

[54] **DEVICE FOR DELIVERING PARTICULATE MATERIAL**

[76] **Inventor:** Charles R. Vertue, P.O. 2532A
Wharton Glen Ave., Cooksville,
Ontario, Canada

[22] **Filed:** Aug. 7, 1972

[21] **Appl. No.:** 278,320

[30] **Foreign Application Priority Data**

Aug. 5, 1971 Great Britain 36945/71

[52] **U.S. Cl.** 222/193, 302/51

[51] **Int. Cl.** B67d 5/54

[58] **Field of Search** 222/193; 302/51; 141/28

[56] **References Cited**

UNITED STATES PATENTS

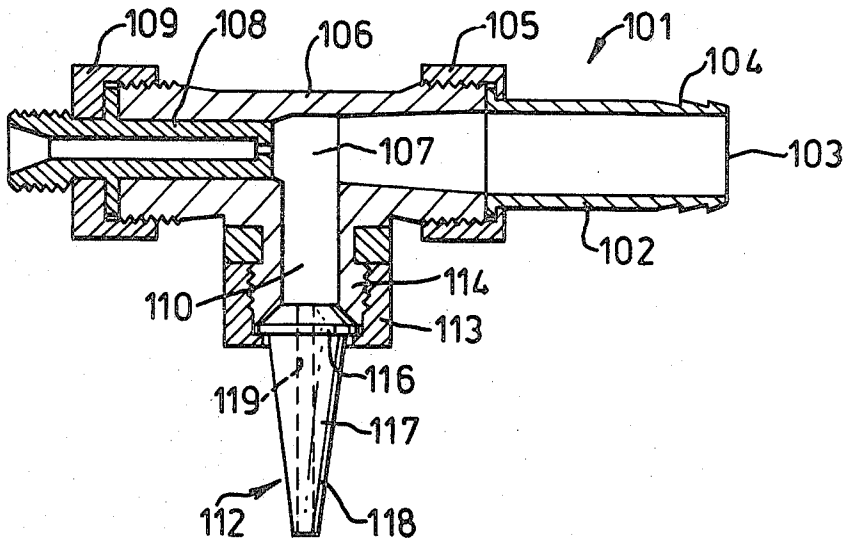
1,664,803	4/1928	Agassiz	222/193
3,134,513	5/1964	Ashman	222/193

Primary Examiner—Richard A. Schacher
Attorney, Agent, or Firm—Sughrue, Rothwell, Mion,
Zinn & Macpeak

[57] **ABSTRACT**

A device for delivery of particulate material, e.g. to a spray gun, has a gas flow passage communicating with an outlet, an inlet in the passage for connection to a fluidized bed of the particulate material, and a gas flow constriction for discharging compressed gas into the passage to entrain the particulate material from the inlet to the outlet. The inlet communicates with the fluidized bed through an inlet nozzle having an inlet passage extending from a mouth, the inlet nozzle having an outer surface which tapers towards the mouth and converges with the inlet passage at the mouth to form a thin edge around the mouth which counteracts build-up of particulate material at the mouth.

5 Claims, 3 Drawing Figures



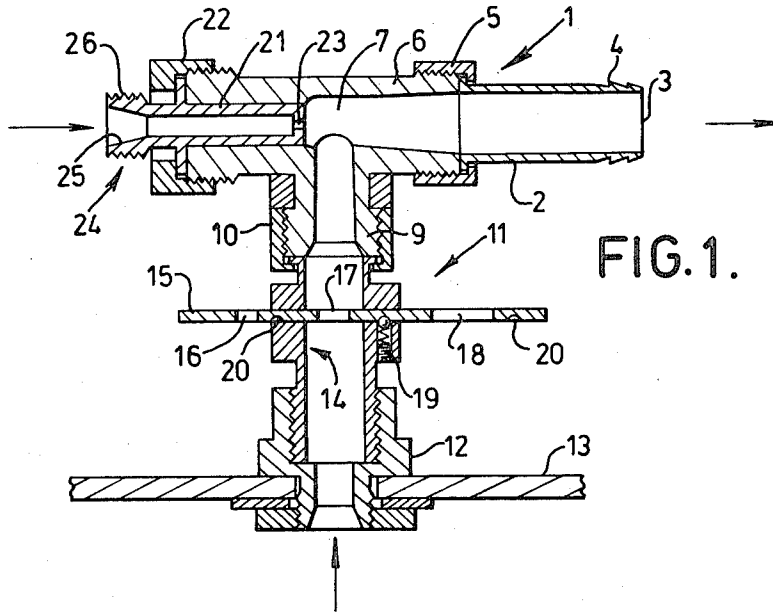


FIG. 1.

