

- [54] **POWDER HOPPER FOR ELECTROSTATIC POWDER SPRAYING APPARATUS**
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- [52] U.S. Cl. 302/57, 222/195, 239/15
[51] Int. Cl. B05b 5/02
[58] Field of Search 239/15, 85; 302/45, 47, 302/53, 57; 222/193, 194, 195

[56] **References Cited**

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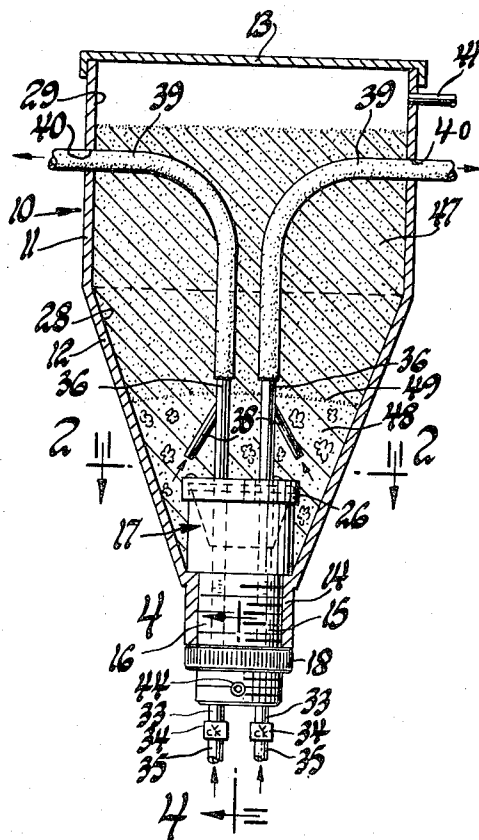
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[57] **ABSTRACT**

A powder hopper for supplying fluidized powder to an electrostatic powder spraying apparatus which includes a hopper body having a conical chamber at the lower end thereof, in which is operatively mounted at least one venturi powder pump means. A fluidizing air chamber is operatively mounted in the lower end of the hopper body, and it has an open upper end which is covered by a diffuser membrane. The venturi powder pump means is provided with an intake conduit disposed above the diffuser membrane. The fluidizing air chamber is operatively connected to a first source of pressurized air for distributing pressurized air into the conical chamber to agitate and fluidize the powder in the lower end of the conical chamber. The venturi powder pump means is operatively connected to a second source of pressurized air at a higher pressure for drawing fluidized powder from the conical chamber and conveying the same to an electrostatic powder spraying apparatus.

