Aug. 12, 1969 F. P. FOLSOM ETAL 3,460,611

HEAT EXCHANGER OF PLATE FIN MODULES

Filed Oct. 6, 1967 2 Sheets-Sheet 1

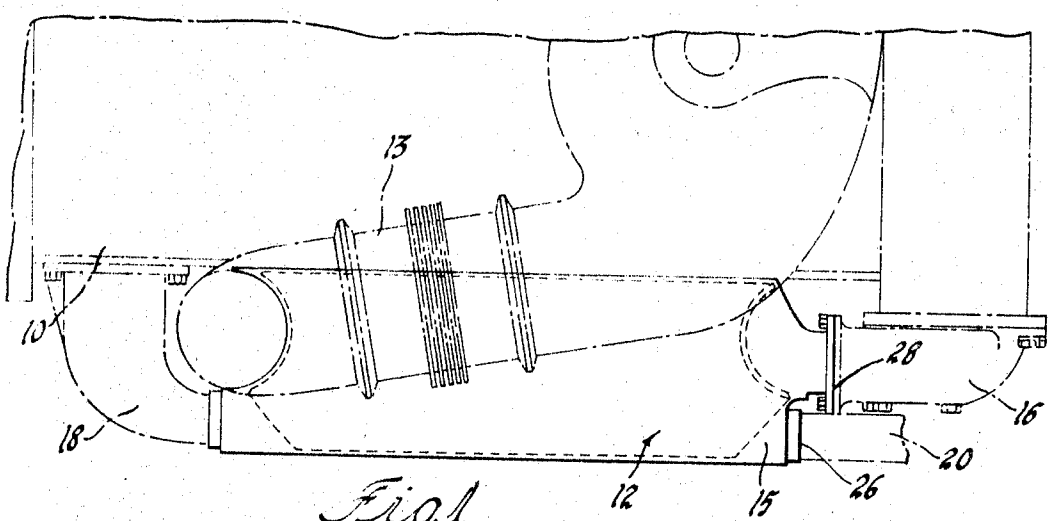


