Nov. 9, 1965 D. JOHNSON 3,216,495

STACKED PLATE REGENERATORS

Filed Aug. 7, 1963 3 Sheets-Sheet 1

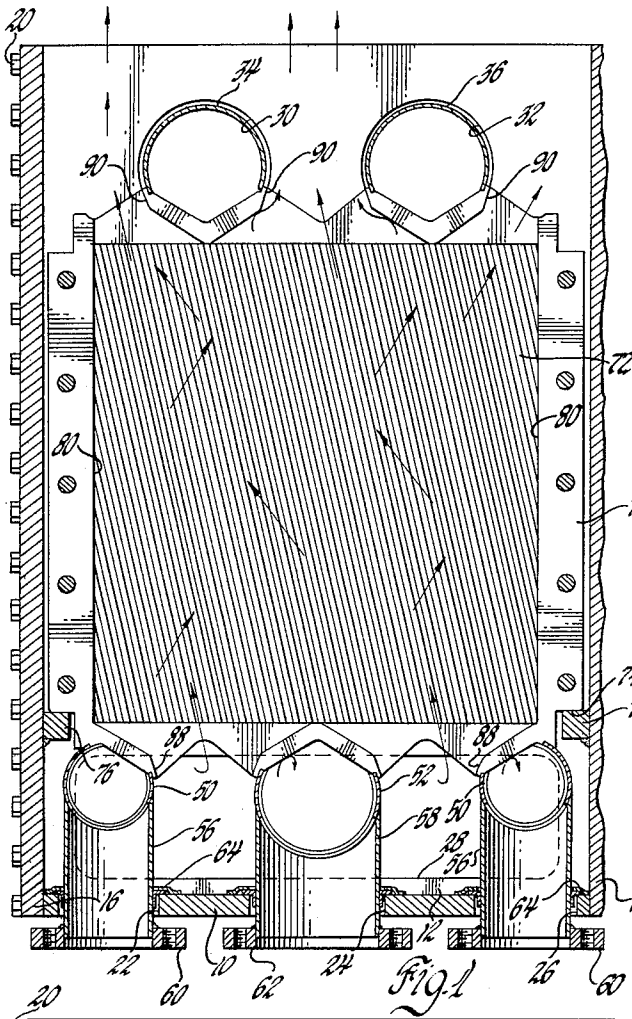


Fig. 1

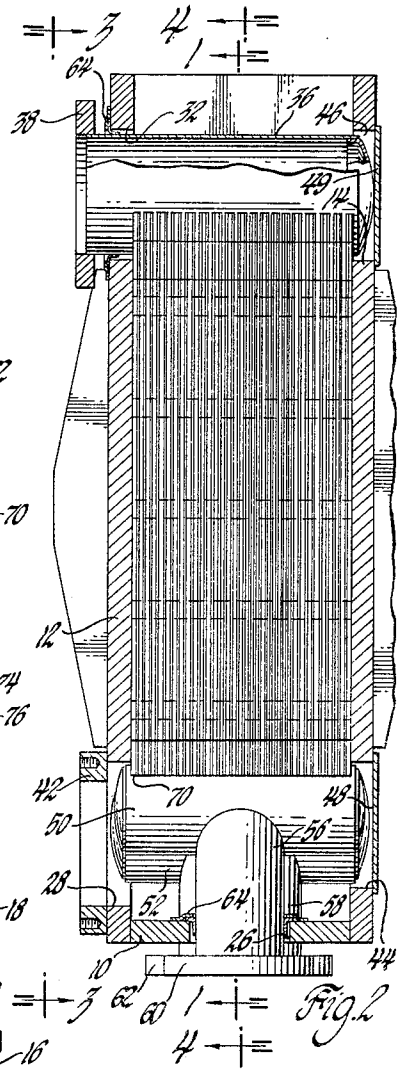


Fig. 2

