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METHOD FOR DRYING AMMONIUM NITRATE AND LIKE MATERIALS

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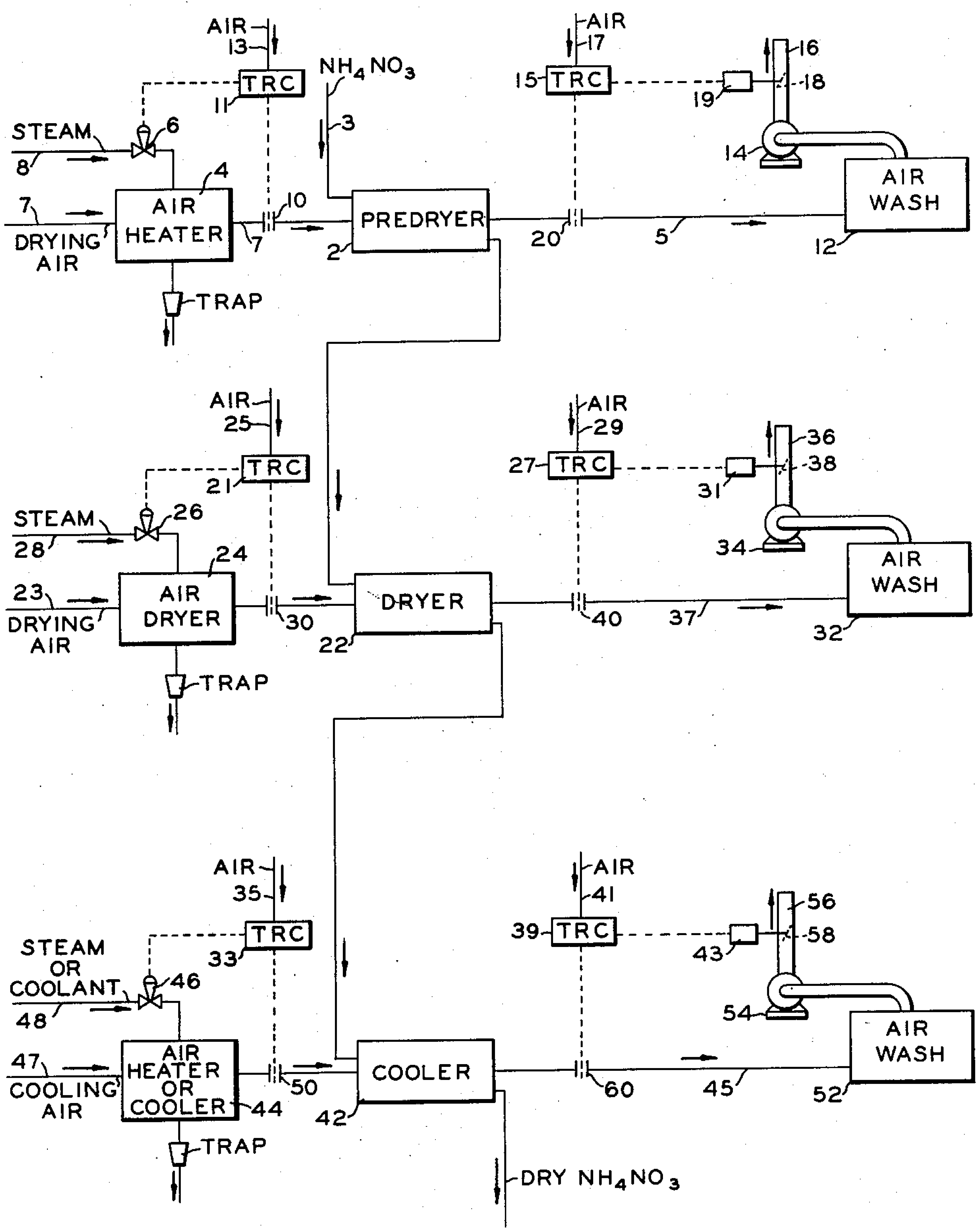

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METHOD FOR DRYING AMMONIUM NITRATE AND LIKE MATERIALS

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1 Claim. (Cl. 34—13)

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This invention relates to the automatic controlling of the drying temperature and drying rate of material. In one of its preferred embodiments my invention relates to the automatic controlling of the drying temperature and drying rate of ammonium nitrate.

In the preparation of various materials, the desired product often contains water which must be removed before the product is marketed. The removal of water from some materials, for example ammonium nitrate, is particularly desirable since such materials cake or ball when stored with the water contained in them. Thus a drying process is a necessary operation in the preparation of such materials.

