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(54) **Heat exchange assembly for unit heaters.**

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Description

This invention generally relates to unit heaters and like apparatus for the treatment of hot air and, more particularly, an improved heat exchange assembly therefor.

It is known that the unit heater is an apparatus used for quickly heating industrial rooms and generally comprises a radiator, frequently with finned tubes, through which an electric fan blows air in the room to be heated. In the place of the radiator, a conventional heat exchanger is also used, in which the heat exchange fluid is the flue gas generated in a chamber directly communicating with said heat exchanger and by the air moved by the electric fan and passing therethrough generally in a cross flow. To generate the flue gas conventional heat sources can be used, such as gas or gas oil burners.

It is also known that in a unit heater the efficiency is given for the most part by the transfer of the heat content or by the heat exchange occurring in the heat exchanger. To increase this heat content transfer, with the surface and the temperature gradient being the same, some approaches have been made, among which the use of suitable turbulence generating devices referred to as "turbulators", introduced in the flues for causing a turbulent flow, an increase of the relative circulation velocity, as well as a special configuration of the flues are cited.

The first system causes a substantial resistance to the flue gas flow which causes a pressurization condition in the combustion chamber and therefore it is not suitable.

The second system resorts for example to the vacuum created by the stack draught and this is almost impossible for the low levels of vacuum so obtainable.

The third system is at present the most used and by means of it the following advantages can be obtained:

- maximizing, with the exchange surfaces being the same, the heat content transfer of the flue gas by bringing them to an optimal outlet temperature;
- obtaining a homogeneous and regular distribution of the outer surface temperature, without ever reaching the condensation soil which could cause acid, aggressive and oxidant condensates corroding the metal;
- lacking of a pressure drop in the movement of the flue gas which can cause a pressurization of the combustion chamber, and
- maintaining the flue gas velocity uniform during their movement.

US-A-2,613,920 discloses a heat exchange assembly for unit heaters and like apparatus for the treatment of hot air comprising a heat exchanger formed of flues and air tubes and a combustion chamber. The air tubes have in cross-section the shape of

a trapezoid with the small base placed at the bottom. The air tubes are arranged side by side in such a manner as to form therebetween a flue. The lower portion of the air tubes forms the roof of said combustion chamber. The flues have in cross-section the shape of a trapezoid with the small base placed at the top and the side walls of said air tubes are provided with impressions for avoiding the laminar flow of the flue gas and imparting thereto the necessary turbulence.

The present invention aims at improving a heat exchange assembly of this type.

More particularly, the heat exchange assembly for unit heaters and like apparatus for the treatment of hot air according to the present invention, of the type comprising a heat exchanger formed of flues and air tubes and a combustion chamber, said air tubes having in cross-section the shape of a trapezoid with the small base placed at the bottom, said air tubes being arranged side by side in such a manner as to form therebetween a flue, the lower portion of the air tubes forming the roof of said combustion chamber, said flues having in cross-section the shape of a trapezoid with the small base placed at the top, the side walls of said air tubes being provided with impressions for avoiding the laminar flow of the flue gas and imparting thereto the necessary turbulence is characterized in that said impressions in the side walls of said air tubes are formed of circular concavities or convexities and are arranged in offset rows in a quincuncial configuration.

The present invention will be now described in more detail in association to a gas operated unit heater and in connection with the accompanying drawings, wherein:

Fig. 1 is a cross sectional view of a gas operated unit heater according to the present invention;

Fig. 2 is a top plan view of the unit heater of Fig. 1;

Fig. 3 is a sectional view taken along the line III-III of Fig. 1;

Fig. 4 is a partial perspective view of the shape of the air tubes, and therefore of the flues, and of the arrangement thereof for forming the heat exchanger; and

Fig. 5 is a plan view of the blank of metal sheet from which each air tube is obtained.

Referring now to the drawings, and particularly to Figs. 1, 2 and 3, there is shown a gas operated unit heater comprising a housing 1 provided with a bottom 2 and a top panel 3, as well as a front panel 4 having an outlet 5 (Fig. 3) for the hot air. The hot air stream can be oriented by means of baffles 6. In the back portion of the housing an electric fan 7 is arranged, which blows in the air from the outside through the heat exchanger 8. Below the heat exchanger 8 a combustion chamber 9 is arranged provided with an extractor 10 of the flue gas flowing from the combustion chamber 9. For the combustion of the gas in the com-

bustion chamber 9 a set of burners 11 are provided. Above the burners 11 a conventional ignition device 12 is arranged, which is connected to a control panel 13 and a valve 14 is provided for controlling the feeding of the combustible gas to the burners.

