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MANUFACTURE OF DRIED EGG MATERIAL

Filed Dec. 11, 1944

2 Sheets-Sheet 1

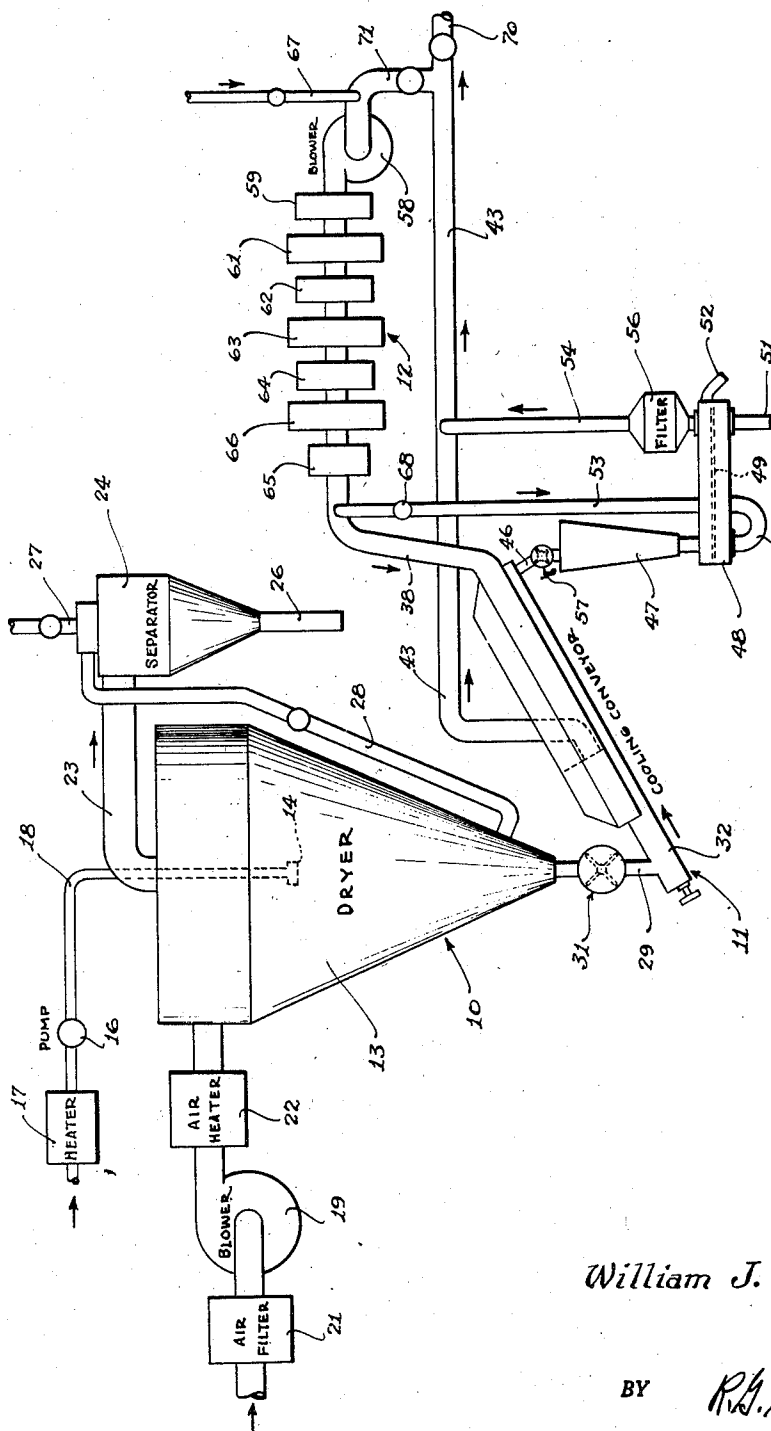


Fig. 1

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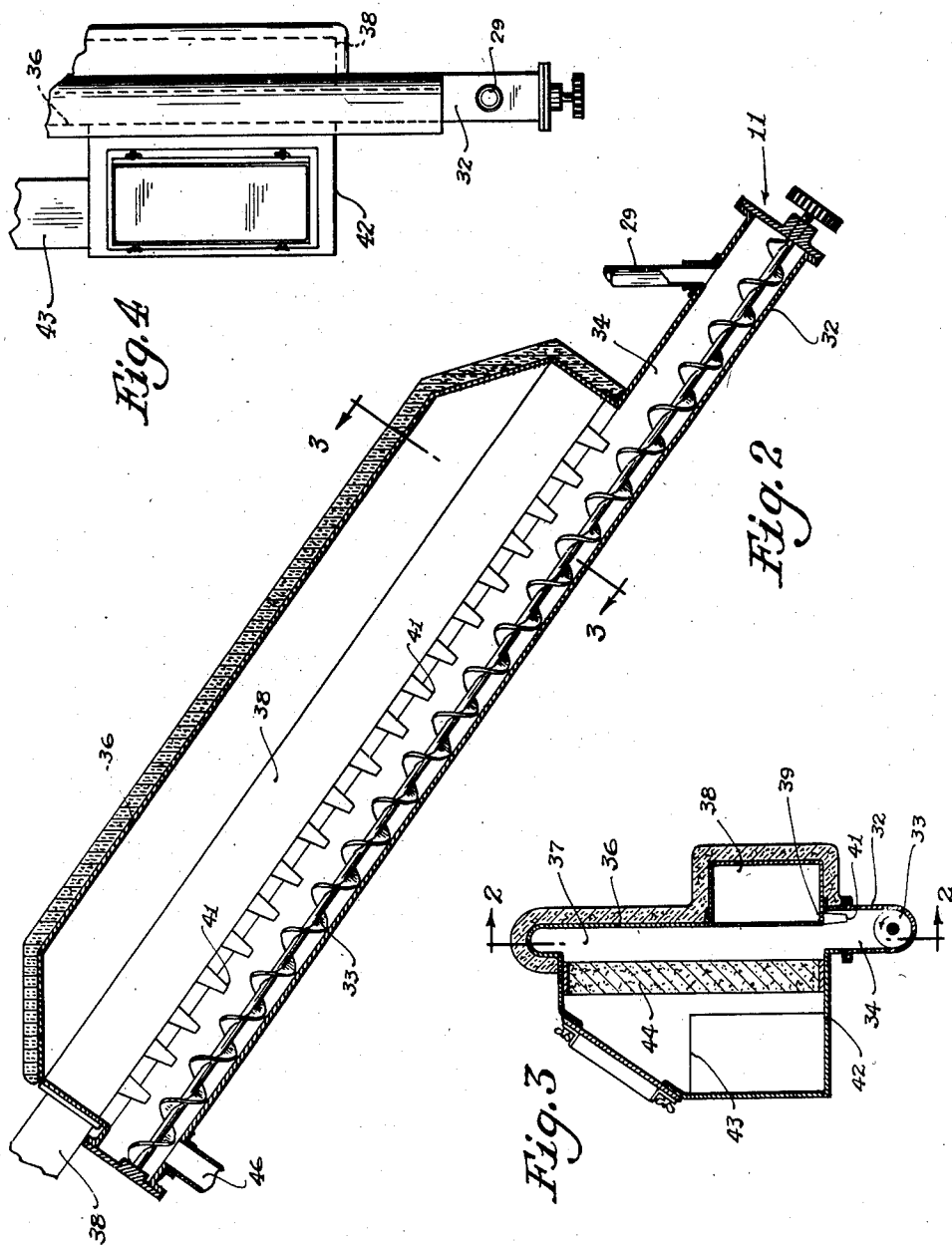
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MANUFACTURE OF DRIED EGG MATERIAL

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2 Sheets-Sheet 2



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MANUFACTURE OF DRIED EGG MATERIAL

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3 Claims. (Cl. 209—3)

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This invention relates to cooling and drying of powdered material and more particularly to an apparatus for reducing the temperature of heated hygroscopic powders, such as powdered eggs from a spray drying operation so as to bring their temperature to substantially atmospheric temperature.

