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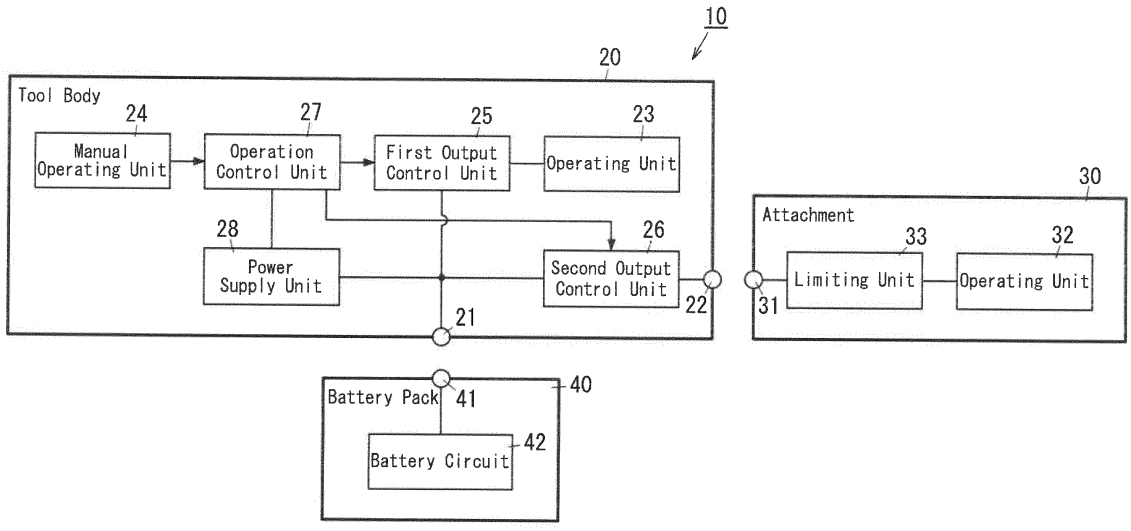
(54) ELECTRIC TOOL AND ATTACHMENT

(57) An object of the present disclosure is to provide an electric tool with the ability to reduce the chances of its tool body being electrically affected by a failure in its attachment and also provide an attachment. An electric tool (10) includes a tool body (20) and an attachment (30) to be attached removably to the tool body (20). The attachment (30) includes: an operating unit (32) to operate with electric power supplied from the tool body (20); and a limiting unit (33) to limit supply of the electric power from the tool body (20) to the operating unit (32) when a failure occurs in the attachment (30).

FIG. 1



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Description

Technical Field

[0001] The present disclosure generally relates to an electric tool and an attachment, and more particularly relates to an electric tool including a tool body and an attachment to be attached removably to the tool body, and an attachment for an electric tool.

Background Art

[0002] Patent Literature 1 discloses an electric tool. The electric tool of Patent Literature 1 is an electric tool with an attachment in which a dust collector (attachment) is attached to a hammer drill (tool body). In Patent Literature 1, a male terminal is provided to protrude from the dust collector, and the hammer drill has an insert port to which the male terminal may be inserted and a female terminal, which is located inside the insert port and is electrically connectible to the male terminal. Electrical connection established between the male and female terminals by joining the dust collector to the hammer drill allows driving power to be supplied from a battery pack to the dust collector.

[0003] According to Patent Literature 1, the dust collector (attachment) includes a motor (operating unit) to be driven with the electric power supplied from the electric tool. Thus, if a failure occurs in the motor, then the hammer drill (the tool body of the electric tool) could be electrically affected by the failure of the motor.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2011-189486 A

Summary of Invention

[0005] It is therefore an object of the present disclosure to provide an electric tool with the ability to reduce the chances of its tool body being electrically affected by a failure in its attachment and also provide an attachment for such an electric tool.

[0006] An electric tool according to an aspect of the present disclosure includes: a tool body; and an attachment to be attached removably to the tool body. The attachment includes: an operating unit configured to operate with electric power supplied from the tool body; and a limiting unit configured to limit supply of the electric power from the tool body to the operating unit when a failure occurs in the attachment.

[0007] An attachment according to another aspect of the present disclosure is designed to be attached removably to a tool body of an electric tool. The attachment includes: an operating unit configured to operate with electric power supplied from the tool body; and a limiting unit configured to limit supply of the electric power from the tool body to the operating unit when a failure occurs in the attachment.

Brief Description of Drawings

[0008]

FIG. 1 is a block diagram illustrating an exemplary embodiment of an electric tool according to the present disclosure;
FIG. 2 is a perspective view of the electric tool;
FIG. 3 is a block diagram of a main part of the electric tool;
FIG. 4 is a block diagram of an attachment according to a first variation of the exemplary embodiment; and
FIG. 5 is a block diagram of an attachment according to a second variation of the exemplary embodiment.

Description of Embodiments

1. Embodiment

1.1 Overview

[0009] FIG. 1 is a block diagram of an electric tool 10 according to an exemplary embodiment. The electric tool 10 includes: a tool body 20; and an attachment 30 to be attached removably to the tool body 20. The attachment 30 includes: an operating unit 32 configured to operate with electric power supplied from the tool body 20; and a limiting unit 33 configured to limit supply of the electric power from the tool body 20 to the operating unit 32 when a failure occurs in the attachment 30.

[0010] In the electric tool 10, when a failure occurs in the operating unit 32 of the attachment 30, the limiting unit 33 limits the supply of electric power from the tool body 20 to the operating unit 32. For example, due to a failure in the operating unit 32, excessive electric power could be supplied from the tool body 20 to the operating unit 32. Even in such a situation, the limiting unit 33 limits the supply of the electric power from the tool body 20 to the operating unit 32. This allows the electric tool 10 to reduce the chances of the tool body 20 being electrically affected by a failure in the attachment 30.

1.2 Configuration

[0011] Next, the electric tool 10 will be described in further detail. The electric tool 10 may be implemented as a hammer drill such as the one shown in FIG. 2. The electric tool 10 includes not only the tool body 20 and the attachment 30 but also a battery pack 40 as well.

[0012] The battery pack 40 serves as a power supply for the tool body 20 and the attachment 30. The battery pack 40 includes a body connector 41 and a battery circuit 42 as shown in FIG. 1. The battery pack 40 further includes a housing 400 for housing the body connector 41

and the battery circuit 42 therein (see FIG. 2).

[0013] The body connector 41 is an element for connecting the battery pack 40 to the tool body 20 both electrically and mechanically. The body connector 41 is implemented as a connector having a mechanical structure (such as a structure to be fitted into the housing 200 of the tool body 20) and an electrical structure (such as a terminal to be connected to an electrical circuit of the tool body 20) for use to have the battery pack 40 removably attached to the tool body 20. Such a body connector 41 is implementable as any known connector, and therefore, a detailed description thereof will be omitted herein.

[0014] The battery circuit 42 is a circuit for supplying electric power to the tool body 20 via the body connector 41. The battery circuit 42 includes a secondary battery and a charging and discharging circuit for the secondary battery. The charging and discharging circuit has the function of outputting the electric power of the secondary battery through the body connector 41 (i.e., discharging function) and the function of charging the secondary battery with electricity supplied from an external power supply (i.e., charging function). Note that the charging and discharging circuit is not an essential constituent element.

