



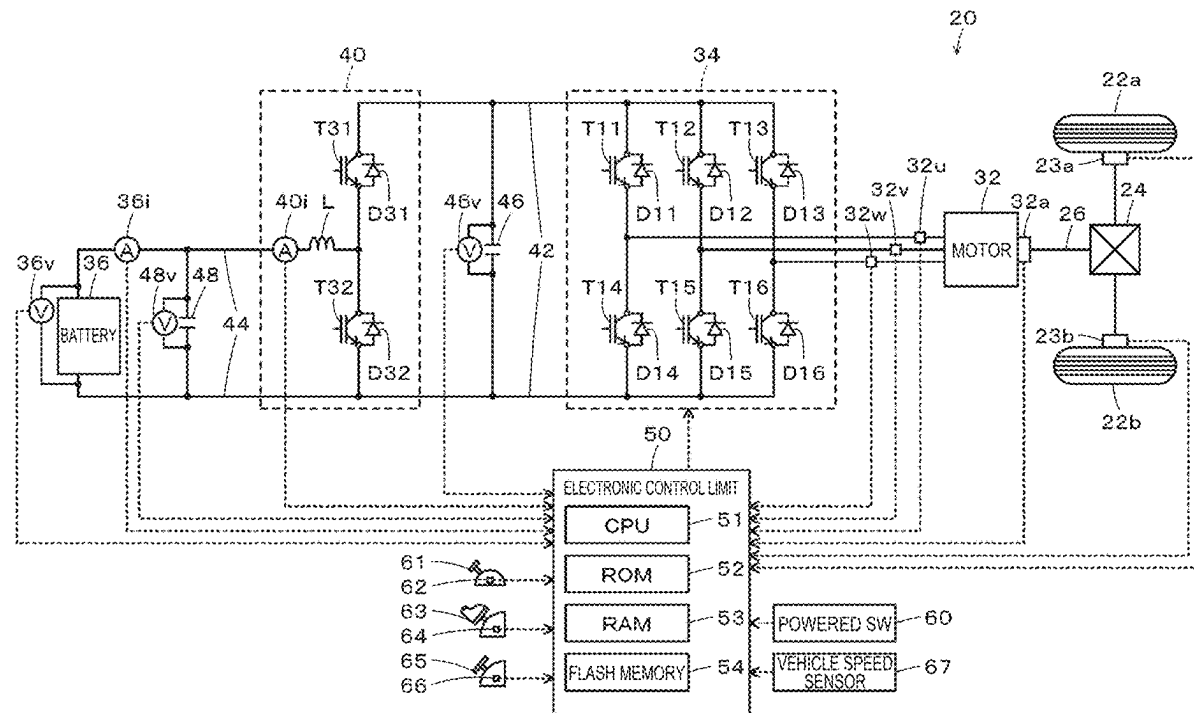
US 20250256585A1

(19) **United States**(12) **Patent Application Publication**
SASAKI et al.(10) **Pub. No.: US 2025/0256585 A1**(43) **Pub. Date: Aug. 14, 2025**(54) **ELECTRIFIED VEHICLE****Publication Classification**(71) Applicant: **TOYOTA JIDOSHA KABUSHIKI**
KAISHA, Toyota-shi (JP)(51) **Int. Cl.**
B60L 15/08 (2006.01)
B60L 3/10 (2006.01)(72) Inventors: **Satoshi SASAKI**, Nagoya-shi (JP);
Toshifumi YAMAKAWA, Okazaki-Shi (JP)(52) **U.S. Cl.**
CPC **B60L 15/08** (2013.01); **B60L 3/106**
(2013.01); **B60L 2210/14** (2013.01); **B60L**
2210/40 (2013.01)(73) Assignee: **TOYOTA JIDOSHA KABUSHIKI**
KAISHA, Toyota-shi (JP)(57) **ABSTRACT**

Electrified vehicle includes a motor connected to drive wheels, an inverter for driving the motor, a power storage device, a boost converter provided between the power storage device and the inverter, and a control device for controlling the inverter and the boost converter. When a predetermined condition is satisfied in which the inverter is controlled by pulse width modulation control and the absolute value of the torque command is equal to or greater than the threshold value, the control device sets the control cycle of the boost converter to be the same as the control cycle of the inverter.

(21) Appl. No.: **18/941,294**(22) Filed: **Nov. 8, 2024**(30) **Foreign Application Priority Data**

