



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**04.04.2012 Bulletin 2012/14**

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

(21) Application number: **11178702.4**

(22) Date of filing: **24.08.2011**

(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: **07.09.2010 JP 2010199613**

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

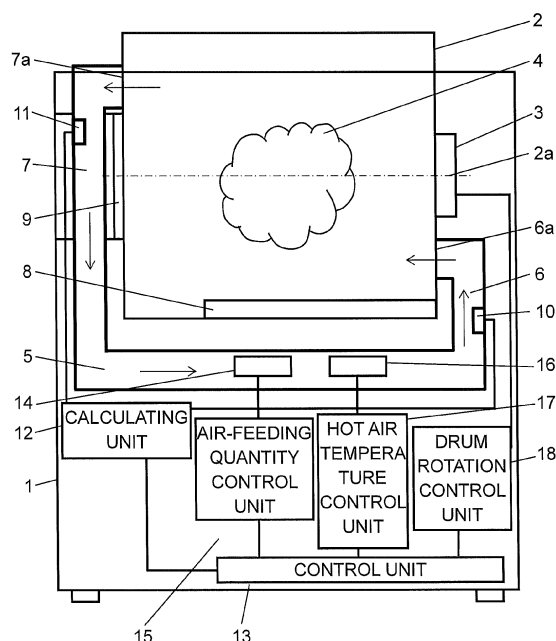
(72) Inventors:  
• **Miura, Yuta**  
**Osaka, 540-6207 (JP)**  
• **Matsuda, Shinichi**  
**Osaka, 540-6207 (JP)**  
• **Hashimoto, Kazuhiko**  
**Osaka, 540-6207 (JP)**  
• **Komatsu, Takashi**  
**Osaka, 540-6207 (JP)**

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

(54) **Clothes dryer**

(57) A clothes dryer (1) of the present invention, which has a rotary drum (2), a motor (3), an air-feeding unit, a heating unit, an air supply passage, and an air discharge passage, is further provided with an air circulation path that circulates a drying air inside the rotary drum, a first humidity sensor (10) for detecting humidity in the drying air that passes through the air supply passage, a second humidity sensor (11) for detecting humidity in the drying air that passes through the air discharge passage, a calculating unit for calculating a change in humidity based on signals from the first humidity sensor and the second humidity sensor, and a control unit (13) for controlling a drying operation. The control unit controls an air-feeding quantity and a temperature of the drying air according to a result of the calculation carried out in the calculating unit.

FIG. 1



## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to a clothes dryer for drying clothes and the like in a rotary drum.

#### 2. Description of the Related Art

**[0002]** In recent years, there have been strong demands for a clothes dryer having superior energy-saving performances, which detects a drying efficiency of clothes in a rotary drum during a drying operation with high precision, and carries out an optimal drying operation.

**[0003]** For example, Unexamined Japanese Patent Publication No. H09-285696 (Patent Document 1) has disclosed a clothes dryer that is provided with functions for detecting a drying efficiency of articles to be dried such as clothes and the like, and for completing a drying step.

**[0004]** Referring to Fig. 4, the following description will discuss the clothes dryer disclosed in the Patent Document 1.

**[0005]** Fig. 4 is a system block diagram showing a conventional clothes dryer.

**[0006]** As shown in Fig. 4, main body 51 of the conventional clothes dryer is provided with, at least, rotary drum 52, heat-exchange type fan 53, heater 54, circulation ducts 55, 56 and 57, calculating unit 58, and humidity sensor 59. Rotary drum 52, heat-exchange type fan 53 and heater 54 are connected to a circulation dehumidifying-type clothes dryer through circulation ducts 55, 56 and 57 so as to form air circulation paths thereof. By rotating heat-exchange type fan 53, air is circulated through circulation ducts 55, 56 and 57 and the inside of rotary drum 52.

**[0007]** Referring to Fig. 4, the following description will discuss controlling operations of a control unit of the conventional clothes dryer having the above-mentioned structure with reference to Fig. 5.

**[0008]** Fig. 5 is a flow chart describing a control method of the control unit in the conventional clothes dryer.

**[0009]** As shown in Fig. 5, after the start of a drying operation, calculating unit 58 first compares a relative humidity level detected by humidity sensor 59 with a first specified value (step S101). When the relative humidity level is less than the first specified value (Yes in step S101), the drying step is completed (step S102), and an air-feeding step is started (step S103). In contrast, the relative humidity level is the first specified value or more (No in step S101), a determination is made as to whether or not any interruption is present (step S106). When any interruption is present (Yes in step S106), the process returns to a main routine, and when no interruption is present (No in step S106), the process returns to step

S101 so that the relative humidity level is compared with the first specified value.

**[0010]** Next, after the start of the air-feeding step, a relative humidity level detected by humidity sensor 59 is compared with a second specified value (step S104). When the relative humidity level is less than the second specified value (Yes in step S104), a determination is made as to whether or not any interruption is present (step S105). In the case where any interruption is present (Yes in step S105), the process returns to the main routine, and when no interruption is present (No in step S105), the process returns to step S104 so that the relative humidity level is compared with the second specified value. On the other hand, in the case where the relative humidity level is the second specified value or more (No in step S104), the interruption determination is carried out (step S106). In the case where any interruption is present (Yes in step S106), the process returns to the main routine, and when no interruption is present (No in step S106), the process returns to step S101 so that the relative humidity level is compared with the first specified value.

**[0011]** In other words, in the air-feeding step after the completion of the drying step, humidity of air discharged from rotary drum 52 is again detected so that the dried state is detected. Thus, when there are any irregularities in the dried state of articles to be dried, the drying step is again carried out so as to reduce the occurrence of irregularities in the dried state.

