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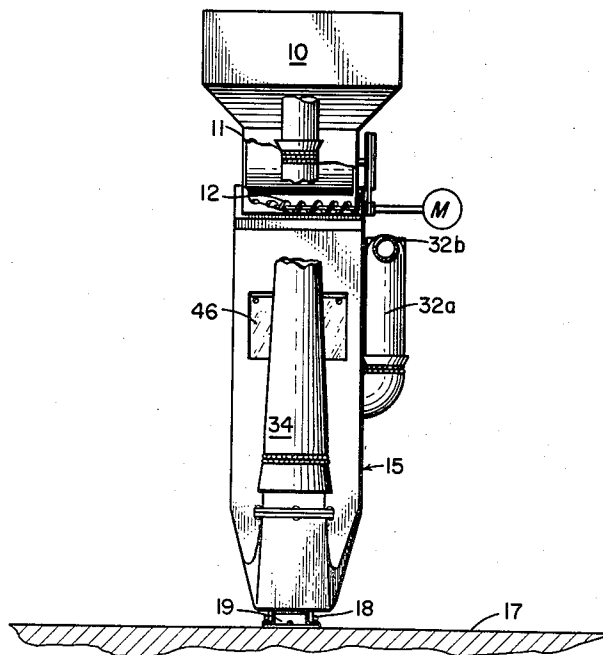
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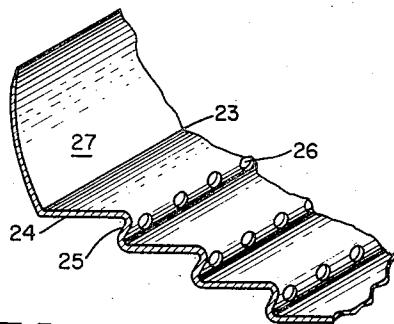
APPARATUS FOR DRYING OR HEATING GRANULAR MATERIAL

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**Fig. 2**



**Fig. 3**

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## APPARATUS FOR DRYING OR HEATING GRANULAR MATERIAL

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6 Claims. (Cl. 34-57)

This invention relates to apparatus for processing granular materials and more particularly to apparatus for drying granular and/or heating material such as ammonium perchlorate and the like, which form a highly explosive dust if mixed with dusty air carrying particles of organic material and comes in contact with an open flame or electric sparks.

Various types of apparatus are in use for drying such materials, which are sometimes highly explosive during the drying operation, but have not been entirely satisfactory for various reasons, some of which are that the known dryers comprise moving parts, thus causing the disadvantage of producing a certain proportion of small size particles and necessitating the provision of seals to contain such fine particles in the system while permitting driving of the moving parts.

An object of the present invention is to provide a maximum mixing of the drying or heating medium with the granular material without the use of any moving parts in the drying or heating chamber, thus avoiding any mechanical breakdown of particle size.

A further object of the invention is to provide a drying apparatus of the kind described in which the working medium is drawn through all parts of the apparatus under suction, thus avoiding any risk of fine particles of granular material leaking out of the apparatus and avoiding the necessity for the provision of rotary seals.

A further object of the invention is to provide a drying and/or heating apparatus for the purpose described which is relatively inexpensive to fabricate and maintain, and yet will produce a satisfactory end product.

With these and other objects in view, the invention comprises an elongated drying or heating chamber having a downwardly sloping floor of stairlike form, heated air or other drying medium flowing through openings in the risers of the steps of the stair being effective to both dry and carry away the particles of the granular material to collecting means.

Further features and objects of the invention will hereinafter appear from the following specification read with reference to the accompanying illustrative drawings.

In the drawings:

Fig. 1 is a side elevation of the apparatus incorporating the drying and/or heating chamber which is a particular feature of the invention and which is shown in section;

Fig. 2 is a fragmentary front elevation of the apparatus looking in the direction of arrow 2 in Fig. 1;

Fig. 3 is a fragmentary projection drawn on a larger scale of the stairlike partition forming the floor of the drying and/or heating chamber.

