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1599193

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(54) PRILL TOWER RAKE

(71) We, W. R. GRACE & Co., a Corporation organised and existing under the Laws of the State of Connecticut, United States of America, of Grace Plaza, 1114 Avenue of the Americas, New York, New York 10036, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for the collection of prills in a prilling tower.

According to one aspect of the present invention we provide a prilling tower including prill cooling and collecting apparatus comprising a horizontal screen disposed to collect prills that have fallen through the tower, the screen having at least one opening therein for exit of prills; a rake above the screen with arms rotating about the screen centre for sweeping the prills inwardly across the screen towards said at least one opening; drive means carried by the rake for rotating the rake; and an air plenum beneath the screen to provide a flow of fluidising, cooling air through the screen. In use of the prilling tower, the rotating rake moves through the fluidised bed of prills and directs the prills into said at least one exit opening which may comprise one or more collection chutes in the perforated screen.

The invention also provides a process for cooling and collecting urea prills that have fallen through a circular prilling tower, without subsequently passing them through a separate cooler, such process comprising collecting said prills on a fluidised bed of prills substantially one inch (25 mm) thick on a horizontal screen, and fluidised by air at 0°F to 120°F. (−18°C to 49°C) whereby the prills are cooled to 100°F to 140°F. (38°C to 60°C); rotating a multibladed rake through the bed to further mix the prills and to sweep them towards a collection exit, the fluidised bed having a shape such that the majority of the bed is swept by said multi-bladed rake; and collecting the thus cooled prills.

In order that the present invention may more readily be understood the following description is given, merely by way of example with reference to the accompanying drawings in which:—

Figure 1 shows a plan view of one form of apparatus according to this invention; and

Figure 2 is a sectional view of the apparatus of Figure 1, taken along the line 2—2.

Referring to Figure 1, it will be seen that immediately within the outer shell 1 of a circular prilling tower along the periphery of the tower, is a circumferential rail 2. Rail 2 is supported by stub beams 19 (Figure 2) affixed to ring plate 23, which is affixed to the tower shell 1. Pinion ring 26 is affixed to the bottoms of stub beams 19 and runs directly underneath the rail 2 around the inner circumference of the tower 1 as shown in Figure 2. The prill rake shown generally at 3, is supported by radially outer wheels 4, one on each side of each arm of the rake, the wheels 4 riding on rail 2 and are journalled in blocks 5. Electric motors 6 underneath the rake arms, near the end of the arm, drive the rake *via* gear reducers 20 through rake gears 7, meshing with pinion ring 26 (as can be best seen in Figure 2).

The rake 3 carries a plurality of rake beams 8, plus a square grate assembly shown generally at 9. Beneath the rake 3 is a horizontal stationary perforated screen 10, which carries one or more prill exit chutes 11, 11*a*. Outside the confines of the perforated screen 10, the outer floor 12 of the prill tower is solid (i.e. imperforate) and, like the screen 10, is horizontal. Beneath the outer floor 12 and the screen 10 is a conveyor belt system 13 for collecting the prills and dropping them onto shaker screens 14, 14*a*, both shown by dotted lines in Figure 1.

Referring now to Figure 2, there will be seen a foundation block 15 carrying a pivot shaft 16 for the rake 3. This shaft 16 is hollow and does not turn. In addition to providing a pivot support for the rake 3, it carries the electric lines running to the motors 6. A part-conical air plenum 17 around the shaft 16 carries an incoming air duct 18.

The gear and motor system is protected by a sheet metal cover 21 shown in dotted lines in Figure 2. Likewise the rake 3 can option-

ally be protected by a sheet metal shroud 22 in the shape of an inverted V. This shroud 22, where fitted, also covers the electric lines running to the motors 6 from support shaft 16.

Either or both of the prill exit chutes 11 and 11*a* can be closed by slide gates 24 and 24*a* actuated by respective air cylinders 25 and 25*a*.

