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BARREL-TYPE COATING APPARATUS

The present invention relates to a barrel-type coating apparatus suitable for the bulk treatment of small parts such as sliders and end stops of slide fasteners, buttons, ornaments or the like.

5 Various barrel-type coating or painting apparatus are known in which a batch of parts is put into a barrel being rotated, and paint is sprayed onto the parts in the barrel. The coated paint on the parts is set, then baked and finally cooled. A sequence of such steps is repeated until the coating of paint on the parts has a desired thickness. A typical example of such apparatus is disclosed in Japanese patent Publication No. 53 - 18063 published on June 13, 1978.

10 According to the disclosed apparatus, a barrel is rotatably mounted in a cup-like drum and all the paint-spraying, setting, baking and cooling steps are carried out in the drum. With the apparatus thus arranged, the drum atmosphere must be expelled from the drum when the baking and cooling steps are proceeded.

20 This causes a great loss of heat energy and requires a relatively long processing time, resulting in reduction of productibility.

It is believed possible by means of the present invention to provide an apparatus for coating batches of parts at an increased degree of rate of production.

It is further believed possible by means of the

present invention is to provide a barrel-type coating apparatus for coating batches of parts with layers of paint which vary in color and thickness for each barrel.

5 According to the present invention, there is provided an apparatus for coating batches of parts, comprising:

 (a) an annular hollow housing rotatable about its axis in a plane, said housing having a series of
10 circumferentially disposed loading and unloading, spraying, setting, baking and cooling compartments separated by flexible screens, and a concentric annular rail extending circumferentially across said compartments;

15 (b) a plurality of barrels disposed in said housing at equal angular intervals for receiving batches of parts and having shafts, respectively, rotatably and pivotably supported outside of said housing, each of said shafts having a portion rollingly
20 riding on said rail such that said shaft portions and said barrels are inclined upwardly with respect to said plane;

 (c) a plurality of paint spray nozzles disposed along said housing in substantially opposed relation to
25 said shafts, respectively, and movable toward and away from said housing; and

 (d) said loading and unloading compartment

(17)

- 3 -

having a first opening for supplying a batch of parts to one of said barrels, and a second opening for discharging a batch of parts having been coated from said housing, said spraying compartment having a third opening through which one of said paint spray nozzles is movable into and out of said housing, said baking compartment having at least one fourth opening for introducing hot air into said baking compartment, said cooling compartment having at least one fifth opening for introducing cool air into said cooling compartment, said first to fifth openings respectively corresponding in position to ones of said barrels while said housing is at rest, said rail including a segmental portion corresponding in position to said second opening and being retractable to a lowered position for tilting a one of said barrels carried thereon to an emptying position.

The invention will be described by way of example with reference to the accompanying drawings, wherein:-

Figure 1 is a plan view of a coating apparatus embodying

the present invention;

Figure 2 is a plan view, partly cut away, of the coating apparatus shown in Figure 1;

Figure 3 is a cross-sectional view taken along line III-III of Figure 2;

Figure 4 is an enlarged cross-sectional view taken along line IV-IV of Figure 2;

Figure 5 is an enlarged cross-sectional view taken along line V-V of Figure 2;

5 Figure 6 is an enlarged cross-sectional view taken along VI-VI of Figure 2, the view showing a barrel in an elevated position;

Figure 7 is a view similar to Figure 6, showing the barrel in a lowered inclined position;

10 Figure 8 is an enlarged cross-sectional view taken along line VIII - VIII of Figure 2, the view showing parts in a coating position

Figure 9 is an enlarged cross-sectional view taken along line IX-IX of Figure VIII-VIII;

15 Figure 10 is an enlarged cross-sectional view taken along line X-X in Figure 2;

Figure 11 is an enlarged cross-sectional view taken along line XI-XI of Figure 10; and

20 Figure 12 is a block diagram of a control circuit for controlling operation of the apparatus shown in Figure 1.

The _____ present invention is particularly usefull when embodied in a coating apparatus such as shown in Figures 1 through 3,
25 generally indicated by the numeral 20.