Fig. 1

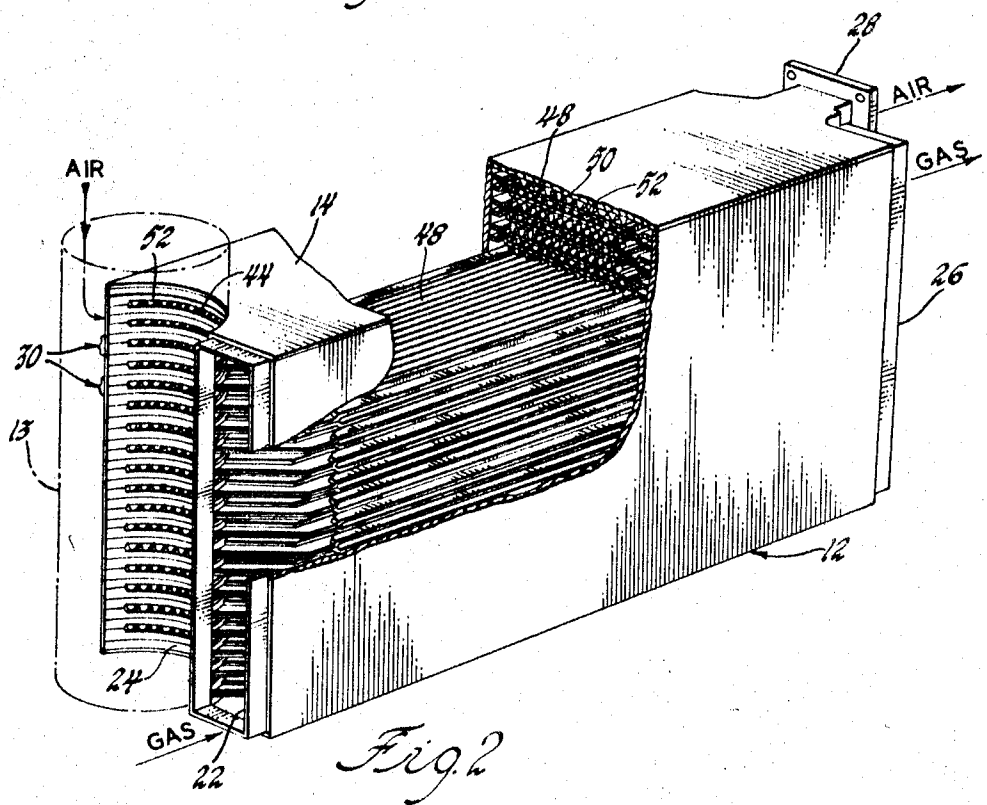


Fig. 2

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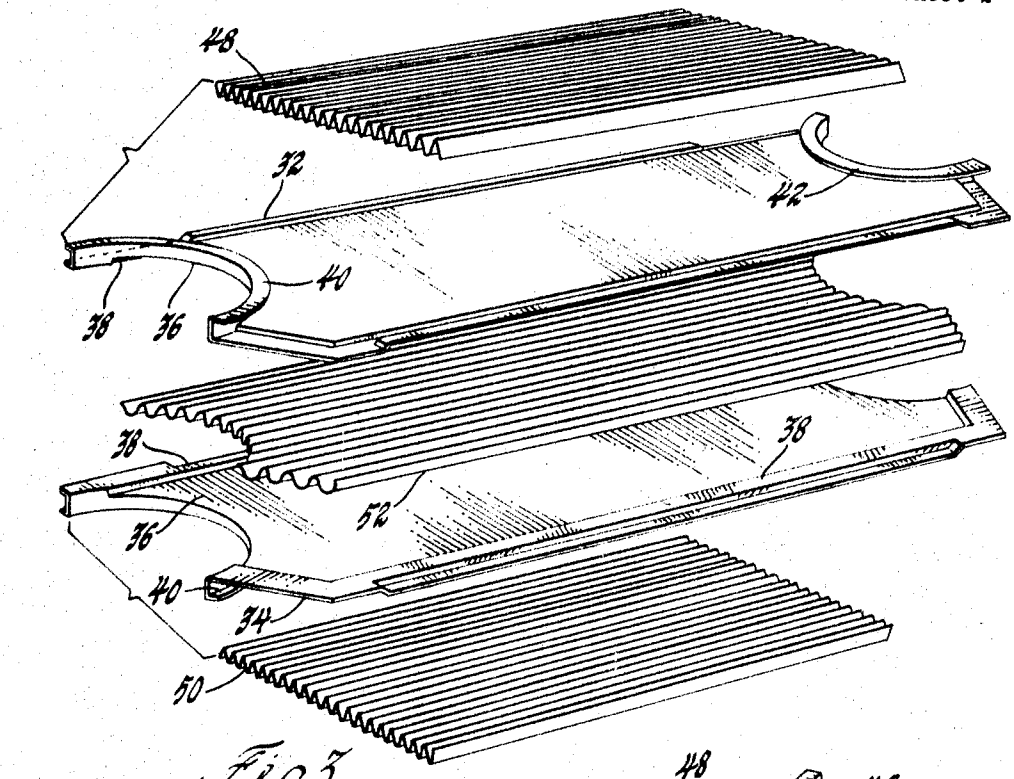