**[0012]** In the conventional clothes dryer, however, power supply to heater 54 is stopped after the completion of the drying step. Then, in the case where there are any irregularities in the dried state of articles to be dried in the air-feeding step, the process again returns to the drying step to again start the power supply to heater 54. Consequently, the frequency to supply power to heater 54 becomes high, thereby increasing energy consumption.

#### SUMMARY OF THE INVENTION

**[0013]** The clothes dryer of the present invention is provided with: a rotary drum for housing clothes; a motor for driving the rotary drum; an air-feeding unit for feeding drying air into the rotary drum; a heating unit for heating the drying air; an air circulation path having an air supply passage and an air discharge passage for circulating the drying air inside the rotary drum, and; a first humidity sensor for detecting humidity in the drying air that passes through the air supply passage; a second humidity sensor for detecting humidity in the drying air that passes through the air discharge passage; a calculating unit for calculating a change in humidity based on signals from the first humidity sensor and the second humidity sensor; and a control unit for controlling a drying operation, wherein the control unit controls an air-feeding quantity and a temperature of the drying air according to a result of the calculation carried out in the calculating unit. With

this structure, it becomes possible to carry out an optimal drying operation without any irregularities in the dried state of clothes, which is superior in energy-saving performances.

## BRIEF DESCRIPTION OF DRAWINGS

### [0014]

Fig. 1 shows a system block diagram showing a clothes dryer according to a first exemplary embodiment of the present invention;

Fig. 2 shows a schematic diagram showing a relationship between the relative humidity and drying efficiency of clothes relative to operation time of the clothes dryer;

Fig. 3 shows a schematic diagram showing a relationship between the drying efficiency of clothes relative to operation time of the clothes dryer and output setting values of air-feeding quantity and temperature of drying air;

Fig. 4 shows a system block diagram showing a conventional clothes dryer; and

Fig. 5 shows a flow chart describing a control method of a control unit of the clothes dryer.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] The following description will discuss exemplary embodiments of the present invention with reference to the drawings. The present invention is not intended to be limited by these exemplary embodiments.

### FIRST EXEMPLARY EMBODIMENT

[0016] Fig. 1 is a system block diagram showing a clothes dryer according to a first exemplary embodiment of the present invention. As shown in Fig. 1, main body 1 of the clothes dryer of the present exemplary embodiment is provided with at least rotary drum 2, motor 3, air circulation path 5 having air supply passage 6 and air discharge passage 7, first humidity sensor 10, second humidity sensor 11, calculating unit 12, and control unit 13.

[0017] Rotary drum 2 shaped a substantially cylinder having a bottom (including a cylinder having a bottom), is installed in main body 1 of the clothes dryer so as to rotate therein. By motor 3 attached to the rear surface side of rotary drum 2, rotary drum 2 is driven to rotate around rotation axis 2a that is disposed in a substantially horizontal direction (including a horizontal direction). Motor 3 is prepared as, for example, a brushless DC motor whose rotation speed can be freely changed by inverter control, such as PCM (Pulse Code Modulation) and PWM (Pulse Width Modulation).

[0018] Opening 9 is formed on the front side of rotary drum 2, that is, on the side opposite to motor 3, and by

opening a freely openable/closeable door (not shown), clothes 4 and the like can be put in or taken out of rotary drum 2. On the inner circumferential side face of rotary drum 2, for example, a plurality of baffles 8 for stirring clothes 4 and the like are formed. Thus, clothes 4 and the like housed inside rotary drum 2 are lifted by baffles 8 formed in rotary drum 2, and stirred inside rotary drum 2 by the rotation of rotary drum 2.

[0019] Air circulation path 5 for circulating a drying air inside rotary drum 2, is allowed to communicate with rotary drum 2 through air supply port 6a and air discharge port 7a formed in rotary drum 2. At this time, air supply port 6a communicates with air supply passage 6 formed on the upstream side of air circulation path 5, and discharge port 7a communicates with air discharge passage 7 formed on the downstream side of air circulation path 5.

[0020] Moreover, first humidity sensor 10 that detects humidity in a drying air that passes through air supply passage 6 and second humidity sensor 11 that detects humidity in a drying air that passes through air discharge passage 7 are installed in air circulation path 5. At this time, first humidity sensor 10 and second humidity sensor 11 are connected to calculating unit 12, and calculating unit 12 is connected to control unit 13. That is, first humidity sensor 10 and second humidity sensor 11 respectively detect the relative humidity in drying steps of air supply passage 6 and air discharge passage 7, and output the detection results to calculating unit 12. Thereafter, the results of calculations carried out in calculating unit 12 are outputted to control unit 13. According to the inputted calculation results, control unit 13 controls at least one of air-feeding quantity control unit 15, hot-air temperature control unit 17, and drum rotation control unit 18 so that a drying operation is carried out.

[0021] Air-feeding quantity control unit 15 controls air-feeding unit 14 such as an air-feeding fan, installed in rotary drum 2 so that the air-feeding quantity of drying air to be fed into rotary drum 2 is controlled.

[0022] Moreover, hot-air temperature control unit 17 controls heating unit 16 such as a heater, installed on the downstream side of air-feeding unit 14, so that the temperature of drying air to be fed into rotary drum 2 is controlled.

[0023] Drum rotation control unit 18 controls motor 3 so as to change the rotation speed of rotary drum 2, switch forward/reversed rotation directions, and control operation time, etc.

[0024] The following description will discuss operations and functions of the clothes dryer having the above-mentioned structure.

[0025] First, upon starting a drying operation, rotary drum 2 rotates at a predetermined rotation speed with motor 3 being controlled by drum rotation control unit 18 of control unit 13. Then, by power-controlling heating unit 16 that is controlled by control unit 13 through hot-air temperature control unit 17, air is heated to a predetermined temperature, and used for drying air. The drying air is directed into rotary drum 2 by air-feeding unit 14

that is controlled by control unit 3 through air-feeding quantity control unit 15.

