

July 22, 1930.

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1,771,141

PROCESS AND APPARATUS FOR DRYING MATERIAL

Filed Feb. 21, 1925

3 Sheets-Sheet 1

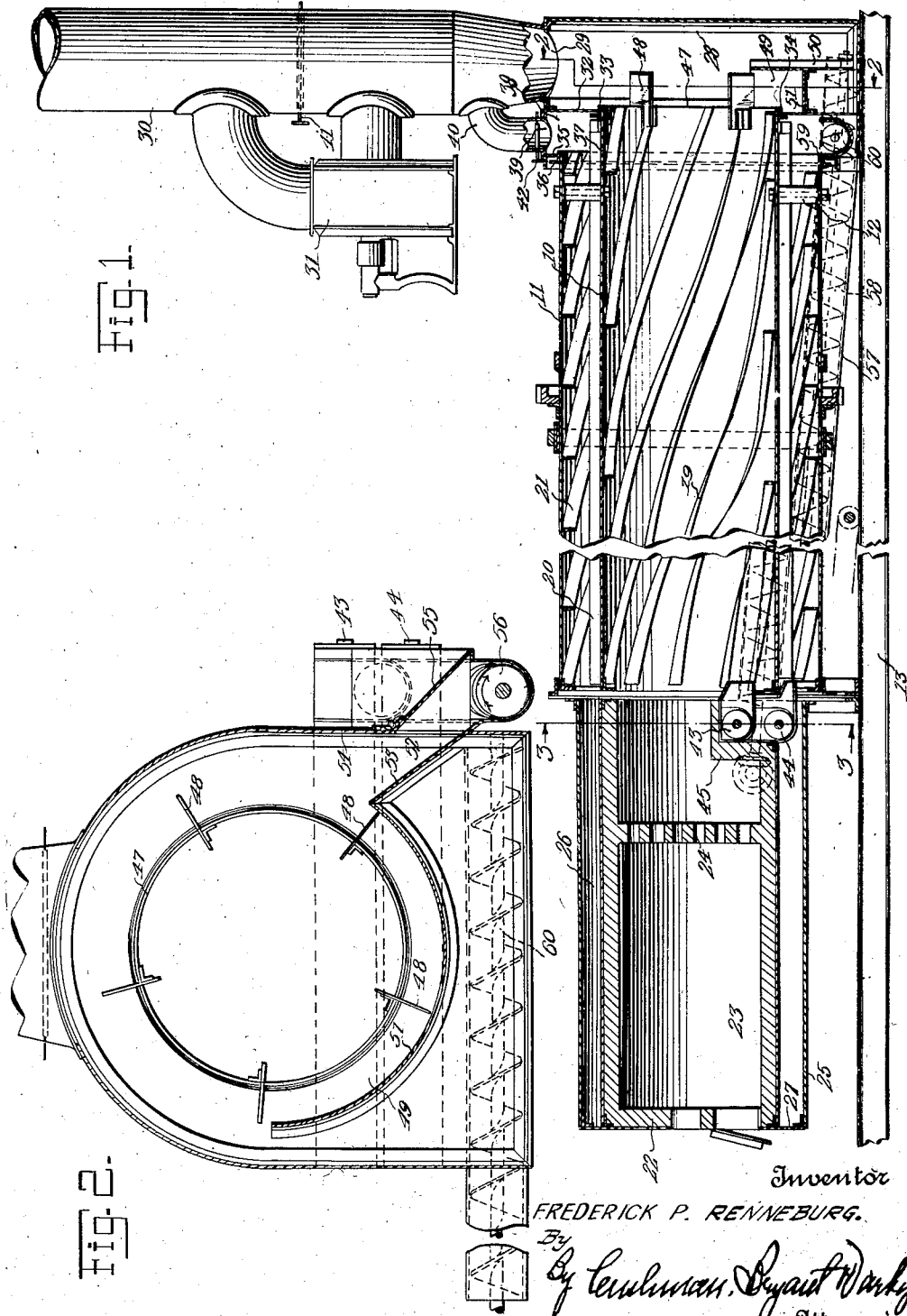


Fig. 1

Fig. 2

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3 Sheets-Sheet 2

FIG. 4.

