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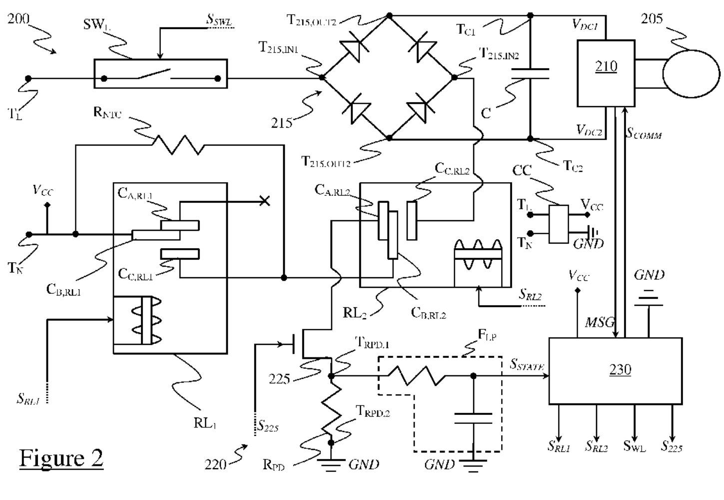

Figure 2

(57) Abstract: A washing and/or drying appliance (100) is proposed. The appliance comprises: an electric load (205), a driving arrangement (210,215,C) for driving the electric load (205), the driving arrangement (210,215,C) having first ($T_{205,IN1}$) and second ($T_{205,IN2}$) terminals coupleable, respectively, to a line terminal (TL) and to a neutral terminal (TN) providing a reference voltage (VCC), an inrush current limiting device (R_{FUSE}; R_{NTC}) and a switching device (RL; RL1) between the reference terminal (TN) and the second terminal (T205,IN2) of the driving arrangement (210,215,C), the switching device (RL;RL1) being operable in first or second states preventing or allowing, respectively, an electric current to flow through the inrush current limiting device (R_{FUSE}, R_{NTC}), and a sensing network (RPD) for sensing the first or second states of the switching device (RL; RL1) and for providing a corresponding state signal (SSTATE; S*STATE), the sensing network (RPD) having a first terminal (TRPD,1), and a second terminal ($T_{RPD,2}$) coupled to a reference terminal providing a further reference voltage (*GND*) lower than the reference voltage (VCC), wherein, during sensing: in the first state of the switching device (RL; RL1) the reference terminal (TN) and the first terminal (TRPD,1) of the sensing network (RPD) being coupled to each other such that the first terminal (TRPD,1) of the sensing network (RPD) receives

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WO 2016/184841 A1

the reference voltage (V_{CC}) and the state signal (S_{STATE}; S^*_{STATE}) takes a first level ($S_{STATE,H}$) equal to the reference voltage (V_{CC}), in the second state the state signal (S_{STATE}, S^*_{STATE}) taking a second level ($S_{STATE,I}$; $S_{STATE,L}$) lower than the first level ($S_{STATE,H}$).

METOHD FOR SAFELY MANAGING ELECTRIC MOTOR ACTIVATION AND DEACTIVATION, AND CORRESPONDING APPLIANCE

DESCRIPTION

Field of the invention

The present invention generally relates to electric appliances, such as washing, drying, washing/drying, dishwashing appliances, both for domestic and professional use. More particularly, the present invention relates to a circuit and a method for safely managing activation/deactivation of electric motors in such appliances.

Background of the invention

Nowadays most of electric appliances, hereinafter appliances, make use of electric motors. In case of a laundry washing appliance, a laundry washing/drying appliances and a laundry drying appliance, the electric motor is intended to rotate a rotatable drum (*i.e.* the rotatable container arranged inside the appliance wherein a laundry load is placed/housed in order to be washed and/or dried).

In order to activate/deactivate the electric motor, the appliance typically comprises electrically-operated switching devices and a power conversion/driving system for converting an AC supply voltage into a DC supply voltage allowing driving of the electric motor.

According to known solutions, the power conversion/driving system comprises a rectifying arrangement and a bulk capacitor for providing said DC supply voltage, and a driving arrangement, fed with said DC supply voltage, for driving the electric motor (*e.g.*, for controlling activation/deactivation thereof). Due to inherently low input resistance exhibited by the power conversion/driving system, especially when the bulk capacitor is initially discharged, large surge currents (or inrush currents) may arise, which are very stressful to power conversion/driving system.

Inrush current limiting devices (*e.g.* including negative temperature coefficient (NTC) thermistor or resistor) connected between the AC power supply and the power conversion/driving system and electrically-operated switching devices in parallel with the inrush current limiting devices, are often used to mitigate the inrush current during starting.

Summary of invention

The Applicant has realized that the known solutions are not satisfactory for modern requirements.

Indeed, each switching device which the known solutions makes use of is prone to errors (*e.g.*, absence of switching), thus impairing appliance operation. Some known solutions provide sensing arrangements for sensing the switching state of the switching devices, however these sensing arrangements provide high-voltage sensing (as typically based on sensing provision/absence of the AC supply voltage through the switching device), which translates into power consumptions not compatible with nowadays restrictive powers saving requirements.

Due to high power consumption of the sensing arrangement, only some of the switching devices are typically sensed (low sensing activity), thus exposing the appliance to reliability issues when failures of the non-sensed switching devices arise.

Low sensing activity also involves that some critical procedures (such as electric motor activation and deactivation procedures) are handled by the appliance in a manner not oriented to avoid safety risks for the user.

One or more aspects of the present invention are set out in the independent claims, with advantageous features of the same invention that are indicated in the dependent claims.

An aspect of the present invention relates to a washing and/or drying appliance. The appliance comprises:

an electric load,

a driving arrangement for driving the electric load, the driving arrangement having first and second terminals coupleable, respectively, to a line terminal and to a neutral terminal providing a reference voltage,

an inrush current limiting device and a switching device between the reference terminal and the second terminal of the driving arrangement, the switching device being operable in first or second states preventing or allowing, respectively, an electric current to flow through the inrush current limiting device, and

a sensing network for sensing the first or second states of the switching device and for providing a corresponding state signal, the sensing network having a first terminal, and a second terminal coupled to a reference terminal providing a further reference voltage lower than the reference voltage. During sensing, in the first state of the switching device the reference terminal and the first terminal of the sensing network being coupled to each other such that the first terminal of the sensing network receives the reference voltage and the state signal takes a first level equal to the reference voltage, in the second state the state signal taking a second level lower than the first level.

According to an embodiment of the present invention, in the second state of the switching device the reference terminal and the first terminal of the sensing network are coupled to each other with interposition of the inrush current limiting device, whereby the second level of the state signal is between the first the reference voltage and the further reference voltage according to a partition between the inrush current limiting device and the sensing network.

According to an embodiment of the present invention, in the second state of the switching device the first terminal of the sensing network is electrically floating, whereby the second level of the state signal is at the further reference voltage by pull-down action of the sensing network.

According to an embodiment of the present invention, the switching device has a first contact electrically coupled, during sensing, to the sensing network, a second contact coupled to the second terminal of the driving arrangement, and a third contact electrically coupled to the reference terminal and contacting the first or second contacts in first or second states, respectively, of the switching device.

According to an embodiment of the present invention, the switching device has a first contact electrically floating, a second contact, and a third contact electrically coupled to the reference terminal and contacting the first or second contacts in first or second states, respectively, of the switching device. The appliance also comprises a further switching device operable in first or second states electrically coupling the second contact of the switching device to the first terminal of the sensing network or to the second terminal of the driving arrangement, respectively.

According to an embodiment of the present invention, the first terminal of the sensing network is coupled, during sensing, to the second contact of the switching device, in the second state of the further switching device the state signal taking a third level equal to the further reference voltage.

According to an embodiment of the present invention, the sensing network is a resistive network.

According to an embodiment of the present invention, the appliance further comprises a filtering arrangement for suppressing disturbances from the state signal.

According to an embodiment of the present invention, the inrush current limiting device is a fusible resistor or a negative temperature coefficient thermistor.

According to an embodiment of the present invention, the electric load is an electric motor, for example a "*Variable-Frequency Drive*" motor or a Brushless DC motor

According to an embodiment of the present invention, the appliance is a laundry washing appliance intended to perform only laundry washing operations, or a laundry drying appliance intended to perform only laundry drying operations, or a laundry washing/drying appliance intended to perform both laundry washing and laundry drying operations.

According to an embodiment of the present invention, the appliance further comprises a mechanical door-lock device for mechanically locking an appliance door thereby preventing door opening when the electric load is activated.

Another aspect of the present invention relates to a method for operating a washing and/or drying appliance. The appliance comprises:

an electric motor and a driving arrangement for driving it, the driving arrangement being coupleable to a line terminal and to a neutral terminal providing a reference voltage, between the neutral terminal and the driving arrangement, an inrush current limiting device and a switching device, the switching device being operable between first and second states allowing and preventing, respectively, an electric current to flow through the inrush current limiting device, and

a sensing arrangement configured for sensing the first or second states of the switching device and for providing a corresponding state signal, in the first state of the switching device the state signal taking a first level equal to the reference voltage, and in the second state of the switching device the state signal taking a second level lower than the first level.

The method comprises, under the control of a control unit of the appliance and in response to a motor activation request:

if the state signal takes the second level, feeding the driving arrangement with a first electric current limited by the inrush current limiting device, and

if communication between the electric motor and the driving arrangement is active, operating the switching device into the second state thereby allowing a second electric current not limited by the inrush current limiting device to be fed to the driving arrangement, and activating the electric motor.

According to an embodiment of the present invention, the appliance further comprises a mechanical door-lock device for mechanically locking an appliance door thereby preventing door opening when the electric motor is activated. The method further comprises enabling mechanical door locking, said feeding the driving arrangement with a first electric current limited by the inrush current limiting device being performed if mechanical door locking is enabled.

According to an embodiment of the present invention, the appliance further comprises a further switching device operable in first or second states electrically coupling the switching device to the sensing arrangement or to the driving arrangement, respectively, in the first state of the further switching device the state signal taking the first or second levels according to the first or second states, respectively, of the switching device. Said enabling mechanical door locking if the state signal takes the second level comprises:

operating the switching device in the first state,

if the state signal takes the first level, operating the switching device in the second state, and

if the state signal takes the second level, performing said enabling mechanical door locking.

According to an embodiment of the present invention, in the second state of the further switching device the state signal takes a third level lower than the first and second levels. The method further comprises, after said enabling mechanical door locking:

if mechanical door locking is enabled, operating the further switching device in the second state, and

performing said operating the switching device into the second state if communication between the electric motor and the driving arrangement is active and if the state signal takes the third level.

According to an embodiment of the present invention, the method further comprises, in response to a motor deactivation request:

if motor deactivation has occurred, operating the further switching device into the first state, and

if the state signal takes the second level, operating the switching device into the first state and disenabling mechanical door locking.

According to an embodiment of the present invention, the method further comprises, in response to a motor deactivation request:

if motor deactivation has occurred, operating the switching device into the first state, and

if the state signal takes the first level and if a predefined time period has passed since motor deactivation request, disenabling mechanical door locking.

Brief description of the annexed drawings

These and other features and advantages of the present invention will be made apparent by the following description of some exemplary and non limitative embodiments thereof; for its better intelligibility, the following description should be read making reference to the attached drawings, wherein:

Figure 1 shows a perspective view of an appliance wherein the present invention may be applied;

Figure 2 schematically shows a portion of a circuit system of the appliance according to an embodiment of the present invention;

Figures 3 and **4** show simplified flowcharts of respective procedures implemented by the circuit system of **Figure 2** according to an embodiment of the present invention;

Figure 5 schematically shows a portion of a circuit system of the appliance according to another embodiment of the present invention, and

Figures 6 and **7** show simplified flowcharts of respective procedures implemented by the circuit system of **Figure 5** according to an embodiment of the present invention.

Detailed description of preferred embodiments of the invention

Referring now to the drawings, **Figure 1** schematically shows an appliance **100**, for example for domestic use (*i.e.*, a household appliance), wherein the present invention may be applied. The appliance **100** may for example be a laundry washing appliance intended to perform only laundry washing operations (*i.e.*, without laundry drying operations), a laundry drying appliance intended to perform only laundry drying operations (*i.e.*, without laundry washing operations), or a laundry washing/drying appliance intended to perform both laundry washing and laundry drying operations (as generically illustrated in the figure, and to which reference will be made in the following by way of a non-limiting example only).

The appliance **100** preferably comprises a substantially parallepiped-shaped cabinet **105**, which encloses an inner compartment.

In the exemplarily considered appliance **100** (which is intended to perform both laundry washing and laundry drying operations), the inner compartment accommodates a tub (not visible), adapted to be filled with washing water, and a (*e.g.*, perforated) rotatable drum **110** mounted therein (in either a horizontal or vertical orientation) adapted to house the laundry to be treated (*i.e.*, the laundry to be washed and/or dried, in the example at issue). Anyway, according to the considered appliance (and, hence, according to the treatment the appliance is intended/designed to perform), the inner compartment may accommodate, instead of the tub and the rotatable drum **110**, any suitable treatment chamber (*e.g.*, a rotatable, non-perforated drum in case of a laundry drying appliance).

