

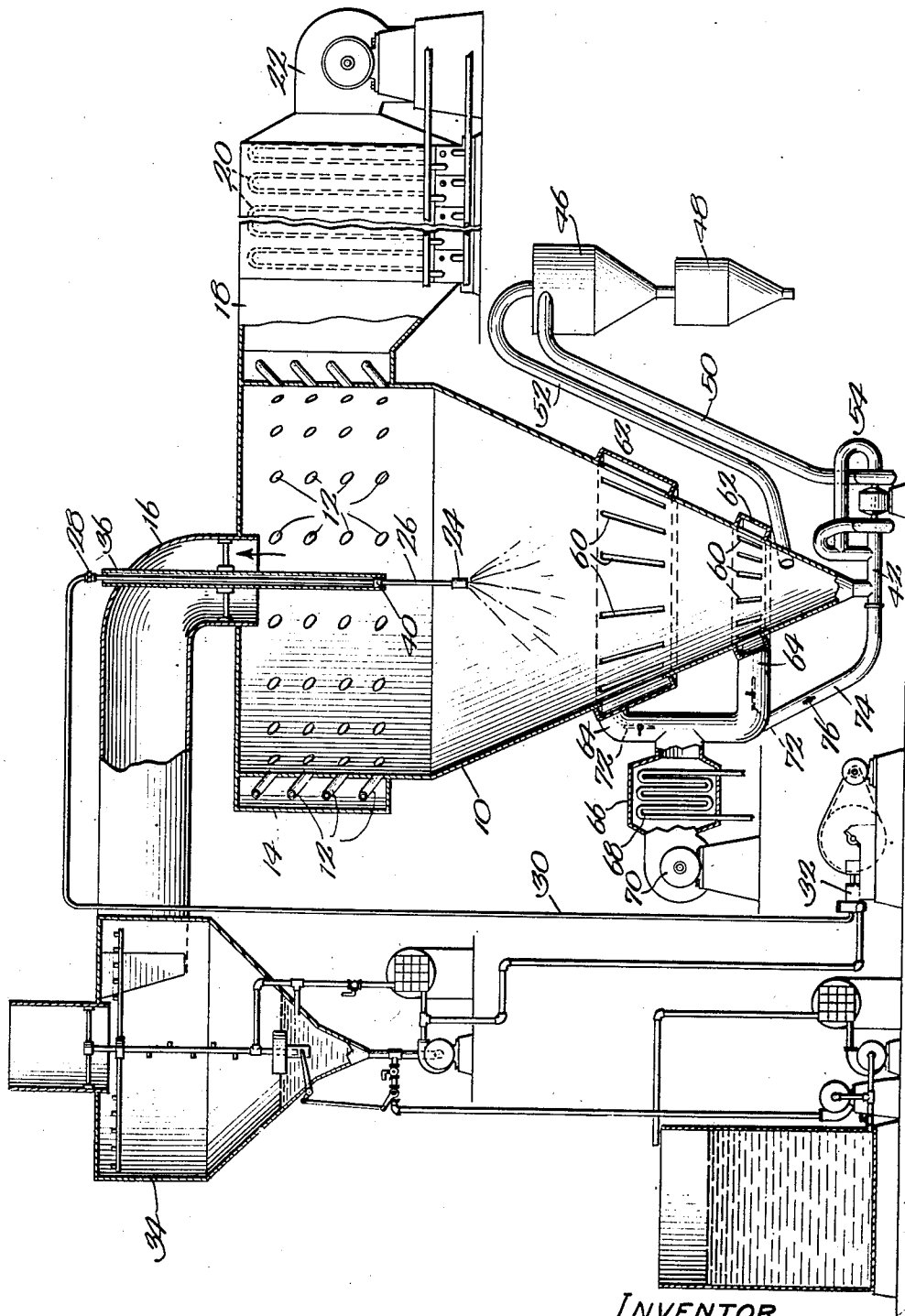
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1,829,477

PROCESS OF AND APPARATUS FOR DRYING LIQUIDS

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PROCESS OF AND APPARATUS FOR DRYING LIQUIDS

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This invention relates to an improved process and apparatus for the recovery of the solid contents of liquids, especially those whose solids melt at the practical working

5 temperature of desiccating apparatus. Examples of such solids are malt extract and certain fruit juices which after having their moisture removed remain in a melted or sticky condition at the practical working temperature of the apparatus. Appropriate apparatus and an appropriate process are set forth in Patents No. 1,078,848 and No. 1,107,784 respectively. When dealing with the type liquid mentioned, the desiccated material instead of being delivered in finely divided condition tends to cohere in chunks or large masses which are apt to clog the apparatus and are otherwise unsatisfactory. Again, in the desiccating of certain materials containing albuminoids or other constituents which are easily damaged by high temperature, such as eggs, it is necessary, with the old apparatus and process, to operate at a considerably reduced temperature, which reduces the capacity of the apparatus below a practical operating point.