For economical reasons, it is desirable to carry out such a drying process at the maximum possible rate and temperature. However, if the drying process for such materials is carried out at too high a temperature or too fast, the material may be changed to an undesirable form or composition. Thus in a drying process of the type mentioned the object is to dry the material as rapidly as possible without undesirably altering its form or composition.

In order to accomplish this objective, the drying temperature and drying rate must be very closely controlled. In the past, such control has been attempted by utilizing manual methods of control in the drying process. Of course such a procedure has been unsatisfactory due to overcorrecting and lag in applying corrections in an attempt to accomplish the degree of control necessary. Such overcorrections and lag in applying corrections cause an undesirable slowing of the drying process or an undesirable change in the product or both.

In the preparation of solid ammonium nitrate, the product exists as granule ammonium nitrate containing water. For the reasons previously mentioned this water must be removed by subjecting the ammonium nitrate to a drying process. It is desirable to retain this granule form and yet carry out the drying process as rapidly as possible. If the process is carried out at too high a temperature or too fast, the granules split and undesirable fine particles result.

By the practice of my invention, the drying temperature and drying rate of material are closely and automatically controlled by automatically controlling the temperature of the drying agent both before and after contact of said drying agent with the material being dried, thereby permitting the drying process to be carried out at the maximum rate without undesirably changing the form or composition of the material being dried.

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An object of my invention is to control closely the drying temperature and drying rate of material, for example, ammonium nitrate.

Another object is to provide a simple, economic and dependable method of closely and automatically controlling the drying temperature and drying rate of material, for example, ammonium nitrate.

Another object is to provide the close control necessary in a drying process to carry the process out at the maximum speed without undesirably altering the material being dried.

Still another object of my invention is to automatically control the temperature of the drying agent before and after contact with the material being dried.

From the discussion and disclosure herein made, other objects will be apparent to one skilled in the art.

According to my invention, the temperature of a fluid drying agent is automatically controlled, by suitable means, before and after contact with the material being dried, thereby closely and automatically controlling the temperature and rate of drying. By practicing my invention in the drying process of material, for example ammonium nitrate, the drying process may be carried out at the maximum rate possible without undesirably altering the material being dried.

One preferred embodiment of my invention is indicated in the attached drawing which is a flow sheet of a drying process illustrating a practice of my invention as applied to ammonium nitrate as the material being dried and air as the drying agent. The individual apparatus and control instruments are well known in operation and design. From the following discussion and disclosure, it will be clear to one skilled in the art that the practice of my invention is not necessarily limited to the exact type and location of the control instruments shown nor to the materials and conditions of operation utilized for purpose of illustration.

In the figure, the ammonium nitrate or other material to be dried is fed by conveyor belt 3 into inclined rotating predryer 2, the drying air being fed into predryer 2 by entering drying air line 7 through air heater 4. The air is heated to the desired initial temperature by air heater 4 and maintained at that temperature by temperature recorder controller 11. The temperature controller 11 has a bulb or other temperature measuring device 10 located in drying air line 7 between air heater 4 and predryer 2 and operating diaphragm valve 6 in steam line 8 by the air furnished by instrument air supply line 13 in known manner. The drying air is drawn from predryer 2 through exit drying air line 5 and passed through air washer 12 by exhaust fan 14 and vented into the atmosphere through vent 16. The rate of flow of the drying air through predryer 2 is controlled in accordance with my invention by temperature recorder controller 15. The temperature recorder controller 15 has a bulb or other temperature measuring device 20 in exit drying air line 5 between predryer 2 and air washer 12 and operating damper 18 located in vent 16 through diaphragm motor 19 by air furnished by instrument air supply line 17.

The predried ammonium nitrate from predryer 2 is then gravity fed into inclined rotating dryer 22. The drying air is fed into dryer 22 by entering drying air line 23 through air heater 24. The drying air is maintained at the selected initial temperature by temperature recorder controller 21, the temperature controller having a bulb or other temperature measuring device 30 in drying air line 23 between air heater 24 and dryer 22. Temperature controller 21 operates diaphragm valve 26 in steam line 28 by the air furnished by instrument air supply line 25. The drying air is drawn from dryer 22 in exit drying air line 37 through air washer 32 by exhaust fan 34 and vented into the atmosphere through vent 36. The rate of flow of drying air through dryer 22 is controlled by temperature recorder controller 27, which has a bulb or other temperature measuring device 40 in exit drying air line 37 between dryer 22 and air washer 32. Temperature controller 27 operates damper 38 in vent 36 through diaphragm motor 31 by air furnished by instrument air supply line 29.

