

United States Patent

[11] 3,592,446

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[21] Appl. No. **825,570**
[22] Filed **May 19, 1969**
[45] Patented **July 13, 1971**

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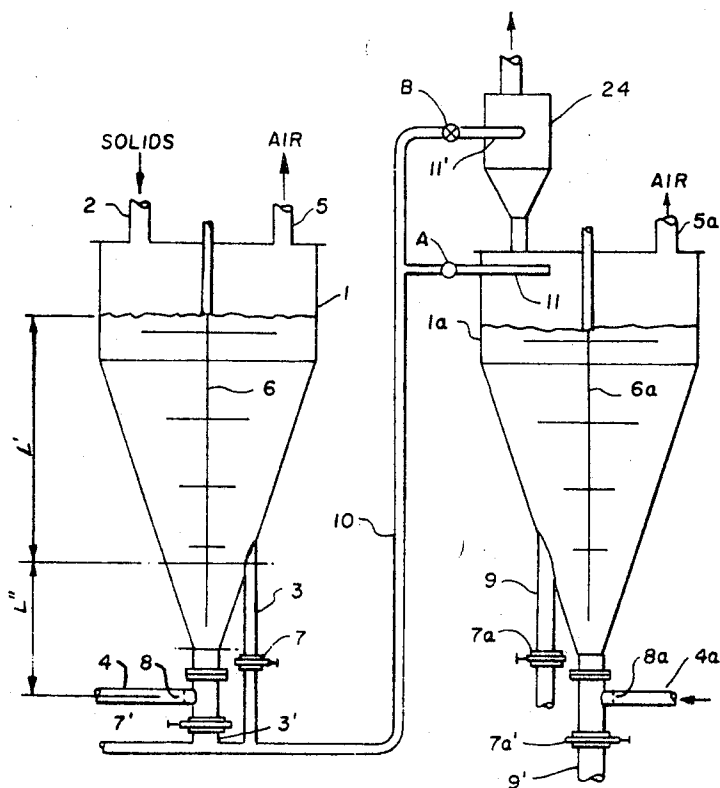
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[54] METHOD AND APPARATUS FOR CONTINUOUS BLENDING OF GRANULAR MATERIALS 9 Claims, 7 Drawing Figs.

[52] U.S. Cl. 259/67,
259/111
[51] Int. Cl. B01f 7/18
[50] Field of Search 259/7, 8,
67, 68, 66, 4, 95, 60, 64, 65

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ABSTRACT: This invention relates to a method and apparatus for continuous blending of granular materials having the same or different particle size or density, comprising one or more containers tapered downwardly and inwardly, each having a stirrer rotatable about a vertical axis for stirring the granular material at the same time air is passed therethrough. Two or more stages in series may be arranged, either side-by-side or vertically in tandem, between which stages solids may be conveyed pneumatically or by gravity flow.



