The invention here relates to improved methods and apparatus for spray coating articles of manufacture with electrically charged particles of liquid coating material, also herein referred to generally as paint, and more particularly to the coating of a plurality of articles grouped about an atomizing device which projects a spray of liquid particles to be deposited on the articles under the influence of an electrostatic field. Any desired type of atomizing device may be employed.

The copending application of C. C. Simmons, Serial No. 274,509, filed March 5, 1952, now issued as Patent No. 2,908,343, dated October 1, 1959, discloses an electrostatic spray coating system in which the articles to be coated are moved in a circular or arcuate path about an atomizing device. A spray of liquid particles is atomized from the atomizer and projected generally radially of said atomizer to be deposited under the influence of an electrostatic field on the surfaces of the surrounding articles which follow a circular path to take advantage of the natural annular pattern of the radiating spray. In the application it is pointed out that if the articles to be coated have a substantial vertical extent, that is, a vertical extent considerably greater than the vertical width of the annular spray pattern, coating of the entire article surfaces can be achieved by reciprocating the atomizing device substantially along its axis with the limits of reciprocation corresponding generally to the vertical extent of the articles being coated.

In many industries such as the coating of hot water heater jackets, automobile hoods, fenders, and the like it is frequently desired to change the color or character of the coating material, normally synthetic enamels and paints, with the least possible interruption of the coating operation. For example, it may be desired to coat a succession of water heater jackets moving on a conveyor line with white enamel for an hour or so and then change over to another color with the least possible delay. Likewise, it may be desired to paint a batch of about a dozen automobile hoods with red enamel and to paint the next batch of hoods with green enamel.

It may also be desirable to move the atomizing device out of its normal coating position as a "gap" or the absence of articles on a moving conveyor reaches the coating zone in order to prevent waste of coating material and to prevent undesired coating of the surrounding fixtures and the conveyor itself. In addition, when atomizing atomizing devices of the type described in the aforementioned application are started or stopped on the articles then traversing the "loop" around the atomizing device may tend to receive uneven or nonuniform coating due to the somewhat erratic nature of the spray as the atomizing device is brought up to or reduced in speed and as the feeding of liquid coating material is initiated or terminated.

In a preferred form of my invention apparatus is provided for electrostatically coating articles having a substantial vertical dimension which move on a conveyor along a substantially circular path around an atomizer, preferably of the rotating annular-edged type. The atomizer is mounted for movement along a vertical axis and an open-ended shroud which lies generally concentric with the vertical axis is adapted to receive the atomizer. A reciprocating device is provided to move the atomizer along its vertical axis and into and out of the shroud. Means may be provided for supplying liquid coating material to the atomizer while it lies within the shroud and for initiating a spray of finely divided electrically charged liquid particles projected radially outward from the atomizer into a quiescent atmosphere. Suitable control means in conjunction with said reciprocator are used for moving the atomizer out of said shroud and into coating relation with the surrounding articles and for reciprocating the atomizer along the vertical dimension of the atomizer electrostatically to deposit charged spray particles on the articles. The control means may be either automatic or manually operated. While the atomizer is positioned within the shroud, changes in the color of the coating material may be effected or other desired operations performed with minimum loss of coating material and without coating material being deposited in an undesirable manner on articles, the conveyor itself, or adjacent fixtures.

The invention in its various embodiments is particularly adapted to solve the aforementioned coating problems. One object of my invention is to provide a system for changing colors and/or types of coating materials in electrostatic coating with a minimum loss of coating material and without necessity for lengthy interruption of operations. Another object is to eliminate waste of coating material and improper painting of articles occasioned by the starting or stopping of the atomizing device or by gaps in the conveyor line. A further object of the invention is to provide a simple, inexpensive and extremely flexible spray coating system.