**[0026]** Clothes 4 that are loaded into rotary drum 2 are lifted upward by baffles 8 when rotary drum 2 is rotated, and stirred. Thus, clothes 4 and the drying air are made in contact with each other so that moisture of clothes 4 is removed so as to be dried.

**[0027]** Referring to Figs. 2 and 3, the following description will discuss a specific control method for a clothes dryer.

**[0028]** Fig. 2 is a schematic diagram showing a relationship between the relative humidity and a drying efficiency of clothes relative to operation time of a clothes dryer of the first exemplary embodiment. In other words, Fig. 2 shows relationships among relative humidity RH1 (20) of air supply passage 6 detected by first humidity sensor 10, relative humidity RH2 (21) of air discharge passage 7 detected by second humidity sensor 11 and a drying efficiency  $\eta$  (22) of clothes 4 inside rotary drum 2 in a drying step, relative to operation time  $t$  in the present first exemplary embodiment. Additionally, the drying efficiency refers to a value obtained by dividing a difference between detection signals inputted from first humidity sensor 10 and second humidity sensor 11 by output setting values of air-feeding quantity and temperature.

**[0029]** As shown in Fig. 2, the drying step is transferred from a preheat drying step to a constant-rate drying step and then to a reduced-rate drying step. The preheat drying step corresponds to a period from operation start time  $t = 0$  to completion time  $t_1$  of the preheat drying step. The constant drying step corresponds to a period from completion time  $t_1$  of the preheat drying step to completion time  $t_2$  of the constant drying step. The reduced-rate drying step corresponds to a period from completion time  $t_2$  of the constant drying step to completion time  $t_3$  of the drying operation. In this case, an accumulated period of time of the preheat drying step, the constant-rate drying step, and the reduced-rate drying step is determined as the drying operation time.

**[0030]** Calculating unit 12 detects relative humidity RH1 (20) and relative humidity RH2 (21) in the preheat drying step, and when relative humidity RH1 (20) has reached a predetermined value, it detects time  $t_1$  at which the preheat drying step has been completed. In this case, the predetermined value refers to a value at which the value of relative humidity RH1 (20), which has been determined by the output setting value of the air-feeding quantity of air-feeding quantity control unit 15 and the output setting value of the temperature of hot-air temperature control unit 17, becomes constant. Then, based upon detected time  $t_1$ , completion time  $t_2$  of the constant-rate drying step is set.

**[0031]** In the case where the amount of clothes is large, time  $t_1$  becomes longer since a long period of time is required until relative humidity RH1 (20) has reached the predetermined value. On the other hand, in the case where the amount of clothes is small, time  $t_1$  becomes shorter, since so much time is not required until relative

humidity RH1 (20) has become the predetermined value. For this reason, since the amount of clothes 4 can be determined based upon the length from the start of an operation to time  $t_1$ , it is possible to determine whether the period of time of the constant-rate drying step is made longer or shorter.

**[0032]** Moreover, in the case where clothes 4 are in a more moistened state, since a long period of time is required until relative humidity RH1 (20) has reached the predetermined value, time  $t_1$  becomes longer. In contrast, in the case where clothes 4 are in a more dried state, since so much time is not required until relative humidity RH1 (20) has reached the predetermined value, time  $t_1$  becomes shorter. For this reason, since the state of clothes 4 can be determined depending on the period of time from the start of the operation to time  $t_1$ , it is possible to determine whether the period of time of the constant-rate drying step is made longer or shorter. Thus, according to the amount and state of clothes 4, operation time of the constant-rate drying step can be optimized.

**[0033]** Next, calculating unit 12 detects relative humidity RH1 (20) of air supply passage 6 and relative humidity RH2 (21) of air discharge passage 7 in the constant-rate drying step, and in the case where relative humidity RH2 (21) starts becoming smaller than a predetermined value (stable value), detects time  $t_2$  at which the constant-rate drying step has been completed. The reason for this is because, since the surface of clothes 4 is moistened state up to the constant-rate drying step, hot air for drying clothes 4 evaporates moisture on the surface of clothes 4 so that, since warm air containing a fixed amount of moisture is discharged, relative humidity RH2 (21) becomes constant. In contrast, in the reduced-rate drying step, as the surface of clothes 4 is dried up, moisture to be evaporated from the surface of clothes 4 becomes smaller by hot air used for drying clothes 4; therefore, relative humidity RH2 (21) becomes smaller. For this reason, based upon completion time  $t_2$  of the constant-rate drying step, completion time  $t_3$  for the drying operation is set. In this case, the predetermined value refers to a value at which the value of relative humidity RH2 (21), which has been determined by the output setting value of the air-feeding quantity of air-feeding quantity control unit 15 and the output setting value of the temperature of hot-air temperature control unit 17, becomes constant.

**[0034]** In the case where the amount of clothes is large, since a long period of time is required until relative humidity RH2 (21) has become smaller than the predetermined value, time  $t_2$  becomes longer. In contrast, in the case where the amount of clothes is small, since so much time is not required until relative humidity RH2 (21) has become smaller than the predetermined value (stable value), time  $t_2$  becomes shorter. For this reason, depending on the period of time from time  $t_1$  to time  $t_2$ , it is possible to determine whether the period of time  $t_3$  is made longer or shorter.

**[0035]** Furthermore, in the case where clothes 4 are in a more moistened state, since more time is required

until relative humidity RH2 (21) has become smaller than the predetermined value (stable value), time t2 becomes longer. In contrast, in the case where clothes 4 are in a more dried state, since so much time is not required until it has become smaller than the predetermined value (stable value), time t2 becomes shorter. For this reason, depending on the period of time from time t1 to time t2, it is possible to determine whether the period of time t3 is made longer or shorter. Thus, since the completion time of the drying operation is set depending on the amount and state of clothes 4, it becomes possible to complete the drying operation at optimal time.

