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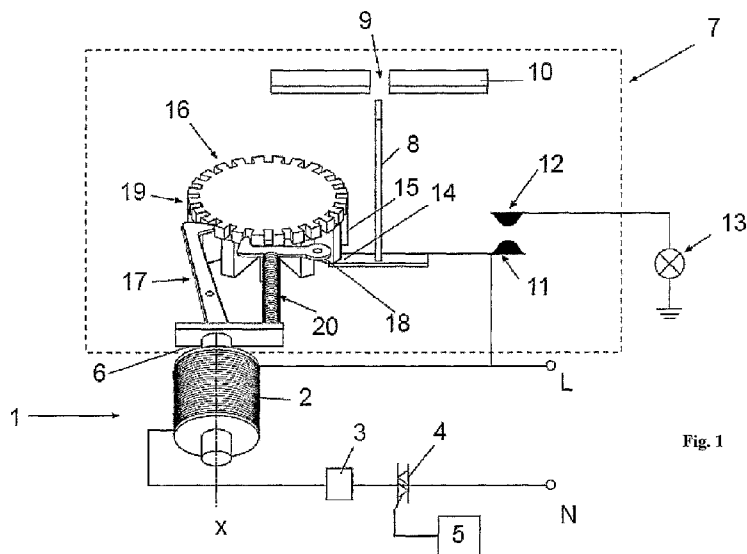


Fig. 1

(57) Abstract: The present invention relates to a method for locking and unlocking a door of a household appliance, wherein door locking means are actuated by an electric actuator when the latter receives a voltage exceeding a preset value. The method comprises a household appliance safety locking step wherein the locking means are set to a door locking position and a positive temperature coefficient thermistor arranged in series with the actuator is heated for the purpose of increasing its resistance up to such a value that, when the full power voltage of the household appliance is applied across the actuator-thermistor pair, a voltage drop below said preset value will be generated across the actuator. A device capable of implementing said method is also described.

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DEVICE AND METHOD FOR LOCKING AND UNLOCKING THE DOOR OF A HOUSEHOLD APPLIANCE

DESCRIPTION

The present invention relates to a method for locking and unlocking the door of a household appliance according to the preamble of claim 1, as well as to an associated door lock.

In particular, the present invention relates to the field of washing and drying machines, wherein it is necessary to ensure that the load door is locked during some laundry treatment steps which are considered to be dangerous.

By way of example, it is important to ensure that the user cannot open the door when the spinning cycle is taking place, because any contact with the fast-turning drum might be dangerous.

For this reason, washing and/or drying machines are provided with devices for locking and unlocking the door.

Among the solutions known in the art, there are locking and unlocking devices which utilize an electric actuator in order to control the door locking and unlocking function.

Since the reaction times of an electric actuator are very short, e.g. just a few tens of milliseconds, these devices are referred to as "instantaneous type".

Safety Standards require that any malfunction or fault, e.g. a short circuit or "diode mode" operation of the triac that generates the actuator control pulses, must not be sufficient to allow the door to unlock.

For this reason, several solutions are available wherein the door unlocking function utilizes at least two pulses.

Solutions of this kind are known from patents EP0808935 and US6,334,637.

In patent EP0808935, the electric actuator consists of a solenoid in which a movable element can slide axially. When pulses are applied to the solenoid,

the movable element moves to a position which depends on the number and polarity of the applied pulses. The actuator is thus controlled in such a manner that the movable element extends to at least two locking positions

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and can move backwards inside the solenoid to a door unlocking position.

In patent US6,334,637, the electric actuator consists of a solenoid in which a sliding ferromagnetic core is moved by applying an alternating voltage to the solenoid for short intervals of time.

- 5 Each voltage pulse applied to the solenoid causes the movable element to move and engage into a mechanical transmission which can cyclically take three positions, i.e. two door locking positions and one door unlocking position.

10 The safety level imposed by the Standards is thus achieved through the aforementioned mechanical transmission, which requires that two pulses be applied to the solenoid in order to switch from a locking position to the unlocking position.

15 It is the object of the present invention to provide a method and an alternative device for controlling the locking and unlocking of the door of a household appliance, in particular a washing and/or drying machine.

This object is achieved through a method and a device incorporating the features set out in the appended claims, which are intended as an integral part of the present description.

20 The present invention is based on the general idea of using a thermistor, in particular a PTC (Positive Temperature Coefficient) thermistor, arranged in series with the solenoid of the electric actuator as a safety device against any unintentional unlocking of the door due to malfunctions or faults such as a short circuit or "diode mode" operation of the triac controlling the power to the solenoid.

25 In particular, the invention provides for a safety locking step to be carried out before the potentially dangerous operating steps of the machine, wherein the door of the household appliance is locked and the thermistor is heated for the purpose of increasing its resistance up to a value such that, even if the full power voltage of the household appliance is applied across the
30 actuator-thermistor pair, the voltage drop generated across the actuator will be lower than the voltage value to be exceeded for the electric actuator to

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actuate the locking and unlocking means.

This solutions ensures that any malfunctions or faults will affect the thermistor instead of the solenoid, which consequently will not unlock the door of the household appliance.

- 5 In addition, this solution allows to prevent the door from being unlocked should any electric malfunctions or faults occur, without necessarily requiring a double unlocking pulse nor the use of any particular transmission in order to achieve the safety conditions set out by the Standards.

