United States Patent [19]

Kurschner et al.

[11] **3,710,850**

[45] **Jan. 16, 1973**

[54] UNRESTRAINED ROTOR

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[52] **U.S. Cl.** **165/9,** 165/10, 64/17

[51] **Int. Cl.**.....**F28d 19/04**

[58] **Field of Search** 165/8, 9, 10; 64/17

[56] **References Cited**

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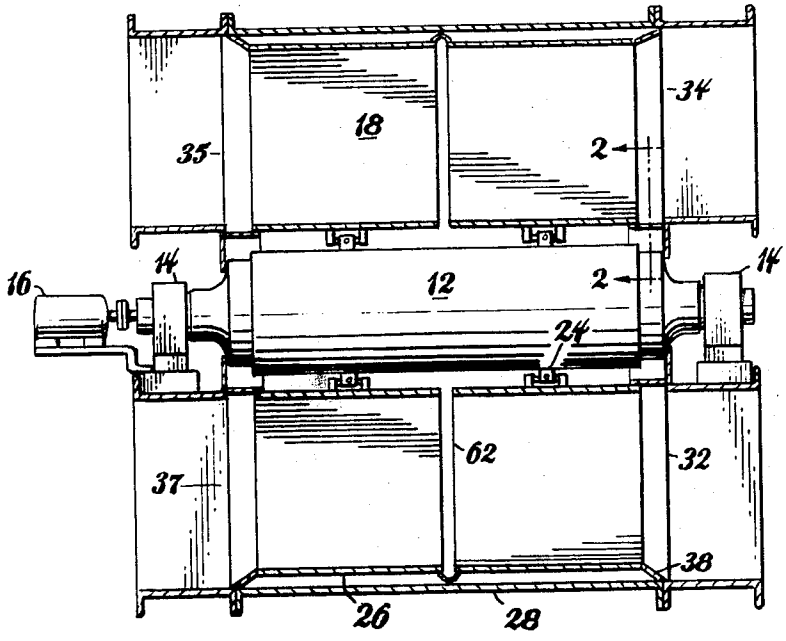
[57] **ABSTRACT**

A rotor structure for a rotary regenerative heat exchanger is defined wherein the rotating elements of a rotor subject to differential thermal expansion and to a concentration of stresses that effect cracking and failure of the usual welded joints therebetween are replaced by pivotal connections that allow relative movement sufficient to accommodate thermal expansion and thus preclude structural failure.

9 Claims, 7 Drawing Figures



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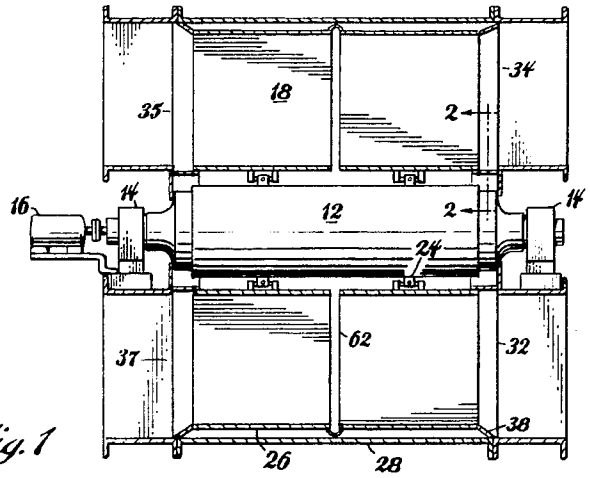

