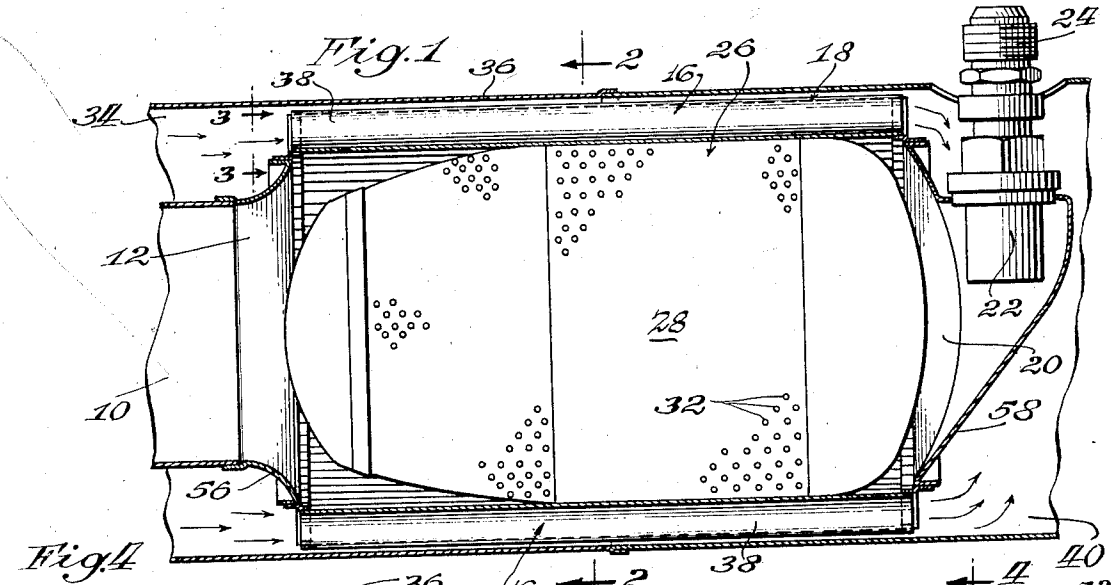
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HOLLOW FIN HEAT EXCHANGER

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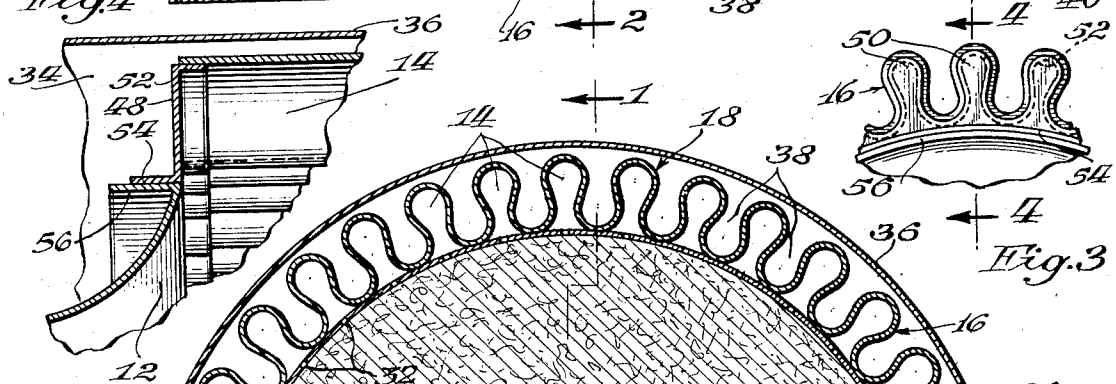







Fig. 2

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# UNITED STATES PATENT OFFICE

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## HOLLOW FIN HEAT EXCHANGER

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6 Claims. (Cl. 257—241)

My invention pertains to hollow fin heat exchangers and is more particularly concerned with, but not limited to, hollow fin heat exchangers of the kind used in heaters for aircraft and similar vehicles.

Heaters have been developed having heat exchangers provided with hollow fins. These hollow fins have straight sides which taper in cross section from a relatively broad base to a narrow tip and hot gases of combustion flow lengthwise of the interior of these hollow fins and supply heat to ventilating air which flows through passages located between these hollow fins. In such heaters, the flow of the hot gases of combustion is at a maximum through the wider part of the fin adjacent the base thereof and at a minimum through the narrow part of the fin adjacent the tip thereof, whereas the flow of ventilating air is at a maximum adjacent the tip of the fin and a minimum adjacent the base of the fin, with the result that the tips of the fins are relatively cool while the bases of the fins are extremely hot.

The unequal heating of the fins reduces the transfer of heat from the hot gases to the ventilating air and sets up stresses in the heat exchanger, with resulting distortion and fatigue of the metal. Such heaters are designed for use in aircraft and the metal of which the heat exchanger is formed is made of minimum thickness to reduce weight and increase efficiency by reducing the length of the metallic path of travel for the heat transferred from the hot gases to air. Under some conditions, the sides of the hollow fins tend to produce a drumming noise when subjected to particular periodic vibrations.

