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

(11) EP 2 927 366 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.10.2015 Bulletin 2015/41

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

(21) Application number: **14162965.9**

(22) Date of filing: **31.03.2014**

(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

(71) Applicant: **Electrolux Appliances Aktiebolag**
105 45 Stockholm (SE)

(72) Inventor: **Driussi, Paolo**
33080 Porcia (PN) (IT)

(74) Representative: **Petruccelli, Davide et al**
Electrolux Italia S.p.A.
Corso Lino Zanussi 30
33080 Porcia (PN) (IT)

(54) **Laundry treatment apparatus and method of operation**

(57) Method of correcting an estimation of an apparatus operation value for a laundry treatment apparatus (2), in particular a laundry dryer or a washing machine having a drying function, wherein the apparatus (2) comprises: a laundry treatment chamber (18) for treating laundry, a heat pump system (4) comprising a first heat exchanger (10) for heating a refrigerant, a second heat exchanger (12) for cooling a refrigerant, an expansion means (16) and a compressor (14) for circulating a refrigerant fluid (R) through a refrigerant loop (6) of the heat pump system (4), a detector means for detecting at least one operation parameter of the treatment apparatus (2), a control unit (9) for controlling the operation of the treatment apparatus (2), wherein the control unit (9) is adapted to determine an initial estimation of an apparatus operation value based on at least one detected operation parameter, and wherein the control unit is adapted to execute an algorithm for correcting the initial estimation of an apparatus operation value and/or for correcting a current apparatus operation value based on at least one detected operation parameter, a data storage means (34) for storing an estimated operation value, wherein the method comprises: estimate an initial operation value and/or a current operation value, subsequently estimate a present operation value by executing the algorithm during an apparatus operation cycle, and correct the initial operation value and/or a current operation value to or by using the estimated present operation value.

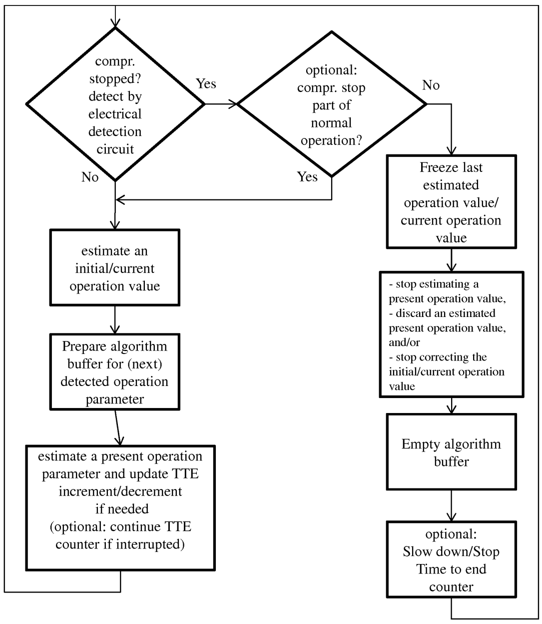

Fig. 3a

EP 2 927 366 A1

Description

[0001] The invention relates to a method of operating a laundry treatment apparatus, in particular a laundry dryer or a washing machine having a drying function, and relates to a laundry treatment apparatus.

[0002] US 6,941,674 B2 discloses a method for detecting a residual drying time of a clothes dryer. When a user starts a drying operation of the dryer, a preset clothes drying time is displayed on a display and a countdown of the preset time is started. After a predetermined time, the residual humidity of the clothes is detected with a humidity detector having two electrodes arranged in the dryer drum. Additionally the temperature of process air at the drum outlet is detected. A controller is adapted to calculate a load of the dryer by using the detected moisture and temperature values. An estimated drying time is determined from a look-up table in dependency of the calculated laundry load. The countdown of the preset drying time is replaced by a countdown of the estimated drying time.

[0003] EP 2 679 718 A1 discloses a method for operating a laundry apparatus comprising a heat pump system. A passive switching device comprising a thermo protector circuit is provided for a compressor of the heat pump system. The thermo protector circuit is activated or opened when a predetermined temperature, voltage or current is exceeded, such that the compressor is switched-off. The passive switching device is not controllable by a control unit of the laundry apparatus. A monitoring means is provided to detect whether the thermo protector circuit is activated or open.

[0004] It is an object of the invention to provide an improved method of operating a laundry treatment apparatus and an improved treatment apparatus adapted to execute the method.

[0005] The invention is defined in claims 1 and 11, respectively. Particular embodiments are set out in the dependent claims.

[0006] According to claim 1, a method of correcting an estimation of an apparatus operation value for a laundry treatment apparatus, in particular a laundry dryer or a washing machine having a drying function, is provided. The treatment apparatus comprises a laundry treatment chamber or drum for treating laundry, and a heat pump system comprising a first heat exchanger for heating a refrigerant, a second heat exchanger for cooling a refrigerant, an expansion means and a compressor for circulating a refrigerant fluid through a refrigerant loop of the heat pump system.

[0007] A detector means is provided to detect at least one operation parameter of the treatment apparatus. For example an operation parameter may be selected from: a power consumption of the compressor motor, a motor for rotating the treatment chamber, a fan motor and/or the total power consumption of the treatment apparatus, a driving torque of a motor for rotating the treatment chamber, a temperature of drying air entering and/or leaving the treatment chamber, a refrigerant temperature, motor speed, and an electrical parameter of a motor such as current, voltage, phase, or parameters derived therefrom, in particular a drum torque. With respect to the term 'operation parameter' it is pointed out that it refers to actual parameters which change during the course of an apparatus operation cycle (drying cycle). In particular a user selection, e.g. of a specific program cycle, is not regarded as an operation parameter as described above.

[0008] A control unit is provided to control the operation of the treatment apparatus, wherein the control unit is adapted to determine an initial estimation of an apparatus operation value based on at least one detected operation parameter. 'Initial' refers to an estimation before, at or immediately or in a short period (with respect to the total drying time) after the beginning or start of a drying cycle. Further, the control unit is adapted to execute an algorithm for correcting the initial estimation of an apparatus operation value based on at least one detected operation parameter. The apparatus comprises a data storage means or a data buffer for storing estimated operation values.

[0009] The estimated operation value may be selected from at least one of the following: an operation cycle time-to-end value (TTE) or residual drying time value, a residual humidity value, a latent power, a laundry load and a process airflow amount. Each of the apparatus operation values may be derived from calculations depending on one or more of the above mentioned operation parameters. For example the estimation of an initial apparatus operation value may be determined by executing the above mentioned algorithm. Preferably, an estimated operation value corresponds to a condition of a (running) operation cycle or a condition of the laundry to be dried, wherein the estimated apparatus operation value may be used to determine whether a condition is satisfied for considering a drying cycle to be completed, e.g. to determine a residual drying time.

[0010] Latent power is the power necessary to evaporate the laundry water, i.e. to dry the laundry. Latent power is directly proportional to a drying rate and can therefore be used in place of the drying rate to determine an end of a drying cycle. By estimating the latent power in the dryer, the condition (i.e. the threshold) for ending the drying cycle may be determined. In general, the latent power can be estimated by computing a flow energy balance that considers all the energy flows across a closed volume. In particular, the latent power of an apparatus may be a function of air temperature at the drum inlet and outlet, drum speed, drum torque, air fan speed and it depends on the structure/operation of the appliance (i.e. the geometry, the materials etc.). Alternatively the latent power may be a function of air temperature at the drum inlet and outlet, the compressor power consumption during the system operation, air fan speed and it depends on the structure/operation of the appliance (i.e. the geometry, the materials etc.).

[0011] Due to the specific architecture of some dryers (for example in the washer-dryers), it becomes quite complex/expensive to use a dedicated sensor (e.g. a humidity sensor) to determine an operation parameter, e.g. residual laundry humidity. In case of determining the residual humidity of the laundry, the residual humidity may be estimated by monitoring other signals already available in the machine. For example the air temperatures measured in some specific points of the drying circuit, e.g. at the drum input or at the condenser input.

[0012] Additionally or alternatively the control unit is adapted to determine a current operation value, i.e. an actual operation value of the currently or presently running drying cycle. An initial operation value may be determined differently to determining a current operation value. For example a current operation value may be determined from a look-up table which discloses the progress (e.g. decrease) of a respective operation value over time, starting from an estimated initial operation value. For example when a current residual humidity value is to be determined as the current apparatus operation value, the control unit may be adapted to determine the current residual humidity from a look-up table which discloses the decrease of the residual humidity over time (starting from an estimated operation value as described above), such that the respective current residual humidity value may be determined by monitoring the elapsed time and reading the corresponding humidity value from the look-up table. Alternatively a current operation value may be determined by executing the above algorithm.

