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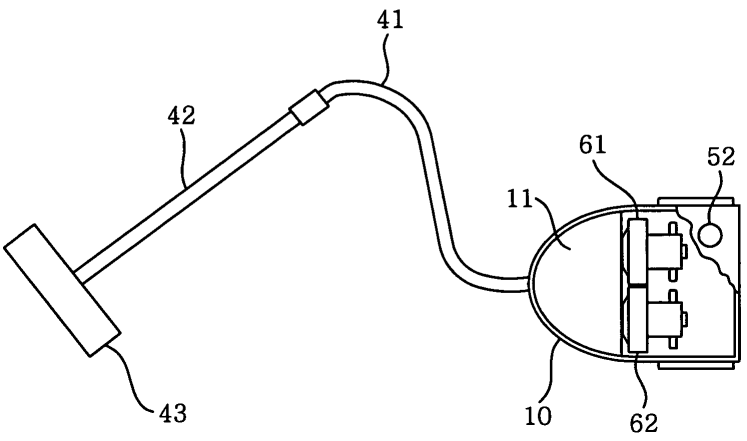
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(54) **Vacuum cleaner**

(57) A vacuum cleaner (10) includes a first (61) and a second (62) electric blower for generating a suction force, wherein a sum of maximum input levels or maximum power consumptions of the first and the second electric blower is set to be about 1600 W or greater. Further, respective suction inlets of the first and the second electric blower (61,62) are respectively communicated with a dust chamber (11) of a vacuum cleaner main body, and the first and the second electric blower are installed in parallel to each other in an air duct of the vacuum cleaner.

FIG. 1



EP 1 743 563 A2

Description

[0001] The present invention relates to a high-input vacuum cleaner featuring a high input (high maximum power consumption) required especially in Europe, Asia such as China, the Middle and Near East and so forth, and also capable of allowing a user to vary an input thereof depending on circumstances, thus providing a high usability.

[0002] A configuration of a conventional vacuum cleaner will be first explained with reference to Figs. 9 to 12.

[0003] As shown in Figs. 9 and 10, vacuum cleaner 30 includes volume or slide type input control unit 52 for adjusting an operation input as desired depending on circumstances; electric blower 1 for generating a suction force; main controller 37 for controlling an operational status of electric blower 1; and triac 36 for performing a phase control of electric blower 1. Electric blower 1 has a motor and a fan unit.

[0004] The configuration of vacuum cleaner 30 will be further explained using a circuit block diagram shown in Fig. 10. Electric blower 1 has two input terminals, one of which is connected to one side of commercial power supply via triac 36, while the other is connected to the other side of commercial power supply 55. Main controller 37 adjusts a conduction phase angle for turning on triac 37 for performing a phase control thereof according to a set value of input control unit 52, so that the electric power supplied to electric blower 1 is controlled at a desired power level.

[0005] Recently, there are demands for high-input vacuum cleaners in Asia such as China, the Middle and Near East and so forth, requiring electric blower 1 employed therein to be operable at a high-input level.

[0006] Furthermore, along with the demands for the high-input operation, there is also a demand for vacuum cleaner 30 capable of operating in a wide range of the input levels, not just limited to the maximum input level, because if it can be operated only at the maximum level, the usability thereof would become restricted. In another word, there is a functional demand for adjusting an operation input of the vacuum cleaner as desired by manipulating input control unit 52 for adjusting an input volume or the like depending on the circumstance under which the vacuuming is performed.

[0007] To control an input of conventional vacuum cleaner 30, a phase control of triac 36 is performed to control electric blower 1 as illustrated in Fig. 11A, during which a phase angle θ for turning on electric blower 1 is adjusted, whereby a power supplied to electric blower 1 is changed. Herein, when executing the input control through the conduction phase control, there are generated such as second, third, fourth and higher harmonics (harmonic currents) whose fundamental frequencies are identical to a frequency of a commercial power supply. Fig. 11B shows a relationship between a phase angle and a harmonic level generated in response thereto. In general, the harmonic level is highest at the phase angle of about 90°, and when the phase angle changes from 90° to 0° (or from 90° to 180°), the harmonic level decreases. Further, an electric blower whose maximum input level is high causes a relatively high harmonic level, whereas an electric blower whose maximum input level is low causes a relatively low harmonic level.

[0008] However, the harmonic level is governed by local regulations. Thus, if the harmonic level generated by a vacuum cleaner does not satisfy the regulations, it cannot be put on the local market as a product. Typically, as for a high-input electric blower whose maximum input is greater than about 1500 W when assembled to a vacuum cleaner, if the electric blower is operated within an operation range where its phase angle is close to 90° (i.e., within a range from X° to Y° shown in Fig. 11B), the harmonic level generated in response thereto would exceed a regulated level, although there may be some exceptions depending on the type of the electric blower. On the contrary, in case of a relatively low-input electric blower whose maximum input is less than a level ranging from about 1400 W to about 1500 W, the generated harmonic level do not exceed the regulated level at any value of the phase angle, so that an input control can be conducted within the entire range of the phase angle from 0 to 180° (see Fig. 11B).

[0009] As explained, if electric blower 1 is designed to be operated at a high-input for use in a high-input vacuum cleaner 30, the harmonic level increases, and it is strictly required to fall within the regulated level in the entire range of the input levels. Accordingly, in the conventional vacuum cleaner, the input level can be varied only within a range corresponding to the phase angles except for the range from X° to Y°, as shown in Figs. 12A and 12B.

[0010] For the reasons as mentioned above, it has been very difficult to realize a high-input vacuum cleaner whose maximum input is about 1600 W or more, capable of providing a wide range of the input levels.

[0011] Disclosed in, for example, Japanese Patent Laid-open Application No. S63-274396 (Reference 1) is a method for implementing a high-input vacuum cleaner capable of suppressing harmonic currents below a regulated level by employing an input control method of alternating a phase angle for controlling an electric blower between a small and a large value periodically. However, as a side effect of driving the electric blower through the control method described in Reference 1, vibrations and noises of the electric blower are increased, which, in turn, increases vibration of the main body of the vacuum cleaner, making it difficult for the user to use.

[0012] It is, therefore, an object of the present invention to provide a high-input vacuum cleaner whose maximum input is not smaller than about 1600 W as required in the market and whose input level can be adjusted as desired within the entire range smaller than or equal to the maximum input level.

[0013] To solve the problem described above, a vacuum cleaner in accordance with the present invention

includes a first and a second electric blower for generating a suction force, wherein a sum of maximum input levels or maximum power consumptions of the first and the second electric blower is set to be about 1600 W or greater.

[0014] With this configuration, a high input level of the vacuum cleaner is made to be available, and harmonic currents due to the phase control can be suppressed, thereby implementing a vacuum cleaner capable of an input control within an entire input level lower than or equal to a maximum input level.

[0015] In accordance with the present invention, there is provided a vacuum cleaner including a first and a second electric blower for generating a suction force, wherein a sum of maximum input levels or maximum power consumptions of the first and the second electric blower is set to be about 1600 W or greater. Thus, the vacuum cleaner is operable at a high input level higher than or equal to about 1600 W, and the input adjustment value covers an entire input range, thereby implementing a high suction performance of the vacuum cleaner.

[0016] Preferably, respective suction inlets of the first and the second electric blower are respectively communicated with a dust chamber of a vacuum cleaner main body, and the first and the second electric blower are installed in parallel to each other in an air duct of the vacuum cleaner. Thus, the vacuum cleaner is operable at a high input level higher than or equal to about 1600 W, and the input adjustment value covers an entire input range, thereby implementing a high suction performance of the vacuum cleaner.

