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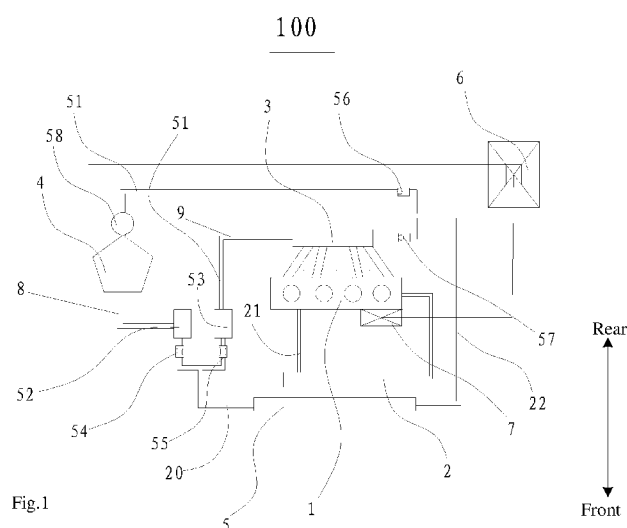
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(54) **Title:** HYBRID VEHICLE

(57) **Abstract:** A hybrid vehicle (100) is provided. The hybrid vehicle (100) includes: an engine assembly (1); a first radiator (2) adapted to cool the engine assembly (1); a turbocharger (7) adapted to turbocharge air in the turbocharger (7) using gases exhausted from the engine assembly (1); an intercooler (3) adapted to cool the turbocharged air and adapted to supply the cooling air to the engine assembly (1); a driving motor assembly (4); a second radiator (5) disposed in front of the first radiator (2); a first cooling pipe (8) coupled between the second radiator (5) and the driving motor assembly (4); and a second cooling pipe (9) coupled between the second radiator (5) and the intercooler (4). The hybrid vehicle (100) has increased cooling effects, i.e. improved heat dissipation effects.

HYBRID VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and benefits of Chinese Patent Application No. 201310314248.0, filed with the State Intellectual Property Office of P. R. China on July 24, 2013, the entire content of the above-identified application is incorporated herein by reference.

FIELD

Embodiments of the present disclosure relate to a vehicle, and more particularly to a hybrid vehicle.

BACKGROUND

Vehicles have been developed rapidly. In order to improve fuel economy, supercharged engine assembly is applied to the hybrid vehicle. A cooling system of the hybrid vehicle not only needs to cool the supercharged engine assembly, but also need to cool electrical components of the hybrid vehicle. Thus more and more cooling systems are required, for example, a high-temperature radiator for cooling the engine, a low-temperature radiator for cooling the intercooler, and a low-temperature radiator for cooling the electrical components. Because the front cabin of the vehicle has limited space, the arrangement of the cooling systems is difficult. With the increasing of the radiators, wind resistance of the front cabin is increased and remaining space of the front cabin is further limited, which may decrease the cooling effect.

SUMMARY

Embodiments of the present disclosure seek to solve at least one of the problems existing in the prior art to at least some extent.

Accordingly, a hybrid vehicle may be provided, the hybrid vehicle may have an increased cooling effect, i.e. improved heat dissipation effects. The hybrid vehicle according to embodiments of the present disclosure may include: an engine assembly; a first radiator adapted to cool the engine assembly; a turbocharger adapted to turbocharge air in the turbocharger using gases exhausted from the engine assembly; an intercooler adapted to cool the turbocharged air and adapted to supply the cooling air to the engine assembly; a driving motor assembly; a second

radiator disposed in front of the first radiator; a first cooling pipe coupled between the second radiator and the engine assembly; and a second cooling pipe coupled between the second radiator and the intercooler.

In some embodiments, the hybrid vehicle further includes a first pump disposed at the first cooling pipe, and a second pump disposed at the second cooling pipe.

In some embodiments, an output speed of the first pumps is adjustable, and an output speed of the second pumps is adjustable.

In some embodiments, the hybrid vehicle further includes a first flow regulating device disposed at the first cooling pipe; and a second flow regulating device disposed at the second cooling pipe.

In some embodiments, each of the first and second flow regulating devices includes a flow regulating valve.

In some embodiments, the hybrid vehicle further includes a first sharing duct defining a first end coupled to a first end of the second radiator, and a second end coupled to upstream ends of the first and second cooling pipes respectively; and a second sharing duct defining a first end coupled to downstream ends of the first and second cooling pipes respectively, and a second end coupled to a second end of the second radiator.

In some embodiments, the hybrid vehicle further includes a first one-way valve disposed at the first cooling pipe; and a second one-way valve disposed at the second cooling pipe.

In some embodiments, the hybrid vehicle further includes a temperature detecting device disposed at the first cooling pipe and downstream of the driving motor assembly.

In some embodiments, the temperature detecting device includes a temperature sensor.

In some embodiments, a formula $0 < T \leq T_{\max}$ is satisfied, where T is a temperature of a cooling liquid in the first cooling pipe measured by the temperature detecting device, $T_{\max}$ is a maximum operating temperature of the driving motor assembly, in which a rotation speed of the first pump is positively related to the temperature T .

In some embodiments, when a temperature of a charge air of the engine assembly reaches a predetermined maximum charge air temperature and $0 < T \leq T_1$, where T_1 is a temperature of the cooling liquid in the first cooling pipe, a speed of the second pump is negatively related to the temperature T .

In some embodiments, when a temperature of a charge air of the engine assembly reaches a

predetermined maximum charge air temperature and $T_1 < T \leq T_{\max}$, where T_1 is a temperature of the cooling liquid in the first cooling pipe, a rotation speed of the second pump is the same as that at which $T=T_1$.

In some embodiments, when a temperature of a charge air of the engine assembly reaches a predetermined maximum charge air temperature and $T=T_{\max}$, a rotation speed of the second pump is zero and a compressor of the turbocharger stops operating.

