United States Patent

[11] 3,578,296

[72] Inventors Michel Boucraut
Metz;
Imre Toth, Longeville les Metz; Jean Pierre Reyter, Maizieres les Metz, France
[21] Appl. No. 837,101
[22] Filed June 27, 1969
[45] Patented May 11, 1971
[73] Assignee Institut De Recherches De La Siderurgie Francaise
St. Germain-en-Laye, Yvelines, France
[32] Priority July 10, 1968
[33] France
[31] 158562

[54] APPARATUS FOR TREATING PARTICULATE MATERIALS
10 Claims, 2 Drawing Figs.

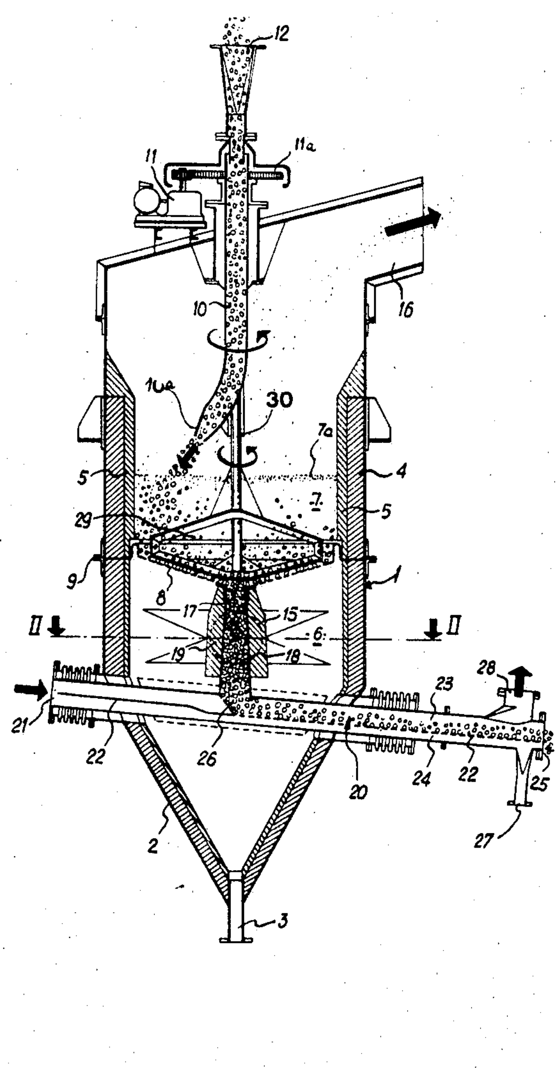
[52] U.S. Cl. 263/21A, 34/57R
[51] Int. Cl. F27b 15/08
[50] Field of Search 263/21 (A), 21 (B); 34/57 (A), 57 (D)

[56] References Cited
UNITED STATES PATENTS

2,699,375	1/1955	Johannsen et al.	263/21A
3,360,866	1/1968	Shirai	34/57A

Primary Examiner—John J. Camby
Attorney—Michael S. Striker

ABSTRACT: Apparatus for drying particulate materials having particles of different sizes comprises an upright vessel provided with a grate whose upper surface slopes toward a central opening and receives material from a rotary distributor. Products of combustion are fed into the vessel below the grate so that the ascending gas fluidizes the material above the grate. The material travels toward and into the opening of the grate and is evacuated by way of a central conduit to enter an adjustable pneumatic conveyor which classifies treated material according to size. A revolving scraper is employed to prevent clogging of the grate and/or caking of material along its upper surface.



