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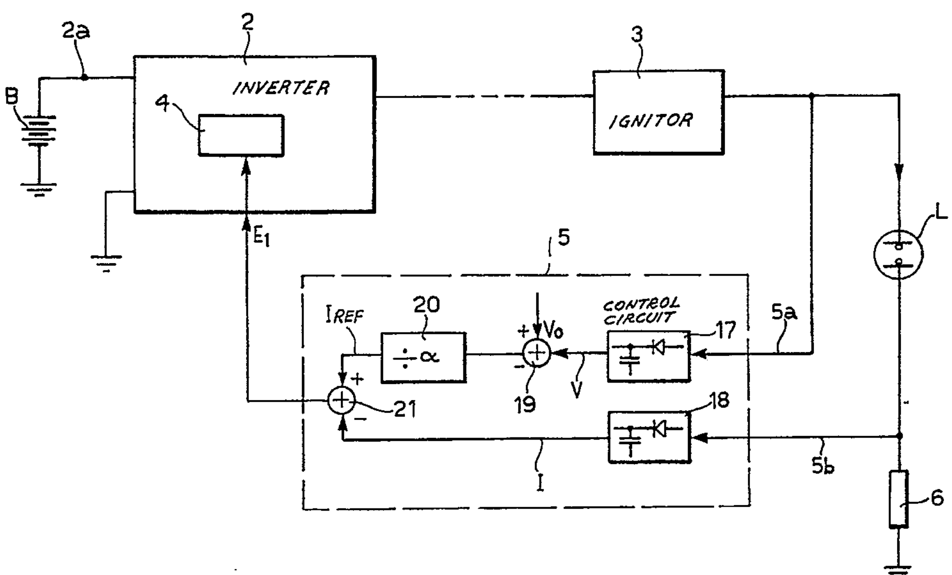
(54) A device for supplying power to gas-discharge lamps for use in motor vehicles.

(57) The device includes an inverter (2) with an input (2a) for connection to the battery (B) of the vehicle and an output (2b) for connection to a lamp (L) by means of an ignitor (3). The inverter (2) includes a regulator (4) which is adapted to modify a characteristic, for example the frequency, of the current supplied to the lamp (L) in operation.

The device also includes a feedback control circuit (5) for monitoring the electrical power supplied to the lamp (L) and for generating and supplying to the regulator (4) of the inverter (2) a signal for causing a substantially constant power to be supplied to the lamp (L).

FIG. 3



EP 0 429 402 A2

A DEVICE FOR SUPPLYING POWER TO GAS-DISCHARGE LAMPS FOR USE IN MOTOR VEHICLES

The present invention relates to a device for supplying power to gas-discharge lamps for use in a vehicle.

More specifically, the invention relates to a supply device comprising:
an inverter with an input for connection to the battery of the vehicle, and
an ignitor connected to the output of the inverter for connection to (at least) one gas-discharge lamp,
the inverter including a regulator which is adapted to modify a characteristic of the current supplied to the lamp in operation.

When used in a motor vehicle, this type of supply device cannot always ensure the correct supply to the lamp, particularly because of variations in the battery voltage, in the ambient temperature and in the voltage across the terminals of the lamp.

The object of the present invention is to provide a device for supplying power to gas-discharge lamps which can prevent these problems.

According to the invention, this object is achieved by means of a supply device of the type specified above, whose main characteristic lies in the fact that it also includes a feedback control circuit for monitoring the electrical power supplied to the at least one lamp in operation and for supplying the regulator of the inverter with a signal for causing a substantially constant power to be supplied to the at least one lamp.

Further characteristics and advantages of the invention will become clear from the detailed description which follows with reference to the appended drawings, provided purely by way of non-limiting example, in which:

Figure 1 is a diagram showing a device according to the invention for supplying gas-discharge lamps,
Figure 2 is a diagram similar to that of Figure 1, showing the structure of a feedback control circuit in greater detail, and
Figure 3 is a diagram similar to that of Figure 2, showing a variant of the feedback control circuit.

In Figure 1, a conventional device for supplying power to a gas-discharge lamp L is indicated 1. The supply device includes an inverter 2 with an input 2a for connection to the battery B of the vehicle and an output 2b connected to the lamp L by means of an ignitor 3 with a passive resonant L-C circuit of known type.

The inverter 2 includes, in known manner, a regulator 4 which is adapted to modify a characteristic (for example, the frequency and/or the duty-cycle) of the current supplied to the lamp L.

According to the invention, the supply device 1 is associated with a feedback control circuit, generally indicated 5, having two inputs 5a and 5b. The input 5a is connected to the output of the ignitor 3 to monitor the voltage supplied to the lamp L in operation. The input 5b is connected to a resistor 6 between the lamp L and earth to monitor the current I flowing in the lamp.