The inner compartment (*i.e.*, the rotatable drum **110**) is accessible through an access door **115** (shown in a closed configuration), preferably provided on a front panel **105_F** of the cabinet **105** for loading/unloading the laundry.

The inner compartment also accommodates, not visible in such a figure, a number of well-known electronic, electro-hydraulic and/or electro-mechanical components, which form (as a whole) a circuit system allowing operation of the appliance **100**.

Hereinafter, reference will be also made to **Figure 2**, which schematically shows a portion of a circuit system **200** according to an embodiment of the present invention. In the following, in order to take into account possible circuit system variants, all falling within the scope of the present invention, the term coupling will be used for denoting both direct and indirect coupling (unless explicitly referring to direct coupling, when relevant for the present invention).

The circuit system **200** comprises one or more electric loads, such has the electric load **205**, for example an electric motor for drum rotation. Preferably, although not necessarily, the electric motor **205** is a "*Variable-Frequency Drive*" (VFD) motor or a Brushless DC motor, so that control of drum rotation speed (*e.g.*, according to an actual laundry load, and/or to an actual amount of washing water within the rotatable drum **110**) is possible. However, as will be understood from the following description, the present invention may be applied for any electric load (for example, an electric heater, a drain or recirculation pump, a fan).

In the considered embodiment, the circuit system **200** also comprises a driving arrangement, generally configured for driving the electric motor **205**. In order to achieve that, the driving arrangement preferably comprises a motor module **210**, powered between first V_{DC1} and second V_{DC2} DC supply voltages, for controlling activation and deactivation of the electric motor **205**, as well as a power conversion arrangement for providing said DC supply voltages V_{DC1},V_{DC2} according to an AC supply voltage selectively received from supply (*e.g.*, line) $\mathbf{T_L}$ and reference (*e.g.*, neutral) $\mathbf{T_N}$ terminals of an AC power supply.

Preferably, the power conversion module comprises a rectifying circuit (*e.g.*, a diodes bridge) **215**, having two input terminals $\mathbf{T_{215,IN1}}$,$\mathbf{T_{215,IN2}}$ (selectively coupleable to the line $\mathbf{T_L}$ and neutral $\mathbf{T_N}$ terminals, respectively) for receiving the AC supply voltage and two output terminals $\mathbf{T_{215,OUT1}}$,$\mathbf{T_{215,OUT2}}$ for providing pulsed DC voltages (deriving from full-wave rectification of the AC supply voltage), and a smoothing (or bulk) capacitor **C**, whose terminals $\mathbf{T_{C1}}$,$\mathbf{T_{C2}}$ are electrically coupled to the output terminals $\mathbf{T_{215,OUT1}}$,$\mathbf{T_{215,OUT2}}$, respectively, of the rectifying circuit **215** for smoothing the pulsed DC voltages into said DC supply voltages V_{DC1},V_{DC2}. By virtue of the considered implementation, the input terminals $\mathbf{T_{215,IN1}}$,$\mathbf{T_{215,IN2}}$ of the rectifying circuit **215** also represent, by the logical viewpoint, input terminals of the driving arrangement as a whole (although the motor module **210**, typically provided as a dedicated printed circuit board, is structurally separated from the power conversion module **215**,**C**), the driving arrangement **210**,**215**,**C** being thus selectively coupleable to the line $\mathbf{T_L}$ and neutral $\mathbf{T_N}$ terminals by means of the input terminals $\mathbf{T_{215,IN1}}$,$\mathbf{T_{215,IN2}}$, respectively.

The circuit system **200** also comprises an AC-DC conversion circuit (denoted by the reference **CC** in the figure) comprising transforming, rectifying and regulating components for receiving the AC supply voltage and providing one or more further DC voltages, such as a lower reference, or ground, voltage *GND* (*e.g.*, 0V), and an upper reference voltage *Vcc* (*e.g.*, a 5V DC voltage with respect to the ground voltage *GND*) for powering electronic components of the appliance **100** (as mentioned in the following). As visible in the figure, the neutral terminal $\mathbf{T_N}$ is preferably set at the upper reference voltage *Vcc* (so as to allow proper driving of power components of the appliance **100**, *e.g.* triacs, not shown).

An inrush current limiting device $\mathbf{R_{NTC}}$ (better discussed in the following) is provided between the neutral terminal $\mathbf{T_N}$ and the input terminal $\mathbf{T_{205,IN2}}$ of the rectifying circuit **215** (*i.e.*, of the driving arrangement **210**,**215**,C) in order to limit large peak surge currents, or inrush currents, flowing through (thus electrically stressing) the rectifying arrangement **215** and the bulk capacitor **C** (especially when the bulk capacitor **C** is initially discharged).

Selective coupling between line $\mathbf{T_L}$ and neutral $\mathbf{T_N}$ terminals and the rectifying circuit **215** is achieved by means of a number of electrically-operated switching devices. As illustrated, a safety switch (*e.g.*, a door switch) $\mathbf{SW_L}$ is provided between the line terminal $\mathbf{T_L}$ and the input terminal $\mathbf{T_{215,IN1}}$ of the rectifying arrangement **215**, whereas a switching arrangement is provided between the neutral terminal $\mathbf{T_N}$ and the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215**.

According to the exemplary illustrated embodiment, the switching arrangement comprises a (*e.g.*, electromagnetic) relay $\mathbf{RL_1}$ having bypass functions (thus, referred to as bypass relay $\mathbf{RL_1}$ hereinafter) electrically coupled to the neutral terminal $\mathbf{T_N}$, and a (*e.g.*, electromagnetic) relay $\mathbf{RL_2}$ having safety functions (thus, referred to as safety relay $\mathbf{RL_2}$ hereinafter) provided between the bypass relay $\mathbf{RL_1}$ and the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying circuit **215** (the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays being assumed preferably structurally similar to each other).

For the purposes of the present disclosure, the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays comprise respective contacts $\mathbf{C_{A,RL1}}$,$\mathbf{C_{B,RL1}}$,$\mathbf{C_{C,RL1}}$ and $\mathbf{C_{A,RL2}}$,$\mathbf{C_{B,RL2}}$,$\mathbf{C_{C,RL2}}$, as well as a coil of wire wrapped around an iron core. A central contact of each relay, *e.g.* the contact $\mathbf{C_{B,RL1}}$,$\mathbf{C_{B,RL2}}$, is movable with respect to the other, or fixed, (mechanically separated and electrically insulated) side contacts of the same relay (*i.e.* the side contacts $\mathbf{C_{A,RL1}}$,$\mathbf{C_{C,RL1}}$ and $\mathbf{C_{A,RL2}}$,$\mathbf{C_{C,RL2}}$, respectively). In absence of current across the coil (relay de-energization), the central contact $\mathbf{C_{B,RL1}}$,$\mathbf{C_{B,RL2}}$ of each relay $\mathbf{RL_1}$,$\mathbf{RL_2}$ is electrically coupled to a respective side contact, *e.g.* the contact $\mathbf{C_{A,RL1}}$,$\mathbf{C_{A,RL2}}$ (and an air gap, and hence electrical insulation, is established between the central contact $\mathbf{C_{B,RL1}}$,$\mathbf{C_{B,RL2}}$ and the opposite side contact $\mathbf{C_{C,RL1}}$,$\mathbf{C_{C,RL2}}$). When instead an electric current is passed through the coil (relay energization), a magnetic field is generated that activates movement of the central contact $C_{B,RL1}$,$C_{B,RL2}$ from the side contact $C_{A,RL1}$,$C_{A,RL2}$ to the respective side contact $C_{C,RL1}$,$C_{C,RL2}$ (until mechanical and electrical contacting is established therebetween). Thus, in the considered embodiment, the bypass RL_1 and safety RL_2 relays are in a first, de-energized, state wherein the central contacts $C_{B,RL1}$,$C_{B,RL2}$ contact the side contacts $C_{A,RL1}$,$C_{A,RL2}$, respectively, and are operable in a second, energized, state wherein the central contacts $C_{B,RL1}$,$C_{B,RL2}$ contact the side contacts $C_{C,RL1}$,$C_{C,RL2}$, respectively.

In the exemplary illustrated embodiment, the side contact $C_{A,RL1}$ of the bypass relay RL_1 is floating, whereas the central contact $C_{B,RL1}$ of the bypass relay RL_1 is electrically coupled to the neutral terminal T_N (so as to contact the side contact $C_{A,RL1}$ or the side contact $C_{C,RL1}$ in the de-energized or energized states, respectively, of the bypass relay RL_1). The side $C_{A,RL2}$,$C_{C,RL2}$ and central $C_{B,RL2}$ contacts of the safety relay RL_2 are instead electrically coupled to the input terminal $T_{215,IN2}$ of the rectifying arrangement **215**, to a sensing arrangement **220** (as discussed in the following) and to the side contact $C_{C,RL1}$ of the bypass relay RL_1, respectively. In other words, in the de-energized state of the safety relay RL_2, the side contact $C_{C,RL1}$ of the bypass relay RL_1 is electrically coupled to the sensing arrangement **220** (through the side $C_{A,RL2}$ and central $C_{B,RL2}$ contacts of the safety relay RL_2), and in the energized state of the safety relay RL_2 the side contact $C_{C,RL1}$ of the bypass relay RL_1 is electrically coupled to the input terminal $T_{215,IN2}$ of the rectifying circuit **215**, whereas the bypass relay RL_1 in the energized state identifies said first configuration of the switching arrangement (*i.e.*, electric current being prevented from flowing through the inrush current limiting device R_{NTC}) and the bypass relay RL_1 in the de-energized states identifies said second configuration of the switching arrangement (*i.e.*, electric current being allowed to flow through the inrush current limiting device R_{NTC}).

The door switch SW_L can be switched between an opened, or off, condition electrically decoupling the line terminal T_L and the input terminal $T_{215,IN2}$ of the rectifying arrangement **215** from each other thereby preventing, in door-opened configuration, energization of the electric motor **205** (and/or of any other electric loads downstream the door switch **SW_L**), and a closed, or on, condition. When the door switch **SW_L** is instead in the closed condition, electrical coupling between the line terminal **T_L** and the input terminal **$T_{215,IN2}$** of the rectifying arrangement **215** is established, and mechanical lock of the door **115** is commanded (*e.g.*, by means of a proper door-lock command, not shown, provided to a proper mechanical door-lock device, also not shown). Preferably, such a mechanical lock is provided to prevent opening of the door for safety reasons, *e.g.* when the electric motor **205** is activated, when washing or rinsing water is provided within the tub, when a dangerous temperature in the inner compartment is detected, or when the drum **110** is still rotating.

Thus, when the door switch **SW_L** is in the opened condition, no activation of the electric motor **205** arises (regardless of the bypass **RL_1** and safety **RL_2** relays states, either energized or de-energized states), and when the door switch **SW_L** is in the closed condition, energization of the electric motor **205** can take place only upon energization of the safety relay **RL_2** (thus allowing the AC supply voltage from the line **T_L** and neutral **T_N** terminals to be fed across the input terminals **$T_{215,IN1}$**,**$T_{215,IN1}$** of the rectifying arrangement **215**).

The inrush current limiting device **R_{NTC}** may be a fusible resistor or, as in the exemplary considered embodiment, a negative temperature coefficient (NTC) thermistor electrically coupled in parallel with the bypass relay **RL_1**. According to the exemplary illustrated embodiment, the NTC thermistor **R_{NTC}** is electrically coupled between the central **$C_{B,RL1}$** and side **$C_{C,RL1}$** contacts of the bypass relay **RL_1**.

Basically, the NTC thermistor **R_{NTC}** is a resistive component whose resistance decreases as its temperature increases. During startup, with the door switch **SW_L** in the closed condition, the bypass relay **RL_1** in the de-energized state and the safety relay **RL_2** in the energized state (so that the neutral terminal **T_N** is electrically coupled to the input terminal **$T_{215,IN2}$** of the rectifying arrangement **215** through the NTC thermistor **R_{NTC}** and the safety relay **RL_2**, *i.e.* the central **$C_{B,RL2}$** and side **$C_{C,RL2}$** contacts thereof), the temperature of the NTC thermistor **R_{NTC}** is cold and its resistance is high, and a relatively low starting current is allowed to flow therethrough. As operation continues, the temperature of the NTC thermistor $\mathbf{R_{NTC}}$ increases (due to starting current flowing therethrough) and its resistance decreases, thereby an increasing amount of starting current is allowed to flow therethrough. After startup completing or preset time elapsing, the bypass relay $\mathbf{RL_1}$ is operated into the energized state (*i.e.*, central contact $\mathbf{C_{B,RL1}}$ of the bypass relay $\mathbf{RL_1}$ being moved into contact with the side contact $\mathbf{C_{C,RL1}}$ thereof), thus bypassing (*i.e.*, substantially short-circuiting) the NTC thermistor $\mathbf{R_{NTC}}$ and allowing a working current (substantially depending on the AC supply voltage and on the experienced impedance) to be fed to the rectifying arrangement **215** (through the bypass relay $\mathbf{RL_1}$, *i.e.* the central $\mathbf{C_{B,RL1}}$ and side $\mathbf{C_{C,RL1}}$ contacts thereof, and the safety relay $\mathbf{RL_2}$, *i.e.* the central $\mathbf{C_{B,RL2}}$ and side $\mathbf{C_{C,RL2}}$ contacts thereof).

