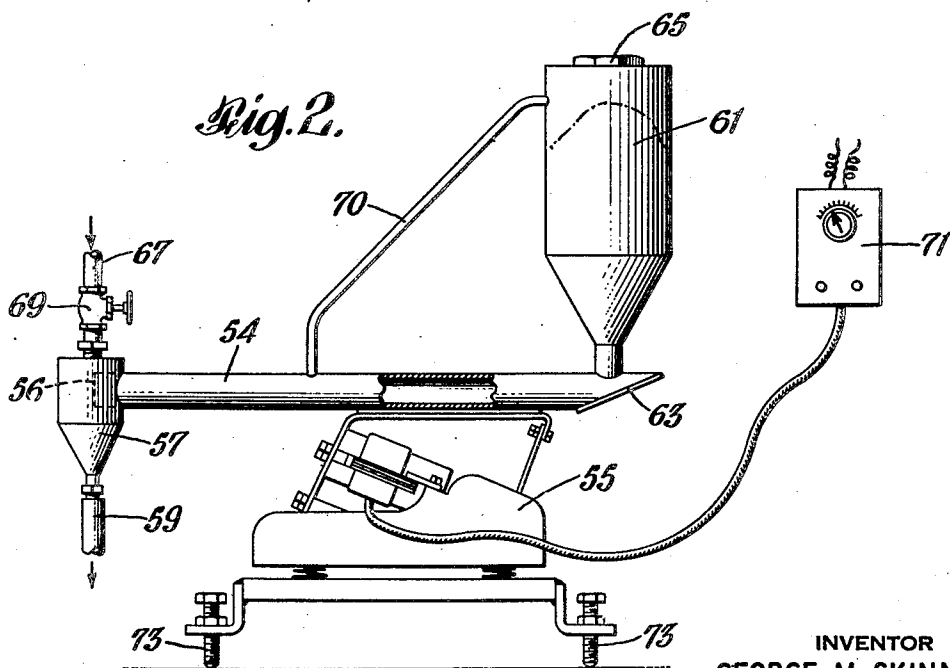
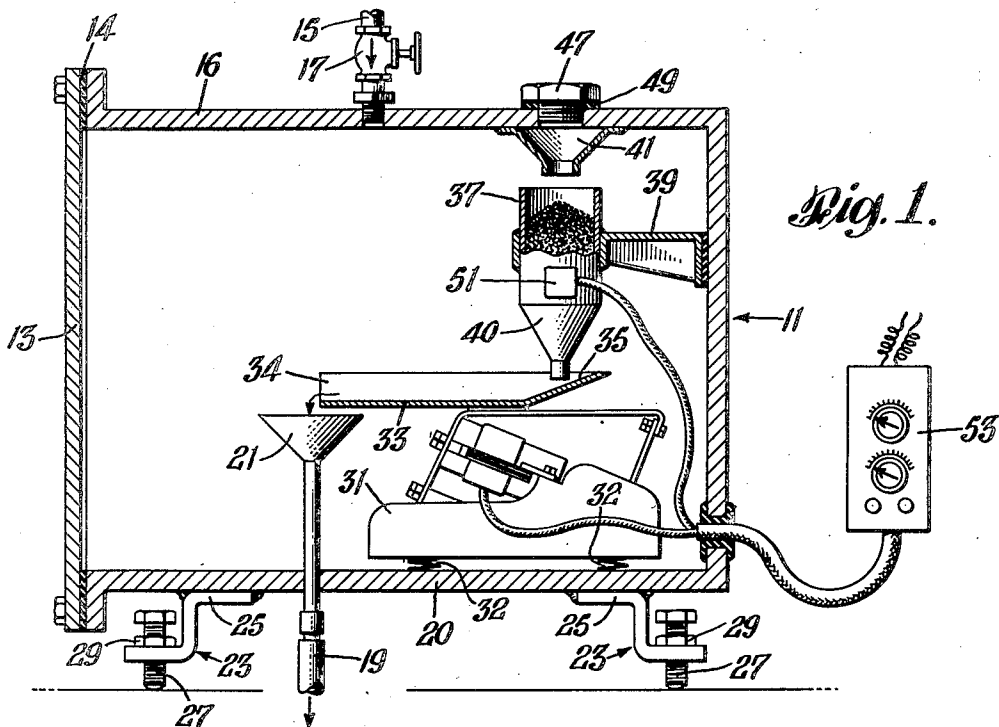