Molten urea at approximately 280°F. is sprayed from the top of the prill tower 1 from an arrangement of shower-head type devices (not shown) down through a stream of rising atmospheric air. This rising air emanates from two sources, namely through ports in the tower side wall or shell 1 above the rake, and from the air duct 18. The portion of this air which was introduced along air duct 18 rises through the fluidising screen 10, and so on upwards, where it mingles with the other portion of the air, and passes on up through the prilling tower. The liquid urea droplets are cooled through the solidification point to about 180°F. The newly formed urea prills accumulate on the flat bottom of the prill tower, said bottom comprising imperforate outer floor 12 plus perforate screen 10, and are moved to the centre of screen 10 by the rake 3, as the rake rotates around pivot shaft 16. The electric motor 6 drives the rake *via* gear 7, because of the driving contact of the gear 7 with pinion ring 26. Wheels 4 riding on rail 2 carry the weight of the rake 3.

About one-third of the circular horizontal cross-sectional area of the base of the prill tower 1 consists of a fluid bed cooler (i.e. screen 10) through which atmospheric air is blown. The new prills are cooled to a nominal temperature of about 100°F. on the fluid bed. The grate 9 breaks up any oversized prill aggregations. At the centre of the fluid bed the discharge ducts 11 and 11*a* are arranged such that the cooled prills move to these ducts and tumble down on to conveyor belts 13 and 13*a*, which carry the prills from the tower. The prills thus recovered can be treated on shaker screens 14 and 14*a* for selection of prills of any desired screen size. When preparing very small prills (i.e. of an average size of 850 microns diameter) the air flow in duct 18 can be closed off, and these small prills will cool without being fluidised. Feed grade prills are of this small type.

Although we have shown exit chutes 11 toward the centre of the fluidised bed, actually one or more exit chutes can be placed anywhere within the prill fluidising area, and the rake beams 8 correspondingly adjusted to carry prills to such exit(s).

In prior art systems, when a rake is used as the device for removing newly formed prills from a prill tower it is usual to provide an external prill cooler. This cooler is generally a rotating drum through which atmospheric air is blown. Not only is this an additional piece of rotating equipment which requires operation and maintenance, but also the cooler requires its own dust control system and affects the surface of the prills, which promotes the tendency to cake.

By coupling the prill tower fluid bed cooler with the rake 3 it is possible to (1) eliminate the need for a separate large rotating drum cooler and (2) eliminate the need for the cooler's dust control system, since the dust produced by the fluid bed cooler in the presently proposed system is captured in the primary prill tower dust control system. A further improvement is provided in that the rake 3 reduces the detrimental effect caused by localised clogging of the fluid bed, which is caused by drops of molten urea. These factors combine to provide a more efficient and reliable prilling process.

We have tried a variation of this apparatus in which the fluidising prills were caused to flow over weirs at the perimeter of the fluidising bed, without any action by a rake. However, to lead the prills falling in the tower into the central prill fluidising area, it was necessary for them to drop down through a cone, apex down, thereby to concentrate the prill flow into the area of the perforated screen. When this is done, however, the hot prills tended to cake on the inner surfaces of the converging cone walls. It was necessary to shut the tower down from time to time to clean out the cone. We have no such trouble with the apparatus of the present invention.

In the preferred embodiment of the apparatus, the prill tower 1 is about 200 feet (61.5 metres) high by 50 feet (15.4 metres) inner diameter. It carries conventional dust scrubbers on its top. The capacity is 1200 short tons (1,090,000 Kg) of urea per day. At the spray head the urea temperature is 285°F. (140°C). Prill size is 850—2100 microns diameter.

The rake 3 is 50 ft. (15.4 metres) long, and rotates at 1.5 rpm. The motors 6 and 6*a* are 25 horsepower (18.64 kilowatts) each.

The square grate 9 is 11 feet (3.4 metres) square.

The screen 10 is wire mesh (built from several pieces), and the mesh is No. 20, U.S. Screen.

