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(54) **HOT AIR GENERATOR**

HEISSLUFTERZEUGER

GENERATEUR D'AIR CHAUD

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(73) Proprietor: **TECNOCLIMA S.p.A.**
38057 Pergine Valsugana (Trento) (IT)

(72) Inventor: **VESCOVI, Alfonso**
I-38068 Rovereto (Trento) (IT)

(74) Representative: **Carloni, Franco**
c/o Calvani, Salvi & Veronelli S.r.l.,
Piazza Duca d'Aosta, 4
20124 Milano (IT)

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Description

Technical field

[0001] The present invention generally relates to the field of heating of industrial and civil facilities and, in particular, it relates to a new type of hot air generator.

Background Art

[0002] It is known that hot air generators generally comprise a combustion chamber where the combustion of a liquid or gas fuel takes place, an air-flue gas heat exchanger, a fan assembly that provides for a forced circulation of air, and a supporting frame on which the enclosure panels are applied, usually internally covered with a thermal insulating material to limit the thermal radiation from the furnace to the outside environment.

[0003] The combustion chamber is delimited by a housing in the interior part of which a liquid or gas fuel burner is located. A manifold communicating with the combustion chamber collects the flue gas and conveys it to the heat exchanger.

[0004] The heat exchanger is generally formed by a series of plates or tubes the surfaces of which are touched internally by the hot stream formed by the flue gas, and externally by the air stream to be heated. A final manifold collects the flue gas running through the heat exchanger and diffuses it through an outlet into the surrounding atmosphere. The fan can be of the axial or centrifugal kind and provides for an air circulation through the heat exchanger. Air in contact with the heat exchanger is heated and sent back to the surrounding environment.

[0005] Document DE 199 39 017 A1 discloses a heat exchanger, particularly for hot air generators of the kind mentioned above, which comprises a number of flat chamber-like modules, which modules are stacked and interconnected mechanically and in flow communication via openings in the modules and connecting sleeves surrounding the openings. This heat exchanger costs less to manufacture and service than other traditional heat exchangers, however it exhibits a low thermal efficiency because the heat transfer is penalised by the circumstance the flue gas velocity inside the heat exchanger is not constant, but decreases instead with the reduction in temperature and specific volume of the flue gas.

[0006] Document EP 0 431 446 A1 discloses a hot air generator comprising a combustion chamber, a gas burner, an air-flue gas heat exchanger, a fan for the forced circulation of the combustion products, and a fan for the forced circulation of the air to be heated. The heat exchanger is formed of a set of air tubes arranged side by side and supported at both ends thereof. The air tubes are arranged in spaced relationship so as to provide therebetween hollow spaces forming the flues. The air tubes have a cross-section which decreases with the reduction in temperature of the combustion products flowing into the heat exchanger so as to keep the flow velocity of the combustion products constant Accordingly, the heat exchanger exhibits a good thermal efficiency. However, a drawback of the heat exchanger is that it necessitates a rather long time and involves a rather high cost to manufacture, particularly because of the extensive welding operation required for its assembly and the time it takes for assessing the quality of the weld before the product is marketed.

Disclosure of Invention

[0007] The object of the present invention is to provide a hot air generator comprising a heat exchanger which is both economical to manufacture and thermally efficient.

According to the present invention, this object is achieved by a hot air generator including a liquid or gas fuel burner, a combustion air inlet, a combustion chamber, an air-flue gas heat exchanger, a fan providing for a forced flow of combustion products, a flue gas outlet, a fan providing for a forced flow of air to be heated, wherein: the heat exchanger is formed of a plurality of parallel spaced plates arranged in pairs and joined together on their edges, each pair of plates encloses a space provided for the flow of combustion products and has circular connections provided for the passage of combustion products into and from said enclosed space, the pairs of plates are arranged horizontally in side-by-side spaced relationship and are interconnected mechanically and in flow communication via sleeve-like connecting elements arranged around the circular connections, the interconnected pairs of plates are pressed together in a gastight manner by springs, tie bolts and spacers, characterised in that the interconnected pairs of plates included lower, intermediate and upper arrays of paired plates, wherein the arrays are arranged in series with respect to the direction of flow of combustion products, the direction of flow of combustion products in the intermediate array being opposite to the direction of flow of the combustion products in the lower and upper arrays, and the pairs of plates in the arrays decreasing in number and distance with the reduction in the temperature and specific volume of combustion products in order to maintain constant flow velocity of combustion products in the heat exchanger.

Brief description of drawings

[0008] The invention will now be described in more detail with reference to the attached drawings, in which:

Figure 1 is a side elevation view of the interior of the hot air generator according to the present invention,
Figure 2 is a cross-section view of the hot air generator along line II-II of figure 1,
Figure 3 is a cross-section view of the hot air generator along line III-III of figure 1,
Figure 4 is a longitudinal section view of the burner

of the hot air generator according to the present invention,
Figure 5 is a cross-section view of the burner of the hot air generator along line V-V of figure 4,
Figures 6 and 7 are a plan view of the upper part, respectively of the lower part, of a plate of the heat exchanger of the hot air generator of the present invention,
Figure 8 is a cross-section view of the plate of figure 6 taken along line VIII-VIII of figure 6,
Figure 9 is a longitudinal view of the plate of figure 6 taken along line IX-IX of figure 6,
Figure 10 is a section view of a connection element between a pair of plates of the heat exchanger of the hot air generator according to the present invention,
Figure 11 is a partial section view of the connection element of figure 10,
Figure 12 is s plan view of the connection element of figure 11, and
Figure 13 is a longitudinal section partial view of the heat exchanger of the hot air generator according to the present invention.

Best mode for carrying out the Invention

[0009] Referring now to figures 1, 2 and 3, these figures show a hot air generator according to the present invention, indicated generally with GA.

