

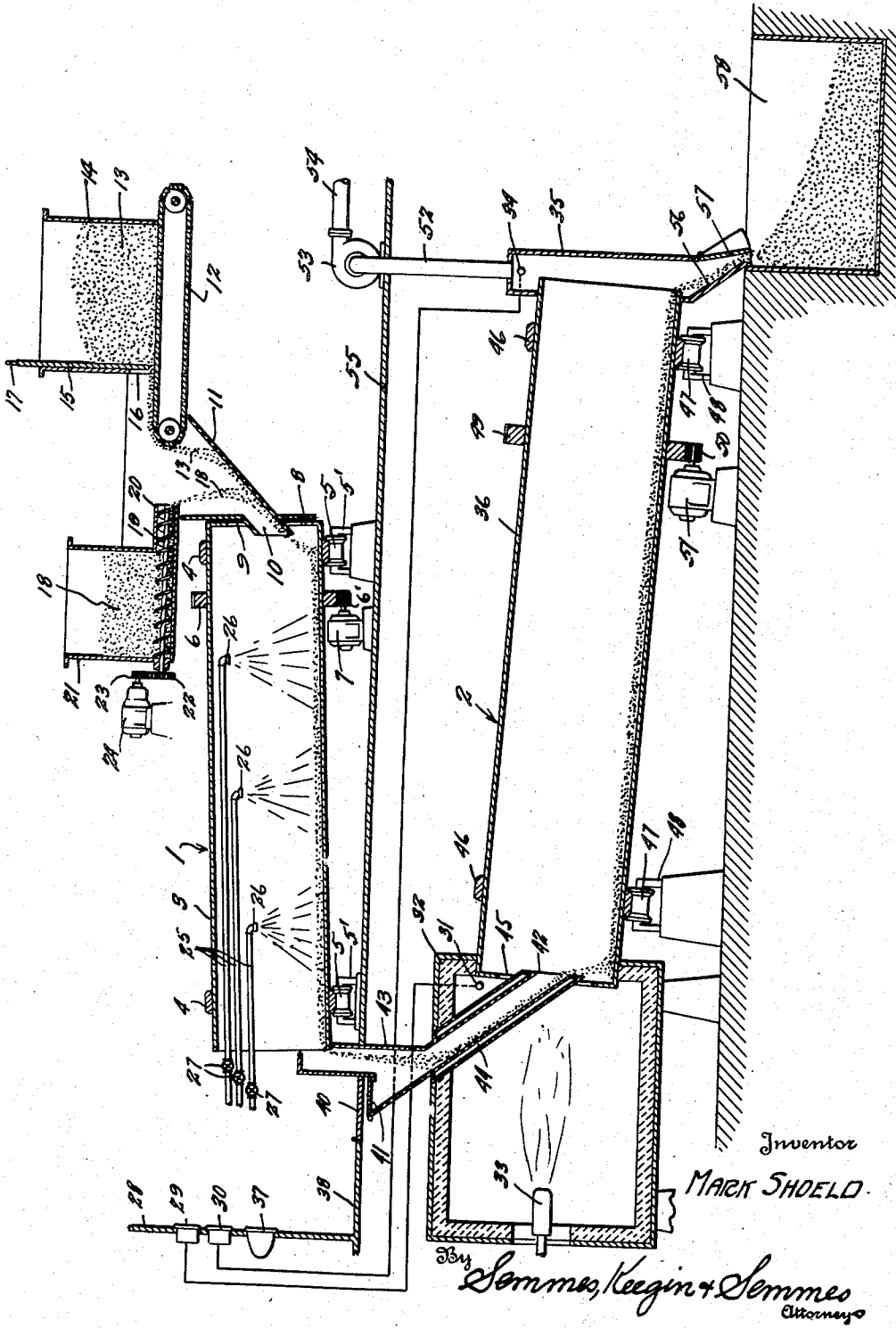
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METHOD FOR MAKING GRANULAR SUPERPHOSPHATE

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## METHOD FOR MAKING GRANULAR SUPERPHOSPHATE

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21 Claims. (Cl. 71-40)

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This invention relates to the manufacture of granular superphosphate.

