Aug. 29, 1961 R. LITWINOFF 2,998,200

SYSTEM FOR PRODUCING PULVERIZED COAL

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Fig. 1.

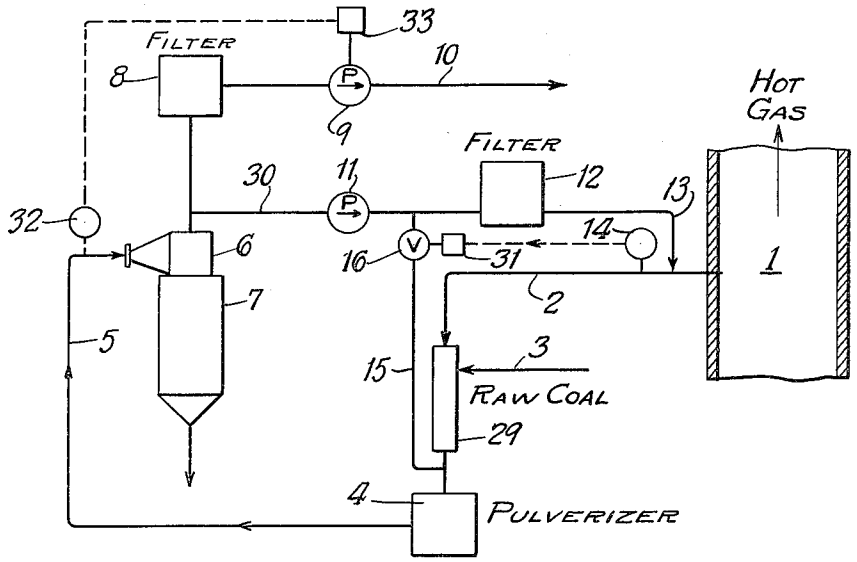
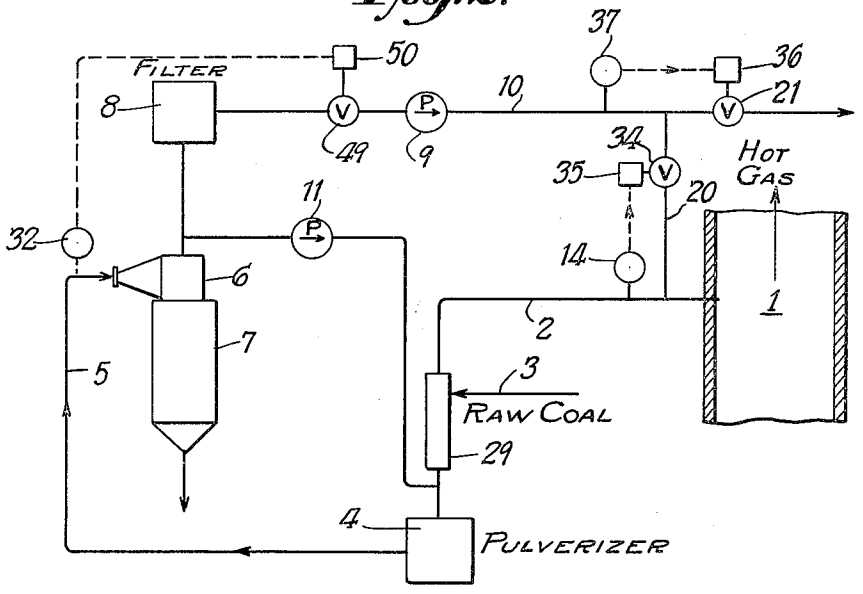


Fig. 2.



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Fig. 3.

