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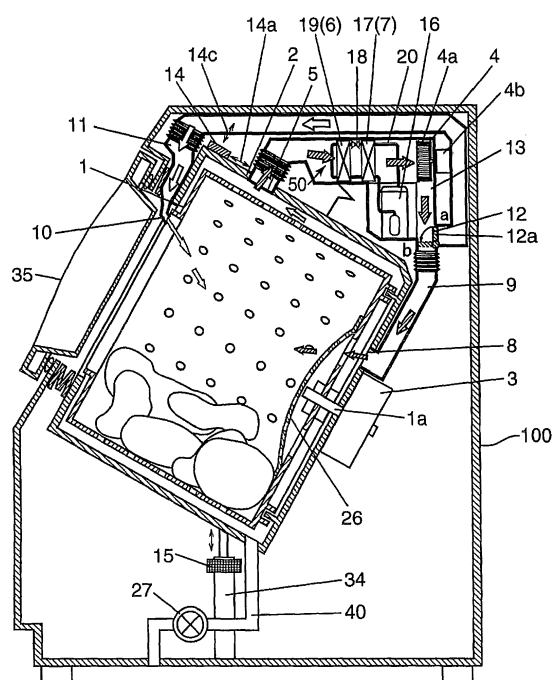
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(54) **Drying machine and washing and drying machine**

(57) A drying machine includes a first air duct 9 with a first blowoff opening 8 opened at a rear side of a drum 1; a second air duct 11 with a second blowoff opening 10 opened at a front side of the drum 1, the second blow-off opening 10 having a smaller cross-sectional blowing area than that of the first blowoff opening 8; wherein an air duct is switched between said first air duct and said second air duct in a drying process based on a result of determination by the entanglement determination section which determines if an entanglement of clothes has occurred in the drum 1, and where the first air duct 9 is selected, drying air of larger airflow quantity than that where the second air duct 11 is selected is spouted from the first blowoff opening 8, and where the second air duct 11 is selected, drying air at higher pressure and higher speed is spouted from the second blowoff opening than that where the first air duct 9 is selected.

FIG.1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a drying machine for drying clothes and a washing and drying machine for washing and drying clothes.

2. Description of the Related Art

[0002] Conventionally, in the drum-type drying machine and the washing and drying machine, drying air is spouted in the drum through the air duct to contact clothes to deprive moisture from clothes to dry clothes. In the meantime, the resulting high moisture drying air is exhausted to the air duct outside the drum. In particular, the drying of clothes is done in the limited narrow space in the drum. Therefore, clothes twine mutually in the drying, the drying air does not contact the entangled parts of clothes, and the drying time required increases. Moreover, there is a problem in that clothes after the lingua of the drying enter the state that the solid wrinkle attaches while having twined. Various methods are considered for the solution to these problems (For instance, Japanese laid-open patent publication No. Hei 7-185196/1995).

[0003] The conventional drum-type drying machine and the washing and drying machine of Japanese laid-open patent publication No. Hei 7-185196/1995 includes a drum for storing clothes to be dried, a motor which rotates the drum in reciprocal directions, a hot air supplying unit with a fan for supplying hot air into the drum and a heater. The foregoing conventional drum-type washing and drying machine further includes a load variation amount detection means that detects an amount of variation in the motor load per rotation of the drum, wherein it is determined that an entanglement of clothes to be dried has actually occurred when the amount of variation in the motor load per rotation of the drum becomes a predetermined value or above, and the motor is driven in reverse direction. Namely, only when the entanglement of clothes to be dried has actually occurred, the reversal driving of the drum is carried out. As a result, a driving outage time of the motor for the reverse driving of the drum can be minimized, and a time required for drying can be reduced.

[0004] With the foregoing conventional structure, however, where the long-sleeved clothes (sports shirt and long trousers etc.) are mutually entangled strongly, in particular, the clothes cannot be unraveled sufficiently by merely carrying out the reverse driving of the drum.

[0005] In addition, when the drying of a large amount of clothes is performed in the limited space of the drum, clothes are difficult to be moved. Then, the drying air is liable to reach only limited parts of the clothes that face the blowoff opening. On the other hand, the drying air cannot reach the clothes positioned away from the blow-

off opening with ease. Therefore, uneven drying levels of the clothes are liable to occur depending on the positions of the clothes in the drum, resulting in uneven finish of the drying of clothes in the drum. Moreover, a longer drying time is increased more than necessary to avoid insufficient drying of the clothes, which causes the problems of a longer time, and a larger heating energy required for drying clothes. As a solution to the foregoing problem, various methods have been proposed (For instance, see Japanese laid open patent publication No. 259549/2008).

[0006] The conventional drum-type washing and drying machine described in Japanese laid open patent publication No. 259549/2008 comprises a blower that inhales air from a water tank and spouts air, a heater that heats air, provided in the downstream of the blower, a switching device that switches the spouting end of the air inhaled by the blower, a front-side blowoff opening provided so as to oppose a drum opening, for spouting air from the switching device in the rotating drum, a back-side blowoff opening provided at the rear side of the rotating drum, for spouting air from the switching device in the rotating drum, and a control section that controls the blower, the heater, and the switching device, etc. Then, the control section controls the switching device in such a manner than the spouting end of the air inhaled into the blower is not switched in the constant rate drying process, and the spouting end of the air inhaled to the blower is switched in the lapse rate drying process. As a result, the drying air spouted from either the front-side blowoff opening or the rear-side blowoff opening in the constant rate drying process. On the other hand, the drying air spouted from the other of the front-side blowoff opening and the rear-side blowoff opening in the lapse rate drying process. Namely, when it is switched to the lapse rate drying process from the constant rate drying process, the drying air is spouted against the washing to which the drying air cannot be reached with ease in the constant rate drying process. As a result, the washing can be dried without irregularity in a short period of time.

[0007] According to the foregoing conventional structure, when the drying operation is carried out using both the lapse rate drying process and the constant rate drying process, the spouting end of the drying air can be switched at a timing of switching to the lapse rate drying process. However, when carrying out the drying operation without having a significant constant rate drying process, there may be no timing for switching the spouting end of the drying air. There are many high performance drum-type washing and drying machines in which directly before the drying process, the clothes are subjected to the spinning process for a long time with high speed rotations (for example, the drum rotation number of 1,500 rpm or above, and the dehydration-rate at the completion of the spinning process reaches 80 % or above). In the drum-type washing and drying machine of such a high dehydration performance, it is likely to be entered the lapse rate drying process when being switched from the

spinning process to the drying process. Therefore, the spouting end of the drying air cannot be switched at the timing of switching from the constant rate drying process to the lapse rate drying process.

[0008] Moreover, the above-mentioned conventional structure only executes the switching of a spouting end of the drying air between the constant rate drying process or the lapse rate drying process. Therefore, the drying process is not carried out while detecting the drying level of the clothes. Moreover, it cannot be determined whether the uneven drying condition of clothes is solved to a sufficient level.

[0009] According to the foregoing structure, the spouting end of the drying air is simply switched between the constant rate drying process and the lapse rate drying process, and the drying operation is not performed while detecting the drying level of the clothes. Furthermore, it is not determined if an uneven drying state has been solved to a sufficient level.

[0010] As described, the foregoing conventional structure has a problem in that it is difficult to surely reduce uneven drying of the clothes.

SUMMARY OF THE INVENTION

[0011] It is an object of the present invention to provide a drying machine and a washing and drying machine, which realize a shorter drying time and suppress generation of wrinkles of clothes to be dried.

[0012] In order to achieve the foregoing object, a drying machine in accordance with one aspect of the present invention includes: a drum for storing clothes to be dried; a drum drive section for rotatably driving said drum; an entanglement determination section for determining if entanglement of clothes has occurred in said drum; a first air duct with a first blowoff opening which is opened to said drum; a second air duct with a second blowoff opening which is opened to said drum, said second blowoff section having a smaller cross-sectional blowing area than that of said first blowoff section; an air duct switch section which selectively switches between said first air duct and said second air duct; a blower section which blows drying air into said drum from said first blowoff opening when said first air duct is selected for blowing drying air into said drum, and blows drying air into said drum from said second blowoff opening when said second air duct is selected, said drying air from said first blowoff opening being of larger airflow quantity than said drying air from said second blowoff opening; and a control section which controls said air duct switch section based on a result of determination by said entanglement determination section so as to selectively switch between said first air duct and said second air duct in a drying process.

[0013] According to the foregoing arrangement, it is possible to provide a drying machine and a washing and drying machine, which effectively solve the entanglement of the clothes in the drying process while reducing power consumption, and which realize a shorter drying time and

suppress generation of wrinkles of clothes to be dried.

[0014] In order to achieve the foregoing object, the drying machine in accordance with another aspect of the present invention includes: a drum for storing clothes to be dried; a drum drive section for rotatably driving said drum; a blower section for blowing drying air into said drum; a first air duct with a first blowoff opening which is opened at a rear side of said drum; a second air duct with a second blowoff opening which is opened at a front side of said drum; an air duct switch section which selectively switches between said first air duct and said second air duct; an oscillation detection section which detects an oscillation of said drum; and a control section which controls the air duct switch section based on a result of detection by said oscillation detection section to selectively switch between the first air duct and the second air duct in a drying process.

[0015] According to the foregoing structure of the present invention, it is possible to realize a drying machine and a washing and drying machine which surely reduce uneven drying of clothes by switching the blowoff opening of the drying air while accurately detecting the drying level based on an output value of the oscillation detection section.

[0016] These and other objects, features and advantages of the present invention will become more apparent upon the reading of the following detailed description. Further, advantages of the present invention will become more apparent in the following description with reference to accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a cross-sectional side view showing the schematic configuration of the drum-type washing and drying machine in accordance with one embodiment of the present invention.

Fig. 2 is a block diagram showing the schematic configuration of the drum-type washing and drying machine of Fig. 1.

Fig. 3 is a perspective view showing the schematic configuration of one example of an oscillation detection section of the drum-type washing and drying machine.

Fig. 4 is a graph showing output examples of the oscillation detection section of the drum-type washing and drying machine.

Fig. 5 is an explanatory view showing one example of the state of clothes in the drum while the drying process is being carried out.

Fig. 6 is an explanatory view showing another example of the state of clothes in the drum while the drying process is being carried out.

Fig. 7 is a flowchart showing one example of the process of switching the air duct in the drum-type washing and drying machine.

Fig. 8 is a cross-sectional side view showing the schematic structure of the drum-type washing and drying machine in accordance with one embodiment of the present invention.

Fig. 9 is a perspective view showing the schematic configuration of another example of an oscillation detection section of the drum-type washing and drying machine.

Fig. 10 is a flowchart showing another example of the process of switching the air duct in the drum-type washing and drying machine.

Fig. 11 is a block diagram showing the schematic configuration of the drum-type washing and drying machine in accordance with another embodiment of the present invention.

Fig. 12 is a graph showing the relationship between the drying time and an integrated output value of an oscillation detection section 14.

Fig. 13 is a flowchart showing one example of the air duct switching process in the drum-type washing and drying machine.

Fig. 14 is a flowchart showing another example of the process of switching the air duct in the drum-type washing and drying machine.

DETAILED DESCRIPTION OF THE INVENTION

[0018] The following descriptions will explain the drum-type washing and drying machine in accordance with one embodiment of the present invention with reference to figures. The following embodiments are specific examples of the present invention and not of the nature to limit the technical scope of the present invention.

[0019] Fig. 1 is a cross-sectional side view showing the schematic configuration of the drum-type washing and drying machine in accordance with one embodiment of the present invention.

[0020] As shown in Fig. 1, a barrel-shaped drum 1 for storing therein the washing has a bottom surface and is opened at the front. The drum 1 is housed in a barrel housing 2 serving as a water tank for storing washing water, and is supported in a cabinet 100. On the back surface of the barrel housing 2, mounted is a drum drive motor (drum drive section) 3 for rotating the rotation shaft of the drum 1, which is sloped upwards to the front. To the barrel housing 2, connected are a feed duct with a feed valve 25 (see Fig. 2) and a discharge duct 40 with a discharge valve 27.

[0021] The cabinet 100 has a door 35 provided so as to face the opening of the drum 1 so that the user can place the clothes of the washing in and take them out of the drum 1 by opening the door 35.

[0022] On the inner wall of the drum 1, a plurality of projection bodies are provided, and a rotating operation (tumbling operation) is performed in which clothes are lifted up as being caught by these plural projection bodies while rotating the drum 1 at low speed, and the clothes are then dropped from an appropriate height position.

[0023] The drying air for drying the clothes is sent to the blower section 4, and deprives moisture from the washing in the drum 1 and becomes humid. The resulting humid drying air is discharged to the outside of the drum 1 through the discharge opening 5 on the side face of the drum 1. The dehumidifier section 6 dehumidifies the drying air as discharged. The heater section 7 heats the resulting drying air as dehumidified by the dehumidifier section 6. The drying air as being heated is directed either to the first air duct 9 or the second air duct 11, and is then blown again into the inside of the drum 1. Here, the first air duct 9 has the first blowoff opening 8, which is opened at the rear side of the drum 1. On the other hand, the second air duct 11 has the second blowoff opening 10 which is opened at the front side of the drum 1. The first blowoff opening 8 of the first air duct 9 has a larger cross-sectional blowing area than the second blowoff opening 10 so that drying air of larger airflow quantity with smaller loss in pressure can be spouted into the drum 1 as compared to the drying air spouted from the second air duct 11. On the other hand, the second blowoff opening 10 of the second air duct 11 has a smaller cross-sectional blowing area than that of the first blowoff opening 8, so that the drying air of higher pressure and higher speed can be spouted into the drum 1 from the second blowoff opening 10 than the drying air spouted from the first blowoff opening 8.

[0024] For the drum-type washing and drying machine, generally the space between the front side of the drum 1 that rotates and the barrel housing 2 is minimized to avoid the clothes from being caught. Therefore, it is difficult in terms of space to provide a large blowoff opening at small loss in pressure in such a small space. However, it is possible to provide the second blowoff opening 10 with relatively small cross-sectional blowing area which spouts air with high speed and pressure. On the other hand, there is a space room for providing the first blowoff opening 8 with a relatively large opening at the rear bottom of drum 1. Then, by covering the first blowoff opening 8 with a big cover 26 with a high aperture rate consisting of a large number of small holes, the clothes can be prevented from being caught in the first blowoff opening. Therefore, on the rear bottom surface of the drum 1, the first blowoff opening 8 with a relatively small loss in pressure can be provided.

[0025] In the case where the clothes are rotated by rotating the drum 1 with the rotation shaft which is sloped upwards to the front, small clothes such as socks, handkerchiefs, and briefs are liable to be biased to the rear interior of the drum 1. On the other hand, the long sleeved clothes such as underwear of the long sleeve, drawers, long sleeve business shirts; long sleeve pajamas, etc. are liable to be biased to the front interior of the drum 1. When the drying operation is carried out with respect to the mixture of the small clothes and the long sleeved clothes, by spouting the drying air of a large quantity from the first blowoff opening 8 formed in the rear interior of drum 1, the drying air is first reached to the small clothes

biased at the bottom of the drum 1 and then reached to the length large clothes placed in the front of the drum 1 through such small clothes. Therefore, both small clothes and the long sleeved clothes can be dried in an efficient manner. For small clothes in particular, it is possible to dry with relatively few wrinkles. On the other hand, the long sleeved clothes twist easily and have wrinkles easily are liable to be biased to the front interior of the drum 1. In this case, by applying the wind (drying air) from the second blowoff opening 10 at the front of the drum 1, it is possible to increase the drying speed. In this case, by spouting drying air at high speed and high pressure that is spouted from the second blowoff opening 12, the entangled clothes can be unraveled effectively. Furthermore, by spouting the drying air at high pressure and high speed from the second blowoff opening 10 against the long sleeved clothes, the clothes are liable to be stretched and to move well. As a result, the entangled clothes can be unraveled, and the wrinkles can be reduced effectively.

[0026] The air duct switch section 12 is provided at a branch section between the first air duct 9 and the second air duct 11, on the downstream side of the blower section 4. This air duct switch section 12 switches the air duct for the drying air either to the first air duct 9 or to the second air duct 11. The air duct switch section 12 has a drive section (not shown) for rotatably driving the valve 12a which is rotatably supported by the branch section between the first air duct 9 and the second air duct 11. When the valve 12a is rotated to the a-side in Fig. 1 to close the second air duct 11, the first air duct 9 is opened; the drying air blown from the blower section 4 passes in the first air duct 9. On the other hand, when the valve 12a is rotated to the b-side in Fig. 1 to close the first air duct 9, the second air duct 11 is opened, and the drying air blown from the blower section 4 passes the second air duct 11.

[0027] In the air duct 13, the blower section 4 and the air duct switch section 12 are provided, the air passes through the discharge opening 5, the defumidifier section 6 and the heater section 7 in this order, and the drying air is spouted again into the drum 1 either from the first blowoff opening 8 or the second blowoff opening 10, to circulate the drying air in the drum-type washing and drying machine.

