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C. E. IMPEY ET AL

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COMBINATION RADIANT AND CONVECTION HEATING SYSTEM

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2 Sheets-Sheet 1

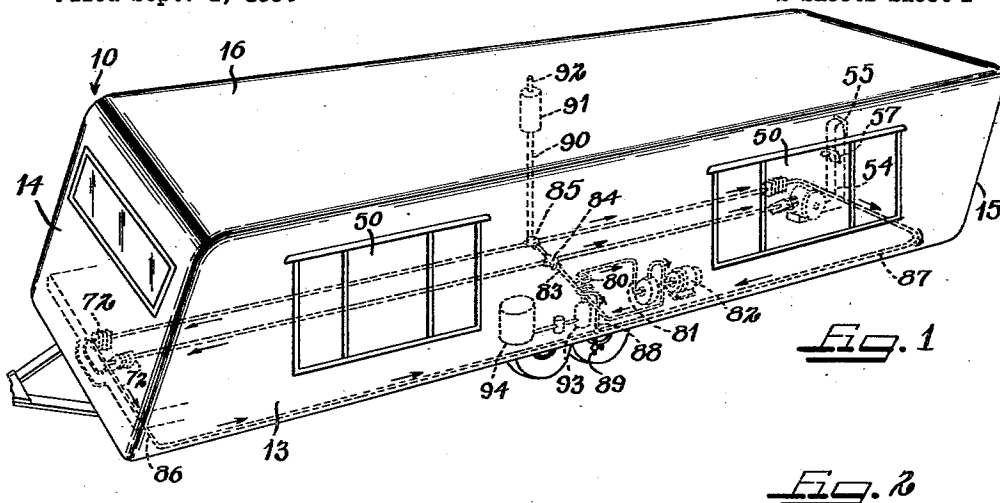


Fig. 2

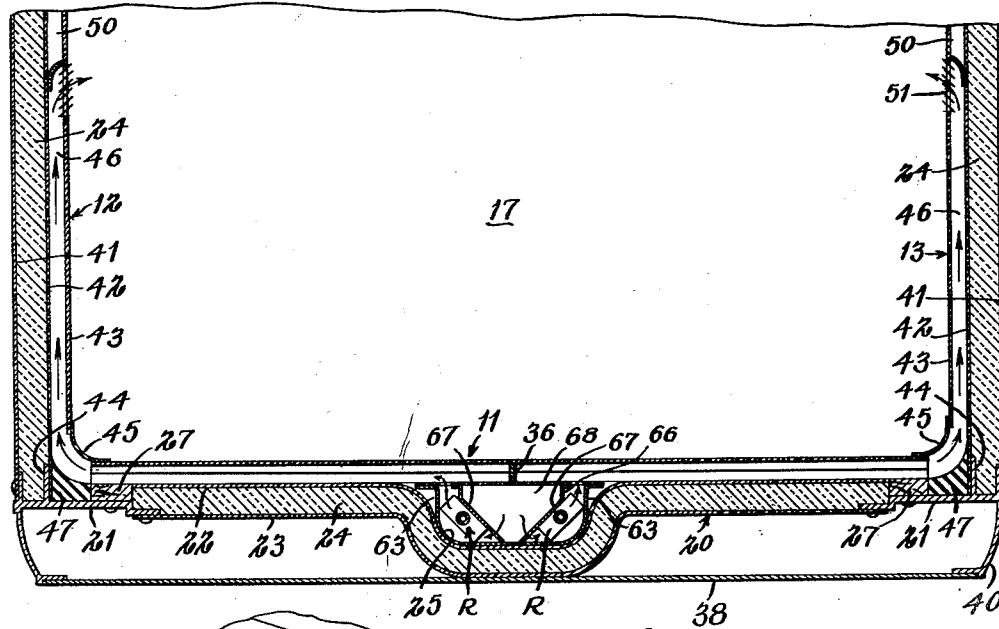
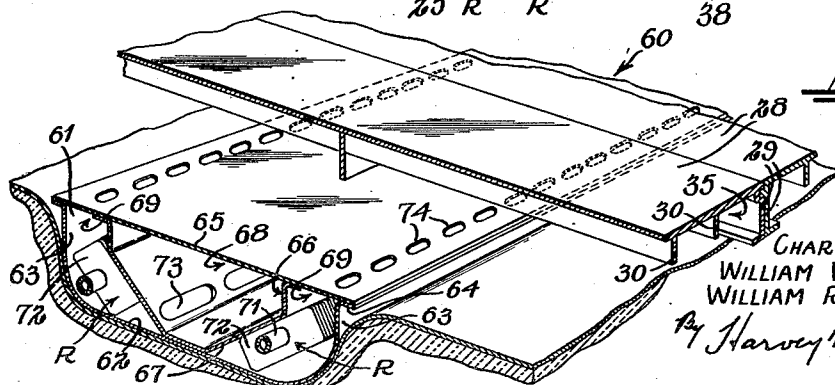