**[0036]** Fig. 3 is a schematic diagram showing a relationship between the drying efficiency of clothes relative to operation time of the clothes dryer and output setting values of the air-feeding quantity and the temperature of drying air in the present first exemplary embodiment. Fig. 3 schematically shows changes in drying efficiency  $\eta$  (22) of clothes 4 inside rotary drum 2 in a drying step relative to operation time t, the output setting values 23 of the air-feeding quantity of air-feeding quantity control unit 15 and the temperature of hot-air temperature control unit 17 in the present first exemplary embodiment.

**[0037]** As shown in Fig. 3, after the start of a drying operation, control unit 13 controls the preheat drying step, with the output setting value of air-feeding quantity control unit 15 and the output setting value of hot-air temperature control unit 17 being set at constant values. At this time, drying efficiency  $\eta$  (22) of clothes 4 inside rotary drum 2 rises from operation start time  $t = 0$  to completion time t1 of the preheat drying step, in the same manner as in Fig. 2.

**[0038]** Next, in the constant-rate drying step, the drying operation proceeds, with drying efficiency  $\eta$  (22) being kept constant; however, in the case of entanglement of clothes 4 in the middle of the operation, drying efficiency  $\eta$  (22) is lowered. In the case of reduced drying efficiency  $\eta$  (22) of clothes 4 inside rotary drum 2, control unit 13 detects the degree of entanglement of clothes 4. Then, according to the degree of entanglement of clothes 4 thus detected, drum rotation control unit 18 changes settings of the rotation speed of rotary drum 2 and the rotation direction. For example, in order to quickly return reduced drying efficiency  $\eta$  (22) to the value of drying efficiency  $\eta$  (22) prior to the reduction, it allows rotary drum 2 to rotate at high speeds as well as at low speeds, or controls rotary drum 2 so as to forwardly and reversely rotate for predetermined periods of time. Thus, the entanglement of clothes 4 is lessened so as to dry clothes 4 so that drying efficiency  $\eta$  (22) is improved.

**[0039]** At this time, upon detection of entanglement of clothes 4, control unit 13 reduces the output setting value of the air-feeding quantity of air-feeding quantity control unit 15 and the output setting value of the temperature of hot-air temperature control unit 17 according to the degree of entanglement of clothes 4. More specifically, upon detection of the degree of entanglement of clothes 4, control unit 13 controls hot-air temperature control unit

17 to reduce the temperature of the drying air. When the entanglement of clothes 4 is lessened, it increases the output setting value of the temperature of hot-air temperature control unit 17, and returns the value to its original output setting value. In the same manner, upon detection of the degree of entanglement of clothes 4, control unit 13 controls air-feeding quantity control unit 15 to reduce the air-feeding quantity of drying air. When the entanglement of clothes 4 is lessened, it increases the output setting value of the air-feeding quantity of air-feeding quantity control unit 15, and returns the value to its original output setting value. That is, in the case of reduction of drying efficiency  $\eta$  (22) of clothes 4 inside rotary drum 2, the output setting values of the air-feeding quantity and the temperature of drying air are lowered. In contrast, when drying efficiency  $\eta$  (22) of clothes 4 inside rotary drum 2 is turned to rise, it returns the output setting values of the air-feeding quantity and the temperature of drying air to the original output setting values.

**[0040]** The following description will discuss why the output setting values of the air-feeding quantity and the temperature of drying air are lowered based upon the reduction of drying efficiency  $\eta$  (22) so as to carry out controlling.

**[0041]** In the case of the entanglement of clothes 4, since the surface area of clothes 4 that is made in contact with hot air for drying clothes 4 is narrowed, moisture is hardly evaporated from the surface of clothes 4. For this reason, in the case where control unit 13 carries out controlling, with the output setting value of the air-feeding quantity of air-feeding quantity control unit 15 and the output setting value of the temperature of hot-air temperature control unit 17 being kept constant, energy that does not devote to evaporation becomes greater; that is, when control unit 13 carries out controlling, with the output setting value of the air-feeding quantity of air-feeding quantity control unit 15 and the output setting value of the temperature of hot-air temperature control unit 17 being kept constant, a wasteful energy consumption occurs. Therefore, as shown in Fig. 3, the output setting value of the air-feeding quantity of air-feeding quantity control unit 15 and the output setting value of the temperature of hot-air temperature control unit 17 are lowered so that the energy required for generating hot air to be fed into rotary drum 2 is reduced. On the other hand, in the case where the entanglement of clothes 4 is lessened, since the surface area of clothes 4 that is made in contact with hot air for drying clothes 4 is widened, moisture is more easily evaporated from the surface of clothes 4. Therefore, the output setting value of the air-feeding quantity of air-feeding quantity control unit 15 and the output setting value of the temperature of hot-air temperature control unit 17 are returned to the original values so that the energy required for generating hot air to be fed into rotary drum 2 is increased. With this arrangement, by optimally setting the air-feeding quantity and the temperature of drying air in response to the change in the drying efficiency of clothes 4 inside rotary drum 2,

it is possible to achieve a drying operation in which more energy is saved.

**[0042]** Next, in a reduced-rate drying step after the completion of the constant-rate drying step, control unit 13 carries out controlling, with the output setting value of air-feeding quantity control unit 15 and the output setting value of hot-air temperature control unit 17 being kept constant values. Thus, drying efficiency  $\eta$  (22) of clothes 4 inside rotary drum 2 is lowered from completion time  $t_2$  of the constant-rate drying step to completion time  $t_3$  of the reduced-rate drying step.