Many powdered materials, for example, powdered eggs, are extremely hygroscopic. When produced in conventional spray drying equipment, they are discharged from such equipment at a relatively high temperature. For example, in the drying of eggs the temperature of the powder when discharged from the drying cone in conventional process will range from 190° to 210° F. depending considerably upon the operating conditions adopted for the drying cone and the amount of moisture which is left in the egg powder. Before packaging, this material must be cooled to temperatures not substantially exceeding 80° F. It has been extremely difficult to prevent such a hygroscopic powder from absorbing moisture from atmospheric air or cooling air during the cooling operation, particularly when extreme low moisture content powders are required, for example, powders containing between .5 and 2.5% moisture.

Prior processes have attempted to produce such low moisture content powder by operating the spray drying apparatus with a low liquid input and high temperature in order to reduce the moisture content of the powder substantially below that required in the finished product. This was done so that a substantial increase in moisture content could be tolerated during the cooling operation due to absorption of moisture from air brought into contact with the powdered material during the cooling operation. In addition to the problem of moisture absorption during cooling it has been extremely difficult to obtain sufficiently intimate contact between the powder and a cooling medium to efficiently abstract heat from such powders.

The present invention provides an improved apparatus for abstracting heat from the powder by bringing the heated powdered material repeatedly into intimate contact with cold air in a continuous operation. Also, the present invention contemplates the employment of cold air having an extremely low moisture content such that substantial amounts of moisture can be vaporized from the powder during the cooling operation. This enables the powder to be discharged from the spray drying step with a moisture content considerably above that required in

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the final product which in turn enables a very much higher liquid input to be employed in the spray drying operation and also enables the powder to be discharged from the spray drying operation at a relatively low temperature. The lower temperature of the material from the spray drying operation reduces the amount of cooling required in the cooling steps and this coupled with the fact that evaporation of moisture from the powder during cooling assists materially in cooling the powder, reduces the cooling load so that an increase in liquid input can also be accomplished in a given cooling apparatus. Thus, by employing extremely dry air in the cooling operation, the entire process is made more efficient and the amount of material capable of being dried and cooled in a given apparatus is very substantially increased.

It is therefore an object of the present invention to provide an improved apparatus for producing hygroscopic powders of extremely low moisture content from liquid materials containing solids in solution or suspension.

Another object of the invention is to provide an improved apparatus for cooling powdered material in which the powder is mechanically conveyed while being repeatedly subjected to blasts of refrigerated air in order to intimately mix the powder with the cool air.

A further object of the invention is to provide an apparatus for cooling hygroscopic material in which powder is maintained in contact with refrigerated air having an extremely low moisture content for a substantial period of time and until the powder is placed in packages.

Other objects and advantages of the invention will appear in the following description of a preferred embodiment of the invention, this description being made in connection with the attached drawing, in which:

Figure 1 is a schematic diagram of a complete system particularly useful in converting liquid egg material into cooled powdered material having a low moisture content;

Figure 2 is a vertical section through a cooling apparatus in accordance with the present invention, said section being taken on line 2—2 of Figure 3;

Figure 3 is a sectional view taken on the line 3—3 of Figure 2; and

Figure 4 is a fragmentary plan view of the apparatus shown in Figures 2 and 3.

Referring more particularly to the drawing, 10 indicates in general a spray drying apparatus

which may be similar to conventional spray drying apparatus for converting liquid material containing solids in solution or suspension into powdered material, 11 indicates in general cooling apparatus for the powdered material discharged from the spray drying apparatus 10, and 12 indicates in general apparatus for providing refrigerated air having a very low moisture content.

