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(54) **THIN LINE CONFORMAL COATING APPARATUS AND METHOD**

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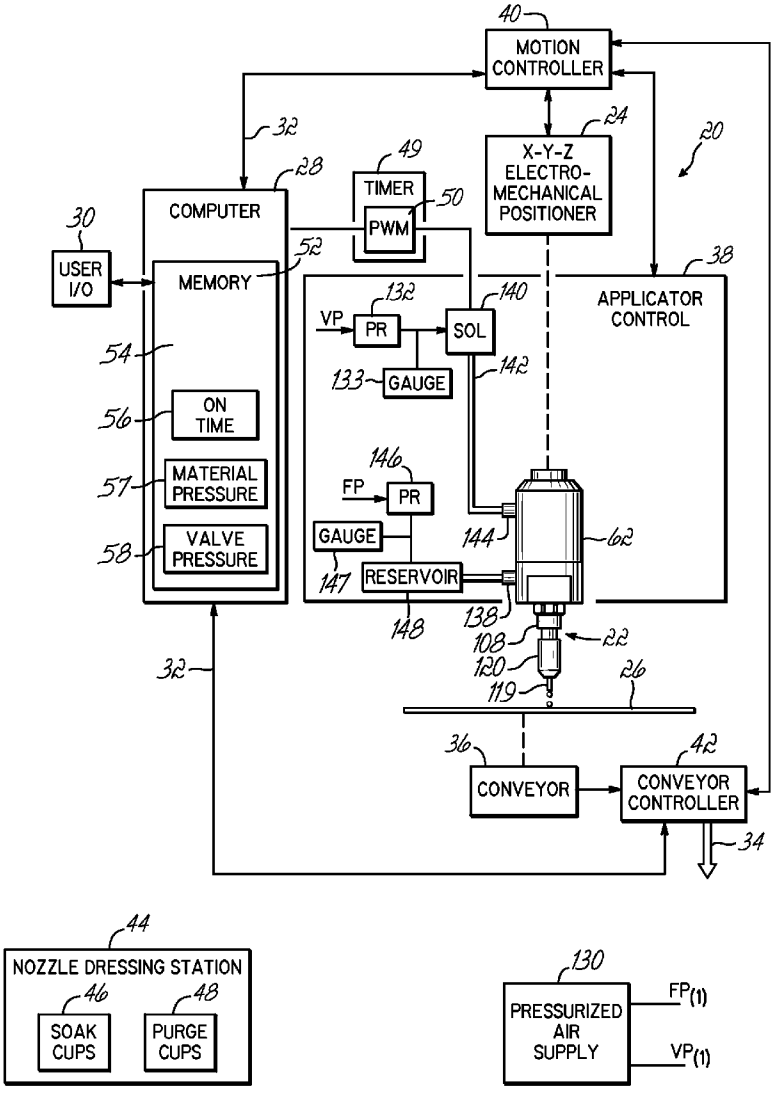
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(57) **ABSTRACT**

A coating system with an applicator that has an air cylinder with a needle valve. A control has a timer that provides a string of electrical pulses to a solenoid. With each pulse, the solenoid applies pressurized air to a cylinder piston, thereby opening the needle valve and permitting coating material to flow past the needle valve. The needle valve is closed for durations of time between pulses, and the coating material is ejected from a dispensing needle in response to closings of the needle valve.



