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3,363,665

DOUBLE DRUM DRYER WITH REMOVABLE EXTERNAL HEATING MEANS

Filed Nov. 23, 1964

3 Sheets-Sheet 1

Fig. 1

PRIOR ART

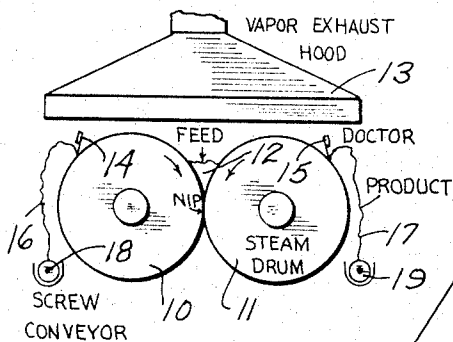
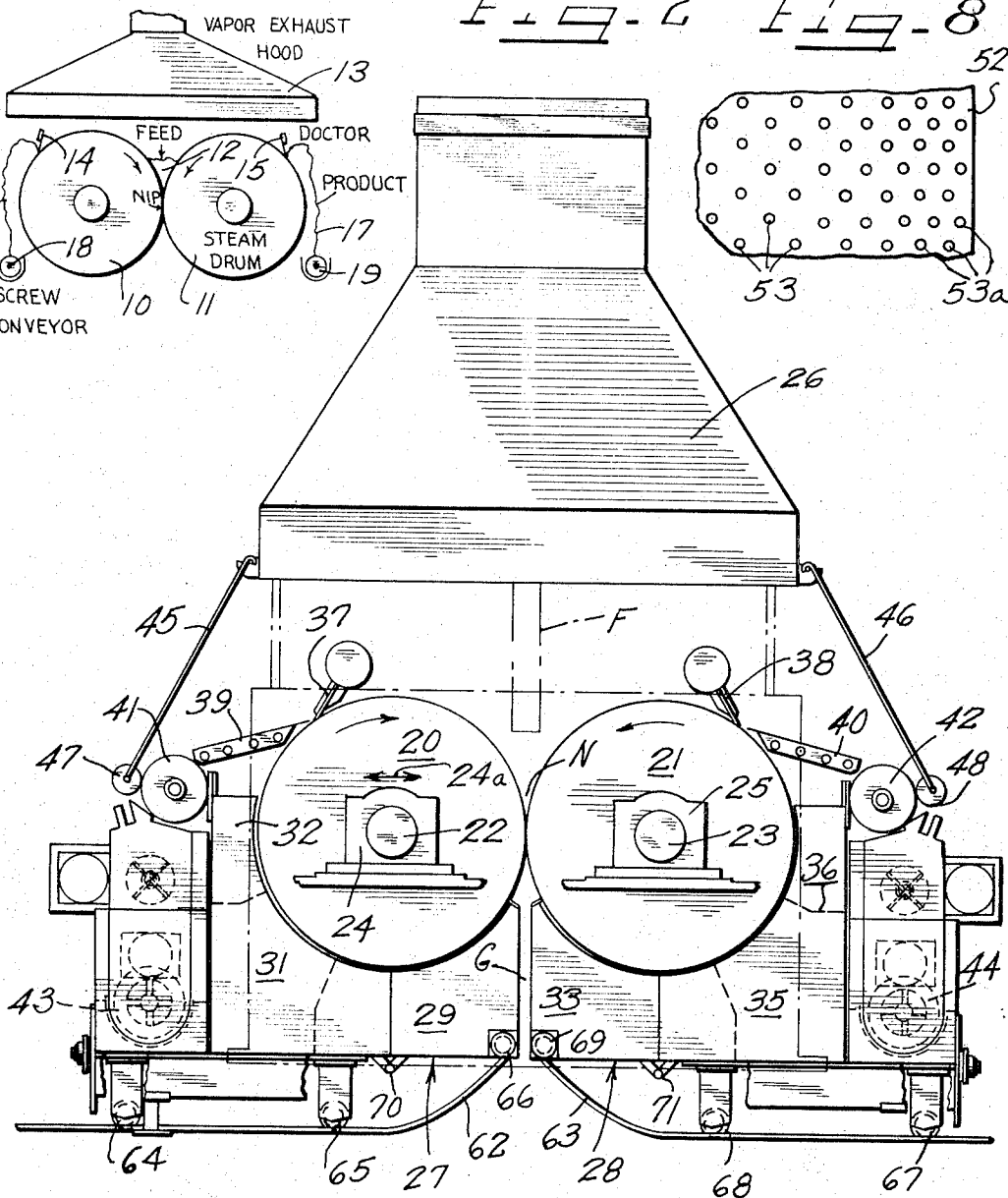


