

Jan. 26, 1965

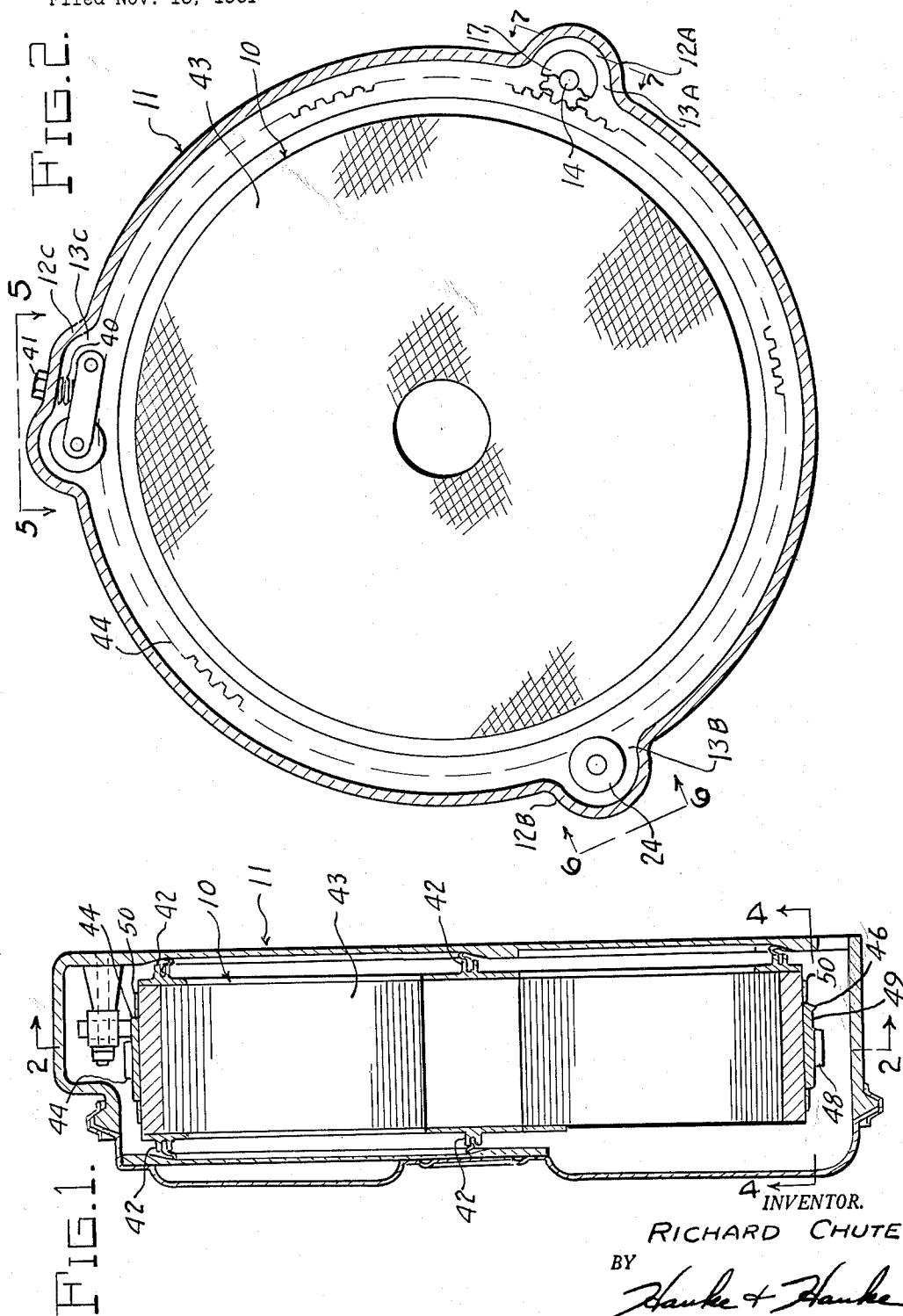
R. CHUTE

3,167,115

REGENERATOR RIM ATTACHMENT

Filed Nov. 13, 1961

2 Sheets-Sheet 1



INVENTOR.
RICHARD CHUTE
BY
Hauke & Hauke
ATTORNEYS

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2 Sheets-Sheet 2

FIG. 3.

