June 25, 1968 S. STRANITI ET AL 3,389,746

ROTARY REGENERATOR HAVING CONCENTRIC CYLINDRICAL MATRICES

Filed June 21, 1967 3 Sheets-Sheet 1

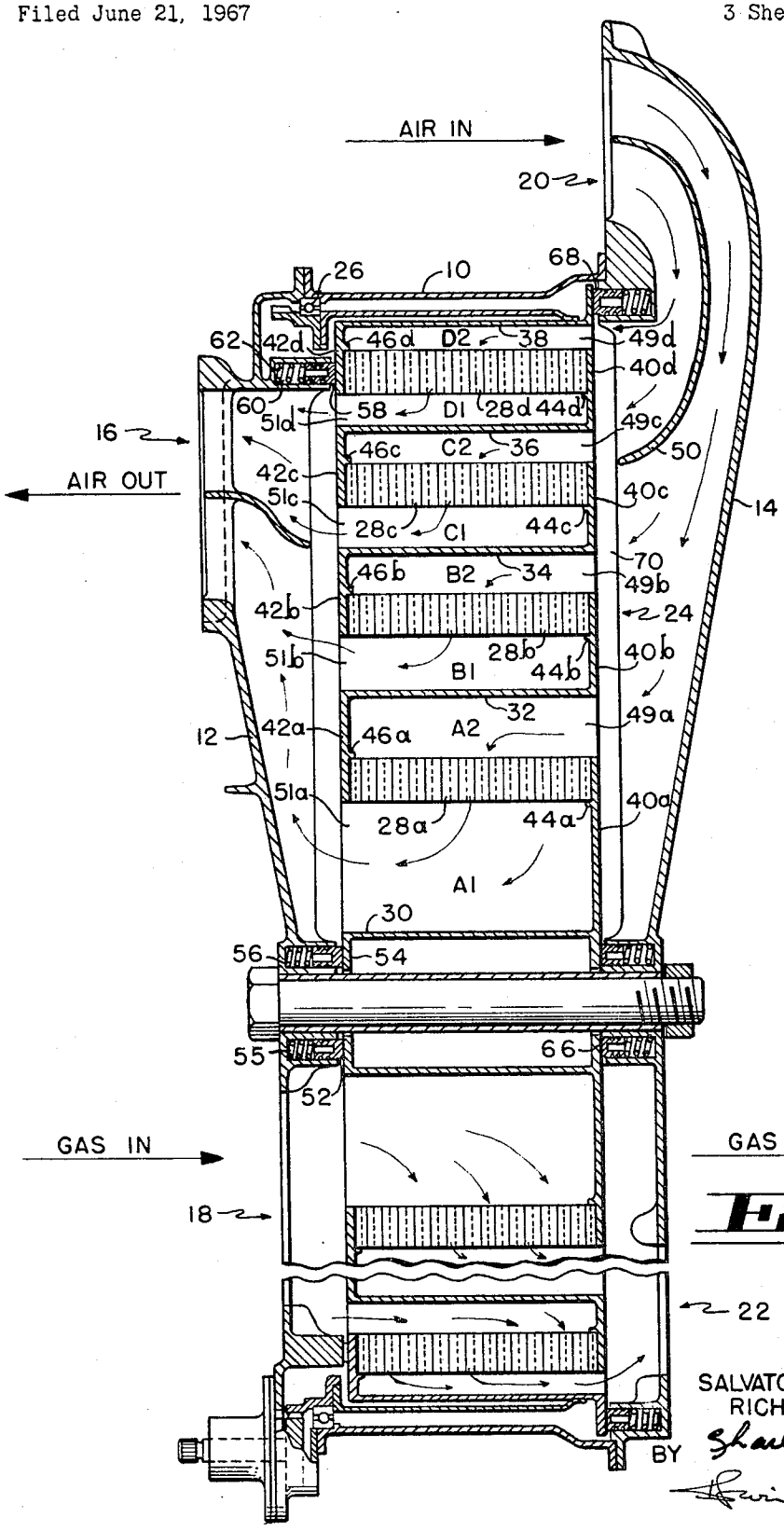


Fig 1

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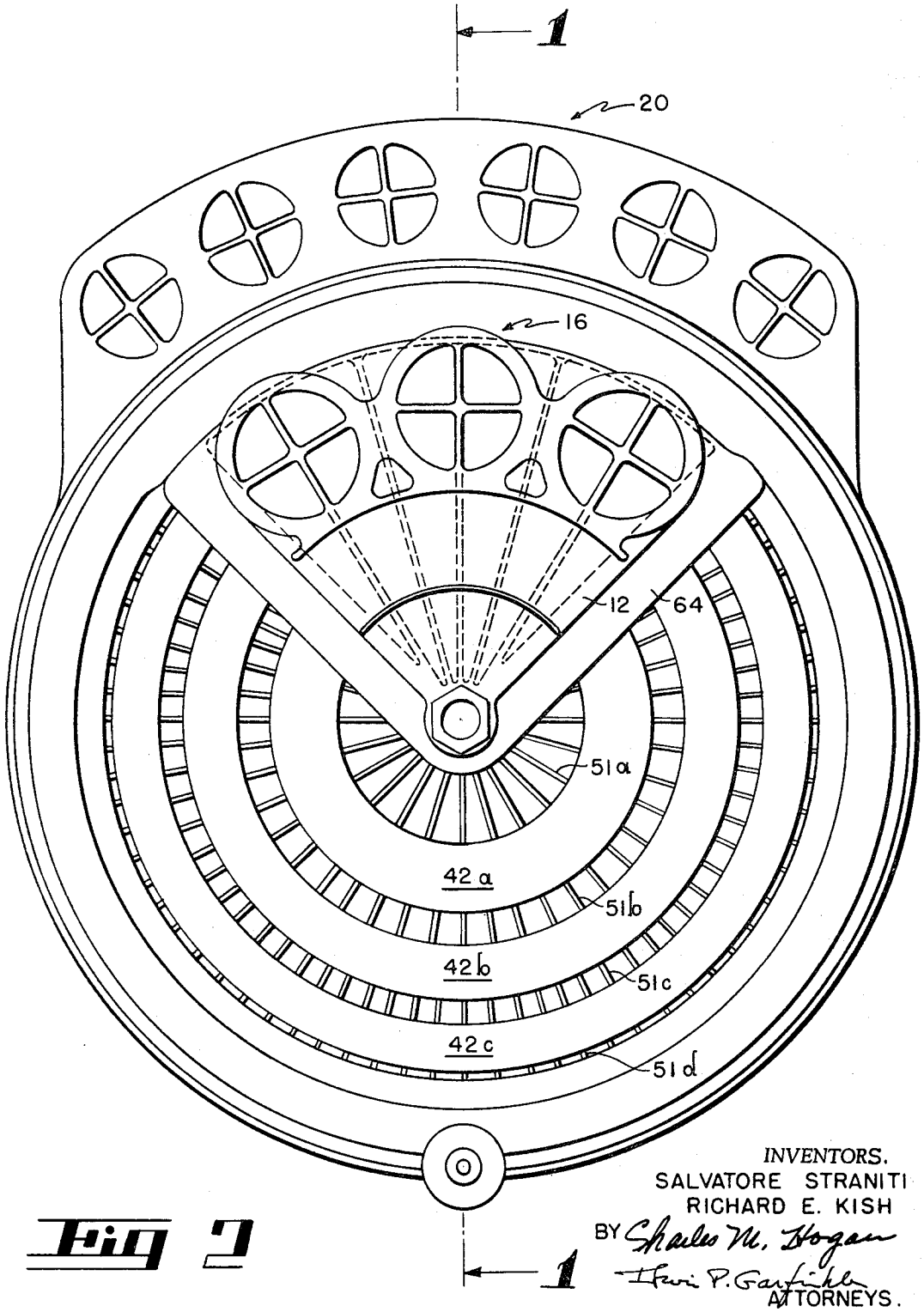


