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[54] **METHOD AND APPARATUS FOR CONTINUOUSLY DRYING A DRIPPING WET, GRANULAR OR LUMPY MATERIAL**

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[51] **Int. Cl.** **F26b 9/00**

[58] **Field of Search** 34/164, 10, 12, 14, 216, 34/217

[56] **References Cited**

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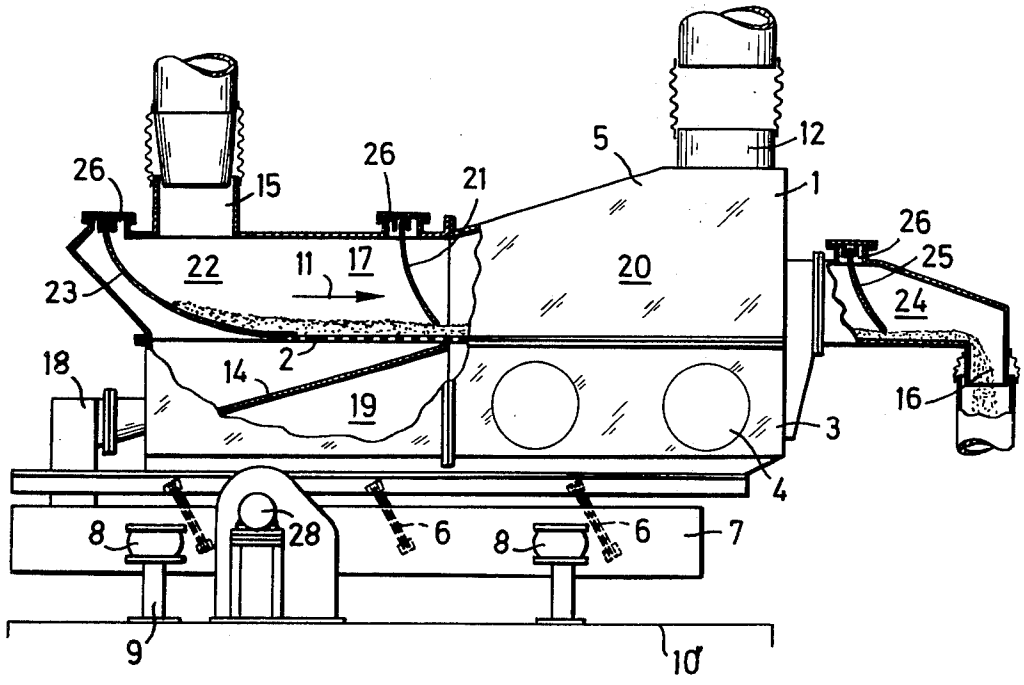
[57] **ABSTRACT**

A method and apparatus for continuously drying a dripping wet granular material which may be caked together characterized by draining the liquid from the material in a dehydration zone as it is received on a vibrating conveyor trough and then subsequently contacting the drying material with hot gases in a drying zone to remove the remaining moisture. Preferably, the hot gases are isolated in the drying zone by aprons between the drying zone and both the dehydration zone and a discharge chamber. The apparatus also preferably includes a distribution chamber having a flexible and elastic incline bottom to prevent breaking of fragile materials as they are being introduced onto the conveyor trough at the beginning of the dehydration zone.

5 Claims, 2 Drawing Figures



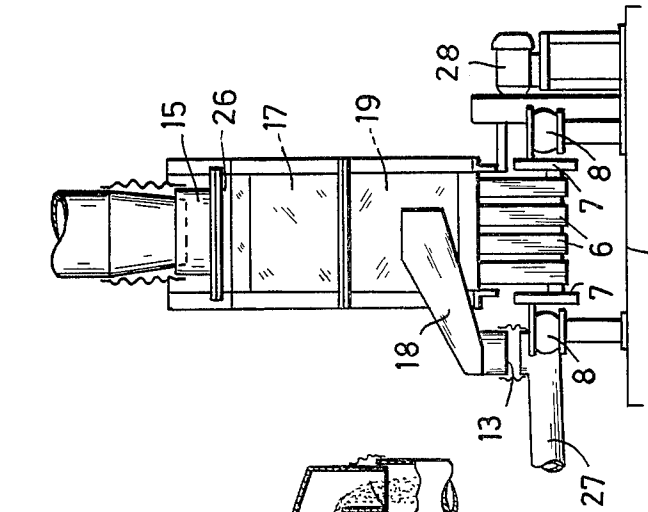

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FIG.2

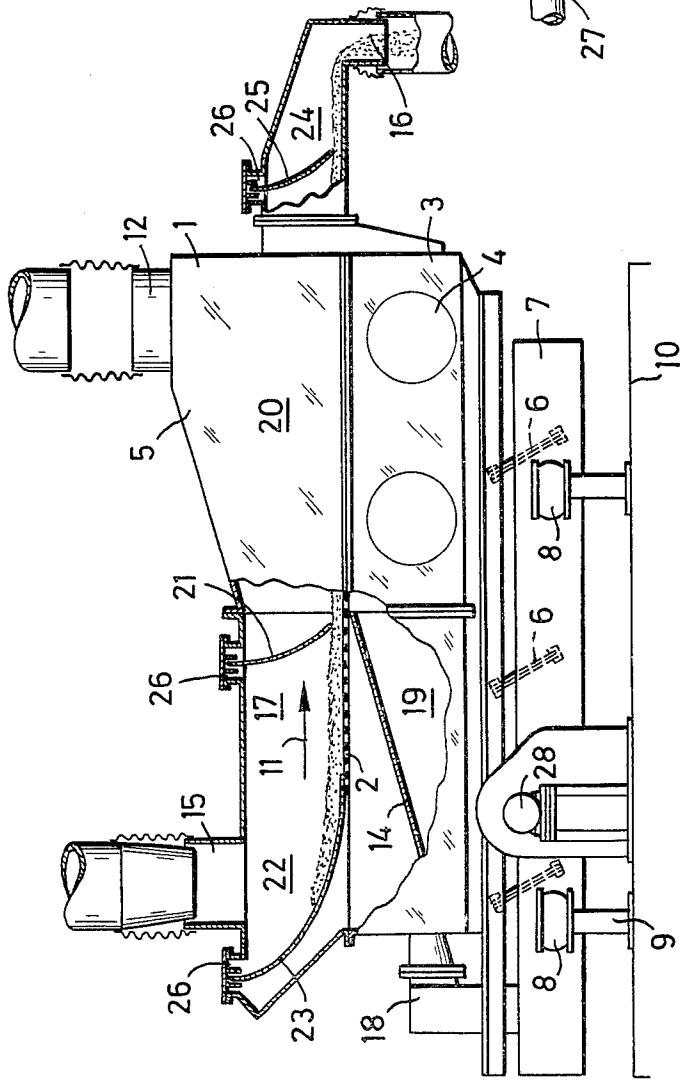
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FIG.1

METHOD AND APPARATUS FOR CONTINUOUSLY DRYING A DRIPPING WET, GRANULAR OR LUMPY MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a method and apparatus for the continuous drying of dripping wet, granular and/or lumpy materials with the aid of a vibrating conveyor chute or trough, which has a perforated bottom and extends from a material charging inlet to a material discharging aperture as it passes through a dehydration zone and drying zone.

2. Prior Art

Previously, dripping wet, granular and/or caked or lumpy materials were dried in the following manner. With the aid of a mechanically driven dehydration unit, for example, a dehydration drum, the liquid was separated from the material to a great extent. The still moist material was subsequently delivered by an additional conveyor device to a drying unit, for example, a throughput dryer, in which the liquid still adhering to the particles of material was dried off. This method, however, has the disadvantage that for the complete drying of the dripping wet material, at least three separate machine units were necessary. Thus, the prior art method resulted in high production costs, and required an appreciable space for the necessary equipment.

SUMMARY OF THE INVENTION

The present invention obviates the disadvantages of the known drying method and, particularly for the chemical industry, makes possible the withdrawal of liquid and the drying of dripping wet, granular and/or lumpy or caked materials in a simple and economical manner with the aid of a single machine unit or apparatus.

In accordance with the invention, the problem is solved in that the liquid is first drawn or drained from the materials in the conveyor trough with reference to the direction of feed in a dehydration zone and subsequently the remaining moisture is dried off with the aid of hot gases. By the arrangement of the apparatus, the individual steps of the method which are required for the drying of dripping wet materials are substantially stretched out or extended in their timely sequence, so that a greater output of materials and therewith a more economical establishment of the drying method can be attained. Furthermore, the method of the invention enables the unitary control of the drying operation by means of a single technically controlled installation, which in accordance with experience permits a more simple manipulation for the attendant personnel, so that frequent encroachments proportionate thereto which could disadvantageouly influence the drying process are prevent.

In a preferred embodiment of the invention, the hot drying gases are substantially isolated to the drying zone. In this manner, the entire heat content of the hot gases may be utilized for the removal of the remaining moisture of the material being dried. This isolation also prevents any flow of the gases into the dehydration zone in which the gases would cause a non-desirable evaporation of particles of liquid and accordingly an appreciable loss of heat energy.

