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

(11) EP 2 336 419 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.06.2011 Bulletin 2011/25

(21) Application number: **10189023.4**

(22) Date of filing: **27.10.2010**

(51) Int Cl.:
D06F 58/28 *(2006.01)*

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

(30) Priority: **18.11.2009 JP 2009262690**
18.11.2009 JP 2009262691

(71) Applicant: **Panasonic Corporation**
Kadoma-shi
Osaka 571-8501 (JP)

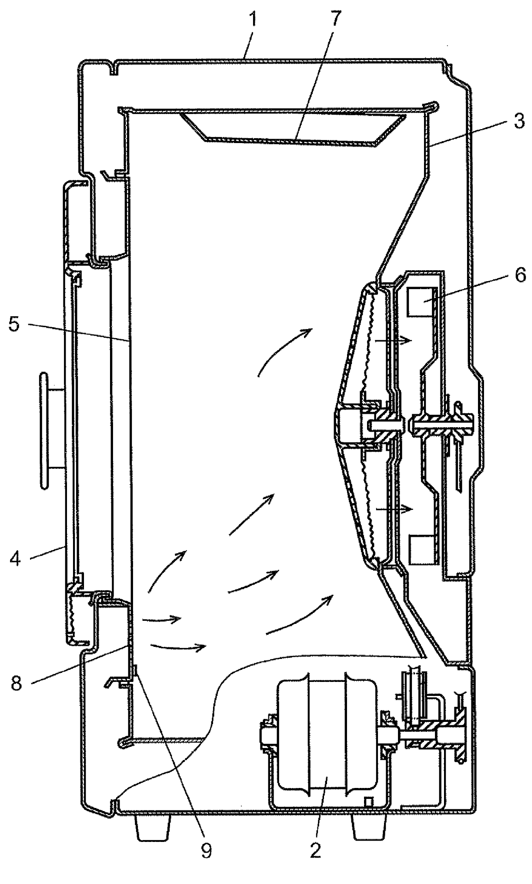
(72) Inventors:
- **Matsuda, Shinichi**
  Osaka 540-6207 (JP)
- **Kawai, Tetsuo**
  Osaka 540-6207 (JP)

(74) Representative: **Schwabe - Sandmair - Marx**
Patentanwälte
Stuntzstraße 16
81677 München (DE)

(54) **Clothes dryer**

(57) A clothes dryer includes a rotary drum (3), a motor (2), a heating unit (14), a blower fan (6), a dryness detector (9), and a controller (11). The rotary drum (3) accommodates wet articles. The motor (2) rotates the rotary drum (3). The heating unit (14) heats drying air. The blower fan (6) supplies the drying air heated by the heating unit (14) to inside the rotary drum (3). The dryness detector (9) detects resistance values of the wet articles in the rotary drum (3). The controller (11) controls the motor (2) based on an output of the dryness detector (9). More specifically, the controller (11) rotates the rotary drum (3) at a second rotation speed (r2) slower than a first rotation speed (r1) if the dryness detector (9) detects only resistance values greater than a predetermined value in a first predetermined time (T1) from a start of drying operation by rotating the rotary drum (3) at the first rotation speed (r1).

FIG. 1



EP 2 336 419 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to clothes dryers for drying wet articles, such as clothes, in a rotary drum.

BACKGROUND ART

[0002] A conventional clothes dryer completes its operation automatically based on dryness detected by a dryness detector. Fig. 10 is a sectional view of the conventional clothes dryer disclosed in the Japanese Patent Unexamined Publication No. H6-327899.

[0003] In this clothes dryer, motor 52 is provided at the bottom of housing 51. Rotary drum 54 is provided in housing 51, and blower fan 53 is provided at the back of housing 51. Motor 52 rotates rotary drum 54 and blower fan 53. Heater 55 is provided at the front of housing 51. Hot air heated by heater 55 is supplied to rotary drum 54 through hot-air outlet 56 by the rotation of blower fan 53. Baffle 57 tumbles clothes in rotary drum 54, and the hot air dries the clothes.

[0004] Electrode 58 that detects dryness of clothes is disposed underneath hot-air outlet 56 of rotary drum 54. When clothes tumbled in rotary drum 54 make contact with electrode 58 during the drying operation, electrode 58 detects resistance values of clothes, so as to detect dryness of clothes.

[0005] The Japanese Patent Unexamined Publication No. 2000-229200 discloses a prior art of appropriately controlling the drying operation even if a quantity of clothes to be dried is small. In this clothes dryer, an operation time is set based on dryness detected by the dryness detector if a clothes quantity determination unit determines that a quantity of clothes is small. A quantity of clothes is determined based on contact frequency of clothes with the electrode. Dryness is detected when the clothes make contact with the electrode. Accordingly, quantity and dryness of clothes are determined by contacting of clothes on the electrode. Therefore, for example, the rotation of drum is inverted for a certain period in order to detangle the entangled clothes or change positions of clothes in the rotary drum. Then, the quantity and dryness of clothes are determined.

[0006] However, with the above conventional structure, clothes may not make contact with electrode 58 if a quantity of clothes to be dried inside rotary drum 54 is small. This may disable detection of dryness. Therefore, drying takes place for a period set by predicting the time needed for completing drying, without being based on dryness of clothes. In this case, clothes may be dried excessively or insufficiently, depending on moisture variations in clothes to be dried. This results in insufficient drying or wasting of power consumption due to excessive drying.

[0007] Furthermore, the rotary drum is rotated to tumble clothes, and to make clothes satisfactorily exposed to the drying air supplied to the rotary drum during the drying operation. Clothes are lifted up by the baffles, and then dropped to make contact with the electrode. However, if a quantity of clothes is small, clothes lifted upward by the baffles tumble while retained by the baffles from underneath, and thus the clothes do not make contact with the electrode. Accordingly, if a quantity of clothes is small in a system of determining clothes quantity and dryness by contacting of clothes contact with the electrode, it is difficult for clothes to make contact with the electrode accurately by inverted driving of the rotary drum.

SUMMARY OF THE INVENTION

[0008] The present invention offers a clothes dryer that can accurately detect dryness of clothes, and optimally dry the clothes when a small quantity of clothes is dried. The clothes dryer of the present invention includes a rotary drum, a motor, a heating unit, a blower fan, a dryness detector, and a controller. The rotary drum accommodates a wet article (an article to be dried). The motor rotates the rotary drum. The heating unit heats the drying air. The blower fan supplies the drying air heated by the heater to inside the rotary drum. The dryness detector detects a resistance value of the wet article in the rotary drum. The controller controls the motor based on an output of the dryness detector. More specifically, the controller reduces the rotation speed of the rotary drum from a first rotation speed to a second rotation speed if the dryness detector only detects resistance values greater than a predetermined value in a first predetermined period from a start of drying operation by rotating the rotary drum at the first rotation speed.

[0009] This enables dropping of the wet article rotated in a state retained by a baffle of the rotary drum from underneath to the bottom of the rotary drum from a predetermined position lifted up by the baffle. The wet article thus contacts the dryness detector, and its resistance value can be detected. As a result, dryness of clothes at drying a small quantity of clothes can be accurately detected, and thus clothes can be optimally dried in just proportion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is a sectional view of a clothes dryer in accordance with a first exemplary embodiment of the present invention.

Fig. 2 is a sectional view illustrating a circulating air passage of the clothes dryer shown in Fig. 1.

Fig. 3 is a perspective view of a dryness detector of the clothes dryer shown in Fig. 1.

Fig. 4 is a block diagram of the clothes dryer shown in Fig. 1.

Fig. 5 is a system diagram of the clothes dryer shown in Fig. 1.

Fig. 6 is a timing chart illustrating the operation of the clothes dryer shown in Fig. 1.

Fig. 7 is a timing chart illustrating the operation of a clothes dryer in accordance with a second exemplary embodiment of the present invention.

Fig. 8 is a sectional view of a clothes dryer in accordance with a third exemplary embodiment of the present invention.

Fig. 9 is a timing chart illustrating the operation of a clothes dryer in accordance with a fourth exemplary embodiment of the present invention.

Fig. 10 is a sectional view of a conventional clothes dryer.

DETAILED DESCRIPTION OF THE INVENTION

[0011] Exemplary embodiments of the present invention are described bellow with reference to drawings. However, the scope of the present invention is not limited to these exemplary embodiments. Same reference marks are given to structures same as that described in a previous exemplary embodiment to omit duplicate detailed description.

(FIRST EXEMPLARY EMBODIMENT)

[0012] Figs. 1 and 2 are sectional views of a clothes dryer in the first exemplary embodiment of the present invention. Fig. 2 illustrates circulating air passage 18. Fig. 3 is a perspective view of a dryness detector of the clothes dryer. Fig. 4 is a block diagram of this clothes dryer, and Fig. 5 is a system diagram of this clothes dryer. As shown in Figs. 1 to 5, the clothes dryer includes housing 1, motor 2, rotary drum 3, blower fan 6, dryness detector 9, rotation speed detector 10, controller 11, circulating air passage 18, heat pump device 12, temperature detector 19, and temperature setting unit 20.