Feb. 13, 2024 (JP) 2024-019512





 UNIVERSITY OF THE PACIFIC

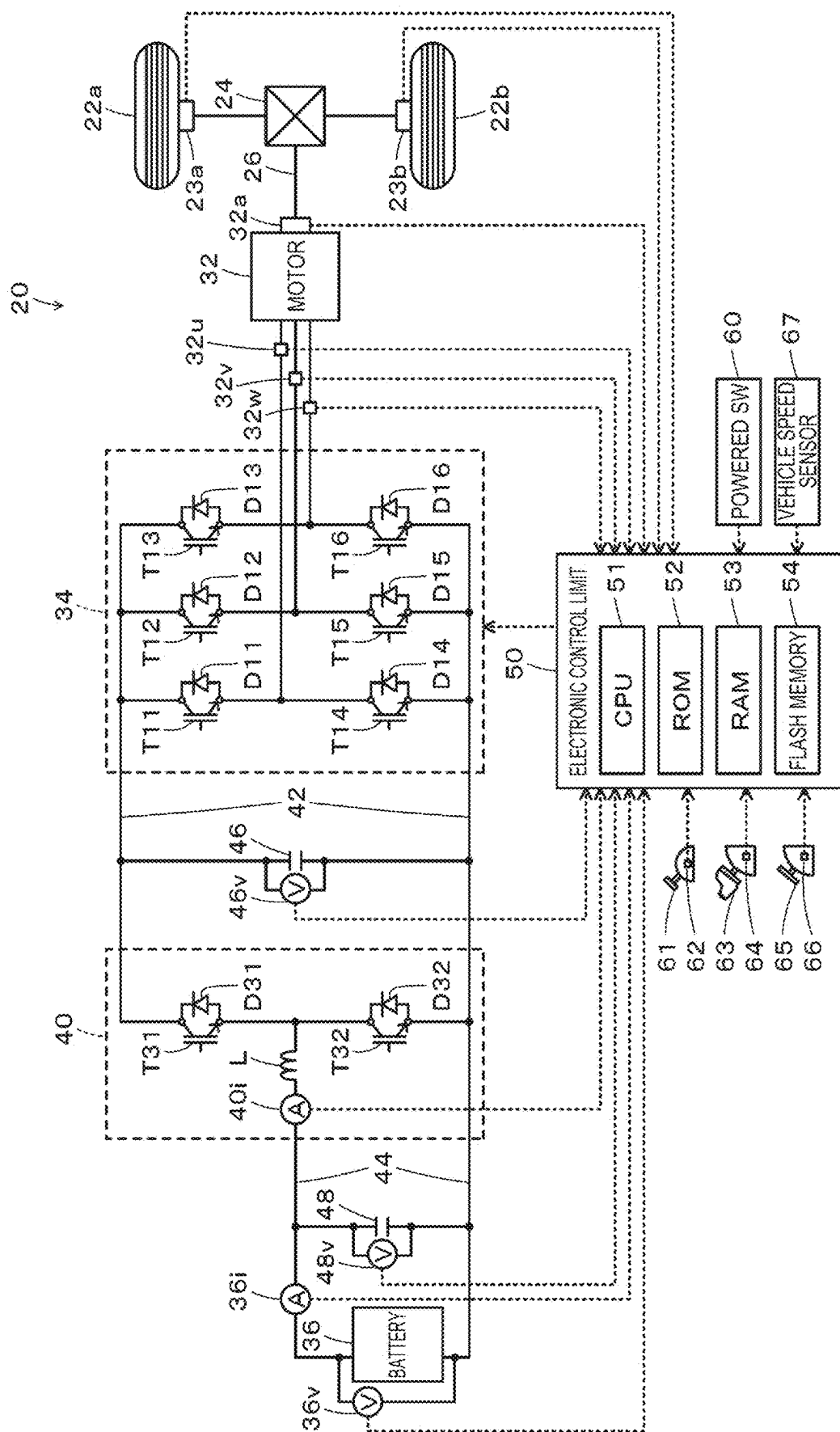


FIG. 2A

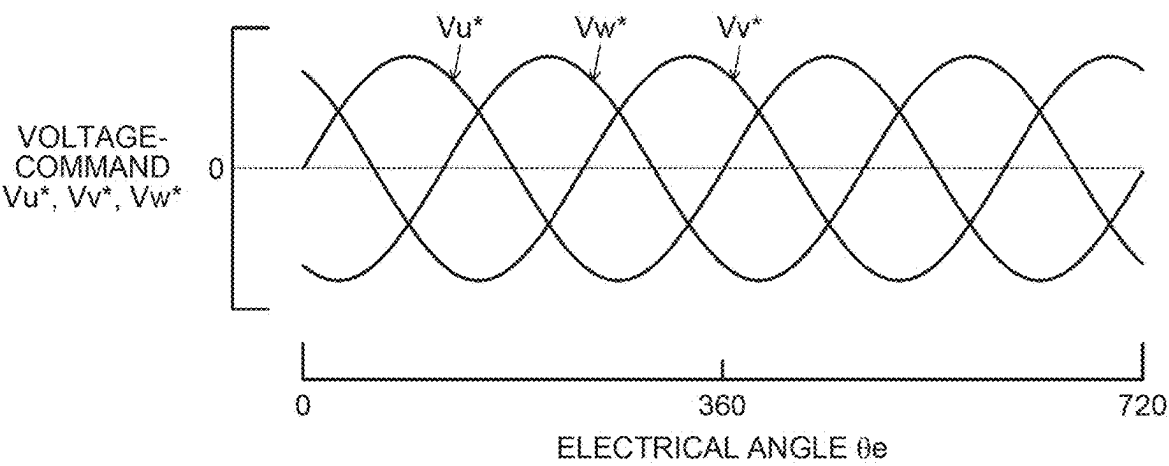


FIG. 2B

