United States Patent [19]

Gerlovich

[11] **3,741,149**

[45] **June 26, 1973**

[54] **AUTOMATIC MACHINE FOR SPRAYING THE INTERIOR OF CONTAINER SHELLS**

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[73] Assignee: **Rheem Manufacturing Company,** New York, N.Y.

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[52] **U.S. Cl.** **118/2,** 118/317, 118/323, 118/326

[51] **Int. Cl.** **B05c 7/02,** B05c 11/16

[58] **Field of Search** ..... 118/301, 319, 317, 118/326, 50, 50.1, 323; 134/144, 167 R

[56] **References Cited**

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2,026,080	12/1935	Ziska	118/326 X
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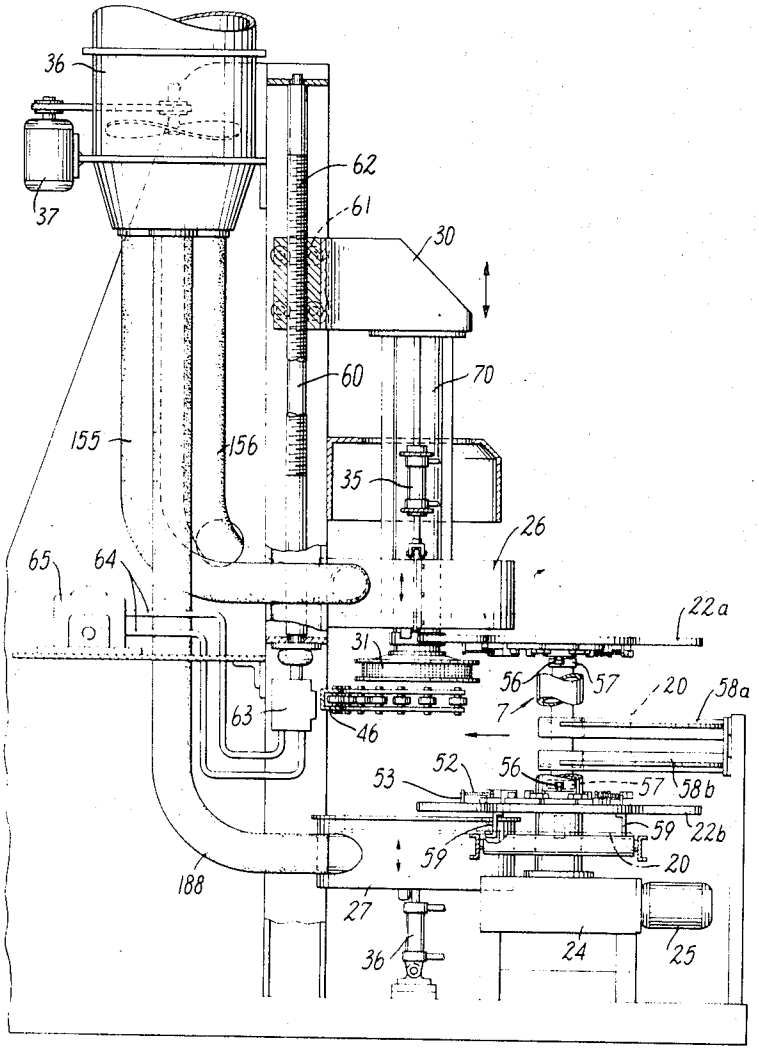
Primary Examiner—John P. McIntosh

Attorney—Watson, Leavenworth & Kelton

[57] **ABSTRACT**

A machine for automatically spraying the interior of hollow bodies such as drum shells or pails or other hollow container shells embodying an indexing turret type machine in which the articles are fed thereto in upright position with the axis vertical at one station and are indexed to a spraying station where shrouds advance over the end or ends of the article and a rotary centrifugal spray head makes a down and up cycle in the interior, the article then being indexed to a release station. The machine includes special features concerning a suction means in connection with the shrouds for drawing off vapors from the spraying area at each end of the shell in a uniform suction pressure condition throughout the peripheral extent and in a manner to prevent spray material being deposited on the outer surface of the body; magnetic means for holding the article within the turret in its rapid indexing steps; and a paint supply means for the rotary and reciprocatory spray head including a stationary paint supply tube and valve seat with a coaxial non-rotary elongated valve member within the tube; the entire operation being automatically controlled by an electrical circuitry embodying limit switches, solenoids and related elements.

4 Claims, 11 Drawing Figures



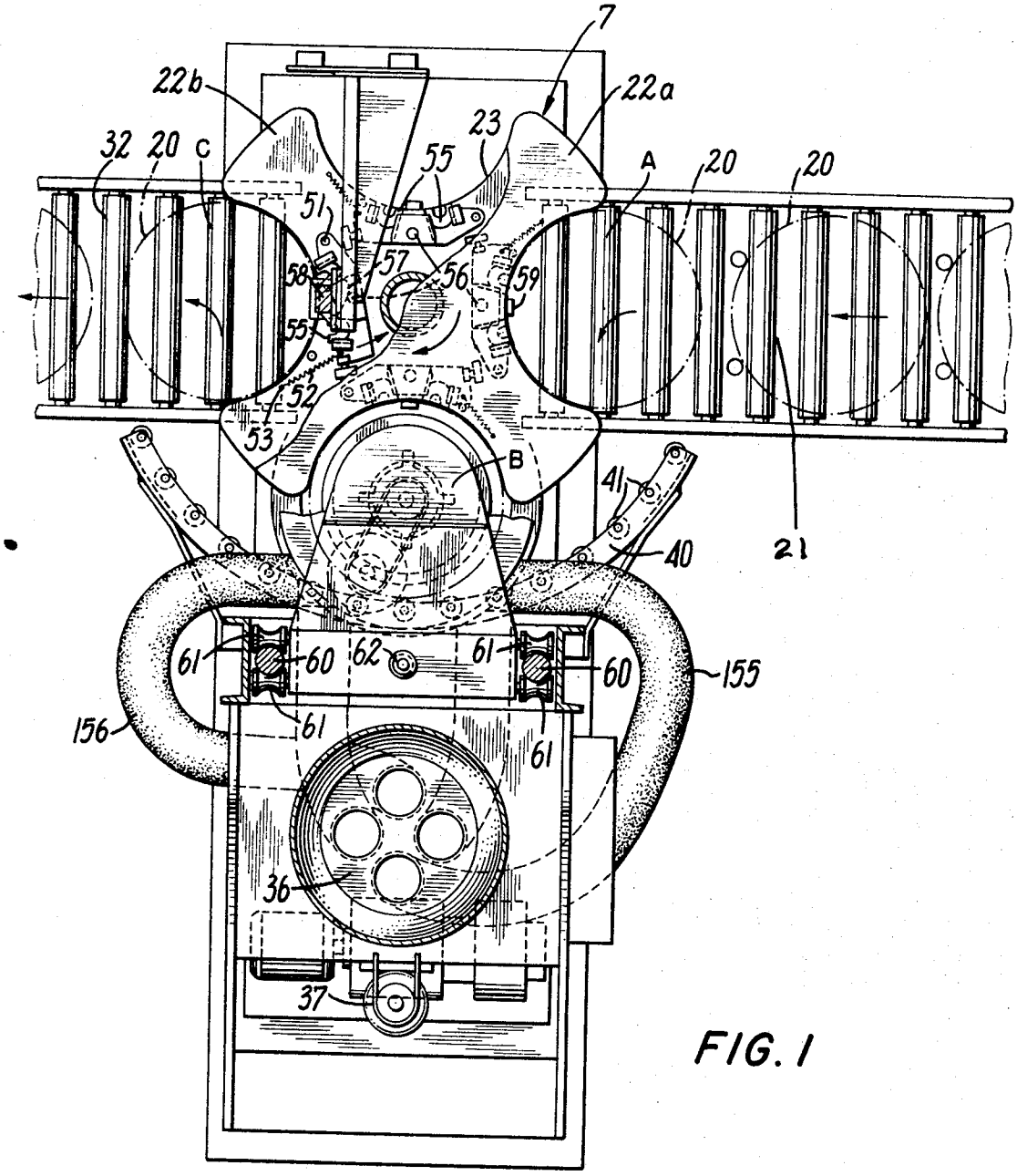

7
22b
22a
23
32
20
C
55
A
20
20
51
58
57
56
59
55
52
53
B
41
40
21
61
60
62
61
60
155
156
61
61
36
37

