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(54) Safety device for laundry drier.

(57) A safety device for a laundry drier adapted to cut the electric power supply to the machine in case of insufficient or totally absent drying air circulation due to clogging of the filter (14) and/or stoppage of the electric motor (23) of the blower (9) and the drum (5) caused by failure or functional defects of the motor.

The safety device comprises control means (18,37,19; 44,37,19; 48) connected to the heater element (13) and to the protection thermostat (15) of the machine for controlling the power supply to the machine or the interruption thereof as a function of the reset time of the protection thermostat (15) after the response temperature of the thermostat has been attained.

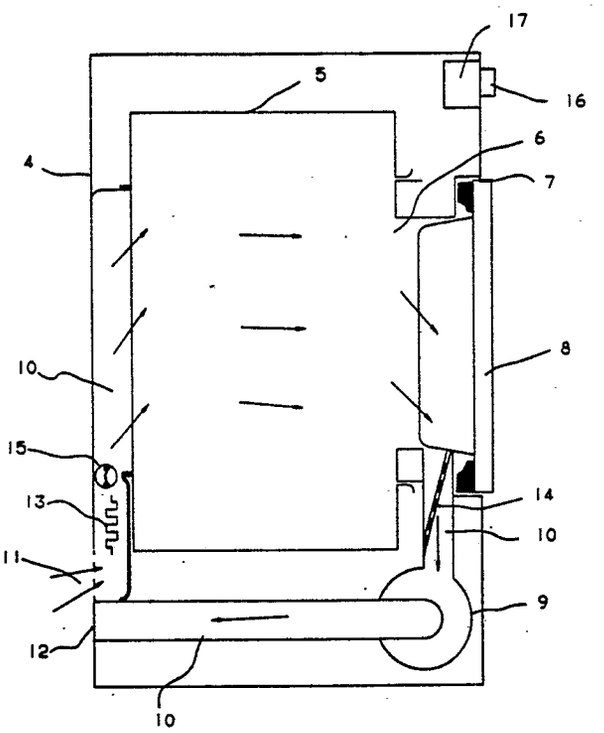

FIG. 1

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SAFETY DEVICE FOR LAUNDRY DRIER

The invention relates to a safety device for a laundry drier adapted to cut the electric power supply to the machine when the flow of heated drying air is absent or insufficient for adequately drying the laundry.

Known laundry driers substantially comprise a blower and at least one heater element for circulating a flow of heated air through a conduit equipped with a filter for retaining fluff and any foreign bodies, to the interior of a drum containing the laundry to be dried and adapted to be rotated by the electric motor driving said blower.

The heater element is conventionally connected to the electric circuit of the machine, together with a conventional protection thermostat operating to energize and to deenergize the heater element in response to the temperature of the circulating air.

In this manner it is possible to maintain the temperature of the heater element within predetermined limits to thereby avoid the danger of failure of the heater element itself and of damage of the machine as a whole and of the laundry contained in the drum.

Under normal operating conditions of the machine, i.e. when the filter is not clogged by fluff or any foreign bodies, and the drum and the blower are properly rotated by the motor, so that there is a proper circulation of air through the machine, the heater element is thermostatically controlled either by the already mentioned protection thermostat for the purposes stated above, or by special control thermostats additionally provided in the electric circuit of the machine and calibrated to different response temperatures, these additional thermostats being activated respectively in consideration of the type and the amount of fabrics to be dried.

Under operating conditions, on the other hand, in which the circulation of air through the machine is hampered by partial clogging of the filter by fluff and any odd foreign bodies, or when such air circulation is completely absent due to complete clogging of the filter, the protection thermostat operates to energize and to deenergize the heater element at a much higher switching frequency than under normal operating conditions, due to the elevated temperature attained in the interior of the machine.

Under these conditions it is thus difficult to usefully exploit the heat generated by the heater element, so that the machine is not capable of executing satisfactory drying cycles, there being the additional danger of the functional components of the machine being damaged after some time due to overheating and possible scorching.

By its operation under abnormal conditions there exists the danger of the protection thermostat itself being damaged, necessitating its repair or replacement.

For avoiding such inconveniences due to the clogged state of the filter, various types of per se known control devices have been associated to the filter for giving an indication of this state necessitating the filter to be cleaned or replaced, and for interrupting the electric power supply to the electric components of the machine.

