April 30, 1940. K. TOENSFELDT 2,199,015

COMBINED DRIER AND SEPARATOR

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Fig. 2

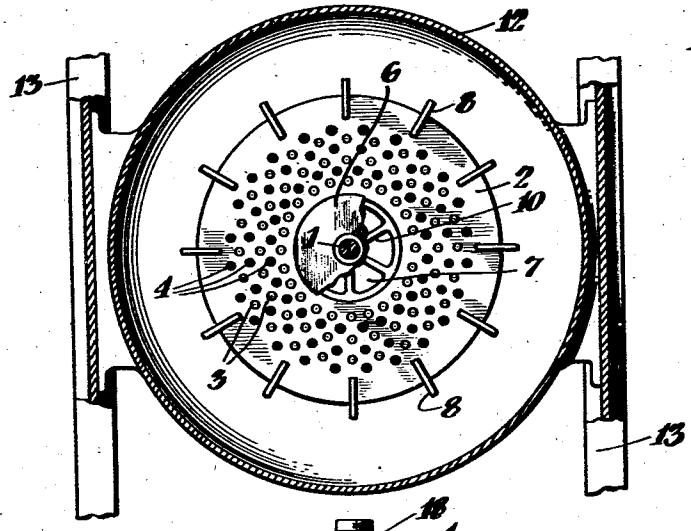

Fig. 1

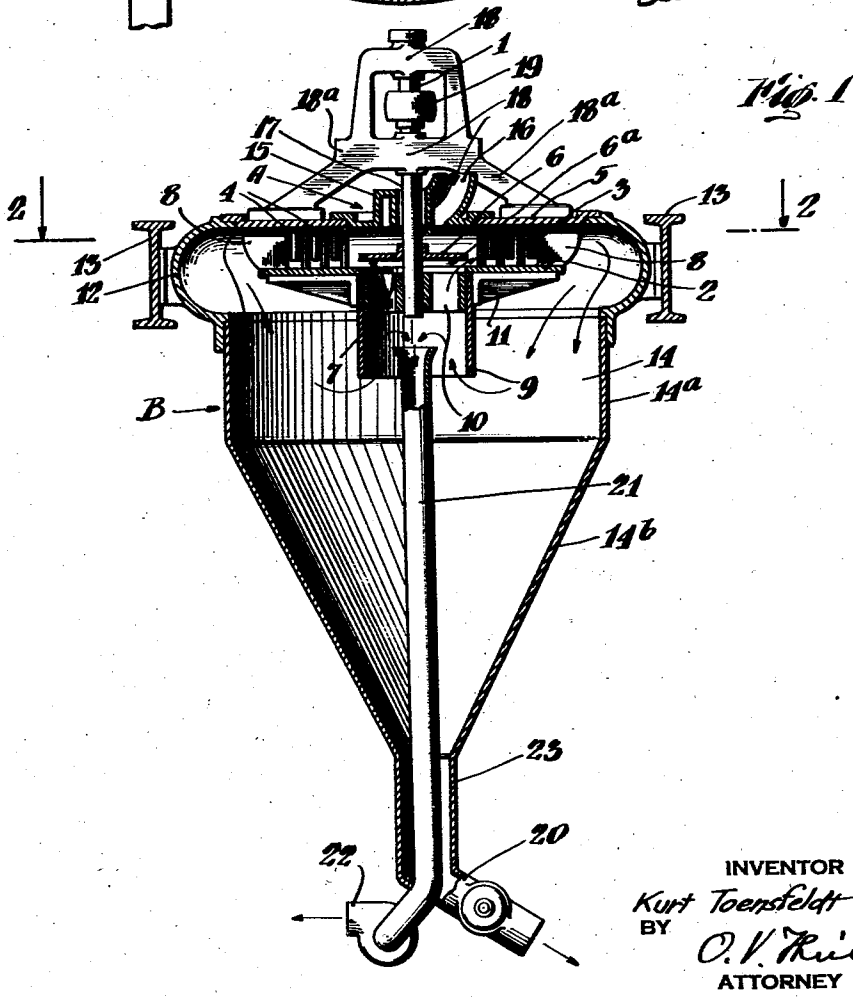

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Fig. 3

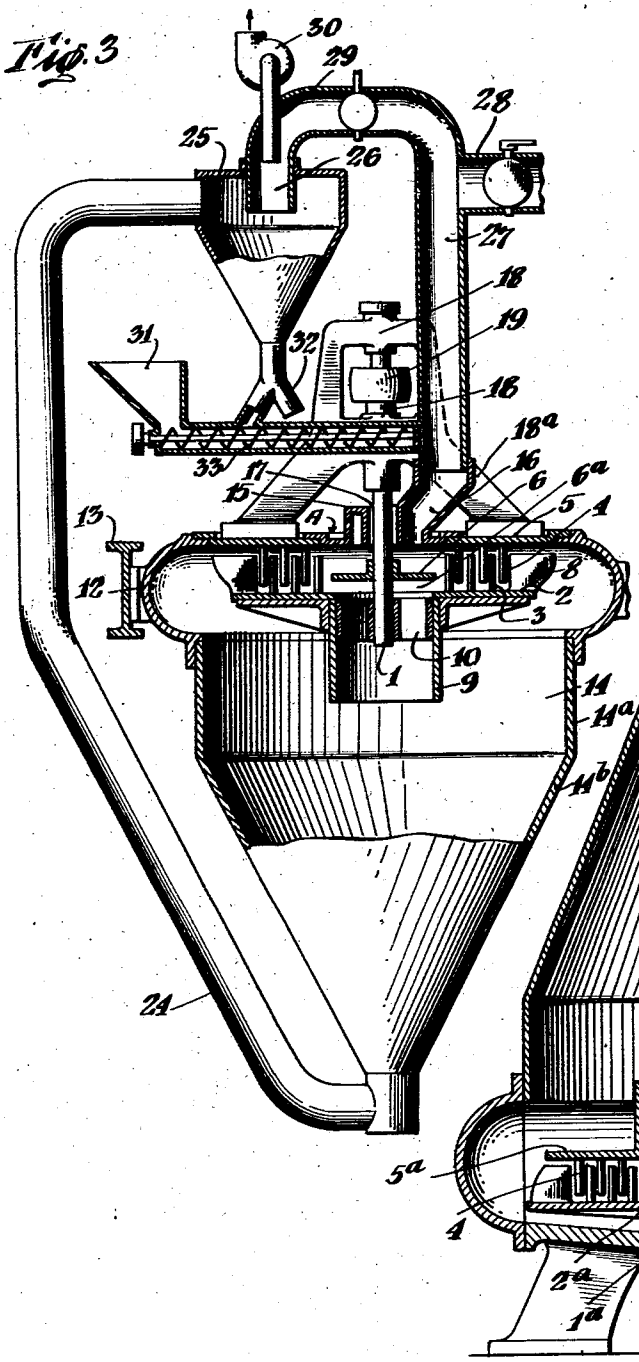
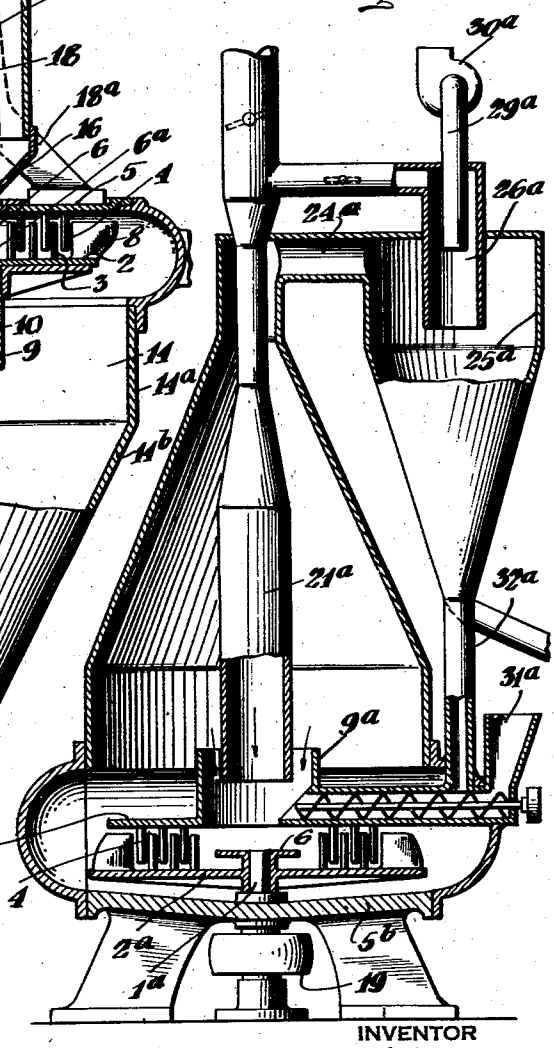


Fig. 4



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2,199,015

COMBINED DRIER AND SEPARATOR

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Application December 15, 1937, Serial No. 179,803

6 Claims. (Cl. 34—34)

The invention relates to apparatus for disintegrating and simultaneously drying wet materials in the presence of drying gases and thereafter separating the comminuted dried material from the gases.

