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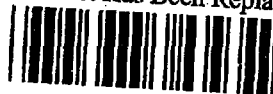
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Circuit arrangement.

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The invention relates to a circuit arrangement for operating a high-pressure discharge lamp with which the high-pressure discharge lamp supplies a luminous flux of at least 60% of the nominal luminous flux 1 s after ignition already, which circuit arrangement comprises

- 5 - a static converter for generating a DC voltage,
- a commutator provided with lamp connection terminals,
- means A for current stabilization during stable lamp operation through controlling of the static converter,
- means B for operating the lamp with an increased run-up current and an
- 10 increased power as compared with nominal operation on the basis of an instantaneous lamp voltage signal.

A circuit arrangement of the kind mentioned in the opening paragraph is
15 known *inter alia* from EP-A-443795.

Important types of high-pressure discharge lamps are high-pressure sodium lamps, high-pressure mercury lamps and metal halide lamps. A comparatively high luminous flux immediately after switching-on of the lamp is required especially when a high-pressure discharge lamp serves as a motorcar headlamp. Metal halide
20 lamps whose discharge vessels contain *inter alia* Xe are particularly suitable for motorcar headlamp applications.

A disadvantage of the known arrangement is that the luminous flux of the lamp after ignition in the case of a cold start exhibits a considerable fluctuation during the run-up of the lamp to a stable operating condition. This fluctuation may amount to
25 more than half the nominal luminous flux under certain circumstances. The occurrence of such a major luminous flux fluctuation is unpleasant both for the user and for the other road users, and may even lead to hazardous traffic situations.

The nominal lamp voltage often lies between 60 and 110 V in practice.

This depends to a high degree on the lamp manufacturing technology.

A reduction of the nominal lamp voltage, all other circumstances remaining the same, will lead to an increase in the nominal current, which results in a rise in ohmic losses.

- 5 The choice of a higher lamp voltage, all other circumstances remaining the same, in general leads to a greater electrode spacing. This is undesirable particularly for reflector lamps, as in the case of motorcar headlamp systems, because the formation of the illumination beam depends to a high degree on the dimension of the light source, *i.e.* the discharge path between the electrodes of the discharge lamp.

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It is an object of the invention to restrict the occurrence of a fluctuation in the luminous flux to a considerable degree, while maintaining a lumen output of 60% of the nominal value one second after ignition of the cold lamp.

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- A circuit arrangement according to the invention is for this purpose characterized in that the circuit arrangement comprises means C such that the operation at the increased power comprises at least a portion for connection to and transition to
20 nominal operation, which portion has a falling characteristic with a time constant independent of lamp voltage. It was surprisingly found to be possible to counteract luminous flux fluctuations to a considerable degree by having the final portion of the run-up take place by means of a falling characteristic with a time constant independent of lamp voltage. The choice of the moment may be determined, for example,
25 empirically. Preferably, this moment is determined by the circumstance that the instantaneous lamp voltage reaches a preset limit value.

- It was experimentally found that the achievement of a lamp voltage of approximately half the nominal value is a suitable limit value. It is preferable, accordingly, to cause the increased power to fall in accordance with the falling
30 characteristic with a time constant independent of lamp voltage from the moment this lamp voltage is reached. Preferably, the means C comprise a timer circuit for realising a fixed time constant as the lamp voltage independent time constant. Further improvement is possible in that the means C are provided with two timer circuits with

mutually differing fixed time constants.

These and other aspects of the invention will be explained in more detail with reference to a drawing in which

Fig. 1 is a diagram of a circuit arrangement according to the invention,

5 Fig. 2a shows a portion of the circuit arrangement of Fig. 1 in more detail,

Figs. 2b and 2c show modifications of a portion of the circuit arrangement of Fig. 2a,

10 Fig. 3 is a graph showing the lamp current and lamp voltage as a function of time for a lamp operated on the circuit arrangement of Fig. 1, and

Fig. 4 is a graph showing the luminous flux as a function of time accompanying the lamp current and lamp voltage of Fig. 3.

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15 In Fig. 1, reference numerals 1 and 2 denote terminals for connecting the circuit arrangement to a supply source. In the embodiment shown, a battery 3 acts as the supply source. A static converter 4 is shown, serving to generate a DC voltage which is subsequently applied to a commutator 5. The commutator 5 is provided with lamp connection terminals 6, 7 between which a high-pressure discharge lamp 8 is
20 connected.