Further objects and advantages of the present invention will become
10 apparent from the following description and from the annexed drawings, wherein:

- Fig. 1 shows a locking device according to the present invention;
- Fig. 2 shows a detail of the device of Fig. 1 in the position of door unlocked ;
- 15 - Fig. 3 shows a detail of the device of Fig. 1 in the position of door locked;
- Fig. 4 is a time-based diagram of the voltage applied to the door lock device according to a first embodiment of the method according to the present invention;
- Fig. 5 is a time-based diagram of the voltage applied to the door lock
20 device according to a second embodiment of the method according to the present invention;
- Fig. 6 is a time-based diagram of the voltage applied to the door lock device according to a third embodiment of the method according to the present invention;
- 25 - Fig. 7 shows a first curve representing the increase in the voltage applied to the device according to the present invention during an operating step prior to dangerous cycles of the household appliance, and
- Fig. 8 shows a second curve representing the increase in the voltage applied to the device according to the present invention during an operating
30 step prior to dangerous cycles of the household appliance.

Fig. 1 diagrammatically shows a locking device according to the present

invention.

The device has a pair of terminals (L and N) for its connection to the wires (phase and neutral, respectively) of a single-phase AC power line.

5 The device comprises an electric actuator 1 comprising a solenoid 2 connected to phase and neutral through a PTC thermistor 3 and a triac 4.

The triac 4 is essentially a switch controlled by a control unit 5 (in particular a microcontroller) which regulates the opening and closing thereof, thus adjusting the current flow through solenoid 2 and thermistor 3. Preferably, microcontroller 5 carries out a phase control of triac 4 in order
10 to apply to the solenoid-thermistor pair an alternating voltage having a root mean square value between zero and a maximum value obtained when the triac is kept constantly closed.

In the case shown in Fig. 1, when triac 4 is closed the solenoid-thermistor pair is connected across the phase and neutral terminals, and therefore said
15 maximum value matches the root mean square value of the power voltage.

Inside solenoid 2 there is an axially sliding ferromagnetic core 6 which represents a movable element capable of engaging with locking means 7, which will be described below, so as to move them from a door locking position to a door unlocking position.

20 In the preferred embodiment, locking means 7 comprise a movable rod 8 which can engage into an aperture 9 and stop the movement of a slider 10, thus locking the door.

On one side of rod 8 there is a metal contact 11, e.g. a copper plate, of a master switch 12 that, when closed, allows power to be supplied to loads 13
25 of the household appliance, e.g. motor, pumps, etc.

On the other side, rod 8 has a protrusion 14 that engages under teeth 15 of a cogwheel 16.

The wheel 16 also has an upper toothing 19 acted upon by a lever 17 which makes wheel 16 turn.

30 In particular, lever 17 makes wheel 16 rotate at each stroke in such a manner that protrusion 14 of rod 8 alternatively engages either under a tooth 15

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(position p1 in Fig. 2) or within the space between two consecutive teeth 15 (position p2 in Fig. 3).

Lever 17 is slideably mounted in a direction parallel to the longitudinal axis (x) of solenoid 2, so that movable element 6, when engaging lever 17, will turn wheel 16.

A ratchet 18 acts upon the toothing 19 in order to prevent the wheel 16 from turning in the opposite direction to the motion caused by lever 17.

Ratchet 18 is held against the wheel by a spring 20 acting between the ratchet and lever 17.

Through lever 17, spring 20 exerts a force onto movable element 6 to push it into solenoid 2.

For wheel 16 to turn, the movable element must therefore be pushed out of the solenoid by a force being great enough to overcome the resistance of spring 20.

This is attained by applying to the solenoid a voltage having an root mean square value higher than a preset value.

When switch 4 is opened, the voltage across the solenoid drops to zero, and thus spring 20 brings movable element 6 back into the solenoid.

As shown in Fig. 1, teeth 15 of wheel 16 are so spaced that at each stroke of lever 17 the wheel moves by an angle corresponding to one tooth 19, with protrusion 14 being alternatively held either in a lower position p1 (shown in Fig. 2), corresponding to a situation wherein the door is unlocked and switch 12 is open, or a position p2 (shown in Fig. 3), in which protrusion 14 gets between two teeth 15 and allows rod 8 to come back up and engage slider 10, thus closing switch 12.

Fig. 4 shows a time-based diagram that clearly illustrates the control carried out by microcontroller 5 for the purpose of providing the machine safety locking function.

Fig. 4 indicates the root mean square value of the voltage applied across the solenoid-thermistor pair of Fig. 1.

The wash cycle starts at time t_0 and lasts until time t_1 ; as known, said cycle

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includes different steps with the drum being turned in alternate directions.

In the example described herein, during the wash cycle the drum is turned at rather low speeds, e.g. approx. 45-55 rpm, and with a small quantity of water in the tub; for this reason, the wash step is not considered to be dangerous.

The details of the wash cycle are not relevant for the purposes of the present invention; therefore, hereafter they will not be described any further.

The rinse step takes place from time t_1 to time t_2 , wherein the drum is turned at high speeds (exceeding 60 rpm) and there is more water in the tub than during the wash step; this step is therefore considered to be dangerous and therefore the door must remain locked for its entire duration.

In the embodiment example of Fig. 4, when the wash cycle is started the microcontroller closes the triac, so that the full power voltage of the household appliance is applied across the solenoid-thermistor pair; in this example, said voltage is assumed to be the mains voltage typically available in household environments, namely 220V rms @50Hz in Europe and 110V rms @60Hz in the USA.

The solenoid and the thermistor remain energized for the whole wash and rinse steps.

At time t_0 the impedance of the solenoid and of the thermistor is substantially the same, amounting to a few tens of Ohms, so that the drop across the solenoid amounts to several tens of Volts and exceeds the aforementioned preset value; thus, movable element 6 is pushed out of the solenoid by a length and with a force that overcome the resistance of spring 20 and consequently trip the wheel.

