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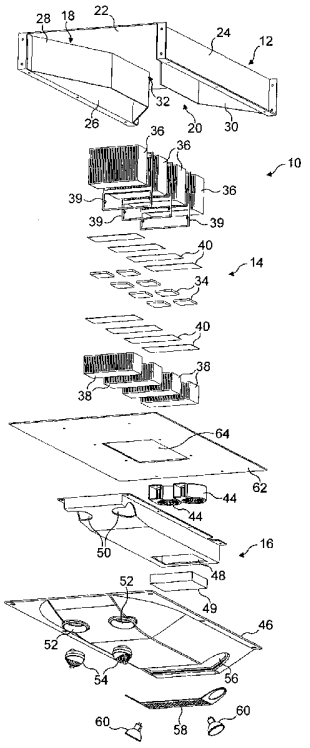
(54) Title: VEHICLE AIR CONDITIONING DEVICE



(57) Abstract: The present invention provides a vehicle air conditioning system comprising a duct (74) positioned to receive a through flow of air as a result of movement of the vehicle, an air accumulation space (76) separate from said duct and in fluid communication with an interior space of the vehicle and a set of Pellier elements (34) positioned partially in said duct and partially in said air accumulation space, the Peltier elements being operable to transfer heat energy between said duct and air accumulation space.

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Vehicle Air Conditioning Device

The present invention relates to an air conditioning device for a vehicle and in particular to an air conditioning device for an interior passenger or operator space of a vehicle.

It is known to provide ventilation and climate control arrangements for the interior space of a vehicle. In a simple form, ventilation can be achieved by the provision of an opening to the exterior of the vehicle, which opening allows air outside of the vehicle to be directed to the interior of the vehicle. Typically the provision of ducting enables the movement of the vehicle to force air through the aperture, while a fan may be provided to move air through the opening when the vehicle is stationary.

It will be appreciated that such a system is not suitable in instances where it is desired to keep outside air from entering the interior of the vehicle. In such instances the vehicle may be provided with an internal climate control system where air already within the vehicle interior is moved by the provision of fans and heated or cooled by the use of appropriate heating and cooling means. Such systems are usually complex and include, for example, closed loop evaporation refrigeration systems, electrical heaters and thermostatically controlled operating systems. The systems are typically designed to be incorporated into the vehicle when it is first built and as such their retrofitting to an already built vehicle, or a vehicle not intended at the outset to have such a system, may be difficult if not impossible.

According to the present invention there is provided a vehicle air conditioning system comprising a duct adapted to receive a through flow of air as a result of movement of the vehicle, an air accumulation space separate from said duct and a heat pump means positioned partially in said duct and partially in said air accumulation space, the heat pump being operable to transfer heat energy between said duct and air accumulation

space, and said duct and air accumulation space being arranged such that air flow through the duct is prevented from communicating with the air accumulation space.

The duct is preferably provided with a throat and advantageously the duct portion of the heat pump is positioned at said throat. The air accumulation space may preferably surround and substantially enclose the portion of the heat pump means provided therein. The accumulation space may comprise an enclosure having an inlet and an outlet. The enclosure may project into an interior space of a vehicle. In such an embodiment the outlet may be provided with a nozzle operable to direct air from said enclosure to said interior space. A plurality of outlets and nozzles may be provided. Alternatively the enclosure may be arranged so as to be in fluid communication with an interior space of a vehicle via a conduit extending between the outlet and an aperture of said interior space. The accumulation space is preferably provided with an air movement means, such as a rotary fan, operable to move air over the portion of the heat pump means positioned in the air accumulation space.

The heat pump means are preferably of the electrical type. The heat pump means may comprise a peltier device having heat sinks or exchangers associated with opposing sides thereof. The heat pump may comprise a plurality of peltier devices and associated heat exchangers.

The duct and air accumulation space may share a common wall. The wall may be provided with an aperture shaped to accommodate the heat pump means.

