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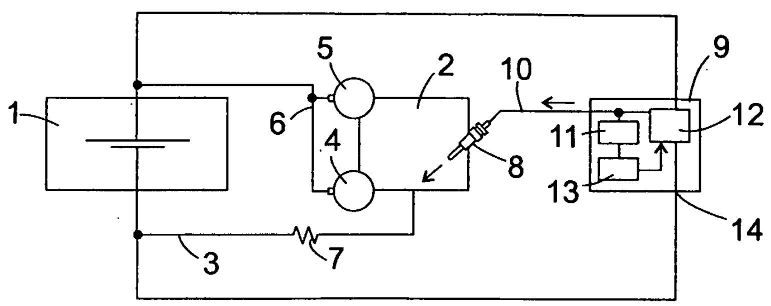
Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **A system and method for controlling resistive loads with ground return connected to the engine ground**

(57) A controller (9) for controlling electrical power supplied to one or more loads comprises
a first supply terminal for connecting to a supply potential,
a second supply terminal (14) for connecting to a ground potential,
a set of output terminals ($10;10_1,10_2$,...) for connecting to a respective load ($8;8_1,8_2$,...), the set comprising at least one output terminal,
a power supply circuit (12) for supplying a power-controlled intermittent current to each output terminal ($10;10_1,10_2$,...),
a voltage measuring means (11) for measuring a first voltage level (U_{ON}) at an output terminal ($10;10_1,10_2$,...) of said set during an ON period of the intermittent current supplied to this terminal, and for measuring a second voltage level (U_{OFF}) at an output terminal ($10;10_1,10_2$,...) of said set during an OFF period of the intermittent current supplied to this terminal, and
a power control means (13) for controlling the power of said intermittent current based said first and second voltage levels.
The problem solved is to control power supplied to a load in a reliable way which is not influenced by a deviation between ground potentials of a power controller and of the load itself.

Fig. 1



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Description

[0001] The present invention relates to a power controller for operating a load at constant power and to a method of controlling such a load. As a specific example, the invention relates to a glow plug controller, a Diesel engine comprising such a controller and a method of controlling glow plug heating in a Diesel engine.

[0002] A glow plug is conventionally used in a Diesel engine for pre-heating a cylinder thereof, so as to facilitate self-ignition of an air-fuel mixture in the combustion chamber. Usually, a glow plug is operated during a starting and a warm-up phases of a Diesel engine; when the engine is operating continuously, the glow plug is normally off.

[0003] Conventionally, glow plugs had an elongate shape with a glowing element supported at an end thereof and would be mounted in a cylinder wall of the engine with the glowing element extending into the combustion chamber. Recently, other shapes of glow plugs have been introduced, to which the present invention is also applicable. Therefore, the term "glow plug" is used in the present description in a purely functional sense and shall not be construed to imply a specific shape.

[0004] A glowing control system for a modern Diesel engine may comprise a set of glow plugs, usually one glow plug being associated to each cylinder of the engine, an electronic glow plug controller for supplying a heating current to the glow plugs, and wiring for interconnecting the controller, the glow plug(s) and a vehicle battery. A glow plug conventionally comprises an electrical conductor which is heated by a current flowing through it, and which has a resistivity which increases with temperature. If a high voltage is applied while the temperature of the heating material is still low, there is a risk that the heating material will fuse, so that the live time of the glow plug is short. If the applied voltage is low enough to avoid a risk of fusing, the heating power of the glow plug decreases substantially while it is heating up, and there is a risk that a temperature which is high enough for self-ignition cannot be reached. It is therefore necessary to control the heating power applied to the glow plug during the heating process, in order to avoid both excessive heating power at the beginning and insufficient heating power at a later stage of the process. This might be done by means of a glow plug controller comprising a PWM (pulse width modulation) circuit for supplying a PWM (pulse width modulated) heating current having a given duty factor to the glow plug, power measuring means for measuring the power of the PWM heating current flowing through the glow plug and control means for adapting the duty factor of the PWM heating current according to a deviation between the measured power and a desired power.

[0005] However, such power measuring means have a problem in that a measurement of the power of the PWM heating current carried out in the controller depends on the difference between the output potential of the PWM circuit and the ground potential of the controller, whereas the heating power generated in the glow plug is a function of the PWM potential and the ground potential at the heating plug. Although ground terminals of the controller and of the glow plug are electrically connected via an engine block and a vehicle frame, their ground potentials may be different, in particular due to currents flowing from other electrical consumers and/or sources to the battery via the ground and which may cause voltage drops between different locations of the ground.

[0006] It is readily seen that a similar problem arises when other types of loads are operated in an environment similar to that of the above-mentioned glow plugs, in which a power source drives various loads and the voltage between terminals of a first load may vary according to the current absorbed by a second load.

