REGENERATIVE HEAT EXCHANGER WITH MOVEABLE MATRIX

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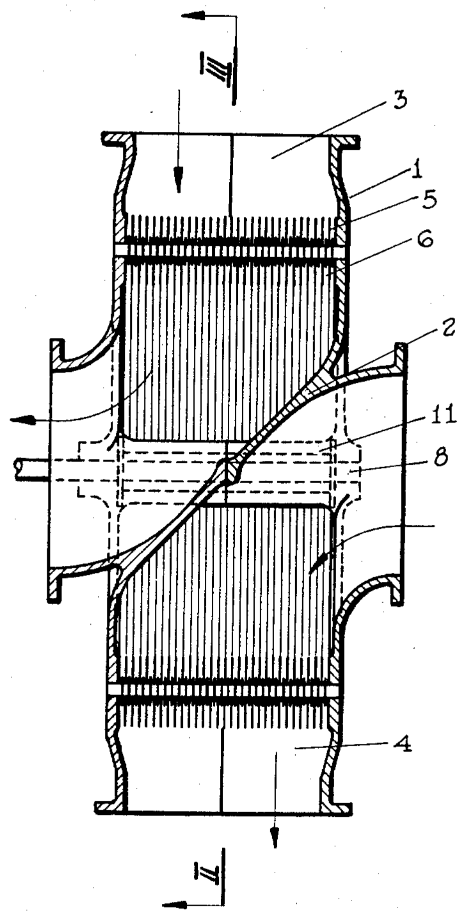

Fig. 1

INVENTOR
GÜNTHER LANGE

BY Dicke and Craig.
ATTORNEYS

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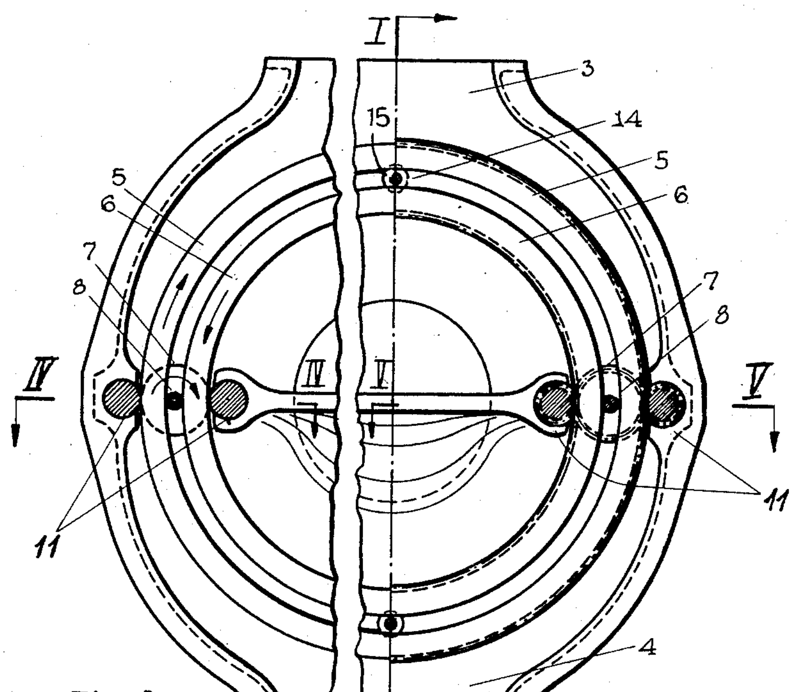

