

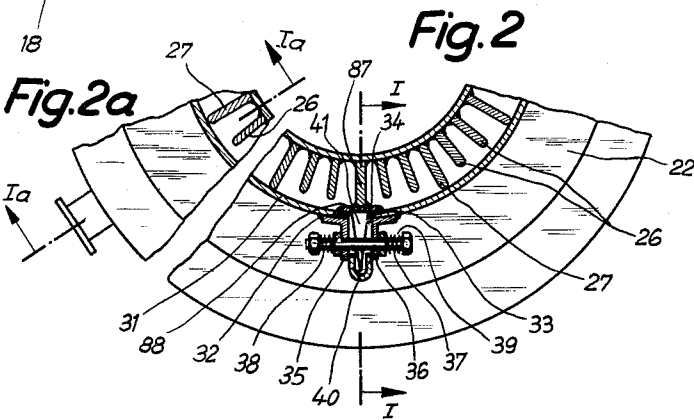
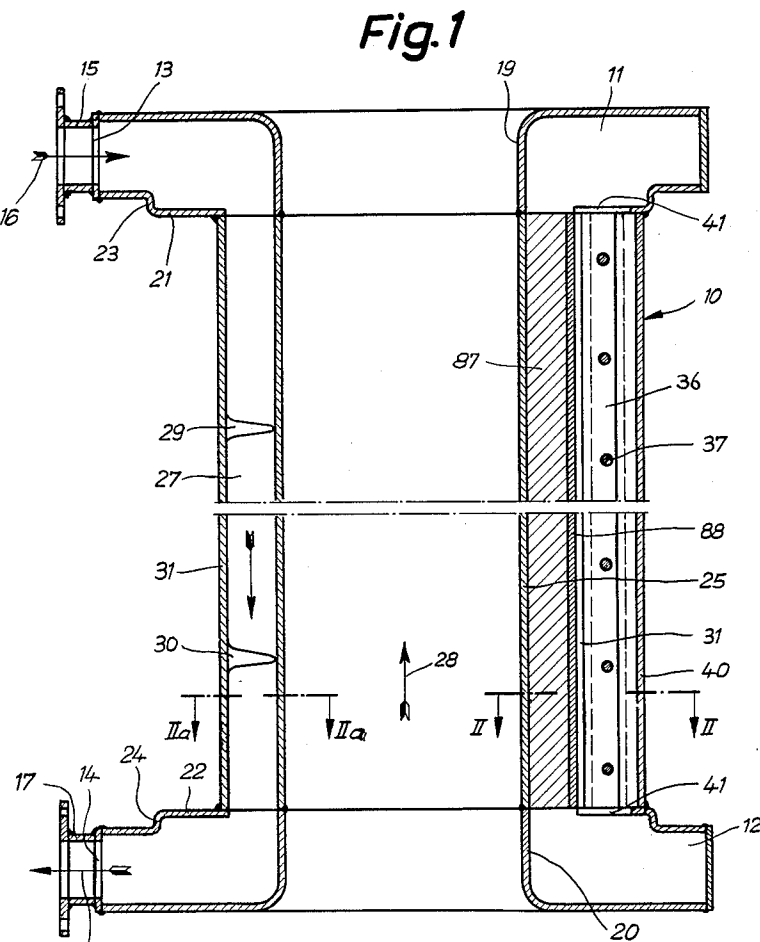
Sept. 5, 1961

