

(19)



(11)

EP 3 683 506 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.07.2020 Bulletin 2020/30

(51) Int Cl.:
F24C 15/32 (2006.01)

(21) Application number: **19382027.1**

(22) Date of filing: **17.01.2019**

(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

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(54) **SYSTEM FOR GENERATING STEAM WITH PREHEATING AREA, AND METHOD FOR GENERATING STEAM WITH PREHEATING AREA**

(57) The system for generating steam in ovens comprises an injection tube (2) for injecting water into a cooking chamber (4) of the oven by means of a valve (1), generating steam in said cooking chamber (4), wherein said injection tube (2) comprises a preheating area (3) where water accumulates before being injected into the cooking chamber (4).

The method comprises the steps of determining a water injection flow rate (C); determining a water injection

regulation flow rate (C_{REG}); determining the volume (V) of said preheating area (3); calculating the actuation time (W_H) of said valve (1); and calculating the time (T) between the start of two consecutive water injections by means of the following formula:

It makes it possible to generate more steam with the same volume of water and with a lower likelihood of deterioration of the turbine.

EP 3 683 506 A1

Description

[0001] The present invention relates to a system and method for generating steam in ovens, which make it possible to improve the injection temperature of water to generate said steam.

Background of the invention

[0002] Professional ovens are specialised machinery for cooking and processing food with extensive and very precise control over the internal conditions of the cooking chamber. These ovens make it possible to control temperature, the stability thereof both at very low temperatures and at high temperatures, humidity, the heat transfer of steam, the homogeneous conditions inside the oven, etc.

[0003] Controlling humidity in the cooking chamber is a crucial factor to ensure the correct preparation of some foods and dishes in modern cooking. Having control over the steam in the cooking chamber makes it possible to work with very important components of the final result of the cooked dish, such as juiciness, texture, colour, etc.

[0004] A professional oven must guarantee a very stable and precise control over the humidity inside, which includes controlling the level, the generation and the extraction of steam to properly and specifically cook each food. The correct circulation of steam throughout the interior of the cooking chamber is essential to ensure homogeneous conditions, or in other words, that all foods will be subjected to the same conditions for delivering an appropriate and professional result.

[0005] Many modern culinary processes require having control over the level and homogeneity of the humidity inside the cooking chamber. Therefore, they also require the convection mechanisms that regulate the concentration of steam and circulation thereof to function in the most convenient and precise manner possible, without any complications.

[0006] Currently, there are several ways to generate steam in an oven: by means of a boiler, by direct injection, evaporation, etc.

[0007] One of the most common methods is direct injection, which involves injecting water either into the centre of the turbine or on one or several points of the blades of the turbine.

[0008] The injection tube is usually located at a point considered more advantageous or strategic on the blade, which is where the water precipitates. If the chamber is not already saturated with steam, more or less steam will be generated depending on the water inlet temperature.

[0009] Likewise, the injection temperature of water affects the useful life of the turbine: the lower the difference between its temperature and the temperature of the injected water, the less thermal shock caused, with which there is a lower likelihood of warping or imbalances or of the turbine breaking.

[0010] Each manufacturer and model uses different points and tube inclination angles to try to get the largest amount of steam. Likewise, depending on the degree of humidity desired and the actual degree of humidity, manufacturers can adjust the flow rate needed to generate or maintain desired steam levels at the chamber.

[0011] The flow rate of water injected into the oven is generally regulated on a pulsed basis for a set period of time, with the injection being repeated at the end of each period, and so on.

[0012] In addition and as a general rule, the solenoid valves are provided with a flow rate controller that limits the amount of water that is injected, regardless of inlet pressure.

[0013] The steam generation systems used in professional ovens known today generate a limited amount of steam and their turbines are very likely to deteriorate due to thermal shock.

[0014] Therefore, an object of the present invention is to provide a system for generating steam in ovens that generates more steam with the same volume of water and in which the likelihood of deterioration of the turbine due to thermal shock is lower.

Description of the invention

[0015] The system and method of the invention resolve the drawbacks mentioned above and exhibit other advantages that will be described below.