[0013] As shown in Figs. 1 and 2, door 4 is provided at the front of housing 1. Cylindrical rotary drum 3 is rotatably provided in housing 1. Door 4 opens and closes opening 5 for loading and unloading rotary drum 3 with clothes and the like. Blower fan 6 is provided at the back of rotary drum 3 in housing 1. Motor 2 is provided at the bottom in housing 1, and rotates rotary drum 3 and blower fan 6 via a belt (not illustrated).

[0014] Multiple baffles 7 (e.g., three or four pieces) are made on an inner circumferential face of rotary drum 3 at a predetermined interval so as to protrude inward. Baffles 7 lift up and tumble clothes as rotary drum 3 rotates. The drying air supplied from blower fan 6 is directed inside rotary drum 3 through inlet (hot-air outlet) 8 provided at the front of housing 1 underneath opening 5.

[0015] Dryness detector 9 is provided near and underneath inlet 8 such that dryness detector 9 faces inside rotary drum 3. Dryness detector 9 detects resistance values of clothes when the clothes are tumbled in rotary drum 3 and make contact with dryness detector 9, so as to detect dryness of clothes. As shown in Fig. 3, dryness detector 9 includes two electrodes 9A and insulating member 9B electrically insulating between electrodes 9A. Dryness detector 9 detects resistance values of clothes bridging and contacting both electrodes 9A.

[0016] Rotation speed detector 10 detects a rotation speed (number of revolutions per unit time) of rotary drum 3. As shown in Fig. 4, rotation speed detector 10 includes magnet 10A provided in rotary drum 3, and lead switch 10B disposed facing magnet 10A. Controller 11 receives an output signal of dryness detector 9 detecting resistance values of clothes and an output signal indicating the rotation speed of rotary drum 3 detected by rotation speed detector 10, using lead switch 10B. The structure of rotation speed detector 10 is not limited to this structure. For example, rotation speed detector 10 may optically detect the rotation speed of rotary drum 3.

[0017] Heat pump device 12 dehumidifies and heats the drying air, and then directs the air into rotary drum 3 through inlet 8. As shown in Fig. 5, heat pump device 12 includes compressor 13, radiator 14, pressure reducer15, heat absorber 16, and pipeline 17. Compressor 13 compresses refrigerant. Radiator 14 releases the heat of the compressed refrigerant. Pressure reducer 15 reduces pressure of the refrigerant with high-pressure. In heat absorber 16, the refrigerant whose pressure has been reduced to low pressure absorbs heat from the environment. Pipeline 17 connects compressor 13, radiator 14, pressure reducer 15, and heat absorber 16 in this sequence, so as to circulate the refrigerant. The refrigerant circulates in pipeline 17 in the direction shown by an arrow in Fig. 5 to establish a heat pump cycle. Radiator 14 configures a heating unit that heats the drying air flowing in circulating air passage 18.

[0018] As shown in Figs. 2 and 5, circulating air passage 18 communicates with rotary drum 3, and thus the drying air flows inside circulating air passage 18. Radiator 14 and heat absorber 16 of heat pump device 12 are disposed in circulating air passage 18 through which the drying air is directed from blower fan 6 to rotary drum 3. It is effective that the drying air is dehumidified before being heated. Accordingly, radiator 14 and heat absorber 16 are provided in the circulating air passage, and in addition, heat absorber 16 is disposed before (upstream) of radiator 14 in the direction that the drying air flows. This enables dehumidification of the drying air.

[0019] In circulating air passage 18, temperature detector 19 is provided downstream of radiator 14. Temperature detector 19 detects temperature of the drying air directed to rotary drum 3. Blower fan 6 takes in air inside rotary drum 3 from an outlet (not illustrated) provided at the back of rotary drum 3 to circulating air passage 18. Note here that blower fan 3 may alternatively be provided in circulating air passage 18 using an electric-powered fan or the like.

[0020] Controller 11 controls driving of rotary drum 3, blower fan 6, and heat pump device 12 based on outputs of dryness detector 9, rotation speed detector 10, and temperature detector 19.

[0021] The operation and effect of the clothes dryer as configured above are described below. A user opens door 4, loads rotary drum 3 with clothes to be dried, and starts the drying operation. Then, motor 2 drives rotary drum 3 and blower fan 6. In addition, compressor 13 of heat pump device 12 is driven. They operate at preset operation speeds, respectively. As described above, rotation speed detector 10 detects the rotation speed of rotary drum 3. Controller 11 controls the rotation speed of rotary drum 3 to predetermined first rotation speed r1 (e.g. 50 r.p.m.) based on an output of rotation speed detector 10.

[0022] Baffles 7 lift up clothes in rotary drum 3, and then drop them from a predetermined height to tumble the clothes. Blower fan 6 supplies dry hot air so as to dry the clothes. Temperature detector 19 detects temperature of the hot air, and controller 11 controls the temperature of hot air to a predetermined set temperature (e.g., 70 °C) by controlling temperature setting unit 20 based on an output of temperature detector 19. When the clothes tumbled inside rotary drum 3 make contact with dryness detector 9, dryness detector 9 detects resistance values of the clothes bridging and contacting two electrodes 9A, so as to detect dryness of the clothes.

[0023] Fig. 6 is a timing chart illustrating the operation of this clothes dryer. More specifically, the timing chart indicates a time-dependent change of counting number Y and the operations of rotary drum 3, compressor 13, and blower fan 6. Counting number Y is the number of hits in unit time detected by dryness detector 9 in which resistance values of clothes are smaller than a predetermined value when a quantity of clothes is small. Counting number Y indicates the number of resistance values smaller than the predetermined value detected by dryness detector 9, for example, in 10 seconds. The predetermined value is set, for example, to 5 MΩ.

[0024] If the quantity of loaded clothes is small, the clothes lifted up by baffles 7 at first rotation speed r1 continue their rotation while being retained by baffles 7 from underneath, and do not drop. The clothes thus do not make contact with dryness detector 9. Accordingly, counting number Y in first predetermined time period T1 (e.g., 1 minute) from the start of drying operation is 0,

[0025] If counting number Y remains 0 when first predetermined time period T1 elapses, controller 11 reduces the rotation speed of rotary drum 3 from first rotation speed r1 to predetermined second rotation speed r2 (e.g., 35 r.p.m.). Then, dryness detector 9 detects resistance values of the clothes during second predetermined time period T2 (e.g., 2 minutes). By reducing the rotation speed of rotary drum 3 to predetermined second rotation speed r2, a centrifugal force applied to the clothes retained by baffles 7 from underneath becomes weak, and thus the clothes drop from a predetermined height, making contact with dryness detector 9.

[0026] After first predetermined time period T1 from the start of drying operation, the clothes are still heavily wet, and thus dryness detector 9 detects a resistance value smaller than a resistance value of dried clothes. Accordingly, resistance values of the clothes detected by dryness detector 9 in second predetermined time period T2 are smaller than the predetermined value, and counting number Y is not 0. As the drying operation continues, and the clothes are dried by time point t1, counting number Y becomes 0 again. Controller 11 calculates remaining drying time period T3 based on maximum value y2 of counting number Y by time point t1, and time point t1 when Y becomes 0. More specifically, the quantity of clothes is detected from y2, and easiness of drying clothes and moisture content can be recognized from t1. Accordingly, controller 11 can set T3 that is the time period for continuing drying.

[0027] Controller stops the operation of compressor 13 of heat pump device 12 when drying operation time period T3 passes and reaches time point t2. Then the operations of rotary drum 3 and blower fan 6 are extended up to time point t3, and the drying operation completes at time point t3. Clothes include textile articles that can be dried in rotary drum 3, and are thus not limited to clothing.

[0028] As described above, controller 11 uses dryness detector 9 to detect resistance values of clothes during first predetermined time period T1 from the start of drying operation at first rotation speed r1. If a resistance value smaller than the predetermined value is not detected in this period and only resistance values greater than this predetermined value are detected, controller 11 reduces rotary drum 3 to second rotation speed r2. Then, controller 11 uses dryness detector 9 to detect resistance values of the clothes in second predetermined time period T2. By controlling the rotation speed in this way, the clothes tumbled while retained by baffles 7 of rotary drum 3 from underneath can be dropped to the bottom of rotary drum 3 from a predetermined position lifted up by baffles 7. Accordingly, the clothes make contact with dryness detector 9, and thus dryness detector 9 can detect resistance values of the clothes. Controller 11 can accurately detect dryness of the clothes even if a small quantity of clothes is dried. The clothes dryer can thus optimally dry clothes in just proportion.