[0013] The method of correcting an apparatus operation value comprises the steps: estimate an initial operation value and/or a current operation value as described above, subsequently estimate a present operation value by executing the algorithm during an apparatus operation cycle, and correct or update the initial operation value and/or the current operation value to the estimated present operation value. The method provides two options for correcting:

(i) the estimated initial operation value (i.e. a value at a starting point) may be corrected during a drying cycle, and additionally or alternatively
(ii) a current operation value may be corrected.

[0014] With respect to the first option (i), for example the value of the initial residual humidity (initial operation value) is corrected, such that e.g. the control unit determines a present residual humidity based on a different look-up table. With respect to option (ii), for example a current operation value like the current residual drying time (i.e. the actual value) is corrected to the estimated present operation value, e.g. a residual drying time countdown is reset to the estimated present residual drying time.

[0015] The above described method provides that an estimated (initial) operation value is corrected during an apparatus operation cycle. In particular the correction of an estimated apparatus operation value may be executed repeatedly during an operation cycle. Thus an estimation of an apparatus operation parameter is (repeatedly) corrected during apparatus operation, such that an apparatus operation value is determined more precisely, for example an estimation of an operation cycle end or the estimation of a condition which indicates an operation cycle end (e.g. estimated residual humidity e.g. as selected by a user) is determined more precisely. The above method provides an improved method of operating a treatment apparatus as it is prevented that a drying process is stopped too early or too late, which would cause the laundry mass to be still wet or even damaged because of over-drying.

[0016] Preferably an estimation of a present operation value and correction of the initial/current operation value is executed continuously or repeatedly during an apparatus operation cycle. For example an estimation of a present operation value and correction of the initial/current operation value is executed at least three times during an apparatus operation cycle, e.g. every 1 to 5 min. Thereby an estimated operation value is repeatedly adapted to actual operating condition of the treatment apparatus, which is represented by the at least one detected operating parameter.

[0017] According to a preferred embodiment correcting or updating of the initial/current operation value to the present operation value is executed in incremental steps. I.e. the initial/current operation value is gradually adapted to the present operation value in small steps over time, such that a 'jump' of the initial/current operation value is prevented. For example, when a first estimated present operation value is higher than an estimated initial operation value, the initial operation value is increased over time in small steps or increments to the first present operation value. While the initial operation value is increased in increments, a subsequent second estimation of a present operation value may be executed. The second estimated present operation value either verifies the first present operation value, such that the initial value is further increased in increments. Alternatively the second estimation shows that the second present operation value is not as high as the previously determined first present operation value, such that the incremental increase of the initial operation value is stopped or corrected towards the lower second present operation value.

[0018] In an embodiment the incremental correction of the initial operation value and/or a current operation value is made by adding a fraction of the difference between the estimated present operation value and the initial operation value and/or current operation value to the initial operation value and/or current operation value as the increment. For example, if the estimated current operation value is A_{n-1} (from previous correction algorithm run), the estimated present operation value is B (from the running correction algorithm) and the fraction is F, the corrected current operation value An = A_{n-1} + (B- A_{n-1})/F; with n is the number of times the correction algorithm is executed.

The fraction F is > 1, for example F ≥ 5, 8, 10, 15 or 20.

[0019] Preferably the at least one detected operation parameter depends on compressor switch-on-time. For example when the compressor is switched-off, the refrigerant temperature decreases and the temperature of process air entering/leaving the drum decreases, or the latent power of the apparatus decreases, such that the at least one detected operation parameter may be a refrigerant temperature, a process air temperature and/or latent power of the apparatus or any other parameter depending on compressor switch-on-time. The treatment apparatus further comprises a compressor monitoring means adapted to determine whether the compressor is switched-on or switched-off. The method comprises carrying out at least one of the following steps when determining that the compressor is switched-off: stop estimating a present operation value, discard an estimated present operation value, stop correcting the initial/current operation value, and/or maintain a current operation value.

[0020] When the compressor is switched-off a drying operation is interrupted, as the heat pump system does not generate heat for drying the laundry. When trying to determine or estimate a present operation value depending on operation parameters depending on compressor switch-on time, this would lead to a wrong or incorrect estimation of the operation value. To avoid an incorrect estimation, the estimation of an operation value is stopped, the correction of an initial/current operation value is stopped or an estimated present operation value is discarded, when the compressor is switched-off.

[0021] Preferably the apparatus comprises at least one passive switching device not controllable by the control unit. The passive switching device includes a thermo protector circuit adapted to cut the power supply to the compressor when a predetermined temperature threshold, a voltage load threshold and/or a current threshold are/is exceeded, For example a thermal overload protection is provided for the compressor. The at least one passive switching device prevents a damage of the compressor due to too high current/voltage values and/or overheating. When the passive switching device is in an open state the compressor is not powered or switched-off. The at least one passive switching device has to be in a closed state to provide that the compressor is powered or switched-on (provided that any other (active) switching device, which may be provided to controllable switch the compressor on/off, is also switched-on or in a closed state).

[0022] The apparatus comprises a monitoring means to detect whether the thermo protector circuit is opened or closed. When monitoring that the thermo protector circuit is opened at least one of the following steps is carried out: stop estimating a present operation value, discard an estimated present operation value, stop correcting the initial/current operation value, and/or maintain current operation value. This embodiment is directed to the case where the compressor operation is interrupted due to an activated or opened thermo protector circuit, e.g. a thermo switch is opened due to an increase of refrigerant temperature. To prevent incorrect estimation of an operation value, the estimation of a present operation value may be stopped or estimated present operation values may be discarded.

[0023] Preferably the monitoring means includes at least one of the following: a system for monitoring the temperature of the refrigerant; a sensing circuit to detect a change of potential and/or current at an assembly comprising the compressor and the thermo protector circuit. For example the following two different ways of detecting the activation of the thermo protector circuit may be implemented: the first one includes monitoring the temperature of the refrigerant by means of temperature sensors; the second one includes monitoring the electric assembly comprising the compressor and the thermo protector circuit by means of dedicated sensing circuits. For example the temperature may be measured at the outlet of the second heat exchanger and/or at the inlet of the expansion means.

[0024] Preferably, the system for monitoring the temperature of the refrigerant comprises the control unit and at least a sensor adapted to measure the temperature of the refrigerant at a predetermined position of the heat pump system and to convey the information to the control unit. The control unit is able to recognize the opening of the thermo protector circuit when the temperature of the refrigerant reaches or decrease below a predetermined value and an active switching device is switched-on for the compressor. Preferred the system for monitoring the temperature of the refrigerant is adapted to maintain in a data storage a reference parameter for an expected temperature measured in a predetermined position of the heat pump system, monitor temperature values detected by the sensor, responsive to an anomaly of the monitored values with respect to the at least one reference parameter, and determining the activation of the thermo protector circuit.

[0025] The reference parameter may include a predetermined threshold in the variation in the gradient of a curve representing the values of monitored temperature over time, wherein the step of determining an anomaly includes the steps of: building a curve with the detected values of temperature over time; measuring the gradient of the curve at regular time intervals; comparing successive measured gradients for determining if the difference exceeds the predetermined threshold. Preferably, the step of determining the existence of an anomaly includes filtering the curve with a low-pass numeric filter.

[0026] Preferred, the sensing circuit comprises at least an electrical detecting circuit connected to at least one of the following: a connection point located between the thermo protector circuit and the compressor; a connection point located between the thermo protector circuit and the line or the neutral of the power mains to which the compressor is connected; a connection point located between the compressor and the line or the neutral of the power mains to which the compressor is connected.

[0027] Preferably, the compressor is connected in series with the thermo protector circuit, the assembly formed by the compressor and the thermo protector circuit being connected to a power main, wherein the sensing circuit comprises: the control unit, connected to the at least first active switching device; at least a first electrical detecting circuit connected to a connection point between the thermo protector circuit and the compressor, on one hand, and to the control unit, on the other hand; the control unit evaluating the output of the at least first electrical detecting circuit in accordance with the active switching device being in deactivated (opened) or activated (closed) condition, in order to evaluate the status of thermo protector circuit.

[0028] According to a preferred embodiment, the compressor and/or the thermo protector circuit is electrically connected to the active switching device, the control unit detecting the output of the detecting circuit when the active switching device is open and closed.

[0029] Preferably, the control unit is also connected to a connection point located between the compressor and the active switching device or located between the thermo protector circuit and the active switching device, through a second detecting circuit.