Rod 8 thus engages into aperture 9 and the door is locked (position p2 in Fig. 3).

As time goes by, the thermistor warms up due to losses (this phenomenon is known as self-heating), and so its resistance increases.

After a few seconds, the resistance of the thermistor becomes much greater than that of the solenoid, therefore the voltage drop across the solenoid is

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reduced through the effect of the solenoid-thermistor resistive divider.

Under these conditions, the strength of spring 20 overcomes the force exerted onto movable element 6, which then goes back into the solenoid, while rod 8 stays engaged with slider 10.

5 Due to the different resistance of the solenoid and the heated PTC thermistor, any malfunctions or faults will mainly affect the thermistor and only to a very small extent the solenoid, so that they cannot cause a sufficient voltage drop across the solenoid to cause a new actuation of the locking means (rotation of wheel 16), which would unlock the door.

10 It is therefore apparent that this solution advantageously allows to keep the door locked during essentially the whole period of time t_0 - t_2 .

When rinsing is over, the washing machine carries out a series of rotations which are necessary in order to detach the laundry items adhered to one another at the periphery of the drum due to the effect of the spinning
15 performed during the rinse cycles.

During this step, the method according to the invention provides for de-energizing solenoid 2 and thermistor 3 through a command sent by microcontroller 5 to open triac 4.

The thermistor can thus cool down and its impedance decreases.

20 After a short period of time, the length of which depends on the characteristics of the thermistor (typically 10-15 seconds), the impedance of the solenoid and of the thermistor become comparable again.

At this point (instant t_3), microcontroller 5 can apply a voltage pulse across the solenoid-thermistor pair in order to trip lever 17 and wheel 16, thus
25 moving rod 8 from the position p2 to the position p1, in which the door is unlocked.

In the example of Fig. 4, said unlocking pulse has an amplitude equal to the power voltage and a duration t_3 - t_4 of 40 ms, corresponding to two power voltage cycles, assuming a frequency of 50 Hz.

30 According to this embodiment, if the user wants to open the door during the wash step, which is not regarded as dangerous, he/she has to press a push-

button or turn a knob in order to instruct the microcontroller to unlock the door.

The microcontroller receives the user's instruction and opens triac 4 in order to let thermistor 3 cool down, after which it sends an unlocking pulse as described above.

Referring now to the example of Fig. 5, there is shown an alternative solution for controlling the device for locking and unlocking the door of a household appliance.

At time t_0 , a 220V 40ms pulse is applied (t_0 - t_5) across the solenoid-thermistor pair; due to the reasons explained above, said pulse trips wheel 16 and moves rod 8 from the door unlocking position p1 to the door locking position p2.

During the wash step, the solenoid remains de-energized until time t_5 ; during the interval t_5 - t_6 the microcontroller, following an instruction sent by the user (and after having verified that the household appliance is not carrying out a dangerous operating step) can instantly unlock the door by sending a new 220V pulse to the solenoid-thermistor pair.

Prior to the rinse step (which is regarded as dangerous), the invention provides for putting the machine in a safety condition, so that a malfunction or fault (such as a short circuit or the triac operating in "diode mode") cannot cause the door of the household appliance to unlock as rinsing is taking place.

At time t_6 , prior to the dangerous rinse step, microcontroller 5 acts upon triac 4 to increase the voltage applied across the solenoid-thermistor pair, so that said voltage increases without the voltage drop across the solenoid exceeding the value at which the locking means are actuated; this is made possible by the increased thermistor resistance.

In other words, microcontroller 5 progressively increases the duty cycle of triac 4 so as to increase the root mean square value of the voltage applied across the solenoid-thermistor pair without thereby determining the actuation of the locking means, because the voltage on the solenoid is

always too low to allow said actuation.

By increasing the voltage according to a sufficiently slow ramp (or series of steps), it is possible to warm up the thermistor and increase its resistance in order to keep the voltage drop across the solenoid constantly below that
5 limit value above which movable element 6 causes wheel 16 to rotate.

At time t_7 , the voltage applied to the solenoid-thermistor pair is maximum, and the conditions, previously described with reference to Fig. 4, come up again, according to which no malfunction occurring during the rinse step can cause the door to unlock.

10 If any malfunctions or faults occur during the wash step which cause the door to unlock without a user's request, microcontroller 5 detects the opening of master switch 12 and applies a new pulse to the solenoid-thermistor pair in order to lock the door.

If the fault is due to a short circuit or to the triac operating in "diode mode",
15 a new locking pulse cannot of course be sent, but the machine will be in a safe condition with all loads turned off.

If several dangerous operating steps are to be carried out (e.g. rinsing and spinning) alternated to non-dangerous steps, according to a preferred embodiment according to the present invention the method forces the
20 solenoid-thermistor pair to remain energized during all dangerous steps, while still keeping the voltage drop across the solenoid below the value of actuation of the locking means.

The dangerous operating steps may also include those steps of wash treatment wherein the temperature of the wash liquid exceeds 50°C
25 (although these steps are not regarded as dangerous by the Standards currently in force). The solenoid-thermistor pair may therefore be conveniently kept energized, while keeping the voltage drop across the solenoid below the value of actuation of locking means, also when the temperature of the wash liquid is higher than 50°C.

30 This situation is shown in Fig. 6, where the microcontroller puts the machine in the safe condition again before a second dangerous step (e.g. a

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spin step) by applying a voltage pulse (instants t_8 - t_9) such that rod 8 is moved to the locking position.