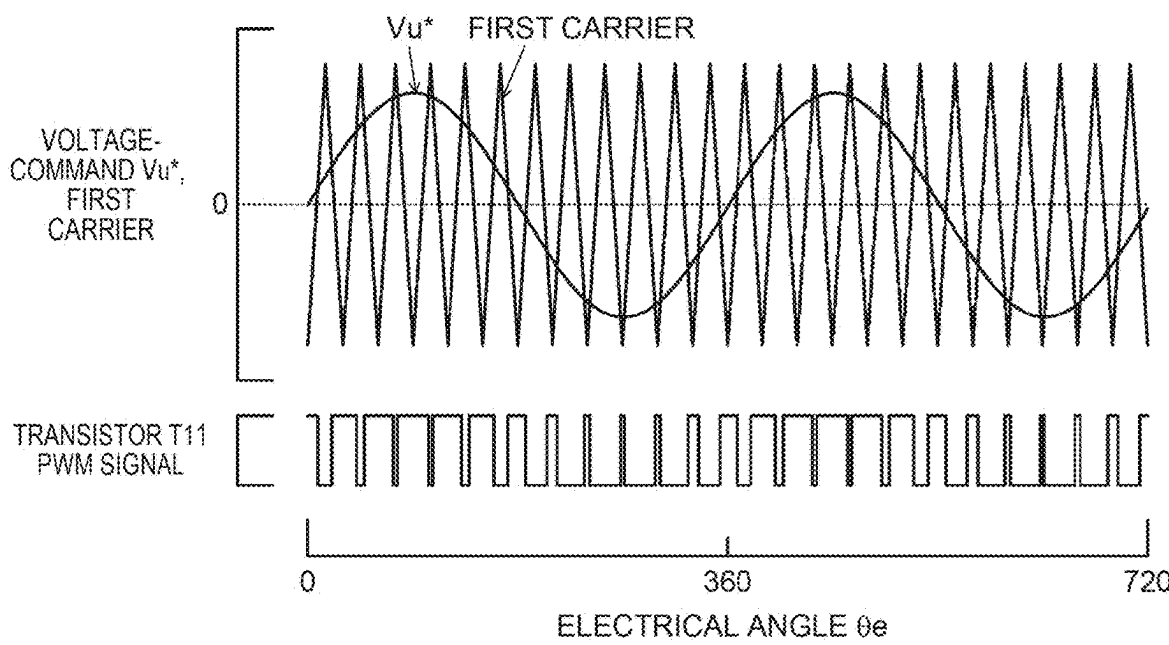


FIG. 3

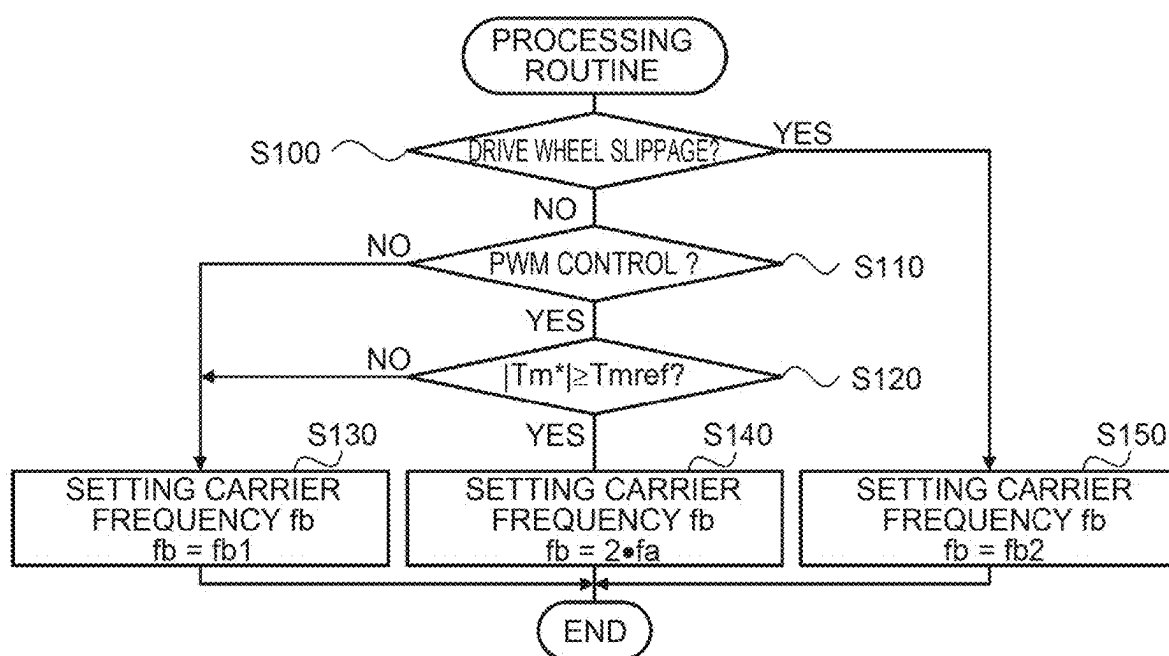


FIG. 4A

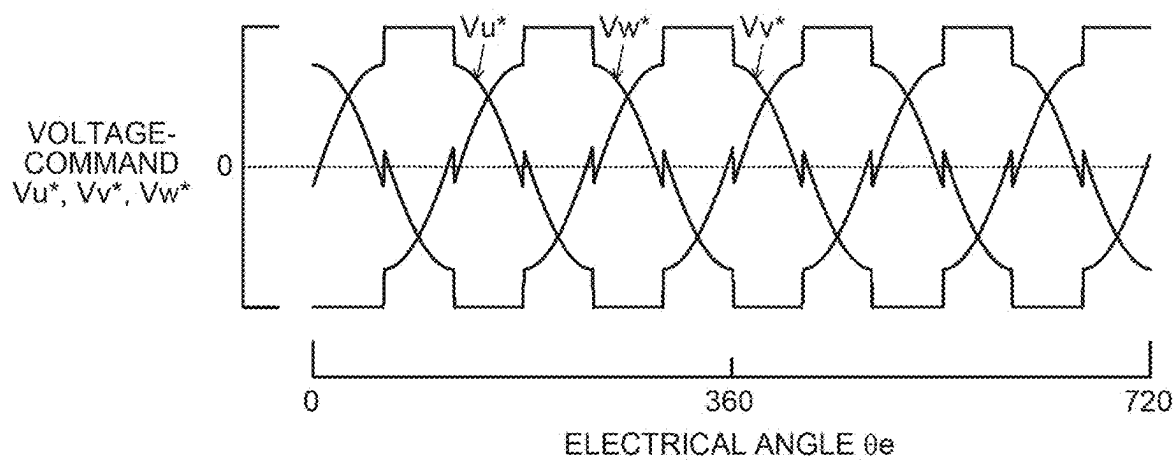
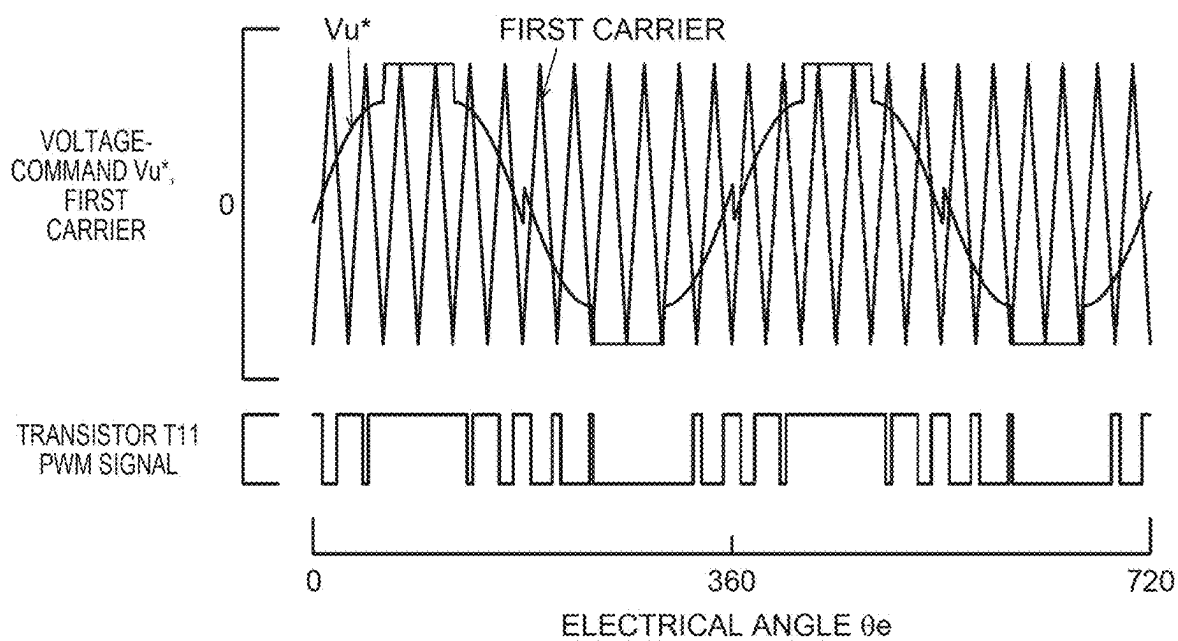