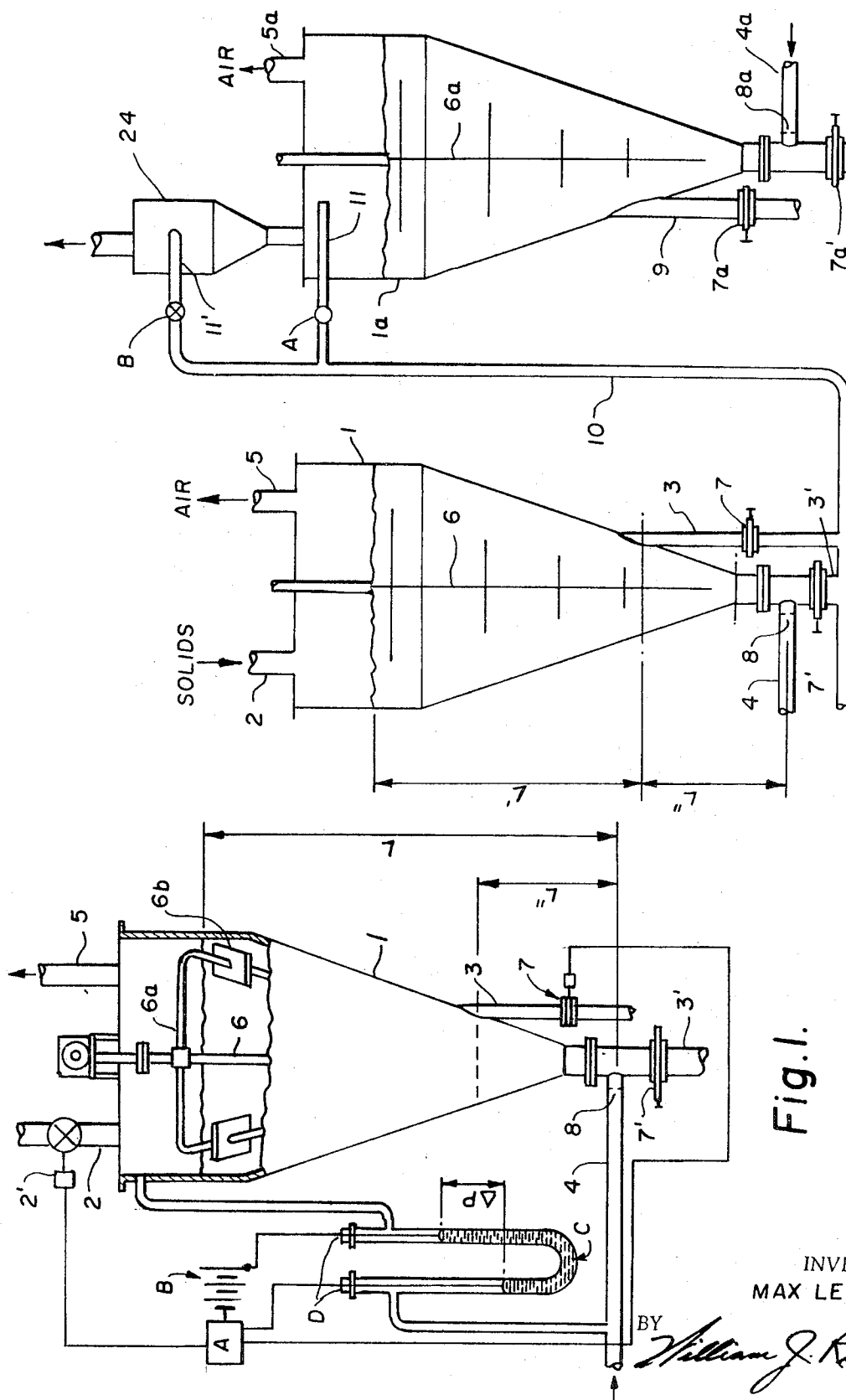


Fig. 2.

Fig. 1.

