Aug. 25, 1942. B. G. FREUND 2,293,728

DEHYDRATING METHOD AND APPARATUS

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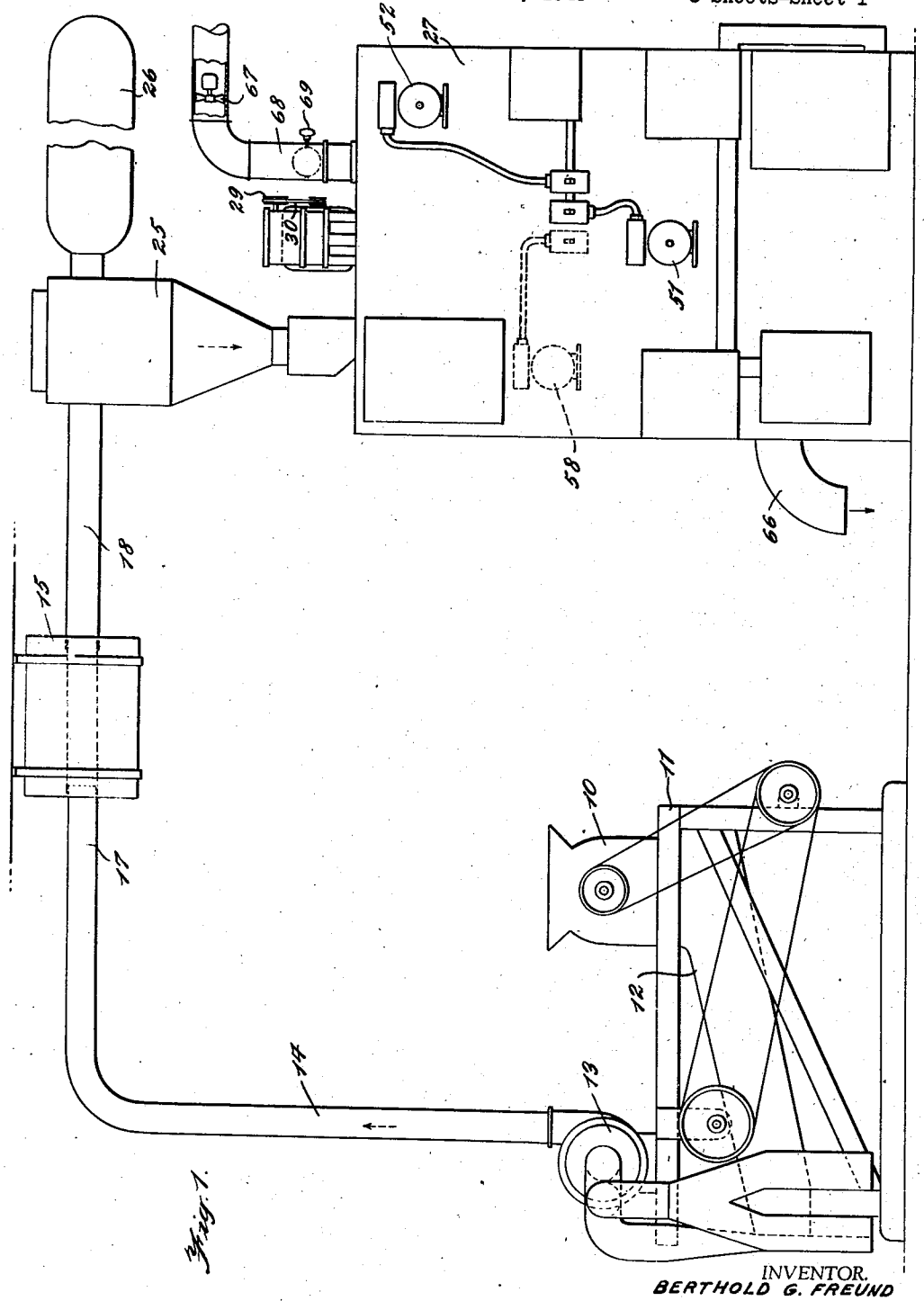


Fig. 1.