Referring now to Fig. 1, the numeral 10 indicates a hopper into which damp granular material is delivered by any suitable means. Since the material may contain lumps, a lump breaker is indicated at 11, the material is then passed through feed-screw 12 which is provided to spread the material, and a length of conduit 13 to the inlet port 14, where it is delivered to a floor 23 located within the chamber indicated at 15.

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The chamber is preferably provided with lagging 16 and is mounted on a floor or other surface 17. In the embodiment shown, the chamber 15 is of wedge shape, for a reason later explained, and is preferably adjustably mounted on a pivot 18 supported by bracket 19, and a suitable raising and lowering means is indicated at 20. A scale 21 mounted on the floor 17 and a pointer 22 mounted on the casing and moving over the scale enables any required adjustment in inclination of the drying chamber to be noted. Of course, if the inclination of the floor most suitable to the operation has been previously determined the adjustments shown for varying the inclination of the chamber may be dispensed with.

As shown in Fig. 1, but referring more particularly to Fig. 3, the floor of the chamber generally indicated at 23 is of washboard or stairlike form comprising a plurality of treads 24 connected by risers 25. As clearly shown in Fig. 3, the risers are perforated across their length in any preferred pattern of openings for instance as indicated at 26 and a top riser or deflector 27 is arranged to abut a preferably arcuate end wall 28 of the casing extending from the bottom wall 29 of the casing to the top wall 30, which slopes downwardly to the lower end of the casing at which point an outlet port 31 is provided. Heater and blower 32 draws air from means, which is later described, and delivers the heated air through conduit 32a to the space 33 below the stepped partition 23 and through conduit 32b to above the inlet port 14 in a direction to aid the flow of material downwardly therethrough, thus maintaining uniformly high temperature of the air throughout the chamber 15, so that the material receives maximum heating in its passage over the partition or floor 23.

The heated air flows through the perforated risers of the partition, and because of the narrow outlet port 31, attains sufficient velocity to carry the particles of the dried material upwardly through a length of flexible conduit 34, to suitable collecting means illustrated as a cyclone separator 37. The dried and heated particles are carried into the cyclone separator and are collected in a suitable receptacle 38 for delivery from the apparatus. The greater part of the drying medium from the separators 37 is routed back to the blower 32 through conduit 39 while a small portion is delivered through conduit 40 to eject fines passing from the separator from the system. A means for collecting these fines is shown diagrammatically as a screen 42.

A small make-up blower 41 supplies air to the main air heater and blower 32 to replace air passing out of the system through conduit 40.

The inclination of the floor 23 may be fixed, but it is preferably made independently adjustable in the chamber, in addition to, or in substitution for, means adjusting the inclination of the chamber, by mounting the lower end of the floor unit on a pivot 43 and supporting the upper end by machine screws 44 passing through one or other of a series of holes drilled in the walls of the casing of the drying chamber, the holes not occupied by the machine screws supporting the drying floor being closed by similar machine screws 45. An access door 46 is provided to enable the machine operator to make the simple adjustment required, the deflector 27 remaining in contact with the curved end wall 28 whatever the position of the drying floor. It will be obvious that transparent observation panels may be fitted wherever it is desirable to note the functioning of the apparatus, for instance the access door 46 may be transparent to enable the feeding of material to the upper end of the drying floor to be observed. Another observation window may be located at the outlet end 31 of the drying chamber to enable the observer to check the complete drying of the material.

## Operation

The apparatus is first put into operation by starting the blower 32 and separator 37 which will heat the air or other drying and heating medium and bring the apparatus to the desired temperature and establish the necessary flow of air under suction therethrough. Damp or cold granular material is delivered into hopper 10 and evenly distributed by the feed screw 12 across the top treads of the stairlike drying floor 23. Air from the space 33 below the partition will flow through the perforated riser portions of each of the steps of the drying floor thus mixing with the material falling freely across the orifices, insuring that any dried, and therefore lighter particles are carried out of the body of the material, while the still damp and heavier particles are moved across the tread portion of the successive steps by the flow of air. The shape of the chamber combined with the suction produced by the cyclone separator 37 will cause the air to flow at increasing speed toward the outlet port 31 and insures that the dried or heated particles are carried out of the chamber without the necessity for any mechanical parts to affect the delivery of the dried particles to the separating means.

