

Feb. 17, 1959

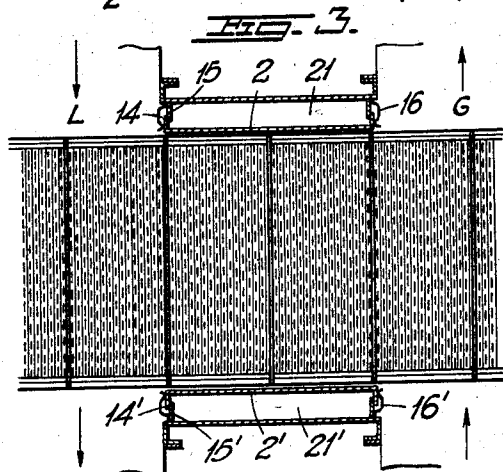
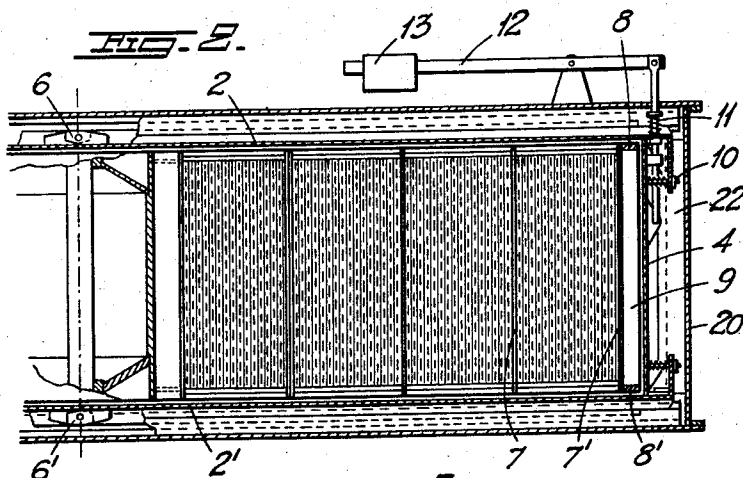
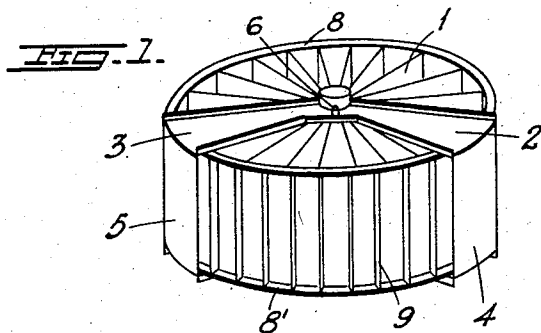
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2,873,952