The general object of the invention is to provide improved apparatus for performing these operations.

More specifically the invention relates to apparatus of this sort in which the drying-disintegrating apparatus comprises a member rotating about a vertical axis, the disintegrated dried material being thrown out tangentially at the periphery of this member. In such devices as heretofore arranged the gases conveying the dried material are led to a cyclone separator or concentrator by means of a duct which delivers the material-bearing gases into the cyclone at its upper circumference in such a direction as to cause a whirling or gyratory motion. As a result of such gyratory motion the gases give up the particles of the dried material, which then collects at the lower part of the conical portion of the cyclone, while the gases having given up their burden of solids are taken off centrally. Such apparatus and its operation entails some disadvantageous features and includes some elements which I have found unnecessary. The object of the present invention may therefore be more specifically said to be the provision of apparatus of this sort in which a portion of the apparatus formerly necessary is dispensed with and in which the action is such as to avoid some loss of energy and therefore to be more economical.

The invention will be described in connection with the drawings accompanying this specification. In these drawings Fig. 1 illustrates one form of the invention in vertical central section, Fig. 2 is a section on line 2—2 of Fig. 1; Fig. 3 is a view similar to that of Fig. 1 showing a variation and also showing some auxiliary apparatus, and Fig. 4 shows a further form of the inventive idea.

Referring first to the form of the invention illustrated in Figs. 1 and 2, the drying-disintegrating portion of the apparatus, generally designated by A, is located directly on top of the separating element or cyclone B.

The disintegrating drier A comprises a vertical shaft 1 to which is secured by means described below an annular plate 2 carrying a plurality of upwardly extending pins 3 arranged in circles concentric with the shaft 1. In the particular case illustrated there are three such concentric circles. Other pins 4 are arranged in circles concentric with the first set and alternating with them, these pins being secured to a stationary part. In the form illustrated they are secured to the top cover 5 of the drier and extend downward from it. Also secured to the shaft 1 is a plate 6 which is preferably slightly larger than the opening 7 in the annular plate 2. The plate 6 is placed on the shaft slightly above the annular plate 2 so that there is an opening 6a left between the two. Secured to plate 2 at its outer circumference are fan blades 8. Extending downward from the inner edge of the annular plate 2 is a sleeve 9. This is secured to the shaft 1 by means such as the spider 10, and the annular plate 2 is secured to the sleeve 9 by means of the brackets 11.

The stationary plate 5 is secured to an annular race or channel 12 which encompasses or encircles the drier and extends somewhat below it. Preferably, this channel is made semi-circular in cross section or at least of rounded form. This annular channel 12 serves as a convenient means for supporting the entire apparatus. In the form illustrated, for example, it is secured to the beams 13—13, and from its lower end is hung the cyclone casing 14. The plate 5 rests on its upper end and the bearings 18—18, in which shaft 1 is supported, is carried by the brackets 18a—18a which are secured to plate 5.

Adjacent to its center the plate 5 carries the member 15 which is provided with the feed opening 16 through which the wet material to be dried as well as the drying gases are supplied. The inner end of this channel 16 is so disposed that it discharges the material on the plate 6. The element 15 embraces the shaft 1 but is slightly spaced from it as at 17. This permits air to circulate between the shaft and the element, thereby keeping the shaft from becoming heated and transmitting heat to the shaft bearings, 18—18. 19 is a pulley by means of which the shaft is rotated.

The cyclone comprises the usual two parts, namely, the upper cylindrical portion 14a and the lower downwardly tapered or conical portion 14b. In the form of the apparatus illustrated in Fig. 1 this cyclone is a separator, i. e., it completely separates the solids from the gases, the solids collecting in the lower part of 14b and being removed through the connection 20.

The separated gases are taken out of the cyclone by means of the tube 21 which extends axially upward from the bottom, terminating within the sleeve 9. Preferably a short small-diameter cylindrical length 23 is inserted be-

tween the bottom of the conical part 14b and the offtake 20, this length 23 enclosing but being spaced from tube 21. A fan 22 is placed in the outlet end of 21, serving to draw the gases out of the cyclone.