As mentioned above, the circuit system **200** also comprises a sensing arrangement **220**, selectively coupleable to the side contact $\mathbf{C_{A,RL2}}$ of the safety relay $\mathbf{RL_2}$. Broadly speaking, the sensing arrangement **220** is configured for sensing the first or second states (*i.e.*, the energized or de-energized states) of the bypass relay $\mathbf{RL_1}$, as well as the energized or de-energized states of the safety relay $\mathbf{RL_2}$ (being the sensing allowed/prevented based on the de-energized/energized state of the safety relay $\mathbf{RL_2}$), and for providing a corresponding signal S_{STATE} (hereinafter, state signal). As better discussed herebelow, by virtue of the considered circuit system **200** implementation, the state signal S_{STATE} may advantageously take three different levels according to the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays states, namely a low level $S_{STATE,L}$ equal to the lower reference voltage *GND*, a high level $S_{STATE,H}$ equal to the upper reference voltage V_{CC}, and an intermediate level $S_{STATE,I}$ between the low $S_{STATE,L}$ and high $S_{STATE,H}$ levels.

In order to achieve that, the sensing arrangement **220** comprises a sensing network, for example a (*e.g.*, resistive) pull-down network $\mathbf{R_{PD}}$ (schematically represented as a single resistor in the figure, and referred to as pull-down resistor in the following), having a first terminal $\mathbf{T_{RPD,1}}$ providing the state signal S_{STATE} and adapted to be electrically coupled to the side contact $\mathbf{C_{C,RL2}}$ of the safety relay $\mathbf{RL_2}$

(and hence, to the side contact $\mathbf{C_{C,RL1}}$ of the bypass relay $\mathbf{RL_1}$) and a second terminal $\mathbf{T_{RPD,2}}$ receiving the lower reference voltage *GND*.

Preferably, as illustrated, a filtering arrangement (*e.g.*, a low pass filter) $\mathbf{F_{LP}}$ is provided for suppressing possible disturbances from (*i.e.*, associated with) the state signal S_{STATE}– anyway, as should be readily understood, embodiments are possible wherein the filtering arrangement $\mathbf{F_{LP}}$ is not provided, in which case the state signal S_{STATE} may be directly taken from the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$.

As mentioned above, the safety relay $\mathbf{RL_2}$ is operable in a first, energized, state electrically coupling the side contact $\mathbf{C_{C,RL1}}$ of the bypass relay $\mathbf{RL_1}$ to sensing arrangement **220** (*i.e.*, to the pull-down network $\mathbf{R_{PD}}$) or in a second, de-energized, state electrically coupling the side contact $\mathbf{C_{C,RL1}}$ of the bypass relay $\mathbf{RL_1}$ to the input terminal $\mathbf{T_{215,IN2}}$ of the driving arrangement **210**,**215**,**C**, respectively. Preferably, as illustrated, the actual sensing start is controlled by means of an electrically-operated switching device (*e.g.*, a MOS transistor) **225** between the side terminal $\mathbf{C_{C,RL2}}$ of the safety relay $\mathbf{RL_2}$ and the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$ – with the sensing start that may take place, as herein exemplary considered, according to closed/opened states of the MOS transistor **225** controlled according to corresponding values of a control signal S_{225}.

During sensing, the following configurations of the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays states may be discriminated (and signaled, through the respective high $S_{STATE,H}$, low $S_{STATE,L}$ or intermediate $S_{STATE,I}$ levels of the state signal S_{STATE}):

<u>Bypass relay $\mathbf{RL_1}$ in the energized state and safety relay $\mathbf{RL_2}$ in the de-energized state</u>.

In this configuration, the NTC thermistor $\mathbf{R_{NTC}}$ is short-circuited (bypassed) by the bypass relay $\mathbf{RL_1}$, thus the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$ and the neutral terminal $\mathbf{T_N}$ are both at the upper reference voltage V_{CC}. Otherwise stated, the neutral terminal $\mathbf{T_N}$ and the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$ are coupled to each other such that the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor receives the upper reference voltage V_{CC}. In other words, a direct coupling (unless unavoidable parasitic components - such as wires, contacts $\mathbf{C_{B,RL1}}$,$\mathbf{C_{C,RL1}}$ and MOS transistors **225** parasitic resistances) is established between the neutral terminal $\mathbf{T_N}$ and the pull-down resistor $\mathbf{R_{PD}}$. Thus, the state signal S_{STATE} takes the high level $S_{STATE,H}$.

<u>Safety relay **RL2** in the energized state (bypass relay **RL1** either in the energized or de-energized states)</u>.

In this configuration, the central contact $\mathbf{C_{B,RL2}}$ of the safety relay $\mathbf{RL_2}$ is electrically coupled to the side contact $\mathbf{C_{C,RL2}}$, the side contact coupled to the sensing arrangement **220** (*i.e.*, the side contact $\mathbf{C_{A,RL2}}$) being instead floating (*i.e.*, no direct or indirect coupling between the neutral terminal $\mathbf{T_N}$ and the pull-down resistor $\mathbf{R_{PD}}$ takes place). As a result of that, by effect of the pull-down resistor $\mathbf{R_{PD}}$, the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$ is pulled-down to the lower reference voltage *GND*. Thus, the state signal S_{STATE} takes the low level $S_{STATE,L}$.

<u>Bypass **RL1** and safety **RL2** relays in the de-energized state</u>

In this configuration, the neutral terminal $\mathbf{T_N}$ and the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$ are coupled to each other with interposition of the NTC thermistor $\mathbf{R_{NTC}}$. Thus, no direct coupling between the neutral terminal $\mathbf{T_N}$ and the pull-down resistor $\mathbf{R_{PD}}$ takes place, and a conductive path is generated from the neutral terminal $\mathbf{T_N}$ and the pull-down resistor $\mathbf{R_{PD}}$ through the NTC thermistor $\mathbf{R_{NTC}}$ and the safety relay $\mathbf{RL_2}$ (*i.e.*, the central $\mathbf{C_{B,RL2}}$ and side $\mathbf{C_{C,RL2}}$ contacts thereof). As a result of that, the upper reference voltage V_{CC} at the neutral terminal $\mathbf{T_N}$ experiences a partition between the NTC thermistor $\mathbf{R_{NTC}}$ and the pull-down resistor $\mathbf{R_{PD}}$ (omitting possible resistive effects of the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays and/or of the transistor **225**). Hence, the state signal S_{STATE} takes the intermediate level $S_{STATE,I}$ (whose value depends on NTC thermistor $\mathbf{R_{NTC}}$ and pull-down resistor $\mathbf{R_{PD}}$ sizing, not limiting for the present invention).

As better discussed in the following, when the state signal S_{STATE} takes levels different from the expected one in a current (expected) bypass **RL_1** and safety **RL_2** relays configuration, other problems to the bypass relay **RL_1** or to the safety relay **RL_2** or to the NTC thermistor **R_{NTC}** or to the circuit system may also be inferred (such as contacts and/or resistors wear).

The circuit system **200** further comprises a control unit **230**, for example a microcontroller/microprocessor. As conceptually represented in the figure, the control unit **230** is configured to receive the state signal S_{STATE} (or, in the considered example, a filtered version thereof) from the sensing arrangement **220** (*i.e.*, the first terminal **$T_{RPD,1}$** of the pull-down resistor **R_{PD}**) and standard error/control messages *MSG* from the motor module **210**, and, accordingly, to control the door switch **SW_L**, the bypass **RL_1** and safety **RL_2** relays and the MOS transistor **225** (*e.g.*, by means of respective control signals S_{SWL},S_{RL1},S_{RL2},S_{225}) and to command motor module **210** (and, hence, electric motor **205**) activation/deactivation (*e.g.*, by means of command signals S_{COMM}). The control unit **230** is herein assumed to be capable of commanding mechanical lock of the door (by means of the door lock command), and determining whether such a mechanical lock has taken place correctly.

The illustrated circuit system **200** allows achieving a low-voltage sensing, which makes it highly power-saving and reliable. Moreover, the circuit system **200** makes use of a single sensing arrangement for sensing the states of both bypass **RL_1** and safety **RL_2** relays, thus some critical procedures (such as electric motor activation and deactivation procedures, discussed below) may be handled by the appliance **100** in a manner totally oriented to avoid safety risks for the user, while substantially unaffecting power consumption.

Figure 3 shows a simplified flowchart of a motor activation procedure **300**, carried out under the control of the control unit **230** in response to a motor activation request, according to an embodiment of the present invention. Broadly speaking, the motor activation procedure **300** is aimed at activating the electric motor **205** if, from a default configuration wherein the bypass **RL_1** and safety **RL_2** relays are both in the de-energized state (*i.e.*, the state signal S_{STATE} takes the intermediate level $S_{STATE,I}$), mechanical door locking is enabled, the starting current (*i.e.*, the electric current limited by the NTC thermistor $\mathbf{R_{NTC}}$) is correctly fed to the driving arrangement **205**,**210**,C, communication between the electric motor **205** and the driving arrangement **205**,**210**,**C** is active, and the working current is allowed to be fed to the driving arrangement **205**,**210**,**C** (*i.e.*, bypass relay $\mathbf{RL_1}$ in the de-energized state and safety relay $\mathbf{RL_2}$ in the energized state). In addition, as better discussed herebelow, the motor activation procedure **300** also performs check phases aimed at evaluating bypass relay $\mathbf{RL_1}$, safety relay $\mathbf{RL_2}$ or NTC thermistor $\mathbf{R_{NTC}}$ failures.

The motor activation procedure **300** starts by operating the bypass relay $\mathbf{RL_1}$ into the energized state (action block **305**), and by checking (decision block **310**) whether S_{STATE}=$S_{STATE,H}$ – which means that bypass relay $\mathbf{RL_1}$ energization has taken place correctly, the safety relay $\mathbf{RL_2}$ is in the de-energized state (as expected from the last motor deactivation procedure), and no malfunction affect the NTC resistor $\mathbf{R_{NTC}}$.

In the negative case (exit branch **N** of the decision block **310**), the motor activation procedure **300** ends without that motor activation takes place (activity block **360**), possibly by displaying an error code and/or emitting a sound alarm signal indicative of detected or inferred errors. Among the inferable errors, a low level $S_{STATE,L}$ of the state signal S_{STATE} (instead of the expected high level $S_{STATE,L}$) may denote NTC thermistor $\mathbf{R_{NTC}}$ open-circuit or undesired energized state the safety relay $\mathbf{RL_2}$, an intermediate level $S_{STATE,I}$ of the state signal S_{STATE} (instead of the expected high level $S_{STATE,H}$) may denote a bypass relay $\mathbf{RL_1}$ energization failure, whereas a level different from the high $S_{STATE,H}$, intermediate $S_{STATE,I}$ and low $S_{STATE,L}$ levels may denote a generic error of the sensing arrangement **220**.

Otherwise (exit branch **Y** of the decision block **310**), the motor activation procedure **300** continues by operating the bypass relay $\mathbf{RL_1}$ into the de-energized state (activity block **315**) and by checking (decision block **320**) whether S_{STATE}=$S_{STATE,I}$ (*i.e.*, whether the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays are both in the de-energized state and no malfunction affect the NTC resistor $\mathbf{R_{NTC}}$).

In the negative case (exit branch **N** of the decision block **320**), the motor activation procedure **300** ends without that motor activation takes place (activity block **360**), possibly by displaying an error code and/or emitting a sound alarm signal indicative of detected or inferred errors. Among the inferable errors, a high level $S_{STATE,H}$ of the state signal S_{STATE} (instead of the expected intermediate level $S_{STATE,I}$) may denote NTC thermistor $\mathbf{R_{NTC}}$ short-circuit or bypass relay $\mathbf{RL_1}$ de-energization failure, a low level $S_{STATE,L}$ of the state signal S_{STATE} (instead of the expected intermediate level $S_{STATE,I}$) may denote NTC thermistor $\mathbf{R_{NTC}}$ open-circuit or undesired energized state the safety relay $\mathbf{RL_2}$, whereas a level different from the high $S_{STATE,H}$, intermediate $S_{STATE,I}$ and low $S_{STATE,L}$ levels may denote, as before, a generic error of the sensing arrangement **220**. Undesired energized state of the safety relay $\mathbf{RL_2}$ is the least likely error that could affect the circuit system **200** at decision blocks **310** and **320** (indeed, as better understood from the following description, safety relay $\mathbf{RL_2}$ de-energization state is ensured before ending each motor deactivation procedure).

Back to decision block **320**, if instead the state signal S_{STATE} takes the intermediate level $S_{STATE,I}$ (exit branch **Y** of the decision block **320**), the motor activation procedure **300** continues by switching the door switch $\mathbf{SW_L}$ into the closed configuration (by means of the signal S_{SWL}, so that electrical coupling between the line terminal $\mathbf{T_L}$ and the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215** is established), and by providing the door lock command to the mechanical lock of the door (activity block **325**), thereafter correct door locking is checked at the decision block **330**.