[0029] Note that one of the following cases can be assumed if counting number Y is 0 during first predetermined time period T1.

(1) Rotary drum 3 is empty.

(2) Only dried clothes exist in rotary drum 3.

(3) Quantity of clothes in rotary drum 3 is small, and thus wet clothes do not make contact with dryness detector 9.

[0030] Therefore, controller 11 reduces the rotation speed of rotary drum 3 to second rotation speed r2 to detect resistance values of clothes by dryness detector 9 in second predetermined time period T2. If dryness detector 9 detects a resistance value smaller than the predetermined value, it can be assumed that the quantity is small, although rotary drum 3 is loaded with wet clothes.

[0031] If a detected resistance value is smaller than the predetermined value, controller 11 preferably uses temperature setting unit 20 to reduce the temperature of drying air from first temperature th1 (e.g., 70 °C) to second temperature th2 (e.g., 50 °C) in the operation. This control enables controller 11 to accurately detect dryness in case that the quantity of clothes to be dried is small, and thus the clothes can be dried with less power consumption during the drying operation. More specifically, for example, the rotation speed of compressor 13 may be reduced from first rotation speed R1 (e.g., 60 r/s) to second rotation speed R2 (e.g., 30 r/s) to decrease output power in the operation.

[0032] The predetermined value used for determining a resistance value detected in first predetermined time period T1 and the predetermined value used for determining a resistance value detected in second predetermined time period T2 may be either same or different.

[0033] If heat pump device 12 is employed, and radiator 14 is used as a heating unit, as in this exemplary embodiment, the temperature of drying air can be dropped by reducing the rotation speed of compressor 13 to reduce the output power. Alternatively, if a heater is used as the heating unit, the power of heater may be reduced. In addition, if the heater is used, circulating air passage 18 is not necessary. In other words, the control in this exemplary embodiment is applicable to the conventional clothes dryer described with reference to Fig. 10.

[0034] In the control by controller 11, second predetermined time period T2 for detecting resistance values of clothes is preferably set longer than first predetermined time period T1. This setting increases chances of clothes tumbled and dropped in rotary drum 3 making contact with dryness detector 9. Accordingly, dryness of a small quantity of clothes can be accurately detected.

(SECOND EXEMPLARY EMBODIMENT)

[0035] Fig. 7 is a timing chart illustrating the operation of a clothes dryer in the second exemplary embodiment of the present invention. A basic structure and a part of control of the clothes dryer in this exemplary embodiment are the same as those of the first exemplary embodiment. More specifically, controller 11 detects resistance values of clothes, using dryness detector 9, during first predetermined time period T1 (e.g., 1 minute) from the start of drying operation. If dryness detector 9 does not detect a resistance value smaller than a predetermined value in this period, controller 11 reduces the rotation speed of rotary drum 3 to predetermined rotation speed r2. In other words, if counting number Y of dryness detector 9 in first predetermined time period T1 is 0, controller 11 reduces the rotation speed of rotary drum 3 to predetermined rotation speed r2.

[0036] In the clothes dryer in this exemplary embodiment, controller 11 then detects resistance values of the clothes in second predetermined time period T2, using dryness detector 9. If resistance values of the clothes smaller than a predetermined value are not detected, controller 11 stops the operation of heat pump device 12. In other words, if counting number Y of dryness detector 9 is 0 in second predetermined time period T2, controller 11 stops the operation of heat pump device 12.

[0037] More specifically, if counting number Y of dryness detector 9 in second predetermined time period T2 is 0, controller 11 detects that the clothes are dry or rotary drum 3 is empty. Therefore, controller 11 stops heat pump device 12 when second predetermined time period T2 elapses, and also stops the operation of rotary drum 3 and blower fan 6 to complete the drying operation.

[0038] With the above structure, end of drying can be accurately detected when a quantity of clothes to be dried is small. This prevents damage to fabric of clothes due to excessive drying, and also eliminates wasteful power consumption. Or, idle running of the drying operation can be prevented.

[0039] The predetermined value used for determining a resistance value detected in first predetermined time period T1 and the predetermined value used for determining a resistance value detected in second predetermined time period T2 may be either same or different also in this embodiment.

(THIRD EXEMPLARY EMBODIMENT)

[0040] Fig. 8 is a sectional view of a key part of a clothes dryer in the third exemplary embodiment of the present invention. Control of the clothes dryer in this exemplary embodiment is the same as that in the first or second exemplary embodiment. The clothes dryer in this exemplary embodiment is characterized in that dryness detector 9 is disposed near and underneath an opening provided at the front of rotary drum 3, and drying air is supplied from inlet 8 provided at the back of rotary drum 3 toward dryness detector 9.

[0041] Rotating shaft 3A of rotary drum 3 tilts upward to the front, and rotary drum 3 is rotatably accommodated in housing 1. A tilt angle of rotating shaft 3A is set to about 20 to 30 degrees. Inlet 8 is provided at the back of rotary drum 3, and outlet 21 is provided underneath opening 5 at the front of rotary drum 3. The drying air discharged through outlet 21 circulates in circulating air passage 18 from inlet 8 to rotary drum 3. The drying air which becomes moistened and low temperature after contacting clothes in rotary drum 3 enters circulating air passage 18 through outlet 21, and reaches heat absorber 16 through lint filter 22.

[0042] The moistened drying air is cooled down and dehumidifies in heat absorber 16, and becomes dry air. Then, this dry air is heated in radiator 14, and becomes hot air, which is supplied to rotary drum 3 through inlet 8. The hot air is blown toward dryness detector 9 disposed near and underneath opening 5. Other structures are the same as that in the first exemplary embodiment. Components with same effects as that in the first exemplary embodiment are given the same reference marks to omit duplicate detailed description.

[0043] By tilting rotary drum 3 upward to the front, the user can easily take out clothes at the bottom of rotary drum 3 from opening 5, improving usability. However, clothes tumbled inside rotary drum 3 drop disproportionately at the back. This makes clothes difficult to make contact with dryness detector 9 provided underneath opening 5 at the front. In other words, accurate detection of dryness of a small quantity of clothes and better usability by facilitating take-out of clothes contradict each other.

[0044] With the above structure, the drying air supplied from blower fan 6 can push the clothes tumbled in rotary drum 3 to the front where dryness detector 9 is provided. The dropped clothes thus reliably contact dryness detector 9. Accordingly, the clothes tumbled in the state retained by baffles 7 of rotary drum 3 from underneath can be dropped from a predetermined position lifted up by baffles 7 without being disproportionately concentrated at the back. Resistance values of the clothes making contact with dryness detector 9 can thus be detected. As a result, the clothes can be easily taken out, and also the clothes can be optimally dried in just proportion by accurately detecting dryness if a small quantity of clothes is dried.

[0045] Furthermore, dryness detector 9 is provided near outlet 21 where the drying air is discharged from rotary drum 3. Since inlet 8 is provided at the back of rotary drum 3, air is blown through inlet 8 toward dryness detector 9. As a result, the drying air flows toward dryness detector 9 while the clothes tumbled in rotary drum 3 are satisfactorily exposed to the drying air.

(FOURTH EXEMPLARY EMBODIMENT)

[0046] Fig. 9 is a timing chart illustrating the operation of a clothes dryer in the fourth exemplary embodiment of the present invention. A basic structure and a part of control of the clothes dryer in this exemplary embodiment are the same as that in the third exemplary embodiment. More specifically, controller 11 detects resistance values of clothes during first predetermined time period T1 from the start of drying operation. If a resistance value smaller than a predetermined value is not detected, controller 11 reduces the rotation speed of rotary drum 3 to predetermined rotation speed r2, and dryness detector 9 detects resistance values of clothes during second predetermined time period T2.

[0047] The clothes dryer in this exemplary embodiment is characterized in that a volume of drying air supplied through inlet 8 to dryness detector 9 is intermittently increased. In other words, after reducing the rotation speed of rotary drum 3 to predetermined rotation speed r2, as described above, controller 11 controls an air-feeding volume of blower fan 6 while dryness detector 9 detects resistance values of clothes during predetermined time period T2. More specifically, as shown in Fig. 9, controller 11 controls blower fan 6 to intermittently (e.g., every 10 seconds) increase predetermined air volume Q2 (e.g., $3m^3$/min) to air volume Q1 (e.g., $4m^3$/min). This control of air volume continues from the start of drying operation to the end of second predetermined time period T2 in which resistance values of clothes are detected. Then, as clothes are dried, controller 11 operates blower fan 6 with predetermined air volume Q2 until time point t1 when counting number Y becomes 0.

[0048] Controller 11 calculates remaining drying time period T3 based on maximum value y2 of counting number Y by time point t1, and time point t1 when Y becomes 0. When drying time period T3 passes and the operation reaches time point t2, the operations of rotary drum 3 and blower fan 6 are extended to time point t3, and the drying operation completes at time point t3.