[0016] According to a first aspect, the present invention relates to a system for generating steam in ovens, which comprises an injection tube for injecting water into a cooking chamber of the oven by means of a valve, generating steam in said cooking chamber, and wherein said injection tube comprises a preheating area where water accumulates before being injected into the cooking chamber.

[0017] Advantageously, said injection tube also comprises an injection conduit, with the preheating area being placed between said injection tube and said injection conduit.

[0018] In addition, said preheating area is preferably arranged at a different level with respect to said injection tube or to said injection conduit.

[0019] Advantageously, said preheating area is located adjacent to a heat-generating zone of the oven, which preferably comprises at least one resistor or heat exchanger.

[0020] According to three alternative embodiments, said preheating area is a U-shaped portion where the water accumulates in the lower part of said U-shaped portion; said preheating area is a bent portion where the water accumulates in the lower part of said bent portion; or said preheating area is a cavity, where the water accumulates in the lower part of said cavity.

[0021] According to a second aspect, the present invention relates to a method for generating steam using the steam generation system described above, which comprises the steps of:

- determining a water injection flow rate (C);
- determining a water injection regulation flow rate (C_{REG});
- determining the volume (V) of said preheating area (3);
- calculating the actuation time (W_H) of said valve (1) by applying the following formula:

$$W_H = V/C_{REG}$$

and

- calculating the time (T) between the start of two consecutive water injections by means of the following formula:

$$T = W_H \cdot (C_{REG}/C)$$

[0022] According to a preferred embodiment, said flow rate (C) is less than or equal to 10 ml/s and said regulation flow rate (C_{REG}) is also less than or equal to 10 ml/s.

[0023] Consequently, the system and method according to the present invention exhibit at least the following advantages:

- More steam is generated with the same volume of water.

[0024] With the present invention, more steam is generated in the cooking chamber since less water is necessary to produce the same amount of steam at a higher water inlet temperature.

- Lower likelihood of deterioration of the turbine.

[0025] The thermal shock suffered by the turbine of the oven with the preheated water is lower than the thermal shock suffered with traditional injection systems. As a consequence of the above, there is less imbalance and a lower likelihood of the turbine breaking.

Brief description of the drawings

[0026] To aid a better understanding of the above, drawings have been attached, in which a practical embodiment has been schematically represented and only by way of a non-limiting example.

Figure 1 is a perspective view of a system for generating steam in ovens of the present invention, according to a first embodiment;

Figure 2 is an elevational view of a part of the water injection tube according to the embodiment of Figure 1;

Figure 3 is an elevational view of a part of the water injection tube according to a second embodiment; and

Figure 4 is an elevational view of a part of the water injection tube according to a third embodiment.

Description of preferred embodiments

[0027] The present invention relates to a system and method which make it possible to improve the injection temperature of water in an oven for generating steam. This is achieved through modifications in the injection tube and by adapting both the water injection time and the injection period between water injections, maintaining the flow rate.

[0028] As shown in Figure 1, the oven comprises at least one injection tube 2, which defines a preheating area 3, and a cooking chamber 4 such that the water is not injected into the cooking chamber 4 until the volume of said preheating area 3 is exceeded, as will be explained below.

[0029] This preheating area 3 is located in a heat-generating zone of the oven, as close as possible to a convection

resistor or heat exchanger of the oven.

[0030] In addition, the oven also comprises a valve 1, such as a solenoid valve, with a flow rate controller. The outlet of the flow rate controller is connected to the injection tube 2. When water is injected, this water is stored in the preheating area 3 to increase its temperature.

[0031] In the following injection, the preheated water will be injected into a turbine 5 of the oven, and cold water will be stored again in the preheating area 3, which will be heated before being injected, and so on.

[0032] Three possible embodiments of the preheating area 3 defined in the injection tube 2 are shown in the figures.

[0033] In all of these embodiments, the cold water is always in the lower part of the preheating area 3, while the hot water overflows and is injected into the turbine 5 of the oven through an injection conduit 6.

[0034] According to a first embodiment, Figure 2 shows that this preheating area 3 is defined by a U-shaped section, such that the water accumulates in the lower part of said U-shaped section.

