

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
11 March 2004 (11.03.2004)

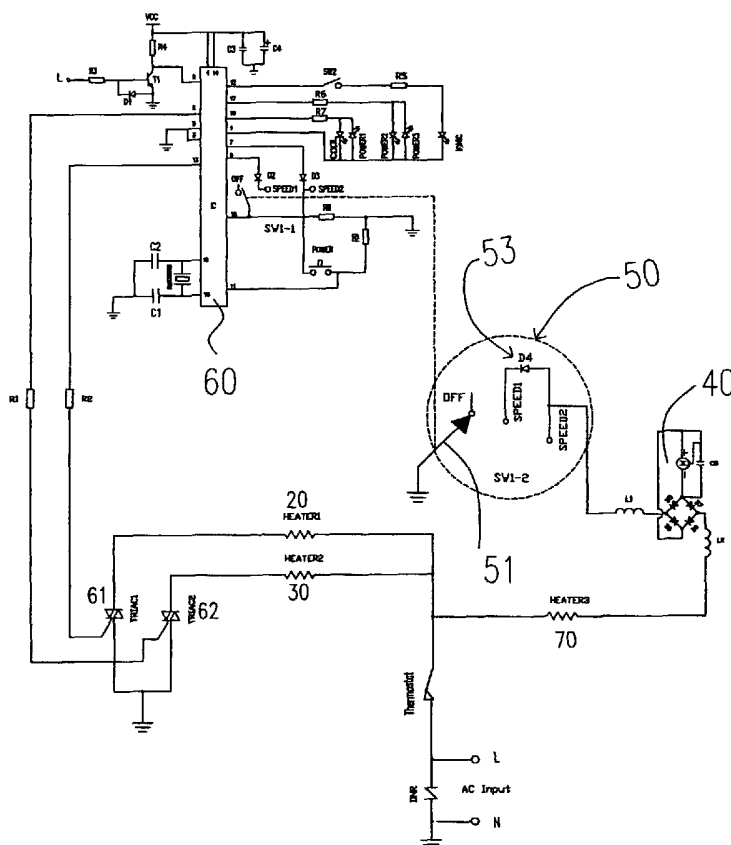
PCT

(10) International Publication Number
WO 2004/019726 A1

- (51) International Patent Classification⁷: **A45D 20/30**, H05B 1/02
- (21) International Application Number: PCT/IB2003/003457
- (22) International Filing Date: 22 August 2003 (22.08.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
HK1048722 28 August 2002 (28.08.2002) CN
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- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) Title: HAIR DRYER WITH IMPROVED HEATING POWER CONTROL AND CIRCUITS THEREFOR



(57) Abstract: A personal care device, such as a hair blower, a hair dryer (1), a fan-heater, or the like, including at least 2 sets of independently switchable heating elements (20, 30) which are actuated during non-overlapping half-cycles when said device is selected to operate at a pre-defined setting corresponding to a condition below the maximum heating power level. This device provides variable heating power output by non-dissipative means and at the same time reduces adverse harmonics.



Declaration under Rule 4.17:

- *of inventorship (Rule 4.17(iv)) for US only*

Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HAIR DRYER WITH IMPROVED HEATING POWER CONTROL AND CIRCUITS THEREFOR

FIELD OF INVENTION

The present invention relates to personal care devices and, more particularly, to an alternating current operated personal care device provided with heating elements and a motor driven fan. More specifically, although of course not solely limiting thereto, this invention relates to hair dryers and fan heaters with a plurality of heating power and fan-speed settings. This invention also relates to non-dissipative power variation schemes and circuit arrangements therefor.

BACKGROUND OF THE INVENTION

Personal care devices with heating elements and a motor driven fan are generally used to enhance personal comfort or personal grooming. For example, a fan-heater provides a convenient and localized heating source with forced air circulation so that warm air can be delivered to a person within a short time.

A hair dryer is another example of such a personal care device in which hot or warm air is delivered towards a person for hair styling or other appropriate applications. In such applications, a wide range of heating power level variation and fan-speeds are usually required in order to meet with the specific personal comfort or grooming requirements. For example, a high heating power level with

a high fan-speed may be required to blow dry and style wet hair while a moderate heating level and a moderate fan-speed may be required for gentle hair styling.

Similarly, in the case of fan-heaters, a high heating power and a high fan-speed will be required to expeditiously warm up a cold space while a moderate or a low heating level and fan-speed may be required to maintain a room at a relatively comfortable temperature and humidity. To accommodate such a wide range of varying power requirements, heating elements provided in such personal care devices must be able to operate on a wide range of power output. The typical power ratings of heating elements for use in this type of personal care devices are usually between a few hundred Watts to a maximum of 2,000 - 3,000 Watts. In order to provide a variable heating power output, variable resistors, or rheostats, are usually serially connected with the heating elements to dissipate a certain portion of the electrical energy so that a reduced heating power is generated by the heating elements. This conventional heating power variation by the use of dissipative resistive elements means unnecessary power dissipation and wasted energy.

Another possible alternative approach is by way of a technique commonly known as power chopping. In this technique, the heating elements are only activated only during a certain portion of the complete cycle of the alternating current power source. However, this approach is not entirely useful or generally desirable for use in personal care devices because strong adverse harmonics are usually generated as a side effect of the power chopping and the high resulting

harmonics are an obstacle to fulfil the electro-magnetic compliance ("EMC") requirements imposed by many national or regional authorities.

Hence, it will be highly desirable if personal care devices equipped with heating elements and motor driven fans can be provided with improved heating element arrangements and/or heating control arrangements so that a variable heating power output can be provided by non-dissipative means while fulfilling the generally stringent EMC requirements.

OBJECT OF THE INVENTION

Accordingly, it is an object of the present invention to provide personal care devices with variable heating power output by utilizing non power-dissipative means and schemes with reduced adverse harmonics. At a minimum, it is an object of the present invention to provide personal care devices with alternative heating element arrangements and actuation schemes and configurations for the choice of the public.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided an alternating current operated personal care device, such as a hair blower, a hair dryer, a fan-heater, or the like, said device including a main housing, user control interfacing means, controlling means, a motor, air driving means and at least a first heating element, said alternating current being characterised by a sequence of consecutive positive and negative half-cycles of a pre-determined frequency, said

first heating element being independently switchable by said controlling means, said user control interfacing means provide means for a user to vary the heating power level of said device, said heating power level being variable by selectively supplying power to said first heating element during pre-determined half-cycles of said alternating current by actuating said first heating element at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.

According to a second aspect of the present invention, there is provided a non-dissipative power reduction scheme for use with alternating current source operated devices or apparatuses, said scheme includes the utilization of user control interfacing means, controlling means, a motor, air driving means and at least a first heating element, said alternating current being characterised by a sequence of consecutive positive and negative half-cycles of a pre-determined frequency, said first heating element being independently switchable by said controlling means, said user control interfacing means provide means for a user to vary the heating power level of said device, said heating power level being variable by selectively supplying power to said first heating element during pre-determined half-cycles of said alternating current by actuating said first heating element at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.

Preferably, said user control interfacing means further include means for a user to vary the motor speed of said device, said motor speed being variable by

selectively supplying power to said motor during pre-determined half-cycles of said alternating current by actuating said motor at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.

