ABSTRACT OF THE DISCLOSURE

A seal for a rotary regenerative heater wherein a plurality of sealing blocks are positioned radially and axially of the rotor to cooperate with surfaces of the rotor to avoid leakage between the heating fluid and the fluid being heated. Each of the blocks is supported on the heater housing for adjustable movement in a plane including the axis of rotor rotation so as to maintain a preferred surface to surface relationship of the seals in all adjusted positions.

The present invention relates to improvements in the construction of adjustable seals for a regenerative heater, and more particularly to the construction and arrangement of an adjustable assembly supporting a sealing member in a rotary regenerative heater.

The use of rotating drums to support heat exchange surfaces, where the surfaces are alternately heated by a heating fluid and then gives up its heat to a fluid to be heated, is well known in the art. Such regenerative heaters are provided with various forms of sealing devices to avoid or at least minimize by-passing of the heat exchange surfaces or leakage between the heating fluid and the fluid to be heated.

In rotary regenerative heat exchangers having the heat exchange surfaces mounted in a rotating cylindrical drum or rotor and enclosed in a stationary housing, the radial and axial seals separating the heating fluid and the fluid to be heated must be effective to avoid leakage between the surfaces of a rotary regenerative heat exchanger is greatly influenced by the degree or amount of leakage between the fluids at the axial and radial seals. The present invention is directed to the construction and arrangement of axial and radial seals mounted on the stationary housing of a rotary regenerative heater and adjustable to establish and maintain a preferred clearance between stationary and moving parts.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

Of the drawings:

FIG. 1 is an isometric view, partly in section, of a regenerative heat exchanger containing the axial and radial seals of the present invention;

FIG. 2 is a schematic view, greatly simplified, of a rotary regenerative heater arranged with axial seals constructed in accordance with the present invention;

FIG. 3 is an enlarged detail view of a seal assembly in the course of installation shown in FIG. 2;

FIGS. 4 and 5 are plan and end views, respectively, of the seal assembly shown in FIG. 3;

FIG. 6 is a diagrammatic view of a seal assembly in its relationship in a rotary regenerative heater;

FIG. 7 is a diagrammatic view of a seal assembly in its angular relationship to the rotor of a rotary regenerative heater; and

FIGS. 8 and 9 are enlarged schematic views showing the relationship between the seals of the present invention and the rotor.

While the adjustable seal assembly of the invention is illustrated as applied in a regenerative heater of the type shown in U.S. Patent 3,229,753, it will be appreciated the seal is equally applicable to other types of rotary regenerative heaters.

As shown in FIG. 1, the rotating element or drum 10 of a regenerative air heater is mounted for rotation about a horizontal axis formed by a horizontal shaft 11 supported at opposite ends in bearings, such as at 12. It will be understood the axis of rotation may be horizontal, vertical or inclined, insofar as the present invention is concerned. The drum 10 is of circular cross-section and includes equi-angularly spaced partitions 13 extending radially outwardly from the shaft to the outer circumference 14 of the drum. Suitable heat exchange elements or surfaces 15 are positioned at axially spaced positions in the sectors between the adjacent parts 13 to absorb heat from a heating fluid, and after rotational movement, to transfer such heat to a fluid to be heated.

The rotor 10 is enclosed by a housing 16 having suitable inlets and outlets for the heating fluid and for the fluid to be heated. The housing 16 is provided with imperforate end plates 16A with the fluid inlets and outlets arranged radially with respect to the axis of rotation. Suitable circumferential seals 17 are provided to avoid or at least minimize by-pass leakage of the fluids between the housing 16 and the rotor 10. A seal band arrangement, including radial seals 18 and axial seals 20, is mounted on the housing to encircle the rotor and to thereby separate the heater into two chambers A and B for separate movement of the two fluids through the heater.

As shown in FIG. 1, the heating fluid such as hot flue gases enters the chamber A of the housing 16 through an upper inlet 21, enters the rotor 10 between the partitions 13 to pass outwardly in opposite generally axial horizontal directions through the spaced masses of heat exchange surfaces 15. Thereafter the cooled heating fluid enters the plenum chambers 22A positioned at opposite ends of the rotor between the surfaces 15 and the end plates 16A of the housing 16. From the chambers 22A the cooled heating fluid discharges from the housing 16 through outlets (not shown) on the back of the housing. The fluid to be heated, such as combustion air, enters the chamber B of the housing 16 through inlets (not shown) and plenum chambers 22B on opposite sides of the rotor 10 to pass inwardly in a generally horizontal direction through the heat exchange surfaces 15. After combining in the sector spaces between the surfaces 15, the heated fluid passes radially outwardly through the chamber B to discharge through an outlet 23. The chambers 22A and 22B are separated by the band seals.

The axial seals 20 are shown in detail in FIGS. 2 to 7 inclusive. As schematically shown in FIG. 2, each seal 20 includes a block 25 having its face 26 shaped to the configuration of the rotor surface. A spaced series of
plates or fingers 27 inclined in the direction of drum rotation are secured to the face 26 and assembled with their outer ends conforming to the adjacent surface of the rotor 10 and to thereby form a labrinth type of seal when positioned closely adjacent the surfaces of the rotor. The circumferential dimension of the seal 20 is at least equal to and usually slightly exceeds the arcuate spacing of adjacent partitions 13. The radial seals 18 are of generally sectoral shape with their outer end curved to conform with the outer circumference of the rotor 10 and to match the corresponding dimension of the axial seal face 26. As shown in the embodiment of FIG. 1, the rotor 10 is shaped as a cylinder with its outer surfaces including the ends of the partitions and the end circumferential rim members 19 finished to provide sealing surfaces cooperating with the sealing elements 17, 18 and 20. Under some circumstances the end surfaces of the rotor may be shaped as truncated cones, as may be required for rotor structural reasons. In either case, the radial seals will cooperate with a substantially flat rotor surface, as compared with a curved rotor surface with the axial seals. As shown in FIGS. 8 and 9, the axial and radial seals are disposed perpendicular to each other and are of generally similar construction side from the difference in sealing surface configuration.

In the construction of the seal 28 it is necessary to finish the face 26 to the same curvature as that of the matching surfaces of the rotor. A layout is shown in FIG. 7 where the radius of the drum 10 is used to draw an arc 31 which represents the arcute sealing surface of the drum. The dot-dash lines 32 and 33 represent the centerlines of adjacent partitions 13 with the included angle X therebetween. A radius reference line 34 bisects the angle X, with the lines 32, 33 and 34 intersecting at O, which represents the axis of rotation of the rotor 10. The points of intersection of the center lines 32 and 33 with the curve 31 are projected parallel to the radius line 34 to form reference points 35 and 36 lying on a curve having a radius L' equal to the radius L of the arc 31, where the curve so formed will produce the proper contour of face 26 of a block 25. With the radii L and L' being equal and the points 35 and 36 equidistant on opposite sides of the radius line 34 the seal block 25 may be moved along the line 34 to insure equal spacing between the seal block face and the matching surface of the rotor 10. It is necessary, however, to install the axial seal adjusting mechanism hereinafter described with a fixed angular relationship as shown in FIG. 6. In such an arrangement the radius line 34 passing through the axis of rotor rotation O must also lie in a plane passing through the rotor axis so as to maintain the proper sealing relationship throughout the axial length of the rotor.

