Oct. 30, 1962 H. BRANDT 3,061,275

ROTARY REGENERATIVE HEAT EXCHANGER INCLUDING A FLEXIBLE ROTARY CONSTRUCTION AND AN IMPROVED ROLLER SUPPORT THEREFOR

Filed March 16, 1960 2 Sheets-Sheet 1

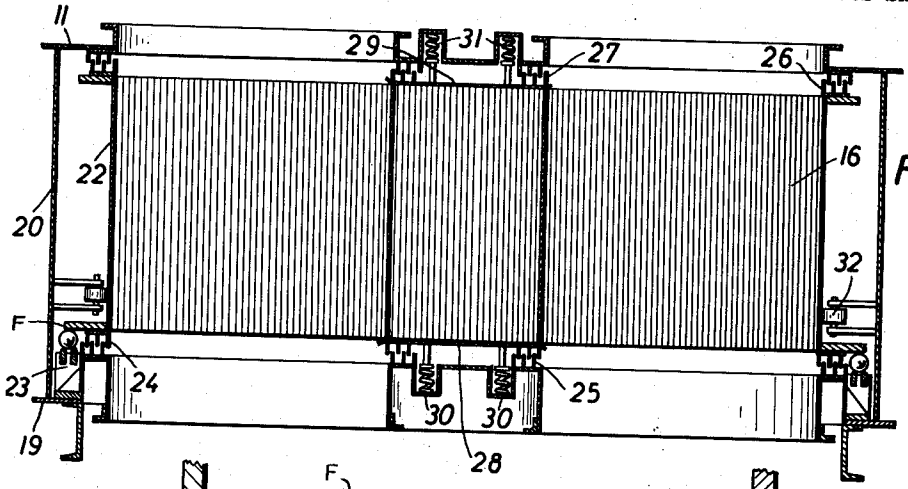


Fig. 1

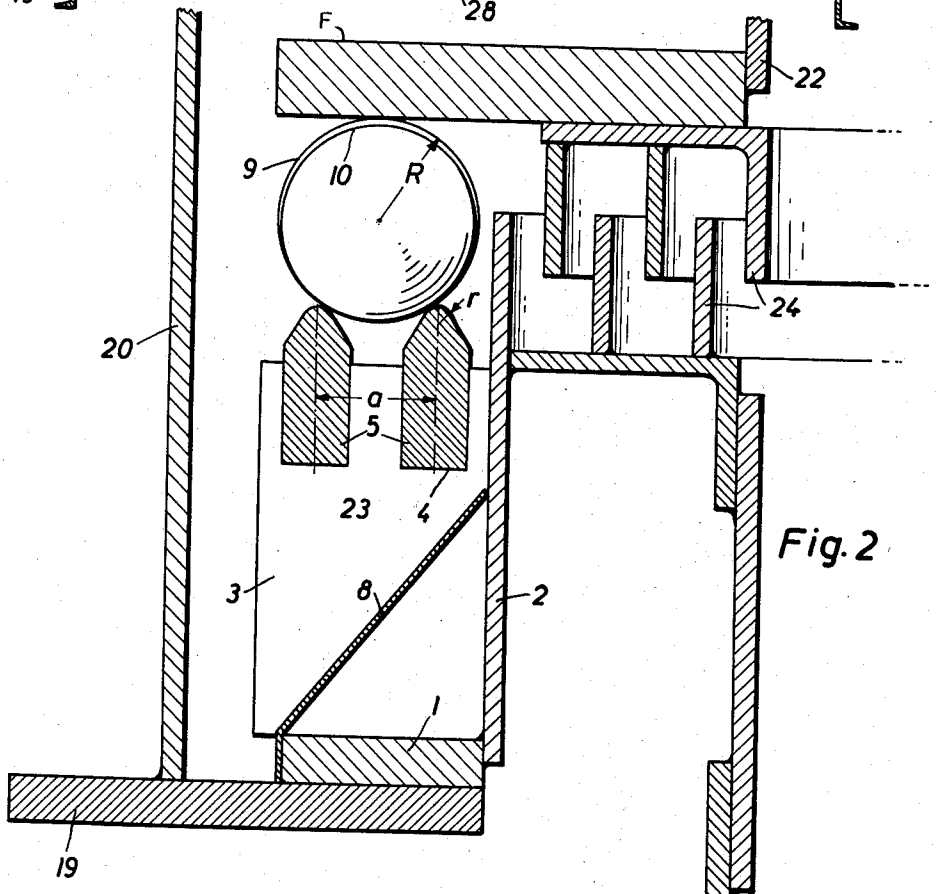


Fig. 2

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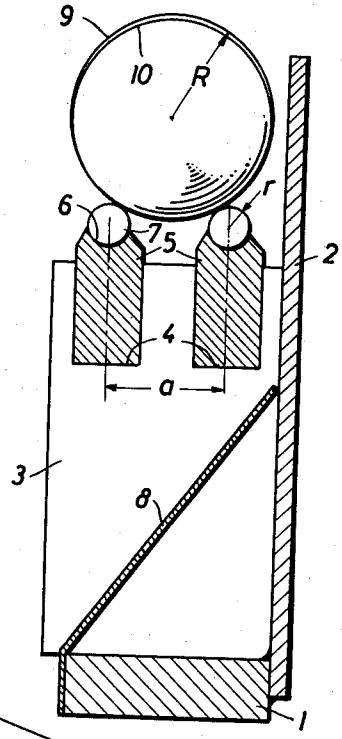


Fig. 3

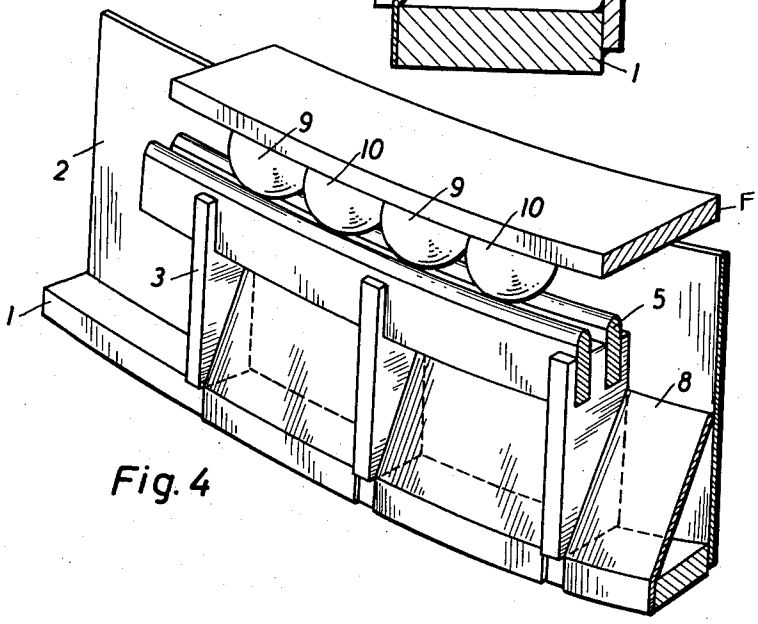


Fig. 4

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ROTARY REGENERATIVE HEAT EXCHANGER INCLUDING A FLEXIBLE ROTARY CONSTRUCTION AND AN IMPROVED ROLLER SUPPORT THEREFOR

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The present invention relates broadly to the art of heat exchangers.

More particularly, this invention relates to certain improvements in rotary regenerative heat exchangers of the type comprising a stationary casing accommodating a rotor of flexible construction.

Still more particularly, this invention relates to certain improvements in the heat exchanger art as exemplified in my prior United States Patent No. 2,744,731, dated May 8, 1956, and entitled "Regenerative Heat Exchanger."

In that patent, there is disclosed a regenerative heat exchanger including a stationary casing having upper and lower channels providing inlets and outlets for a fluid to be cooled and a fluid to be heated, within the casing is disposed a rotor of flexible construction, having a vertical axis and carrying a continuous external flange about the lower periphery thereof. As is known in the art, heat exchange surfaces are carried by the rotor and annular bearing means are mounted between the flange and the stationary casing to support the entire peripheral edge of the rotor during operation.

With a rotor of flexible construction in which at least the side wall is made of light gauge sheet steel, the problem of providing a proper bearing support is critical and my prior patent is directed to solving this problem.

Usually in heat exchangers of this type the hot gases are fed in from the top while the air to be heated enters from the bottom and flows upwardly through the rotor. Thermal deformation forces act on the rotor in such a manner that the latter has a tendency to rise, while due to the yieldability of the construction, the weight of the rotor counteracts the deformation at the bottom so that the final deformation is at a minimum. The rotor can expand radially because it is supported at the bottom by a horizontal bearing surface on a plurality of balls having only a lower centering guideway.

