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REGENERATOR MATRIX

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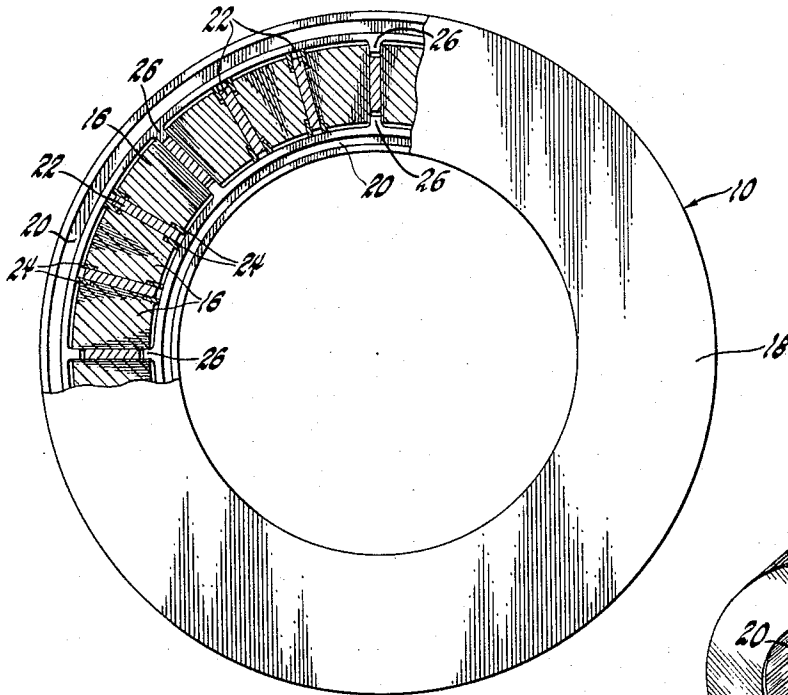


Fig. 1

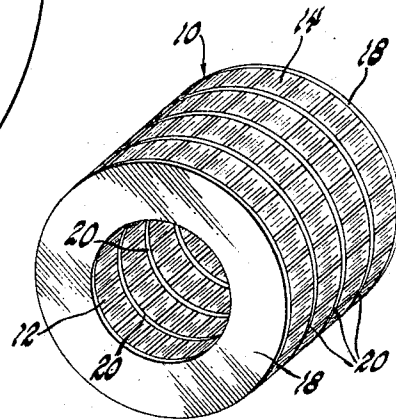


Fig. 2

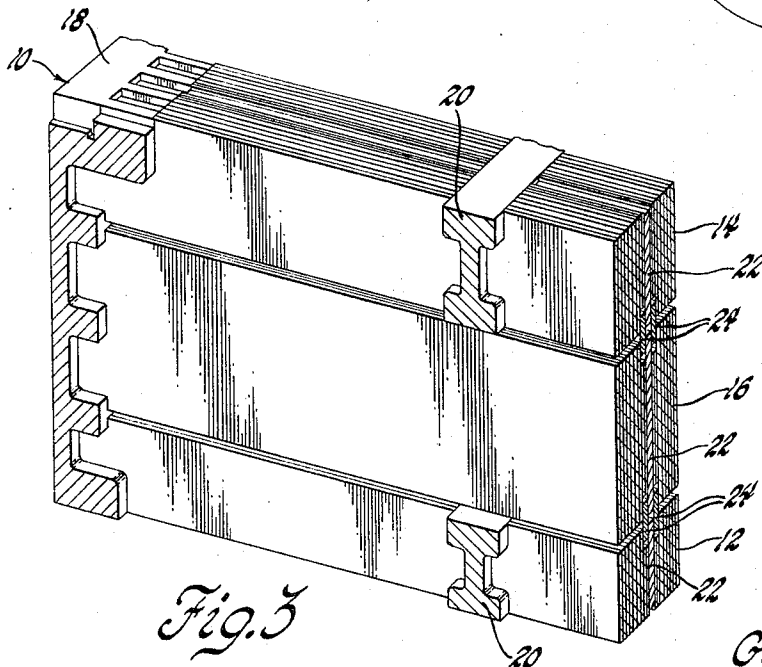


Fig. 3

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REGENERATOR MATRIX

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4 Claims. (Cl. 165—8)

This invention relates to a regenerator for use with a gas turbine and more particularly to an improved rotary regenerator structure having a matrix designed to minimize distortion in the regenerator caused by thermal stresses set up by temperature differences across the regenerator.

The invention relates more particularly to heat exchangers of the regenerator drum type in which the rotor rotates within a casing through the paths of both the exhaust gases from the turbine and the intake charge of compressed cooled air. The paths of the exhaust gases and of the compressed air are separated by seals running along the length of the regenerator, thereby dividing the drum into a hot gas and a cold air side, respectively, in which the gas can flow in counter-directions through the matrix. The hot exhaust gases, in passing through the hot gas side of the regenerator, release their heat to the matrix in that portion of the regenerator, so that as the regenerator rotates, the hot matrix portion of the regenerator passes into the cold air side, where the heat is transferred from the hot matrix to the cold compressed air. With this type of regenerator, the length of the gas path through the matrix can be very small, but the temperature difference between the inside diameter and the outside diameter of the regenerator is a substantial fraction of the full temperature difference between the hot turbine exhaust gas and the cold compressed air temperature, so that the various parts of the regenerator are subjected to very large differences of temperature. In order to maintain an effective seal along the length of the regenerator it is important to keep the drum as nearly cylindrical in shape as possible.