[0007] This problem might be resolved by providing a dedicated conductor between the ground terminal of the first load and the PWM circuit, enabling the latter to measure not only its output potential, but also the ground potential of the first load. The costs of such a solution, however, would not be negligible, not only because of the cost of providing and mounting the dedicated connection, but also because a more complicated structure of the voltage measuring means would be necessary for measuring the two voltages.

[0008] An other possibility would be to isolate the first load from the vehicle ground altogether and to provide two conductors between the power controller and the first load. In that case, it would be sufficient to measure a voltage difference between the two conductors, but it is problematic to ensure a reliable isolation between the first load and the motor block. An isolation failure might cause the controller to supply an excessive current which would destroy the first load.

[0009] There is a need, therefore, to be able to control power supplied to a load in a reliable and simple way which is not influenced by a deviation between ground potentials of a power controller and of the load itself.

[0010] This need is satisfied by a power controller comprising a first supply terminal for connecting to a supply potential, a second supply terminal for connecting to a ground potential, a set of output terminals for connecting to a respective load, the set comprising at least one output terminal, a power supply circuit for supplying a power-controlled intermittent current to each output terminal, the power controller being characterized in that the power supply circuit comprises a voltage measuring means for measuring a difference between a first voltage level at an output terminal of said set during an ON period of the intermittent current supplied to this terminal and a second voltage level at an output terminal of said set during an off period of the intermittent current supplied to this terminal, and a power control means for controlling the power of the intermittent current based on said difference.

[0011] Alternatively, the voltage measuring means may be for measuring said first and second voltage levels, and the power control means is for controlling the power of the intermittent current based on said first and second voltage levels.

[0012] The invention makes use of the fact that if the heating current supplied to the glow plug is an intermittent current, the output terminal of the controller will be pulled to the ground potential of the load during an OFF period of the intermittent current. There is therefore no need to provide an extra conductor for transmitting the ground potential of the load to the controller, and there is no isolation needed between the load(s) and the ground of the controller, either.

[0013] Preferably, the power supply circuit is a PWM circuit, the intermittent current is a PWM current, and the power control means controls a duty factor of said PWM current.

[0014] According to a first embodiment of the controller, the voltage measuring means is adapted to measure said first and second voltage levels consecutively at a same output terminal. This allows for a particularly simple controller design which can control the power supplied to one or more loads based on first and second voltage levels measured at a same one of these loads.

[0015] According to a second embodiment, the set comprises a plurality of output terminals, and the output current at one of said output terminals is phase shifted with respect to the output current at another one of said terminals. In this way, the fluctuation of the total heating current supplied by the power supply circuit to several loads is less than in case of all loads being supplied in-phase currents, whereby the energetic efficiency of the controller is improved.

[0016] A further advantage of this embodiment is that the voltage measuring means can be adapted to measure said first and second voltage levels simultaneously at two of said output terminals or to measure directly the voltage difference between these two terminals. Therefore, the difference between the first and second voltage levels can be obtained immediately without having to store temporarily one of said voltage levels.

[0017] The above cited need is also satisfied by a combustion engine comprising an engine block having at least one cylinder and a load associated to said cylinder, a battery, and a power controller as defined hereabove, wherein the battery, the load and the power controller are connected to a common ground.

[0018] Preferably, the combustion engine is a Diesel engine and the load is a glow plug.

[0019] The need is further satisfied by a method of controlling a set of loads comprising at least one load, the method comprising the steps of:

a) applying an intermittent current to each load of said set;
b) measuring a first voltage level between terminals of a load of said set during an ON period of its respective intermittent current;
c) measuring a second voltage level between terminals of a load of said set during an OFF period of its respective intermittent current;
d) estimating a mean power of at least one of said intermittent currents based on the difference between said first and second voltage levels;
e) controlling the duty factor of said at least one intermittent current so as to decrease a deviation between the estimated mean power and a target power.

[0020] Alternatively, a difference between a first voltage level at a terminal of a load of said set during an ON period of its respective intermittent current and a second voltage level at a terminal of a load of said set during an OFF period of its respective intermittent heating current can be measured, and a mean power of at least one of said intermittent currents is estimated based on said difference.

[0021] Further features and advantages of the invention will become apparent from the subsequent description of embodiments thereof referring to the appended drawings.

Fig. 1 is a schematic block diagram of the electric system of a car comprising a glow plug controller according to the present invention;

Fig. 2 is a flow chart of processing carried out by the glow plug controller of Fig. 1;

Fig. 3 is a graph which illustrates the heating voltage output by the glow plug controller of Fig. 1 as a function of time;

Fig. 4 is a block diagram of the electric system of a car in which each cylinder has an associated glow plug;

Fig. 5 is a flow chart of processing carried out by the glow plug controller of Fig. 4; and

Fig. 6 illustrates heating voltages applied to two of said glow plugs as a function of time.

