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COMBINATION DRYER AND COOLER

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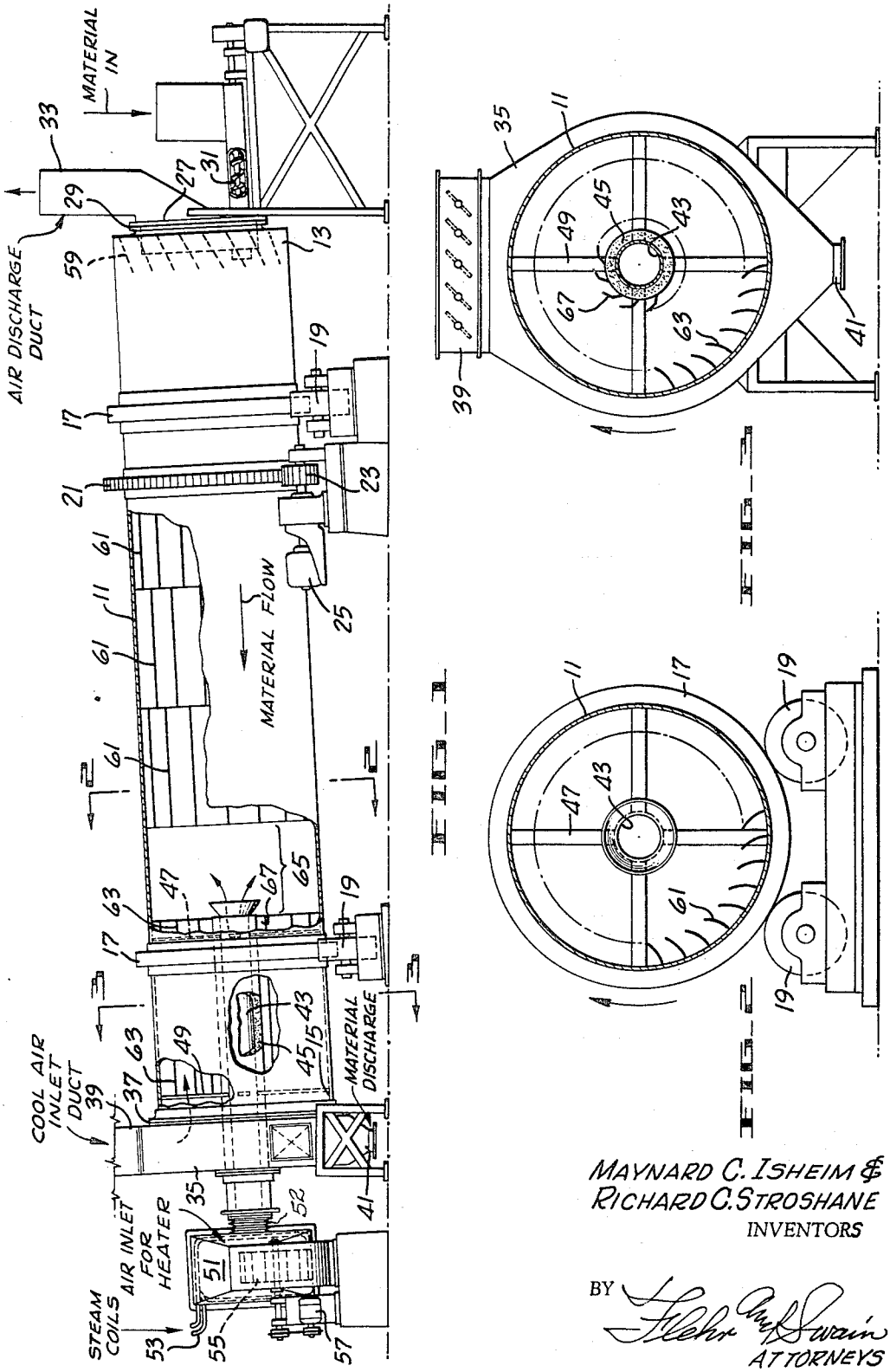


FIG. 3

FIG. 1

FIG. 2

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COMBINATION DRYER AND COOLER

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6 Claims. (Cl. 263—33)

This is a continuation of application Ser. No. 287,631, filed June 13, 1963, and now abandoned.