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DEHYDRATING METHOD AND APPARATUS

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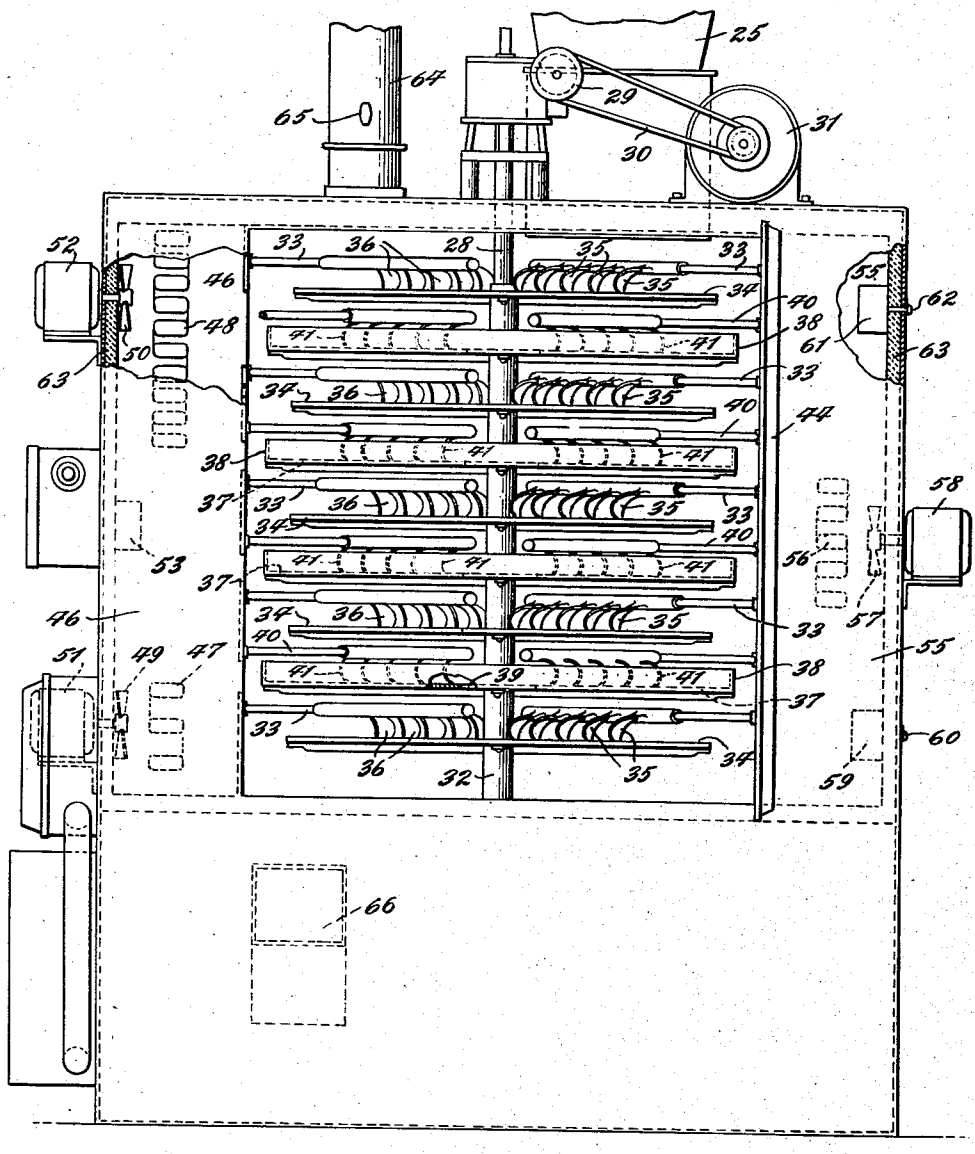


Fig. 2.