Preferably, said personal care device further including a second heating element and said scheme further includes the utilisation of a second heating element, wherein said heating power level being variable by selectively supplying power to said first heating element, said second heating element or a combination of said first and said second heating elements during pre-determined half-cycles of said alternating current, said first heating element, said second heating element or said combination of heating elements being actuated at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.

Preferably, the heating power level of said device can be reduced by distributing the operation, that is, the operation power or current, of said heating elements among pre-determined half-cycles of said alternating current to reduce the overlapping between the operation of said heating elements.

Preferably, the heating power level of said device can be reduced by distributing the operation, that is, the operation power or current, of said heating elements and said motor among pre-determined half-cycles of said alternating current to reduce the overlapping between the operation of said motor and said heating elements.

Preferably, said motor is provided with operating current, or is operated, during pre-determined selective half-cycles of said alternating current to reduce speed, said motor being actuated at or near the beginning or zero-crossing point of pre-determined half-cycles of said alternating current.

Preferably, said user control interfacing means include a plurality of pre-defined settings so that a user can select a heating level and a fan speed, said heating level being selectable between a maximum heating level and a plurality of non-maximum heating levels, said fan speed being selectable between a maximum speed and at least a non-maximum speed,

said controlling means being configured so that when said user control interface is set at a pre-determined non-maximum heating level, said first heating element is actuated during pre-determined half-cycle intervals of the alternating current source and said motor is actuated during pre-determined half-cycles including during half-cycles when said first heating element is not actuated.

Preferably, at another pre-defined setting of said user control interfacing means, said motor is also actuated during some pre-determined half-cycles during which said first heating element is being actuated.

Preferably, at another pre-defined setting of said user control interfacing means, said second heating element is actuated at pre-determined half-cycles during which said first heating element is non-actuated.

Preferably, at another pre-defined setting of said user control interfacing means, said motor operates at half-cycles during which both said first and second heating elements are actuated.

Preferably, at another pre-defined setting of said user control interfacing means, each said first and said second heating element is serially connected with a switching device.

Preferably, said switching device is a triac.

Preferably, neither heating elements nor said motor operate during some of the half-cycles of said alternating current source.

Preferably, a third heating element is serially connected with said motor.

Preferably, said device is a hair care device such as a hair dryer, a hair blower or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention will be explained by way of example and with reference to the accompanying drawings, in which:

Fig. 1A and Fig. 1B are respectively the longitudinal cross-sectional view and rear transversal sectional view of a first embodiment of a hair dryer of the present invention.

Fig. 1C is a schematic circuit diagram showing the arrangement of heating elements, a motor, controlling means and user control interfacing means of a hair dryer of a preferred embodiment of the present invention,

Fig. 2 is a schematic waveform diagram generally showing the operating timing of the device of Fig. 1 with the first heating element and the motor turned on during every alternate positive half-cycle and at a first speed,

Fig. 3 is a schematic waveform diagram generally showing the operating timing of the hair dryer of Fig. 1 with the first heating element turned on during every alternate complete cycle of the alternating current supply and the motor turned on during every alternate positive (or upper) half-cycle and at a first speed,

Fig. 4 is a schematic waveform diagram showing the operating timing of the motor under the same conditions of Fig. 2 with the first heating element turned on during every alternate negative (or lower) half-cycle and the second heating element turned on during every fourth upper-half cycle,

Fig. 5 is another waveform diagram showing the relative operating timing of the hair dryer with the first heating element and the second heating element turned on during every third non-overlapping complete cycle of the alternating current supply and the motor turned on during every alternate positive half-cycle and at the first speed,

Fig. 6 is another waveform diagram showing the relative operating timing of the hair dryer with the first heating element turned on during every negative (or

lower) half-cycle of the alternating current source, the second heating element turned on during every positive (or upper) half cycle of the alternating current supply and the motor turned on during every alternate positive half-cycle and at the first speed,

Fig. 7 is another waveform diagram showing the relative operating timing of the hair dryer with the first heating element turned on during every alternate complete cycle of the alternating current source, the second heating element turned on during every other alternate complete cycle of the alternating current supply not overlapping with the operating complete cycles of the first heating element and the motor turned on during every alternate positive half-cycle and at the first speed,

Fig. 8 is another waveform diagram showing the relative operating timing of the hair dryer with the first heating element turned on during every negative (or lower) half-cycle of the alternating current source, the second heating element turned on during every positive (or upper) half cycle of the alternating current supply and the motor always turned on during each and every half-cycle of the alternating current source and at a second, higher, speed,

Fig. 9 is a schematic waveform diagram generally showing the operating timing of the hair dryer of Fig. 1 with the first and second heating elements respectively turned on during every alternate complete cycle of the alternating current supply and the motor always turned on during each and every half-cycle of the alternating current source at the second, higher, speed,

Fig. 10 is another waveform diagram showing the relative operating timing of the hair dryer with the first heating element turned on during every cycle of the alternating current source, the second heating element turned on during every alternate complete cycle of the alternating current supply and the motor always turned on during each and every half-cycle of the alternating current source and at the second, higher speed,

Fig. 11 is a schematic waveform diagram generally showing the operating timing of the hair dryer of Fig. 1 with the first heating elements always turned on during each and every complete cycle of the alternating current supply, the second heating element turned on during each alternate cycle of the alternating current supply, and the motor always turned on during each and every half-cycle of the alternating current source at a second, higher, speed,

Fig. 12 is a schematic waveform diagram generally showing the operating timing of the hair dryer of Fig. 1 with the first and second heating elements always turned on during each and every complete cycle of the alternating current supply and the motor always turned on during each and every half-cycle of the alternating current source at a second, higher, speed,

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figs. 1A, and 1C, there are shown sectional views of a hair dryer 1 embodying the present invention. In Fig. 1C, there is shown a schematic circuit diagram showing an example of a preferred circuit arrangement for the hair

dryer of Figs. 1A and 1B. The hair dryer 1 includes a main housing 10 with a barrel 11 and a handle 12. The electrical circuitry includes a first heating element 20, a second heating element 30, a motor 40, a motor driven fan 41, user control interfacing means 50 including a speed control switch 51 and a heating power control switch 52, and controlling means which is a micro-controller 60 in the present embodiment. The controlling means and other peripheral or related circuitry can be mounted or connected to a printed circuit board 69.

Each of the first heating element 20 and the second heating element 30 is independently connected to the micro-controller 60 via a switching device which is a triac for the purpose of illustration in this embodiment. Of course, other appropriate switching devices may also be used. The motor may, for example, be a DC motor connected with a third heating element 70 so that the total potential drop across the motor 40 and the third heating element 70 is equivalent to the voltage output of the rectifying circuit without the need of further voltage adjustment.

The motor or fan speed control in the present embodiment is by way of a selectable switch 51 having, for example, "off", "speed1" and "speed2" settings. The motor 40 is set to run at its highest speed when the switch is at the "speed2" setting and will be at stand-still when set to the "off" position. The motor speed is intermediate between standing-still and the highest speed when at the "speed1" setting. The speed control at "speed1" is achieved by a serially connected diode 53 between the motor 40 and the power supply circuit. When the motor speed switch 51 is set to the "speed1" setting for a reduced speed, only the positive half-cycles

of the alternating power supply will flow into the rectifying bridge. As a result, the motor will operate at a reduced power and therefore at a lower speed.

