

Sept. 12, 1967

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3,341,124

SPRAYING METHOD AND APPARATUS

Filed June 21, 1965

3 Sheets-Sheet 1

FIG. 1.

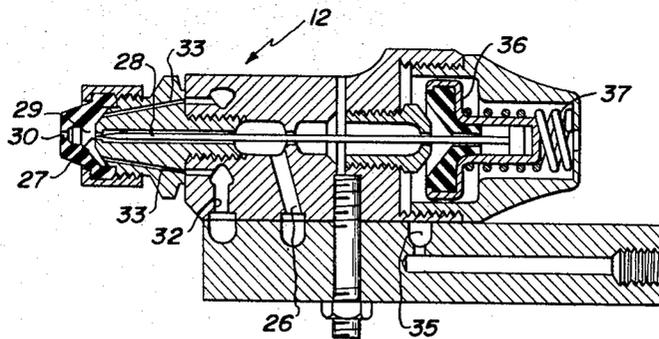
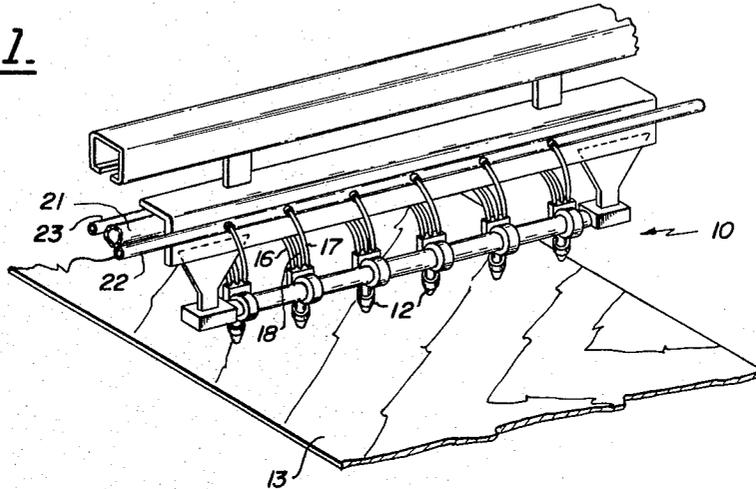


FIG. 2.

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3 Sheets-Sheet 3

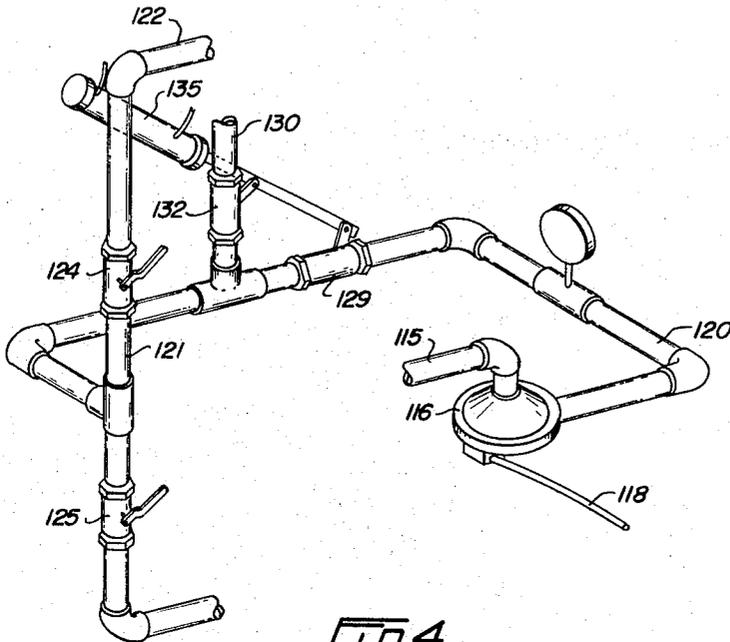


FIG. 4.

