(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 610 764 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
19.02.2020 Bulletin 2020/08

(21) Application number: **17905613.0**

(22) Date of filing: **10.04.2017**

(51) Int Cl.:
A47K 10/48 *(2006.01)*

(86) International application number:
PCT/JP2017/014702

(87) International publication number:
WO 2018/189787 (18.10.2018 Gazette 2018/42)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Mitsubishi Electric Corporation**
Chiyoda-ku
Tokyo 100-8310 (JP)

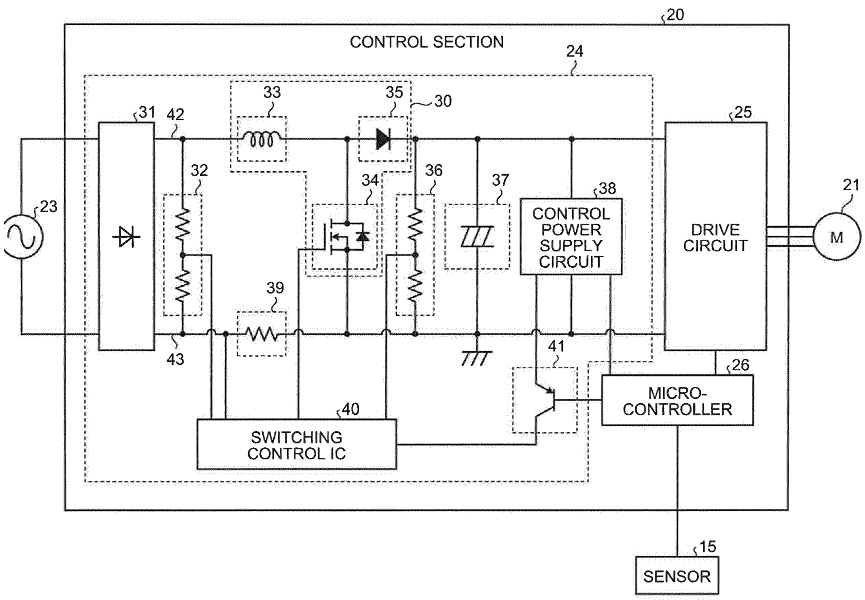
(72) Inventors:
- **NARITANI, Kunihiro**
  Tokyo 102-0073 (JP)
- **SAITO, Fumio**
  Tokyo 100-8310 (JP)

(74) Representative: **Witte, Weller & Partner**
Patentanwälte mbB
Postfach 10 54 62
70047 Stuttgart (DE)

(54) HAND DRYER

(57) A hand dryer includes a housing including a hand insertion portion into which a hand is insertable, an air blower that provides an airflow to jet into the hand insertion portion, and a hand sensor (15) that detects a hand inserted in the hand insertion portion. The hand dryer includes a power supply unit (24) that includes a booster circuit (30) for boosting a DC voltage, a drive circuit (25) that receives power supply from the power supply unit and drives the air blower, and a control processing unit (26) that controls the operation of the booster circuit on the basis of actual data representing an actual result of whether a hand is detected by the hand sensor.

FIG.3



Printed by Jouve, 75001 PARIS (FR)

Description

Field

[0001] The present invention relates to a hand dryer for drying wet hands.

Background

[0002] In order to maintain hand hygiene, it is required that hands be properly washed and the washed wet hands be dried hygienically. In order to enable hygienic drying of the hands, one may use a hand dryer that dries hands by blowing off water droplets with a jet of airflow.

[0003] When a hand is detected in a hand insertion portion of the hand dryer, the hand dryer activates a blower to direct a jet of airflow into the hand insertion portion. The hand dryer stops the blower when the hand is removed from the hand insertion portion and thus is not detected. The hand dryer is required to cut down the time taken from detection of the hand to the activation of the blower. The hand dryer is also required to reduce standby power with the blower out of operation.

[0004] Patent Literature 1 discloses a blower including a boost converter that boosts an AC voltage supplied from an AC power supply and converts the voltage into a DC voltage. The boosting of the boost converter can downsize the blower and increase the voluime of supplied air.

[0005] Patent Literature 2 discloses a technique of providing a hand dryer with a clock function such that an interval at which a hand sensor is intermittently driven is changed in accordance with a time period. The hand dryer lengthens such an interval during the time period providing the descreased frequency of use, such that the standby power can be reduced reducing difficulty of the use of the hand dryer.

Citation List

Patent Literature

[0006]

Patent Literature 1: Japanese Patent No. 5158101
Patent Literature 2: Japanese Patent Application Laid-open No. 2002-177165

Summary

Technical Problem

[0007] For the hand dryer including the blower according to the technique of Patent Literature 1, operation of the boost converter after the detection of a hand results in a delay in activating the blower because it takes a time for the boost converter to boost the direct current to a desired voltage value. In a case where the boost converter is always operated in order to enable quick activation of the blower, the standby power of the hand dryer is increased. The hand dryer according to the technique of Patent Literature 2 requires an operation for setting the time period. The hand dryer is required to not only cut down the time necessary to start blowing air but also reduce the standby power.

[0008] The present invention has been made in view of the above, and an object of the present invention is to provide a hand dryer capable of cutting down the time required to start blowing air and reducing standby power as well.

Solution to Problem

[0009] To solve the above problem and achieve the object, the present invention provides a hand dryer comprising: a housing including a hand insertion portion into which a hand is insertable; an air blower to provide an airflow to jet into the hand insertion portion; a hand sensor to detect a hand inserted in the hand insertion portion; a power supply unit including a booster circuit to boost a DC voltage; a drive circuit to receive power supply from the power supply unit and drive the air blower; and a control processing unit to control an operation of the booster circuit on the basis of actual data representing an actual result of whether a hand is detected by the hand sensor.

Advantageous Effects of Invention

[0010] The hand dryer according to the present invention has an effect of cutting down the time required to start blowing air and reducing the standby power as well.

Brief Description of Drawings

[0011]

FIG. 1 is a perspective view of a hand dryer according to a first embodiment of the present invention.
FIG. 2 is a cross-sectional view of the hand dryer taken along line II-II of FIG. 1.
FIG. 3 is a diagram illustrating a configuration of a control section illustrated in FIG. 2.
FIG. 4 is a diagram illustrating a configuration of the control section according to a modification to the first embodiment.
FIG. 5 is a block diagram illustrating a functional configuration of a microcontroller illustrated in FIG. 3.
FIG. 6 is a block diagram illustrating a hardware configuration of the microcontroller illustrated in FIG. 3.
FIG. 7 is a diagram for explaining control of a boost operation at the time the hand dryer according to the first embodiment is on standby.
FIG. 8 is a flow chart illustrating the procedure of an operation by the microcontroller illustrated in FIG. 5 for storing actual data.
FIG. 9 is a table illustrating examples of actual data stored in an actual data storage unit illustrated in FIG. 5 and parameters stored in a parameter storage unit.
FIG. 10 is a flow chart illustrating the procedure of control of the boost operation in the hand dryer according to the first embodiment.
FIG. 11 is a flow chart illustrating the procedure of control of the boost operation in the hand dryer according to the first embodiment.
FIG. 12 is a table for explaining control of the boost operation in the hand dryer according to a second embodiment of the present invention.
FIG. 13 is a table illustrating examples of actual data stored in the actual data storage unit illustrated in FIG. 5 and parameters stored in the parameter storage unit.
FIG. 14 is a table for explaining control of the boost operation in the hand dryer according to a third embodiment of the present invention.
FIG. 15 is a table illustrating examples of actual data stored in the actual data storage unit illustrated in FIG. 5 and parameters determined.
FIG. 16 is a diagram for explaining control of the boost operation in the hand dryer according to a fourth embodiment of the present invention.
FIG. 17 is a flow chart for explaining control of the boost operation in the hand dryer according to a fifth embodiment of the present invention.
FIG. 18 is a diagram illustrating a configuration of the control section of the hand dryer according to a seventh embodiment of the present invention.
FIG. 19 is a table illustrating an example of actual data stored in the actual data storage unit illustrated in FIG. 5.
FIG. 20 is a diagram illustrating a configuration of the control section of the hand dryer according to an eighth embodiment of the present invention.
FIG. 21 is a table for explaining control of the boost operation in the hand dryer according to a ninth embodiment of the present invention.
FIG. 22 is a table illustrating an example of actual data stored in the actual data storage unit illustrated in FIG. 5 and an example of frequency.
FIG. 23 is a table for explaining control of the boost operation in the hand dryer according to a tenth embodiment of the present invention.
FIG. 24 is a table illustrating an example of actual data stored in the actual data storage unit illustrated in FIG. 5 and an example of frequency.

Description of Embodiments

[0012] A hand dryer according to embodiments of the present invention will now be described in detail with reference to the drawings. Note that the present invention is not limited to the embodiments.

First Embodiment

[0013] FIG. 1 is a perspective view of a hand dryer 1 according to a first embodiment of the present invention. The hand dryer 1 has a housing 3 including a hand insertion portion 2 into which a hand is insertable. The hand insertion portion 2 is opened at top and opposite lateral sides thereof. A hand can be inserted into the hand insertion portion 2 from the top side or the opposite lateral sides. The housing 3 forms an outer shell of the entiety of the hand dryer 1. A front portion 4, which is a part of the housing 3, defines the front side of the hand insertion portion 2. A back portion 5, which is a part of the housing 3, defines the back side of the hand insertion portion 2. Note that the front side is a side facing a user who uses the hand dryer 1, as viewed from the hand dryer 1. The back side is a side opposite to the front side, as viewed from the hand dryer 1.

[0014] A water receiving portion 6 is located at the bottom of the hand insertion portion 2. The water receiving portion 6 is provided with a drain outlet for discharging received water to a drain tank 7. The housing 3 is provided with a drain passage through which water from the drain outlet flows to the drain tank 7. FIG. 1 and FIG. 2 to be described later omit illustration of the drain outlet and the drain passage. The drain tank 7 stores water from the drain passage. The drain tank 7 is provided on the front side of a lower part of the housing 3. The drain tank 7 is removable from the housing 3.

[0015] FIG. 2 is a cross-sectional view of the hand dryer 1 taken along line II-II of FIG. 1. The hand dryer 1 includes a blower 10 which is an air blower that provides an airflow to jet into the hand insertion portion 2. The blower 10 is provided inside the housing 3. The blower 10 includes a direct current (DC) brushless motor 21 as a drive source, and a turbofan 22 that is rotated by the drive of the DC brushless motor 21.

[0016] A nozzle 11, which is provided on a surface of the front portion 4, faces the hand insertion portion 2. A nozzle 12, which is provided on a surface of the back portion 5, faces the hand insertion portion 2. The hand dryer 1 is designed such that an airflow directed from the blower 10 through a duct 13 formed inside the front portion 4 jets from the nozzle 11 into the hand insertion portion 2. The hand dryer 1 is also designed such that an airflow directed from the blower 10 through a duct 14 formed inside the back portion 5 jets from the nozzle 12 into the hand insertion portion 2.

[0017] The hand dryer 1 includes a sensor 15 which is a hand sensor that detects a hand inserted in the hand insertion portion 2. The sensor 15 is built in the back portion 5. One example of the sensor 15 is a range sensor. The sensor 15, which is a range sensor, includes a light emitting element that emits infrared light and a light receiving element that detects infrared light reflected by a hand that is a target of measurement. FIG. 2 omits illustration of the light emitting element and the light receiving element. The sensor 15 detects the presence or absence of a hand in the hand insertion portion 2 on the basis of an angle of the infrared light incident on the light receiving element. The sensor 15 may be a sensor other than the range sensor as long as the sensor can detect a hand inserted in the hand insertion portion 2. The sensor 15 may be built in the front portion 4.

[0018] An air inlet 16 is located on the back side of the lower part of the housing 3. The blower 10 takes an airflow from the air inlet 16 into a duct 17 formed inside the housing 3, and directs the airflow from the duct 17 to the ducts 13 and 14. An air filter 18 for removing foreign matter from the airflow taken into the duct 17 is attached to the air inlet 16. Note that the hand dryer 1 may include a heater for heating the airflow to be directed to the ducts 13 and 14.

[0019] A control section 20 for controlling the entirety of the hand dryer 1 is provided inside the housing 3. The control section 20 starts the blower 10 when a hand is detected by the sensor 15. The control section 20 stops the blower 10 when the hand is removed from the hand insertion portion 2 and is no longer detected by the sensor 15.

[0020] FIG. 3 is a diagram illustrating a configuration of the control section 20 illustrated in FIG. 2. The control section 20 includes a power supply unit 24, a drive circuit 25, and a microcontroller 26. The power supply unit 24 includes a booster circuit for boosting a DC voltage. The drive circuit 25 is supplied with power from the power supply unit 24, thereby driving the DC brushless motor 21. The microcontroller 26 serves as a control processing unit.

[0021] A rectifier circuit 31 of the power supply unit 24 is connected to a commercial AC power supply 23. The rectifier circuit 31 outputs a DC voltage by full-wave rectification of an AC voltage from the commercial AC power supply 23. A resistor voltage divider 32 serves as a voltage detector. The resistor voltage vidider 32, which is located on the output side of the rectifier circuit 31, is connected between a DC bus 42 on a positive voltage side and a DC bus 43 on a negative voltage side. The power supply unit 24 includes an inductor 33, a switching element 34, and a fast recovery diode 35. The inductor 33, the switching element 34, and the fast recovery diode 35 define a boost converter 30 servsing as the booster circuit. The boost converter 30 increases a voltage value of the DC voltage from the rectifier circuit 31 to a predetermined voltage value.

[0022] The inductor 33 is connected to the DC bus 42. The switching element 34, which is located on the output side of the inductor 33, is connected between the DC buses 42 and 43. The switching element 34 is a Metal Oxide Semiconductor Field Effect Transistor (MOSFET) or an Insulated Gate Bipolar Transistor (IGBT) which is a semiconductor element having a switching function.

[0023] An anode of the fast recovery diode 35 is connected to the output side of the inductor 33. A resistor voltage divider 36 serves as a voltage detector. The resistor voltage divider 36, which is located on the side of a cathode of the fast recovery diode 35, is connected between the DC buses 42 and 43. A smoothing capacitor 37, which is located on the output side of the resistor voltage divider 36, is connected between the DC buses 42 and 43. A control power supply circuit 38, which is located on the output side of the smoothing capacitor 37, is connected between the DC buses 42 and 43. A resistor 39 serves as a current detector. The resistor 39, which is disposed on the DC bus 43, is connected between the resistor voltage divider 32 and the switching element 34.

[0024] When the switching element 34 is turned on, electric charge is accumulated in the inductor 33. When the switching element 34 is switched from an on state to an off state, the inductor 33 releases the accumulated electric charge. Supplying the electric charge from the inductor 33 through the fast recovery diode 35 charges the smoothing capacitor 37. The smoothing capacitor 37 reduces noise by smoothing the voltage.

[0025] A switching control integrated circuit (IC) 40 controls the switching operation of the switching element 34. The switching control IC 40 detects the DC voltage output from the rectifier circuit 31 with the resistor voltage divider 32. The switching control IC 40 detects the current from the inductor 33 with the resistor 39. The switching control IC 40 detects the voltage output from the boost converter 30 with the resistor voltage divider 36. The switching control IC 40 controls the operation of the switching element 34 on the basis of these results of detection, thereby allowing the phase of the rectified voltage and the phase of the rectified current to match.

[0026] The switching control IC 40 functions as a power factor improvement circuit that allowing the phase of the voltage and the phase of the current to macth such that a power factor of the power supply unit 24 comes close to one, which prevents or reduces the generation of a harmonic current component. The boost converter 30 functions as an active filter for preventing or reducuing the harmonic current component. Moreover, the switching control IC 40 controls the operation of the switching element 34 to adjust the voltage value from the boost converter 30 to be a desired voltage value.

[0027] The control power supply circuit 38 supplies power to the drive circuit 25, the microcontroller 26, and the switching control IC 40. A switching element 41 is a semiconductor element having a switching function, and is a bipolar transistor. The switching element 41 is connected to the microcontroller 26, the control power supply circuit 38, and the switching control IC 40.

[0028] When a hand is detected by the sensor 15, the microcontroller 26 carries a current to the base of the switching element 41, thereby turning on the switching element 41. When the switching element 41 is turned on, the control power supply circuit 38 supplies power to the switching control IC 40. The switching control IC 40 is supplied with the power to thereby turn on the switching element 34. When the switching element 34 is turned on, the boost converter 30 starts the boost operation. When the voltage output from boost converter 30 reaches a desired voltage value, the control power supply circuit 38 supplies power to the drive circuit 25. The drive circuit 25 is supplied with the power to thereby drive the DC brushless motor 21. The microcontroller 26 switches on and off the switching element 41 to thereby control the boost operation of the boost converter 30 such that the boost operation is switched between an on state and an off state. The microcontroller 26 also executes feedback control of the drive circuit 25.

[0029] Note that the control section 20 may be modified so that the function of the microcontroller 26 includes the function of the switching control IC 40. FIG. 4 is a diagram illustrating a configuration of the control section 20 according to a modification to the first embodiment. In the modification, the microcontroller 26 controls the switching operation of the switching element 34. The microcontroller 26 detects the DC voltage output from the rectifier circuit 31 with the resistor voltage divider 32. The microcontroller 26 detects the current from the inductor 33 with the resistor 39. The microcontroller 26 detects the voltage output from the boost converter 30 with the resistor voltage divider 36. The microcontroller 26 controls the operation of the switching element 34 on the basis of these results of detection, thereby allowing the phase of the rectified voltage and the phase of the rectified current to match. Moreover, the microcontroller 26 controls the operation of the switching element 34 to thereby adjust the voltage value from the boost converter 30 to be a desired voltage value. The microcontroller 26 switches on and off the switching element 34 to therbey control the boost operation of the boost converter 30 such that the boost operation is switched between an on state and an off state.

