METHOD OF AND APPARATUS FOR FLUIDIZING PARTICULATE SUBSTANCE

The present invention relates to improvements in a method and apparatus for forming and conveying a fluidized bed of solid particles, wherein a body of gas, for instance dehumdified, cold air, is mixed with a mass of solid particles to impart fluidity to the mass so that it flows like a body of fluid.

Fluidized beds of solid particles have been variously used, for instance to transport such particles, to desiccate particles containing moisture, to impart a desired temperature thereto, i.e., to heat or cool them, to subject them to chemical processing, and the like.

It is a primary object of this invention to provide an improved method and apparatus for fluidizing solid particles, including powders.

It is another object of the invention to provide a continuous processing system wherein solid particles may be supplied at one end, fluidized for uniform processing, and continuously discharged at the other end.

It is still a further object to provide a fluidizing apparatus operating without any mechanical agitating means but capable of forming and conveying a uniform fluidized bed of solid particles for producing a product of uniform quality.

It is yet another object to provide an efficient cooling and drying system for solid particles in a fluidized bed containing only relatively small amounts of resident particles.

The above and other objects and advantages are accomplished in accordance with the present invention by forming a fluidized bed of solid particles on a downwardly tapering conical funnel wall having a circular cross section of downwardly decreasing diameter. The solid particles are supplied to the funnel from above near or at its upper edge, and a body of gas is introduced through a plurality of slits in the funnel wall in such a manner that a vortex of gas circles or whirls along the wall to mix with the solid particles and thereby to produce a fluidized bed thereof and move the particles downwardly along the wall in a thin swirling bed. The gas may be introduced into the funnel at a uniform velocity but, for most effective fluidizing of the particles, the body of gas is introduced through the slits in a direction substantially tangential to the circular cross section of the funnel wall, and the vortex of gas is distributed so that the velocity thereof is in direct proportion to the diameter of the conical wall, thus forming a uniform fluidized bed of substantially constant thickness along the funnel wall. In this case, the body of gas is introduced through the slits from a sealed chamber or wind box surrounding the funnel, the gas being blown into the chamber to form a whirling stream or vortex of gas in the chamber whence it passes thruogh the slits into admixture with the solid particles. The resultant fluidized bed does not bubble in the manner of a boiling liquid as it moves along the funnel wall, as has been the case in some conventional fluidizing methods. The fluidized bed moves in the form of a thin layer of particles along the wall.

The apparatus of this invention comprises a funnel with a downwardly tapering conical wall having a circular cross section of downwardly decreasing diameter. The funnel has an open top, a discharge port at the lower end for discharging the solid particles, and a plurality of slits, preferably arranged in adjacent circular rows along the wall. A cover member covers the open funnel top and has an inlet port for supplying the solid particles to the conical wall at or near its upper edge, and a gas escape port. A casing surrounds the funnel and forms a chamber therewith, and a duct is connected to the casing for supplying a body of gas to the chamber, the body of gas being passed inwardly from the chamber through the slits into the funnel.

The above and other features of the invention will become more apparent from the following detailed description of a now preferred embodiment thereof, taken in conjunction with the accompanying drawing wherein:

FIG. 1 is a longitudinal sectional view of an apparatus for fluidizing solid particles according to the invention;

FIG. 2 is a cross sectional view along line 2—2 of FIG. 1;

FIG. 3*a* is a developed view of the slitted conical wall of the apparatus;

FIG. 3*b* is an enlarged perspective view of a preferred embodiment of the slits in the conical wall;

FIGS. 3*c* and 3d are respective sectional views taken along lines c—c and d—d of FIG. 3*b*; and

FIG. 4 is a view similar to that of FIG. 3*a*, showing a slitted blank welded together from a plurality of pre-cut segmental portions for forming the funnel wall.

If desired and advantageously, the illustrated fluidizing apparatus may form the bottom portion of a drying tower for spray drying milk so that the solid milk particles are received in the funnel of the apparatus from the spray drying tower, for instance in a tower of the type described and claimed in our copending application Ser. No. 820,902, filed May 1, 1969.

Referring now to the drawing and first to FIG. 1, there is shown a funnel with a downwardly tapering conical wall **1** having a circular cross section of downwardly decreasing diameter. The funnel has an open top which is covered by cover member **3** having an inlet port **10** adjacent the periphery thereof for supplying solid particles to the funnel close to the upper edge thereof, and a gas escape or exhaust port **9** coaxial with the vertical axis of the funnel. The lower end of the funnel has a coaxial discharge port **11** for discharging the solid particles. A casing **2** surrounds the funnel and forms a sealed wind box chamber therewith, the upper end of the casing having a flange mating with annular flanges of the cover member **3** and the funnel wall **1**, which flanges are fastened together by bolts **6** cooperating with nuts **7**, gaskets **4** and **5** being interposed between the flanges to provide a fluid-tight seal. A flexible conduit **14** is clamped to the lower end of the casing **2** and the discharge port **11** by clamping rings **15** and **16** to provide another fluid-tight seal.

While it would be possible to connect inlet gas duct **8** to the casing **2** at any point of the casing, for instance in a radial direction, the preferred embodiment shown in FIG. 2 illustrates the duct connected to the casing for supplying a body of gas to the sealed wind box chamber in a direction tangential to the circular cross section of the funnel wall **1** at or near the upper, large-diameter end thereof. Gas, such as dehumidified cold air, is blown into the duct **8** from a blower (not shown).