Dec. 18, 1962 F. SCHAUB ETAL 3,068,584

PROCESS FOR THE TREATMENT OF DIVIDED MATERIALS

Filed July 9, 1958

2 Sheets-Sheet 1

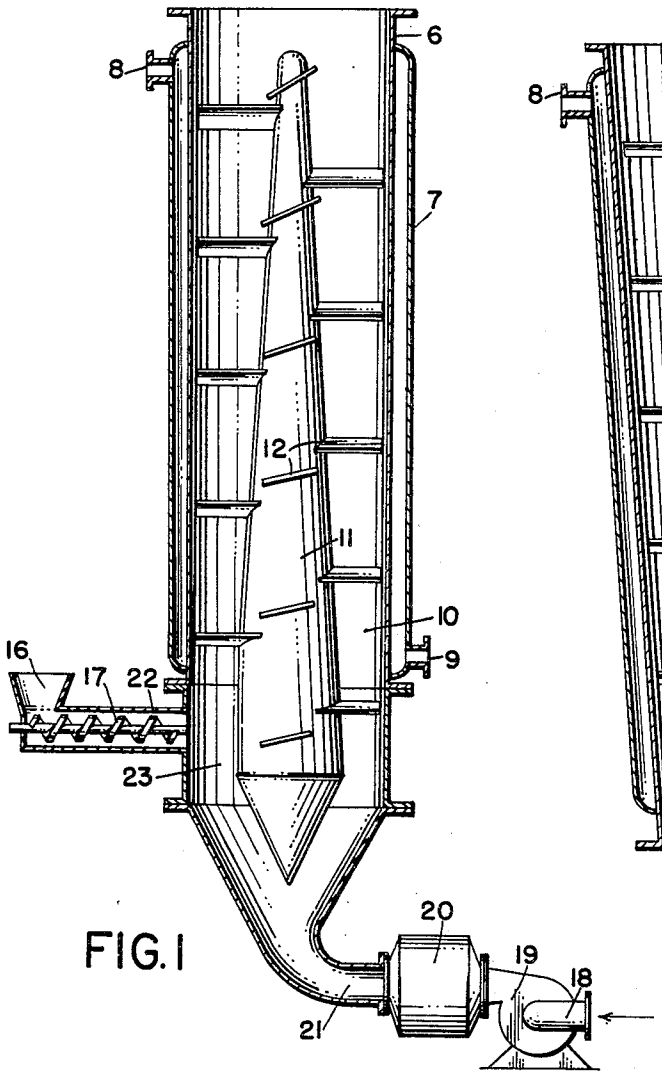


FIG. 1