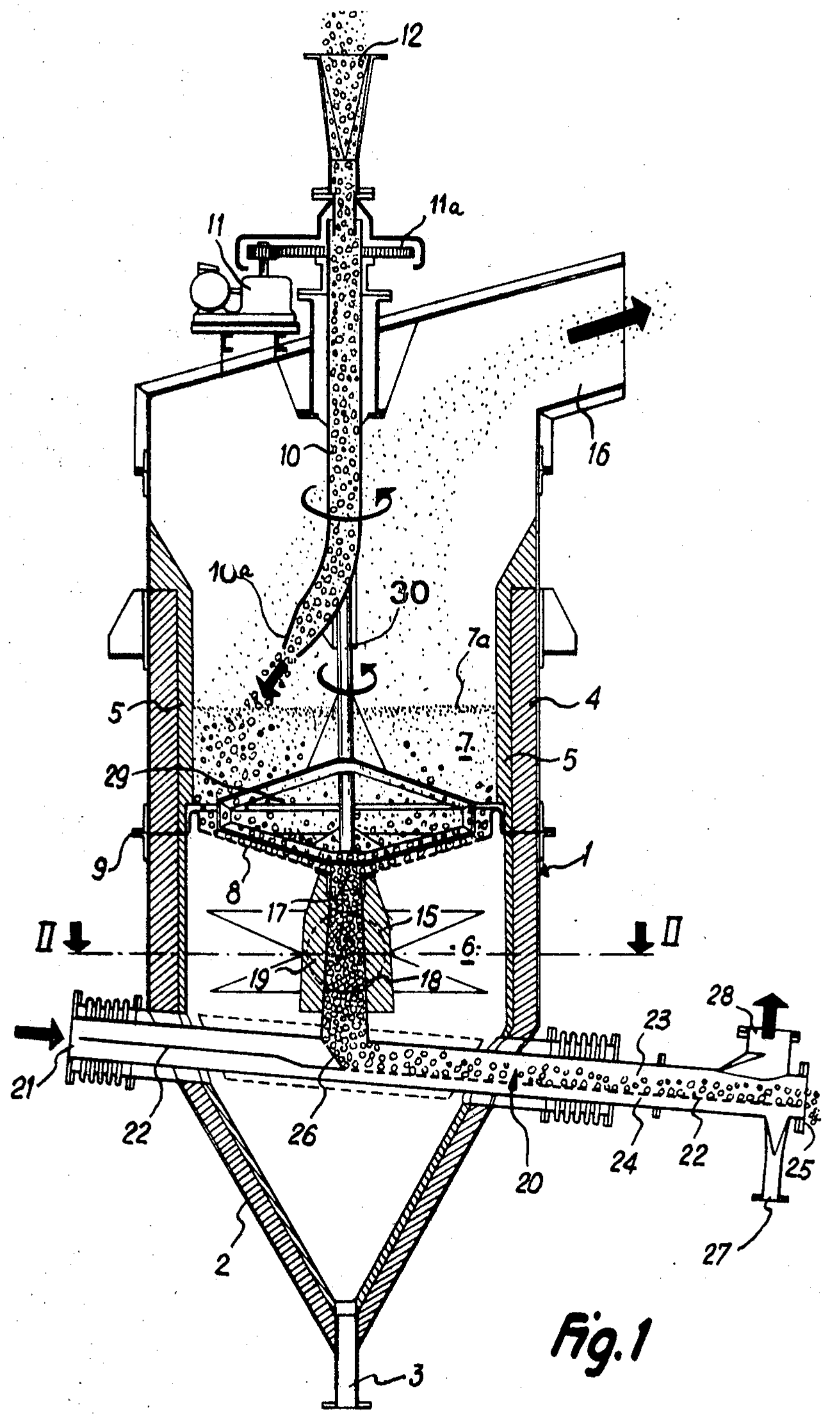


Fig.1

Inventors
Michel Boucraut
Imre Toth and Jean
Pierre Reyter
By: Michael S. Striker
Attorney

