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METHOD FOR DRYING FINELY DIVIDED MATERIALS

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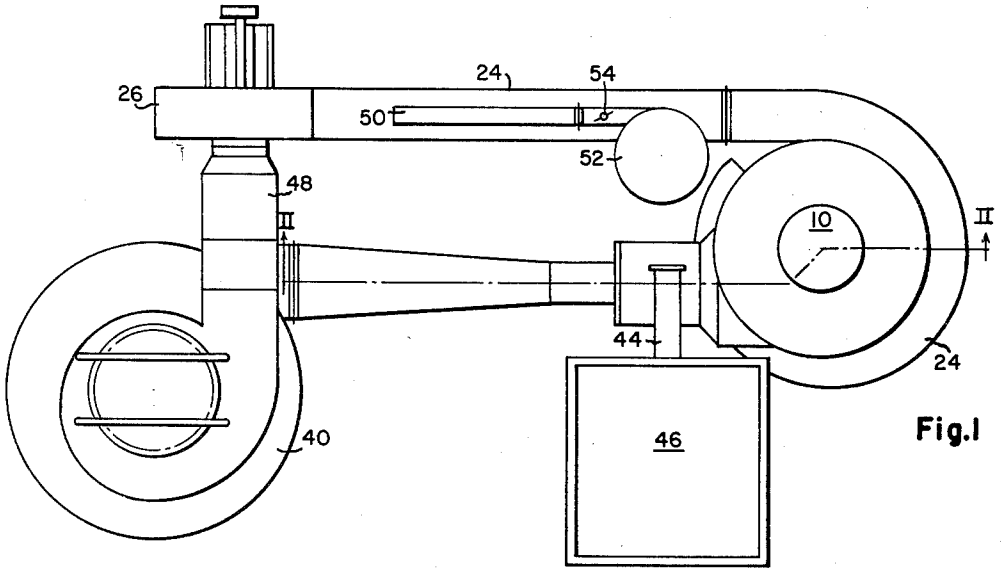