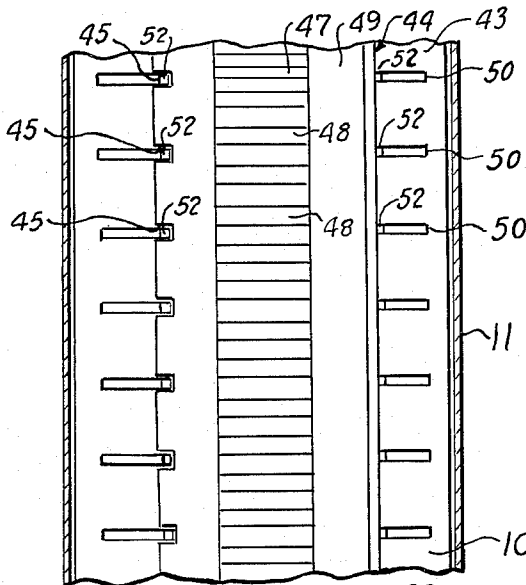
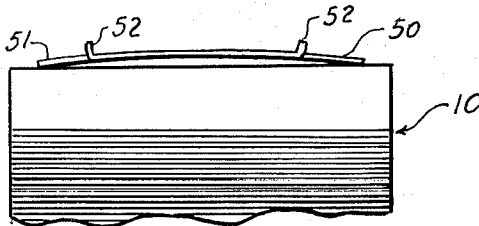


FIG. 4.

FIG. 5.

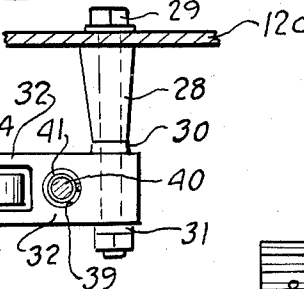


FIG. 6.

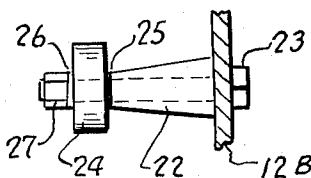
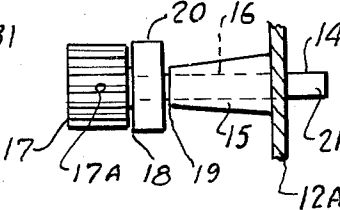


FIG. 7.



INVENTOR.

RICHARD CHUTE

BY

Hauke + Hauke

ATTORNEYS

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2

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REGENERATOR RIM ATTACHMENT

Richard Chute, Huntington Woods, Mich., assignor to Continental Motors Corporation, Muskegon, Mich., a corporation of Virginia

Filed Nov. 13, 1961, Ser. No. 151,944

7 Claims. (Cl. 165-7)

My invention relates to heat exchange apparatus and more particularly to attaching a metal driving rim to a ceramic core for a rotary regenerative type heat exchanger.

In a preferred rotary regenerator of the type ordinarily used with a turbine engine, a cylindrical matrix of heat absorbent material rotates in a stationary housing. The housing is provided with seals and duct work which define, as far as possible, two distinct sections. Exhaust gases are directed through one of these sections thereby relinquishing heat to the rotating matrix. Compressed air, on its way to the combustion chamber, passes through the other section absorbing this heat by contact with the matrix core. A desirable diminution in the temperature of the exhaust gas is effectuated while at the same time energy, in the form of heat, is retained in the engine which would otherwise be lost.

Due to the wide variation in temperatures between the hot exhaust gases and the cooler compressed air and also by reason of the pressure differential existing between these gases, forces are generated within the apparatus which ordinarily cause warpages and distortions of the parts which may result in a breakdown of the attempted separation of gas and air. This problem has long been attacked through the provision of sealing means designed to compensate for such distortions but as yet this method of solution has not been too successful. Another way of solving the problem is to produce a structure upon which the effects of heat are minimal. With this objective in view, experiments have been made using a ceramic matrix core since such material has an almost zero coefficient of expansion. The use of such a core, however, produces another problem. Since the matrix is to be rotated, preferably circumferentially, a metal rim must be provided encompassing the core and being geared to some driving means. Due to the great difference in expansion coefficients between ceramic and metal such a rim will expand as the regenerator heats up and become separated from the ceramic core structure.

It is an object of the present invention then to provide a metal rim attached by resilient means to a ceramic core in a heat exchange apparatus which will compensate for the differences in the rate of thermal expansion between these two materials.

Another object of the present invention is to provide a geared metal rim which may be used as a means of circumferentially driving a ceramic core structure.

Still another object is to provide a mathematically shaped spring element which is easily constructed and which may be inserted laterally between a ceramic core and a metal rim to provide frictional engagement therebetween at all stages of operation of the heat exchange apparatus regardless of deflections and warpage.

