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(54) IMPROVEMENTS IN OR RELATING TO APPARATUS FOR CONTACTING ONE SUBSTANCE WITH ANOTHER SUBSTANCE

(71) I, ERIC HARALD CARLSSON, of Planteringsvägen 7B, 262 00 Angelholm, Sweden, a subject of the King of Sweden, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to apparatus for contacting one substance with another substance and of the type described in British patent specification 1,265,719.

British patent specification 1,265,719 discloses a drying apparatus of a highly efficient type. It has a very comprehensive field of use comprising especially the drying or thickening of liquid, semi-solid or solid materials. However, the field of use of this apparatus is not restricted to drying alone, but comprises any establishing of contact between two fluids or materials, such as liquid-gas contact, gas-gas contact and, liquid-liquid contact, for chemical reactions. This applies also to the field of use of the apparatus according to the present invention, which should be borne in mind when the invention is explained in the following with reference to the drying of liquid, semi-solid or solid materials with gas.

According to the present invention there is provided apparatus for contacting a first substance, such as a liquid, semi-solid or solid material, with a second substance, such as drying gas, the apparatus comprising a container having a bed with a plurality of spherical contact bodies adapted to be circulated through the container in a path which, in the order mentioned, comprises a material application zone in which the first substance is to be applied to the contact bodies, a main processing zone located in the upper part of the bed, a peripheral point of introduction for the second substance, a final processing zone located in the lower part of the bed, and a separation zone located beneath the bed for separating processed material from the contact bodies, the separation zone inclu-

ding a perforated bottom permitting the passage of processed material therethrough but retaining the contact bodies, and means for returning the contact bodies to the material application zone and including a centrally disposed screw conveyor extending downwardly toward the perforated bottom and comprising a sleeve surrounding the screw and rotatable relative thereto, wherein the material application zone include material application means rotatably mounted at the upper end of the screw conveyor and including spreading means mounted for rotation with the sleeve of the screw conveyor, and the screw conveyor at its lower end has separating means consisting of rotary infeed arms secured to the sleeve of the screw conveyor for rotation therewith and for feeding contact bodies from the lowermost part of the bed to a gap formed within and beneath the infeed arms, the gap being formed by an inner separation rotor connected to the shaft of the screw conveyor for rotation therewith and an outer stationary separation stator concentric with the inner separation rotor, the perforated bottom being disposed beneath said gap.

To improve the separation of processed material from the contact bodies, the separation rotor and the separation stator are preferably provided with plates projecting into the gap.

During treatment of material which tends to become tacky when heated, the gap may be provided around its upper periphery with gas supply means for supplying cooling air.

In a preferred embodiment of the apparatus for treating liquid material with gas, the material application means comprise a bowl disposed upon and extending around the rotary sleeve, a rotary liquid receiver connected to the shaft of the screw conveyor and extending down into said bowl for introducing the liquid into said bowl, rotary spiral arms connected to the shaft of the screw conveyor, extending down into the

bowl and adapted to tumble and feed the contact bodies to the outer margin of said bowl, rotary spreading arms connected with the outer periphery of said bowl and extending toward the outer wall of the container and adapted to spread contact bodies arriving from said bowl over the bed in the container.

The liquid receiver preferably comprises a receiving tray disposed around the shaft of the screw conveyor and discharge pipes extending downwardly from said receiving tray into the bowl.

In a preferred embodiment of the apparatus for treating semi-solid or pasty material with a gas, the material application means comprise supply means for supplying the semi-solid or pasty material through an upper hollow part of the screw conveyor shaft to distributing pipes located at the lower part of said hollow part, mixing arms located at the upper part of the screw conveyor for mixing the first substance discharged from the distributing pipes with the contact bodies, a bowl mounted on and extending around the rotary sleeve, spiral arms connected with the screw conveyor shaft and extending down into the bowl, spreading pipes connected with the bowl, and a circular lid covering the bowl and extending from the screw conveyor shaft to the distributing pipes.

Advantageously the supply means are in the form of an auxiliary screw conveyor located in the upper hollow part of the screw conveyor shaft, the mixing arms being disposed above the distributing pipes and on respectively, the shaft and the sleeve of the screw conveyor.

