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

(11) **EP 3 933 091 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.01.2022 Bulletin 2022/01

(21) Application number: **21182227.5**

(22) Date of filing: **29.06.2021**

(51) Int Cl.:
D06F 34/26 *(2020.01)*
D06F 105/26 *(2020.01)*
D06F 58/20 *(2006.01)*
D06F 103/32 *(2020.01)*
D06F 105/62 *(2020.01)*

(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
Designated Validation States:
KH MA MD TN

(30) Priority: **30.06.2020 TR 202010344**

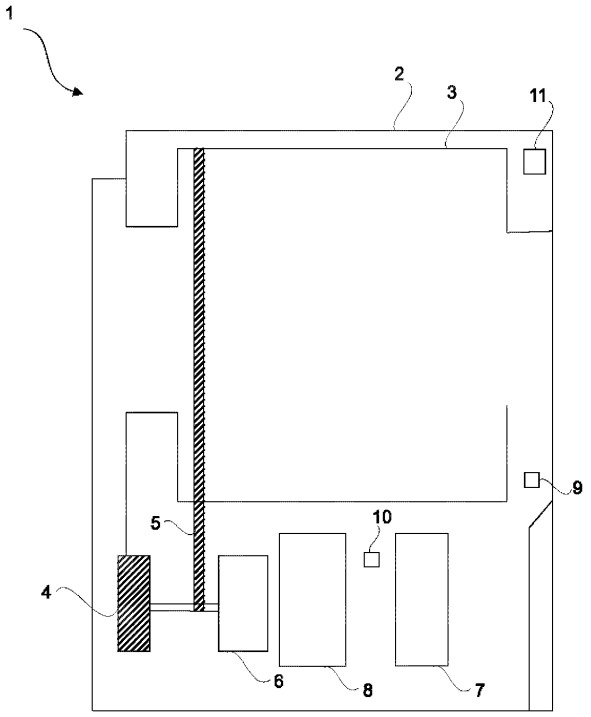
(71) Applicant: **Arçelik Anonim Sirketi**
34445 Istanbul (TR)

(72) Inventors:
- **TASTAN, Dogan**
  34445 ISTANBUL (TR)
- **ERCAN, Onur**
  34445 ISTANBUL (TR)
- **ARSLAN, Sergen Erkan**
  34445 ISTANBUL (TR)
- **GEZE, Emre**
  34445 ISTANBUL (TR)
- **ISIKLI, Ceyhan**
  34445 ISTANBUL (TR)

(54) **A LAUNDRY DRYER**

(57) The present invention relates to a laundry dryer (1) comprising a body (2); a drum (3) which is disposed in the body (2) and wherein the laundry is loaded; a motor (4) which drives and rotates the drum (3); a belt (5) which transmits the movement of the motor (4) to the drum (3); a fan (6) which provides the circulation of the drying air in the drying cycle; an evaporator (7) which dehumidifies the drying air; a condenser (8) which heats the dehumidified drying air; a first temperature sensor (9) which is disposed at the air outlet of the drum (3) and which measures the temperature of the drying air at the outlet of the drum (3); and a second temperature sensor (10) which is disposed between the evaporator (7) and the condenser (8) and which measures the temperature of the drying air passed over the evaporator (7).

Figure 1



EP 3 933 091 A1

Description

[0001] The present invention relates to a laundry dryer with improved safety.

[0002] In laundry dryers, the drum is moved by means of a belt driven by a motor. The laundry loaded into the drum is rotated in the drum and tumbled by means of the baffles. While being processed in the drum, the laundry may get stuck in the gaps between the baffle and the door depending on the fullness of the drum and the type of the laundry. The laundry which gets stuck may prevent the rotation of the drum, and in some cases, mechanically lock the rotation of the drum. In this case, since the drum gets stuck, the motor connected to the belt also gets locked and starts to heat up. In some cases, after the locking of the drum, the motor shaft continues rotating. The metal pulley around which the belt is wound, which rotates together with the motor shaft, continues rotating with the belt thereon in a manner to increase the heat, and after a time, may cause the breaking of the belt.

[0003] In the International Patent Application No. WO2008077968, a washer/dryer is disclosed, wherein the breaking of the belt is detected by the variation in the temperature of the heater by means of a temperature sensor provided on the heater.