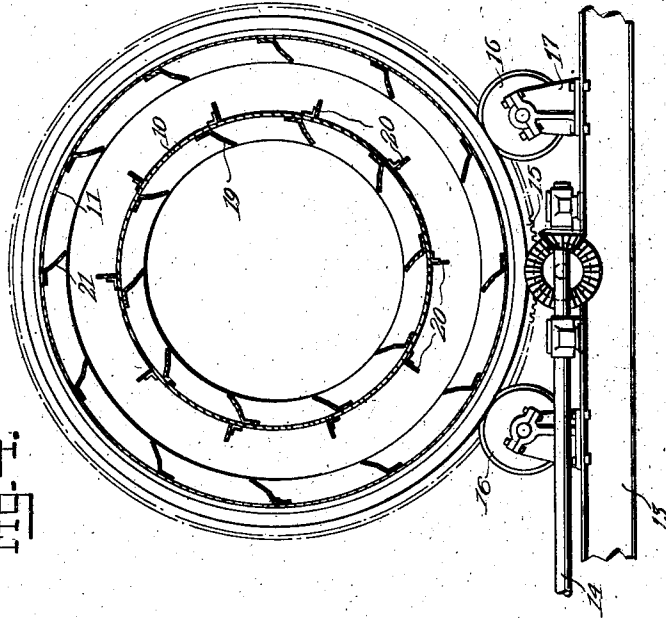
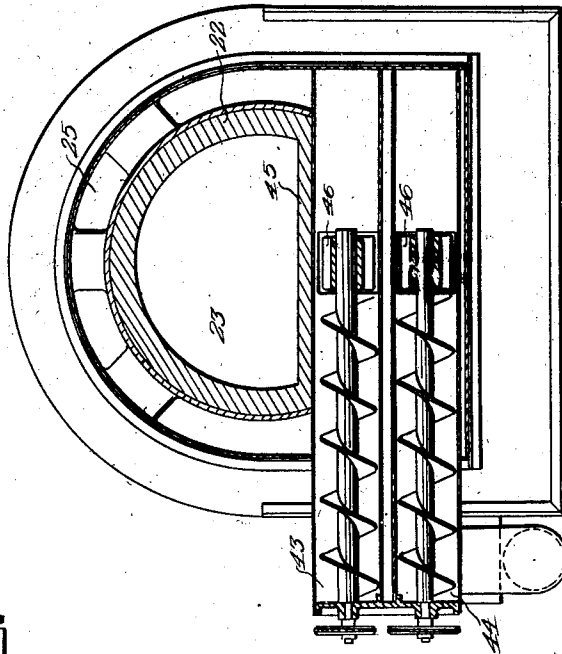


FIG. 3.



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Filed Feb. 21, 1925

3 Sheets-Sheet. 3

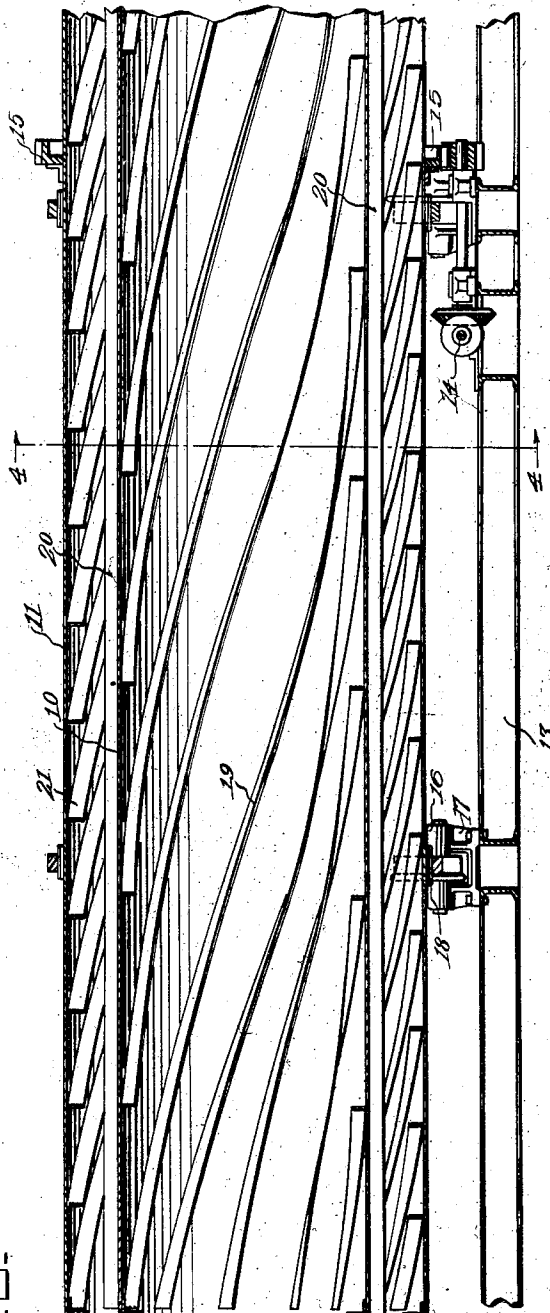


FIG. 5.

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PROCESS AND APPARATUS FOR DRYING MATERIAL

Application filed February 21, 1925. Serial No. 10,870.

The present invention relates to a process and apparatus for drying materials possessing various characteristics, and accomplishes a complete withdrawal of the moisture content by use of the drying medium in a simple and efficient manner.

It is recognized in the drying art that direct contact and mixture of a drying medium, such as heated air, with the material under treatment, is conducive to the best results. In the case of large capacity driers, however, such practice has been attended by the serious factor of condensation of the generated vapors and the consequent return of moisture into the material. Condensation is primarily due to the length of drying apparatus which must necessarily be employed, and the resultant course of the drying medium, the heat capacity of which becomes dissipated during its passage through the drying chamber in contact with the material. Thus at points remote from the entrance of the drying medium into the chamber, the temperature of the heated air is reduced, and the previously generated vapors in the form of steam have a natural tendency to condense and mix with the material.