[0028] The blower section 4 is provided between the heater section 7 and the air duct section 12, and the drying air heated at the heater section 7 is sent to the downstream side of the air duct 13. When the air duct is switched to the first air duct 9 by the air duct switch section 12, the blowing fan 4a of the blower section 4 is driven in such a manner that the airflow quantity of the drying air which passes the first air duct 9 is of a larger airflow quantity than that of the second air duct 11. On the other hand, when the air duct for blowing drying air is switched to the second air duct 11 by the air duct switch section 12, the blowing fan 4a of the blower section 4 is driven in such a manner that the drying air spouted from the

second blowoff opening 10 of the second air duct 11 is of a predetermined speed that is higher than that of the drying air spouted from the first blowoff opening 8. For example, the velocity of the air that spouted from the first blowoff opening can be set to around 10 m/s, and the velocity of the air that spouted from the second blowoff opening 10 can be set to around 50 m/s or above. However, the velocity of the air spouted from the first blowoff section 8 or the second blowoff section 10 is not limited to the above as long as the velocity of the air spouted from the second blowoff section 10 is higher than that of the air from the first blowoff section 8.

[0029] According to the drum-type washing and drying machine of the present embodiment, the air that passes through the first air duct 9 is of larger airflow quantity than that passes through the second air duct 11, the velocity of the air spouted from the second blowoff section 10 of the second air duct 11 is higher than that from the first blowoff section 8, and based on the result of determination of the entanglement (to be explained later) in the drying process, it is switched between the first air duct 9 and the second air duct 11 by the air duct switch section 12. The discharge opening 5 is provided at position more away from the first blowoff opening 8 than from the second blowoff opening 10 (i.e., the discharge opening 5 is formed at position closer to the second blowoff opening 10 than to the first blowoff opening 8). Therefore, the discharge opening 5 is formed at position more to the front half than the back half. The discharge opening 5 may be provided in a vicinity of the second blowoff opening 10 at the front side of the drum 1 at position most away from the first blowoff opening 8 among positions where the discharge opening 5 can be formed.

[0030] As described, by forming the discharge opening 5 at position closer to the second discharge opening 10 at the front side of the drum 1 and to be away from the first blowoff opening 8, a longer distance can be ensured between the first blowoff opening 8 and the discharge opening 5. As a result, while the air is spouting from the first blowoff opening 8 provided at the back side of the drum 1, the drying air from the first blowoff opening 8 can be widely spread over the space in the drum 1. It is therefore possible to make the clothes contact the drying air in the drum 1 in an efficient manner, and to dry the clothes using small power consumption.

[0031] Incidentally, even where the discharge opening 5 is provided in a vicinity of the second blowoff opening 10, while the air is spouting from the second blowoff opening 10 at the front side of the drum 1, the drying air at high pressure and high speed spouted from the second blowoff opening 10. As a result, the drying air can reach entire space from the front to the back in the drum 1. As a result, a desirable contact between the drying air and the clothes is not disturbed, thereby maintaining the effect of stretching the wrinkles by spouting drying air at high pressure and high speed.

[0032] Moreover, the discharge opening 5 is provided above the drum 1, so that the drying air after having con-

tacted the clothes can be discharged in a sufficient manner. Incidentally, in the drum-type drying machine without washing function, it is possible to form the discharge opening 5 at positions other than the position above the drum 1. For the drum-type washing and drying machine, however, to avoid the effect of the washing water, it is preferable to form the discharge opening at position above the water level of the washing water.

[0033] The second blowoff opening 10 is formed in the front upper portion in the drum 1. Therefore, it is possible to spout the drying air from the second blowoff opening 10 at high pressure and high speed effectively against the moving clothes as being lifted up with the rotations of the drum 1, thereby effectively reducing the wrinkles of the clothes.

[0034] Incidentally, although the explanations of the present embodiment have been given through the case where only one first blowoff opening 8 is provided for the first air duct 9, a plurality of first blowoff openings 8 may be provided. Similarly, in the present embodiment, only one second blowoff opening 10 is provided for the second air duct 11; however, a plurality of second blowoff openings 11 may be provided.

[0035] Under the barrel housing 2, provided is a dumper 34 which supports the barrel housing 2 and attenuates the oscillations of the barrel housing 2 when rotating the drum 1 in the weight unbalanced state due to the clothes as being biased in the drum 1 when carrying out the spinning process or the like. To this bumper 34, mounted is a cloth amount detection section 15 which detects an amount of the clothes by detecting a change in displacement amount, which moves up and down the shaft of the dumper 34 by a change in weight due to clothes in the barrel housing 2 to be supported.

[0036] The drum-type washing and drying machine of the present embodiment adopts the heat pump method which carries out dehumidification and heating, and is provided with a heater 50. This heat pump device 50 comprises a compressor 16 that compresses a refrigerant, a condenser 17 that condenses heat from the refrigerant, that becomes high temperature and high pressure as being compressed, a decompressor 18 which decompresses the refrigerant at high pressure; a heat absorber 36 which deprives heat from the surroundings by the refrigerant which becomes low pressure as being decompressed; and a duct 31 which connects the above four members to circulate therein the refrigerant. The heat absorber 36 in this heat pump device is the dehumidifier section 6, and the condenser 17 is the heater section 7.

[0037] Incidentally, the drum-type washing and drying machine of the present embodiment is not limited to the structure, which dries clothes in the heat-pump system. For example, the dehumidifier section 6 may adopt the water-cooling system that sprays water directly against the drying air.

[0038] As shown in Fig. 2, the drum-type washing and drying machine is provided with the control section 70. This control section 70 controls the sequential operation

of washing, rinsing, spinning process based on the setting information to be input by the user via the input setting section 32 and the monitoring of the operation state in respective sections. For example, in the drying process, the control section 70 controls the rotations of the drum drive motor 3, and operations of the blower section 4, the dehumidifier section 6 and the heating section 7, and further controls the air duct switch section 12 between the first air duct 9 and the second air duct 11. Incidentally, the control section 70 controls washing, rinsing, spinning operations, and displays in the display section 33 the states in the drying process on the display section 33. This control section 70 is made up of, for example, a CPU (Central Processing Unit) not shown, a ROM (Read Only Memory) which stores the program, a RAM (Random Access Memory) which stores a program or data when executing various processes, an input/output interface and a bus which connects these members.

[0039] In the drum-type washing and drying machine, an AC power 23 is rectified by a rectifier 28, and is further rectified by the rectifying circuit made up of a coil reactor 29 and a smooth capacitor 30. Then, the drum drive motor 3 is rotationally driven by the inverter circuit 22 using the DC power as rectified as the drive power. The control section 70 controls the rotations of the drum drive motor 3 based on the drive instructions to be input from the input setting section 32 and the monitoring information in the driving state to be detected by each detection section. Furthermore, the control section 70 controls the operations of necessary load such as a feed valve 25, a discharge valve 27, a blower section 4, a dehumidifier section 6, a heater section 7, etc.

[0040] The drum drive motor 3, for example, includes a stator provided with three phase winding 3a, 3b, and 3c, and a rotor provided with permanent magnet in two poles, and a rotor with a permanent magnet in two poles, and is configured as a DC brushless motor provided with three position detection elements 19a to 19c. This drum drive motor 3 is rotationally controlled by the inverter circuit 22 which permits PWM control by the switching elements 22a to 22f. The rotor position detection signal to be detected by the position detection elements 19a to 19c is input to the control section 70. The control section 70 outputs the control signal to the inverter drive circuit 21 based on the rotor position detection signal, and PWM controls the ON/OFF state of the switching element 22a to 22f based on the rotor position detection signal via the inverter drive circuit 21. As described, the control section 70 controls the conduct with respect to the three-phase winding 3a, 3b, and 3c of the stator, and rotates the rotor of the drum drive motor 3 at a predetermined rotation speed. Incidentally, the control section 70 detects the states in signals a periodic cycle of a signal every time the state of signal in any of the position detection elements 19a to 19c has changed, and computes the rotation speed of the rotor based on the periodic cycle as detected by the rotation number detector 19 as an internal function.

[0041] Above the front opening of the barrel housing 2, provided is an oscillation detection section 14 which detects oscillations or impact of the barrel housing 2. An output value from the oscillation detection section 14 is used for determining if the entanglement of the clothes has occurred in the drying process (detailed explanations will be described later). In the present embodiment, as shown in Fig. 3, as an example of the oscillation detection section 14, adopted as an acceleration sensor is an acceleration sensor, which permits detection of acceleration in three directions (detection directions 14a, 14b and 14c) which intersect at right angles. Here, the detection direction 14a is set in the direction of the rotation shaft 1a of drum 1. When viewed from the front opening of the drum 1, the detection direction 14b is the right and left horizontal direction. The detection direction 14c is a substantially vertical in the top and bottom direction, which is orthogonal to the detection directions 14a and 14b. The oscillation detection section 14 adjusts the mounting direction to the barrel housing 2 so that oscillations in respective directions of the detection directions 14a, 14b and 14c can be monitored. Incidentally, the detection direction of the acceleration sensor is not limited to the detection directions 14a, 14b and 14c, and it may be arranged so as to detect accelerations in other directions.

[0042] The installation position of the oscillation detection section 14 provided in the barrel housing 2 is not particularly limited. However, in the case of adopting the acceleration sensor as the oscillation detection section 14, it is preferable to install the acceleration sensor at position away from a dumper 34, which attenuates oscillations of the barrel housing 2. By installing the acceleration sensor at position away from the dumper 34, it is possible to detect highly sensible oscillations.

[0043] In the present embodiment, as a position for detecting oscillations of the barrel housing 2 with the highest sensitivity, the acceleration sensor is provided in the upper portion on the front opening side of the barrel housing 2. For the acceleration sensor, the acceleration sensor of any of the semiconductor type, mechanical type, and optical type may be used. In particular, the semiconductor acceleration sensor suited for compact size is preferably adopted. In the present embodiment, the acceleration sensor that can detect accelerations in three directions (three axes) of the detection directions 14a, 14b and 14c is detected. However, the number of detection axes of the acceleration sensor is not limited to three. For example, an acceleration sensor of one to three axes that can detect the acceleration in at least one direction of the detection directions 14a, 14b and 14c may be adopted.

[0044] By the way, the acceleration sensor as the oscillation detection section 14 may be used for detecting the weight unbalanced state due to the clothes biased in the drum 1 in the spinning process of the clothes by rotating the drum 1 at high speed. Therefore, the acceleration sensor as the oscillation detection section 14 may be used both for the determination of the occurrence of

the entanglement of the clothes in the drying process and determination of the weight unbalanced state in the spinning process.

[0045] Incidentally, the oscillation detection section 14 is not limited to the acceleration sensor. For example, as shown in Fig. 8, in place of the acceleration sensor, an angular velocity sensor 38 may be adopted as the oscillation detection sensor. The angular velocity sensor 38 detects an angular velocity when the barrel housing 2 is displaced as being oscillated. For example, as shown in Figs. 8 and 9, the installation direction of the angular velocity 38 at the barrel housing 2 is adjusted so that the angular velocity in the rotation direction 38a with an axis in the left and right horizontal direction when viewed from the front opening of the drum 1 can be detected. However, it should be noted here that the rotation direction 38a to be detected by the angular velocity sensor 38 is not limited to this, and it may be arranged so as to detect the angular velocity in other rotation direction. The angular velocity of the barrel housing 2 to be detected by the angular velocity sensor 38 is the same irrespectively of the position of the barrel housing 2. For the angular velocity sensor 38, it is not necessary to be provided at position away from the dumper 34, and the degree of freedom for the installation position is high. For angular velocity sensor 38, for example, a mechanical type, fluid type or optical type gyroscope, or the like may be adopted. In particular, the mechanical type (oscillation type) gyroscope suited for compact size is preferably adopted.

[0046] In the present embodiment, explanations have been given through the case where as the oscillation detection sensor 14, only one acceleration sensor shown in Fig. 1 or the angular velocity sensor 38 shown in Fig. 8 is provided at the barrel housing 2. However, the present invention is not intended to be limited to this, and for the oscillation detection sensor 14, plural acceleration sensors or plural angular velocity sensors 38 may be provided at the barrel housing 2. Furthermore, it may be arranged so as to provide both an acceleration sensor and an angular velocity sensor 38 at the barrel housing 2. For the oscillation detection section 14, it is possible to improve the precision in the oscillation detection by adopting a plurality of sensors as the oscillation detection section.

[0047] In the following, operations, functions and effects of the drum-type washing and drying machine having the foregoing structure will be explained in details.

[0048] First, the generation of the entanglement of the clothes in the drying process of the clothes will be considered. When drying a relatively large amount of clothes in a narrow drum space, since the clothes can be moved only in the small space, the entanglement of the clothes is liable to occur. Moreover, when drying the clothes including long sleeved clothes, the long sleeve portions of the clothes are liable to be entangled with other portions of the clothes. If the drying process is continued, the number of the wrinkles of the clothes as dried is liable to be increased. Furthermore, since the drying air is difficult

to contact the entangled parts, an overall time required for drying will be increased; the drying process will be completed in the state where the entangled parts have not been dried to a sufficient level, which causes users' dissatisfaction as an irregular drying is generated.

[0049] In view of the foregoing, the present embodiment is arranged such that based on an output value of the oscillation detection section 14 fixed to the barrel housing 2, the entanglement determination section 20 of the control section 70 shown in Fig. 2 determines accurately if an entanglement of the clothes has occurred in the drum 1. The mechanism of this structure of the present embodiment will be explained.

[0050] When the clothes as lifted up by the tumbling of the drying process are dropped in the drum 1, the resulting impact is transmitted to the barrel housing 2, which houses the drum 1. As the drying process progresses from the start, clothes are dehumidified and the moisture content decreases gradually. Therefore, the impact to be transmitted to the barrel housing 2 becomes smaller gradually. Therefore, an output value of the oscillation detection section 14 fixed to the barrel housing 2 becomes smaller as the drying process progresses. Furthermore, depending on the degree of the entanglement of the clothes in the drum, an output value of the oscillation detection section 14 will differ. Namely, in the state where the entanglement of the clothes in the drum 1 has not occurred (or small), the clothes lifted up by the tumbling in the drum 1 drops at small intervals. Therefore, an impact to the drum 1 is small, and an output value of the oscillation detection section 14 shows a small oscillation value.

[0051] On the other hand, when an entanglement of the clothes occurs in the drum 1, the clothes are dropped as a heavy mass in the drum 1, and an impact to the drum 1 becomes larger. In this case, as a matter of course, an output value of the oscillation detection section 14 fixed to the barrel housing 2 shows a larger oscillation value as compared to that in the state where the entanglement of the clothes has not occurred.

[0052] As described, in the case of carrying out the drying process while maintaining the state of the clothes without an entanglement of the clothes (or the entanglement has occurred but very little), an output value of the oscillation detection section 14 is reduced gradually as the drying process progresses. In contrast, when an output value of the oscillation detection section 14 increases, it can be determined that an entanglement of the clothes has occurred in the drum 1.

[0053] Furthermore, in the case where an output value of the oscillation detection section 14 is reduced significantly after the entanglement of the clothes has occurred in the drum 1, i.e., an output value is reduced by a larger amount than a reduction amount which can be expected as the drying process progresses, it can be determined that the entanglement of the clothes in the drum is unraveled.

[0054] In the present embodiment, based on the output

value of the oscillation detection section 14 (oscillation level of the barrel housing 2), the entanglement determination section 20 of the control section 70 determines the entangled state of the clothes. When it is determined that the entanglement has occurred, the air at high pressure and high speed spouted from the second blowoff opening 10 of the second air duct 11 against the entangled clothes to unravel the entangled clothes effectively. On the other hand, when the entanglement determination section 20 determines that the entanglement has not occurred, the drying air in large airflow quantity at low speed is spouted from the first blowoff opening 8 of the first air duct 9. As described, it is determined if an entanglement has occurred in the drying process, and by appropriately switching between the first air duct 9 and the second air duct 11 based on the determination, it is possible to reduce the entanglement of the clothes, and to reduce the required power consumption.

[0055] As described, based on the result of determination by the entanglement determination section 20, in the middle of the drying process, the first air duct 9 and the second air duct 11 is switched at an appropriate timing so that the entangled clothes can be unraveled effectively with single blower section 4. Furthermore, where the entanglement has not occurred in the drying process, the drying process is performed by spouting drying air of large airflow quantity at low speed. It is therefore possible to reduce an overall power consumption as compared to the case of continuously spouting the drying air at high pressure and high speed. As described, the drum-type washing and drying machine of the present embodiment, it is possible to realize drying operation with small entanglement of the clothes while realizing a reduction in power consumption.

[0056] Fig. 4 is a graph which shows an output value of the oscillation detection section 14 which varies as the drying process progresses wherein the x-axis indicates the time as passed in the drying process, and the y-axis indicates the output value (oscillation speed) of the oscillation detection section 14. Fig. 5 shows the state of the clothes in the drum 1 for the amplitude A in Fig. 4. Fig. 6 shows the state of the clothes in the drum 1 for the amplitude B in Fig. 4.

[0057] For the oscillation detection section 14, a semiconductor acceleration sensor is adopted which is capable of detecting respective accelerations in three directions (14a, 14b and 14c) which mutually intersect at right angles as the oscillation detection section 14. Fig. 4 shows the results of detection of the acceleration of the barrel housing 2 in the direction of the rotation shaft 1a (i.e., the detection direction 14a) of the drum 1 when the number of rotations in the drum 1 in the drying process is set to 47 rpm. This is because, in the drying process with the above number of rotations, the acceleration in the detection direction 14a is the largest among the above three directions (i.e., the highest sensibility).