[0035] In the second embodiment, shown in Figure 3, the preheating area 3 is defined by a bent section that rises between the injection tube 2 and the injection conduit 6, such that the water accumulates in the lower part of this bent section.

[0036] In the third embodiment, shown in Figure 4, the preheating area 3 is defined by a cavity or chamber also placed between the injection tube 2 and the injection conduit 6, such that the water accumulates in the lower part of this cavity.

[0037] To preheat the water more effectively, in addition to the preheating area 3 provided for preheating the water, it is also advisable for a relationship to exist between the flow rate C, the flow rate controller of the solenoid valve C_{REG} , the injection time W_H and the period between injections T.

[0038] The first parameter is the water injection flow rate C. This flow rate is usually between 0 and 10 millilitres per second. The required flow rate is calculated by the oven control electronics, and is a function of the temperature of the cooking chamber 4, the temperature of a saturation sensor, the amount of food, and other parameters.

[0039] The work cycle C_T is defined as the time during which the solenoid valve is active (W_H), divided by the time during which it is active and inactive ($W_H + W_L$)

$$C_T = W_H / (W_H + W_L)$$

[0040] For example, as the flow rate C is, at most, 10 millilitres per second, and the work cycle C_T is comprised between 0 and 1, it is clear that C_{REG} , the flow rate controller of the solenoid valve 1, must also be 10 millilitres per second.

[0041] Once the required flow rate C has been defined, the work cycle C_T is calculated as

$$C_T = C / C_{REG}$$

[0042] V is defined as the volume of water housed in the preheating area 3 to determine the filling in each injection of the volume V of the preheating area. For this to happen, the solenoid valve 1 is activated with the controller during one W_H such that

$$V = C_{REG} \cdot W_H$$

is fulfilled.

[0043] Therefore, the W_H value, which causes the volume V to fill completely, is

$$W_H = V / C_{REG}$$

[0044] Consequently, the work cycle C_T is

$$C_T = W_H / (W_H + W_L) = (V / C_{REG}) / ((V / C_{REG}) + W_L) = V / (V + C_{REG} \cdot W_L)$$

where W_L it is the period of time where no injections take place.

[0045] To therefore obtain

$$W_L = (V/C_{REG}) \cdot (1/C_T - 1)$$

[0046] The period between injections T is

$$T = W_H + W_L = W_H = V/C_{REG} + (V/C_{REG}) \cdot (1/C_T - 1) = (V/C_{REG}) \cdot (1/C_T) = W_H (1/C_T)$$

[0047] That is, for a required flow rate C, and after setting a value of the flow rate controller C_{REG} and a volume V of the preheating area 3, the oven calculates the optimal values W_H and T, which maximise the inlet temperature of the water that is injected while minimising the time between injections T.

$$W_H = V/C_{REG}$$

$$T = W_H \cdot (C_{REG}/C)$$

[0048] Example: the flow rate controller of the oven is $C_{REG} = 4$ ml/s and the volume V of the preheating area 3 is 20 ml. A flow rate C = 1 ml/s is required. Therefore:

$$W_H = 20 \text{ ml} / 4 \text{ ml/s} = 5 \text{ s}$$

$$T = 5 \text{ s} \cdot (4 \text{ ml/s} / 1 \text{ ml/s}) = 20 \text{ s}$$

[0049] The oven will activate the injection solenoid valve 1 for 5 seconds every 20 seconds. This ensures an increase in temperature of the water that accumulates in the preheating area 3, and it is not until the following injection that this water, which has already been preheated, enters the cooking chamber 4.

[0050] Although reference has been made to several specific embodiments of the invention, it is obvious to a person skilled in the art that the system and the method described are subject to numerous variations and modifications, and that all the details mentioned can be replaced by other technically equivalent ones, without departing from the scope of protection defined by the claims attached hereto.

