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

(11) EP 1 867 775 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.12.2007 Bulletin 2007/51

(51) Int Cl.:
D06F 39/04 *(2006.01)*

(21) Application number: **06115406.8**

(22) Date of filing: **13.06.2006**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

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(54) Circuit arrangement for an electric household appliance

(57) Circuit arrangement for an electric household appliance comprising an electric heating element (2) and one or more load impedances (3-5) connected in parallel with respect to electric power-supply terminals (L,M) adapted to be connected to a line voltage for supplying an alternating electric current to the heating element (2) and the load impedances (3-5), control means (6) for continuously monitoring the value of the current (9-11) flowing through the load impedances (3-5), solid-state switch means (12) connected in series with the heating element (2) and adapted to modulate the conduction cycle time of the heating element (2) for regulating the current (8) flowing through the heating element (2), said control means (6) being adapted to drive said solid-state switch means (12) such that the value of the overall current flowing into the circuit does not exceed a pre-determined limit value.

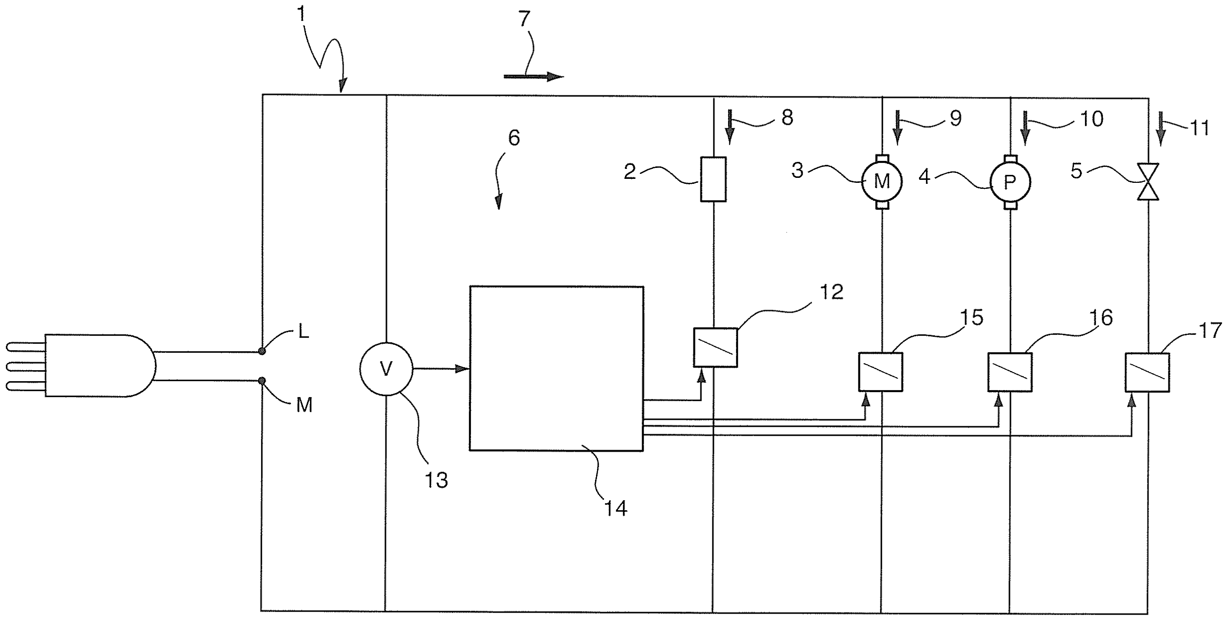

FIG. 2

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Description

[0001] The present invention refers to a circuit arrangement for an electric household appliance, in particular for a washing and/or drying machine.

[0002] Washing and/or drying machines are generally known in the art to be provided with an electric heating element or resistor to heat up the washing liquor and/or the drying air. They further comprise a motor to rotatably drive the perforated drum containing the items to be washed and/or dried, an electromagnetic valve to let water into the tub or outer drum of the machine, a drain pump to let off the water from the tub, and an electric blower to circulate the drying air through the drum.

[0003] A washing machine comprises a power-supply circuit A, such as the one illustrated in Figure 1, in which the electric heating element B, the motor C, the pump D and the electromagnetic valve E are connected in parallel relative to a pair of power-supply connection terminals F, G.

[0004] These terminals F, G are adapted to be connected to a line voltage supply so as to provide an alternating current to the electric loads B, C, D, E.

[0005] In turn, such electric loads B, C, D, E must be designed and rated so that the value of the current that on the whole flows across the circuit A at a given effective, i.e. root-mean-square power-supply voltage does not exceed a given highest allowable value, as provided for by the safety standards applying in the various countries worldwide.

[0006] This highest allowable value, in fact, is duly indicated by the individual appliance manufacturers and, based on such value, the national testing laboratories perform a number of standard tests aimed at certifying compliance of the circuit with the applying standard requirements.

[0007] Most of the manufacturers usually indicate 10A as the highest allowable value of total current circulating across the power-supply circuit of a washing and/or drying machine, as measured at a standard effective power-supply voltage ranging between 230V -10% and 230V + 15%. Some other manufacturers indicate 12A or even 16A as the highest allowable value. The standard tests aimed at certifying compliance of the circuit with the applying standard requirements are more severe for higher value of the total current circulating in the circuit.

[0008] Obviously, for a same machine model to be able to be marketed and used unmodified throughout Europe in general, the total current circulating in its circuit shall not exceed a highest allowable value that is consistent with the highest allowable values indicated by the manufacturers and accordingly admitted by the countries, 10A, for example.

[0009] The current that flows into the circuit, i.e. the total current that flows thereacross, is made up by the individual contributions due to the currents flowing in the various circuit branches where there are connected the electric heating element B and the other electric actuators C, D, E, wherein the current energizing the heating element B is certainly the one that contributes to the greatest extent to the overall current in the circuit A.