[0030] The compressor may be connected in series with the thermo protector circuit, the assembly formed by the compressor and the thermo protector circuit being connected to a power main, and wherein the sensing circuit comprises: the control unit connected to the active switching device; a shunt evaluation electrical circuit, connected to a shunt device, placed in series to the assembly formed by the compressor and the thermo protector circuit, so as to monitor the current flowing in the shunt device, the control unit evaluating the output of the shunt evaluation electrical circuit, in accordance with the active switching device being switched-on for the compressor, in order to evaluate the status of the thermo protector circuit. Preferably, the shunt device is placed between at least one of the following: compressor and line or neutral of the power mains; thermo protector circuit and active switching device; compressor and active switching device; thermo protector circuit and line or neutral of the power mains; compressor and thermo protector circuit.

[0031] Estimating a present operation value and correcting an initial/current operation value may be (re)started when monitoring that the compressor is switched-on and/or when monitoring that the thermo protector circuit is closed. I.e. when the compressor is re-started, the interrupted (normal or previous) operation cycle is continued, such that an estimation and correction of the operation value may be resumed.

[0032] According to a preferred embodiment a (re)start of estimating a present operation value and correcting an initial/current operation value is delayed for a predetermined time after monitoring that the compressor is switched-on and/or after monitoring that the thermo protector circuit is closed. This is useful to avoid acquiring operating parameters before a reasonable stabilization of the compressor and the heat-pump system working conditions are fully re-established. For example a delay of 2 min. to 5 min. may be implemented. Preferably the apparatus comprises a timer means for counting down a residual drying time, wherein the estimated apparatus operation value is a residual drying time or cycle time-to-end (TTE). The method comprises the following steps: estimate an initial residual drying time, store the estimated initial residual drying time, start countdown from the initial residual drying time, detect the at least one operation parameter during an apparatus operation cycle and execute the algorithm to determine a present residual drying time and correct the countdown of the initial residual drying time to the present residual drying time. When monitoring that the compressor is switched-off and/or the thermo protector circuit is opened, as outlined above, at least one of the following steps is carried out: stop countdown of the residual drying time and store current residual drying time value, stop executing the algorithm, discard the at least one detected operation parameter, and/or discard the determined present residual drying time.

[0033] In particular, a residual humidity value may be measured indirectly from any of mentioned operation parameters. For example the higher a torque of the drum motor the higher the laundry weight, i.e. the higher the residual laundry humidity. Furthermore, a residual drying time value may be derived from a determined or estimated residual humidity value. In particular an indirect measurement or estimation of a residual humidity value is useful for a washing machine having a dryer function (washer-dryer). In this case a drum arranged in a tub is provided. A direct measurement of the laundry humidity via electrodes which are arranged at the drum would be error-prone, as the electrodes are exposed to washing water during a washing cycle. For example washing water or detergent on the electrodes could deteriorate the humidity detectors measuring accuracy.

[0034] According to a preferred embodiment a laundry treatment apparatus is provided as described above, wherein a control unit of the treatment apparatus is adapted to control the apparatus operation according to the above described method. As described above the apparatus comprises at least one passive switching device which is not controllable by the control unit. The passive switching device includes a thermo protector circuit adapted to cut the power supply to the compressor when a predetermined temperature threshold, a voltage load threshold and/or a current threshold are/is exceeded, wherein when the passive switching device is in an open state the compressor is not powered. A monitoring means is provided to detect whether the thermo protector circuit is opened or closed, i.e. to detect whether the compressor is powered or not powered. The compressor is connected in series with the thermo protector circuit, wherein an assembly formed by the compressor and the thermo protector circuit is connected to a power main. The monitoring means comprises a sensing circuit to detect a change of potential and/or current at the assembly, wherein the sensing circuit comprises: (i) the control unit, connected to the active switching device which is located on the line or the neutral of the power mains to which the compressor is connected; and (ii) an electrical detecting circuit connected to a connection point located between the thermo protector circuit and the active switching device, on the one hand, and to the control unit, on the other hand.

[0035] With the above described monitoring circuit the control unit is adapted to evaluate the output of the electrical detecting circuit with the active switching device being switched-off in order to evaluate the status of thermo protector circuit.

[0036] In the following another inventive aspect is described which can be combined with the above method and apparatus for correcting (updating) an apparatus operation value - or can be applied individually independent thereof. Then the above aspects or features are applicable in part or in any arbitrary combination with the following another aspect. This aspect is represented in the following method, embodiments thereof, apparatus and embodiments thereof which mutually can be combined partially of in features with each other.

[0037] According to this aspect a method of determining or identifying the kind of operation problem occurring during an operation of a laundry treatment apparatus is provided. Unless otherwise mentioned, method steps and apparatus features described below correspond to above described method steps and apparatus features. The treatment apparatus, in particular a laundry dryer or a washing machine having a drying function, comprises: a control unit controlling the operation of the treatment apparatus, a laundry treatment chamber for treating laundry, a heat pump system comprising a first heat exchanger for heating a refrigerant, a second heat exchanger for cooling a refrigerant, an expansion means and a compressor for circulating a refrigerant fluid through a refrigerant loop of the heat pump system, at least one active switching device controllable by the control unit for selectively switching on/off the compressor, at least one passive switching device not controllable by the control unit, the passive switching device including a thermo protector circuit adapted to cut the power supply to the compressor when a predetermined temperature threshold, a voltage load threshold and/or a current threshold are/is exceeded, wherein when the passive switching device is in an open state the compressor is not powered, and a monitoring means to detect whether the thermo protector circuit is opened or closed, wherein the monitoring means includes: a system for monitoring the temperature of the refrigerant, and a sensing circuit to detect a change of potential and/or current at an assembly comprising the compressor and the thermo protector circuit.

[0038] The method of determining or identifying the kind of operation problem occurring during an operation of a laundry treatment apparatus comprises the following steps:

(i) continuously or repeatedly monitor the refrigerant temperature during a drying cycle,

(ii) when monitoring a decrease of refrigerant temperature while the thermo protector circuit is closed and/or while the sensing circuit detects a predetermined operating voltage and/or current, open the at least one active switching device,

(iii) when monitoring a decrease of refrigerant temperature while the thermo protector circuit is open and/or while the sensing circuit does not detect a predetermined operating voltage and/or current, open the at least one active switching device until:

> (iiia) monitoring that the thermo protector circuit is closed and/or the sensing circuit does detect a predetermined operating voltage and/or current, and/or
>
> (iiib) a predetermined recovery time of the at least one passive switching device is elapsed, and

(iv) when monitoring that the thermo protector circuit is opened and/or the sensing circuit does not detect a predetermined operating voltage and/or current after elapse of the predetermined recovery time, stop the apparatus operation cycle and/or deactivate the treatment apparatus.

[0039] The monitoring means to detect whether the thermo protector circuit is opened or closed may be any of the above or below described circuits.

[0040] As outlined above, when monitoring a drop of the refrigerant temperature, the control unit is adapted to switch-off the at least one active switching device as the temperature drop signals a possible operation problem. In particular, the switching-off of the active switching device is a consequent act after the refrigerant drop has been detected. When additionally the sensing circuit is sensing a predetermined (i.e. correct) operating voltage, that means that the compressor operates correct (thermo protector circuit closed) and the drop of the capillary temperature may be caused by a different reason, for example by a leakage on the refrigeration circuit.

[0041] In the other case, when sensing a refrigerant temperature decrease and additionally the sensing circuit returns or senses a null voltage, this means that a fault on the compressor circuit has occurred. For example the thermo protector circuit is open, a wiring is broken or defect, or the compressor is defective (e.g. compressor gripped).

[0042] When the thermo protector circuit has been activated or opened, the thermo protector circuit is adapted to recover its closed state after a predetermined recovery time time, which may be about 10 to 20 min. As described above when sensing that the thermo protector circuit is closed and/or when the sensing circuit detects a predetermined operating voltage and/or current, the at least one active switching device is closed, such that the compressor is powered.

[0043] When a permanent fault such as a broken electrical motor wire occurs, the fault remains after the predetermined recovery time of the thermo protector circuit. Thus when the predetermined recovery time elapses without the sensing device sensing a predetermined operating voltage/current, a wiring problem or a defective compressor is identified.

[0044] Preferably the above method comprises additionally the following steps: when the sensing circuit detects a predetermined operating voltage and/or current, the at least one active switching device is switched-on, and when the sensing circuit does not detect a predetermined operating voltage and/or current after a predetermined recovery time of the at least one passive switching device is elapsed, the drying cycle is stopped and/or the treatment apparatus is deactivated/switched-off.

