

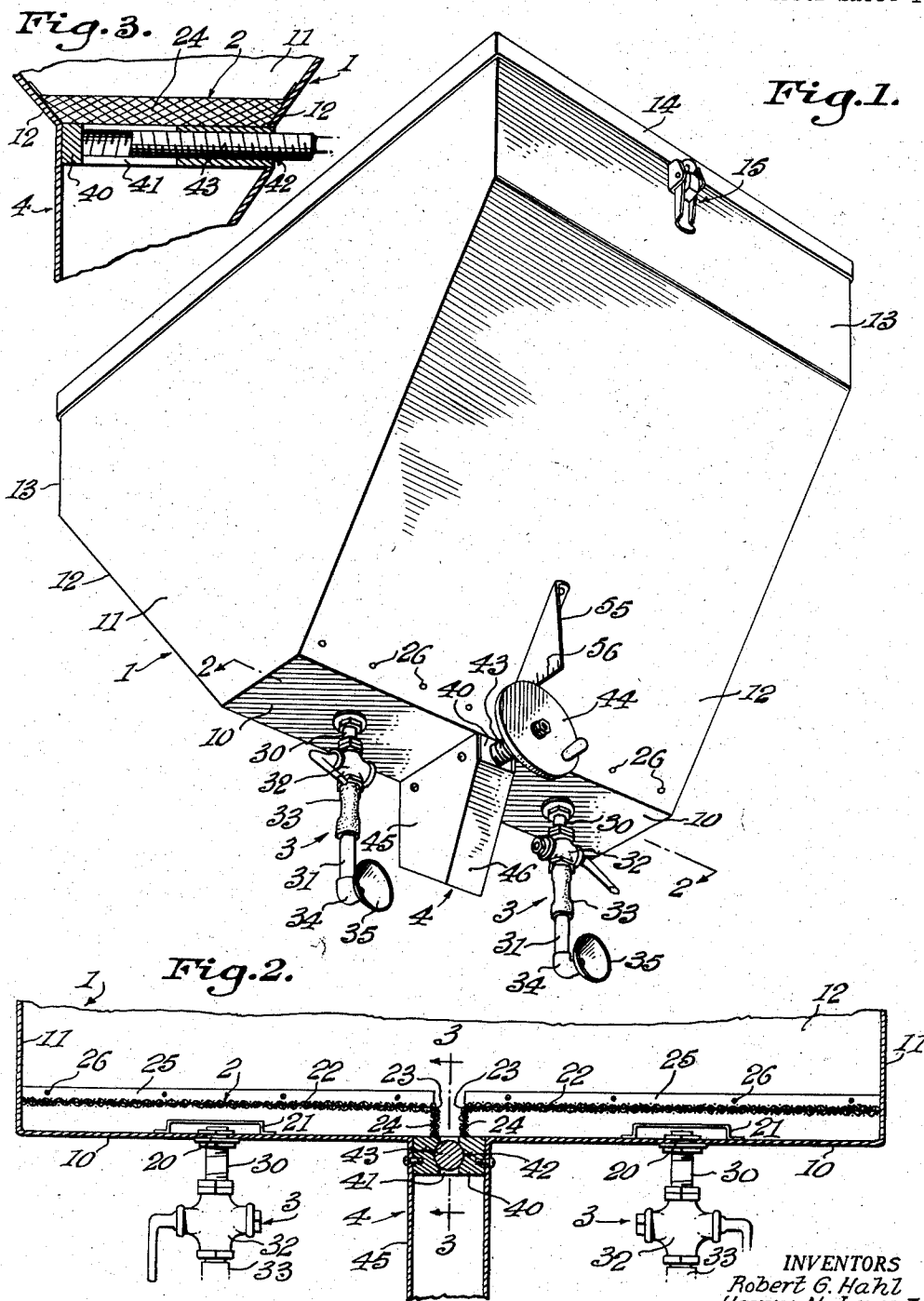
April 21, 1959

R. G. HAHL ET AL
FLUIDIZED SOLIDS DIFFUSER

2,883,240

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3 Sheets-Sheet 1



