized after the starting button 178 is released, the terminals 257 and 258 being normally closed by the mercury switch 264 after partial rotation of the cam shaft.

As these terminals 257 and 258 are likewise adapted to be interconnected by the switch blade 200 of the magnetic contactor 195, the contacts 206 and 207 thereof being connected in multiple with one set of the contacts of the mercury switch 264, it will be seen that if the mercury switch 264 and the contactor switch blade 200 are both opened at the same time, or the stop button 216 is pressed, the operating coil 154 of the motor starter 153 will be deenergized, thereby opening this circuit and causing either or both of the motors 38 and 110 operating at that time to be shut off. If, however, the double-throw mercury switch 264 is tipped when the magnetic contactor 195 has been actuated by the closing of the mercury switch 260 so that the contacts 206 and 207 are disconnected by the separation therefrom of the switch blade 200, and the contacts 208 and 209 are connected by the switch blade 201 of the magnetic contactor 195, the circuit through the terminals 208 and 209 will first be closed so as to actuate the coils of the timing relay 180. As the mercury switch 264 is tipped further the circuit, through the terminals 257 and 258, will be opened and the holding circuit of the magnetic starter 153 will accordingly be opened through the contacts 167 and 168 thereof, thereby deenergizing the starter operating coil 154 and allowing the motor starter 153 to open.

Upon the actuation of the coils of the timing relay 180, in the manner above described, the switch blade 193 thereof, which is in series with the pole 186 of the mercury switch 181, is closed upon the contact 191, thereby providing a holding

circuit for the coils 182. When the cam shaft 124 rotates the cam 263 a predetermined distance from its rest position, such as seventy-five degrees, the mercury switch 260 is tipped, closing the circuit through the terminals 255 and 256, which actuate the operating coil 196 of the magnetic contactor 195 in series therewith. The closing of the magnetic contactor 195 closes the circuit through its contacts 202 and 203, also through the contacts 208 and 209, and opens the circuit through the contacts 206 and 207. The closing of the circuit through the contacts 202 and 203 closes a holding circuit to hold the magnetic contactor 195 in its closed position after an additional revolution of the cam 263 by a predetermined amount, such as one hundred and ninety degrees, the circuit through the contacts 255 and 256 being again opened by the opening of the mercury switch 260 before the rest position of the cam shaft 124 is again reached.

With the arrival of the cam shaft 124 at its rest position it brings the cam 267 into position to tip the mercury switch 264 so as to open the circuit through the right-hand set of contacts thereof, thereby opening the circuit through the terminals 257 and 258, deenergizing the motor starter operating coil 154 opening the motor starter 153. The same action closes the circuit through the left-hand contacts of the mercury switch 264, closing the circuit through the terminals 258 and 259 and starting the timing relay 180. Since the magnetic contactor 195 receives current from the motor side of the starter 153 only, it will immediately open when the motors are shut off, thereby closing the circuit through its contacts 206 and 207, and opening the circuit through its contacts 202 and 203, the magnetic contactor 195 now being in the position shown in Figure 10. This gives the same effect as tilting the mercury switch 264 back to its original position. After the timing relay 180 has operated for the predetermined period of time for which it is set, the mercury switch 181 associated with it is tipped, thereby closing the circuit through its poles 184 and 185. This action again closes the circuit through the operating coil 154 of the motor starting switch, and then opens the circuit between the poles 185 and 186 of the mercury switch 181, thereby deenergizing both of the holding coils 182 and 183 and causing the timing relay 180 to become inoperative.

Since the holding circuit of the timing relay 180 is broken at the contacts 191 and 193 before the mercury switch 181 can again assume its normal position, the timing relay 180 will not again be energized until the circuit through the terminals 258 and 259 is again closed by a complete revolution of the cam shaft 124 and cam 267. The time setting of the timing relay 180 should preferably be more than two or three seconds, otherwise, the mercury switch 181 associated with it will be held in a position continually closing the circuit between the poles 185 and 184, thereby making the stop switch 216 inoperative.