[0045] Preferably the above method comprises additionally or alternatively the following steps: when the sensing circuit does not detect a voltage/current after a predetermined recovery time of the at least one passive switching device is elapsed, or when monitoring that the thermo protector circuit is opened after elapse of the predetermined recovery time, a corresponding error message is memorized in a memory of the control unit and/or displayed in a display of the treatment apparatus. With this feature the kind of error or fault of the treatment apparatus is conveniently identifiable for a user.

[0046] Preferably the above method of determining or identifying the kind of operation problem occurring during an operation of a laundry treatment apparatus comprises additionally or alternatively the following steps: wherein after the sensing circuit detects a predetermined operating voltage/current and the at least one active switching device is switched-on (i.e. the switch is closed), the estimation to determine a present operation value and to correct an initial/current operation value as described above is restarted.

[0047] Reference is made in detail to preferred embodiments of the invention, examples of which are illustrated in the accompanying figures, which show:

Fig. 1 a schematic view of a laundry treatment apparatus having a heat pump system,

Fig. 2 a schematic block diagram of components of the treatment apparatus of Fig. 1,

Fig. 3a a flow chart illustrating a method of correcting an estimation of an apparatus operation value for a laundry treatment apparatus,

Fig. 3b a flow chart illustrating an alternative method of of correcting an estimation of an apparatus operation value for a laundry treatment apparatus,

Fig. 3c a schematic representation of a sensing circuit adapted to detect the activation of a thermo protector circuit, and

Fig. 4 a flow chart illustrating a method of identifying the kind of operation problem occurring during an operation of a laundry treatment apparatus.

[0048] Fig. 1 depicts in a schematic representation of a laundry treatment apparatus 2 which in this embodiment is a heat pump tumble dryer. Alternatively the laundry treatment apparatus 2 may be a washing machine having a drying function (washer-dryer) or other laundry treatment apparatus. In case of a washer dryer, the laundry treatment chamber or drum 18 is arranged in a tub. In the exemplary laundry dryer the apparatus components are arrange in an apparatus housing 3.

[0049] The tumble dryer 2 as shown in Fig. 1 comprises a heat pump system 4, including in a closed refrigerant loop 6 in this order of refrigerant flow B: a first heat exchanger 10 acting as evaporator for evaporating the refrigerant R and cooling process air A, a compressor 14, a second heat exchanger 12 acting as condenser for cooling the refrigerant R and heating the process air, and an expansion device 16 from where the refrigerant R is returned to the first heat exchanger 10. Together with the refrigerant pipes connecting the components of the heat pump system 4 in series, the heat pump system 4 forms a refrigerant loop 6 through which the refrigerant R is circulated by the compressor 14 as indicated by arrow B. If the refrigerant R in the heat pump system 4 is operated in the transcritical or totally supercritical state, the first and second heat exchanger 10, 12 can act as gas heater and gas cooler, respectively.

[0050] The process air flow A within the treatment apparatus 2 is guided through a compartment 18 of the treatment apparatus 2, i.e. through a compartment 18 for receiving articles to be treated, e.g. a drum 18, which may be rotated by means of a drum motor 17. The articles to be treated are textiles, laundry 19, clothes, shoes or the like. In the embodiments described here these are preferably textiles, laundry or clothes. The process air flow is indicated by arrows A in Fig. 1 and is driven by a process air blower 8 or fan. The process air channel 20 guides the process air flow A outside the drum 18 and includes different sections, including the section forming the battery channel 20a in which the first and second heat exchangers 10, 12 are arranged. The process air exiting the second heat exchanger 12 flows into a rear channel 20b in which the process air blower 8 is arranged. The air conveyed by blower 8 is guided upward in a rising channel 20c to the backside of the drum 18. The air exiting the drum 18 through the drum outlet (which is the loading opening of the drum) is filtered by a fluff filter 22 arranged close to the drum outlet in or at the channel 20.

[0051] When the heat pump system 4 is operating, the first heat exchanger 10 transfers heat from process air A to the refrigerant R. By cooling the process air to lower temperatures, humidity from the process air condenses at the first heat exchanger 10, is collected there and drained to a condensate collector, which is preferably arranged below the heat exchangers 10, 12. The process air which is cooled and dehumidified after passing the first heat exchanger 10 passes subsequently through the second heat exchanger 12 where heat is transferred from the refrigerant R to the process air. The process air is sucked from exchanger 12 by the blower 8 and is driven into the drum 18 where it heats up the laundry 19 and receives the humidity therefrom. The process air exits the drum 18 and is guided in front channel 20d back to the first heat exchanger 10. The main components of the heat pump system 4 are arranged in a base section 5 or basement of the dryer 2.

[0052] Fig. 2 shows a simplified block diagram of the control and controlled components of the laundry treatment apparatus which is here exemplified by dryer 2. Program selection, setting of program options and program start are made by a user via input panel 7. A display 7a informs the user on the program status, operation status and other - for example it indicates a time-to-end TTE.

[0053] As shown in Fig. 2, the dryer 2 comprises an active switch or relay 26 controlled by the control unit 9 to selectively switch the compressor 14 on/off. Additionally a passive switching device 28 is provided, in this embodiment a thermo protector switch or circuit, which is not controllable by the control unit 9. The passive switching device 28 is adapted to cut the power supply to the compressor 14 e.g. when a predetermined temperature threshold, a voltage load threshold and/or a current threshold are/is exceeded. Thus, when the passive switching device 28 is open or activated, the compressor 14 is not powered (switched-off), and when the passive switching device is closed or de-activated the compressor is powered (switched-on). Additionally the active switching device 26 has to be in a closed state to allow the compressor being switched-on.

[0054] A detector means is provided to determine at least one operation parameter of the treatment apparatus. The at least one operation parameter may be one or more of the following parameter: a power consumption of a motor (e.g. the compressor motor, the drum motor 17, a fan motor) and/or the total power consumption of the treatment apparatus, a driving torque of the drum motor 17, a temperature of drying air entering and/or leaving the treatment chamber 18, a refrigerant temperature, an electrical parameter of a motor such as current, voltage, phase, or parameters derived therefrom, in particular a drum torque, and motor speed.

[0055] The control unit 9 is adapted to determine an estimation of an initial apparatus operation value based on at least one of the detected operation parameters as mentioned above. The estimated apparatus value may be one or more of the following: an operation cycle time-to-end value (TTE), a residual humidity value, a latent power, a laundry load and a process airflow amount. For example a laundry load may be derived from a detected drum torque value. The detected operation parameter and/or the estimated operation value(s) may be stored in a data storage means or data buffer 34.

[0056] Further, the control unit 9 is adapted to execute an algorithm based on the at least one detected operation parameter for correcting the estimation of the initial apparatus operation value and/or for correcting a current apparatus operation value. An initial operation value is an operation value estimated at a beginning of a drying cycle. Preferably some minutes after starting the drying operation (e.g. by starting drum agitation) or after the heat pump system operates in a steady state. There are two possible ways of correcting an operation value: (i) an estimated initial value may be corrected, e.g. such that depending on the initial operation value a respective look-up table may be used to determine a residual humidity or a TTE, or (ii) a current operation value may be corrected, wherein the current operation value may be a value which is determined e.g. from a countdown of an initial operation value or from a look-up table which discloses the process of the operation value over time (e.g. decrease of residual humidity over time). As a correction of an estimated operation value is repeatedly executed during an operation cycle, a very precise estimation of the operation value is possible up to the end of the operation cycle.

[0057] Fig. 3a depicts a flow chart illustrating an example for the method of correcting an estimation of an apparatus operation value for a laundry treatment apparatus 2 as described above. The operation value estimated based on at least one detected operation parameter may be a residual laundry humidity value, wherein the operation cycle time-to-end (TTE), i.e. the residual drying time, is corrected depending on the estimated residual laundry humidity.

[0058] In this particular embodiment, the at least one detected operation parameter is dependent on the compressor switch-on time. Consequently the operation value which is estimated based on the at least one operation parameter is also dependent on the compressor switch-on time. The above mentioned correction algorithm would lead to wrong estimations in case they use signals detected during an off-status of the compressor 14 or in an unknown status of the compressor 14. If this should happen, the dryer 2 may stop the drying process too early or too late causing the laundry mass to be still wet or energy is wasted due to over-drying.

[0059] In order to get a correct estimation of the operation value (here: residual humidity), i.e. for avoiding incorrect estimations, the control unit 9 is adapted to execute or implement the method as shown in Fig. 3a and as described in the following.

[0060] During a drying operation cycle a monitoring means of the dryer 2, which is adapted to determine whether the compressor 14 is switched on or off, continuously or repeatedly monitors whether the compressor

14 is switched on/off. When the compressor 14 is switched-on, the above described correction of an initial operation value and/or current operation value is executed.