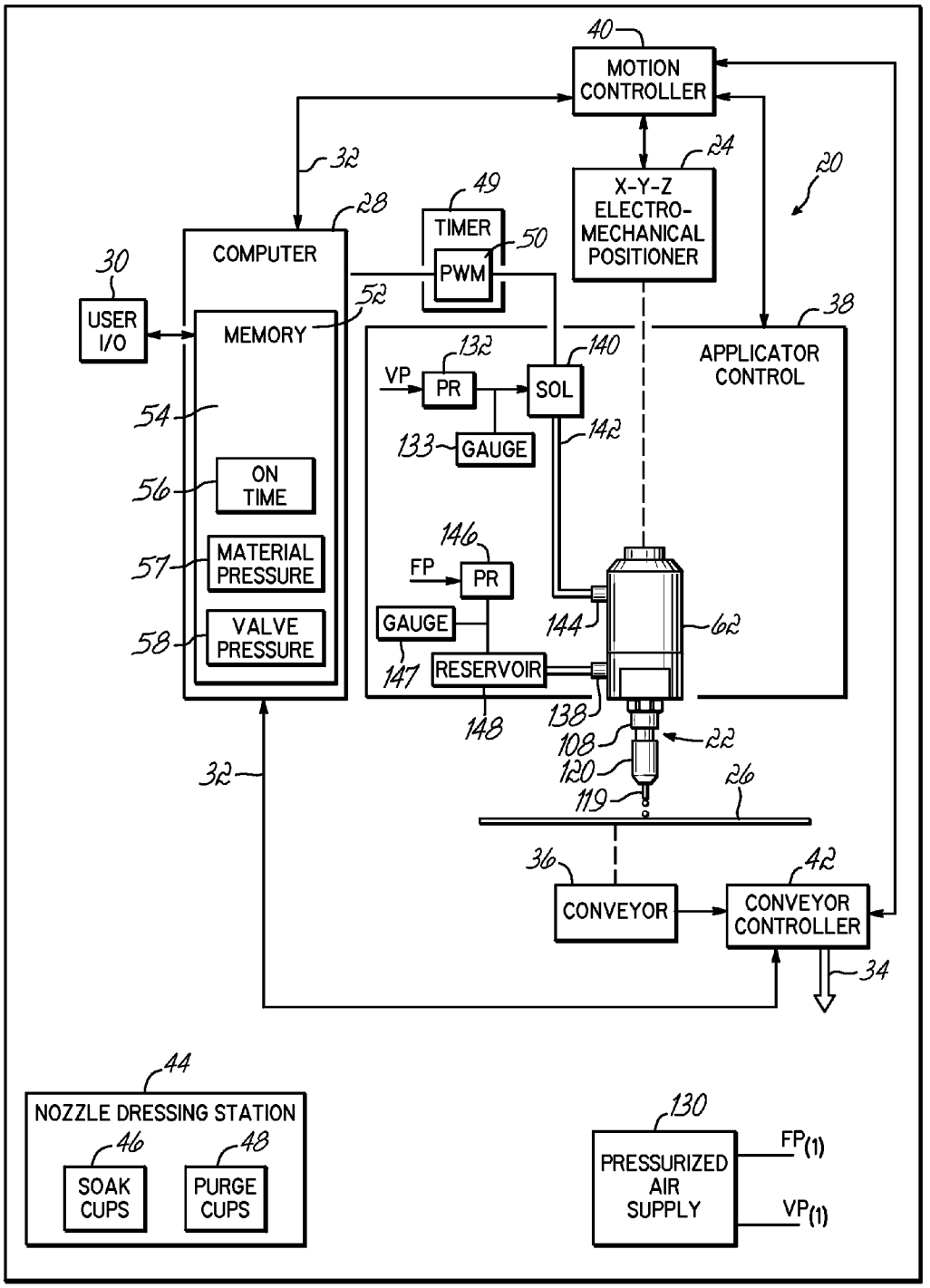

40
MOTION CONTROLLER
32
24
X-Y-Z ELECTRO-MECHANICAL POSITIONER
20
49
TIMER
50
PWM
28
COMPUTER
30
USER I/O
52
MEMORY
38
APPLICATOR CONTROL
132
VP
PR
140
SOL
54
133
GAUGE
142
56
ON TIME
146
FP
PR
57
MATERIAL PRESSURE
GAUGE
144
62
58
VALVE PRESSURE
147
RESERVOIR
148
138
108
22
120
119
26
32
36
42
CONVEYOR
CONVEYOR CONTROLLER
34
44
NOZZLE DRESSING STATION
46
SOAK CUPS
48
PURGE CUPS
130
PRESSURIZED AIR SUPPLY
FP(1)
VP(1)