[0010] The hot air generator comprises an atmospheric type liquid or gas fuel burner 1 mixing a correct amount of fuel, fed by an electrical valve 2, with oxygen contained in air taken in through intake connector 3 and creating a radial type flame 9. Gases produced by the combustion, after an inversion of their stream inside the combustion chamber 4, are conveyed to successive arrays of elements of flue gas exchange pipes, connected in parallel and forming an horizontal exchanger 5. The combustion products are sucked through a centrifugal type fan 6 and, after having transferred their heat to the air inside the heat exchanger, they are ejected outside through the outlet connector 7. Air to be heated is forced through the heat exchanger by an axial or centrifugal type fan 8 and streams along the surface of the heat exchanger, warming up in contact therewith.

[0011] Figures 4 and 5 show a burner of the hot air generator according to the present invention. The burner 1 internally exhibits a Venturi pipe 10 having such a geometry as to permit operation with a prevailing amount of primary air P and reduced amount of secondary air S. In addition, the external surface 11 of burner 1 shows a series of holes 12 having variable diameter, so as to permit the formation of a flame distributed along a semicircular arc of the burner cross-section and to display a maximum height of the flame at the extremity of the semicircular arc and a minimum height of the flame at the midpoint of the semicircular arc. In this way, an efficient heat distribution is achieved inside the combustion chamber 4.

[0012] Figures from 6 to 9 show a plate 13 of the heat exchanger. Plate 13 has a series of cross type turbulence inducing imprints 14 for the gas that assure high efficiency and limited loss of pressure and a pair of buckling preventing spacing imprints 15 that allow to keep the upper and lower parts of the plate mutually spaced. In order to facilitate the plate assembly, height sizing imprints 16 are provided as well as circular connection connections 17 for the mutual connection of the plates in order to form the heat exchanger.

[0013] Figures from 10 to 12 show the connection element 18 that allows mutual connection of a pair of plates 13 of the heat exchanger horizontally placed one on top of the other. This connection element 18 assures a seal to the plates 13 even in the absence of welding. The connection element shows heat dissipating fins 19 as well as a tapered portion 20 having a wide contact surface. The connection element is configured in such a way as to act as a manifold for the combustion products flowing from the lower to the upper plate of the heat exchanger. The connection between the plates of the heat exchanger is obtained through pressure contact between the surfaces of plates 13 and that of the connection element 18. The circular drawing of plates 13 is carried out on the external surface in order to provide for an efficient cooling of the material, an excellent mechanical resistance to compressive stress and a low pressure loss. In addition, because of the conical shape of the drawing, the contact surface with the connection element is as wide as possible and allows to offset normal manufacturing tolerances.

[0014] As it can be seen from figure 13, the compressive force holding together the plates of the heat exchanger is achieved through springs 21, tie bolts 22 and spacers 23. The tie bolt 22, together with spacers 23, assures a correct positioning of plates 13 at a fixed mutual distance and the springs 21 surrounding tie bolts 22 provide for a constant lateral compressive force on plates 13, offsetting normal expansions originating from temperature changes.

[0015] According to the present invention, it is possible to change the number and distance of the plates forming each array in order to keep the velocity constant of the combustion products when their temperature and specific volume decrease, as a result of the thermal exchange with air. This allows to maximize the performance of the thermal exchange and to gear the heat exchanger to different requirements of thermal exchange.

Claims

1. Hot air generator (GA) including:

- a liquid or gas fuel burner (1),
- a combustion air inlet (3),
- a combustion chamber (4),
- an air-flue gas heat exchanger (5),

- a fan (6) providing for a forced flow of combustion products.
- a flue gas outlet (7).
- a fan (8) providing for a forced flow of air to be heated,

wherein:

- the heat exchanger (5) Is formed of a plurality of parallel **spaced plates (13) arranged in pairs and joined together on** their edges,
- each pair of plates (13) encloses a space provided for the flow of combustion products and has circular connections (17) provided for the passage of combustion products into and from said enclosed space,
- the pairs of plates (13) are arranged horizontally in side-by-side spaced relationship and are interconnected mechanically and in flow communication via sleeve-like connecting elements (18) arranged around the circular connections (17),
- the interconnected pairs of plates (13) are pressed together in a gastight manner by springs (21), tie bolts (22) and spacers (23)

characterised in the burner has an external surface having a circular cross-section and a series of holes arranged on an upper semicircular arc of the external surface of the burner and having variable diameter in order to generate flames having decreasing heights from the end of the semicircular arc to the upper midpoint, and the interconnected pairs of plates (13) include lower, intermediate and upper arrays of paired plates (13), wherein the arrays are arranged in series with respect to the direction of flow of combustion products and the pairs of plates (13) of each array are arranged in parallel with respect of the direction of flow of combustion products, the direction of flow of combustion products In the intermediate array being opposite to the direction of flow of combustion products in the lower and upper arrays, and the pairs of plates (13) in the arrays decreasing in number and distance with the reduction in the temperature and specific volume of combustion products in order to maintain constant flow velocity of combustion products in the heat exchanger.

2. Hot air generator according to claim 1, **characterised in that** the openings (17) in the plates (13) have a taper and the sleeve-like connecting elements (18) include tapered portions (20) matching the taper of the openings (17) in the plates (13).

3. Hot air generator according to claim 1, **characterised in that** the sleeve-like connecting elements (18) are provided with external heat dissipating fins (19).

4. Hot air generator according to claim 1, **characterised in that** the plates (13) are provided with turbulence inducing imprints (14) for efficient thermal exchange.

5. Hot air generator according to claim 1, **characterised in that** the paired plates (13) are kept apart by height-sizing imprints (15).

