United States Patent [19]

McInnes

[11] **3,926,666**

[45] **Dec. 16, 1975**

[54] **METHOD AND APPARATUS FOR CLEANING AND PLATING ARTICLES WITHIN A PLURALITY OF ROTATING BARRELS**

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[73] Assignees: **Harry P. Bowman; Clifford J. Millhouse; Russell E. Bowers,** all of Flint, Mich. ; part interest to each

[22] Filed: **Aug. 29, 1973**

[21] Appl. No.: **392,479**

Related U.S. Application Data

[60] Division of Ser. No. 252,313, May 10, 1972, Pat. No. 3,855,107, which is a continuation-in-part of Ser. No. 89,409, Nov. 13, 1970, abandoned.

[52] **U.S. Cl.** ..... **134/25 R;** 134/33; 134/134; 134/159

[51] **Int. Cl.²** **B08B 3/04**

[58] **Field of Search** ..... 204/201, 213, 214; 134/78, 134/79, 134, 10, 23, 25 R, 33, 34, 66, 69, 157, 158, 159, 160

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Assistant Examiner—Richard V. Fisher
Attorney, Agent, or Firm—Barnes, Kisselle, Raisch & Choate

[57] **ABSTRACT**

A cleaning and plating method and apparatus comprising a plurality of tank assemblies arranged in series through which a batch of articles to be cleaned and plated is moved successively. Each tank assembly comprises a tank containing liquid treating or plating material. A barrel is at least partly submerged in each tank and is rotated about its longitudinal axis. The ends of the barrel are open and the barrel is formed with baffles on the interior thereof. When the barrel is rotated in one direction, the articles are agitated through the liquid and when the barrel is rotated in the other direction, the articles are elevated and deposited on a chute for transfer to the next succeeding tank assembly. Provision is made for supplying electrical power to some of the assemblies in order to plate the article. Novel barrel means are provided for minimizing drainage problems. Further, a novel chute system and barrel support system are included. Finally, a novel recirculating system for short-term treatment is provided.

53 Claims, 20 Drawing Figures

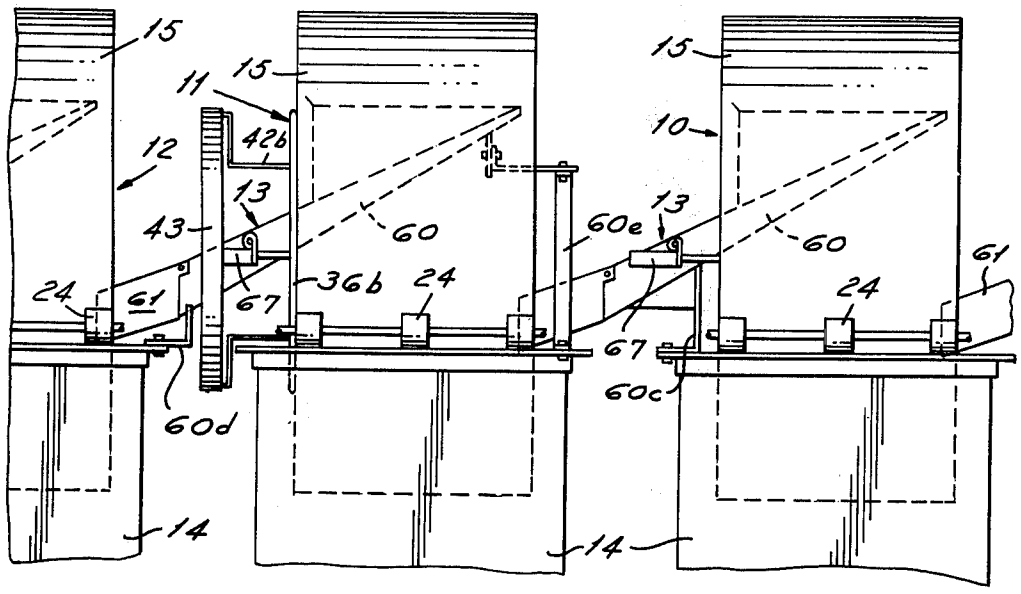


FIG. 1

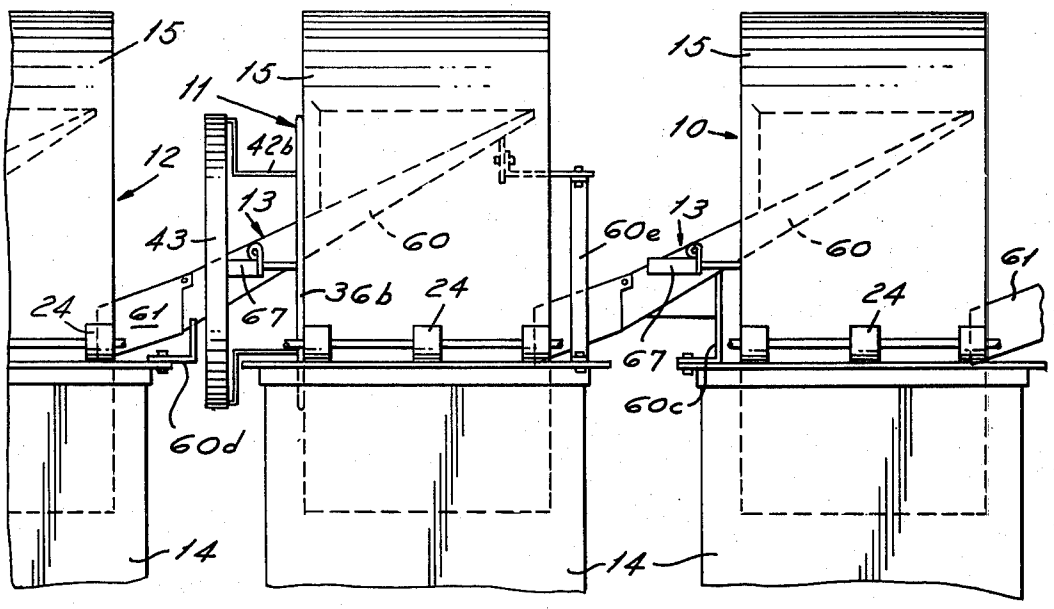
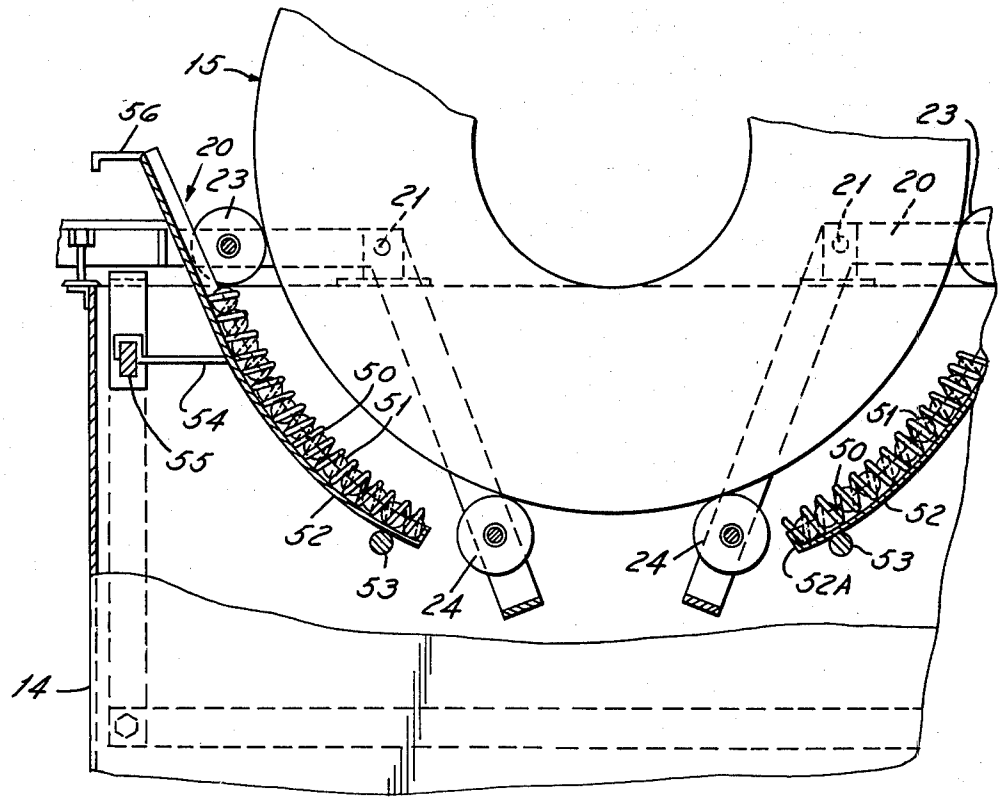