In a preferred embodiment of the apparatus for treating solid material with gas, the material application means comprise a bowl mounted on and extending around the rotary sleeve, rotary spreading arms connected with the outer periphery of the bowl and extending toward the outer wall of the container, said spreading arms serving to distribute the contact bodies arriving from the bowl over the bed within the container, and a carriage for spreading the solid material, disposed between the outer margin of the bowl and the wall of the container and above the bed, said carriage being provided with an opening in its bottom and having disposed therein a rotary conical spreading roller, said carriage being adapted to rotate about the centre of the container ahead of the spreading arm in the direction of rotation.

In a preferred embodiment of the apparatus according to the invention for treating chip material with gas, the material application means comprise discharge passages located at the upper part of the screw conveyor on the rotary sleeve, discharge arms located on the upper part of the screw conveyor shaft for discharging the chip material

and the contact bodies through the discharge passages, a lid located above the discharge passages and the discharge arms and extending cylindrically around the uppermost part of the screw conveyor shaft, said lid surrounding a supply space for the first substance, and supply means for supplying said chip material into the supply space enclosed by the lid.

The invention will be more fully understood from the following description of embodiments thereof, given by way of example only, reference being made to the accompanying drawings, in which:—

Fig. 1 is a diagrammatic view of a plant comprising a drying apparatus according to the invention;

Fig. 2 shows an apparatus according to the invention, the infeed means of which are designed for liquid material;

Fig. 3 is a cross-sectional view of the apparatus shown in Fig. 2, taken along line III—III in Fig. 2;

Fig. 4 is a partial view of an apparatus according to the invention, with infeed means for semi-solid material;

Figs. 5, 6 and 7 are partial views of infeed means for solid material in an apparatus according to the invention;

Fig. 8 is a partial view of another embodiment of an apparatus according to the invention, with supply means for semi-solid or viscous material;

Fig. 9 is a partial view of an embodiment of an apparatus according to the invention, with supply means for chipped products.

The plant illustrated in Fig. 1 comprises a fan 2 driven by a motor 1 and connected to a main pipe 3 comprising an air filter 4 and a heat exchanger 5 in which the air circulating through the main pipe can be heated to an appropriate temperature. The heat exchanger 5 may be rendered inoperative when highly sensitive material is to be treated, so that air at or below room temperature flows through the main pipe 3 to an apparatus container 6 of a drying apparatus according to the invention. To this end, the pipe 3 is connected to a passage 7 extending around the container 6 and communicating with the interior thereof. The lower part of the container 6 is connected via a pipe 8 to a number of cyclones 9 which, when dry matter is to be recovered from a liquid, as in the embodiment illustrated, serve to separate the dry matter from the drying air which escapes to atmosphere via an air pipe 10 and a suction fan 12 operated by a motor 11 or, as shown, is fed back into the main pipe 3. The drying air, saturated with the gas from the liquid, also leaves the container 6 through pipes 13.

If a wholly closed system is desired or necessary, for instance for treating evil-smelling or poisonous matter, the drying air or gas leaving the container 6 via the pipes

13 is recirculated to the fan 2, as is shown in Fig. 1. The liquid that has evaporated during drying is separated by means of a condenser A, for instance a scrubber, before the drying gas is recirculated to the fan 2.

As mentioned above, the apparatus shown in Fig. 2 is of the generic type disclosed by British patent specification 1,265,719 and the details common to both apparatuses, for instance the contact bodies, will therefore be but briefly described. Furthermore, the apparatus according to Fig. 2 will be described with reference to the drying of liquid with gas.

The drying apparatus comprises a container 6 with a large number of spherical contact bodies 14, preferably of plastics material. Situated in the centre of the container, is a screw conveyor 16 operated by a motor 15 for circulating the contact bodies 14 from the lower to the upper part of the container. During operation, the contact bodies are circulated continuously by the screw conveyor 16 in an upward direction within the central part of the container and downwardly under the action of gravity within the circumferential parts of the container 6 surrounding the central part with the screw conveyor 16. Material to be dried is supplied through one or more conduits 17 within the upper part of the container. Drying gas is supplied through the passage 7 disposed around the periphery of the container and communicating, via openings in the container shell, with in-air passages 18. Ready-processed material is discharged through pipe 8 (Fig. 1). Consumed drying gas is discharged both through pipe 8 and through pipes 13 (see Fig. 1). From the operational point of view, the apparatus is divided into four zones, viz. a material application zone, a main drying zone, a final drying zone, and a separation zone.