If mechanical lock of the door has failed, exit branch **N** of the decision block **330**, the motor activation procedure **300** ends (activity block **360**), as the possibility of opening the door **115** when the electric motor **105** is activated is not prevented. Otherwise, exit branch **Y** of the decision block **330**, it meaning that the electric motor **105** can be activated without risks for any user accidentally tenting to open the door **115**, the motor activation procedure **300** goes on by operating the safety relay $\mathbf{RL_2}$ into the energized stated (activity block **335**) - thereby allowing the AC supply voltage to be fed across the input terminals $\mathbf{T_{205,IN1}}$,$\mathbf{T_{205,IN2}}$ of the rectifying arrangement **215** and a limited inrush current (*i.e.*, the inrush current limited by the

NTC thermistor $\mathbf{R_{NTC}}$) to softly charge the bulk capacitor **C** at the DC supply voltages V_{DC1},V_{DC2} - and by checking (decision block **340**) whether safety relay $\mathbf{RL_2}$ energization has taken place correctly - *i.e.*, whether S_{STATE}=$\mathrm{S_{STATE,L}}$ indicating that the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays are in the de-energized and energized states, respectively, and no malfunction affects the NTC thermistor $\mathbf{R_{NTC}}$.

In the negative case (exit branch **N** of the decision block **340**), the motor activation procedure **300** ends (activity block **360**), possibly by displaying proper error codes and/or emitting alarm signals indicative of the detected error.

In the positive case (exit branch **Y** of the decision block **340**), another check is performed for determining (decision block **345**) correct, active and functioning communication between the electric motor **205** and the motor module **210** by means of the standard error/control messages *MSG*. If correct, active and functioning communication between the electric motor **205** and the motor module **210** is determined (exit branch **Y** of the decision block **345**), the bypass relay $\mathbf{RL_1}$ is operated into the energized state (activity block **350**) - so that the working current substantially depending on the AC supply voltage and on the experienced impedance is entirely fed to the rectifying arrangement **215**) - and motor module **210** activation (and, hence, electric motor **205** correct and safe activation) is commanded by means of the command signals S_{COMM} (activity block **355**), otherwise (exit branch **N** of the decision block **345**) the motor activation procedure **300** ends (activity block **360**) possibly by displaying proper error codes and/or emitting alarm signals indicative of the detected error. As visible in the figure, the motor activation procedure **300** ends in any case after electric motor **205** activation.

Turning now to **Figure 4**, it shows a simplified flowchart of a motor deactivation procedure **400** carried out by the control unit **230** in response to a motor deactivation request, according to an embodiment of the present invention. Broadly speaking, the motor deactivation procedure **400** is aimed at disenabling mechanical door locking only if, upon motor deactivation has occurred, the safety relay $\mathbf{RL_2}$ is operated into the de-energized state (*i.e.*, state signal S_{STATE} taking the intermediate level $\mathrm{S_{STATE,I}}$, so that no electric current is allowed to flow to the driving arrangement

210,**215**,**C** any longer), and the bypass relay **RL**$_1$ is operated into the de-energized state (for consistency with a following motor activation procedure, wherein, as discussed above, the bypass **RL**$_1$ and safety **RL**$_2$ relays in the de-energized states represent the preferred default starting configuration for inferring failures).

The motor deactivation procedure **400** starts by commanding, by means of the command signals S_{COMM}, deactivation of the electric motor **205** (activity block **405**) in response to the motor deactivation request, and by operating the safety relay **RL**$_2$ into the de-energized state (action block **420**) as soon as the electric motor **205** has stopped or, anyway, after a predefined time interval has elapsed from the command signals S_{COMM}. This is conceptually represented in the figure by loop connection between a decision block **410** (wherein electric motor **205** stopping is checked) and a decision block **415** (wherein predefined time interval elapsing is checked). Briefly, the motor deactivation procedure **400** keeps running the decision blocks **410**,**415** as long as the electric motor **205** has not stopped (exit branch **N** of the decision block **410**) and the predefined time interval has not elapsed (exit branch **N** of the decision block **415**). Instead, if (*i.e.*, as soon as) the electric motor **205** has stopped (exit branch **Y** of the decision block **410**), or the predefined time interval has elapsed without that the electric motor **205** has stopped (exit branch **Y** of the decision block **415**), the safety relay **RL**$_2$ is operated into the de-energized state (activity block **420**). As should be understood, elapsing of the predefined time interval might mean that communication between the electric module **205** and the motor module **210** is temporary or permanently prejudiced (in which case the motor module **210** may not have deactivated the electric motor **205**, or may not have received confirmation about electric motor **205** stopping), so that operating the safety relay **RL**$_2$ into the de-energized state allows safely interrupting electric motor **205** powering in any case.

The motor deactivation procedure **400** goes on by checking (decision block **425**) whether the bypass relay **RL**$_2$ de-energization has taken place correctly and the bypass relay **RL**$_1$ is energized, as expected – *i.e.*, whether the bypass **RL**$_1$ and safety **RL**$_2$ relays are in the energized and de-energized states, respectively, namely whether S_{STATE}=$\mathrm{S}_{\mathrm{STATE,H}}$.

In the negative case (exit branch **N** of the decision block **425**), meaning that safe interruption of electric motor **205** powering is not possible, emergency procedures, not shown, are invoked (possibly, by displaying an error code and/or emitting a sound alarm signal indicative of the detected error), thereafter the motor deactivation procedure **400** ends (activity block **440**). Preferably, the motor deactivation procedure **400** ends by displaying proper error codes and/or emitting alarm signals indicative of detected or inferred errors. Similarly to the above, among the inferred errors, a low level $S_{STATE,L}$ of the state signal S_{STATE} (instead of the expected high level $S_{STATE,L}$) may denote safety relay $\mathbf{RL_2}$ de-energization failure, an intermediate level $S_{STATE,I}$ of the state signal S_{STATE} (instead of the expected high level $S_{STATE,H}$) may denote undesired de-energized state the bypass relay $\mathbf{RL_1}$, whereas a level different from the high $S_{STATE,H}$, intermediate $S_{STATE,I}$ and low $S_{STATE,L}$ levels may denote, as before, a generic error of the sensing arrangement **220**.

If instead the state signal S_{STATE} takes the high level $S_{STATE,H}$ (exit branch **Y** of the decision block **425**), the motor deactivation procedure **400** goes on by operating the bypass relay $\mathbf{RL_1}$ into the de-energized state (activity block **430**), and by disenabling mechanical door locking (activity block **435**) -preferably, while switching on the door switch $\mathbf{SW_L}$ by means of the control signal S_{SWL}, so as to cause electrical decoupling between the line terminal $\mathbf{T_L}$ and the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215**), thereafter the motor deactivation procedure **400** ends (activity block **440**).

As mentioned above, bypass relay $\mathbf{RL_1}$ de-energization, altough not necessary, is advantageously carried out for consistency with a following motor activation procedure (such as the motor activation procedure **300** discussed in the foregoing) providing the de-energized state of both bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays as default starting configuration for inferring failures – anyway, nothing prevents from carrying out bypass relay $\mathbf{RL_1}$ de-energization at the start of the motor activation procedure **300**. For the same reasons, as illustrated, no check of whether bypass relay $\mathbf{RL_1}$ de-energization has taken place correctly is carried out after the activity block **430** (this check being indeed carried out at the start of the motor activation procedure following the motor de-activation procedure **400**), although this should not be construed limitatively.

Turning now to **Figure 5**, it schematically shows a portion of a circuit system **500** of the appliance **100** according to another embodiment of the present invention. The circuit system **500** is similar to the circuit system **200**, reason why, in the following, same or similar elements will not be discussed again for the sake of conciseness.

Specifically, according to the considered embodiment, the circuit system **500** comprises, as above, the electric motor **205**, the motor module **210** (powered between the first V_{DC1} and second V_{DC2} DC supply voltages), the power conversion arrangement for (selectively) providing said DC supply voltages V_{DC1},V_{DC2} according to the AC supply voltage selectively received from the line $\mathbf{T_L}$ and neutral $\mathbf{T_N}$ terminals of the AC power supply, and the sensing arrangement **220**.

The power conversion arrangement comprises, as before, the rectifying arrangement **215**, whose input terminals $\mathbf{T_{215,IN1}}$,$\mathbf{T_{215,IN2}}$ are selectively coupleable to the line $\mathbf{T_L}$ and neutral $\mathbf{T_N}$ terminals, respectively, for receiving the AC supply voltage and whose output terminals $\mathbf{T_{215,OUT1}}$,$\mathbf{T_{215,OUT2}}$ provide pulsed DC voltages, and a smoothing (or bulk) capacitor **C**, whose terminals $\mathbf{T_{C1}}$,$\mathbf{T_{C2}}$ are electrically coupled to the output terminals $\mathbf{T_{215,OUT1}}$,$\mathbf{T_{215,OUT2}}$, respectively, of the rectifying arrangement **215** for smoothing the pulsed DC voltages into said DC supply voltages V_{DC1},V_{DC2}.

Selective reception of the AC supply voltage from line $\mathbf{T_L}$ and neutral $\mathbf{T_N}$ terminals is achieved by means of a number of electrically-operated switching devices, comprising, as above, a door switch $\mathbf{SW_L}$ provided between the line terminal $\mathbf{T_L}$ and the input terminal $\mathbf{T_{215,IN1}}$ of the rectifying arrangement **215**, and a switching arrangement provided between the neutral terminal $\mathbf{T_N}$ and the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215**. Differently from the above, the switching arrangement comprises a single (*e.g.*, electromagnetic) relay **RL** having both bypass and safety functions (thus, referred to as bypass/safety relay hereinafter), and electrically coupled between the neutral terminal $\mathbf{T_N}$ and the input terminal

$\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215**. The use of a single relay **RL** makes the circuit system **500** more simple and cheap than the circuit system **200**.

The bypass/safety relay **RL**, *e.g.* structurally similar to the bypass $\mathbf{RL_1}$ and safety $\mathbf{RL_2}$ relays, comprises side (fixed) contacts $\mathbf{C_{A,RL}C_{C,RL}}$ electrically coupled to a sensing arrangement **520** and to the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215**, respectively, and a central contact $\mathbf{C_{B,RL}}$, movable with respect to the side contacts $\mathbf{C_{A,RL}C_{C,RL}}$, electrically coupled to the neutral terminal $\mathbf{T_N}$. In the considered example, the bypass/safety relay **RL** is herein assumed, in the de-energized state (*i.e.*, in absence of current across the coil), with the central contact $\mathbf{C_{B,RL}}$ electrically coupled to a respective side contact (*e.g.* the side contact $\mathbf{C_{A,RL}}$), and, in the energized state (*i.e.*, in presence of an electric current across the coil)with the central contact $\mathbf{C_{B,RL}}$ electrically coupled to the other side contact (*i.e.*, the side contact $\mathbf{C_{C,RL}}$).

In order avoid (in the off condition of the door switch $\mathbf{SW_L}$) large peak surge currents, or inrush currents, flowing through (thus electrically stressing) the door switch $\mathbf{SW_L}$, the rectifying arrangement **215** and the bulk capacitor **C** (especially when the bulk capacitor **C** is initially discharged), the circuit system **500** also comprises an inrush current limiting device, for example a NTC thermistor (as before) or, as in the exemplary considered embodiment, a fusible resistor $\mathbf{R_{FUSE}}$ electrically coupled in parallel with the bypass/safety relay **RL** for mitigating the inrush current experienced during startup. According to the exemplary illustrated embodiment, the fusible resistor $\mathbf{R_{FUSE}}$ is electrically coupled between the central $\mathbf{C_{B,RL}}$ and side $\mathbf{C_{C,RL}}$ contacts of the bypass/safety relay **RL** (and, hence, between the neutral terminal $\mathbf{T_N}$ and the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215**).

Basically, a fusible resistor is a standard resistor by the electrical viewpoint, and if further designed to open without flames when overloaded (thus, sometimes also referred to as flameproof resistor). The use of the fusible resistor $\mathbf{R_{FUSE}}$ instead of the NTC thermistor $\mathbf{R_{NTC}}$ makes the circuit system **500** cheaper than the circuit system **200**, and ensures a constant starting current to be fed to the rectifying arrangement during startup.

Thus, by proper sizing of the fusible resistor $\mathbf{R_{FUSE}}$, during startup (door switch $\mathbf{SW_L}$ in the on condition and bypass/safety relay **RL** in the de-energized state) the neutral terminal $\mathbf{T_N}$ is electrically coupled to the input terminal $\mathbf{T_{215,IN2}}$ of the rectifying arrangement **215** through the fusible resistor $\mathbf{R_{FUSE}}$, and a fixed starting current (depending on fusible resistor $\mathbf{R_{FUSE}}$ resistance) is allowed to flow therethrough. After startup completing or preset time elapsing, the bypass/safety relay **RL** is operated into the energized state (*i.e.*, central contact $\mathbf{C_{B,RL}}$ thereof moved to the side contact $\mathbf{C_{C,RL}}$), thus bypassing (*i.e.*, substantially short-circuiting) the fusible resistor $\mathbf{R_{FUSE}}$ and allowing a working current (substantially depending on the AC supply voltage and on the experienced impedance) to be fed to the rectifying arrangement **215** (through the bypass/safety relay **RL**, *i.e.* the central $\mathbf{C_{B,RL}}$ and side $\mathbf{C_{C,RL}}$ contacts thereof).

