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(71) **Applicant: CATERPILLAR INC.** [US/US]; 510 Lake Cook Road, Suite 100, Deerfield, Illinois 60015 (US).

(72) **Inventors:** **KHALIL, Ahmed**; 2920 West School Street, Dunlap, IL 61525 (US). **WAI, Jackson**; 11521 North Duunmore Drive, Dunlap, Illinois 61525 (US). **GERDES, Jesse**; 11114 N. Crestpoint Lane, Dunlap, IL 61525 (US). **THORNE, James**; 2601 W Lake Ave, A6, Peoria, IL 61615 (US). **SAAD, Amir**; 1415 N Taft ST #P194, Arlington, Virginia 22201 (US).

(74) **Agent:** **GREENE, Jeff A.** et al.; Caterpillar Inc., 100 NE Adams Street - AH9510, Peoria, IL 61629-9510 (US).

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AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
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HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
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OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
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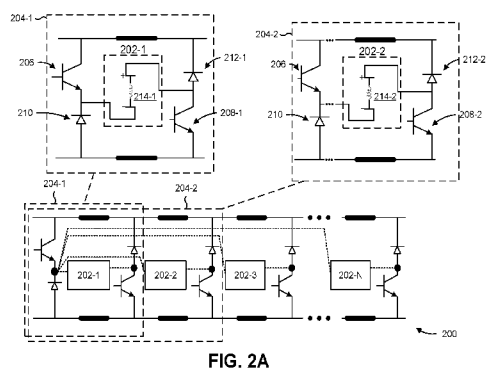


FIG. 2A

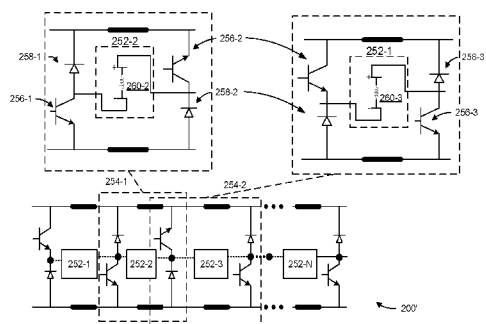


FIG. 2B

(57) Abstract: An electrical inverter may include a plurality of phase modules to provide a plurality of phase outputs. Two or more of the plurality of phase modules may share a common insulated-gate bipolar transistor.

Description

INVERTER TOPOLOGY

Technical Field

The present disclosure relates generally to an inverter and, more
5 particularly, to an inverter topology for an electric motor of a machine.

Background

A machine may include a transmission coupled to a power source,
such as an internal combustion engine or an electric motor to enable the machine
to be repositioned and/or to travel between locations. With increased interest in
10 energy conservation and avoidance of use of fossil fuels, use of electric motors is
becoming more common. Electric motors may be used to convert electrical
energy into mechanical power to drive the machine. For example, electric motors
may be used in a vehicle, a backhoe loader, a cold planer, a wheel loader, a
compactor, a feller buncher, a forest machine, a forwarder, a harvester, an
15 excavator, an industrial loader, a knuckleboom loader, a material handler, a motor
grader, a pipelayer, a road reclaimer, a skid steer loader, a skidder, a telehandler,
a tractor, a dozer, a tractor scraper, or other equipment.

Alternatively, some machines may include both an electric motor
and an internal combustion engine. For example, an electrical drive train of a
20 machine, such as a tractor, may include an internal combustion engine, a
generator coupled to the internal combustion engine, a direct current (DC) power
source, and a motor. In this case, the internal combustion engine may be used to
reposition the machine, and the generator, the DC power source, and the motor
may be used to drive one or more implements of the machine. An inverter may
25 be coupled to the DC power source and the motor to convert DC to AC power.
The inverter may provide the AC power to the generator to electrically drive the
motor and/or to electrically brake the motor.

The motor may be a switched reluctance (SR) motor, which may
be controlled using open-loop table-based control based on phases provided by
30 the inverter. However, an inverter topology for driving such a motor may require

two power switches and two diodes for each phase of the inverter. This may result in a quantity of $2n$ components for the inverter topology, where n represents a quantity of phases of the inverter. In another inverter topology, capacitors may be added to the inverter to receive energy from a phase being
5 switched from on to off. These components may be expensive and/or prone to failure, damage, and/or the like.