[0022] In Fig. 1, a car battery 1 is shown having a positive terminal, also referred to in the following as the supply voltage terminal, and a negative terminal, also referred to as the ground terminal. An engine block 2 is connected to the ground terminal by a ground conductor 3 which comprises at least a major portion of the metallic frame of the vehicle. An electric starter motor 4 and an electric generator 5 are mechanically connected to a crankshaft, not shown, of the engine. They are electrically connected to the supply terminal of battery 1 by supply conductors 6 and to the ground terminal via ground conductor 3. When the starter motor 4 or the generator 5 is in operation, considerable currents flow through ground conductor 3, which may give rise to voltage drops between spaced-apart points of the ground conductor 3, as indicated in Fig. 1 by a resistor symbol 7.

[0023] A glow plug 8 in engine block 2 has a terminal connected to a glow plug controller 9 by a single conductor cable 10. Another terminal of the glow plug 8 is connected to ground conductor 3 via engine block 2.

[0024] Glow plug controller 9 has a ground terminal 14 connected to ground conductor 3. Due to the above-mentioned currents that may be flowing in ground conductor 3, the potential at ground terminal 14 may differ from that of engine block 2. Glow plug controller 9 comprises a voltage sensor 11 for measuring a voltage between wire 10 and ground terminal 14, a PWM circuit 12 for outputting a PWM current to wire 10 according to an input duty factor signal, and a power control circuit 13 for generating the duty factor signal input to PWM circuit 12 based on the voltage detected by voltage sensor 11.

[0025] The operation of power control circuit 13 is explained referring to the flowchart of Fig. 2. In step S1, the power control circuit 13 waits for the PWM circuit 12 to assume an ON state. In other words, the power control circuit 13 is triggered by a rising flank of the output voltage from PWM circuit 12. When the PWM voltage has switched to ON, control circuit 13 determines the voltage level U_{ON} in wire 10 in step S2 and the current I_{ON} through wire 10 in step S3. The control circuit 13 then waits for the PWM circuit 12 to switch off again in step S4. When this has happened, voltage sensor 11 obtains the voltage level U_{OFF} of conductor wire 10 in step S5. As pointed out above, U_{OFF} may be non-zero due to currents flowing between the battery 1 and other devices along ground 3. Therefore, the effective voltage across glow plug 8 can be approximated by U_{ON}-U_{OFF}. It is an approximation, because the two voltage levels are measured at different times and the currents that cause U_{OFF} to be non-zero may vary. Based on the data obtained in steps S2, S3, S5, power control unit 13 sets a new duty factor α for the next pulse to be output by PWM circuit 12 according to

$$\alpha = P_{target}/(I_{ON}\ (U_{ON}-U_{OFF})),$$

wherein P_{target} denotes the desired heating power of glow plug 8.

[0026] A typical sequence of PWM voltage pulses on wire 10 is illustrated in Fig. 3. It is assumed here that during the time interval shown in the graph of Fig. 3 the temperature and, hence, the resistance of the glow plug 8 do not change substantially, so that variations of the duty factor (i.e the pulse width) can be attributed to fluctuations of ground potential U_{OFF}, as explained below.

[0027] In a first time interval, from to to t_1, U_{OFF} is 0, and the duty factor of the voltage pulses shown is

$$\alpha = P_{target}/(I_{ON}\ U_{ON}).$$

[0028] At t_1, during an off phase of a PWM circuit, U_{OFF} assumes a positive, non-zero value. The duty factor α for the first pulse P1 after t_1 has been obtained based on measurements taken at the rising and falling flanks of the pulse P0 immediately preceding t_1. Therefore, the width of pulse P1 is the same of that of P0. The duty factor α for the next pulse P2 is obtained by carrying out step S2 of Fig. 2 immediately after the rising flank of P1 and step S5 immediately after the falling flank. At this time, a positive value of U_{OFF} is measured in step S5, causing the duty factor of P2 and the following pulses to be set higher than those of P0 and P1.

[0029] At t_2, during a pulse denoted P3, U_{OFF} becomes zero again. This is taken account of when determining the duty factor of pulse P4 immediately following P3.

[0030] During pulse P5, U_{OFF} becomes negative. This is detected at the decreasing flank of P5 in step S5 and can thus be immediately taken account of for determining the duty factor of subsequent pulse P6, which thus becomes narrower.

[0031] From the above, it is readily apparent that the device and method of the invention allow for a very strict control of the heating power of glow plug 8. Any change in U_{OFF} occurring within a PWM pulse is taken account of in the next pulse, and a change occurring between two PWM pulses is taken account of in the second pulse after the change, so that substantial fluctuations of heating power cannot last longer than approx. one duty cycle of the PWM signal.