Claims

1. System for generating steam in ovens, which comprises an injection tube (2) for injecting water into a cooking chamber (4) of the oven by means of a valve (1), generating steam in said cooking chamber (4), **characterised in that** said injection tube (2) comprises a preheating area (3) where water accumulates before being injected into the cooking chamber (4).
2. The system for generating steam in ovens according to claim 1, wherein said injection tube (2) also comprises an injection conduit (6), with the preheating area (3) being placed between said injection tube (2) and said injection conduit (6).
3. The system for generating steam in ovens according to claim 2, wherein said preheating area (3) is arranged at a different level with respect to said injection tube (2) and/or said injection conduit (6).
4. The system for generating steam in ovens according to any one of the preceding claims, wherein said preheating area (3) is located adjacent to a heat-generating zone of the oven.
5. The system for generating steam in ovens according to claim 4, wherein said heat-generating zone of the oven comprises at least one resistor or heat exchanger.

6. The system for generating steam in ovens according to any one of the preceding claims, wherein said preheating area (3) is a U-shaped portion, where the water accumulates in the lower part of said U-shaped portion.

7. The system for generating steam in ovens according to any one of the claims 1 to 5, wherein said preheating area (3) is a bent portion, where the water accumulates in the lower part of said bent portion.

8. The system for generating steam in ovens according to any one of the claims 1 to 5, wherein said preheating area (3) is a cavity, where the water accumulates in the lower part of said cavity.

9. Method for generating steam using the system for generating steam according to any one of the preceding claims, **characterised in that** it comprises the steps of:

- determining a water injection flow rate (C);
- determining a water injection regulation flow rate (C_{REG});
- determining the volume (V) of said preheating area (3);
- calculating the actuation time (W_H) of said valve (1) by applying the following formula:

$$W_H = V/C_{REG}$$

and

- calculating the time (T) between the start of two consecutive water injections by means of the following formula:

$$T = W_H \cdot (C_{REG}/C)$$

10. The method for generating steam according to claim 9, wherein said flow rate (C) is less than or equal to 10 ml/s.

11. The method for generating steam according to claim 9, wherein said regulation flow rate (C_{REG}) is less than or equal to 10 ml/s.

