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(54) Title: SOLIDS FLOW METER FOR INTEGRATED BOILER CONTROL SYSTEM

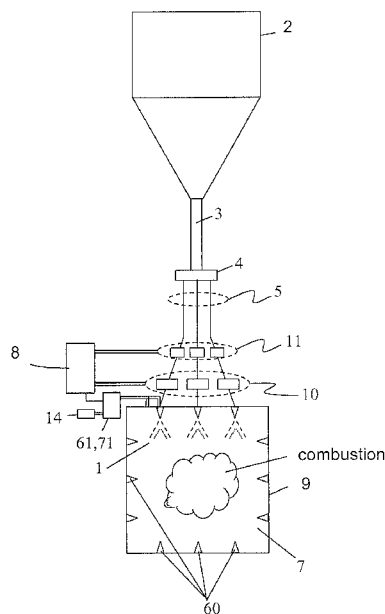


Fig. 1

(57) Abstract: A combustion control system [100] for a combustion system [7] having a plurality of fuel pipes [5]. The combustion control system [100] including a plurality of flow meters [10], a controller [8], fuel flow controls [11] and secondary air controls [61,62,72]. Each meter [10] is adapted to monitor flow of fuel within a respective one of the fuel pipes [5] by sensing a pressure field within the fuel pipe [5]. A controller [8] receives the flow information from each of the flow meters [10], to evaluate performance of the combustion system [7]. Controller [8] also providing control information for controlling the flow of secondary air dampers [61,62,71] into the combustion system [7], and optionally controlling the flow of fuel in each fuel pipe [5].



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ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

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ML, MR, NE, SN, TD, TG).

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SOLIDS FLOW METER FOR INTEGRATED BOILER CONTROL SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates to coal-fired combustion systems, and more particularly to more efficient coal-fired combustion systems that accurately measure fuel flow and adjust secondary air flow based upon the measured fuel flow.

2. Description of the Related Art

[0002] In various coal-fired combustion systems, such as a boiler or furnace, a pulverizer is used to feed pulverized coal to the combustion system through a number of fuel pipes. Typically, the flow rate of coal through the fuel pipes cannot be accurately measured with intrusive flow meters due to the erosive environment within the coal pipe. Periodic measurements are used to adjust riffle distributors to provide approximately the same fuel flow through each fuel feed lines, balancing the lines.

[0003] Fuel line imbalance can cause improper air/fuel ratio and improper combustion in various portions of the combustion system. This affects carbon loss and can lead to production of undesired emissions such as carbon monoxide (CO), various nitrogen compounds (NO_x), as well as various volatile organic compounds and others. Such emissions can cause a plant to be out of emissions compliance or run inefficiently.

[0004] Thus, what are needed are methods and apparatus for accurate measurement of fuel flow for improved control over combustion systems, leading to improved efficiency and reduced emissions.

BRIEF SUMMARY OF THE INVENTION

[0005] The present invention may be embodied as a combustion control system [100] for a furnace [7] comprising a plurality of fuel pipes, the system comprising:

[0006] a plurality of flow meters [10], each meter [10] adapted for monitoring a flow of fuel within a respective one of the fuel pipes [5] by sensing a pressure field within the fuel pipe [5]; and

[0007] a controller [8] for receiving flow information from each of the flow meters [10], evaluating performance of the furnace [7], and providing control information for controlling secondary air flow into said furnace [7].

[0008] At least one secondary air flow control [61,62,71] receives the control information and controls the secondary air flowing into said furnace [7] creating more efficient combustion and reduced emissions.

[0009] The present invention may also be embodied as a method [20] for controlling operation of a combustion system [7], the method comprising:

[0010] obtaining fuel flow information [22] from at least one fuel tube [5] from a flow meter [10], each flow meter [10] comprising a sensor for sensing information regarding a pressure field within a respective fuel pipe [5] carrying the flow of fuel to the nozzle [6]; and

[0011] adjusting at least one air flow control [61,62,71] according to the fuel flow information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The subject matter which is regarded as the invention is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0013] FIG. 1 depicts aspects of one embodiment of a combustion system according to the present invention;

[0014] FIG. 2 is a partially cut-away perspective view of fuel nozzles, air nozzles and dampers, as they would appear within the wall of furnace.

[0015] FIG. 3 is an enlarged perspective view of a sold fuel nozzle and an air nozzle of FIG. 2; and

[0016] FIG. 4 depicts aspects of a method for using the flow meter.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Disclosed methods and apparatus providing for accurate measurement of fuel flow. The measurements provide for improved control over combustion systems, such as a boiler combustion system, leading to improved efficiency. In general, the teachings herein make use of at least one low-frequency, ultrasonic, non-intrusive solids flow meter. The at least one flow meter may be disposed in a variety of locations, and as an example, may be used to measure flow to each windbox within a boiler combustion system.

