Jan. 20, 1959 H. KAMP 2,869,249

APPARATUS FOR DRYING AND SIMULTANEOUSLY COOLING WHITE SUGAR COMING FROM A DRIER

Filed Dec. 6, 1955 2 Sheets-Sheet 1

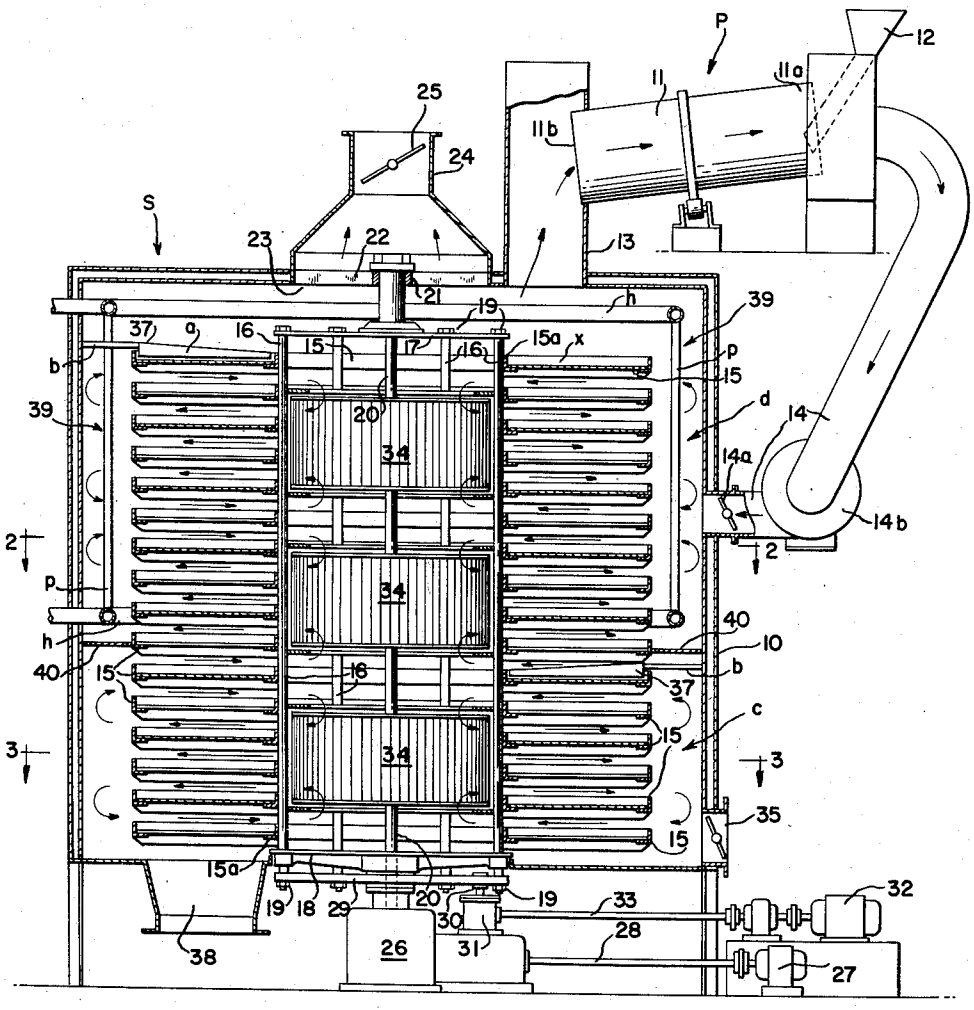


FIG. 1.

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Fig. 2.

