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[54] **GAS DISCHARGE LIGHTING ARRANGEMENT WITH REVERSIBLE ION SUPPLY**

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[58] **Field of Search** ..... 315/108, 109, 200 R, 205

[56] **References Cited**

UNITED STATES PATENTS

1,010,197	11/1911	Snook et al.	315/109 X
1,746,670	2/1930	Meyer	315/109
1,914,883	6/1933	Cottrell	315/108

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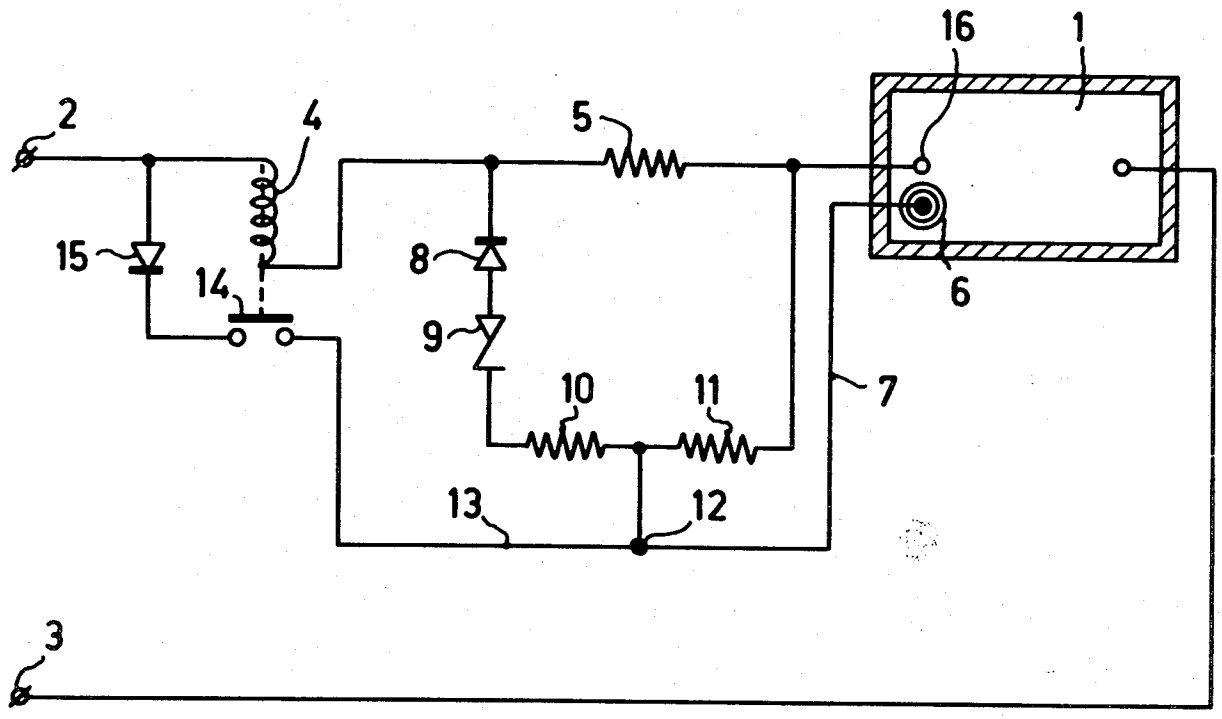
[57] **ABSTRACT**

An electric discharge lamp with an ion reservoir to which a DC voltage of reversible polarity is applied so that the gas pressure within the lamp can be easily increased or decreased. By using several ionizable materials in the lamp, the color of the emitted light can be changed by adding or removing one of said materials.