Fig. 2 Fig. 8



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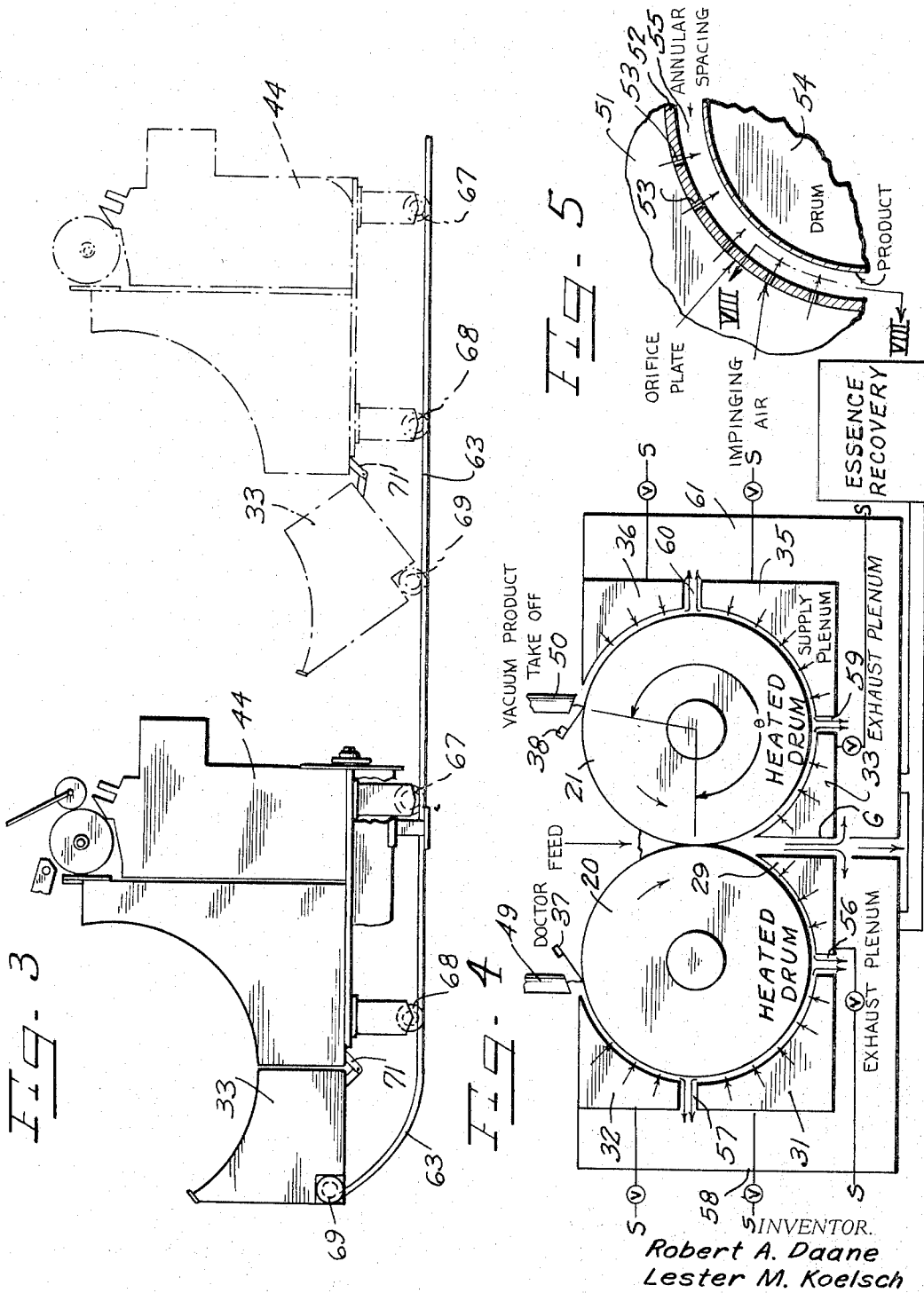
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FIG. 7