One object of my invention is to provide a process and apparatus capable of desiccating the class of liquids above mentioned without the formation of chunks or masses of the material, and to make it possible to operate at a higher temperature than heretofore has been practicable, without damaging the product. Generally speaking, this is accomplished by providing a cool zone within the desiccating chamber in a manner which will be hereinafter described. The effect is enhanced by the fact that dry air is introduced; also that dry, cool air may be introduced at the delivery pipe; also that a disintegrator or pulverizer is provided for reducing to fine particles any lumps or masses that may have passed out of the drying chamber.

Another object of the invention is to provide means for creating a strong cyclonic flow of heated air having a downward trend which causes it to converge toward the bottom of the drying chamber whence it will be deflected upward along the central axis of the chamber, past the spray issuing from the spray nozzle

and on through the outlet duct at the top of the chamber, thus thoroughly exposing the atomized liquid to the drying effect of the hot air.

I accomplish my object in the manner illustrated in the accompanying diagram, which shows a complete working apparatus, the same being shown chiefly in vertical section.

In the form selected to illustrate the invention the desiccating chamber is cylindrical at the upper portion and converges downward and inward at the lower portion. Heated air for drying the liquid is blown into it from the upper portion through nozzles 12 which slant obliquely downward and inward into the chamber from the bustle pipe 14. The latter constitutes a duct for supplying heated air under pressure to the drying chamber. It encircles the said chamber at the upper portion as illustrated. It has been found that this arrangement of the nozzles is especially advantageous for it produces a cyclonic effect in which the air not only whirls around the vertical axis of the chamber but also moves downward into the converging portion of the chamber, whence it is deflected upwards along the central axis and passes out through the air outlet duct 16 which will be hereinafter again referred to. An air flow of this character has been found to be most efficient.

Heated air under pressure is supplied to the bustle pipe by heating and blowing apparatus shown at the upper right portion of the figure. In the form shown this consists of a casing 18 containing heating coils 20. Air is blown through this casing past the coils by means of a blower 22 of any appropriate design. Located within the drying chamber 10 is a spray nozzle 24 which sprays or atomizes the liquid to be treated. The liquid is supplied to this nozzle under pressure through a pipe 26 which is disconnectably connected at its upper end by a coupling 28 to a pipe 30 which leads from a force pump 32. The pipe 26 enters the drying chamber through a stationary tube 36 and for sealing purposes has sleeve 40 which seats at the lower end of the tube.

The outlet duct 16, previously mentioned,

leads from the closed upper portion of the drying chamber to carry away the air which is laden with the moisture removed from the liquid which is being treated. It commonly happens that this air carries with it a small percentage of the solids from the drying chamber, and in order to recover these the duct is not led directly to the atmosphere, but is led preferably to a recovering chamber 34. This recovery chamber is not particularly concerned with my present invention and as one very much like it is shown in the aforesaid Patent 1,078,848 it need not be here described in detail. The same is true of that portion of the apparatus which supplies the liquid to be treated to the force pump 32.

The drying chamber connects at the bottom with an outlet duct 42 which leads to apparatus for delivering to a barrel or other receptacle (not shown). In the form illustrated this apparatus has two collecting chambers 46, 48 connected in tandem, the upper one being connected to a delivery pipe 50 through which the powder is conveyed to the upper chamber 46 and a return or vent pipe 52, by which such powder as is not deposited is returned to the lower end of the drying chamber.

At the lower right portion of the figure I have shown apparatus 54 interposed between duct 42 and duct 50 for pulverizing any cohering masses which may be received from the drying chamber, but this apparatus is optional and is not intimately concerned with my present invention. Pulverizing apparatus of this kind is shown and described in U. S. Letters Patent No. 1,392,656 except that the fan at the right of the unit, discharging to duct 50, is not particularly described therein and cooperates in promoting the above mentioned return of undeposited powder through the pipe 52 to be again passed to the collecting chamber 46 by way of the duct 50.

I will now describe one of the novel features of the apparatus, by the aid of which I have made it possible efficiently to handle liquids which are sticky at the temperature at which drying apparatus is usually operated.