In some embodiments, the turbocharger includes: a turbine shaft; a turbine wheel coupled to the turbine shaft and adapted to rotate about a central axis of the turbine shaft; a compressor shaft having a central axis coincided with the central axis of the turbine shaft; a compressor wheel coupled to the compressor shaft and adapted to rotate about the central axis of the compressor shaft; and a clutch coupled between the compressor shaft and the turbine shaft.

In some embodiments, the clutch is an electromagnetic clutch.

Additional aspects and advantages of embodiments of present disclosure will be given in part in the following descriptions, become apparent in part from the following descriptions, or be learned from the practice of the embodiments of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and advantages of embodiments of the present disclosure will become apparent and more readily appreciated from the following descriptions made with reference to the accompanying drawings, in which:

Fig. 1 is a schematic view illustrating a hybrid vehicle according to an embodiment of the present disclosure;

Fig. 2 is a schematic view illustrating a hybrid vehicle according to another embodiment of the present disclosure;

Fig. 3 is a schematic view illustrating a turbocharger of a hybrid vehicle according to an embodiment of the present disclosure;

Fig. 4 is a schematic graph illustrating a relation between a rotation speed of a first pump and a temperature of a cooling liquid in a first cooling pipe of a hybrid vehicle according to an embodiment of the present disclosure; and

Fig. 5 is a schematic graph illustrating a relation between a rotation speed of a second pump and a temperature of a cooling liquid in a first cooling pipe of a hybrid vehicle according to an

embodiment of the present disclosure.

DETAILED DESCRIPTION

Reference will be made in detail to embodiments of the present disclosure. The same or
5 similar elements and the elements having same or similar functions are denoted by like reference numerals throughout the descriptions. The embodiments described herein with reference to drawings are explanatory, illustrative, and used to generally understand the present disclosure. The embodiments shall not be construed to limit the present disclosure.

In addition, terms such as “first” and “second” are used herein for purposes of description and
10 are not intended to indicate or imply relative importance or significance. Thus, features limited by “first” and “second” are intended to indicate or imply including one or more than one these features. In the description of the present disclosure, “a plurality of” relates to two or more than two.

In the description of the present disclosure, unless specified or limited otherwise, it should be
15 noted that, terms “mounted,” “connected” “coupled” and “fastened” may be understood broadly, such as permanent connection or detachable connection, electronic connection or mechanical connection, direct connection or indirect connection via intermediary, inner communication or interreaction between two elements. These having ordinary skills in the art should understand the specific meanings in the present disclosure according to specific situations.

In the description of the present disclosure, a structure in which a first feature is “on” a
20 second feature may include an embodiment in which the first feature directly contacts the second feature, and may also include an embodiment in which an additional feature is formed between the first feature and the second feature so that the first feature does not directly contact the second feature, unless otherwise specified. Furthermore, a first feature “on,” “above,” or “on top of” a
25 second feature may include an embodiment in which the first feature is right “on,” “above,” or “on top of” the second feature, and may also include an embodiment in which the first feature is not right “on,” “above,” or “on top of” the second feature, or just means that the first feature has a sea level elevation larger than the sea level elevation of the second feature. While first feature “beneath,” “below,” or “on bottom of” a second feature may include an embodiment in which the
30 first feature is right “beneath,” “below,” or “on bottom of” the second feature, and may also include an embodiment in which the first feature is not right “beneath,” “below,” or “on bottom

of' the second feature, or just means that the first feature has a sea level elevation smaller than the sea level elevation of the second feature.

A hybrid vehicle according to embodiments of the present disclosure will be described with reference to Figs. 1-5.

5 As shown in Fig. 1, a hybrid vehicle 100 includes an engine assembly 1, a first radiator 2, a turbocharger 7, an intercooler 3, a driving motor assembly 4, a second radiator 5, a first cooling pipe 8 and a second cooling pipe 9.

The engine assembly 1 is adapted to supply power to the hybrid vehicle 100 by burning fuels, so the temperature of the engine assembly 1 is usually high.

10 The first radiator 2 is adapted to cool the engine assembly 1. The first radiator 2 is coupled with the engine assembly 1 via a first connecting member 21, for example, a connecting hose tube. The first radiator 2 is adapted to supply a cooling liquid, for example, water, to the engine assembly 1 to cool the engine assembly 1, so as to decrease the temperature of the engine assembly 1.

15 The turbocharger 7 is adapted to turbocharge air in the turbocharger 7 using gases exhausted from the engine assembly 1 so as to provide a turbocharged air. In some embodiments, the turbocharger 7 includes a turbine 73 and a compressor 74 disposed coaxially with the turbine 73. High-temperature gases exhausted from the engine assembly 1 is discharged to the turbine 73, and expand to drive a turbine wheel 731 of the turbine 73 to rotate, which drives a compressor wheel 20 741 of the compressor 74 to rotate. Then the air charged into a shell of the compressor 74 is compressed by the compressor wheel 741, and the compressed air is supplied to a combustor of the engine assembly 1.

The intercooler 3 is adapted to cool the turbocharged air to provide a cooling air and adapted to supply the cooling air to the engine assembly. In other words, the intercooler 3 may cool the 25 compressed air compressed by the compressor 74.

The driving motor assembly 4 is adapted to supply power to the hybrid vehicle 100. It can be understood that, the driving motor assembly 4 is well known to a person skilled in the art, so that the detailed description thereof is omitted herein.

The second radiator 5 is disposed in front of the first radiator 2. In other words, the air firstly 30 passes through and cools the second radiator 5, and then passes through and cool the first radiator 2.

The second radiator 5 is adapted to cool the driving motor assembly 4 and the intercooler 3. For example, the second radiator 5 is adapted to cool the air in the air charge system and other electronic components. However, a temperature of the air in the air charge system and other electronic components is much lower than the temperature of the engine assembly 1, such that when the air finishes cooling the second radiator 5, it can be used to effectively cool the first radiator 2.