The operation of the synchronizing circuit 151 is controlled by the action of the cams 230 and 231 on the cam shaft 124. When the starting switch 178 is pressed and the motor starter 153 closed, it will be seen from Figure 10 that only the cam driving motor 110 is connected to the current mains 169, 170 and 171. This causes the cam driving motor 110 to operate, rotating the cam shaft 124 and raising the carrier arms 75. After a predetermined amount of rotation of this shaft 124, such as one hundred degrees, the carrier arms 75 will be completely raised, whereupon the cam 231 operates to close the chain driving motor switch 234, thereby starting the chain driving motor 38 and causing the chain 87 to move the carrier arms 75 horizontally. As the chain bracket roller 89 travels out from underneath the synchronizing switch trip roller 245, the falling of this trip roller 245 will mechanically lock the chain switch 234 in a closed position and open the cam motor switch 233. By this time, however, the cam 230 has rotated but a sufficient amount to raise the push rod 235 and close the auxiliary cam motor switch 232 so that for a short time both motors 38 and 110 will operate together.

After the cam shaft 124 and cam 230 rotate through an additional predetermined amount, such as one hundred and sixty degrees, the cam motor switch 232 will be opened, thereby stopping the cam driving motor 110 and halting the rotation of the cam shaft 124. Any further revolving of the cam shaft 124 would tend to lower the work carrier arms 75 on the machine. After the conveyor chain 87 has carried the carrier arms 75 the required distance, as governed by the spacing of the arms, the synchronizing switch trip roller 245 will again be operated, thereby opening the chain motor switch 234, stopping the horizontal motion of the conveyor chain 87 and closing the cam motor switch 233. This action again starts the cam motor 110 and causes the cam shaft 124 to rotate to lower the work carrier arms 75. The synchronizing switch circuit 151 is complete in itself, and the machine could be operated without either the intermittent or the safety control circuits.

The operation of the safety circuit has been sufficiently described in connection with the description of the circuit itself. Should the machine for any reason be out of time, one of the switches 270, 271, 272, 279 or 282 will be opened without its corresponding switch being closed at the same time, thereby opening the circuit supplying current to the motor starter operating coil 154, and accordingly opening the motor starter 153 and causing both motors 38 and 110 to be deenergized. The starting button 178, under these circumstances, is ineffective to re-start the machine because the safety circuit 152 is in series with it. Accordingly, it is necessary to adjust the machine so that it is properly timed before the starting button 178 becomes effective to start the machine.

The three safety switches 270, 271 and 272, operated by the chain bracket roller 89, are mounted in such a position that in the raised position of the machine the roller 277 is engaged by the chain bracket roller 89 to hold the switch 271 in closed circuit. At the same time, however, the switch 282 is maintained in open circuit by the rotation of the cam 263 on the cam shaft 124. After the cam 263 has rotated through a predetermined amount, such as one hundred degrees, thereby raising the carrier arms 75 for forward travel, the cam 263 tilts the mercury switch 282 to close its contacts, thereby bridging the contacts of the switch 271 and permitting the chain bracket roller 89 to become disengaged from the roller 277 and open the switch 274 without opening the safety circuit. When this occurs, however, the roller 278 is immediately engaged by the chain bracket roller 89 to open the mercury switch 272.

Meanwhile, the left-hand contacts of the switch 279, connected in multiple with the contacts of

the switch 272, have been closed by the rotation of the cam 263, thereby rendering the opening of the circuit in the chain-operated switch 272 ineffective to stop the machine. The right-hand contacts of the switch 279, however, remain open, and until these are closed the subsequent chain bracket roller 89 cannot pass the roller 276 of the switch 270 without stopping the machine. However, after the cam shaft 124 and the cam 263 have rotated a predetermined amount, such as two hundred degrees, the mercury switch 279 will again be operated to close the right-hand contacts thereof so that the chain bracket roller 89 is then permitted to engage the roller 276 and operate its associated switch 270, thereby insuring the return of the lifter arm 130 and lifter pad 134 to their retracted positions, ready to receive the next carrier arm roller 71.

Thus, by the three circuits shown in Figure 10 the various mechanical and electrical elements are caused to cooperate in timed relationship so that they operate at predetermined times and produce the predetermined results of lifting the carrier arms at the proper point, transporting these arms horizontally a predetermined amount, lowering the carrier arms so that the work-pieces pass into the next tank, and then moving the carrier arms forward horizontally until the foregoing cycle of operations is repeated. The safety circuit, as previously explained, is inoperative as long as the various elements of the machine are maintained in properly timed relationship. In the event that any circumstance arises which interferes with the proper timing of the machine, the safety circuit immediately becomes operative to stop the driving motors and prevent damage to the machine. The electrical safety circuit 152 is, therefore, entirely supplementary to the mechanical safety device consisting of the shear pins 68 associated with the chain driving sprocket 62.