FIG. 4B



ELECTRIFIED VEHICLE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2024-019512 filed on Feb. 13, 2024, incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to an electrified vehicle.

2. Description of Related Art

[0003] Conventionally, an electrified vehicle has been proposed (for example, refer to Japanese Unexamined Patent Application Publication No. 2010-263719 (JP 2010-263719 A)), the electrified vehicle including a boost converter that boosts and outputs a voltage from a power storage device, an inverter that converts DC power from the boost converter into multi-phase AC power and outputs the multi-phase AC power, and a motor that is rotationally driven by the multi-phase AC power output from the inverter. In the electrified vehicle, when there is a requirement for a temperature rise control of the power storage device, and when a calculation value of an output voltage of the boost converter that is a minimum limit required for rotational driving of the motor is equal to or less than a temperature rise control voltage for the temperature rise control of the power storage device, the output voltage of the boost converter is set to the temperature rise control voltage, and a carrier frequency of the boost converter is set to a voltage rise control carrier frequency to increase the temperature of the power storage device. On the other hand, in this case, when the calculation value exceeds the temperature rise control voltage, the carrier frequency of the boost converter is set to a normal control carrier frequency, and the output voltage of the boost converter is set to the calculation value to avoid a temperature rise control.

SUMMARY

[0004] In the electrified vehicle, when the inverter is controlled by a pulse width modulation (PWM) control and the torque of the motor is comparatively large, there may be cases in which control of the boost converter is comparatively largely disturbed due to a current ripple of a control cycle of the inverter at an output side (inverter side) of the boost converter, and a current ripple at an input side (power storage device side) of the boost converter becomes comparatively large.

[0005] An objective of the electrified vehicle of the present disclosure is to suppress a current ripple on a power storage device side of a boost converter from becoming comparatively large.

[0006] The electrified vehicle of the present disclosure adopts the following techniques in order to achieve the objective.

[0007] An electrified vehicle of the present disclosure includes a motor connected to a drive wheel, an inverter that drives the motor, a power storage device, a boost converter provided between the power storage device and the inverter,

and a control device that controls the inverter and the boost converter based on a torque command of the motor.

When the control device controls the inverter by a pulse width modulation control, and a predetermined condition in which an absolute value of the torque command is equal to or more than a threshold is established, the control device sets a control cycle of the boost converter to be identical to a control cycle of the inverter.

[0008] In the electrified vehicle of the present disclosure, when the control device controls the inverter by a pulse width modulation control and a predetermined condition is established, the predetermined condition being an absolute value of the torque command is equal to or more than a threshold, the control device sets a control cycle of the boost converter to be identical to a control cycle of the inverter. As a result, control of the boost converter can be suppressed from being comparatively largely disturbed due to a current ripple of a control cycle of the inverter on an output side (inverter side) of the boost converter. As a result, a current ripple on an input side (power storage device side) of the boost converter can be suppressed from becoming comparatively large.

[0009] In the electrified vehicle of the present disclosure, the control device may control the inverter by the pulse width modulation control in a control cycle corresponding to twice a first carrier frequency and control the boost converter in a control cycle corresponding to a second carrier frequency, and when the predetermined condition is established, the control device may set the second carrier frequency to twice the first carrier frequency. In this case, when the control device controls the inverter by the pulse width modulation control using three-phase modulation, the control device may control the inverter in a control cycle corresponding to twice the first carrier frequency.

[0010] In the electrified vehicle of the present disclosure, the control device may control the inverter by the pulse width modulation control in a control cycle corresponding to twice a first carrier frequency and control the boost converter in a control cycle corresponding to a second carrier frequency, and when the predetermined condition is established, the control device may set the second carrier frequency to be identical to the first carrier frequency. In this case, when the control device controls the inverter by the pulse width modulation control using two-phase modulation, the control device may control the inverter in a control cycle corresponding to the first carrier frequency.