The first cooling pipe 8 is coupled between the second radiator 5 and the driving motor assembly 4. The second cooling pipe 9 is coupled between the second radiator 5 and the intercooler 3. In other words, the cooling liquid discharged from the second radiator 5 flows through the intercooler 3 and the driving motor assembly 4 respectively, in order to independently cool the intercooler 3 and the driving motor assembly 4. Conventionally, each of the intercooler and driving motor assembly needs a radiator respectively. Compared to the conventional arrangement, the number of radiators is reduced, thus the wind resistance is reduced, the arrangement is easy and the cost is reduced.

In some embodiments, the second radiator 5 is coupled with the driving motor assembly 4 via a second connecting member 51, for example, a connecting hose tube, thus forming the first cooling pipe 8. And the second radiator 5 is coupled with the intercooler 3 via the second connecting accessory 51, thus forming the second cooling pipe 9.

According to embodiments of the present disclosure, the intercooler 3 and the driving motor assembly 4 are both cooled by the second radiator 5. In comparison with a conventional hybrid vehicle having two radiators for the driving motor assembly and the intercooler respectively, the number of radiators is reduced, thus the wind resistance is reduced, the arrangement is easy and the cost is reduced. The second radiator 5 is disposed in front of the first radiator 2, then the cooling requirements of the driving motor assembly 4, the intercooler 3 and the engine assembly 1 may be satisfied.

In some embodiments, as shown in Fig.1, the hybrid vehicle 100 further includes a first pump 52 disposed at the first cooling pipe 8, and a second pump 53 disposed at the second cooling pipe 9. The first pump 52 and the second pump 53 may be both electric pumps.

The first pump 52 is adapted to drive the cooling liquid for cooling the driving motor assembly 4 to circulate, and to drive a cooling liquid in the first cooling pipe 8 to flow, thereby the cooling effect may be improved.

Similarly, the second pump 53 is adapted to drive a cooling liquid for the intercooler 3 to circulate, and to drive a cooling liquid in the second cooling pipe 9 to flow, thereby the cooling effect is enhanced.

5 In some embodiments, output rotating speeds of both the first and second pumps 52, 53 are adjustable. In other word, by adjusting the output rotating speeds of the first and second pumps 52, 53, flow rates of the cooling liquids in the first cooling pipe 8 and the second cooling pipe 9 may be adjusted. Thus the demanding cooling effect may be achieved by adjusting the output rotation speeds of the first and second pumps 52, 53 in accordance with actual situations.

10 In some embodiments, as shown in Fig.1, the hybrid vehicle further includes a first flow regulating device 54 disposed at the first cooling pipe 8, and a second flow regulating device 55 disposed at the second cooling pipe 9.

The first flow regulating device 54 is adapted to regulating the flow rate of the cooling liquid in the first cooling pipe 8, and the second flow regulating device 55 is adapted to regulating the flow rate of the cooling liquid in the second cooling pipe 9. Each of the first and second flow
15 regulating devices includes a flow regulating valve.

The first flow regulating device 54 is disposed at the first cooling pipe 8, so the effect for cooling the driving motor assembly 4 may be regulated by regulating the flow rate of the cooling liquid in the first cooling pipe 8. And the second flow regulating device 55 is disposed at the second cooling pipe 9, so the effect for cooling the intercooler 3 may be regulated by regulating
20 the flow rate of the cooling liquid in the second cooling pipe 9.

The cooling liquid of the second radiator 5 is used to cool both the driving motor assembly 4 and the intercooler 3. In some embodiments, the flow rates of the cooling liquids in the first cooling pipe 8 and second cooling pipe 9 may be regulated via the first pump 52, the second pump 53, the first flow regulating device 54 and second flow regulating device 55, thus achieving the
25 optimized cooling effect.

In some embodiments, the he first pump 52, the second pump 53, the first flow regulating device 54 and second flow regulating device 55 are controlled by an ECU 6 (Electronic Control Unit).

30 In an embodiment of the present disclosure, as shown in Fig.2, the first flow regulating device 54 and second flow regulating device 55 are not included in the hybrid vehicle 100. The flow rates of the cooling liquids in the first cooling pipe 8 and second cooling pipe 9 are regulated by

regulating the output rotation speeds of the first pump 52 and the second pump 53.

In an embodiment of the present disclosure, as shown in Fig.1, the hybrid vehicle further includes a first sharing duct 20 and a second sharing duct 22. Two ends of the first cooling pipe 8 are coupled to the second radiator 5 via the first and second sharing ducts 21, 22 respectively; and two ends of the second cooling pipe 9 are coupled to the second radiator 5 via the first and second sharing ducts 21, 22 respectively. In other words, the first sharing duct 20 defines a first end coupled to a first end of the second radiator 5, and a second end coupled to upstream ends of the first and second cooling pipes 8, 9 respectively. The second sharing duct 22 defines a first end coupled to downstream ends of the first and second cooling pipes 8, 9, respectively, and a second end coupled to a second end of the second radiator 5.

In this way, after cooled in the second radiator 5, the cooling liquid is discharged from the second radiator into the first sharing duct 20, and then flows into the first and second cooling pipes 8, 9 respectively. After the driving motor assembly and the intercooler 3 are cooled by sub-cooling fluids in the first and second cooling pipes 8, 9 respectively, to the sub-cooling fluids are joined in the second sharing duct 22 and flow back to the second radiator 5. It can be understood that, when the second pump is not working, all the cooling liquid in the first sharing duct 20 is discharged into the first cooling pipe 8 to cool the driving motor assembly 4.

In some embodiments, the hybrid vehicle 100 further includes a first one-way valve 56 and a second one-way valve. The first one-way valve 56 is disposed at the first cooling pipe 8, and the second one-way valve 57 is disposed at the second cooling pipe 9.