6. Hot air generator according to claim 1. **characterised in that** the burner (1) is tubular in shape and circular in cross-section, the upper half portion of the burner (1) including holes (12) having variable diameter and providing a flame formation which is distributed along an upper semicircular arc of a cross-section of the burner (1) and exhibits a maximum height of flame at the end points of the semicircular arc and a minimum height of flame at the midpoint of the semicircular arc.

Patentansprüche

1. Heisslufterzeuger (GA) mit:

- einem Brenner (1) für flüssigen oder gasförmigen Brennstoff,
- einem Verbrennungsluftzugang (3),
- einer Brennkammer (4),
- einem Luft-Abgas-Wärmetauscher (5)
- einem Ventilator (6), der den forcierten Umlauf der Verbrennungsprodukte herstellt,
- einem Gasrohrausgang (7),
- einem Ventilator (8) zum Verwirklichen einer zu erwärmenden Druckluftströmung,

worin,

- der Wärmetauscher (5) aus einer Vielzahl von paarweise angeordneten, an ihren Kanten miteinander verbundenen parallel distanzierten Platten (13) gebildet ist,
- jedes Paar der Platten (13) einen für die Strömung der Verbrennungsprodukte vorgesehenen Raum einschließt und kreisförmige Verbindungen (17) hat, die für den Durchgang der Verbrennungsprodukte in und aus dem eingeschlossenen Raum vorgesehen sind,
- die Paare der Platten (13) horizontal nebeneinander in einer distanzierten Beziehung angeordnet und mechanisch miteinander verbunden sind und über buchsenartige Verbindungselemente (18), die um die kreisförmigen Verbindungen (17) angeordnet sind, in einer Strömungskominunikation stehen,
- die untereinander verbundenen Paare der Platten (13) mittels Federn (21), Zugbolzen (22) und Abstandstücken (23) gasdicht zusammen-

gepresst sind,

der Brenner eine Außenfläche mit einem kreisförmigen Querschnitt und einer Reihe von Löchern hat, die auf einem oberen halbkreisförmigen Bogen der Außenfläche des Brenners angeordnet und von unterschiedlichen Durchmessern sind, um Flammen zu erzeugen, die vom Ende des halbkreisförmigen Bogens hin zum oberen Mittelpunkt unterschiedliche Höhen haben, und **dadurch gekennzeichnet, dass** die miteinander verbundenen Paare der Platten (13) untere, mittlere und obere Ränge gepaarter Platten (13) aufweisen, wobei die Ränge gegenüber der Strömungsrichtung der Verbrennungsprodukte serienmäßig angeordnet sind, und die Paare der Platten (13) eines jeden Ranges parallel zur Strömungsrichtung der Verbrennungsprodukte vorgesehen sind, wobei die Strömungsrichtung der Verbrennungsprodukte im mittleren Rang entgegengesetzt zur Strömungsrichtung der Verbrennungsprodukte im unteren und oberen Rang ist, und die Paare der Platten (13) in den Rängen anzahlmäßig und abstandsmäßig mit der Reduzierung der Temperatur und dem spezifischen Volumen der Verbrennungsprodukte abnehmen, so dass eine konstante Strömungsgeschwindigkeit der Verbrennungsprodukte im Wärmetauscher beibehalten wird.

2. Heisslufterzeuger nach Anspruch 1, **dadurch gekennzeichnet, daß** die Öffnungen (17) in den Platten (13) eine Auskeilung haben und die buchsenartigen Verbindungselemente (18) ausgekeilte Abschnitte (20) aufweisen, die mit der Auskeilung der Öffnungen (17) in den Platten (13) zusammenpassen.

3. Heisslufterzeuger nach Anspruch 1, **dadurch gekennzeichnet, daß** die buchsenartigen Verbindungselemente (18) mit äußeren Wärmezerstreuflügeln (19) ausgestattet sind.

4. Heisslufterzeuger nach Anspruch 1, **dadurch gekennzeichnet, dass** die Platten (13) mit wirbelerzeugenden Abdrücken (14) für einen wirksamen Wärmeaustausch ausgestattet sind.

5. Heisslufterzeuger nach Anspruch 1, **dadurch gekennzeichnet, dass** die gepaarten Platten (13) mittels Höhenabstandsabdrücken (15) distanziert werden.

6. Heisslufterzeuger nach Anspruch 1, **dadurch gekennzeichnet, dass** der Brenner (1) eine Rohrform und einen kreisförmigen Querschnitt hat, wobei der obere Teil des Brenners (1) Löcher (12) von unterschiedlichem Durchmesser hat, die eine Flammenbildung bewirken und die entlang einem oberen halbkreisförmigen Bogen eines Querschnitts des Brenners (1) verteilt sind und an den Endstellen des halbkreisförmigen Bogens eine maximale Flammenhöhe und im Mittelpunkt des halbkreisförmigen Bogens eine geringste Flammenhöhe zeigen.