This invention relates to dryers and coolers and more particularly to a combination dryer and cooler for use with granulated or powdered materials such as sugar, fertilizer, plastics, heat sensitive chemicals and the like.

While the uses to which the combination dryer and cooler, in accordance with the invention, may be employed are diverse as set forth above, this invention will be described in connection with such a dryer and cooler for use in the sugar industry.

At the present time in the manufacture of granulated sugar, moist sugar crystals are first dried until they have a moisture content of from about .025 to .05% moisture. Subsequent to the drying step, which is accomplished by the application of heat, the warm sugar may be packaged for shipment. However, packaging of such warm sugar, especially in bulk, present a consequent problem of caking whereby the sugar crystals agglomerate to form relatively large lumps.

In view of the caking problem many refineries have made it their practice to cool the sugar once it has been dired, such that the packaged sugar is not subject to agglomeration. Ordinarily the drying and cooling steps have been accomplished by two individual units, the dryer unit ordinarily being a rotating drum through which the sugar flows in one direction, while heated air or other gas flows in the opposite. The dried sugar is then conveyed to a cooler which is a device similar to the drier but in which cooled air or gas is passed through the sugar.

Recognizing the inefficiencies of such a system, there have been proposals to combine the dryer and cooler in a single rotary device which includes a partition separating the cooling from the drying section. Heated air is circulated through the drying section and cooled air circulated throguh the cooling section. The partition separating the two sections requires a relatively elaborate baffle to permit the sugar to pass from the drying section to the cooling section while at the same time preventing the passage of air. In such combination systems it is obvious that not only is there the added cost of the material passing and air separating partition but also there is the obvious lack of economy in the loss of sensible heat, from the dried sugar, which is swept away by the cooling air.

In addition to the above disadvantages of both the two unit dryer and cooler and the single unit dryer and cooler, is the problem that the rotary units must be breached more than twice. In the two unit system, each end of both units must be breached to permit the entrance and passage of air and material handled. In the combination units of the prior art, the rotating drum must be breached somewhere intermediate the ends to provide means to withdraw the cooling and/or drying air.

In view of the above it is a general object of this invention to provide an improved combination dryer and cooler.

It is a more particular object of this invention to provide a combination dryer and cooler wherein no partition is required to separate the heating and cooling gases.

It is another object of this invention to provide a combination dryer and cooler having the aforementioned characteristics and which employs the sensible heat in the dried sugar to provide part of the heat of vaporization required to evaporate moisture from the still damp sugar.

It is still another object of this invention to provide a combination dryer and cooler of the above mentioned character wherein a single rotary cylinder is employed and further wherein the rotary cylinder need be breached only at the ends thereof, such that connection of stationary air flow ducts may be made with a minimum of expense.

The above and other objects and features of the invention will become more clearly apparent upon a review of the following description in conjunction with the accompanying drawing, in which:

FIGURE 1 is an overall elevational view partly broken away and showing the combination cooler and dryer in accordance with the invention;

FIGURE 2 is a sectional view taken along the lines 2—2 of FIGURE 1; and

FIGURE 3 is a sectional view taken along the lines 3—3 of FIGURE 1.

Referring to the drawing, in which like parts are identified by like reference numerals throughout, there is shown a generally cylindrically shaped shell **11**, arranged for rotation about its axis. The material inlet end **13** of the shell **11** is raised slightly higher than the discharge end **15** whereby gravity feed of the material to be dried and cooled is permitted. A pair of riding rings **17** are secured about the shell and are each disposed to ride on associated trunnion rolls **19**. A girt gear **21** is likewise fixed on the shell **11** and is disposed to cooperate with a drive pinion **23** connected to the shaft of a motor **25**, or similar prime mover device.