[0058] However, the present invention is not intended to be limited to the case of detecting the acceleration in

the detection direction 14a. Namely, it is preferable to read an oscillation value in a direction of the highest sensitivity according to the structure of the drum, the support structure of the barrel housing 2, the drum 1 (inclined angle of the drum 1, the dumper 34 which supports the barrel housing 2, the structure of mounting the support spring, etc.) or the number of rotations of the drum 1, etc., and it is not intended to be limited to the structure of reading the acceleration in a specific direction. As described, it is desirable that the oscillation detection section 14 be composed as a multi-axial sensing type sensor, which permits the oscillating detections of not less than two axes, and that the oscillation components in plural directions are read so that the value that shows the highest sensitivity in the tumbling operation in the drying process can be selected.

[0059] Fig. 5 shows the state where the clothes that are not entangled much are lifted up by the rotations of the drum is dropped at small intervals. In this case, since an impact to barrel housing 2 is small, an acceleration peak-to-peak value (amplitude A in Fig. 4)) is minute, i.e., about 0.03 G

[0060] Next, the explanations will be given on the state where the clothes are not entangled much (Fig. 5) to the state where the clothes are entangled strongly (Fig. 6). Fig. 6 shows the state where the clothes that are entangled strongly to form a heavy mass are lifted up by the rotations of the drum is dropped. In this case, an impact to barrel housing 2 is large, and the acceleration peak-to-peak value (amplitude B in Fig. 4) is increased, i.e., about 0.05 G. Originally, as the drying process progresses, the impact to barrel housing 2 becomes smaller gradually since the moisture of clothes is dehumidified, and the weight of clothes lightens, and the output of oscillation detection section 14 becomes smaller. However, it is possible to determine if the entanglement has occurred based on an output value of the oscillation detection section 14, which increase as the entanglement of the clothes becomes stronger.

[0061] Fig. 7 is a flowchart that shows a switch timing of the air duct based on the result of determination by the entanglement determination section 20.

[0062] When the drying process is started, the entanglement determination section 20 starts monitoring an output value (oscillation value V) from the oscillation detection section 14 (S1). At the start of the drying process, it is determined that the entanglement of the clothes has not occurred yet, the control section 70 is set to use the first air duct 9 of large cross-sectional blowing area with small loss in pressure, and the drying air in large airflow quantity at low speed is spouted from the first blowoff opening 8 from the back of the drum 1 against the clothes (S2). Specifically, the control section 70 controls the air duct switch section 12 to open the first air duct 9, and sets the rotation rate of the blowing fan motor 4b to be relatively low, so that drying air of large airflow quantity can be obtained by driving the blower section 4 with low power consumption. In this case of using the first air duct

9, since the loss in pressure is small, it is possible to generate the drying air of large airflow quantity even when driving the lower section 4 at low rotation rate of the blowing fan motor 4b with low power consumption. Therefore, when the drying process is being carried out under the conditions of S2, it is possible to reduce the time required for drying the clothes with smaller power consumption.

[0063] If the drying process is being carried out without an occurrence of strong entanglement, an impact to the barrel housing 2 will be kept small. Therefore, an oscillation value V to be detected by the oscillation detection section 14 will not be increased, but reduced gradually as time passes in the drying process (oscillating value V decreases gradually). As described, while the state of small entanglement of clothes is maintained, an oscillation value V indicated by the oscillation detection section 14 will not be increased by a predetermined value ΔV_1 (first predetermined value) or more from the oscillation value V detected directly before by the oscillation detection section 14 (NO in S3), and the drying process is to be continued under the conditions defined in S2.

[0064] On the other hand, if entanglement of cloth has occurred, an impact to the barrel housing 2 becomes larger. When an oscillation value V detected by the oscillation detection section 14 is increased by not less than a predetermined value ΔV_1 (first predetermined value) from the oscillation value V detected directly before (YES in S3), the entanglement determination section 20 determines that the entanglement has occurred (S5). Here, the control section 70 sets the blowing fan motor 4b to rotate at higher speed so that the drying air of higher pressure and higher speed can spout from the second blowoff opening 10 having a smaller cross-sectional blowing area than that of the first blowoff opening 8 (S6). Namely, the control section 70 controls the air duct switch section 12 to open the second air duct 11, and controls the blower section 4 to increase the rotation rate of the blowing fan motor 4b. In this way, by spouting air at high pressure and high speed, the entangled clothes can be unraveled.

[0065] As described, as the entangled clothes is unraveled by receiving air at high pressure and high speed, an impact to the barrel housing 2 will be reduced gradually. Then, when an oscillation value V of the oscillation detection section 14 is decreased by a predetermined value ΔV_2 (second predetermined value) or more from the oscillation value V detected directly before by the oscillation detection section 14 (YES in S7), the entanglement determination section 20 determines that the entanglement of the clothes has been unraveled (S9). In this case, the sequence goes back to S2, i.e., the control section 70 switches the air duct switch section 12 to switch an air duct to the first air duct 9.

[0066] Thereafter, the steps in S2 to S9 are repeated until the drying process has been completed (YES in S4 or YES in S8).

[0067] In the above steps S3 and S7, the entanglement determination section 20 of the control section 70 mon-

itors an oscillation value V of the oscillation detection section 14 to determine if an oscillation value V has been increased by a predetermined value ΔV_1 or more (S3) or decreased by a predetermined value ΔV_2 or more (S7). Here, the oscillation value V of the oscillation detection section 14 indicates a peak value (see Fig. 4) when the clothes as being lifted up with the rotations of the drum 1 has dropped. Here, the entanglement determination section 20 may be arranged so as to peak-hold a maximum oscillation value V at predetermined time intervals, and stores in the memory the peak hold value of the oscillation value V at predetermined intervals. Then, the entanglement determination section 20 can determine if the oscillation value V is increased by a predetermined value ΔV_1 or more (S3) or decreased by a predetermined value ΔV_2 or more (S7) by comparing the current oscillation value V with the previous oscillation value at very predetermined intervals. In this case, the predetermined time intervals can be set as desired or according to needs. Incidentally, in one rotation of the drum 1, the oscillation value V has a plurality of peak values. However, when the clothes are entangled to be a big heavy mass, such big mass of the clothes drops within the drum 1 one in one rotation of the drum 1. Therefore, in order to detect oscillations caused by the drop of the mass of the clothes in a predetermined time interval, it is preferable to set the predetermined interval longer than the time required for one rotation of the drum 1.

[0068] Here, since the weight of the dehumidified clothes decreases gradually, an impact to the drum in the case of generating the entanglement of the clothes will also decrease gradually. It is therefore preferable that the predetermined values ΔV_1 and ΔV_2 as criterion for the determination if the entanglement has occurred be adjusted to be reduced gradually in the drying process according to the drying level of the clothes as the drying process progresses. Specifically, with respect to the first and second predetermined values ΔV_1 and ΔV_2 set for the period of 30 minutes from the start of the drying process, the first and second predetermined values for the period of next 30 minutes can be set to $\Delta V_1 \times 0.9$ and $\Delta V_2 \times 0.9$, and the first and second predetermined values for the following period of 30 minutes can be set to $\Delta V_1 \times 0.8$ and $\Delta V_2 \times 0.8$. In this way, it is possible to determine if an entanglement has occurred with high precision as the drying process progresses.

[0069] The foregoing adjustments of the first and second predetermined values ΔV_1 and ΔV_2 are executed by the entanglement detection section 20 of the control section 70. The control section 70 has a timer (not shown) which measures the time elapsed in the drying process. For the timer, an internal timer in the control section as an operational internal function may be used. However, the timer may be provided independently of the control section 70. The control section 70 (entanglement detection section 20) executes a control operation shown in the flowchart of Fig. 7 by starting the counting of a time elapsed from the start of the drying process by the timer

from the start of the drying process, and adjusting the predetermined values ΔV_1 and ΔV_2 at every 30 minutes.

[0070] In the present embodiment, the predetermined values ΔV_1 and ΔV_2 are adjusted at every 30 minutes. However, the present invention is not limited to the above, and it may be arranged so as to adjust the predetermined values ΔV_1 and ΔV_2 at every predetermined time, for example, at every 20 minutes. For the timing of adjusting the predetermined values ΔV_1 and ΔV_2 , it is not necessarily to adjust them at equal time intervals. For example, it may be arranged so as to adjust them at every 30 minutes from the start of the drying process, and thereafter adjust them at every 30 minutes. Namely, the predetermined values ΔV_1 and ΔV_2 may be adjusted step by step at prescribed time intervals.

[0071] Furthermore, in view of that an overall time required for the drying process differs depending on the amount of the clothes to be dried (the larger is the amount of clothes, the longer time required for an overall drying process), and the processing speed of drying clothes differs, the timing of adjusting the predetermined values ΔV_1 and ΔV_2 may be adjusted according to an amount of clothes. Namely, the amount of the clothes is detected by the cloth amount detection section 15, and the control section 70 determines the timing of adjusting the predetermined values ΔV_1 and ΔV_2 according to the result of detection. For example, it may be arranged such that when an amount of the clothes is large, the predetermined values ΔV_1 and ΔV_2 are adjusted at every 30 minutes from the start of the drying process; on the other hand, when an amount of the clothes is smaller, the predetermined values ΔV_1 and ΔV_2 are adjusted every 25 minutes from the start of the drying process.

[0072] Furthermore, an impact to the drum 1 due to a drop of the clothes increases as the amount of the clothes (total weight) increases, and the weight of the entangled parts when the entanglement has occurred also increase accordingly. It is therefore preferable that the predetermined values ΔV_1 and ΔV_2 , as criterion for the determination if the entanglement has occurred, be adjusted to increase, as the amount of clothes in the drum 1 increases. For example, in the washing and drying machine (or drying machine) having the rated drying capacity of the clothes of 6 kg, with respect to the first and second predetermined values ΔV_1 and ΔV_2 set for the clothes in an amount of from 5 kg to 6 kg based on the determination by the cloth amount detection section 15, the predetermined values for the clothes in an amount of from 4 kg to 5 kg can be set to $\Delta V_1 \times 0.9$ and $\Delta V_2 \times 0.9$, the clothes in an amount of from 3 kg to 4 kg can be set to $\Delta V_1 \times 0.8$ and $\Delta V_2 \times 0.8$, the clothes in an amount of from 2 kg to 3 kg can be set to $\Delta V_1 \times 0.7$ and $\Delta V_2 \times 0.7$, and the clothes in an amount of from 1 kg to 2 kg can be set to $\Delta V_1 \times 0.6$ and $\Delta V_2 \times 0.6$. Incidentally, when the cloth amount determination section determines that the amount of clothes is less than 1 kg, entanglement is less likely to occur. Therefore, it may be arranged not to set the predetermined values ΔV_1 and ΔV_2 when the amount

of clothes is determined to be less than 1 kg.

[0073] The foregoing adjustments of the predetermined values ΔV_1 and ΔV_2 set according to the amounts of the clothes (mass) stored in the drum 1 are carried out by the entanglement detection section 20 of the control section 70 based on the results of detection by the cloth amount detection section 15. Before starting washing, the cloth amount detection section 15 detects an amount of the clothes placed in the drum 1. Specifically, the cloth amount detection section 15 detects an amount of the clothes set in the drum 1 based on the difference between i) the position of the shaft of the dumper 34 in the state where the barrel housing 2 is empty without water (the drum 1 is empty without clothes), and ii) the position of the shaft of the dumper 34 in the state where the barrel housing 2 is empty without water directly before introducing therein water for the start of washing, but the drum 1 has clothes set therein. Then, based on the result of detection of the cloth amount detection section 15, the entanglement detection section 20 of the control section 70 adjusts the predetermined values ΔV_1 and ΔV_2 as described above. Then, the control operation shown in the flowchart of Fig. 7 is executed. By determining the amount of clothes set in the drum in the foregoing manner, it is possible to determine if an entanglement has occurred with high precision.

[0074] Incidentally, the predetermined values ΔV_1 and ΔV_2 as criterion for the determination if the entanglement has occurred may be set to the same value, or different values.

[0075] For other sequence, where an entanglement of the clothes has already occurred at the start of the drying process (Fig. 10) is to be considered. First, when the drying process is started, the entanglement determination section 20 starts monitoring an output value (oscillation value V of the barrel housing 2) from the oscillation detection section 14 (S11). At the start of the drying process, if the entanglement of the clothes has occurred, and an oscillation value of V' set according to the cloth amount information or above is detected (YES in S12), it is determined that the entanglement has occurred (S13). The control section 70 controls to use the second air duct 11 having a smaller cross-sectional blowing area with a large loss in pressure to spout the drying air at high pressure and high speed from the second blowoff opening 12 at the front of the drum 1 against the clothes (S 14). Namely, the control section 70 controls the air duct switch section 12 to open the second air duct 11 to set the rotation rate of the blower fan motor 4b to high speed. In this case, by spouting drying air at high speed and high pressure from the second blowoff opening 12, the entangled clothes can be unraveled effectively. As the entangled clothes are unraveled with the air at high pressure and high speed, an impact against the barrel housing 2 is reduced gradually. Then, when the oscillation value of the oscillation detection section 14 is reduced to be lower than the entanglement oscillation value V' (YES in S15), the entanglement determination section 20 determines

that the entanglement has been unraveled. In this case, the control section 70 moves the sequence onto S 17 to switch the air duct to the first air duct 9 by the air duct switch section 12.

5 **[0076]** On the other hand, in the case where the entanglement of the clothes has not occurred at the start of the drying process, an oscillation value to be detected should be lower than the oscillation value V' set according to the amount of clothes (NO in S12). In this case, the sequence goes to S 17 directly after the start of the drying process, and S 17 to S24 are executed. The operations in S17 to S24 are the same as those of S2 to S9 of Fig. 7, and explanations thereof shall be omitted here.

10 **[0077]** Concerning the determination of the entanglement after the sequence moves to S 17 to the completion of the drying process, it may be arranged to determine an occurrence of the entanglement based on the difference in oscillation value (see S18 to S24), or as in the start of the drying process, it may be arranged to determine an occurrence of the entanglement based on an absolute oscillation value.

15 **[0078]** Where the clothes include those made of chemical fiber, or the like with low water content, or the clothes are entangled strongly due to a mixture of clothes in many kinds (material, shape, etc., of the clothes), it is determined if an entanglement has occurred at the start of the drying process in S12 and S 13 as described above. Then, when drying operation is started by spouting drying air at high pressure and high speed against the clothes, the entanglement of the clothes which hinder un uniform drying can be unraveled in an early stage, thereby reducing the time required for the drying process.

20 **[0079]** As described, by spouting air at high pressure and high speed against the clothes only when the entanglement of clothes has occurred, while spouting air of large airflow quantity against the clothes when the entanglement of clothes has not occurred by reducing the rotation rate of the blower fan motor 4b with small power consumption, the drying process with smaller entanglement can be realized, as compared to the case of spouting drying air at high pressure and high speed. By carrying out a drying operation with respect to the clothes with small entanglement, it is possible to realize an excellent drying finish with few wrinkles.

25 **[0080]** In the present embodiment, for the cloth amount detection section 15, explanations have been given through the case of detecting changes in amount of displacement in up and down direction of the axis of the dumper 34. However, the present invention is not intended to be limited to this. For instance, a cloth amount detection section that detects a rotational speed, driving current, and the amount of the variation of the torque etc. of the drum drive motor 3 that rotates the drum 1 may be adopted.

30 **[0081]** According to the present embodiment, the control section 70 automatically changes the predetermined values ΔV_1 and ΔV_2 based on a result of detection by the cloth amount detection section. However, even for the

structure without the cloth amount detection section 15, an amount of clothes is input by the user from the input setting section 32, and the control section 70 changes the predetermined values ΔV_1 and ΔV_2 based on the input by the user.

[0082] In the present embodiment, explanations will be given on the structure wherein it is determined if an entanglement has occurred based on a result of detection by the oscillation detection section 14 made up of an acceleration sensor and an angular velocity sensor. However, the present invention is not intended to be limited to this. For example, an entanglement determination section may be adopted, which detects a change in rotation number, drive current, torque, etc., of the drum drive motor 3 which rotates the drum 1, and which determines that an entanglement of clothes has occurred when a change in amount of the load of the drum drive motor 3 in the drying process is at a predetermined value or above. Incidentally, as compared to the case of determining if an entanglement of clothes has occurred based on a change in amount of load of the drum drive motor 3, it is more desirable to determine if an entanglement of clothes has occurred based on a result of detection by the oscillation detection section which detects oscillations of the barrel housing 2 which increase or decrease according to the level of the entanglement of the clothes.

[0083] As described, a drying machine in accordance with one aspect of the present invention includes a drum which stores clothes to be dried, a drum drive section which rotatably drives the drum, an entanglement determination section, an entanglement determination section which determines if an entanglement of the clothes has occurred in the drum; a first air duct having a first blowoff opening which is opened to the drum; a second air duct with a second blowoff opening which is opened to said drum, said second blowoff section having a smaller cross-sectional blowing area than that of said first blowoff section; an air duct switch section which selectively switches between the first air duct and the second air duct, wherein when the first air duct is selected, drying air of larger airflow quantity spouted from the first blowoff opening than the case where when the second air duct is selected, and when the second air duct is selected, drying air of her pressure and higher speed spouted from the second air duct than the case where when the first second air duct is selected; a control section is provided for controlling the air duct switch section based on a result of determination by the entanglement determination section, to switch between the first air duct and the second air duct in the drying process.