**[0043]** Additionally, the present embodiment has been explained by exemplifying a structure in which, according to the degree of entanglement of clothes 4, the output setting value of air-feeding quantity control unit 15 and the output setting value of hot-air temperature control unit 17 are changed; however, the present invention is not intended to be limited by this structure. For example, the controlling may be carried out by changing either one of the output setting value of air-feeding quantity control unit 15 and the output setting value of hot-air temperature control unit 17. With this arrangement, by optimally setting the air-feeding quantity or the temperature of drying air according to the change in the drying efficiency of clothes 4 inside rotary drum 2, it is possible to achieve a drying operation in which more energy is saved.

**[0044]** Moreover, the present embodiment has been explained by exemplifying a structure in which hot-air temperature control unit 17 controls heating unit 16 such as a heater; however, the present invention is not intended to be limited by this structure. For example, it may control a heat pump or the like using an inverter-controlled compressor with its rotation speed being variably changed. With this arrangement, it is possible to achieve a clothes dryer having a superior energy saving performance.

## Claims

### 1. A clothes dryer comprising:

a rotary drum for housing clothes;  
 a motor for driving the rotary drum;  
 an air-feeding unit for feeding drying air into the rotary drum;  
 a heating unit for heating the drying air;  
 an air circulation path having an air supply passage and an air discharge passage for circulating the drying air inside the rotary drum, and;  
 a first humidity sensor for detecting humidity in the drying air that passes through the air supply passage;  
 a second humidity sensor for detecting humidity in the drying air that passes through the air discharge passage;  
 a calculating unit for calculating a change in humidity based on signals from the first humidity

sensor and the second humidity sensor; and  
 a control unit for controlling a drying operation, wherein

the control unit controls an air-feeding quantity and a temperature of the drying air according to a result of the calculation carried out in the calculating unit.

2. The clothes dryer according to claim 1, wherein the calculating unit calculates signals from the first humidity sensor and the second humidity sensor during a preheat drying step, and sets a completion time of a constant-rate drying step.
3. The clothes dryer according to claim 1, wherein the calculating unit calculates signals from the first humidity sensor and the second humidity sensor during a constant-rate drying step, and sets a drying operation completion time.
4. The clothes dryer according to claim 1, wherein the control unit detects a degree of entanglement of clothes in a constant-rate drying step according to a result of calculation carried out in the calculating unit.
5. The clothes dryer according to claim 4, wherein the control unit controls a temperature of the drying air according to the degree of entanglement of clothes.
6. The clothes dryer according to claim 4, wherein the control unit controls an air-feeding quantity of the drying air according to the degree of entanglement of clothes.
7. The clothes dryer according to any one of claims 4 to 6, wherein the control unit further controls rotation of the rotary drum according to the degree of entanglement of clothes.