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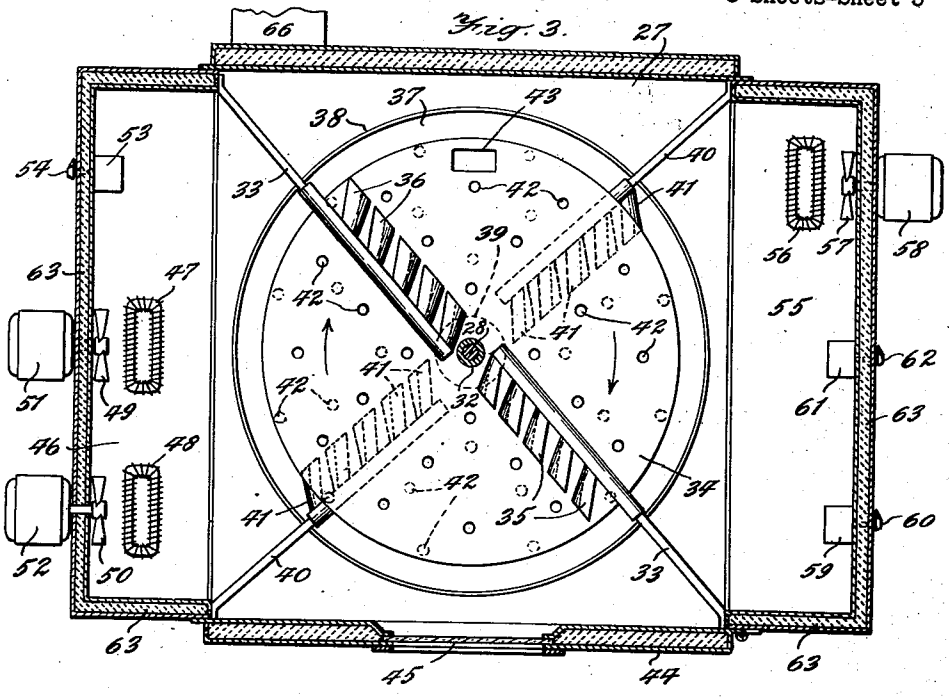
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DEHYDRATING METHOD AND APPARATUS

Filed June 11, 1940 3 Sheets-Sheet 3

Fig. 3.



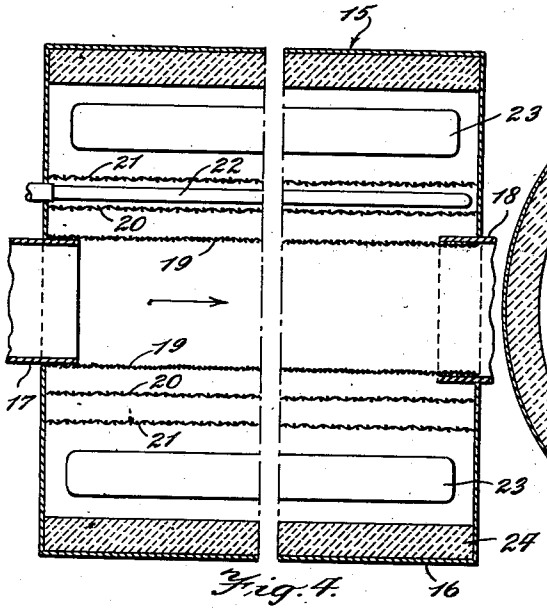


Fig. 4.

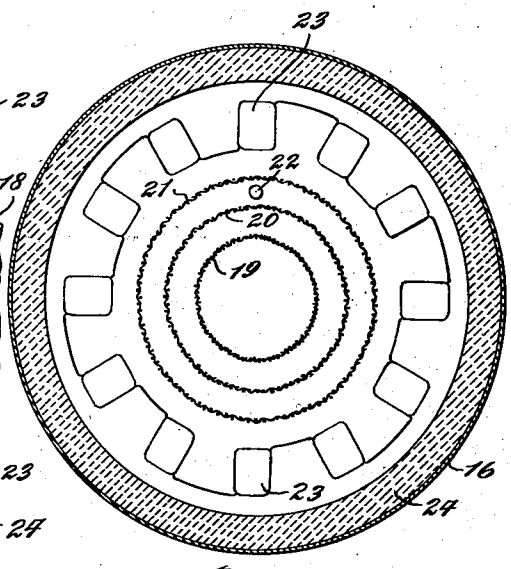


Fig. 5.

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UNITED STATES PATENT OFFICE

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DEHYDRATING METHOD AND APPARATUS

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Application June 11, 1940, Serial No. 339,860

20 Claims. (Cl. 99—199)

The invention relates to a method and apparatus for dehydrating or desiccating materials, such as cellulose products, like alfalfa, green sawdust, wood flour, etc., and food products, including fish, meats, vegetables, fruits, and the like, for instance, brewery mash.