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3 Sheets-Sheet 2

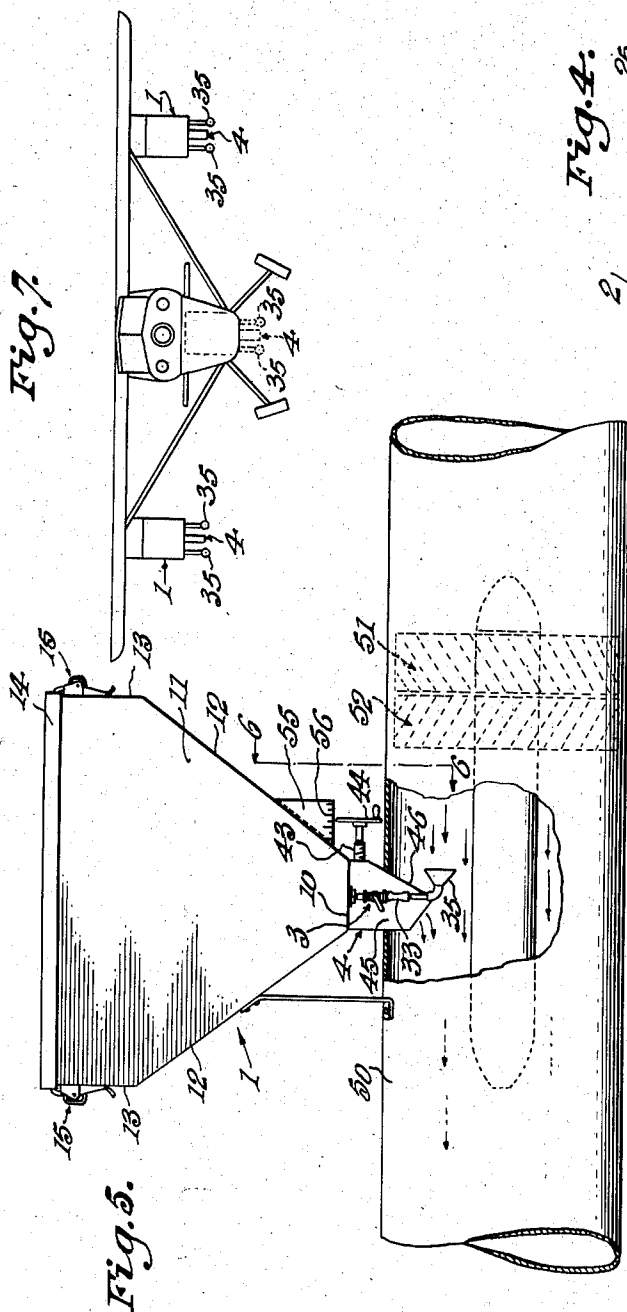


Fig. 5.

Fig. 7.

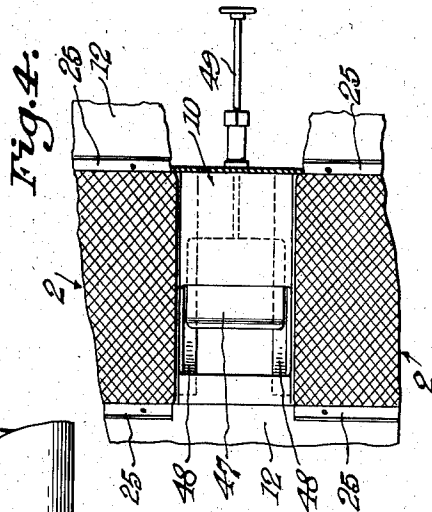
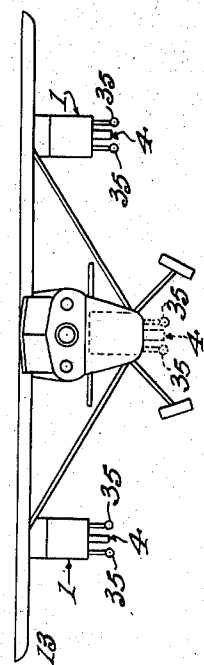


Fig. 4.