FIG. 1

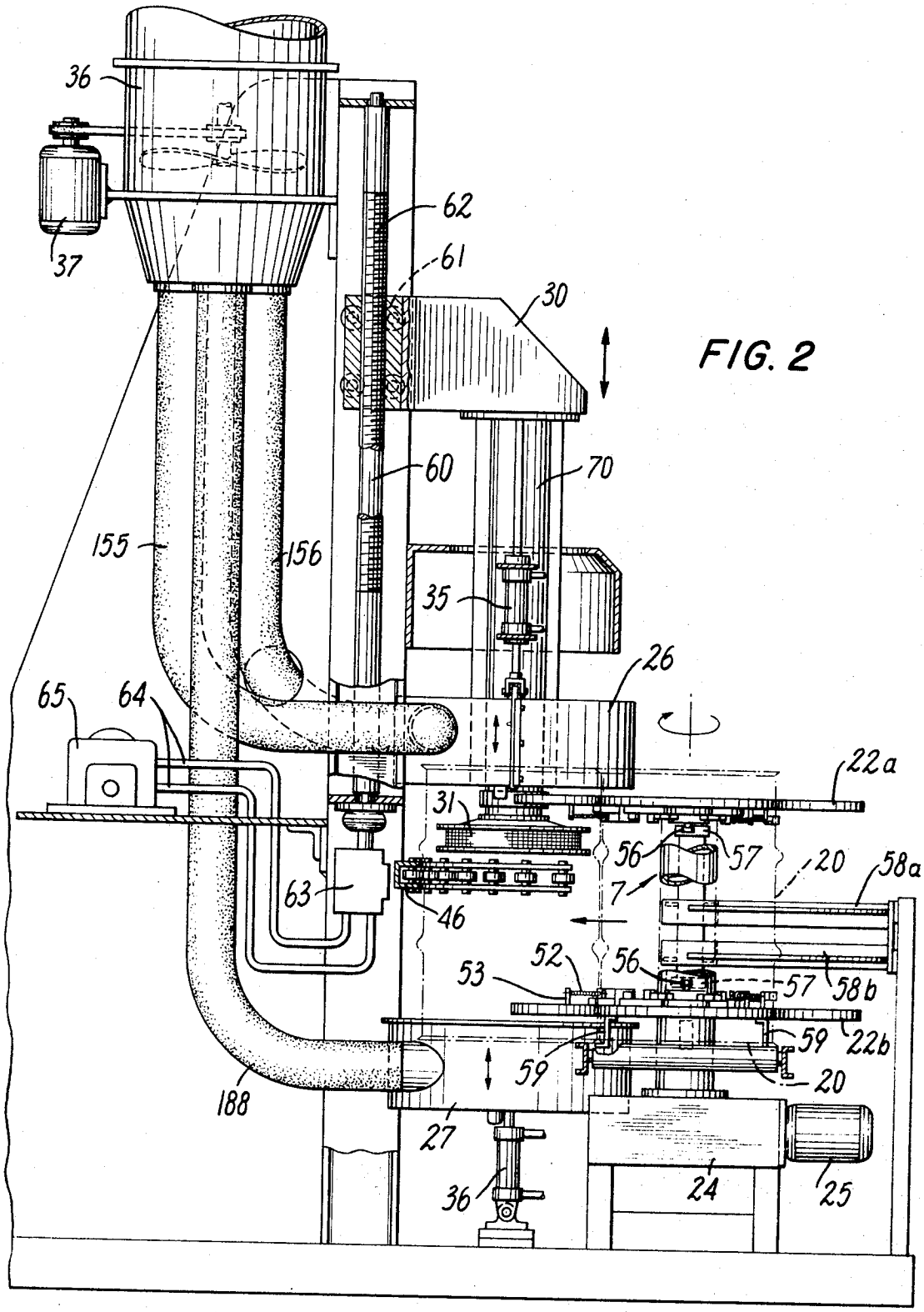

36
37
62
61
30
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70
155
156
35
26
65
64
22a
31
56
57
20
58a
63
46
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56
57
58b
59
22b
59
20
188
27
36
24
25

FIG. 2

FIG. 3

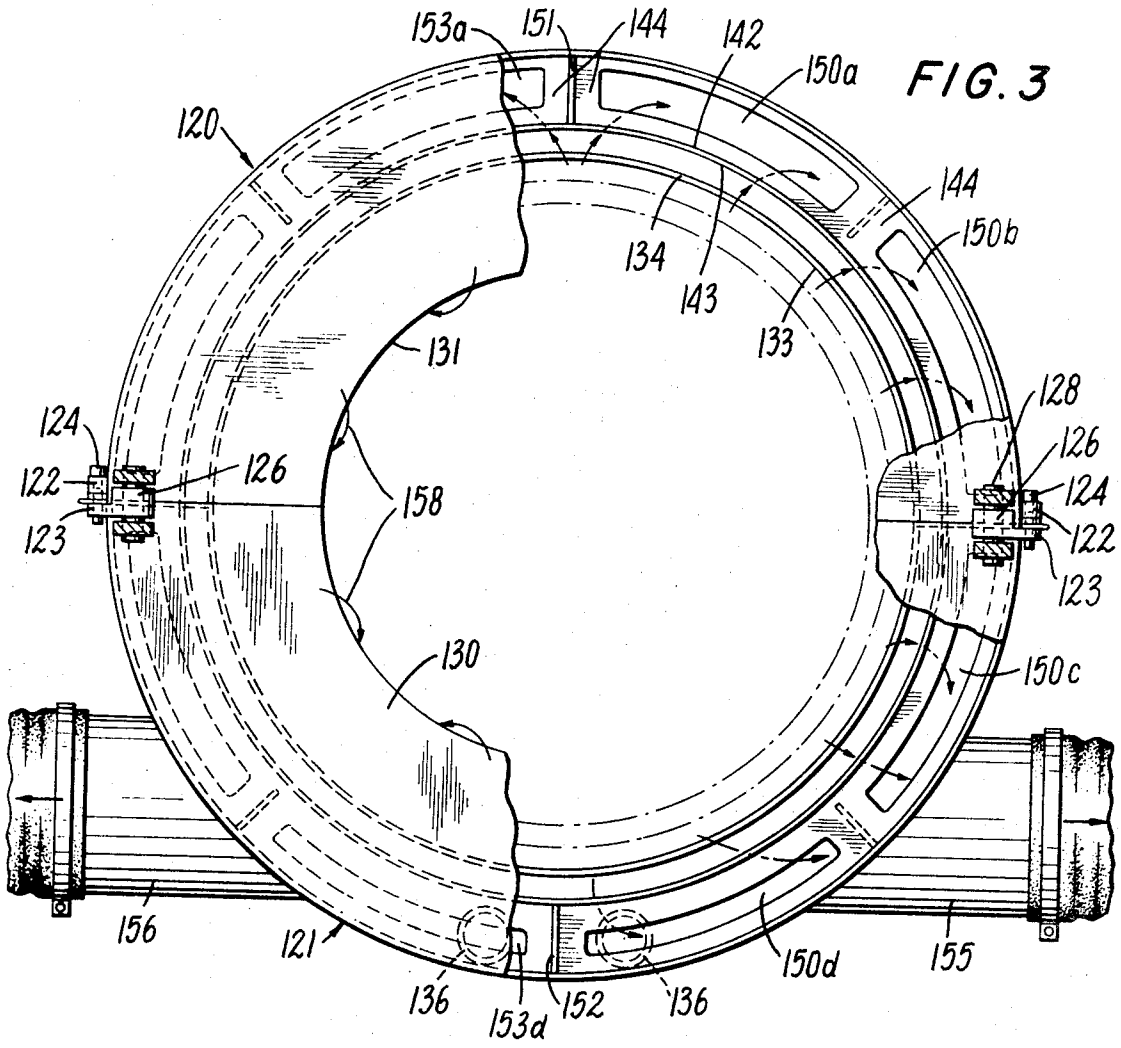

153a
151
144
142
150a
120
144
150b
134
143
133
131
128
126
124
122
123
124
126
122
158
123
130
150c
156
121
136
153d
152
136
150d
155