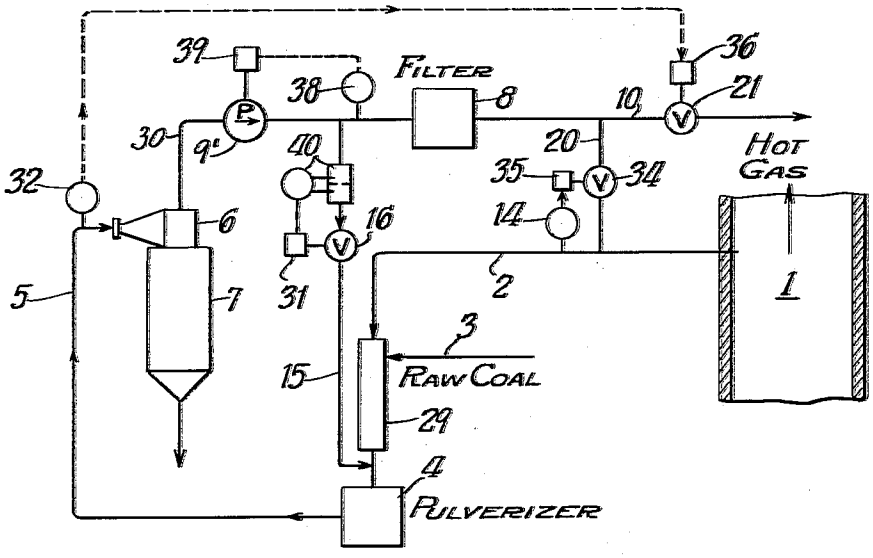
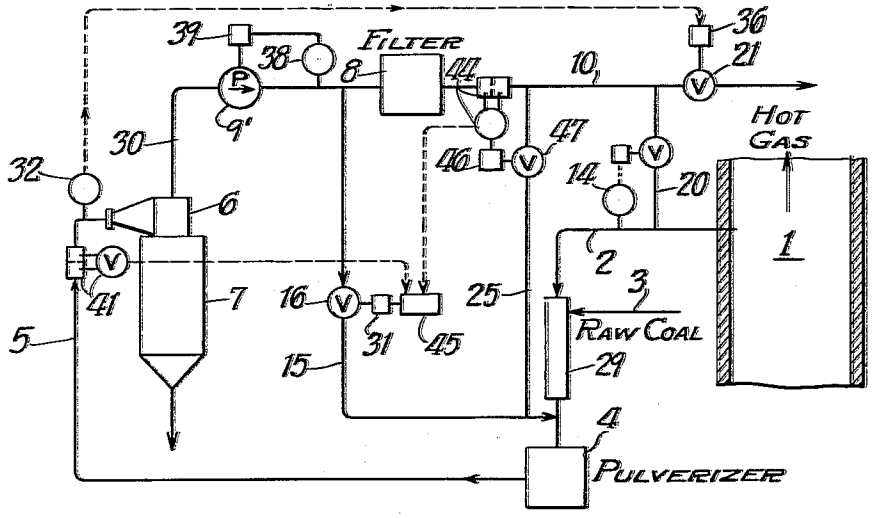


Fig. 4.



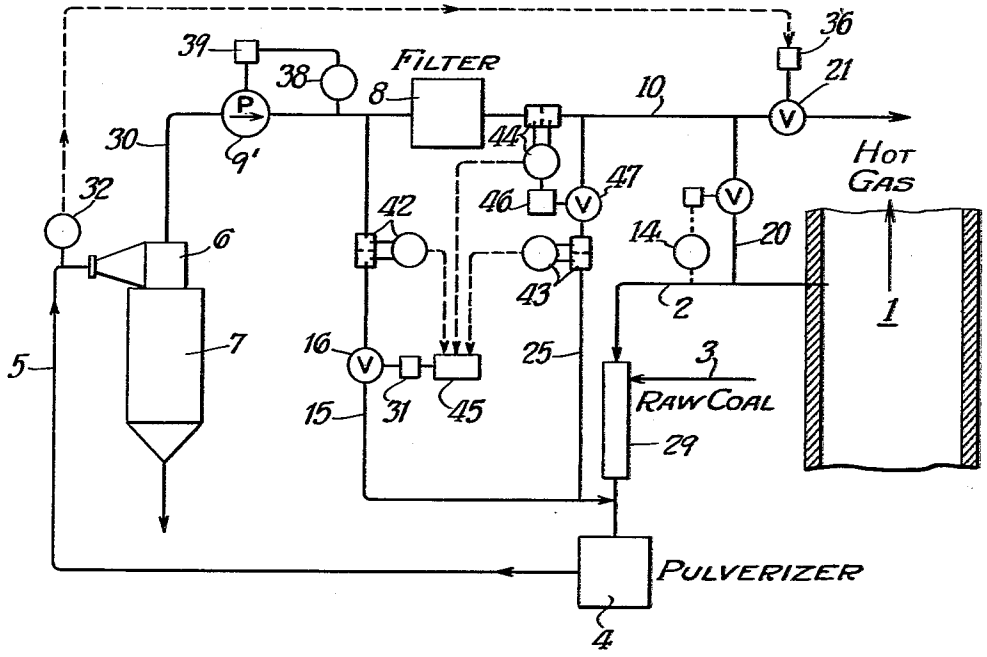
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Fig. 5.