6 Claims, 7 Drawing Figures



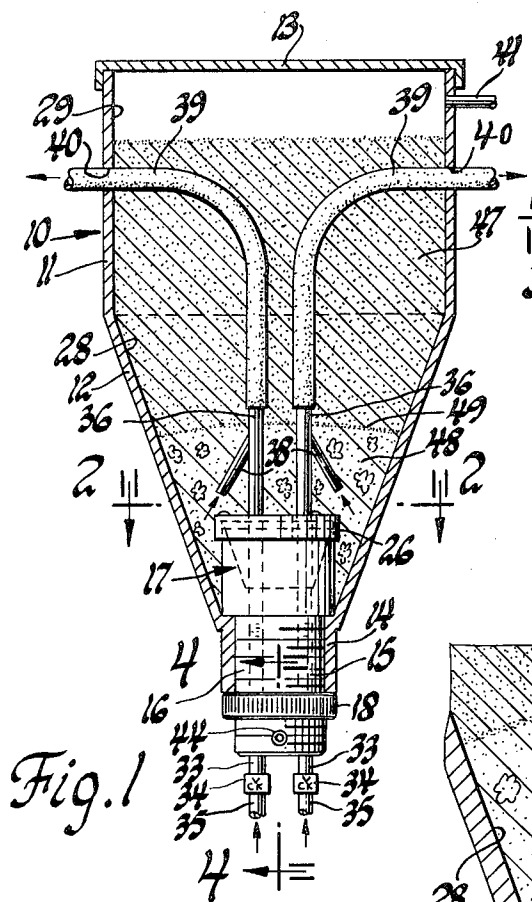


Fig. 1

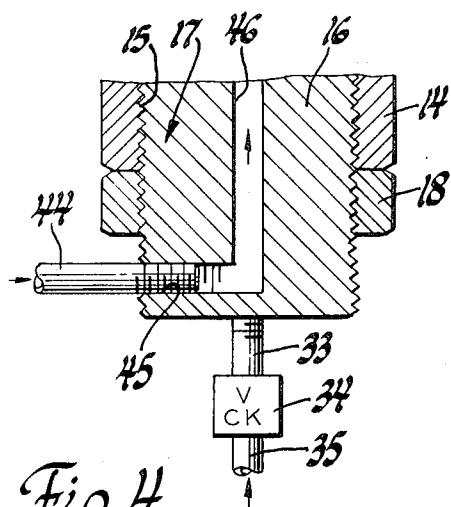


Fig. 4

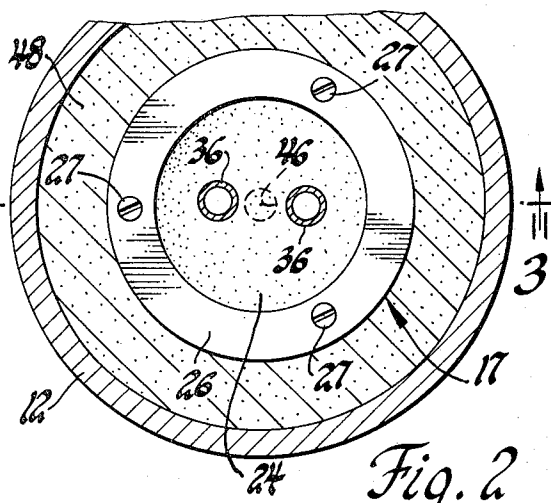