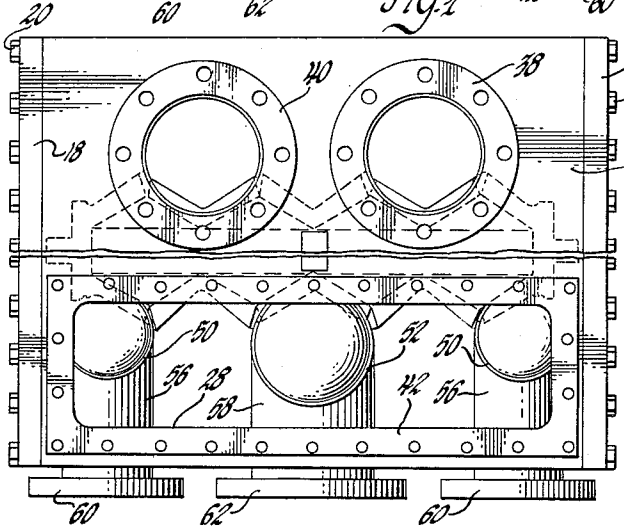


Fig. 3

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STACKED PLATE REGENERATORS

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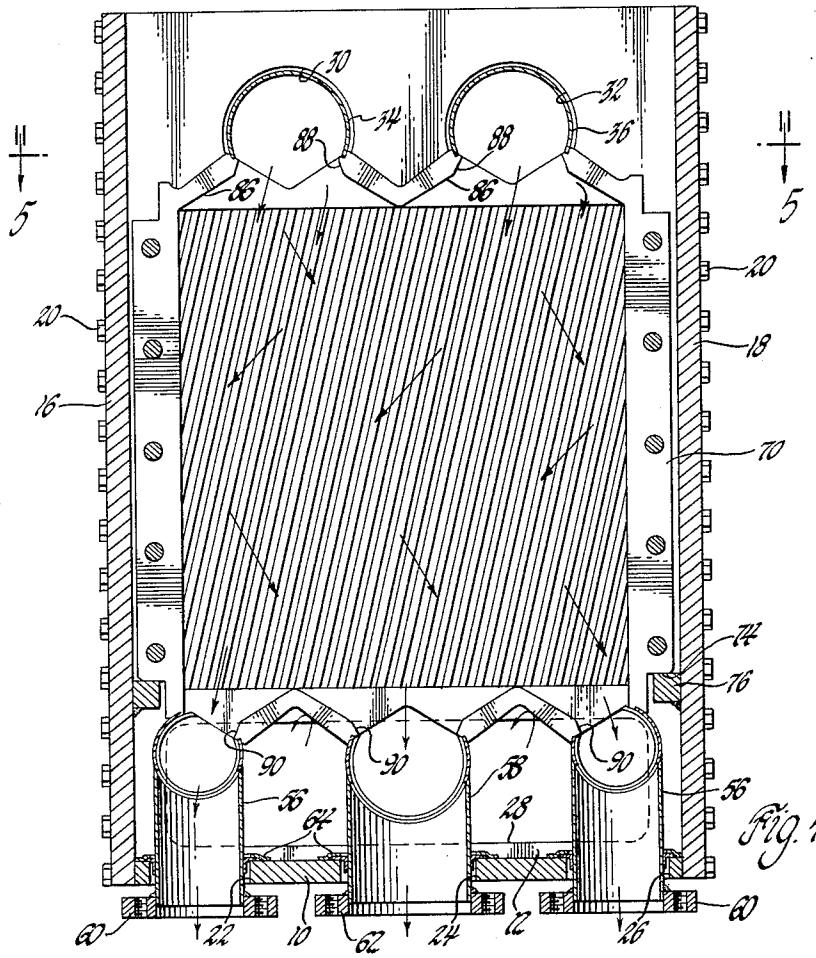