Fig. 3



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Fig. 4

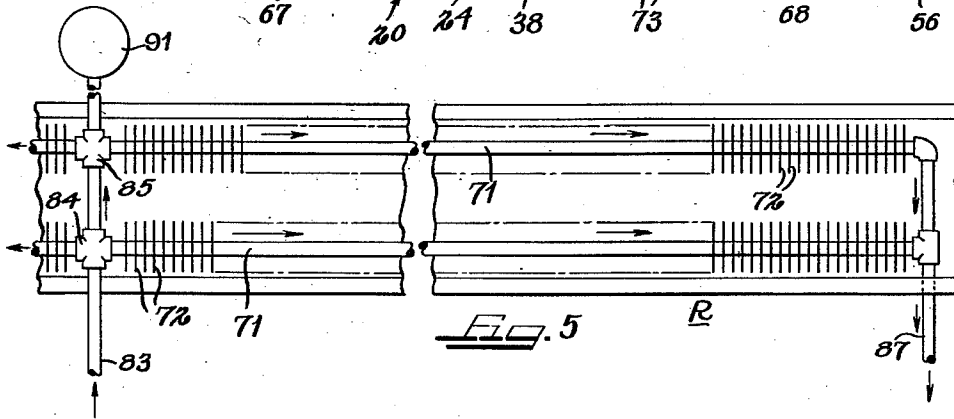
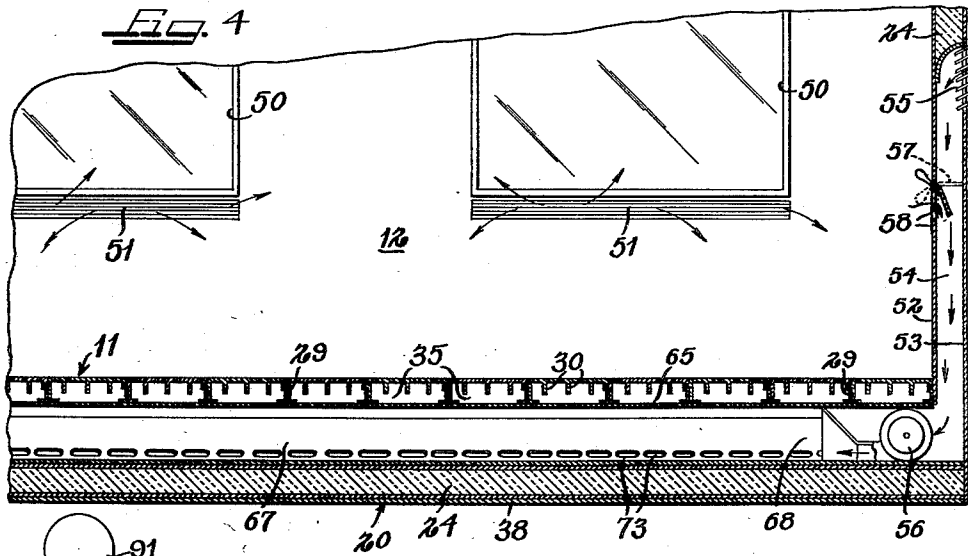