The processes and apparatus of the prior art for the dehydrating or drying of these materials involve the exposure of the product to be dried to a comparatively high and uniform temperature. In contradistinction to this prior art method and apparatus, the products of which were deficient in that they were not properly dried because the moisture content of the material was not gradually and in the proper proportion and speed removed from the product, the process and apparatus of the present invention provide for the drying of the material to be accomplished in a plurality of stages. The material, in accordance with my invention, is first brought to the condition in which this graduated drying can be properly and most efficaciously applied, whereupon the exact amount of heat necessary to remove a specific quantity of the moisture contained in the material is applied at each stage of the drying process. The drying at each stage, in accordance with the present invention, is controlled to prevent excessive drying, both from the point of view of the time element and the quantity of heat applied, so as to prevent scorching of the product.

In accordance with the present invention, the gradual drying, in stages, of the material, is accomplished by controlled temperature and air circulation producing a grading of the heat applied to the material, the heat thus applied at each stage being exactly in proportion to the amount of moisture still contained in and to be removed from the material. The material to be dried is first subjected to a predehydrating step which is itself completely controlled as to the temperature of the heat being applied, the first degree of heat being effective to open the pores of the material, so as to permit the subsequent uniform application of the final drying heat to the material.

In its broadest aspects, the present invention consists in the provision of an apparatus whereby the material to be dried, whether a cellulose product or a food product, is first disintegrated by a rotary cutter or mill into substantially uniformly sized particles, which uniformly sized particles are then conducted through an automatically feeding and automatically discharging predehydrating device, from which it is conducted to a hopper disposed above the main dehydrating unit of the apparatus, through which unit the material is gradually passed in succeeding levels constituted of a series of discs and circular platforms and stationary scraping devices, the material being passed in sequence from a section of the dehydrating apparatus, in which a certain amount of heat and circulation is applied to the material, to a second section in which a heat of a uniform temperature of lesser degree is applied to the material, and finally to a section of the apparatus in which the degree of heat applied is still less. In each of the sections of the main dehydrating unit, the degree of heat being applied to the material is controlled by a suitable apparatus, the air circulation involved in the application of such heat being similarly controlled by suitable devices attached to the unit.

By certain novel features of the apparatus and by the combination of a series of steps in the carrying out of the dehydrating process, there is secured, in accordance with the present invention, a substantially complete control of the temperature and of the air circulation resulting in a uniform graduation of the heat being applied to the material in order to dry it, with the distribution of the heat at the various stages being dependent upon or in proportion to the amount of moisture, which is still contained in the material at the specific stage, and it is, therefore, to be removed at such stage, and each of the subsequent stages. For securing the proper and uniform application of this graduated heat and air circulation, I provide novel means for automatically agitating the material to be dried in order to expose, during the heat treatment, all of the parts and surfaces of the material and the minute particles thereof uniformly to the heat and to the air circulation.

An important feature of my invention is the provision of the predehydrating unit which is effective to bring the material, prior to its introduction into the main drying unit, to a condition in which the individual particles thereof will be in just the proper state conducive to the gradual, uniform, and complete dehydration thereof. The function of such pre-dehydrating unit, which, just like the main dehydrating unit, must be carefully controlled with respect to the amount and the degree of heat being applied to the material, is to so condition the material, for instance, by opening the pores of the individual particles, so that when the material finally reaches the main dehydrating unit, it is capable of receiving the comparatively high de-

gree of heat applied at the first stage of the main dehydrating process without the danger of scorching the material as has been frequently the difficulty with the processes and apparatus of the prior art, in which the high degree of heat abruptly applied to the material sought to be dehydrated has caused a destruction of the cellular structure of the material and the scorching of the outer surfaces of the individual particles while leaving the interior portions substantially moist.

My novel dehydrating apparatus is characterized also by the provision of a series of rotating supporting surfaces for the material to be dried within the main dehydrating unit, constituting platforms upon which the material is exposed to the necessary amount and degree of heat for just the proper duration of time, with the agitation of the individual particles of the mass of material being accomplished by fixed scrapers which scrape the material, after the proper degree of exposure to the heat and air circulation, to the next platform and thus sequentially throughout the extent of the main dehydrating unit to the discharge outlet thereof.