In further embodiments of the invention, the method includes the steps of controlling the feed and withdrawal of the hot gases with respect to one another so that in the drying zone, practically the ambient pressure prevails. By the step of controlling the pressure in the drying zone, the method is advantageously attained and almost no steam of gases escapes along the conveyor trough which escaping gas may contain injurious particles of dust. Furthermore, the control of the pressure in the drying zone prevents the entry of cold air which would disadvantageously affect the degree of efficiency of the drying process. The step of controlling also enables the step of isolating to be accomplished with the provision of simple constructive measures, such as sealing of the dehydration zone from the drying zone as well as also a sufficient sealing of the drying zone with respect to the atmosphere.

The invention relates additionally to a single device or apparatus which dehydrates the dripping wet material and dries the material to perform the method. The apparatus includes an enclosure having a vibrating conveyor trough with perforated bottom, means for charging material, means for discharging material and means for creating a flow of hot gases in a drying zone. In this apparatus, one end of the conveyor trough is disposed beneath the means for charging and is adjacent a dehydration zone which is defined by a water collection device provided with a discharge aperture disposed beneath the one end. The other end of the conveyor trough is in a drying zone which is defined by the means creating a flow of hot gases which includes a gas distribution device provided with at least one gas inlet which distribution device is preferably arranged beneath the trough. The apparatus has a compact construction so that an economical installation is made possible even with restricted space conditions. The relatively high investment costs of the previously known drying installations, which consisted of at least one dehydration unit and one drying unit, are thereby substantially diminished.

In an embodiment of the apparatus according to the invention, the dehydration chamber or zone is separated from the drying chamber or zone by means for isolating which preferably is a flexible apron extending transversely to the longitudinal axis of the trough and reaching approximately the surface of the material. In this manner with the aid of simple, constructive measures, an almost complete seal is attained between the dehydration zone and the drying zone. Upon utilization of an apron of flexible material, the latter may lie directly on the drying material, so that advantageously the liquid mist caused by the vibrating movement of the trough is held back and at the same time the desired seal between the two treatment zones is supported. In an advantageous manner, the drying material is easily retained with the aid of the apron, so that in the dehydration zone with uniform load of material, the dehydration conditions are improved.

In a further embodiment of the device or apparatus according to the invention, the charging means with a material charging aperture which is in communication with the dehydration zone or chamber of the conveyor trough through a distributing chamber which has an inclined bottom consisting advantageously of an elastic or flexible material. The advantage of this embodiment consists that the material delivered to the apparatus is distributed uniformly in the front area or end of the dehydration chamber and that a rapid dehydration may

take place and accordingly the flow of material through the apparatus is substantially increased.

Another advantage of the construction of the embodiment of the invention is that the elastic or flexible bottom of the distributing chamber also vibrates so that caking of material during distribution on the conveyor trough are prevented and an even distribution of material can be obtained. The elastic construction of the bottom also provides an additional protection for brittle materials which are to be dried and which during charging are especially inclined to brittle-breakage.

In a preferred embodiment of the device or apparatus according to the invention, the drying chamber or zone is in connection with a discharge chamber and an apron, which is preferably adjustable and is preferably flexible, is located between the drying zone and discharge chamber and extends approximately to the material surface. The advantages of the apron is a simple sealing of the drying chamber with respect to the surrounding atmosphere and a damming of the material being conveyed on the trough. In this way, it is possible according to the conveyor characteristics of the drying material, which, as experience shows, may vary widely with different amounts of moisture to attain a constant time for passage of the material through the drying chamber so that each small grain of material experiences about the same drying time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic illustration with parts in section of the apparatus of the present invention; and

FIG. 2 is a front view of the apparatus of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The principles of the present invention are particularly useful in a drying apparatus having a conveyor trough 1 which has a perforated bottom 2 having holes of a size determined by the grain size of the material being dried. The trough 1 is closed on all sizes to form an enclosure of the apparatus.

The enclosure is oscillatably connected by a plurality of spring guides or suspensions 6 to a countermass or frame 7 which is suspended by rubber buffers 8 on supports 9 which extend from a base frame 10. To provide the oscillatory movement for the enclosure and trough 1, an oscillating drive 28, which may be either an eccentric or inertia drive, is mounted as the base 10 and connected to the enclosure for the trough 1.

The enclosure for the conveyor trough 1 is provided with means for charging which includes a material charging aperture or opening 15 and means for discharging a material which includes a material discharge aperture or opening 16. The trough 1 extends along the length of the enclosure and conveys material in direction 11 through four individual zones or chambers. A material distribution chamber or zone 22 is arranged directly beneath the aperture 15 and distributes the wet material to the trough 1 which conveys the material through a dehydration zone or chamber 17 into a drying zone or chamber 20. From the drying zone 20, the trough 1 conveys the material into a discharge zone or chamber 24 which is attached by a flange to the drying chamber 20 and has the aperture 16.

Underneath the perforated bottom 2 there is arranged in the area of the dehydration zone 17, a water collection device 19, which preferably consists of a simple container with slanting or inclined bottom 14 and which device prevents the flow of hot gases through the overlying perforated bottom and isolates the dripping or draining liquid from the hot gases. In the lower area of the water collection device 19 (FIG. 2) the device has a water-flow-off device 18, which has a discharge aperture 13 which may, for example, be connected to a waste-water conduit 27.

In the drying chamber or zone 20, a hot gas distribution device or means 3 is arranged beneath the perforated bottom 2 of the trough. The distribution device may be a wind-box with hot gas inlets 4 which are in communication with a source of hot gas, such as a hot gas producer (not shown). The enclosure above the bottom 2 includes a gas discharge hood 5 to close the drying zone 20 and the hood has an upwardly extending portion which terminates with a gas-discharge conduit 12 which is connected to a suction blower (not shown).

The distribution chamber 22 has an inclined bottom 23, which advantageously is constructed of a rubber or elastic material and extends transversely to the longitudinal axis of the trough 1 over the entire width of the trough 1. Approximately in the middle of the trough in the area between the dehydration zone 17 and the drying zone 20, preferably a separating apron 21 extends transversely to the longitudinal axis of the trough and extends from the upper wall of the enclosure to approximately the surface of the material on the bottom 2. The apron 21 separates or isolates the dehydration zone 17 and drying zone from one another. This separating apron 21 consists advantageously of an elastic material, for example, rubber or the like. In the discharge chamber 24, adjacent to the drying zone 20, a stoppage apron 25, which is preferably of a flexible construction, is provided to extend transversely to the direction 11 and to reach approximately to the material surface. The stoppage apron 25 covers the cross section of the discharge chamber 24 and accordingly seals the drying chamber 20 with respect to the surrounding atmosphere.

The inclined bottom 23, the separating apron 21 and the stoppage apron 25 each may extend through a separate closable mounting slot 26 which extend transversely to the axis of the trough. Thus, each of these members or elements may be easily exchanged after wear. Each of the mounting slots 26 may be provided with means to enable adjusting the length of the aprons 21 and 25 or the length of the bottom 23 according to the characteristics of the material to be dried.

In operation the dripping wet, granular and/or lumpy materials are continuously supplied through the material supply opening 15 of the distribution chamber 22 onto the one end of the conveyor trough 1. The wet materials first encounter the inclined, elastic bottom 23 of the distribution chamer 22 which uniformly distributed the material over the width of the trough 1 as it reaches the perforated bottom 2 of the dehydration chamber 17. Due to the vibrating movements of the trough 1, the material is almost completely dehydrated in a short time. The liquid derived from the dripping wet material drains through the perforated bottom into the water collection device 19 and then flows along bottom 14 to the water discharge device 18. The water discharge device 18 discharges the liquid through opening 13 into a waste-water conduit 27 which may convey the liquid to a liquid purification system (not shown).

Due to the elastic nature of the bottom **23** of the distribution chamber **22,** the dripping wet material, which has a tendency for caking, is centrifuged again by the bottom **23** and this self-purification effect results and clogging in the area of the material inlet is permanently prevented.

The elastic apron **21,** which is arranged approximately in the middle of the conveyor trough **1,** between the dehydration zone **17** and drying zone **20,** prevents any mist or water spray present in the dehydration chamber from entering the drying zone **20.** The apron **21** also retains the material and aids in uniformly distributing it over the surface of the perforated bottom, so that a rapid dehydration of the charged material is achieved.

After the material has been almost completely dehydrated in the dehydration zone **17,** it is conveyed into the drying zone **20,** in which the remaining moisture is dried off. To dry the material, hot gases are introduced through the openings **4** of the wind-box **3,** to flow through the openings in the perforated bottom **2** of the drying chamber **20** and through the layer of material disposed on the bottom. The hot gases will absorb the residual moisture and are then discharged through the gas discharge conduit of hood **5** which conduit is connected to a suction device. Advantageously, the hot gas supply and hot gas discharge are controlled and proportioned to one another so that the pressure in the drying zone is substantially the same as the surrounding pressure.

