Feb. 1, 1955 W. D. YERRICK 2,701,129

ROTARY VALVE REGENERATOR

Filed March 5, 1952 2 Sheets-Sheet 1

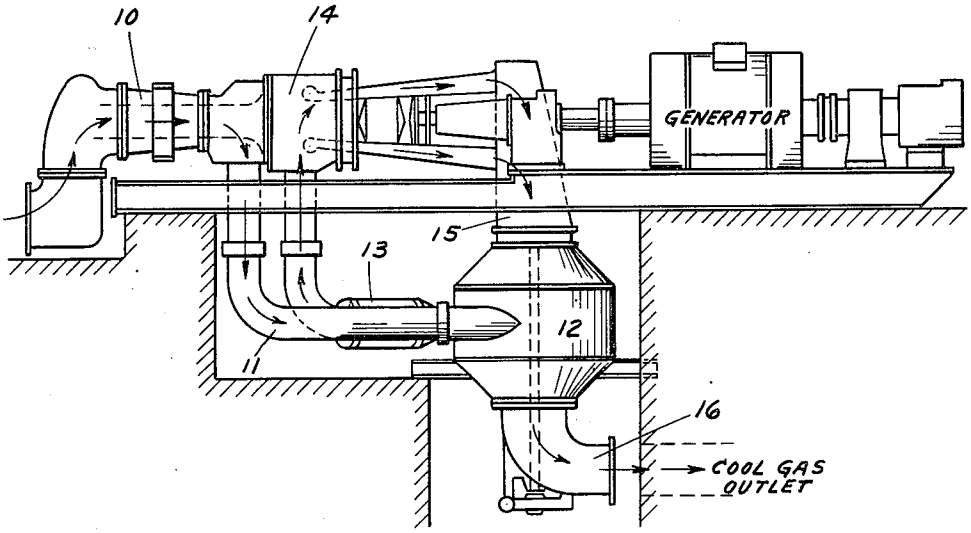


Fig. 1.

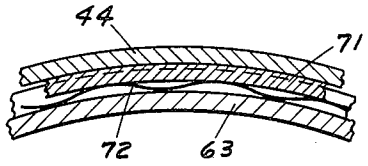


Fig. 7.

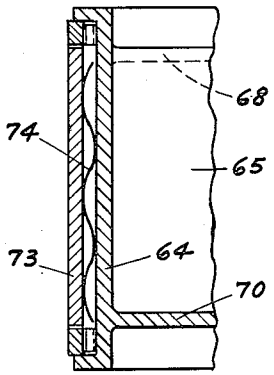


Fig. 8.

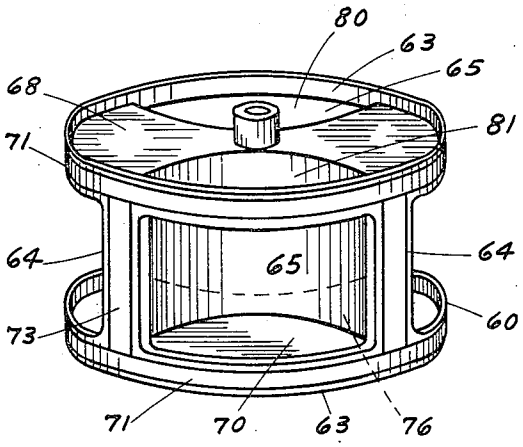


Fig. 6.

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ROTARY VALVE REGENERATOR

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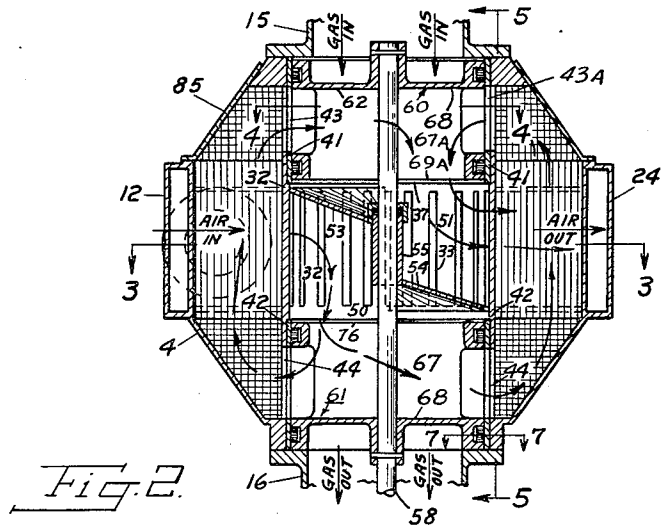


Fig. 2.

