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(54) **METHOD OF PROTECTING THE SIEVE WALL OF THE COMBUSTION CHAMBER OF A FIRED HEAT EXCHANGER, AND A FIRED HEAT EXCHANGER FITTED WITH PROTECTION OF THE SIEVE WALL OF THE COMBUSTION CHAMBER**

VERFAHREN ZUM SCHUTZ DER SIEBWAND DER VERBRENNUNGSKAMMER EINES BEHEIZTEN WÄRMETAUSCHERS UND BEHEIZTER WÄRMETAUSCHER MIT SCHUTZ DER SIEBWAND DER BRENNKAMMER

PROCÉDÉ DE PROTECTION DE LA PAROI DE TAMIS DE LA CHAMBRE DE COMBUSTION D'UN ÉCHANGEUR DE CHALEUR À COMBUSTION ET ÉCHANGEUR DE CHALEUR À COMBUSTION POURVU D'UNE PROTECTION DE LA PAROI DE TAMIS DE LA CHAMBRE DE COMBUSTION

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Description

[0001] The invention concerns a method of protecting the sieve wall of the combustion chamber of a fired heat exchanger, and a fired heat exchanger fitted with protection of the sieve wall of the combustion chamber. The solution is applicable to all devices equipped with fired heat exchangers, and particularly in boilers of domestic water heating installations.

[0002] In fired heat exchangers, the fumes which form in the combustion chamber flow through the ducts connected to the combustion chamber through the sieve wall and heat the water flowing around the ducts in the water chamber. Known are many structures of such heat exchangers and device systems employing heat exchangers of the type. Different structures and shapes of individual structural elements of heat exchangers are used to adjust them to specific locations of their application and aimed at improving their heat parameters. In particular, known are different solutions in which the purpose of specific shapes and mutual positioning of individual elements of the exchanger is to improve effectiveness of heat exchange, economise on the materials, etc. Usually, devices fitted with fired heat exchangers work in systems which enable measuring the temperature of the fumes and the water they heat, where the operation of such elements as the fuel valve, exhauster, or ignition electrode are controlled according to the measured temperature. The precipitation which occurs when the device fitted with a fired heat exchanger is in operation leads to accumulation of deposit (the so-called limescale) on the sieve wall of the combustion chamber on the side of the water chamber. Limescale is a good insulator, and when accumulated on the sieve surface it prevents heat transfer from the sieve surface to water. Hence, an excessive build-up of limescale not only deteriorates heat parameters of the heat exchanger, but may also cause damage to the sieve wall in effect of overheating. To prevent it, permissible working times are defined for specific types of devices fitted with fired heat exchangers, after the lapse of which the device should be switched off and the limescale removed. This is the only heretofore known way to protect the sieve wall of the combustion chamber from damage, frequently ineffective though, as the device users tend not to comply with the maintenance instructions.

[0003] Known from the international patent application published under No. WO 2012/158050 A1 is the fired heat exchanger comprising an outer jacket which encases a set of vertically running pipe elements anchored in sieve walls on both ends, a gas combustion chamber positioned over the upper sieve wall and a baffle mounted crosswise to the pipe elements.

[0004] The heat exchanger disclosed in publication US 2012/0138278 has an outer jacket with an inner set of vertical pipe elements fastened at their opposing ends in upper and lower sieve walls, gas combustion chamber located above the upper sieve wall and partitions mount-

ed crosswise of the pipe elements according to the preamble of the independent claims. The main components in the structure of fired heat exchangers known to date are: the combustion chamber with a sieve bottom, and fume ducts in the water chamber connected to the sieve bottom. The whole system is encased in the outer jacket and closed with the cover of the combustion chamber; it is fitted with water inlet and outlet, fume exhaust, and burner elements. Such heat exchangers usually work in systems fitted with temperature sensors at the water inlet and outlet, as well as valve sets and a unit which controls the functioning of the exchanger. In known fired heat exchangers the protection of the sieve wall of the combustion chamber is ensured by appropriate pre-treatment of water or selection of specific shapes for individual structural elements, which is intended to reduce limescale accumulation. There are no fired heat exchangers known today in which the sieve wall of the combustion chamber would be entirely protected from damage caused by the accumulating limescale, irrespective of the shapes, sizes, or mutual arrangement of key elements of the heat exchanger.

