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(54) **A DRYER**

TROCKNER

SÈCHE-LINGE

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Description

[0001] The present invention relates to a dryer wherein the malfunctions that occur during the drying process are identified.

[0002] In dryers, during operation, malfunctions can occur such as clogging of the filter and condenser, obstruction of the air passageway, the motor locking up and not rotating the drum or the drying air blower, the blower dislodging from the motor shaft, the drum getting jammed and being forced in rotating or decrease in the mains voltage. Not being able to detect these malfunctions correctly in due time results in the decrease of the drying performance and damaging of the laundry. The malfunctions of the dryer generally interrupt or considerably limit the flow of the drying air, moreover the temperature of the drying air increases excessively. The temperature of the heater used in the dryer is kept under control by security elements such as NTC, thermostat, or thermal protector. Under normal working conditions, the heater operates within a certain temperature range under control of the NTC or the thermostat. When the temperature of the heater starts rising up rapidly because of a malfunction, the heater thermostat de-energizes the heater at the set high temperature limit; however, the temperature continues rising for a while due to thermal inertia. In this case, the non-return thermal protector used for the last safety precaution in heaters is actuated against excessive temperature rise and stops the operation of the heater. The actuation of the non-return thermal protector is an unwanted situation and the heater can only be energized again after repair by the service.

[0003] The motor that activates the drum containing the laundry and the blower activating the drying air is protected against excessive heating by a motor thermal protector; however, in case of an error it takes time for the motor thermal protector to be energized and hot air is sent over the laundry as long as the motor operates.

[0004] Various methods are used in the conventional technique for detecting the malfunctions of the dryer during operation.

[0005] In the European Patent No EP 0312072 a safety device used in laundry driers is explained. The safety device is adapted to cut the electric power supply to the machine in case of insufficient or totally absent drying air circulation due to clogging of the filter and/or stoppage of the electric motor of the blower and the drum caused by failure or functional defects of the motor.

United States Patent US 6,158,148 discloses a method to detect impermissible operating states in a dryer with a laundry drum. Temperature is detected periodically downstream of a heater and upstream of the drum. If a difference value or gradient of this temperature is greater than a predetermined value, a counting value is incremented. If said counting value is greater than a predetermined counting value, then the heating of the dryer is turned off and/or an operating state display is activated. The aim of the present invention is the realization of a dryer wherein the malfunctions that occur during the drying process and partially or entirely obstruct air flow in the drum can be detected.

The dryer realized in order to attain the aim of the present invention is explicated in the claims.

In the dryers, the laundry is emplaced in a drum actuated by a motor and the drying air, activated by a blower, heated by a heater and circulated in the circulation channel between the blower and the drum, is blown over the laundry. The temperature variations of the drying air are detected by means of a temperature sensor disposed in the circulation channel and whether or not there is a malfunction that partially or entirely prevents air flow in the drum and what type of a malfunction there is and if there is one identified with the evaluation of the temperature change rate of the drying air by the control unit are detected. The temperature sensor, integrated with the thermostat or as a separate unit, is disposed close to the heater or at a point farther away.

The control unit evaluates the derivative of the heater temperature change according to time, or in other words, the control unit evaluates the temperature change rate for identifying which malfunction is confronted with during operation of the dryer, such as locking of the motor, the blower not rotating, clogging of the filter or the condenser, the drum rotating with difficulty and dropping of voltage or jamming of the drum.

In an embodiment of the present invention, when the heater, operating in an on-off manner under control of the thermostat, is on and while the drying air temperature in the vicinity of the heater is increasing from the set low temperature to the set high temperature of the thermostat, the rate of change in temperature of the drying air is evaluated by the control unit for determining whether there is malfunction and the type of malfunction if there is one.

[0006] In another embodiment of the present invention, when the heater, operating in an on-off manner under control of the thermostat, is off and the temperature of drying air in the vicinity of the heater is increasing by effect of thermal inertia, the rate of increase in temperature of the drying air is evaluated by the control unit.

[0007] In another embodiment of the present invention, when the heater, operating in an on-off manner under control of the thermostat, is off and while in the cooling phase after the effect of thermal inertia ends, the rate of decrease in temperature of the drying air is evaluated by the control unit.

[0008] The dryer realized in order to attain the aim of the present invention is illustrated in the attached figures, where:

Figure 1 - is the schematic view of dryer.

Figure 2 - is the graph showing changes in the heater temperature with respect to time in a dryer.

Figure 3 - is the graph showing changes in the heater temperature with respect to time, which increases due to thermal inertia in a dryer.

