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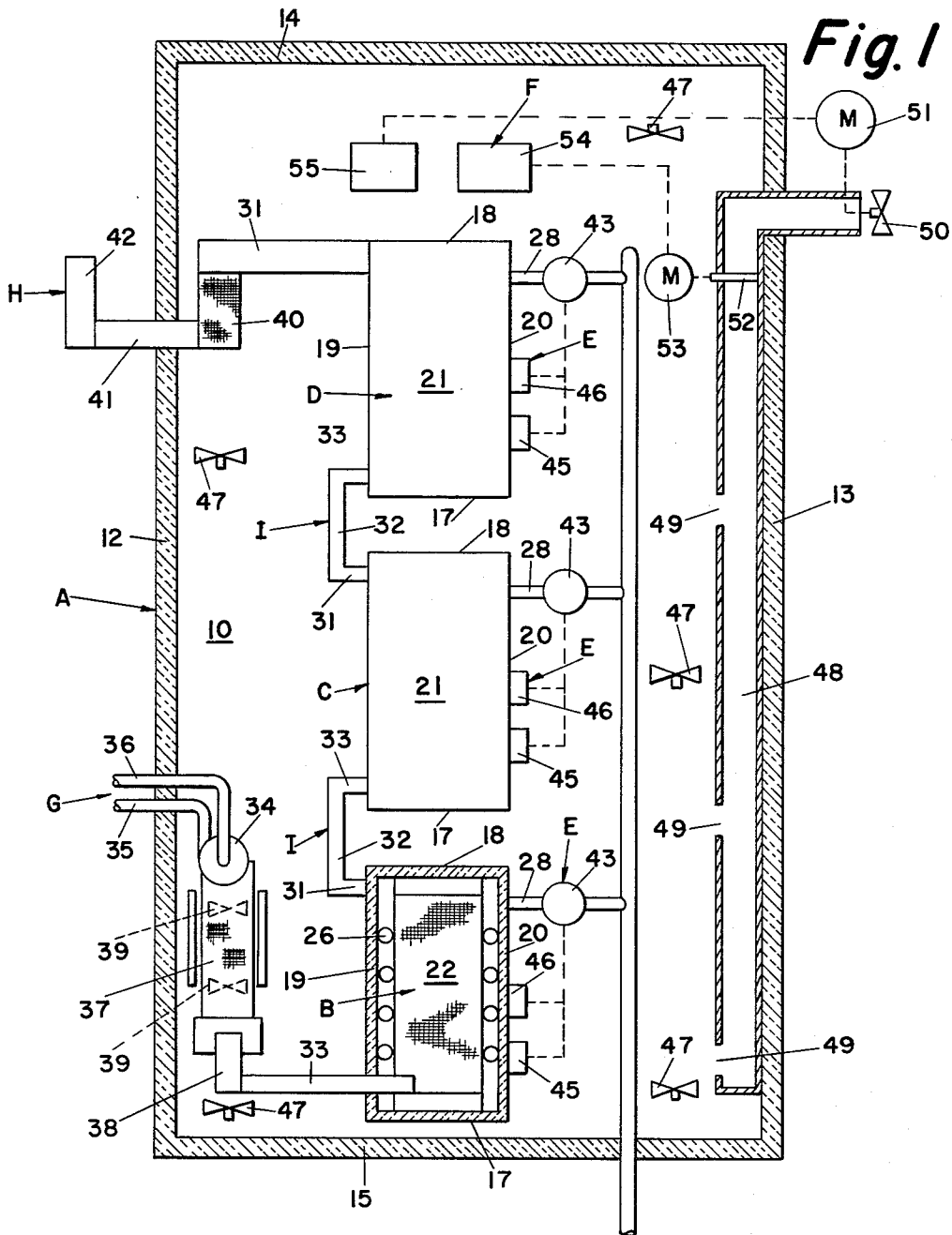
B. ARENA