[0030] FIG. 5 is a block diagram illustrating a functional configuration of the microcontroller 26 illustrated in FIG. 3. The microcontroller 26 includes an input unit 51, a control arithmetic unit 52, and a storage unit 53. The input unit 51 serves as a functional unit for receiving input from the sensor 15. The control arithmetic unit 52 serves as a functional unit for performing control on the entirety of the microcontroller 26 and implementing arithmetic operation executed by the microcontroller 26. The storage unit 53 serves as a functional unit for storing data.

[0031] The control arithmetic unit 52 includes a storage processing unit 54, a timer 55, and a boost control unit 56. The storage processing unit 54 serves as a functional unit for executing processing that stores actual data on hand detection. The timer 55 serves as a functional unit for measuring time. The boost control unit 56 serves as a functional unit for controlling the boost operation of the boost converter 30. The storage unit 53 includes an actual data storage unit 57, and a parameter storage unit 58. The actual data storage unit 57 serves as a functional unit for storing actual data by the processing executed by the storage processing unit 54. The parameter storage unit 58 stores various parameters used to control the boost operation.

[0032] The functions of the microcontroller 26 are implemented on a program analyzed and run by the microcontroller 26. Note that a part of the functions of the microcontroller 26 may be implemented on hardware by wired logic.

[0033] FIG. 6 is a block diagram illustrating a hardware configuration of the microcontroller 26 illustrated in FIG. 3. The microcontroller 26 includes a Central Processing Unit (CPU) 61, a Read Only Memory (ROM) 62, a Random Access Memory (RAM) 63, an Electrically Erasable Programmable Read Only Memory (EEPROM) 64, and an input interface (I/F) 65. The CPU 61 executes various processings. The ROM 62 is a non-volatile memory. The RAM 63 includes a program storage area and a data storage area. The EEPROM 64 is a rewritable non-volatile memory. The parts illustrated in FIG. 6 are connected to one another via a bus 66.

[0034] The ROM 62 stores a program for various processings. The program is loaded to the RAM 63. The CPU 61 expands the program in the program storage area in the RAM 63 and executes various processings. The data storage area in the RAM 63 is a work area used in the execution of the various processings. The EEPROM 64 stores various data. The functions of the control arithmetic unit 52 illustrated in FIG. 5 are implemented using the CPU 61. The functions of the storage unit 53 are implemented using the EEPROM 64. The function of the input unit 51 is implemented using the input I/F 65. Note that the microcontroller 26 may have a built-in memory other than the EEPROM 64. The functions of the storage unit 53 may be implemented using such a built-in memory.

[0035] Next, the control performed by the microcontroller 26 on the boost converter 30 will be described. The boost control unit 56 of the microcontroller 26 turns on the boost operation when the sensor 15 detects a hand with the boost operation of the boost converter 30 in an off state. The boost control unit 56 turns off the boost operation when the sensor 15 no longer detects a hand. While waiting for the sensor 15 to detect a hand, additionally, the boost control unit 56 enables control for turning on the boost operation of the boost converter 30 on the basis of the actual data stored in the actual data storage unit 57 illustrated in FIG. 5. On the basis of the actual data in a first cycle period in the past, the microcontroller 26 controls the operation of the boost converter 30 when waiting for the sensor 15 to detect a hand during a second cycle period following the first cycle period.

[0036] The actual data is data representing an actual result of whether a hand is detected by the sensor 15. The storage processing unit 54 of the microcontroller 26 illustrated in FIG. 5 turns the result of whether a hand is detected in each preset unit time, into data on the basis of the result of detection by the sensor 15, such that the storage processing unit 54 accumulates, in the actual data storage unit 57, the actual data that is time series data. The unit time in the first embodiment is ten seconds. The boost control unit 56 controls the boost operation of the boost converter 30 on the basis of the actual data in a preset cycle period. The cycle period in the first embodiment is 24 hours. A parameter indicating the cycle period and a parameter indicating the unit time are stored in the parameter storage unit 58. Note that the length of the unit time and the length of the cycle period can be set to be any length.

[0037] The boost control unit 56 determines, from the actual data, a time at which a hand was detected in the first cycle period, such that the boost control unit 56 determines a time at which to turn on the boost operation and a time at which to turn off the boost operation as the boost control unit 56 waits for the hand detection in a second cycle period. The first cycle period is the past cycle period. The second cycle period is the current cycle period. The microcontroller 26 controls the boost operation during standby on the basis of a record of usage of the hand dryer 1 in the past cycle.

[0038] The microcontroller 26 turns on the boost operation around the same time as the time at which the hand dryer 1 was used in the past cycle period. Moreover, the microcontroller 26 turns off the boost operation during the same time period as a time period during which the hand dryer 1 was not used in the past cycle period. The hand dryer 1 can reduce standby power as compared to a case where the boost operation is always in an on state throughout the cycle period. Because it is expected that the hand dryer 1 is used around the same time as the time at which the hand dryer 1 was used in the past, the hand dryer 1 turns on the boost operation around that time. The hand dryer 1 can stand ready to start blowing the air when it is expected that the hand dryer 1 is used.

[0039] FIG. 7 is a diagram for explaining control of the boost operation at the time the hand dryer 1 according to the first embodiment is on standby. FIG. 7 illustrates a time chart of actual data in a past cycle period C-1, and a time chart of the state of the boost operation in a current cycle period C0. The past cycle period C-1 is the first cycle period. The current cycle period C0 is the second cycle period. In FIG. 7, the time axis representing time T-1 of the cycle period C-1 and the time axis representing time T0 of the current cycle period C0 indicate the same points of time on different dates correspondingly. Note that the numeral "-1" of the cycle period "C-1" indicates that this cycle period is located one cycle before the cycle period "C0".

[0040] In the actual data, "0" indicates that a hand was not detected by the sensor 15, and "1" indicates that a hand was detected by the sensor 15. The rising in the time chart represents the actual data "1", and the falling represents the actual data "0". As for the state of the boost operation, the rising in the time chart indicates that the boost operation is turned on. The falling in the time chart indicates that the boost state is turned off.

[0041] Assume that a hand was detected in a unit time starting at time t1 of the cycle period C-1. The microcontroller 26 turns on the boost operation at a time earlier by a parameter α than time t1 in the cycle period C0. The parameter α is a start parameter for setting the start of the boost operation. In the first embodiment, the parameter α, which is a preset certain time set, is 120 seconds. The microcontroller 26 also turns off the boost operation at a time later by a parameter β than time t1. The parameter β is an end parameter for setting the end of the boost operation. In the first embodiment, the parameter β, which is a preset certain time, is 120 seconds. The parameter α and the parameter β are stored in the parameter storage unit 58 illustrated in FIG. 5. The value of the parameter α and the value of the parameter β can be set to any values.

[0042] Similar to time t1, the microcontroller 26 controls the boost operation to turn on or off the boost operation around each of times t2, t3, t4, t5, and t6 at which a hand was detected. As for the unit time for each of time t3 and time t4, a time earlier than time t4 by the parameter α precedes a lapse of the parameter β from time t3. The microcontroller 26 keeps the on state of the boost operation from a time earlier than time t3 by the parameter α to a time later than time t4 by the parameter β.

[0043] FIG. 8 is a flow chart illustrating the procedure of the operation by the microcontroller 26 illustrated in FIG. 5 for storing the actual data. For example, the microcontroller 26 executes the operation illustrated in FIG. 8 when the actual data is not stored in the actual data storage unit 57 with the hand dryer 1 powered on. The microcontroller 26 may also execute the operation illustrated in FIG. 8 when updating the actual data. The microcontroller 26 may accumulate the actual data at all times as the hand dryer 1 is powered on.

[0044] In starting the operation for storing the actual data, the timer 55 of the microcontroller 26 starts counting in step S1. For example, the timer 55 continues counting every second. Moreover, referring to a count value representing the count on the timer 55, the storage processing unit 54 monitors whether a hand is detected by the sensor 15. In step S2, on the basis of the count value on the timer 55, the storage processing unit 54 determines whether or not ten seconds, which is the unit time, have elapsed since the start of the counting. If the unit time has not elapsed since the start of the counting (No in step S2), the timer 55 of the microcontroller 26 continues counting until the unit time elapses from the start of the counting.

[0045] If the unit time has elapsed since the start of the counting (Yes in step S2), in step S3, the storage processing unit 54 stores, in the actual data storage unit 57, data indicating whether a hand is detected within the unit time. When a hand is not detected within the unit time, the storage processing unit 54 writes "0" in a data storage location for the unit time within the actual data storage unit 57. When a hand is detected within the unit time, the storage processing unit 54 writes "1" in the data storage location for the unit time within the actual data storage unit 57.

[0046] Next, in step S4, the storage processing unit 54 resets the count value of the timer 55. In step S5, referring to a parameter of the cycle period stored in the parameter storage unit 58, the storage processing unit 54 determines whether or not storing of the actual data for the cycle period is completed.

[0047] If the storing of the actual data for the cycle period is not completed (No in step S5), the microcontroller 26 returns to step S1 and continues the operation for obtaining data for the next unit time. If the storing of the actual data for the cycle period is completed (Yes in step S5), the microcontroller 26 ends the operation for storing the actual data. Note that the microcontroller 26 may continue the operation for storing the actual data for the next cycle period after completing the storing of the actual data for one cycle period.

[0048] FIG. 9 is a table illustrating examples of the actual data stored in the actual data storage unit 57 illustrated in FIG. 5 and parameters stored in the parameter storage unit 58. A data number is a number representing the order of the unit time in time series of the actual data. In the example illustrated in FIG. 9, the data number is assigned every ten seconds that are the unit time in 24 hours that is the cycle period C-1 in which the actual data was acquired. A reference character (i) indicating the data number is an integer in the range of 1 to 8640 inclusive. Detected data is data indicating whether a hand is detected in every unit time. Detected data "0" indicates that a hand was not detected in the unit time. Detected data "1" indicates that a hand was detected in the unit time.

[0049] In the example illustrated in FIG. 9, each of the parameter α and the parameter β is a constant value of 120 seconds. Note that "start point T-1 (i) of unit time", "start time T0on (i) of boost operation", and "end time T0off (i) of boost operation" illustrated in FIG. 9 are parameters calculated in the process of arithmetic operation performed by the microcontroller 26 and are not stored in the storage unit 53. The unit "(s)" of each of the parameters α, β, T-1 (i), T0on (i), and T0off (i) illustrated in FIG. 9 represents the second. The parameters T-1 (i), T0on (i), and T0off (i) each represent the time that has elapsed from the start point of the cycle period for the actual data.

[0050] On the basis of the data number of the detected data "1" indicating that a hand was detected, the microcontroller 26 determines the start time T0on (i) that is the timing at which to start the boost operation of the boost converter 30. On the basis of the data number of the detected data "1" indicating that a hand was detected, the microcontroller 26 determines the end time T0off (i) that is the timing at which to end the boost operation of the boost converter 30.

[0051] Referring now to FIG. 9, a description is made as to the determination of the start time T0on (i) and the end time T0off (i). On the basis of the actual data read from the actual data storage unit 57, the boost control unit 56 of the microcontroller 26 calculates the start point T-1 (i) of the unit time having the detected data "1" among the unit times. In the example illustrated in FIG. 9, the start point T-1 (119) of the unit time for the data number "119" providing the detected data "1" is calculated to provide 1180 seconds.

[0052] The boost control unit 56 subtracts the parameter α from the start point T-1 (i) of the unit time in the past cycle period C-1 to thereby obtain the start time T0on (i) of the boost operation in the current cycle period C0. In the example illustrated in FIG. 9, the boost control unit 56 subtracts α=120 (s) from T-1 (119)=1180 (s) to thereby calculate the start time T0on (119)=1060 (s). The boost control unit 56 turns on boosting of the boost converter 30 at the calculated start time T0on (i).

[0053] Moreover, the boost control unit 56 adds the parameter β to the start point T-1 (i) of the unit time in the past cycle period C-1 to thereby obtain the end time T0off (i) of the boost operation in the current cycle period C0. In the example illustrated in FIG. 9, the boost control unit 56 adds β=120 (s) to T-1 (119)=1180 (s) to thereby calculate the end time T0off (119)=1300 (s). The boost control unit 56 turns off boosting of the boost converter 30 at the calculated end time T0off (i).

[0054] Note that in the example illustrated in FIG. 9, the start point T-1 (5) of the unit time for the data number "5" providing the detected data "1" is calculated to provide 40 seconds, such that the start time T0on (5) of the boost operation is calculated to ptovide minus 80 seconds. In this case, the boost control unit 56 may start the boost operation 80 seconds before the start point of the current cycle period C0, or may start the boost operation at the start point of the cycle period C0.

[0055] FIGS. 10 and 11 are flow charts illustrating the procedure of control of the boost operation in the hand dryer 1 according to the first embodiment. In step S11, the hand dryer 1 is brought into connection to the commercial AC power supply 23 illustrated in FIG. 3, such that the hand dryer 1 is powered on. In step S12, the hand dryer 1 enters a standby state with the boost operation of the boost converter 30 turned off. Note that the hand dryer 1 is designed such that the boost operation is brought to an on state to thereby operate the blower 10 whenever a hand is detected by the sensor 15 after the hand dryer 1 is powered on. Step S12 and subsequent steps illustrate the procedure of the operation with the hand dryer 1 in the standby state where no hand is detected by the sensor 15.

[0056] In step S13, the boost control unit 56 illustrated in FIG. 5 determines whether or not the actual data is stored in the actual data storage unit 57. If the actual data is not stored in the actual data storage unit 57 (No in step S13), the microcontroller 26 acquires the actual data by executing the operation according to the procedure illustrated in FIG. 8 in step S14. The microcontroller 26 stores the acquired actual data in the actual data storage unit 57. The hand dryer 1 proceeds to step S15 if the actual data is stored in the actual data storage unit 57 (Yes in step S13), or if the actual data is acquired in step S14.

[0057] In step S15, the boost control unit 56 determines whether or not the current time has reached the time corresponding to the start point of the cycle period C-1 for the actual data. If the current time has not reached the time corresponding to the start point of the cycle period C-1 (No in step S15), the microcontroller 26 waits until the current time reaches the time corresponding to the start point of the cycle period C-1. If the current time has reached the time corresponding to the start point of the cycle period C-1 (Yes in step S15), the timer 55 of the microcontroller 26 starts counting in step S16. The time at which the counting starts in step S16 is defined as the start point of the current cycle period C0.

[0058] In step S17, referring to the actual data stored in the actual data storage unit 57, the boost control unit 56 sets a data number "Xn". The data number "Xn" provides the detected data "1" that is the data indicating that a hand was detected. The data number "Xn" is a variable. In step S17 that is the first step after the start of the counting in step S16, the data number "Xn" is set to "X1" which is a first data number after the start point of the cycle period C-1. In executing steps S17 to S22 for the first time, the boost control unit 56 executes processing with Xn set to X1 (Xn=X1).

[0059] The boost control unit 56 reads the parameter α from the parameter storage unit 58. In step S18, the boost control unit 56 subtracts the parameter α from a start point T-1 (Xn) of the unit time for the data number "Xn" set in step S17, thereby obtaining a start time T0on (Xn) of the boost operation. That is, the boost control unit 56 calculates T0on (Xn) that satisfies the relationship of the following expression (1).

$$\mathrm{T0on(Xn)=T\text{-}1(Xn)-\alpha} \quad \ldots \quad (1)$$

[0060] In step S19, referring to the count value on the timer 55, the boost control unit 56 determines whether or not a current time Tnow has reached the start time T0on (Xn) calculated in step S18. That is, the boost control unit 56 determines whether or not the relationship of the following expression (2) is satisfied. Note that the time Tnow is a variable that changes with the lapse of time.

$$\mathrm{Tnow \geq T0on\ (Xn)} \quad \ldots \quad (2)$$

[0061] If the current time Tnow has not reached the start time T0on (Xn) (No in step S19), the microcontroller 26 waits until the current time Tnow reaches the start time TC0on (Xn). When the current time Tnow has reached the start time TC0on (Xn) (Yes in step S19), the boost control unit 56 turns on the boost operation of the boost converter 30 in step S20.

[0062] The boost control unit 56 reads the parameter β from the parameter storage unit 58. In step S21, the boost control unit 56 adds the parameter β to the start point T-1 (Xn) of the unit time for the data number "Xn" set in step S17, thereby obtaining an end time T0off (Xn) of the boost operation. That is, the boost control unit 56 calculates T0off (Xn) that satisfies the relationship of the following expression (3).

$$\mathrm{T0off\ (Xn)=T\text{-}1\ (Xn)+\beta} \quad \ldots \quad (3)$$

[0063] In step S22, referring to the count value on the timer 55, the boost control unit 56 determines whether or not the current time Tnow has reached the end time T0off (Xn). That is, the boost control unit 56 determines whether or not the relationship of the following expression (4) is satisfied.

$$Tnow \geq T0off\ (Xn)\ ...\quad (4)$$

[0064] When the current time Tnow has reached the end time T0off (Xn) (Yes in step S22), the boost control unit 56 turns off the boost operation of the boost converter 30 in step S23. In step S24, the boost control unit 56 determines whether or not the processing for controlling the boost operation is completed for all data numbers providing the detected data "1" in the actual data.

[0065] If the processing is not completed for all the data numbers (No in step S24), in step S25, the boost control unit 56 refers to the actual data and updates the data number "Xn" providing the detected data "1". If step S25 is the first step after the processing up to step S24 with Xn set to X1 (Xn=X1), the boost control unit 56 updates the data number "Xn" to change "X1" to "X2". The data number "X2" is a data number providing the detected data "1", following the first data number "X1". The boost control unit 56 then executes the processing of step S18 and subsequent steps with Xn set to X2 (Xn=X2).