The foregoing and other objects and advantages of my invention will be fully understood from the following detailed description of various embodiments thereof, with reference to the accompanying drawings wherein:

FIG. 1 is a side elevation view, somewhat diagrammatic, showing one embodiment of my invention;

FIG. 2 is a plan view of the apparatus shown in FIG. 1 for coating articles carried on a continuously moving conveyor line;

FIG. 3 is a plan view of a somewhat modified form of the apparatus shown in FIG. 1 adapted for coating individual batches of grouped articles;

FIG. 4 is a detailed diagrammatic illustration of one type of atomizer control system for the apparatus shown in FIG. 1; and

FIG. 5 is a detailed diagrammatic illustration of a liquid supply system for use with the apparatus shown in FIG. 1.

Referring first to FIGS. 1 and 2, apparatus is shown for coating a succession of large cylindrical articles such as hot water heater jackets. The articles 10 (only two of which are illustrated in FIG. 1) are hung by means of hangers 11 from a conveyor track 12. The track includes a circular or arcuate portion called a loop (most clearly shown in FIG. 2) which guides articles 10 in a
path about a central vertical axis X as shown in FIG. 1. As the articles traverse this circular portion of the con-
veyor track their centers lie equidistant from axis X. Conventional means including a rotator 14 mounted on
each hanger 11 and a rotator bar 15 suspended from the tracker bar to provide the causes the articles to rotate about
their individual axes as they move along the circular por-
tion of conveyor track 12.

An atomizer having a rotatable substantially hori-
tzontal disc 17 is mounted for reciprocation on the upper
end of an electrically insulated shaft 16 made of suitable insulating material such as polyester bonded fiberglass.
The center of disc 17 is aligned with vertical axis X and
a motor 20 is used to rotate the disc about axis X.

Insulated shaft 18 is mounted on a reciprocating de-
vice shown generally as 23 housed within a pit 23 which
may be located beneath the floor 24 of the building
wherein the coating apparatus is installed. An open-
ended cylindrical shroud 26 is mounted concentric
with axis X and above or in the pit 23. An annular trough
27 is mounted on the lower portion of the interior wall
of the shroud and the trough slopes downwardly to a
drain line 28. This line discharges into a liquid receiv-
ing tank 29 from which liquid may be removed by a line
30 for reformulation or recovery of its usable com-
ponents.

The reciprocator 22 is adapted to move the atomizer
along axis X substantially between position A, wherein
the disc 17 is shown by dotted lines in FIG. 1, and position C, wherein the disc shown in solid lines is located within shroud 26. Control means to be described are provided to recip-
crate the atomizer between positions A and B for coating
articles 10 at selected times to bring the atomizer down into shroud 26.

Both the shroud 26 and the articles 10 are electrically
grounded. By connecting the atomizer to a source of
high voltage 33, a potential difference in the order of
100,000 volts is maintained between the atomizer and
the grounded articles when the atomizer is in the coating zone (between positions A and B) and between the
atomizer and the grounded shroud when the atomizer lies
within the shroud (position C).

In order to move the atomizer in the desired manner
means such as illustrated in FIG. 4 may be used although
other moving means can be used without departing from
the scope of my invention. Reciprocator 22 includes a
hydraulically operated piston 33 within a cylinder 34. A cam bar 36 is rigidly mounted on the piston rod which
also carries insulated shaft 18.

Hydraulic oil from a reservoir 38 is supplied under
pressure by pump 39 to feed lines 41 and 42. Line 42
supplies oil continuously to the upper end of cylinder 34.
Line 41 is connected to a two position directional control
valve 44 which in its position as shown by dotted lines
in FIG. 4 connects line 41 to line 47 and thence to the
lower end of cylinder 34. In the position shown by solid
lines in FIG. 4, valve 44 drains oil from the lower end
of cylinder 34 and returns the oil through a line 49 to
reservoir 38.

When both lines 42 and 47 and hence both ends of
cylinder 34 are connected to the pressure side of pump
39, the piston 33 will move upwardly due to the greater
lower area of piston 33 exposed to the pressure of the
hydraulic oil and when oil is drained from the lower end
of the cylinder, the piston will move downwardly.

Thus movement of the piston and hence of the atomizer
is controlled by the position of directional control
valve 44.