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POWDER DISPENSING

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POWDER DISPENSING

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This invention relates to a method of and apparatus for dispensing powdered material with a flowing stream of gas.

Among the objects of the invention are the provision of a novel method of and apparatus for dispensing powdered material with a stream of gas whereby the rate of powder dispensing is independent of the rate of gas flow; whereby powdered materials can be dispensed at a substantially constant and reproducible rate; whereby powdered materials can be successfully dispensed over a wide range of powder flow rates varying from a very small rate to a very large rate; and whereby powdered materials of different types and particle sizes can be successfully dispensed. Other objects are the provision of novel powder dispensing apparatus whereby the rate of powder dispensing can be adjusted sensitively; and the provision of such apparatus which is simple in construction, dependable in operation, and economical to construct and maintain.

The above and other objects, and the novel features of the invention, will become apparent from the following description, having reference to the annexed drawing, wherein:

Fig. 1 is a vertical midsectional view of one type of powder dispenser constructed in accordance with the principles of the invention; and

Fig. 2 is a side elevational view, partly broken away and in section, showing a modified form of powder dispenser.

In accordance with this invention, I feed powder particles continuously into a generally horizontal path, propel the powder particles in a stream along the path by supporting and vibrating the particles, drop the particles from the path under the influence of gravity, and carry away the dropped particles by a stream of gas. This method is advantageously performed automatically by powder dispensing mechanism which includes a powder guiding conduit having an outlet, a powder feeding device arranged to feed powder to the guiding conduit at a point remote from its outlet, and a vibrator operatively associated with the guiding conduit for so vibrating the conduit that powder flows to the outlet. A powder delivery conduit has an entrance so positioned as to receive the powder leaving the outlet of the powder guiding conduit, and suitable means is provided for also introducing a flowing stream of gas into the delivery conduit to carry the powder away. The rate of powder dispensing can be controlled independently of the gas flow, as by varying such factors as the inclination of the powder guiding conduit, the orientation of the vibration axis with respect to the longitudinal axis of the powder guiding conduit, and the intensity and/or rate with which the powder guiding conduit is vibrated. Control of the intensity of vibration can be accomplished by controlling the amplitude; control of the rate of vibration by controlling the frequency.

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In one type of powder dispenser embodying the principles of the invention, shown in Fig. 1, a gas-tight housing 11 having an opening at one side closed by a cover plate 13 bearing against a gasket 14 is supplied with a flowing stream of gas by a gas supply conduit 15 coupled to the top wall 16 of the housing in any suitable manner and controlled by a valve 17. An upright powder delivery conduit 19 extending from the inside to the outside of the housing 11 through the bottom wall 20 has a flaring funnel-like entrance 21 within the housing for receiving powder and gas. The housing 11 is supported on a suitable level surface, such as a floor or a table, by a plurality of vertically adjustable legs 23, desirably four arranged at the corners of a rectangle, so arranged that the housing can be tilted in any desired direction by properly adjusting the legs. Each of the legs 23 comprises a bracket 25 secured to the housing 11, and a vertical bolt 27 threaded into the bracket and carrying a lock nut 29.

An electromagnetic vibrator 31 rests on springs 32 on the floor of the housing 11 and supports in a generally horizontal position an open powder guiding conduit or trough 33. The trough 33 has an open end 34 forming an outlet for powder positioned above the funnel-like entrance 21, and is closed at the end remote from the outlet by a wall 35 which slopes downwardly toward the outlet.

