June 23, 1970 S. STRANITI ET AL 3,516,482

ROTARY REGENERATOR WITH RECTANGULAR MATRIX SECTIONS

Filed Sept. 13, 1968 2 Sheets-Sheet 1

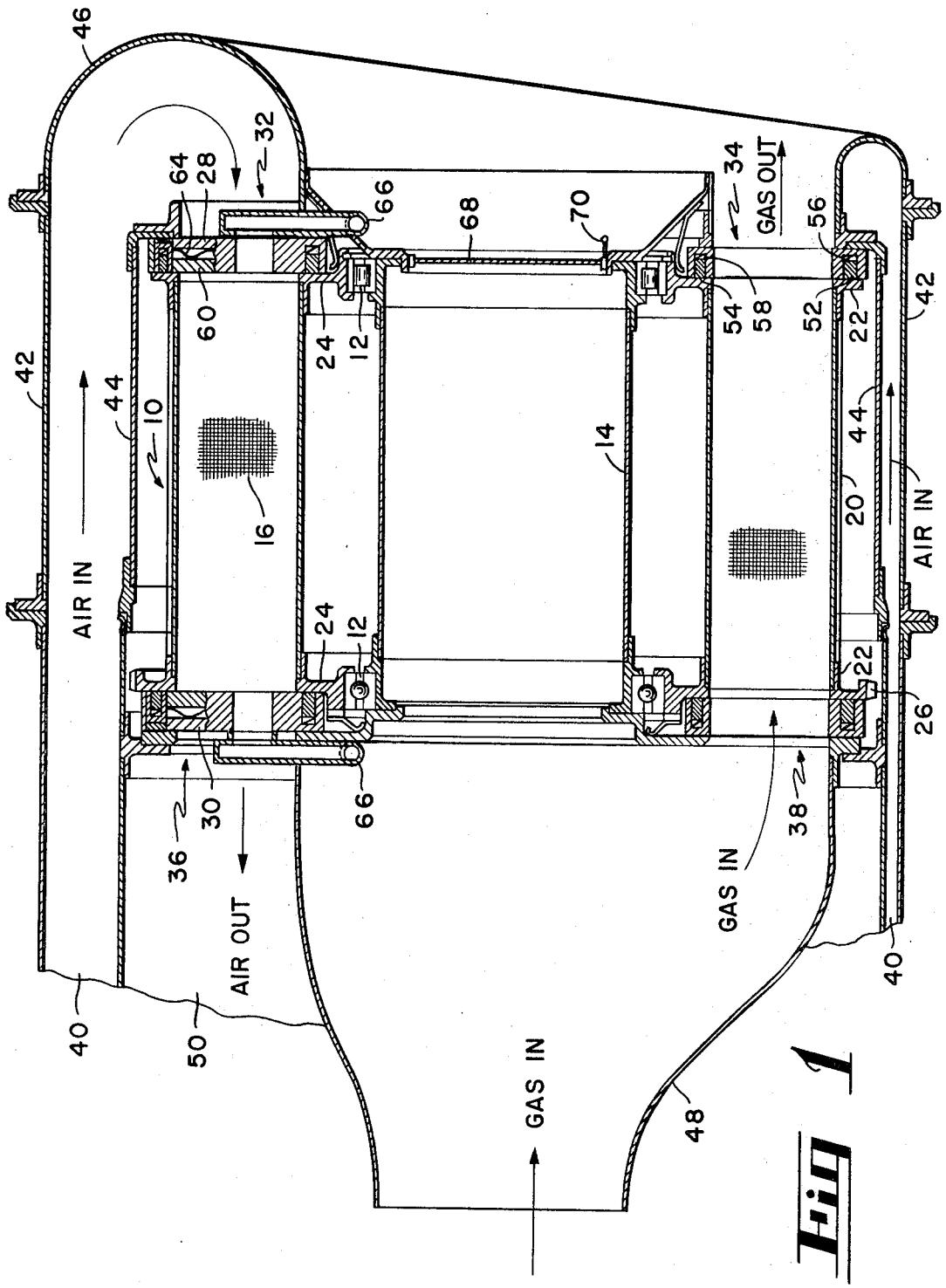


Fig 1

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Fig 1

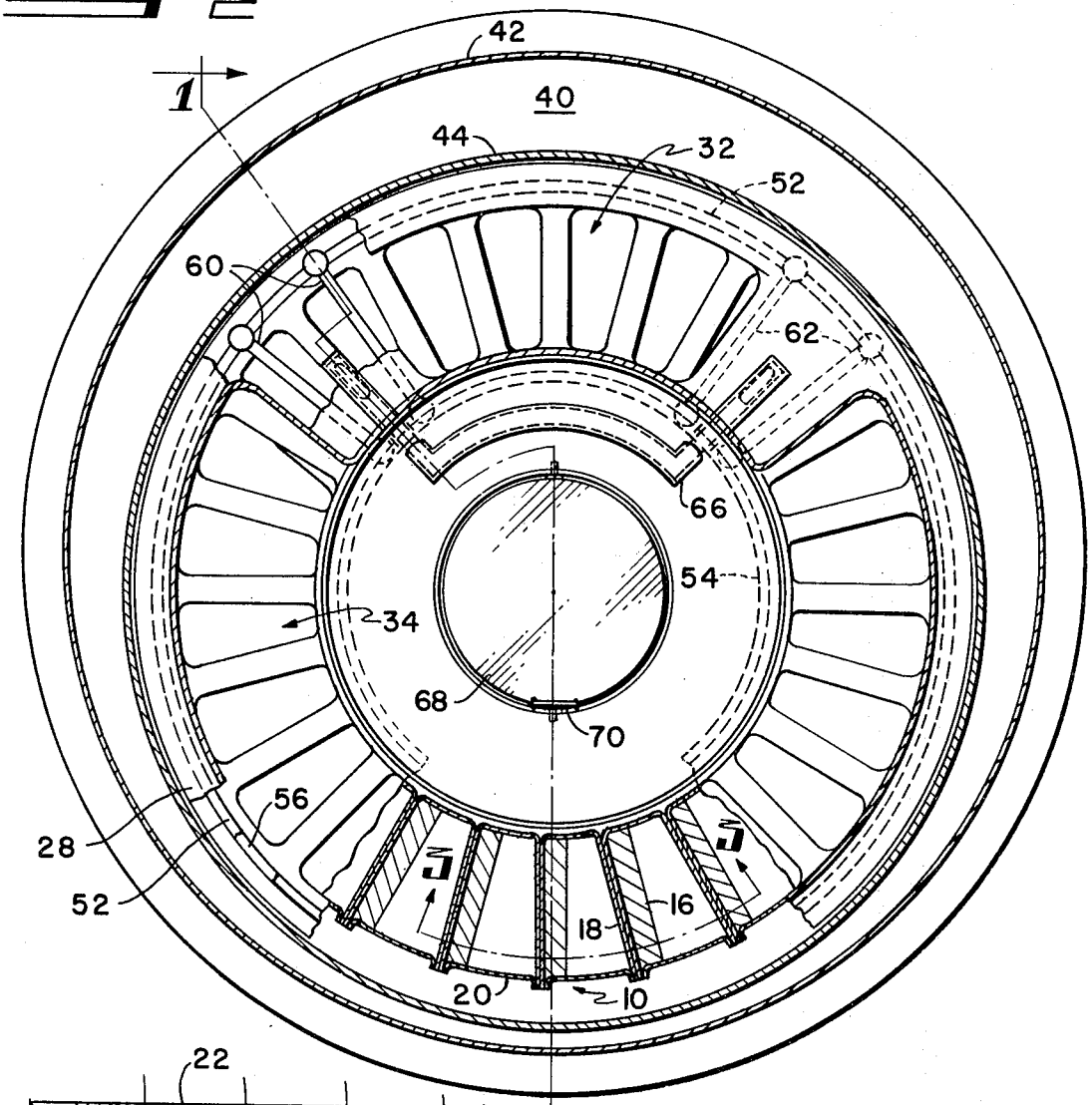
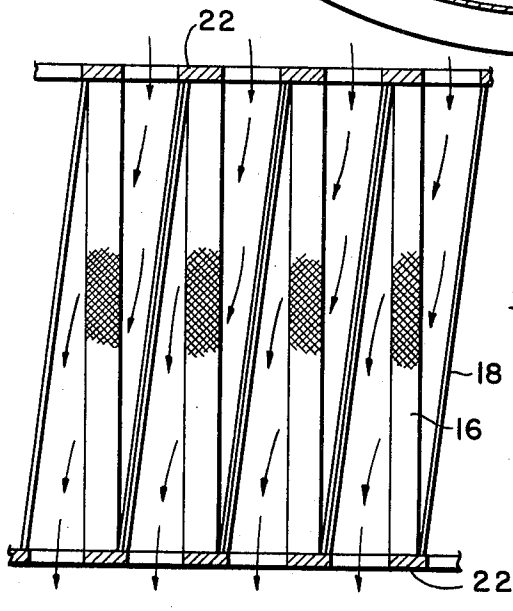


Fig 3



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ROTARY REGENERATOR WITH RECTANGULAR MATRIX SECTIONS

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U.S. Cl. 165—7 2 Claims

ABSTRACT OF THE DISCLOSURE

A heat exchanger is constructed with a plurality of rectangular sections of wire mesh, axially extending and radially supported matrices positioned within a rotating cylindrical drum. The matrices are retained diagonally within axial channels so that the axial flow of gases is directed transversely through each matrix.