[0015] The tool body 20 includes a power supply connector 21, an attachment connector 22, an operating unit 23, a manual operating unit 24, a first output control unit 25, a second output control unit 26, an operation control unit 27, and a power supply unit 28 as shown in FIG. 1. The tool body 20 further includes a protection circuit 29 as shown in FIG. 3. The tool body 20 further includes a housing 200 (see FIG. 2). The housing 200 houses the power supply connector 21, attachment connector 22, operating unit 23, manual operating unit 24, first output control unit 25, second output control unit 26, operation control unit 27, power supply unit 28, and protection circuit 29 shown in FIG. 1.

[0016] The power supply connector 21 is an element for connecting the battery pack 40 to the tool body 20 both electrically and mechanically. The power supply connector 21 is implemented as a connector having a mechanical structure (such as a structure to be fitted into the housing 400 of the battery pack 40) and an electrical structure (such as a terminal to be connected to an electrical circuit of the battery pack 40) for use to have the battery pack 40 removably attached to the tool body 20. The power supply connector 21 corresponds to the body connector 41 of the battery pack 40. Connecting the body connector 41 to the power supply connector 21 allows the battery pack 40 to be attached removably to the tool body 20. Such a power supply connector 21 is implementable as any known connector, and therefore, a detailed description thereof will be omitted herein.

[0017] The attachment connector 22 is an element for connecting the attachment 30 to the tool body 20 both electrically and mechanically. The attachment connector 22 is implemented as a connector having a mechanical structure (such as a structure to be fitted into the housing 300 of the attachment 30) and an electrical structure for use to have the attachment 30 removably attached to the tool body 20. The attachment connector 22 includes, as the electrical structure, terminals (a pair of output terminals 221 and 222) to be connected to the electrical circuit of the attachment 30 as shown in FIG. 3. Such an attachment connector 22 is implementable as any known connector, and therefore, a detailed description thereof will be omitted herein.

[0018] The operating unit 23 has a mechanical structure and electrical structure for performing the function as the tool body 20. The operating unit 23 includes a holder 231 for holding a tip tool 50 (see FIG. 2) and a motor for rotating the tip tool 50 held by the holder 231. The operating unit 23 further includes a handle 232 for moving the tip tool 50 held by the holder 231 along the axis of rotation of the tip tool 50 (i.e., in the forward/backward direction). Using the handle 232 allows the user to adjust the position of the holder 231 (i.e., the position of the tip tool 50) with respect to the attachment 30. As shown in FIG. 2, the tip of the tip tool 50 may stick out of the attachment 30. Examples of the tip tool 50 include gonbits, drill bits, driver bits, ironwork drills, and gimlets. The tip tool 50 is replaced as needed, and therefore, is not a constituent element of the operating unit 23.

[0019] The manual operating unit 24 is an interface allowing the user to operate the tool body 20. The manual operating unit 24 includes a trigger switch 241 for activating the operating unit 23 as shown in FIG. 2.

[0020] The first output control unit 25 has the function of generating electric power (first driving power) for operating the operating unit 23 of the tool body 20 based on the electric power supplied from the battery pack 40 via the power supply connector 21 and outputting the electric power to the operating unit 23. The first output control unit 25 is controlled by the operation control unit 27, and applies either a predetermined voltage or a predetermined current to the operating unit 23. The first output control unit 25 may be implemented as a switching power supply or any other known power electronic component, and a detailed description thereof will be omitted herein.

[0021] The second output control unit 26 has the function of generating electric power (second driving power) for operating the attachment 30 based on the electric power supplied from the battery pack 40 via the power supply connector 21 and outputting the electric power to the attachment connector 22. The second output control unit 26 is controlled by the operation control unit 27 and outputs either a predetermined voltage or a predetermined current via a pair of output terminals 221 and 222 of the attachment connector 22. As can be seen, the tool body 20 is configured to supply electric power to the attachment 30 based on the electric power received at the power supply connector 21. This allows the single battery pack 40 to supply electric power to both the tool body 20 and the attachment 30. The second output control unit 26 may be implemented as a switching power supply or

any other known power electronic component, and a detailed description thereof will be omitted herein.

[0022] The operation control unit 27 has the function of controlling the first output control unit 25 and the second output control unit 26 (i.e., control function) responsive to the operation of the manual operating unit 24. For example, while the trigger switch 241 of the manual operating unit 24 is ON, the operation control unit 27 has first driving power output from the first output control unit 25 to the operating unit 23 and also has second driving power output from the second output control unit 26 to the attachment connector 22. The operation control unit 27 includes at least one processor and at least one memory. The control function described above is performed by having the at least one processor execute a program stored in the at least one memory.

[0023] The power supply unit 28 has the function of generating electric power for operating the operation control unit 27 of the tool body 20 (i.e., control power) based on the electric power supplied from the battery pack 40 via the power supply connector 21 and outputting the electric power to the operation control unit 27. The power supply unit 28 may be implemented as a regulator (such as a three-terminal regulator) or any other known power electronic component, and a detailed description thereof will be omitted herein.

[0024] The protection circuit 29 includes a current fuse 291 (see FIG. 3). The current fuse 291 is provided between one of the pair of output terminals 221 and 222 of the attachment connector 22 (i.e., the output terminal 221) and the second output control unit 26. The rated current value of the current fuse 291 is defined based on the range of the operating current of the operating unit 32 of the attachment 30 in a normal state. Specifically, the rated current value of the current fuse 291 is set such that the current fuse 291 is blown when a failure occurs in the attachment 30.

[0025] The attachment 30 includes a body connector 31, the operating unit 32, and the limiting unit 33 as shown in FIG. 1. The attachment 30 further includes a housing 300 for housing the body connector 31, the operating unit 32, and the limiting unit 33 therein (see FIG. 2). In this embodiment, the attachment 30 is implemented as a dust collector. That is to say, the attachment 30 is used to collect the debris (such as wood chips and iron chips) left when the tool body 20 is used. A dust box 34 for storing the dust collected by the dust collector is configured to be attached removably to the housing 300 of the attachment 30 as shown in FIG. 2.

[0026] The body connector 31 is an element for connecting the attachment 30 to the tool body 20 both electrically and mechanically. The body connector 31 is implemented as a connector having a mechanical structure (such as a structure to be fitted into the housing of the tool body 20) and an electrical structure for use to have the attachment 30 removably attached to the tool body 20. The body connector 31 includes, as the electrical structure, terminals (a pair of input terminals 311 and 312) to be connected to the electrical circuit of the tool body 20 as shown in FIG. 3. The body connector 31 corresponds to the attachment connector 22 of the tool body 20. Connecting the body connector 31 to the attachment connector 22 allows the attachment 30 to be attached removably to the tool body 20. At this time, the pair of input terminals 311 and 312 of the body connector 31 are respectively electrically connected to the pair of output terminals 221 and 222 of the attachment connector 22.

[0027] The operating unit 32 has a mechanical structure and an electrical structure for performing the function as the attachment 30. In this embodiment, the attachment 30 is implemented as a dust collector. Thus, the operating unit 32 is a sucker for sucking the dust left when the tool body 20 is used into the dust box 34, and includes the motor 321 as its electrical structure. That is to say, having the motor 321 of the operating unit 32 operate allows the dust to be collected into the dust box 34 by the sucker. The motor 321 is connected between the pair of input terminals 311 and 312 of the body connector 31 as shown in FIG. 3. The operating unit 32 (motor 321) is configured to operate with the voltage applied between the pair of input terminals 311 and 312.

[0028] A failure in the attachment 30 is herein supposed to be a failure of the motor 321 of the operating unit 32. For example, the failure of the motor 321 may be locking (immobilization) of the motor 321 or dielectric breakdown of the motor 321. When such a failure occurs in the motor 321, an unexpectedly excessive current could flow through the motor 321 (i.e., through the operating unit 32).

