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HEAT EXCHANGER

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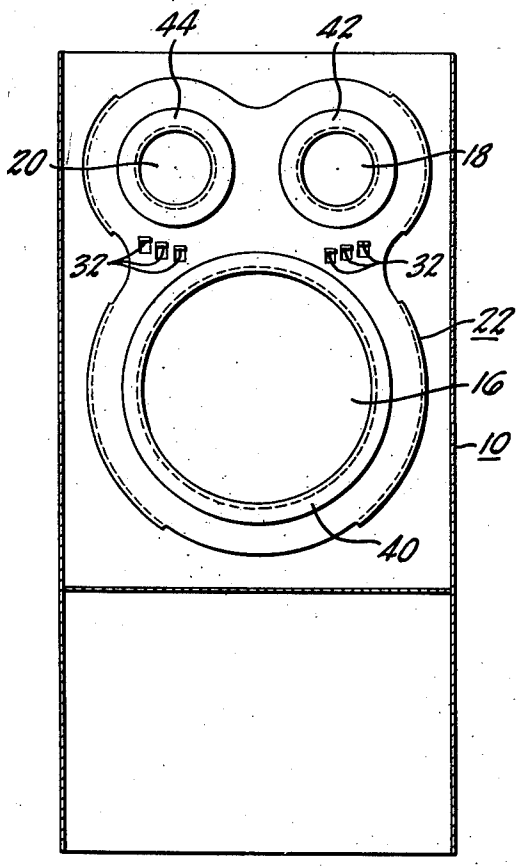


Fig. 1.

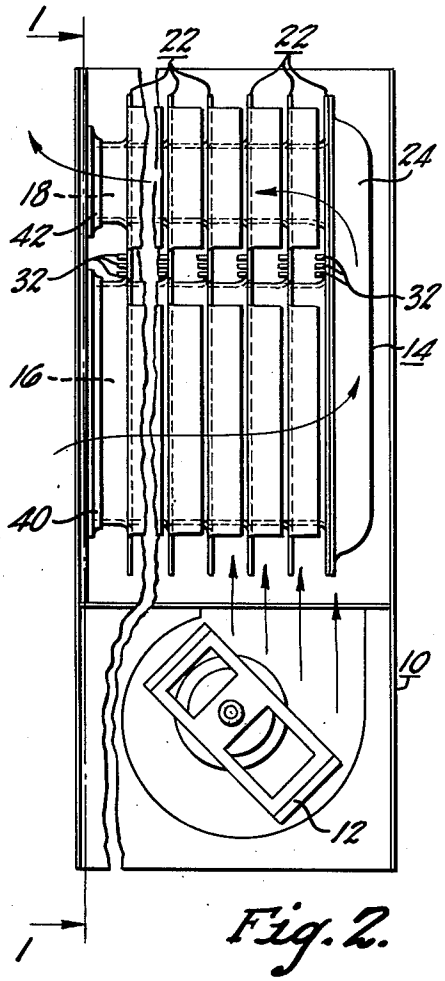


Fig. 2.

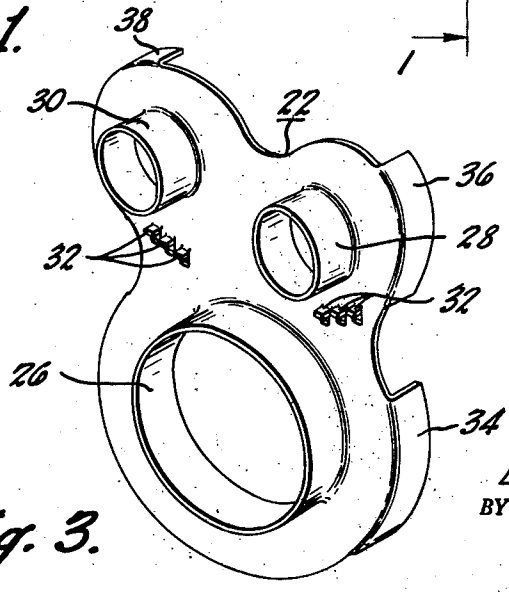


Fig. 3.

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HEAT EXCHANGER

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This invention pertains to heat exchangers, and particularly to exchangers adapted to effect an interchange of heat between two fluids.

