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APPARATUS FOR TREATING GRANULAR MATERIALS

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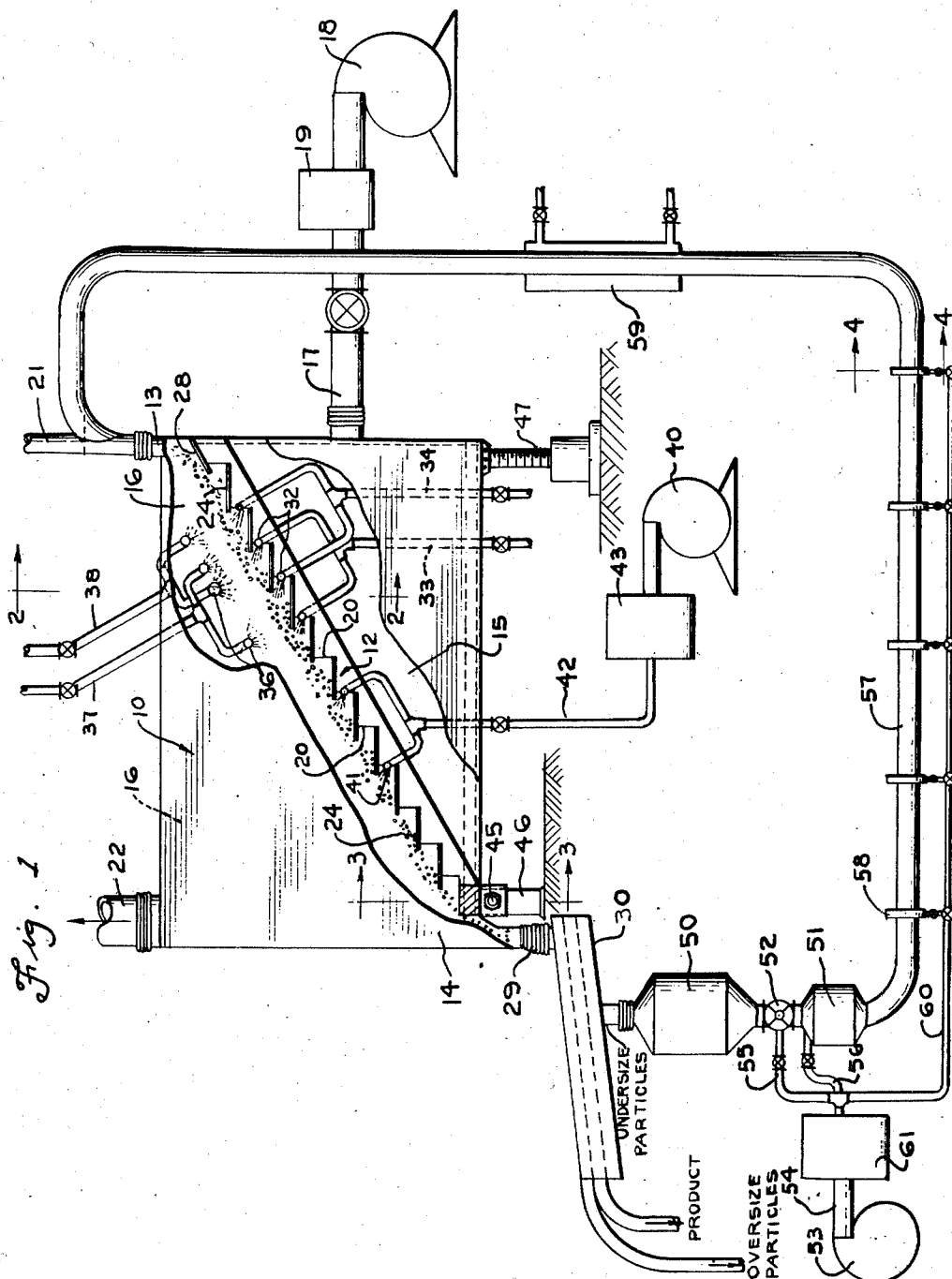