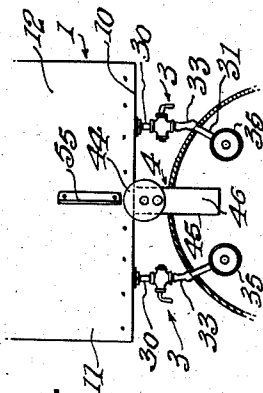


Fig. 6.

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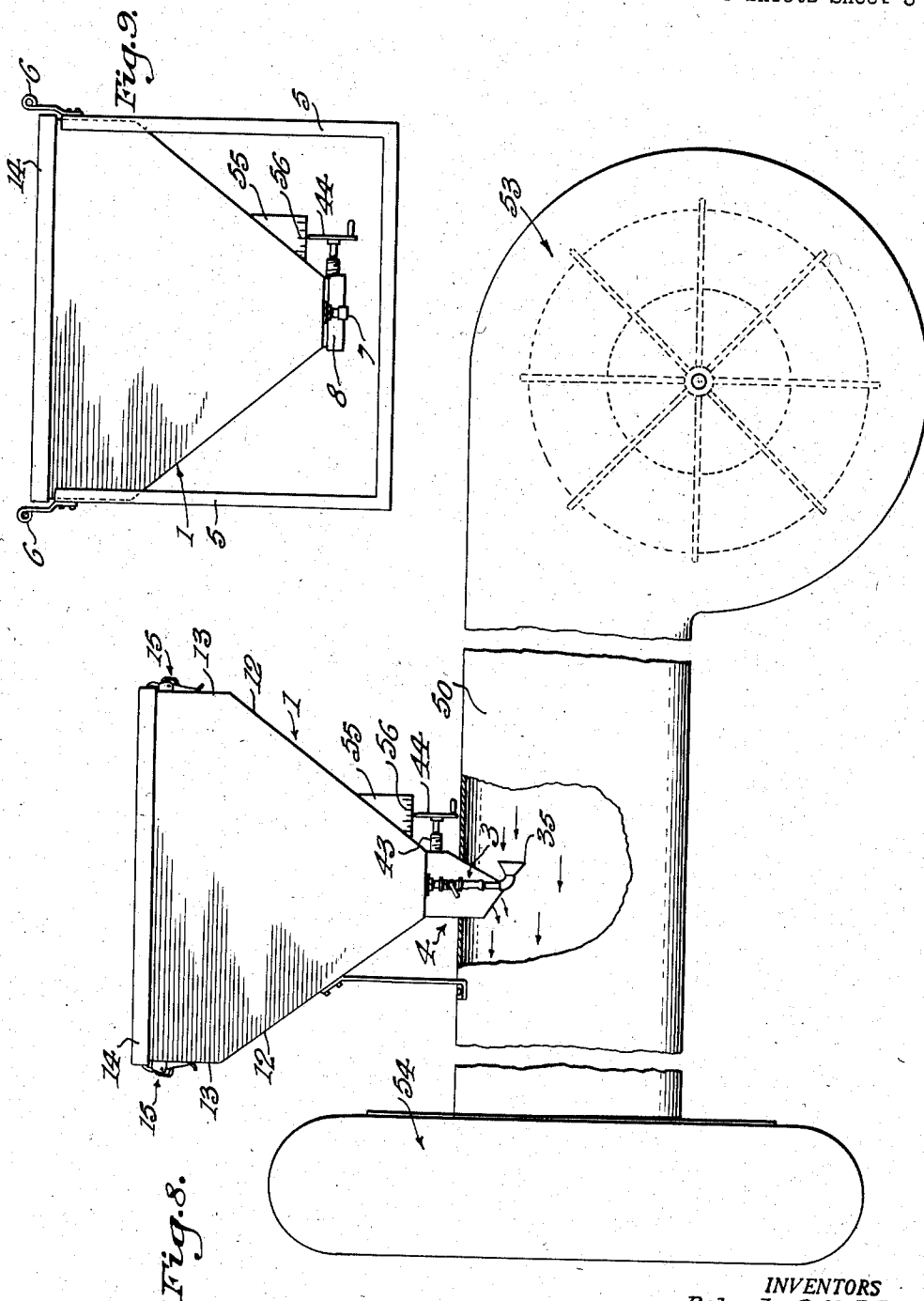
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3 Sheets-Sheet 3



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FLUIDIZED SOLIDS DIFFUSER

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10 Claims. (Cl. 302—29)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

The present invention relates to improvements in diffusers for comminuted solids, either granular or pulverant, and particularly to improvements in the means for fluidizing solids and introducing the fluidized comminuted solids into an ambulant fluid medium of diffusion or dispersion.

