Sept. 16, 1958 W. HRYNISZAK 2,852,233

REGENERATIVE HEAT EXCHANGERS ESPECIALLY FOR COMBUSTION TURBINES

Filed Dec. 23, 1952

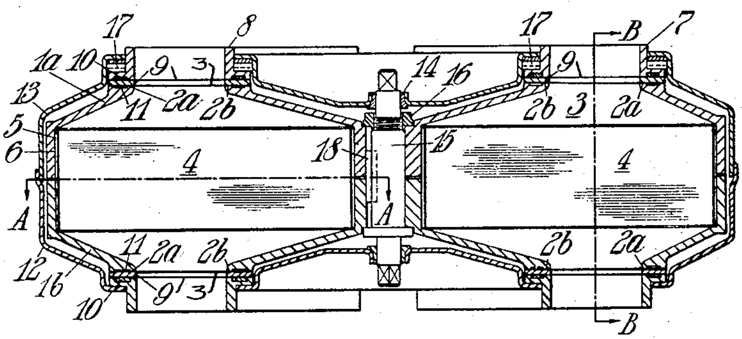

Fig.1.

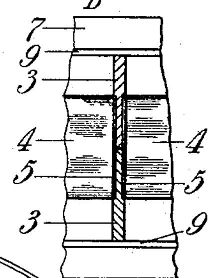

Fig.3.

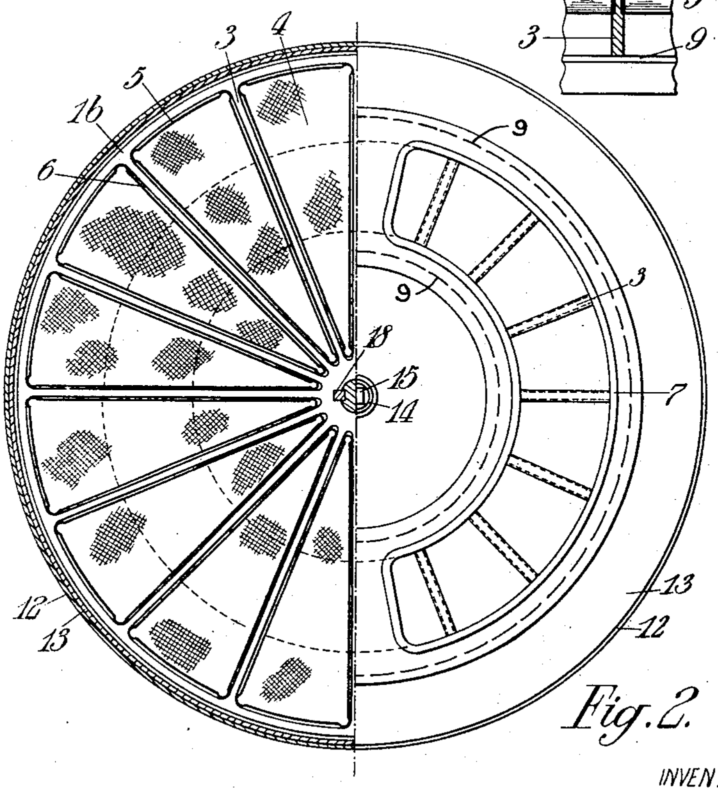

Fig.2.

INVENTOR

WALDEMAR HRYNISZAK

BY

ATTORNEYS

United States Patent Office

2,852,233

Patented Sept. 16, 1958

2,852,233

REGENERATIVE HEAT EXCHANGERS ESPECIALLY FOR COMBUSTION TURBINES

Waldemar Hryniszak, Newcastle-upon-Tyne, England, assignor to C. A. Parsons & Company Limited, Newcastle-upon-Tyne, England

Application December 23, 1952, Serial No. 327,829

4 Claims. (Cl. 257—6)

This invention relates to regenerative heat exchangers or air preheaters especially for combustion turbines.

More particularly the invention relates to regenerative heat exchangers of the disc type.

The problems associated with this type of heat exchanger include the achievement of an effective seal, low parasitic pressure losses, ease of manufacture and low cost.