Fig. 5

Fig. 6

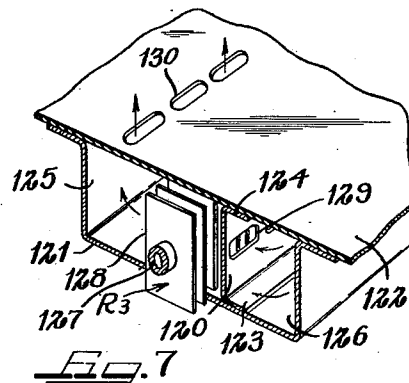
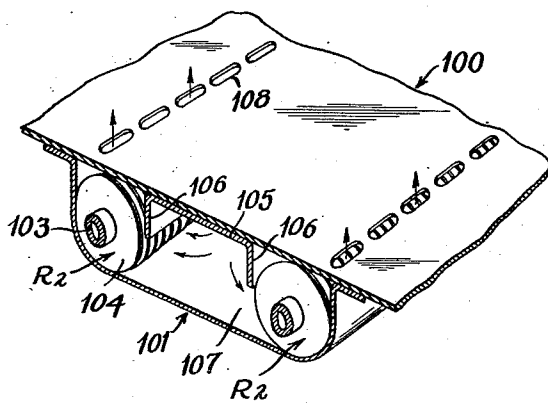


Fig. 7

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COMBINATION RADIANT AND CONVECTION HEATING SYSTEM

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The improved heating system comprising the present invention has been designed for use primarily in connection with the heating of buses, house trailers, and other road vehicles. The system is, however, capable of other uses, for example, the heating of railway passenger cars and other similar vehicles.

Specifically, the present invention relates to an improved system of "trench heating," so-called because the heat radiating instrumentalities proper are disposed within a trench-like depression formed in a floor structure wherein they underlie the main floor and are thus concealed from view.

It is among the principal objects of the invention to provide an improved trench heating system for road or railway vehicles of the type outlined above in which the heating effect obtained within the enclosure to be heated is partly the result of heat radiation from the main floor of the vehicle and partly the result of air entering the trench and directed into contact with the heat radiating element of the system, whereby the air is heated and passes through openings into the enclosure, the heating effect produced in either instance being of a uniform nature at all regions within the enclosure to produce uniform temperature distribution and consequent maximum occupant comfort.

Another object of the invention, in a heating system of this character, relates to the constructional aspects of the vehicle wherein the heat radiating devices per se are assembled and installed within a duct construction which constitutes a "package type" unit capable of being manufactured at the factory as a prefabricated, transportable sub-assembly for shipment to the vehicle assembly plant for installation in the floor trench of the vehicle, sub-floor during assembly of the vehicle body for subsequent connection in the heating system.

The provision of a duct construction or sub-assembly of the type briefly outlined above which, in the main, may be constructed of sheet metal and which therefore may be manufactured at a low cost; one which is of light weight construction, and one which may, with but slight modification or variation in its constructional details, be adapted for use in different environments to accommodate vehicles having differently compartmented enclosures, are further desirable features that have been borne in mind in the development of the present invention.

In the accompanying two sheets of drawings forming a part of this specification, several embodiments of the invention have been shown.

In these drawings:

Fig. 1 is a perspective view, somewhat schematic in its representation, of an enclosed vehicle, for example, a house trailer to which the heating system of the present invention has been applied;

Fig. 2 is an enlarged fragmentary sectional view taken on the vertical plane represented by the line 2-2 of Fig. 1;

Fig. 3 is a fragmentary perspective view, partly in sec-

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tion, of a portion of the floor construction of the vehicle of Fig. 1 showing the heating system of the present invention applied thereto;

Fig. 4 is a fragmentary sectional view taken substantially centrally and vertically through the rear end of the vehicle shown in Fig. 1;

Fig. 5 is a fragmentary plan view of a portion of the sub-assembly units employed in connection with the invention with the top plate thereof removed;

Fig. 6 is a fragmentary perspective view, partly in section, of a modified form of sub-assembly; and

Fig. 7 is a fragmentary perspective view similar to Fig. 6 showing another modified form of sub-assembly.