Revendications

1. Générateur d'air chaud (GA) comprenant :

un brûleur de combustible liquide ou gazeux (1),
un orifice d'admission d'air de combustion (3),
une chambre de combustion (4),
un échangeur de chaleur air-gaz d'évacuation (5),
un ventilateur (6) produisant un écoulement forcé des produits de combustion,
un orifice de sortie de gaz d'évacuation (7),
un ventilateur (8) produisant un écoulement forcé de l'air à chauffer,

dans lequel :

l'échangeur de chaleur (5) est formé d'une pluralité de plaques espacées parallèles (13) disposées en paires et jointes au niveau de leurs bords,
chaque paire de plaques (13) entoure un espace prévu pour l'écoulement des produits de combustion et possède des connexions circulaires (17) prévues pour le passage des produits de combustion vers et depuis ledit espace entouré,
les paires de plaques (13) sont disposées horizontalement espacées et côte à côte et sont mécaniquement raccordées entre elles et en communication d'écoulement via des éléments de raccordement en forme de manchons (18) disposés autour des connexions circulaires (17),
les paires de plaques raccordées entre elles (13) sont pressées ensemble de manière étanche au gaz au moyen de ressorts (21), boulons d'assemblage (22) et entretoises (23),

caractérisé en ce que le brûleur comporte une surface externe possédant une section transversale circulaire et une série de trous disposés sur un arc semi circulaire supérieur de la surface externe du brûleur et présentant un diamètre variable afin de générer des flammes de hauteur décroissante de l'extrémité de l'arc semi circulaire au point intermédiaire supérieur, et
les paires de plaques raccordées entre elles (13) comprennent des groupes inférieur, intermédiaire et supérieur de paires de plaques (13), dans lequel les groupes sont disposés en série par rapport à la direction d'écoulement des produits de combustion et les paires de plaques (13) de chaque groupe sont disposées en parallèle par rapport à la direction

d'écoulement des produits de combustion, la direction d'écoulement des produits de combustion dans le groupe intermédiaire étant opposée à la direction d'écoulement des produits de combustion dans les groupes inférieur et supérieur, et les paires de plaques (13) dans les groupes diminuant en nombre et en distance avec la réduction de la température et du volume spécifique des produits de combustion afin de maintenir une vitesse d'écoulement constante des produits de combustion dans l'échangeur de chaleur.

2. Générateur d'air chaud selon la revendication 1, **caractérisé en ce que** les ouvertures (17) dans les plaques (13) possèdent un cône et les éléments de raccordement en forme de manchons (18) comprennent des parties coniques (20) qui correspondent aux cônes des ouvertures (17) dans les plaques (13).
'

3. Générateur d'air chaud selon la revendication 1, **caractérisé en ce que** les éléments de raccordement en forme de manchons (18) sont munis d'ailettes externes de dissipation de chaleur (19).

4. Générateur d'air chaud selon la revendication 1, **caractérisé en ce que** les plaques (13) sont munies d'empreintes productrices de turbulence (14) pour un échange thermique efficace.

5. Générateur d'air chaud selon la revendication 1, **caractérisé en ce que** les paires de plaques (13) sont gardées séparées par des empreintes de dimensionnement en hauteur (15).

6. Générateur d'air chaud selon la revendication 1, **caractérisé en ce que** le brûleur (1) est de forme tubulaire et de section transversale circulaire, la moitié supérieure du brûleur (1) comprenant des trous (12) présentant un diamètre variable et produisant une formation de flammes qui est distribuée le long d'un arc supérieur semi circulaire d'une coupe transversale du brûleur (1) et montre une hauteur des flammes maximale au niveau des points d'extrémité de l'arc semi circulaire et une hauteur des flammes minimale au niveau du point intermédiaire de l'arc semi circulaire.