The circuit arrangement is also provided with means A, indicated with I in the Figure, for current stabilization during stable lamp operation through controlling of the static converter. II denotes means B for operating the lamp at an increased current and increased power on the basis of an instantaneous lamp voltage signal.
25 Finally, III denotes means C which ensure that during the run-up of the lamp the operation at increased power comprises at least a portion for connection to and transition to nominal operation with a falling characteristic and a time constant independent of lamp voltage.

A portion of the diagram comprising the means A, B and C of a practical
30 embodiment is depicted in more detail in Fig. 2a. VIa and IIa denote signal connection points of the means A, further denoted I, which carry an instantaneous lamp voltage signal and an instantaneous lamp current signal, respectively. A signal representing an instantaneous lamp power is derived from these signals at 10 and subsequently

compared with a reference signal V_{ref} at 11, the outcome serving as a control signal S for controlling the static converter.

The signal representing the instantaneous lamp power may be formed in that the signals V_{la} and I_{la} are multiplied. This provides an accurate representation of the power, however, it does require a comparatively complicated circuit.

A fair approximation of the lamp power is obtained by summation of the signals V_{la} and I_{la} . Such an approach has been found to be very suitable in practice for lamp stabilization control and can be realised, for example, by means of a simple resistance network.

To achieve that the connected high-pressure discharge lamp supplies a luminous flux of at least 60% of the nominal luminous flux after 1 s, facilities are provided for operating the lamp temporarily with an increased current, called run-up current, and an increased power compared with nominal operation. For this purpose, the lamp voltage signal V_{la} in the embodiment described is also connected via an impedance 21 to a comparison circuit 22 in which the instantaneous lamp voltage signal is compared with a reference value $V_{la_{ref}}$. The outcome of this comparison is subsequently deducted from the signal representing the instantaneous lamp power formed at 10 by means of a summation circuit 23.

II is also provided with means D for automatic adaptation of the run-up of the lamp in the case of ignition after a short interruption. For this purpose, II is provided with a capacitor 24 which together with the ohmic impedance 21 acts as a low-pass filter during the lamp run-up after ignition in the cold state. The voltage across the capacitor 24, accordingly, accurately follows the change in the lamp voltage signal V_{la} during the run-up.

The capacitor 24 also forms part of a discharging circuit 200 in which the discharging time of the capacitor 24 is a measure for the degree of cooling-down of the connected lamp after the supply of the lamp has been disconnected.

When the lamp is restarted after a short interruption, on the one hand the voltage across the capacitor 24 will have fallen, while on the other hand the lamp voltage signal V_{la} abruptly rises to a comparatively high value. The low-pass filter characteristic of the combination of ohmic impedance 21 and capacitor 24 results in that the lamp voltage signal V_{la} causes a comparatively large charging current to flow through the ohmic resistance 21 to the capacitor 24. This means that a reduced voltage



as compared with the instantaneous value of the lamp voltage signal V_L will be applied to the input of the comparison circuit 22. It is achieved by this that the run-up function is automatically corrected relative to a run-up from the cold state after re-ignition in the case of a short interruption of the supply to the lamp. The signal coming from the
5 comparison circuit 22 is deducted from the power signal at 23, after which this power signal is compared with a reference value V_{ref} .

According to the invention, means C, indicated with III in the drawing, are also provided such that the operation at the increased power comprises a portion for connection to and transition to nominal operation which has a falling characteristic with
10 a fixed time constant as a lamp voltage independent time constant. For this purpose, a timer circuit is included in the embodiment described, formed by resistors 30, 31 and a capacitor 32, which timer circuit is so connected in the circuit that the signal coming from the comparison circuit 22 is blocked the moment this has fallen to a preset threshold value. The timer circuit then supplies a signal which is a function of the
15 discharging current of the relevant capacitor 32 only. It is achieved by this that the signal has a falling characteristic with a fixed time constant. To ensure that the signal determined by the timer circuit is carried during the run-up of the lamp only, i.e. those conditions when considerable light fluctuations are in danger of occurring, charging of the relevant capacitor 32 takes place through the signal coming from the comparison
20 circuit 22. To limit the voltage across capacitor 32, and thus the nominal duration of the portion of the falling characteristic having the fixed time constant, the capacitive means 32 are shunted by zener diode means 33.