The coating apparatus 20 comprises a ring-shaped or annular housing 21 rotatably mounted on an annular

base 22 via a plurality of rollers 23, the base 22 being laid on a building floor 24. The apparatus 20 further includes a drive mechanism 25 disposed on the building floor 24 within a space defined by an inner
5 peripheral wall 26 of the housing 21. The drive mechanism 25 includes a vertical drive shaft 27 rotatably mounted on a frame 28 of the mechanism 25 and extending in alignment with the central axis of the housing 21. A stepper motor 29 is mounted on the frame
10 28 and coupled with the drive shaft 27 via a speed reducer or reduction gear train 30 to rotate the drive shaft 27 intermittently. A plurality of angularly spaced connecting arms 31 extends radially inwardly from the housing's inner peripheral wall 26 to a hub 32
15 fasten to the shaft 27 for corotation therewith. With this arrangement, when the stepper motor 29 is energized, the shaft 27 drives the housing 21 to rotate intermittently on the base 22.

As shown in Figure 3, the housing 21 has a
20 hollow body and includes a horizontal partition wall 33 dividing an interior space in the housing 21 into a pair of upper and lower chambers 34, 35. An annular rail 36 is disposed on the partition wall 33 adjacent to the inner peripheral wall 26 and projects into the
25 upper chamber 34. The inner peripheral wall 26 has an annular horizontal slot 37 extending substantially in lateral alignment with the rail 36.

A plurality (twelve being shown in Figure 2) of barrels 38 of wire mesh is disposed in the housing's upper chamber 35 at equal angular intervals. Each of the barrel 38 has a radially outwardly opening end 39 and is mounted on a column 40 by a shaft 41 connected concentrically to the other end of the barrel 38 and extending through the horizontal slot 37. The shaft 41 includes a universal joint 42 disposed outside of the housing 21 and is rotatably supported on the column 40 disposed between the housing 21 and the drive mechanism 25. A motor 43 is supported on the column 40 and has a drive gear 44 held in driving mesh with a driven gear 45 mounted on the shaft 41. The barrels 38 rotate about the respective shafts 41 upon energization of the respective motors 43. A pair of guide rollers 46, 46 extends parallel to the shaft 41 and the rollers 46, 46 are rotatably supported at their opposite ends on a pair of support plates 47, 47 which is mounted on the shaft 41 between the barrel 38 and the universal joint 42. As shown in Figure 11, the support plates 47, 47 have a substantially triangular shape, the shaft 41 and the rollers 46 being disposed respectively adjacent to corners of the triangular support plate 47. The barrels 38 are inclined upwardly with the guide rollers 46, 46 on each shaft 41 rollingly sliding on the annular rail 36 on the partition wall 33.

As shown in Figure 2, the upper chamber 34 in

the housing 21 has five compartments 48 - 52 separated by five flexible screens 53. The compartments 48 - 52 comprise a loading and unloading compartment 48, a spraying compartment 49, a setting compartment 50, a baking compartment 51 and a cooling compartment 52, all the compartments being arranged in succession in the clockwise direction in this figure. Each of the screens 53 preferably is made of rubber or canvas cloth and, as shown in Figure 4, depends from a top wall of the housing 21 across the upper chamber 34. A plurality of vertical slots 54 extends from a lower end of the screen 53 and terminates short of an upper end of the same so that the barrels 38 can pass smoothly through the screens 54 when the housing 21 is being rotated.

The circumferential extent of each compartment 48 - 52 depends on a necessary period of time for carrying out a predetermined process in the compartment 48 - 52. In the illustrated embodiment, the spraying compartment 49 receives one barrel 38, each of the loading and unloading, setting and cooling compartments 48, 50, 52 receives two barrels 38, and the baking compartment 51 receives the rest or five barrels 38.