FIG. 1

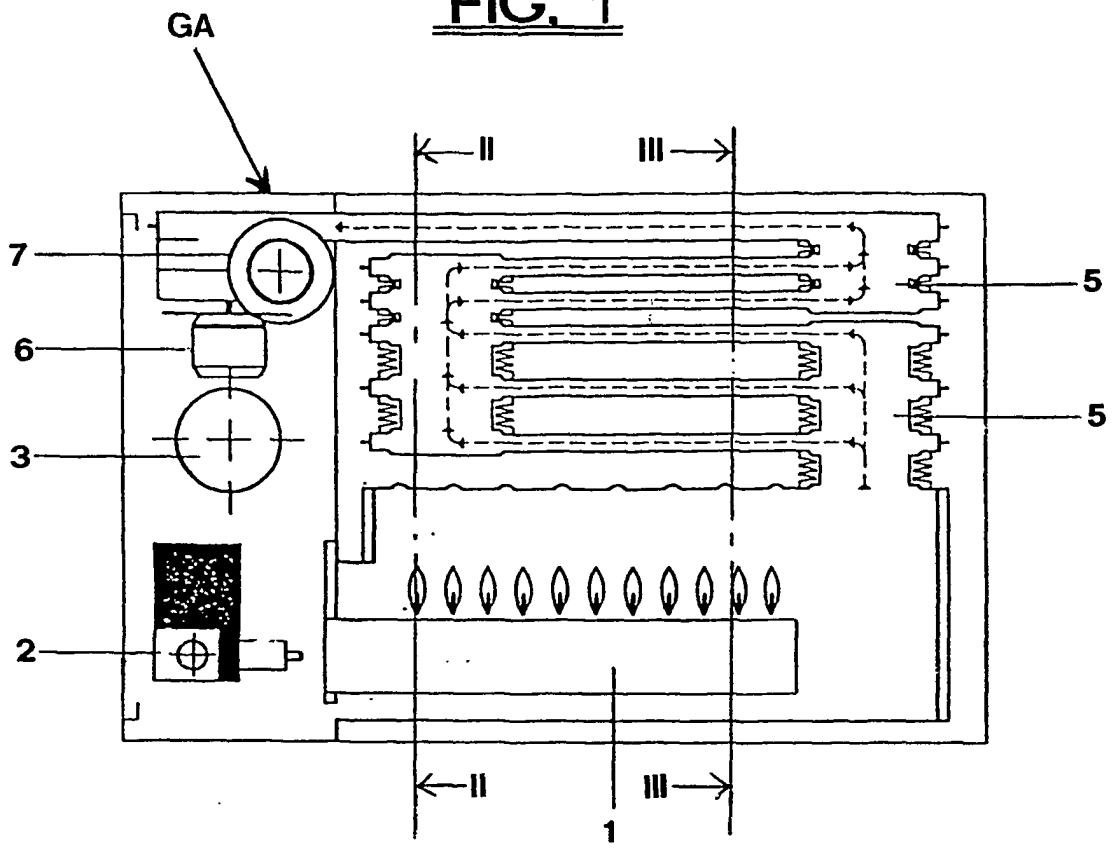


FIG. 2

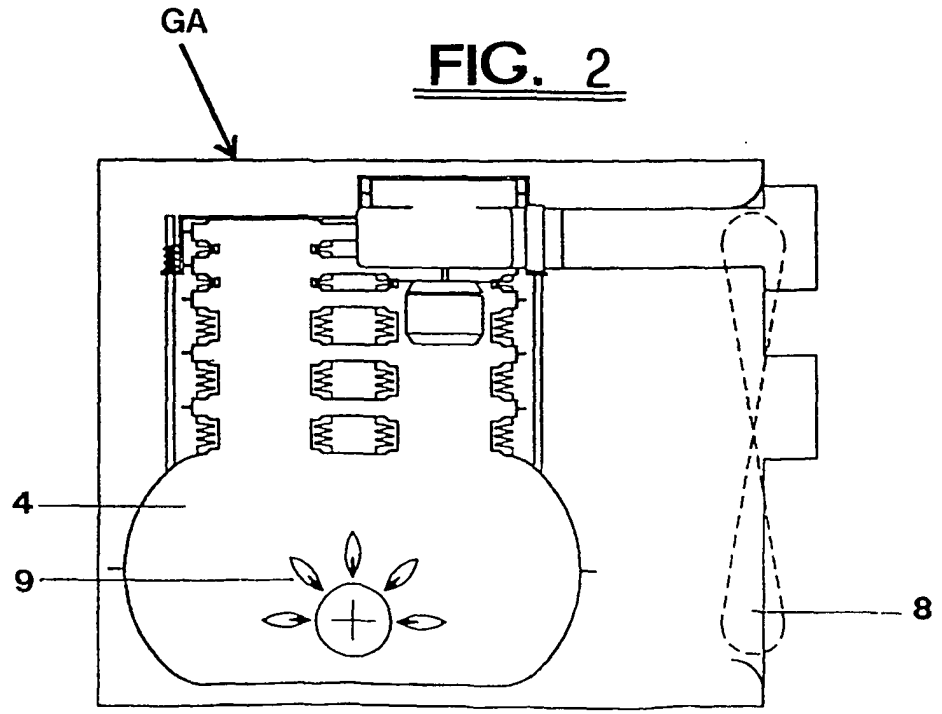


FIG. 3

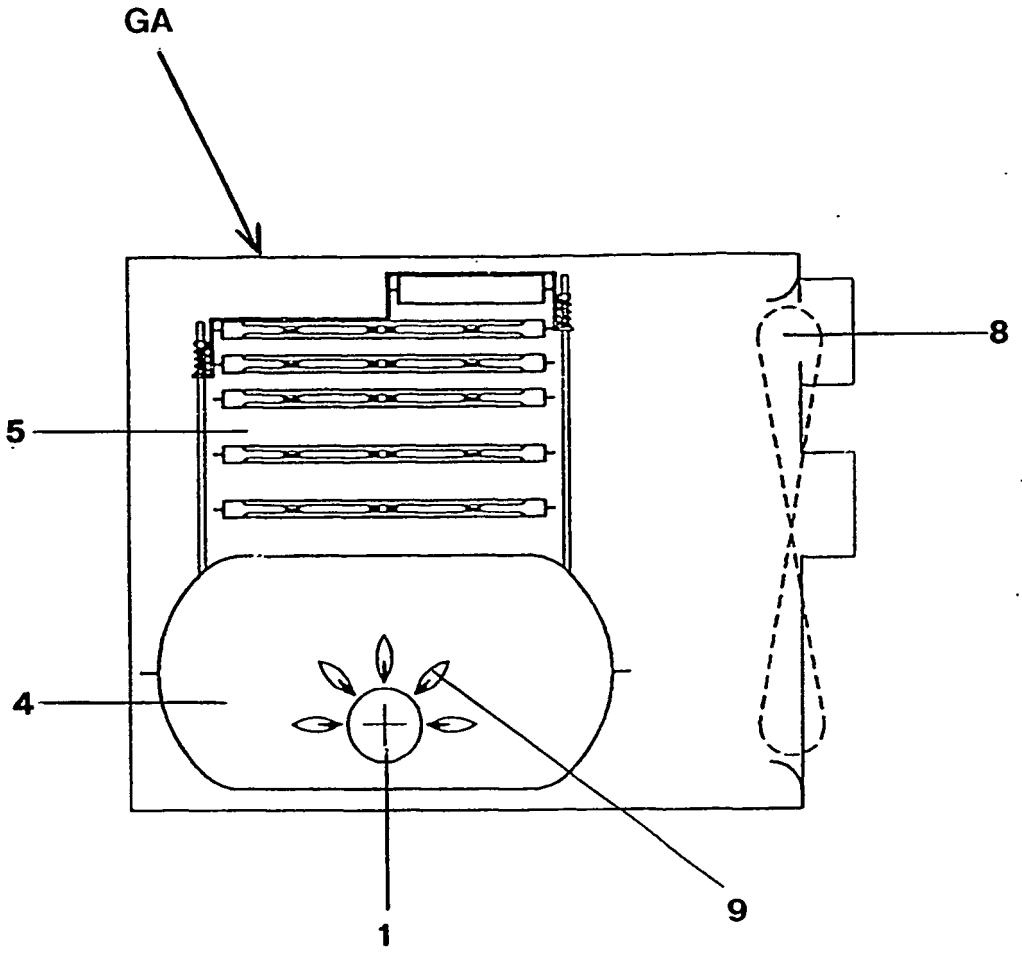


FIG. 5