The sensing arrangement **520** comprises, similarly to the sensing arrangement **220**, the pull-down resistor $\mathbf{R_{PD}}$, whose first terminal $\mathbf{T_{RPD,1}}$ is adapted to be electrically coupled to the side terminal $\mathbf{C_{A,RL}}$ of the bypass/safety relay **RL** (*e.g.*, as above, by means of the MOS transistor **225**, or other electrically-operated switching device) and whose second terminal $\mathbf{T_{RPD,2}}$ is configured to receive the lower reference voltage *GND*, and, preferably, the filtering arrangement $\mathbf{F_{LP}}$.

The sensing arrangement **520**, when coupled to the side contact $\mathbf{C_{A,RL}}$ of the bypass/safety relay **RL** (MOS transistor **225** in the on condition), is intended to sense the (energized or de-energized) state of the bypass/safety relay **RL** and to provide a corresponding state signal S^*_{STATE}. As better discussed herebelow, by virtue of the considered circuit system 5**00** implementation, the state signal S^*_{STATE} may take two different levels according to the bypass/safety relay **RL** state, namely the low $S_{STATE,L}$ and high $S_{STATE,H}$ levels.

During sensing, the following bypass/safety relay **RL** states may be discriminated (and signaled, through the respective high $S_{STATE,H}$ or low $S_{STATE,L}$ levels of the state signal S^*_{STATE}):

Bypass/safety relay **RL** in the energized state

In this state, the fusible resistor $\mathbf{R_{FUSE}}$ is short-circuited (bypassed) by the bypass/safety relay **RL**. The central terminal $\mathbf{C_{B,RL}}$ of the bypass/safety relay **RL** is electrically coupled to the side terminal $\mathbf{C_{C,RL}}$, the side terminal coupled to the sensing arrangement **520** (*i.e.*, the side terminal $\mathbf{C_{A,RL2}}$) being instead floating. As a result of that, by effect of the pull-down resistor $\mathbf{R_{PD}}$, the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$ is pulled down to the lower reference voltage *GND*. Thus, the state signal S^{*}_{STATE} takes the low level $S_{STATE,L}$.

Bypass/safety relay **RL** in the de-energized state

In this state, the first terminal $\mathbf{T_{RPD,1}}$ of the pull-down resistor $\mathbf{R_{PD}}$ and the neutral terminal $\mathbf{T_N}$ are both at the upper reference voltage V_{CC} (as being directly coupled to each other). Thus, the state signal S^{*}_{STATE} takes the high level $S_{STATE,H.}$

As better discussed in the following procedures, errors to the bypass/safety relay **RL** or to the fuse resistor $\mathbf{R_{FUSE}}$ may also be inferred when the state signal S^{*}_{STATE} takes a level different from the expected one.

The circuit system **500** further comprises a control unit **530**, similar to the control unit **230**, configured to receive the state signal S^{*}_{STATE} from the sensing arrangement **520** and the standard error/control messages *MSG* from the motor module **210**, and, accordingly, to control the door switch $\mathbf{SW_L}$, the bypass/safety relay **RL** and the MOS transistor **225** (*e.g.*, by means of respective control signals S_{SWL},S_{RL},S_{225}) and to command motor module **210** (*e.g.*, by means of the command signals S_{COMM}). As for the control unit **230**, the control unit **530** is herein assumed to be capable of commanding mechanical lock of the door **115** (by means of the door lock command), and determining whether such a mechanical lock has taken place correctly.

Figures 6 and **7** show simplified flowcharts of respective procedures implemented by the circuit system of **Figure 5** according to an embodiment of the present invention.

With reference first to **Figure 6**, it shows a motor activation procedure **600** carried out under the control of the control unit **530** in response to a motor activation request, according to an embodiment of the present invention. Broadly speaking, the motor activation procedure **600** is aimed at activating the electric motor **205** if, from a default configuration wherein the bypass/safety **RL** is in the de-energized state (*i.e.*, the state signal S_{STATE} takes the high level $S_{STATE,H}$), mechanical door locking is enabled, the starting current (*i.e.*, the electric current limited by the fuse resistor $\mathbf{R_{FUSE}}$) is correctly fed to the driving arrangement **205**,**210**,C, communication between the electric motor **205** and the driving arrangement **205**,**210**,C is active, and the working current is allowed to be fed to the driving arrangement **205**,**210**,C (*i.e.*, bypass/safetyrelay **RL** in the energized state). In addition, as better discussed herebelow, the motor activation procedure **600** also performs check phases aimed at evaluating bypass/safety relay **RL** or fuse resistor $\mathbf{R_{FUSE}}$.

The motor activation procedure **600** starts by checking (decision block **605**) whether S^*_{STATE}=$S_{STATE,H}$ – it meaning that bypass/safety relay **RL** is in the de-energized state (as expected from the last motor deactivation procedure), and no malfunction affect the fuse resistor $\mathbf{R_{FUSE}}$.

In the negative case (exit branch **N** of the decision block **605**), the motor activation procedure **600** ends without that motor activation takes place (activity block **640**), possibly by displaying an error code and/or emitting a sound alarm signal indicative of detected or inferred errors. Among the inferable errors, a low level $S_{STATE,L}$ of the state signal S^*_{STATE} (instead of the expected high level $S_{STATE,H}$) may denote fuse resistor $\mathbf{R_{FUSE}}$ short-circuit or undesired bypass/safety relay **RL** energized state, whereas a level different from the high $S_{STATE,H}$ and low $S_{STATE,L}$ levels may denote a generic error of the sensing arrangement **520**.

Otherwise (exit branch **Y** of the decision block **605**), the motor activation procedure **600** goes on by enabling mechanical door locking (activity block **610**), thereafter correct door locking is checked at the decision block **615**.

If mechanical lock of the door has failed, exit branch **N** of the decision block **615**, the motor activation procedure **600** ends (activity block **640**), as the possibility of opening the door **115** when the electric motor **205** is activated is not prevented. Otherwise, exit branch **Y** of the decision block **615**, it meaning that the electric motor **205** can be activated without risks for any user accidentally tenting to open the door **115**, the motor activation procedure **600** goes on by determining (decision block **620**) correct, active and functioning communication between the electric motor **205** and the motor module **210** by means of the standard error/control messages *MSG*.

If correct, active and functioning communication between the electric motor **205** and the motor module **210** is determined (exit branch **Y** of the decision block **620**), the bypass/safety relay **RL** is operated into the energized state (activity block **625**) - so that the working current substantially depending on the AC supply voltage and on the experienced impedance is entirely fed to the rectifying arrangement **215**). Otherwise, the motor activation procedure **600** ends without that motor activation takes place, possibly by displaying an error code and/or emitting a sound alarm signal indicative of the detected error. Preferably, the error detected in this case may be either fusible resistor $\mathbf{R_{FUSE}}$ opening (so that the motor module **210**, being not powered, is not able to provide the standard error/control messages *MSG* to the control unit **530**) or motor module **210** malfunctioning.

Then, decision block **630**, the motor activation procedure **600** checks wether bypass/safety relay **RL** energization has taken place correctly - *i.e.*, whether $S^*_{STATE}=S_{STATE,L}$. In the affirmative case (exit branch **Y** of the decision block **630**), motor module **210** activation (and, hence, electric motor **205** correct and safe activation) is commanded by means of the command signals S_{COMM} (activity block **635**), thereafter the motor activation procedure **600** ends (activity block **640**).

If instead bypass/safety relay **RL** energization has not taken place correctly (exit branch **N** of the decision block **630**), the motor activation procedure **600** ends (activity block **640**) without motor activation, possibly by displaying proper error codes and/or emitting alarm signals indicative of detected or inferred errors. Among the inferable errors, a level different from the high $S_{STATE,H}$ and low $S_{STATE,L}$ levels may denote, as before, a generic error of the sensing arrangement **520**.

Turning now to **Figure 7**, it shows a simplified flowchart of a motor deactivation procedure **700** carried out under the control of the control unit **530** in response to a motor deactivation request, according to an embodiment of the present invention. Broadly speaking, the motor deactivation procedure **700** is aimed at disenabling mechanical door locking if motor deactivation has occurred, and if, after operating the bypass/safety relay **RL** into the energized state, the state signal S^{*}_{STATE} takes the high level $S_{STATE,H}$ and if a predefined time period has passed since motor deactivation request.

The motor deactivation procedure **700** starts by commanding, by means of the command signals S_{COMM}, deactivation of the electric motor **205** (activity block **705**) in response to the motor deactivation request, and by operating the bypass/safety relay **RL** into the de-energized state (action block **720**) as soon as the electric motor **205** has stopped or, anyway, after a predefined time interval has elapsed from the motor deactivation request (or, alternatively, from transmission of the command signals S_{COMM}). This is conceptually represented in the figure by loop connection between a decision block **710** (wherein electric motor **205** stopping is checked) and a decision block **715** (wherein predefined time interval elapsing is checked). Briefly, the motor deactivation procedure **700** keeps running the decision blocks **710**,**715** as long as the electric motor **205** has not stopped (exit branch **N** of the decision block **710**) and the predefined time interval has not elapsed (exit branch **N** of the decision block **715**). Instead, if (*i.e.*, as soon as) the electric motor **205** has stopped (exit branch **Y** of the decision block **710**), or the predefined time interval has elapsed without that the electric motor **205** has stopped (exit branch **Y** of the decision block **715**), the bypass/safety relay **RL** is operated into the de-energized state (activity block **720**). As discussed above, elapsing of the predefined time interval might mean that communication between the electric module **205** and the motor module **210** is temporary or permanently prejudiced (in which case the motor module **210** may not have deactivated the electric motor **205**, or may not have received confirmation about electric motor **205** stopping), so that operating the bypass/safety relay **RL** into the de-energized state allows safely interrupting electric motor **205** powering in any case. Indeed, bypass/safety relay **RL** de-energization causes intervention of the fusible resistor **R_{FUSE}**, and hence unpowering the motor module **210** (in fact, the inrush current through the fusible resistor **R_{FUSE}** is not sufficient to keep the electric motor **205** powered).

The motor deactivation procedure **700** goes on by checking (decision block **725**) whether the bypass/safety relay **RL** de-energization has taken place correctly – *i.e.*, whether S^*_{STATE}=$S_{STATE,H}$.

In the negative case (exit branch **N** of the decision block **425**), the motor deactivation procedure **700** ends (activity block **740**) without door unlocking (so as to prevent the user from opening the door **115** in a not safe condition of the appliance **100**), preferably by displaying proper error codes and/or emitting alarm signals indicative of detected or inferred errors. Similarly to the above, among the inferred errors, a level different from the high $S_{STATE,H}$ and low $S_{STATE,L}$ levels may denote a generic error of the sensing arrangement **520**.

If instead the state signal S^*_{STATE} takes the high level $S_{STATE,H}$ (exit branch **Y** of the decision block **725**), the motor deactivation procedure **700** goes on by disenabling mechanical door locking (activity block **735**) - preferably, while switching off the door switch **SW_L** by means of the control signal S_{SWL}, so as to cause electrical decoupling between the line terminal **T_L** and the input terminal **$T_{215,IN2}$** of the rectifying arrangement **215**) - after a safety time interval (*e.g.*, from bypass/safety relay RL de-energization) has elapsed(decision block **730**), thereafter the motor deactivation procedure **700** ends (activity block **740**).

Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply to the invention described above many logical and/or physical modifications and alterations. More specifically, although the invention has been described with a certain degree of particularity with reference to preferred embodiments thereof, it should be understood that various omissions, substitutions and changes in the form and details as well as other embodiments are possible. In particular, different embodiments of the invention may even be practiced without the specific details (such as the numeric examples) set forth in the preceding description for providing a more thorough understanding thereof; on the contrary, well known features may have been omitted or simplified in order not to obscure the description with unnecessary particulars.

*****

CLAIMS

1. Washing and/or drying appliance (**100**) comprising:

an electric load (**205**),

a driving arrangement (**210**,**215**,C) for driving the electric load (**205**), the driving arrangement (**210**,**215**,**C**) having first (**$T_{205,IN1}$**) and second (**$T_{205,IN2}$**) terminals coupleable, respectively, to a line terminal (**T_L**) and to a neutral terminal (**T_N**) providing a reference voltage (V_{CC}),

an inrush current limiting device (**R_{FUSE}**;**R_{NTC}**) and a switching device (**RL**;**RL_1**) between the reference terminal (**T_N**) and the second terminal (**$T_{205,IN2}$**) of the driving arrangement (**210**,**215**,C), the switching device (**RL**;**RL_1**) being operable in first or second states preventing or allowing, respectively, an electric current to flow through the inrush current limiting device (**R_{FUSE}**,**R_{NTC}**), and

a sensing network (**R_{PD}**) for sensing the first or second states of the switching device (**RL**;**RL_1**) and for providing a corresponding state signal (S_{STATE};S^*_{STATE}), the sensing network (**R_{PD}**) having a first terminal (**$T_{RPD,1}$**), and a second terminal (**$T_{RPD,2}$**) coupled to a reference terminal providing a further reference voltage (*GND*) lower than the reference voltage (V_{CC}), wherein, during sensing:

in the first state of the switching device (**RL**;**RL_1**) the reference terminal (**T_N**) and the first terminal (**$T_{RPD,1}$**) of the sensing network (**R_{PD}**) being coupled to each other such that the first terminal (**$T_{RPD,1}$**) of the sensing network (**R_{PD}**) receives the reference voltage (V_{CC}) and the state signal (S_{STATE};S^*_{STATE}) takes a first level ($S_{STATE,H}$) equal to the reference voltage (V_{CC}), in the second state the state signal (S_{STATE}, S^*_{STATE}) taking a second level ($S_{STATE,I}$;$S_{STATE,L}$) lower than the first level ($S_{STATE,H}$).