The heating power control switch **52** includes a plurality of power output settings corresponding to a plurality of heating power output levels. The micro-controller **60** controls the heating power output level by detecting the instantaneous position of the heating power control switch or selector **51** and sends out actuation signals to the switches connected with the heating elements to selectively actuate the heating elements to obtain a wide range of heating power variation. The actual operation of the heating elements is controlled by the micro-controller **60**, for example, via the switching devices **61**, **62** according to pre-determined manners programmed in the micro-controller. Specific examples of power control by such selective actuation will be explained below.

General principles of operation of the present invention will be explained in further details by referring to the schematic waveform or timing diagrams showing the relative operating timing of the first heating element, the second heating element and the motor. In the accompanying waveform diagrams, the following legend generally applies:-

1. vertical hatched line means the motor is in operation,
2. hatched lines extending upwards from left to right indicates the first heating element (heater "a" in drawing) in operation,

3. hatched lines moving downwardly from left to right indicates the second heating element (heater “b” in drawing) in operation,
4. combined hatched lines means simultaneous operation of components represented by their respective hatched lines.

Referring to Figs. 2 to 7, there are shown a series of timing or waveform diagrams in which the motor **40** of the hair dryer is set to operate at “speed1” (slow). It will be appreciated that, when the speed control is set at speed1, the power supply to the motor is serially connected via a diode (D4) so that only positive half-cycles of the alternating current power supply can pass through the diode to operate the motor.

In the specific operating conditions of Fig. 2, the heating power level is set to “low” and the first heating element **20** is actuated during the negative half-cycles (lower half-cycles) of the alternating current supply during which the diode D4 is not conducting.

In this specific low heating power configuration, the micro-controller **60** does not activate the switching device **62** connected to the second heating element **30**. On the other hand, the micro-controller will activate the first heating element **20** during the negative half-cycles of the power supply by actuating the switching device **61** at the beginning of the negative half-cycles. This is done by detecting the negative zero-crossing of the alternating current power supply and sending out actuation signals to the switching device **61** at the appropriate time. This

distributed operation of the motor **40** and the first heating element **20** by allowing conduction during alternate half-cycles of the alternating current supply helps to reduce the power level differences between adjacent half-cycles of the alternating current supply and this has helped to alleviate adverse harmonics. It has also been observed that activation of the devices, namely, the motor and the heating element at the beginning or the zero-crossing points of the alternating current supply waveform plays an important role in alleviating adverse effects due to the harmonics. Naturally, the conduction angles of triacs need to be considered although it is desirable to activate the devices at the zero-crossing points.

Referring to Fig. 3, the motor is still set to operate at “speed1”. In this configuration, only the first heating element **20** is operated to provide a low heating power output by a different operating timing. In order to reduce the overall heating power output of the device, the first heating element **20** is actuated during every alternate complete cycle of the power supply and no heating element is actuated during the next alternating power cycle. Thus, in this configuration, the motor **40** and the first heating element **20** will operate simultaneously during alternate positive half-cycles of the operation of the motor. In other words, the motor **40** operates at every positive half-cycles while the first heating element **20** and the motor **40** will simultaneously operate during every fourth positive half-cycle of the alternating current supply cycle.

Referring to Fig. 4, the motor operating conditions are generally identical to that of Figs. 2 and 3 while an increased heating power output level is required. In

this configuration, the first heating element **20** is actuated during each of the lower or negative half-cycles of the alternating current supply and the second heating element **30** is actuated during each alternate upper or positive half-cycles. It will be appreciated that the aggregate of the power output in this configuration will be higher than that of Figs. 2 and 3 because of the more extensive actuation timing of the first **20** and second **30** heating elements. It will also be appreciated that the second heating element will operate simultaneously with the motor during each alternative positive half-cycles.

Referring now to Fig. 5, the motor speed is still set at “speed1” and the heating power output is at a medium level. In this configuration, it will be noted that the operating pattern of the first heating element **20**, the second heating element **30** and the motor **40** will repeat itself after every sixth half-cycle of the alternating current power supply. It will also be noted that, in this configuration, each of the heating elements will be actuated during 1/3 of the time of the alternating power supply and there is a distribution of the actuation timing to make the power requirement more evenly distributed.

Referring to Fig. 6, the motor is still set with “speed1”. In this configuration, the heating power output corresponds to the “high” level and it will be observed from this Figure that the first heating element **20** is actuated during each negative half-cycle of the alternating current supply while the second heating element **30** is actuated during each upper half-cycle of the alternating current supply. As the heating elements are actuated during alternate half-cycles, the

power usage during adjacent half-cycles is generally similar since the power consumption by the motor is usually lower than that of the heating elements. As a result, adverse harmonics can be substantially reduced by the distribution of the actuation timing of the heating elements with a reduced non-dissipative power reduction.

Referring to the timing diagram of Fig. 7, it will be noted that the first heating element 20 is turned on during every alternate complete cycle of the alternating current source and the second heating element 30 is turned on during the next alternate complete cycle of the alternating current supply when the first heating element is not turned on similar to the operating conditions in the previous Figures. The motor 40 is turned on during each and every positive or upper half-cycle of the alternating current supply. As explained before, the heating elements are generally of a higher power rating than the motor 40. As a result, this distribution in heating power actuation generally reduces the power differences between adjacent power cycles and the resulting adverse harmonics will be alleviated.

Referring to Figs. 8-12, the motor is now set to operate at "speed2", i.e. at a higher speed. In this configuration, the motor obtains its power from the full alternating power supply via a full-wave rectifier. Thus, it will be noted that the motor is supplied with operating power during each and every half-cycles of the alternating current supply. In the specific operation of Fig. 8, the first and second

heating elements operate respectively at the lower and upper half-cycles of the current supply.

Referring to Fig. 9, it will be appreciated that the heating elements are actuated at alternate non-overlapping complete full cycles of the alternating current supply. In other words, when the first heating element **20** is actuated during a full cycle comprising consecutive upper and lower half-cycles, the second heating element **30** is turned off during this full cycle. During the next complete full cycle, the second heating element **30** is turned on while the first heating element **20** is turned off.

Referring to Fig. 10, it will be appreciated that the first heating element **20** is turned on during every cycle of the alternating current source and the second heating element is turned on during every alternate complete cycle of the alternating current supply. This arrangement provides heating power output which is near the maximum power output available from the device when both the first **20** and the second **30** heating elements are always turned on.

Referring to Fig. 11, there is shown a further alternative heating power output arrangement. It will be noted in this configuration that the actuation of the heating elements are substantially identical to that of Fig. 10, although the second heating element **30** is now always turned on while the first heating element is only turned on during each alternate complete cycle of the alternating current supply. Of course, the operating timing and conditions of the first and second heating element can be reversed without loss of generality.

Fig. 12 shows the operational configuration when the hair dryer 1 is at the maximum heating power output when both the first 20 and second 30 heating elements are turned on all the times.

