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54 **High-performance heat exchanger.**

57 High-performance heat exchanger (1) for the recovery of heat such as for example reacted gas, with bayonet tubes, comprising between the central tubes, called first tubes (4), and the outer tubes, called second tubes (6), heat exchange resistances which are situated at least partially lengthwise along said first tubes (4) and which are created by inserting third tubes (8) between said second (6) and first tubes (4).

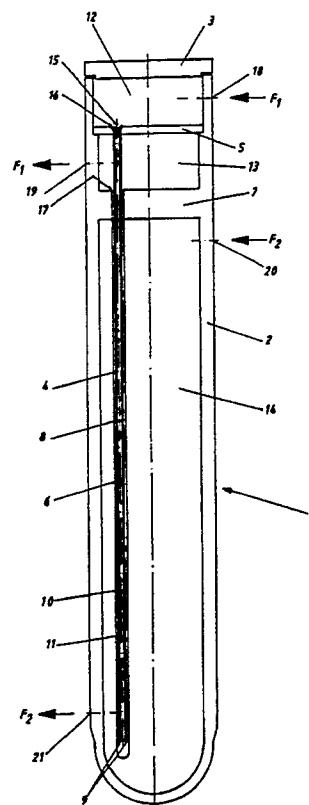


FIG. 4

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The invention concerns a high performance heat exchanger for the recovery of heat such as for example reacted gas, comprising a plurality of first tubes projecting from an upper tube plate and open at the bottom which are bayoned to a plurality of second tubes projecting from a lower tube plate and closed at the bottom, with an airspace between the external wall of said first tubes and the internal wall of said second tubes.

The fundamental importance of heat exchange in chemical plants is well known.

Equally well known is the importance of providing heat exchangers with optimal performance both from the point of view of reliability in operation and of investments costs, and more especially with regard to exchangers used in chemical processes requiring high pressures and operating temperatures with very aggressive fluids, as for example in plants for the synthesis of ammonia, where the choice of materials is as essential as the design of the exchanger itself, which should be utterly reliable in order to avoid failures. Failures which should lead to plant standstill with incalculable damage as a consequence of non-production, or risks to operational safety.

A great deal of literature has been produced describing the State of the Art as regards designs for heat exchangers in wide use and operating in general under non-critical conditions. In particular, exchangers are known which have fixed heads, hairpin tubes or bayonet tubes with a single tube plate. Floating-head heat exchangers are also known.

All the above exchangers, however, suffer from serious drawbacks under critical operating conditions with high-pressure and high-temperature fluids.

The drawback with fixed-head exchangers (Fig. 1) is that they do not permit the easy expansion of the single parts between the tubes and the shell, a rigidity which implies the possibility of mechanical failures. Hairpin or U-shaped exchangers (Fig. 2) have the advantage over fixed-head exchangers of permitting the free expansion of tubes, but they do not solve the problem completely because the two zones in the tube plate on the fluid inlet and outlet side in U-shaped tubes are at different temperatures, giving rise to deformations of the plate, hence material stress.

On the other hand, exchangers with bayonet-shaped tubes, which permit the free expansion of the tubes, while the tube-plate is not subject to deformations, can be conveniently adopted only in those cases where the fluid inside the bayonet-tubes is at boiling point, but not where the fluid to be cooled or heated does not change its physical state, whether liquid or in gas form. That is because in this case the unavoidable heat exchange,

called parasitical exchange, between the inner tube and the outer tube of each element of the bayonet exchanger prevents the efficient heat exchange between the outer tube and the fluid in the shell, hence the correct operation of the exchanger.

It is therefore the purpose of the invention to provide a heat exchanger with structural and operating characteristics such as to provide absolute operating reliability, and particularly so under critical operating conditions with high pressure and temperature while at the same time maintaining an optimal heat exchange and a reduction in investment and operating costs for the maintenance of said exchangers and overcoming the drawbacks described above with reference to the known technique.

This purpose and others which will be better illustrated by the description which follows, are achieved with a high performance heat exchanger for the recovery of heat such as for example from reacted gas, of the type described in the introduction to the description and in claim 1, characterized by the fact that it comprises a plurality of first tubes projecting from an upper tube-plate and open at the bottom which are bayonet-joined to a plurality of second tubes projecting from a lower tube-plate and closed at the bottom, with an airspace between the outer wall of said first tubes and the inner wall of said second tubes, in which heat exchange resistances are provided. These resistances are situated at least partially lengthwise along said first tubes.

In an embodiment of the invention, said resistances consist of dead zones of stagnant fluid, and more particularly of still, non-circulating fluid.