Usually, the bearings are in the form of an annular series of balls mounted in a guideway of U-shaped cross section with the legs of the U directed vertically. This guideway is constructed of individual segments, which must be welded together in view of the necessary size of the bearing diameters which lie between 3 and 10 cm. After the formation of the segmental, U or channel-shaped members into a ring, only the welded seams inside the raceways for the bores are machined and smoothed, while the remaining surfaces of the bearing circumference of the ring remains untreated, because an accurate alignment and machining of these bearing rings is quite difficult and expensive to accomplish in view of the size of the bearing diameters, thus, the balls run inside a U section on relatively rough cylindrical surfaces. A further disadvantage results in that dust or packing material can enter into the bearing arrangement from the rotor since fresh air enters under pressure and the balls are in frictional contact with four plane bearing surfaces, which can result under certain circumstances in considerable bearing wear. The radial guidance of the balls between the two upright flanges of the U-shaped bearing rings is incomplete since the balls must have sufficient play from the commencement of use inside this U-shaped section and this play increases in the course of time due to wear.

A primary object of this invention is to keep off the

heat extensions from the bearing members, which cause considerable changes of forms, therefore it is aspired to build a ball-bearing in a manner, that different heat extensions between the stationary centering guiding rails of the balls and the rotating construction may be compensated, together it is desirable to have a great accuracy in fitting the bearing surfaces, thereby running in completely smooth after a short time, which structure is such as to reduce wear of all bearing parts to a minimum.

It is, therefore, a particular object of the invention to provide a support for the balls comprising two ring means with narrow annular bearing surfaces which may remain untreated, said ring means mounted in parallelism in grooves provided in vertically disposed supports in turn secured to annular supporting means, the said vertical supports extending radially of the axis of the heat exchanger and the grooves accommodating the ring means having such depth as to ensure that the space between the ring means remains constant and since a greater vertical extent of the ring means lies within the grooves then projects above the top of the vertical supports, any tendency to deformation due to heat effects is practically eliminated.

It is a further specific object to provide an arrangement in which the two permanently spaced ring means are provided at their upper surface with grooves and a wire which constitutes a ball-contacting surface is imbedded in each of these grooves.

Further and more specific objects will be apparent from the following description taken in connection with the accompanying drawing in which:

FIGURE 1 illustrates diagrammatically in longitudinal section a rotary regenerative heat exchanger including the improved roller support,

FIGURE 2 is an enlarged fragmentary vertical cross-sectional view illustrating such roller support in more detail,

FIGURE 3 is a fragmentary view similar to FIGURE 2 but illustrating a modified form of ball-contacting surface,

FIGURE 4 is a fragmentary perspective view of the relationship shown in FIGURE 2,

The FIGURE 1 arrangement is similar to the relationship disclosed in my prior Patent 2,744,731. Thus, the rotary regenerative heat exchanger includes a rotor **22**, of light gauge sheet metal which, in known fashion, is provided with sheet metal lamellae **16**. The rotor is of somewhat flexible construction and is disposed within a casing arrangement which includes a side structure **20**, a top closure **11** of thin sheet metal or light structural sections and a lower structure of heavier structural section including an annular, horizontally extending ring **19**. The support for the rotor is effected by the annular arrangement of rolling bearing means denoted generally at **23** arranged at the outer periphery of the bottom of the rotor between the horizontal flange F carried by the rotor and the lower casing support structure, particularly the ring **19**. The sealing of this rotor is provided by a labyrinth joint packing **24** including alternating annular flanges on the lower part of the casing and rotor respectively. Similar packings **25**, **26** and **27** are provided internally at the bottom of the rotor and at the inner and outer peripheries at the top of the rotor. Here it is to be noted that the inner packings **25** and **27** are not between the casing and the rotor, but between the casing and packing plates **28** and **29**, these plates serving to separate the two media, e.g. hot gas and air respectively, and being divided in the radial direction. It has been found that the use of this packing in rotary regenerative heat exchangers is particularly useful because it provides full security against the exit of dust while the heat losses compared with the saving in power consumption is of subordinate importance. It is primarily the low power consumption which makes this construction particularly valuable. The joints

between the parts of the plates are toothed and intermeshed, see FIGURE 7 of Patent 2,744,731, and the plates are pressed into sealing contact with the rotor by springs **30** and **31**. It will be understood that this spring pressure takes into account the weight of the plates and in consequence differs in the two locations.

The centering of the rotor in this example is effected by rollers **32** arranged in the casing against which the rotor bears with the lower part of its outer periphery.