In a modification of the embodiment described, a further improvement is realised in that III is provided with two timer circuits with mutually differing fixed time
25 constants. This is shown in Fig. 2b. Compared with the timer circuit shown in Fig. 2a, the resistor 30 is here replaced by a resistor network formed by resistors 301 and 302 and a diode 303. The one timer circuit with the first fixed time constant is formed by the discharging circuit 32, 31, 301, 303. When the voltage at point 304 has fallen so far that the voltage across diode 303 is equal to the voltage drop caused by its internal
30 impedance, the second timer circuit with the second fixed time constant becomes active, which timer circuit is formed by the discharging circuit 32, 31, 301, 302.

Another modification of the embodiment described is shown in Fig. 2c and comprises instead of a zener diode 33 a transistor circuit 330 in series with a diode



331 for reducing losses in the circuit arrangement.

Time averaging also takes place in the comparison circuit 22 in the embodiment described for achieving stability of the control circuit. Time averaging also takes place in the comparison step at 11 for forming the control signal S for controlling
5 the static converter.

It is favourable for discharge lamp life to operate the lamp at a negative polarity relative to earth. To form the signal representing the power, a polarity change of V_{la} is provided in this connection in the embodiment described.

A practical realisation of the circuit arrangement as described with
10 reference to the Figure was used for operating a 35 W high-pressure discharge lamp which contains in addition to Hg also Xe and metal halides. The nominal lamp voltage is approximately 90 V and the nominal lamp current approximately 0.4 A. A 12 V battery served as the supply source.

Fig. 3 shows the run-up of the lamp voltage (curve 100) and lamp current
15 (curve 101) upon ignition from the cold state.

Fig. 4 shows the measured luminous flux (curve 102) on the same time base as used in Fig. 3. For comparison, a curve 103 in Fig. 4 shows the measured luminous flux in the case in which the circuit arrangement is not provided with means
C.

20 The transition to the falling characteristic with fixed time constant takes place at moment X.

A comparison of the luminous flux indicated by curve 102 with that indicated by curve 103 renders it clear that after the moment X the luminous flux exhibits a much smaller fluctuation when the lamp is operated on the circuit
25 arrangement according to the invention than when the lamp is operated on a circuit arrangement according to the present state of the art. Curves 200 and 201 in Fig. 4 indicate the maximum and minimum values, respectively, for the luminous flux as allowed by the SAE standard.



Claims:

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1. A circuit arrangement for operating a high-pressure discharge lamp with which the high-pressure discharge lamp supplies a luminous flux of at least 60% of the nominal luminous flux 1 s after ignition already, which circuit arrangement comprises
 - a static converter for generating a DC voltage,
 - 5 - a commutator provided with lamp connection terminals,
 - means A for current stabilization during stable lamp operation through controlling of the static converter,
 - means B for operating the lamp with an increased run-up current and an increased power as compared with nominal operation on the basis of an
 - 10 instantaneous lamp voltage signal,
- characterized in that the circuit arrangement comprises means C such that the operation at the increased power comprises at least a portion for connection to and transition to nominal operation, which portion has a falling characteristic with a time constant independent of lamp voltage.
- 15 2. A circuit arrangement as claimed in Claim 1, characterized in that the transition to the portion of the falling characteristic with lamp voltage independent time constant takes place when the instantaneous lamp voltage reaches half the nominal lamp voltage value.
 3. A circuit arrangement as claimed in Claim 1 or 2, characterized in that
 - 20 the means C comprise an RC circuit for realising a fixed time constant as the time constant which is independent of lamp voltage.
 4. A circuit arrangement as claimed in Claim 1, 2 or 3, characterized in that a signal representing an instantaneous lamp power is realised by summation of a signal representing the instantaneous lamp voltage and a signal representing the instantaneous
 - 25 lamp current.
 5. A circuit arrangement as claimed in Claim 1, 2, 3 or 4, characterized in that also means D are present for automatic adaptation of the run-up phase of the lamp in the case of ignition after a short interruption.