FIG. 4

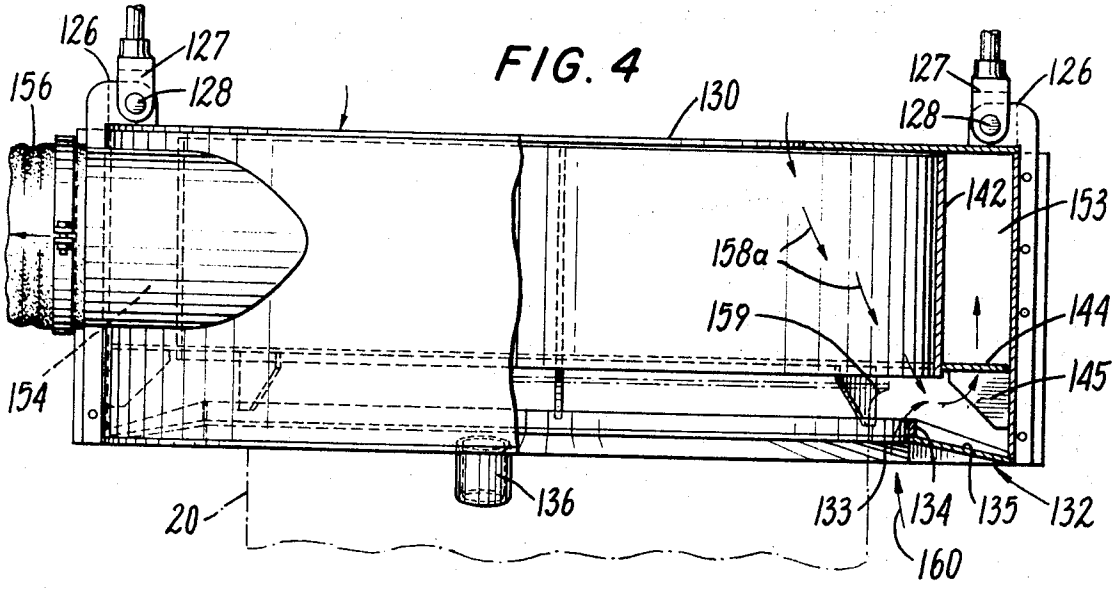

126
127
128
156
130
127
126
128
142
153
158a
159
144
154
145
20
136
133
134
135
132
160