FIG. 1

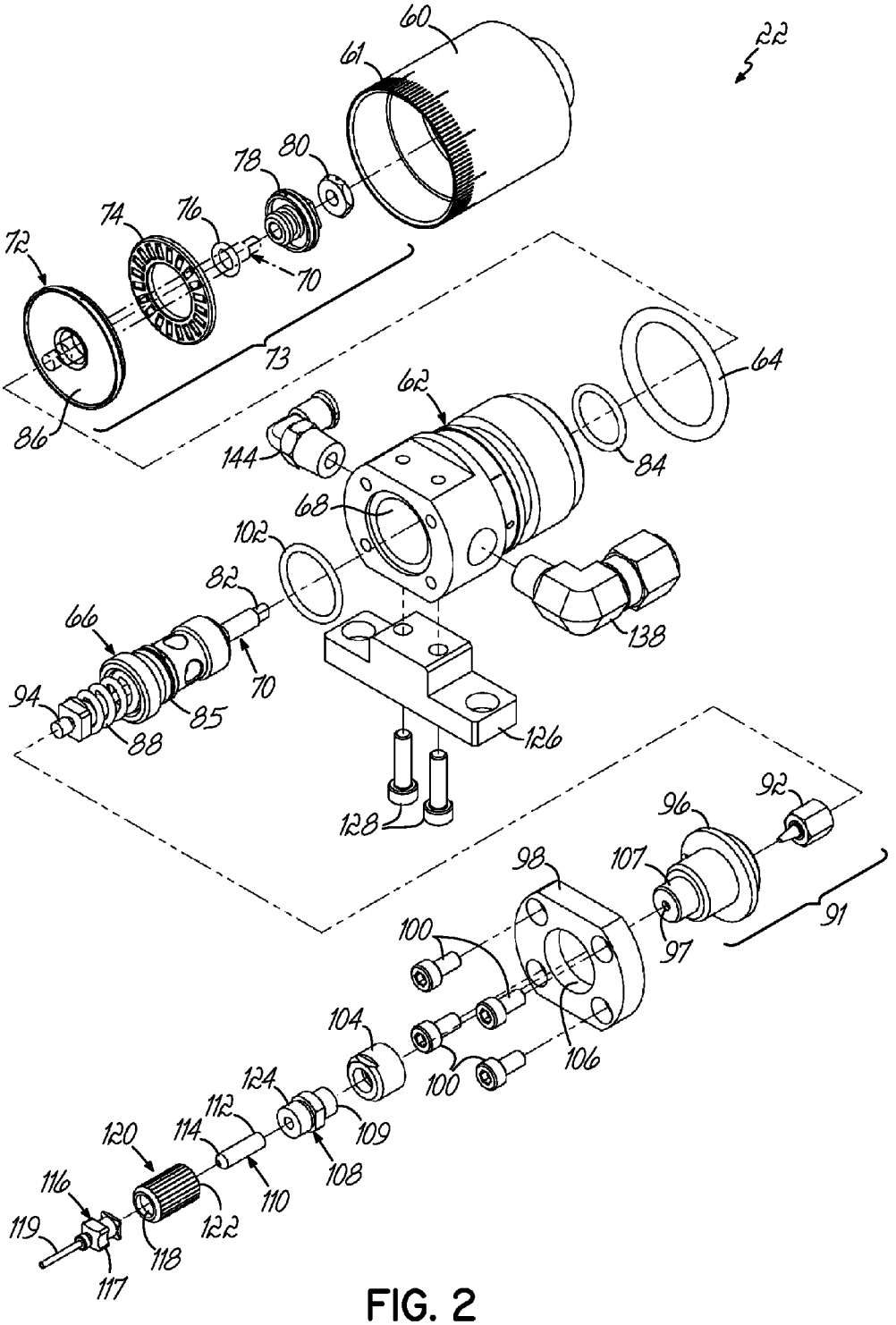

60
61
22
78
80
74
76
72
70
73
64
62
144
84
86
68
102
82
66
138
94
85
70
88
126
128
96
92
98
107
91
97
100
104
106
100
124
112
109
120
114
108
116
110
122
119
118
117

FIG. 2

THIN LINE CONFORMAL COATING APPARATUS AND METHOD

RELATED APPLICATIONS

[0001] The present application claims the filing benefit of US. Provisional Application Ser. No. 60/829,049, filed Oct. 11, 2006, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention generally relates to applying conformal coating materials and more particularly, to an applicator for applying conformal coatings to electrical components.

BACKGROUND OF THE INVENTION

[0003] Conformal coating is the process of applying a dielectric material onto an electrical component, for example, a printed circuit ("PC") board or a device mounted thereon, to protect it from moisture, fungus, dust, corrosion, abrasion, vibration, chemicals, tin whiskers and other environmental stresses. Conformal coating materials range from solvent based materials that cure by evaporation of the solvent, to "100% solids" conformal coating materials. Common conformal coating materials include silicones, acrylics, urethanes, epoxy synthetic resins, paralyne and various polymers. When applied to PC boards, an insulative resin film of uniform thickness is formed as a solvent evaporates or, as a solvent free material is cured.

[0004] Automated selective coating systems are known which have conformal coating dispensers that dispense material in various patterns, with varying deposition accuracies and producing coatings with varying thicknesses. For instance, a dispenser may dispense material in the form of a straight bead, a bead that is continuously rotated in a curved or circular pattern, and/or a bead that is subsequently atomized. Beads tend to produce coatings that are generally thicker than those for atomized sprays. Furthermore, depending on material viscosities as well as material/board surface tension interactions, a bead deposited on a board may spread to locations where no coating is desired. Moreover, in atomized sprays, injecting a supply of material with pressurized air to achieve atomization often creates significant overspray, thus depositing atomized droplets outside a target area.

[0005] These current dispensing methods have features that in some applications lead to undesirable coating results including greater than desirable minimum coating areas and less than desirable edge definition capability. With more recent conformal coating applications, it is desirable to have a capability of coating even smaller areas or smaller geometries. This capability, however, primarily depends on the type of dispenser used to apply the coating material and perhaps more specifically, the control a dispenser provides over the dispensed material.

[0006] With current dispensers that dispense beads or atomized sprays, there is a limit to which the size of the wetted area, or contact area of the bead or spray on a component, can be minimized. As a result, such current dispensers have minimum coating areas, i.e., an area where it is practical to use such a dispenser for conformal coating applications, which may be too large for more current applications. This becomes even more significant as boards and components get smaller and component densities on such boards increase.

[0007] Known needle valve dispensers control dispensing of a conformal coating material by controlling a time that a needle valve is open as well as an applied pressure of the conformal coating material being supplied to the needle valve. Such known needle valve dispensers also have some short comings, for example, first, it is difficult to control a flow of lower viscosity conformal coating materials. While there is no standard measure that distinguishes lower viscosity materials from higher viscosity materials, as an example, lower viscosity materials include but are not limited to materials that have viscosities that are less than one thousand centipoise. In order to reduce splash of lower viscosity materials through known needle valve dispensers, the dispensing tip must be maintained as close to the surface of the substrate as possible, for example, within several millimeters ("mm"). On PC boards that are densely populated, the requirement that the dispensing tip be maintained so close to the substrate surface may severely limit the application of known needle valve dispensers. Second, the inability of known needle valve dispensers to sharply cutoff a flow of conformal coating material results in dripping, drooling, poor flow control and generally, a less precise application. For example, the coating material can only be applied to within about 0.060 inch ("in") or about 1.5 mm of a keep-out area, that is, an area where no conformal coating material is to be applied. Third, known needle valve dispensers have an inherent problem of allowing coating materials to cling to, and partially cure on, the dispensing tip, which leads to clogs and may reduce the repeatability and accuracy of the dispensing process.