[0017] Preferably, a suction inlet of the first electric blower is communicated with a dust chamber of a vacuum cleaner main body while a suction inlet of the second electric blower is communicated with an air exhaust side of the first electric blower, and the first and the second electric blower are installed in series in an air duct of the vacuum cleaner. Thus, the vacuum cleaner is operable at a high input level higher than or equal to about 1600 W, and the input adjustment value covers an entire input range, thereby implementing a high suction performance of the vacuum cleaner especially through a high vacuum level.

[0018] Preferably, the vacuum cleaner further includes a first controller for controlling the first electric blower; a second controller for controlling the second electric blower; an input setting unit; a commercial power supply; and a main control unit for controlling the first and the second controller in response to a signal from the input setting unit, wherein the first electric blower and the second electric blower are connected to the commercial power supply via the first controller and the second controller, respectively. Thus, the vacuum cleaner is operable at a high input level higher than or equal to about 1600 W, and the input adjustment value covers an entire input range, thereby implementing a high suction performance of the vacuum cleaner especially through a high vacuum level.

[0019] Preferably, an operation input is adjusted to a desired input level by means of an input setting unit in such a manner that the vacuum cleaner is operable at any input level ranging from the minimum input level to the maximum input level, wherein, if the operation input falls within a range from a minimum input level to about 1/2 of a maximum input level, $\theta 2$ is maintained at about 180° and the second electric power is not turned on whereas $\theta 1$ is controlled between about 180° to about 0° inclusive such that the vacuum cleaner is operated at the desired input level, and if the operation input falls with in a range from about 1/2 of the maximum input level to the maximum input level, $\theta 1$ is maintained at about 0° and the first electric blower is operated in a fully conducting state whereas $\theta 2$ is controlled between about 180° to about 0° inclusive such that the vacuum cleaner is operated at the desired input level, and wherein $\theta 1$ and $\theta 2$ designate phase angles for turning on the first and the second electric blower, respectively, and are controlled by the first and the second controller, respectively. Thus, the vacuum cleaner is operable at a high input level higher than or equal to about 1600 W, and the input adjustment value covers an entire input range, thereby implementing a high suction performance of the vacuum cleaner especially through a high vacuum level.

[0020] Preferably, an operation input is adjusted to a desired input level by means of an input setting unit in such a manner that the vacuum cleaner is operable at any input level ranging from the minimum input level to the maximum input level, wherein the first and the second electric blower are operated at respective phase angles of $\theta 1$ and $\theta 2$, and the main control unit controls the first and the second controller to obtain specific values of $\theta 1$ and $\theta 2$ at which a sum of power supply harmonics generated as a result of operating the first and the second electric blowers does not exceed a predetermined level, through which control mechanism, and wherein $\theta 1$ and $\theta 2$ designate phase angles for turning on the first and the second electric blower, respectively, and are controlled by the first and the second controller, respectively. Thus, the vacuum cleaner is operable at a high input level higher than or equal to about 1600 W, and the input adjustment value covers an entire input range, thereby implementing a high suction performance of the vacuum cleaner especially through a high vacuum level.

[0021] The above and other objects and features of the present invention will become apparent from the following description of preferred embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic view of a vacuum cleaner in accordance with a first preferred embodiment of the present invention;

Fig. 2 sets forth a circuit block diagram of the vacuum cleaner in accordance with the first preferred embodiment of the present invention;

Fig. 3A shows an input level as a function of an input adjustment value of the vacuum cleaner in accordance with the first embodiment of the present inven-

tion; Fig. 3B describes a phase angle for turning on a first electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the first embodiment of the present invention; and Fig. 3C depicts a phase angle for turning on a second electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the first embodiment of the present invention;

Fig. 4A shows an input level as a function of an input adjustment value of the vacuum cleaner in accordance with a second preferred embodiment of the present invention; Fig. 4B describes a phase angle for turning on a first electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the second embodiment of the present invention; and Fig. 4C depicts a phase angle for turning on a second electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the second embodiment of the present invention;

Fig. 5 presents a schematic view of a vacuum cleaner in accordance with a third preferred embodiment of the present invention;

Fig. 6 depicts a schematic view of a vacuum cleaner in accordance with a fourth preferred embodiment of the present invention;

Fig. 7 illustrates a circuit block diagram of the vacuum cleaner in accordance with the fourth preferred embodiment of the present invention;

Fig. 8A shows an input level as a function of an input adjustment value of the vacuum cleaner in accordance with a fourth preferred embodiment of the present invention; Fig. 8B describes a phase angle for turning on a first electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the fourth embodiment of the present invention; and Fig. 8C depicts a phase angle for turning on a second electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the fourth embodiment of the present invention;

Fig. 9 offers a schematic view of a conventional vacuum cleaner;

Fig. 10 provides a circuit block diagram of the conventional vacuum cleaner;

Fig. 11A is a graph showing a conduction region of a driving input voltage for driving an electric blower in the conventional vacuum cleaner; and Fig. 11B is a graph showing harmonic levels as a function of a phase angle; and

Fig. 12A shows an input level as a function of an input adjustment value of in the conventional vacuum cleaner; and Fig. 12B describes a phase angle for turning on an electric blower as a function of an input adjustment value in the conventional vacuum cleaner.

[0022] Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings. Here, it is to be noted that the present invention is not limited thereto.

(First preferred embodiment)

[0023] A first preferred embodiment of the present invention will be described in connection with Figs. 1 to 3C. In the description, parts identical to those of the conventional example as described above will be assigned same reference numerals, and their explanation will be omitted.

[0024] Fig. 1 is a schematic view of a vacuum cleaner in accordance with a first preferred embodiment of the present invention; Fig. 2 sets forth a circuit block diagram of the vacuum cleaner; Fig. 3A shows an input level as a function of an input adjustment value of the vacuum cleaner; Fig. 3B describes a phase angle for turning on a first electric blower as a function of the input adjustment value of the vacuum cleaner; and Fig. 3C depicts a phase angle for turning on a second electric blower as a function of the input adjustment value of the vacuum cleaner.

[0025] As shown in Fig. 1, vacuum cleaner 10 includes first electric blower 61 and second electric blower 62. The sum of maximum power consumptions of first and second electric blower 61 and 62 is equal to or greater than about 1600 W. That is, the maximum power consumption of vacuum cleaner is equal to or greater than about 1600 W. Suction inlets of electric blowers 61 and 62 are respectively communicated with dust chamber 11 of electric blower 30.

[0026] As shown in Fig. 2, first electric blower 61 and second electric blower 62 are phase-controlled by first controller 63 and second controller 64, respectively. First and second controllers performs a phase control by adjusting phase angles for turning on first electric blower 61 and second electric blower and 62, respectively, based on commands from main control unit 65 indicating conduction phase angles of the electric blowers, wherein the conduction phase angles are defined as phase angles for turning on the electric blowers. Main control unit 65 controls the operation of vacuum cleaner 10 in compliance with an input adjustment value set by a user manipulating input control unit 52.

