



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 0 768 500 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.04.1997 Bulletin 1997/16

(51) Int. Cl.⁶: **F24F 13/08**

(21) Application number: **96116274.0**

(22) Date of filing: **10.10.1996**

(84) Designated Contracting States:
DE ES FR GB GR IT PT

(30) Priority: **13.10.1995 JP 292075/95**
25.12.1995 JP 351085/95

(71) Applicant: **SANYO ELECTRIC Co., Ltd.**
Moriguchi-shi, Osaka (JP)

(72) Inventors:
• **Sakaino, Kazuaki**
Ora-gun, Gunma (JP)
• **Okawa, Kazunobu**
Ashikaga-shi, Tochigi (JP)

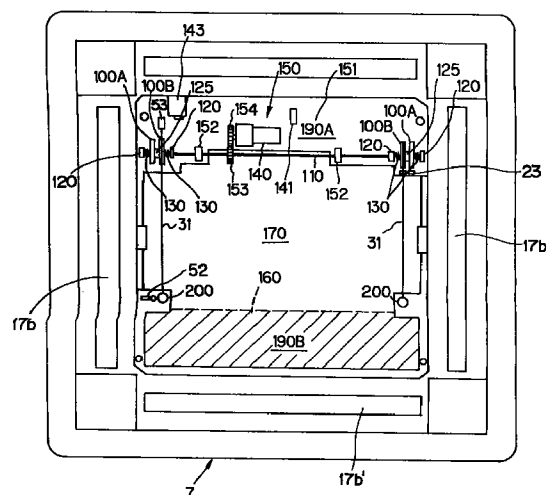
- **Nawata, Yukito**
Ota-shi, Gunma (JP)
- **Fukushima, Teiichi**
Ora-gun, Gunma (JP)
- **Niizato, Atsushi**
Ora-gun, Gunma (JP)
- **Arai, Kouji**
Ota-shi, Gunma (JP)
- **Osu, Shinichi**
Kiryu-shi, Gunma (JP)

(74) Representative: **Glawe, Delfs, Moll & Partner**
Patentanwälte
Postfach 26 01 62
80058 München (DE)

(54) **Elevation controller for air suction grille**

(57) An in-ceiling mount type air conditioner (50) including an operation switch (51) for switching a power supply status of a power source to an elevating motor (140) for elevating an air suction grille (9), upper-limit position detectors (52,53) for detecting the upper-limit and lower-limit positions of the air suction grille (9) respectively, a forced stop detector for detecting the forced stop of the air suction grille, a timer (143) for counting a predetermined time from the actuation of the upper-limit position detector (52), and a controller for stopping the elevating motor (140) when the timer (143) counts the predetermined time after the air suction grille (9) reaches the upper-limit position and keeping the air suction grille (9) to stop when the forced stop of the air suction grille is detected by the forced stop detector.

FIG. 3



EP 0 768 500 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a mount structure of an air suction grille for an in-ceiling mount type air conditioner having an unit body mounted in a ceiling, and an elevation control system for the air suction grill.

2. Description of Related Art

There is generally known an in-ceiling mount type air conditioner having a face panel mounted on a ceiling, in which the face panel is provided with an air suction grille for sucking air therethrough and a filter is provided in the air suction grille (as disclosed in Japanese Laid-open Patent Application Hei-2-233920). In this type air conditioner, the filter is allowed to be detached from the air suction grille by detaching the air suction grille from the decoration panel. Therefore, maintenance works such as a filter detaching work to clean the filter, a work for exchanging the filter by a new one can be more easily performed as compared with conventional types.

According to the in-ceiling mount type air conditioner as described above, the face panel and the air suction grille are necessarily mounted on the ceiling, and thus a work for detaching the air suction grille from the face panel must be performed at a high position. Therefore, although the filter detaching work becomes simpler, there occurs such a situation that the filter is hardly exchanged by a new one or cleaned, so that the driving operation of the air conditioner is continued without using sufficient performance of the air conditioner.

In order to avoid such a situation, the air conditioner may be designed so that the air suction grille is supported on the lower surface of the face panel so as to be freely movable upwardly and downwardly by an elevating motor. With this design, the air suction grille can be moved downwardly from the ceiling to a lower position in a room for the filter clean or exchange work, and thus this work can be performed at the lower position. However, this design of the air conditioner needs an operating system (control system) for elevating (upwardly and downwardly moving) the air suction grille. The operating (control) system must be designed to have not only a function of elevating the air suction grille, but also a function of stopping the air suction grille at any position in the vertical direction.

For example, in the case where the air suction grille is supported by plural suspension cords or the like so that it can be freely moved upwardly and downwardly, there may occur the problem that the air suction grille is kept inclined at its top (upper limit) position due to unbalance of the length of the cords and some gap occurs between the face panel and the air suction grille.

Further, in the case where plural air conditioners

are mounted in the ceiling, the plural air suction grilles are sometimes required to be moved downwardly substantially simultaneously, however, at slight time intervals among the air suction grilles to exchange plural exchanges for new ones at the same time. In this case, when the air suction grilles are downwardly moved to check one of the air suction grilles (hereinafter referred to as a "check target grille"), the following problem may occur. That is, if any obstacle such as a piece of furniture such as a chest or the like is located beneath an air suction grille which is different from the check target grille, this air suction grille is driven to move downwardly even when it abuts against the obstacle because an user pays his or her attention to the check target grille and thus he does not push a stop key. This movement of the air suction grille is continued, and the downward (draw-out) movement of the cords is continued although the air suction grille which is abutting against the obstacle is forcedly stopped by the obstacle. Therefore, the cords are slacked and entangled, resulting in disturbance of the upward movement of the suction grille.

SUMMARY OF THE INVENTION

The present invention has been achieved to overcome the above problems, and a first object of the present invention is to provide an in-ceiling mount type air conditioner in which an air suction grille can be stopped at any position and no gap occurs between a face panel and the air suction grille at the top (upper limit) position of the air suction grille, and also in which suspension cords for suspending the air suction grille are prevented from being slacked and entangled.

A second object of the present invention is to provide an in-ceiling mount type air conditioner which can prevent a motor from continuously rotating under an overload, so that the driving operation of the motor under overload can be reduced to a practical level.

A third object of the present invention is to provide an in-ceiling mount type air conditioner in which an operation switch is prevented from being actuated again once the operation switch is stopped, whereby a slack preventing limit switch which is actuated by the operation switch is not continuously actuated.

A fourth object of the present invention is to provide an in-ceiling mount type air conditioner in which a relay for driving a motor is preferentially reset (switched) at all times to prevent a power source from being short-circuited even instantaneously.

A fifth object of the present invention is to provide an in-ceiling mount type air conditioner in which a relay coil is prevented from being conducted when the air conditioner is stopped.

In order to attain the above objects, according to a first aspect of the present invention, an in-ceiling mount type air conditioner in which an air suction grille is supported so as to be freely movable upwardly and downwardly through an elevating motor for the air suction grille, includes an operation switch which can switch a

power supply status from a power source to the elevating motor for the air suction grille.

In the in-ceiling mount type air conditioner as described above, the operation switch comprises a rotary type pull switch, and the air suction grille may perform a series of repetitive movements of downwardly moving, stopping, upwardly moving and stopping in this order.

The in-ceiling mount type air conditioner as described above may further include stop means for stopping the driving of the elevating motor when the downward movement of the air suction grille is forcibly stopped during the downward movement of the air suction grille.

In the in-ceiling mount type air conditioner as described above, the air suction grille may be supported by suspension cords, and the draw-out/rewinding operation of the cords may be performed by the rotational movement of the elevating motor, whereby the air suction grille is upwardly and downwardly moved.

The in-ceiling mount type air conditioner as described above may further include stop means for detecting slack of the cords and stopping the movement of the elevating motor when the suspension cords are slacked during the downward movement of the air suction grille.

The in-ceiling mount type air conditioner as described above may further include timer means for continuing the rewinding operation of the suspension cords for a predetermined time when the air suction grille reaches its upper limit position.

According to another aspect of the present invention, an in-ceiling mount type air conditioner in which one ends of suspension cords are secured to an air suction grille, the other ends of the suspension cords are wound around pulleys, the pulleys are connected to a shaft through a clutch which idles the pulleys when a predetermined load or more is applied to the pulleys, the shaft is linked to a motor for driving the air suction grille, and the elevating motor is driven to perform the draw-out/rewinding operation of the suspension cords, whereby the air suction grille is upwardly and downwardly moved, comprises an operation switch for switching the power supply status of a power source to the elevating motor, upper limit position detecting means for detecting the upper limit position of the air suction grille, a timer for counting a predetermined time from the actuation of the upper limit position detecting means, and control means for stopping the elevating motor after the air suction grille reaches the upper limit position and the timer counts the predetermined time.

The in-ceiling mount type air conditioner as described above may further include a monitoring circuit for monitoring a driving voltage of the elevating motor.

In the in-ceiling mount type air conditioner, when the driving voltage of the elevating motor which is detected by the monitoring circuit is above a predetermined value, the elevating motor is stopped by the control means after the predetermined time elapses.

The in-ceiling mount type air conditioner may further include stop keeping circuit for keeping the stop status of the air suction grille until the operation switch is actuated again once the elevating movement of the air suction grille is stopped.

The in-ceiling mount type air conditioner may further include a relay circuit which comprises plural relays and is adapted to control the elevating movement of the elevating motor, and the relay circuit is provided with a delay circuit for preferentially resetting a relay for driving the elevating motor and then resetting the other relays after a time lapse from the reset of the elevating motor driving relay.

The in-ceiling mount type air conditioner may further include a relay circuit which comprises plural relays and is adapted to control the elevating movement of the elevating motor, all the relays of the relay circuit being allowed to be reset when the air suction grille is stopped at its upper limit position.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinally sectional view showing a first embodiment of an in-ceiling mount type air conditioner according to the present invention;

Fig. 2 is a perspective view showing the in-ceiling mount type air conditioner of Fig. 1;

Fig. 3 is a plan view showing the in-ceiling mount type air conditioner of Fig. 1 when an air suction grille is detached therefrom;

Fig. 4A is a perspective view showing the in-ceiling mount type air conditioner of Fig. 1 when the air suction grille is suspended therefrom, and Fig. 4B is an enlarged view showing a hook of the air suction grille of Fig. 4A;

Fig. 5 is a flowchart showing a process flow of the first embodiment;

Fig. 6 is a plan view showing a second embodiment of the in-ceiling mount type air conditioner in which a slack detection sensor is provided, and corresponds to Fig. 3;

Fig. 7 is a diagram showing the air suction grille of the second embodiment of Fig. 6 and peripheral equipments containing the slack detection sensor;

Fig. 8 is a circuit diagram of a control circuit for an air suction grille elevating motor in the in-ceiling mount type air conditioner of Fig. 1;

Fig. 9 is a circuit diagram showing an improved control circuit for the air suction grille elevating motor of Fig. 8;

Figs. 10A and 10B are flowcharts showing a downwardly moving operation and an upwardly moving operation of the air suction grille respectively;

Fig. 11 is a functional diagram showing the operation of the control circuit of the controller of Fig. 11; and

Fig. 12 is a functional diagram showing the operation of a relay driving circuit of the controller of Fig. 9.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments according to the present invention will be described with reference to the accompanying drawings with reference to the accompanying drawings.