FIG. 5

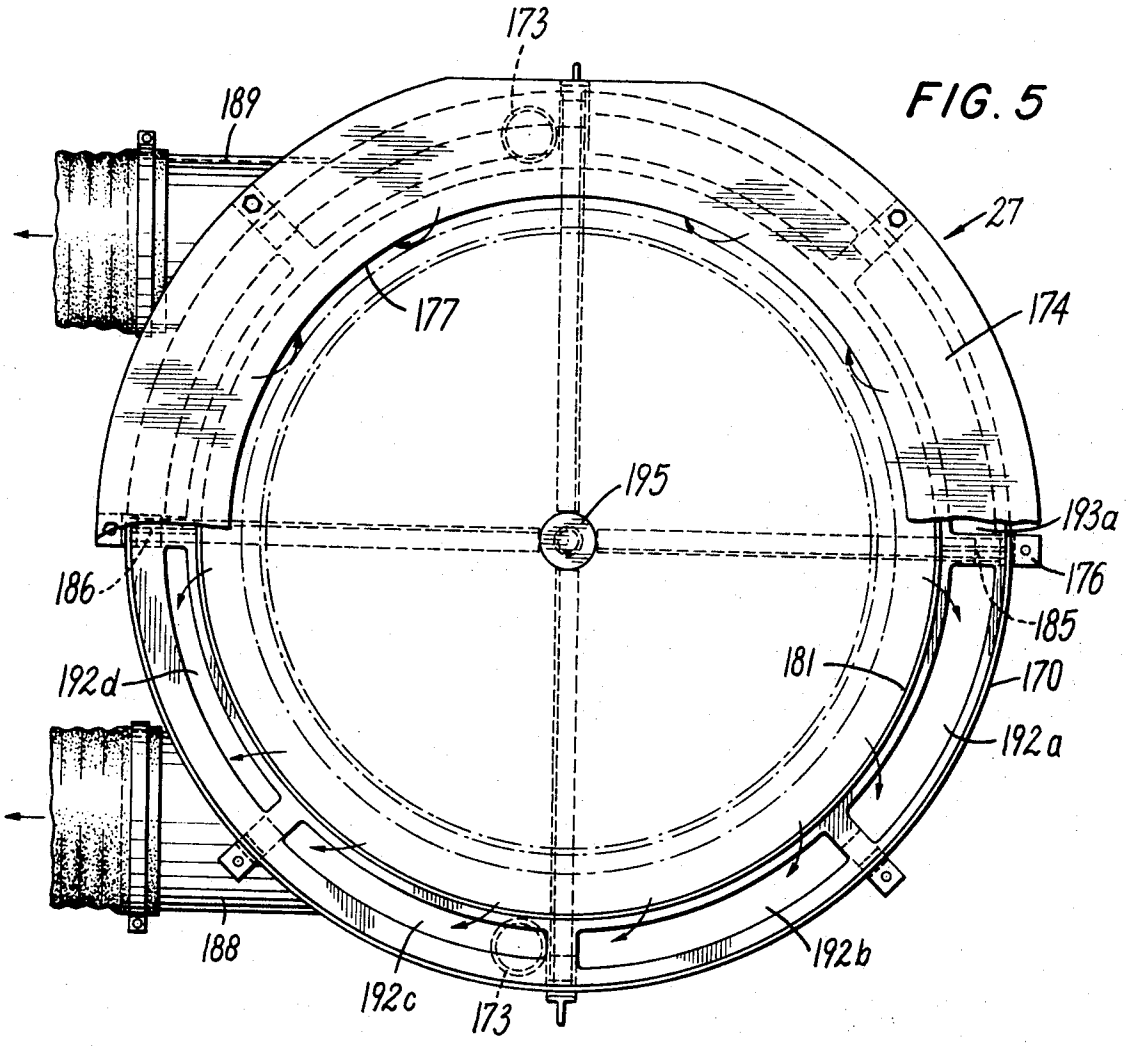

173
189
27
177
174
195
193a
176
186
185
181
192d
170
192a
188
192b
192c
173

FIG. 6

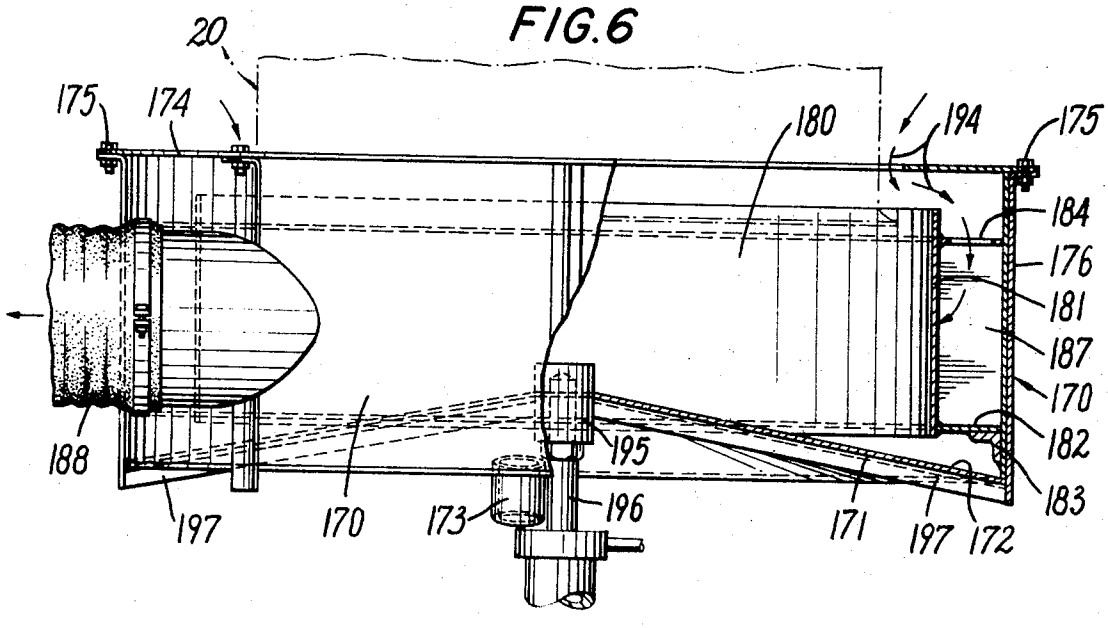

20
175
174
180
194
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197
172

FIG. 7

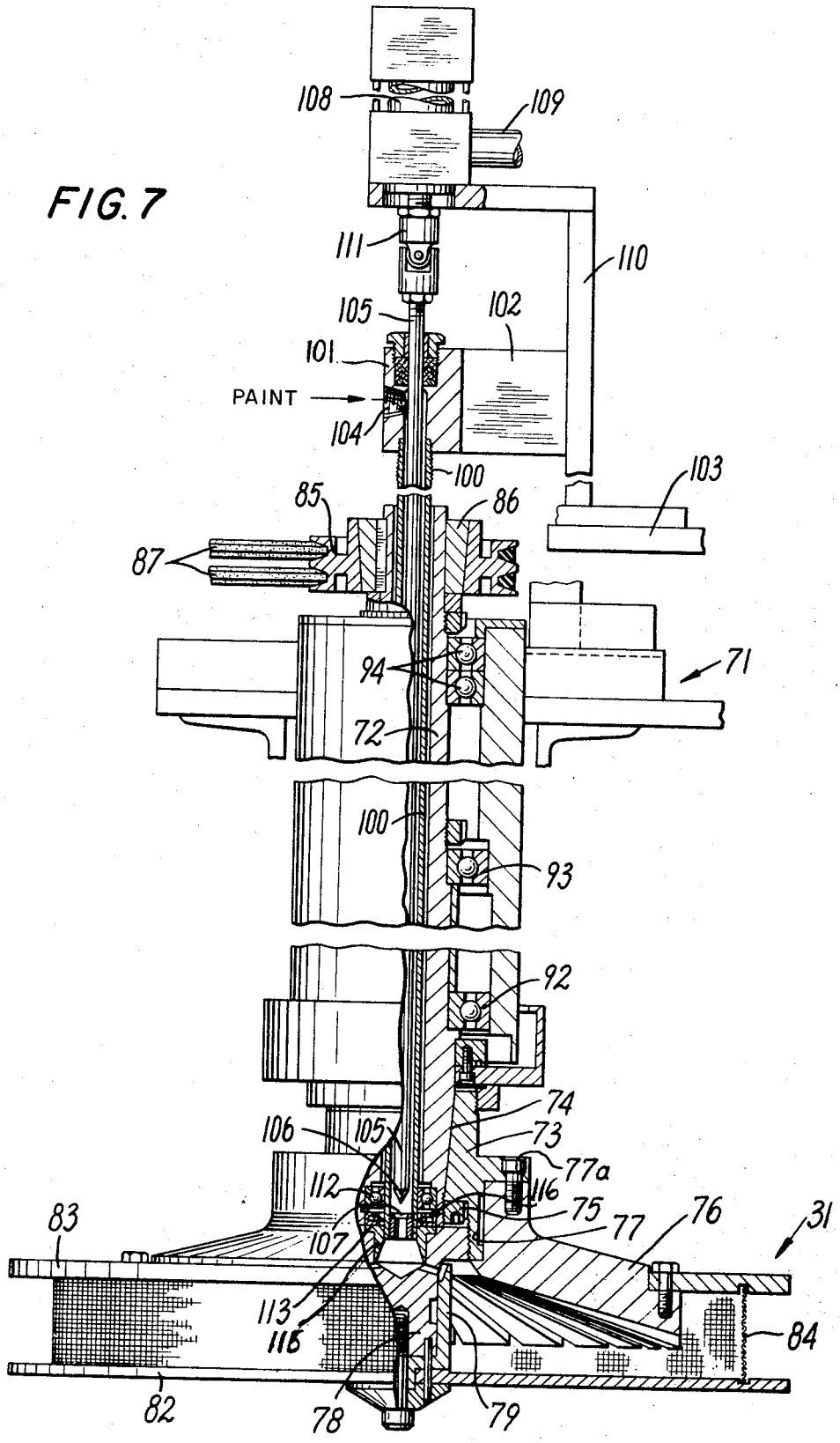
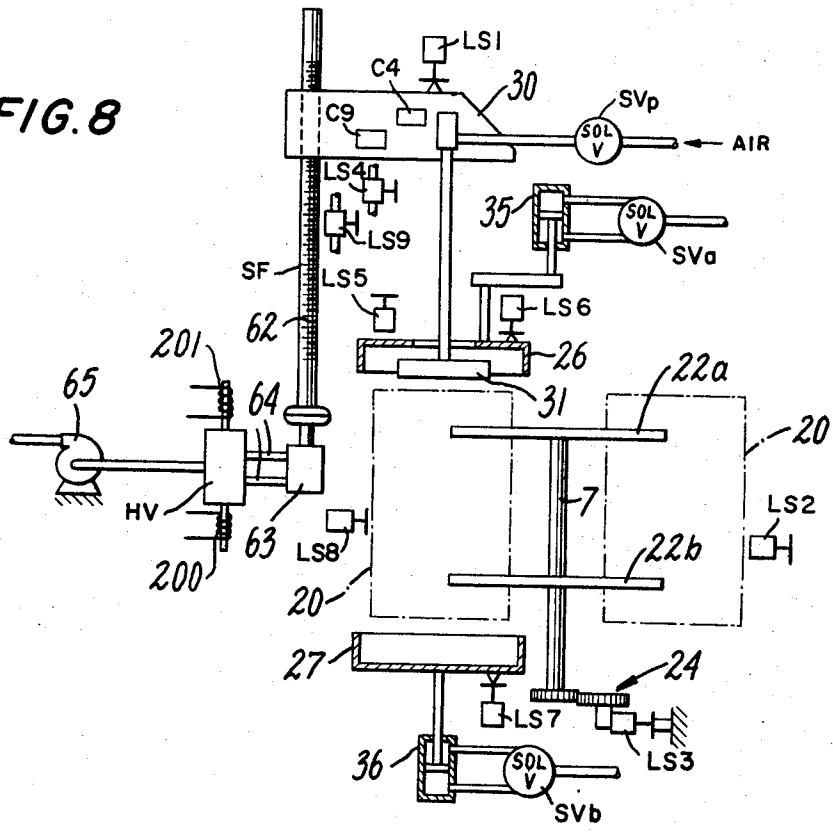

108
109
111
110
105
102
101
PAINT
104
100
103
85
86
87
71
94
72
100
93
92
74
106
105
73
77a
112
116
75
77
76
31
83
107
113
116
84
82
78
79

FIG. 8


LS1
C4
30
SVp
C9
SOL V
AIR
LS4
35
LS9
SOL V
SVa
SF
LS5
LS6
62
201
26
22a
65
64
31
20
7
LS2
HV
63
LS8
22b
200
20
27
24
LS7
LS3
36
SOL V
SVb

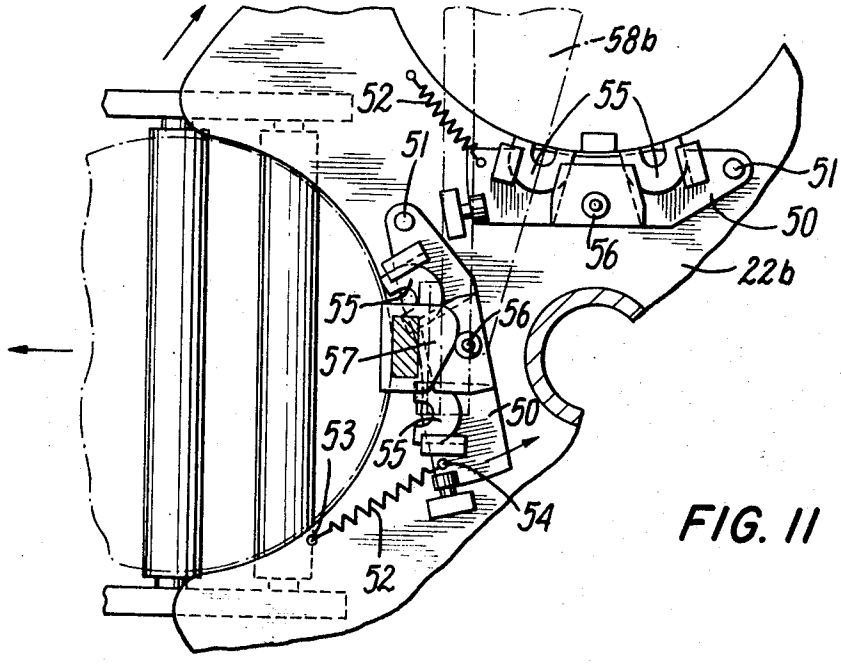
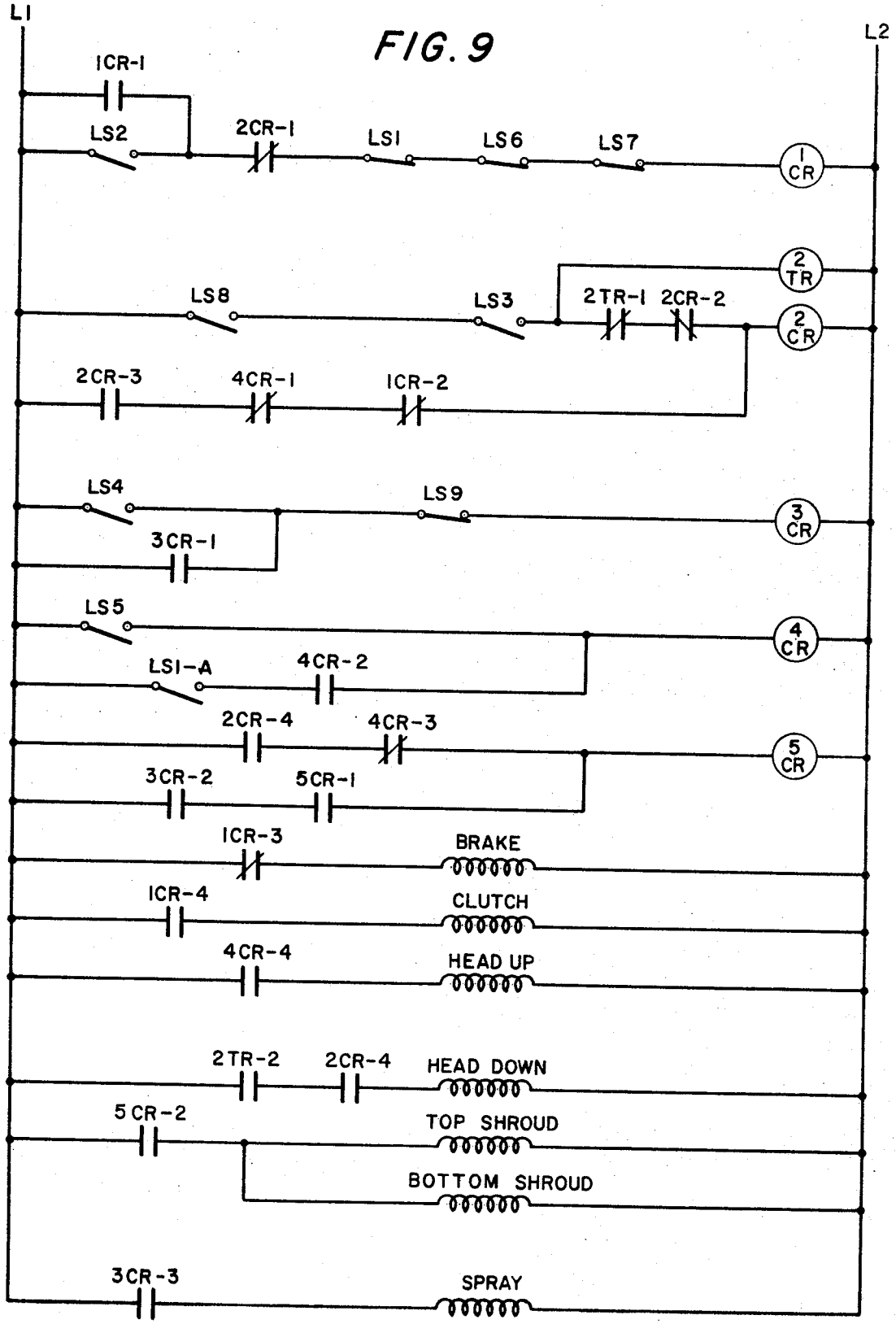