Although these control devices function in a satisfactory and reliable manner, they are totally ineffective in the absence of the drying air flow due to failure or functional defects of the electric motor of the laundry drier resulting in the blower and the drum of the machine not being rotated.

Also in this case, the same inconveniences as noted above could come about in machines of this type due to the difficulties regarding the dissipation of the heat generated by the heater element.

It would therefore be desirable, and is an object of the present invention, to provide a safety device for a laundry drier capable of ensuring satisfactory and reliable operation of the machine while preventing the occurrence of the above noted inconveniences under unfavourable operating conditions of the machine, that is, when the filter is partially or completely clogged and/or when the blower and the drum are not properly rotated in the course of a drying cycle.

In particular, the operation of a safety device of this type should be based on the principle of determining the reset time of the protection thermostat after the response temperature of the thermostat has been attained both under normal operating conditions and under unfavourable operating conditions of the laundry drier.

In response to whether or not the thus measured reset time lies within predetermined limits, the present safety device thus causes the power supply to the laundry machine to be maintained or to be interrupted.

These and other objects are attained according to the invention by the present safety device for a laundry drier substantially comprising a blower and at least one heater element for causing heated air to circulate through a conduit and the interior of a drum containing the laundry to be dried, said blower and said drum being adapted to be rotated by an electric motor connected to the electric circuit of the machine, together with said heater element and a protection thermostat of a conventional type, and optionally a per se known indicator device, said electric circuit being adapted to be switched be-

tween two operative states, namely, an energized state and a deenergized state. The safety device is characterized by comprising control means connected to said heater element, said protection thermostat and said optionally provided indicator device for switching the said electric circuit to one or the other operative state in response to the reset time of said protection thermostat after the response temperature of this thermostat has been attained.

The invention will be better understood from the following description, given by way of example with reference to the accompanying drawings, wherein:

fig. 1 shows a diagrammatic sectional view of a laundry drier to which the present invention is applicable, and

figs. 2, 3 and 4 show three embodiments of electric circuit diagrams for the laundry drier of fig. 1.

Diagrammatically shown in fig. 1 is a laundry drier of conventional construction, comprising a housing 4 and a rotatable drum 5 adapted to contain the laundry to be dried and mounted within housing 4 in a per se known manner, said drum being provided with an access opening 6 aligned with a corresponding front opening 7 of housing 4 and adapted to be closed by a door 8 hinged to housing 4 so as to permit the laundry to be dried to be charged and discharged into and from drum 5, respectively.

The present laundry drier further comprises a blower 9 adapted to be rotated by the electric motor (not shown) also used for rotating drum 5, and communicating with a drying air circulation conduit 10 itself communicating with the interior of drum 5 and defined by the walls of housing 4 and drum 5.

Conduit 10 is also provided with respective air inlet and outlet openings 11, 12 and contains at least one heater element 13 as well as a filter 14 of conventional type provided respectively for heating the drying air and for retaining fluff and any foreign matter entrained by the air flow generated by blower 9 and circulating through conduit 10 and the interior of drum 5.

Associated to heater element 13 is a protection thermostat of conventional type disposed in conduit 10 and responsive to the temperature of the circulated air.

In particular, protection thermostat 15 is connected in a manner to be described to the electric circuit of the drier together with heater element 13, and calibrated so as to consecutively energize and deenergize heater element 13 during each drying cycle so as to maintain the temperature of the circulating air between pre-established levels to thereby avoid the danger of damage to the heater element, to the laundry drier as a whole, and to the laundry contained in the drum.

The present laundry drier finally comprises a number of conventional control elements (shown in fig. 1 is a rotatable knob 16 associated to a program control unit 17) for selecting the duration of a drying cycle and the maximum temperature in dependence of the type and amount of fabrics charged into drum 5.

With reference to fig. 2, there is shown a circuit diagram incorporating a safety device according to a first embodiment of the invention.

This device substantially comprises an electronic control circuit including a comparator 18 connected to the electric circuit of the drier together with a switch relay 19 in the manner and for purposes to be described, said electric circuit also including program control unit 17 connected on the one hand to a main conductor 20 via a breaker switch 21 adapted to be operated by switch relay 19, and on the other hand to a second main conductor 22 through the electric motor 23 for rotating blower 9 and drum 5, and/or through heater element 13 and protection thermostat 15 connected in series therewith.

In particular, comparator 18 serves the funcion, in a manner to be described below, of determining wether or not the resetting of protective thermostat 15 subsequently to its response temperature having been attained occurs within a pre-established time interval corresponding to the operative condition of the drier in which filter 14 is not clogged by fluff or other foreign matter and both blower 9 and drum 5 are properly rotated by motor 23.

