Aug. 17, 1937. C. E. BILL 2,090,177

METHOD OF AND APPARATUS FOR DRYING SPECIAL MATERIALS

Filed April 20, 1936

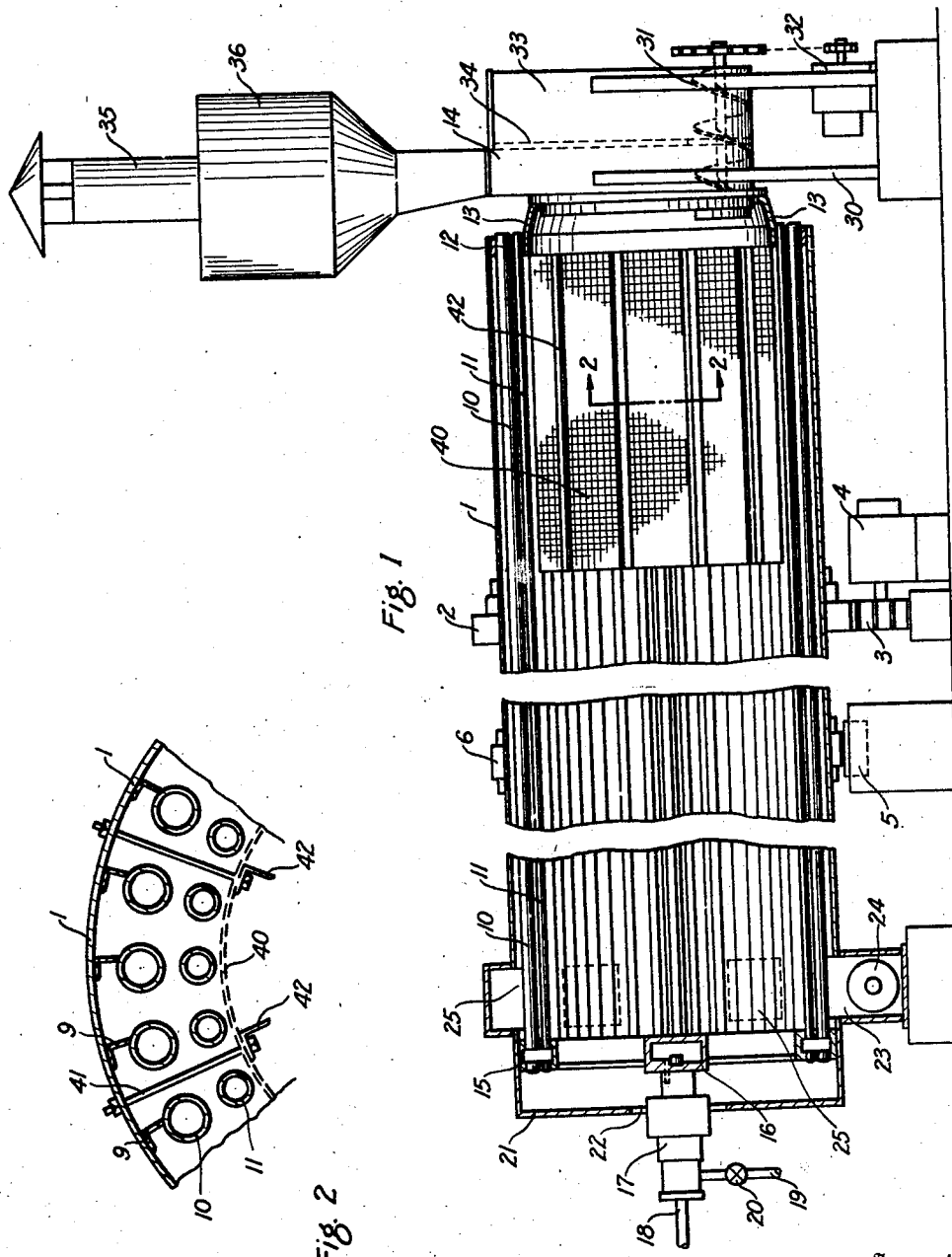

Fig. 1

Fig. 2

Inventor
Clifford E. Bill

By W E Sherwood
Attorney

Patented Aug. 17, 1937

2,090,177

UNITED STATES PATENT OFFICE

2,090,177

METHOD OF AND APPARATUS FOR DRYING SPECIAL MATERIALS

Clifford E. Bill, Louisville, Ky., assignor to Louisville Drying Machinery Company, Incorporated, Louisville, Ky., a corporation of Kentucky

Application April 20, 1936, Serial No. 75,407

11 Claims. (Cl. 34—6)

This invention relates to the art of drying special materials which have the characteristic of adhering to drying surfaces and forming scaly deposits upon the same. More particularly, it relates to an improved method of and apparatus for rapidly and efficiently drying materials useful in the various arts. For example, the invention has been used successfully in the drying of zinc oxides, lithopone, titanium oxides, white lead, bentonite, carbon black, and various clays, pigments and silicas. It is to be expressly understood, however, that although the invention is described as being especially well adapted to the drying of these enumerated substances it is by no means limited to use solely with those substances. On the contrary, the invention may well be used in the drying of many other materials capable of being dried in the conventional rotary drier.

As is well known to those skilled in the art, the drying of certain substances, as for example, titanium oxide, presents a rather difficult problem. In preparing this and other substances used as ingredients in paints it is customary to grind the same in a mill, dewater the substance and deposit the same in a drier. Since the substance to be dried may have as much as 40% or more of moisture when entering the drier and may be required to have as little as one-tenth of 1% moisture when leaving the drier, it is obvious that an efficient drying process must take place. Many of the substances encountered in the art contain so much moisture that they may be pumped into the drier or may be moved in a plastic state by means of a conveyor. Upon entering the revolving drier such substances first tend to agglomerate into large, sticky masses which must be broken up by mechanical means such as flights or barriers disposed so as to shower the substance even in smaller masses across the drier cross section. However, if such a substance were permitted to drop directly upon the hot heating surface of the drier's steam tubes, it would tend to form a film upon the tubes, wedge in masses between the tubes and dry in an inefficient manner. The hard scale formed upon the tubes would also appear in the final product as small flinty particles which are objectionable and lower the value of the dried material.

This problem has long been known and various attempts have been made to overcome the same. The common expedient has been to provide a solid apron inside the inner row of steam tubes and to drop the wet material on this apron to effect a partial drying before permitting the material to contact the hot tubes. In such an installation the drying effect is quite limited, since the conduction of heat from the tubes at the feed end of the drier is lost. This then results in the use of a longer drier, a longer drying period and a less efficient process in order to accomplish the desired end. Other constructions adapted to permit the material to contact only a part of the surface of the steam tubes or to prevent the material from wedging under the tubes have been used, but due to expense in manufacture and to the fact that the caking of the material was only partially reduced, these attempts have not been successful. In addition, the mixing of predried materials with the incoming wet material prior to entering the drier has been tried for the purpose of lowering the average moisture-content of the material entering the drier, but this too has not resulted in a solution of the problem.

As a result of experimentation it has been found that if small particles of the wet material, after entering the drier, are used as a heat conducting agent near the feed end of the drier and the bulk of the wet material is kept from direct contact with the hot tubes near the feed end of such drier, a more efficient process will result and the disadvantages in drying the special materials above noted will be overcome.

This invention, therefore, has as a chief object the provision of an efficient method of drying special materials whereby the caking of the material on the drying surfaces is eliminated.

Another object is the teaching of a method of drying special materials wherein the above object is accomplished without sacrificing the rapidity of drying or the degree of drying.

Another object is the provision of a simple and practicable apparatus for carrying out the drying process.

Other objects and advantages of the invention will become evident as the description proceeds when considered in connection with the accompanying drawing, in which

Figure 1 is a partial sectional view of one form of apparatus suitable for carrying out the invention and

Figure 2 is a sectional view taken on line 2—2 of Figure 1.

As disclosed in Figure 1 a cylindrical rotary drier 1 is provided with a gear 2 upon its outer surface. This gear is adapted to mesh with a second gear 3 driven by any suitable prime mover 4 and to rotate the drier at a controlled rate of speed. Supporting rolls 5, one of which is shown, afford a secure bearing surface for collars 6

affixed to the outer surface of the drier and function to sustain the weight of the drier. Drier 1 is mounted with a slight inclination extending from the elevated feed end to the depressed outlet end and the material introduced into the drier travels therethrough under the influence of gravity due to this construction.

The drier is provided with a plurality of steam tubes 10 and 11 of different sizes serving as a drying means. Such tubes are preferably arranged concentrically about the periphery of the drier in two rows with the row of smaller tubes 11 nearer the center of the drier. For the purpose of lifting material and showering it across the drier cross section, conventional barriers or flights 9 may be interposed between tubes 10 and drier surface 1 and may function in the manner hereinafter described. The steam tubes are housed near the feed end of the drier in a plate 12 which terminates in a centrally disposed collar 13 adapted to coact with the stationary inlet housing 14 to provide a secure joint between the rotary and stationary elements.

At the outlet end of the drier the tubes 10 and 11 are housed in a manifold member 15 connected to a centrally disposed chamber 16 by suitable pipes (not shown) in a manner similar to that disclosed in the United States Letters Patent, No. 1,139,663 issued to Charles E. Geiger. Although this particular construction of the drier forms no essential part of the present invention, it may be stated that the steam is supplied to tubes 10 and 11 and the condensate is removed therefrom in a simple and efficient manner by means of this construction. Connected to chamber 16 is a housing 17 of any suitable construction adapted to provide an efficient joint between the stationary elements and the rotating drier and functioning to supply steam to the drier from a steam source 18 and to remove condensate from the drier tubes through an outlet pipe 19 controlled by a valve 20.

Enclosing the outlet end of drier 1 is a stationary housing 21 having an aperture 22 adjacent its center whereby air may be drawn into the drier by natural or forced draft. Disposed beneath the housing 21 is a receptacle 23 into which the dried material may pass and from which it may be removed by any suitable means such as a conveyor 24. Drier 1 is provided adjacent the outlet end with a plurality of openings 25 aligned with receptacle 23 of housing 21 and forming a ready exit for the material leaving the drier.

At the feed end of the drier a stationary housing 14 is supported upon pedestals 30 in alignment with the collar 13 of rotating drier 1. Mounted adjacent the bottom of such housing is a suitable means 31 for introducing the material to be dried into the drier. As shown, this means comprises a conveyor driven by a suitable prime mover 32, but it will be apparent that other means such as pumps or the like can be used without departing from the invention depending upon the special material being handled. Housing 14 is preferably constructed with a separate feed compartment 33 separated from the remainder of the housing by a partition 34 for the purpose of insuring the proper travel of exhaust air from the drier. Material may be introduced into the open upper end of compartment 33 by any suitable means.

One important factor in the efficient operation of the drier disclosed resides in the fact that the material being dried passes countercurrent to a stream of hot air which is enabled to contact the material intimately and to carry off the moisture liberated from the material as it dries. In order to insure this efficient moisture removing action a vapor stack 35 of substantial height and having an enlarged chamber 36 is constructed above housing 14 and provides a means for increasing the natural draft of air through apertures 22 at the outlet end of drier 1 as well as providing a means for recapturing small dust particles of the dried material which may be carried out by the air. It is contemplated that other means for effecting this action may be employed, as for example, incorporating a fan into housing 14 to provide a forced draft on drier 1 and exhausting the air into a conventional cyclone separator. It will be obvious, therefore, that the means employed as well as the size of drier used will depend primarily upon the characteristics of the material being dried.

By the use of the construction hereinabove described many types of wet material may be dried rapidly and efficiently. It is found, however, that certain materials have the characteristic of caking upon tubes 10 and 11 when deposited directly upon the same in their wet state. Titanium oxide and materials of this type are customarily introduced into compartment 33 with as much as 40% moisture and must be dried to as little as one-tenth of 1% moisture before being removed by conveyor 24. In order to prevent this caking upon the drying surfaces and at the same time avoid an unduly long drying period or sacrifice the degree of drying, means are provided to overcome this disadvantage.

As shown in the drawing, a screen 40 is mounted interiorly of the inner row of tubes 11 and extends a substantial distance lengthwise of the drier. The screen abuts against collar 13 of the drier at its inlet end and forms a perforated shelf upon which the heavy masses of wet material are deposited by means 31. Referring now to Figure 2, it will be noted that screen 40 is supported out of direct contact with tubes 11 and is held securely in place by fastening means 41 attached to the body of drier 1. The particular material and mesh of the screen will depend largely upon the wet material being dried and forms no essential part of the invention. In order to make the screen more effective it has been found advisable to provide flights or members 42 on the interior of the screen for the purpose of picking up masses of the material as the drier rotates and dropping the same against a lower part of the screen. As before, the necessity of using such flights will depend primarily upon the specific material being handled.

When using the complete drying apparatus thus disclosed it is found that the following drying process results. When a wet material is deposited in the drier by means 31 it is caught by the flights 42 on the screen and is dropped against the surface of the screen. Small particles of the material break off and pass through screen 40 into direct contact with the hot steam tubes and are dried without caking upon the hot surfaces. This desirable result is believed to result from the fact that these particles have insufficient mass or weight to press against the hot tubes and to form a scale as is the case when a heavy wet mass of the same material contacts the same tubes. The dried or partially dried small particles are then showered back through screen 40 as the drier continues to rotate and are mixed

with the heavy masses of material still on the screen.

As a result of this admixture of dry small particles having no caking tendency and having a low moisture content with the heavy mass of material having a pronounced caking tendency and a high moisture content, the characteristics of the mass of material on the screen are materially changed in a short period of time. It is thought that this change in the caking characteristic results from both a mechanical and a thermal action. The mechanical mixing of dried particles into a sticky mass of wet material due to the action of the rotating drier and the concurrent reduction of moisture content in the wet material due to the action of the heat in the drier and the carrying off of moisture by the air stream appears to be the cause of this desirable change.

It is found that the material has been so changed by the time it reaches the end of screen 40 that it will voluntarily break into small masses as it falls from screen 40 upon the tubes 10 and 11. These small masses have a large proportion of dried particles of the material kneaded into them and also have a much lower moisture content than does the wet material first entering the drier. As a result these small masses have no caking tendency and will begin to break up into smaller and smaller masses as they pass on through the drier.

In addition to the function of being mechanically mixed and kneaded into the wet, sticky mass of material the small particles passing through screen 40 also serve a useful function as a heat transfer agent. It is estimated that as much as one third of the material on screen 40 may be passing back and forth through the screen by the time the material has moved to the end of such screen. These small particles also represent a constantly changing portion of the original mass of material and in the aggregate there results a substantial amount of indirect heat transfer from the tubes 9 and 10 to the wet material on the screen. Consequently, the moisture content of the wet material is appreciably lowered and an effective drying operation is taking place without the possibility of the undesired caking action resulting.

Simultaneously with this drying action the wet material is receiving heat by radiation from the hot tubes and by contact with the air stream passing in contact with those tubes. Such air moreover carries with it small dried dust particles which contact the wet material and mix with the same. The effect of this concurrent heating of the wet material and the removal of its moisture through the constantly moving stream of hot air results in a rapid drying of the material on the screen and in a rapid diminution of its tendency to cake upon a hot surface.

When the material passes from screen 40 into direct contact with the hot drying surfaces its caking tendency has been eliminated as described above. The material then continues through the drier and upon reaching openings 25 it has been reduced in size and moisture content to the point where it can be removed by conveyor 24 and moved to a storage point without further treatment.

Having thus described the invention, it is apparent that other modifications of structure may be employed to serve the same objectives without departing from the scope of the same.

I claim:—

1. The method of rapidly drying a material susceptible to caking on hot drying surfaces comprising, introducing a wet mass of material without preliminary drying into a zone heated by radiation from the drying surfaces, drying small particles from the wet mass upon the drying surfaces, destroying the caking tendency of the wet mass by kneading the small dried particles of the same material into the wet mass, while in the zone of radiation, and then depositing the mixed mass of material upon hot drying surfaces of substantially uniform temperature in order to dry the same rapidly and uniformly.

2. The method of rapidly drying a material and inhibiting caking of the same upon hot drying surfaces comprising, heating a mass of wet material by contact with a body of hot air and by radiation from the hot drying surface out of contact with the material preliminary to drying such material, separately drying small particles of the same material by contact with the drying surfaces, mixing the small dried particles with the same mass of wet material from which they were separated and rapidly completing the drying by bringing the entire mixed mass of material into contact with the drying surfaces.

3. The method of rapidly drying a material having the characteristic of caking upon a drying surface comprising, depositing a damp mass of the material upon a screen, rotating the screen to cause small particles of the material to pass into contact with the drying surface, mixing the heated small particles with the same larger masses of material on the screen from which they were separated and partially drying such larger masses to destroy the caking tendency of the same and then bringing the larger masses into direct contact with the drying surfaces and rapidly completing the drying of the same.

4. The method of rapidly drying a wet material such as titanium oxide having the characteristic of caking upon a drying surface comprising, effecting a heat transfer to the wet material by contact with a body of heated air, concurrently heating the material by radiation from a drying surface, concurrently breaking off particles of the material insufficient in size to cake upon the drying surface, bringing such particles into contact with the drying surfaces and drying the particles, mixing the dried particles with the same mass of wet material from which they were separated to dry the material partially and to destroy the caking tendency of the same and then bringing the partially dried material into direct contact with the drying surfaces in order to complete the drying rapidly.

5. The method of rapidly drying a material susceptible to caking on hot drying surfaces comprising, introducing a mass of the wet material without preliminary drying into a zone heated by surfaces of substantially constant temperature, heating the material in a preliminary step within the heating zone by contact with a body of hot air and by radiation from said surfaces while holding the material out of direct contact with said surfaces, separately drying small particles of the material insufficient in size to cake upon the surfaces, physically mixing the dried, small particles with the larger masses of the same material held out of contact with the drying surfaces and finally bringing the entire mass of mixed materials into direct contact with the drying surfaces to complete the drying rapidly and uniformly.

6. The method of drying a material susceptible

to caking on hot drying surfaces comprising, introducing a wet mass of the material without preliminary treatment into a zone heated by radiation from surfaces of substantially constant temperature, continuously moving the material through the heating zone while temporarily holding the larger masses of the material out of direct contact with the hot surfaces until the caking tendency of the same is destroyed and then depositing the entire mass of material directly upon the hot drying surfaces and drying the same rapidly and uniformly.

7. The method of drying a material susceptible to caking on hot drying surfaces comprising, introducing a wet mass of the material into a zone heated by surfaces of substantially constant temperature, temporarily holding the larger masses of wet material out of direct contact with the hot surfaces, passing small particles of the material back and forth between the large masses and the drying surfaces until the caking tendency of the entire mass is destroyed and then depositing the entire mass of material directly upon the hot drying surfaces and drying the material rapidly and uniformly.

8. In a rotary drier having exposed steam tubes serving as drying surfaces, material-lifting means disposed upon the inner surface of the drier, a screen member providing a space out of contact with the tubes and extending a short distance longitudinally of the drier from the feed end of the same, means for depositing a material to be dried inside the screen, and mechanical means disposed inside the screen for breaking up such material whereby small particles of the material may pass through the screen into contact with the drying surfaces and material-lifting means and fall back through the screen to mix with the larger masses of material to effect a partial drying of the same prior to bringing the larger masses of material in direct contact with the exposed steam tubes.

9. In a rotary drier of the class described, an inclined cylindrical casing having steam tubes longitudinally disposed therein, material-lifting means disposed upon the inner surface of said casing, a screen positioned interiorly of the tubes and extending a short distance longitudinally of the drier from the feed end of the same, means for feeding a mass of wet material upon the screen, means disposed inside the screen for separating the material into smaller portions, means for passing a current of air through the drier and exhausting the same at the feed end of such drier, and means for removing the dried material at the outlet end of the drier whereby a wet material entering the drier may be dried successively by contact with hot air, by mixing with hot particles of the material and by direct contact with the heating surfaces and may be removed from the drier without caking upon the heating surfaces.

10. The method of preparing for drying a material normally having a tendency to cake upon hot drying surfaces comprising, retaining the large masses of material out of direct contact with the hot drying surfaces while in the drying zone, separating small particles of material from the large masses of material, drying the small particles of material and kneading the dried particles into the large masses of material to form a readily divisible mass of non-caking material suitable for depositing directly upon the hot drying surfaces.

11. The method of destroying the caking tendency of a wet material passing through a drying process comprising, heating by radiation a wet material out of direct contact with the hot drying surfaces, removing moisture from the material during the heating step, separating small particles of material from the large masses of material in the heating zone, drying the small particles upon the hot drying surfaces from which the larger masses of material are receiving radiated heat, and kneading the dried particles into the large masses of heated material to form a readily divisible mass of non-caking material suitable for depositing directly upon the hot drying surfaces.

CLIFFORD E. BILL.