Figure 4 - is the graph showing changes in temperature of the heater with respect to time in the cooling phase after being de-energized in a dryer.

[0009] The elements illustrated in the figures are numbered as follows:

1. Dryer
2. Drum
3. Motor
4. Blower
5. Circulation channel
6. Heater
7. Temperature sensor
8. Control unit
9. Thermostat

[0010] The dryer (1) comprises a drum (2) wherein the laundry is emplaced, a motor (3) that actuates the drum (2) to enable its rotation, a blower (4) for circulating the air in the drying cycle, a circulation channel (5) wherein the drying air circulates, a filter for removing the fibers circulating in the drying air, a condenser for removing the moisture in the drying air, a heater (6) disposed in the circulation channel (5) for heating the drying air and a thermostat (9) for operating the heater (6) on and off and heating and cooling within a certain temperature range (Tcut-on - Tcut-off).

[0011] The dryer (1) of the present invention comprises the features of claim 1.

[0012] During the operation of the dryer (1), if at a unit of time (dt) a difference is seen by comparing the rate of temperature change (dT1/dt) detected by the temperature sensor (7) with the temperature change rates (dT/dt) recorded in memory, then the control unit (8) decides that a malfunction has occurred according to the magnitude of the difference between the detected and reference temperature change rate ((dT1/dt) - (dT/dt)) and determines which malfunction is confronted with such as locking of the motor (3), the blower (4) not rotating, clogging of the filter or the condenser that entirely prevent air flow in the drum (2), the drum (2) rotating with difficulty or dropping of voltage that partially prevent air flow in the drum (2).

[0013] In an embodiment of the present invention, the temperature sensor (7) is disposed in the vicinity of the heater (6) in the circulation channel (5) and detects the drying air temperature (T1) in the vicinity of the heater (6). If there is malfunction that prevents or limits air flow, the drying air temperature (T1) in the vicinity of the heater (6) rises rapidly since there is insufficient air flow for cooling the heater (6) and the rapid increase (dT1/dt), in the drying air temperature (T1) is detected by the temperature sensor (7) and evaluated by the control unit (8).

[0014] In another embodiment of the present invention, the temperature sensor (7) is disposed at a point farther away from the heater (6), e.g. at the exit of the drum (2) and detects the drying air temperature (T1). In this embodiment, a simple, calibrated temperature sensor (7) is used without being directly affected by the heater (6) temperature. For example, the temperature value detected by the temperature sensor (7) is multiplied by a coefficient to calculate the drying air temperature (T1).

[0015] In another embodiment of the present invention, the control unit (8) evaluates the rate of increase (dT1/dt) in the drying air temperature (T1) and compares the temperature rate of increase (dT1/dt) with the reference temperature increase rate (dT/dt) when the heater (6), operating in on and off under control of the thermostat (9), is in the on mode and while the drying air temperature (T1) in the vicinity of the heater (6) is increasing from the set low temperature (Tcut-on) to the set high temperature (Tcut-off) of the thermostat (9) for deciding whether there is malfunction that prevents or limits air flow and the type of malfunction if there is one (Figure 2).

[0016] In another embodiment of the present invention, when the heater (6), operating on and off under control of the thermostat (9), is in the off mode and while the drying air temperature (T1) in the vicinity of the heater (6) is increasing due to thermal inertia, the control unit (8) evaluates the rate of increase (dT1/dt) in the drying air temperature (T1) and compares the temperature rate of increase (dT1/dt) with reference temperature increase rate (dT/dt) for deciding whether there is malfunction that prevents or limits air flow and the type of malfunction if there is one (Figure 3).

[0017] In this embodiment, distinctive disparities are formed between the temperature increase rates (dT1/dt) of the drying air in the vicinity of the heater (6) in different types of malfunctions that prevent or limit air flow, and a malfunction that entirely prevents air flow can be easily discriminated from a malfunction that partially prevents air flow. If there is malfunction that entirely prevents air flow, when the heater (6) is in the off mode, the temperature of the drying air (T1) shows a rapid increase due to thermal inertia and takes a longer time for entering the cooling phase as well. If there is even a partial air flow over the heater (6) when the heater (6) is in the off mode, the temperature of the drying air (T1) in the vicinity of the heater (6) increases slower due to effect of thermal inertia and after a short while the temperature rise stops and cooling begins.

[0018] In another embodiment of the present invention, when the heater (6) operating on and off under control of the thermostat (9), is in the off mode and while the heater (6) is in the cooling phase after the thermal inertia effect ends, the control unit (8) evaluates the rate of decrease (dT1/dt) in drying air temperature (T1) in the vicinity of the heater (6), and compares the temperature decrease rate (dT1/dt) with the reference temperature decrease rate (dT/dt) for deciding whether there is malfunction that prevents or limits air flow and the type of malfunction if there is one (Figure 4).

