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(54) **Electric household appliance**

(57) An electric household appliance (1) having a casing (2); a revolving laundry drum (3), which houses laundry for drying, and is mounted for rotation about its longitudinal axis (L) inside the casing (2); a hot-air generator (5); an electric motor (7) for rotating the laundry drum (3); at least two passive electric components (15) for dissipating in the form of heat a given electric power (P_E) to heat the air supply to the laundry drum (3) to a

given temperature (t); and an electronic control unit (20), which controls the electric motor (7) to rotate the laundry drum (3) in a first rotation direction (D1) or an opposite second rotation direction (D2), and, at the same time, controls the passive electric components (15), so that the electric power (P_E) dissipated in heat by the passive electric components differs in the two rotation directions (D1,D2).

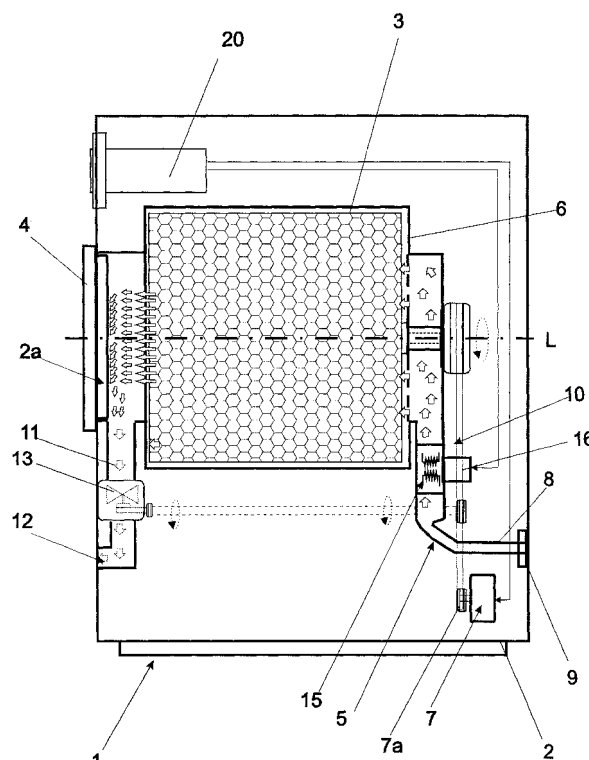


Fig. 1

Description

[0001] The present invention relates to an electric household appliance.

[0002] More specifically, the present invention relates to an electric household appliance corresponding to a home washing machine with a laundry drying device, or to a home laundry tumble drier, to which the following description refers purely by way of example.

[0003] As is known, home tumble driers substantially comprise a parallelepiped-shaped casing; a cylindrical laundry drying tub or chamber fixed horizontally inside the casing, directly facing a laundry loading/unloading opening formed in the front face of the casing; a door hinged to the front face of the casing to rotate to and from a work position closing the opening in the front face to seal the drying tub; a cylindrical, perforated-wall laundry drum housed to rotate axially inside the drying tub; and an electric motor for rotating the laundry drum about its longitudinal axis inside the drying tub.

[0004] Tumble driers of the above type also comprise a hot-air generator designed to circulate inside the drying tub a stream of hot, low-moisture air, which, as it flows through the laundry drum, flows over and rapidly dries the laundry inside the drum. More specifically, the drier comprises a hot-air generator, in turn comprising a drying circuit connected to the drying tub; a heating element, normally defined by a single electric resistor located along the drying circuit to heat the air before it is fed into the drying tub; and a ventilation device, comprising an intake fan rotated by the electric motor to circulate the air inside the drying circuit.

[0005] As is known, users also need to be able to operate the drier at night, to take advantage of lower night-time energy rates, which obviously calls for a considerable reduction in the noise level of the drier.

[0006] Patent Application EP1564324A1, filed by the present Applicant, describes a drier featuring a memory containing various "normal" user-selectable drying programs, each of which controls the motor to rotate the fan and the drum at sufficiently high predetermined drying speeds; and a user-selectable "night drying program", which operates the fan and the drum at "low" rotation speed, i.e. lower than the "normal" drying program drying speeds, to reduce the noise level of the fan and drum.