Embodiments of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows an exploded perspective view of a device according to a first embodiment of the present invention;

Figure 2 shows a perspective view of an assembled device in the cab of a vehicle;

Figure 3 shows an exploded perspective view of a device according to a second embodiment of the present invention; and

Figure 4 shows a diagrammatic view of an alternative embodiment of a device according to the present invention.

Referring firstly to figures 1 and 2 there is shown a cooling device generally designated 10. The device 10 comprises a duct 12, a heat pump 14 operable to provide a source of cooled air, and a cooled air collection and distribution assembly 16. In the embodiment shown, the device 10 is adapted to be fitted to an upper region of the cab of a rail vehicle 63. The device 10 is positioned such that the duct 12 is aligned with a ventilation opening 65 at the front of the vehicle 63.

The duct 12 may be considered to be open sided and is provided with an inlet 18 and an outlet 20, a base 22 and opposed outer walls 24, 26. The duct 12 further includes a pair of opposed inner walls 28,30 which are arranged to reduce the cross-sectional area of the duct 12 from the inlet 18 to a throat 32, before increasing the cross-sectional area of the duct 12 towards the outlet 20. In the embodiment shown, the inner walls 28, 30 run substantially parallel to one another at the throat 32 so as to provide a throat 32 of constant cross-sectional dimensions over a predetermined distance.

The heat pump 14 comprises a plurality of substantially planar peltier elements 34 having heat exchanger members 36, 38 arranged on opposing sides thereof. Gaskets 39 are provided between the members 36, 38. Intermediate the peltier elements 34 and the exchanger members 36, 38, are positioned thermally conductive pads 40 which serve both to ensure an uninterrupted thermal conduction path between the elements 34 and the exchanger members 36, 38 and to electrically insulate the elements 34 from the members 36,38. The heat exchanger elements 36, 38 are manufactured from aluminium alloy and are provided with a plurality of spaced fins so as to maximise their respective surface areas.

The air collection and distribution assembly 16 comprises an air collection tray 42 defining an air accumulation space having sited therein a pair of fans 44 and a decorative casing panel 46 which, in use encloses the tray 42. The tray 42 is further provided with an inlet aperture 48 adjacent the respective inlets of the fans 44, and a

pair of outlet apertures 50 spaced from the respective outlets of the fans 44. The casing panel 46 further includes a pair of outlet apertures 52 having movable nozzles 54 located therein and an inlet aperture 56 covered by a grill 58. It will be appreciated that the respective inlet and outlet apertures 48, 50, 52, 56 of the tray 42 and the casing panel 46 align with one another, in use. A particle filter 49 is provided between the inlets 48,56 to remove airborne particles drawn into the casing panel inlet 56 by the fans. The filter 39 thus prevents particulate matter being drawn through the air accumulation space and ejected through the outlets 50,52. The filter 39 may be periodically replaced by removing the casing panel 46. The tray 42 may additionally be provided with a sump positioned below the heat exchanger elements 38 to catch any condensate which my form thereon. The sump may advantageously be provided with a drain to permit the removal of condensate from the sump. The grill 58 further includes a pair of lamps 60.

The device 10 additionally includes a divider panel 62 which, in use, separates the duct 12 from the air collection and distribution assembly 16 and prevents the flow of air between the duct 12 and the assembly 16. The panel 62 is provided with an aperture 64 which conforms to the size and shape of the heat pump 14. When the device 10 is assembled, it will be appreciated that the heat pump 14 extends through the aperture 64 such that the heat exchange members 36 of one side are positioned in the throat 32 of the duct 12, while the heat exchange members 38 of the other side project into the air collection tray 42. The one face of the divider panel 62 serves to close the open side of the duct 12 such that air entering the inlet 18 must pass through the throat 32 and hence through the heat exchanger members 36 to reach the outlet 20. The air collection tray 42 is attached to the other face of the divider panel 62 so as to substantially enclose a space into which the remaining heat exchanger members 38 project.