With the first one-way valve 56 disposed at the first cooling pipe 8, the cooling liquid in the first cooling pipe 8 flows only in one direction, which may prevent the cooling liquid in the second cooling pipe 9 from flowing back to the first cooling pipe 8, thus preventing the cooling liquid from circulating in the first cooling pipe 8. Therefore the influence on cooling effect of the first cooling pipe 8 caused by circulation of the cooling liquid in the first cooling pipe 8 may be reduced or even avoided, i.e., the influence on the effect for cooling the driving motor assembly 4 may be reduced or even avoided. Similarly, with the second one-way valve 57 disposed at the second cooling pipe 9, the cooling liquid in the second cooling pipe 9 flows in one direction, which may prevent the cooling liquid in the first cooling pipe 8 from flowing back to the second cooling pipe 9, thus preventing the cooling liquid from circulating in the second cooling pipe 9. Therefore the influence on the cooling effect of the second cooling pipe 9 caused by the circulation

of the cooling liquid in the second cooling pipe 9 may be reduced or even avoided, that is, the influence on the effect for cooling the intercooler 3 may be reduced or even avoided.

In some embodiments, the hybrid vehicle 100 further includes a temperature detecting device 58. The temperature detecting device 58 is disposed at the first cooling pipe 9 and downstream of the driving motor assembly 4. In an embodiment, the temperature detecting device 58 includes a temperature sensor. The temperature detecting device 58 is adapted to measure a temperature of the cooling liquid which has cooled the driving motor assembly 4.

It can be understood that, downstream of the driving motor assembly 4, the nearer to the driving motor assembly 4, the higher the temperature of the cooling liquid is, so the temperature of the cooling liquid measured by the temperature detecting device 58 can reflect an operating temperature of the driving motor assembly 4. In an embodiment, the temperature detecting device 58 is closely adjacent to the driving motor assembly 4 in order to measure the temperature of the cooling fluid which has cooled the driving motor assembly 4 right now. In this way, the operating temperature of the driving motor assembly 4 may be reflected reasonably, and the cooling liquid may be distributed more reasonably according to practical requirements by controlling ECU 6. In some embodiments, the temperature detecting device 58 can be more than one.

When a temperature T , a formula $0 < T \leq T_{\max}$ is satisfied, where T is a temperature of a cooling liquid in the first cooling pipe measured by the temperature detecting device, $T_{\max}$ is a maximum operating temperature of the driving motor assembly, in which a rotation speed of the first pump is positively related to the temperature T . The maximum operating temperature $T_{\max}$ of the driving motor assembly 4 is determined by the characteristics of the driving motor assembly 4. In view of driving motor assemblies of different hybrid vehicles, the maximum operating temperatures of these driving motor assemblies may be the same or different.

It can be understood that, in an embodiment, the maximum operating temperature $T_{\max}$ of the driving motor assembly 4 is a predetermined value. When the temperature of the driving motor assembly 4 exceeds the maximum operating temperature $T_{\max}$ of the driving motor assembly 4, low operation efficiency of the of the driving motor assembly 4 is caused, the driving motor assembly 4 may be damaged in some serious conditions. Therefore the operating temperature of the driving motor assembly 4 may be below the maximum operating temperature $T_{\max}$. When the operating temperature of the driving motor assembly 4 is less than the maximum operating temperature $T_{\max}$, the driving motor assembly 4 can work normally and steadily. The maximum

operating temperature $T_{\max}$ can be given different values according to characteristics of different kinds of driving motor assemblies.

The rotation speed of the first pump 52 is positively related to the temperature T , that is, the higher the temperature T measured by the temperature detecting device 58 is, the higher the rotation speed of the first pump 52 is. Similarly, the lower the temperature T is, the lower the speed of the first pump 52 is.

As shown in Fig.4, the temperature of the cooling liquid (which is in the first cooling pipe 8 and has cooled the driving motor assembly 4) measured by the temperature detecting device 58 is T , and the T includes T_4 , T_3 , T_2 and T_1 all being specific temperatures measured by the temperature detecting device 58, where $T_4 < T_3 < T_2 < T_1$. A rotation speed of the first pump 52 is defined as n , and n includes n_4 , n_3 , n_2 and n_1 all being specific rotation speeds of the first pump 52, where $n_1 < n_2 < n_3 < n_4$. As shown in Fig.4, with the increase of the temperature T , the rotation speed n of the first pump 52 increases.

It is noted that, T_1 is a temperature of the cooling liquid in the first cooling pipe 8 when a temperature of a charge air of the engine assembly reaches a predetermined maximum charge air temperature. The temperature T may be linearly or non-linearly related to the rotation speed n of the first pump 52. The corresponding relation between the temperature T and the rotation speed n can be obtained by experiments.

It can be understood that, the higher the temperature T is, the higher the operating temperature of the driving motor assembly 4 is. It needs more cooling liquid to cool the driving motor assembly 4 at this time, so the rotation speed of the first pump 52 is increased to deliver more cooling liquid to cool the driving motor assembly 4. Then the driving motor assembly 4 can work normally in the ideal temperature environment, and the stability of the hybrid vehicle is improved.

During the temperature increase of the driving motor assembly, the rotation speed of the first pump is increased to deliver more cooling liquid to cool the driving motor assembly 4, thus improving the effect for cooling the driving motor assembly 4. Correspondingly, at this time, the rotation speed of the second pump 53 may be gradually decreased, and less cooling liquid is delivered to the intercooler 3, and the temperature of the charge air is gradually increased.

When the temperature of air which is cooled by the intercooler 3 measured by a charge air temperature sensor in the engine assembly 1 reaches a predetermined maximum charge air

temperature, the second pump 53 is operating with a certain rotation speed to ensure the performance of engine assembly 1. At this time, the temperature of the cooling liquid in the first cooling pipe 8 is T_1 .

As shown in fig.5, the temperature of the cooling liquid in the first cooling pipe 8 measured by the temperature detecting device 58 is T , and T specifically includes T_4, T_3, T_2 and T_1 , where $T_4 < T_3 < T_2 < T_1$. A rotation speed of the second pump 52 is n' , and n' specifically includes n_4', n_3', n_2' and n_1' , where $n_1' < n_2' < n_3' < n_4'$. It is noted that, T_1 is the temperature of the cooling liquid in the first cooling pipe 8 when the temperature of the charge air of the engine assembly 1 is at the predetermined maximum charge air temperature.