An open-topped powder feeding hopper 37 is mounted within the housing 11 by a bracket 39 and has a funnel-like lower portion 40 arranged above the sloping wall 35 for feeding powder to the powder guiding conduit 33. For quickly and easily replenishing the supply of powder in the hopper 37, a funnel 41 is secured to the top wall 16 of the housing above the open top of the hopper 37 and in line with an opening in the top wall which is closed by a threaded removable and replaceable plug 47 bearing against a gasket 49.

To assist in feeding powder from the hopper 37 into the trough 33 a second vibrator 51 is mounted on the side of the hopper. However, operation of the second vibrator is usually unnecessary because the powdered material generally feeds in a satisfactory manner solely under the influence of gravity. By proper selection of particle size and moisture content, gravity flow of most powders can be assured.

In the operation of the powder dispenser shown in Fig. 1, the vibrator 31 vibrates the trough 33 rapidly with a differential motion and causes the powder which feeds from the hopper 37 to travel down the incline 35 and along the trough to the outlet 34 from which it drops into the funnel-like entrance 21 of the delivery conduit 19. The slip angle of any particular powder will determine the equilibrium position of the material in the entrance end of the trough. In general, the powder surface is nearly parallel

to the incline 35 down to the point at which the powder surface becomes parallel to the bottom of the trough. Meanwhile gas from the gas supplying conduit 15 flows under pressure into the housing 11, and into the conduit 19 through the entrance 21, picking up the powdered material and carrying it away through the delivery conduit. The rate of gas flow can be varied by adjusting the valve 17. The rate of powder dispensing can be varied by varying the vibration of the trough 33 as by an amplitude controller 53 outside of the housing, or by changing the inclination of the trough 33 in a vertical plane with respect to the horizontal by tilting the housing 11 in the manner previously described, or by changing the vibration axis orientation. Ordinarily, the dispenser is operated with the trough 33 inclined slightly upwardly toward its outlet 34 and with the axis of vibration at about 45° to the longitudinal axis of the trough, but the rate of powder dispensing can be decreased by increasing the angle of inclination, and can be increased by decreasing the angle of inclination so that the trough approaches the horizontal or even is inclined downwardly toward the outlet. The limiting upward inclination of the trough 33 is dependent on several variables such as powder characteristics, trough shape and surface finish, and nature of vibration. Under one definite set of conditions an upward angle of about 25° was the maximum for powder movement. When the second vibrator 51 on the hopper is used, its vibration can be controlled independently by the vibration controller 53.

The vibrator 31, shown by way of illustration only, is an alternating current vibrator controlled by a rheostat controller, such as is shown in U. S. Patent 2,187,717 granted January 23, 1940 to C. S. Weyandt. Other types of vibrators, of course, can be used successfully for operating my novel powder dispenser. For example, the trough 33 can be vibrated hydraulically, pneumatically, or by an unbalanced rotating armature, all in a well-known manner. Vibrator 51 on the hopper 37 can be of any suitable construction, such as an electrically operated magnetic vibrator of the type used in bells and buzzers.

In dispensing one type of powdered material screened to a size of 60 mesh (Tyler) or finer with compressed air, using the powder dispenser of Fig. 1, the flow of powder remained constant within about 15% at three different air flows, as shown in the following table:

Air Flow, cu. ft./hr.	Powder Flow, grams/ minute
100	109-122
150	120-130
200	109-123

This dispenser also has operated successfully with a constant flow of air and a widely variable powder discharge rate from the trough 33 into the delivery conduit 19. For example, using a constant air flow of 150 cu. ft./hr., the powder flow was varied between 1 and 130 grams/minute successfully.