[0032] Fig 4 illustrates a second embodiment of the electric system of a Diesel engine which is distinguished from the system of Fig. 1 by the fact that several glow plugs 8_1, 8_2, ..., are connected to glow plug controller 9 by wires 10_1, 10_2, ..., each of the glow plugs 8_1, 8_2, ... being associated to a cylinder 15_1, 15_2, ... of the engine block 2. In principle, the power control circuit 13 of this controller 9 might operate according to the method of Fig. 2, supplying PWM pulses simultaneously to each of the glow plugs 8_1, 8_2, ... However, powering several glow plugs with simultaneous pulses imposes a high load on the battery 1 at the time of the pulses, which may cause the battery voltage to decrease noticeably while the pulses last. Under these circumstances, part of the energy stored in the battery 1 will be lost by heating the battery 1 instead of heating the glow plugs 8_1, 8_2, ... This problem can be avoided by supplying the glow plugs 8_1, 8_2, ... with PWM heating currents which are phase-shifted with respect to each other, so that the pulses of a given glow plug heating current will coincide with gaps between pulses in the heating current of another glow plug. In this way, a continuous load is imposed on the battery 1, and its energy is used more efficiently.

[0033] A phase shift between the heating currents of the different glow plugs 8_1, 8_2, ... allows for an operating method of power control circuit 13 which is different from the one shown in Fig. 2 and which will be explained referring to the flowchart of Fig. 5. In this flowchart, two heating currents PWM1, PWM2 are considered, which are preferably phase shifted with respect to each other by approximately 180°C. It should be noted, however, that the method is operable for any non-zero phase shift.

[0034] In step S11, the power control circuit 13 waits for an instant when PWM1 is on and PWM2 is off. When such an instant occurs, the power control circuit 13 measures the voltage ΔU between wires 10_1, 10_2 carrying the heating currents PWM1 and PWM2, respectively. This voltage can be obtained by means of voltage sensors of the same type as voltage sensor 11 of Fig. 1, connected between a respective associated one of conductor wires 10_1, 10_2, ... and the ground terminal 14 of glow plug controller 9 and by calculating the difference between the voltages detected by the two voltage sensors associated to conductor wires 10_1, 10_2 respectively, or by using a single voltage sensor connected directly between wires 10_1, 10_2.

[0035] In step S13 the instantaneous current ION in wire 10_1 is detected. Step S14 then calculates the duty factor α for PWM 1 according to the expression

$$\alpha = P_{target}/(I_{ON}\ \Delta U)$$

and controls the width of the next pulse of PWM1 according to this duty factor.

[0036] If steps S11 to S14 are carried out during a single pulse of the heating current PWM1, the duty factor α obtained in step S14 can be used to control the width of this same pulse. According to the method of Fig. 5, the duty factor α can be adapted to variations of the ground potential still faster than by the method of Fig. 2. Since ΔU is obtained by a single measurement or two simultaneous measurements there is no need to buffer voltage samples so that the hardware of power control circuit 13 can be simplified.

[0037] Fig. 6 is a graph illustrating the waveforms of heating currents PWM1, PWM2 in case of fluctuations of the ground voltage level of engine block 2, in analogy to Fig. 3. Vertical dash-dot lines indicate instants at which step 11 of the procedure illustrated in Fig. 5 is carried out. From to to t_1 the ground voltage is zero, and the pulses forming the heating currents PWM1, PWM2 have a constant width. At t_1, the ground voltage becomes positive, so that ΔU detected in step S12 at time t_1' in the course of pulse P1 of PWM1 is smaller than usual. This is taken account of by increasing the duty factor α of P1, which is shown in Fig. 6 to be noticeably longer than immediately preceding pulse P0.

[0038] In the meantime, the method of Fig. 5 is applied mutatis mutandis to heating current PW2, too, so that the pulses of the latter also become longer after t_1.

[0039] At time t_2 the ground voltage becomes 0 again, which is detected in step S12 at time t_2'. This is taken account of by reducing the width of pulse P3.

[0040] Similarly, the ground voltage becoming negative at time t_3 is detected at step S12 at time t_3', in the course of pulse P6, causing that same pulse P6 to be shortened.

Claims

1. A controller (9) for controlling electrical power supplied to one or more loads, comprising
a first supply terminal for connecting to a supply potential,
a second supply terminal (14) for connecting to a ground potential,
a set of output terminals (10; 10_1, 10_2, ...) for connecting to a respective load (8; 8_1, 8_2, ...), the set comprising at least one output terminal,
a power supply circuit (12) for supplying a power-controlled intermittent current to each output terminal (10; 10_1, 10_2, ...),
characterized in that it further comprises a voltage measuring means (11) for measuring a first voltage level (U_{ON}) at an output terminal (10; 10_1, 10_2, ...) of said set during an ON period of the intermittent current supplied to this terminal, and for measuring a second voltage level (U_{OFF}) at an output terminal (10; 10_1, 10_2, ...) of said set during an OFF period of the intermittent current supplied to this terminal, and a power control means (13) for controlling the power of said intermittent current based said first and second voltage levels.