[0066] On the other hand, if the current time Tnow has not reached the end time T0off (Xn) (No in step S22), in step S26, the boost control unit 56 refers to the actual data stored in the actual data storage unit 57 and sets the data number "Xn+1". The data number "Xn+1" provides the detected data "1", following the data number "Xn". The data number "Xn+1" is a variable. If step S26 is the first step after the processing up to step S22 with Xn set to X1 (Xn=X1), the boost control unit 56 sets the data number "Xn+1" to "X2". As with step S25 described above, the data number "X2" is the data number providing the detected data "1", following the first data number "X1".

[0067] In step S27, the boost control unit 56 subtracts the parameter α from a start point T-1 (Xn+1) of the unit time for the data number "Xn+1" set in step S25, thereby obtaining a start time T0on (Xn+1) of the boost operation. That is, the boost control unit 56 calculates T0on (Xn+1) that satisfies the relationship of the following expression (5).

$$T0on\ (Xn+1) = T\text{-}1\ (Xn+1) - \alpha\ ...\quad (5)$$

[0068] In step S28, the boost control unit 56 refers to the count value on the timer 55 and determines whether or not the current time Tnow has reached the start time T0on (Xn+1) calculated in step S26. That is, the boost control unit 56 determines whether or not the relationship of the following expression (6) is satisfied.

$$Tnow \geq T0on\ (Xn+1)\ ...\quad (6)$$

[0069] If the current time Tnow has not reached the start time T0on (Xn+1) (No in step S28), the boost control unit 56 returns to step S22 for the data number "Xn". On the other hand, if the current time Tnow has reached the start time T0on (Xn+1) (Yes in step S28), in step S29, the boost control unit 56 updates the data number "Xn", keeping the boost operation on. In step S29, the data number "Xn" is set to the same data number as the data number "Xn+1" set in step S26. When "X2" is set as the data number "Xn+1" in step S26, the boost control unit 56 sets the data number "Xn" as "X2". The boost control unit 56 then executes the processing of step S21 and subsequent steps with Xn set to X2 (Xn=X2).

[0070] In step S24, if the processing is completed for all the data numbers (Yes in step S24), the microcontroller 26 ends the boost operation control based on the actual data. Assuminng that the actual data illustrated in FIG. 9 is used, the boost control unit 56 updates the data number "Xn" to be "5", ... "119", "121", "122", ... in step S25 or step S29.

[0071] In a case where a hand is detected by the sensor 15 during the execution of the processing after step S12, the microcontroller 26 turns on the boost operation by interrupt processing and brings the blower 10 into operation. In a case where the timer 55 is counting, the microcontroller 26 allows the counting to continue during the interrupt processing. The microcontroller 26 may accumulate the actual data on the basis of a result of detection of a hand by the sensor 15 for the current cycle period C0 in which the boost operation is controlled as the hand dryer is in the standby state. The microcontroller 26 may store the actual data accumulated in the current cycle period C0 together with past actual data, or may overwrite the past actual data with the actual data accumulated in the current cycle period C0. The microcontroller 26 may continue processing based on the actual data for the current cycle period C0 after completing the processing according to the procedure illustrated in FIGS. 10 and 11. The microcontroller 26 controls the boost operation in a cycle period following the cycle period C0.

[0072] The microcontroller 26 may sequentially control the boost operation and accumulate the actual data on the assumption that the cycle period is 24 hours. During a first one of successive cycle periods, the microcontroller 26 may accumulate the actual data, keeping the boost operation on at all times; during the subsequent cycle periods, the microcontroller 26 may control the boost operation.

[0073] According to the first embodiment, the hand dryer 1 controls the boost operation of the boost converter 30 on the basis of the actual data representing the actual result of whether a hand is detected. The hand dryer 1 starts the boost operation at a start time set on the basis of the time at which a hand was detected in a past cycle period. The hand dryer 1 can stand ready to start blowing the air when it is expected that the hand dryer 1 is used. The hand dryer 1 can reduce standby power by not performing the boost operation at the other times. The hand dryer 1 controls the boost operation on the basis of the actual data accumulated in the microcontroller 26. The hand dryer 1, which does not require setting the time period for performing the boost operation in the standby state, can eliminate the need for a complicated input operation for setting conditions. The hand dryer 1, which is not required to have an input operation unit for inputting the time period and a display unit for displaying content of the input, can thus have a simple configuration.

[0074] As described above, the hand dryer 1 has an effect of being able to cut down the time required to start blowing the air and reduce the standby power.

Second Embodiment

[0075] FIG. 12 is a table for explaining control of the boost operation in the hand dryer 1 according to a second embodiment of the present invention. The hand dryer 1 according to the second embodiment sets the start and end times of the boost operation, using a start parameter and an end parameter determined on the basis of the frequency of the detected data "1" indicating that a hand was detected by the sensor 15. Parts that are identical to those in the first embodiment above are denoted by the same reference numerals as those in the first embodiment, whereby redundant description will be omitted.

[0076] FIG. 12 illustrates "low", "medium", and "high" representing frequency classifications. A frequency F, which is a first frequency, represents the number of pieces of detected data "1" included in a first determination period. The first determination period is a period set by dividing a first cycle period that is the cycle period for the actual data. For example, the first determination period is set to one hour. A criterion for the frequency classification "low" is that the frequency F is equal to or less than nine. A criterion for the frequency classification "medium" is that the frequency F is between ten and 20 inclusive. A criterion for the frequency classification "high" is that the frequency F is equal to or more than 21. The parameter α, which is the start parameter, is set to increase in value from 60 seconds to 120 seconds and then to 180 seconds as the frequency increases from "low" to "medium" and then to "high". The value of the parameter β, which is the end parameter, is the same as the value of the parameter α. The parameter storage unit 58 illustrated in FIG. 5 stores the values of the parameters α and β set on a per frequency-classification basis. Note that the length of the first determination period can be set to any length. Also, the number of frequency classifications is not limited to three but may be two or four or more. The criteria for the frequency classifications can be set in any manner. The values of the parameters α and β by frequency classification can be set to any values.

[0077] FIG. 13 is a table illustrating examples of the actual data stored in the actual data storage unit 57 illustrated in FIG. 5 and the parameters stored in the parameter storage unit 58. The frequency F illustrated in FIG. 13 is a parameter calculated in the process of arithmetic operation performed by the microcontroller 26 and is not stored in the storage unit 53.

[0078] The microcontroller 26 uses the parameter α determined on the basis of the frequency F of the detected data "1" in the first determination period, thereby obtaining the start time that is the timing at which to start the boost operation of the boost converter 30. The microcontroller 26 also uses the parameter β determined on the basis of the frequency F of the detected data "1" in the first determination period, thereby obtaining the end time that is the timing at which to end the boost operation of the boost converter 30.

[0079] A description will be made as to the determination of the parameter α and the parameter β with reference to FIG. 13. The pieces of the detected data having the data numbers "1" to "360" are detected data indicating whether a hand is detected in the first determination period that is one hour from the start point of the cycle period C-1. The pieces of the detected data having the data numbers "1" to "360" include 21 pieces of detected data "1" indicating that a hand was detected. The boost control unit 56 illustrated in FIG. 5 determines that the frequency classification of the detected data "1" in the first determination period is "high" on the basis of the criterion illustrated in FIG. 12. The boost control unit 56 determines the parameter α and the parameter β for the data numbers "1" to "360" to be 180 seconds on the basis of the determination that the frequency classification is "high". For the first determination period of the other data numbers as well, the boost control unit 56 determines the parameter α and the parameter β on the basis of the frequency classification as with the first determination period for the data numbers "1" to "360".

[0080] According to the second embodiment, the hand dryer 1 uses the parameter α and the parameter β determined on the basis of the frequency of detection of a hand, such that the start and end times of the boost operation can be set on the basis of the frequency of use of the hand dryer 1. The hand dryer 1 can set the longer duration of the boost operation as an expected frequency of use is higher; the hand dryer 1 can set the shorter duration of the boost operation as the expected frequency of use is lower. The hand dryer 1 can thus control the boost operation in correspondence to the frequency of use.

Third Embodiment

[0081] FIG. 14 is a table for explaining control of the boost operation in the hand dryer 1 according to a third embodiment of the present invention. The hand dryer 1 according to the third embodiment changes the start parameter and the end parameter on the basis of a second frequency that is the frequency of detection of a hand in a second cycle period in which the boost operation is controlled as the hand dryer 1 waits for the hand detection. Parts that are identical to those in the first and second embodiments above are denoted by the same reference numerals as those in the first and second embodiments, whereby redundant description will be omitted.

[0082] The classifications "low", "medium", and "high" illustrated in FIG. 14 are similar to the classifications illustrated in FIG. 12 of the second embodiment. A second determination period is a 20-minute period set by dividing the current cycle period that is the second cycle period. The second determination period is the period of 20 minutes from the time corresponding to the start point of the first determination period in the second embodiment. A frequency Fn which is the second frequency represents the number of times a hand is detected in the second determination period.

[0083] The boost control unit 56 illustrated in FIG. 5 changes the parameters α and β determined from the actual data on the basis of the frequency Fn. In the third embodiment, values of the parameters α and β determined from the actual data may be referred to as "reference values". For example, the reference values are the values of the parameters α and β illustrated in FIG. 12. Note that the length of the second determination period can be set to any length.

[0084] In a case where the frequency classification is "low" and the frequency Fn is equal to or less than three, the parameter α, which is the start parameter, is set to 60 seconds which is the same value as the reference value. In a case where the frequency classification is "low" and the frequency Fn is equal to or more than four, the parameter α is set to 120 seconds which is a value larger than the reference value. The boost control unit 56 changes the parameter α from 60 seconds, i.e., the reference value to 120 seconds in the case where the frequency Fn is equal to or more than four in the frequency classification "low". That is, the frequency classification based on the actual data is "low" but the frequency Fn becomes equal to or more than four. As a result, the microcontroller 26 determines that the frequency of use of the hand dryer 1 is increased in the current cycle period compared to the cycle period of the actual data, thereby performing an adjustment to increase the duration of the boost operation.

[0085] In a case where the frequency classification is "medium" and the frequency Fn is between four and seven inclusive, the parameter α is set to 120 seconds which is the same value as the reference value. In a case where the frequency classification is "medium" and the frequency Fn is equal to or less than three, the parameter α is set to 60 seconds which is a value smaller than the reference value. The boost control unit 56 changes the parameter α from 120 seconds, i.e., the reference value to 60 seconds in the case where the frequency Fn is equal to or less than three in the frequency classification "medium". That is, the frequency classification based on the actual data is "medium" but the frequency Fn is equal to or less than three. As a result, the microcontroller 26 determines that the frequency of use of the hand dryer 1 is decreased in the current cycle compared to the cycle of the actual data, thereby performing an adjustment to decrease the duration of the boost operation.

[0086] As illustrated in FIG. 14, the value of the parameter α is set for each range of the frequency Fn in each of the "low", "medium", and "high" classifications. The value of the parameter β, which is the end parameter, is the same as the value of the parameter α. The parameter storage unit 58 illustrated in FIG. 5 stores the preset values of the parameters α and β. Note that the range of the frequency Fn, which is a criterion for changing the values of the parameters α and β from the reference values, can be set to any range. The values of the parameters α and β for each range of the frequency Fn can also be set to any values.

[0087] FIG. 15 is a table illustrating examples of the actual data stored in the actual data storage unit 57 illustrated in FIG. 5 and the parameters determined. The frequency Fn illustrated in FIG. 15 is a parameter calculated in the process of arithmetic operation performed by the microcontroller 26 and is not stored in the storage unit 53.

[0088] A description will be made as to changes in the parameter α and the parameter β with reference to FIG. 15. Assume that the reference values of the parameters α and β in one hour for the data numbers "1" to "360" are 180 seconds corresponding to the frequency classification "high" illustrated in FIG. 12. The boost control unit 56 sets the parameters α and β to 180 seconds during 20 minutes of one hour in the current cycle period. Such 20 minutes corresponds to the second determination period and the data numbers "1" to "120". That one hour corresponds to the data numbers "1" to "360".

[0089] During the 20 minutes, the boost control unit 56 also monitors the frequency Fn that is the number of unit times at which a hand is detected. When the frequency Fn equals "6", the parameters α and β are 120 seconds for the classification "high" and "$Fn \leq 7$" illustrated in FIG. 14. The boost control unit 56 changes the parameters α and β from 180 seconds to 120 seconds. The boost control unit 56 sets the parameters α and β to 120 seconds during 40 minutes corresponding to the data numbers "121" to "360". As discussed above, the microcontroller 26 determines from the frequency Fn that the current frequency of use of the hand dryer 1 has changed from that in the cycle period of the actual data, and changes the duration of the boost operation. The boost control unit 56 also changes the parameters α and β on the basis of the frequency Fn for the data numbers "361" and on as with the data numbers "1" to "360".

[0090] According to the third embodiment, on the basis of the frequency of detection of a hand in the current cycle period, the hand dryer 1 can change the parameters α and β obtained from the actual data. The hand dryer 1 can thus control the boost operation in correspondence to a change in the status of use.

[0091] Note that in the third embodiment, the hand dryer 1 may omit the determination of the frequency classifications "low", "medium", and "high" from the past actual data and determine the parameters α and β on the basis of the frequency of detection of a hand in the current cycle period.

Fourth Embodiment

[0092] FIG. 16 is a diagram for explaining control of the boost operation in the hand dryer 1 according to a fourth embodiment of the present invention. The hand dryer 1 according to the fourth embodiment stops the boost operation based on the actual data on the basis of a result of detection of a hand in the current cycle period that is the second cycle period in which the boost operation is controlled as the hand dryer waits for the hand detection. Parts that are identical to those in the first embodiment above are denoted by the same reference numerals as those in the first embodiment, whereby redundant description will be omitted.

[0093] FIG. 16 illustrates a time chart of the actual data in the past cycle period C-1 and a time chart of each of a result of detection of a hand and a state of the boost operation in the current cycle period C0. In FIG. 16, the time axis representing time T-1 of the cycle period C-1 and the time axis representing time T0 of the current cycle period C0 indicate the same points of time on different dates correspondingly.

[0094] The boost control unit 56 illustrated in FIG. 5 stops the boost operation based on the actual data in a case where a hand is not detected in the first determination period of the current cycle period C0. The first determination period in the fourth embodiment is one hour. Note that the length of the first determination period can be set to any length.

[0095] FIG. 16 illustrates an example where, in a first determination period H1 of the current cycle period C0, the boost control unit 56 controls the boost operation to bring the boost operation to the on/off state on the basis of the actual data in the past cycle period C-1, as with the first embodiment. In a case where there is no unit time at which a hand is detected in the first determination period H1, the boost control unit 56 keeps the boost operation in the standby state, in the off state throughout a first determination period H2 following the first determination period H1. That is, when a hand is not detected in the first determination period, the boost control unit 56 determines that the frequency of use of the hand dryer 1 is significantly lower than that in the past cycle period, and stops the boost operation based on the actual data.

[0096] The boost control unit 56 keeps the boost operation in the standby state, in the off state throughout the cycle period C0 after the first determination period H2. With the boost operation in the standby state kept in the off state throughout the cycle period C0, the microcontroller 26 can reduce standby power in a situation where the frequency of use of the hand dryer 1 is significantly lower than that in a normal cycle period. Note that in a case where a hand is detected in the cycle period C0 after the first determination period H2, the boost control unit 56 resumes control of the boost operation based on the actual data in the cycle period C-1.

[0097] In a case where the cycle period C0 ends with no hand detected after the first determination period H2, the boost control unit 56 resumes, in the next cycle period C1, control of the boost operation based on the actual data in the cycle period C-1. The cycle period C1 follows the cycle period C0. Note that in a case where the cycle period C1 has a first determination period in which a hand is not detected, the boost control unit 56 keeps the boost operation in the standby state, in the off state throughout the cycle period C1 as well.

[0098] For example, when the current cycle period C0 falls on a day on which a facility equipped with the hand dryer 1 is closed, the frequency of use of the hand dryer 1 can be significantly lower than the frequency of use in the cycle period C-1 up to the previous day. The boost control unit 56 keeps the boost operation in the standby state, in the off state throughout the cycle period C0, therey reducing wasteful standby power on the day the facility is closed.

[0099] Note that the boost control unit 56 may stop the boost operation based on the actual data, not only when there is no unit time at which a hand is detected in the first determination period, but when the number of unit times is equal to or less than a preset threshold. In this case as well, the microcontroller 26 can reduce standby power in the situation where the frequency of use of the hand dryer 1 is significantly low. For example, the boost control unit 56 can stop the boost operation in the standby state in a case where the hand dryer 1 is used a little on the day the facility is closed. The boost control unit 56 may resume the boost operation in the standby state when the number of unit times at which a hand is detected exceeds a threshold after stopping the boost operation in the standby state. The threshold may be set by an operation on an input unit provided in the hand dryer 1. Note that illustration of the input unit is omitted. As in the second or third embodiment, the hand dryer 1 according to the fourth embodiment may obtain the timings at which to start and end the boost operation.

[0100] According to the fourth embodiment, on the basis of the result of detection of a hand in the current cycle period, the hand dryer 1 stops the boost operation based on the actual data. The hand dryer 1 can reduce standby power in the situation where the frequency of use of the hand dryer 1 is significantly low.

Fifth Embodiment

[0101] The hand dryer 1 according to a fifth embodiment of the present invention accumulates the actual data in a plurality of cycle periods. Parts that are identical to those in the first to fourth embodiments above are denoted by the same reference numerals as those in the first to fourth embodiments, whereby redundant description will be omitted. In the fifth embodiment, the actual data storage unit 57 illustrated in FIG. 5 stores the actual data for a plurality of cycle periods.