[0029] The limiting unit 33 includes a current fuse 331. The current fuse 331 is provided between one of the pair of input terminals 311 and 312 of the body connector 31 (i.e., the input terminal 311) and the motor 321 of the operating unit 32. That is to say, the limiting unit 33 includes the current fuse 331 provided on an electrical path through which the electric power supplied from the tool body 20 is delivered to the operating unit 32. The rated current value of the current fuse 331 is determined based on the range of the operating current of the operating unit 32 of the attachment 30 in a normal state. Specifically, the rated current value of the current fuse 331 is set such that the current fuse 331 is blown when a failure occurs in the attachment 30. In this embodiment, the tool body 20 includes the current fuse 291 between the second output control unit 26 and the output terminal 221 as shown in FIG. 3. In other words, the tool body 20 includes the current fuse 291 to be electrically connected in series to the current fuse 331. Nevertheless, the rated current value of the current fuse 331 of the limiting unit 33 is smaller than the rated current value of the current fuse 291 of the tool body 20. This increases the chances of the current fuse 331 being blown earlier than the current fuse 291 when a failure occurs in the attachment 30. That is to say, even though the tool body 20 includes the current fuse 291, the current fuse 291 of the attachment 30

is blown earlier than the current fuse 291. This increases the chances of, even if a failure occurs in the attachment 30, the need to replace the current fuse 291 of the tool body 20 with a new one being eliminated.

[0030] When the electric tool 10 described above is used, the battery pack 40 and the attachment 30 are attached to the tool body 20. In this embodiment, the tool body 20 includes the power supply connector 21 to which the battery pack 40 is attached and is configured to operate with the electric power received at the power supply connector 21. That is to say, the tool body 20 is an electric tool to be driven by a battery. This eliminates the need to connect the tool body 20 to an AC outlet with a cable, thus making the electric tool 10 easier to handle. In addition, the tool body 20 further includes the attachment connector 22 with the pair of output terminals 221 and 222. The attachment 30 includes the body connector 31 having the pair of input terminals 311 and 312 to be electrically connected to the pair of output terminals 221 and 222, respectively, and designed to be attached removably to the attachment connector 22. The operating unit 32 is configured to operate with the voltage applied between the pair of input terminals 311 and 312. This reduces the number of terminals required to supply electric power from the tool body 20 to the attachment 30. This allows a cheaper connector with a smaller number of terminals to be used as the attachment connector 22 and the body connector 31, thus contributing to cost reduction.

1.3 Operation in the case of failure

[0031] Next, it will be described how the electric tool 10 operates when a failure occurs in the attachment 30. When a failure occurs in the attachment 30, the amount of current flowing through the operating unit 32 (motor 321) increases. In that case, once the value of the current flowing through the motor 321 exceeds the rated current value of the current fuse 331 of the limiting unit 33, the current fuse 331 will be blown before long. This electrically isolates the motor 321 from the input terminal 311 of the body connector 31, and eventually, from the tool body 20 (second output control unit 26) as well. In this manner, the limiting unit 33 limits the supply of electric power from the tool body 20 to the operating unit 32 when a failure occurs in the attachment 30. This allows the electric tool 10 to reduce the chances of the tool body 20 being electrically affected by a failure in the attachment 30.

[0032] In this embodiment, the current fuse 331 of the limiting unit 33 is blown to limit the supply of electric power from the tool body 20 to the operating unit 32. Nevertheless, this reduces the chances of the current fuse 291 of the tool body 20 being blown, thus increasing the chances of causing no problem even without repairing the tool body 20 or replacing some parts thereof. In other words, the failure would be dealt with successfully just by repairing the attachment 30 or by replacing some parts of the attachment 30 or even the attachment 30 itself. In addition, the limiting unit 33 makes the current fuse 331 perform the function of limiting the supply of electric power from the tool body 20 to the operating unit 32, thus simplifying the configuration and contributing to cost reduction.

2. Variations

[0033] Note that the embodiment described above is only an exemplary one of various embodiments of the present disclosure and should not be construed as limiting. Rather, the exemplary embodiment described above may be readily modified in various manners depending on a design choice or any other factor without departing from the scope of the present disclosure. Some variations of the exemplary embodiment will be enumerated one after another.

2.1 First variation

[0034] FIG. 4 illustrates an attachment 30A according to a first variation. This attachment 30A includes the body connector 31, the operating unit 32, and a limiting unit 33A.

[0035] The operating unit 32 includes the motor 321. The motor 321 is connected between the pair of input terminals 311 and 312 of the body connector 31.

[0036] The limiting unit 33A includes a switch 331A and a control circuit 332A.

[0037] The switch 331A is provided on an electrical path through which the electric power supplied from the tool body 20 is delivered to the operating unit 32. As shown in FIG. 4, the switch 331A is inserted between the motor 321 and the input terminal 312 of the body connector 31. More specifically, the switch 331A is implemented as a field-effect transistor (FET) and has its drain electrically connected to the motor 321 and its source electrically connected to the input terminal 312. Alternatively, the switch 331A may also be implemented as a semiconductor switching element other than an FET or any other controllable switch (such as an electromagnetic relay).

[0038] When the value of current flowing through the operating unit 32 is greater than a predetermined value, the control circuit 332A controls the switch 331A to limit the supply of electric power from the tool body 20 to the operating unit 32. The control circuit 332A includes a power supply circuit 333A and a driver circuit 334A.

[0039] The power supply circuit 333A is a circuit for supplying driving power to the driver circuit 334A. The power supply circuit 333A includes a transistor Tr10, a resistor R10, and a Zener diode ZD10. The transistor Tr10 is electrically connected between the pair of input terminals 311 and 312 of the body connector 31. The transistor Tr10 is implemented as an NPN transistor, and has its collector electrically connected to the input terminal 311 and its emitter electrically connected to the input

terminal 312. The resistor R10 is electrically connected between the collector and base of the transistor Tr10. The Zener diode ZD10 has its cathode electrically connected to the base of the transistor Tr10 and its anode electrically connected to the ground. Such a power supply circuit 333A lowers the voltage between the pair of input terminals 311 and 312 to a range suitable for driving the driver circuit 334A. The configuration of the power supply circuit 333A is well-known in the art, and a detailed description thereof will be omitted herein.

[0040] The driver circuit 334A is a circuit for driving the switch 331A. The driver circuit 334A includes resistors R11, R12, and R13, and a comparator CP10.

[0041] The resistors R11 and R12 together form a series circuit. This series circuit is electrically connected between the emitter of the transistor Tr10 of the power supply circuit 333A and the input terminal 312. The resistor R13 is electrically connected between the source of the switch 331A and the input terminal 312.

[0042] The comparator CP10 includes a non-inverting input terminal, an inverting input terminal, and an output terminal. In the comparator CP10 with this configuration, while the voltage applied to the inverting input terminal is equal to or less than the voltage applied to the non-inverting input terminal, the output at the output terminal remains at high level. On the other hand, when the voltage applied to the inverting input terminal exceeds the voltage applied to the non-inverting input terminal, the output at the output terminal falls from high level to low level.