Diffusers of the types that have been used previously for the fluid diffusion or conveyance of sand, fertilizer, insecticide, concrete, fuel, and chemical fire extinguishers and for ash ejection or car unloading have required mechanical feeder means, extensive auxiliary fluid ducting or high pressure systems. Mechanical feeder means have included chain and buckets, agitators, roller valves or dispensers, worms, screws, propellers and numerous gears, pulleys, or other mechanical means to drive those elements. Pneumatic diffusers previously used have included pluralities of by-pass routes, jets and agitators, and multiple stages of fluidification or high pressures. Systems utilizing mechanical feeder means and systems having extensive ducting or areas of changing pressures have a common fault in that accumulations of the comminuted solid from clinging, caking, and clogging cause reduced flow.

The present invention is primarily directed to the simplification of the means for fluidization and feeding of a comminuted solid into an ambulant fluid through utilization of the kinetic energy of the fluid and through use of the relationship between pressure and velocity in the fluid flow at the location of the feeding to accomplish both fluidization and feeding; the simplified means including a minimum of mechanical elements, none of which are moving elements. The invention is similarly directed to the provision of a comminuted solids diffuser adaptable to the exhaust side of a fluid pump without the use of negative pressures or "suction" by attachment to the intake side of a pump so as to reduce to a minimum those structures which may impede material flow or which may collect or precipitate the comminuted solid from fluid suspension. The invention is also directed to those other novel combinations, improvements or forms of diffusers, dispersers and material handling devices for comminuted solids particularly adapted to or growing from the simplified fluidization and feeding means of the present invention.

Other objects and advantages of the invention will be apparent as the description proceeds and the features of novelty will be pointed out in particularity in the appended claims.

In the accompanying drawings, illustrating a preferred embodiment of the improvements comprising the invention:

Fig. 1 is a perspective view of a fluidizer and feeder for a diffuser for comminuted solids embodying the preferred features of the invention removed from an ambulant fluid system;

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Fig. 2 is a fragmentary vertical section of the diffuser taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary vertical section of the diffuser taken on the line 3—3 of Fig. 2 showing the screw metering valve in detail;

Fig. 4 is a plan view of an alternative metering valve;

Fig. 5 is a side elevation, partly in section, of a diffuser combining the feeder illustrated in Fig. 1 with a means for producing and utilizing an ambulant fluid supply;

Fig. 6 is a vertical section taken on the line 6—6 of Fig. 5;

Fig. 7 illustrates the feeder of Fig. 1 applied to a different means for producing an ambulant fluid supply;

Fig. 8 is a broken side elevation, partly in section, showing the feeder of Fig. 1 applied to two different means for producing an ambulant fluid supply; and

Fig. 9 is a side elevation of the fluidizer and feeder of Fig. 1 adapted to serve as a material transporter for the comminuted solids to be diffused.

Referring more particularly to Figs. 1 and 2 of the drawings, the diffuser illustrated is generally comprised of a hopper shaped container or fluidizer and feeder 1, having bottom 10, opposite vertical sides 11, opposite sloping sides 12 with upper vertical portions 13, removable top 14, aerators 2, fluid collectors or scoops 3, and metering-discharge nozzle 4. Sides 12 are sloped, being at least 50° from the horizontal, to create a bottom 10 of area much less than an area of cross section taken higher and to present a minimum interior angle with the bottom for a purpose to be explained later. Top 14 is provided with a gasket and latches 15 to effect a pressure sealed closure which permits maintenance of pressure differentials as will be explained and which prevents dispersion or leakage of materials from the reservoir.