[0102] FIG. 17 is a flow chart for explaining control of the boost operation in the hand dryer 1 according to the fifth embodiment of the present invention. In the fifth embodiment, the microcontroller 26 illustrated in FIG. 5 accumulates the actual data for seven cycle periods C0, C1, C2, ... and C6 and controls the boost operation based on the accumulated actual data.

[0103] In step S31, the microcontroller 26 accumulates first actual data which is the actual data in the first cycle period C0 that is a first cycle period. The microcontroller 26 accumulates and stores first accumulated data in accordance with the procedure similar to the procedure illustrated in FIG. 8.

[0104] In step S32, the microcontroller 26 controls the boost operation in the second cycle period C1 on the basis of the first accumulated data stored in step S31. The microcontroller 26 controls the boost operation in acordacne with the procedure similar to the procedure illustrated in FIGS. 10 and 11. Simultaneously with the control of the boost operation, the microcontroller 26 accumulates second actual data that is the actual data in the second cycle period C1. The microcontroller 26 accumulates and stores second accumulated data in accordance with the procedure similar to the procedure illustrated in FIG. 8.

[0105] In step S33, the microcontroller 26 executes control of the boost operation in a third cycle period C2 on the basis of the first and second accumulated data stored up to step S32. The boost control unit 56 illustrated in FIG. 5 may calculate, from the first accumulated data and the second accumulated data, an average value of the frequencies F illustrated in FIG. 13 in individual first determination periods. The boost control unit 56 determines the start parameter and the end parameter on the basis of the average value of the frequencies F. The boost control unit 56 determines the start parameter and the end parameter by a method similar to that in the second embodiment. Using the determined start and end parameters, the boost control unit 56 sets the start and end times of the boost operation in the third cycle period C2.

[0106] Moreover, in step S33, simultaneously with the control of the boost operation, the microcontroller 26 accumulates third actual data that is the actual data in the third cycle period C2. The microcontroller 26 accumulates and stores third accumulated data in accordance with the procedure similar to the procedure illustrated in FIG. 8.

[0107] In step S34, the microcontroller 26 controls the boost operation in fourth to seventh cycle periods C3, C4, C5, and C6 in the manner similar to that for the third cycle period C2. The microcontroller 26 also accumulates fourth to seventh actual data, which is the actual data in the fourth to seventh cycle periods C3, C4, C5, and C6, in the manner similar to that for the third cycle period C2. The microcontroller 26 then ends accumulation of the actual data for the seven cycle periods C0, C1, C2, ... and C6 and control of the boost operation based on the accumulated actual data.

[0108] According to the procedure illustrated in FIG. 17, in controlling the boost operation in the seventh cycle period C6, the microcontroller 26 sets the start and end times of the boost operation on the basis of the average value of the frequencies F calculated from the first to sixth actual data. The microcontroller 26 can determine the tendency of the frequency of use of the hand dryer 1 with high accuracy by using the actual data accumulated in the plurality of previous cycle periods. Beacsue the hand dryer 1 can control the boost operation on the basis of the determined tendency of the frequency of use, the hand dryer 1 can reduce a wasted boost operation. As a result, the hand dryer 1 can effectively reduce standby power.

[0109] As in the fourth embodiment, the microcontroller 26 may stop the boost operation based on the actual data in a case where the frequency of detection of a hand in the first determination period is significantly low. In calculating the average value of the frequencies F, the microcontroller 26 may exclude the actual data for the cycle period in which the boost operation is stopped. For example, the microcontroller 26 can calculate the average value of the frequencies F, excluding the actual data on a holiday. As a result, the microcontroller 26 can grasp the tendency of the frequency of use of the hand dryer 1 with higher accuracy.

[0110] The microcontroller 26 is not necessarily limited to accumulating the actual data for the seven cycle periods and controlling the boost operation based on the accumulated actual data. The microcontroller 26 may accumulate the actual data and control the boost operation for less than seven or more than seven cycle periods.

[0111] For example, the microcontroller 26 may accumulate the actual data for each day of a month and control the boost operation based on the accumulated actual data. In this case, the microcontroller 26 may control the boost operation by calculating the average value of the frequences F for individual days of the week. The microcontroller 26 can calculate the average value for each day of the week by using the actual data in every seven cycle periods. Alternatively, the microcontroller 26 may calculate the average value of the frequences F on the basis of all the actual data other than the actual data on a holiday.

[0112] The microcontroller 26 may also accumulate the actual data for each day of a year and control the boost operation based on the accumulated actual data. In this case as well, the microcontroller 26 may control the boost operation by calculating the average value of the frequences F for each day of the week. The microcontroller 26 may control the boost operation by calculating the average value of the frequences F on a monthly or seasonal basis. The microcontroller 26 can control the boost operation in correspondence to a change in the frequency of use over the year. For example, the microcontroller 26 can control the boost operation by grasping the period of holidays established per year. As in the second or third embodiment, the hand dryer 1 according to the fifth embodiment may obtain the timings at which to start and end the boost operation.

[0113] According to the fifth embodiment, the hand dryer 1 accumulates the actual data for the plurality of cycle periods and controls the boost operation on the basis of the accumulated actual data. The hand dryer 1 can thus control the boost operation by grasping the tendency of the frequency of use with high accuracy and effectively reduce the standby power.

Sixth Embodiment

[0114] The hand dryer 1 according to a sixth embodiment of the present invention provides a cycle period that is not a preset time but a period from the time when the hand dryer 1 is powered on to the time when the hand dryer is powered off. In the sixth embodiment, the cycle period in which the actual data is accumulated and the cycle period in which the boost operation is controlled on the basis of the actual data are each the period from the time when the hand dryer 1 is powered on to the time when the hand dryer is powered off. The hand dryer 1 according to the sixth embodiment can accumulate the actual data and control the boost operation as in the first to fifth embodiments except that the cycle period is set in a different manner from the cycle period in the first to fifth embodiments. In the sixth embodiment, the cycle period is the time from when the commercial AC power supply 23 illustrated in FIG. 3 is turned on to when the power supply 23 is turned off.

[0115] The hand dryer 1 may be powered on at the same time or in the same time period everyday, and powered off at the same time or the same time period everday. For example, the power is turned on eight o'clock in the morning and turned off nine o'clock in the evening. In this case, when the cycle period is set to 24 hours in advance, the actual data for the cycle period is not accumulated. This means that it is always determined in step S13 of FIG. 10 that the actual data is not be stored. As a result, the microcontroller 26 cannot execute the processing in step S14 and the subsequent steps.

[0116] By providing the cycle period that is the time from when the hand dryer 1 is powered on to when the hand dryer 1 is powered off, the hand dryer 1 can store the actual data for the cycle period and control the boost operation based on the stored actual data. Taking into account an exceptional situation where the power supply is never turned off, the microcontroller 26 may accumulate the actual date over a preset period of time and stop accumulating the detected data after a lapse of this period of time. In a case where a time period in which past actual data is not stored comes but the power supply is not turned off, the microcontroller 26 may keep the boost operation in the standby, in the on or off state at all times.

[0117] As in the second or third embodiment, the hand dryer 1 according to the sixth embodiment may obtain the timings at which to start and end the boost operation. Moreover, the hand dryer 1 according to the sixth embodiment may stop the boost operation based on the actual data, on the basis of the result of detection of a hand in the current cycle period, as with the fourth embodiment. The hand dryer 1 according to the sixth embodiment may also store the actual data for a plurality of cycle periods as with the fifth embodiment.

[0118] According to the sixth embodiment, the hand dryer 1 accumulates the actual data and controls the boost operation, providing the cycle period that is the time from when the hand dryer 1 is powered on to when the hand dryer 1 is powered off. As in the first to fifth embodiments, the hand dryer 1 can cut down the time required to start blowing the air and reduce the standby power.

Seventh Embodiment

[0119] FIG. 18 is a diagram illustrating a configuration of the control section 20 of the hand dryer 1 according to a seventh embodiment of the present invention. Parts that are identical to those in the first to sixth embodiments are denoted by the same reference numerals as those in the first to sixth embodiments, whereby redundant description will be omitted. The hand dryer 1 according to the seventh embodiment changes the duration of the boost operation on the basis of air temperature.

[0120] The hand dryer 1 includes a thermistor 60 that is a temperature measurement unit. The thermistor 60 measures the air temperature. The microcontroller 26 obtains a result of measurement of the air temperature from the thermistor 60. The thermistor 60 is attached to the inside or the outside of the housing 3 of the hand dryer 1 illustrated in FIG. 1. The thermistor 60 may be mounted inside the control section 20. The temperature measurement unit is not limited to the thermistor 60, but may be any temperature measurfement unit capable of measuring the air temperature. The temperature measurement unit is not limited to the one attached to the hand dryer 1 but may be one installed at a location away from the hand dryer 1. The temperature measurement unit may be a thermometer that measures the air temperature of a room in which the hand dryer 1 is installed or the air temperature of the living space of a user. The hand dryer 1 may include a communication unit for receiving temperature information from the temperature measurement unit located at a remote location. FIG. 18 omits illustration of the communication unit. On the basis of temperature data acquired, the microcontroller 26 corrects the duration for which the boost converter 30 is operated.

[0121] FIG. 19 is a table illustrating an example of the actual data stored in the actual data storage unit 57 illustrated in FIG. 5. In the seventh embodiment, the actual data includes the unit-time-by-unit-time temperature data measured by the thermistor 60. The storage processing unit 54 illustrated in FIG. 5 stores, in the actual data storage unit 57, the temperature data acquired from the thermistor 60 within the unit time together with the detected data. For example, the storage processing unit 54 stores the temperature data together with the detected data in step S3 illustrated in FIG. 8.

[0122] A "temperature difference" illustrated in FIG. 19 represents a difference between the temperature measured in the unit time of the current cycle period and the temperature data included in the actual data. A "β correction value" is a correction value calculated on the basis of the temperature difference, and represents a correction value for the parameter β that is the end parameter. Note that the "temperature difference" and the "β correction value" are parameters calculated in the process of arithmetic operation performed by the microcontroller 26 and are not stored in the storage unit 53. The unit of the "temperature" and "temperature difference" illustrated in FIG. 19 is degrees Celsius (°C). The unit of the "β correction value" is seconds (s).

[0123] In controlling the boost operation, the boost control unit 56 of the microcontroller 26 reads, from the actual data storage unit 57, the temperature data corresponding to the data number providing the detected data "1". The boost control unit 56 subtracts the read temperature data from a measured value of the current temperature to thereby calculate the temperature difference.

[0124] For example, the β correction value per 1 °C of temperature difference is set to minus 10 seconds when the temperature difference is a positive value, while the β correction value per 1 °C of temperature difference is set to plus 10 seconds when the temperature difference is a negative value. The boost control unit 56 calculates the β correction value from the temperature difference on the basis of such setting. The boost control unit 56 obtains the end time of the boost operation on the basis of the parameter β corrected by the calculated β correction value. Note that the parameter β prior to being corrected by the β correction value may be any of: the parameter β of the first embodiment that is fixed regardless of the frequency of detection of a hand; the parameter β of the second embodiment that is determined from the frequency F; and the parameter β of the third embodiment that is changed on the basis of the frequency Fn. Note that the method for calculating the β correction value from the temperature difference is not limited to the method according to the seventh embodiment but may be changed as appropriate.

[0125] For the data number "5" providing the detected data "1" in the example illustrated in FIG. 19, the temperature difference obtained by subtracting, from the current temperature, the temperature of 17°C in the actual data is calculated to provide minus 3°C. On the basis of this temperature difference of minus 3°C, the boost control unit 56 calculates plus 30 seconds as the β correction value. For example, the boost control unit 56 calculates the end time of the boost operation for the data number "5" on the basis of a result of adding 30 seconds that is the β correction value to 120 seconds that is the parameter β illustrated in FIG. 9. Addition of plus 30 seconds to 160 seconds resulting from 40 seconds + β corrects the end time TOoff (5) for the data number "5" in FIG. 9 to 190 seconds.

[0126] For the data number "359" providing the detected data "1" in the example illustrated in FIG. 19, the temperature difference obtained by subtracting, from the current temperature, the temperature of 21°C in the actual data is calculated as plus 2°C. The boost control unit 56 calculates minus 20 seconds as the β correction value on the basis of the temperature difference of plus 2°C. In one example, the boost control unit 56 calculates the end time of the boost operation for the data number "359" on the basis of 160 seconds which is a result of subtracting 20 seconds from 180 seconds that is the parameter β illustrated in FIG. 13.

[0127] The hand dryer 1 delays the end time of the boost operation as the temperature difference is larger on the negative side, thereby enabling control for increasing the duration of the boost operation in the standby state as the air temperature decreases. For example, when installed in a toilet room, the hand dryer 1 can control the boost operation, matching the general tendency of the frequency of use of the toilet to increase as the air temperature decreases. The hand dryer 1 can thus perform control of the boost operation in correspondence to a change in the air temperature when the change in the air temperature can change the frequency of use.

[0128] Note that the boost control unit 56 may correct the parameter α that is the start parameter, by using a correction value calculated on the basis of the temperature difference. The hand dryer 1 can change the duration of the boost operation by correcting at least one of the parameter α and the parameter β. In the case where the frequency of use decreases as the air temperature decreases, or where the frequency of use increases as the air temperature increases, the hand dryer 1 may perform control such that the duration of the boost operation increases as the temperature difference is larger on the positive side.

[0129] As in the second or third embodiment, the hand dryer 1 according to the seventh embodiment may obtain the timings at which to start and end the boost operation. Moreover, the hand dryer 1 according to the seventh embodiment may stop the boost operation based on the actual data, on the basis of a result of detection of a hand in the current cycle period, as with the fourth embodiment. The hand dryer 1 according to the seventh embodiment may also store the actual data for a plurality of cycle periods as with the fifth embodiment. Moreover, as with the sixth embodiment, the hand dryer 1 according to the seventh embodiment may provide the cycle period that is the period from the time when the hand dryer 1 is powered on to the time when the hand dryer is powered off.

[0130] According to the seventh embodiment, the hand dryer 1, which changes the duration of the boost operation on the basis of the air temperature, can perform control of the boost operation in correspondence to a change in the air temperature.

Eighth Embodiment

[0131] FIG. 20 is a diagram illustrating a configuration of the control section 20 of the hand dryer 1 according to an eighth embodiment of the present invention. Parts that are identical to those in the first to seventh embodiments are denoted by the same reference numerals as those in the first to seventh embodiments, whereby redundant description will be omitted. The hand dryer 1 according to the eighth embodiment includes a clock 70 that provides the microcontroller 26 with time information.

[0132] The microcontroller 26 obtains the time information from the clock 70. Using the current time, the hand dryer 1 controls the boost operation in the first to seventh embodiments. The clock 70 may also be one that presents the date and the day of the week as well as the time. The microcontroller 26 obtains information on the date and the day of the week together with the time information from the clock 70. Using the current date and day of the week, the hand dryer 1 can control the boost operation in the first to seventh embodiments.

[0133] Even in a case where the commercial AC power supply 23 is turned off periodically, the hand dryer 1 can always know the time without setting the time when the commercial AC power supply 23 is turned on. The clock 70 may be provided in the hand dryer 1 of any of the first to seventh embodiments. According to the eighth embodiment, providing the hand dryer 1 with the clock 70 enables the hand dryer 1 to control the boost operation, using the current time.

Ninth Embodiment

[0134] FIG. 21 is a table for explaining control of the boost operation in the hand dryer 1 according to a ninth embodiment of the present invention. The hand dryer 1 according to the ninth embodiment determines the frequency classification of the detected data "1" in a third determination period different from the first determination period of the second embodiment. Parts that are identical to those in the first to eighth embodiments are denoted by the same reference numerals as those in the first to eighth embodiments, whereby redundant description will be omitted.

[0135] The third determination period includes a period preceding a start point of the unit time for a data number (i) and a period following the start point. For example, the third determination period is one hour including 30 minutes before the start point of the unit time and 30 minutes after the start point. In such an example, the length of the third determination period is the same as the length of the first determination period, but the setting of the end point of the start point of the third determination period differs from the setting of the first determination period. The third determination period is a period set by being shifted on a per data-number basis.

[0136] A frequency Fm, which is a first frequency, represents the number of pieces of the detected data "1" included in one hour that is the third determination period. Note that the length of the third determination period can be set to any length. FIG. 21 illustrates "low", "medium", and "high" representing the frequency classifications. The frequency classifications in the ninth embodiment are similar to that of the second embodiment illustrated in FIG. 12.

[0137] FIG. 22 is a table illustrating an example of the actual data stored in the actual data storage unit 57 illustrated in FIG. 5 and an example of the frequency Fm. The frequency Fm illustrated in FIG. 22 is a parameter calculated in the process of arithmetic operation performed by the microcontroller 26 and is not stored in the storage unit 53.

[0138] A description will be made as to determination of the parameter α and the parameter β with reference to FIG. 22. The start point of the third determination period for the unit time of the data number "181" is the time 30 minutes before the start point of the unit time of data number "181"; thus, this start point is the time that is the start point of the unit time of the data number "1". The end point of the third determination period for the unit time of the data number "181" is the time 30 minutes after the start point of the unit time of data number "181"; thus, this end point is the time that is the end point of the unit time of the data number "360". The frequency Fm is the number of pieces of the detected data "1" in one hour from the start point to the end point of the third determination period. According to the example of

FIG. 22, the frequency Fm for the unit time of the data number "181" is 21 times. The boost control unit 56 determines, from the criteria illustrated in FIG. 21, that the frequency classification is "high". On the basis of the determination that the frequency classification is "high", the boost control unit 56 determines that each of the parameter α and the parameter β for the data numbers "181" is 180 seconds.

