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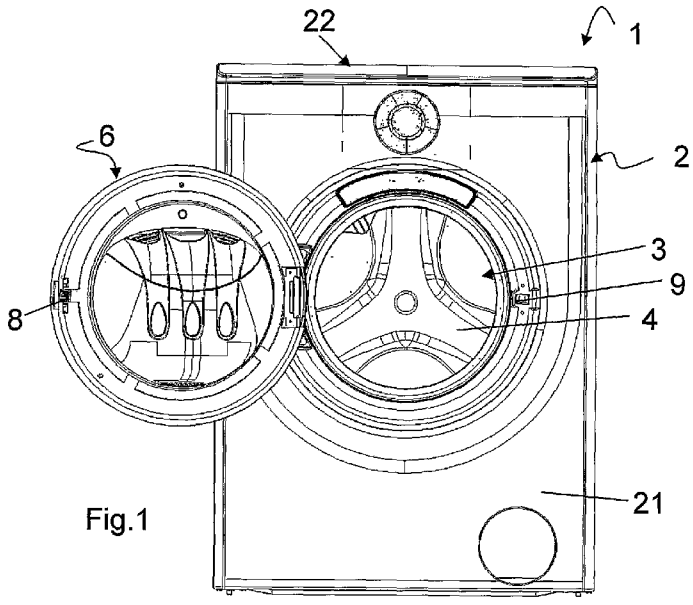


Fig.1

(57) Abstract: The present invention relates to a household appliance (1) comprising a structure (2) having a load opening (3) and a door (6) adapted to close said opening (3). A door locking device allows to lock the door (6) when the latter is closed. The door locking device comprises an electric actuator (13) acting in response to a control signal received at a control input (A, B). The household appliance also comprises a capacitor (28) and a switch (27) connected in a manner such that in a first position of said switch (27) the capacitor is connected to a voltage source (30), hence getting charged, and in a second position of said switch (27) the capacitor (28) is connected to the control input (A5B) of the electric actuator, hence getting discharged.

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HOUSEHOLD APPLIANCE WITH A DOOR LOCKING DEVICE

DESCRIPTION

The present invention relates to a household appliance according to the preamble of claim 1.

The invention is preferably and advantageously applicable within the field of laundry washing and/or drying machines, but it is also applicable to other household appliances, such as ovens, provided with a door adapted to close a load opening.

As known, laundry is loaded into washing/drying machines through an opening that can be closed by means of a door; likewise, foodstuffs are placed into oven muffles through a load opening that can be closed by means of a door.

It is also known that some operational phases of these machines (e.g. the spin cycle of a washing machine or the high-temperature phases of an oven) might bring about dangerous situations should the user open the door.

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

For this reason, these 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".

Some examples of washing or drying machines equipped with such an electric actuator are known from patents EP0808935, US6,334,637 and EP1808558.

In all cases, safety measures are taken in order to prevent a single possible malfunction or fault from being the cause of the door to unlock.

In patent EP0808935, safety is ensured by providing an electric actuator which can take two consecutive lock positions and one unlock position, so that a

malfunction cannot cause the door to unlock.

In patent US6,334,637, the electric actuator acts upon a mechanical transmission which can take three positions cyclically, i.e. two door locking positions and one door unlock position.

In this case as well, just like EP0808935, in order to unlock the door it is necessary to send two control pulses to the electric actuator.

Although they work properly, these solutions suffer from the drawback that they are quite complex and not wholly immune from certain malfunctions which may cause a double actuation of the actuator.

In patent EP1808558, safety is attained by exploiting the physical properties of the PTC thermistor commonly arranged in series with the solenoid for limiting any short-circuit current and preventing it from burning the door locking components. In detail, the machine described in EP1808558 keeps the solenoid and the thermistor energized in a manner such that the electric resistance of the latter exceeds a value at which the current flowing through the solenoid is reduced to a value so as to prevent the actuator from being activated.

This solution suffers from the drawback that the door will not unlock until the thermistor has cooled down; therefore, a long time is required for unlocking the door.

It is the object of the present invention to provide an alternative household appliance solution which, preferably, allows to overcome the drawbacks suffered by the solutions known in the art.

In particular, the present invention aims at making the household appliance safe by utilizing a door locking device which allows the door to be unlocked quickly when necessary, while at the same time simplifying and reducing the cost of the door locking control system.

These and other objects of the present invention are achieved through a circuit of a household appliance, in particular a laundry washing and/or drying machine, incorporating the features set out in the appended claims, which are intended as an integral part of the present description.

The present invention is based on the idea of controlling the electric actuator of the door locking device by generating electric pulses through the discharge of a properly sized capacitor.

Once charged, the capacitor is connected in parallel to the power supply terminals of the actuator through a switch, in particular a relay, controlled by the control system of the household appliance.

The switch can be set to two positions, one of which is an idle position taken when no command is being sent to the switch; in this idle position, the capacitor is connected to the electric actuator and is discharged, whereas in the other position the capacitor is connected to a voltage source (e.g. an electric line or a battery) and is charged.