My apparatus is characterized also by the disposition of the air circulation producing units or blowers which, together with the suitably disposed heating elements, controlled by thermostats, provide the application of the graduated degree and quantity of heat and air circulation necessary to produce a properly and completely dried product.

A specific embodiment of an apparatus constructed in accordance with my invention, and which is suitable for carrying out my novel process, is illustrated in the accompanying drawings, in which Fig. 1 is a front view of the complete apparatus, including the cutting mill, the pre-dehydrating unit, and the main dehydrating unit; Fig. 2 is a vertical section through the main dehydrating unit; Fig. 3 is a horizontal section through the main dehydrating unit; Fig. 4 is a vertical longitudinal section through the pre-dehydrating unit; and Fig. 5 is a vertical transverse section through said pre-dehydrating unit.

Referring more particularly to the drawings, in which similar reference characters identify similar parts in the several views, the material disintegrating unit of my novel apparatus comprises a cutter or mill 10 of conventional construction mounted upon a table 11, with a gravitational delivery pipe 12 connected to the cutter from which the material to be dehydrated in fine, uniform particles is sucked by blower fan 13, to pipe 14 leading to the pre-dehydrating unit. The cutter 10 is operated by a system of belts and pulleys from an electric motor (not shown) the grinding mill per se constituting no part of the present invention and therefore not being fully described herein.

The pre-dehydrating unit, generally designated at 15 and shown in longitudinal and transverse section in Figs. 4 and 5, respectively, is constituted of an elongated cylindrical casing 16, having an inlet pipe 17, entering the same at one end and an outlet pipe 18 of slightly larger diameter extending from the opposite end of the casing, both of the pipes 17 and 18 being centrally disposed longitudinally of the casing. The material to be dried in the pre-dehydrating unit passes therethrough from the pipe 17 to the pipe 18 in the elongated conduit circumscribed by screening 19 of approximately 80 to 100 mesh. This screening 19 forms a cylinder which is approximately four inches in diameter and is surrounded by a second cylindrical screen 20 of approximately 60 to 80 mesh, with a distance of approximately one inch between the screens. The screen 20 is in turn surrounded by a third screen 21, of between 40 and 60 mesh, again with a distance of one inch between the screens. Longitudinally extending throughout the casing 16 and disposed between the screens 20 and 21 is a thermostat 22 controlling the heat disseminated by a plurality of electrical heating units 23 disposed concentrically throughout the unit and extending substantially throughout the length thereof. Along the inner surface of the cylindrical casing 16 is provided insulation 24 of approximately one inch thickness. The entire pre-dehydrating unit is approximately 15 inches in diameter.

From the pre-dehydrating unit 15, the material to be further dried is conducted through the pipe 18 to a hopper 25, the progress of the material through the pre-dehydrating unit and the pipe 18 into the hopper 25 being enhanced by the air suction device 26. From the hopper 25 the material enters the main dehydrating unit which will now be described:

The unit is housed in a chamber 27 through the center of which extends a vertical shaft 28 rotated by gearing connected to pulley 29 rotated by means of a belt 30 by a motor 31 through the speed regulation of which the speed of rotation of the shaft 28 is controlled. Surrounding and secured to the shaft 28 in any convenient manner, for instance, by being keyed thereto, is a pipe 32 from which extend four radial supports to which is secured a flat disc 34. Above the upper surface of each disc are positioned two series of blades 35 and 36, depending from supports 33, extending from two opposite corners of the chamber, the first series of blades extending in one direction from the pipe 32, and the second in the diametrically opposite direction from such pipe. Intermediate each of two adjacent discs 34 is a circular platform 37 supported upon radial brackets extending from the pipe 32 and having their peripheral edges bound by an upwardly extending flange 38. Each of the circular platforms 37 has a central aperture 39 immediately surrounding the pipe 32.

Extending from the two other corners of the chamber 27 and disposed to saddle the radius of each of the circular platforms 37, is a bracket 40 from which depend a series of blades 41, with one series, on one half of a platform 37 extending in one direction and the series overlying the other half of the same platform extending in the diametrically opposite direction.