In the presence of this operative condition, characterized by the proper circulation of the drying air through the machine, comparator 18 acts to maintain program control unit 17, and thus all of the other electric components of the machine, in the energized state for executing the selected drying cycle.

On the other hand, in the operative condition of the machine with filter 14 clogged by fluff or other foreign matter and/or motor 23 failing to properly rotate blower 9 and drum 5, characterized by insufficient or even completely absent air circulation through the machine, the resetting of protection thermostat 15 after each switching operation takes place at progressively increasing time intervals, because the thermostat is exposed to progressively higher temperatures.

Under these conditions comparator 18 acts to deenergize program control unit 17 and thus all of the other electric components of the machine to thereby prevent a drying cycle from being executed.

While comparator 18 causes program control

unit 17 to be maintained in the deenergized state it additionally causes the malfunction of the machine to be indicated until it has been attended to.

For performing these operations, comparator 18 has its first input 24 connected to the junction 25 between heater element 13 and protection thermostat 15 through a rectifying and voltage limiter circuit 26 and a time constant circuit 27 of conventional type.

In particular, time constant circuit 27 is composed of a series of R-C elements (i.e. resistor-capacitor circuits) interconnected and dimensioned so as to generate, in the presence of a constant input voltage applied to circuit 27 by circuit 26, an exponentially rising DC output voltage to be applied to first input 24 of comparator 18.

Circuits 26 and 27 are additionally connected parallel to one another to respective energization conductors 28 and 29 themselves connected to main conductor 22 by a common conductor 30.

The second input 31 of comparator 18 is connected on the one hand to first main conductor 20 by a conductor 32 and a rectifying and voltage limiting circuit 33, and on the other hand to second main conductor 22 by conductors 34 and 30, comparator 18 being finally provided with an energizing conductor 35 connected to conductor 32 at the output side of circuir 33 and to conductor 30.

Second input 31, in particular, has applied to it a DC reference voltage at a pre-established level determined by circuit 33 and and adapted to be compared to the voltage applied to first input 24 for controlling the energization and deenergization of the machine in the manner to be described below.

The output 36, finally, of comparator 18 is connected to main conductor 22 through a transistorized power control circuit 37 of conventional type and switching relay 19, the latter being connected in parallel with a signalling device 38 comprising a warning lamp,an acoustic warning device or any other suitably device of this kind, said power control circuit having an energizing conductor 39 connected to conductor 32 at the output side of circuit 33 and to conductor 30.

The thus composed safety device operates as follows: To start the execution of a drying cycle, a main switch 40 of the electric circuit of the machine is closed, and program control unit 17 is adjusted to the maximum temperature and duration of the drying cycle to be executed in accordance with the type and amount of laundered fabrics charged into the drum.

Under these conditions, switching relay 19 remains deenergized to keep breaker switch 21 closed, so that program control unit 17 is energized to control the energization of motor 23 and heater element 13 with protection thermostat 15 being closed.

After the laundry drying cycle has been thus started it is thermostatically controlled by specific ones of a number of control thermostats (not shown) connected to the electric circuit of the machine and calibrated to various temperature limits.

As the drying cycle proceeds, and as long as the response temperature of protection thermostat 15 is not attained, first input 24 of comparator 18 has no voltage applied thereto so that comparator 18 acts to maintain switching relay 19 as well as signalling device 38 deenergized. The latter device thus indicates the correct execution of the drying cycle.

When the response temperature of protection thermostat 15 is attained, the latter opens, so that the energization through thermostat 15 is interrupted, heater element 13 continuing to be energized from the mains through circuits 26, 27 and conductors 28, 29, 30.

As a result, time constant circuit 27 acts to generate an exponentially rising DC voltage to be applied to first input 24 of comparator 18 for comparison to the preestablished reference DC voltage applied to second input 31 of comparator 18.

In particular, time constant circuit 27 is dimensioned so that the voltage generated thereby rises gradually while remaining lower than said reference voltage as long as the protection thermostat remains open and until this thermostat is reset after a time interval within preestablished limits corresponding to the operative condition of the machine with proper circulation of the drying air.

During the successive opening and subsequent closing operations of protection thermostat 15, the logic state of comparator 18 remains thus unchanged, as a result of which switching relay 19 as well as signalling device 38 remain dee-ergized as before.