[0139] The third determination period for the data number "182" is moved down by one unit time, that is, 10 seconds, from the third determination period for the data number "181". The start point of the third determination period for the data number "360" is the time that is the start point of the unit time of the data number "181". The end point of the third determination period for the data number "360" is the time that is the end point of the unit time of the data number "540". According to the example of FIG. 22, the frequency Fm for the unit time of the data number "360" is seven times. The boost control unit 56 determines, from the criteria illustrated in FIG. 21, that the frequency classification is "low". On the basis of the determination that the frequency classification is "low", the boost control unit 56 determines that each of the parameter α and the parameter β for the data numbers "360" is 60 seconds.

[0140] As described above, the boost control unit 56 shifts the third determination period on a per data-number basis, which in turn obtains the frequency Fm, such that the boost control unit 56 determines the frequency classification. By shifting the third determination period, the boost control unit 56 can reduce a deviation in the result of determination that can occur ue to an uneven frequency of use within a certain period. The microcontroller 26 can thus determine the frequency of use of the hand dryer 1 with high accuracy.

[0141] In the third determination period, the length of the period preceding the start point of the unit time for the data number (i) may be different from the length of the period following the start point. For example, the third determination period may include 40 minutes before the start point of the unit time and 20 minutes after the start point. Alternatively, the third determination period may be one that does not include the period preceding the start point of the unit time for the data number (i) or does not include the period following the start point. The third determination period may be one hour before the start point of the unit time or one hour after the start point.

[0142] The hand dryer 1 according to the ninth embodiment may stop the boost operation based on the actual data, on the basis of a result of detection of a hand in the current cycle period, as with the fourth embodiment. The hand dryer 1 according to the ninth embodiment may also store the actual data for a plurality of cycle periods as with the fifth embodiment. Moreover, as with the sixth embodiment, the hand dryer 1 according to the ninth embodiment may provide the cycle period that is the period from the time when the hand dryer 1 is powered on to the time when the hand dryer is powered off. The hand dryer 1 according to the ninth embodiment may also change the duration of the boost operation on the basis of the air temperature, as with the seventh embodiment. Furthermore, the hand dryer 1 according to the ninth embodiment may include the clock 70 as with the eighth embodiment.

[0143] According to the ninth embodiment, the hand dryer 1 determines the parameter α and the parameter β on the basis of the frequency of detection of a hand in the third determination period. The hand dryer 1 can accurately determine the frequency of use of the hand dryer 1 and can control the boost operation in correspondence to the status of the frequency of use.

Tenth Embodiment

[0144] FIG. 23 is a table for explaining control of the boost operation in the hand dryer 1 according to a tenth embodiment of the present invention. The hand dryer 1 according to the tenth embodiment changes the start parameter and the end parameter on the basis of a second frequency that is the frequency of detection of a hand in the second cycle period in which the boost operation is controlled as the hand dryer waits for the hand detection. In the tenth embodiment, the second frequency is the number of times a hand is detected in a fourth determination period different from the second determination period in the third embodiment. Parts that are identical to those in the first to ninth embodiments are denoted by the same reference numerals as those in the first to ninth embodiments, whereby redundant description will be omitted.

[0145] The fourth determination period is a period preceding the start point of the unit time in the current cycle period. For example, the fourth determination period is 20 minutes before the start point of the unit time. In such an example, the length of the fourth determination period is the same as the length of the second determination period, but the setting of the start point and the end point of the fourth determination period differs from the setting of the second determination period. The fourth determination period is the period set by being shifted on a per unit-time basis in the second cycle period. A frequency Fp, which is the second frequency, represents the number of times a hand is detected in the second determination period. FIG. 23 illustrates "low", "medium", and "high" representing the frequency classifications. The frequency classifications in the tenth embodiment are similar to that of the third embodiment illustrated in FIG. 14.

[0146] A description will be made herein as to, mainly, a change in the value of the parameter β which is the end parameter, and a change in the value of the parameter α that is the start parameter will be described later. On the basis of the frequency Fp, the boost control unit 56 illustrated in FIG. 5 changes the parameter β determined from the actual data. In the tenth embodiment, the values of the parameters α and β determined from the actual data may be referred to as reference values. For example, the reference values are the values of the parameters α and β illustrated in FIG. 21. Note that the reference values may be the values of the parameters α and β illustrated in FIG. 12. The length of the fourth determination period can be set to any length.

[0147] FIG. 24 is a table illustrating an example of the actual data stored in the actual data storage unit 57 illustrated in FIG. 5 and an example of the frequency Fp. The frequency Fp illustrated in FIG. 24 is a parameter calculated in the process of arithmetic operation performed by the microcontroller 26 and is not stored in the storage unit 53.

[0148] A description will be made as to a change in the parameter β with reference to FIG. 24. The start point of the fourth determination period for the unit time of the data number "121" is the time 20 minutes before the start point of the unit time of the data number "121"; thus, this start point is the time that is the start point of the unit time of the data number "1". The end point of the fourth determination period for the unit time of the data number "121" is the time that is the end point of the unit time of the data number "120"; thus, this end point is the time that is the start point of the unit time of the data number "121". The frequency Fp is the number of the detected data "1" in 20 minutes from the start point to the end point of the fourth determination period. According to the example of FIG. 24, the frequency Fp for the unit time of the data number "121" is seven times.

[0149] In a case where the frequency classification determined from the actual data is "high" for the unit time of the data number "121", the boost control unit 56 determines, from the criteria illustrated in FIG. 23, that the parameter β of the data number "121" is 120 seconds. In this example, the boost control unit 56 changes the value of the parameter β from 180 seconds, which is the reference value, to 120 seconds. Because the frequency Fp in the current cycle period is lower than the standard frequency for the classification "high", the boost control unit 56 determines that the current frequency of use of the hand dryer 1 becomes lower than that provided by the actual data. As a result, the boost control unit 56 performs an adjustment for reducing the duration of the boost operation.

[0150] The fourth determination period for the data number "122" is moved down by one unit time, that is, 10 seconds, from the fourth determination period for the data number "121". The start point of the fourth determination period for the data number "182" is the time that is the start point of the unit time of the data number "122". The end point of the fourth determination period for the data number "182" is the time that is the end point of the unit time of the data number "181"; thus, this end point is the time that is the start point of the unit time of the data number "182".

[0151] As described above, the boost control unit 56 shifts the fourth determination period on a per data-number basis, which in turn determines the frequency Fp. By shifting the fourth determination period, the boost control unit 56 can reduce a deviation in the result of determination that can occur due to an uneven frequency of use within a certain period. The microcontroller 26 can thus determine the frequency of use of the hand dryer 1 with high accuracy.

[0152] Note that the data on whether a hand is detected during 20 minutes before the start point of the unit time is not collected for the unit times of the data numbers "1" to "120" before the start point of the unit time. The boost control unit 56 may keep the parameter β at the reference value for the unit times of the data numbers "1" to "120". Alternatively, for the unit times of the data numbers "1" to "120", the boost control unit 56 may change the parameter β, using data in the last 20 minutes of the cycle period immediately preceding the current cycle period.

[0153] The boost control unit 56 changes the parameter α as with the parameter β. The fourth determination period for the parameter α is shifted earlier in time than the fourth determination period for the parameter β. The fourth determination period for the parameter α may be a period from the time 25 minutes before the start point of the unit time to the time five minutes before the start point of the unit time. The end point of the fourth determination period for the parameter α may be set to the time earlier than the time that is the maximum value of the parameter α before the start point of the unit time.

[0154] Note that in the tenth embodiment, the hand dryer 1 may omit the determination of the frequency classifications "low", "medium", and "high" from the past actual data and determine the parameters α and β on the basis of the frequency of detection of a hand in the current cycle period.

[0155] The hand dryer 1 according to the tenth embodiment may stop the boost operation based on the actual data, on the basis of a result of detection of a hand in the current cycle period, as with the fourth embodiment. The hand dryer 1 according to the tenth embodiment may also store the actual data for a plurality of cycle periods as with the fifth embodiment. Moreover, as with the sixth embodiment, the hand dryer 1 according to the tenth embodiment may provide the cycle period that is the period from the time when the hand dryer 1 is powered on to the time when the hand dryer is powered off. The hand dryer 1 according to the tenth embodiment may also change the duration of the boost operation on the basis of the air temperature, as with the seventh embodiment. Furthermore, the hand dryer 1 according to the tenth embodiment may include the clock 70 as with the eighth embodiment.

[0156] According to the tenth embodiment, on the basis of the frequency of detection of a hand in the fourth determination period, the hand dryer 1 can change the parameters α and β obtained from the actual data. The hand dryer 1 can accurately determine the current frequency of use of the hand dryer 1 and can control the boost operation in correspondence to a change in the status of use.

[0157] The configuration illustrated in the above embodiments merely illustrates an example of the content of the present invention, and can thus be combined with another known technique or partially omitted and/or modified without departing from the scope of the present invention.

Reference Signs List

[0158] 1 hand dryer; 2 hand insertion portion; 3 housing; 4 front portion; 5 back portion; 6 water receiving portion; 7 drain tank; 10 blower; 11, 12 nozzle; 13, 14, 17 duct; 15 sensor; 16 air inlet; 18 air filter; 20 control section; 21 DC brushless motor; 22 turbofan; 23 commercial AC power supply; 24 power supply unit; 25 drive circuit; 26 microcontroller; 30 boost converter; 31 rectifier circuit; 32, 36 resistor voltage divider; 33 inductor; 34, 41 switching element; 35 fast recovery diode; 37 smoothing capacitor; 38 control power supply circuit; 39 resistor; 40 switching control IC; 42, 43 DC bus; 51 input unit; 52 control arithmetic unit; 53 storage unit; 54 storage processing unit; 55 timer; 56 boost control unit; 57 actual data storage unit; 58 parameter storage unit; 60 thermistor; 61 CPU; 62 ROM; 63 RAM; 64 EEPROM; 65 Input I/F; 70 clock.

Claims

1. A hand dryer comprising:

a housing including a hand insertion portion into which a hand is insertable;
an air blower to provide an airflow to jet into the hand insertion portion;
a hand sensor to detect a hand inserted in the hand insertion portion;
a power supply unit including a booster circuit to boost a DC voltage;
a drive circuit to receive power supply from the power supply unit and drive the air blower; and
a control processing unit to control an operation of the booster circuit on the basis of actual data representing an actual result of whether a hand is detected by the hand sensor.

2. The hand dryer according to claim 1, wherein on the basis of the actual data in a first cycle period, the control processing unit controls the operation of the booster circuit when the control processing unit waits for the detection by the hand sensor in a second cycle period following the first cycle period.

3. The hand dryer according to claim 1 or 2, wherein the actual data includes detected data and a data number, the detected data indicating whether a hand is detected in each unit time, the data number being a number representing an order of the unit time in a time series of the actual data.

4. The hand dryer according to claim 3, wherein on the basis of the data number of the detected data indicating that a hand was detected, the control processing unit determines a timing at which to start the operation of the booster circuit.

5. The hand dryer according to claim 4, wherein on the basis of the data number of the detected data indicating that a hand was detected, the control processing unit determines a timing at which to end the operation of the booster circuit.

6. The hand dryer according to claim 4 or 5, wherein the control processing unit obtains the timing at which to start the operation of the booster circuit, by using a parameter determined on the basis of a first frequency that is a frequency of the detected data indicating that a hand was detected.

7. The hand dryer according to claim 5 or 6, wherein the control processing unit obtains the timing at which to end the operation of the booster circuit, by using a parameter determined on the basis of the first frequency that is the frequency of the detected data indicating that a hand was detected.

8. The hand dryer according to claim 6 or 7, wherein the first frequency is the number of pieces of the detected data indicating that a hand was detected in a first determination period set by dividing the first cycle period of the actual data.

9. The hand dryer according to any one of claims 6 to 8, wherein the control processing unit changes the parameter on the basis of a second frequency that is a frequency of detection of a hand in the second cycle period in which the operation of the booster circuit is controlled as the control processing waits for the hand detection.

10. The hand dryer according to claim 9, wherein the second frequency is the number of times a hand is detected in a second determination period set by dividing the second cycle period.

11. The hand dryer according to claim 6 or 7, wherein the first frequency is the number of pieces of the detected data indicating that a hand was detected in a third determination period set by being shifted on a per data-number basis, the data number being the number representing the order of the unit time in a time series of the actual data.

12. The hand dryer according to claim 9, wherein the second frequency is the number of times a hand is detected in a fourth determination period set by being shifted on a per unit-time basis in the second cycle period.

13. The hand dryer according to any one of claims 1 to 12, wherein the control processing unit stops control of the operation of the booster circuit based on the actual data, on the basis of a result of detection of a hand in the second cycle period in which the operation of the booster circuit is controlled as the control processing unit waits for the hand detection.

14. The hand dryer according to any one of claims 1 to 13, wherein the control processing unit includes an actual data storage unit to store the actual data.

15. The hand dryer according to claim 14, wherein the actual data storage unit stores the actual data for a plurality of cycle periods.

16. The hand dryer according to any one of claims 1 to 15, wherein a cycle period in which the actual data is accumulated and a cycle period in which the operation of the booster circuit is controlled on the basis of the actual data are each a period from a time when the hand dryer is powered on to a time when the hand dryer is powered off.

17. The hand dryer according to any one of claims 1 to 16, wherein on the basis of air temperature, the control processing unit corrects the duration in which the booster circuit is operated.

18. The hand dryer according to any one of claims 1 to 17, further comprising a clock to provide time information to the control processing unit, wherein
the control processing unit controls the operation of the booster circuit, using the time information.