2. Washing and/or drying appliance (**100**) according to Claim 1, wherein in the second state of the switching device (**RL_1**) the reference terminal (**T_N**) and the first terminal (**$T_{RPD,1}$**) of the sensing network (**R_{PD}**) are coupled to each other with interposition of the inrush current limiting device (**R_{NTC}**), whereby the second level ($S_{STATE,I}$) of the state signal (S_{STATE}) is between the first the reference voltage (V_{CC})

and the further reference voltage (*GND*) according to a partition between the inrush current limiting device (**R_{NTC}**) and the sensing network (**R_{PD}**).

3. Washing and/or drying appliance (**100**) according to Claim 1, wherein in the second state of the switching device (**RL**) the first terminal (**$T_{RPD,1}$**) of the sensing network (**R_{PD}**) is electrically floating, whereby the second level ($S_{STATE,L}$) of the state signal (S_{STATE}) is at the further reference voltage (*GND*) by pull-down action of the sensing network (**R_{PD}**).

4. Washing and/or drying appliance (**100**) according to Claim 3, wherein the switching device (**RL**) has a first contact (**$C_{A,RL}$**) electrically coupled, during sensing, to the sensing network (**R_{PD}**), a second contact (**$C_{C,RL}$**) coupled to the second terminal (**$T_{205,IN2}$**) of the driving arrangement (**210**,**215**,**C**), and a third contact (**$C_{B,RL}$**) electrically coupled to the reference terminal (**T_N**) and contacting the first (**$C_{A,RL}$**) or second (**$C_{C,RL}$**) contacts in first or second states, respectively, of the switching device (**RL**).

5. Washing and/or drying appliance (**100**) according to Claim 1 or 2, wherein the switching device (**RL_1**) has a first contact (**$C_{A,RL1}$**) electrically floating, a second contact (**$C_{C,RL1}$**), and a third contact (**$C_{B,RL1}$**) electrically coupled to the reference terminal (**T_N**) and contacting the first (**$C_{A,RL1}$**) or second (**$C_{C,RL1}$**) contacts in first or second states, respectively, of the switching device (**RL_1**), and wherein

the appliance (**100**) also comprises a further switching device (**RL_2**) operable in first or second states electrically coupling the second contact (**$C_{C,RL1}$**) of the switching device (**RL_1**) to the first terminal (**$T_{RPD,1}$**) of the sensing network (**R_{PD}**) or to the second terminal (**$T_{215,IN2}$**) of the driving arrangement (**210**,**215**,**C**), respectively.

6. Washing and/or drying appliance (**100**) according to Claim 5, wherein the first terminal (**$T_{RPD,1}$**) of the sensing network (**R_{PD}**) is coupled, during sensing, to the

second contact ($C_{C,RL1}$) of the switching device (RL_1), and wherein in the second state of the further switching device (RL_2) the state signal (S_{STATE}) takes a third level ($S_{STATE,L}$) equal to the further reference voltage (*GND*).

7. Washing and/or drying appliance (**100**) according to any of the preceding Claims, wherein the sensing network (R_{PD}) is a resistive network (R_{PD}).

8. Washing and/or drying appliance (**100**) according to any of the preceding Claims, further comprising a filtering arrangement (F_{LP}) for suppressing disturbances from the state signal (S_{STATE}, S^{*}_{STATE}).

9. Washing and/or drying appliance (**100**) according to any of the preceding Claims, wherein the inrush current limiting device (R_{FUSE};R_{NTC}) is a fusible resistor (R_{FUSE}) or a negative temperature coefficient thermistor (R_{NTC}).

10. Washing and/or drying appliance (**100**) according to any of the preceding Claims, wherein the electric load (**205**) is an electric motor, for example a "*Variable-Frequency Drive*" motor or a Brushless DC motor

11. Washing and/or drying appliance (**100**) according to any of the preceding Claims, wherein the appliance is a laundry washing appliance intended to perform only laundry washing operations, or a laundry drying appliance intended to perform only laundry drying operations, or a laundry washing/drying appliance intended to perform both laundry washing and laundry drying operations.

12. Washing and/or drying appliance (**100**) according to any of the preceding Claims, wherein the appliance (**100**) further comprises a mechanical door-lock device for mechanically locking an appliance door (**120**) thereby preventing door opening when the electric load (**205**) is activated.

13. Method (**300**,**400**;**600**,**700**) for operating a washing and/or drying appliance (**100**), the appliance (**100**) comprising:

an electric motor (**205**) and a driving arrangement (**205**,**210**,**C**) for driving it, the driving arrangement (**210**,**215**,**C**) being coupleable to a line terminal ($\mathbf{T_L}$) and to a neutral terminal ($\mathbf{T_N}$) providing a reference voltage (V_{CC}),

between the neutral terminal ($\mathbf{T_N}$) and the driving arrangement (**210**,**215**,**C**), an inrush current limiting device ($\mathbf{R_{FUSE}}$;$\mathbf{R_{NTC}}$) and a switching device (**RL**;$\mathbf{RL_1}$), the switching device (**RL**;$\mathbf{RL_1}$) being operable between first and second states allowing and preventing, respectively, an electric current to flow through the inrush current limiting device ($\mathbf{R_{FUSE}}$,$\mathbf{R_{NTC}}$), and

a sensing arrangement (**220**) configured for sensing the first or second states of the switching device (**RL**;$\mathbf{RL_1}$) and for providing a corresponding state signal (S_{STATE};S^*_{STATE}), in the first state of the switching device (**RL**;$\mathbf{RL_1}$) the state signal (S_{STATE};S^*_{STATE}) taking a first level ($S_{STATE,H}$) equal to the reference voltage (V_{CC}), and in the second state of the switching device (**RL**;$\mathbf{RL_1}$) the state signal (S_{STATE}, S^*_{STATE}) taking a second level ($S_{STATE,I}$;$S_{STATE,L}$) lower than the first level ($S_{STATE,H}$),

the method comprising, under the control of a control unit (**230**,**530**) of the appliance (**100**) and in response to a motor activation request:

if (**310**;**605**) the state signal (S_{STATE};S^*_{STATE}) takes the second level ($S_{STATE,I}$;$S_{STATE,L}$), feeding (**335**,**340**;**615**) the driving arrangement (**205**,**210**,**C**) with a first electric current limited by the inrush current limiting device ($\mathbf{R_{FUSE}}$;$\mathbf{R_{NTC}}$), and

if (**345**;**620**) communication between the electric motor (**205**) and the driving arrangement (**205**,**210**,**C**) is active, operating (**350**;**625**) the switching device (**RL**,$\mathbf{RL_1}$) into the second state thereby allowing a second electric current not limited by the inrush current limiting device ($\mathbf{R_{FUSE}}$;$\mathbf{R_{NTC}}$) to be fed to the driving arrangement (**205**,**210**,**C**), and activating (**355**;**635**) the electric motor (**205**).

14. Method (**300**,**400**;**600**,**700**) according to Claim 13, wherein the appliance (**100**) further comprises a mechanical door-lock device for mechanically locking an appliance door (**120**) thereby preventing door opening when the electric motor (**205**)

is activated, wherein the method (**300**,**400**;**600**,**700**) further comprises enabling (**325**;**610**) mechanical door locking, and wherein said feeding (**335**,**340**;**615**) the driving arrangement (**205**,**210**,**C**) with a first electric current limited by the inrush current limiting device (**R**$_{FUSE}$;**R**$_{NTC}$) is performed if (**330**;**615**) mechanical door locking is enabled.

15. Method (**300**) according to Claim 14, wherein the appliance (**100**) further comprises a further switching device (**RL**$_2$) operable in first or second states electrically coupling the switching device (**RL**$_1$) to the sensing arrangement (**220**) or to the driving arrangement (**205**,**210**,**C**), respectively, in the first state of the further switching device (**RL**$_2$) the state signal (S_{STATE}) taking the first ($S_{STATE,H}$) or second ($S_{STATE,I}$) levels according to the first or second states, respectively, of the switching device (**RL**$_1$), and wherein said enabling (**325**) mechanical door locking if (**310**;**605**) the state signal (S_{STATE}) takes the second level ($S_{STATE,I}$) comprises:

operating (**305**) the switching device (**RL**$_1$) in the first state,

if (**310**) the state signal (S_{STATE}) takes the first level ($S_{STATE,I}$), operating (**315**) the switching device (**RL**$_1$) in the second state, and

if (**320**) the state signal (S_{STATE}) takes the second level ($S_{STATE,I}$), performing said enabling (**325**;**610**) mechanical door locking.

16. Method (**300**) according to Claim 15, wherein in the second state of the further switching device (**RL**$_2$) the state signal (S_{STATE}) takes a third level ($S_{STATE,L}$) lower than the first ($S_{STATE,H}$) and second ($S_{STATE,I}$) levels, the method further comprising, after said enabling (**325**;**610**) mechanical door locking:

if (**330**) mechanical door locking is enabled, operating (**335**) the further switching device (**RL**$_2$) in the second state, and

performing said operating (**350**) the switching device (**RL**$_1$) into the second state if (**345**) communication between the electric motor (**205**) and the driving arrangement (**205**,**210**,**C**) is active and if (**340**) the state signal (S_{STATE}) takes the third level ($S_{STATE,L}$).

17. Method (**400**) according to Claim 14, 15 or 16, further comprising, in response to a motor deactivation request:

if (**410**,**415**) motor deactivation has occurred, operating (**420**) the further switching device (**RL_2**) into the first state, and

if the state signal (S_{STATE}) takes the second level ($S_{STATE,I}$), operating (**430**) the switching device (**RL_1**) into the first state and disenabling (**435**) mechanical door locking.

18. Method (**700**) according to Claim 14, further comprising, in response to a motor deactivation request:

if (**710**,**715**) motor deactivation has occurred, operating (**720**) the switching device (**RL**) into the first state, and

if the state signal (S_{STATE}) takes the first level ($S_{STATE,H}$) and if (**730**) a predefined time period has passed since motor deactivation request, disenabling (**735**) mechanical door locking.

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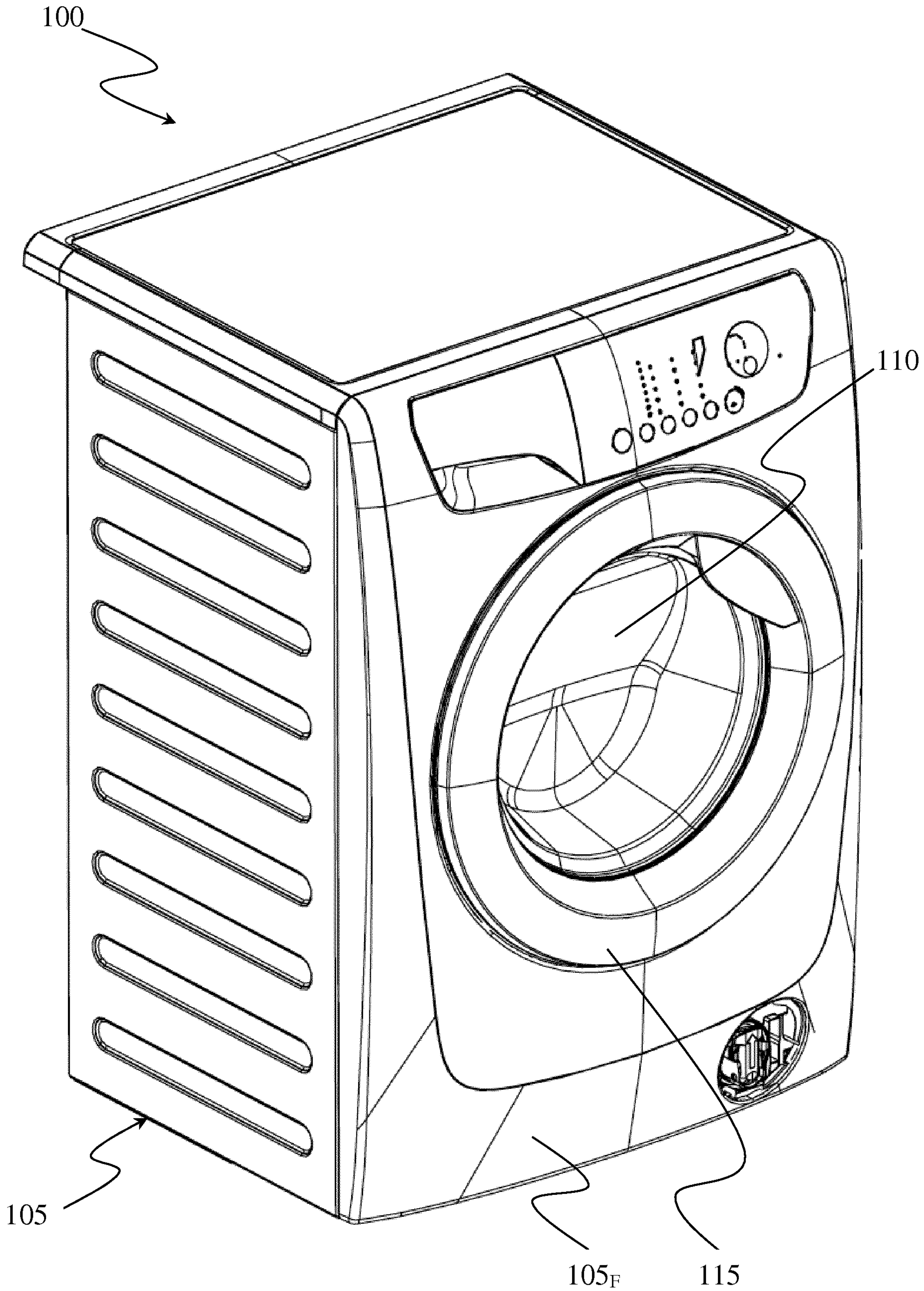