In the interchange of heat between two gaseous fluids which are separated by a material of high thermal conductivity, several factors which affect the efficiency of heat exchange must be considered. Among these factors are: the amount of heat transfer area in intimate contact with the fluids; and the boundary layer resistance to the exchange of heat between one fluid and the material of high thermal conductivity, and the material and the other fluid. In the design of heat exchangers, as will be appreciated by those skilled in the art, some compromise as to unit size and blower capacity must be made, which necessarily reduces the efficiency of the unit. Radiator sections, which are traversed by the hot fluid, have long been used to increase the thermal efficiency of heat exchangers. However, prior radiator sections do not lend themselves readily to modern production techniques. Accordingly, among my objects are the provision of a heat exchanger composed of radiator sections of simple design; the further provision of a radiator section which may be readily assembled with other like radiator sections to form a heat exchanger of any desired capacity; and the still further provision of a heat exchanger including means for reducing the boundary layer resistance to heat interchange, and, yet, increase the effective heat transfer area.

The aforementioned and other objects are accomplished in the present invention by constructing the radiator sections from sheet metal stampings. Specifically, each radiator section comprises a sheet metal stamping having three annular projections, which constitute conduits for the flow of hot gaseous fluids. One of the conduits, the inlet, is of substantially greater size than the other two conduits, which are the outlets. Moreover, the three conduits are interconnected by a header when the heat exchanger is assembled, as will appear more fully hereinafter. Each stamping is also formed with a plurality of staggered ears that are employed to establish turbulences in the outer fluid so as to reduce the boundary layer resistance to a minimum. In addition, the stampings are formed with a plurality of arcuate wings so as to increase the effective heat transfer area of each radiator section in the heat exchanger.

In assembling a heat exchanger from the stampings, or radiator sections, the conduit projections are placed in nesting relation, after which, the joints between each radiator section are brazed with copper, or some other suitable metal or alloy. The brazing, or bonding, operation is preferably carried out in a controlled atmosphere furnace so as to prevent undesirable chemical reactions between the brazing material and the sheet metal stampings. Thereafter, the heading interconnecting the three conduits at the rear is attached, also by brazing if desired, and suitable connections are made for coupling the large conduit to the outlet of a combustion chamber, and the small conduits to a stack.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a front view, in section, of a warm air furnace embodying the heat exchanger of this invention, taken along line 1—1 of Fig. 2.

Fig. 2 is a fragmentary side view, in elevation, of the furnace shown in Fig. 1.

Fig. 3 is a view in perspective of one of the sheet metal radiator sections.

With particular reference to Fig. 1, the invention is disclosed in conjunction with a furnace having a rectangular casing 10 of sheet metal. As is shown in Fig. 2, the casing 10 houses a blower 12 by which means, air may be circulated in contiguous relation of the exterior of the heat exchanger, denoted generally by the numeral 14.

The heat exchanger 14 includes an inlet opening 16 for the admission of hot flue gases from a combustion chamber, not shown, and a pair of outlets 18 and 20 for the discharge of the flue gases into a stack, likewise not shown. The heat exchanger, per se, comprises a plurality of radiator sections 22 and a header 24, the purpose of which will be described hereinafter. Any suitable number of radiator sections 22 may be used to form a heat exchanger of the desired capacity.

With reference to Fig. 3, the detailed construction of each radiator section 22 will be described. Each radiator section 22 comprises a sheet metal stamping composed of low carbon steel. It has long been recognized by those skilled in the art, that the efficiency of heat interchange between two fluids separated by a metallic member is not materially effected by the thermal conductivity of the material separating the two fluids. That is, all metals have a rather high thermal conductivity, and while it is true that some metals, such as copper, have a thermal conductively substantially greater than steel, it has been determined that for a given shape and configuration of the metallic member, the efficiency of heat interchange between the two fluids separated by the metallic member is not substantially affected by the type of metal employed.

However, it has been determined that one of the critical factors which directly effects the interchange of heat between two fluids separated by a metallic member, is the boundary layer resistance between each of the fluids and the metallic member. With this criterion in mind, it is readily apparent that to obtain high thermal efficiency in a heat exchanger, it becomes necessary to reduce the boundary layer resistance to an absolute minimum. Morevover, it has long been recognized that one of the most effective ways to reduce boundary layer resistance to a minimum is to establish turbulence in the flow of fluids having intimate contact with the metallic member.