[0049] By intermittently increasing the volume of drying air supplied to dryness detector 9, clothes that are exposed to the drying air inside rotary drum 3 can be distributed in a balanced manner, in addition to the effects of the first and the third exemplary embodiments. Therefore, drying by air can be encouraged, and clothes satisfactorily contact dryness detector 9.

[0050] In the above description, air volume from blower fan 6 is intermittently increased from the start of drying operation to the end of second predetermined time period T2. However, air volume may be intermittently increased until time point t1 when counting number Y becomes 0 as clothes are dried. In this case, clothes can be efficiently dried, and also end of drying when counting number Y becomes 0 can be accurately detected.

[0051] This exemplary embodiment also refers to the clothes dryer equipped with the rotation axis of rotary drum 3 horizontal or tilted upward to the front. However, the exemplary embodiment is also applicable to a washer/dryer with a washing feature that allows operations from washing to drying. In this case, clothes can be easily taken out, and also water consumption during washing can be reduced.

[0052] Each exemplary embodiment can be combined as required, and also a part of each exemplary embodiment can be combined.

[0053] As described above, the clothes dryers in the exemplary embodiments of the present invention include rotary drum 3, motor 2, radiator 14 as a heating unit, blower fan 6, dryness detector 9, and controller 11. Rotary drum 3 accommodates clothes that are wet articles. Motor 2 rotates rotary drum 3. The heating unit heats the drying air. Blower fan 6 supplies the drying air heated by the heating unit to inside rotary drum 3. Dryness detector 9 detects resistance values of the wet articles in rotary drum 3. Controller 11 controls motor 2 based on an output of dryness detector 9. More specifically, if dryness detector 9 detects only resistance values greater than a predetermined value in first predetermined time period

T1 from the start of drying operation by rotating rotary drum 3 at first rotation speed r1, controller 11 reduces the rotation speed of rotary drum 3 to second rotation speed r2 that is slower than first rotation speed r1.

[0054] A small quantity of clothes is tumbled in a state retained by baffles 7 from underneath due to a centrifugal force of rotary drum 3. This structure enables dropping of the clothes lifted up by baffles 7 toward the bottom of rotary drum 3. Accordingly, dryness detector 9 can detect resistance values of the clothes by contacting the clothes. In case of drying a small quantity of clothes, dryness can thus be accurately detected, and clothes can be optimally dried in just proportion.

[0055] Still more, it is preferable to provide temperature detector 19 for measuring temperature of drying air, and temperature setting unit 20 for controlling the temperature of drying air based on an output of temperature detector 19. Controller 11 preferably controls the heating unit to reduce the temperature of drying air, using temperature setting unit 20, if resistance values detected by dryness detector 9 in second predetermined time period T2 are smaller than a predetermined value after controller 11 reduces the rotation speed of rotary drum 3 to second rotation speed r2. These structure and control enable accurate detection of dryness in case of drying a small quantity of clothes and clothes can be dried with less power consumption in the drying operation.

[0056] In other words, heat pump device 12 including radiator 14 as the heating unit is provided and output power of compressor 13 is reduced if resistance values detected by dryness detector 9 in second predetermined time period T2 are smaller than the predetermined value.

[0057] Moreover, if dryness detector 9 detects only resistance values greater than the predetermined value in second predetermined time period T2, heat pump device 12 is stopped to prevent damage to fabric of clothes due to excessive drying.

[0058] Furthermore, second predetermined time period T2 is preferably longer than first predetermined time period T1. This setting increases chances of clothes tumbled and dropped in rotary drum 3 making contact with dryness detector 9. This results in increasing dryness detection accuracy for a small quantity of clothes.

[0059] As described above, the clothes dryer of the present invention accurately detects dryness of a small quantity of clothes, and optimally dries the clothes. Accordingly the present invention is effectively applicable to clothes dryers.

Claims

1. A clothes dryer comprising:

a rotary drum for accommodating a wet article;
a motor for rotating the rotary drum;
a heating unit for heating drying air;
a blower fan for supplying the drying air heated by the heating unit to inside the rotary drum;
a dryness detector for detecting a resistance value of the wet article in the rotary drum; and
a controller for controlling the motor based on an output of the dryness detector;
wherein the controller starts rotating the rotary drum at a first rotation speed, and reduces a rotation speed of the rotary drum to a second rotation speed slower than the first rotation speed if the dryness detector only detects a resistance value greater than a predetermined value during a first predetermined time period from a start of drying operation.

2. The clothes dryer according to claim 1, further comprising:

a temperature detector for measuring a temperature of the drying air; and
a temperature setting unit for controlling the temperature of the drying air based on an output of the temperature detector;
wherein the dryness detector detects a resistance value of the wet article in a second predetermined time after reducing the rotation speed of the rotary drum to the second rotation speed; and
the controller controls the heating unit to reduce the temperature of the drying air, using the temperature setting unit, if the resistance value detected by the dryness detector is smaller than a predetermined value.

3. The clothes dryer according to claim 1, further comprising a heat pump device, the heat pump device comprising:

a compressor for compressing refrigerant;
a radiator for releasing heat of the compressed refrigerant;
a pressure reducer for reducing pressure of the refrigerant at high pressure;
a heat absorber for removing heat around the refrigerant whose pressure is reduced to low pressure; and
a pipeline connecting the compressor, the radiator, the pressure reducer, and the heat absorber in this sequence to circulate the refrigerant;
wherein the radiator serves as the heating unit;
the dryness detector detects a resistance value of the wet article during a second predetermined time period after the rotation speed of the rotary drum is reduced to the second rotation speed; and
the controller reduces an output of the compressor if the resistance value detected by the dryness detector is smaller than a predetermined value.

4. The clothes dryer according to claim 1, further comprising a heat pump device, the heat pump device comprising:

a compressor for compressing refrigerant;
a radiator for releasing heat of the compressed refrigerant;
a pressure reducer for reducing pressure of the refrigerant at high pressure;
a heat absorber for removing heat around the refrigerant whose pressure is reduced to low pressure; and
a pipeline connecting the compressor, the radiator, the pressure reducer, and the heat absorber in this sequence to circulate the refrigerant;
wherein the radiator serves as the heating unit; and
the controller stops the heat pump device if the dryness detector detects only a resistance value greater than the predetermined value in a second predetermined time period after reducing the rotation speed of the rotary drum to the second rotation speed.

5. The clothes dryer according to any one of claims 3 and 4, further comprising:

a circulating air passage communicated with the rotary drum, the drying air being passed through the circulating air passage;
wherein the radiator is provided in the circulating air passage, the heat absorber is provided in the circulating air passage upstream the radiator in a flow direction of the drying air, and the heat absorber dehumidifies the drying air.

6. The clothes dryer according to any one of claims 2 to 5, wherein the second predetermined time period is longer than the first predetermined time period.

