

[54] **SPRAY GUN SYSTEM FOR SLURRY**
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[57] **ABSTRACT**

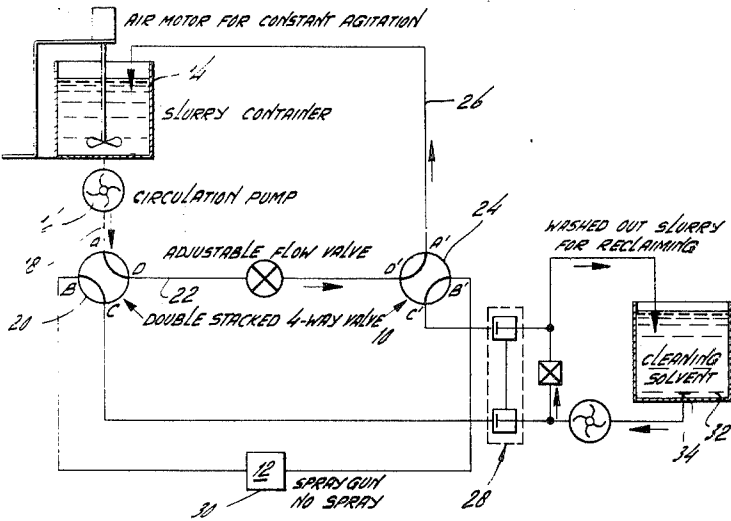
A spray gun for liquid slurry of the type using atomized air as the propellant medium, particularly a four-way valve system for said gun enabling selective spray of solvent or slurry while continuously flowing solvent and slurry through closed circulation systems. The continuous flowing of solvent through the gun and absent the slurry enables a clean flushing of the gun and eliminates slurry buildup in the gun inner chambers and nozzle.