3,209,465

METHOD AND APPARATUS FOR DRYING ALIMENTARY PASTE

Filed Sept. 18, 1962

2 Sheets-Sheet 1



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Fig. 2

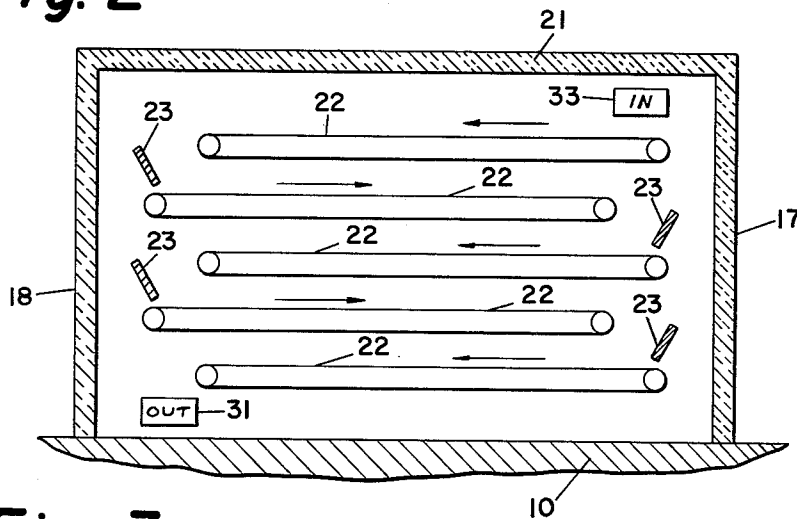
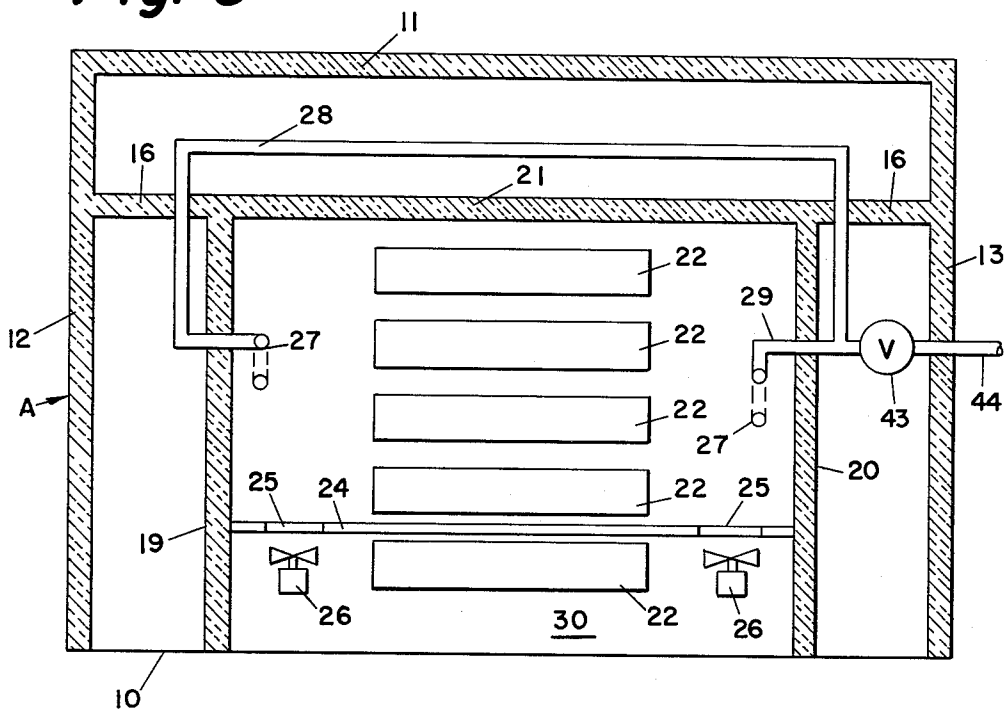


Fig. 3



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3,209,465

METHOD AND APPARATUS FOR DRYING ALIMENTARY PASTE

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This invention pertains to an improved method and apparatus for drying short lengths of extruded alimentary paste and is also applicable to the drying of egg noodles and related products. More particularly, it pertains to drying apparatus and method of control used in connection with said apparatus.