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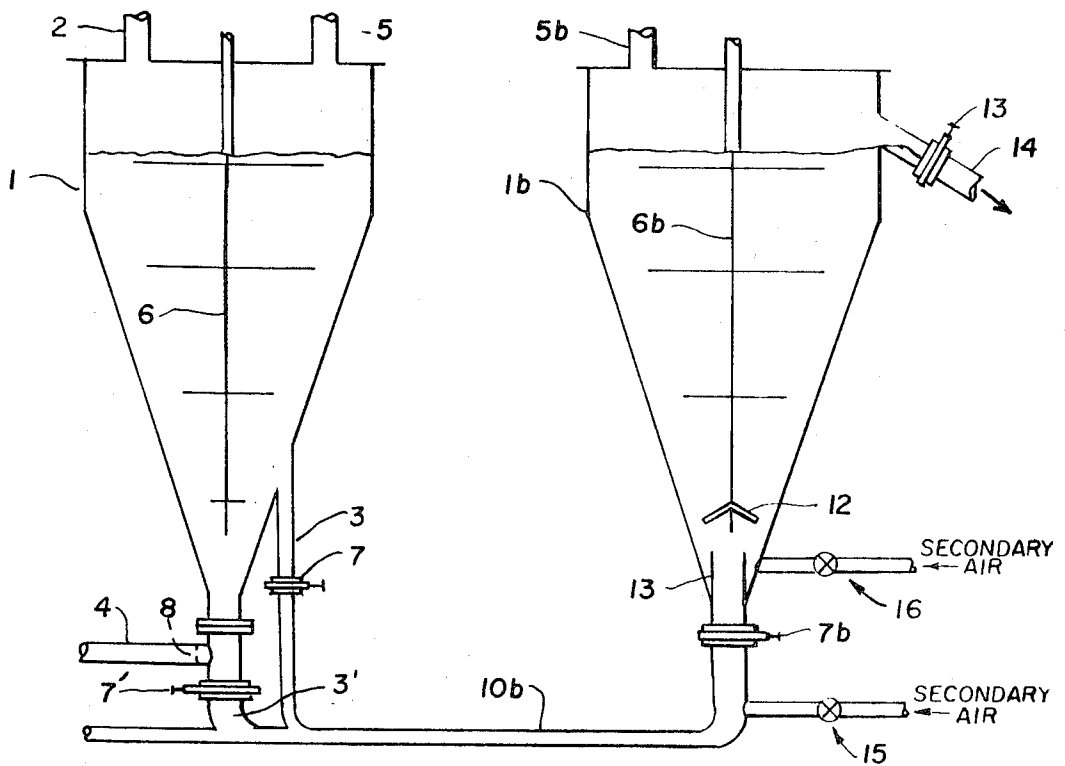


Fig. 3.

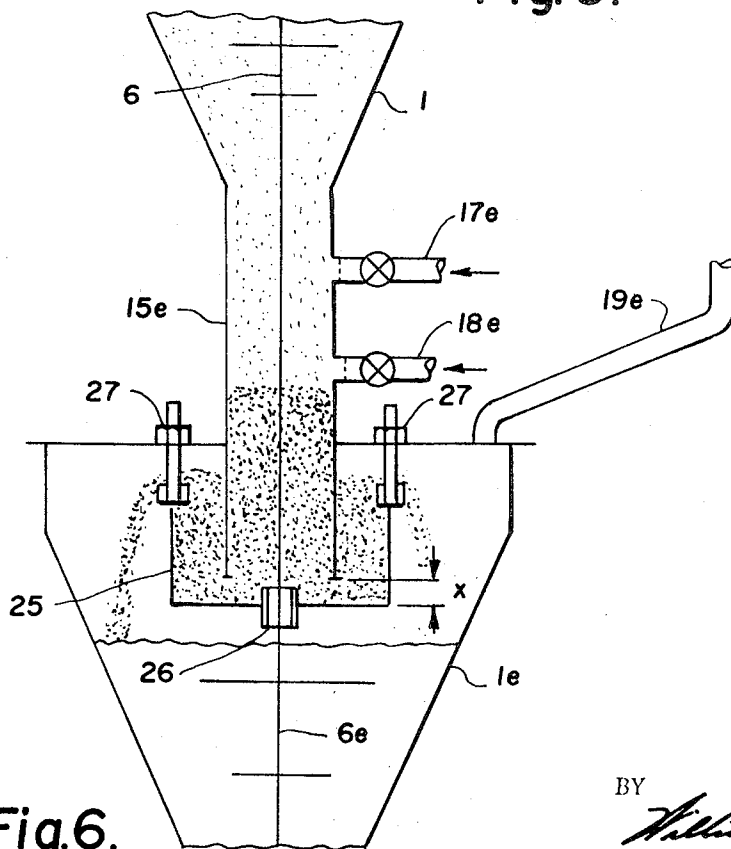


Fig.6.