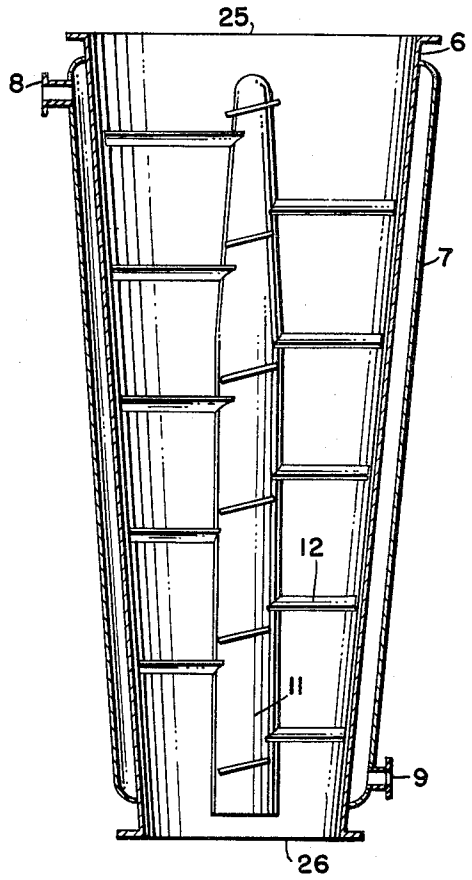


FIG. 3

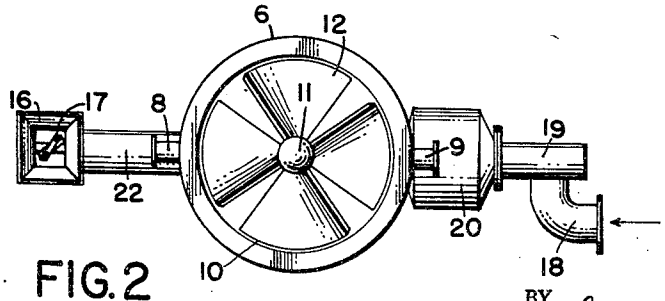


FIG. 2

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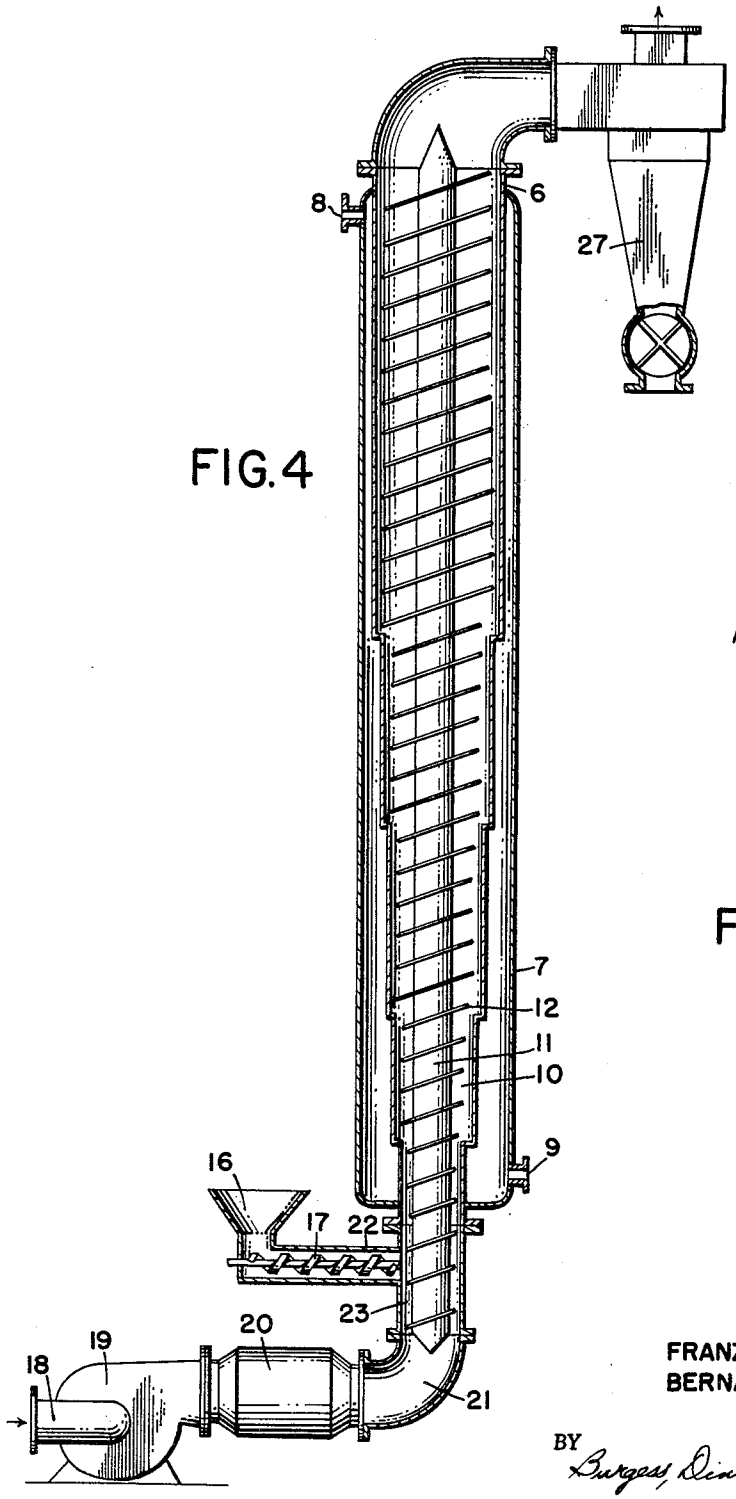