[0043] The output terminal of the comparator CP10 is electrically connected to the gate of the switch 331A. The inverting input terminal of the comparator CP10 is electrically connected to the node of connection between the source of the switch 331A and the resistor R13. This causes a voltage corresponding to the current flowing through the motor 321 (i.e., a detected voltage) to be applied to the inverting input terminal of the comparator CP10. The non-inverting input terminal of the comparator CP10 is electrically connected to the node of connection between the resistors R11 and R12. This causes a voltage (reference voltage) on which a determination is made whether or not the value of the current flowing through the motor 321 is an abnormal value, to be applied to non-inverting input terminal of the comparator CP10. The reference voltage is a voltage corresponding to the predetermined value, and is determined by the output voltage of the power supply circuit 333A and the resistance value of the resistors R11 and R12. That is to say, the output voltage of the power supply circuit 333A and the resistance values of the resistors R11 and R12 are determined to turn the switch 331A OFF when a failure occurs in the attachment 30A.

[0044] Next, it will be described how the electric tool 10 operates when a failure occurs in the attachment 30A. When a failure occurs in the attachment 30A, the amount of current flowing through the operating unit 32 (motor 321) increases. In this case, when the voltage (i.e., the detected voltage) applied to the inverting input terminal of the comparator CP10 exceeds the voltage (i.e., the reference voltage) applied to the non-inverting input terminal of the comparator CP10, the output at the output terminal of the comparator CP10 falls from high level to low level to turn the switch 331A OFF. This causes the motor 321 to be electrically isolated from the input terminal 312 of the body connector 31, and eventually from the tool body 20 (second output control unit 26) as well. In this manner, the limiting unit 33A limits the supply of electric power from the tool body 20 to the operating unit 32 when a failure occurs in the attachment 30A. This reduces the chances of the tool body 20 being electrically affected by a failure in the attachment 30A.

[0045] As can be seen, according to the first variation, the switch 331A is used to limit the supply of electric power from the tool body 20 to the operating unit 32. Thus, unlike a situation where a fuse (which may be either a current fuse or a temperature fuse) is used to limit the supply of electric power from the tool body 20 to the operating unit 32, the limiting unit 33A may be used again. This eliminates the need to replace a part (i.e., the switch 331A) of the limiting unit 33A even when a failure occurs in the attachment 30A. In addition, the limiting unit 33A makes the control circuit 332A control the switch 331A. This allows the timing to limit the supply of electric power from the tool body 20 to the operating unit 32 to be controlled more accurately.

[0046] Note that the limiting unit 33A does not have to turn the switch 331A OFF. Alternatively, the limiting unit 33A may also limit the electric power supplied from the tool body 20 to the operating unit 32 by making the switch 331A operate in an active region, instead of turning the switch 331A OFF.

2.2 Second variation

[0047] FIG. 5 illustrates an attachment 30B according to a second variation. This attachment 30B includes the body connector 31, the operating unit 32, and a limiting unit 33B.

[0048] The operating unit 32 includes the motor 321. The motor 321 is connected between the pair of input terminals 311 and 312 of the body connector 31.

[0049] The limiting unit 33B includes a temperature fuse 331B and a control circuit 332B.

[0050] The temperature fuse 331B is provided on an electrical path through which the electric power supplied from the tool body 20 is delivered to the operating unit 32. As shown in FIG. 5, the temperature fuse 331B is inserted between the motor 321 and the input terminal 312 of the body connector 31.

[0051] The control circuit 332B blows the temperature fuse 331B when the value of current flowing through the operating unit 32 is greater than a predetermined value. The control circuit 332B includes a power supply circuit 333B and a driver circuit 334B.

[0052] The power supply circuit 333B is a circuit for

supplying driving power to the driver circuit 334B. The power supply circuit 333B has the same configuration as the power supply circuit 333A. Such a power supply circuit 333B lowers the voltage between the pair of input terminals 311 and 312 to a range suitable for driving the driver circuit 334B.

[0053] The driver circuit 334B is a circuit for blowing the temperature fuse 331B. The driver circuit 334B includes the resistors R11, R12, and R13, the comparator CP10, a transistor Tr11, and another resistor R14.

[0054] The resistors R11 and R12 together form a series circuit. This series circuit is electrically connected between the emitter of the transistor Tr10 of the power supply circuit 333B and the input terminal 312. The resistor R13 is electrically connected between the temperature fuse 331B and the input terminal 312.

[0055] The resistor R14 is a resistor for heating and generates heat when supplied with electricity. The resistor R14 has one terminal thereof connected to a predetermined portion of the temperature fuse 331B. Allowing a current to flow through the resistor R14 causes the resistor R14 to generate heat, thus blowing the temperature fuse 331B with the heat generated by the resistor R14.

[0056] The transistor Tr11 is implemented as a field-effect transistor (FET), and has its drain electrically connected to the temperature fuse 331B via the resistor R14 and its source electrically connected to the ground.

[0057] The comparator CP10 includes a non-inverting input terminal, an inverting input terminal, and an output terminal. In the comparator CP10 with this configuration, while the voltage applied to the non-inverting input terminal is equal to or less than the voltage applied to the inverting input terminal, the output at the output terminal remains at low level. On the other hand, when the voltage applied to the non-inverting input terminal exceeds the voltage applied to the inverting input terminal, the output at the output terminal rises from low level to high level.

[0058] The output terminal of the comparator CP10 is electrically connected to the gate of the transistor Tr11. The non-inverting input terminal of the comparator CP10 is electrically connected to the node of connection between the temperature fuse 331B and the resistor R13. This causes a voltage (i.e., a detected voltage) corresponding to the current flowing through the motor 321 to be applied to the non-inverting input terminal of the comparator CP10. The inverting input terminal of the comparator CP10 is electrically connected to the node of connection between the resistors R11 and R12. This causes a voltage (reference voltage), on which a determination is made whether or not the value of the current flowing through the motor 321 is an abnormal value, to be applied to the inverting input terminal of the comparator CP10. The reference voltage is a voltage corresponding to the predetermined value, and is determined by the output voltage of the power supply circuit 333B and the resistance values of the resistors R11 and R12. That is to say, the output voltage of the power supply circuit 333B and the resistance values of the resistors R11 and R12 are determined to blow the fuse 331B when a failure occurs in the attachment 30B.

[0059] Next, it will be described how the electric tool 10 operates when a failure occurs in the attachment 30B. When a failure occurs in the attachment 30B, the amount of current flowing through the operating unit 32 (motor 321) increases. In this case, when the voltage (i.e., the detected voltage) applied to the non-inverting input terminal of the comparator CP10 exceeds the voltage (i.e., the reference voltage) applied to the inverting input terminal of the comparator CP10, the output at the output terminal of the comparator CP10 rises from low level to high level to turn the transistor Tr11 ON. This allows a current to flow through the resistor R14 and causes the resistor R14 to generate heat, thus blowing the temperature fuse 331B out with the heat generated by the resistor R14. This causes the motor 321 to be electrically isolated from the input terminal 312 of the body connector 31, and eventually, from the tool body 20 (second output control unit 26) as well. In this manner, the limiting unit 33B limits the supply of electric power from the tool body 20 to the operating unit 32 when a failure occurs in the attachment 30B. This reduces the chances of the tool body 20 being electrically affected by a failure in the attachment 30B.

[0060] As can be seen, according to the second variation, the limiting unit 33B makes the control circuit 332B blow the temperature fuse 331B. This allows the timing to limit the supply of electric power from the tool body 20 to the operating unit 32 to be controlled more accurately.

2.3 Other variations

[0061] Note that the limiting unit does not have to have the exemplary configuration described above. Alternatively, a circuit breaker may also be used as the limiting unit.