[0019] In the case the drying air flow is normal, the drying air temperature (T1) in the vicinity of the heater (6) rapidly drops since the desired air flow over the heater

(6) is provided and cooling down is slower when there is a malfunction that entirely or partially obstructs air flow since there will be an insufficient air flow over the heater (6).

[0020] In the embodiments wherein the temperature sensor (7) is disposed in the vicinity of the heater (6), furthermore the temperature sensor (7) is integrated with the thermostat (9) and both operate as a single unit thereby less space is occupied. By the temperature sensor (7) - thermostat (9) unit, besides detecting the rate of increase (dT1/dt) in the drying air temperature (T1) for evaluation by the control unit (8), the heater (6) is enabled to operate on and off within a range of low temperature (Tcut-on) and high temperature (Tcut-off).

[0021] In the dryer (1), if a temporary malfunction such as dropping of voltage is detected as a result of the control unit (8) evaluating the rate of change (dT1/dt) in the drying air temperature (T1), the heater (6), when in the off mode, is not operated even if an actuating signal is received from the thermostat (9) and kept waiting for a while, and after the waiting time the heater (6) is restarted and the rate of change (dT1/dt) in the drying air temperature (T1) is evaluated, controlling whether or not the voltage drop failure is over. In case the failure continues, the motor (3) is also turned off besides the heater (6) and kept waiting for a while and afterwards the heater (6) and the motor (3) are restarted for controlling whether or not the failure is over.

[0022] In the dryer (1), if a malfunction such as jamming of the drum (2) with the laundry is detected as a result of the control unit (8) evaluating the rate of change (dT1/dt) in the drying air temperature (T1), the heater (6) is turned off for a while and during this time the motor (3) is rotated to the left and right for opening the drum (2) jam.

[0023] After waiting by turning off the heater (6) and the motor (3) or operating the motor (3) by rotating to the right and left, if the control unit (8) detects that the malfunctions are repeating as a result of evaluating the rate of change (dT1/dt) in the drying air temperature (T1), the energy delivered to all the components is cut off, the dryer (1) is changed to malfunction mode and the user is warned by elements like the follower LED flashing on and off.

[0024] In the dryer (1) of the present invention, the malfunctions encountered during operation are identified with the temperature sensor (7) disposed in the circulation channel (5) and by the control unit (8) that evaluates the data received from the temperature sensor (7) and preventive measures are taken for avoiding discoloration and damage in the laundry.

Claims

1. A dryer (1) that comprises

- a drum (2) wherein the laundry is emplaced,
- a motor (3) that actuates the drum (2) for rotating thereof,
- a blower (4) for circulating the air in the drying cycle,
- a circulation channel (5) wherein the drying air circulates,
- a heater (6) disposed in the circulation channel (5) for heating the drying air,
- a thermostat (9) for operating the heater (6) on and off and heating and cooling within a certain temperature range (Tcut-on - Tcut-off),
- a temperature sensor (7) disposed in the vicinity of the heater (6) in the circulation channel (5) that detects the temperature (T1) of the drying air (T1) in the vicinity of the heater (6), and
- a control unit (8) configured to determine the change values in temperature (T) with respect to time (t) of the drying air in normal flow and to record these in memory as a reference, (ref = temperature (T) - time (t) graph), further configured to compare the temperature change rate (dT1/dt) of the drying air detected by the temperature sensor (7) with the reference temperature change rate (dT/dt) and to decide, there is malfunction that limits air flow in the drum if the detected rate (dT1/dt) of temperature change of the drying air is different from the reference temperature change rate (dT/dt),

characterized by

the control unit (8) that is configured to evaluate the rate of increase (dT1/dt) in the drying air temperature (T1) when the heater (6), operating on and off under control of the thermostat (9), is in the off mode and while the drying air temperature (T1) in the vicinity of the heater (6) is increasing due to thermal inertia.

2. A dryer (1) as in Claim 1, **characterized by** the control unit (8) that is configured to determine which malfunction it is confronted with such as locking of the motor (3), the blower (4) not rotating, clogging of the filter or the condenser that entirely prevent air flow in the drum (2), the drum (2) rotating with difficulty or dropping of voltage that partially prevent air flow in the drum (2), according to the magnitude of the difference ((dT1/dt) - (dT/dt)) between the detected rate of temperature change and the reference temperature change rate.