[0018] In FIG. 1, the combustion system shown includes a pulverizer 2 that provides pulverized sold fuel. The solid fuel particles are entrained in a flow of air through a fuel line 3 to a splitter 4.

[0019] The pulverized solid fuel is passed through a plurality of fuel pipes 5. The splitter 4 may be a riffling distributor that adjusts the flow through each of the fuel pipes 5.

[0020] The fuel then flows through a plurality of fuel nozzles 60. The fuel nozzles 60 are disposed on an interior wall 9 of a furnace 7. The pulverized solid fuel is burned in furnace 7.

[0021] The combustion control system 100 employs at least one flow meter 10. Each of the flow meters 10 generally senses a pressure field within a fuel pipe 5 (or similar component). Exemplary technology for the flow meter 10 may include low frequency, ultrasonic and/or solids monitoring technologies.

[0022] Additionally, a fan 14 provides air through dampers 61, 71 and into furnace 7.

[0023] Further shown in FIG. 1 is a plurality of flow controls 11. The flow controls 11 may be riffle distributors such as those described in US Patent 7,017,501 Issued March 28, 2006 to Jeffrey Mann entitled "Rifle Distributor for a Fossil Fuel Fired Combustion Arrangement".

[0024] The flow controls 11 provide for limited control flow of fuel flow to the plurality of nozzles 6, and thus work in combination with other components of the combustion control system 100. However, additional control is required to provide more efficient combustion.

[0025] Additional air is provided by a fan 14 “secondary air”. This secondary air is provided through dampers 61, 71 and into the furnace to adjust the fuel/air mixture for efficient combustion.

[0026] Each of the flow meters 10 provides measurement data (also referred to as “flow information”) of fuel flow through each of the fuel tubes 5. In one embodiment, the flow measurement data is sent to a controller 8. The controller 8 then determines appropriate adjustments to flow of fuel and secondary air and sends commands for manipulation of each of the respective flow controls 11 and dampers 61, 71. The flow controls 11 and dampers 61, 71 include apparatus as necessary for at local and/or remote operation.

[0027] The controller 8 may include apparatus as deemed appropriate for receiving flow measurement data and controlling flow. For example, the controller 8 may include a personal computer (PC) equipped with additional electronics (such as analog to digital converters, and other such additional equipment). The controller 8 may be a shared use unit, such as in the case of a PC, and may generally be realized simply as software (i.e., machine executable instructions stored on machine readable media). In other embodiments, the controller 8 may be a dedicated unit, such as realized by implementation of a local unit installed proximate to at least one of the flow meters 10 and the flow controls 11. In such latter embodiments, the controller 8 may be realized in the form of a low cost dedicated processor supported by a dedicated power supply, machine executable instructions stored on machine readable media, such as in read-only-memory, and other such components.

[0028] Of course, the controller 8 may have a variety of inputs for evaluating and controlling performance of the combustion system. That is, the controller 8 may receive operational information as inputs. Exemplary operational information includes such parameters as temperature, constituents of effluent (such as a concentration of NO_x) and other such parameters. In general, each input parameter provides the controller 8 with information needed for controlling the flow of secondary air into the furnace to result in improved efficiency of the combustion system.

[0029] In addition, the controller 8 may include fuel characterization data. Characterization data may be useful for qualify aspects of measurements. For example, the characterization data may include information such as density and/or particle size of a particular fuel type. Accordingly, characterization data may be useful, particularly in combination with operational data (such as flow rates) to refine measurement data produced by the flow meters 10.

[0030] It should be recognized that the example of FIG. 1 is merely illustrative. For example, flow meters 10 may be deployed at least one of before and after flow controls 11 and/or any splitter(s) 4. Flow controls 11 may be omitted, or at least partially omitted. Certain components such as the flow control 11, the flow meter 10, the controller 8 and the splitter 4 may be incorporated into a single unitary structure (i.e., for a single component).

[0031] In general, each flow meter 10 is a low frequency, ultrasonic, non-intrusive solids flow meter 10. The flow meter 10 may be used anywhere deemed appropriate in the combustion system to more accurately measure flow of fuel to a combustion delivery device, such as the plurality of nozzles 6. With the measurement data, combustion controls systems can tune the furnace 7 for desired purposes (such as improved efficiency and/or reductions in solid and gaseous emissions).