Each of the discs 34 is provided with a plurality of apertures 42 indiscriminately disposed throughout the surface of the disc for the purpose hereinafter described. Each of such discs, in addition, is provided with a pocket 43 near the peripheral edge thereof.

The chamber 27 is provided with a door 44 in which there may be conveniently positioned a window 45 to permit visual observation of the operation of the unit.

On one side of the chamber 27 is an auxiliary chamber 46, in which may conveniently be housed electric heaters 47 and 48 and companion air circulating devices, for instance, fans 49 and 50. The motors 51 and 52 for these fans may be conveniently positioned outside of the chamber but supported upon the wall thereof. Disposed between the heaters 47 and 48 approximately

centrally of the vertical extent of the chamber 46 is a rheostat 53 controlled by a dial or knob 54 extending outside of the chamber.

On the opposite side of the chamber 27 is a second auxiliary chamber 55 within which approximately centrally of the vertical extent of the chamber are disposed the heater 56 and fan 57, the latter operated by electric motor 58, mounted exteriorly on the wall of the chamber. Below the heater 56 is a rheostat 59 and its control knob 60, extending outside of the chamber and above such heater is rheostat 61 and its control knob 62.

The entire unit, including the front and rear faces of the main chamber 27 and the exterior walls of the auxiliary chambers 46 and 55 are provided with insulation 63.

From the top of the chamber 27 extends the exhaust outlet 64 with a damper control knob 65, while the material after dehydration issues through an outlet conduit 68.

As the material to be dried passes through the main chamber with the progressive dehydration thereof as hereafter described, it first encounters the heat impinged against it by the circulation caused by the fan 50, the heat emanating from electric heaters 48, maintaining a temperature of approximately 180° F.; at the next stage of the dehydration, the material is acted upon by the blasts of heated air circulated by the fan 57 and emanating from the heaters 56, maintaining a temperature of approximately 140° F.; and thereafter in the third or final stage of the dehydration process, the material is acted upon by the heated air impinged against it by the fan 49, the heat, at 120° F. emanating from the heaters 47.

The material to be dried, upon entrance into the main chamber 27 is dropped from the hopper 25 on to the topmost disc 34. As the disc rotates, the material is scraped by the arcuate blades 36, extending immediately above the disc. The operation of shovelling the material from the disc to the next succeeding platform and from the platform to the next succeeding disc is repeated throughout the extent of the rotating portion of the dehydrating unit. Instead of depending upon the shovelling of the material to the peripheral edge of each of the discs, each of such discs as shown in Fig. 3 is provided with a plurality of staggered holes of approximately one inch in diameter throughout the surface of the disc, through which holes the material can drop through the disc to the next succeeding platform. I have found that approximately 24 of these staggered holes in each disc are capable of providing a smooth continuity of operation with excellent results as to the dehydration of the material being treated. It will be noted that the alternate batteries of discs and platforms are divided into three series or stages, the first of which is supplied with hot air by means of the topmost blower and electric heat element, the air being impinged against the material being dried being heated to between 160 to 200° F., the medium of 180° being given hereinabove as illustrative. I have found that after the pre-dehydrating process to which the material has been subjected prior to the introduction into the main dehydrating unit, this quantity of heat is as much as the material will stand without destroying its cellular structure. The next battery of discs and platforms receive heat at between 140 and 160° F., 140° being given as illustrative hereinabove, while the last battery receives heat at between 100 and 120°. The moisture taken out of the material by the heated air is dissipated by an exhauster, the saturated air being let out of the chamber by means of the suction fan 67, positioned at the top of the chamber within the pipe 68 and controlled by a damper 69. It will be understood by those skilled in the art that a condenser of conventional construction may be used for this purpose.

I have found that there is a certain relationship between the angularity of the blades, their arcuate disposition and the efficiency with which the complete dehydration of the material acted upon is accomplished. The angularity of the blades must be such that at one complete revolution of the disc, the entire surface of such disc has been scraped by the blades. I have found by experimentation that this angularity of the blades to the vertical is approximately 70°.

The purpose of the blades is to automatically stir or agitate the particles of the material being dried, which material forms a layer of approximately ¼ inch in thickness upon the discs during the heat treatment so as to expose all surfaces and parts of the individual particles of the material substantially uniformly to the heat being applied thereto.