Fig. 4

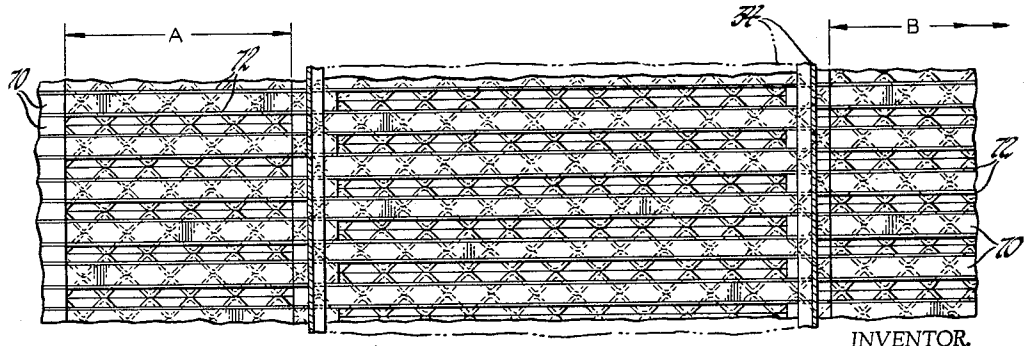


Fig. 5

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STACKED PLATE REGENERATORS

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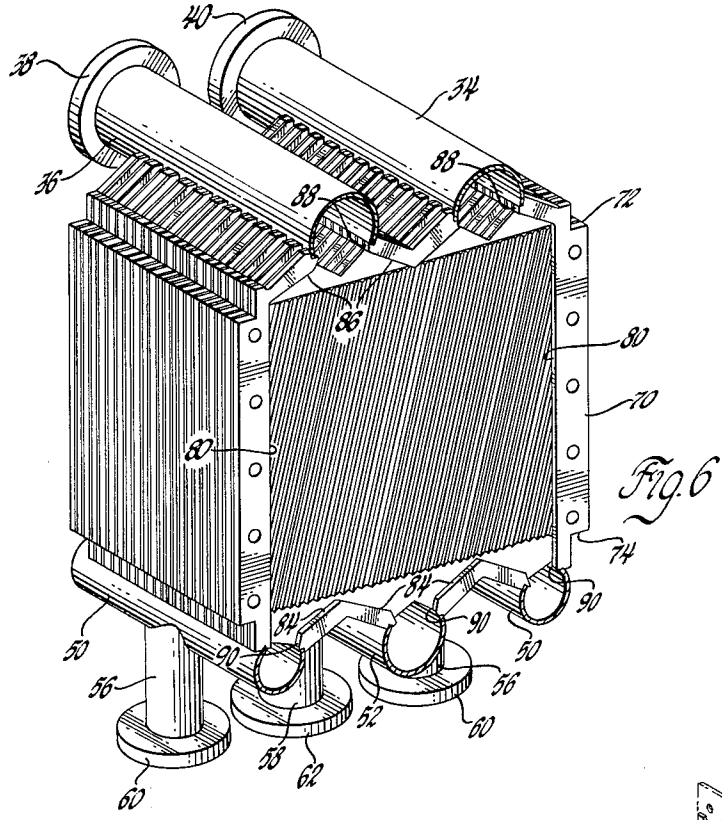


Fig. 6

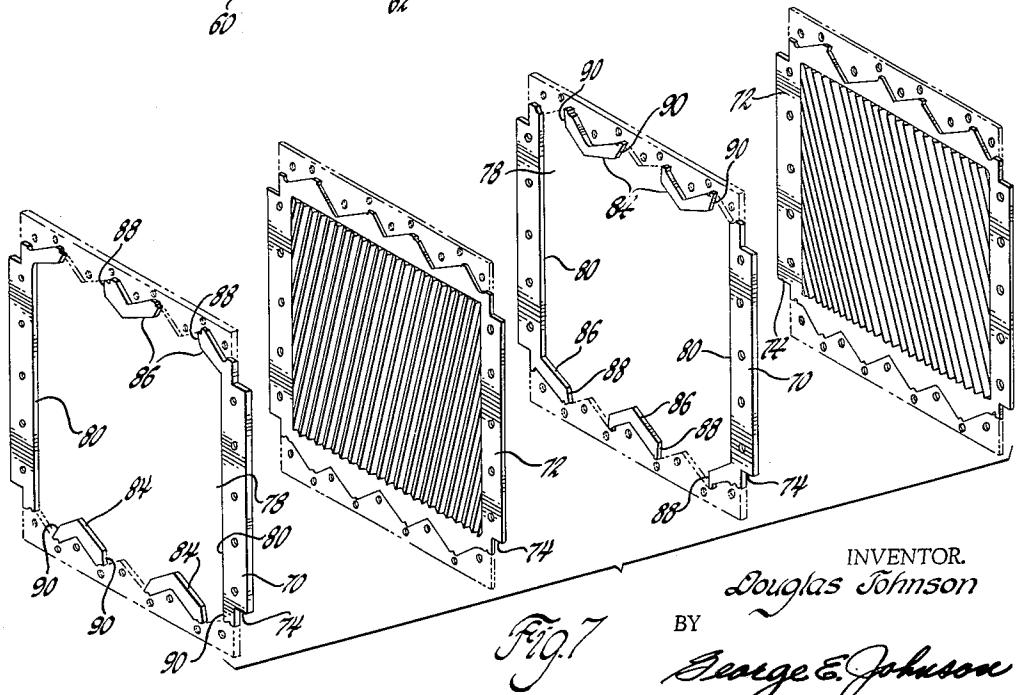


Fig. 7

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STACKED PLATE REGENERATORS

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Filed Aug. 7, 1963, Ser. No. 300,437
1 Claim. (Cl. 165—166)

This invention relates to heat transfer structures and more particularly to regenerators for transferring heat from one fluid to another such as from hot engine exhaust gas to relatively cool combustion air.

