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54 **GAS COOLER FOR HEAT TRANSFER BY RADIATION.**

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## Description

The invention relates to a gas cooler for cooling a flow of gas, mainly by radiation, in particular for cooling gas directly downstream of a gasification reactor for the gasification of solids, said gas cooler comprising an oblong vertically positioned circular-cylindrical pressure vessel with an upper inlet for gas and ash and an outlet for cooled gas in the vicinity of top of the vessel, a lower discharge for slag and in the vessel a heat exchange element with heat exchange surfaces extending substantially throughout the length of the vessel and being composed of tubes for carrying water and steam under high pressure, said heat exchange element including a first hollow, vertical circular section open at the ends and which is coaxial with the pressure vessel, and a second similar section located within the first section coaxially therewith, thereby defining a first central gas passage through which the gas from the gas inlet is allowed to flow vertically downwards, and a second gas passage between the lower open ends of the second and the first section and in which the direction of the gas flow is reversed by 180°, and a third gas passage formed by the interspace between the first and the second section through which the gas flows vertically upwards to the gas outlet in the vicinity of the top of the vessel.

The gas discharging from such a gas reactor may have a pressure of about 30 bar and a temperature of 1400°C or more, and the gas generally entrains liquid ash. In view of a subsequent washing operation, the gas is being cooled to about 200°C in several steps. The initial cooling is effected by means of a radiation cooler of the above mentioned type.

In order to obtain the highest possible efficiency of the plant producing the gas and in which the gas is possibly later on utilized, it is necessary to reuse the heat extracted from the gas by the cooling in the radiation cooler. This is done by running water and steam through the heat exchange elements in the cooler in a two-phase flow under high pressure, following which the steam is separated in an associated plant and utilized in a steam turbine plant.

In gas coolers of this type it is aimed at cooling the entrained liquid ash so much that it solidifies before the gas leaves the cooler and, if possible, before the gas reaches the bottom of the vessel. The gas passage has vertical walls, so that the slag does not deposit on said walls but is by gravity carried towards the bottom of the vessel where a water bath is generally arranged for cooling possible unsolidified ash particles. At the bottom of the vessel there is further provided a discharge device for batchwise removal of the slag while maintaining the pressure in the vessel.

As the gas flowing into the cooler at the top has a high temperature, the heat transfer in this area is very large and the heat transfer mainly takes place by

radiation. In step with the falling gas temperature a comparatively larger heat transfer area is required in order to cool the gas and the ash particles before reaching the bottom of the vessel and in prior art gas coolers this area is obtained by increasing the length of the heat exchange element and thus the length of the vessel until obtaining the necessary heat exchange area. Such long vessels suffer from the drawback that they are expensive and difficult to build and transport in a horizontal position, partly due to the length proper of the vessel but also because stiffeners and supports intended to carry the heat exchange element when the vessel is vertical have no effect when the vessel is horizontal and it is therefore necessary to install supplementary stiffeners in order to carry the heat exchange element in the last mentioned position. A gas cooler of the above mentioned type is known from US patent No. 4 493 291.

It is the object of the invention to provide a radiation cooler without the above described drawbacks.

In accordance with the invention this object is solved with the gas cooler of the generic kind in that it comprises a second heat exchange element centrally positioned in the lowermost portion of the first passage and a third heat exchanger element positioned in the uppermost portion of the third passage, that the second and the third heat exchanger elements are divided into separate, vertical, plane panels and that the tubes constituting the second heat exchanger element continue directly in the tubes constituting the third heat exchange element.

With the centrally located second heat exchanger element it is obtained that the liquid ash may be cooled so strongly that it solidifies prior to separation from the gas flow and the third heat exchanger element provides for obtaining a strong increase of the heat transfer area in the area of the cooler where the gas temperature is lowest and where the heat is partially transferred by convection. Heat exchange surfaces that are smooth and impede the collection of slag particles and which further present a comparatively small resistance to the passage of gas are obtained by designing the third heat exchange element as separate, plane, vertical panels. By making the tubes constituting the second heat exchange element continue directly in the tubes forming the third heat exchange element, it is further obtained that the two-phase flow of water and steam through the tubes may continue directly from one heat exchange element to the next one without being disturbed by flowing through conventional headers at the outlet from one heat exchange element and at the inlet for the following heat exchange element, respectively. The two-phase flow is very sensitive to changes in resistance and direction in the piping system, since such changes easily cause a separation of the flow in its two phases, resulting in a substantially reduced heat transfer and when the separated phases are united in

a header this may give rise to water hammering and cavitation in the pipe system. The piping according to the invention further provides for reducing the flow resistance on the gas side as well as on the coolant side.