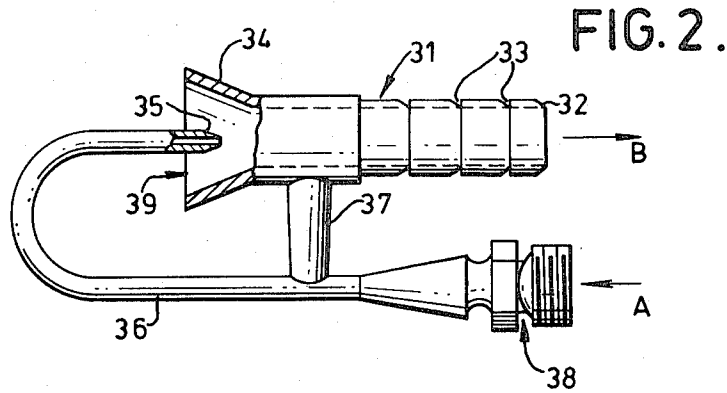


FIG. 2.

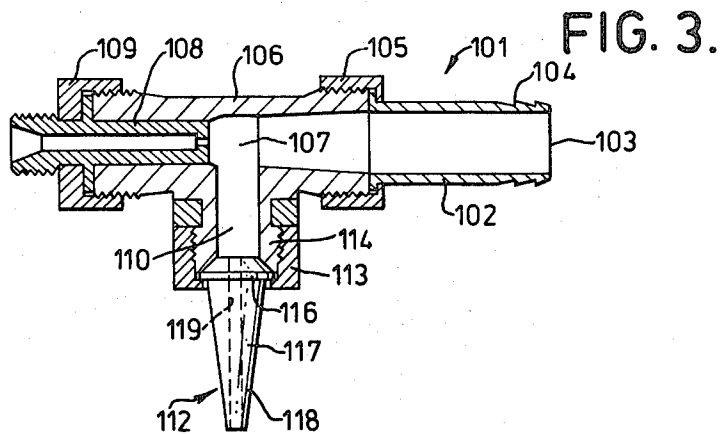


FIG. 3.

DEVICE FOR DELIVERING PARTICULATE MATERIAL

This invention relates to a device for converging particulate material e.g. to a spray gun.

It is well established in the art of coating that powders such as synthetic resins in powder form (usually pigmented) and powdered metals, may be conveniently and economically sprayed onto a wide variety of substrates to form coatings thereon with considerable advantages over liquid (e.g., paint) spraying, in particular with respect to pollution problems and recovery of unused material for reuse.

However, existing devices for supplying particulate material to spray guns have suffered from certain limitations and disadvantages, especially in respect of the ability to provide on a continuous basis a substantially uniform supply of particulate material capable of coating a relatively large area of substrate in uniform manner without the risk of breakdown or blockage of supply. There thus exists a need in the art for a simple and efficient means of continuously supplying particulate material uniformly to a spray gun while permitting the possibility of changing powder without the inconvenience of partially dismantling the equipment in order to clean out or purge the previous powder and furthermore to afford the facility of operating a plurality of spray guns from a single bulk source.

The invention provides a device for conveying particulate material, comprising means defining a first passage for the flow of gas under pressure, means defining an outlet communicating with said first passage, means defining an inlet opening into said first passage for the flow of the particulate material to the first passage, a constriction in said first passage for directing a forced supply of gas along said first passage towards said outlet to draw the particulate material through said inlet and to cause the particulate material to be entrained by the gas along said first passage to said outlet, and an inlet nozzle through which said second passage extends, said inlet nozzle having means defining a second passage communicating with said inlet, a mouth for the entry of the particulate material into said second passage, and an outer surface which tapers towards said mouth and converges with said second passage at said mouth.