[0061] When the monitoring means determines that the compressor 14 is switched-off, it is optionally determined whether the compressor switch-off is part of a normal dryer operation, i.e. whether the compressor 14 has been switched-off intentionally. For example in case a refrigerant is too hot, but still sufficient cooling/heating capacity of the heat pump system is available for drying (e.g. close to the end of a drying cycle), the update procedure must not be interrupted. In particular a TTE countdown does not have to be stopped.

[0062] When determining that the compressor stop or switch-off is unintentional, the last estimated operation value or the current operation value is frozen or maintained in the data buffer 34. Estimation of a present operation value may be stopped, an estimated present operation value may be discarded, and/or a correction of the initial/current operation value may be stopped. Optionally the countdown of a cycle time-to-end may be slowed down or a TTE counter may be stopped.

[0063] When the monitoring means detects that the compressor 14 is restarted or switched-on, the above described correction of the initial/current operation value is restarted and the TTE is updated. A delay may be provided between the determination of the re-establishment of the compressor-on status and the moment in time in which the algorithm or a correction of initial/current operation values are re-activated. This is useful to avoid acquiring parameters before a reasonable stabilization of the compressor and the heat pump system working conditions are fully re-established.

[0064] Fig. 3b shows a flow chart illustrating an alternative method of correcting an estimation of an apparatus operation value for a dryer 2 as described above.

[0065] Unless otherwise mentioned the above described method steps of Fig. 3a correspond to the the method steps of Fig. 3b. In contrast to the method shown in Fig. 3a, in the method as shown in Fig. 3b it is monitored whether the active switch 26 is closed, i.e. switched-on/off, such that the compressor 14 is powered/not powered. I.e. when the active switch 26 is switched-on, the compressor is powered (switched-on), and when the active switch 26 is switched-off (i.e. open) the compressor 14 is not powered (switched-off). Thus when determining that the active switch 26 is closed the above described correction of an initial/current operation value is executed. When determining that the active switch 26 is open the above described interruption of an operation value correction or estimation is provided.

[0066] The method shown in Fig. 3b may be implemented by using the schematically depicted representation of a sensing circuit as shown in Fig. 3c. By means of the depicted sensing circuit and the control unit 9, an activation of the passive switching device 28 may be detected while the active switch 28 is in an open state.

[0067] The sensing circuit has been designed in view of providing a sensing circuit that is cost-efficient and that can be easily adapted to an existing compressor control circuit. The arrangement depicted in Fig. 3c requires that the active switch 26 is open (i.e. the compressor 14 is switched-off) to evaluate the status of the passive switching device 28. In particular, when the active switch 26 is closed, an electrical detecting circuit 30 detects the neutral potential of the neutral line N independently from the status of the passive switching device 28.

[0068] As shown in Fig. 3c, the compressor 14 is connected in series with the passive switching device 28 (e.g. a thermo protector circuit). The assembly formed by the compressor 14 and passive switching device 28 is connected to a line L and a neutral N of a power main. The control unit 9 is connected to the active switch 26 which is located on the neutral N to which the compressor 14 is connected. An electrical detecting circuit 30 is connected via a sensing wire 32b to a connection point between the passive switching device 28 and the active switch 26 on the one hand and via a sensing wire 32a to the control unit 9 on the other hand.

[0069] For example, the active switch 26 is switched-off or opened as soon as a decrease of refrigerant temperature is detected, which may result from the compressor 14 being switched-off (i.e. the passive switching device 28 may be opened). After opening the active switch 26, the detecting circuit 30 is no longer 'blind' and the status of the passive switching device 28 can be determined. I.e. when the detecting circuit 30 detects a (normal or desired) operating voltage or current of the compressor 14, the active switch 26 is closed. When the detecting circuit 30 does not detect an operating voltage/current, the active switch 26 remains open, and the correction and estimation of operation values is suspended or stopped as shown in Fig. 3b.

[0070] Fig. 4 depicts a flow chart of a method for identifying or specifying the kind of operation problem which may occur during an operation of a laundry treatment apparatus 2 as described above. For example the above described sensing circuit of Fig. 3c may be used for implementing the below described method.

[0071] The refrigerant temperature is monitored continuously or repeatedly during an operation cycle of the apparatus 2. When a decrease of the refrigerant temperature is detected the active switch 26 is opened and a timer is started to measure the compressor switch-off time.

[0072] When a sensing circuit (e.g. a sensing circuit as described above) detects an operating voltage or current, no electrical fault has occurred. For example a refrigerant leak may be the cause of the refrigerant temperature drop. Subsequently the compressor 14 may be switched-on, i.e. the active switch 26 may be closed and an estimation and correction of an operation value may be restarted as described above.

[0073] When a or the sensing circuit does not detect an operating voltage/current after a predetermined recovery time of the passive switching device 28 is elapsed (e.g. 20 min), a wiring problem or a defect of the compressor 14 is indicated. Subsequently the operation of the treatment apparatus is stopped. A corresponding error message may be memorised or displayed for precisely identifying the problem involving the machine.

Reference Numeral List

[0074]

2	heat pump tumble dryer
3	casing/ housing
4	heat pump system
5	base section
6	refrigerant loop
7	input panel
7a	display
8	blower
9	control unit
10	first heat exchanger (evaporator)
12	second heat exchanger (condenser)
14	compressor
16	expansion device
17	drum motor
18	drum (laundry compartment)
19	laundry
20	process air channel
20a	battery channel
20b	rear channel
20c	rising channel
20d	front channel
22	fluff filter
26	active switch (relay RL)
28	passive switch / thermo switch
30	electrical detecting circuit (ECS1)
32a-b	sensing wire (S1, UCS1)
34	data storage means / data buffer
L	line of power mains
N	neutral of power mains
A	process air
B	refrigerant flow
R	refrigerant

Claims

1. Method of correcting an estimation of an apparatus operation value for a laundry treatment apparatus (2), in particular a laundry dryer or a washing machine having a drying function, wherein the apparatus (2) comprises:

    a laundry treatment chamber (18) for treating laundry,
    a heat pump system (4) comprising a first heat exchanger (10) for heating a refrigerant, a second heat exchanger (12) for cooling a refrigerant, an expansion means (16) and a compressor (14) for circulating a refrigerant fluid (R) through a refrigerant loop (6) of the heat pump system (4),
    a detector means for detecting at least one operation parameter of the treatment apparatus (2),
    a control unit (9) for controlling the operation of the treatment apparatus (2), wherein the control unit (9) is adapted to determine an initial estimation of an apparatus operation value based on at least one detected operation parameter, and wherein the control unit is adapted to execute an algorithm for correcting the initial estimation of an apparatus operation value and/or for correcting a current apparatus operation value based on at least one detected operation parameter,
    a data storage means (34) for storing an estimated operation value, wherein the method comprises:
    estimating an initial operation value and/or a current operation value,
    subsequently estimating a present operation value by executing the algorithm during an apparatus operation cycle, and
    correcting the initial operation value and/or a current operation value to or by using the estimated present operation value.

2. Method according to claim 1,
wherein estimation of a present operation value and correction of the initial/current operation value is executed continuously or repeatedly during an apparatus operation cycle, and/or
wherein estimation of a present operation value and correction of the initial/current operation value is executed at least two times during an apparatus operation cycle.

3. Method according to claim 1 or 2,
wherein the estimated operation value is selected from at least one of the following operation values:

    an operation cycle time-to-end value (TTE),
    a residual humidity value,
    a latent power,
    a laundry load, and
    a process airflow amount, and

    wherein the at least one detected operation parameter is selected from at least one of the following operation parameters:

    a power consumption of a compressor motor, a motor for rotating the treatment chamber, a cooling fan motor and/or the total power consumption of the treatment apparatus,

a driving torque of a motor for rotating the treatment chamber,
a temperature of drying air entering and/or leaving the treatment chamber,
a refrigerant temperature,
an electrical parameter of a motor of the treatment apparatus, and
motor speed of a motor of the treatment apparatus.

4. Method according to claim 1, 2 or 3, wherein correcting of the initial/current operation value to the present operation value is executed in incremental steps.

5. Method of claim 4, wherein the incremental correction of the initial operation value and/or a current operation value is made by adding a fraction of the difference between the estimated present operation value and the initial operation value and/or current operation value to the initial operation value and/or current operation value as the increment.

6. Method according to any of the previous claims, wherein the at least one detected operation parameter depends on compressor switch-on-time, wherein the apparatus (2) comprises a compressor monitoring means adapted to determine whether the compressor (14) is switched-on or switched-off, and wherein when determining that the compressor (14) is switched-off, carrying out at least one of the following:

stop estimating a present operation value,
discard an estimated present operation value,
stop correcting the initial/current operation value, and/or
maintain current operation value.