FIG.1

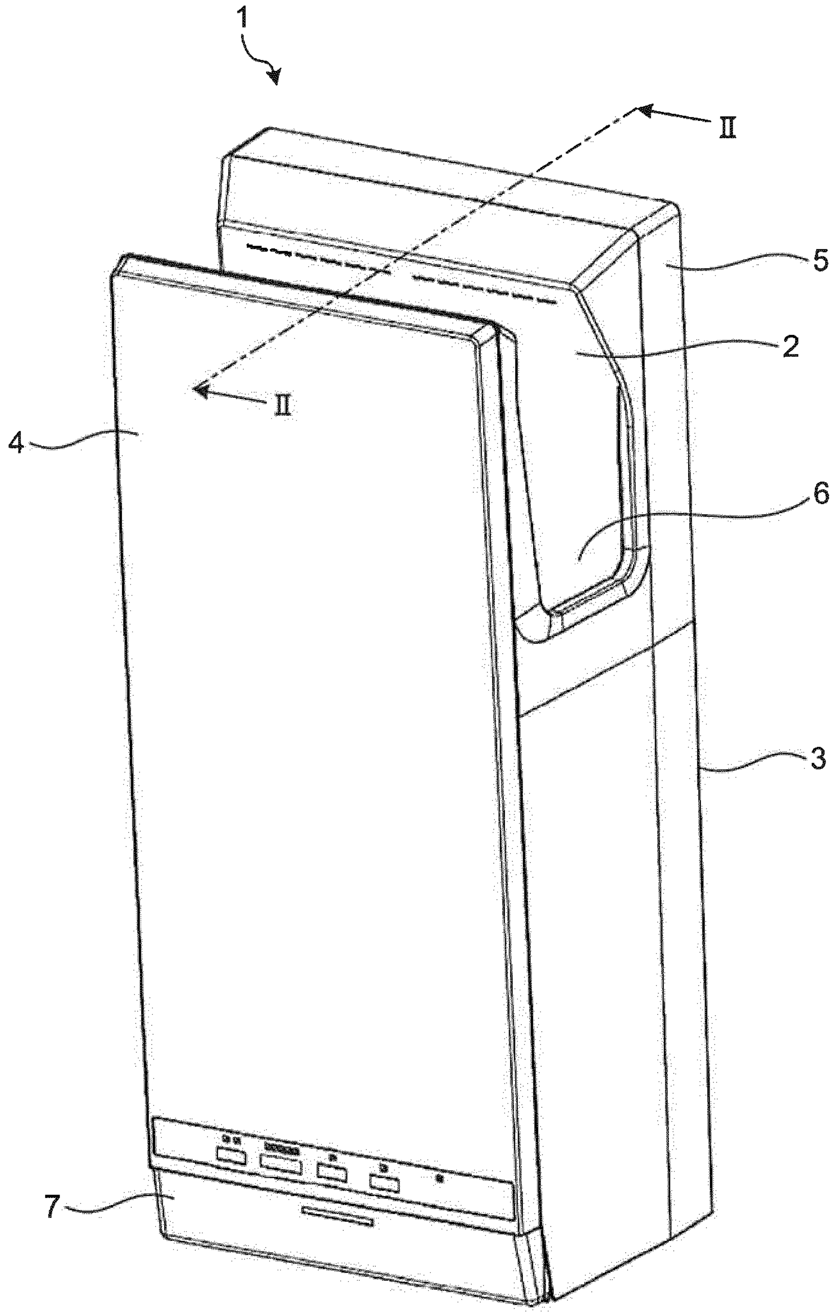


FIG.2

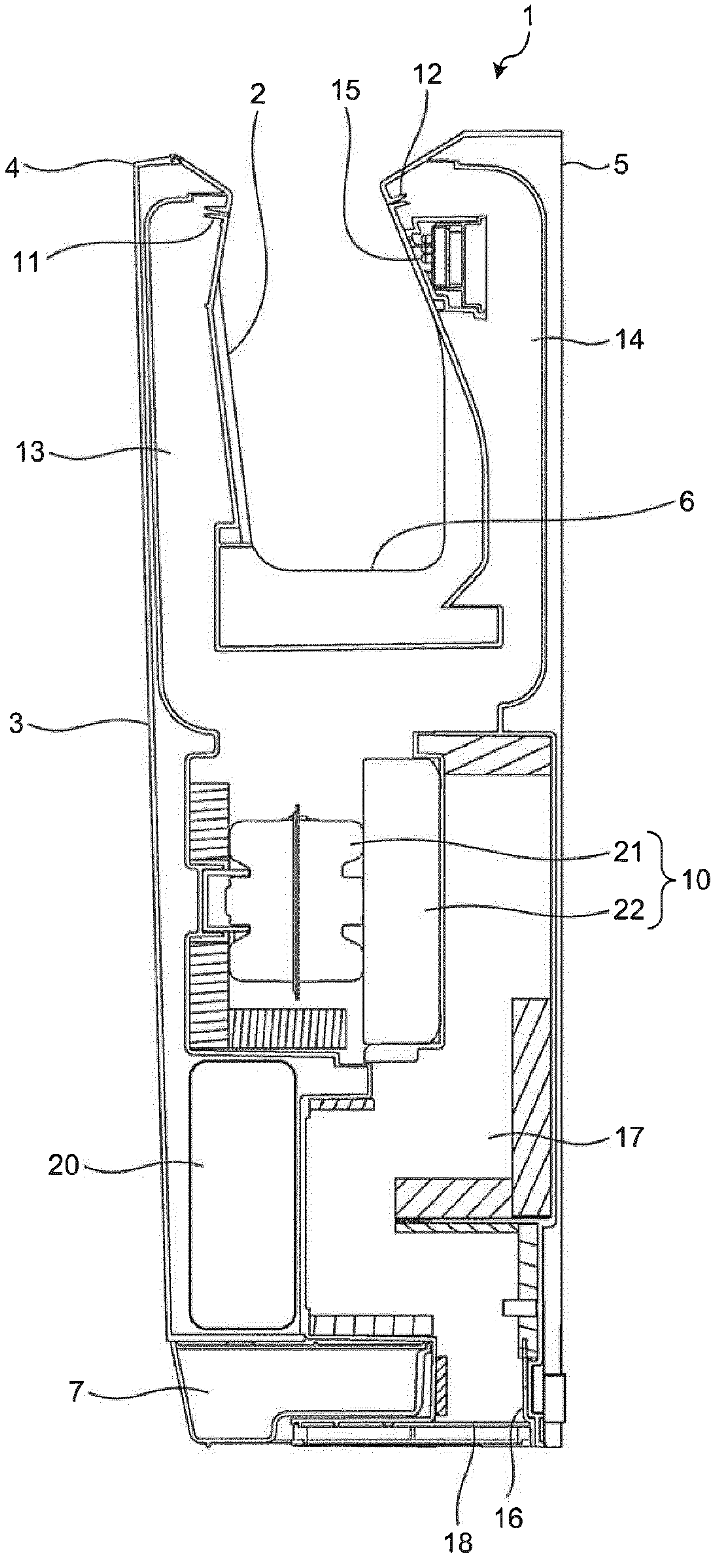


FIG.3

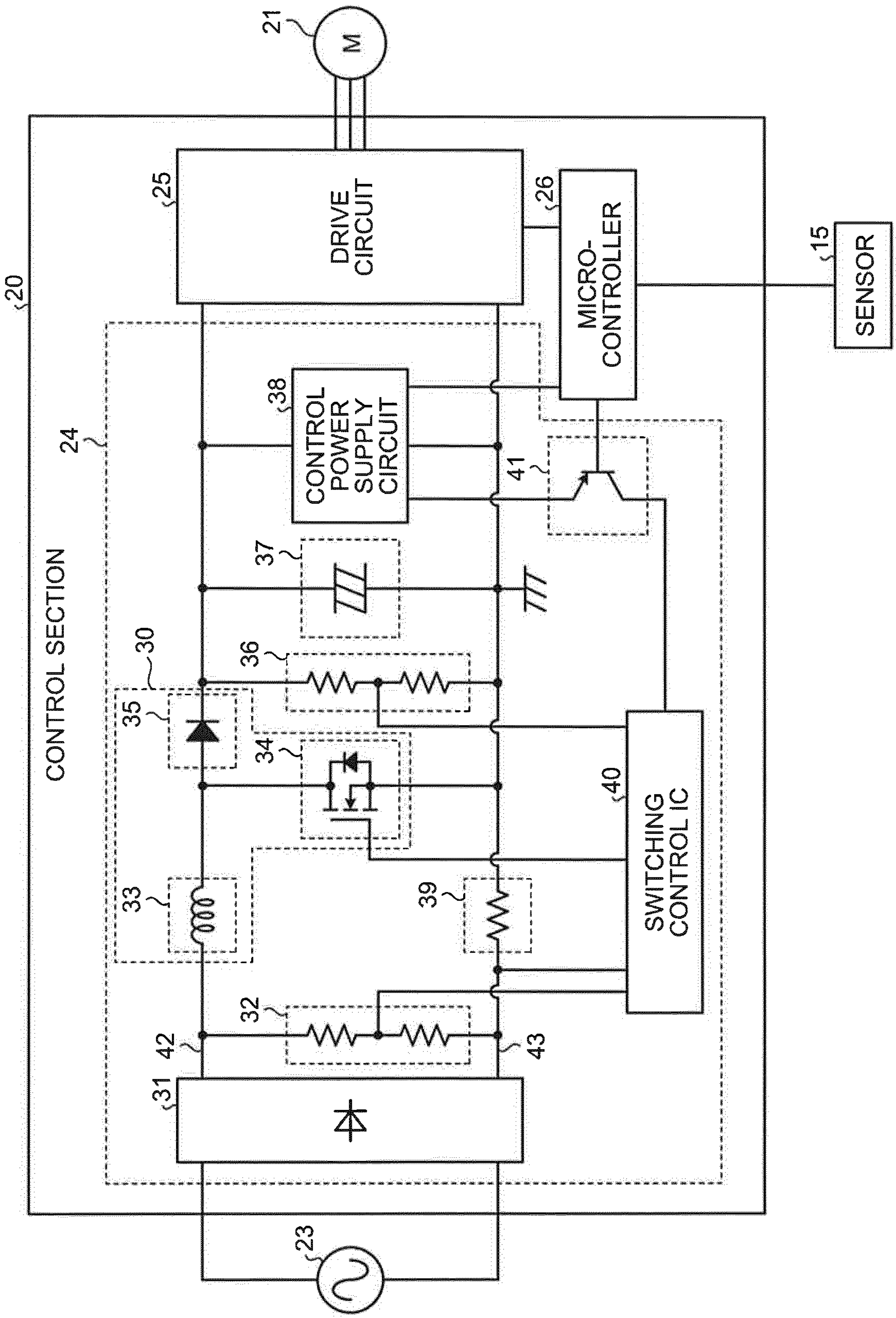

M
21
20
DRIVE CIRCUIT
25
MICRO-CONTROLLER
26
SENSOR
15
CONTROL SECTION
24
CONTROL POWER SUPPLY CIRCUIT
38
41
37
36
30
35
34
SWITCHING CONTROL IC
40
39
33
32
42
43
31
23

FIG.4

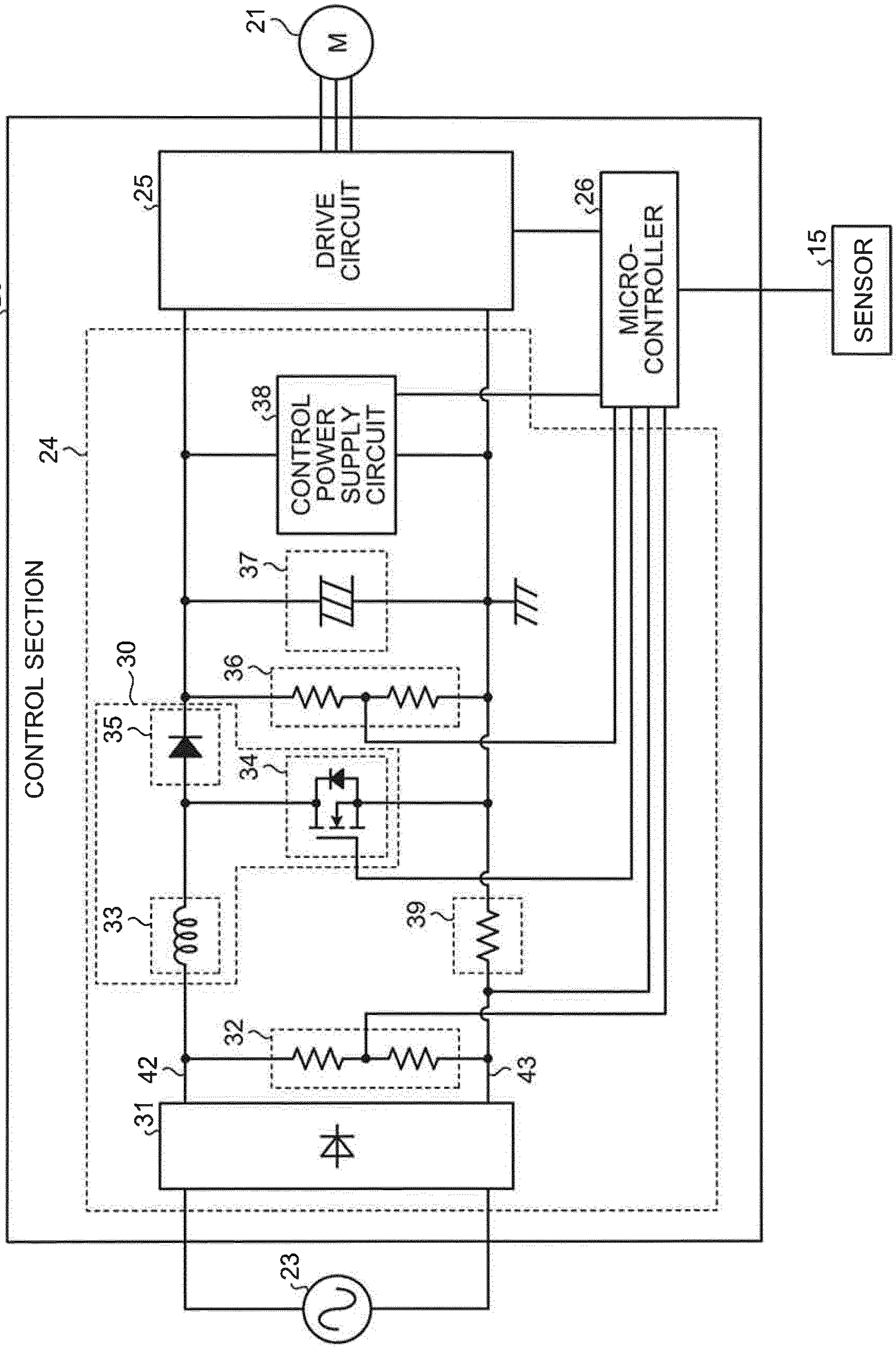

20
21
M
25
DRIVE CIRCUIT
26
MICRO-CONTROLLER
15
SENSOR
24
CONTROL SECTION
38
CONTROL POWER SUPPLY CIRCUIT
37
36
30
35
34
33
39
32
42
43
31
23

FIG.5

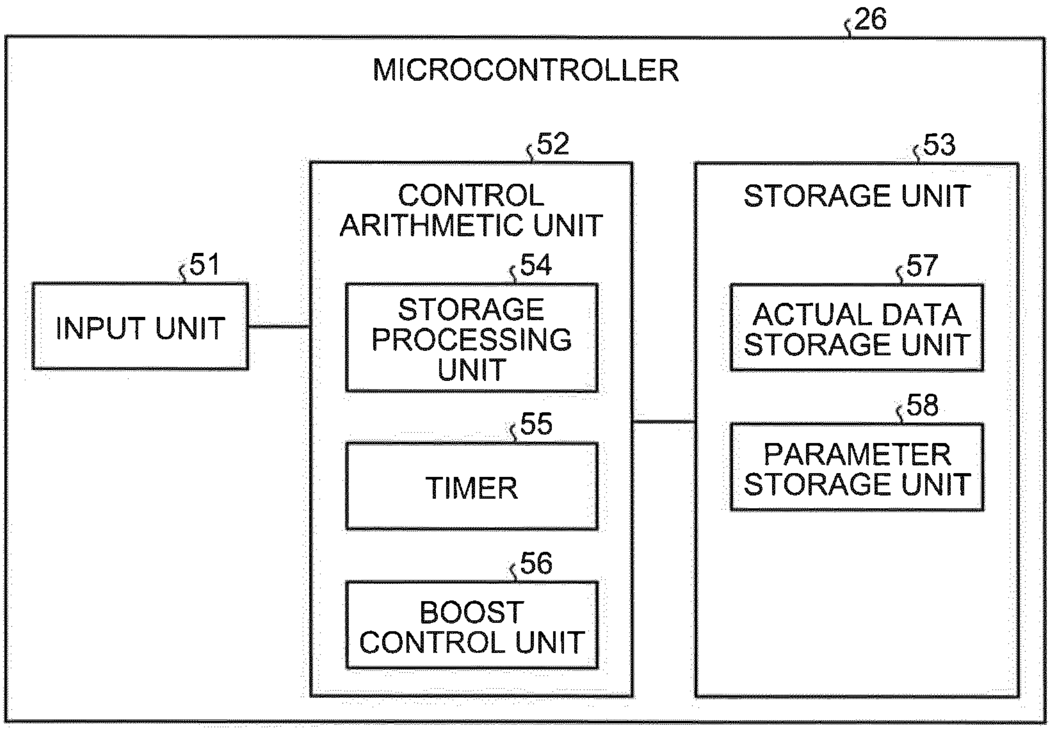

26
MICROCONTROLLER
52
CONTROL ARITHMETIC UNIT
53
STORAGE UNIT
51
INPUT UNIT
54
STORAGE PROCESSING UNIT
57
ACTUAL DATA STORAGE UNIT
55
TIMER
58
PARAMETER STORAGE UNIT
56
BOOST CONTROL UNIT