FIG. 1

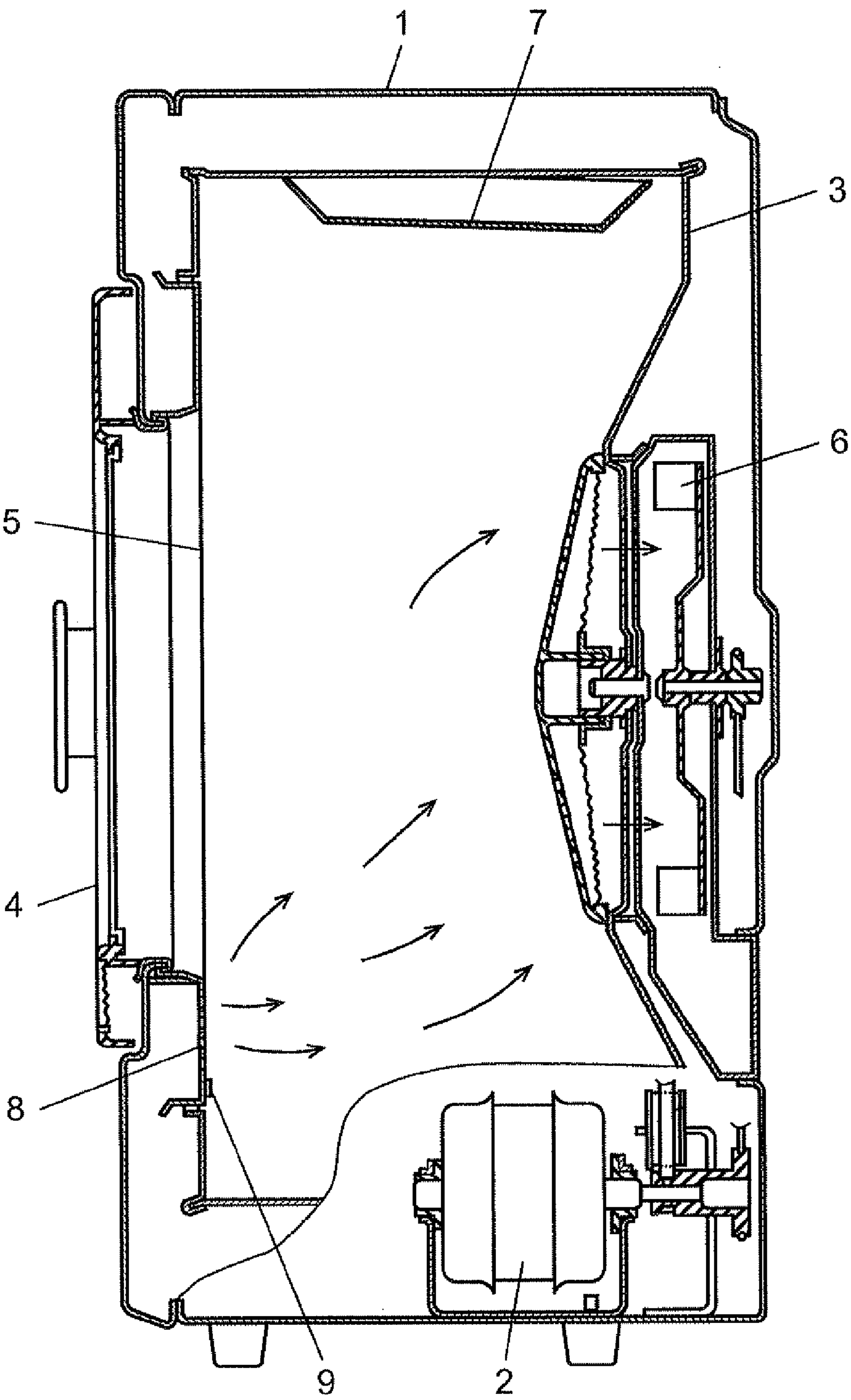


FIG. 2

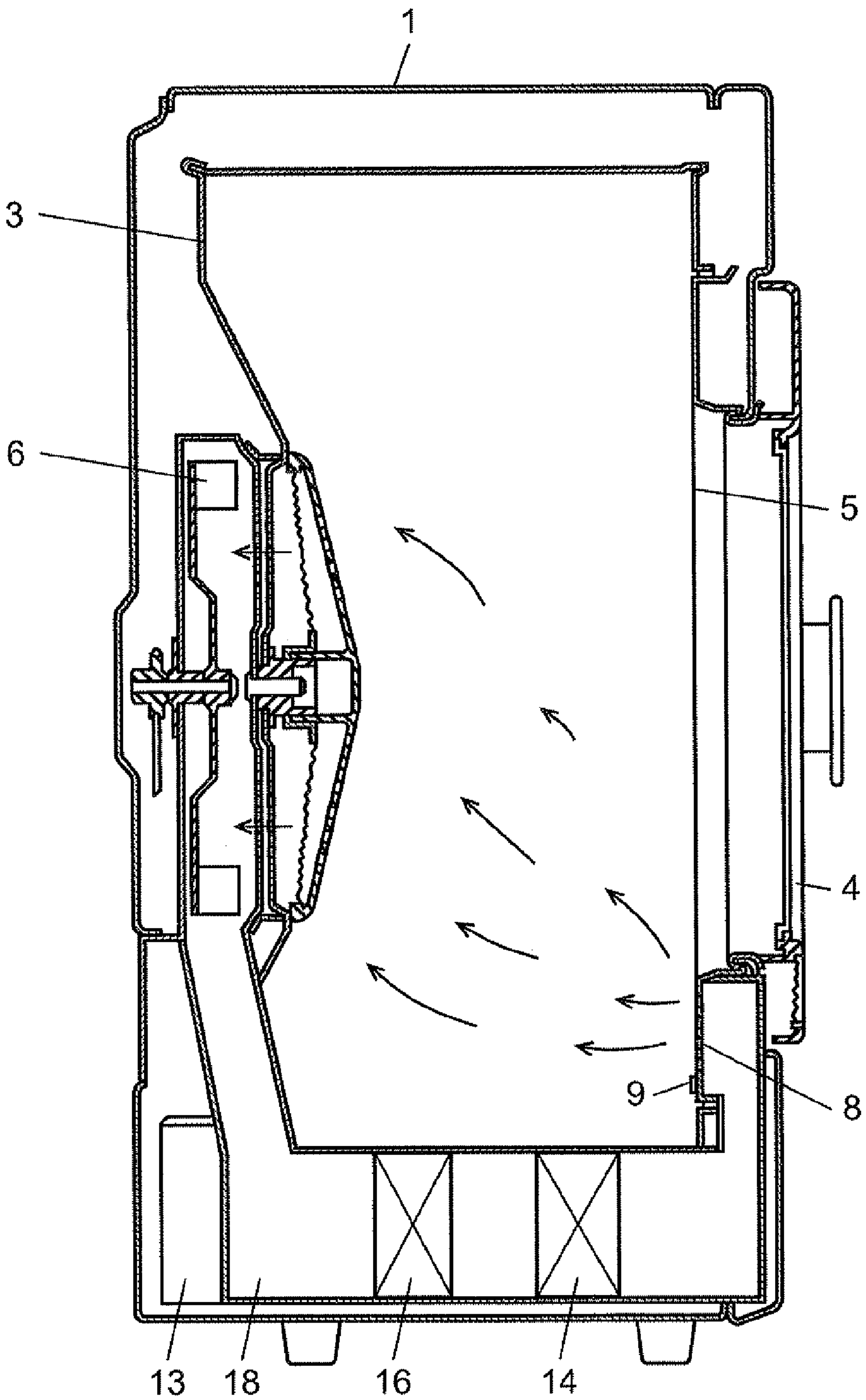


FIG. 3

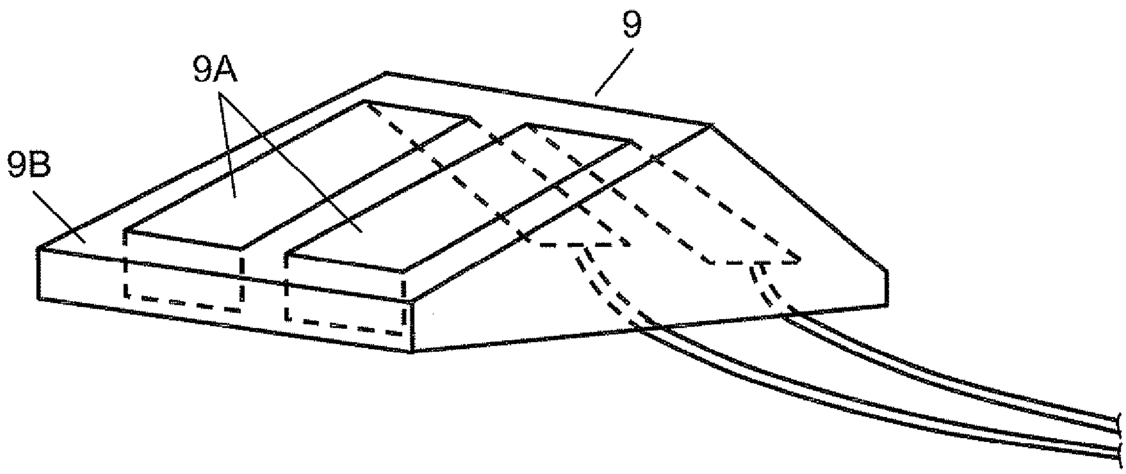


FIG. 4

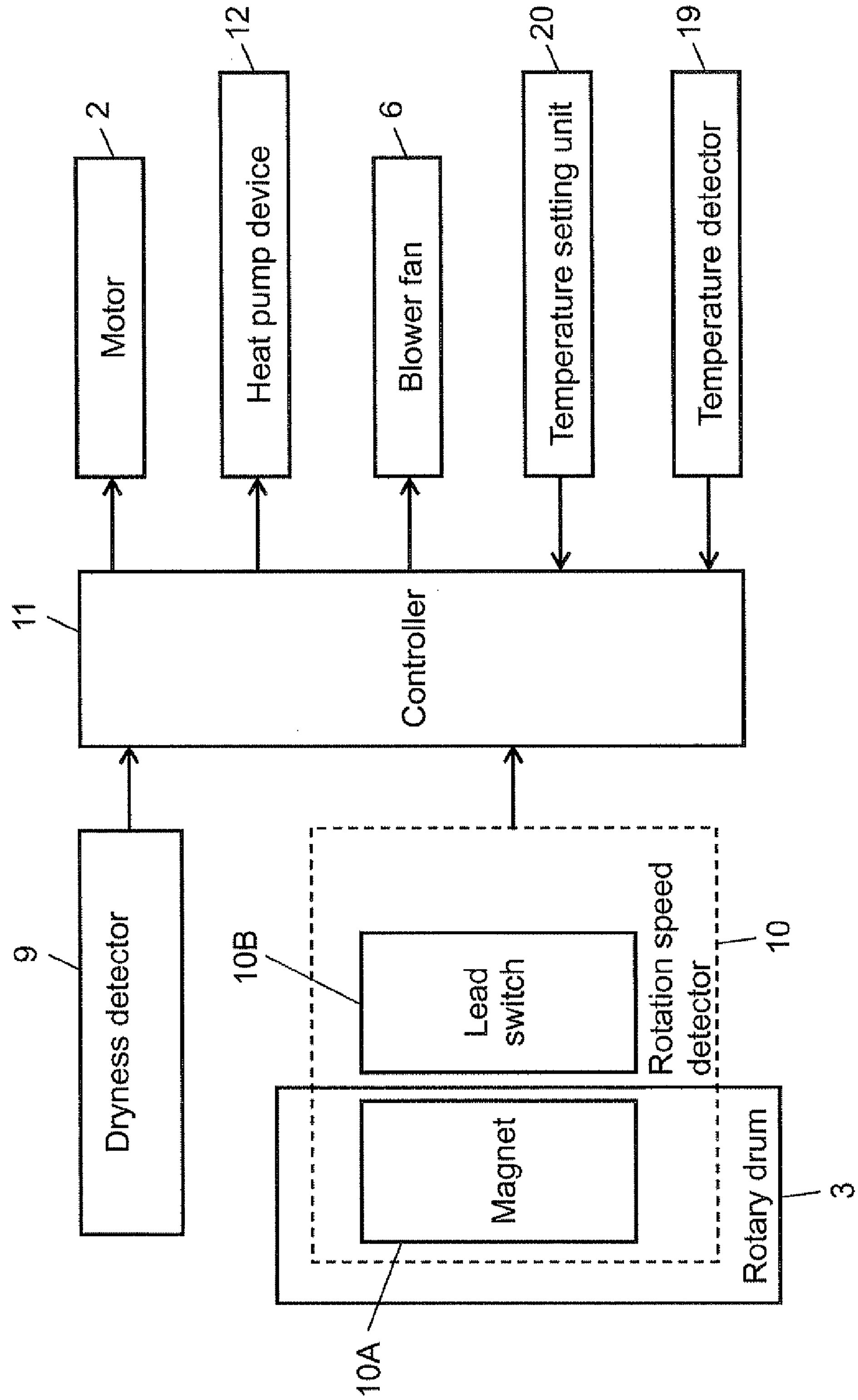

Motor
2
Heat pump device
12
Blower fan
6
Temperature setting unit
20
Temperature detector
19
Controller
11
Dryness detector
9
Lead switch
10B
Rotation speed detector