[0005] The method of protecting the sieve wall of the combustion chamber of a fired heat exchanger, consisting in the removal, in any known way, of limescale accumulating on the sieve wall of the combustion chamber on the side of the water chamber according to the invention consists in that before a fired heat exchanger is started, the control unit of the fired heat exchanger is preprogrammed with a threshold temperature T_g defined for the sieve wall of the combustion chamber, whereupon, during the operation of the fired heat exchanger, the actual temperature T_a of the sieve wall of the combustion chamber is measured on the side of the water chamber using an additional temperature sensor. The signal from the additional temperature sensor is transmitted to the control unit and processed, following which the value of the actual temperature T_a is compared against the threshold temperature T_g . When both temperature values are equal, the control unit generates an alarm signal which informs that the fired heat exchanger should be/ is being switched off. Then, once the fired heat exchanger is off, the limescale accumulated on the sieve wall of its combustion chamber is removed in any known way.

[0006] The generated alarm signal is the main control signal which automatically closes the valve supplying fuel to the fired heat exchanger.

[0007] Preferably, the main control signal transmitted from the control unit is accompanied by an additional signal which starts light and/or sound message in the signaling unit.

[0008] In one of the embodiments, the generated alarm signal is an acoustic and/or sound signal only, in response to which the heat exchanger is switched off manually.

[0009] Preferably, the actual temperature T_a of the sieve wall is measured and recorded on a continuous basis.

[0010] In another embodiment, the actual temperature T_a of the sieve wall is measured and recorded cyclically at predetermined intervals.

[0011] The fired heat exchanger with protection of the sieve wall of the combustion chamber, fitted with an outer jacket which encases the combustion chamber, to which fume ducts placed in the water chamber adjacent to the combustion chamber are connected through the sieve wall and where the fired heat exchanger is connected to the control unit, according to the invention, is characterised in that it is fitted with an additional temperature sensor mounted in the socket on the sieve wall of the combustion chamber on the side of the water chamber and connected, either via a wire or wirelessly, to the control unit, which is not a part of the fired heat exchanger.

[0012] The additional temperature sensor is connected to the control unit via a connecting wire led through the pass-through port fixed tightly in the wall of the outer jacket.

[0013] In the first embodiment the socket of the additional temperature sensor is a separate element fixed to the sieve wall.

[0014] In another embodiment the socket of the additional temperature sensor takes the form of an indentation in the sieve wall.

[0015] In yet another embodiment of the exchanger the additional temperature sensor is wireless.

[0016] The method and the heat exchanger according to the invention solve the problem of ensuring reliable and effective protection of the sieve wall of the combustion chamber from damage caused by overheating, whatever the fired heat exchanger type and irrespective of reckless maintenance.

[0017] An exemplary embodiment of the solution according to the invention is shown on the drawing where Fig. 1 depicts the diagram of the system in which the exchanger works, Fig. 2 shows a fragment of the heat exchanger with the sieve wall protection in the first embodiment, Fig. 3, Fig. 4, Fig. 5 and Fig. 6 - the exchanger sieve wall in embodiment two, three, four, and five, respectively.

[0018] An exemplary method of protecting the sieve wall is executed in the system shown on Fig. 1. A fired heat exchanger 1 is fitted with an outer jacket 2, inside which there is the combustion chamber 3 and water chamber 4 separated with a sieve wall 5, and equipped with inlet and outlet stub pipes for the supply and discharge of water and fumes. The exchanger is fitted with valve 6 which supplies the fuel, blower 7 and ignition electrode 8, all connected to the control unit 9. Other elements connected to the control unit 9 are: sensor one of temperature T1 at the water outlet, sensor two of temperature T2 at the water inlet, sensor three of temperature T3 at the fume outlet, and an additional sensor of temperature T4 mounted on the sieve wall 5 of the combustion chamber 3, on the side of the water chamber 4. The control unit 9 is pre-programmed with the operation parameters for the specific fired heat exchanger 1, and then,

