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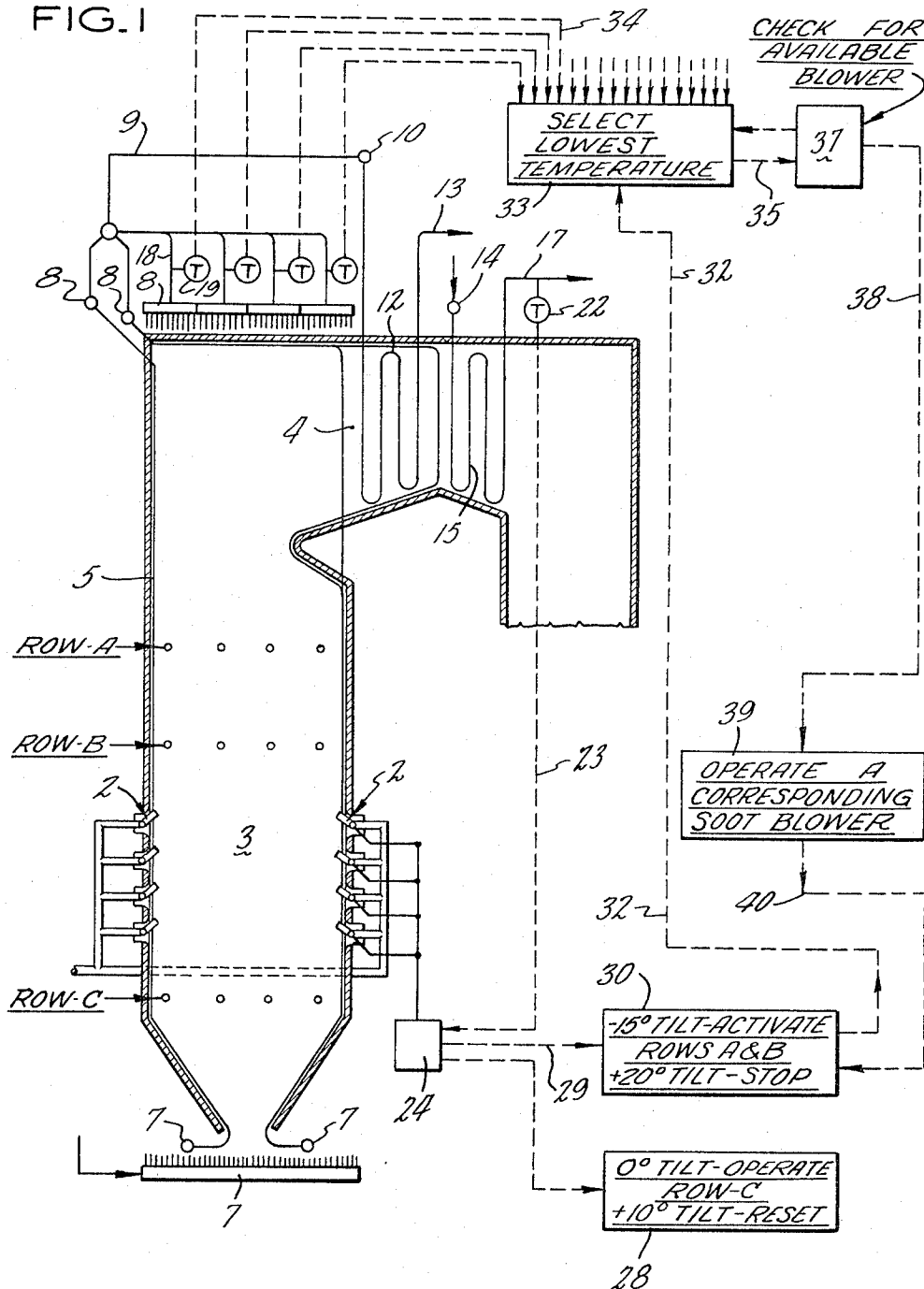
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SOOT BLOWER OPERATION FOR VAPOR GENERATOR FURNACES