[0004] In the International Patent Application No. WO2008065106, a washer/dryer is disclosed, wherein the breaking of the belt is detected by means of the air sensor disposed in the vicinity of the fan.

[0005] The aim of the present invention is the realization of a laundry dryer wherein the locking of the rotation of the drum is quickly detected.

[0006] The laundry dryer of the present invention comprises a body; a drum which is disposed in the body; a motor which drives and rotates the drum; a belt which transmits the movement of the motor to the drum; a fan which provides the circulation of the drying air in the drying cycle; an evaporator which dehumidifies the drying air; a condenser which heats the dehumidified drying air; a first temperature sensor which is disposed at the air outlet of the drum and which measures the temperature of the drying air at the outlet of the drum; and a second temperature sensor which is disposed between the evaporator and the condenser and which measures the temperature of the drying air passed over the evaporator.

[0007] The laundry dryer of the present invention further comprises a control unit which determines whether the rotation of the drum is locked or not by using the temperature difference between the temperature value received from the first temperature sensor and the temperature value received from the second temperature value. After the start of the drying process, the drying air is heated to a certain temperature depending on the program selected by the user. In the expected operational conditions after the temperature of the drying air is increased to the predetermined temperature, the difference between the temperature value received from the first temperature sensor and the temperature value received from the second temperature sensor remains almost constant. When the rotation of the drum is locked, the temperature difference between the two sensors starts to quickly decrease. This is caused by the fact that when the rotation of the drum is locked, the temperature value received from the first temperature sensor starts to decrease while the temperature value received from the second temperature sensor starts to increase. Thus, the locking of the rotation of the drum can be more quickly detected. Moreover, when one of the temperature sensors malfunctions and starts to continuously measure a constant value, the locking of the rotation of the drum can be detected by using the temperature difference changing depending on the variations in the other temperature sensor.

[0008] In an embodiment of the present invention, the laundry dryer comprises the control unit which calculates the temperature difference values between the temperature value received from the first temperature sensor and the temperature value received from the second temperature sensor at intervals predetermined by the producer and which records the calculated temperature difference values in the memory thereof; which, when the number of the recorded temperature difference values reaches a number predetermined by the producer, calculates the average of the recorded temperature difference values by excluding the minus values from the calculation of the average and which records the calculated value as the average temperature difference value in the memory thereof; which compares the recorded average temperature difference value with the nth previous average temperature difference value, n being predetermined by the producer; and which determines that the rotation of the drum is locked when the difference between the compared average temperature difference values exceeds a threshold value predetermined by the producer. Due to reasons such as a part of the air outlet of the drum being closed by the laundry during the drying process, the temperature values received from the first temperature sensor disposed at the air outlet of the drum may vary instantaneously. Therefore, in order to prevent an erroneous decision by the control unit due to instantaneous erroneous measurements, when n temperature difference values, n being predetermined by the producer, are recorded in the memory, the average of said temperature difference value is calculated. The air leaving the drum through the air outlet is cooled down by being passed over the evaporator having a cold surface. Therefore, the temperature value of the drying air at the air outlet of the drum since the start of the drying process is higher than the temperature value thereof after being passed over the evaporator. Even when the rotation of the drum is locked, this situation continues for 80 seconds as of the moment of the locking. The average does not include the cases where the temperature value received from the second temperature value is higher than the first temperature sensor due to sensor-inducted instantaneous errors in temperature measurements or any other

reasons, that is where the temperature difference value is below zero. The calculated average temperature difference value is compared with the nth previous average temperature difference value, n being predetermined by the producer. If the difference between the two average temperature difference values compared is higher than a threshold value predetermined by the producer, the control unit decides that the rotation of the drum is locked.

[0009] In an embodiment of the present invention, the laundry dryer comprises the control unit which starts the safety algorithm phase after deciding that the rotation of the drum is locked. After the start of the safety algorithm phase, first, the drum is stopped for 5 seconds. Afterwards, the drum is rotated counterclockwise for 20 seconds. Afterwards, the drum is stopped for 5 seconds and then rotated clockwise for 20 seconds. Finally, the drum is stopped for 5 seconds and then rotated counterclockwise for 20 seconds, and then the safety algorithm phase is terminated. In the safety algorithm phase, the drum is moved clockwise and counterclockwise so as to free the same from the locked position.