[0062] Also, the protection circuit 29 of the tool body 20 may include a switch in place of the current fuse 291. That is to say, the protection circuit 29 may have the same configuration as the limiting unit (33, 33A, 33B). Nevertheless, when a failure occurs in the attachment 30, the limiting unit (33, 33A, 33B) suitably starts operating earlier than the protection circuit 29. Furthermore, if the attachment 30 includes the limiting unit (33, 33A, 33B), then the tool body 20 may have no protection circuit 29.

[0063] Optionally, not the tool body 20 but the attachment 30 may include the second output control unit 26. In that case, the attachment connector 22 and the body connector 31 need to include terminals for electrically connecting the operation control unit 27 of the tool body 20 to the second output control unit 26, thus causing an increase in the number of terminals of the attachment connector 22 and body connector 31. That is why it is recommended that the tool body 20 include the second output control unit 26.

[0064] Furthermore, the electric tool 10 according to each of the exemplary embodiment and its variations described above includes the battery pack 40, i.e., a so-called "battery-driven" electric tool. However, the electric tool 10 does not have to be the battery-driven electric tool. Alternatively, the electric tool 10 may be supplied with electric power by an external power supply such as a commercial AC power supply, instead of the battery pack 40. In that case, the power supply connector 21 of the tool body 20 may be a cable with a plug to be connected to an AC outlet or a connector to which a cable to be connected to an external power supply is connected.

[0065] In the exemplary embodiment and its variations described above, the electric tool 10 is implemented as a hammer drill. However, the technical concept of the present disclosure is applicable to any other types of electric tools, not just the hammer drill. Examples of other types of electric tools include screwdrivers, drills, wrenches, hammers, nibblers, grinders, saws, circular saws, and nail guns.

[0066] Also, in the exemplary embodiment and its variations described above, the attachment 30 is implemented as a dust collector. However, the technical concept of the present disclosure is applicable to any other types of attachments, not just the dust collector. Examples of other attachments include lighting units, blowers, laser pointers, and laser markers.

3. Aspects

[0067] As can be seen from the foregoing description of the exemplary embodiment and its variations, an electric tool (10) according to a first aspect includes: a tool body (20); and an attachment (30; 30A; 30B) to be attached removably to the tool body (20). The attachment (30; 30A; 30B) includes an operating unit (32) and a limiting unit (33; 33A; 33B). The operating unit (32) is configured to operate with electric power supplied from the tool body (20). The limiting unit (33; 33A; 33B) is configured to limit supply of the electric power from the tool body (20) to the operating unit (32) when a failure occurs in the attachment (30; 30A; 30B). The first aspect reduces the chances of the tool body (20) being electrically affected by a failure in the attachment (30; 30A; 30B).

[0068] In an electric tool (10) according to a second aspect, which may be realized in combination with the first aspect, the limiting unit (33) includes a current fuse (331) provided on an electrical path through which the electric power supplied from the tool body (20) is delivered to the operating unit (32). According to the second aspect, the function of limiting the supply of electric power from the tool body (20) to the operating unit (32) is performed by the current fuse (331), thus simplifying the configuration and contributing to cost reduction.

[0069] In an electric tool (10) according to a third aspect, which may be realized in combination with the second aspect, the tool body (20) includes a current fuse (291) that is electrically connected in series to the current fuse (331) of the limiting unit (33). The current fuse (331) of the limiting unit (33) has a smaller rated current value than the current fuse (291) of the tool body (20). According to the third aspect, even though the tool body (20) includes the current fuse (291), the current fuse (291) of the attachment (30) is blown earlier than the former current fuse (291). This increases the chances of, even if a failure occurs in the attachment (30), the need to replace the current fuse (291) of the tool body (20) with a new one being eliminated.

[0070] In an electric tool (10) according to a fourth aspect, which may be realized in combination with any one of the first to third aspects, the limiting unit (33A) includes a switch (331A) provided on an electrical path through which the electric power supplied from the tool body (20) is delivered to the operating unit (32). According to the fourth aspect, unlike the situation where a fuse (which may be either a current fuse or a temperature fuse) is used to limit the supply of electric power from the tool body (20) to the operating unit (32), the limiting unit (33A) may be used again. Thus, even if a failure occurs in the attachment (30A), there is no need to replace any parts (such as the switch 331A) of the limiting unit (33A).

[0071] In an electric tool (10) according to a fifth aspect, which may be realized in combination with the fourth aspect, the limiting unit (33A) includes a control circuit (332A) configured to limit the supply of the electric power from the tool body (20) to the operating unit (32) by controlling the switch (331A) when a value of current flowing through the operating unit (32) is greater than a predetermined value. The fifth aspect allows the timing to limit the supply of the electric power from the tool body (20) to the operating unit (32) to be controlled more accurately.

[0072] In an electric tool (10) according to a sixth aspect, which may be realized in combination with any one of the first to fifth aspects, the limiting unit (33B) includes a temperature fuse (331B) and a control circuit (332B). The temperature fuse (331B) is provided on an electrical path through which the electric power supplied from the tool body (20) is delivered to the operating unit (32). The control circuit (332B) is configured to blow the temperature fuse (331B) when a value of current flowing through the operating unit (32) is greater than a predetermined value. The sixth aspect allows the timing to limit the supply of electric power from the tool body (20) to the operating unit (32) to be controlled more accurately.

[0073] In an electric tool (10) according to a seventh aspect, which may be realized in combination with any one of the first to sixth aspects, the tool body (20) includes a power supply connector (21) to which a battery pack (40) is attached, and is configured to operate with electric power received at the power supply connector (21). The seventh aspect eliminates the need to connect the tool body (20) to an AC outlet via a cable, thus making the electric tool (10) easier to handle.

[0074] In an electric tool (10) according to an eighth aspect, which may be realized in combination with the

seventh aspect, the tool body (20) is configured to supply electric power to the attachment (30; 30A; 30B) based on the electric power received at the power supply connector (21). The eighth aspect allows the single battery pack (40) to supply electric power to both the tool body (20) and the attachment (30; 30A; 30B).

[0075] An electric tool (10) according to a ninth aspect, which may be realized in combination with the seventh or eighth aspect, further includes a battery pack (40) to be attached removably to the power supply connector (21). The ninth aspect eliminates the need to connect the tool body (20) to an AC outlet via a cable, thus making the electric tool (10) easier to handle.

[0076] In an electric tool (10) according to a tenth aspect, which may be realized in combination with any one of the first to ninth aspects, the tool body (20) includes an attachment connector (22) having a pair of output terminals (221, 222). The attachment (30; 30A; 30B) includes a body connector (31). The body connector (31) has a pair of input terminals (311, 312) to be electrically connected to the pair of output terminals (221, 222), respectively. The body connector (31) is to be attached removably to the attached connector (22). The operating unit (32) is configured to operate with a voltage applied between the pair of input terminals (311, 312). The tenth aspect reduces the number of terminals required to supply electric power from the tool body (20) to the attachment (30; 30A; 30B). This allows a cheaper connector with a smaller number of terminals to be used as the attachment connector (22) and the body connector (31), thus contributing to cost reduction.

[0077] An attachment (30; 30A; 30B) according to an eleventh aspect is designed to be attached removably to a tool body (20) of an electric tool (10). The attachment (30; 30A; 30B) includes an operating unit (32) and a limiting unit (33; 33A; 33B). The operating unit (32) is configured to operate with electric power supplied from the tool body (20). The limiting unit (33; 33A; 33B) is configured to limit supply of the electric power from the tool body (20) to the operating unit (32) when a failure occurs in the attachment (30; 30A; 30B). The eleventh aspect reduces the chances of the tool body (20) being electrically affected by a failure in the attachment (30; 30A; 30B).