Valve 44 may be moved from one position to the
other by means of two electrically operated solenoids 45 and
46 which are controlled by means of a nor-

3,128,201

4. Cam operated switch S2 is adjustably positioned on
a bracket 57 so that as the end of cam bar 36 passes up-
wardly it moves switch 52 into its “on” position to en-
gefine solenoid 45 and reverse valve 44 when disc 17
reaches position A as shown in FIG. 1. Switch 56 is
positioned on bracket 57 so that as the end of cam bar
36 passes downwardly it moves switch 56 into its “on”
position which, when switch 54 is on, energizes solenoid
46 to reverse valve 44 as disc 17 reaches position B.

However, cylinder 34 is of sufficient length to allow piston
33 to move downwardly so that the disc can be moved
into position on the articles to be coated.

Liquid is supplied to the upper surface of disc 17
through an opening in the center of the disc by means
of an axial passageway in the rotatable shaft of motor
20 connected to a liquid supply line 58. Liquid is fed to
line 58 through a valve system within housing 60 which
is mounted on reciprocator 22. Various forms of liquid
supply systems may be used depending upon the require-
ments of the coating operation. One such system adapted to supply three separate liquids to the atomizer
is shown in detail in FIG. 5, it being understood that
my invention is in no way limited to this particular liquid
supply system.

Housing 60 is shown in FIG. 5 in dotted lines with sup-
ply line 59 leading to the atomizer. Three separate re-
servoirs for liquids are designated as 61, 62 and 63.

Liquid may be fed at a metered rate from each of the
reservoirs by means of respective flow control C, wherein
lines 64, 65 and 66 and serving reservoirs 61, 62 and 63 respectively. Line 71 from pump 65, line 72 from pump 66, and line 73 from pump 67 are manifolded into atomizer supply
line 58 within housing 60. The supply of liquids to line
58 from lines 71, 72 and 73 is controlled by means of valves
75, 76, 77 and 78 also within housing 60.

Pump 65 is driven by electric motor 81; pump 66 by
motor 82; and pump 67 by motor 83. Valve 75 is
operated by an electric solenoid 85; valve 76 by solenoid
86; and valve 77 by solenoid 87. Motor 81 and solenoid
85 are connected with and controlled by a manually
operate-able on-off liquid supply switch 91. Likewise,
motor 82 and solenoid 86 are connected with a similar
switch 92, and motor 83 and solenoid 87 with a

93.

The operation of the coating apparatus shown in FIGS.
1, 2, 4 and 5 will now be described. If it is desired, for
example, to coat some of the articles with white enamel
and some with blue enamel, liquid reservoir 61 is filled
with white enamel, reservoir 62 with a clear thinner,
and reservoir 63 with blue enamel. At the start the
atomizer is in position C within shroud 26 and piston 33
is in its lowestmost position within cylinder 34 as shown in FIG. 4. The atomizer motor 26 is energized to cause disc 17
to rotate preferably at a rate of many hundreds of revolu-
tions per minute. High voltage source 32 is also en-
ergized to create an electrostatic field of high potential
between the charged edge of the disc and the grounded
shroud 26. If articles are first to be coated white, switch
91 is closed to operate motor 81 which drives pump 65
and to activate solenoid 85 which opens valve 75. Thus
white enamel from reservoir 61 is fed at a positively
controlled rate through supply line 58 to the upper surface
of the rotating disc.

Under the influence of centrifugal force the white en-

65

amal will gradually spread over the surface of the disc
as a thin expanding liquid film. As the enamel leaves
the disc it will be atomized from the edge of the film under the
influence of the electrostatic field as a spray of finely
divided liquid particles. The spray will be electro-
statically attracted to and deposited on the interior wall of
shroud 26, thus permitting the newly initiated spray to
become fully operative before being moved into coating
relation with the articles. Any appreciable amount of
liquid deposited on the interior wall of shroud 26 will flow

75
down the wall into trough 27 and drain off into tank 29 and thus liquid will not be wasted. While disc 17 is being brought to its full speed, the conveyor pump 39 and the articles 10 are moved at a continuous uniform rate along conveyor track 12. Reciprocator pump 39 is then activated to pump oil into feed lines 41 and 42. Switch 54 is closed to operate solenoid 46 which moves valve 44 into the position shown in FIG. 4 by dotted lines whereby both lines 42 and 47 are connected to pump 39 to move downwardly so that the atomizer rises out of shroud 26 into coating relation with the articles moving around the loop portion of conveyor track 12.