Fig. 1

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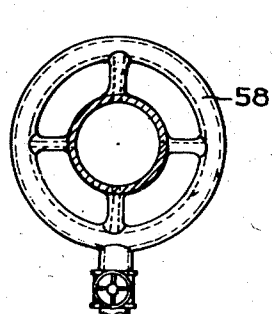
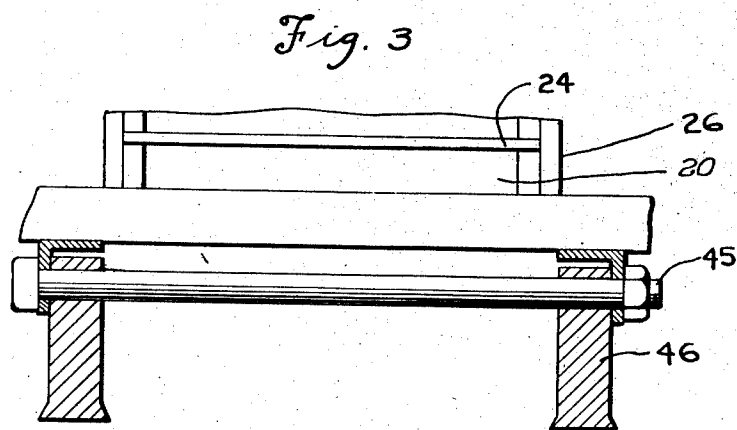
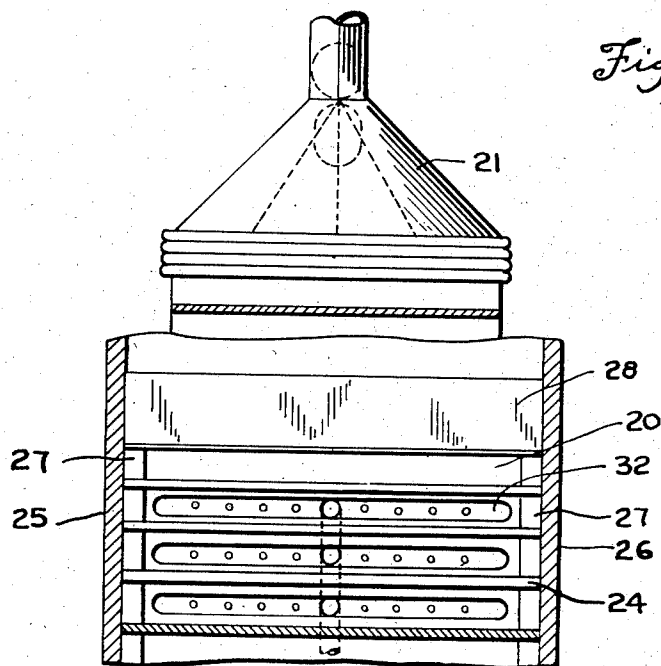
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2 Sheets-Sheet 2



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APPARATUS FOR TREATING GRANULAR MATERIAL

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5 Claims. (Cl. 91-44)

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The present invention relates to the treatment of granular or powdered materials to modify the character thereof while they are being conveyed in an aerated state. In its preferred aspects, the present invention relates to the treatment of hot, spray-dried soap particles to cool and/or to condition the same and to otherwise convert the same into a form suitable for packaging, and to apparatus for effecting such treatment.

The invention will be illustrated in connection with a detailed description of a method of treating and conditioning soap particles, particularly hot, spray-dried soap particles, while they are being conveyed. In particular it will be described in connection with a process of treating hot spray-dried soap particles to cool the same while they are being conveyed towards packaging apparatus.

It is to be understood that the present invention is not to be construed as limited to the treatment of hot spray-dried soap to cool the same, for it may be used to condition and convey granular or powdered synthetic detergent material or other surface active agents in discrete particle form, or powdered milk, etc., or to effect a chemical reaction between a granular material and an aeriform body which serves to convey the same, as for example to form combustible gases by treating pulverized coal with hot steam while utilizing the latter as a conveying means for the former. Other uses of the process will readily suggest themselves from the foregoing and from the following detailed description of the preferred embodiment of the invention.