The unit heater till now described is of a conventional design.

The feature of this unit heater is given by the configuration of its heat exchanger 8. This comprises a set of air tubes 15 arranged side by side and supported at both the ends, i.e. the air inlet and outlet ends, by conventional support elements. The air tubes 15 are arranged in spaced relationship so as to provide therebetween hollow spaces 16 forming the flues 17. Thus, the lower portion of the air tubes 15 forms the roof of the combustion chamber 9.

The side walls 21 of the air tubes 15 are provided with a set of impressions 18 having a circular shape in plan view and forming concavities or convexities. These impressions 18 are arranged in rows offset to each other in such a manner that in each air tube formed of two side walls 21 a concave impression of each row of one side wall 21 lies in front to a convex impression of the other side wall 21 (Fig. 3). The function of the impressions 18 is to impart to the flue gas passing through the flues 17 so formed the required turbulence in order to avoid the laminar flow which would negatively affect the heat exchanger operation. In particular, the upper row of the impressions 18 is made so as to assure the correct spacing of the outlet portion of the flues and the possibility to comfortably carrying out the cleaning thereof.

The configuration and the arrangement of the air tubes and therefore of the resultant flues can best be seen in Figs. 4 and 5.

As can be seen in Fig. 5, each air tube 15 is formed from a single blank B of steel sheet comprising a center portion C of rectangular shape from the small sides of which rectangular flanges 24 terminating in tabs 25 extend and from the large sides of which trapezoidal flanges 22 terminating in tabs 23 extend.

This blank is then subjected to a press-forming operation in which the center portion C is bent over, the flanges 22 are outwardly bent by 90° and the flanges 24 are inwardly bent by 90°, whereas the tabs 23 and 25 are 90°-bent with the respect to the relative flanges so as to form a tube having a cross-section in the shape of a trapezoid with the small base forming the bottom wall 19 and the large base forming the top wall 20. The inclined sides of the trapezoid are formed by the side walls 21 of the so press-formed tube. The bottom wall 19 is then slightly curved, as can be seen from the drawings and this is obtained by a drawing operation.

After the press-forming operation of the blank B, each of the tab 23 is welded, as indicated by S, to a corresponding tab 23 of an adjacent air tube formed from another blank, and the pair of tabs 25 are welded

together, also indicated by S, so as to form the top wall 20 of the air tube. Therefore, the side walls 21 are inclined by an angle β with respect to the vertical and this inclination of the side walls 21 allows the flues 17 formed between two air tubes 15 to have a cross-section decreasing from the bottom to the top so as to impart to the flue gas flowing therein a venturi effect increasing their flow velocity.

The so formed heat exchanger has therefore air tubes 15 having in cross-section the shape of a trapezoid with the small base placed at the bottom and flues 17 formed between each pair of air tubes 15 having in cross-section the shape of a trapezoid with the small base placed at the top.

As the so formed heat exchanger 8 is mounted to the unit heater, the curved bottom walls 19 of the assembled air tubes 15 form the roof of the combustion chamber 9 and this due to the above described construction of the heat exchanger. This construction avoids also the requirement to provide the conventional tube plates to be welded to the tubes and therefore the costs of this welding operation. Furthermore, this construction avoids also a discontinuity zone and weak points. The curved shaping of the bottom walls 19 of the air tubes 15 promotes the flow of the flue gas therein, minimizes the resistance to the flow and gives a preferential direction which better reacts to the expansion. The air tubes 15 obtained according to the invention from a single blank of metal sheet allow them to be assembled by carrying out a straight-line and simple welding operation of the tabs 25 and the tabs 23.

From the foregoing it can be seen that the flue gas produced by the gas burnt in the burners 11 move upwardly through the flues 17 formed by the hollow spaces 16 between each pair of air tubes 15 (Fig. 1). During the passage through the flues, the velocity of the flue gas increases due to the venturi effect provided by the inclination of the side walls 21 and contact the impressions 18 in such a manner as to be deflected alternatively in opposite directions, thereby following a sinuous path imparting thereto the necessary turbulence. Once the flue gas is flowed out the flues 17, it is extracted by the flue gas extractor 10. In the meantime, the air blown in by the electric fan 7 passes through the air tubes 15 in a direction perpendicular to that of the flue gas and the air is therefore heated and flows out the outlet 5 provided in the housing 1, oriented by the baffles 6. The sinuosity of the flues formed by the impressions can be seen also in Fig. 2.