The term "particulate material" used herein is generally intended to refer to powder. However, fine crystalline, granular or flocculant material, or, in fact, any material which can be readily entrained in a gas flow is for the present purposes to be regarded as particulate material.

In one embodiment of the device and method of the invention, the source of particulate material comprises a fluidized bed of particulate material. The device of the invention is suitable for use in electrostatic spray coating operations, in which case the spray gun will be provided with means for electrostatically charging the particulate material passing therethrough.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made by way of example, to embodiments thereof illustrated in the accompanying drawings, in which:

FIG. 1 shows a cross-sectional view of a device for delivering particulate material to a spray gun;

FIG. 2 is a side view, partly broken away, of another device for delivering particulate material to a spray gun; and

FIG. 3 shows a cross-sectional view of a third device for delivering particulate material to a spray gun.

Referring now to FIG. 1 of the accompanying drawings, the device comprises a pipe 1 having a generally hollow cylindrical down-stream portion 2 terminating in an outlet end 3 provided exteriorly with a plurality of annular ridges 4 to permit ready connection to a flexible hose (not shown) attached to a spray gun. Cylindrical portion 2 is connected by means of a screw-fitting collar 5 to an upstream portion 6 of pipe 1 having a generally frusto-conical hollow internal configuration of Venturi shape widening towards and aligning with portion 2 so as to provide a generally smooth gas flow passage. Upstream portion 6 terminates in inlet portion 7 of pipe 1 which communicates with a conduit 9 disposed substantially perpendicularly to the general longitudinal axis of pipe 1. Conduit 9 is secured by a collar 10 in internally aligned arrangement with restrictor means 11 which, in turn, is screwed into a generally cylindrical hollow plug member 12 disposed through the side wall 13 of a fluidized bed, so that a continuous aligned longitudinal passage is provided from said fluidized bed to the inlet end 7 of pipe 1. The restrictor means 11 comprises a hollow cylindrical portion 14 provided with a restrictor plate 15 which is disposed transversely through said portion 14 and formed with a plurality of apertures 16, 17 and 18 of different sizes, the largest corresponding approximately to the internal size of the portion 14. A grub screw, spring and ball bearing detent arrangement 19 is located in one side of the restrictor means 11, the ball bearing being engageable with recesses 20 in the plate 14 to permit ready movement of said plate into a series of positions locating and securing any desired size of aperture concentrically in the cylindrical portion 14.

Nozzle means 21 snug fits into one end of the pipe 1 axially parallel thereto and is secured therein by a screw collar 22. The inner end of nozzle means 21 is provided with a nozzle opening 23 which communicates with inlet portion 7 of pipe 1. Inlet end 24 at the outer end of nozzle means 21 is formed internally with an outwardly opening flared frusto-conical surface and is formed externally with screw threading 26 or other suitable means for connection to a flexible air supply hose or the like (not shown).

The various parts of the device can be readily dismantled for replacement or cleaning purposes and the restrictor means 11 can optionally be omitted or replaced by a different type of restrictor means, such as a gate valve. The precise disposition of the nozzle 23 with respect to the inlet portion 7 of the pipe 1 and the conduit 9 can, if desired, be arranged to be variable, so that the nozzle 23 is movable in the longitudinal direction of the pipe 1, whereby adjustment to the optimum disposition, depending on the rate of air flow and the nature particle size and density of the powder being used, can be attained.

In operation of the device, the fluidized bed is activated, and compressed air is supplied to the nozzle means 21 as indicated diagrammatically by the arrow in FIG. 1. Passage of air through the nozzle opening 23 and along the pipe 1 causes a suction effect in the conduit 9, resulting in withdrawal of air and powder from the fluidized bed through the conduit 9 as indicated di-

agrammatically by the arrow in FIG. 1. The air and powder mixture is drawn through the conduit 9 into the inlet end 7 of the pipe 1, becomes entrained in the air supply passing therethrough and, in turn, passes along pipe 1 and thereafter through a flexible hose (not shown) attached to outlet end 3 of pipe 1. The mixture subsequently reaches a spray gun (not shown) for spraying onto a substrate. Conveniently, the air supply to nozzle means 21 is initiated and discontinued in response to actuation of the trigger of the spray gun.