In the present invention, this problem is successfully met by a method which consists in subjecting the material to separate and successive stages of drying, agitating the material during its transfer from one stage to another, and withdrawing the generated vapors during each of said stages of the drying operation.

The material is treated in a drying chamber where it is agitated in contact with the heated air supplied directly from any desired heating means. As the air and material mix, moisture is withdrawn from the material, and the generated vapors thus evolved are exhausted from the chamber at some point remote from the entrance of the drying medium. The material is then delivered into an agitator which releases any particles of contained steam and conveyed thereby to the second drying chamber. A separate and fresh supply of heated air is circulated in contact with the material in the second chamber, and as the material is

thrown about and mixed with the heated air, it is simultaneously subjected to heat radiating from the first drying chamber. The steam generated in the second chamber is likewise withdrawn at some point distant from the point of entrance of the drying medium. By this process, a complete extraction of moisture from the material is accomplished and the heated air is utilized with maximum efficiency. By exhausting the generated steam during each stage of the drying operation and at points remote from the points of initial application of the drying medium, to the material, condensation is eliminated.

The invention employs a drier of the rotating drum type, having concentric drums to receive the material. Each drum is formed with means for agitating the material and conveying it through the drums, as well as for assisting the circulation of the drying medium and the generated vapors. Heating means are provided for furnishing each drum with a direct supply of drying medium which will circulate over and be mixed with the material under treatment. For moving the generated vapors, such as steam, an exhausting apparatus is employed, having a separate connection with each drum, and this construction also contributes to the circulation of the heated air through the drums, as well as to propel the generated vapors in a direction appropriate for removal. The material is transferred from one drum to another by some type of conveyor having means for agitating or working the material during transit. By the use of this apparatus, the process above described is readily practiced, with the result that the ultimate product delivered is in a thoroughly dried condition.

It is proposed to employ but a single heating means for furnishing the supply of heated air to each chamber, and to use heat radiating from the inner drum to dry material which is being passed through the outer drum.

In the drawings:

Figure 1 is a longitudinal sectional view of the apparatus.

Figure 2 is a section on the line 2—2 of Figure 1.

Figure 3 is a section on the line 3—3 of Figure 1.

5 Figure 4 is a view in transverse section on the line 4—4 of Figure 5, showing the concentric drums, and the means for rotating them.

10 Figure 5 is a longitudinal section of the concentric drums constituting the drying chambers.

Referring to the drawings, the numerals 10 and 11 designate, respectively, the inner and outer drums which form the primary and secondary drying chambers of the apparatus. These drums are concentric, as shown, and are rigidly joined by bolts 12, or in any other desired manner, at several points throughout their length.

20 The apparatus is mounted upon a base 13, and the drums are rotated by means of a shaft 14 operating suitable bevel gearing having connection with a spur pinion which meshes with a band gear 15 on the outer drum. The shaft 14 and gearing are supported on the base, and it will, of course, be understood that any desired means may be employed for rotating the drums, the construction shown being found quite efficient. The drums are supported for rotation at points adjacent their ends upon rollers 16 which are mounted in trunnions carried by the supporting blocks 17, and said rollers are adapted to ride on bands 18 secured to the periphery of the outer drum. The inner drum 10 is formed interiorly with spiral fins or shelves 19 and exteriorly with straight longitudinal fins 20. The fins 20 extend radially from the periphery of the inner drum, as best shown in Figure 4. The outer drum is formed with spiral fins or shelves 21, similar to the fins 19, on the inner drum. These spiral fins serve to agitate any material placed in the drums and direct it toward one end thereof. They also perform the function of assisting the circulation of heated air used for drying, and, likewise, also act, to some extent, to propel steam generated in the drying operation, in a direction appropriate for withdrawal from the drums. The purpose of the fins 20 will be presently described, and at this point it will also be observed that the inner drum is of a length greater than that of the outer drum, as shown in Figure 1. At one end of the drums there is positioned a furnace or other suitable heating structure 22, having a fire chamber 23, the walls of which are extended, and terminate substantially flush with the wall of the inner or primary drying chamber 10. A perforated wall or barrier 24 is arranged in the fire chamber a sufficient distance from the entrance to the inner drum to prevent flame from entering the inner drum and injuring materials therein. By means of the furnace

22, a direct supply of heated air is introduced into the primary drying chamber 10.

70 Disposed about the furnace 22 is a casing or jacket 25, which defines an air space 26, to which air is admitted, and subjected to heat radiated from the furnace. The air is drawn into the air space 26 through suitable ports 27, and a damper means is provided as will be presently described for regulating the admittance of air into the jacket in accordance with circumstances incident to the drying operation. The casing wall 25 communicates substantially flush with the wall of the outer drum 11, and, therefore, a direct supply of heated air is furnished to the secondary drying chamber.