In the embodiment illustrated, the material application zone comprises the conduit 17 feeding the liquid or slurry to be dried to material application means including a liquid receiver 19 in the form of a planar tray provided at its margin with downwardly directed discharge pipes and mounted around the screw conveyor shaft. The discharge pipes terminate just above a wetting bowl 20 secured around a sleeve 21 of a screw conveyor. The sleeve 21 is rotatably mounted around the screw 16 of the conveyor by means of a sprocket 22, a chain 23, and a motor 24 (Fig. 3). Rotation is preferably conducted in such a manner that, when the screw 16 is rotated in one direction, the sleeve will rotate in the other direction. The speeds of rotation are not critical, but may be varied as deemed suitable. Extending into the wetting bowl 20 are also, in addition to the discharge pipes of the liquid receiver 19, a pair of spiral arms 25 forming part of the material application means and connected with the screw

conveyor shaft. The liquid receiver serves to conduct liquid from the conduit 17 directly down into the wetting bowl 20, without coming into contact with e.g. the upper side of the spiral arms 25 on which thick layers of dried liquid would otherwise collect. In the wetting bowl, the liquid comes into contact with the contact bodies 14 that have been transferred thereto by the screw conveyor 16. Under the action of the spiral arms 25, the contact bodies are tumbled within the liquid so that an intimate contact and a uniform liquid layer is established on the surface of the contact bodies which are then led towards and beyond the margin of the wetting bowl 20 where spreading means in the forms of arms 26 take over. The spreading arms 26 which extend from the outer margin of the wetting bowl 1, towards the inner wall of the container 6, are secured to said outer margin and consequently are rotated therewith. The spreading arms serve to spread the contact bodies in a uniform layer on the underlying bed 27, without producing an angle of repose.

The second zone which is a main drying zone, begins at the bed 27 of coated contact bodies 14 and comprises the upper part of said bed. In the main drying zone, the downwardly travelling contact bodies encounter an upwardly directed drying gas stream from the radially arranged in-air passages 18. This countercurrent transport of contact bodies and drying gas provides for maximum drying effect in the main drying zone. After the main drying zone and in the lower part of the bed, more particularly beneath the point of gas introduction in the in-air passages 18, the final drying zone begins in which, as the name indicates, final drying of the material applied to the contact bodies takes place. In contradistinction to the main drying zone, the gas in the final drying zone is conducted concurrently with the contact bodies, thereby ensuring that the last drying phase is conducted as leniently as possible. This is especially important when it is desired to avoid overheating of sensitive materials, such as foodstuffs and the like. Finally, the contact bodies 14 arrive at the fourth and last zone, i.e. the separation zone which is located in the lowermost part of the container 6 and in which the ready-processed material is separated from the contact bodies which are then returned to the material application zone by the screw 16 for the next drying cycle.

As will appear from Fig. 2, the separation zone comprises several cooperating members, the first of which are two infeed arms 28 located in the lowermost part of the bed and directly above a constriction in the cross-sectional area of the container. As will appear from Fig. 3, the infeed arms 28, as seen from above, are of spiral shape with

an area increasing from the centre of the container. The height of the inlet opening of the infeed arms is substantially constant across the cross-sectional area, as shown in Fig. 2, and preferably corresponds to the total diameter of 2 to 5, preferably 3 contact bodies. This has proved to be a favourable dimension since it prevents the spherical contact bodies from getting stuck in the passages of the infeed arms. The above-mentioned constriction, together with a separation rotor 29 located centrally within the lowermost part of the container, forms a relatively narrow circular gap towards which the contact bodies 14 are moved by the infeed arms 28. In order completely to separate the ready-processed material from the surface of the contact bodies, the separation rotor 29 in the gap is provided with plates 30 projecting into said gap and made of stainless steel or other chemically resistant material, and furthermore the gap is formed by a separation stator 31 which, like the separation rotor, is provided with plates 32 projecting into the gap. The separation rotor 29 is connected with the shaft of the screw 16 and formed as a cylinder surmounted by a cone on the outside of the sleeve 21. Experiments have shown that the radial distance from the centre line of the gap to the centre of the apparatus is preferably about 0.5-1 m since a greater distance would result in unacceptably high peripheral speeds of the plates 30 and the separation rotor 29. It should be borne in mind that this applies to a rate of revolution of about 10-40 rpm of the screw 16, and that with other speeds other values are, of course, obtained. Provided underneath the gap is a perforated separation bottom 33 which is so shaped that it allows the dried material to pass, while retaining the contact bodies freed from this material. The clean contact bodies are then conveyed upwardly to the material application zone by the screw 16 extending down against the separation bottom.