2. A controller (9) for controlling electrical power supplied to one or more loads,comprising
a first supply terminal for connecting to a supply potential,
a second supply terminal (14) for connecting to a ground potential,
a set of output terminals (10_1, 10_2, ...) for connecting to a respective load (8_1, 8_2, ...), the set comprising at least one output terminal,
a power supply circuit (12) for supplying a power-controlled intermittent current to each output terminal (10_1, 10_2, ...), **characterized in that** it further comprises a voltage measuring means (11) for measuring a difference (ΔU) between a first voltage level at an output terminal (10_1) of said set during an ON period of the intermittent current (PWM1) supplied to this terminal (10_1), and a second voltage level at an output terminal (10_2) of said set during an OFF period of the intermittent current (PWM2) supplied to this terminal (10_2), and a power control means (13) for controlling the power of said intermittent current (PWM1) based said difference (ΔU).

3. The controller of claim 1 or 2, **characterized in that** the power supply circuit (12) is a PWM circuit (12), the intermittent current (PWM1) is a PWM current, and the power control means (13) controls a duty factor (α) of said PWM current.

4. The controller of claim 1, 2 or 3, **characterized in that** the voltage measuring means (11) is adapted to measure said first and second voltage levels consecutively at the same output terminal (10).

5. The controller of claim 1, 2 or 3, **characterized in that** the set comprises a plurality of output terminals (10_1, 10_2, ...), and that the output current (PWM1) at one of said output terminals (10_1) is phase shifted with respect to the output current (PWM2) at another one (10_2) of said terminals.

6. The controller of claim 5, **characterized in that** the voltage measuring means (11) is adapted to measure said first and second voltage levels (U_{ON}, U_{OFF}) simultaneously at two of said output terminals (10_1, 10_2).

7. A combustion engine comprising an engine block (2) having at least one cylinder (15) and a load (8) associated to said cylinder (15), a battery (1), and a controller (9) according to any of the preceding claims, wherein the battery (1), the load (8) and the controller (9) are connected to a common ground (3).

8. The combustion engine of claim 7, **characterized in that** it is a Diesel engine and the load (8) is a glow plug.

9. A method of controlling a set of loads (8; 8_1, 8_2, ...), the set comprising at least one load (8; 8_1, 8_2, ...), the method comprising the steps of:

a) applying an intermittent current (PWM1, PWM2) to each load (8; 8_1, 8_2, ...) of said set;
b) measuring (S2) a first voltage level (U_{ON}) at a terminal (10; 10_1, 10_2, ...) of a load (8; 8_1, 8_2, ...) of said set during an ON period of its respective intermittent current (PWM1, PWM2);
c) measuring (S5) a second voltage level (U_{OFF}) at a terminal (10; 10_1, 10_2, ...) of a load (8; 8_1, 8_2, ...) of said set during an OFF period of its respective intermittent current;
d) estimating a mean power of at least one of said intermittent currents (PWM1, PWM2) based on said first and second voltage levels (U_{ON}, U_{OFF}):
e) controlling (S6) the duty factor (α) of said at least one intermittent current (PWM1, PWM2) so as to decrease a deviation between the estimated mean power and a target power.

10. A method of controlling a set of loads (8; 8_1, 8_2, ...), the set comprising at least one load (8; 8_1, 8_2, ...), the method comprising the steps of:

a) applying an intermittent current (PWM1, PWM2) to each load (8; 8_1, 8_2, ...) of said set;
b) measuring (S12) a difference (ΔU) between a first voltage level (U_{ON}) at a terminal (10; 10_1, 10_2, ...) of a load (8; 8_1, 8_2, ...) of said set during an ON period of its respective intermittent current (PWM1, PWM2) and a second voltage level (U_{OFF}) at a terminal (10; 10_1, 10_2, ...) of a load (8; 8_1, 8_2, ...) of said set during an OFF period of its respective intermittent current (PWM1, PWM2);
c) estimating a mean power of at least one of said intermittent currents (PWM1, PWM2) based on said difference (ΔU);
d) controlling (S14) the duty factor (α) of said at least one intermittent current (PWM1, PWM2) so as to decrease a deviation between the estimated mean power and a target power.