Fig 1

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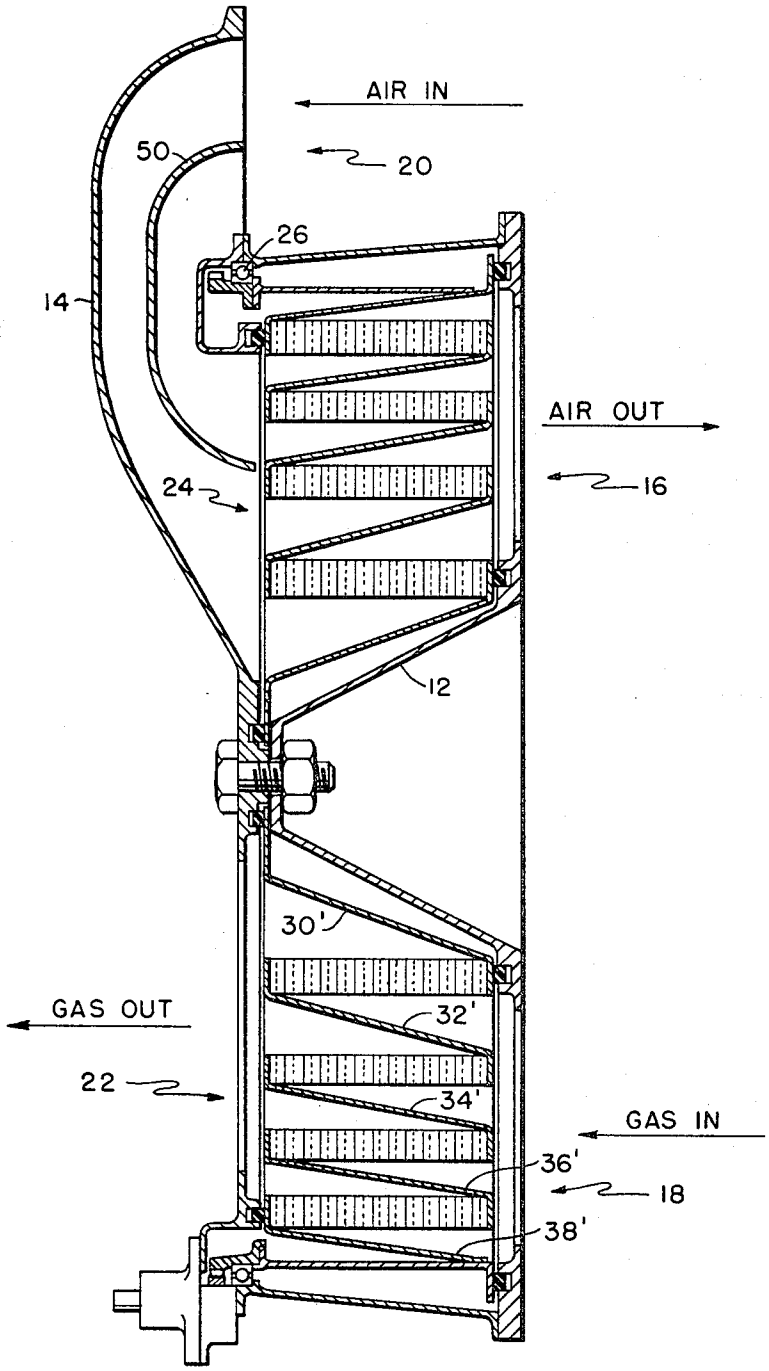


Fig 3

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ROTARY REGENERATOR HAVING CONCENTRIC CYLINDRICAL MATRICES

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3 Claims. (Cl. 165—9)

ABSTRACT OF THE DISCLOSURE

A heat exchanger is constructed with a plurality of concentrically positioned rotating matrices. Each matrix is divided circumferentially into a plurality of segments and the mounting for the matrices provides for the radial flow of fluids therethrough. The hot and cold gases passing through the heat exchanger are maintained separated, except for minimum crossover, by means of face contact running seals.

Prior art

The prior art teaches two general types of rotary regenerators for use in conjunction with gas turbine engines. The disk type of rotary regenerator provides axial gas flow through the rotating matrix and permits face-type sealing. Face-type sealing is generally regarded as advantageous because the extreme temperature changes which occur with each revolution of the matrix do not significantly affect the seal. However, the disk type of regenerator has a short axial dimension, and therefore requires a large radial dimension for effective heat exchanging. In many gas turbine applications, space limitations will not permit the required diameter.

The second type uses a rotating hollow cylindrical drum-type matrix through which the fluid flows radially. This arrangement is advantageous in that an effective heat exchange area can be provided within a given diameter by increasing the axial dimension of the matrix to the extent necessary. However, the cylindrical matrix requires axial seals which are difficult to maintain, particularly where large temperature gradients occur, and thus is inferior to the disk type matrix in this regard.

Summary

The present invention combines the advantages of both the disk and drum type of regenerators by using a plurality of rotating concentric cylindrical matrices. The matrices and the fluid-flow passages are divided into many segments by means of radial ribs, and the fluid-in and fluid-out passages are separated from one another by walls concentric with the matrices. With this construction all face contact seals of the kind found in disk-type regenerators are used. These seals are relatively insensitive to thermal gradients, and can be kept in contact either by springs or by pressure balancing. Furthermore, the axial dimension of the matrix can be maintained at a minimum for any given matrix diameter.

Objects

It is an object of this invention to provide a rotary regenerator comprised of a plurality of concentric cylindrical matrices, the sealing between the fluid being accomplished by face contact seals.

Another object of this invention is to provide a rotary regenerator having an axial dimension comparable to a disk-type rotary regenerator, but having a diameter comparable to a cylindrical-type regenerator and being sealed with face contact seals.

Still another object of this invention is to provide a rotary regenerator having a plurality of concentric heat exchanging matrices, the fluid-flow passages through said regenerator being divided into a plurality of segments defined by a plurality of radical ribs and concentric walls, the rotating seals for the inlets and outlets being face contact seals.

Drawings

For further objects of this invention reference should now be made to the accompanying drawings in which:

FIGURE 1 is a cross section of one embodiment of this invention taken through the line 1—1 in FIGURE 2;

FIGURE 2 is a plan view of one embodiment; and

FIGURE 3 is a cross-sectional view of a second embodiment of this invention.

First embodiment

The disclosed rotary regenerator is intended for use in combination with a gas turbine engine, the heat of the exhaust gases being exchanged with the heat of the intake air for preheating the air prior to combustion. Referring to the embodiment shown in FIGURES 1 and 2 of the drawings, the regenerator is contained within a stationary, generally cylindrical housing **10**, the forward end of which is closed by a sectored wall **12** and the rear end of which is closed by a sectored wall **14**. The wall **12** is provided with a plurality of circular air outlet openings **16** which deliver heated compressed air to the engine (not shown) and an exhaust gas inlet **18** through which the exhaust gases from the engine enter the regenerator. The wall **14** is similarly provided with a plurality of air inlet openings **20** formed in the shape of an intake scoop and an exhaust gas outlet opening **22**. As best seen in FIGURE 2, the openings **16** and **20** in walls **12** and **14**, respectively, are formed in an approximately 90 degree sector, while the openings **18** and **22** occupy the remainder of the wall space.

The rotary regenerator, generally indicated at **24**, is made up of a composite cylindrical structure which is rotatably mounted within the housing **10** on bearings **26**. In the embodiment shown, the regenerator **24** consists of four heat exchanging matrices **28***a* to **28***d*, each of which is supported between adjacent concentric drums **30**, **32**, **34**, **36**, and **38**. The concentric drums **30**, **32**, **34**, **36**, and **38** are provided with radially outwardly extending end walls **40***a*, **40***b*, **40***c*, and **40***d*, respectively, while the drums **32**, **34**, **36**, and **38** are provided with radially inwardly extending end walls **42***a*, **42***b*, **42***c*, and **42***d*, respectively. The matrix **28***a* is fixedly supported between the lips **44***a* and **46***a* on the walls **40***a* and **42***a*, respectively. Similarly, the matrices **28***b*, **28***c*, and **28***d* are fixedly supported between the lips **44***b*, **44***c*, and **44***d* and **46***b*, **46***c*, and **46***d* formed on the walls **40***b* to **40***d* and **42***b* to **42***d*, respectively. When assembled, the drums and matrices form a composite structure having fluid passages A1, A2, B1, B2, C1, C2, D1, and D2 formed therein.