Under an operative condition, on the other hand, of the machine, characterized by insufficient or totally absent air circulation due to clogging of filter 14 and/or stoppage of blower 9 caused by failure or functional defects of motor 23, the resetting of protection thermostat 15 does no longer occur within the pre-established time limits, but only after longer intervals due to the causes explained before.

Under these conditions the DC voltage generated by time constant circuit 27 and applied to first input 24 of comparator 18 continues to rise during this extended interval to finally reach a level above that of the reference value applied to second input 31 of comparator 18, as a result of which the logic state of the latter is changed to render its output 36 conductive.

In this manner comparator 18 automatically causes the power supply to the machine to be

interrupted by the energization of switching relay 19 through power control circuit 37, resulting in breaker switch 21 being opened and signalling device 38 being energized to indicate the malfunction of the machine and the need thereof to be attended to.

For preventing the interruption of the power supply from causing the logic state of comparator 18 to be changed back due to the absence of a voltage at first input 24, with the consequent undesirable resumption of the power supply and deenergization of signalling device 38, the present safety device is provided with a feedback circuit 41 connected between output 36 and first input 24 of comparator 18.

In the present example this feedback circuit 41 comprises a diode 42 connected to be conductive in the direction towards first input 24 of comparator 18, and at least one reistor 43 connected in series with said diode for applying to first input 24 a voltage at a level higher than that of the reference voltage applied to second input 31 as long as a voltage appears at output 36 of comparator 18.

The same result could obviously be obtained with a feedback circuit of a construction other than the one described without thereby leaving the scope of protection of the invention.

With reference now to fig. 3, there is shown a second embodiment of the present safety device incorporated in an electric circuit comprising the same components as already shown in fig. 2 and therefore designated by the same reference numerals.

In this case the safety device comprises an electronic counter circuit 44 of conventional type performing a similar function as comparator 18 in fig. 2 and energized from the mains through a rectifying and voltage limiter circuit 33 and conductors 32 and 45.

An input 46 of counter circuit 44 is connected to the junction 25 between heater element 13 and protection thermostat 15 through a rectifying and voltage limiting circuit 26, the output 47 of counter circuit 44 being connected to transistorized power control circuit 37 itself connected and energized as in the first embodiment.

Also in this case, each drying cycle of the machine is controlled by program control unit 17 acting to keep breaker switch 21 closed by maintaining switching relay 19 as well as signalling device 38 in the deenergized state.

Program control unit 17 thus controls the energization of motor 23 and heater element 13 in series with protection thermostat 15, the latter being in its closed state.

Under these conditions, which are maintained as long as the response temperature of protection thermostat is not attained, circuit 26 is at zero voltage, so that counter circuit 44 remains inactive and switching relay 19 is not energized.

Only when the response temperature level of protection thermostat 15 is attained, the latter opens so that the power supply therethrough is interrupted while heater element 13 continues to be energized from the mains through circuit 26 and conductor 28.

As a result, rectifying and voltage limiter circuit 26 acts to generate a constant DC voltage so as to cause start pulses to be applied to input 46 of counter circuit 44.

In particular, counter circuit 44 is designed to activate transistorized power control circuit 37 only at the end of a time interval comprised within preestablished limits during which protective thermostat 15 is reset under normal operating conditions of the machine with correct circulation of the drying air.

In this manner counter circuit 44 is repeatedly activated and deactivated as long as the resetting of protection thermostat 15 occurs within these preestablished time limits. Under these conditions power control circuit 37 is therefore not activated, so that switching relay 19 always remains deenergized as does also signalling device 38.

Under an operative condition of the machine, on the other hand, with insufficient or totally absent circulation of the drying air for the reasons explained above, the resetting of protection thermostat 15 occurs after a time interval longer than that determined by counter circuit 44 for the reasons explained before.

Under these circumstances counter circuit 44 continues to operate even after expiry of the preestablished time limit as long as protection thermostat 15 remains open. This results in power control circuit 37 being activated to energize switching relay 19, so that breaker switch 21 is opened to interrupt the power supply to the machine, and at the same time to energize signalling device 38 for indicating this abnormal operating state of the machine.

The energization of switching relay 19 and signalling device 38 is maintained unchanged due to the fact that power control circuit 37 always remains activated until the malfunction of the machine has been attended to.

This solution thus permits the feedback circuit previously provided for these purposes to be omitted.