According to a preferred embodiment of the invention the tubes connecting the second heat exchange element with the third exchange element pass between the tubes in the second section and are firmly connected therewith. The continuous tubes act in this way as suspensions for the second heat exchange element, thereby providing a supplementary stiffening.

A second embodiment is characterized in that the tubes forming the heat exchange surfaces extend mainly vertically and are preferably welded together to form membrane walls. These measures provide for obtaining heat exchange surfaces on which slag particles do not collect.

A further embodiment is characterized in that the first and/or the second section at the bottom is/are provided with inlet tubes which in the second gas passage constitute a screen for slag particles. In this design of the water inlet tubes to the heat exchange element it is obtained that larger ash particles entrained with the gas are prevented from penetrating into the third gas passage.

In some further preferred embodiments the panels of the second heat exchange element may have a radially outer edge firmly connected with the heat exchange surface of the second section and the panels of the third heat exchange element may each be firmly connected with heat exchange surfaces in the first and the second section. This provides for obtaining an advantageous mutual stiffening between the heat exchange surfaces that is effective in the vertical position as well as in the horizontal position of the vessel.

In an embodiment the first section, the second section and the third heat exchange element may at the top be connected with a common discharge header for water and steam and the header may be supported in the top portion of the vessel and may itself carry the total weight of all three heat exchange elements. The common discharge header may be suspended in the end plate or may for instance be supported by seats fastened by welding at the top of the shell. As the total weight of all the heat exchange elements in the vertical position of the vessel is supported by the common discharge header, it is only necessary to guide the heat exchange elements at the bottom in a known manner so as to be movable in the longitudinal direction to cater for the thermal expansion. The frequently complicated and bulky stiffening used in prior art coolers may thus be omitted. Due to the cylindrical shape of the heat exchange elements they are sufficiently rigid to allow transportation of the cooler in the horizontal direction without the need

for supplementary stiffeners. This embodiment presents the further advantage that the maintenance of the heat exchange surfaces is facilitated, because the elements may be lifted as a unit out of the vertical vessel after the top thereof has been dismantled.

The invention will now be explained in detail with reference to various embodiments and to the drawings, in which

Fig. 1 is a somewhat schematic, longitudinal section along line I-I in Fig. 2 of a radiation cooler according to the invention,

Fig. 2 is a section along line II-II in Fig. 1,

Fig. 3 is a cross-section of the upper portion of a second embodiment of the radiation cooler, and Fig. 4 is a cross-section as in Fig. 3 of a third embodiment of the radiation cooler.

The radiation cooler illustrated in Fig. 1 consists of an oblong, circular-cylindrical pressure vessel 1 with a shell 2 and provided at the top and at the bottom with end plates 3 and 4, respectively. The upper end plate 3 includes a pipe stub 5 to be connected with a conduit, not shown, for the supply of hot gas to the radiation cooler. The end plate 3 has an internal, thermal insulation 6 to protect against the heat impact from the gas and the corrosive action from molten ash entrained with the gas. To cool the insulation 6 a cooling coil 7 is inserted therein.

Closely beneath the end plate 3 the shell accommodates a pipe stub 8 for the discharge of cooled gas from the radiation cooler. The lowermost end plate 4 is provided with a pipe stub 9 to be connected with a device, not shown, for the removal of cooled slag from the bottom 4 of the vessel while keeping vessel 1 under pressure.

A first heat exchanger element having a first section 10 designed as a circular-cylindrical tube open at either end and whose tubular wall is a membrane wall with vertically extending tubes is accommodated within the vessel and coaxially therewith. Section 10 is spaced apart from the shell 2 but is located close thereto. A second section 11 of the heat exchange element is structured in the same manner as section 10 but has a smaller diameter and is accommodated within section 10 coaxially with the vessel. Section 11 extends from the same level at the top of the vessel as section 10 but is somewhat shorter than section 10. Between sections 10 and 11 there is, moreover, in the third gas passage 14 vertical equidistant panels 10a positioned in planes containing the vessel axis.

Due to this design and positioning of sections 10 and 11 a first central gas passage 12 is provided which is defined by the inside face of section 11, a second gas passage 13 formed by the vessel space between the lowermost open ends of sections 10 and 11 and a third gas passage 14 constituted by the interspace between sections 10 and 11. In the lower portion of the first gas passage 12 and concentrically with the vessel there is located a second heat ex-

changer element 15 substantially structured as panels 15a of vertical membrane walls arranged in planes containing the vessel axis and the radial outer edges of which are secured to the membrane walls of section 11. The lowermost end of the heat exchange element 15 is located on a level flush with the lowermost open end of section 11.