15
11
15
42b
12
13
43
60
24
61
67
36b
24
60d
14
15
10
60e
13
60
61
24
67
60c
14

FIG. 2


15
56
20
23
21
23
21
20
50
51
54
55
52
53
24
24
51
50
52
53
52A
14

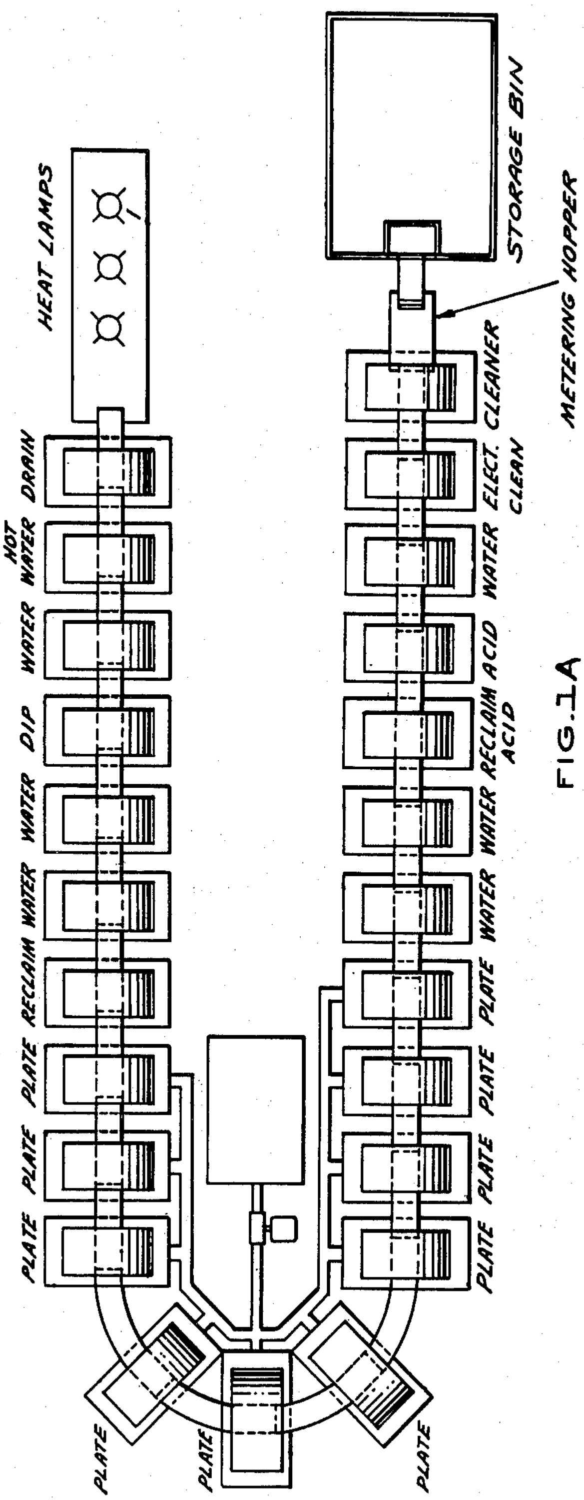

STORAGE BIN
METERING HOPPER
HEAT LAMPS
ELECT. CLEANER
CLEAN
WATER
ACID
RECLAIM ACID
WATER
WATER
PLATE
PLATE
PLATE
PLATE
PLATE
PLATE
PLATE
PLATE
PLATE
PLATE
RECLAIM
WATER
WATER
DIP
WATER
HOT WATER
DRAIN

