ARRANGEMENT FOR CONTROLLING THE THROUGHPUT OF A FINE PULVERULENT MATERIAL THROUGH A PORT

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When it is desired to control the throughput of a pulverulent material through a port, certain difficulties are met which depend on the fineness of the pulverulent particles and on the desired throughput; for instance, if the output port has a very reduced area, one is naturally led to fluidize the powder so that the latter may pass through the port after the manner of a more or less viscous liquid. However, the flow is hindered by the opposing ascensional movement of the fluidizing gases. It is, it is true, possible to make the pressure rise inside the container so that the powder is stored but the output speed would increase considerably and when it is desired to obtain a small throughput such a modus operandi is not applicable.

In the case where it is proposed to ensure easily the flow of a fine powder at a comparatively low speed through a port of reduced cross-sectional area, there is a hindrance which is due to the accumulation of granular material, forming an arch and stopping the throughput, chiefly when the minimum size of the port is of a magnitude comparable with the diameters of the larger particles.

The object of my invention consists in cutting out said difficulty through an arrangement which prevents the formation of such arches and ensures thus a ready flow of a fine pulverulent material, even at a comparatively slow speed, through an opening of a reduced cross sectional area whereby the flow of pulverulent grains is performed through gravity with or without the assistance of an auxiliary fluid pressure.

With this result in view, my invention has for its object an arrangement ensuring and adjusting the throughput, through a narrow port, of a fine pulverulent material stored inside a receiver. Said arrangement is characterized by a circular port at the lower end of the container, inside which port is fitted a frustoconical needle valve the tip of which is directed downwardly, said needle valve being arranged so as to form an annular output area around the needle valve inside the port. Said needle valve is provided with means for constraining it to rotate with a view to breaking up the agglomerated masses of pulverulent material and with means for shifting it vertically inside the port so as to adjust and stop the throughput.

Arrangements are known which seem at first sight to be similar to those disclosed hereinabove and which include a central rotary member. But it should be remarked that they are practically very different and that, generally speaking, the rotary member in these prior arrangements is designed so as to give the powder an axial movement which furthers its flow whereas my invention is of a sole object to prevent the formation of arches constituted by agglomerated granular material.

According to a further feature of the invention corresponding to the case where the annular port opens into a chamber inside which the pressure is higher than atmospheric pressure, said chamber being connected with a pipe with the container holding the fine pulverulent material to be fed so as to produce inside said container a pressure equal to that prevailing inside the chamber and to make the output of pulverulent material independent of the absolute value of said pressure, I have shown diagrammatically a non-limiting embodiment thereof in the accompanying drawings, wherein:

Fig. 1 is a vertical cross-section of said embodiment. Fig. 2 is a similar partial view on a larger scale of a modification of said embodiment.

Fig. 3 shows an arrangement similar to that illustrated in Fig. 1 wherein the output port opens into a chamber the pressure in which is above atmospheric pressure.

As illustrated in the drawing, there is provided a closed container 1 provided with an outlet port 2 in its lower part and with a pipe 3 feeding compressed gas under the control of a gate 4, whereby it is possible to admit the compressed gas as required above the mass of pulverulent material stored inside the container 1. A pressure gauge 6 allows adjusting the pressure and a pipe 7 provided with a gate 8 forms means wherethrough any excess gas may escape or, if desired, may be recovered. Obviously, the system of valves 4 and 8 allows adjusting the pressure indicated by the pressure gauge 6 to any desired value ranging between atmospheric pressure and the pressure prevailing inside the gas feeding channel 3.

The mass of pulverulent material is fed preferably for continuous operation through conventional means for conveying pulverulent material, as shown diagrammatically at 9, in association with a hopper 10 and connected with a pipe 11 opening into the upper end of the container 1. If intermittent operation is sufficient, it is possible to cut out this arrangement 9 feeding the pulverulent material and to close the pipe 11 through any suitable closing means which are removed each time the container is to be filled.

At the lower end of the container, the port 2 has preferably a frustoconical shape and inside said port there extends a correspondingly shaped frustoconical needle valve 12 the outline of which matches preferably that of the port 2. Said needle valve 12 is carried by a rod 13 the upper end of which is provided with a collar 14 engaging with the interposition of a ball bearing 15 a support 16. The latter is rigid with a vertical threaded rod 17 which is shifted vertically when it is caused to rotate, through a controlling handwheel 18, inside a stationary nut 19, said nut being secured for instance to the container 1. This arrangement allows positioning the needle valve 12 inside the port 2 at a height such that the annular gap, formed between the needle valve and the wall of the port, may provide the desired throughput.

Such an arrangement does not allow obtaining small throughputs when the pulverulent material is of an adhesive nature. The use of a plurality of ports for the admission of fluidizing gas as shown at 2a in Fig. 2 and of which some are located very near the output port 2 allows fluidizing the pulverulent material, but if said pulverulent material is of a very adhesive nature, arches of agglomerated material will soon form above the annular output port. Their gradual building up is associated with a reduction and irregularity in the throughput and after a short time, a stoppage of the latter. Now my invention has for its object to remove this drawback.