Fig. 2

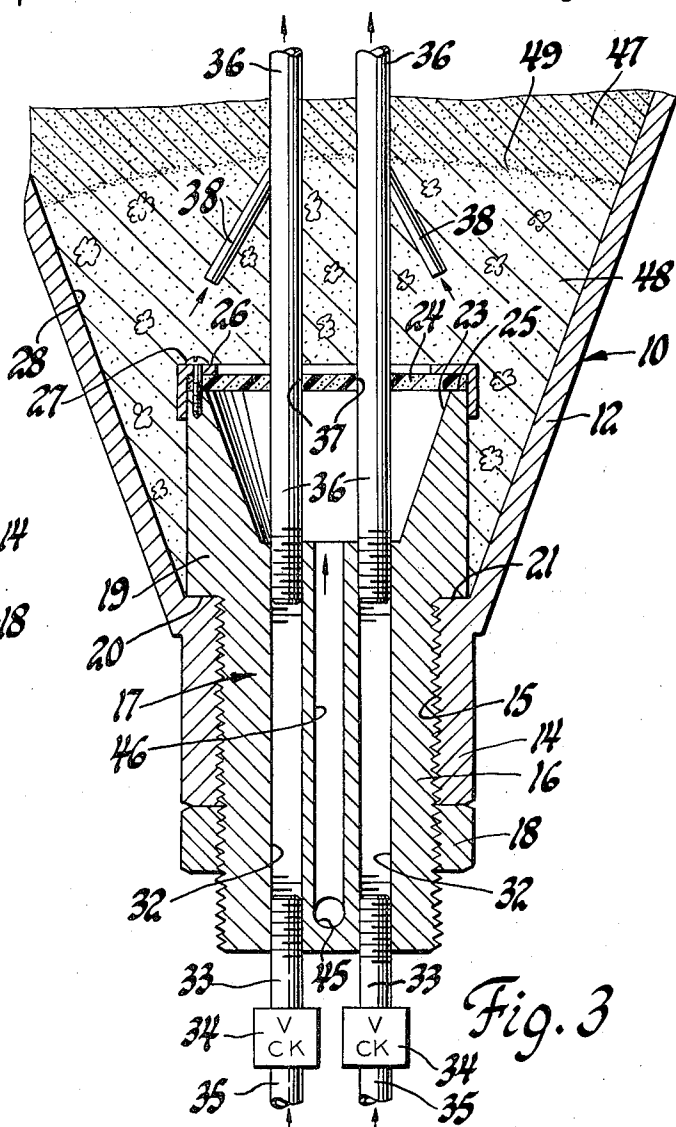
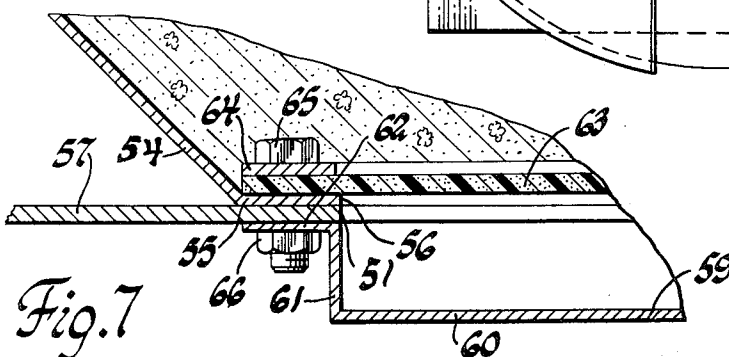
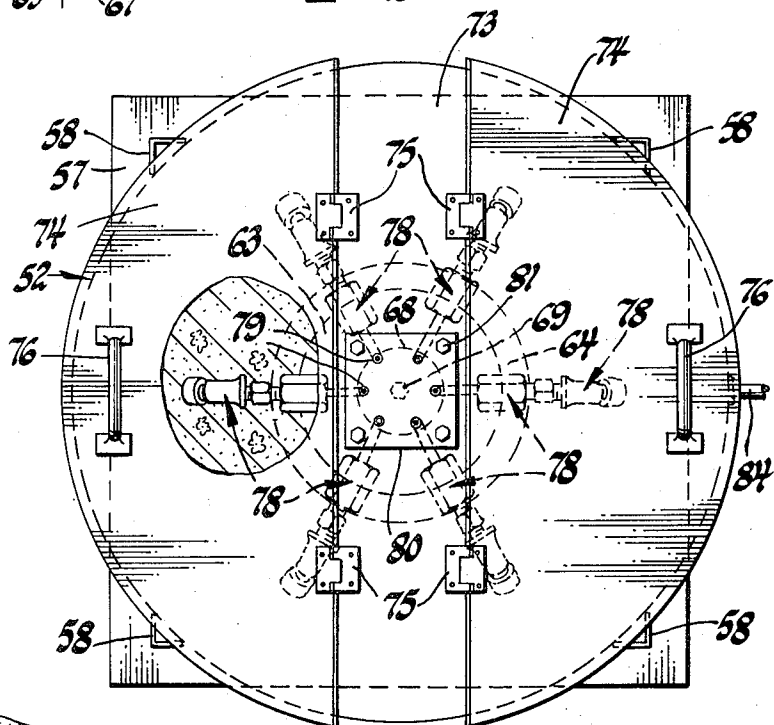
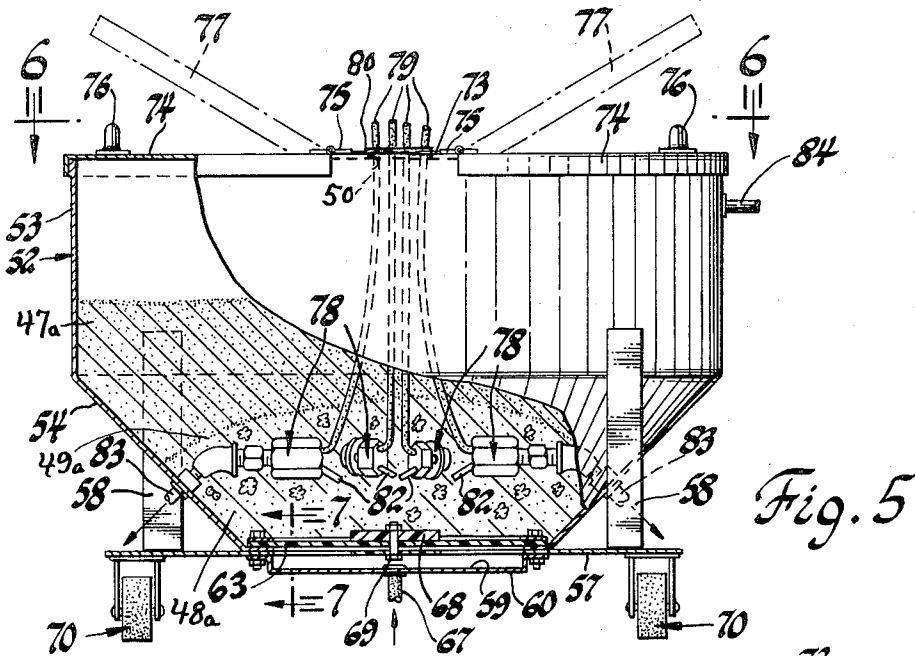