FIG. 1

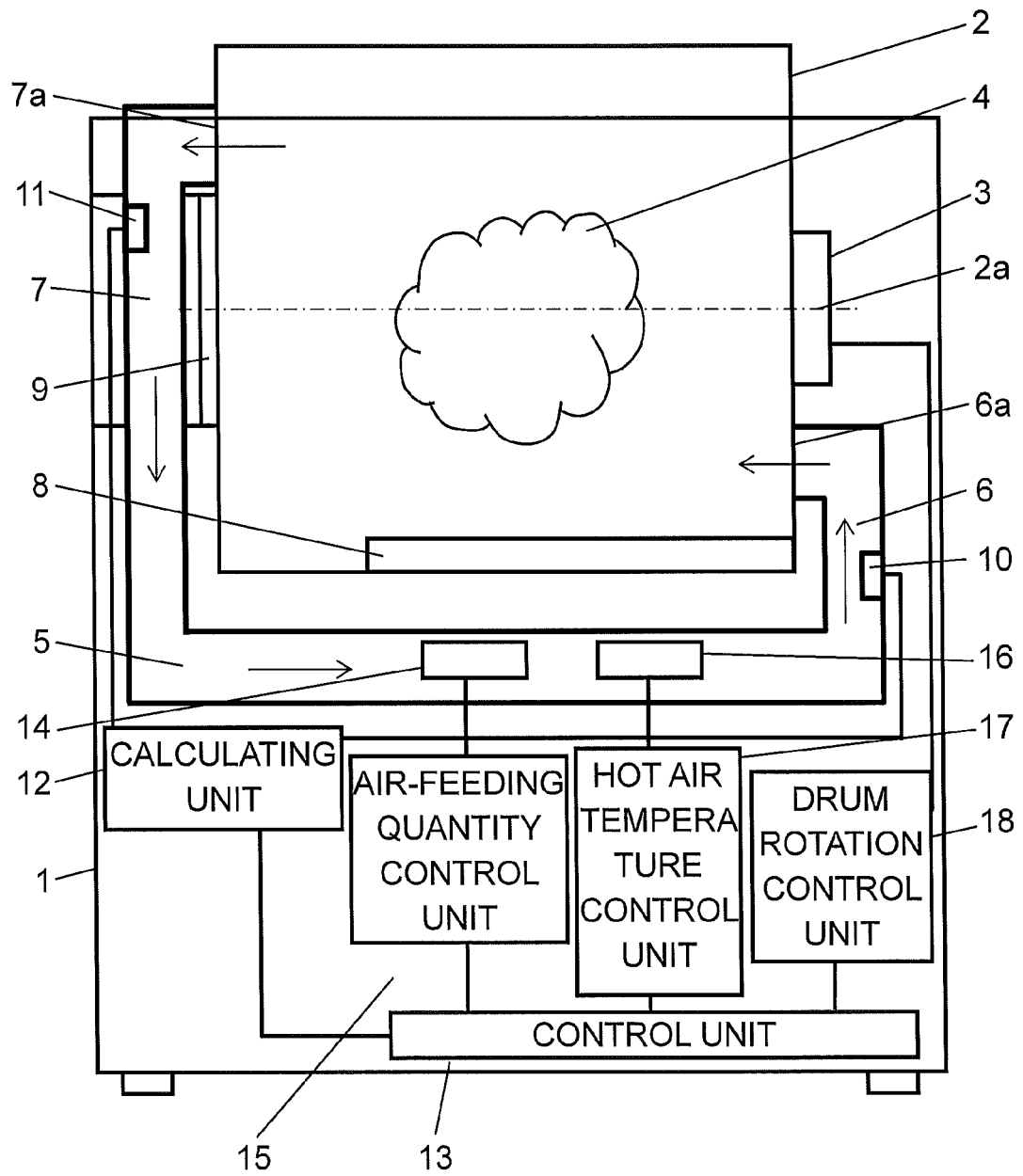


FIG. 2

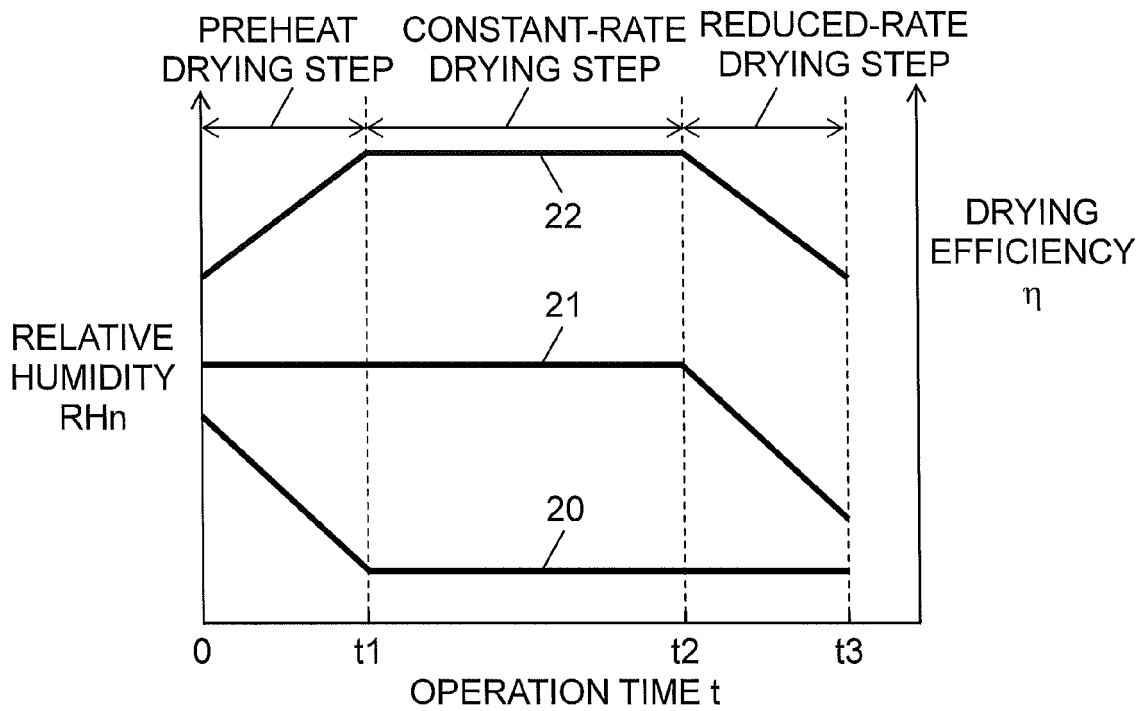


FIG. 3