This solutions allows to ensure the necessary safety of the household appliance and to prevent the door from accidentally unlocking in the event of a fault or a malfunction.

Should a malfunction arise, the switch will quickly switch between the capacitor charge and discharge positions, but this will not imply the activation of the electric actuator, since the capacitor will not be able to get charged sufficiently.

Likewise, should the relay fail, it will stay in the idle position, thus preventing the capacitor from charging again and therefore the door from unlocking.

It follows that this solution allows for a fast operation of a one-pulse door locking device, i.e. a door locking device which at each actuation of the electric actuator switches from the door locking position to the door unlocking position and vice versa.

This solution also appears to be particularly efficient, because it does not necessarily require the adoption of costly safety measures.

In fact, the capacitor discharge allows a limited energy to be delivered to the door locking input, thus avoiding the risk that a fault will cause high short-circuit currents to reach the door locking device. Unlike prior-art solutions, this solution allows to manufacture a safe household appliance even without

using a safety PTC, thus proving to be less expensive.

Further objects and advantages of the present invention will become apparent from the following description and from the annexed drawings which illustrate (by way of non-limiting example) some preferred and advantageous embodiments thereof, wherein:

Fig. 1 shows a laundry washing and/or drying machine;

Fig. 2 shows a door locking device of the machine of Fig. 1;

Fig. 3 shows a control circuit of the door locking device of the machine of Fig. 1;

Fig. 4 shows an alternative embodiment of the circuit of Fig. 3;

Fig. 5 shows a detail of the circuit of Figs. 2 and 4;

Fig. 6 shows an alternative embodiment of the circuit of Fig. 5;

Fig. 7 is a sectional view of an oven equipped with a door locking device according to the invention;

Fig. 8 shows a detail of the oven of Fig. 7.

Referring now to Fig. 1, there is shown a front-loading laundry washing machine 1, i.e. of the type wherein structure 2 of machine 1 has a load opening 3 on one of side walls 21 that support top cover 22.

Through load opening 3, the user places the laundry to be washed into a drum 4 which is rotated in a known manner by a motor, not shown in the drawing.

Drum 4 thus rotates inside a tub 5 supplied with water and washing agents, such as detergents and softeners.

Load opening 3 is closed by a door 6, which is shown in the open position in Fig. 1.

When door 6 is closed, a portion thereof is within structure 2 of the machine, while another portion remains outside the structure.

A catch 8 is mounted on the door side inserted in the load opening.

When the door is closed, catch 8 is inserted into a matching aperture 9 provided in wall 21 in adjacency to load opening 3, where it is held by a door locking device, not shown in Fig. 1, during all those operational phases of the machine which are considered to be dangerous, e.g. during a spin cycle or a

high-temperature wash cycle.

For this purpose, the door locking device is controlled by the control system of machine 1, which determines when to lock and when to unlock door 6 according to the operating conditions and to the signals received from the sensors connected thereto.

An example of a door locking device is shown in Fig. 2.

When inserted into aperture 9, catch 8 triggers suitable catch retaining means (of the type known from US6,334,637 and not shown in the drawings), which bring slide 10 to a position where aperture 11 obtained in slide 10 becomes aligned with the sliding direction of rod 12.

In this way, when rod 12 engages into aperture 11, slide 10 can no longer move and the engaging means retain catch 8. The door is thus locked.

Rod 12 is moved through the combined action of an electric actuator 13 and a mechanical transmission which allow rod 12 to be moved alternately in and out of aperture 11 at each activation of the actuator.

In more detail, the door locking device of Fig. 2 has a control input comprising two input terminals (A and B) that receive the control signals, in particular voltage signals.

The device comprises an electric actuator 13 that comprises a solenoid 14 connected to the input terminals.

Solenoid 14 is preferably connected directly to terminals A,B of the control input. However, according to an alternative embodiment solenoid 14 may be connected to the control input by means of a thermistor, e.g. a PTC (Positive Temperature Coefficient) thermistor arranged in series with solenoid 14.

A ferromagnetic core 15 slideably mounted within solenoid 14 provides a movable element capable of engaging with the mechanical transmission that drives rod 12.

At the base of rod 12 there is a metal contact 16, e.g. a copper plate, of a master switch 17 that, when closed, allows power to be supplied to loads 18 of the household appliance, e.g. motor, pumps, etc.

On the side opposite to that of contact 16, the base of rod 12 has a protrusion

19 which engages from below with teeth 20 of a toothed wheel 21.

Wheel 21 also has an upper toothing 22 acted upon by a lever 23 in order to rotate wheel 21.

In particular, the upper toothing is so shaped that each stroke of lever 23 rotates wheel 21 in a manner such that protrusion 19 of rod 12 alternately engages with the underside of a tooth 20 and within the gap between two successive teeth 20. As a consequence, at every stroke of lever 23 rod 12 will be moved in and out of aperture 12, thus locking or unlocking door 6 of machine 1.