Fig. 2 Fig. 3

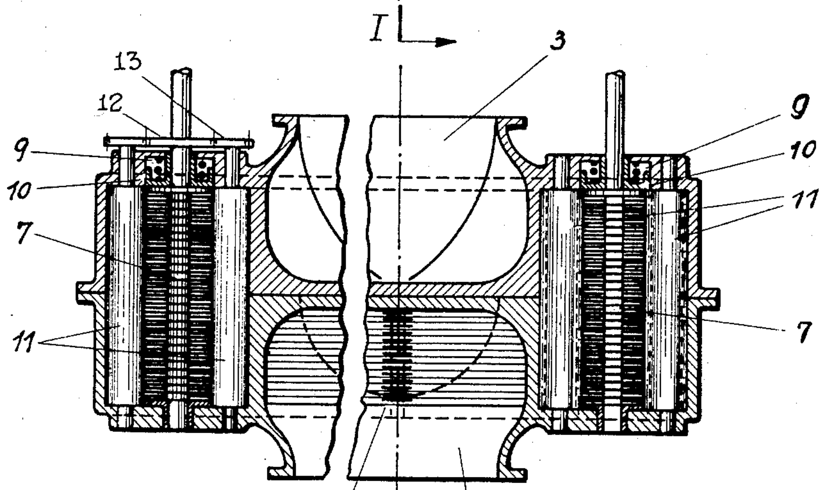

Fig. 4 Fig. 5

INVENTOR
GÜNTHER LANGE

BY Dicke and Craig
ATTORNEYS

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REGENERATIVE HEAT EXCHANGER WITH MOVEABLE MATRIX

Günther Lange, Munich, Germany, assignor to BMW Triebwerkbau Gesellschaft mit beschraenkter Haftung

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12 Claims. (Cl. 257—269)

This invention relates to regenerative heat exchangers with moveable matrix. Regenerators of this type are advantageously used in all applications where it is desired to transfer heat from a hot to a cooler medium, for example from hot exhaust gases to cooler air, as is the case in furnace installations, gas turbines, and the like.

In regenerative heat exchangers having a moveable matrix comprising chambers filled with wire mesh or the like, heavy transfer losses are encountered due to the compressed air contained in the flow passages of the moveable matrix being carried over from the air side to the gas side. Moreover, there are leaking losses due to leakages at the sealing faces between air side and gas side along the surface of the heat exchanger matrix. These leakages increase in proportion with the length of the sealing faces and with the distortion caused by heat stresses. Undesirable accumulation of deposits on the surface of the heat exchanger matrix are encountered already after a relatively short time of operation, which results in reduced efficiency of the heat exchanger and in a pronounced increase of pressure losses. In consideration of the possibility of deposit accumulation, the reduction of the hydraulic diameter and consequently the increase of the coefficient of heat exchange, must be limited.

There are other types of regenerative heat exchangers in which the rotating matrix consists of individual discs separated by spacers, the discs and the spacers being arranged on a common shaft and kept under lateral pressure, the shaft imparting rotational movement to the discs. Slots in the separating wall between the gas spaces allow the passage of the discs, the edges of these slots serving at the same time as a seal between the two heat exchanging media. Due to the individual sealing of each disc, the entire sealing length increases enormously, which results in high friction losses. With small hydraulic radia—i.e. small distances between two adjacent discs for obtaining high coefficients of heat exchange with small pressure losses—the sealing elements of the separating wall are reduced to thin sheet metal strips which cannot be realized in practice. Consequently, in these known types of heat exchangers, the coefficient of heat exchange is limited by considerations of practicability.

In order to eliminate the above mentioned drawbacks, it is an object of the invention to provide a regenerative heat exchanger the heat exchanging matrix of which comprises two concentrically arranged stacks of annular lamellae which rotate in opposite directions and which, in the plane of separation between the air side and the gas side, are resiliently urged into sealing engagement with spacing discs arranged between the individual lamellae. Sealing at the inner and outer radial surfaces of the stacks of lamellae is preferably accomplished by means of rotating bodies.

According to the invention, the drive of the concen-

trically arranged stacks of lamellae, which rotate in opposite direction, is effected by frictional engagement between the spacing discs and the lamellae. However, according to a further feature of the invention, the drive may also be effected by means of the rotating bodies which in this case are formed as gears the teeth of which are in meshing engagement with corresponding teeth of the lamellae.

The sealing spacing discs are preferably assembled on two shafts which may be serrated, and which are coupled with each other on one end and connected with suitable drive means.