As the end of cam bar 36 passes over switch 56 with the atomizer at position B, switch 56 will return to its normally open position without affecting the movement of piston 33. However, as the end of the cam bar passes over switch 52 and the atomizer is at position A, switch 52 will return to its normally closed position to activate solenoid 45 and terminate the connection of line 47 to the pump. Thus, of course causes the reversal of piston 33 and downward movement of the atomizer. Then as the cam bar moves downwardly over switch 56 solenoid 46 will be activated to cause the reversal of piston 33 and upward movement of the atomizer. Thereupon the atomizer will continue to reciprocate through the coating zone (between positions A and B) and white enamel will be applied electrostatically to the surfaces of the articles being rotated and moved along the loop portion of the conveyor track.

When it is desired to change the color of the coating material during operation of the conveyor line and without undesirable coating of any articles, the atomizer may be stopped by means of switch 35. With the disc continuing to rotate, liquid supply switch 91 is opened to stop pump 65 and close valve 75 in order to cut off the supply of white enamel to supply line 58. Thereupon switch 92 is closed to operate motor 52 which drives pump 66 and to activate solenoid 66 which opens valve 76. This causes thinner from reservoir 63 to be fed at a relatively rapid rate through supply line 58 to the surface of the rotating disc. Pumping thinner through the system will purge the supply line and surface of the rotating disc and flush them clean of white enamel.

This cleaning action takes only about 10 seconds and at the end of that time switch 92 may be opened to cut off the supply of thinner. At the same time switch 93 is closed to operate motor 83 which drives pump 67 and to activate solenoid 87 which opens valve 77 whereby white enamel from reservoir 63 will be fed through supply line 58 to the surface of the disc. As soon as the new spray of blue enamel has been established, the reciprocator switch 54 may be closed to raise the atomizer out of the shroud and into the coating zone to continue coating articles, this time with blue enamel.

If it is desired to stop the coating operation or to interchange it for a short interval such as occasioned by a temporary gap in articles on the conveyor line, reciprocator switch 54 is opened. The next downward stroke of the piston will carry the atomizer to position C within shroud 26 where the spray of enamel particles will be intercepted by the shroud. In order to prevent piston 33 from striking the bottom of cylinder 34 that may be exerted in any direction, cylinder 34 may be of the self-sustaining or throttling type as is well known in the art. In case of temporary absence of articles on the conveyor line, the atomizer may continue to operate within the shroud until, by the closing of switch 54, the atomizer is again caused to rise out of the cylinder 34. The atomizer 11 is then rotated about the central vertical axis 112 of hanger 111. Articles are arranged on a succession of adjacent hangers 111 depending from conveyor track 12. Articles 110 are grouped on these hangers and the hangers spaced along conveyor track 12 so that a given number of hangers (seven hangers each carrying three automotive hoods in the embodiment shown in FIG. 3) substantially fill the circular loop portion of the conveyor track about an atomizer such as has been previously described.

A driving sprocket 115 is located in the throat of the loop portion of the conveyor track. This sprocket drives an endless chain 116 which follows a path from the sprocket and generally around the conveyor loop. Arranged to mesh with chain 116 and driven thereby are a plurality of sprockets 118 each mounted axially on one of the hangers 111 to rotate each hanger about its vertical axis 112.

If it is desired to coat the first batch of grouped automotive hoods red and the next batch green, reservoir 61 may be filled with red paint, reservoir 62 with thinner and reservoir 63 with green paint. The first batch of grouped hoods are moved into position and stopped on the loop portion of the conveyor track. Voltage source 33 is energized and the atomizer within shroud 26 rotated and supplied with red paint to initiate a spray of charged red paint. When the spray has become stabilized, the atomizer is raised into coating position by closing reciprocator switch 54. Immediately prior to raising the atomizer into coating position, driving sprocket 115 is energized. This causes endless chain 116 to move along its extent to rotate sprockets 118 on each of hangers 111 and the articles 110 about the axes 112 of the hangers. Thus as the atomizer reciprocates through the coating zone the grouped automobile hoods will be rotated at a controlled rate to receive a uniform application of red paint on their exterior surfaces.