[0007] Though effective in terms of noise reduction, the drier in Patent Application EP1564324A1 has various drawbacks. Reducing the rotation speed of the drum with respect to the normal drying program drying speeds, in fact, results in poor distribution of the laundry inside the drum, which tends to form into a ball, thus resulting, on the one hand, in uneven drying of the laundry on the inside, and, on the other, in overheating of the laundry on the outside.

[0008] It is an object of the present invention to provide an electric household appliance, in particular a home laundry drier, which, on the one hand, implements a speed- and noise-reducing "night drying program", and,

on the other, provides for more efficient drying of the laundry to eliminate the aforementioned drawbacks.

[0009] According to the present invention, there is provided an electric household appliance as claimed in Claim 1 and, preferably, though not necessarily, in any one of the Claims depending directly or indirectly on Claim 1.

[0010] According to the present invention, there is also provided a method of operating an electric household appliance, as claimed in Claim 9.

[0011] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic side view of a tumble drier in accordance with the teachings of the present invention;

Figure 2 shows a block diagram of the control circuit of the Figure 1 drier.

[0012] Number 1 in Figure 1 indicates as a whole an electric household appliance preferably corresponding to a home laundry drier, which substantially comprises a preferably, though not necessarily, parallelepiped-shaped casing 2; a laundry drum 3, which houses the laundry for drying, and is housed in axially rotating manner inside casing 2, in a preferably, though not necessarily horizontal position, directly facing a laundry loading/unloading opening 2a formed in the front face of casing 2; a door 4 hinged to the front face of casing 2 to rotate to and from a work position closing opening 2a in the front face to seal laundry drum 3; and a preferably, though not necessarily, open-circuit hot-air generator 5 housed inside casing 2 and designed to circulate inside laundry drum 3 a stream of hot, low-moisture air, which flows over and rapidly dries the laundry inside the drum.

[0013] Drier 1 also comprises at least an electric motor 7 preferably a variable velocity rotation motor or similar for rotating laundry drum 3 about its longitudinal axis L, preferably, though not necessarily, inside a drying tub 6 housed inside casing 2. In the Figure 1 example, longitudinal axis L coincides with the longitudinal axis L of drying tub 6.

[0014] With reference to Figure 1, hot-air generator 5 gradually draws air in from outside laundry drum 3; heats the intake air to a predetermined temperature; and draws the moisture-laden air out of laundry drum 3.

[0015] In other words, hot-air generator 5 continuously draws in, heats, and feeds outside air into laundry drum 3 to rapidly dry the laundry inside the drum, and exhausts the moisture-laden air from laundry drum 3 to the outside.

[0016] In the Figure 1 example, hot-air generator 5 comprises an air intake manifold 8 having a first end connected to the rear wall of laundry drum 3, and a second end connected to an air intake 9 formed preferably, though not necessarily, in casing 2; an electric heating device 10 located preferably, though not necessarily, along intake manifold 8 to heat the airflow through intake

9; an exhaust manifold 11 connecting laundry drum 3 to an exhaust outlet 12 in a wall of casing 2; and a centrifugal fan 13 located preferably, though not necessarily, along exhaust manifold 11 to produce, inside intake manifold 8 and exhaust manifold 11, a stream of air which flows through laundry drum 3 and over the laundry inside the drum, and is then exhausted to the outside.

[0017] Centrifugal fan 13 is connected by a transmission mechanism (shown by the dash line) to electric motor 7, which rotates both fan 13 and laundry drum 3 about their respective axes of rotation.

[0018] Casing 2, drying tub 6, laundry drum 3, and electric motor 7 are all parts commonly used in the industry, and are therefore not described in detail.

[0019] With reference to Figures 1 and 2, heating device 10 comprises two or more passive electric components 15, which dissipate electric power by Joule effect to heat the air supply to laundry drum 3; and a control module 16 for controlling passive electric components 15 to regulate the energy dissipated by passive electric components 15 in the form of heat by Joule effect.

