

Sept. 24, 1968

G. J. FAIRBANKS

3,402,764

HEAT EXCHANGER

Filed Jan. 20, 1966

3 Sheets-Sheet 1

FIG. 3.

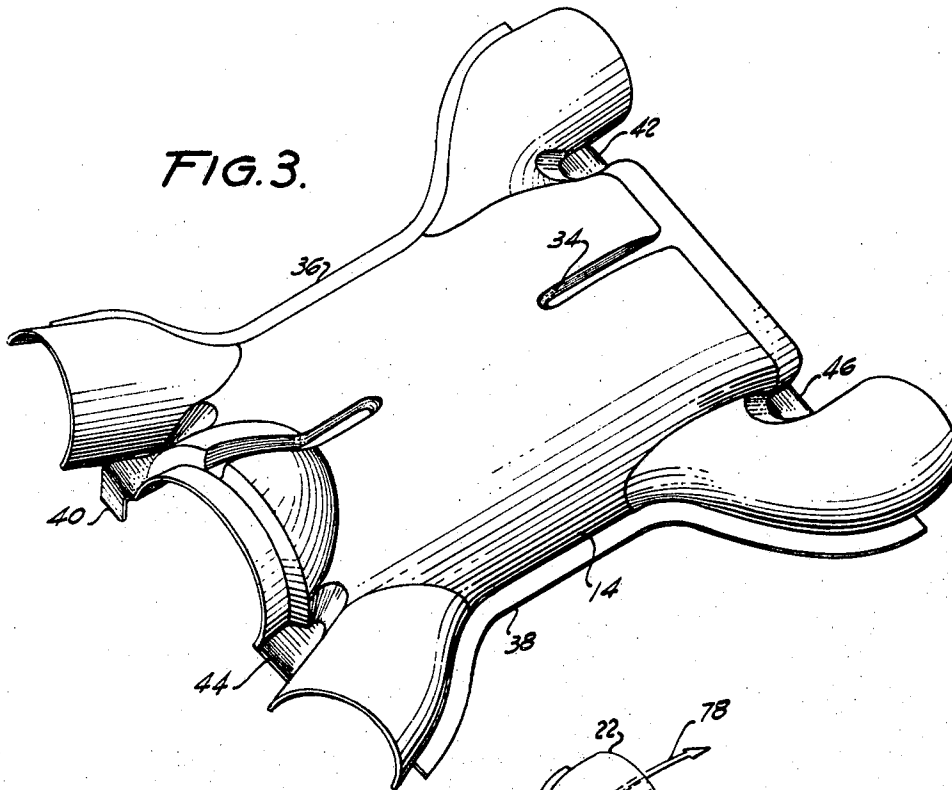
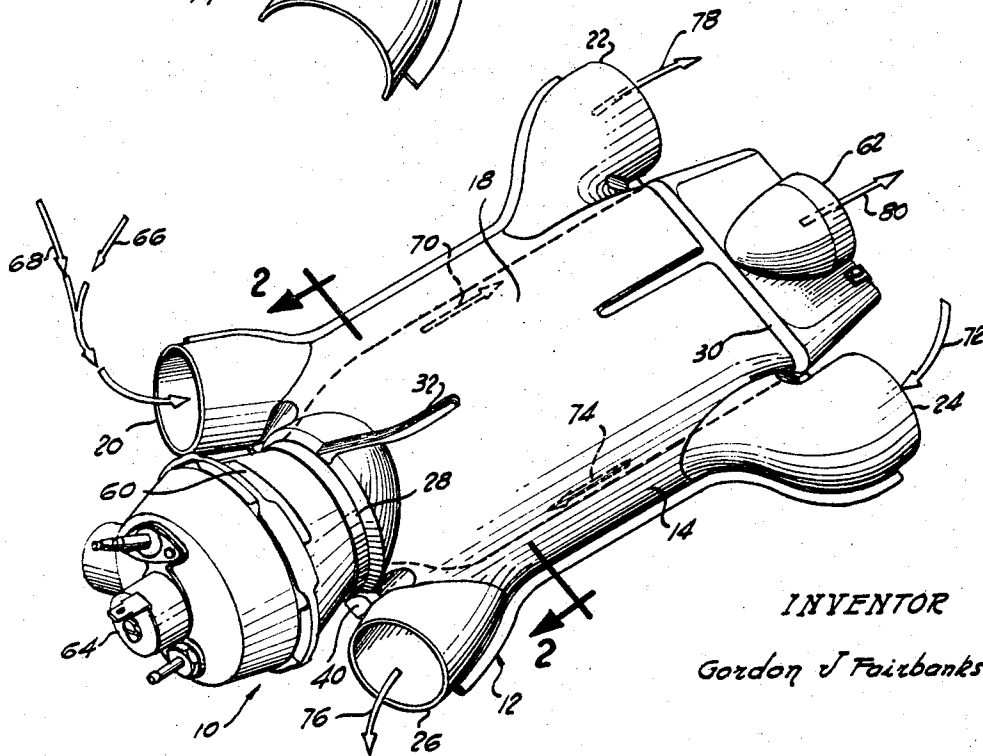