F. M. HEYN
CYLINDRICAL RADIATION RECUPERATOR WITH
UPPER AND LOWER AIR DISTRIBUTOR

2,998,962

Filed Sept. 8, 1958

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Fig. 3

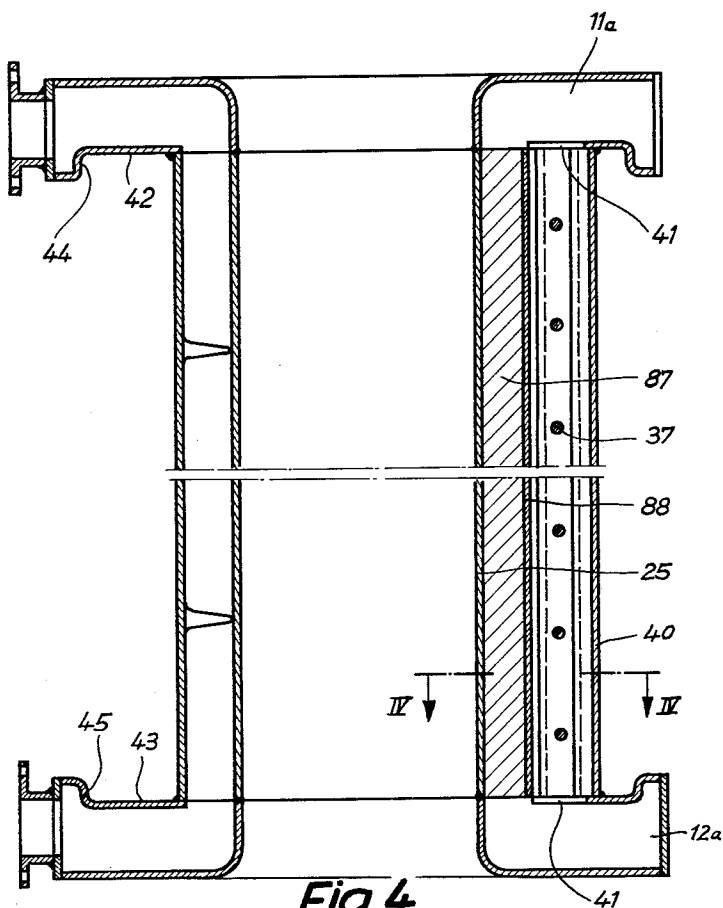
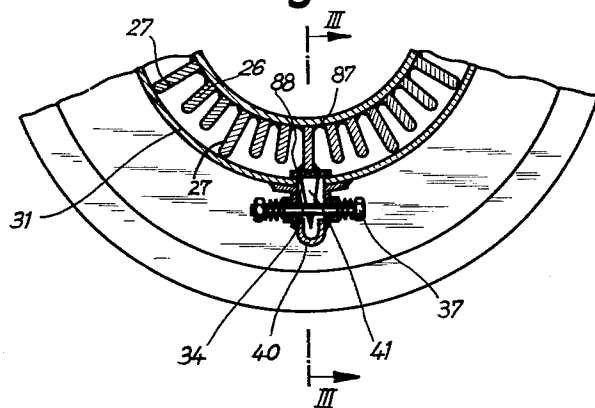


Fig. 4



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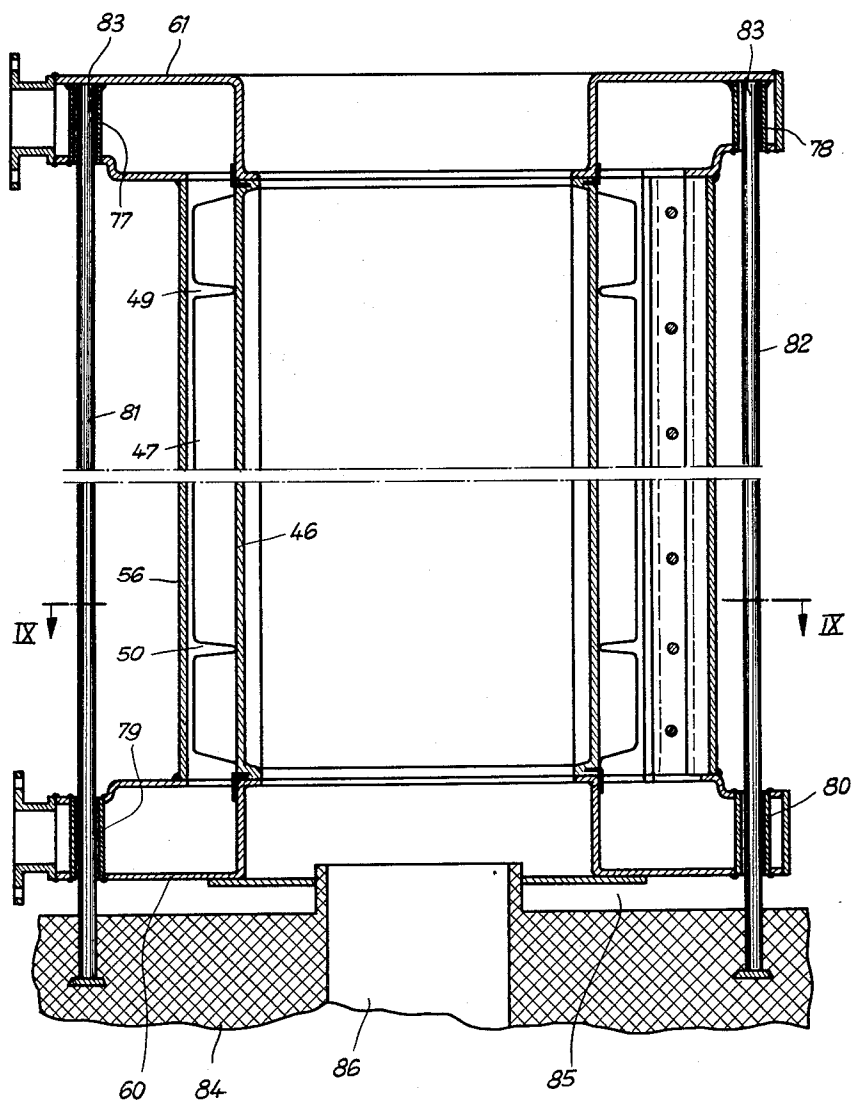
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Fig. 5