The drying of macaroni and similar rod or tube like doughy materials has long presented a series of problems which have not been solved by the prior art. Improper drying causes macaroni to stick together, get crooked or emerge with a cracked surface. Of these problems, cracking or "checking" is most serious since when such material is cooked by the housewife it falls apart. Overdrying can also cause loss, by the manufacturer, of a high percentage of his product.

Prior art solutions of the problem, as exemplified by Patent 1,976,280 posed solutions based upon absolute humidity control. If the air in the dryer was too low in moisture content, an atomizer or sparger added water vapor. If too much moisture was present in the air a cooling coil was made to operate and condense out moisture. Heater steam was under thermostatic control. Such devices ignored the moisture content of the product being dried and further proceeded on the assumption that maintenance of constant humidity conditions would give proper drying. These devices also failed to recognize that such control measures were not suitable for large pieces of apparatus wherein conditions could easily differ from point to point and were especially insensitive to changes in product characteristics.

I have now discovered that it is possible to dry macaroni and similar products using a completely different theory of control and apparatus which reflects this theory of operation. Briefly, I use only wet bulb temperature as a control parameter and maintain a constant differential in various zones of the apparatus, between wet bulb and dry bulb temperature. As will be observed by reference to any standard psychrometric chart, when a fixed differential is maintained between wet and dry bulb temperatures relative humidity is not thus maintained constant. Thus at a dry bulb temperature of 85° F. and a wet bulb temperature of 80° F. (i.e. a 5 degree depression) percent relative humidity is about 86%. Yet when the wet bulb temperature is 75° F. and the dry bulb is 80° F. the same 5 degree depression, the percent relative humidity is about 84%. I embody and utilize this control principle by creating a series of drying zones, each with individual differentials between wet and dry bulb temperatures and further modify the humidity of a common environmental zone within which the drying zones are contained.

Accordingly it is an object of my invention to provide a novel method of drying alimentary paste which will minimize product losses and give a product free of checking and made up of discrete well defined pieces.

It is also an object of this invention to provide a method of drying alimentary paste utilizing a series of drying zones in each of which a set differential between wet and dry bulb temperatures is maintained and enclosing these zones in a common humidity modified environment.

Another object of the invention is to provide apparatus for drying alimentary paste which will give a final product

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having a uniform moisture content which does not permit of checking, overdrying or tackiness.

Still another object of the invention is to provide a series multistage drying apparatus where wet bulb temperature in each stage is the sole control parameter for each stage and wherein, further, a common humidity modified environment is provided for all drying stages.

Other objects of this invention are to provide an improved drying method and apparatus which is sturdy in construction, economical to operate, automatically controlled, requires a minimum of maintenance and repair, eliminates waste production and is highly efficient in operation.

Other objects of the invention will be apparent to those skilled in the art from a consideration of the drawings and description which follow. In the drawings, wherein like numerals designate like parts:

FIGURE 1 represents a diagrammatic plan view of an apparatus embodying the invention which utilizes the method of the invention.

FIGURE 2 represents a longitudinal sectional view of a typical dryer stage or zone of the invention.

FIGURE 3 represents a typical transverse sectional view of the dryer stage or zone shown in FIGURE 2, and shows the relationship between a typical dryer stage and the environmental chamber in which it is located.

As best shown in FIGURE 1, apparatus used in the invention comprises a humidity modified environmental chamber or zone A, within which are contained a series of dryers B, C, and D. Each drier is provided with an identical control assembly E and the chamber A is also provided with humidity modulating means F. Associated with chamber A are product feed means G and product discharge means H. The various dryers (e.g., B, C, D) each are provided with associated product transfer means I.