FIG. 1.

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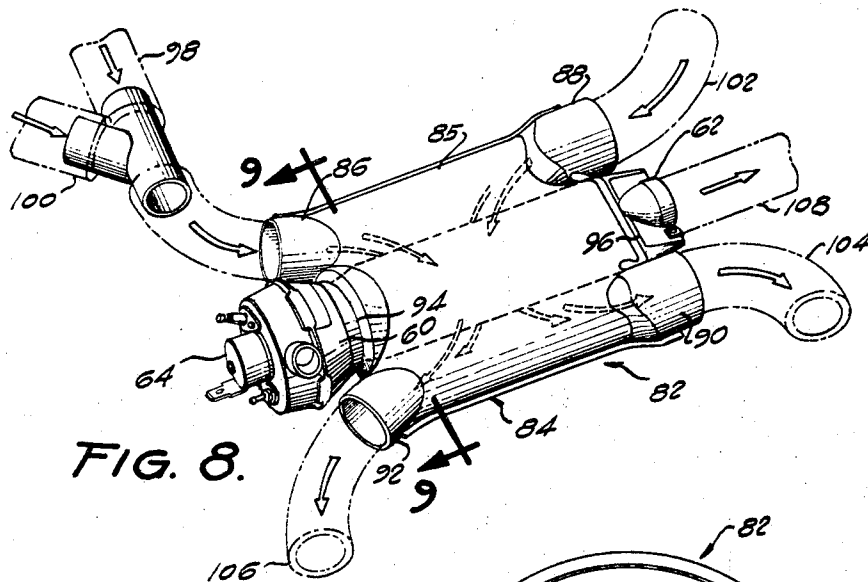


FIG. 8.

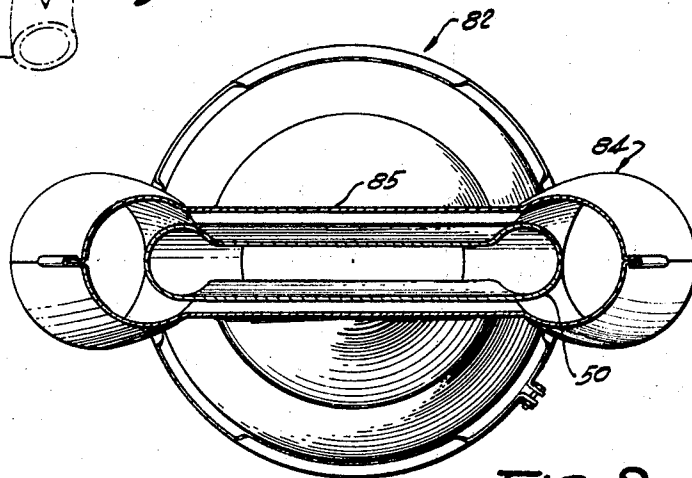


FIG. 9.

