June 9, 1942. W. C. GOSS 2,285,508

INTERNALLY HEATED DRIER

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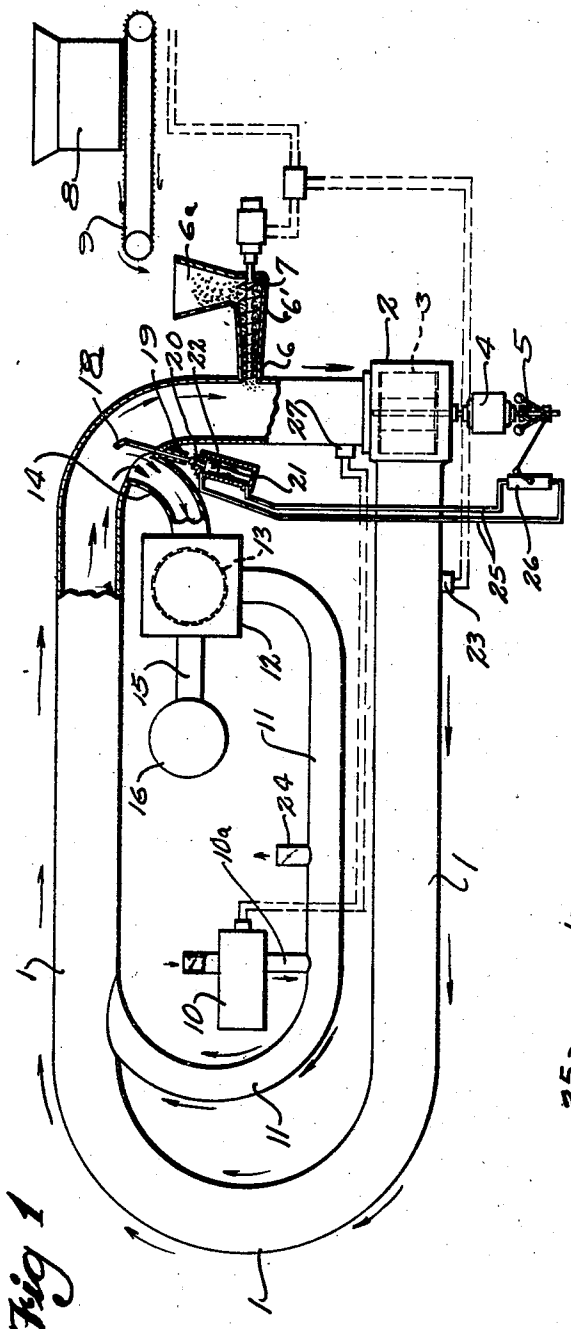

Fig 1

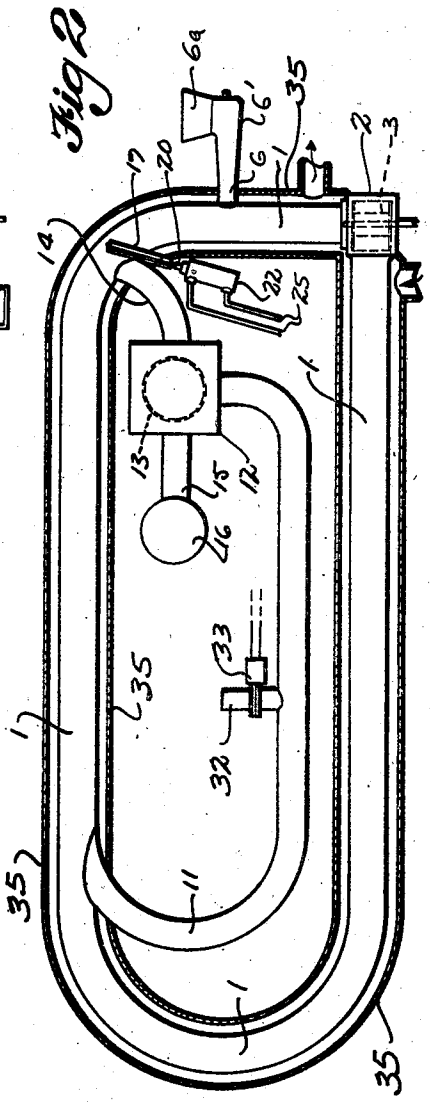

Fig 2

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INTERNALLY HEATED DRIER

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7 Claims. (Cl. 263—15)

This invention relates to improvements in driers and has reference more particularly to an equipment designed for the drying of comminuted material preparatory to its being briquetted.