58b
52
55
51
51
50
56
22b
55
56
57
50
53
55
54
52

FIG. 11

FIG. 9


L1
L2
1CR-1
LS2
2CR-1
LS1
LS6
LS7
1 CR
2 TR
LS8
LS3
2TR-1
2CR-2
2 CR
2CR-3
4CR-1
1CR-2
LS4
LS9
3 CR
3CR-1
LS5
4 CR
LS1-A
4CR-2
2CR-4
4CR-3
5 CR
3CR-2
5CR-1
1CR-3
BRAKE
1CR-4
CLUTCH
4CR-4
HEAD UP
2TR-2
2CR-4
HEAD DOWN
5 CR-2
TOP SHROUD
BOTTOM SHROUD
3CR-3
SPRAY

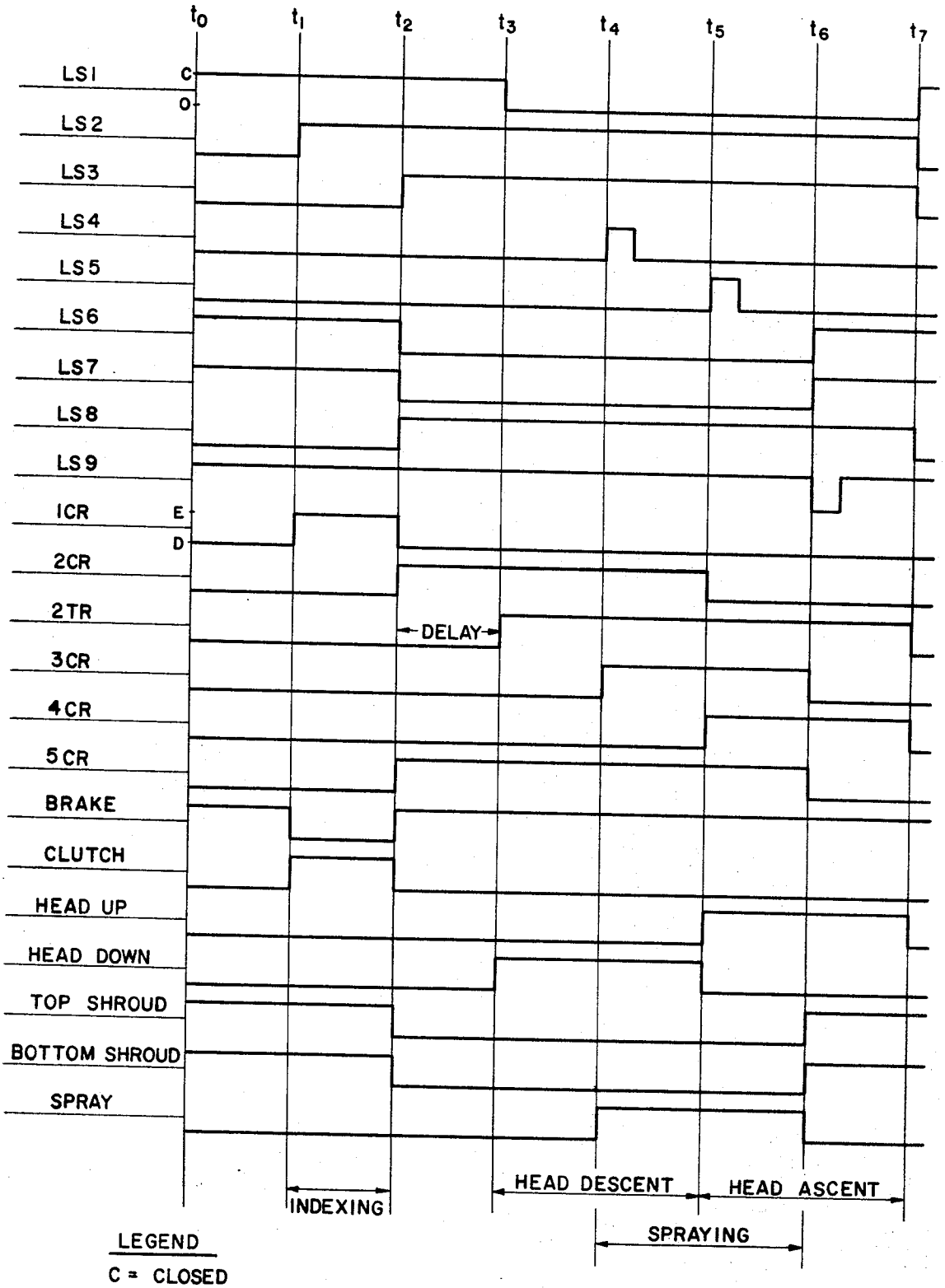

t0
t1
t2
t3
t4
t5
t6
t7
LS1
C
O
LS2
LS3
LS4
LS5
LS6
LS7
LS8
LS9
ICR
E
D
2CR
2TR
DELAY
3CR
4CR
5CR
BRAKE
CLUTCH
HEAD UP
HEAD DOWN
TOP SHROUD
BOTTOM SHROUD
SPRAY
INDEXING
HEAD DESCENT
HEAD ASCENT
SPRAYING
LEGEND
C = CLOSED
O = OPEN
E = ENERGIZED
D = DEENERGIZED

FIG. 10

AUTOMATIC MACHINE FOR SPRAYING THE INTERIOR OF CONTAINER SHELLS

THE GENERAL FIELD AND BACKGROUND OF THE INVENTION

Turret type machines for automatically spraying the interior of containers have been known for many years. The U.S. Pats. to Murch, No. 2,103,270 and Eberhart, No. 2,189,783 are illustrative. Each discloses an automatic spraying machine having a rotary turret with arc-shaped pockets in which cans are positioned as the turret is indexed to successive stations including a spraying station. In Eberhart, for example, the spray gun has a solenoid operated needle valve, which is automatically controlled whereby the valve remains closed when there is no can body at the spraying station. Electrical circuitry is provided for automatically controlling the events of the cycle. Each patent shows a suction exhaust duct for carrying off excess spray fumes. In the case of these two patents the articles comprising cans are rotated and the spray heads are non-rotary the articles being rotated by means of magnetic chucks which are movable into engagement with the can ends. The U.S. Pats. to Goetchius No. 2,408,709, Ransburg, No. 2,754,227 and Makowski et al. No. 3,044,894 disclose spraying machines in which the spray head is rotary and is mounted on a vertical reciprocatory slide and automatic controls are provided particularly for the paint valve.