[0084] According to the foregoing structure, as the air duct which spouts the drying air into the drum which houses the clothes, two air ducts of the first air duct and the second air duct are provided, and the air duct switch section switches between these two ducts. The first blowoff opening of the first air duct has a larger cross-sectional blowing area than the second blowoff opening, and of smaller loss in pressure than that from the second blowoff

opening of the second air duct. Further, where the first air duct is selected, the drying air of larger airflow quantity is spouted into the drum that that in the case where the second air duct is selected. In this case, as the loss in pressure of the first air duct is small, it is possible to obtain the air of large airflow quantity even when drying the blower section with relatively low power consumption.

[0085] By using the air with large airflow quantity, it is possible to reduce the drying time and the power consumption. On the other hand, the second air flow opening of the second air duct has smaller cross-sectional blowing area than the first blowoff opening.

[0086] Further, when the second air duct is selected, the drying air of higher pressure and higher speed is spouted into the drum from the second blowoff opening than that in the case of selecting the first air duct.

[0087] In this case, the clothes can be stretched by receiving air at high pressure and high speed. It is therefore possible to unravel the entanglement of the clothes.

[0088] Here, it is determined if the entanglement of the clothes has occurred in the drum by the entanglement determination section, and based on the results of determination, it is selectively switched between the first air duct and the second air duct in the drying process.

[0089] For example, in the case where the entanglement has occurred, the second air duct is selected, while in the case where the entanglement of the clothes has not occurred, the first air duct can be selected. As a result, it is possible to dry clothes by the single blower section. Furthermore, when it is confirmed that the entanglement has occurred in the drying process, the entanglement of the clothes can be unraveled by spouting the drying air at high pressure and high speed from the second air duct. Therefore, the clothes can be dried again by the air of large airflow quantity with smaller power consumption as compared to that of high speed air. The arrangement of the present invention which unravels the entanglement of the clothes by drying them with the drying air at high pressure and high speed is more effective to prevent the entanglement of the clothes and reduce the drying time and the wrinkles of the clothes as compared to the conventional arrangement of unraveling the clothes by rotating the drum in reverse direction.

[0090] It is preferable that the first blowoff opening is opened at the back of the drum, and the second blowoff opening is opened at the front of the drum.

[0091] According to the foregoing structure, in the case of drying clothes within a small space in the drum, when the amount of clothes is relatively large, the clothes can be the liquor ratio to which it can freely move in the clothes is small. It is therefore possible to dry clothes without being entangled much even for the clothes which are liable to be entangled. Moreover, when drying the clothes including long sleeved clothes, the long sleeve portions of the clothes are liable to be entangled with other portions of the clothes. If the drying process is continued, the number of the wrinkles of the clothes as dried is liable to be increased. In view of the foregoing, when the en-

tanglement has occurred, the clothes are stretched out to unravel the entanglement of the clothes by the drying air at high pressure and high speed from the front of the drum to spread the clothes in the drum. As a result, it is possible to make the entire clothes contact the drying air evenly, and it is possible to complete the drying of the air at shorter time without irregular drying.

[0092] It is preferable that the control section controls the air duct switch section to be switched to the second air duct when the entanglement determination section determines that the entanglement has occurred.

[0093] According to the foregoing structure, by arranging so as to switch to the air of high pressure and high speed which permit the entanglement to be unraveled, only when the entanglement of the clothes has occurred, it is possible to minimize the period of drying with high speed and high velocity. As a result, while effectively suppressing the entanglement of the clothes, it is possible to reduce an overall time required for drying and an amount of power consumption.

[0094] It is preferable that the control section controls the air duct switch section based on a result of determination by the entanglement determination section, to switch between the first air duct and the second air duct in the drying process.

[0095] According to the foregoing structure, when the entanglement of the clothes has not occurred, it is switched to the first air duct as it is not necessary to dry clothes with the air at high pressure and high speed for unraveling the clothes. Where the first air duct is selected, the drying air of large airflow quantity is spouted into the drum from the first blowoff opening that is opened at the back side of the drum as compared to the case of selecting the second air duct. Here, when the loss in pressure of the first air duct is small, it is possible to obtain the air in large airflow quantity even by drying the blower section with relatively small power consumption. As a result, it is possible to reduce the drying time and an amount of power consumption by the air of large airflow quantity.

[0096] With the foregoing structure, it is preferable to further comprise the oscillation detection section for detecting oscillations of the drum, wherein the entanglement determination section determines that when the output value from the oscillation detection section is increased by the first predetermined value or larger, and that the entanglement of the clothes has been unraveled when the output value of the oscillation detection section is reduced by not less than the predetermined value.

[0097] According to the foregoing structure, when the entanglement of the clothes has occurred in the drying process, an impact to the drum when the clothes become entangled and heavier drops increases, and oscillations of the drum also increase. By recognizing the phenomenon in the drum, it is possible to determine the entanglement of the clothes. Namely, as the drying process progresses, the water content of the clothes is gradually reduced as being dehumidified. Therefore, if the entanglement of the clothes has not occurred, an impact to the

drum should be reduced gradually. Therefore, an output value of the oscillation detection section of the drum is reduced gradually as the drying process progresses. Against this tendency, if an output value from the oscillation detection section is increased by the first predetermined value or larger, it is determined that entanglement has occurred in the drum. An output value from the oscillation detection section is reduced by the second predetermined value or larger, i.e., a gradual amount of reduction as the drying process progresses, it is determined that the entanglement of the clothes in the drum has been unraveled. As described, by directly detecting an impact to the drum which changes depending on with or without the entanglement of the clothes in the drying process by the oscillation detection section to determine if the entanglement has occurred, it is possible to determine if the entanglement has occurred more accurately than the conventional method of determination of the entanglement based on an amount of change in load of the drum drive section.

[0098] It is preferable that the entanglement determination section reduces the first predetermined value and the second predetermined value as time passes in the drying process.

[0099] With the foregoing structure, the weight of dehumidified clothes decreases gradually according to the dehumidification level as the drying process progresses. As a result, an impact to the drum due to the entanglement of the clothes is also becomes smaller gradually as the drying process progresses. Therefore, by reducing the first predetermined value and the second predetermined value as time passes in the drying process, a still higher precision entanglement determination can be realized.

[0100] With the foregoing structure, it is preferable to further comprise the cloth amount detection section for detecting the amount of the clothes in the drum, wherein the entanglement determination section changes the time interval for reducing the first predetermined value and the second predetermined value according to an amount of clothes detected by the cloth amount detection section.

[0101] With the foregoing structure, in the case of decreasing the first predetermined value and the second predetermined value stepwise at time intervals, the time interval (the adjustment timing of reducing the first predetermined value and the second predetermined value stepwise) is changed according to an amount of clothes to be dried. Namely, the overall time for the drying process changes according to the amount of the clothes to be dried (that is, a longer time is required for drying for a larger amount of clothes as it takes longer time for moisture vaporization), and the progress speed of the drying of the clothes is also different. In view of the foregoing, the cloth amount detection detects the amount of the clothes in the drum, and the entanglement determination section changes the first predetermined value and the second predetermined value step by step according to

the amount of the clothes (for example, the larger is the amount of clothes, the longer is the set interval). As a result, a high precision determination of entanglement can be ensured irrespectively of the amount of the clothes while controlling at low power consumption.

[0102] With the foregoing structure, it is preferable to further comprise the cloth amount detection section that detects an amount of clothes in the drum 1, wherein the entanglement determination section sets the first predetermined value and the second predetermined value according to the amount of clothes detected by the cloth amount detection section.

[0103] According to the foregoing structure, when the entanglement of the clothes occurs in the drum, the weight of the clothes that twine and became masses becomes heavier according to the amount of the clothes in the drum (total weight). If the weight of clothes that twine and became masses becomes heavier, an impact to the drum increases accordingly. Therefore, the first specified value and the second specified value as the criterion of an occurrence of the entanglement are set according to the amount of clothes, thereby ensuring high precision determination of entanglement irrespectively of the amount of the clothes.

[0104] It is preferable that the oscillation detection section is an acceleration sensor. With this structure, an impact to the drum can be detected as acceleration, and a level of an impact to the drum, which increases or decreases according to the level of the entanglement of clothes can be determined with high precision. As a result, an entanglement determination can be performed with high precision.

[0105] It is preferable that the oscillation detection section is an angular velocity sensor. With this structure, an impact to the drum can be detected as an angular velocity, and a level of an impact to the drum, which increases or decreases according to the level of the entanglement of clothes can be determined with high precision. With this structure, an entanglement determination can be performed with high precision. Additionally, the angular velocity of the drum is identical at either position of the operation part in a vicinity of the drum. Therefore, the degree-of-freedom at the installation position of the oscillation detection section can be improved.

[0106] A washing and drying machine according to the present invention includes the cloth drying of any of the foregoing structures, and a water tank for storing the washing water which houses the accommodation section. As described, when applying the present invention to any of the foregoing washing and drying machines, it is possible to realize the washing and drying machine capable of drying the clothes with small entanglement of the clothes at low power consumption.

(Second Embodiment)

[0107] Hereafter, the second embodiment of the present invention is explained referring to the drawings.

[0108] The basic structure of the drum-type washing and drying machine in accordance with the second embodiment is the same as the drum-type washing and drying machine in accordance with the first embodiment shown in Fig. 1, Fig. 2, Fig. 9, etc. Therefore, the same reference numerals are assigned, and explanations thereof shall be omitted here.

[0109] The operations, functions and effects of the drum-type washing and drying machine of the present embodiment will be explained mainly for the points different from the drum-type washing and drying machine in accordance with the present embodiment.

[0110] According to the present embodiment, based on an oscillation value detected by the oscillation detection section fixed to the barrel housing 2, the control section 170 shown in Fig. 11 determines the drying level of the clothes in the drum 1 (portions of the clothes on the side of the flowoff opening is dried sufficiently) with accuracy. This mechanism will be explained below.

[0111] In the drying process, the drying process is carried out by selecting either the air duct of either the first air duct 9 or the second air duct 11. Since the water content of the clothes in the drum 1 is reduced gradually as the drying process progresses, the weight of the clothes becomes lighter gradually. As a result, an impact to the drum 1 (an oscillation value detected by the oscillation detection section 14) when the clothes are dropped in the drum 1 is reduced gradually. Here, in the state where only the clothes at positions in a vicinity of the blowoff opening of the selected air duct are dried to a sufficient drying level, a water content to be removed from the clothes is reduced gradually, and accordingly a change in amount of weight of the clothes is reduced. As a result, an oscillation value to be detected by the oscillation detection section 14 is also reduced. It is therefore possible to determine the drying level of the clothes on the side closer to the blowoff opening of the air duct as selected (the clothes on the side of the blowoff opening is dried to a sufficient level) based on the result of detection by the oscillation detection section 14.

[0112] According to the control section 170 in accordance with the present embodiment, it is possible to surely reduce uneven drying of clothes by switching the blowoff opening of the drying air while accurately detecting the drying level based on the result of detection of the oscillation detection section 14. With reference to Fig. 12, the switching of the air duct based on the results of detection by the oscillation detection section 14 will be explained.

[0113] Fig. 12 is a graph showing the relationship between the drying time and an integrated output value of an oscillation detection section 14.

[0114] Here, as an oscillation detection section 14, adopted is a semiconductor acceleration sensor which detects respective accelerations in three directions (14a, 14b and 14c) which intersect at right angles. The results of accelerations of the barrel housing 2 in the directions of the rotation axis 1a of the drum (detection direction 14a) are shown in Fig. 1, provided that the number of

rotations of the drum 1 in the drying process is set to 47 rpm. This is because the oscillation value in the detection direction 14a shows the largest oscillation value (i.e., the highest sensitivity).

[0115] However, the present invention is not limited to the arrangement of detecting the accelerations in the detection direction 14a. Namely, it is desirable to read the oscillation value in the direction which shows the highest sensitivity according to the structure of the main body, the support structure of the barrel housing 2, the drum (inclination angle of the drum, the mount structure of the dumper 34 or the support spring which support the barrel housing), but the present invention is not intended to be limited to reading the oscillation in a specific direction. As described, it is preferable to adopt the oscillation detection section 14 is constituted by a multiaxial sensing type sensor which is capable of reading oscillation components in a plurality of directions, and to read the oscillation components in a plurality of directions so that the oscillation value in the direction which shows the highest sensitivity can be selected in the tumbling operation in the drying process. For example, the detection axis of the oscillation detection section 14 changes according to the number of rotation in the drying process, to select the detection axis which is the most sensitive to the actual number of rotations. In this case, at the initial stage at the start of the drying process, the level of change in axis of the oscillation detection section 14 is confirmed to select the detection axis which shows the higher sensitivity, to control switching according to changes in the detection axis.

[0116] By the way, while the drum 1 rotates once, outputs (accelerations) from the oscillation detection section 14 show several peaks. In Fig. 12, an integrated value of an acceleration peak-to-peak value for 10 rotations of the drum 1 as detected by the oscillation detection section 14 is set to an oscillation value A_{pp} detected by the oscillation detection section 14. Then, the control section 170 carries out a sampling of an oscillation value A_{pp} at every 10 minutes.

[0117] In Fig. 12, the first air duct 9 is selected at a start of the drying process, and the operation of drying the clothes is performed by spouting the drying air from the first blowoff opening 8 into the drum 1. Then, as the drying process using the first air duct 9 progresses, the oscillation value A_{pp} detected by the oscillation detection section 14 is reduced gradually. Here, when the oscillation value A_{pp} detected by the oscillation detection section 14 is reduced, and an amount of reduction ΔA_{pp} of the oscillation value A_{pp} per unit time (10 minutes in Fig. 12) becomes lower than the predetermined value ΔA_{pp1} , it is determined that the clothes in a vicinity of the first blowoff opening 8 of the first air duct 9 as currently selected is dried to a sufficient level, with which, the air duct is to be switched. In Fig. 12, when 80 minutes have elapsed from the start of the drying process, it is switched from the first air duct 9 to the second air duct 11.

[0118] Here, where the drying operation continues us-

ing the first air duct 9 without switching the air duct at the above timing, as shown in Fig. 12(a), the oscillation value A_{pp} detected by the oscillation detection section hardly changes. This indicates that the clothes on the side of the first blowoff opening have been dried to a sufficient level. Even if the drying operation continues without switching the air duct at the above timing, while the moisture to be removed from the clothes in a vicinity of the air duct is very little, the clothes at position far from the air duct will not be dried to a sufficient level. In the case of switching the air duct at the above timing, as shown in Fig. 12(b), the oscillation value A_{pp} is reduced again directly after switching the air duct, and the water content of the clothes in the drum is reduced. This shows that by switching the air duct to the second air duct 11, the clothes on the side of the second blowoff opening 10 progresses, which was not dried to a sufficient level, progresses. With this operation, a partially occurred uneven drying of the clothes in the drum 1 can be solved in an efficient manner.

[0119] Fig. 13 is a flowchart showing the timing of switching the air duct based on the results of detection by the oscillation detection section 14.

[0120] When the drying process is started, the control section 170 starts monitoring the oscillation value to be detected by the oscillation detection section 14 (S31). For example, the integrated value of 10 rotations of the drum 1 of the peak-to-peak value of the accelerations detected by the oscillation detection section 14 is set to the oscillation value A_{pp} to be detected by the oscillation detection section 14. Incidentally, the multiplication period of oscillating value A_{pp} is not limited to this, and can be set as desired.

[0121] Then, the control section 170 opens the first air duct 9 by controlling the air duct switch section 12, and starts driving the operation of drying the clothes by spouting the drying air into the drum 1 from the first blowoff opening 8 (S32). Then, the control section 170 determines if an amount of decrease ΔA_{pp} of the oscillating value A_{pp} per unit time (for example, for 10 minutes) is below the first predetermined value ΔA_{pp1} (S33). Where the clothes in the drum 1 is drying appropriately without a problems and the clothes become lighter gradually, the oscillation value A_{pp} to be detected by the oscillation detection section 14 is reduced gradually. While the moisture is being removed from the clothes and the drying operation progresses, the drying operation continues under the conditions shown in Fig. 32 without having the amount of reduction ΔA_{pp} of the oscillation value A_{pp} per unit time reduced below the first oscillation value A_{pp1} (YES in S33), and the drying operation continues under the conditions shown in S32.

[0122] Thereafter, when the oscillation value A_{pp} detected by the oscillation detection section 14 is reduced, and an amount of reduction ΔA_{pp} of the oscillation value A_{pp} per unit time becomes lower than the first predetermined value ΔA_{pp1} (NO in S33), it is determined that the clothes in a vicinity of the first blowoff opening 8 of the first air duct 9 as currently selected is dried to a suf-

ficient level. Here, the control section 170 controls the air duct switch section 12 to open the second air duct 11. Then, the drying operation is switched to dry clothes by spouting the drying air from the second blowoff opening 10 to the drum 1 (S34). As a result, the operations of drying the clothes on the side of the second blowoff opening 10 progresses, and an oscillation value A_{pp} to be detected by the oscillation detection section 14 is reduced gradually. Then, the drying operation continues using the second air duct 11 until the amount of reduction ΔA_{pp} of the oscillation value A_{pp} per unit time becomes lower than the second predetermined value ΔA_{pp2} , i.e., lower than the first predetermined value ΔA_{pp1} .

[0123] Thereafter, when the amount of reduction ΔA_{pp} of the oscillation value A_{pp} per unit time becomes lower than the second predetermined value ΔA_{pp2} (NO in S35), the control section 170 determines that the clothes at both sides of the first blowoff opening 8 and the second blowoff opening 10 are dried evenly without having an irregular drying state (i.e., all the clothes in the drum), thereby terminating the drying operations.