The separation device operates on the following principle. In the lower part of the bed 27, the contact bodies 14 with the material in a substantially dry state are passed cocurrently with a drying gas stream towards the infeed arms 28. The bodies 14 are caught by the infeed arms and moved towards the centre of the container to the annular separation gap. When passing through the gap, the bodies are moved into intimate rubbing contact with one another and with the plates 30, 32 projecting into the gap and rotating relative to one another, whereby dried material is completely and rapidly removed from the contact bodies 14. This removal is further facilitated by the intense gas stream which the reduction in area produces in the gap and which carries along all loose flakes of dried material and

ensures that the material is moved in the intended direction through the perforated separation bottom 33 to the pipe 8 for conveyance to the separation cyclones 9 shown in Fig. 1. By suitable control of the suction fan 12 and the pressure fan 2 the gas flow and thus the temperature in the container and the gap can be adjusted to the desired value.

The apparatus shown in Fig. 2 has an additional passage 34 extending around the lower cylindrical part of the container 6 in conjunction with the previously mentioned annular separation gap. The passage 34, which can be dispensed with for most applications, serves to supply cooling air to eliminate any tendency to tackiness in materials showing this tendency when heated, and to facilitate separation of the dried material.

Fig. 4 shows another embodiment of the infeed means which is especially intended for feeding semi-solid or paste-like material. To establish adequate contact between the material as fed and the contact bodies, and to ensure that a material layer is formed on the surface of the contact bodies, the arrangement is such that the material as fed will contact the contact bodies already at a distance down into the screw conveyor. For this reason, the shaft of the screw conveyor 16 is hollow in its upper part 35, and within this hollow part of the shaft an auxiliary screw conveyor 36 is provided which is operated by a motor 37 and forms part of material application means. In the embodiment illustrated, the upper end of the hollow part of the shaft of the screw 16 is formed as a receiving hopper 38 for the material which is to be introduced, and the lower end of the hollow part of the shaft has distributing pipes 39 through which the material is discharged into the space between the screw 16 and the sleeve 21. As is shown in Fig. 4, the feed screw 16 terminates just below the distributing pipes 39. Above the distributing pipes 39 a mixing zone 40 is provided, comprising mixing arms 41 and 42 secured to the shaft of the screw 16 and to the inner wall of the sleeve 21, respectively. These mixing arms contribute to the establishment of the above-mentioned adequate contact required between the supplied material and the contact bodies. Like the apparatus according to Fig. 2, the apparatus shown in Fig. 4 is provided at the upper end of the sleeve 21 with a bowl 20 secured around the sleeve 21, and with a pair of rotary spiral arms 25 projecting into the bowl 20. As in Fig. 2, the spiral arms 25 of Fig. 4 are connected with the shaft of the screw 16 and adapted, upon rotation, to move the contact bodies towards the margin of the bowl. To provide for an efficient spreading of the coated contact bodies 14 over the underlying bed, the apparatus according to Fig. 4 is

provided with spreading means in the form of pipes 43 secured to the margin of the bowl 20. The spreading pipes 43 preferably extend from the bowl margin a short distance downwardly toward the bed. Furthermore, the spreading pipes, as seen from above, may preferably show a slight rearward curvature in the direction of rotation. To establish a positive feed of the coated contact bodies through the spreading pipes 43, and also to protect the coated bodies, the bowl is provided with a lid 44 that can be removed for inspection and repairs.