In the normal operation of a spray-drying operation to form spray-dried soap particles, the particles, as they are withdrawn from the bottom of the spray tower, are at a temperature of about 170° to 195° F. and have a moisture content of about 8 to 14%. These particles are not in a suitable condition for packaging, for generally if spray-dried soap particles are packaged at a temperature in excess of about 95° F., there is a strong tendency for masses of these particles to stick or cake together and form lumps. These lumps are undesirable because they interfere with the free flow of the particles from the packages and because the lumps do not dissolve rapidly in water.

In accordance with the present invention, cooling of the hot soap particles withdrawn from a spray tower, is effected on a stationary, perforated sloping bed or table down which the particles travel towards the packaging apparatus, their movement being aided by air or

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other aeriform body. In the practice of the invention the hot particles are introduced at or near the top of the perforated sloping table and air is introduced through the perforations from beneath the table into the mass of particles to aerate and cool the same. The air passes through the perforations in the table, preferably in the general direction of the product discharge end of the table and this air aids in carrying the particles down the table towards the discharge end and cools them while they are being so conveyed. The soap particles when first introduced onto the sloping perforated bed may be at a temperature and have a moisture content as set forth above, or they may be either cooler or hotter and contain more or less moisture. In any event they are in a condition unsuitable for packaging.

The air which is brought in contact with the hot soap particles to aerate, convey and cool them should be of a temperature and relative humidity and in such quantity as to reduce the temperature of the soap particles to about 95° F. or below during the time that the soap particles are moved from the top to the bottom of the sloping perforated bed, with a possible change in moisture. The air used to obtain the necessary conveying and cooling of the hot soap particles may be ambient air or it may be air which has been conditioned as to temperature and/or moisture content.

When spray-dried organic detergent particles are contacted with air, their moisture content may increase, decrease or remain substantially unchanged depending upon the relative humidity of the air and the moisture content of the particles. The term "equilibrium humidity" is used herein to mean that relative humidity of air which effects neither a substantial increase nor decrease in the moisture content of spray-dried organic detergent particles with which the air is in contact. Over the range of moisture contents encountered in the present process, the equilibrium humidity is practically directly proportional to the moisture content of the soap particles, which are discharged from the spray tower with a moisture content within the range of about 8% to 14%, usually 10% to 12%. Soap particles, for example, having about 8% moisture are in equilibrium with air of 50% relative humidity, whereas soap particles having about 14% moisture are in equilibrium with air of 78% relative humidity. The relative humidity of the air used in the process of the invention to cool and transport the organic detergent particles

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preferably does not exceed the equilibrium humidity and advantageously is lower. By using air having a relative humidity below the equilibrium humidity, moisture is evaporated from the soap particles, thereby intensifying the cooling effect of contacting soap particles with air and permitting the use of less conditioned air, or of conditioned air of higher temperature or an intermediate combination of both while obtaining the same cooling effect of air at equilibrium humidity.

When the relative humidity of the cool air is higher than the equilibrium humidity for the soap, moisture from the air condenses on the soap particles and this condensation increases the temperature of the soap particles somewhat and to this extent defeats the object of contacting the particles with relatively cool air to cool the same. Generally, therefore, when the air is to be used to cool relatively hot soap particles, the relative humidity of the cooling air is not higher than the equilibrium humidity of air for soap of the moisture content being treated, as pointed out above. It may, however, be higher where it is desired to raise the temperature and/or moisture content of the soap being treated to meet a desired need.

During the period of contact of the hot soap particles with air to effect cooling it is essential that the particles be in a state of turbulence or agitation so as to insure intimate contact of the air with the entire surface of the particles being treated. This agitation, however, should not be so intense as to cause substantial breakage of the particles. In accordance with the present invention the agitation is brought about by the passage of air under pressure through a mass of the particles on the sloping perforated bed. The air aerates these particles and places them in a more or less fluidized condition and in that condition the particles are conveyed to the bottom of the sloping table, from which point they are then delivered to suitable apparatus for packaging. By conveying the particles of soap downwardly on a sloping perforated table by means of air, more efficient cooling of the particles takes place and the force of the air necessary to effect movement of the particles is not so great as to induce in the particles such a state of agitation and turbulence as to cause substantial breakage of the particles and the production of objectionable quantities of "fines."