In the manufacture of granular superphosphate, a preferred form of process is one in which the superphosphate, with sufficient water, is agitated to produce agglomerated particles. These agglomerated particles are then subjected to a drying step under further agitation to form hard, dry granules. Ordinarily, this type of process is carried out in apparatus which comprises a rotary drum in which the particles are agglomerated. Particles thus agglomerated are subjected to the drying step in another rotary heated drum.

Another form of process comprises agglomerating or "conditioning" and then drying in the same rotary drum in different sections of the drum. An aqueous medium may be added to produce the desired initial moisture content to assist in the agglomeration.

The granular superphosphate obtained comprises hard, dry, globoid, nodular, encrusted and indurated particles having several times the crushing strength of ordinary fully cured den superphosphate.

When fresh superphosphate directly from the den is charged into the "conditioner" of the granulating unit, there is in many instances sufficient variation as to physical condition of the den super to make this operation impractical. The difficulty is that at times the agglomeration in the conditioner is excessive so that large lumps form, and occasionally a clayey mass is formed. This causes trouble due to sticking of the material in the conditioner and the dryer, and the final material is too large and non-uniform as to size and moisture content. When the material from the dryer is too large the amount of dust produced during the subsequent milling operation is excessive. Up to the time of this invention it was necessary to put the fresh super into preliminary storage or to rasp and aerate it, so as to allow proper control of particle size in the conditioner. This procedure entailed, of course, considerable extra cost due to the rehandling of the material and storage facilities required.

By means of this invention, fresh den super can be transferred directly from the den to the conditioner, and the particle size from the conditioner can be controlled within the accuracy that the commercial application of the process requires. This is accomplished by feeding in a determined amount of dry material to the feed end of the conditioner where it enters with the fresh den super.

The maximum capacity of the granulating unit is obtained by using super from a stationary den, unshaved and unrasped, because the den super is at the maximum possible temperature. It is therefore important, if maximum capacity is desired, to avoid storing or rasping the super prior to granulation. Using this invention it is

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possible to do so. In other words there is not only saving due to elimination of handling, rasping and storing charges, but the capacity of the granulating unit is also increased.

Any dry or reasonably dry material may be used as the additive, as for instance sand, if it is required to cut the concentration of  $P_2O_5$  in the final product. Well cured den super may be used. The most suitable material is, however, classifier dust, which is obtained in the following manner.

The granulated material from the unit goes to storage for a minimum of approximately 10 days. When shipping granular superphosphate, the material from storage is passed over a screen to eliminate any oversize. This oversize goes to a mill, is crushed, and is returned to the screen. The entire product from the screen is passed through a pneumatic classifying system where substantially all fines are removed. The dust free material is discharged into bags ready for shipment. The amount of classifier dust may vary from 10 to 20% of the total production.

Instead of using pneumatic classification, double screening may be used. The net result will however be approximately the same.

The classifier dust may be sold by itself or mixed with regular den super and sold as run of pile or cut to 16%. The advantage of using it back in the granulating system is however quite considerable as has been pointed out above. Moreover, the dust has a high percentage of available  $P_2O_5$ .

As an addition substance, dry phosphate rock may be used and this material is particularly suitable when it is desired to make cut superphosphate in territories where it is undesirable to add sand as filler. An additional advantage is obtained when the ground phosphate rock is used because some of the  $P_2O_5$  in this becomes available without the use of any extra sulphuric acid. In other words when phosphate rock has to be used to produce a cut grade of granular superphosphate, there is a distinct acid economy obtained.

Among the objects of the invention are to reduce handling, save time and cost of production, and insure a more uniform product.

Other objects will be apparent from the description of the apparatus used and the process as set forth.

The single figure of the drawing is a diagrammatic illustration of a form of apparatus which I may employ, the apparatus being shown in section.