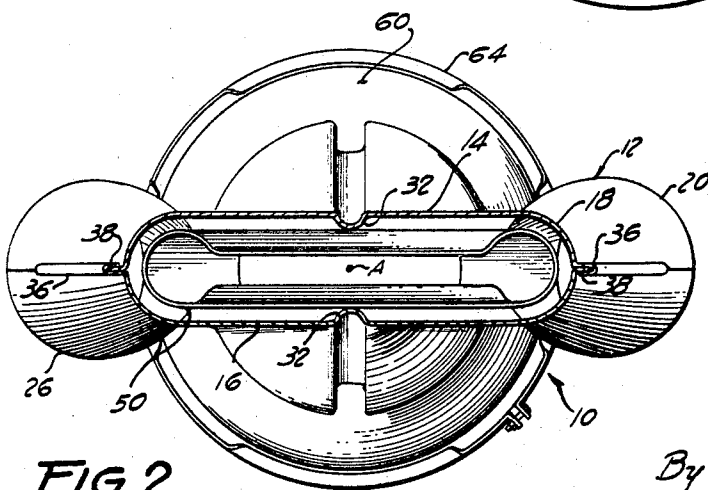


FIG. 2.

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3 Sheets-Sheet 3

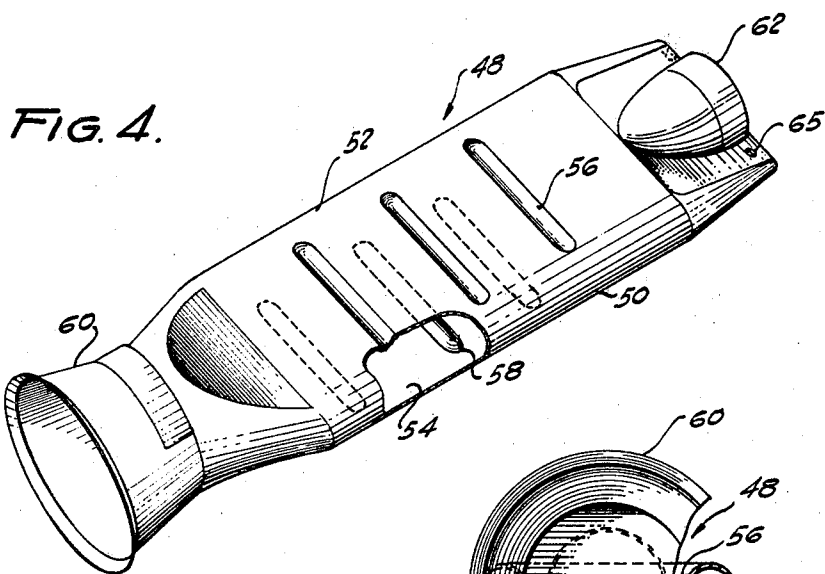


FIG. 6.

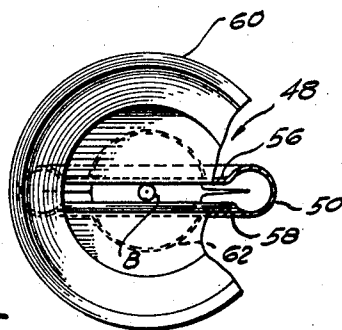
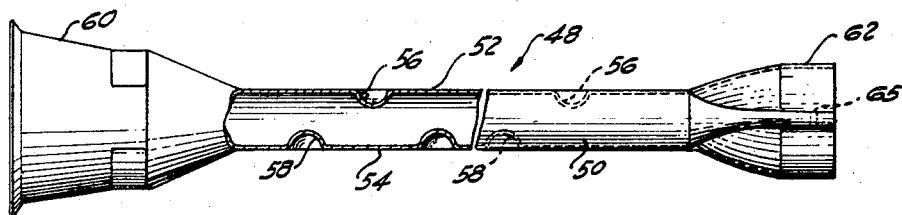


FIG. 5.

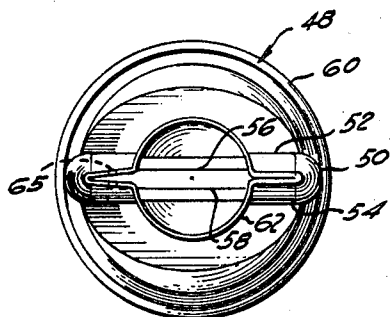


FIG. 7.