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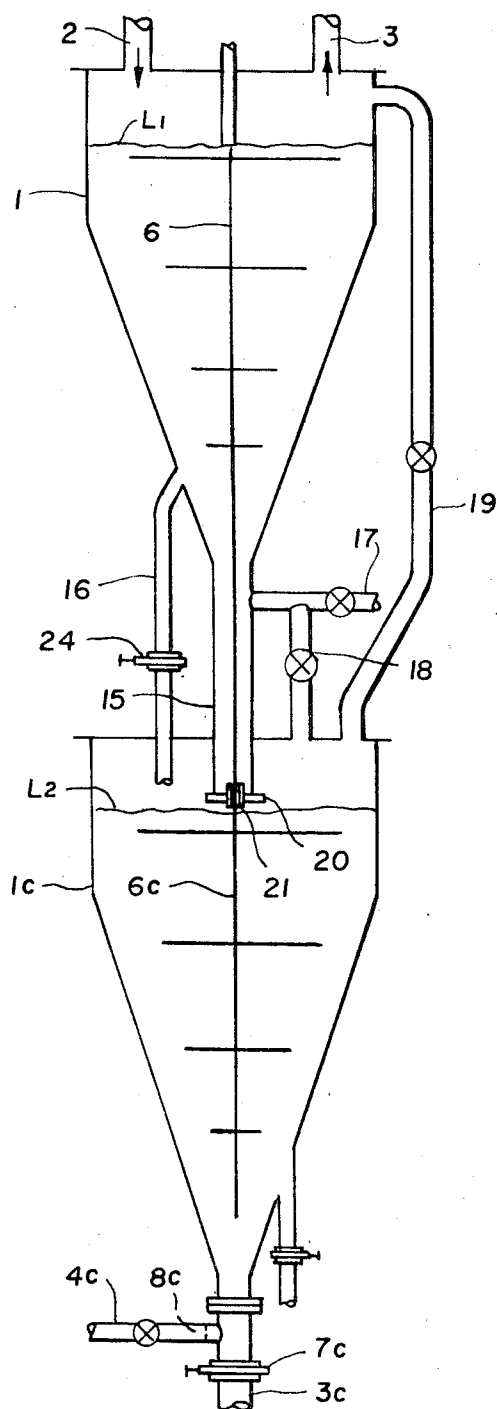


Fig. 4.

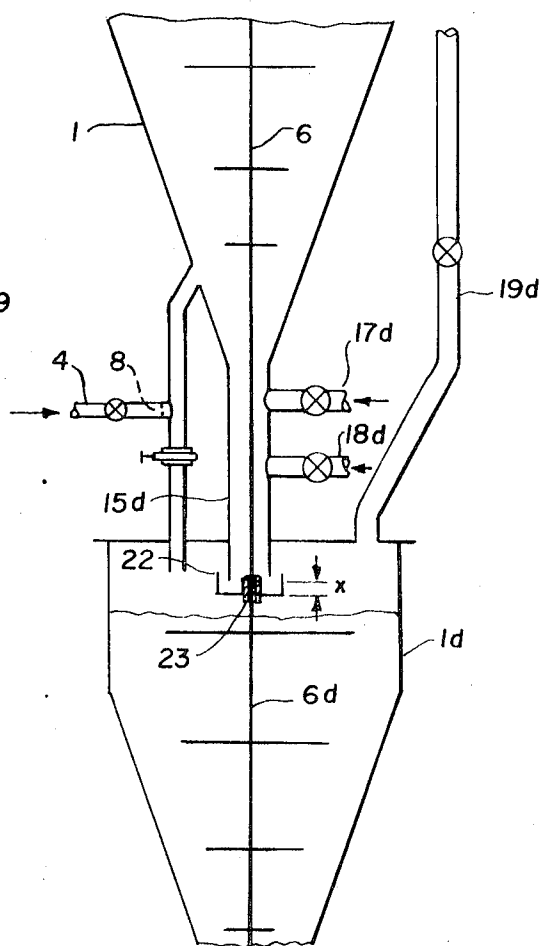


Fig. 5.