Fig. 1

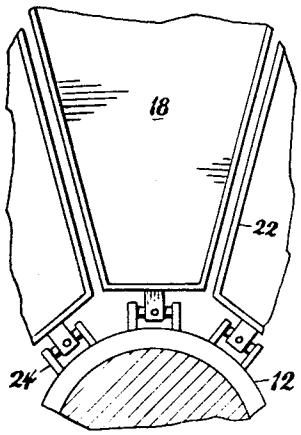

Fig. 2

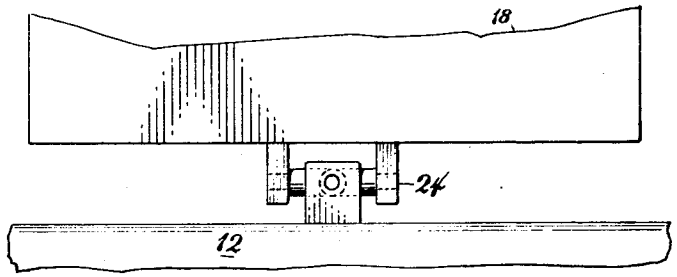

Fig. 3

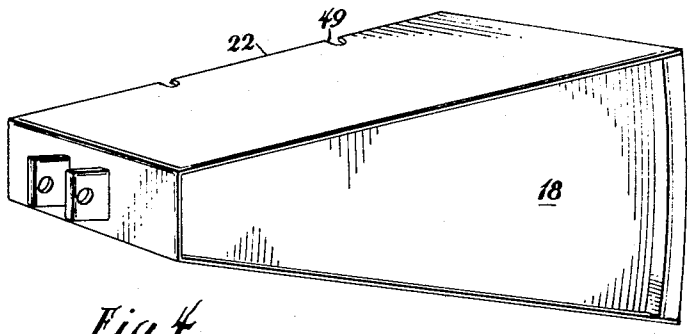

Fig. 4

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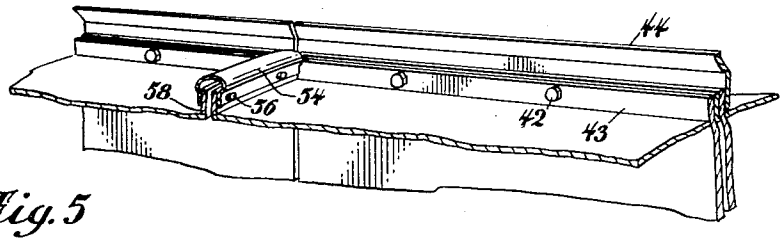

Fig. 5

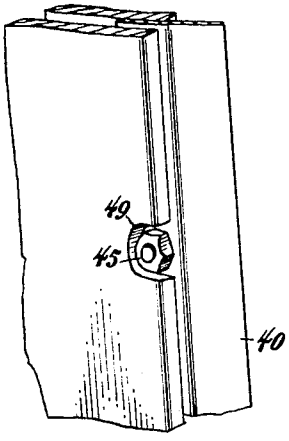

Fig. 6

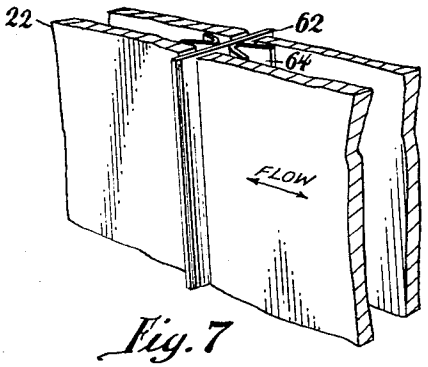

Fig. 7

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UNRESTRAINED ROTOR

SUMMARY OF THE INVENTION

In rotary regenerative heat exchange apparatus a rotor having radial compartments that carry a mass of heat absorbent material rotates alternately between a hot and a cold fluid in order that heat absorbed from the hot fluid may in turn be transferred to the cold fluid flowing therethrough.

The rotor is surrounded by a housing formed with end plates at spaced ends that have openings to simultaneously direct the heating fluid and the fluid to be heated through spaced compartments of the rotor.

Rotary regenerative heat exchange apparatus is effective and widely used but it is especially effective for applications having small overall size and operating at modest temperature differentials where thermal deformation is not significant.

Inasmuch as the present trend is toward the use of large heat exchangers that operate at high temperatures having significant thermal deformation, it is becoming increasingly difficult to maintain the structural integrity of the heat exchanger. This is mainly true because excessive thermal deformation of the component parts results in a cracking or breaking of the welded joints therebetween and the eventual failure of the structural apparatus.