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SYSTEM FOR PRODUCING PULVERIZED COAL

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6 Claims. (Cl. 241—33)

The present invention relates to a system for the production of pulverized coal.

In the system according to the invention steam of a relatively low temperature and obtained during sifting of the pulverized coal is admixed to the relatively hot gas which is used for drying and transporting the coal for reducing the temperature of the drying gas to a suitable value.

A plant according to the invention comprises at least one drying apparatus for the coal to be pulverized in which apparatus the coal is dried by contact with a hot gas, a coal dust mill, a dust sifter in which the coal dust is separated from the vapor-laden drying gas, a dust bunker, a filter for removing residual coal dust from the vapor-laden gas leaving the sifter, means for removing vapor-laden gas to the outside, and means for admixing vapor-laden gas to the gas which is used for drying and transporting the coal.

The raw coal must usually be dried before it enters the pulverizer. If the pulverized coal is used as fuel for a steam generator, the hot products of combustion leaving the generator are frequently used for drying the raw coal. Since the products of combustion are in gas state they will henceforth also be called combustion gas or flue gas, in contradistinction to gas which may be used as fuel and which is conventionally termed "fuel gas." Since the temperature of the drying gas should not exceed, for example, 700° C. and there is no locality in the flues of the steam generator where the combustion gas has this temperature at all load conditions, it is conventional to tap gas at two places from the steam generator, the temperature of the combustion gas being 700° C. at one of these places when the steam generator operates at low load, whereas at the other place the temperature of the combustion products reaches 700° C. only when the generator operates at full load. By suitable mixing of the combustion gases tapped at different localities the desired gas temperature can be obtained at different loads of the boiler. Instead of tapping combustion gas from two different places of the boiler flue, the gas may be tapped at one locality only where the gas temperature is above 700° C. at all load conditions and it has been proposed to mix this gas with air in order to reduce the gas temperature to the desired temperature. The last mentioned method is objectionable because oxygen is introduced with the air into the drying gas so that the danger of fire or explosion is considerably increased.

The aforedescribed disadvantages of tapping products of combustion of a relatively high temperature from one locality of the boiler flue and cooling the products of combustion by admixing air are avoided by the present invention in which the cooling effect is produced by means of vapor produced during drying of the coal which vapor is inert for all practical purposes. It is possible, in many cases, to tap the vapor directly from the vapor circuit for answering the following purposes: Cooling of the drying gases before they enter the mill, transporting the coal, preliminary sifting and return of too large coal granules to the mill, transporting the pulverized coal to the dust separator, and separating the vapor-laden gas from the coal dust and sifting the coal dust in the dust separator.

If the distribution of the particle sizes of the coal dust passed by the dust separator is unfavorable and/or if the coal is easily flammable, admixture of vapor which is taken directly from the vapor circuit is usually not advisable because it increases the danger of fire. In this case it is advisable to clean the cooling vapor before it is mixed with the combustion gases from the boiler, for example, by means of a filter, such as an electrofilter or a textile bag filter, or the like. The vapor which is taken from the vapor circuit may be conducted through a special fine dust separator, for example, a fine filter and subsequently admixed to the flue gases. The vapor may also be taken from the vapor exhaust duct through which the vapor is discharged into the atmosphere downstream of a fine dust separator which is usually required in waste vapor conduits discharging into the atmosphere. In this case no second fine dust separator need be provided.

A further object of the invention is the provision of control means to maintain the temperature of the vapor-laden gas, which carries the pulverized coal from the pulverizer to a sifter in which the gas and the vapor are separated from the pulverized coal, at a level which facilitates sifting and avoids spontaneous combustion. These control means are preferably responsive to the temperature of the mixture entering the sifter and cause a reduction of the amount of vapor and gas freed from coal dust exhausted into the atmosphere upon an increase of the temperature of the mixture above a predetermined level, so that more vapor is available to be mixed with the drying gas, and vice versa.