Referring now to the drawings in detail and particularly to Fig. 1, the heating system of the present invention has been shown as being applied to a house trailer coach 10 but it will be understood that the illustration is purely exemplary and the system may, with or without modification, be used for the heating of buses or other road vehicles or rolling stock such as railway passenger cars.

The coach 10, with certain exceptions that will appear presently, is of conventional design and includes a composite floor 11, composite side walls 12 and 13 (Fig. 2) and composite front and rear walls 14 and 15, respectively. The coach further includes a top wall or roof 16 which may be of a suitable insulated type and which bears no specific relation to the present heating system other than to complete the trailer enclosure 17 undergoing heating.

The composite floor 11 is best illustrated in Figs. 2 and 3 and comprises a sub-floor 20 supported from a pair of longitudinally extending metal side sills or beams 21. The sub-floor includes upper and lower spaced sheet metal members 22 and 23 between which there is interposed a suitable insulating material 24 which is preferably either preformed or of the package type. The members 22 and 23 may be unitary or these expanses may consist of overlapping widths of the sheet material. The central regions of the sheet metal members 22 and 23 are deformed to provide a longitudinal trough or trench 25 which extends substantially the entire length of the coach floor 11 and in which trench there is adapted to be installed a completely assembled "package type" heating unit, three forms of which have been illustrated in Figs. 3, 6 and 7, respectively, and which, independently and in combination with the heating system as a whole, constitutes a novel feature of the present invention. The details of these units will be set forth presently.

Supported at their ends on longitudinally extending wooden beams 27, which may be of the 2" x 4" variety are a plurality of transversely extending interlocking main floor channels 28 having side flanges 29 (see also Fig. 4) and intermediate depending ribs or flanges 30. The side flanges 29 are supported on the sub-floor assembly 20 and the ribs 30 are of lesser extent than the flanges 29 so that there is a clear air space or duct 35 within each channel 28. The channels 28 are preferably formed of aluminum on account of the lightness of this metal and also on account of its excellent heat-conductive qualities. A series of baffles 36 (Figs. 2 and 3) extend longitudinally through slots 37 formed in the ribs 30 for air distribution purposes as will be described subsequently. A bottom shield or plate 38 is coextensive with the floor 11 and is secured at its longitudinal edges to skirts 40 which depend from the side sills 21.

The side walls 12 and 13 are of similar construction and each wall includes an outer panel or "skin" 41, an intermediate wall panel 42 and an inner panel 43 which in part defines the enclosure 17. The panels 41 and 42 are secured as by welding or riveting to vertical sill flanges 44 and insulating material 24 is disposed between these two panels. The inner wall panel 43 is supported at its

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lower edge by means of curved metal strips 45 from the interlocking channels 28. The space 46 existing between the panels 42 and 43 communicates with the various ducts 35 existing within the channels 28. Longitudinally extending resilient sealing members 47 are supported on the side sills 21 between the wooden beams 27 and the inner sill flanges 44. The side walls 12 and 13 are provided with the usual window openings 50 and, as shown in Figs. 2 and 4, louvered air discharge openings 51 establish communication between the space 46 and the enclosure 17 immediately below the window openings 50.

The rear wall 16 (Fig. 4) includes inner and outer wall panels 52 and 53, respectively, between which there is contained insulating material 24. A space 54 is provided for intake of air from a louvered opening 55 (see also Fig. 1) and this space communicates with the trench 25 through a suitable blower 56 by means of which air is circulated through the passages provided for it by the heating system as will be described when the operation of the system is set forth. A damper 57 on the inner wall panel 54 regulates the volume of fresh air admitted to the system and also allows air within the enclosure 17 to be proportionately restricted through the system, an opening 58 being formed in the wall panel 54 for this purpose.

In Figs. 3, 6 and 7 there have been shown three forms of heating and heat distributing assemblies capable of being operatively installed within the trench 25 beneath the floor channels 28 for operative connection in the heating system. Each of these assemblies is in the form of a "package type" unit capable of being manufactured and assembled at the factory and shipped in its entirety to the coach assembly plant for installation purposes. The unit shown in Fig. 3 is designated in its entirety at 60 and includes an elongated, trough-like, U-shaped member 62 of sheet metal having a flat bottom 62, and upstanding side walls 63 provided with laterally turned flanges 64 extending along their upper edges. A cover plate 65 extends across the trough member 61 and is suitably secured to the flanges 63 by spot welding or screws, thus providing a tubular casing structure.