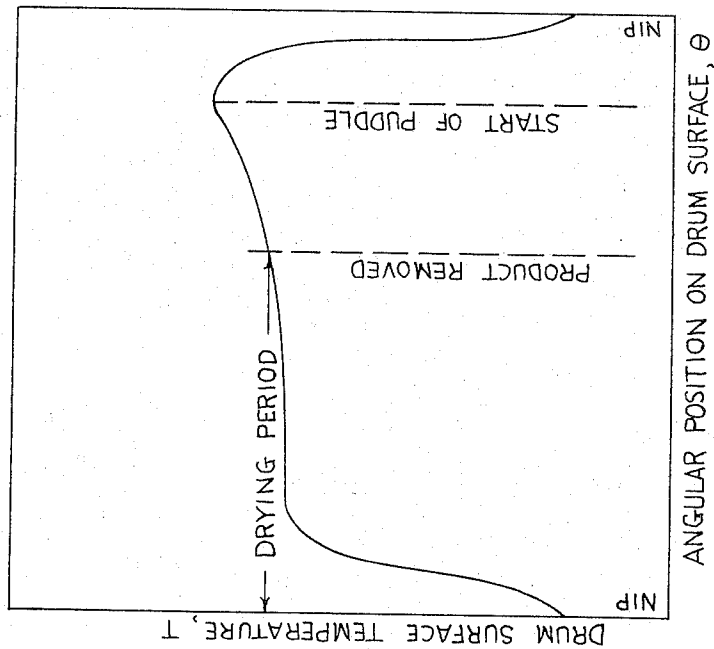
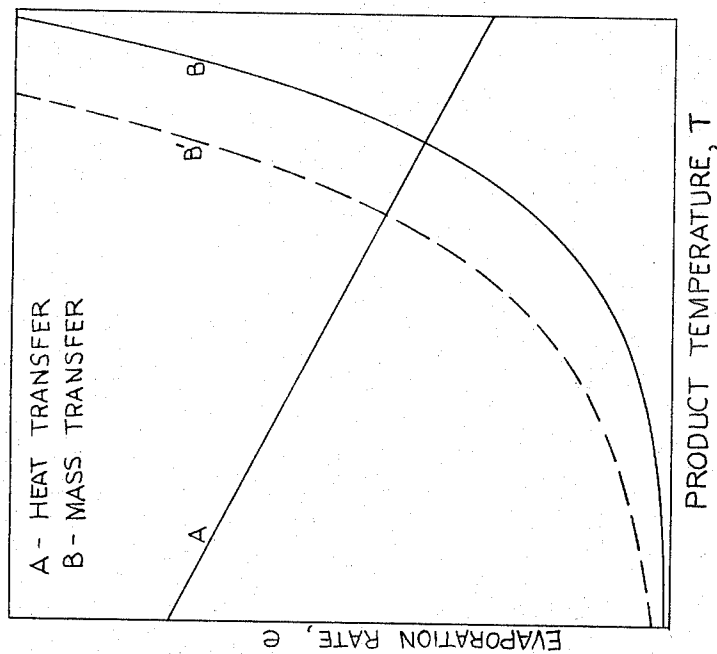


FIG. 6



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DOUBLE DRUM DRYER WITH REMOVABLE EXTERNAL HEATING MEANS

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8 Claims. (Cl. 159—10)

The present invention relates to improvements in food
dryers and particularly to a double drum dryer of the
type having a pair of heated dryer drums ranged to re-
ceive a slurry of food product in a nip therebetween
and to rotate toward each other so as to form a thin
layer of product on the surface of the drum with the
layer being removed from the surface after it has been
dried thereon.

More particularly a conventional double drum dryer
maintains a puddle of slurry immediately ahead of a
narrow nip between the drums which is typically on the
order of 0.001 inch to 0.003 inch wide. The drums are
continually rotated toward each other to form a product
layer on each of the drum surfaces, and the layer is dried
by heat transferred from the cylinders which may be
heated from steam within the drums or cylinders. Control
is obtained in devices presently available by the rota-
tional speed of the drums, the heat of the steam within
the drums, the thickness of the layer formed in the
drum surfaces and these factors are adjusted so the
product reaches a desired final moisture content at an
angular distance of about 225° from the nip where the
product is scraped off each of the drums by a doctor
blade to fall onto a screw conveyor or other transport
means. A vapor hood is usually positioned above the
drums for keeping vapor out of the machine room.

A disadvantage of present systems of the type above
described is that since the sole heat transfer to the
product is through the dryer drum wall the steam is
maintained at a temperature to maintain the drum sur-
face at an upper temperature limit which is dictated by
the maximum permissible limit of the food product at
some location along the surface of the drum. In other
words, the food slurry or layer on the drum surface
cannot be exposed to very high temperatures for a long
period of time or the product will be damaged and the
drum can be heated only to a temperature within limits
that will not overheat the product at a point along the
drum periphery. Yet a rapid processing of the food is
desirable to reduce the size of the equipment needed
and increase production and decrease the time that the
product must be exposed to the drying process. In many
instances lowering the drying temperature of foods is
desirable in order to minimize harmful chemical and
physical reaction. Some harmful reactions can be pre-
vented by limiting the available heat energy (maintain-
ing a low temperature to an extent that the undesirable
chemical or physical reaction cannot be initiated). More
frequently, however, the advantage of a low product tem-
perature arises from its direct relationship to the rate of
the reaction, i.e. the lower the temperature the slower
the reaction rate.

Proteins are particularly heat sensitive and can easily
be coagulated at high temperatures. For example, egg
white contains proteins which are denatured when the
product temperature reaches 52° C. However, the rate
of coagulation of the denatured proteins at 52° C. is ex-
tremely slow. If the temperature of the egg white is
raised to 62° C., the coagulation speed of the proteins
increases 600 fold. Consequently, if a satisfactory drying
procedure can be accomplished at a low product temper-
ature on the drum surfaces food products with excellent
solubility characteristics and normal functional proper-

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ties will be achieved. Many other food constituents are
altered during high temperature drying. Skim milk pow-
der dried on an ordinary drum dryer at conventional
temperatures is usually light tan in color. The tan color
is due to the protein-lactose reaction which is enhanced
by high temperature. Maintenance of a low tempera-
ture becomes increasingly important as the milk becomes
more concentrated during the drying period.