when the exchanger is in operation, the first, second, and third sensor of temperatures T1, T2, and T3 send information to the control unit 9, i.e. the temperature of water at inlet and outlet, temperature of fumes discharged from the exchanger, and the data concerning the water flow rate. The data are processed in a known way in the control unit 9 to signal S_S which controls the functioning of valve 6 through which the fuel is supplied and of blower 7 by selecting an optimal fuel and air mix, and the gas flow rate. Before starting the device, the control unit 9 is also pre-programmed with the threshold value of temperature T_g of the sieve wall 5, defined for the specific fired heat exchanger 1. In the exemplary embodiment $T_g = 130^\circ \text{C}$. After the device containing a fired heat exchanger 1 has been started, the actual temperature T_a of the sieve wall 5 on the side of the water chamber 4 is measured continuously by an additional sensor of temperature T4. The data are recorded and processed in the control unit 9 where the measured actual temperature T_a is compared against the adopted threshold temperature T_g . When the device is working, limescale builds-up gradually on the sieve wall 5 which constitutes the bottom of the combustion chamber 3, on the side of the water chamber 4, thus reducing the reception of heat by the water flowing around the sieve wall and in consequence increases the temperature of the sieve wall 5. When the actual temperature T_a becomes the same in value as the threshold temperature T_g , i.e. when $T_a = T_g$, the control unit 9 generates an alarm signal off transmitted to valve 6, blower 7, and ignition electrode 8 in the form of the main control signal S_G . The main control signal S_G closes valve 6 which supplies the fuel and switches off the blower 7 which supplies air to the mix burnt in the combustion chamber 3. This switches the exchanger off automatically. At the same time an additional signal S_D is transmitted from the control unit 9 to the signaling unit 10, which switches on a light message, such as a text communication on the display of the signaling unit 10, informing that maintenance of the device is required. The additional signal S_D may also trigger an acoustic alarm. Once the device is switched off automatically as described above, the limescale built-up on the sieve wall 5 is removed. This is done under any known technology appropriate for the specific installation and type of the deposit. The installation should be disconnected from the water circulation system which should then be filled with an appropriate solution of a deposit-dissolving preparation. Once the descaling and flushing is complete, the installation is re-connected to the water circulation system in which the device containing the fired heat exchanger works.

[0019] The heat exchanger with the protection of the sieve wall in the exemplary embodiment is a fired heat exchanger 1 of a condensing boiler used in domestic central heating installations, connected to the control unit 9. The exchanger is equipped with a cylindrical outer jacket 2 which encases the water chamber 4 having a cylindrical combustion chamber 3 installed in its upper part. Forming the bottom of the combustion chamber 3 is the

sieve wall 5 with openings in which vertical pipes are anchored to serve as ducts 11 in which the fumes formed in the combustion chamber flow through the water chamber 4. The sieve wall 5 is conical in shape with its apex pointing down. In the first exemplary embodiment shown on Fig. 2, there is a socket 12 accommodating the additional sensor of temperature T4 fixed at the edge of the surface of the sieve wall 5, on the side of the water chamber 4. The terminal 13 of the additional sensor of temperature T4 is led through the pass-through port 14 fixed tightly to the wall of the outer jacket 2 and then connected via a wire to the control unit 9. Socket 12 is wedge-shaped and the additional sensor of temperature T4 and its terminal 13 are positioned horizontally. Fig. 3 and Fig. 4 show two embodiments in which the additional sensor of temperature T4 is positioned at an angle, parallel to the conical sieve wall 5, where the sensor socket 12 takes the form of an appropriately shaped indentation in the sieve wall 5. In another embodiment shown on Fig. 5 the additional sensor of temperature T4 with the terminal 13 is positioned at an angle slanting downwards inside the water chamber 4, where its measurement head is fixed in the socket 12 formed in the sieve wall 5, and the terminal 13 has wires 15 led outside through the pass-through port in the wall of the outer jacket 2. The solution can also be executed using an additional wireless sensor of temperature T4, as shown on Fig. 6. In this embodiment the signals containing information on the measured actual temperature T_a are transmitted wirelessly from the additional sensor of temperature T4 to the control unit 9.

[0020] In the exemplary embodiments the exchanger will be switched-off automatically by the control unit when the temperature of the sieve wall rises by ca. 100°C above its temperature measured in a limescale-free exchanger.