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2 Sheets-Sheet 1

FIG. 1



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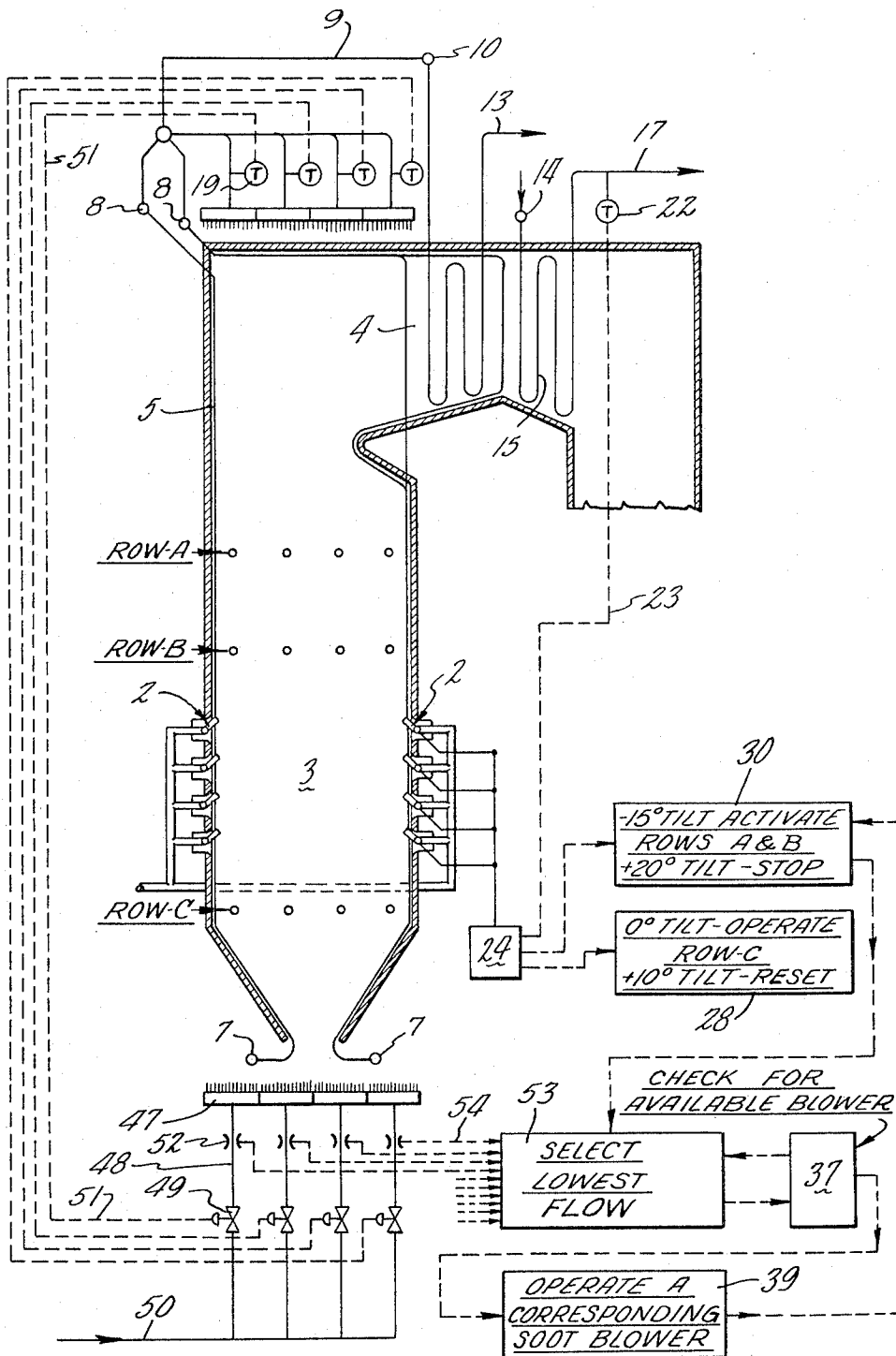
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FIG. 2



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SOOT BLOWER OPERATION FOR VAPOR GENERATOR FURNACES

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This invention relates to vapor generator furnaces and particularly to a method and apparatus for furnace wall soot blower operation.

In steam generating units burning coal or other ash bearing fuels there has always been a problem with ash deposits on the walls of furnaces. These deposits effectively insulate the walls, decreasing the furnace heat absorption, disturbing the balance of heat absorption throughout the unit, and in some cases, decreasing the efficiency of the unit. Furthermore, excessive buildup of this ash can lead to conditions where the slag bridges over the burners requiring a shutdown for cleaning and, in some cases, a heavy accumulation of slag suddenly falls off the walls damaging the floor of the furnace. This problem is becoming more critical since units are being built with high furnace heat release rates and poorer quality coals are being burned.