Turning now to FIG. 2 of the accompanying drawings, the device comprises a generally cylindrical pipe 31 having an outlet end 32 and provided exteriorly with a plurality of spaced annular grooves 33 to facilitate attachment of a hose (not shown) leading to a spray gun (not shown). The pipe 31 is provided with an outwardly flared inlet end 34 of generally frusto-conical configuration opening to a mouth 39. Disposed in the open mouth 39 of pipe 31 is a nozzle 35 connected to the end of a tube 36 which connects with an air supply hose (not shown) screwed on end 38 of the tube 36. For compactness, the tube 36 is of U-shaped configuration and is secured to the pipe 31 by a welded strut 37.

In operation of the device, an air supply hose is secured to the end 38 of tube 36 and a flexible hose (not shown) communicating with a spray gun (not shown) is fitted over outlet end 32 of pipe 31 and securely held thereon by the frictional effect of the annular grooves 33. The device is then immersed in a source of loose particulate material, preferably, a fluidized bed, and compressed air is supplied to tube 36 in the direction diagrammatically indicated by arrow A. A jet of air emerges from the nozzle 35 and creates a suction effect in the mouth 39 of pipe 31, resulting in the influx of particulate material from the fluidized bed. The particulate material becomes entrained in the air issuing from the nozzle 35 and passes down the pipe 31 and thence to the spray gun for application to substrate.

It can thus be seen that the device shown in FIG. 2 is both compact and portable and can be readily removed from the fluidized bed and immersed in another bed of different powder. Of course, a plurality of the devices connected to a plurality of spray guns can be used in connection with a single fluidized bed.

If desired the device can be modified such that the relative disposition of the nozzle 35 with respect to the mouth 39 of pipe 31 is adjustable so that an optimum disposition of the nozzle with respect to inlet end 34 of pipe 31 for any given type of powder and intended air flow velocity can be achieved. Generally speaking, the opening of nozzle 35 should be just downstream of the plane of the annular lip of the inlet end 34 of pipe 31. If the end of the nozzle is too far outside the inlet end 34 of the pipe 31, a certain amount of undesirable turbulence may be caused and efficiency is liable to drop. On the other hand, if the nozzle is inserted too far into the inlet end 34, e.g., level with the junction between frusto-conical inlet end 34 and the cylindrical portion of pipe 31, the possibility of blockage can occur in the relatively more restricted annular space between the nozzle 35 and the inside of the pipe 31 and, moreover, powder pick-up is reduced.

The foregoing devices have been described for operation with an air supply. However, if appropriate, the air supply can be replaced by a supply of another gas, e.g., an inert gas such as nitrogen. The devices of the invention have been found particularly suitable for use

in connection with an electrostatic type of spray gun for the electrostatic coating of substrates.

In further embodiments, the nozzle may be directed slightly tangentially with respect to the pipe, so as to impart a component of circulatory motion to the flow of air and material in the pipe.

FIG. 3 shows a modification of the device of FIG. 1. In this modification, there is provided a pipe indicated generally by reference numeral 101 having a generally hollow cylindrical downstream portion 102 terminating in an outlet end 103. On the exterior of the outlet end 103 there is provided a plurality of annular ridges 104 for connection to a flexible hose attached to a spray gun, the hose and spray gun being not shown in the drawings. Cylindrical portion 102 is connected by means of a screw-threaded collar 105 to an upstream portion 106 of the pipe 101. The upstream portion 106 has a generally frusto-conical hollow internal configuration of Venturi shape widening towards and aligned with portion 102, and terminates in an inlet portion 107.

A nozzle forming a gas flow restrictor 108 is secured, by a screw-threaded collar 109, to the end of the pipe 101 opposite the outlet end 3. An inlet for the particulate material is formed by a passage 110, which extends perpendicularly to, and opens into, the upstream portion of pipe 106.

It will be readily appreciated that the parts of the modification of FIG. 3 thus far described have a resemblance to the corresponding parts shown in FIG. 1.

However, in this modification a further nozzle in the form of a restrictor for restricting the flow of particulate material into and along the passage 110 is provided as a flow restrictor member indicated generally by reference numeral 112.