The material completely dried upon passage through the drying chamber **20** is conveyed into the discharge chamber **24** and conveyed through the discharge opening **16** to a collecting device or container (not shown). By means of the stoppage apron **25** of the discharge chamber **24,** the drying chamber **20** is sealed against the surrounding atmosphere and at the same time the material being dried is held back. In this manner, a uniformly high layer of material is produced on the bottom **2** of the drying chamber **20,** so that a uniform distribution and flow-through of the hot gases is attained through the entire material to be dried which material is disposed on the bottom **2.** This is an advantage particularly when granular or lumpy materials are processes which have a strong shrinkage phenomena during drying and for which the height of the temperature and the time of the thermic effect must be accurately maintained. Through the adjustability of the hold-back apron **25,** the period of time in the drying zone can be changed or adjusted. Thus, with an optimum use of the amount of heat present in the hot gases and according to the characteristics of the material, the duration of time necessary for the material in the drying chamber can be adjusted in a simple manner, so that for the individual particles of material, almost the same drying periods are insured.

The construction of the vibration dryer according to the invention is not limited solely to the embodiment illustrated as a sample construction. Particularly, the position of the separating apron **21** between the dehydration zone **17** and the drying zone **20** may be adapted to the characteristics in each case of the goods or materials to be dried. Thus, for example, it is possible without departing from the scope of the invention, and with dripping wet goods which permit a very rapid dehydration, to provide a dehydration chamber or zone of shorter length. Thus, the inclined bottom **23** of the distribution chamber **22** may be at least partially perforated in a sieve-like manner, so that the advantage of the compact construction of the dryer according to the invention is more clearly apparent.

Although minor modifications might be suggested by those versed in the art, it should be understood that we wish to employ within the scope of the patent granted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

We claim:

1. An apparatus for the continuous drying of dripping wet granular material, comprising an enclosure having a vibrating conveyor trough with a perforated bottom, said enclosure having means for charging the material to be dried onto one end of the conveyor trough and means for discharging dried material from the other end of the trough, means disposed in the enclosure beneath said one end of the conveyor trough for collecting liquid dripping through the perforated bottom of the trough, said collecting means including a liquid discharge opening, and means for creating a flow of hot gases through a portion of the conveyor troughs to form a drying zone to dry material thereon, said means for creating including a gas distribution device having at least one hot gas inlet on one side of the trough and a hot gas outlet on the opposite side, said collecting means isolating the dripping liquid from the flow of hot gases, said means for discharging material comprising a discharge chamber having a material discharge opening, said discharge chamber being in connection with the drying zone by an opening having means for isolating the flow of hot gases from the discharge chamber, said means for isolating including an adjustable and flexible apron extending transversely across the direction of a flow of the material into the discharge chamber, said apron contacting the surface of the flow of material.

2. An apparatus according to claim **1,** wherein the means for charging material include a material charging opening in connection with a distribution chamber having an incline bottom of elastic material, said distribution chamber distributing material from the charging opening onto the one end of the conveyor trough.

3. An apparatus for the continuous drying of dripping wet granular material, comprising an enclosure having a vibrating conveyor trough with a perforated bottom, said enclosure having means for charging the material to be dried onto one end of the conveyor trough and means for discharging dried material from the other end of the trough, means disposed in the enclosure beneath said one end of the conveyor trough for collecting liquid dripping through the perforated bottom of the trough, said collecting means including a liquid discharge opening, means for creating a flow of hot gases through a portion of the conveyor troughs to form a drying zone to dry material thereon, said means for creating including a gas distribution device having at least one hot gas inlet on one side of the trough and a hot gas outlet on the opposite side, and said enclosure including means for isolating a flow of gas in the drying zone from the portion of the enclosure containing the means for collecting liquid, said means for isolating including a flexible apron extending transversely to the longitudinal axis of the trough and reaching approximately to the surface of the material moving thereon.

4. An apparatus according to claim 3, wherein the means for discharging material comprises a discharge chamber having a material discharge opening, said discharge chamber being in connection with the drying zone by an opening having means for isolating the flow of hot gases from the discharge chamber said means for isolating including an adjustable and flexible apron extending transversely across the direction of flow of the material into the discharge chamber, said apron contacting the surface of the flow of material.

5. An apparatus according to claim 3, wherein the means for charging material include a material charging opening in connection with a distribution chamber having an incline bottom of elastic material, said distribution chamber distributing material from the charging opening onto the one end of the conveyor trough.

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