Figs. 5, 6 and 7 show a third embodiment of the infeed means designed especially for feeding and distributing solid material, such as grass. As in Fig. 2, the apparatus is equipped with a screw conveyor including a screw 16 and a sleeve 21, material application means including a bowl 20 secured around the sleeve, and spreading means including one or more spreading arms 26 secured to the bowl. However, when the material to be treated is solid, the contact bodies 14 are not in the bowl 20 contacted by the supplied material in the bowl 20, as in the embodiment according to Fig. 2. Instead, contact is first established during distribution of the bodies over the bed 27. For this reason, the conduit 17 and the liquid receiver 19 of Fig. 2 have in this embodiment been replaced by a spreading carriage 45 disposed above the bed 27 and so designed that solid material, such as grass, is spread uniformly over the bed 27 by means of a conical spreading roller 46 disposed in the bottom of the carriage. The carriage is preferably secured to the bowl 20 for rotation therewith about the centre of the container 6. For rotation, the conical spreading roller 46 is provided at its end facing the container wall with a gear engaging corresponding teeth around the periphery of the container wall, and is mounted with its other end in the bowl 20. To provide for a uniform spreading of the material over each unit area of the bed 27, the opening in the bottom of the carriage 45 and the roller corresponding to said opening are conically tapered towards the centre of the container 6. The spreading roller shown in the drawings is a spiked roller, but it will be obvious that other roller types suited to the spreading of solid or piece material may also be employed. Furthermore, it is obvious that the carriage 45 instead of having a single spreading roller 46 may have two or more spreading rollers, and that the apparatus may have two or several carriages 45 travelling in the path indicated by the arrow in Fig. 5 across the bed 27. To achieve the desired stratified structure of the bed, illustrated in Fig. 6, the spreader arm 26 should preferably rotate immediately after the carriage 45, thereby to prevent spread, light-weight material, such as grass, from being lifted and

carried along by the upwardly directed gas stream passing through the bed 27.

The embodiment, illustrated in Fig. 8, for viscous materials corresponds substantially to the embodiment illustrated in Fig. 4, like details being identified by like numerals. However, the infeed material application means according to Fig. 8 is somewhat simplified relative to the arrangement according to Fig. 4 and lacks inter alia the auxiliary screw 36 and the receiving hopper 38 shown in Fig. 4. Instead, the material is fed directly through a pipe 47 connected to the hollow part of the screw shaft, as shown in the Figure. The material is fed through the pipe 47 to the hollow part 35 of the screw and the distributing pipes 39 by feed means (not shown), preferably in the form of screw conveyor means.

Fig. 9 shows an embodiment of infeed material application means particularly useful for feeding chip products. As in the embodiments illustrated in Figs. 2 and 4, the screw 16 is provided in its upper part with discharge arms 25 discharging a mixture of contact bodies and chipped material through spreading passages 43 connected with the rotary sleeve 21 disposed around the screw conveyor. Situated above the discharge arms 25 and the spreading passages 43 is a lid 44 extending upwardly in the form of a cylindrical shell and enclosing a space into which the chipped material is fed by a screw conveyor 48.

There is thus provided an apparatus giving an efficient supply of material to be treated in the apparatus and an efficient separation of the processed material. It is thus possible to treat materials of widely different consistencies and structures in one and the same apparatus with minor modifications only. This has not been possible before. Furthermore, the apparatus can be very large and still operate satisfactorily and reliably.

WHAT I CLAIM IS:—

1. Apparatus for contacting a first substance such as a liquid, semi-solid or solid material, with a second substance, such as a drying gas, the apparatus comprising a container having a bed with a plurality of spherical contact bodies adapted to be circulated through the container in a path which, in the order mentioned, comprises a material application zone in which the first substance is to be applied to the contact bodies, a main processing zone located in the upper part of the bed, a peripheral point of introduction for the second substance, a final processing zone located in the lower part of the bed, and a separation zone located beneath the bed for separating processed material from the contact bodies, the separation zone including a perforated bottom permitting the passage of processed



provided with spreading means in the form of pipes 43 secured to the margin of the bowl 20. The spreading pipes 43 preferably extend from the bowl margin a short distance downwardly toward the bed. Furthermore, the spreading pipes, as seen from above, may preferably show a slight rearward curvature in the direction of rotation. To establish a positive feed of the coated contact bodies through the spreading pipes 43, and also to protect the coated bodies, the bowl is provided with a lid 44 that can be removed for inspection and repairs.