Fig. 3



POWDER HOPPER FOR ELECTROSTATIC POWDER SPRAYING APPARATUS

SUMMARY OF THE INVENTION

This invention relates to the electrostatic powder spraying art and, more particularly, to a novel and improved powder hopper for supplying fluidized powder to an electrostatic powder spraying apparatus.

Heretofore attempts have been made to provide powder hoppers for electrostatic powder spraying apparatuses which included the providing of pressurized air for agitating the powder in the hopper. However, such prior art hoppers included the use of the same high pressure air for agitating the powder as was used for drawing the fluidized powder into a venturi pump means for conveying the same to an electrostatic powder spraying apparatus. The last mentioned procedure has a disadvantage in that the fluidizing of the entire hopper does not provide a good draft or pull into the intake nozzle of a venturi pump means. Furthermore, the fluidizing of all of the powder in the powder hopper does not provide a homogeneous powder to a powder spraying apparatus because the grains of the powder tend to segregate by gravity after a predetermined time of operation, and stratification of the powder occurs in accordance with the different sizes of powder grains. This stratification of the grains of the powder prevents the forming of a homogeneous fluidized powder which results in inefficient powder spraying operations by a powder spraying apparatus being fed by such a hopper. A further disadvantage of the prior art hoppers wherein all of the powder in the hopper is fluidized is that such a system tends to provide surging in the powder supply system to a powder spraying apparatus. Still another disadvantage of the prior art systems is that the fluidizing of all of the powder in the hopper tends to cause a build-up in the venturi inlet pipe which decreases the amount of fluidized powder admitted to the venturi pump gun and a resultant inefficient system. In view of the foregoing, it is an important object of the present invention to provide a novel and improved powder hopper for electrostatic powder spraying apparatuses which overcomes the aforementioned disadvantages of the prior art powder hoppers.

It is another object of the present invention to provide a novel and improved powder hopper for electrostatic powder spraying apparatuses which is simple and compact in construction, economical to manufacture and efficient in operation.

It is a further object of the present invention to provide a novel and improved powder hopper for electrostatic powder spraying apparatuses which provides fluidizing action to the powder in the hopper only in the area immediately adjacent to the intake of a venturi powder pump means so as to provide for efficient and homogeneous fluidizing of the powder before it is drawn into the venturi powder pump means.

It is still another object of the present invention to provide a novel and improved powder hopper for electrostatic powder spraying apparatuses which includes a hopper body having an upper cylindrical chamber and a communicating lower conical chamber, a fluidizing air chamber operatively mounted in the lower end of the hopper body with an open upper end communicating with the lower end of the conical chamber. The hopper is provided with means for conveying pressur-

ized air into said fluidizing air chamber for flow into the lower conical chamber at a first pressure to agitate and fluidize the powder in the lower end of the conical chamber. A diffuser membrane is operatively mounted over the open upper end of the fluidizing air chamber for evenly distributing the pressurized air flowing from the fluidizing air chamber into the conical chamber. The powder hopper is provided with at least one venturi powder pump means operatively mounted in the conical chamber in a position spaced above and adjacent the diffuser membrane. The venturi powder pump means is provided with an intake conduit for admitting fluidized powder from the conical chamber. The powder hopper is provided with means for operatively supplying pressurized air at a second and higher pressure to the venturi pump means to draw fluidized powder through the intake means into the venturi pump means. The powder hopper is provided with conduit means for conveying the pressurized air and fluidized powder from the venturi powder pump means to an electrostatic powder spraying apparatus. The powder hopper is provided with vent means for venting the hopper to a suitable source, as for example, a powder spray booth. The powder hopper may be constructed and arranged to hold at least two venturi pump means for manually operated powder spraying operations and in another embodiment it may be provided with a plurality of venturi pump means for supplying fluidized powder under pressure to a plurality of automatically operated electrostatic powder spraying guns.