[0124] In S33 and S35, it is determined if the amount of reduction ΔA_{pp} of the oscillation value A_{pp} per unit time (10 minutes) becomes lower than the first predetermined value ΔA_{pp} or the second predetermined value ΔA_{pp2} ; however, the unit time is not intended to be limited to 10 minutes, but may be 5 minutes, or any time may be set.

[0125] In S33 and S35, it is determined if the amount of reduction ΔA_{pp} of the oscillation value A_{pp} detected by the oscillation detection section 14 per unit time is below the first predetermined value ΔA_{pp1} or the second predetermined value ΔA_{pp2} . Alternatively, it may be arranged such that a reduction ratio per unit time of the oscillation value A_{pp} becomes lower than the first predetermined value or the second predetermined value.

[0126] Furthermore, according to an amount of clothes in the drum (total amount), an impact to the drum 1 when the clothes drop (an oscillation value A_{pp} to be detected by the oscillation detection section 14) also differs. In response, it is desirable that the cloth amount detection section 15 detects the amount of the clothes in the drum 1 to adjust the first predetermined value ΔA_{pp1} and the second predetermined value ΔA_{pp2} according to the amount of clothes as detected. Namely, the larger is the amount of the clothes in the drum 1, the larger is the oscillation value A_{pp} to be detected by the oscillation detection section 14, and therefore the first predetermined value ΔA_{pp1} and the second predetermined value ΔA_{pp2} are set larger. On the other hand the smaller is the amount of the clothes in the drum 1, the smaller is the first predetermined value ΔA_{pp1} and the second predetermined value ΔA_{pp2} . For example, in the washing and drying machine (or drying machine) having the rated drying capacity of the clothes of 6 kg, with respect to the first and second predetermined values ΔA_{pp1} and ΔA_{pp2} , the predetermined values for the clothes in an

amount of from 4 kg to 5 kg can be set to $\Delta A_{pp1} \times 0.9$ and $\Delta A_{pp2} \times 0.9$, those for the clothes in an amount of from 3 kg to 4 kg can be set to $\Delta A_{pp1} \times 0.8$ and $\Delta A_{pp2} \times 0.8$, those for the clothes in an amount of from 2 kg to 3 kg can be set to $\Delta A_{pp1} \times 0.7$ and $\Delta A_{pp2} \times 0.7$, those for the clothes in an amount of from 1 kg to 2 kg can be set to $\Delta A_{pp1} \times 0.6$ and $\Delta A_{pp2} \times 0.6$, and those for the clothes in an amount below 1 kg can be set to $\Delta A_{pp1} \times 0.5$ and $\Delta A_{pp2} \times 0.5$. Incidentally, where the cloth amount detection section 15 determines that the amount of the clothes is below 1 kg, since irregular drying condition is less likely to occur, the air duct is not switched.

[0127] The foregoing adjustment of the first and second predetermined values ΔA_{pp1} and ΔA_{pp2} according to the amount of the clothes stored in the drum 1 are executed by the control section 170 based on the results of detection of the cloth amount detection section 15. Before carrying out washing, the cloth amount detection section 15 detects the amount of the clothes (total weight) to be placed in the drum 1. Specifically, the cloth amount detection section 15 detects an amount of the clothes set in the drum 1 based on the difference between i) the position of the shaft of the dumper 34 in the state where the barrel housing 2 is empty without water (the drum 1 is empty without clothes), and ii) the position of the shaft of the dumper 34 in the state where the barrel housing 2 is empty without water directly before introducing therein water for the start of washing, but the drum 1 has clothes set therein. Then, based on the result of detection of the cloth amount detection section 15, the entanglement detection section 20 of the control section 70 adjusts the predetermined values ΔV_1 and ΔV_2 as described above. Then, based on the result of detection of the cloth amount detection section 15, the control section 170 adjusts the predetermined values ΔA_{pp1} and ΔA_{pp2} . Then, the control operation shown in the flowchart of Fig. 13 is executed. By setting the first or second predetermined values ΔA_{pp1} or ΔA_{pp2} according to an amount of the clothes in the drum 1, it is possible to accurately determine the switch timing of switching the air duct or the timing of terminating the drying operation.

[0128] In the present embodiment, as the cloth amount detection section 15, explanations have been given through the case of detecting changes in amount of displacement in up and down direction of the axis of the dumper 34. However, the present invention is not intended to be limited to this. For instance, a cloth amount detection section which detects a rotational speed, driving current, and the amount of the variation of the torque etc. of the drum drive motor 3 that rotates the drum 1 may be adopted, and which detects an amount of the clothes in the drum based on variations in load of the drum drive motor 3.

[0129] According to the present embodiment, the control section 170 automatically changes the first and second predetermined values ΔA_1 and ΔA_2 based on a result of detection by the cloth amount detection section 15.

However, even for the structure without the cloth amount detection section 15, an amount of clothes is input by the user from the input setting section 32, and the control section 170 adjusts the predetermined values ΔA_{pp1} and ΔA_{pp2} based on the input by the user.

(Third Embodiment)

[0130] In the above second embodiment, the first air duct 9 or the second air duct 11 is selected without specifying neither of the airflow quantity and the velocity of the air.

[0131] In the present embodiment, however, when the first air duct 9 is selected, air of larger flow airflow quantity spouted therefrom into the drum 1 than the case where the second air duct 11 is selected. On the other hand, when selecting the second air duct 11, drying air of higher pressure and higher speed spouted therefrom into the drum 1 than the case where the first air duct 9 is selected. As a result, it is possible to reduce wrinkles of the clothes while reducing power consumption by spouting the drying air of higher pressure and higher speed.

[0132] The basic structure of the drum-type washing and drying machine) of the present embodiment is the same as those of the first and second embodiment shown in Figs. 1, 9 and 11. In the following, explanations will be given mainly on the structures different from those of the first and second embodiments.

[0133] The first blowoff opening 8 of the first air duct 9 has a larger cross-sectional blowing area than that of the second blowoff opening 10, and therefore, the drying air of larger airflow quantity than that from the second air duct 11 can spout into the drum 1 with smaller loss in pressure. The second blowoff opening 10 of the second air duct 11 has a smaller cross-sectional blowing area than that of the first blowoff opening 8, and therefore, the drying air of higher pressure and higher speed than that from the second air duct 11 can spout into the drum 1.

[0134] For the drum-type washing and drying machine, usually the space between the front side of the drum 1 that rotates and the barrel housing 2 is formed to be minimized to avoid the clothes from being caught. Therefore, it is difficult in terms of space to provide the large blowoff opening with small loss in pressure in such a small space. However, it is possible to provide the second blowoff opening 10 with relatively small cross-sectional blowing area, which spouts air at high pressure and high speed. On the other hand, there is a space room that provides the first blowoff opening 8 with a relatively large opening at the rear bottom of drum 1. Then, by covering the first blowoff opening 8 with a big cover 26 with a high aperture rate consisting of a large number of small holes, the clothes can be prevented from being caught in the first blowoff opening. Therefore, the first blowoff opening 8 with a relatively small loss in pressure can be provided on the rear bottom surface of the drum 1.

[0135] In the case where the clothes are rotated by rotating the drum 1 with the rotation shaft which is sloped

upwards to the front, small clothes such as socks, handkerchiefs, and briefs are liable to be biased to the rear interior of the drum 1. On the other hand, the long sleeved clothes such as underwear of the long sleeve, drawers, long sleeve business shirts, long sleeve pajamas, etc. are liable to be biased to the front interior of the drum 1. When the drying operation is carried out with respect to the mixture of the small clothes and the long sleeved clothes, by spouting the drying air of a large quantity from the first blowoff opening 8 formed in the rear interior of drum 1, the drying air is first reached to the small clothes biased at the bottom of the drum 1 and then reached to the length large clothes placed in the front of the drum 1 through such small clothes. Therefore, both small clothes and the long sleeved clothes can be dried in an efficient manner. For small clothes in particular, it is possible to dry with relatively few wrinkles. On the other hand, the long sleeved clothes twist easily and have wrinkles easily are liable to be biased to the front interior of the drum 1. In this case, by spouting drying air from the second blowoff opening 10 at the front of the drum 1, it is possible to increase the drying speed. In this case, by spouting the drying air at high speed and high pressure from the second blowoff opening 12, the entangled clothes can be unraveled effectively. Furthermore, by spouting the drying air at high pressure and high speed from the second blowoff opening 10 against the long sleeved clothes, the long sleeved clothes are liable to be stretched, and move by receiving air. As a result, the entangled or twisted clothes can be unraveled, and the wrinkles can be reduced effectively.

[0136] When the air duct is switched to the first air duct 9 by the air duct switch section 12, the blowing fan 4a of the blower section 4 is driven in such a manner that the airflow quantity of the drying air which passes the first air duct 9 is of a larger airflow quantity than that of the second air duct 11. On the other hand, when the air duct for blowing drying air is switched to the second air duct 11 by the air duct switch section 12, the blowing fan 4a of the blower section 4 is driven in such a manner that the drying air spouted from the second blowoff opening 10 of the second air duct 11 is of a predetermined speed that is higher than that of the drying air spouted from the first blowoff opening 8. For example, the velocity of the air that spouted from the first blowoff opening can be set to around 10 m/s, and the velocity of the air that spouted from the second blowoff opening 10 can be set to around 50 m/s or above. However, the velocity of the air spouted from the first blowoff section 8 or the second blowoff section 10 is not limited to the above as long as the velocity of the air that spouted from the second blowoff section 10 is higher than that of the air from the first blowoff section 8.

[0137] According to the drum-type washing and drying machine of the present embodiment, the air that passes through the first air duct 9 is of larger airflow quantity than that passes through the second air duct 11, the velocity of the air that spouted from the second blowoff section 10 of the second air duct 11 is higher than that from the

first blowoff section 8, and based on the result of detection by the oscillation detection section in the drying process, it is switched between the first air duct 9 and the second air duct 11 by the air duct switch section 12.

[0138] The discharge opening 5 is provided at position more away from the first blowoff opening 8 than from the second blowoff opening 10 (i.e., the discharge opening 5 is formed at position closer to the second blowoff opening 10 than to the first blowoff opening 8). Therefore, the discharge opening 5 is formed at position more to the front half than the back half. The discharge opening 5 may be provided in a vicinity of the second blowoff opening 10 at the front side of the drum 1 at position most away from the first blowoff opening 8 among positions where the discharge opening 5 can be formed.

[0139] As described, by forming the discharge opening 5 at position closer to the second discharge opening 10 at the front side of the drum 1 and to be away from the first blowoff opening 8, a longer distance can be ensured between the first blowoff opening 8 and the discharge opening 5. As a result, while the air is spouting from the first blowoff opening 8 provided at the back side of the drum 1, the drying air from the first blowoff opening 8 can be widely spread over the space in the drum 1. As a result, it is possible to make the clothes contact the drying air in the drum 1 in an efficient manner, and to dry the clothes using small power consumption.

[0140] As a result, where the air is spouting from the first blowoff opening 8 provided at the back side of the drum 1, the drying air from the first blowoff opening 8 can be widely spread over the space in the drum 1. It is therefore possible to make the clothes contact the drying air in the drum 1 in an efficient manner, and to dry the clothes using small power consumption.

[0141] Incidentally, even where the discharge opening 5 is provided in a vicinity of the second blowoff opening 10, while the air is spouting from the second blowoff opening 10 at the front side of the drum 1, the drying air at high pressure and high speed spouted from the second blowoff opening 10. As a result, the drying air can reach entire space from the front to the back in the drum 1. As a result, a desirable contact between the drying air and the clothes is not disturbed, thereby maintaining the effect of stretching the wrinkles by spouting drying air at high pressure and high speed.

[0142] The second blowoff opening 10 is formed in the front upper portion in the drum 1. Therefore, it is possible to spout the drying air from the second blowoff opening 10 at high pressure and high speed effectively against the moving clothes as being lifted up with the rotations of the drum 1, thereby effectively reducing the wrinkles of the clothes.

[0143] Fig. 14 is a flowchart showing the operation of switching the air duct in accordance with the third embodiment. The flowchart of Fig. 14 differs from that of the second embodiment shown in Fig. 13 in the drying conditions in S32 and S34. Namely, in the third embodiment, the drying process is carried out under the conditions of

S32' and S34' in Fig. 14 in replace of the conditions of S32 and S34 of Fig. 13.

[0144] Specifically, at the start of the drying process, the control section 170 sets the conditions of carrying out the drying operation to use the first air duct 9 having a larger cross-sectional blowing area with small loss in pressure, so that the drying air of large airflow quantity with low velocity is spouted from the first blowoff opening 8 formed at the back of the drum 1 (S32'). Namely, the control section 170 controls the air duct switch section 12 to open the first air duct 9 and sets the number of rotations of the blower fan motor 4a to relatively low. In this case, since the loss in pressure of the first air duct 9 is small, it is possible to ensure the drying air of large airflow quantity even when drying the blower section 4 with small power consumption by setting the number of rotations of the blower fan motor 4b to be relatively small. As a result, while the drying operation is being carried out under the conditions set in S32', it is possible to reduce the drying time and the power consumption.

[0145] Thereafter, when the oscillation value A_{pp} to be detected by the oscillation detection section 14 is reduced, and the amount of reduction ΔA_{pp} of the oscillation value A_{pp} per unit time is reduced below the first oscillation value A_{pp1} (YES in S33), the control section 170 sets the conditions for carrying out the drying process to spout the drying air at high pressure and high speed from the second blowoff opening 10 having a smaller cross-sectional blowing area than the first blowoff opening 8 by rotating the blower fan motor 4b at high speed (S34'). Namely, the control section 170 controls the air duct switch section 12 to open the second air duct 11, and the blower section 4 to increase the number of rotations of the blower fan motor 4b. In this case, it is possible to reduce the wrinkles of the clothes effectively by the air at high pressure and high speed.

[0146] As described, by adopting the arrangement of the third embodiment in addition to the arrangement of the second embodiment in which the blowoff opening of the drying air is switched while detecting the drying level with high precision based on the results of detection by the oscillation detection section, it is possible to realize not only the effect of reducing irregular drying, but also the effect of reducing the wrinkles of the clothes by the drying air at high pressure and high speed while reducing power consumption.

[0147] A drying machine in accordance with one aspect of the present invention includes: a drum for storing clothes to be dried; a drum drive section for rotatably driving said drum; a blower section for blowing drying air into said drum; a first air duct with a first blowoff opening which is opened at a rear side of said drum; a second air duct with a second blowoff opening which is opened at a front side of said drum; an air duct switch section which selectively switches between said first air duct and said second air duct; an oscillation detection section which detects an oscillation of said drum; and a control section which controls the air duct switch section based on a

result of detection by said oscillation detection section to selectively switch between the first air duct and the second air duct in a drying process.

[0148] According to the foregoing structure, as the air duct for spouting drying air into the drum which stores clothes, two air ducts of the first air duct and the second air duct are provided, to be selectively switched by the air duct switch section. Then, the drying operation is performed using either the first air duct or the second air duct as selected. Here, since the water content of the clothes in the drum is reduced gradually as the drying process progresses, the weight of the clothes becomes lighter gradually. As a result, an impact to the drum (an oscillation value detected by the oscillation detection section) when the clothes are dropped in the drum is reduced gradually. Here, in the state where only the clothes at positions in a vicinity of the blowoff opening of the selected air duct are dried to a sufficient drying level, a water content to be removed from the clothes is reduced gradually, and accordingly a change in amount of weight of the clothes is reduced. As a result, an oscillation value to be detected by the oscillation detection section 14 is also reduced. It is therefore possible to determine the drying level of the clothes on the side closer to the blowoff opening of the air duct as selected (the clothes on the side of the blowoff opening is dried to a sufficient level) based on the result of detection by the oscillation detection section 14. As a result, it is possible to surely reduce an irregular drying of clothes by switching the blowoff opening of the drying air while accurately detecting the drying level based on the result of detection of the oscillation detection section.

[0149] It is preferable that while the drying process is being carried out using the first air duct as selected, the control section controls the air duct switch section to switch the air duct to the second air duct when an amount of reduction or a ratio of reduction per unit time of the oscillation value detected by said oscillation detection section is reduced below the first predetermined value. According to the foregoing structure, when the oscillation value detected by the oscillation detection section is reduced, and an amount of reduction or a ratio of reduction per unit time of the oscillation value detected by said oscillation detection section is reduced below the first predetermined value, it is determined that the clothes in a vicinity of the first blowoff opening of the first air duct as selected has been dried to a sufficient level. Then, at this timing, by switching the air duct from the first air duct to the second air duct, it becomes possible to dry effectively the clothes in a vicinity of the second blowoff opening. As a result, a partial uneven drying of the clothes in the drum can be prevented effectively.

[0150] It is preferable that when an amount of reduction or a ratio of reduction per unit time of the oscillation value detected by said oscillation detection section becomes smaller than the second predetermined value which is smaller than the first predetermined value while said drying process is being carried out by using the second air

duct as selected, said control section controls to terminate the drying operation.

[0151] According to the foregoing structure, after switching the air duct from the first air duct to the second air duct, an oscillation value detected by the oscillation detection section is reduced again, to be smaller than the second predetermined value which is smaller than the first predetermined value, it can be determined that both the clothes on the side of the first blowoff opening and the side of the second blowoff opening (all the clothes in the drum) have been dried to a sufficient level. As a result, it is possible to determine the timing of terminating the drying operation with high precision.