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Fig. 6 Fig. 7

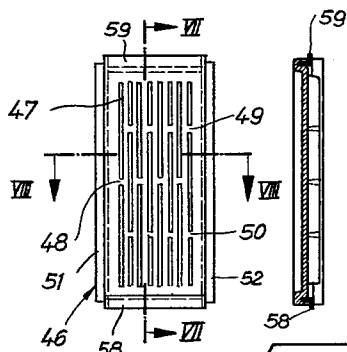


Fig. 8



Fig. 9

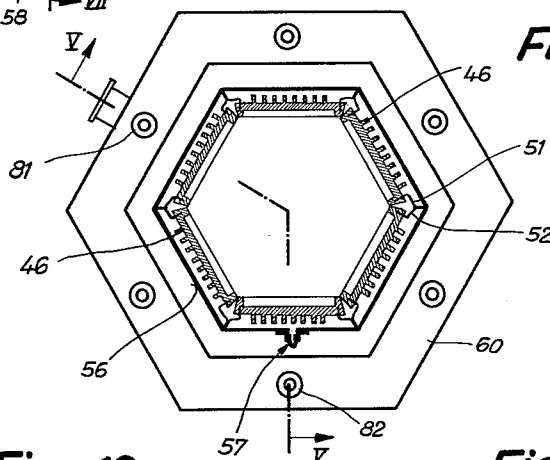


Fig. 10

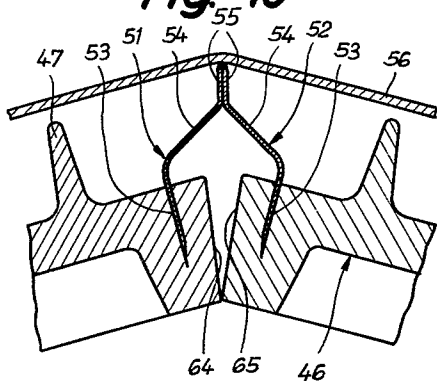
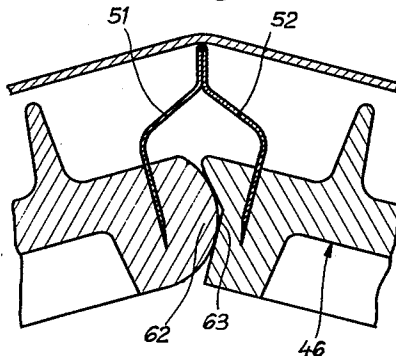


Fig. 11



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Fig. 13a

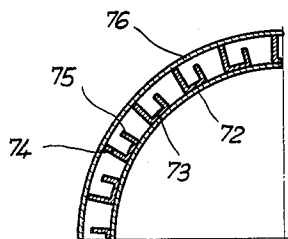


Fig. 13b

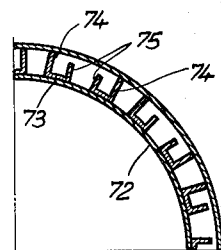


Fig. 12a

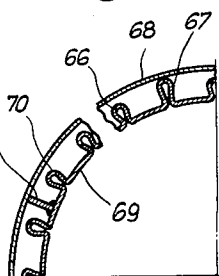


Fig. 12b

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CYLINDRICAL RADIATION RECUPERATOR WITH UPPER AND LOWER AIR DISTRIBUTUTOR

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Claims priority, application Germany Sept. 10, 1957
13 Claims. (Cl. 257-246)

The present invention relates to a radiation recuperator with an upper and a lower air or gas distributing container. Due to their employment at high waste gas temperatures, the material of radiation recuperators is subjected to very high stress. The wall temperature may approach the temperature of the heating medium if the heat transfer from the latter to the wall of the recuperator is selected high. This can be obtained by shaping the heat transfer surfaces in a special way.