One attempt to improve inverters is disclosed in China Patent No. CN107884652 that was filed by Hefei Kewell Power System Co., Ltd. on April 6, 2018 (“the ‘652 patent”). In particular, the ‘652 patent discloses a high voltage
10 DC electronic load control system. The load control system, disclosed in the ‘652 patent, includes multiple DC chopper type insulated-gate bipolar transistors (IGBTs), thereby providing a feedback system for load control.

However, reduction of a quantity of IGBTs and/or other components in an inverter topology may be advantageous with regard to
15 improving functioning of a machine, an electrical drive train, an inverter, and/or the like. The inverter topology of the present disclosure solves one or more problems set forth above and/or other problems in the art.

Summary

According to some implementations, the present disclosure is
20 related to an electrical inverter. The electrical inverter may include a plurality of phase modules to provide a plurality of phase outputs. Two or more of the plurality of phase modules may share a common insulated-gate bipolar transistor.

According to some implementations, the present disclosure is related to a system. The system may include a multi-phase electrical inverter.
25 Two or more phase modules, of a plurality of phase modules of the multi-phase electrical inverter, may share a common transistor and a common diode. The system may include a motor coupled to the multi-phase electrical inverter.

According to some implementations, the present disclosure is related to an inverter. The inverter may include a plurality of electromagnets.
30 The inverter may include a plurality of diodes coupled to the plurality of electromagnets to provide a voltage. The inverter may include a plurality of

insulated-gate bipolar transistors coupled to the plurality of electromagnets and the plurality of diodes to selectively activate the plurality of electromagnets to cause a phase output from the inverter. A first insulated-gate bipolar transistor, of the plurality of insulated-gate bipolar transistors, may be coupled to a first
5 electromagnet and to a second electromagnet of the plurality of electromagnets. A second insulated-gate bipolar transistor, of the plurality of insulated-gate bipolar transistors, may be coupled to the second electromagnet and to a third electromagnet of the plurality of electromagnets. A third insulated-gate bipolar transistor, of the plurality of insulated-gate bipolar transistors, may be coupled to
10 the third electromagnet and not to the first electromagnet and not to the second electromagnet.

Brief Description Of The Drawings

Fig. 1 is a diagram of an example machine that includes an inverter.

15 Figs. 2A and 2B are diagrams of example inverter topologies that may be used with the machine of Fig. 1.

Detailed Description

This disclosure relates to an inverter topology. The inverter topology has universal applicability to any machine utilizing such an inverter
20 topology. The term “machine” may refer to any machine that performs an operation associated with an industry such as, for example, mining, construction, farming, transportation, or any other industry. As some examples, the machine may be a vehicle, a backhoe loader, a cold planer, a wheel loader, a compactor, a feller buncher, a forest machine, a forwarder, a harvester, an excavator, an
25 industrial loader, a knuckleboom loader, a material handler, a motor grader, a pipelayer, a road reclaimer, a skid steer loader, a skidder, a telehandler, a tractor, a dozer, a tractor scraper, and/or the like. Moreover, one or more implements may be connected to the machine and controlled using an electric motor associated with the inverter topology described herein.

Fig. 1 is a diagram of an example machine 100 that includes an inverter topology. The machine 100 is shown as a track type tractor but may include any type of machine that includes an inverter topology capable of providing a phase output to control an electric motor of machine 100.

5 As shown, machine 100 may have a power source 102, an electric drive system 104, a traction system 106, an inverter 108, a motor 110, and a drive shaft 112. The power source 102 is configured to supply power to the machine 100. In some implementations, the power source 102 may be a direct current (DC) power source. The power source 102 may be operably arranged to receive
10 control signals from the operator controls 114 in operator station 116. The, the power source 102 may be operably arranged with the electric drive system 104 and/or an implement 118 to selectively operate the electric drive system 104 and/or the implement 118 according to control signals received from the operator controls 114. The power source 102 may provide operating power for the
15 propulsion of the electric drive system 104 and/or the operation of the implement 118 via, for example, the electric drive system 104, the inverter 108, the motor 110, the drive shaft 112, and/or the like.