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3,402,764

HEAT EXCHANGER

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Stewart-Warner Corporation, a corporation of Virginia
Filed Jan. 20, 1966, Ser. No. 521,961
16 Claims. (Cl. 165—51)

ABSTRACT OF THE DISCLOSURE

A heat exchanger including a heat transfer tube secured in a housing formed with extensions that define a pair of inlet passageways and a pair of outlet passageways one each adjacent the opposed end corners of the housing whereby to accommodate two fluid flow paths through the housing about the heat transfer tube.

My present invention relates generally to heat exchangers and more particularly to booster heat exchangers adapted to be incorporated in the heating and defrosting systems of automatic vehicles. The heat exchangers of my present invention are modified embodiments of the heat exchanger disclosed in my copending application, Ser. 521,960, filed Jan. 20, 1966, and may be used in a vehicle heating system of the type disclosed in U.S. Patent No. 3,325,100, issued June 13, 1967 to Gordon J. Fairbanks and Vernon N. Tramontini.

It is an object of my present invention to provide an improved heat exchanger which may be used for example as part of a booster heater incorporated in a vehicle heating system, and which is more compact and less expensive than prior conventional booster heat exchangers.

It is another object of my present invention to provide a heat exchanger which is fabricated of only three parts, a housing formed of two sections and a core formed of a single heat transfer tube, whereby parts and assembly costs are minimized.

It is another object of my present invention to provide a heat exchanger, as described, wherein the two sections of the housing are identical thereby simplifying manufacture, inventory and assembly.

It is a further object of my present invention to provide a heat exchanger, as described, wherein the outer cross sectional perimeter of the single heat transfer tube is correlated to the inner cross sectional area thereof to afford a predetermined desired effective heat transfer coefficient.

It is a further object of my present invention to provide an embodiment of booster heat exchanger which accommodates two effectively divided air flow paths therethrough in opposite longitudinal directions.

It is a still further object of my present invention to provide a booster heat exchanger wherein the elements are so arranged that it may be readily incorporated in a standard vehicle heating system, such as used in the Volkswagen vehicle, without extensive alteration of the system.

Now in order to acquaint those skilled in the art with the manner of constructing and using heat exchangers in accordance with the principles of my present invention, I shall describe in connection with the accompanying drawings preferred embodiments of my invention.

In the drawings:

FIGURE 1 is a perspective view of one embodiment of burner and heat exchange assembly incorporating the principles of my present invention;

FIGURE 2 is a sectional view, taken substantially along the line 2—2 in FIGURE 1, looking in the direction indicated by the arrows;

FIGURE 3 is a perspective view of one section of the housing of the assembly of FIGURE 1;

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FIGURE 4 is a perspective view of a heat transfer tube incorporating the principles of my present invention;

FIGURE 5 is a foreshortened side elevational view of the heat transfer tube of FIGURE 4, with a portion being broken away and shown in section;

FIGURE 6 is an elevational view of the left-hand end of the heat transfer tube of FIGURE 5;

FIGURE 7 is an elevational view of the right-hand end of the heat transfer tube of FIGURE 5;

FIGURE 8 is a perspective view of another embodiment of burner and heat exchange assembly incorporating the principles of my present invention; and

FIGURE 9 is a sectional view, taken substantially along the line 9—9 in FIGURE 8, looking in the direction indicated by the arrows.

Referring now to FIGURES 1 and 2, there is indicated generally by the reference numeral 10 one embodiment of burner and heat exchange assembly incorporating the principles of my present invention. The assembly 10 includes a hollow housing or casing 12 comprised of two sections 14 and 16, one of which is shown alone in FIGURE 3. The housing 12 has an elongated body portion 18 of generally oblong or flattened cross section. Viewing FIGURE 2, the dot A indicates the longitudinal axis of the body portion, an imaginary horizontal line passing through the longitudinal axis corresponds to the major cross sectional axis, and an imaginary vertical line passing through the longitudinal axis corresponds to the minor cross sectional axis.

The housing 12 is formed with outwardly projecting extensions 20, 22, 24 and 26 one each adjacent the opposed end corners of the body portion 18. The extensions 20 and 22 are on one side of a plane passing through the longitudinal and minor cross sectional axes of the body portion, while the extensions 24 and 26 are on the other side of the plane. The extensions 20 and 24 respectively define first and second inlet passageways, and the extensions 22 and 26 respectively define first and second outlet passageways, all of which passageways are open to the interior of the body portion 18.