As best seen in FIGURE 2, each of the passages is segmented by circumferentially spaced radial ribs **49***a* and **51***a* to **49***d* and **51***d*, the ribs **49***a* to **49***d* extending radially inwardly from their associated drums **32** to **38**, respectively, and the ribs **51***a* to **51***d* extending radially outwardly from their associated drums **30** to **36**, respectively.

Air entering the air inlet opening **20** is directed by baffes **50** to the regenerator **24** where it enters the segmented passages A2 to D2. The air is then directly radially through each of the matrices **28***a* to **28***d* and into the segmented passages A1 to D1 from which the air exits through the openings **16** in the wall **12**. The exhaust gases from the gas turbine engine passing through the opening **18** enter the passages A1 to D1, pass through the matrices

28*a* to 28*d* and exit from the passages A2 to D2 through the opening 22 in the wall 14.

For the purposes of sealing the inlet exhaust gases from the outlet air, the wall 12 is provided with several seals. An inner annular seal 52 is positioned coaxially with the rotating matrix 24 with its sealing surface maintained in face contact with the end wall 54 of the drum 30. The seal 52 is maintained within an appropriately contoured annular groove 55 in the wall 12 and is maintained against the wall 54 by means of springs 56. Similarly, an outer annular seal 58 is maintained. Seal 58 is positioned within an annular grove 60 in the wall 12 and is maintained under pressure against the end wall 42*d* by means of springs 62. As best seen in FIGURE 2, the inner and outer seals are interconnected by means of radial ribs 64 (see FIGURE 2) which are in face contact with all of the end walls 42*a*–42*d*.

The inlet air is similarly sealed from the outlet exhaust gases at the rear of the heat exchanger by means of an inner annular seal 66 and an outer annular seal 68 maintained in compression against the opposite end walls of the drums 30 and 38, respectively. Radial ribs 70 interconnect the seals 66 and 68 in the same manner as the seals 52 and 58 are interconnected.

Second embodiment

The second embodiment illustrated in FIGURE 3 is the same as the embodiment of FIGURES 1 and 2 with the exception that FIGURE 3 used concentric drums 30′–38′ which are truncated cones rather than cylinders. This configuration serves to provide a more efficient flow of fluid through the apparatus.

We claim:

1. A rotary heat exchanger for transferring the heat from a relatively hot fluid to a relatively cool fluid, the combination comprising:

a stationary, generally cylindrical housing having end walls, the opposing end walls being provided with an opposing inlet and outlet port for said relatively hot fluid and an inlet and outlet port for said relatively cool fluid;

a heat exchanger rotatably mounted within said housing, said heat exchanger comprising a plurality of hollow drums, each of said drums having first and second annular flanges at opposite ends thereof, the first flange extending radially inwardly and the second flange extending radially outwardly;

a plurality of cylindrical heat exchanging matrices each concentrically supported between the inwardly extending and outwardly extending flanges of adjacent drums, the surfaces of said drums and said flanges forming a plurality of passages for directing said fluids through each of said matrices;

a plurality of radial ribs secured to the surfaces of each of said drums and extending to each matrix face for circumferentially segmenting said passages, said ribs extending axially the entire length of said drums between opposing flanges; and

sealing means affixed to each of said end walls and maintained in running contact with said flanges, said sealing means separating the ports on each wall for preventing the mixture of said relatively hot fluids and said relatively cool fluids.

2. The invention as defined in claim 1 wherein said hollow drums are truncated cones.

3. The invention as defined in claim 1 wherein each of said sealing means is provided for maintaining the relatively hot fluid substantially separated from the relatively cool fluid and comprises first and second stationary, annular seals in face contact with the flanges of the innermost and outermost drums and first and second radial ribs extending between said first and second annular seals, the segments between said ribs defining said ports.

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