March 8, 1960 W. L. SLATER, JR 2,927,658

REDUCING POWDER BULK

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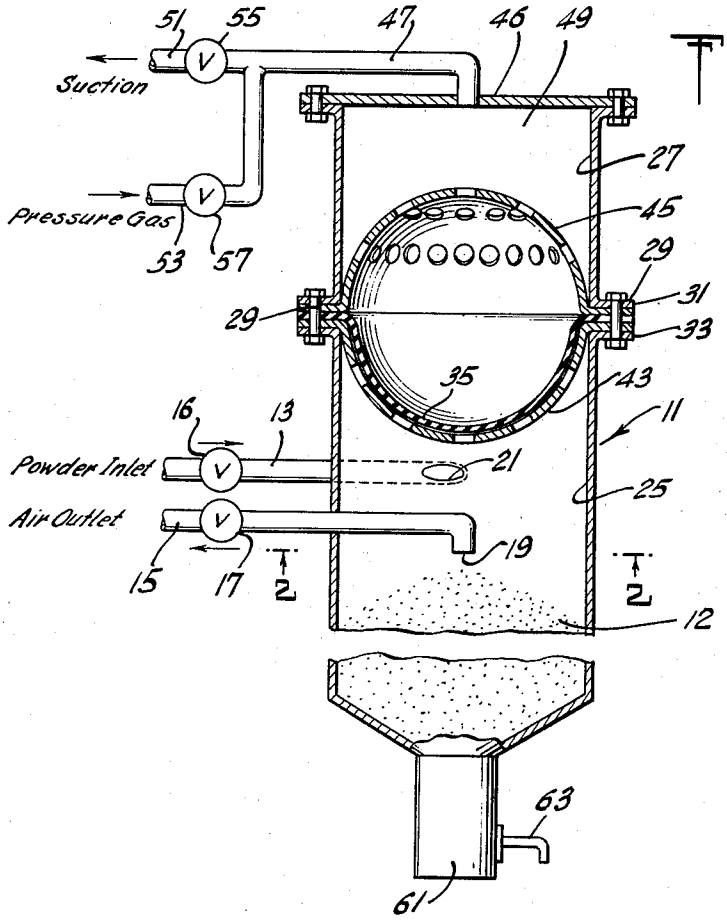


Fig. 1.

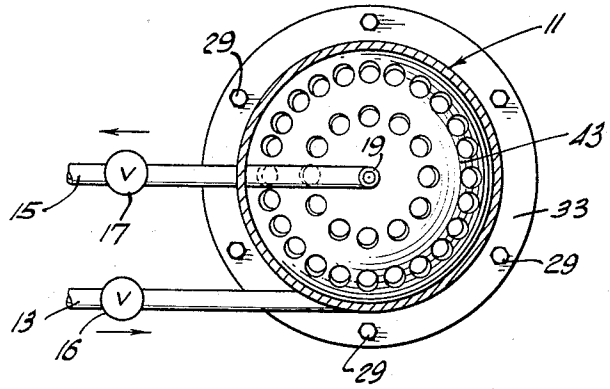


Fig. 2.

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REDUCING POWDER BULK

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9 Claims. (Cl. 183—1)

The present invention relates to a novel method for reducing the bulk of a mass of powder having air or other gas entrained therein. It is also concerned with a novel apparatus for performing the method in a rapid, efficient and economical manner.

When a very fine powder is introduced into a container, such as a silo, it often contains a great deal of entrained air which causes the apparent density of the powder to be much less than its true density. This problem is especially prevalent when the power has been conveyed to the silo in an air stream. For example, fine fluffy ground talc having a fineness such that all passes through a 325 mesh U.S. standard screen, and many particles are as small as 10 microns or less, tends to assume a very large bulk. Powdered talc of such fineness has been found to occupy as much as five times the volume of the same weight of talc in a coarser size. This, of course, presents a difficult problem when a finely powdered material must be loaded from a silo into bags or barrels since it is desirable to load the maximum weight into a container without including a large volume of air.

Powder may be deaired by pulling a vacuum on a silo, but this results in the loss of fine particles out the vacuum line.

In accordance with the present invention the bulk of a mass of powder is greatly reduced by introducing the powder into the bottom of a silo to fill the silo only partially whereby empty space is provided above the level of the powder. Then the volume of the space above the powder is expanded so as to provide a zone of reduced pressure above the powder, with the result that gas flows out of the mass of powder into the space and the powder compacts and settles. While the volume of the space above the powder may be expanded in any desired way, as by mechanically, hydraulically or pneumatically raising a piston or flexing a diaphragm, I prefer the latter and will describe such a device to illustrate the principles of the invention.

In the drawings:

Fig. 1 is a vertical sectional view of a silo having a flexible diaphragm for performing the method of the invention; and Fig. 2 is a cross sectional view taken along the line 2—2 in Fig. 1.