3. A dryer (1) as in Claim 1 or 2, **characterized by** the control unit (8) being configured to evaluate the rate of increase (dT1/dt) in the drying air temperature (T1) when the heater (6), operating on and off under control of the thermostat (9), is in the on mode and while the drying air temperature (T1) in the vicinity of the heater (6) is increasing from the set low temperature (Tcut-on) to the set high temperature (Tcut-off) of the thermostat (9).

4. A dryer (1) as in any of Claims 1 to 3, **characterized by** the control unit (8) being configured to evaluate the rate of increase (dT1/dt) in the drying air temperature (T1) when the heater (6), operating on and off under control of the thermostat (9), is in the off mode and while the drying air temperature (T1) in the vicinity of the heater (6) is increasing due to thermal inertia.

5. A dryer (1) as in any of Claims 1 to 4, **characterized by** the control unit (8) being configured to evaluate the rate of decrease (dT1/dt) in the drying air temperature (T1) in the vicinity of the heater (6) when the heater (6), operating on and off under control of the thermostat (9), is in the off mode and while the heater (6) is in the cooling phase after the effect of thermal inertia ends.

Patentansprüche

1. Trockner (1), der Folgendes umfasst

   - eine Trommel (2), in die die Wäsche gegeben wird,
   - einen Motor (3), der die Trommel (2) betätigt, um sie zu drehen,
   - ein Gebläse (4) zum Zirkulieren der Luft im Trocknungszyklus,
   - einen Zirkulationskanal (5), in dem die Trocknungsluft zirkuliert,
   - eine Heizeinrichtung (6), die im Zirkulationskanal (5) angeordnet ist, um die Trocknungsluft zu erwärmen,
   - ein Thermostat (9) zum Aktivieren und Deaktivieren der Heizeinrichtung (6) und zum Erwärmen und Kühlen innerhalb eines bestimmten Temperaturbereichs (Tcut-on - Tcut-off),
   - einen Temperatursensor (7), der in der Nähe der Heizeinrichtung (6) im Zirkulationskanal (5) angeordnet ist und die Temperatur (T1) der Trocknungsluft (T1) in der Nähe der Heizeinrichtung (6) misst, und
   - eine Steuereinheit (8), die dazu konfiguriert ist, die Änderungswerte der Temperatur (T) der Trocknungsluft in Bezug auf die Zeit (t) bei normaler Strömung zu bestimmen und diese als Referenz (ref = Temperatur (T) - Zeit (t) Graph) im Speicher aufzuzeichnen, ferner dazu konfiguriert ist, die vom Temperatursensor (7) gemessene Temperaturänderungsrate (dT1/dt) der Trocknungsluft mit der Referenztemperaturänderungsrate (dT/dt) zu vergleichen und zu entscheiden, dass eine Störung vorliegt, die die Luftströmung in der Trommel einschränkt, wenn die gemessene Rate (dT1/dt) der Temperaturänderung der Trocknungsluft sich von der Referenztemperaturänderungsrate (dT/dt) unterscheidet,

   dadurch gekennzeichnet, dass
   die Steuereinheit (8) dazu konfiguriert ist, die Anstiegsrate (dT1/dt) der Trocknungslufttemperatur (T1) zu beurteilen, wenn die Heizeinrichtung (6), die unter Steuerung des Thermostat (9) aktiviert und deaktiviert wird, im deaktivierten Zustand ist, und während die Trocknungslufttemperatur (T1) in der Nähe der Heizeinrichtung (6) aufgrund von Wärmeträgheit ansteigt.

2. Trockner (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Steuereinheit (8) dazu konfiguriert ist, anhand der Größe der Differenz ((dT1/dt) - (dT/dt)) zwischen der gemessenen Rate der Temperaturänderung und der Referenztemperaturänderungsrate zu bestimmen, mit welcher Störung sie konfrontiert wird, etwa einem Blockieren des Motor (3), einem nicht drehenden Gebläse (4), einer Verstopfung des Filters oder des Kondensators, die einen Luftstrom in der Trommel (2) vollständig verhindert, Schwierigkeiten beim Drehen der Trommel (2) oder Abfall der Spannung, die den Luftstrom in der Trommel (2) teilweise verhindern.

3. Trockner (1) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Steuereinheit (8) dazu konfiguriert ist, die Anstiegsrate (dT1/dt) der Trocknungslufttemperatur (T1) zu beurteilen, wenn die Heizeinrichtung (6), die unter Steuerung des Thermostat (9) aktiviert und deaktiviert wird, im aktivierten Zustand ist, und während die Trocknungslufttemperatur (T1) in der Nähe der Heizeinrichtung (6) von der eingestellten niedrigen Temperatur (Tcut-on) zur eingestellten hohen Temperatur (Tcut-off) des Thermostats (9) ansteigt.