While I have described a specific embodiment of my invention, and particularly one specific form of an apparatus for carrying out my novel process, it is obvious that modifications therein, particularly in the arrangement and configuration of the several parts of such apparatus, and in the steps of the process may be made without departing from my invention.

I claim:

1. Process for dehydrating cellulose products, foods, and the like, which comprises disintegrating the material into substantially uniformly sized minute particles, subjecting the material to pre-dehydration to a degree removing only a small quantity of the moisture contained therein, and then completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage.

2. Process for dehydrating cellulose products, foods, and the like, which comprises disintegrating the material into substantially uniformly sized minute particles, subjecting the material to pre-dehydration to a degree removing only a small quantity of the moisture contained therein, and then completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage, the first drying stage being conducted at a comparatively high temperature, sufficient to remove a quantity of the moisture contained in the material without destroying its cellular structure, the intermediate stage at somewhat lower temperature, and the final stage at a still lower temperature.

3. Process for dehydrating cellulose products, foods, and the like, which comprises disintegrating the material into substantially uniformly sized minute particles, subjecting the material to pre-dehydration to a degree removing only a small quantity of the moisture contained therein, and then completely drying the material in a plurality of drying stages by providing controlled heated air of different degrees for each stage in proximity to the material, and circulating said heated air through said material while it is being agitated.

4. Process for dehydrating cellulose products, foods, and the like, which comprises disintegrat-

ing the material into substantially uniformly sized minute particles, subjecting the material to pre-dehydration to a degree removing only a small quantity of the moisture contained therein, and then completely drying the material in a plurality of drying stages by providing controlled heated air of different degrees for each stage in proximity to the material, and circulating said heated air through said material while it is being agitated, the first drying stage being conducted at a comparatively high temperature sufficient to remove a quantity of the moisture contained in the material without destroying its cellular structure, the intermediate stage at somewhat lower temperature, and the final stage at a still lower temperature.

5. The method of dehydrating cellulose products, foods, and the like, which comprises disintegrating the material into uniformly minute particles, pre-heating the material to effect a partial dehydration thereof, and thereafter completely drying the material in a plurality of drying stages while the material is being agitated.

6. The method of dehydrating cellulose products, foods, and the like, which comprises disintegrating the material into uniformly minute particles, pre-heating the material to effect a partial dehydration thereof, and thereafter completely drying the material in a plurality of drying stages, agitating the material during each drying stage, so as to expose all surfaces of the particles thereof uniformly to the drying heat, said drying being carried out by means of controlled heat of different degrees of temperature for each stage, the first drying stage being conducted at a comparatively high temperature, the intermediate stage at somewhat lower temperature, and the final stage at a still lower temperature, the material being fed from one drying stage to the next succeeding stage after completion of the degree of agitation and application of sufficient heat to remove a quantity of moisture from the material without scorching it.

7. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for preheating the material to pre-dehydrate the same by removing only a small quantity of the moisture contained therein, and means for completely drying the material in a plurality of drying stages.

8. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for distintegrating the material into substantially uniformly sized minute particles, means for preheating the material to pre-dehydrate the same by removing only a small quantity of the moisture contained therein, and means for completely drying the material in a plurality of drying stages, said last named means comprising a plurality of heating units, one for each drying stage, one of said heating units providing heat at a comparatively high temperature, the heating unit at the intermediate stage providing heat at a somewhat lower temperature, and the unit at the final stage providing heat at a still lower temperature.

9. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for subjecting the material to pre-dehydration, and means for thereafter completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage, said pre-dehydrating means comprising a cylindrical casing, a plurality of tubular screens surrounding the path of the material through said casing, a plurality of heating elements disposed longitudinally of the casing and surrounding said tubular screens, and means for controlling the temperature of the heat emanating from said heaters.

10. In an apparatus for dehydrating cellulose products, foods, and the like, means for subjecting the material to pre-dehydration prior to the final, complete drying of the material, said pre-dehydrating means comprising a cylindrical casing, a plurality of tubular screens surrounding the path of the material through said casing, a plurality of heating elements disposed longitudinally of the casing and surrounding said tubular screens and means for controlling the temperature of the heat from said heaters.

