Jan. 28, 1969 P. R. LAGUILHARRE 3,423,843

EQUIPMENT FOR DRYING BY SPRAY ATOMIZATION

Filed April 10, 1967 Sheet 1 of 2

Fig. 1

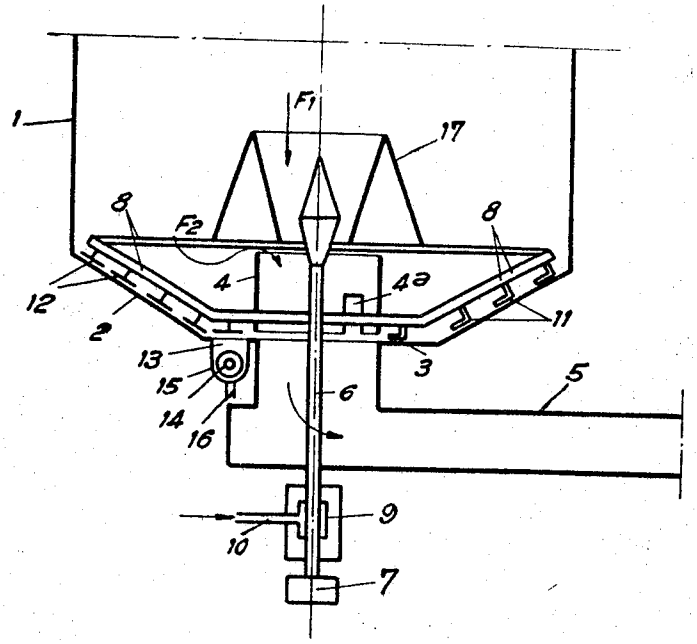

Fig. 2

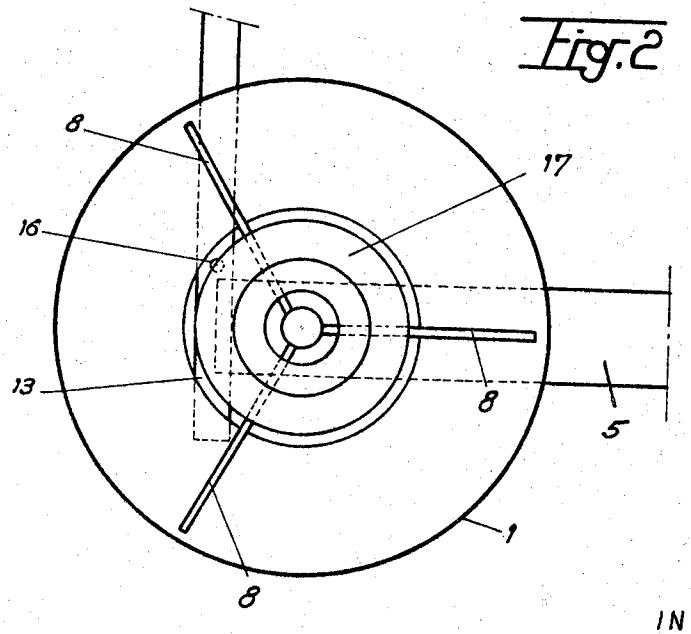

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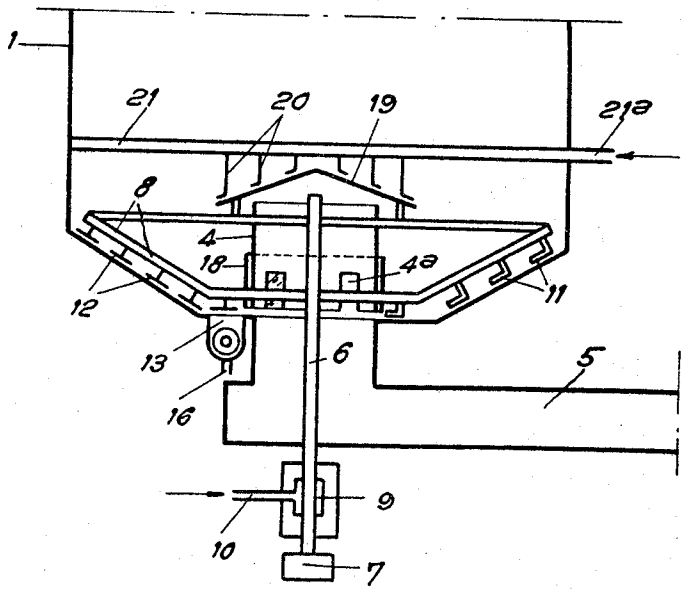
Fig. 3