11. The method of claim 9 or 10, wherein the intermittent current (PWM1, PWM2) is a PWM current.

12. The method of claim 9, 10 or 11, wherein the first and second voltage levels (U_{ON}, U_{OFF}) are measured consecutively (S2, S5) at the same load (8).

13. The method of claim 9 or 10, wherein PWM currents (PWM1, PWM2) are applied at different phases to at least two loads (8_1, 8_2, ...) and the first and second voltage levels (U_{ON}, U_{OFF}) are measured simultaneously (S12) at said two loads (8_1, 8_2, ...).

14. The method of one of claims 9 to 13, wherein the set of loads is a set of glow plugs in a Diesel engine.

Amended claims in accordance with Rule 137(2) EPC.

1. A controller (9) for controlling electrical power supplied to one or more loads, comprising
a first supply terminal for connecting to a supply potential,
a second supply terminal (14) for connecting to a ground potential,
a set of a plurality output terminals (10_1, 10_2, ...) for connecting to a respective load (8_1, 8_2, ...),
a power supply circuit (12) for supplying a power-controlled intermittent current to each output terminal (10_1, 10_2, ...), a voltage measuring means (11) for measuring a first voltage level (U_{ON}) at an output terminal (10_1, 10_2, ...) of said set during an ON period of the intermittent current supplied to this terminal, and for measuring a second voltage level (U_{OFF}) at an output terminal (10_1, 10_2, ...) of said set during an OFF period of the intermittent current supplied to this terminal, or for measuring a difference (ΔU) between said first voltage level and said second voltage level and a power control means (13) for controlling the power of said intermittent current based said first and second voltage levels or said difference,
characterized in that the output current (PWM1) at one of said output terminals (10_1) is phase shifted

with respect to the output current (PWM2) at another one (10_2) of said output terminals.

2. The controller of claim 1, **characterized in that** the power supply circuit (12) is a PWM circuit (12), the intermittent current (PWM1) is a PWM current, and the power control means (13) controls a duty factor (α) of said PWM current.

3. The controller of claim 1 or 2, **characterized in that** the voltage measuring means (11) is adapted to measure said first and second voltage levels consecutively at the same output terminal (10).

4. The controller of claim 1 or 2, **characterized in that** the voltage measuring means (11) is adapted to measure said first and second voltage levels (U_{ON}, U_{OFF}) simultaneously at two of said output terminals (10_1, 10_2) .

5. A combustion engine comprising an engine block (2) having a plurality of cylinders (15_1, 15_2, ..., 15_n) and a load (8_1, 8n, ..., 8_n) associated to each cylinder (15_1, 15_2, ..., 15_n), a battery (1), and a controller (9) according to any of the preceding claims, wherein the battery (1), the loads (8_1, 8n, ..., 8_n) and the controller (9) are connected to a common ground (3).

6. The combustion engine of claim 5, **characterized in that** it is a Diesel engine and the loads (8_1, 8n, ..., 8_n) are glow plugs.

7. A method of controlling a set of loads (8_1, 8_2, ...), the set comprising a plurality of loads (8_1, 8_2, ...), the method comprising the steps of:

a) applying an intermittent current (PWM1, PWM2) to each load (8; 8_1, 8_2, ...) of said set;
b) measuring (S2) a first voltage level (U_{ON}) at a terminal (10_1, 10_2, ...) of a load (8_1, 8_2, ...) of said set during an ON period of its respective intermittent current (PWM1, PWM2) and measuring (S5) a second voltage level (U_{OFF}) at a terminal (10_1, 10_2, ...) of a load (8_1, 8_2, ...) of said set during an OFF period of its respective intermittent current, or measuring (S12) a difference (ΔU) between said first and second voltage levels;
d) estimating a mean power of at least one of said intermittent currents (PWM1, PWM2) based on said first and second voltage levels (U_{ON}, U_{OFF}) or on said difference (ΔU) ;
e) controlling (S6) the duty factor (α) of said at least one intermittent current (PWM1, PWM2) so as to decrease a deviation between the estimated mean power and a target power,

characterized in that the intermittent current (PWM1) applied to one of said loads (8_1) is phase shifted with respect to the intermittent current (PWM2) applied to another one (8_2)of said loads.

8. The method of claim 7, wherein the intermittent current (PWM1, PWM2) is a PWM current.

9. The method of claim 7 or 8, wherein the first and second voltage levels (U_{ON}, U_{OFF}) are measured consecutively (S2, S5) at the same load (8).

10. The method of claim 7 or 8, wherein the first and second voltage levels (U_{ON}, U_{OFF}) are measured simultaneously (S12) at said two loads (8_1, 8_2, ...) .