Reference Signs List

[0078]

10	Electric Tool
20	Tool Body
21	Power Supply Connector
22	Attachment Connector
221, 222	Output Terminal
291	Current Fuse
30, 30A, 30B	Attachment
31	Body Connector
311, 312	Input Terminal
32	Operating unit
321	Motor
33, 33A, 33B	Limiting Unit
331	Current Fuse
331A	Switch
331B	Temperature Fuse
332A, 332B	Control Circuit
40	Battery Pack
41	Body Connector

Claims

1. An electric tool comprising:

   a tool body; and
   an attachment to be attached removably to the tool body,
   the attachment including:

   an operating unit configured to operate with electric power supplied from the tool body; and
   a limiting unit configured to limit supply of the electric power from the tool body to the operating unit when a failure occurs in the attachment.

2. The electric tool of claim 1, wherein
   the limiting unit includes a current fuse provided on an electrical path through which the electric power supplied from the tool body is delivered to the operating unit.

3. The electric tool of claim 2, wherein
   the tool body includes a current fuse to be electrically connected in series to the current fuse of the limiting unit, and
   the current fuse of the limiting unit has a smaller rated current value than the current fuse of the tool body.

4. The electric tool of any one of claims 1 to 3, wherein
   the limiting unit includes a switch provided on an electrical path through which the electric power supplied from the tool body is delivered to the operating unit.

5. The electric tool of claim 4, wherein
   the limiting unit includes a control circuit configured to limit the supply of the electric power from the tool body to the operating unit by controlling the switch when a value of current flowing through the operating unit is greater than a predetermined value.

6. The electric tool of any one of claims 1 to 5, wherein
   the limiting unit includes:

   a temperature fuse provided on an electrical

path through which the electric power supplied from the tool body is delivered to the operating unit; and

a control circuit configured to blow the temperature fuse when a value of current flowing through the operating unit is greater than a predetermined value.

7. The electric tool of any one of claims 1 to 6, wherein the tool body includes a power supply connector to which a battery pack is attached, and is configured to operate with electric power received at the power supply connector.

8. The electric tool of claim 7, wherein
the tool body is configured to supply the electric power to the attachment based on the electric power received at the power supply connector.

9. The electric tool of claim 7 or 8, further comprising a battery pack to be attached removably to the power supply connector.

10. The electric tool of any one of claims 1 to 9, wherein the tool body includes an attachment connector having a pair of output terminals,
the attachment includes a body connector having a pair of input terminals to be electrically connected to the pair of output terminals, respectively, the body connector being to be attached removably to the attached connector, and
the operating unit is configured to operate with a voltage applied between the pair of input terminals.

11. An attachment to be attached removably to a tool body of an electric tool, the attachment comprising:

an operating unit configured to operate with electric power supplied from the tool body; and

a limiting unit configured to limit supply of the electric power from the tool body to the operating unit when a failure occurs in the attachment.

FIG. 1

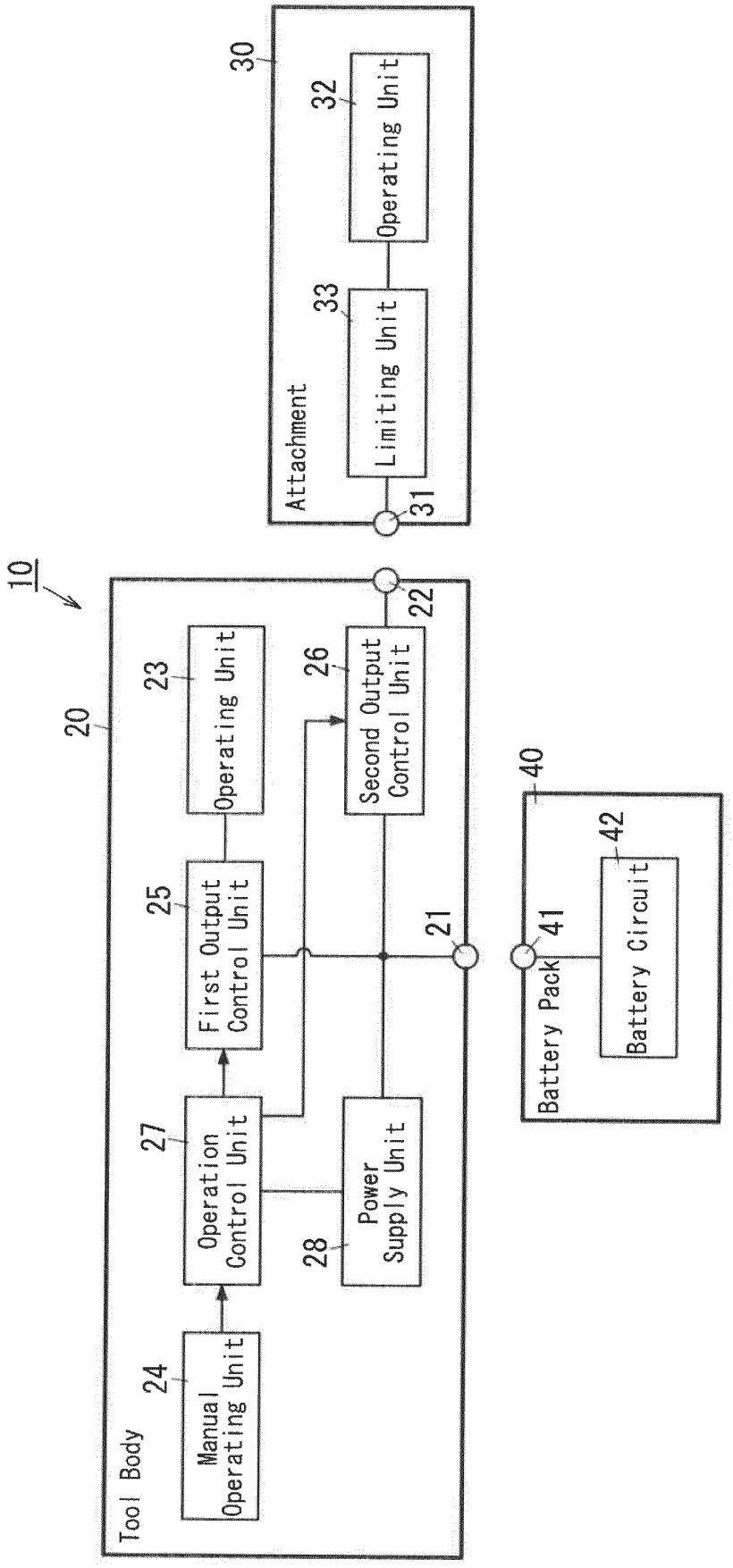

10
Tool Body
20
Manual Operating Unit
24
Operation Control Unit
27
First Output Control Unit
25
Operating Unit
23
Power Supply Unit
28
Second Output Control Unit
26
21
22
Attachment
30
Limiting Unit
33
Operating Unit
32
31
Battery Pack
40
41
Battery Circuit
42