The spray drying apparatus 10 may include a vortex cone 13 into which a heated liquid material is sprayed by a nozzle indicated diagrammatically at 14. The liquid material may be delivered to the nozzle 14 from any suitable source of supply (not shown) by a pump 16 through a flow heater 17 and a conduit 18 into the nozzle 14. A supply of heated air may be introduced into the cone 13 by means of a blower 19 supplied with air through an air filter 21, the blower 19 forcing the air through an air heater 22 into the cone 13. It will be understood that the air from the air heater 22 is introduced into the cone 13 adjacent the top and tangentially thereof in accordance with known spray drying operations. Also, in accordance with conventional spray drying operations the spent air is withdrawn from the cone centrally of its top through a conduit 23 and delivered to a cyclone separator 24 for removing powdered materials from the air. These powdered materials are collected in the separator 24 and may be removed therefrom through a discharge conduit 26, the cleaned air being discharged through a conduit 27. If desired a controlled amount of the air discharged from the separator 24 may be recirculated through the drier cone 13 by means of a conduit 28.

The dried and heated powder may be discharged from the bottom of the drier cone 13 through a conduit 29 through any suitable discharge mechanism such as a star valve 31 into the lower end of a cooling conveyor casing 32 as shown more clearly in Figures 2 to 4. The cooling conveyor casing 32 may contain a screw conveyor element 33 and be enlarged above the conveyor element 33 to provide a space 34. The conveyor casing 32 is inclined as shown in Figures 1 and 2 so that rotation of the conveyor element 33 causes the powdered material to be moved upwardly through the conveyor housing 32. For a major portion of the length of the conveyor element 33 the conveyor housing is provided with an exhaust duct 36 providing an enlarged space 37 elongated in a vertical direction. Also, an air inlet duct 38 is positioned above and to one side of the conveyor housing 32 so as to have a portion 39 projecting over the conveyor element 33. The inlet 38 is provided with a plurality of nozzles 41 spaced along the duct and directed downwardly to direct blasts of air against the material being carried upwardly to the conveyor housing 32 by the conveyor element 33.

The rotation of the conveyor element 33 is preferably counter-clockwise in Figure 3 so that the material tends to pile up on the flights of the conveyor directly beneath the nozzles 41. These nozzles thus blow the material clockwise around the conveyor element so that the direction of the resulting upward blast of the conveyor element tends to carry the powdered material upwardly in the conveyor housing. The powdered material is thus carried upwardly into the space 37 in the exhaust duct 36 and maintained in intimate contact with the cooling air. The powdered material gravitates downwardly in this space on to the conveyor element 33 to be again struck by another blast of air and forced upwardly into the space

37. The powder is thus repeatedly subjected to blasts of cold air while being mechanically conveyed and is largely maintained in an intimate admixture with the air in the space 37. As shown most clearly in Figures 1 and 4, the lower portion of the conveyor housing 32 is provided with a laterally extending compartment 42 to which a discharge or recirculation duct 43 is connected. As shown in Figure 3, the compartment 42 contains a filter element 44 having an enlarged face extending parallel to the vertical elongated space 37. Spent cooling air passes through the filter element 44 into the compartment 42 and is withdrawn therefrom through the duct 43.

The cooled powder is discharged from the cooling conveyor through the conduit 46 and, as shown in Figure 1, the conduit 46 connects with a cone 47 in turn connected with a sifter 48. The details of the sifter are not shown but any conventional type of enclosed sifter mechanism including a screen 49 shown in dotted lines may be employed, provision ordinarily being made to vibrate the screen 49. Sifted material is discharged from the sifter 48 through a conduit 51 while oversized material is discharged through a conduit 52. The conduit 51 ordinarily leads to a filling machine which will provide an air seal on the powder discharge, but a star valve may be used in the conduit 51 if desired. In order to further cool the material being sifted, cooled air may also be delivered into the bottom of the sifter 48 through a conduit 53 and withdrawn through a conduit 54 having an air filter 56 therein, the conduit 54 connecting with the duct 43. In order to prevent heated air from the cooling conveyor from reaching the sifter 48 the conduit 46 may be provided with a star valve 57.