FIG. 4

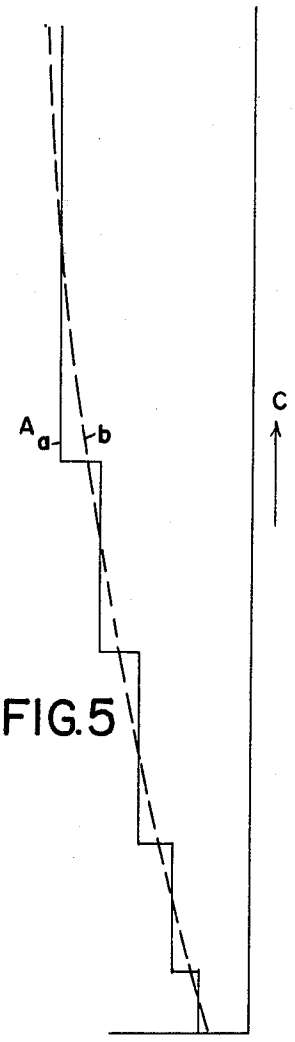


FIG. 5

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PROCESS FOR THE TREATMENT OF DIVIDED MATERIALS

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5 Claims. (Cl. 34—8)

This invention relates to the treatment of divided materials which are entrained in a gas to effect a transfer of materials between the divided material and the gas.

In copending application Serial No. 572,559, filed March 19, 1956, there is described a method for drying wet finely divided material which involves dispersing the material in a gas and then passing the gas through an elongated chamber which is provided with a heating jacket suitable for use in supplying heat to the entrainment or dispersing by transfer through the chamber wall and thus aiding in the drying of the finely divided material. According to this method, the dispersion is passed axially through the chamber along a helical path.

It has been found that substantially improved results are realized when drying divided material by the method of the aforementioned pending application, by employing an amount of carrier gas for the divided material substantially equal to the amount necessary to satisfactorily entrain the divided material. It has been further found, when operating in this improved manner employing reduced amounts of carrier gas, a great difference between the volume of inlet and the volume of outlet gas exists when drying material having high moisture contents. The considerable increase in volume of outlet gas is caused by the fact that a great volume of vapor is liberated from the solid particles being dried. When the cross-sectional flow area along the helical path is constant, the great increase in gas volume along the flow path, greatly increases flow velocity and consequently unnecessarily high pressure losses occur. Moreover, we have found, that reduced drying capacities are incidental to the described conditions of great increase of volume along the flow path. According to the invention, these difficulties are overcome by maintaining a substantially constant flow velocity of the gas along the helical path.

The invention will be further described with reference to the accompanying drawings, wherein specific embodiments of the invention are depicted. In the drawings:

FIG. 1 is a schematic representation in elevation, of a device according to the invention;

FIG. 2 is a plan view of the device shown in FIG. 1;

FIG. 3 is a schematic representation, in elevation, of another embodiment of the invention;

FIG. 4 is a schematic representation, in elevation, of another embodiment of the invention, too, and

FIG. 5 is a schematic representation of the relation between the cross-sectional flow area and the volume of carrier gas.

In the various figures, like reference characters refer to corresponding parts.

In the embodiment shown in FIG. 1, the device of the invention comprises an elongated chamber **6** having a heating jacket **7** which is provided with an inlet nozzle **8** and discharge nozzle **9**. A center pipe **11** is disposed axially within the elongated chamber in spaced relationship therewith and provides annular space **10** for the passage of the medium to be treated. Radially extending guide vanes **12** are disposed at spaced intervals along the center pipe **11**, and serve to aid in defining a helical path through the annular space **10**.