Lever 23 is slideably mounted in a direction parallel to the longitudinal axis (x) of solenoid 14, so that movable element 15, when engaging lever 23, will turn wheel 21.

A ratchet 24 acts upon toothing 22 in order to prevent wheel 21 from turning in the opposite direction to the motion caused by lever 23.

Ratchet 24 is held against the wheel by a spring 25 acting between the ratchet spike and lever 23.

Through lever 23, spring 25 exerts a force onto movable element 15 to push it into solenoid 14.

For wheel 21 to turn, the movable element must therefore be pushed out of the solenoid by a force great enough to overcome the resistance of spring 25.

This is attained by applying a pulse having sufficient energy to the solenoid.

Regardless of its particular shape and special transmission, the door locking device may be thought of as a black box which, upon reception of a command at input terminals A and B, locks or unlocks door 6 of machine 1.

For the purposes of the present invention, the door locking device may without distinction be either of the type wherein the door is unlocked by means of a single pulse (e.g. like the one described above with reference to Fig. 2) or of the type wherein the door is unlocked by means of two or more pulses (i.e. of the type that requires two or more pulses for the door to unlock, as described in US6,334,637).

Fig. 3 shows a door locking control circuit which, for the reason explained

above, is represented as a circuit block 26 having a control input A,B.

The control circuit comprises a switch, which in the example of Fig. 3 comprises or consists of a relay 27.

Relay 27 is normally in an idle position in which capacitor 28 is connected to input terminals A and B of door locking device 26.

Through control module 29, relay 27 is switched to a second position that connects capacitor 28 to a voltage source that charges it.

Selected capacitor 28 must accumulate sufficient energy to actuate door locking device 26 when connected to the input terminals of the latter.

In the example of Fig. 3, the capacitor is charged by an alternating voltage 30 rectified by diode 31 connected in series between relay 27 and voltage source 30.

In the preferred embodiment, voltage source 30 consists of the domestic power mains to which machine 1 is connected.

Since the domestic power voltage is 220V @ 50Hz (or 110V @ 60Hz in the USA), in order to prevent high currents from burning diode 31, a resistor 32 arranged in series with diode 31 is used for limiting the current flowing through the diode.

Resistor 32 also provides the effect of fixing the charge time of capacitor 28; this resistor is therefore chosen to be sufficiently large to prevent any malfunction which may accidentally switch the relay from charging the capacitor up to a voltage value high enough to trigger the actuator of door locking device 26 once the relay has returned to its idle position.

Referring to this embodiment example, the preferred components are the following: a 1N4007 diode 31, a 22μF (400V) capacitor 28, a 27KΩ resistor 32, and a relay 27 capable of withstanding up to 2A @ 250V.

Fig. 4 shows an alternative embodiment wherein the voltage source is a direct voltage source, e.g. a 12V battery or a 12VDC line, e.g. taken from the power supply of the machine 1.

In this case, source 130 being a direct one, diode 31 of Fig. 3 is not required; however, a resistor 132 is still used, which must be sized appropriately for

fixing the charge time of capacitor 128.

The latter is sized in a manner such that, once completely charged, the energy released at the input of the door locking device is enough to trigger it; considering for example a door locking device like the one shown in Fig. 2, the capacitor must have sufficient energy to rotate wheel 21.

Just like the example of Fig. 3, when door locking device 26 is to be actuated (in order to lock or unlock the door), a control circuit 129 energizes relay 127, thereby connecting the capacitor 128 to the power supply for the time necessary for it to get charged, after which relay 127 is de-energized in order to connect the capacitor to control input A,B of door locking device 26.

Fig. 5 shows a control module which may without distinction be used as a module 29 for the control circuit of Fig. 3 or as a module 129 for the circuit of Fig. 4.

Relay 27 or relay 127, respectively, will therefore be connected to terminals OUT1 and OUT2.

In the example of Fig. 5, microcontroller 33 has two ports 34 and 35 for supplying a relay control voltage to terminals OUT1 and OUT2.

Microcontroller 33 is preferably the same microcontroller that belongs to the control system of the machine and controls the operation thereof; however, it may alternatively be a dedicated microcontroller.

Port 34 is connected to terminal OUT1 through a pnp-type BJT transistor (36) in a common emitter configuration, with the emitter connected to direct supply voltage VCC and the collector connected to terminal OUT1. The base of transistor 36 is connected to port 34 of the microcontroller through a resistor 37, and to the voltage VCC through a resistor 38.

Port 35 is connected to terminal OUT2 through an npn-type BJT transistor (39) in a common emitter configuration, with the emitter connected to ground and the collector connected to terminal OUT2. The base of transistor 39 is connected to port 35 of the microcontroller through a resistor 40, and to ground through a resistor 41.

Between terminals OUT1 and OUT2 there is a protection diode D1 whose

cathode is connected to terminal OUT1.