FIG.6

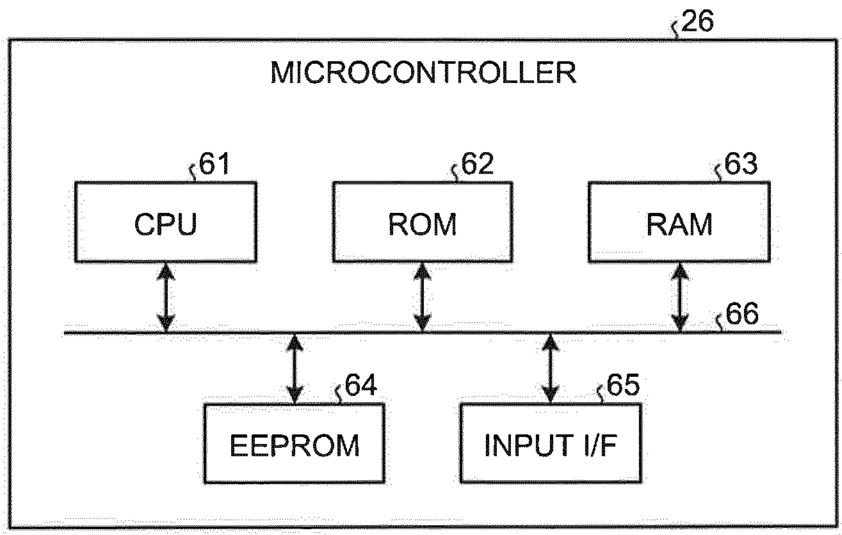

26
MICROCONTROLLER
61
CPU
62
ROM
63
RAM
66
64
EEPROM
65
INPUT I/F

FIG.7

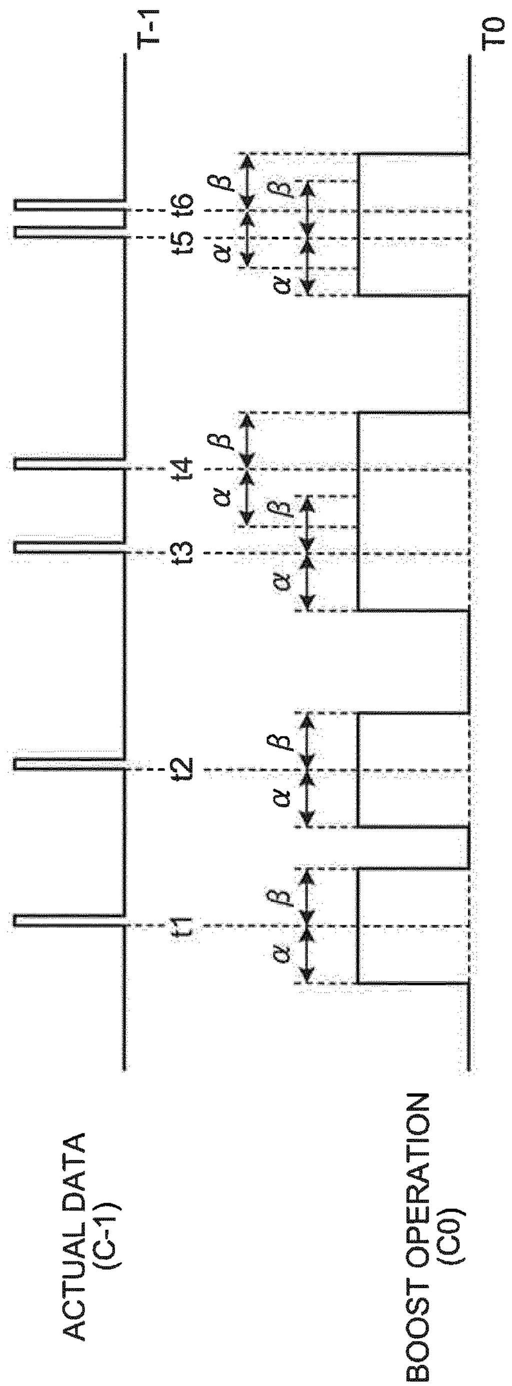


FIG.8

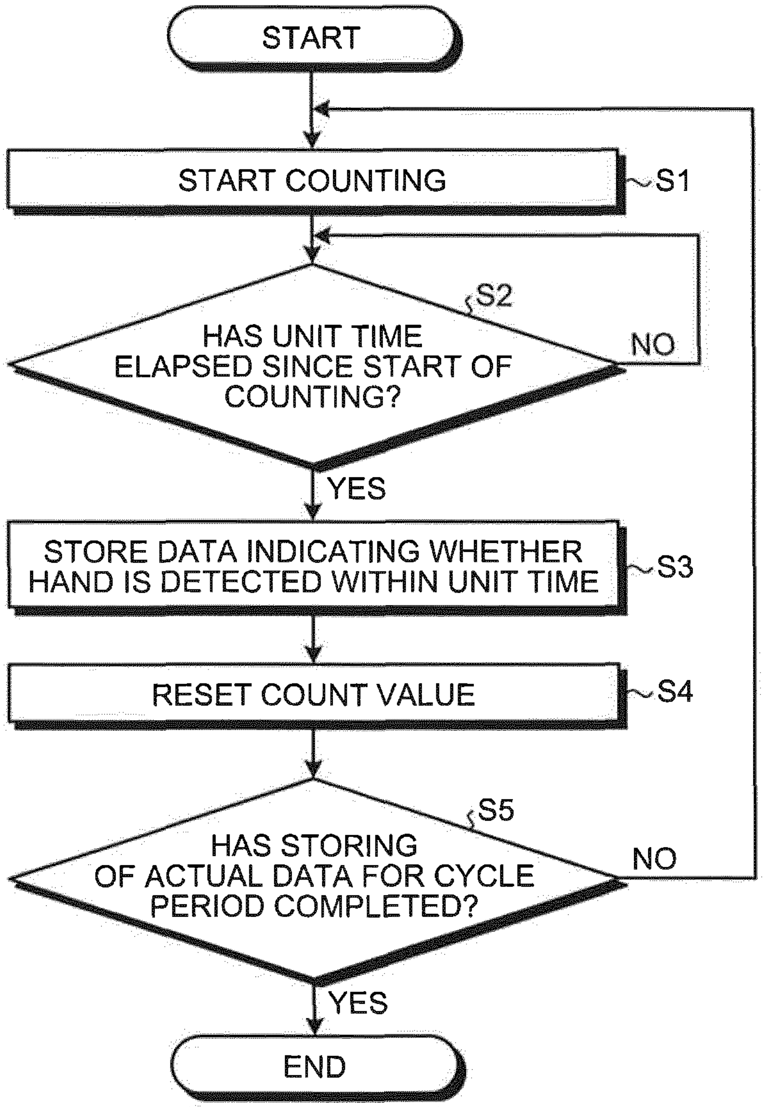

START
START COUNTING
S1
S2
HAS UNIT TIME ELAPSED SINCE START OF COUNTING?
NO
YES
STORE DATA INDICATING WHETHER HAND IS DETECTED WITHIN UNIT TIME
S3
RESET COUNT VALUE
S4
S5
HAS STORING OF ACTUAL DATA FOR CYCLE PERIOD COMPLETED?
NO
YES
END

FIG.9

DATA NUMBER (i)	DETECTED DATA	α (s)	β (s)	START POINT OF UNIT TIME T-1(i) (s)	START TIME OF BOOST OPERATION T0on(i) (s)	END TIME OF BOOST OPERATION T0off(i) (s)
1	0	120	120	0		
2	0			10		
3	0			20		
4	0			30		
5	1			40	40-α	40+β
···	···			···	···	···
119	1			1180	1180-α	1180+β
120	0			1190		
121	1			1200	1200-α	1200+β
122	1			1210	1210-α	1210+β
···	···			···	···	···
180	0			1790		
181	1			1800	1800-α	1800+β
182	1			1810	1810-α	1810+β
183	1			1820	1820-α	1820+β
184	0			1830		
185	0			1840		
186	0			1850		
187	0			1860		
···	···			···	···	···
8638	0			86370		
8639	0			86380		
8640	0			86390		

FIG.10

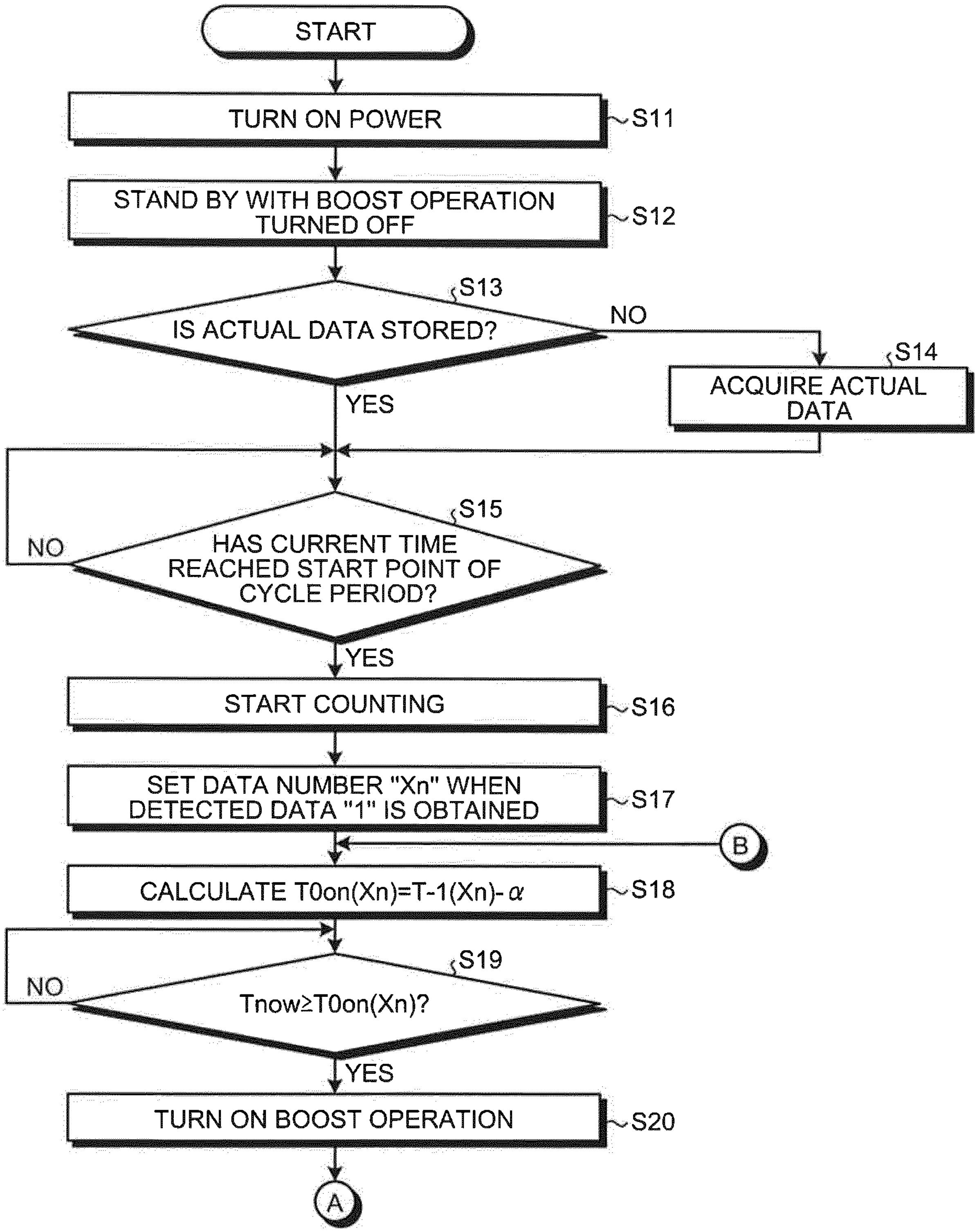

START
TURN ON POWER
S11
STAND BY WITH BOOST OPERATION TURNED OFF
S12
S13
IS ACTUAL DATA STORED?
NO
S14
ACQUIRE ACTUAL DATA
YES
S15
NO
HAS CURRENT TIME REACHED START POINT OF CYCLE PERIOD?
YES
START COUNTING
S16
SET DATA NUMBER "Xn" WHEN DETECTED DATA "1" IS OBTAINED
S17
B
CALCULATE T0on(Xn)=T-1(Xn)-α
S18
S19
NO
Tnow≥T0on(Xn)?
YES
TURN ON BOOST OPERATION
S20
A

FIG.11

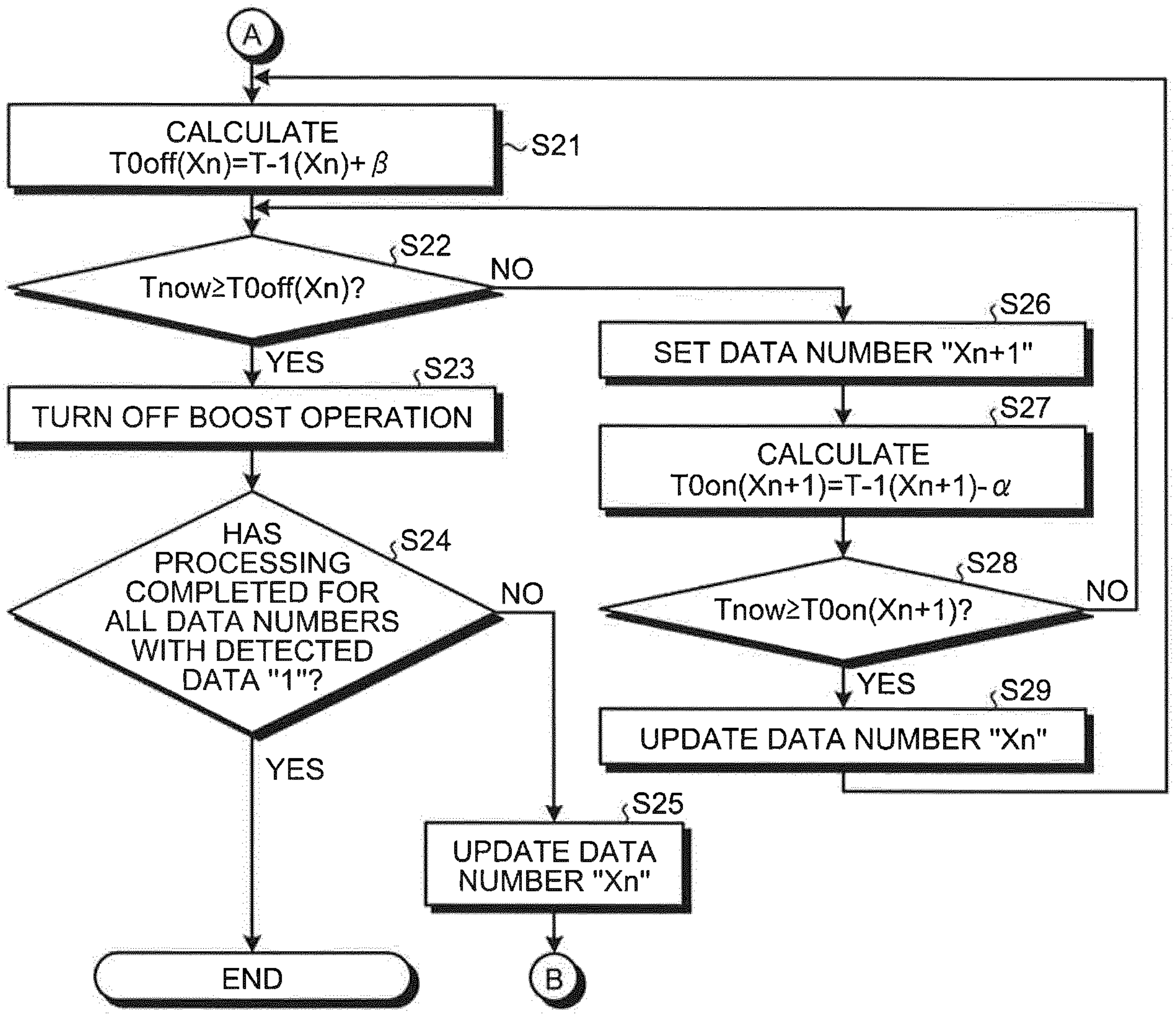


FIG.12

FREQUENCY CLASSIFICATION	FREQUENCY F (/Hr)	α (s)	β (s)
LOW	F≤9	60	60
MEDIUM	10≤F≤20	120	120
HIGH	21≤F	180	180

FIG.13

DATA NUMBER (i)	DETECTED DATA	α (s)	β (s)	FREQUENCY F (/Hr)
1	0	180	180	21
2	0			
3	0			
4	0			
5	1			
···	···			
179	0			
180	0			
181	1			
···	···			
359	1			
360	1			
361	1	60	60	7
···	···			
719	0			
720	0	120	120	19
721	0			
···	···			
1079	1			
1080	0			
1081	0	···	···	···
···	···	···	···	···
8638	0	120	120	15
8639	0			
8640	0			

FIG.14

FREQUENCY CLASSIFICATION	FREQUENCY F (/Hr)	α (s)	β (s)
LOW	Fn≤3	60	60
	4≤Fn	120	120
MEDIUM	Fn≤3	60	60
	4≤Fn≤7	120	120
	8≤Fn	180	180
HIGH	Fn≤7	120	120
	8≤Fn	180	180

FIG.15

DATA NUMBER (i)	DETECTED DATA	α (s)	β (s)	FREQUENCY Fn (/20min)
1	0	180	180	6
2	0			
3	0			
4	0			
5	1			
...	...			
119	0			
120	0			
121	1	120	120	
...	...			
179	1			
180	1			
181	1			
...	...			
358	0			
359	0			
360	0			
...	...	...	...	...
8638	0	...	...	...
8639	0			
8640	0			