Other objects, features and advantages of this invention will be apparent from the following detailed description, appended claims, and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational section view of a two-gun powder hopper made in accordance with the principles of the present invention.

FIG. 2 is a fragmentary, enlarged, horizontal section view of the structure illustrated in FIG. 1, taken along the line 2—2 thereof, and looking in the direction of the arrows.

FIG. 3 is a fragmentary, elevational section view of the structure illustrated in FIG. 2, taken along the line 3—3 thereof, and looking in the direction of the arrows.

FIG. 4 is a fragmentary, enlarged, elevational section view of the structure illustrated in FIG. 1, taken along the line 4—4 thereof, and looking in the direction of the arrows.

FIG. 5 is an elevational view, partly in section, of a six-gun powder hopper made in accordance with the principles of the present invention.

FIG. 6 is a top plan view of the structure illustrated in FIG. 5, taken along the line 6—6 thereof, and looking in the direction of the arrows.

FIG. 7 is a fragmentary, enlarged, elevational section view of the structure illustrated in FIG. 5, taken along the line 7—7 thereof, and looking in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and in particular to FIG. 1, the numeral 10 generally designates a powder hopper made in accordance with the principles of the

present invention. The hopper 10 includes an upper cylindrical portion 11 and an integral, downwardly extended conical portion 12. The upper end of the hopper portion 11 is enclosed by a suitable cover or lid 13. Integrally formed on the lower end of the conical hopper portion 12 is a reduced diameter cylindrical portion 14 which is provided with a threaded bore 15. Threadably mounted in the bore 15 is the lower end 16 of a fluidizing air apparatus, generally indicated by the numeral 17. A suitable lock nut 18 is adapted to releasably secure the fluidizing apparatus lower end 16 in operative position in the hopper portion 14.

As shown in FIG. 3, the upper end of the fluidizing air apparatus 17 is provided with an enlarged diameter upper end portion 19 which forms a downwardly facing shoulder 20 with the lower portion 16. The shoulder 20 is adapted to be seated against an upwardly facing shoulder 21 formed on the upper end of the hopper portion 14. A conically shaped fluidizing air chamber 23 is formed in the fluidizing air apparatus portion 19 and its upper end is enclosed by a suitable diffuser membrane 24. The diffuser membrane 24 is seated on the upper end 25 of the fluidizing air apparatus portion 19 so as to enclose the upper open end of the chamber 23. The diffuser membrane 24 is secured in place by a suitable hold-down ring 26 which is releasably secured to the fluidizing air apparatus 19 by a plurality of suitable machine screws 27. As best seen in FIG. 1, the fluidizing air apparatus 17 is positioned within a conically shaped chamber 28 formed in the hopper conical portion 12. The conical chamber 28 communicates with a cylindrical chamber 29 in the hopper cylindrical portion 11.

As shown in FIG. 3, a pair of vertically extended bores 32 are formed longitudinally through the fluidizing air apparatus 17 and they communicate with the exterior on the lower end of the portion 16, and with the fluidizing air chamber 23 at the upper ends thereof. Threadably mounted in the lower ends of the bores 32 are a pair of suitable conduits 33. Operatively attached on the lower ends of the conduits 33 are a pair of air check valves 34 which may be of any suitable type. Operatively connected to the check valves 34 are a pair of pressurized air supply lines 35 for connection to a suitable source of pressurized air for supplying air to the bores 32.