[0008] Therefore, there is a need to provide an improved needle valve conformal coating applicator that improves the accuracy and selectivity of material deposition in a conformal coating process.

SUMMARY OF THE INVENTION

[0009] The present invention provides a coating system with a needle valve applicator that may apply lower viscosity conformal coating materials to a substrate with greater accuracy, precision and/or speed than known needle valve applicators and/or may have other advantages. For example, the coating system of the present invention may improve the ability of a needle valve applicator to apply coating material closer to keep-out areas, and/or apply thinner lines of coating material, and/or operate higher above a substrate while maintaining a desired accuracy in the placement of the conformal coating material on the substrate. Such improved coating system performance often eliminates masking and unmasking, thereby substantially reducing handling of the substrate.

[0010] In addition, a coating system of the present invention can provides a needle valve applicator that cleanly ejects coating material from a dispensing needle, thereby preventing the coating material from clinging to, and/or curing on, the dispensing needle. This reduces maintenance and minimizes clogs while maintaining accuracy and increasing repeatability. Further, the coating system of the present invention may allow for coating material discharge volumes that are predictable and repeatable; and therefore, a total volume of conformal coating material applied over an area may be precisely controlled. Such a capability can

substantially reduce waste of the conformal coating material. The coating system of the present invention may provide a needle valve applicator that has a slim profile and thus, can be moved through small spaces between components on PC boards at lower dispense heights, which minimizes splashing when coating with lower viscosity materials. All of the features above can make the coating system of the present invention especially useful when applying a conformal coating material to smaller, densely populated PC boards.

[0011] More specifically, in one exemplary embodiment, the invention provides a coating system with a applicator that has an air cylinder operated by a solenoid connected to pressurized air. A needle valve mounted in the cylinder is opened by the solenoid applying pressurized air to a piston connected to the needle valve. A control has a timer that is operable to provide a string of electrical pulses to the solenoid. With each pulse, the solenoid applies the pressurized air to the piston, thereby opening the needle valve and permitting coating material to flow past the needle valve. The needle valve is closed for durations of time between pulses, and the coating material is ejected from a dispensing needle in response to closings of the needle valve.

[0012] In further aspects of this invention, the timer is a pulse width modulator; and the needle valve is repeatedly opened for durations about equal to an On time stored in the control. The needle valve is closed by a return spring and held closed for durations of time between the pulses.

[0013] In another exemplary embodiment, the invention provides a method of automatically dispensing a coating material onto a substrate with an applicator being movable by a programmable control operating a positioner supporting the applicator. The applicator has a flow channel conducting a coating material from a needle valve to a dispensing needle. The needle valve is movable to an open position by an air cylinder piston in response to a pressurized fluid received from a solenoid, and the needle valve is then movable to a closed position. The method includes applying a string of electrical pulses to the solenoid. The coating material is moved past the needle valve by repeatedly opening the needle valve in response to each pulse in the string of electrical pulses being applied to the solenoid. The coating material is ejected from the dispensing needle by repeatedly closing the needle valve in response to periods of time between pulses in the string of electrical pulses.

[0014] These and other objects and advantages of the present invention will become more readily apparent during the following detailed description taken in conjunction with the drawings herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a schematic block diagram of one exemplary embodiment of a computer controlled conformal coating system.

[0016] FIG. **2** is a disassembled view of an exemplary embodiment of a conformal coating applicator used in the conformal coating system of FIG. **1**.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

[0017] Referring to FIG. **1**, one exemplary example of a conformal coating system **20** includes a conformal coating applicator or dispenser **22** mechanically suspended from an X-Y-Z positioner **24**. The X-Y-Z electro-mechanical positioner **24** includes a drive coupled to independently controllable motors (not shown) in a known manner. The X-Y-Z positioner **24** is capable of rapidly moving the conformal coating applicator **22** with respect to a substrate **26**.

[0018] A computer **28** may be a programmable logic controller ("PLC"), a microprocessor based controller, a hardened personal computer or other conventional programmable control device capable of carrying out the functions described herein as will be understood by those of ordinary skill. A user I/O **30**, for example, a visual display device such as an LCD screen (not shown) and a user input device such as a keyboard (not shown) are connected to the computer **28** in a known manner. The computer provides outputs to a timer **49**, for example, a pulse width modulator ("PWM") **50**, that, in turn, is electrically connected to, and drives, an air solenoid **140**. The PWM **50** creates a series or string of electrical control pulses that are used to operate the solenoid **140** and hence, the conformal coating applicator **22**.

[0019] The computer **28** has a memory **52** for storing operating programs and programmed instructions in a known manner. The memory further includes On time storage **54** and Cycle time storage **56**. The On time storage stores at least one desired value of an On time of a pulse in a pulse string created by the PWM **50**. The Cycle time storage stores at least one desired value of a respective total Cycle time associated with the On time of the pulse. Thus, a pulse Off time is determined by subtracting a stored On time from a stored respective Cycle time.