 The electric drive system 104 may be operably arranged with the power source 102 to selectively propel the machine 100 via control signals from
20 the operator controls 114. The electric drive system 104 may be operably connected to a plurality of ground-engaging members, such as traction system 106, as shown, which may be movably connected to the machine 100 through axles, drive shafts, and/or other components and which may be movably connected to electric drive system 104 via the motor 110 and the drive shaft 112.
25 In some implementations, the traction system 106 may be provided in the form of a track-drive system, a wheel-drive system, or any other type of drive system configured to propel the machine 100. In some implementations, the electric drive system 104 may be operably arranged with power source 102 to selectively operate the implement 118, which may be movably connected to the machine 100
30 and to the electric drive system 104.

The inverter 108 may be electrically connected to the power source 102 and/or the electric drive system 104. In some implementations, the inverter 108 may receive a DC current from the power source 102 and may control a phase of the DC current to provide an AC current to the motor 110, which may be a switched reluctance (SR) motor. Additionally, or alternatively, inverter 108 may provide the AC current to a generator. In this way, the inverter 108 may provide operating power for the propulsion of the machine 100 and/or the operation of the implement 118.

The implement 118 may be operably arranged with the electric drive system 104 such that the implement 118 is selectively movable through control signals transmitted from the operator controls 114 to the electric drive system 104, the inverter 108, the motor 110, the drive shaft 112, and/or the like. The illustrated implement 118 is a tractor loader. Other embodiments can include any other suitable implement for a variety of tasks, such as, for example, dozing, blading, brushing, compacting, grading, lifting, ripping, plowing, and/or the like. Example implements include dozers, augers, buckets, breakers/hammers, brushes, compactors, cutters, forked lifting devices, grader bits and end bits, grapples, and/or the like.

As indicated above, Fig. 1 is provided as an example. Other examples are possible and may differ from what was described in connection with Fig. 1.

Figs. 2A and 2B are diagrams relating to an example inverter topology 200/200'. In some implementations, inverter topology 200/200' may correspond to inverter 108 in Fig. 1.

As shown in Fig. 2A, the inverter topology 200 includes a set of phase modules 202-1, 202-2, 202-3, ..., 202- N configured in an $n+1$ type of inverter topology. In some implementations, N may be 3 (e.g., there may be 3 phase modules 202), and the 3 phase modules 202 may enable a 3-phase inverter, a 6-phase inverter, and/or the like.

As further shown in Fig. 2A and by call-out 204-1, the phase module 202-1 is electrically coupled to a shared switch 206, a non-shared switch

208-1, a shared diode 210, and a non-shared diode 212-1. In some implementations, a switch, such as the shared switch 206, the non-shared switch 208-1, and/or the like may be an insulated-gate bipolar transistor (IGBT). For example, each phase module 202 may share a single IGBT, such as shared switch 5 206. In contrast, each phase module 202 may be associated with a different, respective IGBT, such as a respective non-shared switch 208.

In some implementations, the phase module 202-1 is coupled to an electromagnet 214-1 to provide a phase output to enable inversion of DC current to AC current. A first electrical path is formed, for the phase module 202-1, by 10 the shared switch 206, the non-shared diode 212-1, and the electromagnet 214-1. A second electrical path is formed, for the phase module 202-1, by the non-shared switch 208-1, the shared diode 210, and the electromagnet 214-1. In this case, each electrical path is associated with a voltage source to provide a voltage, and causes electromagnet 214-1 to provide a magnetic field based on the voltage.

15 Similarly, as further shown in Fig. 2A and by call-out 204-2, the phase module 202-2 is electrically coupled to the shared switch 206, a non-shared switch 208-2, the shared diode 210, and a non-shared diode 212-2. In some implementations, the phase module 202-2 is coupled to an electromagnet 214-2 to provide a phase output to enable inversion of DC current to AC current. A 20 first electrical path is formed, for the phase module 202-2, by the shared switch 206, the non-shared diode 212-2, and the electromagnet 214-2. A second electrical path is formed, for the phase module 202-2, by the non-shared switch 208-2, the shared diode 210, and the electromagnet 214-2. In this case, each electrical path is associated with a voltage source to provide a voltage, and causes 25 electromagnet 214-2 to provide a magnetic field based on the voltage.

In this case, each phase module 202 is coupled to the shared switch 206 and the shared diode 210 as well as to a respective non-shared switch 208 and a respective non-shared diode 212. As a result, the phase modules 202 are partially decoupled such that shared switch 206 operates a first electrical path 30 of each phase module 202 and with different respective non-shared diodes 212, but each phase module 202 maintains a second electrical path independently

operated by a respective non-shared switch 208 and with the shared diode 210.