Fig. 1 is a longitudinally sectional view showing a first embodiment of a general in-ceiling mount type air conditioner according to the present invention.

In Fig. 1, reference numeral 50 represents an air conditioner. The air conditioner 50 has an unit body 2 which is formed of sheet metal and accommodated in a ceiling 1, and a face panel 7 which has an air suction port 3 at the center thereof and air blow-out ports 4 at the four sides on the outer peripheral portion thereof and is disposed on a ceiling face 6 so as to cover a ceiling hole formed in the ceiling to mount the air conditioner in the ceiling.

In Fig. 1, reference numeral 10 represents an air blower comprising a turbo fan 11 and a fan motor 13 secured on a ceiling board 12, reference numeral 14 represents a nozzle port for guiding room air from the air suction port 8 to the turbo fan 11, and reference numeral 15 represents a drain pan having an inner rise-up portion 15a and an outer rise-up portion 15b. The drain pan is formed of foaming styrol and designed in a square ring shape. Reference numeral 16 represents a plate fin type heat exchanger which is disposed at the air discharge side of the turbo fan 11 so as to surround the fan in a ring shape. Reference numeral 17 represents a heat insulator which is wound around the peripheral surface of the unit body 2, reference numeral 21 represents an air guide portion for guiding to the air blow-out ports 4 air which is heat-exchanged in a heat exchanger 16, reference numeral 22 represents suspension bolts with which the unit body is suspended to the ceiling frame by suspenders, and reference numeral 24 represents a filter which is mounted at the downstream side of the air suction grille 9.

Next, the main part of this embodiment will be described with reference to Figs. 2 to 4.

Fig. 2 is a perspective view showing an in-ceiling mount type air conditioner shown in Fig. 1, Fig. 3 is a plan view showing the in-ceiling mount type air conditioner of Fig. 1 when an air suction grille is detached from the air conditioner, Fig. 4A is a perspective view showing the in-ceiling mount type air conditioner when the air suction grille is suspended from the air conditioner, and Fig. 4B is an enlarged view showing a hook of the air suction grille. The air suction grille 9 is supported through four suspension cords 31 by the main body of the air conditioner so as to be upwardly and downwardly movable in the vertical direction. Each of the four suspension cords 31 may be formed of a resin wire or metal wire around which vinyl coating is applied, however, it may be a dial cord. As shown in Figs. 4A and 4B, one ends 31a of the four suspension cords 31 are fixed to hooks 90a of air suction grill reinforcing mem-

bers 90. The other ends 31b of two suspension cords 31 of the four suspension cords 31 are wound around main pulleys 100A, and the other ends 31c of the other two suspension cords 31 are wound around main pulleys 100B through rope guides 200 or auxiliary pulleys (not shown).

The fixation of the one ends 31a of the suspension cords 31 to the hooks 90a of the air suction grille reinforcing members 90 may be performed by crimping a binding member 91 onto the one end 31a of each suspension cord 31 in advance, hooking an hook portion 31d of the suspension cord 31 on the hook 90a, and then drawing out the suspension cord 31 in a direction as indicated by an arrow and slightly loosening the cord 31.

Each of the air suction grille reinforcing members 90 are fixed to two sides of the air suction grille 9 by screws or the like. Therefore, the air suction grille reinforcing members 90 function as hooks for the four suspension cords as described above, and also function to structurally reinforce the air suction grille 9 and preventing the filter 24 (Fig. 1) mounted on the air suction face of the air suction grille 9 from being displaced laterally.

Each pair of one main pulley 100A and one main pulley 100B (totally four main pulleys 100A and 100B) are linked to one of both end portions of a shaft 110 as shown in Fig. 3. A hole is formed in each of the main pulleys 100A and 100B, and the shaft 110 is inserted into these holes so that the main pulleys 100A and 100B are freely rotatable. That is, the main pulleys 100A and 100B are supported by the shaft 110 so as to be freely rotationally idled through the holes. Further, fixing members 123 are fixed to the shaft portions of the shaft 110 through plural screws, and a rotational force transmission means such as a coil spring, a leaf spring, electro-magnet or the like (hereinafter referred to as "coil spring") 130 is interposed between the fixing members 120 and the main pulleys 100A, 100B. Reference numeral 125 represents a freely-rotatable ring.

In such a situation that the dead weight of the air suction grille 9 (or the same level force) is merely applied to the four suspension cords 31, the fixing members 120, the main pulleys 100A, 100B and the rings 125 are allowed to be integrally rotated through the coil spring 130. Accordingly, in this case, the draw-out/rewinding operation of the four suspension cords is carried out in synchronism with the rotational movement of the shaft 110. On the other hand, when a larger or excessive load is applied the four suspension cords 31, the main pulleys 100A and 100B are allowed to be idled against the spring force of the coil spring 130.

Further, according to this embodiment, a driving system 150 for elevating the air suction grille 9, that is, a driving system 150 containing the main pulleys 100A, 100B, the shaft 110, the clutch containing the rotational force transmission means, a motor 140 for elevating the air suction grille as described above, etc., are collectively arranged on a support plate 150 extending within the opening portion of the unit body 2 as shown in Fig.

2.

As shown in Fig. 3, the support plate 151 is fixed on the face panel 7, and the driving system 150 as described above is fixed to the side of the face panel 7. Further, an electrical equipment box 160 for accommo-

5 dating various electrical elements to control the air conditioner is disposed to extend in the opening portion of the unit body 2 and confront the support plate 151. That is, the electrical equipment box 160 and the support plate 151 are disposed to extend in the opening portion which is regarded as an air take-in port of the unit body 2. The support plate 151 is disposed to extend in an area 190A while the electrical equipment box 160 is also disposed to extend in an area 190B. However, the air conditioner is designed so that the air take-in function thereof is not disturbed by the location of the electrical equipment box 160 and the support plate 151 as described above, and sufficient air can be taken from the residual space. The driving system 150 as described above is fixed to the face panel 7, and the electrical equipment box 160 is fixed to the unit body 2.

The driving system 150 will be described in more detail with reference to Fig. 3.

The shaft 110 is freely rotatably mounted through two bearings 152 on the support plate 151, and a gear 153 is fixed to the substantially center portion of the shaft portion of the shaft 110. The gear 153 is engaged with a gear 154, and the gear 154 is fixed to the output shaft of the motor 140 for elevating the air suction grille as described above. Reference numeral 141 represents a capacitor for the motor, and reference numeral 143 represents a timer (for correction) as described later.

A pull switch (operation switch) 51 as shown in Fig. 2 is provided to perform the start and stop operation of the elevating movement (upward and downward movement) of the air suction grille 9, and an upper-limit (top) position detecting sensor 52 and a lower-limit (bottom) position detecting sensor 53 are provided as shown in Fig. 3. The lower-limit position detecting sensor 53 detects the lower-limit position of the air suction grille 9 on the basis of the draw-out length of at least one suspension cord. Specifically, the draw-out length of the suspension cord 31 is detected on the basis of the number of turns (height) of the suspension cord 31 which is wound around the main pulley 100B.

The operation switch is not limited to the pull switch 51. For example, it may be a fixed type such as a wall-mount type. In this case, the fixed type switch may be connected to the elevating motor 140 through a cable. Besides, the operation switch may be built as a remote controller or built in a remote controller for controlling the operation of the air conditioner.

Next, the operation of the air conditioner of this embodiment will be described with reference to the flowchart of Fig. 5.

For example, when a pull stick or the like is prepared and the pull switch 51 is pulled with the pull stick (a pull operation is carried out) (S1), the motor 140 for elevating the air suction grille is forwardly rotated to

drive the driving system 150, and the air suction grille 9 is started to move downwardly through the suspension cords 31 (S2). Subsequently, when the pull operation of the pull switch 51 is further carried out (S3), the downward movement of the air suction grille 9 is stopped (S4). Subsequently, when the pull operation of the pull switch 51 is further carried out (S5), the elevating motor 140 is reversely rotated, and the air suction grille 9 turns its movement to the upward movement (S6).

10 In this embodiment, a rotary type pull switch is used as the pull switch 51. When the pull operation of the pull switch is repetitively carried out, the elevating motor 140 repeats "forward rotation", "stop" and "reverse rotation" in this order, and thus the air suction grille 9 also repeats a "downward movement", a "stop motion", an "upward movement" and a "stop motion" in this order. If in step S6 the air suction grille 9 arrives at the upper-limit position after the air suction grille 9 turns its motion to the upward movement, the upper-limit position detecting sensor 52 is actuated. At the same time, the timer 143 is actuated and after a predetermined time X seconds (for example, 0.3 to 2 seconds) elapse (S7), the reverse rotation of the elevating motor 140 for the air suction grille 9 is stopped, so that the upward movement of the air suction grille 9 is stopped (S8).

When the air suction grille 9 is lifted up toward the main body of the air conditioner by the four suspension cords 31, the air suction grille 9 may be lifted up in an inclined position in some cases because all of the four suspension cords 31 do not have the same length. However, according to this embodiment, even when the air suction grille 9 is lifted up while its attitude is inclined, the reverse rotation of the elevating motor 140 is stopped after the predetermined time (X seconds) elapses from the actuation of the upper-limit position detecting sensor 52, and thus the main pulleys 100A, 100B continue to rotate for the predetermined time until all the suspension cords 31 are perfectly taken out. That is, the four suspension cords 31 are continued to be taken up until the air suction grille 9 is kept in a horizontal position and come into complete contact with the face panel 7. In this case, the main pulleys 100A, 100B around which some suspension cords of the four suspension cords 31 have been taken up are idled around the shaft portion of the shaft 110 until the other suspension cords are perfectly taken up.

During the downward movement of the air suction grille 9, the downward movement of the air suction grille 9 is stopped (S4) by pulling the pull switch 51 as described above (S3), so that the air suction grille 9 can be temporarily stopped at any position. As not illustrated in Fig. 2, the filter 24 for cleaning air (Fig. 1) is mounted on the upper portion of the air suction grille 9, and thus various works such as an exchange work, a clean work, etc. are allowed to be performed on the filter 24 at a low position by moving the air suction grille 9 from the ceiling face 6 downwardly and temporarily stopping it in the course of the downward movement thereof.

Accordingly, as compared with the case where

these works are carried out at the high position, not only the works can be performed more easily, but also the safety of the works can be enhanced.

The air suction grille 9 which moves upwardly may be fixed to the face panel by an air suction grille lock means (not shown). However, the lock mean is not indispensably used, and thus it is omitted from the illustration of this embodiment. Referring to Fig. 2, a magnet 43 may be provided to the face panel 7 as a simple air suction grille lock means to lock the air suction grille 9 with magnetic force.