At the top end of the heat exchange element 15 the tubes constituting the membrane walls extend obliquely upwards and out through the membrane walls of section 11, following which they continue upwards through gas passage 14, forming there a third heat exchange element 16 terminating on a level below the gas outlet pipe stub 8. As illustrated in Fig. 2, the heat exchange element 16 is formed by several vertical panels 16a each of which is manufactured as a membrane wall with vertically extending tubes.

In the embodiment illustrated in Fig. 1 the first and the second heat exchange element 15 has at the bottom a inlet header for coolant. The coolant passes directly from the heat exchange element 15 to the heat exchange element 16 without flowing at first through a discharge header and an inlet header for the heat exchange elements 15 and 16, respectively. At the top the heat exchange elements have a common discharge header 20 for coolant. The discharge header 20 is by means of the outlet tubes suspended at the end plate 3, and the total weight of all of the heat exchange elements is thus carried by the discharge header. The inlet header includes guides, not shown, limiting the radial movement of the heat exchange elements, but allowing the heat exchange elements to move freely in the longitudinal direction of the vessel under the influence of the prevailing temperature and pressure conditions.

As mentioned above, the tubes continue from the membrane walls of the second heat exchange element 15 through the membrane walls of the second section 11. This is done by interlacing the tubes from the two heat exchange surfaces in a known manner. In the area of interlacing the tubes from the two heat exchange surfaces are further welded together, thereby ensuring a good support and stiffening of the upper end of the second heat exchange element 15 as well as of the lower end of the third heat exchange element 16. By such a utilization of the inlet and discharge headers of the individual heat exchange elements and their membrane walls as stiffeners and supporting elements, the complicated stiffening used in prior art radiation coolers and which, on one hand, is bulky and, on the other hand involves the risk of accumulation of slag particles is thus avoided. The above described stiffening in the cooler according to the invention is also sufficient in situations where the cooler is being transported substantially in the vertical direction.

In the embodiment illustrated in Fig. 3 the first heat exchanger is structured substantially as men-

tioned in the description of Fig. 1 but the third heat exchange element 16 is in this figure shown as panels of vertical membrane walls tangentially disposed in the third gas passage 14.

In the embodiment shown in Fig. 4 the vertically extending membrane walls of the third heat exchange element 16 are firmly connected with the membrane walls of the first and second heat exchange elements. This offers an additional mutual stiffening of the first, the second and the third heat exchange element in the uppermost section of the vessel.

The radiation cooler according to the invention operates in the following manner. Hot gas from a gasification reactor flows through pipe stub 5 at a temperature in the range of 1400°C or more, and further down through the first central gas passage 12. In this first area a very strong heat transfer takes place mainly due to radiation. In the following part of the gas passage 12 the gas is further cooled upon sweeping down along the second heat exchanger element. The temperature of the gas and the entrained liquid ash is thereby lowered so much that at least the finer ash particles have completely solidified upon reaching the second gas passage 13. Due to the inertia and by gravity bigger molten ash particles continue directly down towards the bottom 4 of the vessel, a water bath being arranged there for cooling the ash particles. The collected slag may be discharged through pipe stub 9 by means of a sluice arrangement while keeping the vessel under pressure. While the gas is flowing through the gas passage 13 the direction of the gas flow is being reversed by 180° and the gas now flows upwards in the gas passage 14 while being still cooled. The gas temperature will gradually fall so much that the heat transfer to the heat exchanger elements, in particular when the gas flows through the third heat exchange element, substantially takes place by convection. The gas leaves the cooler through pipe stub 8 at the top portion of the third heat exchange element.

In view of the fact that all heat exchange elements are designed as membrane walls with vertical tubes, slag adhering to the walls in the first gas passage will be swept towards the vessel bottom by the gas flow assisted by the gravitational force. The change in direction of the gas flow in the second gas passage further contributes to separating heavier slag particles falling down into the bottom of the vessel and the vertical surfaces in the third gas passage also contribute to prevent possible accumulation of particles.

In the embodiment illustrated in Fig. 1 the first section 10 and the second section 11 have at their bottom a common inlet header 23 and the tubes 21 from this inlet header to the second section 11 are drawn so as to form a screen for slag particles in the second gas passage 13. Moreover, this contributes to

preventing larger particles from being passed further upwards through the third passage 14.

With the view of further preventing slag particles from accumulating on the heat exchange surfaces, mechanical vibration means may be positioned at the inlet header 23, because the side guides for the heat exchange elements here allow some movement of said elements, thereby allowing the vibration means to work with a particularly high efficiency. In the upper part of the vessel, in particular in the upper part of the third gas passage 14 it may be advantageous to insert soot blowers for cleaning the vertical ducts between the vertical membrane walls of the fourth heat exchange element because the effect of the vibration means in this area will be lower due to the stiffer structure in the area.