The cooling air supplied to the cooling conveyor 11 and to the sifter 48 must have an extremely low moisture content if moisture is to be removed from the powder during cooling and the powder produced in the system is to have a low moisture content. The present invention employs a plurality of air coolers and air dehydrators in series. Thus fresh air may be drawn through the pipe 67 which is connected to the inlet of a blower 58 which forces the air through an air cooler 59, then through a dehydrator 61, through a second air cooler 62, a second dehydrator 63, a third air cooler 64, a third dehydrator 66, and a filter 65 into the supply duct 38. Air from the duct 43 may be discharged through the outlet pipe 70 or all or any portion may be recirculated to the system through the conduit 71. The details of the air coolers are not shown but in accordance with conventional practice they may contain cooling coils either in the form of refrigerant evaporators or brine or water cooling coils, the air being blown over such coils. The dehydrators 61, 63 and 66 will ordinarily contain dehydrating material such as activated alumina or silica gel. It has been found that removal of moisture from the air by absorption materially increases the temperature of the air and in order to reduce the temperature and moisture content of the air to the desired low extent repeated cooling and dehydrating operations are employed, the last dehydrating operation being followed by an air cooling step. Any number of coolers and dehydrators may be used, and we have found that two or three are usually sufficient. The relative proportions of the cooled air going to the cooling conveyor and to the sifter may be adjusted by the valve 68.

The process of the present invention will be specifically described with reference to liquid egg

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material since this material is one of the most difficult to process as dried powdered eggs are extremely hygroscopic and absorb moisture readily. In carrying out the process of the present invention the liquid egg material may be heated to a temperature of approximately 135° F. in the heater 17 and sprayed into the drying cone 13 through the nozzle 14. Filtered air is heated in the air heater 22 to approximately 300° F. A 4 to 4½% moisture content in the powdered eggs delivered from the process is about the minimum that can be obtained when employing drying air which has been refrigerated but not otherwise dehydrated in the cooling operation unless the drying cone is worked at very low capacity so as to reduce the moisture content of the material discharged therefrom to a very low value thus enabling an increase in moisture content during cooling to be tolerated. For example air at 80° F. and having a dew point of approximately 40° F. has the same vapor pressure as egg powder at 80° F. with a 4½% moisture content so that there is no interchange of moisture. It is relatively easy to produce a moisture content of 4½% in the material discharged from the drying cone 13 and a relatively large liquid input can be obtained. A much lower moisture content than this is however desired in powdered eggs, for example, between .5 and 2.5%. It has been attempted to obtain this low moisture content by discharging a powdered material having even a lower moisture content from the cone 13 and allowing moisture pick-up in the cooling apparatus. This means that excessive drying must take place in the cone 13, that the liquid input of the cone is very materially reduced and that the powder is discharged from the cone at high temperatures thus placing a higher cooling load on the cooling apparatus. Also hydration of the egg powder during cooling liberates substantial amounts of heat which must be removed by the cooling air. By such operation a 1.5 to 2.0% moisture content is about the best that can be obtained and this is accomplished at the expense of a very material decrease in throughput and efficiency in the operation.

By employing refrigerated air having an extremely low moisture content in the cooling apparatus of the present invention it has been found that the moisture content can actually be reduced in the apparatus enabling a higher moisture content material to be discharged from the cone 13, thus allowing the liquid input to be increased and resulting in a lower temperature discharge from the cone. For example, in producing an egg powder having a 1½% moisture content, the powder can be discharged from the cone 13 with a moisture content of approximately 3% and at a temperature of from 160° to 170° F. whereas in prior attempts it was necessary to obtain approximately a 1.2% moisture content discharge from the cone and the discharge temperature was approximately 190° to 205° F. Under the conditions of the present invention the required temperature of the spray drying cone is thus reduced by approximately 40° to 45° F. and the liquid input increased by approximately 30 to 35%.