[0021] The described embodiments do not exhaust all possible structural variants of either fired heat exchangers, or fixings of the additional temperature sensor to the sieve wall through which the combustion chamber is connected with the ducts in which the fumes flow in exchangers of the type.

Claims

1. A method of protecting the sieve wall of the combustion chamber of a fired heat exchanger, consisting in the removal, in any known way, of limescale accumulating on the sieve wall of the combustion chamber on the side of the water chamber, **characterised in that** before a fired heat exchanger is started, the control unit (9) of the fired heat exchanger (1) is preprogrammed with a threshold temperature T_g defined for the sieve wall (5) of the combustion chamber (3), whereupon, during the operation of the fired heat exchanger (1) the actual temperature T_a of the sieve wall (5) of the combustion chamber (3) is measured on the side of the water chamber (4)

using an additional temperature sensor (T4), the signal from which is transferred to the control unit (9) and processed, following which the value of the actual temperature T_a is compared against the threshold temperature T_g , and when both temperature values are equal, the control unit (9) generates an alarm signal off of the fired heat exchanger (1); once the fired heat exchanger (1) is off, the limescale accumulated on the sieve wall (5) of its combustion chamber (3) is removed in any known way.

2. The method according to Claim 1, **characterised in that** the generated alarm signal is the main control signal (S_G) which automatically closes the valve (6) supplying fuel to the fired heat exchanger (1).
3. The method according to Claim 2 **characterised in that** the main control signal (S_G) transmitted from the control unit (9) is accompanied by an additional signal (S_D) which starts a light and/or sound message in the signaling unit (10).
4. The method according to Claim 1 **characterised in that** the generated alarm signal is an acoustic and/or sound signal, in response to which the heat exchanger (1) is switched off manually.
5. The method according to Claims 1 - 4 **characterised in that** the actual temperature T_a of the sieve wall (5) is measured and recorded on a continuous basis.
6. The method according to Claims 1 - 4 **characterised in that** the actual temperature T_a of the sieve wall (5) is measured and recorded cyclically at predetermined intervals.
7. A fired heat exchanger with protection of the sieve wall of the combustion chamber, fitted with an outer jacket (2) which encases the combustion chamber (3), to which the fume ducts (11) placed in the water chamber (4) adjacent to the combustion chamber (3) are connected through the sieve wall (5) and where the fired heat exchanger is connectable to a control unit (9), **characterised in that** it is fitted with an additional temperature sensor (T4) mounted in the socket (12) on the sieve wall (5) of the combustion chamber (3) on the side of the water chamber (4) and connectable, either via a wire or wirelessly, to the control unit (9), which is not a part of the fired heat exchanger.
8. The fired heat exchanger according to Claim 7, **characterised in that** the additional temperature sensor (T4) is connectable to the control unit (9) via a terminal (13) led through the pass-through port (14) fixed tightly in the wall of the outer jacket (2).
9. The fired heat exchanger according to Claim 8, **char-**

acterised in that the socket (12) of the additional temperature sensor (T4) is a separate element fixed to the sieve wall (5).

10. The fired heat exchanger according to Claim 8, **characterised in that** the socket (12) of the additional temperature sensor (T4) takes the form of an indentation in the sieve wall (5).
11. The fired heat exchanger according to Claim 7, **characterised in that** the additional temperature sensor (T4) is wireless.