[0020] The coating system **20** is provided with one or more standard RS-232 busses **32** and one or more SMEMA communications busses **34**, which are compatible with most types of other automated equipment utilized in substrate production assembly lines. The motion controller **40** and a conveyor controller **42** are in electrical communications with the computer **28** and with each other. Thus, a system control includes the computer **28**, the PWM **50**, the motion controller **40**, the applicator control **38** and the conveyor controller **42**, if used.

[0021] The substrate **26**, for example, a PC board, onto which a conformal coating is to be applied, is supported in an operative relationship with the conformal coating applicator **22** in a known manner. Depending on the application, one or more substrates **26** may be coated in a batch mode; or optionally, the substrates **26** may be moved continuously past the applicator **22** by a conveyor **36**. The conveyor **36** is of a conventional design and has a width which may be adjustable to accept PC boards of different dimensions. The conveyor **36** may also include pneumatically operated stop and locate mechanisms, and the conveyor **36** is operated by a conveyor controller **42** in a known manner.

[0022] The exemplary embodiment may further include a nozzle dressing station **44** that includes one or several soak cups **46**, a purge cup **48** and/or other nozzle dressing tools that can be used to clean an applicator tip in a known manner depending on the specific properties of the conformal coating used.

[0023] Referring to FIG. **2** the conformal coating applicator **22** has a packing cartridge **66** that supports a piston rod **70**, which is inserted into a bore **68** of an air cylinder body **62**. An air cylinder piston **72**, thrust bearing **74**, O-ring **76** and lock nut seal **78** are then mounted on the piston rod **70**. A lock nut **80** is then threaded onto a piston rod end **82** to secure the air cylinder piston **72**, thrust bearing **74**, O-ring **76**

and lock nut seal **78** onto the piston rod **70** to form a unitary piston assembly **73** with respect to the air cylinder **62**. O-ring **76** seals the packing cartridge **66** within the air cylinder **62**. O-ring **85** seals the pressurized coating material within the cylinder bore **68**, and O-ring **84** seals the pressurized air within the cylinder bore **68**. An air cylinder cap **60** is threadedly mounted on the air cylinder **62** with an O-ring **64** providing a seal resistance to rotation of the cap **60**. A mounting bracket **126** is attached to the air cylinder **62** by fasteners **128**, and the mounting bracket **126** may be used to mount the applicator **22** to the positioner **24** of FIG. **1**.

[0024] The piston assembly **73** is moveable lengthwise with respect to the packing cartridge **66**. In response to a pressurized air applied against a surface **86** of piston **72**, the piston assembly **73** moves to the right as viewed in FIG. **2**, which motion compresses a return spring **88** that is secured over the piston rod **70** by a nut **94**. Upon the pressurized air being removed from the pneumatic piston **72**, the return spring **88** returns the piston assembly **73** to its original longitudinal position with respect to the air cylinder **62**.

[0025] A needle valve **91** has a needle **92** and a mating seat **96**. The needle **92** is threaded onto an opposite piston rod end **94** and thus, is movable by the piston assembly **73**. A seat **96** is mounted to one end of the air cylinder **62** by a mounting plate or cap **98** that is secured by a fasteners **100**. An O-ring **102** provides a fluid seal between the seat **96** and the air cylinder **62**. Thus, when assembled, the air cylinder bore **68** is bounded at one end by the air cylinder piston **72**; and the bore **68** is bounded at an opposite end by the seat **96**. Further, the bore **68** is fluidly coupled via connector **144** to pressurized air that fills the bore **68** between the O-ring **84** and the piston **72**. The bore **68** is also fluidly coupled via connector **138** to a pressurized source of conformal coating material that fills the bore **68** between the O-ring **85** and seat **96**. The seat **96** has a flow channel **97** throughwhich the conformal coating material passes when the needle valve **91** is open. The air cylinder cap **60** has a scale marked on its circumference, and rotating the cap **60** provides a microadjustment of a positive stop that limits a displacement of the piston assembly **73** and hence, the needle **92** when the needle valve **91** is opened. Thus, the air cylinder cap **60** provides a control of conformal coating material through the needle valve **91**.

[0026] A nozzle adaptor **104** extends through a bore **106** of the mounting cap or plate **98** and is threaded onto one end **107** of the seat **96**. A holder **108** has one end **109** threaded into the nozzle adaptor **104**. A capillary tube **110** has one end **112** threaded into the holder **108**. A dispensing needle **116** is inserted into an end **122** of a retaining nut **120**, which has a larger bore that accepts a hub **117** of the dispensing needle **116**. Thus, only a tip **119** of the dispensing needle **116** extends through a smaller bore at an opposite end **118** of the retaining nut **120**. An opposite end **114** of the capillary tube **110** slides into a bore of a dispensing needle **116**, and the retaining nut end **122** is threaded to an end **124** of the holder **108**, thereby securing the dispensing needle **116** to the applicator **22**.

