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(54) Title: HEATING, VENTILATING AND AIR CONDITIONING SYSTEM FOR ELECTRIC VEHICLE OR HYBRID ELECTRIC VEHICLE

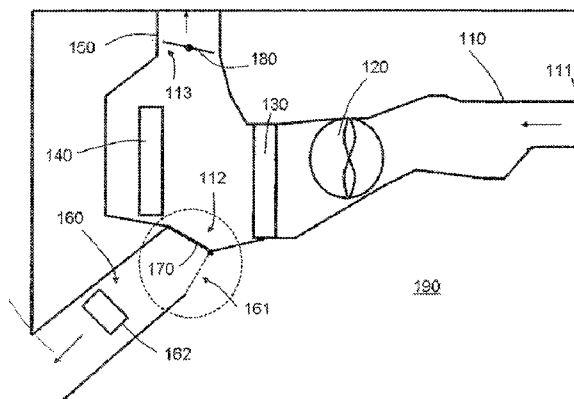


FIG. 1

(57) Abstract: A Heating, Ventilating and Air Conditioning (HVAC) system for an electric vehicle or hybrid electric vehicle comprises a casing (110), a blower (120) disposed within the casing (110) and a battery air duct (160) disposed outside the casing (110). The casing (110) includes a first air inlet (111) provided upstream of the blower (120) and a first air outlet (112) provided downstream of an evaporator (130). The battery air duct (160) is connected to the first air outlet (112). The battery air duct (160) has a battery air inlet (161) communicating with the interior of a cabin (190) and an air intake control valve which controls the air fed to the battery with options: (a) feeding cooled air from the HVAC system through the first air outlet (112); (b) feeding air from the cabin (190) through the battery air inlet (161); (c) feeding air from the combination of (a) and (b). The air intake control valve comprises a first flap (170, 270) which is movable between two extreme positions. The first flap (170, 270) closes the first air outlet (112) in the first extreme position and closes the battery air inlet (161) in the second extreme position. The structure of the HVAC system is optimized, and the occupied space of the system and the manufacture cost are decreased.



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## HEATING, VENTILATING AND AIR CONDITIONING SYSTEM FOR ELECTRIC VEHICLE OR HYBRID ELECTRIC VEHICLE

### FIELD OF THE INVENTION

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The present invention discloses an HVAC (Heating, Ventilating and Air Conditioning) system for an electric vehicle or hybrid electric vehicle, in particular an HVAC system to conduct conditioned air in the cabin as well as to adjust temperature of the battery cells.

### BACKGROUND OF THE INVENTION

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In consideration of the rarefaction of oil as well as environment protections, researches and developments on electric vehicles and hybrid electric vehicles have been conducted, resulting in the maturity of technologies related to electric vehicles and hybrid electric vehicles.

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In electric vehicles and hybrid electric vehicles, the battery powering the engine comprises a plurality of battery cells, in particular of the NiMH or Lithium-ion type. A proper running of the battery typically requires a certain temperature range to which the battery should be subjected. However, the temperature of the battery usually exceeds that range due to environmental temperatures, heats from the vehicle engine and the battery itself, etc. HVAC systems are thus required to adjust the temperature of the battery, in particular to cool the battery cells to avoid efficiency decreases or even explosions of the battery cells due to overheating.

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US application No. 2006/0073378 discloses an HVAC system for an electric vehicle or hybrid electric vehicle. The HVAC system disclosed in US application No. 2006/0073378 comprises an air conditioning apparatus for cabin, in which are arranged a blower, an evaporator, and a radiator. The air conditioning apparatus is provided with an opening on the bottom, said opening being in communication with the duct leading to the battery, thereby at least a portion of the cooled air at low temperature provided by the air conditioning apparatus for cabin could be used to cool the battery. A first flap combined with a second flap is provided at the opening. The first flap opens or closes the opening leading to the duct, and the second flap opens or

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closes an opening supplying air to the radiator. Moreover, the HVAC system is capable of utilizing the air outside the cabin to cool the battery. The duct is provided with an air intake for introducing the air outside the cabin, as well as a third flap to open or close the said air intake. The HVAC system according to US application No.2006/0073378 has a complicated structure,  
5 with a large number of parts thereof.

### **SUMMARY OF THE INVENTION**

The present invention aims to further optimize the structure of the HVAC system for an  
10 electric vehicle or hybrid electric vehicle, thereby decreasing the occupied space of the system and the manufacturing cost.