The electrical circuit as described above is disclosed and claimed in my copending application, Ser. No. 91,169, filed July 17, 1936.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

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

1. In combination in an electroprocessing machine, a tank, a hollow container for holding articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, means for driving said horizontal conveyor, independent means for driving said raising and lowering mechanism; and devices including means responsive to the arrival of said container at one of said predetermined locations for rendering said conveyor inoperative while rendering said raising mechanism operative.

2. In combination in an electroprocessing machine, a tank, a hollow container for holding articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, means for driving said horizontal conveyor, independent means for driving said raising and lowering mechanism; and devices including means responsive to the arrival of said container at one of said predetermined locations for rendering said conveyor inoperative while rendering said raising mechanism operative and means responsive to the raising of said container to a predetermined height for rendering said raising mechanism inoperative while rendering said conveyor operative.

3. In combination in an electroprocessing machine, a tank, a hollow container for holding articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, means for driving said horizontal conveyor, independent means for driving said raising and lowering mechanism; and devices including means responsive to the arrival of said container at one of said predetermined locations for rendering said conveyor inoperative while rendering said raising mechanism operative, means responsive to the raising of said container to a predetermined height for rendering said raising mechanism inoperative while rendering said conveyor operative and means responsive to the arrival of the raised container at another predetermined location for rerendering said conveyor inoperative while rendering said lowering mechanism operative.

4. In combination in an electroprocessing machine, a tank, a hollow container for holding articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, means for driving said horizontal conveyor, independent means for driving said raising and lowering mechanism; and devices including means responsive to the arrival of said container at one of said predetermined locations for rendering said conveyor inoperative while rendering said raising mechanism operative, means responsive to the raising of said container to a predetermined height for rendering said raising mechanism inoperative while rendering said conveyor operative, means responsive to the arrival of the raised container at another predetermined location for rerendering said conveyor inoperative while rendering said lowering mechanism operative and means responsive to the lowering of said container to a predetermined level for rendering said lowering mechanism inoperative while rerendering said conveyor operative.

5. In combination in an electroprocessing machine, a tank, a hollow container for holding articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, a motor for driving said horizontal conveyor, an independent motor for driving said raising and lowering mechanism; and an electric circuit including means responsive to the arrival of said container at one of said predetermined locations for deenergizing said conveyor motor while energizing said raising and lowering motor.

6. In combination in an electroprocessing machine, a tank, a hollow container for holding

articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, a motor for driving said horizontal conveyor, an independent motor for driving said raising and lowering mechanism; and an electric circuit including means responsive to the arrival of said container at one of said predetermined locations for deenergizing said conveyor motor while energizing said raising and lowering motor and means responsive to the lifting of said container to a predetermined height for deenergizing said raising and lowering motor while reenergizing said conveyor motor.

7. In combination in an electroprocessing machine, a tank, a hollow container for holding articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, a motor for driving said horizontal conveyor, an independent motor for driving said raising and lowering mechanism; and an electric circuit including means responsive to the arrival of said container at one of said predetermined locations for deenergizing said conveyor motor while energizing said raising and lowering motor, means responsive to the lifting of said container to a predetermined height for deenergizing said raising and lowering motor while reenergizing said conveyor motor and means responsive to the arrival of the lifted container at another predetermined location for deenergizing said conveyor motor while reenergizing said raising and lowering motor to lower said container.

8. In combination in an electroprocessing machine, a tank, a hollow container for holding articles to be treated, a conveyor for moving said container horizontally relatively to said tank, means for rotating said container during said horizontal motion, movable driven mechanism for raising and lowering said container at predetermined locations along said tank, a motor for driving said horizontal conveyor, an independent motor for driving said raising and lowering mechanism; and an electric circuit including means responsive to the arrival of said container at one of said predetermined locations for deenergizing said conveyor motor while energizing said raising and lowering motor, means responsive to the lifting of said container to a predetermined height for deenergizing said raising and lowering motor while reenergizing said conveyor motor, means responsive to the arrival of the lifted container at another predetermined location for deenergizing said conveyor motor while reenergizing said raising and lowering motor to lower said container and means responsive to the lowering of said container to a predetermined level for deenergizing said raising and lowering motor while reenergizing said conveyor motor.