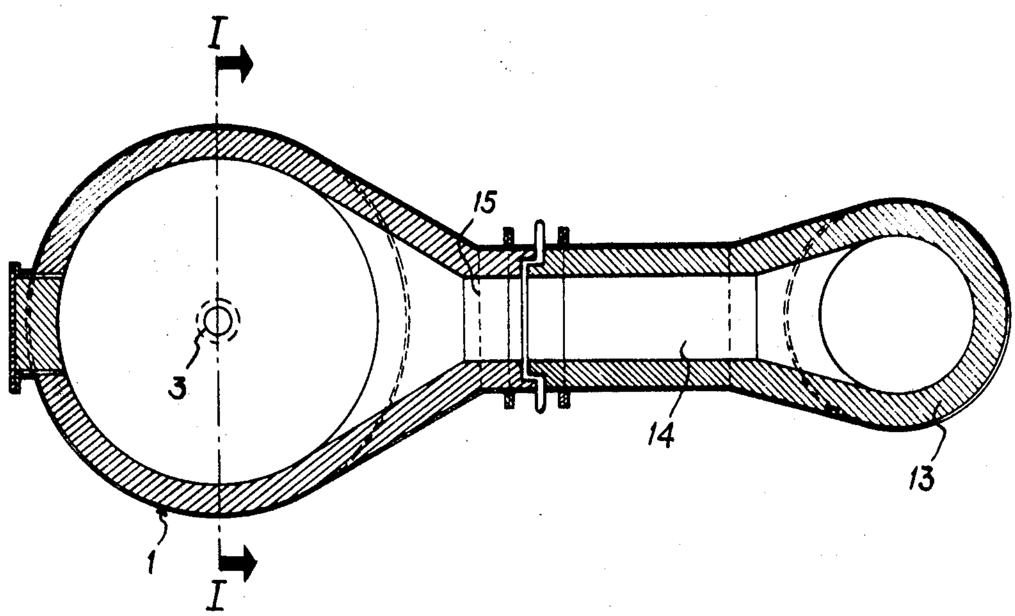


Fig. 2

Inventors:
Michel Boucraut
Imre Tóth and
Jean Pierre Rigler
by Michael S. Striker
Attorney

APPARATUS FOR TREATING PARTICULATE MATERIALS

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for treating particulate materials, particularly for drying materials whose particles vary in size within a rather wide range, for example, between 0 and 20 millimeters. Still more particularly, the invention relates to apparatus wherein the materials are treated in fluidized state.

SUMMARY OF THE INVENTION

An object of the invention is to provide an apparatus which can effect uniform treatment of materials whose particles vary within a wide range, which can treat large quantities of particulate material per unit of time, and which can be readily adjusted to treat a particulate material at the desired rate.

Another object of the invention is to provide an apparatus wherein the treated material can be classified according to size, not only during treatment but also upon completion of treatment, and wherein certain fractions of the material can be evacuated or segregated from the remainder during or even prior to completion of treatment.

A further object of the invention is to provide a compact apparatus which is particularly suited for expulsion of moisture from granular or like particulate materials and wherein segregation of undesirable fractions, particularly dust, can be effected simultaneously with expulsion of moisture.

An additional object of the invention is to provide the apparatus with novel material feeding, distributing, agitating and evacuating devices.

Still another object of the invention is to provide an apparatus which can be used for treatment of different types of materials.

The improved apparatus comprises a vessel, preferably an upright cylinder, a grate dividing the vessel into upper and lower chambers and having a preferably conical upper surface which slopes toward a substantially centrally located opening therein, feeding means preferably including a rotary distributor whose outlet orbits about the opening of the grate to supply material onto the upper surface of the grate at a uniform rate, means for admitting into the lower chamber a gaseous treating fluid (for example, hot combustion products which are admitted to the lower chamber from a combustion chamber adjacent to one side of the vessel) which rises through the permeable grate and fluidizes the material in the upper chamber, preferably with attendant segregation of dust and gradual descent of treated material toward and into the opening, and evacuating means for withdrawing treated material including conduit means provided in the lower chamber to receive particles from the grate. The evacuating means preferably further comprises an adjustable pneumatic conveyor which receives particles from the conduit means and is provided with means for classifying the particles according to size.

It is further desirable to provide in the upper chamber a rotary scraper or a like device which prevents caking of material and clogging of interstices of the grate.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a central vertical sectional view of an apparatus which embodies the invention, the section being taken in the direction of arrows as seen from the line I–I of FIG. 2; and

FIG. 2 is a horizontal sectional view as seen in the direction of arrows from the line II–II of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is shown an apparatus which comprises an upright cylindrical vessel 1 for drying of particulate material. The vessel 1 comprises an outer shell of sheet metal and its lower end portion 2 forms a cone having at its center a cleaning opening 3. The internal surface of the metallic shell of the vessel 1 is coated with an insulating brickwork 4 and the latter is provided with a liner 5 of concrete or other refractory material.

A gas-permeable grate 8 is installed in and divides the vessel 1 into a lower chamber 6 and an upper chamber 7. The grate 8 is of conical shape and its upper surface slopes toward a centrally located material discharging opening 17. The marginal portion 9 of the grate 8 is sealingly clamped between the adjoining cylindrical sections of the vessel 1.

The particulate material which is to be dried and/or otherwise treated in the vessel 1 is continuously admitted into the upper chamber 7 by a feeding unit which includes a tubular distributor here shown as a spout 10 having at its lower end an outlet 10*a* which orbits about the opening 17 to effect uniform distribution of admitted material on the upper surface of the grate 8. For example, the size of particles in the material which is admitted by the distributor 10 may vary between 0 and 20 millimeters, and the purpose of treatment can be to reduce the moisture content of all particles regardless of their size. The initial moisture content may be between 10 and 25 percent by weight. The means for rotating the distributor 10 about the axis of the vessel 1 comprises an electric motor 11 or an analogous prime mover which transmits torque to the upper portion of the distributor by way of a gear reducer 11*a*. The prime mover 11 is mounted on a bracket or platform carried by the top wall of the vessel 1. The upper end of the distributor 10 receives particulate material from a fixedly mounted funnel 12 which in turn receives material from any suitable source, not shown. An advantage of the distributor 10 (whose outlet 10*a* is offset from the opening 17) is that it prevents direct entry of particles into the opening 17 without adequate treatment. This is particularly important in the case of large and hence heavier particles. Furthermore, the orbiting outlet 10*a* insures satisfactory homogenization of material in the upper chamber 7.