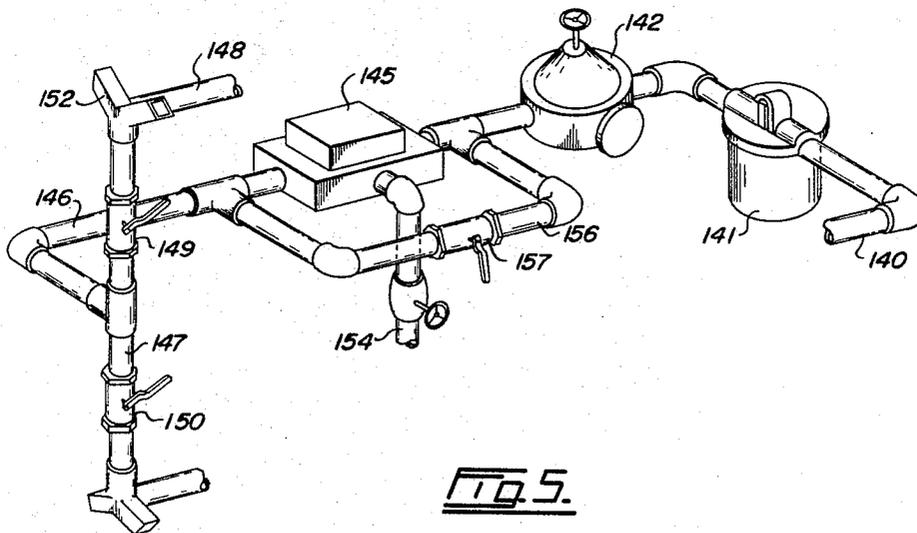


FIG. 5.

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3,341,124

SPRAYING METHOD AND APPARATUS

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27 Claims. (Cl. 239-8)

ABSTRACT OF THE DISCLOSURE

Method and apparatus for spraying liquids, such as glue, on to veneers and the like by separately directing liquid and a gaseous fluid, such as air, to at least one spray nozzle, maintaining the pressure of the gaseous fluid substantially equal to the liquid pressure during variations in the viscosity of the liquid and in the conditions in the spray nozzle, and, preferably, maintaining the volume of liquid being directed to the nozzle constant regardless of changes in the liquid pressure.

This invention relates to method and apparatus particularly for spraying rapid drying, high solids fluids, such as plywood glue.

This apparatus is primarily designed for spraying glue on veneers during the manufacture of plywood, but it can be used for spraying other fluids, and particularly rapid drying and/or high solids fluids.

Plywood glues are conventionally applied by mechanical glue spreaders employing grooved rubbers rolls to carry the glue and transfer it to the plywood veneers. Many attempts have been made in the past to apply plywood glues by spraying, but have been abandoned due to the many problems encountered, and particularly because of the need for frequent cleaning of the spray heads, which become clogged with dried glue which upsets the spray pattern and/or seriously reduces the amount of glue applied.

The present method and apparatus eliminate these problems. The method comprises directing glue under pressure to a plurality of internal air-mix nozzles each having a single spray orifice. For the sake of convenience, reference will be made mainly to a single nozzle or gun in the general description. Air is directed to the nozzle at a pressure substantially equal to the glue pressure to mix with the glue before passing therewith through the orifice. The air is preferably left on continuously with the glue either flowing continuously or being intermittently shut off from the nozzle. This method has been carried out successfully with continuous glue flow and at 6 to 15 glue cycles per minute for eight hours without blocking of the nozzles with glue solids. The cycling rate can be changed to suit the requirement, that is, the required spread level being used, the area of veneer being covered each cycle and the rate at which veneers are moved beneath the nozzles.

With most automatic spray guns of the prior art, the atomizing air is turned off at the same time as or slightly after the fluid, to clear the nozzles of the fluid. However, this procedure is entirely unsatisfactory when spraying rapid drying, high solids fluids, such as plywood glues. When this is done, a thin film of dried solid is left at the nozzle orifices which rapidly fills up, with eventual blocking of the orifices. This generally takes place within 30 to 60 minutes.

It is preferable in the present method to leave the atomizing air on continuously, the nozzle orifice being thus cleared of fluid and ensuring that a build up of glue solids does not take place in the interior of the gun or

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inside the orifice thereof, that would otherwise result in blockage and consequent distortion of the spray pattern. Spray guns or nozzles of the present apparatus operated in accordance with the present invention have been shut down for comparatively long periods such as, for example, eight hours without cleaning prior to re-starting.