The heretofore known constructions, however, do not always prevent a local overheating. The uniform arrangement of ribs and other inserts mounted on the side of the air or the gas and increasing the heat transfer does not suffice by itself. An essential condition for a uniform heat transfer to the air or gas to be heated and for obviating a local overheating consists in maintaining a uniform distribution of the medium to be heated over the circumference of the wall of that recuperator portion through which the flue gases pass. Such uniform distribution can be obtained by large distributing and collecting containers as well as by guiding surfaces or guiding ribs. These elements of construction, however, do not assure a uniform distribution if, due to a non-uniform cross section of the respective space through which the medium to be heated passes, strand-shaped higher resistances and therefore an unfavorable and non-uniform distribution of the air or gas to be heated are encountered.

It is, therefore, an object of the present invention to provide a radiation recuperator of the above mentioned general type which will overcome the above outlined drawbacks.

It is another object of this invention to provide a cylindrical radiation recuperator which will assure a uniform distribution of the air or gas to be heated over the space between the radiation body and the outer wall of the recuperator.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

FIG. 1 is a longitudinal section through a recuperator according to the present invention.

FIG. 2 is a transverse section along the line II-II of FIG. 1.

FIG. 2a is a transverse section along the line IIa-IIa of FIG. 1.

FIG. 3 represents a longitudinal section through a recuperator somewhat modified over that of FIG. 1, the section of FIG. 3 being taken along the line III-III of FIG. 4.

FIG. 4 is a section taken along the line IV-IV of FIG. 3.

FIG. 5 represents a longitudinal section along the line V-V of FIG. 9 and illustrates a further modification of the present invention.

FIGS. 6 to 8 and 10 and 11 illustrate in different views and partly in section cast segments and their connections as they may be employed in connection with FIG. 5.

FIG. 9 illustrates on a somewhat smaller scale a section along the line IX-IX of FIG. 5.

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FIGS. 12a, 12b, 13a and 13b illustrate various embodiments of guiding ribs and spacer elements.

General arrangement

According to the present invention, the upper radiation body through which the flue gases pass has its outside provided with uniform spacer elements over which the outer wall is placed elastically, said outer wall being provided with an expansion fold along its longitudinal edges. Due to the spacer elements, which have precisely the same height, the outer wall when tensioned elastically will be held uniformly spaced from the inner wall or radiation body. Thus, a uniform distribution of the air or gas to be heated is effected over the intermediate chamber between the radiation body and the outer wall, while the intermediate chamber has a uniform cross section over its circumference.

The spacer elements may be rigidly connected to the emanating body as, for instance, by welding. Furthermore, the spacer elements may also be designed as continuous or interrupted sheet metal pieces, ledges, bar or the like. In order to be able to tension the outer wall with regard to the inner wall or radiation body to such an extent that the outer wall will have its inner side in engagement with all spacer elements whereby a uniform cross section of the space between inner wall and outer wall will be formed, the air distributing containers are provided with an annular expansion trough or with an annular expansion arch. If the outer wall is expanded or relieved from expansion, the expansion groove or expansion bulging portion will compensate for the movement of the outer wall relative to the rigid air or gas distributing container.

According to a particularly advantageous embodiment of the invention, the radiation body comprises cast segments interconnected by cast-in steel bars simultaneously serving as spacer elements, about which the outer wall is elastically expanded. The cast-in steel bars have a double purpose namely to hold the outer wall uniformly spaced from the inner wall or radiation body formed from cast segments, and furthermore to interconnect the individual cast segments. For purposes of increasing the seal between two cast segments adjoining each other, one longitudinal edge of the cast segments shows an angle-shaped cutout, while the other longitudinal edge has a corresponding rounded-off portion.

According to a further advantageous embodiment of the invention, the upper and the lower air or gas distributing containers are provided with holding bushings through which extend supporting columns supporting the freely suspended recuperator, while the upper distributing container rests upon the upper end of the recuperator.