85 It will be observed that the primary and secondary drying chambers are each furnished with a direct supply of heating medium, and that the sources of such supply are separate. However, only one heating means is necessary, and each chamber is continuously provided with a fresh supply of heated air.

90 While a furnace has been described as a desirable heating means, it is quite obvious that any other suitable type of heating structure may be employed, but it is highly important that the supplies of drying medium be communicated directly to the primary and secondary chambers, with the fewest intervening obstacles, so that there will be no loss of heat.

100 Disposed at the ends of the drum; opposite the position of the furnace, is a stationary casing, indicated at 28. This casing is supported on the base, and is of the general configuration illustrated in Figure 2, that is, the top is curved or semi-circular in cross section and terminates in side walls which are relatively straight. The casing 28 is formed in its top with an opening 29, which communicates with a flue or stack illustrated at 30. The flue 30 has communication with an exhaust apparatus, preferably a suction blower fan, indicated as a whole at 31. The inner or primary drying chamber 10 opens into the casing 28, and when material is under treatment in this chamber, any steam or vapors generated are drawn off through the flue by the action of the blower 31. Likewise, the blower causes a circulation of the heated air introduced from the furnace through the inner drums, and serves to propel the vapors formed toward the mouth of the drum for prompt withdrawal. Secured to the casing 28 at a point intermediate its ends is a partition, indicated in Figure 1 by the numeral 32. This partition surrounds the projecting end of the inner drum 10, and the drum is provided with a circular band, angular in cross section, as shown at 33. This band 33 forms a wiping joint 34 with the stationary partition 32 when the inner drum is rotated.

130 Adjacent one end the casing 28 has secured

thereto a partition 35 which surrounds the projecting end of the outer drum. This adjacent end of the outer drum is provided with an angular band similar to the band 33, and co-operates with the partition 35 to form a wiping joint 36 similar to the joint 34, when the outer drum is rotated.

By means of the joint 34, the inner drum is sealed from the space between it and the outer drum. Thus steam generated during the first stage of the operation cannot enter the secondary chamber, but is directly exhausted from the primary chamber through the flue 30. This also serves to increase the circulating action of the drying medium through the inner drum, as will be readily understood.

It will be seen that the inner drum is of a length greater than the outer drum, and this difference in length and the provision of the partitions 32 and 35 forming wiping joints with the respective drums, serves to define a circular chamber 38, which is sealed from the inner drum, but which is arranged at the mouth of the outer drum for communication therewith.

This chamber 38, the peripheral walls of which are defined by the casing 28, is formed in the top with an opening 39 communicating with the chamber 38, and also with a flue or pipe 40 extending upward into the main flue 30. The exhaust action of the blower fan 31 is, therefore, transmitted through the flue 30 and pipe 40 to the chamber 38, so that steam or vapors may be separately withdrawn from the secondary drying chamber. This arrangement likewise circulates the drying medium in the outer drum and causes the vapors generated to move toward the chamber 38. It will here be noted that separate provision is made for continuously exhausting any vapors generated during each stage of the drying operation. Further, the withdrawal of the vapors is accomplished in each chamber at a point remote from the entrance of drying medium, and serves, as before stated, in each case, to circulate the heated air through the drum in contact with the material, as well as to cause the steam to advance through the drum toward appropriate points for withdrawal. Since condensation of the steam is due to the lowering of the temperature of the heated air the more removed it is from the point of initial application of the drying medium, it will be readily understood that the withdrawal of the vapors separately from each drying chamber and at a point remote from the entrance of the drying medium thereto, provides effectively against any condensation of the moist gases and their consequent return to the material. Suitable dampers 41 and 42 are provided in the flue 30 and pipe 40, respectively, for

regulating the action of the blower fan upon the primary and secondary chambers.

Material to be treated is supplied to the inner and outer drums 10 and 11 by means of conveyors of the spiral screw type, indicated respectively at 43 and 44. These feeding means, as shown in Figure 3, are arranged at right angles to the said drums. The adjacent end of the furnace at this point is reduced, as shown at 45, and the conveyors extend into communication with the drums beneath the squared recess formed by such reduced portion. Wings 46 at the terminals of the conveyor screws throw the material directly into the drums, and the heated air from the furnace and jacket is thus at once brought into contact with the material so delivered.

Material supplied to the drums in a moist condition is subjected to the drying medium, and is conveyed in a direction toward the casing 28 by reason of the spiral fins 19 and 21 formed on the interior of each drum.