By setting output 34 low and output 35 high, across terminals OUT1-OUT2 there will be a voltage drop which will be substantially equal to VCC; this voltage will allow to control the relay.

This solution proves to be advantageous for the application described herein, since it is very robust; a couple of electric faults, although serious enough to activate the relay, will not make it switch between its two positions, thus not causing door 6 to unlock accidentally. The risk that door 6 may unlock accidentally is therefore very remote.

In this embodiment example, the voltage VCC is 5V and the various components have the following specifications: 1N4148 diode D1, 2kΩ resistors 37 and 40, 10kΩ resistors 38 and 41, BC817 transistor 37, BC807 transistor 36.

Fig. 6 shows a solution which is alternative to that of Fig. 5 for providing control module 29 or 129.

In this embodiment, terminal OUT1 is connected to the power supply VCC, while terminal OUT2 is connected to the collector of an npn-type BJT transistor (42) in grounded emitter configuration.

Output OUT2 is kept normally high because of the connection to output OUT1 provided through the relay.

In order to ground terminal OUT2 and generate a potential difference equal to Vcc across terminals OUT1 and OUT2, microcontroller 33 outputs a pulse train at port 43.

Capacitor 44, connected to port 43, is a filter which allows to cut the direct voltage that would be outputted at port 43 in the event of a failure of the port itself.

The pulse train generated by microcontroller 33 in normal operating conditions can however pass through capacitor 44, and is rectified by rectifier 45 consisting of diode pair 46 and 47.

A filter 48, made up of resistors 49, 50 and capacitor 51, is arranged in series with rectifier 45.

Filter 48 is a low-pass filter that lets direct current flow through while cutting any noise (in fact, a certain number of pulses are required for charging capacitor 51, until a voltage high enough to activate the BJT 42 is achieved).

The output signal of filter 48 drives transistor 42, whose base-to-emitter junction is protected by means of a resistor 52.

In this embodiment example, the voltage VCC is 5V and the various components have the following specifications: 220nF capacitor 44, 1N4148 diodes 46 and 47, 1kΩ resistor 49, 2kΩ resistor 50, 47kΩ resistor 52, 22μF capacitor 51, BC817 transistor 42.

The present invention is not limited to a front-loading laundry washing machine of the type described with reference to Fig. 1; the invention is in fact applicable to any laundry washing and/or drying machine, e.g. washing machines, washing/drying machines, clothes dryers, whether of the front-loading or top-loading type and whether fitted with a dispenser built in the door or in the casing of the machine.

Furthermore, the present invention is also applicable to any electric appliance provided with a door and a door locking device.

Such an appliance will thus be equipped with a circuit for controlling a door locking device of an electric appliance, said door locking device comprising an electric actuator acting in response to a control signal received at a control input.

The circuit according to the present invention comprises an input for connecting to a voltage source and an output for connecting to the electric actuator input.

In order to control the door locking device, the circuit comprises a capacitor and a switch.

The capacitor and the switch are connected in a manner such that in a first position of the switch the capacitor is connected to the voltage source, hence getting charged, and in a second position of the switch the capacitor is connected to the control input of the electric actuator, hence getting discharged.

In particular, the door locking device described above with reference to a laundry washing and/or drying machine may also be used in other types of household appliances having an opening closed by a door.

By way of example, the invention is also applicable to ovens, in particular to pyrolytic ovens.

As known, the latter are commonly equipped with a door locking device which prevents the door from being opened during the pyrolysis phase, wherein the temperature in the muffle reaches very high values.

According to the current European regulations, the door locking function is mandatory if the temperature exceeds 425°C, whether the appliance is a pyrolytic or catalytic oven.

It follows that ovens too may be fitted with a door locking device of the type described above with reference to Figs. 2 to 6, thereby attaining all the safety and cost advantages offered by such a solution.

Fig. 7 is a sectional view of a built-in pyrolytic oven 700, i.e. of the type that can be inserted into a recess of a kitchen cabinet.

Oven 700 comprises a muffle 701 that defines the cooking cavity, and a pair of heating elements 702 (in particular electric resistors or halogen lamps) which allow to obtain the desired temperature in the muffle.

The muffle is closed by a door 703 that can be locked in the closed position by means of a door locking device 704, shown in more detail in Fig. 8.

In the example of Figs. 7 and 8, the door is hinged to the lower part of oven cabinet 705; the door therefore opens by pivoting about a horizontal axis.

In the upper part, door 703 has a tooth 706 onto which an arm 707 of the door locking device engages; said arm ends with a coupling profile that defines a seat for tooth 706, so that door 703 can be locked in position after having been closed. The seat may be substantially U-shaped.

In a preferred embodiment, the oven is equipped with a door locking device of the type described with reference to Figs. 2 to 6; when the door is closed, arm 707 is automatically moved to the closed position, thus moving slide 10 to a position in which aperture 11 obtained in slide 10 becomes aligned with the

sliding direction of rod 12.