The output of the feedback control circuit 5 is connected to the regulator 4 of the inverter 2.

In use, as will become clearer from the following, the feedback control circuit 5 monitors the electrical power supplied to the lamp L and generates and supplies to the regulator 4 of the inverter a signal for causing a substantially constant power to be supplied to the lamp.

A first embodiment of the feedback control circuit 5 is shown in Figure 2 in which parts and elements already described above have again been given the same reference numerals.

In the embodiment of Figure 2, the circuit 5 includes an attenuator 7 and an amplifier 8 which receive signals indicative of the voltage applied to the lamp L and of the current flowing through the lamp, respectively. The outputs of the attenuator 7 and the amplifier 8 are connected to an analog multiplier 9 which thus outputs a signal proportional to the power supplied to the lamp.

The signal output by the analog multiplier 9 passes through a filter 10 which, essentially, performs an averaging operation and outputs a signal indicative of the average power supplied to the lamp. This signal reaches a comparison circuit 11 which is formed, for example, with the use of an operational amplifier and outputs an error signal E_p indicative of the difference between the signal from the filter 10 and a predetermined constant reference, indicated k. The error signal E_p is supplied, after amplification at 12, to the input of the regulator 4 of the inverter 2.

Although its concept is quite simple, the embodiment shown in Figure 2 requires the use of an analog multiplier circuit and, as is well known, these are quite complicated and problematical.

A variant which is simpler but nevertheless accurate and reliable in operation is shown in Figure 3.

The embodiment shown in Figure 3 is based on the following considerations.

Generally, in a cartesian representation (first quadrant) in which the voltage V is shown on the ordinate and the current I on the abscissa, a curve of the loci of the points at which the power P (P = $_{V\,I}$) is constant is a hyperbola which descends as the current increases. At least within a narrow range of voltage and current values, this curve can be approximated by a straight line with a negative slope and hence having an equation of the type:

$V = -\alpha I + V_0 \quad \alpha > 0, V_0 > 0 \qquad (1)$

This equation can also be written in this form:

$$I = \frac{-V+V_0}{\alpha} \qquad (2)$$

As will now be seen, the feedback control circuit 5 of Figure 3 puts Equation (2) above into practice.

In Figure 3, the circuit 5 includes two peak detectors 17 and 18 which output respective signals indicative of the peak values of the voltage supplied to the lamp L and of the current flowing through the lamp, respectively. These peak values will simply be indicated V and I respectively.

The output of the peak detector 17 is connected to an adder circuit 19 which adds algebraically a constant positive voltage V_0 to the voltage -V.

The output of the adder circuit 19 is connected to an attenuator circuit 20 which in fact reduces the amplitude of the signal received by a constant factor. The attenuator 20 therefore has an output signal, indicated I_{REF}, given by the equation:

$$I_{REF} = \frac{-V+V_0}{\alpha}$$

which is just like Equation (2) above.

The signal $I_{REF}$is thus indicative of the level at which the current in the lamp L must be maintained in order to ensure that the power supplied to the lamp is kept constant. Obviously, this is true within the limits of the linear approximation described above.

The attenuator circuit 20 and the peak detector 18 are connected to a comparison circuit 21 which adds algebraically the signals supplied to it and outputs an error signal E_I indicative of the difference between the current I actually flowing through the lamp L and the current I_{REF} necessary to keep the power supplied to the lamp constant.

As stated above, the feedback control circuit 5 of Figure 3 is a simpler circuit which can nevertheless operate reliably and with sufficient accuracy.

Claims

1. A device for supplying power to gas-discharge lamps (L) for use in a vehicle, comprising:
an inverter (2) with an input (2a) for connection to the battery (B) of the vehicle, and
an ignitor (3) connected to the output (2b) of the inverter (2) for connection to at least one gas-discharge lamp (L),
the inverter (2) including a regulator (4) which is adapted to modify a characteristic of the current supplied to the lamp in operation,
characterised in that it also includes a feedback control circuit (5) for monitoring the electrical power supplied to the at least one lamp (L) in operation and for supplying the regulator (4) of the inverter with a signal (E_P; E_I) for causing a substantially constant power to be supplied by the inverter (2) to the at least one lamp (L).

2. A device according to Claim 1, characterised in that the feedback control circuit (5) has
a first input (5a) for connection to the ignitor (3) for monitoring the voltage supplied to the at least one lamp (L) in operation,
a second input (5b) connected to a resistor (6) which is intended to be connected in series with the at least

one lamp (L), for monitoring the current flowing through the at least one lamp in operation, and

means (7-11; 17-21) for processing the signals supplied to the first and second inputs (5a, 5b) in operation and adapted to generate an error signal (E_P; E_I) indicative of the extent to which the power supplied to the at least one lamp (L) differs from a predetermined value, the error signal (E_p; E_I) being supplied to the regulator (4) of the inverter (2).