THE PRIOR ART

The prior art teaches several 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 disk type matrix. This permits face-type sealing which is generally regarded as advantageous because the extreme temperature changes which occur with each revolution of the matrix have relatively minor effect on the seal. However, the disk type of matrix requires a short axial length and hence a relatively large diameter for effective heat exchanging. In many gas turbine applications the diameter of the regenerator is limited, and disk type exchangers cannot be used.

The second type uses a rotating hollow cylindrical 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.

A third type of rotary regenerator is described in the U.S. patent to Straniti et al. 3,389,746 assigned to the same assignee as this invention. This patent discloses and claims a heat exchanger comprised of a plurality of concentrically positioned rotating cylindrical matrices, each of which is divided circumferentially into a plurality of segments. This construction has the advantage over a disk-type matrix in that face-type seals may be used, and it has the advantage of the drum-type matrix in that a relatively small diameter is permitted.

SUMMARY OF THE INVENTION

The present invention is an improvement over the Straniti et al. U.S. Pat. 3,389,746 in that it simplifies the construction of the regenerator by utilizing an axially short cylinder in which a plurality of rectangular matrices are radially positioned. This construction permits the use of face-type seals, and at the same time permits a relatively large heat exchange area.

OBJECTS

It is an object of this invention to provide a rotary regenerator for exchanging the heat between two fluids, said exchanger being comprised of a plurality of radially disposed, axially extending matrices fixedly positioned within a rotating drum, the fluids flowing axially through the drum and transversely through the matrices, the sealing between the fluids being accomplished by face contact seals.

THE DRAWINGS

FIG. 1 is a cross section of a preferred embodiment taken through the line 1—1 in FIG. 2;

FIG. 2 is an end view of the embodiment of FIG. 1 with certain portions broken away to illustrate interior details; and

FIG. 3 is a laid out section taken through the line 3—3 in FIG. 2.

THE PREFERRED 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 intake air prior to combustion.

The regenerator, generally indicated as **10**, is rotatably supported by means of bearings **12** on a stationary hollow shaft **14**. The regenerator **10** is comprised of a plurality of porous wire mesh matrices **16**, each of which is positioned within a fluid impervious U-shaped channel **18**. Each channel **18** is capped by a member **20** providing a conduit with open ends.

As shown in the drawings, the matrices **16** are disposed axially, while the channels **18** are arranged at a small angle (approximately 15°) with respect to the axis, so that the matrices are positioned diagonally with respect to the channels, as best seen in FIG. 3. An equivalent arrangement would be to position the channels axially with the matrices arranged at an angle to the axis. The arrangement as shown is advantageous for manufacturing purposes since it is less difficult and costly to form the sheet metal channels at an angle than to provide a complex form for the matrices. With either construction, any fluid flowing axially into one end of a conduit passes transversely through a diagonally disposed matrix **16** and exits axially at the opposite end. A plurality of the channels **18**, with the matrices contained therein are joined circumferentially to form a complete annulus.

In effect, the regenerator consists of two concentric cylinders, the annular space between the cylinders being segmented into a plurality of generally axially extending fluid conduits, and with the radially disposed matrices being positioned diagonally within the channels.

The regenerator **10** is completed by flanged sealing plates **22** which are welded to each end of the annulus. The sealing plates **22** are provided with openings which match the open ends of the channels, but which cover the ends of the matrices **16**.

The flanges **24** at the inside diameter of the sealing plates **22** incorporate the outer races of the bearings **12** which rotatably support the regenerator **10**. The flange at the outer diameter of the sealing plates **22**, located at the front of the regenerator, includes a ring gear **26** which is rotatably driven from a source (not shown).

The air and gas passages through the regenerator **10** are defined by annular seal carrier plates **28** and **30** located at the ends of the regenerator. The seal carrier plate **28** is provided with an air inlet opening **32** covering approximately 25% of the area of the annulus of the plate **28** and with a gas outlet opening **34** covering the remaining approximately 75% (less the space between the openings). Similarly, the seal carrier plate **30** is provided with an air outlet opening **36** covering approximately 25% of the area of the annulus of the seal plate **30** and with a gas inlet opening **38** covering the remaining approximately 75% of the area.