As an alternative, slide 10 may be actuated at a second time by the oven control unit.

During all those operational phases which are considered to be dangerous, e.g. during the pyrolysis phase, the oven control unit actuates the door locking device by moving rod 12 to the position in which it engages aperture 11, so as to lock arm 707 and door 703.

It is apparent, however, that many changes may be made to the present invention by those skilled in the art without departing from the protection scope thereof as stated in the appended claims.

In particular, the components of the control circuits illustrated herein by way of non-limiting example with reference to Figs. 3 and 4 shall be sized appropriately in accordance with the door locking type and the input signals required for its activation.

The mechanical components may be subject to changes as well. For example, as known, an oven door may open or close by turning about a vertical axis; in this case, the door locking device may be arranged on a side upright of the oven, rather than in the upper part thereof. Without any distinction, the door locking device may be located either in a central position or in a lateral position with respect to the door.

Likewise, the retaining and coupling means that allow a household appliance's door to be locked may be different while still using the same principle and electronic circuit of the invention as described with reference to Figs. 2 to 6.

CLAIMS

1. Household appliance, comprising
a structure (2) having a load opening (3),
a door (6) adapted to close said opening (3), and
a door locking device adapted to lock said door (6) when said door is closed,
wherein said door locking device comprises an electric actuator (13) acting in response to a control signal received at a control input (A,B),
characterized by comprising a capacitor (28) and a switch (27) connected in a manner such that in a first position of said switch (27) said capacitor is connected to a voltage source (30), hence getting charged, and in a second position of said switch (27) said capacitor (28) is connected to the control input (A,B) of the electric actuator, hence getting discharged.

2. Household appliance according to claim 1, wherein said switch comprises a relay, and wherein said second position is an idle position of said relay.

3. Household appliance according to claim 1 or 2, wherein said switch is driven by a drive signal generated by a control module, said control module comprising a microcontroller (33) comprising two control ports (34,35) connected to the bases of two transistors (36,39) for the purpose of driving the latter,
wherein said two transistors (36,39) are provided in a common emitter configuration, a first one (39) of said two transistors having the emitter connected to ground, and a second one (36) of said two transistors having the emitter connected to a supply voltage,
and wherein said drive signal is taken across the collectors (OUT1,OUT2) of said two transistors (36,39).

4. Household appliance according to claim 3, wherein the collectors of said two transistors are connected by means of a diode.

5. Household appliance according to claim 1 or 2, wherein said switch is driven by a drive signal generated by a control module, said control module comprising a microcontroller (33) comprising a control port (43) connected to the base of a transistor (42) in grounded emitter configuration,

wherein said control port (43) is connected to the base of said transistor (42) through a first filter (44) adapted to cut a direct voltage, a rectifier circuit (45) whose output is connected to said filter, and a second low-pass filter (48) connected between the output of said rectifier circuit and the base of said transistor (42),

and wherein said drive signal is taken across a direct supply voltage (OUT1) and the collector (OUT2) of said transistor (42).

6. Household appliance according to any of the preceding claims, wherein said electric actuator (13) comprises a solenoid (14) connected directly to said control input (A,B).

7. Household appliance according to any of claims 1 to 5, wherein said electric actuator comprises a solenoid (14) connected to said control input (A,B) by means of a thermistor.

8. Household appliance according to any of the preceding claims, wherein said door locking device is adapted to alternately lock and unlock said door every time a control signal is received at said control input.

9. Household appliance according to any of the preceding claims, wherein said household appliance is a laundry washing and/or drying machine (1).

10. Household appliance according to any of the preceding claims, wherein said household appliance is an oven (700), in particular a pyrolytic oven.

11. Circuit for controlling a door locking device of an electric appliance, said door locking device comprising an electric actuator (13) acting in response to a control signal received at a control input (A,B),

characterized in that it comprises an input for connecting to a voltage source (30) and an output for connecting to the input (A,B) of the electric actuator (13), and that, in order to control the door locking device, the circuit comprises a capacitor (28) and a switch (27) connected in a manner such that in a first position of said switch (27) said capacitor is connected to a voltage source (30), hence getting charged, and in a second position of said switch (27) said capacitor (28) is connected to the control input (A,B) of the electric actuator, hence getting discharged.

12. Circuit according to claim 11, wherein said switch comprises a relay, and wherein said second position is an idle position of said relay.