Patentansprüche

1. Verfahren zum Schutz der Siebwand der Verbrennungskammer eines beheizten Wärmetauschers, wobei die Kesselsteinschicht an der Siebwand der Verbrennungskammer von der Wasserseite mit einem bekannten Verfahren entfernt wird, **dadurch gekennzeichnet, dass** vor dem Einschalten des beheizten Wärmetauschers (1) der vorgegebene Wert der Grenztemperatur T_g der Siebwand (5) der Verbrennungskammer (3) in die Steuerung (9) des beheizten Wärmetauschers (1) eingegeben wird und beim Betrieb des beheizten Wärmetauschers (1) die aktuelle Temperatur T_a der Siebwand (5) der Verbrennungskammer (3) von der Seite der Wasserkammer (4) mittels eines zusätzlichen Temperaturfühlers (T4) gemessen wird und das Fühlersignal zur Steuerung (9) übertragen wird, wobei der Wert der aktuellen Temperatur T_a verarbeitet und mit dem Wert der Grenztemperatur T_g verglichen wird und wenn die beiden Temperaturen gleich sind, die Steuerung (9) ein Alarmsignal zum Ausschalten des beheizten Wärmetauschers (1) generiert wird und nach dem Ausschalten des Wärmetauschers die Kesselsteinschicht nach dem bekannten Verfahren von der Siebwand (5) der Verbrennungskammer (3) entfernt wird.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** als das Alarmsignal das Hauptsteuerungssignal (S_G) generiert wird, das das Brennstoffzufuhrventil (6) des beheizten Wärmetauschers (1) automatisch schließt.
3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** zusammen mit dem Steuerungssignal (S_G) die Steuerung (9) das zusätzliche Signal (S_D) sendet, das im Signalgeber (10) ein Licht- und/oder Tonsignal einschaltet.
4. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** als das Alarmsignal ein Licht- oder Tonsignal für das manuelle Ausschalten des Wärmetauschers (1) generiert wird.

5. Verfahren nach Anspruch 1 - 4, **dadurch gekennzeichnet, dass** die aktuelle Temperatur T_a der Siebwand (5) ständig gemessen und aufgezeichnet wird.

6. Verfahren nach Anspruch 1 - 4, **dadurch gekennzeichnet, dass** die aktuelle Temperatur T_a der Siebwand (5) regelmäßig in vorgegebenen Intervallen gemessen und aufgezeichnet wird.

7. Beheizter Wärmetauscher mit Schutz der Siebwand der Verbrennungskammer, der über eine Verbrennungskammer (3) im Außenmantel (2) verfügt, mit welcher über die Siebwand (5) Abgaskanäle (11) verbunden sind, die in der Wasserkammer (4) angebracht sind, die an der Verbrennungskammer (3) anliegt, wobei der beheizte Wärmetauscher mit der Steuerung (9) verbunden ist, **dadurch gekennzeichnet, dass** er über einen zusätzlichen Temperaturfühler (T4) im Sitz (12) an der Siebwand (5) der Verbrennungskammer (3) auf der Seite der Wasserkammer (4) verfügt, das drahtgebunden oder kabellos mit der Steuerung (9) verbunden ist, welche nicht zum Wärmetauscher gehört.

8. Beheizter Wärmetauscher nach Anspruch 7, **dadurch gekennzeichnet, dass** der zusätzliche Temperaturfühler (T4) mit der Steuerung (9) drahtgebunden über den Anschluss (13) und die in der Wand des Außenmantels (2) dicht eingebaute Durchführung (14) verbunden ist.

9. Beheizter Wärmetauscher nach Anspruch 8, **dadurch gekennzeichnet, dass** der Sitz (12) des zusätzlichen Temperaturfühlers (T4) ein separates Element darstellt, das an der Siebwand (5) montiert ist.

10. Beheizter Wärmetauscher nach Anspruch 8, **dadurch gekennzeichnet, dass** der Sitz (12) des zusätzlichen Temperaturfühlers (T4) als eine Vertiefung der Siebwand (5) ausgeführt ist.

11. Beheizter Wärmetauscher nach Anspruch 7, **dadurch gekennzeichnet, dass** der zusätzliche Temperaturfühler (T4) ein kabelloser Fühler ist.

Revendications

1. Procédé de protection de la paroi de tamis de la chambre de combustion d'un échangeur de chaleur à combustion consistant à l'enlèvement avec chaque méthode connue d'une couche de calamine déposée sur la paroi de tamis de la chambre de combustion du côté de la chambre d'eau, **caractérisé en ce que**, avant le démarrage de l'échangeur de chaleur à combustion (1), une valeur prédéterminée de température limite T_g de la paroi de tamis (5) de