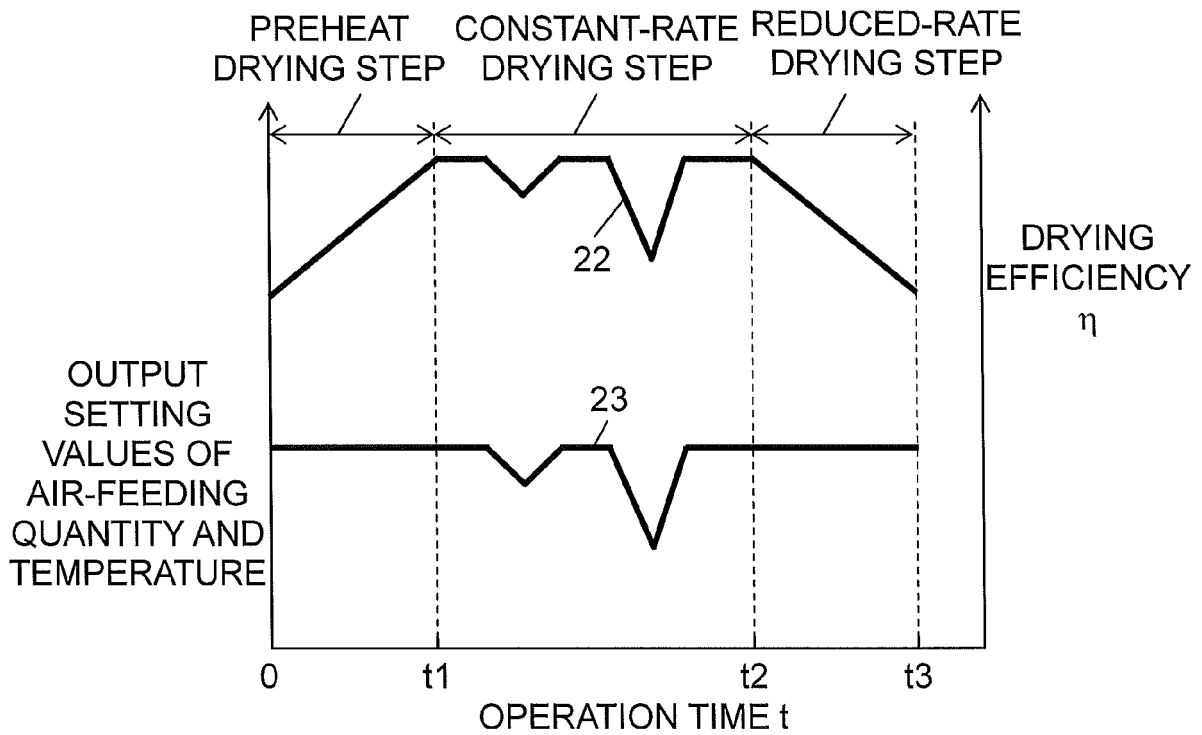


FIG. 4

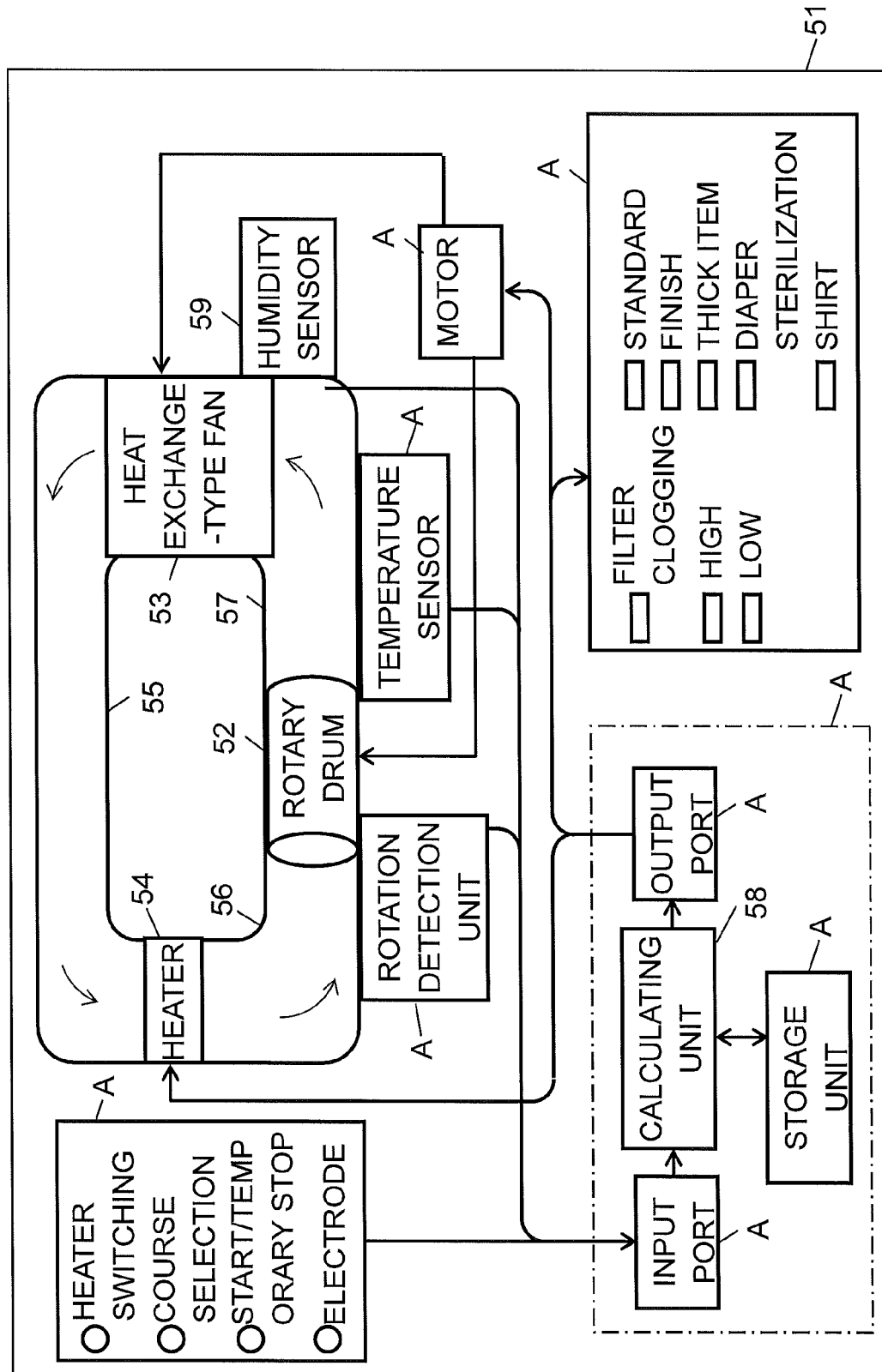
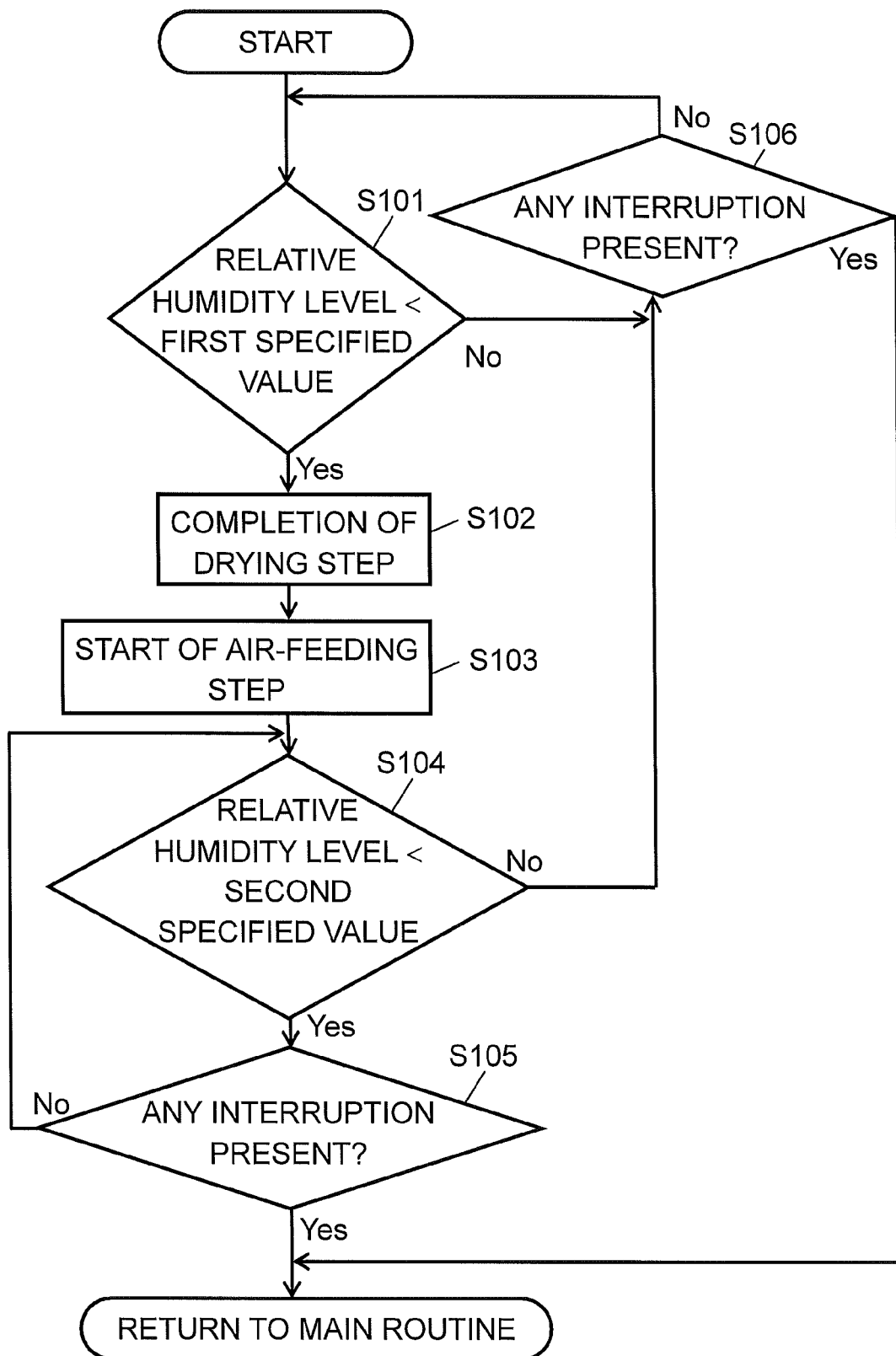