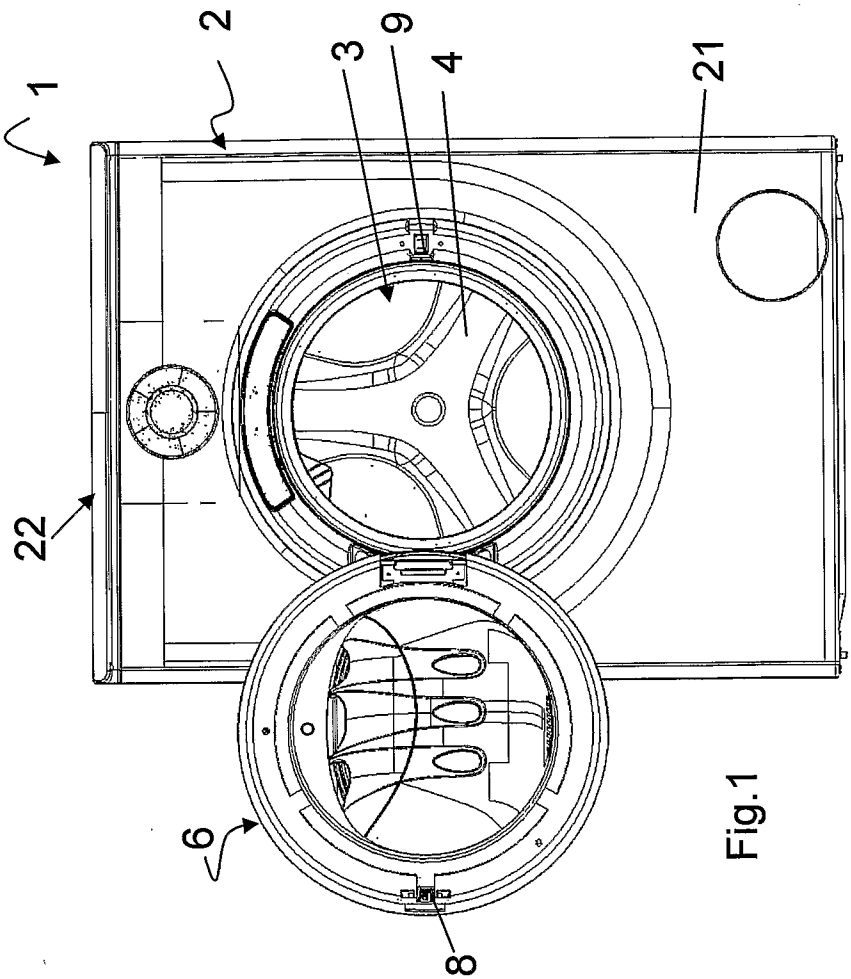


Fig.1

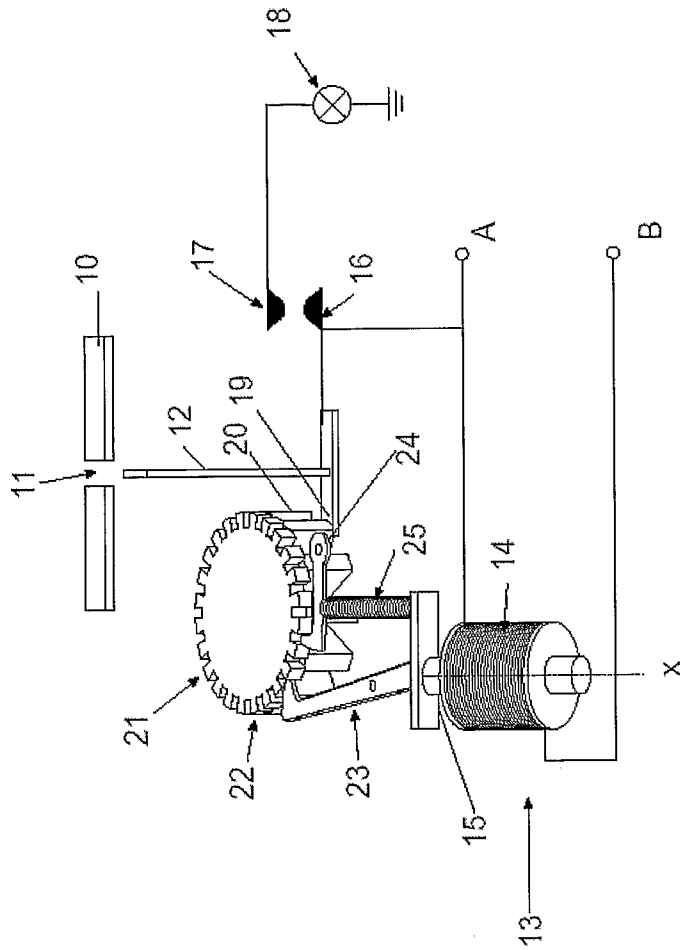