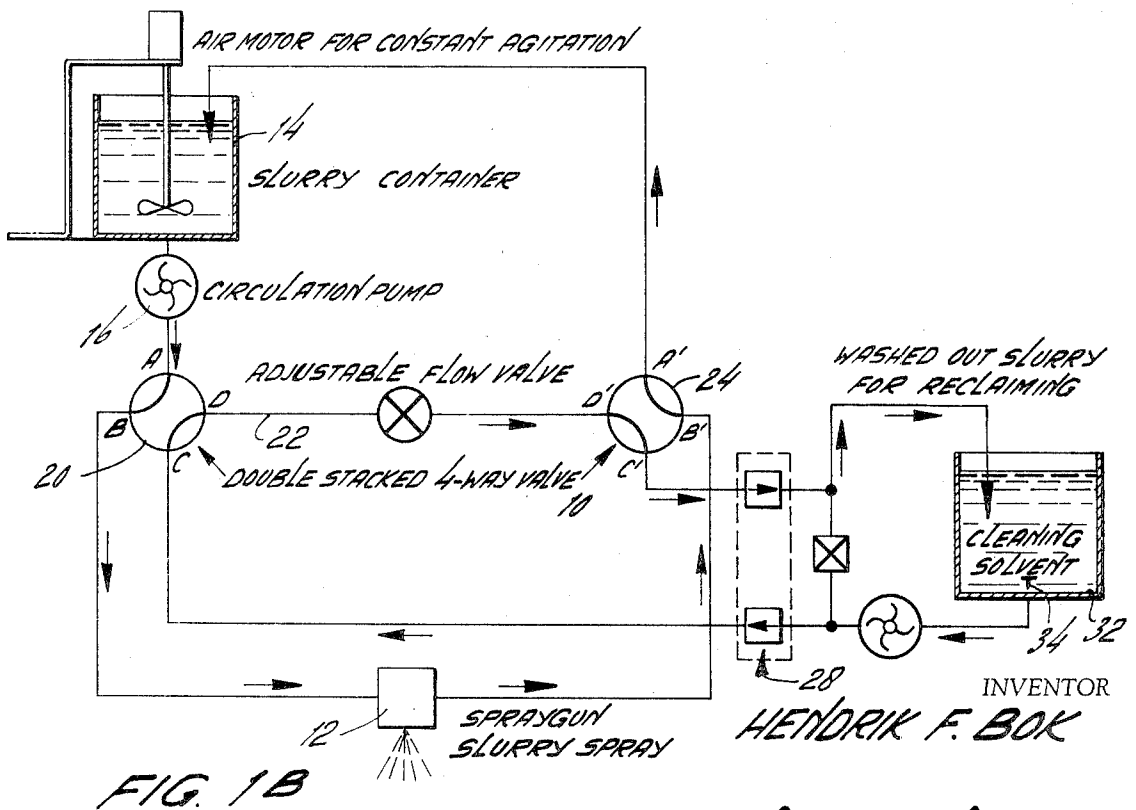
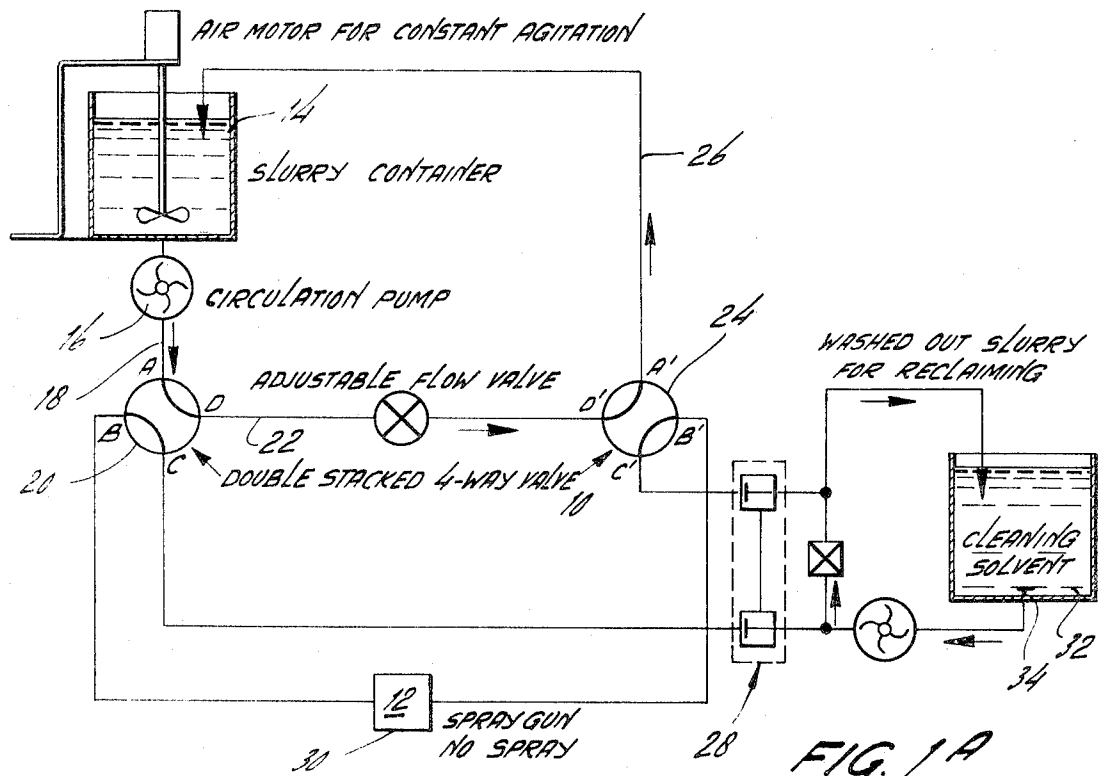
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9 Claims, 6 Drawing Figures





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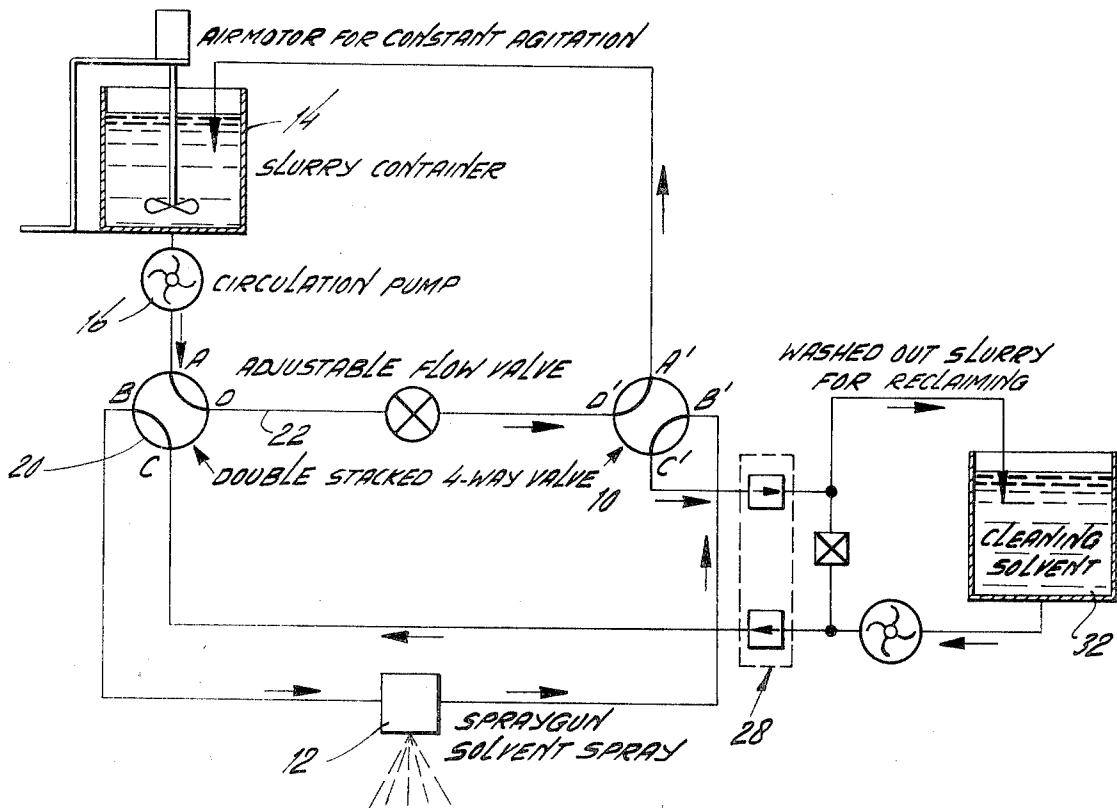


