

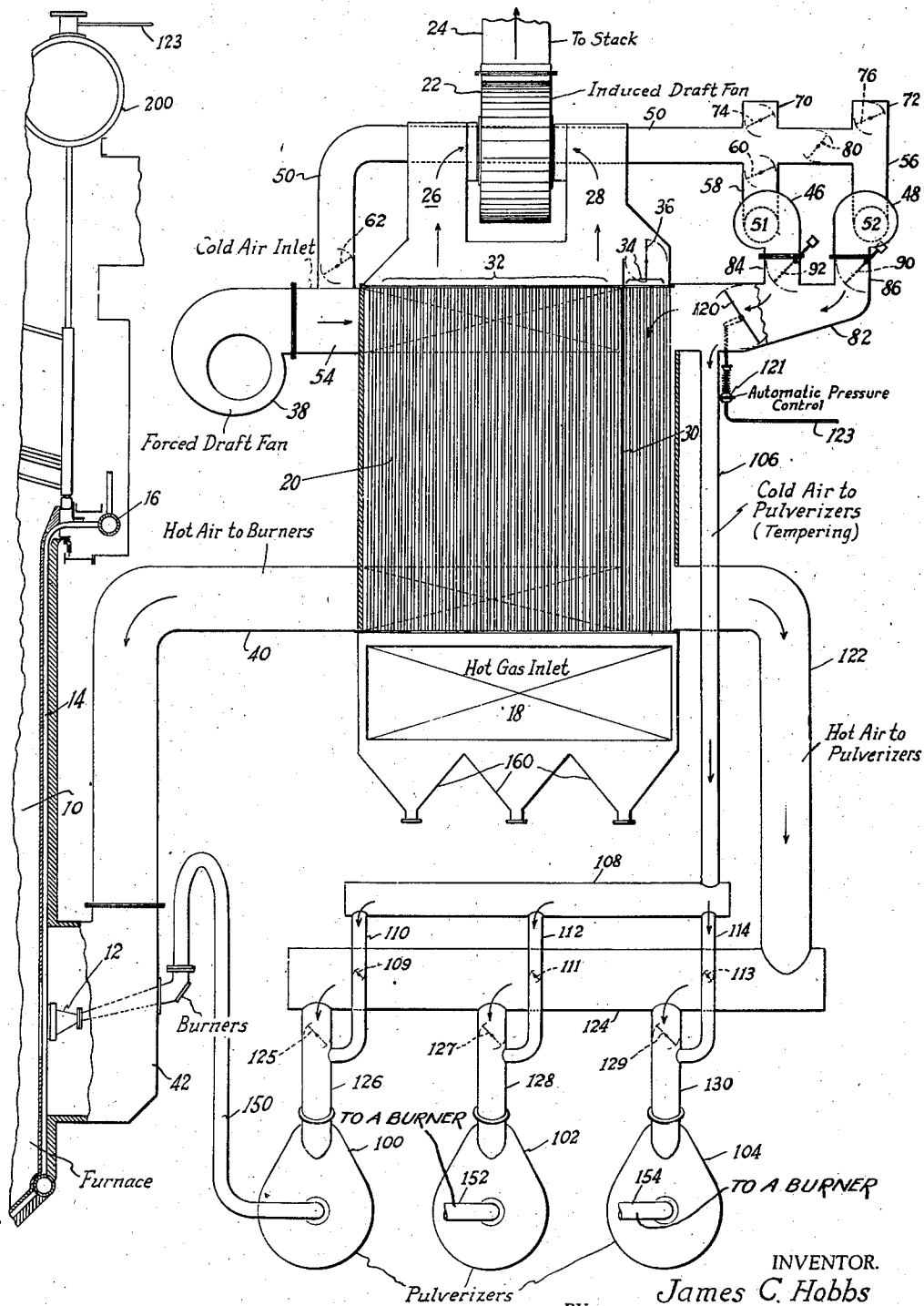
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COMBUSTION SYSTEM

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COMBUSTION SYSTEM

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The present invention relates to steam generator installations in which solid fuel is burned in suspension in air in pulverized form, and in connection with which a pulverizer reduces the solid fuel to a fineness permitting it to be carried and permitting its effective combustion in suspension. The invention is particularly applicable to direct fired type of pulverizing and burning installations wherein a current of air passing through the pulverizer also carries the pulverized fuel in suspension to the furnace burners and acts in part to support the combustion of the fuel.