The discharge end or mouth 47 of the inner drum is provided with a plurality of radially projecting paddles 48 secured to the periphery of the drum in any desired manner. The material is delivered from the primary chamber into a segmental transversely disposed trough 49 arranged in the casing 28. This trough is defined by a side wall 50 of segmental form, which extends a sufficient height above the discharge end of the inner drum to prevent materials from being thrown or spread about the casing. The other side wall is defined by the partition 32, previously described. A bottom 51 connects the side walls 32 and 50, and, as shown in Figure 2, this bottom wall is of arcuate form. The walls of the trough terminate at one side of the drums slightly above the mouth of the inner drum, and at this point an inclined chute or passageway is provided, defined by a wall 53, which is joined to the bottom 51, the adjacent wall 54 of the casing and the hinged gate or wall 55 being secured exteriorly of the casing. Suitable side walls, not shown, also define the chute, which has been shown in section in Figure 2. The paddles 48 are adapted to work in the trough to collect the material and move it to a point where it drops through the chute 52 into a closed conveyor, illustrated at 56. It will be seen that the conveyor wall is so connected to the chute that the material is at no time exposed to the air, and that since the trough 49 is arranged in proximity to the flue 30 during the transfer of the partially dried material in the inner drum 10 to the conveyor 56, it is constantly under force of the exhaust fan or blower 31.

The conveyor 56 comprises a cylindrical casing 57, in which is arranged, preferably, a screw 58 adapted to be rotated in any suitable manner. The conveyor is arranged at

one side of the drums in parallel relation thereto, and is inclined to lead partially dried material delivered from the inner drum, into the feeding screw 44 for delivery to the secondary or outer drying chamber. The spiral conveyor is employed, since this will serve to agitate the material and break up and release any particles of steam, some of which will, of necessity, be intimately mixed with the material. This conveyor is also subject, to some extent, to the exhaust action of the blower, as will be readily seen. The material is introduced into the secondary chamber in an excellent condition for the second stage of the drying operation.

In the secondary chamber, the material is subjected to and mixed with the heated air from the jacket 26. As it is moved through the drum toward the casing, the steam generated is being withdrawn through the chamber 38 and pipe 40. The dried product is delivered from the mouth 59 of the outer drum directly into a conveyor 60 arranged at right angles to the said drum, and the material is conveyed to any desired point. It will be observed that at the point of final discharge, the means for exhausting generated vapors, will exert its action so that at no time in either the first or second stages of the drying operation will condensation occur.

The feeding screws, agitating conveyor and shaft 14 for rotating the drums may be operated from a single prime mover, or each of these devices may be separately actuated in accordance with circumstances surrounding the arrangement of the apparatus and the character of the material under treatment.

It will be understood that the material is first delivered into the inner drum 10, where it is subjected to the action of heated air direct from the furnace. By reason of the spiral fins, the material is thrown about in intimate contact with the air, and, at the same time, is conveyed in a direction toward the casing 28. This arrangement of the fins also serves in a degree to circulate the drying medium, and, likewise, to propel the gaseous vapors toward the said casing and in proximity to the flue 30 and blower 31. The material in partially dried condition is delivered from the inner drum into the trough arranged at the end thereof, and by reason of the segmental wall 50, all of the material, as it empties from the mouth of the inner drum is confined in the trough. The paddles on the end of the inner drum which work in the trough, pick up the material and carry it to a point where it drops through the chute into the agitating conveyor. The generated vapors, as previously explained, are drawn from the inner drum, and discharged exteriorly of the apparatus, by reason of the flue 30 and the exhaust action of the blower fan.

The material delivered into the agitating conveyor is carried upward to the feeding

screw for the outer drum. Material delivered into the outer drum is subjected to a fresh supply of warm air from the jacket about the furnace, and is agitated and conveyed in the same manner as material in the inner drum. In addition, by reason of the straight longitudinal fins upon the periphery of the inner drum, the material is retained in contact with the inner drum so that it becomes subjected to heat radiating from the inner drum. Thus, in the second stage of the drying operation, the material is thoroughly dried, and, at the same time, the generated vapors are withdrawn from the chamber 38. The blower fan exerts a similar action upon the drying medium and steam in the outer chamber, so that the vapors are drawn toward the chamber 38, where they are readily withdrawn.

The process thus proceeds in two distinct and separate stages, and the material is transferred from one stage to another by means of a conveyor in which the said material is thoroughly agitated, so that on its delivery to the second drying chamber, steam particles which may have been contained therein are loosened or broken up. This materially assists in the complete withdrawal of moisture during the second heating.

The apparatus is simple and enables the process to be practiced in such a manner that the drying mediums are efficiently utilized and there is no opportunity for condensation of any steam or generated vapors. The drier can be made of any size without destroying its efficiency, and it will be equally clear that various changes may be resorted to without materially altering the scope of the invention.

I claim:

1. In a drier, primary and secondary drying elements arranged one within the other, means for supplying a separate freshly heated drying medium to each element, and means for circulating such fresh drying mediums and withdrawing the resultant vapors at a point remote from the entrance of said drying medium.

2. In a drier, primary and secondary drying elements arranged one within the other, means adjacent one end of said elements for supplying a separate freshly heated drying medium to each element, and means adjacent the other end of said elements for circulating the drying mediums and withdrawing resultant vapors.

3. In a drier, rotary primary and secondary drying elements arranged one within the other, means adjacent one end of said elements for supplying a freshly heated drying medium to each element, and means adjacent the other end of said elements for circulating the drying mediums therethrough and withdrawing resultant vapors.