In another preferred embodiment, the hair dryer is a generally identical to the hair dryer of Figure 1 except that only a single switchable heating element (corresponding to the first heating element of the hair dryer 1) is provided instead of two as in the case of the embodiment discussed above. In this embodiment, the heating power can be varied by selective actuating the heating element during predetermined half cycles of the alternating current supply and by beginning to supply power to the heating element at or near the beginning or the zero-crossing point of the alternating current supply to alleviate adverse harmonics. Similarly, the motor speed can be reduced by selective actuating the motor during predetermined half cycles of the alternating current supply and by beginning to supply power to the motor at or near the beginning or the zero-crossing point of the alternating current supply, also to alleviate adverse harmonics.

It will be noted from the circuit diagram of Fig. 1 that the third heating element 70, which is serially connected with the motor, is always turned on when the motor is turned on. This serial connection of the third heating element 70 to the motor 40 is provided to equalize the potential differences between the rectifying circuit output and the motor voltage rating to avoid the need of additional voltage adjusting means.

In general, it should be noted that it is highly desirable that the higher power consumption devices, including the heating elements and the motor, are preferably triggered, activated or actuated at the beginning or the zero-crossing instant or point of the alternating current cycles or half cycles to alleviate adverse harmonics.

While the present invention has been explained by reference to the preferred embodiments and operation configuration described above, it will be appreciated that the embodiments are only examples provided to illustrate the present invention and are not meant to be restrictive on the scope and spirit of the present invention. More specifically, while the present invention has been explained by reference to hair dryers, it should be appreciated that the invention would be applicable, whether with or without modifications, to other alternating current devices such as hair blowers, fan heaters and the like. This invention should be determined from the general principles and spirit of the invention as described above.

In particular, variations or modifications which are obvious or trivial to persons skilled in the art, as well as improvements made on the basis of the present invention, should be considered as falling within the scope and boundary of the present invention. Furthermore, while the present invention has been explained by reference to a hair dryer, it should be appreciated that the invention can apply, whether with or without modification, to other personal care device. More specifically, the present invention also at least provide a solution to overcoming the

difficulty in overcoming EMC in non-dissipative power reduction arrangements by means of power actuation techniques generally described above.

CLAIMS

1. An alternating current operated personal care device including a main housing, user control interfacing means, controlling means, a motor, air driving means and at least a first heating element, said alternating current being characterised by a sequence of consecutive positive and negative half-
5 cycles of a pre-determined frequency, said first heating element being independently switchable by said controlling means, said user control interfacing means provide means for a user to vary the heating power level of said device, said heating power level being variable by selectively supplying power to said first heating element during pre-determined half-cycles of said
10 alternating current by actuating said first heating element at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.
2. A personal care device according to claim 1, wherein said user control interfacing means further include means for a user to vary the motor speed of
15 said device, said motor speed being variable by selectively supplying power to said motor during pre-determined half-cycles of said alternating current by actuating said motor at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.
3. A personal care device according to claim 1, further including a second
20 heating element, wherein said heating power level being variable by

selectively supplying power to said first heating element, said second heating element or a combination of said first and said second heating elements during pre-determined half-cycles of said alternating current, said first heating element, said second heating element or said combination of heating elements being actuated at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.

4. A personal care device according to any one of claims 1, 2 or 3, wherein the heating power level of said device can be reduced by distributing the operating current of said heating elements among pre-determined half-cycles of said alternating current to reduce the overlapping between the operation of said heating elements.
5. A personal care device according to any one of claims 1, 2 or 3, wherein the heating power level of said device can be reduced by distributing the operating current of said heating elements and said motor among pre-determined half-cycles of said alternating current to reduce the overlapping between the operation of said motor and said heating elements.
6. A personal care device according to any one of claims 1, 2 or 3, wherein said user control interfacing means include a plurality of pre-defined settings so that a user can select a heating level and a fan speed, said heating level being selectable between a maximum heating level and a plurality of non-maximum heating levels, said fan speed being selectable between a maximum speed and at least a non-maximum speed,

said controlling means being configured so that when said user control interface is set at a pre-determined non-maximum heating level, said first heating element is actuated during pre-determined half-cycle intervals of the alternating current source and said motor is actuated during pre-determined half-cycles including during half-cycles when said first heating element is not actuated.

7. A personal care device according to claim 6, wherein, at another pre-defined setting of said user control interfacing means, said motor is also actuated during some pre-determined half-cycles during which said first heating element is being actuated.
8. A personal care device according to claim 6, wherein, at another pre-defined setting of said user control interfacing means, said second heating element is actuated at pre-determined half-cycles during which said first heating element is non-actuated.
9. A personal care device according to claim 6, wherein, at another pre-defined setting of said user control interfacing means, said motor operates at half-cycles during which both said first and second heating elements are actuated.
10. A personal care device according to claim 6, wherein, at another pre-defined setting of said user control interfacing means, each said first and said second heating element is serially connected with a switching device.
11. A personal care device according to claim 10, wherein said switching device is a triac.

12. A personal care device according to any one of claims 1, 2 or 3, wherein neither heating elements nor said motor operate during some of the half-cycles of said alternating current source.
13. A personal care device according to any one of claims 1, 2 or 3, wherein a
5 third heating element is serially connected with said motor.
14. A personal care device according to any one of claims 1, 2 or 3, wherein said device is a hair care device such as a hair dryer, a hair blower or the like.
15. A non-dissipative power variation scheme for use with an alternating current source, said scheme includes the utilization of user control interfacing
10 means, controlling means, a motor, air driving means and at least a first heating element, said alternating current being characterised by a sequence of consecutive positive and negative half-cycles of a pre-determined frequency, said first heating element being independently switchable by said controlling means, said user control interfacing means provide means for a user to vary
15 the heating power level of said device, said heating power level being variable by selectively supplying power to said first heating element during pre-determined half-cycles of said alternating current by actuating said first heating element at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.
- 20 16. A non-dissipative power variation scheme according to claim 15, wherein said user control interfacing means further include means for a user to vary the motor speed of said device, said motor speed being variable by selectively supplying power to said motor during pre-determined half-cycles

of said alternating current by actuating said motor at or near the beginning or zero-crossing point of the said pre-determined half-cycles of said alternating current.

17. A non-dissipative power variation scheme according to claim 15, further
5 including a second heating element, wherein said heating power level being variable by selectively supplying power to said first heating element, said second heating element or a combination of said first and said second heating elements during pre-determined half-cycles of said alternating current, said first heating element, said second heating element or said combination of
10 heating elements being actuated at or near the beginning or zero-crossing
18. A non-dissipative power variation scheme according to claim 15, wherein the heating power level of said device is reduced by distributing the operating of said heating elements among half-cycles of said alternating current to reduce the overlapping between the operation of said heating elements.
- 15 19. A non-dissipative power variation scheme according to claim 15, wherein the heating power level of said device is reduced by distributing the operating of said heating elements and said motor among half-cycles of said alternating current to reduce the overlapping between the operation of said motor and said heating elements.
- 20 20. A non-dissipative power variation scheme according to claim 15, wherein said motor is operated during pre-determined selective half-cycles to reduce speed, said motor being actuated at or near the beginning or zero-crossing point of said alternating current.