Prior to the spin step (instants t_{10} - t_{11}), a heating step is performed again on PTC thermistor 3 (instants t'_6 - t'_7), wherein the thermistor resistance increases and makes the electric actuator become essentially "immune" from malfunction.

At the end of the spin cycle, the machine is in a safe condition. When the user sends a door unlocking command, microcontroller 5 generates a voltage pulse (instants t_{12} - t_{13}) to unlock the door.

The PTC thermistor heating step (aiming at increasing the thermistor resistance) can be carried out by increasing the voltage applied across the solenoid-thermistor pair according to a strictly increasing monotonic curve, e.g. a ramp (as shown in Fig. 5), or according to a non-decreasing monotonic curve, comprising for example step-like profiles.

In order to reduce the length of the thermistor heating step, according to an embodiment of the invention the microcontroller controls the triac in such a manner that a rather high voltage is applied right away, e.g. 40 V rms, which voltage is anyway lower than the value at which the force exerted onto the movable element overcomes the resistance of the return means (e.g. the spring 20 of Fig. 1).

Following said step, the microcontroller can increase the applied voltage according to a ramp, as shown in Fig. 7.

Fig. 8 shows another possible curve representing the increase in the voltage applied across the solenoid-thermistor pair, wherein between time t_6 and time t_8 the voltage is increased according to a ramp having a different slope than the ramp from t_8 to t_7 .

It is also conceivable that, once an upper limit voltage value has been reached (e.g. 80 V rms) through a ramp-like increase profile, the voltage is then brought to its maximum value (220 V rms) through a step-like increase profile.

According to a variant of the invention, once the PTC thermistor has

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warmed up and has reached a resistance value which is high enough to make the actuator immune from malfunction (this time having been estimated by means of laboratory tests and being therefore known by microcontroller 5), triac 4 is then controlled by microcontroller 5 in such a manner as to apply
5 across the solenoid a voltage having a root mean square value which is lower than the 220V power voltage but anyway great enough to ensure that the current flowing through the PTC thermistor can keep the latter's resistance at a sufficiently high value. The value of the voltage to be applied to the solenoid is determined on the basis of the fact that the heating caused
10 by the current flow must be sufficient to prevent the PTC thermistor from cooling down; since this current can be obtained by means of a voltage lower than the maximum voltage (220V rms) across the phase and neutral terminals, a reduction in energy consumption is also obtained. The preferred values of the voltage to be constantly applied to the solenoid are between
15 80V and 150V rms.

The root mean square voltage lower than 220V rms can be obtained through a phase control which, by modulating the closing instant of the triac 4, allows to suitably cut a portion of the half-waves of the alternating voltage and obtain the desired root mean square value.

20 Alternatively, the root mean square voltage lower than 220V rms can be obtained through a waveform consisting of a sequence of wave trains of the mains voltage, said sequence of wave trains being predetermined and in particular depending on the root mean square value of the voltage to be applied to the solenoid (and consequently to the PTC thermistor arranged in
25 series with the solenoid). For example, if a voltage of $(220/X)V$ rms (where $X > 1$) is to be applied to the solenoid, a power cycle may be implemented wherein the solenoid is supplied with the full mains voltage (e.g. 220V @ 50Hz) for a time corresponding to N half-waves of the mains voltage (where N is a whole number ≥ 1) and then de-energized by opening the triac 4 for a
30 time corresponding to $N \cdot (X-1)$ half-waves of the mains voltage. In this example, the waveform therefore consists of a series of N wave trains

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followed by a null voltage for a period corresponding to $N \cdot (X-1)$ half-waves mains voltage.

It is clear however that many changes may be made by those skilled in the art to the device and method for locking the door of a household appliance
5 described herein.

In particular, the invention is not limited to the locking means described with reference to Figs. 1-3: several alternative mechanical solutions may in fact replace the above-described cogwheel and lever 17 used for transmitting the locking/unlocking command from the movable element to the locking
10 means.

Furthermore, triac 4 may be replaced with any other electromechanical or semiconductor-type switch.

Triac 4 and microcontroller 5 may then be arranged on an independent printed circuit connected to a module containing the solenoid, the thermistor
15 and the locking and unlocking means.

Finally, in addition to self-heating, the thermistor resistance may also be increased by using external devices, such as heating elements, thus further reducing the heating step duration.

CLAIMS

1. Method for locking and unlocking a door of a household appliance, wherein door locking means are actuated by an electric actuator when said actuator receives a voltage exceeding a preset value, characterized by comprising a household appliance safety locking step
5 wherein said locking means are set to a door locking position and a thermistor arranged in series with said actuator is heated in order to increase its resistance up to such a value that, when the full power voltage of the household appliance is applied across the actuator-thermistor pair, a voltage drop below said preset value will be generated across the actuator.
- 10 2. Method according to claim 1, wherein said actuator comprises a solenoid adapted to move a movable element slideably mounted inside said solenoid, and wherein said thermistor is connected in series with said solenoid and is heated by current flowing through said solenoid.
3. Method according to claim 2, wherein said safety locking step comprises
15 the following steps:
 - applying to the solenoid-thermistor pair a voltage such that the voltage drop across the solenoid (2) has a root mean square value exceeding said preset value, so as to set said locking means (7) to said door locking position (p2),
 - 20 - keeping said solenoid (2) – thermistor (3) pair energized.
4. Method according to claim 3, wherein said solenoid (2) – thermistor pair is kept energized until any of the following conditions takes place:
 - a user of said household appliance sends a door unlocking command,
 - at least one operating step of the household appliance during which the
25 door must not be allowed to be opened is completed.
5. Method according to claim 3 or 4, wherein said voltage applied across the solenoid (2) – thermistor (3) pair is maintained until all operating steps of the household appliance during which the door must not be allowed to be opened are completed.
- 30 6. Method according to claim 2, wherein said safety locking step comprises

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the following steps:

- applying to the solenoid (2) - thermistor (3) pair a voltage pulse such that the voltage drop across the solenoid (2) has a root mean square value exceeding said preset value, so as to set said locking means (7) to said door
5 locking position (p2),

- prior to an operating step of the household appliance during which the door must not be allowed to be opened, performing a thermistor heating step wherein the voltage applied to the solenoid-thermistor pair is increased in such a manner that the applied voltage increases up to a maximum value
10 without the voltage drop across the solenoid exceeding said preset value due to the increased resistance of said thermistor,

- keeping said solenoid (2) – thermistor (3) pair energized.