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EQUIPMENT FOR DRYING BY SPRAY ATOMIZATION

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U.S. Cl. 34—57 18 Claims
Int. Cl. F41g 17/18, 17/34

ABSTRACT OF THE DISCLOSURE

A spray atomization drying device having a tower-like chamber with a bottom wall on which is deposited powder. The bottom wall of the chamber contains a first outlet for the powder and a separate independent outlet for the drying air. Rotating scrapers mounted within the chamber supply the powder to the first outlet. Shell means, a portion of which is movable, permits the device to be converted whereby the powder deposited on the base is removed from the chamber with the drying air.

This invention relates to equipment for drying by spray atomization of the type in which the material to be dried, which is presented either in the state of a solution or a suspension in a liquid, is sprayed in the form of a highly divided mist into a drying chamber through which is circulated a stream of hot air, thereby making it possible to obtain the dried material in a powdered form.

In some units of this type which are at present known, the powder which results from the drying process and which collects at the bottom of the drying chamber is wholly discharged with the drying air and directed towards separating units (usually cyclones) in which the powder is separated from the drying air.

In other units of known types, only a small proportion of the powder which is formed is discharged with the drying air and directed towards the separating units, the major part of the powder which collects at the bottom of the drying chamber being extracted directly from this latter.

The invention is directed to a drying chamber which is constructed for the purpose of operating with two independent outlets for the powder and for the drying air. Some of the elements of said chamber can also be advantageously arranged so that, by means of a simple transformation, it is possible to change over at will and with great ease from the design solution which comprises two independent outlets to the design solution which comprises one outlet for discharging the entire quantity of the powder together with the drying air.

The drying chamber in accordance with the invention, as designed in principle in the form of a cylindrical tower provided with a flat or slightly conical annular base, the central opening of which is adapted to communicate with a duct which is connected to units for separating the powder, there being placed above said base at least one rotating radial arm and members carried by said arm in proximity to said base for the purpose of producing a sweeping action on the powder which is deposited thereon, is essentially characterized in that a shell which extends up to a predetermined height within said chamber is joined to the central opening of the base in order to ensure effective separation between the powder which is deposited on said base and

the drying air which is discharged through the said central opening, a suitable outlet being additionally formed in the base of the chamber for the purpose of discharging the powder which is downwardly impelled by the sweeping members.

Under these conditions, the discharge of the drying air which contains a small proportion of the powder and the discharge of the major part of the powder are carried out respectively through the central shell and through the outlet formed in the base of the chamber.

The sweeping members carried by the rotating arms which are mounted above the base can accordingly consist of either scrapers or blowing nozzles of the type described in French Patent No. 982,625 of Jan. 18, 1949, or of scrapers and nozzles employed in combination. The powder outlet can be connected to a pneumatic device for the withdrawal of powder or, alternatively, said outlet can consist of a slot beneath which can be disposed a mechanical extraction device which advantageously consists of a screw-conveyor or worm mounted in a trough which is provided with a discharge orifice.

According to another feature of the invention, in order to permit the transformation of the drying chamber into a chamber comprising a single outlet for the drying air and for the whole quantity of powder, the central shell can be made readily detachable or convertible in such a manner as to permit the possibility of establishing at the level of the base of the chamber a communication between said base and the pipe for the discharge of drying air so that the powder which is deposited on the base can thus be removed with the drying air.

The above-mentioned communication between the base of the drying chamber and the drying-air discharge pipe can be established in a number of different ways, a few non-limitative examples of which are given hereunder:

The central shell can be provided at the bottom and immediately above the level of the base of the chamber with slots which can be closed off by movable or detachable plates or by a second shell which is concentric with the first and capable of angular displacement when the chamber is intended to have two separate outlets for the drying air and for the powder.

The central shell can be formed by two superposed shells, the lower shell which is adjacent to the base of the drying chamber being demountable in order to form between the upper shell and the base a free space which permits the discharge of the powder with the drying air when it is desired to provide the chamber with only one outlet.

The rotating arms which are disposed above the base of the chamber are in principle of hollow construction and connected to a pressurized-air duct, said arms being provided with blowing nozzles which have their openings near the base and in a direction such that the action of said nozzles can be either added to or substituted for the action of the aforesaid scrapers or utilized in order to reinforce the action of said scrapers which can either be detachable or articulated in order that they may be rendered inoperative at will.