This invention therefore, provides an arrangement whereby the rotor of a rotary regenerative heat exchanger is comprised of independent sector-shaped baskets pivotally supported by a rotatable rotor post whereby movement effected by thermal expansion or contraction of one element thereof is not transmitted to a member adjacent thereto, and whereby the concentration of stresses as effected by a differential of expansion does not cause the cracking or breakage of weldments and ultimate failure of the rotor structure. While the apparatus is operating under near constant conditions that do not produce excessive expansion of parts or the excessive concentration of stress, the rotor is firmly supported by the central rotor post in a manner that precludes relative movement between its component parts.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a sectional elevation of a heat exchanger constructed in accordance with the invention,

FIG. 2 is an enlarged detail as seen from line 2—2 of FIG. 1 showing an arrangement by which sector-shaped rotor compartments are pivoted to the rotor post,

FIG. 3 is an enlarged cross-sectional view showing the details of a typical pivotal basket attachment,

FIG. 4 is a perspective view of an individual element basket,

FIG. 5 is a perspective view of a sealing arrangement extending around axially spaced layers of the rotor,

FIG. 6 is a perspective view in section of a radial seal including a cutaway side panel of an adjacent basket, and

FIG. 7 is a perspective view of a radial sealing arrangement between axially spaced basket layers.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The arrangement of the drawing shows a rotary regenerative heat exchanger having a horizontal rotor post **12** supported by bearings **14** and rotated about its axis by means of the drive motor **16** that is connected through a suitable reduction gearing to the rotor post. A mass of heat absorbent material **18** is contained in independent, open ended, sector-shaped containers or baskets **22** are secured to the rotor post by pivotal attachments **24** to form a composite rotor **26** that upon rotation within the surrounding housing **28** is adapted to intermittently coincide with the spaced openings **32**, **34**, **35** and **37** in opposite ends of the surrounding rotor housing whereby fluids passing through the housing are directed through the heat absorbent material of the rotor.

While the entire rotor is subjected to alternating extremes of temperature, it has been found that the inner ends of baskets that comprise the portion of the rotor adjacent the rotor post are subjected to greater temperature variation than the radial outer ends, therefore maximum thermal expansion occurs adjacent the rotor post. Moreover, the adjacent rotor post operates continuously in a relatively cool atmosphere so there is considerable differential of expansion between the rotor and the rotor post. Thus the usual welded or other type of integral joint used to connect the rotor to the rotor post is subjected to a differential of expansion and unequal stresses that produces cracking and breaking of the weldment and destruction of the structure. Therefore, according to this invention the radial inner ends of the baskets are pivotally secured by universal joints to the rotor post to permit limited relative movement therebetween, while the radial outer ends of adjoining baskets that are subjected to little relative thermal deformation may be connected by bolts **42** into an integral annular shell that surrounds the rotor.

Circumferential seals **38** positioned around the end edges of the rotor and axial sealing means **44** shown in FIG. 5 of the leaf-type are held to flanges **43** at the arcuate ends of adjacent baskets so they extend outwardly and rub against the surrounding rotor housing **28** to preclude the flow of air through the space therebetween during its passage between the inlet and the outlet. The bolts **42** that connect adjoining baskets also hold the axial seals **44** in position at the periphery of the rotor. Sealing means **40** shown in FIG. 6 extending radially between baskets from the inner to the outer ends of the rotor are adapted to reach axially thereof sufficient to bridge the space between the adjacent end parts of the rotor and the rotor housing. The radial seals **40** are connected by bolts **45** to only one of adjacent baskets while the other is cutaway in the manner shown at **49** in FIGS. **4** and **6** to provide freedom of movement. Thus, each basket is secured to baskets adjacent thereto only at the ends of the arcuate outer wall so as to provide an integral annular shell extending around the rotor. At the same time, the radial sides of each basket are entirely independent from each adjoining basket and are thus free to expand or contract laterally without interference while each sector-shaped basket is secured by a pivotal attachment **24** to the rotor post **12** to provide adequate support therefor but to permit limited relative movement therebetween.