The flow restrictor member 112 is secured to the inlet end of the passage 110 by a threaded collar 113, which is in threaded engagement with the outer surface of a duct portion 114 extending from the pipe portion 106 and integral therewith, the duct portion 114 defining the passage 110.

The collar 113 engages an annular shoulder 116, formed on the flow restrictor member 112, for urging the outlet end of the latter against the correspondingly formed inlet end of the duct portion 114.

The flow restrictor member 112 has an inlet portion 117, which is formed with a frusto-conical outer surface 118. The frusto-conical outer surface 118 converges in a direction away from the inlet end of the passage 110.

In addition, an opening in the form of a bore 119 extends longitudinally through the flow restrictor member 112 and is axially aligned with the passage 110.

When the device is in use, the inlet portion 117 of the flow restrictor member 112 is inserted into a chamber containing a fluidized bed of the particulate material. Gas, preferably air or an inert gas, is then supplied under pressure to the flow restrictor 108 and discharged therefrom at high speed past the inlet 107, which causes the particulate material and air mixture to be drawn from the fluidized bed through the bore 119, the passage 110 and the inlet 107, and entrained along the pipe 101 to the outlet end thereof.

It has been found that this flow restrictor member 112 has the advantage that it reduces settling of the particulate material on the flow restrictor, which settling may otherwise lead to a partial or even a complete

blockage of the flow of the particulate material and result in a choking effect on the discharge of particulate material through the outlet end 103 of the pipe 101.

It has been found that, by appropriate selection of the diameter of the bore 119 in relation to the internal diameter of the hose from the outlet end 103 to the gun, the rate of discharge of the particulate material through the hose can be increased and/or the gas pressure applied to the gas flow restrictor can be decreased. Using a 1/2 inch diameter hose, experiments have provided the following results:

Bore 119 (in.)	Area of Bore 119 (sq. in.)	Gas Inlet Pressure (p.s.i.)	Powder Throughput per hour (pounds)	Ratio Area of Powder Inlet to Area of Hose
0.100	0.008	5	7 1/2	24.5 to 1
0.100	0.008	10	16	
0.100	0.008	20	22 1/2	
0.125	0.012			16 to 1
0.156	0.019	5	22 1/2	10 to 1
0.156	0.019	10	30	
0.156	0.019	20	39	

I claim:

1. A device for conveying particulate material, comprising:
 - a. means defining a first passage for the flow of gas under pressure,
 - b. means defining an outlet communicating with said first passage,
 - c. means defining an inlet opening into said first passage for the flow of the particulate material to the first passage,
 - d. a constriction in said first passage for directing a forced supply of gas along said first passage towards said outlet to draw the particulate material through said inlet and to cause the particulate material to be entrained by the gas along said first passage to said outlet, and
 - e. an inlet nozzle having means defining a second pas-

sage communicating with said inlet, a mouth for the entry of the particulate material into said second passage, and an outer surface which tapers towards said mouth and converges with said second passage at said mouth.

2. A device as claimed in claim 1, wherein means are provided for readily releasably securing said nozzle to said device.

3. A device as claimed in claim 1, wherein said constriction is formed by a gas flow restrictor insert provided in said first passage.

4. A device as claimed in claim 1, wherein a powder inlet passage connects said second passage to said inlet, and said second passage forms a flow restrictor for restricting flow from said mouth to said inlet.

5. A device for conveying particulate material, comprising:

- a. means defining a first passage for the flow of gas under pressure,
- b. means defining an outlet communicating with said first passage,
- c. means defining an inlet particulate into said first passage for the flow of the particulate material to the first passage,
- d. a constriction in said first passage for directing a forced supply of gas along said first passage towards said outlet to draw the particulate material through said inlet and to cause the particulate material to be entrained by the gas along said first passage to said outlet; and
- e. an inlet nozzle having means defining an axial inlet passage aligned with and communicating with said inlet, a mouth at one end of said inlet passage for the entry of the particulate material into said axial inlet passage, and a frusto-conical outer surface which tapers towards said mouth and converges with said inlet passage at said mouth to form a knife-edge around said mouth.

* * * * *

40

45

50

55

60

65

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,795,348

Dated March 5, 1974

Inventor(s) Charles R. Vertue

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE SPECIFICATION:

Column 1, line 4, "converging" should read "conveying".

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents