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METHOD FOR DRYING CARBOHYDRATE MATERIAL RICH IN HYGROSCOPIC SUBSTANCES

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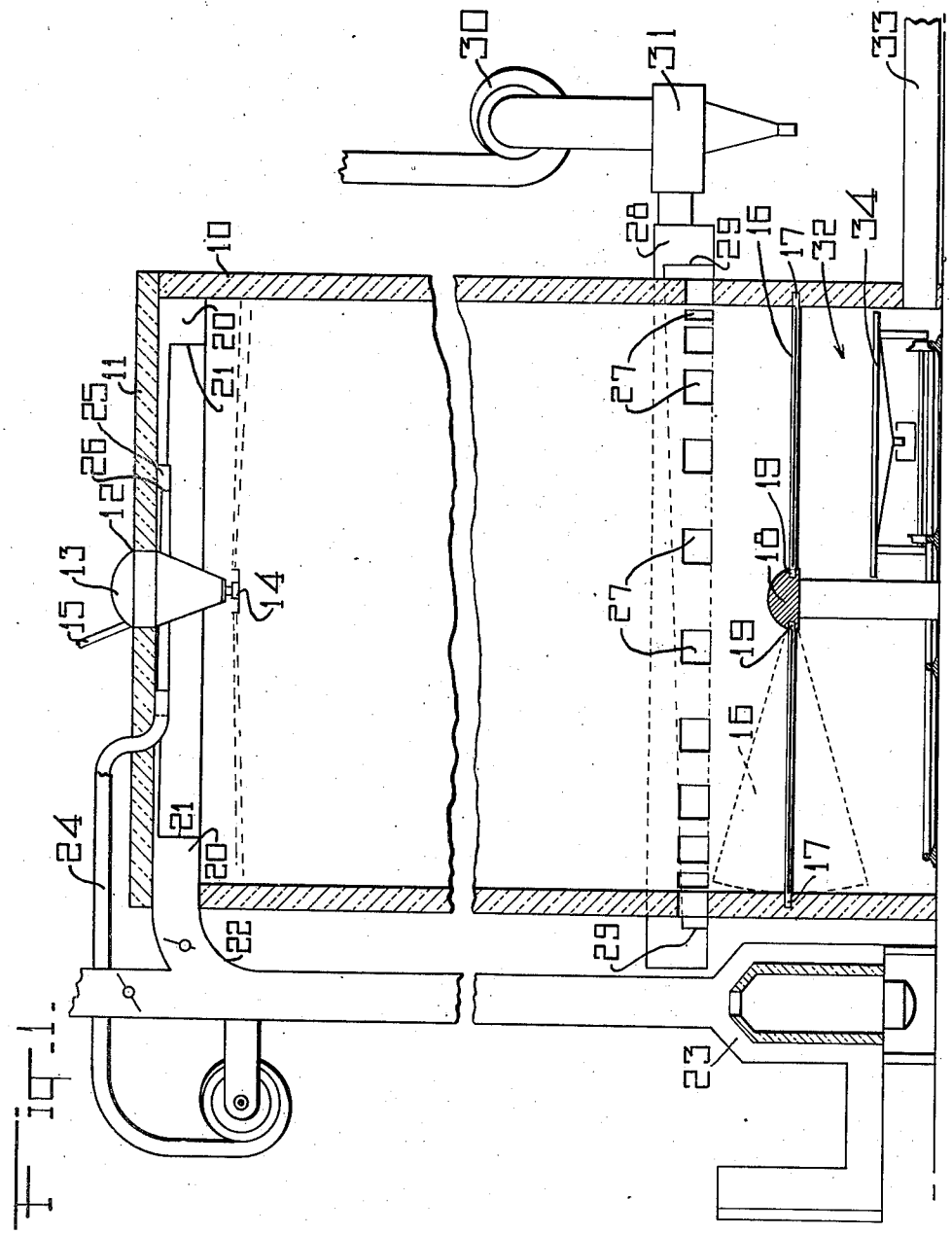


Fig. 1.

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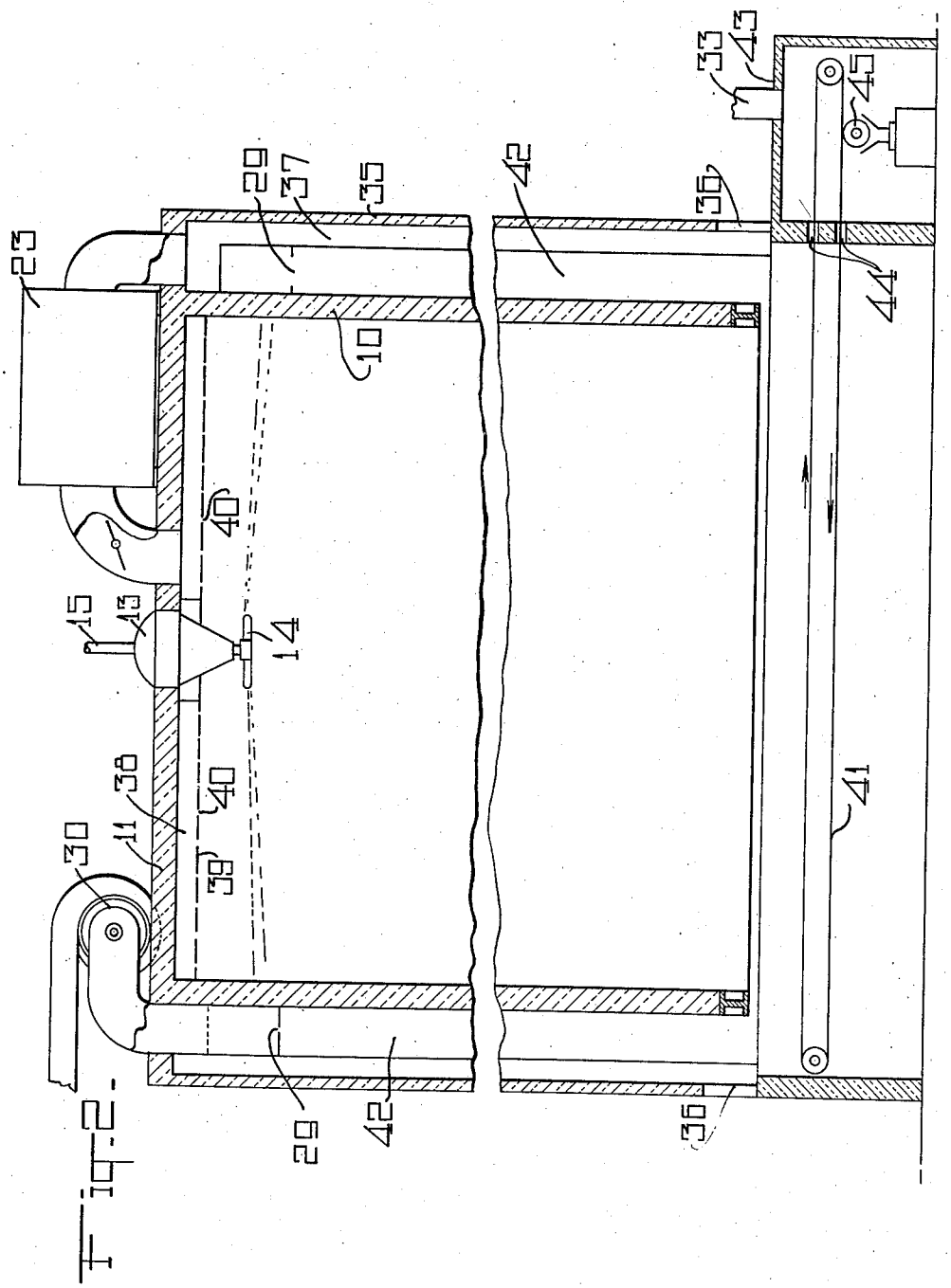


Fig. 2.

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UNITED STATES PATENT OFFICE

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METHOD FOR DRYING CARBOHYDRATE MATERIAL RICH IN HYGROSCOPIC SUBSTANCES

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Application November 3, 1931, Serial No. 572,812

7 Claims. (Cl. 99—5)

This invention relates to a method for drying carbohydrate material rich in sugar or other hygroscopic substances.

The invention has for its object generally the provision of an improved process for drying comminuted material of the character indicated in a quick and convenient manner.

More specifically, the invention has for its object the provision of an improved and continuous process for drying comminuted carbohydrate material rich in fruit sugar, for example, the comminuted pulp of ripe fruits, such as bananas, by spraying the same into a relatively highly heated zone in a manner to remove moisture therefrom rapidly, collecting the material in a less highly heated zone under such controlled humidity conditions that the material will not become wet, and transferring the material without appreciably disturbing its lie into a cooler zone under such controlled humidity conditions that the material remains substantially dry.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

This application is a continuation in part of our copending application, Serial No. 478,660, filed April 29, 1930.

The invention accordingly comprises the several steps and the relation and order of one or more of such steps with respect to each of the others, as exemplified in the following detailed disclosure and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a view partly in section and partly in elevation showing a drying tower adapted to dry comminuted material of the character indicated; and

Fig. 2 is a view partly in section and partly in elevation of a modified form of a drying tower and its associated drying chamber adapted to dry and deliver for packaging comminuted material of the character indicated.

Heretofore, attempts to secure dry powdered carbohydrate substances rich in hygroscopic material, such as fruit sugars, have been commercially unsuccessful. In many cases, drying equipment has been so designed that the material handled has been largely scorched or burnt. Apparatus admirably adapted to dry materials containing little or no hygroscopic substances has been found unsuited for operation with materials relatively rich in hygroscopic substances. If, for example, the pulp of ripe fruit, such as bananas, is sprayed in the ordinary commercial spray-drying tower the resulting product is very largely charred and burnt, the sugar content becomes caramelized, and the product becomes a closely adhering sticky caramel-like mass, which cannot be efficiently handled commercially.

Heretofore, no means has been provided for the satisfactory removal of hot dried carbohydrate material from a drying tower of the type indicated while the drying process is in operation. As a result such material as may have collected in an unscorched condition in the base of the tower has been removed by scraping or shovelling while hot, or else the drying process has been discontinued and the entire apparatus permitted to cool. Where the material has been removed in a hot condition, the scraping or shovelling to which it was uniformly subjected caused it to adhere or pack together to such an extent that subsequent drying was materially retarded and the lumps could not be broken up without milling or grinding.

In connection with the invention hereinafter described an apparatus is disclosed wherein comminuted carbohydrate material rich in fruit sugars or other hygroscopic substances, such, for example, as the comminuted pulp of dead ripe bananas, ripe peaches, etc., may be rapidly and continuously dried, removed, and packaged economically without charring or burning the material, without scraping the material, or in any way packing it together or causing it to adhere, and without regrinding the dried powder.

The invention contemplates passing the comminuted carbohydrate material from a relatively intensely heated drying atmosphere to an atmosphere of normal temperature, but always under such controlled humidity conditions that the powdered carbohydrate material is never permitted to become wet. By means of this process, a stream of comminuted carbohydrate material rich in hygroscopic fruit sugars may be continuously fed into the drying chamber and the dry powdered material continuously removed from the chamber and packaged. Not only is the process of this invention capable of continuous operation and hence of great commercial advantage, but the product, the dry fruit powder, retains in a concentrated form the aroma and flavor of the original fruit, and hence is admirably adapted as a base for flavorings, sauces, etc.

In the embodiment of the invention shown, comminuted sugar-containing carbohydrate ma-

terial obtained by finely grinding the pulp of ripe fruits, such as peaches or bananas, is introduced into the drying chamber by spraying and caused to pass immediately through a relatively highly heated zone of circulated air or other drying gaseous medium. The finely divided material is thereafter collected at the bottom of the chamber in a zone where the temperature has been sufficiently reduced to prevent scorching or caramelizing of the sugar content. This is preferably accomplished by removing the heated gases from the chamber at a point sufficiently above the place of deposit of the dry material so that the accumulated material is not subjected to the direct scorching action of the hot gases. It is advisable to maintain the temperature of the gases adjacent the deposit floor at such a point that their relative humidity is such that the deposited material will not become wet. In drying, the gases take up from the sprayed material a considerable amount of moisture before the material is deposited, and they must therefore be maintained at a relatively high temperature. It has been found that the temperature of the gases adjacent the deposit floor should preferably be maintained at a point somewhat above the temperature at which the sugar content of the dry material becomes soft and plastic. Hence the condition of the material on the deposit floor is ordinarily such that the individually dried particles are slightly adherent because of the relatively high temperatures of the gases adjacent thereto, even though the material itself is not wet.

The invention contemplates the transfer of the deposited material from this deposit zone of relatively high heat to a zone having a temperature such that the sugar content of the material will be cooled to hardness. This cooling zone has also, preferably, an atmosphere of such controlled humidity that the dry comminuted powder will not tend to absorb any moisture. The transfer of the deposited powder from the relatively hot zone at the base of the drying chamber to the cooler zone is preferably accomplished without disturbing the lie of the powder, for it has been found that if the warm, slightly adhering powder in the base of the chamber is lumped or scraped together, it has a tendency to adhere closely and to resist all efforts to break it again into finely comminuted particles without grinding.

After the powder has been adequately cooled it may be packaged in air-tight containers, still under such conditions of controlled humidity that the powder has no tendency to absorb moisture and become wet or sticky.

In the embodiment of the invention shown, 10 denotes a main cylindrical wall forming a drying tower which may be of any desired height and width, for example 32 feet high and 22 feet in diameter, and which may be constructed of any suitable material, for example hollow tiling. The cylindrical wall when built to a desired height may be roofed over in any convenient manner, for example, by means of a reinforced concrete slab 11 which has a central opening 12. In this opening is disposed a motor 13 or other driving means which actuates a spray head 14 which sprays the material to be dried across the upper portion of the tower. A conduit 15 is provided entering the roof 11 adjacent to the motor 13 and arranged to supply the comminuted material directly to the spray head 14 whereby the same is thrown centrifugally outward across the upper portion of the tower. The material then falls in the form of a mist or fine snow through the chamber.

The bottom of the heating chamber is preferably of a construction which permits the deposited material to be transferred from the heated zone in the tower to a cooler chamber beneath the tower without disturbing its lie. In the embodiment of the invention shown in Fig. 1 the bottom of the heating chamber is composed of a plurality of rotatable sectors 16 of any convenient size which are disposed side by side so as to form a continuous bottom. Each sector thus formed is pivoted to the wall of the tower at its outer center point as indicated at 17, and at its inner central point to a central supporting member 18 as indicated at 19.

The sectors may be formed of top and bottom canvas sheets, and their supporting pivots may be hollow and adapted to supply to the interior of each sector cooled de-humidified air which may be furnished through the central support 18 in a manner not shown, and which may be drawn off through the upper canvas cover of each sector and the deposited material thereon, thus aiding in preventing charring or burning of the deposited material. If, however, the pivoted sectors are positioned at a proper distance beneath the hot air exhaust openings in the wall of the drying chamber, for example, 6 feet in an apparatus of the type herein described, the apparatus will function and the process may be performed without danger of charring or burning the dry material even though the sectors be made of a non-porous substance, for example sheet metal.

The gaseous drying medium is preferably introduced into the drying chamber at the top. To this end an annular duct 20 is shown as disposed about the wall 10 at the top and has its inner side wall 21 cut short so as not to extend fully up against the top 11, whereby there is provided one or more annular spaces between the edge of wall 21 and the ceiling of the chamber through which the drying medium enters. A supply duct 22 is arranged to pass through the wall 10 and communicate with the duct 20 at a convenient point. The annular space between the ceiling 11 and the inner edge 21 of the duct 20 is preferably smallest at the point of entry of the supply duct 22 and largest at a point on the wall of the drying chamber directly opposite, so that a substantially uniform supply of the drying medium is furnished at all points around the circumference of the upper portion of the chamber wall. The drying medium introduced by the supply duct is drawn from any convenient source, for example from a heating furnace 23 which pre-heats the medium to the desired temperature. Intermediate the heating furnace 23 and the entry of the duct 22 into the wall 10 of the chamber, a supplemental duct 24 may be provided adapted to take some of the pre-heated drying medium and divert it so that it may enter the drying chamber through the duct 25 which is positioned about the motor 13 and which is provided with an inner edge 26 which fails to make contact with the roof 11 so that a supply of the heated drying medium is furnished to the center of the upper portion of the tower and flows down upon the comminuted material immediately after it leaves the spray head 14. With the use of the supplemental duct 24 and its associated parts, eddies which normally arise in the sprayed mist and which tend to cause the sprayed material to be-

come deposited upon the roof the drying chamber, are broken up and substantially all the material is caused to float downward slowly through the chamber.

An exhaust for the heating gases is provided and in the embodiment of the invention shown comprises a plurality of openings 27 in the wall of the drying chamber. These openings may be formed by the omission of regular intervals about the chamber wall of one or more tiles. Surrounding these exhaust openings 27 is an exhaust duct 28 which may be provided along the edge adjacent the openings in the chamber wall with a baffle 29, which acts not only to prevent the sprayed material from being drawn into the exhaust duct, but also to regulate the strength of the exhaust at different portions on the circumference of the chamber wall. This baffle is preferably largest at that portion of the exhaust duct which is directly connected to the exhaust fan 30, and preferably smallest at that point in the exhaust duct which is directly opposite said connection, so that an equal amount of the heated gases may be withdrawn through each of the exhaust ports 27. Intermediate the exhaust duct 28 and the exhaust fan 30, a dust-collector 31 may be provided to salvage such of the dried material as may have passed the baffle 29.