A stationary inlet head **27** is connected to the inlet end **13** of the shell by means of a conventional breaching seal **29**. The inlet head **27** receives a screw feeder **31** by which the material to be dried and cooled is fed into the interior of the shell **11**. The head **27** also receives a discharge duct **33** through which the air, having passed through the shell **11**, is discharged to the atmosphere or alternatively, to a drop out chamber to collect particles of the dried material which may have been caught by the air stream.

At the discharge end **15** of the shell **11** is disposed a stationary discharge breaching **35** connected to the rotary shell **11** by means of a conventional seal **37**. The breaching **35** includes a cooling air inlet **39** and a cooled material discharge chute **41**. The discharge chute **41** may be fitted with conventional seals (not shown) to prevent passage of air from the atmosphere to the inside of the shell **11**.

Within the shell **11** there is included a hot gas inlet duct **43** covered by heat insulating material **45**. The duct **43** is connected to the shell **11** by means of spiders **47** and **49** for rotation with the shell. The duct extends through the breaching **35** and is connected to a stationary hot air plenum and duct **51** by means of a conventional spring loaded slip ring seal **52**. Air in the plenum and duct **51** is heated by means of steam coils **53** and a blower **55** is activated by motor **57** merely to overcome the air flow resistance of the plenum and steam coils. Air movement through the shell **11** is caused by applying a negative pressure to the discharge duct **33** by means of the exhaust fan (not shown).

The interior of the shell is provided with a plurality of spiral flights **59** to urge the material from the screw feeder quickly into the main body of the shell **11** and to prevent any pile up of the material directly in front of the feeder **31**. A plurality of lifting flights **61** are disposed through the main portion of the shell **11** between the outlet of the hot gas inlet duct **45** and the inlet end **13**. These flights serve to tumble and cascade or shower the material to be dried for adequate exposure to the hot air passing therethrough.

Additional lifting flights **63** are connected to the shell **11** in the vicinity of the hot gas duct **43** and perform the same function as the flight **61**. A gap **65** exists between

flights **61** and **63** to provide reduced turbulence of the material to be dried and cooled in that area of the shell **11** from which the hot gas is exhausted from the duct **43**. Flights **67** (FIGURE 3) are disposed about the duct **43** and insulation **45** to provide further turbulence of the material to be cooled.

In the operation of the combination dryer-cooler as shown in the drawing, material to be dried and cooled is fed into the rotating shell **11** by means of the screw feeder **31**. The material is then quickly urged towards the center of the shell **11** by means of the spiral flights **59** and continues to travel down the shell **11** by means of gravity. Flights **61** continue to lift, drop and tumble the material to be dried whereby uniform exposure of the individual granules to the air is provided. Upon reaching the area of the gap **65** cascading action ceases and the material tends to slide along the bottom of the shell **11** until it reaches the flights **63** and **67** wherein cascading action is resumed. This cascading continues until the material reaches the discharge end **15** of the shell **11** at which time it passes through the discharge chute **41**.

Assuming the material applied through the screw feeder **31** is relatively damp, heated air or other gas is required to supply the necessary heat of evaporation for drying. For this purpose, air at an elevated temperature, is drawn from the duct and plenum **51**, through the duct **43**. The air flow is provided by means of the negative pressure produced at the discharge duct **33** by means of an exhaust blower (not shown).

The hot gas in the duct **43** therefore, passes through the cascading granular material to evaporate the moisture therein. In order to cool the warm material, cooling air is drawn into the shell **11** through the inlet duct **39** and the breaching **35**. The cooling air may be at reduced temperatures such for example, as 50 to 80° F. As the cooling air passes through the cascading material in the area of the flights **63** and **67**, the air picks up the sensible heat of the material being cooled. Consequently, as the cooling air reaches the area of the gap **65** its temperature is substantially increased and it as well as the air from the duct **43**, supplies the heat of evaporation for use in drying the material. Thus, the area of the shell **11** corresponding to the flights **61** may be designated the drying section and the area of the shell **11** corresponding to the flights **63** and **67** may be considered the cooling section.