From the foregoing, it can be seen that the focus of the invention is formed by the flues 17 obtained by arranging side by side the air tubes 15 and then welding this air tubes to each other, as above described. A further feature of these flues is the shape, the dimension and the arrangement of the impressions 18, the main function of which is to avoid the occurrence

of a laminar flow therethrough and the provision therein of a turbulence that continuously mixes them, by eliminating at the same time the pressure drop.

A second feature of the flues according to the invention is the trapezoidal shape thereof. The main purpose of this trapezoidal shape is to maintain by venturi effect to a high level the flow velocity of the flue gas which, because of their cooling, decrease in volume.

Furthermore, a better distribution of the outer surface temperature is obtained, with resulting increase of the heat exchanger efficiency.

The heat exchanger according to the present invention has also the advantage of being of easy construction because it is sufficient to carry out a blanking operation only for obtaining the starting blank of the air tube, a subsequent press-forming operation for forming the air tube with the flanges 22 and 24 terminating in 90°-bent tabs 23 and 25, respectively and a final continuous welding operation for welding to each other the tabs 25 of the air tubes and the tabs 23 of the air tube to an associated tab 23 of an adjacent air tube.

This type of heat exchanger, having a high efficiency which is promoted by the low resistance to the flue gas passage can be of course used, besides with the unit heaters provided with extractor and sealed chamber as those herein described, also with apparatus provided with natural draught.

Claims

1. Heat exchange assembly for unit heaters and like apparatus for the treatment of hot air of the type comprising a heat exchanger formed of flues (17) and air tubes (15) and a combustion chamber (9), said air tubes (15) having in cross-section the shape of a trapezoid with the small base placed at the bottom, said air tubes being arranged side by side in such a manner as to form therebetween a flue (17), the lower portion of the air tubes (15) forming the roof of said combustion chamber (9), said flues (17) having in cross-section the shape of a trapezoid with the small base placed at the top, the side walls of said air tubes (15) being provided with impressions (18) for avoiding the laminar flow of the flue gas and imparting thereto the necessary turbulence, characterized in that said impressions (18) in the side walls (21) of said air tubes (15) are formed of circular concavities or convexities and are arranged in offset rows in a quincuncial configuration.
2. Heat exchange assembly according to claim 1, characterized in that the upper row of said impressions (18) is made so as to assure the correct spacing of the outlet portion of the flues (17)

and the possibility to comfortably carrying out the cleaning thereof by means of a conventional flue brush.

3. Heat exchange assembly according to claim 1, characterized in that the bottom (19) of the air tubes (15) is rounded in order to decrease the inlet resistance of the flue gas in the flues (17).

Patentansprüche

1. Wärmeaustauscheinheit für Lufterhitzer und derartige Geräte zur Behandlung von Heißluft von der Art bestehend aus einem Wärmeaustauscher, der aus Rauchrohren (17) und Luftrohren (15) gebildet ist, und einer Brennkammer (9), wobei die Luftrohre (15) einen trapezförmigen Querschnitt aufweisen, dessen geringere Grundlinie nach unten gerichtet ist, indem die Luftrohre derart nebeneinander angeordnet sind, daß sie dazwischen jeweils ein Rauchrohr (17) bilden, der untere Teil der Luftrohre (15) die Decke der Brennkammer (9) bildet, die Rauchrohre (17) einen trapezförmigen Querschnitt haben, dessen geringere Grundlinie nach oben gerichtet ist, die Seitenwände der Luftrohre (15) mit Vertiefungen (18) versehen sind, um ein laminares Fließen der Rauchgase zu vermeiden und diesen die nötige Turbulenz zu verleihen, dadurch gekennzeichnet, daß die Vertiefungen (18) der Seitenwände (21) der Luftrohre (15) von kreisförmigen Vertiefungen oder Wölbungen gebildet und in versetzten Reihen in einer Quincunxstellung angeordnet sind.
2. Wärmeaustauscheinheit nach Anspruch 1, dadurch gekennzeichnet, daß die obere Reihe der Vertiefungen (18) derart ausgeführt ist, daß ein korrekter Abstand des Austrittsteils der Rauchrohre (17) und die Möglichkeit, deren Reinigung in einfacher Weise mit einer üblichen Bürste vorzunehmen, gewährleistet sind.
3. Wärmeaustauscher nach Anspruch 1, dadurch gekennzeichnet, daß der Boden (19) der Luftrohre (15) abgerundet ist, um den Eintrittswiderstand der Rauchgase in den Rauchrohren (17) zu verringern.