With such pulverizing and burning installations, and particularly when they are used in conjunction with a steam generator, it is desirable to use preheated air for the suspension of the pulverized fuel in its discharge from the pulverizer to the furnace and also for the additional air required to complete the combustion of the fuel. The temperature requirements of the two streams of air differ, the ratio of one air volume to the other also differs, and the total quantities vary with boiler load, yet for reason of economy it is desirable to raise their temperature by the same source of heat, the waste stack gases.

In addition, the air which is passed through the pulverizer is subjected to greater flow resistance and the pressure at which it is supplied must be higher than the secondary air which is passed directly from the source of heat to the furnace.

It is an object of my invention to provide such an advantageous arrangement of air heating surface and fans, with respect to the waste gases from the boiler furnace, and the pulverizing and burning equipment, that the two streams of air can be effectively supplied at the required pressures, temperatures, total volume, and volume ratios; without consumption of excessive power to drive the fans.

Attempts to pulverize coal of a high moisture content have shown serious reductions in mill output. Such coal has further interfered with effective operation of the mill, or pulverizer, and increased its power requirements to such an extent that it is necessary to provide some method or apparatus for drying the coal either before or during its passage through the pulverizer.

When air is forced through the pulverizer to assist pulverization and to carry away the pulverized coal, it can also be used to dry this coal if its temperature is high enough, but this temperature must not be so high as to cause excessive distillation of the volatiles.

The quantity of this primary air must be adjusted to the requirements of pulverizing and of

carrying the pulverized coal in suspension to the burners, but the temperature of such quantity must be adjusted to the requirements of drying coal of variable moisture content, while the quantity of secondary air must be so adjusted that the sum of the quantities of primary and secondary air is adjusted to the rate of fuel feed to be no more than sufficient to completely burn it, and the temperature of the secondary air must be as high as practicable. Thus, the total air quantity must vary with the fuel burned which in this system is equal to that pulverized, but the ratio of primary to secondary air must vary with rate of pulverization, while the temperature of the primary air is adjusted to coal moisture and that of the secondary is kept as high as practicable.

It is not only preferable that the primary and secondary air be supplied to the pulverizer within the above mentioned volume and temperature limits, but that the primary air normally be supplied at a pressure higher than the pressure of the secondary air because of the fact that the former acts as carrier air in classifying and transporting the pulverized fuel through the pulverizer to a burner and is subject to flow restrictions which increase the pressure drop. It is an object of this invention to provide a system which will solve these problems without provision of separate air heaters at separate positions in the path of the flue gases leaving the boiler furnace and without excessive power consumption by the fans.

A further object of the invention is to provide a combined steam boiler and pulverized fuel fired furnace system in which the supply of primary air is automatically controlled, preferably in response to variations in the pressure of the steam in the boiler. In conjunction with this invention the primary air is supplied by a plurality of fans, any one of which may be selectively made operative and inoperative without an accompanying multiple operation of air-flow controllers.

Other objects of the invention will appear as the accompanying description proceeds.

The invention will be described with reference to the accompanying drawing which shows diagrammatically a system embodying the invention.

The illustrative system includes a furnace fired by pulverized fuel burners. When the furnace is a part of a steam generator, walls of the furnace may include wall tubes connected into the boiler circulation through headers such as the header. In such an installation, the furnace gases pass across steam generating tubes and then to the inlet of an air heater. Con-

duits may be appropriately arranged for so directing the furnace gases.

Beyond the air heater 20 is an induced draft fan 22 which discharges into conduit 24 connected to a stack or other suitable gas outlet. The inlets of this fan are connected to the furnace gas discharge outlet of the air heater by the parts 26 and 28 of an appropriate breeching.

In such a system as that disclosed, primary air passes through fuel pulverizers to the burners, acting as carrier air to cause the pulverized fuel of proper fineness to move to the burners, and a larger quantity of secondary air passes into the ignition zone of the burners, independently. When both the primary air and the secondary air are to be heated in independent parts of the same air heater, the latter is divided by such a partition as that indicated at 30. As shown, all that part, 32, of the air heater to the left of this partition is employed for heating the secondary air, the remaining part 34 being used for heating primary air. In the latter part of the air heater a plurality of furnace gas passages lead from the inlet 18 to the breeching 28 and the heating of the primary air may be regulated by a controller 36 positioned at the furnace gas outlet of the air heater part 34.

The part of the air heater which acts upon the secondary air is supplied with air by a forced blast fan 38 and the secondary air is discharged from the air heater part 32 to a duct 40 leading to an air box 42 which encloses the burners 12.

When the primary air forced draft fans 46 and 48 have their inlets 51 and 52 connected to the discharge side of the fan 38, the fans 46 and 48 act as boosters to cause the primary air to be delivered to the pulverizers at a pressure higher than that of the secondary air delivered to the burners. An arrangement of elements whereby such operation can be effected includes the duct 50 leading from the fan 38 and communicating with the cold air inlet (inlet to the heater) 54 at one end and with the primary fan branches 56 and 58 at its other end. The controller 60 in the branch 58 will permit the fan 46 to be repaired or replaced without interfering with the operation of the fan 48, and the controller 62 will regulate the air delivered to the primary air system by the fan 38.

The primary air fans 46 and 48 may be, when desired, independently connected on their inlet sides to the atmosphere through the branches 70 and 72, normally closed by the controllers 74 and 76. In the event that the fan 48 is to be temporarily taken out of service, the primary air fan 46 may be effectively continued in operation by operating the controller 80 to close that part of the conduit 50 between the branches 58 and 56.

By the provision of air inlets 70 and 72, fan 46 or 48 can draw air from the atmosphere, allowing the entire discharge capacity of fan 38 to be directed through the section 32 of the heater and used as secondary air.

The air inlet side of the primary air section of the air heater communicates with a manifold 82 having the branches 84 and 86 communicating with the discharge sides of the fans 46 and 48. These branches are preferably provided with automatically operating check dampers 90 and 92 which combine with the pressure operated controller 120 to facilitate the operation of the system. This controller is preferably responsive to steam pressure variations, and for that purpose it may be actuated by a diaphragm operator 121 connected by the tube 123 to the

drum 200 of the boiler. With this arrangement automatic regulation is attained, whether one or both of the primary air fans are in service. The control mechanism is simplified by making one controller take care of two fans and a plurality of pulverizers. Furthermore, it is a great convenience for the operators to be able to transfer from one fan to another without bothering with additional air-flow controllers.

In order that the primary air delivered to the pulverizers 100, 102 and 104, may be tempered according to the moisture content of the fuels, and other conditions, the pulverizers are directly connected with the manifold 82 by a cold air duct 106, its manifold 108, and the branches 110, 112, and 114. In practice, all of this tempering or regulation may be done by the operation of the controllers 109, 111, and 113, because by opening these, the higher pressure air in the cold air in the cold air manifold 108 causes enough tempering to obtain the desired pulverizer, or mill, temperatures. The pressure of the air in the manifold is greater than the pressure of the air supplied through the duct 122 because of the by-passing of the primary air heater.

The duct 122 leads from the primary air side of the air heater part 34 to a manifold 124. The latter communicates directly with the pulverizers through the branches 126, 128 and 130 which supply heated primary air direct to the pulverizers. The previously mentioned tempering air branches 110-114 preferably communicate with the branches 126-130 at the sides of the latter as shown in the drawing, and dampers 125, 127 and 129 in the branches 126-130 may be installed to provide for the independent control of the pulverizers and allow one pulverizer to be repaired while the others are operating.

Each of the burners 12 may be independently connected to a single pulverizer, and for the purposes of illustration, the conduit 150 is shown connecting one of the burners to the pulverizer 100. Similar conduits 152 and 154 connect the other pulverizers separately to other burners.

Referring again to the air heater, it will be understood that the furnace gases originating in the furnace 10 pass into the inlet 18 at one side of the air heater and that solids carried in suspension by the furnace gases may be accumulated in the dust hoppers 160 for periodic removal. The temperature of the gases entering the inlet 18 will vary according to furnace operating conditions, such as rating, percentage of excess air, etc., and the variation in the heat transfer in the air heater must be compensated for in order to provide the proper primary air temperature required by the moisture content of the fuel being pulverized.

In the operation of the illustrative apparatus, the primary air may be delivered to the pulverizers at a pressure higher than the pressure of the secondary air and the temperature of the primary air may be regulated independently of the temperature of the secondary air. Thus, the temperature of the primary air may be kept sufficiently high to have adequate drying effect upon high moisture content fuels supplied to the pulverizers and at the same time the temperature of the primary air may be kept below a point at which it would cause excessive release of the volatiles in the coal being pulverized.

The forced blast fans for the primary air are so positioned that they act upon air at a low temperature, and therefore, they act more effec-

tively and economically than they would when both secondary air and primary air are intermingled and heated in the same air heater and the primary air fans located beyond the air discharge side of the air heater. The life of the primary air fans under such circumstances is increased and economy of original installation, as well as economy of maintenance are promoted. Furthermore, with the system shown, the operation of the system can be continuous even when one of the primary air fans must be temporarily taken out of service for repair or replacement.

What is claimed is:

1. In a pulverized fuel system comprising, a furnace, a burner, a pulverizer supplying the burner with fuel, an air heater divided into sections in which secondary air is heated separately from primary air, means for causing secondary air to flow through one of said sections to the burner at a predetermined pressure, means including a primary air line for causing primary air to flow at a higher pressure from the first means through another of said sections to the pulverizer and thence to the burner, and a by-pass for unheated air leading from the primary air inlet of the heater and joining the primary air line on the inlet side of the pulverizer.

2. In a pulverized fuel firing system for steam boiler furnaces, fuel burning means through which pulverized fuel is projected into the furnace, an air heater divided into sections in which primary air and secondary air are separately heated, means including a forced draft fan causing secondary air to pass through one of said sections to the fuel burning means, pulverizers supplying fuel to the fuel burning means, a by-pass through which tempering air is supplied as a part of the primary air passing through the pulverizers, a plurality of forced draft fans causing primary air to flow through the by-pass and through the other section of the heater, means automatically closing the outlet of one of the last named forced draft fans when it is separately stopped, and means for controlling the flow of tempering air and heated primary air to the pulverizers in response to variations in the steam pressure of the boiler.

3. A pulverized fuel combustion system, a furnace fired by pulverized fuel burner means, a pulverizer connected to the burner means so as to supply pulverized fuel and primary air thereto, an air heater contacted by the furnace gases and having a secondary air heating section separated from a primary air heating section, means directly connecting the air outlet of the secondary air section to the ignition zone of the burner means, means directly connecting the air outlet of the primary air heating section to the pulverizer, a forced draft fan supplying air to the secondary air heating section and causing it to move under pressure to the ignition zone, a plurality of forced draft fans for the primary air having their inlets connected with the discharge side of the forced draft fan for the secondary air, duct means connecting the discharge sides of the primary air fans to the air inlet of the primary air heater section, a conduit leading directly from said duct means to the heated primary air connection to the pulverizer, means whereby the temperature of the primary air delivered to the pulverizer may be controlled by varying the volume of heated primary air passing to the pulverizer or the volume of unheated primary air passing to the connection between the primary air section and the pulverizer, damper means

acting upon furnace gases independently heating the primary air section of the heater to control the temperature of the primary air, means whereby either or both of the primary fans may have their inlet sides connected directly to the atmosphere while the connection with the cold air outlet of the secondary air forced draft fan is closed, and means whereby the operation of the system will be continued when either one of the primary air fans is removed for the purpose of repair or replacement.

4. In a pulverized fuel firing system for a steam boiler furnace, fuel burner means, means for supplying secondary air to the burner means, a primary air heater, pulverizers, means for connecting the heater to the pulverizers for the supply of heated primary air thereto, a by-pass connected to the pulverizers for the delivery of unheated primary air thereto, said by-pass communicating with the inlet of the heater and said connecting means, a plurality of primary air fans, separate check dampers for the primary air fans automatically closing the outlet of any one of said fans which may be temporarily rendered inoperative, and means responsive to variations in steam pressure of the boiler for controlling the flow of primary air through the heater and through the by-pass.

5. In a pulverized fuel combustion system, a furnace fired by a pulverized fuel burner, a pulverizer, means for connecting the discharge side of the pulverizer to the burner, a primary air heater, a connection between the pulverizer and the heater whereby primary air is delivered to the pulverizer, means including a forced draft fan for causing a movement of heated primary air to said connection to the pulverizer, a by-pass connection which permits a movement of unheated primary air to said connection, a forced draft fan causing secondary air to move to the ignition zone of the burner, and means connecting the inlet side of the primary air fan to the discharge side of the secondary air fan.

6. In a combustion system, a furnace, a fuel pulverizer, a fuel burner means receiving pulverized fuel and primary air from the pulverizer, a main supply of air under super-atmospheric pressure provided by a main fan, means for bypassing a part of the main air supply and increasing its pressure as it is conducted as primary air to the pulverizer, means for dividing the by-passed primary air into parallel streams, means for heating the air in one of the streams so that two streams of primary air at widely different temperatures pass toward the pulverizer, means providing for the uniting of the primary air streams in regulated volumes before the pulverizer is reached, and means providing for a supply of secondary air to the burner means from said main air supply.

7. In a combustion system, a furnace, a plurality of independently operable burners for the furnace, a plurality of fuel pulverized through each of which pulverized fuel and primary air is supplied to a burner, a single blower through which passes the primary air for the pulverizers and the secondary air for the burners, connections leading from the discharge side of the blower to the secondary air inlets of all of the burners, other connections leading from the discharge side of the blower to the primary air inlets of all of the pulverizers, said other connections including an additional blower, means for heating part of the primary air, means included in said other connections for causing the re-

maining part of the primary air to by-pass the heating means, means whereby the said primary air parts are combined before entering the pulverizers.

- 5 8. A pulverized fuel firing system comprising, in combination, a furnace, a pulverizer, a burner, a secondary air heater, a primary air heater, an auxiliary cold air forced draft fan delivering primary air to the primary heater and thence to
10 the pulverizer so that it entrains pulverized fuel and carries it to the burner, and a main cold air forced draft fan delivering secondary air to the auxiliary fan and the secondary air heater in parallel, the secondary air being directed from
15 the secondary heater to the furnace.

9. In a combustion system, a furnace, a fuel burner, an air heater divided into first and second air heating sections adapted to be heated by gases from the furnace, means whereby said air heating sections are arranged for parallel gas flow
20 therethrough, means forming a furnace gas inlet and a furnace gas outlet common to said sections,

means including a forced draft fan causing air to pass through the first of said sections to the burner, means including a fan causing air to pass from the second of said sections to the furnace, and means for controlling the heating gas
5 flow over the first air heater section to regulate the temperature of the air therefrom.

10. In a combustion system, a furnace, an air heater for the secondary and primary air to support combustion in the furnace, the air
10 heater being divided into separate first and second air heating sections adapted to be heated by gases from the furnace, means whereby said air heating sections are arranged for parallel gas
15 flow therethrough, means forming a furnace gas inlet and a furnace gas outlet common to said sections, independent means causing air to pass through said sections to the furnace, and means for controlling the heating gas flow over the
20 first air heater section to regulate the temperature of the air therefrom.

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