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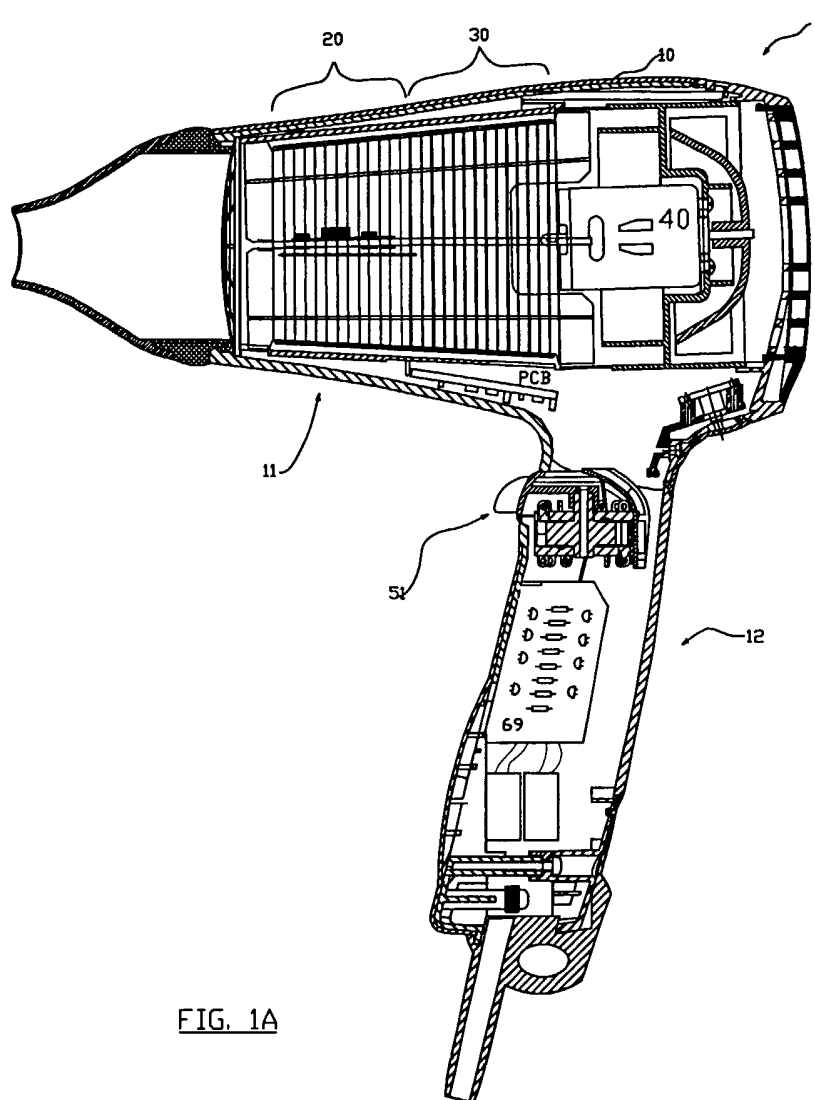


FIG. 1A

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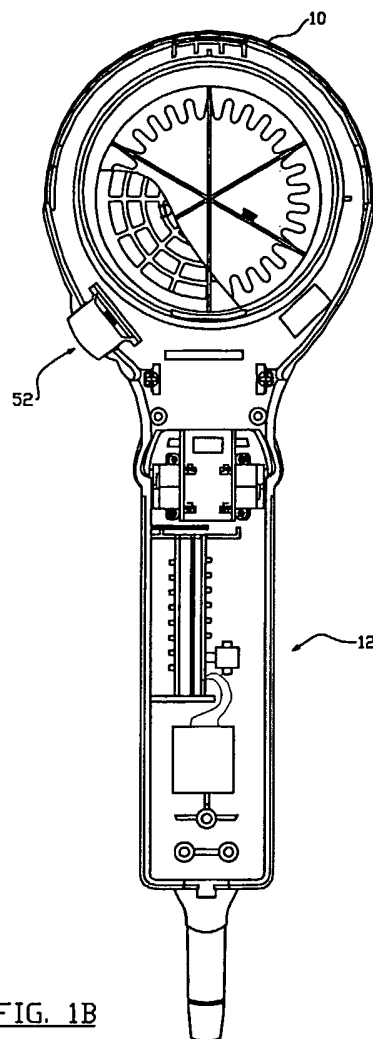