[0032] In some embodiments, the flow meter(s) 10 are used in conjunction with flow controls 11 such as local air dampers 61, 71. Through flow measurement and appropriate control of the air dampers within windboxes near the coal nozzles, the local stoichiometry can be evenly maintained within the furnace. The local stoichiometry within the furnace 7 can also be measured with the flow meter(s) 10 being located anywhere downstream of the windboxes in the flue gas stream, including within the furnace, a stack, a heat exchanger, a gas clean-up system, and other such components. Locating the flow meters downstream provides for further enhancements to control.

[0033] One exemplary flow meter 10 is a device produced by CIDRA Corporation of Wallingford Connecticut, and offered under the tradename "SONARTRAC." This device exhibits array processing techniques to "listen" to, and interpret pressure fields generated by turbulent pipe flows. The flow meter provides accurate, reliable, non-intrusive and robust flow measurement for a wide range of single phase and multiphase flows. The device may be

clamped on to an existing fuel pipe 5 or fuel line 3, thus eliminating process disruptions associated with installing other types of flow meters, such as integrated devices.

[0034] Exemplary flow meters 10 include those disclosed in U.S. Patent No. 7,330,797, entitled "Apparatus And Method For Measuring Settlement Of Solids In A Multiphase Flow" and incorporated herein in its entirety by reference. This patent discloses a method and apparatus for measuring a parameter of a flow passing through a pipe is provided, wherein the apparatus includes at least two spatial array of sensors disposed at different axial locations along the pipe, wherein each of the sensors provide a signal indicative of unsteady pressure created by convection with the flow within the pipe at a corresponding axial location of the pipe. The apparatus also includes a signal processor configured to determine the flow rate at the circumference location of each sensor array in response to the respective measured unsteady pressures. The signal processor compares the velocity of the flow at each respective location and provides a signal indicative the presence of solids settled at the bottom of the pipe and/or the level of the settled solids in the pipe, in response to an uncharacteristic increase in the velocity of a lower portion of the flow in comparison to the velocity measured above the lower portion of the flow.

[0035] Other exemplary flow meters 10 include those disclosed in U.S. Patent No. 7,295,933, entitled "Configurable Multi-Function Flow Measurement Apparatus Having An Array Of Sensors" and incorporated herein in its entirety by reference. This patent discloses a configurable multi-function flow measurement apparatus is provided that can selectably function to measure the speed of sound propagating through a fluid flowing within a pipe and/or to measure pressures disturbances (e.g. eddies) moving with a fluid to determine respective parameters of the flow propagating through a pipe and detects the health of an industrial process. The configurable flow measurement device can also be selectable to function as a system diagnostic meter that provides a diagnostic signal indicative of the health of the industrial process, namely health of pumps, valves, motors and other devices in an industrial flow loop. The apparatus includes a sensing device that includes an array of strained-based or pressure sensors used to measure the acoustic and convective pressure variations in the flow to determine desired parameters. In response to a remote or local configuration signal, a control logic selects the desired function of the flow measurement apparatus.

[0036] Further examples of flow meters 10 include those disclosed in U.S. Patent No. 7,322,245, entitled "Apparatus And Method For Measuring A Fluid Flowing In A Pipe Using Acoustic Pressures" and incorporated herein in its entirety by reference. This patent discloses apparatus for sensing applications where at least one parameter of at least one fluid in a pipe is measured using a spatial array of acoustic pressure sensors placed at predetermined axial locations x_1 , x_2 , x_3 along the pipe. The pressure sensors provide acoustic pressure signals $P_1(t)$, $P_2(t)$, $P_3(t)$ on lines, which are provided to signal processing logic which determines the speed of sound a_{mix} of the fluid (or mixture) in the pipe using acoustic spatial array signal processing techniques with the direction of propagation of the acoustic signals along the longitudinal axis of the pipe. Numerous spatial array-processing techniques may be employed to determine the speed of sound a_{mix} . The speed of sound a_{mix} is provided to the logic, which calculates the percent composition of the mixture (e.g., water fraction, or any other parameter of the mixture) or fluid, which is related to the sound speed a_{mix} . The logic may also determine the Mach number M_x of the fluid. The acoustic pressure signals $P_1(t)$, $P_2(t)$, $P_3(t)$ measured are lower frequency (and longer wavelength) signals than those used for ultrasonic flow meters, and generally tolerant to in-homogeneities in the flow. No external source is required and thus may operate using passive listening. The apparatus will work with arbitrary sensor spacing and with as few as two sensors if certain information is known about the acoustic properties of the system.