To realize the above objects, the present invention provides an HVAC (Heating, Ventilating and Air Conditioning) system for an electric vehicle or hybrid electric vehicle, comprising: a casing, a blower disposed within the casing and an air duct for the battery disposed outside the casing. The casing includes a first air intake opening provided upstream of the blower and a first air discharge opening provided downstream of the blower, wherein the air duct for the battery is connected to the first air discharge opening. The air duct for the battery has an air intake opening for the battery communicating with the interior of a cabin, and an air intake  
15 controlling valve for battery which controls the air fed to the battery with options:

- (a) feeding cooled air from the HVAC system through the first air discharge opening ;
- (b) feeding air from the cabin through the air intake opening for the battery;
- (c) feeding air from the combination of (a) and (b).

25 In the above mentioned HVAC system, the air intake controlling valve for the battery comprises a first flap which simultaneously controls the first air discharge opening and the air intake opening for the battery. The first flap is movable between two extreme positions. Moreover, the first flap closes the first air discharge opening in the first extreme position, and closes the air intake opening for the battery in the second extreme position.

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The casing further comprises a second discharge opening for feeding air to the cabin and a closing valve for controlling the second discharge opening.

When the cabin air temperature is below or equal to 15°C, the closing valve is in the open position and the first flap is in the first extreme position. When the cabin air temperature is above 15°C but below or equal to 20°C, the closing valve is in the close position, and the first  
5 flap is in the second extreme position. Finally, when the cabin air temperature is above 20°C, the closing flap is in the open position and the first flap is in the second extreme position.

A secondary blower is also provided inside the air duct for the battery.

10 The first flap comprises a closing portion and a pivoting portion, wherein the closing portion has a shape of plate, and the first flap is pivotably mounted to the casing or the air duct for the battery via the pivoting portion.

Alternatively, the first flap comprises a closing portion, a pivoting portion and a supporting  
15 portion, wherein the closing portion is provided with a cylindrical surface, the first flap is pivotably mounted to the air duct for the battery via the pivoting portion, and the supporting portion connects the pivoting portion and the closing portion.

The casing is further provided with a second air intake opening between the first air intake  
20 opening and the blower, wherein the first air intake opening is connected to the exterior of the cabin, and the second air intake opening is connected to the interior of the cabin.

A filter is also provided between the first air intake opening and the blower.

25 The first air intake opening and the second air intake opening are controlled by a second flap which is movable between two extreme positions, and the second flap closes the first air intake opening in the first extreme position and closes the second air intake opening in the second extreme position.

30 The second flap comprises a closing portion and a pivoting portion, wherein the closing portion has a shape of plate, and the second flap is pivotably mounted to the casing via the pivoting portion.

The second flap comprises a closing portion, a pivoting portion and a supporting portion, wherein the closing portion is provided with a cylindrical surface, the second flap is pivotably mounted to the casing via the pivoting portion, and the supporting portion connects the pivoting portion and the closing portion.

The present invention simplifies the structure of the HVAC system significantly, which saves the spaces occupied and decreases the number of the parts, thereby decreasing the manufacturing costs.

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### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a schematic view of a HVAC system for an electric vehicle and hybrid electric vehicle in accordance with a first embodiment of the present invention;

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Figure 2 is a schematic structural view of a first flap in accordance with the first embodiment of the present invention;

Figure 3 is a schematic view of a HVAC system for an electric vehicle and hybrid electric vehicle in accordance with a second embodiment of the present invention;

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Figure 4 is a schematic structural view of a first flap in accordance with the second embodiment of the present invention;

Figure 5 is a schematic view of a HVAC system for an electric vehicle and hybrid electric vehicle in accordance with a third embodiment of the present invention.

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### **DETAILED DESCRIPTION OF THE INVENTION**

Following is a detailed description of different embodiments of the present invention in connection with the accompanying drawings.

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Figure 1 is a schematic view of a HVAC system for an electric vehicle and hybrid electric vehicle in accordance with a first embodiment of the present invention. As shown in Figure 1, the HVAC system comprises a casing 110, a blower 120 disposed within the casing 110, an evaporator 130 and a radiator 140 disposed downstream of the blower 120, etc.

5

The HVAC system further comprises an air duct for the cabin 150 disposed outside the casing 110 to supply conditioned air into the cabin (not shown), and an air duct for the battery 160 to supply conditioned air into the battery (not shown).

10 The casing 110 has a first air intake opening 111 provided upstream of the blower 120, as well as a first air discharge opening 112 and a second air discharge opening 113 provided downstream of the evaporator 130. The first air discharge opening 112 is completely different from the second air discharge opening 113, both in positions and functions. In other words, the first air discharge opening 112 is connected to the air duct for the battery 160, solely to supply  
15 the conditioned air into the battery cells via the air duct for the battery 160. The second air discharge opening 113 is connected to the air duct for the cabin 150, serving as a typical opening in HVAC systems to supply the conditioned air to the cabin.

The blower 120 creates an airflow within the casing 110 between the first air intake opening  
20 111 and the first air discharge opening 112 and/or the second air discharge opening 113. As a consequence, terms 'downstream' and 'upstream' in the present specification are defined in relation with the airflow direction within the casing 110 between the first air intake opening 111 and the first air discharge opening 112 and/or the second air discharge opening 113.

