United States Patent

[11] 3,580,545

[72] Inventor Edward D. O'Brien
Woodside, Calif.

[21] Appl. No. 858,213
[22] Filed May 23, 1969
[45] Patented May 25, 1971
[73] Assignee Stauffer Chemical Company
New York, N.Y.
Continuation-in-part of application Ser. No. 652,922, July 12, 1967, now abandoned.

[54] APPARATUS FOR AGGLOMERATING DUSTS AND THE LIKE

10 Claims, 8 Drawing Figs.

[52] U.S. Cl. 259/3
[51] Int. Cl. B01f 9/06
[50] Field of Search 259/3, 14, 15, 2, 49, 50, 51, 81, 82

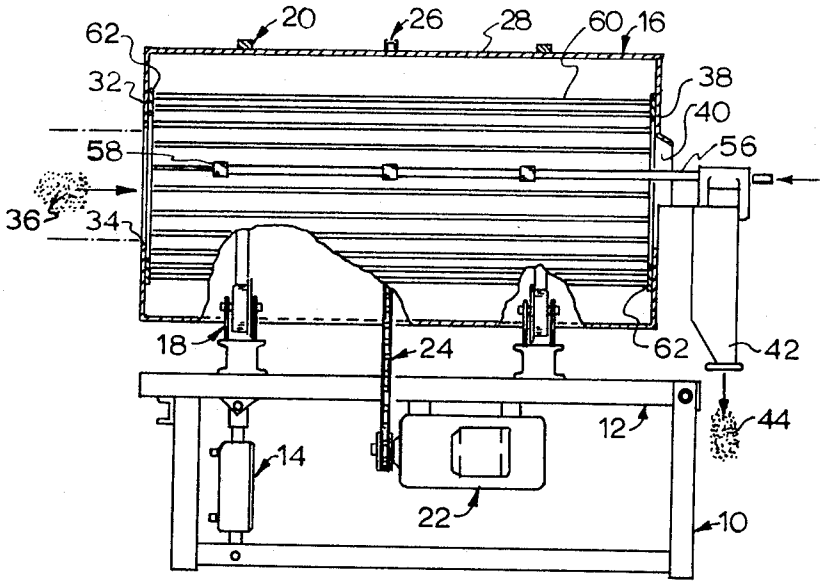
[56] References Cited

UNITED STATES PATENTS

2,618,865	11/1952	Arnold	259/3
2,924,513	2/1960	Altimier	259/3
3,407,511	10/1968	Camm	259/3

Primary Examiner—Robert W. Jenkins
Attorneys—Daniel C. Block and Edwin H. Baker

ABSTRACT: Apparatus for agglomerating fine particles including a rotatable mixer, generally resembling a rotary drum dryer, having optionally a conveyor, such as a spiral vane, as an aid in moving particulate base material therethrough, an applicator, such as a manifold with spray nozzles for applying a liquid or another solid particulate material to the base material and thereby effecting coating and agglomeration of the base material, and lifter elements mounted within the mixer and rotatable therewith adapted to move through the normally relatively dormant central region of the mass of base material and thereby cause the base material in this region to become mixed with the base material in the normally actively moving inner and outer regions of said mass.