In short, according to this embodiment, the elevating motor 140 is driven by pulling the pull switch 51 to rotate the shaft 110 and thus the main pulleys 100A and 100B which are linked to the shaft 110 through the clutches, and the suspension cords 31 which are wound around the main pulleys 100A and 100B are drawn out or rewound, whereby the air suction grille 9 is automatically elevated. Therefore, when the air cleaning filter 24 is checked for maintenance, it can be pulled down and checked for maintenance at a low position (or any position)

Further, according to this embodiment, the air suction grille repeats the "downward movement", the "stop motion", the "upward movement" and the "stop motion" in this order by pulling the rotary type pull switch, so that the air suction grille can be stopped at any position by a simple operation.

Further, only one elevating motor 140 for the air suction grille may be used for the air conditioner of this embodiment. Therefore, the cost-up of the air conditioner can be more suppressed, and the air conditioner can be designed in a simpler structure and with less trouble in operation as compared with an air conditioner in which plural elevating motors 140 are provided.

Further, when a large load is applied to the air suction grille, the clutches work to allow the main pulleys 100A and 100B to be idled, thereby preventing the elevating motor 140 from being burnt. In addition, even when the four suspension cords 31 are unbalanced in length during the rewinding operation of the cords 31, the unbalanced condition of the length of the suspension cords 31 can be finally absorbed by the idling of the main pulleys 100A and 100B, so that the air suction grille 9 comes into perfect contact with the face panel 7 and thus no gap occurs therebetween.

Next, another embodiment will be described with reference to Figs. 6 and 7.

In the embodiment shown in Figs. 1 to 5, the elevating motor 140 for the air suction grille 9 continues to be driven and thus the air suction grille 9 is not stopped at some midpoint during the downward movement unless the air suction grille 9 arrives at the lower-limit position (for example, the position lower than the ceiling by 2m) or the pull switch 51 is pulled in the course of the downward movement of the air suction grille 9 to stop the air suction grille during its downward motion.

Accordingly, if a piece of furniture such as a chest 80 (see Fig. 7) is located as an obstacle beneath the air

suction grille 9, the air suction grille 9 which is continuing its downward movement abuts against the chest 80 and the downward movement of the air suction grille 9 is forcedly stopped. However, the downwardly moving operation of the air suction grille 9 is continued unless an operator pays his attention to the event and pulls the pull switch 51, so that the suspension cords 31 are slacked. The slacked suspension cords 31 may be entangled, resulting in failure of the upward movement of the air suction grille 9 when the air suction grille 9 is required to be upwardly moved again.

According to the embodiment of Figs. 6 and 7, a sensor 65 is newly provided to detect the slack of the suspension cords 31 when the suspension cords 31 slack as indicated by a dotted line.

When the sensor 65 is actuated, the driving operation of the elevating motor 140 for the air suction grille is stopped. As shown in Fig. 7, the sensor 65 has a spring 67, and the tip 67a of the spring 67 is hooked on a suspension cord 31c. The spring 67 is normally urged downwardly as indicated by a dotted line. However, when the tip 67a is hooked on the suspension cord 31c, the spring 67 is upwardly urged as indicated by a solid line under the tension of the suspension cord 31c. That is, the spring 67 is upwardly urged at all times by the tension of the suspension cord 31c. If the suspension cord 31c slacks, the spring 67 is downwardly urged as indicated by the dotted line by the spring force of the spring 67. In this case, for example, the contact point of a limit switch 69 is opened, and the driving of the elevating motor 140 is stopped.

According to this embodiment, if the air suction grille 9 abuts against a chest 80 (Fig. 7) and the suspension cords 31 slack as indicated by the dotted line, the sensor 65 detects the slack of the suspension cords 31 to stop the driving of the elevating motor 140 for the air suction grille 9. Therefore, the air suction grille 9 is prevented from continuing to downwardly moving, and thus the suspension cords 31 are prevented from slacking and thus being entangled, so that the safety for an operator during the downward movement of the air suction grille can be ensured.

Fig. 8 shows a control circuit for the elevating motor for the air suction grille in the in-ceiling mount type air conditioner. In the control circuit shown in Fig. 8, reference numeral 201 represents a rotary switch connected to the operation switch, reference numeral 202 represents a relay driving power source, reference numeral 203 represents an upper-limit switch corresponding to the upper-limit position detecting sensor 52, reference numeral 204 represents a timer corresponding to the timer 143 as described above, reference numeral 206 represents a lower-limit switch corresponding to the lower-limit position detecting sensor 53, reference numeral 207 represents a slack detecting limit switch corresponding to the slack detection sensor 65 as described above, reference numeral 208 represents a regenerative (damping) resistor, reference numerals 209, 210, 211 and 212 represent relays, reference

numeral 140 represents a motor for elevating the air suction grille (hereinafter referred to as "elevating motor"), reference numeral 214 represents a motor driving power source, reference numeral 214a represents an up-switch, and reference numeral 214b represents a down-switch.

Next, the operation of the control circuit shown in Fig. 8 will be described.

When the air suction grille is required to be upwardly moved, the rotary switch 201 is switched to an upward movement status by pulling the pull switch 51. Through this switching operation of the rotary switch 201, the relay 209 is conducted to close its contact point, subsequently the relay 211 is conducted to close its contact point, and the up-switch 214a is closed to rotate the elevating motor 140, whereby the air suction grille 9 is upwardly moved. When the air suction grille 9 upwardly moves to the upper-limit position, the air suction grille 9 closes the limit switch 203 to apply power to the timer 204. After a predetermined time elapses from the power supply to the timer 204, the timer 204 supplies current to the coil of the relay 205 to open the contact point thereof and stop the motor 140.

On the other hand, when the air suction grille is required to be downwardly moved, the relays 210 and 212 are successively conducted, and the motor 140 is rotated in the opposite direction to that during the upward movement thereof. At this time, if the air suction grille 9 downwardly moves to the lower-limit position, the limit switch 7 is opened and the motor 140 is stopped. On the other hand, if the air suction grille 9 abuts against an object in the course of the downward movement thereof, the slack of the suspension cords with which the grille 9 is suspended is detected by the switch 206 to stop the motor.

According to the air conditioner Of the first and second embodiments as described above, if during the upward and downward movement of the air suction grille 9, the limit switch 203 does not work due to failure or other cause when the air suction grille 9 arrives at the upper-limit position, the motor 140 does not stop at that position and continues to rotate. It is an overload to the motor 9 that the driving operation of the motor 140 is continued for a time period from the time when the air suction grille 9 arrives at the upper-limit position until the driving operation of the motor 140 is forcedly stopped by the timer 204. If the motor 140 is driven over a predetermined time (for example, 0.3 to 4.0 seconds), the motor 140 may be out of order (problem 1).

Further, according to the air conditioner of the first and second embodiments as described above, during the downward movement of the air suction grille 9, the contact points of the switches 206 and 207 may be closed due to vibration or the like because the operating range of these switches is narrow. For example, when the air suction grille 9 is stopped because it abuts against a person, the air suction grille 9 starts its downward movement if the person goes sufficiently away from that position. However, if the person merely stoops

down to avoid abutting against the air suction grille 9, he abuts against the air suction grille again just after that action. Therefore, the motor 140 repeats the on/off operation during a short time, and the repetitive on/off operation of the motor 140 causes deterioration of the motor 140 (problem 2).

Still further, according to the air conditioner of the first and second embodiments as described above, when the operation of the air suction grille is switched from the driving status to the stop status, short-circuit current flows in the circuit due to the time lag between the reset times (switching times) of the relays in the circuit. For example, when the air suction grille stops in the course of the downward movement, the relay 210 and the relay 212 (214b) are switched (that is, the relay 210 of Fig. 8 is switched from the position as indicated by dotted lines to the position as indicated by solid line and the down-switch 214b is switched from the position as indicated by dotted lines to the position as indicated by solid lines), whereby the motor 140 is stopped. There is a time lag in turn-off time between these two relays 210 and 212 due to a manufacturing error or the like, and thus the relays 210 and 212 may be simultaneously kept to the ON-state. That is, there may exist such a situation that the relay 210 is in the position as indicated by the solid lines while the down-switch 214b is in the position as indicated by the dotted lines. Actually, since the relay 212 has a longer reset time than the relay 210, the current flows from the anode of the power source 214 through one of the contact points of the down-switch 214b, the contact point of the preferentially reset (switched) relay 210, the regenerative resistor 208 of about 0.5Ω , the other contact point of the down-switch 214b and the cathode of the power source 214. The time period for which the current flows is a very small value (about several mseconds), however, the current amount is very large because the impedance of the circuit (the resistance of the regenerative resistor 208, etc.) is very small. Therefore, such short-circuit current has a great adverse effect on the elements of the circuit (problem 3).

Still further, according to the air conditioner of the first and second embodiments as described above, the relay 205 is still supplied with current even after the motor 140 is stopped by the timer 204. If the relay 205 is kept energized for a long time, the relay 205 is heated due to the increase in temperature of the coil, which promotes abrasion of the contact points. Under a practical use, it is considered that the operator does not carry out the switch operation once the air suction grille is held in the air conditioner. In this case, the relay 5 may be left energized for a long term (from several days to several months) until the air suction grille is downwardly moved to clean the filter of the air suction grille (problem 4).

Next, a third embodiment according to the present invention which can solve the problems 1 to 4 of the first and second embodiments as described above will be described.

Fig. 9 shows a controller for the elevating motor for

the air suction grille in the in-ceiling mount type air conditioner according to the present invention.

In Fig. 9, reference numeral 220 represents a rotary type pull switch, and the contact point thereof is switched to "stop", "down", "stop" and "up" in this order every time the rotary type pull switch is pulled.

The controller includes a control circuit 225, and the control circuit 225 receives input signals from the rotary switch 220, an upper-limit switch 221, a lower-limit switch 222, a slack detection switch 223 for detecting the slack of the suspension cords, and a motor operating voltage detection circuit 240, and supplies its output signal to relay driving circuits 229/234.

When the air suction grille arrives at the lower-limit position during the downward movement, the lower-limit switch 222 works to stop the air suction grille 9. On the other hand, when the air suction grille 9 abuts against an obstacle such as a chest or the like and the suspension cords 31 are slacked in the course of the downward movement, the detection switch 223 works to stop the air suction grille 9. In this embodiment, the control circuit 225 is further provided with a stop keeping function for keeping the stop status of the air suction grille 9. With this function, the air suction grille 9 is not moved unless the rotary switch 220 is operated.

Further, as described above, when the air suction grille 9 abuts against the upper limit switch 221 during the upward movement, the timer of the control circuit 225 works to stop the air suction grille 9 after the predetermined time elapses.