As shown in Figures 2 and 5, a chute 55 projects into the loading and unloading compartment 48 through a supply opening 56 in an outer peripheral wall 57 of the housing 21, the chute 55 being directed toward the open

- 8 -

end 39 of one (left in Figure 2) of the barrels 38 received in the compartment 48 for loading a multiplicity of small parts (not shown) into the barrel 38. As shown in Figures 6 and 7, the partition wall 33 of the housing has an opening 58 through which the other barrel 38 in the compartment 48 can move from the upwardly tilted position (Figure 6) to a downwardly titled emptying position (Figure 7) for discharging the painted parts out of the barrel 38. More specifically, the annular rail 36 includes a separated segmental portion 59 secured to the distal end of the piston rod of a fluid-actuated cylinder 60 mounted on the housing 21, the portion 59 corresponding to the opening 58 in radial direction and being vertically retractable out of the rest of the annular rail 36. When the cylinder 60 is actuated to retract the piston rod, the segmental portion 59 is moved downwardly to allow the rollers 46 resting thereon to be lowered until the barrel 38 is moved through the opening 58 to the downwardly tilted emptying position of Figure 7. The parts in the barrel 38 are then thrown out through the open end 39 and a discharge opening 61 in the housing's outer peripheral wall 57, onto a horizontal belt conveyor (not shown) for storage or additional processing. A bottom wall of the housing 21 has a sloped surface 62 disposed beneath the opening 58 and inclining down toward the discharge opening 61 for allowing the painted parts to slide by

their own weights along the surface 62 downwardly toward the discharge opening 58.

As shown in Figure 8, the outer peripheral wall 57 of the housing 21 has an opening 63 through which a paint spray nozzle 64 is movable into and out of the spraying compartment 49 for spraying an atomized mist of paint into the barrel 38 to spray-deposit the paint on the parts in the barrel 38. A structure for supporting and actuating the spray nozzle 64 is described below.

As shown in Figure 2, the housing 21 has no opening communicating with the setting compartment 50 except the horizontal slot 37 which is provided for the passage of the shafts 41.

Referring again to Figures 2 and 3, there is shown a hot-air blower 65 disposed along the baking compartment 51. The blower 65 comprises an elongate heat-generating unit 66 mounted on the housing's outer peripheral wall 57 and a total of five blower pipes 67 communicating at opposite ends with the heat-generating unit 66 and the baking compartment 51. Each of the pipes 67 has one end received in an inlet opening 68 in the housing's outer peripheral wall 57 and opening toward the open end 39 of a corresponding one of the barrel 38 received in the compartment 51. The heat generating unit 66 includes a heater 69 and a power-driven fan 70 disposed behind the heater 69 to

- 10 -

force air through the heater 69, the blower pipes 67, and the open ends 39 into the respective barrels 38, thereby baking the coated paint on the parts in the barrels 38. Hot air blown into the barrels 38 then
5 returns from the compartment 51 to the heat-generating unit 66 through a plurality of holes 71 (Figure 2) in the horizontal partition wall 33 and then through a plurality of holes 72 (one shown in Figure 2) in the outer peripheral wall 57.

10 As shown in Figure 2, a cool-air blower 73 is disposed along the cooling compartment 52 and includes an elongate duct 74 mounted on the housing's outer peripheral wall 57 and a pair of blower pipes 75 communicating at opposite ends with the duct 74 and the
15 cooling compartment 52. As shown in Figure 10, each of the pipes 75 has one end fitted in an inlet opening 76 in the outer peripheral wall 57 and opening toward the open end 39 of a corresponding one of the barrels 38 received in the compartment 52. A power-driven fan 77
20 is disposed in the duct 74 to draw the outside air through a hole 78 into the duct 74 and to force air through the pipes 75 and the open ends 39 into the respective barrels 38 to cool the parts therein. Cool air blown into the barrel 38 is discharged from the
25 cooling compartment 52 through the horizontal slot 37 in the inner peripheral wall 26.