### Claims

1. A gas cooler for cooling a flow of gas, mainly by radiation, in particular for cooling gas directly downstream of a gasification reactor for the gasification of solids, said gas cooler comprising an oblong vertically positioned circular-cylindrical pressure vessel (1) with an upper inlet (5) for gas and ash and an outlet (8) for cooled gas in the vicinity of the top of the vessel, a lower discharge (9) for slag and in the vessel (1) a heat exchange element with heat exchange surfaces extending substantially throughout the length of the vessel and being composed of tubes for carrying water and steam under high pressure, said heat exchange element including a first hollow, vertical circular section (10) open at the ends and which is coaxial with the pressure vessel (1), and a second similar section (11) located within the first section (10) coaxially therewith, thereby defining a first central gas passage (12) through which the gas from the gas inlet (5) is allowed to flow vertically downwards, and a second gas passage (13) between the lower open ends of the second (11) and the first section (10) and in which the direction of the gas flow is reversed by 180°, and a third gas passage (14) formed by the interspace between the first (10) and the second section (11) through which the gas flows vertically upwards to the gas outlet (8), characterized in that it comprises a second heat exchange element (15) centrally positioned in the lowermost portion of the first passage (12) and a third heat exchange element (16) positioned in the uppermost portion of the third passage (14), that the second and the third heat exchange elements are divided into separate, vertical, plane panels (15a, 16a) and that the tubes constituting the second heat exchange element (15) continue directly in the tubes constituting the third heat exchange

element (16).

2. A gas cooler as claimed in claim 1, characterized in that the tubes connecting the second heat exchange element (15) with the third exchange element (16) pass between the tubes in the second section (11) and are firmly connected therewith, which section thus carries the second heat exchange element (15).
3. A gas cooler as claimed in claim 1 or 2, characterized in that the tubes forming the heat exchange surfaces extend mainly vertically and are preferably welded together to form membrane walls.
4. A gas cooler as claimed in any of the preceding claims, characterized in that the first (10) and/or the second section (11) at the bottom is/are provided with inlet tubes (21) which in the second gas passage (13) constitute a screen for slag particles.
5. A gas cooler as claimed in any of the preceding claims, characterized in that the panels (15a) of the second heat exchange element (15) have a radially outer edge firmly connected with the heat exchange surface of the second section (11).
6. A gas cooler as claimed in any of the preceding claims, characterized in that each of the panels (16a) of the third heat exchange element (16) is firmly connected with heat exchange surfaces in the first (10) and the second (11) section.
7. A gas cooler as claimed in any of the preceding claims, characterized in that the first section (10), the second section (11) and the third heat exchange element (16) are connected at the top with a common discharge header (20) for water and steam and that the common discharge header (20) is supported at the top portion of the vessel (1) and carries by itself the total weight of all three heat exchange elements.
8. A gas cooler as claimed in any of the preceding claims, characterized in that it includes soot blowers, preferably at the top portion of the second heat exchange element and mechanical vibration means, preferably in the areas at the inlets or outlets of the heat exchange elements for cleaning the heat exchange surfaces during operation.