Figs. 5, 6 and 7 show a third embodiment of the infeed means designed especially for feeding and distributing solid material, such as grass. As in Fig. 2, the apparatus is equipped with a screw conveyor including a screw 16 and a sleeve 21, material application means including a bowl 20 secured around the sleeve, and spreading means including one or more spreading arms 26 secured to the bowl. However, when the material to be treated is solid, the contact bodies 14 are not in the bowl 20 contacted by the supplied material in the bowl 20, as in the embodiment according to Fig. 2. Instead, contact is first established during distribution of the bodies over the bed 27. For this reason, the conduit 17 and the liquid receiver 19 of Fig. 2 have in this embodiment been replaced by a spreading carriage 45 disposed above the bed 27 and so designed that solid material, such as grass, is spread uniformly over the bed 27 by means of a conical spreading roller 46 disposed in the bottom of the carriage. The carriage is preferably secured to the bowl 20 for rotation therewith about the centre of the container 6. For rotation, the conical spreading roller 46 is provided at its end facing the container wall with a gear engaging corresponding teeth around the periphery of the container wall, and is mounted with its other end in the bowl 20. To provide for a uniform spreading of the material over each unit area of the bed 27, the opening in the bottom of the carriage 45 and the roller corresponding to said opening are conically tapered towards the centre of the container 6. The spreading roller shown in the drawings is a spiked roller, but it will be obvious that other roller types suited to the spreading of solid or piece material may also be employed. Furthermore, it is obvious that the carriage 45 instead of having a single spreading roller 46 may have two or more spreading rollers, and that the apparatus may have two or several carriages 45 travelling in the path indicated by the arrow in Fig. 5 across the bed 27. To achieve the desired stratified structure of the bed, illustrated in Fig. 6, the spreader arm 26 should preferably rotate immediately after the carriage 45, thereby to prevent spread, light-weight material, such as grass, from being lifted and

carried along by the upwardly directed gas stream passing through the bed 27.

The embodiment, illustrated in Fig. 8, for viscous materials corresponds substantially to the embodiment illustrated in Fig. 4, like details being identified by like numerals. However, the infeed material application means according to Fig. 8 is somewhat simplified relative to the arrangement according to Fig. 4 and lacks inter alia the auxiliary screw 36 and the receiving hopper 38 shown in Fig. 4. Instead, the material is fed directly through a pipe 47 connected to the hollow part of the screw shaft, as shown in the Figure. The material is fed through the pipe 47 to the hollow part 35 of the screw and the distributing pipes 39 by feed means (not shown), preferably in the form of screw conveyor means.

Fig. 9 shows an embodiment of infeed material application means particularly useful for feeding chip products. As in the embodiments illustrated in Figs. 2 and 4, the screw 16 is provided in its upper part with discharge arms 25 discharging a mixture of contact bodies and chipped material through spreading passages 43 connected with the rotary sleeve 21 disposed around the screw conveyor. Situated above the discharge arms 25 and the spreading passages 43 is a lid 44 extending upwardly in the form of a cylindrical shell and enclosing a space into which the chipped material is fed by a screw conveyor 48.

There is thus provided an apparatus giving an efficient supply of material to be treated in the apparatus and an efficient separation of the processed material. It is thus possible to treat materials of widely different consistencies and structures in one and the same apparatus with minor modifications only. This has not been possible before. Furthermore, the apparatus can be very large and still operate satisfactorily and reliably.