As shown in Figures 1, 2, 8 and 9, the

spray-nozzle supporting and actuating structure or means comprises a pair of concentric rings 79, 80 respectively disposed inwardly and outwardly of the annular housing 21 in concentric relation thereto, and
5 a plurality of angularly spaced connector bars 81 extending between the inner and outer rings 79, 80 to connect them together. The connector bars 81 correspond in number to the barrels 38 and each overlies a corresponding one of the shafts 41 of the
10 respective barrels 38. The outer ring 80 is supported on a plurality of poles 82 at its circumferential portions spaced at equal angular intervals. Each of the connector bars 81 has on its underside a longitudinal groove 83 extending from the outer ring 80
15 toward the inner ring 79, the groove 83 having a generally T-shaped cross section. A vertical support bar 84 is slidably mounted in the groove 83 and supports the paint spray nozzle 64. The support bar 84 is connected to the distal end of the piston rod of a
20 fluid-actuated cylinder 85 mounted on the connector bar 81 adjacent to the inner ring 79. When the cylinder 85 is actuated to retract the piston rod, the support bar 84 moves from the position of Figure 3 to the position of Figure 8 in which the spray nozzle 64 projects
25 through the opening 63 into the spraying compartment 49.

To coat the parts with finished layers of paint which vary in thickness and color for each barrel 38,

operation of the coating apparatus 20 is controlled such that the number of spraying operation is automatically detected for each barrel 38, and when the detected number of spraying operation of one barrel 38
5 corresponds to a predetermined figure, the barrel 38 is tilted downwardly to discharge the parts therefrom. The discharged parts have a finished layer of paint of a desired thickness and color. To this end, a plurality of limit switches 86 is disposed on the
10 building floor 24 along the outer periphery of the housing 21, each switch 86 corresponding in position to a respective one of the barrels 38. A pair of actuating projections or lugs 87, 88 is attached to the housing 21 below the spraying compartment 49 and the
15 discharge opening 58, respectively. The actuating lugs 87, 88 respectively correspond in position to the barrel 38 in the compartment 49 and the barrel 38 supported on the rail's segmental portion 59 in the loading and unloading compartment 48. The lugs 87, 88
20 are engageable with two of the limit switches 86 to actuate them while the annular housing is at rest. Upon actuation, each of the limit switches 86 send an electric signal to a central circuit 89 shown in Figure 12.

25 The control circuit 89 is provided for a respective one of the barrels 38 and comprises a counter 90 receiving electric signals from a

corresponding one of the limit switches 86, a first driver circuit 91 connected in series with the counter 90 to send an operation signal to the cylinder 60 in response to an output signal from the counter 90, a
5 reset circuit 92 connected with the counter 90 and the first drive circuit 91 to reset the counter 90 in response to an output signal from the driver circuit 91, and a second driver circuit 93 connected with the limit switch 68 and the cylinder 85 to actuate the
10 latter in response to the signal from the limit switch 86. Since the counter 90 receives the electric signals twice from the limit switch 86 during one cycle of revolution of the housing 21, a figure registered in the counter is twice as large as the number of spraying
15 operation to be carried out.

The coating apparatus 20 operates as follow: In Figure 2, the parts to be spray-painted are loaded through the opening 57 (Figure 5) and the open end 39 into one of the barrels 38 that is empty in a position
20 A. The housing 21 is angularly moved in the counter-clockwise direction in this figure to bring the spraying compartment to the position A where the opening 63 is held in alignment with the barrel's open end 39. At the same time, the actuating lug 87 engages
25 the limit switch 86 to actuate the latter to energize the second drive circuit 93 (Figure 12). Energization of the drive circuit 93 causes the cylinder 85 to

retract the piston rod, thereby enabling the nozzle 64 to project through the opening 63 into the spraying compartment 49 (Figure 8).

The housing 21 is temporarily stopped for
5 spray-painting operation and the barrel 38 is continuously rotated by one of the motors 43. Paint is sprayed from the spray nozzle 64 onto the parts in the barrel 38 being rotated, the amount of paint coated in one spraying operation is such that it will form a
10 layer of paint on the parts which is much thinner than a finished layer having a desired thickness. Excessive paint that is discharged but not sprayed onto the parts will escape through the wire mesh of the barrel 38, thereby permitting the parts to be coated with an even
15 layer of paint without irregular paint deposition thereon.