[0027] Referring back to FIG. **1**, in this exemplary embodiment, a pressurized air supply **130** provides an air pressure VP, for example, a shop air pressure, to a pressure regulator **132** that may be mounted on the conformal coating applicator **22**. A gage **133** monitors the regulated air pressure applied to a solenoid **140**, and an air line **142** conducts the regulated pressurized air from the solenoid **140** to an air fitting **144** connected to the air cylinder body **62**. The pressurized air supply **130** further provides an air pressure FP to a pressure regulator **146** that may be mounted on the positioner **24** and thus, does not move with the applicator **22**. A gage **147** monitors the regulated air pressure that is applied to a liquid reservoir **148**. The liquid reservoir **148** may be a syringe of conformal coating material that is commercially available from a supplier, the regulated air pressure from the pressure regulator **146** may be applied to a plunger located in one end of the syringe. Thus, the liquid reservoir **148** supplies a pressurized conformal coating material to the air cylinder **62**. The pressure regulator may be adjusted to change the pressure of the conformal coating material supplied from the reservoir **148** to the air cylinder **62**.

[0028] In operation, prior to initiating a conformal coating application cycle, a user must set up the coating system **20** for a particular application. In that process, desired values for system variables are determined; and those desired values are often application dependent. For example, desired values for system variables may depend on the conformal coating material being used, its viscosity, the specifications of the conformal coating as applied to the substrate, current environmental conditions, desired applicator velocity and similar factors. One variable value that the user may select is a general size of droplet to be applied by the dispensing needle **116**. Dispensing needles may be selected that have respective internal flow paths of different diameters; and hence, larger dispensing needles may be chosen to provide larger droplets and smaller dispensing needles may be chosen when smaller droplets are desired.

[0029] The user may also determine a PWM On time, a PWM Cycle time and a desired material flow through the needle valve **91**. Again, the desired values for those variables are application dependent. The material flow through the needle valve **91** may be adjusted by turning or microadjusting the air cylinder cap **60** shown in FIG. **2**, which is effective to adjust the open position or stroke of the needle **92**. Material flow through the needle valve **91** may also be varied by changing the pressure on the conformal coating material by adjusting regulated air pressure from the pressure regulator **146**. Often, a number of test substrates are coated, and the variables adjusted until a desired coating application is obtained. The positioning program provided by the motion controller **40** may also be changed depending on various setup factors, for example, how high the dispensing tip **119** can be raised from the substrate **26** and still provide a conformal coating within specifications.

[0030] For given conformal coating materials, a table of starting default values of regulated air pressures from pressure regulator **146**, air cylinder cap adjustments and On time and Cycle time values may be stored in memory **50** of the computer **28**. The user I/O **30** may be used to set and adjust the values in the On time storage **54** and the Cycles time storage **56**. In one exemplary embodiment, the gages **133**, **147** may have visual displays and the pressure regulators **132**, **146** may be manually adjustable. However, in another exemplary embodiment, the gages **133**, **147** may provide respective pressure feedback signals to the computer **28**; and the pressure regulators **132**, **146** may have inputs permitting the computer **28** to change and set the respective regulated pressures. Further, the memory **52** may provide On time storage **54**, Cycle time storage **56**, regulated coating material pressure storage **57** and regulated valve pressure storage;

and the values stored in the memory **52** may be set and/or changed by the user operating the user I/O **30**.

[0031] After the On time, Cycle time, coating material air pressure and needle valve open position are set, the user I/O may be used to initiate an automatic cycle of operation. Data representing a desired dispensing cycle is stored in the memory **50** of the computer **28** that, in turn, communicates control signals to the motion controller **40**. The motion controller **40** commands the X-Y-Z positioner **24** to move the applicator **22** to desired locations with respect to the substrate **26**. When it is desirable to apply a conformal coating to the substrate **26**, the motion controller **40** provides a command signal to the computer **28** that, in turn, operates the PWM **50** with the desired On times and Cycle times. During each On time, the PWM **50** provides a pulse to the solenoid **140** causing it to change state and apply a regulated valve air pressure to piston surface **86** (FIG. **2**). The valve air pressure causes the piston assembly **73** and needle **92** to overcome the biasing force of the piston return spring **88** and move to the right as viewed in FIG. **2**. That motion displaces the needle **92** away from the seat **96**, thereby opening the needle valve **91** for a duration of the On time. While the needle valve **91** is open, conformal coating material may flow through a downstream flow path, that is, a flow path through the seat flow channel **97**, the holder **108**, the capillary tube **110** and the dispensing needle **116**. In many applications, the coating material pressure and needle open position are set, so that when the needle valve **91** is open, a volume of conformal coating material flows past the needle valve **91**, which is about equal to the volume of conformal coating material most recently ejected from the dispensing needle **116**. At the end of the On time, the solenoid **140** switches back to its original state; and the valve air pressure is removed from the air cylinder piston **72**.

[0032] The time between two pulse On times is defined as a pulse Off time; and during the pulse Off time, the piston return spring **88** rapidly moves the piston **72** and needle **92** to the left, as viewed in FIG. **2**, until the needle **92** again engages the seat **96**, thereby closing the needle valve **91** and terminating the flow of conformal coating material past the needle valve **91**. However, the rapid return action of the needle **92** creates a pressure spike in the downstream flow path, which causes a droplet of conformal coating material to be sharply discharged from the dispensing needle **116**. Further, the pressure spike is effective to cleanly eject the droplet of conformal coating material from the dispensing needle tip **119**, thereby substantially preventing conformal coating material from clinging to the dispensing needle **116**. At the end of the Cycle time, the computer **28** again operates the PWM **50** to produce a pulse to the solenoid **140** with the desired On time.