Where sliding seals are used an effective seal can only be obtained where the extent of the sealing area is limited. The larger this area the greater the amount of distortion and hence unevenness. The effective gap between the sliding areas of the rotor and stator depends on this unevenness.

Simple flow of the gases or fluids to and from the matrix heat is the effective heat exchanging part of the heat exchanger, is essential if parasitic pressure losses are to be kept low. There should be as few bends as possible in the flow paths and expansion or contraction should be avoided.

Just as the extent of the matrix area is important in connection with the pressure loss in the matrix, so is the extent of the smallest area in the ducts leading to and from the matrix important as far as additional pressure losses due to these ducts is concerned.

From a cost and ease of manufacture point of view the heat exchanger should be simple in form and suitable for mass production. Further if ceramics are used for the parts forming the seals then a limit in the size is imposed from a production point of view. A further limitation is imposed when high precision grinding must be employed for the sealing faces.

All the parts must be simple, easy to replace and interchangeable.

The object of the invention is to provide an improved disc type regenerative heat exchanger which meets the above-mentioned requirements, and which can be used to build up a composite heat exchanger. To this end I refer to the heat exchanger described below as a heat exchanger element that is to say an element which is a complete heat exchanger in itself but which is used in the main with similar elements to build up a complete heat exchanger.

Referring to the accompanying diagrammatic drawings:

Figure 1 is a cross-section of a regenerative heat exchanger element according to one form of the present invention;

Figure 2 is a section on the line A—A of Figure 1 looking in the direction of the arrows;

Figure 3 is a section on the line B—B of Figure 1 looking in the direction of the arrows.

As to Figure 2, the section has been fully shown only on the left side, the right remaining in elevation.

In carrying the invention into effect in the form illustrated by way of example, the rotor casing consists of two similar halves **1***a*, **1***b* each in the form of annular elements or rings bounded by sealing faces **2***a*, **2***b*. Either these rings only or the whole of the rotor is made of

ceramics. For this reason the maximum outside diameter of the rotor is about 10 inches. The casing halves are evenly subdivided by ribs **3** which extend to the same plane as the sealing faces **2***a* and **2***b* and form part of the seal.

In the segments of the rotor casing formed by the ribs **3** is embedded a matrix **4** which may for example consist of nests of wire gauze. It is located in a frame **5** the outer shape of which conforms with the shape of the segment in which it is accommodated. A gap **6** is left between the matrix frames and walls of the segment to allow the matrix to expand.

Two similar combined gas ducts and pressure plates **7** and **8** form part of the stator. To these combined gas ducts and pressure plates are fixed sealing rings **9** made of ceramics. Instead of this the whole gas duct and pressure plate may be made of ceramics. Between the plate, if is is not made of ceramics, and the stationary sealing ring is arranged a heat resistant packing **10**. The contact surfaces of the stationary sealing ring **9** and rotating sealing faces **2***a*, **2***b* are ground very smooth so as to provide an efficient seal. For this purpose and to reduce wear, each of the rotating sealing faces **2***a*, **2***b* has a groove **11** so that it touches the stationary sealing ring **9** only along two narrow annular projections.

Two substantially similar stator casing halves **12**, **13** are preferably pressed from sheet metal and welded together to accommodate the rotor.

The gas ducts of the pressure plates project through arcuate openings in these casing halves.

These stator casing halves also form bearings **14** for a shaft **15** fixed in the rotor say by a nut **16**.

On the cold side of the heat exchanger wave shaped springs **17** press the pressure plates **8** and the sealing ring **9** against the sealing faces **2***a* and **2***b* to afford the necessary gas tightness.

The shaft **15** drives rotor **1** through key **18** and the drive may be fitted to either end of the shaft. The drive may be by hydraulic or electric motor or mechanical means through gears from the work turbine shaft.

The annular opening of each rotor casing half has as a width (radial) diversion which is less than the corresponding diversion of the matrix and ribs. The inlet and outlet openings bounded by the rotary sealing faces **2***a* and **2***b* together with the edges of the radial ribs **3** make contact with the stationary sealing plate **9** forming rubbing seals as the matrix and its casing rotate. The ribs seal the hot gas side from the cold gas side, and the rings seal both hot and cold gas sides from the atmosphere.