More specifically stated, the invention relates to driers for cellulosic material, and comprises a continuous, circuitous tube into which the material to be dried is delivered, and with which tube a fan is associated for creating a violent circulation of material around the circuit, and wherein a quick and thorough drying operation of the material is effected by the application of a blast of hot gases into the tube; the present invention being somewhat in the nature of an improvement upon the disclosures in United States Letters Patent No. 1,985,250, issued December 25, 1934, to O. P. M. Goss and Worth C. Goss.

It is the principal object of the present invention to provide a drier of the character above stated that will effect its intended function quickly and thoroughly; which may be employed to either dry and heat the comminuted material to a condition desired for briquetting by a hot process, or may be employed to warm the material and regulate the moisture content thereof so that it may be briquetted under the plasticizing action of the contained moisture.

It is also an object of the present invention to provide a drier of a portable character and of such construction that it is adapted to being transported in connection with apparatus designed for the briquetting of straw and the like.

Another object of the invention resides in the provision of a novel means for extracting dried material from the mass as circulated in the drying tube under influence of the propelling fan, and in the provision for automatically controlling the said means in accordance with the load on the propelling fan.

Other objects of the invention reside in the details of construction and combination of parts and in the automatic control of the device in operation, as will hereinafter be fully described.

In accomplishing these and other objects of the invention, I have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawing, wherein—

Fig. 1 is a diagrammatic illustration of a drier embodying the present invention.

Fig. 2 is a similar view illustrating a modified, or alternative construction.

Referring more in detail to the drawing—

In the construction as shown in Fig. 1, 1 designates the main drier tube which would be of substantial diameter and length, and continuous in that it forms a closed loop, or circuit. Interposed in the tube, as a part of the circuit, is a housing 2, containing a suction and propelling fan 3 of such kind that in operation it will function to maintain violent circulation of the enclosed gases in the tube circuit in the direction designated by the arrows adjacent the tube. Any suitable power device, such as an electric motor, as designated at 4, may be employed to drive the fan at the proper speed. As here shown, the motor has direct connection with the fan shaft, and there is a ball governor device 5 operated by the motor for a purpose presently explained in connection with the control of the discharge of dried material from the tube.

The material to be dried, such as comminuted straw, sawdust or other cellulosic material, is delivered into the tube 1, at a point adjacent the inlet side of the fan housing 2, through a feed tube 6. Preferably, the feeding of the material is effected by the action of an Archimedean screw 7, which, as here shown, is contained in an enlargement 6' of the tube 6 and operates to keep the tube 6 packed with the comminuted material, so that the material will operate effectively as a closure means whereby outside air is kept from entering the tube 1 through this inlet, and gases inside the tube 1 are kept from escaping therethrough.

The material to be dried may be delivered to tube 6 and the screw 7 by any suitable means. Preferably, it would be received at the receiving end of the feed screw directly from the device by which it is reduced to its desired comminuted condition. In this view, I have indicated a hammer mill, as at 8, and a conveyer 9 which operates to deliver the comminuted material from the mill into the receiving hopper 6a of the delivery tube 6.

Should the comminuted material, in its entrance into the tube 1 from the tube 6, be packed by reason of the feeding pressure exerted by screw 7, it will quickly be broken up upon entering the housing 2, by the action of the fan 3, and is then easily carried in suspension about the tube 1 by the gas current.