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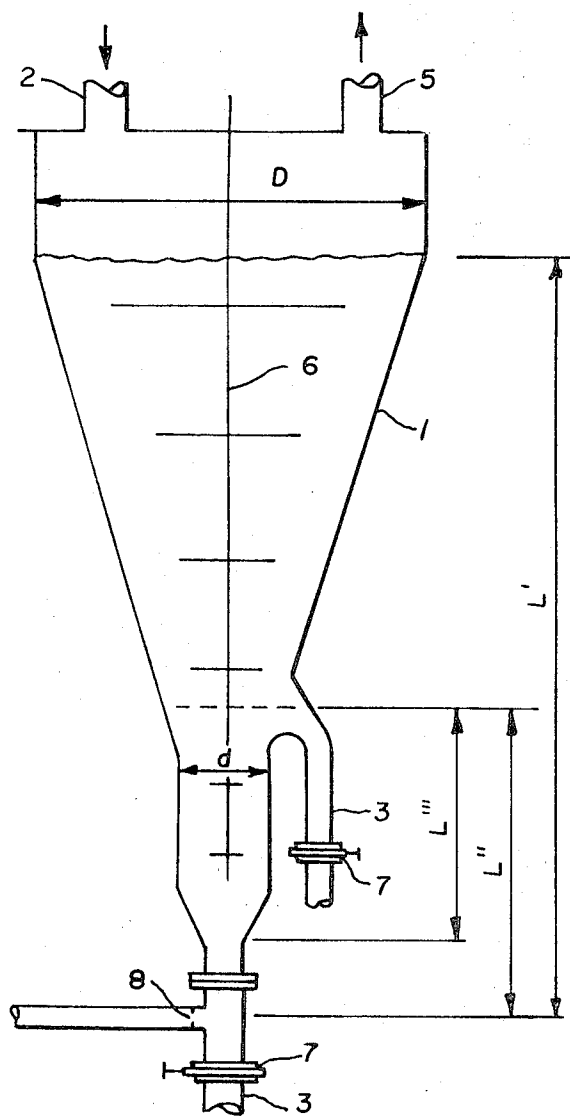


Fig. 7.

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METHOD AND APPARATUS FOR CONTINUOUS BLENDING OF GRANULAR MATERIALS

This invention relates to a method and apparatus for continuous blending of granular materials having the same or different density or particle size and constitutes an improvement over the batch-type method, such as described in my British Pat. No. 943,085. Since in the batch method, stirring must be stopped and the container must be emptied after each aerated blending operation, appreciable time is consumed between the charging of one batch and that of the next batch.

Another disadvantage is that the capital investment per unit weight of material to be mixed is appreciable and the reproducibility of results is short of that desired.

Most blenders commonly used in the art operate on the principle of tumbling. However, homogeneous mixtures are not obtained when the density differences or particle sizes are appreciable. In such cases, tumbling effects actual separation of matter with the heavier layer particles concentrating near the bottom of the bed.

An object of the present invention is to provide a novel method and apparatus for continuous aerated blending of granular materials so as to effect substantial labor savings.

Another object is to provide a novel method and apparatus which involves smaller capital investment and cost of operation than is obtainable by the batch method.

A further object of the invention is to provide a novel method and apparatus for continuous blending of granular materials so as to obtain better overall reproducibility of blending results, in particular, better uniformity of the mixed materials.

A still further object of the invention is to provide an improved apparatus having considerably greater capacity for a given floor space.

Another object of the invention as compared to the aforesaid tumbling principle and batch method is to render individual mixes more homogenous by keeping the heavier or larger particles in the charge in place, while applying careful mechanical stirring and just sufficient aeration so that no segregation will result.

Other objects and advantages will become more apparent from a study of the following description taken with the accompanying drawings wherein:

FIG. 1 is an elevational view, partly in cross section, showing a single stage apparatus embodying the principles of my invention;

FIG. 2 is a schematic view of a two-stage machine embodying the invention, wherein mixed particles of air are conveyed to the top of the second stage;

FIG. 3 is a two-stage machine wherein mixed particles and air from the first stage are pneumatically conducted to the bottom of the second stage;

FIG. 4 is a two-stage system, with the units arranged vertically in tandem;

FIGS. 5 and 6 show a two-stage system in vertical tandem, as in FIG. 4, but including certain modifications; and

FIG. 7 is a modification of FIG. 1.