[0027] Below, an operation of the vacuum cleaner configured as described above will be explained. A user would operate the vacuum cleaner by setting an input level of the vacuum cleaner within an operable input range from a minimum input level to a maximum input level. If the input set by the user is within a range less than or equal to 1/2 of the maximum input level, no power is supplied to second electric blower 62 (i.e., its conduction phase angle is set to be 180°), and first electric blower 61 is operated by setting its conduction phase angle such that the desired input level is obtained. Further, if the input set by the user is within a range greater than or equal to 1/2 of the maximum input level, first electric blower 61 is set to be in a fully conducting state (i.e., its conduction phase angle is set to be 0°), and second electric

blower 62 is operated by setting its conduction phase angle such that the desired input level is obtained. By this combination of operations, it is possible to operate the vacuum cleaner within the entire input range from the minimum input level to the maximum input level.

(Second preferred embodiment)

[0028] A second preferred embodiment of the present invention will be described with reference to Fig. 4. In the description, parts identical to those of the conventional example described above will be assigned same reference numerals, and explanation thereof will be omitted.

[0029] Fig. 4A shows an input level as a function of an input adjustment value of the vacuum cleaner in accordance with a second preferred embodiment of the present invention; Fig. 4B describes a phase angle for turning on a first electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the second embodiment of the present invention; and Fig. 4C depicts a phase angle for turning on a second electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the second embodiment of the present invention.

[0030] A user would operate the vacuum cleaner by setting an input for the vacuum cleaner within an operable input range from a minimum input level to a maximum input level. If the vacuum cleaner is operated, desired powers are supplied to both of first electric blower 61 and second electric blower 62. Let $\theta 1$ and $\theta 2$ respectively designate the conduction phase angles of first and second electric blower 61 and 62 that are respectively controlled by first controller 63 and second controller 64, and let X° and Y° designate specific phase angles satisfying the condition that the sum of the harmonics generated by the two electric blowers does not exceed a regulated level with a range from X° to Y°. The input adjustment value and the operational statuses of electric blowers 61 and 62 are controlled by a preset conduction pattern. One example of the conduction pattern is illustrated in Figs. 4A to 4C.

[0031] Here, the operation of the first preferred embodiment will be explained. The range from the minimum input level to the maximum input level is first divided into six input regions: a first region including the minimum input level to a sixth region including the maximum input level. In the first region, both of the electric blowers are powered on even at a minimum input level. Both $\theta 1$ and $\theta 2$ decrease as an input adjustment value increases, and the first region ends when $\theta 1$ and $\theta 2$ reach about 1/2 of X°. At a start of the second region, $\theta 1$ returns to 180°, and $\theta 2$ is set to be X°. Then, with an increase of the input adjustment value, θ 1 gradually decreases starting from 180° while θ 2 remaining constant, and the second region ends when θ 1 reaches X°. At a start of the third region, $\theta 1$ returns to 180° and $\theta 2$ is set to be Y°. With an increase of the input adjustment value, $\theta 1$ gradually decreases starting from 180° while $\theta 2$ remaining constant, and the third region ends when $\theta 1$ reaches X° again as in the second region. At a start of the fourth region, $\theta 1$ returns to 180°, and $\theta 2$ is set to be 0°. With an increase of the input adjustment value, $\theta 1$ gradually decreases starting from 180° while $\theta 2$ remaining constant, and the fourth region ends when $\theta 1$ reaches X° again, as in the second region. At a start of the fifth region, both $\theta 1$ and $\theta 2$ are set to be Y°. With an increase of the input adjustment value, θ 1 gradually decreases starting from Y° while $\theta 2$ remaining constant, and the fifth region ends when $\theta 1$ reaches 0°. At a start of the sixth region, $\theta 1$ returns to Y° and $\theta 2$ is set to be 0°. With an increase of the input adjustment value, θ 1 decreases starting from Y° while $\theta 2$ remaining constant, and the sixth region ends when $\theta 1$ reaches 0° again as in the fifth region. By setting the conduction states described above in response to the input adjustment value, vacuum cleaner 10 is operated such that its input is gradually varied within a range from the minimum input level to the maximum input level.

[0032] Herein, it is to be noted that the above-described conduction pattern is just an example and the same effect can be obtained by employing another type of conduction pattern.

(Third preferred embodiment)

[0033] A third preferred embodiment of the present invention will be described in conjunction with Fig. 5. Parts identical to those of the conventional example will be assigned same reference numerals, and their description will be omitted.

[0034] As shown in Fig. 5, vacuum cleaner 10' includes first electric blower 61 and second electric blower 62. The suction inlet of first electric blower 61 is communicated with dust chamber 11 of vacuum cleaner 10', and second electric blower 62 is disposed downstream of first electric blower 61. First and second electric blower 61 and 62 are controlled by the same control mechanism as described in the first or the second preferred embodiment.

[0035] By arranging the two electric blowers of the vacuum cleaner in series as described above, the vacuum pressure of the vacuum cleaner can be increased. Thus, in accordance with the present invention, a high-input vacuum cleaner featuring a high-dust collecting capacity can be provided.

(Fourth preferred embodiment)

[0036] A fourth preferred embodiment of the present invention will be descried with reference to Figs. 6 to 8. Parts identical to those of the conventional example will be assigned same reference numerals, and their description will be omitted.

[0037] Fig. 6 depicts a schematic view of a vacuum cleaner in accordance with a fourth preferred embodiment of the present invention; Fig. 7 illustrates a circuit block diagram of the vacuum cleaner in accordance with

the fourth preferred embodiment of the present invention; Fig. 8A shows an input level as a function of an input adjustment value of the vacuum cleaner in accordance with a fourth preferred embodiment of the present invention; Fig. 8B describes a phase angle for turning on a first electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the fourth embodiment of the present invention; and Fig. 8C depicts a phase angle for turning on a second electric blower as a function of the input adjustment value of the vacuum cleaner in accordance with the fourth embodiment of the present invention

[0038] As shown in Fig. 6, vacuum cleaner 10'' includes: dust chamber 11; electric blower 71 installed to communicate with dust chamber; hose 41 connected to dust chamber 11; extension line 42; and bottom nozzle 48. Bottom nozzle 48 has: rotation brush 44 for scraping up dusts on a floor to thereby facilitate dust collection; and driving unit 72 for driving rotation brush 44. An output side of driving unit 72 and rotation brush 44 are connected with each other via belt 45 serving as a motive power transfer means. The maximum power consumption of electric blower 71 is equal to or greater than about 1500 W, and the maximum power consumption of driving unit 72 is equal to or greater than about 100 W, making the maximum power consumption of vacuum cleaner 10'' to be about 1600 W or greater.

[0039] As illustrated in Fig. 7, electric blower 71 is phase-controlled by first controller 73, while driving unit 72 is phase-controlled by second controller 74. First and second controller 73 and 74 execute the phase controls of electric blower 71 and driving unit 72 in response to commands from main control unit 75 indicating conduction phase angles of electric blower 71 and driving unit 72, respectively. Main control unit 75 controls the operation of vacuum cleaner 10'' in compliance with an input adjustment value set by a user by means of input control unit 52.

[0040] Now, an operation of vacuum cleaner 10'' having the above configuration will be explained. A user would operate the vacuum cleaner by setting an input within an operable input range from a minimum input level to a maximum input level. In an operation at the minimum input level, a conduction phase angle $\theta 3$ of electric blower 71 controlled by first controller 73 gradually decreases starting from 180°. Further, a conduction phase angle $\theta 4$ of driving unit 72 controlled by second controller 74 is maintained at Z° that is lower than a phase angle for a fully conducting state (i.e., 180° in this case). With an increase of an input adjustment value of vacuum cleaner 10'', $\theta 3$ gradually decreases to reach a phase angle X° at which the power supply harmonic level exceeds a regulated level, and $\theta 4$ remains constant. If the input adjustment value of vacuum cleaner 10'' is further increased, $\theta 3$ is maintained at X°, and $\theta 4$ is decreased from Z° to 0° in response to the input adjustment value. If the input adjustment value of vacuum cleaner 10'' is further increased after $\theta 3$ reaches 0°, $\theta 3$ is set to be Y°, and $\theta 4$ is maintained at 0°. If the input adjustment value of vacuum cleaner 10'' is further increased after that, $\theta 3$ is gradually decreased from Y° to 0°.