Openings 60 are formed in the sides of the drying chamber near the lower portion, these openings in the illustrated case being in the form of two horizontal rows of vertically arranged slots spaced equi-distantly and leading from two wind boxes or bustle pipes 62 which encircle the chamber and are supplied with cold air through ducts 64 leading from a casing 66. This casing contains cooler pipes 68, past which air is forced by means of a blower 70 of any appropriate design. The pipes 68 contain refrigerated brine or other cooling fluid, with the result that as the air passes them it becomes chilled to

any desired degree. The chilling of the air also has the effect of condensing the moisture from the air and drying it and thus there is a double effect produced upon the material. It is reduced to a lower temperature and is commingled with air which is much dryer than the rest of the air in the drying chamber. Dampers 72 are provided in ducts 64 so that the flow through them may be controlled as the operator sees fit.

A duct 74 leads from the duct 64 to the delivery duct 42 issuing from the bottom of the drying chamber. This is provided with a damper 76 for controlling the flow of cold air through it. The purpose of this is to provide alternate means for chilling the desiccated material as it leaves the drying chamber, to prevent cohesion and adhesion and to reduce the temperature of the product prior to its introduction into the final storage receptacle. Duct 74 may be used either by itself or in conjunction with the ducts 64 supplying cool air to bustle pipes 62 and openings 60.

In practice, let it be assumed that the pump 32 is forcing the liquid to be treated out through the spray nozzle 24, and that the blower 22 is forcing air past the heating coils 20 into the wind box 14. Let it also be assumed that the blower 70 is forcing air past the cooling coils 68 into the cold air ducts 64. The liquid to be treated issues from spray nozzle 24 in finely divided condition, and tends to spread radially outward and also to descend. As a result of the inclination and position of the air nozzles 12 the heated air from the wind box enters the drying chamber in a series of jets directed partially circumferentially, partially radially inward, and partially downward, the result being that a whorl or cyclonic effect is produced of special type, that is, one in which the flow is helically downward. This causes the air first to hug the walls of the chamber, but as the chamber converges toward the bottom, and the air must ultimately escape, it is finally deflected upward along the central axis of the chamber and ultimately out through the outlet duct 16. This causes a very intimate exposure of the liquid particles to the air, with the result that the moisture is extracted to a very high percentage of efficiency and the desiccated material descends toward the bottom of the chamber. Heretofore in acting upon liquids whose solid contents tend to cohere at the ordinary temperature at which such apparatus is operated, chunks or masses formed in the chamber. It also adhered to the sides of the chamber. An attempt was made to prevent this by reducing the operating temperature, but this decreased the efficiency of the apparatus and rendered it impractical. In my apparatus, however, as the solid material descends it comes into a zone where the air is chilled, that is, it comes into

the zone of the air jets issuing from the openings 60 in the side walls of the chamber. This immediately reduces the temperature of the particles to a point which keeps them hard and non-cohesive, the result being that they neither adhere to each other nor to the sides of the chamber. Furthermore the effect of the air streams issuing from the openings 60 is to blow the material away from the sides of the chamber, and hence they have a tendency to remain in the central portions of the chamber until they reach the bottom of the chamber or nearly so. Thus it becomes practicable to treat liquids which would otherwise tend to clog the apparatus and to collect in masses with a resulting inferiority of product.

Another result of the chilling of the air at the bottom of the chamber is that it makes it practicable to operate the drying chamber at the usual high temperature employed for materials which when desiccated do not have much tendency to cohere. This, of course, makes for efficiency and increases the capacity of the apparatus as a whole. This effect is enhanced by the fact that the air in becoming chilled also loses its moisture, and hence is dry as it comes into contact with the treated material. This of course promotes the drying as well as the cooling effect on the product.

Still another advantage is that as the material remains for so short a period in contact with the highly heated air, and is so soon projected into the cool zone, it becomes practicable to operate upon albumens and similar materials, the quality of which deteriorates or the character of which changes if subjected for any appreciable period to a temperature equal to that at which it is desirable to operate the apparatus for ordinary materials.

Still another advantage is this: Ordinarily the product which is delivered from the drying chamber is at quite an elevated temperature, and frequently enters the barrel or other storage receptacle in the same condition. This is frequently deleterious to the product, as it tends to generate additional heat, and in fact in some cases spontaneous combustion has occurred. With my apparatus the desiccated material becomes greatly reduced in temperature before it finally leaves the apparatus, and consequently the danger of spontaneous heating in the final storage receptacle is avoided.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. Substance treating apparatus comprising a treating chamber, means at one end of said treating chamber for directing treating gas into the same in a circumferential and longitudinal direction to produce an advancing spiral gas current traveling toward the other end of said chamber, said chamber hav-

ing its main gas outlet at its first named end providing for egress of gas internally of said advancing current, to thus cause said gas current to return to the first named end of said chamber internally of its path of advancing movement, means for introducing substance to be treated substantially centrally of said returning current of gas to pass outwardly therethrough and into said advancing spiral gas current to be advanced thereby toward the said other end of said chamber, and means at the said other end of said chamber providing for the egress of treated substance.

2. The method of treating substances which comprises producing a longitudinally advancing spiral current of treating gas, causing said current to return in the opposite longitudinal direction internally of its path of advancing movement, introducing the substance to be treated in finely divided condition substantially centrally of said returning current of gas to pass outwardly therethrough and into said advancing spiral gas current, and withdrawing treated substance adjacent the locus of reversal of movement of said gas current.

3. Substance treating apparatus comprising a treating chamber, means at one end of said treating chamber for directing treating gas into the same in a circumferential and longitudinal direction to produce an advancing spiral gas current traveling toward the other end of said chamber, said chamber having its main gas outlet at its first named end providing for egress of gas internally of said advancing current to thus cause said gas current to return to the first named end of said chamber internally of its path of advancing movement, means at the said other end of said chamber for introducing cooler gas and creating a cooled zone adjacent the locus of reversal of movement of said gas current, means for introducing substance to be treated substantially centrally of said returning current of gas to pass outwardly therethrough and into said advancing spiral gas current to be advanced thereby to said cooled zone, and means providing for the egress of treated substance from said cooled zone.

4. Substance treating apparatus comprising a treating chamber, means for creating an advancing spiral current of treating gas traveling from one end of said chamber toward the other end thereof, said chamber having its main gas outlet at its first named end providing for egress of gas internally of said advancing current to thus cause said gas current to return to the first named end of said chamber internally of its path of advancing movement, means at the said other end of said chamber for introducing cooler gas and creating a cooled zone adjacent the locus of reversal of movement of said gas current, means for introducing substance to be treated substantially centrally of said returning cur-

rent of gas to pass outwardly therethrough and into said advancing spiral gas current to be advanced thereby to said cooled zone, and means providing for the egress of treated substance from said cooled zone.

5. Substance treating apparatus comprising a vertical treating chamber, means at the top of said treating chamber for directing treating gas into the same in a circumferential and longitudinal direction to produce an advancing spiral gas current traveling toward the bottom of said chamber, said chamber having its main gas outlet at its top providing for egress of gas internally of said advancing current to thus cause said gas current to return to the top of said chamber internally of its path of advancing movement, means at the bottom of said chamber for introducing cooler gas and creating a cooled zone adjacent the locus of reversal of movement of said gas current, means for introducing substance to be treated substantially centrally of said returning current of gas to pass outwardly therethrough and into said advancing spiral gas current to be advanced thereby to said cooled zone, and means providing for the egress of treated substance from said cooled zone.

6. Substance treating apparatus comprising a downwardly tapering vertical treating chamber, means for creating an advancing spiral current of treating gas traveling from the top of said chamber toward the bottom thereof, said chamber having its main gas outlet at its top providing for egress of gas internally of said advancing current to thus cause said gas current to return to the top of said chamber internally of its path of advancing movement, means at the narrow end of said chamber for introducing cooler gas and creating a cooled zone at the narrow end thereof, means for introducing substance to be treated substantially centrally of said returning current of gas to pass outwardly therethrough and into said advancing spiral gas current to be advanced thereby to said cooled zone, and means providing for the egress of treated substance from said cooled zone.

7. The method of drying substances which comprises producing a longitudinally advancing spiral current of drying gas, causing said current to return in the opposite longitudinal direction internally of its path of advancing movement, producing a cooled zone adjacent the locus of reversal of movement of said gas current, and introducing the substance to be dried in finely divided condition substantially centrally of said returning current of gas to pass outwardly therethrough and into said advancing spiral gas current to be advanced thereby to said cooled zone.

8. The method of drying substances which comprises producing a downwardly advancing

ing spiral current of drying gas, causing said current to return upwardly internally of its path of downward movement, producing a cooled zone adjacent to the locus of reversal of movement of said gas current, and introducing the substance to be dried in finely divided condition substantially centrally of said upwardly returning gas current to pass outwardly therethrough and into said downwardly advancing spiral gas current to be carried downwardly thereby to said cooled zone.

9. Substance treating apparatus comprising a vertical chamber of substantially circular cross-section, means associated with the upper part of said chamber providing for the introduction of a flow of treating gas substantially tangentially thereof and its egress substantially centrally thereof to produce a cyclonic current of gas flowing generally from the periphery of said chamber toward the center thereof, means associated with the lower portion of said chamber for admitting an additional flow of treating gas to said chamber to create a zone therein substantially excluding said first named flow and to thence progress toward the point of egress of said first named flow to mingle with and exit with the same, means for introducing the material to be treated into the mixed gases approaching said point of egress to pass outwardly therethrough into said first named flow and thence into said zone substantially excluding said first named flow, and means providing for the withdrawal of treated substance from said zone.

10. The method of treating substances which comprises creating an inwardly flowing cyclonic current of treating gas in the upper part of a treating chamber and withdrawing gas from the vortex thereof, creating a flow of auxiliary treating gas in the lower part of the treating chamber substantially excluding said first named treating gas from a zone therein and flowing therefrom into said vortex to mingle with and be withdrawn with said first named gas, introducing the substance to be dried substantially centrally of said vortex to pass outwardly through said mixed gases into said first named current and thence into said zone from which said first named gas is substantially excluded, and withdrawing the treated substance from said zone.

11. In combination, a spray drying apparatus embodying a drying chamber having a main drying zone and a zone to which the substantially dried particles pass therefrom, means for withdrawing a stream of gas and particles from said last named zone, means for separating the bulk of said particles from said stream, and means for returning the unseparated particles to said last named zone without again exposing them in said main drying zone.

12. Substance treating apparatus comprising a drying chamber provided with a product discharge at one end; and means for withdrawing a stream of gas and product from said product discharge, separating the bulk of the product therefrom, and reintroducing said stream and remaining product adjacent said product discharge end to mingle with the stream being withdrawn therefrom.

13. Substance treating apparatus comprising a drying chamber provided with a product discharge at one end; and means for withdrawing a stream of gas and product from said product discharge, mingling auxiliary conditioning gas therewith, separating the bulk of the product therefrom, and reintroducing said stream and remaining product adjacent said product discharge end to mingle with the stream being withdrawn therefrom.

14. Substance treating apparatus comprising a drying chamber of generally circular cross-section decreasing toward its product-discharge end; means for creating a spiral current of drying gas advancing from the larger end of the chamber toward its product discharge end; said chamber having its main gas outlet at its first named end providing for egress of gas internally of said advancing current to thus cause said gas current to return to the first named end of said chamber internally of its path of advancing movement, and means for withdrawing a stream of gas and product from said product-discharge end, separating the bulk of the product therefrom, and reintroducing said stream adjacent said product-discharge end.

15. Substance treating apparatus comprising a drying chamber of generally circular cross-section decreasing toward its product-discharge end; means for creating a spiral current of drying gas advancing from the larger end of the chamber toward its product-discharge end; said chamber having its main gas outlet at its first named end providing for egress of gas internally of said advancing current to thus cause said gas current to return to the first named end of said chamber internally of its path of advancing movement; means for introducing auxiliary conditioning gas adjacent said product-discharge end, and means for withdrawing a stream of gas and product from said product-discharge end, separating the bulk of the product therefrom, and reintroducing said stream adjacent said product-discharge end.

16. Substance treating apparatus comprising a drying chamber of generally circular cross-section decreasing toward its product-discharge end; means for creating a spiral current of drying gas advancing from the larger end of the chamber toward its product-discharge end; said chamber having its main gas outlet at its first named end providing

for egress of gas internally of said advancing current to thus cause said gas current to return to the first named end of said chamber internally of its path of advancing movement; means for introducing auxiliary conditioning gas adjacent said product-discharge end; and means for withdrawing a stream of gas and product from said product-discharge end, mingling further auxiliary conditioning gas therewith, separating the bulk of the product therefrom and reintroducing said stream adjacent said product-discharge end.

17. The improvement in the art of separating a substance from a liquid comprising the same which consists in spraying the liquid into a body of hot drying gas to separate the substance as finely divided particles suspended in gas, cooling said suspended particles, segregating a stream of gas and cooled suspended particles, separating the bulk of said particles from said stream, and returning and re-mingling the remaining suspended particles with other cooled suspended particles to be re-passed through the separating process therewith.

18. The improvement in the art of separating a substance from a liquid comprising the same which consists in spraying the liquid into a body of hot drying gas to separate the substance as finely divided particles suspended in gas, creating a body of cooler gas to receive said suspended particles from said hot drying gas, withdrawing a stream of said cooler gas and suspended particles and separating the bulk of said particles from said stream, and re-mingling the particles unseparated from said stream with other particles in said body of cooler gas to be repassed through the separating process therewith.

In witness whereof, I have hereunto subscribed my name.

FRANK HOWARD DOUTHITT.