3 Sheets-Sheet 1

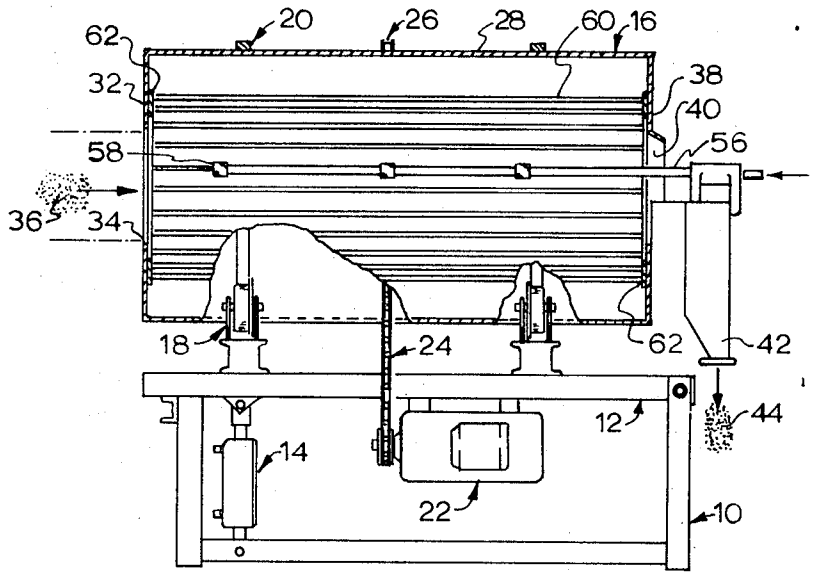


FIG. 1

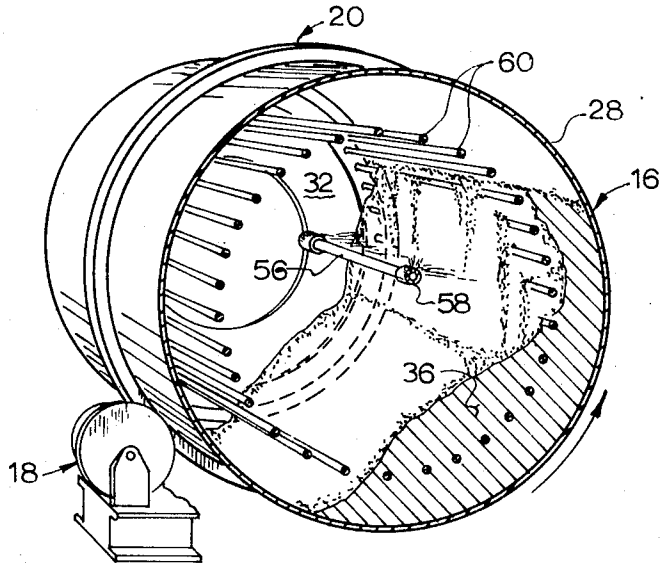


FIG. 2

INVENTOR.
EDWARD D. O'BRIEN
BY Edwin H. Baker
ATTORNEY

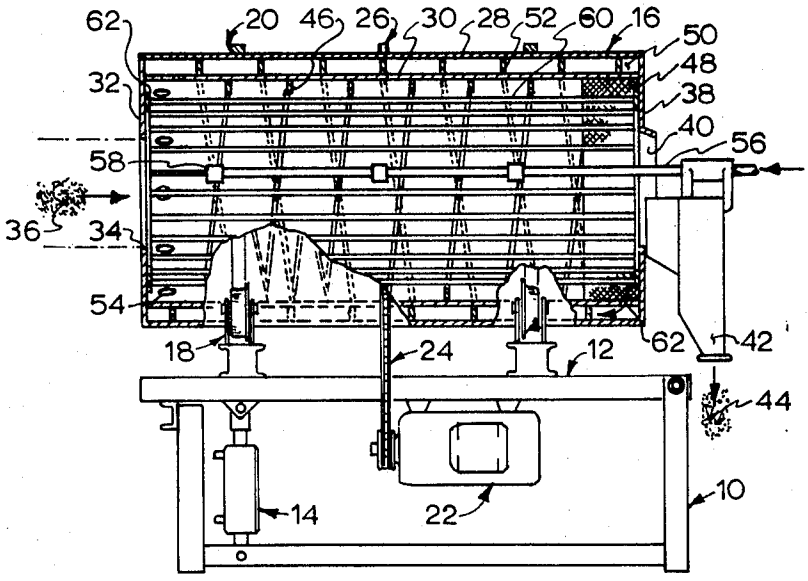


FIG. *3

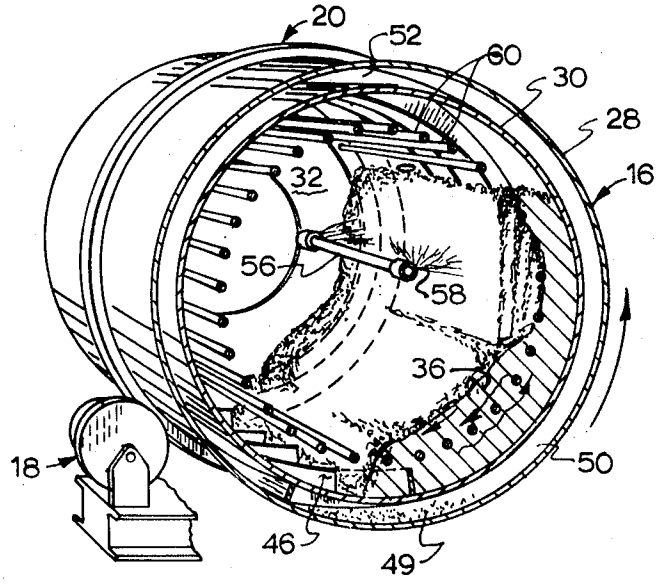


FIG. *4

INVENTOR.
EDWARD D. O'BRIEN
BY Edwin N. Baker
ATTORNEY

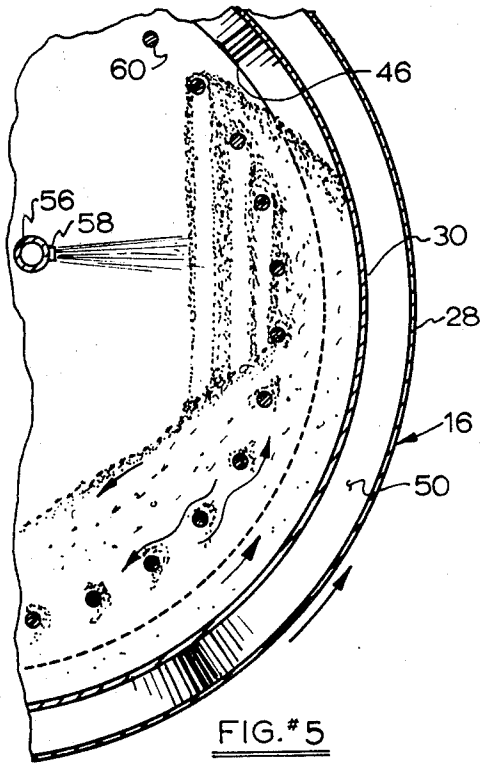


FIG. #5

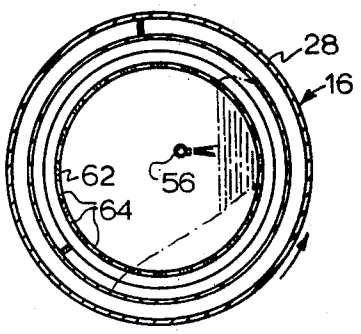


FIG. #6

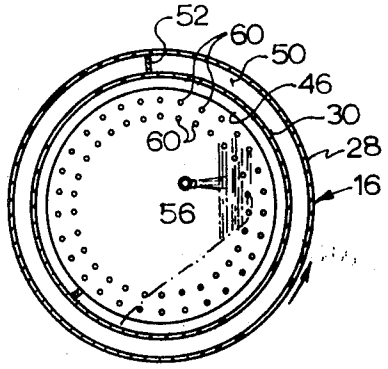


FIG. #7

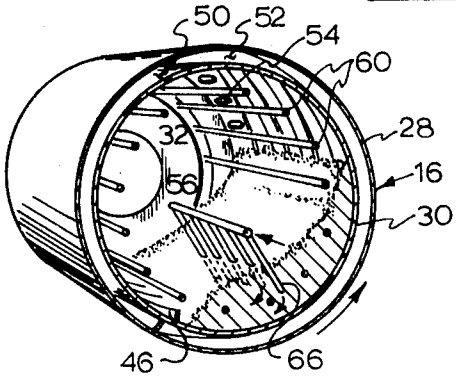


FIG. #8

INVENTOR.
EDWARD D. O'BRIEN

BY Edwin N. Baker

ATTORNEY

APPARATUS FOR AGGLOMERATING DUSTS AND THE LIKE

This application is a continuation-in-part of copending application Ser. No. 652,992, filed July 12, 1967, now abandoned.

In a drum having an input end adapted to receive fine particles to be agglomerated by application of an agglomerating agent, an output end to discharge the particle agglomerates, optionally an internal peripheral spiral vane, or other suitable conveyor element, to convey the material through the drum, an applicator to apply the agglomerating agent to the particles, as by either spraying the same into one or more falling curtains of particles or by injecting the same into the main mass of particles at the bottom of the drum, the improvement comprising the provision of a plurality of elongated rods, or the equivalent thereof, disposed substantially parallel to each other and to the longitudinal axis of the drum and radially inwardly of the conveyor element, or, if no conveyor element is present, then radially inwardly