[0010] In this connection, it should further be noticed that users in each country are generally supplied with a determined effective power-supply voltage, whose value can vary within a pre-established range.

[0011] Now, taking the values of the effective power-supply voltage supplied in the various European countries into account along with the related variability ranges admitted in such countries, it can be readily found that the power-supply circuit of a same washing and/or drying machine may be connected to a effective power-supply voltage varying 187V through to 254V depending on the particular country in which the machine happens to be used and operate.

[0012] Accordingly, the ohmic value of the electric heating element is generally selected as to provide an adequate heating power, as required for the washing and/or drying cycles of the machine to be able to be performed in a most appropriate manner, and - at the same time - to ensure that the current flowing into the circuit of the machine does not exceed a highest allowable value set so as to comply with the safety standards applying in the various countries.

[0013] It can be most readily appreciated that the different effective voltages in the various national power-supply lines give rise to a considerable variation in the value of the current that flows across the heating element and - as a result - a considerable variability in the heating power that is actually available in the machine at any time.

[0014] Indicated by way of example in the table below are some data aimed at giving a more precise idea about the situations that may arise out of the afore-described conditions, as referred to the case that the power-supply circuit of the machine is required to allow a total current of 10A to flow thereacross as the highest allowable value set to comply with the applying safety standards.

Voltage	Resistance	Current R	Power
254	27.3	9.3	2362.2
230	27.3	8.42	1936.6
187	27.3	6.85	1280.95

[0015] In the example considered above, an electric heating element with a rating of 27.3 Ohm would enable the total current circulating in the circuit to substantially avoid exceeding the highest allowable value of 10A. At an effective line voltage of 230V, the current flowing across the heating element B has a value of 8.42A. The overall current flowing across the power-supply circuit of the machine is therefore equal to the sum of 8.42A and the contribution due to the currents flowing in the circuit branches in which the other electric actuators are connected, wherein the heating element and the electric actuators will of course have been sized so that, when all loads are being energized at the same time, the maximum value of the current in the circuit keeps at a value of around 10A. The heating power of the heating element amounts to 1936.6 W under the circumstances.

[0016] When the power-supply connection terminals of the circuit are connected to an effective line voltage of 187V, the current flowing across the heating element is as low as 6.85A and the heating power decreases to just 1280.95 W.

[0017] When the power-supply connection terminals of the circuit are on the contrary connected to a effective line voltage of 254V, the current flowing across the heating element increases to 9.3A and the heating power rises to as high as 2363.22 W. In this particular case, it can be noticed that the current across the heating element is quite close to the overall highest allowable value.

[0018] The ohmic value of the electric heating element therefore ensures that the overall current circulating across the power-supply circuit of the machine does not generally exceed the required value of 10A in the presence of an effective line voltage that may vary from 184V to 254V depending on the country in which the machine is operated. However, it can at the same time be most readily noticed how the heating power of the heating element may vary from a minimum of 1280.95 W to a maximum of 2363.22 W according to the actual effective line voltage being supplied. In some cases, therefore, the actually available heating power may be rather low so that significantly longer times will be required to heat up the washing liquor or the drying air, thereby affecting the overall performance capabilities of the machine.

[0019] In addition, even in the most favourable situation, i.e. the one in which the effective value of the line voltage is 254V and all electric actuators in the machine are de-energized, so that the entire current in the circuit is flowing across the sole heating element, the highest heating power available is 2363.22 W.

[0020] While it would be possible for a heating power of 2540 W to be actually reached in the presence of a effective voltage of 254V when the electric actuators are in a de-energized condition and the highest allowable value of the current in the circuit is 10A, the power-supply circuits as generally used in the prior art do not practically allow such power value to be reached by simply selecting the appropriate rating of the heating element (i.e., 25.4 Ohm), since the total current circulating in the circuit would rise to well beyond the highest allowable value of 10A when the electric actuators in the machine are energized concurrently.

[0021] It is furthermore quite apparent that a same power-supply circuit designed and sized for carrying a current of up to 10A as the highest allowable value thereof, would simply not be able to effectively and efficiently use a maximum current of 16A circulating across it, as this would on the other hand be fully admitted by the safety standards applying in some countries. In these cases, in view of possibly obtaining a higher heating power consistently with the constraint of the highest allowable value of the current, the need arises for the heating element to be replaced with another one provided with an appropriate ohmic rating. However, owing to the same considerations as set forth hereinbefore, even in this case it is practically impossible for a heating power to be provided to the actual extent that would on the other hand be allowed for by both the line voltage value and the highest value of the overall current across the circuit admitted by the applying safety standards.

[0022] Some non-European countries are delivering effective line voltages that are definitely lower, e.g. 100V or 110V, than the European ones. Even in these cases, a power-supply circuit designed and sized for an effective line voltage comprised between 230V -10% and 230V +15% would require some appropriate modifications in view of enabling an adequate heating power to be provided; in particular, it would also require a heating element with a different ohmic rating. Owing again to the same considerations as set forth hereinbefore, it is however practically impossible for a heating power to be obtained to the maximum rating that would be allowed for by the effective value of the line voltage and the highest allowable value of the current.

[0023] It is therefore a main object of the present invention to provide a circuit arrangement for an electric household appliance, such as in particular a washing and/or drying machine, which is effective in doing away with the above-cited drawbacks of cited known art.

[0024] Within this general object, it is further a purpose of the present invention to provide a circuit arrangement that is capable of providing the maximum heating power that is obtainable from the value of the effective line voltage supplied to the circuit and the highest allowable value of the current across such circuit.

[0025] Another purpose of the present invention is to provide a circuit arrangement that is capable of adapting to both different values of the effective line voltage and different highest allowable values of the overall current across the circuit, while using the same heating element.

[0026] According to the present invention, these aims, along with further ones that will become apparent from the following disclosure, are reached in a circuit arrangement incorporating the features as defined and recited in the claims appended hereto.