Metering-discharge nozzle 4 located centrally of the bottom of container 1 is provided for the introduction of fluidized material into the passing fluid stream by Pitot-tube action. The nozzle 4 includes an elongated metering-block 40 extending transversely at the midpoint of the container and forming that part of the floor or bottom 10 of the container between the aerators. As illustrated in Figs. 2 and 3, block 40 is provided with an elongated longitudinal slot 41 extending from near one end to about the middle of the block and is also provided with longitudinal threaded bore 42 through the end remote from slot 41. Bore 42 extends to communicate with slot 41 which is also threaded in prolongation of the bore. Screw 43, provided with control wheel 44, is threaded into bore 42 causing the slot 41 to constitute an adjustable metering valve. A plate 55 having an index 56 thereon is mounted on the hopper 1 adjacent the control wheel 44 to indicate the degree of opening of the slot 41. The discharge nozzle 4 also includes a spout portion 45 surrounding block 40 and depending from bottom 10 of the container; the spout portion being comprised of open ended ducting of three vertical walls and wall 46 on the upstream side of the container inclined inwardly from the lower edge of block 40 so as to constrict the throat of the spout. Because inclined wall 46 is longer than its opposite wall and the remaining two parallel side walls end in diagonal edges, spout 45 terminates in a discharge port opening to the downstream side of the spout. The slope and length of inclined wall 46 are so arranged as to terminate wall 46 approximately directly below the upstream edge of slot 41 so that material may drop from slot 41 through the spout without touching the spout. The difference in length between wall 46 and its opposite wall is sufficient to cause fluid passing around the nozzle to create a space of lowered pressure in the wake of the nozzle and thereby create a

Pitot-tube action when the spout is introduced into an ambulant fluid.

As illustrated in Fig. 4, the feeding apparatus is not dependent on the screw metering valve illustrated in Fig. 3 but may be fitted with a slide valve. In the valve of Fig. 4, slide 47 runs in self-purging grooves between bottom 10 and rails 48 and is operated by plunger 49. It has been discovered by tests operated by the inventors that the relative value of the valves of Fig. 3 and Fig. 4 varies with the materials used and that the screw valve is better with arid materials and that the slide valve is better with materials that have a propensity to crystallize or gather moisture from the atmosphere.

Container 1, constituting the reservoir for the comminuted solids to be dispersed, is also provided with aerators 2 substantially covering the bottom area on either side of the exit aperture into nozzle 4. The aerators for the fluidization of the comminuted solids by the action of low pressure diffused fluid depend for operation on fluid diffusing panels 22 which may be of any porous material that will pass the fluid but will not pass the comminuted solid. In the preferred embodiment, panels 22 are of woven natural, glass or plastic fibers overlying or sandwiched between a layer or layers of supporting wire mesh. Commercially available fluid diffusing panels of the nature forming the subject matter of U.S. Patent 2,665,035 to Schemm may be used. As illustrated in Fig. 2, panels 22 are generally parallel to but spaced from bottom 10 of the container so as to create a space around baffle 21 to aid in diffusion and pressure equalization of the fluid. The panels 22 cover the entire bottom 10 except for the immediate area of slot 41 previously described. At slot 41 the panels are bent to form shoulders 23 and opposite inwardly facing portions 24 of the panels. Portions 24 assure a flow of fluid to and through such comminuted solids as may be in the space immediately above slot 41 to prevent clogging of the discharge passage. Filters 22 are removably secured in place by flanges 25 and self-taping screws 26.

Fluid is passed to and through the aerator by the action of fluid collectors 3 acting on the principle of a Pitot-tube. Each collector 3 consists of lengths of pipe 30 and 31 connected to interjacent valve 32 and pliable conduit or tubing 33 with the free end of pipe 30 secured into port 20 in bottom 10 of the container. Pipe 31 extending substantially normal to the bottom of the container, as adjusted by distortion of the pliable tubing 33, is provided with an elbow 34 and a truncated cone fluid scoop 35. In normal operation, fluid collector 3 with scoop 35 facing into the passing ambulant fluid converts a portion of the velocity pressure to static pressure and conveys fluid flow through port 20 in the container, around baffle plate 21, through the fluid diffusing panel and into the supply of comminuted solids.