[0011] In the electrified vehicle of the present disclosure, when slippage due to idling of the drive wheel occurs, the control device may shorten a control cycle of the boost converter compared to when slippage due to idling of the drive wheel does not occur.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Features, advantages, and technical and industrial significance of exemplary embodiments of the disclosure will be described below with reference to the accompanying drawings, in which like signs denote like elements, and wherein:

[0013] FIG. 1 is a schematic configuration diagram of a battery electric vehicle 20 according to an embodiment of the present disclosure;

[0014] FIG. 2A is an explanatory diagram showing an embodiment of a state of generating a PWM of the phase voltage command V_u^* , V_v^* , V_w^* and the transistor T11 of

each phase when the inverter **34** is controlled by PWM control using three-phase modulations;

[0015] FIG. 2B is an explanatory diagram showing an embodiment of a state of generating a PWM of the phase voltage command V_u^* , V_v^* , V_w^* and the transistor **T11** of each phase when the inverter **34** is controlled by PWM control using three-phase modulations;

[0016] FIG. 3 is a flowchart illustrating an example of a processing routine repeatedly executed by the electronic control unit **50**;

[0017] FIG. 4A is an explanatory diagram showing an exemplary aspect of generating PWM of the phase voltage command V_u^* , V_v^* , V_w^* and the transistor **T11** of each phase when the inverter **34** is controlled by PWM control using the two-phase modulation; and

[0018] FIG. 4B is an explanatory diagram showing an exemplary aspect of generating a PWM of the phase voltage command V_u^* , V_v^* , V_w^* and the transistor **T11** of each phase when the inverter **34** is controlled by PWM control using a two-phase modulation.

DETAILED DESCRIPTION OF EMBODIMENTS

[0019] Embodiments for carrying out the present disclosure will be described with reference to the drawings. FIG. 1 is a schematic configuration diagram of a battery electric vehicle **20** according to an embodiment of the present disclosure. As illustrated in the drawing, battery electric vehicle **20** of the embodiment includes a motor **32**, an inverter **34**, a battery **36** as a power storage device, a boost converter **40**, and an electronic control unit **50** as a control device.

[0020] The motor **32** is configured as a three-phase AC motor, and includes a rotor in which a permanent magnet is embedded in a rotor core, and a stator in which a three-phase coil is wound around the stator core. The rotor of the motor **32** is connected to a drive shaft **26** connected to the drive wheel **22a**, **22b** via a differential gear **24**.

[0021] The inverter **34** is used to drive the motor **32** and is connected to the boost converter **40** via the high-voltage-side power line **42**. The inverter **34** includes transistors **T11** to **T16** as six switching elements, and six diodes **D11** to **D16** connected in parallel to each of the six transistors **T11** to **T16**. Transistor **T11** to **T16** are arranged in pairs of two so as to be source side and sink side with respect to the positive line and negative line of the high-voltage side power line **42**, respectively. Each of the connecting points of the transistors which are the pair of the transistors **T11** to **T16** is connected to each of the three-phase (U-phase, V-phase, and W-phase) coils of the motor **32**. Therefore, when a voltage is applied to the inverter **34**, the electronic control unit **50** adjusts the ratio of the on-time of **T16** from the pair of transistors **T11**, thereby forming a rotating magnetic field in the three-phase coil of the motor **32** and rotationally driving the motor **32** (rotor). A smoothing capacitor **46** is attached to the positive line and the negative line of the high-voltage-side power line **42**.

[0022] The battery **36** is configured as, for example, a lithium-ion secondary battery or a nickel-hydrogen secondary battery, and is connected to the boost converter **40** via the low-voltage-side power line **44**. A smoothing capacitor **48** is attached to the positive line and the negative line of the low-voltage-side power line **44**.

[0023] The boost converter **40** is connected to the high-voltage-side power line **42** and the low-voltage-side power

line **44**, and includes a transistor **T31**, **T32** as two switching elements, two diode **D31**, **D32** connected in parallel to each of the two transistor **T31**, **T32**, and a reactor **L**. The transistor **T31** is connected to the positive line of the high-voltage-side power line **42**. The transistor **T32** is connected to the transistor **T31** and the negative line of the high-voltage-side power line **42** and the negative line of the low-voltage-side power line **44**. The reactor **L** is connected to the connecting points of the two transistors **T31**, **T32** and the positive line of the low-voltage-side power line **44**. As the ratio of an "on" time of the transistors **T31**, **T32** is adjusted by the electronic control unit **50**, the boost converter **40** raises the voltage of electricity in the low voltage-side power lines **44** and supplies this electricity to the high voltage-side power lines **42**, or lowers the voltage of electricity in the high voltage-side power lines **42** and supplies this electricity to the low voltage-side power lines **44**.

[0024] The electronic control unit **50** includes a micro-computer having a CPU **51**, ROM **52**, RAM **53**, a flash memory **54**, an input and output port, and a communication port.

[0025] The electronic control unit **50** receives signals from various sensors via input ports. For example, the electronic control unit **50** receives the rotational speed N_{wa} , N_{wb} from the rotational speed sensor **23a**, **23b** attached to the drive wheel **22a**, **22b**. The electronic control unit **50** also receives the rotational position θ_m from the rotational position sensor **32a** for detecting the rotational position of the rotor of the motor **32**, and the phase current I_u , I_v , I_w from the current sensor **32u**, **32v**, **32w** for detecting the phase current of each phase of the **25** motor **32**. The electronic control unit **50** also receives a voltage V_b from a voltage sensor **36v** mounted between terminals of the battery **36** and a current I_b from a current sensor **36i** mounted at an output terminal of the battery **36**. The electronic control unit **50** also receives a current I_L from a current sensor **40i** mounted in series with the reactor **L** of the boost **30** converter **40**, a voltage V_H of a capacitor **46** (high-voltage-side power line **42**) from a voltage sensor **46v** mounted between terminals of the capacitor **46**, and a voltage V_L of a capacitor **48** (low-voltage-side power line **44**) from a voltage sensor **48v** mounted between terminals of the capacitor **48**. The electronic control unit **50** also receives a start signal from the power switch **60**, a shift position SP from the shift sensor **62** for detecting the operation position of the shift lever **61**, an accelerator operation amount Acc from the accelerator pedal position sensor **64** for detecting the depression amount of the accelerator pedal **63**, a brake pedal position BP from the brake pedal position sensor **66** for detecting the depression amount of the brake pedal **65**, and a vehicle speed V from the vehicle speed sensor **67**.