4. Trockner (1) nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Steuereinheit (8) dazu konfiguriert ist, die Anstiegsrate (dT1/dt) der Trocknungslufttemperatur (T1) zu beurteilen, wenn die Heizeinrichtung (6), die unter Steuerung des Thermostat (9) aktiviert und deaktiviert wird, im deaktivierten Zustand ist, und während die Trocknungslufttemperatur (T1) in der Nähe der Heizeinrichtung (6) aufgrund von Wärmeträgheit ansteigt.

5. Trockner (1) nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Steuereinheit (8) dazu konfiguriert ist, die Abnahmerate (dT1/dt) der Trocknungslufttemperatur (T1) in der Nähe der Heizeinrichtung (6) zu beurteilen, wenn die Heizeinrichtung (6), die unter Steuerung des Thermostat (9) aktiviert und deaktiviert wird, im deaktivierten Zustand ist, und während die Heizeinrichtung (6) sich nach dem Ende der Wirkung der Wärmeträgheit in der Kühlphase befindet.

Revendications

1. Un sèche-linge (1) qui comprend

- un tambour (2) dans lequel le linge est placé
- un moteur (3) qui actionne et tourne le tambour (2)
- un ventilateur (4) pour circuler l'air dans le cycle de séchage,
- un canal de circulation (5) dans lequel l'air de séchage circule,
- un dispositif de chauffage (6) qui est disposé dans le canal de circulation (5) pour chauffer l'air de séchage,
- un thermostat (9) pour allumer et éteindre le dispositif de chauffage (6) et pour chauffer et refroidir dans une certaine plage de température (Tcut-on - Tcut-off),
- un capteur de température (7) qui est disposé à proximité du dispositif de chauffage (6) dans le canal de circulation (5) et qui détecte la température (T1) de l'air de séchage (T1) à proximité du dispositif de chauffage (6), et
- une unité de commande (8) qui détermine les valeurs de variation par rapport au temps (t) dans la température (T) de l'air de séchage dans un écoulement normal et qui les enregistre dans sa mémoire comme référence (ref = graphique température (T) - temps (t)), et en outre qui compare le taux de variation de température (dT1/dt) de l'air de séchage détecté par le capteur de température (7) avec le taux de variation de température de référence (dT/dt) et qui décide qu'il y a un dysfonctionnement qui limite l'écoulement d'air dans le tambour si le taux détecté (dT1/dt) de variation de température de l'air de séchage est différent du taux de variation de température de référence (dT/dt),

caractérisé par
l'unité de commande (8) qui évalue le taux d'augmentation (dT1/dt) dans la température de l'air de séchage (T1) lorsque le dispositif de chauffage (6), qui est allumé et éteint sous la commande du thermostat (9), est dans le mode arrêt et lorsque la température de fair de séchage (T1) à proximité du dispositif de chauffage (6) augmente en raison de l'inertie thermique.

2. Un sèche-linge (1) selon la Revendication 1, **caractérisé par** l'unité de commande (8) qui détermine de quel dysfonctionnement il s'agit comme le blocage du moteur (3), le ventilateur (4) non tournant, l'encrassement du filtre ou du condenseur qui empêchent complètement l'écoulement de l'air dans le tambour (2), le tambour (2) tournant avec difficulté ou la baisse de tension qui empêchement partiellement l'écoulement de l'air dans le tambour (2), en fonction de l'ampleur de la différence ((dT1/dt) - (dT/dt)) entre le taux détecté de variation de température et le taux de variation de température de référence.

3. Un sèche-linge (1) selon la Revendication 1 ou 2, **caractérisé par** l'unité de commande (8) qui évalue le taux d'augmentation (dT1/dt) dans la température de l'air de séchage (T1) lorsque le dispositif de chauffage (6), qui est allumé et éteint sous la commande du thermostat (9), est dans le mode de marche et lorsque la température de l'air de séchage (T1) à proximité du dispositif de chauffage (6) augmente à partir de la température de réglage bas (Tcut-on) à la température de réglage haut (Tcut-off) du thermostat (9).

4. Un sèche-linge (1) selon l'une quelconque des revendications de 1 à 3, **caractérisé par** l'unité de commande (8) qui évalue le taux d'augmentation (dT1/dt) dans la température de l'air de séchage (T1) lorsque le dispositif de chauffage (6), qui est allumé et éteint sous la commande du thermostat (9), est dans le mode arrêt et lorsque la température de l'air de séchage (T1) à proximité du dispositif de chauffage (6) augmente en raison de finertie thermique.