In a modified form of powder dispenser shown in Fig. 2 no housing of the type shown in Fig. 1 is needed. Instead of a powder guiding trough, a tubular powder guiding conduit 54 is mounted on a vibrator 55 in a generally horizontal position. The open outlet end 56 of the tubular con-

duit 54 projects into a funnel-like housing 57 forming the entrance to the delivery conduit 59, and gas-tightly engages the wall to prevent the escape of gas. Compressed gas is supplied to the entrance housing 57 by a gas supply conduit 67 controlled by a valve 69. A closed powder feeding container or hopper 61 is gas-tightly and rigidly mounted on the guiding conduit 54 between the outlet end 56 and an inclined closure 63 remote from the outlet end in position to feed powder on the closure and into the guiding conduit. Powder can be added to the hopper 61 through a powder filling opening into which is threaded a removable and replaceable plug 65. A pressure equalizing conduit 70 extending up from the powder guiding conduit 54 and opening into the hopper 61 at a point above the powder level, insures the proper feeding of powder from the hopper by maintaining the gas pressure in the hopper at least as great as the pressure of the gas entering the entrance housing 57 from supply conduit 67.

In operating the powder dispenser shown in Fig. 2, the rigidly connected powder guiding conduit 54 and hopper 61 are vibrated simultaneously by the single vibrator 55, and the vibration is controlled by a controller 71, as in Fig. 1. The inclination of the guiding conduit 54 is adjusted in a vertical plane with respect to the horizontal by changing the vertical position of legs 73 which are similar to those shown in Fig. 1. As in Fig. 1, the powder guiding conduit can be horizontal or can be tilted up or down with respect to its outlet.

Powder dispensers constructed in accordance with the principles of this invention will operate successfully on many different powdered materials of widely varying particle size, and will dispense powder at constant and reproducible rates over a wide range of powder dispensing rates which are substantially independent of gas flow rates.

Specific embodiments of the invention have been described herein only for illustrating the principles of the invention. It is apparent that changes in the construction and relative arrangement of parts can be made within the scope of the invention as defined in the claims appended hereto.

I claim:

1. A powder dispenser comprising a gas tight housing, a powder guiding conduit in said housing having an outlet; powder feeding means in said housing arranged to feed powder to said powder guiding conduit at a point remote from said outlet; means for vibrating said powder guiding conduit to cause the flow of powder to said outlet; a powder delivery conduit extending from the inside to the outside of said housing and having an entrance so positioned as to receive the powder leaving said outlet; and means for introducing a flowing stream of gas under pressure into said housing and thence into said delivery conduit for carrying such powder through said delivery conduit.

2. A powder dispenser according to claim 1, also comprising means for tilting said housing to vary the inclination of said guiding conduit with respect to the horizontal.

3. A powder dispenser according to claim 1, also comprising means for vibrating said powder feeding means.

4. A powder dispenser according to claim 1, also comprising means for vibrating said powder feeding means, and means separately controlling the

vibration of said powder guiding conduit and said powder feeding means.

5. A powder dispenser comprising a tubular powder guiding conduit having an outlet; a gas-tight powder container gas-tightly connected into said conduit at a point remote from said outlet for feeding powder to said guiding conduit; a powder delivery conduit having an entrance gas-tightly engaging said guiding conduit in position to receive powder from said outlet; a gas supply conduit communicating with said delivery conduit near said entrance for supplying a flowing stream of gas under pressure thereto; and means for vibrating said powder guiding conduit to cause the flow of powder to said outlet.

6. A powder dispenser according to claim 5, also comprising means for maintaining in said container a pressure at least as great as the pressure of the gas entering said delivery conduit.

7. A powder dispenser according to claim 5, also comprising a pressure equalizing conduit opening at one end into said powder container and so arranged at the opposite end as to be exposed to the gas pressure exerted by gas entering said delivery conduit.

8. A powder dispenser according to claim 5, wherein said powder container is rigidly secured to said powder guiding conduit and is vibrated therewith.