FIG. 1C

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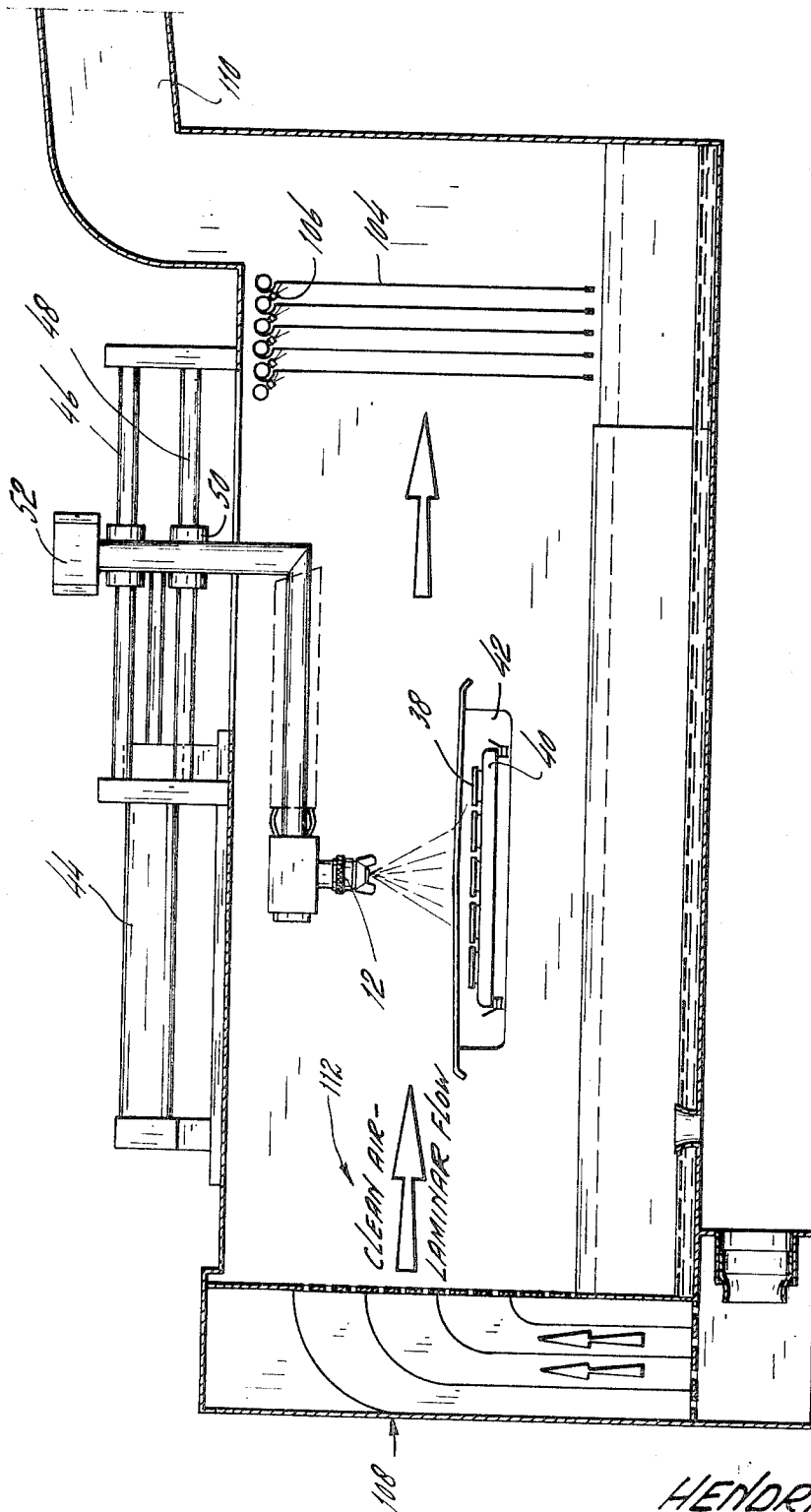