When the desired thickness of paint has been deposited, reciprocator switch 54 is opened to cause the atomizer to move out of coating position and into shroud 26. While within the shroud a change to green paint can be effected in the manner previously described. At the same time rotation of driving sprocket 115 and the hangers is discontinued and the first batch of red painted automotive hoods are moved out of the loop portion of conveyor track 12 so that a second batch of automotive hoods may be moved into the loop to be coated with green paint.

While there has been shown and described in detail two embodiments of my invention, it should be understood that the invention is capable of various modifications. For example, the reciprocating mechanism for the atomizer and/or the shroud may be mounted above rather than below the coating zone. Also, additional colors or types of liquid coating material may be used with the system by increasing the number of supply lines manifolded into line 58. These and many other changes may be made in the construction and operation of the apparatus without departing from the spirit and scope of my invention as set forth in the appended claims.

1. A method of electrostatically spray coating articles with different types of coating materials comprising distributing a plurality of articles to be coated along a circular path about a predetermined axis, positioning a reciprocable spray source along said axis, initiating a radially expanding annular charge of charged liquid particles of a given type from said source while said source is located beyond the extremities of the articles and within a shroud on which the spray particles are deposited, moving said spray source along said axis into coating relation with the articles to deposit charged spray particles on articles, reciprocating said spray source along said axis supported by a hanger 111 whereby the exterior surfaces of the hoods to be coated are arranged to form a substantially continuous surface while being rotated about the central vertical axis 112 of hanger 111. Articles are arranged on a succession of adjacent hangers 111 depending from conveyor track 12. Articles 110 are grouped on these hangers and the hangers spaced along conveyor track 12 so that a given number of hangers (seven hangers each carrying three automotive hoods in the embodiment shown in FIG. 3) substantially fill the circular loop portion of the conveyor track about an atomizer such as has been previously described.

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3,128,201 generally between the extremities of the articles to effect a coating of the articles, returning said spray source to within said shroud, terminating said spray, flushing out said spray source with a cleaning fluid, initiating from said spray source a radially expanding spray of charged liquid particles of a different type, and again moving said spray source along said axis into coating relation with articles to be coated.

2. A method of electrostatically spray coating articles comprising the steps of initiating a radially expanding spray of dispersed particles of liquid coating material from a source within a stationary spray confining shroud, moving a succession of articles to be coated along a predetermined path remote from said shroud and having a loop portion substantially concentric with the radially expanding spray of liquid particles, automatically moving said spray source along a predetermined path out of said shroud and into coating relation with articles moving along said loop portion, maintaining said articles and said shroud at ground potential, creating an electrostatic field between the articles and the spray particles projected from said spray source while in coating relation with the articles and between the shroud and the spray particles when the spray source is within the shroud, said field being of sufficient strength electrostatically to cause the deposition of liquid particles on the articles to form a coating thereon, and terminating the coating of articles by moving said spray source along its predetermined path to within said shroud.

5. An electrostatic spray coating system comprising a reciprocating atomizer, a reciprocator for moving the atomizer along a predetermined path and a color-change position, a conveyor for moving a succession of articles to be coated past said atomizer in its article-coating position, a shroud surrounding said atomizer in its color-change position, a conveyor for propelling spray particles of liquid projected from said atomizer while in said color-change position, a source of high voltage for establishing between the atomizer on the one hand and the shroud and the articles on said conveyor on the other hand a spray particle-depositing electrostatic field, a first line for supplying liquid-coating material A to said atomizer, a second line for supplying a cleaning fluid to said atomizer, a third line for supplying liquid-coating material B to said atomizer, said three lines running to said atomizer to supply liquid thereto for atomization as a spray of charged liquid particles, a first valve in said first line, a second valve in said second line, a third valve in said third line, and means for selectively controlling said first, second and third valves while said atomizer is in its color-change position within said shroud.