Threadably mounted in the upper ends of each of the bores 32 is a venturi air supply line 36 which extends upwardly through suitable holes 37 formed through the diffuser membrane 24 and into the conical powder chamber 28. Operatively connected to each of the conduits 36 is an angled, short intake conduit 38 which communicates at its upper end with conduit 36 and which is open at its lower end and communicates with the conical powder chamber 28. Each intake conduit 38 is positioned at an acute angle relative to its respective conduit 36 so as to form a venturi means with its respective conduit 38.

As shown in FIG. 1, a flexible conduit, as a tubing 39, is operatively connected at its inner end to the upper end of each of the conduits 36. Each of the tubes 39 extends outwardly through a bore 40 formed through the hopper cylindrical wall 11. The tubes 39 are operatively connected to a suitable electrostatic powder spray gun in a conventional manner, as for example, to a spray gun in a manner as disclosed in the co-pending application, Ser. No. 237,439, entitled "Nozzle For

Electrostatic Powder Spraying Apparatus," and which application is assigned to the assignee of this application.

As shown in FIG. 1, the upper end of the cylindrical chamber 11 is provided with a suitable vent conduit 41 for operative connection to the powder spray booth used with the electrostatic powder spraying apparatus. As shown in FIG. 4, the conical chamber 28 is provided with means for conveying pressurized air into the conical chamber for agitating and fluidizing powder in the lower end of the conical chamber. A conduit 44 has one end threadably mounted in an inlet passage 45 in the lower end 16 of the fluidizing air apparatus 17. The conduit 44 is adapted to be connected to a suitable source of air under pressure. The pressurized air supplied by the conduit 44 is at a lower pressure than the pressurized air supplied by the conduit 35. For example, the pressure of the fluidizing air in the conduit 44 may be from three to seven p.s.i. and the higher pressurized powder conveying air in the conduits 35 may be from five p.s.i. to about 30 p.s.i.

The pressurized air admitted to the passage 45 is conveyed through the interconnected axial, vertical passage 46 into the fluidizing air chamber 23 of the fluidizing air apparatus 17.

In use, the powder hopper 10 is provided with a supply of suitable paint powder indicated by the numeral 47 in FIGS. 1 and 3. After the conduits 39 have been operatively connected to their respective electrostatic powder spraying apparatuses, air under pressure is admitted through the conduit 44 and into the fluidizing chamber 23 from where it passes upwardly through the diffuser membrane 24 into the fluidizing chamber 28. The diffuser membrane 24 provides a back pressure to limit the air passing into the chamber 28 and to spread it out over the area underneath the venturi intake conduits 38, which is the area desired to be fluidized.

Any suitable membrane material may be employed for the diffuser membrane 24. A satisfactory membrane material is one sold on the market under the trademark "BYON" by the Atlas Minerals and Chemicals Division of ESB, Inc., of Mertz Town, Pennsylvania, under catalog No. 363957. The fluidizing air in the chamber 28 fluidizes the powder in the lower area of the chamber 28, as indicated by the numeral 48. The numerals 49 in FIGS. 1 and 3 indicate the division line between the lower portion of the chamber 28 in which the powder is being fluidized and the packed powder 47. Any air bubbles which may pass upwardly through the packed powder 47 are conveyed through the vent conduit 41 to the aforementioned powder spray booth.

When the operator of an electrostatic powder spraying apparatus connected to one of the conduits 34 starts his apparatus, air under pressure enters through the respective conduit 35 and passes out through the venturi pump means conduit 36. The passage of the pressurized air through the conduit 36 sucks the fluidized powder from the fluidizing chamber area 48 through the intake conduit 38 and into the conduit 36.

It has been found that the apparatus illustrated in FIGS. 1 through 4 provides an optimum mixture of air and powder, with the use of a minimum volume of pressurized air. It is preferable, that the distance between the intake end of the powder intake conduits 38 and

the membrane 24 be maintained within a range of about 1 inch to 2½ inches.