In this way, inverter topology 200 reduces a quantity of diodes and switches relative to a fully decoupled $2n$ type of inverter topology wherein each phase module is associated with two non-shared switches and two non-shared diodes.

5 For example, an $n+1$ inverter topology achieved by inverter topology 200 is associated with a quantity $t = n+1$ switches (wherein t represents a quantity of IGBTs used as the switches) and a quantity $d = n+1$ diodes (wherein d represents a quantity of diodes), and wherein n represents a quantity of phase modules 202 in the inverter topology 200 ($n = N$). In this way, inverter topology 200 reduces a
10 quantity of switches and diodes relative to the $2n$ inverter topology associated with a quantity $2n$ switches and $2n$ diodes.

As shown in Fig. 2B, the inverter topology 200' includes a set of phase modules 252-1, 252-2, 252-3, ..., 252- N configured in another $n+1$ type of inverter topology.

15 As further shown in Fig. 2B, and by call-out 254-1, the phase module 252-2 is electrically coupled to a shared switch 256-1, a shared diode 258-1, a shared switch 256-2, and a shared diode 258-2. In some implementations, a switch, such as the shared switch 256-1, the shared switch 256-2, and/or the like may be an insulated-gate bipolar transistor (IGBT).

20 In some implementations, the shared switch 256-1 and the shared diode 258-1 are shared with the phase module 252-1, which includes an electromagnet 260-1 (not shown). In some implementations, the phase module 252-2 is coupled to an electromagnet 260-2 to provide a phase output to enable inversion of DC current to AC current. A first electrical path is formed, for the
25 phase module 252-2, by the shared switch 256-1, the shared diode 258-2, and the electromagnet 260-2. A second electrical path is formed, for the phase module 252-2, by the shared switch 256-2, the shared diode 258-1, and the electromagnet 260-2.

30 Similarly, as further shown in Fig. 2B, and by call-out 254-2, the phase module 252-2 is electrically coupled to the shared switch 256-2, the shared diode 258-2, a shared switch 256-3, and a shared diode 258-3. In some

implementations, the phase module 252-3 is coupled to an electromagnet 260-3 to provide a phase output to enable inversion of DC current to AC current. A first electrical path is formed, for the phase module 252-3, by the shared switch 256-2, the shared diode 258-3, and the electromagnet 260-3. A second electrical path is formed, for the phase module 252-3, by the shared switch 256-3, the shared diode 258-2, and the electromagnet 260-3.

In this case, each phase module 252-2 through 252-N-1 is coupled to a set of two shared switches 256 and shared diodes 258. Phase modules 202-1 and 202-N (e.g., end phase modules) are coupled to a non-shared switch and a non-shared diode. In this way, the phase modules are partially decoupled, thereby reducing a quantity of diodes and switches relative to a fully decoupled $2n$ type of inverter topology wherein each phase module is associated with two non-shared switches and two non-shared diodes. For example, the $n+1$ inverter topology shown by inverter topology 200' is associated with a quantity $n+1$ switches and $n+1$ diodes, wherein n represents a quantity of phase modules 252 in the inverter topology 200', thereby reducing a quantity of switches and diodes relative to the $2n$ inverter topology associated with a quantity $2n$ switches and $2n$ diodes.

In this way, based on using inverter topology 200/200', an input DC current may be inverted into an output AC current using a reduced quantity of diodes and switches relative to other inverter topologies, thereby improving manufacturability and/or the like for an inverter, a machine, and/or the like.

Industrial Applicability

The inverter topology 200/200' may be used with the machine 100 and the power source 102 to enable utilization of the electric drive system 104 of the machine 100. During operation of the machine 100, switches and/or diodes of the inverter topology 200/200' may be activated and/or deactivated based on control signals to cause the inverter topology 200/200' to provide a desired phase to invert DC current provided by the power source 102 for utilization as AC current by the electric drive system 104, the motor 110, and/or the like, thereby enabling movement of the machine 100 via the traction system 106 and/or

movement of the implement 118. In some implementations, the inverter topology 200/200' may be coupled to a motor, such as the motor 110 of the electric drive system 104, and may provide a plurality of phase outputs to the motor 110 of the electric drive system 104 to control rotation of the drive shaft 112.