Fig.1

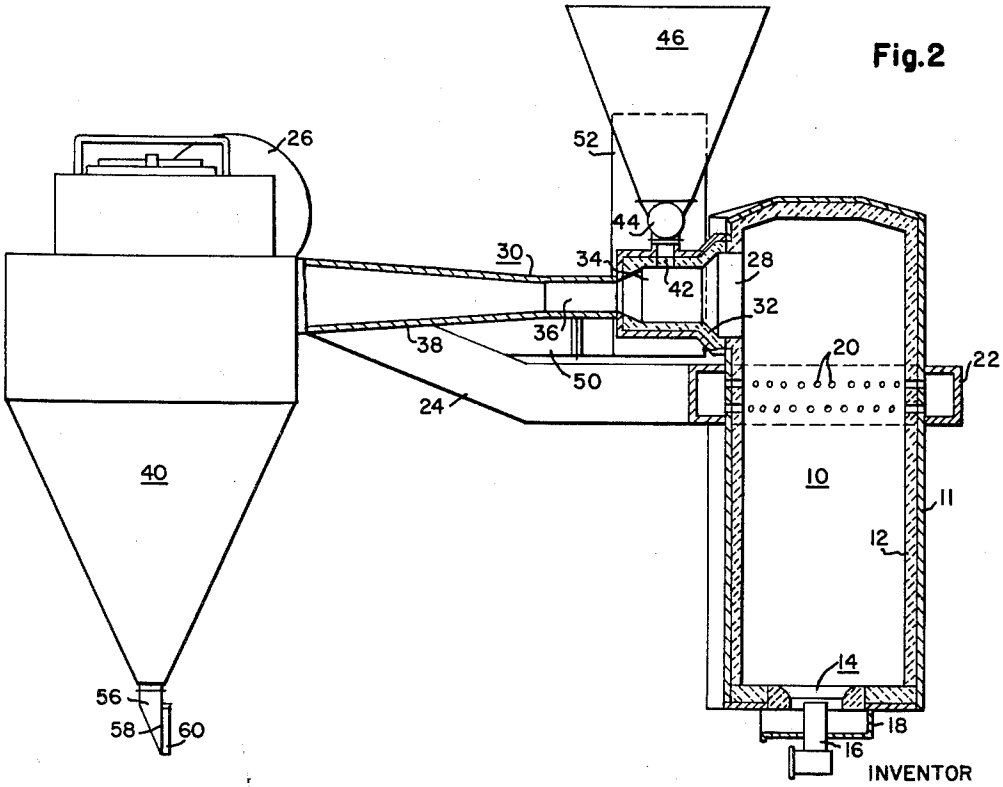


Fig.2

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METHOD FOR DRYING FINELY DIVIDED MATERIALS

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This invention relates to a method for entrainment drying finely divided materials by direct heat exchange with hot gases of high velocity, and more particularly to a method of the type described in which drying is achieved by a hot gas stream traveling along a horizontal path.

Although not limited thereto, the present invention is particularly adapted for use in drying coal particles which become wet due to passage through a washing process or for other reasons. Coal drying is commonly achieved in an upright column having a stream of vertically ascending gas passing therethrough. In such an arrangement, the coal is conveyed into the lower portion of the column whereby the stream of ascending hot gas at high velocity will volatilize the water in the material while carrying the dried coal particles to the top of the column where they may be collected in a cyclone separator or other similar apparatus.

Although coal dryers of the type described above are suitable for some applications, they have certain inherent disadvantages. One such disadvantage resides in the fact that the vertical column must be of relatively great height, thereby rendering the equipment bulky and space consuming. Probably a more serious limitation of vertical column dryers, however, is the relatively small particle size which they can accommodate. The maximum diameter of particles which can be dried in such equipment is about ⅜ inch. Larger particles will not be elevated by the vertically ascending gas stream and will fall to the bottom of the column. Consequently, it is necessary that the coal or other material be classified to eliminate large sized particles before it is fed into a vertical column dryer.

The present invention has as its principal object the provision of a method for drying particles of widely varying sizes whereby the necessity for preliminary classification is eliminated. Specifically, coal particles up to 4 inches in diameter or larger may be accommodated by the apparatus of the invention.

Another object of the invention resides in the provision of a drying method in which drying is achieved in an entrained gas stream of high velocity over a relatively short horizontal distance. The invention is thus contrasted with conventional vertical column dryers wherein the coal must be conveyed by the air stream over a relatively long vertical distance.

Another object of the invention resides in the provision of drying method which is economical, as well as highly efficient in operation.

As will become apparent from the following detailed description, the invention employs a horizontal, rather than vertical, conduit for a high velocity stream of hot gas. As is well known, the rate at which coal particles are dried in such an arrangement is a function of the relative velocity between the particles and the gas stream. Accordingly, the horizontal conduit is in the nature of a venturi tube, and the wet coal is introduced into the gas stream beyond a restricted portion of the venturi

arrangement where the velocity of the gas has been increased. Means are also incorporated into the conduit design to further increase the velocity of the gas stream after the coal has been fed therein. This produces a very high velocity of the gas stream and the particles which it carries such that when the particle-carrying mixture passes into a flared portion of the conduit of gradually increasing diameter, the gas stream and the particles will decelerate; however, the rate of deceleration of the particles will be less than that of the gas stream so that the relative velocity between the gas and particles, as well as the heat transfer characteristics, are maximized. The dried coal is then collected in a cyclone separator having a discharge opening at its lower extremity. Means are provided for maintaining the pressure within the cyclone separator at or slightly below atmospheric pressure whereby the dried product may be gradually emptied through the discharge opening while avoiding the possibility of coal particles being reinserted into the gas stream.

The above and other objects and features of the invention will become readily apparent from the following detailed description taken in connection with the accompanying drawings which form a part of this specification and in which:

FIGURE 1 is a top view of the apparatus of the invention; and

FIGURE 2 is a partially broken away side view of the apparatus shown in FIG. 1, with the broken away portion being taken along line II—II of FIG. 1.