[0027] Features and advantages of the present invention will anyway be more readily understood from the description that is given below by way of nonlimiting example with reference to the accompanying drawings, in which:

- Figure 1 is a schematical view of a circuit arrangement according to the prior art;
- Figure 2 is a schematical view of a circuit arrangement according to a first embodiment of the present invention;
- Figure 3 is a schematical view of a circuit arrangement according to another embodiment of the present invention;
- Figure 4 is a schematical view of a circuit arrangement according to a further embodiment of the present invention.

[0028] With reference to the above-cited Figures, the circuit arrangement - as generally indicated with the reference numeral 1 - for an electric household appliance, and in particular for a washing and/or drying machine, comprises an electric heating element or resistor 2 for heating up the washing water and/or the drying air, and one or more load impedances 3-5 connected in parallel relative to electric power-supply terminals L, M, which are adapted to be connected to a power-supply line voltage for providing the electric heating element 2 and the load impedances 3-5 with an alternating electric current.

[0029] The circuit arrangement 1 comprises control means 6 adapted to monitor the value of the current 9-11 flowing through the load impedances 3-5 of the circuit; it further comprises solid-state switch means 12 that are connected in series with the heating element 2, and are adapted to modulate the conduction cycle time of the heating element 2 for regulating the current 8 across the heating element 2.

[0030] The control means 6 are adapted to drive said solid-state switch means 12 in such a way that the value of the overall current 7 entering the circuit does not exceed a pre-determined limit value.

[0031] The load impedances 3-5 represent the electric actuators that are usually provided in a washing and/or drying machine, i.e. an electric motor to rotatably drive the perforated drum containing the items to be washed and/or dried, a drain pump to let off the washing liquor, an electromagnetic valve to let water into the tub, as well as one or more electric fans to circulate the drying air through the drum and convey cooling air to the condenser arrangement.

[0032] The value of the overall current 7 flowing into the circuit arrangement 1 is equal to the sum of the current 8 flowing through the heating element 2 and the individual currents 9-11 flowing across the branches of the circuit 1, which the load impedances 3-5 are connected to.

[0033] The control means 6 are adapted to continuously detect the value of the currents 9-11 flowing through the load impedances 3-5, and to operate the solid-state switch means 12 accordingly, so as to enable a current 8 to flow through the heating element 2, whose value, when summed up to the values of the currents 9-11 energizing the load impedances 3-5, does not exceed the pre-established limit value, i.e. the highest allowable value set by the applying safety standards.

[0034] According to a first embodiment of the present invention, the control means 6 comprise a voltmeter 13 connected in parallel to the electric power-supply terminals L, M to continuously detect the value of the effective line voltage being supplied to the machine.

[0035] The control means 6 further comprise a programmable processing unit 14, e.g. in the form of an integrated circuit or a microprocessor, connected to the voltmeter 13 so as to be able to receive the so detected value of the effective line voltage being supplied. This programmable processing unit 14 is adapted to monitor the operating state of the load impedances 3-5 via control interfaces 15-17 arranged in series with the load impedances 3-5 in the respective branches of the circuit arrangement 1.

[0036] Stored in the programmable processing unit 14 there are the ohmic resistance values of the load impedances 3-5 and, based on the signals it receives from the voltmeter 13, as well as the signals it receives from the interface elements 15-17, the unit itself is thus able to calculate the value of the current 9-11 flowing through the load impedances 3-5.

[0037] Accordingly, based on such calculated value of the current 9-11 flowing through the load impedances 3-5, the programmable processing unit 14 is adapted to drive the solid-state switch means 12 to limit the root-mean-square, i.e. effective current 8 across the heating element 2, so that the total current 7 flowing into the circuit arrangement 1 does not exceed the pre-established limit value that has been set in the programmable processing unit 14.

[0038] In practice, the programmable processing unit 14 is arranged so as to be able to ensure that the value of the total current circulating in the circuit 1 does never rise beyond the pre-set limit value. Since the programmable processing unit 14 works by continuously monitoring the current 9-11 flowing through the load impedances 3-5, it is capable of continuously determining the highest value of the current 8 that may be allowed to flow through the heating element 2 without causing said limit value to be exceeded.

[0039] The programmable processing unit 14 is furthermore able to continuously drive the solid-state switch means 12 so as to enable the current 8 across the heating element 2 to constantly take the highest possible value consistently with the values of the currents 9-11 across the low impedances 3-5 and, most obviously, with the pre-set highest allowable value set in the programmable unit as provided for by the applying standards.

[0040] In other words, via said solid-state switch means 12, the programmable processing unit 14 is adapted to limit the effective current 8 that passes through the heating element 2 in a manner that the value of such current 8, as added to the value of the currents passing through the load impedances 3-5, is exactly equal to said limit value.

[0041] In the case that the value of the current 9-11 across the load impedances 3-5 is zero, owing to the latter being de-energized, the programmable processing unit 14 is adapted to operate the solid-state switch means 12 so as to enable a current 8 to pass through the heating element 2, whose value is equal to the limit value.

[0042] It can therefore be readily appreciated that the present invention enables a heating power to be constantly delivered, which is the highest available one at any moment, consistently with the value of the effective line voltage and the highest allowable value of the overall current in the circuit.

[0043] The solid-state switch means 12 comprise electronic semiconductor components that are specifically designed to perform a pulse-width modulation on the alternating current so as to limit the root-mean-square, i.e. effective value of the current passing through the heating element 2.

[0044] Current limitation is performed by modulating the conduction cycle time of the heating element 2 in that the solid-state switch means 12 are triggered with an appropriate delay - variable from zero through to the duration of the half-cycle - with respect to the beginning of each half-wave.

[0045] In this connection, the solid-state switch means 12 may for example comprise a TRIAC, silicon controlled rectifiers (SCRs), or similar devices based on MOSFET technology.