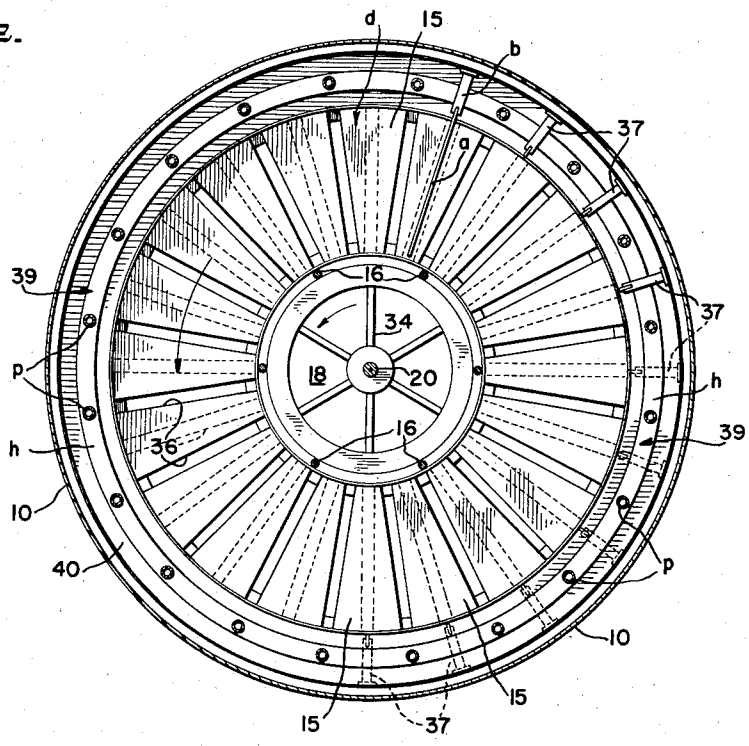
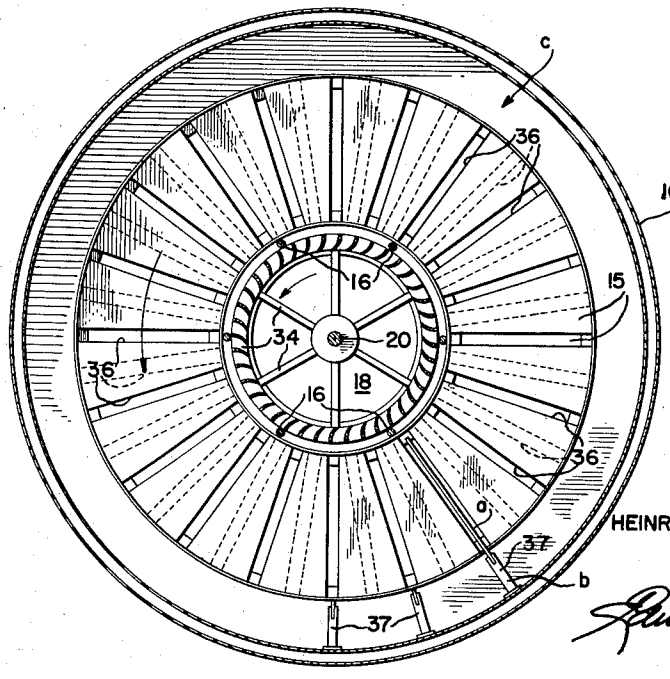


Fig. 3.



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APPARATUS FOR DRYING AND SIMULTANEOUSLY COOLING WHITE SUGAR COMING FROM A DRIER

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Claims priority, application Germany December 7, 1954

14 Claims. (Cl. 34—65)

The present invention relates to an apparatus for drying and simultaneously cooling the white sugar coming from a centrifuging station; and while the present invention is not limited to the treatment of fine crystalline sugar, it is of particular advantage in the treatment of such sugar especially.