Collectors 3 and nozzle 4 creating opposite pressure areas because of their 180° difference in orientation constitute a pressure differential mechanism for moving the fluidized solid by both pressure and suction. Insertion of the diffuser into a fluid flow, either gaseous or liquid, produces both of the foregoing Pitot-tube actions and results in an internal flow from aerators to discharge nozzle. Diffused fluid, passing from aerators to nozzle, passes through the solids supply causing a fluffing or boiling and a subsequent entrainment of the comminuted solids on the fluid stream resulting in the desired fluidization. In the instant apparatus, the convergence of the sides of the container toward the bottom, but with retention of exterior angles of at least 50° between the sides and the horizontal, ensures that gravitational flow of the solids will be unimpaired by mechanical obstructions, clinging or caking, and that the aerators covering substantially the entire bottom of the container will remain covered so long as any of the unfluidized comminuted solid remains. This uniform coverage of the aerators

prevents the fluid from bypassing the solid as happens in systems having high or inclined aerators. Control of the rates of fluidification and flow can be effected by adjustment of valves 32 in the fluid collectors and the metering valve.

The apparatus described can be operated in combination with any of a number of systems of ambulant fluids, but is particularly adaptable to the systems illustrated in Figs. 5, 6, 7 and 8. In the system of Figs. 5 and 6 the fluidized solid is fed to a high velocity ambulant fluid on the discharge side of a generator. In this preferred embodiment, the velocity of the ambulatory fluid through ducting or conduit 50 is created by axial flow fan 51, a high performance fan of minimum diameter. Stationary cylindrical vane 52 is exemplary of means that can be employed to decrease torque or turbulence in the fluid flow without obstructing flow of the fluidized solids.

Figs. 7 and 8 are illustrative of other systems of ambulant fluids to which the present invention is peculiarly adapted by reason of its dependence solely on fluid velocity for its power and operation. Fig. 7 shows the fluidizer and feeder combined with an aircraft to form a diffuser in a gaseous medium in which the generator and the feeder move relative to the fluid supply as typical of use in dusting operations. Because the atmosphere through which the apparatus passes is the ambulant fluid supply, and because of the weight limitations inherent in airborne operations, the efficacy of the simplicity of the instant invention is made apparent and emphasized by this embodiment. The absence of the weight of mechanical feeding means, controls and power supplies in the instant diffuser permits attachment of the diffuser in different ways as illustrated in Fig. 7. Remote control of the metering valve may be through the use of a simple flexible cable. The feeder may be suspended from an exterior surface as a wing or mounted in the fuselage with only the pressure differential means protruding into the fluid.

Fig. 8, illustrating in the central section the same container 1 and conduit 50 combination of Fig. 4, shows that the discharge of a centrifugal fan or blower 53 may be used to produce a high velocity fluid and also illustrates that a centrifugal pump 54 may be used to create the ambulant fluid by "suction" if the nature of the solid is such that it will not build up on moving parts of pump 54 or otherwise interfere with its operation.

In Fig. 9, the same container 1 of Fig. 1 is provided with supporting frame 5 and lifthooks 6 to serve as a material transporter as well as a feeder for a diffuser. In this application, the extremities of collectors 3 and nozzle 4 may be removed and capped as indicated at 7 and 8 to facilitate transportation without damage. Use of the container as a material transporter permits the comminuted solids to be moved, stored, and fed to a diffusing medium without rehandling. Fig. 9 is also illustrative of the fact that the same apparatus may be utilized primarily as a transporter for comminuted solids and unloaded by a fluid system comparable to those illustrated for diffusing.

It is to be understood that the form of the invention herein shown and described is a preferred example of the same and that various changes in size, shape and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the appended claims.

Having thus described our invention, what we claim as new and wish to secure by Letters Patent is:

1. Apparatus for fluidization and diffusion of comminuted solids comprising a closed reservoir for comminuted solids, means in the reservoir for fluidizing comminuted solids, means for creating and directing a stream of fluid past the reservoir, relatively oppositely facing duct means extending generally parallel from the reservoir into a fluid stream created by said means for creating and directing a stream of fluid, one said oppositely facing duct means being an open ended Pitot tube oriented to receive

the force of fluid flowing in the stream and to convey that force and flow into said means for fluidizing, another said oppositely facing duct means being an open ended discharge nozzle oriented to discharge fluidized solids from the reservoir in a direction approximately 180° from the direction of facing of said Pitot tube whereby actuation of the means for creating and directing a stream of fluid will cause the Pitot tube to convey fluid to the reservoir to fluidize any solids therein and convey those solids through the discharge nozzle into the stream of fluid.