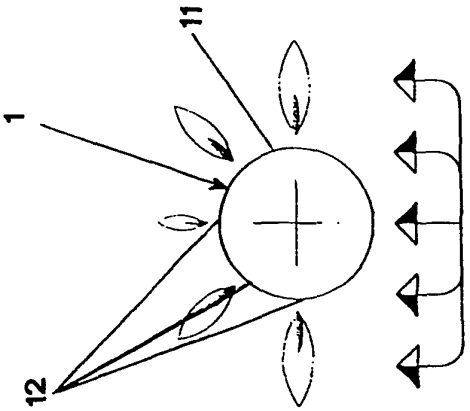


FIG. 4

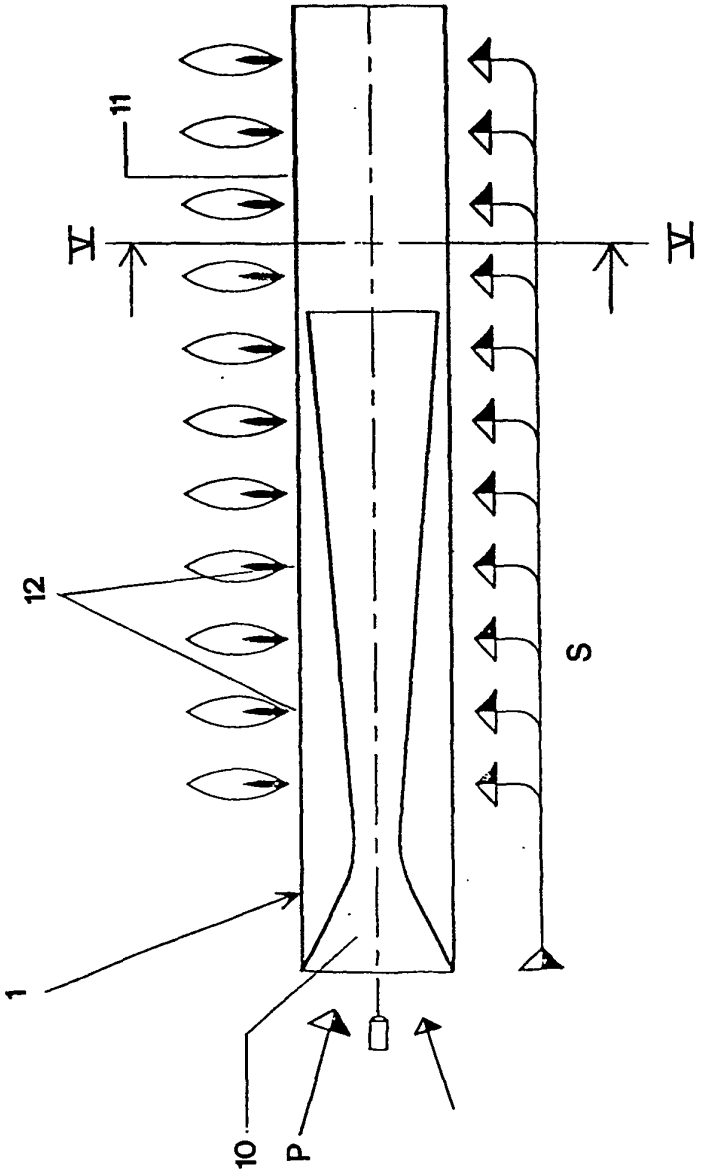


FIG. 6

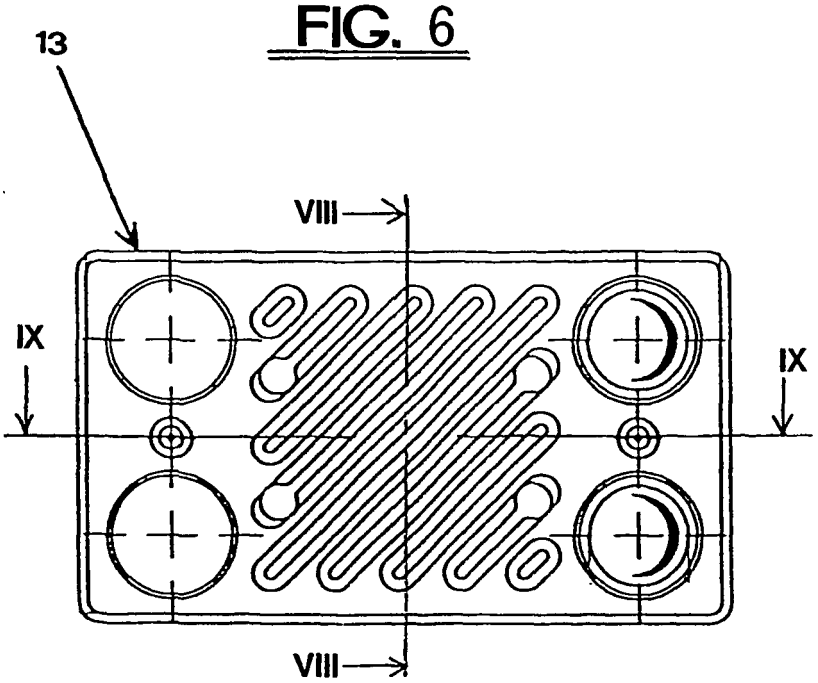
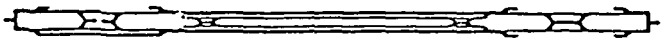