- la chambre de combustion (3) est introduite à l'unité de commande (9) de l'échangeur de chaleur à combustion (1), et pendant l'exploitation de l'échangeur de chaleur à combustion (1) la température actuelle T_a de la paroi de tamis (5) de la chambre de combustion (3) du côté de la chambre d'eau (4) est mesurée au moyen d'un capteur de température supplémentaire (T4), dont le signal est envoyé à l'unité de commande (9), la valeur de température actuelle T_a est traitée et comparée avec la valeur de température limite T_g , et après l'alignement de ces températures un signal d'alarme pour l'arrêt de l'échangeur de chaleur à combustion (1) est généré par l'unité de commande (9), et ensuite, après son arrêt, la couche de calamine à partir de la paroi de tamis (5) de la chambre de combustion (3) est enlevée avec une méthode connue.
2. Le procédé selon la revendication 1 **caractérisé en ce que**, en tant que signal d'alarme, un signal de commande principal (S_G) est généré, qui ferme automatiquement la soupape (6) d'alimentation en carburant à l'échangeur de chaleur à combustion (1). 20
 3. Le procédé selon la revendication 2, **caractérisé en ce que**, en même temps que le signal de commande principal (S_G), un signal supplémentaire (S_D) est envoyé de l'unité de commande (9) qui active un message lumineux et ou sonore dans le générateur de signaux (10). 25 30
 4. Le procédé selon la revendication 1, **caractérisé en ce que**, en tant que signal d'alarme, un signal acoustique et / ou sonore est généré, sur la base duquel l'échangeur de chaleur (1) est arrêté manuellement. 35
 5. Le procédé selon la revendication 1 - 4 **caractérisé en ce que** la température actuelle T_a de la paroi de tamis (5) est mesurée et enregistrée en continu. 40
 6. Le procédé selon la revendication 1 - 4 **caractérisé en ce que** la température actuelle T_a de la paroi de tamis (5) est mesurée et enregistrée cycliquement à des intervalles de temps prédéterminés. 45
 7. Échangeur de chaleur à combustion pourvu d'une protection de la paroi de tamis de la chambre de combustion comportant à l'intérieur de la chemise extérieure (2) une chambre de combustion (3) avec laquelle, par l'intermédiaire de la paroi de tamis (5) sont reliés les canaux (11) d'écoulement de gaz situés dans la chambre d'eau (4) adjacente à la chambre combustion (3), l'échangeur de chaleur à combustion étant relié à une unité de commande (9), **caractérisé en ce qu'il** est muni d'un capteur de température supplémentaire (T4) placé dans le siège (12) sur la paroi de tamis (5) de la chambre de combustion (3) du côté de la chambre d'eau (4) et 50 55
 8. Échangeur de chaleur à combustion selon la revendication 7, **caractérisé en ce que** le capteur de température supplémentaire (T4) est relié par câble à l'unité de commande (9) par l'intermédiaire d'un raccordement (13) mené à travers un port de passage (14) intégré de manière étanche dans la paroi de la chemise extérieure (2). 5
 9. Échangeur de chaleur à combustion selon la revendication 8, **caractérisé en ce que** le siège (12) du capteur de température supplémentaire (T4) constitue un élément séparé fixé à la paroi de tamis (5). 10 15
 10. Échangeur de chaleur à combustion selon la revendication 8, **caractérisé en ce que** le siège (12) du capteur de température supplémentaire (T4) constitue un évidement formé dans la paroi de tamis (5). 20
 11. Échangeur de chaleur à combustion selon la revendication 7, **caractérisé en ce que** le capteur de température supplémentaire (T4) est un capteur sans fil. 25
- relié par câble ou sans fil à l'unité de commande (9), qui ne fait pas partie de l'échangeur de chaleur.