Instead of making the aforementioned control responsive to the temperature of the mixture entering the sifter, it is within the purview of the present invention to make the control responsive to the moisture content of the vapor-gas-coal dust mixture entering the sifter. In this case the amount of vapor-laden gas removed from the system is increased if the moisture content of the mixture entering the sifter exceeds a predetermined value so that less vapor is available for admixture to the drying and transporting gas, and vice versa.

The novel features which are considered characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, and additional objects and advantages thereof will best be understood from the following description of embodiments thereof when read in connection with the accompanying drawing in which:

FIG. 1 is a diagrammatic illustration of a plant for producing pulverized coal and including two filtering apparatuses.

FIGS. 2 to 4 are diagrammatic illustrations of modified coal pulverizing plants which have only one dust filter.

FIG. 5 is a diagrammatic illustration of a modification of the plant shown in FIG. 4.

Referring more particularly to FIG. 1, numeral 1 designates a part of the flue of a steam boiler from which products of combustion which are in the form of a hot gas are tapped through a duct 2. Coal is fed into the duct 2 through a feeder line 3 and partly dried by contact with the hot gases in a drying apparatus 29 interposed in the duct 2 which may be widened to form a chamber at the locality where the feeder line 3 is connected to the duct. The dried coal enters a pulverizer 4 in which it is reduced to dust. The coal dust is conducted through a duct 5 into a dust sifter 6 from which the dust falls into a bunker 7. The vapor-laden gas separated in the sifter 6 passes through a fine dust separator 8 which retains the dust which may be carried along by the vapor. Thereupon the vapor is blown by a blower 9 through a pipe 10 into the atmosphere.

A conduit 30 is connected with the sifter 6 for con-

ducting a part of the vapor-laden gas from the sifter 6 to a blower 11 which forces the vapor-laden gas to a fine dust separator or filter 12 and therefrom through a pipe 13 into the combustion gas duct 2 for cooling the hot combustion gas. A pipe 15 branches from the vapor conduit between the blower 11 and the fine dust separator 12 for conducting vapor into the combustion gas duct 2 downstream of the drying apparatus 29 and close to and upstream of the pulverizer 4 or directly into the pulverizer.

A temperature sensitive device 14 is connected with the combustion gas duct 2 which device responds to the temperature of the gases tapped from the flue 1 and mixed with vapor supplied through the pipe 13. The temperature sensitive device 14 produces control pulses which control the operation of a servomotor 31 which actuates a valve 16 in the vapor conduit 15.

Additional valves, not shown, may be interposed in the pipe 13 upstream and downstream of the fine dust separator 12 which valves are also controlled by the temperature sensitive device 14.

Since it may be important that the temperature or the moisture of the vapor upstream of the sifter 6 be maintained at a predetermined level, a temperature or moisture sensitive device 32 is provided at the inlet of the sifter. The device 32 produces control pulses for regulating a servomotor 33 which controls the speed of the blower 9. By suitable adjustment of the valve 16 and of the speed of the blower 9 the temperature or moisture content of the coal dust and vapor-laden gas entering the sifter 6 and the temperature at the point where the vapor and the combustion gas are mixed can be maintained at a desired constant level by suitable distribution of the vapor-laden gas separated in the sifter 6 in the conduits 10, 30, 15 and 13. Since the vapor is inert danger of explosion in the ducts through which coal or coal dust passes is eliminated. If a temperature responsive device 32 is used, it causes the servomotor 33 to reduce the speed of the blower 9 upon an increase of the temperature in the duct 5 above a predetermined value so that less vapor is removed from the system and more vapor is recirculated through the conduits 13 and 15. If a moisture sensitive device is used, the device causes the servomotor 30 to increase the speed of the blower 9 upon an increase of the moisture in the duct 5 so that more vapor is removed from the system and less vapor is recirculated through the conduits 13 and 15.