When the temperature of the charge air of the engine assembly reaches the predetermined maximum charge air temperature and $0 < T \leq T_1$, the rotation speed of the second pump 53 is negatively related to the temperature T . In other words, the higher the temperature T is, the lower the rotation speed n' of the second pump 53 is. Similarly, the lower the temperature T is, the higher the speed n' of the second pump 53 is.

When the temperature of the charge air of the engine assembly 1 reaches the predetermined maximum charge air temperature, that is, $T = T_1$, the rotation speed of the second pump 53 is n_1' .

It can be understood that, the higher of the temperature of the cooling fluid in the first cooling pipe 8 is, it is required larger amounts of the cooling liquid to cool the driving motor assembly 4. Therefore the rotation speed of the first pump 52 is increased to deliver more cooling liquid to cool the driving motor assembly 4, and the rotation speed of the second pump 53 is decreased, such that the driving motor assembly 4 can work steadily in the ideal temperature environment, and the stability of the hybrid vehicle is improved.

The temperature T may be linearly or non-linearly related to the rotation speed n' of the second pump 53. The corresponding relation between the temperature T and the rotation speed n' , the corresponding relation between the rotation speed of the first pump and T_1 , and the corresponding relation between the rotation speed of the second pump and T_1 can be obtained by experiments.

When the temperature of the charge air of the engine assembly reaches the predetermined maximum charge air temperature and $T_1 < T \leq T_{\max}$, the rotation speed n' of the second pump 53 is the same as that at which $T = T_1$. That is, when the temperature T does not reach the maximum operating temperature $T_{\max}$, and $T_1 < T \leq T_{\max}$, the rotation speed of the second pump 53 is the

same as that at which $T=T_1$. In other words, the rotation speed n' of the second pump 53 is kept at a value of n_1' .

When the temperature of the charge air of the engine assembly reaches the predetermined maximum charge air temperature and $T=T_{\max}$, a rotation speed of the second pump 53 is zero and
5 a compressor 74 of the turbocharger 7 stops operating. That is, when the temperature of the cooling liquid in the first cooling pipe 8 reaches the maximum operating temperature $T_{\max}$, the driving motor assembly 4 is firstly cooled, and the second pump 53 stops operation at this time. That is, no cooling liquid is supplied to cool the intercooler 3. All the cooling liquid in the second radiator 5 is used to cool the driving motor assembly 4, so as to reduce the temperature of the
10 driving motor assembly 4 and to improve the stability of the hybrid vehicle.

At the same time, the compressor 74 also stops operating. In other words, the air charged into the engine assembly 1 is not compressed, and the engine assembly becomes a naturally aspirated engine, thus reducing the temperature of charge air which is kept below the maximum charge air temperature.

15 Referring to Fig 5, when $0 < T \leq T_1$, as the temperature of the cooling liquid in the first cooling pipe 8 which has cooled the driving motor assembly 4 is increasing, the rotation speed of the second pump 53 is decreasing. When $T = T_1$, the rotation speed of the second pump 53 is n_1' .

When $T_1 < T < T_{\max}$, the rotation speed of the second pump 53 is the same as that at which $T = T_1$, i.e. n_1' . In other word, when the temperature of the cooling liquid in the first cooling pipe 8
20 does not reach the maximum operating temperature $T_{\max}$, and $T_1 < T < T_{\max}$, the rotation speed of the second pump 53 is kept at a value of n_1' .

When $T = T_{\max}$, the rotation speed of the second pump 53 is zero and the compressor 74 of the turbocharger 7 stops operating. At this time, all the cooling liquid in the second radiator 5 is used to cool the driving motor assembly 4.

25 It can be understood that, the temperature T measured by the temperature detecting device 58 may be linearly or non-linearly related to the rotation speed n' of the second pump 53.

In some embodiments, as shown in Fig. 3, the turbocharger 7 includes a turbine 73, a compressor 74, a clutch 71 and a housing 75. The turbine 73 includes a turbine shaft 732 and a turbine wheel 731. The compressor 74 includes a compressor shaft 742 and a compressor wheel
30 741. In some embodiments, the clutch 71 is an electromagnetic clutch, and the clutch 71 is adapted to electronically couple with the ECU 6. The ECU 6 is adapted to control the engage or disengage

of the clutch 71. The turbine wheel 731 is coupled to the turbine shaft 732 and adapted to rotate about a central axis of the turbine shaft 732. The compressor shaft 742 has a central axis coincided with the central axis of the turbine shaft 732. The compressor wheel 741 is coupled to the compressor shaft 742 and adapted to rotate about the central axis of the compressor shaft 742. The clutch 71 is coupled between the compressor shaft 742 and the turbine shaft 732.

Gases exhausted from the engine assembly 1 is discharged to the turbocharger 7 via an exhausted gas inlet 76, and expands to drive the turbine wheel 731 to rotate about the central axis of the turbine shaft 732, then the turbine wheel 731 rotates to drive the turbine shaft 732 to rotate. The clutch 71 is engaged to engage the turbine shaft 732 and the compressor shaft 742, so the compressor shaft 742 rotates to drive the turbine shaft 732 to rotate, and the compressor wheel 741 connected with the compressor shaft 742 is driven to rotate. The compressor wheel 741 may compress air charged via the inlet 78, then the compressed air flows out via the outlet 79 to cool the intercooler 3.

When a speed of the engine assembly 1 is increased, the gas exhausting speed is increased and the rotation speed of the turbine wheel 731 is increased accordingly. Then the compressor wheel 741 can compress more air to charge more air into a cylinder of the hybrid vehicle. The increase of air pressure and air density may be capable of burning more fuel. At this time, as the amount of fuel is increased, the output power of the engine assembly 1 is improved, thereby the fuel economy may be improved and engine emissions may be reduced.

When $T=T_{\max}$, the ECU6 may control the clutch 71 to disengage, so that the turbine wheel 731 rotates without driving the compressor wheel 741 to rotate.

According to embodiments of the present disclosure, the driving motor assembly 4 may be cooled firstly. In some embodiments, the second pump 53 even stops operating according to the actual situation. In other words, no cooling liquid is supplied to cool the intercooler 3, and all the cooling liquid in the second radiator 5 is used to cool the driving motor assembly 4, so that the driving motor assembly 4 may work steadily at a temperature below the maximum operating temperature $T_{\max}$. Then the stability of the hybrid vehicle may be improved.