Considering now the environmental chamber or zone A it includes a floor 10, a ceiling 11, side walls 12 and 13, end walls 14 and 15, and hung false ceiling pieces 16, which together define a large six-sided chamber or zone.

Within the chamber A are located a group of dryers B, C, and D through which product to be dried is fed in series. The number of dryers used is a function of the weight and moisture content of the product being dried and may vary from two to six. Merely for purposes of exposition, three dryers have been shown in FIGURE 1. The dryers themselves are those of the prior art and, particularly suitable are dryers of the type shown and described in Patent No. 2,074,458, issued to N. J. Cavagnaro on March 23, 1937, which is incorporated herein by reference, modified as will be indicated in the description which follows.

Each dryer comprises a zone or chamber defined by a front end wall 17, rear end wall 18, side walls 19 and 20, and ceiling 21. They may be erected directly on floor 10 or may be provided with an independent floor. Within each dryer are a plurality of longitudinal conveyors 22 with associated aprons 23 for carrying product through the dryer in a zig-zag, top to bottom path such as is shown by the arrows in FIGURE 2. The conveyors are of a type shown in the above patent and are provided with conventional drive means. It is preferred that the belts themselves be of wire mesh or other foraminous material so that flow of air may occur through and around the product. If desired, various air baffling systems as shown in Patent No. 1,976,280 which issued on Oct. 9, 1934, to O. J. Fischer may be incorporated so as to establish fixed patterns for air circulation within each dryer. Patterns of air flow within each dryer are further determined by providing a transverse internal wall or bulkhead 24, best seen in FIGURE 3. The bulkhead is provided

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with a plurality of orifices 25 and proximate each orifice is provided a motor driven fan or blower 26. Also provided within each dryer are a plurality of radiators 27 which are preferably of finned-tube construction and which are provided with steam through lines 28 and 29. The alignment of orifices 25 is such that air is propelled at high velocity by fans 26 over radiators 27 to effect efficient heat transfer. The portion of the dryers beneath bulkhead 24 thus constitutes a plenum or chamber 30 within which air is present at a pressure less than that above the bulkhead 24. No special provision need necessarily be made to supply air to plenum 30, since openings for removing product from the dryer provide sufficient leakage to make up for dry air which is vented from the balance of the dryer structure. The walls 17, 18, 19, 20 as well as the ceiling 21 are of relatively air-tight construction but are provided with a plurality of man holes, doors and the like so that conveyor components may be serviced and maintained.

Interstage product transfer means include a horizontal conveyor 31, onto which lowest conveyor 22 discharges and which removes the product from the dryer. Conveyor 31 in turn feeds a bucket elevator or cleated high pitch conveyor 32 which in turn discharges onto a horizontal feed conveyor 33. Conveyor 33 may be of the reciprocating point of discharge type or be provided with a moving plow so that the product which it discharges is spread evenly across uppermost conveyor belt 22.

The feed of product to the first dryer B and the removal of product from the last dryer D are atypical of the interstage product transfer means. Any suitable means may be used for feed and removal, the system shown being merely exemplary.

The product feed means G includes a cyclone separator 24 to which damp product is pneumatically conveyed through feed line 35, which penetrates chamber wall 12. Carrier air is vented, outside of chamber A by vent line 36. Material is discharged from the cyclone 34, as with a star valve or other rotary air-sealing feeding device onto or vibration screen or conveyor 37 which, in turn, discharges into the boot of bucket elevator 38. Material is discharged by the elevator onto conveyor 33 and is thus fed to dryer B. Screen 37 may be used to remove fines and dust from the product and may also be provided with fans 39 which circulate air from chamber A over and around the product to initiate drying.

Product discharge means H includes a horizontal dryer discharge conveyor 31 which feeds a vibrating screen 40 which separates fines from the product and simultaneously advances it to conveyors 41 and 42 which carry the product out of environmental chamber A into a packaging area.