An object of this invention is to provide a regenerator of simplified structure having a minimum of parts and potentially presenting ease for the supplying of suitable manifolding to maintain separation of fluids involved in heat exchange within the regenerator.

To this end, a feature of the present invention is a regenerator characterized by multiple plates arranged in a stack, these plates including corrugated plates separated by spacer plates all cooperating to define crossed paths of two fluids, the crossed paths being separated by the corrugated plates, and the spacer plates aiding in defining inlet and outlet ports forming continuations of said paths and communicating with suitable manifolding.

This and other important features of the invention will now be described in detail in the specification and then pointed out more particularly in the appended claim.

In the drawings:

FIGURE 1 is a sectional view looking in the direction of the arrows **1**—**1** in FIGURE 2 showing one embodiment of the present invention, and the path of one of the two fluids involved—i.e. hot engine exhaust gas—being indicated with arrows.

FIGURE 2 is a sectional view of the regenerator shown in FIGURE 1 with some parts broken away better to illustrate the construction;

FIGURE 3 is a view in elevation looking in the direction of the arrows **3**—**3** in FIGURE 2 to show top and bottom portions;

FIGURE 4 is a view similar to that of FIGURE 1 looking in the direction and section of the arrows **4**—**4** in FIGURE 2, but showing arrows giving the direction of flow of the second fluid involved—i.e. combustion air.

FIGURE 5 is an enlarged view looking in the direction of the arrows **5**—**5** in FIGURE 4 and showing some combustion or hot gas outlet ports with one manifold being sectioned and hot gas as well as relatively cold air outlets being illustrated;

FIGURE 6 is a perspective view of the integrated inner regenerator structure of FIGURES 1–5, the supporting outer casing being omitted; and

FIGURE 7 is an exploded view of two spacer plates and two corrugated plates in their positional order in the regenerator assembly with outlines of opposite end or marginal portions of each plate being shown in dot-and-dash lines to indicate portions removed before and subsequent to the integration of the plates into a unit.

The regenerator illustrated in the drawings shows manifolding including an outer casing having a bottom wall **10**, a front wall **12**, a back wall **14**, and opposite side walls **16** and **18**. These are held together by suitable bolts **20**. The two side walls **16** and **18** are solid whereas the bottom wall **10** bears three apertures as indicated at **22**, **24** and **26**. The lower part of the front wall **12** is apertured as shown at **28**. This aperture is somewhat rectangular and large for the free admission of hot gas as will further appear. The top portion of the front plate **12** is apertured at **30** and **32** for the retention of two upper manifold tanks **34** and **36**, respectively. The tanks **34** and **36** are similar in that a spaced end of each tank bears a flange **38** or **40**. The margin of the opening **28** at the bottom

portion of the casing is reinforced by a rectangular frame **42** which is adapted to be attached to a pipe conduit for the conveying of the hot gas.

The back plate **14** bears apertures **44** and **46** but these are closed off by suitable plates **48** and **49**, respectively, so that closed ends of the tanks in the regenerator are covered.

In addition to the two upper tanks **34** and **36**, three lower tanks are also provided. These tanks are in the form of two smaller tanks **50** and one intermediate larger tank **52**. These three tanks are provided with two vertical conduits **56** and one larger vertical conduit **58** in such a way that each tank with its corresponding vertical conduit makes a T-form cold air outlet portion of the regenerator. The two conduits **56** bear flanges **60** for connection with a system requiring heated air and the conduit **58** bears a flange **62** for a similar function. One end of each tank **34** and **36** as well as each vertical conduit **56** or **58** is provided with sealing means engaging the outer casing and indicated at **64**. This sealing means may take various forms but, in the drawing, each seal is illustrated as two engaging annular sheet metal members with one of the members being joined to a tank or conduit and the other being suitably joined to the casing.