Referring now to the drawings, the embodiment of the invention shown includes an upright cylindrical air heating furnace, generally indicated at **10**. The furnace comprises an outer cylindrical shell of sheet steel **11** or the like having refractory material **12** lining its inner periphery. At the bottom of furnace **10** is a flare type pulverized coal burner **14** having a centralized conduit **16** which conveys pulverized coal to the combustion area. Also included in the burner **14** is an air inlet duct **18** which conveys air to the combustion area where it is intimately mixed with the pulverized coal. Initial ignition of the coal may be secured by means of an oil or gas torch, not shown, although a hand torch may be used if desired. It will be understood that although a pulverized coal burner is shown in the embodiment of the invention illustrated herein, an oil burner, gas burner, or any similar device may be employed to effect the desired results.

Slightly above the median portion of the furnace **10** are a plurality of circumferentially spaced holes **20** which extend through the refractory material **12** in the wall of furnace **10**. These holes communicate with a circular duct or conduit **22** which is connected through duct extension **24** to the outlet port of a rotary blower **26**. As will be understood, the blower **26** forces a stream of gas through ducts **24** and **22** into the interior of furnace **10** where its temperature is raised by the action of burner **14**.

The heated gas leaves furnace **10** through a port **28** and is conveyed into a horizontally extending drying conduit, generally indicated at **30**. As shown, the drying conduit **30** is in the nature of a venturi tube having a frustoconical inlet section **32** connected at its small diameter end to a cylindrical section **34**. The left end of section **34**, as shown in FIG. 2, is also frustoconical in configuration, and communicates at its small diameter end with a second cylindrical section **36**. The other end

of section 36 is then connected to the small diameter end of a third frustoconical section 38 which leads to the inlet port of a cyclone separator 40. The gas entering sections 32 and 34 will be at a relatively high temperature; and, accordingly, these sections are lined with refractory material as is the furnace 10. Wet coal is conveyed into the cylindrical portion of section 34 through opening 42. This opening, in turn, communicates with a screw type feeder 44 which conveys the wet material from hopper 46 to the interior of drying conduit 30.

As shown in FIG. 1, the outlet port of cyclone separator 40 is connected to the inlet port of rotary blower 26 through duct 48. The products of combustion from furnace 10 are vented to the atmosphere through duct 50 and scrubber 52, with duct 50 having a damper 54 therein. Dried coal falls to the bottom of cyclone separator 40 where it is discharged through a chute 56 having an opening 58 at its lower extremity. A flap 60 of resilient material such as rubber is bolted or otherwise securely fastened to the chute above the top of opening 58, the arrangement being such that the flap may bow outwardly under the weight of coal in the cyclone and permit it to fall onto a conveyor or the like, while preventing air from being sucked into the cyclone.

As was stated above, the efficiency of a drying operation of the type shown herein is dependent upon the temperature of the gas passing through drying conduit 30 as well as the velocity of the gas relative to the coal which is to be dried. Accordingly, the tapered section 32 is provided to maximize the velocity of the gas stream before it reaches opening 42 where wet coal is conveyed into the drying conduit 30. It will be noted that the coal is merely dropped into the interior of section 34 whereby it will initially have a zero component of horizontal velocity. On the other hand, the gas stream will have a high component of horizontal velocity. A maximum drying effect is, therefore, achieved within cylindrical section 34 where the relative velocity between the coal and the gas stream is very great. It will be noted, however, that when the coal-carrying gas stream enters section 38, the velocities of both the coal particles and the gas stream are decreased. However, the coal particles, having a greater mass than the air, will decelerate at a lower rate than the gas stream so that there again will be relative velocity between the coal particles and the gas stream, and further drying will take place. In order to maximize the relative velocity between the decelerating coal particles in section 38 and the decelerating gas stream, it is important to first increase their velocity as much as possible after leaving section 34. To this end, the left end of section 34 as shown in FIG. 2 is tapered as it leads into reduced-diameter section 36 to thereby increase the velocity of the coal-carrying mixture which then decelerates in section 38