As has been stated, each drier is provided with a control assembly E. An important component of the assembly is a steam control valve 43. The valves may be of any conventional modulating type and may be operated by air motors, hydraulically or electrically. Flow of steam from header 44 to lines 28 and 29 is controlled by these valves. The control parameter, in each instance, is the wet bulb temperature in the respective dryer with which the valve is associated. The wet bulb temperature may conveniently be measured, recorded and translated into an output signal by wet bulb recorder 45. Suitable devices, known in the instrumentation art as electronic contact recording and/or indicating controllers generate an output which is proportional to wet bulb temperature. Suitable instruments for this purpose are covered by Patents 2,123,091; 2,135,078; 2,216,635; 2,220,590; 2,230,093; 2,272,256; 2,272,257; 2,361,885 and 2,487,266. But for the purposes of this invention all that is needed is a device which will give an output proportional to wet bulb temperature. It cannot be overemphasized that wet bulb temperature in the dryer is not controlled but merely measured and used as a control parameter. Fans 26 within each dryer

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are run continuously and thus wet bulb temperature is substantially uniform throughout the drier, varying with characteristics of the product feed, indirectly with ambient conditions external to the drier and with a host of other variables impossible to describe or control. The signal from recorder 45 is fed via a suitable transmitter into a dry bulb temperature recorder-controller 46 where it is used to vary the controller set point. The controller thus maintains any desired relationship between the two variables (i.e. wet bulb and dry bulb temperatures) while controlling only one (i.e. dry bulb temperature). Controllers suitable for use in this application are described in Taylor Instrument Co. Bulletin 98,291, September 1960 ed. (copyright 1958) and are covered by Patents 1,827,766; 1,889,792; 2,135,078; 2,320,993; 2,224,589 and 2,224,620. It is also possible to combine the functions of recorder 45 and controller 46 in a single instrument incorporating both functions. The system, in effect, causes dry bulb temperature to keep a fixed pre-set pre-determined increment above wet bulb temperature. In the operation exemplified in FIGURE 1 the fixed increments (i.e. dry bulb temperature less wet bulb temperature) found suitable for drying of macaroni are dryer B—2° F.; dryer C—5° F.; dryer D—12° F. With this system wet bulb temperature chases dry bulb temperature but never catches it. With extremely wet product, wet bulb temperatures will rise within the dryers but the relation each bears to dry bulb temperature will stay the same.

An important part of the system is the effect on environmental chamber A of humidity modulation means F. The chamber is provided with a plurality of fans 47 which run continually and insure uniformity of environment throughout the chamber and around the exterior of the dryers. It should be remembered that environmental air from chamber A finds its way into plenums 30 (as where conveyor 31 penetrates wall 19) and that similarly air under positive pressure leaks from the dryers into chamber A (as where conveyor 33 penetrates wall 18). This circulation further makes possible a rapid realization of equilibrium conditions. Equilibrium is further favored by the provision of a false ceiling defined by ceiling pieces 16 which are provided wherever dryer ceiling 21 does not exist. Steam pipe 28 heats this area as does radiation from the dryers. This heat prevents ceiling condensation and the construction also tends to insulate chamber A. The walls of chamber A and the dryers are also insulated.

Chamber A is provided with an exhaust duct 48 which runs the length of the chamber and is provided with a plurality of inlet ports 49. One end of the duct is provided with an exhaust fan 50 powered by a motor 51. The duct is also provided with a damper 52 operated by a motor 53. Motor 53 is controlled by a relative humidity recorder-controller 54 such as is described in Taylor Instrument Bulletin 98,410 of August 1961 and F1-17 of October 1958 and is designated as model X-100-J-1111. This device effects on-off (as distinguished from proportioning) operation of damper 52 and is set to open the dryer only so long as percent relative humidity exceeds a predetermined point. A setting found suitable in actual operation is 70% R.H. If humidity rises above that point within chamber A then air is exhausted therefrom. Outside air is then allowed to leak into the chamber through such obvious leakage points as where conveyor 41 penetrates wall 12. Once humidity has dropped, by virtue of addition of outside air, to a value below 70% the damper closes. The same result could be accomplished with on-off operation of motor 51 but it is preferred to control exhaust with the damper 52 and allow motor 51 to run continuously without the wear and tear caused by constant starting and stopping. Yet if percent relative humidity in chamber A is significantly lower than 70% (or any value pre-set on controller 54), motor 51 will run without doing any useful work. Consequently, another similar on-off con-