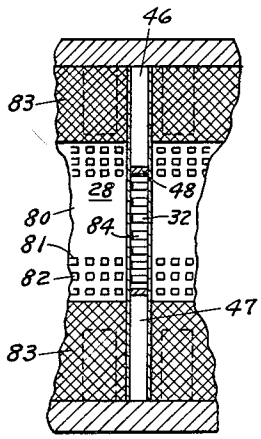


Fig. 5.

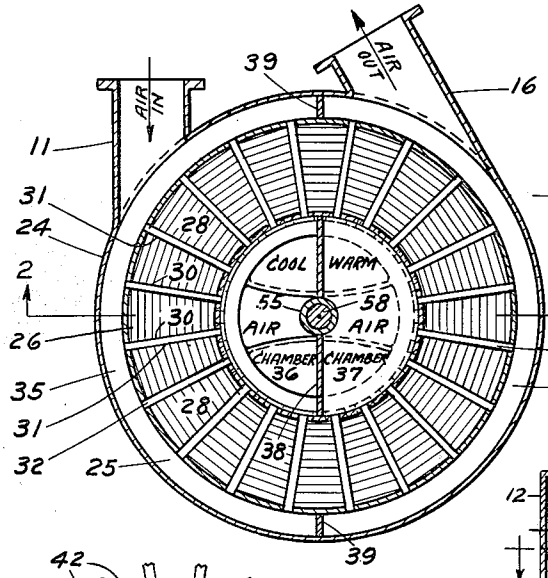
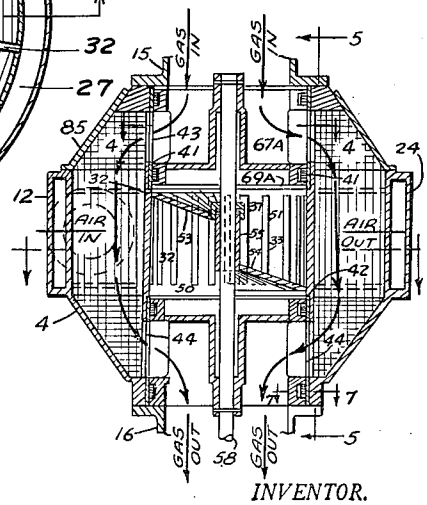


Fig 3

Fig 9



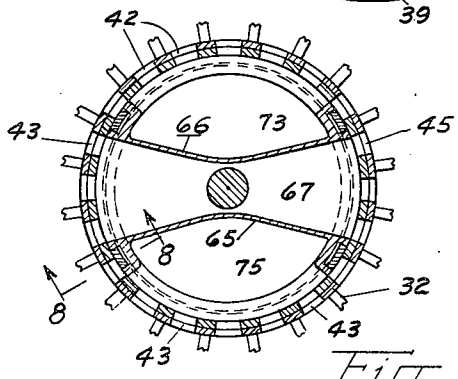


Fig. 4.

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2,701,129

ROTARY VALVE REGENERATOR

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Application March 5, 1952, Serial No. 274,854

3 Claims. (Cl. 257—6)

The present invention relates to heat exchange apparatus and particularly to improvements in regenerative preheaters.

The invention is particularly concerned with regenerative preheaters in which a body of heat exchange material is first contacted by a heating gas and subsequently traversed by another gas, such as air, to which the heat is imparted. Regenerative preheaters are known, both those of the types in which the mass of heat exchange material is moved with respect to the streams of gas and air and other types in which the mass of material is stationary and the alternate flow of the gaseous fluids thereover is controlled by valve means. The invention particularly contemplates improvements in a rotary valve type of regenerative preheater to render it more compact, simple in construction and suitable for use with gases at high pressures.

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 diagrammatic elevational view of a gas turbine plant equipped with a regenerator embodying the present invention.

Figure 2 is a vertical elevation on a larger scale of the regenerator shown in Figure 1.

Figures 3 and 4 are transverse sectional views on the correspondingly designated section lines of Figure 2.

Figure 5 is a sectional elevation on the line 5—5 in Figure 2.

Figure 6 is a perspective view on a reduced scale of one of the rotary gas flow valves shown in Figure 2.

Figures 7 and 8 are sectional views along correspondingly designated section lines in Figure 2 showing sealing devices between the rotary valves and adjacent casing parts.

Figure 9 is a vertical elevation of the regenerator showing the rotary valves turned 90° from the position shown in Figure 2.

In Figure 1 the numeral **10** designates an air compressor from which the air passes through a conduit **11** to the regenerator **12** from which the heated air flows to the combustor **13** and then to the gas turbine **14**. The exhaust from turbine **14** flows through a duct **15** so that heat is recovered therefrom in the regenerator **12** and the cooled gas is discharged through outlet **16**.

The regenerator **14** of Figure 1 is shown in detail in Figures 2 to 8; it comprises an outer casing **24** which through frustro-conical at either end is generally cylindrical and closed at each end except for gas inlet **15** and outlet **16** within casing **24** is an annular heat exchange mass or core **26**. The annular heat exchange mass **26** is made up of a plurality of wedge shaped compartments **28** defined by radial partitions **30, 31** extending between inner and outer circular wall members **33, 34** that bound the mass **26**. The wedge shaped compartments **28** contain foraminous heat absorbing material and are circumferentially spaced from each other by spacing the adjacent radial partitions **30, 31** so as to form between them air conduits **32** that extend from the marginal annular space **35** between the outer casing **24** and the annular heat exchange core **26** to the central chamber within the inner circular wall **33** that bounds the annular core **26**. This inner circular space is divided into air inlet and outlet chambers **36, 37** by a diametrically extending wall **38** which is in alignment with the radial partitions **39** so that the space between the outer casing **24** and the annular

heat exchange mass **26** is divided into the inlet manifold **25** supplied by the duct **11** and the air outlet manifold **27** from which heated air is taken off through the duct **16**.

As appears in Figures 2 and 4, sleeves **41, 42** which are in effect parts or extensions of the circular inner wall **33** bounding the annular heat exchange core **26** are formed with circumferentially spaced ports **43, 44** which are circumferentially located in the sleeves **41, 42** above and below the circular wall proper **33**. The ports **43, 44** are at circumferential locations between rather than in axial alignment with the spaced air conduits **32** formed through the core. Thus, gas and air may flow to and from the upper and lower parts of the central space of the regenerator to enter and leave the compartments **28** that contain heat exchange material through the ports **42, 43** in the inner walls of the compartments. The air conduits **32** that lie intermediate the compartments **28** extend up and down into the sleeves **41, 42** as appears at **46** and **47** in Figure 5 between the ports **43** or **44** but are separated from the upper and lower parts of the central spaces **36, 38** by closure bars **48** so that the air flowing in the conduits **32** does not mingle with either gas or air passing through the ports **46, 47** to or from the central space of the regenerator. The middle portion of the central space **36**, bounded by diametrically extending wall **38** within the heat exchange core **28** is divided into an air inlet chamber **50** and air outlet chamber **51** (Figure 2) by convex semi-circular or conical diaphragms **53, 54** extending outwardly from the upper and lower ends of a center sleeve **55** which is part of partition **38** (Figure 3) to the inner circular wall **33** of the core **28** respectively at the upper end of the sleeve **55** on one side of the diametric diaphragm **38** and at the lower end of the sleeve on the other side as appears in Figure 2.

A shaft **58** extending through the central sleeve **55** drives a pair of rotary valve members **60, 61** one of which is shown in perspective in Figure 6. The valve members are more or less spool or drum like in form consisting of arcuately spaced ring members **63** joined at circumferentially spaced intervals by the columns **64** extending parallel to the axis of either valve. Convexly curved diaphragms **65, 66** (Figures 4 and 6) extend across the central part of the valve member and are spaced to set off a central air space **67** within the valve, this being closed at the top side (Figure 6) by an irregularly shaped web plate **68**. The other side of air space **67** in either valve opens toward air inlet and outlet chambers **50, 51**. At the lower end of the valve member the spaces between the transverse diaphragms **65, 66** and the ring **63** are closed by sector shaped plates **70**. The column members **63** of the rotary valve carry circumferential seals **71** held against the inner surface of the sleeves **41, 42** by the spring **72** (Figure 7) while the vertical columns **64** carry sealing shoes **73** pressed by springs **74** against the sleeve **41** or **42**. The valve members **60, 61** at either end of the regenerator are similar in construction but are reversed or upside down with respect to each other as appears in Figure 2.

The middle portion of the heat exchange core in each compartment **28** may be made up of a plurality of metallic plates **80** that are formed with a plurality of passages or perforations **81** with the material therefrom bent to form tab-like extensions as in Holm Patent 2,558,752 dated July 3, 1951, while the upper and lower sections of each compartment **28** contain heat absorbing material in the form of metallic screens or grids **83**. The air conduits **32** at least in their vertically middle portions are provided with zig-zag folded or corrugated plates **84** which not only serve to brace the walls of the passages **32** but also constitute heat transfer surface therein.

With the construction described above, air from the compressor **10** flows to the regenerator **12** through the duct **11** and enters the air inlet manifold **25**. The air then flows through the radial conduits **32** between the compartmetns **28** to the central air chamber **36** and being confined to downward flow by the conical diaphragm **53** flows down through the centrally located air port **71** at the upper end of the lower valve **61** to the central air space **67** (Figure 4) within the valve, which space is bounded laterally by the transverse diaphragms **65, 66**. The air leaves from both sides of the space **67** to pass

through the ports 43 and 44 into the lower ends of compartments 28 at both sides of the axis of the regenerator. The air then flows over wire mesh surfaces 83 and the tab surface 80 in the compartments 28 that then communicate with the air space 67 of the valve 61 and flowing upwardly is discharged through the ports 43 and 43A into the central air space 67A of the upper valve 62 entering the latter from both ends of the space to flow downwardly through the port 69A into the air outlet chamber 51 at the right side of diametrical partition 38 (Figure 3). From the air outlet chamber 51 the air flows through air conduits 32 at the right hand side of the partitions 38 and 39 into the air outlet manifold 27 to be taken off through the duct 16 on its way to the combustor 13 (Figure 1).

While air flows to the regenerator, as described above, gas entering at the top through the duct 15 and flowing into the spaces 80 and 81 at either side of the diaphragms 65 and 66 in the upper air valve 60, being excluded from the air space 67 by the web 68. From the gas spaces 80, 81 of the upper valve 60 the gas flows laterally and radially through ports 43, 43A into those compartments 28 that are located within the area bounded by the opposite ends of the two diaphragms 65 and 66 that extend across the central part of the valve. Entering the compartments 28 at their upper ends, the gas flows downwardly over the wire and tabbed heat absorbing surface therein and discharging through corresponding ports 44 at the lower portions of the compartments flows into the gas spaces 80, 81 in the lower valve 61 and outwardly through the ports 80, 81 at the lower end of the valve at either side of the web like parts 65, 66 to pass into the gas discharge conduit 16.

By making the end portions of the compartments frustro-conical all of the heat exchange material may be easily removed from any heat exchange compartment 28 upon removal of the detachable cover plates 85.

The regenerative preheater described above is simple and compact in construction and may carry a relatively large mass of effective heat transfer surface in a small space. It may also be ruggedly constructed and with the arrangements disclosed is adapted for use with gaseous fluids at high pressures.

What I claim is:

1. A regenerative heater having a generally cylindrical casing closed at opposite ends with gas inlet and outlet ducts connecting into the central portions of opposite ends of said casing; an annular heat exchange core in said casing bounded by inner and outer circular walls concentric with said casing and dividing the interior thereof into a centrally located circular fluid chamber surrounded by said core and an annular manifold space located outwardly of said core between it and said casing; radial members subdividing said core into a plurality of wedge shaped compartments for containing foraminous heat absorbing material; circumferential rows of fluid ports so formed in the said inner circular wall adjacent the ends of said casing as to place the interior of said compartments in communication at the ends of said casing with said central space; radially extending walls dividing said manifold space into an inlet manifold and into an outlet manifold; an air inlet duct connected to one of said manifolds and an air outlet duct connected to the other manifold; means forming fluid conduits extending through said core from both said manifolds to said central chamber; a central partition subdividing said central chamber into an air inlet chamber communicating with the radial conduits extending from said inlet manifold and an air outlet chamber in communication with the air conduits extending to said air outlet manifold; fluid distributing valves located in said central fluid chamber in positions adjacent the ends of said casing, said valves formed with fluid passages communicating with said gas inlet and outlet and placing them in communication with the ports of certain of said compartments and other passages placing the ports of other compartments in communication with said central air inlet and outlet chambers; a pair of diaphragms spaced axially of said casing and extending in opposite directions from the sides of said partition to said inner circular wall member, one at a level adjacent one of said valves and the other spaced axially therefrom at a level adjacent the other of said valves for closing off said air inlet chamber from the central space adjacent said one valve and closing off said air outlet chamber from the central portion of said chamber at the opposite end of said casing adjacent said other valve, and means for rotating said valves in synchronism to simultaneously direct heating gas through certain of said compartments and air through other compartments.

2. A regenerative heater having a generally cylindrical casing closed at opposite ends with gas inlet and outlet ducts connecting into the central portions of opposite ends of said casing; and annular heat exchange core in said casing bounded by inner and outer circular walls concentric with said casing and dividing the interior thereof into a centrally located circular fluid chamber surrounded by said core and an annular manifold space located outwardly of said core between it and said casing; radial members subdividing said core into a plurality of wedge shaped compartments for containing foraminous heat absorbing material; fluid ports so formed in the said inner circular wall adjacent the ends of said casing as to place the interior of said compartments in communication at the ends of said casing with said central space; diametrically aligned radially extending partitions dividing said manifold space into an inlet manifold and into an outlet manifold; an air inlet duct connected to one of said manifolds and an air outlet duct connected to the other manifold; means forming fluid conduits extending through said core from both said manifolds to said central chamber; a central diametrical partition aligned with said radial partitions and subdividing said central chamber into an air inlet chamber communicating with the radial conduits extending from said inlet manifold and an air outlet chamber in communication with the air conduits extending to said air outlet manifold; fluid distributing valves located in said central fluid chamber in positions adjacent the ends of said casing, said valves formed with fluid passages communicating with said gas inlet and outlet and placing them in communication with the ports of certain of said compartments and other passages placing the ports of other compartments in communication with said central air inlet and outlet chambers; a pair of diaphragms spaced axially of said casing and extending in opposite directions from the sides of said diametrical partition to said inner circular wall member, one at a level adjacent one of said valves and the other spaced axially therefrom at a level adjacent the other of said valves for closing off said air inlet chamber from the central space adjacent said one valve and closing off said air outlet chamber from the central portion of said chamber at the opposite end of said casing adjacent said other valve; and means for rotating said valves in synchronism to simultaneously direct heating gas through certain of said compartments and air through other of said compartments.

3. A regenerative air preheater as recited in claim 1 wherein each of said rotary valves comprises ring members axially spaced to engage said inner circular wall member at either side of a circumferential row of ports therein; transverse diaphragms extending between said rings in symmetrical relation with respect to the axis of rotation of said valve; a web member closing the space between said diaphragms at one side edge thereof; and other webs extending between said diaphragms at their other side edges and one of said ring members.

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