[0020] More specifically, control module 16 controls electric motor 7 to rotate laundry drum 3 in a first rotation direction D1 or a second rotation direction D2 opposite first rotation direction D1, and controls passive electric components 15 to regulate the electric power P_E dissipated by passive electric components 15 in the form of heat, so that the temperature t of the air heated by passive electric components 15 assumes a first value t_1 when laundry drum 3 is rotated in the first rotation direction D1, or a second value t_2 , different from first value t_1 , when laundry drum 3 is rotated in the second rotation direction D2.

[0021] More specifically, passive electric components 15 of heating device 10 comprise resistors 15 series- or parallel-connected to one another between two electric power lines 18 at respective reference voltages; and control module 16 comprises a number of switching devices 19, each interposed between one of the two power lines 18 and a respective resistor 15.

[0022] More specifically, in the Figure 2 example, heating device 10 comprises two resistors 15, each connected to a power line 18 via a respective switching device 19. More specifically, the two resistors 15 may have different resistances, e.g. one of the two resistors 15 may have a higher resistance than the other.

[0023] Drier 1 also comprises an electronic control unit 20, which controls electric motor 7 to vary the rotation speed v and/or the rotation direction D of the drive shaft 7a of the motor, and controls control module 16 to regulate the energy dissipated by resistors 15 and so vary the heat produced and, hence, the temperature t of the air supply to drum 3.

[0024] More specifically, electronic control unit 20 comprises a memory unit 21 containing a number of user-selectable drying programs, each comprising information indicating: total drying cycle time DT ; the rotation speed/ v of drum 3 during the drying cycle; and the electric power

supply P_E to resistors 15.

[0025] More specifically, the drying programs comprise at least one "low-noise drying program" containing the following parameters: total drying program time DT ; rotation time/s of motor 7 in first rotation direction D1; rotation time/s of motor 7 in second rotation direction D2 opposite first rotation direction D1; rotation speed v_1 of motor 7 in first rotation direction D1; and rotation speed v_2 of motor 7 in second rotation direction D2.

[0026] Drier 1 also comprises an interface unit 22, which allows the user to select the low-noise drying program from the various memorized drying programs, and so transmit a signal to electronic control unit 20 to commence drying the laundry in accordance with the low-noise program.

[0027] Drier 1 operates as follows. Following user selection of the low-noise drying program, electronic control unit 20 sets switching devices 19 to a first configuration to dissipate in heat a first electric power $P_E = P_{E1}$, and, at the same time, controls electric motor 7 to rotate drive shaft 7a of the motor in first rotation direction D1 at a first slow rotation speed $v = v_1$. More specifically, the first rotation speed v_1 of drive shaft 7a of electric motor 7 may be approximately 2000 rpm, and the first rotation direction of drive shaft 7a of electric motor 7 may rotate laundry drum 3 clockwise (in Figure 2).

[0028] After a predetermined time ΔT_1 , e.g. about 60 seconds, electronic control unit 20 sets switching devices 19 to a second configuration to dissipate a second electric power P_{E2} , preferably lower than P_{E1} , and so lower the temperature $t_2 < t_1$ of the air supply to drum 3, and, at the same time, controls electric motor 7 to rotate drive shaft 7a of the motor in second rotation direction D2 at a second slow rotation speed $v_2 \leq v_1$. More specifically, the second rotation speed v_2 may be about 2000 rpm or less, and the second rotation direction D2 of drive shaft 7a of electric motor 7 may rotate laundry drum 3 anticlockwise (in Figure 2).

[0029] More specifically, the first configuration of switching devices 19 activated by control unit 20 may comprise closing a first switching device 19 to power a first resistor 15, and opening a second switching device 19 to zero heat generation by the second resistor 15; and the second configuration of switching devices 19 may comprise closing the second switching device 19 to power the second resistor 15, and opening the first switching device 19 to zero Joule heat generation by the first resistor 15.

[0030] It should be pointed out that the change in the rotation direction of drum 3 in the low-noise drying program conveniently prevents balling of the laundry, by distributing it on the inner wall of drum 3 and so enabling uniform drying; while the reduction in Joule heat generated as the drum rotates in second rotation direction D2, i.e. after the laundry is distributed on the inner wall of laundry drum 3, reduces the air temperature $t_2 < t_1$, and so greatly reduces the risk of overheating the laundry inside drum 3.