As noted above the patents to Eberhart and Murch each discloses in general the embodiment of an exhaust fan and connecting ducts for drawing off vapors from the area of the spraying operation. The U.S. Pat. to Ziska No. 2,026,080 may also be referred to as disclosing that idea in general.

The assignee of the present invention has for many years operated a simple non-indexing machine for spraying the internal surface of the drum in which the drum is mounted with its axis horizontal and shrouds are brought up over each end and a reciprocatory spray head is arranged to extend through one of the shrouds into the interior of the drum.

Various prior patents are directed to specific forms of centrifugal spray heads and associated elements, one such patent, issued to the assignee of the present invention, is Ingram U.S. Pat. No. 2,850,322. A patent of some relevance is Martin U.S. Pat. No. 2,992,778 showing a rotary spray head with the flow of paint controlled by a long needle valve having a seat closely adjacent the spray head, but in this case the container shell is reciprocated relative to the spray head, the latter being fixed axially. A more recent patent Walling U.S. Pat. No. 3,516,385 discloses an apparatus for painting the interior of long sections of pipes which includes a spray head at the end of a long reciprocal stem and a valve control rod extending through the stem to the spray head, the latter being rotated by an air motor at the spray head supplied with pressurized air conducted down the long stem.

The art of centrifugal sprayers is very extensive and the foregoing is not intended by any means to be complete but only perhaps indicative of known various types of machines and arrangements insofar as the prior art has been explored.

THE PRESENT INVENTION

As heretofore indicated the invention concerns a machine for spraying the interior of hollow shells such as drums or the like which are open-ended cylindrical articles. The machine includes a turret rotatable on a vertical axis having peripheral pockets for holding the shells, means being provided for delivering the shells successively in upright vertical position to the turret and being indexed thereby to a spray station and then to a release station. The machine is fully automatic being completely controlled by a system of switches, solenoids, valves and related elements which insure that indexing of the turret occurs only when a shell arrives at the turret from the supply conveyor and that the spray head is caused to traverse the interior of the shell when there is one located at the spray station and only if one is so located.

The shell is held in the turret during rapid indexing by a combination of means which includes magnets which grasp the metal shell at the initial supply station and hold it until indexed to the delivery station where cam means positively force the magnets from contact with the shell permitting the shells to move away automatically.

At the spray station shrouds are automatically advanced over the ends of the shell prior to activation of the spray means, the shrouds being of a special construction and being connected to suction means the arrangement and functioning being such that a uniform suction pull is exerted uniformly around the corresponding ends of the drum thereby to assure the uniform removal of spray fumes and as a concomitant to insure against any channeling of air and vapors such as to disturb the uniform application of the paint.

A spray head and its mounting and operating means are arranged to advance into the upper end of the shell and the start and stop of the paint flow are accurately and sharply controlled by a needle valve located at the spray head itself whereby there is no lag in the start and stop of the spray such as can occur when there is a substantial length of paint conduit between the valve and the rotating spray head.

Further novel features of the principles of the invention and the advantages will be made more apparent from a consideration of a particular embodiment thereof as described hereinafter and illustrated in the drawings, in which:

FIG. 1 is a plan view showing the major elements and arrangement of the machine;

FIG. 2 is a vertical view looking from the right in FIG. 2;

FIG. 3 is a plan view of the upper shroud with some parts of the outer shell broken away;

FIG. 4 is a vertical view partly in section of the shroud of FIG. 3;

FIG. 5 is a plan view of the lower shroud with upper portions of the casing broken away;

FIG. 6 is a vertical view of the shoud of FIG. 5 with parts of the vertical walls of the shell broken away;

FIG. 7 is a vertical view of the spray head with its operating connections, various parts being broken away to show the interior construction;

FIG. 8 is a diagrammatic view showing the major elements of the indexing and shroud and spraying mechanism together with the various limit switches in the electrical system, the diagrammatic showing being in conjunction with the electrical control system;

FIG. 9 pictures the automatic control electrical system;

FIG. 10 comprises a timing diagram which may be read in conjunction with the electrical circuitry of FIG. 9 and the diagrammatic structure showing of FIG. 8; and,

FIG. 11 is a fragmentary showing on an enlarged scale the magnetic means for holding the shells in the turret pockets.

GENERAL FEATURES

For the general features reference is made to FIGS. 1 and 2. With minor structural variations the machine is adapted to the spraying of the interior of different hollow bodies such as drum shells or pail bodies, the particular articles illustrated being drums **20** open at both ends. The spray material will depend upon the circumstances but may be referred to as paint. The drums are advanced on a roller conveyor **21** to a receiving or supply station A of the spray machine where the drums are picked up seriatim by the machine conveyor comprising in the present case a rotary turrent T with top and bottom discs **22***a* and **22***b* respectively. The discs have concave pockets **23** into which the drums fit. From Station A the drums are indexed clockwise in FIG. 1 to Station B. The indexing mechanism indicated generally at **24** in FIG. 2 may be of a known type such as a Geneva type driven by motor **25.**

At Station B top and bottom shrouds **26** and **27** advance over the top and bottom ends respectively of the drums **20.** A main head or slide **30** carrying a rotary centrifugal spray head **31** then travels down and back during which the interior of the drum is sprayed, after which the shrouds **26** and **27** are retracted and the drum is indexed to Station C where it is released and moved away on roller conveyor **32.** Details of the shrouds and the spray mechanism will be described hereinafter. In the case of container bodies having one closed end the bottom shroud can of course be omitted or rendered inactive.

Translation of the shrouds is effected through air cylinder and piston means automatically controlled as shown most clearly in diagrammatic form in FIG. **8** the cylinder for the upper shroud **26** being indicated at **35** the air being controlled through solenoid operated valve SV*a*, and the cylinder for the lower shroud **27** controlled through solenoid operated valve SV*b*. Each of the shrouds is connected to a suction fan **36** operated by electrical motor **37** the details of the conducting passages being described more fully hereinafter.

To maintain the drums within the pockets **23** of the turret against particularly the centrifugal force acting thereon during the intermittent rapid angular shifting magnetic means are associated with each of the turret discs **22***a* and **22***b* for releasably holding any body of paramagnetic material such as the steel drums in the present embodiment. In addition an arc-shaped outer wall **40** extends around the turret provided with rollers **41** along which the drums ride. This latter means is particularly useful in case for example the drum is out of round and does not make full contact with the magnets. Referring more specifically to the magnetic means, for the lower disc **22***b* the elements are mounted on the upper surface thereof there being a pivoted magnet at each pocket **23.** In FIG. **1** the upper disc **22***a* is broken away to show the magnetic means mounted on the upper surface of lower disc **22***b*, but the details appear more fully in FIG. **11.** The means includes a lever **50** pivoted at **51** urged clockwise in FIG. **11** by spring **52** fastened at one end at **53** to the turret plate and at the other end at **54** to the lever **50.** The magnetic means may comprise electromagnets or permanent magnets the latter being here employed and comprising two horseshoe magnets **55** mounted on lever **50** adapted to contact the drum **20** and hold it during the angular travel of the turret from the drum pick up Station A to the spray Station B and on to the drum exit Station C where a roller **56** on lever **50** contacts a stationary cam **57** forcing the magnets free of the drum permitting free removal of the drum on the inclined roller conveyor **32.** Similar magnetic means are positioned on the lower surface of upper turret plate **22***a* at each of the pockets **23.** The cams **57** may be suitably mounted on any fixed support comprising here an arm **58***a* for the cam for the upper turret plate **22***a* (FIG. 2) and an arm **58***b* for the lower turret plate **22***b*.

To aid in holding the drums from sliding down in the turret head the bottom turret plate has a downwardly extending hook **59** at each concave notch pocket **23** which engages under the bottom edge of the drum.

