June 20, 1967 G. BOJNER ETAL 3,325,912

APPARATUS FOR TREATMENT OF LOOSE MATERIALS WITH GASEOUS MEDIUMS

Filed March 22, 1965

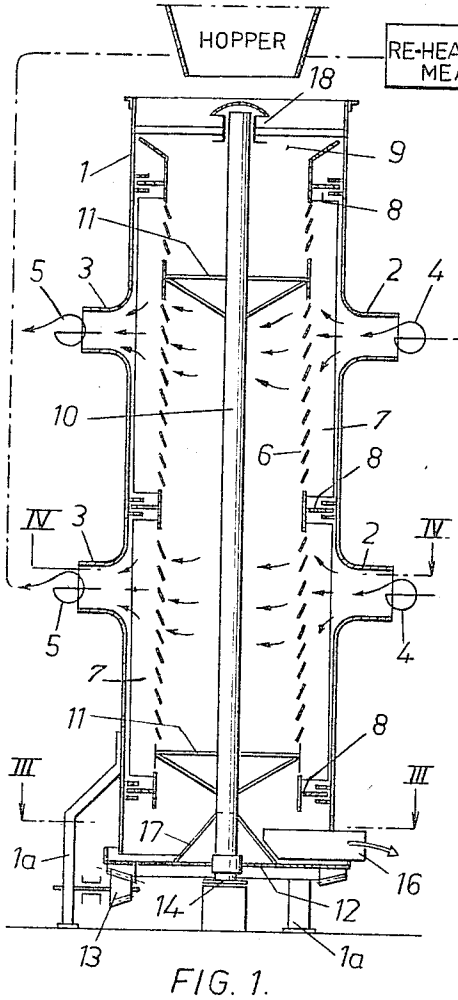

FIG. 1.

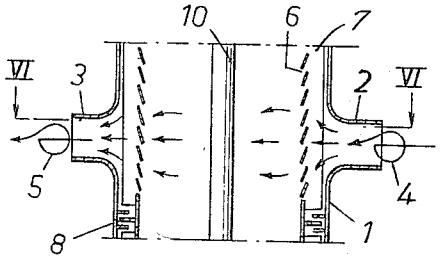

FIG. 2.

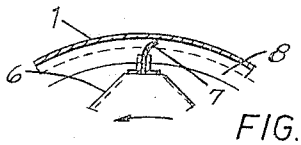

FIG. 7.

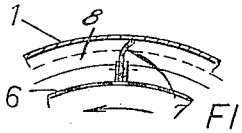

FIG. 8.

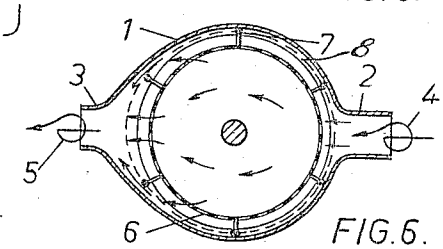

FIG. 6.

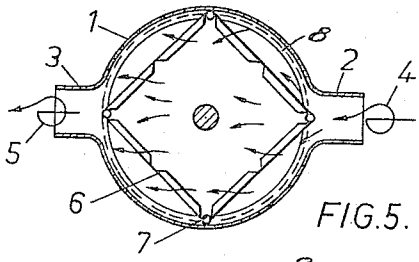

FIG. 5.

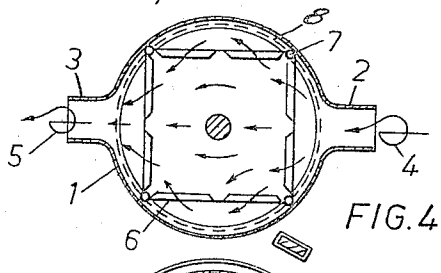

FIG. 4.

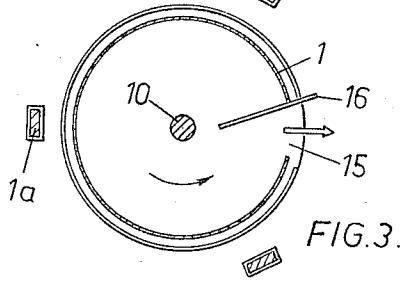

FIG. 3.

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APPARATUS FOR TREATMENT OF LOOSE MATERIALS WITH GASEOUS MEDIUMS

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This invention relates to an apparatus for the treatment of loose materials with a gaseous medium, especially for drying or cooling materials of said type by means of a gaseous medium, which is hot or cold, respectively.