[0010] In an embodiment of the present invention, after the termination of the safety algorithm phase, the control unit compares the temperature value received from the first temperature sensor and the temperature value received from the second temperature sensor. The control unit continues the drying process if the temperature value received from the first temperature sensor is higher than the temperature value received from the second temperature sensor.

[0011] In an embodiment of the present invention, after the termination of the safety algorithm phase, the control unit decides that the rotation of the drum cannot be freed from the locked position and restarts the safety algorithm phase if the temperature value received from the first temperature sensor is lower than or equal to the temperature value received from the second temperature sensor.

[0012] In an embodiment of the present invention, the control unit warns the user audibly and/or visually if the temperature value received from the first temperature sensor is lower than or equal to the temperature value received from the second temperature sensor after the safety algorithm phase repeated n times, n being predetermined by the producer. The error of the locking of the rotation of the drum is conveyed to the user via the display of the laundry dryer. In the laundry dryers comprising sound devices, the user can be warned audibly. Thus, the user is enabled to be informed in advance of the error.

[0013] By means of the present invention, a laundry dryer is realized, wherein the locking of the rotation of the drum is quickly detected before the belt breaks.

[0014] The advantages of the laundry dryer of the present invention will be disclosed with the detailed description of the embodiments with reference to the accompanying figure, where:

Figure 1 - is the schematic view of the laundry dryer in an embodiment of the present invention.

[0015] The following numerals are referred to in the description of the present invention:

1. Laundry dryer
2. Body
3. Drum
4. Motor
5. Belt
6. Fan
7. Evaporator
8. Condenser
9. First temperature sensor
10. Second temperature sensor
11. Control unit

[0016] The laundry dryer (1) comprises a body (2); a drum (3) which is disposed in the body (2) and wherein the laundry is loaded; a motor (4) which drives and rotates the drum (3); a belt (5) which transmits the movement of the motor (4) to the drum (3); a fan (6) which provides the circulation of the drying air in the drying cycle; an evaporator (7) which dehumidifies the drying air; a condenser (8) which heats the dehumidified drying air; a first temperature sensor (9) which is disposed at the air outlet of the drum (3) and which measures the temperature of the drying air at the outlet of the drum (3); and a second temperature sensor (10) which is disposed between the evaporator (7) and the condenser (8) and which measures the temperature of the drying air passed over the evaporator (7). The drying air is sent into the drum (3) through the rear wall of the drum (^). The drying air is passed through the filter (not shown in the figures) disposed in the vicinity of the door (not shown in the figures) and leaves the drum (3) The first temperature sensor (9) is positioned in the vicinity of the air outlet of the drum (3) through which the drying air leaves the drum (3), preferably behind the filter. The first temperature sensor (9) is an NTC temperature sensor. The drying air leaving the drum (3) is passed over the evaporator (7) with a cold surface to be dehumidified. The temperature of the dehumidified drying air is measured by the second temperature sensor (10) disposed between the evaporator (7) and the condenser (8). The second temperature sensor (10) is an NTC temperature sensor. Then, the drying air is passed over the condenser (8) to be heated and sent into the drum (3).

[0017] The laundry dryer (1) of the present invention comprises a control unit (11) which determines whether the rotation of the drum (3) is locked or not by using the temperature difference value between the temperature value received from the first temperature sensor (9) and the temperature value received from the second temperature sensor (10). Since the rotation of the fan (6) is also locked when the rotation of the drum (3) is locked, the heated air cannot be sent into the drum (3). Therefore, the temperature value measured by the first temperature

sensor (9) at the air outlet of the drum (3) starts to decrease. In the course of time, the decrease in the measured temperature value continues almost with a linear acceleration. The second temperature sensor (10) disposed between the evaporator (7) and the condenser (8) measures the temperature of the drying air which is cooled down after passing over the evaporator (7). Since the cooled down air cannot pass over the second temperature sensor (10) after the locking of the rotation of the drum (3), the temperature value received from the second temperature sensor (10) starts to increase. After the locking of the drum (3), the decrease rate of the temperature at the air outlet of the drum (3) is close to the increase rate of the temperature of the region between the evaporator (7) and the condenser (8). Therefore, after the locking of the drum (3), the decrease rate of the difference between the temperature value received by the first temperature sensor (9) and the temperature value received from the second temperature sensor (10) becomes higher. By using the temperature difference value between the two sensors (9, 10), a more reliable detection is provided compared to the data which would be received from a single sensor. In a version of the present invention, the control unit (11) compares the temperature difference value obtained by deducting the temperature value received from the first temperature value (9) from the temperature value received from the second temperate value (10) with a predetermined threshold value, and quickly determines the locking of the rotation of the drum (3).