In some foods, vitamins can be destroyed at high tem-
peratures. Thiamine, for example, is decomposed com-
pletely when a thiamine containing food at pH 9 is
heated at 100° C. for 20 minutes. Significant quantities
of thiamine are lost during conventional drum drying.
Lower product temperatures prevent a loss of thiamine
and other heat sensitive constituents. As the temperature
of the product is increased, the vapor pressures of the
volatile flavoring constituents are likewise increased. Con-
sequently low temperatures of the products are desir-
able during drying to prevent excessive loss of flavor con-
stituents during drying.

In addition to low temperatures it is desirable to have
a control of product temperatures at different stages
during drying. In some instances, a food product must
be heated to a high temperature during the initial stages
of manufacture. For example, a lactose solution must be
maintained above 83.3° C. during the early stages of dry-
ing if beta-lactose crystals are desired. During the manu-
facture of pregelatinized starch, the starch granules must
be heated above 70° C. at the beginning so that the gran-
ules become thoroughly gelatinized prior to drying. Some
heat sensitive foods can tolerate only a mild heat treat-
ment at the beginning of the drying cycle but after an
appreciable amount of water has been removed, the
drying temperature can be increased without detrimental
results. For example, egg whites should be kept below
48° C. until the solids content reaches 65%. Thereafter,
the temperature can be raised to about 75° C. without
harmful results.

Another desirable feature of a drying process is the
control of the bulk density which is an important property
of dried foods in that it influences the cost of packaging
and the rehydration characteristics of the product. A high-
ly porous product (low bulk density) such as is obtained
by foaming during drying is generally advantageous from
the standpoint of rapid drying and rehydration. Product
concentration and the rate of moisture removed both have
an influence on the extent of foaming. By being able to
control the rate of drying at all stages of the process, maxi-
mum control of bulk density is possible. For example, by
first determining the concentration and location on the
drum where a given product exhibits desirable foaming
properties, and controlling the pressure at the desired
point to achieve optimum foaming an improved product
would result. This will enhance the rate of drying, lower
the final bulk density, and in many cases yield a product
of improved rehydration properties.

It is further significant in the drying process to control
the frame or moisture content of the food product. It is
well known that the keeping quality and reconstitution
characteristics of dried food materials are related to their
moisture contents. For example, dry milk stored at 3%
moisture will reconstitute better and will have better
(more natural) color and flavor than the same product
stored at 5% moisture. For each dried product there is a
moisture content, usually quite low, that will result in a
reconstituted product of maximum quality. Achievement
of optimum moisture content in a product dried by a
conventional drum drying system quite often results in
thermal damage of some sort. By obtaining a higher rate
of heat and moisture transfer than heretofore possible,
the attainment of (1) a lower moisture content than con-

ventional drum drying when using equal conditions of time and temperature is possible and (2) less thermal damage (better reconstitution characteristics) than conventional drying drum processing is possible.

In a drying process, the essence recovery is a significant factor. Commercial drying invariably results in a loss of volatile flavoring components to an extent that consumer acceptance is diminished. One way of restoring a portion of the original flavor is to use an essence recovery device in connection with the drying process. By adding the recovered essences to the dry product a considerable improvement in flavor can be achieved. Essence recovery involves passing vapors arising from the early stages of evaporation through a low temperature fractionating column. The desired flavor components are thereby collected in a highly concentrated form. It is therefore desirable to be able to capture vapors arising from the product particularly in the first drying which occurs in order to collect the vapors and pass them through an essence recovery device.

In drying certain types of food products the control of the atmosphere is helpful to obtain an improved product. For example, if a product is particularly susceptible to oxidation, drying under an atmosphere of nitrogen would be helpful or necessary. Furthermore, an additive to the atmosphere such as sulfur dioxide if incorporated into the drying atmosphere would achieve an antibrowning effect. Relative humidity of the atmosphere if controlled at certain critical locations is helpful in obtaining an optimum drying process for procedures in certain food products.

Thus it is an objective of the present invention to provide a drying mechanism which provides an improved food product and which incorporates structural features capable of accomplishing one or all of the foregoing advantages including: (1) rapid moisture removal from the food product at low drying temperatures; (2) control of the product temperature during drying; (3) control of bulk density; (4) control of the final moisture content of the food product; (5) possibility of essence recovery; and (6) control of the composition of the atmosphere during drying.

It is a further general objective of the invention to provide an improved double drum type of drying mechanism which is capable of increasing the evaporation rate for any given product temperature and moisture content during drying and can maintain a controlled low vapor pressure on the exposed drying surface.

A still further object of the invention is to provide a double drum drying system which utilizes drying control hoods establishing drying zones that increase the heat transfer to the food product and achieve greatly increased drying rates at the same or lower product temperatures as compared to conventional systems.

A further object of the invention is to provide a device which makes it possible to modify and control temperature variations on the dryer drum and to control the temperature history experienced by the product as it passes through the drying system whereby optimum drying conditions of temperature, pressure and atmosphere for the product can be achieved at all stages of moisture for obtaining a product having an optimum condition and for increasing drying speed and optimum output for a dryer of a given size.

Other objects, advantages and features will become more apparent with the teaching of the principles of the invention in connection with the disclosure of the preferred embodiments thereof in the specification, claims and drawings, in which:

FIGURE 1 is a schematic elevational view showing a drum dryer of conventional design of a type heretofore used;

FIGURE 2 is a somewhat schematic elevational view with parts removed for clarity of a dryer mechanism con-

structed and operating in accordance with the principles of the present invention;

FIGURE 3 is a fragmentary schematic view showing relative positions of certain parts for servicing of the dryer mechanism;

FIGURE 4 is a schematic elevational view showing a somewhat modified form of the dryer;

FIGURE 5 is an enlarged fragmentary sectional view in somewhat schematic form showing the drying operation;

FIGURES 6 and 7 are diagrams illustrating operational relationships of factors of the mechanism; and

FIGURE 8 is a fragmentary sectional view taken substantially along line VIII—VIII of FIGURE 5.

On the drawings:

As illustrated in FIGURE 1, dryers of the type heretofore used embodied parallel opposed heated steam drums 10 and 11 forming a nip therebetween in which a puddle 12 of a food product slurry was contained to form a thin layer of the food product on the drums as they rotated. The food product is supplied by a feed mechanism and the layers of food product were dried during the time they were held on the drum surfaces until they were scraped off by doctor blades 14 and 15 the product 16 and 17 dropping down into screw conveyors 18 and 19. An overhead hood 13 is provided for preventing the escape of excess steam into the dryer room. In the mechanism of the present invention, as shown in FIGURE 2, opposed parallel counter-rotation heated dryer drums 20 and 21 are positioned to form a narrow nip N therebetween. An overhead feed mechanism F provides a slurry of food product to the nip.

The dryer drums 20 and 21 are supported on shafts 22 and 23 carried in end bearings 24 and 25. The end bearings are relatively laterally adjustable so as to control the spacing between the drums and thereby control the thickness of the layer of food product which forms on the drum surfaces. The bearing 24 may be provided with suitable mechanism to be laterally adjustable as indicated schematically by the arrowed line 24a. For example, the bearing may be carried on a slide with a threaded rod and follower not employed for adjusting the horizontal position of the bearing, and the bearings at both ends will be similarly adjustable to maintain a parallel position and a uniform nip between the drums 20 and 21.

A vapor exhaust hood 26 is provided above the drying cylinders and its primary purpose is to keep vapor out of the drying room.

As the food slurry forms a layer on the drum surfaces and is carried downwardly through the nip N, some particles will separate and fall downwardly and a gap G is provided extending vertically downwardly to admit these particles. Suitable collecting means may be provided for receiving the particles and these are reprocessed.

Heat is transferred to the food product from the heat within the heated drums 20 and 21 and heat is also transmitted to the food product from the outer surface of the layer from a series of air chambers or hoods which direct a flow of high velocity hot air from round orifices onto the product layer. The hot air hoods are arranged in sections to control the air temperature over successive segments of the circumference of the drums and as the temperature content of the product decreases the temperature of the air discharge against the outer surface is also decreased. The layer of food product on the drum 20 successively passes air hoods 29, 31 and 32. The layer of food product on the drum 21 successively passes air hoods 33, 35 and 36. As the dried food product is carried upwardly beyond the hoods, it is doctored from the surface of the drums by doctor blades 37 and 38 and slides over onto shields 39 and 40. The shields may be heated by steam lines and if desired suction nozzles may be employed to aid in removing the food product from the drums as it is doctored from the surface thereof. The product slides off the shields onto side rollers 41 and 42

which rotate and drop the product downwardly onto screw conveyors 43 and 44. The screw conveyors carry the dried product out to a cross end conveyor, not shown, to be packaged. Heated air flow to the individual hoods is obtained from suitable supply sources indicated at S, with flow through the hoods controlled by valves V.

Shields 45 and 46 are provided to prevent the escape of vapor and these are supported at their upper ends on the hood 26 and at their lower ends they have rollers 47 and 48 which ride on the rolls 41 and 42.

As above stated, the temperature of the air in the hoods or plenums 29, 31 and 32 and 33, 35 and 36 is reduced progressively around the drums away from the nip N. For example, in drying a product such as potatoes, a satisfactory operation has employed a temperature of 600° F. for the first plenums. The second plenums 31 and 35 employed a temperature of 300° F. and the third plenums 32 and 36 employed a temperature of 200° F. The maximum temperature employed by each successive plenum is determined by the maximum temperature which will enjoy rapid evaporation of the moisture without damaging or adversely effecting the particular food product which is being dried. The drums are steam heated and the temperature therein will be on the order of the temperature of saturated or slightly super-heated steam such as at 220° F.