[0026] The electronic control unit **50** outputs various control signals via an output port. For example, the electronic control unit **50** outputs a control signal from the transistor **T11** to **T16** of the inverter **34** and a control signal to the transistor **T31**, **T32** of the boost converter **40**. The electronic control unit **50** calculates the electric angle θ_e and the rotational speed N_m of the motor **32** based on the rotational position θ_m of the rotor of the motor **32** from the rotational position sensor **32a**. The electronic control unit **50** calculates the power storage ratio SOC of the battery **36** based on the integrated value of the current I_b of the battery **36** from the current sensor **36i**.

[0027] In battery electric vehicle 20 of the embodiment configured in this way, the electronic control unit 50 (CPU 51) sets the required torque T_d^* required for the drive shaft 26 based on the accelerator operation amount Acc and the vehicle speed V, sets the set required torque T_d^* to the torque command T_m^* of the motor 32 so as to be outputted to the drive shaft 26, and performs the switching control of the transistor T31, T32 of the boost converter 40 and the switching control of T16 from the transistor T11 of the inverter 34 based on the torque command T_m^* .

[0028] The electronic control unit 50 controls the inverters 34 by pulse-width modulation (PWM) control or square-wave control based on the modulation factor R_m . Here, the modulation factor R_m is defined as the ratio of the effective value of the output voltage (the applied voltage of the motor 32) to the input voltage of the inverter 34 (the voltage V_H of the high-voltage-side power line 42). Instead of the modulation factor R_m , PWM control or the square-wave control may be selected based on the torque command T_m^* and the rotational speed N_m . Hereinafter, PWM control will be described. Since the rectangular wave control is not the core of the present disclosure, a detailed description thereof will be omitted.

[0029] In PWM control, the electronic control unit 50 generates the PWM signal from the transistors T11 to T16 using a first PWM signal generating process, and performs the switching control from the transistors T11 to T16 using the generated PWM signal from the transistors T11 to T16. In the first PWM signal-generating process, the phase current I_u, I_v, I_w of each phase of the motor 32 is coordinate-transformed (three-phase-two-phase transformation) using the electric angle θ_e of the motor 32 to calculate the current I_d, I_q of the d-axis and the q-axis. Subsequently, the current command I_d^*, I_q^* of the d-axis and the q-axis is set based on the torque command T_m^* of the motor 32. Then, the d-axis, the difference between the current I_d, I_q and the current command I_d^*, I_q^* of the q-axis is canceled by the current feedback control d-axis, calculates the voltage command V_d^*, V_q^* of the q-axis, the calculated d-axis, the voltage command V_d^*, V_q^* of the q-axis coordinate conversion by three-phase modulation using the electric angle θ_e of the motor 32 (2-3-phase conversion) to calculate the phase voltage command V_u^*, V_v^*, V_w^* of each phase. PWM of T16 is generated from the transistor T11 by using the phase-voltage command V_u^*, V_v^*, V_w^* of each phase and the first carrier wave (triangular wave) of the first carrier frequency f_a obtained in this manner. As the first carrier frequency f_a , for example, a 2.5 kHz to 5 kHz degree is used. FIGS. 2A and 2B are explanatory diagrams illustrating an exemplary manner of generating the phase-voltage command V_u^*, V_v^*, V_w^* of each phase and PWM of the transistor T11 when the inverter 34 is controlled by PWM control using two-phase modulation. FIG. 2A shows the phase-voltage command V_u^*, V_v^*, V_w^* of each phase, FIG. 2B shows how to generate PWM of the transistor T11. In the embodiment, the first PWM signal generating process is executed at timings of peaks and valleys of the first carrier wave, that is, at a control cycle $(1/(2 \cdot f_a))$ corresponding to twice the first carrier frequency f_a .

[0030] In the control of the boost converter 40, the electronic control unit 50 generates a second PWM signal generating process to generate the transistor T31, T32's PWM signal, and performs the switching control of the transistor T31, T32 using the generated PWM signal of the

transistor T31, T32. In the second PWM signal generating process, first, the target voltage V_{Htag} of the high-voltage-side power line 42 is set based on the torque command T_m^* and the rotational speed N_m of the motor 32, and the target current I_{Ltag} of the reactor L is calculated by the voltage feedback control so that the difference between the voltage V_H of the high-voltage-side power line 42 and the target voltage V_H^* is canceled out. Subsequently, the duty command D^* is calculated by the current feedback control so that the difference between the current I_L of the reactor L and the target current I_L^* is canceled out, and PWM of the transistor T31, T32 is generated using the calculated duty command D^* and the second carrier wave (triangular wave) of the second carrier frequency f_b . In the embodiment, the second PWM generating process is executed at the timings of peaks or valleys of the second carrier wave, that is, at the control cycle $(1/f_b)$ corresponding to the second carrier frequency f_b .

[0031] Next, the operation of battery electric vehicle 20 according to the embodiment, in particular, the setting process of the second carrier frequency f_b will be described. FIG. 3 is a flow chart illustrating an exemplary process routine that is repeatedly executed by the electronic control unit 50 (CPU 51).