In all cases, the central shell can be surmounted by a deflector and air distributor proper as contemplated in French Patent No. 1,388,856 of Dec. 26, 1963, the function of which is to regularize the distribution of the hot-air filaments in downward flow motion within the chamber in order to prevent any concentration of said filaments near the center-line of said chamber, the consequence of which would be to produce a substantial entrainment of powder towards the air outlet. Said deflector can ad-

vantageously be constituted by two coaxial frusto-conical shells having opposite conicities and joined together at their top bases. This arrangement makes it possible in particular to obtain a reduction in height with respect to the conical shape illustrated in the above-cited French patent. The shell can also be constructed in the form of a simple cone which, in this case, is surmounted by a sweeping device for the purpose of moving down to the base of the chamber the powder which is deposited on the top face thereof.

Whatever the shape adopted, the air-distributing deflector can be rigidly fixed to one of the rotating arms which are intended to effect the sweeping of the chamber base, in which case said deflector is rotatable whilst any sweeping device with which it may be provided is stationary. Alternatively, said deflector can be rigidly fixed to the chamber, in which case it is stationary whilst its own sweeping device is rotatably coupled to the arms which are intended to sweep the base of the chamber.

The central shell also can either be angularly fixed in a stationary position or coupled to the rotary sweeping arms in order to rotate with these latter.

Further particular features of the invention will be brought out by the complementary description which now follows below, reference being made to the accompanying drawings which are given solely by way of example and not in any limiting sense, and in which:

FIG. 1 is a diagrammatic vertical cross-section of one form of construction of the drying chamber in accordance with the invention; in the left-hand portion of the figure is shown the arrangement of the elements which are employed in order to obtain two separate outlets for the drying air and for the powder, and in the right-hand portion of the figure is shown the arrangement which corresponds to the obtainment of a single outlet for both the air and the powder;

FIG. 2 is a plan view corresponding to FIG. 1;

FIG. 3 is a diagrammatic cross-section of an alternative form of construction.

In the exemplified embodiment which is illustrated in FIG. 1, the reference numeral **1** designates the lower cylindrical portion of the drying chamber of a spray-dryer, the base of which comprises a slightly conical wall **2** followed by an annular horizontal portion **3**. The central opening of said horizontal portion **3** as shown in this embodiment is joined to a shell **4** which extends up to a given height within the chamber **1** and the lower end of which is connected to a duct **5** through which drying air is discharged after having passed through the chamber **1**, said duct being connected in turn at the other end thereof to units for separating the powder such as cyclones (which have not been shown in the drawings). In this embodiment, the shell **4** is provided at the lower end with slots **4***a* which can either be covered or uncovered at will by means of demountable plates (not shown) which are attached to said shell.

There is mounted in the center-line of the shell **4** a shaft **6** which can be rotatably driven by any suitable mechanism as shown diagrammatically at **7** and which is provided at the upper end thereof with arms **8** (provision being made for three arms in the example shown) which extend radially within the chamber **1** (as shown in FIG. 2).

In this form of execution, the shaft **6** is of hollow construction and is connected by means of a rotary seal **9** to a compressed-air blowing pipe **10**. The arms **8** which are joined to the upper end of said shaft are also hollow and provided in each case with blowing nozzles **11** as shown diagrammatically on the right-hand side of FIG. 1, said nozzles being directed towards the base **2–3** of the drying chamber **1**. Each arm is additionally provided opposite to the base **2–3** with scrapers **12** which are shown diagrammatically on the left-hand side of the figure; these scrapers can be detachably fixed on the arms **8** in order that they may be detached at will. As a preferred alternative, said scrapers are pivotally mounted on said arms so that they can thus be raised in order to be rendered inoperative or lowered to the position shown in the figure for the purpose of scraping the base **2–3** of the drying chamber.

In the horizontal portion **3** of the base of the drying chamber **1**, there is formed a powder outlet **13** which is preferably constituted by a transverse slot of fairly substantial dimensions, beneath which there can be mounted an extraction screw-conveyor **14** mounted in a trough **15** which is provided at one end with a discharge outlet **16** (as shown in FIG. 2). The slot **13** can be shut off at will by means of a removable cover (not shown) which is constituted, for example, by a sheet-member.