It has been found that the powder tank 10 with its novel fluidizing system does not use as much compressed air as the prior art powder hoppers. The prior art hoppers fluidize the whole tank with the powder spraying air and thus require more compressed air. The structure illustrated in FIGS. 1 through 4 provides a powder tank wherein the powder is aerated by a separate air system so that the venturi pump means is better able to pick up the fluidized powder and deliver the powder to an electrostatic spraying gun at a more steady and even rate, without pulsations and surging in the system. In the prior art powder tanks, wherein the entire tank is fluidized with the same air that is used to convey powder to the pump, it has been found that surging in the system occurs and that the powder grains segregate out in various layers in accordance with gravity, and that it is not possible to provide a homogeneous fluidized mixture of powder and air. The prior art devices require actually pressurizing the entire tank which requires a tightened clamp-down lid, as opposed to the applicant's tank, wherein the entire tank is not fluidized, and any fluidizing air which escapes up through the powder 47 merely passes out through the vent conduit 41 to the powder spray booth. The check valves 34 prevent a back load on the system when the air to the conduits 35 is disconnected or turned off.

FIGS. 5, 6 and 7 illustrate a second embodiment of the invention which is adapted for feeding a plurality of automatically operated electrostatic powder spraying apparatuses.

As shown in FIGS. 5 and 6, the second embodiment of the invention includes a hopper generally indicated by the numeral 52 that has an upper cylindrical portion 53 and an integral, downwardly extended conical portion 54.

As illustrated in FIG. 7, the lower end of the hopper conical portion 54 is provided on its lower end with an integral, horizontal, circular flange 55 which has an inner circular periphery 56 that forms an opening into the lower end of the conical hopper portion. The hopper 52 is rollably mounted on a structure which includes a horizontal base plate 57 on which is seated the hopper flange 55. The base plate 57 is provided with a circular central opening 51 which is aligned with the opening 56 through the flange 55.

As shown in FIGS. 5 and 6, the hopper 52 is supported on the base plate 57 by a plurality of vertically disposed angle bars 58 which have their lower ends secured, as by welding, to the plate 57, and their upper ends secured, as by welding, to the outer face of the cylindrical hopper portion 53. As shown in FIG. 5, the base plate 57 is operatively attached to a plurality of suitable rollers 70 for rollably mounting the hopper 52.

As shown in FIG. 7, fluidizing air chamber 50 is operatively mounted in the lower end of the hopper conical portion 54, and it includes a lower circular horizontal wall or plate 60, and an integral upwardly extended peripheral wall 61. Integrally attached to the upper end of the chamber wall 61 is a circular attachment flange 62 which is seated against the lower face of the base plate 57 around the openings 56 and 58. A circular diffuser membrane 63, made from the same material as the diffuser membrane 24 of the first embodiment, is seated over the chamber 59 with its periphery seated

on the upper face of the hopper flange 55. The membrane 63 and the aforementioned chamber structure is held in position by a plurality of suitable bolts 65 and nuts 66. The bolts 65 pass through an annular hold-down ring 64 which is seated on the upper face of the membrane 63, around the periphery thereof.

As shown in FIG. 5, the fluidizing air chamber 59 is provided with an inlet conduit 67, which is disposed centrally on the plate 60. Pressurized air is admitted through the conduit 67 into the chamber 59 for subsequent passage through the membrane 63 and into fluidizing action in the lower part of the hopper conical portion 54. The central portion of the membrane 63 is covered by a circular blocking member 68 made from any suitable material, as metal or plastic. The circular blocking member 68 is disposed centrally on the membrane 63, and it is secured in place by any suitable means, as by suitable bolt and nut means 69.

As shown in FIGS. 5 and 6, the upper end of the hopper cylindrical portion 53 is enclosed by suitable cover means, which includes a centrally mounted plate 73 that is fixedly secured to the upper end of the cylindrical hopper portion 53 by suitable means, as by welding. A pair of covers 74 are each hingedly secured by a pair of hinges 75 to the opposite sides of the cover mounting plate 73. Each of the covers 74 is provided with suitable handles 76 for swinging the covers upwardly to the dotted line open position shown by the numerals 77 in FIG. 5.

As shown in FIGS. 5 and 6, the hopper 52 is provided with a plurality of venturi pump means, generally indicated by the numerals 78. The venturi pump means 78 are disposed in a circle in the lower conical hopper portion 54. Each of the venturi pump means is provided with a pressurized air conduit 79 which has one end attached to its respective venturi pump means, and the other end extended upwardly through the hopper plate 73 and out through a suitable mounting plate (FIG. 6) 80. The plate 80 covers a hole 50 (FIG. 5) in the plate 73, and it is secured in place on the plate 73 by suitable machine screws as 81 (FIG. 6).