As shown in FIGS. 3, 4 and 5, the block 25 is attached to a plate 37 which is strengthened by radial plates 38 and mounted on a tubular member 40. The member is provided with a rack 41 which is slidingly fitted in a slot 42 formed in a hub or bearing sleeve 43 mounted in a frame 44 which, after proper alignment, is welded to the structure of the housing 16. Movement of the seal block 25 along the radial plane including the radius line 34 is obtained by rotation of a worm 45 which is mounted on a shaft 46 operable in bearings 47 and 48 attached to the frame 44. The outer end of shaft 46 is suitably provided with flatted ends 59 to accommodate a suitable wrench for seal adjustment purposes, (see FIG. 1). The edges of the plate 37 are provided with curved sealing strips 51 to engage the adjacent partitions and form the ends of the seals of the invention, an opening is provided in the housing 16 to accommodate the axial and radial seals. As shown particularly in FIG. 2, the opening 52 is bounded on top and bottom by horizontally extending plates or shelves 53 and 54, respectively. The shelves are positioned as accurately as possible during construction and assembly so as to be parallel to and equidistant from a radial plane passing through the axis of rotor 10 rotation, i.e. a plane including the radial line 34. Since the housing 16 is a welded assembly, it is desired that the said axial and radial seal surfaces extend in a line substantially parallel to and inwardly at an angle substantially equal to one half the angularity of the adjacent partitions. The threaded members 55 are each adjusted to project beyond the surface of the sealing plates 27 a distance corresponding to the desired clearance between the seal and the corresponding surface of the rotor 10. With each of the threaded members 55 adjusted to the desired position, the ends of the threaded members will correspond to the reference points indicated in FIG. 7 by numerals 35 and 36.

When the axial sealing assembly is inserted into housing opening 52 (FIG. 2), and with the rotor partitions 13 located as shown, the assembly is advanced until the members 55 contact the surfaces of elements 14 substantially as shown by the dash lines in the drawing. Shims may be necessary between the upper surface of shelf 54 and the bottom of frame 44 to accurately attain the desired alignment. The frame 44 may then be welded to the shelf 54 and the centerline of the seal adjustment mechanism will coincide with the plane containing the radius line 34. For purposes of maintaining the desired alignment of the seal, it is desirable to secure the upper end of the frame 44 to the shelf 53, using filler members, as necessary. It will be noted the contact of the members 55 with the surfaces of elements 14 not only accurately align the seal assembly in the plane of FIG. 2, but also insures parallel alignment between the surfaces of elements 14 not only accurately aligns the seal assembly in the plane of FIG. 2, but also insures parallel alignment between the surfaces in a plane normal to that of FIG. 2. Thus, movement of the seal adjustment mechanism will move the seal in a true radial plane containing the reference line 34.

The radial seals are also provided with threaded members which engage corresponding surfaces on the rotor, so that when installed in a manner similar to that of the axial seals, movement of the radial seals will also be in a plane including the line 34.

While in accordance with the provisions of the statutes I have illustrated and described herein the best form and mode of operation of the invention now known to me, those skilled in the art shall understand that certain improvements may be made in the form of the apparatus disclosed without departing from the spirit of the invention covered by my claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

What is claimed is:

1. A rotary regenerative heater having a rotor of circular cross-section rotatable about its central axis, said rotor having a plurality of equi-spaced imperforate radial partitions extending outwardly to the circumference of said elements and forming a plurality of sectoral shaped portions therein, heat exchange surfaces positioned in said sectoral portions, means mounted on said partitions forming sealing surfaces thereon, walls defining a housing enclosing said rotor, means for separately passing a fluid to be heated and a heating fluid over said heat exchange surfaces, said heating fluid passing in a direction opposite to the flow of the said fluids passing through said elements including axial and radial seal means mounted on said housing for movement along a radial plane intersecting the axis of rotation of said rotary element, each of said sealing means having a sealing surface conforming in configuration with a matching sealing surface on said rotary element, and means for individually adjusting each
of said sealing means only along the radial plane of said axis of rotation including a plurality of blocks each having a sealing surface on the inner surface thereof, each block having a member mounted on the geometric center of the outer face thereof, and a hub mounted on said housing to support each of said members with the block thereon for adjusting movement in said radial plane.

2. A rotary regenerative heater according to claim 1, wherein the sealing surfaces formed on the outer ends of said partitions lie in a curved plane having a common radius.

3. A rotary regenerative heater according to claim 1, wherein the sealing surfaces on the axial ends of said rotor form substantially flat surfaces equi-angularly inclined from the central axis of said rotor.

4. A rotary regenerative heater according to claim 1, wherein said member mounted on the outer surface of each block is positioned substantially in the center of the block and its axis is normal to the sealing surface of each block.

References Cited

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