Referring to the drawing I have shown a conditioner 1 and a drier 2. The conditioner 1 comprises a hollow metallic cylinder 3 having rings 4 thereon which are adapted to roll on rollers 5 mounted on supports 5'. There are a plurality of rollers at each ring 4. The metallic cylinder 3 is

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rotated by means of a ring gear 6 driven by a pinion 6' mounted on the shaft of a motor 7. It is to be understood that reduction gearing may be employed between the motor and the pinion 6', but for purposes of illustration no such reduction gearing is shown. The metallic cylinder is provided with a partially closed end 8 having an aperture 9 therein into which sticks a spout 10 of a hopper 11. A slat conveyor or belt 12, which is adapted to be driven from some source of power, not shown, conveys fresh den superphosphate 13 from a superphosphate hopper 14. The superphosphate is delivered to the hopper 14 by means of a clam shell bucket which takes the material directly from the den, or some other means of transportation may be employed.

There is a sliding door 15 provided in one side of the hopper 14 adjacent an aperture 16. The door 15 is provided with a handle 17. By raising or lowering the door 15, the amount of fresh den superphosphate 13 which is conveyed by the slat conveyor 12 can be determined.

Fed also into the hopper 11 is a dry, finely divided material 18 which may be sand, fully cured superphosphate, classifier dust, ground phosphate rock, or some other similar material. This material 18 is fed by means of a screw conveyor 19 operating in a conveyor box 20 located at the bottom of a hopper 21. The screw 19 is rotated by means of a gear 22 meshing with a pinion 23 driven by a variable speed motor 24.

Adapted to discharge an aqueous medium into the conditioner 1 are pipes 25 having nozzles 26. Valves 27, which may be manually operated by an operator, control the amount of aqueous medium discharged into the interior of the conditioner 1.

Mounted on an instrument panel 28 are meters 29 and 30. The meter 29 is connected electrically to a pyrometer 31 located in a refractory lined combustion furnace 32, heated by a gas burner 33. The meter 30 is electrically connected to a thermometer 34 which is located in a discharge breeching 35 which covers the end of a rotary cylinder 36 which forms the drier 2. The temperature of the hot gases entering the drier 2 and leaving the drier 2 are readable on the meter faces 29 and 30 respectively.

Mounted on the instrument panel 28 is a flood light 37 which is directed into the open end of the conditioner 1. A supporting platform 38 is located adjacent the open end of the conditioner 1. The conditioner 1 is slanted downward from the end into which the fresh den superphosphate is discharged. An operator standing on the platform 38 at all times can visually inspect, by means of the floodlight 37, the interior of the conditioner 1, and regulate by means of valves 27 the condition of the material in the conditioner 1. The operator must be present on the platform at all times and by adjustment of the regulating valves 27, he maintains a constant physical condition of the material leaving the conditioner and entering the drier.

In the operating floor is a trap door 40 which is on hinges and provides easy access to a clean-out door 41 in a water-jacketed chute 42. A wall 43 forming the vertical upper section of chute 42 prevents the conditioned agglomerated particles from falling out of the upper end of the chute.

The water-jacketed chute 42 is provided with a water jacket 44 in which cooling fluid is circulated to prevent overheating of the chute. The connections for sending the fluid through the water jacket are not shown. The lower end of

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the chute discharges into the upper end of the drier 2, which has an aperture 45 into which the lower end of the chute projects.

The rotary cylinder 36 which comprises the drier is slanted from the horizontal and is provided with rings 46 adapted to be supported by rollers 47 mounted on supports 48. As is the case with the construction of the conditioner 1, there are a plurality of rollers 47 at each station to rotatably support the rotary cylinder 36. To rotate the cylinder 36 of the drier 2 I have shown a ring gear 49 driven by a pinion 50 mounted on the shaft of a motor 51. Here again reduction gearing may be used if desired, but such a construction is not shown in order to simplify the illustration of the apparatus.