The velocity of the air which is introduced into the mass of particles on the perforated sloping bed in accordance with the present invention may vary over a wide range, the minimum being that velocity which is just sufficient to provide intimate contact between the treating air and the individual particles of soap in the mass, and to convey or to aid these particles in travelling down the sloping table. A flow of about 0.125 to about 0.25 cubic foot per second per square foot of bed area satisfactorily aerates a mass of soap particles in accordance with the present invention. A practical maximum air flow is somewhat below that at which the soap particles become airborne and can be conveyed vertically. The air velocity in accordance with the present invention should, preferably, be well below the maximum and within the limits where the particles are converted into a substantially fluidized state.

In accordance with the present invention soap particles may be given other or additional treatments as they are being conveyed or caused to travel down the sloping perforated bed. Thus,

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for example, in their transit down the bed these soap particles may be heated instead of cooled. Or they may be sprayed with additional soap solution to build up the size of the particles. Or the particles may be sprayed with solutions of other materials such as sodium carbonate, sodium silicate or other builders to modify the characteristics of the soap particles. Also, if desired, the soap particles being conveyed down the sloping perforated bed may be treated with conditioned air, either to adjust the moisture content, for example, or to dry the coatings of material which have been sprayed onto the soap particles.

The invention will be readily understood from the following detailed description of a conveying and cooling system illustrated in the accompanying drawings wherein:

Figure 1 is a schematic showing of apparatus suitable for carrying out the invention, parts of the apparatus being broken away to show the arrangement of the sloping perforated cooling bed and other details;

Fig. 2 is a fragmentary transverse section through the cooling chamber of the apparatus, taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary transverse section taken substantially along the line 3—3 of Fig. 1, showing the mechanism for tilting the cooling chamber to adjust the slope of the perforated sloping cooling bed; and

Fig. 4 is an enlarged transverse section taken along the line 4—4 of Fig. 1, to show a detail of the apparatus used to introduce air into one of the lines of the system.

The conveying and cooling mechanism of the present invention consists essentially of an elongated cooling chamber 10, of substantially rectangular cross section, having a top and bottom and side and end walls, in which a sloping perforated bed 12 is installed. Hot spray-dried soap particles or similar granular material of not over 10 to 20 mesh, suitably 50 to 100 mesh, or finer are carried by air or other aeriform body on the bed from the feed end 13 to the discharge end 14. Perforated bed 12 slopes from the feed end to the discharge end, the slope varying widely, as desired, say from about 5 to 45 degrees. In connection with the use of the apparatus for cooling soap particles, the slope of bed 12 is, preferably, in the order of about 5 to 10 degrees, although it may be steeper as shown in the drawings. The slope of the bed, which is preferably somewhat less than the slope at which free flow of the powdered material occurs, aids in the desired movement of the particles.

Perforated bed plate 12 divides the cooling chamber into a lower air distributing compartment 15 and an upper plenum chamber 16. Air is brought into compartment 15 through line 17 which is in communication with air compressor 18. A receiver or tank 19 may be interposed in line 17 and this tank may be used to receive and store the air under pressure which is delivered from the compressor, or to receive the air and condition it as to temperature and/or moisture content. For that purpose the tank may include means for conditioning the air.

The air under pressure in the lower compartment 15 passes through the perforations or lower openings 20 in bed 12 and through the mass of soap particles which are formed on the bed as the soap is introduced into the cooling chamber through the soap distributing inlet 21. The air passing into the mass of soap particles aerates the same and conveys them down the

sloping perforated table. The air which passes through or rises from the mass of soap particles passes through plenum chamber 16 and out through outlet 22 along with any dust which may become entrained therewith.