FIG. 1A

FIG. 3

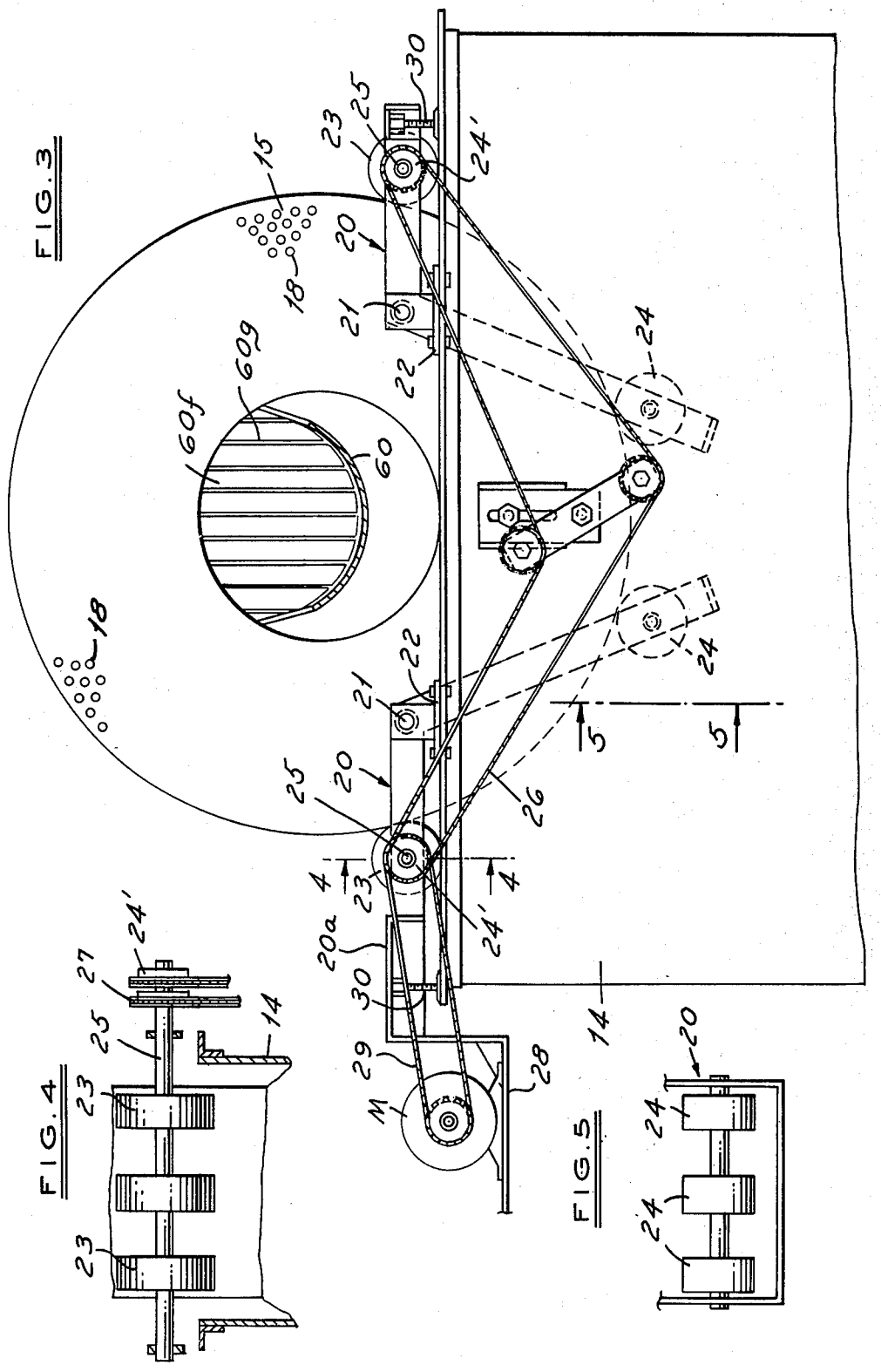


FIG. 4

FIG. 5

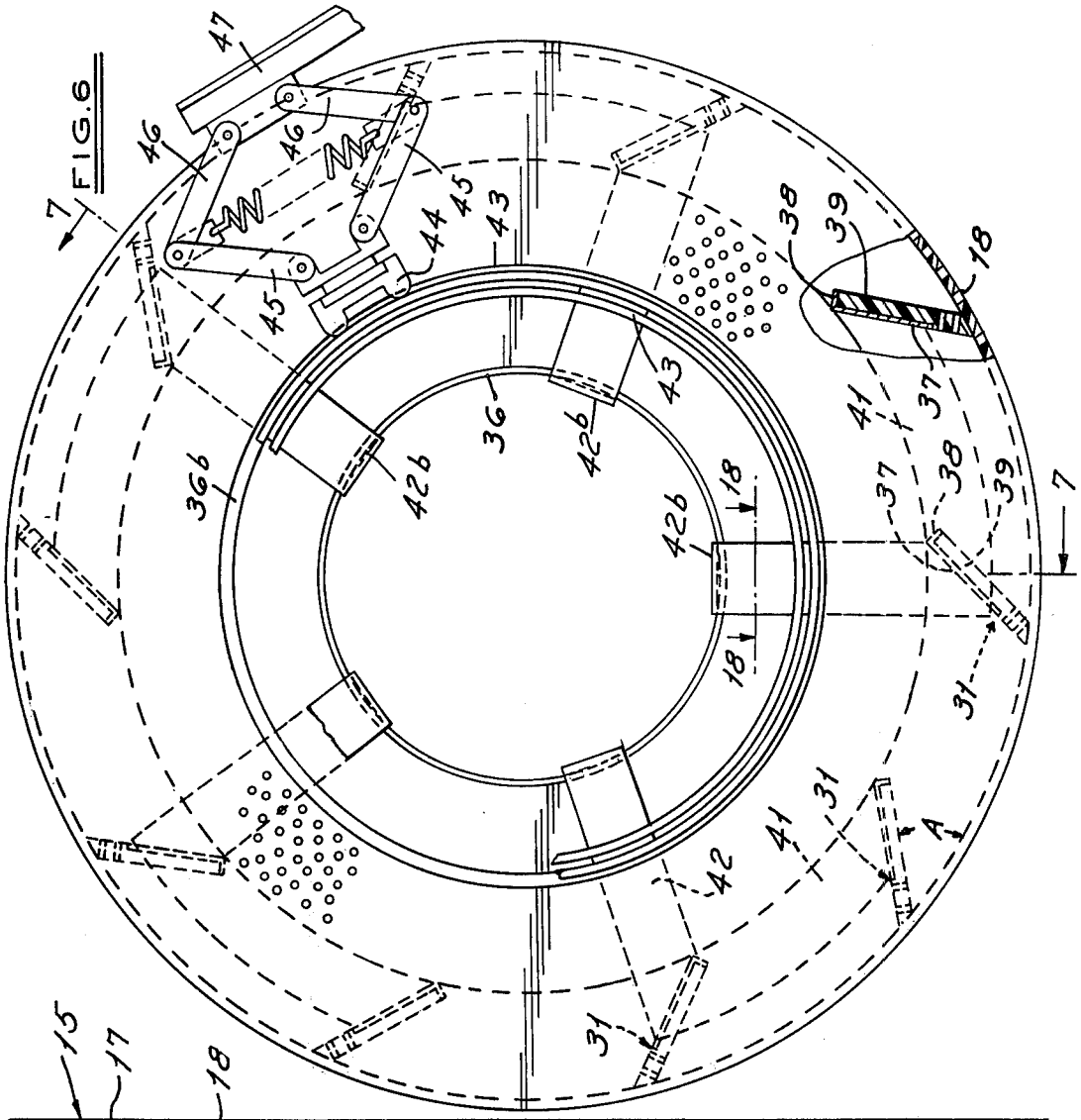


FIG. 6

FIG. 7

FIG. 8

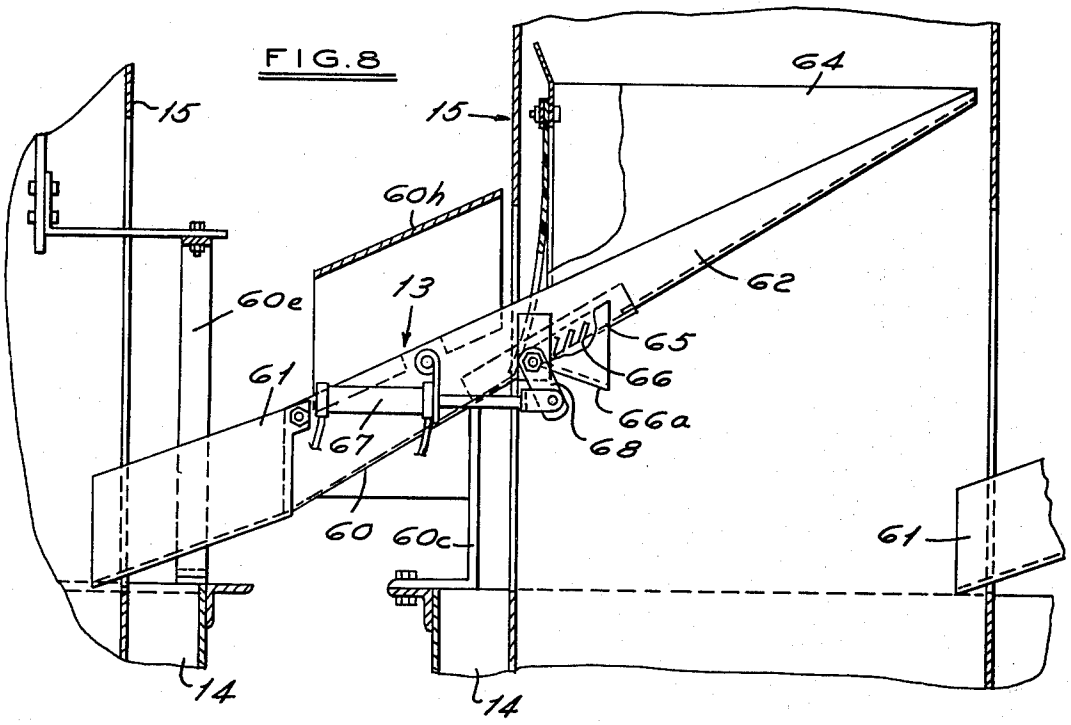
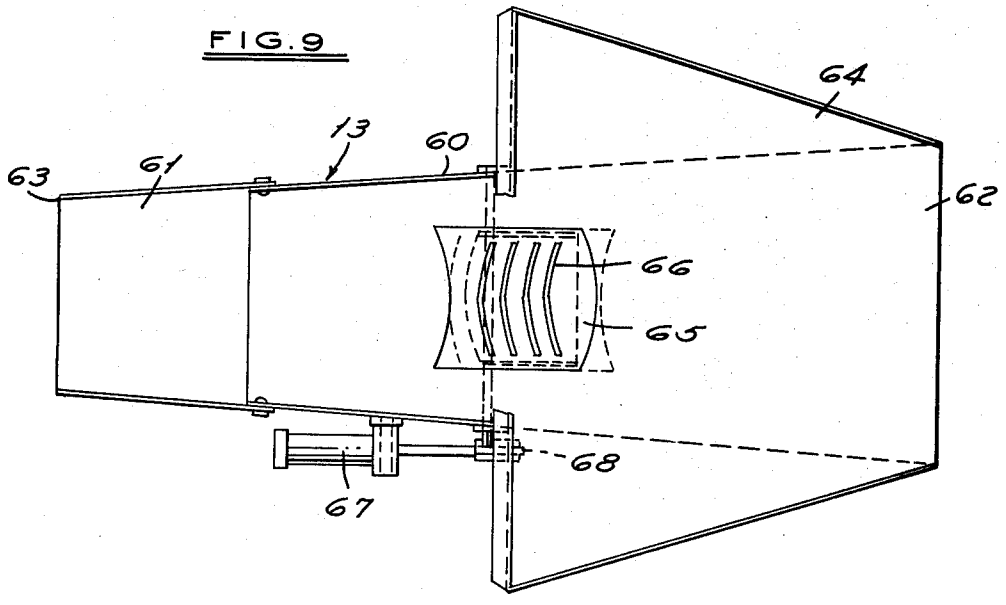