With reference now to fig. 4, there is shown a third embodiment of the present safety device incorporated in an electric circuit of a laundry drier including breaker switch 21,program control unit 17, heater element 13, protection thermostat 15 and motor 23 each connected in the circuit as described before.

In this case, however, breaker switch 21 is the movable contact of a manually resettable thermostat 48 of conventional type, provided with a heater element 49 thermally associated to said contact and connected between main conductor 22 and junction 25 between heater element 13 and protection thermostat 15.

The purpose of manually resettable thermostat 48 is to interrupt the power supply to the machine when the temperature of the drying air rises above pre-established limits, for instance when there is an insufficient air circulation or even none at all for the reasons stated before.

Connected in parallel to thermostat contact 21 is a signalling device 38 of the same kind as described above.

This embodiment od a safety device operates as follows: On initiation of each laundry drying cycle under the control of program control unit 17, contact 21 of thermostat 48 is closed, permitting program control unit 17 to energize heater element 13, protection thermostat 15 and motor 23.

As long as protection thermostat 15 remains closed in the course of the drying cycle, heater element 49 of thermostat 48 is not energized, as a result of which contact 21 remains closed to thereby keep signalling device 38 short-circuited. The signalling device is thus not energized to thereby indicate the correct operative state of the machine.

Only after the response temperature of protection thermostat has been attained, the latter opens to interrupt the power supply therethrough, whereupon heater element 13 continues to be energized from the mains through heater element 49 of manually resettable thermostat 48.

This results in a gradual heating up of heater element 49, causing progressive dilatation of movable contact 21 without, however, causing the latter to open during the time interval intervening between the opening and closing of protection thermostat 15 under normal operating conditions.

Under an operative condition of the machine, on the other hand,resulting in a rising of the drying air temperature above a pre-established limit, the resetting of protection thermostat occurs after a longer time interval than before, the resulting longer duration of the energization of heater element 49 of thermostat 48 causing contact 21 to open, to thereby interrupt the power supply to the machine and to energize signalling device 38.

Claims

1. A safety device for a laundry drier substantially comprising a blower and at least one heater element for creating a circulation of heated air through a conduit and the interior of a drum containing the laundry to be dried, said blower and said drum being adapted to be rotated by an electric motor connected to an electric circuit of the drier together with said heater element, a protection thermostat of conventional type and optionally a per se known signalling device, said electric circuit being adapted to be switched between two operative states, namely, an energized state and a deenergized state, characterized by comprising control means (18,37,19; 44,37,19, 48) connected to said heater element (13), said protection thermostat (15) and said optionally provided signalling device (38) for switching said electric circuit to one or the other operative state depending on the time interval for resetting said protection thermostat (15) after the response temperature thereof has been attained.

2. A safety device according to claim 1, characterized in that said control means include a comparator (18), a transistorized power control circuit (37) and a switching relay (19) of conventional type connected in parallel to said signalling device (38) and associated to a breaker switch (21) in said electric circuit of the drier, said comparator (18) being adapted to control said relay (19) through said power control circuit (37) in response to comparison of the levels of voltages applied respectively to a first (24) and a second (31) input of said comparator (18).

3. A safety device according to claim 2, characterized in that said first input (24) of said comparator (18) is connected to said heater element (13) and said protection thermostat (15) through a time constant circuit (27) of conventional type adapted to generate an exponentially rising DC voltage determined in accordacne with the time interval for resetting said protection thermostat (15).

4. A safety device according to claim 2, characterized in that said second input (31) of said comparator (18) has applied thereto a DC reference voltage at a pre-established level.

5. A safety devcie according to claim 2, characterized in that it includes a feedback circuit (41) of a per se known type connected between the output (36) and said first input (24) of said comparator (18) for maintaining said first input (24) at a voltage level above that applied to said second input (31) when a voltage appears at said output (36).

6. A safety device according to claim 1, characterized in that said control means comprises an electronic counter circuit (44), a transistorized power control circuit (37) and a switching relay (19) of conventional type connected in parallel with said signalling device (38) and associated to a breaker switch (21) in said electric circuit of the drier, said counter circuit (44) being connected to said heater

element (13) and said protection thermostat (15) and adapted to control the energization of said relay (19) through said power control circuit (37) at the end of a pre-established time interval determined by the time interval for resetting said protection thermostat (15).