9. In combination in an electroprocessing machine, a tank, containers for holding articles to be treated, means for moving said containers horizontally through said tank, means for rotating said containers during said horizontal motion, means for lifting said containers at predetermined points along said tank, means for driving said horizontal moving means, and independent means for driving said lifting means, said container-rotating means comprising a rotatable screw shaft running along said tank and worm gears associated with said containers and adapted to mesh with said screw shaft in the lowered positions of said containers.

10. In combination in an electroprocessing machine, a plurality of frame uprights, chain guides having trough-like portions along their lower edges attached to said uprights and interconnecting the same, sprockets associated with said uprights, a conveyor chain mounted on said sprockets and arranged to be guided by said chain guides, a plurality of work carriers attached to said chain, and means on said work carriers for engaging said chain guides to support said chain and said work carriers, said work carriers comprising brackets attached to said chain and work-holding members pivotally attached to said brackets, each of said brackets having a plurality of spaced rollers adapted to engage said chain guides and said trough-like portions.

11. In combination in an electroprocessing machine, a plurality of frame uprights, chain guides attached to said uprights and interconnecting the same, spockets associated with said uprights, a conveyor chain mounted on said sprockets and arranged to be guided by said chain guides, a plurality of work carriers attached to said chain, and means including spaced rollers on said work carriers for engaging said chain guides to support said chain and said work carriers, said chain guides being formed with an upwardly directed trough-like portion along their lower edges for engagement by said supporting rollers, said work carriers comprising brackets attached to said chain and work-holding members pivotally attached to said brackets, each of said brackets having at least one of said spaced rollers adapted to engage the trough-like portion in said chain guides for vertical support and lateral guidance.

12. In combination in an electroprocessing machine, a plurality of frame uprights, chain guides attached to said uprights and interconnecting the same, sprockets associated with said uprights, a conveyor chain mounted on said sprockets and arranged to be guided by said chain guides, a plurality of work carriers attached to said chain, and means including spaced rollers on said work carriers for engaging said chain guides to support said chain and said work carriers, said work carriers comprising brackets attached to said chain and work-holding members pivotally attached to said brackets, each of said brackets having a pair of rollers on its upper portion engaging the upper portion of said chain guide and an additional pair of rollers on its lower portion engaging the trough-like portion of said chain guide for vertical support and lateral guidance.

13. In an electroprocessing machine, a plurality of standards having widened top and bottom portions, frame members adapted to interconnect said top portions, columns of variable length adapted to support said standards upon the floor, said frame members being adapted to form chain guides, a sprocket chain arranged to travel in said chain guides, sprockets for supporting said sprocket chain, rotatable containers for conveying work-pieces operatively connected to said sprocket chain, arms attached to at least two of said standards, rotating screw shafts supported in said arms, and gears meshing with said screw shafts and operatively connected to said work-conveying containers for rotating said work-con-

veying containers during the conveyance thereof by said sprocket chain.

14. In an electroprocessing machine, a frame, a motor supported by said frame, a pair of longitudinally disposed rotatable screw shafts supported by said frame, a plurality of rotatable work carriers, gears operatively connected to rotate said carriers and meshing with said screw shafts, a conveyor for conveying said work carriers horizontally while said carriers are being rotated by said screw shafts, a sprocket chain interconnecting said motor and said screw shafts, and idler sprockets arranged to guide said sprocket chain.

15. In an electroprocessing machine, a frame, a motor supported by said frame, a pair of longitudinally disposed rotatable screw shafts supported by said frame, a plurality of rotatable work carriers, gears operatively connected to rotate said carriers and meshing with said screw shafts, a conveyor for conveying said work carriers horizontally while said carriers are being rotated by said screw shafts, an additional longitudinal shaft supported by said frame, lifting means for lifting said work carriers at predetermined positions operated by said shaft, a sprocket chain interconnecting said motor and said screw shafts, and idler sprockets arranged to guide said sprocket chain, said sprocket chain being arranged to operatively interconnect said motor and said lifting means operating shaft.

16. In an electroprocessing machine, a frame, a motor supported by said frame, a pair of longitudinally disposed rotatable screw shafts supported by said frame, a plurality of rotatable work carriers, gears operatively connected to rotate said carriers and meshing with said screw shafts, a conveyor for conveying said work carriers horizontally while said carriers are being rotated by said screw shafts, a sprocket chain interconnecting said motor and said screw shafts, and idler sprockets arranged to guide said sprocket chain, said motor being arranged on top of said frame and said sprocket chain extending downwardly therefrom to said shafts.

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