Upon completion of spray deposition of paint on the parts, the housing 21 is driven by the drive mechanism 25 to complete two steps of intermittent
20 angular movement during which time the coated paint on the parts in the barrel 38 being rotated is set in the setting compartment 50.

The housing 21 is then rotated stepwise to advance five steps of angular movement. Hot air is
25 blown from the pipes 67 into the barrel 35 contained in the baking compartment 51 to heat the parts for baking the paint coating on the parts. Then, the housing 21

is further rotated intermittently to advance two steps of angular movement. Cool air is introduced from the pipes 75 into the barrel 38 received in the cooling compartment 52 to cool the baked paint on the parts.

- 5 The barrel 38 is continuously rotated during the baking and cooling steps.

The housing 21 is further rotated stepwise to bring the discharge opening 58 (Figure 6) into the position A, whereupon the actuating lugs 88 actuates
10 the limit switch 86 to send an electric signal to the counter 90.

One cycle of operation of painting the parts is thus completed. The sequence of the steps is repeated until the layer of coated paint on the parts has a
15 desired thickness. After the predetermined number of spraying steps has been carried out and when the limit switch 86 sends an electric signal to the counter 90, the counter 90 sends an output signal to the driver circuit 91 whereupon the cylinder 60 is actuated to
20 retract its piston rod and hence the rail's segmental portion 59. Thus, the barrel 38 resting on the shaft 41 is tilted downwardly to the emptying position (Figure 7) to discharge the painted parts therefrom. The parts then slide down along the sloped surface
25 toward the discharge opening 61. The counter 90 is reset by a signal from the drive circuit 91.

The foregoing operation of the apparatus 20 has

been described only in connection with the barrel 38 disposed at the position A. The same description can be applied to other barrels 38 disposed respectively at positions B through L, by simply shifting the sequence of the steps by one step successively in the counter-clockwise direction in Figure 2. For easy understanding, the sequence of processing steps at each of the respective positions A - L is shown in the following table. In this table, the latter L denotes the loading step, P the spray-painting step, S the setting step, B baking step, C the cooling step and D the discharging step.

Table

Step Position	0 1 2 3 4 5 6 7 8 9 10 11											
A	L	P	S	S	B	B	B	B	B	C	C	D
B	D	L	P	S	S	B	B	B	B	B	C	C
C	C	D	L	P	S	S	B	B	B	B	B	C
D	C	C	D	L	P	S	S	B	B	B	B	B
E	B	C	C	D	L	P	S	S	B	B	B	B
F	B	B	C	C	D	L	P	S	S	B	B	B
G	B	B	B	C	C	D	L	P	S	S	B	B
H	B	B	B	B	C	C	D	L	P	S	S	B
I	B	B	B	B	B	C	C	D	L	P	S	S
J	S	B	B	B	B	B	C	C	D	L	P	S
K	S	S	B	B	B	B	B	C	C	D	L	P
L	P	S	S	B	B	B	B	B	C	C	D	L

(31)

- 17 -

The apparatus 20 thus constructed has the following advantages: Since the baking and cooling compartments 51, 52 have respective atmospheres which are continuously maintained respectively at suitable temperatures for the baking and cooling treatments, the baking and cooling steps can be proceeded in a relatively short period of time without loss of heat energy, thus improving productibility. With each of the paint spraying nozzles 64 being provided for a respective one of the barrels 38, the parts can be coated with finished layers of paint which vary in color and thickness for each barrel 38.