Heretofore, sugar, coming from a centrifuging station, or the like, has been delivered to a pre-drying step—such as a rotating hopper or drum—where it is dried preliminarily by conducting through the drum all of the heated air from a subsequent or secondary drying step, which heated air is then exhausted to the atmosphere in a continuous stream from said drum. The partially dried sugar is then passed to be subjected to said subsequent step. Although such initial or predrying is advantageous, it has been found that, when treating fine crystalline sugar, the sugar crystals, delivered from the preliminary drying step to the second drying step, contain sufficient moisture as tends to cause them to cake together or form conglomerates in the first stages of the second drying step, due to the small amount of changing or shifting of the sugar layers in the drum unless the initial drying is carried out to decrease the water content of the sugar to a specified amount while the layers of material are constantly moved, for example in a rotating drum or like device. It could be established that the frequent changing of the layers of the sugar masses, while still moist, does not exert any unfavourable influence on the maintenance of the structure of sugar crystals, the sharp-edged formation, and so on, provided that their heat content does not fall below 0.2%.

It is proposed, according to the present invention, that a controlled component quantity of the heated exhaust air from the second drying step be conducted through the preliminary drier, of the type referred to above, under a forced draft and that this air should return into the second drier after flowing through the preliminary drier, so that a forced air circulation is set up thus conserving the heat in the system and intensifying the drying action of the heated air in both drying steps.

This may be accomplished by varying the output of a circulating fan fitted in the return conduit of the preliminary drier, fitting at least one throttle valve in the return pipe of the fan and so on, thus making it possible for the amount of air circulated through the preliminary drier to be adapted to the given conditions.

Another essential advantage of this method, just stated, is that sugar dust from the preliminary drier is kept in the system and is not discharged directly into the atmosphere thereby eliminating the necessity for a dust extractor or collector at the preliminary drier. The constant circulation of the sugar masses in the preliminary drier and the velocity at which the warm air from the second drier travels through the said preliminary drier are the cause of ultra-fine sugar crystals being entrained by the air. When operating in accordance with the present invention, these crystals pass with the returned air stream into the second drier in which they are deposited. This action depends largely upon separate air-circulation zones being maintained within the second drier, and in this regard such is done as will presently be explained.

Another object of this invention is the provision of a secondary drying and cooling apparatus of novel construction and organization, which receives the sugar, being treated, from the preliminary drier and which is designed to function most efficiently and advantageously in carrying out the aims of this treating process—that is, during the entire drying and cooling by this secondary drier, the layers of sugar, being subjected to the treatment, are disturbed or rearranged as few times and as gently as possible to assure that the sharply defined edges, the glitter or brilliance and the crystal structure of the fine-grained sugar is maintained. To this end, the secondary drier is preferably divided into an upper drying zone and a lower cooling zone and has disposed therein a plurality of superimposed annular discs, which form trays, so arranged and mounted that after each cycle of relative movement, between said trays and another part, the sugar is transferred to the next subjacent tray, until dried and cooled when it is discharged from the secondary drier. The arrangement is such that cool or atmospheric air is drawn into the lower portion of the cooling zone by a fan means and flows radially from the fan means in paths over certain of the annular trays and then, after a sharp change in direction, is drawn back again by the fan means over certain others of said trays in radial paths on opposite sides of said first radial paths, a component portion or quantity of said air, so circulated, always passing upwardly into the next superjacent area of the drier, and so on, to the top of said drier where the air, or a portion thereof, may be discharged through a controllable chimney stack. However, when said circulated air in the drier passes from the cooling zone to the drying zone, it has been heated somewhat by the exchange of heat from the sugar it has been cooling; and within the drying zone, the temperature of said air is raised by heating means disposed therein to assist the air in the drying of the sugar on the trays therein, a controlled portion of this heated air from the upper part of the drying zone being introduced into the preliminary drier and then recirculated back into the drying zone of said secondary drier, when it intermingles and combines with the air being circulated over the trays. Thus, any ultra-fine sugar crystals or sugar dust that becomes entrained into the circulating currents, passing through the preliminary drier, are separated out of said currents within the secondary drier at the places where the air in the latter changes direction—i. e., more especially at the outer edges of said trays—and are deposited on the layers of sugar on said trays, hence making it possible for air discharged through the exhaust chimney or stack to be freed from entrained sugar crystals.