The invention refers to a particular class of said apparatus, viz. apparatus of the type comprising a tower with a stationary casing, and a receptacle surrounded by said casing and having a perforated envelope wall, said casing having substantially opposed inlet and outlet openings for the gaseous medium which thereby is allowed to flow transversely through the central inner space of the perforated envelope wall, said casing and said receptacle having openings at the top for feeding the loose material into the central inner space of the perforated envelope wall and openings at the bottom for discharging the loose material as treated.

The term "loose material" is used to designate material in the form of pieces or other constituent parts, which are not packed to a comparatively dense mass or charge in the receptacle but will form a loose mass or charge that will fill up the receptacle, while having a great number of small spaces between the individual pieces of constituent parts so that the gaseous medium can pass through these spaces. Illustrative examples of mineral materials, which can be treated in towers of the present type are lime stone or ore (such as iron ore) in the form of pieces of suitable size, and illustrative examples of fibrous materials are grassy and similar vegetable materials, wooden chips, match splints (match sticks) and flocculated or milled cellulose.

Tower apparatus of the class indicated above have, when compared with horizontal drum apparatus, such as driers, the advantage that the receptacle can be filled completely, whereby the volume of the apparatus is utilized to a greater extent, but there is a serious disadvantage, which hitherto has prevented every extensive use of tower apparatus as driers, viz. that the heating action of the hot drying medium is concentrated substantially to the middle portions of the charge lying directly between the gas inlet and outlet openings of the stationary receptacle, the lateral portions of the charge being only slightly heated by the hot drying medium.

The primary object of the invention is to create a tower apparatus of the class indicated above, in which the gaseous medium flowing transversely through the receptacle is caused to pass as uniformly as possible over the entire cross-section of the receptacle so as to secure an efficient action on the loose material in the receptacle.

A tower apparatus according to the invention is characterized by the following features. The receptacle preferably having a circular or polygonal cross-section, for example, is rotatably mounted relatively the stationary casing of the tower and is provided for rotation during the passing of the gaseous medium transversely through the central inner space of the perforated envelope wall and through the loose material contained therein so that successively new portions of the cross-section of the perforated envelope wall and of the loose material charge will be within the transversal flow of the gaseous medium. Sealing means are disposed between the rotatable envelope

wall and the stationary casing, which preferably has a circular cross-section, said sealing means being provided for dividing the circumference of the perforated envelope wall into a plurality of mutually isolated passage zones for the gaseous medium, at least one of said zones being always in direct connection with the inlet opening for the gaseous medium and at least one substantially opposed zone being in direct connection with the outlet opening for the gaseous medium.

For instance, when the tower apparatus according to the invention is used as a drier, the hot gaseous medium is blown into the loose material through one of said zones and then this very same quality of gaseous medium after being cooled and charged with moisture is allowed to leave the charge of loose material and the receptacle through the zone that is diametrically opposite to the entrance zone or at least nearly opposite to the same. However, according to the rotation of the receptacle these zones are circumferentially displaced, and when the receptacle has performed half a revolution the entrance zone has changed to be the outlet zone, the entering hot gaseous medium now contacting first those portions of the charge that for half a revolution ago were passed by the out-going cooled gaseous medium. Hereby, an intense drying effect is obtained. It also should be observed that dust and the like matter, which possibly can collect in the perforation at the blowing-out, will again be blown into the charge under the action of the entering gaseous medium, when the receptacle has rotated half a revolution. The loose material is always subjected to the action of passing gaseous medium but of varying temperature. The feature that the loose material to be dried is in this way subjected to varying temperature, is very advantageous because thereby a higher temperature of the entering gaseous medium can be allowed, as the loose material is only for a short moment subject to the hottest gaseous medium. It is easy to have the receptacle completely filled with downwards moving loose material by discharging the loose material at the bottom simultaneously with feeding new loose material into the apparatus at the top, feeding and discharging preferably being synchronized by means of well-known automatic control systems.

In a preferred embodiment, a space formed around the rotatable perforated envelope wall of the receptacle, within the stationary casing, is divided vertically in several compartments above each other, having each an inlet opening and an outlet opening for the gaseous medium. This division in compartments is made by transversely extending sealing means within said space, this sealing means being supported by the rotatable receptacle and providing a circular sealing against the stationary casings.