7. Method according to any of the previous claims, wherein the apparatus (2) comprises
at least one passive switching device (28) not controllable by the control unit (9), the passive switching device (28) including a thermo protector circuit adapted to cut the power supply to the compressor (14) when a predetermined temperature threshold, a voltage load threshold and/or a current threshold are/is exceeded, wherein, when the passive switching device (28) is in an open state, the compressor (14) is not powered, and
a monitoring means to detect whether the thermo protector circuit is opened or closed,
wherein the method comprises:
when monitoring that the thermo protector circuit is opened, carrying out at least one of the following:

stop estimating a present operation value,
discard an estimated present operation value,
stop correcting the initial/current operation value, and/or
maintain current operation value.

8. Method according to any of the previous claims, comprising:

restart estimating a present operation value and correcting initial/current operation value, when monitoring that the compressor (14) is switched-on and/or when monitoring that the thermo protector circuit is closed.

9. Method according to any of the previous claims, comprising:

delay restart of estimating a present operation value and correcting initial/current operation value for a predetermined time after monitoring that the compressor (14) is switched-on and/or after monitoring that the thermo protector circuit is closed.

10. Method according to any of the previous claims, wherein the apparatus comprises a timer means for counting down a residual drying time,
wherein the method comprises:

determine an initial residual drying time,
store the determined initial residual drying time,
start countdown from the initial residual drying time,
detect the at least one operation parameter during an apparatus operation cycle and execute the algorithm to determine a present residual drying time, and
correct countdown of the initial residual drying time to the present residual drying time,
wherein when monitoring that the compressor (14) is switched-off and/or the thermo protector circuit is opened, carry out at least one of the following:

stop countdown of the residual drying time and store current residual drying time value,
stop executing the algorithm,
discard the at least one detected operation parameter, and/or
discard the determined present residual drying time.

11. Laundry treatment apparatus (2), in particular a laundry dryer or a washing machine having a drying function, wherein the apparatus (2) comprises a control unit (9) for controlling the operation of the treatment apparatus (2), wherein the control unit (9) is adapted to carry out a method according to any claim 1 to 10.

12. Laundry treatment apparatus (2) according to claim

11, in particular a laundry dryer or a washing machine having a drying function, wherein the apparatus (2) comprises:

a laundry treatment chamber (18) for treating laundry,
a heat pump system (4) comprising a first heat exchanger (10) for heating a refrigerant, a second heat exchanger (12) for cooling a refrigerant, an expansion means (16) and a compressor (14) for circulating a refrigerant fluid (R) through a refrigerant loop (6) of the heat pump system (4),
a detector means for detecting at least one operation parameter of the treatment apparatus (2),
a control unit (9) for controlling the operation of the treatment apparatus (2),
wherein the control unit (9) is adapted to determine an initial estimation of an operation value based on at least one detected operation parameter, and wherein the control unit (9) is adapted to execute an algorithm for correcting the initial estimation of an operation value and/or for correcting a current operation value based on at least one detected operation parameter,
a data storage means (34) for storing an estimated operation value,
wherein the control unit (9) is adapted to control the operation of the treatment apparatus by:

estimating an initial operation value,
subsequently estimating a present operation value by executing the algorithm during an apparatus operation cycle, and
correcting the initial operation value and/or a current operation value to or by using the estimated present operation value.

13. Laundry treatment apparatus according to claim 12, wherein the apparatus (2) comprises at least one passive switching device (28) not controllable by the control unit (9), the passive switching device (28) including a thermo protector circuit adapted to cut the power supply to the compressor (14) when a predetermined temperature threshold, a voltage load threshold and/or a current threshold are/is exceeded, wherein when the passive switching device (28) is in an open state the compressor (14) is not powered, and
a monitoring means to detect whether the thermo protector circuit is opened or closed,
wherein the compressor (14) is connected in series with the thermo protector circuit, and an assembly formed by the compressor (14) and the thermo protector circuit is connected to a power main,
wherein the monitoring means comprises a sensing circuit to detect a change of potential and/or current at the assembly, wherein the sensing circuit comprises:

the control unit (9), connected to the active switching device (26) which is located on the line (L) or the neutral (N) of the power mains to which the compressor (14) is connected; and
an electrical detecting circuit (30) connected to a connection point located between the thermo protector circuit and the active switching device (26), on the one hand, and to the control unit (9), on the other hand; and

wherein the control unit (9) is adapted to evaluate the output of the electrical detecting circuit with the active switching device (26) being switched-off in order to evaluate the status of thermo protector circuit.

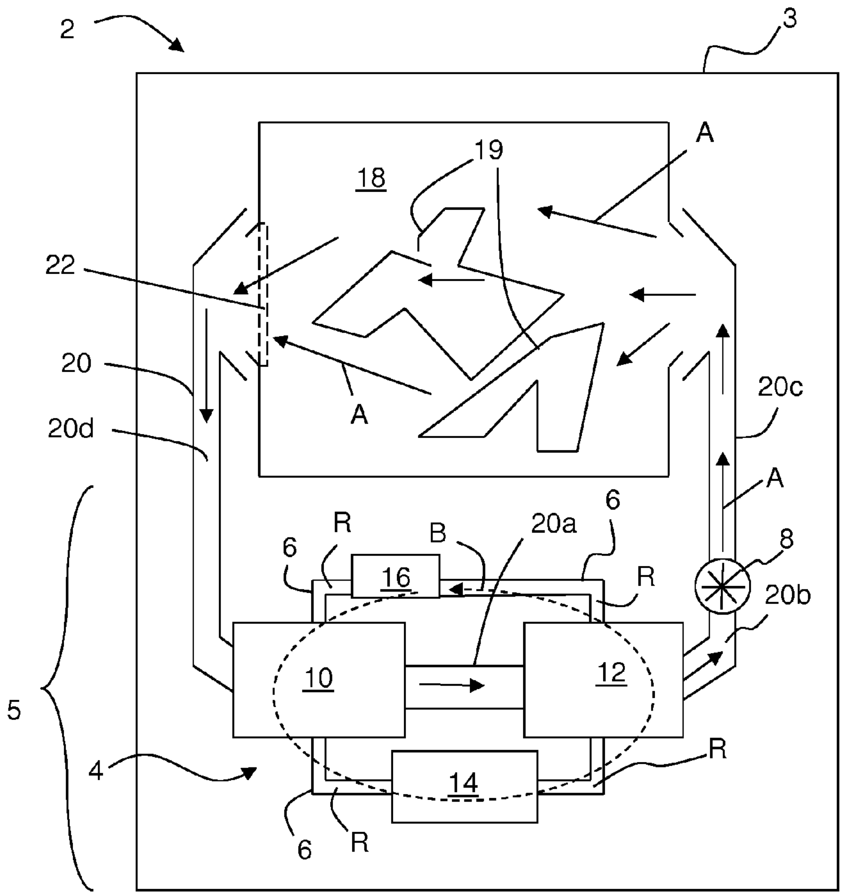
2
3
A
19
18
22
20
20d
20c
A
A
6
R
B
20a
6
8
20b
R
16
10
12
5
4
14
R
6
R

Fig. 1

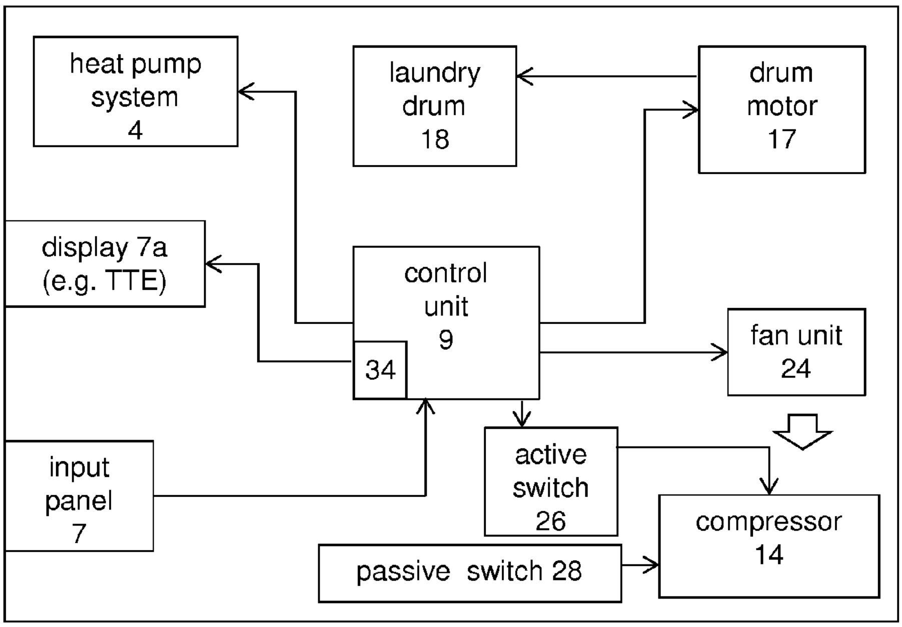
heat pump system 4
laundry drum 18
drum motor 17
display 7a (e.g. TTE)
control unit 9
34
fan unit 24
active switch 26
input panel 7
compressor 14
passive switch 28