A constructional embodiment of the invention as above set forth, is shown by way of one example in the accompanying drawings, wherein:

Figure 1 is a vertical sectional view, somewhat diagrammatic, of the secondary annular disc drier with a preliminary drier associated therewith in order to illustrate the invention;

Figure 2 is a horizontal transverse view through the secondary drier and taken substantially on line 2—2 of Figure 1; and

Figure 3 is a view similar to Figure 2 and is taken substantially on line 3—3 of Figure 1.

Referring to the drawings, in which like characters designate similar and like parts throughout the several views, and with particular reference to Figure 1, the secondary drier is generally indicated at S, into the upper

portion of which a preliminary drier P discharges. The secondary drier comprises a housing **10**, preferably cylindrical in form and closed at its top and bottom ends.

The preliminary drier P may be of any approved type but is here shown as a rotatable cylinder or drum **11** inclined to the horizontal and disposed above the housing **10** to discharge thereinto. The sugar masses are introduced into the upper load-receiving end **11a** of the drum from a hopper **12** and are initially dried in said drum by the constant rearrangement of the layers of sugar therein due to the rotation of the drum and the passage thereover and therethrough of heated air being drawn from the upper portion of the secondary drier S and which enters the discharge end **11b** of the drum **11**—counter to the passage of the sugar through the drum **11**—and is drawn through and from the other end of the drum by a suction fan **14b** in a conduit **14** which discharges into the lower portion of the drier zone *d* of the secondary drier S, the passage of the return air from the drum **11** through the conduit **14** being regulated and controlled by the valve or damper **14a**. When so dried preliminarily, the sugar is controllably discharged from its end **11b**, into the upper end of the housing **10** of the secondary drier S, a conduit or chute **13** being provided for this purpose.

The secondary drier S comprises a multiplicity of super-imposed annular trays **15** concentrically arranged and spaced apart sufficiently to accommodate a layer of sugar crystals thereon and to permit an air stream of sufficient volume to pass between said trays. The trays **15**, so disposed, are secured at their inner circumferences, at **15a**, to a circular series of spaced and vertically positioned rods **16**, which have their ends threaded and extending through disc-like plates **17** and **18** and secured thereto by nuts **19**, or other suitable means, thus forming a cylindrical cage closed at its ends with the trays **15** extending radially outward therefrom. The cage is journalled at its longitudinal axis on a vertical shaft **20** positioned centrally of the housing **10** and having its ends projecting beyond the end plates **17** and **18**.

The upper end of the shaft **20** is journalled in a bearing **21** carried by a spider **22** extending across an air exhaust opening **23** in the top wall of the housing **10** and to which top wall the spider is secured. A chimney or stack **24** extends upwardly from the exhaust opening **23** and is provided with a regulating valve or damper **25**.

The lower end of said shaft is partially supported by a gearing casing **26** disposed under the bottom of the housing **10** and is connected to suitable gearing in said casing, which gearing is connected to the motor **27** by a transmission shaft **28** for rotating said shaft **20** independently of the cage (**16**, **17** and **18**) carrying the trays **15**.

The lower ends of the rods **16** have an internal gear **29** secured thereto below the end plate **18**, which gear is driven by a pinion **30** carried by a gear-box **31** and connected to a motor **32** by transmission shaft **33**, whereby the annular disc-trays **15** may be rotated about, but independently of, the shaft **20**.