The discharge breeching 35 is connected to a pipe 52 which leads to the suction side of a blower 53 which is adapted to suck the gases through the pipe 52 and discharge them through a pipe 54. The blower 53 is mounted on a platform 55 upon which are mounted the supports 5' for the rollers 5 in which the conditioner unit is adapted to be rotatably supported.

The discharge breeching 35 is provided with a discharge chute 56. Mounted on the discharge chute 56 is a swinging door 57 which prevents the blower 53 from sucking too much fresh air into the discharge breeching 35. By this construction of the swinging door a suction is created in the interior of the drier 2 and the gases from the interior of the drier 2 are discharged through the pipe 54. The dried granular particles are delivered into a receiving pit 58 from which they may be taken by means of a clam shell bucket, or some other conveying mechanism.

Fresh unrasped super 13 direct from the den is charged into hopper 14. The den super may as an example have the following average composition:

|                 | Per cent |
|-----------------|----------|
| Moisture        | 10.56    |
| Total $P_2O_5$  | 20.03    |
| Insol. $P_2O_5$ | 3.04     |
| Avail. $P_2O_5$ | 16.99    |

This is a truly representative average and there may be slight variation in the composition especially as to moisture content between the top and the bottom of the den. The temperature of the material will also vary somewhat depending upon what part of the den it comes from.

The classifier dust charged into hopper 21 is ordinarily of very uniform condition. A sample for instance may analyze as follows:

|                 | Per cent |
|-----------------|----------|
| Moisture        | 1.7      |
| Total $P_2O_5$  | 21.3     |
| Insol. $P_2O_5$ | 1.2      |
| Avail. $P_2O_5$ | 20.1     |

Conveyor feeder 12 and screw feeder 19 are so adjusted that the classifier dust represents 10% of the total feed. In other words, the ratio of fresh super to classifier dust is 9 to 1 by weight.

The amount of water added to the material in the conditioner through sprays 10 averages approximately 1.2%. This does not mean that there is a uniform addition, because the operator on the platform gives constant attention to the physical condition of the material in the conditioner and regulates the amount of water by means of valves 27, so that every minute of the day visual observation governs the proper physical condition of the material going to the dryer. The instant water additions may vary

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from practically nothing to 2% or more. The range is generally from about  $\frac{1}{2}\%$  to 2%.

This water addition is so critical for proper operating conditions that a small fraction of a percent will produce a major change of physical condition of the material.

The average addition of about 1.2% mentioned above, with the given average composition of super and classifier dust, means that the material from the conditioner to the dryer has an average moisture content practically identical with that of the super fed or  $10\frac{1}{2}\%$ . This clearly brings out the point that the classifier dust addition is for the purpose of regulation, which is of paramount practical importance for the successful commercial carrying out of the process.

The granulated super from the dryer has the following composition:

|                 | Per cent |
|-----------------|----------|
| Moisture        | 5.15     |
| Total $P_2O_5$  | 21.08    |
| Insol. $P_2O_5$ | 2.75     |
| Avail. $P_2O_5$ | 18.33    |

This material is allowed to stand in storage for a minimum of approximately 10 days. After passing through the shipping unit the final material in the bags analyzes as follows:

|                 | Per cent |
|-----------------|----------|
| Moisture        | 1.67     |
| Total $P_2O_5$  | 21.44    |
| Insol. $P_2O_5$ | 1.18     |
| Avail. $P_2O_5$ | 20.26    |

It will be noted that the acidulation is regulated so that the final product is just above 20% available  $P_2O_5$ . The reason for this is that 20% is the standard commercial grade that has been established for granular superphosphate.

In connection with the moisture changes in the material during the process, the following is of interest.