When the present apparatus is put to use as a high temperature drier, the drying gases in the tube 1 are preferably maintained at a constant temperature of approximately 430° Fahrenheit. This heat is derived by use of a heating device, such as an oil burner, of suitable kind, as designated at 10, arranged to deliver its hot inert gases through a blast tube 10a into a tube 11, which in turn, discharges directly into the main tube 1.

As will be noted in the drawing, there is an automatic separator device associated with the drier tube. This separator comprises a closed housing 12 containing a centrifugal separating fan 13. The housing 12 is connected by means of a pipe 14 with pipe 1, to receive material from

the latter, and the return tube 11 leads from the housing 12 past the oil burner where the blast tube 10a enters it; then the tube 11 curves laterally and opens into tube 1 in the direction of the flow of gases therein.

The fan 13 may be driven by any suitable means, and the function of the fan is to separate the dried material from the gases diverted into the housing 13, through tube 14, and to deliver the hot gases again into the drying circuit through the tube 11, and to discharge the dried material through a tube 15 leading from the fan housing 12 into a hopper 16 for delivery from the hopper to storage or to a point of use, such as a briquette press. This separating fan might be replaced by a separating cyclone of conventional design.

It will be understood that since the discharge end of tube 11 enters tube 1 in the direction of flow of gases in the latter tube, there will be no tendency of back pressure in tube 11, but rather, suction will be created to draw gases from the housing 12 of the separating device. Also, since the pipe 14 leads from the pipe 1 at the sheltered side of a bend, or turn, therein, it is necessary to provide means for diverting the dried material thereinto. In the present instance, I have illustrated use of a baffle plate or damper 18 for this purpose; the plate extending inwardly from the inside wall of tube 1 just beyond the entrance into pipe 14, and by reason of its extending into the tube 1, it operates as a deflector for diverting the material that strikes it, into tube 14, and thus to the separating fan.

In the event that the material being dried has an excessive moisture content so that the oil burner is incapable of maintaining the temperature at the proper degree in the tube 1, the speed of the feed screw 7 is automatically reduced or temporarily stopped under the control of a secondary thermostat 23, which would shut off the feed of fresh material through the screw 7. This would only occur if the temperature in the tube 1 drops below 420° F. When the temperature again rises to 430° F., the feeding of fresh material is again resumed through the screw 7. It is also contemplated that the mill 8 and the conveyor 9 be controlled by this same thermostat, 23, so that its speed of operation will be reduced or stopped, accordingly, with the feed screw 7.

The plate or damper 18 is slidable in a guide 19 and has a rod 20 at its outer end connected with a piston 21 in an air cylinder 22. The action of the piston whereby to adjust the damper into or out of the tube 1, is effected by application of air pressure to the cylinder and this is accomplished through a pipe 25 under control of a valve 26; the valve being controlled by the governor device 5 connected with the motor 4. Thus, when the motor is slowed down, by reason of too rapid feeding of material into the circulating tube, the fan 3 will be slowed down, and the deflector plate will project further into tube 1 accordingly to take more material from the tube.

The separating device 13 is of standard construction, and by itself forms no part of this invention. Briefly, it is of that character whereby centrifugal action operates to deliver the dried material to one point of discharge; that is, to the tube 15, leading to hopper 16, and the air or gases are forced to another point of outlet. In this instance, the gases diverted to the housing 13 are returned to the system through the pipe 11 and in their passage to the pipe 1, are mixed with the hot gases from the oil burner to reduce the temperature of the latter to not more than 700° F.

By reason of the high degree of heat employed in the drying tube 1, and the fact that moisture contained in the material being dried will be converted into steam by this heat, it is necessary to provide a steam outlet for the system and this preferably is from pipe 11 as herein designated at 24. Also, it is desirable that the temperature of the gases in tube 1 be kept substantially at a constant degree of temperature and for this purpose, I have installed a thermostatic device 27 in a side wall of tube 1, at the inlet side of fan housing 2. This thermostatic device could be of any conventional type, as now universally used in heating plants for burner control, and would be connected electrically or otherwise in the oil burner control system to cut off the heat when it reaches a predetermined degree, and to turn it on when the temperature falls to another predetermined degree.