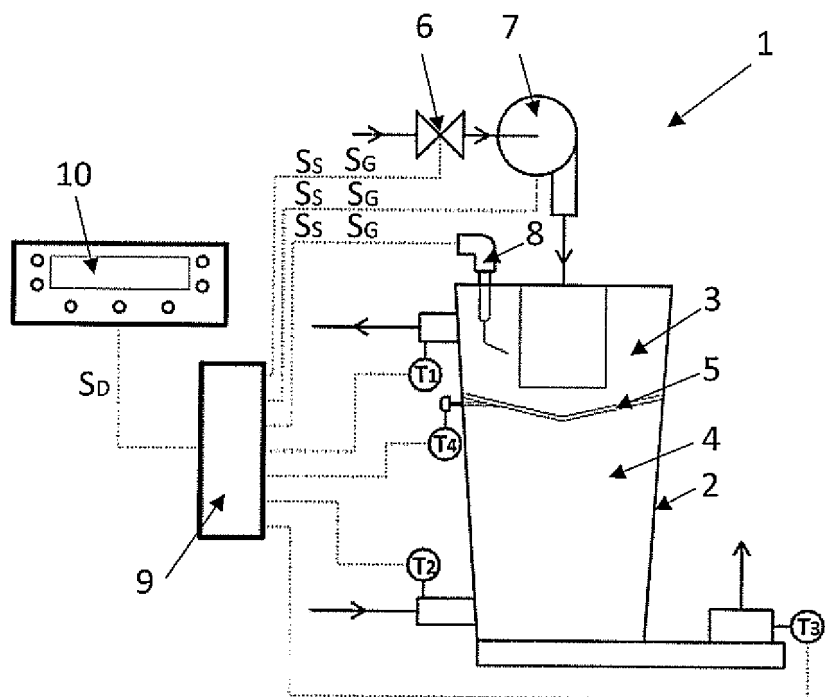


Fig.1

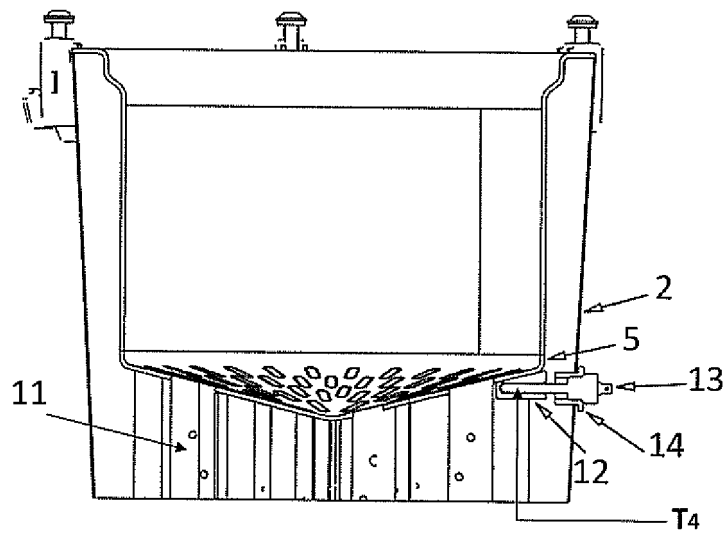


Fig.2

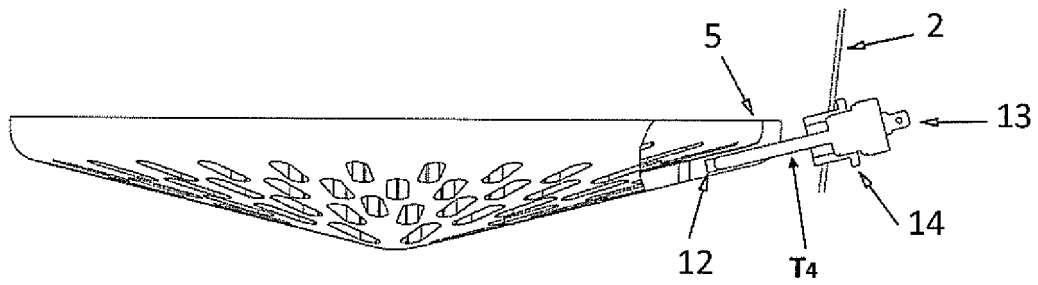


Fig.3

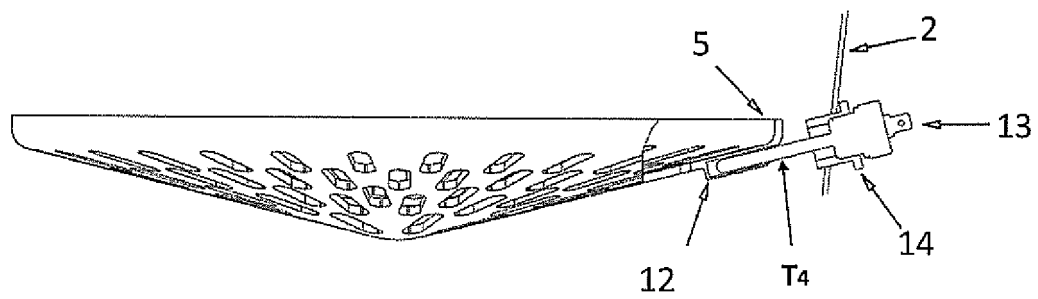