The fresh den super has a moisture content of about  $10\frac{1}{2}\%$ . The material from the conditioner to the dryer has the same average moisture content of  $10\frac{1}{2}\%$ . The granulated super from the unit shows about 5% moisture. The moisture elimination in the dryer is therefore about  $5\frac{1}{2}\%$ . The shipping material has a moisture of about  $1\frac{1}{2}\%$ . There is therefore an apparent difference of  $3\frac{1}{2}\%$  moisture between the material from the granulating unit and the material as shipped. Careful investigation has shown that the true moisture loss between these two points is only  $1\frac{1}{2}\%$  and is due to handling and transfer through the shipping unit. The balance of 2% is changed from free water to fixed water, that is chemically bound water that does not go off at  $100^\circ C$ . by the standard method of moisture determination.

The remarkable efficiency of the process from the standpoint of accelerated curing is seen from the above given example. Set forth in a somewhat simpler manner on the basis of percentage of acidulation during the various steps of the process the result is as follows:

|                                     | Per cent acidulation |
|-------------------------------------|----------------------|
| Super from den entering conditioner | 84.7                 |
| Material from dryer                 | 87.0                 |
| Material shipped                    | 94.5                 |

The definition for "% acidulation" is the available  $P_2O_5$  as a percentage of the total  $P_2O_5$ . This may be written:

$$\frac{\% \text{ available } P_2O_5}{\% \text{ total } P_2O_5} \times 100$$

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By the accurate control of the moisture content and the general consistency of the fresh den superphosphate at the agglomerating step, a substantially uniform agglomerated material is delivered from the conditioning step to the drying step. A final granulated product is obtained in which there is a minimum of variation in particle size with a relatively small percentage of fines or oversized particles.

While I have shown a process and apparatus which are illustrative of my invention, it is to be understood that I am to be limited only by the scope of the appended claims and the showing of the prior art.

I claim:

1. A method of manufacturing granular superphosphate comprising adding 10% by weight of dry finely divided material to fresh superphosphate, then adding an aqueous medium to bring the mixture to the desired consistency for agglomeration, agglomerating the mixture, and then drying the agglomerated particles.

2. A method of manufacturing granular superphosphate comprising adding sand to fresh superphosphate, then adding an aqueous medium to bring the mixture to a moisture content approximately the same as the fresh superphosphate, agglomerating the mixture, and then drying the agglomerated particles.

3. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing a dry finely divided substance with the fresh superphosphate, then adding an aqueous medium, to bring the mixture to a moisture content approximately the same as the fresh superphosphate, then agglomerating by agitating, and then drying while agitating.

4. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing dry sand with the fresh superphosphate, then adding about 2% of aqueous medium, then agglomerating by agitating, and then drying while agitating.

5. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing 10% by weight of a dry finely divided substance with the fresh superphosphate, then adding an aqueous medium, agglomerating the material by tumbling in a rotary drum, and drying the agglomerated particles while tumbling in a rotary drum.

6. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing dry sand with the fresh superphosphate, then adding an aqueous medium to bring the mixture to a moisture content about the same as the fresh superphosphate, agglomerating the material by tumbling in a rotary drum, and drying the agglomerated particles while tumbling in a rotary drum.

7. A method of agglomerating fresh superphosphate, comprising adding dry finely divided material to the fresh den superphosphate and passing the fresh den superphosphate through a rotary drum, inspecting the mixture in the drum while adding an aqueous medium to obtain a mix-

ture having a moisture content about the same as the moisture content of the fresh superphosphate, and regulating the aqueous medium to conform with the requirements as determined by the inspection.

8. A method of agglomerating fresh superphosphate comprising adding dry sand to the fresh den superphosphate and passing the fresh den superphosphate through a rotary drum, inspecting the mixture in the drum while adding an aqueous medium to obtain a mixture having a moisture content about the same as the fresh superphosphate, and regulating the aqueous medium to conform with the requirements as determined by the inspection.