### Patentansprüche

1. Gaskühler zur Kühlung eines Stroms von Gas, hauptsächlich durch Strahlung, besonders zur

- Kühlung von Gas direkt stromabwärts eines Vergasungsreaktors für die Vergasung fester Stoffe, umfassend einen länglichen senkrecht platzierten kreiszylindrischen Druckbehälter (1) mit einem oberen Einlaß (5) für Gas und Schlacke, einem Auslaß (8) für gekühltes Gas nahe dem Oberteil des Behälters und einem unteren Auslaß (9) für Schlacke, einen im Behälter (1) angeordneten Wärmeaustauschelement mit Wärmeaustauschflächen, die sich größtenteils über die ganze Länge des Behälters erstrecken, und aus Rohren zusammengesetzt sind, die für Führung von Wasser und Wasserdampf unter hohem Druck eingerichtet sind, erwähntes Wärmeaustauschelement umfassend einen ersten hohlen, senkrechten, zirkularen und bei den Enden offenen Abschnitt (10), der mit dem Druckbehälter koaxial ist, und einen zweiten in dem ersten Abschnitt (10) platzierten und damit koaxialen ähnlichen Abschnitt (11), sodaß eine erste zentrale Gaspassage (12), durch welche das Gas vom Gasauslaß (5) vertikal abwärts strömen kann, und eine zweite Gaspassage (13) zwischen den unteren offenen Enden des zweiten (11) und des ersten Abschnitts, und in welche die Richtung des Gasstroms 180° gewendet wird, und eine dritte vom Zwischenraum zwischen der ersten (10) und zweiten (11) gebildeten Gaspassage (14), und durch welche das Gas vertikal aufwärts zum Gasauslaß (8) strömt, definiert werden, dadurch gekennzeichnet, daß der Gaskühler ein im untersten Teil der ersten Passage (12) zentral platziertes zweites Wärmeaustauschelement (15) und ein im obersten Teil der dritten Passage (14) platziertes drittes Wärmeaustauschelement (16) umfaßt, daß die zweiten und dritten Wärmeaustauschelemente in separate, senkrechte, ebene Paneele (15a, 16a) geteilt sind, und daß die Rohre, die das zweite Wärmeaustauschelement (15) bilden, direkt in die Rohre übergehen, die das dritte Wärmeaustauschelement (16) bilden.
2. Gaskühler nach Anspruch 1, dadurch gekennzeichnet, daß die Rohre, die das zweite Wärmeaustauschelement (15) mit dem dritten Wärmeaustauschelement (16) verbinden, durch die Rohre in dem zweiten Abschnitt (11) verlaufen und damit fest verbunden sind, welcher Abschnitt somit das zweite Wärmeaustauschelement (15) trägt.
3. Gaskühler nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Rohre, die die Wärmeaustauschflächen bilden, hauptsächlich senkrecht verlaufen, und vorzugsweise zusammengeschweißt sind, um Membranwände zu bilden.
4. Gaskühler nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der erste (10) und/oder der zweite Abschnitt (11) unten mit Einlaßrohren (21) versehen ist/sind, die in der zweiten Gaspassage (13) einen Auffangrost für Schlackenpartikeln bilden.
5. Gaskühler nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Paneele (15a) des zweiten Wärmeaustauschelementes (15) eine radial äußere Kante aufweisen, die mit der Wärmeaustauschfläche des zweiten Abschnitts (11) fest verbunden ist.
6. Gaskühler nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jedes der Paneele (16a) des dritten Wärmeaustauschelementes (16) mit der Wärmeaustauschfläche des ersten und des zweiten Abschnitts (11) fest verbunden ist.
7. Gaskühler nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der erste Abschnitt (10), der zweite Abschnitt (11) und das dritte Wärmeaustauschelement (16) mit einem gemeinsamen Auslaßkasten (20) für Wasser und Wasserdampf oben verbunden sind, und daß der gemeinsame Auslaßkasten (20) im oberen Teil des Behälters (1) aufgehängt ist und das gesamte Gewicht aller drei Wärmeaustauschelemente selbst trägt.
8. Gaskühler nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß er Rußgebläse, vorzugsweise beim oberen Teil des zweiten Wärmeaustauschelementes, und mechanische Vibrationsorgane, vorzugsweise in den Bereichen bei den Einläßen oder Ausläßen des Wärmeaustauschelementes, für die Reinigung der Wärmeaustauschflächen in Betrieb umfaßt.

## Revendications

1. Refroidisseur de gaz pour le refroidissement d'un courant de gaz, essentiellement par rayonnement, en particulier refroidissement de gaz directement en aval d'un réacteur de gazéification de solides, ledit refroidisseur de gaz comportant un récipient oblong (1) placé verticalement, de forme cylindrique à section circulaire, résistant à la pression, ayant, dans le haut, une entrée (5) de gaz et de cendres et une sortie (8) de gaz refroidis à proximité du haut du récipient ainsi qu'une sortie inférieure (9) de scories, ce récipient (1) logeant un élément échangeur de chaleur à parois échangeuses de chaleur qui s'étend essentiellement sur toute la longueur du récipient et qui est composé de tubes de transport d'eau et de va-