The central shell **4**, which is in this case rigidly fixed for rotation with the arms **8** is surmounted by an air-distributing deflector **17** which is located substantially in the center-line of the chamber **1** and the function of which is to regularize the distribution of the hot-air filaments within this latter and to lengthen their path in order to assist the deposition of powder on the base **2–3**. In this example, the above-mentioned deflector, which is also rigidly fixed to the rotating arms **8**, is advantageously constituted by two frusto-conical shells having opposite conicities and joined together at their top bases which have substantially the same diameter. Thus, as stated earlier, this shape permits of a reduction in height compared with a deflector which consists of a simple cone.

The operation of the device as thus constituted is as follows:

In order to obtain separate extraction of the major part of the powder on the one hand and of the drying air on the other hand, the slots **4***a* of the shell **4** are closed off as shown in the left-hand portion of FIG. 1 and the powder delivery slot **13** is freed. The supply of blowing air within the shaft **6** and arms **8** is either cut off or reduced and the scrapers **12** are placed in the scraping position. The powder which collects on the base **2–3** of the drying chamber **1** is then swept by the scrapers **12** and discharged through the outlet **13**, then extracted by means of the screw-conveyor **14** should provision be made for this latter, whilst the drying air which circulates downwardly inside the chamber **1** is permitted to pass towards the duct **5** both centrally of the air distributor **17** and between this latter and the top portion of the shell **4**, as indicated by the arrows F_1 and F_2.

In order to obtain an extraction of the entire quantity of powder with the drying air, the slots **4***a* of the shell **4** are uncovered as shown in the right-hand portion of FIG. 1, the powder outlet **13** is closed and, depending on whether it is desired to utilize either the scraper system or blowing system for the purpose of sweeping the powder or both systems conjointly, the scrapers **12** are left in the operating position while cutting off the supply of blowing air to the shaft **6** and arms **8**. Alternatively, the admission of blowing air is initiated whilst the scrapers **12** are either removed or lifted to their inoperative positions; or else the scrapers **12** are left in the operative position while simultaneously initiating the admission of blowing air into the shaft **6** and arms **8**. Under these conditions, the powder which collects on the base **2–3** of the chamber **1** is carried down into the duct **5** through the apertures or slots **4***a* of the shell **4**, either by the scrapers **12** or by the blowing air which is discharged through the nozzles **11** carried by the rotating arms **8** or by both the scrapers **12** and the blowing air at the same time; thus the powder is directed towards the cyclone separators at the same time as the drying air which is permitted to pass, as in the previous example, in the direction of the arrows F_1 and F_2, a fraction of said powder being additionally directed through the slots **4***a* of the shell **4**.

In the alternative form which is shown in FIG. 3, the slots **4***a* of the shell **4** are no longer covered by the addition of plates fixed in a demountable manner on the shell **4** but are closed off by a second shell **18** which is mounted concentrically with the first and provided with corre-

sponding slots. Said second shell is capable of angular displacement relatively to the shell **4** in such a manner as to be brought at will into a position in which it closes off the slots **4***a*, as can be seen in the left-hand portion of FIG. 3, or into a position in which its own slots coincide with the slots **4***a*, thereby uncovering these latter as shown in the right-hand portion of the figure. In addition, the air-distributing deflector which is mounted above the shell **4** is constituted by a conical deflector **19** which is also rigidly fixed to the rotating arms **8**. In this example, the powder which is deposited on the top surface of the deflector is swept so as to be projected onto the base **2–3** of the chamber **1** by suitably oriented and stationary blowing nozzles **20** which are branched on a tube **21**, said tube being adapted to pass diametrically through the chamber **1** and to admit at one end **21***a* a compressed-air blowing stream. The sweeping of the powder which is deposited on the deflector **19** could also be carried out by scraping by means of scrapers which are rigidly fixed to a stationary transverse arm.

As will be understood, the invention can also give rise to many different constructional variants in which some of the arrangements employed in the different forms of execution herein described and illustrated can be judiciously combined.

Moreover, in all cases, a rotational flow motion could be imparted to the drying air as it passes through the chamber **1** in order to enhance the separation of air from the powder and to increase the amount of powder which is deposited on the base of the drying chamber. The rotational motion referred-to can be obtained by means of directing-fins disposed either in the hot-air admission duct at the top of the chamber or within the air outlet at the bottom of the chamber, inside the central shell or alternatively within the interior or at the periphery of the air-distributing deflector which is located above said shell.