25 The first air discharge opening 112 is disposed in the casing 110, downstream of the blower 120 and the evaporator 130. Advantageously, the air discharge opening 112 is disposed in the casing 110 upstream of the radiator 140.

Despite figure 1 schematically illustrates that the first air discharge opening 112 and the second  
30 air discharge opening 113 are disposed on different sides of the casing , it should not be considered as limiting, but rather, the relative positions between the first air discharge opening 112 and the second air discharge opening 113 could be optimized freely dependent on the

position of the battery within the electric vehicle or the hybrid electric vehicle as well as the position of the air duct for the cabin 150.

As shown in Figure 1, the air duct for the battery 160 further comprises an air intake opening for the battery 161 leading to the outside of the casing. Preferably, the air intake opening for the battery 161 could be disposed around or close to the first air discharge opening 112, thereby enabling a simplified design of an air intake controlling valve for the battery, which is used to open or close the air intake opening for the battery 161 and disposed around or close to the first air discharge opening 112.

Preferably, the air intake opening for the battery 161 is in communication with the interior of the cabin 190. Thus, clean and/or recycled air of proper temperature in the cabin could be sucked into the air duct for the battery 160 via said air intake opening for the battery 161, thereby cooling the battery. In a preferred embodiment in accordance with the present invention, the air intake controlling valve for battery controls the air fed to the battery with options:

- (a) feeding cooled air from the HVAC system through the first air discharge opening 112 ;
- (b) feeding air from the cabin through the air intake opening for the battery 161;
- (c) feeding air from the combination of (a) and (b).

It is because that the air intake opening for the battery 161 in communication with the interior of the cabin is provided in the air duct for the battery 160, clean and/or recycled air of proper temperature in the cabin could serve as another source of the cooled air fed to the battery cells in addition to the air conditioned by the HVAC system, thereby increasing the reliability of the system for cooling the battery and saving energy.

Alternately, the air intake opening for the battery 161 could also communicate with the exterior of the cabin. In case of air intake opening for the battery 161 communicating with the exterior of the cabin, the air outside the cabin (i.e., environmental air and/or fresh air) will serve as another source of cooled air, it may thus be necessary to provide an additional filter upstream of the air intake opening for the battery 161.

In comparison, an additional filter is not required in case of an air intake opening 161 in communication with the interior of the cabin, thereby simplifying the structure of the HVAC system, and eliminating the energy cost due to the additional filter.

- 5 According to another alternative, the air intake opening for the battery 161 could also communicate with the exterior of the cabin and with the interior of the cabin 190. Preferably, a selecting mode flap is provided to select the air from the exterior of the cabin and/or from the interior of the cabin 190.
- 10 However, an additional filter may also be provided at the air intake opening for the battery 161 of the air duct for the battery 160, in order to ensure the cleanliness of the cooled air.

In the first embodiment, the air intake controlling valve for the battery of the HVAC system takes the form of a first flap 170. The first flap 170 is used to open or close the air intake  
15 opening for the battery 161 and the first air discharge opening 112. The first flap 170 could be positioned into the casing 110, or into the air duct for the battery 160. Preferably, according to a particular alternative embodiment, a secondary blower 162 is also arranged inside the air duct for the battery 160. Those skilled in the art could understand that, the secondary blower 162 could be positioned inside the air duct for the battery 160 and downstream of the air intake  
20 opening for the battery 161. Moreover, other air feeding devices could be used without providing a secondary blower 162.

The structure of the first flap 170 in accordance with the first embodiment of the present invention is schematically shown in Figure 2. As shown in Figure 2, the first flap 170  
25 comprises a closing portion 1701 and a pivoting portion 1702. The closing portion 1701 has a shape of plate, being pivotably mounted into the casing 110 or the air duct for the battery 160 through the pivoting portion 1702. Figure 2 schematically illustrates that the closing portion 1701 is of a rectangular shape. It should be understood, by those skilled in the art, that the shape of the closing portion 1701 is not limited to rectangular, but any shape that could close,  
30 in a sealing way, the first air discharge opening 112 and/or the air intake opening for the battery 161.

As shown in Figure 1, the first flap 170 is movable between two extreme positions. The solid line within the dashed circle illustrates the situation where the first flap 170 is in the first extreme position. The first flap 170 in the first extreme position closes the first discharge opening 112, admitting only the air (preferably, clean or recycled air of proper temperature in the cabin) from the air intake opening for the battery 161 into the air duct for the battery 160.