It has been found that the best results are attained by using an internal air-mix nozzle in the apparatus with a single large orifice. Nozzles of this type are less sensitive to blockage and easier to clean than the external air-mix type with their multiplicity of small external air holes. The orifice size of each nozzle will depend upon the immediate requirements, but it is preferable to use an orifice size which will operate in the pressure range of 30 to 120 p.s.i. to give the desired volume of fluid or glue. The actual size of each orifice will depend on the volume required and viscosity of the fluid being sprayed, and 0.080 inch has been found satisfactory with conventional plywood glues having a viscosity of 500-7000 centipoises, measured on the Brookfield Model LSU Viscometer at 6 r.p.m. with a No. 3 spindle. Too large an orifice requires excessive amounts of air to atomize the fluid, while too small an orifice will result in excessively high operating pressures.

It is preferable that the pressure of the atomizing air be substantially equal to the fluid pressure at all times. If the atomizing air pressure drops appreciably below the fluid pressure, there is a decrease in atomizing efficiency, also fluid is forced back into the air lines causing a machine-gun effect, drying and blockage. If the atomizing air pressure rises appreciably over the fluid pressure, air pressure distribution across the length of the air header becomes unbalanced, causing variations in the fluid flow rate for one or more nozzles, resulting in reduced fluid output and distorted spray patterns for the affected nozzles. In addition, too low an air pressure results in poor atomization and blockage within a short time, whereas too high an air pressure results in an increased overspray.

The apparatus according to the present invention for spraying glue includes an internal air-mix nozzle having a spray orifice, means for directing glue under pressure to the nozzle, means for directing air under substantially the same pressure as the glue pressure to the nozzle to mix with the glue before passing therewith out through the nozzle orifice, and preferably control means for intermittently shutting off the glue directing means whilst leaving the air on. The shutting off and turning on of the supply of glue to the nozzles is controlled in any desired manner, such as by synchronized timing mechanisms. It is also preferable to provide the apparatus with means for directing cleaning fluid through any parts thereof which come into contact with the glue so that the apparatus can be completely cleaned out before any relatively long shut down.

Operation of this apparatus may be continuous or intermittent. When the latter, the spray guns or nozzles can be controlled by switches operated by the plywood veneer beneath the nozzles. This veneer preferably travels at a rate of from between 50 and 200 f.p.m., either in a continuous strip or in discrete sections, with the space between the sections so timed as to be beneath the guns when the sections are stopped. In an intermittent operation, to insure full spread level within one inch of a starting point at a line speed of 200 f.p.m., requires that full fluid flow be reached within $\frac{1}{40}$ th of a second of the guns opening. In order to meet this requirement, means are provided to keep the fluid lines under full operating pressure during the "off" periods. As the operating pressure varies during the functioning of the apparatus owing to changes in the viscosity of the glue as a result of

temperature changes, different glue mixes and changing conditions in the system, the operating pressure is maintained at the level which existed just prior to the shut off. Means also is included which can be operated during any off cycle to introduce a small volume or slug of cleaning fluid, such as water, into the atomizing air supply to remove any glue solids that may tend to build up in the nozzles.

The apparatus includes a regulating pump for directing glue to the spray nozzles at a constant rate of flow regardless of pressure changes in the glue flow owing to the nature of this product. A by-pass for this pump is opened when the spray nozzles are closed. A supply pump having a capacity much greater than is needed, directs glue to the regulating pump. A by-pass around the supply pump has a control valve therein by means of which the pressure of the glue directed to the regulating pump is governed. The control valve is in turn controlled by a sensing element in the pressure line from the regulating pump so that said control valve is operated to keep the pressure in the glue supplied to the regulating pump substantially the same as the pressure in the glue being directed to the nozzles by the latter pump. Means is provided for cutting off the control valve from said sending element when the nozzles are closed so that said control valve remains at the last setting until the nozzles are opened again.

Preferred apparatus for carrying out the present method is illustrated in the accompanying drawings, in which,

FIGURE 1 is a perspective view of a plurality of spray guns for spraying glue on to the upper surfaces of plywood veneers,

FIGURE 2 is a section through a typical internal air-mix nozzle,

FIGURE 3 is a diagrammatic layout of the glue supplying system,

FIGURE 4 is a diagrammatic layout of the system for supplying atomizing air to the nozzle, and

FIGURE 5 is a diagrammatic layout of the air system for operating the spray nozzles.