The depth of the fluidising prill bed is about one inch. (25 mm). The rake beams 8 dip into the bed by about 1/2 inch (12.5 mm).

Air is blown into the unitary air plenum 17 at the rate of 175,000 feet^3/minute (5097 m^3/min). This provides a flow through the fluidising screen of about 300 feet^3/min/sq.ft. (10.25 m^3/min/m^2). The air feed is drawn from ambient air, e.g. at atmospheric pressure and at a temperature of 0 to 120°F. (−19°C to 49°C). Additional air (about 325,000 feet^3/min (9467 m^3/min) is blown into the tower through ports in the side of the

tower (not shown), above the rake 3.

The prills are cooled preferably to 100—140°F. (38°C to 60°C).

As shown in Figure 1, the square, four-sided grate 9 carries prill sweeping arms 9*a* which gather in prills from the central region of the screen 10 and sweep them through the grate towards the prill collection chutes 11 and 11*a*. Some of these arms extend inwardly as far as a circular support 9*b*; the others are located near opposed corners of the square grate 9.

Thus, during operation of the prill-collecting rake, prills from near the outer part of the tower floor are initially swept in radially inwardly directed incremental steps by the successive passes of the rake arms until eventually they are within the area of sweeping of the grate arms 9*a* whereupon they are rapidly gathered in the radially inward direction through the grate 9 and above the exit chutes 11, 11*a* to leave the tower.

WHAT WE CLAIM IS:—

1. A prilling tower including prill cooling and collecting apparatus comprising a horizontal screen disposed to collect prills that have fallen through the tower, the screen having at least one opening therein for exit of prills; a rake above the screen with arms rotating about the screen centre for sweeping the prills inwardly across the screen towards said at least one opening; drive means carried by the rake for rotating the rake; and an air plenum beneath the screen to provide a flow of fluidising, cooling air through the screen.

2. A prilling tower according to claim 1, in which an imperforate floor surrounds the horizontal screen.

3. A prilling tower according to claim 1 or 2, wherein said plenum is a unitary chamber below the screen and from which cooling air flows upwardly through the screen to fluidise the prills on the screen.

4. A prilling tower according to claim 1, 2 or 3, in which the rake is supported at least in part on a circumferential support carried by the prilling tower.

5. A prilling tower according to claim 4, in which the said circumferential support is a circular rail.

6. A prilling tower according to claim 5, in which the rake support comprises wheels that make rolling contact with the rail.

7. A prilling tower according to claim 4, 5 or 6, in which the circumferential support includes a ring gear.

8. A prilling tower according to claim 7, in which the rake drive means is located at the ends of the rake arms to rotate the rake by drive contact with the ring gear.

9. A prilling tower according to any one of the preceding claims, in which the rake has at its centre a four-sided grate carrying prill-sweeping arms.

10. A process for cooling and collecting urea prills that have fallen through a circular prilling tower, without subsequently passing them through a separate cooler, such process comprising collecting said prills on a fluidised bed of prills substantially one inch (25 mm) thick on a horizontal screen, and fluidised by air at 0°F to 120°F. (−18°C to 49°C) whereby the prills are cooled to 100°F to 140°F (38°C to 60°C); rotating a multi-bladed rake through the bed to further mix the prills and to sweep them towards a collection exit, the fluidised bed having a shape such that the majority of the bed is swept by said multi-bladed rake; and collecting the thus cooled prills.

11. Prill collecting and cooling apparatus according to claim 1 constructed and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

12. A process for cooling and collecting urea prills according to claim 10, substantially as hereinbefore described with reference to the accompanying drawings.