In the embodiment of the invention shown in Fig. 1 the cooling chamber 32 into which the dry material is conveyed after it has been deposited upon the floor of the drying chamber is shown as positioned within the walls of the drying tower and directly beneath the sectors 16 which comprise the deposit floor of the tower. This cooling chamber is preferably connected through the duct 33 with a device for conditioning and dehumidifying air, and air at a temperature below the point at which the sprayed material softens is conveyed thereby into the chamber 32 in such quantities and under such humidity conditions that the atmosphere of that chamber is kept at a temperature which will cause the heated comminuted material deposited upon the sectors 16 to cool to a point where it may be shaken readily from the inverted sectors into a receiving tray or carriage 34, which may be mounted upon rails and thus readily moved beneath any sector from which the material is to be removed. The drying material, after having been collected in the tray 34, may be removed to a chamber, not shown, where atmospheric conditions are kept at such relative humidity that the material will not become wet or sticky, and there sealed in air-tight containers.

In performing the process and using the apparatus of the invention most satisfactory results are obtained by first determining the maximum temperature to which the dried comminuted fruit powder will be subjected in cammerical handling. For ordinary shipments in the United States a temerature of 110° F. may be arbitrarily selected. That moisture content of the dried fruit powder which will cause caking and hardening of the powder at the maximum temperature of commercial handling should then be determined. For example, with a dry powder made from the pulp of ripe bananas a moisture content in excess of 2.5% causes the powdered banana pulp to cake and harden at a temperature of about 115° F. The moisture content of such a product should, therefore, be fixed at not greater than 2.5% if it is to be handled without caking at temperatures not exceeding 110° F.

Having determined the maximum moisture content permissible in the dried powder a drying gas should be used in the chamber in such quantity and with such entering temperature as to insure that the powder sprayed through the chamber will be dried to the desired point. For example, in a drying tower of 7500 cubic feet capacity, the use of 7500 cu. ft. per minute of a drying medium as, for example, air, preheated so as to have a temperature at the point of inlet of from 450° to 500° F., will adequately dry comminuted banana pulp sprayed into the top of the tower at the rate of approximately 20 lbs. per minute. Under such conditions the upper tower temperature will run in the neighborhood of from 325° to 350° F., and the temperature of the exhaust gases at the outlet will approximate 200° F. As the dried powder is deposited upon the tower bottom an appreciable distance below the cutlet, the temperature at the point of deposit will be considerably below that of the exhaust gases and may approximate 140° F. at which temperature the deposited material shows no tendency to scorch.

As the drying medium takes up a considerable quantity of water from the comminuted carbohydrate material in the tower, the relative humidity of the hot gases at or near the point of deposit of the material is found to approach 35% under the conditions outlined above. Any attempt to reduce the temperature at the point of deposit of the dried material causes an increase in the percentage of relative humidity of the gases at that point. As it has been found that a relative humidity in excess of 35% causes the dried banana powder to take up moisture, it is highly desirable that the temperature of the gases directly over the deposit floor be maintained at such a point that their relative humidity does not exceed 35%.

At this temperature, i. e. approximately 140° F., the sugars in the dried material are soft and plastic and if the material is disturbed it will pack tightly and stick to any instrument used to remove it. The densely-packed and closely-adhering masses which are formed if the lie of the powder is disturbed, can not be readily broken up without grinding.

This invention contemplates as a further step in the process the transference of the dried material from the heated atmosphere at the base of the tower to a cooler atmosphere, where it may be cooled below the point of stickiness of the sugar content under such controlled humidity conditions that the product takes up no more moisture.

This is accomplished in the embodiment of the invention shown in Fig. 1 by rotating the segments of the tower floor so that what was the floor of the tower before rotation becomes the roof of the chamber beneath the tower. As has been pointed out above, the process indicated has been calculated to produce a powder which will contain not more than 2.5% of moisture at a temperature of 110° F. and which will, therefore, crumble into a dry, fluffy, non-adhering powder at or below that temperature. Accordingly, in following out the process described above, with the pulp of ripe bananas as the material processed, the atmospheric conditions in the chamber below the tower should be so maintained that the temperature in this chamber is less than 110° F. and the relative humidity less than 35%, for when the relative humidity is maintained be-

low 35% the powdered banana pulp does not take up moisture at any temperature.