If the difference in thermal expansion between the rotor post and the surrounding rotor is substantial, or other conditions should promote excessive structural deformation of the rotor, a plurality of layers of element baskets, each independently pivoted to the rotor post, may be provided to minimize the deformation of the rotor. In such an application as shown by FIG. 5 the axially spaced layers of element may be joined by flexible sealing means 54 secured by bolts 56 to the flanges 58 that extend circumferentially around the arcuate peripheral edge of the rotor. Other sealing means 62 shown in FIG. 7 comprising an elongate bar with spring sections 64 on opposite sides thereof adapted to abut adjacent baskets may be inserted between baskets in axially spaced sections to limit the flow of fluid to the interior of the adjacent baskets so it will flow through and contact the heat absorbent element carried thereby.

While this invention has been described with reference to the thermal embodiments illustrated in the drawing, it is evident that numerous other changes may be made without departing from the spirit of the invention, and it is intended that all matters contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. Rotary regenerative heat exchange apparatus having a central rotor post, a plurality of baskets arranged in juxtaposition around the rotor post to comprise a rotor, a mass of heat absorbent material contained in the baskets of the rotor, housing means surrounding the rotor including inlet and outlet ports for a heating fluid and a fluid to be heated, means for rotating the rotor about its axis, and pivotal connections securing baskets to the rotor post to accommodate relative movement therebetween.

2. Rotary regenerative heat exchange apparatus having a horizontal rotor post, bearing means supporting said rotor post for rotation about its horizontal axis, a plurality of sector-shaped baskets arranged in juxtaposition around the rotor post to comprise an annular rotor, a mass of heat absorbent material carried in the baskets of the rotor, housing means surrounding the rotor having inlet and outlet ports for a heating fluid and the fluid to be heated, means for rotating the rotor about its axis whereby the sector-shaped baskets are alternately aligned with the inlet and outlet ports for the heating fluid and the fluid to be heated, means connecting the outer wall of each basket to baskets adjacent thereto to form a composite rotor with an outer annular wall concentric to the rotor post, and a pivotal coupling securing each basket to the rotor post whereby there may be relative movement therebetween.

3. Rotary regenerative heat exchange apparatus having a central rotor post as defined in claim 2 wherein the rigid annular wall around the rotor post is concentric thereto.

4. Rotary regenerative heat exchange apparatus including a central rotor post and a composite rotor shell as defined in claim 2 having radial sealing means intermediate adjacent baskets extending axially toward the end plates of the surrounding housing to bridge the leakage path therebetween.

5. Rotary regenerative heat exchange apparatus including a central rotor post and a surrounding rotor as defined in claim 4 wherein each radial sealing means is affixed to only one of the adjacent sector-shaped compartments of the rotors.

6. Rotary regenerative heat exchange apparatus including a central rotor post and a composite rotor shell as defined in claim 2 wherein the pivotal couplings joining the sector-shaped baskets to the rotor post lie at a midpoint between the edges of the face of the adjacent rotor basket.

7. Rotary regenerative heat exchange apparatus having a horizontal rotor post, a plurality of sector-shaped baskets with axially open ends arranged in radial juxtaposition around the rotor post to provide an annular basket layer, a plurality of layers of said baskets axially spaced along the rotor post, a mass of heat absorbent material carried in the baskets of the rotor, housing means including inlet and outlet ports for heating fluid and a fluid to be heated surrounding the rotor, means for rotating the rotor about its axis within the rotor housing, a universal joint securing each basket of the rotor to the rotor post, and flexible sealing means joining the arcuate periphery of the axially spaced layers of the rotor to preclude fluid leakage while permitting relative movement therebetween.

8. Rotary regenerative heat exchange apparatus as defined in claim 7 having means joining the periphery of radially adjacent baskets into an integral shell concentric with the rotor post.

9. Rotary regenerative heat exchange apparatus as defined in claim 7 including axial sealing means lying between ends of radially adjacent baskets and extending radially to bridge the space between the rotor and surrounding rotor housing to preclude fluid flow therebetween.

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