of the inside wall of said drum, and adapted to be laterally moved through the normally relatively dormant region of the main mass of particles at the bottom of the drum to disturb and move the particles within said dormant region and cause them to be mixed with actively moving particles located outside of said dormant region and to lift particles out of said main mass and cause them to thereafter cascade downwardly onto said main mass in the form of one or more curtains of falling material into which the agglomerating agent may be sprayed without the deposit of any agglomerating agent on said rods.

The subject apparatus also embodies means for screening out fines adjacent the output end of the drum and for returning them lengthwise of the drum into the input end of the drum.

With reference to the general purpose, use and function of the subject apparatus, and to the types, identities, sizes and other characteristics of the particulate materials and agglomerating agents which the subject apparatus may readily handle, such is known or easily determined by those skilled in the art.

THE DRAWINGS

FIG. 1 is a view in side elevation, partly broken away and partly in section, of one form of apparatus embodying the invention;

FIG. 2 is an endwise view in perspective, taken from the output end of the drum portion of the apparatus of FIG. 1;

FIG. 3 is a view in side elevation, partly broken away and partly in section of another form of apparatus embodying the invention;

FIG. 4 is an endwise view in perspective, taken from the output end of the drum portion of the apparatus of FIG. 2;

FIG. 5 is an enlarged partial view in transverse section of the drum portion of the apparatus of FIG. 2 illustrating the mode of operation of a preferred form of the improvement embodying the subject invention;

FIG. 6 is a view in transverse section of the drum portion of a modified form of the apparatus of the invention;

FIG. 7 is a view in transverse section of another modified form of the apparatus of the invention; and

FIG. 8 is a view in perspective, an end of the drum being shown in section, of another modified form of the apparatus of the invention.

Referring to the drawings, with particular initial reference to FIG. 1 or FIG. 3, the apparatus may generally comprise a frame 10 having an angularly adjustable bed 12, two-way acting power means 14 to selectively position bed 12 at any desired angle relative to the horizontal, a cylindrical drum 16, means 18 and 20 to rotatably support the drum on bed 12, and variable speed drive means 22, 24, and 26 to rotate the drum.

In the embodiment of the apparatus of this invention shown in FIGS. 1 and 2, drum 16 comprises: an outer cylindrical shell or wall 26; an annular end plate 32 defining an input opening 34 for the base particulate material 36; an annular end plate 38 defining an output opening 40 disposed in feed relation to a receiver 42 for the agglomerate material 44; an agglomerating agent feed line 56 provided with a plurality of spaced spray nozzles 58 (FIG. 2); and a cylindrical bundle of parallel spaced cylindrical rods 60 carried by end rings 62 positioned against drum end plates 32 and 38.