In this embodiment, the controller is newly provided with the motor operating voltage detection circuit 240. The motor operating voltage detection circuit 240 monitors the voltage when the motor 140 is actuated, and detects whether the load current of the motor 140 is in the normal range. If the load current of the motor 140 exceeds a value (for example, 600mA) which is determined by the rating of the motor, the motor 140 is stopped. With this control operation of the motor operating voltage detection circuit 240, the problems 2 of the first and second embodiments can be solved.

A damping (regenerative) resistor 227 is provided to prevent the motor 140 from rotating due to its dead weight of the air suction grille 9 in the stop state, and it is connected to the motor 140 in series when the motor 140 is stopped. The relay 228/223 serves to release the connection between the damping resistor 227 and the motor 140.

Under the control of the control circuit 225, the relay driving circuit 229/234 drives the relay 228/231 for the upward movement of the air suction grille 9 and the relay 233/236 for the downward movement of the air suction grille 9. A delay circuit is built in the relay driving circuit 229/234 to first separate the motor driving relay 231 (231a)/236 (236b) from the damping resistor 227 (i.e., separate the power source 239 from the motor 140), and then energize the relay 228/233 to connect the damping resistor 227 to the motor 140 after receiving the contact input of the relay 228/233. Therefore, at

the time when the motor 140 is stopped, the relay 228/233 is reset with a time lag from the separation of the damping resistor 227 from the motor driving relays 231/236. Accordingly, the power source 239 and the damping resistor 227 are prevented from being short-circuited to each other, so that the problem (3) of the first and second embodiments can be solved.

In the above-described embodiment, the transistors 230/232 (for upward movement) and 235/237 (for downward movement) are used to drive the relays, however, another simple method using no transistors may be used.

Further, in the above-described embodiment, a power source system is divided into two power sources of the power source 226 for the relay/control circuit 226 and the other power source 239 used to drive the motor. This is because the load of the motor 140 greatly varies between the upwardly moving operation and the downward moving operation, so that the variation of the power source voltage becomes large and thus it is impossible to set a reference voltage for detecting the motor operating voltage, and also because the operation of the control circuit 225 is stabilized.

The motor operating voltage detection circuit 240 starts to monitor the voltage after a predetermined time (for example, 50 to 300ms) elapses from the start of rotation of the motor 140 so that rush current flowing at the time when the motor starts to rotate is erroneously detected as an overload.

Reference numerals 231a and 236b represent an up-switch and a down-switch respectively.

Next, the operation of the controller of Fig. 9 will be described.

When the motion of the air suction grille 9 is shifted from the stop motion to the downward motion by operating the rotary switch 220, the control circuit 225 operates the relay driving circuit 234 for the downward movement to move the air suction grille 9 downwardly if it is supplied with no input from the lower-limit switch 222, the slack detection switch 223 and the motor operating voltage detection circuit 240. The relay driving circuit 234 for the downward movement first switches on the transistor 235 to energize the relay 223. The relay 223 opens one contact point thereof to separate the damping resistor 227 from the motor 140, and closes the other contact point thereof. Upon reception of an input at the contact point, the relay driving circuit 234 switches on the transistor 237 to energize the relay 236. Through this operation, the down-switch 236b is closed, so that current flows from the right side to the left side in the motor 140 as shown in Fig. 9 and the motor is forwardly rotated to move the air suction grille 9 downwardly.

When the lower-limit switch 222 or the slack detection switch 223 is actuated to close the contact point thereof in the course of the downward movement of the air suction grille 9, the control circuit 225 stops the output to the relay driving circuit 234. When the contact point of the switch 222/223 is opened in the above state,

the control circuit 225 supplies no output to the relay driving circuit 234, so that the air suction grille 9 is kept to be stopped. Accordingly, the problem (1) of the first and second embodiments can be solved. The keeping of the stop status is released by operating the rotary switch 20.

When no output is supplied from the control circuit 225, the relay control circuit 234 first switches off the transistor 237 to interrupt the current from flowing in the relay 236 and release the relay 236b for the downward movement, whereby the power supply to the motor 140 is interrupted to stop the motor 140. Thereafter, the transistor 235 is switched off after lapse of 5 to 20ms by the delay circuit to connect the damping resistor 227 and the motor 140 to each other.

When the contact point of the rotary switch 220 is switched to the upwardly moving state by operating the rotary switch 220, the relay driving circuit 229 for the upward movement is operated to move the air suction grille 9 upwardly. The relay driving circuit 229 for the upward movement first switches on the transistor 230 to drive the relay 228. The relay 228 releases one contact point thereof to separate the damping resistor 227 from the motor 140 and closes the other contact point thereof. Upon reception of an input at the contact point, the relay driving circuit 234 switches on the transistor 232 to energize the relay 231. With this operation, the up-switch 231 is closed, so that the current flows into the motor 140 from the left side to the right side in Fig. 9 to rotate the motor 140 so that the air suction grille 9 is moved downwardly.

In the upward motion of the air suction grille 9, the current flows in the opposite direction to that in the downward motion of the air suction grille 9. The upward motion of the air suction grille 9 is stopped on the basis of the input from the upper-limit switch 221 or the motor operating voltage detection circuit 240. Upon receiving this input, the control circuit 225 stops its output to the relay driving circuit 229 after a predetermined time elapses. When the input from the control circuit 225 is stopped, the relay driving circuit 229 switches off the transistor 232 to cut off the current to the relay 231. Through this operation, the up-switch 231a is opened and the power supply to the motor 140 is cut off to stop the rotation of the motor 140. In this state, there is no relay which is supplied with current even when the rotary switch 220 selects the upward movement of the air suction grille 9. Accordingly, the problem (4) of the first and second embodiments can be solved. In order to downwardly move the air suction grille 9, the rotary switch 220 is operated twice.

Figs. 10A and 10B are flowcharts for showing the downward moving operation and the upward moving operation of the air suction grille 9 as described above respectively.

In the downwardly moving operation of Fig. 10A, the rotary pull switch is switched to select the downward movement (down ON) in step 300, and it is judged in step 302 whether the down limit switch 222 is switched

to ON. If the down limit switch 222 is not switched on, the process goes to step 304 to judge whether the suspension cords 31 are slacked. If the slack preventing switch 223 is judged not to be switched on in step 304, the process goes to step 306. In step 306, the relay 233 is switched on, and in step 308 the relay 236 is switched on. If a predetermined time of 100msec has elapsed in step 309, the process goes to step 310. If in step 310 an overload of the motor is detected by the detection circuit 240, the process goes to step 318 after 4 seconds elapses in step 312. On the other hand, if in step 310 no overload is detected for the motor by the detection circuit 240, the process goes to step 314. If in step 314 at least one of the lower-limit switch 222 and the slack switch 223 is switched on, the process goes to step 318. On the other hand, if in step 314 neither the switch 222 nor the switch 223 is switched on, the process goes to step 316. If the switch 316 is not switched off (i.e., switched on), the process returns to step 310. On the other hand, if the switch 220 is switched off in step 316, the relay 236 is switched off in step 318. After 20msec elapses in step 320, the relay 233 is switched off in step 322 and the downwardly moving operation is stopped in step 324.

The upwardly moving operation (step 400/424) of Fig. 10B is substantially similar to the downwardly moving operation except for the operating elements, and thus the description thereof is omitted.

Figs. 11 and 12 shows operation functions which are performed in response to various input signals during various driving operations of the air suction grille, and output results thereof.

As described above, according to the present invention, the power supply status to the elevating motor for the air suction grille is switched by changing over the operation switch. Therefore, the elevating motor is repetitively subjected to the forward rotation/reverse rotation in accordance with the power supply state, whereby the air suction grille can be elevated upwardly and downwardly. Further, since the air suction grille can be stopped at any position by switching the operation switch, the air suction grille can be stopped at any suitable position so as to meet various conditions, for example, when the air suction grille is required to be located at a lower place or is required not to be located at a lower place in accordance with the mount position of the air conditioner. Therefore, the exchange work of the filter which is the final purpose of the above operation can be facilitated.

Further, the air suction grille is supported with plural suspension cords so as to be freely movable upwardly and downwardly. In this case, even when the air suction grille is inclined at the upper-limit position due to unbalance in length among the suspension cords, the elevating motor continues to be actuated until the timer counts the predetermined time, and thus a pulley around which a shorter suspension cord is wound is idled at the upper-limit time for that time. Therefore, the winding operation of the suspension cords is continued until a

longer suspension cord is perfectly wound around another pulley, so that the inclined attitude of the air suction grille is corrected to the horizontal attitude and no gap occurs between the face panel and the air suction grille at the upper-limit position of the air suction grille.

Further, since the air suction grille repetitively makes the downward motion, the stop motion, the upward motion and the stop motion in this order by pulling the rotary pull switch, the air suction grille can be stopped at any position by a simple operation.

Still further, when the downwardly-moving air suction grille abuts against an obstacle such as a chest or the like and thus the downward motion thereof is forcedly stopped, the driving of the elevating motor is stopped and thus the air suction grille is stopped at that position, whereby the safety can be ensured. When the air suction grille is linked to the suspension cords, the slack of the suspension cords is detected in the course of the downward motion thereof to stop the subsequent driving of the elevating motor. Therefore, the air suction grille continues to stop at that position, and the suspension cords are prevented from being entangled, whereby the safety can be more ensured.

Still further, according to the in-ceiling mount type air conditioner of the present invention, the circuit for monitoring the operating voltage of the motor is provided to prevent the motor from continuing to rotate under an overload, so that the overload driving of the motor can be reduced to the practical level. In addition, the stop keeping circuit is provided in the control circuit to prevent the slack preventing limit switch from being continuously actuated. Therefore, once the air suction grille is stopped, it continues to stop at that position unless the operation switch is operated again.

Further, the delay circuit is provided in the relay driving circuit to preferentially resetting the motor driving relay, so that no short-circuit occurs in the circuit. In addition, since the stop operation of the air suction grille at the upper-limit position is carried out by resetting the coil, no current flows in the coil when the air suction grille is stopped.

Claims

1. An in-ceiling mount type air conditioner in which an air suction grille is supported so as to be freely movable upwardly and downwardly by an elevating motor for the air suction grille, characterized by including an operation switch which can switch a power supply status from a power source to the elevating motor for the air suction grille.
2. The in-ceiling mount type air conditioner as claimed in claim 1, wherein said operation switch comprises a rotary type pull switch, and said air suction grille repetitively makes a series of a downward motion, a stop motion, an upward motion and a stop motion in this order.