7. Method according to claim 6, wherein the increase in said applied voltage follows a non-decreasing monotonic curve.

15 8. Method according to claim 7, wherein said curve is a strictly increasing monotonic curve.

9. Method according to claim 7 or 8, wherein said curve comprises a ramp.

10. Method according to any of claims 7 to 9, wherein said curve comprises a first step at which the applied voltage reaches a value which is lower than
20 said preset value.

11. Method according to any of the preceding claims, wherein a microcontroller controls the opening and closing of a switch (4) adapted to connect said electric actuator (1) to the power voltage of the household appliance in order to regulate the voltage applied to the actuator-thermistor
25 pair.

12. Method according to claim 11, wherein said microcontroller receives a door unlocking command from a user of said household appliance.

13. Method according to claim 12, wherein said microcontroller determines whether it is possible to unlock the door or not, and if yes it opens said
30 switch in order to cool down said thermistor and subsequently applies to the actuator-thermistor pair such a voltage that the voltage drop across said

actuator is such that said locking means are actuated and brought to an unlocking position.

14. Method according to claim 12, wherein said microcontroller determines whether it is possible to unlock the door or not, and if yes it applies to the actuator-thermistor pair such a voltage that the voltage drop across said actuator is such that said locking means are actuated and brought to an unlocking position.

15. Method according to any of the preceding claims, wherein said locking means (7) alternatively take a door locking position or a door unlocking position.

16. Method according to any of the preceding claims, wherein said thermistor is a positive temperature coefficient thermistor.

17. Method according to any of claims 2 to 16, wherein once the thermistor has been heated and has reached a resistance value such that when the full power voltage of the household appliance is applied across the actuator-thermistor pair a voltage drop is generated across the actuator which is below said preset value, a voltage having a root mean square value which is lower than the root mean square value of the mains voltage used for powering said household appliance is applied to the solenoid.

18. Device for locking and unlocking a door of a household appliance, characterized by being adapted to implement the method according to any of claims 1 to 17.

19. Device according to claim 18, comprising:

- locking means adapted to take at least a door locking position and a door unlocking position,

- an electric actuator (1) comprising a movable element (6) which can slide inside a solenoid (2) so as to take at least one position of engagement with said locking means (7) and to cause the latter to move from the locking position to the unlocking position when the voltage drop across said solenoid (2) exceeds a preset value,

- a positive temperature coefficient thermistor (3) connected in series with

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said solenoid in such a manner that the resistance of said thermistor increases as current flows through the solenoid (2), and
-command and control means (4,5) adapted to control the voltage applied to said solenoid (2) and said thermistor (3),

5 characterized in that said command and control means (4,5) are adapted to set said locking means to a door locking position (p2) and to keep them in said locking position (p2) by heating said thermistor in order to increase its resistance up to a value such that, when the full power voltage of said household appliance is applied across the solenoid-thermistor pair, a voltage
10 drop is generated across the solenoid which is lower than said preset value.

20. Device according to claim 19, additionally comprising counteracting means (20) adapted to generate a return force countering the actuation force that pushes said movable element towards the locking means when voltage is applied to said solenoid, so that said movable element only actuates said
15 locking means when said actuation force is greater than a preset threshold.

21. Device according to claim 19 or 20, wherein said command and control means are adapted to:

- apply to said solenoid (2) a voltage which is higher than said preset value in order to lock said door,
- 20 - keep said solenoid (2) and said thermistor (3) energized.

22. Device according to claim 21, wherein said command and control means are adapted to:

- receive an unlocking command from a user of said household appliance,
- verifying if said household appliance is carrying out an operating step
25 during which the door must not be allowed to be opened,
- keeping said solenoid (2) and said thermistor (3) energized until:
 - said door unlocking command is received,
 - it is verified that at least one operating step of the household appliance during which the door must not be allowed to be opened is completed.

30 23. Device according to claim 19, wherein said control and command means comprise a microcontroller (5) adapted to carry out a phase control of a

switch connecting said solenoid to the power voltage of said household appliance.

24. Device according to any of claims 19 to 23, wherein said control and command means are adapted to increase the voltage applied across the solenoid-thermistor pair, so that said applied voltage increases without the voltage drop across the solenoid exceeding said preset value due to the increased resistance of said thermistor.

25. Device according to claim 24, wherein said control and command means are adapted to increase said applied voltage prior to a predetermined operating step of said household appliance.

26. Device according to claim 25, wherein the increase in said applied voltage follows a non-decreasing monotonic curve.

27. Device according to claim 25, wherein said curve is a strictly increasing monotonic curve.

28. Device according to claim 26 or 27, wherein said curve comprises a ramp.

29. Device according to claim 26 or 27 or 28, wherein said curve comprises a first step at which the applied voltage reaches a value which is lower than said preset value.

30. Device according to any of claims 19 to 29, wherein said locking means cyclically take the locking position and the unlocking position.