5 Thus, using the inverter topology 200/200' enables operation of the machine 100 with a reduced quantity of diodes and/or switches for an inverter of the machine 100, thereby reducing cost, improving manufacturability, reducing a likelihood of failure, and/or the like relative to use of other inverter topologies.

10 As used herein, the articles "a" and "an" are intended to include one or more items, and may be used interchangeably with "one or more." Also, as used herein, the terms "has," "have," "having," or the like are intended to be open-ended terms. Further, the phrase "based on" is intended to mean "based, at least in part, on."

15 The foregoing disclosure provides illustration and description, but is not intended to be exhaustive or to limit the implementations to the precise form disclosed. Modifications and variations are possible in light of the above disclosure or may be acquired from practice of the implementations. It is intended that the specification be considered as an example only, with a true
20 scope of the disclosure being indicated by the following claims and their equivalents. Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the disclosure of possible implementations. Although each dependent claim listed below may directly depend on only one claim, the disclosure of
25 possible implementations includes each dependent claim in combination with every other claim in the claim set.

10
Claims

1. An electrical inverter (108), comprising:
a plurality of phase modules (202/252) to provide a plurality of
phase outputs,
5 wherein two or more of the plurality of phase modules (202/252)
share a common insulated-gate bipolar transistor (206/256).
2. The electrical inverter (108) of claim 1, wherein the
plurality of phase modules (202/252) share a single insulated-gate bipolar
10 transistor (206/256), and
wherein each phase module, of the plurality of phase modules, is
coupled to a corresponding non-shared insulated-gate bipolar transistor (208).
3. The electrical inverter (108) of claim 1, wherein a first
15 phase module (202/252), of the plurality of phase modules (202/252), and a
second phase module (202/252), of the plurality of phase modules (202/252),
share a first insulated-gate bipolar transistor (206/256), and
wherein the second phase module and a third phase module, of the
plurality of phase modules, share a second insulated-gate bipolar transistor
20 (206/256).
4. The electrical inverter (108) of claim 3, wherein the first
insulated-gate bipolar transistor (206/256) and the second insulated-gate bipolar
transistor (206/256) are different insulated-gate bipolar transistors (206/256).
25
5. The electrical inverter (108) of claim 1, wherein the two or
more of the plurality of phase modules (202/252) share a common diode
(210/258).

6. The electrical inverter (108) of claim 1, wherein the plurality of phase modules (202/252) share a single common diode (210/258), and
- wherein each phase module (202/252), of the plurality of phase modules (202/252), is coupled to a corresponding non-shared diode (212).
7. The electrical inverter (108) of claim 1, wherein a first phase module (202/252), of the plurality of phase modules (202/252), and a second phase module (202/252), of the plurality of phase modules (202/252), share a first diode (210/258), and
- wherein the second phase module (202/252) and a third phase module (202/252), of the plurality of phase modules (202/252), share a second diode (210/258).
8. The electrical inverter (108) of claim 7, wherein the first diode (210/258) and the second diode (210/258) are different diodes (210/258).
9. A system, comprising:
- a multi-phase electrical inverter (108),
- wherein two or more phase modules (202/252), of a plurality of phase modules (202/252) of the multi-phase electrical inverter (108), share a common transistor (206/256) and a common diode (210/258); and
- a motor coupled to the multi-phase electrical inverter (108).
10. The system of claim 9, wherein a phase module (202/252), of the plurality of phase modules (202/252) connects to a voltage source to provide a voltage, and comprises an electromagnet (214/260) that is configured to provide a magnetic field based on the voltage.