Revendications

1. Unité d'échange de chaleur pour réchauffeur d'air et appareils similaires pour le traitement de l'air chaud de genre comportant un échangeur de chaleur formé de tubes de fumée (17) et de tubes pour l'air (15) et une chambre de combustion (9),

lesdits tubes pour l'air (15) ayant une section transversale à trapèze avec la petite base orientée vers le bas, lesdits tubes pour l'air étant arrangés côté à côté pour créer entre eux un tube de fumée (17), la partie inférieure desdits tubes pour l'air (15) formant le ciel de ladite chambre de combustion (9), lesdits tubes de fumée (17) ayant une section transversale à trapèze avec sa petite base orientée vers le haut, les parois latérales desdits tubes pour l'air (15) étant pourvues d'empreintes (18) de façon à éviter un écoulement laminaire des gaz de fumée et à leur donner la turbulence nécessaire, caractérisée en ce que lesdites empreintes (18) dans les parois latérales desdits tube pour l'air (15) sont formées des concavités ou des convexités circulaires et sont arrangées en rangées décalées selon une disposition à quinconce.

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2. Unité d'échange de chaleur selon la revendication 1, caractérisé en ce que la rangée supérieure desdites empreintes (18) est formée de façon à assurer la distance correcte de la partie terminale des tubes de fumée (17) et la possibilité d'effectuer en manière confortable son nettoyage au moyen d'une brosse conventionnelle.

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3. Unité d'échange de chaleur selon la revendication 1, caractérisé en ce que le fond (19) desdits tubes pour l'air (15) est arrondi de façon à réduire la résistance d'entrée des gaz de fumée dans lesdits tubes de fumée (17).