For purposes of forming the guiding ribs or guiding surfaces and at the same time for purposes of forming the spacer elements, the radiating containers may be provided with U-shaped profiles or structural members with legs of different lengths. The longer legs will in such instance serve as spacer element, whereas the shorter leg will serve as guiding rib. The radiation body may also be provided with outwardly extending folds serving as guiding ribs between which will be arranged the spacer elements which may, for instance, be welded thereto. The guiding ribs and the spacer elements may also be formed by outwardly extending folds of the walls of the radiation body, while the folds forming the spacer elements have a height greater than the folds forming the guiding ribs.

Structural arrangement

Referring now to the drawings in detail, the recuperator 10 illustrated therein comprises an upper annular air or gas distributing box or container 11 and a lower air or gas distributing box or container 12. The cir-

cumference of the air distributing containers 11 and 12 are provided with openings 13 and 14 respectively. The air or gas to be heated passes in the direction of arrow 16 through a connection 15 and opening 13 into the container 11. The heated air or gas is discharged from the container 12 in the direction of the arrow 18 through opening 14 and a connection 17.

The upper distributing container 11 has an inner cylindrical wall 19, while the lower distributing container 12 has a corresponding inner wall 20. The upper distributing container 11 as well as the lower distributing container 12 are provided with a bulging portion 21 and 22 respectively which are de-limited toward the outside by a section 23 and 24 respectively.

The inner cylinder jacket or radiation body 25 is mounted upon the inner cylinder wall 20 of the lower distributing container 12 and is connected to wall 20 in any convenient manner, for instance by welding. The upper distributing container 11 rests by means of its cylindrical inner wall 19 upon the upper end of the radiation body 25. The inner jacket or radiation body 25 has ribs 26 (FIGS. 2 and 2a) substantially uniformly distributed over the outer circumference of the radiation body 25. Arranged between ribs 26 are spacer elements 27 of substantially uniform height. In the embodiment shown in FIG. 2, the spacer elements and ribs are welded to the inner wall through which the flue gases pass in the direction of the arrow 28. If desired, the ribs 26 may extend from one end of the inner wall to the other end thereof in a continuous manner or they may be interrupted as shown in FIG. 1 at 29 and 30.

Placed around the spaced elements 27 is an outer wall 31 the longitudinal edges 32, 33 of which define therebetween a gap 34. Mounted on said longitudinal edges 32, 33 of the outer wall 31 are angle irons 35, 36 which extend in longitudinal direction of the recuperator. The said angle irons 35, 36 are provided with a plurality of transverse aligned bores through which extend threaded bolts 37 with springs 38, 39 therearound. These springs press the angle irons 35, 36 against each other in a resilient manner when the bolts 37 are tightened. Mounted on the outer marginal portion of the angle irons 35, 36 is an expansion fold 40 of flexible metal. When the angle irons 35, 36 are pressed against each other or are moved away from each other, the legs of the U-shaped expansion fold spread or move toward each other accordingly.

The lower end and the upper end of the angle irons 35, 36 and of the expansion fold 40 are connected with the bulged portions 21, 22 respectively of the upper and lower distributing containers 11, 12 respectively. At the level of the expansion fold 40, the bulged portions 21, 22 are provided with a wedge-shaped cutout 41. By means of this cutout in cooperation with the sections 23, 24 of the upper and lower distributing containers, the movement of the wall 31 during the tensioning of the same about the spacer elements 27 will be compensated for with regard to the rigid distributing containers 11, 12. Therefore, wall 31 may have its upper and lower marginal portion connected to the distributing containers.

At the level of the cutout 41 there is provided an element 87 having a flat iron 88 connected to the upper edge thereof. The height of the element 87 and the thickness of the flat iron 88 correspond together to the height of the remaining spacer elements 27. Flat iron 88 bridges the distance between the longitudinal edges 32, 33 of the outer wall 31.

Referring now to FIG. 3, the embodiment illustrated therein differs from that of FIGS. 1 and 2 in that instead of the bulged-out portions 21, 22 there is provided an expansion trough 42, 43 at the upper and lower distributing containers 11a, 12a respectively which troughs are de-limited toward the outside by wall portions 44 and 45 and in cooperation with the wedge-shaped cutout 41 at the level of the expansion fold 40 will bring about

a compensation during the tensioning of the outer wall 31.