2. Apparatus for fluidization and diffusion of comminuted solids comprising a reservoir with sides converging downwardly from a removable pressure tight top to a bottom of reduced area, means for creating and directing flow of fluid past the bottom of said reservoir, porous aerator means within the reservoir proximate and parallel to the bottom, Pitot-tube means connected to said reservoir and communicating with said fluid flow for directing a portion of the fluid flow into the reservoir to the space between the bottom thereof and the porous aerator, Pitot-tube nozzle means extending into the fluid flow from the bottom of the reservoir for delivery of fluidized solids downstream into the fluid flow whereby flow of fluid past the reservoir will cause aeration, fluidization and discharge into the flow of fluid of any comminuted solid within the reservoir.

3. A comminuted solids diffuser comprising a reservoir having a removable pressure tight top and sides converging downwardly to a flat bottom of reduced area, a conduit for a high velocity fluid stream proximate but spaced from the bottom of the reservoir, a fluid pump communicating with the conduit for forcing a fluid stream through the conduit, said bottom having a port and a discharge nozzle surrounding the port and depending from said bottom into said conduit forming a discharge passage from the interior of the reservoir to the conduit, said nozzle having an upstream side wall with respect to the conduit and fluid pump inclined with the stream flow, having a downstream side wall substantially normal to the axis of the conduit and terminating closer to said bottom so as to form a downstream facing discharge port, an aerator located in the interior of the reservoir and isolating a space thereof, said aerator being proximate and parallel to but spaced slightly from the bottom of the reservoir, said aerator being porous to the fluid to be used but impervious to the comminuted solids to be diffused, a tube secured in the bottom of the reservoir in communication with the space isolated by the aerator, extending into said conduit, and having a terminal portion in communication with the interior of the conduit facing upstream, whereby a fluid stream, caused by activation of the fluid pump, passing the nozzle and tube will cause material within the reservoir to be aerated, fluidized and drawn through the discharge nozzle into the fluid stream by the Pitot-tube actions of the tube and the nozzle.

4. The combination of claim 3 having a metering valve interposed in the said discharge passage between the reservoir and the conduit.

5. The combination of claim 4 having a metering valve imposed in said tube.

6. Apparatus for fluidization and diffusion of comminuted solids comprising a pressure isolated reservoir for comminuted solids, means for creating and directing a stream of fluid past the reservoir, and velocity-actuated pressure differential means communicating between the fluid stream and the interior of the reservoir for aerating, fluidizing and injecting into the fluid stream any comminuted solids located in the reservoir, said velocity-actuated pressure differential means including a fluid flow actuated porous aerator within the reservoir proximate and parallel to the reservoir wall nearest the fluid stream, a Pitot-tube extending from between the aerator and said reservoir wall into the fluid stream and having the open-

ing thereof directed upstream, and a discharge nozzle communicating between the interior of the reservoir and the fluid stream and having a discharge port facing substantially downstream to direct fluid velocity from the stream to the aerator through the Pitot-tube for fluidization of material in the reservoir and creating pressure in the interior of the reservoir, whereby fluidized material is drawn from the reservoir into the fluid stream through the nozzle by low pressure created at the discharge port and in the nozzle by the Pitot tube effect of the downstream orientation of the nozzle.