In order to obtain a 1½% moisture content in the egg powder at 80° F. the dew point of the cooling air after absorbing moisture from the eggs must be approximately -17° F. which means that the dew point of the air originally brought into contact with the egg powder must be somewhat lower, for example, -25° F. By

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employing cooling air with the lower dew point mentioned and repeatedly bringing fresh refrigerated air into contact with the egg powder, with the air at a low temperature, for example 35° to 40° F., a cooled product containing approximately 1½% moisture at 80° F. can be obtained. In this connection, it is noted that fresh cooled air is brought into contact with the cooled powder being discharged from the cooling conveyor 32 through nozzles 41 adjacent the upper end of the conveyor housing 32 and that this air travels downwardly through the conveyor housing so as to be discharged through the filter 44. This air picks up moisture from the powdered mixture resulting in further cooling thereof but is constantly diluted with fresh air of low moisture content from the nozzles 41. However, the powder being discharged from the conveyor is brought into intimate contact with fresh cooled air of low moisture content and also after being discharged from the conveyor housing 32, the powder, separated from the heated cooled air in the conveyor housing 32, is again contacted with cool air of low moisture content in the sifter 48. That is to say the relatively cool powder in the sifter 48 is brought into contact with cool low moisture content air directed from the supply duct 38.

A table giving per cent moisture in the finished powder and the necessary dew points of the cooling air in contact with the powder at the time of discharge at various temperatures is given below.

Table

Per Cent Moisture in Finished Powder	Dew Point of Cooling Air in Contact with Finished Powder		
	Powder Cooled to 90° F.	Powder Cooled to 80° F.	Powder Cooled to 70° F.
.5	-50	-57	-65
1.0	-32	-43	-55
1.5	-9	-17	-26
2.	+5	-4	-17
2.5	+16	+8	-3
3.0	+25	+15	+6
3.5	+33	+24	+15
4.0	+43	+32	+23
4.5	+50	+41	+30

From the above table, it will be seen that for powder having a moisture content below 2.5% and discharge temperatures of 80° F. or below the cooling air supplied must have an exceedingly low moisture content. For example when producing an egg powder having a 2.5% moisture content, the eggs can be delivered into the drying cone at a temperature of 135° F. and withdrawn at approximately 150° to 160° F. The air entering the drying cone can be heated to approximately 300° F. and withdrawn at 160 to 170° F. The humidified air can be introduced into the drying conveyor at a temperature of approximately 40° F. while having a dew point of approximately -10° F. The egg powder discharged from the drying cone and introduced into the drying conveyor can have a moisture content of approximately 4%. Approximately 1.5% moisture can be removed from the egg powder during cooling, this removal of moisture also assisting in cooling.

To obtain a .5% moisture content in the discharged powder it is necessary to supply a greater amount of cooling air which has a still lower moisture content. That is to say the cooling air

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in contact with the egg powder at 80° F. must have a dew point of at least -57° F. which means that the dew point of the air before it absorbs moisture from the powder must be somewhat lower than this, for example -65 to -70° F. depending upon the amount of moisture which must be removed from the powder and the volume of air employed. Also when producing an egg powder having a .5% moisture content the throughput through the entire apparatus will ordinarily be decreased over that when a 1½% moisture content is being produced so that the egg powder enters the cooling apparatus at a moisture content somewhat less than 3%, for example, 1.5 to 2% but at a higher temperature, for example, 180 to 190° F. In any case a substantial amount of moisture is withdrawn from the powder during the cooling operation by repeatedly bringing the powder into intimate contact with cool air having an extremely low moisture content.