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1599193 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

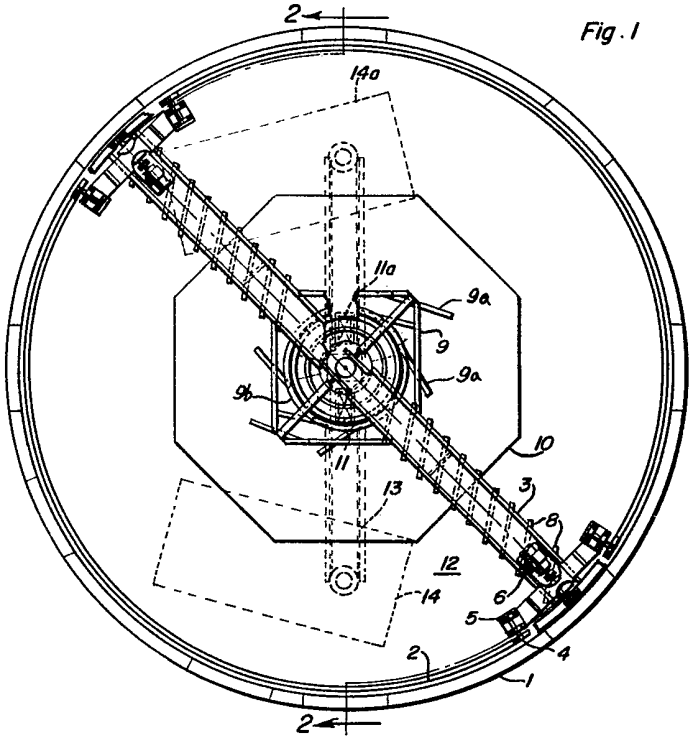

Fig. 1

1599193 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

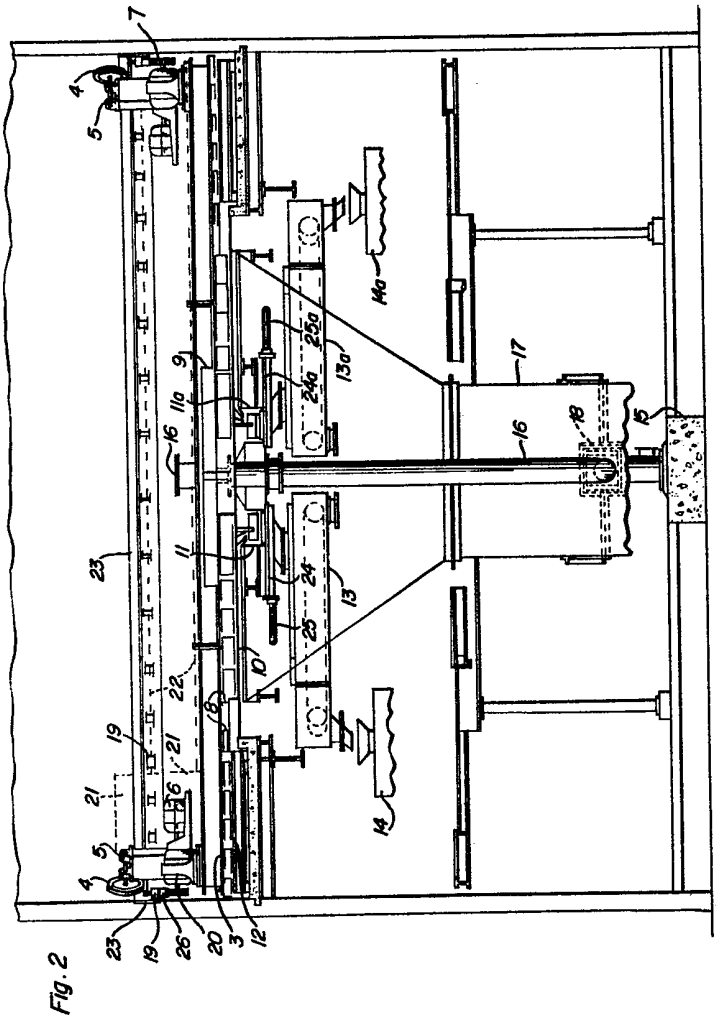

Fig. 2