Figure 1

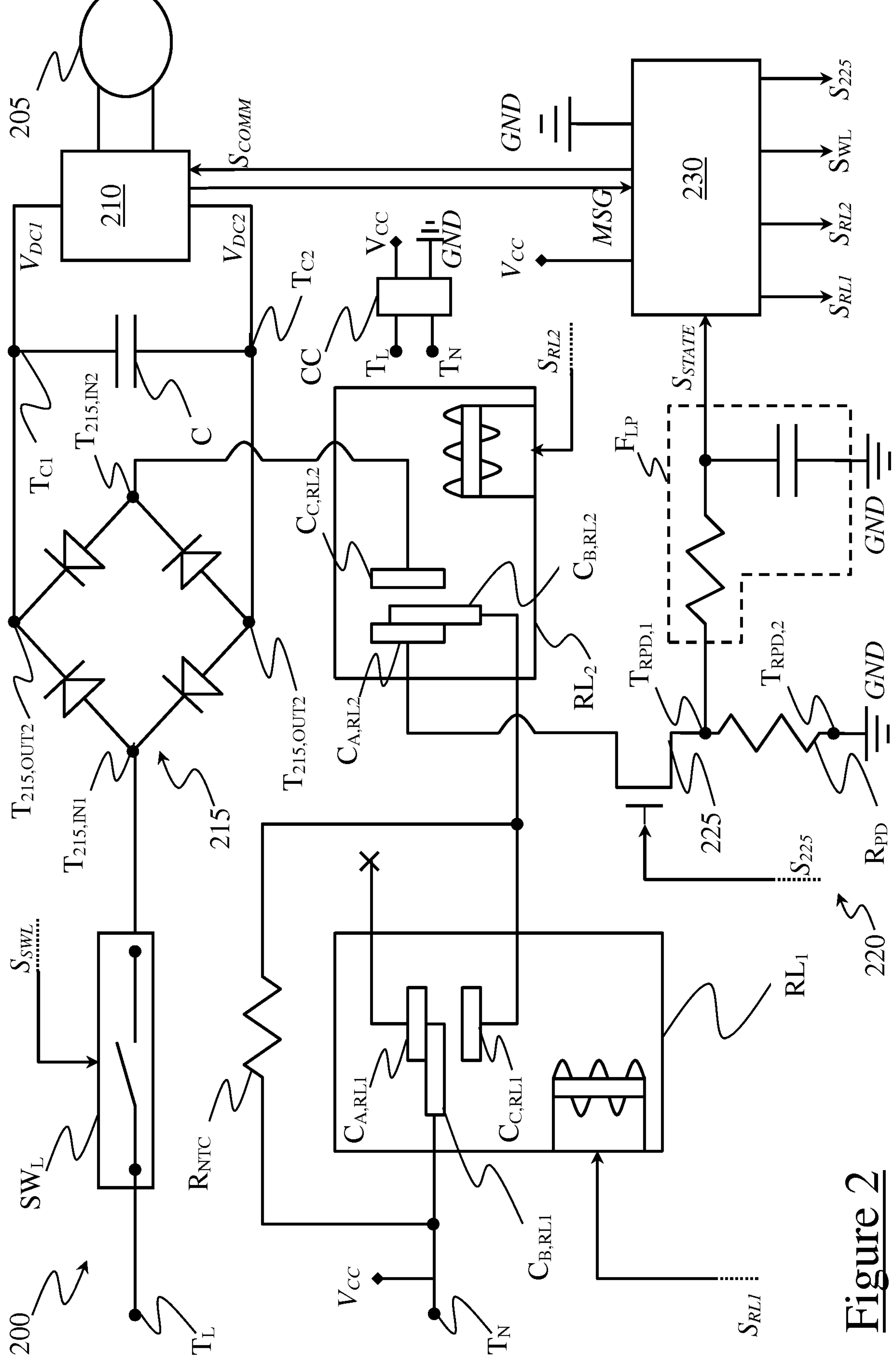
205
210
230
S_{COMM}
MSG
GND
V_{CC}
S_{225}
S_{WL}
S_{RL2}
S_{RL1}
V_{DC1}
V_{DC2}
T_{C1}
T_{C2}
C
CC
T_L
T_N
$T_{215,IN2}$
$T_{215,IN1}$
$T_{215,OUT2}$
215
$C_{C,RL2}$
$C_{B,RL2}$
$C_{A,RL2}$
RL_2
F_{LP}
S_{STATE}
$T_{RPD,1}$
$T_{RPD,2}$
R_{PD}
225
220
RL_1
R_{NTC}
SW_L
S_{SWL}
$C_{A,RL1}$
$C_{C,RL1}$
$C_{B,RL1}$
200

Figure 2

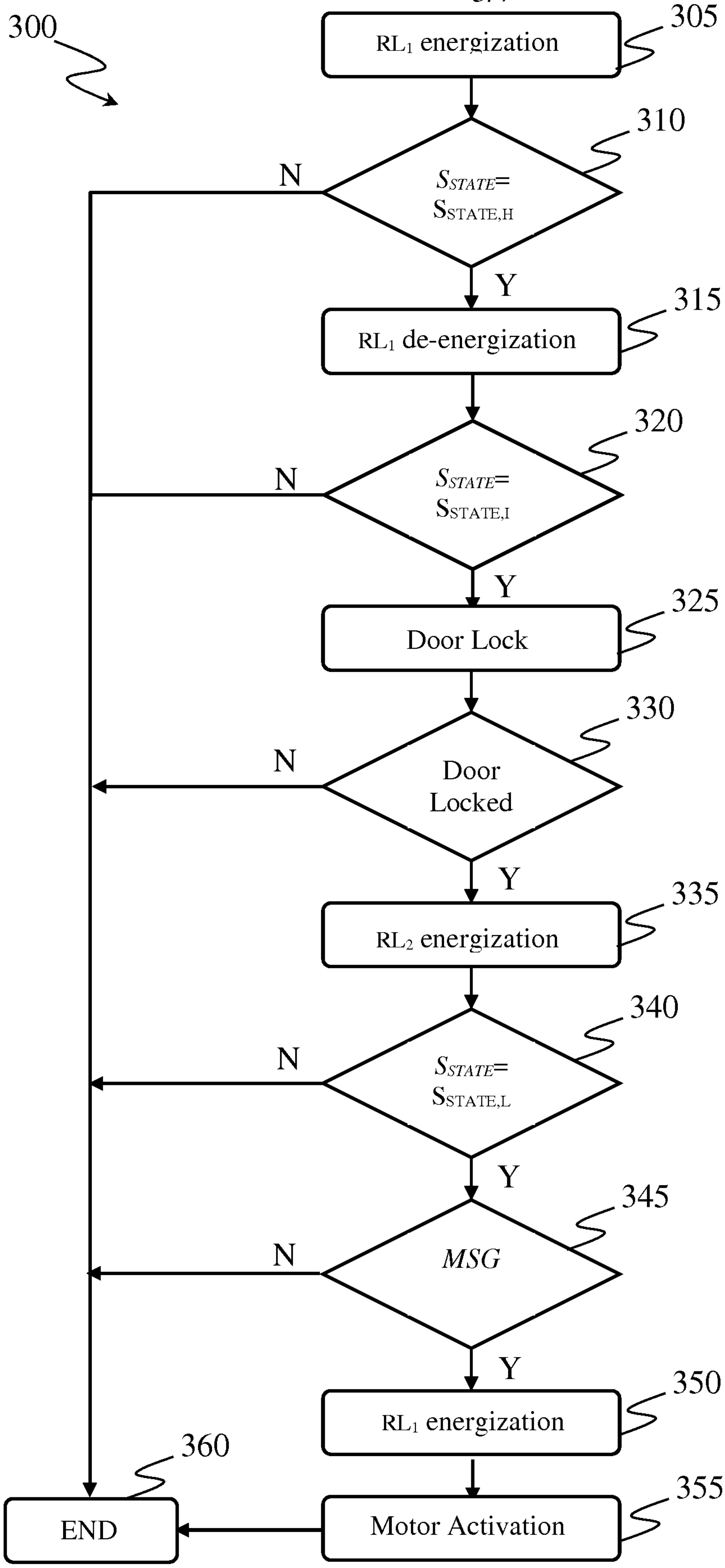
300
RL1 energization
305
310
N
SSTATE=
SSTATE,H
Y
RL1 de-energization
315
320
N
SSTATE=
SSTATE,I
Y
Door Lock
325
330
N
Door
Locked
Y
RL2 energization
335
340
N
SSTATE=
SSTATE,L
Y
345
N
MSG
Y
RL1 energization
350
360
END
Motor Activation
355

Figure 3

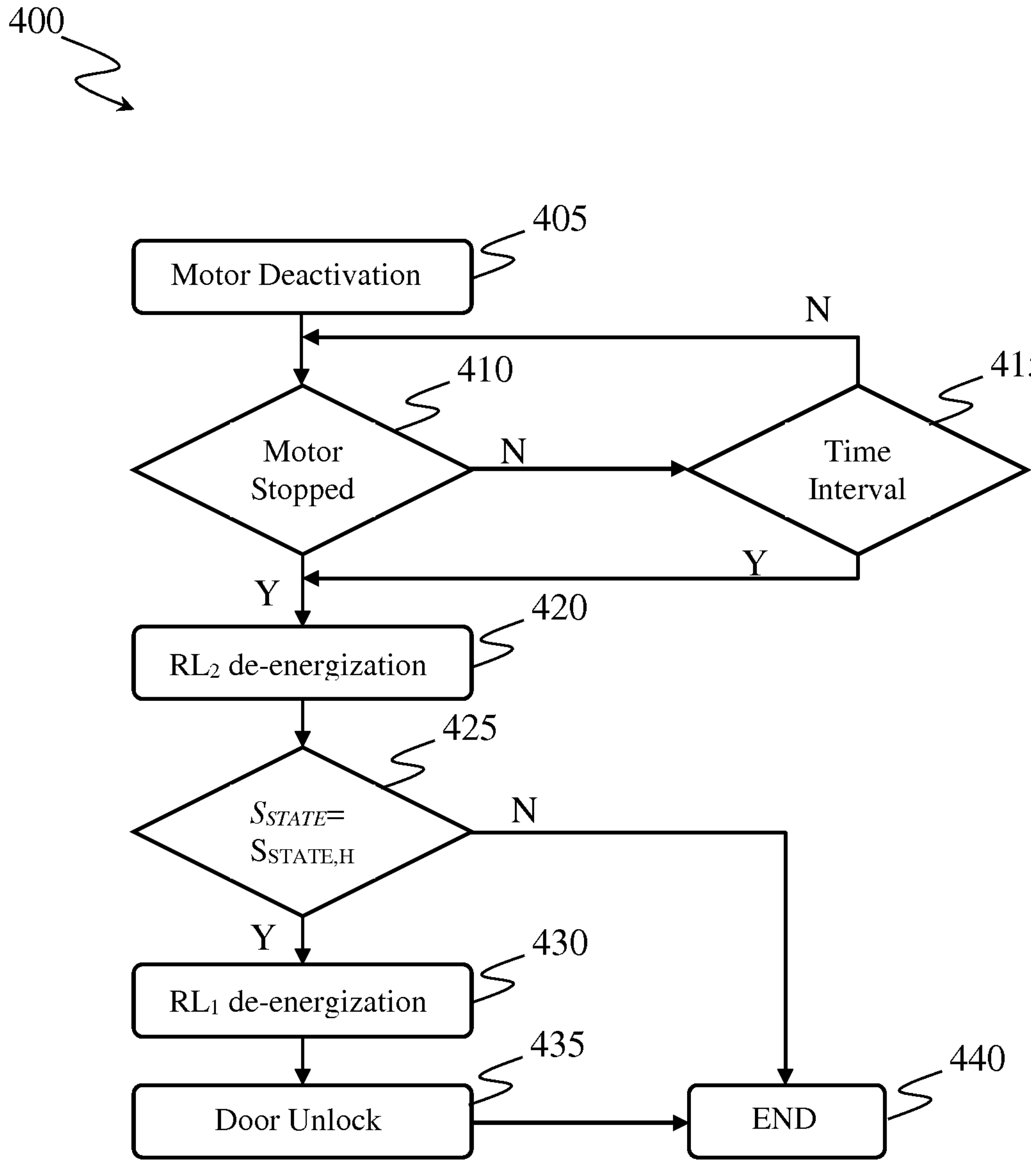
400
405
Motor Deactivation
N
410
415
Motor Stopped
N
Time Interval
Y
Y
420
RL2 de-energization
425
SSTATE= SSTATE,H
N
Y
430
RL1 de-energization
435
440
Door Unlock
END