[0032] When the process of FIG. 3 is executed, the electronic control unit 50 first determines whether the drive wheel 22a, 22b slippage occurs due to idling (S100). This determination process can be performed, for example, by comparing the rotational speed change rates ΔN_{wa} and ΔN_{wb} , which are changes in the rotational speed N_{wa} , N_{wb} of the drive wheel 22a, 22b per unit time, with the thresholds ΔN_{wref} . It should be noted that the rotation speed change rate ΔN_m , which is a change amount of the rotational speed N_m of the motor 32 per unit time, may be compared with the threshold value ΔN_{mref} .

[0033] When the electronic control unit 50 determines that slippage due to idling of the drive wheel 22a, 22b has not occurred in S100, it determines which of PWM control and the square-wave control the inverter 34 is controlling (S110), and determines whether or not the absolute value of the torque command T_m^* of the motor 32 is equal to or greater than the threshold T_{mref} (S120). S110, S120 process is a process of determining whether or not there is a possibility that the control of the boost converter 40 is disturbed relatively greatly by the current ripple of the control cycle $(1/(2 \cdot f_a))$ of the inverter 34 at the output side of the boost converter 40 (the inverter 34 side), and the current ripple at the input side of the boost converter 40 (the battery 36 side) becomes relatively large.

[0034] Electronic control unit 50, when it is determined that the inverter 34 is controlled by the rectangular wave control in S110, or when it is determined that the absolute value of the torque command T_m^* of the motor 32 in S120 is less than the threshold T_{mref} , the input side of the boost converter 40 (battery 36 side) current ripple is determined to be relatively low, set a predetermined frequency f_{b1} to the second carrier frequency f_b (S130), the routine ends. Here, as the predetermined frequency f_{b1} , for example, a 10 kHz to a 15 kHz degree is used.

[0035] The electronic control unit 50 determines that the inverter 34 is controlled by PWM control in S110, and when S120 determines that the absolute value of the torque command T_m^* of the motor 32 is equal to or larger than the threshold T_{mref} , it determines that there is a possibility that

the current ripple on the input side (the battery 36 side) of the boost converter 40 is relatively large, sets the frequency twice the first carrier frequency f_a in the second carrier frequency f_b (S140), and ends the routine. That is, the control cycle ($1/f_b$) of the boost converter 40 is the same as the control cycle ($1/(2 \cdot f_a)$) of the inverter 34. As a result, it is possible to suppress the control of the boost converter 40 from being disturbed by the current ripple of the control cycle ($1/(2 \cdot f_a)$) of the inverter 34 at the output side of the boost converter 40 (the inverter 34 side). As a result, it is possible to suppress the current ripple on the input side (the battery 36 side) of the boost converter 40 from becoming relatively large. The inventors also confirmed this by analysis and experiments.

[0036] When the electronic control unit 50 determines that slippage due to idling of the drive wheel 22a, 22b has occurred in S100, a predetermined frequency f_{b2} higher than the predetermined frequency f_{b1} is set in the second carrier frequency f_b (S150), and the routine ends. That is, when slippage due to idling of the drive wheel 22a, 22b is occurring, the control cycle ($1/f_b$) of the boost converter 40 is made shorter than when slippage due to idling of the drive wheel 22a, 22b is not occurring. Thus, the control stability of the boost converter 40 can be ensured. As the predetermined frequency f_{b2} , for example, a value larger than the predetermined frequency f_{b1} by several kHz to about 10 kHz is used.

[0037] In battery electric vehicle 20 of the above-described embodiment, when the drive wheel 22a, 22b does not slippage due to idling and the inverter 34 is controlled by PWM control and the absolute value of the torque command T_m^* of the motor 32 is equal to or larger than the threshold T_{mref} , the control cycle ($1/f_b$) of the boost converter 40 is made equal to the control cycle ($1/(2 \cdot f_a)$) of the inverter 34. As a result, it is possible to suppress the control of the boost converter 40 from being disturbed by the current ripple of the control cycle ($1/(2 \cdot f_a)$) of the inverter 34 at the output side of the boost converter 40 (the inverter 34 side). As a result, it is possible to prevent the current ripple on the input side (the battery 36 side) of the boost converter 40 from becoming relatively large.

[0038] In the above-described embodiment, the electronic control unit 50 executes the first PWM signal generating process at the timings of the peaks and valleys of the first carrier wave, that is, at the control cycle ($1/(2 \cdot f_a)$) corresponding to twice the first carrier frequency f_a , but is not limited thereto. For example, the first PWM signal generating process may be performed at a peak timing or a valley timing of the first carrier wave, that is, at a control cycle ($1/f_a$) corresponding to the first carrier frequency f_a . In this case, when the drive wheel 22a, 22b does not slippage due to idling and the inverter 34 is controlled by PWM control and the absolute value of the torque command T_m^* of the motor 32 is equal to or larger than the threshold T_{mref} , the control cycle ($1/f_b$) of the boost converter 40 may be made equal to the control cycle ($1/f_a$) of the inverter 34 by setting the first carrier frequency f_a in the second carrier frequency f_b .

[0039] In the above-described embodiment, the electronic control unit 50 controls the inverters 34 by PWM control using three-phase modulations, but the present disclosure is not limited thereto. For example, the inverters 34 may be controlled by PWM control using two-phase modulations. In this case, in the first PWM signal generating process, in