In forming the stack of plates into an interior unit for the regenerator, relatively thick spacer plates **70** are stacked alternately with relatively thin corrugated plates **72**, all these plates prior to assembly being substantially rectangular with corner sections removed as easily seen by inspection of FIGURES 6 and 7. The corner portions are removed to form downwardly facing shoulders as at **74** ultimately to rest on horizontal members **76**, as seen in section in FIGURE 1, thereby to support the integral stack of plates within the casing. As set forth above, the spacer plates **70** are relatively thick compared with the plates **72**, but it will be noted in FIGURE 7 that each spacer plate **70** bears a large opening **78** defined by parallel and opposite edge surfaces **80** and saw tooth surfaces at top and bottom including surfaces **84** and **86** of that same plate. The surfaces **86** are so placed as to limit the extent of two spacers or ports **88** in each plate **70** and the surfaces **84** are placed to limit three spaces or ports **90**. These spaces or ports are subsequently formed because after the stack is assembled, opposite marginal portions shown in dot-and-dash lines illustrated in FIGURE 7 are removed from the spacer plates and corrugated plates. It is to be noted that adjacent spacer plates **70** are reversed in position so that one spacer plate **70** will have the two ports **88** at the top and three ports **90** at the bottom and the next spacer plate will have two ports **88** at the bottom and the three ports **90** at the top. The top and bottom marginal portions are readily removed by machining from the integrated stack of plates **70** and **72** so that the assembled and ported stack will appear as best seen in FIGURE 6.

The plates are notched to receive opposed wall portions of each of the tanks from which wall portions are cut away as best seen in FIGURES 1 and 4. It should also be noted that the corrugations of one corrugated plate are inclined to the corrugations of each adjacent corrugated plate and that the apices (FIGURE 5) of one corrugated plate **72** extend to and are in contactual relation with the apices of the corrugations of the adjacent plate or plates **72**. It will be noted that every other spacer plate **70** blocks the space between two corrugated plates **72** in the area A and B (FIGURE 5) but is removed to permit upward flowing in the same plane through a port **88** and into the tank **34**. The other spacer plates **70** are open in the area A and B but form a closure to the tank **34** in the corresponding planes. In a similar way three ports **90** are provided for each spacer plate and these lead from the three tanks at the bottom or upwardly through the top of the outer casing.

In operation of the generator, hot gas is admitted into the casing by way of the rectangular opening **28**. This gas enters alternate zones defined by the corrugated plates **72** by way of the lower ports **88** (FIGURE 1) formed in alternate spacer plates. It then passes up through intricate passages between adjacent corrugated plates and then is discharged through the upper ports **90** and up through the top of the casing in cooled condition. The air on the other hand, which is to gain heat from the combustion gas, is admitted through the upper tanks **34** and **36** and after flowing counter to the flow of hot gas and through the stack of plates, attains a heated state and is discharged through the conduits **56** and **58**.

What particularly should be noted is that in the formation of the integral stack of alternating spacer plates and corrugated plates, portions of the spacer plates essential in defining the ports **88** and **90** would drop away from the assembly if the plates were not brazed or otherwise made into an integral assembly before the marginal parts drawn in the dot-and-dash lines in FIGURE 7 are removed by machining. With the produce and structure outlined, however, manufacture is much facilitated and manifolding is easily achieved to suit a particular situation and at the same time the structure is simplified despite the thinness of each of the corrugated plates and the necessary relatively greater thickness of each of the spacer plates.

I claim:

A regenerator comprising a stack of corrugated plate members and spacer frame members arranged alternately and each having flat side and end marginal portions, a portion comprising straight corrugations in each of said corrugated plate members, an opening in each of

said spacer frame members partially defined by the corresponding flat marginal portions, the corrugations in each corrugated plate member traversing the openings of the adjacent spacer frame member and being inclined to the corrugations in the next corrugated plate member, opposed side margins of each member of said stack being joined to side margins of at least one adjacent member, the joined side margins of all of said members forming impermeable opposite sides of said stack, other margins of each of said members cooperating with adjacent members of the stack to define alternately arranged inlet and outlet ports at each of the ends of said stack, said spacer frame members being similar in outline to facilitate connection with manifold ducting and alternately reversed end for end in position to accommodate the countercurrent flow of separate fluids through said ports and along opposite surfaces of each of said corrugated portions, said stack of corrugated plate members and spacer frame members being brazed together, and each spacer frame member being thicker than each corrugated plate member.

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