- peur sous haute pression, ledit élément échangeur de chaleur comprenant une première section (10) circulaire, creuse, verticale, ouverte aux extrémités et placée coaxialement avec le récipient résistant à la pression (1), et une seconde section similaire (11) placée coaxialement dans la première section et définissant ainsi un premier passage central de gaz (12) à travers lequel les gaz provenant de l'entrée de gaz (5) peuvent s'écouler verticalement vers le bas et un second passage de gaz (13) entre les extrémités inférieures ouvertes de la seconde section (11) et de la première section (10) et dans lequel le sens d'écoulement des gaz est inversé de 180°, ainsi qu'un troisième passage de gaz (14) formé par l'espace intermédiaire entre la première section (10) et la seconde section (11) et par lequel les gaz s'écoulent verticalement vers le haut jusqu'à la sortie de gaz (8), **caractérisé** par le fait qu'il comprend un second élément échangeur de chaleur (15) situé centralement dans la partie inférieure du premier passage (12) et un troisième élément échangeur de chaleur (16) placé dans la partie supérieure du troisième passage (14), en ce que les second et troisième éléments échangeurs de chaleur sont répartis en panneaux plans, verticaux, séparés (15a, 16a), et en ce que les tubes constituant le second élément échangeur de chaleur (15) se prolongent directement dans les tubes constituant le troisième élément échangeur de chaleur (16).
2. Refroidisseur de gaz selon la revendication 1, **caractérisé** en ce que les tubes reliant le second élément échangeur de chaleur (15) au troisième élément échangeur de chaleur (16) passent entre les tubes dans la seconde section (11) et sont fermement reliés à celle-ci, ladite section portant ainsi le second élément échangeur de chaleur (15).
3. Refroidisseur de gaz selon les revendications 1 ou 2, **caractérisé** en ce que les tubes formant les surfaces échangeuses de chaleur s'étendent essentiellement verticalement et sont, de préférence, soudés les uns aux autres pour former des parois composées de tubes.
4. Refroidisseur de gaz selon une quelconque des revendications précédentes, **caractérisé** en ce que la première section (10) et/ou la seconde section (11) est/sont, dans le fond, pourvue(s) de tubes d'entrée (21) qui dans le second passage de gaz (13) forment écran aux particules de scories.
5. Refroidisseur de gaz selon une quelconque des revendications précédentes, **caractérisé** en ce que les panneaux (15a) du second élément échangeur de chaleur (15) ont un rebord extérieur radial fermement relié à la surface échangeuse de chaleur de la seconde section (11).
6. Refroidisseur de gaz selon une quelconque des revendications précédentes, **caractérisé** en ce que chacun des panneaux (16a) du troisième élément échangeur de chaleur (16) est fermement relié aux surfaces échangeuses de chaleur de la première section (10) et de la seconde section (11).
7. Refroidisseur de gaz selon une quelconque des revendications précédentes, **caractérisé** en ce que la première section (10), la seconde section (11) et le troisième élément échangeur de chaleur (16) sont, au sommet, reliés à une tête commune (20) de sortie d'eau et de vapeur, et ce que la tête commune (20) de sortie est supporté dans la partie haute du récipient (1) et supporte, elle-même, le poids total de l'ensemble des trois éléments échangeurs de chaleur.
8. Refroidisseur de gaz selon une quelconque des revendications précédentes, **caractérisé** par le fait qu'il comporte des dispositifs de soufflage de suie, de préférence dans la partie haute du second élément échangeur de chaleur, et des moyens de vibrage mécanique, de préférence dans les zones des entrées ou sorties des éléments échangeurs de chaleur, pour le nettoyage des surfaces échangeuses de chaleur en cours de fonctionnement.

