

June 8, 1954

S. I. TRULSSON ET AL
REGENERATIVE HEAT EXCHANGING APPARATUS
HAVING COOLED PARTITION WALLS

2,680,598

Filed Feb. 16, 1951

2 Sheets-Sheet 1

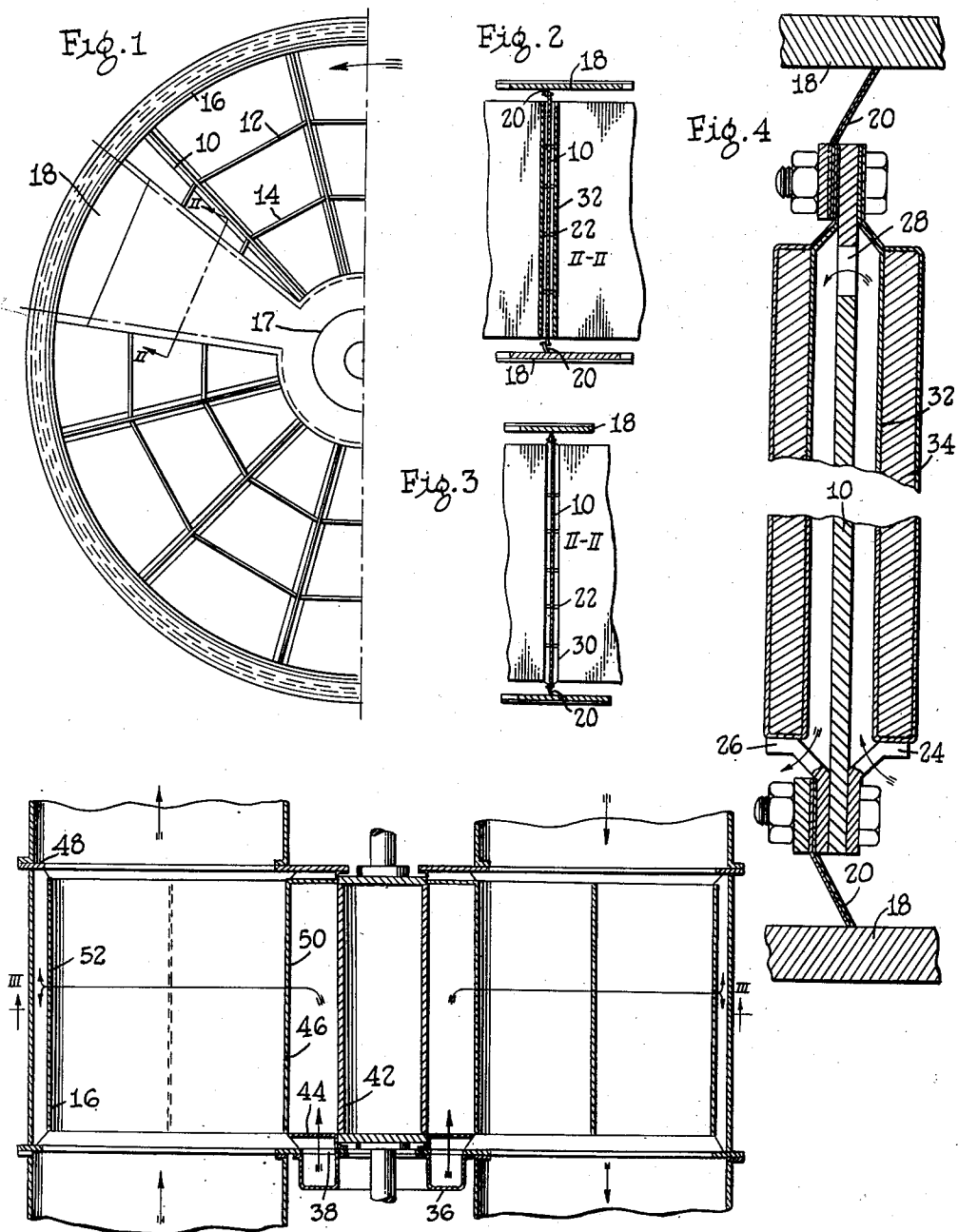


Fig. 5

INVENTORS
SVEN IVAR TRULSSON
HANS ROBERT NILSSON

BY

Jarvis M. Miller
their ATTORNEY

June 8, 1954

S. I. TRULSSON ET AL
REGENERATIVE HEAT EXCHANGING APPARATUS
HAVING COOLED PARTITION WALLS

2,680,598

Filed Feb. 16, 1951

2 Sheets-Sheet 2

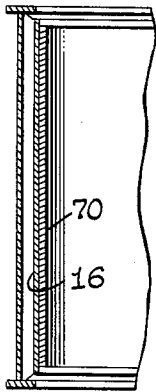


Fig. 7

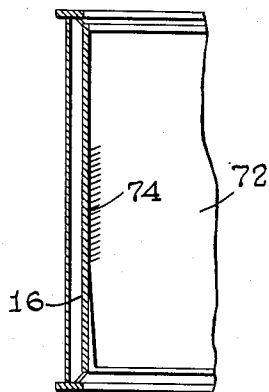


Fig. 8

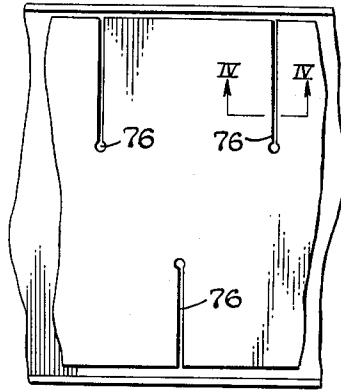


Fig. 9

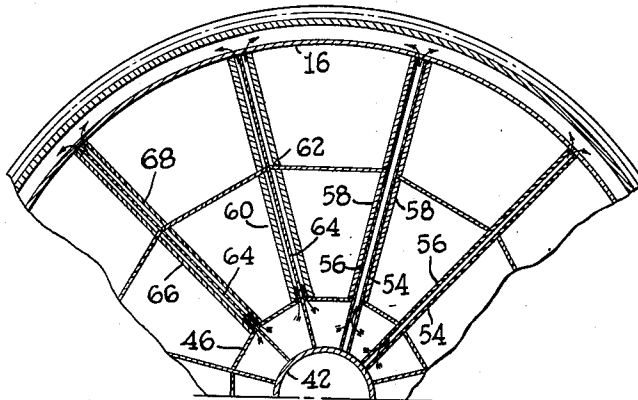


Fig. 6

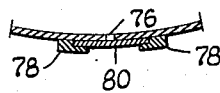


Fig. 10

INVENTORS

SVEN IVAR TRULSSON
HANS ROBERT NILSSON

BY

Jarvis Mante
their ATTORNEY

UNITED STATES PATENT OFFICE

2,680,598

REGENERATIVE HEAT EXCHANGING APPARATUS HAVING COOLED PARTITION WALLS

Sven Ivar Trulsson, Enskede, and Hans Robert Nilsson, Ektorp, Stockholm, Sweden, assignors, by mesne assignments, to Jarvis C. Marble, New York, N. Y., Leslie M. Merrill, Westfield, N. J., and Percy H. Batten, Racine, Wis., trustees

Application February 16, 1951, Serial No. 211,318

Claims priority, application Sweden March 3, 1950

18 Claims. (Cl. 257—6)

1

The present invention relates to rotary regenerative heat exchangers of the kind in which a rotor is mounted within a stationary housing structure and particularly to those parts of the rotor which support members for providing a seal between the rotor and the stationary structure. The alternating and uneven heating and cooling causes warping of the rotor, so that considerable difficulty is encountered in maintaining a satisfactory sealing between the stationary and rotating parts of the heat exchanger. To overcome these difficulties it has hitherto been proposed to provide sealing devices which automatically adjust themselves when the rotor changes dimensions and shape. Instead of trying to attain more effective automatically adjustable sealing devices the present invention solves the problem more directly by providing suitable cooling for the radially directed partition walls, forming a part of the rotor which supports sealing members, resulting in reduced temperature differences in these partition walls. By this expedient, the warping of the rotor is reduced and consequently effective sealing is facilitated. According to the present invention, this cooling is attained by the provision of partition walls dividing the rotor into a plurality of sector shaped compartments containing heat transfer elements, built in such a way that a gas, preferably air, serving as a cooling medium, may be conducted along the partition walls at suitable places, either in radial or axial direction.

A suitable embodiment of the invention may be formed so that the radial partition walls are composed of an intermediate plate which may be provided with sealing members at its upper and lower ends, and side-walls of heat insulating material, which are placed on each side of said plate and spaced therefrom to form two flow channels, which at one end are provided with openings and at the opposite end are in communication with each other by means of openings in the intermediate plate so that, when one side of the partition walls is facing the air side of the heat exchanger, air under higher pressure than that of the gas on the opposite side of the partition wall, is caused to flow over to the gas side through said channels, whereby the double sided sweeping of the intermediate plate results in a desired decrease in the temperature differences in said plate.

This and other embodiments of the invention are shown on the accompanying drawings, which together with the following description disclose the nature of the invention more in detail.

2

Fig. 1 illustrates from above the housing of a regenerative air preheater with its rotor.

Fig. 2 is a section of a partition wall on the line II—II in Fig. 1.

Fig. 3 is another embodiment of a partition wall according to Fig. 2.

Fig. 4 illustrates on an enlarged scale the upper and the lower part of the partition wall shown in Fig. 2.

Fig. 5 shows in section a regenerative air preheater having partition walls constructed according to one of the embodiments of the invention.

Fig. 6 is a fragmentary cross section of the preheater taken on the line III—III in Fig. 5.

Fig. 7 is a sectional view of one embodiment of the rotor shell.

Fig. 8 illustrates the connection between a partition wall and the rotor shell.

Fig. 9 shows a form of rotor shell seen from the inside of the rotor, in which the shell is provided with slots for avoiding heat stresses.

Fig. 10 is a section seen from above on the line IV—IV in Fig. 9.

As will be seen from the figures the embodiments shown are adapted to provide regenerative air preheaters of the Ljungström type, having a rotor divided into sector shaped compartments provided with sealing members on the upper as well as on the lower sides, said rotor being placed in a rotor housing, having inlet and outlet openings in the end plates thereof for countercurrent flow of gas and air.

At 10 is denoted one of the radial partition walls of the rotor which are interconnected by two walls 12 and 14, the outer shell 16 and the hub 17 of the rotor. The gas channel and the air channel are separated by sector plates 18 forming end plates of the rotor housing, one of said sector plates being shown in Fig. 1. A section of this sector plate taken on the line II—II in Fig. 1, is shown in Fig. 2 and Fig. 3 each showing one embodiment of the radial partition walls according to the invention. From said figures it is seen how the radial sealing members 20 separate the air from the gas side, when the partition wall 10 is placed between one pair of sector plates 18. To avoid exposure of the partition walls 10 to such great temperature variations that the sealing between the sector plates 18 and the sealing members 20 is impaired, the partition walls 10 shown in Figs. 2 and 3 are provided with a heat insulating outer wall on each side. Said outer walls are spaced from the intermediate wall 10 by means of distance elements 22, so that two ducts are formed, which communicate with the gas

channel on the one side and with the air channel on the other side of the partition wall, through openings at the bottoms of said ducts, i. e. inlet openings 24 and outlet openings 26. These openings are seen in Fig. 4 showing the upper and lower part of the embodiment in Fig. 2 on an enlarged scale. At the upper end the two ducts are in communication through openings 28 in the intermediate wall 16. Since the pressure on the air side is greater than that on the gas side, air will flow in through the inlet openings 24 and pass through the duct to the right in Figs. 2-4, through the openings 28, and down through the left duct and out through the outlet openings 26, whereby heat is absorbed by the air flow from the plate 19 and partly from the outer walls. The temperature differences in the intermediate plate 19 will thus be so materially reduced that deformations of undesirable magnitude of the same are avoided.

The outer walls may either consist of ordinary plate walls 30, as in the embodiment shown in Fig. 3, or be composed of double walled plates 32, enclosing insulating material 34, which effectively insulates the intermediate plate 19. In the embodiments hereinbefore shown and described the circulation of the cooling air is effected by means of the pressure difference between the air and the gas side. The advantages of this system are among others that no auxiliary fan is required for the cooling air and that the same cooling air sweeps along the intermediate plate in two directions and along both faces of the same, whereby very effective results are obtained in reducing the temperature differences in the intermediate plate.

Some other suitable embodiments of radial partition walls according to the invention are shown in Figs. 5 and 6.

In Fig. 5 a regenerative air preheater is illustrated in longitudinal section. The horizontal arrows in the figure show the direction of flow of the cooling air flowing radially along the partition walls. The cooling air supplied by a separate cooling air fan or by the ordinary fresh air fan is conducted first into an annular space 36 located below the rotor housing, from which the air flows out through openings 38 in the annular space 36 into another space, which is bounded by inner sealing members of the rotor and the rotor hub. By means of openings 44 in the bottom of the rotor the latter space is in communication with a series of spaces each founded by the rotor hub 42, a plate 46 and the end plates of the rotor.

Between the hub 42 and the outer shell 16 the radial partition walls are fixed by means of welding. As seen from Fig. 6 said partition walls may be constructed in several ways, the characteristic feature of all of them being that they are composed of channel forming walls for through-flow of cooling air. Through these channels in the partition walls the cooling air flows out through slots 52 in the outer shell 16 into the space between the same and the rotor housing in which outlet openings 48 may be provided and connected with conduits conducting the heated air into the air channel behind the preheater. The space surrounding the rotor hub 42 is in communication with the ducts in the partition walls through slit shaped openings 50 in the plate 46. To prevent the lower portions of the partition walls from being cooled too much, since the fresh air flowing in the left channel in the direction of the arrow in Fig. 5 also acts as cooling air on the partition walls, the slit shaped openings 46 begin at a certain distance up in the rotor. The slit shaped outlet openings 52 in the

outer shell plate are also formed in the same way. Since every radial partition wall is constructed according to the invention, all partition walls, wherever they may be upon one turning of the rotor, will be exposed to cooling air. In order to enable a certain variation of this cooling air the inlet openings 38 in the annular space 36 may be made larger on the gas side than on the air side. Moreover, the slit shaped openings 50 in the plate 46 may be in a form of widening through-flow area, seen in the direction of main flow of the fresh air.

The design of the partition walls according to this embodiment of the invention with cooling air flowing substantially radially along the partition walls, is shown in Fig. 6 by various examples. These various examples are shown in section on the line III—III in Fig. 5.

The most simple of these embodiments consists of two spaced plates 54 and 56. A more effective and also more expensive embodiment is provided with insulating material 58 on the outer face of the plates 54 and 56. Another suitable embodiment may consist of two insulating walls 60 and 62, between which an intermediate plate 64 is provided, by means of which a cooling of the same is effected on both of its sides. In a fourth embodiment shown by way of example the insulating walls 60 and 62 are replaced by ordinary plate walls, 66 and 68. These partition walls may of course be constructed in several other ways according to the invention, all having the object of cooling the partition walls to reduce the temperature differences therein.

Fig. 7 shows in section a part of the rotor shell 16. This will of course also be exposed to considerable temperature variations and resultant variations in dimensions. In order to greatly reduce these temperature variations the outer shell 16 is provided on the inner side with heat insulating material 70.

A manner of fastening the partition walls to the shell of the rotor is shown in Fig. 8. At 72 is denoted a partition wall, at 15 the shell of the rotor and at 74 a weld between the shell and the partition wall. The weld takes up only a part of the short side of the partition wall, since the same is obliquely cut at the lower part to allow this portion of the partition wall to expand freely. In doing so, buckling of the shell and of the partition walls is to a great extent avoided, which buckling might occur upon driving a regenerative heat exchanger resulting in considerable difficulties for attaining effective sealing.

Still another way to avoid buckling of the shell 16 is shown in Figs. 9 and 10. In Fig. 9 the shell is seen from the inside, whereby two slits 76 are cut to extend upwardly and downwardly, respectively, from the lower and upper edges of the plate. On the outside of the plate two angle irons 78 are fastened by welds on both sides of the slit. These irons are shown in Fig. 10 which is a section on the line IV—IV in Fig. 9. The irons are shown in cross section, and between them is inserted a plate 80 preventing air and gas from passing through the slits. The width of the plate 80 allows a certain relative movement of the iron when the shell is contracting or expanding.

The invention is of course not limited to the embodiments herein shown and described but may of course be varied in still further embodiments within the scope of the invention.