[0018] In another embodiment of the present invention, the laundry dryer (1) comprises the control unit (11) which calculates the temperature difference values between the temperature value received from the first temperature sensor (9) and the temperature value received from the second temperature sensor (10) at intervals predetermined by the producer and which records the calculated temperature difference values in the memory thereof; which, when the number of the recorded temperature difference values reaches a number predetermined by the producer, calculates the average of the recorded temperature difference values by excluding the minus values from the calculation of the average and which records the calculated value as the average temperature difference value in the memory thereof; which compares the recorded average temperature difference value with the nth previous average temperature difference value, n being predetermined by the producer; and which determines that the rotation of the drum (3) is locked when the difference between the compared average temperature difference values exceeds a threshold value predetermined by the producer. The difference between the temperature value received from the first temperature sensor (9) and the temperature value received from the second temperature sensor (10) is calculated each second and recorded in the memory. When the number of these recorded values reach a number predetermined by the producer, the average of said values is calculated without taking into account the temperature difference values where the temperature value received from the second temperature sensor (10) is higher than the temperature value received from the first temperature sensor (9), and the calculated average temperature difference value is recorded in the memory. For example, in the preferred embodiment of the present invention, the average of the 15 calculated temperature difference values is calculated without taking into account the minus values. The reason behind not taking into account the minus temperature difference values is to prevent the temperature difference values unexpectedly calculated as minus due to various reasons from decreasing the average temperature difference value. Since the first temperature sensor (9) and the second temperature sensor (10) measure the temperature values each second and the control unit (11) calculates the difference between these calculated values, the control unit (11) calculates the average temperature difference value each 15 seconds. The reason behind calculating the average of the temperature difference values at intervals predetermined by the producer is to prevent the control unit (11) from making an erroneous decision as a result of the possible instantaneous erroneous measurements by the sensors (9, 10). In other words, this enables the control unit (11) to make a more correct decision. The temperature difference values without any minus values are taken into account once while calculating the average. At the end of 60 seconds, four average temperature difference values related to each 15-second period are calculated. The calculated average temperature difference value is compared with the third previous average temperature difference value. For example, the average temperature difference value calculated between 175th and 190th seconds of the drying cycle is compared with the average temperature difference value calculated between 130th and 145th seconds. Within approximately 60 seconds after the rotation of the drum (3) is locked, there is a difference of more than 1.5 degrees between the temperature of the drying air at the air outlet of the drum (3) and the temperature thereof after passing over the evaporator (7). The control unit (11) decides that the rotation of the drum (3) is locked if there is a decrease of more than 1.5 degrees between the two compared average temperature difference values. Thus, after the rotation of the drum (3) is locked, this situation is determined by the control unit (11) within a short time of approximately 60 seconds.

[0019] In another embodiment of the present invention, the laundry dryer (1) comprises the control unit (11) which, after the locking of the rotation of the drum (3), starts a safety algorithm phase comprising the steps of stopping the drum (3), rotating the drum (3) counterclockwise and rotating the drum (3) clockwise, wherein said steps are executed in an order predetermined by the producer. After it is determined that the rotation of the drum (3) is locked, the safety algorithm phase is started. In the safety algorithm phase, the drum (3) is stopped for a time predetermined by the producer, and then rotated coun-

terclockwise for another time predetermined by the producer. Afterwards, the drum (3) is stopped for a time and then rotated clockwise. In the safety algorithm phase, by constantly changing the rotational direction of the drum (3), the drum (3) is tried to be freed from the jamming causing the locking of the rotation thereof.

[0020] In an embodiment of the present invention, the laundry dryer (1) comprises the control unit (11) which, after the end of the safety algorithm phase, resumes the drying process if the temperature value received from the first temperature sensor (9) is higher than the temperature value received from the second temperature sensor (10). Since the hot air can be sent into the drum (3) when the drum (3) rotated in different directions during the safety algorithm phase is freed from the locking position and starts to freely rotate, the temperature value received from the first temperature sensor (9) starts to increase. On the other hand, the temperature value received from the second temperature sensor (10) starts to decrease. The control unit (11) determines that the drum (3) is freed from the locking position if the value received from the first temperature sensor (9) is higher than the value received from the second temperature sensor (10), and the drying process is resumed from the moment it is determined that the rotation of the drum (3) is locked.