4. In a drier, rotary primary and second-

ary drying elements arranged one within the other, means adjacent one end of said elements for supplying a fresh heating medium to each element, means for feeding material to each element, means formed on the elements for agitating the material and directing its passage through the elements, and means adjacent the other end of said elements for circulating the drying mediums therethrough and withdrawing resultant vapors from each element.

5. In a drier, rotary primary and secondary drying elements arranged one within the other, means for supplying material to each element, means for supplying a drying medium to each element comprising a furnace and a chamber heated thereby, means formed on said elements for agitating the material and directing its passage through the elements, means formed on one of said elements for retaining the material in drying relation to the other of said elements, and a flue communicating with each element and having means for circulating the drying mediums therethrough and exhausting resultant vapors.

6. In a drier, rotatable primary and secondary drying elements arranged one within the other, means for supplying a freshly heated drying medium thereto, means for feeding material to each element, means for transferring partially dried material delivered from one element to the feeding means for the second element, and means remote from both of said first mentioned means for circulating the drying medium over the material and withdrawing moist air from said elements.

7. In a drier, rotatable primary and secondary drying elements arranged one within the other, means for supplying a drying medium thereto, means for feeding material to each element, and means for mechanically agitating and transferring partially dried material delivered from one element to the feeding means for the second element.

8. In a drier, rotatable primary and secondary drying elements arranged one within the other, means for supplying a drying medium thereto, means for feeding material to each element, means for mechanically agitating and transferring partially dried material delivered from one element to the feeding means for the second element, and means for circulating the drying mediums through said elements and exhausting resultant vapors therefrom.

9. In a drier, rotatable primary and secondary drying elements, means for supplying a drying medium thereto, means for feeding material to each element, means formed on the elements for directing the passage of material therethrough, a conveyor adapted to receive partially dried material at one end of one of said elements and to agitate and de-

liver such material to the opposite end of the other element, and means for circulating the drying mediums through said elements and exhausting resultant vapors therefrom at the point of greatest vapor density.

10. In a drier, rotatable primary and secondary drying elements, means for supplying a drying medium thereto, means for feeding material to each element, means formed on the elements for directing the passage of material therethrough in a direction away from said feeding means, means for receiving partially dried material at one end of one of said elements and delivering such material in agitated condition to the opposite end of the other of said elements, means formed on one of said elements for holding material in drying relation to the other of said elements, and means for circulating the drying mediums through said elements and exhausting resultant vapors therefrom and from said last mentioned means.

11. In a drier, a drying chamber comprising concentric drying elements, means for supplying a fresh drying medium to each of said elements, and means for circulating such drying medium through the elements and exhausting resultant vapors therefrom.

12. In a drier, a drying chamber comprising concentric drying elements, means comprising a furnace and a chamber heated thereby for supplying a freshly heated drying medium to each element, and means for circulating the drying mediums through said elements and exhausting the resultant vapors therefrom.

13. In a drier, a drying chamber comprising rotatable drying elements, means for supplying a freshly heated drying medium to each element comprising a furnace and a chamber heated thereby, and means for circulating the drying mediums through said elements and exhausting the resultant vapors therefrom.

14. In a drier, a drying chamber comprising rotatable concentric drying elements, means for supplying a separate freshly heated drying medium to each element comprising a furnace and a chamber heated thereby, and means for circulating the drying medium through said elements and exhausting the resultant vapors therefrom at the point of greatest vapor density, said last mentioned means comprising an exhaust fan and a flue communicating with each element.

15. In a drier, a drying chamber comprising rotatable concentric elements, means for supplying a separate freshly heated drying medium to each element, means for feeding material to each element, means for conveying partially dried material from one of said elements to the feeding means of the other element in an agitated condition, and means for circulating the drying mediums through said elements and exhausting the resultant

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vapors therefrom at the point of greatest vapor density.

16. In a drier, a drying chamber comprising concentric drums, means for supplying material to each of said drums, means for supplying a separate freshly heated drying medium to each of said drums, the inner of said drums being adapted to initially receive material to be dried and being formed with means for directing the material there-
 10 through, means for receiving the material at the discharge end of said inner drum and delivering it to the outer drum, and means for circulating the drying mediums over the ma-
 15 terial in each drum and exhausting resultant vapors therefrom at the point of greatest vapor density.

17. In a drier, a drying chamber comprising concentric drums, means for feeding ma-
 20 terial thereto, means for supplying a separate freshly heated drying medium to each drum, said drums being formed with means for agi-
 25 tating and directing the material there- through in one direction, and means for cir- culating the drying mediums through said drums and exhausting the resultant vapors therefrom at the point of greatest vapor density.

18. In a drier, a drying chamber compris-
 30 ing concentric rotatable drums, means for feeding material thereto, means for supply- ing a separate freshly heated drying medium to each drum, said drums being formed with means for agitating and directing the ma-
 35 terial therethrough in one direction, and means for continuously circulating the dry- ing mediums through said drums and ex- hausing the resultant vapors therefrom at the point of greatest vapor density.