An object of my invention is to provide a new and improved hollow fin heat exchanger which avoids these disadvantages of the prior art and which is more efficient, more quiet, and free from internal stresses.

Another object of my invention is to provide a hollow fin heat exchanger in which all parts of the fins are maintained at a uniform temperature.

Another object of my invention is to provide a new and improved hollow fin heat exchanger in which the flow of the hot gases through the hollow fins is greater adjacent the tips of these fins than adjacent the bases thereof and wherein the flow of ventilating air between the hollow fins is greater adjacent the bases of the fins than adjacent the tips thereof.

Another object of my invention is to provide a lightweight heat exchanger which is more rigid and free from vibration than the heat exchangers of the prior art.

Another object of my invention is to provide a hollow fin heat exchanger in which the cross-sectional area of the hollow fins is greater adjacent their tips than adjacent their bases.

Other objects and advantages will become apparent as the description proceeds.

In the drawing:

Fig. 1 is a longitudinal, sectional view of an internal combustion heater embodying a preferred form of my invention and is taken on the irregular line 1—1 of Fig. 2;

Fig. 2 is an enlarged, transverse, cross-sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a partial end view of the heat exchanger and is taken on the line 3—3 of Fig. 1; and

Fig. 4 is a partial, sectional view of the heat exchanger taken on the line 4—4 of Fig. 3.

In Fig. 1, I have illustrated my invention as being embodied in a heater which is supplied with hot gases of combustion from a space 10 which may be either a combustion chamber especially provided for the heater or which may be the interior of a pipe communicating with the exhaust manifold of an internal combustion engine or other suitable source of supply of hot gas. The hot gases pass from the space 10 through a flaring annular inlet 12 into the passages 14 formed in the hollow fins 16 of my novel heat exchanger 18. These gases flow lengthwise of the passages 14 and give up their heat to the heat exchanger 18 and are then discharged into an outlet chamber 20 communicating with an exhaust fitting 22 illustrated as provided with threads 24 to facilitate the attachment thereto of any suitable exhaust pipe.

A muffler 26 is located in the heat exchanger 18 and has a sheet metal shell 28 which is filled with heat resisting, sound absorbing material 30, such, for example, as glass wool or stainless steel wool. The shell 28 is provided with a plurality of small openings 32 which constitute acoustic-couplings between the passages 14 and the interior of the muffler shell and permit sound vibrations contained in the hot gases to pass into the glass wool and be absorbed thereby.

Ventilating air to be heated is supplied to the heater through the inlet end 34 of a casing 36 which surrounds the heat exchanger 18 and cooperates therewith to form air passages 38 between the fins 16. The outlet end 40 of the casing 36 may communicate either directly with the interior of the aircraft cabin or other space to be heated or may discharge the heated air into a series of ventilating ducts which distribute this

air to selected locations. Flow of ventilating air through the casing 36 may be created by rams or blowers for forcing the air into the casing inlet 34 or by suction means for drawing the heated air from the casing outlet 40, or by a combination of both.

The hollow fins 16 are shown most clearly in cross-section in Fig. 2 and in this figure it will be readily apparent that these fins are of bulbous shape and are wider adjacent their tips 42 than they are adjacent their bases 44. On the other hand, the air passages 38 are wider adjacent the bases 44 than they are between the bulging tips of the fins. In the embodiment shown in the drawing, this particular arrangement of gas and air passages is accomplished by the reverse, transverse, curvature of the tips of the fins as compared with the bases of these fins and this reverse curvature produces a fin having a curved side wall which will not vibrate or produce a drumming noise even though the heat exchanger 18 is made of extremely thin and light material.

In Fig. 2, the heat exchanger 18 is illustrated as being formed of sheet metal such, for example, as stainless steel which has been rolled or pressed between dies to form the hollow fins. The plate was then bent into the form of a tube and the overlapping edges welded together, as indicated at 46, to form the completed heat exchanger. While such a construction is highly satisfactory, my invention is not limited to heat exchangers made in this particular way and any other suitable method of making the heat exchanger may be employed.

Because the cross-section of gas passages 14 is greater adjacent the tips of the fins, the hot gases flowing through these fins flow at a greater rate adjacent the tips thereof than adjacent the bases of these fins. Since the rate of heat exchange between the hot gases and fins increases with the rate of flow, more heat is transferred from the hot gases to the tips of the fins than is transferred from the hot gases to the bases of these fins. The increased cross-section of the passages 38 adjacent the bases of the fins results in increased flow of ventilating air adjacent these bases and faster removal of the heat therefrom. In a properly designed heat exchanger embodying my invention, the entire area of the heat exchanger is maintained at substantially the same temperature and a more efficient heater can be obtained by operating the entire area of the heat exchanger at the maximum permissible temperature.

