Dec. 6, 1960 J. C. VICKLAND 2,963,279

HEAT EXCHANGER

Filed May 9, 1956

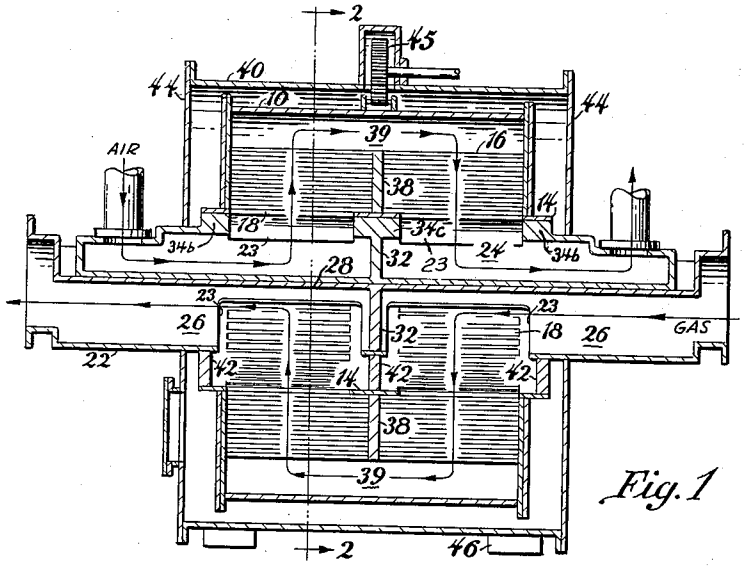


Fig. 1

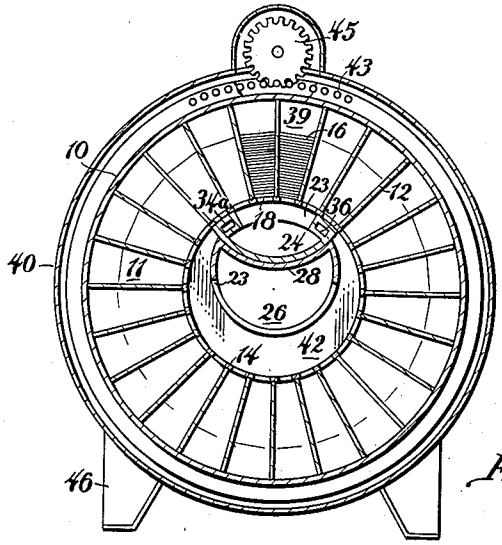


Fig. 2

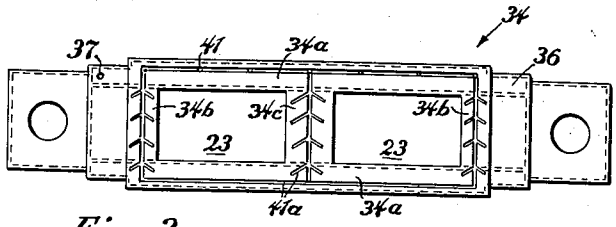


Fig. 3

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2,963,279

Patented Dec. 6, 1960

2,963,279

HEAT EXCHANGER

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Filed May 9, 1956, Ser. No. 583,794

6 Claims. (Cl. 257—267)

The present invention relates generally to heat exchange apparatus and more particularly to an improved form of regenerator for the transfer of heat between hot exhaust gases and air for combustion in a gas turbine cycle.

The invention is concerned generally with regenerative air preheaters in which a body of heat exchange material is first traversed by a heating gas and subsequently traversed by another gas such as air to which the heat is imparted. The body of heat exchange material carried by a rotor is surrounded by a housing formed with openings to permit the flow of gas and air to and through the heat exchange material, and in order to preclude the flow of gas or air through the clearance space between the rotor and housing in such a way as to bypass the heat exchange material, it is customary to provide the rotor with sealing means which separate the relatively movable parts.

The present invention contemplates an improved structural arrangement for a regenerative heat exchange device of the rotary type wherein the sealing means which separates the relatively movable parts is self-adjustable to a minimum clearance by the weight of the rotor.

The invention will be best understood from consideration of the following description of an illustrative embodiment of the invention when read in conjunction with the accompanying drawings in which:

Figure 1 is a longitudinal section of a heat exchanger constructed according to this invention.

Figure 2 is a transverse section of the invention along the line 2—2 of Figure 1.

Figure 3 is a top plan view of the air distribution manifold of the invention showing provision for lubricating the bearing surface formed thereon.

In the drawings the numeral 10 designates an outer cylindrical shell of a rotor that is divided into a series of circumferentially adjacent sector shaped compartments 11 by radial partitions 12 which connect it with an inner shell 14. The rotor compartments 11 each contain a mass of regenerative heat transfer material 16 having a myriad of passages therethrough for the alternate flow of hot and cold fluid.

For the purposes of the present invention the mass 16 does not fill each compartment 11 but extends from the inner shell 14 radially outward to a point short of the outer shell 10 so as to leave a space in each compartment for flow of fluid axially of the rotor between the outer margin of the mass 16 and the shell 10 as will appear hereinafter. The inner rotor shell 14 is provided with two axially spaced sets of inlet and outlet ports 18 arranged in circumferential series and opening into each compartment. The hot and cold fluids are supplied to the rotor through a central duct 22 extending axially through the inner cylindrical rotor shell 14 having openings 23 axially spaced to permit fluid to flow from the central duct to and through the compartments containing heat transfer material.

The central duct 22 is divided into upper and lower

passageways 24 and 26 by an axially extending partition 28, and each passageway is further divided by a central division plate 32 lying midway between the ends of the rotor and normal to its longitudinal axis. In addition to duct 22 providing passageways for the supply of various fluids to the heat exchanger, the upper portion of duct 22 is provided with a bearing designated generally 34 which engages the inner surface of shell 14 and supports the rotor of the heat exchanger for rotation about its horizontal axis. This bearing is effective as a seal to prevent mixing of the hot and cold gases passing through the heat exchanger and prevent the gases entering the rotor through the upper chamber from escaping therefrom with the bearing having surfaces surrounding the openings 23 leading from the upper chamber into the rotor and sealingly engaging the inner surface of shell 14. This bearing 34 includes the circumferentially spaced bearing surfaces 34*a* extending longitudinally of the rotor and on opposite sides of the openings 23 (Figures 2 and 3) with the circumferential dimension of each of the surfaces 34 being substantially greater than the corresponding dimension of the ports 18 provided in shell 14 so that they overlap these ports and accordingly are always in sealing engagement with shell 14. Extending intermediate the surfaces 34*a* are the arcuate surfaces 34*b* and 34*c* which conform with the inner surface of shell 14 with surfaces 34*b* being positioned immediately outward of and surface 34*c* positioned inbetween the two sets of ports 18 provided in the shell so that these arcuate bearing surfaces engage imperforate portions of shell 14. In order to facilitate lubrication of the bearing the upper portion of duct 22 is reinforced and cored as shown at 36 to permit the flow of lubricant from inlet 37 through ports 41 to the grooves 41*a* in the bearing surfaces.

The central duct 22 is of lesser diameter than the inner rotor shell 14, and with the rotor resting upon the bearing surface 34 thereof a gap necessarily exists between the lower portion of duct 22 and the corresponding portion of the inner shell 14. To close this gap that exists a pair of crescent shaped filler plates 42 are fixed symmetrically to the lower portion of the outer surface of the central duct adjacent its ends and a third such plate is mounted in radial alignment with division plate 32.

Plate 32 extends radially across the duct 22 so as to force fluid flowing therethrough to be turned outward through port 23 and flow radially outward through compartments 11 and over the mass 16 in these compartments. An annular baffle 38 in radial alignment with plate 32 extends from the inner rotor shell 14 into spaced relation with the outer shell 10 and effectively divides the rotor into two sections causing the fluid flowing through the rotor to make a U-shaped pass, first flowing from the inlet port 23 radially outward over the mass 16 then being turned by the annular passage 39 and directed radially inward over the mass 16 on the other side of baffle 38 and into outlet port 23.

A cylindrical housing 40 having end plates 44 centrally apertured to receive the central duct 22 is arranged to enclose the rotor 10. The apertured end plates support the central duct 22 which is secured thereto and which in turn supports the rotor assembly. A pair of feet 46 are provided for the rotor housing to maintain the housing properly oriented so that bearing surfaces 34 are maintained symmetrically positioned relative to a vertical plane containing the axis of the rotor. A pin rack 43 concentrically positioned around the outer shell 10 of the rotor is driven by a drive pinion 45 connected to any prime mover not illustrated.