9. A powder dispenser according to claim 5, also comprising means for varying the inclination of said powder guiding conduit.

10. A powder dispenser according to claim 5, also comprising means for controlling the vibration of said powder guiding conduit to regulate the rate of powder dispensing.

11. A gas-tight powder dispenser comprising a powder guiding conduit having an outlet; means arranged to feed powder to said powder guiding conduit at a point remote from said outlet; means for vibrating said powder guiding conduit to cause such powder to flow toward said outlet; a powder delivery conduit having a portion positioned so as to receive the powder leaving said outlet; and means for flowing a stream of gas downwardly into such portion of said delivery conduit for carrying such powder therethrough.

12. A gas-tight powder dispenser comprising a powder guiding conduit having an outlet; powder feeding means arranged to feed powder to said powder guiding conduit at a point remote from said outlet; means for vibrating both said powder feeding means and said powder guiding conduit to aid the feed of powder to said guiding conduit and to cause the flow of such powder to said outlet; a powder delivery conduit having a portion positioned so as to receive powder from said outlet; and means for flowing a stream of gas into such portion of said delivery conduit for carrying such powder therethrough.

13. A gas-tight powder dispenser comprising a powder guiding conduit having an outlet; powder feeding means arranged to feed powder to said powder guiding conduit at a point remote from said outlet; means for vibrating said powder guiding conduit to cause the flow of such powder to said outlet; control means for varying the vibration of said guiding means to regulate the rate of powder flow; a powder delivery conduit having a portion positioned so as to receive the powder leaving said outlet; and means for flowing a stream of gas into such portion of said delivery conduit for carrying such powder therethrough.

14. A gas-tight powder dispenser comprising a powder guiding conduit having an outlet; powder

feeding means arranged to feed powder to said powder guiding conduit at a point remote from said outlet; means for vibrating said powder guiding conduit to cause the flow of such powder to said outlet; means for adjusting the inclination of said guiding conduit with respect to the horizontal; a powder delivery conduit having a portion positioned so as to receive the powder leaving said outlet; and means for flowing a stream of gas into such portion of said delivery conduit for carrying such powder therethrough.

15. A gas-tight powder dispenser according to claim 14, wherein said powder guiding conduit at a point remote from said outlet is provided with a wall sloping downwardly toward said outlet, and wherein said powder feeding means is arranged to feed powder upon said wall.

16. A gas-tight powder dispenser comprising, in combination, a powder feeding hopper, an approximately horizontal powder guide having a powder inlet disposed under the powder outlet of said hopper, the powder guiding surface of said guide being imperforate and smooth, a substantially upright powder delivery conduit having a funnel-like portion disposed to receive powder discharged from the outlet of said powder guide, means for causing a stream of gas to flow downwardly through such portion, and a vibrator operatively associated with said powder guide, the whole interior of said dispenser being otherwise gas-tight, and the space above the powder in said hopper being in gas communication with the space above the powder in said powder guide.

17. A gas-tight powder dispenser comprising a powder delivery conduit; a powder guiding conduit arranged at an angle to said powder delivery conduit and having an outlet arranged to discharge powder into the delivery conduit; means for vibrating said guiding conduit to cause powder to flow along said guiding conduit and through its outlet into said delivery conduit; and means for supplying gas under pressure to the gas-tight dispenser whereby to cause a stream of gas to flow through said powder delivery conduit.

18. A powder dispenser comprising a tubular powder guiding conduit having an outlet; a closure for said conduit remote from said outlet; a gas-tight powder container gas-tightly connected into said conduit between said outlet and said closure for feeding powder to said guiding conduit; a powder delivery conduit having an entrance gas-tightly engaging said guiding conduit in position to receive powder from said outlet; a gas supply conduit communicating with said delivery conduit near said entrance for supplying a flowing stream of gas under pressure thereto; and means for vibrating said powder guiding conduit to cause the flow of powder to said outlet.

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