It will be understood that the peltier elements 34, in use, have a "hot" side and a "cold" side. The elements are arranged such that the "hot" side is in contact with the heat exchange members 36 positioned in the duct 12, and the "cold" side is in contact with the heat exchange members 38 positioned in the collection tray 42. It will thus be appreciated that operation of the peltier elements 34 results in cooling of the tray heat

exchange members 38 and heating of the duct heat exchange members 36 with the result that heat energy is transferred from the collection tray 42 to the duct 12. The fans 44 are operable to draw air from within the vehicle cab 63 and pass it over the tray heat exchange members 38.

The cooled air is then introduced to the cab 63 by the nozzles 54. Heat accumulated in the duct heat exchange members 36 is dissipated by the flow of air there across resulting from movement of the vehicle. The heat storage capacity of the duct heat exchange members 36 is chosen such that when the vehicle is stationary during normal operating conditions, for example when stopped at a station, the duct heat exchange members 36 do not exceed a predetermined temperature. The heat pump 14 is provided with a thermostatically controlled operation system which deactivates the peltier elements in the event that the duct heat exchange members 36 approach a predetermined cut-off temperature. Such a situation may occur when the vehicle remains stationary for a prolonged period of time.

In the embodiment shown in figures 1 and 2 the device 10 is configured so as to be a self contained unit that can be readily retrofitted to a vehicle. The size and shape of the duct 12 is configured to match that of a ventilation conduit provided in a rail vehicle. The device 10 may thus be readily fitted to a vehicle by removing an appropriate length of the existing duct and fitting the device 10 in its place. The necessary power connections to operate the peltier elements 34, fans 44 and lamps 60 may be made to the existing electrical system of the vehicle 62.

Referring now to figure 3 there is shown an alternative embodiment of a cooling device, generally designated 90, according to the present invention. Features common to the embodiment of figures 1 and 2 are identified with like reference numerals. The device 90 differs from the device 10 of figures 1 and 2 in a number of respects described below. Firstly, the divider panel 62 is provided with a plurality of apertures 64 rather than a single aperture. Each aperture 64 is sized to receive therein a peltier element 34, however the aperture is smaller than the heat exchanger members 36,38 which contact each side of the peltier element 34. It will thus be appreciated that the heat exchanger

members 36,38 rest on the divider panel 62 and sandwich the peltier element 34 received in the aperture. The solid gaskets 39 of the embodiment of figures 1 and 2 are omitted and in their place a wet silicon sealer is employed between the heat exchanger members 36,38 and the divider panel 62. Optionally, the thermally conductive pads 40 may be replaces with a thermally conductive grease applied to and surrounding the peltier elements 34.

The duct 12 differs in that it is of a single wall construction rather than a twin wall construction. The air collection tray 42 is of a two piece construction comprising a fore portion 92 and an aft portion 94. The fore portion 92 includes a sump 96 having a drain tube 98 and a pair of air collection cavities 100. The aft portion 94 includes the inlet aperture 48 which is shrouded by a conduit 102 extending between the collection tray aperture 48 and the casing panel inlet aperture 56. The conduit 102 is arranged to receive and retain the particle filter 49 and grill 58, while the fans 44 are mounted in the aft portion 94 over the inlet aperture 48.

The sump 96 is provided to receive any condensate which may drip form the lower heat exchanger members 38, for example during periods of high humidity. The sump 96 is positioned in the fore portion 92 so as not to be below the lower heat exchanger members 38 but is provided adjacent and upstream the edge of the heat exchanger members 38 closest the duct inlet 18. The term upstream is construed with reference to the flow through the duct 12. The base 104 of the tray fore portion 92 may be inclined towards the sump 96 so as to convey condensate thereto. The positioning of the sump 96 intermediate the base 104 and collection cavities 100 so as to prevent condensate reaching the cavities 100. Each air collection cavity 100 is provided with an aperture 106 connectable to a conduit 108 extending to a nozzle 54. The air collection tray 42 is provided in two portions 92,94 so as to enable the aft portion 94, including the fans 44 and filter 49 to be removed from the device 90 without the need to remove the entire air collection tray 42. The aft portion 94 may need to be removed so as to service or replace the fans 44 and/or filter 49.