[0152] With the foregoing structure, it is preferable to further comprise a cloth amount detection section which detects an amount of clothes in the drum, wherein said control section sets the first predetermined value or the second predetermined value according to an amount of clothes detected by said cloth amount detection section.

[0153] Where a level of an impact to the drum caused when the clothes drop in the drum (oscillation value detected by the oscillation detection section) differs according to an amount of clothes (total amount) in the drum, the amount of clothes in the drum is detected by the cloth amount detection section to set the first determined value and the second determined value according to the amount of clothes detected. Specifically, the larger is the amount of the clothes in the drum, the larger is the oscillation value to be detected by the oscillation detection section, and therefore the first predetermined value and the second predetermined value are set larger. On the other hand, the smaller is the amount of the clothes in the drum, the smaller is the first predetermined value and the second predetermined value. As described, by setting the first predetermined value or the second predetermined value according to the amount of the clothes in the drum, it is possible to determine the timing of switching the air duct or terminating the drying operation with high precision.

[0154] With the foregoing structure, it is preferable that said first blowoff opening has a larger cross-sectional blowing area than that of said second blowoff opening, wherein said blower section blows drying air into said drum in such a manner than when said first air duct is selected, drying air of larger airflow quantity is spouted from said first blowoff opening into the drum than that in the case of selecting the second air duct, while when said second air duct is selected, drying air of higher pressure and higher speed is spouted from said second blowoff opening into the drum than that in the case of selecting said first air duct.

[0155] According to the foregoing structure, the first blowoff opening has a larger cross-sectional blowing area than that of said second blowoff opening and has small loss in pressure. Then, when the first air duct is selected, drying air of larger airflow quantity spouted into the storage room from the first blowoff opening which is opened at the rare side of the storage room. In this case, since

the first air duct has small loss in pressure, it is possible to generate air in large airflow quantity even when drying the blower section at relatively small power consumption. By spouting air in large airflow quantity, the drying time can be reduced with smaller power consumption. On the other hand, the second blowoff opening of the second air duct has a smaller cross-sectional blowing area than that of said first blowoff opening. Then, when the second air duct is selected, the drying air of higher pressure and higher speed is blown into the storage room from the second blowoff opening which is opened at the front side of the storage section. In this case, by spouting air at high pressure and high speed, the clothes (long sleeved clothes which are liable to be biased to the front side of the storage section) are stretched, thereby reducing wrinkles. As a result, the effects of not only reducing uneven drying while reducing power consumption, but also reducing wrinkles of the clothes by spouting drying air at high speed and high pressure.

[0156] A washing and drying machine in accordance with the present invention includes the drying machine of any of the foregoing structure, and a water tank for storing washing water, which houses the storage section. By using the drying machine of any of the foregoing structures, it is possible to realize a washing and drying machine, which is capable of surely reducing uneven drying of clothes.

[0157] In the first through third embodiments, explanations have been given on the drum-type washing and drying machine provided with both washing and drying functions. However, the present invention is not limited to this, and is applicable to the drying machine without the washing functions, and may adopt the structures of the drum-type washing and drying machine shown in Fig. 1 excluding the washing functions. For example, for the drying machine without having washing functions, the barrel housing 2, which serves as a water tank shown in Fig. 1, is not necessarily to be connected to the feed duct or the discharge duct 40, and therefore may be formed simply as a housing of the drum 1 not as a water tank. For other basic structures, those of the drum-type washing and drying machine shown in Fig. 1 may be adopted.

[0158] It should be appreciated that specific embodiments and examples described in the column, Detailed Description of the Invention, are merely intended to clarify the technical contents of the invention. It is therefore understood that the invention is neither limited nor construed narrowly by these specific embodiments but may otherwise be variously embodied within the spirit and the scope of the following claims of the invention.

Industrial Applicability

[0159] A drying machine and the washing and drying machine of the present invention is widely applicable not only to a domestic drum-type drying machine or washing and drying machine but also to a business use drum-type drying machine or washing and drying machine.

[0160] In particular, the invention further relates to the following embodiments which are parts of the description. Advantageous features of the different embodiments can be combined with each other in one embodiment. It is further possible to omit one or more features from a specific embodiment. The omitted one or more features are not necessary for the specific embodiment.

[0161] Preferred embodiments and/or features of the invention are indicated as follows:

A. A drying machine, characterized in that:

a drum for storing clothes to be dried;
a drum drive section for rotatably driving said drum;
an entanglement determination section for determining if entanglement of clothes has occurred in said drum;
a first air duct with a first blowoff opening which is opened to said drum;
a second air duct with a second blowoff opening which is opened to said drum, said second blowoff section having a smaller cross-sectional blowing area than that of said first blowoff section;
an air duct switch section which selectively switches between said first air duct and said second air duct;
a blower section which blows drying air into said drum from said first blowoff opening when said first air duct is selected for blowing drying air into said drum, and blows drying air into said drum from said second blowoff opening when said second air duct is selected, said drying air from said first blowoff opening being of larger airflow quantity than said drying air from said second blowoff opening; and
a control section which controls said air duct switch section based on a result of determination by said entanglement determination section so as to selectively switch between said first air duct and said second air duct in a drying process.

B. The drying machine according to embodiment no. A, characterized in that:

said first flowoff opening is opened at a rear side of said drum, and said second blowoff opening is opened at a front side of said drum.

C. The drying machine according to embodiment no. A or B, characterized in that:

when said entanglement determination section determines that the entanglement of clothes has occurred, said control section controls said air duct switch section to switch the air duct to said second air duct.

D. The drying machine according to any one of embodiments nos. A to C, characterized in that:

when said entanglement determination section determines that there is no entanglement of clothes, said control section controls said air duct switch section to switch the air duct to said first air duct. 5

E. The drying machine according to any one of embodiments nos. A to D, characterized by further comprising: 10

an oscillation detection section for detecting an oscillation of said drum, 15
wherein said entanglement determination section determines that entanglement of clothes has occurred when an output value from said oscillation detection section is increased by not less than a first predetermined value, and determines that the entanglement of clothes has been unraveled when an output value from said oscillation detection section is reduced by not less than a second predetermined value. 20

F. The drying machine according to embodiment no. E, characterized in that: 25

said entanglement determination section reduces the first predetermined and said second predetermined value as time passes in the drying process. 30

G. The drying machine according to embodiment no. F, characterized by further comprising: 35

a cloth amount detection section which detects an amount of clothes in said drum, wherein said entanglement determination section changes a time interval for reducing the first predetermined value and the second predetermined value step by step according to an amount of clothes detected by said cloth amount detection section. 40

H. The drying machine according to any one of embodiments nos. E to G, characterized by further comprising: 45

a cloth amount detection section which detects an amount of clothes in said drum, wherein said entanglement determination section sets the first predetermined value and the second predetermined value based on an amount of the clothes detected by the cloth amount detection section. 50

I. The drying machine according to any one of em-

bodiments no. E to H, characterized in that said oscillation detection section is an acceleration sensor.

J. The drying machine according to any one of embodiments no. E to H, characterized in that said oscillation detection section is an angular velocity sensor.

K. A drying machine characterized by comprising:

a drum for storing clothes to be dried;
a drum drive section for rotatably driving said drum;
a blower section for blowing drying air into said drum;
a first air duct with a first blowoff opening which is opened at a rear side of said drum;
a second air duct with a second blowoff opening which is opened at a front side of said drum;
an air duct switch section which selectively switches between said first air duct and said second air duct;
an oscillation detection section which detects an oscillation of said drum; and
a control section which controls the air duct switch section based on a result of detection by said oscillation detection section to selectively switch between the first air duct and the second air duct in a drying process.

L. The drying machine according to embodiment no. K, characterized in that:

while the drying process is being carried out using the first air duct as selected, the control section controls the air duct switch section to switch the air duct to the second air duct when an amount of reduction or a ratio of reduction per unit time of the oscillation value detected by said oscillation detection section is reduced below the first predetermined value.

M. The drying machine according to embodiment no. L, characterized in that:

when an amount of reduction or a ratio of reduction per unit time of the oscillation value detected by said oscillation detection section becomes smaller than the second predetermined value which is smaller than the first predetermined value while said drying process is being carried out by using the second air duct as selected, said control section controls to terminate the drying operation.

N. The drying machine according to embodiment nos. L or M, characterized by further comprising:

a cloth amount detection section which detects an amount of clothes in the drum, wherein said control section sets the first predetermined value or the second predetermined value according to an amount of clothes detected by said cloth amount detection section.

O. The drying machine according to any one of embodiment nos. L to N, characterized in that:

said first blowoff opening has a larger cross-sectional blowing area than that of said second blowoff opening, wherein said blower section blows drying air into said drum in such a manner than when said first air duct is selected, drying air of larger airflow quantity is spouted from said first blowoff opening into the drum than that in the case of selecting the second air duct, while when said second air duct is selected, drying air of higher pressure and higher speed is spouted from said second blowoff opening into the drum than that in the case of selecting said first air duct..

P. A washing and drying machine, characterized by comprising:

a drying machine according to any one of embodiments nos. A to O; and
a water tank for storing washing water, wherein said water tank houses said drum.

Claims

1. A drying machine comprising:

a drum (1) for storing clothes to be dried; and
a drum drive section (3) for rotatably driving said drum (1); **characterized in that** the drying machine comprises:

a blower section (4) for blowing drying air into said drum (1);
a first air duct (9) with a first blowoff opening (8) which is opened at a rear side of said drum (1);
a second air duct (11) with a second blowoff opening (10) which is opened at a front side of said drum (1);
an air duct switch section (12) which selectively switches between said first air duct (9) and said second air duct (11);
an oscillation detection section (14) which detects an oscillation of said drum (1); and
a control section (70) which controls the air duct switch section (12) based on a result of detection by said oscillation detection

section (14) to selectively switch between the first air duct (9) and the second air duct (11) in a drying process.

2. The drying machine according to claim 1, **characterized in that:**

while the drying process is being carried out using the first air duct (9) as selected, the control section (70) controls the air duct switch section (12) to switch the air duct to the second air duct (11) when an amount of reduction or a ratio of reduction per unit time of the oscillation value detected by said oscillation detection section (14) is reduced below the first predetermined value.

3. The drying machine according to claim 2, **characterized in that:**

when an amount of reduction or a ratio of reduction per unit time of the oscillation value detected by said oscillation detection section (14) becomes smaller than the second predetermined value which is smaller than the first predetermined value while said drying process is being carried out by using the second air duct (11) as selected, said control section (70) controls to terminate the drying operation.

4. The drying machine according to claim 2 or 3, **characterized by** further comprising:

a cloth amount detection section (15) which detects an amount of clothes in the drum (1), wherein said control section (70) sets the first predetermined value or the second predetermined value according to an amount of clothes detected by said cloth amount detection section (15).

5. The drying machine according to any one of claims 1 to 4, **characterized in that:**

said first blowoff opening (8) has a larger cross-sectional blowing area than that of said second blowoff opening (10), wherein said blower section (4) blows drying air into said drum (1) in such a manner than when said first air duct (9) is selected, drying air of larger airflow quantity is spouted from said first blowoff opening (8) into the drum (1) than that in the case of selecting the second air duct (11), while when said second air duct (11) is selected, drying air of higher pressure and higher speed is spouted from said second blowoff opening (10) into the drum (1) than that in the case of selecting said first air duct (9).

6. A washing and drying machine, **characterized by** comprising:

a drying machine according to any one of claims
1 to 5; and
a water tank for storing washing water, wherein
said water tank houses said drum (1).

