United States Patent [19]

Kossmann

[11] **3,849,284**

[45] **Nov. 19, 1974**

[54] **APPARATUS METHOD AND VALVE FOR ELECTRODEPOSITING A COATING ON INTERIOR SURFACES OF CONTAINER BODIES**

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[22] Filed: **July 2, 1973**

[21] Appl. No.: **375,458**

Related U.S. Application Data

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[52] **U.S. Cl.** **204/300,** 204/181, 204/275

[51] **Int. Cl.** **C23b 13/00,** C23b 5/68

[58] **Field of Search** 204/300, 299, 275, 181, 204/222; 137/535, 542

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Assistant Examiner—A. C. Prescott
Attorney, Agent, or Firm—Robert P. Auber; Paul R. Audet; George P. Ziehmer

[57] **ABSTRACT**

An electrocoating system comprises an apparatus, method and valve for electrodepositing a coating on interior electrically-conductive surface areas of container bodies.

Container bodies having an open end are timely fed onto circumferentially aligned rows of valves on the exterior of a rotating cylindrical drum containing an electrolytic fluid. Continuous anodic cables extend around the drum, exert axial pressure on the bottoms of the containers, render them anodic, sealingly engage their rims on the valves and thereby open the valves to gravity-feed the fluid into the bodies. With fluid therein, current passed through cathodic electrodes projecting from the valve exteriors into the bodies, electrodeposits a coating on the electrically-conductive surface areas of the container bodies. During continued drum rotation, fluid gravity-drains from the coated bodies back into the drum, and the empty, coated bodies are discharged from the system.

The fluid valve has a fixed exterior and a moveable interior housing. A valve member connected to the exterior housing has an insulated conductive core to which a spring electrode is connected thereto exterior of the valve member. The interior housing is axially moveable against a spring bias to open a passageway in the valve. All parts of the valve are non-conductive in relation to the fluid.

8 Claims, 10 Drawing Figures

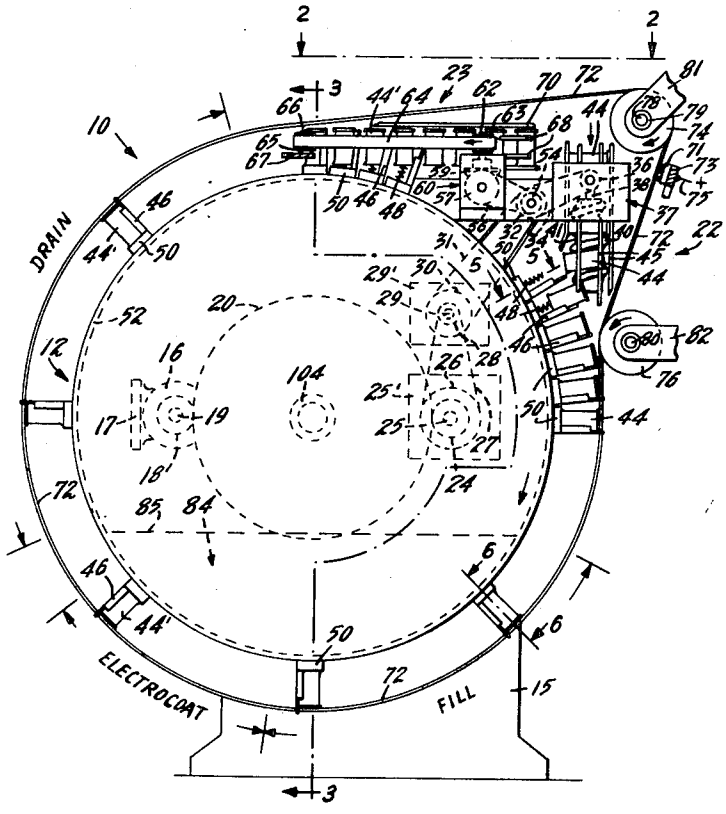


FIG. 1

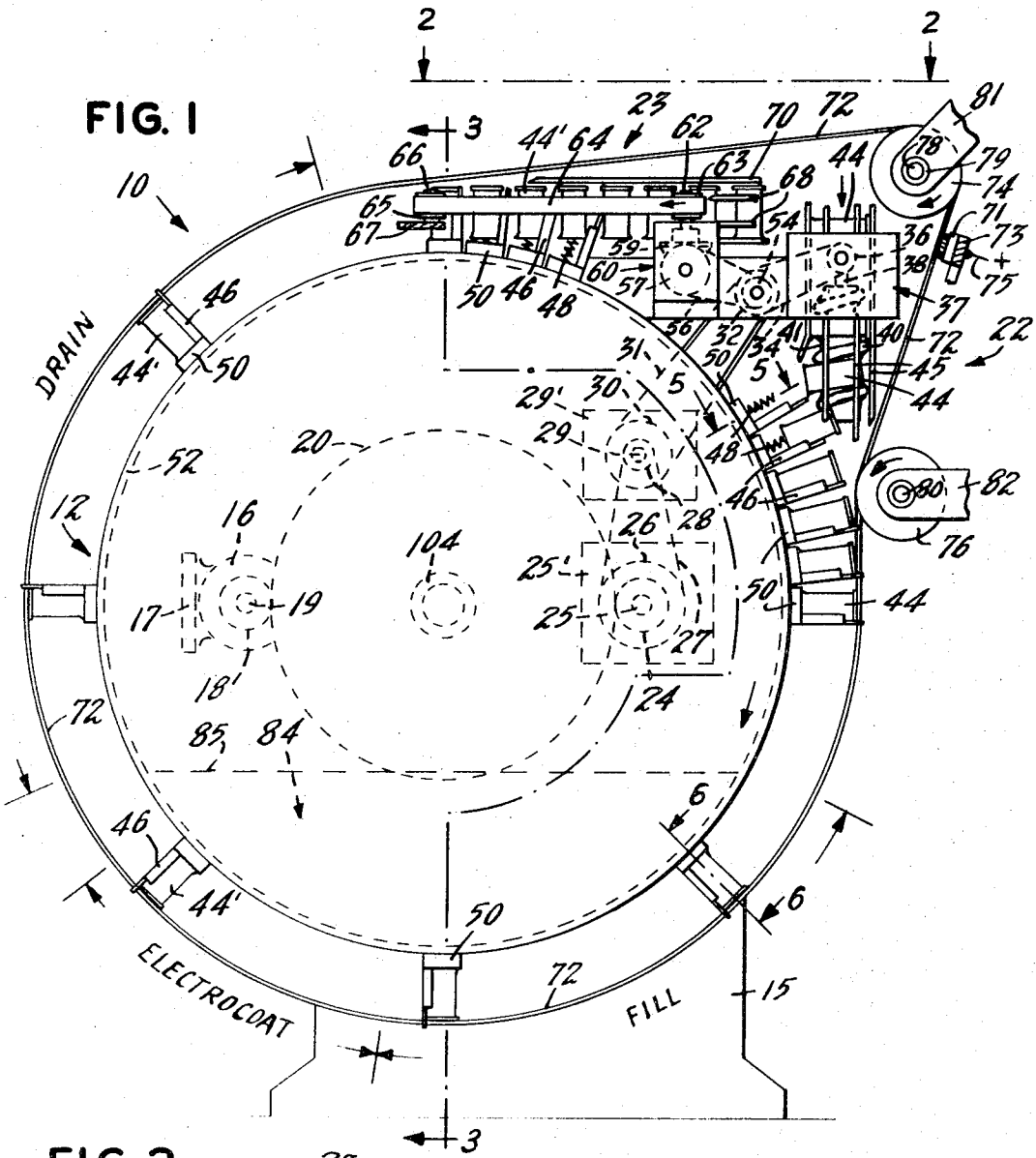


FIG. 2

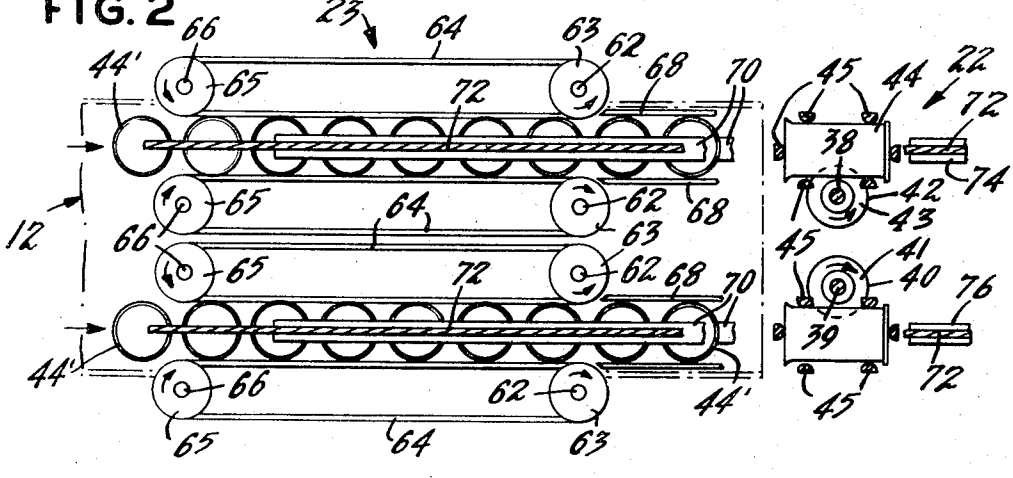


FIG. 3

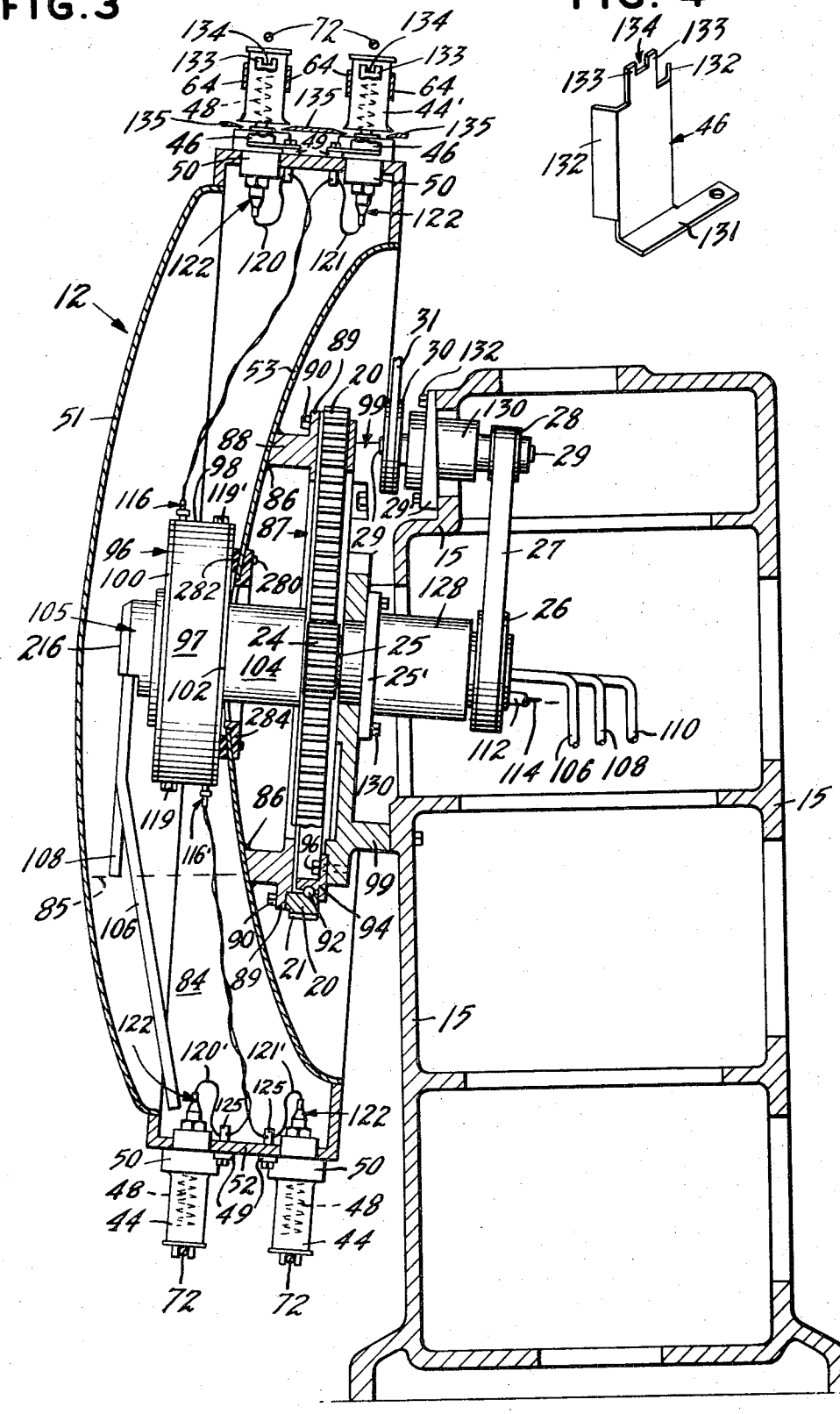


FIG. 4

FIG. 5

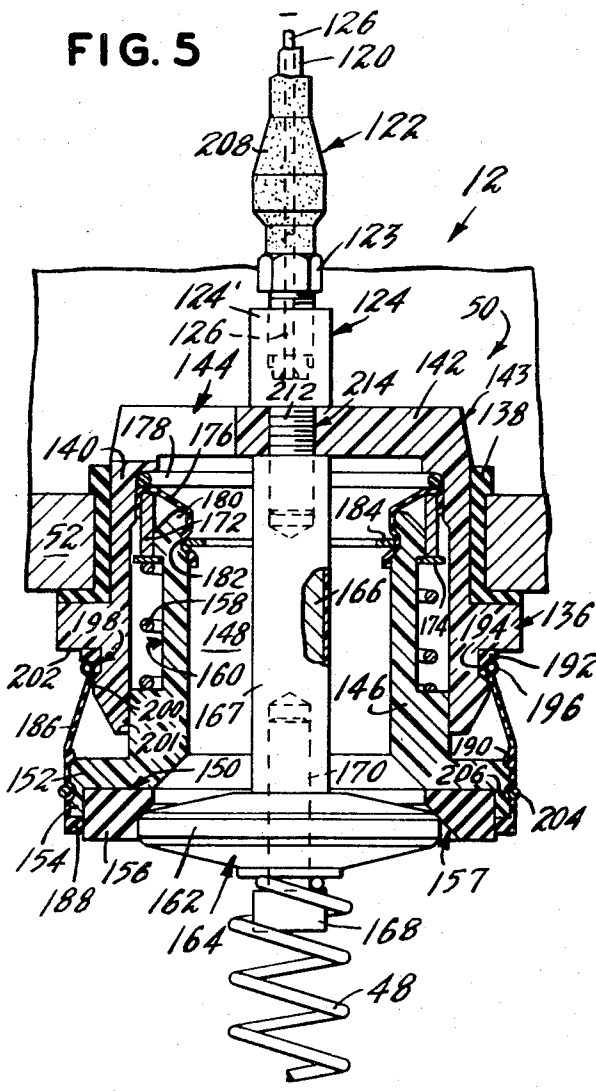


FIG. 6

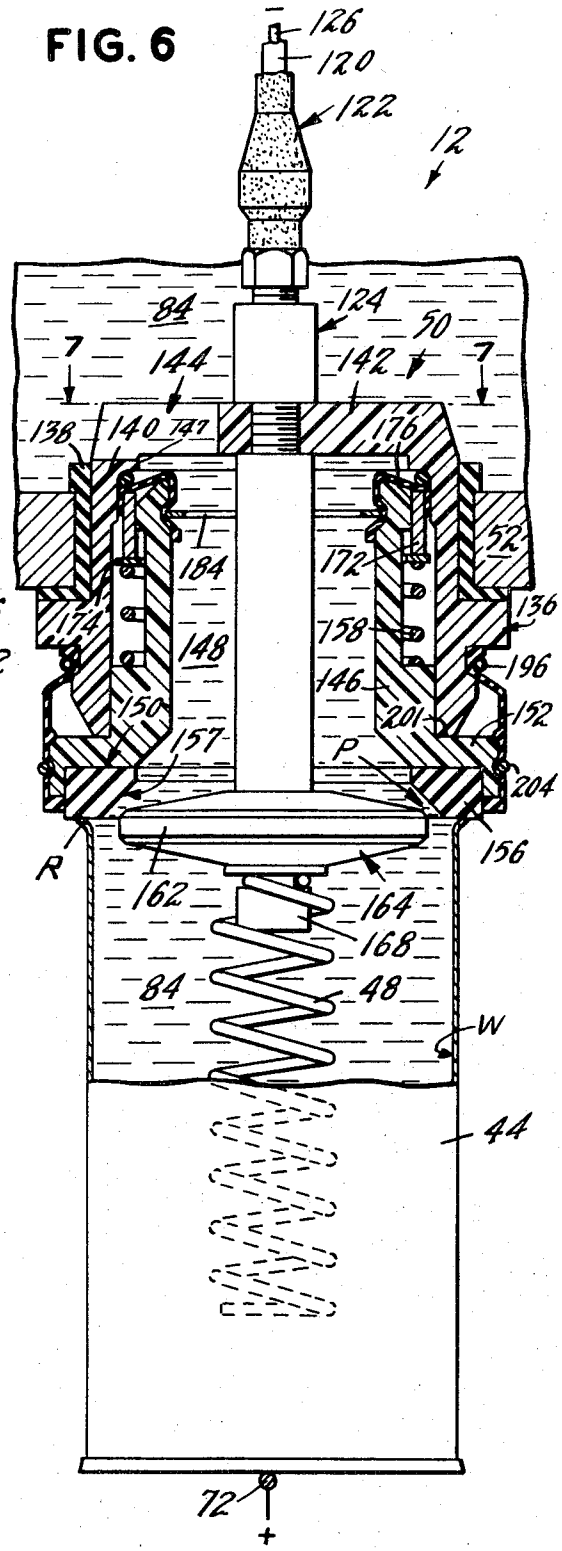


FIG. 7

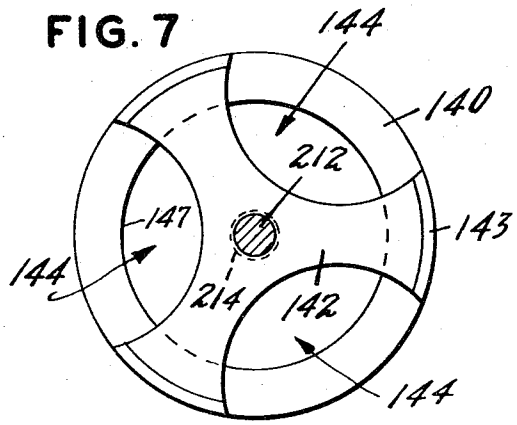


FIG. 8

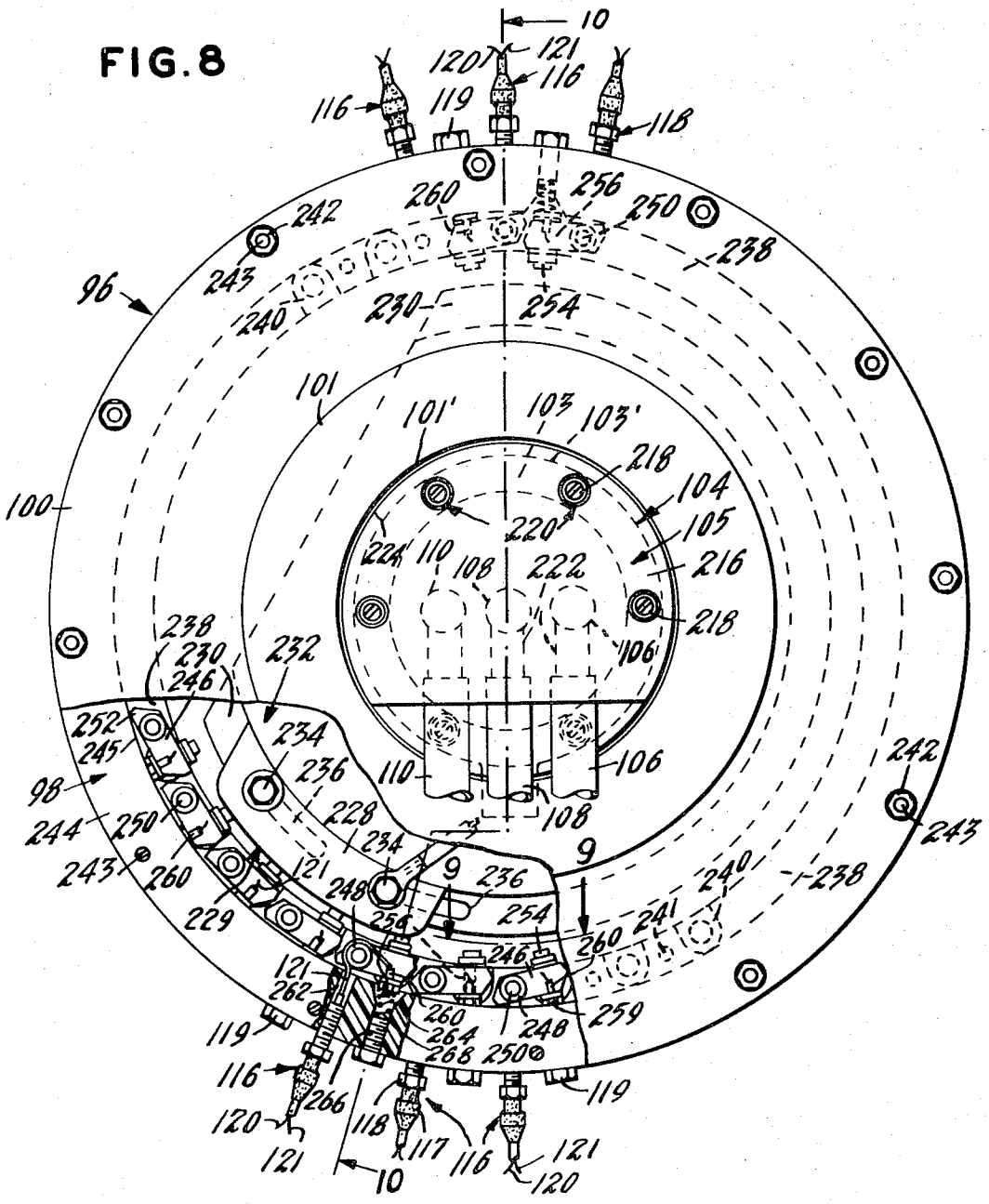

10
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121
116
119
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260
256
250
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243
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101'
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103'
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222'
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106'
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FIG. 9

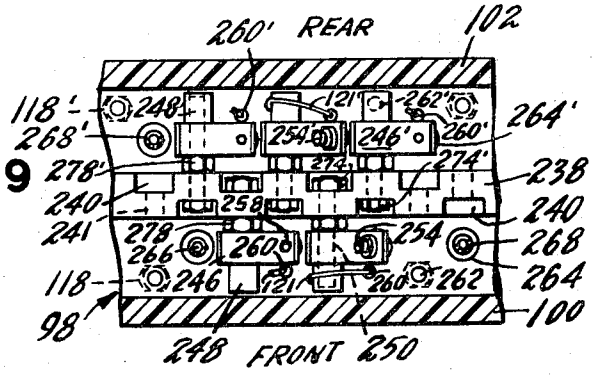
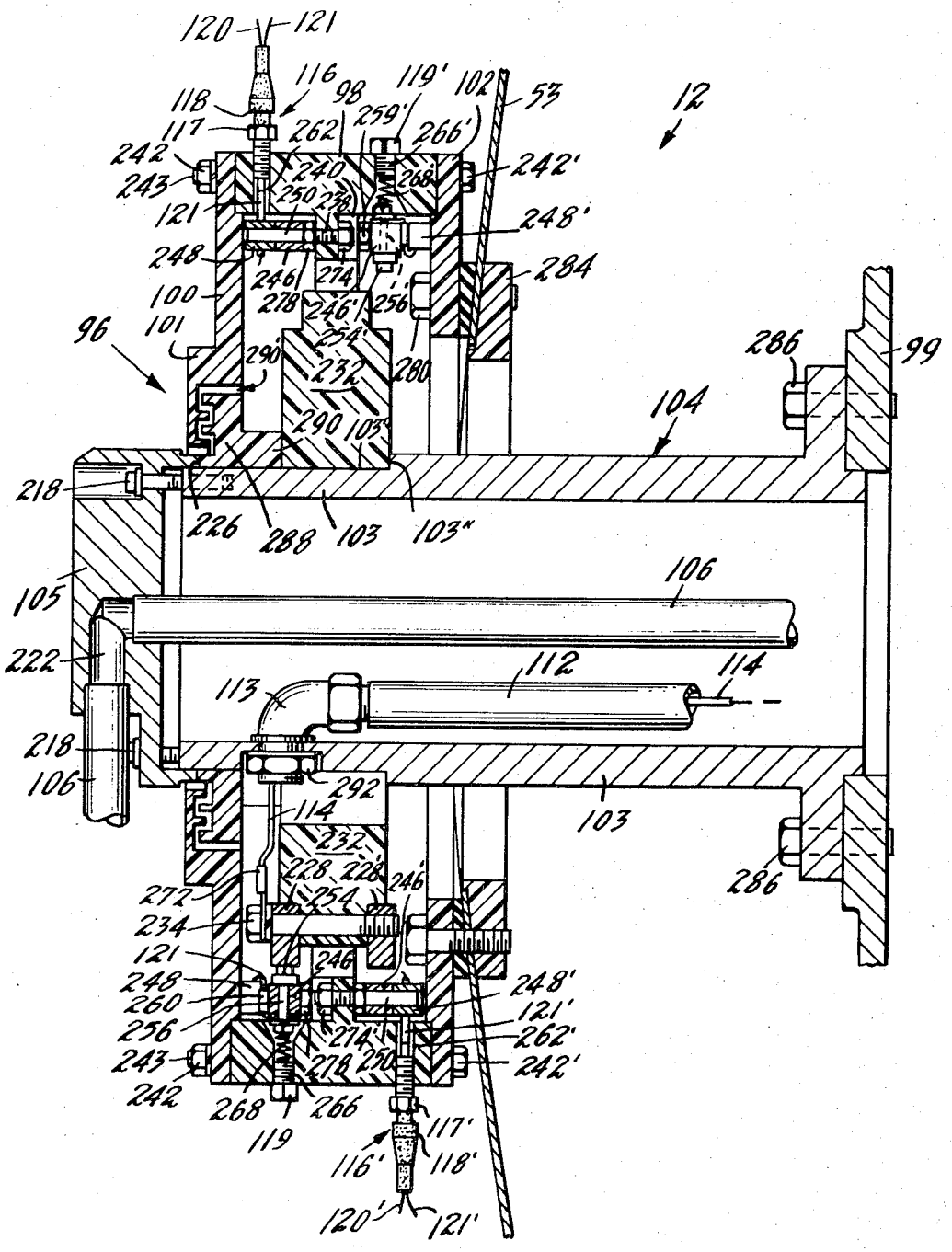

260' REAR
102
118
248
121'
262'
264'
268'
254
246'
260'
274'
278'
238
240
258
241
278
266
260
254
268
246
262
264
98
100
248 FRONT 250

FIG. 10


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98
119'
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53
12
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259'
266'
242
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242'
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238
248'
248
246
274
284
100
278
246'
256
96
101
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232
280
104
290
103'
218
226
288
103
103"
106
105
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APPARATUS METHOD AND VALVE FOR ELECTRODEPOSITING A COATING ON INTERIOR SURFACES OF CONTAINER BODIES

This is a divisional of application Ser. No. 285,643, filed Sept. 1, 1972.

BACKGROUND OF THE INVENTION

This invention relates to the field of electrocoating metal substrates. More particularly, the invention relates to an electrocoating system including apparatus, method and valve for electrodepositing a coating on interior electrically-conductive surface areas of metal container bodies.

Basically, electrocoating is the electrodeposition of organic resinous coating materials on electrically-conductive surface areas, from polyelectrolytic electrocoating material mediums which can be anodic or cathodic aqueous or nonaqueous base bath solutions, suspensions or dispersions. The electrocoating mediums ultimately contain coating ions or polyelectrolytic particles, which, in the case of anodic mediums, carry a negative charge in the bath and when a voltage is applied and current is induced to flow through the medium, migrate to and discharge onto any positively charged surface of a metal substrate, i.e., the anode, which may in contact with the medium. Conversely, the polyelectrolytic particles, in the case of cathodic mediums, carry a positive charge in the medium, and, upon application of a voltage, migrate to and discharge onto any negatively charged surface of a metal substrate, i.e. the cathode, which may be in contact with the medium.

A layer of particulate coating material is electrodeposited adjacent the electrically charged metal substrate as the direct current flows between it and an oppositely electrically charged electrode such as a wire or rod, immersed in the coating bath. The process is driven by an electrical potential which can be in the range of from 1 up to 500 volts, but more typically is from about 50 to 500 volts. The electrodeposition of the coating material takes place only at electrically-conductive surface areas of the metal object because only at such areas is there an electrical circuit and the electrical action which allows the flow of direct current needed to cause the polyelectrolytic particles to be electrodeposited adjacent the electrically-conductive surface.

The thickness of the layer of particulate material electrodeposited is automatically regulated by the characteristically low electrical conductivity of the particular mediums used. Once a certain layer thickness of coating material has attached to the electrically-conductive surface area of the metal substrate, the electrodeposited coating material, in having a low electrical conductivity characteristic, increasingly tends to insulate the surface area from the coating bath in which it is immersed, transforming it into a non-conductive surface, whereby direct current flow therein greatly diminishes and eventually ceases, with the resulting inhibition of further electrodesposition of coating material.

One particular field where it has been found desirable to coat metal substrates is in the manufacturing of metal containers or cans, where it is necessary that all the exposed, uncoated surface areas on the metal can be coated to protect the metal from corrosion.

At present, there is no conventional, commercial apparatus or method of quickly and efficiently electrocoating the interior surfaces of metal can bodies such as used in the packaging of beer or carbonated beverages. Presently, a typical method of perfecting coverage of the coating on the interior of such surfaces to protect them from environmental product attack, is to use a double coat system which involves initially applying a base coat by a roller onto the metal stock while it is in the flat, and, after fabricating the can from the coated stock, spraying a top coat on the interior of the fabricated can or component to seal any scratches, breaks or discontinuities or other electrically porous or conductive areas formed in the base coat during the fabrication operation. The top coat usually is an overall coat since the location of the discontinuities cannot precisely and reliably be ascertained.

While this two coat system has in general been satisfactory, it does have a number of disadvantages, especially in relation to the overall top spray coat. One is that it is relatively difficult to apply an overall top coat at high speeds because of problems usually associated with spraying machines. These include contamination of machine parts due to overspray, the need for frequent cleanups and adjustments of spray heads, and the need to bake the finished ends to drive off solvents that have to be used to obtain the viscosity requisite for spraying top coat materials. The presence of solvents in the spray coat is problematical because they are dangerous to inhale and handle. They also pollute and require expensive exhaust and other pollution-preventing handling systems.

High speed commercial spray coating machines require deposition of repair coats in 2 seconds or less. At such speeds, spraying often does not obtain satisfactory seals of imperfections because the predetermined amount of material sprayed throughout the interior of the can body often does not provide enough material adjacent a particularly large discontinuity to adequately seal it.

Spraying an overall coat often does not provide uniform coatings since too little solvent results in too little coverage in some areas and lumps or accumulations in other areas, and too much solvent causes dripping, sags and runs.

Spraying is wasteful because coating material is applied to the entire interior surface area rather than limitedly as and where it is needed.

Lastly, spraying an overall top coat causes webbing and frilling about the pouring openings of easy-open can ends, due to the top coat completely covering the base coat and often adhering more strongly to the base coat than the base coat to the can ends, when the score-defined easy-open tear out portions are removed therefrom.

The electrocoating system of this invention solves all of the aforementioned disadvantages and problems and others as well. It is fast enough for commercial high speed operation. It has been used for example to repair coat in 2 seconds or less at rates of 600 cans per minute. There is virtually no contamination of machine parts due to overuse, and there is less need for cleanups and adjustments.

The system is selective, self-limiting and nonwasteful. It deposits uniform coatings of sufficient quantity to attain satisfactory single and repair coats which do not web and frill.

The system is advantageous because aqueous electrocoating solutions can be employed therewith. These are not dangerous to handle and prevent pollution of the atmosphere by not requiring solvents. Aqueous materials do not require expensive solvent exhaust and handling systems. An added advantage is that the system of this invention can be used in place of four conventional body spray machines.

This system is especially advantageous because it can be used to apply a single full coat which satisfactorily coats the entire interior surface areas of the container bodies, or it can be used to repair or spot coat only imperfections in a previously applied base coat.

Numerous other advantages of the electrocoating system of this invention including apparatus, method and valve will be apparent as it is better understood from the description which follows, which, taken in conjunction with the drawings, discloses preferred embodiments thereof.

SUMMARY OF THE INVENTION

This invention is an electrocoating system including apparatus, method and a valve for electrodepositing a coating on interior electrically-conductive surface areas of container bodies having an open end. The apparatus comprises a rotatable reservoir or drum having a cylindrical wall, for containing an electrolytic fluid; means for rotating the drum; valve means mounted preferably radially in rowed, radially-aligned spaced pairs around the circumference of the cylindrical wall, for passing the fluid to and from the interior thereof, all portions of the valve means in contact with the fluid being non-conductive in relation thereto; an electrode, preferably a helical spring, connected to and projecting radially from the exterior of the valve means; the valve means including: means for carrying electric current therethrough to the electrode, a housing having fixed and moveable portions, the moveable portion having a mouth therein, a valve member fixedly connected to the fixed housing portion, and preferably having a metal core running therethrough, the core being included within the current carrying means, biasing means mounted between the fixed and moveable housing portions, and a resilient sealing ring located on the mouth of the moveable housing portion and moveably biased by the biasing means into sealing engagement with the valve member; means partly mounted on the drum for creating a potential difference between the electrode and the interior conductive surface areas of the container bodies, the aforementioned portion of the potential creating means, preferably being a commutator assembly means mounted interiorly of the drum and including intermediate circuitry connecting it to the current carrying means; and, means for feeding the container bodies onto the valve means so that the bodies are registered thereon, the electrode projects into the interior of the bodies and the rims of the bodies sealingly engage the sealing ring with pressure sufficient to break the sealing engagement between the valve member and the sealing ring to create a passageway therebetween which allows the fluid to pass through the valve means and into the container bodies during a portion of the reservoir rotation, so that a potential created electrodeposits a coating on interior electrically-conductive surface areas of the container bodies.

The feeding means can include means, preferably cradles, mounted radially on the cylindrical wall adjacent each valve means for receiving the container bodies from a source and placing the bodies in register onto the sealing rings so that the electrode projects into the interior of the bodies. The feeding means can also include means for holding the can bodies in registered sealing engagement on the sealing ring and for providing pressure sufficient to create a passageway between the valve member and the sealing ring which allows the fluid to pass through the valve means and into the container bodies during a portion of the drum rotation so that the potential created during that portion of rotation electrodeposits a coating on interior electrically-conductive surface areas of the container bodies.

The apparatus can also include means connected to the interior of the drum for, preferably pressuredly, charging, leveling and draining the fluid to, in and from the drum, and it can include means for removing the container bodies from the valve means and from the drum. The removing means can include a knife for separating the rims of the container bodies from the sealing ring of the valve means.

The axis of the drum can be tilted and its non-cylindrical walls arcuate, so that liquid on the drum walls does not accumulate thereon but drains toward the bottom portion of the drum.

The method of the invention comprises rotating, preferably continuously, a reservoir or drum containing an electrolytic fluid and having valve means mounted in the exterior walls thereof, the valve means in turn having an electrode projecting therefrom; feeding, preferably simultaneously, the container bodies onto the valve means so that the bodies are registered on the valve means and the electrode projects into the interior of the container bodies, providing axial pressure against the container bodies, preferably against their exteriormost ends, sufficient to sealingly engage the rims of the can bodies against a portion of the valve means and to open the valve means; passing the fluid from the rotating drum through the open valve means and into the sealingly engaged bodies; creating a potential difference between the electrode and the interior surfaces of the bodies when they contain the fluid; and thereby electrodepositing a coating on the interior electrically-conductive surface areas of the bodies.

The pressure providing step can be maintained throughout a major portion of the drum rotation and the fluid passing step, preferably, is effected by gravity. The method can also include the steps of insulating the means for creating the potential and the means for carrying the electric current through the valve means to the electrode, and charging the fluid to the drum and removing the coated container bodies from the valve means and from the reservoir.

The fluid valve of this invention for electrodepositing systems wherein an electrolytic fluid and electric current insulatedly pass through the valve, comprises: a fixed exterior housing mountable on a wall of a reservoir containing the fluid, the exterior housing having a back wall with apertures therein communicating with the interior of the reservoir; a moveable interior housing, interior of and slidingly engaged with the exterior housing, the interior wall of the interior housing defining a central valve chamber and having a mouth opposite the back wall; a resilient sealing ring mounted in the mouth; a valve member fixedly connected at one of

its ends to the back wall, extending axially into the chamber and having legs fixed to and extending transverse to its axis, the axial portion of the valve member having a conductive core connectable to circuitry; an electrode, preferably a helical spring, connected to and projecting, preferably radially, from the exterior of the valve member; means for sealing and preventing fluid from passing between the housing; and biasing means, preferably a helical spring extending around and being abuttingly biased against a support wall of the interior housing, for flexibly biasing the sealing ring and the interior housing into sealing engagement with the valve member legs to seal the fluid valve chamber, the biasing means being inwardly compressible towards the back wall by an axial force so that when the force is sufficient to compress the sealing ring and biasing means, a passageway is created between the valve member legs and the sealing ring which allows fluid to flow from the reservoir to the exterior of the valve chamber.

Preferably, all parts of the valve exposable to the fluid excluding the electrode are non-conductive in relation to the fluid. The biasing means can also include a rigid backing ring adjacent the back wall of the exterior housing for backing the spring, and a rigid lock washer mounted between the backing ring and the spring, for backing the spring and acting as a stop against outward movement of the interior housing. The fluid sealing and preventing means can include an annular, flexible, resilient interior sleeve partly within the chamber and sealingly fastened to the interior of the interior housing and the exterior of the exterior housing to prevent fluid from passing therebetween, and an annular, flexible, resilient exterior sleeve sealingly fastened to and for sealing the exteriors of the interior and exterior housings, exterior of the reservoir wall. The fluid sealing and preventing means can further include an annular, elastomeric O-ring between the back wall and an interior sleeve portion that is adjacent the backing ring.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevation showing the electrocoating apparatus of this invention.

FIG. **2** is a plan view taken substantially along line **2—2** of FIG. **1.**

FIG. **3** is an enlarged vertical section taken substantially along line **3—3** of FIG. **1** showing a portion of the drum and the valves mounted thereon.

FIG. **4** is an enlarged perspective view of one of the cradles mounted on, but shown broken away from, the reservoir of FIG. **3.**

FIG. **5** is an enlarged vertical section through a portion of the electrocoating reservoir and through a fluid valve mounted therein before a can body is placed on the valve.

FIG. **6** is an enlarged vertical section similar to that of FIG. **5,** showing the fluid valve in an open position and liquid passing from the reservoir into a can body placed on the valve and shown partly broken away.

FIG. **7** is a plan view taken substantially along line **7—7** of FIG. **6** showing apertures in the valve housing wall.

FIG. **8** is a front view of the commutator assembly of FIG. **3** with parts broken away showing some of its mechanisms and electrical circuitry.

FIG. **9** is a top view taken substantially along line **9—9** of FIG. **8.**

FIG. **10** is a vertical section taken substantially along line **10—10** of FIG. **8.**

DETAILED DESCRIPTION OF THE INVENTION

In a preferred, exemplary embodiment of this invention, FIG. **1** shows an electrocoating or electrodepositing system generally designated **10** comprising a rotatable reservoir or drum **12** rotatably mounted on a main frame **15.** The reservoir (hereinafter drum) is driven by means for rotating the drum which include drive means such as motor **16,** whose flange **17** is mounted to a frame (not shown). Motor **16** drives pinion gear **18** mounted on shaft **19** which drives main ring gear **20** fixed to an interior wall (not shown) of drum **12.** Ring gear **20** in turn drives feeding means generally designated **22** for feeding container or can bodies **44** onto drum **12,** and discharge or take-off means generally designated **23** (hereafter discharge means) for discharging coated container bodies **44'** from drum **12.** "Coated" in this context means full or repair coated by an electrolytic fluid **84** in drum **12** according to this invention. Ring gear **20** drives both feeding means **22** and discharge means **23** by driving pinion gear **24** rotatably mounted on shaft **25,** mounted on flange **25',** and fixed to pulley **26.** Pulley **26** drives belt **27** which in turn drives pulley **28** rotatably mounted on shaft **29,** mounted on flange **29',** and fixed to pulley **30.** Pulley **30** drives belt **31** shown connected to pulley **32** which in turn drives belt **34** connected to pulley **36.** Box **37** represents mechanism (not shown) sufficient to transfer the rotary motion of pulley **36** into timed simultaneous rotation of feeding means **22** including shafts **38** (shown) and **39** (FIG. **2**) respectively fixedly connected to worm feed screws **40** (shown) and **42** respectively having grooves **41** (shown) and **43** for timedly feeding can bodies **44** to means included within the feeding means such as cradles generally designated **46** for placing the container bodies in register on valve means **50** and on electrodes **48** connected to and projecting from valve means **50** mounted in the exterior of, preferably cylindrical, wall **52** of drum **12.**

Pulley **32,** driven by belt **31** and also fixed to pulley **54** on a shaft (not numbered), drives belt **56** which in turn drives pulley **57** fixed to a set of miter gears **58** (not shown) and **59** connected to other suitable mechanisms in box **60.** The miter gears are connected to other mechanisms (not shown) sufficient to rotate a series of vertical shafts **62** (FIG. **2**) fixedly connected to drive pulleys **63,** on which are mounted continuous discharge or take-off belts **64,** also mounted on series of idler pulleys **65** on shafts **66** mounted to a broken away portion of frame **67.** Pairs of discharge belts **64** engage the sides of "coated" can bodies **44',** lift them from cradles generally designated **46** and transfer them to removal chutes comprised of side discharge guard rails **68** and upper and lower discharge guide rails **70.** Coated can bodies **44'** can be further moved along the guide rails away from electrocoating system **10** by any suitable means such as a series of turrets, guide rails and moving belts (not shown) which, for example, could reverse their direction and move them to other stations for further processing.

As motor **16** drives ring gear **20** to continuously rotate drum **12** in a clockwise direction, and as it also simultaneously and timedly drives worm feed screws **40** and **42** to place uncoated can bodies **44** in register on valves **50,** the can bodies are held in register by holding

means such as continuous cables **72** (one shown) driven by the rotation of drum **12.** Cable **72** passes over roller **74** mounted on shaft **78** and insulating sleeve **79,** and over roller **76** mounted on shaft **80,** each being respectively rotatably mounted on broken away arms **81** and **82.** Brush **71** on arm **73** (broken away) connected by wire **75** to a negative D.C. source (not shown), engages and thereby imparts an anodic, negative charge to cable **72.** Roller **76** brings cable **72** into engagement with cradles **46** and the bottom ends of uncoated container bodies **44.** This imparts the negative charge to bodies **44,** renders them anodic and pressuredly holds the bodies against valves **50** as drum **12** rotates for a major portion of its 360° of rotation. Cable **72** supplies sufficient axial pressure against bodies **44** that their rims of their open ends abutting valve **50** sealingly engage sealing ring **156** (described later) of valve **50,** and the rim pressure opens the valves so that, as substantially hollow drum **12** rotates in a clockwise direction, electrolytic fluid **84** contained therein passes, preferably by gravity, through valve **50** and fills cans **44** on the lower portion of drum **12** without leakage of electrolytic fluid **84** from the system. As further explained later, when can bodies **44** are filled with fluid **84,** a potential is created between electrodes **48** and interior electrically-conductive surface areas of can bodies **44** so that a coating is electrodeposited on the surfaces. As drum **12** continues to rotate the upper portion of cable **72** separates from coated can bodies **44'** and allows them to be removed from valves **50** and cradles **46** for discharge from the system.

FIG. **2** is an enlarged top view taken along lines **2—2** of FIG. **1** and shows a portion of discharge means **23** of the apparatus of this invention. More particularly, FIG. **2** shows an upper portion of cylindrical drum wall **52** underlying a series of aligned shafts **62** and dummy rollers **63,** and **66** and **65,** the former of which are drivingly rotated in such directions that, as shown, the inner portions of upper and lower pairs of discharge belts **64** cooperate to engage the sides of coated can bodies **44'** and thereby participate in their removal from sealing rings **156** and electrodes **48** of valves means **50,** and from cradles **46.** Belts **64** also gradually move the cans along a horizontal plane. The rotation of drum **12** cooperates in the removal of electrodes **48** and cradles **46** from the can bodies. As the bodies are so carried along a horizontal plane, they are passed within the confines of pairs of side guide rails **68** (the uppermost one on each side shown) and upper and lower guide rails **70,** which can pass them to other suitable mechanisms such as turrets, belts and other guide rails (not shown) to further remove the coated bodies to other stations for further processing such as baking and filling.

The right hand portion of FIG. **2** shows the uppermost of can bodies **44** in two respective stacks thereof within guide rails **45,** above their respective worm feed screws **40** (shown in FIG. **1**) and **42** respectively having feed grooves **41** and **43** and being mounted on shafts **38** and **39** for synchronously, simultaneously and timedly feeding can bodies **44** onto cradles **46** and valves **50** of rotating drum **12.** Also shown are portions of cables **72** broken away on their respective, also broken away, rollers **74** and **76.**

FIG. **3** is an enlarged section taken substantially along line **3—3** of FIG. **1.** More particularly, FIG. **3** shows drum **12** having front convex wall **51,** cylindrical wall **52** and rear concave wall **53.** Valves **50** are mounted on cylindrical wall **52** by insulating mounts, generally designated **49,** which also insulatedly mount cradles **46** (broken away) having at their upper ends, notches **134** between and defined by spaced tines **133.**

Fastened or attached to the rear of concave drum wall **53** as by weld **86** are arms **88** of a spider structure **87** whose flanges **89** have screws **90** passing therethrough and which fasten rear drum wall **53** to main ring gear **20** having peripheral teeth **21.** As motor driven pinion gear **18** (FIG. **1**) drivingly rotates main ring gear **20** and drum **12,** the ring gear rotates on friction free ball bearings **92** in grooves within the inside of main gear **20** and within the exterior side of track **94** fixedly attached by screws **96** through its flange to bracket **99** in turn fixedly attached to main frame **15.**

Attached to the interior of rear drum wall **53** by means of bolts **280,** rubber spacers **282** and fastening rings **284,** is a portion of the means for creating a potential between electrodes **48** and interior electrically-conductive surface areas of can bodies **44** mounted on valve **50.** The aforementioned portion of the potential creating means can be a commutator assembly generally designated **96,** having a housing **97** comprised of a cylindrical wall **98** and front and rear walls **100** and **102.** Housing **97** is mounted on hollow support **104** whose axis, it is to be noted, is concentric with that of main ring gear **20.** Running through hollow support **104** are means such as pipes **106** for draining, **108** for leveling, and **110** for filling drum **12** with an electrolytic fluid. The pipes extend through hollow support enclosure cap **105** downwardly into the lower portion of drum **12** to or into the upper level of fluid **84** represented by dashed line **85** (pipe **110** not being shown). The rear portions of pipes **106, 108** and **110** can be connected to suitable means such as pumps for pressuredly or otherwise quickly effecting the draining, leveling and filling actions.

Also extending through hollow support **104** is conduit **112** for carrying wire **114** which can be connected exteriorly of drum **12** to a suitable portion of the potential creating means such as a voltage source (not shown). Conduit **112** carries wire **114** into commutator assembly **96** where it is attached to other portions of the aforementioned means for creating a potential.

As mentioned previously, commutator assembly **96** is affixed to drum **12** and rotates therewith. Connected to commutator assembly exterior cylindrical wall **98** and communicating with a portion of the means for creating a potential within commutator assembly **96** are offset fluid-proof terminals generally designated **116** on the upper, front portion, and **116'** on the lower rear portion of cylindrical wall **98.** Also connected to commutator assembly cylindrical wall **98** are bolts **119'** in the upper rear end, and **119** at the lower front end of wall **98.** Their function will be explained later. Connected to and running from terminals **116** and **116'** is intermediate circuitry comprising respective wires **120** and **121,** and **120'** and **121'** which are part of the potential creating means and which pass through the interior of drum **12,** through apertures in guide mounts **125** and are respectively connected to valves **50** by suitable electrical connecting means such as fluid-proof terminals **122** on the front and rear portions of drum **12.** Wires **120** and **121** and **120'** and **121'** communicate

with and are connected to electrodes **48,** as shown later. Guide mounts **125** reduce the slack of the aforementioned wires and prevent them from flopping around in drum **12** as it rotates. Mounts **125** also act as nuts for insulating mounts **49** on the exterior of cylindrical wall **52.**

FIG. **3** also shows pinion gear **24** fixed to shaft **25** whose central axis, it is to be noted, is offset towards the reader from the axis of hollow support **104.** Shaft **25** runs through bearing **128** attached through its flange by screws **130** to bracket **99,** and it runs through pulley **26** to which it is fixed and drivingly rotates. Pulley **26** drives belt **27** which drives pulley **28** fixedly mounted to shaft **29** running through support bearing **130.** Shaft **29** is fixedly connected to pulley **30** which drives belt **31** shown broken away but connected to other pulleys for driving the feeding and discharge means (FIG. **1**). Support bearing **130** is fastened by means of screws **132** through its flange to frame **15.**

It is to be noted that the axis of hollow support **104** and shafts **25** and **29** are not horizontal but are slightly tipped so that drum **12** is angled slightly outwardly from its top to its bottom. Drum **12** is slightly angled in this manner so that no interior wall surface of the drum extends in a horizontal direction. This is to assure that electrolytic fluid on any interior wall surface of drum **12** can run in at least a somewhat downward direction toward the bottom of the drum for draining. This angularity helps to keep the interior surfaces of the drum clean by preventing fluid material or particles from accumulating on interior surfaces of the drum.

The lower portion of drum **12** shows the bottom closed ends of can bodies **44** pressuredly and sealingly engagedly mounted on valves **50,** filled with electrolytic fluid **84** (not shown) and held in such mounted position by holding means such as continuous cables **72** extending substantially around the circumference of cylindrical drum wall **52.** Cables **72** exert axial pressure against the bottom ends of the can bodies. Cables **72** can be prevented from falling off bodies **44** (or **44'**) and can be held in a substantially diametrical position relative thereto by being held in notches **134** between and defined by spaced tines **133** adjacent the ends of cradles **46.**

The upper portion of FIG. **3** shows cables **72** no longer pressuredly engaging the bottom ends of coated can bodies **44'.** It shows separating knives **135** having separated the rims of bodies **44'** from valves **50** so that respective pairs of discharge belts **64** engaging each side of respective bodies **44'** can carry the bodies from the drum in a substantially horizontal plane as drum **12** cooperatively continues to rotate and carry valves **50** and electrons **48** in a circumferential arc downwardly out of the bodies **44'.** Belts **64** carry the bodies to guide rails **68** and **70** (not shown).

FIG. **4** is an enlarged perspective view of one of cradles **46** shown broken away in FIG. **3.** More particularly, FIG. **4** shows a cradle generally designated **46** having leg mount **131,** arms **132** and spaced tines **133** defining notch **134** into which cable **72** fits during a major portion of the rotation of drum **12.** Leg mounts **131** are fastened by bolts of insulating mounts **49** to drum cylindrical wall **52.** Arms **132** help receive, register and keep registered bodies **44** on valve means **50,** during rotation of drum **12.** They also maintain bodies **44'** in position when cables **72** lose contact with the bottoms of bodies **44'** at approximately the 12 o'clock position (FIG. **1**).

FIG. **5** is an enlarged section taken substantially along lines **5—5** of FIG. **1.** More particularly, FIG. **5** shows valve means such as a fluid valve, generally designated **50,** mounted in a wall of a reservoir such as cylindrical wall **52** of reservoir or drum **12,** the valve means being shown in its closed position with no fluid in its chamber and no container body on its sealing rim **156.**

Fluid valve means **50** is comprised of a fixed exterior housing, generally designated **136,** fixedly mounted on cylindrical drum wall **52** by means of a substantially L-shaped sealing gasket **138,** the exterior housing having a side wall **140** abutting gasket **138** and having a rigid back wall **142** proximate the interior of drum **12** and having apertures **144** therein (one shown) communicating with a portion of the interior of drum **12** which does not contain any of fluid **84.** Fluid valve **50** is also comprised of a moveable interior housing **146** interior of and slidingly engaging exterior housing side wall **140** and defining a central chamber **148.** Interior housing **146** has a mouth generally designated **150** and defined by flanges **152** and **154,** in which is mounted and seated a resilient sealing ring **156** which is biased by biasing means such as helical spring **158** in cutout portion generally designated **160** in the exterior wall of interior housing **146.** The biasing being sufficient to sealingly engage sealing ring **156** against legs **162** of fixed valve member generally designated **164** fixedly connected through current carrying means such as core **166** to back wall **142** adjacent apertures **144** in exterior housing **136.** Connected to and extending or projecting from valve member **164** is an electrode such as helical spring **48** connected to head **168** of phillips screw **170,** also part of the current carrying means, threadedly engaged to core **166.** Biasing means **158** includes rigid backing ring **172** located adjacent back wall **142,** and one or more rigid lock washers **174** mounted between ring **172** and spring **158,** for backing and biasing the spring and interior housing **146** outwardly toward and against legs **162** of valve member **164.** Both ring **172** and lock washer **174** are located between inner housing **146** and exterior housing side wall **140.**

Abuttingly engaged between the interiormost edge of backing ring **172** and an adjacent portion of exterior housing wall **140** is a fluid sealing and preventing means which includes a flexible and resilient annular interior sleeve **176** and an annular elastomeric O-ring **178** for sealing and preventing fluid from chamber **148** from passing between interior and exterior housings **146** and **136.** Interior sleeve **176** extends between annular O-ring **178** and backing ring **172,** around the interiormost edge **180** of interior housing **146** and is abuttingly engaged and compressedly fastened within an annular groove **182** in the interior wall of interior housing **146** defining chamber **148,** by means of one or more rigid lock washers **184** (not shown) which peripherally forces adjacent portion of interior sleeve **176** into annular groove **182.**

Also included as part of the fluid sealing and preventing means is a resilient flexible annular exterior sleeve **186,** having flange **188** engagingly extending around interior housing flange **154** and abuttingly engaging sealing ring **156.** Exterior sleeve **186** has an interior annular bead **190** abuttingly engaging the corner of interior housing flanges **152** and **154.** Exterior sleeve **186**

has at its interiormost end an integral, annular, exterior bead **192** defining an adjacent annular sleeve groove **194** within which an annular coiled garter spring **196** sealingly holds exterior sleeve **186** within annular exterior housing groove **198** formed by annular exterior housing bead **200** and flange wall **202.** Exterior sleeve **186** is sealingly fastened to interior housing flange **154** by means such as annular steel wire **204** which sealingly holds a portion of the exterior sleeve within annular groove **206** in the exterior of interior housing flange **154.**

The upper portion of FIG. **5** shows conductive metal wire portion **126** of an insulated wire such as designated **120** (or **120'**, **121** or **122'**) (FIG. **3**), descending through terminal generally designated **122** and comprised of a connecting screw plug **123** having a non-conductive fluid-proof plastic or other suitable tube-shield **208** thereover. Plug **123** is threadedly engaged within the head of connecting screw jack **124** having a threaded shaft **212** threadedly engaged within bore **214** of exterior housing backwall **142** and within core **166** of valve member **164.** Wire **120** runs through the center of plug **123** and extends down to and contacts a portion of jack head **124'**. Plug **123** can be fastened to connector screw jack **124** or valve means **50** in any conventional manner that will provide a fluid-tight seal and will allow plug **123** to be screwed into jack **124** without unduly twisting the conductive metal wire portion **126.**

FIG. **5** shows electrical circuitry that is part of the potential creating means of this invention. The circuitry includes conductive wire portion **126** of wire **120,** terminal **122,** solid metal core **166,** phillips screw **170,** head **168,** and helical spring electrode **48.** Solid metal core **166** has a non-conductive moisture-proof polyolefin shield **167** therearound. Valve member legs **162** are covered with a similar material (not numbered).

It is to be noted that all portions of fluid valve means **50** which are or might be exposed to electrolytic fluid **84,** excluding electrode **48,** are made of, covered with or otherwise isolated from the current carrying means by, a suitable non-conductive material. For example, the housings can be manufactured of a commercially available rigid, moisture-proof, non-conductive material that will not gall with each other, such as an acetal resin sold under the trade designation "Delrin," a trademark owned by I. E. Dupont de Nemours and Co. Inc., for the interior housing, and a commercially available polycarbonate thermoplastic for the exterior housing. Annular sealing ring **156,** can be made of an elastomer such as isoprene, and O-ring **178** and interior and exterior sleeves **176** and **186** of a suitable non-conductive flexible resilient non-permeable, fluid-sealing elastomer such as a neoprene. The only metal parts employed interior of exterior housing **136,** i.e., spring **158,** backing ring **172,** and lock washers **174** and **184,** are effectively non-conductively isolated from electrode **48** or from any fluid **84** in or flowing through chamber **148.** The current carrying portions of fluid valve means **50,** e.g., solid metal core **166** and phillips screw **170,** preferably are made of steel and are effectively non-conductively isolated from contact with electrolytic fluid **84** and will therefore not have a build-up of particles thereon which would require maintenance, clean-up and possible clogging and inefficient operation of the valve means.

FIG. **6** is an enlarged cross section taken substantially along line **6—6** of FIG. **3.** More particularly, a fluid valve means **50** similar to that in FIG. **5** is shown in an open position. With sufficient axial pressure exerted by cable **72** against the bottom of container **44,** its rim R is presssuredly sealingly engages sealing ring **156** and pushes interior housing **146** inwardly against the bias of spring **158,** such that interior housing flange wall **152** abuts exterior housing lip **201** and the interiormost edge of interior housing **146** flexes interior sleeve **176** inwardly towards aperture **144** of back wall **142.** As interior housing **146** is so moved inwardly and as sealing ring **156** about valve mouth **150** is also moved inwardly, its interior angular wall **157** is moved inwardly away from legs **162** of valve member **164** to break its sealing engagement therewith and thereby create a passageway P between sealing ring **156** and legs **162** which allows electrolytic fluid **84,** which had been in the bottom of drum **12** and within valve chamber **148,** to gravity-pass downwardly through passageway P and fill container body **44.**

As will be explained in detail in relation to FIG. **8,** during a portion of the rotation of drum **12** when electrolytic fluid **84** is within container body **44,** a potential difference is created between spring electrode **48** and interior electrically-conductive surface areas of walls W of container body **44.** Due to the potential created, electric current flows through the circuit comprising the electrode, the fluid and the metal conductive body surface areas. Coating particles are thereby deposited on the surface areas to fully coat their entirety or to repair coat discontinuities in a base coat thereon.

FIG. **7** is a plan view taken substantially along line **7—7** of FIG. **6** and shows an upper portion of exterior housing back wall **142** having a bevelled edge **143,** and having apertures in the wall defined by arcuate walls **144** and in part by wall **147** of exterior housing **136.** FIG. **7** also shows a cross section through the threaded, shaft portion **212** of connector screw jack **124** threadedly fastened within bore **214** to back wall **142.**

FIG. **8** is a front elevation taken from the inside of drum **12** just interior of front wall **51** in FIG. **3.** FIG. **8** shows front wall **216** of enclosure cap **105** having ports **222** and bolts **218** in holes **220** for securing enclosure cap **105** to wall **103** of hollow support **104.** Wall **103** has a stepped surface **103'** therein. Enclosure cap ports **222** join and house pipes **106, 108** and **110** entering from hollow support **104,** and their broken away portions descending therefrom towards the bottom of drum **12** (not shown).

FIG. **8** also shows front wall **100** of commutator assembly **96** having a protruding stepped portion **101** whose lowermost surface **101'** of its lowermost flange is just above cylindrical surface **224** of enclosure cap **105.**

The lower, broken away portion of commutator assembly **96** shows mounted within drum **12,** a portion of the potential creating means of this invention. It is to be noted that commutator assembly **96** of FIG. **3** should be considered as divided transversely in half, and that the largest broken away portion of FIG. **8** shows a portion of the front half of the commutator assembly (see FIG. **9**). The dashed upper portion of FIG. **8** is also the front portion of the assembly interior of housing wall **100.**

The large broken away portion of FIG. **8** shows electrical cam bar **228** fastened to crib **230** of cam support

232 by means of bolts 234 whose threaded shafts pass through apertures 236 and are threadedly engaged to cam bar 228' in the rear portion (not shown) of commutator assembly 96.

It is also to be noted that cam support 232 on which is mounted cam bar 228, a fixedly mounted upon fixed hollow support 104 which is in turn fixed to bracket 99. Commutator assembly housing 97 (FIG. 3) including its exterior front wall 100, protruding stepped portion 101 cylindrical wall 98 and cylindrical wall rib 238, and all of the structure shown mounted on wall 98 and its rib 238 peripheral to or below cam bar 228, rotate around the aforementioned fixed structures 232, 228 and 104.

Cylindrical wall 98 has U-shaped cut-outs 240 in its rib 238 and is fastened to the periphery of housing wall 100 by means of nuts 242 being threadedly fastened to shafts 243. Wall surface 244 of cylindrical wall 98 abutting the interior of wall 100 shows shaft 243 in section. Spacers 248 are mounted on shafts 250. Pivot arms 246 are rotatably mounted on shafts 250 (front ends shown) which pass within bores 241 in rib 238 of cylindrical wall 98. Pivot arms 246 have stop portions 252 which limit their rotation by abutting interior wall surface 245 of cylindrical wall 98. Pivot arms 246 also have electrical contacts which can be carbon brushes or studs 254 mounted therein by their shafts 256 (FIG. 10) passing through arm bores 258 (FIG. 10) and being threadedly engaged by nuts 259 (FIG. 10). Secured to shafts 256 between nuts 259 and the bottom surfaces of pivot arms 246 are electrical connecting lugs 260 having wires 121 therein which extend over spacers 248, down through holes 262 extending radially through cylindrical wall 98, through terminals 116 and through the interior of drum 12 to terminals 122 of valves 50. Each wire 121 is joined as by splicing to another wire 120 and each wire 120 and 121 extends fairly tautly within drum 12 to cylindrical wall 52 thereof, where they are electrically connected to valves 50, as shown in FIG. 3.

FIG. 8 also shows a more deeply broken away portion of cylindrical wall 98 directly underlying contacts 254. FIG. 8 there shows a substantially Y-shaped bore 264 in wall 98 having threadedly secured to its lower portion a threaded stud shaft 266 of a bolt 119, the end of which provides a backing for biasing means, such as helical spring 268, which abuttingly engages contact shaft 256 and nut 259 on the lower end of contact 254 and thereby normally biases contact 254 in its uppermost position. Contacts 254 remain in this position throughout most of the rotation of cylindrical wall 98, commutator assembly 96, and drum 12, i.e., except for the period of rotation during which the contacts engage arcuately shaped surface 229 of cam bar 228. As contacts 254 are rotated clockwise and are passed upwardly to the left around and against electrical cam bar 228, they are moved downwardly on pivot arms 246 against the bias of springs 268.

Although FIG. 8 only shows a few of the contacts, rocker-arms, spacers, terminals, etc., it is to be understood that such mechanisms are located all the way around the periphery of cylindrical wall 98 of commutator assembly 96.

As mentioned previously, it is to be noted that commutator assembly 96 should be considered as having two halves and that the broken away portions of FIG. 8 show only the front portion of the front half of the commutator assembly. This can be more clearly seen in FIG. 9 which is an enlarged top view taken in section through lines 9—9 of FIG. 8. The lower portion of FIG. 9 is the front of commutator assembly 96. If one considered front commutator assembly wall 100 removed from FIG. 9, the front of FIG. 9 would then show the largest cut away portion of FIG. 8.

Shown in FIG. 9 are pivot arms 246 having contacts 254 whose shafts 256 (not shown) are mounted in bores 258 therein and secured thereto by nuts 259 (not shown) which also secure electrical connecting lugs 260 to pivot arms 246. Pivot arms 246 are mounted on shafts 250 passing through and mounted in cylindrical wall rib 238 by means of nuts 274 within U-shaped grooves 240, being threadedly engaged to shafts 250. Shafts 250 pass through bores 241 in rib 238 and have integral nut-shaped flanges 278 acting as spacers between rib 238 and pivot arms 246. Shafts 250 also have mounted thereon spacers 248 which cooperate with flange spacers 278 to maintain pivot arms 246 in an aligned position so that the rotary path of commutator assembly's cylindrical wall 98 will bring contacts 254 into aligned contact with cam bar 228. FIG. 9 shows wire 121, crimped to and running from connecting lug 260, passing over spacer 248 down through hole 262 (dotted circles under spacers 248) in cylindrical wall 98 and down through terminal 116 (not shown) whose connecting screw jack 118 (not shown) is mounted in the bottom of cylindrical wall 98. Also shown in FIG. 9 are Y-shaped bores 264, under contacts 254 (here removed), the bores having springs 268 mounted therein and biased upwardly towards the reader by bolt stud shaft 266.

The rear portion of FIG. 9 is a duplication of the structure just described for the front portion of FIG. 9, except that the rear structures, it is to be noted, are given primed numerical designations and they are offset from the structures in the front.

FIG. 10 is a cross section taken substantially along line 10—10 through commutator asssembly 96 of FIG. 8. More particularly, FIG. 10 shows, mounted within drum 12 on rear wall 53 by means of bolts 280, spacers 282 and ring 284, commutator assembly 96 having rear wall 102 secured to rear drum wall 53 and front wall 100, and, fixed therebetween, cylindrical wall 98. The upper portion of FIG. 10 shows rib 238 of cylindrical wall 98 having shaft 250 extending therethrough and being secured to rib 238 by means of nut 274 in U-shaped groove 240. Shaft 250 has integral flange spacer 278 betweeen pivot arm 246 and rib 238. Wire 121 is shown passing from within commutator assembly 96 through bore 262, terminal connecting screw jack 118, and connecting screw plug 117, where it is joined by wire 122, both wires passing to valves on cylindrical drum wall 52 (not shown).

That portion of cylindrical wall 98 and commutator assembly 96 shown to the right of rib 238, which in FIGS. 8 and 9 has been called the rear of the commutator assembly, shows contact 254' mounted on shaft 256' and secured to rocker arm 246' by nut 259'. Contact 254' is biased in a downward direction by spring 268' and by threaded stud shaft 266' of bolt 119'.

The lower portion of FIG. 10 shows front cam bar 228 and rear cam bar 228' secured to cam support ring 232 by means of bolt 234 passing within apertures 236 (not shown) and being threadedly engaged to cam bar

228'. FIG. 10 shows contact 254 mounted on rocker arm 246 and being biased against and contacting cam bar 228 to thereby close a circuit which allows electrodepositing current to flow from a voltage source (not shown) through wire 114 in conduit 112, connecting lug 272, bolt 234, cam bar 228, contact 254, shaft 256, connecting lug 260, wire 121, which passes over spacer 248 and passes down through offset front structure not shown, i.e., bore 262 and terminal 116 comprising connector screw jack 118 and connector screw plug 117 (such as shown in FIG. 8). At the exterior of terminal 116, as in FIG. 8, wire 121 is joined by wire 120 and both wires run as part of intermediate circuitry to valves 50 on the lower portion of drum 12 (not shown). The aforementioned structure not shown in FIG. 10 but shown in FIG. 8, is the same as the structure through which wire 121' passes at the lower rear of FIG. 10.

Commutator assembly 96 and all of its housing walls 100, 98 and 102 (affixed to rear drum wall) rotate with drum 12 around fixed hollow support 104 secured through its flanges to frame bracket 99 by bolts 286. Commutator assembly 96 rotates around cam support ring 232 fixedly mounted on hollow support 104 by enclosure cap 105 being bolted by bolts 218 to hollow support wall 103 whose recessed flange surface 226 abuts spacer 288 whose hub 290 abuttingly and fixedly engages cam support ring 232 against wall stepped surface 103''.

FIG. 10 also shows that the lower interior surfaces of protruding stepped front wall 101 has flange rings (unnumbered) which cooperate with grooves and opposing flange rings in spacer 288 to form a labyrinth seal for preventing fluid within drum 12 from passing through channel 290 and splashing into commutator assembly 96. FIG. 10 also shows drain pipe 106 (broken away) passing through hollow support 104 and through port 222 downwardly into drum 12. Conduit 112 passing through the interior of hollow support 104 has an elbow 113 and is secured to support 104 by nut 292 engaging flanges of support 104.

As shown in FIG. 9, contacts 254 and 254' are staggered, each separately sending current through wires 121 and 121', respectively staggered terminals 116 and 116', and joining wires 120 and 120', each of which wires 120 and 121 goes to one of an aligned pair of valves 50 and wires 121 and 121' to the next aligned pair of valves 50 on cylindrical wall 52 of drum 12. This staggered arrangement of contacts 254 and 254' means that as a front contact 254 engages cam bar 288, one will leave 288, during which time the number of rear contacts 254' does not change. This keeps the current load fairly constant by not making more simultaneous contacts and therefore larger current demands.

The electrocoating system of this invention for electrodepositing a coating on interior electrically-conductive surface areas of container bodies, can be operated by a method which comprises starting the means for rotating the reservoir, i.e., the drive means which includes the motor 16, which in turn drives pinion gear 18 in a counterclockwise direction. This drives main ring gear 20 and reservoir or drum 12 attached thereto, in a clockwise direction. Main ring gear 20 in turn drives pinion gear 24 and the aforementioned series of belts and pulleys which in turn ultimately drive feeding means 22 for feeding can bodies 44 onto rotating drum 12, and also drive take-off or discharge means 23 for taking the coated can bodies 44' off of drum 12 and discharging them from the system for further processing at other stations.

In the preferred embodiment shown in the drawings, a plurality of uncoated can bodies 44 from a source are individually passed through guide rails 45 defining two stacks, the lowermost can body 44 of each stack being taken within respective grooves 41 and 43 of respective worm feed screws 40 (FIG. 1) and 42 (FIG. 2), which, as they rotate, simultaneously, synchronously and timedly feed their respective can bodies onto each cradle 46 of a pair from a radially-aligned continuous series of such pairs mountedly aligned in two rows around the circumference of synchronously rotating drum 12. Uncoated can bodies 44 are passed from worm feed grooves 41 onto cradles 46 when the cradles are at an angle which allows the can bodies to slide down the cradles and over electrodes 48 protruding from each valve 50 mounted in the drum. Thus, worm feed screws 40 and 42 cooperate with cradles 46 to feed uncoated can bodies 44 in register onto valve means 50.

As drum 12 continues to rotate in a clockwise direction, the rims of each row of uncoated can bodies 44 restingly registered on valves 50 are diametrically, pressuredly engaged by continuous cables 72 driven by drum 12 to rotate in a clockwise direction over rollers 74 and 76. The tautness of cables 72 caused by the passage of cables 72 over the rollers maintains the diametrical pressured engagement with the bottoms of the can bodies throughout rotation of drum 12 until the coated can bodies 44', are taken off drum 12. As shown in FIG. 3, cables 72 are aligned with and are positioned within cradle notches 134 of spaced tines 133 so that the cables remain aligned in diametrical position in relation to the can bodies throughout the rotation of the drum. Cables 72 provide sufficient axial presssure on the bottoms of the can bodies to sealingly engage their rims against sealing rings 156 in mouths 150 of valves 50, and to depress or move interior valve housings 146 inwardly against the bias of their springs 158 to create passageways P between valve member legs 162 and sealing rings 156. Cables 72 are taut enough to maintain this pressure and to maintain passageways P from approximately the 3 o'clock to approximately the 12 o'clock rotational position of drum 12 (FIG. 1).

When the uncoated bodies 44 are sealingly engaged against valves 50 and a passageway has been created leading from drum 12 to the interiors of the bodies, drum 12 continues to rotate. As can bodies 44 on open valves 50 are rotated downwardly, electrolytic fluid 84 within drum 12 gravity-passes through passageways P into the interiors of bodies 44. Fluid 84 gravity-remains therein during drum rotation from about the 4 o'clock to about the 8 o'clock rotation position during which time the electrodeposition process takes place when contacts 254 and 254' engage cam bars 288 and 288'. Fluid 84 in now coated bodies 44' gravity-passes therefrom through passageway P and drains back into drum 12. Fluid 84 continues to drain therefrom as the coated bodies 44' continue to be rotated from about the aforementioned 8 o'clock position to about the 11 or 12 o'clock position, where coated bodies 44' are removed from the drum.

Before uncoated bodies 44 on open valves 50 adjacent the 3 o'clock position are rotated downwardly to a position where fluid 84 begins to pass into the can bodies, a voltage is created in the potential creating means, e.g., in a power supply (not shown) sufficient to

pass requisite current through wire **114** in conduit **112** of hollow support **104**, the electrical circuitry of commutator **96**, wires **120, 120'** and **121, 121'**, and through valve members **162** of valves **50** to spring electrodes **48**.

In the preferred embodiments shown in the drawings, electrode **48** is cathodic, and, current created therein and transferred to electrolytic fluid or coating medium **84** causes coating ions or polyelectrolytic particles therein and carrying a negative charge to migrate to and discharge onto interior electrically conductive, here positively, charged surface areas of the anodic metal can bodies. This electrodeposition or electrocoating process takes place during the time that contacts **254** and **254'** engage cam bars **288** and **288'**, generally between about the 6 and 9 o'clock rotational positions of drum **12**, as shown in the broken away portion of FIG. **8**. The length of time of electrodeposition can be varied by varying the length of the cam bars.

Coated can bodies **44'** are held onto drum **12** by cables **72** until about the 12 o'clock position where the cables angle off the path of rotation of drum **12**, and, as they leave the can bodies, the bodies are grasped between pairs of take-off or discharge belts **64** in a manner that allows the can bodies to be lifted from cradles **46** and from electrodes **48** without the electrodes contacting interior surfaces of the bodies or cradles **46** touching previous removed cans. Both front and rear take-off or discharge means **23** are driven by main ring gear **20** and by various belts and pulleys and they are simultaneously operated in timed, synchronous relationship with the rotation of drum **12** and with feeding means **22**.

The reservoir or drum **12** of this invention can be of any suitable size or shape and can be of any suitable material. Preferably, the reservoir is drum-like and has a cylindrical wall. When the drum is made of stainless steel or another conductive material, it is advantageous to coat the interior of the drum with a suitable material such as a conventional asphalt-epoxy coating (discussed later), that will prevent coating ions or electrolytic particles from depositing upon and accumulating upon the interior walls of the drum.

Fluid valve means **50** can be mounted in drum **12** in any suitable number, order, or arrangement, although it has been found advantageous to mount them in one or more and preferably a plurality of rows of radially aligned pairs. All parts of valve means **50** exposed to electrolytic fluid **84** are non-conductive in relation to fluid **84**. They are isolated from electric current so that all exposed parts and moveable parts are not subject to an accumulation or build-up of coating ions or electrolytic particles thereon. For example, conductive parts such as spring **158** and backing ring **172** are isolated from fluid **84** by interior housing **146**, and stainless steel core **166** of valve **50** is insulated from fluid **84** by non-conductive thermoplastic insulative coatings such as **167** on valve member **164**.

Electrodes **48** preferably are helical springs for preventing can jam up on sealing rings **156** of valves **50**. However, the electrodes can be of any suitable conductive material or design sufficient to deposit the requisite amount of coating ions or electrolytic particles on all interior electrically conductive surfaces areas of can body walls W. The electrode can be of any size or shape sufficient to allow the registered feeding of uncoated can bodies **44** thereover and the systematic continuous take-off of can bodies **44'** therefrom without the electrodes touching or otherwise preventing the take-off and discharge from the electrocoating system.

Cradles **46** can be of any suitable shape and can be of any suitable conductive or non-conductive materials. However it is advantageous that the cradle be conductive when the means for holding the uncoated can bodies **44** on valves **50** has and imparts a negative charge such as cables **72** so that cradles **46** aid in passing this negative charge to the can bodies **44**. When cradles **46** are conductive it is advantageous to mount them on non-conductive mounts to insulate a conductive, e.g., steel drum therefrom.

Feeding means generally designated **22** can include any suitable means for feeding can bodies **44** in timed, simultaneous synchronous registered fashion in relation to the rotation of drum **12** so that the bodies are deposited in cradles **46** and are mounted on electrodes **48** and registered on sealing rings **156** of valves **50**. The feeding means includes cradles **46** or other suitable means for registering the can bodies on the sealing ring of valve means **50**. Feeding means **22** also includes any suitable means such as continuous cables **72** for holding the bodies in registered sealing engagement on sealing rings **156** and for providing pressure sufficient to create passageways P between valve member legs **162** and sealing rings **156**.

This invention is suitable for use with can bodies having either one or two open ends. However, when the bodies have two open ends, the holding means can include means for sealing the exteriormost open end of such bodies to retain the electrolytic fluid **84** therein during the electrocoating depositing process.

Take-off or discharge means **23** can include any suitable means such as knives **134** for separating the rims of the coated can bodies **44'** from the valve means **50**, and can include any suitable means for removing the coated can bodies **44'** from radially protruding electrodes **48** and cradles **46** without electrodes **48** contacting the can bodies or either structure interferring with their removal. Discharge means **23** can also include any suitable means such as guide rails or conveyors for transferring the removed can bodies from the system to another location for further processing.

Container bodies suitable for having coating ions or electrolytic particles deposited upon their interior electrically-conductive surface areas, can be any can body made of conventional materials such as aluminium, tinplate, tin-free steel (TFS), or black plate. The container bodies coated according to this invention can be 2-piece bodies for making 3-piece cans, or 1-piece bodies for making 2-piece cans. The container bodies can have two open ends but preferably they only have one open end. The two-piece bodies for coating can have any conventional side seam construction, and the one-piece cans for coating can be drawn and ironed or impact-extruded.

As mentioned previously, can bodies **44**, herebefore designated "uncoated" has been meant to include container bodies which do not have and are intended to receive a full single coat, or cans which have a base coat which requires a repair coat.

The means for creating a potential between electrodes **48** and can bodies **44** can include any conventional power source. It has been found advantageous to employ a standard, conventional, low ripple, constant voltage source such as that designated Model No.

SCR–500, manufactured by Electronic Measurements Inc.

The amount of voltage employed to electrodeposit a single or repair coat from an organic polyelectrolytic medium can be any sufficient amount depending on the circumstances, preferably the least amount that will give a satisfactory single or repair coat in the time desired for the particular metal substrate and electrocoating medium employed. Typical voltages generally utilized in electrocoating processes are in the range of about 50–500 volts, more commonly from about 100–400 volts.

The polyelectrolytic electrocoating material mediums which can be employed in the electrocoating system of this invention can be any of the organic resin-containing materials utilizable as electrocoating concentrates or baths in metal electrocoating systems. The mediums can be aqueous or non-aqueous, i.e., solvent containing, but preferably they are aqueous. The mediums can be modified, extended, and stabilized with solutilizers or other materials.

Examples of aqueous mediums which can be employed are those disclosed in U.S. Pat. No. 3,230,162 issued to A. E. Gilchrist on Jan. 18, 1966. Disclosed therein are numerous concentrate compositions generally comprising about 50 to 95 percent by weight polycarboxylic acid resin, about 1 to 10 percent water soluble amino compound and the balance water. The polycarboxylic acid resins are film-forming at electrodeposition bath temperatures, and are curable to a tack-free film.

Other aqueous polyelectrolytic electrocoating material mediums which can be employed according to this invention are disclosed in U.S. Pat. No. 3,366,563 issued to Hart on Jan. 30, 1968. Generally, Hart discloses an aqueous electrocoating bath containing a solubilized vehicle resin which comprises the reaction product of a drying oil fatty acid ester or a semi-drying oil fatty acid ester with an alpha, beta-ethylenically unsaturated dicarboxylic acid or an anhydride of such an acid.

Examples of non-aqueous polyelectrolytic electrocoating material mediums which can also be employed are disclosed in U.S. Pat. No. 3,463,714 issued to W. D. Suomi and A. R. Ravve on Aug. 26, 1969. Disclosed therein are electrocoating baths prepared generally by dissolving a carboxyl-containing polymer and a basic nitrogen-containing compound in an organic solvent and adding a sufficient amount of a polar organic non-solvent having a solubility parameter greater than 12 and a hydrogen bond index greater than 7.5 to convert the solution into a suspension.

The polyelectrolytic electrocoating material mediums disclosed in the aforementioned patents are merely examples of some of the many aqueous and non-aqueous mediums which can be employed. For example, also utilizable are non-polycarboxylic acid resins such as rubber lattice suspended resins adsorbed by hydroxyl ions, and resins formulated for example from phenolics, polyvinyl ethers, cellulosic resins, polyimides and silicones.

That the electrocoating system of this invention can be employed to electrocoat interior, electrically-conductive surface areas of can bodies is shown in TABLE I wherein 2-piece drawn and 3-piece regular can bodies (respectively 1-piece and 2-piece during the coating operation), full and repair coated with aqueous electrocoating mediums or baths at rates as fast as 2 seconds, approximately 600 cans/per minute, obtained satisfactory quick tests within the range of from 0 to 1.0 ma.

TABLE I

EXAMPLES	TYPE-CAN	TYPE	BATH Solids Content	BATH Resisitivity (ohm/cm)	T(°F)	VOLTAGE	TIME *** (seconds)	EQUIV. CANS MIN.	QUICK TEST** (milliamperes)
Full Coating									
1	2-piece drawn tinplate	A	10%	1,980	85°	400	4 aapprox.	300	0–0.25
2	do.	do.	do.	do.	do.	500	2 approx.	600	0.5–1.0
Repair Coating									
3	3-piece TFS Miraseam*	B	2.5%	adjusted to 4,800	75° – 80°	200	3.5 approx.	380	0.57
4	do.	do.	2.0%	adjusted to 5,500	80°	100	2.0 approx.	600	0–0.4
5	do.	do.	2.1%	adjusted to 4,400	80°	100	2.5 approx.	520	0–6.0

A and B — Anodic aqueous electrocoating baths prepared by diluting CS576 (for A) and X1222 (for B) (manufactured by Pittsburg Plate Glass Co.) to the indicated percent solids solution, with ionized water. CS576 and X1222 are believed to be roughly 22 percent solids concentrate solutions of butyl acrylate-styrene-methacrylic acid-hydroxyethyl methacrylate and containing no more than 20 wt. % of total polymer units derived from methacrylic and containing no more than 7 wt. % of total polymer units derived from hydroxyethyl methacrylate.

The resistivity of the baths used for full coating the tinplate bodies was unadjusted, whereas that for the TFS bodies was adjusted by contacting the unadjusted bath with a weak electrolyte, CO_2 in the manner disclosed in U.S. Pat. application Ser. No. 209,305 filed on Dec. 14, 1971. The method disclosed in the aforementioned application can advantageously be employed in relation to the electrocoating system of this invention.

In the electrical coating circuitry of this invention, wire **114** (FIG. **10**) is connected to the positive terminal of the power source (not shown), and is ultimately connected through the cam bars, contacts and valves to electrodes **48,** thereby rendering them cathodic. Wire **75** (FIG. **1**) is connected to the negative terminal of the power source and is ultimately connected through the brushes and the cables to container bodies **44** and **44'**, thereby rendering them anodic. When, as shown in TABLE I, an anodic electrolytic fluid or bath such as X1222 fills the container bodies **44,** and the contacts engage the cam bars, negatively charged electrolytic coating particles in the bath migrate to, discharge onto and coat any positively charged interior conductive surfaces of the anodic container bodies.

It has been found highly desirable to isolate, and the embodiment of this invention essentially isolates, the interior surfaces of metal drum **12** from the aforementioned coating circuit.

This prevents electrolytic particles in fluid **84** from being electrodeposited on any such surfaces exposed to the fluid, and it prevents power loss from the power source through the exposures, to drum **12** which preferably is grounded.

Although electrolytic particles from electrocoating fluids would tend to increasingly insulate the exposed area as it coated the area, some recently developed fluids would not so readily coat the area and therefore would allow power loss.

The coating used to insulate the interior of drum **12** can be any coating or coatings suitable for insulating the drum. The type of coating will vary depending on the type of material used to make the drum. For the stainless steel drum of this invention, it has been found advantageous to condition the interior surface as by sand blasting, and to treat the surface with a 0.3 to 1 mil thick layer of a material such as an alcoholic solution, e.g., a "Polyclutch" Wash-Primer preparable by those skilled in the art according to MIL Specification MIL–C–15328, designated UC–40082, by PPG Industries, Inc. A conventional, commercially available material such as a two component system, polyamide-cured, heavy duty coal tar epoxy sold under the trade designation UC40101 by PPG Industries, Inc. can be applied over the primed surface in thick layers of say about 6 mils each.

Of course, when drum **12** is not made of a conductive metal but is made of say a molded, cured glass filament epoxy material, the aforementioned coatings would not be employed.

I claim:

1. A fluid valve for electrodepositing systems wherein an electrolytic fluid and electric current insulatedly pass through the valve, which comprises:

a fixed exterior housing mountable on a wall of a reservoir containing the fluid, the exterior housing having a back wall with apertures therein communicating with the interior of the reservoir,

a moveable interior housing, interior of and slidingly engaged with the exterior housing, the interior wall of the interior housing defining a central valve chamber having

a mouth opposite the back wall,

a resilient sealing ring mounted in the mouth,

a valve member fixedly connected at one of its ends to the back wall, extending axially into the chamber and having legs fixed to and extending transverse to its axis, the axial portion of the valve member having a conductive core connectable to circuitry,

an electrode connected to and projecting from the exterior of the valve member,

means for sealing and preventing fluid from passing between the housings, and

biasing means between the housings for flexibly biasing the sealing ring of the interior housing in sealing engagement with the valve member legs to seal the fluid valve chamber, the biasing means being inwardly compressible toward the back wall by an axial force, so that when the force is sufficient to compress the sealing ring and biasing means, a passageway is created between the valve member legs and the sealing ring which allows fluid to flow from the reservoir to the exterior of the valve chamber.

2. The fluid valve of claim **1** wherein all parts of the valve means excluding the electrode, exposable to the fluid, are non-conductive in relation to the fluid.

3. The fluid valve of claim **2** wherein the biasing means is a helical spring extending around and being abuttingly biased against a support wall of, the interior housing.

4. The fluid valve of claim **3** wherein the biasing means also includes a rigid backing ring adjacent the back wall of the exterior housing for backing the spring.

5. The fluid valve of claim **4** wherein the fluid sealing and preventing means includes an annular flexible resilient interior sleeve partly within the chamber and sealingly fastened to the interior of the interior housing and the exterior of the exterior housing to prevent fluid from passing therebetween.

6. The fluid valve of claim **5** wherein the interior housing has a continuous annular groove therein and the interior sleeve is sealingly engaged to the interior housing by means of at least one lock washer which peripherally forces an adjacent portion of the sleeve into the interior housing groove.

7. The fluid valve of claim **6** wherein the fluid sealing and preventing means includes an annular flexible resilient exterior sleeve sealingly fastened to and for sealing the exteriors of the interior and exterior housings, exterior of the reservoir wall.

8. The fluid valve of claim **7** wherein the electrode is a helical spring, the biasing means also includes a rigid lock washer mounted between the backing ring and the spring for backing the spring and acting as a stop against outward movement of the interior housing, and the fluid sealing and preventing means also includes an annular elastomeric O-ring between the back wall and an interior sleeve portion that is adjacent the backing ring.

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