3. A device according to Claim 2, characterised in that the signal-processing means comprise:

an analog multiplier (9) adapted to output a signal indicative of the product of the signals applied to the first and second inputs (5a, 5b),

a filter (10) adapted to output a signal indicative of an average value of the signal output by the multiplier (9), and

a comparison circuit (11) adapted to output an error signal (E_C) indicative of the difference between the signal output by the filter (10) and a predetermined reference (k).

4. A device according to Claim 2, characterised in that the signal-processing means comprise:

first and second peak detectors (17, 18) connected to the first and second inputs (5a, 5b) respectively, and

a processing circuit (19-21) adapted to output a signal (E_I) proportional to a predetermined linear combination of the signals supplied by the first and second peak detectors (17, 18).

5. A device according to Claim 4, characterised in that the processing circuit comprises:

an adder circuit (19) adapted algebraically to add a signal (V_0) of predetermined fixed amplitude to the signal output by the first peak detector (17),

an attenuator circuit (20) connected to the output of the adder circuit (19), and

a comparison circuit (21) adapted algebraically to add the signal output by the attenuator circuit (20) and the signal output by the second peak detector (18) and to output an error signal (E_I) indicative of the difference between the signals.

FIG. 1

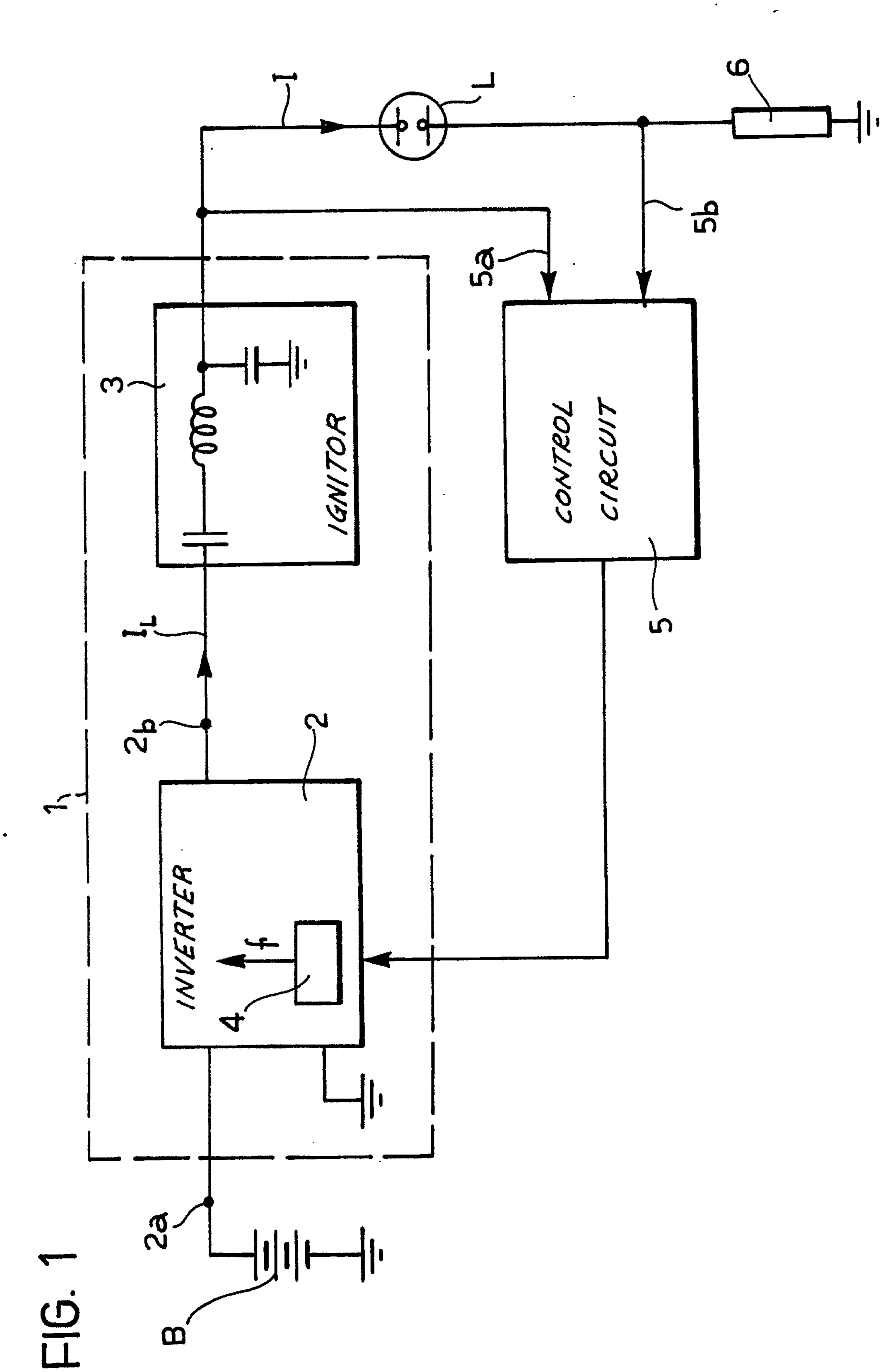
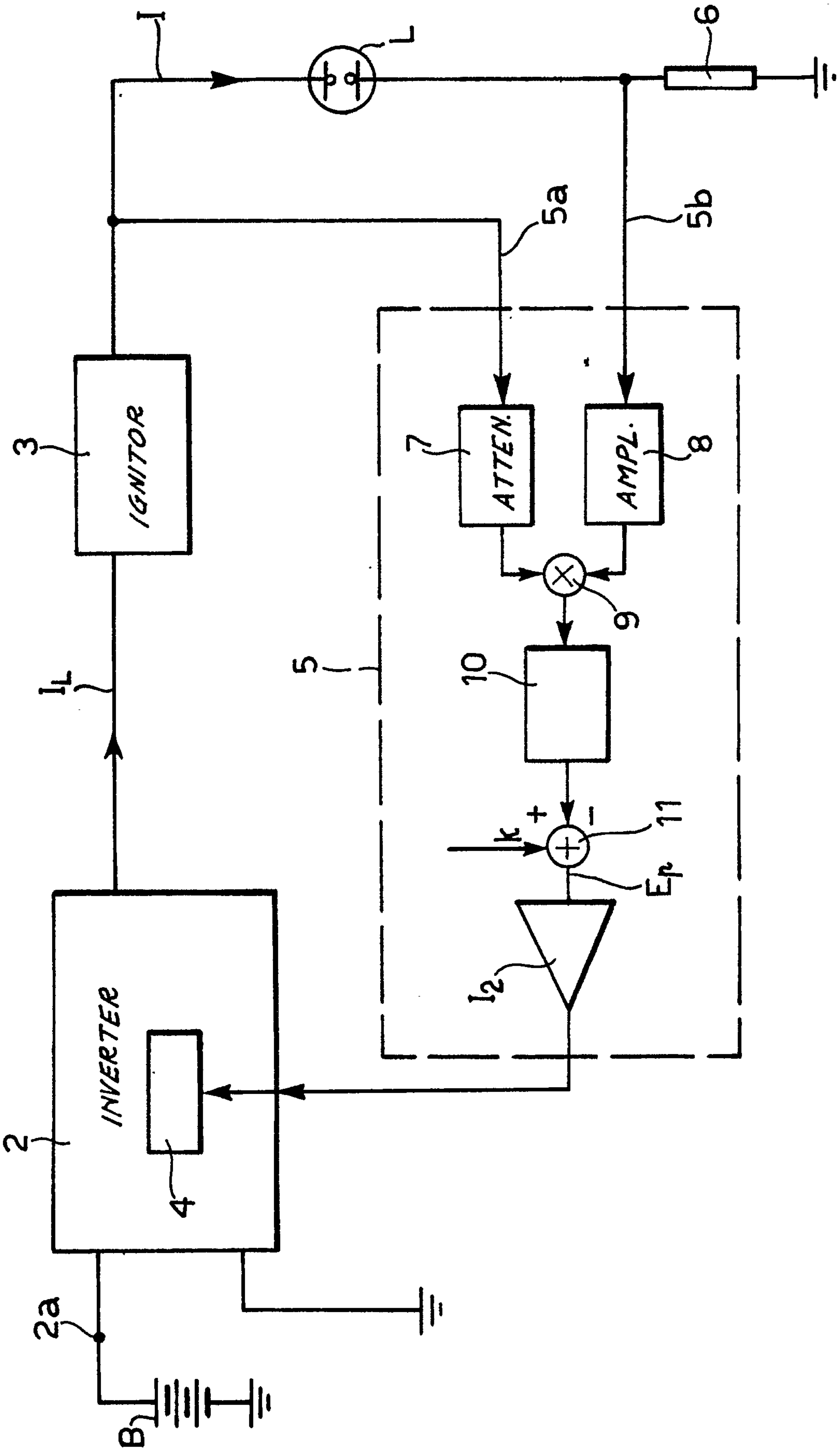


FIG. 2


I
L
6
5a
5b
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IGNITOR
7
ATTEN.
AMPL.
8
9
10
5
I_L
k
+
-
11
E_r
12
INVERTER
2
4
2a
B

FIG. 3