Fan means is mounted fast on the shaft **20** and disposed within the area defined by the circular series of rods **16** to force air back-and-forth over the trays **15** in a slow gradually ascending progression from the lower part of the housing **10** upwardly. This fan means may comprise two or more fans **34**, of the turbine type, spaced along the shaft **20** and within the area surrounded by the annular trays **15** so that, when the shaft **20** is rotated, the air, admitted into the lower end of the housing through a regulating opening or openings **35**, will be forced radially therefrom over certain of said trays **15** and, upon impinging the side wall of the housing **10**, will be drawn back radially of and over certain other trays **15** lying above and below the spaced fans **34**, as indicated by the arrows in Figure 1. However, the next superjacent fan **34** influences a component portion of the air, being so circulated by the next subjacent fan, and draws the same upwardly thereinto, thus causing the cool air admitted at **35** to traverse upwardly for the vertical extent of the trays with a back-and-forth or zig-zag flow to, first, effect complete cooling of the sugar and, secondly, dry the sugar in the most efficient manner. In the drawing, which illustrates a typical arrangement, three fans **34** are shown, one in the cooling zone *c* and two in the drying zone *d*.

As above indicated, the sugar from the preliminary drier P is discharged onto the uppermost tray **15** in a relatively thin layer, as the trays are rotated by their motor **32**. The bottom or supporting surface of each tray **15** is provided with a plurality of radial slots **36** spaced a substantial distance from each other. The slots **36** in one tray **15** are staggered, or out of alignment, with the slots **36** in the next subjacent and superjacent trays. The sugar on these trays **15** is transferred through these slots **36** to the next subjacent annular tray by means of a stripper or scraper device **37**. One such scraper device is provided at each tray and said scraper devices are arranged in progressive spatial relation with respect to each other circumferentially of the housing **10** and with respect to the direction of rotation of said trays **15**, as shown in Figures 1, 2 and 3. Each of these scrapers **37** may comprise a blade *a* extending radially of and in adjusted scraping relation with the sugar-supporting surface of its tray and is supported in this position by a bracket *b* mounted on the side wall of the housing **10**. Thus, the sugar supplied at *x* gradually descends in stages from one tray to the next subjacent tray while being subjected to the drying and/or cooling effect of the slowly ascending air current flowing over the sugar on the tray and while being transferred from tray to tray until the sugar on the lowermost tray is discharged through its slots **36** into the discharge chute **38**.

In order to facilitate the drying of the sugar in the drying zone *d*, the temperature of the slowly ascending air from the cooling zone *c* is increased by heater elements **39** of any suitable type disposed between the outer edges of the trays **15** and the side wall of the housing **10**. These heater elements are here shown as a circular series of vertical and spaced pipes *p* connected at their ends by annular headers *h* through which a heating medium is circulated and about which the air flows. Therefore, in order to confine the heat from said heater element within the drying zone *d*, it is expedient to divide the area between the superimposed trays **15** and the side wall of the housing **10** by providing a partition or annular plate **40** extending inwardly from said side wall to a point just short of the outer circumferential edge of one of the intermediately positioned trays **15**, as shown in Figure 1. So arranged, the partition **40** is a substantial continuation of the tray with only sufficient clearance therebetween to allow free rotation of the tray so that the transfer or passage of the air from the cooling zone *c* into the drying zone *d* can definitely only take place by way of the slots **36** in the trays or through the adjacent fan **34**. It is also preferred that this partition **40** and the tray with which it cooperates be in a plane, at least, approximately that of the lower end or edge of a drier fan **34**, for instance, the intermediate fan **34** as shown in Figure 1.

Operation

Assuming the apparatus to be in operation, the sugar masses introduced at **12** are initially dried in the drum-drier P by the constant rearrangement of the layers of sugar therein due to the rotation of the drum and the passage of heated air therethrough. According to the temperature conditions within the apparatus, the valve **25** in the chimney **24** and the valve **14a** in the conduit **14** will be properly adjusted to permit the required amount of heated air from the upper part of the drying zone *d* of the housing **10** to be drawn by the fan **14b** through the drum **11**, counter to the passage of the sugar therein, thus effecting the preliminary drying of the sugar. This

preliminary drying is carried out to such a degree that it is not possible for the sugar, when discharged into the secondary drier S, to cake in or on the trays **15** thereof.