[0033] The PWM **50** provides a stream or string of pulses rapidly opens and closes the needle valve **91** over very short time periods to eject droplets of conformal coating material from the dispensing tip **119**. The droplets may be dispensed close to each other so that they stitch together to form a line of conformal coating material, and the lines can be dispensed close to each other to apply the conformal coating material over an area. The net result is a conformal coating system that applies lower viscosity conformal coating materials to a substrate with greater accuracy, precision and speed than known needle valve applicators. For example, using the PWM **50** permits the applicator **22** to apply a conformal coating material to within about 0.040 in (1 mm) of a keep-out area and apply a coating material in line widths that are about 0.050 in (1.2 mm) wide with highly distinctive edges. Further, in some applications, the dispensing tip **119** may be elevated up to about 0.480 in (12 mm) above the substrate **26** while maintaining a desired accuracy in the placement of the conformal coating material on the substrate. Such improved performance often eliminates masking and unmasking, thereby substantially reducing handling of the substrate **26**. Further, such improved performance often permit the applicator **22** to be moved at higher velocities and through conformal coating cycles that take less time and are more efficient than coating cycles executed with known needle valve applicators.

[0034] In addition, the rapid pulsing of the needle valve in the conformal coating system causes the droplets of conformal coating material to be ejected cleanly from the dispensing needle tip, thereby preventing conformal coating material from clinging to, and/or curing on, the dispensing needle tip **119**. This reduces maintenance and minimizes clogs while maintaining accuracy and increasing repeatability. The dispensing of droplets by the needle valve **91** provides a droplet volume that is predictable and repeatable; and therefore, the volume of conformal coating material applied over an area can be precisely controlled by the computer **28** and motion controller **40**. The motion controller **40** may be used to control the velocity of the applicator **22**. The computer **28** may be used to control material flow by appropriate selection of an On time and/or selecting a number of times that the PWM **50** cycles the needle valve **91** while the applicator **22** is moving over an area of the substrate **26**. Such a capability substantially reduce waste of the conformal coating material.

[0035] Further, the conformal coating system provides a slim profile for the holder **108**, the retaining nut **120** and the dispensing needle tip **119**, which permits the applicator **22** to moved through small spaces between components on PC boards at lower dispense heights. This design optimizes dispensing selectivity when coating with lower viscosity materials. All of the features above make the conformal coating system **10** shown and described herein especially useful when applying a conformal coating material to smaller and densely populated PC boards.

[0036] While the present invention has been illustrated by a description of various embodiments and while these embodiments have been described in considerable detail, it is not the intention of Applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. For example, in the exemplary embodiments shown and described, the timer **49** is a PWM **50**. However, in other embodiments, other timing circuits or devices may be used that are operative to provide a string of pulses to the solenoid **140**, wherein the time the solenoid **140** is operated to hold the needle valve **91** open is adjustable. Further, in the exemplary embodiments, the timer **49** is shown as a separate component. In other embodiments, the timer **49** may located anywhere that is appropriate for the design. For example, the timer **49** may be a stand-alone programmable or nonprogrammable device, or be a programmable or nonprogrammable component integrated into the I/O of the computer **28** or the motion controller **40**, or be implemented in software in the computer **28** or the motion controller **40**.

[0037] In the exemplary embodiments shown and described, the On time of the PWM **50** is used to operate the solenoid **140** to hold the needle valve **91** open. However, in other embodiments, an Off time of the PWM **50** may be used. In the exemplary embodiments shown and described, the PWM On time and Cycle time are adjustable by a user and stored in a memory **52**. In other embodiments, the Cycle time may be fixed and only the On time may be adjustable and stored. In still further embodiments, only the Off time may be adjustable and stored; or the On time and the Off time may be adjustable and stored; or the Off time and the Cycle time may be adjustable and used.

[0038] In the exemplary embodiments shown and described, a pressurized air supply **130** is used to drive the solenoid **140** and apply a regulated pressure to the reservoir **148**. In other embodiments, other pressurized fluids or gases may be used instead of air. Further, while the exemplary embodiments describe an application of a conformal coating to a substrate **26**, the coating system **10** may be used to apply other coating materials to the substrate **26**.

[0039] In the exemplary embodiments shown and described, the coating system **10** has a control that utilizes motion controller **40** and computer **28**; however, in other embodiments, the control functions discussed herein may be implemented using fewer or more programmable controllers or devices that may be in different locations. Often, application requirements and the availability of resources at different facilities will require different control configurations.

[0040] In the exemplary embodiments shown and described, a return spring **88** is used to close the needle valve **88**; however, in an alternative embodiment, the air cylinder **62** may be a double acting cylinder and operable to move the needle **92** to a closed position.

[0041] Therefore, the invention in its broadest aspects is not limited to the specific remote conveyor belt monitoring system details shown and described. Consequently, departures may be made from the details described herein without departing from the spirit and scope of the claims which follow.