The device 90 is further provided with control box and user interface 110 which projects through an aperture 112 of the casing panel 46. The user interface permits user to control certain aspects of the operation of the device 90, for example the speed of the fans 44. The casing panel 46 is shaped so as define a space 114 between the interior surface thereof and the underside of the air collection tray 52 within which an electronics enclosure 116 is located. The enclosure 116 houses the power and control electronics for the peltier elements 34 and fans 44.

Referring now to figure 4 there is shown an alternative embodiment of the present invention. Components common to the embodiment of figures 1 to 3 are identified with like reference numerals. While the embodiment of figures 1 to 3 is adapted for use in a vehicle cab, the embodiment of figure 3 is adapted for use in a passenger carriage 66. The carriage 66 comprises a passenger accommodation space 68 having a floor 70 and a ceiling 72. A ventilation duct 74 is provided in an upper portion of the carriage and a space 76 is provided between the duct 74 and the ceiling 72. The duct 74 is arranged such that air is caused to move therethrough, indicated by arrows 78, when the carriage 66 is moving. The collection tray 42 of the device 10 is provided with a plurality of conduits 80 which connect the tray 42 to nozzles 82 in the ceiling 72. In the embodiment shown the nozzles 82 are provided with diffusers 84. In use, the device is operable to cool air present in the space 76 and deliver it to the passenger accommodation space 68.

The present invention provides a compact air conditioning system which utilises the cooling effect of moving air resulting from movement of a vehicle yet prevents the passage of said air to the interior of the vehicle. While the above referenced embodiments refer to the provision of cooled air to an interior space of a vehicle, it will be appreciated that the peltier elements may be operated in reverse so as to provide a source of warm air. While the above described embodiments prevent the transmission of air from the duct to the tray, provision may be made elsewhere in the vehicle ventilation system to introduce outside air to the interior of the vehicle. Such air may be mixed with the air heated or cooled within the tray.

Claims

Claims

1. A vehicle air conditioning system comprising a duct positioned to receive a through flow of air as a result of movement of the vehicle, an air accumulation space separate from said duct and in fluid communication with an interior space of the vehicle and a heat pump positioned partially in said duct and partially in said air accumulation space, the heat pump being operable to transfer heat energy between said duct and air accumulation space, wherein the air accumulation space is provided with an air movement means operable to move air over the portion of the heat pump means located in the air accumulation space, and said duct and air accumulation space are arranged such that air flow through the duct is prevented from communicating with the air accumulation space.

2. A system as claimed in claim 1 wherein the duct includes a throat and advantageously the portion of the heat pump positioned in the duct is located at said throat.

3. A system as claimed in claim 1 or claim 2 wherein the air accumulation space preferably surrounds the portion of the heat pump means located therein.

4. A system as claimed in claim 3 wherein the air accumulation space substantially encloses the portion of the heat pump means located therein.

5. A system as claimed claim 3 or claim 4 wherein the accumulation space is defined by an enclosure having an inlet and an outlet.

6. A system as claimed in claim 5 wherein the enclosure projects into the interior space of a vehicle.

7. A system as claimed in claim 5 or claim 6 wherein the enclosure comprises a fore portion having one of the inlet and outlet and an aft portion having the other of the inlet and outlet, wherein the fore and aft portions are separable from one another.

8. A system as claimed in claim 7 wherein the portion of the enclosure having the inlet is removable from the air accumulation space.

9. A system as claimed in any of claims 5 to 8 wherein the enclosure is received within a cover, the cover having apertures aligned with the enclosure inlet and outlet.

10. A system as claimed in claim 9 wherein the cover is provided with illumination means operable to illuminate the interior space.

11. A system as claimed in any of claims 5 to 10 wherein the outlet is provided with a nozzle operable to direct air from the air accumulation space to the interior space.

12. A system as claimed in claim 5 wherein the enclosure is arranged so as to be in fluid communication with an interior space of a vehicle via a conduit extending between the outlet and an aperture in a wall of said interior space.

13. A system as claimed in claim 12 wherein the aperture is provided with a nozzle operable to direct air from the conduit to the interior space

14. A system as claimed in any of claims 5 to 13 wherein the air movement means are operable to move air through from the inlet over the portion of the heat pump means located in the air accumulation space and to the outlet.