The sugar is discharged from the drum **11** onto the uppermost tray **15** within the drying zone *d* in a relatively thin layer due to the rotation of the trays **15**; and, as the layers of sugar crystals are transferred from tray to tray through the slots **36** by the scraper **37**, cool air is drawn into the lower portion of the cooling zone *c* by the fans **34** and caused to pass over the trays in the manner shown by the arrows in Figure 1 and as described above. Due to this manner of circulating the air, it ascends relatively slowly from the cooling zone into the drying zone *d* where its circulation is the same as before but where the air is additionally heated by heaters **39** to effect the drying.

Any ultra-fine sugar particles or sugar dust that are entrained in the air circulated through the drum **11** are returned to the drier zone *d*, where the air discharged therein from conduit **14** intermingles with the heated air circulating between the superimposed trays **15** and the entrained sugar particles are deposited upon the trays, where they combine with the sugar thereon, or otherwise fall to the bottom of the housing, thereby eliminating the necessity for dust collectors or extractors at the preliminary drier and also reduces the waste of the sugar emitted with the exhausted air.

The process which has been described and also the equipment for carrying it into effect can be modified and constructed in various ways within the scope of the invention. It is essential that for the preliminary drying of the sugar an apparatus shall be employed which will guarantee a constant changing of the layers of the sugar masses. Instead of the annular discs trays **15** formed with slots **36**, the trays can also consist of hinged segments which discharge the sugar on to the next subjacent stage when they are hinged downwardly. Furthermore, it is possible for the warm air flowing from the drying zone *d* into the preliminary drier P to be heated, for example, by an air heater or by admixing hot gases.

I claim:

1. A device for drying and cooling white sugar, coming from a centrifuger, comprising a preliminary rotatable drier having a chamber into which the sugar mass is delivered and having a receiving opening at one end portion and a discharge opening at its other end portion; a secondary drier including a housing having an air ingress opening and a controllable air egress opening therein, a closed charging passage means connecting the discharge end of said preliminary drier to said secondary drier adjacent its air egress opening for delivering a charge of sugar to said secondary drier; a closed air conduit connecting the receiving end of said preliminary drier with an intermediate point of said secondary drier at a point remote from its said charging passage to establish a substantially closed air circuit between the said driers; a heating means in the secondary drier and disposed in the path of said circulating air between the connection of said conduit with said secondary drier and the said controlled egress opening and said passage means; and an air-forcing means positioned to force air from said secondary drier through said charging passage and said preliminary drier counter to the passage of the sugar mass therethrough and to return said air to said intermediate and cooler portion of said secondary drier.

2. A device for drying and cooling white sugar, coming from a centrifuger, comprising a preliminary rotatable drier having a chamber into which the sugar mass is delivered and having a receiving opening at one end portion and a discharge opening at its other end portion; a secondary drier including a housing arranged to receive at its upper portion the material, being treated, from the discharge opening of said preliminary drier and having an air ingress opening in its lower portion and a controllable air egress opening at its upper portion, a series

of superimposed and rotatably mounted trays disposed within said housing between said air ingress and egress openings, means for transferring said material from one tray to the next subjacent tray as said trays rotate; a closed charging passage means connecting the discharge end of said preliminary drier and positioned to deliver said material to the uppermost of said trays; a conduit connecting the receiving end of said preliminary drier with said secondary drier at an intermediate point between said air ingress and egress openings to establish a substantially closed air circuit between the said driers; a heating means in the secondary drier above said intermediate point thereof; an air-forcing means in said air conduit to force air from said secondary drier through said charging passage means and said preliminary drier and return said air to a cooler portion of said secondary drier, and means for rotating said trays.

3. The subject-matter of claim 2, further characterized by the air-forcing means being a suction fan in said conduit and said conduit having a throttle valve means therein.

4. The subject-matter of claim 2, further characterized by the means for transferring said material from tray to tray being spaced slots in said trays and scraper means cooperating with said trays to remove the material through said slots as said trays rotate relative to the scrapers.