Fig. 3

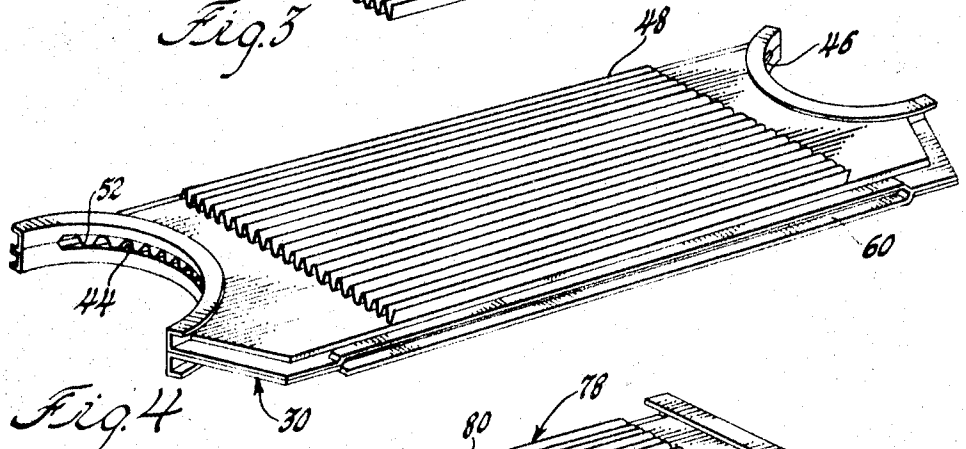


Fig. 4

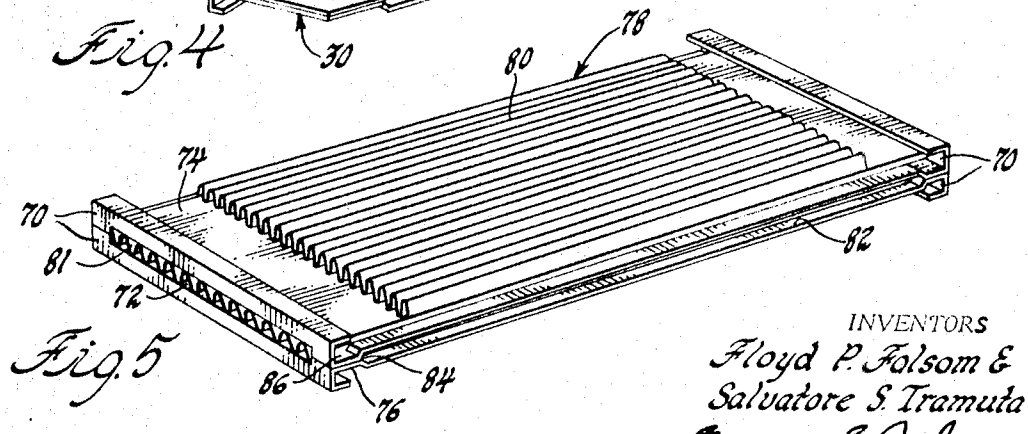


Fig. 5

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HEAT EXCHANGER OF PLATE FIN MODULES

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ABSTRACT OF THE DISCLOSURE

The heat exchanger comprises a stack of sheet metal modules, each module recessed to define channels having corrugated strip fin means in contact with the plates of said modules and on opposite sides thereof and adapted to be arranged in an assembly contained in a casing so as to form separate flow passages for heat exchange between two fluids.

It has been found advantageous to utilize a uniform thickness of sheet material throughout a stack of heat exchanger modules so that no localized adverse expansion and contraction effects are encountered during cyclic heating and cooling. Also, in the interest of lowering costs of manufacture, it is highly advantageous to make a heat exchanger of a stack of plates which are similar in structure and such as to present facing surfaces of such breadth as to contribute an adequate seal wherever desired to separate the flow paths of fluids to be passed through the heat exchanger.

To the above ends, an object of the present invention is to provide a module of two plates recessed to accommodate the flow of two fluids and so formed as to present a reliable and effective basis for sealing around the module perimeter as well as to provide structural strength.

Summary of the invention

In accordance with the present invention the heat exchanger comprises a casing having a plurality of modules made of sheet material and corrugated strip fin means, each module having a perimeter provided with opposing lands and flanges and the sheet material at least partially defining a flow passage for one fluid within the module and spaces on opposite sides of the module which are adapted to form portions of flow passages for a second fluid. The heat exchanger casing is substantially filled with the stack of individually or preformed modules of sheet material each of the modules having a channel construction around its periphery which lends to structural strength and contributes to a sealing effect of each module within itself and also with respect to adjacent modules of the stack.

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

In the drawings:

FIGURE 1 is an elevation view of a recuperator embodying the present invention and as connected to an engine block, the latter and necessary manifolding being shown in dot and dash lines;

FIGURE 2 is a perspective view of the recouperator of FIGURE 1 with a portion broken away better to show the construction and arrows depicting suitable directions of flow for two fluids;

FIGURE 3 is an exploded view in perspective of parts of a module a multiple of which is used in the recuperator of FIGURES 1 and 2;

FIGURE 4 is a perspective view of a unitized module having the components shown in FIGURE 3; and

FIGURE 5 is a perspective view of a modified version of the module of FIGURE 4.

In FIGURE 1, an engine is depicted at 10 upon the side of which is mounted a heat exchanger or recuperator 12. An air inlet manifold is shown at 13 for directing air to one end of the heat exchanger casing 14. Manifolding 16 is shown at the other end of the heat exchanger 12 for conveying heated air to the engine 10. A duct 18 is provided to admit hot or engine exhaust gas to the casing 14 and this gas, after passage through the heat exchanger, may be discharged by way of an outlet duct 20.

With this arrangement, the casing 14 has two inlets 22 and 24 at one end and two outlets 26 and 28 at the other end. It will be understood as the description proceeds that although a concurrent flow of two fluids is contemplated in the arrangement of the drawings, the heat exchanger is equally well adapted to guide countercurrent flow of the fluids.

The casing 14 is substantially filled with a stack of prefabricated modules 30 two of which are bracketed as indicated in FIGURE 2 and one of which is shown in FIGURE 4. Each module comprises two plates 32 and 34 of similar construction (although reversed in position) in that each is characterized by a recessed area 36 on one surface extending longitudinally from opposite end edges and each of these surface areas is between lands 38 extending along opposite side edges on that one surface of the plate. The two plates 36 and 34 are also similar in that they have channels 40 and 42 formed on opposing end edges and extending from a second side of the plate which is opposite the first side. Channels 40 and 42 extend normal to the plate's planer surface and away from the recessed area. Each of these channels includes an end flange offset from the corresponding plate and spaced therefrom. The channels 40 at one end of the module 30 are in registry and fixed together to define an opening 44 (FIGURE 4) leading to the interior of the module as a part of a first fluid flow passage leading through and to an opening 46 at the other end of the module.

Preferably, fluid flow centers or strip fin means 48 and 50 are joined to opposite surfaces of the module 30 in the recessed areas between the marginal lands. Additional strip fin means 52 is retained between the two plates 32 and 34 of each module.

In order to increase the integrity or strength of each module 30, opposite side or marginal edges of the plates are preferably so made as to form channels 60 each of which is U-shaped, parallel with and outside the corresponding registering marginal land of its corresponding module.

The two plates 32 and 34 and the strip fin means 48, 50 and 52 are joined together into the arrangement shown in FIGURE 4. These parts are bonded or soldered together to make an integral unit or module and before that unit is incorporated in a stack of modules it conveniently may be tested and proven to be without leaks or caused to attain that condition. After a stack of tight or sealed modules is realized, they may be bonded together to form an integral unit which, when placed in the casing 14, defines first and second fluid flow passages each of which connects inlets 24 and 22 to outlets 28 and 26 respectively of the casing 14.

