FLUE HAVING AN ADJUSTABLE FLUE GAS FLOW UNIT

Known chimneys or chimney furnaces use flue gas flow units for heating buildings, said devices having displaceable or fixed obstacles for deflecting flue gas for generating flue gas turbulence. The invention relates to a device and method for transferring heat through a flue gas discharge pipe in which pivotal guide plates are inserted in the longitudinal direction of the pipe run, at which the flue gas flow is more or less deflected in a sinusoidal line as function of the pivot angle of the guide plates that can be adjusted during furnace operation. A fan can increase the flue gas flow. An optional furnace heat exchanger generates additional hot water as needed. The controller activates the actuators for the fan, guide plate pivot angle setting, and at least one circulating pump as a function of the prescribed controlled variables such as flue gas temperature, reservoir temperature, heat exchanger performance, or flue gas flow.
Fig. 7
Output comparison pipe jacket heat exchanger with/without flue gas deflection and ventilation

- Measurement series 2: Guide plate angle 90° without ventilation
- Measurement series 1: Guide plate angle 45° with ventilation

Fig. 9

Measuring values 3 min time cycle

Output in watt

1800 1600 1400 1200 1000 800 600 400 200
0
FLUE HAVING AN ADJUSTABLE FLUE GAS FLOW UNIT

CROSS-REFERENCE TO RELATED APPLICATION


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to an apparatus and a method for supplying heat by means of a furnace heat source, which deflects the flue gases in an alternating manner via a guide plate system arranged in the flue and adjustable during operation, and which utilizes the thermal energy in a more efficient manner.

[0004] The heat exchanger, optionally preferably mounted in the interior of a flue gas discharge pipe, operates in conjunction with the guide plate system and feeds the thermal energy to a hot water system.

[0005] Thermal energy storage of the parallel heat generators is performed by using a heat accumulator, for example for heating buildings and/or for producing hot water from drinking water.

[0006] 2. Description of the Prior Art

[0007] Known chimneys or chimney furnaces use flue gas flow devices for heating buildings, said devices having displaceable or fixed obstacles for deflecting flue gas for generating flue gas turbulences.

[0008] Pivotable insert elements for hot gas flues are known which, for reasons of easy cleaning, are designed to be loose and removable in order to reduce the cross-section (see DE 1899898U1: Page 1, paragraph 1; page 2, paragraphs 3 and 4 as well as angular positions of FIGS. 1 and 2).

[0009] Furthermore, flue gas guide inserts are known, which are movably-adjusted once with a tool during start-up by a specialist technician at a determined, fixed position in accordance with the respectively desired operating conditions based on practical tests on site (see DE 9216274U1 page 4, paragraph 1 as well as FIG. 2 by means of nut 12). The rectangular guide plate sections are tightly screwed or welded to one another and rest on one side against the flue gas pipe wall (page 6, paragraph 2) or consist of a metal strip (page 10, paragraph 3).

Presentation of the Technical Problem and Means for the Technical Solution Thereof

[0010] The known immovable or movable flue gas flow devices are not variably adjustable while the furnace heats up or in the course of the ongoing combustion process.

[0011] The flue gas flow devices are either suspended connectionless in the flue gas pipe, without any adjusting device being accessible from outside, or are to be adjusted by technical specialists by means of internal screw connections for an application during start-up in order to take into account the desired operating conditions.

[0012] Manual setting by the operator or automatic setting via a control system is not provided.

[0013] The known movable flue gas flow devices do not use a flue gas pipe heat exchanger and are thus not in a position to withdraw additional thermal energy from the flue gas pipe and to feed it to another parallel heat circuit.

BRIEF SUMMARY OF THE INVENTION

[0014] In view of the foregoing disadvantages inherent in the known types of movable flue gas flow devices now present in the prior art, the present invention provides an improved flue having an adjustable flue gas flow unit, and overcomes the above-mentioned disadvantages and drawbacks of the prior art. As such, the general purpose of the present invention, which will be described subsequently in greater detail, is to provide a new and improved flue having an adjustable flue gas flow unit and method which has all of the advantages of the prior art mentioned herefore and many novel features that result in a flue having an adjustable flue gas flow unit which is not anticipated, rendered obvious, suggested, or even implied by the prior art, either alone or in any combination thereof.

[0015] The apparatus according to the invention and the method associated therewith allow a variable setting of the flue gas flow during furnace operation or while the furnace is heating up.

[0016] The flue gas flow is set by a plurality of guide plates, pivotal about their own central axes, which guide plates are arranged spatially one behind the other in the flue gas pipe in the longitudinal direction and which are deflected from guide plate to guide plate as a function of the alternating pivot angles. The deflection occurs to a greater or lesser extent in a pronounced meandering pattern, depending on the setting of the angular position of the guide plates. The maximum deflection occurs over the entire flue gas cross-section.

[0017] The generation of the meandering deflection of the flue gases by the required alternating pivotal guide plates is preferably brought about in that, for a mechanical connection of the rotary levers, a connecting rod is provided at the respectively opposite pivot points of the rotary levers, which, interconnected in this way, allows a synchronous guide plate adjustment, but in an opposite angle sense from one guide plate to the next.

[0018] A heat exchanger, impinging by an all-enveloping flow of flue gas, which is likewise arranged in the longitudinal direction of the flue gas pipe between the pivotal guide plates and the inner pipe wall of the flue gas discharge pipe, transmits the thermal energy to a hot water system, increases the turbulent flow and, due to the integration within the flue gas discharge pipe, has a large heat exchanger surface.

[0019] For accommodating the pivotal guide plates, the pipe heat exchanger includes a spatially free, gaseous flow chamber, inside which the guide plates, arranged in succession, can be pivoted.

[0020] An electrically-driven fan is used for increasing the flue gas flow or for regulating the oxygen supply, preferably in the fresh air region, in conjunction with the pivotal guide plates and their flow-inhibiting action.

[0021] The activation of the fan takes place as a function of the desired heat output of the flue heat exchanger and/or the
desired flow velocity in the flue gas pipe and/or the temperature in or on the flue gas pipe by way of the control system or by way of manual operation.

[0022] The inventive benefit allows a variable adjustability of combustion as a function of the respectively prevailing operating conditions. As a result thereof, the oxygen supply by ventilation, on the one hand, is utilized as a control variable and the flue gas flow, on the other hand, becomes to a greater or lesser extent turbulent or is inhibited, so that higher temperatures occur in the combustion chamber as a result of the longer residence time of the flue gases.

[0023] In the liquid flow chamber serving to transfer heat to the heat accumulator, each parallel heating circuit disposes of its own actuator which can be activated and adjusted independently of the control system and which consists preferably of a circulation pump.

[0024] By means of the flow rate limiter associated with each heating circuit, the media circuit resistances and/or the media flow rates can be adjusted separately for each heating circuit, either manually or automatically.

[0025] The use of heat carrier liquids, water or solar liquid, is provided for the liquid media region in the flue heat exchanger and the other parallel heating circuits.

[0026] There has thus been outlined, rather broadly, the more important features of the invention in order that the detailed description thereof that follows may be better understood and in order that the present contribution to the art may be better appreciated.

[0027] Numerous objects, features and advantages of the present invention will be readily apparent to those of ordinary skill in the art upon a reading of the following detailed description of presently preferred, but nonetheless illustrative, embodiments of the present invention when taken in conjunction with the accompanying drawings. In this respect, before explaining the current embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of descriptions and should not be regarded as limiting.

[0028] As such, those skilled in the art will appreciate that the conception, upon which this disclosure is based, may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

[0029] It is therefore an object of the present invention to provide a new and improved flue having an adjustable flue gas flow unit that has all of the advantages of the prior art movable flue gas flow devices and none of the disadvantages.

[0030] It is another object of the present invention to provide a new and improved flue having an adjustable flue gas flow unit that may be easily and efficiently manufactured and marketed.

[0031] An even further object of the present invention is to provide a new and improved flue having an adjustable flue gas flow unit that has a low cost of manufacture with regard to both materials and labor, and which accordingly is then susceptible of low prices of sale to the consuming public, thereby making such flue having an adjustable flue gas flow unit economically available to the buying public.

[0032] Still another object of the present invention is to provide a new flue having an adjustable flue gas flow unit that provides in the apparatuses and methods of the prior art some of the advantages thereof, while simultaneously overcoming some of the disadvantages normally associated therewith.

[0033] These together with other objects of the invention, along with the various features of novelty that characterize the invention, are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and the specific objects attained by its use, reference should be made to the accompanying drawings and descriptive matter in which there are illustrated embodiments of the invention.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0034] The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

[0035] FIG. 1: Integrated flue heat exchanger with adjustable flue gas flow device serving as heat generator coupled in parallel.

[0036] FIG. 2: Pivotal guide plates, including the mechanical connecting elements for synchronous angle setting of the guide plates.

[0037] FIG. 3: Sectional drawings through the flue gas discharge pipe at 0° and 90° angle settings of the guide plates.

[0038] FIG. 4: Flue heat exchanger, designed with an internally-inserted coiled pipe.

[0039] FIG. 5: Representation by way of example of the effect on the flue gas flow caused by the guide plates.

[0040] FIG. 6: Flue heat exchanger, designed with internally-inserted water jacket heat exchanger.

[0041] FIG. 7: Tubular rod heat exchanger with feed flow and return flow hollow ring.

[0042] FIG. 8: Tubular rod heat exchanger with 180° loop-shaped pipe bends.

[0043] FIG. 9: Output comparison pipe jacket heat exchanger with/without flue gas deflection and ventilation.

[0044] FIG. 10: Output control with control variable ‘fan’.

[0045] FIG. 11: A side plane view of an alternate embodiment of the adjustable flue gas flow device, including upper and lower support collars, first and second connecting rods, and an intermediate connecting rod.

[0046] FIG. 12: A front plane view of the alternate embodiment adjustable flue gas flow device.

[0047] FIG. 13: A cross-sectional view of the alternate embodiment adjustable flue gas flow device taken along line 13-13 in FIG. 12.

[0048] FIG. 14: A cross-sectional view of the alternate embodiment adjustable flue gas flow device with the guide plates at a 90° setting.

[0049] FIG. 15: A perspective view of an alternate embodiment adjustable flue gas flow device including a bimetal adjustment spring and pre-adjustment holes.

[0050] FIG. 16: A front side plane view of each of the support members including pre-adjustment holes, rotational limiter holes, and a bimetal pre-adjustment spring.
FIG. 17: A partial cross-sectional view of the support members including pre-adjustment holes, rotational limiter holes, and a bimetal pre-adjustment spring.

The same reference numerals refer to the same parts throughout the various figures.

DETAILED DESCRIPTION OF THE INVENTION

(sic) Types of Heating Circuits

Referring now to the drawings, and particularly to FIGS. 1-17, an embodiment of the flue having an adjustable flue gas flow unit of the present invention is shown and generally designated by the reference numeral 10.

A thermal solar installation, supplemented by a chimney furnace installation coupled in parallel, serves as an example of an embodiment for heat transfer for the purpose of heating and hot water generation. It concerns the use of two discontinuously-operating heat sources. Neither the solar plant (1), nor the chimney furnace installation (2), is energetically permanently available or operating continuously. Only with sufficient availability are they used additionally as a supplement to a continuously-operating heat source, the basic system. In contrast thereto, the basic system, also referred to as primary system, is permanently available, operates completely autonomously, such that the parallel heating circuits reduce the energy requirement of the basic system in the embodiment.

Embodiment types are possible which use the chimney furnace installation (2) as the basic system.

In the embodiment exemplified, the solar installation serves as the heat source for the parallel heating circuit 1 (1) while the chimney furnace installation serves as the furnace heat source for the parallel heating circuit 2 (2). The heating circuits, coupled in parallel, supply a heat exchanger (4), which supplies the hot water storage means or the heat accumulator (3) with thermal energy. The heat accumulator (3) is used both for hot water generation as well as for supporting the heating system. FIG. 1 shows the overall arrangement of the heating circuits (1, 2), coupled in parallel, including the components and functions relevant to the invention. The representation of the components of the real plant, serving for plant safety and operational maintenance, was dispensed with. Both for the solar plant as well as for the expansion of the chimney furnace installation, the following components were used additionally, but are not shown:

- 2 mechanical temperature display devices
- Mechanical pressure gauge for pressure display
- Hand-operated shut-off valves
- Overflow valve with blow-off system in the event of excessive pressure
- Connection for an excess pressure storage means
- Excess pressure storage means
- Filling pump

The vent valve (30) is mounted at the highest point of the heating circuit (2), either in the inner or the outer region of the flue heat exchanger (29). The required values of the hysteresis for safe switching on and off of the respective actuators are not mentioned in the description of the embodiment and in the patent claims, but form part of the practical execution of real-world applications.


In the embodiment exemplified, the heat transfer from the chimney furnace installation is performed via a flue heat exchanger (29), which exploits the flue gases (22) of the furnace heat source (2) due to its hollow body design and the integrated installation in the flue gas discharge pipe (28) both in the interior gaseous media chamber (44) as well as in the exterior gaseous media chamber (45) of the flue heat exchanger (29). In the inner hollow body section (44), preferably 6 pivotal guide plates (37) are arranged spatially one behind the other in the longitudinal direction of the flue gas pipe (28) in such a manner that the flue gases (22) flowing therethrough are forcibly guided and deflected. Depending on the pivot angle setting (24) of the guide plates (37), a deflection of the flue gas flow (22) takes place to a greater or lesser extent. The angle setting (24) of the pivotal guide plates (37) is performed by actuating an associated rotary lever (35 or 36) about the shaft axis of the guide plates (37) in an effective angular range from 0° to 90°, so that the effective area cross-section increases with ascending degrees of the angle (24) for an impeded flue gas flow (22). The radial pivoting process of the guide plates (37), with increasing pivot angles (24) from position 0° towards 90°, results in an increasing cross-sectional area for the effective flue gas flow in the inner gaseous flow chamber (44). In the reverse direction, decreasing pivot angles (24) bring about smaller cross-section areas, which forcibly deflect and inhibit the flue gas flow (22), so that with decreasing pivot angles (24) of the guide plates a stronger, turbulent flow within the entire gaseous media chamber (44 and 45) occurs as shown schematically in FIG. 5. The turbulent flue gas flow creates higher friction in the entire gaseous flue heat exchanger region (44, 45), clearly improving the efficiency of heat transfer.

The guide plates (37) used in the embodiment exemplified according to FIG. 2 are mechanically interconnected for specific and mutual adjustability.

A first mechanical connection is brought about by a pivoting lever rod (1) (41), as shown in FIG. 2, which interconnects three pivotal guide plates (37) in such a manner that by actuating the rotary lever 1 (35) identical pivot angles (24) come about as a result of the synchronous motion sequence of these mechanically-interconnected guide plates (37). For this purpose, each second guide plate (37) to be connected, starting with the 1.sup.st guide plate, followed by the 3.sup.rd guide plate and ending with the 5.sup.th guide plate in the longitudinal direction of the flue gas discharge pipe (28), requires, in each case, one mechanical hinge with a pivot point (38) per guide plate (37), the said hinge being mechanically connected to the pivoting lever rod (1) (41).

A second mechanical connection is brought about by a further pivoting lever rod (2) (42), as shown in FIG. 2, which interconnects three pivotal guide plates (37) in such a manner that by actuating the rotary lever 2 (36) identical pivot angles (24) come about as a result of the synchronous motion sequence of these mechanically-interconnected guide plates (37). For this purpose, each second guide plate (37) to be connected, starting with the 2.sup.nd guide plate, followed by the 4.sup.th guide plate and ending with the 6.sup.th guide plate in the longitudinal direction of the flue gas discharge pipe (28), requires, in each case, one mechanical hinge with a pivot point (38) per guide plate (37), the said hinge being mechanically connected to the pivoting lever rod (2) (42).
The two pivoting lever rods (41, 42) are arranged spatially opposite one another on the right side and the left side in the outer region of the guide plates (37) in relation to their axis of rotation, as shown in FIG. 2. The corresponding representation in FIG. 3 shows in section A, at the angular position 0° of the guide plates, the hinges (38) of two guide plates (37) mounted on the right and the left side with a connection, preferably brought about mechanically, of the pivoting lever rod 1 (41) and the pivoting lever rod 2 (42) to the hinges (38). The angle setting of 0° (39) of the guide plates shows a virtually completely open flue gas pipe cross-section. Section A at an angle setting of 90° (40) of the guide plates, according to FIG. 3, on the other hand, shows a virtually completely closed flue gas pipe cross-section.

By means of a connecting rod (43), mechanically interconnecting the two rotary levers (35 and 36) in diagonally rotatable fashion, an opposite, but synchronous direction of motion of the two pivoting lever rods 1 and 2 (41, 42) is attained. This results in identical pivot angle (24) values with a reversed angular orientation from one guide plate (37) to the next. The synchronous pivot angle setting of the guide plates (37) results in a virtually identical flow distribution in the direction of the media flow, even for varying pivot angles (24), when viewed in the longitudinal direction of the flue gas flow (22). The mechanical coupling by mechanical connecting elements (41, 42 and 43) results in a maximum pivot angle range of approximately -90° to +90°.

Since the angle setting of the guide plates of -90° or 90°, as shown in FIG. 3, represents the greatest possible area cross-section in relation to the flue gas flow, this angle setting (24) is particularly suited for cleaning the flue heat exchanger elements and is furthermore a favorable angle setting for the heating-up process of the furnace system (47).

Embodiment Types of the Flue Heat Exchangers

The flue heat exchanger (29) used in the embodiment exemplified, consists of a plurality of tubular steel rods, which are interconnected by using a plurality of 180° pipe bends, as shown in FIG. 8. The arrangement is impinged by the enveloping flow of the gaseous heat carrier medium, similarly to what is shown in FIG. 5. The spatial arrangement of the tubular rods as well as the pipe bends associated with it is done in a loop pattern so that a hollow body of round shape is obtained inside the flue gas pipe (28). The hollow body offers the space required for accommodating the pivotal guide plates (37) and is provided with the return flow connecting sleeve (27) at the beginning of the pipe. The supply flow connecting sleeve (26) is provided at the opposite end of the pipe. The liquid heat carrier medium required for heat transfer is fed to the flue heat exchanger via the connecting sleeves (27, 26). The pipe loop of FIG. 8, provided inside the flue gas pipe (28), is impinged by the enveloping flow of the flue gases, so that a larger heat exchanger surface is obtained for the heat transfer. The enlarged heat exchanger surface allows optimum heat transfer from the gaseous into the liquid heat exchanger media region.

Type of Embodiment for Flue Heat Exchanger

Having a Helically-Designed Coiled Pipe

The integrated flue heat exchanger (29), as a further effective embodiment type, may be formed by a coiled pipe (52) of circular shape, as shown in FIG. 4. The spatial arrangement of the pipe formed from loop to loop is brought about preferably by a sufficiently large air gap of preferably at least 5 mm, such that inside the flue gas discharge pipe a hollow body of round shape is obtained. The hollow body offers the space required for accommodating the pivotal guide plates (37) and is provided with the return flow connecting sleeve (27) at the beginning of the pipe. The supply flow connecting sleeve (26) is provided at the opposite end of the pipe. The liquid heat carrier medium required for heat transfer is fed to the flue heat exchanger via the connecting sleeves (27, 26).

Embodiment Type of Tubular Rod Heat Exchanger with Feed Flow and Return Flow Hollow Ring

In addition, an embodiment of a heat exchanger designed by way of two hollow rings, as shown in FIG. 7, is provided for connecting the tubular rods, in which case the connecting sleeve is provided on the first hollow ring for the feed flow (26) while the connecting sleeve for the return flow (27) is provided on the second hollow ring. The heat exchanger is designed as a hollow body with integrated guide plates (37), through whose inner surface area (44) and outer surface area (45) the flue gas flows as well.

Embodiment Type of Liquid Jacket Heat Exchanger

A further embodiment type of flue heat exchangers (29) is provided, possessing a liquid jacket (51) between two jacketing pipes arranged inside the flue gas discharge pipe (28), through which jacketing pipes the heat carrier liquid flows, and wherein an air gap for flue gas guiding (45) exists between the outer jacketing pipe surface and the inner surface of the flue gas discharge pipe. The heat exchanger is likewise designed as a hollow body with integrated guide plates (37), through the inner surface region (44) of which the flue gas (22) flows as well. FIG. 6 shows the liquid jacket heat exchanger (50).

Fastening of the Flue Heat Exchangers

Mechanical fastening of the flue heat exchanger (29) to the flue gas discharge pipe (28) is performed preferably at the bushings of the connecting sleeves (26, 27), which are passed through two bores, which are located in the outer sheet (46) of the flue gas discharge pipe (28). The connecting sleeves (26 and 27) are fastened over the entire sleeve circumference, in particular for fastening to the outer sheet of the flue gas discharge pipe.

Mechanical Connections of the Heat Exchanger Components

The mechanical attachment of the feed flow and return flow connecting sleeves, of the tubular rods on the pipe bends or hollow rings, as shown in FIGS. 4, 6, 7, and 8, is performed preferably by welding or hard-soldering connections.

Cleaning of Flue Heat Exchangers and Guide Plates

In the embodiment exemplified in FIG. 2, the flue gas discharge pipe (28), in the region of the 90° angle bend, has an extensive cleaning aperture (23), through which the surfaces of the guide plates (24) [sic], the inner surface of the flue gas discharge pipe (28) and the interior of the outer sheet
can be cleaned manually with a cleaning brush. The soot is removed by moving the cleaning brush in and out within the scope of the cleaning intervals required. The cleaning brush is provided with a handle, which can preferably be adjusted stepwise or continuously with regard to its length, such that between the cleaning aperture and the room ceiling a sufficiently large free space exists in order to use the cleaning brush over the entire inner surface area from the cleaning aperture to the furnace (47). The removable lid for closing the cleaning aperture can preferably be detached from or fastened to the flue gas discharge pipe by means of a screw connection.

Textured Surfaces Generate Additional Turbulences

Using textured or rough metal surfaces for the flue gas discharge pipe (28), the flue heat exchanger (29) and the pivotal guide plates (37), generates higher friction of the flue gas flow (22) during transport of the media in the gaseous flow chamber as well as on the media transfer surfaces and improves the heat transfer from the gaseous to the liquid medium, even at low flow rates. Textured surfaces thereby increase the efficiency of the flue heat exchanger (29). The higher friction is caused by turbulences, which, in turn, arises from very diverse internal flue gas flow directions and vortexing thereof. Metal surfaces which consist of tear-drop shaped sheets or honeycomb sheets are particularly suitable.

Ventilation for Enhancing the Flue Gas Flow

An electrically-driven fan (19) is used for enhancing the flue gas flow (22) or, respectively, the regulation thereof, in conjunction with the pivotal guide plates (37) and their flow-inhibiting action. The fan is designed as a pipe fan. The use in the supply air region of the furnace (47), in which the fan (19) presses the supply air, necessary for combustion, into the combustion chamber, is useful as an inexpensive and efficient solution, provided the furnace (47) is equipped with a separate connection for the admission of supply air. Prior to opening the furnace door, the fan (19) is switched off automatically by the control system (5) or manually during the heating-up process, such that, as a result of possible excessive air pressure, no flue gas or dirt particles can escape from the furnace chamber.

Fan in Automatic Mode, Pivot Angle Setting of the Guide Plates by Hand

In the embodiment exemplified, switching-on or switching-off the fan (19) is done automatically by a control and regulating unit (5), which is referred to as control system (5). Switching the fan (19) on and off is performed as a function of the currently prevailing flue heat exchanger temperature (9). The pivotal guide plates (37) are automatically brought into an optimal operating position by the control system and are pivoted, when required, into a firing-up or cleaning position.

Fan Speed and Pivot Angle Setting in Firing-Up Mode

In practice, it has proved advantageous that during firing up the furnace in the cold state, the optimum pivot angle (24) of the guide plates (37) is to be set at approximately 90° while the fan speed should be in the upper range of the desired value, so that the combustion process is performed as rapidly as possible and with low smoke formation. In this context, the adjustable fan speed promotes a reduction of the smoke formation and thus a lower environmental impact.

Optimal Pivot Angle in the Heating Mode

In practice, it has also been found to be advantageous that the angle setting (24) of the guide plates, in a fired-up furnace, is set at an optimal pivot angle of preferably about +/-45°, in order to attain an optimal combustion and combustion output. This pivotal angle represents a favorable operating position.

Use of the Fan Function as from a Minimum Temperature Limit

The fan (19) should preferably only be switched on automatically by the control system (5), if the actual temperature level (9) in the spatial region of the measuring pocket (25) exceeds an application-dependent, measurable or calculated minimum furnace heat exchanger temperature, in particular 50° C. Below this temperature threshold the flue heat exchanger (29) does not supply sufficiently usable thermal energy. The calculated switch-on temperature results from the heat storage temperature (7), plus a temperature hysteresis, which can be specified to be constant, or, preferably, as a variable parameter.

By means of ventilation (19) the basis is established that, in combination with the use of the integrated pivotal guide plates (37), a specific setting of the flue gas flow velocity (22), the resulting combustion performance of the furnace (47) and the flue heat exchanger (29) is attained. This optimizes the efficiency of the flue heat exchanger (29) on the basis of a favorable, plant-specific performance range, as the combustion output is kept constant within specific limits by way of the adjustable flue gas flow velocity (22), maximally, however, for as long as the required fuel is present in the combustion chamber or is refilled in time due to advanced burn-up.

Automatic Control of the Flue Heat Exchanger Output with the Control Variable ‘Fan Speed’

In the embodiment example, the rotational speed variable for the fan (19), depending on the desired flue heat exchanger output, as shown by way of example in FIG. 10, is performed in a stepwise manner. The fan (19), automatically actuated by the control system (5), is adjusted as a function of the control deviation of the flue heat exchanger output predetermined as the desired value and calculated from the actual output value. The control system operates such that the rotational speed variable is increased, if the heat exchanger output is too low and that, conversely, the rotational speed variable is reduced accordingly, if the heat exchanger output is too high.

Fan Actuation in Manual Mode or Combined with Automatic Operation

In a further embodiment type, the fan can be actuated in manual mode by a speed which can be adjusted stepwise or continuously. Activation of the fan (19) with constant rotational speed or a variable rotational speed setting is in this case done on the basis of the experience gained by the operator. Similarly, the execution modes ‘manual’ or ‘automatic operation’ may be selected manually, if required, and combined as a result thereof. Manual operation may be useful, if one wishes to avoid the higher costs of a control system, or if
the actuator efficiencies of automatic regulation are not met. The situation may arise, if, for example, too much or too little fuel was fed, or if the furnace door is opened during furnace operation, whereby the control system cannot work optimally.

Further Embodiment Types and Installation Sites of Ventilation

[0088] Lateral installation on the flue section or in the chimney region as injector-fan (19) seems useful, as in this case the fan (19) presses additional air into the flue gas discharge region, thereby entraining the flue gas from the furnace (47).

[0089] The installation in the flue gas discharge pipe, preferably as far away as possible from the firing chamber, because of the lower temperatures, is likewise possible.

[0090] The fan (19) may furthermore be fitted on the chimney as a chimney crest fan.

Further Embodiment Types of the Flue Heat Exchanger Control Systems and Combinations Thereof

Controlling the Flow Rate with the Control Variable ‘Fan Speed’

[0091] In embodiment types that require a defined flow rate, preferably the execution mode with the control variable ‘fan speed’ should be selected. A possible application in combination with a device for reducing soot particles in furnaces seems useful. These may require ventilation in relation to an adjustable flue gas flow and thus provide a useful combination possibility of soot particle filtration using the ventilation according to the invention. Automatic activation of the fan (19) is performed by the control system (5) as a function of the desired flow velocity (22) in the flue gas pipe (28). In this context as well, a variable fan speed is used as the control variable at the control system output. This control variable is obtained as a function of the control deviation, determined as the desired variable, minus the control deviation calculated from the actual flow rate of the flue gas flow velocity (22) in the flue heat exchanger (29). The control system intervenes in such a manner that the desired rotational speed value serving as the control variable is increased, if the flow gas flow velocity is too low and that, on the other hand, the desired rotational speed value is reduced accordingly if the flow gas flow velocity is too high. Controlling the fan speed without a closed-loop control circuit of the flow velocity, in particular without actual flow value collection, is likewise possible for reasons of simplicity.

Control of Flue Gas Temperature with the Control Variable ‘Fan Speed’ and/or ‘Angular Position of the Guide Plates’

[0092] For embodiment types requiring a specific or minimum flue gas temperature (9), the control variable ‘fan speed’ and/or “angular position of the guide plates” can likewise be applied. A possible application may arise, if the temperature at the chimney crest may not fall below a minimum chimney temperature of preferably 55°C, in order to avoid undesirable sooting of the chimney. Automatic activation of the fan (19) is performed by the control system (5) as a function of the desired flue gas temperature (9) measured in the flue gas pipe (28) or measured outside on the flue gas pipe as the flue gas pipe temperature (9). The determination of the control variable is obtained as a function of the temperature predetermined as the desired value, minus the control deviation determined from the actual temperature level (9). The control system intervenes in such a manner that the desired rotational speed value serving as the control variable is increased continuously or stepwise, if the temperature is too low and that, conversely, the desired rotational speed value is reduced accordingly, if the temperature is too high. The control variable ‘angular position (24)’ of the guide plates’ acts such that the angle settings (24) of the guide plates are to be increased continuously or stepwise, if flue gas temperatures (9) are too low, in order to increase the flue gas flow (22) and that, conversely, the angle settings (24) of the guide plates are to be reduced, if the flue gas temperatures (9) are too high. Both control variables thus complement each other in terms of their desired effect and can be combined.

Controlling the Flow Velocity with the Control Variable ‘Pivot Angle of the Guiding Plates’

[0093] If no rotational speed control or adjustment of the fan speed is possible in ventilation applications, an automatic pivot angle setting of the guide plates can be used. The automatic pivot angle setting (24) of the guide plates is performed by the control system (5), which adjusts a servo drive means (58) in terms of the position of its angle of rotation. In this case, the servo drive means (58) with its shaft outlet is mechanically connected (57) to one of the guide plate shafts on the rotary lever 1 or rotary lever 2 in such a manner that the current position of its angle of rotation determines the pivot angles of the guide plates. The angle setting is performed as a function of the control deviation predetermined as the desired flow value and minus the control deviation determined from the actual flow value of the flue gas flow velocity (22) in the flue heat exchanger (29) such that the guide plate angle (24) serving as the control variable is increased, if the flue gas flow velocity (22) is too low and that, conversely, the guide plate angle (24) is reduced accordingly, if the flue gas flow velocity is too high.

Control of the Flue Heat Exchanger Output with the Control Variable ‘Pivot Angle of the Guide Plates’

[0094] If no rotational speed control or adjustment of the fan speed is possible in ventilation applications, an automatic pivot angle setting of the guide plates can be used. The automatic pivot angle setting (24) of the guide plates is performed by the control system (5), which adjusts a servo drive means (58) in terms of the position of its angle of rotation. In this case, the servo drive means (58) with its shaft outlet is mechanically connected (57) to one of the guide plate shafts on the rotary lever 1 or rotary lever 2 in such a manner that the current position of its angle of rotation determines the pivot angles of the guide plates. The angle setting is performed as a function of the control deviation predetermined as the desired output value and minus the control deviation determined from the actual output value of the flue heat exchanger output such that the guide plate angle (24) serving as the control variable is increased, if the heat exchanger output is too low and that, conversely, it is reduced accordingly, if the heat exchanger output is too high.
Control of the Flue Heat Exchanger Output or the Flow Velocity with the Control Variable ‘Fan Speed’ and a Speed-Correcting Value Derived from the Current Pivot Angle Position of the Guide Plates

To increase the control precision in the control of the flue heat exchanger output or the flow velocity with the control variable ‘fan speed’ a speed correction value is preferably added to the speed control variable or is multiplied as a factor which is determined as a function of the current angular position (24) of the guide plates. The determination of this correction factor can be calculated by using a mathematical formula, or may be determined on the basis of experience gained, or which results from an empirical function and is listed in a table.

Coupling of Heat Circuits in Parallel According to FIG. 1

The embodiment exemplified connects the solar heating circuit (1) by coupling in parallel to the furnace heating circuit (2) by using solar liquid as the heat carrier. Since the current thermal output to be utilized of both equal heat sources should be as high as possible, both heating circuits can be activated simultaneously, provided sufficient thermal energy is available in each case. Each heating circuit (1, 2) has its own circulation pump (10, 11). The parallel heating circuits can thus be activated by the control system (5) independently of one another. Stepwise variable pump speeds can be set for the circulation pumps (10, 11) by manual adjustment during start-up.

The heating circuit coupling in parallel for heat transfer into a heat accumulator (3) is performed in the embodiment exemplified by a heat exchanger (4) via independently-controlled media flows (14, 15 and 31). The control logic and the hydraulic system structure form a co-acting functional unit.

In addition, the media circuit resistances or media flow rates (14, 15) can be adjusted separately for each heating circuit (1, 2) by way of adjusting the flow rate limiter (20, 21) associated with each heating circuit (1, 2). Adjusting the media circuit resistances (20, 21) is likewise performed by manual adjustment during start-up.

Switching on and off of the actuators of the circulation pump (10) and the circulation pump (11) is performed in a temperature-dependent manner by means of the control system (5), which emits a signal (17) for activating the circulation pump (10) as well as signal (18) for activating the circulation pump (11). The control system (5) activates the actuators of the parallel heating circuits as a function of the media temperatures of the heat sources (8, 9) and the media temperature in the heat accumulator (7).

In this context, especially the following 4 operating modes are provided:

Disabling heating circuits 1 and 2
Activating heating circuit 1
Activating heating circuit 2
Activating heating circuits 1 and 2

If only one heat source is activated, the check valves (12 or 13) prevent an undesired flow of media (14 and 15) between the parallel heating circuits (1 or 2).

The heating circuit (2) is activated by switching on the actuator (11) or by the control signal (19). The open check valve (13) causes the flow of the media (15) and (16). Since the check valve (12), located in the heating circuit 1 (1), is closed by the inactive actuator (10), no media flow (14) occurs.

The heating circuit (1) is active when the actuator (10) is switched on and the check valve (12) is forcibly opened by the built-up pressure of the actuator (10), thereby causing the flow of the media (14) and (16). The control system (5) activates the actuator (10) by switching on the control signal (18). Since the check valve (13), located in the heating circuit 2 (2), is closed by the inactive actuator (11), no media flow (15) occurs.

Start-Up Requirements

For safety reasons, the circulation pumps (10) and (11) are only turned on, if the maximum water temperature in the accumulator (7) is not exceeded. The measurable maximum temperature level does, in particular, not exceed 95° C.

To set the optimum operating parameters, a separate switchable, variable-speed pump (10, 11) is used for each heating circuit (1, 2), having e.g. three manually-adjustable base speeds for the media flow setting. In addition, the media circuit resistances can be set by adjusting the setting of the flow rate limiter (20, 22) associated with each heating circuit, so that, when combined, the media flow rates can be set independently from one another.

The optimum operating parameters for setting the flow rate and flow output of the parallel heating circuits during start-up were carried out on the basis of plant-specific and operational requirements. The media flows of the heating circuits (1, 2) are preferably to be set at 1.5 litres/minute, in which case the two circulation pumps (10, 11) are preferably to be set at the lowest output level at about 40 watt power consumption. The minimum output level includes also the overall lowest energy consumption for the necessary media transport for heat transfer. An optimal setting of the media flow exists, in particular, if the media flows of the heating circuits are approximately of the same order of magnitude. The flow rates of the circulation pumps should in this context likewise have approximately the same values. During operation it has been shown, in particular, that this selected setting of the media flows prevents an undesired temperature influence of the respectively switched-on heating circuit on the isochronously switched-off heating circuit.

Activation of the Heat Circuits as a Function of the Associated Actual Temperature Levels

In the embodiment exemplified, the control system (5) activates the heating circuits (1 and/or 2) on the basis of a temperature comparison between the parallel heating circuits, such that that heating circuit or those heating circuits are switched on, which has/have an actual temperature level (8 and/or 9) higher than the heat storage temperature (7). In order to implement the embodiment exemplified, it is necessary to install an actual temperature level transmitter (7) in the lower region of the heat accumulator (3) or in the local region of the heat exchanger (4).

Activation of Heating Circuit 1

The actual temperature level (8) captured in the parallel heating circuit 1 is compared to the temperature in the lower heat accumulator region (7). If the feed temperature of the parallel heating circuit 1 (8) is higher than the temperature in the lower heat accumulator region (7), the circulation pump
(10) of the parallel heating circuit 1 (1) is switched on by the control variable (17) and the heating circuit (14) and (16) is activated. If the feed temperature of the parallel heating circuit 1 (8) is lower than the temperature in the lower accumulator region (7), the circulation pump (10) of the parallel heating circuit 1 (1) is switched off by the control variable (17) and the heating circuit (14) and (16) is not active.

Activation of Heating Circuit 2

[0113] The actual temperature level (9) captured in the parallel heating circuit 2 is compared to the temperature in the lower heat accumulator region (7). If the feed temperature of the parallel heating circuit 2 (9) is higher than the temperature in the lower heat accumulator region (7), the circulation pump (11) of the parallel heating circuit 2 (2) is switched on by the control variable (18) and the heating circuit (15) and (16) is activated. If the feed temperature of the parallel heating circuit 2 (9) is lower than the temperature in the lower accumulator region (7), the circulation pump (11) of the parallel heating circuit 2 (2) is switched off by the control variable (18) and the heating circuit (15) and (16) is not active.

Simultaneous Activation of Heating Circuits 1 and 2

[0114] Both circulation pumps (10 and 11) are active simultaneously, if both actual temperature levels (8 and 9) are higher than the temperature in the lower heat accumulator region (7). In this case, both heating circuits (1 and 2) make an appreciable contribution to heat generation and the output of the heat sources (1, 2) add up. For this reason, the embodiment exemplified is suited, in particular, for coupling heating circuits, if the highest possible level of thermal output is to be attained.

[0115] Due to different applications, a plurality of embodiment types of the heating circuits coupled in parallel arise.

Embodiment Type with Activation of Only One Heat Source of the Heating Circuits 1 or 2

[0116] The heat sources 1 and 2 are used interchangeably. The heat source having a higher media temperature (8 or 9) in comparison to the media temperature in the heat accumulator (7) is used. Only one of the heating circuits (14 or 15) can be activated simultaneously in order to prevent undesired temperature transfers between the heating circuits (14 or 15). The media circuit (14 or 15), which has the higher actual temperature level (8 or 9), is activated by one of the two circulation pumps (10 or 11). This type of embodiment is suitable for applications, where heat transfer must not take place under any circumstances between the heat sources, in particular for applications, where no thermal energy, e.g. from a furnace heat source, may be transferred to solar modules, given that the solar modules are fitted externally on the roof. This type of embodiment thus totally prevents an energy balance between the heating circuits.

[0117] An essential prerequisite for the independent activation of the heating circuits (1, 2) is the installation of the circulation pumps (10 and 11), shown, including the check valves (12) and (13) in the hydraulic diagram shown in FIG. 1. The active circulation pump (10) can only open the check valve (12), while the check valve (13) remains closed in this case. The active circulation pump (11), however, can only open the check valve (13), while, in reverse, the check valve (12) remains closed in this case.

Embodiment Type of Furnace Heating Circuit as a Secondary System

[0118] In this type of embodiment, the furnace heating circuit (2) is used as a secondary system for heating and hot water generation. In this context, the heating circuit (1) forms the primary system coupled in parallel. The embodiment is suited, in particular, for coupling heating circuits, which are supplied by a continuously-available energy source (oil heating, gas heating, heat pumps, long-distance heating, etc.) of heating circuit 1 (1) as well as by a discontinuously-operating energy source (chimney oven, tiled stove, solar heating, etc.) of heating circuit 2 (2). Control (5) may be performed independently of the existing control of the primary system. For this reason, the embodiment exemplified is particularly suitable for plant expansions, wherein an additional furnace heating circuit is retrofitted, without having to adapt or modify the existing control system of the primary system. Furthermore, applications are advantageous, wherein the temperature may not fall below a specific level. Especially for heating drinking water this procedure is useful, if the temperature in a hot water accumulator is to have a temperature of preferably at least 60°C., in order to ensure the required destruction of legionella. The desired temperature level (6) constitutes the threshold of the switch-on temperature for the heat supply of the heating circuit (1). The desired temperature level may be a measurable constant or a variable value.

Activation of Heating Circuit 1 (1)

[0119] If the actual temperature level (7) is lower than the desired temperature level (6), heat supply is performed via the heating circuit 1 (1), which is activated by the control signal (17) and the actuator (10) associated therewith. This causes the media flow to be conducted by the media circuits (14) and (16). The heat supply of the basic system (1) is switched off, if the actual temperature level (7) is higher than the desired temperature level (6).

Activation of Heating Circuit 2 (2)

[0120] The actual temperature level (9) recorded at the parallel heating circuit 2 (2) is compared to the desired temperature (6). If the actual temperature level (9) is lower than the desired temperature (6), the actuator (11) of the parallel heating circuit 2 (2) is switched on by actuating the actuator (18), thus activating the heating circuit 15 and 16. The parallel heating circuit 2 is switched off at a temperature which is below the predetermined desired temperature (6). The energy contributions occurring above the desired temperature (6) are therefore taken over by the parallel heating circuit 2 (2). If the actual temperature level (7) is available to the control unit (5) for temperature comparison with the actual temperature level (9), this procedure would be more effective than tapping off at the desired temperature (6) and would thus be more advantageous in its application.

Embodiment Type of Furnace Heating Circuit as Primary System

[0121] As an alternative, the furnace heating circuit (2), serving as primary system, may be used for heating and hot water production. The heating circuit (1) constitutes in this case the secondary system, coupled in parallel. This embodiment type is suited particularly for coupling of heating circuits, which are supplied by a continuously-available furnace
heat source (tiled stove, chimney oven, pellet heating etc.) of heating circuit 2 (2) as well as by a discontinuously-operating energy source (solar heating etc.) of heating circuit 1 (1). The desired temperature level (6) constitutes the threshold of the switch-on temperature for the heat supply of the furnace heating circuit (2). The desired temperature level may be a measurable constant or a variable value.

[0122] Activation of furnace heating circuit 2 (2): If the actual temperature level (7) in the heat accumulator (3) is lower than the desired temperature level (6), heat supply is performed via the heating circuit 2 (2) which is activated by the control signal (18) and the actuator (11) associated with it. This causes the media flow to be conducted by the media circuits (15) and (16). The heat supply of the basic system (1) is switched off, if the actual temperature level (7) is higher than the desired temperature level (6).

[0123] Activation of heating circuit 1 (1): The actual temperature level (8) recorded at the parallel heating circuit 1 is compared to the desired temperature (6). If the actual temperature level (8) is higher than the desired temperature (6), the actuator (10) of the parallel heating circuit 1 (1) is switched on by actuating the actuator (17), thus activating the heating circuit (14) and (16). The parallel heating circuit 1 is switched off at a temperature which is below the predetermined desired temperature (6). The energy contributions occurring above the desired temperature (6) are therefore taken over by the parallel heating circuit 1 (1). If the actual temperature level (7) is available to the control unit (5) for temperature comparison with the actual temperature level (8), this procedure would be more effective in comparison with tapping off at the desired temperature (6) and would thus be more advantageous in its application.

ADVANTAGES OF THE INVENTION

[0124] The use of pivotal integrated guide plates, including ventilation, reduces the heat losses of the furnace with respect to thermal energy, which enters into the chimney without being utilized, as higher combustion temperatures occur in the furnace and a considerably higher exploitation of the flue gas waste heat takes place than in the known flue heat exchangers. The efficiency improvement is based on higher friction of the flue gases in the gaseous media region. The pivotal guide plates deflect the flue gas as a mechanical obstacle, thereby generating a turbulent flue gas flow, which produces the increased friction. Use of the ventilation, in conjunction with the pivotal guide plates, creates increased pressure in the flue gas pipe, increased flow velocity, stronger turbulences and, therefore, further additional friction in the gaseous media chamber, thereby increasing once again the efficiency of the entire furnace.

[0125] The increase in efficiency is demonstrated graphically in FIG. 9 by way of two output curves (55, 56), which were recorded successively in time and which are shown isochronously in relation to one another. Two test runs were carried out with, in each case, 2 kg of pine wood in a preheated chimney furnace. The wood supply was burnt up per test run in a time period of about 50 minutes and the flue heat exchanger outputs (53) occurring in the course thereof measured by sensor means (32, 33, 34) and calculated time-cyclically with the aid of the control system (5). The flue heat exchanger was arranged externally around the flue gas pipe and the fan was switched on or off manually. The data recordings for both test runs took place at a 5-minute time interval (54). The burn-off process for test run 2 was so adjusted by manually-set supply of the combustion air that it resulted in approximately the same burn-off period of the wood supply as test run 1, in order to bring about the necessary comparability of the output measurements in a defined time frame with combustion being the same. For recording the measurement series 1 (55) the fan was switched on for the entire measuring period at maximum or, respectively, constant output (20 watt), the 4 guide plates, installed in the flue heat exchanger, being set at the same guide plate angle of 45°. When recording the measurement series 2 (56), the fan was switched off and the angle setting of all guide plates was set at 90°, such that the flue gases were able to escape without being affected in the flue gas pipe. The increased output with ventilation and guide plate angle setting of 45°, under the conditions shown, minus the fan current losses, was approximately 31.5% or an about 250.5 W higher flue heat exchanger output.

[0126] In addition, the heat exchanger efficiency is significantly increased, if a larger effective heat exchanger surface from the gaseous into the liquid media space is provided, which is created, if the heat exchanger is impinged by an enveloping flow in the interior of the flue gas furnace pipe. This measure attains doubling of the heat exchanger surface, which allows to expect double the flue heat exchanger output.

[0127] A preferably textured or non-planar guide plate surface enhances the increase in efficiency, as further turbulences or vortexes arise in the gaseous media space.

[0128] The apparatus and process according to the invention are suited, in particular, for a combination with means for reducing soot particles in furnaces which require additional ventilation for adjusting a constant flue gas flow in order to optimize efficiency. The use of soot particle filters will increase significantly in future, as the installation of such filters is prescribed by law for furnace systems in Germany while observing specific deadlines.

[0129] Due to the adjustability of the flue gas volume flow by specifying a measurable or calculated desired speed value for the flue gas fan in conjunction with the adjustability of the pivotal guide plates, combustion control is possible even when using the flue gas pipe heat exchanger.

[0130] FIG. 10 shows the measurement graph of an output control using the control variable ‘fan’ in ‘On’ or ‘Off’ positions. The fan, which served to control the flue heat exchanger output, was operated constantly at maximum nominal rotational speed for this measurement series and was switched on or off when defined output limits were exceeded or not attained. The control principle worked such that the oxygen supply for the combustion process was increased, if the flue heat exchanger output was too low, and, conversely, was reduced by way of the fan function, if the output was too high. The current actual output value resulted from the current heat exchanger media flow and the temperature difference between the feed- and return flow temperature of the flue heat exchanger circuit. The recorded data reflect a testing pattern from lighting the fire, starting with measurement 1, and ending with measurement 136, with which the combustion process and the measuring value recording were systematically concluded due to a lack of firewood. The output thresholds for controlling the ventilation were determined empirically during furnace operation on the basis of installation-specific heat exchanger outputs and defined as follows:

[0131] P Min UG: 240 watt, Lower Output Threshold, including hysteresis for switching off the fan

[0132] P Min OG: 300 watt, fan switch-on power
The alternate embodiment guide plate unit (60) are arranged spatially one behind the other in the longitudinal direction of the flue gas pipe (28) in such a manner that the flue gases flowing therethrough are forcibly guided and deflected. Depending on the pivot angle setting (24) of the guide plates (37), a deflection of the flue gas flow (22) takes place to a greater or lesser extent. The angle setting (24) of the pivotal guide plates (37) is performed by actuating at least one of the guide plates (37) by way of a service drive or rotary drive means (58) about a shaft (57) axis of the guide plate in an effective angular range from 0° to 90°, so that the effective area cross-section increases with ascending degrees of the angle (24) for an unimpeded flue gas flow. The radial pivoting process of the guide plates (37), with increasing pivot angles (24) from position 0° towards 90°, results in an increasing cross-sectional area for the effective flue gas flow (22) in the inner gaseous flow chamber (44). In the reverse direction, decreasing pivot angles (24) bring about smaller cross-section areas, which forcibly deflect and inhibit the flue gas flow (22), so that with decreasing pivot angles (24) of the guide plates a stronger, turbulent flow within the entire gaseous media chamber (44 and 45) occurs as previously shown in FIG. 5. The turbulent flue gas flow creates higher friction in the entire gaseous flue heat exchanger region (44, 45), clearly improving the efficiency of heat transfer.

The alternate embodiment guide plate unit (60) is the best illustrated in FIGS. 11-14, which is received in the inner hollow body section (44). The alternate embodiment guide plate unit (60) can include multiple pivotal guide plates (37), with 4 guide plates being illustrated for exemplary purposes.
manner that by actuating the rotary lever 2 (36) identical pivot angles (24) come about as a result of the synchronous motion sequence of the mechanically-interconnected guide plates (37). The second connecting rod (72) is connected to the second side of the second and fourth guide plates (37b, 37d) by way of a mechanical hinge with a pivot point (76), with the second side being opposite the first side of the first and third guide plates (37a, 37c).

[0148] The first and second connecting rods (70, 72) are arranged spatially opposite one another on substantially the right side and the left side in the outer region of alternating guide plates (37) in relation to their axis of rotation. The corresponding representation in FIGS. 11-13 shows an angular position of 45° and −45° of the guide plates, respectively. It can be appreciated that an angle setting of 0° of the guide plates (37) shows a virtually completely closed off flue gas pipe cross-section, while an angle setting of 90°, FIG. 14, shows a virtually completely opened flue gas pipe cross-section.

[0149] The intermediate connecting rod (74) mechanically interconnects the second and third guide plates (37b, 37c) in diagonally rotatable fashion, which produces an opposite, but synchronous direction of motion of the second and third guide plates (37b, 37c). This results in identical pivot angle (24) values with a reversed angular orientation from one guide plate (37) to the next. The synchronous pivot angle setting of the guide plates (37) results in a virtually identical flow distribution in the direction of the media flow, even for varying pivot angles (24), when viewed in the longitudinal direction of the flue gas flow. The mechanical coupling by the first, second and intermediate connecting rods (70, 72, 74) results in a maximum pivot angle range (24) of the guide plates of approximately −90° to +90°.

Additional Alternate Embodiment Guide Plates

[0150] As an alternative and as best illustrated in FIGS. 15-17, the present invention may include separate driven pivoting guide plates (37) turning around their own axis, with or without any connecting rods or linkages interconnecting guide plates. The guide plates (37) may include at least one bimetal pre-adjustment spring (80) placed about the guide plate pivot pins (78) so as to provide a rotational biasing force against the guide plate (37), respectively. The bimetal pre-adjustment springs (80) are configured to function as a temperature sensor and a pivot motion actuator combined in one device.

[0151] An end (82) of the bimetal pre-adjustment spring (80) is fixedly mounted (welded or screwed or retained) to a surface of the guide plate (80) or guide plate pivot pin (78) at one side thereof. A second end (84) is received in one of four pre-adjustment holes (86) defined through each of the support members (66). The pre-adjustment holes (86) are oriented at −15°, −30°, −45° and −60° from a longitudinal axis of the support members (65), as best illustrated in FIG. 16 which shows a frontal view of both support members (66). It can be appreciated that the guide plates (37) can include notches adjacent at least one of the guide plate pivot pin (78) to accommodate any end or part of the bimetal pre-adjustment spring (80). Consequently allowing for rotation of the guide plates (37) without obstruction from the bimetal pre-adjustment spring (80).

[0152] A limiter (90) can be mounted through at least one limiter hole (88) defined through each of the support members (66). Multiple limiter holes (88) can be defined to limit rotation of the guide plate (37) at 90° and 45°. The limiter (90) extends toward and contacts a surface of the guide plate (37) to limit rotation of the guide plate. Thus it can be appreciated that the bimetal pre-adjustment spring (80) provides a rotational biasing force against the guide plate pivot limiter (88) at room temperature. The limiter (90) can be, but not limited to, a bolt, screw, fastener or pin.

[0153] The rotational biasing forces by the bimetal pre-adjustment spring (80) increase from lower to higher degrees of the selected pre-adjustments holes (86). Therefore the flue gas temperature influence for the pivoting of the guide plates (37) and the resulting deflection of the flue gas flow is much higher if the selected pre-adjustment position is lower. The bimetal pre-adjustment springs (80) work as a temperature sensor and a pivot motion actuator combined in one device.

[0154] The guide plates (37) may have to be rotated 180° to use the −15° or −45° pre-adjustment holes. If this is the case, then the limiters (90) would also have to be mounted at the other support member (66) so as to be located at the other guide plate side.

[0155] It can be appreciated that each or a select number of the guide plates (37) can include the bimetal pre-adjustment spring (80) positioned about one or on each of the guide plate pivot pins (78). Additionally, guide plates (37) including the bimetal pre-adjustment spring (80) can be used without any connecting rods, with each of the guide plates (37) being independently operating by its corresponding bimetal pre-adjustment spring (80).

LIST OF REFERENCE NUMERALS

[0156] (1) Parallel heating circuit 1 with heat source 1, e.g. thermal solar plant
[0157] (2) Parallel heating circuit 2 with heat source 2, e.g. chimney furnace
[0158] (3) Heat accumulator
[0159] (4) Heat accumulator
[0160] (5) Control system
[0161] (6) Desired temperature level heating circuit 1
[0162] (7) Temperature sensor heat accumulator
[0163] (8) Temperature sensor parallel heating circuit 1, media temperature at heat source 1
[0164] (9) Temperature sensor parallel heating circuit 2, media temperature at heat source 2 (flue gas temperature or flue gas pipe temperature)
[0165] (10) Actuator for parallel heating circuit 1, in particular circulation pump with three different speed settings or continuous adjustability
[0166] (11) Actuator for parallel heating circuit 2, in particular circulation pump with three different speed settings or continuous adjustability
[0167] (12) Check valve for the control of the media flow, parallel heating circuit 1
[0168] (13) Check valve for the control of the media flow, parallel heating circuit 2
[0169] (14) Media flow direction parallel heating circuit 1 active
[0170] (15) Media flow direction parallel heating circuit 2 active
[0171] (16) Media flow direction in active parallel heating circuit 1 or active parallel heating circuit 2
[0172] (17) Actuator control parallel heating circuit 1
[0173] (18) Actuator control parallel heating circuit 2
[0174] (19) Electrically-driven fan, control variable ‘fan speed’
[0175] (20) Flow rate limiter for the heating circuit 1
[0176] (21) Flow rate limiter for the heating circuit 2
[0177] (22) Flue gas flow in the gaseous heat carrier medium, flue gas flow velocity
[0178] (23) Cleaning aperture including a lid and wing screw
[0179] (24) Adjustable angular range of the pivotal guiding plates, control variable ‘angular position of guide plates’
[0180] (25) Measuring pocket for temperature sensor
[0181] (26) Feed flow, Vl.
[0182] (27) Return flow, RL.
[0183] (28) Flue gas discharge pipe, including wall connection
[0184] (29) Flue heat exchanger, including all designs
[0185] (30) Ventilation valve
[0186] (31) Connection possibility for further parallel heat sources
[0187] (32) Sensor flow rate measurement for output calculation
[0188] (33) Feed flow temperature for output calculation
[0189] (34) Return flow temperature for output calculation
[0190] (35) Rotary lever 1 for pivoting the guide plates
[0191] (36) Rotary lever 2 for pivoting the guide plates
[0192] (37) Pivotal guide plates, including a pivoting axis provided in the centre thereof
[0193] (38) Hinges with a centre of rotation for pivoting the guide plates
[0194] (39) View of section A: Guide plate angle=0°
[0195] (40) View of section A: Guide plate angle=90°
[0196] (41) Pivotal lever 1 for simultaneous or uniform adjustment of the guide plates
[0197] (42) Pivotal lever 2 for simultaneous or uniform adjustment of the guide plates
[0198] (43) Connecting rod for synchronous pivoting function of all guide plates
[0199] (44) Space for flue gas flow in the interior of the heat exchanger
[0200] (45) Space for flue gas flow between the inner surface of the flue gas discharge pipe and the outer surface of the heat exchanger
[0201] (46) External metal sheet flue gas discharge pipe
[0202] (47) Furnace
[0203] (50) Flue heat exchanger, designed with internally inserted liquid jacket heat exchanger
[0204] (51) Liquid jacket between exterior and interior wall pipe
[0205] (52) Flue heat exchanger, designed with internally inserted coiled pipe
[0206] (53) Flue heat exchanger output in watt
[0207] (54) Measurements: 3 min time cycle
[0208] (55) Measurement series 1: Guide plate angle 45° with ventilation
[0209] (56) Measurement series 2: Guide plate angle 90° without ventilation
[0210] (57) Mechanical connection point for a servo drive means or rotary drive means on the pivoting axis of the guide plates
[0211] (58) Servo drive means or rotary drive means on the pivoting axis of the guide plates
[0212] (60) Alternate embodiment guide plate unit without pivotal lever rods
[0213] (62) Upper support collar for the alternate embodiment guide plate unit
[0214] (64) Lower support collar for the alternate embodiment guide plate unit
[0215] (66) Support members connected the upper and lower support collars
[0216] (68) Hinges or pivot points connecting the guide plates
[0217] (70) First connecting rod for simultaneous or uniform adjustment of the guide plates
[0218] (72) Second connecting rod for simultaneous or uniform adjustment of the guide plates
[0219] (74) Intermediate connecting rod for synchronous pivoting function of all guide plates
[0220] (76) Hinges with a center of rotation for pivoting the guide plates
[0221] (78) Pivot extension of the guide plates
[0222] (80) Bimetal pre-adjustment spring
[0223] (82) An end of the bimetal pre-adjustment spring fixed to the guide plate pivot extension
[0224] (84) A second end of the bimetal pre-adjustment spring
[0225] (86) Multiple bimetal pre-adjustment spring holes located at -15°, -30°, -45° and -60° from a longitudinal axis of the support members
[0226] (88) Limiter holes
[0227] (90) Limiter