ROTARY REGENERATIVE HEAT EXCHANGERS FOR GASEOUS MEDIA

Filed April 13, 1954

2 Sheets-Sheet 1



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Feb. 17, 1959

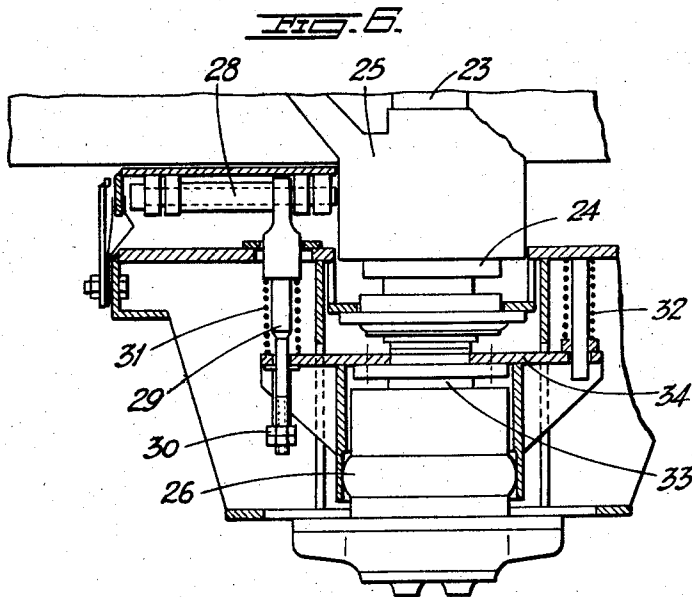
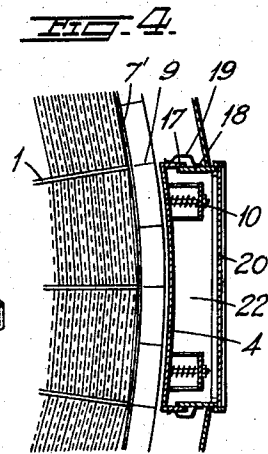
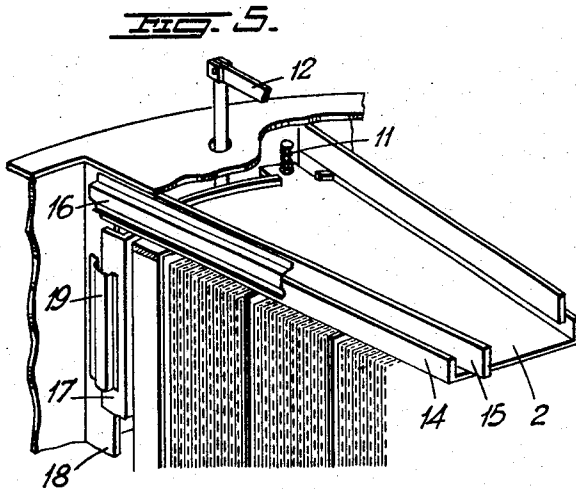
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ROTARY REGENERATIVE HEAT EXCHANGERS FOR GASEOUS MEDIA

Filed April 13, 1954

2 Sheets-Sheet 2



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ROTARY REGENERATIVE HEAT EXCHANGERS FOR GASEOUS MEDIA

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Application April 13, 1954, Serial No. 422,918

12 Claims. (Cl. 257—6)

This invention relates to rotary regenerative heat exchangers for gaseous media, as for example those utilized in thermal power plants for preheating the combustion air by means of the hot flue gas. The principal difficulty in such heat exchangers lies in the fact that the two channels or ducts through which the heat emitting and the heat absorbing media flow must be sealed off from one another, so that a cross flow of the media from one channel to the other is prevented. Several proposals have already been made to obtain this result as far as possible, the problem often being solved by applying different proposals simultaneously in order to obtain a cooperation of their effects.

The problem is especially difficult when the heat exchanger, due to its high capacity is of large dimensions, so that the thermal expansion is at a high value and further irregular distortion and warping of the rotor takes place as its temperature rises as compared to idle condition and also due to the fact that the temperature will continuously vary somewhat during normal operation.

One solution, taking the above mentioned distortion of the rotor particularly into consideration, provides for movable plates located between the rotor end faces and the stationary housing end walls and sealing off the transition zones of the rotor for separating the two main channels. The movable plates are adapted to adjust themselves to distortions of the rotor which occur due to heat expansion of the rotor as a result of normal operation.

The rotary regenerative heat exchanger according to the invention contemplates an improvement of this type and is characterized substantially by a construction in which the upper and the lower end sealing plates of a transition sector are connected with each other by means of a jacket plate covering the rotor at its circumference so that pairs of sealing plates follow the up and down movements of the rotor.

The principle of inter-connecting the two end sealing plates so that they move in pairs is known per se, but heretofore separate connecting rods have been used whereas the jacket sealing plate, also known per se, has formed a separate structural element. These connecting rods accordingly did not follow the up and down movements of the two sealing plates located opposite each other on either side of the rotor.

To interconnect all three of the plates of a dead sector results in a simpler construction and also affords several constructional advantages which will be disclosed more in detail with reference to the drawings. Various improvements according to the invention will also be seen from the drawings.

Fig. 1 illustrates in a diagrammatic view the general basic idea of the invention.

Fig. 2 shows a radial section through such a heat exchanger with a more detailed showing of construction details.

Fig. 3 shows a development of a vertical section through the rotor along a section surface adjacent the rotor jacket and concentric with the rotor axes.

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Fig. 4 shows a fragmentary horizontal section through the heat exchanger in the range of the dead transition zone.