Generally the furnace wall soot blowers are set for sequential operation and their application is dictated by general furnace performance conditions. A typical furnace wall soot blower is described in U.S. Patent 2,662,241 and typical methods of operating these blowers are shown in U.S. Patents 2,811,954 and 3,137,278.

As the furnace walls become dirty the gas temperature leaving the furnace tends to increase and superheaters located in the gas stream produce steam of an increased temperature. Various means are used to control this steam temperature in order to compensate for the dirtiness of the furnace. This includes methods such as tilting burners, spray desuperheating, gas recirculation and superheater gas bypasses. As the furnace dirties up, the control means operates to maintain a preselected steam temperature. The position of the steam temperature controller is sensed and when it reaches a predetermined position, it is known that the furnace walls have reached a particular over-all dirtiness condition. At this time all of the furnace wall blowers are operated to clean the walls with the steam temperature controller moving to an earlier position to maintain steam temperature. As the furnace dirties up again, this cycle is repeated.

The deposition of ash on the furnace walls is not uniform with there being certain areas that tend to dirty rapidly and others which remain relatively clean. General soot blowing of the entire wall accomplishes little in the relatively clean areas. The operation of the soot blowers in these clean areas uses expensive soot blowing media and prolongs the time of the actual soot blowing cycle. Since there is always the possibility of tube erosion due to the soot blower action, operation of soot blowers in a clean furnace zone creates an unnecessary risk with no compensating advantage.

In a circuit lining the walls of a furnace the tubes must be joined in some manner to maintain the over-all structure. This may be done by welding these tubes to bars which cross them transversely on the casing side, or as is now more often done by welding the adjacent tubes continuously throughout their length. Uneven slagging conditions on the furnace side of these tubes results in uneven heat absorption which is reflected in an unbalance of the temperature of the fluid temperatures passing through the furnace wall. This temperature unbalance creates a condition where the hotter tubes want to expand with relation to the colder tubes, setting up stresses in the over-all fur-

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nace wall structure in various locations. Repeated slagging and cleaning of the furnace walls will cause a cycling of these stresses and lead to fatigue failures even at relatively low stresses.

Such a circuit may be controlled so that the outlet temperature is maintained constant regardless of the variations in heat absorption. This is accomplished by measuring the outlet temperature and varying the relative flow in accordance with the heat absorption through the parallel groups of tubes to maintain the temperatures equal. In such a situation a group of tubes receiving high heat absorption will contain the same temperature fluid as the other tubes but it will be operating at a higher heat absorption rate. This higher heat absorption rate, therefore, causes a higher metal temperature in these circuits creating the same type expansion problem as previously discussed although of lesser magnitude.

In my invention a furnace wall circuit is divided into a plurality of groups of tubes, with particular soot blowers being associated with each group. The heat absorbed in each group is determined in some manner such as temperature or fluid flow measurements thereby indicating which of these groups of tubes have excessive ash accumulations along their length. In response to this indication of heat absorption the proper soot blowers are operated corresponding to the particular low heat absorption group so that those circuits with the heaviest ash accumulation may be cleaned first.

It is an object of my invention to provide a method and apparatus whereby soot blowers may be operated for maximum furnace wall cleaning efficiency by operating those in the dirtiest zones first, thereby reducing the amount of soot blowing necessary.

It is a further object to provide a method and apparatus for operating soot blowers so as to obtain more uniform heat absorption and temperatures throughout the furnace walls.

Other and further objects of the invention will become apparent to those skilled in the art as the description proceeds.

With the aforementioned objects in view, the invention comprises an arrangement, construction and combination of the elements of the inventive organization in such a manner as to attain the results desired, as hereinafter more particularly set forth in the following detailed description of an illustrative embodiment, said embodiment being down by the accompanying drawing wherein:

FIGURE 1 represents a once-through unit with the soot blower action responsive to the temperature leaving various groups of tubes within the furnace; and

FIGURE 2 represents a once-through unit in which the soot blower action is responsive to the flow through the various groups of tubes within the furnace walls.

Fuel is delivered through tilting burners 2 into the furnace 3 where combustion takes place with the products of combustion passing out through flue 4 exhausting through a stack (not shown). The walls of the furnace are lined with furnace wall tubes 5 which convey fluid from the inlet headers 7 to the furnace wall outlet headers 8. This fluid enters the walls at a temperature of about 670° F. and a pressure of 4100 p.s.i. reaching the outlet headers at a temperature of about 800° F. and at a pressure of 4000 p.s.i.

This fluid which is now steam is conveyed through cross-over pipe 9 to the superheater inlet header 10 and thence through the superheating surface 12 and through the outlet steam pipe 13. The combustion gases passing through the flue 4 superheat the steam passing through heating surface 12 to a temperature of about 1050° F.

This steam is conveyed to a high pressure turbine (not shown) and returned to the reheat inlet header 14 at

a temperature of about 650° F. and a pressure of about 700 p.s.i. This steam passes through heating surface 15 located in flue 4 and is heated to a temperature of about 1000° F. This steam is then conveyed through steam line 17 to the low pressure turbine (not shown). These two turbine sections are connected to drive an electric generator (not shown).

Furnace wall soot blowers are located in the walls of the furnace at three elevations. The highest elevation is indicated as Row A with a second elevation just above the burners designated as Row B. A third row of blowers designated as Row C is located below the burners. Each of the furnace walls has a general arrangement similar to that of the side wall which is shown in FIGURE 1. The tubes of the furnace side wall are parallel and rise vertically from the lower side wall header 7 to the upper side wall header 8. Each row of soot blowers includes four blowers on the side wall, and the side wall circuit is therefore divided into four groups of tubes. The outlet header 8 is partitioned into four sections with each one of these sections receiving tubes from a particular group. A single relief tube 18 carries the fluid from each header section to the cross-over line 9 where the fluid from all the groups of tubes are joined and mixed. A thermocouple is located in each of the relief tubes 18 so that the temperature of the fluid leaving each group of tubes is sensed by the temperature transmitters 19.

During operation of the unit erratic slag patterns form on the furnace walls causing an unbalance in the heat absorption in the various groups of tubes. This unbalance in heat absorption is reflected in the steam temperature leaving each group of tubes as sensed by the transmitter 19. Those groups of tubes having the heaviest ash accumulation will have a reduced heat absorption and therefore indicate a low temperature leaving the particular section. In accordance with my invention the temperature of the steam leaving each group of tubes is used to determine the location of the heavy slag accumulations and to determine which soot blower will be operated so that the dirtiest zones of the furnace will be cleaned first. This is accomplished by using these temperature impulses to select particular blowers which are to operate when activated. These blowers are activated when the over-all dirtiness of the furnace indicates a general need for soot blowing within the furnace.

A thermocouple in the reheat steam line senses the temperature of the reheated steam in response to which the reheat steam temperature transmitter 22 emits a control signal 23 to the burner tilt controller 24. This controller varies the tilt of the burners 2 within the furnace to maintain the reheat steam temperature at a preselected value. As the furnace walls become dirty, the heat absorption is reduced with an increased temperature of the gases leaving the furnace, and the reheated steam temperature tends to increase. To compensate for this the burners are then automatically tilted downward.

When the burners reach 0 degrees or horizontal tilt, all the soot blowers in Row C are operated independent of any temperature measurements in the relief tubes 18. It has been found that the soot blowers below the burners are more effective when the tilts are in a horizontal or upward position than they are when the tilts are in a downward position. We therefore obtain a general cleaning of the lower portion of the furnace. As this is cleaned, the furnace becomes more efficient and the burners tilt upward to maintain the reheat temperature. Since the lower portion of the furnace is relatively ineffective at horizontal tilt, the cleaning of these walls does not make a great deal of difference in the heat absorption and the tilts rise only slightly to about plus 5 degrees. The controller 28 is not reset to operate the blowers of Row C again until the tilts reach a plus 10 degrees tilt and therefore the slight increase to plus 5 degrees is insufficient to reset the controller. As the furnace dirties up,

the tilts continue downward below horizontal to maintain reheat steam temperature.

At minus 15 degrees tilt the control signal through impulse line 29 to controller 30 operates to activate the soot blowers in Rows A and B. A control signal therefore passes through impulse line 32 indicating a need for soot blowing to the selector controller 33. An auctioneering controller of this type is manufactured by Leeds and Northrup Company. Temperature signals indicating the temperature of the fluid leaving the various groups of tubes are also sent to selector controller 33 through control lines 34 from the temperature transmitters 19. This controller selects the group of tubes having the lowest temperature and emits control signal 35 to operate the soot blowers in Row A or B corresponding to the group of tubes having the lowest temperature. This signal passes to controller 37 which checks for an available blower associated with the particular group of tubes. This controller will alternately select Rows A and B in such a manner that if Row A had last been blown in this particular group of tubes, Row B would be blown on this occasion. This controller would also include a circuit which prevents the soot blower from operating within one hour of the time it has previously operated, thereby avoiding repetitive inefficient operation of soot blowers in one particular group of tubes when the low temperature of the fluid leaving that circuit cannot be so corrected. When an available blower is found, the control signal is passed through control line 38 to controller 39 which acts to operate the particular wall blower. When this blower has completed its operation, control signal passes through control line 40 back to controller 30 to check the position of the tilts. If the tilts are still below a plus 20 degrees tilt, a control signal passes through control line 32 to again select the lowest temperature.

This continues until such a time as the tilts reach a plus 20 degree tilt at which time the wall blowers are deactivated and operation ceases. Since the tilts are now obviously above plus 10 degree tilt, controller 28 is reset so that when the tilts reach horizontal Row C soot blowers will again be operating.

In the particular embodiment of FIGURE 1, the overall furnace dirtiness is detected by sensing the position of the tilting burners which are operating to control the reheat temperature. This general furnace dirtiness could also be obtained by measuring the gas temperature leaving the furnace or by measuring spray quantity which could be used to control reheat steam temperature, or a number of other generally known methods. Also row C could be incorporated with rows A and B operating through the selector controller 33 to operate the soot blowers of row C in accordance with the temperature leaving the associated group of tubes, although on a unit operating with tilting burners, this has been found to be less effective. Also circuits which meander throughout the furnace walls may be used so long as particular soot blowers are associated with various groups of tubes, and circuits may be employed in the furnace walls which are intermeshed or cover only a portion of the furnace walls.

The unit illustrated in FIGURE 2 is similar to that of FIGURE 1. However, this unit includes a flow control system which regulates the flow through the furnace tubes to control the outlet temperature leaving each group of tubes. Accordingly, the inlet header 47 is divided into a number of sections corresponding to each group of tubes. An individual supply tube 48 supplies water to each header section with the flow being controlled by control valves 49. The incoming water passes through line 50 being distributed in the four sections of header 47 (as shown) and to corresponding header sections on the other walls (not shown). The temperature sensing transmitter 19 emits a signal through control line 51 to operate the flow throttling valves 49 which, in turn, control the flow passing through a particular group of

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tubes to maintain the temperature at a predetermined value. The group of tubes having the highest accumulation of ash will have the lowest heat absorption and therefore the lowest flow.

Flow nozzles 52 are associated with each group of tubes and measure the flow passing through that particular group of tubes. The flow control signal passes through control line 54 to selector controller 53. The embodiment of FIGURE 2 then operates in exactly the same manner as that of FIGURE 1 with the control signal 54 passing to controller 53 selecting the lowest value instead of the temperature signal passing through control line 34 to controller 33 selecting the lowest temperature. Other means of determining the flow such as the position of the throttling valves 49 may be used.

Controllers performing the functions required are standard equipment and may be obtained from Leeds and Northrup Company, Bailey Meter Company or Hagan, Inc.

While I have illustrated and described a preferred embodiment of my invention it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes as fall within the purview of my invention.

What I claim is:

1. A vapor generator furnace comprising: means for burning an ash bearing fuel within the furnace; a plurality of groups of tubes lining the walls of said furnace in parallel flow relation; means for passing fluid through said tubes whereby the temperature of the fluid is increased; means for sensing the total heat absorbed by the fluid passing through each of said group of tubes; at least one soot blower associated with each group of tubes; and means for operating a soot blower associated with a group of tubes in response to the heat absorption sensing means related to the corresponding group.

2. A vapor generator furnace comprising: means for burning an ash bearing fuel within said furnace; a plurality of groups of tubes lining the walls of said furnace in parallel flow relation; a soot blower associated with each of said groups of tubes; means for passing fluid through said tubes whereby the temperature of said fluid is increased; means for sensing the temperature of the fluid leaving each group of tubes; and means for operating a soot blower associated with each group of tubes in response to the means for sensing the temperature leaving the corresponding group of tubes.

3. A furnace for a vapor generator comprising: means for burning an ash bearing fuel within said furnace; a plurality of groups of tubes lining at least a portion of the walls of said furnace in parallel flow relation; at least one soot blower associated with each group of tubes; means for passing fluid to be heated through said groups of tubes; means for sensing the temperature of the fluid leaving each group of tubes; means for selecting the group of tubes with the lowest fluid temperature leaving the group of tubes; and means for operating a soot blower associated with that group of tubes which is selected by said selecting means.

4. A furnace for a vapor generator comprising: means for burning an ash bearing fuel within said furnace; a plurality of groups of tubes lining the walls of said furnace in parallel flow relation; at least one wall soot blower associated with each group of tubes; means for passing fluid to be heated through said groups of tubes; means for determining the over-all furnace dirtiness; means responsive to the over-all furnace dirtiness for activating the furnace wall soot blowers; means for sensing the temperature of the fluid leaving each group of tubes; means for selecting the group with the lowest fluid temperature leaving and means for operating a soot blower associated with the group of tubes having the lowest fluid temperature leaving when the soot blowers are activated in response

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to the means for determining the over-all furnace dirtiness.

5. An apparatus as in claim 4 having also a flue for the conveyance of products of combustion from said furnace; steam reheating surface located within said flue; means for determining the temperature of the reheated steam leaving said steam reheating means; tilting burners in said furnace operative in response to said reheated steam temperature sensing means to maintain the reheated steam temperature at a predetermined value; wherein the means for determining the over-all furnace dirtiness comprises means for sensing the degree of tilt of said tilting burners.

6. In a vapor generator furnace having furnace walls lined with a plurality of groups of tubes in parallel flow relation, and a soot blower associated with each group of tubes, the method of operation comprising: passing fluid through each group of tubes; sensing the total heat absorbed by the fluid passing through each group of tubes; selecting the group of tubes having the lowest heat absorption; and blowing a soot blower associated with the corresponding group of tubes.

7. In a furnace for a vapor generator having a plurality of groups of tubes lining the walls of said furnace in parallel flow relation, and a soot blower associated with each group of tubes, the method of operation comprising: burning an ash bearing fuel within said furnace; passing fluid through said tubes in heat exchange relationship with the burning fuel; sensing the temperature of the fluid leaving each group of tubes; selecting the group of tubes having the lowest fluid temperature leaving; and operating a soot blower corresponding to this group of tubes.

8. In a vapor generator furnace having a plurality of groups of tubes lining the walls of said furnace in parallel flow relation and a soot blower associated with each of said group of tubes, the method of operation comprising: burning an ash bearing fuel within said furnace; sensing the over-all furnace dirtiness; passing a fluid through said group of tubes in heat exchange relationship with the burning fuel; measuring the temperature of the fluid leaving each group of tubes; selecting the group of tubes having the lowest fluid temperature leaving; activating the soot blowers in response to the over-all furnace dirtiness; and operating the soot blowers so activated in accordance with the selection of the group having the lowest fluid temperature leaving.

9. A method as in claim 8 including: repeatedly operating soot blowers in response to the temperature leaving the groups of tubes; and stopping operation of the soot blowers when the over-all furnace dirtiness reaches a predetermined value.

10. A vapor generator furnace comprising: means for burning an ash bearing fuel within said furnace; a plurality of groups of tubes lining the walls of said furnace; a soot blower associated with each of said group of tubes; means for passing fluid through said tubes; means for sensing the temperature of the fluid leaving each of said group of tubes; means for regulating the flow through each of said group of tubes; means for controlling the flow regulating means in response to the temperature leaving a corresponding group of tubes to maintain the temperature leaving the group of tubes at a predetermined value; means for sensing the flow through each of said group of tubes; and means for operating a soot blower associated with each group of tubes in response to the flow sensing means of the corresponding group of tubes.

11. In a vapor generator furnace having a plurality of groups of tubes lining the walls of said furnace, and a soot blower associated with each of said group of tubes, the method of operation comprising: burning an ash bearing fuel within said furnace; sensing the over-all furnace dirtiness; passing a fluid through said groups of tubes in heat exchange relationship with the burning fuel; measuring the temperature of the fluid leaving each group of tubes; regulating the flow of the fluid through

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each of said group of tubes to maintain the temperature of the fluid leaving at a predetermined value; sensing the flow through each of said group of tubes; selecting the group of tubes having the lowest flow; activating the soot blowers in response to over-all furnace dirtiness; and operating the soot blowers so activated in accordance with the selection of the group having the lowest flow therethrough.

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