In operation of the device shown in FIG. 1, finely divided material is fed into the hopper **16** and is advanced through the pipe **22** by screw conveyer **17**. A carrier gas, which can be air is drawn through pipe **18** by blower **19** and forced by blower **19** through heater **20** and then on through pipe **21** into the annular space **10** where it is admixed, at **23**, with finely divided material and fluidizes the finely divided material. The resulting dispersion passes into the annular space **10** As can be best seen in FIG 2, the feed pipe **22** directs the finely divided material into the annular space **10**. The center pipe **11**, and the arrangement of the radially extending vanes **12** cooperate to provide an axially extending helical flow path within the annular space **10**, which the dispersion traverses. As the dispersion passes along this path, the particles within the dispersion are thrown outwardly against the inner walls of the elongated chamber **6** so as to form an upwardly moving curtain along this wall. A heating medium is passed through the jacket **7** and provides heat for drying of the particles passing along the helical path. From the elongated chamber **6**, the dispersion passes to a separator **27** or other treating zone (shown in FIG. 4).

Preferably, the amount of carrier gas employed to disperse the particles of divided material is substantially equal to the amount required for satisfactorily dispersing the divided material. It is not necessary to use a great excess of carrier gas. It is sufficient for carrying out the process to use only so much gas as a carrier as is required to disperse the material satisfactorily, the amount of gas being dependent upon the type of material to be treated. The rapid evaporation of moisture results in just as rapid an increase in the amount of gas. The small amount of drying gas means a substantial economy with respect to both the size of apparatus and the energy cost required. Despite its limitation, this amount of gas is of such magnitude, that a change in mass flow rate through the elongated chamber due to evaporation from the wet material being treated, is very considerable, and, according to the invention, the cross-sectional area of the helical flow path is altered along the path so that a substantially constant flow velocity exists throughout the travel of the dispersion through the elongated chamber.

In the embodiment shown in FIG. 1, the guide vanes **12** are arranged so that they aid in defining a helical path for the gas through the annular space **10**, and further, the angle of inclination of the guide means with respect to the axis of the center pipe and elongated chamber, increases along the annular space in the direction of dispersion flow. Further, the center pipe **10** tapers in the direction of dispersion flow so that its cross-sectional area along at least a portion of its length diminishes in the direction of dispersion flow. Thus, the increasing angle of inclination of guide vanes and the change in cross-sectional area of the center pipe aid in providing a continuously changing cross-sectional flow area for the dispersion. Preferably, this increase in flow area is such that it just compensates for the change in mass flow along the flow area and maintains a constant flow velocity along the flow path.

As will be readily appreciated, various arrangements may be employed to obtain the desired variation in flow area along the helical flow path. Thus, the desired variation can be obtained by varying the angle of inclination of the guide vanes only without otherwise varying cross-sections of elements of device. Alternatively, the cross-sectional area of the center pipe alone could be varied. Still another manner of obtaining the desired constant velocity is to taper the elongated vessel in the direction opposite the direction of dispersion flow. Any combination of these variations may be employed to obtain the desired continuously changing cross-sectional area.

In FIG. 3, there is shown a device according to the

invention wherein the angle of inclination of the guide vanes is constant along the length of the elongated chamber **6**, the cross-sectional area of the center pipe **11** is varied over a portion of the length of the center pipe, and the elongated chamber proper is tapered from its discharge end **25** towards its inlet end **26**.

The increase in cross-sectional area may also be effected stepwise as shown in FIG. 4 where pipe sections are arranged one above the other with the cross-sectional area of each section being larger than that of the preceding section. The cross-sectional area may be increased in accordance with evaporation curve, i.e. with a considerable increase in the lower part and with only a moderate increase in the upper part. In general, it is assumed that about two thirds of the liquid evaporates in the lower half and one third in the upper half. The increase in cross-sectional area of the pipe sections is adapted to these conditions and to the increase in gas volume. The increase in cross-sectional area as dependent upon the increase in gas volume is shown in FIG. 5 where *a* is the pipe cross-sectional area, *b* the volume of the flowing medium and *c* the longitudinal direction of the pipe.