15. A system as claimed in claim 14 wherein the air movement means comprise a fan mounted to the enclosure.

16. A system as claimed in any of claims 5 to 15 wherein the inlet is provided with a particle filter.

17. A system as claimed in claim 16 wherein the filter is removable.

18. A system as claimed in any of claims 5 to 17 wherein the enclosure includes a sump positioned to receive condensate from the portion if the heat pump located within the air accumulation space.

19. A system as claimed in claim 18 wherein the sump is provided with a drain to convey condensate from the sump.

20. A system as claimed in any preceding claim wherein the heat pump is electric.

21. A system as claimed in claim 20 wherein the heat pump comprises a peltier device having heat sinks or exchangers associated with opposing sides thereof.

22. A system as claimed in claim 21 wherein the heat pump comprises a plurality of peltier devices and associated heat exchangers.

23. A system as claimed in claim 21 or claim 22 wherein the opposing heat exchangers project into the duct and air accumulation space respectively.

24. A system as described in any preceding claim wherein the duct and air accumulation space share a common wall.

25. A system as claimed in claim 24 wherein the common wall includes an aperture shaped to accommodate the heat pump means therein.

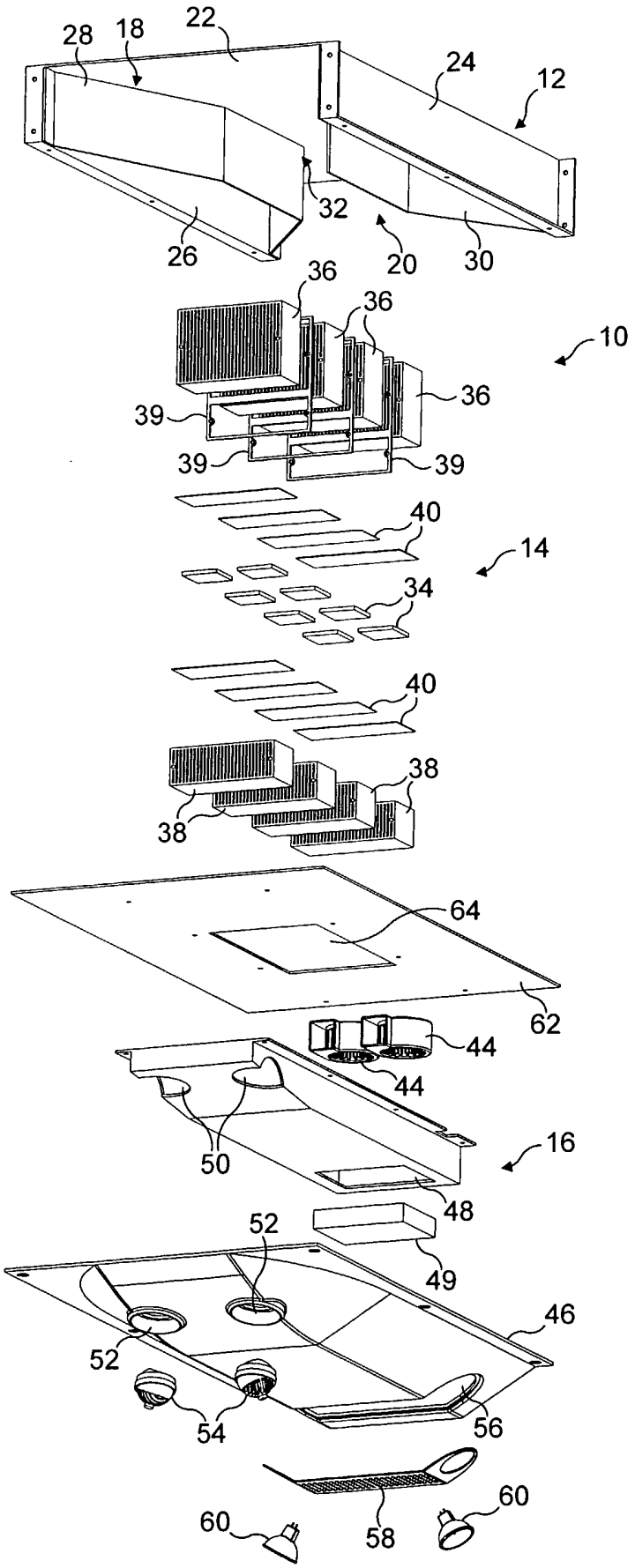
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FIG. 1