3. The in-ceiling mount type air conditioner as claimed in claim 1, further including stop means for stopping the driving of said elevating motor when the downward motion of said air suction grille is forcedly stopped during the downward motion of the air suction grille.
4. The in-ceiling mount type air conditioner as claimed in claim 1, wherein said air suction grille is supported by suspension cords, and the draw-out/rewinding operation of said suspension cords is performed by the rotation of said elevating motor, whereby said air suction grille is upwardly and downwardly moved.
5. The in-ceiling mount type air conditioner as claimed in claim 4, further including stop means for detecting slack of said suspension cords and stopping the movement of the elevating motor when said suspension cords are slacked during the downward motion of said air suction grille.
6. The in-ceiling mount type air conditioner as claim 4, further including timer means for continuing the rewinding operation of said suspension cords for a predetermined time when said air suction grille reaches the upper limit position thereof.
7. The in-ceiling mount type air conditioner as claimed in claim 1, further including a monitoring circuit for monitoring a driving voltage of said elevating motor.
8. The in-ceiling mount type air conditioner as claimed in claim 7, wherein when the driving voltage of said elevating motor which is detected by said monitoring circuit is above a predetermined value, said elevating motor is stopped after the predetermined time elapses .
9. The in-ceiling mount type air conditioner as claimed in claim 1, further including stop keeping circuit for keeping the stop status of said air suction grille until said operation switch is actuated again once the elevating movement of said air suction grille is stopped.
10. The in-ceiling mount type air conditioner as claimed in claim 1, further include a relay circuit which comprises plural relays and is adapted to control the elevating movement of said elevating motor, and said relay circuit is provided with a delay circuit for preferentially resetting a relay for driving said elevating motor and then resetting the other relays after a time lapse from the reset of said elevating motor driving relay.
11. The in-ceiling mount type air conditioner as claimed in claim 1, further including a relay circuit which comprises plural relays and is adapted to control

the elevating movement of said elevating motor, all of said relays of said relay circuit being allowed to be reset when said air suction grille is stopped at the upper limit position thereof.

5

12. An in-ceiling mount type air conditioner which is mounted in a ceiling while embedded in the ceiling and is adapted to air-condition room air through heat-exchange with the room air, comprising:

10

an air suction grille for sucking the room air;
suspension cords having one ends which are secured to said air suction grille;

pulleys around which the other ends of said suspension cords are wound;

15

a clutch for idling each of said pulleys when a predetermined or more load is applied to said pulleys;

a shaft linked to said pulleys through said clutch;

20

an elevating motor which is linked to said shaft and rotates said pulleys through a rotational motion thereof to draw-out/rewind said suspension cords and elevate said air suction grille;

an operation switch for switching a power supply status of a power source to said elevating motor;

25

an upper-limit position detector for detecting the upper-limit position of said air suction grille;
a timer for counting a predetermined time from the actuation of said upper-limit position detector; and

30

a controller for stopping said elevating motor after said air suction grille reaches the upper-limit position and said timer counts the predetermined time.

35

13. The in-ceiling mount type air conditioner as claimed in claim 12, wherein said controller keeps said air suction grille to stop when said air suction grille is forcedly stopped.

40

45

50

55

FIG. 1

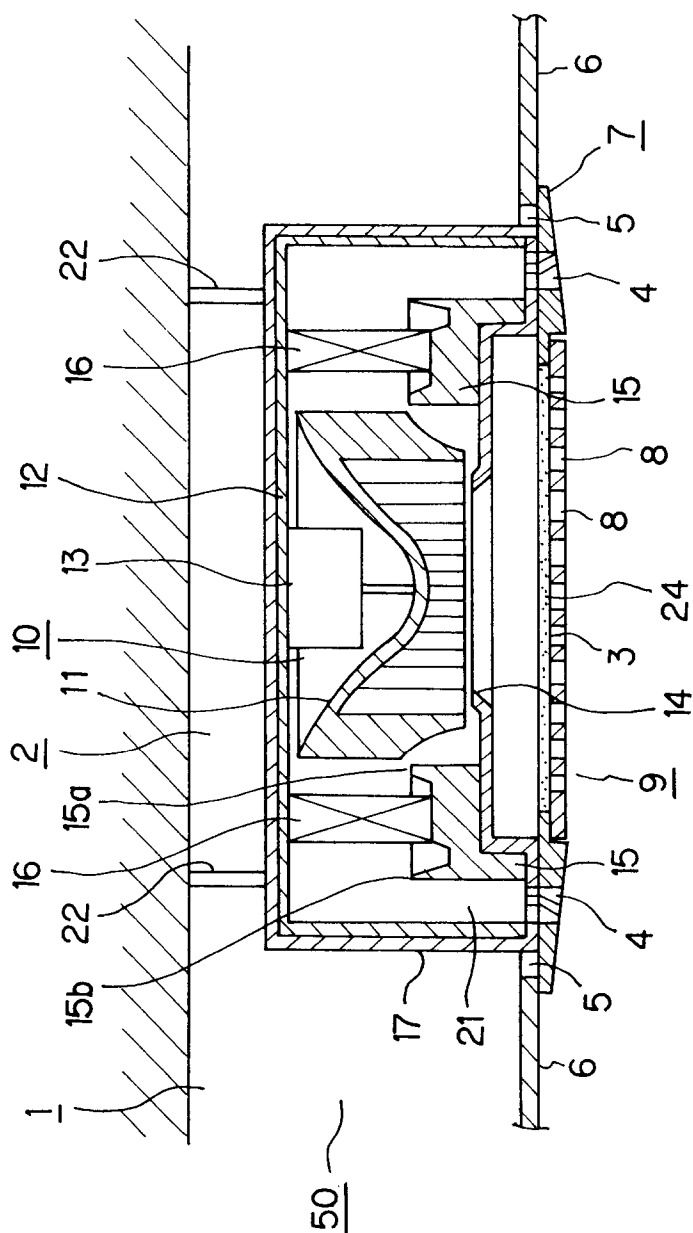


FIG. 2

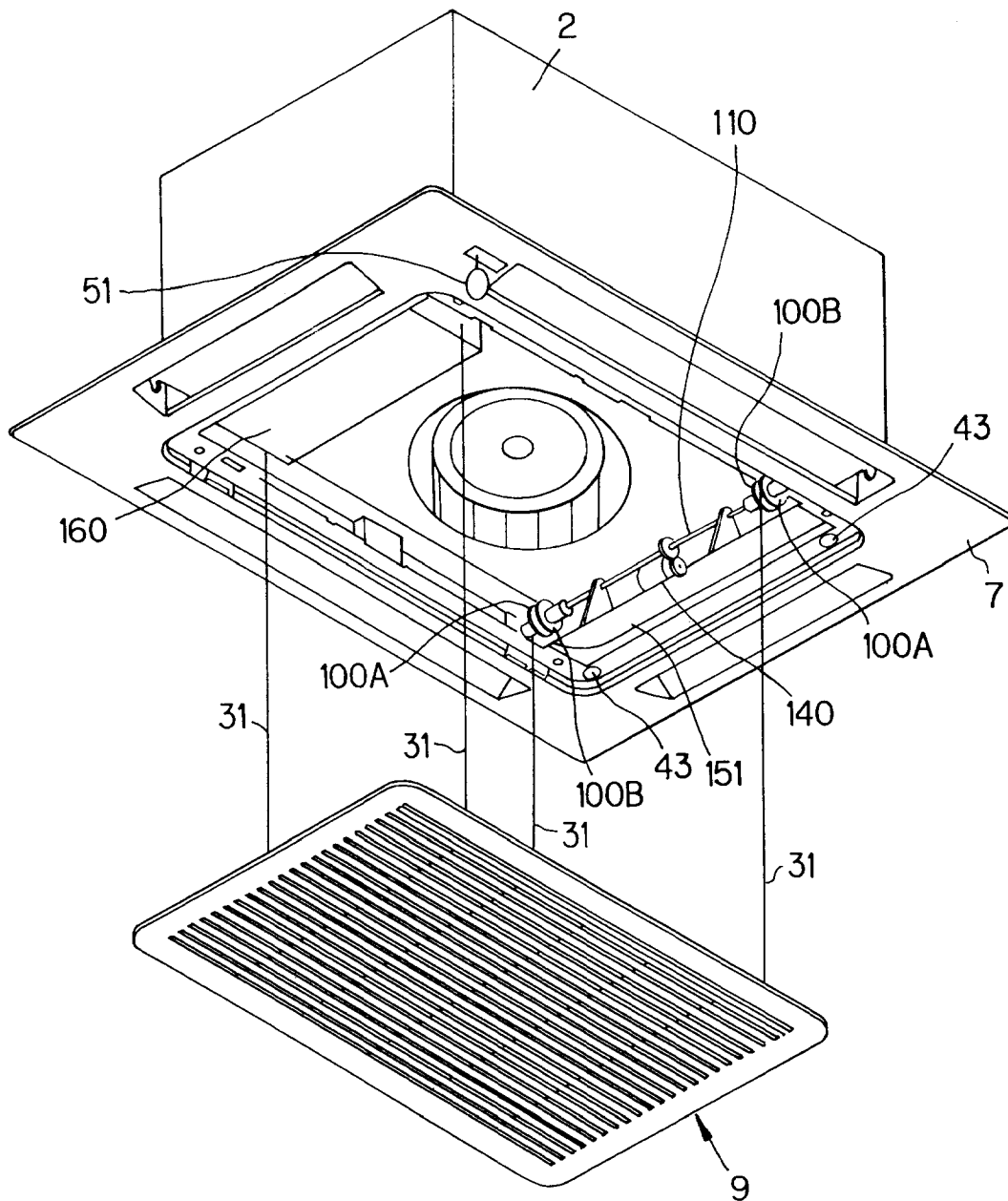


FIG. 3

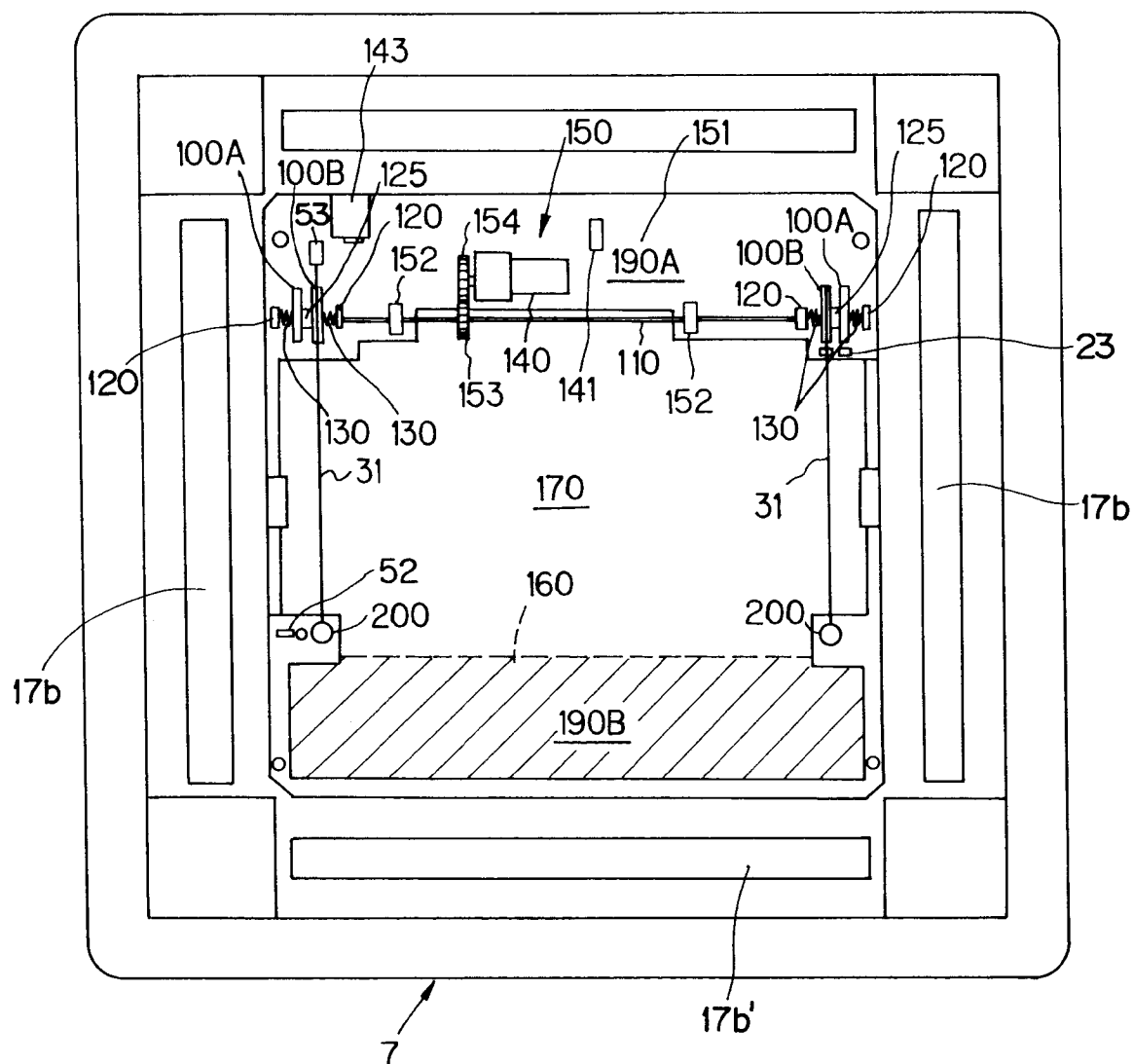


FIG. 4B

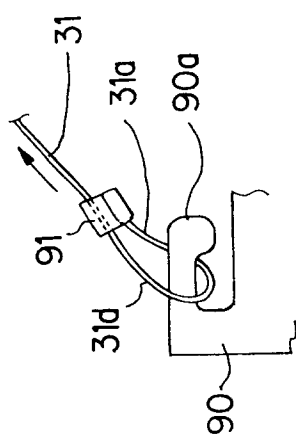


FIG. 4A

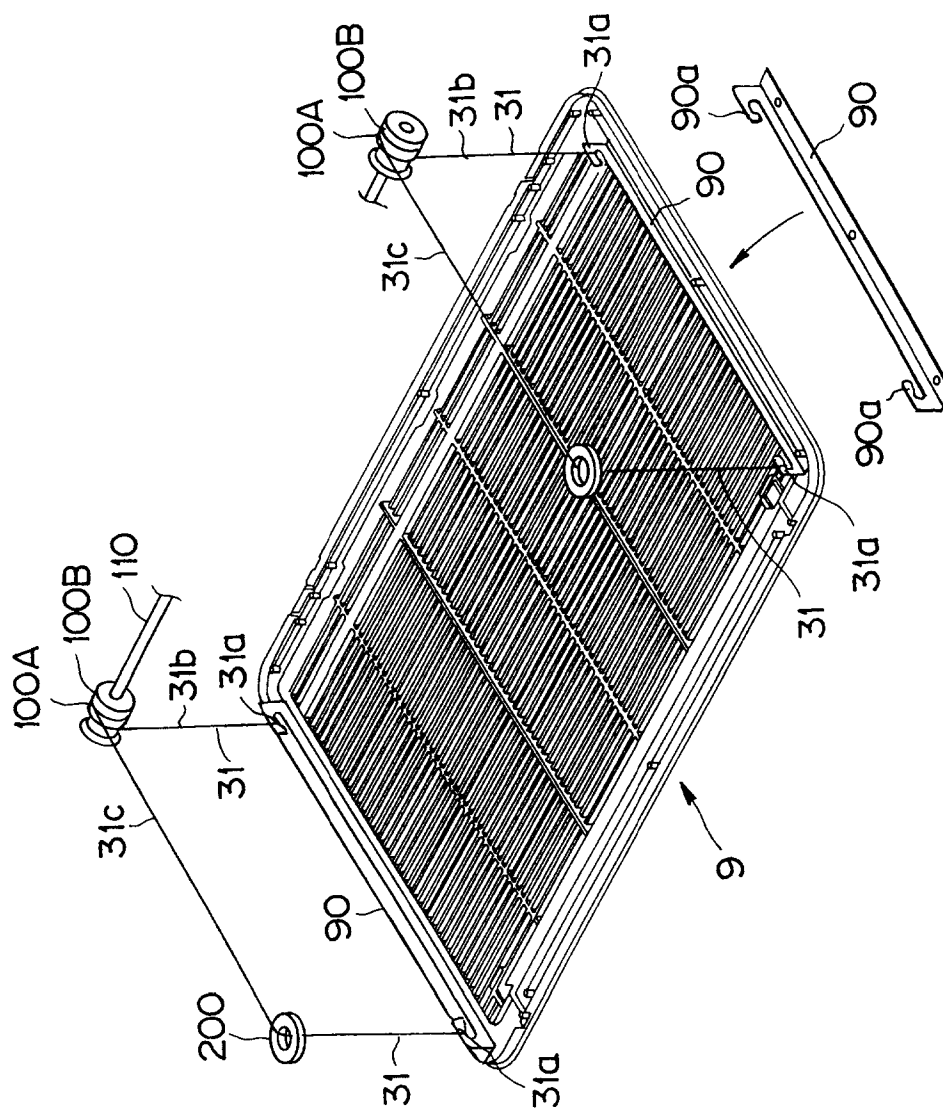


FIG. 5

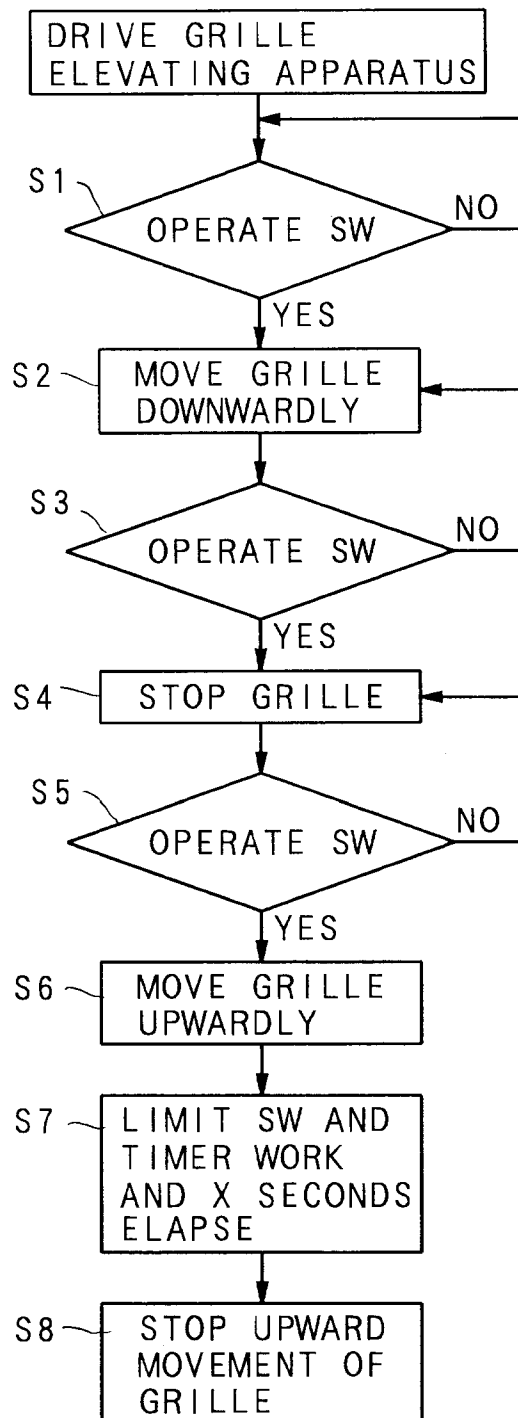


FIG. 6

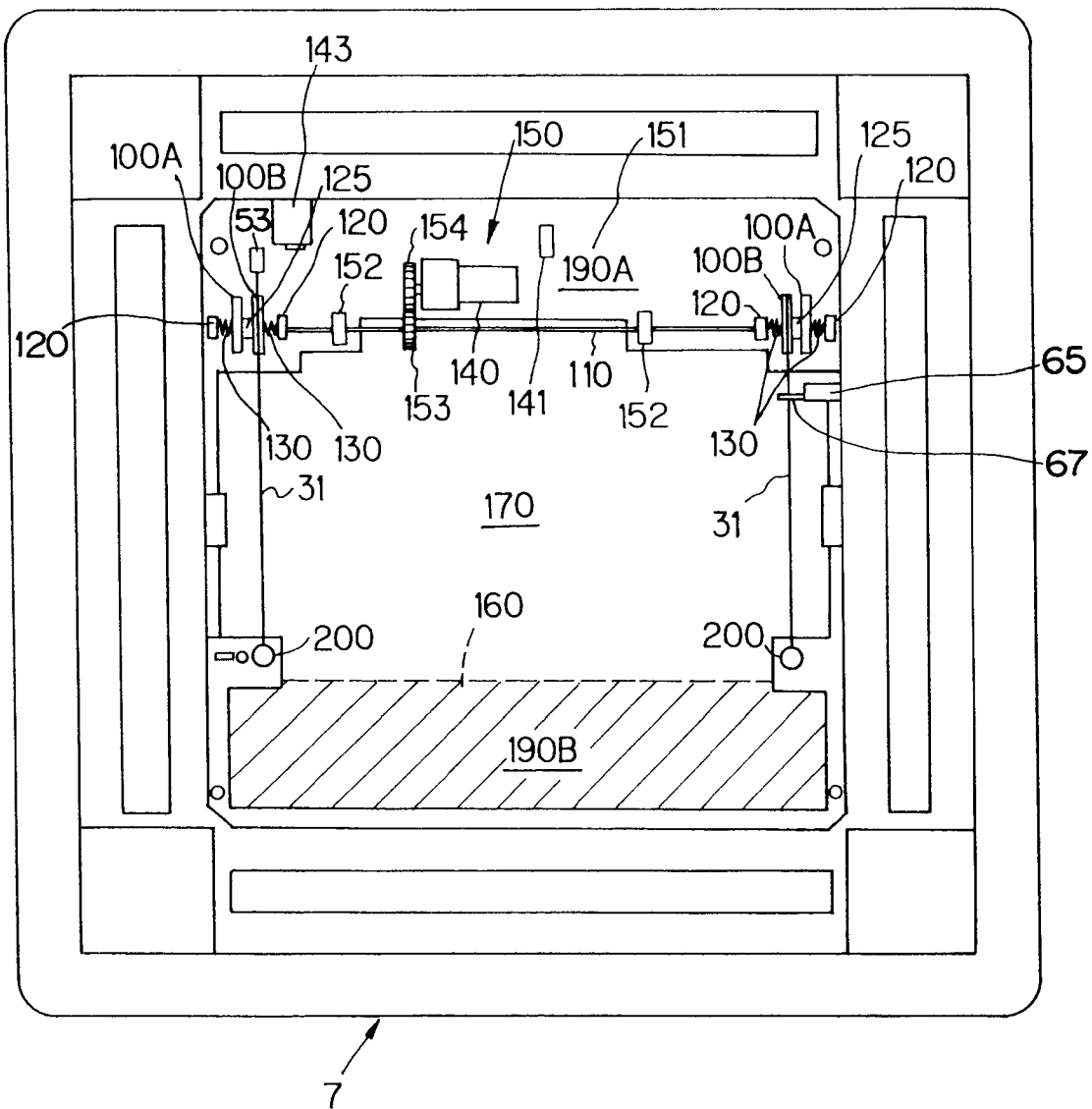


FIG. 7

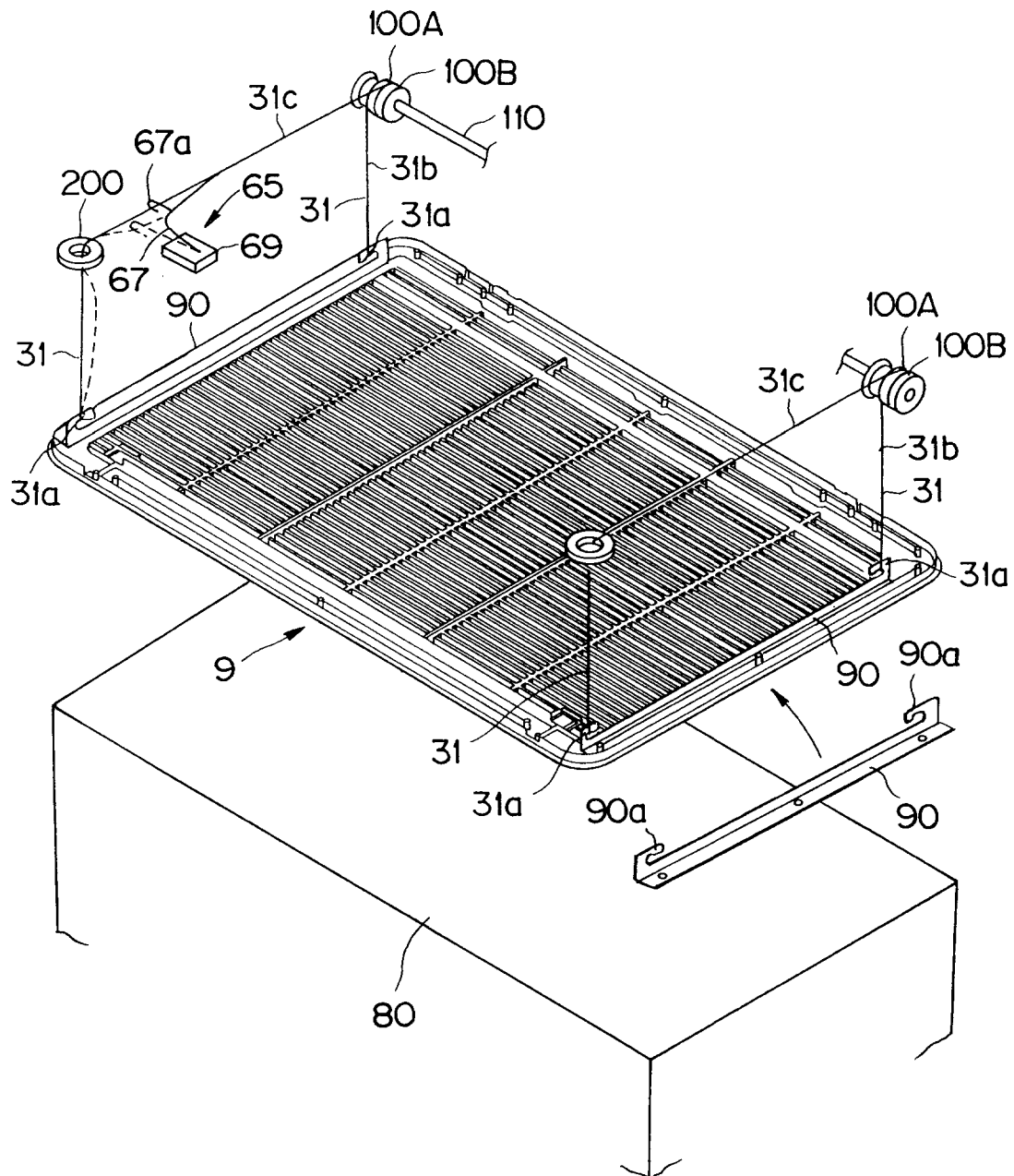


FIG. 8

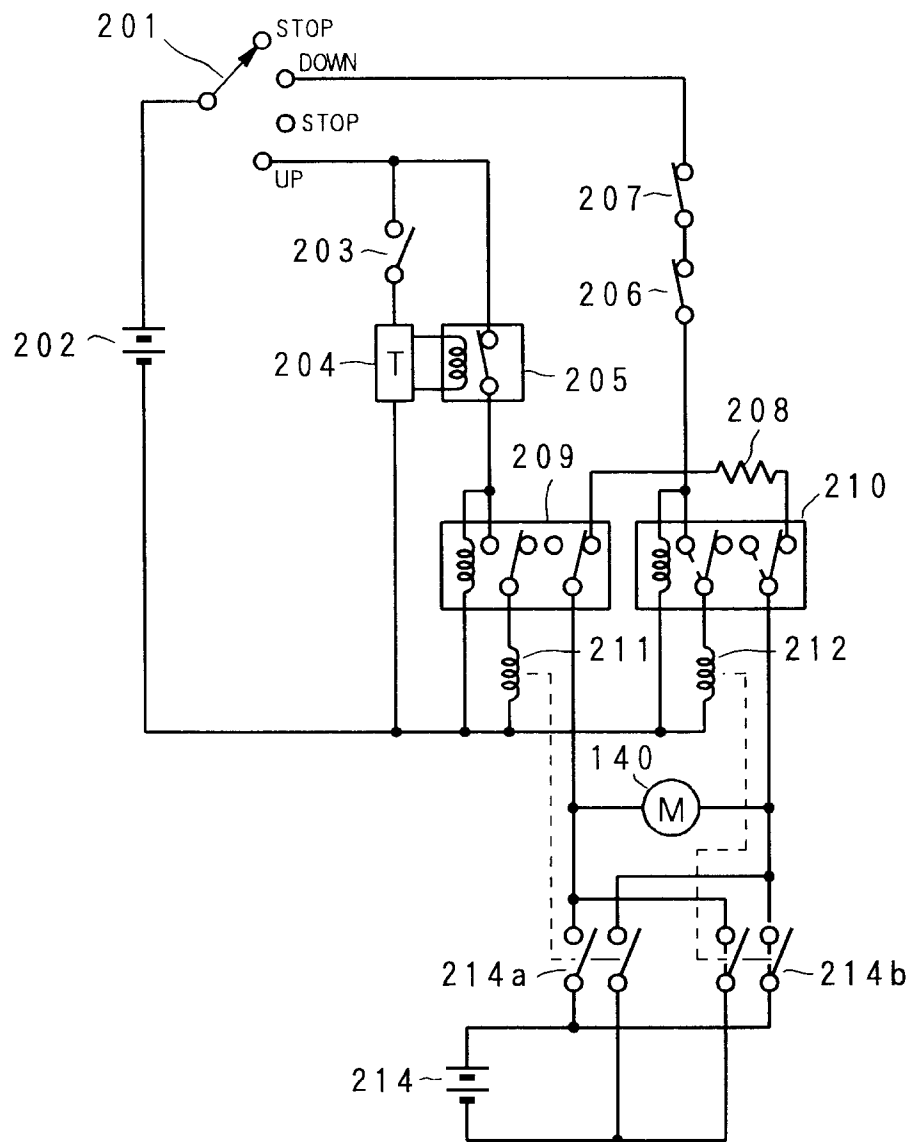