Referring more particularly to FIG. 1 of the drawing, numeral 1 denotes a container substantially in the form of a cone having a vertical shaft 6 which rotates on its axis and which supports, by frame 6a, a plurality of vanes or stirrers 6b disposed around and along the entire height of the shaft for thoroughly mixing the granular materials of the same or different density or particle size fed therein through solids inlet pipe 2. Low-pressure air is fed into air inlet pipe 4, passes through the entire height of the mixture and exhausts through outlet pipe 5. The apparatus so far described is similar to that of the batch-type apparatus disclosed in my British Pat. No. 943,085, except the British apparatus has no solids inlet and outlet ports, whereas the present apparatus has both a solids inlet port as well as a solids outlet port. Also the outlet port of the present apparatus is strategically placed about one-third to

one-fourth of the solids height L. Moreover, synchronization of the solids inlet valve 2' and solids outlet valve 7 is provided which is an absolutely essential requirement for continuous blending.

A screen or porous plate 8 is provided to prevent the solids from entering pipe 4 at shutdowns. The solids are thus simultaneously stirred while air is passed therethrough and then exhausted through pipe 5, either into the atmosphere or into a cyclone to recover any entrained matter. Container 1 may be completely emptied through discharge valve 7' and pipe 3' whenever desired, such as when new mixes are to be blended.

The essential feature of operation of the apparatus in FIG. 1 is that the rate of solids discharge through pipe 3 and valve 7 must be synchronized to the rate of introduction of the solids through inlet pipe 2. Such synchronization may be achieved in various ways. Mechanically it may be accomplished by adjusting the opening of discharge valve 7 until the discharge rate is such as to keep the level L at a constant height throughout the operation of continuous feeding of solids through inlet pipe 2. Perhaps the most likely method of synchronization is by way of determining the differential pressure ΔP of air through the apparatus which is proportioned to L. Since the differential pressure is dependent upon the solids head which the air must penetrate on its upward course, any variations in the level L of the solids will influence differential pressure.

However, the solids level L will vary only if the rate of feed is not the same as the rate of discharge. Hence any level control apparatus, such as are well known in the art, may be used for actuating valve 2' in response to variations in level, L, so that the valve opening will be varied to the extent necessary to keep the level L essentially constant. The most common type of mechanical apparatus for such level control may be one similar to a float operated valve such as commonly used in water closets for toilets in that as the float on level L moves vertically it will, by pivotal mechanical linkage, vary the opening of discharge valve 7 or will merely effect opening or closing thereof sufficiently to maintain the level L at a constant height. Still another method is to cause closing of selective contacts by a member, whose position is controlled by level L, so as to actuate a relay or motor which will operate valve 2' to regulate it in accordance with variations in the level so as to keep the level substantially constant.

A typical control system is shown in FIG. 1. Electrodes D are vertically adjustable so as to be set according to the desired ΔP . If the level L decreases below the desired level, an energizing circuit will be completed through battery B and relay A so as to actuate and open inlet valve 2' to a greater extent and partially close valve 7 and thus synchronize the inlet and outlet flow of solids so as to maintain the desired solids level or height L. If ΔP becomes too high, the flow through inlet valve 2' is reduced, and outlet valve 7 opens to a greater extent. As a modification, either valve may be operated alone as described.

FIG. 7 is a modification of FIG. 1 having a lower cylindrical section having a diameter d no more than one-half of the vessel diameter D and having a height L''' no more than one-third the height of L'. L'' is the height from below the bottom of the cylindrical section.

FIG. 2 is a modification showing a typical two-stage machine wherein the materials to be blended enter through inlet pipe 2 and low-pressure air enters the first stage through inlet pipe 4. The cleaning outlet 3' is also connected to the pneumatic conveying line 4 for cleaning and emptying purposes. But the important operating solids transfer line is again 3. The solids flow control valve 7 is synchronized with the inlet flow through pipe 2 by any of the previously described methods. The mixed solids after stirring and simultaneous aeration are passed pneumatically through pipe 10 by virtue of the introduction of low-pressure air at one end so as to pneumatically convey the partially mixed solids into the top of the second stage by discharging the mixed solids through baffle 11 so as to drop onto the top of the indicated solids level. Air is admitted through inlet pipe 4a into the bottom of the second

stage and the solids control valve 7a is synchronized to the solids feed rate to discharge the mixed solids through outlet pipe 9. Air is exhausted through the top outlet pipe 5a into the atmosphere or to a cyclone 24. That is, by selective operation of valves A and B, the cyclone 24 may or may not be used. For very fine particles, the cyclone may be necessary.