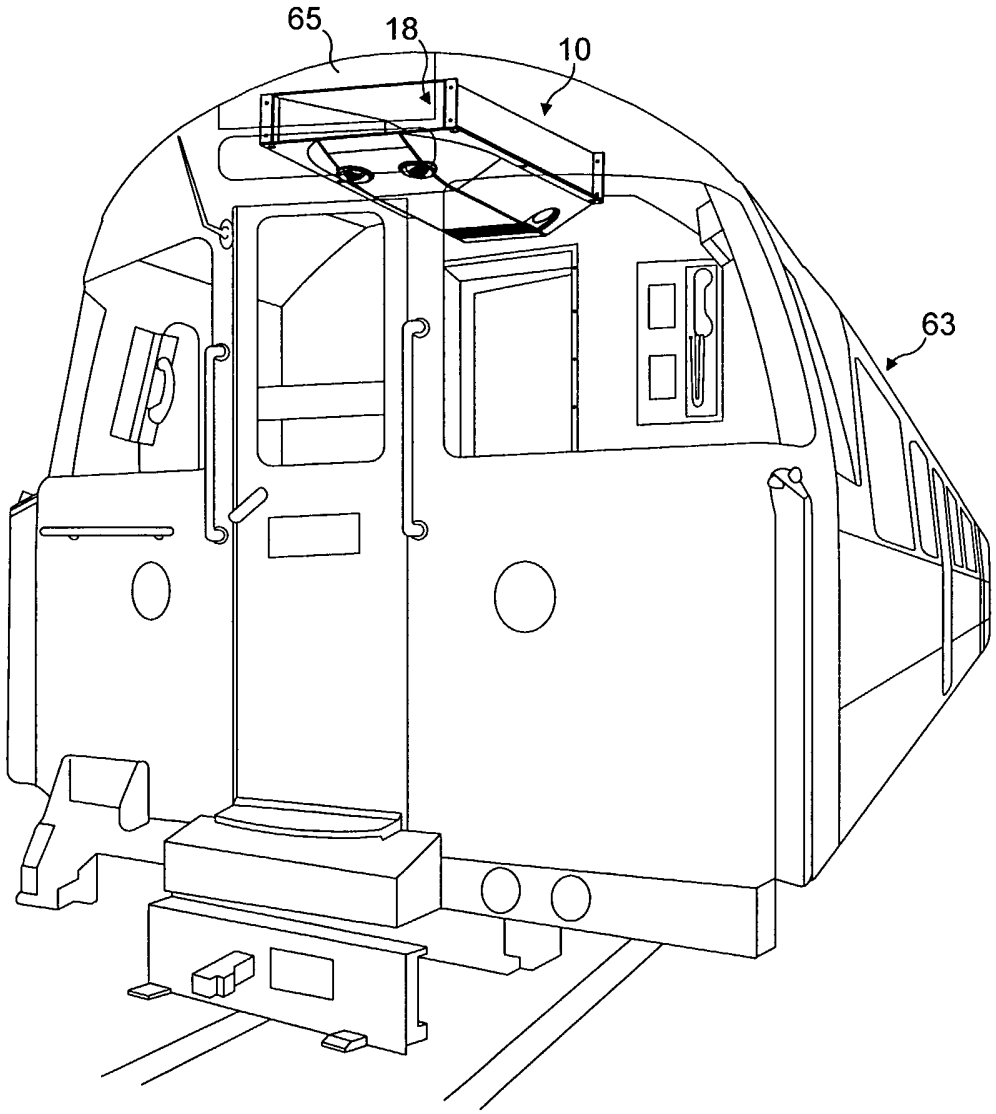

FIG. 2

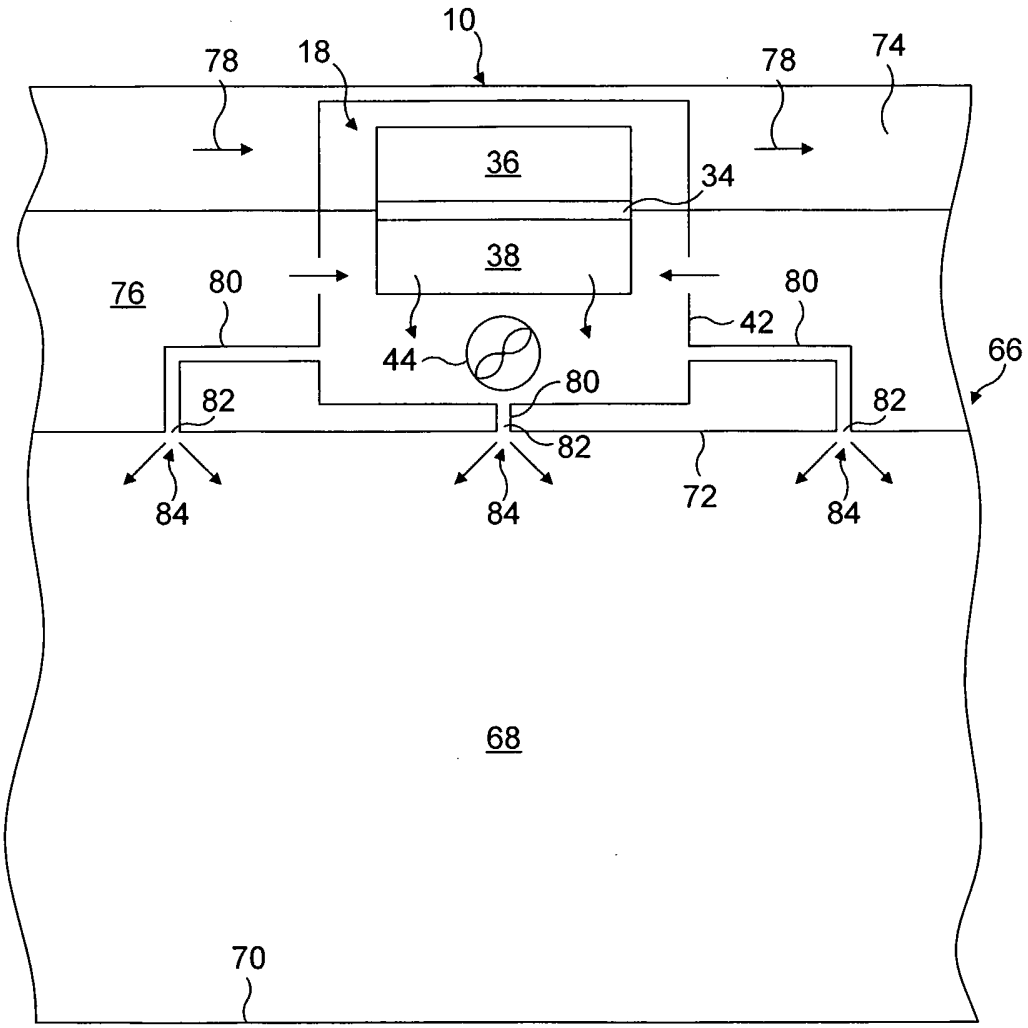

FIG. 3

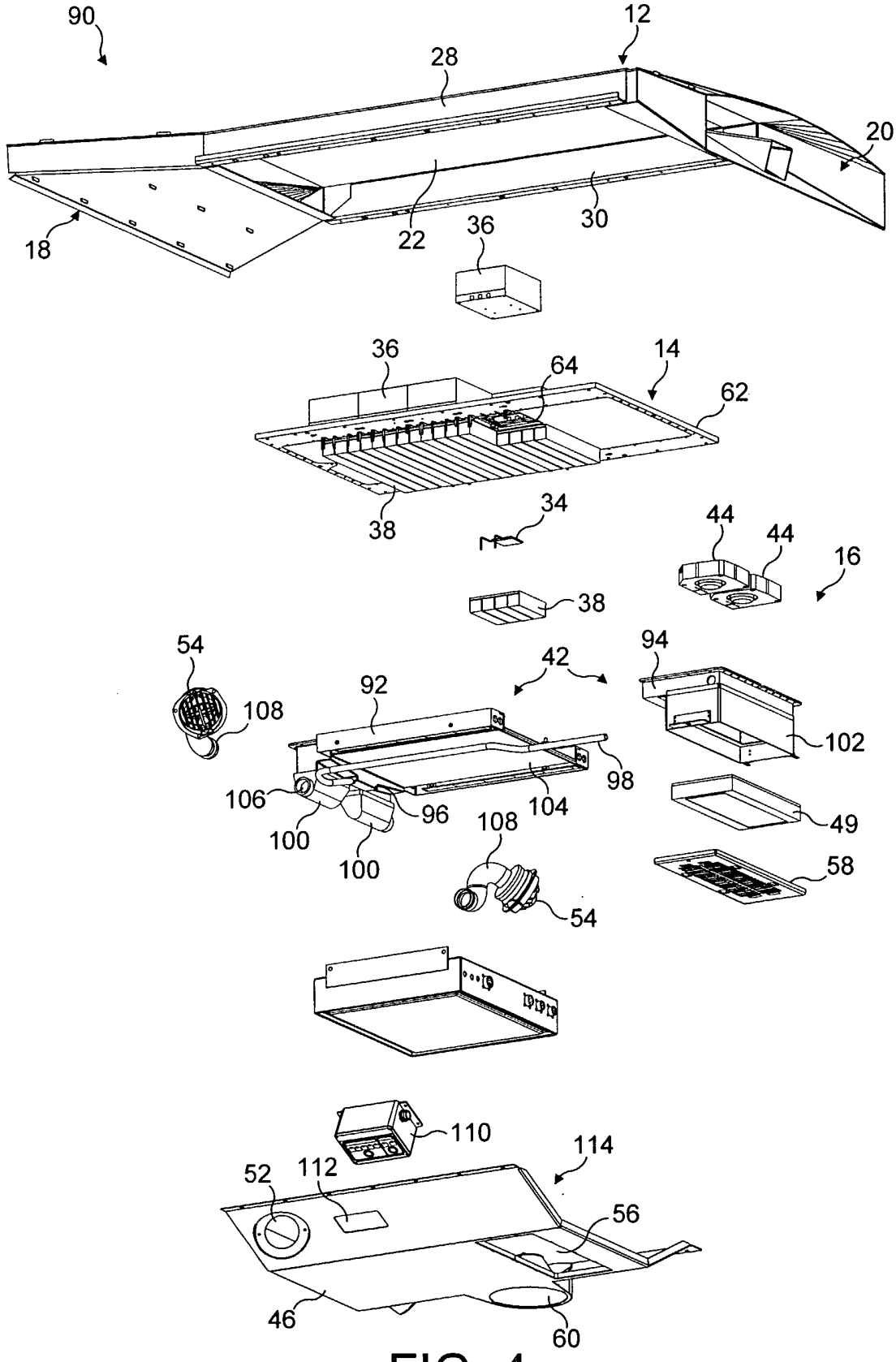
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FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2004/003766

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60H1/00 B60H1/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 598 493 A (PARIENTI RAOUL) 13 November 1987 (1987-11-13) page 4, line 30 - page 9, line 5; figures 1-3,5,8,9	1-25
X	DE 42 07 283 A (WEBASTO KAROSSERIESYSTEME) 9 September 1993 (1993-09-09) column 2, line 42 - column 3, line 26; figure 1	1-9, 11-15, 21-25
X	DE 16 80 846 B (EBERSPAECHER J) 22 April 1971 (1971-04-22) the whole document	1-9, 11-15, 21-25

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 December 2004	22/12/2004

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB2004/003766

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