Reference throughout this specification to “an embodiment,” “some embodiments,” “an example,” “a specific example,” or “some examples,” means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the present disclosure. The appearances of the phrases

throughout this specification are not necessarily referring to the same embodiment or example of the present disclosure. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

5 Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that the above embodiments cannot be construed to limit the present disclosure, and changes, alternatives, and modifications can be made in the embodiments without departing from spirit, principles and scope of the present disclosure.

What is claimed is:

1. A hybrid vehicle comprising:
 - an engine assembly;
 - 5 a first radiator adapted to cool the engine assembly;
 - a turbocharger adapted to turbocharge air in the turbocharger using gases exhausted from the engine assembly;
 - an intercooler adapted to cool the turbocharged air and adapted to supply the cooling air to the engine assembly;
 - 10 a driving motor assembly;
 - a second radiator disposed in front of the first radiator;
 - a first cooling pipe coupled between the second radiator and the engine assembly; and
 - a second cooling pipe coupled between the second radiator and the intercooler.
- 15 2. The hybrid vehicle according to claim 1, further comprising
 - a first pump disposed at the first cooling pipe, and
 - a second pump disposed at the second cooling pipe.
- 20 3. The hybrid vehicle according to claim 1 or 2, wherein an output speed of the first pumps is adjustable, and an output speed of the second pumps is adjustable.
4. The hybrid vehicle according to any one of claims 1-3, further comprising
 - a first flow regulating device disposed at the first cooling pipe; and
 - a second flow regulating device disposed at the second cooling pipe.
- 25 5. The hybrid vehicle according to claim 4, wherein each of the first and second flow regulating devices comprises a flow regulating valve.
6. The hybrid vehicle according to any one claims 1-5, further comprising
 - 30 a first sharing duct defining a first end coupled to a first end of the second radiator, and a second end coupled to upstream ends of the first and second cooling pipes respectively; and

a second sharing duct defining a first end coupled to downstream ends of the first and second cooling pipes respectively, and a second end coupled to a second end of the second radiator.

7. The hybrid vehicle according to any one of claims 1-6, further comprising

a first one-way valve disposed at the first cooling pipe; and

a second one-way valve disposed at the second cooling pipe.

8. The hybrid vehicle according to any one of claims 1-7, further comprising a temperature detecting device disposed at the first cooling pipe and downstream of the driving motor assembly.

9. The hybrid vehicle according to claim 8, wherein the temperature detecting device comprises a temperature sensor.

10. The hybrid vehicle according to claim 8, wherein a formula $0 < T \leq T_{\max}$ is satisfied, where T is a temperature of a cooling liquid in the first cooling pipe measured by the temperature detecting device, $T_{\max}$ is a maximum operating temperature of the driving motor assembly, wherein a rotation speed of the first pump is positively related to the temperature T .

11. The hybrid vehicle according to claim 10, wherein

when a temperature of a charge air of the engine assembly reaches a predetermined maximum charge air temperature and $0 < T \leq T_1$, where T_1 is a temperature of the cooling liquid in the first cooling pipe, a speed of the second pump is negatively related to the temperature T .

12. The hybrid vehicle according to claim 10, wherein

when a temperature of a charge air of the engine assembly reaches a predetermined maximum charge air temperature and $T_1 < T \leq T_{\max}$, where T_1 is a temperature of the cooling liquid in the first cooling pipe, a rotation speed of the second pump is the same as that at which $T = T_1$.

13. The hybrid vehicle according to claim 10, wherein

when a temperature of a charge air of the engine assembly reaches a predetermined maximum charge air temperature and $T = T_{\max}$, a rotation speed of the second pump is zero and a compressor

of the turbocharger stops operating.

14. The hybrid vehicle according to any one of claims 1-13, wherein the turbocharger comprises:

5 a turbine shaft;

a turbine wheel coupled to the turbine shaft and adapted to rotate about a central axis of the turbine shaft;

a compressor shaft defining a central axis coincided with the central axis of the turbine shaft;

10 a compressor wheel coupled to the compressor shaft and adapted to rotate about the central axis of the compressor shaft; and

a clutch coupled between the compressor shaft and the turbine shaft.