FIGURE 5 shows the relationship between an inner wall 52 of a plenum chamber or hood 51 which is similar in construction to the hoods of FIGURE 2. The orifice plate or inner wall 52 has perforations 53 therein for the escape of heated air as indicated by the arrowed lines. The air flows over the surface of the material in the space 55. Typically, the orifices 53 are on the order of $\frac{3}{16}$ " in diameter and the annular space 55 is $\frac{1}{2}$ " in radial dimension. The orifices are uniformly distributed over the area of the plate 52 in an equilateral triangular pattern with about 1½% open area. Exhaust openings are provided for the escape of air which flows through the annular space 55 and these openings are shown at the gap G and spaces 56, 57, 59 and 60 in FIGURE 4. The air escaping through the gaps carrying vapor with it is collected by the exhaust plenums 58 and 61. As shown in FIGURE 8, to obtain uniformity of product, air flow at the ends or edges of the drums is increased. This is accomplished by increasing the frequency of the openings with the edge openings at the edge being closer together as shown by the openings 53a in FIGURE 8, although other means of increasing the heat transfer coefficient could be used such as increasing the size of the openings or the velocity of flow at the end.

In the arrangement of FIGURE 4, the food product is carried in layers on the drums and is subjected to heat for moisture removal over the angle of drum travel θ . At the end of its travel it is scraped off the drum by the doctor blades 37 and 38 and vacuum product take-off conduits 49 and 50 have an opening adjacent the doctors 37 and 38 to draw the dried product up through passages to be packaged or otherwise stored.

The air hoods are shown in FIGURE 2 mounted on rails or tracks 62 and 63. Each group of air hoods for the individual drums 20 and 21 are mounted separately so that they can be withdrawn or roll away from the drums 20 and 21 for cleaning and servicing. The hoods for each drum are constructed in sections with the inner sections 29 and 33 being pivotally mounted to the other sections by hinges 70 and 71. This permits the inner hoods to move up around in close proximity to the drums in operative position and to move away from the drums in servicing position.

FIGURE 3 in the full line position shows the innermost hood section 33 tilted upwardly adjacent the drum. The broken line position to the right in FIGURE 3 shows how the inner section 33 pivots downwardly on its hinge support 71 as its supporting wheel 69 rolls downwardly on the curved tracks 63. Each of the hood sections

have main supporting wheels or rollers and wheels 64 and 65 support the hoods for the drum 20 and wheels 67 and 68 support the hoods for the drum 21. The conveyors are also carried on the wheels with the hoods. The inner wheels 66 and 69 ride on the curved inner portions of the tracks 62 and 63 to carry the inner portions 29 and 33 of the hoods up into the position shown in FIGURE 2 or to permit them to drop downwardly to clear the drums 20 and 21 when the hood assemblies are pulled laterally outwardly.

There are two important conditions related with the drying of the food layer on the drums in a drying system. They are (1) heat transfer to the product and (2) diffusion of vapor from the product.

The transfer to the food layer on the drum consists of the heat transfer from the drum surface to the layer and the heat transfer from the surrounding air to the product surface. In general, this heat transfer rate is given by the following equation:

$$q = k \frac{DT}{DX} + h_a (T_a - T) \quad (1)$$

In this equation the following nomenclature applies:

q = heat transfer rate in B.t.u./hr. ft.².

k = thermal conductivity of dryer drum shell material in B.t.u./hr. ft. ° F.

DT/DX = temperature gradient in the dryer shell at the outer surface in ° F./ft.

h_a = heat transfer coefficient from air to product surface in B.t.u./hr. ft.² ° F.

T_a = temperature of air supplied to ventilating system in ° F.

T = product layer temperature in ° F.

The assumption is made here that the product layer thickness is thin enough and its thermal conductivity is high enough so that we can regard dryer drum surface temperature as being equal to product layer temperature. This assumption will be very accurate over most of the drying range and even for the low moisture content region will be reasonably accurate for product layer thicknesses on the order of .001 inch. While the temperature gradient, DT/DX can be computed for any specific case, it is not related to the basic system parameters in any simple way. However, it is instructive to consider the average value of heat transfer rate over the region of the cylinder covered by the product and this average value may be expressed by the following equation:

$$\bar{q} = \frac{1}{\theta} \int_0^{\theta_1} k \frac{DT}{DX} d\theta = \frac{1}{\theta_1} \int_0^{2\pi} h_c (T_c - T) d\theta = \frac{2\pi}{\theta} h_c (T_c - T) \quad (2)$$

In this equation the following nomenclature applies:

θ = the angular coordinate designating the position on the dryer drum surface in radians. h_c = heat transfer coefficient from steam to dryer drum surface in B.t.u./hr. ft.² ° F. T_c = temperature of steam in dryer drums in ° F.

The average evaporation rate may be expressed by the following equation:

$$\bar{e} = \lambda \bar{q} \quad (3)$$

In this equation the following nomenclature applies:

e = evaporation rate in lb./ft.²/hr.

λ = heat of evaporation in B.t.u./lb.

The evaporation rate as expressed by the vapor diffusion rate is given by the following equation:

$$e = ch_a \ln \left(\frac{1 - P_a}{1 - P_{eff}} \right)$$

In this equation the following nomenclature applies:

P_a = vapor pressure in air surrounding the product in atmospheres.