The action of this apparatus will be obvious but may be briefly stated as follows: The material to be dried, together with the drying gases, is introduced at 16, the material falling on the plate 6. The rapid rotation of this plate causes the material to be thrown outward into the nest of alternately rotating and stationary pegs or pins, the current of hot gases likewise assisting the material to pass through between these pins. The material, while passing outward through the sets of pins, is beaten up and dried. The fan blades 8 cause a rapid circulatory motion of the gases leaving the rotating element. These gases encounter the annular channel 12 and are by it deflected downward into the cyclone, without losing their rotary motion. This rotary motion causes the separation of the solids from the gases in the usual way, the solids being taken off at the bottom and the gases being taken off at the upper central portion.

The space 6a between the annular plate 2 and the plate 6 permits a local circulating of the drying gases, these gases entering the sleeve 9 at its lower part and going upward to this gap and so passing again through the drier. The excess gas leaves through the tube 21.

It will be clear that by the arrangement described I save the extra material that is required if the drier is separately housed from the cyclone and the material-bearing gases are led by a tubular duct from the drier to the cyclone. Moreover, and more important, the gyratory motion imparted to the gases by the fan blades 8 is not destroyed, but the gases are delivered directly into the cyclone with this motion intact, which there results in the separating action. In the former arrangements any gyratory motion of the gases and material leaving the rotating part of the drier was lost in the tubular duct conveying them to the cyclone.

In the form of the invention illustrated in Fig. 3 the drier is identical with that described in connection with the form of Figs. 1 and 2. The cyclone, however, is here only a concentrator. In other words, the material is here not completely separated from the gases but is merely concentrated near the bottom of the conical part and is carried off from this part by means of some of the gases which flow out with the dried material and serve to carry it. The duct for the flow of this current of gas carrying the solids is shown at 24. This current, with its burden of material, is delivered into the separator cyclone 25 where the separation from the gases is completed, the material being taken off at the lower part of the separator and the cleaned gases being removed at the upper part through the outlet 26. Preferably the gases are recirculated and this is done by means of the channel 27, further hot gases being added as required through the incoming branch 28. Excess of gases is taken off by means of the vent 29, preferably from the central part of the outlet channel 26 where these gases are cleanest. A fan 30 assists in removing these excess gases.

In connection with this form of Fig. 3, I further illustrate the usual arrangement whereby some of the dried material is added to the fresh or raw and relatively very wet material coming from hopper 31. As much of the completely dried material as necessary is added and the remainder is taken off through the branch 32. This is in accordance with well known practice and the mixture of returned dry material and raw wet material is delivered by the mixing screw 33 into the channel 27 and so to the charging opening 16.

The arrangement of Fig. 3 is particularly useful in cases where the incoming raw material is very wet whereas the form illustrated in Fig. 1, without the use of any dry return, is adapted for the treatment of material that can be fed directly without any admixture of dried product. It will, however, be understood that the form of Fig. 1 with its separator cyclone can also be used when very wet material is to be treated, in which case, however, the dried material which is to be mixed with the incoming raw material must be raised to the top of the apparatus by means of some form of conveyor. In the form of Fig. 3 an additional conveyor becomes unnecessary as the gases can carry the dried material directly from the lower part of the concentrator to the elevated portion.

In Fig. 4 there is illustrated a form of my invention in which the cyclone is placed in an inverted position and above the drier-disintegrator. The raw material is fed in through the hopper 31a, the required proportion of treated material being added through branch 32a, where such admixture is required. The screw mixer delivers the mixture to the plate 6, which in this case rotates with plate 2a. The shaft 1a extends downward and is driven by means of pulley 19, as will be obvious from an inspection of the drawings. The stationary pins 4 are in this case carried by the stationary plate 5a which has a circular central opening from which the sleeve 9a extends upwardly. A closing bottom cover 5b is used to close up the lower end of the apparatus. The cyclone in this case is of the concentrator type, some of the drying gases, together with the comminuted dried material, being taken off at the tapered upper end of the cyclone through channel 24a, which delivers these gases to the cyclone separator 25a. Controlled amounts of hot gases for drying the material are introduced through the tube 21a extending axially downwardly ending within the sleeve 9a. In this form local recirculation of the drying gases is effected by gases entering the upper end of sleeve 9a passing through the lower end of this sleeve into the drier and outward between the pins.