15. The hybrid vehicle according to claim 14, wherein the clutch is an electromagnetic clutch.

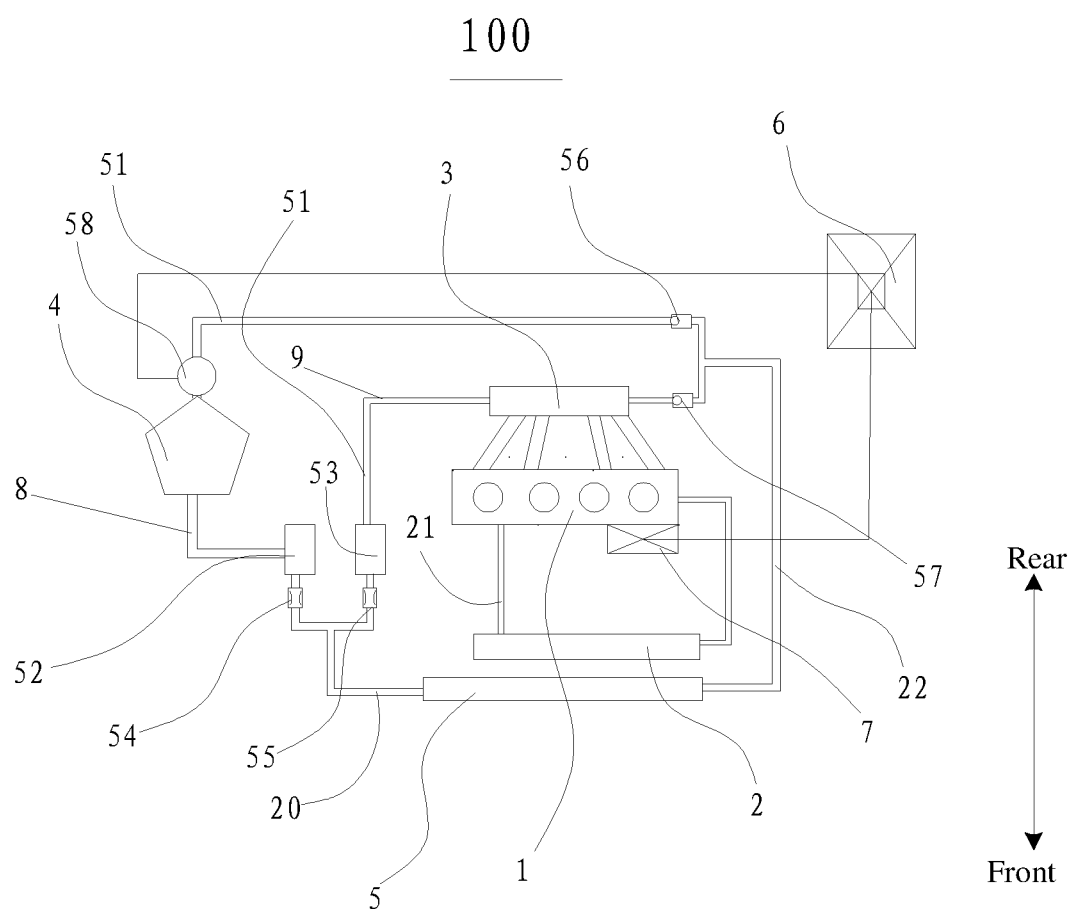
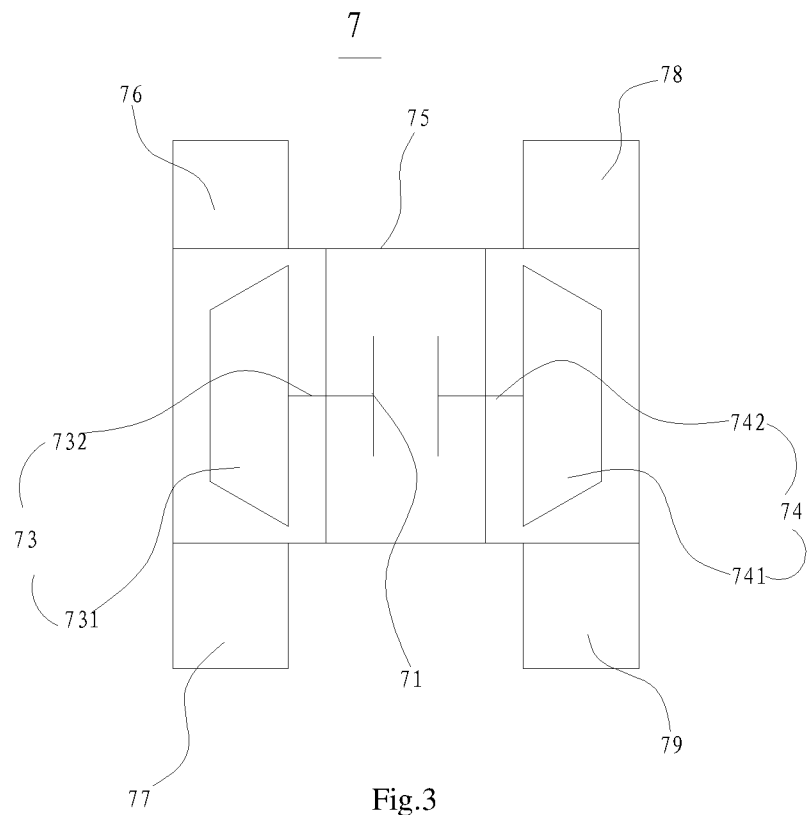
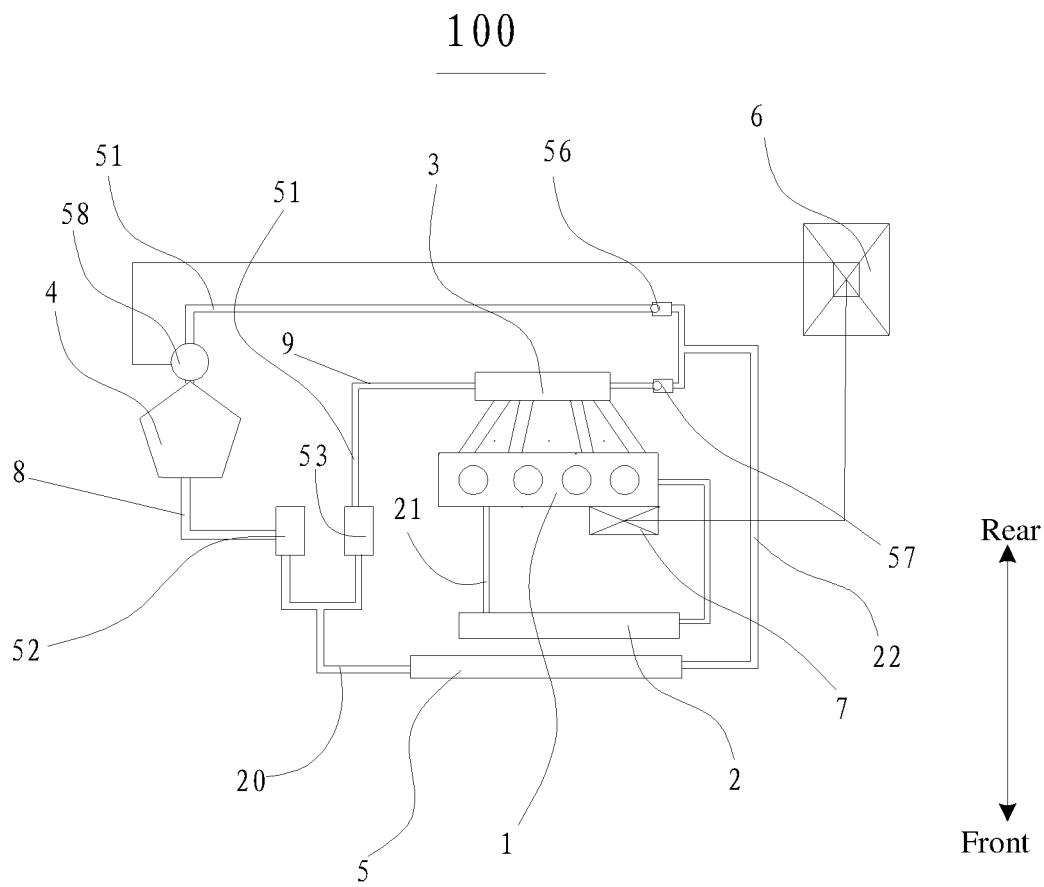