The housing 12 is also formed with an enlarged collar extension 28 at one end of the body portion 18 centrally thereof, and with a transverse flanged mouth portion 30 at the other end of the body portion. In addition, longitudinal inwardly directed ribs 32 and 34, which lie in the plane passing through the longitudinal and minor cross sectional axes of the body portion, are formed in both sections of the housing 12. Still further, each of the housing sections 14 and 16 have opposed side flanges 36 and 38. In assembly, the side flange 36 of each housing section is bent over the side flange 38 of the other housing section. Also, each housing section has tabs 40 and 42 and flats 44 and 46. In assembly, the tabs 40 and 42 of each housing section are bent over the flats 44 and 46 of the other housing section. Finally, the two sections are secured together, as by welding, along their adjoining margins.

The two housing sections 14 and 16, in general each define part of the body portion 18, part of the extensions 20, 22, 24 and 26, part of the collar extension 28, and part of the mouth portion 30. More specifically, the configuration of each housing section on one side of the plane passing through the longitudinal and minor cross sectional axes of the body section is complementary to the configuration of the same section on the other side of this plane. By reason of this arrangement, the two sections of the housing are identical and may be formed in the same set of dies. Thus, manufacture, inventory and assembly of the housing are simplified, with resultant cost savings.

Referring now to FIGURES 4—7, I shall describe the heat transfer core or tube 48 of my present invention which is mounted within the housing 12. The tube 48,

through which hot combustion gases are directed, has an elongated body portion 50 of generally oblong or flattened cross section with substantially parallel opposed faces 52 and 54. The outer cross sectional perimeter of the body portion 50 is correlated to the inner cross sectional area, whereby to establish the proper flow velocity through the tube in relation to the surface area, to afford the desired effective heat transfer coefficient. Viewing FIGURE 6, the dot B indicates the longitudinal axis of the body portion 50, an imaginary horizontal line passing through the longitudinal axis corresponds to the major cross sectional axis, and an imaginary vertical line passing through the longitudinal axis corresponds to the minor cross sectional axis. A tube wherein the dimension of the body portion 50 in the direction of the major cross sectional axis is approximately eight times the dimension in the direction of the minor cross sectional axis has proved satisfactory from a heat transfer standpoint. To create turbulence in the gasses flowing through the tube 48 for optimum heat transfer, sets of transverse inwardly directed ribs 56 and 58 are provided in the opposed faces 52 and 54 in staggered relation.

An outwardly flared collar extension 60 is formed at one end of the body portion 50, and an exhaust coupling extension 62 is formed at the other end thereof. The heat transfer tube 48 is adapted to be formed in a single piece and preferably from a cylindrical tube blank. In assembly of the housing 12 and tube 48 (FIGURE 1), the tube collar 60 is secured in the housing collar 28, and the tube body portion 50 adjacent the exhaust coupling 62 is secured in the transverse housing mouth 30. In assembled relation, the housing ribs 32 and 34 (FIGURES 1 and 2) engage the core 48 for normally effectively dividing the housing longitudinally. Since the booster heat exchanger is fabricated of only three parts, a housing formed of two sections and a core formed of a single heat transfer tube, parts and assembly costs are minimized. Moreover, the use of a single heat transfer tube 48 minimizes the overall size of the heat exchanger. Mounted within the tube collar 60 is a conventional burner unit 64 which includes a fuel spray nozzle and spark ignition elements. Since the burner unit 64 forms no part of my present invention, details of the fuel spray nozzle, the spark ignition elements, the fuel supply system, the combustion air supply system, the electrical system and the control circuit are not shown. An exhaust pipe (not shown) is secured in the exhaust coupling 62 by a bolt fastened through apertures 65 in the side of the coupling.