It will be noted that the total length of the drying conduit 30 is relatively short, being only about six or seven times the diameter of cylindrical section 34. It has been found, however, that coal particles up to 4 inches in diameter or more may be effectively dried in this short distance. The length of the drying conduit 30, of course, depends upon the velocity of the gas stream passing therethrough, it being understood that the length of the column may be decreased as the velocity of the gas is increased. The effect of reduced diameter section 36 is to increase the heat transfer characteristics of the system and thereby also increase the capacity of the dryer.

After the coal particles are separated in cyclone 40, the gas is conveyed through duct 48 to blower 26 which then recirculates a portion of the gas containing the products of combustion of burner 14 to furnace 10. The remaining portion of the products of combustion are vented to atmosphere through duct 50 and scrubber 52. It should be apparent that the pressure in the closed path for the drying air will vary at different locations. Thus, the pressure at the outlet port of blower 26 will be relatively high, while that at the inlet port of the blower will be low. It is of vital importance that the pressure within cyclone separator 40 does not drop far below atmospheric pressure. Otherwise, the partial vacuum created within the cyclone separator will cause atmospheric pressure to hold the flap 60 in closed position and prevent discharge of dried coal through opening 58. Under normal conditions, the pressure within the cyclone separator 40 would be considerably below atmospheric pressure. In order to correct this condition, damper 54 is provided in duct 50 which produces a back pressure and insures that the pressure within the cyclone separator 40 will be at or slightly below atmospheric pressure. Generally speaking, the pressure within the cyclone separator 40 should be between zero and —4 inches of water below atmosphere.

The invention thus provides a means for effectively drying coal particles and the like in sizes up to 4 inches in diameter along a horizontal path of relatively short length. The apparatus of the invention is, therefore, compact and economical in construction as compared with vertical column dryers which require an excessively large amount of space. Although the invention has been shown in connection with a certain specific embodiment, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention.

I claim as my invention:

1. A method for drying finely divided material comprising forming a substantially horizontal moving stream of gas circulating about a closed horizontal path, heating said stream of gas, thereafter increasing the velocity of the heated gas stream and maintaining the increased velocity over a length of the path, feeding wet material at zero horizontal velocity into the stream at a point along said length of the path, again increasing the velocity of the gas along said path after the wet material has been fed therein, continuously and gradually decreasing the velocity of the gas after it has been increased twice, separating dried material from the gas in a closed gas-solid separation chamber immediately after its velocity has been continuously and gradually decreased, maintaining the pressure within said chamber at or slightly below atmospheric pressure and recycling at least a portion of the separated gas from the chamber through said path.

2. A method for drying finely divided material comprising forming a moving stream of gas, heating said stream of gas, thereafter increasing the velocity of the heated gas stream along a horizontal path and maintaining the increased velocity over a length of the horizontal path, feeding wet material at zero horizontal velocity into the stream of gas after its velocity has been increased, again increasing the velocity of the gas along said path after the wet material has been fed therein, continuously and gradually decreasing the velocity of the gas after it has been increased twice, thereafter separating the dried material from the horizontally-traveling gas stream in a cyclone separator, and maintaining the pressure within said cyclone separator at or slightly below atmospheric pressure.

3. A method for drying finely divided material comprising forming a moving stream of gas, heating said stream of gas, thereafter increasing the velocity of the heated gas stream along a single horizontal path and maintaining the increased velocity over a length of the horizontal path, feeding wet material at zero horizontal velocity into the stream of gas at an unobstructed point along said length whereby the material will be immediately conveyed along the horizontal path by the stream of gas, further increasing the velocity of the stream of gas after the wet material has been fed therein, thereafter separating the dried material from the horizontally-traveling gas stream in a cyclone separator, and maintaining the

pressure within said separator at or slightly below atmospheric pressure.

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