FIGURE 2 illustrates the improved ball support in greater detail, which includes a lower horizontal ring **1** which is provided with suitable apertures so that it can be screwed or bolted on to the ring **19** of the stationary casing structure. A vertical annular ring or web **2** is welded to the inner circumference of ring **1**. This ring **2** also functions as the outer wall of the immersion packing or dip seal structure **24**. Uniformly distributed over the circumference of the ring **1** are vertically disposed flat steel supports **3** welded to the ring **1** and to the web **2** at intervals of about 150 mm. apart. The upper free ends of these supports **3** are provided with two notches or grooves **4**, the centers of which are disposed apart by the distance *a*, FIGURE 2. Within these notches are mounted segmental ring-shaped girder sections **5** which constitute the ring means that supports the balls.

In order to provide for easy running of the balls, these girder sections are rounded off at their upper edge so that they are in effect roof-shaped at the top. The radius of curvature *r* for the bearing edges of the ring means should be small so that these edges, which are not machined, or at best only roughly machined, will run in completely smooth after a short time under a surface load of the balls. It is, therefore, advisable not to select this radius *r* unnecessarily large so that no unnecessary dust can accumulate on the upper surface of the ring means.

In order to ensure a safe and stable guidance of the balls between the bearing edges of the parallel girder sections, the distance *a* between the centers of the notches and thus between the centers of the girder sections **5** should be so dimensioned that the distance between the contact points of the balls at two adjacent bearing edges is approximately equal to the radius R of the balls. The distance *a* thus results as the sum of the ball radius R plus the radius of curvature *r* of the arcuate bearing edges of the girders **5**. This sum can deviate to a certain extent, but it is important that the radius *r* for the bearing edges for the balls be selected in a ratio to the radius R of the balls of about .15 to .20R.

Further, an accurate guidance of the balls can be obtained by incorporating in the arrangement between each loaded ball, an unloaded ball, which has less diameter than the adjacent two load-supporting balls. FIGURE 4 shows that the loaded balls **9** have a slightly larger diameter than the spacing, unloaded balls **10**.

If desired, the upper bearing surfaces of the girders can be provided with grooves **6** within which are disposed steel wires **7**, FIGURE 3. This relationship substantially increases the life of the ball bearing.

Any dust that penetrates into the bearing can fall down through the space between the girder sections **5** and the uprights **3** and be deflected outwardly by an inclined dust deflector plate **8**, which extends between each of the uprights **3**. This plate **8** being attached to ring **1** after the latter has been screwed on to the ring structure **9**. Plates **8** not only function to facilitate elimination of dust, but they also provide lateral bracings between the adjacent upright supports **3**.

What is claimed is:

1. In a rotary regenerative heat exchanger of the type including a stationary casing having channels for a fluid to be cooled and a fluid to be heated, a sheet metal rotor of flexible construction rotatably mounted in said casing and movable relative to said channels, mounting means for said rotor comprising a radially extending horizontal flange on the periphery of said rotor providing a horizontal bearing surface extending entirely around said periphery, a plurality of radially disposed, circumferentially spaced, upright, flat support members secured to said casing below said flange, said members having a pair of radially spaced notches in the upper edges thereof, a pair of bearing supporting rails generally rectangular in cross section received in said notches with the upper edges of said rails disposed above the upper edges of said members and with the long transverse dimension of said rails disposed vertically, said rails extending entirely around the periphery of said rotor, the upper edges of said rails being tapered and a plurality of ball bearings engaging the upper edges of said rails and the lower surface of said flange to rotatably support said rotor, the diameter of said ball bearings being greater than the center distance between said rails.

2. A rotary regenerative heat exchanger as claimed in claim 1 in which the distance between the ball engaging points of the rails is approximately equal to the radius of the ball.

3. In a rotary regenerative heat exchanger as claimed in claim 2 and the radius of the curvature of the tapered bearing edges of the rails being selected in a ratio to the radius of the supporting balls of about .15 to .20R, where R equals the radius of the balls.

4. A rotary regenerative heat exchanger as claimed in claim 1 in which said rails have grooves in their upper surfaces and steel wires disposed in said grooves to provide the bearing surfaces for the balls.

5. An improved rotary regenerative heat exchanger as defined in claim 4 in which said support members are secured to said casing through a horizontal ring connected to the casing, a vertical web connected to said ring on the side thereof adjacent the rotor axis, and said upright flat support members being connected to said ring and web.

6. A rotary regenerative heat exchanger as defined in claim 5, and in which an unloaded spacing ball of a diameter slightly less than that of the respective supporting ball bearings is disposed between each pair of supporting ball bearings.

7. In a rotary regenerative heat exchanger as defined in claim 5 and further including outwardly and downwardly inclined deflector and stiffening plates disposed between each of the adjacent upright flat support members and extending from the web at a level slightly below the rails to at least the outer periphery of said outer ring.

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