Whereas the invention has been described with reference to application thereof for the drying of wet material, it is to be realized that the invention is generally applicable to operations involving mass transfer between a divided material in the form of a discrete phase and a gas phase in which the divided material is dispersed, the material transfer being effected by transferred heat between the dispersion and its surroundings as the dispersion traverses a helical path.

The invention finds considerable usefulness in such processes wherein the mass transfer is effected by heating the dispersion of divided material in gas phase as the dispersion passes through the transfer zone, and the gas present in the dispersion and serving as a dispersion agent, is used in an amount substantially equal to merely the amount required to obtain satisfactory dispersion. It will be appreciated, that the proportion of gas required to obtain dispersion will depend on the particular system, i.e. the composition of the gas and divided material and operating condition including particle size of the divided material.

EXAMPLE

In producing polyethylene by the Ziegler process, a pulverulent product having a moisture content of about 100%, based on dry substance, is to be dried to a final moisture content of 0.1%. According to the process of the invention, the solid material is introduced by a feed screw into an elongated drying chamber, the walls of which are heated by a steam jacket. A center pipe is disposed axially within the drying chamber and provided with guide vanes. For dispersing and feeding about 200 kg./hr. of the moist material into the drying chamber, air at a rate of 100 m.^{3}/hr. is admitted through a pipe and imparted a helical movement by guide vanes, this helical movement being brought about below the point where the moist powder is fed. At this point, the drying chamber has a diameter of 110 mm. and the central pipe has a diameter of 60 mm. The drying chamber has a length of 8 meters and its diameter increases along this length to 200 mm., i.e. the cross-sectional flow area is about tripled corresponding to the increase in volume due to the amount of steam envolved during the drying process. The powder leaves the drying chamber with a moisture content of about 0.1%. The pressure drop for the flow through this conically widened elongated chamber is about 180 mm. water. The steam consumption for driving out the moisture is 1.2 kg. of heating steam per kg. of evaporated water.

If a drying chamber having an invariable cross-sectional area is used, a diameter of 150 mm. and an amount of carrier air of about 200 m.^{3}/hr. is required for the same quantity of material to be dried and the pressure drop is about 350 mm. water instead of 180 mm. Also, the specific heat consumption is higher and is 1.4 kg. of heating steam per kg. of evaporated water.

We claim:

1. Method for drying finely divided solid material which comprises entraining the solid material in a heated gas stream, passing the gas stream with the entrained material upwardly through an elongated axially extending drying chamber of substantially circular cross-sectional shape, guiding the gas through said chamber along a substantially helical flow path while maintaining a substantially constant flow velocity by increasing the volume of the flow path through the chamber in direct proportion to gas generated during the drying, said velocity being sufficient to throw the particles of solid material outwardly against the chamber wall forming a moving curtain of particles along the wall, and externally heating the wall to maintain the same at the drying temperature for the material.

2. Apparatus for drying divided material comprising an elongated vertically extending drying chamber of substantially circular cross-sectional shape, guide means positioned in said chamber defining a vertically extending helical flow path of increasing cross sectional flow area, corresponding to an increase in volume compensating for gas generation during drying to allow a substantially constant gas flow velocity along said flow path, means for passing a gas stream with entrained solids to be dried through said flow path at a substantially constant flow velocity sufficient to throw the solids outwardly against the wall of said chamber, and means for externally heating the wall of said chamber.

3. Apparatus, according to claim 2, in which said means for externally heating the wall of said chamber comprises a heating jacket.

4. Apparatus, according to claim 2, in which said guide means comprises guide vanes positioned within said chamber.

5. Apparatus, according to claim 2, including a pipe extending axially through said chamber with guide vanes connected thereto defining said helical flow path, said pipe decreasing in cross-sectional size in an upward direction to form said flow path of increasing cross-sectional flow area.

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