11. The method of one of claims 7 to 10, wherein the set of loads is a set of glow plugs in a Diesel engine.

Fig. 1

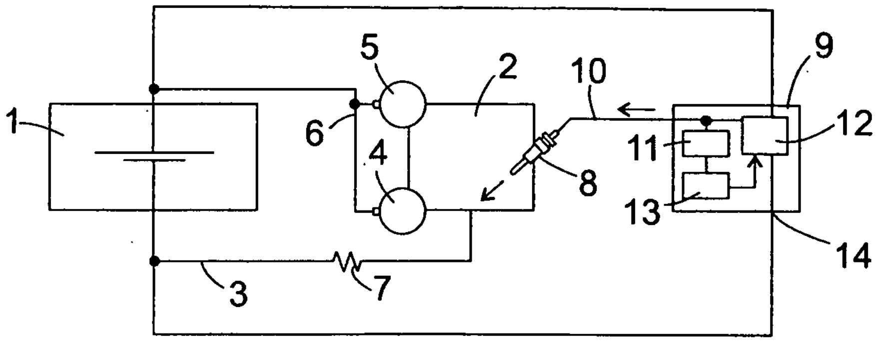


Fig. 2

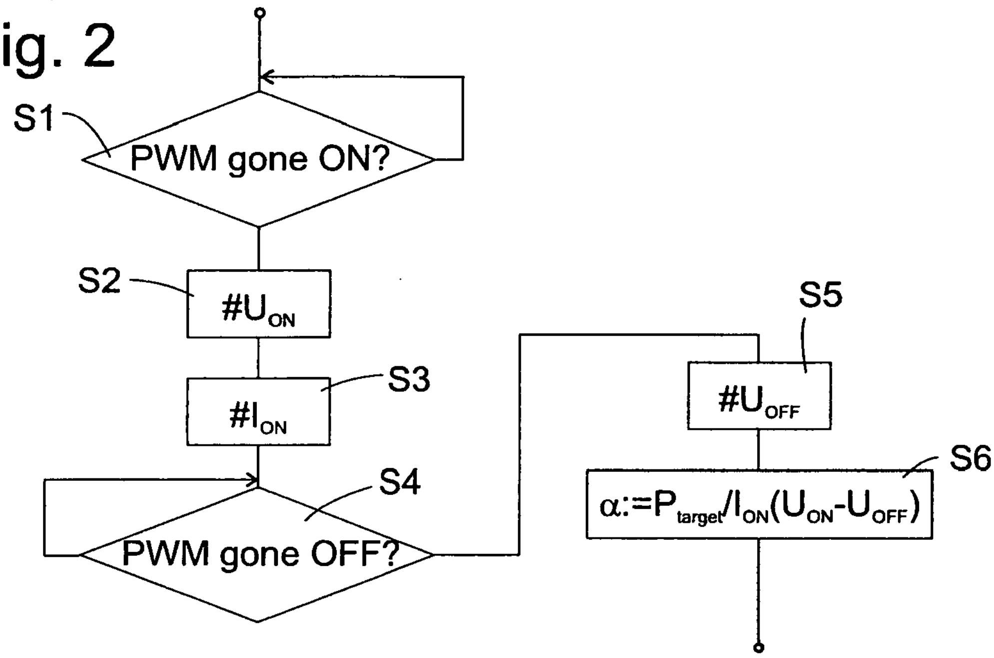


Fig. 3

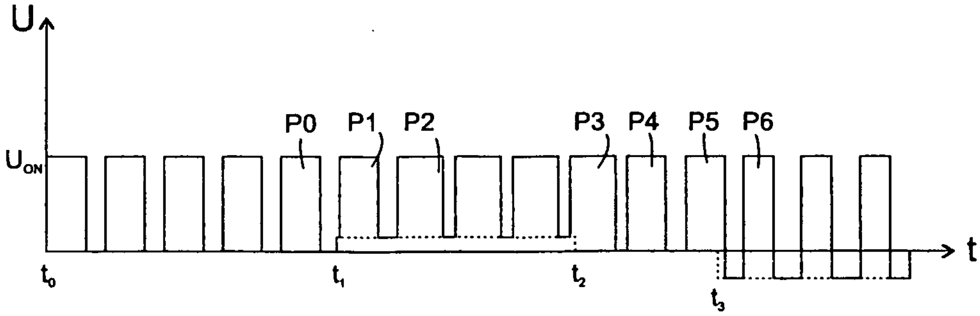


Fig. 4

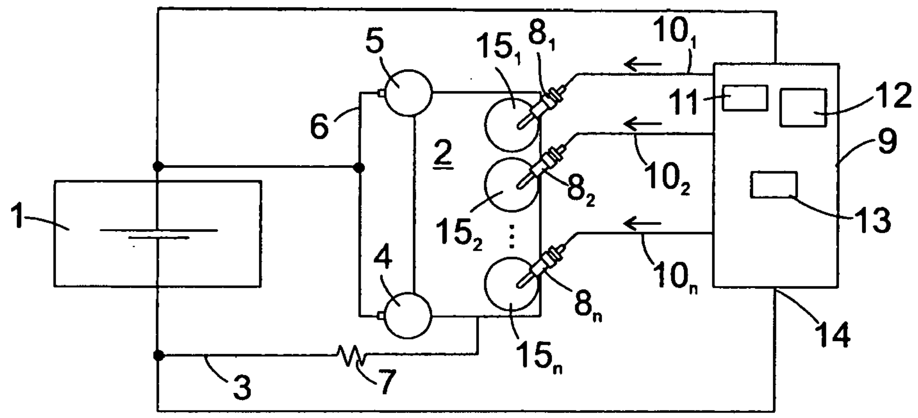


Fig. 5

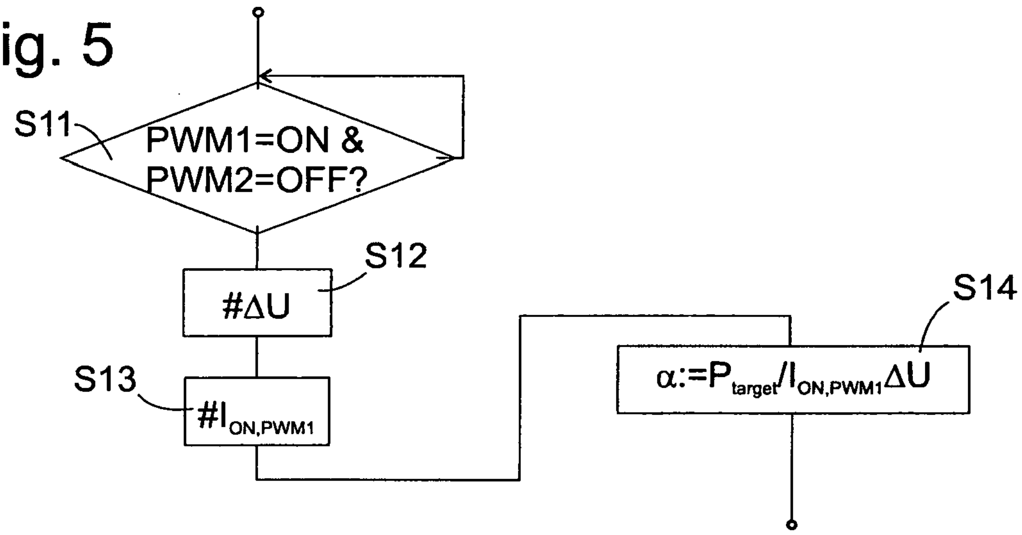
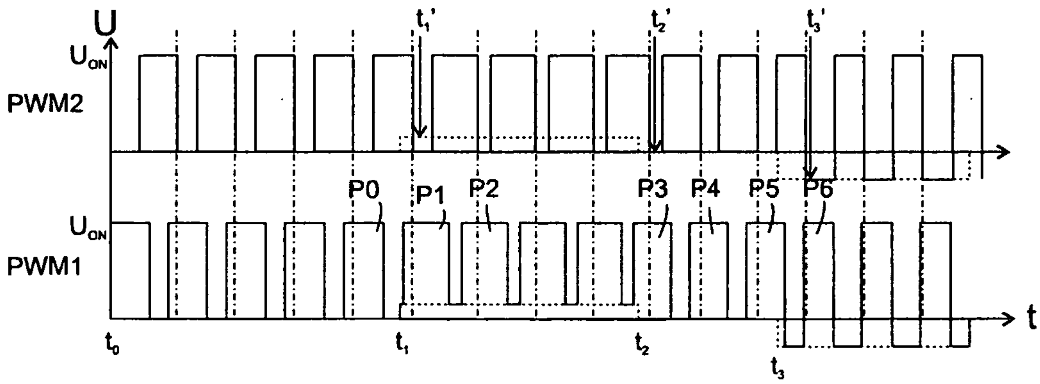


Fig. 6



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EUROPEAN SEARCH REPORT

Application Number
EP 06 02 6131

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 296 20 634 U1 (HELLA KG HUECK & CO [DE]) 6 February 1997 (1997-02-06) * the whole document * -----	1-14	INV. F02P19/02 H03K3/011 H03K3/015 H03K19/003
A	WO 2006/009523 A (COSYLAB D O O [SI]; SIMONCIC URBAN [SI]; GOLOB DAMJAN [SI]; KOVACIC RO) 26 January 2006 (2006-01-26) * the whole document * -----		

TECHNICAL FIELDS SEARCHED (IPC)

F02P
F02N
H03K
H05B
H02J
H02M

The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
The Hague	5 June 2007	Parmentier, Hélène

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