[0041] Through the control method as described above, the vacuum cleaner can be operated within the entire input range from the minimum input level to the maximum input level.

[0042] Further, it is to be noted that the above-described conduction pattern is just an example and the same effect can be obtained by employing another type of conduction pattern.

[0043] The vacuum cleaner in accordance with the present invention as described above is a high-input vacuum cleaner operable within a wide operation input range lower than or equal to a maximum input level. Thus, the usability of the vacuum cleaner can be improved.

[0044] As described above, the vacuum cleaner in accordance with the present invention is operable at a high input level, and further, at any input level within an entire input range from a minimum input level to a maximum input level, so that it can meet local regulations while allowing a high power consumption and a variable input level, thereby improving the usability.

[0045] While the invention has been shown and described with respect to the preferred embodiments, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.

Claims

1. A vacuum cleaner comprising:

   a first and a second electric blower for generating a suction force,
   wherein a sum of maximum input levels or maximum power consumptions of the first and the second electric blower is set to be about 1600 W or greater.

2. The vacuum cleaner of claim 1, wherein respective suction inlets of the first and the second electric blower are respectively communicated with a dust chamber of a vacuum cleaner main body, and the first and the second electric blower are installed in parallel to each other in an air duct of the vacuum cleaner.

3. The vacuum cleaner of claim 1, wherein a suction inlet of the first electric blower is communicated with a dust chamber of a vacuum cleaner main body while a suction inlet of the second electric blower is communicated with an air exhaust side of the first electric blower, and the first and the second electric blower are installed in series in an air duct of the vacuum cleaner.

4. The vacuum cleaner of any one of claims 1 to 3, further comprising:

a first controller for controlling the first electric blower;
a second controller for controlling the second electric blower;
an input setting unit;
a commercial power supply; and
a main control unit for controlling the first and the second controller in response to a signal from the input setting unit,
wherein the first electric blower and the second electric blower are connected to the commercial power supply via the first controller and the second controller, respectively.

5. The vacuum cleaner of claim 4, wherein an operation input is adjusted to a desired input level by means of an input setting unit in such a manner that the vacuum cleaner is operable at any input level ranging from the minimum input level to the maximum input level,
wherein, if the operation input falls within a range from a minimum input level to about 1/2 of a maximum input level, θ 2 is maintained at about 180° and the second electric power is not turned on whereas θ1 is controlled between about 180° to about 0° inclusive such that the vacuum cleaner is operated at the desired input level, and if the operation input falls with in a range from about 1/2 of the maximum input level to the maximum input level, θ1 is maintained at about 0° and the first electric blower is operated in a fully conducting state whereas θ2 is controlled between about 180° to about 0° inclusive such that the vacuum cleaner is operated at the desired input level, and
wherein θ1 and θ2 designate phase angles for turning on the first and the second electric blower, respectively, and are controlled by the first and the second controller, respectively.

6. The vacuum cleaner of claim 4, wherein an operation input is adjusted to a desired input level by means of an input setting unit in such a manner that the vacuum cleaner is operable at any input level ranging from the minimum input level to the maximum input level,
wherein the first and the second electric blower are operated at respective phase angles of θ1 and θ2, and the main control unit controls the first and the second controller to obtain specific values of θ1 and θ2 at which a sum of power supply harmonics generated as a result of operating the first and the second electric blowers does not exceed a predetermined level, through which control mechanism, and wherein θ1 and θ2 designate phase angles for turning on the first and the second electric blower, respectively, and are controlled by the first and the second controller, respectively.

FIG. 1

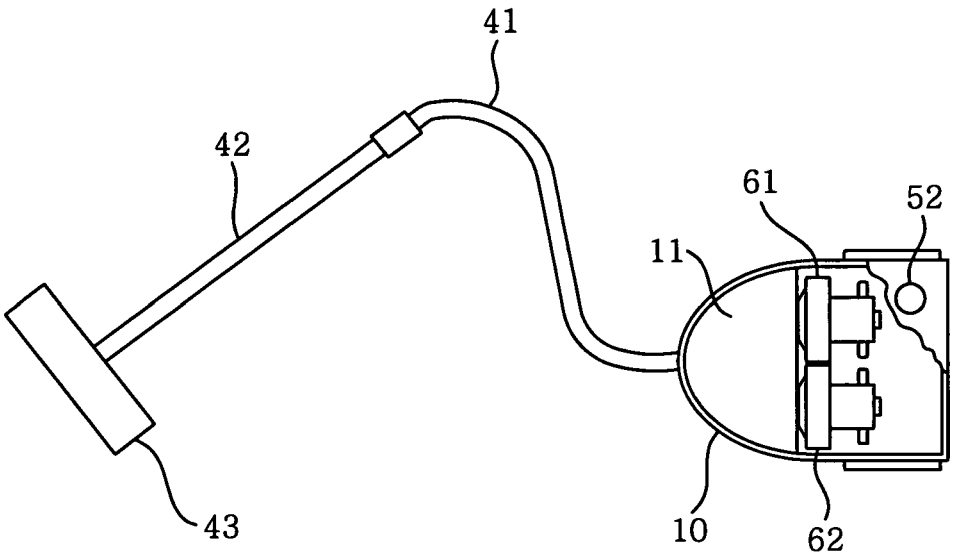


FIG.2

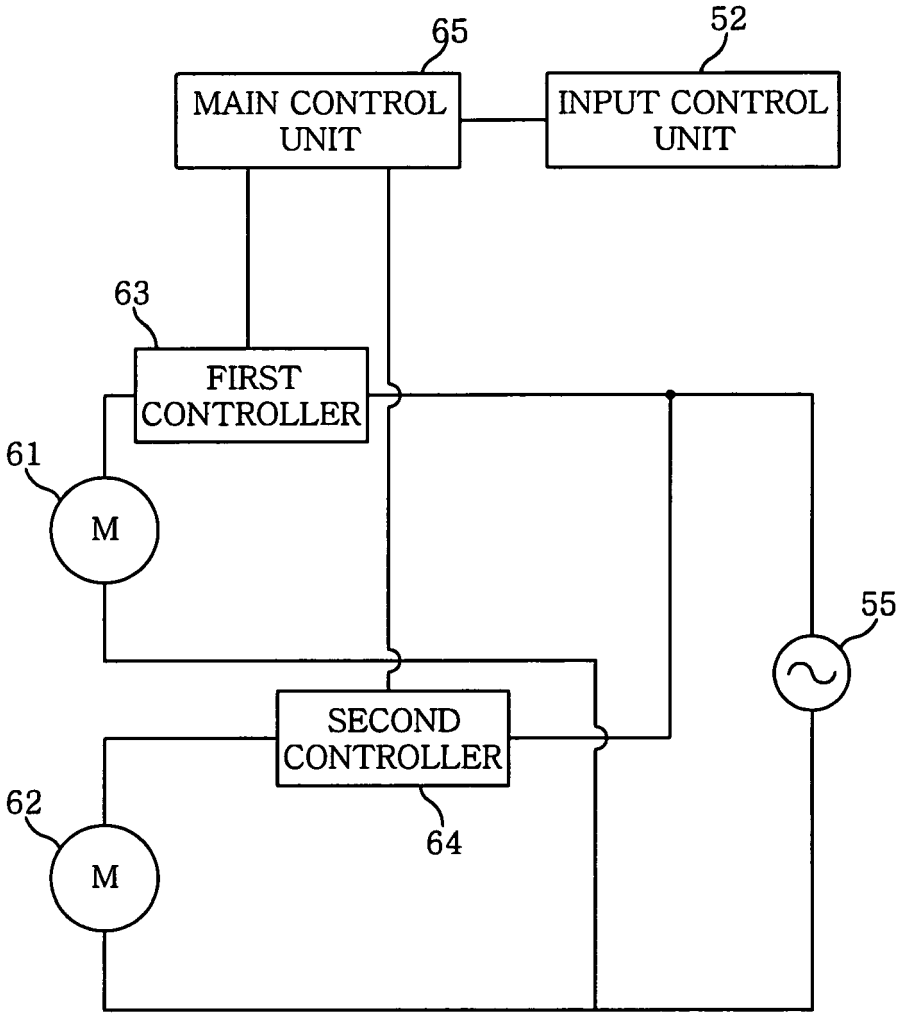

65
52
MAIN CONTROL UNIT
INPUT CONTROL UNIT
63
FIRST CONTROLLER
61
M
55
SECOND CONTROLLER
64
62
M

FIG.3A

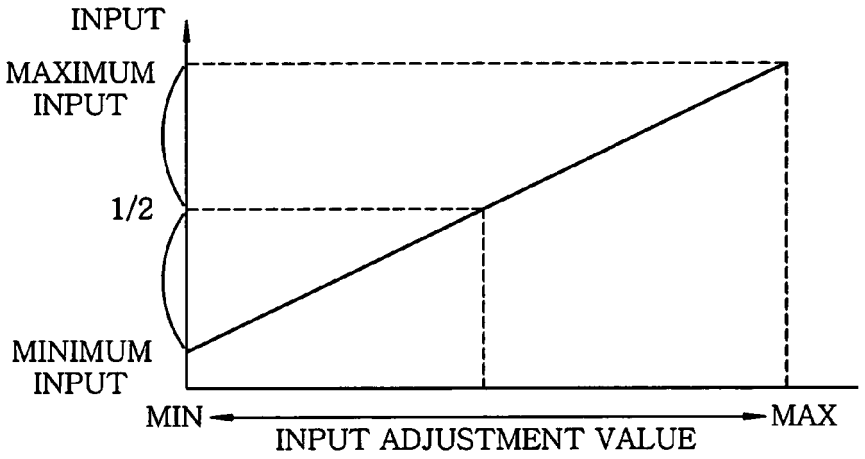


FIG.3B

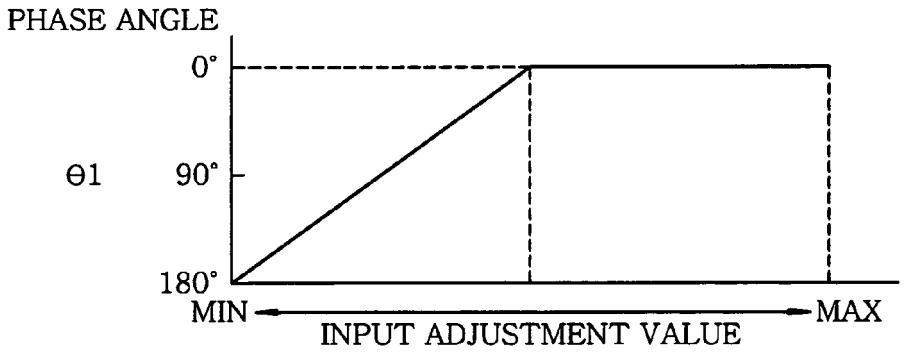


FIG.3C

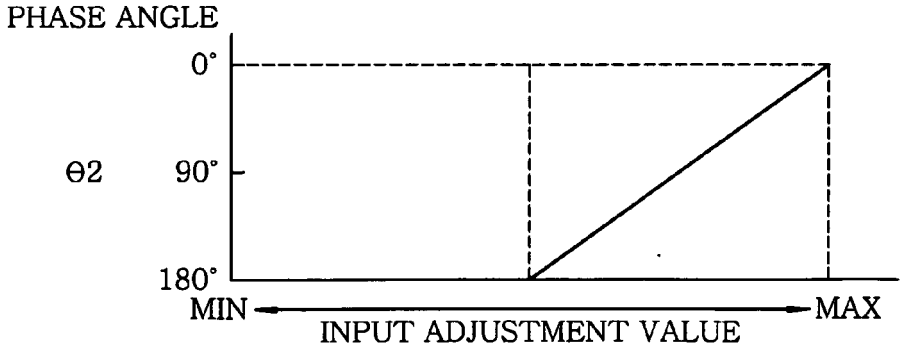


FIG. 4A

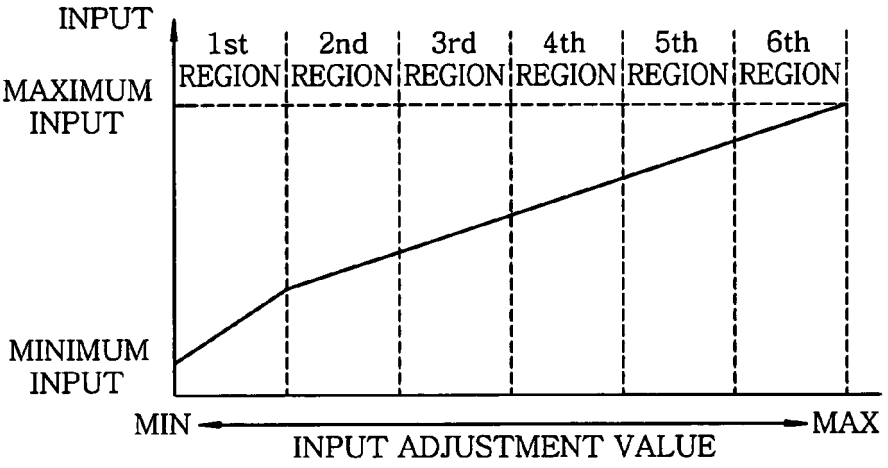


FIG. 4B

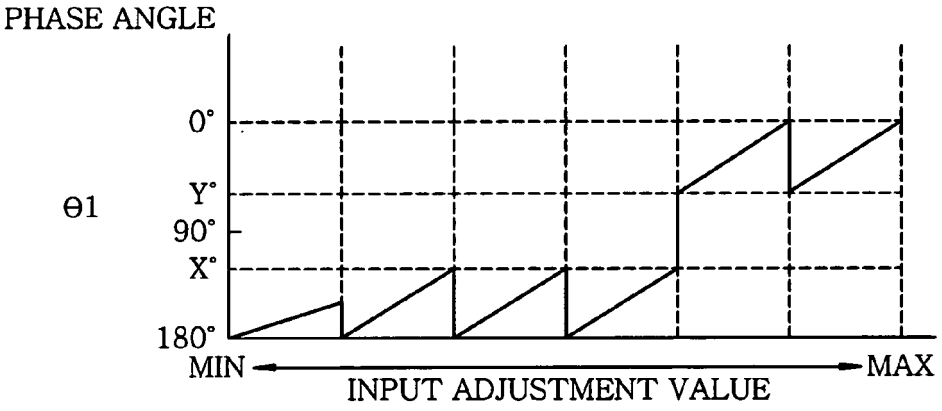


FIG. 4C

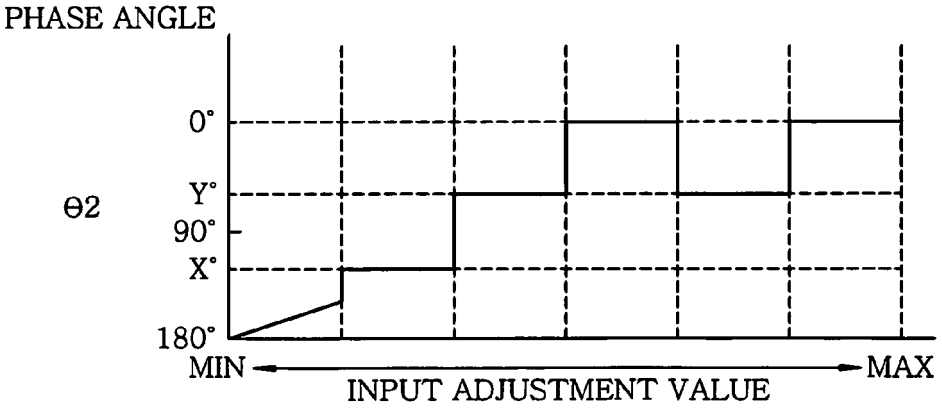


FIG.5

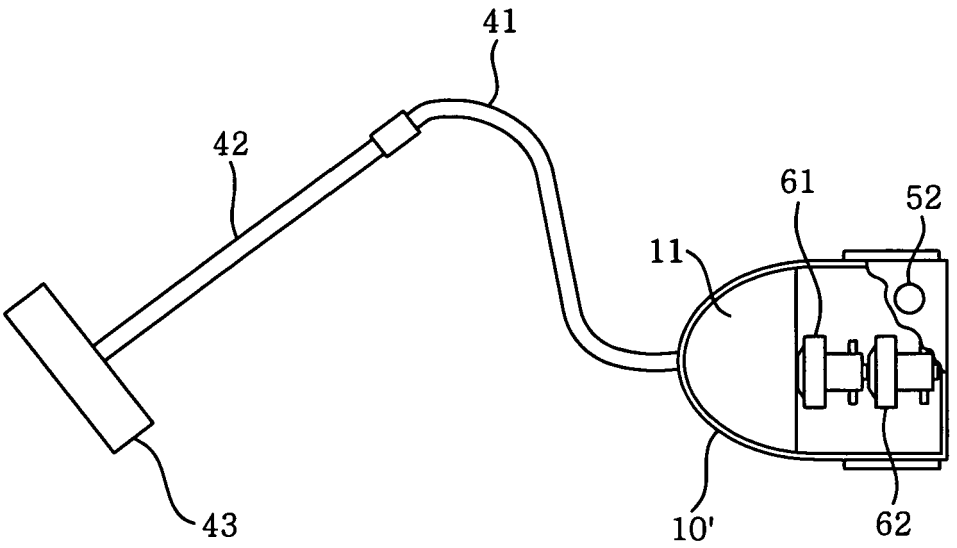


FIG. 6

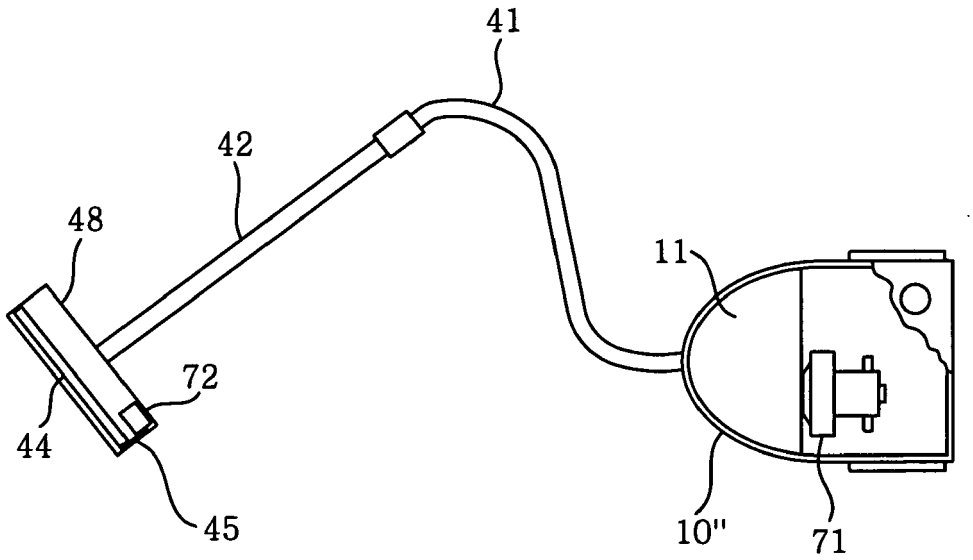


FIG. 7

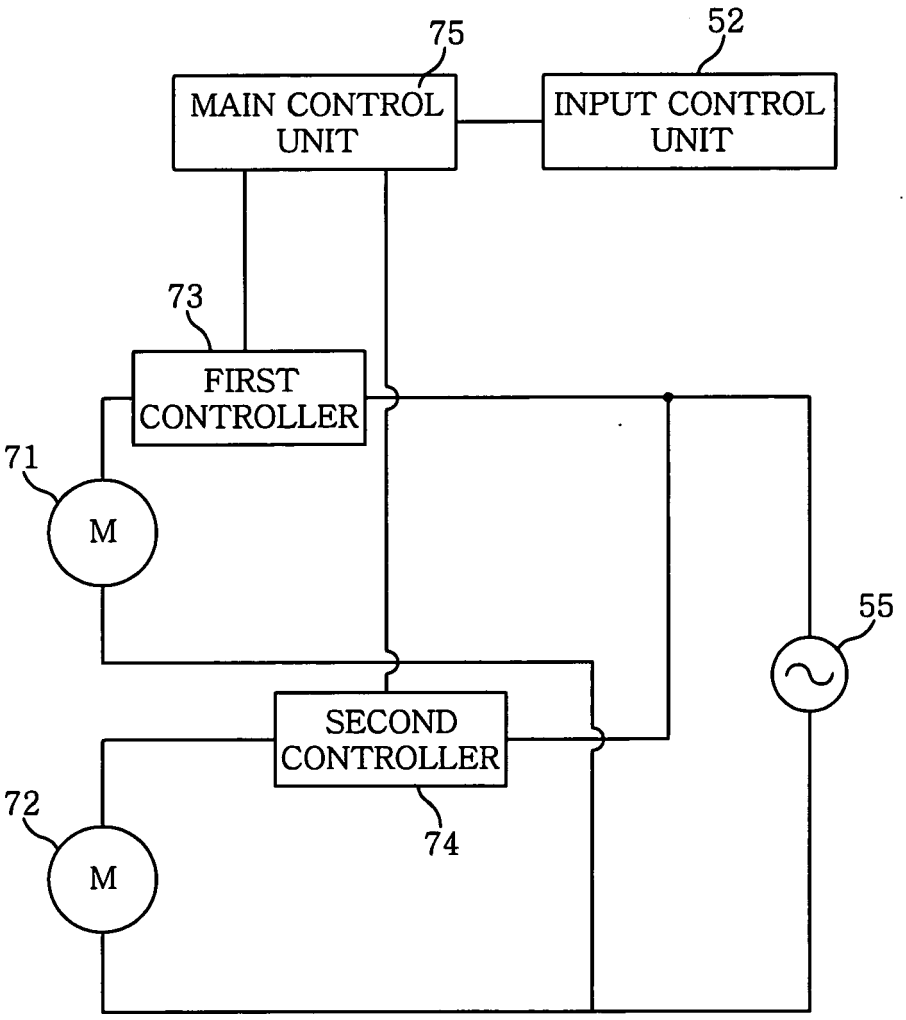

75
52