[0031] After a predetermined time ΔT_2 , the low-noise drying cycle may either terminate the drying cycle or repeat the above steps, i.e. alternate rotation directions D1 and D2 and/or relative rotation speeds v1 and v2 of motor 7 for predetermined times ΔT_i .

[0032] The drier as described above is extremely advantageous, by not only ensuring a low noise level, but also preventing balling and, at the same time, overheating and possible damage, of the laundry.

[0033] Clearly, changes may be made to electric household appliance 1 as described herein without, however, departing from the scope of the present invention as defined in the accompanying Claims.

Claims

1. An electric household appliance (1) comprising a casing (2); a revolving laundry drum (3), which houses laundry for drying, and is mounted for rotation about its longitudinal axis (L) inside said casing (2); hot-air generating means (5) for circulating a stream of hot air inside the laundry drum (3); and electric drive means (7) for rotating said laundry drum (3) about said longitudinal axis (L); said electric household appliance (1) being **characterized by** comprising electric heating means (10) for dissipating in the form of heat a given electric power (P_E) to heat the air supply to the laundry drum (3) to a given temperature (t); and electronic control means (20), which control said electric drive means (7) to rotate said laundry drum (3) in a first rotation direction (D1) or a second rotation direction (D2) opposite said first rotation direction (D1), and control said electric heating means (10) to regulate the electric power (P_E) dissipated in heat by the electric heating means, so that the temperature (t) of the air heated by said electric heating means (10) assumes a first value (t_1) when said laundry drum (3) rotates in said first rotation direction (D1), or a second value (t_2), different from the first value (t_1), when the laundry drum (3) rotates in said second rotation direction (D2).
2. An electric household appliance as claimed in Claim 1, wherein said electric heating means (10) comprise at least two resistors (15).
3. An electric household appliance as claimed in Claim 2, wherein one of the two resistors (15) has a different resistance from the other resistor (15).
4. An electric household appliance as claimed in Claim 2 or 3, wherein said electric heating means (10) comprise at least two switching devices (19), each connected between a respective resistor (15) and an electric power line (18).
5. An electric household appliance as claimed in any

one of the foregoing Claims, wherein said electronic control means (20) control said electric drive means (7) to rotate said laundry drum (3) in said first rotation direction (D1) at a predetermined first rotation speed (v1), or in said second rotation direction (D2), opposite said first rotation direction (D1), at a predetermined second rotation speed (v2) different from the first rotation speed (v1).

6. An electric household appliance as claimed in Claim 5, wherein said electronic control means (20) selectively close/open said switching devices (19) to activate/deactivate the corresponding resistors (15).
7. An electric household appliance as claimed in any one of the foregoing Claims, wherein said electric drive means (7) comprise at least an electric motor (7).
8. An electric household appliance as claimed in Claim 7, wherein said electric motor (7) is a variable velocity rotation motor.
9. A method of operating an electric household appliance (1) comprising a casing (2); a revolving laundry drum (3), which houses laundry for drying, and is mounted for rotation about its longitudinal axis (L); hot-air generating means (5) for circulating a stream of hot air inside the laundry drum (3); and electric drive means (7) for rotating said laundry drum (3) about the longitudinal axis (L); said method being **characterized by** comprising the steps of: setting electric heating means (10), for dissipating in the form of heat a given electric power (P_E), to heat the air supply to the laundry drum (3) to a given temperature (t); controlling said electric drive means (7) to rotate said laundry drum (3) in a first rotation direction (D1) or a second rotation direction (D2) opposite said first rotation direction (D1); and selectively regulating the electric power (P_E) dissipated in heat by the electric heating means (10), so that the temperature (t) of the air heated by said electric heating means (10) assumes a predetermined first value (t_1) when the laundry drum (3) rotates in said first rotation direction (D1), or a predetermined second value (t_2), different from the predetermined first value (t_1), when said laundry drum (3) rotates in said second rotation direction (D2).
10. A method as claimed in Claim 9, wherein said electric heating means (10) comprise two or more resistors (15), each connected to a power line (18) by a respective switching device (19); and said step of selectively regulating the electric power (P_E) dissipated in heat by the electric heating means (10) comprises the step of selectively closing/opening said switching devices (19) to activate/deactivate the corresponding resistors (15).