A modification of the system above described is illustrated in Fig. 2, and the modification resides principally in the means for applying heat to the drying tube 1.

Under certain conditions, it will be desirable to use waste flue gases as the heating medium. However, since these gases might not always be inert chemically, it would be extremely dangerous, from the standpoint of dust explosions, to inject them into the drying tube 1. Therefore, it is desirable that these waste flue gases be utilized exteriorly of tube 1 by applying them within a jacket 30 surrounding tube 1, as shown in Fig. 2; such a jacket being substantially like that shown in the previously mentioned patent. In this way, the drying tube would be heated externally and the material to be dried would be circulated in a pure atmosphere of superheated steam.

When the heat is thus applied, a slight steam pressure is maintained inside the dryer to preclude the possibility of the entrance of any air or gases into the drying tube, this being to prevent dust explosions. To insure this pressure, steam may be admitted from a source of supply 32 under control of an automatic solenoid valve 33, and in practise this steam pressure in the drying tube would never be higher than one-eighth pound per square inch above atmospheric pressure.

In the case that it is desired to introduce waste flue gases directly into the drying tube 1, this may be done with safety if precaution is taken to insure the comparative inertness of the gases before they enter the tube. For example, steam might be added to the gases under the control of a regulating carbon dioxide meter, or the gases might be passed through an additional furnace where any oxygen present would be caused to combine with carbon, thus forming additional carbon dioxide gas. In any event, a regulating carbon dioxide meter would be advisable to use as an insurance of the inertness of the flue gases.

Assuming the apparatus to be so constructed, its use would be as follows:

Comminuted material to be dried will be delivered from its source of supply 8 into tube hopper 6' by the conveyor 9 for delivery by the Archimedean screw 7 through the tube 6 into the tube 1. As this material is thus fed into the tube 1, its packed condition in the tube 6 will preclude the entrance of any air to the system and also will prevent any discharge of gases from

the system through this feed tube passage. Any lumps of comminuted material that might be forced into the tube 1 by reason of the pressure of the feed screw will be readily broken up by the action of the circulating fan 3.

When the apparatus is used as a high temperature drier, a constant temperature of approximately 430° F. will be maintained in the tube 1 through the control of the oil burner 10 by the thermostat 27 that is interposed in the tube 1. The hot gases delivered directly from the burner into the tube 11 will be tempered by mixture with a large volume of spent gases that are discharged from the separator housing 12 into the tube 11 for delivery thereby into the main drier tube 1, at a temperature not in excess of 700°.

As the comminuted material is thus violently circulated within the tube 1 by the action of the fan 3, it will be quickly and effectively dried and the dried material will be discharged from the tube to the separator by the diverting action of the damper or baffle 18. The material, which becomes dry and dustified, is deflected into pipe 14 by the baffle, due to the fact that the heavier, undried material will be thrown to the outside of the bend of the tube and the lighter material forced to the inside, where it contacts with the baffle. The disposition of the baffle in the bend of the tube 1, as illustrated, facilitates this mode of separating the dried material from the undried material in the tube 1, and makes possible the present control by the governor 5.

Material received along with the hot gases within the separating apparatus 12 is diverted by reason of centrifugal action, to the outlet 15 leading to the hopper 16, while the spent gases are directed into tube 11 for return to the system after being mixed with the hot gases from the oil burner.

To prevent overload of the drier with material, the deflecting baffle will be pulled in or extended in accordance with the speed of operation of the fan 3. This is to regulate the quantity of comminuted material in suspension in the air in the drier tube 1 at any time and the regulation of the deflecting baffle is accomplished through the connection described, with the governor 5. The operation is such that when the fan 3 slows down slightly, which may be due to heavy load of material in the drier tube, the baffle will be extended further into the tube, thus causing the discharge of more dried material. If, on the other hand, the fan is sped up, the baffle will be retracted accordingly, thus allowing a greater quantity of comminuted material to remain in suspension in the drier tube.