The above-described burner and heat exchange assembly 10 is especially adapted to be incorporated directly in a standard vehicle heating system of the type used, for example in the Volkswagen vehicle, wherein heated air is transmitted in independent paths to two separate outlets in the passenger compartment. In this standard system, air is normally heated in two exhaust gas heat exchangers connected to opposed halves of the engine. Referring again to FIGURE 1, when incorporating the assembly 10 in the standard system described, the inlet extension 20 is connected to one of the exhaust gas heat exchangers, the inlet extension 24 is connected to the other exhaust gas heater exchanger, and the outlet extensions 22 and 26 are independently connected to the two outlets in the passenger compartment. The noted connections are effected with conventional conduits or ducts. When the assembly 10 is incorporated in the system disclosed in the aforesaid copending application of Gordon J. Fairbanks and Vernon N. Tramontini, one of the inlet extensions, preferably extension 20, is also connected to an auxiliary ventilating air blower.

Air flowing from the one exhaust gas heat exchanger, as represented by the arrow 66, and supplemental air flowing from the auxiliary blower, as represented by the arrow 68, is directed through the housing 12 about the core 48 in the longitudinal direction indicated by arrow

70, while air flowing from the other exhaust gas heat exchanger, as represented by the arrow 72, is directed through the housing 12 about the core 48 in the opposite longitudinal direction indicated by the arrow 74. The burner 64 is adapted to selectively supply hot products of combustion to the interior of the core 48 from which heat is exchanged to the air flowing through the housing 12. The heated air leaving the booster assembly 10, as represented by the arrows 76 and 78, is directed to the two outlets in the passenger compartment, while the cooled products of combustion, as represented by the arrow 80, pass from the heat transfer core 48 through the exhaust fitting 62. The burner 64, the auxiliary ventilating air blower, and the air flow from the exhaust gas heat exchangers to the booster heater assembly 10, may be automatically controlled in the manner disclosed in the afore-mentioned copending application of Gordon J. Fairbanks and Vernon N. Tramontini.

During operation of the booster heater, the housing ribs 32 and 34 effectively divide the two oppositely directed air flow paths. Thus, longitudinal or axial flow through the booster heat exchanger is maintained for providing balanced heat at the passenger compartment outlets. Although each pair of housing ribs 32 and 34 are separated for a short distance, in normal operation there is insignificant intermixing of the two paths of air at such locations because substantially no pressure differential exists between them. However, the separations of each pair of ribs 32 and 34 permit auxiliary air introduced only at the inlet extension 20 to pass to both outlet extensions 22 and 26 for transmission to the two passenger compartment outlets, for example, when the vehicle engine is not operating.

Referring now to FIGURES 8 and 9, there is indicated generally by the reference numeral 82 another embodiment of burner and heat exchange assembly which incorporates the principles of my present invention, and which is adapted to be united in a vehicle heating system of the type used in the Volkswagen vehicle. The assembly 82, which is in general similar to the assembly 10, includes a hollow housing or casing 84 comprised of two sections that define an elongated body portion 85 of generally oblong cross section with slightly enlarged longitudinal sides, and a single heat transfer tube identical to the tube 48. The housing 84 is formed with first and second inlet extensions 86 and 88, first and second outlet extensions 90 and 92, an enlarged collar extension 94 in which is secured the collar extension 60 of the heat transfer tube, and a transverse flanged mouth portion 96 in which is secured the tube body portion 50 adjacent the exhaust coupling 62. As in the assembly 10, the two sections of the housing 84 are identical and each have a configuration on one side of the plane passing through the longitudinal and minor cross sectional axes of the body section 85 that is complementary to the configuration of the same section on the other side of this plane. Also, a burner unit 64 is mounted in the tube collar 60. In contrast to the assembly 10, the inlet extensions 86 and 88 are on the same side of the assembly 82, while the outlet extensions 90 and 92 are on the opposite side. In addition, no longitudinal ribs are provided in the housing 84. Consequently, the two air flow paths cross within the housing 84 with resultant intermixing thereof. When assembled in a vehicle heating system, the inlet extension 86 is connected through duct means 98 with one exhaust heat gas exchanger and through intersecting duct means 100 with an auxiliary blower, the inlet extension 88 is connected through duct means 102 with the other exhaust gas heat exchanger, the outlet extensions 90 and 92 are connected through duct means 104 and 106 with the passenger compartment outlets, and the exhaust coupling 62 communicates with an exhaust pipe 108. The general air flow pattern through the housing 84 is indicated by the several arrows.