15
15
64
60h
62
60e
13
65
61
66
66a
67
68
60
60c
61
14
14

FIG. 9


64
13
60
63
61
62
66
65
68
67

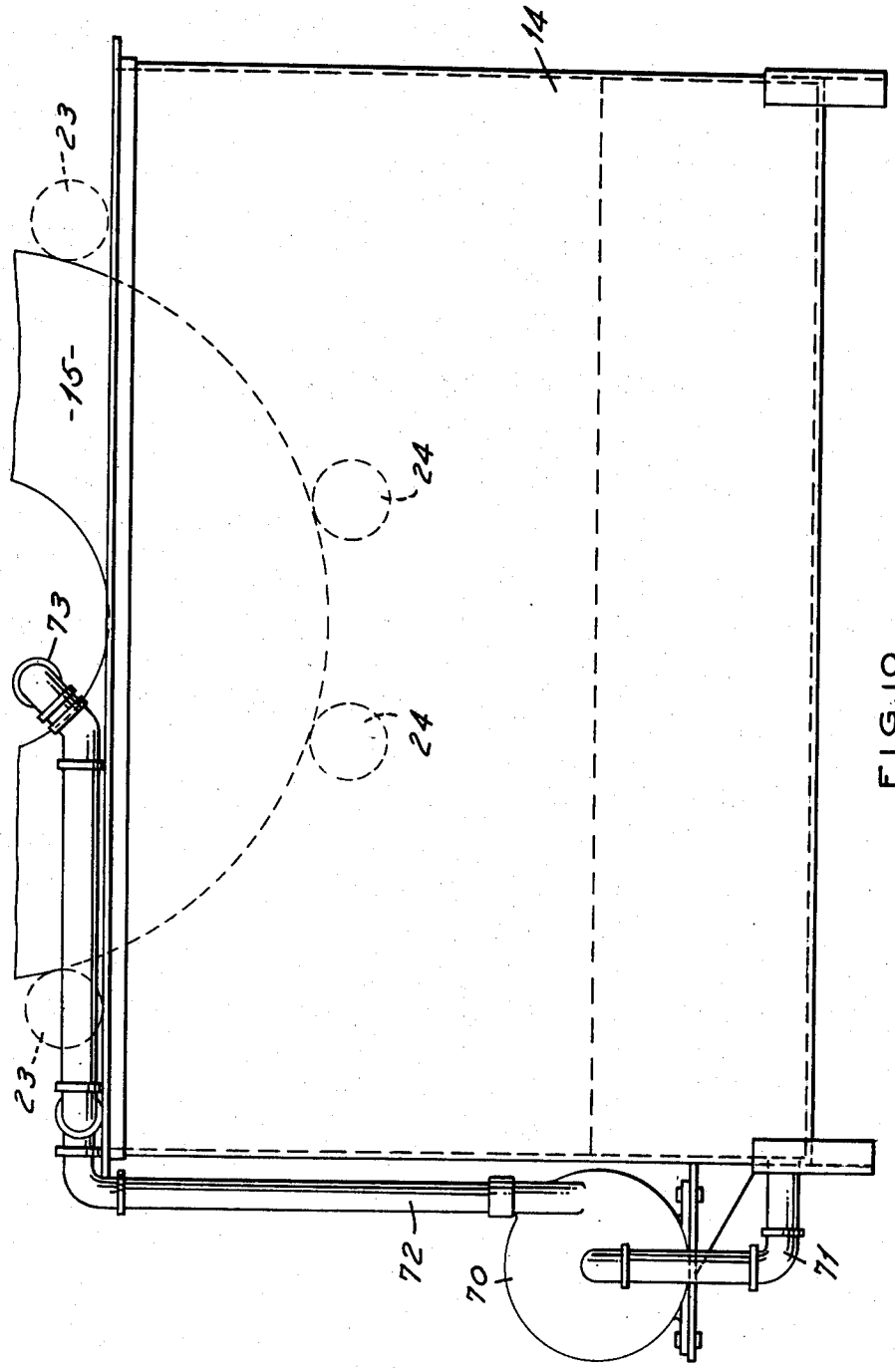


FIG. 10

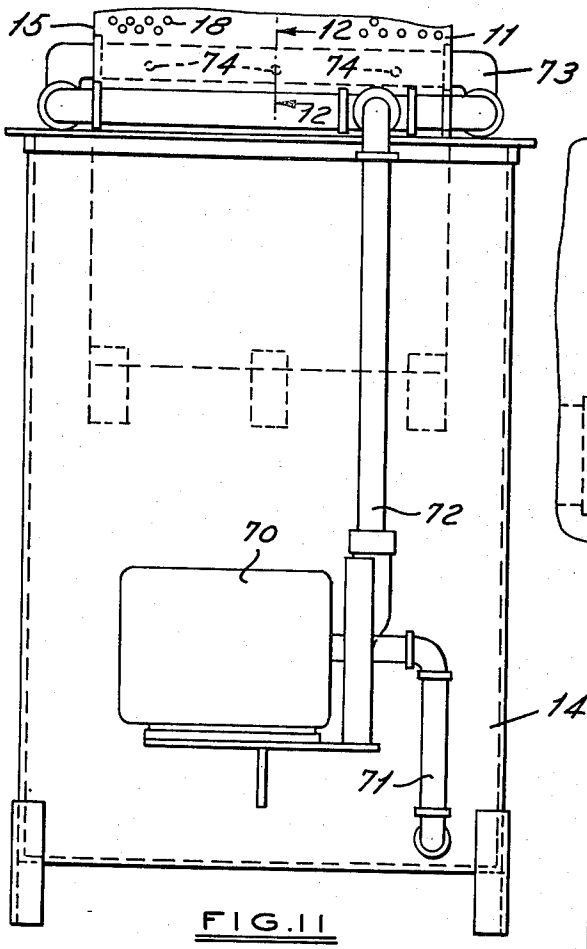


FIG. 11

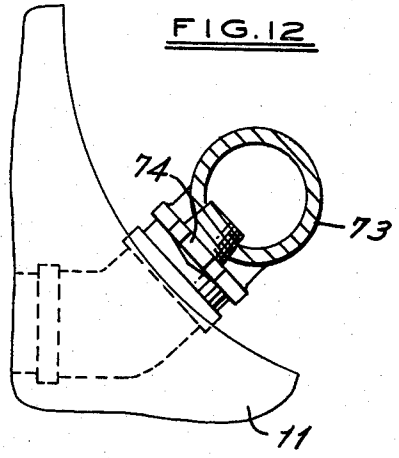


FIG. 12

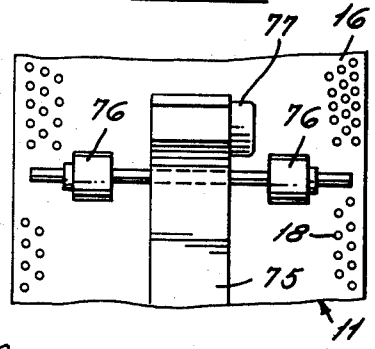


FIG. 14

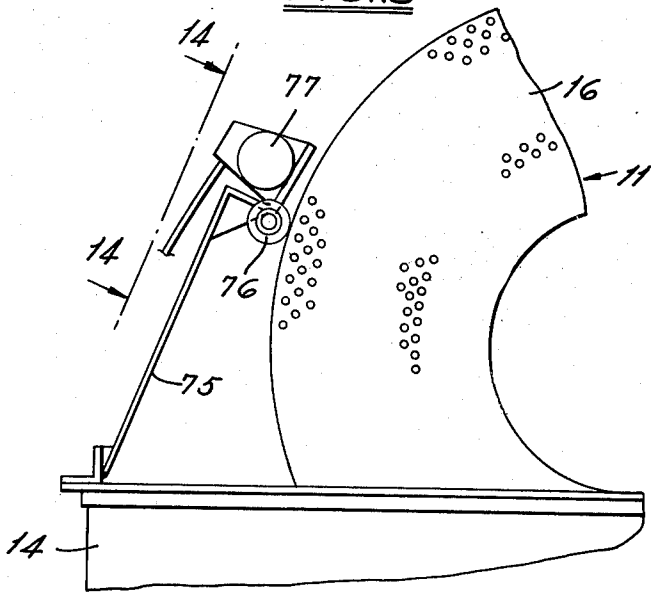


FIG. 13

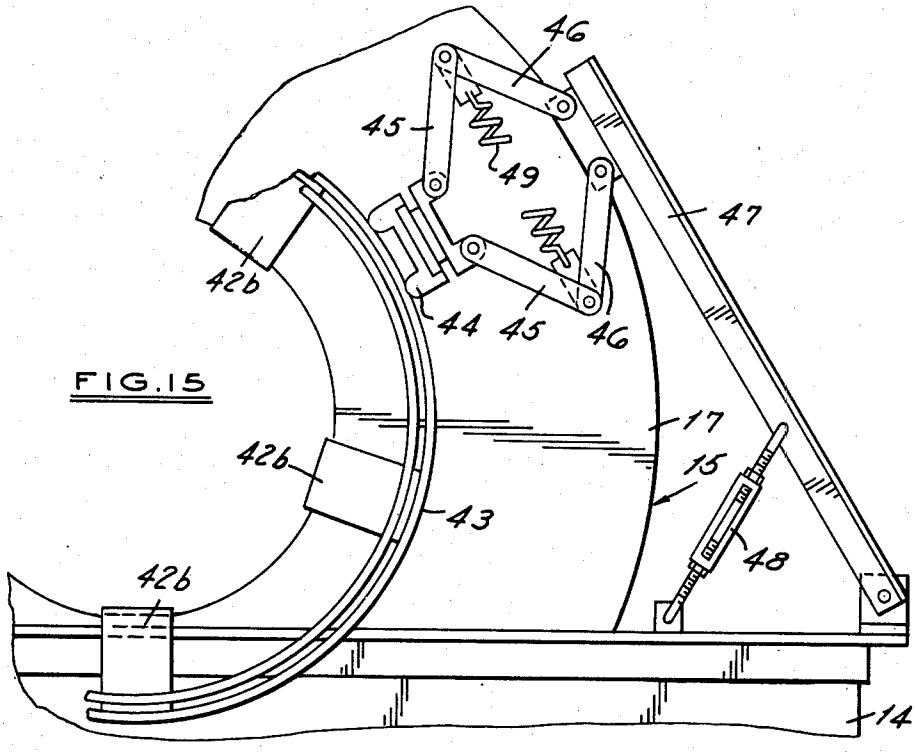


FIG. 15

FIG. 17

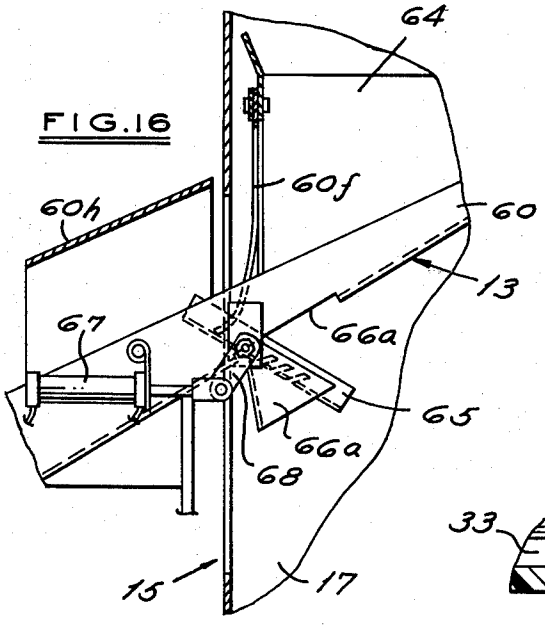
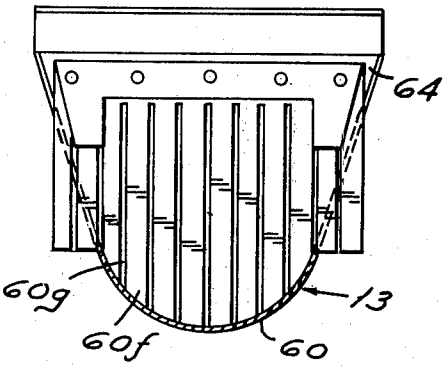