Fig.2

Fig.3

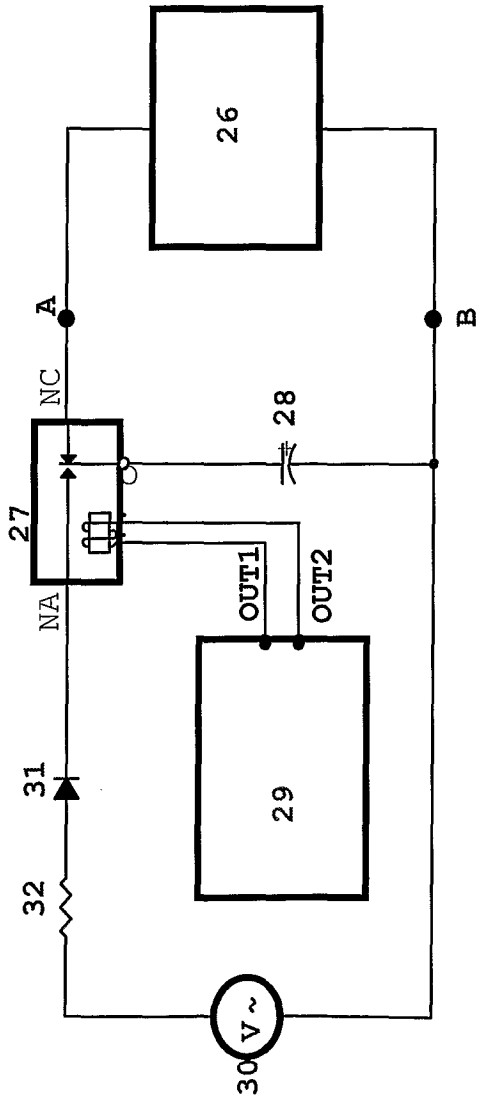
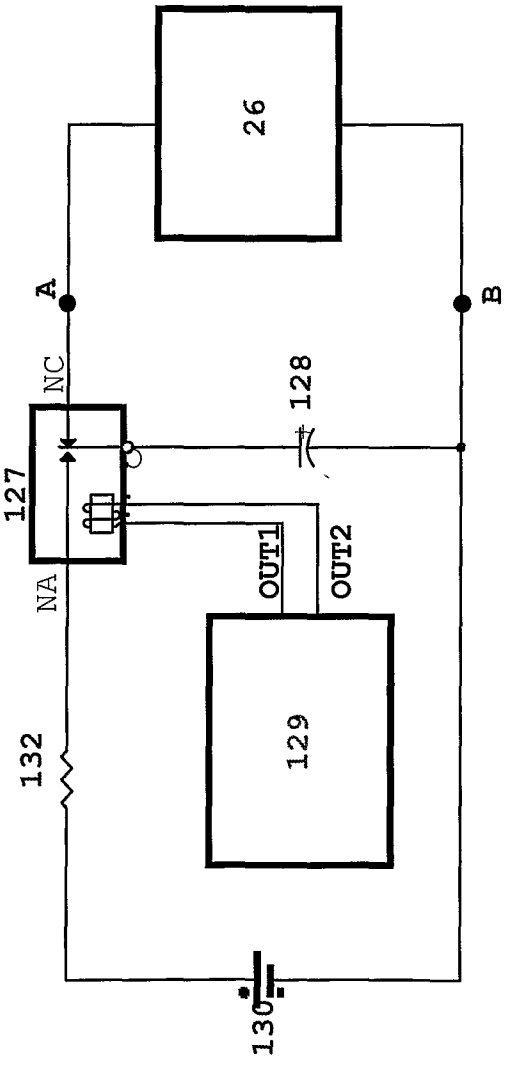