The two embodiments of heat exchangers of my present

invention may be used, as illustrated, as part of a booster heater incorporated in a vehicle heating system. As a consequence of the essentially flat, three-part construction, these heat exchangers are more compact and less expensive than prior heat exchangers. Moreover, in each embodiment of heat exchanger, the planes of the outer ends of two of the extensions at one end of the housing, namely the extensions 20 and 26 in assembly 10 and the extensions 86 and 92 in assembly 82, are oblique to the plane passing through the longitudinal and minor cross sectional axes of the body portion of the housing, while the planes of the outer ends of the other two extensions at the other end of the housing, namely the extensions 22 and 24 in assembly 10 and the extensions 88 and 90 in assembly 82, are normal to the designated plane. These configurations permit the heat exchangers to be readily incorporated in a standard vehicle heating system, such as used in the Volkswagen vehicle, without extensive alteration of the system, and in a manner accommodating a compact and efficient arrangement of associated air-conveying ducts. Finally, the housing sections and heat transfer tube may be inexpensively fabricated from cold rolled carbon steel, low grade stainless steel or the like.

While I have shown and described what I believe to be preferred embodiments of my present invention, it will be understood by those skilled in the art that various rearrangements and modifications may be made therein without departing from the spirit and scope of my invention.

I claim:

1. A heat exchanger comprising a housing having an elongated body portion with an outer wall, a single elongated heat transfer tube with an outer wall secured in said housing, said housing being formed with extensions that define a pair of inlet passageways and a pair of outlet passageways one each adjacent the opposed end corners of said body portion of said housing, and a fluid flow area being defined essentially by and intermediate of said outer walls of said housing and said heat transfer tube whereby to accommodate two fluid flow paths through said housing and across the surface of said heat transfer tube between said inlet and outlet passageways.

2. The heat exchanger of claim 1 wherein the outer cross sectional perimeter of said heat transfer tube is correlated to the inner cross sectional area thereof to afford a predetermined desired effective heat transfer coefficient.

3. The heat exchanger of claim 1 wherein said heat transfer tube has an elongated body portion of generally oblong cross section.

4. The heat exchanger of claim 3 wherein the planes of the outer ends of two of said extensions at one end of said body portion are oblique to a plane passing through the longitudinal and minor cross sectional axes of said body portion of said housing, and wherein the planes of the outer ends of the other two of said extensions at the other end of said body portion are normal to said plane passing through the longitudinal and minor cross sectional axes of said body portion of said housing.

5. The heat exchanger of claim 3 wherein said housing is fabricated of two sections each defining part of said body portion of said housing and part of each of said extensions.

6. The heat exchanger of claim 3 wherein said housing is fabricated of two sections secured together along their adjoining margins with the configuration of each section on one side of a plane passing through the longitudinal and minor cross sectional axes of said body portion of said housing being complementary to the configuration of the same section on the other side of said plane.

7. In a heat exchanger: a housing comprising an elongated body portion of generally oblong cross section, an extension defining a first inlet passageway adjacent one end of said body portion on one side of a plane

passing through the longitudinal and minor cross sectional axes of said body portion, an extension defining a first outlet passageway adjacent the other end of said body portion on said one side of said plane, an extension defining a second inlet passageway adjacent said other end of said body portion on the other side of said plane, and an extension defining a second outlet passageway adjacent said one end of said body portion on said other side of said plane; a single heat transfer tube secured in said housing and having an elongated body portion of generally oblong cross section spaced from the body portion of said housing; the area intermediate said heat transfer tube and said body portion of said housing on said one side of said plane between said first inlet and first outlet passageways being unobstructed thereby accommodating a fluid flow path in one longitudinal direction through said housing about the body portion of heat transfer tube; and the area intermediate said heat transfer tube and said body portion of said housing on said other side of said plane between said second inlet and second outlet passageways being unobstructed thereby accommodating a fluid flow path in the opposite longitudinal direction through said housing about the body portion of said heat transfer tube.