FIG. 16



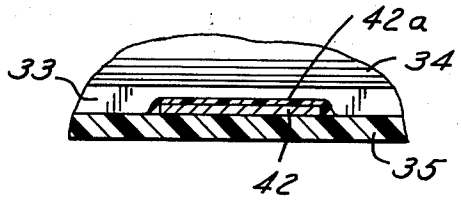


FIG. 18

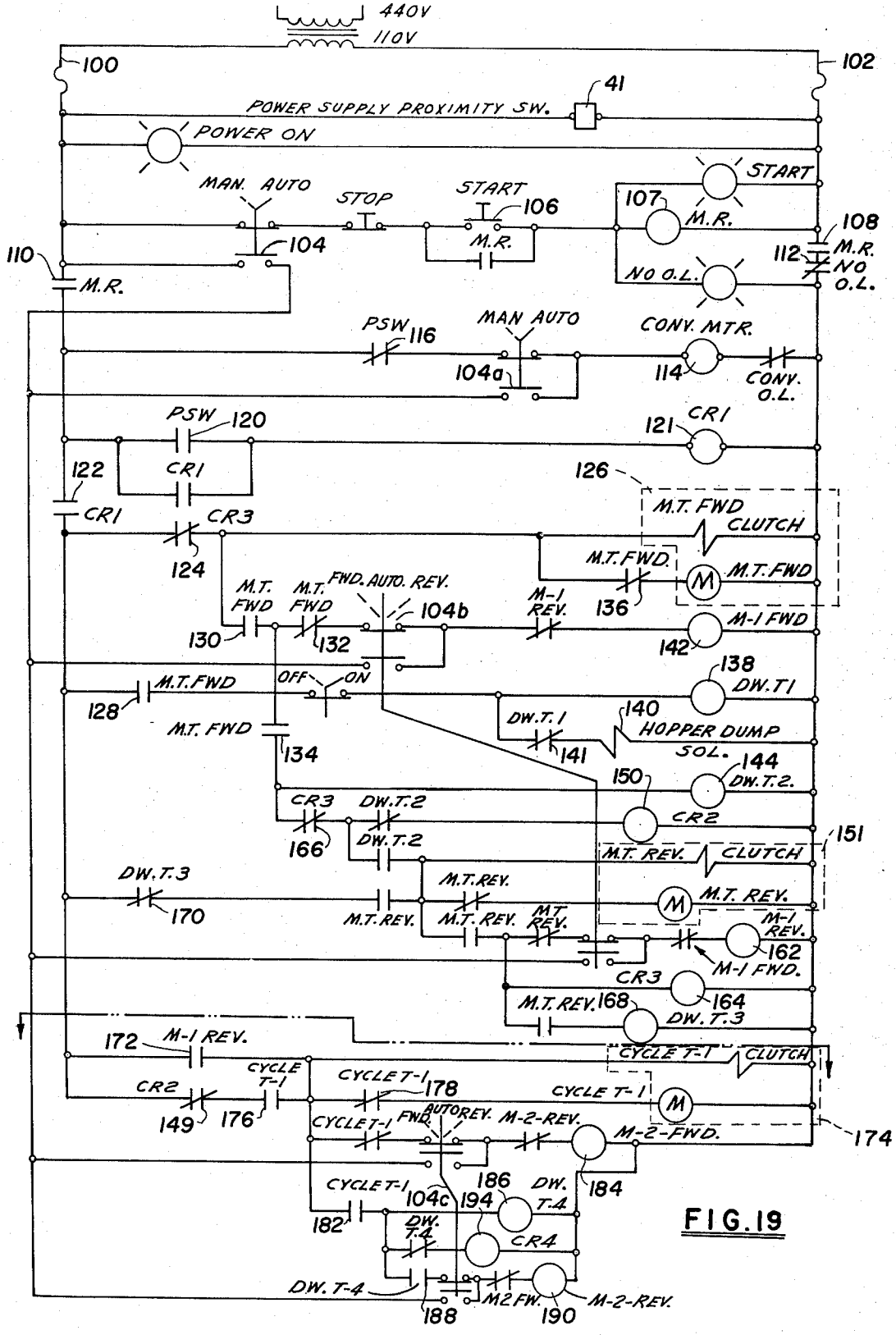

440V
110V
100
102
41
POWER SUPPLY PROXIMITY SW.
POWER ON
MAN. AUTO
STOP
START
106
104
M.R.
107
M.R.
START
108
112
M.R.
NO
O.L.
NO O.L.
110
M.R.
PSW
116
MAN AUTO
104a
CONV. MTR.
114
CONV.
O.L.
PSW
120
CR1
121
122
CR1
CR1
CR3
124
126
M.T. FWD
CLUTCH
M.T. FWD.
M.T. FWD
M.T.
FWD
M.T.
FWD
FWD. AUTO. REV.
104b
M-1
REV.
136
M-1 FWD
130
132
142
138
M.T. FWD
OFF
ON
DW.T1
128
DW.T.1
140
HOPPER DUMP
SOL.
M.T. FWD
134
141
144
150
DW.T.2.
CR3
DW.T.2
CR2
166
DW.T.2
151
M.T. REV.
CLUTCH
DW.T.3
M.T.REV.
M.T. REV.
M.T. REV.
M.T.
REV.
M-1
REV.
170
M.T. REV.
M.T. REV.
162
M-1 FWD.
CR3
M.T. REV.
168
164
DW.T.3
172
M-1 REV.
CYCLE T-1
CLUTCH
CYCLE
T-1
CYCLE T-1
178
CR2
CYCLE T-1
M
149
176
CYCLE T-1
FWD.
AUTO
REV.
M-2-REV.
M-2-FWD.
174
CYCLE T-1
186
DW.
T-4
184
104c
194
182
DW.
T-4
CR4
DW. T-4
M2 FW.
M-2-REV.
188
190

FIG. 19

METHOD AND APPARATUS FOR CLEANING AND PLATING ARTICLES WITHIN A PLURALITY OF ROTATING BARRELS

This is a division of application Ser. No. 252,313 filed May 10, 1972, now U.S. Pat. No. 3,855,107, which in turn is a continuation-in-part of application Ser. No. 89,409, filed Nov. 13, 1970, entitled "Cleaning and Plating Apparatus", now abandoned.

This invention relates to the cleaning and plating of articles.

BACKGROUND OF THE INVENTION

In common types of plating equipment presently utilized commercially, baskets or barrels aremoved successively through various cleaning and plating solutions. The capacity of such equipment is dependent upon the initial construction of the apparatus and it is difficult, if not impossible, to expand the size of the equipment without substantial modification or reconstruction.

In the aforementioned application Ser. No. 89,409, there is shown a cleaning and plating method and apparatus comprising a plurality of tank assemblies arranged in series through which a batch of articles to be cleaned and plated is moved successively. Each tank assembly comprises a tank containing liquid treating or plating material. A barrel is at least partly submerged in each tank and is rotated about its longitudinal axis. The ends of the barrel are open and the barrel is formed with baffles on the interior thereof. When the barrel is rotated in one direction, the articles are agitated through the liquid and when the barrel is rotated in the other direction, the articles are elevated and deposited on a chute for transfer to the next succeeding tank assembly.

Among the objects of this invention are to provide an improved barrel system, chute system, support system for the barrel, and recirculating system for short-term plating.

SUMMARY OF THE INVENTION

In accordance with the invention there is provided a cleaning and plating method and apparatus comprising a plurality of tank assemblies arranged in series through which a batch of articles to be cleaned and plated is moved successively. Each tank assembly comprises a tank containing liquid treating or plating material. A barrel is at least partly submerged in each tank and is rotated about its longitudinal axis. The ends of the barrel are open and the barrel is formed with baffles on the interior thereof. When the barrel is rotated in one direction, the articles are agitated through the liquid and when the barrel is rotated in the other direction, the articles are elevated and deposited on a chute for transfer to the next succeeding tank assembly. Provision is made for supplying electrical power to some of the assemblies in order to plate the article. Novel barrel means are provided for minimizing drainage problems. Further, a novel chute system, and barrel support system are included. Finally, a novel recirculating system for short-term treatment is provided.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary side elevational view of a portion of a system embodying the invention.

FIG. **1A** is a partly diagrammatic plan view of a cleaning and plating system embodying the invention.

FIG. **2** is a fragmentary part sectional end view of a portion of the system shown in FIG. **1.**

FIG. **3** is an end view of a portion of the system shown in FIG. **2,** parts being broken away.

FIG. **4** is a fragmentary sectional view on an enlarged scale taken along the line **4—4** of FIG. **3.**

FIG. **5** is a fragmentary sectional view taken along the line **5—5** in FIG. **3.**

FIG. **6** is a side elevational view of a barrel utilized in the system, parts being broken away.

FIG. **7** is a sectional view taken along the line **7—7** of FIG. **6.**

FIG. **8** is a part sectional, side elevational view of a portion of the system shown in FIG. **1,** parts being broken away.

FIG. **9** is a fragmentary part sectional plan view of a portion of the system shown in FIG. **8,** parts being broken away.

FIG. **10** is a fragmentary end elevational view of a portion of a modified system.

FIG. **11** is a side elevational view of a portion of the system shown in FIG. **10.**

FIG. **12** is a fragmentary sectional view taken along the line **12—12** in FIG. **11.**

FIG. **13** is a fragmentary end elevational view of a further modified form of the invention.

FIG. **14** is a fragmentary view taken along the line **14—14** of FIG. **13.**

FIG. **15** is a fragmentary view on an enlarged scale of the portion of the structure shown in FIG. **6.**

FIG. **16** is a fragmentary sectional view of a portion of the structure shown in FIG. **8** showing the parts in a different operative position.

FIG. **17** is a fragmentary front elevational view of a portion of the apparatus shown in FIG. **16** with parts being broken away.

FIG. **18** is a sectional view through a side wall of a portion of the apparatus shown in FIG. **6.**

FIG. **19** is a schematic wiring diagram of the wiring system that may be utilized with the invention.

DESCRIPTION

The invention generally relates to a cleaning and plating system such as that disclosed in the aforementioned application Ser. No. 89,409.

Referring to FIGS. **1 1A** and **2,** the cleaning and plating system embodying the invention is shown in connection with zinc plating of articles but, as will be apparent, it can be adapted to other types of plating. As shown in FIG. **1,** the articles to be plated are fed from a metering hopper periodically in a batch to a first tank assembly **10.** The articles are treated in the tank assembly **10** and then are delivered, as presently described, to a successive tank assembly **11.**

The tank assemblies **10, 11** as well as the other tank assemblies **12** in the system are of substantially identical construction, as will be hereinafter described, except that where electrical power is required for plating, additionl provision is made for the application of such elecrical power.

After treatment in tank assembly **10,** the articles are then fed to another tank assembly **11** and so on to successive assemblies in order. By the arrangement shown, each tank assembly is working or performing a function on a batch of the articles while the other tank

assemblies are providing their functions on other batches of the articles.

In zinc plating, the successive tank assemblies perform the functions designated, namely, cleaning, electrically cleaning, water treatment or rinsing, acid rinse, reclamation of acid, plating, reclaiming the plating solution, water rinse, dipping for surface treatment, water rinse, hot water rinse and drain, before passage out of the system.

In the transfer of articles between sucessive assemblies, chutes **3** are provided as presently indicated.

As discussed above, each tank assembly **10–12,** as well as additional tank assemblies in the system, which are not shown, is substantially identical in construction except for the inclusion or omission of the electrical components for applying power.

Referring to FIG. **1,** each tank assembly **10–12** includes a container or tank **14** which is adapted to hold the treating or plating liquid, as the case may be. Each tank assembly further includes a barrel **15** that is generally cylindrical and includes an outer cylindrical wall **16** and annular flat radial end walls **17** (FIGS. **6, 7**). The barrel **15** is made of plastic material such as polypropylene and the walls **16, 17** are formed with holes **18** to permit the ready passage of liquid therethrough.

Referring to FIGS. **2–5,** each barrel is rotatably supported in its respective tank by an arrangement which includes spaced pairs of levers **20** that are pivoted alongside the ends of the barrel on shafts **21** rotatably mounted on brackets **22** intermediate the ends of the levers **20.** Opposed levers **20** rotatably support rubber faced drive rollers **23** at one end and idler rollers **24** at the other, the drive and idler rollers on each lever **20** engaging the drum at circumferentially spaced points. The drive rollers **23** are driven by sprockets **24'** on the shafts **25** of the drive rollers **23** which extend between opposed levers **20.** An endless chain **26** is trained so that the drive rollers are driven simultaneously. Another sprocket **27** on one of the shafts **25** is driven by a motor M mounted on an extension **28** of the lever arm **20***a* so that the motor M is exteriorly of the tank in order to avoid contamination of the tank from liquid and other matter as the motor operates. Each arm **20** is adapted to engage an adjustable stop **30** on the tank.

Referring to FIGS. **6** and **7,** the barrel **15,** as heretofore described, comprises cylindrical outer wall **16** and spaced radial walls **17** of plastic material such as polypropylene each of which is provided with a plurality of openings **18** therethrough. The walls are welded to one another to form a unitary structure. Baffles **31** also made of plastic material extend transversely between the spaced radial walls **17.** The outermost portions of the baffles **31** are provided with holes **32** therethrough to minimize the tendency for liquid to collect and be trapped so that the liquid will not be transferred from one tank to the other during rotation of the barrel thereby obviating contamination of the liquid of one tank with that of the other. In addition, an annular member **33** is mounted at the juncture of the inner surfaces of the wall **17** and wall **18.** These walls **33** are also made of plastic material. Walls **33** include inner annular surfaces **34** that taper radially inwardly away from the center of the drum and function to keep the parts from lodging between the chute and the walls of the barrel.