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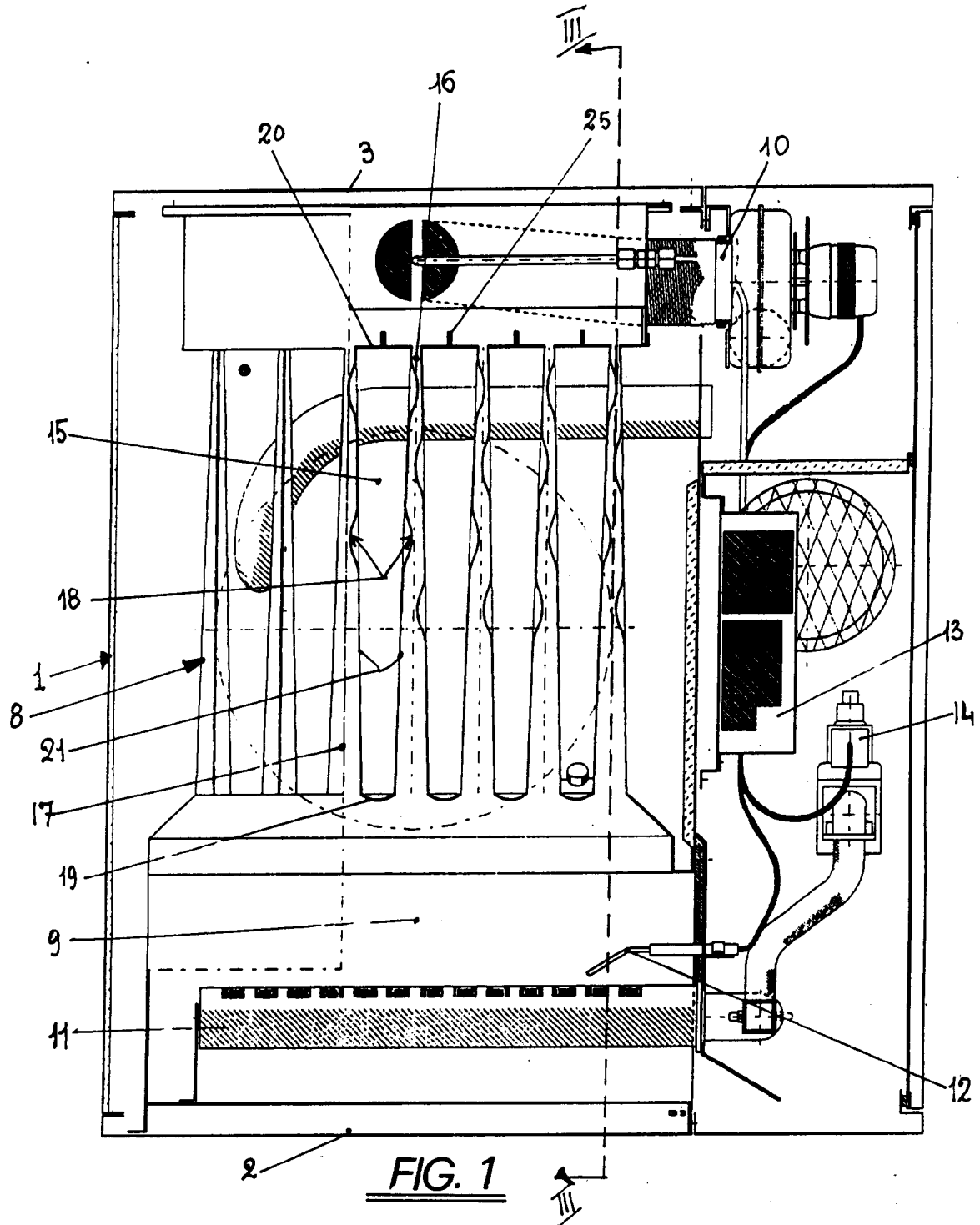
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