WHAT I CLAIM IS:—

1. Apparatus for contacting a first substance such as a liquid, semi-solid or solid material, with a second substance, such as a drying gas, the apparatus comprising a container having a bed with a plurality of spherical contact bodies adapted to be circulated through the container in a path which, in the order mentioned, comprises a material application zone in which the first substance is to be applied to the contact bodies, a main processing zone located in the upper part of the bed, a peripheral point of introduction for the second substance, a final processing zone located in the lower part of the bed, and a separation zone located beneath the bed for separating processed material from the contact bodies, the separation zone including a perforated bottom permitting the passage of processed



material therethrough but retaining the contact bodies, and means for returning the contact bodies to the material application zone and including a centrally disposed screw conveyed extending downwardly toward the perforated bottom and comprising a sleeve surrounding the screw and rotatable relative thereto, wherein the material application zone includes material application means rotatably mounted at the upper end of the screw conveyor and including spreading means mounted for rotation with the sleeve of the screw conveyor, and the screw conveyor at its lower end has separating means consisting of rotary infeed arms secured to the sleeve of the screw conveyor for rotation therewith and for feeding contact bodies from the lowermost part of the bed to a gap formed within and beneath the infeed arms, the gap being formed by an inner separation rotor connected to the shaft of the screw conveyor for rotation therewith and an outer stationary separation stator concentric with the inner separation rotor, the perforated bottom being disposed beneath said gap.

2. Apparatus as claimed in claim 1, wherein the separation rotor and the separation stator are provided with plates projecting into the gap.

3. Apparatus as claimed in either claim 1 or claim 2, wherein the gap is provided around its upper periphery with gas supply means.

4. Apparatus as claimed in any one of claims 1—3, wherein the material application means comprise

(a) a bowl disposed upon and extending around the rotary sleeve,

(b) a rotary liquid receiver connected to the shaft of the screw conveyor and extending down into said bowl for introducing the first substance into said bowl,

(c) rotary spiral arms connected to the shaft of the screw conveyor, extending into the bowl and adapted to tumble and feed the contact bodies to the outer margin of said bowl,

(d) rotary spreading arms connected with the outer periphery of said bowl and extending toward the outer wall of the container and adapted to spread contact bodies arriving from said bowl over the bed in the container.

5. Apparatus as claimed in claim 4, wherein the liquid receiver comprises a receiving tray disposed around the shaft of the screw conveyor and discharge pipes extending downwardly from said receiving tray into the bowl.

6. Apparatus as claimed in any one of claims 1-3, wherein the application means comprise

(a) supply means for supplying the first

substance through an upper hollow part of the screw conveyor shaft to distributing pipes located at the lower part of said hollow part,

(b) mixing arms located at the upper part of the screw conveyor for mixing the first substance discharged from the distributing pipes with the contact bodies,

(c) a bowl mounted on and extending around the rotary sleeve,

(d) spiral arms connected with the screw conveyor shaft and extending down into the bowl,

(e) spreading pipes connected with the bowl, and

(f) a circular lid covering the bowl and extending from the screw conveyor shaft to the distributing pipes.

7. Apparatus as claimed in claim 6, wherein the supply means are in the form of an auxiliary screw conveyor located in the upper hollow part of the screw conveyor shaft, the mixing arms being disposed above the distributing pipes and or, respectively, the shaft and the sleeve of the screw conveyor.

8. Apparatus as claimed in any one of claims 1—3, wherein the material application means comprise

(a) a bowl mounted on and extending around the rotary sleeve,

(b) rotary spreading arms connected with the outer periphery of the bowl and extending toward the outer wall of the container, said spreading arms serving to distribute the contact bodies arriving from the bowl over the bed within the container, and

(c) a carriage for spreading the first substance, disposed between the outer margin of the bowl and the wall of the container and above the bed, said carriage being provided with an opening in its bottom and having disposed therein a rotary conical spreading roller, said carriage being adapted to rotate about the centre of the container ahead of the spreading arm in the direction of rotation.

9. Apparatus as claimed in any one of claims 1—3, wherein the material application means comprise

(a) discharge passages located at the upper part of the screw conveyor on the rotary sleeve,

(b) discharge arms located on the upper part of the screw conveyor shaft for discharging the first substance and the contact bodies through the discharge passages,

(c) a lid located above the discharge passages and the discharge arms and extending cylindrically around the uppermost part of the screw conveyor shaft, said lid surrounding a supply space for the first substance, and

(d) supply means for supplying said first



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substance into the supply space enclosed by
the lid.

11. Drying apparatus substantially as
herein described with reference to the
5 accompanying drawings.

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303-306 High Holborn,
London, W.C.1.

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