We claim:

1. Regenerative heat exchange apparatus com-

prising stationary housing structure providing adjacent channels for flow of different fluid media between which heat is to be exchanged and a rotor mounted for rotation within said structure, said rotor having a series of radial partitions for dividing the rotor into a plurality of sector-shaped compartments, said compartments containing regenerative heat exchange material and said rotor being mounted so that said material is passed successively through said ducts, each of said partitions comprising spaced plate members providing ducts for flow of a cooling fluid, and ports for admitting and exhausting a cooling fluid to and from said ducts.

2. An exchanger as defined in claim 1 in which said partitions comprise at least two substantially parallel and closely spaced radially extending walls forming between them a space for the flow of said cooling medium.

3. An exchanger as defined in claim 2 in which each of said partitions comprises a radially extending main partition wall and parallel side plate members spaced from the main wall to provide cooling ducts on either side of the main partition wall.

4. An exchanger as defined in claim 3 in which said side plate members comprise heat insulating material.

5. An exchanger as defined in claim 1 in which said stationary housing structure includes sector plates between which the rotor is located and said partitions carry radially extending sealing members cooperating with said sector plates as the rotor revolves.

6. An exchanger as defined in claim 5 in which the inlet and outlet ports for said ducts communicate with different ones of said channels when said sealing members are in sealing relation with said sector plates, whereby to utilize flow of fluid through said spaces from one to the other of said channels due to differential pressure therein to cool said partitions.

7. An exchanger as defined in claim 6 in which each of said partitions comprises a main partition wall carrying said sealing means and side wall member at either side thereof providing a cooling duct on each side of said main wall, the inlet and outlet ports being located respectively in different ones of said ducts at the same end of the rotor and the ducts being connected at the opposite end of the rotor.

8. An exchanger as defined in claim 1 in which said ports are located at the radially inner and outer ends of said ducts for flow of cooling fluid radially of the ducts.

9. Regenerative heat exchange apparatus comprising stationary housing structure having a generally cylindrical casing, sector plates at the ends of said casing and means providing two adjacent channels for flow of different fluids through said casing, a rotor mounted for rotation in said structure between said sector plates, said rotor comprising a hub portion, a shell concentric with and

spaced inwardly of and adjacent to said casing and radially extending partitioning means connecting said hub portion and said shell, said partitions comprising spaced wall members providing ducts therebetween for flow of cooling fluid generally radially through said partitions.

10. An exchanger as defined in claim 9 including means for supplying cooling fluid to the radially inner portions of said ducts and for exhausting the cooling fluid from the radially outer portions of said ducts to the space between said shell and said casing.

11. An exchanger as defined in claim 10 in which the means for supplying cooling fluid to said ducts includes axially extending slot-like inlet openings in the radially inner portions of said partitioning means.

12. An exchanger as defined in claim 11 including means for supplying cooling fluid to said inlet openings from one end of said casing structure.

13. An exchanger as defined in claim 12 in which said inlet openings are axially of increasing width from said one end to control the flow of fluid to said ducts.

14. An exchanger as defined in claim 10 in which the means for exhausting cooling fluid from said ducts comprises axially extending slot-like outlet openings in the rotor shell.

15. An exchanger as defined in claim 1 in which said rotor includes a generally cylindrical outer shell and heat insulating material on the inner surface of said shell.

16. An exchanger as defined in claim 1 in which said rotor includes a generally cylindrical outer shell, said shell being provided with spaced longitudinally extending slots to permit variable expansion of the shell without buckling.

17. An exchanger as defined in claim 16 including cover plates for covering the openings made by said slots and means for mounting said cover plates to permit relative movement thereof with respect to the shell.

18. An exchanger as defined in claim 1 in which said rotor comprises an outer generally cylindrical shell and in which said partitions are attached to said shell for only a portion of their axial length, the remainder being relieved to permit relative radial movement between the outer end of the partitions and the shell.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,762,320	Wood	June 10, 1930
2,045,152	Lebre	June 23, 1936
2,345,204	Lodwig	Mar. 28, 1944

FOREIGN PATENTS

Number	Country	Date
517,600	Great Britain	Feb. 2, 1940
587,035	Great Britain	Apr. 11, 1947