A still further object is to provide a plurality of wheel elements which in combination with a uniquely constructed metal rim operate to maintain a rotating matrix at a predetermined pitch.

Still further objects and advantages of the present invention will readily occur to one skilled in the art upon reference to the accompanying drawings illustrating a preferred embodiment of the invention in which like characters refer to like parts throughout the several views and in which

FIG. 1 is a lateral cross sectional view of a preferred rotary regenerative heat exchange apparatus embodying the present invention.

FIG. 2 is a cross sectional view of the preferred apparatus taken substantially at the line 2-2 of FIG. 1.

FIG. 3 is a fragmentary view of structure shown in FIG. 1 but with parts removed to better illustrate the present invention.

FIG. 4 is an enlarged fragmentary cross sectional view taken substantially on line 4-4 of FIG. 1.

FIG. 5 is a fragmentary sectional detail view taken substantially at line 5-5 of FIG. 2.

FIG. 6 is a fragmentary sectional view taken substantially at line 6-6 of FIG. 2, and

FIG. 7 is a fragmentary sectional view taken substantially at line 7-7 of FIG. 2.

Referring now to the drawings for a detailed description of the present invention, FIG. 1 shows a preferred regenerator as comprising a substantially cylindrical matrix 10 rotatably carried in an encompassing housing 11. The housing 11 which preferably is also substantially cylindrical in configuration is provided with a plurality of radially spaced protrusions shown at 12A, 12B and 12C shown in FIG. 2. These enclose chambers 13A, 13B and 13C respectively.

Referring now to FIGS. 2 and 7, a drive shaft 14 is rotatably carried in the protruding portion 12A through a boss 15. The drive shaft 14 has an end portion 16 disposed within the chamber 13A having a drive gear 17 fixed at its extreme end by a convenient means such as a pin 17A. Washers 18 and 19 are provided to separate a freely rotatable pilot wheel 20 from the drive gear 17 and the boss 15. The drive shaft 14 has an extended portion 21 which is adapted to be connected to a convenient source of power such as a turbine engine (not shown).

The protruding portion 12B is provided with a boss 22 as can best be seen in FIG. 6 extending into the chamber 13B. The boss 22 carries a bolt 23. The bolt 23 acts as a shaft for a freely rotatable pilot wheel 24, similar in construction to the wheel 20 of FIG. 7, and with washers 25 and 26 disposed on each side of the wheel 24. The bolt 23 is provided with a nut 27 to complete the assembly. The protruding portion 12C has a boss 28 as can best be seen in FIG. 5 extending into the chamber 13C. The boss 28 carries a bolt 29 which carries washers 30 and 31 separated by a forked member 32. The forked member 32 has end portions 32A which are provided with aligning holes 33 through which passes a bolt 34 acting as the shaft for a freely rotatable pilot wheel 35 and washers 36 and 37. The pilot wheel 35 is similar in construction to the wheels 20 and 24 of FIGS. 5 and 6. A nut 38 holds the wheel 35 and washers 36 and 37 on the bolt 34. The forked element 32 is provided with a toroidal recess 39 having an axis substantially normal to the axis of the aligning holes 33. The recess 39 provides the seat for a spring 40 and a bolt 41 which passes through the protrusion 12C and the spring 40 as seen in FIG. 2.

The housing 11 is provided with sealing means 42 which may be in the nature of the sliding seal assemblies described in my copending application Serial No. 151,945, filed November 13, 1961.

The matrix 10 preferably comprises a core structure 43 of any ceramic or porcelain material known in the art and a metal rim structure 44. One edge of the rim 44 is provided with a plurality of annularly spaced slots 45 as can best be seen in FIG. 4. The other edge is provided with an annular radially outwardly extending flange portion 46. A substantially centrally positioned rib portion 47 is provided with gear teeth 48 which mesh

with the teeth of the drive gear 17. The flanged portion 46 and the rib portion 48 define the edges of a smooth annular track 49 wide enough to accommodate the pilot wheels 20, 24 and 35.

The metal rim 44 is spaced from the core structure 43 by means of a plurality of annularly spaced, laterally inserted spring members 50. The spring members 50, as can best be seen in FIG. 3, each have a somewhat arcuate base portion 51 and a pair of spaced upright extensions 52. The extensions 52 define an annular path around the periphery of the core structure 43. On one side the upright extensions 52 fit into the slots 45, while on the other side, the extensions 52 rest against the side of the flanged portion 46.