The lower chamber 6 of the vessel 1 constitutes a wind box or wind chest which receives pressurized gaseous treating fluid serving to expel moisture from particulate material in the chamber 7 and to simultaneously effect a desirable fractionization or classification of material above the upper surface of the grate 8 while maintaining the bulk of such material in a fluidized state. In the illustrated embodiment, the means for admitting treating fluid into the lower chamber 6 comprises a combustion chamber 13 (see FIG. 2) wherein a suitable fuel is combusted and the resulting hot combustion products are thereupon conveyed into the chamber 6 by way of a conduit 14 whose discharge end 15 is also shown in FIG. 1 at a level below the opening 17 of the grate 8. The interstices of the grate 8 insure uniform distribution of treating fluid which rises into the chamber 7 and effects fluidization of particulate material above the upper surface of the grate. Such fluidization insures an optimum drying action because the ascending hot gases can contact the entire external surface of each particle. Not only is the drying action very effective but the time required for drying a unit quantity of particulate material is extremely short.

The rate at which hot combustion products are admitted from the combustion chamber 13 into the lower chamber 6 of the vessel 1 is preferably regulated as a function of the average particle size of treated material. As a rule, the rate of admission of gases into the chamber 6 will be selected in such a way that the heaviest particles (with a size of close to 20 millimeters) are subjected to minimal fluidization and thus tend to descend toward and onto the upper surface of the grate 8 to advance gradually toward and into the opening 17. Consequently, such largest and heaviest particles are mainly contacted by gases whose temperature is higher than the temperature of gases which contact the strata of smaller particles located at a level above the layer of heaviest particles. Thus, the drying action of gases is most intensive in the region immediately above the upper surface of the grate; this is desirable because it insures uniform drying action, i.e., the largest particles are dried to the same extent as the medium-sized particles thereabove despite the fact that their absolute humidity is higher and that their specific surface is smaller. Medium-sized particles occupy the central zone of the fluidized bed in the upper chamber **7** and form a substantially stable stratum whose upper level is shown at **7***a*. This reference character is intended to denote that horizontal layer of the fluidized bed which contains particles of a certain size, namely, those particles which are just as likely to be entrained with dust (smallest particles) by the ascending spent treating fluid as to be entrained with heavier particles toward the opening **17** of the grate **8**. The smallest particles whose presence in the finally treated product might be undesirable are entrained by the ascending treating fluid and leave the vessel by way of an outlet **16**. The escaping gases can be separated from dust in a filter, cyclone (not shown) or in any other suitable dust collecting device so that the gases which enter the atmosphere are at least substantially free of impurities.

At the present time, it is preferred to combust in the chamber **13** a suitable fuel in the presence of air which is admitted in quantities substantially exceeding the minimum quantity needed for proper oxidation. In this way, the quantity of hot treating gases which are admitted into the lower chamber **6** of the vessel **1** can be varied within a wide range without changing the ratio of calorific input to the moisture-containing particulate material. Inversely, one can maintain the rate of fluidizing gas at a constant value while changing the thermal input.