These conditions are accomplished in the embodiment of the invention shown in Fig. 1 by supplying to the chamber beneath the tower a conditioned, de-humidified supply of air. For convenience in gathering and packaging the material, the temperature of this air supply may be maintained at or about 90° F. and its relative humidity is preferably kept below 35% for safety. It has been found that in a chamber where such conditions are maintained, the deposited material will dry and become fluffy in a relatively short time. If will remain in place upon the ceiling of the chamber until it is shaken therefrom into a receiving tray. The time for drying and removing the material from the chamber is considerably less than that employed in accumulating an adequate deposit upon the new surface of the chamber floor, formed by the rotation of the sectors of the floor.

After the material has been removed from the ceiling of the cooling chamber, it may be taken to a packaging room, not shown, where it may be sifted and packaged in air-tight containers under such controlled humidity conditions that the relative humidity does not exceed 35% and the temperature does not exceed 110° F., the pre-determined maximum temperature of handling. When these conditions are maintained, the packaged product will continue dry and non-adhering at all temperatures below 110° F. Should that temperature be reached and exceeded, the packaged powder may temporarily become sticky and adherent, but when a temperature less than 110° F. is again reached, the powder will again become dry and easily broken up into finely-divided particles.

A modified form of apparatus adapted to perform the process of the invention is shown in Fig. 2. In the embodiment of the invention there shown the drying tower is provided with an inner wall 10 and an outer wall 35. The outer wall 35 is provided around its periphery at any suitable points with inlets or openings 36 through which air is drawn into a cylindrical duct 37 which extends substantially the entire height of the tower immediately within the outer wall 35. From this duct the air is drawn through an air-conditioning and heating unit 23 and then fed into a shallow chamber 38 immediately beneath the roof 11 of the drying chamber. This shallow chamber against the roof of the drying chamber is formed by a plate 39 having a multitude of outlets 40 so positioned and arranged that the hot drying gases are fed downwardly into the sprayed material over substantially the whole area of the roof of the chamber.

The inner wall 10 of the chamber preferably terminates, save for suitable supports, at a height from four to five feet above a movable endless belt 41 so positioned beneath the walls 10 of the chamber that all of the dried powder will fall upon some portion of the belt. Between the inner wall 10 of the chamber and the air duct 37, an outlet air duct 42, cylindrical in shape and extending substantially the full height of the chamber, is provided. This duct is preferably considerably larger in size than the inlet duct 37, so that the speed of passage of the exhaust gases around the bottom of the wall 10 and through the duct 42 will be slow and considerably less than the speed of the unconditioned gases taken in through the vents 36. With such a construction, it is found that the exhaust gases do not carry with them into the exhaust duct 42 any of the dried powder.

It is important that the belt 41 upon which the powder is deposited be positioned a sufficient distance below the bottom of the wall 10 of the chamber so that the hot exhaust gases will not be drawn into close contact with the material on the belt, and so that the temperature of the gases contacting with the material on the belt will not be sufficiently high to scorch or char it. The exhaust gases passing between the wall 10 of the chamber and the intake duct 37 aid, by pre-heating the unconditioned air taken in through the vents 36, in increasing the efficiency of the apparatus.

Adjacent the base of the tower, a cooling and packaging chamber 43 is provided. The endless belt 41 is preferably constantly moving in the direction shown by the arrows in Fig. 2 so that the material deposited upon it will be carried from beneath the drying chamber into the cooling and packaging chamber 43. The belt preferably passes through a narrow opening 44 between the tower and the cooling chamber. This opening should be kept as small as possible in order to prevent any hot gases from passing into the cooling chamber with the dried material, and to insure against such event the cooling chamber should be provided with an atmosphere at slightly greater pressure than that adjacent the opening 44 in the drying chamber, so that there will be a tendency for air to flow from the cooling chamber through the opening 44 into the drying chamber and out with the exhaust gases. Suitable means may be provided as at 45 in the cooling chamber for scraping the dried and cooled material from the traveling belt 41 and gathering it in suitable containers. The material may be packaged in air-tight containers within the chamber 43, which should be provided through the duct 33 with an adequate supply of conditioned air at a temperature which will permit workmen to package the material without discomfort and with such relative humidity that the dried powder will not become wet.