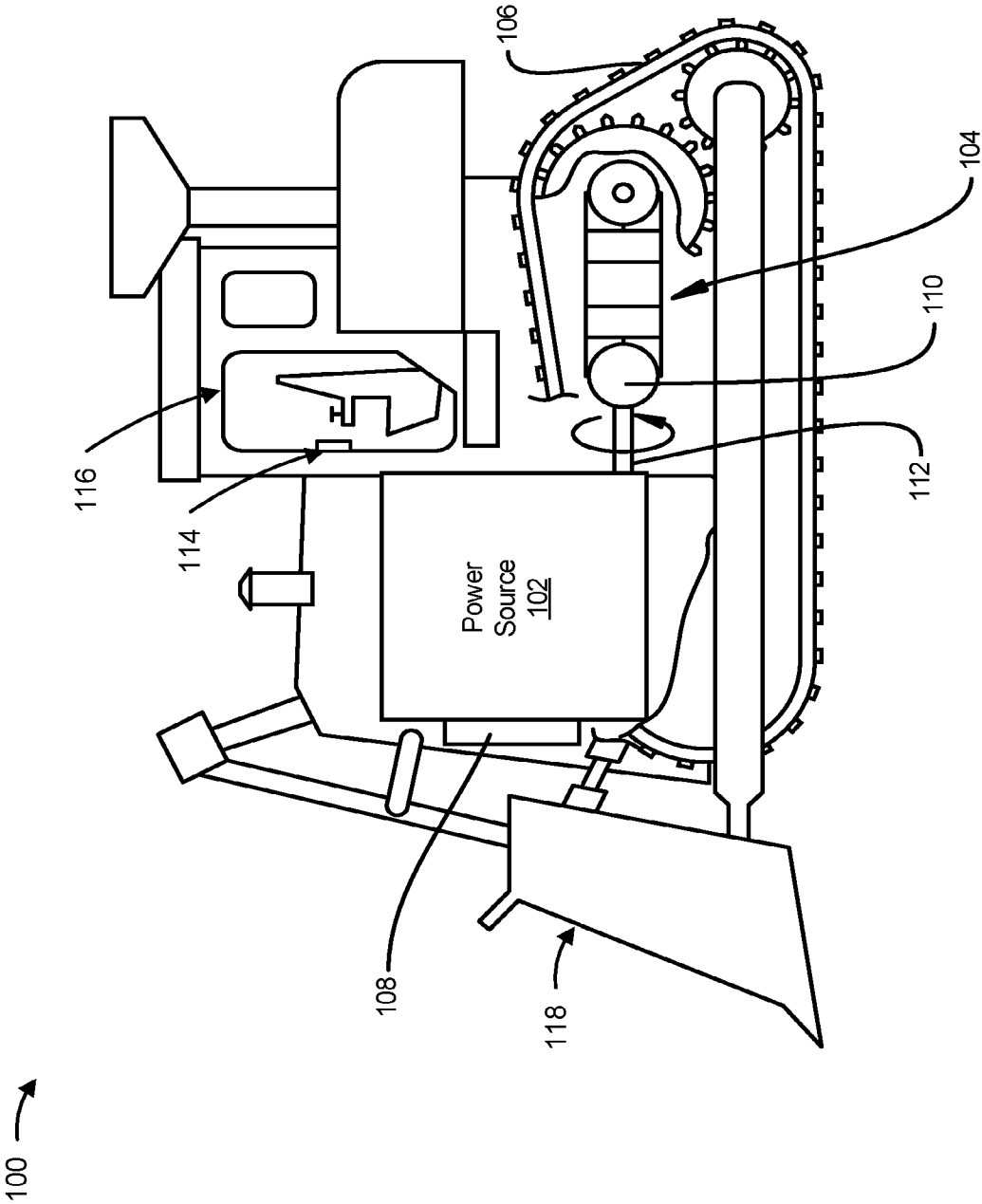


FIG. 1

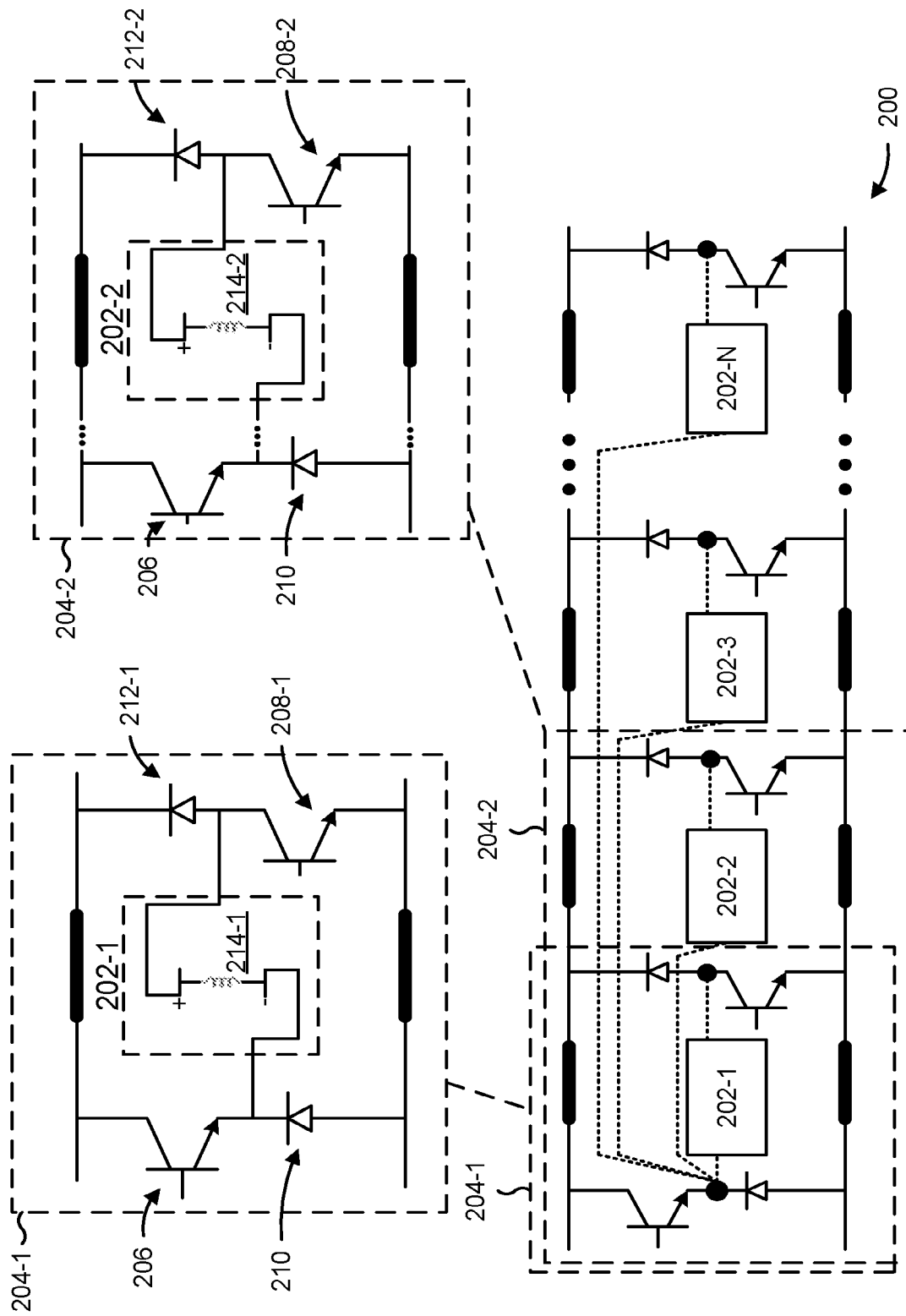


FIG. 2A

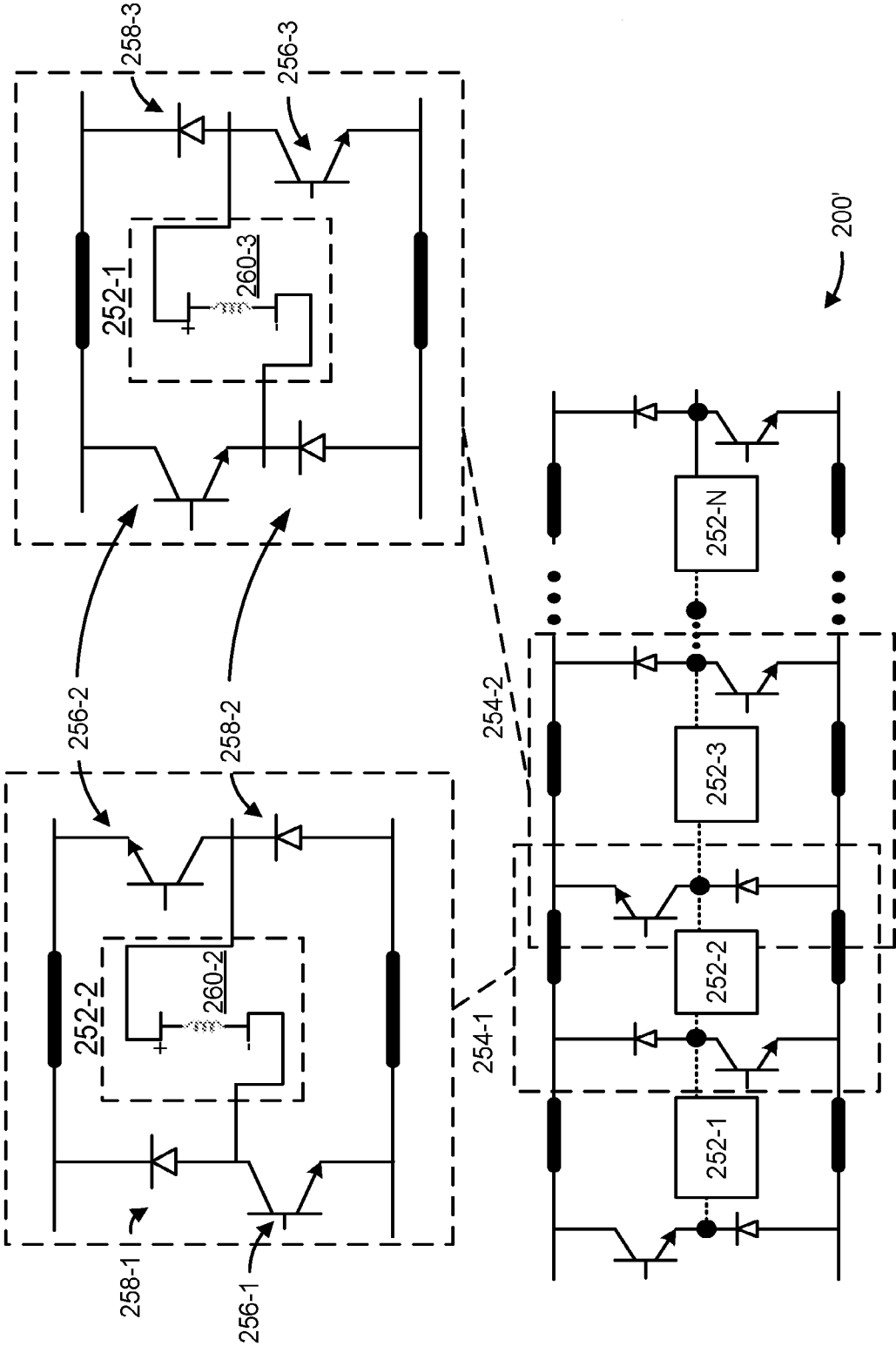


FIG. 2B

A. CLASSIFICATION OF SUBJECT MATTER**H02M 7/5387(2007.01)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)

H02M 7/5387; H02J 7/00; H02M 7/44; H02M 7/48; H02M 7/539

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: inverter, phase module, output, IGBT(insulated gate bipolar transistor)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5280421 A (RIK W. A. A. DE DONCKER et al.) 18 January 1994	1,9-10
Y	See column 1, lines 20-35, column 3, lines 4-66 and figure 1.	2-8
Y	KR 10-2012-0091965 A (KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY) 20 August 2012 See paragraphs 21-47 and figures 1-5.	2-8
A	JP 2009-050042 A (YOKOHAMA NATIONAL UNIV.) 05 March 2009 See claims 1-4 and figures 1-8.	1-10
A	JP 2013-090511 A (DENSO CORP.) 13 May 2013 See claims 1-3 and figures 1-6.	1-10
A	CN 106301053 A (STATE GRID CORPORATION OF CHINA et al.) 04 January 2017 See claims 1-3 and figures 1-3.	1-10



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

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"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)

"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

"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

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"&" document member of the same patent family

Date of the actual completion of the international search

29 November 2019 (29.11.2019)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea



Facsimile No. +82-42-481-8578

Authorized officer

JANG, Gijeong

Telephone No. +82-42-481-8364



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2019/046097

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5280421 A	18/01/1994	None	
KR 10-2012-0091965 A	20/08/2012	KR 10-1261357 B1	06/05/2013
JP 2009-050042 A	05/03/2009	None	
JP 2013-090511 A	13/05/2013	None	
CN 106301053 A	04/01/2017	None	