P_{eff} = the effective vapor pressure at the product layer in atmospheres.

C = a constant factor in mass transfer coefficient in lb./ft.²/° F./B.t.u.

For the evaporation of free water, P_{eff} is equal to the saturation pressure corresponding to the temperature of the water surface. For a food product with a small moisture content, we may still use the above relationship if P_{eff} is taken to mean a properly adjusted function of the saturation pressure corresponding to the product layer temperature. The ratio of P_{eff} to P_{sat} will generally depend on product moisture layer thickness and drying rate. However, the usefulness of the concept lies in the fact that for any given product over a reasonably limited range of layer thickness and drying rate, this ratio will approximately be a unique function of the moisture content.

FIGURE 6 illustrates the above relationships between drying rate and the product temperature. Curve "A" shows the average drying rate as expressed by Equations 1, 2 and 3 where it is seen that, as the average product temperature increases, the temperature differences decrease and consequently heat transfer and drying rate decrease linearly. Curve "B" shows drying rate as expressed by Equation 4 above. As the product temperature increases, P_{eff} increases and evaporation rate and product temperature prevailing for any given condition is then determined by the intersection of curves "A" and "B." The effect of the air caps 31, 35 e.g. is to increase h_a and to reduce P_a as compared with a conventional system. With the particular air cap design disclosed, it can achieve heat transfer coefficients of 40 to 60 B.t.u./hr./ft.²/° F. and the vapor pressure in the supply air can be maintained at negligible values. The effect of this is to increase curve "B" (illustrated curve B') and thus leading to a higher evaporation rate and a lower product temperature. The second effect of the air cap is to increase the heat transfer, which then increases curve "A" leading to still further increase in evaporation rate. Depending on air velocity, temperature, etc., it may be seen that addition of air hoods may lead to either higher or lower product temperature, depending on the relative amounts by which curve "A" and curve "B" are increased. For example, using cold air and with a decreased dryer drum steam pressure it is possible to achieve the result of no increase in drying rate, but an appreciable decrease in product temperature. On the other hand, using hot air, the device can achieve greatly increased drying rates and the same product temperature as would be experienced with a conventional system. For other appropriate combinations of controllable conditions, the mechanism may both increase product drying rate and decrease product temperature.

If under all conditions the device maintains the minimum practical product layer thickness on the dryer drum then it is obvious that an increase in drying rate involves a higher speed of drum rotation in a shorter time during which any part of the product is being dried and during which it is exposed to elevated temperatures. Thus, the addition of hot air hoods to the double drum food dryer makes it possible to both reduce the maximum temperature experienced by the product during drying and the time during which it experiences that temperature. Typical results show that the use of air hoods with moderate temperature air and with a reduced steam pressure in the drums lead to a reduction in maximum product temperature from a value of 250° F. with a conventional system to a value of 180° F. after the addition of the air hoods. Results show that the product drying rate was doubled while the maximum temperature was reduced from the value of 250° to 230°.

FIGURE 7 qualitatively shows how the temperature of the drum surface varies with angular position on a conventional system. The temperature is depressed as the drum surfaces pass through the product slurry puddle. Then there is a rapid rise to the temperature prevailing during drying. The drying temperature increases as mois-

ture content decreases; then after the product is scraped off the drum, surface temperature rises at a somewhat more rapid rate until it again reaches the product slurry puddle.

The air hoods are compartmented circumferentially so that each compartment may be independently controlled with respect to air impingement velocity and air temperature. This makes it possible to modify the circumferential temperature variation around the dryer drum or, in other words, to modify the temperature history experienced by the product as it passes through the drying system. Thus, we have with the use of air hoods an opportunity to tailor this temperature history in whatever manner is required to minimize the deleterious effect of time and temperature on the product as it is being dried.

The air hood design is optimized from the standpoint of heat transfer coefficient obtainable for any given air blowing power. However, an increase in open area in any region of the orifice plate to a value greater than one and one-half percent (1½% to 3%) will result in a higher heat transfer coefficient for any given plenum pressure. These facts can be used to modify the temperature profile across the width of the dryer system. Because of mechanical considerations, it is typical to have reduced heat transfer rates near the edges of the cylinders. This can be compensated for by increasing the open area in the orifice plates in these edge regions. This increased heat transfer coefficient toward the edges of the drum is extremely important in that it greatly improves the uniformity of the product across the width of the dryer drums and in addition increases the effective width of the dryer drums by a substantial amount. Although an increase in the open area of the orifice plate results in a higher air flow rate and as a consequence thereof causes the edge regions of the air impingement system not to operate optimally from the standpoint of power expenditure it does provide the needed increase in heat transfer and the small increase in power consumption is greatly outweighed by the advantages outlined above.

Thus, it will be seen that I have provided an improved food drying structure which meets the objectives and advantages above set forth. The mechanism provides for an improved product avoiding disadvantages heretofore available and provides for improved features of construction and servicing.