The steam discharge outlet 24 from the tube 11 will be provided with a suitable yieldable damper or valve which is so regulated as to open or close, to a greater or lesser degree, by the pressure inside of tube 11. The purpose of this valve is to prevent any intake of air into the tube; also, to vent the necessary quantity of steam and spent gas from the drier. Thus, the danger of explosion is minimized as with a higher gas pressure inside the drier than there is atmospheric pressure outside, any gas leaking through the cracks in the equipment will be to the outside rather than to the inside. Thus, the comminuted material will be dried in an inert atmosphere, consisting of steam, nitrogen and carbon dioxide. This inert gas obviously would make impossible any explosive action inside the equipment.

In case the apparatus is to be used to prepare material for briquetting under what might be called the plastic process, which utilizes only moderate temperature in the comminuted material; for example, 200° F., and a moisture content in the material of approximately six per cent by weight, the main drier tube 1 will be operated at a very much lower temperature; for example 250° F. Under such conditions, steam may be admitted to the tube 1 to add moisture to the material if this is necessary, or, if the material contains more than 6% moisture content, steam will be generated sufficient that a part will be expelled through the outlet port 24 provided.

When the drier is used to prepare material for this so-called plastic process, it tends to have a larger tonnage capacity than when it is used to dry or heat material to an extremely high temperature.

If the moisture required to supply the required moisture content is not available as steam, a small water spray may be introduced into the drier tube at a convenient point to add moisture that will turn to steam under the action of hot gases.

Where the drier is to be used for the purpose of drying rather coarse material, such as wood chips or comminuted cornstalks, there is a particularly desirable action inherent in the operation of the apparatus. This function is one of comminution of the material as it is driven around and around the drying duct. Each time a large piece of material passes through the fan, small pieces will be broken therefrom so that a large piece of material gradually decreases in size. It is an inherent property of the deflecting baffle that only small pieces of material will be deflected into the separating device, due to the fact that the mass of any large pieces of material in the air stream will carry them to the outside of the bend in the tube by centrifugal force, on the inside of which the deflecting baffle is set. Small light pieces of material, however, are not thrown to the extreme outside section of the duct and will be caught by the deflecting baffle and then separated from the gas stream. Thus, the drying apparatus not only causes a reduction in moisture content of any material fed thereinto, but also reduces the size of any large particles which may be present in the material being dried. This property of comminution may be regulated by the specific arrangement of the deflecting baffle. If extremely fine material is desired, the baffle is completely hidden on the inside bend of the drying duct. If it is desired to permit egress of larger pieces, then the separating baffle may be nearer the intake side of the bend in the duct.

Driers of this character may be constructed as either portable or stationary equipment. In either instance, they afford quick and thorough drying of material and provide also for a control of moisture content when such is desirable. The feed of material and the control of heat supplied by the burner is automatic and, as a whole, the equipment is relatively simple and inexpensive.

Having thus described my invention, what I claim as new therein and desire to secure by Letters Patent is:

1. In a drying apparatus, a continuous tubular duct, means for feeding material into the duct for drying means for supplying hot, drying gases into the duct, means interposed in the duct for

propelling the drying gases about the duct with a velocity whereby the material will be carried in suspension therein, a motor for the propelling means, a device outside the duct for the separation of dried material from its carrying gases, a by-passing tube leading into said device from the duct, a gas return tube from the device to the duct, a movably mounted baffle for diverting gases with material carried in suspension therein from the duct into said by-passing tube and into the separating device, and a device operatively connected with the baffle, and responsive to changes in load placed on the motor to adjust the baffle for the deflection of a greater or lesser amount of gases in accordance with the change in load placed on the motor.