FIG. 3 is a modified two-stage arrangement as in FIG. 2 except that the solids after mixing in the first stage are not separately conveyed into the top of the second stage by separate air but, instead, the solids are pneumatically conveyed directly into the bottom of the second stage by pipe 10b into which air is fed at one end to provide not only for movement of the mixture in pipe 10b but at the same time fluidizing the charge in the second stage in container 1b at the right of FIG. 3. For better operation, the air entry tube 13 should be somewhat extended and covered by a baffle 12 to prevent solids from falling back into the pipe 10b at shutoffs. Instead of the baffle 12, a pipe with a bend at an angle ranging from 90° to 180° may be attached to the upper mouth portion of tube 13. As the conveying air carries the solids from stage no. 1 to stage no. 2, by entering the second stage the velocity of the air becomes smaller and the conveyed solids deposit as a bed. For proper operation of such a system, the air velocity through pipe 10b must be carefully coordinated with that required to aerate the charge in the second stage. In some instances it may be necessary to provide secondary aeration air either through 15 or 16.

The two stage system shown in either FIG. 2 or FIG. 3 is most suitable for cases where carefully prepared blends are needed and where the solids handled have sufficiently good flow properties to permit transfer pneumatically as shown. If desired, additional stages may be added to FIGS. 2 or 3 if more uniform blends are required.

As the solids are introduced into the second stage through pipe 10b, the bed is established in the second stage and stirred. As the level of the bed reaches the solids level indicated in FIG. 3, the mixed solids will overflow and pass through adjustable valve 13 and outlet pipe 14.

FIG. 4 shows a two-stage machine but wherein the stages, instead of being side by side as in FIGS. 2 and 3, are stacked or arranged vertically in tandem. This arrangement has the advantage that only one stirrer motor and speed reducer is needed for both stages, because both stirrers for stages 1 and 2 are on a common shaft. A sealing arrangement is provided for the stirrer shaft as it passes from the upper or first stage to the lower or second stage, thus eliminating the necessity for stuffing boxes and the like. To provide such seal, the solids bed itself may be used as will be explained hereinafter.

In operation, solids to be blended enter stage 1 through inlet pipe 2 to provide a solids level L_1 as shown. It should be noted that the solids will be retained in the first stage, that is, in container 1, since valve 24 is closed and no appreciable amount of solids can fall through the bearing sleeve 21 which is inserted in the closing flange 20 and through which the stirrer shaft 6-6c passes. Air is introduced through valve 17 while valve 18 remains closed and the charge is stirred. As soon as sufficient stirring and simultaneous aeration occurs to provide a homogenous mixture, valve 24 is opened so as to permit the now partially blended solids to overflow into the bottom container 1c, that is, the second stage. Before level L_2 is obtained, air is admitted through inlet pipe 4c and through porous plate 8c and the stirrers already in operation blend the solids to uniformity. As soon as the solids level L_2 is obtained, the solids control valve 7c is manipulated and the mixed solids are discharged through outlet pipe 3c. The exhaust air from stage 2 may be passed either through valve 18 to assist with aeration of the first stage or it may be bypassed through pipe 19 to the top of stage 1 and exhausted through pipe 3 to the atmosphere or to a cyclone.

FIG. 5 shows a modification similar to FIG. 4 except that instead of a closing flange 20 at the bottom portion 15d of the first stage, there is provided an adjustable trough 22 formed externally of sleeve 23 and which may be vertically adjusted

through a distance X for varying the opening and discharge rate from the first to the second stage. Low-pressure air is introduced into pipes 17d and 18d, each having a valve, also into pipe 4.