Referring to FIGURE 1 of the drawings, spraying apparatus 10 includes a plurality of spray guns or nozzles 12 located side by side and adapted to spray glue on to plywood veneers 13 moved therebeneath. Each gun 12 is connected by pipes 16, 17 and 18 to the glue header 21, air header 22 and air header 23, respectively. Header 21 supplies glue under pressure to the nozzles, header 22 supplies air under pressure to operate, that is, to open and close, the nozzles, while header 23 supplies atomizing air under pressure to said nozzles. A similar set of nozzles and associated elements, not shown, can be provided simultaneously to spray glue on to the lower surfaces of veneer 13.

FIGURE 2 illustrates a typical internal air-mix gun or nozzle 12. Glue from a pipe 16 is directed through a passage 26 in the gun, through an orifice 27 controlled by needle 28 to a mixing chamber 29 and out through the given orifice 30. Atomizing air from a pipe 18 travels through a passage 32 and a plurality of fine passages 33 into chamber 29 to atomize the glue. Operating air from one of the pipes 17 travels through a passage 35 against a piston 36 connected to needle 28 to move the latter to open orifice 27. A spring 37 moves piston 36 and the needle to close orifice 27 when the operating air is shut off.

Referring to FIGURE 3, a glue supply line 40 from a storage tank, not shown, has a valve 41 therein and is connected by a pipe 43 to a glue supply pump 44, which is driven by a variable source of power, not shown. This pump feeds glue through pipe 46 to a multiple filter system 47. A by-pass pipe 49 extends between pipes 43 and 46 around pump 44, said pipe 49 having a back pressure control valve 50 therein. The pressure of the glue supplied to filter 47 is regulated by valve 50 and is indicated by a pressure gauge 52 in pipe 46.

Filter system 47 includes two removable filter units 55 and 56, only one of which is in operation at a time. Valves 58 and 59 can be manipulated to direct the glue from pipe 46 to either of the units 55 or 56. Units 55 and 56 have air bleed valves 60 and 61, respectively, near the upper ends thereof.

With this arrangement, when one filter unit is in operation, say for example, unit 56, unit 55 can be removed, cleaned out and restored. When this has been done, valve 58 can be opened a little to allow the glue to flow into unit 55 until it is filled, valve 60 being open at this time to allow air to escape therethrough. The capacity of pump 44 is such that this does not affect the pressure in pipe 46.

Glue is drawn out of filter system 47 through pipe 64 by a regulating pump 65 which is driven by a variable source of power, not shown. A pressure gauge 67 is provided in pipe 64, and readings on this gauge and gauge 52 indicate the need for a change over from one filter unit to the other in system 47.

Pump 65 directs glue through a pressure pipe 70 and another pipe 71 having a valve 72 therein to a vertical pipe 73. The upper end of pipe 73 is connected by a flexible hose 74 to glue header 21 of spray unit 10. Pipe 73 has an upper valve 76 therein. Pipe 73 also extends downwardly and is adapted to be connected to the glue manifold of a lower spraying apparatus 10, not shown. A lower valve 78 is provided in pipe 73.

A by-pass pipe 82 extends from pressure pipe 70 to pipe 64, and said pipe 82 has a two-way control valve 83 therein which is normally open, and is closed by an air cylinder 85 which is operated when nozzles 12 are open. Cylinder 85 can be connected into the same air system as operating air header 22.

A sensing unit 88 is provided in pressure pipe 70, said unit being connected by a hydraulic line 89 to the control unit 90 of control valve 50. Sensing unit 88 is designed to operate control valve 50 so as to maintain the pressure in pipe 46 and, consequently, pipe 64, at substantially the same pressure as that of the glue in pressure pipe 70. A shut-off valve 91 is provided in pipe 89, and this valve is closed when nozzles 12 are closed. This maintains control valve 50 at its previous setting so that the pressure in pipes 46 and 64 is maintained at the level which existed just prior to the shutting off of nozzles 12.

As it is desired to periodically flush out the pipe system, a number of water supply pipes and drain valves are provided. For example, a supply pipe 94 having a valve 95 therein is connected to pipe 71 near vertical pipe 73, and a drain valve 96 is provided at the junction of pipes 70 and 71. A supply pipe 98 having a control valve 99 therein is connected to by-pass pipe 82. Supply pipes 102 and 103 having valves 104 and 105 therein, respectively, are connected to pipe 64 near filter unit 47 and pipe 43. A drain valve 108 is connected to pipe 46.