26
A
B
NC
28
27
OUT1
OUT2
NA
31
29
32
V~
30

Fig.4


26
A
B
NC
128
127
OUT1
OUT2
NA
132
129
130

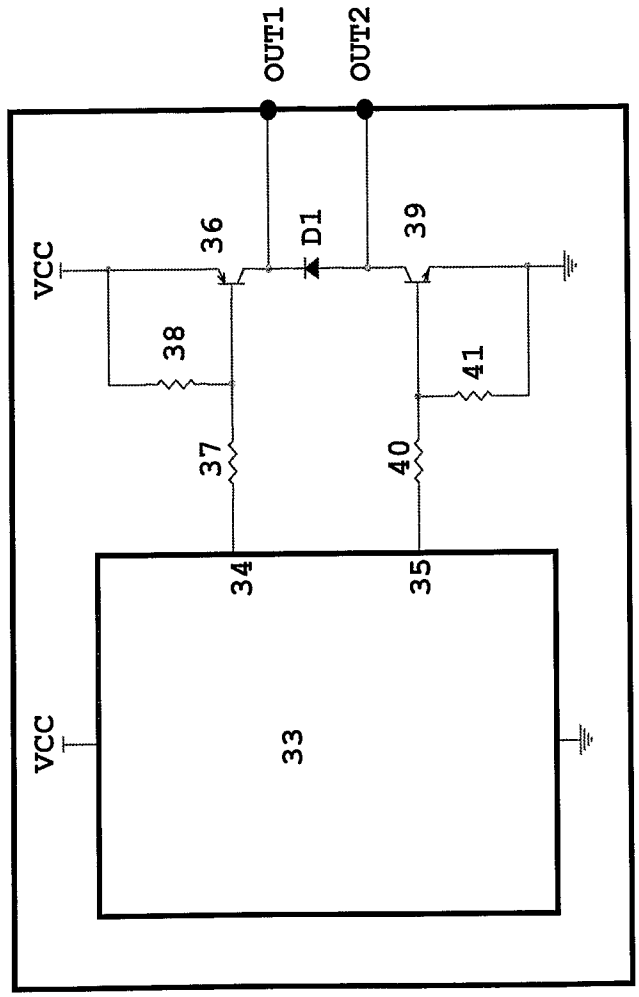


Fig.5

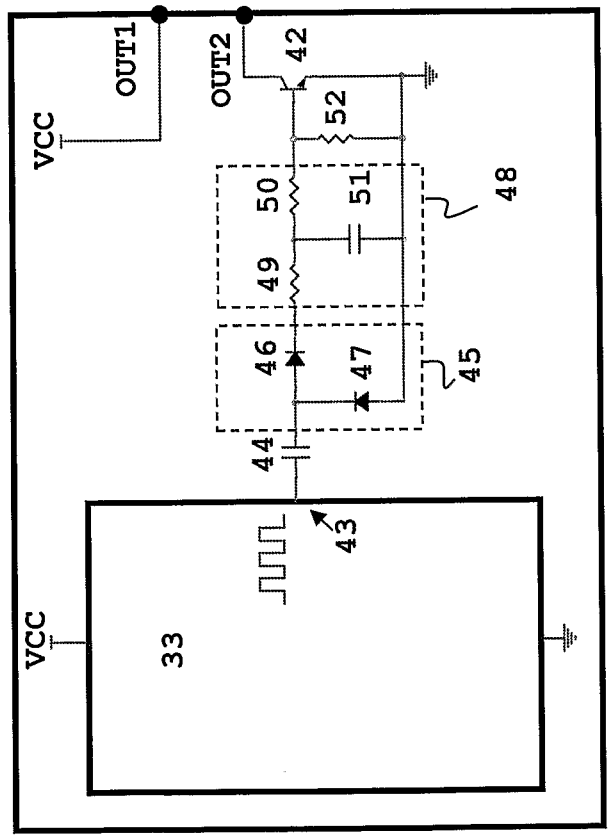


Fig.6

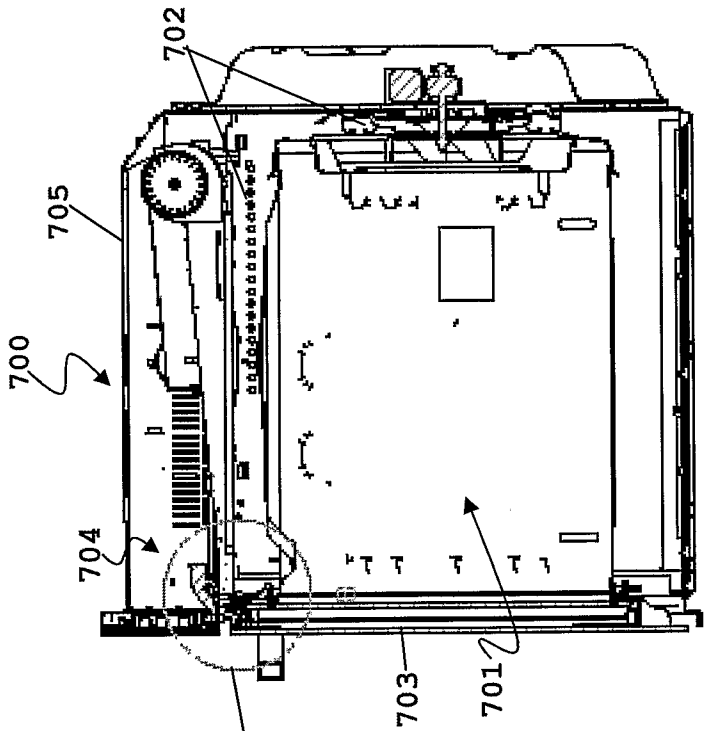


Fig.7

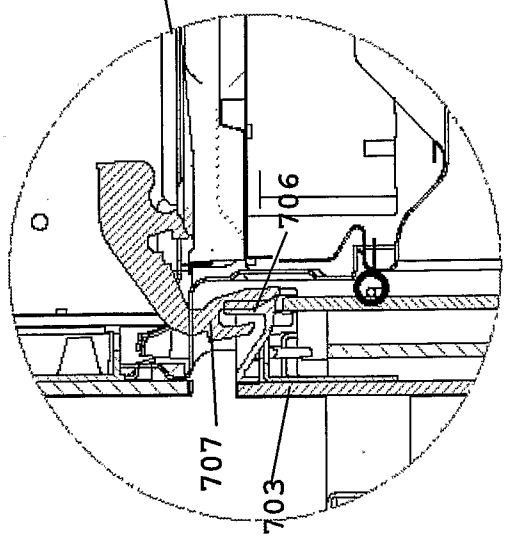


Fig.8