The division of the heat exchanging matrix into an outer and an inner stack of annular lamellae presents substantial advantages. In consideration of the fact, that, also under conditions of laminar flow, the coefficient of heat transfer is highest at the point of initial contact between the heat exchanging media, and then decreases progressively due to the formation of boundary layers, it is an important feature of the invention, that the cooler boundary layers which form during the passage of the gas through the outer stack of lamellae, are separated from said stack upon leaving it, and in the lamellae-free space mix with hotter gases from the inner core zones, whereupon they come again into heat exchanging contact with new heat exchange surfaces when entering the inner stack of lamellae which rotates in the opposite direction. This results in a substantial increase of heat transfer. Furthermore, the distortion of the individual lamellae caused by heat stresses, is considerably reduced by subdividing the lamellae into two concentric annular stacks.

The spacing discs provided in the plane of separation between gas side and air side, fill the space between two adjacent lamellae and prevent the passage of air to the gas side due to the fact that they are resiliently urged into sealing contact with the lamellae. At the same time, these spacing discs serve for the continuous cleaning of the heat exchanging surfaces and, for increasing their cleaning effect, may additionally be provided with scraping edges at their periphery which may take the form of teeth or of other suitable cut-outs.

Sealing of the stacks of lamellae at the inner and outer peripheral plane of separation of the two gas spaces is preferably accomplished by means of rotating bodies which, dependent on the kind of drive used for the heat exchanger matrix, are formed as cylindrical rolls or as gears. In the first case, the cylindrical rolls are advantageously coupled with the drive shafts by means of transmission members, such as gears or driven chains.

For assuring free flow passages between the adjacent lamellae, at least one row of guide rollers are provided on the air side as well as on the gas side.

Further objects and features of the invention will be apparent from the following description when read in connection with the accompanying drawings in which two embodiments of the invention are shown by way of example only. In the drawings;

Fig. 1 is a longitudinal sectional view of the regenerative heat exchanger according to the invention, taken on line I—I of Fig. 3;

Fig. 2 is a cross-sectional view of one half of the heat exchanger, wherein the rotating heat exchanger matrix is driven by frictional engagement;

Fig. 3 is a cross-sectional view of one half of the heat exchanger, wherein the rotating heat exchanger matrix is driven by means of toothed guide rolls;

Fig. 4 is a horizontal section through the half of the heat exchanger shown in Fig. 2; and

Fig. 5 is a horizontal section through the half of the heat exchanger shown in Fig. 3.

As shown in the drawings, a housing 1 subdivided into an air space 3 and a gas space 4 by a separating wall 2, contains the rotating heat exchanger matrix consisting of individual elements independent of each other, and which in the embodiment illustrated comprises two concentrically arranged stacks 5 and 6 of annular lamellae. Spacing discs 7 mounted on shafts 8 are arranged in the plane of separation between the gas spaces 3 and 4, and between the two stacks of lamellae, in such a manner that the spacing discs fill the spaces between the individual adjacent lamellae in their entire radial depth. The spacing discs 7 and the individual lamellae of stacks 5 and 6 are kept under resilient pressure by means of springs 9 and thrust members 10. This ensures air-tight sealing of the gas-spaces against each other.

Cylindrical rollers 11 which also serve to guide the stacks of annular lamellae, are used for sealing the inner and outer peripheral surfaces of the lamellae. At least one of the guiding members is resiliently mounted in order to compensate for expansion of the lamellae due to heat. In the embodiment shown in Figs. 2 and 4, rotation of the stacks of lamellae is effected by frictional engagement between the spacing discs and the individual lamellae, the spacing discs 7 being mounted rotationally fast on the drive shafts 8, for example by means of serrations. Advantageously, the drive shafts 8 are coupled with the guide rollers 11 by means of suitably dimensioned gears 12, 13, in order to eliminate any relative sliding movement between the lamellae and the spacing discs. Instead of gears it is also possible to use other transmission members, such as drive chains and the like.

In the embodiment shown in Figs. 3 and 5, rotation of the stacks of lamellae is effected by means of the spacing discs 7 which are formed as gears, and of the guide rollers 11 which are likewise in the form of gears and are in continuous meshing engagement with corresponding teeth of the annular lamellae 5 and 6.