31. Household appliance comprising a door and a device for locking or unlocking said door according to any of claims 18 to 30.

32. Household appliance according to claim 31, wherein said command and control means (4,5) are adapted to increase the voltage applied across the solenoid-thermistor pair up to a maximum value which is lower than the root mean square value of the power voltage of said household appliance.

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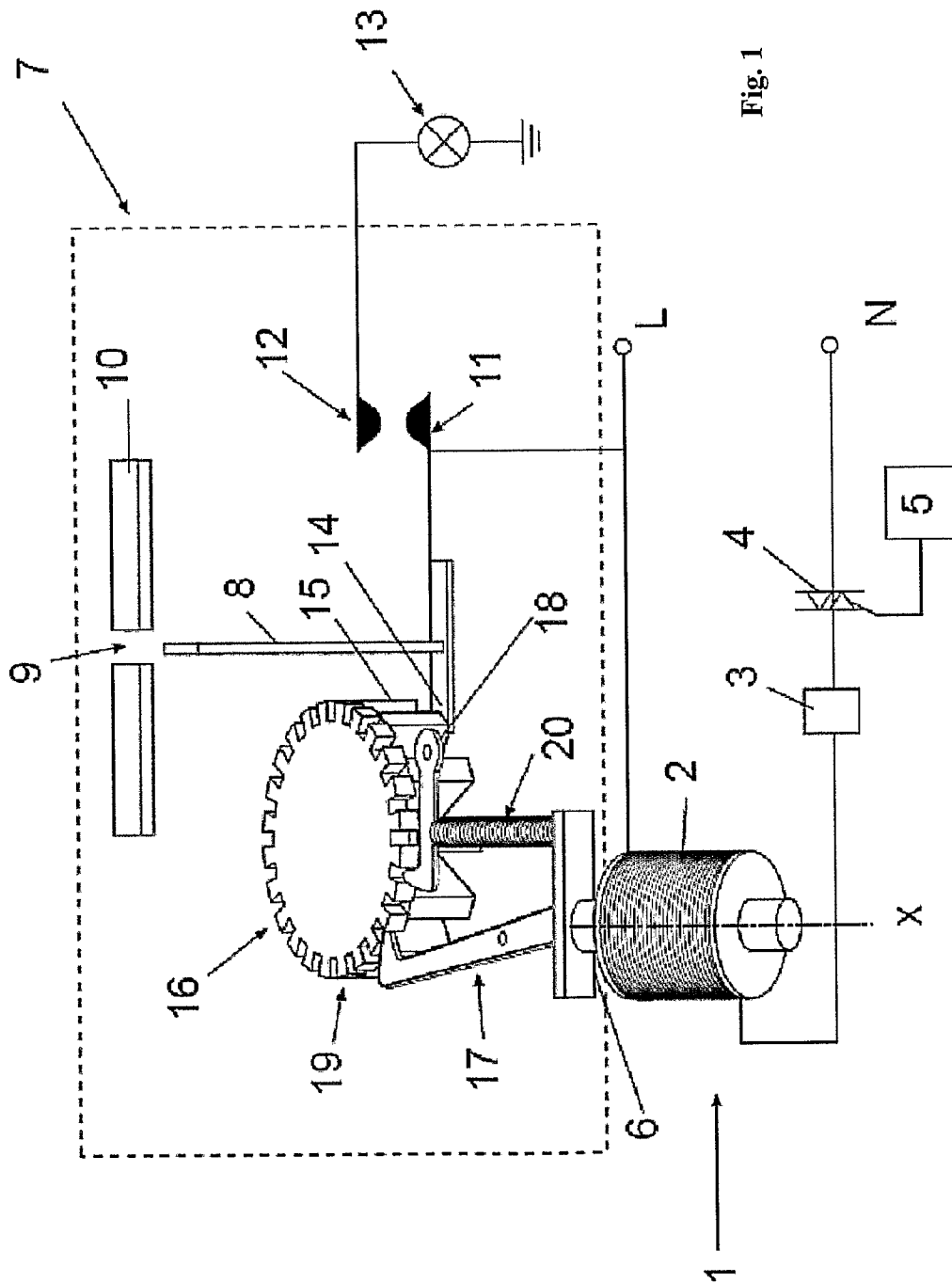