FIGURES 1 to 4 inclusive depict an arrangement in which the channels 40, 42 of the modules are all in proper registry to suit the manifolding for the engine 10. It should be noted that each channel describes a smooth line or curve so no break or weld, which could negate a leakproof construction, is present. In FIGURE 5, the same advantages are obtained but in this particular embodiment the headers of a module are each in the form of a straight flange 70 aiding in partially defining an opening 72 leading to the recessed areas between the plates 74 and 76 of the module 78. Strip fin means 80 is shown on only one

side of the module 78 but, of course, one of the same may be used on the other side and strip fin means 81 is shown as being between the plates and extending the full length of the module. In this modification, an edge channel 82 is shown which stops short of each end or header as at 84 thereby defining spaces such as the space 86 which serves as an inlet or outlet to fluid flow between adjacent modules.

When individual plate modules are formed as herein disclosed, allowance is made inherent in the arrangement to allow for differential expansion between adjacent passages. After stacking it is possible and often preferred to join the headers or end flanges only of adjacent modules ultimately to serve as parts of a manifold.

We claim:

1. A parallel flow plate-fin heat exchanger comprising: a substantially rectangular casing having two distinct fluid openings in each of its opposite ends; a stack of sheet metal modules substantially filling said casing; each of said modules including two plates having their side edges and their end edges joined together respectively; each of said plates having a recessed surface area extending longitudinally on one surface of the plate and defined between raised marginal lands on said one surface which extend longitudinally on opposite side edges of said plates; each of said plates having channels formed on opposite end edges; said channels extending from a second surface of said plate in a direction normal to the plate and offset from said recessed area; each of said channels having an edge flange disposed parallel to and overlying the surface of said plate; said one surface of a plate positioned to oppose said one surface of an adjacent plate with the marginal lands of said plates being sealingly joined together to form said module; the facing recessed surface areas of said joined plates forming a longitudinally directed first fluid flow passage through the module; said channels which extend from plates of adjacent modules being in alignment to define a second fluid flow passage parallel to said first fluid flow passage and between the plates of adjacent modules and the sides of said casing, said first and second channels having corrugated strip fin means in contact with said plates on opposite sides thereof; said first fluid flow passage extending through the module from one of said openings in one end of said casing to one of said openings in an opposite end of said casing; said second fluid flow passage extending between adjacent modules parallel to said first fluid flow passage from the second opening in one end of said casing to the second opening in an opposite end of said casing.

2. A parallel flow plate-fin heat exchanger comprising: a substantially rectangular casing having two distinct openings in each of its opposite ends; a stack of sheet metal modules substantially filling said casing; each of said modules including two plates having their side edges and their end edges joined together respectively; each of said plates having a recessed surface area extending longitudinally on one surface of the plate and defined between raised marginal lands on said one surface which extend longitudinally on opposite side edges of said plates; each of said plates having channels formed on opposite end edges; said channels extending from a second surface of said plate in a direction normal to the plate and offset from said recessed area; each of said channels having an edge flange disposed parallel to and overlying the surface of said plate; said one surface of a plate positioned to oppose said one surface of an adjacent plate with the marginal lands of said plates being sealing joined together to form said module; the facing recessed surface areas of said joined plates forming a longitudinally directed first fluid flow passage through the module; said channels which extend from plates of adjacent modules being in alignment and having their end flanges joined together to define a second fluid flow passage parallel to said first fluid flow passage and between the plates of adjacent modules and the sides of said casing; said channels forming curved end faces on said modules; strip means both between modules and between plates within a module throughout said stack to transfer heat between said plates and fluids within said first and second fluid flow passages, said first and second channels having corrugated strip fin means in contact with said plates on opposite sides thereof; said first fluid flow passage extending through the module from one of said openings in one end of said casing to one of said openings in an opposite end of said casing; said second fluid flow passage extending between adjacent modules parallel to said first fluid flow passage from the second opening in one end of said casing to the second opening in an opposite end of said casing; and recessed U-shaped channels on said one surface of the plates within said marginal lands and along opposite side edges to impart rigidity to said plates.

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