The dried ammonium nitrate from dryer 22 is gravity fed into inclined rotating cooler 42. The cooling air is fed into cooler 42 by entering cooling air line 47 through air heater 44. It is understood that in certain cases the temperature of the air may be such that the air must be cooled instead of heated before being passed to cooler 42. In such a case, 44 becomes an air cooler 44 and steam line 48 becomes coolant line 48. The cooling air is maintained at the selected initial temperature by temperature recorder controller 33 operating diaphragm valve 46 in steam line 48 by air supplied by instrument air supply line 35. The bulb or temperature measuring device 50 for temperature recorder controller 33 is located in cooling air line 47 between air heater 44 and cooler 42. The exit cooling air is drawn from cooler 42 in exit cooling air line 45 by exhaust fan 54 through air washer 52 and vented into the atmosphere through vent 56. The rate of flow of cooling air through cooler 42 is controlled by temperature recorder controller 39 by operating damper 58 through diaphragm motor 43 by air furnished by instrument air supply line 41. The bulb or other temperature measuring device 60 for temperature recorder controller 39 is located in exit cooling air line 45 between cooler 42 and air washer 52.

In the practice of my invention, using as an example ammonium nitrate as the material to be dried and air as the drying agent, and referring to the attached drawing, if the entering drying air in line 7, as measured by bulb 10, falls below a selected initial temperature, the air pressure exerted on diaphragm valve 6 through instrument air supply line 13 is changed by temperature recorder controller 11. The

change of pressure opens further the valve in steam line 8 allowing more steam to pass through air heater 4 thereby returning the temperature of the entering drying air to the selected value. If the temperature of the entering drying air rises above the selected value, the air pressure from instrument air supply line 13 to diaphragm valve 6 is changed by temperature recorder controller 11 such that diaphragm valve 6 reduces the flow of steam in steam line 8 to air heater 4, thereby allowing the temperature of the entering air to return to the selected value. Thus the drying temperature of the ammonium nitrate is automatically controlled.

If the drying air temperature leaving predryer 2 through exit drying air line 5 falls below a selected value, as measured by bulb 20, indicating too slow a drying rate, the air pressure exerted on diaphragm motor 19 through instrument air supply line 17 is changed by temperature recorder controller 15. The change in pressure on diaphragm motor 19 moves damper 18 toward an open position in vent 16 allowing the rate of flow of air through predryer 2 to increase thus increasing the rate of drying in predryer 2. As the rate of flow of air increases, the rate of drying increases and the temperature of the exit drying air rises to the selected value. If the temperature of the exit air rises above the selected value indicating too fast a drying rate, the air pressure from instrument air supply line 17 to diaphragm motor 19 is changed by temperature recorder controller 15 such that diaphragm motor 19 moves damper 18 toward a closed position. The closing of damper 18 reduces the rate of flow of air through predryer 2 thereby decreasing the drying rate. As the rate of flow of air through predryer 2 decreases, the rate of drying decreases and the temperature of the exit drying air falls to the selected value.

If the air leaving cooler 42 through exit line 45, as measured by bulb 60, falls below the selected value indicating insufficient cooling, the air pressure exerted on diaphragm motor 43 through instrument air supply line 41 is changed by temperature recorder controller 39. The change in pressure on diaphragm motor 43 turns damper 58 toward a closed position in vent 56 thus decreasing the flow of air through cooler 42. Decreasing the flow of air through cooler 42 increases the extent of cooling and returns the temperature to the selected value. If the exit air temperature rises above the selected value, indicating excess cooling, the air pressure from instrument air supply line 41 to diaphragm motor 43 is changed by temperature recorder controller 39 such that diaphragm motor 43 moves damper 58 in vent 56 toward an open position thus increasing the flow of air through cooler 42. Increasing the flow of air through cooler 42 decreases the extent of cooling and returns the temperature to the selected value.

Although my invention is primarily directed at controlling the rate and temperature of drying, it will be apparent to one skilled in the art, after reading the disclosure of my invention herein made, that the practice of my invention is equally advantageous in a cooling process as is indicated in the example and disclosures herein given. Thus although the language of the disclosure and claims herein made speaks primarily in terms of controlling drying temperatures and rates, I intend that the disclosure and claims of my invention include cooling operations as well as drying operations that may occur in a drying process.

As the temperature and rate of drying must be closely controlled in each stage of the drying of ammonium nitrate, my invention can be advantageously practiced in any or all of the various ammonium nitrate drying stages.