Pump 65 directs a predetermined volume of glue to nozzles 12 regardless of variations of pressure in pipe 70, such variations being caused by changes in the viscosity of the glue or other conditions in the system. Control valve 50 is operated so that pump 44 supplies glue through filtering system 47 to pump 65 at substantially the same pressure as the pressure in pipe 70. Thus, the output pressure of pump 44 varies as the pressure in pipe 70 varies. This ensures a constant feed to pump 65, and the latter has very little work to do so that it actually functions to keep the volume of glue supplied to the nozzles constant. If the nozzles are closed, valve 83 is opened so that the output of pump 65 is by-passed to the inlet thereof. As valve 91 is closed when the nozzles are closed, control valve 50 remains at the setting it had just prior to the closing of the nozzles. As a result of this, pump 44 maintains the pressure in line 64 at the same level it had just prior to the shutting of the nozzles so that the instant the nozzles are opened again, the glue starts to flow therefrom at the desired rate.

FIGURE 4 diagrammatically illustrates the system of supplying air to nozzles 12. Air under pressure is supplied to the system through pipe 115 from a suitable source, not shown. Pipe 115 extends to a pressure regulator 116 which is controlled by sensing element 88 of FIGURE 3. To this end, a pipe 118 extends from the regulator to pipe 89 between element 88 and valve 91. This ensures the pressure of air travelling through pipe 120 from regulator 116 being substantially the same as the glue supplied to nozzles 12. Pipe 120 extends to a vertical pipe 121, the upper end of which is connected by a flexible hose 122 to air manifold 23 of spraying apparatus 10. The lower end of pipe 121 is adapted to be connected to the atomizing air header of a lower spraying apparatus 10. Upper and lower valves 124 and 125 are provided in pipe 120.

As stated above, when the supply of glue to nozzles 12 is shut off, the supply of atomizing air is continued to keep the orifices of the nozzles clear. Regulator 116 maintains the pressure of the atomizing air at substantially the same level as the pressure of the glue supplied to the nozzles. It is desirable to clean out the nozzles periodically during periods when the glue supply is shut off. To this end a normally open valve 129 is provided in pipe 120, and a water supply pipe 130 is connected to said pipe between valve 129 and vertical pipe 121. A normally closed valve 132 is provided in pipe 130. Air valve 129 and valve 132 are operated by an air cylinder 135. The controls for cylinder 135 are not shown since these are standard equipment. When it is desired to clean out the nozzles during a shut-down of the glue, cylinder 135 is operated to close valve 129 and open valve 132. The latter valve is left open only long enough to direct a slug of water into pipes 120 and 121, after which the valve is closed and air valve 129 opened. The opening of valve 129 causes the air in the pipe to force the slug of water through the pipe system and nozzles 12 at a rapid rate so that the latter are constantly cleaned at the mixing chambers and orifices thereof.

FIGURE 5 diagrammatically illustrates the operating air system of the apparatus. Air under pressure from a suitable source is directed through pipe 140, through an oiler 141 and a pressure regulator 142 to a solenoid operated control two-way valve 145. A pipe 146 extends from this valve to a vertical pipe 147, the upper end of which is connected by a flexible hose 148 to the operating air header 22 of spraying apparatus 10. The lower end of pipe 147 is adapted to be connected to the operating air header of a lower spraying apparatus 10. Upper and lower control valves 149 and 150 are provided in pipe 147. A dump or exhaust valve 152 is connected to pipe 47 near hose 148, said valve being adapted quickly to exhaust air from manifold 22 when the air supply is shut off. In addition to this, an exhaust pipe 154 may be provided at valve 145 which is opened when the valve operates to close off the supply of operating air to the spraying apparatus.

A by-pass pipe 156 having a control valve 157 therein extends from pipe 140 to pipe 146 around control valve 145. With this arrangement, valve 157 may be manually manipulated to open and close nozzles 12 during cleaning and checking operations without disturbing valve 145.

What I claim as my invention is:

1. A method of spraying a glue fluid by means of one or more nozzles without nozzle clogging, which comprises directing glue fluid under pressure to an internal air-mix nozzle having a spray orifice, directing gaseous fluid under pressure to said nozzle to atomize the glue fluid before passing therewith out through the orifice maintaining the pressure of the gaseous fluid substantially equal to the glue fluid pressure during variations in the viscosity of said glue fluid and in the conditions in said nozzle, and intermittently shutting off one of said fluids being directed to the nozzle while maintaining the flow of the other of said fluid thereto.