In the plant shown in FIG. 2 a part of the vapor passing through the exhaust conduit 10 is diverted through a pipe 20 into the combustion gas duct 2. The temperature of the resulting mixture is controlled by means of a valve 34 interposed in the conduit 20 which valve is actuated by a servomotor 35 whose operation is controlled by the temperature responsive device 14. The latter is connected to the duct 2 downstream of the connection of the vapor pipe 20 with the duct 2. If desired, a throttle valve 21 may be provided in the exhaust pipe 10 downstream of the connection of the pipe 20. The valve 21 is actuated by a servomotor 36 whose operation is controlled by a pressure sensitive device 37 which is connected with the pipe 10 upstream of the connection to the pipe 20 so that a desired pressure of the vapor entering the pipe 20 is maintained. Instead of controlling the speed of the blower 9 according to the temperature of the matter entering the sifter 6 a valve 49 may be interposed in the control pipe 10 and actuated by a servomotor 50 which is controlled by the temperature sensitive device 32 so that the valve 49 is opened upon a decrease of the temperature in the duct 5 below a predetermined value for decreasing the amount of vapor introduced into the pulverizer 4.

FIG. 3 shows a plant which is similar to that shown in FIG. 2 but having only one blower 9'. In the plant shown in FIG. 3 the power consumed by the blower 9' is greater than the power which is consumed by the blowers in the plants shown in FIGS. 1 and 2. However, in certain cases the total energy consumed will be equal or even less because the output of the blower 9' varies very little or not at all. The blower can, therefore, operate at optimum efficiency all the time.

Instead of placing the fine dust separator 8 downstream of the blower 9', it may be arranged upstream of the blower, as is shown in FIGS. 1 and 2, in which case the separator may have to be larger. This arrangement, however, has the advantage that only clean gas passes through the blower. The plant shown in FIG. 3 may be controlled in the following manner: If desired, the pressure upstream of the fine dust separator 8 or the amount of matter passing through the blower may be maintained constant by suitable control of the speed of the blower 9' This speed control may be effected by a pressure sensitive device 38 which is connected upstream of the separator 8 to the pipe 10 for removing the vapor-laden gas from the sifter 6. The device 38 produces control pulses which control the operation of a servomotor 39 which controls the speed of the blower 9'. The temperature of the matter entering the sifter 6 is regulated by means of a throttle valve 21 in the exhaust pipe 10 for removing gas-laden vapor from the system to the outside. A temperature sensitive device 32 is connected with the inlet of the sifter 6, the device producing control pulses which control the operation of a servomotor 36 which actuates the valve 21 similarly to the operation of the valve 49 in FIG. 2. A valve 34 in the conduit 20 connecting the exhaust pipe 10 with the hot gas duct 2 is controlled in response to the temperature of the vapor-laden mixture passing through the duct 2 downstream of the connection with the pipe 20. A pipe 15 which is connected to the pipe which interconnects the blower 9' and the dust separator 8 for supplying vapor-laden gas to the duct 2 downstream of the introduction of raw coal into the duct 2 is equipped with a valve 16. The latter is controlled according to the amount of vapor-laden gas passing through the pipe 15 so that this amount is maintained constant. For this purpose an orifice 40 is interposed in the pipe 15 upstream of the valve 16. The pressure difference upstream and downstream of the orifice 40 is used for controlling the operation of a servomotor 31 which actuates the valve 16.

FIG. 4 illustrates a further modification of a system according to the invention. In addition to the pipe 15 which is connected upstream of the separator 8 to the pipe 30 receiving vapor-laden gas from the outlet of the sifter 6 a pipe 25 is connected to the exhaust pipe 10 downstream of the fine dust separator 8, the pipe 25 terminating in the pipe 15 and the latter being connected to the duct 2 at a point downstream of the introduction of raw coal into the duct 2. The valve 16 which is interposed in the pipe 15 is operated in response to the amount of vapor-laden gas passing through the pipe 25 and in response to the amount of matter passing through the duct 5. To accomplish the aforesaid control of the valve 16 a flow responsive means 41 is interposed in the duct 5 and a flow responsive means 44 is interposed in the pipes 15, 25, respectively. The flow responsive means 41 and 44 generate pulses which are combined in a device 45 for actuating a servomotor 31 which operates the valve 16. The control pulses generated by the flow responsive means 44 are not only transmitted to the device 45 but also to a servomotor 46 which controls the operation of a valve 47 in the conduit 25.

FIG. 5 illustrates an arrangement in which the pulses produced by a flow responsive means 42 which is interposed in the pipe 15 and the pulses produced by a flow responsive means 43 in the pipe 25 are used for controlling the valve 16. The pulses generated by the flow responsive means 44 in the exhaust pipe 10 are superimposed on the combined pulses produced by the devices 42 and 43 for controlling the valve 16 in emergency situations.