5. Un sèche-linge (1) selon l'une quelconque des revendications de 1 à 4, **caractérisé par** l'unité de commande (8) qui évalue le taux de diminution (dT1/dt) dans la température de l'air de séchage (T1) à proximité du dispositif de chauffage (6) lorsque le dispositif de chauffage (6), qui est allumé et éteint sous la commande du thermostat (9), est dans le mode arrêt et lorsque le dispositif de chauffage (6) est dans la phase de refroidissement après que l'effet de l'inertie thermique se termine.

Figure 1

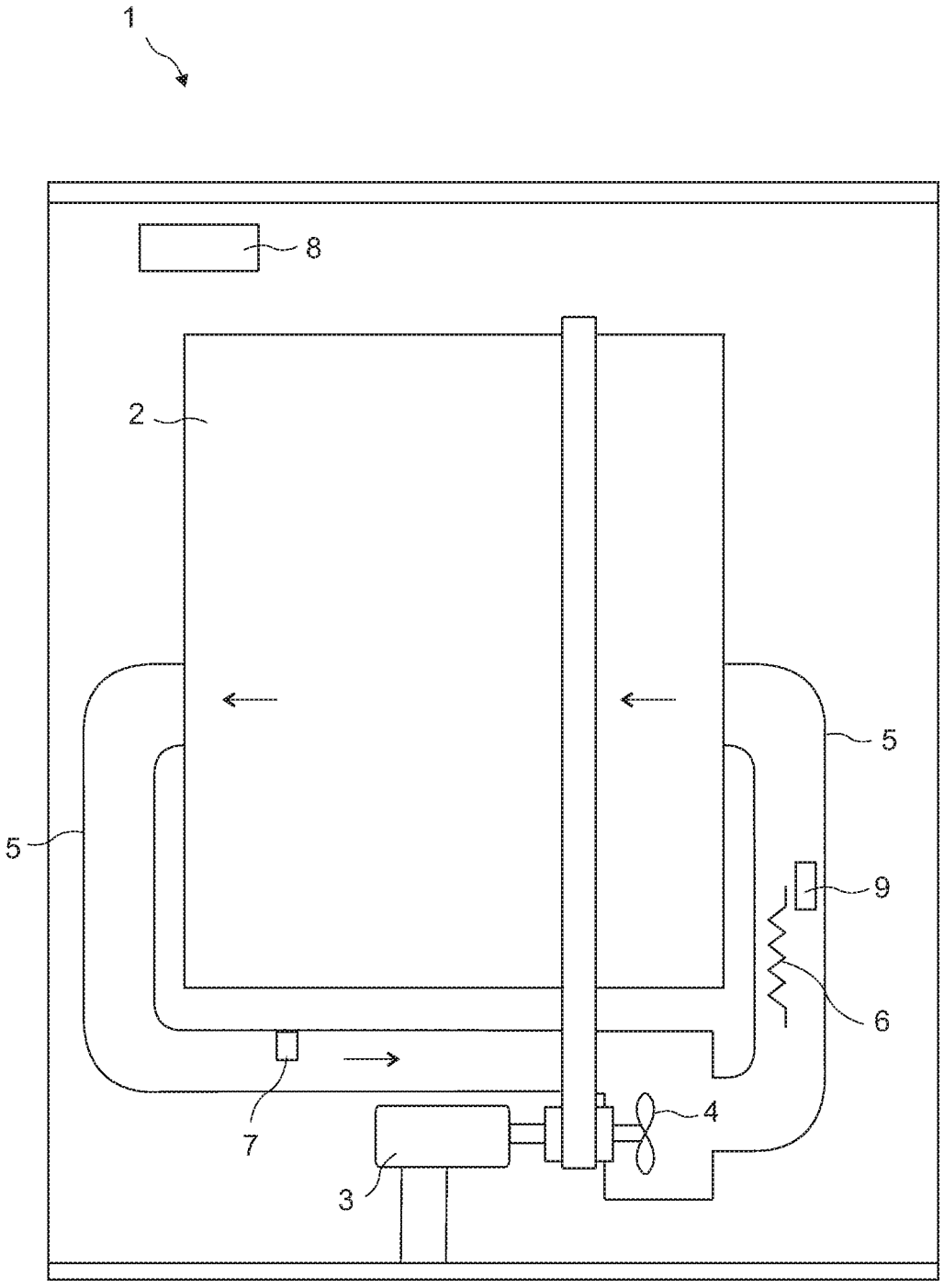