Further objects and features of the invention will appear from the following description, when read with reference to the accompanying drawing, which illustrates by way of example a preferred embodiment of a tower apparatus according to the invention, and in which:

FIG. 1 is a vertical central cross-section through the tower apparatus with the cylindrical stationary casing and the rotatable central receptacle with associated parts;

FIG. 2 is a vertical central cross-section through a portion of the tower apparatus according to a modification of the receptacle;

FIG. 3 is a horizontal cross-section on the line III—III in FIG. 1;

FIG. 4 is a horizontal cross-section on the line IV—IV in FIG. 1;

FIG. 5 is the same horizontal cross-section as in FIG. 4 but shows the central receptacle in a different position of rotation;

FIG. 6 is a horizontal cross-section on the line VI—VI in FIG. 2;

FIG. 7 illustrates on a greater scale one vertically extending sealing means as shown in FIG. 4 or 5;

FIG. 8 illustrates on a greater scale one vertically extending sealing means as shown in FIG. 6.

In the drawing, the reference numeral **1** indicates the stationary casing, which is standing on a support **1***a*, for instance a tripod, and which is shown as cylindrical, although it also could be conical (tapering upwards), **2** indicates two inlets for the gaseous medium, disposed at different levels above each other, **3** indicates two corresponding outlets for the gaseous medium, located diametrically opposite to the inlets, **4** indicates two blowers for blowing the gaseous medium into the respective inlets under suitable pressure, **5** indicates two suction blowers for drawing the gaseous medium out from the apparatus, **6** is the rotatable receptacle having an envelope wall with a perforation, for instance so-called eyelid perforation or apertures in the form of slots or the like, **7** is vertically extending linear sealing means between the envelope wall of the rotatable receptacle and the stationary casing, said sealing means consisting of rubber strips or other elastic or resilient material and preferably being attached to and supported by the rotatable receptacle, **8** is transversely extending or annular sealing means between the rotatable envelope wall of the receptacle and the stationary casing, for instance made as labyrinth packing means, **9** is the feed opening for the loose material, provided at the top of the receptacle and the casing and supplied from a hopper indicated above, **10** is the central driving shaft, which is rotatably mounted with respect to the stationary casing, **11** is arms or spokes by means of which the rotatable envelope wall of the receptacle is attached to the central driving shaft, **12** is a bottom plate or disc, firmly attached to the driving shaft and supporting the charge of loose material, the bottom end of the envelope wall of the receptacle being spaced from said bottom disc and being open towards the same, **13** is a driving transmission for imparting a rotary movement to the bottom disc and the central shaft and comprising for instance a conical pinion meshing with a gear ring on the underside of the bottom disc, said pinion being driven from a suitable motor unit (not shown), **14** is an axial or thrust bearing, supporting the driving shaft and the bottom disc together with the loose material constituting the charge of said disc, **15** in the discharge opening for the loose material, provided in the stationary casing at the lower end of the same but immediately above the bottom disc, **16** is a stationary guiding vane attached to the casing and extending in the discharge opening of the same for causing the loose material to be fed out under the action of the rotating bottom disc, **17** is a conical body provided centrally on the bottom disc for guiding the loose material outwards (in radial direction) and facilitating the discharge of the same, and **18** a radial bearing for the top end of the driving shaft, said radial bearing (only diagrammatically shown) being supported from the stationary casing by means of radially extending arms.

In the embodiment according to FIGS. 1 to 5, the perforated envelope wall of the rotatable receptable **6** has a polygonal cross-section, preferably a square cross-section, and four linear sealing means **7** (see also FIG. 7) are provided along the corners of the envelope wall of the rotatable receptacle and are supported by the same, whereby four segmental spaces are formed between the stationary casing and each side of the polygonal envelope wall, corresponding to the passage zones for the gaseous medium. The flow pattern for the gaseous medium is indicated by small arrows in FIGS. 4 and 5. In the modified embodiment according to FIGS. 2 and 6, the perforated envelope wall of the rotatable receptacle **6** has a circular cross-section, annularly spaced from the stationary casing, and six linear sealing means **7** (see also FIG. 8) are distributed over the circumference of the perforated cylindrical envelope wall and preferably supported by the same, whereby six passage zones for the gaseous medium are formed around the circumference of said envelope wall. The flow pattern for the gaseous medium is indicated by small arrows in FIG. 6. As shown in FIG. 6, the outlet **3** for the gaseous medium is substantially larger than the inlet **2**, thus constituting an enlarged chamber for collecting the gaseous medium coming from several adjacent zones. This has also the advantage that the rate of flow is substantially reduced in the space directly before the outlet so that the gaseous medium flowing out will not carry much dust.