FIG. 1B

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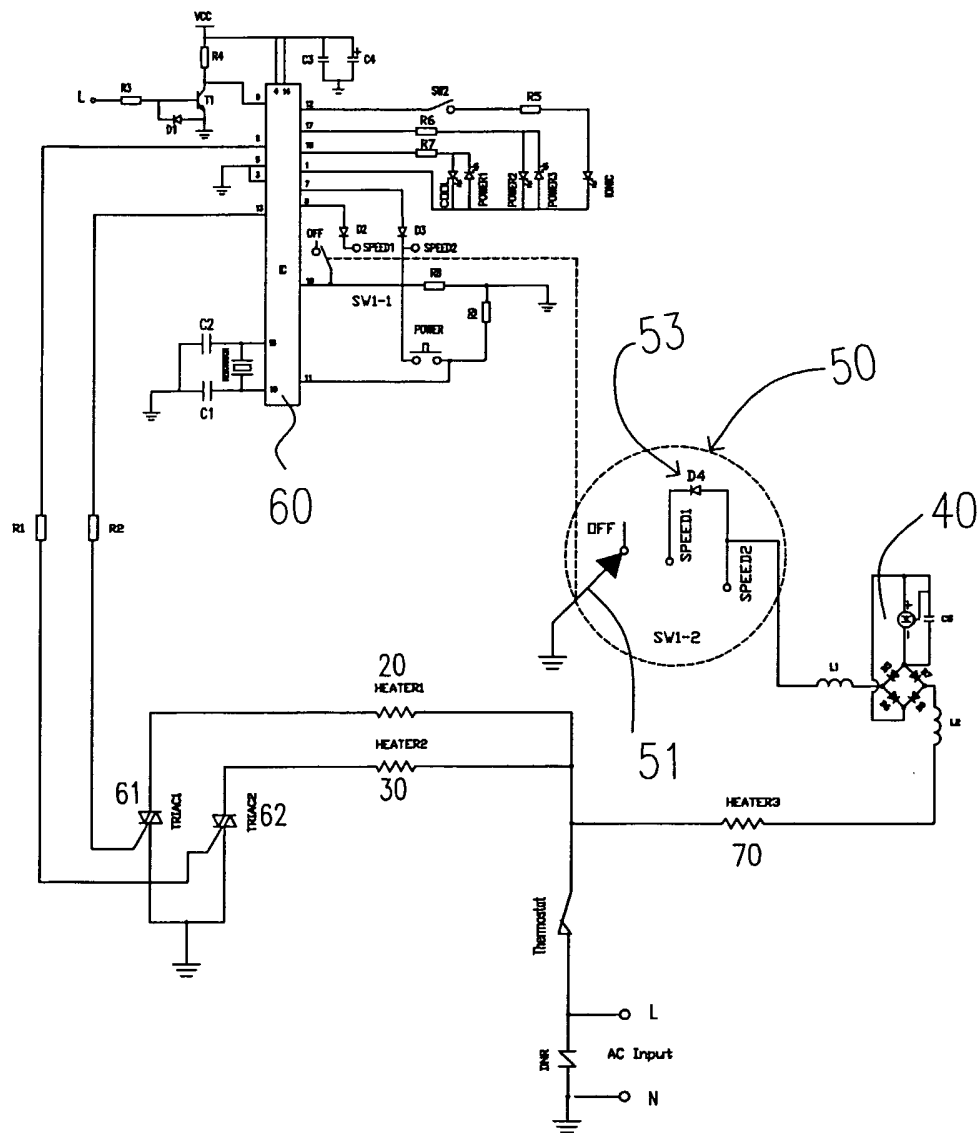
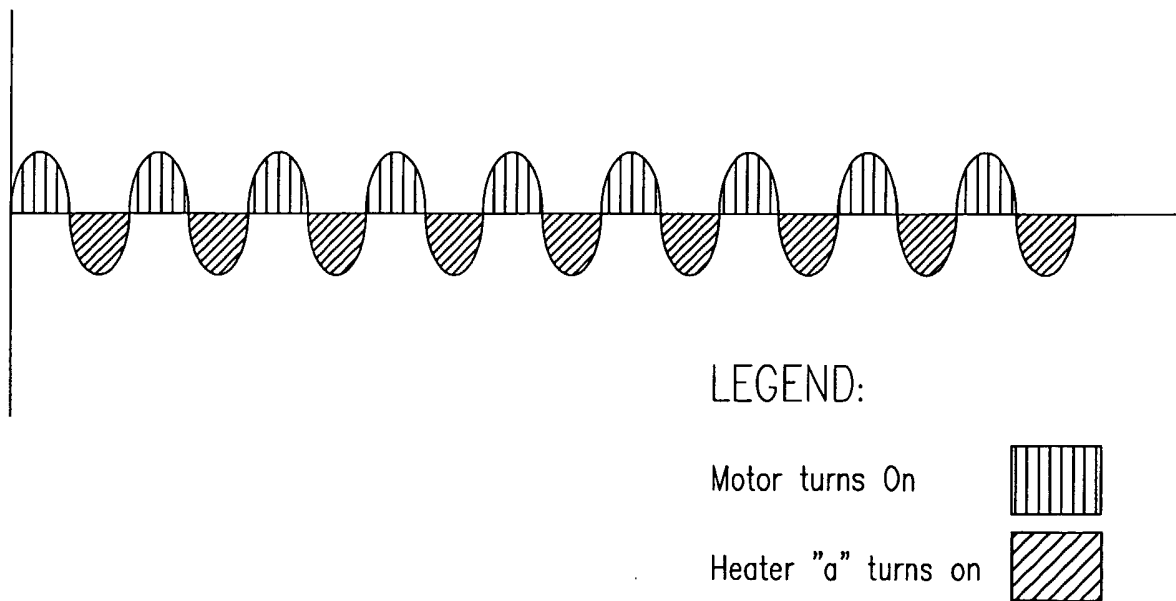


FIG. 1C

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FIG.2



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FIG. 3

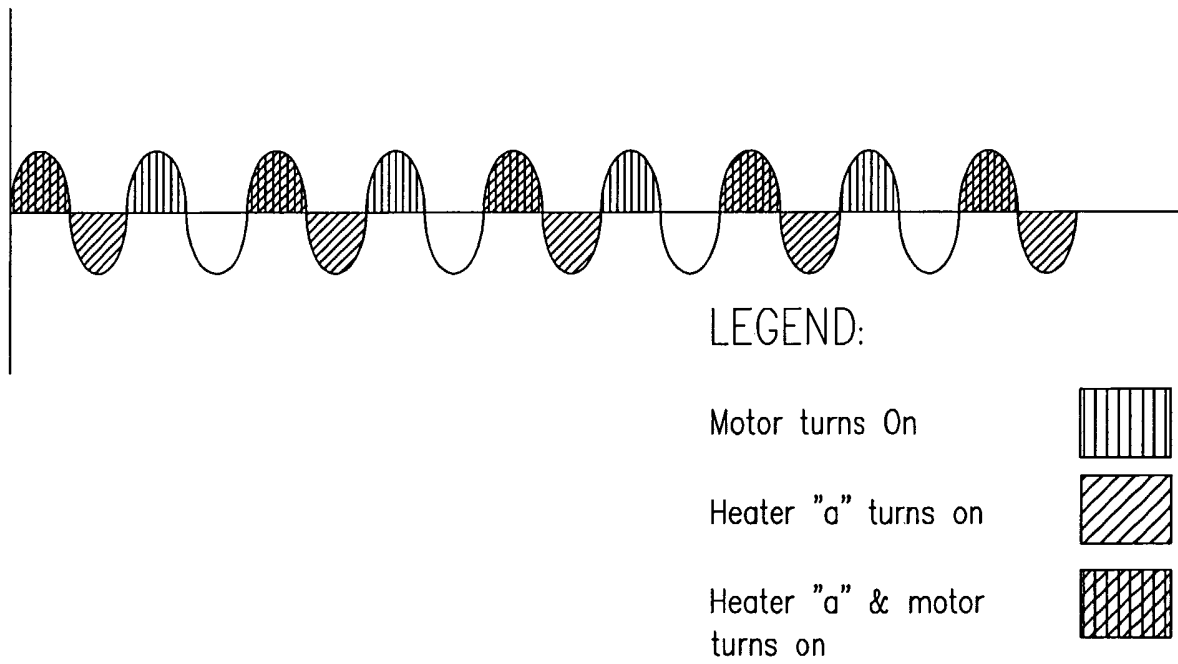
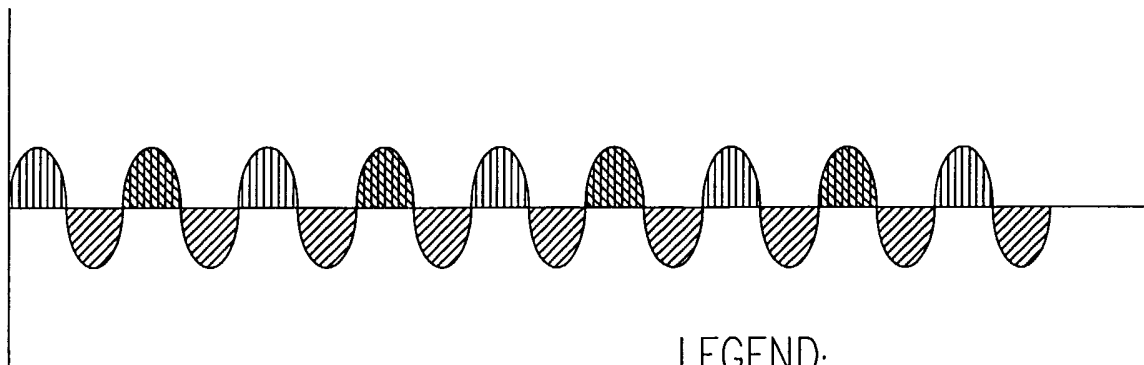
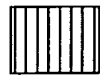


FIG.4



LEGEND:

Motor turns On



Heater "a" turns on

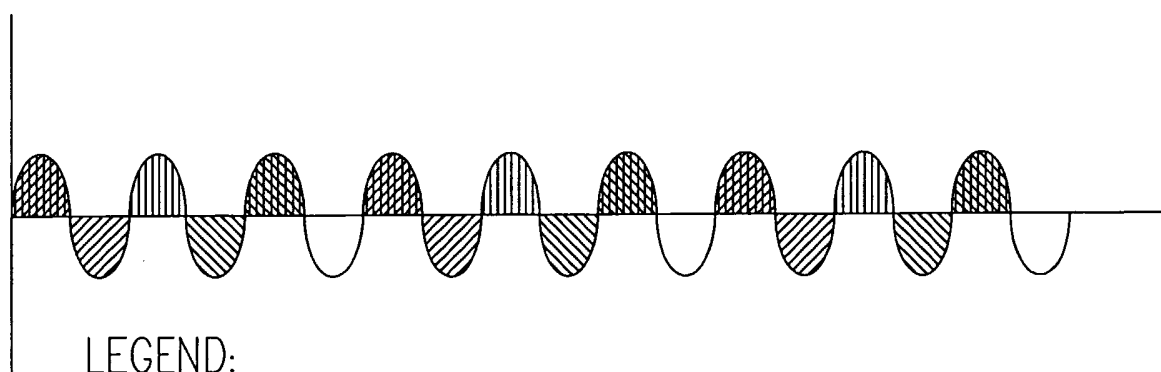


Heater "a" & motor
turns on



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FIG.5



Motor turns On



Heater "a" turns on

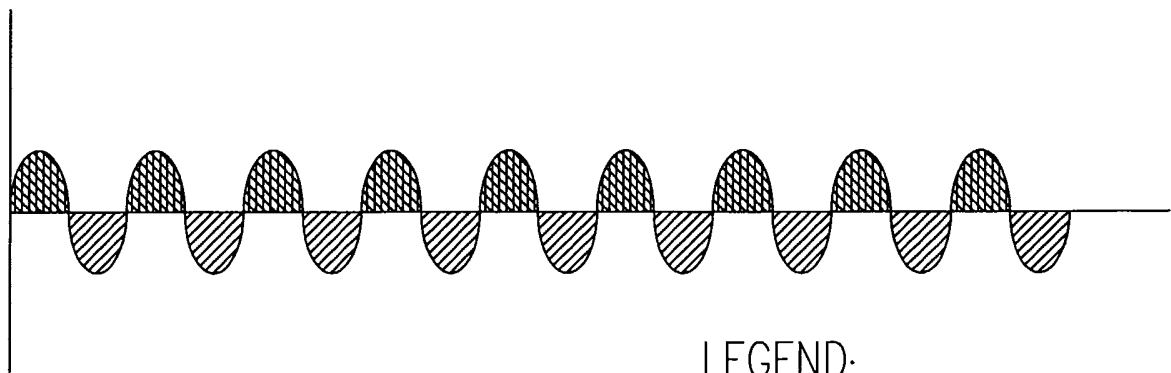


Heater "b" turns on

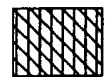
Heater "a" & motor
turns onHeater "b" & motor
turns on

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FIG.6



LEGEND:

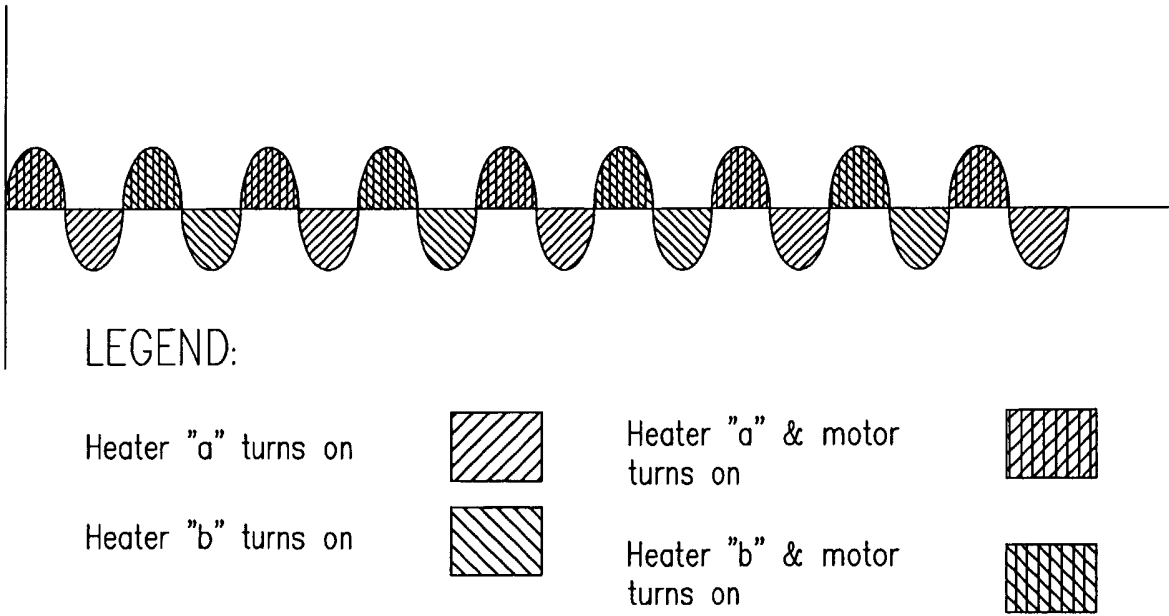
Heater "b" & motor
turns on

Heater "a" turns on



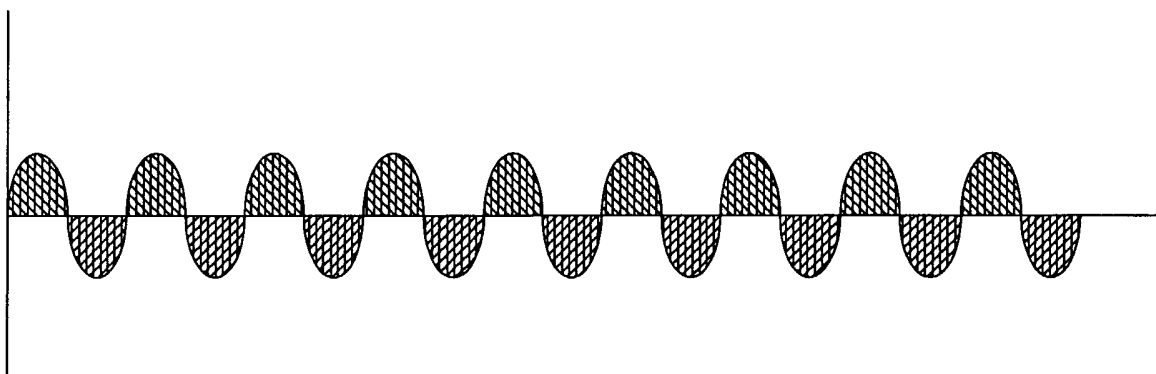
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FIG.7