Figure 2

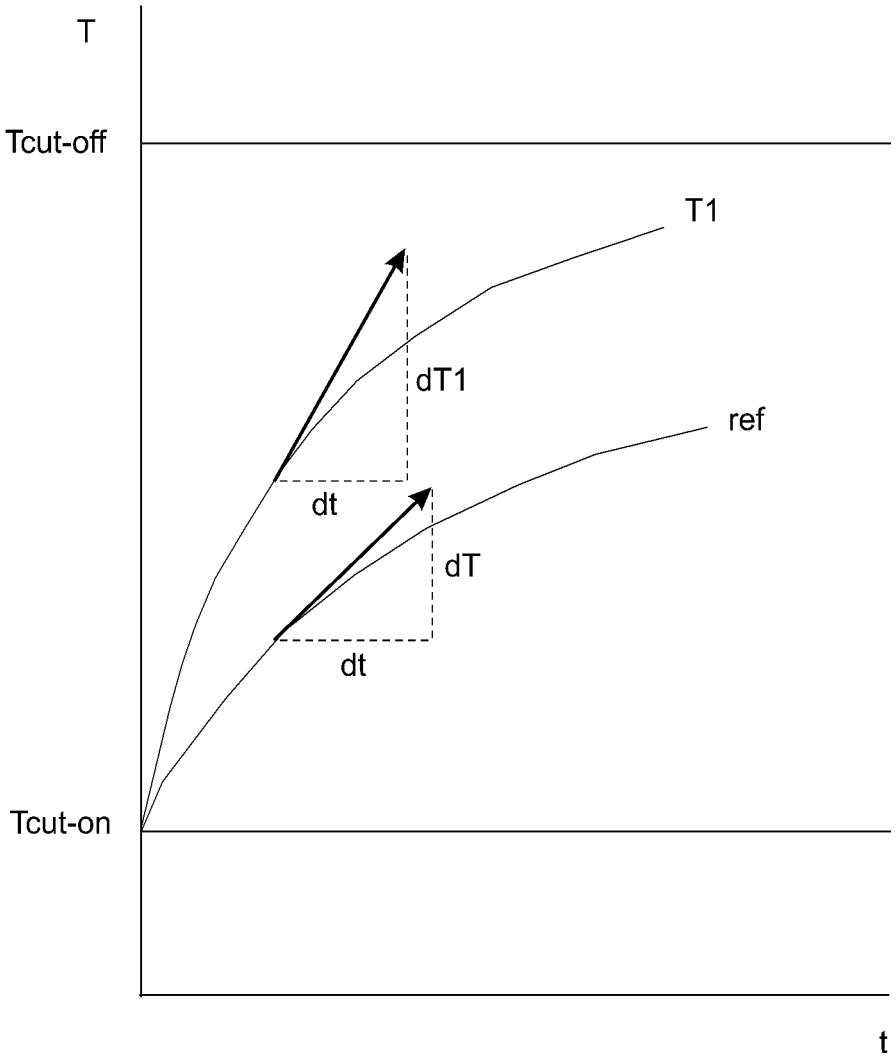


Figure 3

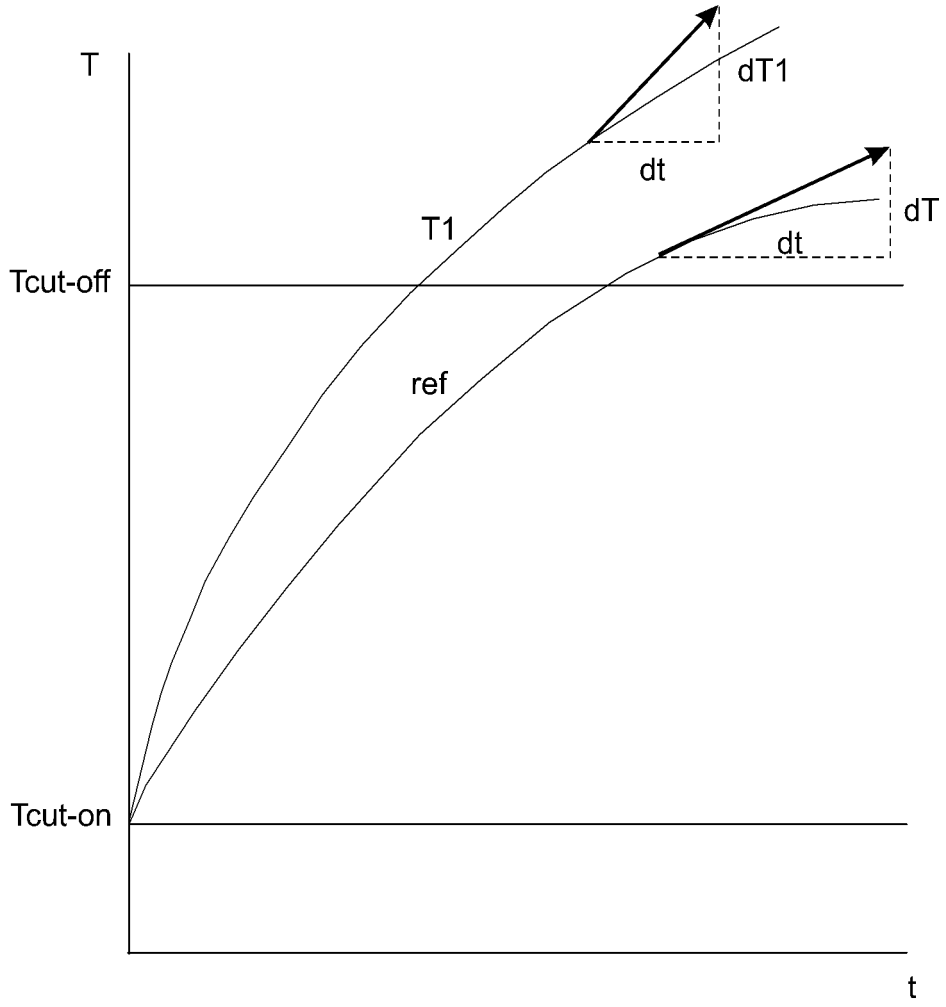
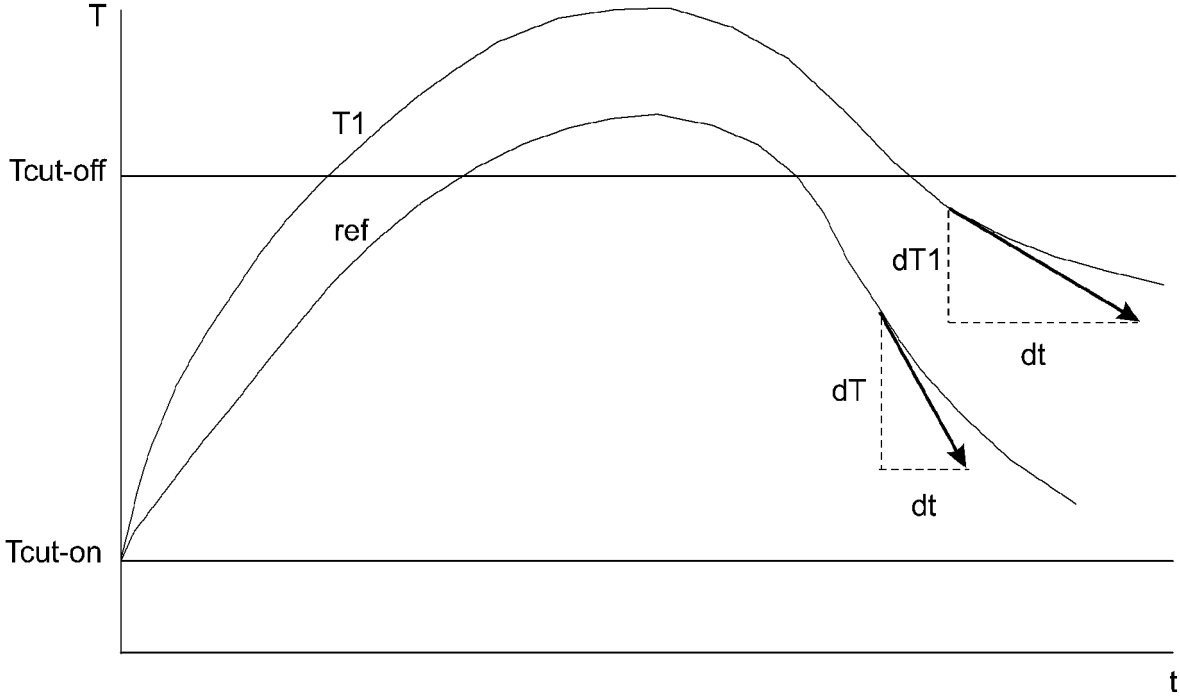


Figure 4



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 0312072 A **[0005]**
- US 6158148 A **[0005]**