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FIG.1

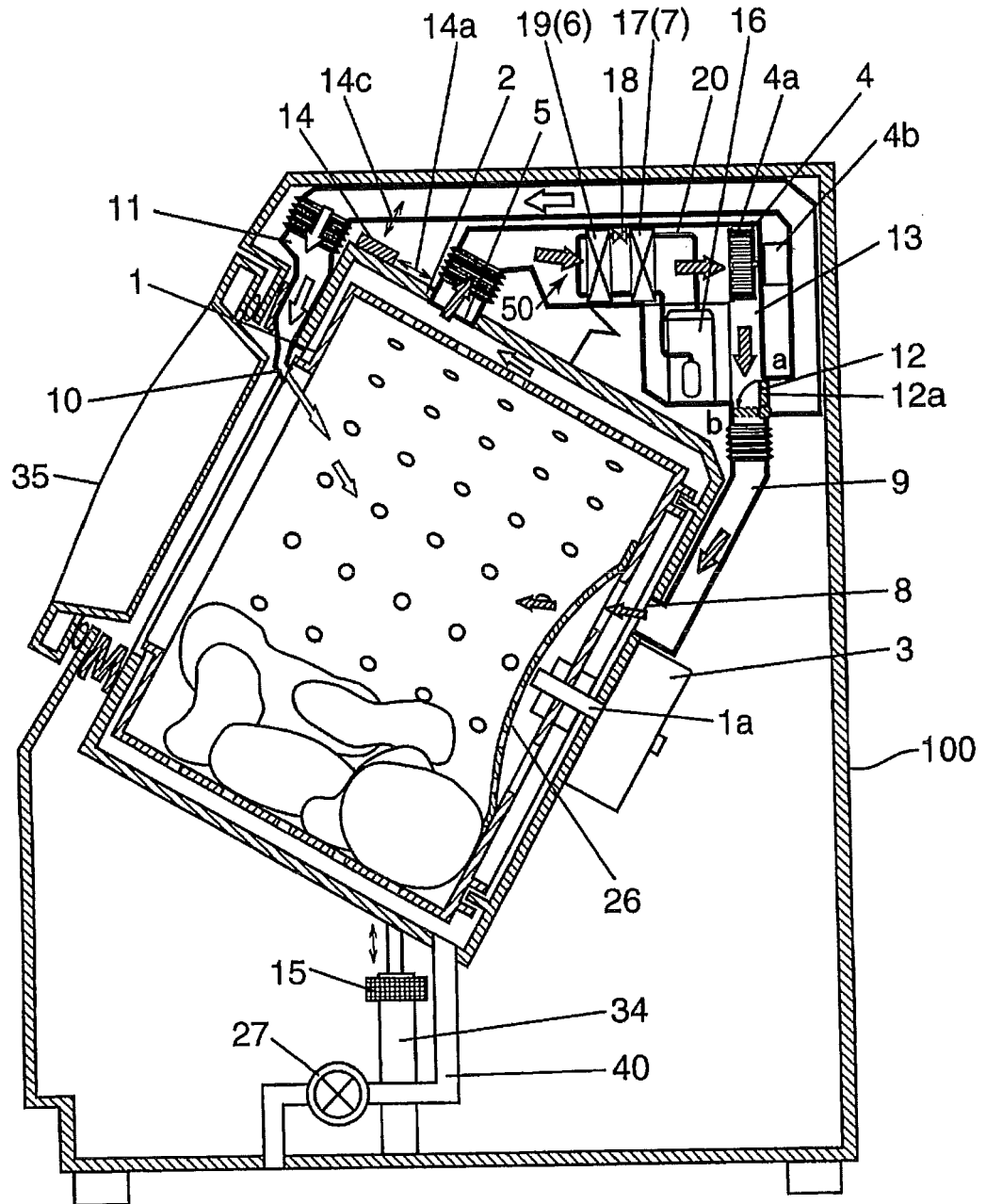


FIG.2

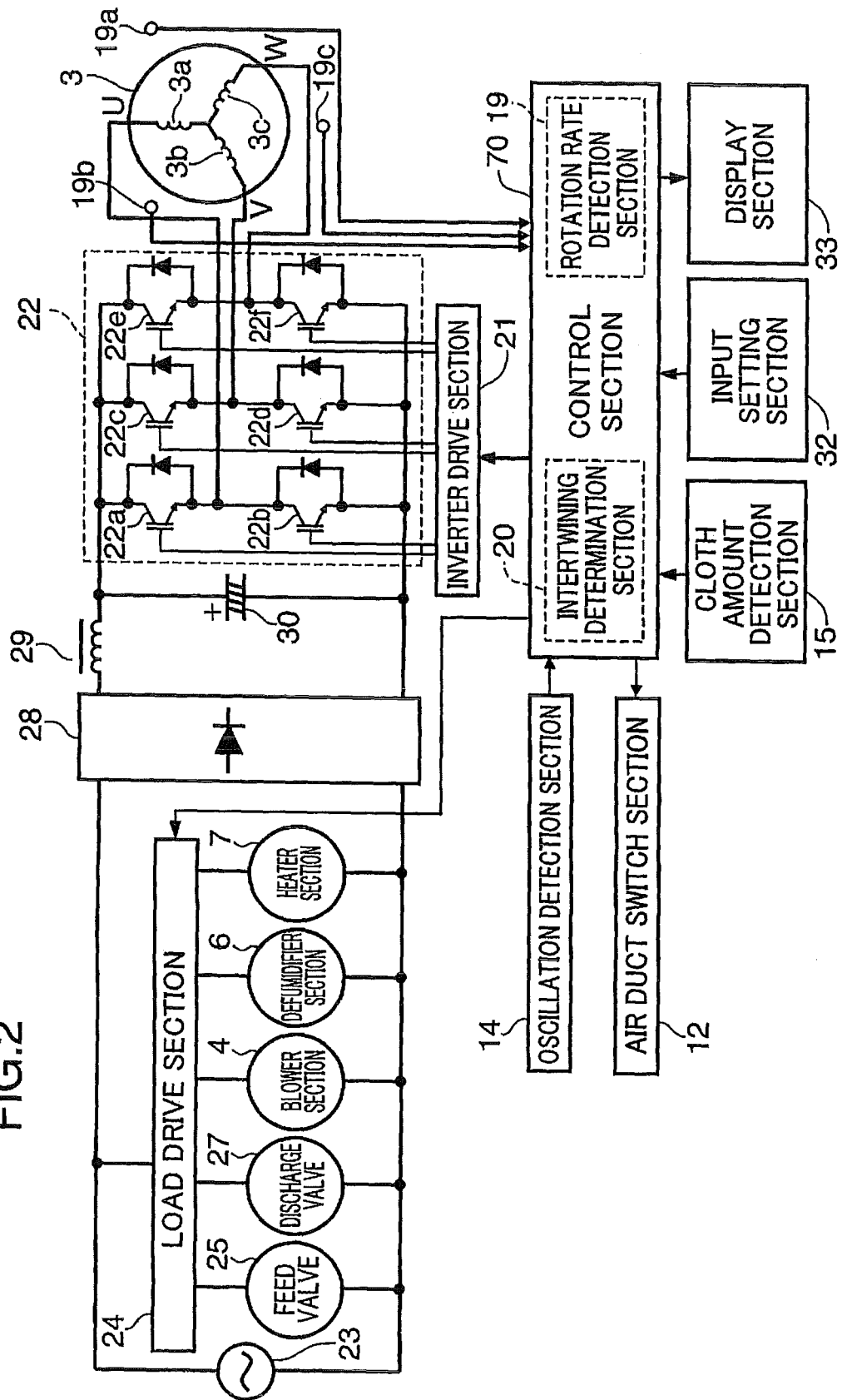


FIG.3

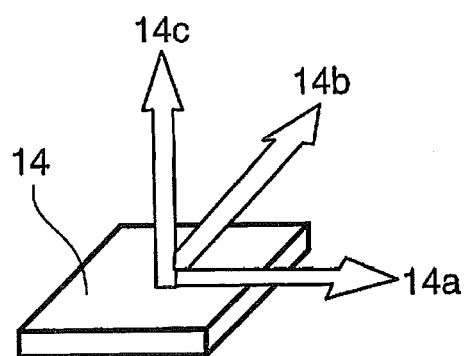


FIG.4

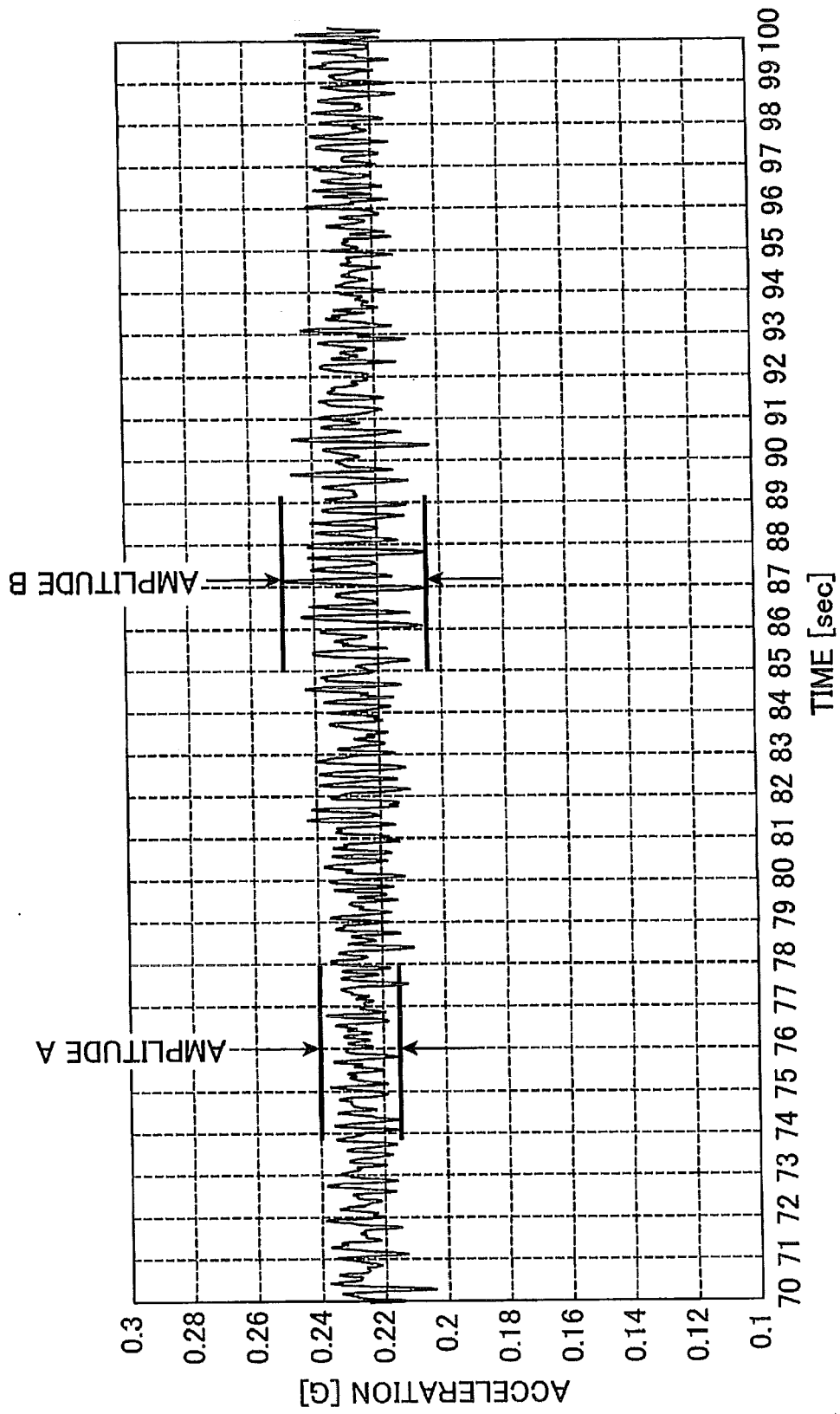


FIG.5

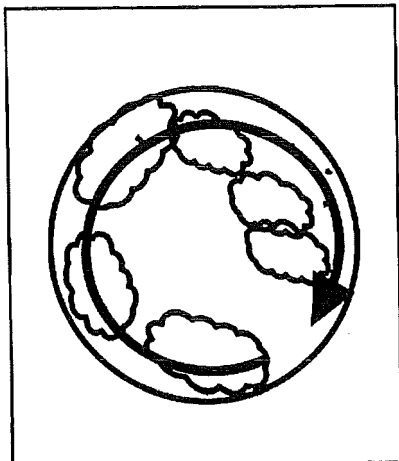


FIG.6

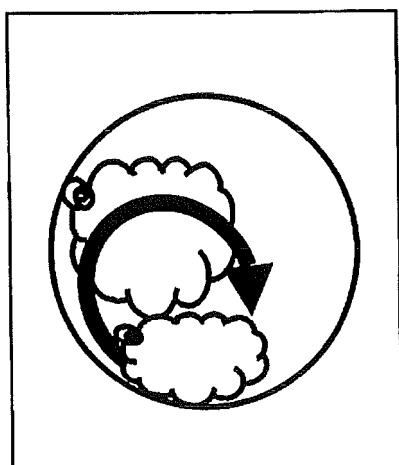


FIG.7

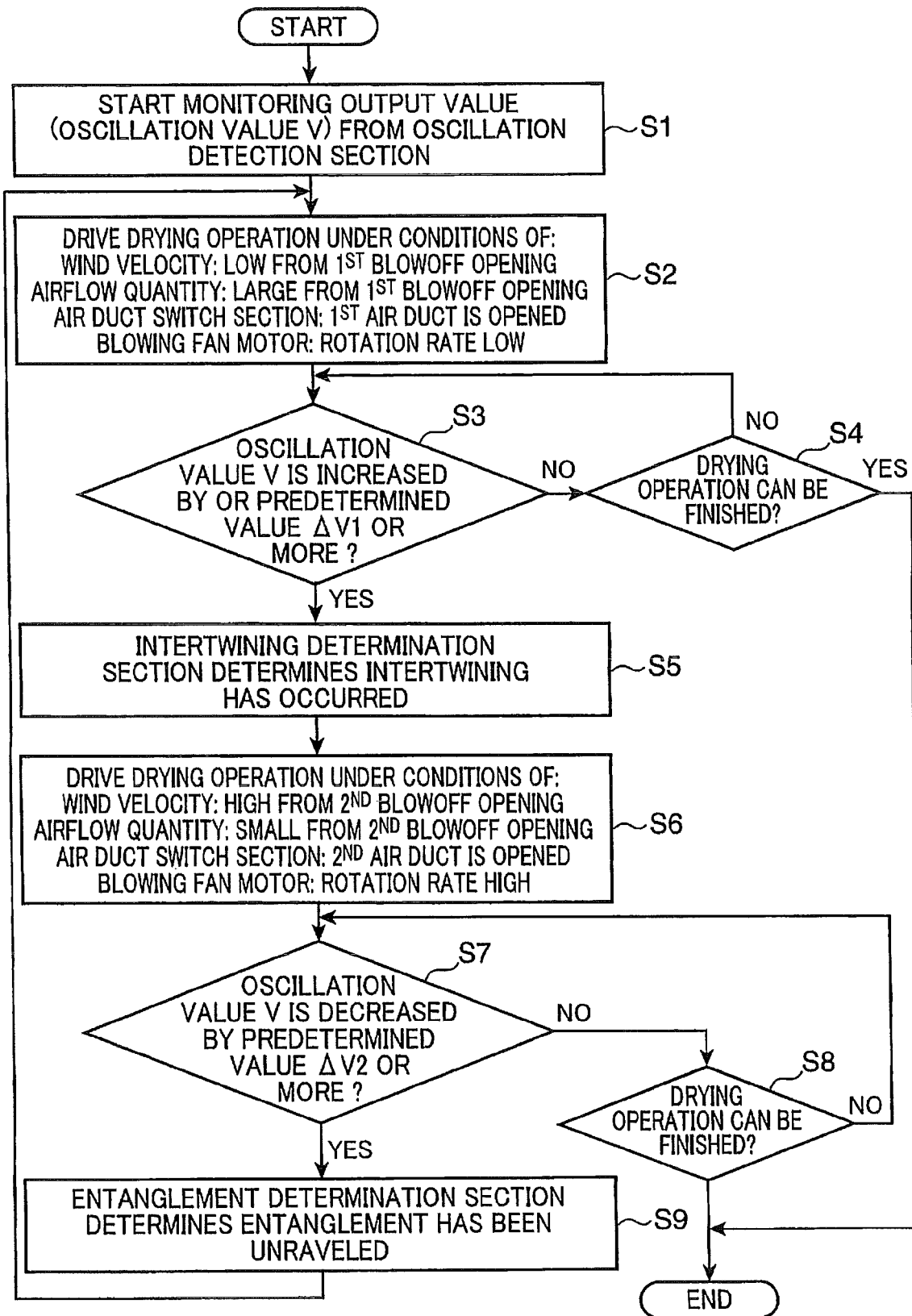


FIG.8

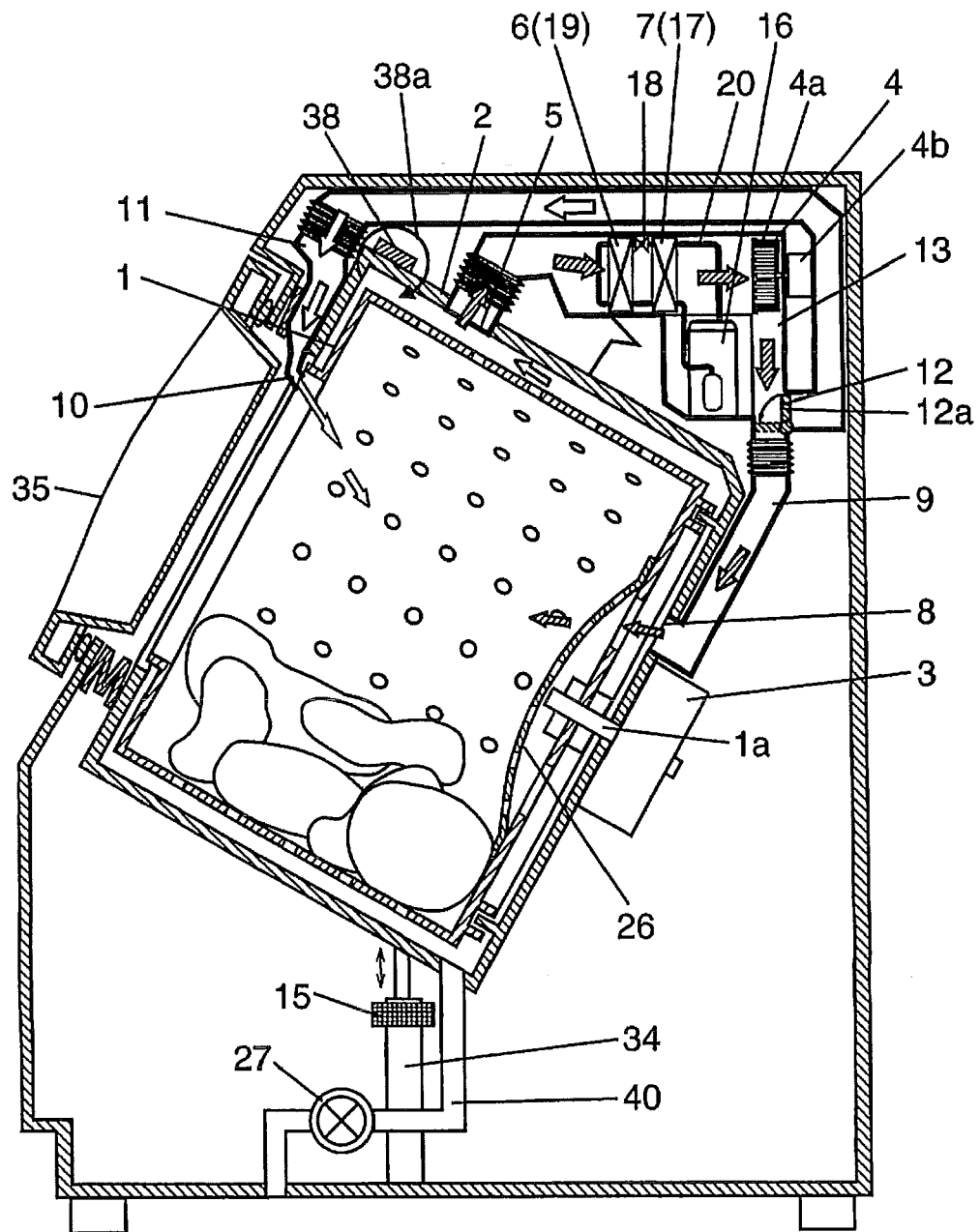


FIG.9

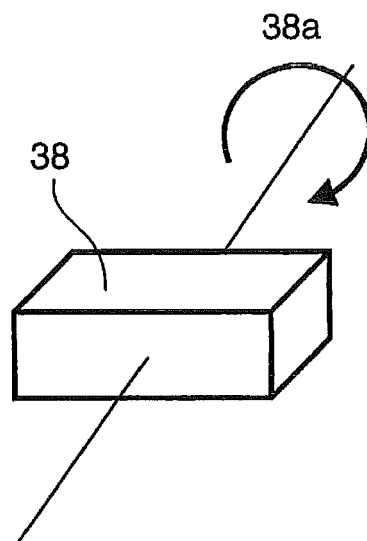


FIG.10

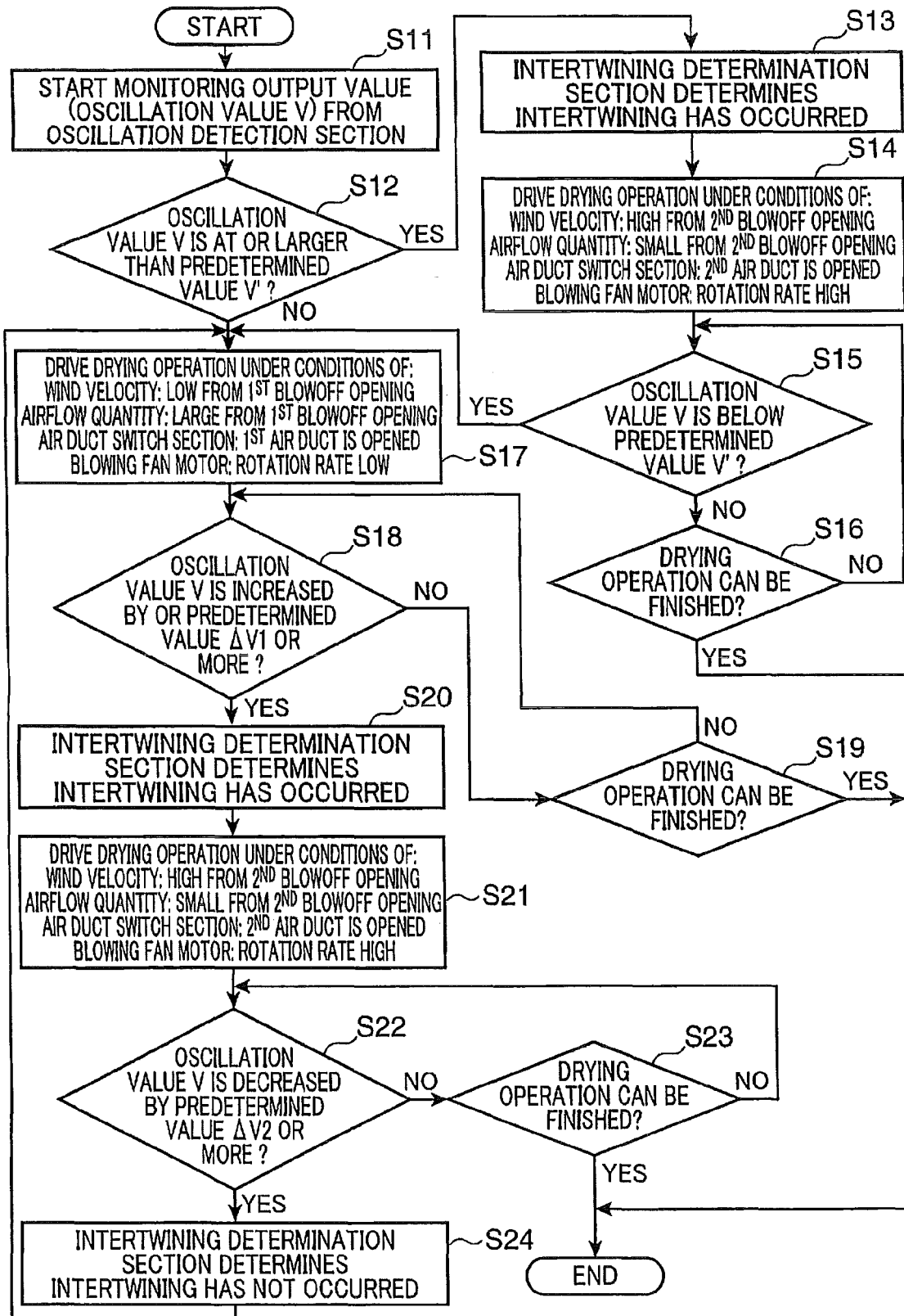


FIG.11

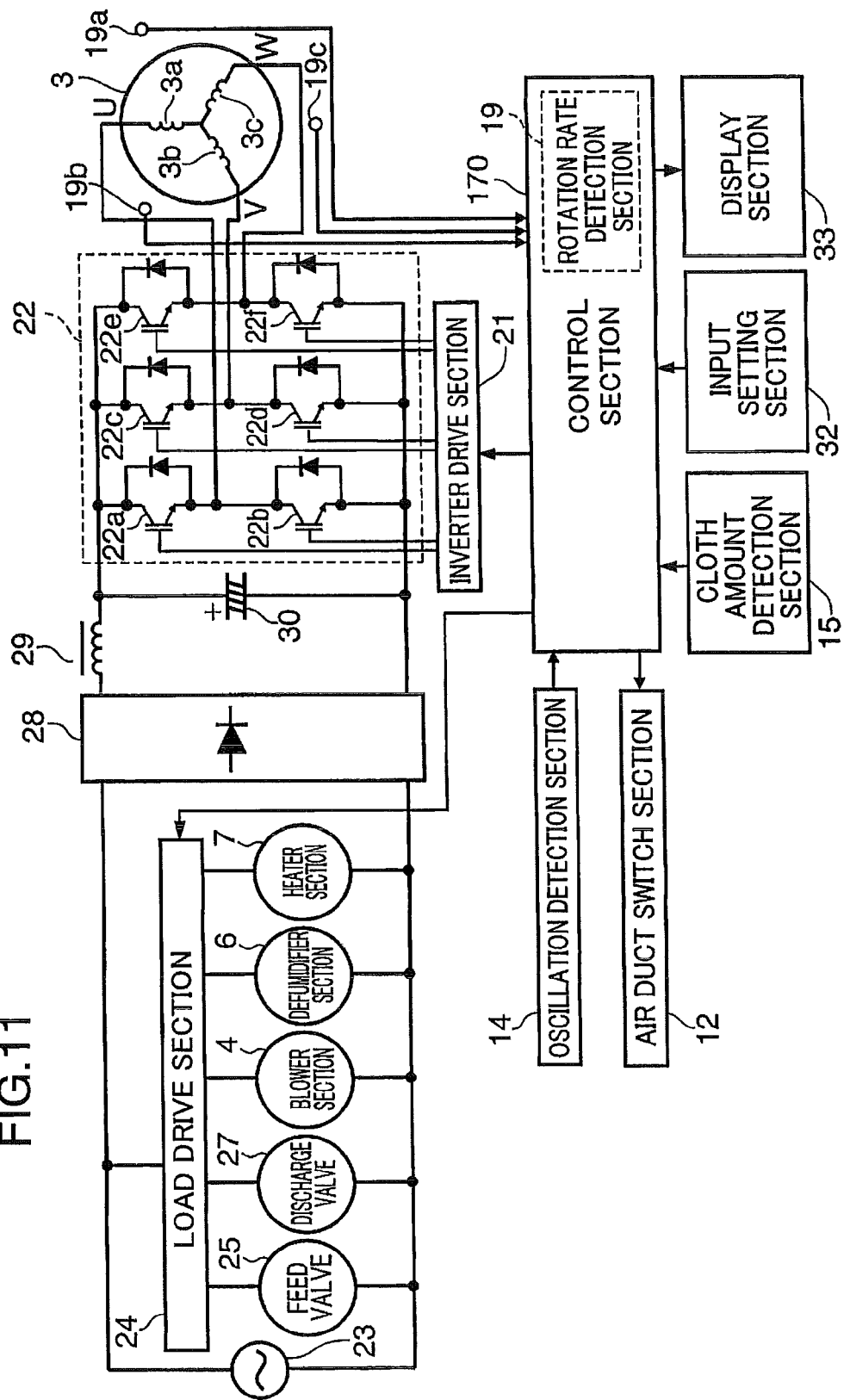


FIG.12

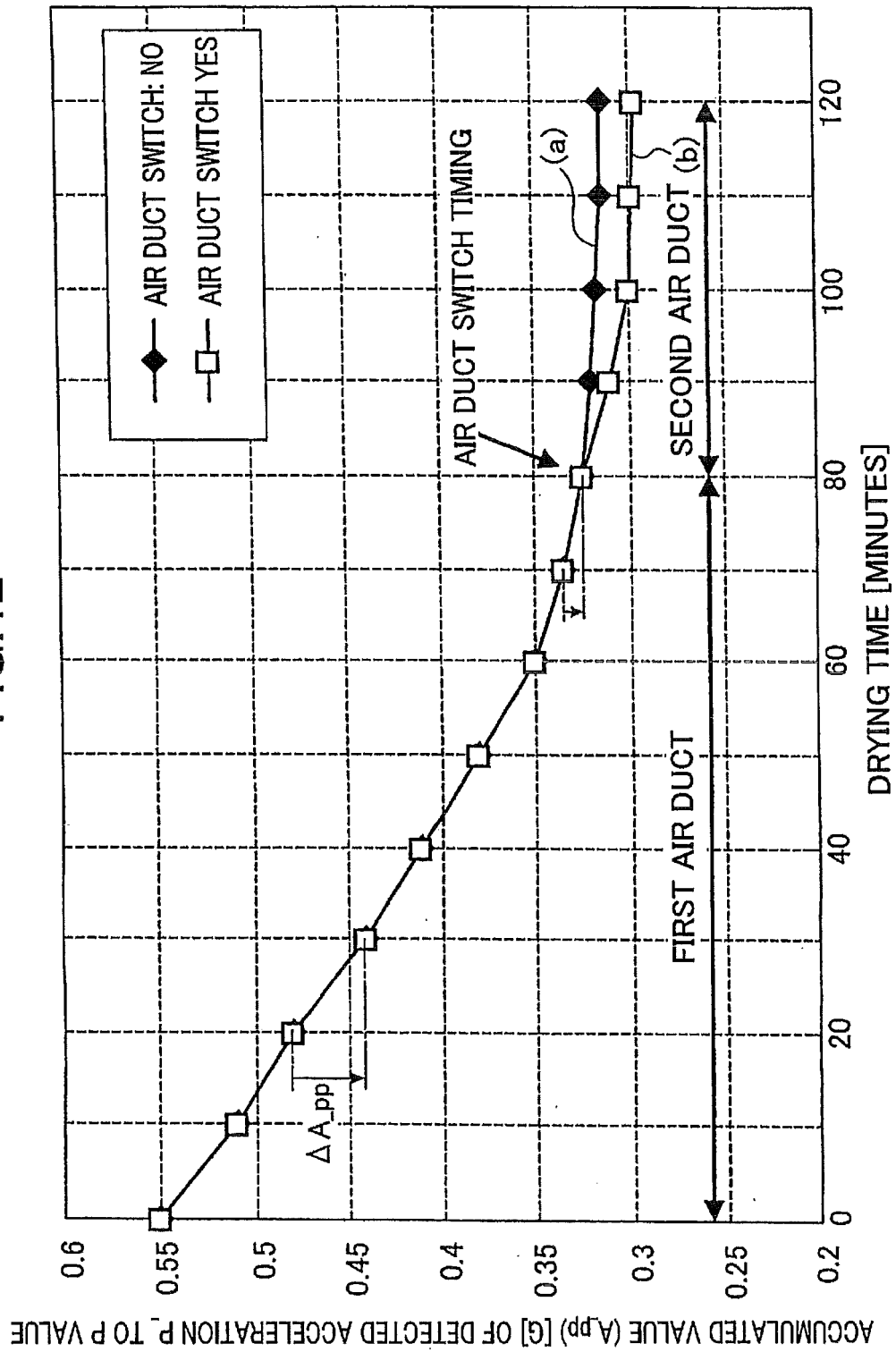


FIG.13