Further, each barrel is provided with axially extending portions **36** along the inner periphery defining the openings and an annular bead **36***a* is provided on the outer surface thereof to cause liquid draining along the inner surface of the radial walls **17** to be directed downwardly toward the liquid in the tank. An annular bead **36***b* is provided on the outer surface of radial walls **17** adjacent the next successive tank to prevent liquid on said outer surface from passing downwardly onto the electrical connections below.

Each barrel includes a plurality of baffles **31** that extend at an acute angle A with respect to the inner surface of wall **16,** the angle A ranging between **35** degrees and **55** degrees, and being preferably **45°.**

Where electrical power is required to be applied to the liquid in order to perform a plating function, a metal plate **37** is provided on preferably all the baffles so that as the barrel rotates, at least three metal plates **37** are within the liquid at all times. Each baffle plate **37** comprises electrically conductive plate such as titanium or the like which includes a flange **38** engaging the inner periphery of each baffle. Each plate **37** is positioned in a recess **39** in the baffle **31** so that the surface of plate **37** is flush with the exposed surface of baffle **31.** Adjacent pairs of baffles **37** are electrically interconnected by arcuate metal portions **41** and radial copper members **42** extend, covered by a layer of plastic **42***a* (FIG. **18**), to brackets **42***b* which are electrically connected thereto and extend axially to an external collector ring **43** through which an electrical or cathode connection is made to the plating solution. An electrical connection is made to the ring or bus bar **43** by a spring loaded brush member **44** which engages the bus bar **43.** As shown in FIGS. **6** and **15,** brush **44** is mounted on the ends of arms **45** which are in turn pivoted to arms **46, 47.** The arms **46** are pivoted to a lever **47** that is maintained in adjustable angular position on the tank by a turnbuckle **48.** A spring **49** extends between the pivots of the arms **45, 46** to one another to yieldingly urge the brush member **44** against the outer periphery of the bus bar **43.** In this manner, the brush member **44** is maintained in contact with the bus bar **43** but is spaced vertically above the tank to minimize any tendency of the liquid to contact the electrical parts. Electrical current is supplied to the brush **44.**

Referring to FIG. **2,** the anode for plating is provided by an anode retainer in the form of a helical coil spring **50** in which the anode balls **51** are placed. A bracket **52** holds spring **50** in an arcuate configuration. A stop **52***a* on bracket **52** closes one end of the spring **50** and engages transverse bars **53** in the tank while a bracket arm **54** hooks over an electrical bar **55** for providing the other electrical lead as needed. In this manner, a large anode area is provided in close proximity to the periphery of the barrel. A handle **56** on bracket **50** facilitates removal and replacement.

Referring to FIGS. **8** and **9,** each chute **13** comprises sections or portions **60, 61** pivoted to one another. Portion **60** forms a greater angle with the horizontal than portion **61.** The chute **13** further flares from a wide transverse section **62** adjacent the upper end within the tank to a narrow section **63** at the adjacent tank to which the parts are fed (FIG. **9**). In addition, the chute includes flared portions **64** at its upper end within the tank as shown in FIG. **9** which extend upwardly and forwardly to assist in collecting the parts and directing them downwardly during the transfer when the barrel rotation is reversed.

The chute section **60** includes a pivoted portion **65** that has V-shaped drain slots **66** therein. Chute portion

65 is normally positioned in the broken line position exposing opening 66*a* so that parts will be returned to the barrel and be prevented from passing to the adjacent barrel when the barrel is rotated in the normal running direction. A secondary wall or scoope 66*a* is provided beneath slots 66 and tapers downwardly and inwardly to guide the liquid passing through slots 66 to the interior of barrel 15. The exterior or lower surface of chutes 13 is coated with a plastisol which functions to reduce noise while the upper surface is uncoated to facilitate movement of the articles being treated. The section is pivotable by a linkage including a cylinder 67 which acts through a lever 68 fixed to chute portion 65.

Where electrical current is not supplied to the tank assembly, each chute 13 is supported by a bracket 60*c* on the tank as shown in FIGS. 1*a* and 8. Where electrical current is supplied to the tank assembly, spaced brackets 60*d* and 60*e* are utilized in order to accommodate the electrical bus bar 43.

A curtain 60*f* of resilient plastic material is fixed at its upper end to the chute and extends downwardly into contact with the chute. The curtain 60*f* has vertical reinforcing ribs 60*g* which provide sufficient force to prevent articles being treated from bouncing out of the chute during normal rotation but insufficient to prevent the parts from moving down the chute during transfer. To prevent the articles from inadvertently bouncing out of the chute during transfer an arcuate cover 60*h* is mounted on the chute.

Where the parts are only to be subjected to a liquid treatment for a short period of time less than that to which the parts are treated in other tanks of the system, the modified tank assembly shown in FIGS. 10–12 may be used which is substantially identical to other tank assemblies except that wherein a pump 70 exteriorly of the tank 14 functions through pipes 71, 72 to feed the liquid for any prescribed period to both ends of transverse or axial pipe 73 provided with nozzles 74 which direct the liquid downwardly onto the parts. The functioning of the pump 70 may be timed to any lesser time less than the total time that the parts are in the drum. In this form, the liquid level in the tank is below the lower end of the barrel.

Where the parts being treated are intricate or very small, as in the case of small screws, in order to prevent the parts from collecting in any corner and the like, provision is made for vibrating the barrel when the barrel is rotated to deliver the parts to the next drum. As shown in FIGS. 13 and 14, this includes a spring arm 75 pivoted to the tank at one end and having rollers 76 frictionally engaging the periphery of the barrel. A vibrator 77 is provided on the arm and vibrates during this rotation of the barrel to vibrate the drum.

Operation

In operation, conveyor 11 is actuated to feed articles to metering hopper 12. The metering hopper in turn periodically feeds a batch of articles to the first tank assembly 13. The tank assembly is then rotated for a predetermined period of time in one direction to treat the articles and then the rotation is reversed to elevate and feed the articles to the next successive tank assembly 14. The tank assembly 14 then rotates to treat the articles. After tank assembly 13 is delivering the articles to tank assembly 14, a new batch of articles is delivered to the tank assembly 13. In this fashion after a predetermined interval of time corresponding to the number of tank assemblies, each tank assembly is either treating articles or delivering articles to the next successive tank assembly.

The number of tank assemblies for any particular operation, that is any particular treatment, depends upon the amount of time required for that treatment. Thus, a tank assembly is provided for the shortest needed treatment. Then if there is another treatment that requires a greater length of time, that particular treatment utilizes two or more tank assemblies so that a portion of the treatment occurs during one cycle of the tank and another portion of the treatment occurs in the other tanks.

The operation of the control circuitry is more completely described in the aforementioned application Ser. No. 89,409 but may be briefly summarized as follows: A forward master timer and a reverse master timer are associated with tank assembly 13 and control respectively the forward and reverse rotation of the barrel of tank assembly 13 (the first barrel). A timer is associated with the barrel of each subsequent tank assembly and is electrically interlocked with the barrels of the immediately preceding and succeeding tank assemblies. The forward master timer controls the operation of the first barrel in the forward direction for a preselected forward cycle time after which the reverse master timer controls the operation of the barrel in reverse for a preselected reverse cycle time. Such a forward-reverse cycle is automatically repeated for each batch of articles. As soon as the first barrel goes into reverse, the timer for the barrel of tank assembly 14 (the second barrel) is initiated through an electrical interlock which runs the second barrel forward for a preselected time and then in reverse. (When the second barrel goes into reverse, it starts the timer for the barrel of tank assembly 15. This same interlocking arrangement is repeated between succeeding barrels). The combined forward and reverse cycle times of each barrel are identical. Because the forward cycle times of each barrel subsequent to the first are only approximately equal, the reverse cycle time compensates for the differences between them since a barrel continues to run in reverse until its forward cycle is initiated by the preceding barrel going into reverse. Thus, if the forward cycle time of the second barrel is greater than the forward cycle time of the third barrel, the reverse cycle time of the third barrel is correspondingly greater than the reverse cycle time of the second barrel. The cycle times are so adjusted that the reverse cycle of the barrel having the shortest reverse cycle of all is sufficiently long to discharge the batch of articles therefrom. With this background the detailed operation of the control circuitry is now described.

During normal cleaning or plating, the barrel of each drum rotates in a clockwise direction as viewed in FIG. 6 to cause a tumbling and agitation of the parts. During this operation, the pivoted portion 65 is in the down or broken line position (FIG. 8). Any parts that may inadvertently be delivered to the chute 60 are returned back through the opening in the chute to the tank by the pivoted portion 65. Further, any liquid delivered to the chute 60 inadvertently will be directed through the opening provided by the downward position of the portion 65 away from the chute to the interior of the tank.

The annular beads 36*a* function to minimize any tendency of the liquid on the interior surfaces on the wall 17 to pass out of the openings at the center thereof. Further, the annular bead 36*b* prevents liquid

from contacting the bus bar.

In the barrels where electrical circuit is required, the desired current is provided by the plates **37.** The arrangement of the plates and associated conductive plates at **41, 42** recessed in corresponding grooves provides for a smooth surface on the interior of the barrel as well as on the baffles **31.** The tapered surface **34** prevents parts from collecting at the corners and thereby minimizes the tendency of any parts being lodged between the chute and the barrel. The openings **39** in the baffles **31** also facilitate the elimination of liquid collection. Curtain **60***f* prevents any parts from bouncing off the chute and out of the barrel.

When each barrel is reversed, the baffles **31** function to elevate the parts and deliver them to the upper end of the chute. Since the upper end of each chute is flared as at **64,** the delivery of the parts is facilitated. During the discharge, the pivoted portion **65** is in the upper or solid line position shown in FIG. **8,** to guide the parts to the next barrel. Slots **66** permit liquid to drain through the slots to the secondary scoop **66***a* back into the tank so that liquid is not carried over. The coating of the underside of the chute sections minimizes the noise incident to transfer of the parts between tank assemblies.