In the form of the invention shown in Fig. 2 the cooling chamber may be positioned directly beneath the drying tower as shown, for example, in Fig. 1, in which case the endless belt 41 would serve as the roof of the cooling chamber and the floor of the tower, and suitable powder-removing means and packaging means would be positioned within the chamber formed by the belt and base of the tower.

In operation the form of drying tower shown in Fig. 2 is operated substantially as is the form shown in Fig. 1. The ground or comminuted material, such as banana pulp, is fed in at the top of the chamber and sprayed uniformly across the chamber by means of the spray head. The material then falls through the heated atmosphere that is supplied through the inlet ducts and floats downwardly, being deposited upon the floor formed by the belt 41. The heated gases are drawn off through the walls of the tower at a point appreciably above the level of the deposit floor and the dried material is withdrawn by movement of the belt from within the tower to a cooling room where it may be packaged as desired.

Claims to apparatus such as set forth in this case are included in applicants' copending application Serial No. 700,691, filed December 2, 1933, as a continuation-in-part of the present case.

Since certain changes in carrying out the above process and in the construction set forth which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described our invention what we claim as new and desire to secure by Letters Patent is:

1. The process of drying comminuted carbohydrate material containing hygroscopic substances which comprises subjecting comminuted particles of the material to a quick drying heated atmosphere, collecting the dried material in an atmosphere having a temperature below the scorching point of the material and having a relative humidity such that the material does not take up moisture, and transferring the material without disturbing its lie to an atmosphere having a temperature such that the material becomes hard and having such relative humidity that the material will not take up moisture.

2. The process of drying comminuted carbohydrate material containing hygroscopic substances which comprises spraying comminuted particles of the material into a chamber provided with a quick drying heated atmosphere, depositing the material within the chamber under such temperature conditions that the material will not scorch and under such conditions of relative humidity that the material will not take up moisture, removing the material from the chamber without substantially disturbing its lie, and subjecting the material to a cooling atmosphere of such temperature that the comminuted particles of the material will become non-adherent and of such relative humidity that the material will not take up moisture.

3. The process of drying comminuted carbohydrate material containing hygroscopic substances which comprises spraying comminuted particles of the material into a dry atmosphere having a temperature in excess of 300° F., collecting the dried material in an atmosphere having a temperature below the scorching point of the material and having a relative humidity not exceeding 35%, and transferring the material without substantially disturbing its lie to a cooling atmosphere having a temperature below 110° F. and a relative humidity not exceeding 35%.

4. The process of drying comminuted fruit particles rich in hygroscopic sugars which comprises projecting comminuted particles of fruit pulp into a quick drying heated atmosphere, collecting dried particles in an atmosphere having a temperature below the charring point of the sugar content and having a relative humidity such that the hygroscopic material will remain dry, and transferring the material without disturbing its lie to a cooling atmosphere having a temperature such that the sugar content of the material becomes non-plastic and having a relative humidity such that the material remains dry.

5. The process of preparing dried comminuted fruit pulp which comprises subjecting comminuted particles of the material to a quick drying heated atmosphere until the moisture content of the particles is less than the maximum permissible if the material is to remain dry at normal atmospheric temperatures, collecting the dried material at a temperature at which it will not char and in an atmosphere of such relative humidity that it will not wet, transferring the material without disturbing its lie to a cooling atmosphere having a temperature such that the comminuted particles of the material will become non-adherent and having a relative humidity such that the material will not wet, and packaging the material when cooled in hermetically-sealed containers.

6. The process of drying the comminuted pulp of ripe bananas which comprises subjecting the comminuted pulp to a hot drying temperature in the neighborhood of 325° F., collecting the dried material in an atmosphere having a temperature in the neighborhood of 140° F. and having a relative humidity not exceeding 35%, and transferring the collected material without disturbing its lie to a cooling atmosphere having a temperature below 110° F. and having a relative humidity not exceeding 35%.

7. The process of drying comminuted carbohydrate material containing hygroscopic substances which comprises subjecting comminuted particles of the material to a quick drying heated atmosphere, collecting the dried material in an atmosphere having a temperature below the scorching point of the material and having a relative humidity such that the material does not take up moisture, transferring the material without disturbing its lie to an atmosphere having a temperature such that the material becomes hard and having such relative humidity that the material will not take up moisture, and packaging the material in such atmosphere.

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