2. A method of spraying a glue fluid by means of one or more nozzles without nozzle clogging, which comprises directing glue fluid under pressure to an internal air-mix nozzle having a spray orifice, directing gaseous fluid under pressure to said nozzle to atomize the glue fluid before passing therewith out through the orifice maintaining the pressure of the gaseous fluid substantially equal to the glue fluid pressure during variations in the viscosity of said glue fluid and in the conditions in said nozzle, intermittently shutting off one of said fluids being directed to the nozzle while maintaining the flow of the other of said fluids thereto, and redirecting said one fluid to the nozzle after it has been shut off therefrom.

3. A method of spraying a glue fluid by means of one or more nozzles without nozzle clogging, comprising directing glue fluid under pressure of from about 30 to about 120 p.s.i. to an internal air-mix nozzle having a spray orifice, directing gaseous fluid under pressure to said nozzle to atomize the glue fluid before passing therewith out through the orifice maintaining the pressure of the gaseous fluid substantially equal to the glue fluid pressure during variations in the viscosity of said glue fluid and in the conditions in said nozzle, and intermittently shutting off one of said fluids being directed to the nozzle while maintaining the flow of the other of said fluids thereto.

4. A method of spraying liquid by means of one or more nozzles without nozzle clogging, comprising directing liquid under pressure to a spraying nozzle, directing air to said nozzle at a pressure substantially equal to the liquid pressure to atomize the liquid at the nozzle, shutting off the liquid being directed to the nozzle, and inserting a slug of cleaning fluid into the air being directed to the nozzle to clean out the latter.

5. A method of spraying liquid by means of one or more nozzles without nozzle clogging, which comprises directing liquid under pressure to a spraying nozzle, directing air to said nozzle at a pressure substantially equal to the liquid pressure to atomize the liquid at the nozzle, shutting off the liquid being directed to the nozzle, momentarily shutting off the atomizing air, injecting a slug of cleaning fluid into the path along which said atomizing air normally travels, and redirecting the atomizing air to the nozzle to force the cleaning fluid therethrough.

6. A method of spraying a glue fluid by means of one or more nozzles without nozzle clogging, which comprises directing a constant volume of glue fluid under pressure regardless of variations in said pressure to a spraying nozzle, maintaining a supply of glue fluid to be directed to the nozzle at substantially the same pressure as said glue fluid being directed to the nozzle, and directing gaseous fluid to said nozzle at a pressure substantially equal to the pressure of the glue fluid being directed to the nozzle to atomize the glue fluid at said nozzle.

7. A method of spraying a glue fluid by means of one or more nozzles without nozzle clogging, which comprises directing a constant volume of glue fluid under pressure to a spraying nozzle regardless of changes in the pressure of the glue fluid due to variations in the viscosity thereof and in the conditions in said nozzle, maintaining a supply of glue fluid to be directed to the nozzle at substantially the same pressure as said glue fluid being directed to the nozzle, directing gaseous fluid to said nozzle at a pressure substantially equal to the pressure of the glue fluid being directed to the nozzle to atomize the glue fluid at said nozzle, periodically shutting off the flow of glue fluid to the nozzle, and maintaining the supply of glue fluid at substantially the same pressure as the pressure of the flow of glue fluid just prior to the shutting off of the latter.

8. A method of spraying liquid by means of one or more nozzles without nozzle clogging which comprises directing a constant volume of liquid under pressure to a spraying nozzle regardless of changes in the pressure of the glue fluid due to variations in the viscosity thereof

and in the conditions in said nozzle, maintaining a supply of liquid to be directed to the nozzle at substantially the same pressure as said liquid being directed to the nozzle, directing air to said nozzle at a pressure substantially equal to the pressure of the liquid being directed to the nozzle to atomize the liquid at said nozzle, shutting off the liquid being directed to the nozzle, and inserting a slug of cleaning fluid into the air being directed to the nozzle to clean out the latter.