The vertically translatable support head **30** carrying the spray head **31** is supported and guided on a pair of spaced vertical gibs **60** each gib being engaged by a pair of opposed rolls **61** (FIG. **1**) in the head **30**, the head being traversed up and down by feed screw **62** operated by a reversible rotary hydraulic motor **63** connected through pipes **64** with pump **65.**

THE SPRAY MECHANISM

Referring first to FIG. **2** the spray head is carried on a long tubular member **70** depending from head **30** which extends through the upper shroud **26.** Details sufficient to illustrate the principal features are shown in FIG. **7.** The non-rotary tubular column **70** is supported by appropriate structural parts within the head **30** including in the present case the bracket plate **71.** Rotatably mounted within the column is a main tubular member **72** which carries fixed thereon at its lower end the spray head **31.** The details of the spray head may vary in construction but it is generally similar to that of the previously cited U.S. Pat. to Ingram No. 2,850,322. As here shown it includes a coupling sleeve **73** having a tapered press fit indicated at **74** on the lower end of the tubular member **72** being secured thereon by nut **75.** The disc like body part **76** of the spray head is fitted over a short tubular extension **77** of sleeve **73** and is held by suitable set screw means one being shown at **77***a*. Threaded interiorly of the tubular extension **77** is a paint distributor head **78** over which is located the cup shaped element **79,** the parts **78** and **79** and the lower face of the body part **76** having communicating passages for the radial centrifugal distrubution of the paint as described more fully in the above noted U.S. Pat. No. 2,850,322. The spray head also includes a lower disc **82** and an upper annular disc **83** suitably secured in place and with one or more outer annular screens **84** or perforated sheets to aid in breaking up the paint droplets.

Rotation is imparted to the tubular member **72** and its spray by any suitable means which in the present case comprises a pulley **85** secured on a hub **86** which in turn is keyed to the upper end of member **72** the pulley being driven through V-belts **87** from a motor (not shown) mounted within the main head **30.**

The column **70** and tubular member **72** are of considerable length and the latter is supported in the former

at several vertically spaced points by ball bearings indicated at **92, 93** and **94** and suitable lubricant seals are provided where needed.

Paint is supplied to the spray head through a long stationary tube **100** threaded at its upper end into a coupling member **101** fixedly supported by brackets **102** and **103** in the main head **30.** Paint is delivered to tube **100** by means of a flexible tube connection to the opening **104** from a source outside the head **30.** Control of the paint supply to the spray head is by means of a long non-rotary valve rod **105** extending down through sleeve **100** and having a conical or needle valve **106** at its lower end adapted to cooperate with a valve seat **107** threaded into the lower end of paint supply tube **100** and stationary therewith. Axial shifting of rod **105** is effected through a small air cylinder **108** having a pipe connection **109** for pressure air automatically controlled with the valve normally biased to closed position. The air cylinder is of course supported in fixed position in main head **30** by suitable means such as the bracket arm **110.** Because of the length of valve rod **105** which may be several feet, the connection from the air cylinder piston thereto is through a universal joint **111** which avoids any binding and permits instantaneous free shifting of the rod. As previously stated the valve rod **105** and paint supply tube **100** are fixed against rotation and accordingly are supported in the lower end of rotary sleeve **72** by suitable bearing means comprising as here shown an annular radial ball bearing **112.** An oil seal ring **113** is also provided below the bearing **112.** The arrangement and relation of the parts are such as to enable the paint tube **100** and the valve rod **105** to be withdrawn for cleaning. In this respect the lower end of tube **100** has a close but slidable fit in a bushing **115** secured in the distributor head **78** to rotate therewith. Suitable fluid sealing means such as indicated at **116** are provided to prevent paint from escaping upwardly along the exterior of the tube **100.**

THE SHROUDS

As heretofore described the machine has an upper and a lower shroud each adapted when a drum is located at Station B to be advanced over the corresponding end of the drum during spraying of the drum each shroud being connected through flexible conduits to the suction fan **36** to draw off fumes and paint mist. Of importance is the fact that the shrouds and their respective connections to the suction are arranged and related such that a substantially uniform evacuating force is applied throughout the annular peripheral area at each end of the drum to maintain a proper balance and a uniform application of paint. As another major result and advantage the arrangement functions to produce air flow paths such as to prevent paint from being deposited on the exterior of the drums.

Referring first to the upper shroud **26** shown in detail in FIGS. **3** and **4** it comprises an outer cylindrical shell made in two semicircular halves **120** and **121.** The half section **120** has vertical flanges **122** projecting radially from the outer surface at the faces adjoining the section **121** and the latter has similar complementary flanges **123** whereby bolts **124** may be inserted in holes in the opposed flanges to secure together the two half sections. One of the flanges of each pair has a lug **126** extending radially inwardly over the top whereby a U-shaped clevis **127** may be hinged at **128** thereon the clevises being connected to a cross bar which in turn is connected to the piston rod of the air cylinder **35** for raising and lowering the shroud. The shell includes an annular top plate **130** having a central opening **131** to permit free passage therethrough of the spray head column **70.** The shell also has an annular bottom plate **132** with a central opening **133** adapted to receive the upper end of the drum shown in broken lines at **20** in FIG. **4.** The bottom plate includes a vertically extending flange **134** and the plate is dished upwardly toward the center to provide an inclined annular surface **135** resulting in an outer trough wherein any excess paint may collect and drain off through stub pipes **136.**

Mounted within the shell is an annular baffle means which includes an open ended cylindrical part **142** providing a central open space having a diameter determined by the inner wall of the cylindrical part as indicated at **143** in FIG. **3.** The peripheral surface of the cylindrical part **142** has an outwardly horizontally extending flange **144** adapted to rest on small vertical flanges or lugs **145** rigid with and extending radially inwardly from the inner wall of the outer shell thereby to position and support the inner baffle part. The flange **144** has a series of segmental openings, as may be noted in FIG. **3,** for the flow of air therethrough. The openings **150***a*, *b*, *c* and *d* progressively decrease in radial width and area beginning with **150***a*.

Vertical walls **151** and **152** projecting radially outward from the periphery of cylindrical part **142** define a semi-cylindrical annular collector space or chamber **153** between the cylindrical part **142** and the outer shell. The opposite half of the baffle means includes segmental openings **153***a* to **153***d* in the horizontal flange **144** similar to the openings **150***a* to **150***d* communicating with a space **154** similar to space **153.** Opposed suction pipes **155, 156** communicate through the outer shell with the inner spaces **153** and **154** respectively, and at or near the respective smaller segmental openings **150***d* and **153***d*. The pipes are connected to the fan **36** as appears in FIGS. **1** and **2.** Functionally, therefore, a suction force is applied in the shroud and adjacent the drum end which is substantially uniform throughout the peripheral extent. The air mingled with paint vapors drawn out by the suction follows two general paths. At the top air flows downwardly through the opening **130** around the spray head **70** following the paths indicated by the arrows **158, 158**a. At the bottom of the shroud the air path is upwardly along the exterior surface of the drum part the drum flange **159** in accordance substantially with the arrows **160.** This upward flow of air past the drum end and to the suction is an important feature. Commonly the drums have been painted and/or lithographed exteriorly prior to the internal spraying and any deposit on the outer surface from the internal spray would ruin the appearance. The current of air upwardly along the drum end prevents spray particles from reaching the outer surface of the drum. The air following the paths **158***a* and **160** continues up through the segmental openings in flanges **144** into the spaces **153** and **154** and out the corresponding pipes **155, 156.** Since the suction normally would be the strongest adjacent the outlet to the suction pipes, such effect in the present construction is offset by restricting the air path by the narrower segmental openings **150***d* and **153***d* and progressively increasing the size of the openings the farther they are positioned from the outlet pipe. The degree of variation in the size of the openings will vary depending

upon the circumstances. In a particular case illustrated herein where the central opening of the baffle is about two feet the segmental opening **150***a* had about twice the area of the opening **150***d*. Other specific arrangements may be employed to obtain uniform suction distribution as by varying the angular extent or the spacing of the openings.

The lower shroud **27** shown in detail in FIGS. **5** and **6** differs structurally from the upper shroud but embodies the same principles. It includes an outer cylindrical shell **170** with a bottom wall **171** which is dished upwardly toward the center to result in an inclined surface **172** whereby paint drippings are collected and drain off through a pair of stube pipes **173**. A flat annular top cover plate **174** is secured to the outer shell by means of set screws **175** threaded into vertical strips **176** secured to the peripheral surface of the shell. The cover plate has a central opening **177** through which the drum indicated at **20** in broken lines is adapted to extend. Mounted within the shell is the baffle part **180** which includes a main cylindrical part defined by the wall **181** having a bottom flange **182** extending radially outwardly from the periphery. A series of lugs **183** are secured to the inner wall of the outer shell and serve to support the flange **182** and thereby the baffle part **180** thereon. An upper flange **184** also extends radially outwardly from the periphery of the wall **181** with a close fit within the shell. Also extending outwardly from the periphery of wall **181** are a pair of vertical flanges **185, 186** located 180° apart thereby defining two semicircular spaces enclosed between the inner cylindrical part **181** and the outer shell, one such space being indicated at **187** in FIG. **6**. A suction pipe **188** communicates with the space **187** and a suction pipe **189** communicates with the other semicircular space.