11. In an apparatus for dehydrating cellulose products, foods, and the like, means for subjecting the material to pre-dehydration prior to the final, complete drying of the material, said pre-dehydrating means comprising a cylindrical casing, a plurality of tubular screens surrounding the path of the material through said casing, said screens being successively, from the center of the casing outwardly, of finer mesh, a plurality of heating elements disposed longitudinally of the casing and surrounding said tubular screens, and means for controlling the temperature of the heat emanating from said heaters.

12. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for subjecting the material to pre-dehydration, and a multi-stage dehydrating unit for completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage, said multi-stage dehydrating unit comprising a heating unit for the first drying stage providing a comparatively high temperature, a second heating unit for the intermediate stage providing heat at a somewhat lower temperature, and a third heating unit for the final stage providing heat at a still lower temperature.

13. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for subjecting the material to pre-dehydration, and a multi-stage dehydrating unit for completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage, said multi-stage dehydrating unit comprising a heating unit for the first drying stage providing a comparatively high temperature, a second heating unit for the intermediate stage providing heat at a somewhat lower temperature, and a third heating unit for the final stage providing heat at a still lower temperature, said multi-stage dehydrating unit also comprising a chamber, a plurality of rotatable discs positioned therein, means for rotating said discs, and scrapers mounted above said discs for agitating the particles of the material to be dried and to shovel the same from one disc to an underlying disc in succession through the chamber from the top to the bottom thereof.

14. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for sub-

jecting the material to pre-dehydration, and a multi-stage dehydrating unit for completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage, said multi-stage dehydrating unit comprising a chamber, a plurality of rotatable discs positioned therein, means for rotating said discs, and scrapers mounted above said discs for agitating the particles of the material to be dried upon rotation of said discs and to shovel the same from one disc to an underlying disc in succession through the chamber from the top to the bottom thereof.

15. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for subjecting the material to pre-dehydration, and a multi-stage dehydrating unit for completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage, said multi-stage dehydrating unit comprising a chamber, a plurality of rotatable discs positioned therein, means for rotating said discs, a plurality of circular platforms disposed between said discs, and stationary scrapers mounted above said discs and platforms for agitating the particles of the material to be dried and to shovel the same from one disc to the underlying platform in successive series through the casing from the top to the bottom thereof.

16. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for subjecting the material to pre-dehydration, and a multi-stage dehydrating unit for completely drying the material in a plurality of drying stages by means of controlled heat of different degrees for each stage, said dehydrating unit comprising a chamber, a plurality of rotatable discs positioned therein, means for rotating said discs, and scrapers mounted above said discs for agitating the particles of the material to be dried and to shovel the same from one disc to an underlying disc in succession through the chamber from the top to the bottom thereof, and means for supplying heat to said material in stages throughout the vertical extent of the chamber and at different temperatures successively reduced from the top to the bottom of said chamber.

17. Apparatus for dehydrating cellulose products, foods, and the like, which comprises means for disintegrating the material into substantially uniformly sized minute particles, means for subjecting the material to pre-dehydration, and means for completely dehydrating the material in a plurality of drying stages by controlled heat of different degrees for each stage comprising a chamber, a plurality of rotatable discs positioned therein, means for rotating said discs, a plurality of circular platforms disposed between said discs, scrapers mounted above said discs and platforms for agitating the particles of the material to be dried and to shovel the same from one disc to the underlying platform in successive series through the chamber from the top to the bottom thereof, means for supplying heated streams of air to said material in stages throughout the vertical extent of the chamber at different temperatures successively reduced from the top to the bottom of said chamber, and a plurality of blower units positioned within the chamber in proximity to, and so as to be effective to direct the heated streams of air against, the material to be dried.

18. An apparatus as claimed in claim 14, in which the scrapers are disposed from brackets extending over the discs, alternate series of said scrapers being disposed so as to shovel the material in opposite directions.

19. An apparatus as claimed in claim 14, in which the scrapers are disposed from brackets extending over the discs, alternate series of said scrapers being disposed so as to shovel the material in opposite directions, said scrapers having an angularity to the vertical of approximately 70°.

20. An apparatus as claimed in claim 15, in which the scrapers are disposed from brackets extending over the discs and platforms, alternate series of said scrapers being disposed so as to shove the material in opposite radial directions upon said discs and platforms, respectively.

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