9. A method of spraying liquid by means of one or more nozzles without nozzle clogging which comprises directing a constant volume of liquid under pressure regardless of variations in said pressure to a spraying nozzle, maintaining a supply of liquid to be directed to the nozzle at substantially the same pressure as said liquid being directed to the nozzle, directing air to said nozzle at a pressure substantially equal to the pressure of the liquid being directed to the nozzle to atomize the liquid at said nozzle, shutting off the liquid being directed to the nozzle, momentarily shutting off the atomizing air, injecting a slug of cleaning fluid into the path along which said atomizing air normally travels, and redirecting the atomizing air to the nozzle to force the cleaning fluid therethrough.

10. Apparatus for spraying a glue fluid, which comprises an internal air-mix nozzle having a spray orifice, means for directing glue fluid under pressure to the nozzle, means for directing gaseous fluid under pressure to the nozzle to atomize the glue fluid before passing therewith out through the orifice means for maintaining the pressure of the gaseous fluid substantially equal to the fluid pressure regardless of variations in the viscosity of said glue fluid and in the conditions in said nozzle, and control means for intermittently shutting off the directing means one of said fluids without stopping the flow of the other of said fluids to the nozzle.

11. Apparatus for spraying a glue fluid, comprising an internal air-mix nozzle having a spray orifice, means for directing liquid under from about 30 to about 120 p.s.i. to the nozzle, means for directing gaseous fluid under pressure to the nozzle to atomize the glue fluid before passing therewith out through the orifice means for maintaining the pressure of the gaseous fluid substantially equal to the fluid pressure regardless of variations in the viscosity of said glue fluid and in the conditions in said nozzle, and control means for intermittently shutting off the directing means one of said fluids without stopping the flow of the other of said fluids to the nozzle.

12. Apparatus for spraying liquid comprising a spraying nozzle, means for directing liquid under pressure to the nozzle, means for directing air to the nozzle at a pressure substantially equal to the liquid pressure, means for shutting off the liquid being directed to the nozzle, and means for inserting a slug of cleaning fluid into the air being directed to the nozzle to clean out the latter.

13. Apparatus for spraying liquid comprising a spraying nozzle, means for directing liquid under pressure to the nozzle, means for directing air to the nozzle at a pressure substantially equal to the liquid pressure, means for shutting off the liquid being directed to the nozzle, means for shutting off the atomizing air, and means for injecting a slug of cleaning fluid into the path along which said atomizing air normally travels, said cleaning fluid being forced through the nozzle when the atomizing air is again directed to said nozzle.

14. Apparatus for spraying liquid comprising a spray nozzle, first pump means for directing a constant volume of liquid under pressure regardless of variations in said pressure to said nozzle, second pump means for directing liquid to the first pump means, control means for maintaining the pressure of the liquid being directed to the second pump means at substantially the same pressure as the liquid being directed to the nozzle, and means for directing air to the nozzle to atomize the liquid at said nozzle.

15. Apparatus for spraying liquid comprising a spray nozzle, first pump means for directing a constant volume of liquid under pressure regardless of variations in said pressure to said nozzle, second pump means for directing liquid to the first pump means at substantially the same pressure as the liquid being directed to the nozzle, means for directing air to the nozzle to atomize the liquid at said nozzle, means for shutting off the flow of liquid to the nozzle, and control means maintaining the liquid being directed to the first pump means at substantially the same pressure as the pressure of the liquid just prior to shutting off of the latter.

16. Apparatus for spraying liquid comprising a spray nozzle, first pump means for directing a constant volume of liquid under pressure regardless of variations in said pressure to said nozzle, second pump means for directing liquid to the first pump means, control means for maintaining the pressure of the liquid being directed to the second pump means at substantially the same pressure as the liquid being directed to the nozzle, means for directing air to the nozzle to atomize the liquid at said nozzle, means for shutting off the flow of liquid to the nozzle, and means for inserting a slug of cleaning fluid into the air being directed to the nozzle to clean out the latter.

17. Apparatus for spraying liquid comprising a spray nozzle, first pump means for directing a constant volume of liquid under pressure regardless of variations in said pressure to said nozzle, second pump means for directing liquid to the first pump means, control means for maintaining the pressure of the liquid being directed to the second pump means at substantially the same pressure as the liquid being directed to the nozzle, means for directing air to the nozzle to atomize the liquid at said nozzle, means for shutting off the flow of liquid to the nozzle, means for shutting off the flow of atomizing air, and means for injecting a slug of cleaning fluid into the path along which the atomizing air normally travels, said cleaning fluid being forced through the nozzle when the atomizing air is again directed to said nozzle.