FIG. 9

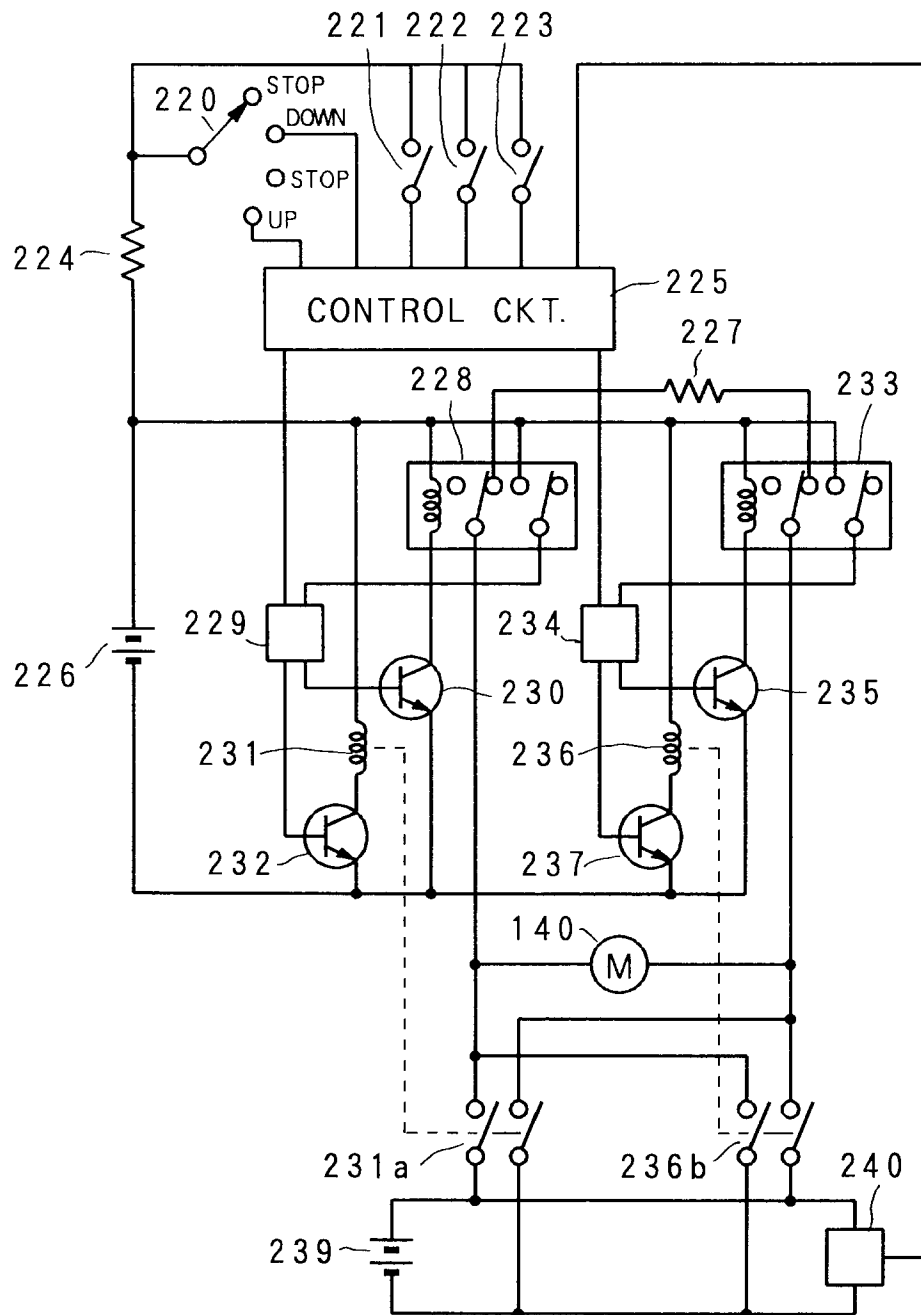


FIG.10A

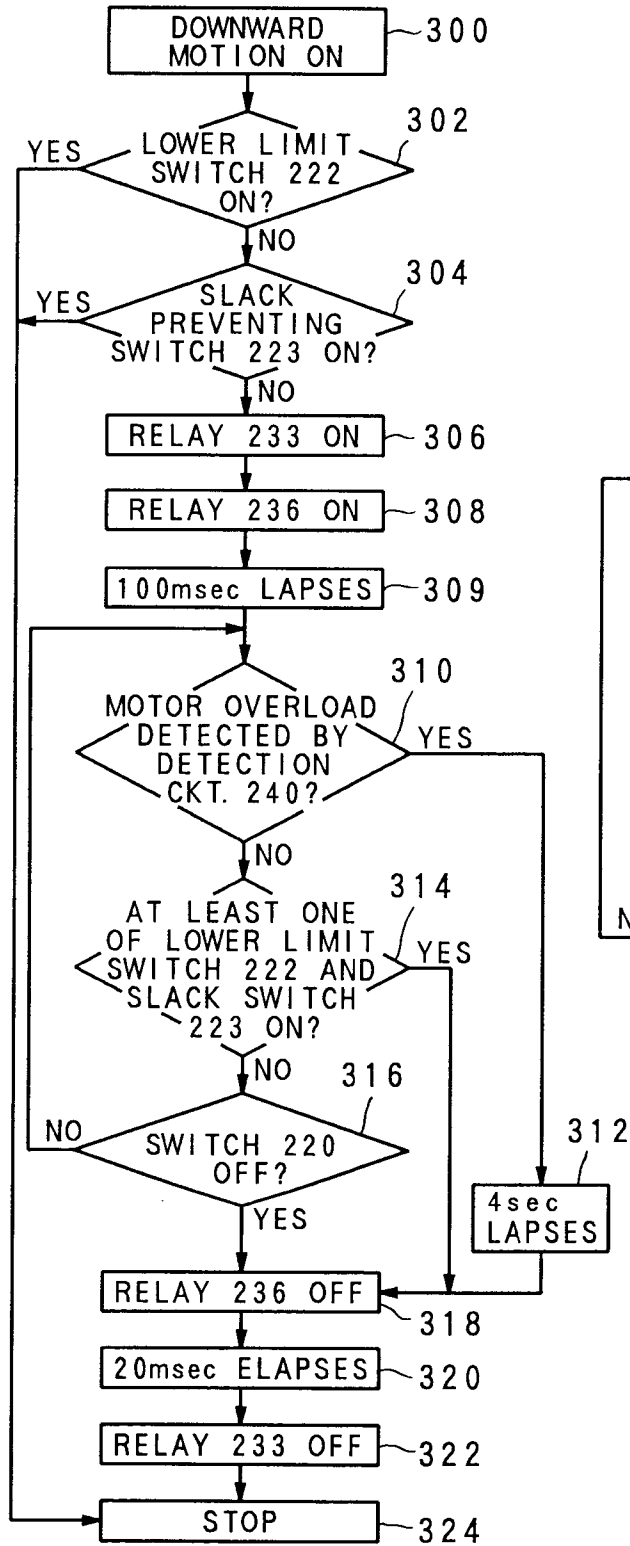


FIG.10B

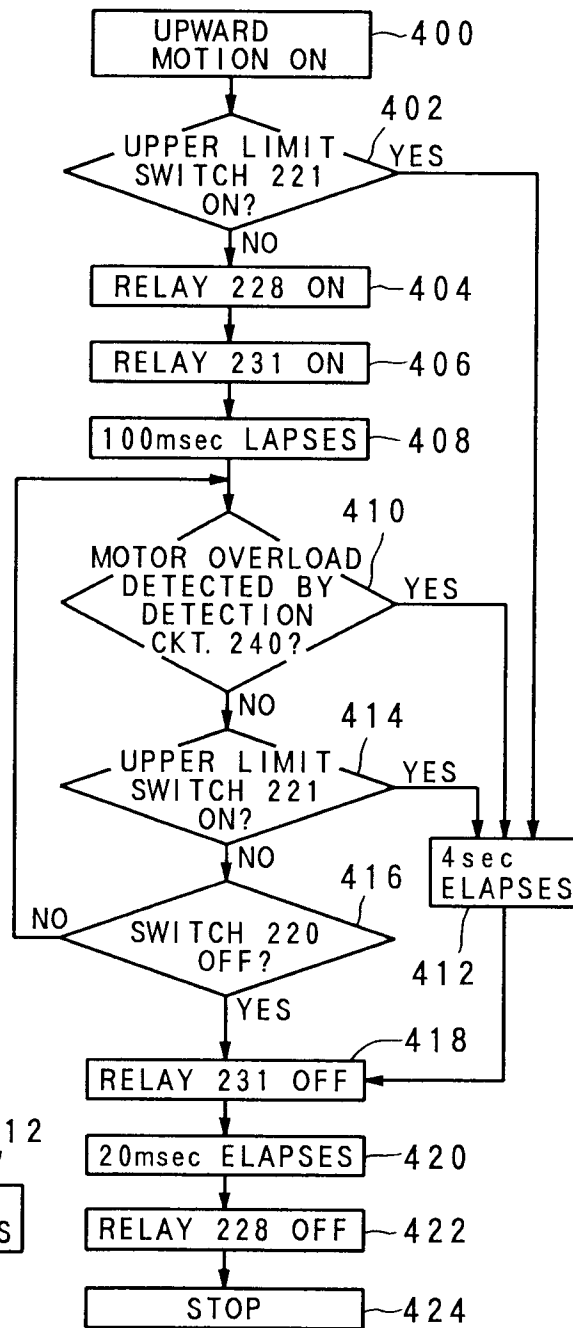


FIG.11

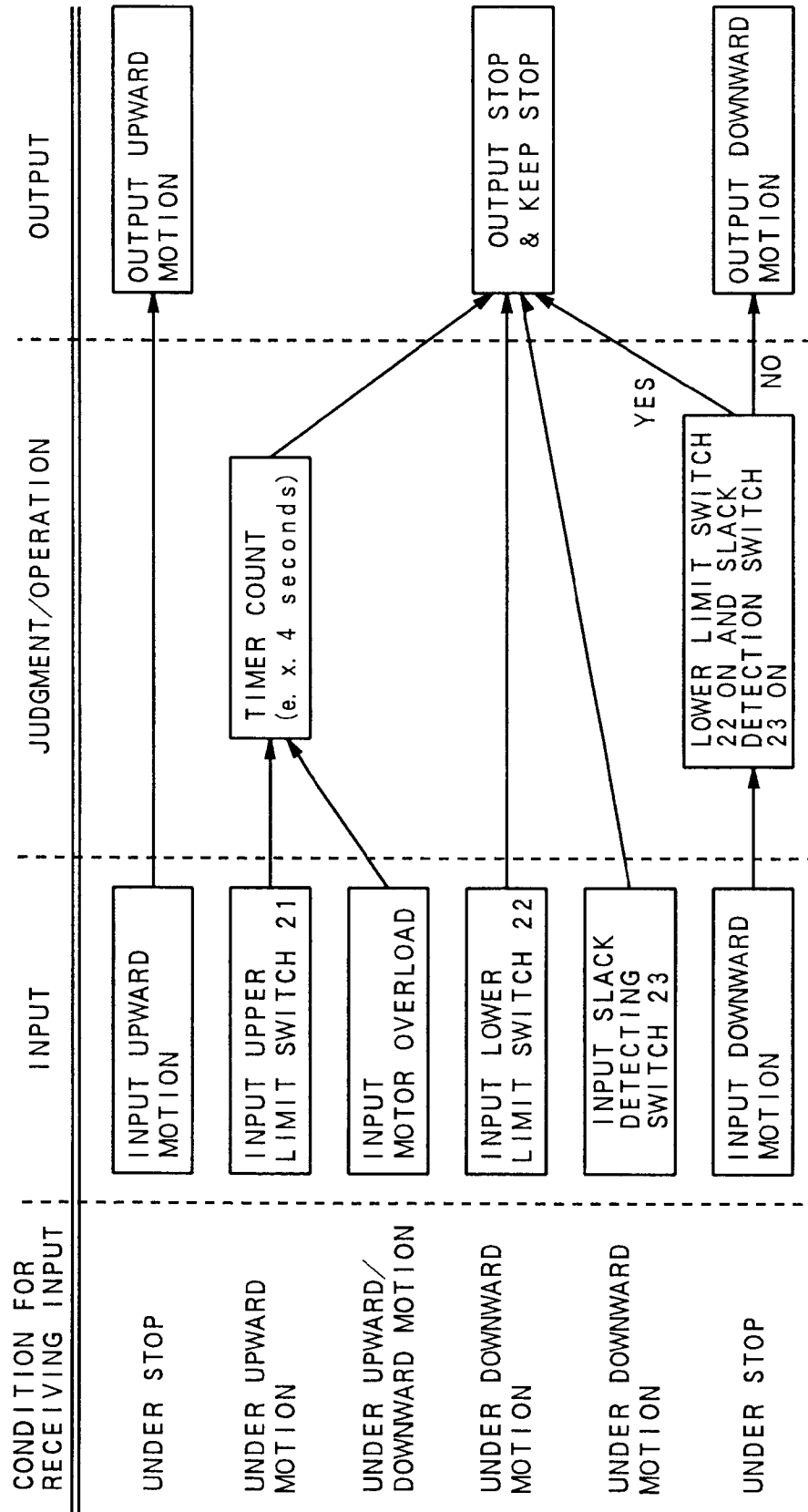


FIG. 12