It is seen that an improved combination dryer-cooler has been provided. In the apparatus as set forth in the invention it is apparent that heated air from the cooling section combines with externally preheated air from the hot air duct as it enters into the drying section and that no special partitions are required to prevent air flow from one section to the other.

We claim:

1. In a combination dryer-cooler wherein substantially complete drying and cooling operations take place within a single rotary unit, a substantially cylindrical shell having a material inlet end for receiving material to be dried and cooled within the shell and a material discharge end for discharging material that has passed through the shell, means mounting said shell for rotation about its longitudinal axis such that material deposited into said inlet end is advanced longitudinally through said shell towards said material discharge end, an outlet gas duct mounted adjacent the material inlet end of said shell for permitting gases to be discharged from said shell, a drying gas duct extending through the material discharge end of said shell and a substantial distance into the interior thereof, said drying gas duct defining a region for the injection of drying gas into said shell, and together with said outlet gas duct, defining a drying section therebetween and inside of the shell so that when injected, said drying gas moves through said drying section to the outlet gas duct, a cooling gas duct mounted adjacent the material discharge end of said shell for introducing a cooling gas directly into the shell, said cooling gas duct together with said drying gas duct defining a cooling section therebetween and inside of the shell so that when introduced, said cooling gas moves through said cooling section end to said region for the injection of drying gas, said cooling gas mixing with the dried heated material throughout said cooling section to cool the same and to receive sensible heat therefrom prior to passage of said heated cooling gas into the drying section, said heated cooling gas then intermixing with the drying gas at said region for the injection of drying gas to proceed with the drying gas through said drying region and to mix with the material to heat and dry the same.

2. A dryer-cooler as in claim **1** further including means disposed within said cooling section of said shell for lifting and cascading the material passing therethrough.

3. A dryer-cooler as in claim **2** further including means disposed within said drying section of said shell for lifting and cascading the material passing therethrough, said last named means being spaced from like means within said cooling section.

4. A dryer-cooler as in claim **1** further including means for supplying a heated drying gas to said drying gas duct.

5. A dryer-cooler as in claim **1** in which said cooling duct means is mounted to said shell in gas tight relation therewith, and further including means supplying a cooling gas directly to said cooling duct means.

6. In a combination dryer-cooler wherein the drying and cooling operations take place within the same unit, substantially cylindrical shell means having an inlet end to receive moist material to be processed and a discharge end for discharging dried cooled material, means mounting said shell means for rotation about its axis whereby the inlet end is higher than the discharge end, said shell means being formed to provide a drying section within the shell adjacent the inlet end and a cooling section adjacent the discharge end, means at the inlet end of said shell, means for introducing material to be dried and cooled to the interior of said drying section, and means at the discharge end of said shell means for discharging dried cooled material from the interior of said cooling section, duct means mounted within the shell and extending through said discharge end of the shell and through said cooling section to a point of discharge within said shell means, means for supplying heated drying gases to said duct means and thereby to said drying section, said drying section extending from said point of discharge of the heated drying gases to the inlet end of said shell means, cooling duct means mounted in gas-tight relation adjacent the discharge end of said shell means, and means to supply a cooling gas to said cooling duct means and thereby to said cooling section, said cooling section extending from the discharge end of said shell means to said point of discharge of the heated drying gases whereby the cooling gases passing through said cooling section extract heat from the dry heated material passing through the cooling section while at the same time being heated by said material, said heated cooling gases thereafter mixing with said drying gases, and discharge duct means in gas-tight relation adjacent the inlet end of said shell means for discharge of said intermixed gases.

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