7. A safety device according to claim 1, characterized in that said control means comprises a manually resettable thermostat (48) provided with a heater element (49) thermally associated to a contact (21) disposed in parallel with said signalling device (38) and connected in the electric circuit of the machine, said heater element (49) being connected to said heater element (13) and to said protection thermostat (15) and adapted to control the actuation of said contact (21) in accordacne with the time interval required for the resetting of said protection thermostat (15).

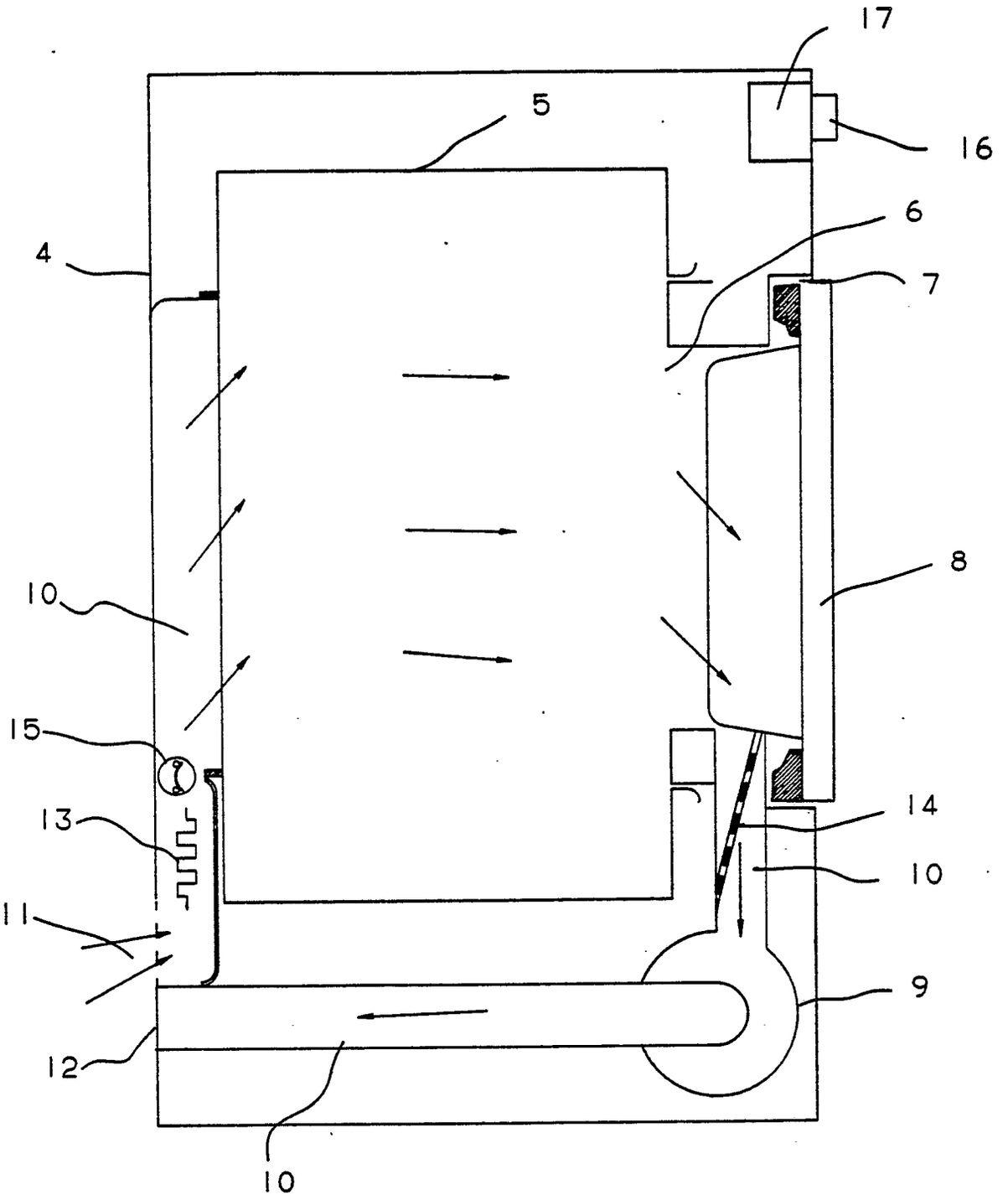

FIG. 1

Fig 2)