[0046] In a further embodiment of the present invention, which is illustrated in Figure 3, the control means 6 comprise an ammeter 18 that is connected to the programmable processing unit 14 and is adapted to measure the value of the total current 7 flowing into the circuit 1. The ammeter 18 is provided upstream to both the heating element 2 and the load impedances 3-5.

[0047] Based on the values it receives from the ammeter 18, the programmable processing unit 14 is thus able to continuously monitor the value of the current flowing through the load impedances 3-5 in the respective branches of the circuit.

[0048] The programmable processing unit 14 is then able to drive the solid-state switch means 12 so as to regulate the value of the current 8 flowing through the heating element 2, so that the overall current across the circuit, as detected and measured by the ammeter 18, does not rise beyond the pre-set limit value, in a manner that is fully similar to the afore-described one in connection with the first embodiment.

[0049] In a still further embodiment of the present invention, which is illustrated in Figure 4, the control means 6 comprise an ammeter 19-21 connected in series with each one of the load impedances 3-5 to monitor the current 9-11 flowing through the branches of the circuit 1 where said load impedances 3-5 are connected, and an ammeter 22 connected in series with the heating element 2 and the solid-state switch means 12 to detect the value of the current across the heating element 2. Based on the data delivered by the ammeters 19-21, the programmable processing unit 14 drives the solid-state switch means 12 to regulate the value of the current 8 passing through the heating element 2, so that the overall current circulating in the circuit 1 does not exceed the pre-set limit value at any moment, in a manner that is fully similar to the afore-described one in connection with the embodiments considered hereinbefore.

[0050] An example of the way in which the present invention works is given now with reference to the Table below.

Voltage	Resistance	Current	Power	Current	Power
254	18.7	10	2540	8.82	2240.28
230	18.7	10	2300	8.7	2001
187	18.7	10	1870	8.4	1570.8

[0051] In this example, the pre-set limit value for the overall current allowed to circulate in the circuit 1 is 10A, whereas a value of 18.7 Ohm has been selected as a rating for the heating element 2.

[0052] With an effective line voltage of 254V and all load impedances 3-5, i.e. all electric actuators of the washing and/or drying machine de-energized, the programmable processing unit 14 operates the solid-state switch means 12 in a manner that the current 8 across the heating element 2 is at its the highest possible value, i.e. 10A. The resulting heating power amounts to 2540 W, which is the highest value that can be obtained according to the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit. In this connection, it should be noticed that, without the control means 6 and the solid-state means 12, through the heating element 2 there would pass a current 13.58A, actually. When for instance the electric motor is energized, a current 9-11 of 1.18A flows along the circuit branch where the motor is connected. The programmable processing unit 14 drives the solid-state switch means 12 so that the current 8 passing through the heating element 2 takes a value of 8.82A, i.e. the highest possible value for the overall current circulating in the circuit to avoid exceeding the limit value of 10A. The resulting heating power amounts to 2240.28 W, which is again the highest value that can be obtained based on the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit.

[0053] With an effective line voltage of 230V and all load impedances 3-5 de-energized, the programmable processing unit 14 drives the solid-state switch means 12 in a manner that the current 8 across the heating element 2 is at its the highest possible value, i.e. 10A. The resulting heating power therefore amounts to 2300 W, which is the highest value that can be obtained according to the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit. When for instance the electric motor is energized, a current 9-11 of 1.3A flows along the circuit branch where the motor is connected. Accordingly, the programmable processing unit 14 drives the solid-state switch means 12 so that the current 8 passing through the heating element 2 takes a value of 8.7A, i.e. the highest possible value for the overall current circulating in the circuit to avoid exceeding the limit value of 10A. The resulting heating power amounts to 2001 W, which is again the highest value that can be obtained based on the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit.

[0054] With an effective line voltage of 187V and all load impedances 3-5 de-energized, the programmable processing unit 14 holds the solid-state switch means 12 constantly on to constantly keep the heating element 2 in a conducting state, so as to avoid limiting the current passing through the heating element 2, whose ohmic value (18.7 Ohm) determines a current of 10A. The resulting heating power therefore amounts to 1870 W, which is the highest value that can be obtained according to the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit. When for instance the electric motor is energized, a current 9-11 of 1.6A flows along the circuit branch where the motor is connected. Accordingly, the programmable processing unit 14 drives the solid-state switch means 12 so that the current 8 passing through the heating element 2 takes a value of 8.4A, i.e. the highest possible value for the overall current circulating in the circuit to avoid exceeding the limit value of 10A. The resulting heating power amounts to 1570.8 W, which is once again the highest value that can be obtained based on the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit.

[0055] Further examples of current regulation based on the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit are set forth in the following Tables, wherein the values indicated in the column under "Input Current" are the limit values of the current allowed to circulate in the circuit on the whole, whereas the values indicated in the columns under "Heating Current", "Motor Current" and "Pump Current" are the values of the current flowing through the heating element 2, the drive motor and the pump of a washing machine, respectively.

Line Voltage	Input Current	Heating Current	Motor Current	Pump Current
230	10	8.4	1.6	0
230	10	10	0	0
230	10	8	1.6	0.4

Line Voltage	Input Current	Heating Current	Motor Current	Pump Current
254	10	8.7	1.3	0
254	10	10	0	0
254	10	8.2	1.3	0.5

Line Voltage	Input Current	Heating Current	Motor Current	Pump Current
187	10	8.1	1.9	0
187	10	10	0	0
187	10	7.8	1.9	0.3

[0056] More generally, by appropriately driving the solid-state switch means 12, the programmable processing unit 14 is of course able to allow an effective current 8 to pass through the heating element 2, whose value is capable of being regulated up to the highest value that can be used without exceeding the limit value of 10A set for the total current allowed to circulate in the circuit. In other words, when the effective line voltage is for instance 254V and all load impedances 3-5 in the machine are de-energized, the programmable processing unit 14 can drive the solid-state switch means 12 such that the current 8 across the heating element 2 has a lower value than the highest possible one of 10A. In this way, it would therefore be possible for a heating power to be delivered, which is adjustable up to the highest available value according to the effective line voltage being supplied to the machine and the limit value of the current allowed to circulate in the circuit, as this has already been described above in connection with the examples considered hereinbefore.