[0037] FIG. 2 is a partially cut-away perspective view of fuel nozzles 60, air nozzles 80 and dampers 61, 71 as they would appear within the wall of furnace (9, 7 of FIG. 1). The plurality of solid fuel nozzles 64 typically receive pulverized coal entrained in a stream of primary air that passes through a primary outlet of solid fuel nozzles 64 into the furnace.

[0038] Optionally, there may be liquid fuel nozzles 63 which burns a combustible liquid (such as oil) fed through a liquid fuel pipe 69.

[0039] There is also additional air for combustion, referred to as "secondary air" that is provided to the furnace through separate outlets in both the solid fuel nozzles 64, and liquid fuel nozzles 63. These are shown in greater detail in FIG. 3.

[0040] Also show here are the boiler tubes 12 that carry water, are heated and produce steam.

[0041] FIG. 3 is an enlarged perspective view of a solid fuel nozzle 60 and an air nozzle 70 of FIG. 2. Pulverized coal is entrained in a stream of primary air and passes through fuel pipe 5 (shown in phantom) and out of primary outlet 67 of solid fuel nozzle 60.

[0042] In this embodiment, secondary air is provided through an upper fuel nozzle damper 61, passes through a partition of duct 65 and to upper secondary outlets 66 of solid fuel nozzle 60. Also, secondary air enters through lower fuel nozzle damper 62, through a separate partition of duct 65 and out of lower secondary outlets 68 of solid fuel nozzle 60.

[0043] Similarly, secondary air enters through air nozzle damper 71, through a duct 75 and out of an air nozzle 70 into the furnace for combustion.

[0044] All dampers are shown in a closed position in FIG. 3, however, they are controllable to open and close, or be adjusted to any position between these positions under the control of controller (8 of FIG. 1). Standard electric motors and known electronics may be used to implement the actuation of the dampers. This effectively controls the amount of secondary air being provided to the furnace thereby adjusting the combustion characteristics.

[0045] As stated above, each fuel pipe 5 is independently monitored, and each damper is independently adjusted. The adjustments are based upon the flow measured for each fuel pipe 5. This therefore, allows for independent monitoring and adjustment of each fuel nozzle 60 to provide a more accurate and cleaner combustion.

[0046] Referring now to FIG. 4, there is shown an exemplary flowchart depicting a method for adjustment of operation of the system using the flow meter 10. In FIG. 4, a process for controlling flow 20 is initiated, such as by the controller 8. The process begins by initializing the equipment for operation in step 21.

[0047] In step 22, fuel flow is measured in each of the fuel pipes 5.

[0048] Optionally, in step 23, the flow controls 11 may be adjusted. These may be performed on every pass through this flowchart, or less often. Similarly, if step 23 is performed, another fuel flow measurement similar to that of step 22 is performed.

[0049] In step 25, the amount which the fuel flow for a specific fuel pipe 5 being measured differs from the other fuel pipes 5 is determined. It is then calculated how much extra air, or reduced air is required to cause combustion from the measured fuel pipe 5 to become optimal. This is determined by employing optimal stoichiometry calculations.

[0050] In step 26, the additional or reduced air flow calculated is converted to one or more damper settings.

[0051] In step 27, the calculation unit (8 of FIG. 1) sets one or more dampers to the calculated damper settings (or as close as possible to the calculated damper settings.)

[0052] In step 28 it is determined if the operation of the furnace is to be completed. If so, processing continues at step 29 and the system is shut down.

[0053] If not, then processing continues at step 22.

[0054] Generally, the process for controlling flow 20 continues unabated until shutdown 29 of the combustion system 100.

[0055] It should be recognized that the teachings herein provide a number of advantages. That is, as fuel, generally from a plurality of pulverizers 2 is fed through a series of fuel splitters 4 to split into various pipes 5, inherent inconsistencies result. For example, the pipe splitters 4 may be inherently inaccurate in splitting the coal within the piping 5 and result in uneven distribution of fuel to the nozzles 6 within the furnace 7. This maldistribution of fuel results in different localized stoichiometries that may not be optimal for proper furnace operation.

[0056] Particular features provided include continuous measurement of fuel to the furnace for each fuel nozzle, thus providing improved furnace combustion and emissions control; an integrated control system may be realized which accepts a local fuel feed measurement signal and changes furnace operations, such as secondary air damper settings, to improve performance; a non-intrusive, solids flow meter which accurately measures the fuel rate without flow meter erosion can be integrated with a furnace controls system; a non-intrusive, solids flow meter which accurately measures a primary air flow through each fuel pipe is provided, and permits for close control of an air-to-coal ratio which minimizes NO_x formation at a tip of the fuel nozzle; a non-intrusive, solids flow meter which accurately

measures particle size distributions to the furnace provides for better controls over furnace combustion and emissions; and measurement of the flow of coal to individual fuel nozzles may be performed with a high accuracy.

[0057] One skilled in the art will recognize that the teachings herein may be employed with a variety of pulverizers 2 as well as a variety of furnaces 7 (i.e., combustion chambers). More specifically, the use of flow meters 10 is generally limited only by the sensitivity and other such parameters of a given flow meter 10 for monitoring of a specific flow. In that regard, particular flow meters 10 may be selected to account for, or be particularly sensitive to parameters including: flow rate, pipe diameter, piping wall thickness, materials used in the piping, size of particulate matter in the fuel, phase, including multi-phase flow, moisture content and other such properties.

[0058] Further, the flow meters 10 may be provided as part of a retrofit to existing combustion systems. For example, the flow meters 10 may be mounted onto existing piping 5 and integrated with existing controllers 8. Accordingly, a system making use of the teachings herein may also include computer software (i.e., machine readable instructions stored on machine readable media). The software may be used as a supplement to existing controller software (and/or firmware) or as an independent package.

[0059] The computer readable medium, may include any type of media, such as for example, magnetic storage, optical storage, magneto-optical storage, ROM, RAM, CD ROM, flash or any other computer readable medium, now known or unknown, that when executed cause a computer to implement the method of the present invention. These instructions may provide for equipment operation, control, data collection and analysis and other functions deemed relevant by a user.

[0060] Further, the kit may include all other necessary components as may be needed for successful installation and operation. Example of other components include, without limitation, electrical wiring, power supplies, motor and/or manually operated valves, computer interfaces, user displays, assorted circuitry, assorted housings, relays, transformers, and other such components.

[0061] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

CLAIMS

What is claimed is:

1. A combustion control system for a furnace comprising a plurality of fuel pipes, the system comprising:
 - a plurality of flow meters, each meter adapted for monitoring a flow of fuel within a respective one of the fuel pipes by sensing a pressure field within the fuel pipe; and
 - a controller for receiving flow information from each of the flow meters, evaluating performance of the furnace, and providing control information for controlling secondary air flow into said furnace.
2. The combustion control system as in claim 1, further comprising at least one secondary air flow control for receiving the control information and controlling the secondary air flowing into said furnace.
3. The combustion control system as in claim 1, wherein the controller comprises fuel characterization data for qualifying the flow information.
4. The combustion control system as in claim 1, wherein the controller comprises an input for receiving operational information comprising at least one of temperature information and flue gas composition information.
5. The combustion control system as in claim 1, further comprising machine executable instructions stored on machine-readable media, the instructions comprising instructions for:
 - estimating fuel flow information; and
 - adjusting at least one secondary air flow control according to the fuel flow information.

6. The combustion control system as in claim 5, further comprising instructions for at least one of:
 - initiating the estimating; and
 - shutting down the flow meter.
7. The combustion control system as in claim 5, further comprising instructions for controlling secondary air flow according to operational information.
8. The combustion control system as in claim 1, wherein the flow meter is adapted for monitoring a multi-phase flow.
9. The combustion control system as in claim 1, wherein the flow meter comprises clamping features for clamping to the fuel pipe.
10. The combustion control system as in claim 1, wherein the plurality of sound-based sensors is disposed at predetermined axial locations along the fuel pipe.
11. A method for controlling operation of a combustion system, the method comprising:
 - obtaining fuel flow information from at least one fuel tube from a flow meter, each flow meter comprising a sensor for sensing information regarding a pressure field within a respective fuel pipe carrying the flow of fuel to the nozzle; and
 - adjusting at least one air flow control according to the fuel flow information.
12. The method as in claim 11, wherein the step of adjusting comprises the steps of:
 - calculating the optimal air flow for the fuel flow information obtained;
 - converting the calculated optimal air flow to an approximate damper opening setting; and
 - adjusting at least one damper to the approximate damper opening setting.
13. The method as in claim 11, wherein at least one of the obtaining and the adjusting is performed on a real-time basis.

14. The method as in claim 11, further comprising referencing characterization data to refine an estimate of the flow information.
15. The method as in claim 11, wherein controlling the flow of fuel comprises controlling a flow of coal from a pulverizer.
16. The method as in claim 11, wherein the adjusting is performed to improve an efficiency of the combustion system.
17. The method as in claim 11, wherein the adjusting is performed to limit formation of pollutants by the combustion system.

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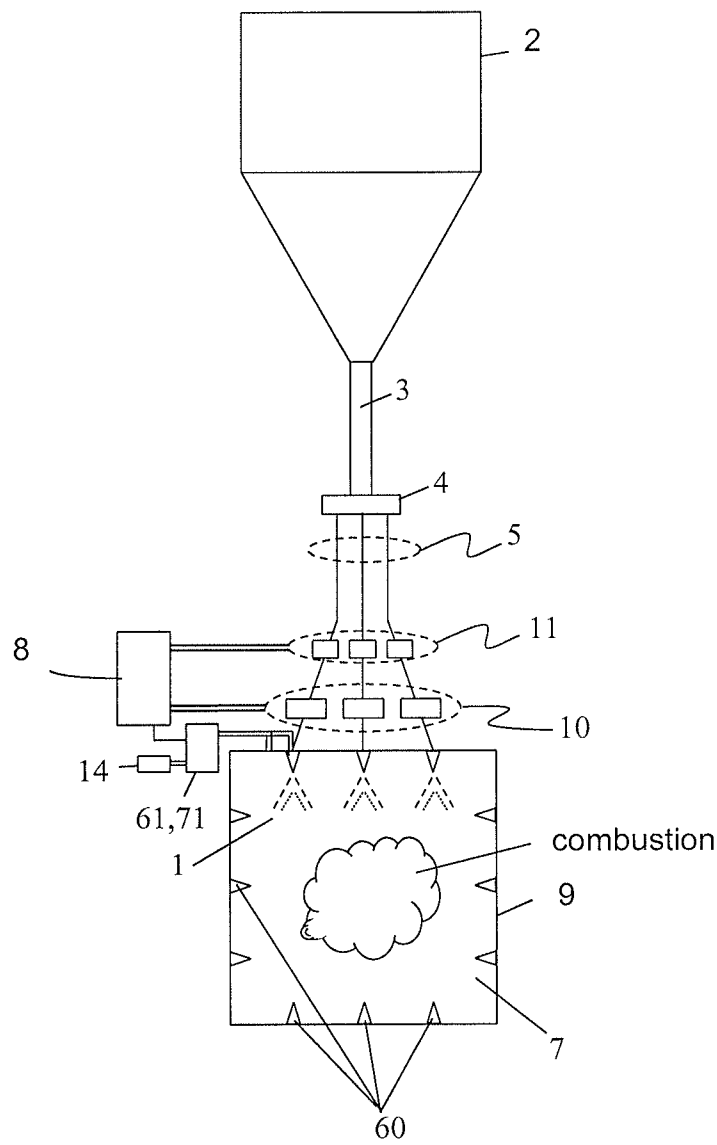


Fig. 1

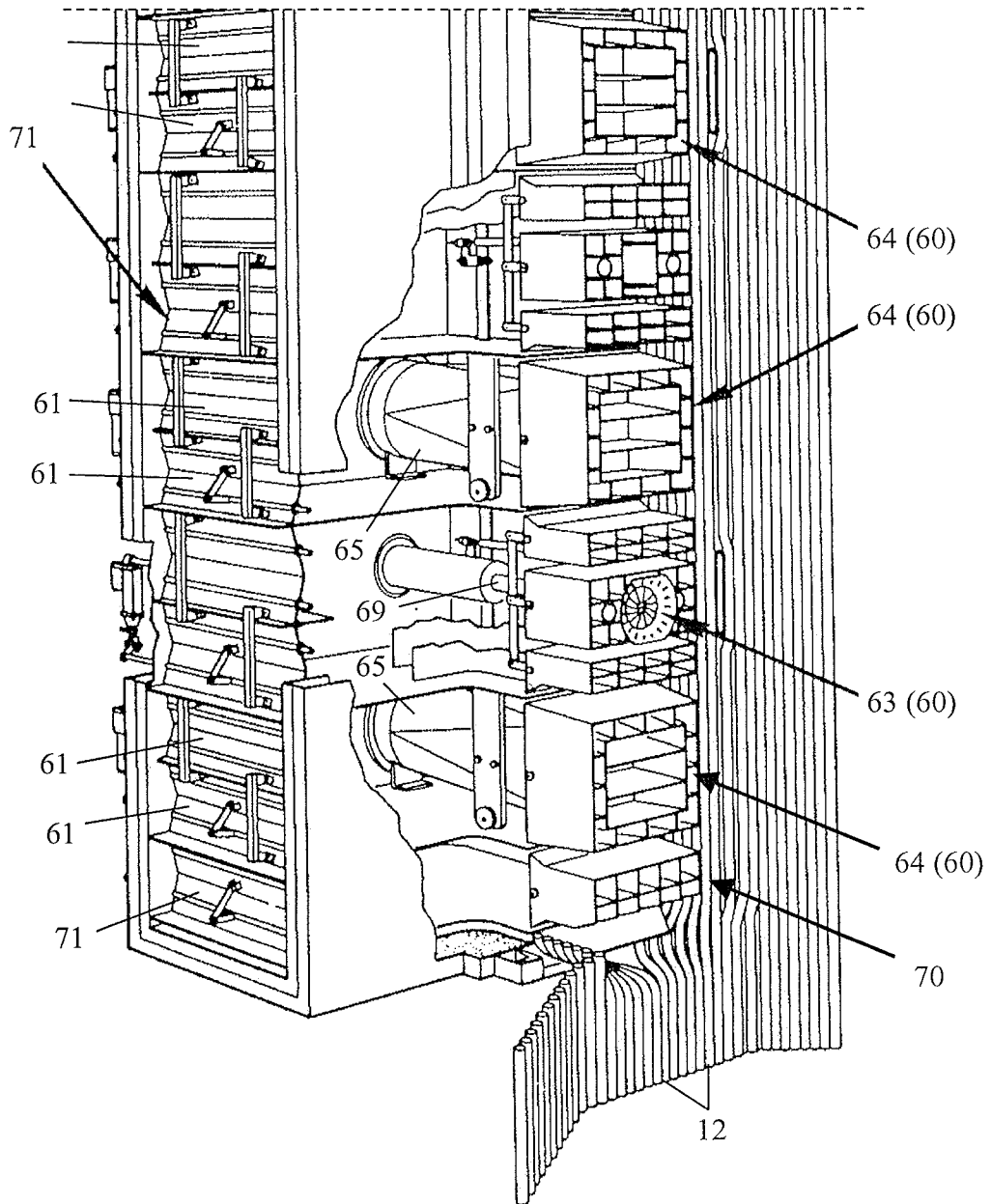


Fig. 2

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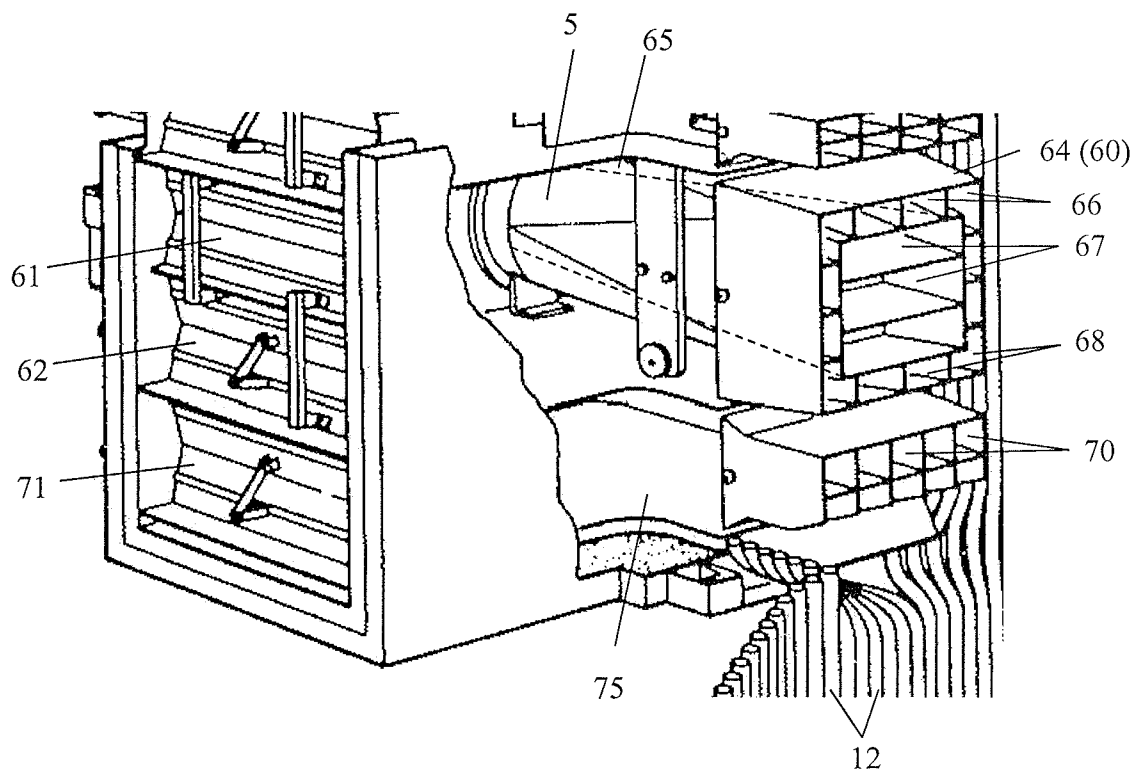
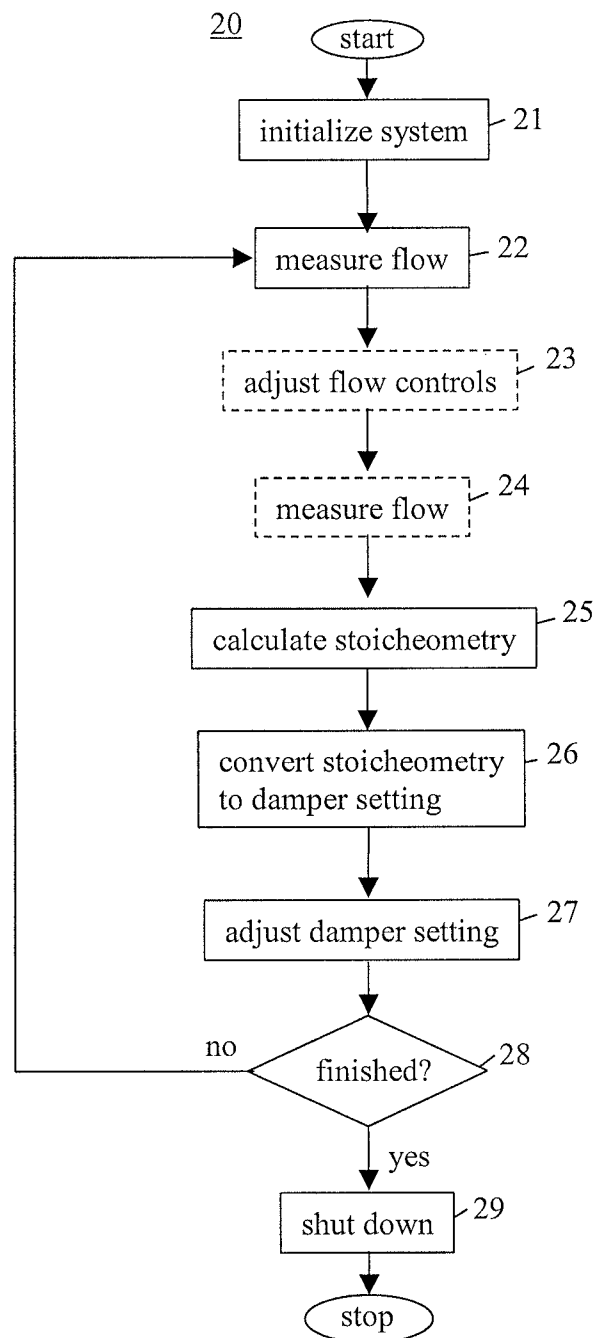


Fig. 3

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*Fig. 4*

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/029889

A. CLASSIFICATION OF SUBJECT MATTER

INV. F23K3/02 F23N3/00 F23N5/18
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F23K F23N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2008/133051 A1 (BABCOCK HITACHI KK [JP]; OHYATSU NORIYUKI [JP]; YOSHIZAKO HIDEHISA [JP] 6 November 2008 (2008-11-06) paragraph [0084] - paragraph [0097]; figures 1-5 & EP 2 143 997 A1 (BABCOCK HITACHI KK [JP]) 13 January 2010 (2010-01-13)	1-17
Y	US 7 330 797 B2 (BAILEY TIMOTHY J [US] ET AL) 12 February 2008 (2008-02-12) cited in the application column 4, line 52 - column 18, line 67; figures 1-15 ----- -/--	1-17

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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Date of the actual completion of the international search

2 June 2010

Date of mailing of the international search report

23/06/2010

Name and mailing address of the ISA/

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Theis, Gilbert

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2010/029889

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 7 322 245 B2 (GYSLING DANIEL L [US] ET AL) 29 January 2008 (2008-01-29) cited in the application column 6, line 13 - column 26, line 10; figures 1-41 -----	1-17
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A	US 5 048 761 A (KIM RAYMOND K [US]) 17 September 1991 (1991-09-17) column 3, line 21 - column 4, line 46; figures 1,2 -----	1,11

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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