It will be appreciated that, except for feed line 56, all of the above-described components of drum 16 rotate together as an integrated construction.

In another embodiment of the apparatus of this invention shown in FIGS. 3 and 4, drum 16 comprises: an outer cylindrical shell or wall 28; an inner cylindrical shell or wall 30; an annular end plate 32 defining an input opening 34 for the base particulate material 36; an annular end plate 38 defining an output opening 40 disposed in feed relation to a receiver 42 for the agglomerate material 44; a spiral conveyor vane 46 to help move the material 36 through the drum; a cylindrical screen 48 of a mesh size to pass fines 49 (FIG. 4) to the annular chamber 50 between shells 28 and 30; a spiral conveyor vane 52 in chamber 50 to return the fines to the input end of the drum; ports 54 at the input end of inner shell 30 to permit the fines to refeed into the inner shell for repassage therethrough; an agglomerating agent feed line 56 provided with a plurality of spaced spray nozzles 58 (FIG. 2); and a cylindrical bundle of parallel spaced cylindrical rods 60 carried by end rings 62 positioned against drum end plates 32 and 38.

The embodiment of the apparatus of this invention shown in FIGS. 3 and 4 shows a conveyor means (spiral conveyor vane 46) disposed within the drum between the inner surface of shell or wall 30 and the cylindrical bundle of parallel spaced cylindrical rods 60. Although it is preferred to so dispose a conveyor means in drum 16 to help move material 36 through the drum, a conveyor means is not necessary to so move material 36.

Again, it will be appreciated that, except for feed line 56, all of the above-described components of drum 16 rotate together as an integrated construction.

With reference to FIGS. 2 and 4, the drum is shown as rotating in a counterclockwise direction, the material 36 therefore tending to assume an overall sloped configuration, being piled up toward the right in FIGS. 2 and 4. As is shown in FIG. 2 the lower strata of material 36 moves in a counterclockwise direction under the influences of rods 60 and a drag effect imparted by shell 30. In the embodiment shown in FIG. 4, the lower strata of material 36 moves in a counterclockwise direction under the influence of vane 46, rods 60 and a drag effect imparted by shell 30. The upper strata of material 36 moves in a clockwise direction under the influence of gravity acting on the sloping pile. Between these oppositely moving upper and lower strata the central strata or region of the material 36 tends to be stationary or dormant between the countermoving upper and lower strata.

One of the functions served by the rods 60 is to move through the dormant region and impart movement to the material within this region, thereby causing this normally dormant material to be moved upwardly and to thereafter become mixed with the normally moving upper and lower strata material. Thus, the rods 60 act as a mixing and homogenizing means. Because of this function of the rods 60, none of the particulate base of feed material may remain covered over and dormant, and therefore, none of the base material passes through the drum without adequate exposure to the agglomerating agent, whether the latter be spray-applied, as in FIGS. 2 and 4—7, or whether it be injection-applied, as in FIG. 8, hereinafter described.

Further important functions served by the rods 60 are as follows: they lift or convey the base material upwardly along the wall of (FIGS. drum (FIGS. 2, 4 and 5) to a greater extent than (FIGS. would occur in their absence; and they permit the material to cascade over and around them, i.e. through the spaces between adjacent rods FIGS. 2, 4 and 5), thereby causing the formation of a plurality of vertically disposed and

horizontally spaced curtains, into which the agglomerating agent is sprayed FIGS. 2, and 4—7).

As indicated in FIGS. 2, 4 and 5, the spray heads or nozzles 58, emit the agglomerating agent, normally and typically a sticky liquid, in a vertically narrow and horizontally broad spray pattern. There are a plurality of curtains of falling material between the nozzles and the particular rod or rods disposed in the path of movement of the agglomerating agent spray. An important consequence of this is neither the rods, nor any of the other components of the drum, become wetted or contacted by the agglomerating agent. Thus, no gumming up of the equipment occurs, and need for equipment stoppages for clean-outs is eliminated. It is of importance, relative to the protection of the rods against wetting by the agglomerating agent, that the agglomerating agent liquid not be atomized by the spray head system. Hence, conventional spray heads are selected to provide a flat, fanshaped droplet spray pattern.