In a particularly advantageous preferred embodiment of the invention, said resistances are provided by inserting a third lot of tubes between the second and the first tubes, the lower end of which is closed on the corresponding lower end of said third tubes.

Advantageously the means further to increase heat resistance and to avoid convection movements are provided inside the airspace between said first and third tubes, more particularly by inserting insulating fluids and/or solids, or by creating vacuum zones.

It has been found even more advantageous, moreover, to make the heat-recovering fluid flow by forced circulation inside the bayonet tubes and the heating fluid (for example reacted gas) transferring the heat is made to flow on the shell side.

It is particularly surprising how the above-mentioned drawbacks can be overcome simply and brilliantly by relegating the parasitical heat exchange between the bayonet's internal and external tube to an absolutely marginal role, without any influence on the process.

The various aspects and advantages of the invention will be better illustrated by the detailed description of an example of embodiment as set out below, and referring to the attached drawings shown in a non-limitative capacity, in which shoes

- Fig. 1 in cross-section with partial axial views a fixed-head exchanger according to the known art,
- Fig. 2 in cross-section with partial axial views a hairpin tube exchanger also according to the known art,
- Fig. 3 in cross-section with partial axial views a bayonet tube exchanger again according to the known art,
- Fig. 4 in cross-section with partial axial views a bayonet tube exchanger according to the invention and
- Fig. 5 a partial axial cross-section of a detail (enlarged scale) of the lower end of one of said first, second and third tubes of the embodiment according to Fig. 4.

In Fig. 1, 2, 3 according to the known art and in Fig. 4 according to a preferred embodiment of the invention, an exchanger for the recovery of heat as for example from reacted gas shown as 1 comprises a shell 2 closed at least at one end by a lid 3. In a preferred

embodiment of the invention (Fig. 4 and 5) the shell 2 has inside a plurality of first tubes 4 projecting from an upper tube-plate 5 which are open at the bottom. First tubes 4 are bayonet-joined to a plurality of second tubes 6 projecting from a lower tube-plate 7 and which are closed at the bottom.

According to a remarkable aspect of the invention, between said second and first tubes 6 and 4 is now inserted a plurality of third tubes 8 projecting from upper tube-plate 5 the lower ends of which are closed on the corresponding lower ends of said first tubes 4 at point 9. A first plurality of airspaces 10 is thus created between the outer wall of said first tubes 4 and the inner wall of said third tubes 8 and a second plurality of airspaces 11 is created between the outer wall of said third tubes 8 and the inner wall of said second tubes 6. The upper tube-plate 5 and the lower tube-plate 7 divide the space inside shell 2 into three spaces or chambers 12, 13 and 14.

The upper chamber 12 comprises a plurality of upper openings 15 and 16 of first tubes 4, respectively third tubes 8, while the intermediate chamber 13 comprises a plurality of upper openings 17 of second tubes 6.

According to a preferred embodiment shown in Fig. 4 and 5 a fluid for heat exchange F1 enters the upper chamber 12 from opening 18 and runs through the plurality of upper openings 15 and 16 of the first, respectively third, tubes 4 and 8.

Inside third tubes 8 are thus obtained dead zones of stagnant fluid F1 to provide insulation between the second and first tubes 6 and 4.

Fluid F1, on the other hand, which has run down along the inside of first tubes 4 without undergoing any noticeable heat exchange, runs up, at the end of the latter, along second tubes 6 inside airspace 11 exchanging heat with a second fluid F2 situated in the shell side.

Fluid F1 then leaves from upper openings 17 into intermediate chamber 13 and then leaves definitively heat exchanger 1 from outlet 19.

The second fluid F2 (i.e., advantageously the hot reacted gas) which entered inside shell 2 from inlet 20 leaves heat exchanger 1 from outlet 21.

Inside airspace 10 are advantageously provided the means of further increasing heat resistance and avoiding convection movements, more particularly with the introduction of fluid and/or solid insulators, or by creating vacuum zones.

The exchangers according to the invention can be applied to any type of reactor, and more particularly to the reactors described in the Applicants' patents (see for example US Patents No. 4372920, No. 4405562, No. 4755362, etc.).