[0021] In an embodiment of the present invention, the laundry dryer (1) comprises the control unit (11) which, after the end of the safety algorithm phase, restarts the safety algorithm phase if the temperature value received from the first temperature sensor (9) is equal to or lower than the temperature value received from the second temperature sensor (10). It is determined that the drum (3) cannot be freed from the locking position if the temperature value received from the first temperature sensor (9) is equal to or lower than the temperature value received from the second temperature sensor (10). In this case, the control unit (11) starts the safety algorithm phase once again so as to free the drum (3) from the locking position.

[0022] In an embodiment of the present invention, the laundry dryer (1) comprises the control unit (11) which, after the safety algorithm phase is repeated for n times, n being predetermined by the producer, warns the user audibly or visually if the value received from the first temperature sensor (9) is equal to or lower than the value received from the second temperature sensor (10). The control unit (11) executes the safety algorithm phase three times at the most in a drying cycle. If the value received from the first temperature sensor (9) is lower than the value received from the second temperature sensor (10) after the safety algorithm phase is repeated three times, it is decided that the locking of the rotation of the drum (3) continues and that the drum (3) cannot be freed from the locking position despite the application of the safety algorithm phases. In this case, the control unit (11) warns the user audibly and/or visually of the locking of the rotation of the drum (3).

[0023] By means of the present invention, a laundry dryer (1) is realized, comprising a control unit (11) which quickly detects the locking of the rotation of the drum (3) by using the temperature difference value between the temperature of the drying air at the outlet of the drum (3) and the temperature of the drying air passed over the evaporator (7) to be dehumidified. Moreover, thus, the risk of the belt (5) breaking off due the locking of the drum (3) is eliminated.

Claims

1. A laundry dryer (1) comprising a body (2); a drum (3) which is disposed in the body (2) and wherein the laundry is loaded; a motor (4) which drives and rotates the drum (3); a belt (5) which transmits the movement of the motor (4) to the drum (3); a fan (6) which provides the circulation of the drying air in the drying cycle; an evaporator (7) which dehumidifies the drying air; a condenser (8) which heats the dehumidified drying air; a first temperature sensor (9) which is disposed at the air outlet of the drum (3) and which measures the temperature of the drying air at the outlet of the drum (3); and a second temperature sensor (10) which is disposed between the evaporator (7) and the condenser (8) and which measures the temperature of the drying air passed over the evaporator (7) **characterized by** a control unit (11) which determines whether the rotation of the drum (3) is locked or not by using the temperature difference value between the temperature value received from the first temperature sensor (9) and the temperature value received from the second temperature sensor (10).

2. A laundry dryer (1) as in Claim 1, **characterized by** the control unit (11) which calculates the temperature difference values between the temperature value received from the first temperature sensor (9) and the temperature value received from the second temperature sensor (10) at intervals predetermined by the producer and which records the calculated temperature difference values in the memory thereof;

   - which, when the number of the recorded temperature difference values reaches a number predetermined by the producer, calculates the average of the recorded temperature difference values by excluding the minus values from the calculation of the average and which records the calculated value as the average temperature difference value in the memory thereof;
   - which compares the recorded average temperature difference value with the nth previous average temperature difference value, n being predetermined by the producer; and which determines that the rotation of the drum (3) is locked

when the difference between the compared average temperature difference values exceeds a threshold value predetermined by the producer.