What is claimed is:

1. A coating system for dispensing a coating material onto a substrate, the coating system comprising:

an applicator comprising

a cylinder and piston configuration adapted to be in fluid communication with a pressurized fluid and the coating material,

a needle valve being operable by the piston to open the needle valve, and

a dispensing needle in fluid communication with the needle valve;

a solenoid fluidly connected between the pressurized fluid and the cylinder; and

a control comprising a timer connected to the solenoid, the timer being operable to provide a string of electrical pulses to the solenoid, each pulse in the string of pulses causing the solenoid to apply the pressurized fluid to the piston, thereby opening the needle valve and permitting a flow of coating material past the needle valve, the needle valve being closed for durations of time between pulses, and the coating material being ejected from the dispensing needle in response to closings of the needle valve.

2. The coating system of claim **1** wherein the timer further comprises a pulse width modulator.

3. The coating system of claim **2** wherein the control further comprises a memory for storing at least one modulator operating parameter selected from an On time, an Off time, a Cycle time or any combination thereof.

4. The coating system of claim **1** wherein the needle valve further comprises a return spring for closing the needle valve for the durations between pulses.

5. The coating system of claim **1** further comprising an adjustable pressure regulator for providing the pressurized fluid.

6. The coating system of claim **1** further comprising a second pressure regulator providing a second pressurized fluid for supplying the coating material under pressure.

7. The coating system of claim **1** wherein the coating material is a conformal coating material and the substrate is a PC board.

8. A coating system for dispensing a coating material onto a substrate, the coating system comprising:

an applicator comprising

a cylinder adapted to be in fluid communication with the coating material and a pressurized fluid,

a piston sealingly located in the cylinder and separating a coating material chamber from a pressurized fluid chamber,

a seat mounted on the cylinder adjacent the coating material chamber and having a flow channel extending therethrough,

a needle locatable against the seat to form a needle valve with the seat, the needle being mechanically connected to the piston and movable by the piston to a first, open position away from the seat, thereby allowing a coating material to pass through the flow channel,

a return spring operable to move the needle to a second, closed position in contact with by the seat, thereby blocking a flow of coating material through the flow channel, and

a dispensing needle in fluid communication with the flow channel for receiving and dispensing the coating material;

a solenoid fluidly connected between the source of pressurized fluid and the cylinder;

a control comprising a timer connected to the solenoid, the timer providing a string of pulses to the solenoid, each pulse in the string of pulses causing the solenoid to apply the pressurized fluid against the piston and cause the piston to move the needle to the open position thereby allowing a quantity of coating material to pass through the flow channel, and the return spring moving the needle into contact with the seat for a duration of time between pulses, and the coating material being ejected from the dispensing needle in response to the return spring moving the needle into contact with the seat.

9. The coating system of claim **8** wherein the timer further comprises a pulse width modulator.

10. The coating system of claim **9** wherein the control further comprises a memory for storing at least one modulator operating parameter selected from an On time, an Off time, a Cycle time or any combination thereof.

11. The coating system of claim **8** wherein the source of pressurized fluid is a source supplying air at a regulated

pressure and the source of pressurized coating material is a source supplying the coating material at a regulated pressure

12. The coating system of claim **8** wherein the coating material is a conformal coating material and the substrate is a PC board.

13. A method of automatically dispensing a coating material onto a substrate with an applicator being movable by a programmable control operating a positioner supporting the applicator, the applicator having a flow channel conducting a coating material from a needle valve to a dispensing needle, the needle valve being movable by a cylinder piston to an open position in response to a pressurized fluid received from a solenoid, and the needle valve then being movable to a closed position, the method comprising:

applying a string of electrical pulses to the solenoid;

moving coating material past the needle valve by repeatedly opening the needle valve in response to each pulse in the string of electrical pulses being applied to the solenoid; and

ejecting the coating material from the dispensing needle by repeatedly closing the needle valve in response to periods of time between pulses in the string of electrical pulses.

14. The method of claim **13** further comprising generating the string of pulses with a timing device.

15. The method of claim **13** further comprising generating the string of pulses with a pulse width modulator.

16. The method of claim **15** further comprising operating the pulse width modulator with an On time stored in a computer, wherein the On time determines a duration of each pulse in the string of pulses.

17. The method of claim **16** further comprising closing the needle valve for a duration of time between the pulses in the string of pulses.

18. A method of automatically dispensing a coating material onto a substrate with an applicator being movable by a programmable control operating a positioner supporting the applicator, the applicator having a flow channel conducting a coating material from a needle valve to a dispensing needle, the needle valve being movable by an air cylinder piston to an open position in response to a pressurized fluid received from a solenoid, and the needle valve then being moved to a closed position, the method comprising:

generating a string of electrical pulses, each pulse having a duration defined by an On time and a duration between pulses being defined by an Off time;

opening the needle valve in response to a pulse being applied to the solenoid and permit coating material to flow past the needle valve toward the dispensing needle;

closing the needle valve for a duration of an Off time, the closing of the needle valve ejecting coating material from the dispensing needle; and

repeating the opening and closing of the needle valve in response to the string of electrical pulses being applied to the solenoid to repeatedly eject coating material from the dispensing needle.

19. The method of claim **18** further comprising operating a timing device to generate the string of electrical pulses.

20. The method of claim **18** further comprising operating a pulse width modulator to generate the string of electrical pulses.

21. The coating system of claim **18** wherein the coating material is a conformal coating material and the substrate is a PC board.

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