Claims

1. High performance heat exchanger (1) for the recovery of heat such as for example reacted gas, comprising a plurality of first tubes (4) projecting from an upper tube plate (5) and open at the bottom which are bayonet joined to a plurality of second tubes (6) projecting from a lower tube plate (7) and closed at the bottom, with an airspace (10) between the external wall of said first tubes (4) and the internal wall of said second tubes (8), characterized by the fact that heat exchange resistances are provided between said first (4) and second (5) tubes.
2. High performance heat exchanger according to claim 1, characterized by the fact that said resistances are situated at least partially lengthwise along the first tubes (4).
3. High performance heat exchanger according to claim 1, characterized by the fact that said resistances consist of dead zones of stagnant fluid, and more particularly of still, non-circulating fluid.
4. High performance heat exchanger according to claim 1, characterized by the fact that said resistances are provided by inserting third tubes (8) between said second (5) and first (4) tubes, the lower end of which is closed on the

corresponding lower end of said third tubes (8).

5. High performance heat exchanger according to claim 4, characterized by the fact that inside the airspace between said first (4) and third (8) tubes, means are provided further to increase heat resistance and to avoid convection movements, more particularly by inserting insulating fluids and/or solids, or by creating vacuum zones.

6. High performance heat exchanger according to the preceding claims, characterized by the fact that the heat recovering fluid is made to flow by forced circulation inside the bayonet tubes and the heating fluid (for example reacted gas) transferring heat is made to flow on the shell side.

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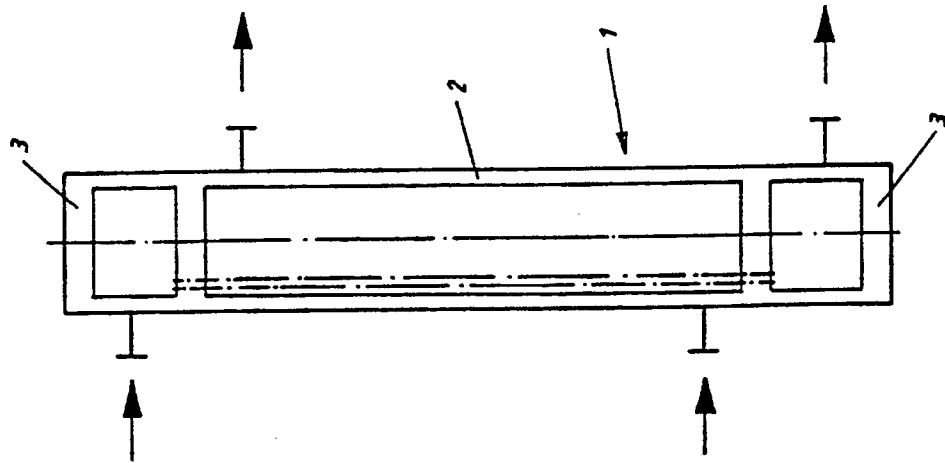