In the systems according to FIGS. 4 and 5 a pressure sensitive device 38 is connected with the pipe 30 down-

stream of the blower 9' and upstream of the connection of the pipe 15. The pressure sensitive device 38 produces control pulses regulating the servomotor 39 which controls the speed of the blower 9' so that a predetermined pressure of the matter entering the separator 8 is maintained.

The invention has been described and illustrated as applied to the production of pulverized coal serving as fuel for a steam generator. The invention can also be applied to systems for pulverizing and drying other matters, for example, fertilizers, chemicals, and the like. The invention is not limited to the production of pulverized coal for combustion purposes but can also be used for the production of pulverized coal for making briquets. Instead of products of combustion other suitable heating or waste gases may be used.

I claim:

1. In a system for producing pulverized coal including a hot gas duct, an apparatus interposed in said duct for drying the raw coal by means of the hot gas in said duct, a pulverizer connected to said duct for receiving dried coal and vapor-laden gas from said drying apparatus, a duct connected to said pulverizer for receiving pulverized coal and vapor-laden gas therefrom, and a sifter connected to said last mentioned duct for separating the pulverized coal from the vapor-laden gas, said sifter having an outlet for the pulverized coal and an outlet for the vapor-laden gas: a conduit connected to said outlet for the vapor-laden gas and to said hot gas duct for mixing vapor to the hot gas for reducing the temperature of the gas to a predetermined value, an exhaust conduit connected to said outlet for the vapor-laden gas for removing vapor-laden gas from the system to the outside, a device connected to said duct connecting said pulverizer and said sifter, said device being responsive to the temperature of the vapor and coal dust laden gas passing from said pulverizer to said sifter and means in said exhaust conduit for controlling the amount of gas removed to the outside, said last mentioned means being connected to said device for increasing the amount of vapor-laden gas removed from the system upon a decrease of the temperature of the vapor and coal dust laden gas passing from the pulverizer to the sifter below a predetermined value, and vice versa, whereby said temperature is maintained at a predetermined level.

2. In a system as defined in claim 1 and wherein said means in said exhaust conduit is in the form of a valve.

3. In a system as defined in claim 1 and wherein said means in said exhaust conduit is a blower, speed control means being connected to said blower and to said temperature responsive device for increasing the speed of said blower upon a decrease of the temperature of the vapor and coal dust laden gas passing from the pulverizer to the sifter below a predetermined value, and vice versa.

4. In a system for producing pulverized coal including a hot gas duct, an apparatus interposed in said duct for drying the raw coal by means of the hot gas in said duct, a pulverizer connected to said duct for receiving dried coal and vapor-laden gas from said drying apparatus, a duct connected to said pulverizer for receiving pulverized coal and vapor-laden gas therefrom, and a sifter connected to said last mentioned duct for separating the pulverized coal from the vapor-laden gas, said sifter having an outlet for the pulverized coal and an outlet for the vapor-laden gas; a conduit connected to said outlet for the vapor-laden gas and to said hot gas duct for mixing vapor to the hot gas for reducing the temperature of the gas to a predetermined value, an exhaust conduit connected to said outlet for the vapor-laden gas for removing vapor-laden gas from the system to the outside, a device connected to said duct connecting said pulverizer and said sifter, said device being responsive to the moisture content of the vapor and coal dust laden gas passing from said pulverizer to said sifter, and means in said exhaust conduit for controlling the amount of gas removed to the outside, said last mentioned means being connected to said device for increasing the amount of vapor-laden gas removed from the system upon an increase of the moisture content of the vapor and coal dust laden gas passing from the pulverizer to the sifter above a predetermined value, and vice versa, whereby said moisture content is maintained at a predetermined level.

5. In a system as defined in claim 4 and wherein said means in said exhaust conduit is in the form of a valve.

6. In a system as defined in claim 4 and wherein said means in said exhaust conduit is a blower, speed control means being connected to said blower and to said moisture content responsive device for increasing the speed of said blower upon an increase of the moisture content of the vapor and coal dust laden gas passing from the pulverizer to the sifter below a predetermined value, and vice versa.

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