The use of the anode holders provides anodes in close conformity to the barrel and, in turn, the parts and facilitates the replacement of the anodes. The novel drive mechanism assures proper drive without exposing the motor to the liquid contents of the tank.

By making the entire barrel of plastic, a sturdy, lightweight, long-lived construction is achieved.

It can thus be seen that a system has been provided wherein substantially identical assemblies, with appropriate modifications, are used for each of the successive stations of the system.

conventional power (110 volts, 60 cycles) is supplied to the control circuitry by lines **100** and **102.** The operating mode is rendered either automtic or manual by means of selector switches **104, 104***a*, **104***b*, **104***c* and is hereinafter described with reference to the automatic mode. In order to initiate operation, start switch **106** is depressed to thereby latch a relay **107** in the usual manner. The actuation of relay **107** allows power to be supplied to the rest of the control circuitry through contacts **108** and **110.** Contacts **112** are provided in series with contacts **108** to disable the control circuitry should one of the barrel motors become overloaded.

A relay **114** operates drive motor **42** of conveyor **11** until contacts **116** are opened by level sensing element **41** to indicate that hopper **12** is full. Next, contacts **120** of sensing element **41** close to thereby latch a relay **121.** The actuation of relay **121** closes contacts **122** so that power is supplied through normally closed contacts **124** to start a forward master timer **126.**

Forward master timer **126** opens and closes a plurality of contacts **128, 130, 132, 134** and **136** in timed relationship. Normally open contacts **128** and **130** close immediately upon initiation of timer **126.** Normally closed contacts **132** and **136** open, and normally open contacts **134** close when timer **126** completes itss timing cycle. After timer **126** times out, it cannot be recycled until it is reset by removing the supply current to it.

The closure of contacts **128** actuates a timing relay **138** which in turn operates a solenoid valve **140** through contacs **141** for a time interval sufficient to discharge the first batch of articles from hopper **12** into barrel **46** of tank assembly **13** by means of the arrangement previously described. The closure of contacts **130** picks up a relay **142** which starts motor **52** of the first barrel (the first motor) in the forward direction.

The first barrel continues to run forward until the opening of contacts **136** terminates the forward cycle of timer **126.** Concurrently, contacts **132** open to turn off the first motor, and contacts **134** close to start a dwell timer **144** and to energize a relay **150.** Relay **150** resets timer **174** of the second barrel through contacts **149.** After the dwell of timer **144,** which affords the first motor sufficient time to come to a stop, contacts **146** and **148** operate to respectively release relay **150** and to start a reverse master timer **151.**

Reverse master timer **151** is similar to forward master timer **126** in that it controls a plurality of timed contacts **152, 154, 156, 158** and **160.** Normally open contacts **152, 154** close immediately upon the initiation of timer **151.** Normally closed contacts **156** and **158** open and normally open contacts **160** close when timer **151** times out.

The closures of contacts **152** and **154** energize relays **162** and **164.** Relay **162** starts the first barrel in reverse while relay **164** resets forward master timer **126** by means of contacts **124.** (The feed to timer **151** is maintained through contacts **152** with contacts **166** being provided to prevent feedback to contacts **134** and timer **144.**)

The first barrel continues in reverse until the opening of contacts **156** terminates the reverse cycle of timer **151.** The concurrent opening of contacts **158** turns off the first motor, and closure of contacts **160** starts a dwell timer **168** which by opening contacts **170** after the dwell, resets timer **151** and starts the next forward cycle of the first barrel by releasing relay **164** to close contacts **124.**

The energization of relay **162** also closes contacts **172** to thereby both initiate timer **174** and start motor **52** of the second barrel (the second motor) in the forward direction so that the second barrel can receive the articles being discharged from the reverse-running first barrel. Timer **174** controls a plurality of timed contacts **176, 178, 180** and **182,** while the forward rotation of the second motor is controlled by a relay **184.** Contacts **176** close concurrently with the start of timer **174** while contacts **178, 180** and **182** are actuated when timer **174** times out

Contacts **176** maintain power to timer **174** after contacts **172** drop out, and the second barrel continues to run forward until the opening of contacts **178** terminates the cycle of timer **174.** Simultaneous with the cycle termination, contacts **180** open to turn off the second motor, and contacts **182** close to pick up a dwell timer **186.** After the dwell of timer **186,** which affords the second motor sufficient time to come to rest, contacts **188** close to pick up relay **190** which runs the second motor in reverse so that it can discharge its articles. The second barrel continues in reverse until the first barrel completes its next forward cycle. Relay **194** controls contacts (not shown) which are interlocked with the control circuitry for the third barrel.

Thus, there has been described control circuitry for operating the first two barrels of the plating apparatus. The forward and reverse master timers establish the operating cycle of the first barrel with each of the succeeding barrels in the apparatus being slaved to its preceding barrel. The portion of FIG. **17** below line A—A is duplicated for each barrel subsequent to the

second barrel, with the electrical interlocks being arranged in similar fashion with the immediately preceding and succeeding barrels. The repetitive fowardreverse cycles of the first barrel sequentially propagate through the entire apparatus so that eventually each barrel is running either forward to receive and process articles or reverse to discharge articles.

I claim:

1. The method of cleaning and plating articles which comprises

providing a plurality of separate substantially identical containers adapted to contain liquid treating material,

providing a barrel in partially submerged relation to the liquid in each said container,

supporting each said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in the liquid in its respective container,

each said barrel having both ends open and having a plurality of baffles on the inner periphery thereof,

rotating each barrel for a predetermined interval of time individual to said barrel in one direction such that the baffles agitate the articles,

thereafter rotating each said barrel in the opposite direction to cause said baffles to elevate the articles and permit them to fall solely by gravity freely downwardly,

and providing a fixed guide path from the interior of one said barrel to the interior of a successive barrel for receiving the articles falling by gravity and thereby guiding the articles as they move solely by gravity during the rotation of said barrel in said opposite direction into the succeeding barrel.

2. The method set forth in claim **1** including the step of controlling the rotation of a succeeding barrel such that the succeeding barrel is rotated in one direction when the articles are transferred thereto from the preceding barrel.

3. The method set forth in claim **1** including the step of controlling the operation of said first-mentioned barrel such that rotation thereof in the other direction for transfer of the articles is prevented unless the succeeding barrel has transferred the articles therefrom to the next succeeding barrel.

4. In an apparatus for cleaning and plating articles, the combination comprising

a plurality of containers adapted to contain liquid treatment material,

a barrel adapted to be partially submerged in liquid in each said container,

each said barrel having a longitudinal axis,

means for supporting said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid in said container when liquid is in the container,

each said barrel having end walls, each said end wall having an opening therethrough extending along the longitudinal axis of said barrel,

each said barrel having a plurality of baffles on the inner periphery thereof extending axially between the barrels,

said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,

the inner edge of the baffles being spaced from the edge of the opening in the end walls,

and chute means extending from the interior of one said barrel adjacent one end wall through the other end wall to the interior of the succeeding barrel such as to guide the articles dropped by the baffles by gravity to the succeeding barrel,

means for mounting said chute means in fixed relationship independently of said barrels,

each said chute means comprising a first portion and a second portion,

said portions forming progressively decreasing angles with the horizontal as the chute extends from one said barrel to the succeeding barrel,

the inclination of said portions of said chute being such that said articles are guided from one said barrel to the succeeding barrel solely by gravity.

5. In an apparatus for cleaning and plating articles, the combination comprising

a barrel adapted to be at least partially submerged in liquid,

said barrel having a longitudinal axis,

means for supporting said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid,

said barrel being open at both ends thereof adjacent the longitudinal axis,

said barrel having a plurality of baffles on the inner periphery thereof,

said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,

and means for vibrating said barrel during rotation thereof,

said last-mentioned means comprising a member movably mounted exteriorly of said barrel and adapted to frictionally engage said barrel and a vibrator on said member.

6. The combination set forth in claim **5** wherein said member is elastic.

7. The combination set forth in claim **5** wherein said member comprises a spring member.

8. The combination set forth in claim **5** including anti-friction means between said member and said barrel.

9. The combination set forth in claim **8** wherein said anti-friction means comprises a roller engaging the periphery of said barrel.

10. In an apparatus for cleaning and plating articles, the combination comprising

a container adapted to contain liquid treating material,

a barrel adapted to be at least partially submerged in liquid in each said container,

said barrel having a longitudinal axis,

means for supporting said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid in said container when liquid is in the container,

said barrel being open at both ends thereof adjacent the longitudinal axis,

said barrel having a plurality of baffles on the inner periphery thereof,
said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,
and chute means extending from the interior of one said barrel to the interior of the other to guide the articles dropped by the baffles to the succeeding barrel,
said means for supporting said barrel comprises spaced pairs of levers,
each said lever being pivoted at a point on said container intermediate the opening and the periphery of said drum,
anti-friction means on the ends of each said lever engaging the periphery of the drum at spaced points on the drum,
and means for driving at least one of said anti-friction means of each said lever.

11. The combination set forth in claim **10** wherein said last-mentioned means comprises a motor mounted on one of said levers beyond the confines of said tank and means extending between said motor and one of said anti-friction means.

12. The combination set forth in claim **10** wherein said drive means includes endless means extending between said driven rollers,
and idler roller means engaging both reaches of said endless means.

13. The combination set forth in claim **12** wherein said idler roller means comprises a lever pivoted intermediate its ends and idler pulleys engaging said reaches of said endless means.

14. In an apparatus for cleaning and plating articles, the combination comprising
a plurality of containers adapted to contain liquid treating material,
a barrel adapted to be at least partially submerged in liquid in each said container,
each said barrel having a longitudinal axis,
means for supporting each said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid in said container when liquid is in the container,
each said barrel being open at both ends thereof adjacent the longitudinal axis,
each said barrel having a plurality of circumferentially spaced baffles on the inner periphery thereof,
said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,
and chute means extending from the interior of one said barrel to the interior of the other to guide articles dropped by the baffles to the succeeding barrel,
each said chute including a portion thereof adjacent said openings which is pivotal out of the plane of said chute during normal operation to permit parts to be directed back into the barrel.