18. Apparatus for spraying liquid comprising a spray nozzle, first pump means for directing through first pipe means a constant volume of liquid under pressure regardless of variations in said pressure to said nozzle, a by-pass around said first pump means through which the liquid travels when the flow of liquid to the nozzle is stopped, second pump means for directing liquid under pressure through second pipe means to the first pump means, control means for maintaining the pressure of the liquid being directed to the first pump means at substantially the same pressure as the liquid being directed to the nozzle, and means for directing air to the nozzle to atomize the liquid at said nozzle.

19. Apparatus as claimed in claim 18 including means for stopping the flow of liquid through the nozzle, and means for directing a slug of cleaning fluid into the atomizing air when the flow of liquid through the nozzle is stopped.

20. Apparatus as claimed in claim 18 including means for shutting off the flow of atomizing air to the nozzle, and means for directing a slug of cleaning fluid into the path along which the atomizing air normally travels, said cleaning fluid being forced through the nozzle when the atomizing air is again directed to the nozzle.

21. Apparatus for spraying liquid comprising a spray nozzle, first pump means for directing through first pipe means a constant volume of liquid under pressure regardless of variations in pressure to said nozzle, a first by-pass around said first pump means through which the liquid travels when the flow of liquid through the nozzle is stopped, second pump means for directing liquid under pressure through second pipe means to the first pump means, said second pump means having the capacity to supply more liquid than is required by the first pump means, a second by-pass around the second pump means through which liquid from the latter normally travels, a

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control valve in said second by-pass to control the flow of liquid therethrough to regulate the pressure of the liquid supplied to the first pump means, sensing means in the first pipe means and connected to said control valve to operate the latter in accordance with the pressure of the liquid being directed to the nozzle, and means for directing air to the nozzle to atomize the liquid at said nozzle.

22. Apparatus as claimed in claim 21 including control means for retaining the control valve when the flow of liquid through the nozzle is stopped in the setting it was in just prior to said stopping of the liquid flow.

23. Apparatus as claimed in claim 21 including means for directing a slug of cleaning fluid into the atomizing air when the flow of liquid to the nozzle is stopped.

24. Apparatus as claimed in claim 21 including means for shutting off the flow of atomizing air to the nozzle, and means for directing a slug of cleaning fluid into the path along which the atomizing air normally travels, said cleaning fluid being forced through the nozzle when the atomizing air is again directed to the nozzle.

25. A method of spraying liquid by means of one or more nozzles without nozzle clogging, comprising directing liquid under pressure to an internal air-mix nozzle having a spray orifice, directing air to said nozzle at a pressure substantially equal to the liquid pressure to atomize the liquid at the nozzle, intermittently shutting off the liquid being directed to the nozzle while maintaining the flow of atomizing air thereto, redirecting the liquid to the nozzle after it has been shut off therefrom, momentarily shutting off the atomizing air when it is desired to clean out the nozzle, injecting a slug of cleaning fluid into the path along which said atomizing air normally travels, and redirecting the atomizing air to the nozzle to force the cleaning fluid therethrough.

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26. A method of spraying glue by means of one or more nozzles without nozzle clogging, which comprises directing glue under pressure to an internal mixing nozzle having a spray orifice, directing air to said nozzle to atomize the glue before passing therewith out through the orifice maintaining the pressure of the air substantially equal to the glue pressure during variations in the viscosity of said glue and in the conditions in said nozzle, selectively shutting off the glue being directed to the nozzle while maintaining the flow of atomizing air thereto, and selectively shutting off the air being directed to the nozzle while maintaining the flow of glue thereto to modify the atomization pattern of the fluid discharge.

27. A method of spraying glue by means of one or more nozzles without nozzle clogging, which comprises directing glue under pressure to an internal mixing nozzle having a spray orifice, directing air to said nozzle to atomize the glue before passing therewith out through the orifice maintaining the pressure of the air substantially equal to the glue pressure during variations in the viscosity of said glue and in the conditions in said nozzle, and selectively shutting off the air being directed to the nozzle while maintaining the flow of glue thereto to modify the atomization pattern of the fluid discharge.

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EVERETT W. KIRBY, *Primary Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,341,124

September 12, 1967

Derek Barnes

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 72, and column 8, lines 19 and 31, for "second", each occurrence, read -- first --.

Signed and sealed this 15th day of October 1968.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents