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(71) Applicant: **exodraft a/s**
5220 Odense SØ (DK)

(72) Inventors:
- **Hansen, Kent Hagbart**
  5450 Otterup (DK)
- **Madsen, René Mulvad**
  5200 Odense V (DK)

(74) Representative: **Plougmann Vingtoft a/s**
Rued Langgaards Vej 8
2300 Copenhagen S (DK)

(54) HEAT RECOVERY SYSTEM

(57) The invention relates to a heat recovery system (1) for installation in a conduit for hot fluid flowing from a heat generating process to the exterior environment. A housing (2) of the system encapsulates an interior space with a first and a second section (5,6), the first section extending between an inlet (3) and an outlet (4) of the housing. A heat exchanger (7) is arranged in the second section. The system comprises at least two dampers (8) movable between a first position (9) in which they are arranged to guide the hot fluid from the inlet to the outlet via the heat exchanger, and a second position (10) in which the first and second sections are separated by the dampers so that the hot fluid is guided from the inlet to the outlet without passing the heat exchanger (7). The dampers (8) have a thermally insulating construction so that when they are in the second position, the first and second sections of the interior space are thermally insulated from each other.

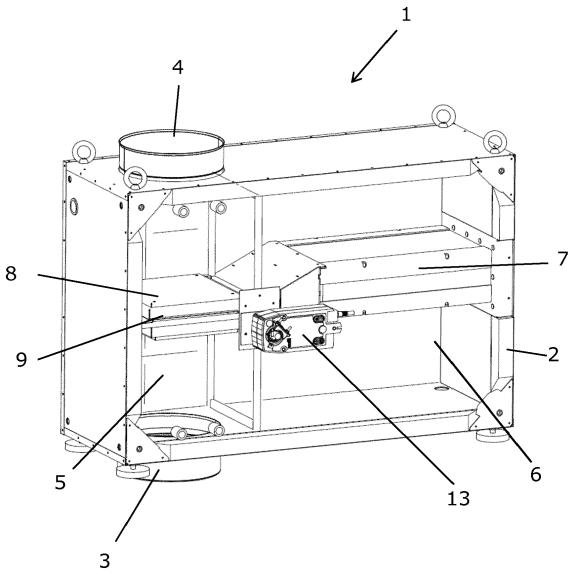

Fig. 3

EP 3 312 543 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to heat recovery systems and in particular to heat recovery systems which are protected against overheating of the heat exchanger.

BACKGROUND OF THE INVENTION

[0002] Heat recovery systems are used to recover at least some of the heat from outgoing hot fluids flowing from a heat generating process to the exterior environment. Such a hot fluid may e.g. be flue gas or processed air. The heat recovery is typically obtained by the use of a heat exchanger. The heat exchange media in the heat exchanger is warmed up by leading the hot fluid from a heat generating process through the heat exchanger, and out to the exterior environment. The warming up of the heat exchange media is achieved without the media being in direct contact with the hot fluid from the heat generating process.

[0003] An essential feature in heat recovery systems is how to control the amount of hot fluid passing through the heat exchanger and hereby protecting the heat exchanger against overheating. Overheating the heat exchanger through a longer period, with a sufficient temperature, may cause severe damage to the heat exchanger.

[0004] Possible applications wherein such a heat recovery system can be used include bakery ovens, food cooking equipment, industrial boilers, heat treatment installations, and drying plants. The recovered energy may e.g. be used to heat water which can be used for other purposes, such as for heating or for cleaning process equipment. The recovered may be stored in a reservoir for later use, e.g. in the form of hot water.

[0005] The presently used solution is a heat recovery system installed, comprising one damper provided between the conduit where the hot fluid is passing upwards towards the external environment and the heat exchanger. The damper can shift between to positions; in one positon to guide the hot fluid through the heat exchanger and to the external environment, and in a second position so the hot fluid is guided directly through the conduit without passing the heat exchanger.

[0006] However, in the second position, a part of the heat exchanger cannot be completely isolated from the conduit, due to the construction of the damper, and some of the hot fluid will inconveniently enter the space in the heat exchanger, not isolated from the conduit. This may result in overheating of the heat exchanger even when the damper is in the second position.

[0007] Hence, an improved heat recovery system would be advantageous, and in particular a heat recovery system which has a higher safety against an overheating of the heat exchanger would be advantageous.

OBJECT OF THE INVENTION

[0008] It is an object of the present invention to provide a heat recovery system, which has a higher safety against overheating of the heat exchanger than for known solutions.

[0009] It is another object of the present invention to provide a heat recovery system, which can isolate the heat exchanger entirely from the conduit through which hot fluid from a heat generating process is transferred to the exterior environment when needed, such as during maintenance and service operations or when there is no need for heat recovery.

[0010] It is another object of at least some embodiments of the present invention to provide a heat recovery system, in which the amount of hot fluid guided through the heat exchanger, is controllable.

[0011] It is a further object of the present invention to provide an alternative to the prior art.

[0012] In particular, it may be seen as an object of the present invention to provide a heat recovery system that solves the above-mentioned problems of the prior art.

SUMMARY OF THE INVENTION

[0013] The above-described object and several other objects are intended to be obtained in a first aspect of the invention by providing a heat recovery system for installation in a conduit for hot fluid flowing from a heat generating process to the exterior environment, the heat recovery system comprising:

- a housing comprising an inlet and an outlet both in fluid connection with the conduit, the housing encapsulating an interior space, and the interior space comprising a first and a second section, the first section extending between the inlet and the outlet,
- a heat exchanger arranged in the second section,
- one or more sensors arranged and adapted to measure at least the temperature at one or more positions within the system,
- at least two dampers which are adapted to move between:
    - ◦ a first position in which they are arranged to guide the hot fluid from the inlet to the outlet via the heat exchanger, and
    - ◦ a second position in which the first section and the second section are separated by the at least two dampers so that the hot fluid is guided from the inlet to the outlet without passing the heat exchanger, the movement of the at least two dampers being controllable by a control unit receiving input from the one or more sensors,

wherein the at least two dampers have a thermally insulating construction so that when they are in the second position, the first and second sections of the

interior space are thermally insulated from each other.

[0014] Such a heat recovery system may e.g. be used in an application as described above but with a higher safety against overheating of the heat exchanger than what is possible with known systems.

[0015] The control unit used to control the movement of the at least two dampers may be a part of the heat recovery system or it may an external unit. It will typically be the same control unit that is used for the control of the whole system including e.g. the operation of the heat exchanger, but it is also possible to have a separate control unit for controlling the movement of the dampers only.

[0016] The temperature may be measured at one or more positions within the system continuously, with predetermined time intervals, or at times dependent on other parameters, such as the actual temperatures measured. It may e.g. be desired to measure the temperature with larger time intervals when the temperature is relatively low than when it is close to exceeding a predetermined threshold value.

[0017] In relation to the present invention, the word "insulation" refers to thermal insulation, even though other kinds of insulation, such as electrical, may also be established.

[0018] Examples of possible applications wherein such a heat recovery system can be used are bakery ovens, food cooking equipment, industrial boilers, heat treatment installations, and drying plants.

[0019] Calculations, measurements and simulations made in relation to the present invention have shown that a heat recovery system according to the present invention can be safely used in systems where the temperature in the hot fluid flowing in the conduit is in the range of 100° to 600° Celsius. The design of a heat recovery system for a given application may e.g. be based on desired or required U-values. The U-value is a measure of the flow of heat through an insulating or building material; the lower the U-value, the better the insulating ability. The SI unit for the U-value is W/m^2K.

[0020] At least one of the at least two dampers may comprise two damper plates arranged spaced apart so that there is an insulating cavity between the damper plates, the damper plates facing towards the first and the second section, respectively, when the at least two dampers are in the second position. In addition to the damper plates and the insulating cavity there between, the dampers typically also comprise further insulating material, such as rock wool or mineral wool. The further insulating material may be placed between damper plates typically made from metal, such as stainless steel. A possible design of the damper plates will be shown in the figures.

[0021] In some embodiments of the invention, the two or more dampers are swivel dampers mounted on spindles. In such embodiments, the movement of the dampers may be driven by at least one motor connected to the spindles. The dampers may be driven by the same motor by use of appropriate gearing, or there may be one motor for each of the spindles. In the latter case, the dampers may move synchronously, or they may be adapted to move either at the same or at different speeds. In alternative embodiments, the two or more dampers are hingedly mounted and moved by at least one actuator. For any configuration of the dampers and the movements thereof, further safety components may be included in the system. One example of a safety measure is that the dampers may be mounted with a spring-return. In case the current to the system is lost, the spring-return will automatically be activated thereby forcing the dampers towards the second position. Thus, the dampers will move to the position in which the heat exchanger is protected against the high temperatures in the hot fluid.

[0022] In some embodiments of the invention, at least one of the at least two dampers can assume one or more stable intermediate positions between the first position and the second position. Such an option can be used to obtain that some of the hot fluid flows through the second section and via the heat exchanger, and some of the hot fluid flows from the inlet to the outlet via the first section. Hereby it might be possible to obtain a more even running of the heat recovery process e.g. to take into account an uneven use of the heat outputted from the heat exchanger. For systems without this option, the dampers will typically be moved to the second position to protect the heat exchanger, when one or more of the monitored temperatures exceeds a predetermined threshold value. The control of which positions a damper can stop in can e.g. be controlled by a damper motor with which the position can be controlled by adjusting the voltage.

[0023] A heat recovery system as described above may further comprise a mounting frame supported by the housing and arranged in the interior space at or near a boundary between the first and second sections, in which heat recovery system the heat exchanger is mounted to the mounting frame by an insulating suspension at an end of the heat exchanger facing towards the first section. The heat exchanger will typically be mounted to the inner surface of an outer wall of the housing at the other end; either directly or via a fitting, such as a bracket. The mounting frame typically also carries the dampers and means for driving the dampers, such as one or more motors or one or more actuators.

[0024] In embodiments of the invention including an insulating suspension, the insulating suspension may comprise:

- two outer plates extending from a suspension point at the mounting frame to two outer surfaces of the heat exchanger, and
- at least one suspension plate extending between the two outer plates and arranged at a distance from the heat exchanger so that the at least one suspension plate forms a heat shield and so that at least two insulating regions are established between the first

section and the heat exchanger. To improve the heat shielding effect, the insulating suspension may comprise two or more suspension plates arranged spaced apart so that three or more insulating regions are established between the first section and the heat exchanger. A possible design of such an insulting suspension will be explained in further details in relation to the figures.

[0025] In a second aspect, the present invention relates to a method of recovering heat from hot fluid flowing from a heat generating process to the exterior environment by use of a heat recovery system according to any of the preceding claims with the dampers being initially in the first position, the method comprising:

- monitoring at least the temperature at one or more positions within the system,
- when at least one monitored temperature exceeds a first predetermined threshold value, the control unit causes the dampers to move to the second position,
- with the dampers in the second position, continue monitoring at least the temperature at one or more positions within the system and when at least one monitored temperature is below a second predetermined threshold value, the control unit causes the dampers to move to the first position.

[0026] The first and second aspects of the present invention may be combined. These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE FIGURES

[0027] The heat recovery system according to the invention will now be described in more detail with regard to the accompanying figures. The figures show one way of implementing the present invention and is not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 schematically shows an example of a heat recovery system according to the present invention with the dampers in the first position.

Figure 2 schematically shows the heat recovery system in figure 1 with the dampers in the second position.

Figure 3 schematically shows a three-dimensional view of the heat recovery system in figures 1 and 2.

Figure 4 shows an alternative heat recovery system in which the dampers are hingedly mounted and moved by at least one actuator.

Figure 5 shows a cross-sectional and enlarged view of a damper of a heat recovery system according to the present invention.

Figure 6 schematically illustrates a three-dimensional view of the heat recovery system in figure 3, showing the flow of the hot fluid from the inlet to the outlet via the heat exchanger.

Figure 7 is a flow-chart of a method according to the present invention.

DETAILED DESCRIPTION OF AN EMBODIMENT

[0028] Figure 1 schematically shows an example of a heat recovery system 1 according to the present invention. The system is for installation in a conduit for hot fluid flowing from a heat generating process to the exterior environment. It could e.g. be bakery ovens, food cooking equipment, industrial boilers, heat treatment installations, and drying plants. The heat recovery system comprises a housing 2 with an inlet 3 and an outlet 4 both in fluid connection with the conduit. The housing 2 encapsulates an interior space which comprises a first section 5 and a second section 6, the first section 5 extending between the inlet 3 and the outlet 4. The heat exchanger 7 is arranged in the second section 6. In the embodiment shown in figure 1, the heat exchanger 7 is mounted to an inner wall of the housing 2 at one end and to an insulating suspension at the other end. This insulating suspension will be described in further details below.

[0029] The illustrated heat recovery system comprises two dampers 8 which are adapted to move between a first position 9 as shown in figure 1 and a second position 10 as shown in figure 2. In the first position 9, they are arranged to guide the hot fluid from the inlet 3 to the outlet 4 via the heat exchanger 7. In the second position 10 of the dampers 8, the first section 5 and the second section 6 are separated by the dampers 8 so that the hot fluid is guided from the inlet 3 to the outlet 4 without passing the heat exchanger 7.

[0030] The dampers 8 have a thermally insulating construction so that when they are in the second position 10, the first 5 and second 6 sections of the interior space are thermally insulated from each other. The choice of dimensions and types of material for the dampers 8 will depend on the actual use of a given system. In presently preferred embodiments of a heat recovery system the dampers 8 should be designed so that they can be safely used for applications where the temperature in the hot fluid flowing in the conduit is in the range of 100° to 600° Celsius. By "safely" is meant without damaging the heat exchanger.

[0031] Figure 3 schematically shows a three-dimensional view of the heat recovery system 1 in figures 1 and 2 with the dampers 8 in the first position 9. The dampers 8 in this embodiment are swivel dampers mounted on spindles 12. The movement of the dampers 8 is driven by a motor 13 connected to the spindles 12. In the em-

bodiment in figure 3, there is one motor 13 driving both spindles 12, but it is also covered by the present invention to have a motor for each spindle, so that the dampers 8 can be driven at different speeds and/or independently of each other. If desired, it would also be possible to design the system so that at least one of the dampers 8 can assume one or more stable intermediate positions (not shown) between the first position 9 and the second position 10.

[0032] Figure 4 shows an alternative way of mounting and moving the dampers 8. In this embodiment, the dampers 8 are hingedly mounted and moved by actuators 17 which are actuated by means of electric voltage or current, pneumatic or hydraulic pressure. The actuators 17 would typically be mounted on the inner part of the housing 2 in the second section 6. Preferably, the sliding member 19 of the actuator is attached to the damper plate 11, which is facing the second section 6 when the damper 8 is in the second position 10, and the fixed member 20 of the actuator is attached to the inner wall of the housing 2. When activated, the sliding member 19 will move from an innermost position in the fixed member 20 to an outermost position, thereby moving the damper 8 between the first and second positions 9,10 or to a position between the first 9 and the second 10 positions.

[0033] The dampers 8 in any of the embodiments in figures 1-3 comprise damper plates 11 arranged spaced apart so that there is at least one insulating cavity 24 between the damper plates 11. The two outer of the damper plates face towards the first 5 and the second 6 section, respectively, when the dampers 8 are in the second position 10, i.e. the position in figure 2. Figure 5 shows a cross-sectional and enlarged view of a damper 8 to better illustrate the design. The illustrated embodiment has three damper plates 11 with a cavity 24 between two of the plates and insulating material 25 between two of the plates 11. The outer damper plate arranged next to the cavity thus forms a heat shield protecting the heat exchanger 7 from heat radiated from the middle damper plate due to the hot fluid.

[0034] The damper plates 11 may e.g. be made from stainless steel, and the insulating material 25 may e.g. be mineral wool. In a proto type system made during the development of the invention, the dampers 8 were made from 4 mm stainless steel plates with 20 mm mineral wool. The choice of insulating material 25 depends on the actual use of the system. When the heat recovery system 1 is used for recovery of hot fluid comprising water and wherein the cooling effect in the heat exchanger 7 is so efficient that the water may condensate, the insulating material should be able to withstand this without degrading.

[0035] Figure 6 schematically illustrates a three-dimensional view of the heat recovery system. Illustrated by the arrows, the figure shows the flow of the hot fluid from the inlet 3 to the outlet 5 via the heat exchanger 7, when the dampers are in the first position 9.

[0036] The heat recovery system shown in figures 1 to 3, further comprises a mounting frame 14 supported by the housing 2 and arranged in the interior space at or near a boundary between the first 5 and second 6 sections. The heat exchanger 7 is mounted to the mounting frame 14 by an insulating suspension at the end of the heat exchanger 7 facing towards the first section 5. The purpose of this design of the insulating suspension is to protect the heat exchanger 7 from heat radiated from the first section 5; in particularly in situations where the dampers 8 are in the second position 10 due to the hot fluid being at so high temperatures that the hot fluid is so warm that it would cause damage to the heat exchanger 7, if it was guided there through. The insulating suspension comprises two outer plates 18 extending from a suspension point at the mounting frame 14 to two outer surfaces of the heat exchanger 7. In the illustrated embodiments, it further comprises two suspension plates 15 extending between the two outer plates 18 and arranged at a distance from the heat exchanger 7 and from each other. Hereby the suspension plates 15 form an array of heat shields to reduce the radiated heat. Furthermore, insulating regions 16 are established between the first section 5 and the heat exchanger 7. The number of suspension plates 15 is determined as part of the design process. Which number to choose for a given system depends on a number of parameters including the dimensions of the plates, the distance between the heat exchanger 7 and the frame 14 as well as the expected temperatures.

[0037] Figure 7 is a flow chart of a method of recovering heat from hot fluid flowing from a heat generating process to the exterior environment by use of a heat recovery system as described above. With the dampers 8 being initially in the first position 9, the method comprises:

- monitoring 27 at least the temperature at one or more positions within the system,
- when at least one monitored temperature exceeds a first predetermined threshold value, the control unit causes 28 the dampers 8 to move to the second position 10,
- with the dampers 8 in the second position 10, continue monitoring 29 at least the temperature at one or more positions within the system and when at least one monitored temperature is below a second predetermined threshold value, the control unit causes 30 the dampers to move to the first position 9.

[0038] For any configuration of the dampers and the movements thereof, further safety components may be included in the system. One example of a safety measure is that the dampers may be mounted with a spring-return. In case the current to the system is lost, the spring-return will automatically be activated, forcing the dampers towards the second position. Thus, the dampers will move to the position in which the heat exchanger is protected against the high temperatures in the hot fluid. Another example of safety measure is that in case the current to

the system is lost, a battery, such as a capacitor, is providing the current necessary for the motor/actuators to move the dampers to the second position 10, and secure that the hot fluid is guided from the inlet 3 to the outlet 4 without passing the heat exchanger 7.

[0039] The heat recovery system 1 further comprises one or more sensors arranged and adapted to measure at least the temperature at one or more positions within the system. In figure 1, sensors 26 are schematically shown at one position in the first section 5 and at one position in the heat exchanger 7. Other sensors (not shown) may be placed at other positions, such as in a reservoir (not shown) for storing heat energy outputted from the heat exchanger 7. This energy may e.g. be used to heat water which can be used for other purposes, such as for heating or for cleaning process equipment. The sensor in the reservoir may be configured to measure the amount and temperature of the fluid in the reservoir. When the temperature exceeds a first predetermined threshold value, the control unit (not shown) initiate a movement of the dampers 8 to the second position 10, and secure that the hot fluid is guided from the inlet 3 to the outlet 4 without passing the heat exchanger 7. The control unit may also initiate a movement of the dampers 8 to the first position 9, so that the hot fluid is guided through the heat exchanger 7, if the heat exchanging media temperature is below a second threshold value.

[0040] Other sensors may be arranged at a position (now shown) in order to measure whether the dampers 8 are being manually moved between the first 9 and second position 10.

[0041] Another sensor (not shown) may be arranged on or in the heat exchanger 7, measuring the temperature on the surface of the heat exchanger 7 or in the heat exchange media. When the temperature exceeds a first threshold value, the control unit initiates a movement of the dampers 8 to the second position 10, and secure that the hot fluid is guided from the inlet 3 to the outlet 4 without passing the heat exchanger 7.

[0042] Other sensors (not shown) may be arranged on the heat exchanger inlet 22 and on the heat exchanger outlet 23 configured for measuring the pressure of the heat exchange media. When the differential pressure excess a first threshold value, the control unit initiates a warning signal, indicating that the heat exchanger need to be serviced or repaired.

[0043] Additionally, a switch (now shown) may be arranged in the heat recovery system, which upon activation provides a signal to the control unit to initiate a movement of the dampers 8 to the second position 10 and thereby secure that the hot fluid is guided from the inlet 3 to the outlet 4 without passing the heat exchanger 7. This option can e.g. be used in relation to service of the system.

[0044] Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms "comprising" or "comprises" do not exclude other possible elements or steps. In addition, the mentioning of references such as "a" or "an" etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

REFERENCES

[0045]

1. Heat recovery system
2. Housing
3. Inlet
4. Outlet
5. First section
6. Second section
7. Heat exchanger
8. Dampers
9. First position
10. Second position
11. Damper plates
12. Spindles
13. Motor
14. Mounting frame
15. Suspension plates
16. Insulating regions
17. Actuator
18. Outer plate
19. Sliding member
20. Fixed member
21. Arrows
22. Inlet of heat exchanger
23. Outlet of heat exchanger
24. Insulating cavity
25: Insulating material
26: Sensors

Claims

1. Heat recovery system (1) for installation in a conduit for hot fluid flowing from a heat generating process to the exterior environment, the heat recovery system comprising:

- a housing (2) comprising an inlet (3) and an outlet (4) both in fluid connection with the conduit, the housing (2) encapsulating an interior space, and the interior space comprising a first (5) and a second (6) section, the first section (5)

extending between the inlet (3) and the outlet (4),
- a heat exchanger (7) arranged in the second section (6),
- one or more sensors (26) arranged and adapted to measure at least the temperature at one or more positions within the system,
- at least two dampers (8) which are adapted to move between:

o a first position (9) in which they are arranged to guide the hot fluid from the inlet (3) to the outlet (4) via the heat exchanger (7), and
o a second position (10) in which the first section (5) and the second section (6) are separated by the at least two dampers (8) so that the hot fluid is guided from the inlet (3) to the outlet (4) without passing the heat exchanger (7), the movement of the at least two dampers (8) being controllable by a control unit receiving input from the one or more sensors,

wherein the at least two dampers (8) have a thermally insulating construction so that when they are in the second position (10), the first (5) and second (6) sections of the interior space are thermally insulated from each other.

2. Heat recovery system according to claim 1, wherein the heat recovery system (1) is adapted to be installed in a conduit where the temperature in the hot fluid flowing in said conduit is in the range of 100° to 600° Celsius.

3. Heat recovery system according to claim 1 or 2, wherein at least one of the at least two dampers (8) comprises two damper plates (11) arranged spaced apart so that there is an insulating cavity (24) between the damper plates (11), the damper plates (11) facing towards the first (5) and the second (6) section, respectively, when the at least two dampers (8) are in the second position (10).

4. Heat recovery system according to any of the preceding claims, wherein the two or more dampers (8) are swivel dampers mounted on spindles (12).

5. Heat recovery system according to claim 4, wherein the movement of the dampers (8) is driven by at least one motor (13) connected to the spindles (12).

6. Heat recovery system according to any of claims 1-3, wherein the two or more dampers (8) are hingedly mounted and moved by at least one actuator (17).

7. Heat recovery system according to any of the preceding claims, wherein at least one of the at least two dampers (8) can assume one or more stable intermediate positions between the first position (9) and the second position (10).

8. Heat recovery system according to any of the preceding claims, further comprising a mounting frame (14) supported by the housing (2) and arranged in the interior space at or near a boundary between the first (5) and second (6) sections, in which heat recovery system the heat exchanger (7) is mounted to the mounting frame (14) by an insulating suspension at an end of the heat exchanger (7) facing towards the first section (5).

9. Heat recovery system according to claim 8, wherein the insulating suspension comprises:

- two outer plates (18) extending from a suspension point at the mounting frame (14) to two outer surfaces of the heat exchanger (7), and
- at least one suspension plate (15) extending between the two outer plates (18) and arranged at a distance from the heat exchanger (7) so that the at least one suspension plate (15) forms a heat shield and so that at least two insulating regions (16) are established between the first section (5) and the heat exchanger (7).

10. Heat recovery system according to claim 8 or 9, wherein the insulating suspension comprises two or more suspension plates (15) arranged spaced apart so that three or more insulating regions (16) are established between the first section (5) and the heat exchanger (7).

11. Method of recovering heat from hot fluid flowing from a heat generating process to the exterior environment by use of a heat recovery system (1) according to any of the preceding claims with the dampers (8) being initially in the first position (9), the method comprising:

- monitoring (27) at least the temperature at one or more positions within the system,
- when at least one monitored temperature exceeds a first predetermined threshold value, the control unit causes (28) the dampers (8) to move to the second position (10),
- with the dampers (8) in the second position (10), continue monitoring (29) at least the temperature at one or more positions within the system and when at least one monitored temperature is below a second predetermined threshold value, the control unit causes (30) the dampers to move to the first position (9).

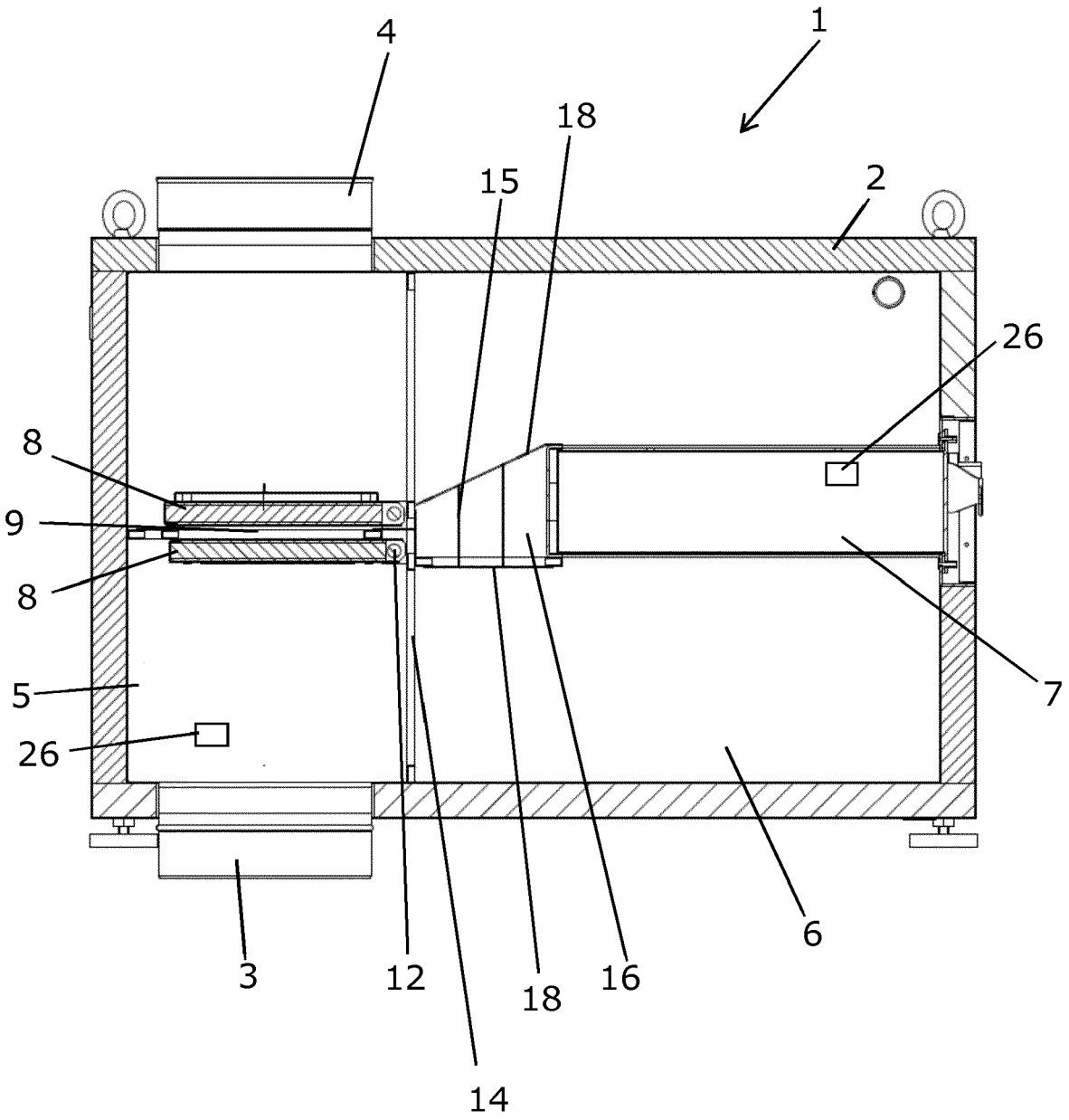

Fig. 1

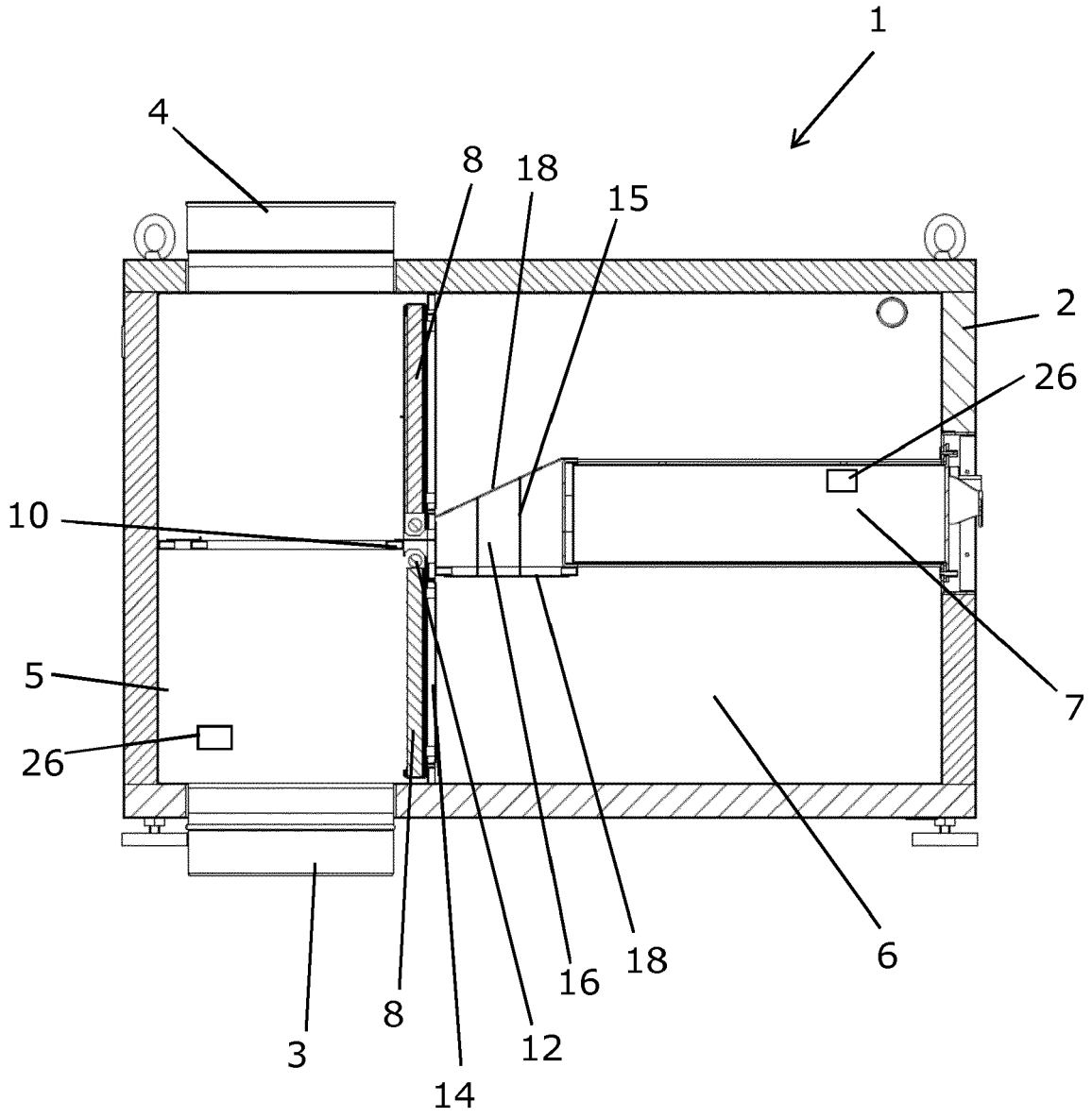

Fig. 2

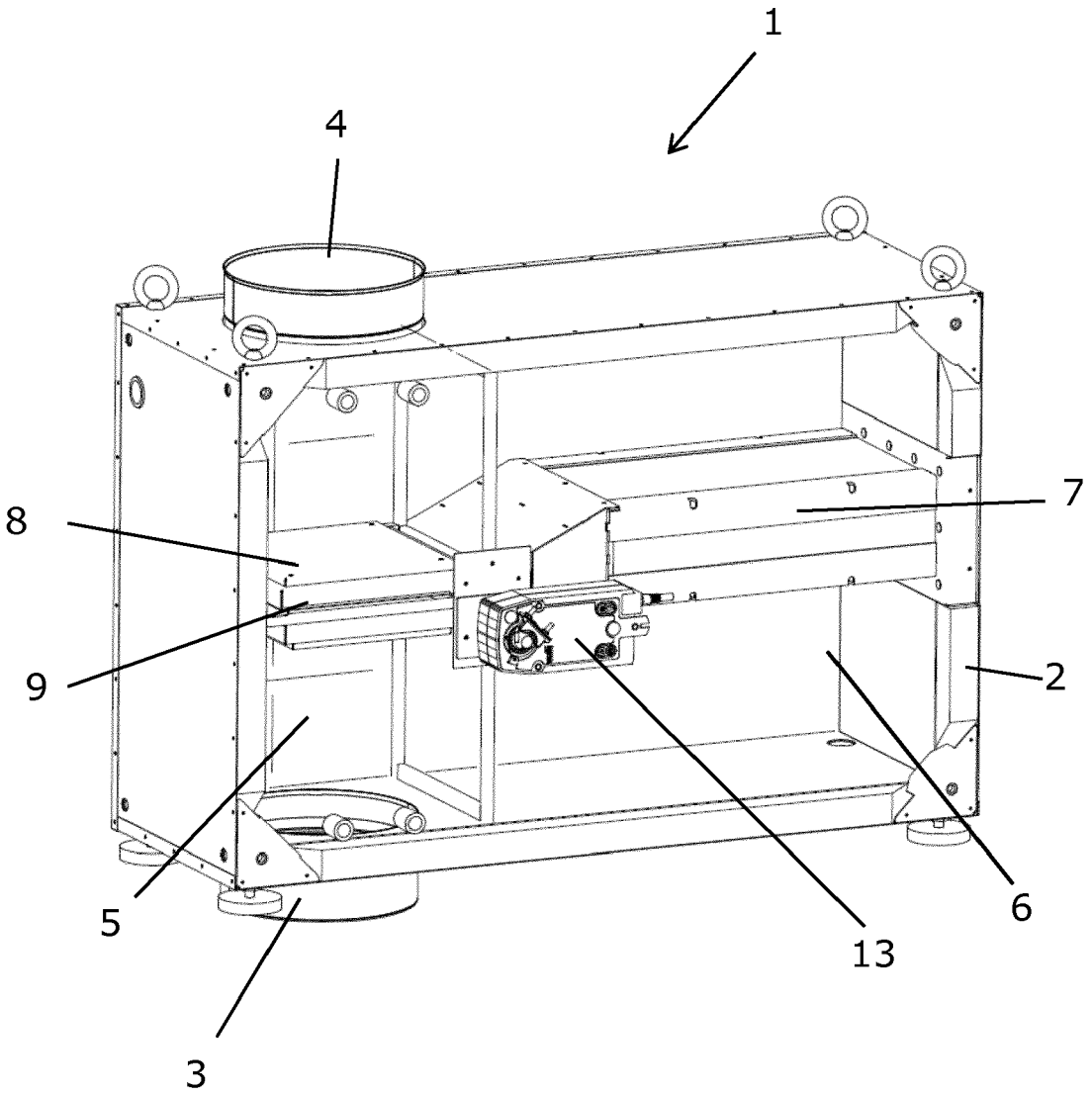

Fig. 3

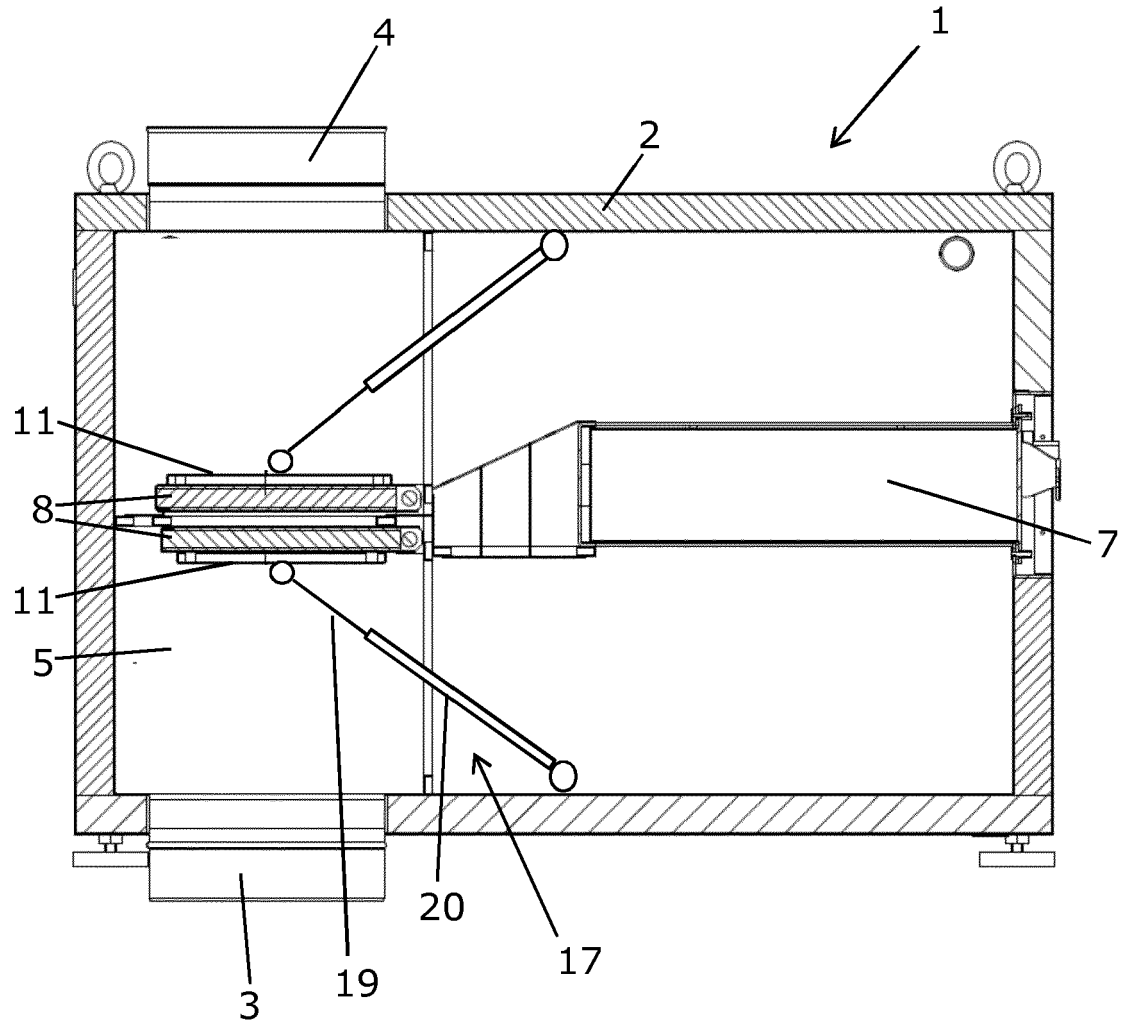

Fig. 4

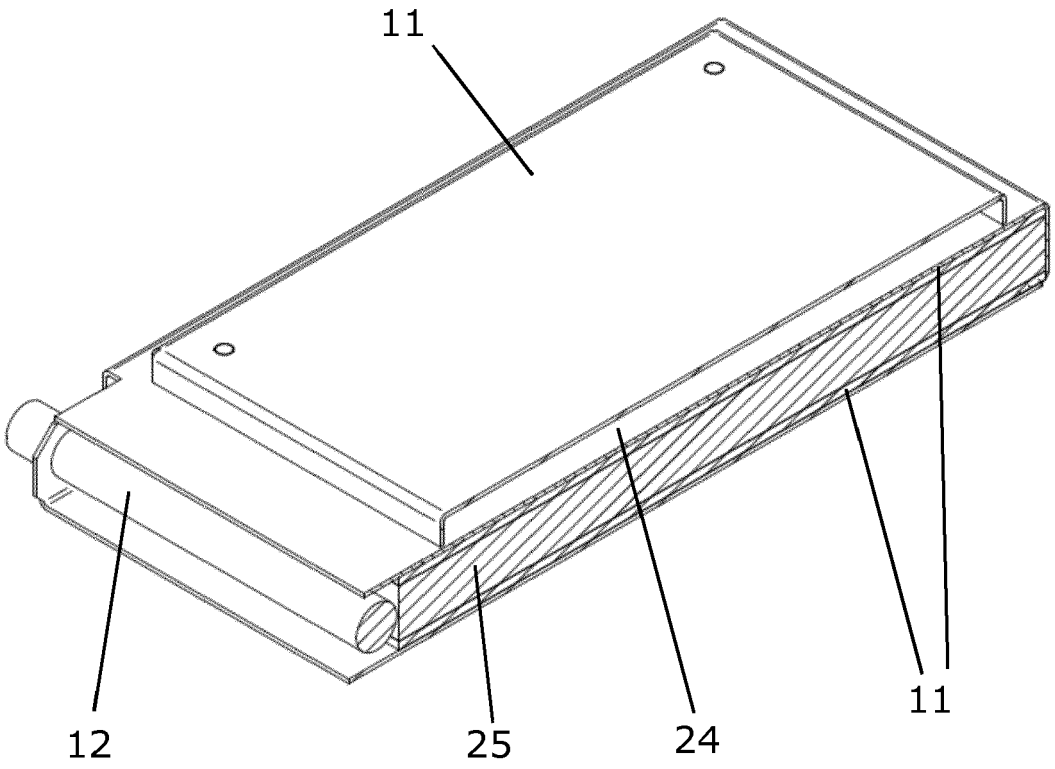

Fig. 5

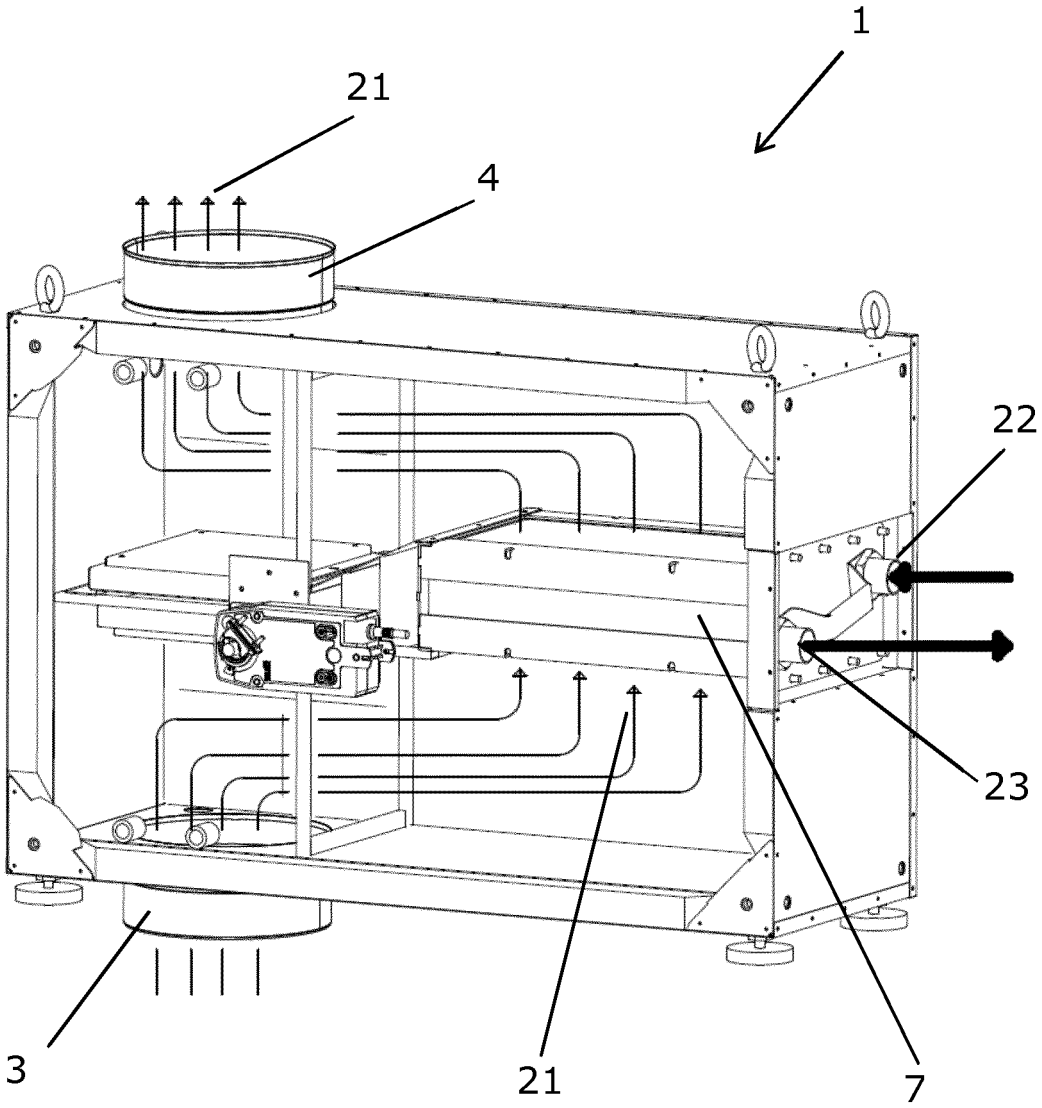

Fig. 6

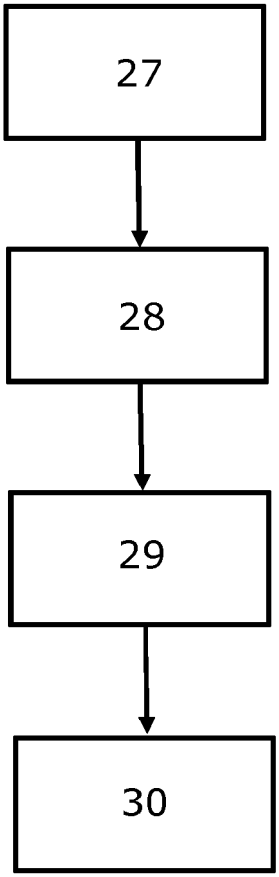

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 5019

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2 498 637 A (BAY THOMAS J) 28 February 1950 (1950-02-28) * column 5, line 54 - column 6, line 5; figure 4 *	1,2,11	INV. F28F27/02 F28D21/00
Y	US 5 950 715 A (JOENSSON NILS-AAKE [SE] ET AL) 14 September 1999 (1999-09-14) * column 3, line 1 - column 4, line 67; figures *	1-7	
Y	EP 1 672 209 A2 (HONEYWELL INT INC [US]) 21 June 2006 (2006-06-21) * paragraph [0025] - paragraph [0064]; figures *	1-7	

TECHNICAL FIELDS SEARCHED (IPC)

F28F
F28D

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	3 February 2017	Arndt, Markus

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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Application Number

EP 16 19 5019

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-7, 11

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 16 19 5019

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-7, 11

   Heat recovery system having a particular damper design

   ---

2. claims: 8-10

   Heat recovery system having a particular insulating suspension design for the heat exchanger

   ---

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 19 5019

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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03-02-2017

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