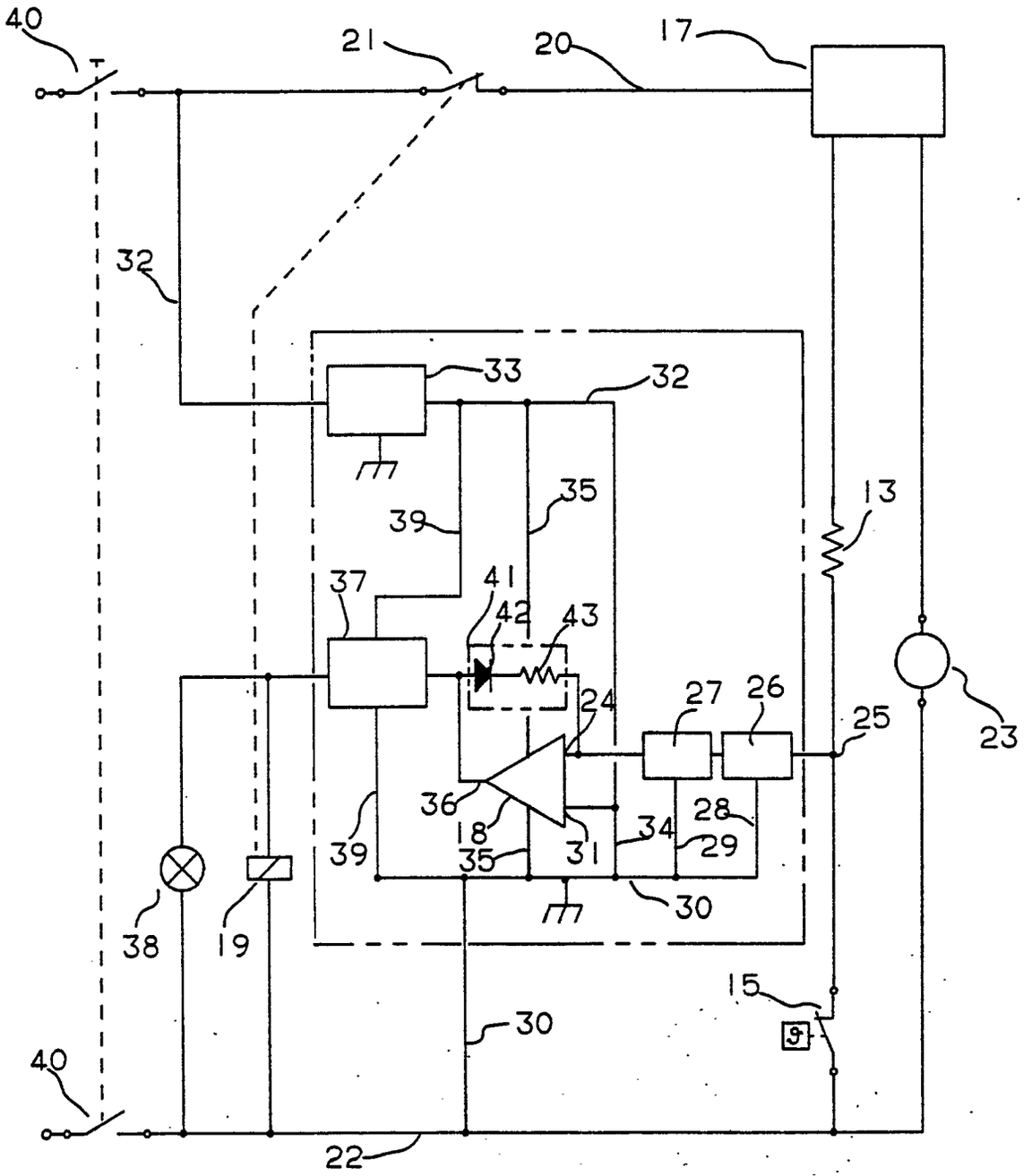
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Fig 3)