The gases that have given up their dried material in the separator 25a are taken off through the central outlet 26a and are returned to the apparatus, together with the fresh heating gases. Excess of gases is removed through vent 29a assisted by the fan 30a.

What I claim is:

1. In a disintegrating drier having a horizontally disposed plate mounted on a vertically rotatable shaft, means for feeding gases together with material to be treated to the center of said plate, and disintegrating means arranged about and outwardly from the center of said plate, all so arranged that gases and material to be dried are directed from the center of said plate outwardly to said disintegrating means and leave the latter tangentially; a cyclone separator coaxial with the drier and located below and adjacent thereto; an annular channel surrounding the drier and connected to the upper part of the cyclone to receive the gases and material dis-

charged tangentially from the drier and to deliver them while whirling to the cyclone separator about its upper portion, the lower portion of the cyclone being frusto-conical for the reception of the material to be separated from the gases; and a vent tube extending outwardly from the upper part of the cyclone for removal of a portion of the gases.

2. In a disintegrating drier having a horizontally disposed plate mounted on a vertically rotatable shaft, means for feeding gases together with material to be treated to the center of said plate, and disintegrating means arranged about and outwardly from the center of said plate, all so arranged that gases and material to be dried are directed from the center of said plate outwardly to said disintegrating means and leave the latter tangentially; a cyclone separator coaxial with the drier and located below and adjacent thereto; an annular channel surrounding the drier and connected to the upper part of the cyclone to receive the gases and material discharged tangentially from the drier and to deliver them while whirling to the cyclone separator about its upper portion, the lower portion of the cyclone being frusto-conical for the reception of the material to be separated from the gases; and a vent tube extending downwardly from the upper central part of the cyclone and projecting through a lower wall portion thereof for removal of a portion of the drying gases.

3. In apparatus as defined in claim 1, said plate comprising an imperforate disk forming a partition between the drier and the upper portion of the cyclone and having a central opening therein communicating with the interior of the latter; a spider securing said disk to said shaft; fan blades mounted near the periphery of said disk; and a second plate secured to said shaft in superposed relation to said disk above the opening therein to receive the material fed into the drier, whereby a recirculation of the drying gases from the cyclone through the opening in said first disk and the space between the two disks may take place.

4. In apparatus defined in claim 1, said plate comprising a disk forming the bottom of the drier and having a central opening therein communicating with the upper portion of said cyclone separator; a spider securing said disk to said shaft; fan blades mounted near the circumference of said disk; a second disk slightly larger than the opening in said first disk secured to said shaft in superposed relation to said first disk for receiving the material fed into the drier; a sleeve extending downwardly into the cyclone from the edge in the opening of said first disk surrounding the upper end of said vent tube for preventing solids passing out with gases flowing through the latter; and means to remove the dry material from the lower end of said cyclone.

5. In a disintegrating drier having a horizontally disposed plate mounted on a vertically rotatable shaft, means for feeding gases together with material to be treated to the center of said plate, and disintegrating means arranged about and outwardly from the center of said plate, all so arranged that gases and material to be dried are directed from the center of said plate outwardly to said disintegrating means and leave the latter tangentially; a cyclone separator coaxial with the drier and located below and adjacent thereto; an annular channel surrounding the drier and connected to the upper part of the cyclone to receive the gases and material discharged tangentially from the drier and to deliver them while whirling to the cyclone separator about its upper portion, the lower portion of the cyclone being frusto-conical for the reception of the material to be separated from the gases; and a vent tube extending downwardly from the upper central part of the cyclone and projecting through a lower wall portion thereof for removal of a portion of the drying gases; a sleeve extending from the frusto-conical portion of said cyclone and surrounding said vent tube, said vent tube projecting through the wall of said sleeve; and means for removing dried material from the outer end of said sleeve.

6. In a disintegrating drier having a horizontally disposed plate mounted on a vertically rotatable shaft, means for feeding gases together with material to be treated to the center of said plate, and disintegrating means located about and outwardly from the center of said plate, all so arranged that gases and material to be dried are directed from the center of said plate outwardly to said disintegrating means and leave the latter tangentially; means forming a chamber coaxial with the drier and having a cylindrical material receiving section located adjacent thereto; an annular channel surrounding the drier and connected to the cylindrical portion of said chamber to receive the gases and material discharged tangentially from the drier and to deliver them while whirling to the cylindrical section of said chamber; and means for withdrawing the dried material and gases from said chamber.

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