The conduits 79 are connected to a suitable source of air under pressure, in the same manner as the conduits 35 for the first embodiment. The conduit 67 is connected to a source of air under lower pressure, in the same manner as the conduit 44 of the first embodiment.

As shown in FIG. 5, each of the venturi pump means 78 is provided with an intake conduit 82 which is disposed in the area just above the membrane 63 which is fluidized by air passing from the chamber 59, in the same manner as in the first embodiment of FIGS. 1 through 4. As shown in FIG. 5, each of the venturi pump means 78 is provided with an outlet conduit 83 through which is fed the pressurized air entering through the respective conduit 79 and the fluidized powder drawn through the respective intake conduit 82.

The numeral 47a indicates the packed powder in the hopper 52. The numeral 48a indicates the area over the member 63 in which the powder is fluidized by the fluidizing air passing through the membrane 63. The numeral 49a indicates the general division line between the fluidized powder area 48a and the packed powder 47a.

As shown in FIG. 5 the hopper 52 is provided with a vent means or vent pipe 84 for conducting air which

passes up through the packed powder 47a to a powder spray booth, in the same manner as for the first embodiment of FIGS. 1 through 4.

It will be understood that the embodiment of FIGS. 5 through 7 functions in the same manner as the first described embodiment of FIGS. 1 through 4.

While it will be apparent that the preferred embodiments of the invention herein disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change.

What is claimed is:

1. A powder hopper for electrostatic powder spraying apparatus comprising:

a. a hopper body having an upper cylindrical chamber and a communicating lower conical chamber;

b. a fluidizing air chamber operatively mounted in the lower end of said hopper body and having an open upper end communicating with the lower end of said conical chamber;

c. means for conveying pressurized air into said fluidizing air chamber for flow into the lower conical chamber to agitate and fluidize the powder in the lower end of the conical chamber;

d. a diffuser membrane operatively mounted over the open upper end of said fluidizing air chamber for evenly distributing the pressurized air flowing from said fluidizing air chamber into said conical chamber;

e. pump means comprising a plurality of annularly disposed venturi powder pumps operatively mounted in said conical chamber in a position spaced above and adjacent to said diffuser membrane;

f. said venturi powder pump means having an intake means for admitting fluidized powder from said conical chamber;

g. means operatively connected to one end of said venturi powder pump means for supplying pressurized air to said venturi powder pump means to draw fluidized powder through said intake means into the venturi pump means; and,

h. means operatively connected to the other end of said venturi powder pump means for conveying the pressurized air and fluidized powder from the venturi powder pump means to an electrostatic powder spraying apparatus.

2. A powder hopper for electrostatic powder spraying apparatus as defined in claim 1, wherein:

a. said hopper body is provided with vent means.

3. A powder hopper for electrostatic powder spraying apparatus as defined in claim 1, wherein:

a. the pressurized air supplied to the venturi powder pump means is at a pressure higher than the pressurized air supplied to the fluidizing air chamber.

4. A powder hopper for electrostatic powder spraying apparatus as defined in claim 1, wherein:

a. said means for supplying pressurized air to said venturi powder pump means includes a check valve means.

5. A powder hopper for electrostatic powder spraying apparatus as defined in claim 1, wherein:

said means for supplying pressurized air to each of the venturi powder pump means includes a conduit extended through said fluidizing air chamber and into said conical chamber and through said diffuser membrane.

6. A powder hopper for electrostatic powder spraying apparatus as defined in claim 1, wherein:

said diffuser membrane is arranged to provide an annular outlet through the membrane into the conical chamber, for passage therethrough of fluidizing air into the conical chamber.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,826,540 Dated July 30, 1974

Inventor(s) Frederick K. Jensen

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

Col. 5, line 58, "50" should be -- 59.

Col 7, line 1 of element (d) "membrane" should be -- membrane.

Signed and sealed this 8th day of October 1974.

(SEAL)

Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents