Sept. 5, 1944. J. M. HALL 2,357,648

SYSTEM OF DEHYDRATING LIQUID PRODUCTS

Filed July 2, 1941

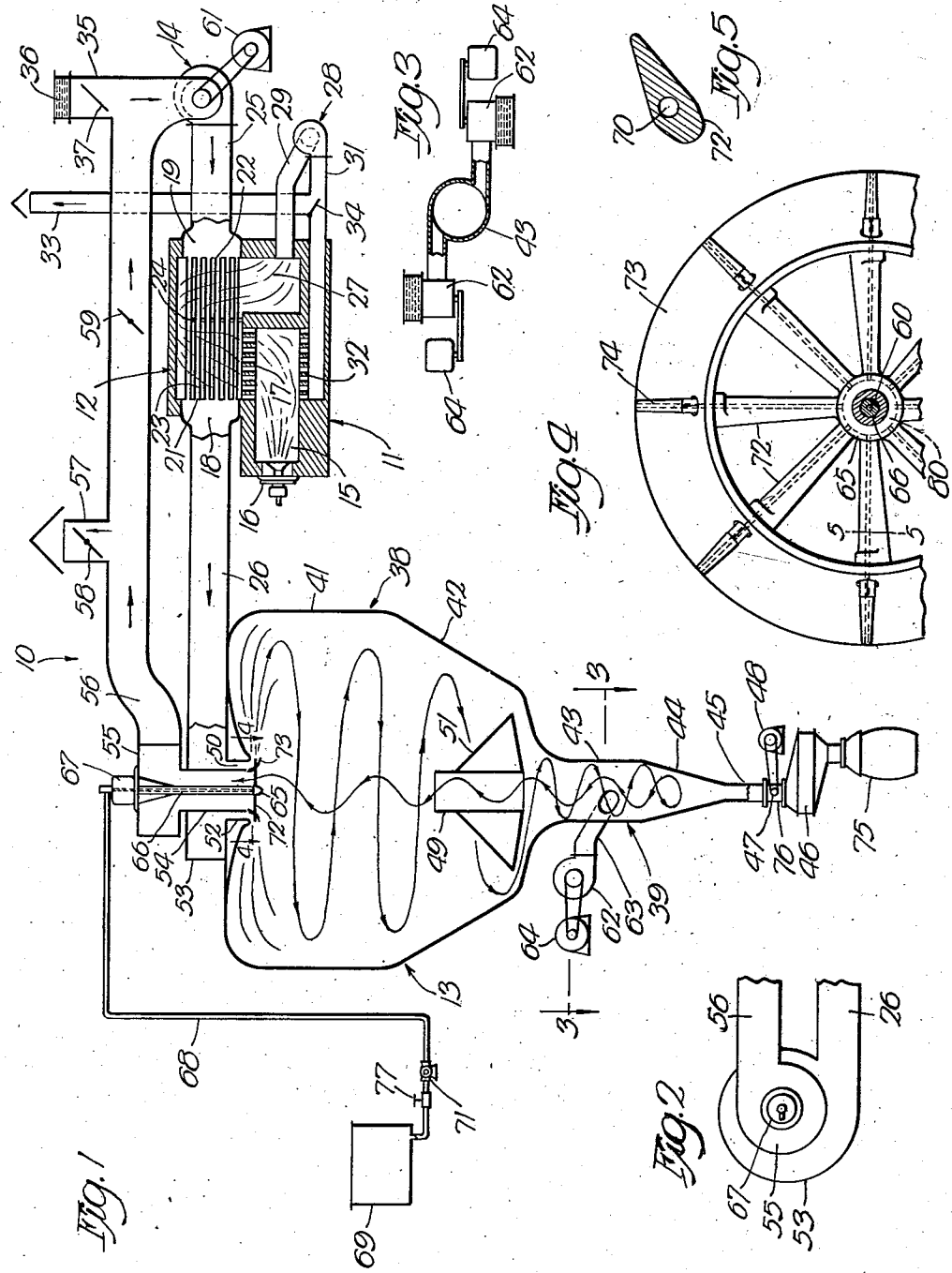


Fig. 1

Fig. 3

Fig. 5

Fig. 4

Fig. 2

INVENTOR.
Joseph M. Hall
BY Mann, Brown & Co.
ATTORNEYS.

Patented Sept. 5, 1944 2,357,648

UNITED STATES PATENT OFFICE

2,357,648

SYSTEM OF DEHYDRATING LIQUID PRODUCTS

Joseph M. Hall, Chicago, Ill., assignor to Drying & Concentrating Company, a corporation of Delaware

Application July 2, 1941, Serial No. 400,758

15 Claims. (Cl. 159—4)

This invention relates to apparatus and process of dehydrating liquid products in a single stage system.

The principal object of the invention is the provision of a system for dehydrating a liquid product in a single dehydrating chamber without the necessity of pretreating the product.

A further object of the invention is the provision of a one-stage dehydrating system having novel means for converting the system into a closed or open system for the circulation of the drying medium.

A still further object of the invention is the provision of new and improved mechanism for cooling the dehydrated material before the same is discharged from the dehydrating chamber.

Another object of the invention is the provision of a new and improved method for removing moisture from a liquid product and an apparatus for dehydrating said product that is simple in construction, inexpensive to manufacture, easily assembled, and that is effective in operation.

Other and further objects and advantages of the invention will appear from the following description, taken in connection with the accompanying drawing, in which—

Fig. 1 is a side elevation, shown more or less diagrammatically, of the entire dehydrating system;

Fig. 2 is a top plan view of the snails located above the dehydrator;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is a section on the line 4—4 of Fig. 1 showing the distributor on an enlarged scale; and

Fig. 5 is a section on the line 5—5 of Fig. 4.

It is common practice in dehydrating liquid products to employ a two-stage apparatus or at least to preheat the liquid product before final dehydration and where the liquid product is dehydrated in a single stage, the liquid product is either sprayed directly into the products of combustion within the combustion chamber of the heating furnace or the gaseous drying medium is heated to an exceedingly high temperature. Such high temperatures may not be objectionable for certain products but in other products, it would destroy some or all of the distinguishing characteristics of the product.

The present invention seeks to dehydrate a liquid product in a single stage within a single chamber and at moderate temperatures.

Referring now to the drawing, the reference character 10 designates a dehydrating system embodying the invention. The system comprises a furnace 11, a heater 12, a chamber 13 for dehydrating and collecting the liquid product, and a fan 14 for discharging a drying medium through the heater for increasing its temperature.

The furnace 11 may be of the usual or any well known construction and is provided with a combustion chamber 15 having, at its forward end, a conventional burner 16 for discharging a mixture of liquid fuel and air into the combustion chamber 15. The upper wall of the combustion chamber is provided, at what will be termed its rear end, with a grill or grates 17 through which the products of combustion flow into the heater 12. The heater is mounted in the upper end of the furnace, in the usual manner.

The heater is provided with a header 18 at its forward end and a header 19 at its rear end. A pair of flue sheets or partitions 21 and 22 separate the heater proper from the headers, as shown in Fig. 1 of the drawing. Suitable tubes or flues 23 have their ends rigidly secured in the flue sheets and constitute passages through which the gaseous drying medium passes for heating the same. One or more baffles 24 are provided in the heater chamber for causing the products of combustion to take a zig-zag course through the heater. A conduit 25 connects the discharge of the fan with the header 19 and a conduit 26 conducts the heated gaseous drying medium to the combined dehydrator and collection chamber 13, as will presently appear.

Suitable means may be provided, if desired, for causing a forced draft through the combustion chamber 15. As shown, the heating chamber is provided with an extension 27 into which the products of combustion flow after passing through the heater 12. A fan 28 is provided for withdrawing the products of combustion from the chamber 27 through an intake conduit 29 of the fan. The discharge conduit 31 of the fan is adapted to discharge beneath the grates or grill 32 of the combustion chamber 15. Extending upwardly from the discharge conduit 31 of the fan is a stack 33 through which some or all of the gas withdrawn from the chamber 27 is adapted to be discharged into the atmosphere. A valve 34, mounted in the conduit 31 posterior to the stack 33, is provided for controlling the amount of gases that are recirculated. The gases passing through the grate or grill 32 mingle with the gases of combustion in the combustion chamber without reducing the amount of gas flowing around these tubes thereby preventing the tubes first exposed to the intense heat of the burning gases from becoming burned or injured. The gaseous drying medium, in the present instance,

is air although it may be other gases, if desired, but for the purpose of description, the drying medium will be assumed to be air in the following description.

Fresh air is adapted to be supplied to the fan 14 through a conduit 35 which is preferably provided, at its outer end, with a screen or filter 36 for removing objectionable foreign matter from the air before it is introduced into the system. A valve 37 is provided for controlling the amount of fresh air introduced into the system.

The combined dehydrator and collector 13 constitutes the sole means in this system for removing moisture from the liquid product. This chamber comprises an upper section 38 and a lower section 39. The upper section 38 comprises an upper cylindrical portion 41 and a lower tapered portion 42. The lower section 39 has an upper cylindrical portion 43, the upper part of which is flared and merges with the lower portion of the upper section 38. The lower portion of the section 39 is tapered as at 44 and terminates in a discharge conduit 45. The material collected in the conduit 45 is discharged onto a mechanical screen 46 through a valve 47 operated by a motor 48.

The lower portion 42 of the upper section of the dehydrator has mounted therein a sleeve or conduit member 49 having attached thereto a hollow cone-shaped deflector 51. The conduit 49 is comparatively short and is supported axially of the dehydrator and through it the upwardly moving inner spiral of the air or drying medium from the lower section passes, as will presently appear.

The upper wall of the dehydrator may, if desired, be slightly depressed and a short conduit 52 arranged axially of the dehydrator and a snail 53 is rigidly attached thereto in such a manner that the snail discharges through the conduit 52. The intake of the snail is connected to the conduit 26 so that heated air from the furnace is caused to descend into the dehydrator in an outer downwardly moving spiral.

Suitable means are provided for conducting the drying medium from the dehydrator. As shown, a conduit 54, extending axially down through the snail 53 and rigidly attached thereto, extends upwardly above the snail and is connected to a discharge snail 55 which discharges into a return conduit 56. The return conduit 56 is provided with a discharge passage 57 through which the drying medium may be discharged from the system. A valve 58 is provided in this passage for controlling the discharge of the air or other drying medium. The conduit 56 is also provided with a valve 59 beyond the conduit 57 for controlling the amount of air flowing through said conduit. The conduit 56 is in communication with the inlet conduit 35 of the fan 14. The fan 14 is operated by a suitable motor 61 as is usual in such constructions.

In most liquid products that are dehydrated, the temperature of the dehydrated product within the dehydrator is above that safe for storage. Suitable means are therefore provided for cooling the dehydrated product before it is discharged from the dehydrator chamber. As shown, the lower section 39 of the dehydrator is provided with means for introducing a current of cool air for cooling the product. In the form of the construction shown in Fig. 1, a fan 62 is provided for introducing air through its discharge conduit 63 into an intermediate section of the upper portion 43 of the lower section of the dehydrator. The conduit 63 delivers air tangentially into the portion 43 in the same direction in which the outer spiral of the drying medium is flowing within this portion of the dehydrator. The fresh air introduced through the passage 63 will not only cool the product but will, to a certain extent, lower the percentage of moisture in the drying medium because the fresh air will usually have a very low humidity. The fan 62 is operated by a suitable motor 64, as is usual in such constructions.

In the operation of the device, the path taken by the drying medium or the air may be traced as follows:

From the fan 14, the air is conducted through the heater 12 where the temperature is raised to the desired degree and then passes into the snail 53 which causes it to rotate about a vertical axis and it is then discharged through the annular passage 50 into the dehydrator where it moves downwardly and radially outwardly forming what, for convenience of description, will be termed the outer spiral. This outer spiral will flow downwardly and around the conical member 51 and beneath the same into the lower section of the dehydrator where it will continue to rotate and will then reverse and move upwardly in an inner spiral rotating in the same direction as the outer spiral. This inner spiral will pass upwardly through the sleeve or conduit 49 axially through the upper section of the dehydrator and will be discharged through the inner conduit 54 into the snail 55 and from the snail 55 along the return conduit 56, a portion or all of which will escape into the atmosphere through the passage 57 depending on the position of the valves 58 and 59. If a portion of the air passes beyond the valve 59, it will mingle with the incoming air in the conduit 35 and be delivered back to the intake of the fan, thus completing its cycle of movement.

In certain types of liquid products, the air will not be recycled but all of it will be discharged at 57 and the entire air used in the process will be continuously introduced through the intake 35 of the fan 14 in which event the valves 37 and 58 will be open and the valve 59 closed.

Suitable means are provided for spraying the liquid product into the outer downwardly moving spiral of air or other gaseous drying medium. In the form of construction shown, a rotating head 65 is employed for this purpose. The head 65 is mounted on a shaft 66 which may be, and preferably is, attached to the armature shaft of a motor 67 mounted on and supported by the snail 55. The shaft 66 is hollow, as shown at 60 in Fig. 4, and is in communication with a pipe or conduit 68 which conducts the liquid product from a reservoir 69. The reservoir 69 may be located above the head 65 so that the liquid product will be fed to the head by gravity or a pump 71 may be provided for delivering the product to the distributor head, as shown in Fig. 1 of the drawing.

The distributor head is provided with radially extending arms 72, Fig. 4, each of which has a bore 70 in communication with the hollow portion 80 of the head and which in turn is in communication with the bore or passage 60 of the shaft 66. The outer ends of the arms 65 are preferably connected together by an annular deflector member 73 which is concave on its outer side for deflecting air entering through the passage 50 downwardly and outwardly across nozzles at the ends of the arms, as will presently appear.

The outer ends of the arms 72 are each pro-

vided with detachable nozzles 74 for spraying the product into the incoming air. The length of the rotating arms 72, or rather the diameter of the deflector 73, is such that the inner spiral of air may move upwardly through the space between the deflector 73 and the head 65 into the discharge conduit 54. In order to assist in the movement of the air and for accentuating the rotation of the inner column of air, the arms 72 are oblong and so arranged that they function as fan blades, as shown more clearly in Fig. 5 of the drawing. These blades rotate in the same direction as the inner and outer spirals of the drying medium.

In tracing the path taken by the liquid product, it is pumped from the reservoir 69 and delivered through the conduit 68 and the passage 60 to the hollow portion 80 of the head 65 of the spray device and from thence passes outwardly through the passages 70 in the arms into the spray nozzles 74 where it is sprayed into the incoming air, this air being heated and the particles being very fine, the moisture is evaporated from the sprayed particles and the dehydrated particles thrown by centrifugal force outwardly against the walls of the dehydrator and fall by gravity from the upper section of the dehydrator into the lower section and from the lower section are discharged by the valve 47 into the mechanical screen 46 and from the screen into a suitable receptacle 75. As the dehydrated product passes downwardly through the lower section of the dehydrator, it is cooled by the fresh air directed into this lower section by the fan 62, as described above.

By lengthening the cylindrical portion 43 of the lower section, the finer material is more efficiently removed from the air. The air, in moving spirally downwardly into the smaller diameter of the lower section, has its velocity increased and this, together with the fresh air entering tangentially into this section, further increases the centrifugal force of the medium whereby a very efficient separation of the material from the air is effected.

If it is not desired to dehydrate the liquid product to such an extent as to produce a dry powder but merely to concentrate the liquid, the feed of the pump, which supplies liquid to the spray head, is increased or less air is recirculated or both and the lower section 76 of the discharge conduit 45 is removed and the receptacle 75 placed directly beneath the discharge conduit 45 for receiving the liquid concentrate. The pump 71 may be of the adjustable feed type or a valve 77 in the conduit 68 anterior of the pump 71 may be employed for controlling the amount of liquid supplied to the pump.

While in the construction shown, the dehydrator chamber is circular in cross-section, it is understood that for convenience in manufacture, it may be polygonal in cross-section. The expression "circular in cross-section" is intended to include the polygonal type since chambers having a large number of sides approach the form of a circle in cross-section.

It is thought from the foregoing, taken in connection with the accompanying drawing, that the construction and operation of my device will be apparent to those skilled in the art and that changes in size, shape, proportion and detail may be made without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In an apparatus for dehydrating a liquid product, a dehydrating chamber having an upper section and a lower section, said upper section being provided with an unobstructed cylindrical portion and a tapered lower portion, said lower section having a cylindrical upper portion flanged at its upper end and merging into the lower portion of the upper section and a tapered lower portion, means for introducing a drying medium into the upper portion of said chamber and for causing the same to move downwardly in said chamber and into said lower portion in an outer spiral and then substantially all of it upwardly out of said chamber in an inner spiral, a rotating head for spraying a liquid product into said outer spiral, and means for introducing fresh air into said outer spiral within the lower section of said chamber for cooling the dehydrated product therein.

2. In a dehydrating apparatus, a dehydrating chamber having a cylindrical portion and a tapered portion below said cylindrical portion, a conduit member extending axially of said chamber within the lower portion of said tapered portion, a cone-shaped deflecting member attached to said conduit member adjacent the upper end thereof, means for introducing a drying gaseous medium into the upper end of said chamber and for causing the same to rotate in a downwardly moving outer spiral outwardly of said conduit, and then to ascend in an inner spiral through said conduit and upwardly from said chamber.

3. In a dehydrating apparatus, a dehydrating chamber having a cylindrical portion and a tapered portion below said cylindrical portion and a restricted portion below said tapered portion, a conduit member extending axially of said chamber within the lower portion of said tapered portion above said restricted portion, a cone-shaped deflecting member attached to said conduit member adjacent the upper end thereof, means for introducing a drying gaseous medium into the upper end of said chamber and for causing the same to rotate in a downwardly moving outer spiral outwardly of said conduit down into said restricted portion for dehydrating a liquid product sprayed therein and then to ascend in an inner spiral through said conduit and upwardly from said chamber, and means for introducing a current of fresh air into said chamber below said conduit for increasing the rotational velocity of said gaseous medium and for cooling the dehydrated product as it passes downwardly into the restricted portion of said chamber.

4. A method of treating a liquid product which comprises introducing a current of gaseous drying medium into a chamber, causing the same to rotate in a downwardly moving outer spiral and then in an upwardly moving inner spiral in contact with the outer spiral, simultaneously spraying a liquid product into said outer spiral only in the upper portion of said outer spiral, and introducing a current of fresh air tangentially into the lower portion of said outer spiral for speeding up the rotation of said spiral and for cooling said product, said last-named air mingling with said drying medium and being discharged from said chamber therewith.

5. In a dehydrating apparatus, a dehydrator chamber comprising an upper portion and a lower portion, said upper portion having means for introducing a gaseous drying medium and for causing the same to move downwardly in an outer spiral within said upper portion and then downwardly in an outer spiral downwardly within said lower portion and then upwardly in an inner

spiral within said outer spirals and out of said chamber, a rotating spray for spraying a liquid product into said outer spiral only, and means for introducing a small stream of fresh cool air tangentially into the lower portion of said chamber into said drying medium for cooling said product and for assisting in the rotation of said outer spiral prior to its discharge from said chamber.

6. In a dehydrating apparatus, a dehydrator chamber, means for introducing a drying medium into said chamber and for causing the same to move spirally downwardly and then substantially all of it spirally upwardly out of said chamber, means for spraying a liquid product into the outer spiral only, and means for introducing a stream of cool air tangentially into the lower portion of said chamber above the lower end thereof for mixing with said medium and for cooling the dehydrated product before it is collected within the lower portion of said chamber.

7. In a dehydrating apparatus, a drying chamber, means for introducing a drying medium in a hollow stream axially into said chamber and for causing the same to move outwardly and downwardly within said chamber in an outer spiral, a tubular member in the lower portion of said chamber supported axially thereof, said means causing said downwardly moving air to reverse and to flow spirally upwardly through said tubular member and through said hollow stream to the point of discharge from said chamber, a rotating spray head for spraying a liquid product into the outer spiral of moving air only, and a deflector plate carried by said head for deflecting the air entering said chamber downwardly and outwardly.

8. In a dehydrating system, a dehydrating chamber comprising an upper cylindrical portion and a lower tapered portion, said tapered portion terminating in a downward extension of greatly reduced diameter, a short tubular member supported immediately above said downward extension and coaxial therewith, and a cone-shaped deflector secured to said tubular member and extending over said extension but spaced therefrom for directing air traveling in a downward spiral into said downward extension.

9. In a dehydrating system, a single combined dehydrator and collector chamber, a heater, a fan, a fresh air intake passage for said fan, a valve for controlling the amount of fresh air admitted through said passage, means for conducting air from said fan through said heater and directly to said dehydrator and collector chamber, means for causing the heated air to enter said chamber in a downwardly moving outer spiral and for discharging substantially all of the same from said chamber in an inner upwardly moving spiral, a conduit for conducting air discharged from said chamber directly back to said fan, a valve controlled discharge passage for said conduit, means for spraying a liquid product into the outer moving spiral of air only for dehydrating said product, and means for introducing fresh cool air tangentially into the lower portion of said chamber for mixing with said heated air for cooling the dehydrated product and for increasing the speed of the outer spiral whereby better separation is accomplished.

10. In a dehydrating system, a single combined dehydrator and collector chamber, a heater, a fan, a valve controlled intake passage for supplying fresh gaseous drying medium to said fan, means for conducting said medium from said fan through said heater and directly to said dehydrator and collector chamber, means for causing the heated medium to enter said chamber in a downwardly moving outer spiral and for discharging substantially all of the same from said chamber in an inner upwardly moving spiral, a conduit for conducting the medium discharged from said chamber directly back to said fan, a valve controlled discharge passage for said conduit, means for spraying a liquid product into the outer moving spiral only for dehydrating said product, means for discharging into the atmosphere a portion or all of the medium entering said last-named conduit, and means for introducing unheated fresh gaseous drying medium tangentially into the lower portion of said chamber for mixing with said heated drying medium for increasing the speed of movement thereof and for cooling the dehydrated product moving therethrough.

11. In a dehydrating system, a single combined dehydrator and collector chamber having an upper section and a lower section, said upper section having an upper cylindrical portion and a downwardly tapered lower portion, said lower section having a cylindrical upper portion flaring at its upper end and merging with the lower portion of the upper section, said lower section having a tapered lower portion, a heater, a fan, a valve controlled intake passage for supplying fresh gaseous drying medium to said fan, means for conducting said medium from said fan through said heater and directly to said chamber, a snail for receiving said medium and for directing the same downwardly into said chamber, means including said fan and snail for causing said medium to rotate within said chamber in an outer spiral downwardly through said upper section into said lower section, said means causing said spirally moving drying medium to reverse and flow upwardly in an inner spiral in contact with said outer spiral and out of said chamber axially thereof, means for conducting said drying medium directly from said chamber back to said fan, a valve controlled discharge passage for said last-named means, means for rotatably spraying a liquid product into the medium only as it enters said chamber, and means for discharging a cooling gaseous medium tangentially into said lower section of said chamber for cooling the dehydrated product within said lower section and for accelerating the movement of the drying medium rotating within said lower section.

12. In a dehydrating system, a single combined dehydrator and collector chamber having an upper section and a lower section, said upper section having an upper cylindrical portion a downwardly tapered lower portion, said lower section having a cylindrical upper portion flaring at its upper end and merging with the lower portion of the upper section, said lower section having a tapered lower portion, a heater, a fan, a valve controlled intake passage for supplying fresh gaseous drying medium to said fan, means for conducting said medium from said fan through said heater and directly to said chamber, a snail for receiving said medium and for directing the same downwardly into said chamber, means including said fan and snail for causing said medium to rotate within said chamber in an outer spiral downwardly through said upper section into said lower section, said means causing said spirally moving drying medium to reverse and flow upwardly in an inner spiral in contact with said outer spiral and out of said chamber axially

thereof, a return conduit for conducting said medium directly back to said fan from said chamber, a valve controlled discharge passage for said return conduit, a rotating spray head, apertured arms radiating outwardly from said head, nozzles detachably connected to the outer ends of said arms and extending into said medium as it enters said chamber, means for supplying a liquid product to said head, arms and nozzles whereby the same is sprayed into the medium only as it enters said chamber, and means for discharging a cooling gaseous medium tangentially into said lower section of said chamber for cooling the dehydrated product within said lower section and for increasing the speed of rotation of the gaseous medium within said lower portion.

13. In a dehydrating system, a single combined dehydrator and collector chamber having merging upper and lower sections of substantially circular cross section and large and small diameters respectively, a heater, a fan, a valve controlled intake passage for supplying fresh gaseous drying medium to said fan, means for conducting said medium from said fan through said heater and directly to said chamber, a snail for receiving said medium and for directing the same downwardly into the upper section of said chamber, means including said fan and snail for causing said medium to rotate within said chamber in an outer spiral downwardly through said upper section into said lower section, said means causing said spirally moving drying medium to reverse and flow upwardly in an inner spiral in contact with said outer spiral and out of said chamber axially thereof, a return conduit for conducting substantially all of said medium directly back to said fan from said chamber, a discharge passage connected to said return conduit, a valve within said passage for controlling the amount of said medium discharged from said system through said passage, a rotating spray head, apertured arms radiating outwardly from said head, nozzles detachably connected to the outer ends of said arms and extending into said medium as it enters said chamber, means for supplying a liquid product to said head, arms and nozzles whereby the same is sprayed into the medium only as it enters said chamber, and means for discharging a cooling gaseous medium into said lower section of said chamber into said spirally moving drying medium for cooling the dehydrated product within said lower section, said cooling gaseous medium entering tangentially in the direction of movement of said drying medium.

14. A method of dehydrating a liquid product and for cooling the dehydrated material, which comprises spraying a liquid product into a downwardly moving outer spiral of gaseous drying medium, causing the dehydrated material to be separated from the medium by centrifugal movement of said medium and material, causing said medium to ascend in said chamber in an inner spiral to a point of discharge, introducing a cool gaseous medium tangentially into said downwardly moving outer spiral through the downwardly moving dehydrated material for cooling said material, increasing the velocity of said drying medium, and for reducing the relative humidity of said drying medium and causing said gaseous medium to mix with said drying medium and ascend with the same to a point of discharge.

15. In a dehydrating system, a dehydrating chamber having a cylindrical upper portion, a tapered lower portion, a more acutely tapered portion below said tapered portion and having its side walls merging into the side walls of said tapered portion, means for introducing a drying medium into said chamber at its upper portion and for causing the same to flow downward therein in an outer spiral and then upwardly in an inner spiral to the discharge from said chamber, a cone deflector at the juncture of said tapered portion and said more acutely tapered portion for modifying the downward movement of said outer spiral, and means for spraying liquid product into the air of said outer spiral, the concentrate of said sprayed material being collected within said lower cylindrical portion.

JOSEPH M. HALL.