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CLAIMS:

1. An apparatus for coating batches of parts, comprising:

(a) an annular hollow housing rotatable about its axis in a plane, said housing having a series of circumferentially disposed loading and unloading, spraying, setting, baking and cooling compartments separated by flexible screens, and a concentric annular rail extending circumferentially across said compartments;

(b) a plurality of barrels disposed in said housing at equal angular intervals for receiving batches of parts and having shafts, respectively, rotatably and pivotably supported outside of said housing, each of said shafts having a portion rollingly riding on said rail such that said shaft portions and said barrels are inclined upwardly with respect to said plane;

(c) a plurality of paint spray nozzles disposed along said housing in substantially opposed relation to said shafts, respectively, and movable toward and away from said housing; and

(d) said loading and unloading compartment having a first opening for supplying a batch of parts to one of said barrels, and a second opening for discharging a batch of parts having been coated from said housing, said spraying compartment having a third



opening through which one of said paint spray nozzles is movable into and out of said housing, said baking compartment having at least one fourth opening for introducing hot air into said baking compartment, said
5 cooling compartment having at least one fifth opening for introducing cool air into said cooling compartment, said first to fifth openings respectively corresponding in position to ones of said barrels while said housing is at rest, said rail including a segmental portion
10 corresponding in position to said second opening and being retractable to a lowered position for tilting a one of said barrels carried thereon to an emptying position.

2. An apparatus according to claim 1, said
15 housing being horizontal.

3. An apparatus according to claim 1, said housing being mounted on an annular stationally base via a plurality of rollers.

4. An apparatus according to claim 1, said
20 housing having a partition wall dividing the interior space of said housing into a pair of upper and lower chambers and supporting said rail, said compartments being disposed in said upper chamber, said second opening being facing to said lower chamber.

25 5. An apparatus according to claim 4, said partition wall including an opening corresponding to said rail's segmental portion in angular direction.



6. An apparatus according to claim 1, including a drive mechanism for intermittently rotating said housing, said drive mechanism including a drive shaft extending along the axis of said annular housing and
5 coupled with a stepper motor, a hub secured to said drive shaft for corotation therewith, and a plurality of angularly spaced arms extending between said housing and said hub to connect them together.

7. An apparatus according to claim 1, said
10 housing including a slot extending in and along an inner peripheral wall thereof, said shafts extending from the respective barrels radially inwardly toward the axis of said housing through said slot.

8. An apparatus according to claim 1, each said
15 flexible screen being made of rubber.

9. An apparatus according to claim 1, each said flexible screen being made of canvas.

10. An apparatus according to claim 1, each said flexible screen having a plurality of slits extending
20 normal to said plane.

11. An apparatus according to claim 1, each of said shaft portions including a pair of rollers extending parallel to said shaft and rotatably mounted on the shaft.

25 12. An apparatus according to claim 1, including a hot-air blower disposed along said baking compartment and including a heat generating unit and a blower pipe



connected at one end with said heat generating unit and fitted in said fourth opening at the other end, said heat generating unit including a heater and a power-driven fan for forcing air through said heater, said pipe, said fourth opening into said baking compartment.

13. An apparatus according to claim 12, said baking compartment including a further opening communicating with said heat generating unit for returning hot air to said heat generating unit.

14. An apparatus according to claim 1, including a cool-air blower disposed along said cooling compartment and including a duct mounted on said housing, a blower pipe communicating at one end with said duct and fitted with said fifth opening, and a power driven fan disposed in said duct for forcing the outside air through said blower pipe and said fifth opening into said cooling compartment.

15. An apparatus according to claim 1, including means for supporting and actuating said paint spray nozzles, said supporting and actuating means comprising a pair of rings respectively disposed inwardly and outwardly of said housing in concentric relation thereto, a plurality of poles supporting one of said rings in a plane parallel to said plane, a plurality of angularly spaced connector bars extending between said rings to connect them together, a support bar mounted



on each of said connector bars and and being slidable longitudinally along said conector bar, said supporting bar supporting one of said paint spray nozzles, and a fluid actuator mounted on one of said connector bars and connected to said support bar for moving said supporting bar and hence said paint spray nozzle into and out of said spraying compartment.

16. An apparatus substantially as described with reference to and as illustrated in the accompanying drawings.

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