MAIN CONTROL UNIT
INPUT CONTROL UNIT
73
FIRST CONTROLLER
71
M
55
SECOND CONTROLLER
74
72
M

FIG.8A

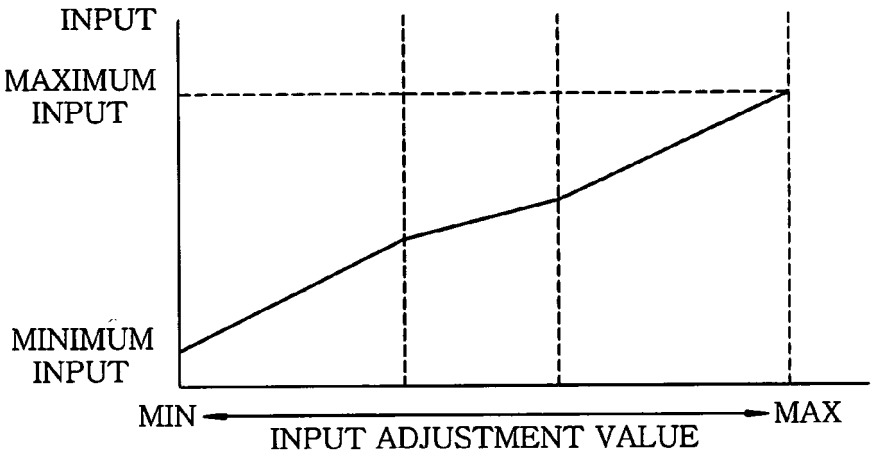


FIG.8B

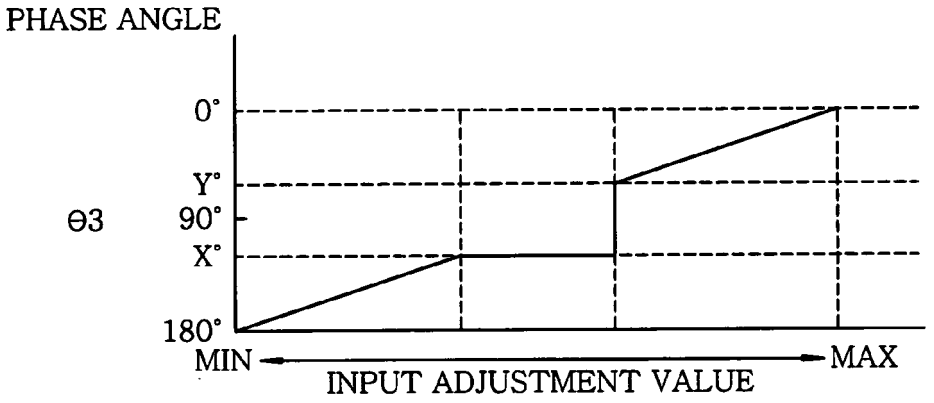


FIG.8C

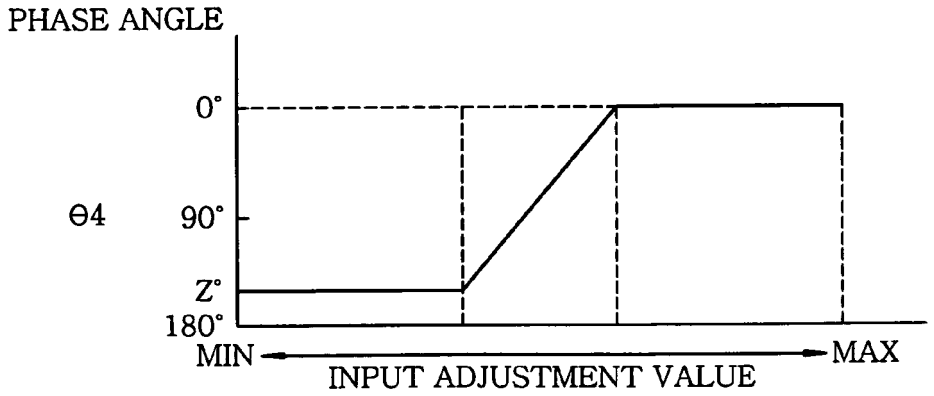


FIG. 9

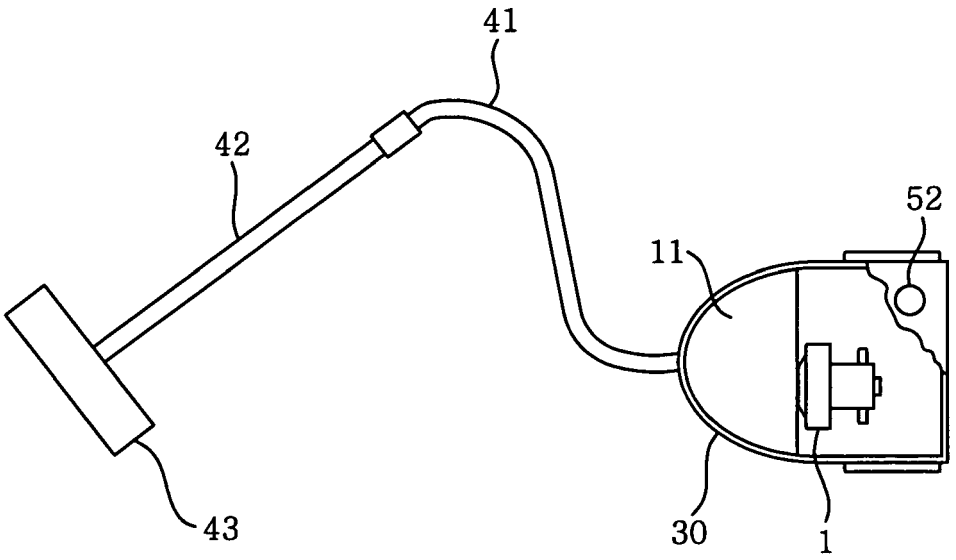


FIG. 10

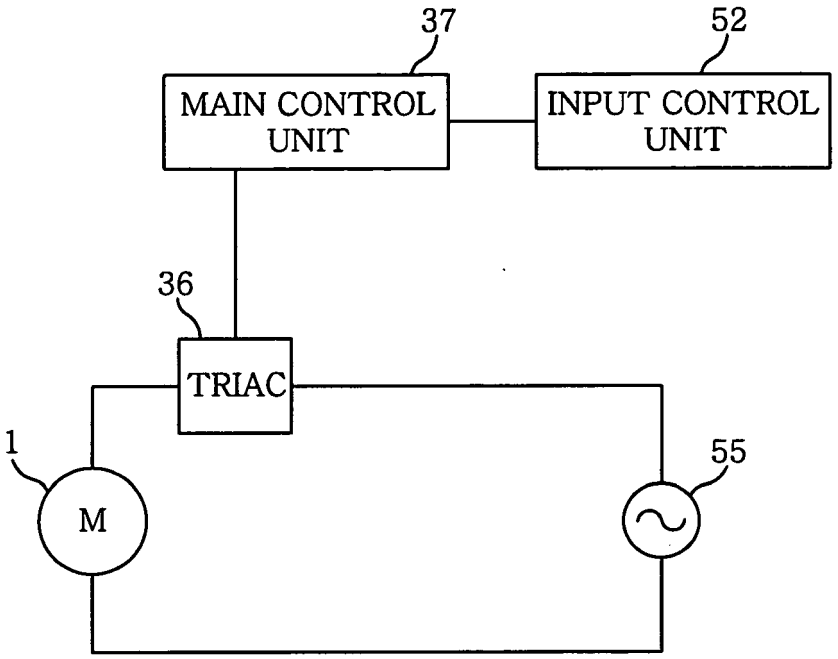


FIG. 11A

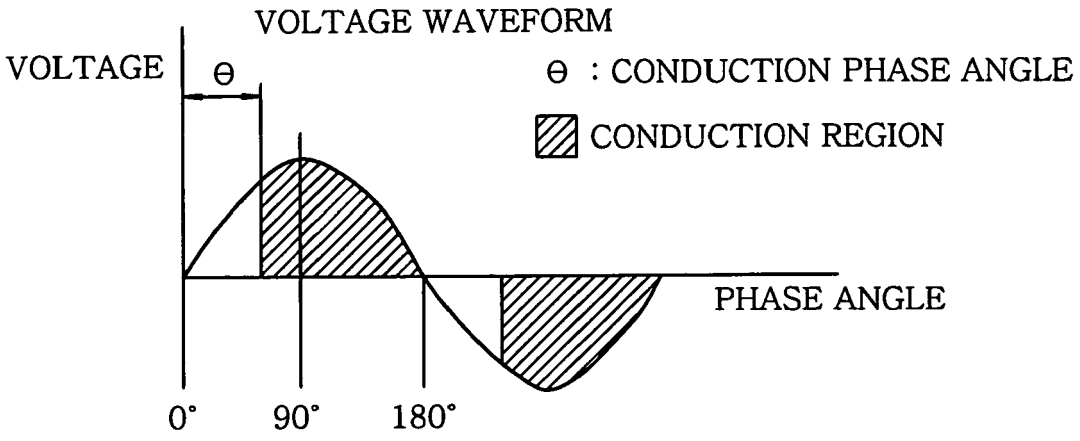


FIG. 11B

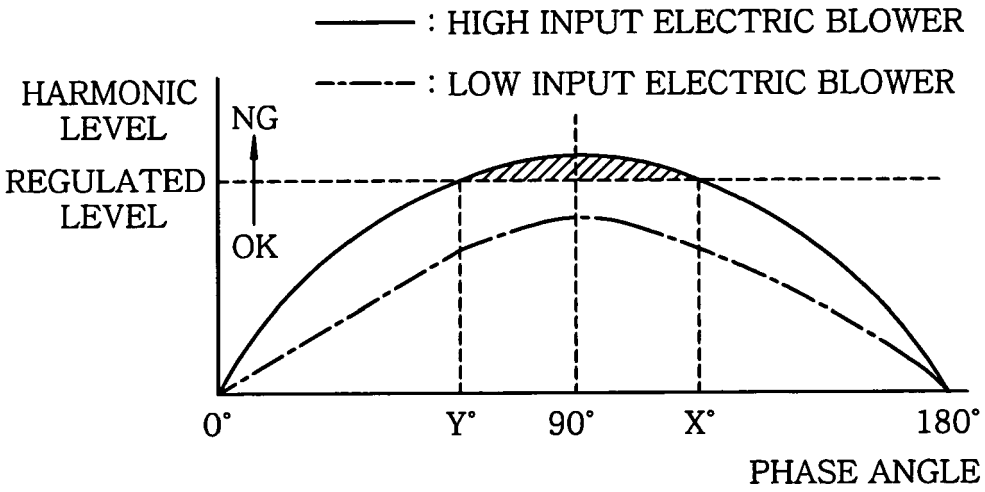


FIG. 12A

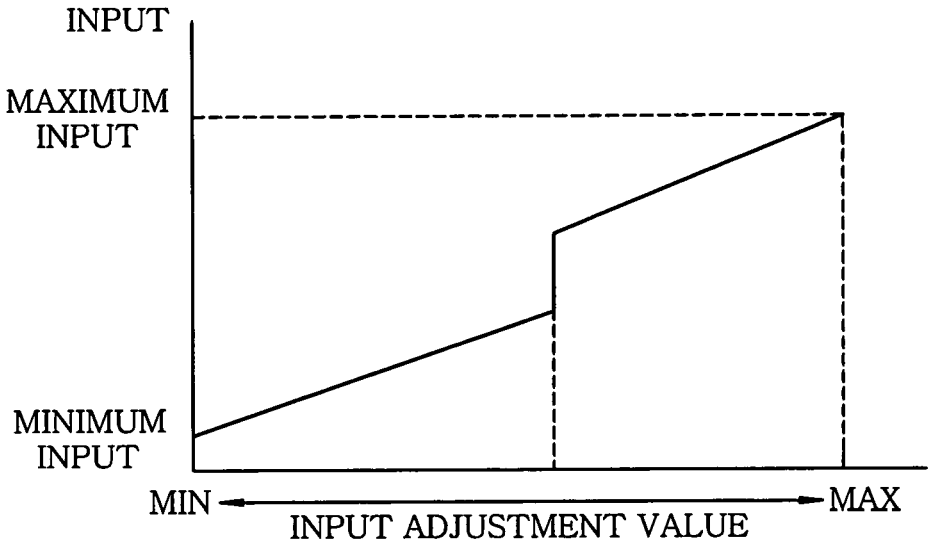
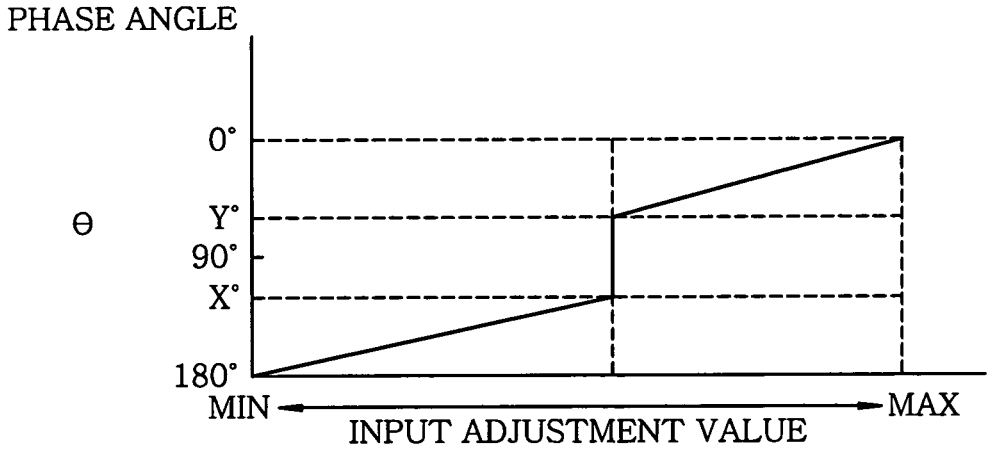


FIG. 12B



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Patent documents cited in the description

- JP 63274396 A **[0011]**