In practice hot gaseous products of combustion are directed through the lower passageway 26 while air to be heated for combustion supporting purposes is directed through the upper passageway 24 in counterflow rela-

tion with respect to the combustion gases. The combustion gases and air pass through the inlet ports 23 leading from these respective chambers and flow radially outward through the compartments 11 that may be in communication with these ports at the time and over the heat transfer means 16 disposed in these compartments, around the end of baffle 38 and then radially inward through the compartments to the respective outlet ports 23 with the gases re-entering their respective passageway through these ports and then passing from their respective passageway to desired points of use or disposal. The hot gases in duct 26 are received at relatively low pressure while the cooler air for combustion flowing through passageway 24 and the aligned compartments of the rotor is received at a comparatively high pressure. Under these conditions any fluid leakage would tend to occur from the high pressure chamber 24 past the bearing surface 34 and the abutting surface of the inner cylindrical shell 14. Such leakage is however effectively precluded by the sealing effect provided by the gravitational force on the rotor acting to maintain the bearing surface 34 in engagement with the inner surface of shell 14. The gravitational force on the rotor is somewhat reduced by an upward force produced by the high pressure fluid in passageway 24 acting on that portion of the rotor subjected thereto. An additional upward force on the rotor may be developed through the use of pressurized lubricants in lubricating passageways 36 of the cored bearing members.

From the foregoing description it will be seen that the high pressure fluid is constantly sealed in the chamber 24 by a sealing contact effected between the inner surfaces of rotor shell 14 and bearing surface 34 with wear between these relatively movable surfaces being maintained at a minimum by proper lubrication of these surfaces by a lubricant supplied through passageways 36 with this lubricant also aiding in the sealing function. However, even if erosion should occur the rotor will bear upon the bearing surfaces 34 to provide a constantly effective seal for the high pressure fluid.

While this invention has been described with reference to the embodiment illustrated in the drawing it should be evident that numerous changes could be made without departing from the spirit of the invention, and it is intended that all matter contained in the foregoing description or illustrated in the accompanying drawing shall be interpreted as illustrative only and not in a limiting sense.

What I claim is:

1. Regenerative heat exchanger apparatus or the like having an annular rotor including concentric inner and outer cylindrical shells joined by radially extending partitions to form a series of circumferentially adjacent sector shaped compartments adapted to carry a mass of regenerative heat transfer material; axially spaced inlet and outlet ports in the inner rotor shell aligned with each of the sector shaped compartments; a central duct extending axially through the inner rotor shell, said central duct having an arcuate upper portion that provides a bearing surface supporting the rotor for rotation about its horizontal axis; a housing surrounding the concentric cylindrical shells including end plates at opposite ends thereof apertured to embrace the central duct; partition means axially dividing the central duct into upper and lower passageways for the spaced flow of high and low pressure fluids; and axially spaced openings in each passageway arranged for sequential alignment with the inlet and outlet ports of the inner rotor shell to permit fluid flow from each passageway to and through the heat transfer material contained in the rotor compartments in alignment therewith.

2. Regenerative heat exchange apparatus as defined in claim 1 wherein the mass of the rotor carried by the central duct induces frictional contact between the inner cylindrical shell of the rotor and the adjacent surface of the high pressure fluid passageway surrounding the axially spaced openings thereof to provide a sealing relationship that effectively contains the high pressure fluid in the upper passageway and the rotor compartments connected thereto.

3. Regenerative heat exchange apparatus as defined in claim 1 wherein each passageway of the center tube is divided by a central partition plate normal to its longitudinal axis at a point midway between axially spaced openings thereof.

4. Regenerative heat exchange apparatus as defined in claim 3 wherein the rotor is divided by annular means in alignment with the partition plate and extending radially outward from the inner rotor shell into spaced relation with the outer rotor shell to provide a U-shaped path for the flow of fluid through the heat transfer material lying between inlet and outlet ports.

5. Regenerative heat exchange apparatus as defined in claim 1 wherein the bearing surface supporting the rotor includes fluid passageways for the supply of lubricating fluid thereto.

6. Regenerative heat exchange apparatus or the like having an annular rotor comprising concentric inner and outer cylindrical shells joined by radially extending partitions to provide a series of circumferentially adjacent compartments; a central duct of lesser diameter than the inner rotor shell extending axially therethrough in supporting contact with the rotor on its upper surface and spaced therefrom on its lower surface; and substantially crescent shaped filler plates fixed to the outer surface of said central duct adjacent the axially remote ends of the rotor to enclose the space between the central duct and the inner rotor shell.

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