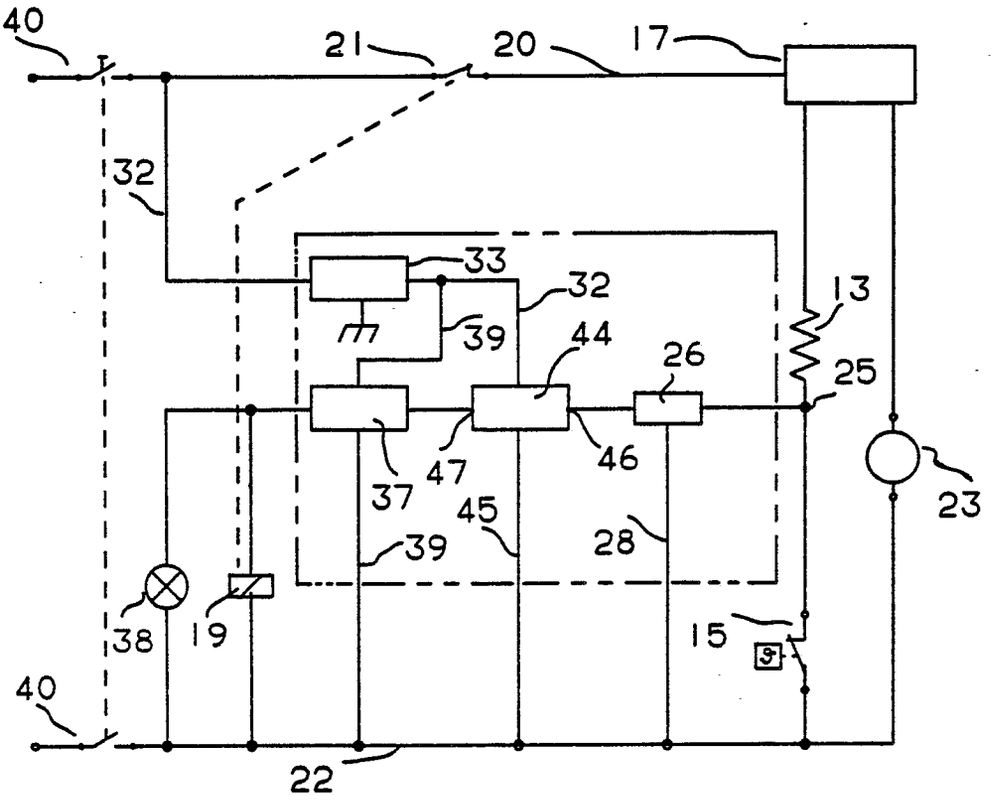
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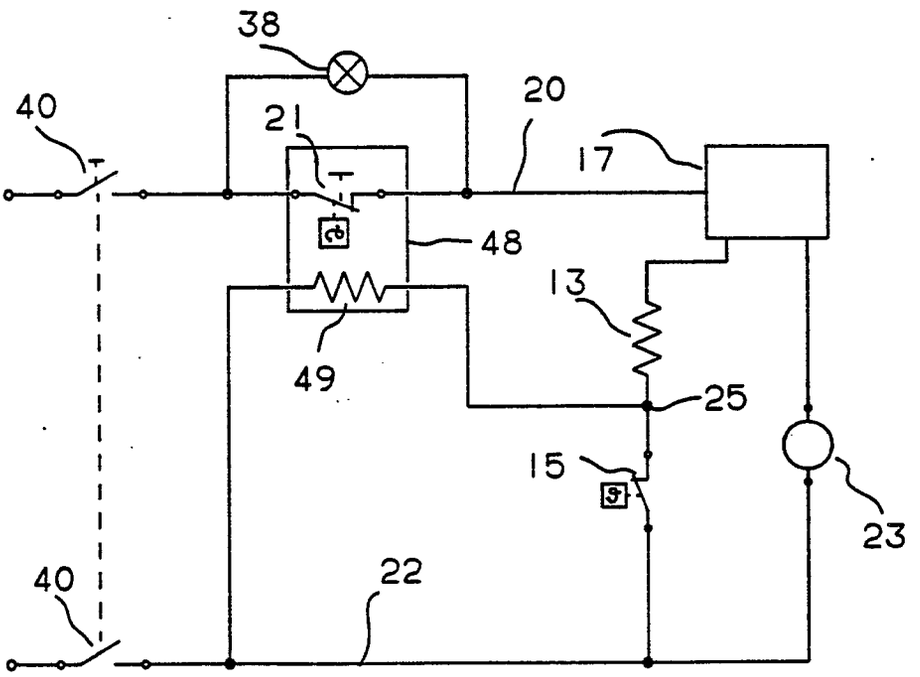
Fig 4)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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 11 7066

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	FR-A-2547327 (THOMSON-BRANDT) * the whole document *	1	D06F58/28
A		2, 6	

X	US-A-3109717 (KING-SEELEY THERMOS CO.) * column 6, line 70 - column 8, line 17; figure 7 *	1	
A		7	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 JANUARY 1989	COURRIER G.L.A.

CATEGORY OF CITED DOCUMENTS

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