In the operation of the cooling chamber it is preferred to maintain the interior thereof at substantially atmospheric pressure and to accomplish this, soap distributing inlet 21 may be in communication with the surrounding air. Outlet 22 may also be in communication with the surrounding air but it is preferred to have it communicate with a suitable exhaust system operating at some pressure lower than atmospheric. This exhaust system may include therein one or more conventional air separating cyclones or one or more dust bag collectors or a combination thereof so that the dust may be separated from the air. The air may be returned to compressor 18, if desired.

Sloping perforated bed 12 consists of a series of horizontally disposed steps or louver plates 24 which extend across the width of the cooling chamber and which are supported in spaced, overlying, stepped relationship between the side walls 25 and 26 of the cooling chamber by supports 27. It will be seen that the forward extremity of each step overlies the rear extremity of a lower step and the reason for this is to prevent the soap particles from falling into the air distributing chamber. Such overlapping of the steps, however, is not essential since the forward extremity of each step may terminate immediately above the rear extremity of a successively lower step. The spacing between the steps may be varied rather widely to meet any desired need. Thus it may vary from about one sixty-fourth of an inch upwardly, and the spacing may be uniform throughout the length of the bed, as shown, or it may vary from section to section.

At the top of sloping perforated bed 12 is a deflecting plate 28 which extends across the cooling chamber immediately below product inlet distributor 21 to deflect the incoming soap particles and direct them onto the sloping perforated bed. When a mass of these soap particles is formed on the bed and the air passes through perforations 20 into this mass the mass becomes aerated or fluidized and flows readily down the bed to the bottom thereof and from the bed the mass drops through a flexible conduit connection 29 to a granular product classifying device of known construction. As the mass falls from bed 12 through flexible connection 29 most of the air separates from the particles of soap and passes out through outlet 22.

Classifier 30 serves to divide the soap particles which have been treated on the sloping bed into three groups, oversize, fines and the desired product which is packaged or otherwise handled. The oversize particles may be returned to the liquid soap which is to be spray-dried. The fines may also be returned to the liquid soap to be spray-dried or they may be discarded. It is preferred, however, to treat these fines in accordance with the present invention to increase the size thereof, as hereinafter described.

In the event it is desired to increase the diameter or thickness of the spray-dried particles with the same or dissimilar material, this may be done in accordance with the present invention as the particles are being carried downwardly and cooled on the sloping bed. Thus, spray nozzles 32 of any desired type may be positioned in the

louver spaces 20 between pairs of overlying steps to throw a fine spray of liquid coating material, soap, sodium carbonate, sodium silicate, etc., as desired, into the mass of soap particles on the sloping bed. As shown in Fig. 2, these nozzles extend substantially throughout the width of the louver spaces 20 but do not block these spaces so as to prevent the entry of air therethrough. These nozzles may be positioned in as many 10 louver spaces and in any location of the sloping bed, as desired; however, it is preferred to position them in adjoining spaces 20 within a limited zone adjacent the top of the sloping table. The liquid to be sprayed is supplied to the nozzles 32 15 under pressure through the lines 33 and 34.

If desired, a bank of nozzles 36 may be positioned in plenum chamber 16 above the nozzles 32 so as to direct a spray of the desired coating material onto the mass of soap particles on the sloping bed. The liquid coating material is supplied under pressure to these nozzles through lines 37 and 38.

Also, if desired, the sloping bed may have a conditioning zone beyond the liquid spraying zone. In the conditioning zone, conditioned air or aeriform body is supplied to the mass of soap particles to dry the coatings which have been sprayed thereon at the spraying zone. Or this conditioning zone may be utilized apart from the spraying zone or in conjunction therewith to condition the particles both as to moisture content and temperature. The aeriform body is supplied under pressure to the conditioning zone from a compressor 40 which is in communication 35 with nozzles 41 through line 42. Nozzles 41 may have any desired shape. They may be elongated, similar to nozzles 32, and they may be positioned in suitable spaces 20 between overlying steps 24 of the sloping bed. A receiver or conditioning tank 43, similar to tank 19, may be supplied in line 42 to either store and/or condition the air supplied by compressor 40.