According to the embodiment of FIG. 5, cast segments 46 are employed for forming the inner portion of the recuperator. The said cast segments 46 are provided with ribs 47 which as is clearly shown in FIG. 6 are interrupted at different levels. The longitudinal edges of the cast segments 46 are provided with cast-in steel bars 51, 52. As will be evident from FIGS. 10 and 11, these steel bars have a straight section 53, an inclined section 54, and a further outer section 55. When connecting two adjacent cast plates or segments 46, the sections 55 of the steel bars 51, 52 are welded to each other. These steel bars simultaneously serve as spacer similar to the spacer elements 27 of FIGS. 1 to 4. Placed around said steel bars 51, 52 is the outer wall 56 which is closed at 57 in the same manner as the wall 31 of FIGS. 1 to 4. The end faces of the cast segments 46 may be provided with cast-in angle irons 58, 59 by means of which said segments are connected to air or gas distributing containers 60, 61. As will be evident particularly from FIG. 11, the longitudinal edges of the cast plates or segments may be provided with rounded portions 62 and complementary angle-shaped depressions 63 so that the rounded portions 62 can nest in said angle-shaped depressions 63. The cast segments 46 make it possible that the heat tensions of the inner wall formed by said cast segments can equalize or compensate each other. Between the adjoining longitudinal edges 64, 65 of the cast segments there may be provided seals of any standard type.

With the embodiment according to FIG. 12a, the inner wall is provided with loops 66, 67 of which the loops 66 form ribs, whereas the loops 67 form spacer elements for the outer wall 68.

With the embodiment according to FIG. 12b, the inner wall 69 is likewise provided with loops 70 which have uniform height and between which spacer elements 71 in form of steel bars are provided.

With the embodiment of FIGS. 13a and 13b, the inner wall 72 has U-shaped profiles or structural members 73 with differently long legs 74, 75. The legs 74 form the spacer elements for the outer wall 76, whereas the legs 75 form the ribs. While with the embodiment according to FIG. 13a, the U-shaped structural members 73 are so arranged that a spacer element is always followed by a rib which latter is followed by a spacer element, the arrangement of FIG. 13b has the structural members 73 so arranged that there are always two successive ribs followed by two successive spacer elements which in their turn are followed by two successive ribs. All illustrated spacer elements may, similar to the ribs, extend over the entire length of the radiation recuperator or may be interrupted. According to the arrangement of FIGS. 5 to 9, the upper distributing container 61 and the lower distributing container 60 are provided with bushings 77, 78 and 79, 80 through which extend and are guided supporting rods 81, 82. The upper end of said supporting rods, at 83, carries the upper distributing container 61 on which the remaining portions of the recuperator are suspended. The lower end of the supporting rods or columns 81, 82 is arranged in the foundation 84, and the lower distributing container 60 is arranged at a certain distance 85 from said foundation. The foundation 84 comprises a passage 86 for the passage and supply of the flue gases.

It is, of course, to be understood that the present invention is, by no means, limited to the particular constructions shown in the drawings but also comprises any modifications within the scope of the appended claims.

What I claim is:

1. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, said distributing containers being provided with an annular expansion

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trough a substantially cylindrical member interposed between and connected to said first and second distributing containers, a plurality of spacer elements radially extending from the outside of said cylindrical member and substantially uniformly distributed over the circumference of said cylindrical member, said spacer elements having each substantially the same height and extending in the radial direction of said cylindrical member, a split tubular member elastically clamped about said spacer elements, and an expansion member in form of a fold extending over the split of said split tubular member along the length thereof and having its longitudinal marginal portions connected to the marginal portions of said split tubular member adjacent the split thereof thereby bridging and sealing said split, said distributing containers communicating with each other through the space confined by said cylindrical member and said split tubular member.

2. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, a tubular member interposed between and connected to said first and second distributing containers, a plurality of spacer elements extending from the outside of said tubular member and welded thereto and distributed over the circumference of said tubular member, said spacer elements having each substantially the same height, and extending outwardly from said tubular member, a split tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said split tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first mentioned tubular member and said split tubular member.

3. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, a first tubular member interposed between and connected to said first and second distributing containers, a plurality of spacer elements extending from the outside of said first tubular member and distributed over the circumference of said first tubular member, said spacer elements having each substantially the same height, and extending outwardly from said first tubular member, a plurality of ribs arranged on the outside of and connected to said first tubular member and extending therefrom to an extent less than said spacer elements, a split second tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said second tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first and second tubular members.

4. A recuperator according to claim 3, in which said ribs extend along the length of said first tubular member in a continuous manner.