- 11.** A method as claimed in Claim 9 or 10, wherein said step of rotating said laundry drum (3) in a first (D1) or second (D2) rotation direction comprises the step of regulating the length of time ($\Delta T1$) ($\Delta T2$) the laundry drum (3) rotates in the first (D1) or second (D2) rotation direction, on the basis of a predetermined user-selectable nighttime drying program.

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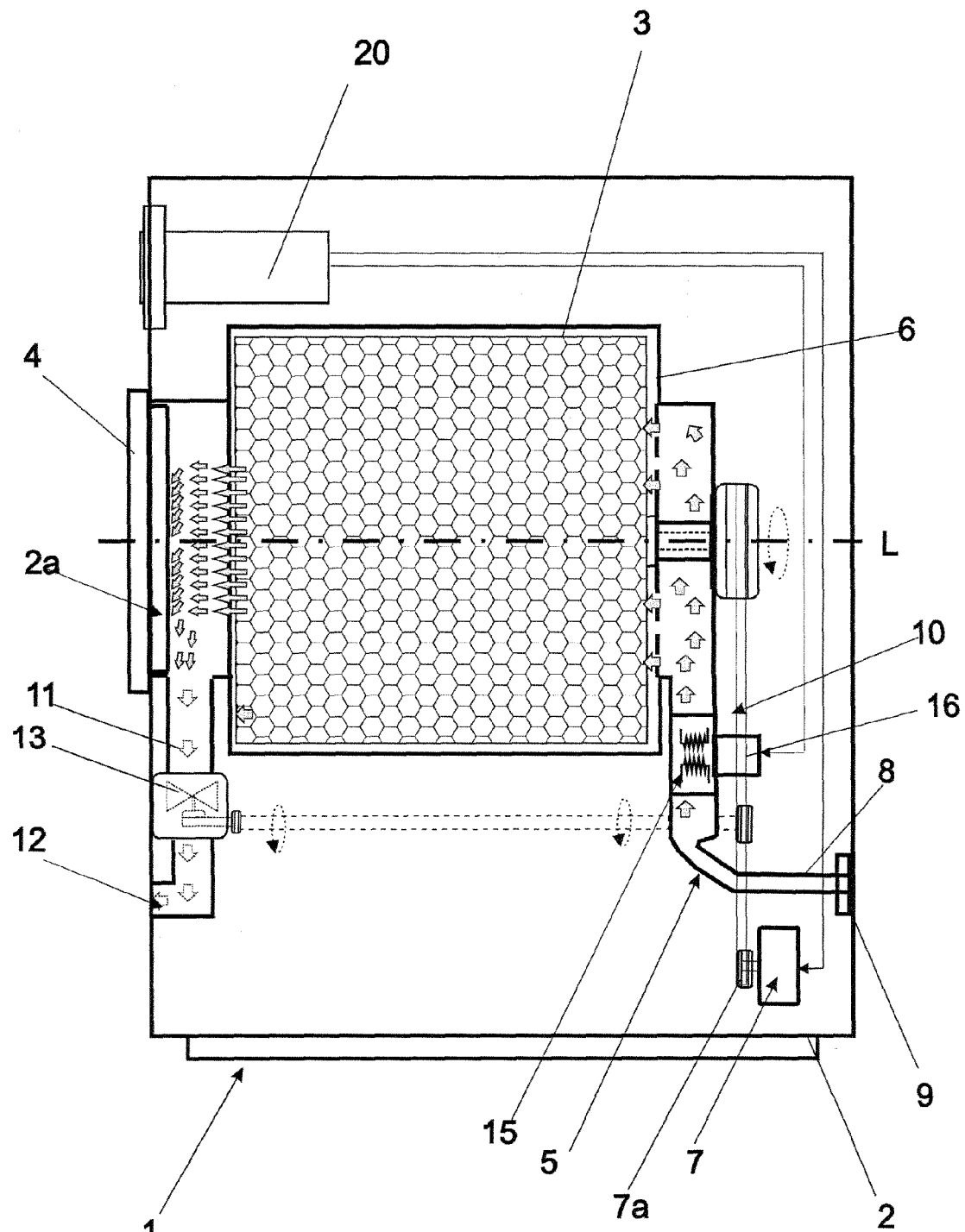