5 The dotted line within the dashed circle illustrates the situation where the first flap 170 is in the second extreme position. The first flap 170 in the second extreme position closes the air intake opening for the battery 161, admitting only the air from casing 110 cooled by the evaporator (namely cooled air, or conditioned air) into the air duct for the battery 160. While the first flap

10 170 is in-between the first extreme position and the second extreme position (not shown) or intermediate position, both of the first air discharge opening 112 and the air intake opening for the battery 161 are partially open, allowing both the air from the air intake opening for the battery 161 and the cooled air from the casing 110 into the air duct for the battery 160, forming an air mixture to cool the battery. The ratio between the airs from the air intake opening for the

15 battery 161 and/or from the casing 110 in the mixture could be adjusted by adjusting the position of the first flap 170.

The casing 110 further comprises a second discharge opening 113 for feeding air to the cabin and a closing valve 180 for controlling the second discharge opening.

20

Preferably, according to a particular arrangement, when the cabin air temperature is below or equal to 15°C, the closing valve 180 is in the open position and the first flap 170 is in the first extreme position, only air from the cabin through the air intake opening for the battery 161 is fed to the battery cells. When the cabin air temperature is above 15°C but below or equal to

25 20°C, the closing valve 180 is in the close position, and the first flap 170 is in the second extreme position, only cooled air from the HVAC system is fed to the battery cells. And when cabin air temperature is above 20°C, the closing flap 180 is in the open position and the first flap 170 is in the second extreme position, only cooled air from the HVAC system is fed to the battery cells. Meanwhile the cooled air from the HVAC system is also fed to the cabin to adjust

30 the cabin air temperature.

By providing an air intake opening for the battery 161, another source for cooled air could be added in addition to the cooled air from the HVAC system to cool the battery cells, thereby increasing the reliability of the system for cooling the battery and increasing the energy efficiency. In particular, in case of providing an air intake opening for the battery 161 communicating with the interior of the cabin, it is not necessary to provide an additional filter, thereby simplifying the structure of the HVAC system, and eliminating the energy cost due to the additional filter.

By adjusting the positions of the second discharge opening 113 and the air intake opening for the battery 161, and providing only one flap to open or close the second discharge opening 113 and the air intake opening for the battery 161, the first embodiment significantly simplifies the structure of the HVAC system, decreases the spaces occupied and lowers the costs.

Figure 3 is a schematic view of the HVAC system for an electric vehicle and hybrid electric vehicle. The structure of the HVAC system in accordance with the second embodiment is similar to the structure of the HVAC system in accordance with the first embodiment. Therefore, similar parts are denoted by similar reference numbers. The only difference is on the structure of the first flap.

Figure 4 is a schematic view of the structure of the first flap 270 in accordance with the second embodiment of the present invention. As shown in Figure 4, the first flap 270 comprises a closing portion 2701, a pivoting portion 2702, and a supporting portion 2703. The closing portion 2701 is provided with a cylindrical surface. The first flap 270 is pivotably mounted into the casing 110 or the air duct for the battery 160 through the pivoting portion 2702. The supporting portion 2703 connects the pivoting portion 2702 and the closing portion 2701. The supporting portion 2703 is preferably of the rod shape, but could be of any other shape. By integrating the closing portion 2701, the pivoting portion 2702 and the supporting portion 2703, the above mentioned three portions could since pivot about the pivotal axis of the pivoting portion 2702.

Similar to the first flap 170 according to the first embodiment, the first flap 270 according to the second embodiment is also movable between two extreme positions, as shown in Figure 3.

In Figure 3, the solid line within the dashed circle illustrates the situation where the first flap 270 is in the first extreme position, while the dotted line illustrates the situation when the first flap 270 is in the second extreme position. The first flap 270 opens and closes the first air discharge opening 112 and the air intake opening for the battery 161 by moving between the two extreme positions, details will not be described again.

By adjusting the positions of the first air discharge opening 112 and the air intake opening for the battery 161, and providing only one flap 270 to open or close both the first air discharge opening 112 and the air intake opening for the battery 161, this embodiment significantly simplifies the structure of the HVAC system, decreases the spaces occupied and lowers the costs

Figure 5 is a schematic view of the HVAC system for an electric vehicle and hybrid electric vehicle. The similarities between the HVAC system in accordance with the third embodiment and the HVAC system in accordance with the second embodiment will not be described again. Therefore, similar parts are denoted by similar reference numbers. The differences between them will be described as follow.

In accordance with the third embodiment of the present invention, the casing 110 further has a second air intake opening 312 provided between the first air intake opening 111 and the blower 120. Wherein the first air intake 111 is in communication with the exterior of the cabin; the second air intake opening 312 is in communication with the interior of the cabin 190.

Furthermore, an air filter 380 may be provided downstream of the first air intake opening 111 and the second air intake opening 312 and upstream of the blower 120, in order to clean the air sucked from the first air intake opening 111 and/or the second air intake opening 312.