place of calculating the phase voltage command V_u^* , V_v^* , V_w^* of each phase by coordinate conversion of the voltage command V_d^* , V_q^* of the d-axis, q-axis (2-phase-3-phase conversion) by three-phase modulation using the electric angle θ_e of the motor 32, the phase voltage command V_u^* , V_v^* , V_w^* of each phase is calculated by coordinate conversion of the voltage command V_d^* , V_q^* of the d-axis, q-axis (2-phase-3-phase conversion) by two-phase modulation using the electric angle θ_e of the motor 32. FIGS. 4A and 4B are explanatory diagrams illustrating an exemplary manner of generating the phase-voltage command V_u^* , V_v^* , V_w^* of each phase and PWM of the transistor T11 when the inverter 34 is controlled by PWM control using two-phase modulation. FIG. 4A shows the phase-voltage command V_u^* , V_v^* , V_w^* of each phase, FIG. 4B shows how to generate PWM of the transistor T11. When the inverter 34 is controlled by PWM control using two-phase modulation, the first PWM signal generating process may be executed at the control cycle corresponding to twice the first carrier frequency f_a ($1/(2 \cdot f_a)$), or the first PWM signal generating process may be executed at the control cycle corresponding to the first carrier frequency f_a ($1/f_a$). In either case, when the drive wheel 22a, 22b is not slippage due to idling and the inverter 34 is controlled by PWM control and the absolute value of the torque command T_m^* of the motor 32 is equal to or larger than the threshold T_{mref} , the control cycle ($1/f_b$) of the boost converter 40 may be the same as the control cycle ($1/(2 \cdot f_a)$ or $1/f_a$) of the inverter 34.

[0040] In the above-described embodiment, the electronic control unit 50 controls the inverters 34 by PWM control using three-phase modulations. In the above-described modification, the electronic control unit 50 controls the inverters 34 by PWM control using two-phase modulations. In general, the three-phase modulation can improve the controllability of the inverter 34 as compared with the two-phase modulation. On the other hand, the two-phase modulation can reduce the switching-loss of T16 from the transistor T11 of the inverter 34 as compared with the three-phase modulation. Therefore, three-phase modulation or two-phase modulation may be selected based on the temperature of the inverter 34 or the like.

[0041] In the above-described embodiment, the electronic control unit 50 sets the predetermined frequency f_{b1} to the second carrier frequency f_b when the inverter 34 is controlled by the square-wave control or when the absolute value of the torque command T_m^* of the motor 32 is less than the threshold T_{mref} when the slippage due to idling of the drive wheel 22a, 22b is not occurring. Further, the electronic control unit 50 sets the second carrier frequency f_b to a predetermined frequency f_{b2} higher than the predetermined frequency f_{b1} when slippage due to idling of the drive wheel 22a, 22b occurs. However, the same frequency may be used as the predetermined frequency f_{b1} and the predetermined frequency f_{b2} .

[0042] In the above-described embodiment, the battery 36 is used as the power storage device, but the present disclosure is not limited thereto. For example, a capacitor or the like may be used as the power storage device.

[0043] In the above-described embodiment, the configuration of battery electric vehicle 20 including the motor 32, the inverter 34, the battery 36, and the boost converter 40 has been described, but the configuration is not limited thereto. For example, in addition to a hardware configuration similar to that of battery electric vehicle 20, a hybrid electric vehicle

configuration including an engine may be employed, or a fuel cell electric vehicle configuration including a fuel-cell in addition to a hardware configuration similar to that of battery electric vehicle **20** may be employed. For hybrid electric vehicle configurations, the drive shaft connected to the first motor and the engine and the drive wheel may be connected to the sun gear and the carrier and the ring gear of the planetary gear respectively, a second motor may be connected to the drive shaft, and a boost converter may be provided between the first, second inverters for driving the first, second motors respectively and the battery. Further, a boost converter may be provided between an inverter that drives a motor and a battery by connecting a motor to a drive shaft connected to the drive wheels via a transmission and connecting an engine to the motor via a clutch.

[0044] The correspondence between the main elements of the embodiments and the main elements of the disclosure described in the column of the means for solving the problem will be described. In the embodiment, the motor **32** corresponds to the “motor”, the inverter **34** corresponds to the “inverter”, the battery **36** corresponds to the “power storage device”, the boost converter **40** corresponds to the “boost converter”, and the electronic control unit **50** corresponds to the “control device”.

[0045] Note that the correspondence between the main elements of the embodiment and the main elements of the disclosure described in the section of the means for solving the problem is an example for specifically explaining the embodiment of the disclosure described in the section of the means for solving the problem, and therefore the elements of the disclosure described in the section of the means for solving the problem are not limited. That is, the interpretation of the disclosure described in the section of the means for solving the problem should be performed based on the description in the section, and the embodiments are only specific examples of the disclosure described in the section of the means for solving the problem.

[0046] Hereinafter, while embodiments for carrying out the present disclosure are described by using embodiments, it is needless to say that the present disclosure is not limited to such embodiments, and can be implemented in various forms without departing from the gist of the present disclosure.

[0047] The present disclosure is applicable to a manufacturing industry of an electrified vehicle and the like.

What is claimed is:

1. An electrified vehicle comprising:

a motor connected to a drive wheel;

an inverter that drives the motor;

a power storage device;

a boost converter provided between the power storage device and the inverter; and

a control device that controls the inverter and the boost converter based on a torque command of the motor, wherein when the control device controls the inverter by a pulse width modulation control, and a predetermined condition in which an absolute value of the torque command is equal to or more than a threshold is established, the control device sets a control cycle of the boost converter to be identical to a control cycle of the inverter.

2. The electrified vehicle according to claim 1, wherein the control device controls the inverter by the pulse width modulation control in a control cycle corresponding to twice a first carrier frequency and controls the boost converter in a control cycle corresponding to a second carrier frequency, and

when the predetermined condition is established, the control device sets the second carrier frequency to twice the first carrier frequency.

3. The electrified vehicle according to claim 1, wherein the control device controls the inverter by the pulse width modulation control in a control cycle corresponding to a first carrier frequency and controls the boost converter in a control cycle corresponding to a second carrier frequency, and

when the predetermined condition is established, the control device sets the second carrier frequency to be identical to the first carrier frequency.

4. The electrified vehicle according to claim 1, wherein when slippage due to idling of the drive wheel occurs, the control device shortens a control cycle of the boost converter compared to when slippage due to idling of the drive wheel does not occur.

* * * * *