FIG. 6 shows in greater detail the adjustable valve of FIG. 5 comprising a trough 25 formed around sleeve 26, which trough is vertically adjustable by bolts 27 through a vertical distance x . By admitting air, either through valve 18e or 17e, the density of the solids column can be controlled such that for a given clearance between cylindrical portion 15e and the bottom of trough 25, the solids will normally overflow from stage 1 to stage 2 as illustrated in dotted lines. The solids in trough 25 thus form a seal between stages.

Still simpler, the solids flow through the clearance x can be easier controlled by leaving either valve 18e or 17e or both in an open position and by regulating the vertical position of trough 25 by bolts 27 or any other suitable mechanical means so that the rate of solids flow through opening x is exactly equal to the feed rate in stage 1. Air is exhausted from the top of container 1e through air outlet tube 19e into the atmosphere or a cyclone.

Of course, if desired, the blended solids discharged from the vertical tandem machine described in FIGS. 4, 5 and 6 may be fed from the bottom thereof to the top of an identical vertical tandem two-stage structure to provide a two- (or more) stage vertical tandem arrangement in series, similar to that described in FIG. 2 (or perhaps FIG. 3).

Thus it will be seen that I have provided a novel method and apparatus for continuous blending of granular materials in one or two or more stages, either in series, side by side where the solids are pneumatically conveyed from stage to stage, or wherein the stages are in vertical tandem and wherein the solids are simultaneously stirred and aerated and pneumatically conveyed after mixing from one stage to the next; furthermore, I have provided a novel sealing arrangement for vertical tandem stages by way of a thick bed acting as a stuffing box for the stirrer.

While I have illustrated and described several modifications of my invention, it will be understood that these are by way of illustration only and that various changes and modifications may be made within the contemplation of my invention and within the scope of the following claims.

I claim:

1. A multistage continuous blending apparatus for granular materials, comprising a first container including stirring means and aerating means for simultaneously stirring and aerating granular materials introduced into the top of the container, a second container also including stirring means and aerating means for simultaneously stirring and aerating the contents thereof, and a discharge pipe adjacent the bottom of the first container and leading into the second container and connected to a source of air so as to pneumatically conduct blended solids and air from the bottom of the first container through said discharge pipe to said second container.

2. A multistage apparatus as recited in claim 1 wherein said discharge pipe for pneumatically conveying blended particles is connected to the top of said second container and wherein an air inlet valve introduces low-pressure air into the bottom of said second container and wherein an outlet valve discharges air from the top of said second container.

3. A multistage apparatus as recited in claim 1 wherein said discharge pipe for conducting blended particles from the first container is connected to the bottom of said second container, and means in said second container for preventing accumulation of granular material in the outlet of said pipe.

4. Apparatus as recited in claim 3 together with a discharge pipe and control valve therein disposed at the upper portion of said second container for regulating the level of mixed granular materials therein.

5. Apparatus as recited in claim 1 wherein said first and second containers are arranged vertically in tandem with a common stirrer shaft.

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6. Apparatus as recited in claim 5 wherein a seal is provided at the bottom and discharge end of the top container, said seal formed of discharged granular material and held in place by a closure flange which surrounds the common shaft of said stirrer.

7. Apparatus as recited in claim 5 wherein the discharge outlet of the top container is in the form of a cylindrical portion of a downwardly tapered portion of the bottom of the container, a vertically adjustable trough surrounding the common stirring shaft for said containers, and means for adjustably spacing said trough from the bottom edge of said cylindrical portion so as to regulate the rate of discharge of

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blended particles discharged from the top container into the bottom container.

8. Apparatus as recited in claim 7 together with a bypass pipe leading from an intermediate portion of the top container to the top portion of the bottom container, and a regulating valve in said bypass pipe.

9. Apparatus as recited in claim 7 together with a pair of air inlet pipes, one connected to the bottom of the top container and the other, to the top of the bottom container, and a second bypass pipe connecting the top portions of said bottom and top containers and including a regulating valve therein.

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