Fig. 1

Fig. 2

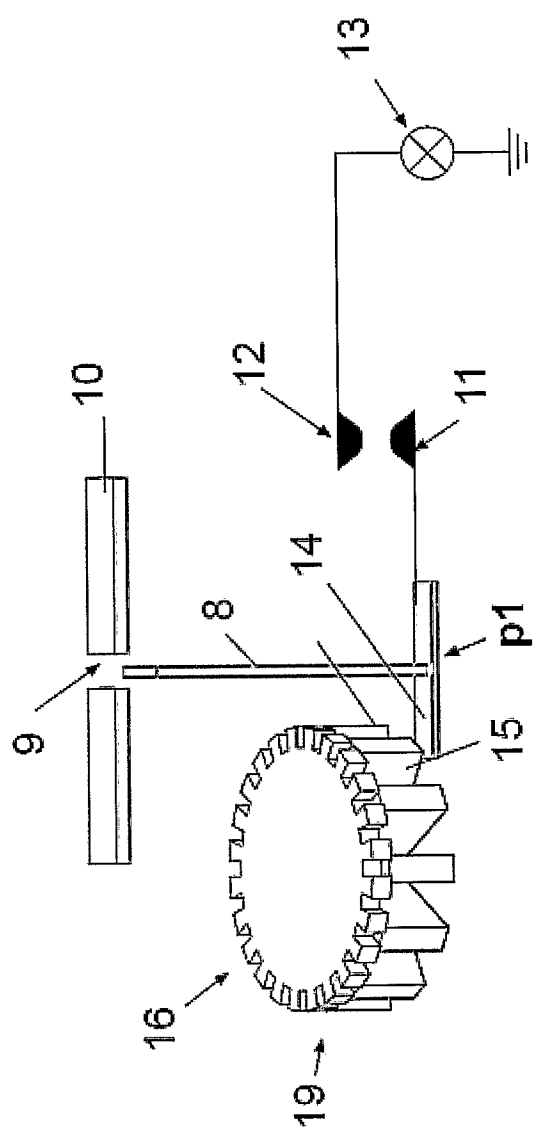


Fig. 3

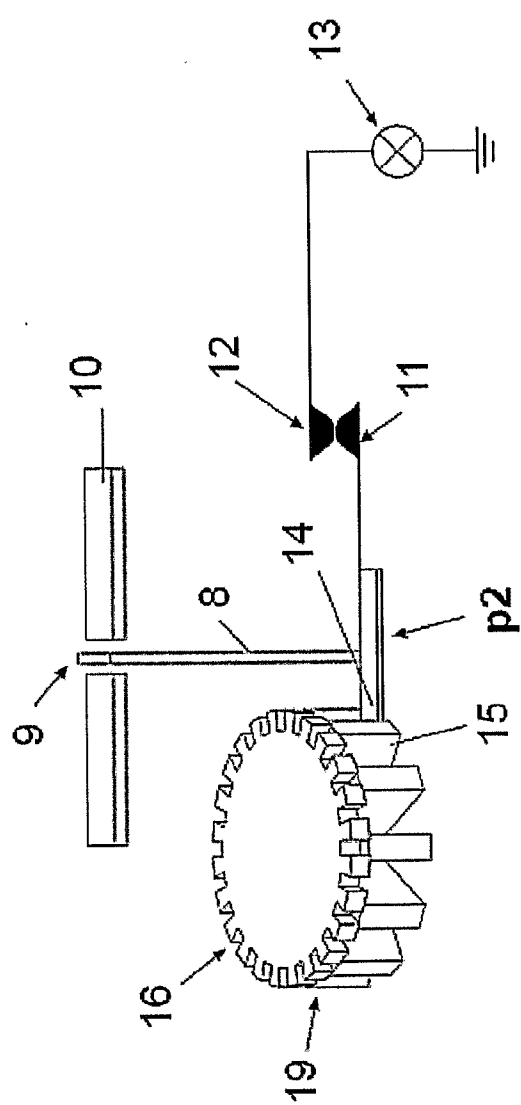


Fig. 4

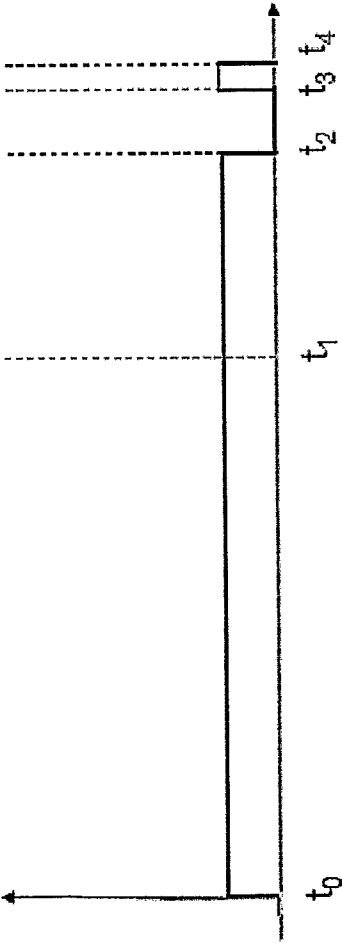


Fig. 5

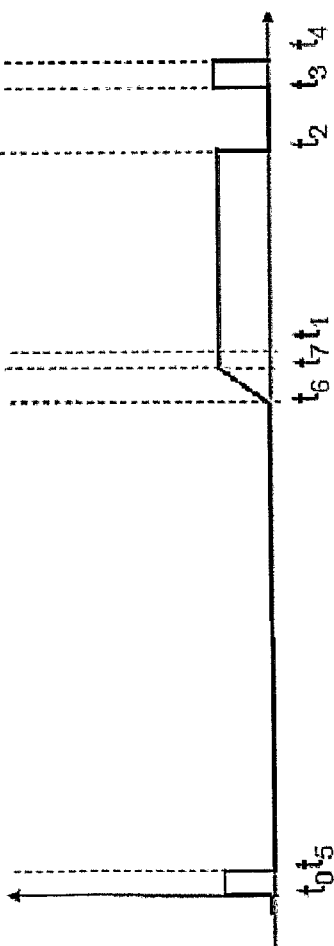


Fig. 6

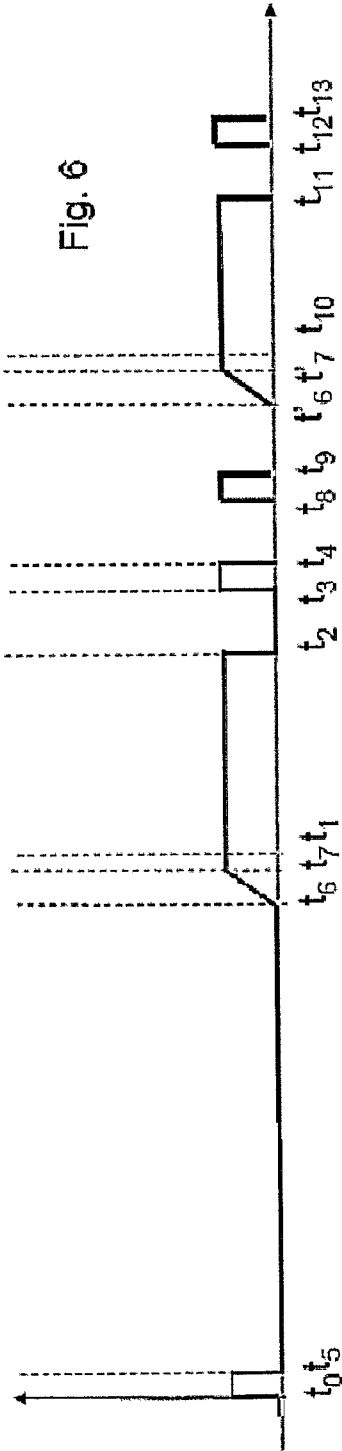


Fig. 7

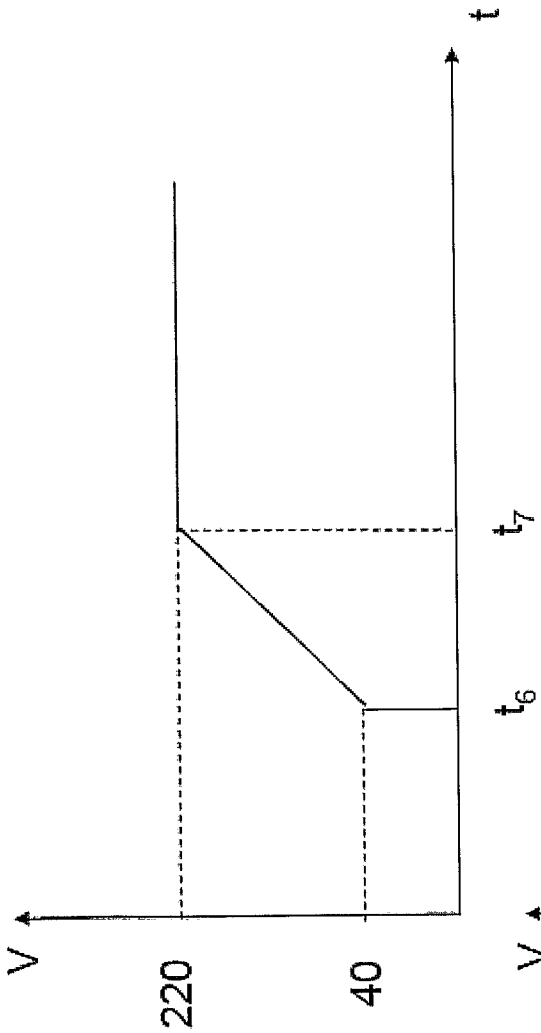
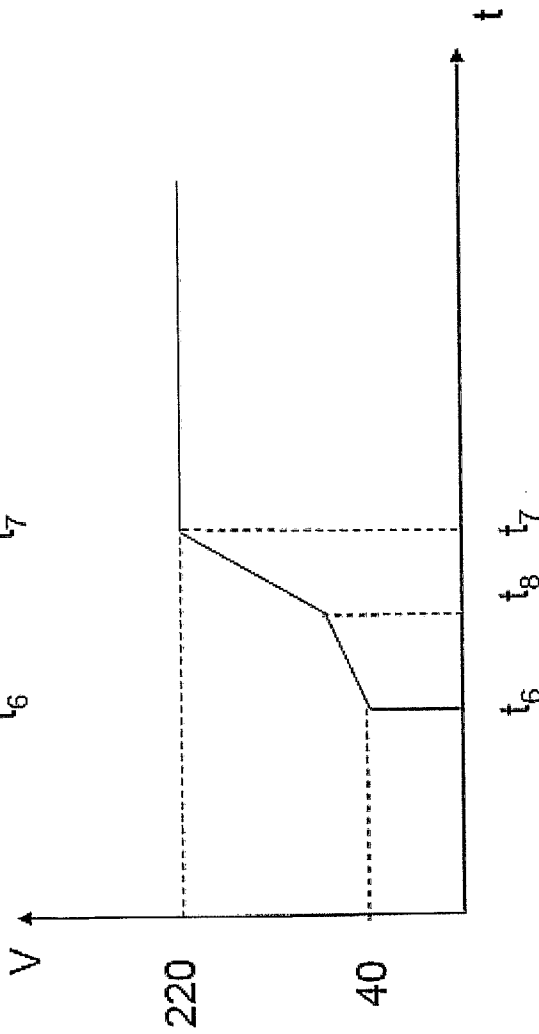


Fig. 8



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2008/000660

A. CLASSIFICATION OF SUBJECT MATTER
INV. D06F37/42 D06F39/14

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 practical, 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.
X	EP 0 439 849 A (ROCCHITELLI ONOFRIO [IT]) 7 August 1991 (1991-08-07) column 5, line 29 - column 7, line 24; figures 1,11,12	1-6, 11-16, 19, 21-23,31
X	EP 1 498 796 A (ELTEK SPA [IT]) 19 January 2005 (2005-01-19) paragraph [0048] - paragraph [0057]; figure 4	1,16,18, 31
X	EP 1 726 750 A (ELETTROTECNICA ROLD SRL [IT]) 29 November 2006 (2006-11-29) paragraph [0015] - paragraph [0027]; figures 2,5	1,16,18, 31
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

23 September 2008

Date of mailing of the international search report

10/10/2008

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Fachin, Fabiano

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2008/000660

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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