FIG. 1

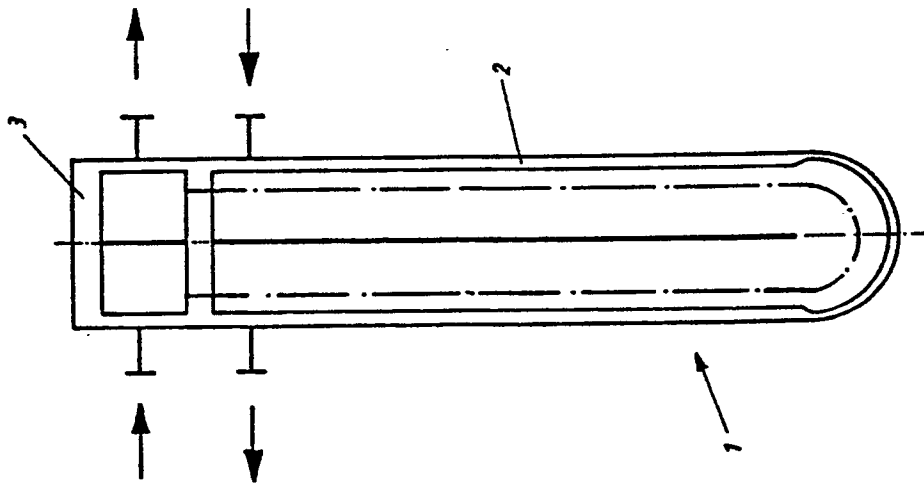


FIG. 2

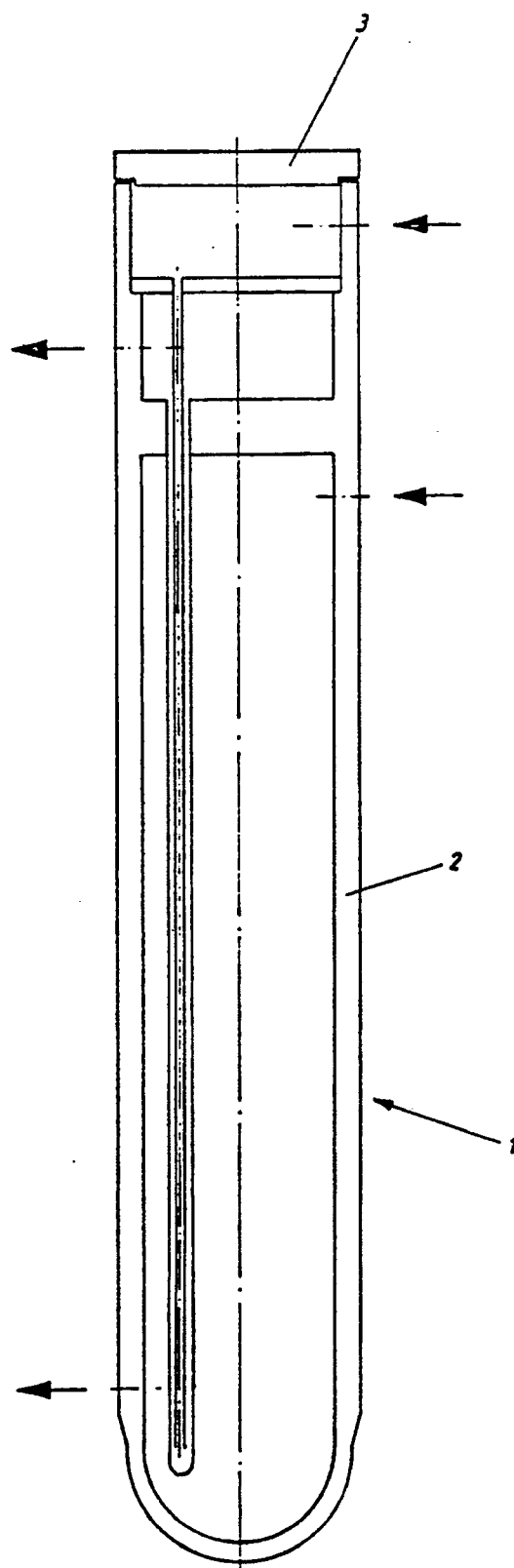


FIG. 3

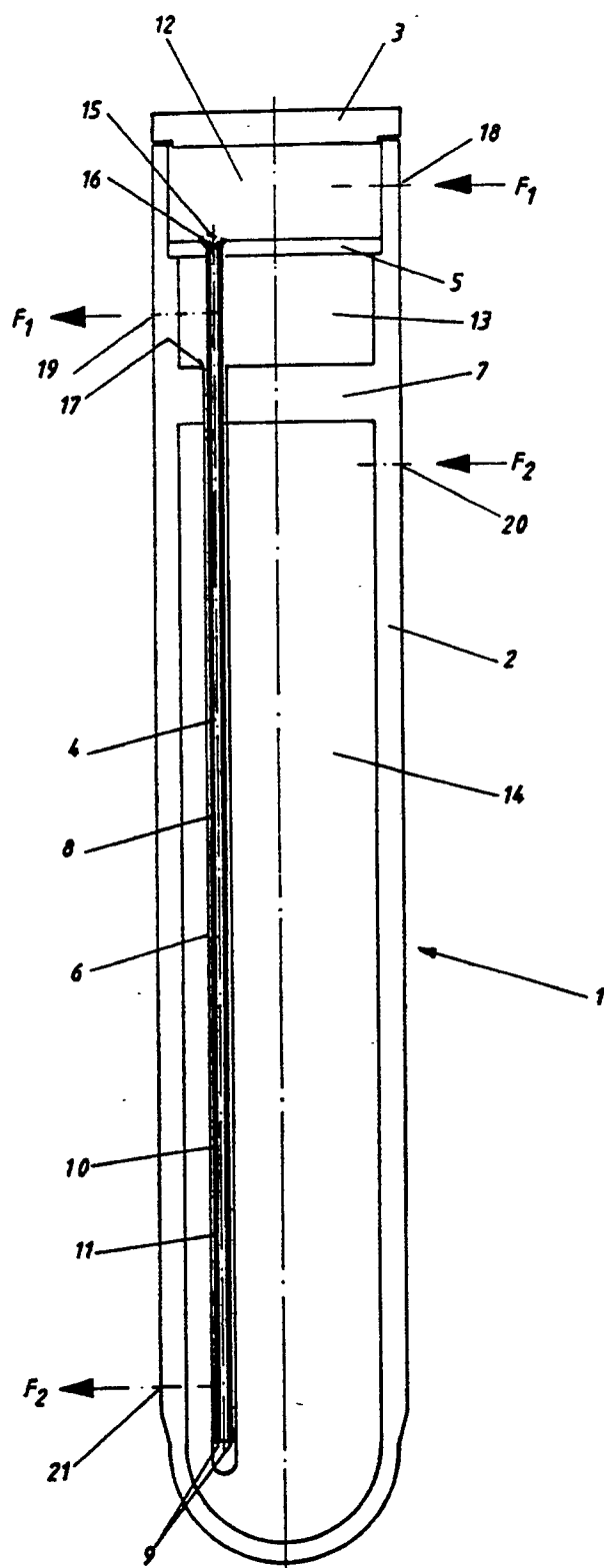


FIG. 4

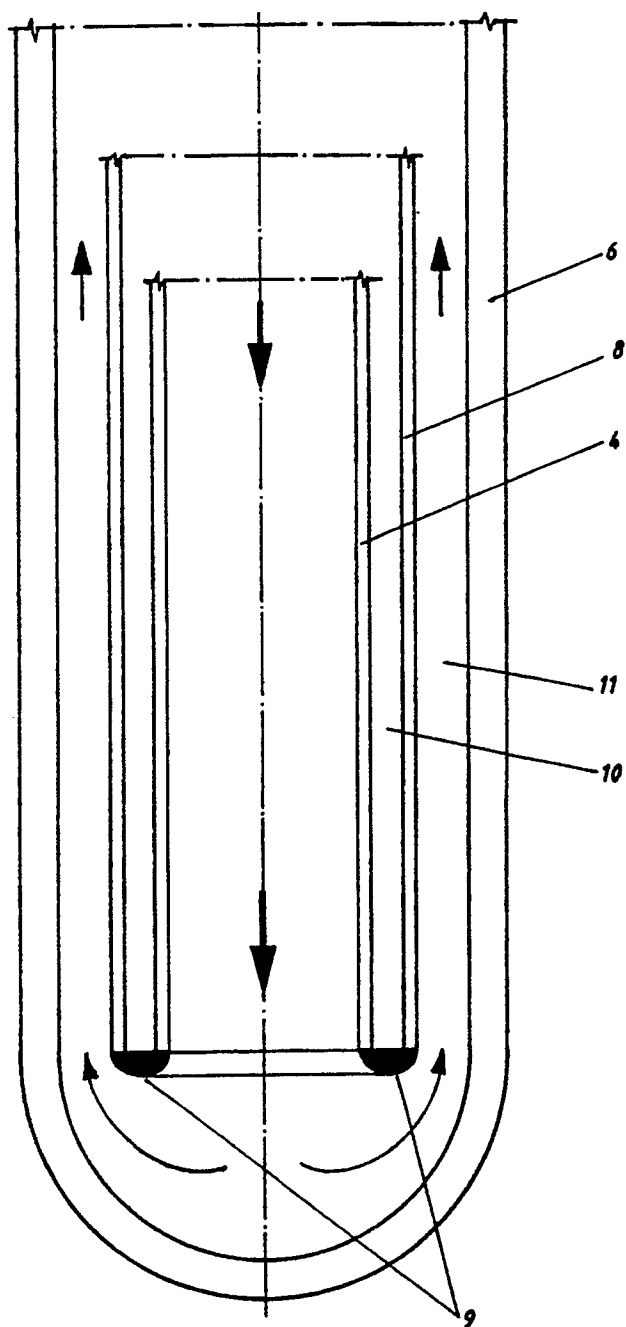


FIG. 5



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EUROPEAN SEARCH REPORT

Application Number

EP 90 10 4829

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
E	CH-A-6 742 58 (AMMONIA CASALE S.A. et al.) * Whole document * - - - -	1-6	F 28 D 7/12
X	US-A-3 861 461 (KISSINGER) * Column 2, lines 7-35; figure 1 *	1-3,6	
Y	- - - -	4,5	
Y	FR-A-1 493 108 (FIVES-PENHOET) * Page 3, left-hand column, lines 21-31; figure 1 *	4,5	
X	US-A-4 290 387 (DE FEO et al.) * Column 4, lines 32-51; figures 3,6 *	1,2,4,5	
Y	- - - -	3,6	
Y	US-A-4 671 351 (RAPPE) * Column 5, lines 2-18; column 7, lines 9-26; figure 2 *	3,6	
X	FR-A-2 241 759 (WESTINGHOUSE ELECTRIC CORP.) * Page 3, lines 5-19; page 6, lines 14-20; figures 1,15 * - - - - -	1,2,4,5	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F 28 D
The present search report has been drawn up for all claims			
Place of search		Date of completion of search	Examiner
The Hague		08 November 90	BELTZUNG F.C.
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