What is claimed is:

1. A drying chamber for spray-dryers, comprising:

cylindrical tower means having an annular base and defining therein a drying chamber, said annular base having a central opening adapted to be coupled with an external duct for discharging the drying air which is passed through said chamber, said base further having a downwardly opening powder discharge orifice formed therein spaced from said central opening;

arm means rotatably mounted within said chamber and means for rotating said arm means, said arm means being mounted above said base and extending radially relative thereto;

sweeping means carried by said arm means adjacent said base for sweeping the powder which is deposited on said base and for discharging the powder downwardly through said powder discharge orifice; and

shell means including peripheral wall means defining upper and lower openings positioned within said chamber adjacent said central opening and extending upwardly above said base for effecting separation between the powder and the drying air whereby the drying air passes out through said central opening and the powder is deposited on said base outwardly of said shell means, said shell means including a movable portion for permitting communication between said central opening and the portion of said base upon which said powder is deposited so as to selectively permit said powder to be discharged through said central opening with said drying air.

2. A drying chamber for spray-dryers as defined in claim **1**, wherein said base comprises a slightly conical peripheral annular portion and a substantially horizontal flat portion in which said central opening is formed.

3. A drying chamber for spray-dryers as defined in claim **2**, wherein said powder discharge orifice is formed in said flat portion of said base.

4. A drying chamber for spray-dryers as defined in claim **1**, wherein pneumatic means are connected to said powder discharge orifice for the purpose of extracting the powder.

5. A drying chamber for spray-dryers as defined in claim **1**, wherein said sweeping means includes scrapers whereby the powder is downwardly impelled through said discharge orifice.

6. A drying chamber for spray-dryers as defined in claim **1**, wherein said shell means includes a central shell member which is removable from said chamber so as to establish communication between said central opening and the portion of said base upon which said powder is deposited so that said powder on said base may be discharged together with the drying air through said central opening.

7. A drying chamber for spray-dryers as defined in claim **1**, wherein said shell means includes a shell provided with slots located immediately above said base, and closure means being provided whereby said slots may be covered or uncovered at will whereby powder can be discharged through the central opening when the slots are uncovered.

8. A drying chamber for spray-dryers as defined in claim **7**, wherein said closure means comprise movable plates which are mounted on said shell.

9. A drying chamber for spray-dryers as defined in claim **7**, wherein said closure means comprise a second shell which is mounted coaxially with said shell and which is capable of angular displacement relative to said shell.

10. A drying chamber for spray-dryers as defined in claim **1**, wherein said shell means comprises upper and lower superposed sections, the lower section being adjacent to said base and being removable so as to make it possible to establish a free space between the upper section and said base.

11. A drying chamber for spray-dryers as defined in claim **1** wherein said rotating arm means is of hollow construction and is connected to a pressurized-air-duct, said sweeping means including blowing nozzles which are connected to said arm means and have their openings near said base, said nozzles being oriented in such a manner as to direct the powder which is deposited on said base towards said powder discharge orifice.

12. A drying chamber for spray-dryers as defined in claim **13**, wherein said sweeping means further includes scrapers mounted on said arm means and being adapted to drive the powder downwardly through said powder discharge orifice, said scrapers being detachable from said arm means.

13. A drying chamber for spray-dryers as defined in claim **13**, wherein said sweeping means further includes scrapers mounted on said arm means and being adapted to impel the powder downwardly through said powder discharge orifice, said scrapers being pivotally mounted on said arm means in such a manner that they can be rendered inoperative at will.

14. A drying chamber for spray-dryers as defined in claim **1**, further including air-distribution means comprising a single cone positioned above said shell means for regulating the downward flow of drying air through said chamber, and second sweeping means arranged above said cone for removing powder which is deposited on the top face of said cone.

15. A drying chamber for spray-dryers as defined in laim **1**, further including air-distribution means rigidly fixed to said rotating arm means and positioned above said shell means for regulating the downward flow of drying air through said chamber.

16. A drying chamber for spray-dryers as defined in claim **1**, further including air-distribution means rigidly fixed to said chamber and positioned above said shell means for regulating the downward flow of drying air through said chamber.

17. A drying chamber for spray-dryers as defined in claim 1, wherein said shell means includes a central shell angularly fixed in a stationary position.

18. A drying chamber for spray-dryers as defined in claim 1, wherein said shell means includes a central shell coupled to said rotating arm means for rotation therewith.

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JOHN J. CAMBY, *Primary Examiner.*