8. The heat exchanger of claim 7 wherein said housing has an enlarged collar extension at said one end of said housing body portion centrally thereof and a transverse flanged mouth portion at said other end of said housing body portion, and wherein said heat transfer tube has an outwardly flared collar extension at one end thereof secured in said collar extension of said housing and an exhaust coupling at the other end thereof with said tube body portion adjacent said exhaust coupling being secured in said flanged mouth of said housing.

9. The heat exchanger of claim 8 wherein said housing is formed with longitudinal inwardly directed ribs which lie in said plane and which engage said heat transfer tube for effectively dividing said two fluid flow paths.

10. The heat exchanger of claim 9 wherein said housing is fabricated of two sections secured together along their adjoining margins with the configuration of each section on one side of said plane being complementary to the configuration of the same section on the other side of said plane.

11. For use in a heat exchanger, a housing having an elongated body portion of generally oblong cross section, said housing being formed with extensions that define a pair of inlet passageways and a pair of outlet passageways one each adjacent the opposed end corners of said body portion of said housing, the planes of the outer ends of two of said extensions at one end of said body portion being oblique to a plane passing through the longitudinal and minor cross sectional axes of said body portion, the planes of the outer ends of the other two of said extensions at the other end of said body portion being normal to said plane passing through the longitudinal and minor cross sectional axes of said body portion, and said housing being fabricated of two sections secured together along their adjoining margins with the configuration of each section on one side of said plane passing through the longitudinal and minor cross sectional axes of said body portion of said housing being complementary to the configuration of the same section on the other side of said plane.

12. For use in a heat exchanger, a housing comprising an elongated body portion of generally oblong cross section and consisting essentially of an outer wall, an extension defining a first inlet passageway adjacent one end of said body portion on one side of a plane passing through the longitudinal and minor cross sectional axes of said body portion, an extension defining a first outlet passageway adjacent the other end of said body portion on said one side of said plane, an extension defining a second inlet passageway adjacent said other end of said body portion on the other side of said plane, an extension

defining a second outlet passageway adjacent said one end of said body portion on said other side of said plane, means defining a first fluid flow path from said first inlet passageway to said first outlet passageway, and separate means defining a second fluid flow path from said second inlet passageway to said second outlet passageway.

13. For use in a heat exchanger, a housing comprising an elongated body portion of generally oblong cross section, an extension defining a first inlet passageway adjacent one end of said body portion on one side of a plane passing through the longitudinal and minor cross sectional axes of said body portion, an extension defining a first outlet passageway adjacent the other end of said body portion on said one side of said plane, an extension defining a second inlet passageway adjacent said other end of said body portion on the other side of said plane, an extension defining a second outlet passageway adjacent said one end of said body portion on said other side of said plane, said housing including an enlarged collar extension at said one end of said body portion centrally thereof and a transverse flanged mouth portion at said other end of said body portion, and said housing having formed therein longitudinal inwardly directed ribs which lie in said plane.

14. The housing of claim 13 wherein the same is fabricated of two sections secured together along their adjoining margins with the configuration of each section on one side of said plane being complementary to the configuration of the same section on the other side of said plane.

15. A heat exchanger comprising a housing, a single heat transfer tube having an elongated body portion of generally oblong cross section secured in said housing with the outer cross sectional perimeter of said heat transfer tube being correlated to the inner cross sectional area thereof to afford a predetermined desired effective

heat transfer coefficient, said housing being formed with extensions that define a pair of inlet passageways and a pair of outlet passageways one each adjacent the opposed end corners of said body portion of said housing whereby to accommodate two fluid flow paths through said housing about said heat transfer tube, and said housing being formed with longitudinal inwardly directed rib means that engage said heat transfer tube for effectively dividing said two fluid flow paths.

16. For use in a heat exchanger, a housing comprising an elongated body portion of generally oblong cross section and consisting essentially of an outer wall, an extension defining a first inlet passageway adjacent one end of said body portion on one side of a plane passing through the longitudinal and minor cross sectional axes of said body portion, an extension defining a first outlet passageway adjacent the other end of said body portion on said one side of said plane, an extension defining a second inlet passageway adjacent said other end of said body portion on the other side of said plane, an extension defining a second outlet passageway adjacent said one end of said body portion on said other side of said plane, an enlarged collar extension at said one end of said body portion centrally thereof and a transverse flanged mouth portion at said other end of said body portion.

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