Nested within the trough member 61 is an elongated duct or partition member 66 of irregular V-shaped design. The duct member 66 is suitably secured within the trough member 63 as by welding and is provided with generally inclined side walls 67 which serve to divide the composite tubular member 65, 66 into three longitudinally extending air passages including a central passage 68 and side passages 69. Disposed within each side passage 69 and extending completely along the length thereof is a radiator assembly each consisting of two aligned radiator units R of the type having a central pipe section 71 for flow of a heating fluid therealong and heat radiating fins 72 spaced therealong. As shown, the fins 72 are of rectangular design and are diagonally disposed within the passages 69 and serve to present a relatively large heat radiating area therein, the radiators being arranged in their diagonal position in the flow path of the air streams so that the air will wipe the entire area of each fin 72.

A row of spaced openings 73 extends along the lower edge of each of the side walls 67 and similar rows of spaced openings 74 are formed along the opposite edges of the cover plate 65. The openings 73 establish communication between the central passageway 68 and the two side passageways 69 while the openings 74 establish communication between each of the side passageways 69 and the various ducts 35 provided by the floor channels 28.

Referring now to Fig. 1, the radiator pipe sections 71 are adapted to be connected in and form an integral part of a closed fluid heating circuit including parallel heating loops one of which accommodates the forward regions of the enclosure 17 and the other of which accommodates the rear regions thereof. The heating circuit extends from a suitable heating coil 80 through a pipe section 81, leading to a pump 82, and from thence through a line 83 extending to a pair of branch fittings 84 and 85.

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The radiator pipe sections 71 of the various radiators are connected to the fittings 84 and 85 and return lines 86 and 87 extend from the ends of the radiator pipe sections 71 along the side wall 13 adjacent the bottom thereof and communicate with a common return pipe 88 leading to the heating coil 80. A suitable drip and discharge fitting 89 extends through the floor 20 below the return pipe 88. A riser 90 extends upwardly from the end of the pipe section 81 to an expansion tank 91 for the heating fluid used in the system. Any suitable heating fluid may be used, for example water or an anti-freeze solution such as ethylene glycol. A pipe 92 may extend from the tank 91 and serve as an inlet for filling the system with the liquid.

A heater 93 is positioned below the heating coil 80 and may be supplied with kerosene or other suitable fuel contained within a fuel tank 94. It will be understood of course that any form of heating means may be employed whether the same be electrical or of the fuel burning type.

During the operation of the system for heating purposes, the system is filled, as previously described, with water or other fluid through the pipe 92. The burner 93 is then lighted for producing the desired amount of heat and the motor M is set into operation to circulate the heating fluid throughout the closed loops provided for it. If desired, automatic control of the system may be effected by employing the usual "Aqua-stat" for the heater and the usual thermostat for controlling the motor.

When the overall temperature of the heating fluid contained within the system has been brought to a desired degree, the radiator assemblies including the pipes 71 and radiating fins 72 become hot and air entering the system through the louvered opening 55 in the rear wall 15 passes downwardly through the passage 54 and enters the blower 56 (Fig. 4) by means of which the air is forced into the rear end of the central passageway 68 provided in the heat distributing unit 26. A certain amount of air pressure is developed within the passage 68 and by virtue of the spaced row of openings 73, the air is caused to traverse the entire longitudinal extent of the passage and flow outwardly in opposite directions into the side passages 69 below the level of the radiators R. The air thus expelled through the openings 73 flow upwardly between the spaced radiating fins 72 and around the pipes 71 from whence it passes through the openings 74 into the various ducts 35 existing within the walls of the aluminum floor channels 28. In order to insure equal distribution of the volume of air to the various ducts 35, the size of the openings 74 may be progressively increased so that these openings gradually become larger as they progress toward the front of the vehicle.