4. An electrostatic spray coating system which comprises an atomizer having a rotatable annular-edged disc mounted for reciprocating movement along a vertical axis, means for rotating the annular-edged disc about its axis, means for feeding a liquid coating material to a surface of the rotating annular-edged disc for formation into a thin liquid film for atomization from the annular edge thereof as a radially expanding annular spray of finely divided liquid particles, a conveyor for distributing a plurality of articles each having a vertical dimension greater than the vertical dimension of said spray along a generally horizontal loop path spaced from and surrounding said atomizer, means including a source of high voltage having one terminal connected to said atomizer for creating a potential difference between said spray particles and the articles to be coated, and means including a reciprocator for repeatedly moving said atomizer along said vertical axis between the upper and lower vertical extremities of the surrounding articles to distribute the spray of liquid coating material over the entire article extent of the articles a determined interval of time, making the atomizer outfeed and outfeed to receive said atomizer to one position and lying beneath the lower extent of the articles, means for maintaining said shroud at substantially the electrical potential of the articles, and means associated with said reciprocator for moving said atomizer at selectively controlled times substantially along said vertical axis beyond the lower extent of said articles and into and out of said shroud.

6. An electrostatic spray coating system comprising a conveyor for distributing a plurality of articles to be coated along a loop path a predetermined defined axis, an atomizer mounted for reciprocating movement generally along said axis, means for feeding a predetermined liquid coating material to said atomizer at a controlled rate for atomization therefrom as an outwardly expanding radial spray of finely divided particles of liquid coating material, means including a source of high voltage for creating a particle-depositing potential difference between the spray particles atomized from said atomizer and the articles on said conveyor, a stationary shroud maintained at the potential of the articles having an open end adapted to receive said atomizer in one position enclosing said axis and lying axially beyond the bounds of the articles on said conveyor, and reciprocating means for moving said atomizer substantially along its defined axis into and out of said shroud, the spray particles being deposited on the articles when the atomizer is outside of said shroud and the spray particles being collected on the interior wall of said shroud when said atomizer is within said shroud.

7. Apparatus of the type described, comprising a rotary distributor device, a non-rotary paint control unit having a main control bore communicating with said distributor device, means for introducing a cleansing liquid to said bore, means for introducing coating material to said bore, and selective control members regulating said respective last named means.

8. Apparatus as defined in claim 7 wherein said control members are electromagnetically operated.

9. Apparatus as defined in claim 7 wherein said rotary distribution device comprises an electrostatically charged atomizer.

10. Apparatus as defined in claim 7 wherein there is additionally provided a stationary shroud cooperating with said rotary distributor device to receive the discharge therefrom when the device and shroud are in predetermined relative position.

11. Apparatus of the type described, comprising a rotary distributor device, a non-rotary paint control unit having a main control bore communicating with said distributor device, means for introducing a cleansing liquid to said bore, means for introducing coating material to said bore, and selective control members regulating said respective last named means, and switch means for
controlling the operation of said pump and said selective control members.

12. Apparatus of the type described, comprising a rotary distributor device, means for reciprocating said rotary distributor device, a stationary shroud co operable with said device in one position, a non-rotary paint control unit having a main control bore communicating with said distributor device, means for introducing a cleansing liquid to said bore, means for introducing coating material to said bore, and selective control members regulating said respective last named means.

13. Apparatus of the type described, comprising a rotary distributor device, means including a hydraulic actuator for reciprocating said rotary distributor device, a stationary shroud co operable with the device in one position of the actuator, a non-rotary paint control unit having a main control bore communicating with said distributor device, means for introducing a cleansing liquid to said bore, means for introducing coating material to said bore, and selective control members regulating said respective last named means.

14. Apparatus of the type described, comprising a rotary distributor device, a non-rotary paint control unit having a main control bore communicating with said distributor device, means for introducing a cleansing liquid to said bore, means including an electric motor and a pump driven thereby for introducing coating material to said bore, electromagnetically operated selective control valves regulating said respective last named means, and switch means for controlling the operation of said pump and said valves.

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