15. The combination set forth in claim **14** wherein said chute includes openings in said last-mentioned portion thereof within said barrel to permit liquid that may fall downwardly on the chute to drain into said barrel when the parts are being delivered to the next adjacent barrel.

16. The combination set forth in claim **15** including a fixed secondary scoop beneath said openings for directing liquid back into said barrel.

17. The combination set forth in claim **16** wherein said openings are generally V-shaped and tapered in the direction of travel of the parts along said chute.

18. The combination set forth in claim **14** wherein said chute has a coating on the exterior surface thereof serving to deaden the noise of parts falling thereon.

19. The combination set forth in claim **18** wherein the upper surface of said chute comprises uncoated metal.

20. The combination set forth in claim **14** wherein the upper end of said chute flares outwardly within said barrel in the direction of travel of said parts when they are discharged to a dimension greater than the diameter of said openings.

21. The combination set forth in claim **14** including a flexible curtain extending downwardly within said barrel into contact with said chute for preventing articles from inadvertently passing out of said chute during normal operation.

22. In an apparatus for cleaning and plating articles, the combination comprising
a plurality of containers adapted to contain liquid treating material,
a barrel adapted to be at least partially submerged in liquid in each said container,
each said barrel having a longitudinal axis,
means for supporting each said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid in said container when liquid is in the container,
each said barrel being open at both ends thereof adjacent the longitudinal axis,
each said barrel having a plurality of circumferentially spaced baffles on the inner periphery thereof,
said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,
chute means extending from the interior of one said barrel to the interior of a successive barrel to guide articles dropped by the baffles to the succeeding barrel, and
each said barrel comprising an outer cylindrical plastic wall,
spaced radial plastic walls extending from said openings to said outer wall.

23. In an apparatus for cleaning and plating articles, the combination comprising
a plurality of containers adapted to contain liquid treatment material,
a barrel adapted to be partially submerged in liquid in each said container,
each said barrel having a longitudinal axis,
means for supporting said barrel rotatably about a fixed generally horizontal axis so that a portion of

the barrel is submerged in liquid in said container when liquid is in the container,

each said barrel having end walls, each said end wall having an opening therethrough extending along the longitudinal axis of said barrel,

each said barrel having a plurality of baffles on the inner periphery thereof extending axially between the barrels,

said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,

the inner edge of the baffles being spaced from the edge of the opening in the end walls,

chute means extending from the interior of one said barrel adjacent one end wall through the other end wall to the interior of the succeeding barrel such as to guide the articles dropped by the baffles by gravity to the succeeding barrel,

means for mounting said chute means in fixed relationship independently of said barrels,

each said chute means comprising a first portion and a second portion,

said portions forming progressively decreasing angles with the horizontal as the chute extends from one said barrel to the succeeding barrel,

said chute having a coating on the exterior surface thereof serving to deaden the noise of articles falling thereon, the upper surface of said chute comprising uncoated metal.

24. In an apparatus for cleaning and plating articles, the combination comprising

a plurality of containers adapted to contain liquid treatment material,

a barrel adapted to be partially submerged in liquid in each said container,

each said barrel having a longitudinal axis,

means for supporting said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid in said container when liquid is in the container,

each said barrel having end walls, each said end wall having an opening therethrough extending along the longitudinal axis of said barrel,

each said barrel having a plurality of baffles on the inner periphery thereof extending axially between the barrels,

said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,

the inner edge of the baffles being spaced from the edge of the opening in the end walls,

chute means extending from the interior of one said barrel adjacent one end wall through the other end wall to the interior of the succeeding barrel such as to guide the articles dropped by the baffles by gravity to tha succeeding barrel,

means for mounting said chute means in fixed relationship independently of said barrels,

each said chute means comprising a first portion and a second portion,

said portions forming progressively decreasing angles with the horizontal as the chute extends from one said barrel to the succeeding barrel,

a flexible curtain extending downwardly within said barrel into contact with said chute for preventing articles from inadvertently passing out of said chute during normal operation.

25. In an apparatus for cleaning and plating articles, the combination comprising

a plurality of container adapted to contain liquid treatment material,

a barrel adapted to be partially submerged in liquid in each said container,

each said barrel having a longitudinal axis,,

means for supporting said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid in said container when liquid is in the container,

each said barrel having end walls, each said end wall having an opening therethrough extending along the longitudinal axis of said barrel,

each said barrel having a plurality of baffles on the inner periphery thereof extending axially between the barrels,

said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,

the inner edge of the baffles being spaced from the edge of the opening in the end walls,

chute means extending from the interior of one said barrel adjacent one end wall through the other end wall to the interior of the succeeding barrel such as to guide the articles dropped by the baffles by gravity to the succeeding barrel,

means for mounting said chute means in fixed relationship independently of said barrels,

each said chute means comprising a first portion and a second portion,

said portions forming progressively decreasing angles with the horizontal as the chute extends from one said barrel to the succeeding barrel,

said chute including a portion thereof adjacent said openings which is pivotal out of the plane of said chute during transfer of articles to permit articles to be directed back into the barrel.

26. The combination set forth in claim **25** wherein said chute includes openings through said last-mentioned portion thereof within said barrel to permit liquid that may fall downwardly on the chute to drain into said barrel when the articles are being delivered out of said barrel.

27. The combination set forth in claim **26** including a fixed secondary scoop beneath said openings for directing liquid back into said barrel.

28. The combination set forth in claim **26** wherein said openings are generally V-shaped and tapered in the direction of travel of the articles along said chute.

29. In an apparatus for cleaning and plating articles, the combination comprising

a plurality of containers adapted to contain liquid treating material,

a barrel adapted to be at least partially submerged in liquid in each said container,

each said barrel having a longitudinal axis,

means for supporting each said barrel rotatably about a fixed generally horizontal axis so that a portion of the barrel is submerged in liquid in said container when liquid is in the container,

each said barrel being open at both ends thereof adjacent the longitudinal axis,

each said barrel having a plurality of circumferentially spaced baffles on the inner periphery thereof,

said baffles extending generally radially inwardly and forming an acute angle with the inner periphery of the barrel such that when the barrel is rotated in one direction, said baffles agitate the articles, and when said barrel is rotated in the opposite direction, said baffles elevate the articles and then cause them to drop,

and chute means extending from the interior of one said barrel to the interior of a successive barrel to guide articles dropped by the baffles to the succeeding barrel,

each said barrel comprising an outer cylindrical plastic wall,

spaced radial plastic walls extending from said openings to said outer wall,

annularly extending surfaces on the interior surfaces of the radial walls adjacent the juncture of the radial walls and the outer wall diverging adjacent said openings axially outwardly from the interior of said spaced walls.

30. The combination set forth in claim **29** wherein said baffles have portions thereof adjacent said cylindrical wall with openings therethrough.

31. The combination set forth in claim **30** wherein said openings comprise holes.

32. The combination set forth in claim **29** including an annular cylindrical wall extending axially inwardly from each said opening,

means forming a bead on the outer periphery of said wall inwardly of said radial wall within said barrel for preventing liquid moving along the inner surface of said radial wall toward said opening.

33. The combination set forth in claim **29** including means mounted exteriorly of at least one said container for directing liquid from adjacent the lower portion of said container to the interior of said barrel.

34. The combination set forth in claim **33** wherein said last-mentioned means includes an axially extending pipe extending through one said opening of said barrel.

35. The combination set forth in claim **29** including nozzle means on said pipe for directing liquid angularly downwardly on parts in said barrel.

36. The combination set forth in claim **29** wherein each said chute means comprises a first portion and a second portion,

said portions forming progressively decreasing angles with the horizontal as the chute extends from one said barrel to the successive barrel.

37. the combination set forth in claim **29** wherein said chute includes a portion thereof adjacent said openings which is pivotal out of the plane of said chute during normal operation to permit articles to be directed back into the barrel.

38. The combination set forth in claim **37** wherein said chute includes openings in said last-mentioned portion thereof within said barrel to permit liquid that may fall downwardly on the chute to drain into said barrel when the parts are being delivered to the next adjacent barrel.

39. The combination set forth in claim **38** including a fixed secondary scoop beneath said openings for directing liquid back into said barrel.

40. The combination set forth in claim **38** wherein said openings are generally V-shaped and tapered in the direction of travel of the parts along said chute.

41. The combination set forth in claim **29** wherein said chute has a coating on the exterior surface thereof serving to deaden the noise of parts falling thereon.

42. The combination set forth in claim **41** wherein the upper surface of said chute comprises uncoated metal.

43. The combination set forth in claim **29** wherein the upper end of said chute flares outwardly within said barrel in the direction of travel of said articles when they are discharged to a dimension greater than the diameter of said opening.

44. The combination set forth in claim **29** including a flexible curtain extending downwardly within said barrel into contact with said chute for preventing articles from inadvertently passing out of said chute during normal operation.

45. The combination set forth in claim **29** including means for vibrating said barrel during rotation thereof.

46. The combination set forth in claim **45** wherein said last-mentioned means comprises a member movably mounted on said tank and adapted to frictionally engage said tank and a vibrator on said member.

47. The combination set forth in claim **45** wherein said member comprises a spring member.

48. The combination set forth in claim **45** including anti-friction means between said member and said barrel.

49. The combination as set forth in claim **48** wherein said anti-friction means comprises a roller engaging the periphery of said barrel.

50. The combination set forth in claim **29** wherein said means for supporting said barrel comprises spaced pairs of levers,

each said lever being pivoted at a point on said container intermediate the opening and the periphery of said drum,

anti-friction means on the ends of each said lever engaging the periphery of the drum at spaced points on the drum,

and means for driving at least one of said anti-friction means of each said lever,

51. The combination set forth in claim **50** wherein said last-mentioned means comprises a motor mounted on one of said levers beyond the confines of said barrel and means extending between said motor and one of said anti-friction means.

52. The combination set forth in claim **50** wherein said drive means includes endless means extending between said driven rollers,

and idler roller means engaging both reaches of said endless means.

53. The combination set forth in claim **52** wherein said idler roller means comprises a lever pivoted intermediate its ends and idler pulleys engaging said reaches of said endless means.

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