The vertically extending linear sealing means **7**, prevent the gaseous medium supplied through the inlet **2**, from flowing directly to the outlet **3** without having passed through the charge contained in the receptacle. In the position shown in FIG. 4, the gaseous medium will enter the receptacle through the passage zone that is directly facing the inlet **2** and thus is in direct connection with the same, and the gaseous medium will flow out from the receptacle through the passage zone that is directly facing the outlet **3**. In the position shown in FIG. 5, the entering gaseous medium will be distributed to the two adjacent passage zones that are in connection with the inlet **2**, and the flowing-out will take place in a corresponding way. In the modified embodiment according to FIG. 6, the relations are similar.

As illustrated in FIG. 1, the transversely extending sealing means **8** are provided for dividing the space between the envelope wall of the receptacle and the casing in two compartments one above the other, said compartments having each one inlet **2** and one outlet **3** for the gaseous medium. These two compartments may be supplied with gaseous mediums of different temperatures. For instance, a drying action by means of a hot gaseous medium can take place in the upper compartment, where the loose material can be rather cold and wet, and a cooling action by means of a cold gaseous medium can take place in the lower compartment. Of course, a greater number of compartments above each other can be provided, for instance four compartments.

This dividing in several compartments above each other will allow an advantageous utilization of circulating gaseous medium, especially in connection with drying. For instance, if the drying gaseous medium has been utilized in a certain compartment and has passed through the loose material contained therein, but has not been sufficiently cooled down or saturated with moisture, it is possible by means of an external re-heating system to raise the temperature of this gaseous medium and thereby increase the heat content of this medium so as to increase the drying effect of the same, and then to blow the re-heated medium into another compartment for absorbing more moisture. When the gaseous medium comprises flue-gases, said raise of temperature can be effected by admixing flue-gases of higher temperature, and when the gaseous medium comprises air, said raise of temperature can be effected by further heating the air in a manner well-known per se.

This important feature of the invention as adopted in connection with drying apparatus is diagrammatically illustrated in FIG. 1 of the drawing by an external conducting circuit including re-heating means, as indicated by dash-and-dot-lines. Thus, the gaseous drying medium, which has passed through a certain drying compartment, preferably the lower one in FIG. 1, is heated additionally in the external re-heating means for increasing the drying capacity of the same, and is then conducted through another drying compartment, in FIG. 1 the upper one, where the loose material is in a different stage of drying. The term "re-heating means" occurring in FIG. 1 is intended to include admixing with flue-gases of higher temperature or raising the temperature in any other suitable way.

It should be noted that in a tower apparatus according to the invention no portions of the charge can move downwards through the rotating receptacle without being the whole time contacted directly by the gaseous medium, and this fact will efficiently contribute to a uniform and rapid drying and cooling, respectively, of the loose material. The speed of rotation of the receptacle should be comparatively low.

The invention is not restricted to the embodiments illustrated in the drawing and described above, modifications being possible without departing from the principles of the invention.

We claim:

1. An apparatus for the treatment of loose materials with a gaseous medium comprising: a tower including a stationary casing; a rotatably mounted receptacle within said casing and having a perforated envelope wall, said perforated envelope wall providing a central inner space; said casing having substantially opposed inlet and outlet openings whereby said gaseous medium is allowed to flow transversely through said central inner space; said casing and said receptacle each having openings at their top for feeding loose material into said central inner space and openings at their bottom for discharging the loose material as treated; means for rotating said receptacle during the transverse flow of said gaseous medium through said central inner space and through said loose material contained therein whereby successively new portions of the cross-section of the perforated envelope wall and of the loose material will be within the transverse flow of the gaseous medium; axially extending sealing means mounted between said rotatable envelope wall and said stationary casing, said sealing means dividing the circumference of the perforated envelope wall into a plurality of mutually isolated passage zones for the gaseous medium, at least one of said zones being always in direct connection with the inlet opening for the gaseous medium and at least one

substantially opposed zone being in direct connection with the outlet opening for the gaseous medium.

2. An apparatus according to claim 1, wherein said perforated envelope wall is provided with transversely extending sealing means dividing the space formed between said perforated envelope wall and said stationary casing into at least two compartments, one above the other, each of said compartments having one of said inlet openings and one of said outlet openings for the gaseous medium.

3. An apparatus according to claim 2, wherein an external conducting circuit for the gaseous medium extends from the outlet of one compartment to the inlet of another compartment, said circuit including re-heating means.

4. An apparatus according to claim 1, wherein said casing and said envelope wall define therebetween a space directly before said outlet opening larger than the space directly inside said inlet opening.

5. An apparatus according to claim 1, wherein said perforated envelope wall is supported by a central driving shaft; a disc, said disc being firmly connected to said shaft; said disc projecting outwardly of and below the stationary casing and supporting the charge of loose material; a feed member supported by said casing within the discharge opening for guiding and discharging the material carried on the bottom disc.

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