My invention allows as a matter of fact bringing a remedy thetore by driving the needle valve 12 into rotation through the agency of a pinion 20 coaxially rigid with the rod 13, said pinion being for instance actuated by a chain 21 engaging a pinion 22 keyed to the shaft of a motor 23 revolving at a very slow speed. Thus, the inner edge of the annular port constituted by the frustoconical valve and the edge of the actual port 2, moving with reference to each other, the arrangement prevents the formation of the arches so that the desired throughput is obtained and does not vary. The area of said annular port may be reduced by depressing the needle valve until said output port assumes the desired reduced area.
Since the pulverulent material is generally of a highly abrading character, it is unnecessary to resort to a high speed of rotation as this would in fact increase the wear of the needle valve and of the outer edge of the port. Similarly, in order to prevent abrasion, the rod 13 enters the container 1 through two guiding bearings 24 and 25 engaged by the rod with a slight clearance, the bearing 24, while the bearing 25 is provided with fluid tight means engaging the rod 13. Between the two bearings is formed a chamber 26 into which is fed through a pipe 27 a gas, similar to that filling the container 1, in a manner such as will maintain inside said chamber 26 a pressure which is slightly higher than that prevailing inside the container. Some gas escapes through the bearing 24 and said gas entering the container 1 prevents the particles of pulverulent material from entering the clearance between the rod 13 and the bearing 24, which cuts out any wear through abrasion. Although the above-mentioned bearings ensure an improved operation, it is possible to insert at the point at which the rod 13 passes out of the container, a conventional stuffing box.

In the case of an adhesive powder, it is possible to further the action of the needle valve by means for instance of bars or blades 28 secured to the wall of the container and of small cooperating blades 29 secured to the actual needle valve. The use of rotary blades is well-known per se, but it is in many cases inefficient, since the pulverulent material rotates as a unit inside the container. This drawback is cut out through the simultaneous use of the stationary blades 28 and of the rotary blades 29. In such a case, a very energetic mechanical shearing of the pulverulent mass is ensured.

On the other hand, in the case of small throughputs, there exists a very simple manner of stopping the flow of pulverulent material, which consists in stopping the rotation of the needle valve 12. Archs of pulverulent material are formed immediately over the annular port, which prevents any misalignment of the location of the needle valve as would occur if it were depressed until the port is completely closed and which avoids also the alternative necessity of returning to zero the overpressure inside the container 1.

The arrangement defined heretofore with reference to Figs. 1 and 2, corresponds to operation with a free flow of the pulverulent material at atmospheric pressure. In practice, it is often necessary to make said material enter a chamber the pressure inside which is above atmospheric, either for said material to remain in said chamber or more generally for it to be conveyed pneumatically elsewhere.

In this case, the parts illustrated in Fig. 1 allow reaching the desired result. The port 2 opening now inside a chamber submitted to a higher pressure, it is sufficient to control the valves 4 and 8 in a manner such that the pressure inside the container 1 rises to a value such as will allow the flow of pulverulent material as previously through the port 2.

However, such an adjustment is intricate and if it is not correctly executed, it risks disturbing in particular the throughput of material through the port 2. For this reason, I have designed an improved arrangement illustrated in Fig. 3 wherein the adjustment of pressure inside the container 1 is ensured automatically so that the said pressure may always assume exactly the desired value.

As illustrated in said Fig. 3, the port 2 opening into a pipe 30 of any desired length, which is intended for powder-conveying purposes. Said pipe may include a metal pipe or else a flexible hose. In fact, it is often of advantage to form it altogether or in part by a tube of yielding rubber which allows directing wherever necessary the jet of pulverulent material 31 passing out of its end.

The progression of the pulverulent material is readily ensured by means of gasform jets passing out of ports 32 formed inside the wall of the pipe 30 as near as possible the main port 2. The gasform fluid fed through a tube 33 has its throughput adjusted by means of a further gate 34. The ports 32 ensure on one hand a continuous mixture between the jet of pulverulent material and the incoming gas whereby said jet of pulverulent material is transformed into a mist of which the different particles are perfectly independent and spaced away from one another and this provides, on the other hand, for the transportation of the mist thus formed through the pipe 30.

The automatic adjustment of the pressure prevailing inside the chamber 1, which adjustment allows reaching the value best suitting the flow of pulverulent material, is readily obtained by means of a tube 35 provided with a gate 36 and through which the container 1 communicates with the end of the tube 30 at a point located beyond the point at which the jet of pulverulent material passes out of said container.

This tube 35 allows the pressure inside the container 1 to assume the value which it should reach so as to ensure the flow of material through the port 2 whatever may be the value of the counter-pressure prevailing immediately underneath said port 2 and consequently the throughput of pulverulent material in the jet is independent of the pressure prevailing on the downstream side of the port.

Obviously, the embodiments described heretobefore and illustrated in accompanying drawings are given solely by way of examples and by no means in a limiting sense and it is of course possible to modify, within the scope of accompanying claims, the shape, relative arrangement and nature of the different parts without unduly widening thereby the scope of my invention. Thus it is possible for instance, to resort to a stationary needle valve and to make the outer edge of the annular port rotate. Similarly, it is possible to make one of the edges of the annular port assume a movement different from the uniform movement of rotation described heretobefore, for instance a reciprocatory rotary movement in both directions or again a vertical movement or any other suitable compound movement.

What I claim is:

1. In combination with an apparatus for feeding a pulverulent material from a vertical container through an annular outlet at its lower end, which comprises means for feeding gas into the container above the level of the pulverulent material, means for controlling the pressure of the gas inside the container, and auxiliary nozzles arranged to blow a gaseous fluid into the container immediately adjacent the said annular outlet a rotatable and vertically adjustable conical needle valve arranged in a port in said container to form the said annular outlet.

2. In combination with an apparatus for feeding a pulverulent material from a vertical container through an annular outlet at its lower end, which comprises means for feeding gas into the upper end of the container above the level of the pulverulent material, means for controlling the pressure of the gas inside the container, an output pipe connected to the said annular outlet, means for applying superatmospheric pressure to said output pipe, a conduit connecting the output pipe with the upper end of the container for producing pressure equilibrium between the container and the output pipe, and means for adjusting the connecting conduit a rotatable and vertically adjustable conical needle valve arranged in a port in said container to form the said annular outlet.

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