As above stated, the mechanism may be used for essence recovery and as shown in FIGURE 4, an essence recovery mechanism may be attached to the exhaust plenum to capture the vapors and process them in the essence recovery mechanism which is shown schematically in FIGURE 4.

The drawings and specification present a detailed disclosure of the preferred embodiments of the invention, and it is to be understood that the invention is not limited to the specific forms disclosed, but covers all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by the invention.

We claim as our invention:

1. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with the drum surfaces movable downwardly into the nip so that a thin layer of food product forms on the drum surfaces, means for heating said drums,

means for supplying a slurry of food product to said nip,

a plurality of dryer hoods positioned successively along the periphery of the drums following said nip for defining drying zones,

a plurality of heated pressurized air supply means independently connected to each of the hoods for delivering a continual flow of air heated to a predeter-

mined temperature for each of said hoods with said temperature selected to heat the product on the drum to a predetermined permissible temperature for the product at the moisture content of the product at the location of said hood, 5

air escape passage means leading away from said zones for the flow of moisture-laden air away from the product, 5

a doctor blade means for removing the product from each of the drum surfaces following said hoods, and a vacuum removal conduit means positioned adjacent the doctor blade means for carrying away dried product doctored from the drum surfaces. 10

2. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with the drum surfaces movable downwardly into the nip so that a thin layer of food product forms on the drum surfaces, means for heating said drums, 15

means for supplying a slurry of food product to said nip, 20

dryer hood means positioned adjacent the respective outer surfaces of the dryer drums following the nip, said hood means being divided into sections hingedly attached to each other for pivotal movement independent of other sections, 25

roller means supporting the hood means for movement beneath the respective drums laterally of the drum axes so that the respective hood means can be moved laterally clear of the respective drums to expose the lower surfaces thereof, a track supporting said roller means and being curved upwardly between the drums for dropping the roller means and inward sections of the hood means as the respective roller means moved laterally outwardly, 30

said inward sections moving upwardly between the drums in the inward operating position of the hood means, 35

and means positioned following the hood means adjacent the outer surfaces of the drums for removing the dried products from each of the drum surfaces. 40

3. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with the drum surfaces movable downwardly into the nip so that a thin layer of food product forms on the drum surfaces, 45

a plurality of independent drying means outwardly of each of the drums for transferring heat to the food product on the drum surfaces, means for increasing the heat transfer to the food product at the ends of the drums, 50

means for supplying a slurry of food product to said nip, 55

a dryer hood means positioned adjacent the respective outer surfaces of the dryer drums following the nip, roller means supporting the respective hood means for movement beneath the respective drums laterally of the drum axes so that the hoods can be moved laterally clear of the drums to expose their lower surfaces, 60

and means for moving the dried product from each of the drums positioned following the hood means. 65

4. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with the drum surfaces movable downwardly into the nip so that a thin layer of food product forms on the drum surfaces, means for supplying a slurry of food product to said nip, 70

means defining a plurality of separate distinct heated drying zones along the peripheries of said drums following said nip, 75

a plurality of means positioned outside the drums for independently heating each of said zones to a predetermined drying temperature applying heat to the outer exposed surface of the product on the drum so that maximum moisture removal is accomplished without exceeding a predetermined permissible temperature for the product at the moisture content of the product in the location of said zone, 5

means for increasing the heat transfer from such heating means to each of such zones at the ends of the drums, 10

and means removing the dried product from each of the drum surfaces following said zones.

5. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with surfaces of the drums movable into the nip so that a thin layer of food product forms on the surfaces, 15

a plurality of independent drying means positioned outwardly of the drums for heating the product on said surfaces, 20

means for increasing heat transfer from such drying means to the food product at the ends of the drums, and means for selectively controlling the pressure and temperature at predetermined independent zones along the circumference of the drums following said nip. 25

6. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with surfaces of the drums movable into the nip so that a thin layer of food product forms on the surfaces, 30

a plurality of independent drying means positioned outwardly of the drums for heating the product on said surfaces, 35

means for increasing the heat transfer from such drying means to the food product at the ends of the drums, and means for recovering the vapor evaporated from the food product immediately following the nip so that said vapor can be passed through an essence recovery system. 40

7. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with the surfaces of the drums movable into the nip so that a thin layer of food product forms on the surfaces, 45

a plurality of independent drying means outwardly of the drums for transferring heat to the food product on the drum surfaces, 50

and means for increasing the heat transfer to the food product at the ends of the drums. 55

8. A mechanism for drying food products comprising, a pair of cylindrical counter-rotatable dryer drums forming an upwardly facing product receiving narrow nip therebetween with the drum surfaces movable downwardly into the nip so that a thin layer of food product forms on the drum surfaces, 60

means for heating said drums, 65

a plurality of independent air chambers positioned sequentially around each of the drums following the nip having a plurality of openings facing the respective drum surfaces, said plurality of openings comprising not more than about 1½ to 3% open area and increasing in frequency at the lateral ends of the respective drums, 70

and means defining a space between said chambers vertically beneath the nip providing for a drop-through of particles separated from the surface layers of product on the drums immediately following the nip. 75

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