9. A process for producing granular superphosphate from superphosphate fresh from the den comprising feeding the fresh superphosphate to a rotating drum that is slanted to the horizontal, together with a finely divided material, throwing a beam of light on the interior of the drum so that the consistency of the mixture can be constantly inspected, introducing into the drum a quantity of an aqueous medium to obtain a mixture having a moisture content about the same as the fresh superphosphate, passing the agglomerated particles from the conditioning step in this drum to a second drum where the particles are subjected to a drying step and elevated temperatures to form hard, dry, encrusted and indurated globule particles of several times the crushing strength of fully cured den superphosphate.

10. A method of manufacturing granular superphosphate comprising adding fully cured den superphosphate to fresh superphosphate, then adding an aqueous medium to bring the mixture to a moisture content about the same as the fresh superphosphate, agglomerating the mixture, and then drying the agglomerated particles.

11. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing 10% by weight of fully cured den superphosphate with the fresh superphosphate, then adding an aqueous medium, then agglomerating by agitating, and then drying while agitating.

12. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing fully cured den superphosphate with the fresh superphosphate, then adding an aqueous medium to obtain a mixture having a moisture content about the same as the fresh superphosphate, agglomerating the material by tumbling in a rotary drum, and drying the agglomerated particles while tumbling in a rotary drum.

13. A method of agglomerating fresh superphosphate comprising adding about 10% by weight of fully cured den superphosphate to the fresh den superphosphate, and passing the fresh den superphosphate through a rotary drum, inspecting the mixture in the drum while adding an aqueous medium to obtain a mixture having a moisture content about the same as the moisture content of the fresh superphosphate, and regulating the aqueous medium to conform with the requirements as determined by the inspection.

14. A method of manufacturing granular superphosphate comprising adding ground phosph-

phate rock to fresh superphosphate, then adding approximately 2% of an aqueous medium to bring the mixture to the desired consistency for agglomeration, agglomerating the mixture, and then drying the agglomerated particles.

15. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing ground phosphate rock with the fresh superphosphate, then adding about 2% of an aqueous medium to bring the mixture to a moisture content about the same as the fresh superphosphate, then agglomerating by agitating, and then drying while agitating.

16. In the manufacture of granular superphosphate, controlling the consistency of superphosphate fresh from the den to enable the agglomeration of particles of substantially uniform size by mixing approximately 10% by weight of ground phosphate rock with the fresh superphosphate, then adding an aqueous medium to bring the mixture to a moisture content about the same as the fresh superphosphate, agglomerating the material by tumbling in a rotary drum, and drying the agglomerated particles while tumbling in a rotary drum.

17. A method of agglomerating fresh superphosphate comprising adding ground phosphate rock to the fresh den superphosphate, and passing the fresh den superphosphate through a rotary drum, inspecting the mixture in the drum while adding an aqueous medium to obtain a mixture having a moisture content about the same as the fresh superphosphate, and regulating the aqueous medium to conform with the requirements as determined by the inspection.

18. A method of agglomerating superphosphate containing material comprising adding dry finely divided material thereto, while adding an aqueous medium to bring the mixture to a moisture content about the same as the superphosphate, agglomerating the mixture and then drying the agglomerated particles.

19. A method of treating den superphosphate to manufacture a granular superphosphate fertilizer comprising adding 10% by weight of dry finely divided material to the den superphosphate, adjusting the moisture content of the mixture to 10½%, forming the mixture into agglomerated particles, tumbling the agglomerated particles in a zone of hot gases until the moisture content of the particles is reduced to about 5% and discharging the particles from the drying zone.

20. A method of treating den superphosphate to manufacture a granular superphosphate fertilizer comprising adding 10% by weight of dry finely divided material to the den superphosphate, adding about 2% of water to the mixture thereby raising the moisture content to around 10½%, forming the mixture into agglomerated particles, tumbling the particles in a zone of hot gases until the moisture content of the particles is reduced to approximately 5%, and discharging the particles from the drying zone.

21. A method of preparing granular superphosphate which comprises mixing with fresh den superphosphate a minor proportion of well cured den superphosphate, adding water thereto in amount to give the mass the proper consistency for agglomeration, and tumbling the mixture in a rotary drum until granules are formed.

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