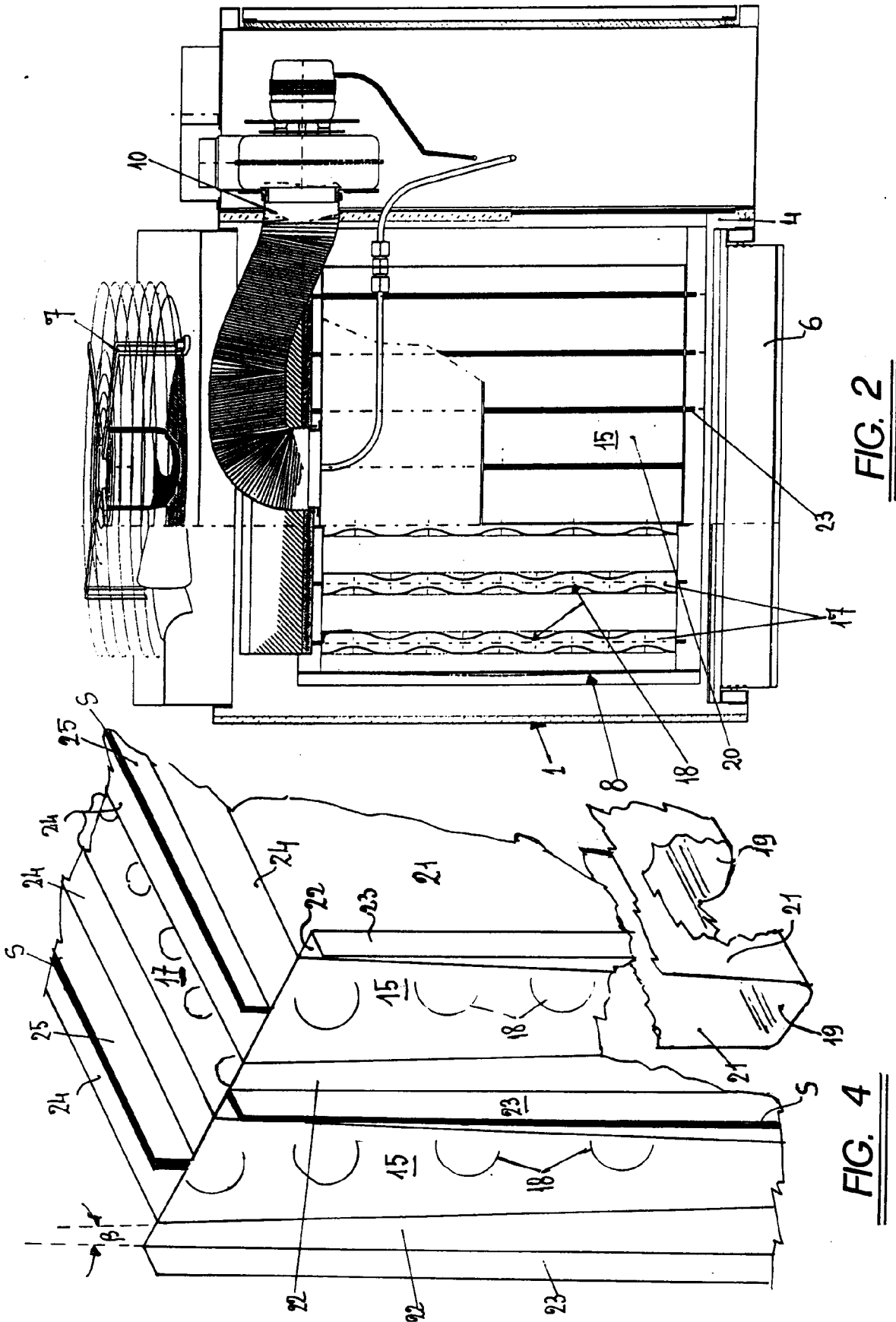
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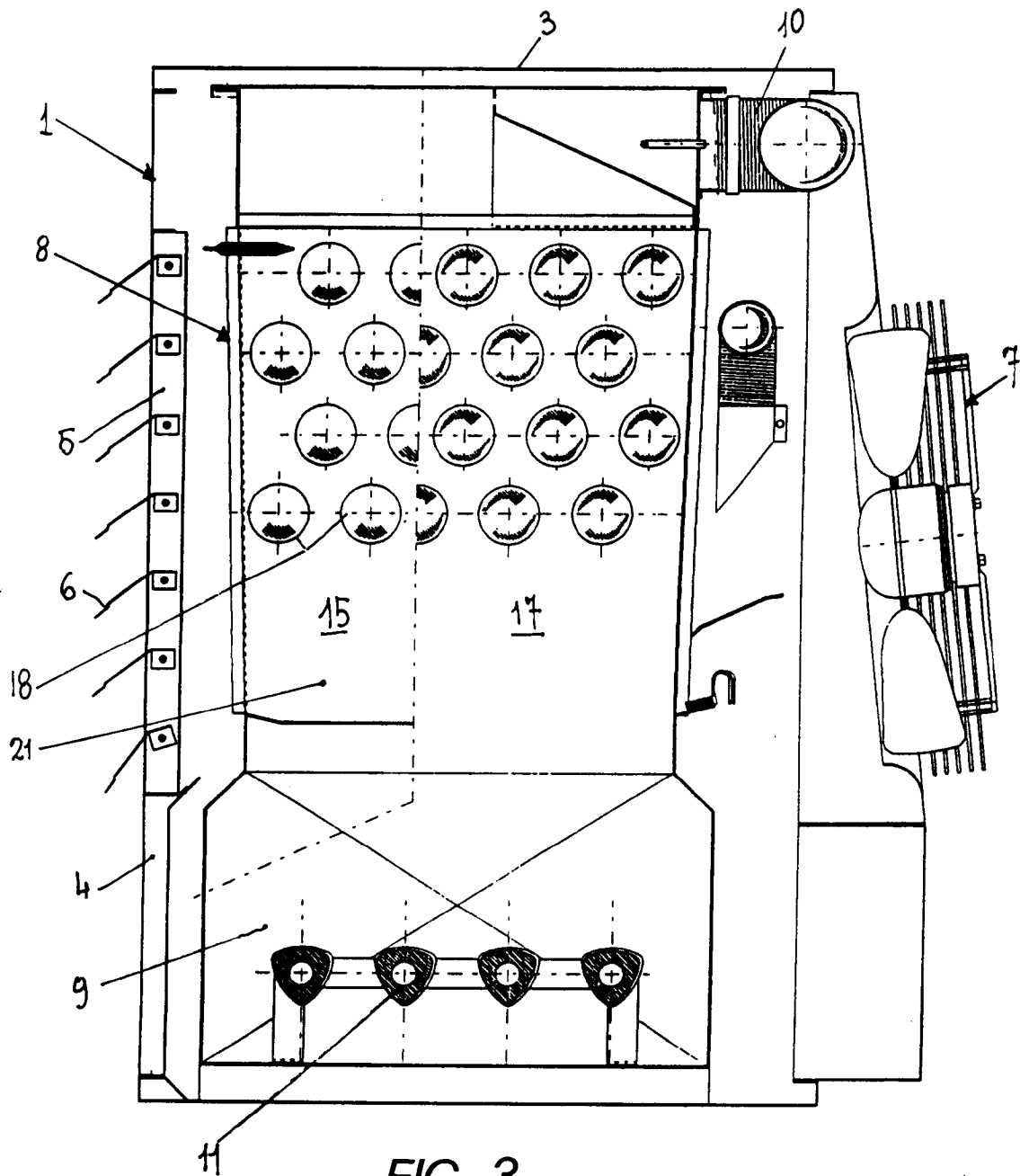


FIG. 3