[0057] In a further embodiment of the present invention, the control interfaces 15-17 comprise solid-state switch means adapted to modulate the conduction cycle time of the load impedances 3-5. In other words, this calls for further solid-state switch means to be connected in series to each such load impedance 3-5 to regulate the current energizing the electric actuators of the washing and/or drying machine so as to make it possible for a possibly required higher current to be made available to energize the heating element 2 consistently with the pre-set limit value of the total current allowed to circulate in the circuit.

[0058] The present invention enables the highest heating power to be delivered at any moment, which is obtainable based on the effective line voltage being supplied to the machine and the limit value of the total current allowed to circulate in the circuit. It is therefore possible for the heating power to be increased when, for example, the drum driving motor is switched off.

[0059] In a washing machine, this practically means that the possibility is given for the time required to heat up the washing liquor to be reduced. In a drying machine, this means that the possibility arises for the preheating phase of the cycle, in which the water contained in the garments to be dried heats up without evaporating, to be reduced to a considerable extent. In both cases, this leads to a corresponding reduction in the time required to complete the whole washing or drying cycle.

[0060] A further advantage of the present invention derives from the fact that it allows the heating power, and therefore the time increase and decrease profiles of the temperature of the washing liquor and the drying air, to be finely adjusted. In the case of a dryer, it is in particular possible for the temperature of the air to be controlled so as to prevent garments made of delicate textile materials to be dried from undergoing overheating during the final portion of the drying process.

Claims

1. Circuit arrangement for an electric household appliance comprising an electric heating element (2) and one or more load impedances (3-5) connected in parallel with respect to electric power-supply terminals (L,M) adapted to be connected to a line voltage for supplying an alternating electric current to the electric heating element (2) and the load impedances (3-5), **characterized in that** it comprises:

   control means (6) for continuously monitoring the value of the current (9-11) flowing through the load impedances (3-5),
   solid-state switch means (12) connected in series with the heating element (2) and adapted to modulate the conduction cycle time of the heating element (2) for regulating the current (8) flowing through the heating element (2),
   said control means (6) being adapted to drive said solid-state switch means (12) such that the value of the overall current flowing into the circuit does not exceed a pre-determined limit value.

2. Circuit arrangement according to claim 1, wherein said control means (6) comprise a voltmeter (13) connected in parallel to the electric power-supply terminals (L, M) to continuously detect the value of the effective line voltage.

3. Circuit arrangement according to claim 1, wherein said control means (6) comprise an ammeter (18) connected upstream to both the heating element (2) and the load impedances (3-5).

4. Circuit arrangement according to claim 1, wherein said control means (6) comprise an ammeter (19-21) connected in series with each one of said load impedances (3-5).

5. Circuit arrangement according to claim 4, wherein said control means (6) comprise an ammeter (22) connected in series with the heating element (2) and the solid-state switch means (12) to detect the value of the current flowing through the heating element (2).

6. Circuit arrangement according to any of the preceding claims, wherein said control means (6) are adapted to monitor

the operating state of the load impedances (3-5) via control interfaces (15-17) that are connected in series to the load impedances (3-5) in the respective branches of the circuit arrangement.

7. Circuit arrangement according to any of the preceding claims, wherein said control means (6) are adapted to determine the value of the currents (9-11) flowing through the load impedances (3-5) on the basis of the values detected by the voltmeter (13) and the signals received from the interface elements (15-17).

8. Circuit arrangement according to any of the preceding claims, wherein, via the solid-state switch means (12), said control means (6) are adapted to regulate the current (8) passing through the heating element (2) such that the value of this current (8), when added to the value of the currents (9-11) flowing through the load impedances (3-5), is equal to said pre-established limit value.

9. Circuit arrangement according to any of the preceding claims, wherein said solid-state switch means (12) comprise electronic semiconductor components adapted to cause the alternating current to undergo a pulse-width modulation so as to limit the effective value of the current passing through the heating element (2).

10. Circuit arrangement according to any of the preceding claims, wherein said solid-state switch means (12) comprise such semiconductor devices as a Triac or silicon controlled rectifiers (SCRs).

11. Circuit arrangement according to any of the preceding claims, wherein said control means (6) comprise a programmable processing unit (14) adapted to receive the values detected by the voltmeter (13) or the ammeters (18-22), and to drive said solid-state switch means (12) accordingly.

12. Circuit arrangement according to any of the preceding claims, wherein there are provided further solid-state switch means that are connected in series to each one of said load impedances (3-5) to regulate the current energizing the load impedances (3-5).

13. Washing and/or drying machine, **characterized in that** it comprises a circuit arrangement according to any of the preceding claims.

14. Method for controlling a circuit arrangement comprising an electric heating element (2) and one or more load impedances (3-5) connected in parallel with respect to electric power-supply terminals (L,M) adapted to be connected to a line voltage for supplying an alternating electric current to the heating element (2) and the load impedances (3-5), **characterized in that** the method comprises the step of:

continuously monitoring the value of the current (9-11) flowing through the load impedances (3-5),
modulating the conduction cycle time of the electric heating element (2) for regulating the current (8) flowing through the heating element (2) such that the value of the overall current flowing into the circuit does not exceed a pre-determined limit value.