Example

In a preferred embodiment of my invention, ammonium nitrate was dried by air in three stages.

Referring to the figure, 26,000 pounds per hour of granule ammonium nitrate from a prilling tower were continuously fed into predryer **2** by conveyor belt **3**. The feed ammonium nitrate was at a temperature of 75° C. and contained 4 weight per cent water. The predried ammonium nitrate leaving predryer **2** was at a temperature of 65° C. and contained 2.75 per cent water. The drying air entering predryer **2** was kept at 75° C. by temperature recorder controller **11**. The drying air left predryer **2** at an average rate of 22,000 cubic feet per minute and contained 3.8 per cent water. The temperature of the exit drying air was kept at 65° C. by temperature recorder controller **15**.

The predried ammonium nitrate at 65° C. containing 2.75 per cent water was gravity fed into dryer **22**. The dried ammonium nitrate left the dryer at 80° C. and contained 0.5 per cent water and was gravity fed into cooler **42**. The drying air entering dryer **22** was kept at 145° C. by temperature recorder controller **21**. The drying air left the dryer at an average rate of 11,000 cubic feet per minute and contained 5.7 per cent water. The temperature of the exit drying air from dryer **22** was kept at 75° C. by temperature recorder controller **27**.

The dried ammonium nitrate entered cooler **42** at 80° C. and 0.5 per cent water content and left the cooler at a rate of 25,000 pounds per hour at 38° C. and contained 0.3 per cent water. The cooled ammonium nitrate was further treated to prevent absorbing of moisture. The air entering cooler **42** was kept at 21° C. by temperature recorder controller **33**. The air left cooler **42** at an average rate of 27,400 cubic feet per minute and contained 2.9 per cent water. The temperature of the exit air was kept at 37° C. by temperature recorder controller **39**.

The foregoing example was directed to ammonium nitrate as the material being dried and air as the drying agent, however other materials such as corn germ, clay, potassium nitrate, cereals, coal, etc. can be dried by the process and apparatus of my invention and also drying agents other than air such as combustion gases resulting from burning gas, oil, coal etc., are suitable for the practice of my invention.

Since various details of construction, locations of instruments, types of instruments utilized for measurements and control, materials to be

dried, and drying agents may be utilized in the practice of my invention, I do not desire to be limited to the single embodiment and illustrations as herein disclosed.

I claim:

As a method for drying granule ammonium nitrate containing water a three stage process which comprises a predrying stage, a drying stage and a cooling stage, with the temperature of drying air in each stage being automatically controlled before contact with said granule ammonium nitrate, and with the rate of flow of said drying air past said granule ammonium nitrate being regulated automatically in each stage by controlling the temperature of said drying air after contact with said granule ammonium nitrate automatically in response to and to compensate for any variation, and wherein the temperature of said drying air before contact with said granule ammonium nitrate is maintained at 75° C. in said predrying stage, 145° C. in said drying stage, and 21° C. in said cooling stage, and wherein the temperature of said drying air after contact with said granule ammonium nitrate is maintained at 65° C. in said predrying stage, 75° C. in said drying stage, and 37° C. in said cooling stage, and wherein said granule ammonium nitrate is introduced into said predrying stage at a temperature of 75° C. and containing 3.5 to 4.5 weight per cent water, and wherein said granule ammonium nitrate is withdrawn from said predrying stage and introduced into said drying stage at a temperature of 65° C. and containing substantially 2.75 weight per cent water, and wherein said granule ammonium nitrate is withdrawn from said drying stage and introduced into said cooling stage at a temperature of 80° C. and containing substantially 0.5 weight per cent water, and wherein said granule ammonium nitrate is withdrawn from said cooling stage at a temperature of 38° C. and containing substantially 0.3 weight per cent water.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
545,120	Cummer	Aug. 27, 1895
748,525	Perry et al.	Dec. 29, 1903
1,312,759	Stacey, Jr.	Aug. 12, 1919
1,676,786	Lissauer	July 10, 1928
1,729,424	Harshow et al.	Sept. 24, 1929
1,750,813	Oakley et al.	Mar. 18, 1930
2,402,192	Williams et al.	June 18, 1946
2,525,535	Erisman et al.	Oct. 10, 1950

OTHER REFERENCES

Serial No. 405,274, Van Aken, (A. P. C.), published May 4, 1943.

The Link-Belt Roto-Louvre Dryer. Book No. 1911, The Link-Belt Company, Chicago, Illinois; pages 5, 7, 15, 18 and 19 relied on.