Fig. 1

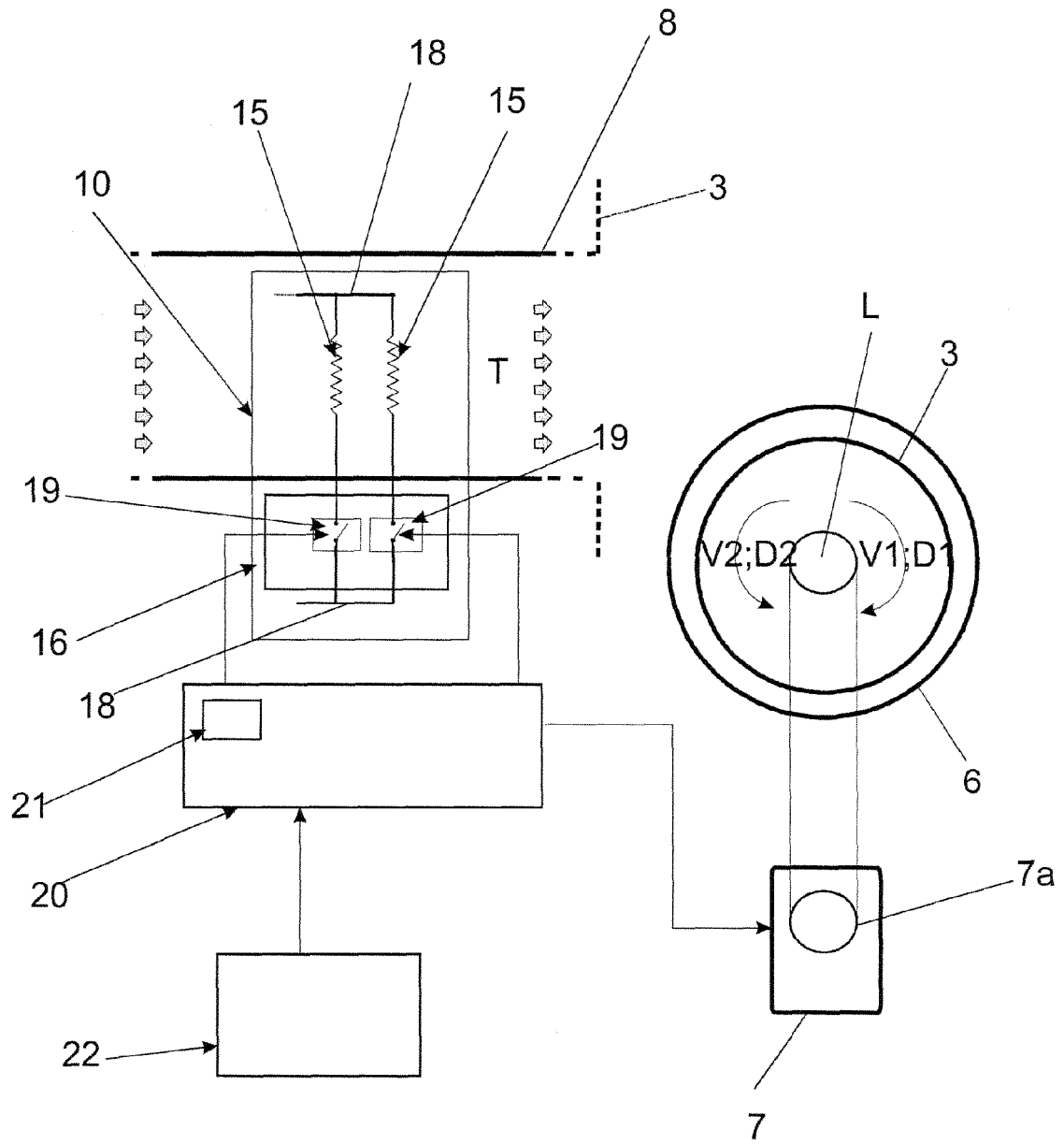


Fig. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 11 4481

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 January 2008	Examiner Clivio, Eugenio
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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