19. In a drier, a drying chamber compris-
 40 ing concentric rotatable drums having com- munication with each other, means for feed- ing material thereto, means for supplying a separate freshly heated drying medium to
 45 each drum, said drums being formed with means for agitating and directing the ma- terial therethrough in one direction, and means for circulating the drying mediums through each drum and exhausting the re-
 50 sultant vapors therefrom at the point of greatest vapor density.

20. In a drier, a drying chamber compris-
 55 ing rotatable concentric drums, means for supplying a separate freshly heated drying medium thereto, means for feeding material to each drum, said drums being formed with spiral fins serving to agitate and move the material through the drums in one direction, and means for circulating the drying me-
 60 diums through each drum and exhausting the resultant vapors therefrom at the point of greatest vapor density.

21. In a drier, a drying chamber compris-
 65 ing rotatable concentric drums, means for supplying a separate freshly heated drying

medium thereto, means for feeding material to each drum, said drums being formed with spiral fins serving to agitate and move the material through the drums in one direction, and means communicating with each drum
 70 for circulating the drying mediums through each drum and exhausting the resultant va- pors therefrom.

22. In a drier, a drying chamber compris-
 75 ing concentric drums, means for supplying a drying medium to each drum, means for feeding material to each drum, means formed on one of said drums for retaining the ma- terial in drying relation thereto, and means communicating with each drum for circu-
 80 lating the drying mediums therethrough and exhausting the resultant gases at the point of greatest vapor density.

23. In a drier, a drying chamber compris-
 85 ing concentric drums, means for supplying a separate freshly heated drying medium to each drum, means for feeding material to each drum, longitudinally extending straight fins formed on the outer periphery of the in-
 90 ner drum, whereby material in the outer drum is held in drying relation to said inner drum, and means communicating with each drum for circulating the drying mediums therethrough and exhausting resultant gases at the point of greatest vapor density.

24. In a drier, a drying chamber compris-
 95 ing rotatable concentric drums, means for supplying a separate freshly heated drying medium to said drums, means for supplying material to each of said drums at one end,
 100 means formed on the inner of said drums for agitating and moving the material for dis- charge at the opposite end thereof, means for receiving the partially dried material at the discharge end of said inner drum and simul-
 105 taneously agitating and conveying such ma- terial to the feeding means for the outer drum, and means for circulating the heating mediums through said drums and withdraw- ing the resultant vapors therefrom at the
 110 point of greatest vapor density.

25. In a drier, a drying chamber compris-
 115 ing concentric drums, primary and auxiliary means for supplying drying mediums to said drums, means for feeding material to said drums, spiral fins formed on said drums for agitating and moving the material in one di-
 120 rection, straight longitudinal fins formed on one of said drums for retaining the material in drying relation thereto, and means com- municating with the discharge end of one drum and the feeding means of the other drum, said means comprising a conveyor having a screw for transferring the material from one to the other of said drums.

26. In a drier, a drying chamber compris-
 125 ing concentric drums, primary and auxiliary means for supplying drying mediums to said drums, means for feeding material to said drums, spiral fins formed on said drums for
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agitating and moving the material in one direction, straight longitudinal fins formed on one of said drums for retaining the material in drying relation thereto, means communicating with the discharge end of one drum and the feeding means of the other drum, said means comprising a conveyor having a screw for agitating and transferring material from one drum to another, and means for circulating the drying mediums through the drums and exhausting the resultant vapors therefrom and from said last mentioned means.

27. In a drier, a drying chamber comprising rotatable concentric drums, primary and auxiliary means for supplying drying mediums to said drums, and means communicating with each of said drums for causing the circulation of said drying medium and withdrawing the resultant vapors from each drum at the point of greatest vapor density.

28. In a drier, a drying chamber comprising rotatable concentric drums, one of said drums being of greater length than the other, means for supplying a drying medium to each of said drums, partition plates forming a chamber defined by the difference in length of said drums, and means communicating with said chamber for withdrawing resultant vapors therefrom.

29. In a drier, a drying element, means for supplying a separately heated drying medium thereto, means for causing a circulation of said drying medium in the element and exhausting the resultant vapors, a second drying element, means for supplying a drying medium thereto, means for conveying partially dried material from the first element to the second element and simultaneously agitating it, and means for circulating the drying medium through said second element and exhausting the resulting vapors from said element at the point of greatest vapor density.

30. In a drier, a plurality of drying elements arranged one within the other, means comprising a primary heater and a secondary heater for supplying a separately heated drying medium to each element, and means for circulating the drying mediums through said elements and exhausting the resultant vapors therefrom.

31. In a drier, a drying chamber comprising drying elements arranged one within the other, means for supplying a separately heated drying medium to each element comprising a primary heater and an auxiliary heater, and means remote from the source of drying medium for withdrawing resultant vapors from said elements and circulating the drying mediums therethrough.

32. In a drier, a plurality of drying elements arranged one within the other, means for supplying a separately heated drying medium to each element and means for feeding

material to each element adjacent one end of each of said drums, and means for withdrawing moist resultant vapors from each of said drums at a point remote from said first mentioned means.