Fig. 2

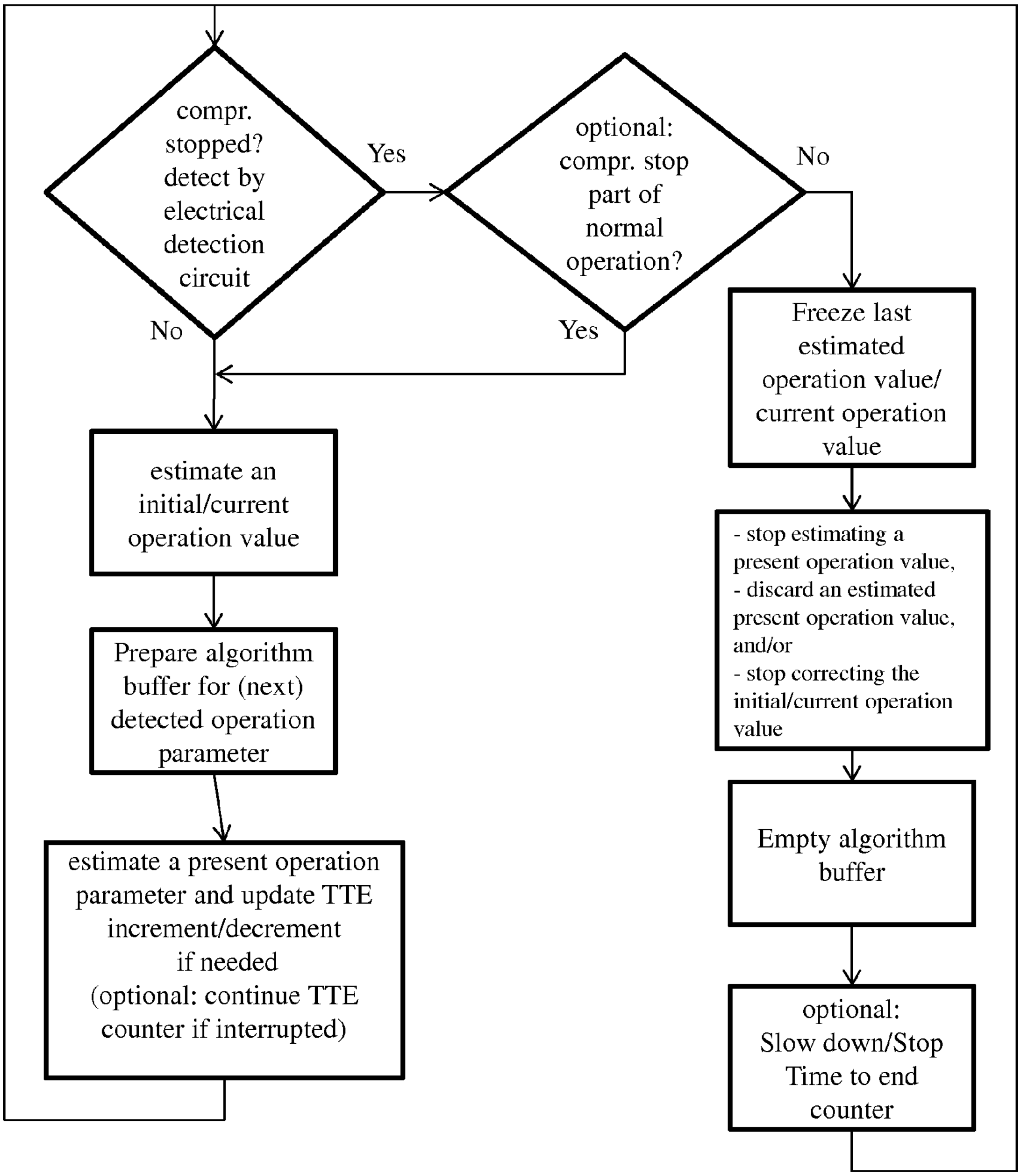
compr. stopped? detect by electrical detection circuit
Yes
No
optional: compr. stop part of normal operation?
No
Yes
Freeze last estimated operation value/ current operation value
estimate an initial/current operation value
- stop estimating a present operation value,
- discard an estimated present operation value, and/or
- stop correcting the initial/current operation value
Prepare algorithm buffer for (next) detected operation parameter
Empty algorithm buffer
estimate a present operation parameter and update TTE increment/decrement if needed (optional: continue TTE counter if interrupted)
optional: Slow down/Stop Time to end counter

Fig. 3a

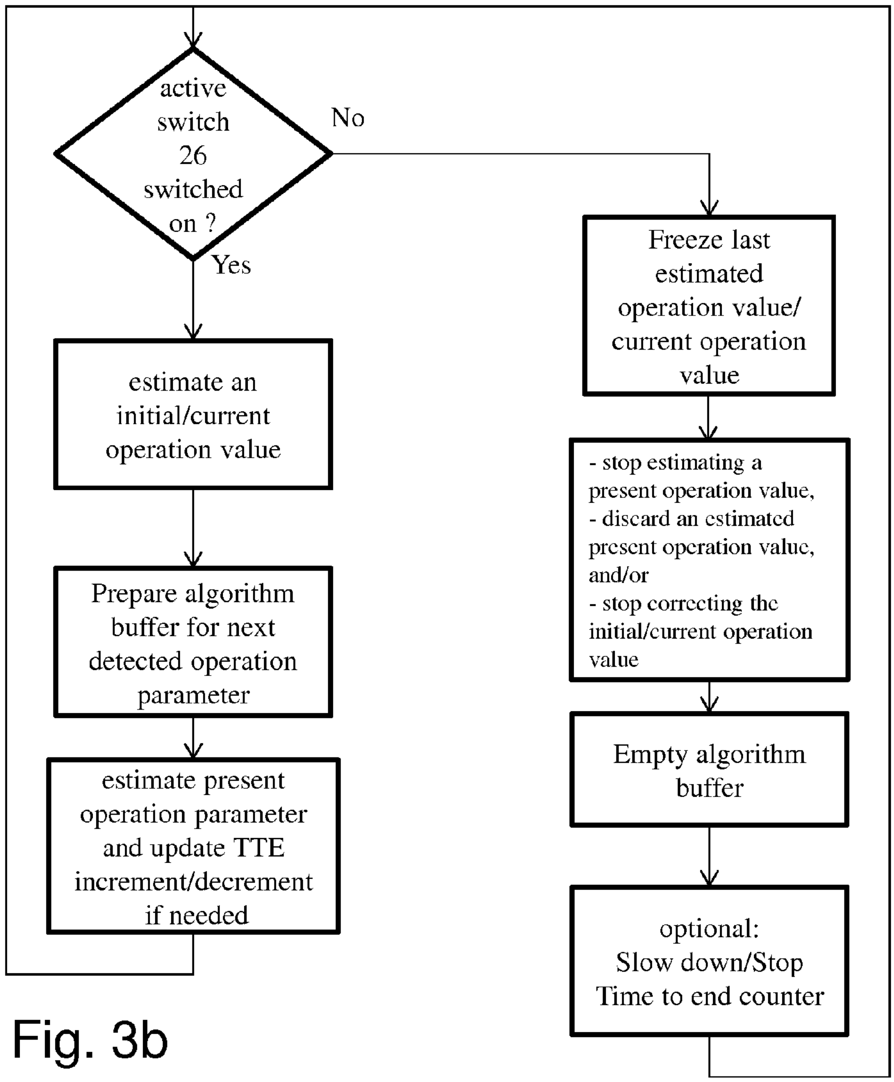
active switch 26 switched on ?
No
Yes
estimate an initial/current operation value
Prepare algorithm buffer for next detected operation parameter
estimate present operation parameter and update TTE increment/decrement if needed
Freeze last estimated operation value/ current operation value
- stop estimating a present operation value,
- discard an estimated present operation value, and/or
- stop correcting the initial/current operation value
Empty algorithm buffer
optional: Slow down/Stop Time to end counter