What is claimed as being new and desired to be protected by Letters Patent of the United States is as follows:

1. A flue heat transfer system for transferring heat from a furnace heat source in a flue gas pipe, said flue heat transfer system comprising:
   - a heat exchanger integrated in a flue gas pipe and possessing a liquid media chamber, impinged by an all-enveloping flue gas flow, said heat exchanger comprising an inner and outer heat exchanger regions, said inner and outer heat exchanger regions having a configuration to be impinged by said flue gas flow;
   - pivotal guide plates arranged spatially one behind the other along a longitudinal axis in said inner heat exchanger region; and
   - a connecting rod mechanically connected between said guide plates;
   in which said guide plates having a configuration that deflects said flue gas flow from said inner heat exchanger region into said outer heat exchanger region up to an exterior wall of said flue gas pipe, such that, at low flue gas temperatures, said guide plates do not cause any deflections of said flue gas flow through said heat exchanger regions and that, with increasing flue gas temperatures, deflections of said flue gas flow as well as a resulting flue gas flow turbulence increases with decreasing angles of said guide plates.

2. The flue heat transfer system according to claim 1, wherein each of said guide plates are pivotable so as to adjust an angle of each of said guide plates to said flue gas pipe about a pivoting axis of said guide plates.

3. The flue heat transfer system according to claim 2, wherein at least one of said guide plates being fitted with at least one drive means selected from the group consisting of a servo drive means, an electrically-driven servo drive means, and a rotary drive means, said drive means having a configuration for adjusting said angle of said guide plates.

4. The flue heat transfer system according to claim 1, wherein said guide plates each further comprising a hinge mechanically connected to said connecting rod, respectively.
5. The flue heat transfer system according to claim 4, wherein said guide plates are at least a first, second, third and fourth guide plate arranged spatially one behind the other in said longitudinal axis in said inner heat exchanger region.

6. The flue heat transfer system according to claim 5, wherein said connecting rod is a first connecting rod mechanically interconnecting said first and third guide plates, and a second connecting rod mechanically interconnecting said second and fourth guide plates.

7. The flue heat transfer system according to claim 6, wherein said first and second connecting rods are substantially parallel with said longitudinal axis during motion.

8. The flue heat transfer system according to claim 6, wherein said first connecting rod having a configuration to produce an equal, but synchronous direction of motion of said first and third guide plates, and said second connecting rod having a configuration to produce an equal, but synchronous direction of motion of said second and fourth guide plates that is opposite said first and third guide plates.

9. The flue heat transfer system according to claim 6 further comprising an intermediate connecting rod mechanically interconnecting said second and third guide plates in diagonally rotatable fashion, said intermediate connecting rod having a configuration to produce an opposite, but synchronous direction of motion of said second and third guide plates.

10. The flue heat transfer system according to claim 1 further comprising an upper support collar, a lower support collar, and a pair of support members in spaced relationship and connecting said upper and lower support collars, wherein said guide plates and said connecting rod are received in an interior of at least one of said upper and lower support collars, and said support members.

11. The flue heat transfer system according to claim 10, wherein said guide plates are pivotally connected to at least one of said upper and lower support collars, and said support members.

12. The flue heat transfer system according to claim 1 further comprising at least one pre-adjustment spring placed at least one guide plate pivot pin at least one of said guide plates, said pre-adjustment spring having a configuration to provide a rotational biasing force against the at least one of said guide plates.

13. The flue heat transfer system according to claim 12, wherein said pre-adjustment spring includes at least one end engaged in at least one pre-adjustment hole defined in at least one of said support members.

14. The flue heat transfer system according to claim 13, wherein said pre-adjustment hole is a plurality of pre-adjustment holes oriented in a radially configuration at different angles from said longitudinal axis.

15. The flue heat transfer system according to claim 13 further comprising a limiter received through wherein at least one limiter hole defined in at least one of said support members, said limiter having a configuration to contact at least one of said guide plates to prevent rotation of the at least one of said guide plates.

16. The flue heat transfer system according to claim 1, wherein said guide plates each feature textured surfaces having a configuration to increase friction of said flue gas flow.

17. The flue heat transfer system according to claim 1 further comprising an electrically-driven fan having a configuration for regulating said flue gas discharge pipe in one of said flue gas discharge pipes, in a fireplace, in a chimney, at an end of a chimney, adjacent to said flue gas discharge pipe, and in a region of a fresh air supply of a furnace.

18. The flue heat transfer system according to claim 2, wherein said heat exchanger further comprising at least one conduit having a configuration to form a hollow body; with said inner heat exchanger region having a configuration to receive said guide plates and said connecting rod.

19. The flue heat transfer system according to claim 18, wherein said conduit is selected from the group consisting of: a plurality of tubular rods, which, together, by using a plurality of 180° pipe bends, form a plurality of pipe loops that are interconnected in series to form said hollow body having a circular shape, said pipe loops having a configuration to be impinged by said enveloping flue gas flow, and wherein said heat exchanger is provided with a connecting sleeve for a return flow at a starting point and a connecting sleeve for a feed flow at an end point; a plurality of tubular rods, which, by means of two hollow rings, respectively provided at a beginning point and an end point of said tubular rods, are interconnected by welding, such that said hollow body having a circular shape is obtained, a first of said hollow ring being provided with a connecting sleeve for a return flow and a second of said hollow rings being provided with a connecting sleeve for a feed flow, said hollow rings having a configuration to be impinged by said enveloping flue gas flow; a coiled pipe, which consists of a circularly curved pipe and each individual loop of which includes an air gap for impinging said heat carrier medium by an all-enveloping said flue gas flow; and a liquid jacket, arranged between two jacketing pipes associated with said flue gas pipe, said heat carrier medium flows through said jacketing pipes, and wherein an air gap is defined between an outer jacketing pipe surface and an inner surface of said flue gas pipe for a portion of said flue gas flow to flow through.

20. A method of using a heat transfer system for transferring heat from a furnace heat source, said method comprising the steps of:
   a) setting a flue gas flow while a furnace is heating up by one of manual operation, and automatic control operation;
   b) setting a rotational speed of ventilation and an angular position of guide plates in a heat exchanger integrated in a flue gas pipe of said furnace;
   c) enveloping a liquid media chamber, said guide plates and inner and outer heat exchanger regions of said heat exchanger with said flue gas flow, said pivotal guide plates being arranged spatially one behind the other in a longitudinal axis in said inner heat exchanger region; and
   d) pivoting at least a first of said guide plates that is mechanically connected to at least another of said guide plates; wherein said guide plates having a configuration to deflect said flue gas flow from said inner heat exchanger region into said outer heat exchanger region up to an exterior wall of said flue gas pipe, such that, at low flue gas
temperatures, said guide plates do not cause any deflec-
tions of said flue gas flow through said inner and outer
heat exchanger regions and that, with increasing flue gas
temperatures, deflections of said flue gas flow as well as
a resulting flue gas flow turbulence increases with
decreasing angles of said guide plates.