The top flange **184** has two sets of segmental openings one set being indicated at **192***a*, *b*, *c* and *d* which are progressively smaller in radial width from the opening **192***a* to the opening **192***d*. A similar arrangement of segmental openings extends counterclockwise in FIG. **5** from the opening **193***a*. The functioning is similar to that described in connection with the upper shroud of FIGS. **3** and **4**, the smaller openings being nearest the outlet pipe. Air is drawn from around the lower drum end particularly downwardly along the exterior surface of the drum and outwardly in a path indicated generally by the arrows **194** and continues through the segmental openings in flange **184** into the semiannular spaces with which the exhaust pipes communicate. As in the case of the upper shroud the segmental openings in the radial baffle flange **184** increase in size progressively away from the connection to the respective suction pipes **188** and **189** to produce a uniform suction pressure and air flow around the drum end. Also the air paths are such as to prevent particles of the internal spray from being deposited on the exterior surface of the drum.

The bottom plate **171** of the shell has a central boss **195** to which is connected the piston rod **196** of the air cylinder **36** for vertically shifting the shroud. Preferably the bottom plate has radially extending reinforcing strips **197**.

THE AUTOMATIC CONTROL ELECTRICAL SYSTEM

The electrical system for automatically controlling the timing of the various operations is illustrated in FIG. **9**. This system includes a plurality of limit switches selectively closed and opened in accordance with particular operations of the coating apparatus and a plurality of relays selectively energized and deenergized by closing and opening of the limit switches and in turn initiating and discontinuing coating apparatus operations. FIG. **8** shows diagrammatically the location of various switches in conjunction with elements of the machine, and FIG. **10** is a timing diagram illustrating the events of a cycle and their relation.

Referring principally at first to FIG. **9**, switch **LS1** is closed when the spray head is in its retracted position. Switch **LS2** is closed when a barrel to be coated is in position at Station A. **LS3** is closed upon completion of each indexing revolution. **LS4** is closed when the spray head descends into the barrel. **LS5** is closed when the spray head descends into it lowermost position in the barrel. **LS6** and **LS7** are closed respectively when the top and bottom shrouds are in their retracted position. **LS8** is closed when the barrel is in position at Station B. **LS9** is opened when the spray head ascends to its uppermost position in the barrel.

Energization of relay **1CR** initiates indexing. Relay **2CR** is energized upon completion of indexing and, with time delay relay **2TR**, initiates descent of the spray head. Energization of relay **3CR** initiates the spraying operation. Energization of relay **4CR** initiates retraction or ascent of the spray head. Relay **5CR** initiates advance of the top and bottom shrouds when energized. In FIG. **9** all circuit elements are indicated in their quiescent state, i.e., prior to the positioning of a barrel at conveyor Station A. The relay contacts, which are of the normally-closed and normally-open types, are identified by correlation to the reference numeral assigned to their parent relay. For example, the contacts of relay **1CR** are identified as **1CR-1** through **1CR-4**. The solenoids for control of the brake and clutch of the indexing mechanism and for other elements are identified by literal designation. The control system circuit elements and solenoids controlled thereby are connected in parallel circuit branches across power lines LI and **L2**, which may be connected through appropriate main circuit breakers to line voltage.

Operation of the control system is best understood by reference to FIG. **10** wherein the states of the control system circuit elements and the controlled solenoids are illustrated against a time scale embracing the spray coating of one barrel.

Discrete time intervals are indicated by the time designations t_0 through t_7. In the interval $t_0 - t_1$, the control system is quiescent and awaits the positioning of the barrel at Station A. During this interval the BRAKE solenoid, energized through contacts **1CR3**, maintains turret T stationary. All other solenoids and all control relays are deenergized. Limit switchs **LS1, LS6** and **LS7** are closed and all other limit switches are open.

At time t_1, **LS2** is closed, indicating a barrel to be in position at Station A, whereupon relay **1CR** is energized through **LS2**, contacts **2CR-1** and closed limit switches **LS1, LS6** and **LS7** and is latched through contacts **1CR-1**. The BRAKE solenoid is accordingly deenergized, contacts **1CR-3** being open, and the CLUTCH solenoid is energized through contacts **1CR-4**.

Indexing commences and continues until t_2 at which time **LS3** closes, one revolution of the index drive being completed. **LS8** also closes as the barrel is thereby positioned at Station B. Relay **2CR** is energized by closure

of these switches through contacts 2TR-1 and 2CR-2. Upon energization, relay 2CR is latched through contacts 2CR-3, 4CR-1 and 1CR-2. Relay 1CR is deenergized by opening of contacts 2CR-1 with resulting energization of the BRAKE solenoid and deenergization of the CLUTCH solenoid. Time delay relay 2TR is supplied with energizing voltage at this juncture. Also, relay 5CR is energized through contacts 2CR-4 and 4CR-3, and latched through contacts 3CR-2 and 5CR-1, and the top and bottom shrouds 26 and 27 are accordingly advanced over the barrel ends through energization of their solenoids through contacts 5CR-2. Valves SVa and SVb close causing the air cylinders 35 and 36 to advance the respective shrouds. Thus, at t_2, the barrel is maintained stationary at Station B and the shrouds are in engagement therewith.

During this time period, valve HV is shifted to a position to cause the spray head to travel downward. Valve HV is a standard type four-way three-position valve double solenoid operated and spring biased to a central neutral position wherein all ports to pump 63 are blocked. Upon the expiration of the preset time delay for relay 2TR, namely, at t_3, relay 2TR is energized whereupon the HEAD DOWN solenoid 200 is energized through contacts 2TR-2 and 2CR-4 which shifts valve HV to a first operative position whereby hydraulic fluid is delivered to motor 63 to rotate screw feed shaft 62 in a direction to lower head 30. The oppositely-poled section LS1-A of LS1 closes.

Upon descent of the spray head 31 into the barrel, at t_4, LS4 is closed by engagement therewith of traveling cam C-4, energizing relay 3CR through closed switch LS9. Relay 3CR is latched through contacts 3CR-1. The spray solenoid SVp (FIG. 8) is energized through contacts 3CR-3 which admits pressure air to air cylinder 108 which opens valve 106 and spray coating of the barrel commences, the spray head descending farther into the barrel. Upon complete descent or bottoming of the spray head at t_5, switch LS5 is closed and relay 4CR is energized, and latched through contacts 4CR-2 and LS1A, whereupon relay 2CR is deenergized, contacts 4CR-1 being opened. At this juncture, the HEAD DOWN solenoid 200 is deenergized, contacts 4CR-2 being opened, and valve HV is spring-biased to its intermediate neutral position. The HEAD UP solenoid 201 is concurrently energized through contacts 4CR-4 shifting valve HV to a second operative position whereby hydraulic motor 63 is reversed and the spray head ascent commences. During spray head ascent, spraying continues.

At t_6, the spray head ascends to its uppermost position in the barrel, and limit switch LS9 is opened by cam C-9, thereby deenergizing 3CR and deenergizing the spray solenoid by opening contacts 3CR-3.

As relay 3CR is deenergized, contacts 3CR-2 open and relay 5CR is deenergized, in turn deenergizing the TOP and BOTTOM shroud solenoids by opening contacts 5CR-2.

As the spray head continues its ascent, it assumes its retracted position whereupon LS1 is closed and oppositely poled section LS1-A is opened thereby deenergizing 4CR at t_7. The HEAD UP solenoid 201 is deenergized, contacts 4CR-4 being opened and valve HV is accordingly spring-biased to its neutral position, stopping hydraulic motor 63.

It should be understood that various changes may be made in the apparatus and system described above and shown in the drawings and different embodiments of the invention could be made without departing from the principles thereof, and it is intended accordingly that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an automatic machine for spraying the interior of hollow bodies embodying a spray head with power means for advancing it into the interior of the body, and a body receiving station and a spray station, and a body conveyor with power means for operating it, the combination therewith of a shroud movable over an end of the body axially thereof at the spray station, power means for moving said shroud, and control means automatically actuated by the presence of a body at said spray station to energize said power means to advance the shroud, said shroud having a connection to a suction source and provided with fluid passages and baffle means arranged to produce a substantially uniform suction pressure around the body end.

2. A machine in accordance with claim 1 in which a like shroud and power moving means therefor are provided for each end of the body.

3. An automatic machine for spraying hollow open ended bodies comprising a turret conveyor for the bodies rotatable about a vertical axis, with respect to a body supply station and a spray station, a shroud vertically movable over each end of the body at the spray station, a spray head vertically movable from a retracted position into the interior of the body at the spray station, power means for operating each of said shrouds and said spray head, and automatic control means actuated by the presence of a drum at the supply station for indexing the turret to move the body to the spray station, and actuated by the body at the spray station to cause the shrouds to advance over the body ends and then in sequence the spray head to advance into the body interior.

4. A machine in accordance with claim 3 in which the said shrouds are each movable by an air cylinder power means automatically controlled.

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