10
Magnet
10A
Rotary drum
3

FIG. 5

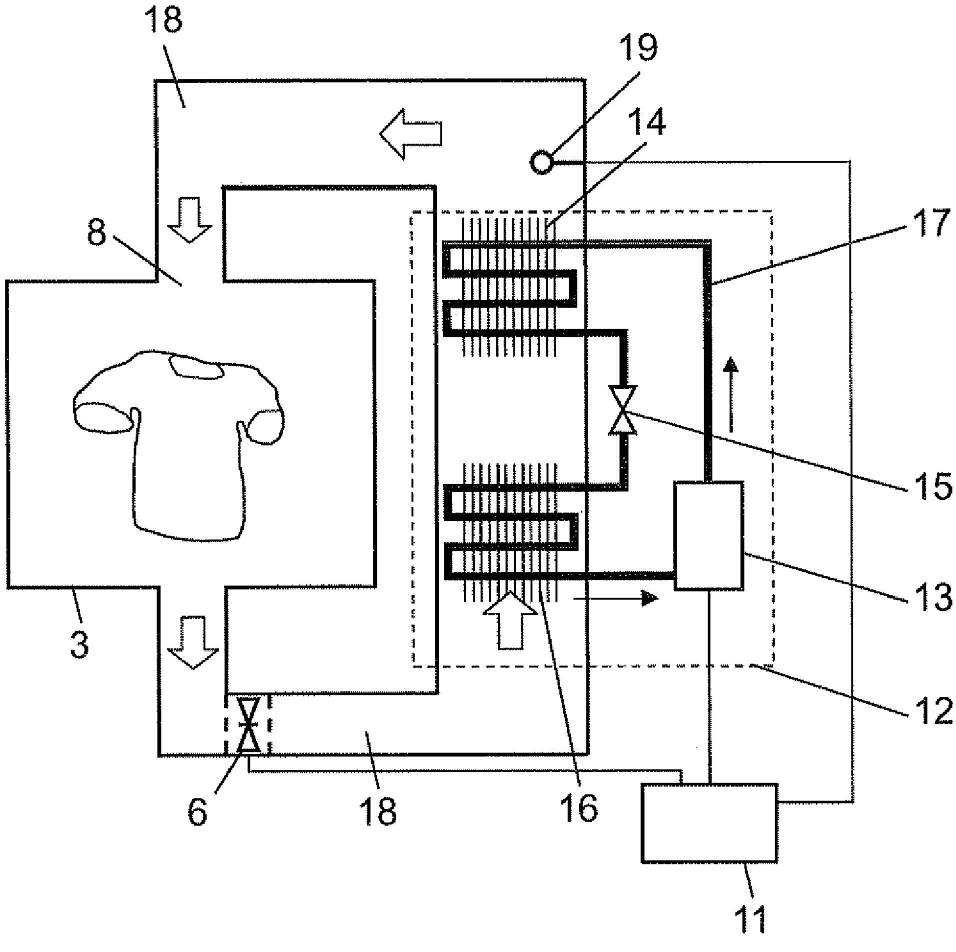


FIG. 6

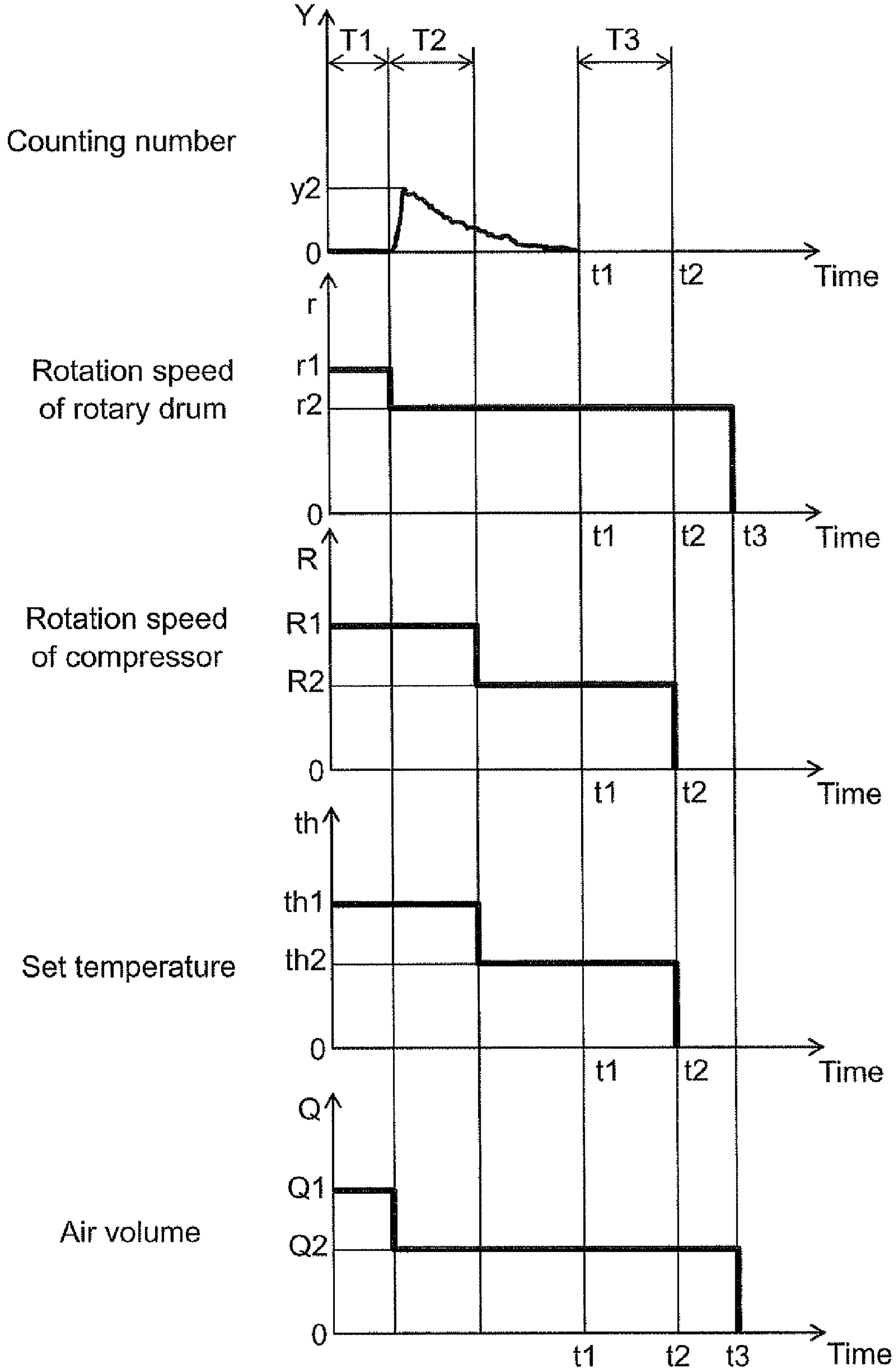

Y
T1
T2
T3
Counting number
y2
0
t1
t2
Time
r
Rotation speed of rotary drum
r1
r2
0
t1
t2
t3
Time
R
Rotation speed of compressor
R1
R2
0
t1
t2
Time
th
Set temperature
th1
th2
0
t1
t2
Time
Q
Air volume
Q1
Q2
0
t1
t2
t3
Time