The air within the ducts 35 applies heat to the main floor so that heat is radiated into the enclosure. The air issuing from the two parallel rows of openings 74 flows outwardly in opposite directions and enters the spaces 46 provided between the inner and outer side wall panels 42 and 43. Finally, the heated air after heating the wall surfaces emerges from the louvered openings 48 at the level of the windowsills and enters the passenger compartment 17 from whence it may be recirculated through the system by entering the opening 58 for return to the blower 56 or it may be expelled from the passenger compartment 17 by exfiltration when the damper 57 is closed upon the opening 58.

From the above description it will be observed that by the heating system just described the passenger compartment 17 is supplied with heat both by convection of the heated air issuing from the openings 51 and by radiation of heat upwardly from the floor surface afforded by the interlocking aluminum floor channels 28. Because of the relatively large heat radiating surfaces afforded by the radiators R which are confined within the relatively small enclosures 69, the air issuing from the openings 74 has been brought to a relatively high degree of heat. This heat flows along the underneath surfaces of the floor

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channels in direct contact therewith and as a result thereof, a considerable portion of this heat may be adsorbed by the floor and wall channels and radiated into the enclosure. Such heat as is not extracted in this manner from the air passes inwardly through the louvered openings 51 to the passenger compartment 17 thus serving principally to heat the upper regions of the compartment.

It should be observed that the wooden beams 27 prevent any direct metal-to-metal contact between the side sills 21 or any other part of the floor sub-structure and the metal floor proper. These beams 27 thus serve both as structural and insulating members so that no appreciable amount of heat will be lost by conduction through the composite floor structure.

In Fig. 6 a modified form of package-type heating unit is disclosed. This unit is designated in its entirety at 100 and is similar in many respects to the unit 26 shown in Fig. 3. The trough member 101 and cover plate 102 remain substantially the same as in the previously described form but the radiators R2 consist of pipe sections 103 having associated therewith circular disk-like radiating fins 104 which nest within the curved bottom regions of the trough member 101. An inverted U-shaped baffle member 105 is welded or otherwise secured to the underneath face of the cover plate 102 and has depending side flanges 106 which terminate short of the trough bottom thus providing in effect elongated slots or openings 107 through which the unheated air forced into the tubular structure by the blower 56 may pass for intimate contact with the heat radiating fins of the radiators R2. The heated air passes outwardly through two rows of openings 108 and enters the ducts 35 as previously described.

In Fig. 7, yet another modified form of package unit is shown. In this form of the unit a vertical partition wall 120 extends between the bottom of the trough member 121 and cover plate 122 and is provided with longitudinal side flanges 123 and 124 which may be welded to the bottom of the trough member and to the cover plate respectively. The member 120 thus divides the space within the trough member 121 into two passageways 125 and 126, respectively. A radiator R3 is disposed within the passageway 125 adjacent the partition 120 and includes pipe sections 127 having associated therewith rectangular heat radiating fins 128 which are vertically disposed. A row of openings 129 extends longitudinally along the partition 120 substantially medially thereof and a similar row of openings 130 are provided longitudinally in the cover plate 122 on the side of the radiator R3 remote from the partition wall 120. The trough member 121 is generally rectilinear in design and when it is installed within the trench 25, the passageway 126 is in communication with the blower 56. Thus it will be seen that air forced into the passageway 126 will be discharged through the openings 129 from whence it will pass across the heat radiating surfaces of the radiator R3 and flow upwardly through the openings 130 into the various ducts 35.

The invention is not to be limited to the exact arrangements of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. For example, while the closed fluid heating system has been described as being designed for the reception therein of a heating medium such as water or ethylene glycol, the system is also capable of being employed as a cooling system. In such an instance the conversion may readily be made by substituting for the heating apparatus disclosed herein a refrigerating apparatus. In such an instance the closed fluid system will contain a suitable refrigerant. Only insofar as the invention has been particularly pointed out in the accompanying claims is the same to be limited.