A further important consequence of spraying the agglomerating agent into one or more active, moving curtains of particulate material is that the end product agglomerate is obtained with a minimum of lumps.

Typical dimensional, operational and other data concerning the apparatus are as follows: a 60 inch diameter drum is a practical size; the rods 60 may be formed of metal and be relatively stiff or they can be resilient, e.g. formed of a flexible rubber; for a 60 inch diameter drum and spray application of agglomerating agent, the rods 60 can, for example, be three-quarter inch in diameter, and adjacent rods can, for example, be located on 2 inch centers; the surface speed of the drum can be, for example, from about 15 to about 60 feet per minute; concentric rows of rods 60 can be employed, as shown in FIG. 7; in lieu of the rods 60, the dormant material can be moved and the falling curtains formed by a cylindrical plate member 62 (FIG. 6), on the order of about one-fourth inch in thickness, having closely spaced staggered ranks and rows of cylindrical holes 64 through which the material falls for spray application; the agglomerating agent may be injected directly into the normally dormant region, as by the feed tube 56 and injection tubes 66 shown in FIG. 8, so that the mixing of agglomerating agent and particulate material takes place by way of panning action; in the panning action operation of the unit of FIG. 8 adjacent rods 60 may be located on 8 inch centers; and dust can be sprayed on sticky particulate matter to form, for example, prills.

As an example of results obtained from use of the herein described apparatus, ground pepper dust of about 200 mesh was converted into agglomerates of about 60 mesh by placing about 55 gallons of the dust into the aforedescribed apparatus and then revolving drum 16 at about 15 r.p.m. for a few minutes and spraying water from nozzles 58 into falling curtains of the pepper.

Optionally, the embodiment of the apparatus of this invention shown in FIGS. 1 and 2 or the embodiment of the apparatus of this invention shown in FIGS. 3—5 can be modified to additionally comprise a spiral conveyor vane disposed within the drum 16 radially inwardly of the cylindrical bundle of parallel spaced cylindrical rods 60 and preferably adjacent thereto. This optional spiral conveyor vane helps move material 36 through the drum, although it is not necessary to so move material 36.

What I claim is:

1. Apparatus comprising a drum having an inlet and an outlet, conveyor means disposed within the drum and responsive to rotative movement to move particulate material through the drum from adjacent said inlet toward said outlet, means for imparting rotative movement to said conveyor means, and means disposed within the drum radially inwardly of the radially inner margin of said conveyor means and adapted to be rotated when said conveyor means is rotated to move through a radially intermediate region of said particulate material and thereby move and tend to lift material within said region, and cause said particulate material to cascade downwardly onto said particulate material in the form of one or more curtains.

2. The apparatus of claim 1, said last-mentioned means having defined therein a plurality of spaced passageways and means operable to discharge a spray of particle-coating medium into the path of movement of particulate material in said curtains.

3. The apparatus of claim 2, said drum being cylindrical, said conveyor means being a spiral vane attached to the inside surface of said drum and having a relatively abbreviated radial dimension, said means for imparting rotative movement to said conveyor means comprising means mounting said drum for rotation and means for rotating said drum.

4. The apparatus of claim 3, said last-mentioned means including a substantially cylindrical plate member supported by said drum substantially coaxially thereof for rotation therewith, said plate member having formed therein a plurality of closely spaced perforations.