Fig.1



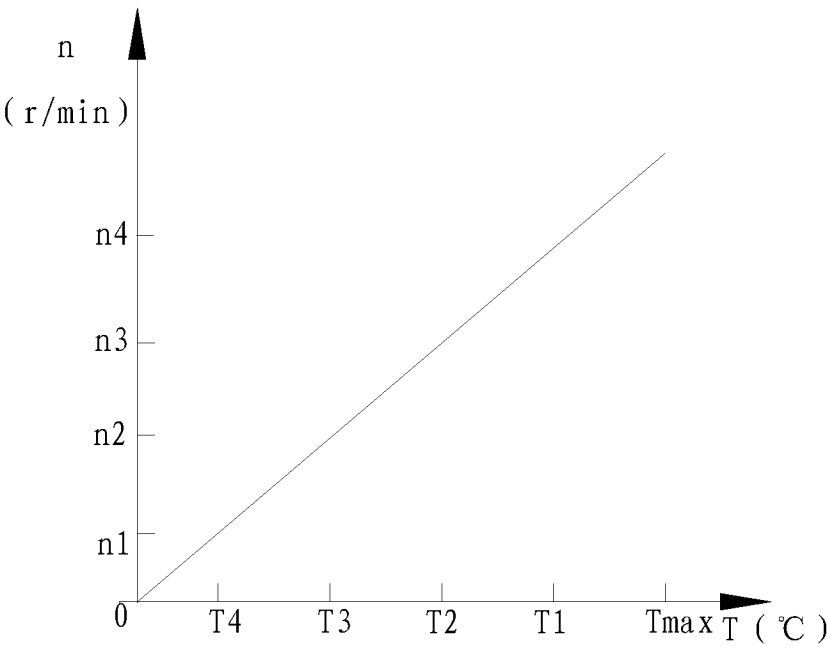


Fig.4

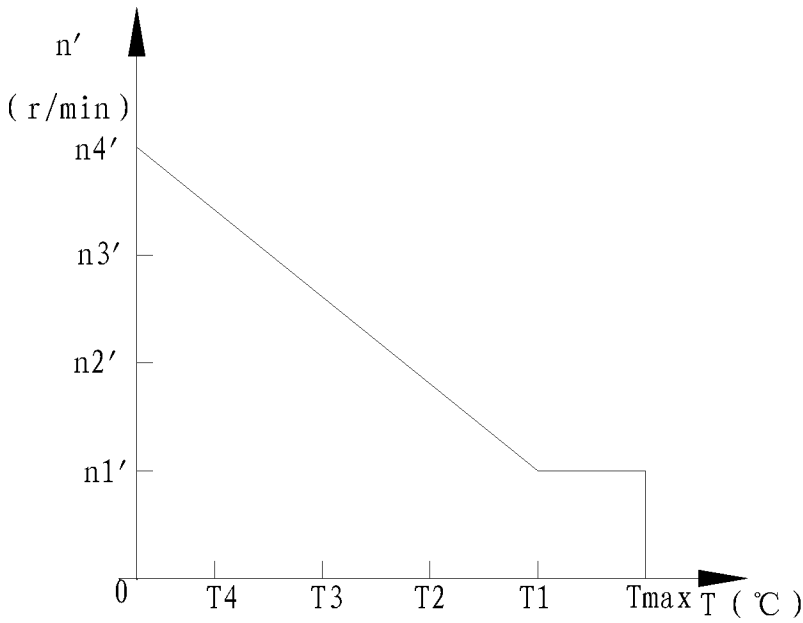


Fig.5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/081907

A. CLASSIFICATION OF SUBJECT MATTER

B60K 11/04(2006.01)i; F01P 3/00(2006.01)i

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)

B60K,F01P,F02B,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 practicable, search terms used)

CNABS, VEN, CNTXT, CNKI; hybrid, heat+, radiator?, exchanger?, cool+, turb+, second, two, auxiliary, assist+, pipe?, duct?, line?, pump?, valve?, temperature, clutch+.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5353757 A (NIPPON DENSO CO) 11 October 1994 (1994-10-11) description, column 4, line 60 to column 5, line 66, column 11, lines 1 to 16; figure 12	1-15
Y	CN 101348073 A (GM GLOBAL TECHNOLOGIES OPERATIONS INC.) 21 January 2009 (2009-01-21) description, page 1 to page 2; figures 1A to 1D	1-15
Y	CN 102874098 A (HYUNDAI MOTOR CO) 16 January 2013 (2013-01-16) description, paragraph [0038] to paragraph [0059]; figures 2-3	1-15
Y	CN 202611859 U (GREAT WALL AUTOMOBILE HOLDING CO) 19 December 2012 (2012-12-19) description, paragraph [0014] to paragraph [0021]; figure 1	14-15
A	CN 101376337 A (BYD CO LTD) 04 March 2009 (2009-03-04) the whole document	1-15
A	FR 2883806 B1 (VALEO SYSTEMES THERMIQUES) 08 August 2008 (2008-08-08) the abstract; figures 1-10	1-15

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

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“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)	“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
“O” document referring to an oral disclosure, use, exhibition or other means	“&” document member of the same patent family
“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

10 September 2014

Date of mailing of the international search report

14 October 2014

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2014/081907

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