The complete element thus consists of a very few simply shaped parts. The rotor casing halves, the combined gas ducts and pressure plates, and the stationary sealing rings are in pairs. The stator casing halves are very similar in shape and have arcuate openings.

Mass-production of the elements is not difficult. High precision machining is not required except for the sealing faces.

In order to minimise the danger of warping because of the temperature gradients, the rotor casing halves incorporating the rotating sealing faces, and the stationary sealing rings are made from suitably selected ceramics. The evenness of the sealing faces may be achieved in this case by precision grinding such as is employed on these materials when used for other purposes.

The combined gas ducts and pressure plates may be precision cast, for instance by the lost wax process, in either iron or heat-resisting steel. If a ceramic coating is used on the duct wetted by the hot gases, possibly due to the fact that no high mechanical stresses are involved, no heat-resisting steel in any part of the element is required.

The thin outer casing is pressed from mild steel sheet, the openings being stamped out and the spindle bearing bushes inserted by pressure. The spindle can be machined on an automatic machine.

Since there are sixteen matrix sections in a complete element, it is important that the manufacture of each section and the assembly of the sections in the casing should be as simple as possible.

To this end the matrix section may be made from light-gauze strip with tabs projecting from the sides. This strip can be cut into lengths, each length being then wrapped round a nest of wire gauze and the tabs bent over to secure the gauzes in the frame. This may be done automatically or otherwise.

The advantages of a regenerative heat exchanger of the kind described above are as follows:

(1) *The use of a tight sliding seal.*—As previously stated it is assumed that an effective seal can only be used where the extent of the sealing areas is limited and, by its smallness, such areas are limited in this element.

(2) *Low parasitic pressure loss.*—The regenerative heat exchanger element described has the advantage of good flow conditions and a low parasitic pressure loss.

(3) *Mass production.*—The small regenerative heat exchanger elements lend themselves to mass production methods, the wall thickness of the stator casing can be reduced and it can be pressed from sheets. High precision machining is not required except for the sealing faces and the parts of the element are simple in design, interchangeable and easy to replace.

(4) *Behaviour in service.*—The small size ensures low speeds of sliding seals and this means reduced wear and longer life.

(5) *Interchange of matrices.*—Matrices may be easily changed and any suitable type may be employed.

What I claim is:

1. In a regenerative heat exchanger and in combination, a disc type rotor comprising two similar annular halves meeting in a substantially radial plane, made of refractory material, and having a maximum rotor diameter of approximately ten inches, each said half consisting of a one-piece integral member having ribs dividing it

into a plurality of similarly shaped segments, peripherally inward and outward walls cooperating with the ribs to form compartments and forming annular inlet and outlet openings flush with the ribs, the said openings being of small width in the radial direction compared with the said compartments, heat exchange matrices contained in the said compartments, and a stator consisting of two similar sheet metal halves with arcuate inlet and outlet openings, refractory ducts carried in the said openings, and sealing rings carried between said ducts and contacting the rotor inlet and outlet openings and ribs in sliding sealing relation.

2. The combination according to claim 1 comprising also spring means between one of the said sheet metal stator elements and the duct carried thereby, for urging the said duct toward the rotor.

3. The combination according to claim 1, comprising also a shaft, means mounting the rotor halves thereon and holding them together, and bearings rotatively supporting the said shaft and in turn supported by the sheet metal stator elements.

4. The combination according to claim 1 in which the matrix comprises a plurality of frame structures fitting in the said segmental spaces and holding the matrix material.

References Cited in the file of this patent

UNITED STATES PATENTS

1,741,225	Dyrssen	Dec. 31, 1929
1,762,320	Wood	June 10, 1930
2,294,214	Seinfeld	Aug. 25, 1942
2,337,956	Yerrick et al.	Dec. 28, 1943
2,347,829	Karlsson et al.	May 2, 1944
2,356,351	Phillips	Aug. 22, 1944
2,631,870	Hodson	Mar. 17, 1953
2,757,907	Williams	Aug. 7, 1956

FOREIGN PATENTS

353,553	Germany	May 20, 1922
649,265	Great Britain	Jan. 24, 1951