Figure 4

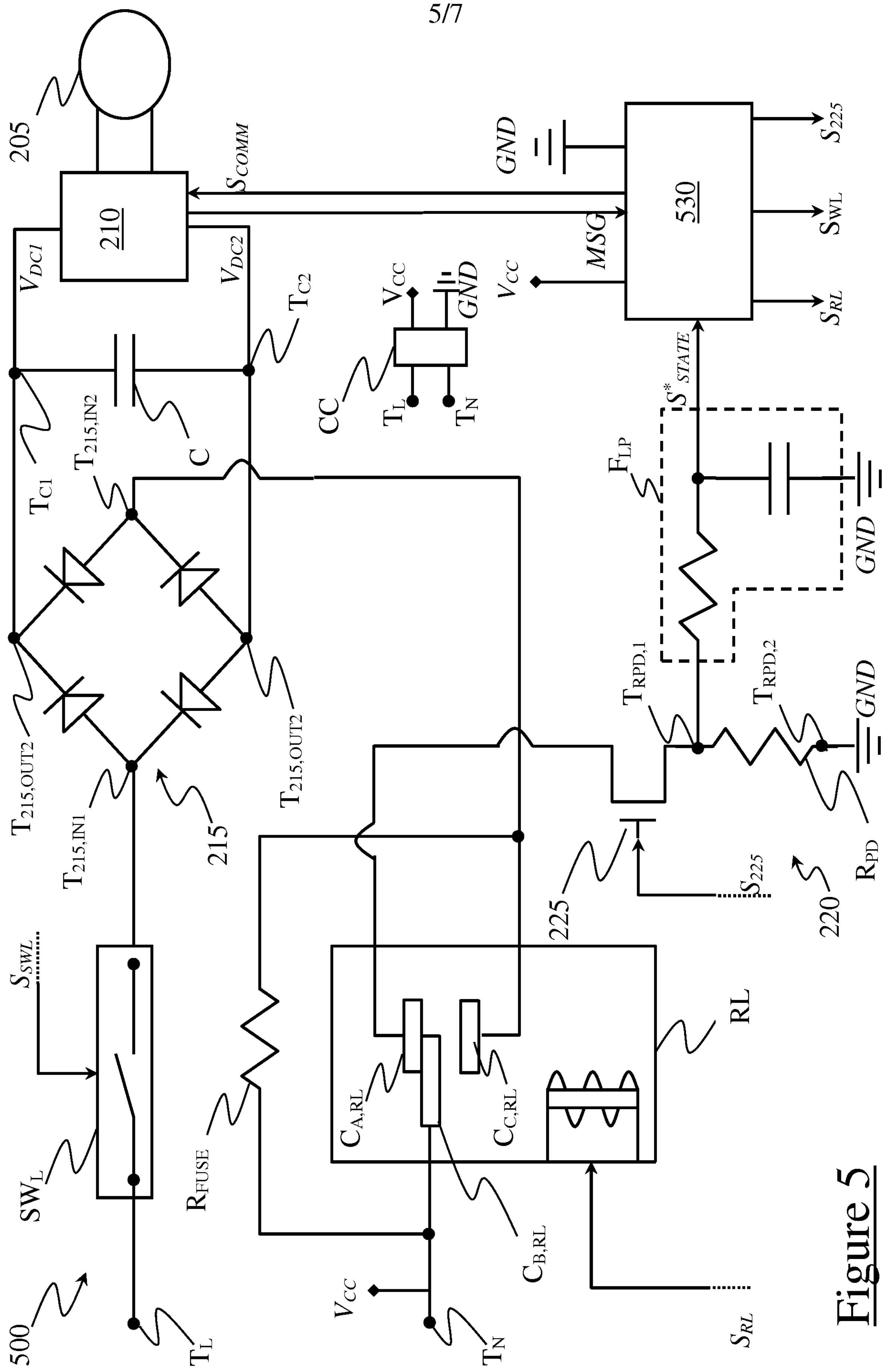
205
210
SCOMM
VDC1
VDC2
TC2
TC1
T215,IN2
C
CC
VCC
GND
TL
TN
MSG
530
S225
SWL
SRL
S*STATE
FLP
TRPD,1
TRPD,2
RPD
220
225
T215,OUT2
T215,IN1
215
SSWL
SWL
RFUSE
RL
CA,RL
CC,RL
CB,RL
500

Figure 5

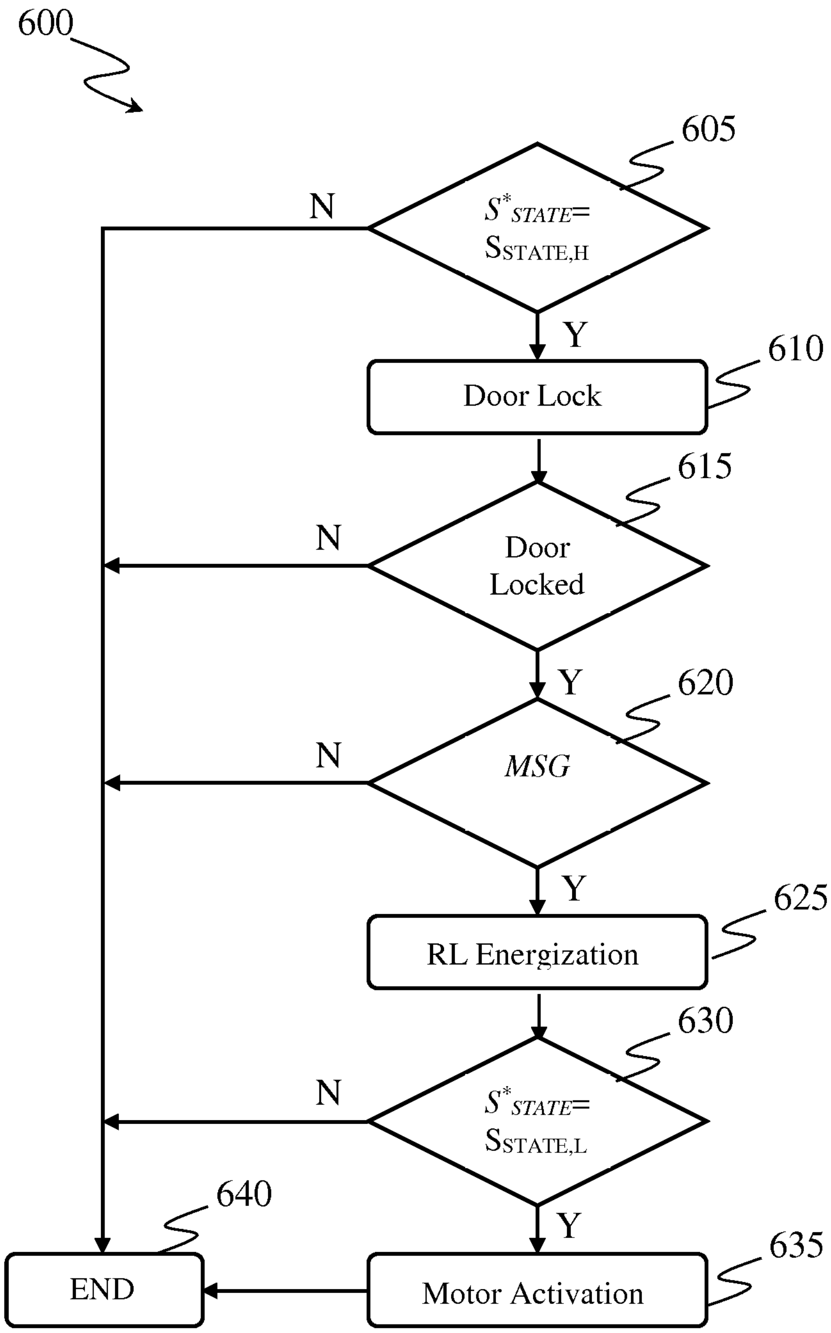
600
605
S^*_{STATE}=
$S_{STATE,H}$
N
Y
610
Door Lock
615
Door
Locked
N
Y
620
MSG
N
Y
625
RL Energization
630
S^*_{STATE}=
$S_{STATE,L}$
N
Y
640
END
635
Motor Activation

Figure 6

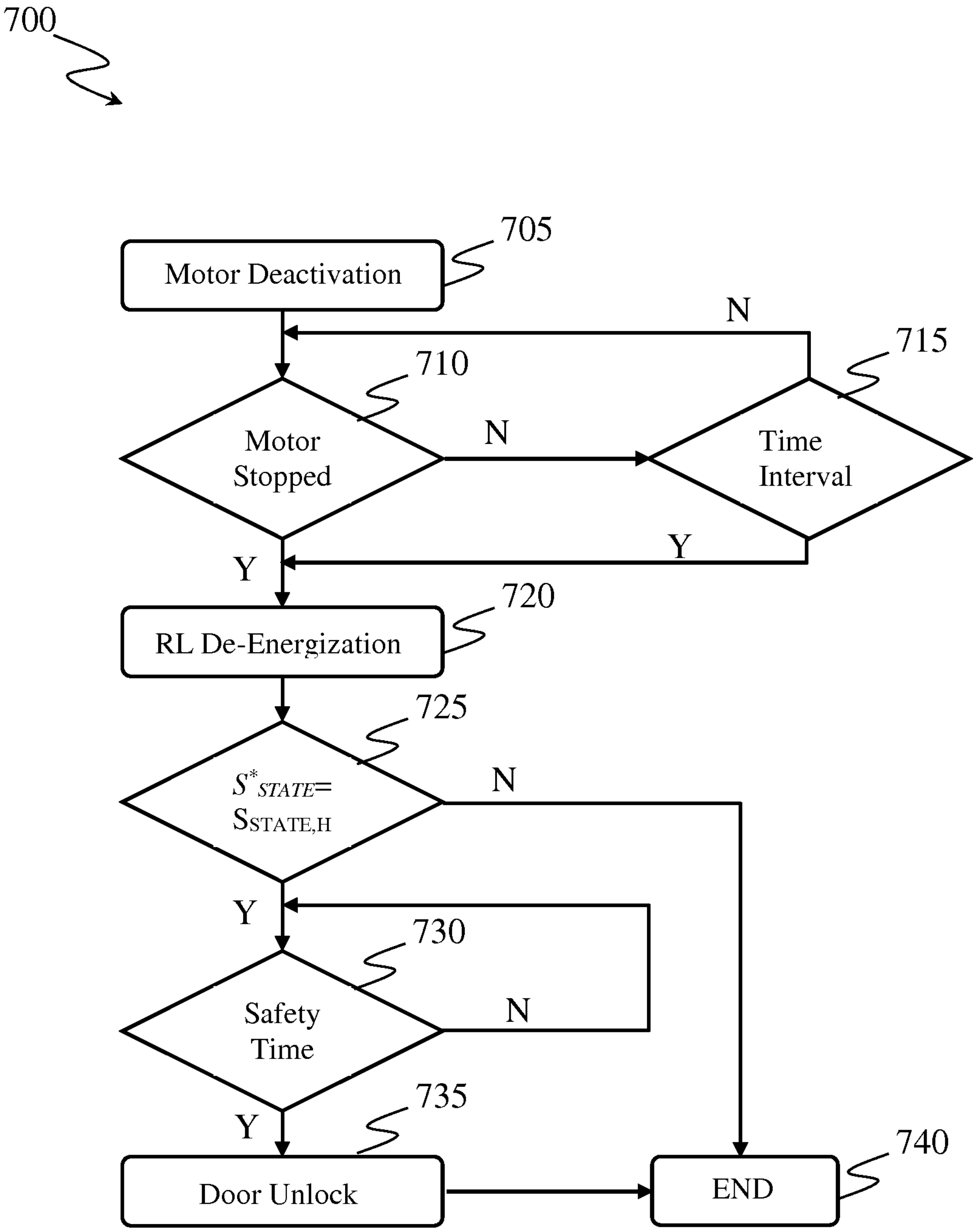
700
705
Motor Deactivation
N
715
710
Motor Stopped
N
Time Interval
Y
Y
720
RL De-Energization
725
S^*_{STATE}= $S_{STATE,H}$
N
Y
730
Safety Time
N
735
Y
740
Door Unlock
END

Figure 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/060991

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06F33/02 D06F37/30 D06F37/42 D06F58/28
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 586 898 A1 (ELECTROLUX HOME PROD CORP [BE]) 1 May 2013 (2013-05-01) the whole document -----	1-18
A	WO 2012/025395 A2 (BSH BOSCH SIEMENS HAUSGERAETE [DE]; ALBAYRAK HASAN GOEKCER [DE]; SEIDL) 1 March 2012 (2012-03-01) the whole document -----	1-18
A	DE 10 2006 060208 A1 (MIELE & CIE [DE]) 26 June 2008 (2008-06-26) the whole document -----	1-18

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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1

INTERNATIONAL SEARCH REPORT

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