FIG. 2

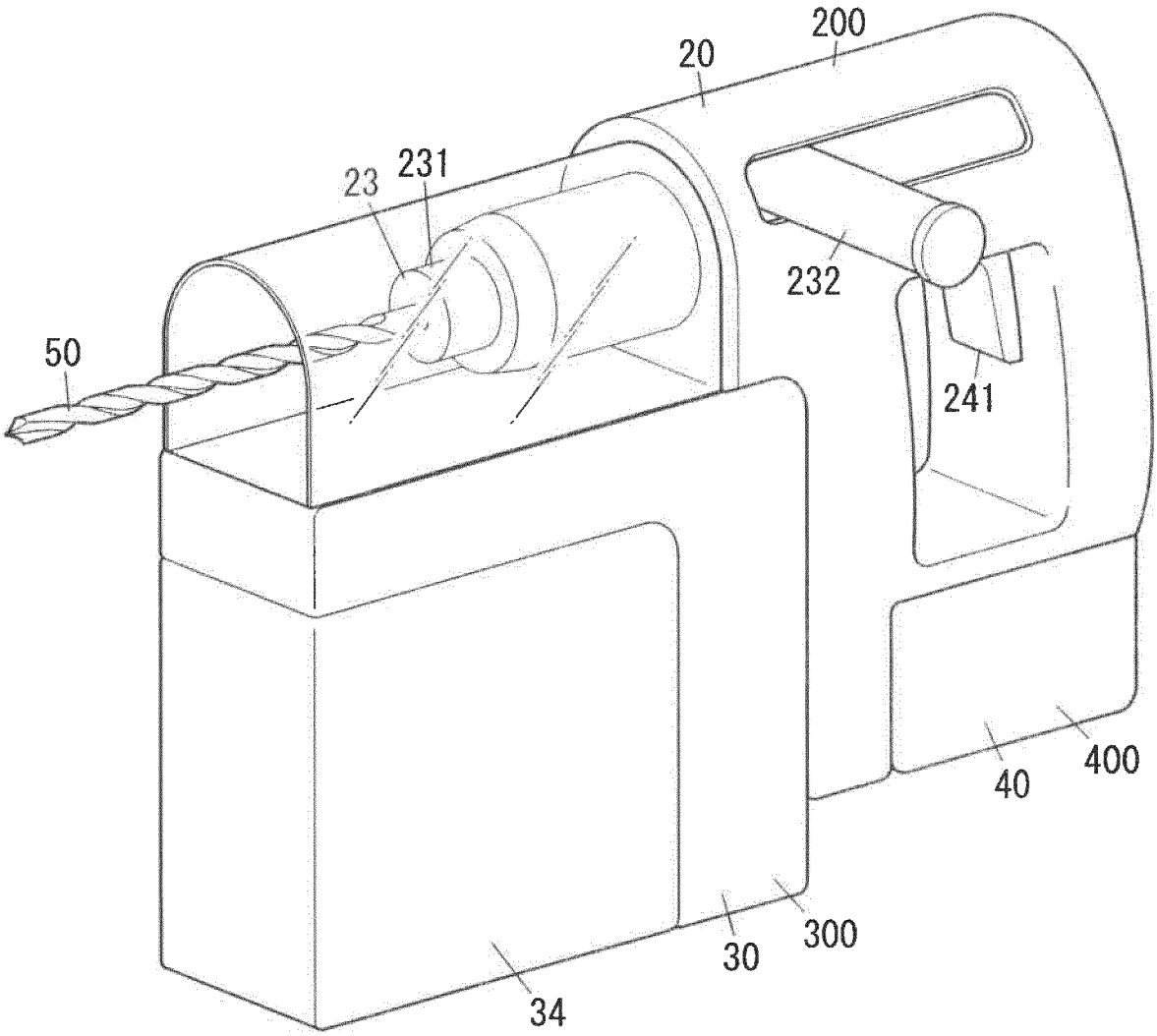


FIG. 3

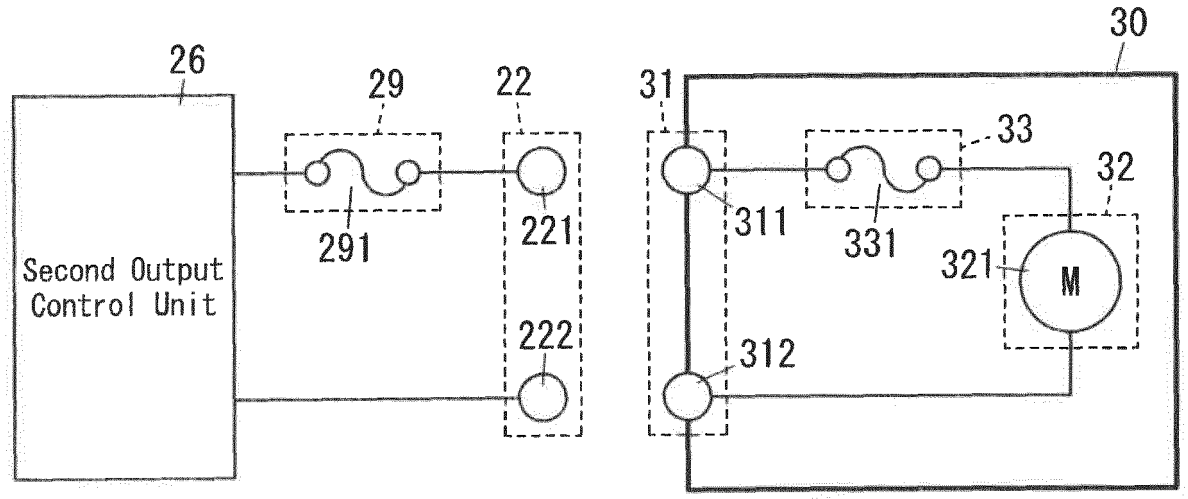

26
Second Output Control Unit
29
291
22
221
222
30
31
311
312
33
331
32
321
M

FIG. 4

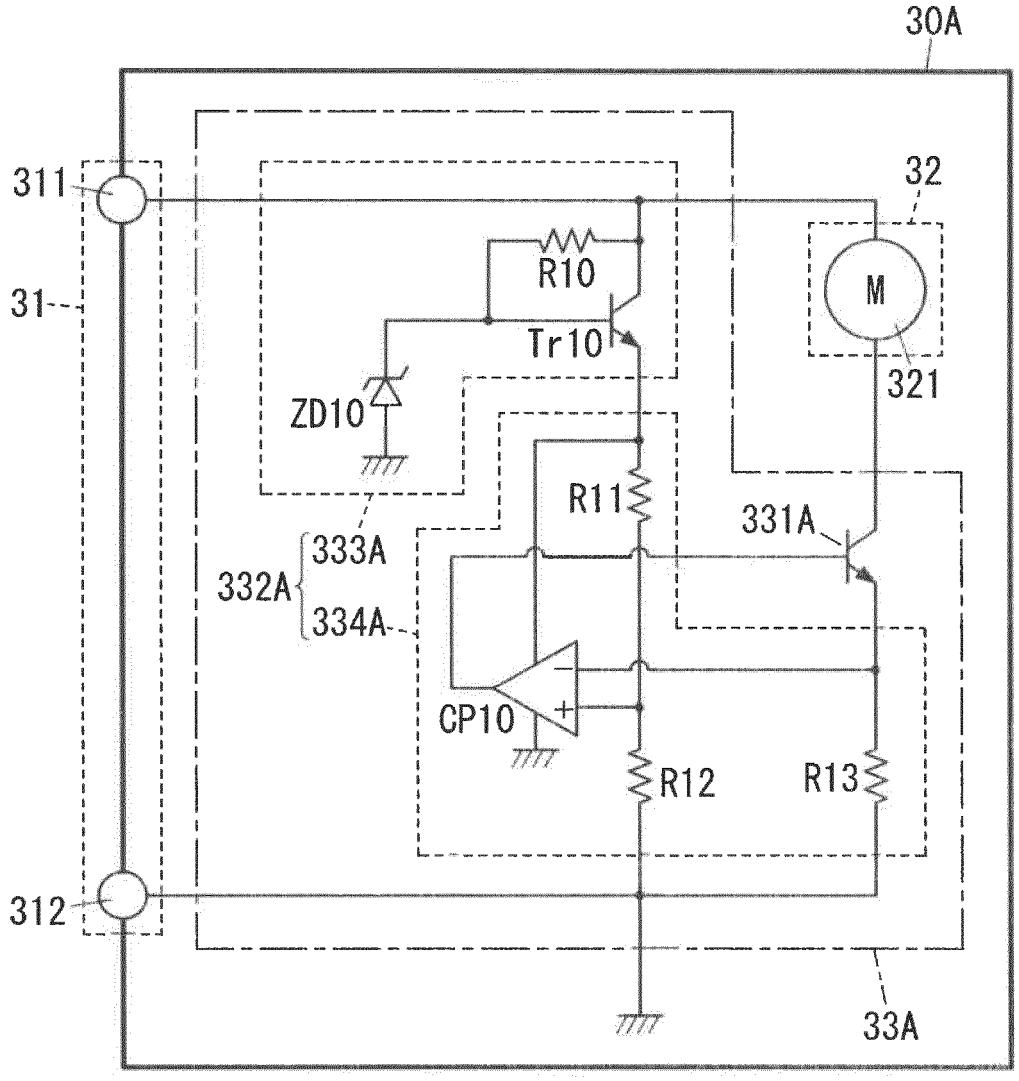
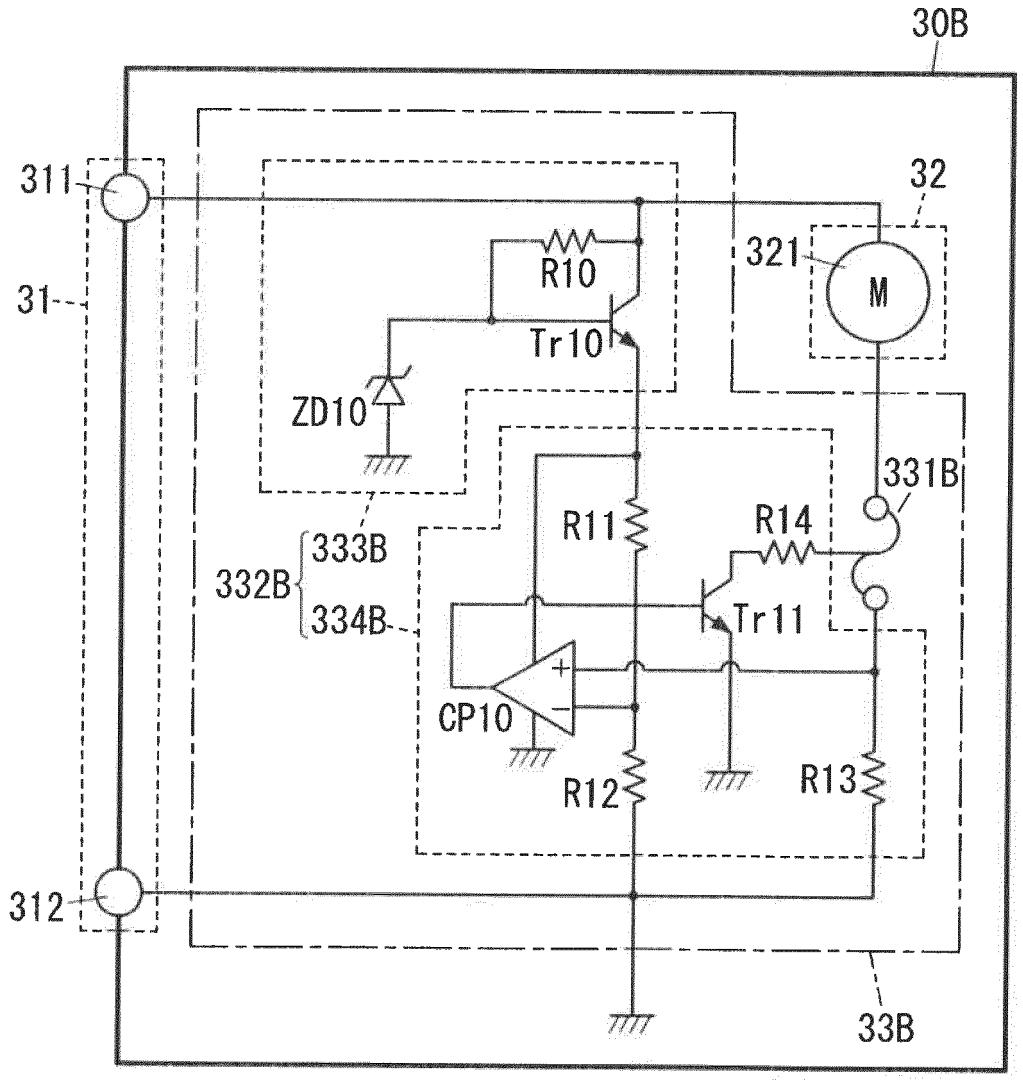

30A
311
31
32
R10
Tr10
M
321
ZD10
R11
331A
333A
332A
334A
CP10
R12
R13
312
33A

FIG. 5


30B
311
31
32
321
M
R10
Tr10
ZD10
331B
R11
R14
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332B
334B
Tr11
CP10
R12
R13
312
33B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/036287

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B25F5/00(2006.01)i, B25D17/18(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)
Int. Cl. B25F5/00, B25D17/18, B23Q11/00, A47L9/28

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2017/145643 A1 (HITACHI KOKI CO., LTD.) 31 August 2017, paragraphs [0037]-[0041], [0061]-[0066], [0081], [0082], [0100]-[0102], fig. 6 (Family: none)	1-4, 7-11
Y	JP 2017-29650 A (MAKITA CORP.) 09 February 2017, paragraphs [0021], [0029], [0030], fig. 6 & US 2017/0040919 A1, paragraphs [0031], [0032], [0039], [0040], fig. 6 & DE 102016114541 A1 & CN 106419730 A	1-4, 7-11
Y	JP 2011-140108 A (MAX CO., LTD.) 21 July 2011, paragraph [0015] (Family: none)	3-4, 7-10

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05.11.2018	20.11.2018

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/036287

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2016-73396 A (MAKITA CORP.) 12 May 2016, paragraphs [0013], [0014] & US 2016/0095487 A1, paragraph [0044] & DE 102015011905 A1 & CN 105476556 A	4-5
A	JP 63-103623 A (MATSUSHITA ELECTRIC WORKS, LTD.) 09 May 1988, fig. 4 (Family: none)	4-5
A	JP 2015-131380 A (MAKITA CORP.) 23 July 2015, paragraphs [0080]-[0085], fig. 3 & US 2015/0200535 A1, paragraphs [0084]-[0089], fig. 3 & EP 2905866 A1 & CN 104779656 A	6
A	JP 2012-55364 A (MITSUBISHI ELECTRIC CORP.) 22 March 2012, paragraphs [0021]-[0023], fig. 4 (Family: none)	3
P, A	JP 2017-196717 A (HITACHI KOKI CO., LTD.) 02 November 2017, paragraphs [0100]-[0104], fig. 7 (Family: none)	1-5, 7-11

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011189486 A **[0004]**