Another factor which directly effects the thermal efficiency of heat interchange, is the amount of effective heat transfer area of the metallic member which separates the two fluids. Thus, if the area is increased, the thermal efficiency should, likewise be increased, and this has been proven to be true. However, spacial limitations in the design of heat exchangers have often resulted in the production of units which are not efficient as they could be, primarily due to the fact that the radiator sections, which comprise the heat exchanger, are not designed to have a maximum heat transfer area.

In the present invention, each radiator section 22 is composed of a sheet metal stamping having three annular projections 26, 28 and 30, which are designed to nest with the openings in an adjacent radiator section. Thus, as is shown in Fig. 2, the rear side of each projection 26, 28

and 30 is bellmouthed so as to receive the front side of the radiator section disposed to the rear thereof. Moreover, each radiator section, or sheet metal stamping, is formed with a plurality of staggered ears 32, which, as shown, are of rectangular configuration. It is to be understood that although only six ears are shown, this is only exemplary and is not to be construed as a limitation, as any number and arrangement thereof could be employed. The purpose of the ears is to establish turbulence in the stream of air forced by the blower 12. Turbulence is established so as to reduce the boundary layer resistance to heat interchange between the outer air and the outer surface of the heat exchanger to a minimum.

Each radiator section, or sheet metal stamping, 22 is also formed with a plurality of arcuate wings or flanges, 34, 36 and 38, which are coaxial with respect to projections 26, 28, and 30, respectively. The wings 34, 36 and 38 increase the effective heat transfer area of each radiator section, and are in intimate contact with one of the fluids. The wings, or flanges, are disposed at substantially right angles to the principal plane of each radiator section as clearly shown in the drawing.

In assembling the heat exchanger 14 from the radiator sections, the radiator sections are first assembled in nested relation, which assembly is permitted by reason of the rear side of conduits 26, 28 and 30 being bellmouthed to receive the front side of the conduits in the radiator section immediately behind it. When the radiator sections are assembled, the wings, or flanges, on opposite sides of each section form substantially vertical channels for the flow of air. As seen in Figure 2, the flanges on each section extend rearwardly and terminate contiguous to the section disposed immediately to the rear thereof. Thereafter, the header 24, which merely connects the conduit formed by projection 26 and conduits formed by projections 28 and 30. Moreover, coupling members 40, 42 and 44 are assembled with the projections of the front end radiator section, so as to enable connections to be made to the combustion chamber and the stack, not shown. Thereafter, the heat exchanger sections are rigidly united by a brazing process, using copper, or some other metal or alloy, which brazing process is carried out in a controlled atmosphere furnace to prevent undesirable chemical reaction between the different metals being used.

From the foregoing, it is apparent that the present invention provides a heat exchanger which readily lends itself to modern mass production techniques. Moreover, the instant heat exchanger capitalizes on the limited space available without any sacrifice in thermal efficiency in that: a maximum heat transfer area is provided; and means are provided to reduce the boundary layer resistance to heat interchange between two fluids to a minimum.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A heat exchanger comprising, a plurality of radiator sections, each radiator section having a pair of annular outlet projections adapted to receive complementary annular outlet projections of the radiator section disposed to the rear thereof, each radiator section also having an annular inlet projection of larger diameter than said annular outlet projections adapted to receive the complementary annular inlet projection of the radiator section disposed to the rear thereof, each radiator section having a pair of vertically spaced arcuate flanges on opposite sides thereof, said arcuate flanges being located at substantially right angles to the principal plane of each section, said flanges extending rearwardly and terminating contiguous to the radiator section disposed to the rear thereof so as to define substantially vertical channels for the flow of air therethrough, said radiator sections forming a pair of outlet conduits for the passage of a fluid in one direction and a single inlet conduit for the flow of said fluid in the opposite direction, and a header interconnecting said inlet conduit and said outlet conduits so as to form a U-shaped path for the flow of said fluid through said heat exchanger.

2. The heat exchanger set forth in claim 1 wherein the annular inlet and outlet projections of each section are of constant diameter and have bellmouthed portions at the rear thereof arranged to telescopically receive the complementary annular inlet and outlet projections of the radiator section disposed to the rear thereof.

3. The heat exchanger set forth in claim 1 wherein each radiator section has a plurality of staggered ears projecting therefrom between each annular outlet projection and the annular inlet projection, said ears being located between said vertically spaced arcuate flanges.

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