33. In a drier, a drying chamber comprising drying elements arranged one within the other, means for feeding material at one end of each of said elements, means in alignment with said elements for supplying a separately heated drying means thereto, and means for circulating a drying medium through said drums withdrawing resultant vapors therefrom at the point of greatest density.

34. In a drier, a drying chamber, means for feeding material thereto, means for passing a separately heated drying medium over said material and in contact therewith, means for moving the material through the chamber, and means for causing the drying medium to circulate through the chamber and withdrawing the moist resultant vapor at a point remote from the point of highest temperature of the chamber.

35. In a drier, a plurality of rotating drying drums concentrically mounted, means for supplying a heating medium to each of said drums, means for feeding material to each of said drums at one end and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density.

36. In a drier, a plurality of drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density.

37. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density.

38. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, conveyors communicating with each of said drums, one conveyor extending from the discharge end of one drum to the feeding means of the other drum, and the second conveyor discharging the dried material.

39. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums, means for feeding ma-

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material to each of said drums and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, spiral fins on said drums and straight

5 fins on one of said drums for directing the material through the drums and supporting it in position to be treated by heat radiated from one of said drums.

40. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, one of said drums being shorter than the other and a partition defining chambers with which said last mentioned means is in communication.

41. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, a trough receiving material discharged from one of said drums, and means moving the material through said trough to an outlet therein.

42. In a drier, a plurality of drying drums rotatably mounted one within the other, means for supplying a heating medium to each of said drums, means for feeding material to each of said drums and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, a trough adjacent one of said drums for receiving material discharged therefrom, and paddles carried by one of said drums and movable in said trough for discharging material through an outlet therein.

43. In a drier, a plurality of concentric elongated drying members, means for feeding material to said members disposed at one end thereof, means for exhausting generated vapors disposed at the opposite end thereof and a heating means having separate communication with each member for supplying a freshly heated drying medium thereto, said heating means being disposed at the feed end of the members.

44. In a drier, a plurality of concentric elongated drying members, means for feeding material to said members disposed at one end thereof, means for exhausting generated vapors disposed at the opposite end thereof and a heating means having separate communication with each member for supplying a freshly heated drying medium thereto, said heating means being disposed at the feed end of the members, and supplying to one of said members a drying medium of different

temperature than that supplied to the other member.

45. In a drier, a plurality of drying members, means for feeding material to said members, means for exhausting resultant vapors from said members and means for supplying drying mediums of different temperatures to said members.

46. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end, means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, one of said drums being shorter than the other and a partition defining chambers with which said last mentioned means is in communication, a trough receiving material discharged from one of said drums and means moving the material through said trough to an outlet therein.

47. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end, means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, one of said drums being shorter than the other and a partition defining chambers with which said last mentioned means is in communication, a trough adjacent one of said drums for receiving material discharged therefrom, and paddles carried by one of said drums and movable in said trough for discharging material through an outlet therein.

48. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a freshly heated drying medium to each of said drums at one end, means for feeding material to each of said drums at the same end, and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, one of said drums being shorter than the other and a partition defining chambers with which said last mentioned means is in communication.

49. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a freshly heated drying medium of different temperatures to each of said drums at one end, means for feeding material to each of said drums at the same end, and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, one of said drums being shorter than the other and a partition defining chambers with which said last mentioned means is in communication.

50. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to

each of said drums, means for feeding material to each of said drums and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, a trough receiving material discharged from one of said drums, means moving the material through said trough to an outlet therein, and a chute communicating with said outlet.

51. In a drier, a plurality of rotating drying drums arranged one within the other, means for supplying a heating medium to each of said drums, means for feeding material to each of said drums and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, a trough receiving material discharged from one of said drums, means moving the material through said trough to an outlet therein, and a conveyor receiving material from said outlet and communicating with the feeding means.

52. In a drier, primary and secondary drying elements arranged one within the other, means for supplying a separate freshly heated drying medium of a different temperature to each element, and means for circulating such drying medium and with drawing the resultant vapors at a point remote from the entrance of said drying medium.

53. In a drier, rotary primary and secondary drying elements arranged one within the other, means adjacent one end of said elements for supplying a freshly heated drying medium of a different temperature to each element, and means adjacent the other end of said elements for circulating the drying mediums therethrough and withdrawing resultant vapors.

54. In a drier, a plurality of drying drums arranged one within the other, means for supplying a heating medium to each of said drums at one end, means for feeding material to each of said drums at the same end, and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, one of said drums being shorter than the other and a partition defining chambers with which said last mentioned means is in communication.

55. In a drier, a plurality of drying drums arranged one within the other, means for supplying a heating medium to each of said drums, means for feeding material to each of said drums and means for withdrawing generated vapors from each of said drums at the point of greatest vapor density, a trough receiving material discharged from one of said drums, and means moving the material through said trough to an outlet therein.

In testimony whereof I have hereunto set my hand.

FREDERICK P. RENNEBURG.