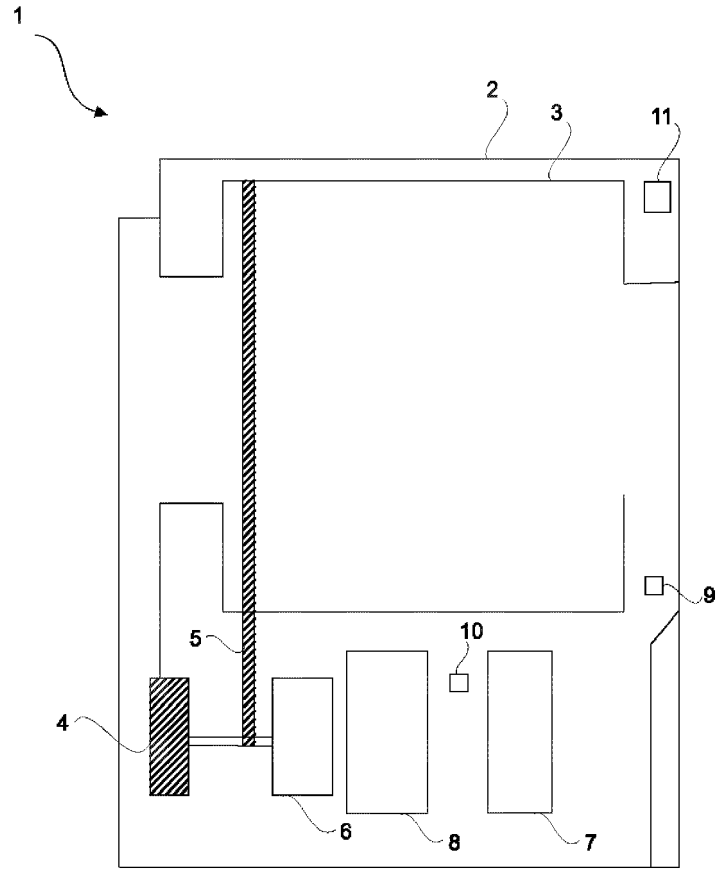
3. A laundry dryer (1) as in any one of the above claims, **characterized by** the control unit (11) which, after the locking of the rotation of the drum (3), starts a safety algorithm phase comprising the steps of stopping the drum (3), rotating the drum (3) counterclockwise and rotating the drum (3) clockwise, wherein said steps are executed in an order predetermined by the producer.

4. A laundry dryer (1) as in Claim 3, **characterized by** the control unit (11) which, after the end of the safety algorithm phase, resumes the drying process if the temperature value received from the first temperature sensor (9) is higher than the temperature value received from the second temperature sensor (10).

5. A laundry dryer (1) as in Claim 3, **characterized by** the control unit (11) which, after the end of the safety algorithm phase, restarts the safety algorithm phase if the temperature value received from the first temperature sensor (9) is equal to or lower than the temperature value received from the second temperature sensor (10).

6. A laundry dryer (1) as in Claim 5, **characterized by** the control unit (11) which, after the safety algorithm phase is repeated for n times, n being predetermined by the producer, warns the user audibly or visually if the value received from the first temperature sensor (9) is equal to or lower than the value received from the second temperature sensor (10).

Figure 1



Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 21 18 2227

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2010/126032 A1 (KIM YANG-HO [KR] ET AL) 27 May 2010 (2010-05-27) * paragraph [0071] - paragraph [0074]; figures 1, 9 *	1-6	INV. D06F34/26 ADD. D06F103/32 D06F105/26 D06F105/62 D06F58/20
A	US 2010/263226 A1 (BALERDI AZPILICUETA PILAR [ES] ET AL) 21 October 2010 (2010-10-21) * paragraph [0029] - paragraph [0043]; figure 1 *	1-6	
A	JP 2016 220743 A (TOSHIBA LIFESTYLE PRODUCTS & SERVICES CORP) 28 December 2016 (2016-12-28) * paragraph [0036] - paragraph [0039]; figures 2, 4 *	1-6	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 November 2021	Diaz y Diaz-Caneja

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 21 18 2227

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.

10-11-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010126032 A1	27-05-2010	AU 2008215295 A1	21-08-2008
		CN 101627156 A	13-01-2010
		DE 112008000412 T5	03-12-2009
		KR 100811487 B1	07-03-2008
		US 2010126032 A1	27-05-2010
		WO 2008100079 A1	21-08-2008
US 2010263226 A1	21-10-2010	AT 511569 T	15-06-2011
		CN 101903587 A	01-12-2010
		DE 102007061519 A1	25-06-2009
		EA 201070749 A1	28-02-2011
		EP 2227585 A1	15-09-2010
		US 2010263226 A1	21-10-2010
		WO 2009080468 A1	02-07-2009
JP 2016220743 A	28-12-2016	JP 6486197 B2	20-03-2019
		JP 2016220743 A	28-12-2016

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

- WO 2008077968 A **[0003]**
- WO 2008065106 A **[0004]**