In the above mentioned designs, because of the providing of the second air intake opening 312 in communication with the interior of the cabin 190, the ratio between the air from the exterior of the cabin and the air from the interior of the cabin in the air sucked into the casing 110 could be adjusted as required, thereby keeping the air fresh and saving energy. Meanwhile, as the air

intake opening for the battery 161 is provided communicating with the exterior of the cabin 190, not requiring a separate filter, thereby simplifying the structure.

In addition, one second flap 390 could open and close the first air intake opening 111 and the  
5 second air intake opening 312. The structure of the second flap 390 could be that of the first  
flap 170 in accordance with the first embodiment, or that of the first flap 270 in accordance  
with the second embodiment. The adjustment of the ratio between the air from the exterior of  
the cabin and the air from the interior of the cabin 190 in the air sucked into the casing 110  
could be implemented by any of the structures. In the embodiment shown in Figure 5, the  
10 second flap 390 is of the plate shape. Certainly, the second flap 390 could be of the structure as  
shown in figure 4 or any other shape that could be recognized by those skilled in the art.

It should be appreciated that, the above mentioned embodiments merely serve to explain the  
technical designs of the present invention, but not to limit the scope thereof. Despite of a  
15 detailed description in conjunction with the preferred embodiments, those skilled in the art  
could recognize the various modifications or alternatives to the technical designs of the present  
invention without departing from the scope thereof.

**CLAIMS**

1. An Heating, Ventilating and Air Conditioning system for an electric vehicle or a hybrid  
5 electric vehicle, comprising:
- a casing (110);
  - a blower (120) disposed within the casing (110), and
  - an air duct for the battery (160) disposed outside the casing (110),
- wherein the casing (110) includes a first air intake opening (111) provided upstream of the  
10 blower (120) and a first air discharge opening (112) provided downstream of the blower (120),  
wherein the air duct for the battery (160) is connected to the first air discharge opening (112),  
and  
wherein the air duct for the battery (160) has an air intake opening for the battery (161)  
communicating with the interior of a cabin (190), and an air intake controlling valve for battery  
15 which controls the air fed to the battery with options:
- (a) feeding cooled air from the Heating, Ventilating and Air Conditioning system through  
the first air discharge opening (112);
  - (b) feeding air from the cabin (190) through the air intake opening for the battery (161);
  - (c) feeding air from the combination of (a) and (b).
- 20
2. The Heating, Ventilating and Air Conditioning system according to claim 1, wherein the air  
intake controlling valve for the battery comprises a first flap (170; 270) which simultaneously  
controls the first air discharge opening (112) and the air intake opening for the battery (161)  
and is movable between two extreme positions, in which the first flap closes the first air  
25 discharge opening (112) in the first extreme position and closes the air discharge opening for  
the battery (161) in the second extreme position.
3. The Heating, Ventilating and Air Conditioning system according to claim 1 or 2, wherein the  
casing (110) further comprises a second discharge opening (113) for feeding air to the cabin  
30 and a closing valve (180) for controlling the second discharge opening (113).
4. The Heating, Ventilating and Air Conditioning system according to claim 3, wherein:

- when the cabin air temperature is below or equal to 15°C, the closing valve (180) is in the open position and the first flap (170; 270) is in the first extreme position;
- when the cabin air temperature is above 15°C but below or equal to 20°C, the closing valve (180) is in the close position, and the first flap (170; 270) is in the second extreme position;
- when cabin air temperature is above 20°C, the closing flap (180) is in the open position and the first flap (170; 270) is in the second extreme position.

5

5. The Heating, Ventilating and Air Conditioning system according to any of claims 1 to 4, wherein a secondary blower (162) is provided inside the air duct for the battery (160).

10

6. The Heating, Ventilating and Air Conditioning system according to any of claims 1 to 5, wherein the first flap (170) comprises a closing portion (1701) and a pivoting portion (1702), wherein the closing portion (1701) has a shape of plate, and the first flap is pivotably mounted into the casing (110) or the air duct for the battery (160) through the pivoting portion (1702).

15

7. The Heating, Ventilating and Air Conditioning system according to any of claims 1 to 5, wherein the first flap (270) comprises a closing portion (2701), a pivoting portion (2702), and a supporting portion (2703), wherein the closing portion (2701) is provided with a cylindrical surface, the first flap is pivotably mounted into the casing (110) or the air duct for the battery (160) through the pivoting portion, and the supporting portion (2703) connects the pivoting portion (2702) and the closing portion (2701).

20

8. The Heating, Ventilating and Air Conditioning system according to any of claims 1 to 7, wherein a filter (380) is provided between the first air intake opening (111) and the blower (120).