One or more rows of guide rollers 14 are provided, on the air side as well as on the gas side. These guide rollers engage between the individual lamellae, thus assuring the free flow passages through the stacks of lamellae. The guide rollers 14 are mounted freely rotatable on shaft 15 which is supported in the housing 1.

I claim:

1. A regenerative heat exchanger provided with two separate fluid passages extending therethrough and having a movable heat exchanger matrix consisting of individual rotating elements independent of each other, said heat exchanger matrix comprising two concentrically arranged stacks of annular lamellae, spacing disks arranged between said individual lamellae in the plane of separation between said two fluid passages, means for resiliently urging said lamellae and said spacing disks into sealing engagement with each other, and means including rotating bodies in contact with the circumferential surfaces of said stacks for sealing the circumferential surfaces of said stacks of lamellae.

2. A regenerative heat exchanger according to claim 1, wherein rotation of said heat exchanger matrix is effected by frictional engagement of said lamellae with said spacing disks.

3. A regenerative heat exchanger according to claim 1, wherein said two stacks of lamellae rotate in opposite directions.

4. A regenerative heat exchanger according to claim 1, wherein said spacing disks, said rotating bodies, and said annular lamellae are tooth-shaped along their circumferences.

5. A regenerative heat exchanger comprising two separate fluid passages therethrough and having a movable heat exchanger matrix consisting of individual rotating elements independent of each other, said heat exchanger matrix comprising two concentrically arranged stacks of annular lamellae, spacing disks arranged between said individual lamellae in the plane of separation between said two fluid passages, means for resiliently urging said lamellae and said spacing disks into sealing engagement with each other, and means for sealing the circumferential surfaces of said stacks of lamellae including rotating bodies in contact with said circumferential surfaces, driving means including shafts for effecting rotation of said heat exchanger matrix by frictional engagement of said lamellae with said spacing disks, and means for mounting said spacing disks on said shafts for common rotation therewith.

6. A regenerative heat exchanger according to claim 5, further comprising spring means including thrust pieces slidably mounted on said shafts for keeping said spacing disks and said stacks of lamellae in continuous resilient engagement with each other through the intermediary of said thrust pieces.

7. A regenerative heat exchanger according to claim 5, further comprising means for drivingly connecting said shafts with said rotating bodies.

8. A regenerative heat exchanger according to claim 1, wherein said spacing disks are provided with scraping edges along the periphery thereof.

9. A regenerative heat exchanger according to claim 1, further comprising at least one row of guided rollers in each of said two fluid passages to assure free flow passage through said stacks of lamellae.

10. A regenerative heat exchanger provided with two separate fluid passages extending therethrough and having a movable heat exchanger matrix consisting of individual rotating elements independent of each other, said heat exchanger matrix comprising two concentrically arranged stacks of annular lamellae, spacing disks arranged between said individual lamellae in the plane of separation between said two fluid passages, means for resiliently urging said lamellae and said spacing disks into sealing engagement with each other, and means for sealing the circumferential surfaces of said stacks of lamellae.

11. A regenerative heat exchanger provided with two separate fluid passages extending therethrough and having a movable heat exchanger matrix consisting of individual rotating elements independent of each other, said heat exchanger matrix comprising two essentially concentrically arranged stacks of annular lamellae, spacing disks arranged between said individual lamellae and located between said two fluid passages, means for resiliently urging said lamellae and said spacing disks into sealing engagement with each other, and means for sealing the circumferential surfaces of said stacks of lamellae.

12. A regenerative heat exchanger provided with two separate fluid passages extending therethrough and having a movable heat exchanger matrix consisting of individual rotating elements independent of each other, said heat exchanger matrix comprising two stacks of annular lamellae, spacing disks arranged between said individual lamellae and located between said two fluid passages, means for resiliently urging said lamellae and said spacing disks into sealing engagement with each other, and means including said spacing disks for sealing the circumferential surfaces of said stacks of lamellae.

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