The operation of the system described above to cool and/or spray soap particles is apparent 45 from the foregoing. In the operation of the system to cool spray-dried soap particles, for example, these particles are introduced on the sloping perforated bed in the cooling chamber through inlet 21. These spray-dried particles 50 may be entered into the cooling chamber directly from the bottom of the spray tower or from some intermediate stage of treatment of these particles to partially cool the same from the 170 to 195° F. temperature at which they are withdrawn 55 from the spray tower. The air supplied to the cooling chamber through line 17 may be ambient air or it may be air which has been conditioned as to temperature and moisture content to effect the desired cooling in the product being entered 60 into the cooling chamber. The entry of this product into the chamber is preferably continuous as is also, of course, the entry of air through line 17. Air may also be entered into the cooling chamber through line 42, if desired, to supplement the cooling action of the air introduced through line 17. The particles being cooled may or may not be sprayed from nozzles 32 and 36 with the same or dissimilar materials, as desired.

As pointed out above, the amount of aeriform body which may be used to convey and cool the particles on the sloping perforated bed may be varied rather widely, as desired. For effective conveying of spray-dried soap particles of a particle size varying from about 50 to 100 mesh

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and finer, the volume of aeriform body passing the louver openings 20 should be in the order of approximately $\frac{1}{4}$ cubic foot per second per square foot of bed area. The condition of the air as to temperature and moisture content will, of course, be governed by the condition of the spray-dried soap particles to be treated.

Each of the lines 17, 33, 34, 37, 38 and 42 is supplied with suitable valves to govern the rates of flow of fluid through these lines.

The slope of the perforated table 12 may be altered as desired to meet any need. This may be accomplished by providing the discharge end of the chamber 10 with a pivot or axle 45, which extends across the bottom of the cooling chamber. Axle 45 is mounted for rotation in suitable side brackets 46 which provide support for the discharge end of the cooling chamber. A jack 47 or other similar lifting device, such as a hydraulic ram, for example, may be provided at the bottom of the cooling chamber beneath the inlet end to pivot the entire cooling chamber about axle 45 and thereby alter the slope of the perforated bed. As is readily apparent, the table may be pivotally mounted within the chamber so that its slope may be varied independently of the latter.

The cooled soap particles discharged from the cooling chamber pass into the classifying device 30 and the desired product is segregated and packaged. The oversized product is returned to the liquid soap being sprayed and the undersized product or fines which pass out of the classifier may be similarly returned. In accordance with the present invention the fines are recirculated to the cooling chamber and are there sprayed with a soap solution and/or a sodium carbonate, sodium silicate, or a suspension or solution of any other material to be deposited on the particles to increase their size, modify their appearance, etc. Thus the fines passing from classifier 30 are passed into a hopper 50 and then into a hopper 51 which is maintained at a higher pressure than the pressure in hopper 50. The passage of the fines from hopper 50 to hopper 51 is through a valve of known construction, such as the star valve 52 or similar device which acts as a pressure seal permitting the passage of granular material from a low pressure to a high pressure zone. Compressed air from compressor 53 passes through line 54 and passes into hopper 51 through valved line 56. Air may also be supplied to the packing of star valve 52 through line 55 to prevent clogging of its operating shaft or axles. If desired, all of the air required in hopper 51 may be introduced therein through line 55.

The fines thus entering hopper 51 are aerated and are conveyed by this air through line 57 which leads into distributing product inlet 21. Additional air may be supplied to line 57 through suitable inlets such as the annular inlets 58 shown in detail in Fig. 4. As many of such air inlets 58, as desired, may be incorporated along line 57. A heat exchange device 59 may be incorporated at some desired portion around line 57 to either heat or cool the air-fines mixture flowing through line 57. Air is supplied to the annular inlets 58 through valved line 60 which is in communication with line 54. A receiving or conditioning tank 61, similar to tanks 19 and 43, may be supplied in line 54.