PRIOR ART

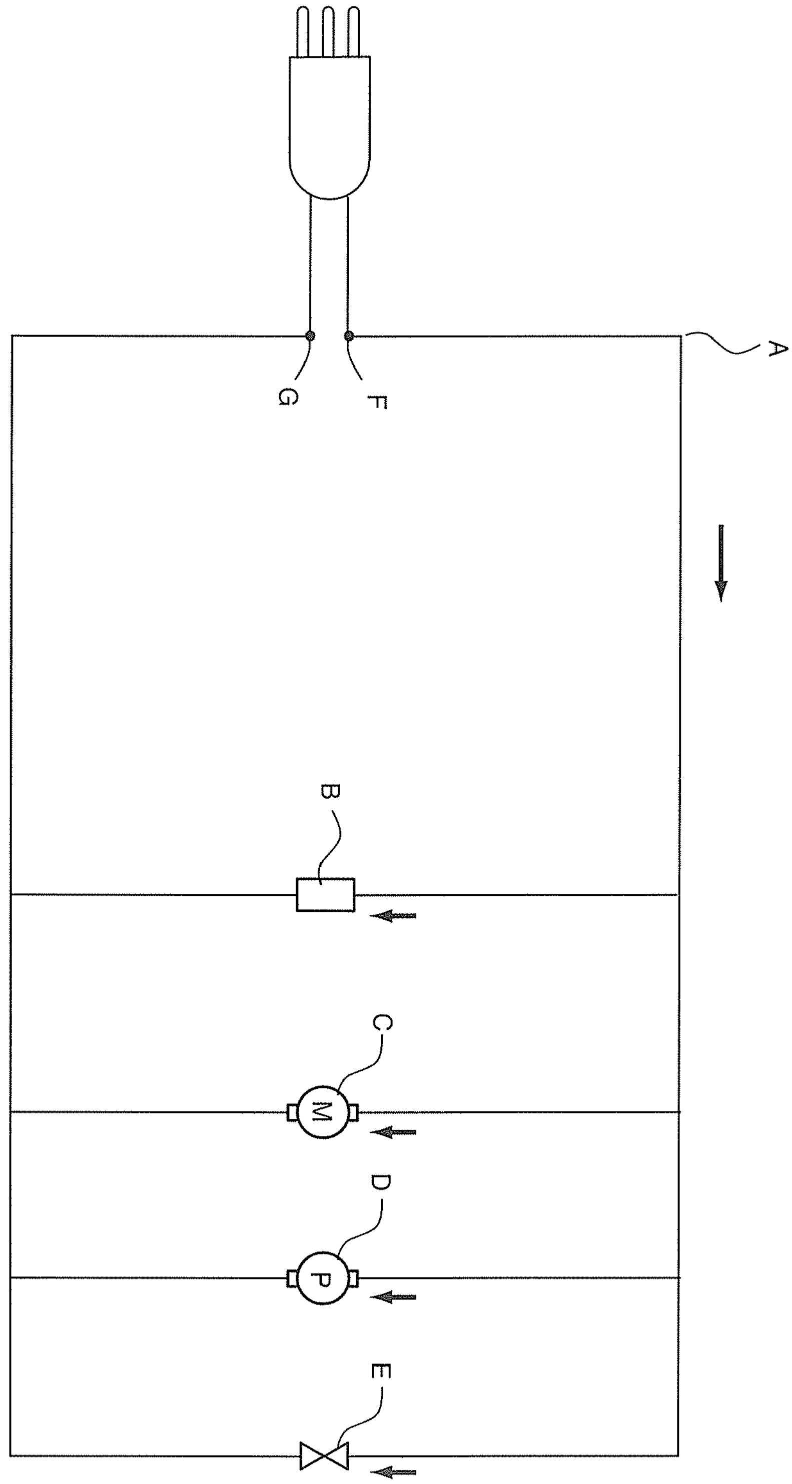

FIG. 1

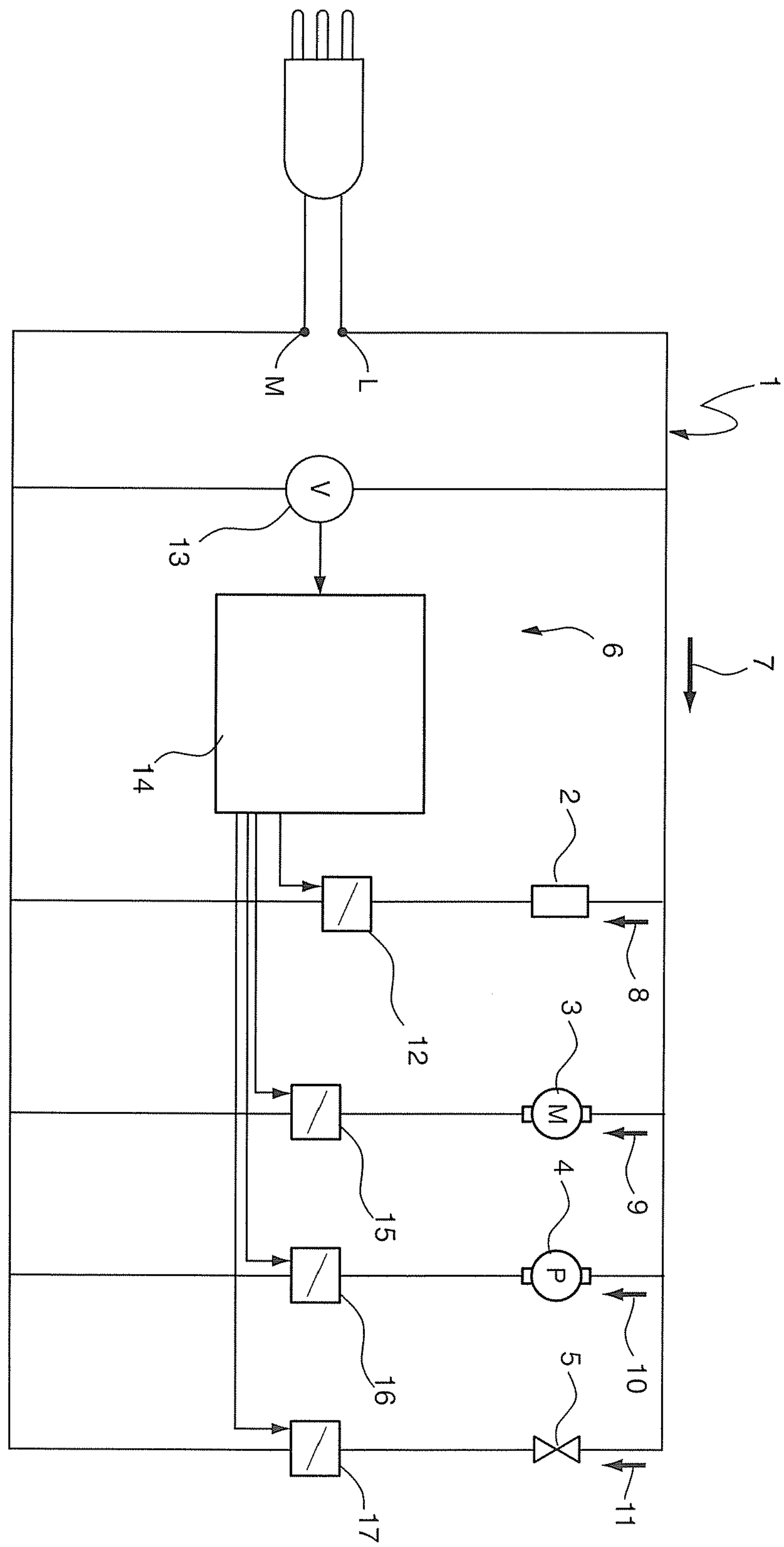

FIG. 2

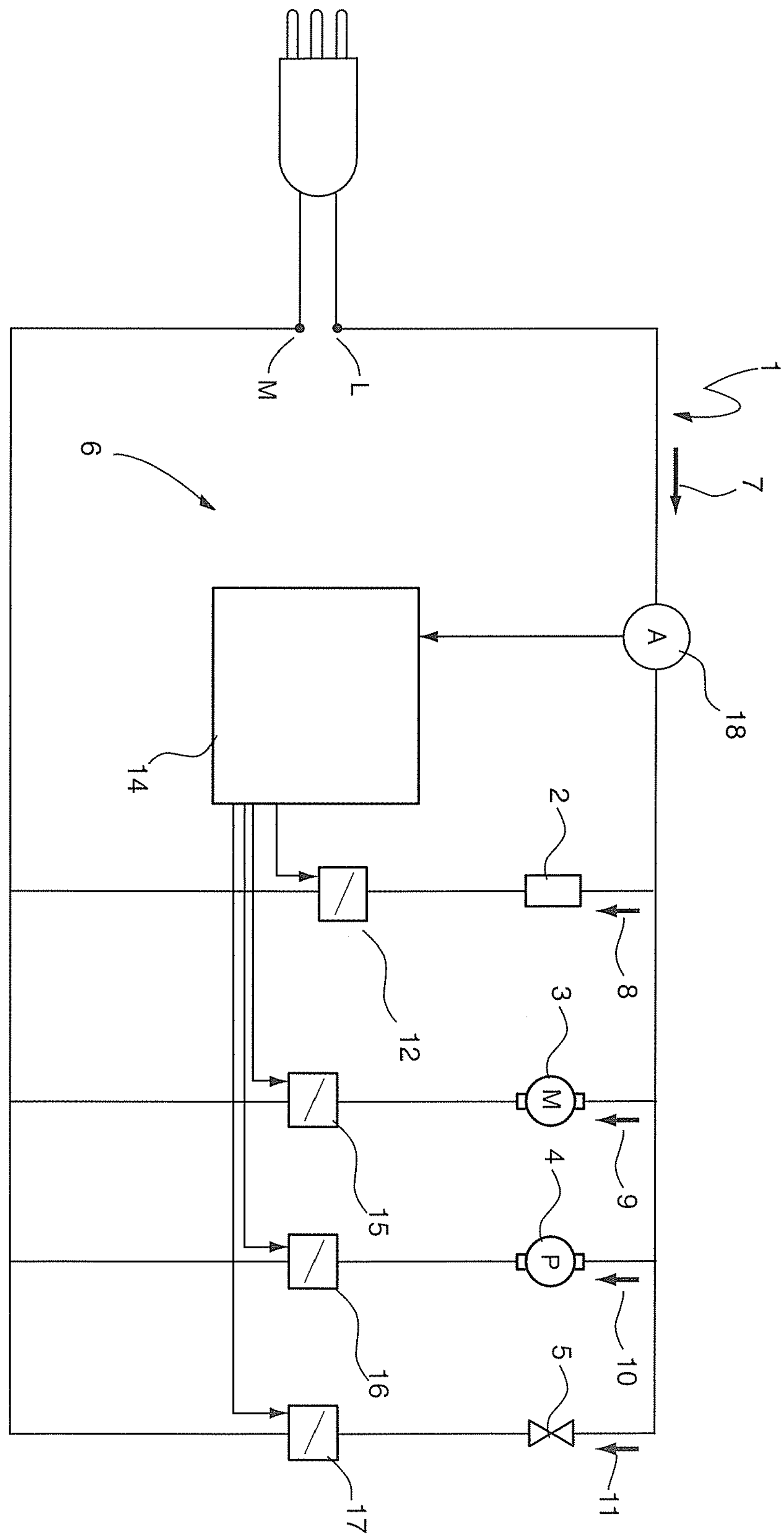

FIG. 3

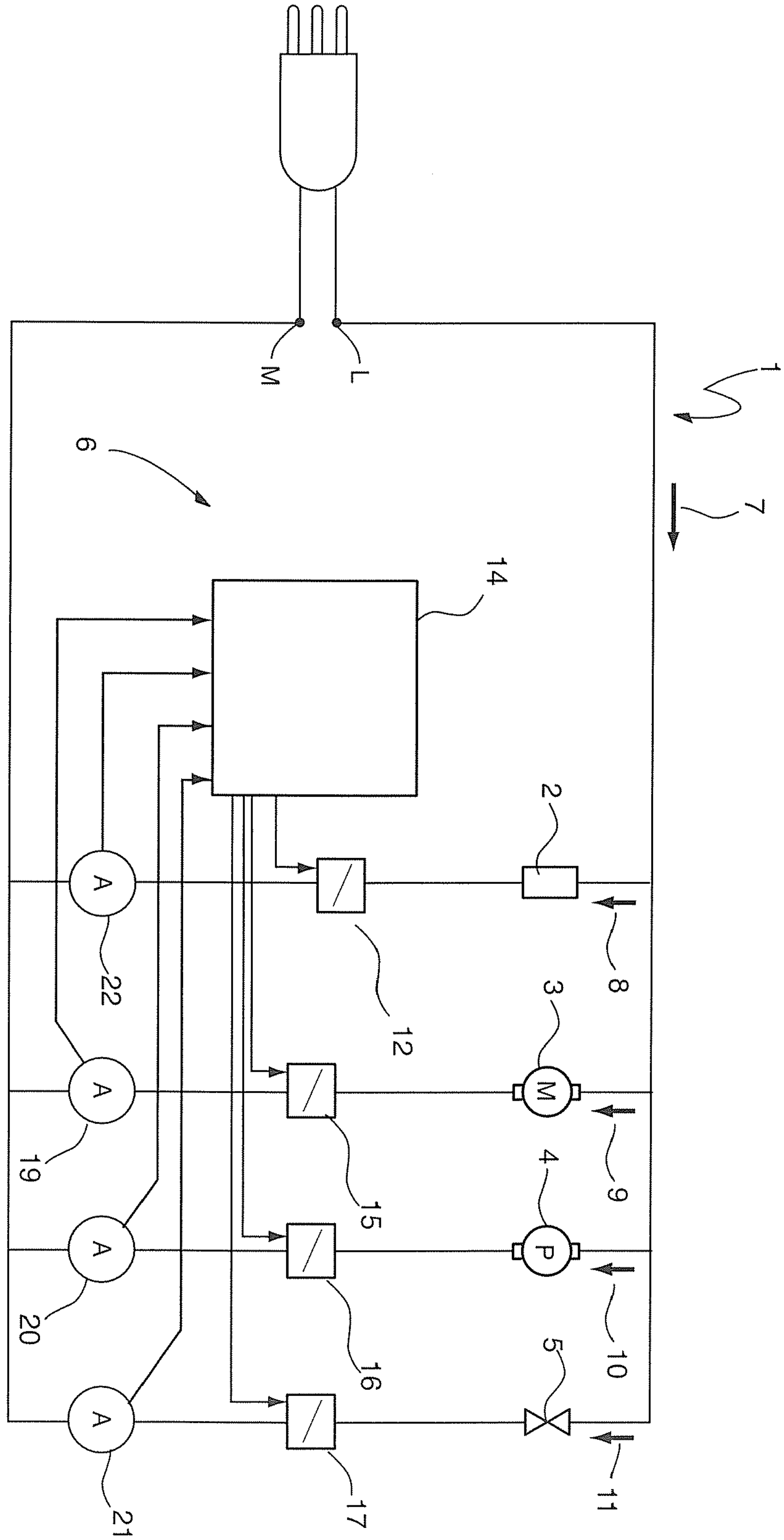

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 11 5406

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 197 48 134 A1 (ROWENTA WERKE GMBH [DE]) 12 May 1999 (1999-05-12)	1,6, 8-10,12, 14	INV. D06F39/04
Y	column 1, lines 3-6; column 2, lines 34-43; claims; abstract, figure 1	13	
A		2-5,7,11	
X	DE 197 42 465 A1 (KAERCHER GMBH & CO ALFRED [DE]) 15 April 1999 (1999-04-15)	1,6, 8-10,12, 14	
A	column 1, lines 40-51; column 3, line 40 - column 4, line 26; abstract; figures 2,3	2-5,7, 11,13	