25

9. The Heating, Ventilating and Air Conditioning system according to any of claims 1 to 8, wherein the casing (110) is further provided with a second air intake opening (312) between the first air intake opening (111) and the blower (120), wherein the first air intake opening (111) is connected to the exterior of the cabin, and the second air intake opening is connected to the interior of the cabin (190).

30

10. The Heating, Ventilating and Air Conditioning system according to claim 9, wherein the first air intake opening (111) and the second air intake opening (312) are controlled by a second flap (390) which is movable between two extreme positions, and the second flap closes  
5 the first air intake opening in the first extreme position and closes the second air intake opening in the second extreme position.
11. The Heating, Ventilating and Air Conditioning system according to claim 10, wherein the second flap (390) comprises a closing portion and a pivoting portion, wherein the closing  
10 portion has a shape of plate, and the second flap is pivotably mounted to the casing via the pivoting portion.
12. The Heating, Ventilating and Air Conditioning system according to claim 10, wherein the second flap (390) comprises a closing portion, a pivoting portion and a supporting portion,  
15 wherein the closing portion is provided with a cylindrical surface, the second flap is pivotably mounted to the casing via the pivoting portion, and the supporting portion connects the pivoting portion and the closing portion.
13. The Heating, Ventilating and Air Conditioning system according to any of claims 1 to 12,  
20 wherein an additional filter is provided at the air intake opening for the battery (161) of the air duct for the battery (160).