FIG. 5





## EUROPEAN SEARCH REPORT

Application Number  
EP 11 17 8702

| 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 2010/037480 A1 (STEFFENS GUENTER [DE])<br>18 February 2010 (2010-02-18)<br>* paragraphs [0029] - [0032]; figure 1 *<br>-----                         | 1                                | INV.<br>D06F58/28                       |
| A,P                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | EP 2 343 412 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 13 July 2011 (2011-07-13)<br>* paragraphs [0023], [0024], [0063], [0064], [0073]; figure 9 *<br>----- | 1-7                              |                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | EP 0 388 939 A1 (SANYO ELECTRIC CO [JP])<br>26 September 1990 (1990-09-26)<br>* the whole document *<br>-----                                           | 1-7                              |                                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                         |                                  | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                         |                                  | D06F                                    |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                         | Date of completion of the search | Examiner                                |
| Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                         | 22 February 2012                 | Stroppa, Giovanni                       |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/> Y : particularly relevant if combined with another document of the same category<br/> A : technological background<br/> O : non-written disclosure<br/> P : intermediate document</p> <p>T : theory or principle underlying the invention<br/> E : earlier patent document, but published on, or after the filing date<br/> D : document cited in the application<br/> L : document cited for other reasons<br/> .....<br/> &amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                         |                                  |                                         |

1  
EPO FORM 1503 03 02 (P04C01)

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

EP 11 17 8702

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.

22-02-2012

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|----|---------------------|----------------------------|---------------------|
| US 2010037480                             | A1 | 18-02-2010          | CN 101663433 A             | 03-03-2010          |
|                                           |    |                     | DE 102007018787 A1         | 23-10-2008          |
|                                           |    |                     | EP 2140062 A2              | 06-01-2010          |
|                                           |    |                     | US 2010037480 A1           | 18-02-2010          |
|                                           |    |                     | WO 2008128931 A2           | 30-10-2008          |
| -----                                     |    |                     |                            |                     |
| EP 2343412                                | A1 | 13-07-2011          | CN 102115972 A             | 06-07-2011          |
|                                           |    |                     | EP 2343412 A1              | 13-07-2011          |
|                                           |    |                     | KR 20110080620 A           | 13-07-2011          |
|                                           |    |                     | US 2011162228 A1           | 07-07-2011          |
| -----                                     |    |                     |                            |                     |
| EP 0388939                                | A1 | 26-09-1990          | DE 69002494 D1             | 09-09-1993          |
|                                           |    |                     | DE 69002494 T2             | 25-11-1993          |
|                                           |    |                     | EP 0388939 A1              | 26-09-1990          |
| -----                                     |    |                     |                            |                     |

**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 H09285696 B [0003]