5. A recuperator according to claim 3, in which each of said ribs consists of spaced sections and extends along the length of said first tubular member.

6. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, said distributing containers being provided with an annular expansion trough, a tubular member interposed between and connected to said first and second distributing containers, a plurality of spacer elements extending from the outside of said tubular member and distributed over the circumference of said tubular member, said spacer elements having each substantially the same height, and extending outwardly from said tubular member, a split tubular member elastically clamped about said spacer elements, and a

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fold-shaped expansion member bridging and sealing the split of said split tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first mentioned tubular member and said split tubular member.

7. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, said distributing containers being provided with an annular expansion bulged-out portion, a tubular member interposed between and connected to said first and second distributing containers, a plurality of spacer elements extending from the outside of said tubular member and distributed over the circumference of said tubular member, said spacer elements having each substantially the same height, and extending outwardly from said tubular member, a split tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said split tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first mentioned tubular member and said split tubular member.

8. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, a tubular member interposed between and connected to said first and second distributing containers, said tubular member being composed of cast segments and steel bars arranged in said cast segments and protruding therefrom toward the outside of said tubular member so as to form spacer elements, said spacer elements extending outwardly from said tubular member substantially to the same extent, a split tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said split tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first mentioned tubular member and said split tubular member.

9. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, a tubular member interposed between and connected to said first and second distributing containers, said tubular member being composed of cast segments and steel bars arranged in said cast segments and protruding therefrom toward the outside of said tubular member so as to form spacer elements, one longitudinal end surface of each of said segments being rounded while the other longitudinal end surface has an angular cutout, the arrangement being such that each rounded end surface of one segment is nested in the angular cutout of the adjacent end surface of the adjacent segment, said spacer elements extending outwardly from said tubular member substantially to the same extent, a split tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said split tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first mentioned tubular member and said split tubular member.

10. A tubular radiation recuperator, which includes: an upper distributing container for receiving the gaseous medium to be heated, a lower distributing container for discharging the heated gaseous medium, a tubular member interposed between and connected to said upper and lower distributing containers, bushings respectively connected to said distributing containers, upright supporting members extending through the bushing of said lower distributing container into the bushing of said upper distributing container and supporting the latter and thereby also said

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tubular member and said lower distributing container, a plurality of spacer elements extending from the outside of said tubular member and distributed over the circumference of said tubular member, said spacer elements extending outwardly from said tubular member substantially to the same extent, a split tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said split tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first mentioned tubular member and said split tubular member.

11. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, a first tubular member interposed between and connected to said first and second distributing containers, a plurality of spacer elements extending from the outside of said first tubular member and distributed over the circumference of said first tubular member, said spacer elements extending outwardly from said first tubular member substantially to the same extent, a plurality of ribs arranged on the outside of and connected to said first tubular member and extending therefrom to an extent less than said spacer elements, said spacer elements and said ribs being formed of structural members of U-shaped cross section with a longer and a shorter leg with the shorter leg forming a rib and the longer leg forming a spacer element, a split second tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said second tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first and second tubular members.

12. A tubular radiation recuperator, which includes: medium to be heated, a second distributing container for discharging the heated gaseous medium, a first tubular member interposed between and connected to said first and second distributing containers, a plurality of spacer elements extending from the outside of said first tubular member and distributed over the circumference of said first tubular member, said spacer elements extending outwardly from said first tubular member substantially to

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the same extent, a plurality of ribs arranged on the outside of and connected to said first tubular member and extending therefrom to an extent less than said spacer elements, said ribs being formed by outwardly extending loops of said first tubular member and being arranged between said spacer elements, a split second tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said second tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first and second tubular members.

13. A tubular radiation recuperator, which includes: a first distributing container for receiving the gaseous medium to be heated, a second distributing container for discharging the heated gaseous medium, a first tubular member interposed between and connected to said first and second distributing containers, a plurality of spacer elements extending from the outside of said first tubular member and distributed over the circumference of said first tubular member, said spacer elements extending outwardly from said first tubular member substantially to the same extent, a plurality of ribs arranged on the outside of and connected to said first tubular member and extending therefrom to an extent less than said spacer elements, said spacer elements and said ribs being formed by outwardly extending loops of said first tubular member, a split second tubular member elastically clamped about said spacer elements, and a fold-shaped expansion member bridging and sealing the split of said second tubular member while being connected to the latter adjacent the split thereof, said distributing containers communicating with each other through the space confined by said first and second tubular members.

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