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FIG. 8

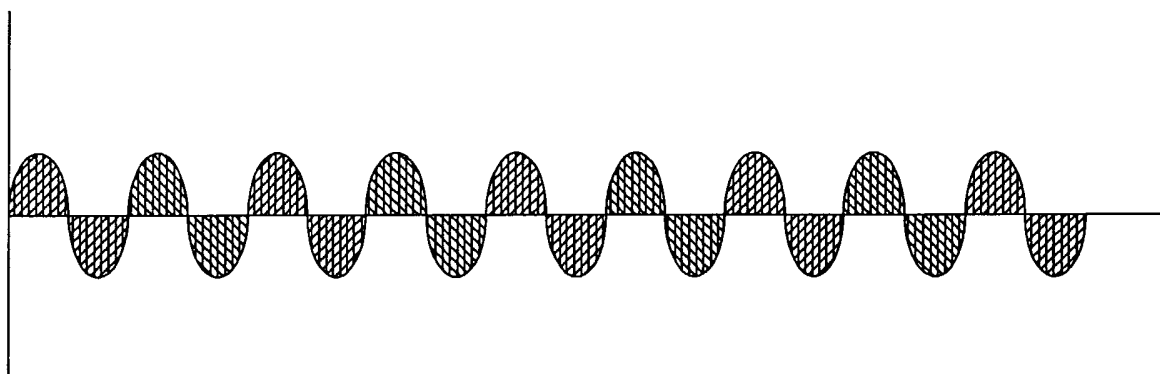


LEGEND:

Heater "a" & motor
turns onHeater "b" & motor
turns on

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FIG.9

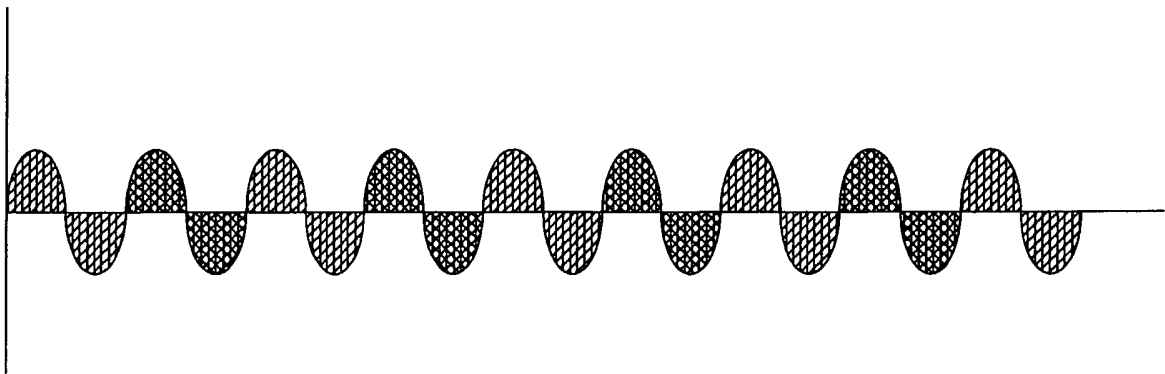


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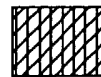
Heater "a" & motor
turns onHeater "b" & motor
turns on

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FIG. 10

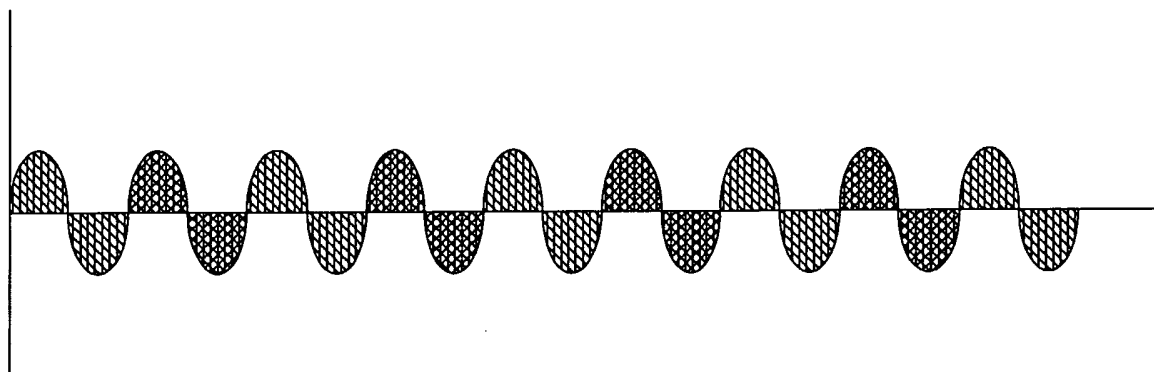


LEGEND:

Heater "a" & motor
turns onHeater "a" & heater "b"
& motor turns on

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FIG. 11

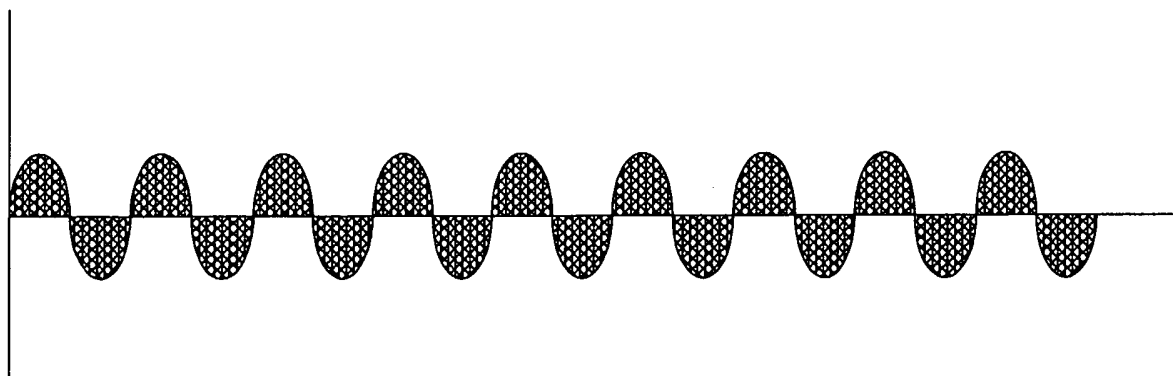


LEGEND:

Heater "b" & motor
turns onHeater "a" & heater "b"
& motor turns on

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FIG.12



LEGEND:

Heater "a" & heater "b"
& motor turns on



INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 03/03457

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A45D20/30 H05B1/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A45D H05B

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 711 988 A (YIP P C ET AL) 8 December 1987 (1987-12-08) column 3, line 32-55; figures 1,2	1,2,6,7, 12, 14-16,20
Y	---	1,2
Y	US 4 085 309 A (GODEL SIEGFRIED ET AL) 18 April 1978 (1978-04-18) abstract; figures 1,2,4A,4B ---	1
Y	GB 2 092 842 A (BRAUN AG) 18 August 1982 (1982-08-18) abstract page 1, line 82-121; figures 1-7 ---	2
Y	US 6 031 210 A (WONKA BORIS) 29 February 2000 (2000-02-29) the whole document ---	2
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☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

19 December 2003

Date of mailing of the international search report

05/01/2004

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Internatl pplication No
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