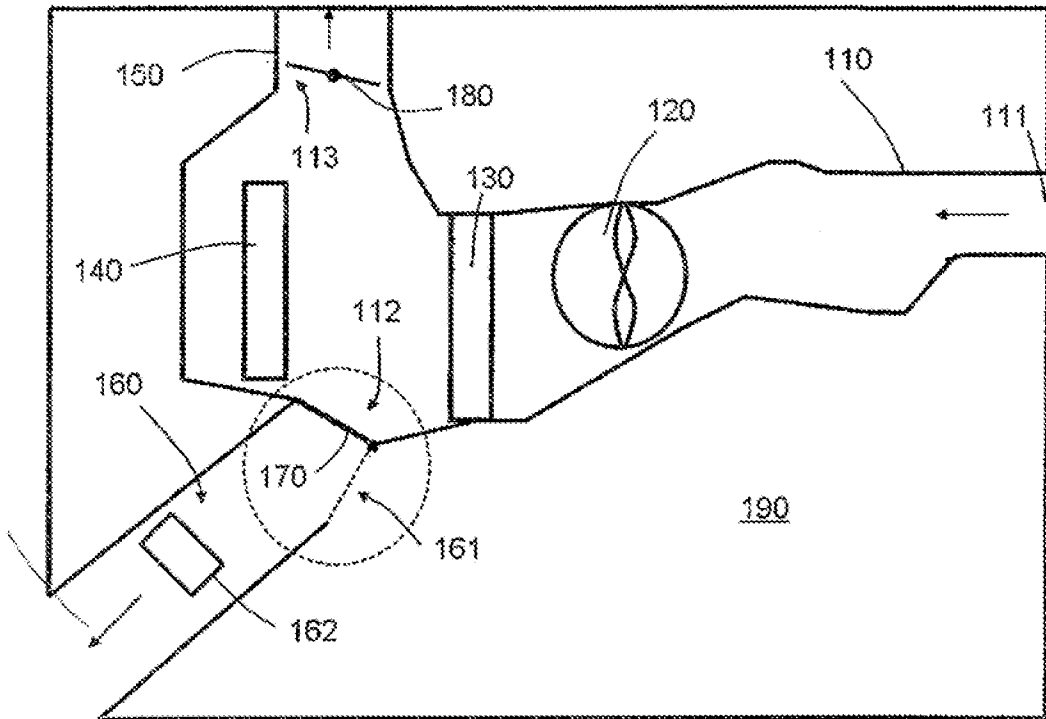


FIG. 1

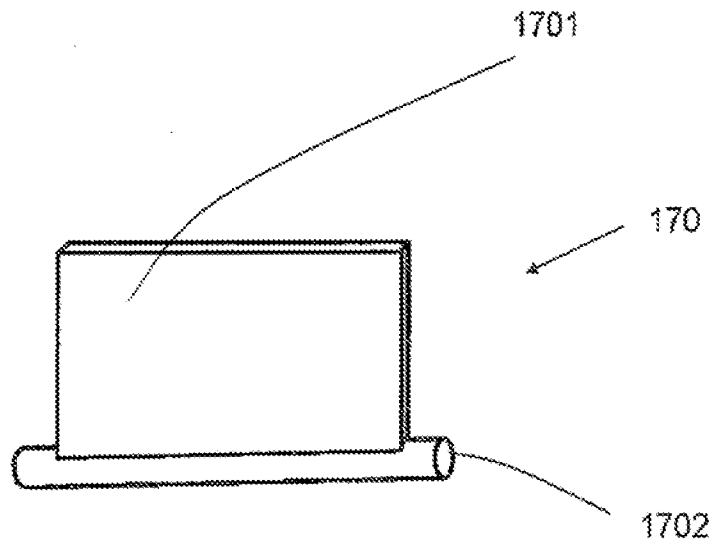


FIG. 2

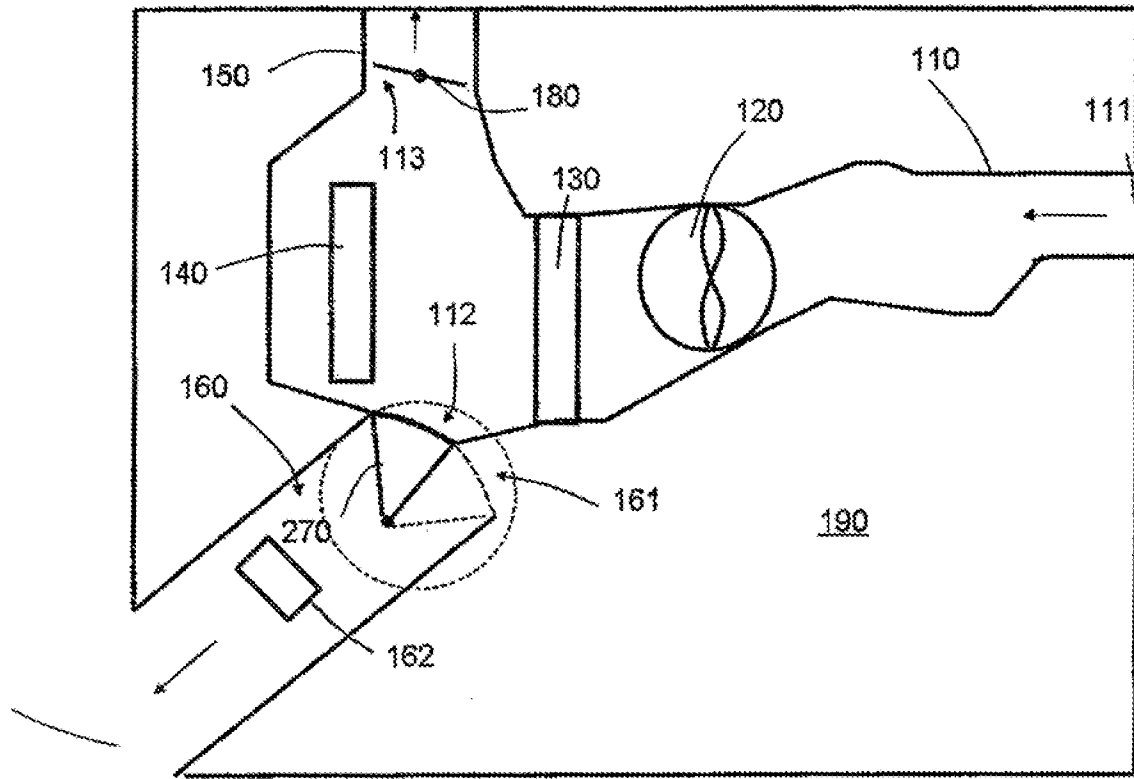


FIG. 3

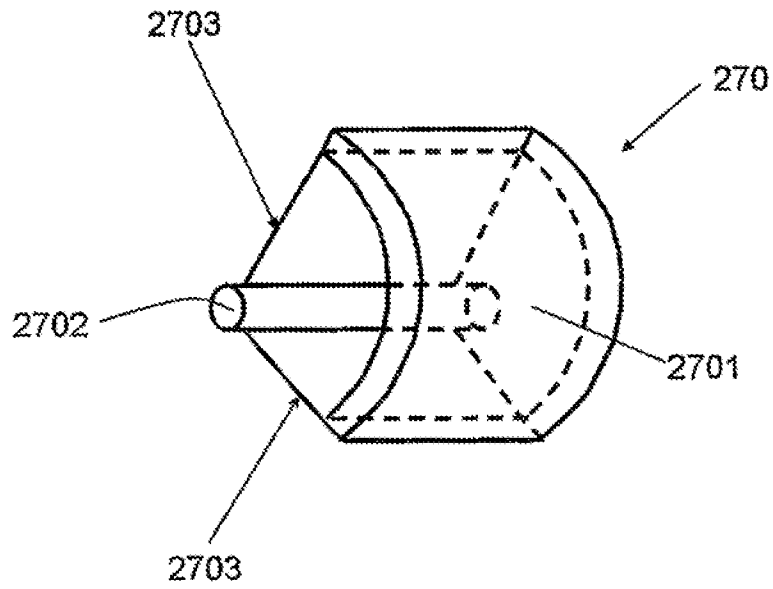


FIG. 4

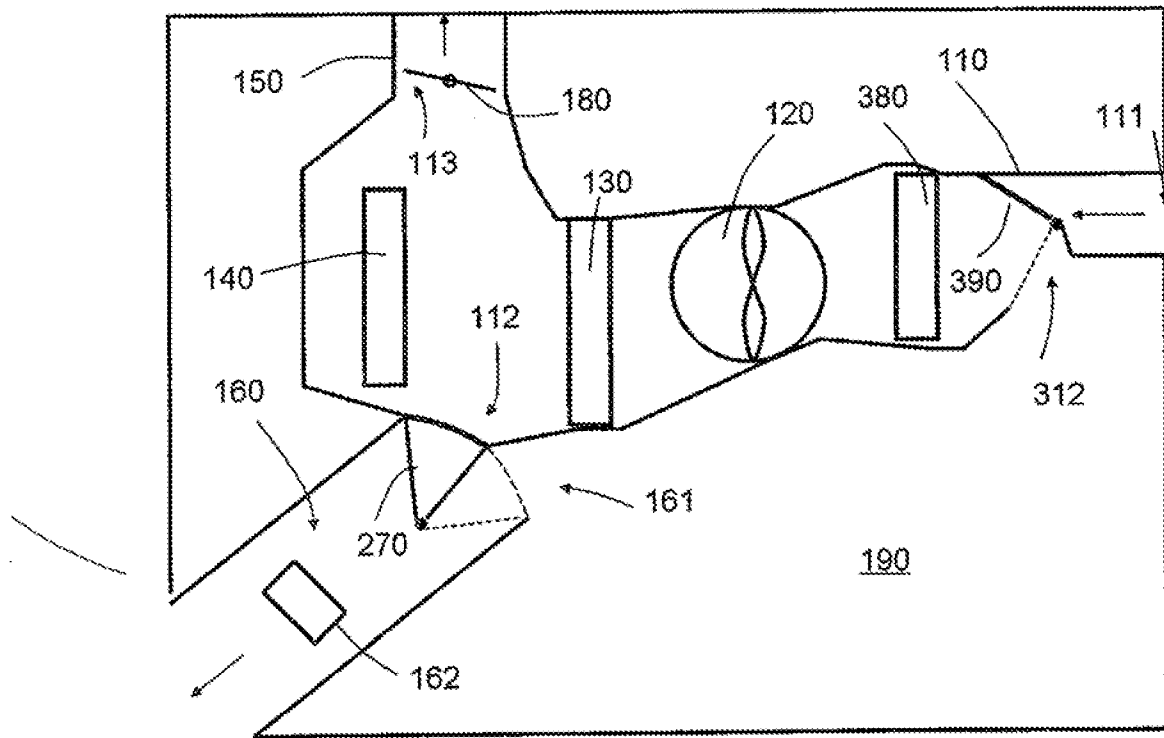


FIG. 5

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/081433

## A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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: B60H1/-, H01M10/-

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 practicable, search terms used)

WPI;EPODOC;CNPAT;CNKI: HVAC, air w condition???, ventilat+, blower/fan, battery/energy, storage, intake/inlet, discharge/outlet, electric/hybrid, vehicle, cool, cabin, compartment, temperature, duct

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN101410261A (TOYOTA MOTOR CO LTD) 15 Apr. 2009 (15.04.2009) description page 9, line 8-page 12, line 5; figures 1-3	1-2,5-6,8-11,13
Y		3-4,7,12
X	CN101479144A (TOYOTA MOTOR CORP) 08 Jul. 2009 (08.07.2009) description page 6, line 8-page 8, line 17; figures 1-3	1-2,5-6,8-11,13
Y		3-4,7,12
Y	US2006/0073378A1 (Hamery et al.) 06 Apr. 2006 (06.04.2006) description paragraphs 0069-0076; figures 5-6	3-4,7,12

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

**15 Jan. 2012(15.01.2012)**

Date of mailing of the international search report

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**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/CN2011/081433

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US2006/0080986A1 (Inoue) 20 Apr. 2006 (20.04.2006) description paragraphs 0073-0138; figure 1	1-6
X	JP2007-185997A (DENSO CORP) 26 Jul. 2007 (26.07.2007) description paragraphs 0020-0084; figures 1-3	1-6,8,13
A	DE102007017019A1 (DAIMLER CHRYSLER AG) 27 Mar. 2008 (27.03.2008) the whole document	1-13
A	CN101386285A(GM GLOBAL TECH OPERATIONS INC) 18 Mar. 2009 (18.03.2009) the whole document	1-13

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
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International application No.

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Continuation of: A. CLASSIFICATION OF SUBJECT MATTER

H01M10/50 (2006.01)i

B60H1/32 (2006.01)i