FIG. 8

FIG. 9



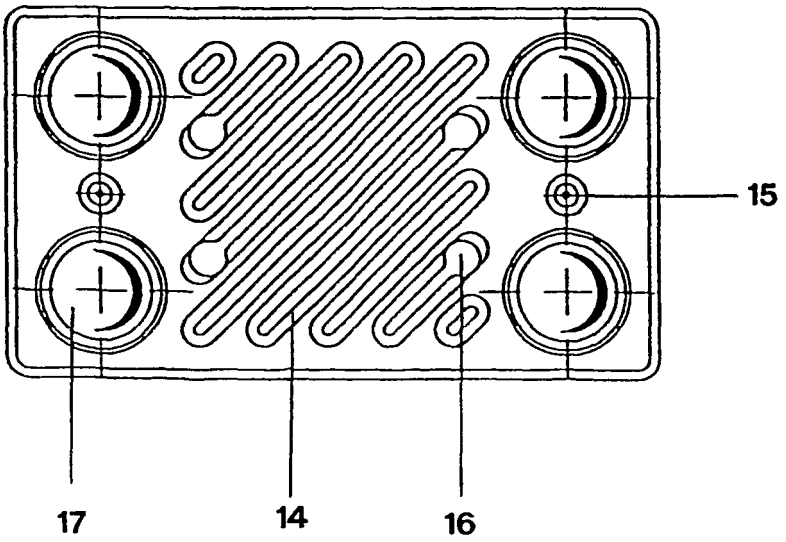


FIG. 7

FIG. 10

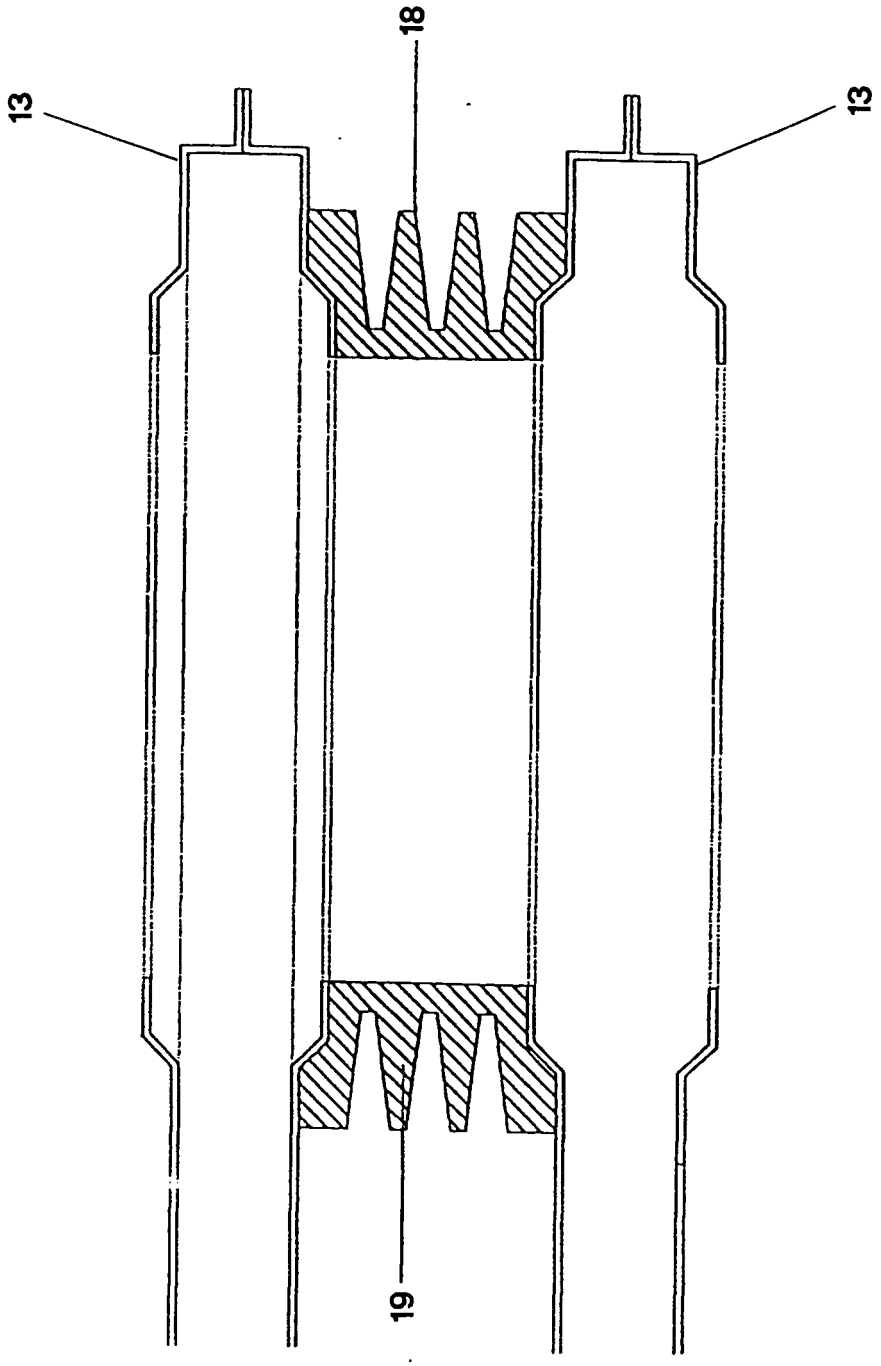


FIG. 12

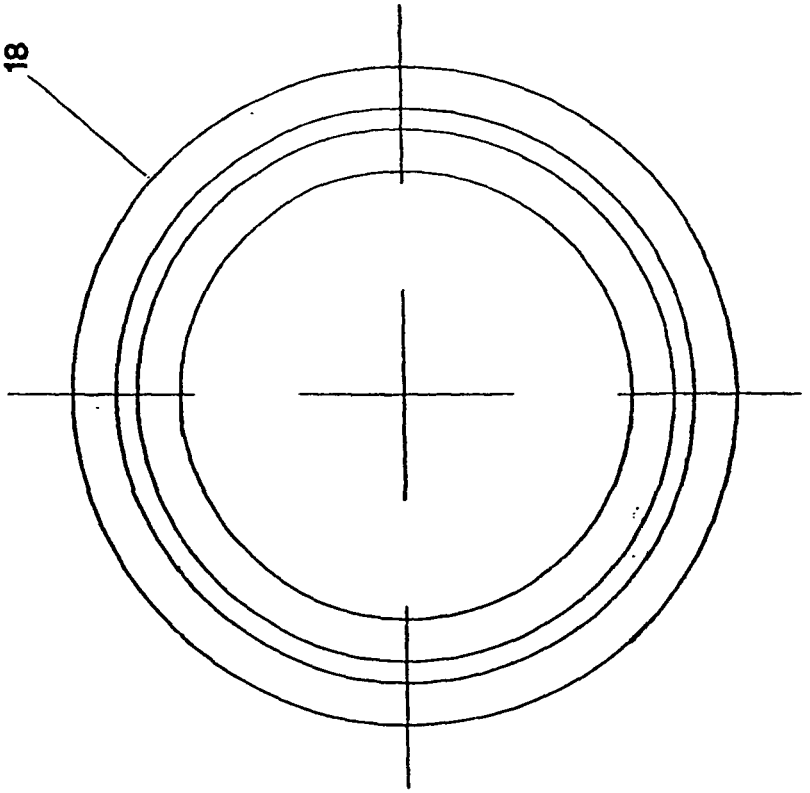


FIG. 11