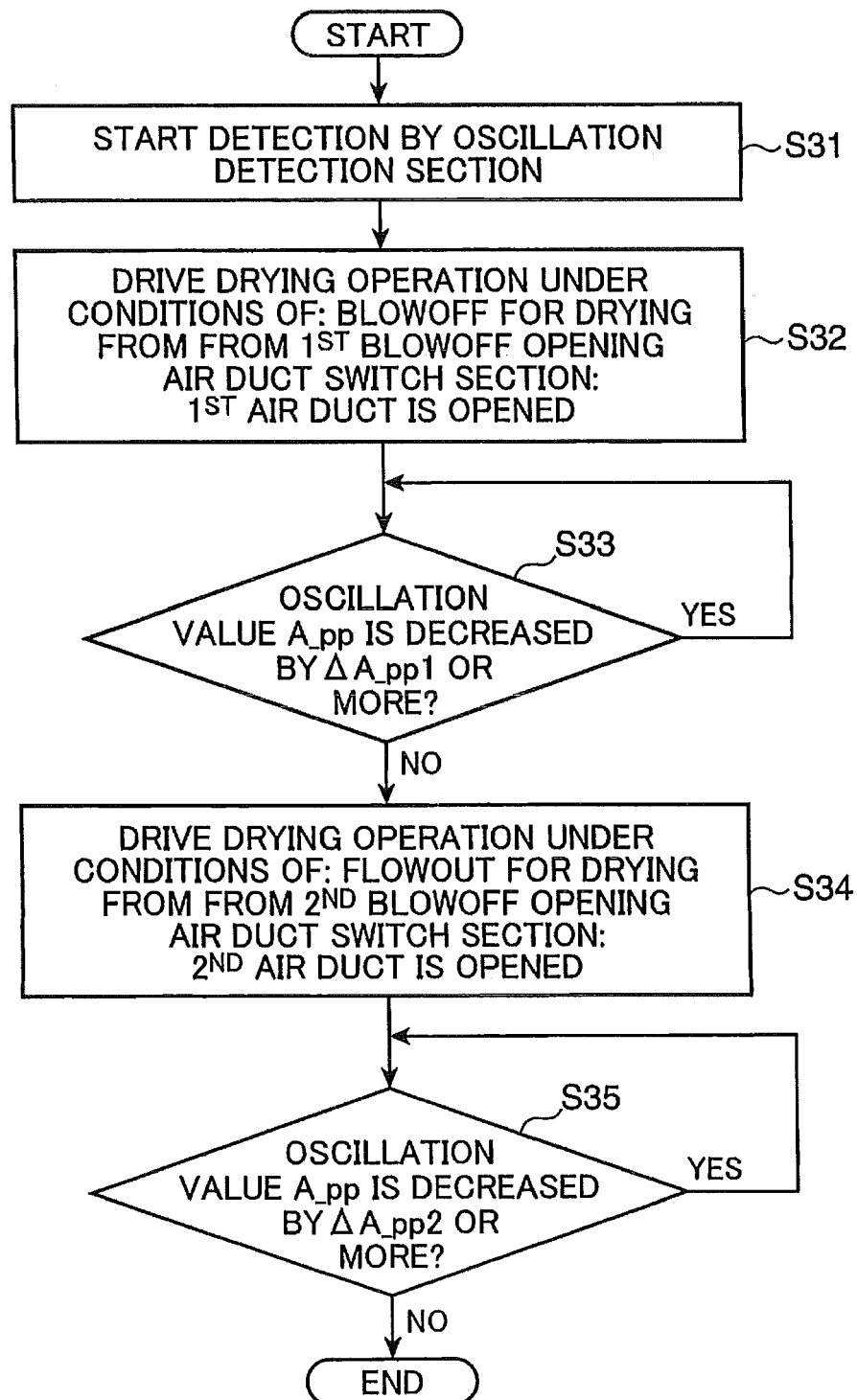
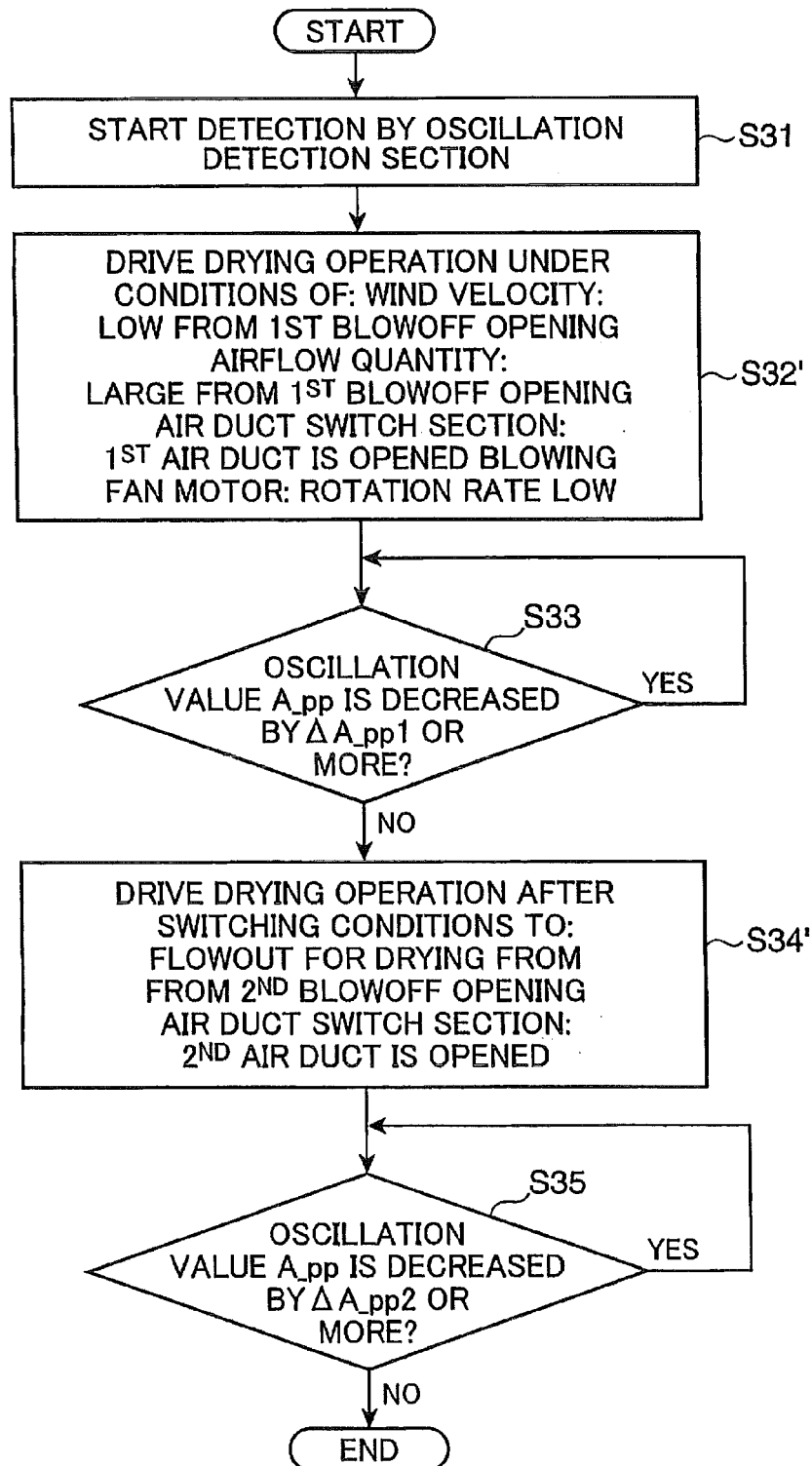


FIG.14





EUROPEAN SEARCH REPORT

Application Number
EP 11 17 4377

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	WO 2004/048673 A2 (KIM SU HEON [US]) 10 June 2004 (2004-06-10) * page 6, lines 23-29; figure 2 *	1-6	
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			D06F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 November 2011	Examiner Stroppa, Giovanni
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 17 4377

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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18-11-2011

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