FIG. 1

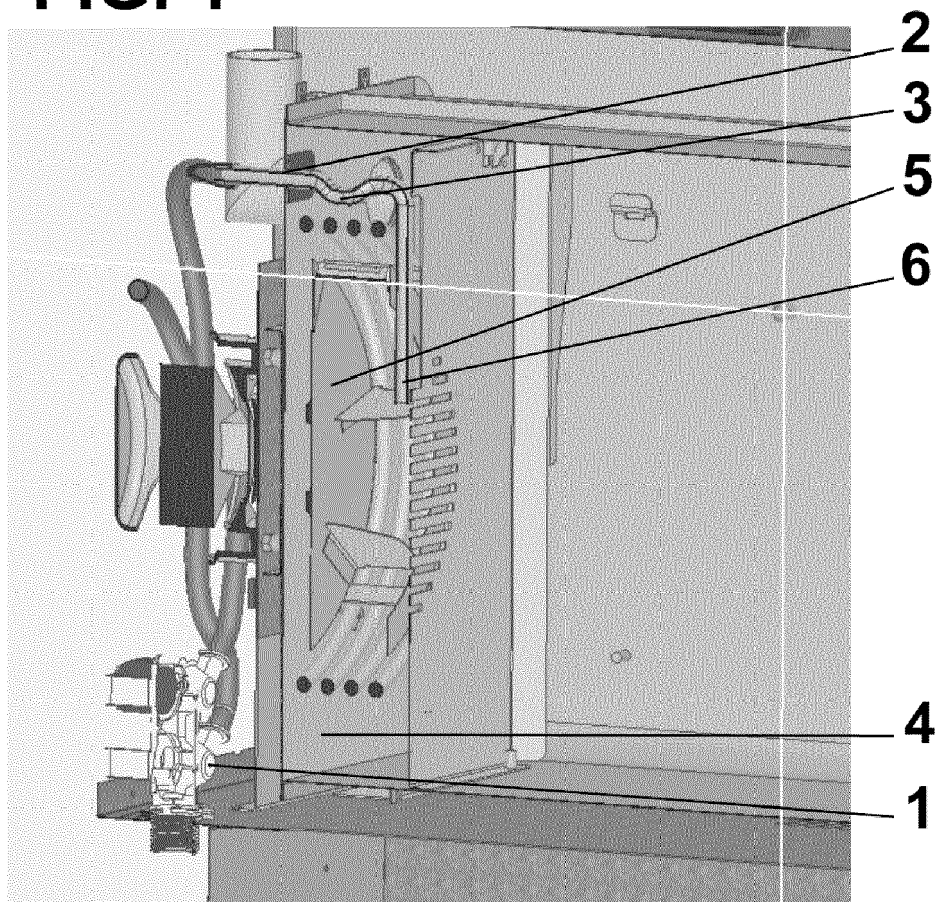


FIG. 2

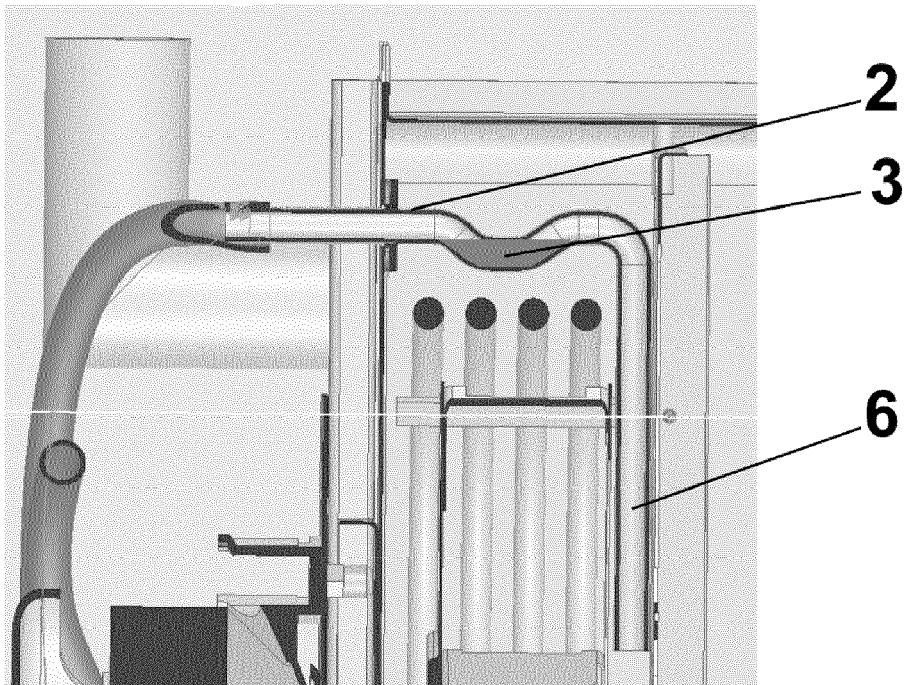


FIG. 3

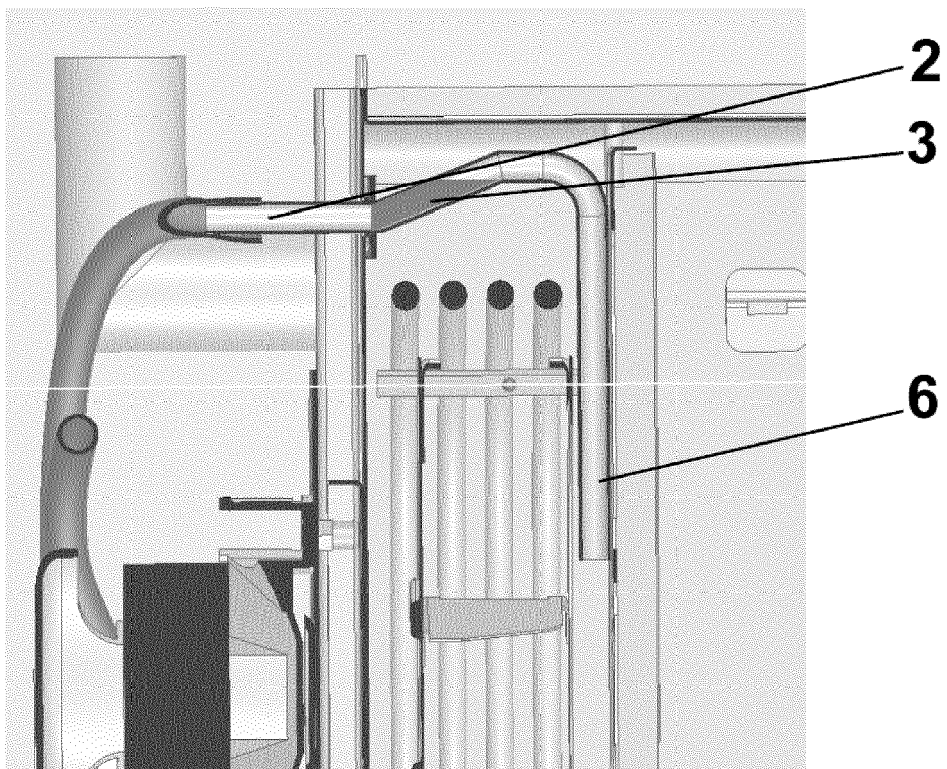
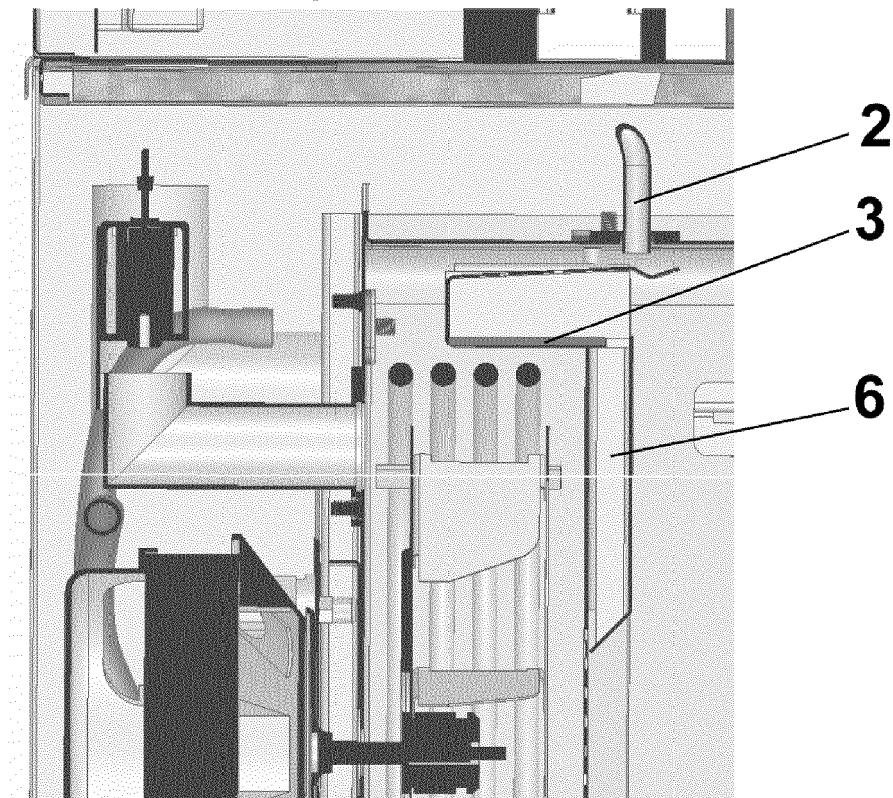


FIG. 4





EUROPEAN SEARCH REPORT

Application Number
EP 19 38 2027

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EPO FORM 1503 03.82 (P04C01)

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X	EP 1 616 515 A1 (BSH BOSCH SIEMENS HAUSGERAETE [DE]) 18 January 2006 (2006-01-18) * paragraphs [0015], [0016], [0018], [0019]; figures 1, 2 *	1-7	TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 June 2019	Examiner Jalal, Rashwan
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	

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

EP 19 38 2027

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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