FIG. 4

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SPRAY GUN SYSTEM FOR SLURRY

BACKGROUND OF THE INVENTION

In general, the spray application of slurry solutions, such as water- or solvent-based glass frit, solder glass, phosphor and other fast settling, nonsoluble materials, is difficult if such applications are to be of low output, consistent in solid percentage and repeatable.

Spray guns are available which have a material inlet and an outlet at the spray gun head, allowing a constant flow of slurry through the gun head to prevent settling of the heavy solids in hoses, gun head and nozzle.

However, conventional spray guns utilize a needle to close the orifice of the nozzle, as spraying is to be terminated. This needle-nozzle combination is the source of some of the problems encountered by spraying slurries. The cavity, formed by the needle seat, cannot be readily flushed by the slurry which circulates through the gun head, particularly if the nozzle is pointed downwardly. The high-weight solids settle in the nozzle tip, causing a severe restriction when the needle is pulled back for spraying. Since most slurries are of an abrasive nature, the needle-nozzle seats are subject to heavy wear, principally because there is always a misalignment of the needle in relationship to the center of the nozzle. This causes wear on one side of the seat, rendering the nozzle and needle useless in a very short time.

The object of this invention is to provide an automatic spray gun for spraying the above-mentioned slurries in applications where precision, cleanliness and repeatability is required. The automatic spray gun head consists basically of two four-way valves, double stacked in one housing with an outlet opening which is placed just above the nozzle. This combined valve gun-head arrangement is mounted via a support tubing by a linear guide system and connected to a drive mechanism. Inside the support tubing is placed a drive mechanism for actuating the four-way valves.

SUMMARY OF THE INVENTION

According to the present invention separate slurry circulation conduits and solvent circulation conduits are maintained so that either or both slurry and solvent may be continuously circulated through the spray gun. As the slurry spraying is completed, the slurry circulation circuit may be short circuited and solvent may be circulated continuously through the spray gun by opening a solvent valve in the solvent circulation circuit, so as to flush out the gun and leave the gun ready for respraying of slurry. As the gun is shut down from solvent or slurry spraying, only the slurry is continuously circulated, the solvent valve has closed the solvent circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a schematic view of the spray gun system in no-spray attitude;

FIG. 1B is a schematic view of the system in slurry spray attitude;

FIG. 1C is a schematic showing the system in a solvent spray, flushing attitude;

FIG. 2 is a vertical section of a proposed spray gun and four-way valve;

FIG. 3 is an end elevation of the four-way valve; and

FIG. 4 is a side elevation of the proposed gun together with a reciprocating mechanism positioned in a spray chamber.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a flow diagram of a slurry and solvent-clean circulation system with a double-stacked slurry/solvent selector four-way valve 10 as a control device operative to "off" and "on" positions for selective slurry/solvent flow-through spray gun head 12.

FIG. 1A shows the gun 12 in the no-spray condition. The slurry constantly circulates from the slurry container 14 via circulation pump 16, supply hose 18 to the upper stacked

four-way valve inlet port A, through rotor passage 20 to the exit port D, via flow canal 22, drilled in the body of the double stacked four-way valve, to the inlet port D1 of the lower stacked valve 24 and via rotor passage to the exit port A1, then back to the slurry container via conduit 26. The solvent cleaning solution is short circuited by the double solenoid valve 28 serving as a solvent "off" control. Neither the solvent cleaning solution nor the slurry will flow through the spray gun head.