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troller 55 controls motor 51. The motor circuit is normally "on" but will open and thus stop the motor when humidity drops a few percent below the value set on controller 54. For instance, where controller 54 is set to open the damper at values above 70% R.H., controller 55 may be set to stop the motor when humidity drops to 65%. In the 65-70% R.H. range motor 51 will run but damper 52 will remain closed.

It will be obvious that various changes could be made in the construction of the apparatus, the exact control instruments used, and that widely different embodiments of the invention, as well as variations in the steps of the method involved, could be made without departing from the scope of the invention as defined in the appended claims. It is therefore intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not limiting.

What is claimed is:

1. Apparatus for drying alimentary paste comprising an environmental chamber including air circulators; a series of independent driers located within said environmental chamber, each of said driers including air circulators and air heaters; means for continuously feeding product to be dried from a point outside of said chamber, through said chamber, to the inlet of the first of said series of driers; means for continuously removing product from the outlet of the last of said series of driers, through said environmental chamber, to a point external thereto; means for continuously moving product through each of said driers seriatim; wet bulb temperature responsive control means in each of said driers operatively associated with the air heater for said drier, said control maintaining a fixed increment between wet bulb and dry bulb temperature in each drier; means for venting air from said environmental chamber to a point external thereto; and relative humidity responsive control means operatively associated with said environmental chamber vent means causing said chamber to be vented when relative humidity therein exceeds a predetermined value.

2. A method of drying alimentary paste comprising the steps of: establishing an insulated environmental zone; continually circulating air through and around the interior of said zone; venting air out of said zone to the exterior thereof when the percent relative humidity in said zone exceeds a predetermined value; establishing a series of independent drying stages within said zone; circulating air continually within each of said drying stages; heating the air circulating in each of said drying stages as necessary to maintain a constant fixed differential between wet bulb and dry bulb temperatures therein; continuously transporting product to be dried from outside of said environmental zone, through said zone, through each of

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said drying stages seriatim and thence, via said zone, to the exterior thereof.

3. The method of claim 2 wherein the air circulating in said environmental zone contacts the product passing through said zone en route to the first of said drying stages and en route from the last of said drying stages.

4. Apparatus for drying alimentary paste comprising an environmental chamber including continually operating fans; a series of independent driers located within said environmental chamber; continually operating air circulators within each drier; air heating means within each drier; conveyor means in each drier for continuously carrying product from top to bottom thereof in a longitudinal zig-zag path; means for continuously feeding product to be dried from a point outside of said chamber, through said chamber, to the inlet of the first of said series of driers; means for spreading said product uniformly onto the conveyor means of each drier as it is delivered thereto; means for continuously carrying product from the outlet of a given drier to the inlet of the next drier in the series of driers; means for continuously removing product from the outlet of the last of said series of driers, through said environmental chamber, to a point external thereto; wet bulb temperature responsive control means in each of said driers, operatively associated with the drier air heating means, said control maintaining a fixed increment between wet bulb and dry bulb temperature in each drier; means for venting air from said environmental chamber to a point external thereto, said means including a blower and a motorized damper; a first relative humidity responsive control means in said chamber operatively associated with said motorized damper, causing said damper to open and said chamber to be vented when relative humidity therein exceeds a predetermined value; and a second relative humidity responsive control means in said environmental chamber operatively associated with said blower, causing said blower to cease to operate when relative humidity in said chamber drops below a predetermined value.

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