5. The subject-matter of claim 2, further characterized by the trays being annular and spaced vertically from each other, supporting means for the trays, and a plurality of fans disposed within the inner circumference of said superimposed annular trays and spaced vertically from each other and positioned to emit air therefrom radially of certain trays and to draw said air back over other trays to said fans for repeated operation of said air and the superjacent fan will cause a portion of the air from the subjacent fan to be influenced thereby, whereby the air ascends gradually and progressively upwardly through the secondary drier, and means for rotating said fans.

6. The subject matter of claim 2, further characterized by an annular partition extending from the side walls of said housing to an intermediate tray of said superimposed trays, thereby dividing the housing into a lower cooling zone and an upper drying zone, and said heating means being disposed in the upper drying zone.

7. In a device for drying and cooling crystalline or granular materials, a housing having openings therein at the lower and upper portions for the ingress and egress of air therethrough and having a partition between said openings dividing said housing into an upper drying zone and a lower cooling zone, a series of superimposed disc-like annular trays positioned in said housing and extending through said zones and mounted for rotation about a common vertical axis and each having a plurality of spaced slots therethrough, the slots of adjacent trays being out of alignment relative to each other, means for delivering said material to the uppermost of said trays, means cooperatively positioned for discharging said material on said trays through said slots upon the next subjacent tray as said trays rotate, a means underlying the lowermost tray to receive said material therefrom and discharge it from said housing, fan means disposed within the area defined by the inner circumferences of said annular superimposed trays and arranged in said cooling zone and in said drying zone to draw cooling air through said ingress opening and discharge the same radially of said trays, and heating means in the drying zone arranged in the path of said circulating air.

8. The subject-matter of claim 7, wherein a vertical shaft is disposed within and extends substantially the length of said housing and said fan means comprises a plurality of turbine-type fans spaced along the length of said shaft.

9. The subject-matter of claim 8, wherein the mount-

ing for said trays comprises spaced header plates mounted at the end portions of said shaft, said plates being connected at their peripheral portions by a spaced series of vertically disposed rods to which the inner circumference of said trays is secured.

10. The subject-matter of claim 7, wherein said heating means is disposed between the outer wall of the housing and the outer circumference of the trays in said drying zone.

11. The subject-matter of claim 7, wherein the slots in said trays are radial thereof and said cooperating discharge means are stationary scrapers overlying each of said trays and supported from the housing.

12. In a device for drying and cooling crystalline or granular materials, comprising a housing having openings therein at its upper and lower portions for the egress and ingress of air therethrough, a driven vertical shaft centrally mounted in said housing and extending substantially the length thereof, a plurality of spaced turbine-type fan members fast on said shaft and spaced along its length, a cage-type supporting member substantially coextensive with and surrounding said shaft and journalled thereon, a series of superimposed disc-like annular trays surrounding said cage member and secured thereto and dimensioned to provide a substantial space between the outer circumference thereof and the side wall of said housing, said trays each having a plurality of radial slots therein staggeredly arranged relative to the slots in the adjacent trays, means associated with each of said trays for discharging the material thereon through said slots to the next subjacent tray, discharge means in the housing underlying the lowermost tray to receive the material discharged from said tray, an annular partition extending inwardly from the side wall of

said housing to an intermediate tray to divide the housing into a lower cooling zone and an upper drying zone, heating means disposed in the drying zone between the outer circumference of said trays and said side wall of the housing, and means for discharging the material onto the uppermost of said trays.

13. The subject-matter of claim 7, wherein the fan means consists of at least one fan in each of said zones and positioned to emit air therefrom radially of certain trays and to draw said air back over other trays to said fan for repeated operations of said air, and disposed relative to each other so that the superjacent fan causes a portion of the air from a subjacent fan to be influenced thereby, whereby the air ascends gradually and progressively upwardly through the secondary drier.

14. The subject-matter of claim 13, wherein the division between the drying and cooling zones is positioned to cause the air moving from one zone to the other to flow through the slots in the trays and the central passage through the trays.

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