FIG. 1B shows the gun in the slurry spray condition. The double-stacked four-way valve 10 is activated and the rotor 20 connects the ports A and ports B and also ports C1 and D1. The slurry now circulates through gun head 12, and because the nozzle orifice 30 is open at all times, the spraying of the slurry will commence. The solenoid valve 28 is opened at the same time when the double-stacked valve is activated and cleaning solution is now circulating via the ports C and D. This will prevent any clogging of the slurry left in the passage. The solids, picked up by the cleaning solution, will be carried to the cleaning solution container 32, and since the suction fitting 34 at the bottom is raised, the solids are allowed to settle on the bottom for easy recovery.

FIG. 1C shows the gun-off condition after the spray is terminated. The double-stacked four-way valve 10 is again placed in the position where the rotor 20 connects the ports A and D and ports D1 and A1, causing the slurry to circulate through the valve itself. After the slurry stops flowing through the gun, the cleaning solution is, for a short period of time, allowed to flush through the gun and will remove all slurry residue by circulation and actually spraying.

After the above-mentioned slurry residue has been removed from the spray gun head, solenoid valve 28 is deactivated and the condition as described with FIG. 1A is restored.

Any time the slurry spray is activated, the gun will cycle in a sequence as shown in FIG. 1B, 1C and 1A.

FIG. 2 shows a cross section of the double-stacked four-way valve. The outlet ports B and B1 are combined in the valve housing to form one single outlet 48, which terminates in the spray gun head, just above the nozzle. The stainless steel rotor 20 rotates through 90° in teflon sleeve 31 with a guide 60 therein. Rotation of rotor 20 is accomplished within the support tubing 35 by means rotor actuator shaft 72.

Solvent and slurry inlet and outlet ducts are generally indicated at 58, 59, 68. The gun body includes a closure cap 54 with spring 56 biasing rotor 20 to operative position. Spray adjustment and assembly mechanism includes boss 64 and fins 66, as shown in FIG. 4.

FIG. 3 shows the top view of the double-stacked four-way valve. The port inlets ABC form the top four-way valve, the port inlets A', B', C' form the lower four-way valve.

FIG. 4 illustrates the automatic spray gun placed in a typical spray chamber 108 used for precision coating of small ceramic substrates 38, placed on a vacuum plate 40 and conveyed through the slots 42 of the spray chamber. The spray gun head is propelled in a reciprocation motion by air cylinder 44, via double guide rail 46, 48 and roller bushings 50.

A rotary actuator 52 is shown on top of the support tubing 35 and is used to activate the rotor 20 of the double-stacked four-way valve through a 90° rotation through shafting supported by bearings 61, 62 and gearing 74, 75.

In FIG. 4 the gun is shown together with a reciprocating apparatus placed within a spray booth of the type having a plurality of staggered baffles 104 at its discharge end 110 with individual spray nozzles 106 communicant with each baffle so as to spray solvent on the baffles, a collecting pan beneath the spray area and a laminar flow clean air source 112 at the end of the spray booth opposite the wetted baffles.

I claim:

1. A spray gun system for air-pressurized spraying of slurry comprising:

A. a source of slurry and a continuous slurry circulation conduit for said slurry;

B. a spray gun with discharge nozzle mounted in said circulation conduit and having:

3

- i. a slurry/solvent selector valve communicant with said circulation conduit;
- ii. an air atomization conduit communicant with said nozzle in said spray gun;
- C. a source of solvent having:
 - i. a continuous solvent circulation conduit for said solvent communicant with said selector valve and;
- D. means driving said selector valve to "off" and "on" positions, said "on" position charging said gun through said circulation conduit with liquid slurry and solvent.
- 2. A spray gun circulation system as in claim 1, said solvent circulation conduit including a solenoid solvent "off" valve.
- 3. A spray gun system for slurry as in claim 1, said spray gun having a double-stacked four-way valve for interconnection with solvent/slurry conduits selectively.
- 4. A spray gun system for slurry as in claim 3, said four-way valve being operable to a no-spray "off" position, while circulating solvent through said spray gun.
- 5. A spray gun system for solvent as in claim 4, said four-

4

way valve in no-spray "off" position admitting continuous flow of slurry through a portion of said solvent conduit and back into said source of slurry.

5 6. A spray gun system for slurry as in claim 5, said valve in solvent spray position permitting a continuous flow of solvent through said gun and back into said source of solvent, while continuously circulating slurry through a portion of said slurry circulation conduit.

10 7. A spray gun system for slurry as in claim 6, including means agitating said source of slurry continuously.

8. A spray gun system for slurry as in claim 7, including independent pump means positioned in said solvent circulation conduit and said slurry circulation conduit.

15 9. A spray gun system for slurry as in claim 4, said four-way being capable of permitting spraying of solvent only through said gun, as slurry is circulated through a portion of said slurry circulation conduit.

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