While the invention is particularly adapted for the drying of egg material, such as whole eggs, egg whites or egg yolks, it is also applicable to the drying of whole and skim milk, soup stocks and other materials having hygroscopic properties and which can be handled in the same type of conveyor equipment.

Obviously, many modifications and variations of the invention hereinbefore specifically described may be made without departing from the scope and spirit thereof and, therefore, only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. An apparatus for cooling heated powdered material comprising an elongated screw conveyor, an elongated housing surrounding said conveyor and providing a chamber thereabove, means for feeding said material to said conveyor, an exhaust duct mounted above said housing for a substantial portion of the length thereof and providing a second chamber elongated in a vertical direction in direct communication with said first-mentioned chamber, an air inlet duct mounted above and to one side of said housing, a plurality of nozzles spaced along the length of said inlet duct and projecting downwardly into said first-mentioned chamber, means including a blower, a dehydrator and a cooler connected to said inlet duct for supplying a cooling gas having a low moisture content to said inlet duct and to said nozzles, said nozzles being so arranged as to direct blasts of said gas against said material being conveyed by said conveyor so as to blow mists of at least a portion of said powdered material into said first-mentioned and second-mentioned chambers to produce an intimate mixture of said gas and said powdered material whereby said material is cooled and dehydrated, and means for discharging said cooled material from said housing.

2. An apparatus for cooling heated powdered material comprising an elongated screw conveyor, an elongated housing surrounding said conveyor and providing a chamber thereabove, means for feeding said material to said conveyor, an exhaust duct mounted above said housing for a substantial portion of the length thereof and providing a second chamber elongated in a vertical direction in direct communication with said first-mentioned chamber, an air inlet duct mounted above and to one side of said housing, a plurality of nozzles spaced along the length of

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said inlet duct and projecting downwardly into said first-mentioned chamber, means including a blower, a dehydrator and a cooler connected to said inlet duct for supplying a cooling gas having a low moisture content to said inlet duct and to said nozzles, said nozzles being so arranged as to direct blasts of said gas against said material being conveyed by said conveyor so as to blow mists of at least a portion of said powdered material into said first-mentioned and second-mentioned chambers to produce an intimate mixture of said gas and said powdered material whereby said material is cooled and dehydrated, a discharge duct mounted above and on the opposite side of said housing from said inlet duct, a filter mounted adjacent to said discharge duct and forming one wall of said second-mentioned chamber to separate said cooled material from said gas, and means for discharging said cooled material from said housing.

3. An apparatus for cooling heated powdered material comprising an elongated screw conveyor, an elongated housing surrounding said conveyor and providing a chamber thereabove, means for feeding said material to said conveyor, an exhaust duct mounted above said housing for a substantial portion of the length thereof and providing a second chamber elongated in a vertical direction in direct communication with said first-mentioned chamber, an air inlet duct mounted above and to one side of said housing, a plurality of nozzles spaced along the length of said inlet duct and projecting downwardly into said first-mentioned chamber, means including a blower, a dehydrator and a cooler connected to said inlet duct for supplying a cooling gas having a low moisture content to said inlet duct and to said nozzles, said nozzles being so arranged as to direct blasts of said gas against said material being conveyed by said conveyor so as to blow mists of at least a portion of said powdered material into said first-mentioned and second-mentioned chambers to produce an intimate mixture of said gas and said powdered material whereby said material is cooled and dehydrated, a discharge duct mounted above and on the opposite side of said housing from said inlet duct, a filter mounted adjacent to said discharge duct and forming one wall of said second-mentioned chamber to separate said cooled material from said gas, means for discharging said cooled material from said housing, an enclosed sifter for receiving said cooled material from said housing, and means including a conduit connected to said inlet duct for supplying an additional amount of said gas into said sifter to contact said material in said sifter for further cooling and drying said powdered material.

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