The distortion problem is complicated by the unavoidable change in configuration of the regenerator matrix between its cold condition when the engine has not been running and its hot condition which it soon reaches during operation of the engine. Thus, in a drum matrix in which the hot gases flow radially outwardly, the inner face will expand more than the outer face, resulting in a substantial distortion of the matrix when hot thereby substantially hindering the effective sealing of the regenerator.

Hence, it is an object of the subject invention to provide a rotary regenerator structure which minimizes the thermal distortion thereby maintaining its original configuration and providing effective sealing at all ranges of engine operation.

It is another object of the subject invention to provide a rotary regenerator comprised of a plurality of shim pack units which are arranged so that they cooperatively minimize thermal distortion due to temperature differences across the regenerator.

Other objects, features, and advantages of the subject invention will become apparent upon reference to the succeeding detailed description of the preferred embodiment and the drawings thereof, wherein:

FIGURE 1 is an end view of the rotary regenerator with parts shown in section;

FIGURE 2 is a perspective view of the rotary regenerator; and

FIGURE 3 is an enlarged perspective view of a cross-section of the rotary regenerator structure.

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Although the drawings and the following specification present a detailed disclosure of a preferred embodiment of the invention, it is to be understood that the invention is not limited to the specific form disclosed, but rather that it is intended to include all modifications, changes, and alternate constructions and methods included in the scope of the principles taught by the subject invention.

Referring to the drawings, it is seen that the subject rotary regenerator is an annulus with a rectangular cross section. The regenerator 10 is comprised of three concentric annular bodies or drum assemblies which cooperate in a manner to be described, so as to minimize thermal distortion in the rotary regenerator. The use of the three concentric drum assemblies also eliminates the high compressive stresses which would exist in a single ring extending through the entire drum. As seen in FIGURE 3, the inner drum 12 and the outer drum 14 are divided into individual sections both in the circumferential direction and the axial direction. The middle drum 16 is divided only in the circumferential direction and is continuous in the axial direction. Each of the three concentric layers is comprised of a plurality of individual shim pack units, which are combined in a specific pattern to result in an overall regenerator structure which minimizes thermal distortion. Each individual shim pack unit may be formed of any of the well known heat exchanger constructions. A good example of such a construction is a plurality of very thin corrugated metal sheets laminated together to form a unitary structure containing a great number of tiny passages and a correspondingly large heat transfer area. The specific details of the construction of the individual shim pack units is not essential for an understanding of the invention and hence will not be discussed further.

The subject regenerator is held together in the radial direction by end rims 18 which secure the three concentric drum assemblies at their axial extremities. The inner and outer drums 12 and 14 are further supported in the radial direction by a plurality of spaced support rings 20. As seen in FIGURE 2 these support rings 20 are spaced at regular intervals in the axial direction on the inner and outer drums 12 and 14. In contrast to this, the middle drum 16 is continuous in the axial direction having no radial support means other than the end rims 18. Hence, the middle drum 16 forms the main heat exchanger area and the supporting structure for the entire assembly. Each of the three concentric rings has axial support beams 22 which separate the individual shim packs in the circumferential direction and provide support to the shim packs in the axial direction. It should be further noted that ample space is provided between each of the individual shim packs in the three concentric drum assemblies so that distortion in one individual shim pack will not be transferred to an adjacent shim pack. Furthermore, flexible seals 24 are installed between the three concentric drums to prevent recirculation of the heat exchanger gas within the three drums. Drums 12 and 14 are located radially on drum 16 by means of locating pins 26 which project from the support rings 20 into the support beams 22.

Summarizing, since the inner and outer rings 12 and 14 are essentially the sealing rings for the subject regenerator, they are divided into a plurality of shim pack sections both in the circumferential and axial directions so that they can best compensate for thermal distortion. These inner and outer shim pack drums are divided and supported by means of the end rims 18, the support rings 20, and the axially extending support beams 22. The middle drum 16 is divided only in the circumferential direction and extends the entire axial length of the regenerator so that it provides the main heat transfer area

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and the main axial support to secure the whole assembly together.

Hence it can be seen that the subject regenerator matrix is designed to compensate for thermal distortion in the circumferential, radial and axial directions by means of the specific components previously described. It then should be clear that the subject invention is a solution to the problem of providing a rotary regenerator which compensates for thermal distortion and maintains its desired shape throughout all ranges of engine operation so that the sealing and efficiency of the regenerator are not affected.

While a specific embodiment of this invention has been shown and described, various changes and modifications may be made within the scope and spirit of the invention as set forth in the following claims.

I claim:

1. A matrix for a radial-flow rotary regenerator comprising, in combination,
 - two spaced coaxial annular end rims defining the ends of the matrix
 - an intermediate annular body extending from one end rim to the other and fixed to the end rims to provide a structural connection between the end rims
 - an outer annular body extending from one end rim to the other and spaced radially outwardly from the intermediate body
 - an inner annular body extending from one end rim to the other and spaced radially inwardly from the intermediate body
 - the three said annular bodies comprising heat exchange material porous to flow radially of the matrix through the bodies

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the outer and inner annular bodies each comprising a plural number of annular sections disposed end-to-end between the end rims

and rigid annular support rings disposed between and connecting adjacent sections of the outer and of the inner annular bodies.

2. A matrix as recited in claim 1 in which the intermediate annular body includes support beams extending axially of the matrix and distributed circumferentially of the matrix interconnecting the end rims.

3. A matrix as recited in claim 2 including pins projecting from said support rings into said support beams to connect the outer and inner annular bodies to the intermediate body.

4. A matrix as recited in claim 1 in which the heat exchange material of the annular bodies is defined by shim packs extending from rim to rim in the intermediate annular body and extending the length of each section in the other annular bodies.

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