It is apparent from the foregoing description that the spring members 50 provide a means to compensate for the variance in heat distortion between the ceramic core structure 43 and the metal rim 44 by providing frictional contact between these two parts at all stages of operation.

As the regenerator heats up and the metal rim begins to expand, the resilient spring members 50 act to take up the slack between the core 43 and the rim 44. In this way rotational force is efficiently supplied to the ceramic core through the rim without regard to warpage and distortion.

The pilot wheels 20, 24 and 35 ride in the track 49 providing the necessary circumferential support between the rotating matrix 10 and the housing 11. The pilot wheel 35, being resiliently pivoted as seen in FIG. 2, when carried by the forked member 32, provides a unique way of adjusting and maintaining the pitch line of the rotating matrix.

It will also be apparent to those skilled in the art that while only one preferred form of the present invention has been illustrated and described, various changes and modifications may be made without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. In a rotary regenerative heat exchanger
 - (a) a housing,
 - (b) a matrix of a heat absorbent material rotatably mounted in said housing and comprising a substantially cylindrical member having a substantially annular exterior surface,
 - (c) a rim member encompassing said annular surface of said matrix and spaced therefrom and constructed of a material having a higher coefficient of thermal expansion than said heat absorbent material,
 - (d) means rotating said rim member, and
 - (e) means drivingly connecting said rim member with said annular surface of said matrix whereby rotation of said rim member produces rotation of said matrix,
 - (f) said connecting means comprising a plurality of spring elements positioned laterally across said annular surface intermediate said matrix and said rim member and spaced annularly about said surface,
 - (g) said spring elements each comprising a base portion resiliently frictionally engaging said annular surface of said matrix and a pair of spaced extensions extending outwardly from said base portion,
 - (h) said rim member being provided with a plurality of annularly spaced slots and a radially extending annular surface spaced from said slots,
 - (i) one of said extensions of each of said spring elements being received by said slots and the other of said extensions frictionally engaging said annular surface of said rim member whereby relative expansions and distortions of said rim member and said matrix during high temperature operating conditions of said heat exchanger is absorbed by said spring

elements to maintain a driving connection therebetween.

2. The apparatus as defined in claim 1 and in which said rotating means comprises a plurality of wheels rotatably carried in said housing, at least one of said wheels being geared, said metal rim being provided with an annular geared rib meshing with said geared wheel, and said other wheels riding on other portions of said rim whereby to provide support for said matrix.

3. The apparatus as defined in claim 1 and in which said core section is ceramic and said rim is metallic.

4. In a rotary regenerative heat exchanger,

(a) a matrix comprising a substantially cylindrical core section of heat absorbent material, a rim member constructed of a material having a higher coefficient of expansion than said core section, and a plurality of annularly spaced, laterally inserted, resilient spring members positioned intermediate said core section and said rim member,

(b) a housing enclosing said matrix,

(c) means carried by said housing for rotating said matrix,

(d) said rim member being provided with an axially extending exterior annular surface and an annular geared portion being provided on said exterior surface of said rim member,

(e) said rotating means comprising a geared member carried by said housing and meshing with said geared portion and means for rotating said geared member, whereby to rotate said rim member,

(f) said rim member being further provided with a plurality of annularly spaced slots and a radially extending annular surface and each of said spring members being provided with a substantially arcuate base portion and a pair of spaced radially outwardly extending extensions, one of said extensions of each of said spring elements being respectively received by said slots and the other of said extension frictionally engaging said radially extending annular surface whereby said spring members are frictionally resiliently secured to said rim member, and

(g) said base portion of said spring members resiliently frictionally engaging said core section whereby to resiliently secure said rim member to said core section so that rotation of said rim member will produce rotation of said core section even during high temperature operating conditions of said heat exchanger.

5. The apparatus as defined in claim 4 and in which said rotating means further comprises,

(a) a plurality of pilot wheels rotatably carried by said housing,

(b) a radially outwardly extending flange portion being provided on said rim member to provide an annular track portion intermediate said geared portion and said flange portion,

(c) said pilot wheels rotatably riding in said track portion whereby to rotatably support said matrix in said housing.

6. The apparatus as defined in claim 4 and in which said base portion of each of said spring elements frictionally resiliently engages two axially spaced portions of said core section.

7. The apparatus as defined in claim 4 and in which said core section is constructed of ceramic material and said rim member is constructed of metal.

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