By raising the rate at which the gas is admitted into the lower chamber **6**, one can increase the size of particles immediately below the level **7***a* in the upper chamber **7**, i.e., the gases escaping by way of the outlet **16** then entrain dust as well as particles whose size is below a desired size. By reducing the rate of gas inflow from the combustion chamber **13**, the operators can reduce the maximum size of particles which are permitted to escape by way of the outlet **16**. In other words, by the simple expedient of changing the rate at which the gas is admitted into the space below the grate **8**, one can regulate the minimum size of particles which leave the chamber **7** by way of the opening **17** and the maximum size of particles which leave the chamber **7** by way of the outlet **16**. If desired, the gas can be admitted at such a rate that practically no particles are permitted to escape by way of the outlet **16**, i.e., that the entire treated material leaves the chamber **7** by way of the opening **17**. It is clear that the apparatus can be equipped with suitable controls which regulate the temperature of gases entering the lower chamber **6**; such regulation is particularly desirable if one wishes to avoid agglomeration or caking of particles in the upper chamber **7**. As a rule, the temperature of gases which enter the lower chamber **6** is regulated in dependency on the type of material treated, the size of particles in the chamber **7** and the length of intervals during which the particles should dwell in the fluidized bed above the grate **8**. For example, suitable detectors can be installed in the chamber **7** at different levels of the fluidized bed above the grate **8** to measure the temperature in the respective zones and to automatically effect a change in temperature of gases which enter the chamber **6** when the measured temperature exceeds a desired optimum temperature. The provision of such detectors (which preferably adjust the gas temperature by way of a suitable regulating device of any known design) insures that no caking of particles can take place in any region of the fluidized bed in the chamber **7**.

The evacuating unit which continuously removes treated particulate material from the vessel **1** comprises a downwardly flaring conduit **18** which is in communication with the opening **17** and is preferably coaxial with the vessel **1**. The conduit **18** further serves as a means for shielding treated material from hot gases entering the chamber **6** by way of the discharge end **15** and is preferably provided with a jacket **19** of heat insulating material. The lower end of the conduit **18** supplies treated particulate material to a pneumatic conveyor **20** which is installed in the lower end portion **2** of the vessel **1** and includes a slightly inclined pipe whose inlet **21** is connected to a suitable source of compressed air (not shown). The pipe accommodates a perforated partition **22** which divides its interior into an upper compartment **23** in direct communication with the conduit **18** and a lower compartment **24** in direct communication with the inlet **21**. The partition **22** is perforated only in the region downstream of the conduit **18**; its perforations insure some slight fluidization of treated material in the compartment **23** to facilitate the transport of such material toward a first outlet **25**. An inclined baffle **26** which is provided with perforations is installed at the lower end of the conduit **18** to guide treated material onto the perforated portion of the partition **22**. The latter also serves as a means for classifying treated material, i.e., the lighter particles can pass through its perforations to enter the lower compartment **24** and to be evacuated by way of a separate second outlet **27**. A third outlet **28** serves for evacuation of air which is admitted by way of the inlet **21**. Compressed air which enters the upper compartment **23** through the openings of the baffle **26** serves to transport heavier particles along the partition **22** and toward the outlet **25**. As a rule, the openings of the partition **22** will be dimensioned in such a way that they permit dust (if any) and particles whose size is below a predetermined value to enter the compartment **24** and to be evacuated and collected independently of larger particles which leave the conveyor **20** at **25**.

FIG. 1 further shows a rotary scraper **29** which is installed in the upper chamber **7** and is preferably driven by the prime mover **11** for the distributor **10** to travel along the upper surface of the grate **8** and to further reduce the likelihood of agglomeration as well as to prevent clogging of perforations in the grate. The scraper **29** is driven by a vertical shaft **30** and may rotate in synchronism with the distributor **10**, either at the same speed or at a different speed. It is clear that the scraper **29** constitutes an optional feature of the apparatus; for example, this scraper need not be used or it may remain idle if the treated material exhibits little or no tendency for caking and/or if the particle size of treated material is substantially uniform.

The advantages of the aforedescribed evacuating unit for treated particulate material are as follows: Since the vertical conduit **18** seals the descending material from hot gases, such material is not subjected to fluidizing during travel from the opening **17** to the baffle **26** so that it forms a substantially solid plug or stack which seals the pneumatic conveyor **20** from the upper chamber **7**. Thus, such plug prevents treating fluid from penetrating into the pipe of the pneumatic conveyor **20** by way of the chamber **7** and opening **17**.

Furthermore, by the simple expedient of changing the rate of air admission at the inlet **21** of the pneumatic conveyor **20**, one can regulate the speed at which the treated material is evacuated by way of the outlets **25** and **27**. In this way, the operators can select the position of the level **7***a* in the upper chamber **7**, i.e., the operators can regulate the height of the fluidized bed above the grate **8** while the rate of admission of treating fluid from the combustion chamber **13** remains constant. Still further, such regulation of air admission at **21** enables the operators to select the period of dwell of particulate material in the upper chamber **7** and hence the intensity of drying action. The apparatus can be equipped with suitable detector means which monitors the position of the level **7***a* and automatically regulates the rate of air admission at the inlet **21**. Such detector means may comprise a conventional radiation detector, for example, one operating with gamma rays. The detector means controls, either directly or by way of a suitable amplifier or the like, a valve which admits compressed air into the pipe of the pneumatic conveyor **20**. It was found that, by appropriate regulation of air admission into the pneumatic conveyor, one can regulate the drying action with a very satisfactory degree of accuracy.