7. In an apparatus for fluidization and diffusion of comminuted solids into a moving fluid having a reservoir adapted for use in conjunction with a moving fluid medium and comminuted solids fluidizing means within the reservoir, the improvements comprising a fluid pick-up tube and a discharge nozzle attached to, communicating with the interior of and extending from the reservoir for insertion into a stream of moving fluid wherein said pick-up tube is an open-ended Pitot tube having its exterior open end facing in a direction substantially normal to the direction of its extent from the reservoir and having its interior end communicating with the fluidizing means within the reservoir and wherein said discharge nozzle is an open-ended duct having its exterior open end facing approximately 180° from the direction of facing of the exterior open end of said Pitot tube whereby insertion of the exterior ends of the pick-up tube and the discharge nozzle into a stream of moving fluid with the open exterior end of the pick-up tube facing upstream will cause fluid to flow to the aerator, fluidization of any comminuted solids in the reservoir, an increase of pressure in the reservoir and a low pressure area at the open exterior end of the discharge nozzle and flow of fluid with entrained comminuted solids from the reservoir through the nozzle and into the stream of moving fluid.

8. A comminuted solids fluidizer and feeder for a comminuted solids diffuser comprising a reservoir having a removable pressure tight top and sides converging downwardly to a flat bottom of reduced area, said bottom having a port and a discharge nozzle surrounding the port and depending from the said bottom forming a discharge passage from the interior of the reservoir, said nozzle having an upstream side wall inclined downwardly away from the upstream side, having a downstream side wall substantially normal to the bottom and terminating closer to said bottom so as to form a downstream facing discharge port, an aerator located in the interior of the reservoir and isolating a space thereof, said aerator being proximate and parallel to but spaced slightly from the bottom of the reservoir, said aerator being porous to the fluid to be used but impervious to the comminuted solids to be diffused, a tube secured in the bottom of the reservoir in communication with the space isolated by the aerator, depending from said bottom, and having a terminal portion in communication with the exterior of the reservoir directed parallel to the bottom and toward said upstream side wall whereby a fluid stream passing the nozzle and tube will cause material within the reservoir to be aerated, fluidized and drawn through the discharge nozzle into the fluid stream by the Pitot-tube actions of the tube and the nozzle.

9. In an apparatus for fluidization and feeding of comminuted solids into a stream of ambulant fluid having a closed reservoir, means for filling the reservoir, means for fluidization of comminuted solids placed in the reservoir, discharge port means, and means for causing a stream of ambulant fluid, the improvements comprising a Pitot tube attached to and protruding from the reservoir so as to extend into a stream of ambulant fluid produced by the means for causing a stream of ambulant fluid, said Pitot tube having its interior end in communication with the aerator within the reservoir and its exterior end open and directed upstream with respect to the stream of fluid

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so as to divert fluid flow to the aerator and a discharge nozzle attached to and protruding from the discharge port means of the reservoir so as to extend into the stream of ambulant fluid, said discharge nozzle having its exterior end open to form a discharge port which is directed downstream with respect to the stream of fluid, said nozzle having a configuration to cause the stream of fluid to create a low pressure in and downstream of said discharge port whereby placing of the filled reservoir with the Pitot tube and discharge nozzle in a stream of fluid will cause diversion of a part of the fluid into the reservoir through the aerator to cause fluidization of the solids and out through the discharge nozzle to carry the solids into the fluid stream.

10. Fluidizing and feeding apparatus for feeding fluidized comminuted solids into a flowing fluid comprising a pressure-actuated reservoir for comminuted solids and a fluid velocity-actuated pressure differential and fluid conducting means communicating between the interior of the reservoir and the flowing fluid for aerating, fluidizing and dispensing comminuted solids located in the reservoir, said fluid velocity-actuated pressure differential and fluid conducting means including a porous aerator within the reservoir proximate and parallel to a reservoir wall, a Pitot tube extending from between the aerator and said

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reservoir wall to the exterior of the reservoir and having an exterior open end portion with axis of opening directed parallel to said wall, and a discharge nozzle communicating between the interior and the exterior of the reservoir and having a discharge port directed 180° from said open end portion of the Pitot, said Pitot tube, porous aerator reservoir and discharge nozzle directing the fluid flow from said exterior open end of the Pitot tube to said discharge port of the discharge nozzle through the path defined by said Pitot tube, aerator, reservoir and discharge nozzle to conduct a portion of any fluid flow impinging on said exterior open end of the Pitot tube through said reservoir and said fluid velocity actuated pressure differential means whereby comminuted solids present in the reservoir will be fluidized and expelled through the discharge port by said fluid flow.

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