While specific embodiments of drying or heating apparatus constructed according to the invention have been described and illustrated, it is to be understood that these embodiments are given by way of illustration only and are not limitative of the invention, the scope of which is defined by the appended claims.

## I claim:

1. A drying and heating apparatus for granular material, comprising: an elongated drying chamber having an upper wall and a lower wall and an inlet opening at one end of the chamber, and an outlet opening in the opposite end at a lower level than the inlet opening; a partition arranged in said chamber to slope downwardly from said inlet opening to said outlet opening to divide said chamber into an upper and a lower compartment, said upper wall and lower wall and partition converging toward each other toward said outlet opening, said partition being formed as a series of steps having tread portions and riser portions, the riser portions of said steps being arranged to admit drying and heating medium between the tread portions into the upper compartment; and an inlet for heated gaseous drying or heating medium communicating with the lower compartment under said partition.

2. A drying and heating apparatus for granular material, comprising: an elongated drying chamber having an upper wall and a lower wall and an inlet opening at one end of the chamber, and an outlet opening in the opposite end at a lower level than the inlet opening; a partition arranged in said chamber to slope downwardly from said inlet opening to said outlet opening to divide said drying chamber into an upper compartment and a lower compartment, said upper wall and lower wall and partition all converging toward each other toward said outlet opening, said partition being formed as a series of steps having tread portions and riser portions, the riser portions of said steps being arranged to admit air between the tread portions into the upper compartment; an inlet for heated air at the inlet end of the lower compartment under said partition; and means to adjust the degree of slope of said stepped partition.

3. A drying and heating apparatus as set forth in claim 2 in which said means for adjusting the degree of slope of said partition comprise means for raising the end of said chamber provided with an inlet opening relatively to the end provided with an outlet opening.

4. A drying and heating apparatus for granular material comprising: a chamber having an upper wall and a lower wall and an inlet opening and an outlet opening at a lower level than said inlet opening; a partition arranged in said chamber sloping downwardly from the inlet opening to the outlet opening and formed as a succession of abrupt steps having treads and perforated riser portions; said upper wall and lower wall and partition all converging toward each other toward said outlet opening; means supplying heated air under pressure below said partition and directing it against the granular material in the general direction of flow of said material through said perforated risers to move the material over the tread portions of the steps and mingle with the material as it drops from one step to the next lower step; and means for collecting the dried granular material, and conduit means interconnecting said collecting means with said means supplying heated air, to recycle air from said collecting means into said inlet opening.

5. A drying and heating apparatus for granular material comprising: a chamber having an upper wall and a lower wall and an inlet opening and an outlet opening, a partition arranged in said chamber sloping downwardly from the inlet opening to the outlet opening, said partition forming an upper compartment above the partition and a lower compartment below the partition, said partition being formed as a succession of abrupt steps having impervious tread portions and perforated riser portions; said upper wall and lower wall and partition all converging toward each other toward said outlet opening; means supplying heated air under pressure below said partition and directing it against the granular material in the general direction of flow of said material as it drops from one step to the next lower step; a conduit in which said dried and heated granular material is raised in a stream of heated air from the outlet opening of said chamber; and means for collecting said dried particles from the stream of heated air, and conduit means interconnecting an upper part of said conduit with said means for supplying heated air, to recycle into the inlet opening, air which has passed out the outlet opening.

6. Apparatus according to claim 5, in which said chamber has progressively decreasing cross-section areas from said inner opening to said outlet opening, whereby the velocity of the air increases toward the outlet opening, in both of said compartments.

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