FIG.16

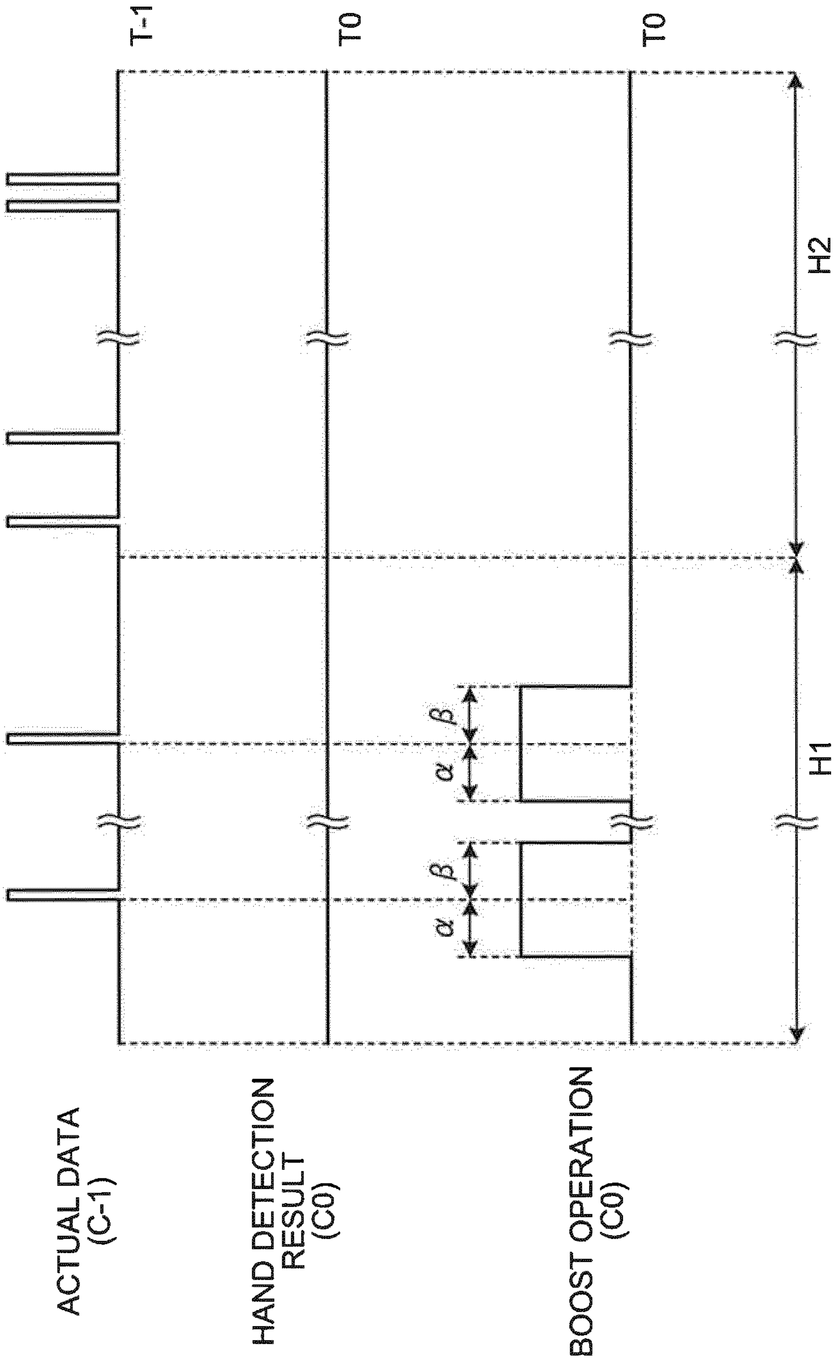

ACTUAL DATA (C-1)
HAND DETECTION RESULT (C0)
BOOST OPERATION (C0)
T-1
T0
T0
α
β
α
β
H1
H2

FIG.17

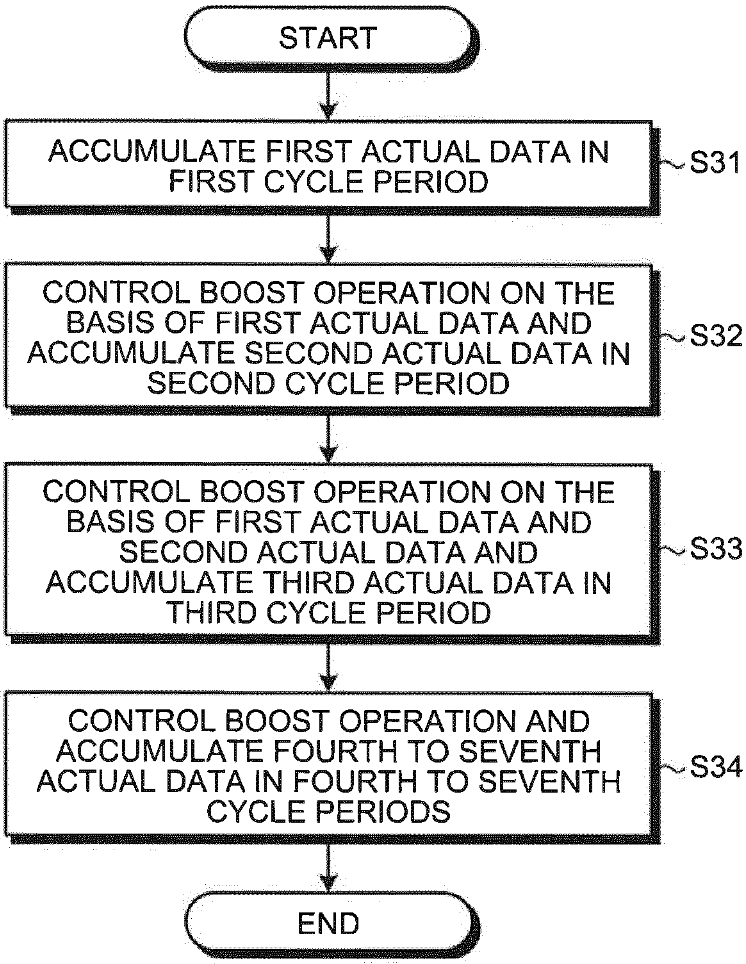

START
ACCUMULATE FIRST ACTUAL DATA IN FIRST CYCLE PERIOD
S31
CONTROL BOOST OPERATION ON THE BASIS OF FIRST ACTUAL DATA AND ACCUMULATE SECOND ACTUAL DATA IN SECOND CYCLE PERIOD
S32
CONTROL BOOST OPERATION ON THE BASIS OF FIRST ACTUAL DATA AND SECOND ACTUAL DATA AND ACCUMULATE THIRD ACTUAL DATA IN THIRD CYCLE PERIOD
S33
CONTROL BOOST OPERATION AND ACCUMULATE FOURTH TO SEVENTH ACTUAL DATA IN FOURTH TO SEVENTH CYCLE PERIODS
S34
END

FIG.18

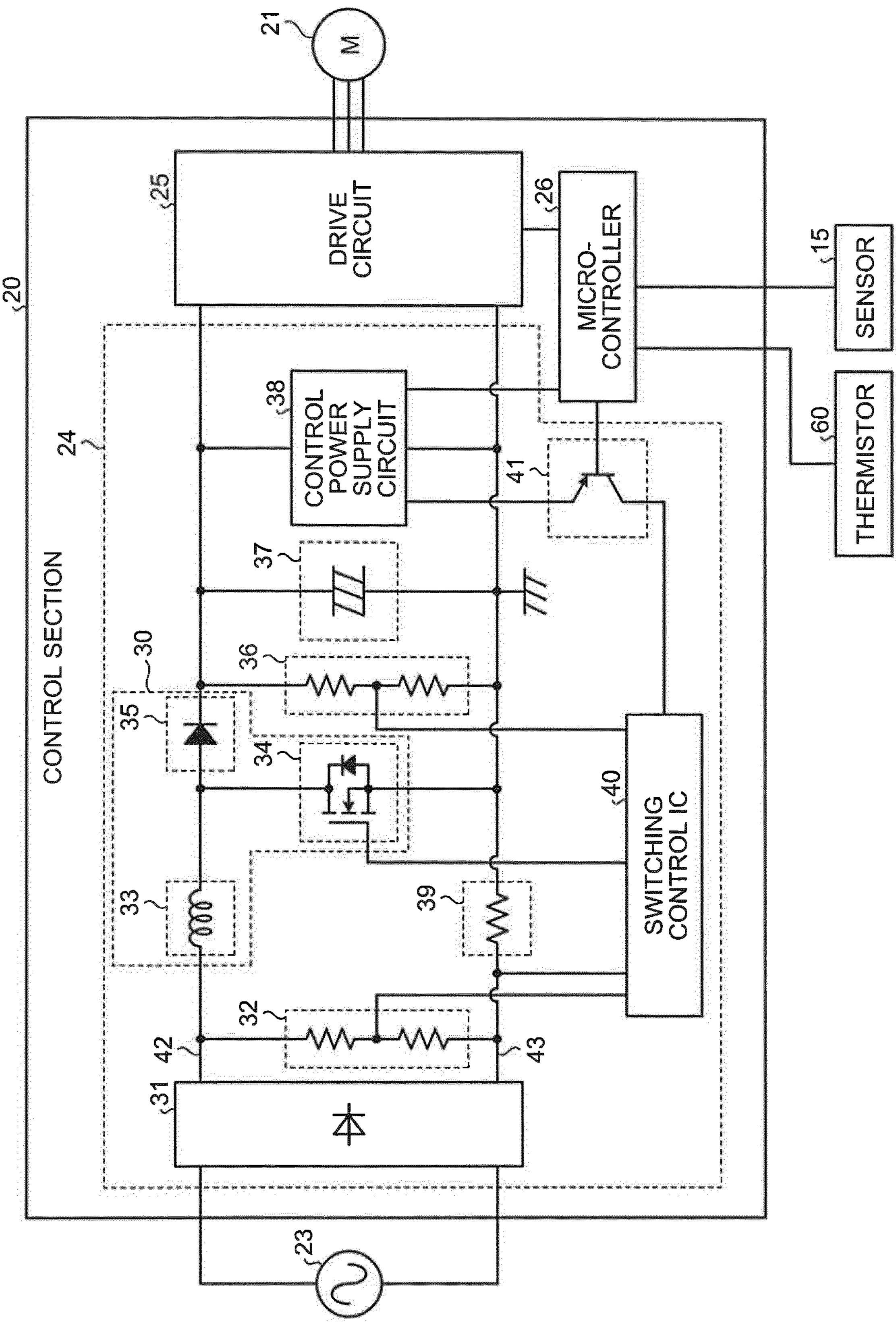

M
21
20
25
DRIVE CIRCUIT
26
MICRO-CONTROLLER
15
SENSOR
60
THERMISTOR
24
CONTROL SECTION
38
CONTROL POWER SUPPLY CIRCUIT
41
37
36
30
35
34
40
SWITCHING CONTROL IC
33
39
32
42
43
31
23

FIG.19

DATA NUMBER (i)	DETECTED DATA	TEMPERATURE (°C)	TEMPERATURE DIFFERENCE (°C)	β CORRECTION VALUE (s)
1	0	17		
2	0	17		
3	0	17		
4	0	17		
5	1	17	-3	+30
···	···	···	···	···
119	0	17		
120	0	17		
121	1	17	-2	+20
···	···	···	···	···
179	1	18	-1	+10
180	1	18	0	0
181	1	18	0	0
···	···	···	···	···
358	0	21		
359	1	21	2	-20
360	1	21	3	-30
···	···	···	···	···
8638	0	···	···	···
8639	0	···	···	···
8640	0	···	···	···

FIG.20

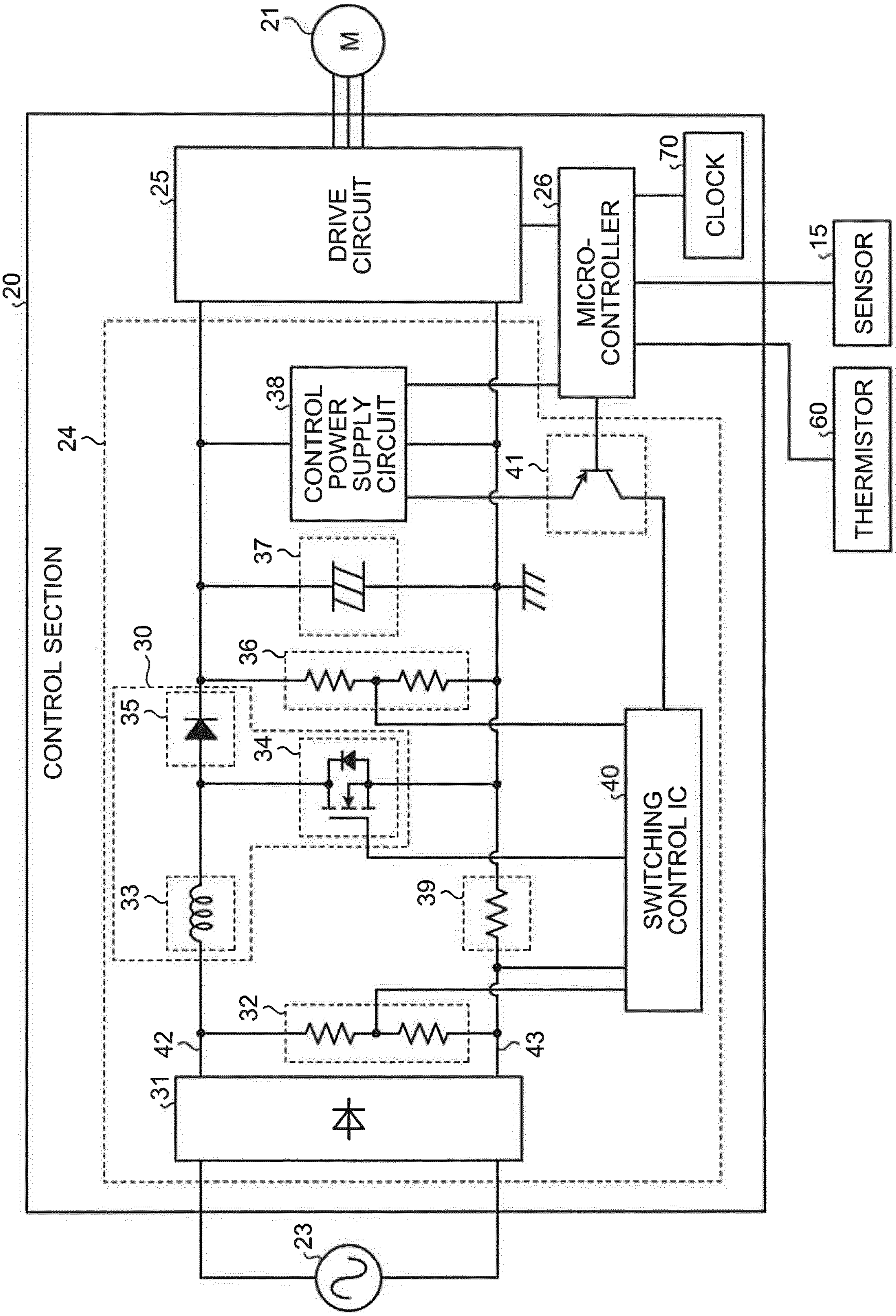

21
M
20
25
DRIVE CIRCUIT
26
MICRO-CONTROLLER
70
CLOCK
15
SENSOR
60
THERMISTOR
24
CONTROL SECTION
38
CONTROL POWER SUPPLY CIRCUIT
41
37
36
30
35
34
40
SWITCHING CONTROL IC
33
39
32
42
43
31
23

FIG.21

FREQUENCY CLASSIFICATION	FREQUENCY Fm (/Hr)	α (s)	β (s)
LOW	F≤9	60	60
MEDIUM	10≤F≤20	120	120
HIGH	21≤F	180	180

FIG.22

<table>
<tr><th rowspan="2">DATA NUMBER (i)</th><th rowspan="2">DETECTED DATA</th><th colspan="6">FREQUENCY Fm (/Hr)</th></tr>
<tr><th>...</th><th>i=181</th><th>i=182</th><th>...</th><th>i=360</th><th>...</th></tr>
<tr><td>1</td><td>0</td><td rowspan="22">...</td><td rowspan="13">21</td><td></td><td rowspan="22">...</td><td rowspan="8"></td><td rowspan="22">...</td></tr>
<tr><td>2</td><td>0</td><td rowspan="13">21</td></tr>
<tr><td>3</td><td>0</td></tr>
<tr><td>4</td><td>0</td></tr>
<tr><td>5</td><td>1</td></tr>
<tr><td>...</td><td>...</td></tr>
<tr><td>179</td><td>0</td></tr>
<tr><td>180</td><td>0</td></tr>
<tr><td>181</td><td>1</td><td rowspan="9">7</td></tr>
<tr><td>...</td><td>...</td></tr>
<tr><td>359</td><td>1</td></tr>
<tr><td>360</td><td>1</td></tr>
<tr><td>361</td><td>1</td><td rowspan="9"></td></tr>
<tr><td>...</td><td>...</td></tr>
<tr><td>539</td><td>0</td><td rowspan="8"></td></tr>
<tr><td>540</td><td>0</td></tr>
<tr><td>541</td><td>0</td><td rowspan="5"></td></tr>
<tr><td>...</td><td>...</td></tr>
<tr><td>...</td><td>...</td></tr>
<tr><td>8638</td><td>0</td></tr>
<tr><td>8639</td><td>0</td></tr>
<tr><td>8640</td><td>0</td></tr>
</table>

FIG.23

FREQUENCY CLASSIFICATION	FREQUENCY Fp (/20min)	α (s)	β (s)
LOW	Fp≤3	60	60
	4≤Fp	120	120
MEDIUM	Fp≤3	60	60
	4≤Fp≤7	120	120
	8≤Fp	180	180
HIGH	Fp≤7	120	120
	8≤Fp	180	180

FIG.24

<table>
<tr><th rowspan="2">DATA NUMBER (i)</th><th rowspan="2">DETECTED DATA</th><th colspan="7">FREQUENCY Fp (/Hr)</th></tr>
<tr><th>…</th><th>i=121</th><th>i=122</th><th>…</th><th>i=182</th><th>i=183</th><th>…</th></tr>
<tr><td>1</td><td>0</td><td rowspan="24">…</td><td rowspan="10">7</td><td></td><td rowspan="24">…</td><td rowspan="11"></td><td rowspan="12"></td><td rowspan="24">…</td></tr>
<tr><td>2</td><td>0</td><td rowspan="10">8</td></tr>
<tr><td>3</td><td>0</td></tr>
<tr><td>4</td><td>0</td></tr>
<tr><td>5</td><td>1</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>117</td><td>0</td></tr>
<tr><td>118</td><td>0</td></tr>
<tr><td>119</td><td>0</td></tr>
<tr><td>120</td><td>0</td></tr>
<tr><td>121</td><td>1</td><td rowspan="14"></td></tr>
<tr><td>122</td><td>1</td><td rowspan="13"></td><td rowspan="7">4</td></tr>
<tr><td>123</td><td>0</td><td rowspan="7">3</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>178</td><td>0</td></tr>
<tr><td>179</td><td>0</td></tr>
<tr><td>180</td><td>0</td></tr>
<tr><td>181</td><td>1</td></tr>
<tr><td>182</td><td>0</td><td rowspan="6"></td></tr>
<tr><td>183</td><td>0</td><td rowspan="5"></td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>8638</td><td>0</td></tr>
<tr><td>8639</td><td>0</td></tr>
<tr><td>8640</td><td>0</td></tr>
</table>

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/014702

A. CLASSIFICATION OF SUBJECT MATTER
A47K10/48(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)
A47K10/48

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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 A	JP 2011-38507 A (Mitsubishi Electric Corp.), 24 February 2011 (24.02.2011), paragraphs [0007], [0025], [0059], [0064], [0077] to [0083]; fig. 1, 4, 6 (Family: none)	1-5,13-18 6-12
Y	JP 2017-56031 A (Toto Ltd.), 23 March 2017 (23.03.2017), paragraphs [0144], [0155] (Family: none)	1-5,13-18
Y	JP 2003-171968 A (Toto Ltd.), 20 June 2003 (20.06.2003), claim 7; paragraphs [0040], [0043], [0064] (Family: none)	2-5,13-18

☒ 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
- "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
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 June 2017 (28.06.17)	11 July 2017 (11.07.17)

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

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/014702

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-11527 A (Toshiba Mitsubishi-Electric Industrial Systems Corp.), 12 January 2006 (12.01.2006), paragraph [0055]; fig. 14 (Family: none)	3-5,13-18
Y	JP 2003-301502 A (Toto Ltd.), 24 October 2003 (24.10.2003), paragraph [0095] (Family: none)	16-18
Y	JP 4-215729 A (Inax Corp.), 06 August 1992 (06.08.1992), paragraphs [0015], [0017]; fig. 1, 2 (Family: none)	17,18
Y	JP 2007-289387 A (Matsushita Electric Industrial Co., Ltd.), 08 November 2007 (08.11.2007), paragraphs [0053], [0055]; fig. 3 (Family: none)	17,18

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 5158101 B **[0006]**
- JP 2002177165 A **[0006]**