2. In a drying apparatus, a continuous tubular drying duct, means for feeding material into the duct for drying, a fan interposed in the duct and operable for propelling the duct gases about the circuit at a velocity whereby the material will be carried in suspension therein, a motor for driving the fan, means for delivering hot drying gases into the duct, a device outside the duct for separating the dried material from the drying gases, a connecting tube through which a part of the stream of circulating gases and contained material may be by-passed from the duct to the said device, a gas return connection from the device to the drying duct, a movable baffle in the duct for the diversion of a greater or lesser part of the stream of circulated gases through the said connecting tube to the separating device, a governor device operable by and responsive to changes in load placed on the motor, and means actuated by the governor device to control the adjustment of the baffle for the diversion of more or less material in accordance with the speed of the fan.

3. In a drying apparatus, a continuous tubular duct, means for effecting a controlled feeding of material into the duct to the exclusion of outside air, propulsion means interposed in the duct and operable for the propelling of the duct gases about the duct at a velocity to carry the received material in suspension therein, a device outside the duct for the separation of dried material from the gases, a tube connecting the duct and said separating device, means for diverting a part of the circulated stream of gases and material from the duct through said tube into said separating device, a pipe connection for the return of the gases from said separating device into the duct, an electrically operated gas burner having a blast tube directed into the gas return pipe to supply the duct with hot gases for the drying of material therein with an incident generation of superheated steam, an electric circuit for the burner, and a pressure relief valve in the return connection.

4. In a drying apparatus, a continuous tubular duct forming a drying circuit, means for effecting a controlled feeding of comminuted, moisture containing material into the duct to the exclusion of outside air, a fan interposed in the duct and operable for the propelling of the duct gases about the drying circuit at a velocity sufficient to carry the received material in suspension therein, a motor for driving the fan, means operable for the injection of hot, inert gases of combustion into the duct at a temperature for heating the circulated gases for drying the material with an incident creation of super-heated steam, a pressure relief valve for the apparatus, a device outside the duct for the separation of dried material from the drying gases, a tube connecting the duct and said device, a movable baffle in the duct for divering a part of the stream of circulated gases to more or less amount, from the drying circuit into the said tube to the said device, a governor operable by and responsive to changes in load placed on the motor, and means controlled by the governor for adjusting the position of the baffle.

5. In a drying apparatus, a continuous, tubular drying duct, having an angular bend at one point, means for effecting a controlled feeding of comminuted material into the duct to the exclusion of outside air, a fan interposed in the duct and operable for the propelling of the duct gases at a velocity whereby the received comminuted material is carried in suspension therein a motor for driving the fan, a device outside the duct for the separation of dried material from its carrying gases, a by-passing connection leading into the said device from the sheltered side of the bend in the drying duct, a gas return connection from the separating device into the drying duct and opening into the latter in such direction as to cause suction to be created therethrough, a baffle adjustably mounted in the drying duct and movable to divert a greater or less proportion of the stream of circulated gases into the separator, a governor operable by and responsive to changes in load placed on the motor, means controlled by the governor for adjusting the position of the baffle, and a gas heating burner having a blast tube opening into the gas return connection for the discharge of hot inert gases into the stream of return gases to heat the circulated gases to high temperature for the drying of material with an incident generation of super-heated steam from the moisture contained in the material, and a pressure relief valve in the return connection for exhaustion of steam.

6. A device as in claim 5 including thermostatic means and means operable under control of the thermostatic means to control the burner circuit so as to maintain a substantially constant drying temperature in the duct gases.

7. In a drying device, a continuous, tubular drying duct, means for effecting a controlled delivery of comminuted material into the duct for drying, means including a driving motor for effecting a circulation of gases in the duct at a velocity whereby the material will be carried in suspension, a device outside the duct for separation of material from gases, a by-passing connection between the drying duct and said device, a gas return connection from said device to the drying duct, an adjustably mounted damper in the duct for diverting a part of the stream of circulated gases to said by-passing connection; said duct having a bend therein slightly in advance of the by-passing connection whereby to effect a centrifugal deflection of the material carried in the stream and said damper being extended into the stream from the inside of the bend whereby to deflect the lighter dried material into the duct, means for adjusting and determining the position of the damper, and a governor responsive to changes in speed of the motor, connected for the actuation of the damper adjusting means.

WORTH C. GOSS.