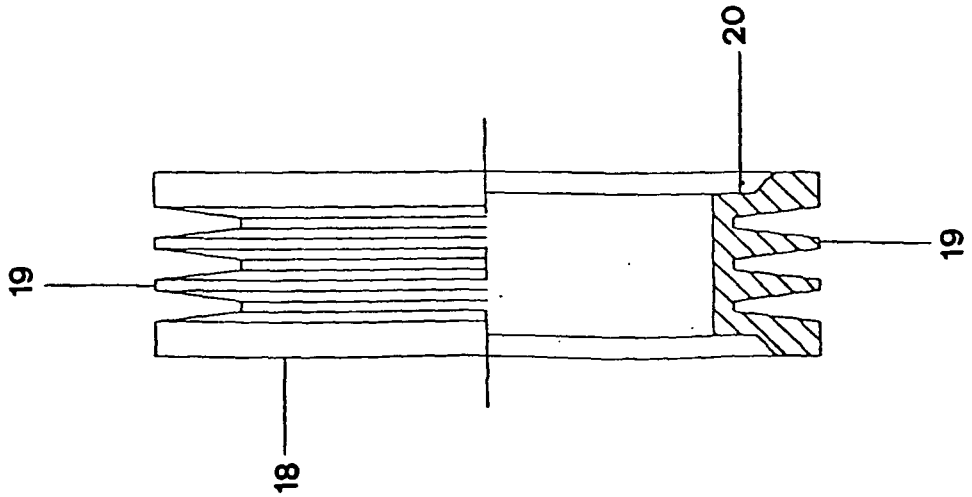
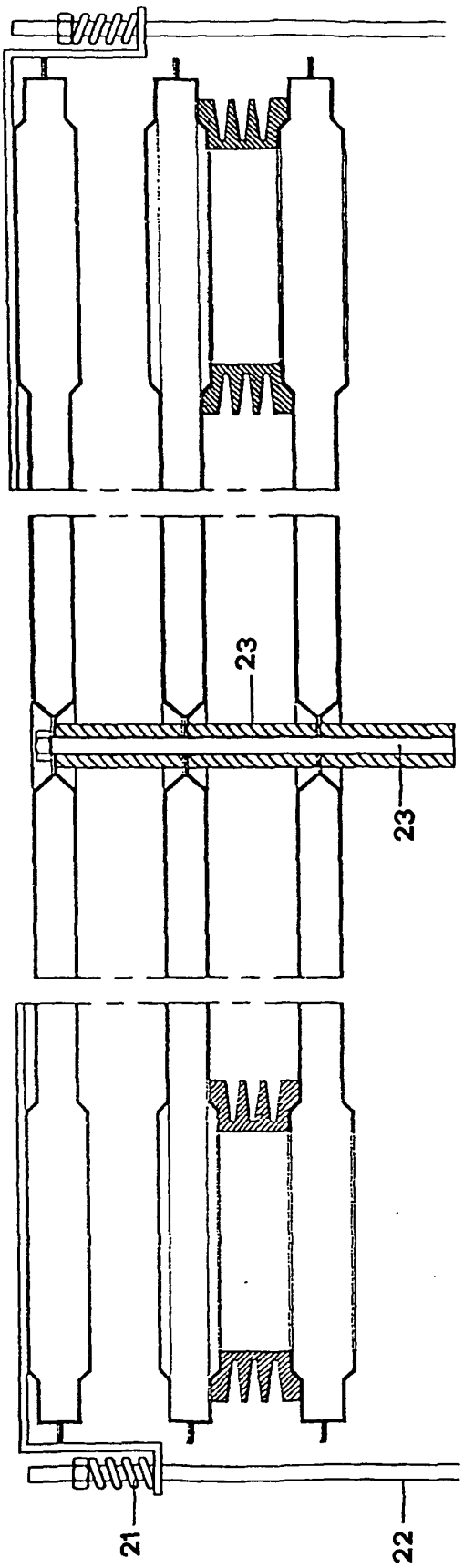


FIG. 13



REFERENCES CITED IN THE DESCRIPTION

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