Fig.4

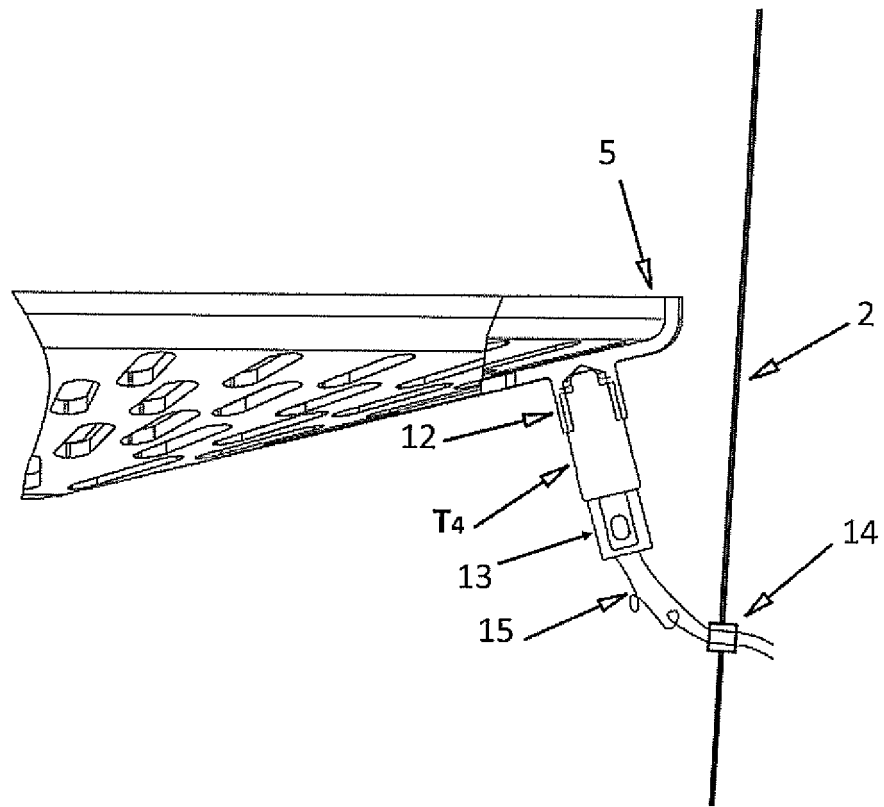


Fig.5

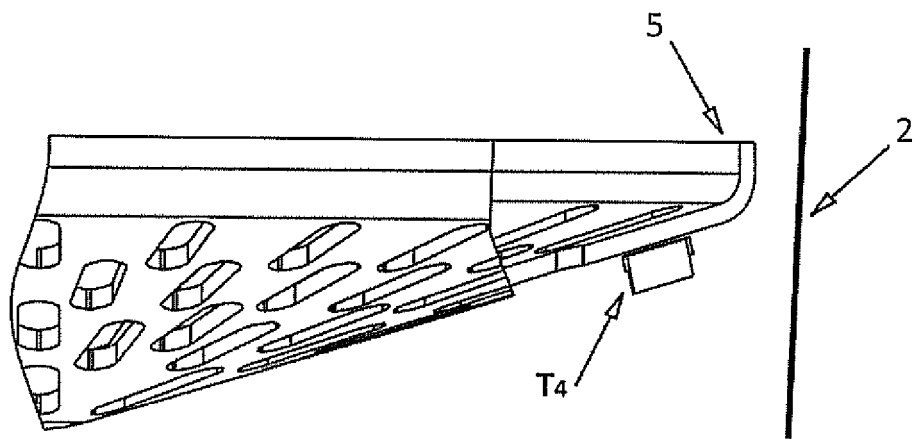


Fig.6

REFERENCES CITED IN THE DESCRIPTION

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