Because the heat exchanger is maintained at substantially uniform temperature throughout its entire area, stresses due to unequal heating are eliminated and the resulting fatigue and distortion of the metal are also avoided. This feature and the inherent rigidity of the heat exchanger due to the absence of flat walls, make it possible to manufacture this heat exchanger of thinner and weaker material than has heretofore been utilized. Through the use of such thinner and lighter material, the weight of the heater is reduced and the efficiency is increased by reducing the metallic path of travel of the heat.

In Fig. 2, the fins 16 are illustrated as having been produced by forming a plurality of reverse curves in the plate from which the heat exchanger is made and these reverse curves are illustrated as being of the same, or substantially the same, diameter. This configuration is desirable for most purposes, but where conditions require, the tips of the fins may be formed by curves having radii shorter or longer than the radii of the curves forming the bases of these fins.

In the detailed views of Figs. 3 and 4, I have illustrated a preferred construction for closing the ends of the hollow fins. This construction includes a ring 48 located at each end of the fins and having radially projecting fingers 50 which correspond in shape to the cross-sectional shapes of the hollow fins. The fingers 50 are provided with projecting flanges 52, which extend into the hollow fins and are adapted to be attached thereto by seam welding or in any other suitable manner. The rings 48 also have annular flanges 54 which may be respectively welded or otherwise suitably attached to the flaring plate 56 providing the heater inlet 12 and the plate 58 which forms the outlet end of the heater.

My novel heat exchanger is not limited to the transmission of heat from burned gases to ventilating air, but may be utilized to transfer heat between any other fluids and is capable of general application. This heat exchanger may be made of any material which is suitable for the use to which the heat exchanger is to be put and the heat exchanger may be fabricated by any suitable method. My invention is not to be construed as limited to the details shown and described, but is to be construed as including all variations and modifications falling within the scope of the appended claims.

I claim:

1. A heat exchanger of the class described, comprising a tubular member of uniform cross section throughout its length and having a plurality of hollow fins constructed and arranged to form unobstructed, external passages therebetween said fins being of bulbous cross-section with tip portions wider than the base portions of the fins, said passages being wider adjacent the bases of the fins than adjacent the tips of the fins, means for directing hot gases through and lengthwise of said hollow fins, and means for directing air lengthwise of said passages.

2. A heat exchanger of the class described, comprising a tubular structure having longitudinally extending hollow fins projecting radially outward therefrom, said fins forming external passages therebetween and being so constructed and arranged that said passages are broader adjacent the bases of said fins than adjacent the tips of said fins, means for directing hot gases lengthwise of said hollow fins, and means for directing ventilating air lengthwise of said external passages.

3. A heat exchanger, comprising a tubular structure having longitudinally extending hollow fins projecting outwardly therefrom, said fins having interiors in open communication throughout their length with the interior of said tubular structure, said fins being wider in cross section adjacent their tips than adjacent their bases, causing the gas flowing on the inside of the fins to have greater velocity adjacent the tips, and said fins forming between them passages which are narrower adjacent the tips of said fins than adjacent their bases, causing the gas flowing on the outside of the fins to have a greater velocity adjacent the bases of the fins than adjacent their tips, means for directing hot gases into said tubular structure and lengthwise of said hollow fins, and means for directing a relatively cool gas lengthwise of said passages.

4. A heat exchanger, comprising a tubular structure having longitudinally extending thin

single-layer hollow fins projecting outwardly therefrom, said fins having interiors communicating throughout their length with the interior of said tubular structure, said fins being wider in cross section adjacent their tips than adjacent their bases, causing the gas flowing in the inside of the fins to have greater velocity adjacent the tips, and said fins forming between them longitudinally unobstructed passages which are narrower adjacent the tips of said fins than adjacent their bases, causing the gas flowing on the outside of the fins to have a greater velocity adjacent the bases, means for directing hot products of combustion into said tubular structure and lengthwise of said hollow fins, and means for directing air lengthwise of said passages.

5. A light weight heat exchanger of high efficiency and adapted for operation at maximum heat output, said heat exchanger comprising a tubular structure formed of a single layer of thin sheet metal having longitudinally extending hollow fins projecting outwardly therefrom, said fins having interiors in open communication with the interior of said tubular structure throughout the length of said fins, said fins forming external passages therebetween which are open to axial flow throughout the length of the heat exchanger, said fins and passages being of substantially uniform cross section throughout the length of the heat exchanger, said fins being wider at points adjacent their tips than at points adjacent their bases whereby fluid flowing inside the hollow fins has a greater velocity adjacent said tips, means for directing a hot fluid into said tubular structure and lengthwise of said hollow fins, and means for directing a relatively cold fluid lengthwise of said external passages.

6. A heat exchanger of the class described, comprising a tubular member having a plurality of hollow fins extending lengthwise of said member, said fins having rounded tips and bases and reversely rounded sides, said fins being wider adjacent their tips than adjacent their bases, means for directing hot gases through said fins and lengthwise thereof, said fins being spaced to provide gas passages therebetween, and means for directing fluid lengthwise of said passages.

SEYMOUR E. HEYMANN.