Fig. 5 shows this dead zone in a detail perspective view.

Fig. 6 shows a specific form of the holder of the lower sector joint.

The general basic idea of the invention will best appear from the diagrammatic view of Fig. 1.

The rotor shown is in a general manner formed with sectors separated by radial walls 1. The heat exchanger in the present case is of the type having two channels of different cross sectional areas, with the front channel being smaller and forming the air channel whereas the rear and larger channel is the gas channel. The two dead transition zones at the upper end face of the rotor are covered by plates 2 and 3 which are movable up and down whereas corresponding cover plates 2' and 3' at the lower end face of the rotor cannot be seen in this figure. Also shown in Fig. 1 are the jacket plate 4 connecting the two end plates 2 and 2' and the jacket plate 5 connecting the two end plates 3 and 3'. Near the rotor shaft the two end faces covering plates 2 and 3 are pivotally mounted by means of a joint 6 for tilting up and down. At the lower end of the rotor this joint corresponds to a joint 6' not visible in Fig. 1. From Fig. 1 it will be evident that upon distortion of the rotor each of the two plate systems may follow the up and down movements of the rotor without difficulty so that the distances between the rotor end faces and the end plates will remain unchanged.

More detailed features of the construction will be seen from Figs. 2 to 4 inclusive, illustrating some of the more important constructional characteristics which are also shown in Fig. 5.

The rotor is divided into separate annular chambers by concentric walls 7 which chambers in turn are divided by the radial walls 1. The outermost concentric wall 7' which accordingly provides the outer wall of the rotor carries at its upper and lower ends circumferential flange rings 8 and 8' respectively so that outside the wall 7' an annular chamber is formed in which radial strips 9 are mounted. These strips 9 are very accurately fitted so that their outer edges as well as the outer edges of the two circumferential ring flanges 8 and 8' on the wall 7' are located on a theoretically accurate cylinder.

In a similar manner all intermediate walls 1 and 7 extend the full height of the rotor. The two end faces of the rotor and the end surfaces of the two ring flanges 8 and 8' are turned in a lathe so as to obtain a completely even surface. Also at their outer circumferences the two flange rings are turned off so that they form true circles and permit an accurate adjustment of the strips 9.

Since in this way there is provided an accurately running rotor it is possible to accurately adjust the jacket plate 4 with respect to the rotor. The jacket plate 4 is for this purpose adjustable in a radial direction by means of adjustable stops 10 of which four are provided for each jacket plate. Each stop 10 consists of a pin fixed to the jacket plate 4 and provided with a pressure spring and at its outer end carrying an adjustable nut. The pressure springs bias the jacket plate towards the outer rotor wall 7' in accordance with the position of the adjustable nut. The springs, however, permit a yielding movement radially outwardly of the jacket plate 4. This is of importance in the event foreign particles enter between the wall 7' and jacket plate 4 which, without such a yieldable arrangement, would be likely to cause damage. In a corresponding manner the distance between the plates 2 and 2', and 3 and 3' respectively is selectively adjustable by means of a pin 11 fixed to the plate

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under consideration and which like the stops 10 are also provided with springs in order to permit a yieldable increase of the distance.

The whole of this device comprising the end sealing plates and the jacket plates, is suspended from one end of a double armed lever 12 the other end of which is loaded by an accurately adjustable counter-weight 13. Due to this weight-balance the whole sealing system may, accordingly, very easily follow all up and down movements of the rotor.

The sealing plates 2 and 2' are provided at their radial edges with upwardly projecting strips 14 and 14' respectively. Fixed to the stationary housing end wall are oppositely disposed corresponding strips 15 and 15'. The two strips of each pair of strips may accordingly move in close proximity to each other to provide a seal between the air channel L and the gas channel G which are disposed on opposite sides of the sealing device, and also results in reinforcing and accurately guiding movement of the sealing assembly. In order to improve the sealing, spring plates 16 and 16' respectively are provided which are fixed to the housing strips 15 and 15' and with their free edges sealingly engaging the strips 14 and 14'. These details are clearly shown in Fig. 3 and also in Fig. 5 in which the spring plate 16 is shown somewhat shortened in order to show the position of the strip.

An exactly corresponding seal is provided for the jacket plate 4 which at its outer edges is provided with strips 17 cooperating with strips 18 rigidly secured to the housing. The space between the two strips is covered by spring plates 19.

The space outwardly of the jacket plate 4 is closed by means of a cover 20 and the removal of this cover permits access to all of the sealing system so that accurate adjustment thereof may be made during operation.

The counter-weight 13 is so adjusted that it balances the whole weight of the sealing system. Naturally the influence of possible pressure differences created in the chambers 21 and 21' behind the end sealing plates 2 and 2' is not balanced. Due to the cross flow of the gaseous media from adjacent channels different pressures may arise which disturb the balance. In order to overcome this the two equalizing chambers 21 and 21' are connected with each other through the chamber 22 formed behind the jacket plate 4.

The above details described in connection with the jacket plate 4 are also to be found in connection with the jacket plate 5.

From the figures and the foregoing description it will be understood that the two channels are well sealed and that only small forces are necessary for adjusting the sealing system. The greatest movement naturally takes place at the circumference of the rotor. The stops 10 and 11 are adjusted during normal operation.

The small adjusting movements required will then automatically follow by the balanced weight system during operation. The rotor is subjected to distortion at the circumference in one direction when the boiler is placed in operation, and back in the other direction when the temperatures are again equalized. The position of the flange rings 8 and 8' is then displaced at the circumference with respect to the hub. The exact circular form of the flange rings will however be maintained. They are only displaced in a direction parallel to the axes. The sealing plates are therefore only displaced due to changes in temperature when starting or stopping. During normal operation they will remain in their adjusted operating position.

The pivots or joints 6 and 6', by means of which the two opposite sealing plates are mounted near the rotor shaft, may be made adjustable from the outside, and for this purpose there may be provided a screw or a link projecting outwardly to a convenient point. An exact adjustment of the distance from the sealing plates at the rotor ends to the rotor end faces is also possible at the

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inner pivoted ends. In many instances it is enough to adjust the pivots before putting the heat exchanger into operation and to leave it in the adjusted position. The movements of the rotor end faces influenced by the temperature difference adjacent the shaft are relatively small. It may however, in spite of this, be of value to provide an automatic readjustment at this point.

In the present heat exchangers of this type the rotor is carried by an upper main support bearing. At the lower end the vertically suspended shaft rests on the rotor hub. Due to the higher temperature present during operation this supporting point will move downwardly to a certain extent. The rotor hub supported at its lower end expands in an upward direction so that at the upper hub end the expansion of the shaft may be partly compensated. When the shaft is at a somewhat lower temperature than the hub this compensation results in substantially maintaining the upper end of the hub in fixed vertical position. Accordingly additional adjusting means at this point may be dispensed with. It is enough to make the above mentioned adjustment manually for the upper pivot point of the upper sealing plate. At the lower pivots however this change of vertical position between a cold condition and a warm operating condition is to be taken into account.

Such a pivot holder for automatically adjusting the lower sealing plate is shown in Fig. 6 and the automatic adjustment is obtained here by means of the bearing. The basic idea of this construction is moreover adaptable not only for the above disclosed embodiments but in general for rotary heat exchangers with the rotor carried at the top, and further also for such heat exchangers with a vertical rotor as well as for those having a horizontal rotor shaft.

In the embodiment illustrated the lower end of the rotor shaft 23 carried at its top is provided with a supporting ring 24 to which the rotor hub 25 is attached. For exact central guiding of the shaft 23 there is provided a guiding bearing 26. The bearing shells 33 of this guiding bearing 26 are not rigidly mounted but are slidable in order that they may follow the up and down movements of the lower end of the shaft 23. The new and characteristic feature of this bearing resides in the fact that the bolt 28 which serves as a pivot point for the end sealing plates is connected with the guiding bearing 26. As the bearing shells 33 of the guiding bearing follow the up and down movements of the lower end of the shaft 23 due to temperature changes, the pivots of the sealing plates will accordingly accurately follow such movement. It is accordingly only necessary to adjust the desired plate distance once.