Fig. 3b

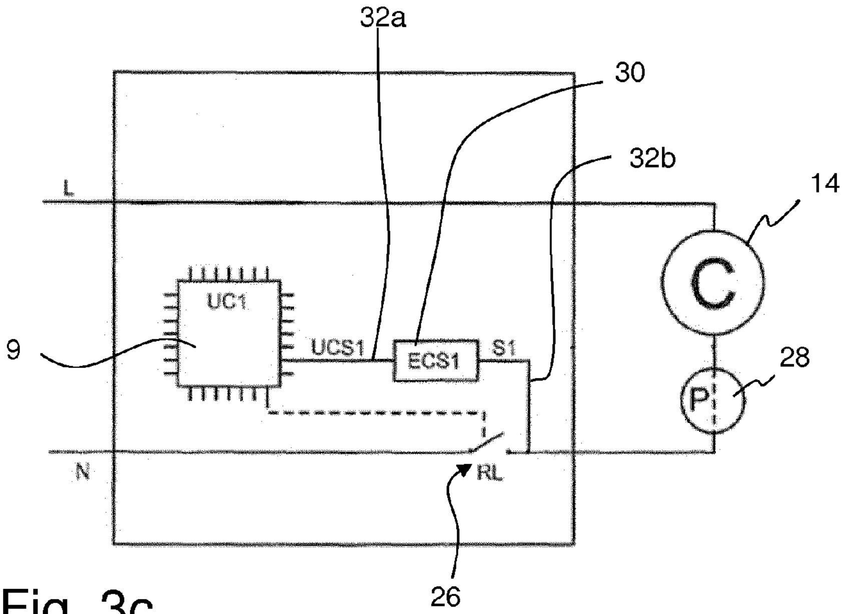
32a
30
32b
14
L
UC1
UCS1
ECS1
S1
C
P
28
9
N
RL
26

Fig. 3c

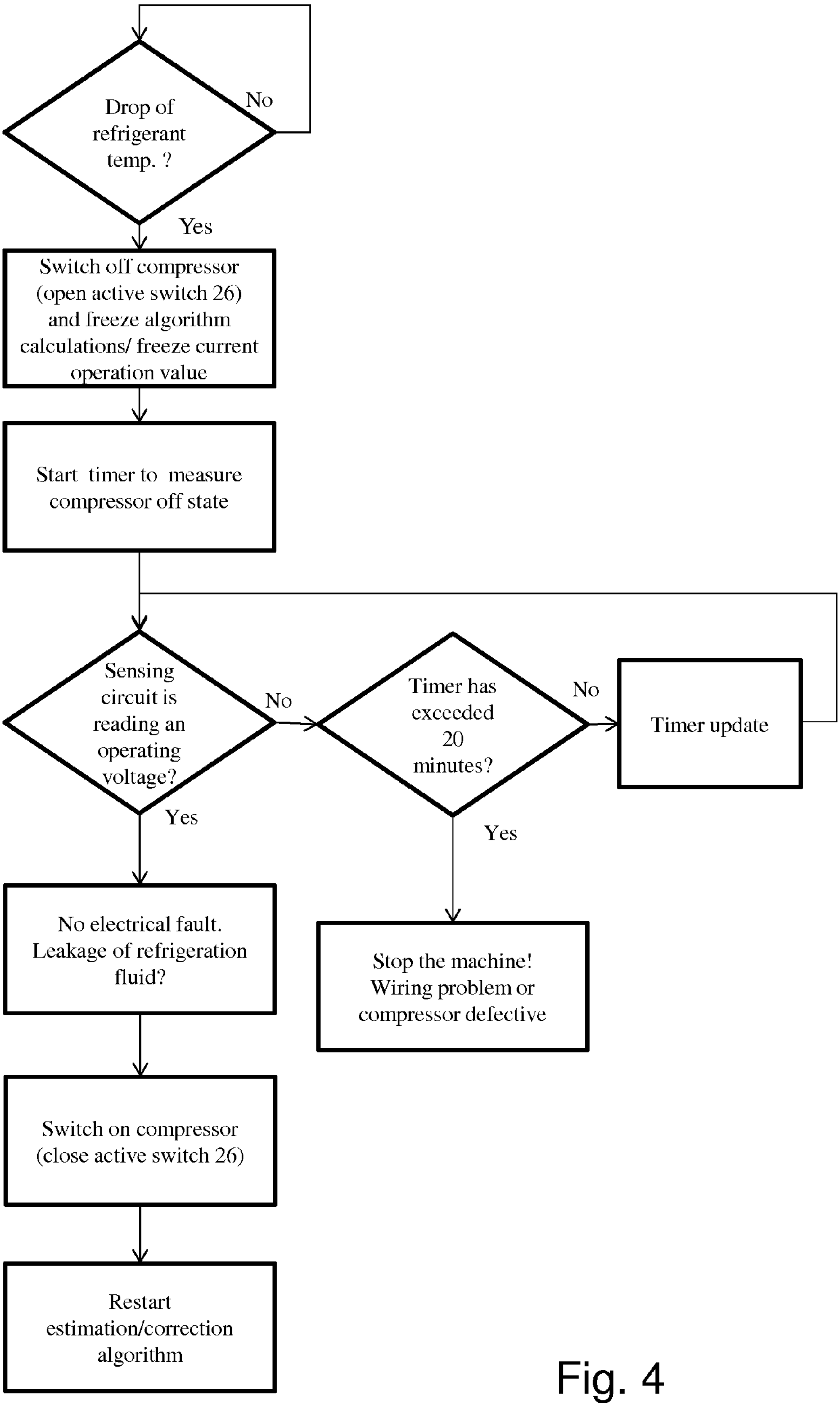
Drop of refrigerant temp. ?
No
Yes
Switch off compressor (open active switch 26) and freeze algorithm calculations/ freeze current operation value
Start timer to measure compressor off state
Sensing circuit is reading an operating voltage?
No
Timer has exceeded 20 minutes?
No
Timer update
Yes
Yes
No electrical fault. Leakage of refrigeration fluid?
Stop the machine! Wiring problem or compressor defective
Switch on compressor (close active switch 26)
Restart estimation/correction algorithm

Fig. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 14 16 2965

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	EP 2 333 149 A1 (V ZUG AG [CH]) 15 June 2011 (2011-06-15)	1-6,8-12	INV. D06F58/28
Y	* the whole document *	7,13	

X	WO 2004/079078 A1 (TOSHIBA KK [JP]; TOSHIBA HA PRODUCTS CO LTD [JP]; TOSHIBA CONSUMER MAR) 16 September 2004 (2004-09-16)	1-6,8-12	
Y	* the whole document *	7,13	

X	JP H04 197398 A (HITACHI LTD) 16 July 1992 (1992-07-16)	1-6,8-12	
Y	* the whole document *	7,13	

E	EP 2 733 252 A1 (ELECTROLUX HOME PROD CORP [BE]) 21 May 2014 (2014-05-21) * the whole document *	1-13	

A,D	EP 2 679 718 A1 (ELECTROLUX HOME PROD CORP [BE]) 1 January 2014 (2014-01-01) * the whole document *	1-13	
	-----		TECHNICAL FIELDS SEARCHED (IPC)
Y,D	US 6 941 674 B2 (PARK DAE-YUN [KR] ET AL) 13 September 2005 (2005-09-13) * the whole document *	7,13	D06F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	14 October 2014	Spitzer, Bettina

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 14 16 2965

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-10-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2333149 A1	15-06-2011	AU 2011253568 A1	07-06-2012
		CN 102560990 A	11-07-2012
		DK 2333149 T3	06-01-2014
		EP 2333149 A1	15-06-2011
		SI 2333149 T1	28-02-2014
WO 2004079078 A1	16-09-2004	CN 1756867 A	05-04-2006
		EP 1605087 A1	14-12-2005
		JP 3977762 B2	19-09-2007
		JP 2004267334 A	30-09-2004
		KR 20050107492 A	11-11-2005
		TW I272328 B	01-02-2007
		US 2006207299 A1	21-09-2006
		WO 2004079078 A1	16-09-2004
JP H04197398 A	16-07-1992	NONE	
EP 2733252 A1	21-05-2014	EP 2733252 A1	21-05-2014
		WO 2014076035 A1	22-05-2014
EP 2679718 A1	01-01-2014	EP 2679718 A1	01-01-2014
		WO 2014001114 A1	03-01-2014
US 6941674 B2	13-09-2005	CN 1580379 A	16-02-2005
		DE 60319521 T2	02-04-2009
		EP 1507038 A1	16-02-2005
		KR 20050018035 A	23-02-2005
		US 2005050763 A1	10-03-2005

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

- US 6941674 B2 **[0002]**
- EP 2679718 A1 **[0003]**