While the invention has been described with particularity with reference to the treatment of spray-dried soap particles to cool and/or coat

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the same with the same and/or dissimilar material, the invention is not to be construed as limited thereto for it may be used for other purposes. Thus, for example, the invention may be used to effect chemical reactions, such as a reaction between fatty acids and caustic soda to form soap. Such reaction may be carried out in accordance with the present invention by introducing onto bed 12 through inlet 21 solid particles of fatty acids, and aerating them with ambient or heated air or gas as described. While these particles are in an aerated or fluidized state they may be sprayed with a hot caustic soda or other alkaline solution through spray nozzles 32 and/or 36 to bring about saponification.

When I refer to "air" in the foregoing, I refer not only to air but to other aeriform bodies such as vapor, gas, etc.

I claim:

1. An apparatus for treating granular material, comprising an enclosed chamber having a product inlet and a product outlet, a perforated bed sloping downwardly in a direction from said product inlet to said product outlet, said bed dividing said chamber into an upper plenum compartment and a lower air distributing compartment and being adapted to receive product entered at said product inlet, said bed being formed of a series of spaced, overlying stepped sheet members which extend substantially across the width of said chamber, an air inlet to said air distributing chamber and an air outlet from said plenum chamber, whereby air entered into said air distributing compartment will pass through the perforations in said bed and aerate soap particles thereon and cause the same to travel to said product outlet, and whereby air passing from said aerated mass into said plenum compartment will pass from said chamber through said air outlet, and means positioned in spaces between said stepped sheet members for spraying a liquid coating material on said granules while the same are on said bed.

2. An apparatus for treating granular material, comprising an enclosed chamber having a product inlet and a product outlet, a supporting surface sloping downwardly in a direction from said product inlet to said product outlet, said surface comprising a series of stepped members dividing said chamber into an upper plenum compartment and a lower air distributing compartment and being adapted to receive granular material entered at said product inlet, an air inlet to said air distributing chamber and an air outlet from said plenum chamber, whereby air entered into said air distributing compartment will pass through the spaces between said stepped members and aerate granular material thereon and cause the same to travel to said product outlet, and whereby air passing from said aerated mass into said plenum compartment will pass from said chamber through said air outlet, and means between two stepped members for spraying a liquid coating material on said granules while the same are on said bed.

3. An apparatus for treating granular material, comprising an enclosed chamber having a product inlet and a product outlet, a supporting surface sloping downwardly in a direction from said product inlet to said product outlet, said sloping surface comprising a series of stepped members dividing said chamber into an upper plenum compartment and a lower air distributing compartment and being adapted to receive gran-

ular material entered at said product inlet, an air inlet to said air distributing chamber and an air outlet from said plenum chamber, whereby air entered into said air distributing compartment will pass through the spaces between said stepped members and aerate granular material thereon and cause the same to travel to said product outlet, and whereby air passing from said aerated mass into said plenum compartment will pass from said chamber through said air outlet, and a plurality of nozzles mounted in spaces between said stepped members for spraying fluid on said granules as they flow from step to step.

4. An apparatus for treating granular material comprising an enclosed chamber having a product inlet and a product outlet, a supporting surface sloping downwardly in a direction from said product inlet to said product outlet, said supporting surface comprising a series of stepped members dividing said chamber into an upper plenum compartment and a lower air distributing compartment and being adapted to receive granular material entered at said product inlet, an air inlet to said air distributing chamber and an air outlet from said plenum chamber, whereby air entered into said air distributing compartment will pass through the spaces between said stepped members and aerate granular material thereon and cause the same to travel to said product outlet, and whereby air passing from said aerated mass into said plenum compartment will pass from said chamber through said air outlet, means comprising a plurality of nozzles mounted in spaces between said stepped members for spraying a liquid coating material on said granules while the same are on said bed, and means for recirculating for retreatment undersize granular material discharged from said bed.

5. An apparatus for treating spray-dried soap particles which comprises an enclosed chamber having a product inlet and a product outlet, a perforated bed comprising a series of stepped members mounted in said chamber on a down-

ward slope from said inlet to said outlet dividing said chamber into an upper compartment and a lower compartment, means located in said lower compartment adjacent to spaces between stepped members near said inlet for spraying particles on said bed with a coating liquid through spaces between said stepped members, means connected with said product outlet for classifying the treated particles, and means for returning the undersize particles to the product inlet for retreatment.

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