5. Apparatus comprising a cylindrical drum having an inlet and an outlet, a spiral vane attached to the inside surface of said drum and having a relatively abbreviated radial dimension and responsive to rotative movement to move particulate material through the drum from adjacent said inlet toward said outlet, means for imparting rotative movement to said spiral vane said means comprising means mounting said drum for rotation and means for rotating said drum and means including a plurality of substantially parallel and substantially equispaced rods extending substantially longitudinally of said drum and supported by said drum for rotation therewith and disposed within the drum radially inwardly of the radially inner margin of said spiral vane and adapted to be rotated when said spiral vane is rotated to move through a radially intermediate region of said particulate material and thereby move and tend to lift material within said region and having defined therein a plurality of spaced passageways through which lifted particulate material drops downwardly, and means operable to discharge a spray of particle-coating medium in the path of movement of particulate material from said passageways.

6. Apparatus comprising a cylindrical drum having an inlet and an outlet, a spiral vane attached to the inside surface of said drum and having a relatively abbreviated radial dimension and responsive to rotative movement to move particulate material through the drum from adjacent said inlet toward said outlet, means for imparting rotative movement to said spiral vane said means comprising means mounting said drum and means disposed within the drum radially inwardly of the radially inner margin of said spiral vane and adapted to be rotated when said spiral vane is rotated to move through a radially intermediate region of said particulate material and thereby move and tend to lift material within said region and having defined therein a plurality of spaced passageways through which lifted particulate material drops downwardly, and means operable to discharge a spray of particle-coating medium in the path of movement of particulate material from said passageways, including means for returning fines from the outlet of said drum to the inlet end thereof, said means comprising a cylindrical shell attached to said drum outwardly and coaxially thereof to define therewith an annular chamber, a screen for admitting fines to said chamber from the outlet end of said drum, a spiral vane within said chamber attached to said shell adapted to move fines through said chamber toward the inlet end of said drum, and a plurality of ports formed in said drum adjacent the inlet end thereof and adapted to pass fines from said chamber into said drum.

7. Apparatus comprising a drum having an inlet and an outlet, means for imparting rotative movement to said drum, means including a plurality of rods extending substantially longitudinally of said drum and supported by said drum and disposed within the drum radially inwardly of the inner surface of said drum and adapted to be rotated when said drum is rotated to move through a radially intermediate region of said particulate material and thereby move and tend to lift material within said region, and having defined therein a plurality of spaced passageways through which lifted particulate material cascades downwardly onto said particulate material in the form of one or more curtains.

8. Apparatus comprising a drum having an inlet and an outlet, means for imparting rotative movement to said drum, means disposed within the drum radially inwardly of the inner surface of said drum and adapted to be rotated when said drum means is rotated to move through a radially intermediate region of said particulate material and thereby move and tend to lift material within said region, and cause said particulate material to cascade downwardly onto said particulate material in the form of one or more curtains, said last-mentioned means having defined therein a plurality of spaced passageways and means operable to discharge a spray of particle-coating medium into the path of movement of particulate material in said curtains.

9. Apparatus comprising a drum having an inlet and an outlet, means for imparting rotative movement to said drum, means disposed within the drum radially inwardly of the inner surface of said drum and adapted to be rotated when said drum means is rotated to move through a radially intermediate region of said particulate material and thereby move and tend to lift material within said region, and cause said particulate material to cascade downwardly onto said particulate material in the form of one or more curtains, said drum being cylindrical, said means for imparting rotative movement to said drum comprising means mounting said drum for rotation and means for rotating said drum.

10. Apparatus comprising a cylindrical drum having an inlet and an outlet, means for imparting rotative movement to said drum, said means comprising means mounting said drum for rotation and means for rotating said drum, and means including a plurality of substantially parallel and substantially equispaced rods extending substantially longitudinally of said drum and supported by said drum for rotation therewith and disposed within the drum radially inwardly of the inner surface of said drum and adapted to be rotated when said drum is rotated to move through a radially intermediate region of said particulate material and thereby move and tend to lift material within said region and having defined therein a plurality of spaced passageways through which lifted particulate material cascades downwardly onto said particulate material in the form of one or more curtains and means operable to discharge a spray of particle-coating medium in the path of movement of particulate material in said curtains.