We claim:

1. In combination with an enclosed passenger vehicle body having a main floor structure comprising inverted

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channel floor units and a sub-floor structure underlying and cooperating with said channel units to provide a plurality of air conduits leading into the vehicle body and formed with a trench having a heating compartment therein, a means located within said trench defining air distributing passageways leading laterally into said heating compartment and also passageways leading from said heating compartment into said air conduits, whereby air is passed from the heating compartment into the enclosed vehicle body, and a heating element positioned within said heating compartment in the flow path of said air.

2. A combination structure as defined in claim 1 characterized in that the heating element is of a type utilizing a hot fluid as a heating medium and is provided with a plurality of heat dissipating fins through which the said air is compelled to pass to be heated.

3. A combination structure as defined in claim 2 characterized in that the said means within said trench defining said air distributing passageways also defines an air supply passageway communicating with the interior of the vehicle body, whereby air from the enclosed body of the vehicle is recirculated through said trench, and further characterized in that a damper is positioned in an extension of said supply passageway to open and close the same.

4. In combination with an enclosed passenger vehicle body having a main floor structure and a sub-floor structure spaced therefrom and formed with a trench therein, a prefabricated heating unit disposed within said trench, said prefabricated unit comprising a tubular casing including a trough-like member positioned within said trench and a top closure for said trough-like member arranged to align with the top surface of the sub-floor structure, and a heating element enclosed in said tubular casing, there being a series of openings in said closure to permit heated air to pass upwardly from said fabricated unit into the space between the main and sub-floor structures of the vehicle to heat the main floor.

5. The combination structure defined in claim 4 characterized by the provision of an electrically operated blower for enforcing circulation of air through the prefabricated unit and into the enclosed vehicle body.

6. The combination of claim 5 characterized in that the enclosed vehicle body includes side walls having air passageways therein leading from the space between the main and sub-floors of said vehicle body and opening into the interior of said enclosed body to deliver air thereto.

7. The combination structure as defined in claim 6 characterized in that the said trench is centrally located and extends lengthwise of the vehicle and in that the said tubular casing of the prefabricated unit corresponds substantially to the configuration of said trench.

8. A combination structure as defined in claim 7 characterized in that an end wall of the vehicle body is provided with an air passageway therein communicating with the external atmosphere and with the interior of the vehicle body and adapted to conduct air into said prefabricated unit to be heated, and in that a damper is positioned in said end wall air passageway to vary the proportions of outside air and air from the enclosed body entering said passageway to be conducted to said prefabricated unit.

9. In a vehicle construction, the combination set forth in claim 6 in which said main floor structure is comprised of a series of inverted generally U-shaped channel members having their lower side edges supported on the sub-floor structure, each of said channel members defining a transverse air passage having its ends in communication with said air passageways in the side walls.

10. A prefabricated heating unit of the character described designed for installation in a trench provided in a vehicle sub-floor, said heating unit comprising an elongated sheet metal body member of trough-like design and U-shaped in cross section, said body member having a substantially flat bottom and upstanding side walls, a cov-

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er plate enclosing the upper end of said member and secured coextensively along its longitudinal edges to the upper edges of said side walls, thus defining an open ended tubular structure, a partition wall extending downwardly from the cover plate of said U-shaped member and co-operating with the tubular structure to define an air supply passage and a heating compartment respectively, there being a transverse passageway leading from said air supply passageway into said heating compartment, and a finned heat radiating device disposed within said heating compartment closely adjacent said partition wall, there being a longitudinally extending row of spaced perforations formed in said cover plate communicating with said heating compartment above the level of said heat radiating device.

11. A prefabricated heating unit as defined in claim 10 characterized in that a plurality of transverse passageways are formed in said partition and leading from said air supply passageway into said heating compartment.

12. A prefabricated heating unit as defined in claim 20

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10 characterized in that a second partition wall extends downwardly from said cover plate and defines a second heating chamber adjacent to and communicating with said air supply passageway and provided with hot air outlets through said cover plate.

13. A prefabricated heating unit as defined in claim 12 characterized in that said partition walls divide said tubular structure into a central air supply passageway and a heating compartment at either side of said air supply passageway, and further characterized by the provision of finned heating units positioned in said heating chambers.

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