For this purpose there is provided a bolt 29 which at its upper end carries the bolt 28. The nut 30 on the bolt 29 determines the distance between the plates as a spring 31, which abuts against a plate 34 resting on the bearing shells 33, urges the bolt 29 upwards against the nut-stop 30. Also the spring 31 permits a yielding movement upon an increase of the distance between the sealing plate and the rotor end face.

It is to be noted that the pivots of the sealing plates 2' and 3' are not diametrically opposite relative to the geometric axes of the rotor shaft but are at one side. The weight of the two sealing plates which rest on one side of the guiding bearing 26 results in an unbalanced loading of the bearing shells. It is however possible to balance this by loading the other side of the bearing to the same extent. For this purpose a spring 32 may be employed which is so dimensioned that its force corresponds to the loading from the sealing plates.

We claim:

1. A rotary regenerative heat exchanger for gaseous media of the character described comprising a rotor and stationary housing structure, said housing structure including end plates having apertures therein separated by sector shaped portions of said end plates and providing two

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channels for flow of different heat exchanging media through said heat exchanger, said rotor having radial partitions dividing the rotor into a plurality of sector-shaped compartments, sealing plates at the ends of the rotor confronting said sector shaped portions of said end plates arranged to seal the ends of said compartments in the transition zones separating the channels for said different media, said sealing plates being hinged at their inner ends and jacket plates sealingly interconnecting each set of the sealing plates at the opposite ends of the rotor, for sealing the rotor at its circumference, the assemblies of said movable sealing plates and said connecting jacket plates being movable to adjust themselves to compensate for distortions of the rotor structure caused by differential thermal expansion of the latter.

2. Structure as defined in claim 1 which includes stop members cooperating with said sealing plates and permitting adjustment of the distance between the two plates at the respective ends of the rotor.

3. Structure as defined in claim 1 which includes stop members cooperating with said jacket plates and permitting selective adjustment of the radial location of said plates.

4. Structure as defined in claim 3 in which the adjustable stop members yieldably press the sealing plates toward the rotor and positively limit the minimum space of said plates while permitting resilient yielding of the plates away from the rotor.

5. Structure as defined in claim 1 in which the radial partitions of the rotor extend through the full height of the rotor and at their opposite ends are in alignment with a circumferential annular flange at each end of the rotor, the entire end face of the rotor being formed to provide a surface accurately formed to lie in a common plane.

6. Structure as defined in claim 5 in which the rotor includes an outer cylindrical shell around which the annular flanges at the ends of the rotor extend, and a plurality of circumferentially spaced axially extending radial strips which are located between said flanges, the outer edges of said strips and the outer circumferences of said flanges being defined by the envelope of a common cylinder.

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7. Structure as defined in claim 1 in which the end and the circumferential sealing plates at each transition zone are provided with flanges projecting toward said stationary housing and said stationary housing is provided with strips rigidly secured thereto and in proximity to said flanges, said strips and flanges together with said sealing plates and the adjacent parts of said stationary housing structure forming a chamber closed on all sides.

8. Structure as defined in claim 7 including resilient sealing members mounted on certain of said strips and in resilient contact with said flanges in cooperative relation with the strips upon which said sealing members are mounted.

9. Structure as defined in claim 7 in which said chambers formed at each transition zone are in communication with one another.

10. Structure as defined in claim 1 in which said rotor includes a central rotor shaft, said rotor shaft having a fixed bearing for axially locating one end of the shaft relative to said stationary housing structure and an axially movable guide bearing at the other end of the shaft, the sealing plates at the end of the rotor at which said guide bearing is located being pivotally mounted and adjustably connected to said guide bearing.

11. Structure as defined in claim 10 including spring means located on the side of the rotor axis opposite the pivotal connection of said sealing plates for balancing the loading on said guide bearing.

12. Structure as defined in claim 11 including adjustable stop means for limiting the distance between the inner ends of the sealing plates and the end face of the rotor.

References Cited in the file of this patent

UNITED STATES PATENTS

2,055,071	Eriksson	Sept. 22, 1936
2,678,194	Horney et al.	May 11, 1954
2,681,209	Mudersbach	June 15, 1954
2,744,731	Brandt	May 8, 1956

FOREIGN PATENTS

709,143	Germany	Aug. 8, 1941
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