FIG. 7

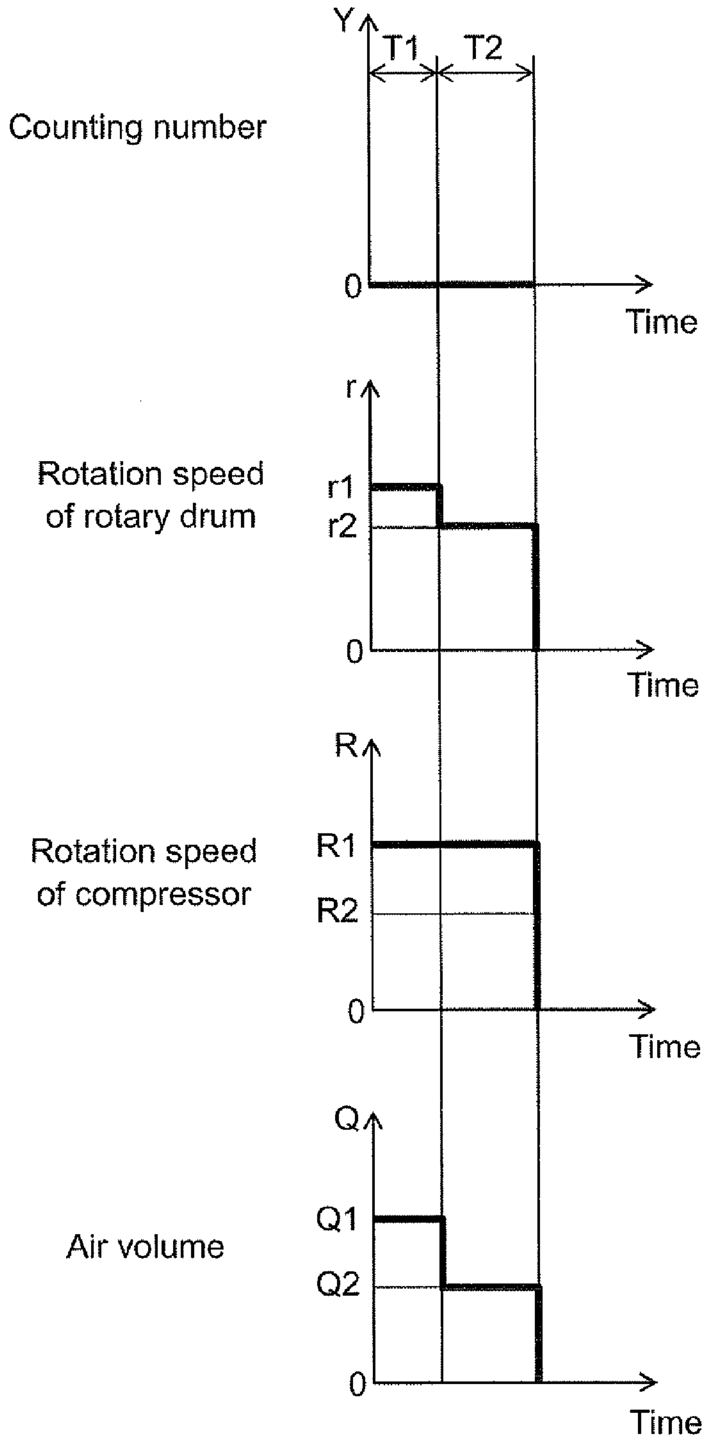

Y
T1
T2
Counting number
0
Time
r
Rotation speed
of rotary drum
r1
r2
0
Time
R
Rotation speed
of compressor
R1
R2
0
Time
Q
Air volume
Q1
Q2
0
Time