The thermal efficiency of the apparatus is also very satisfactory because the aforedescribed control means enable the operators to insure that the particulate material is evacuated as soon as its moisture content is reduced to a desired value. Moreover, the drying action can be varied in a very simple way, either automatically, semiautomatically or by hand, by regulating the temperature of treating fluid and/or the level of fluidized material in the upper chamber **7**. It is further clear that the apparatus is equally suited for other treatment of particulate materials, for example, to contact all particles in the upper chamber **7** with a gaseous fluid which not only dries but also changes certain other characteristics of treated material. Furthermore, the apparatus can be operated with equal advantage by employing other types of feeding, gas admitting and evacuating units. For example, the pneumatic conveyor **20** can be replaced with a vibrating chute, with a chain conveyor or with any other suitable conveyor which can evacuate treated material at a desired (preferably variable) rate. Also, the revolving distributor **10** can be replaced with other means for admitting untreated particulate material in such a way that even the heaviest particles remain in the upper chamber for a predetermined minimum interval of time. The treating fluid may be hot air.

In normal operation, the rate at which the distributor **10** admits material equals the rate at which the material is evacuated by way of the outlets **16**, **25**, and **27**. The level **7***a* is then stable provided, of course, that the rate of gas admission at **15** and **21** is constant and that each successively admitted unit quantity of particulate material contains the same percentage of lightest, medium-sized and heavy particles. The conical grate **8** acts not unlike a funnel; it insures that the heaviest particles dwell in the chamber **7** for desired intervals of time. As stated before, the rate of gas admission from the chamber **13** or from another source of treating gas is preferably such that the heaviest particles are subjected to minimal fluidization, i.e., they tend to descend onto the upper surface of the grate **8** and to travel toward and into the opening **17**. This insures homogeneous treatment of all particle sizes, an this also insures that the treated material which enters the conduit **18** contains substantially the same percentage of lighter, medium-sized and heavier particles as the material which is admitted by the distributor **10**.

The apparatus described may be used for treating different materials, more particularly iron ores or other ores.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of the above outlined contribution to the art.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. Apparatus for treating particulate materials, particularly materials consisting of particles having different sizes, comprising a vessel; a grate dividing said vessel into upper and lower chambers and having an upper surface sloping toward a substantially centrally located opening therein; feeding means for supplying material onto said surface; means for admitting into said lower chamber a gaseous treating fluid which passes through said grate and fluidizes the material in said upper chamber with attendant gradual descent of treated material toward and into said opening; and evacuating means for withdrawing treated particles including conduit means provided in said lower chamber to receive particles from said grate.

2. Apparatus as defined in claim **1**, wherein said upper surface is of conical shape and wherein said feeding means comprises means for effecting substantially uniform distribution of supplied material along said upper surface.

3. Apparatus as defined in claim **1**, wherein said evacuating means comprises means for regulating the rate of evacuation of treated material by way of said conduit means.

4. Apparatus as defined in claim **1**, further comprising rotary scraper means provided in said upper chamber to travel along said upper surface and to thus prevent caking of material and clogging of said grate.

5. Apparatus as defined in claim **1**, wherein said feeding means comprises a rotary distribution having an outlet arranged to travel along the upper surface of said grate.

6. Apparatus as defined in claim **1**, wherein said evacuating means further comprises an adjustable pneumatic conveyor arranged to receive treated particles from said conduit means.

7. Apparatus as defined in claim **6**, wherein said pneumatic conveyor comprises means for classifying treated particles according to size.

8. Apparatus as defined in claim **1**, wherein said vessel comprises an upright cylinder and wherein said means for admitting treating fluid comprises a combustion chamber and conduit means connecting said combustion chamber with said lower chamber.

9. Apparatus as defined in claim **1**, wherein said feeding means comprises a driven distributor which is substantially coaxial with said conduit means and wherein said upper chamber is provided with outlet means for treating fluid.

10. Apparatus as defined in claim **1**, wherein said evacuating means further comprises a pneumatic conveyor having an inclined pipe extending across said lower chamber and having an air-admitting inlet at the one end and a plurality of outlets at the other end thereof, said conveyor further comprising a perforated partition dividing said pipe into a pair of compartments one of which communicates with said conduit means and the other of which communicates with said inlet.