Referring to Fig. 1, a hollow cylindrical vertical container or silo 11 is partially filled with powder 12 blown in through a pipe 13 by compressed air so that the powder laden stream enters the silo tangentially and swirls around to separate the powder from the air. The residual air, free of powder, leaves through an outlet pipe 15 having a downwardly facing entrance 19 located axially within the silo 11 below the exit 21 of powder supply pipe 13 so as to assure substantially complete separation of the powder from the air circulating centrifugally within the silo.

Silo 11 comprises a lower section 25 and an upper section 27 joined together by bolts 29 extending through a pair of annular flanges 31 and 33 which clamp in position

a flexible generally hemispherical concave imperforate diaphragm 35 extending completely across the top of section 25 and down into the space 37 above the mass of powder 12. Diaphragm 35 may be of rubber, vinyl, plastic, or the like.

While not essential to the performance of my novel method, the apparatus is also advantageously provided with a pair of hemispherically curved rigid perforate support partitions or plates 43 and 45 secured between flanges 31 and 33 and arranged below and above the diaphragm 35, respectively. These plates, which may be metal, hardboard or the like, act as supports for the diaphragm so as to prevent its rupture during performance of the method. The top of upper section 27 is closed by a cover 46, and a conduit 47 is attached to the cover and connected into the space 49 within silo 11 above the diaphragm 35, and in turn connects with both a suction pipe 51 leading to any suitable aspirator, and a pressure pipe 53 leading to a source of compressed air or other gas. Pipes 51 and 53 are controlled by valves 55 and 57, respectively.

In operating the silo described above, after the powder has been blown in through conduit 13 and the desired powder level has been reached, valves 16 and 17 are closed, stopping the introduction of powder. Then valve 57 is closed and valve 55 is opened and a suction is applied through conduit 47 to space 49, whereupon the diaphragm 35 is slowly lifted and eventually reversed in curvature. The extent to which diaphragm 35 rises is limited by the upper perforate plate 45. As a result of this action the volume of space 37 is expanded and the gas therein is rarified by reducing its pressure, whereupon air entrained within the mass of powder 12 is extracted and enters into space 37, with resultant compacting and settling of the mass 12.

One flexing of the diaphragm 35 may be all that is required to produce the required powder density. In some cases, however, where a great deal of air is entrained, the diaphragm may require several flexings before enough air has been extracted from the powder. This is accomplished by closing the valve 55 and opening the valve 57, whereupon compressed air enters space 49 through conduit 47 and forces the diaphragm 35 down to its original position adjacent the bottom perforate plate 43. The same result may be obtained simply by having conduit 53 open to the atmosphere whereby atmospheric pressure is restored in space 49. Then valve 57 is again closed, and valve 55 is opened to repeat the flexing of the diaphragm 35 to its top position. It is advantageous to allow several minutes between up and down movements of the diaphragm to cause as much air as possible to leave the powder.

After the powder 39 has been fully compacted to the desired density while retained in the silo, it may be withdrawn from the silo through an outlet 61 controlled by a valve 63, and bagged or otherwise packaged.

Obviously, many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore, only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. Apparatus for reducing the bulk of a mass of powder comprising, in combination, a container for such powder, said container having space therein above said mass; a flexible imperforate diaphragm curving downwardly into said space and operable for expanding the volume of said space and decreasing the pressure therein, whereby gas entrained in said mass of powder is liberated into said space; means for producing a vacuum on the side of said diaphragm remote from said space thereby flexing said diaphragm to a position for reducing the

pressure in said space; and a valve controlled outlet for powder adjacent the bottom of said container.

2. Apparatus in accordance with claim 1, also comprising means for blowing said powder into said container, and means for removing gas from said container during such blowing.

3. Apparatus in accordance with claim 2, also comprising means for arresting the flow of said powder into said container, and means for arresting the flow of gas from said container before said diaphragm is flexed to a position for reducing the pressure in said space.

4. Apparatus in accordance with claim 1 also comprising a perforate partition on the side of said diaphragm remote from said space in position to support said diaphragm for preventing rupture thereof.

5. Apparatus in accordance with claim 1, also comprising means for admitting gas under pressure exceeding that in said space to said diaphragm on the side thereof remote from said space for restoring said diaphragm to its original position.

6. Apparatus in accordance with claim 5, also comprising perforate partitions on both sides of said diaphragm for supporting said diaphragm and preventing rupture during both the evacuating and pressure phases of operation.

7. A method for providing a compact mass of powder of relatively high density which comprises introducing into an enclosed space a mass of such powder having a substantial quantity of gas occluded therein whereby said mass has relatively low density; stopping the introduction of powder into said space; and then extracting gas from said mass of powder by expanding the volume of space unoccupied by said powder and decreasing the pressure therein while said mass of powder is retained in said enclosed space, thereby compacting said mass of powder.

8. A method in accordance with claim 7, also comprising subsequently decreasing the volume of said space to its original size, and then compacting said mass of powder still more by repeating the step of expanding the volume of said space to extract more gas from said powder.

9. A method in accordance with claim 7, wherein said powder is blown into said space by a gas under pressure, said method also comprising separating said powder from said gas within said space, and removing the so separated gas from said space.

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