FIG. 8

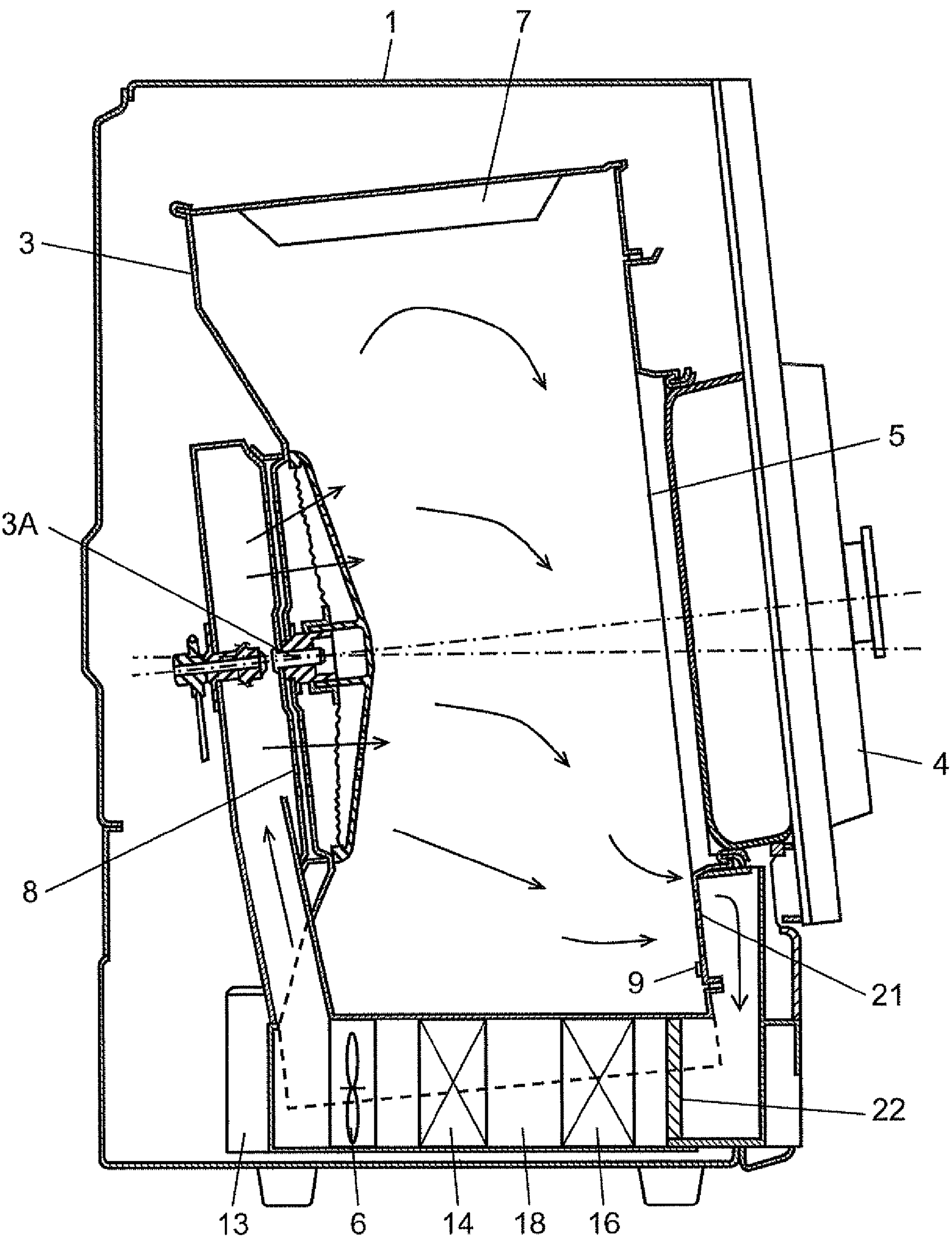


FIG. 9

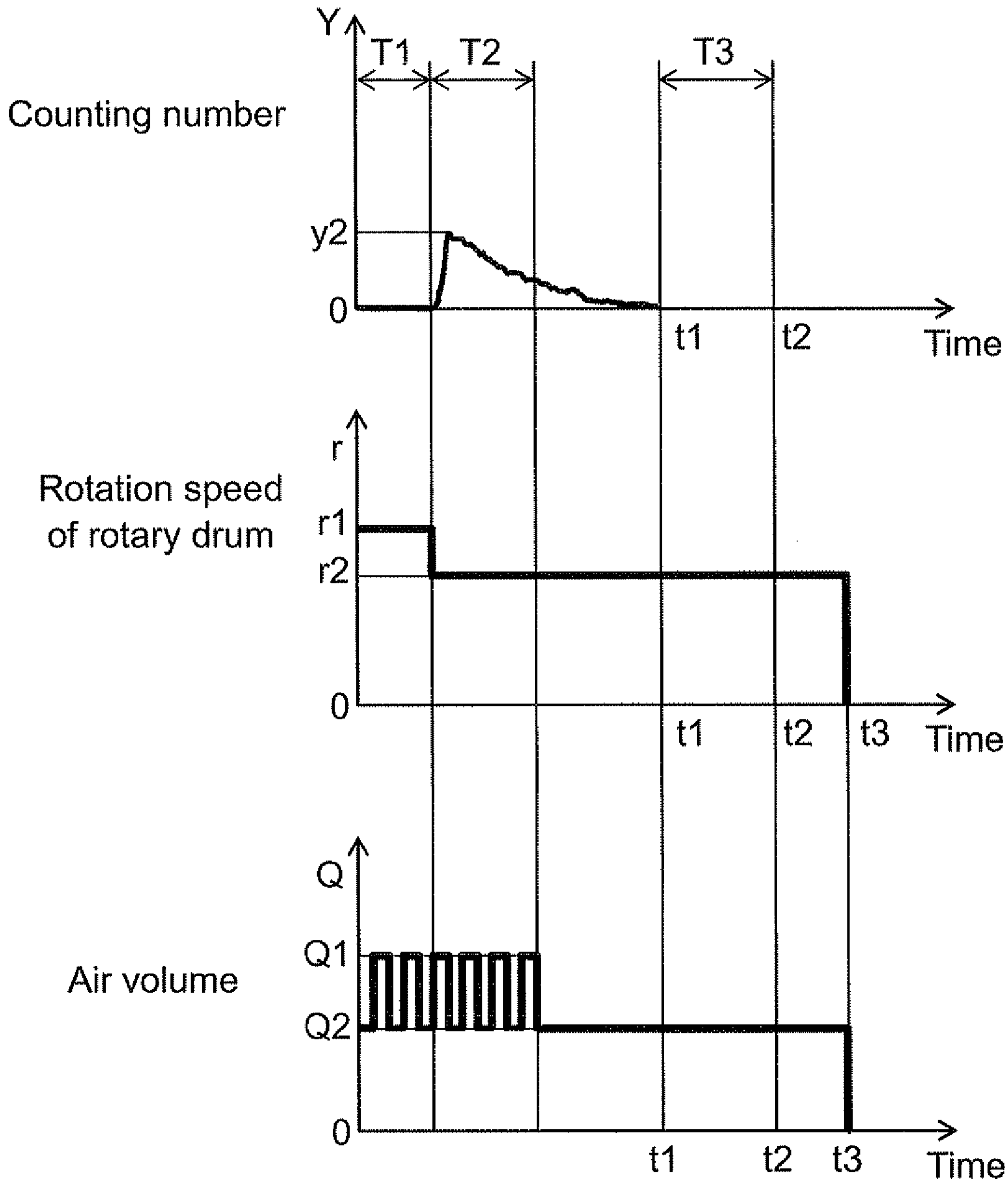
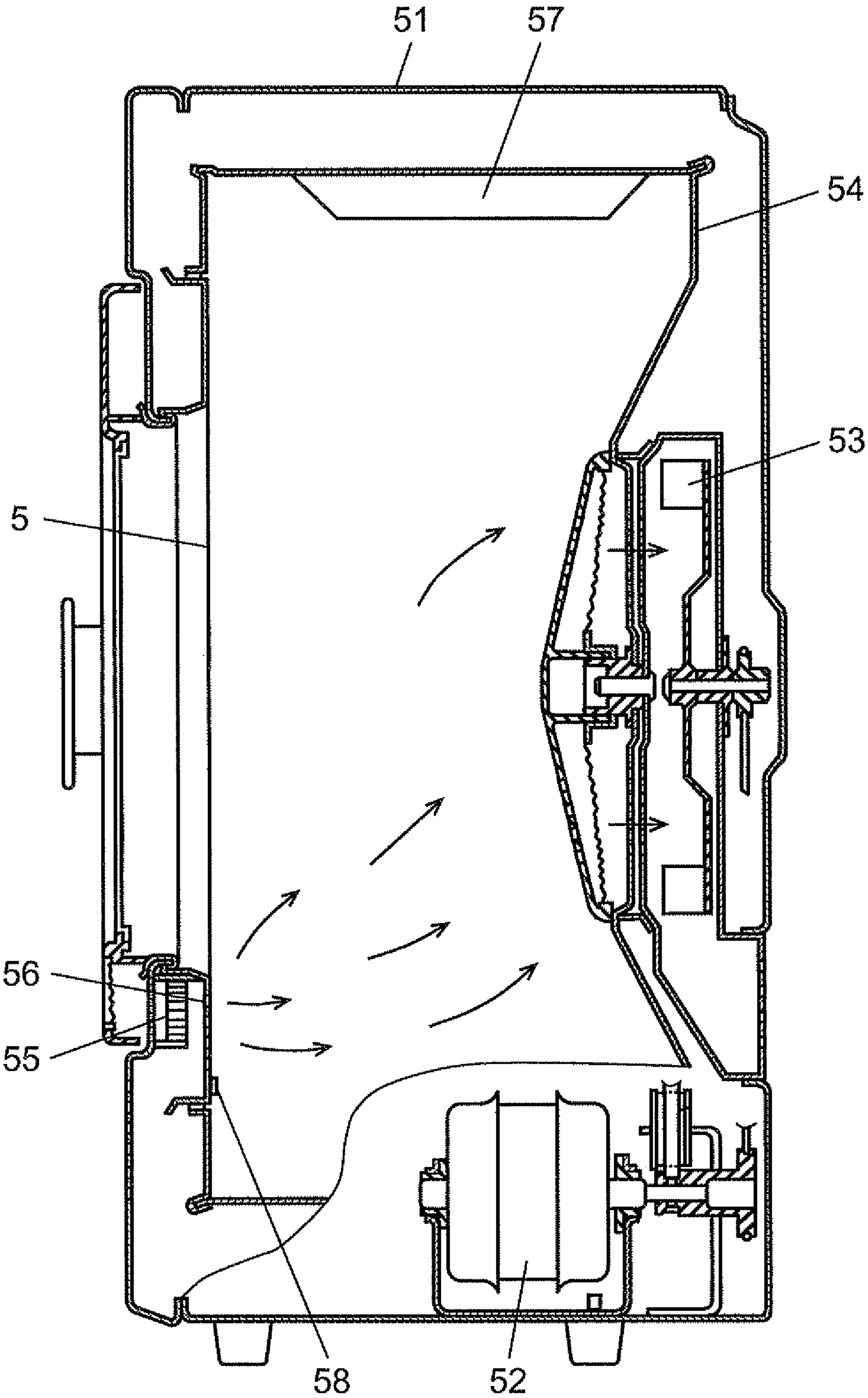

Counting number
Y
T1
T2
T3
y2
0
t1
t2
Time
Rotation speed of rotary drum
r
r1
r2
0
t1
t2
t3
Time
Air volume
Q
Q1
Q2
0
t1
t2
t3
Time

FIG. 10



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 18 9023

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2007/256321 A1 (BAE SUN C [KR] ET AL BAE SUN CHEOL [KR] ET AL) 8 November 2007 (2007-11-08)	1	INV. D06F58/28
A	* paragraphs [0016] - [0026] * * paragraphs [0056] - [0074] * * claims 1-11; figures 1-7 * -----	2-6	
A	WO 2008/077969 A1 (ARCELIK AS [TR]; OZKAHRAMAN HAKAN [TR]; OGUZ HASAN TAHSIN [TR]) 3 July 2008 (2008-07-03) * paragraphs [0012] - [0019] * * figures 1-3 * -----	1-6	
A,D	JP 2000 229200 A (TOSHIBA CORP) 22 August 2000 (2000-08-22) * abstract; figure 4 * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	14 April 2011	Weinberg, Ekkehard

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 18 9023

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-04-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007256321 A1	08-11-2007	DE 102006053379 A1	06-06-2007
WO 2008077969 A1	03-07-2008	EP 2126188 A1	02-12-2009
JP 2000229200 A	22-08-2000	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP H6327899 B **[0002]**
- JP 2000229200 A **[0005]**