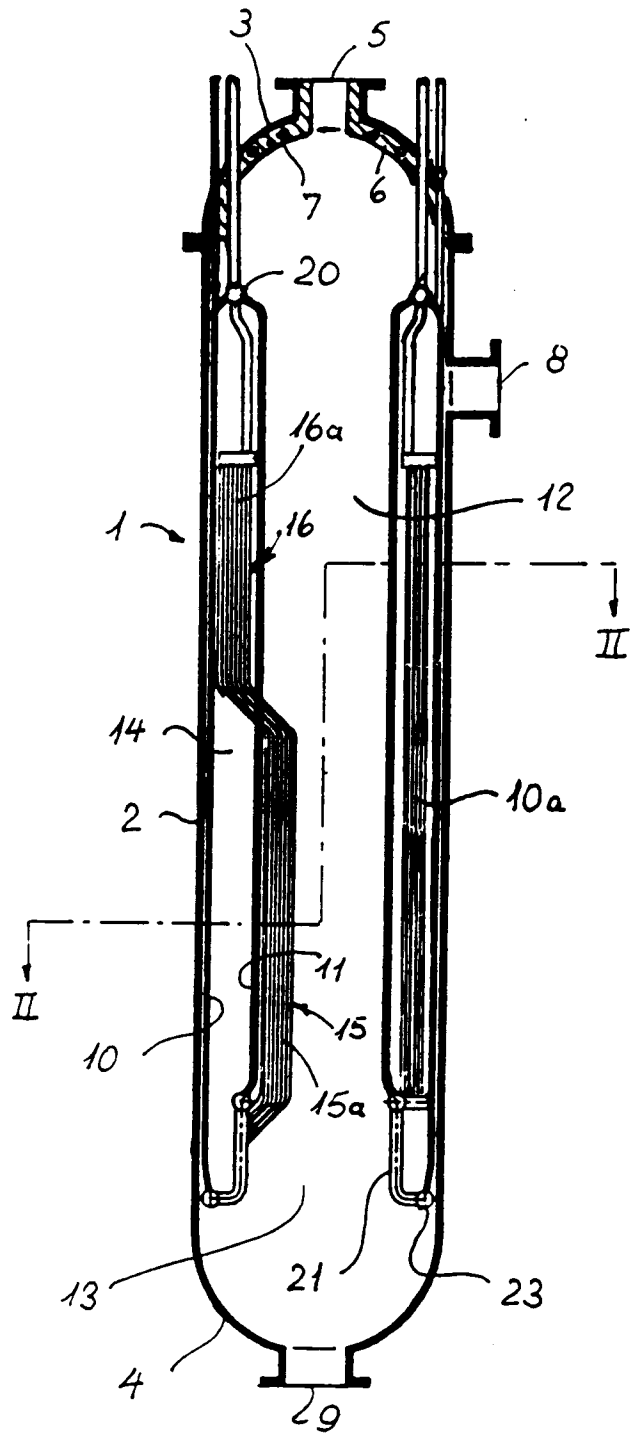


FIG.1

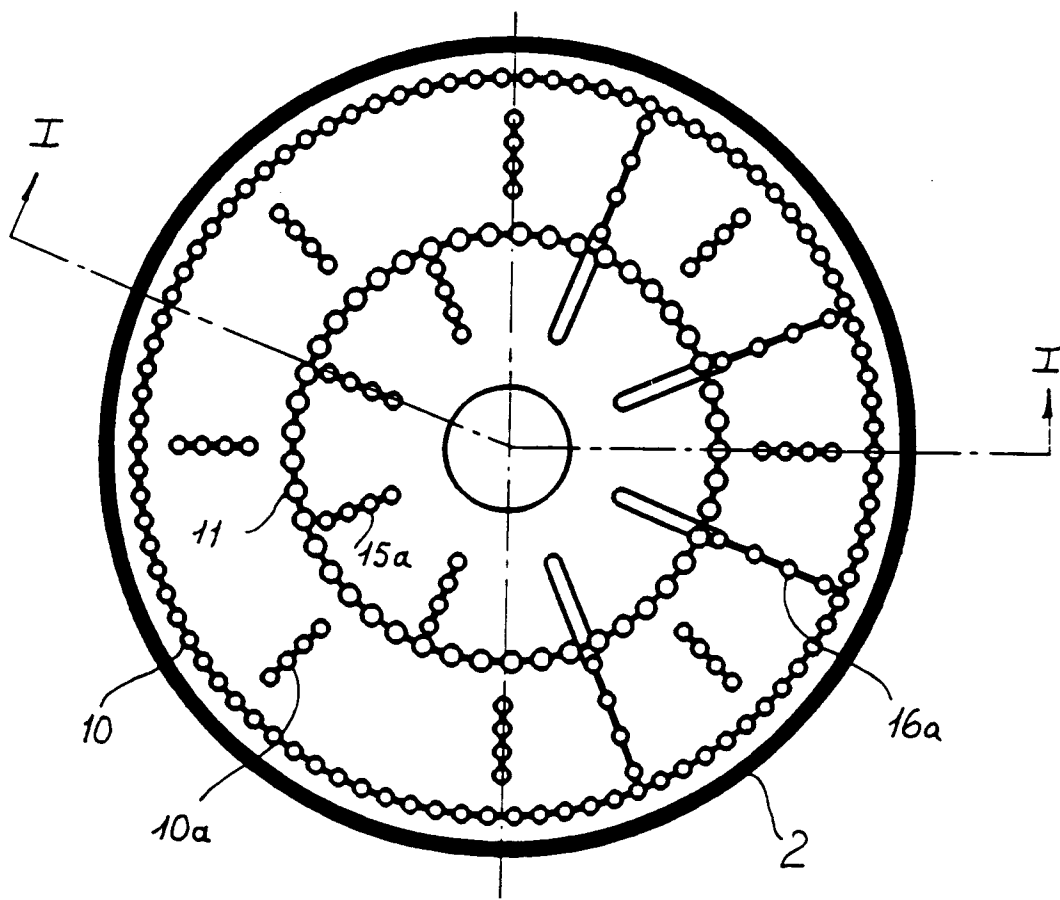


FIG. 2