Y	FR 2 588 580 A1 (CIAPEM [FR]) 17 April 1987 (1987-04-17)	13	
A	* abstract; claim 1; figures *	1-12,14	
A	WO 01/78224 A (FISHER & PAYKEL [NZ]; TODD ROBERT WILLIAM [NZ]; BUTLER RICHARD GEORGE) 18 October 2001 (2001-10-18) * the whole document *	1-14	

TECHNICAL FIELDS SEARCHED (IPC)

D06F
A47L

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	19 October 2006	Clivio, Eugenio

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19-10-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19748134 A1	12-05-1999	ES 2143965 A1	16-05-2000
		FR 2771251 A1	21-05-1999
		IT 1302711 B1	29-09-2000
DE 19742465 A1	15-04-1999	IT MI980614 U1	20-03-2000
FR 2588580 A1	17-04-1987	DE 3663545 D1	29-06-1989
		EP 0223649 A1	27-05-1987
WO 0178224 A	18-10-2001	AT 306741 T	15-10-2005
		AT 306740 T	15-10-2005
		AU 5278901 A	23-10-2001
		AU 5279001 A	23-10-2001
		BR 0109981 A	25-02-2003
		BR 0110096 A	18-02-2003
		CA 2405790 A1	18-10-2001
		CA 2405874 A1	18-10-2001
		DE 60113983 T2	29-06-2006
		DE 60113986 T2	29-06-2006
		DK 1284633 T3	13-02-2006
		DK 1281234 T3	13-02-2006
		EP 1284633 A1	26-02-2003
		EP 1281234 A1	05-02-2003
		HK 1049238 A1	03-03-2006
		HK 1049592 A1	24-03-2006
		JP 2003529431 T	07-10-2003
		JP 3652649 B2	25-05-2005
		JP 2003530810 T	14-10-2003
		NO 20024872 A	09-12-2002
		NO 20024873 A	05-12-2002
		WO 0176448 A1	18-10-2001
		NZ 503866 A	31-01-2003
		NZ 510753 A	29-08-2003
		US 2001045226 A1	29-11-2001

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82