Cool air from the engine compressor is supplied to the regenerator **10** through the air inlet opening **32** from an annular duct **40** comprised of two cylindrical shells **42** and **44** which feed air to an inlet torus **46**. The inlet torus **46** terminates at the air inlet opening **32** of the seal carrer plate **28** to which it is secured. The exhaust

gases from the gas turbine engine are admitted through a duct **48** which terminates at the gas inlet opening **38** in the seal carrier plate **30**. The air passing through the opening **32** in the seal carrier plate **28** passes through the matrices **16** and exits through the air outlet opening **36** into an air outlet conduit **50** defined by the space between the shell **44** and the duct **48**. The exhaust gases entering the opening **38** from the duct **48** traverses the matrices **16** and exits through the gas outlet opening **34** into the atmosphere.

The compressed air entering at the air inlet **32** and exiting at the air outlet **36** is maintaained separate from the exhaust gases entering at the gas inlet **38** and exiting from the gas outlet **34** by means of face-type seals mounted on the seal carrier plates **28** and **30**, respectively, The seals on both plates **28** and **30** are identical so that a description of one set will suffice. Each of the seal carrier plates **28** and **30** is provided with an inner and an outer circumferential groove in which circumferential seals **52** and **54** are positioned. Each of these seals is spring loaded by means of springs **56** and **58**, respectively. The circumferential seals **52** and **54** are intersected by two pairs of radial seals **60** and **62** which are spring loaded by means of springs **64**. Thus, the combination of the two pairs of radial seals and the two circumferential seals serves to entirely enclose both the air sector and the gas sector of the drums at each of the inlet and outlet openings.

In the alternative, the circumferential seals may terminate at the radial seals so that only the air sector is sealed. In such an embodiment, a simple spring leaf seal may surround the remaining sector. The exhaust gas leakage which may result with such a seal would simply be bypassed to the atmosphere, but overall operation would not be affected materially.

The space between the pair of seals **60** communicates with the space between the pair of seals **62** by means of transfer tubes **66** which serve to equalize the pressure loads of the gases at these locations. In addition, the transfer tubes **66** serve to reduce the carry-over loss of entrained air on the high pressure side by dumping this air into the low pressure side. These transfer tubes also serve to reduce the magnitude of any pressure pulse on the matrix assembly.

As noted before, the regenerator **10** is carried on two bearings **12** supported on the hollow shaft **14**. The hollow shaft **14** forms a structural tie between the inlet and outlet casings. The hollow shaft is shown closed by means of a circular closure wall **68**. However, the wall may be pivoted by means of a crank **70** to permit the bypassing of the exhaust gases from the regenerator.

It will be apparent to persons skilled in the art that this invention is subject to various modifications and adaptations. It is intended therefore that the scope of the invention be limited only by the appended claims as interpreted in the light of the prior art.

We claim:

1. In a rotary heat exchanger for transferring the heat from a first fluid to a second fluid, the combination comprising:

a rotatably mounted fluid impervious structure having an annular cross section, the space between the inner and outer peripheries of said structure comprising a plurality of radially segmented conduits, said conduits extending from one end of said structure to the other end at an angle with respect to the axis of rotation of said structure, said ends being open;

a heat exchanging matrix in each of said conduits, each of said matrices extending radially and axially, said matrices being positioned diagonally across a respective conduit, whereby fluid flowing through said conduits passes transversely through each of said matrices;

a first fluid inlet duct and a first fluid outlet-duct, each having an opening communicating with first opposing segments at the ends of said structure;

a second fluid inlet duct and a second fluid outlet duct, each having an opening communicating with second opposing segments at the end of said structure;

sealing means for maintaining said first and second fluids separated, said sealing means including one sealing element for the ducts at each end of said structure, said sealing elements being maintained in contact with a respective end of said structure, and wherein each sealing element comprises:

a seal carrier plate affixed across the openings of the ducts at one end of said structure, said plate having an opening coextensive with a respective segment;

an outer circular sealing element positioned on each plate;

an inner circular sealing element positioned on each plate adjacent the inner periphery thereof, said opening being located between said inner and outer circular sealing elements;

first and second spaced radial sealing elements on each plate, each intersecting said first and second circular sealing elements, adjacent one end of one opening;

third and fourth spaced radial sealing elements intersecting said first and seceond circular sealing elements adjacent the other end of said one opening; and

separate biasing means for each of said sealing elements for maintaining each of said sealing elements in contact with the respective ends of said structure.

2. The invention as defined in claim **1**, and a fluid conduit communicating between the space between said first and second radial seals and the space between said second and third radial seals for equalizing the pressures in said spaces.

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U.S. Cl. X.R.

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