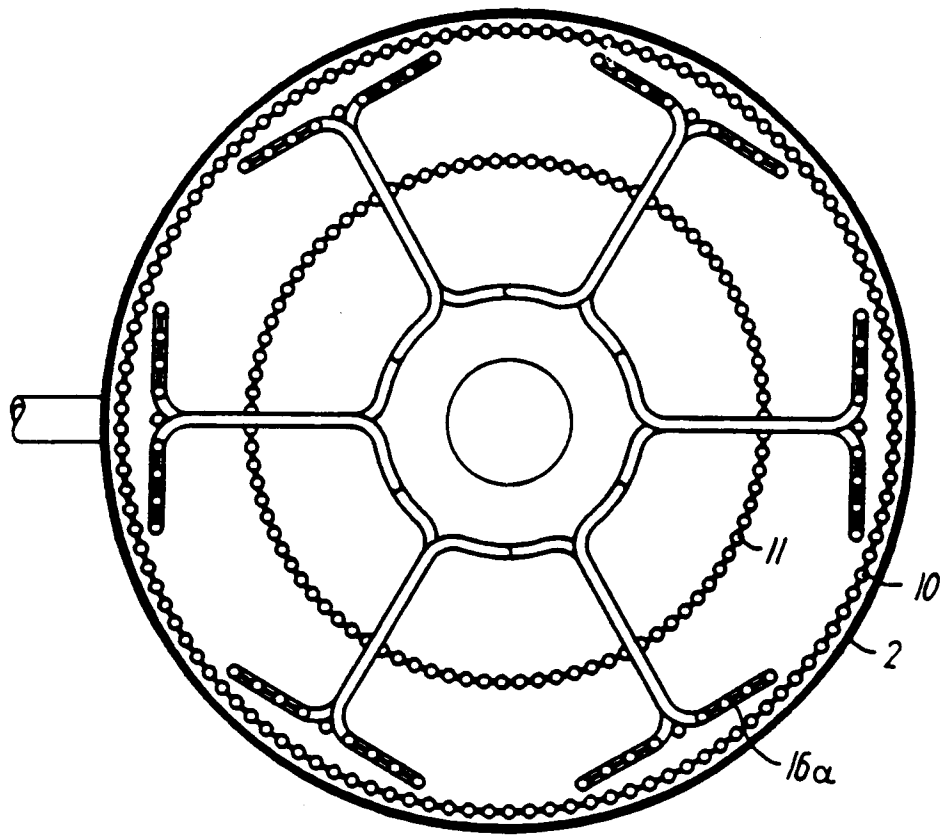


FIG. 3

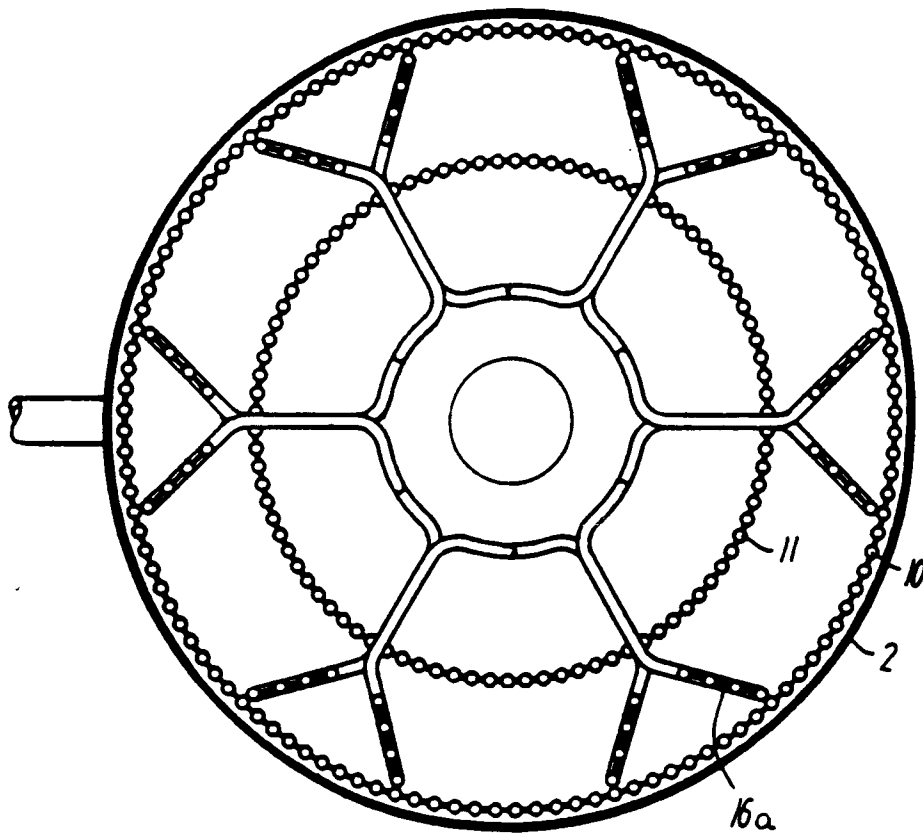


FIG. 4