14 Claims, 1 Drawing Figure



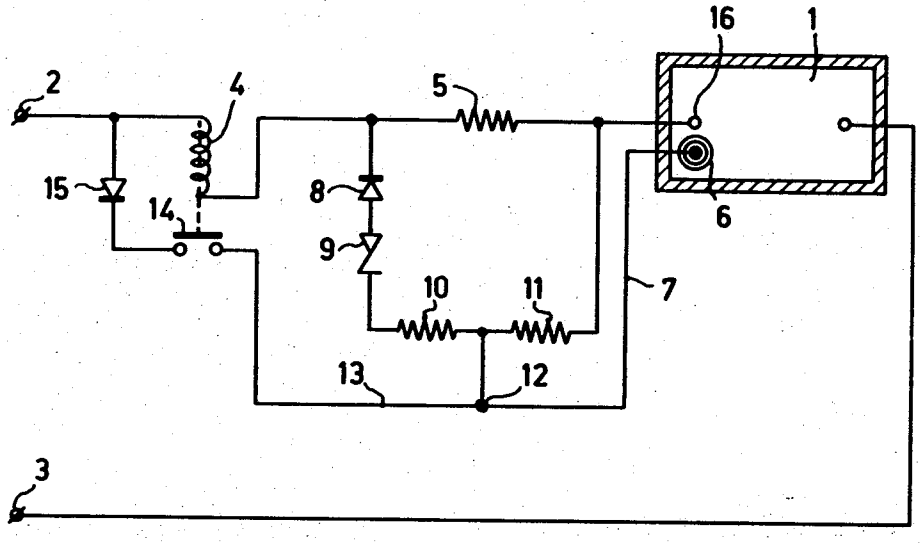


Fig.1

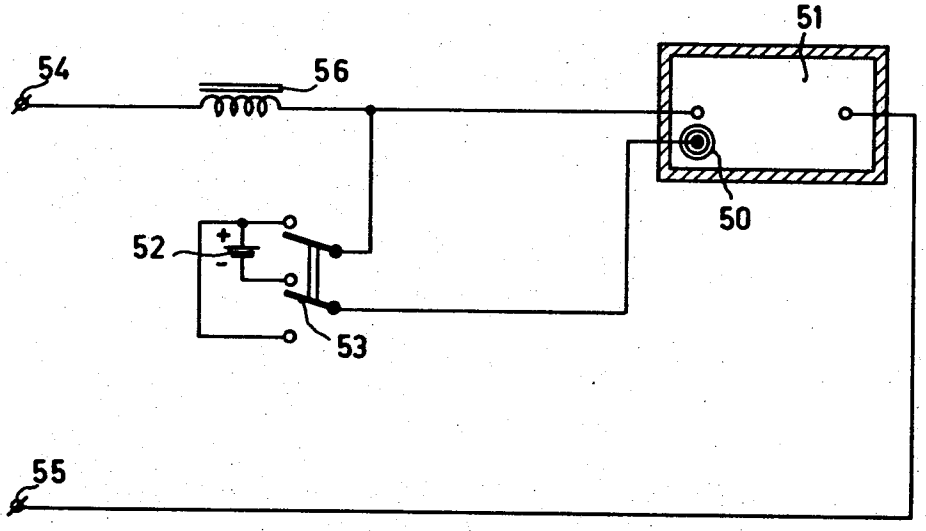


Fig.2

GAS DISCHARGE LIGHTING ARRANGEMENT WITH REVERSIBLE ION SUPPLY

The invention relates to an arrangement provided with a gas and/or vapour discharge lamp including a discharge space, which arrangement has two input terminals intended to be connected to a voltage source, the arrangement serving for supplying the discharge lamp. A reservoir in communication with the discharge space a present for producing ions of a material participating in the discharge in the discharge space. In the operating condition of the lamp is substantially exclusively heated by the discharge in the discharge space, the ions produced in the reservoir being transported by means of an auxiliary direct voltage between the reservoir and the discharge space, i.e. from the reservoir to the discharge space. The invention also relates to a lamp which is particularly suitable for an arrangement of the kind described.

A known arrangement of the above-mentioned type is described, for example, in United Kingdom Patent No. 880,319.

A drawback of this known arrangement is that the ions are transported in one direction only, namely from the reservoir to the discharge space. This means that a shortage of ions in the discharge space can be replenished but an excessive quantity cannot be reduced.

An object of the invention is to be able to both increase and reduce the quantity of a material in the lamp discharge space in a simple manner.

According to the invention an arrangement provided with a gas and/or vapour discharge lamp having a discharge space, which arrangement has two input terminals intended to be connected to a voltage source and which arrangement serves for supplying the discharge lamp, includes a reservoir in communication with the discharge space for producing ions of a material participating in the discharge in the discharge space. In the operating condition of the lamp the reservoir is substantially exclusively heated by the discharge in the discharge space, the ions produced in the reservoir being transported by means of an auxiliary direct voltage between the reservoir and the discharge space from said reservoir to the discharge space, characterized in that the arrangement is provided with means to reverse the polarity of the auxiliary direct voltage so that ions can then be withdrawn from the discharge space.

An advantage of the arrangement according to the invention is that the quantity of a material participating in the discharge not only can be increased, but also can be reduced with the aid of the auxiliary direct voltage. As a result the pressure (of this material) in the discharge space can also be entirely controlled by means of this auxiliary direct voltage during operation of the lamp.

It is true that the reversal of a direct voltage which is applied between an auxiliary reservoir and a discharge space is known per se in an arrangement already described, but in this arrangement as described, for example, in U.S. Pat. No. 1,908,650 heat in the reservoir is always evolved by a source other than that of the main discharge between the electrodes. Said U.S. patent therefore only refers to a transport of particles from the reservoir to the discharge space, but not in the reverse direction. As is apparent from the aforesaid patent it is even a problem to reduce the quantity of this material when this quantity has become too large in the discharge space.

In an arrangement according to the invention the application of the auxiliary direct voltage would, without further steps, only exert an influence on the discharge in the discharge space for a short time if the discharge space were entirely in free communication with the interior of the reservoir. In fact, as soon as the ions withdrawn from the discharge space are neutralized in the reservoir, they would have no preference to stay in the reservoir.

In a preferred embodiment according to the invention in which the auxiliary direct voltage is present between the discharge space on the one hand and an electrical conductor in the reservoir on the other hand, there are successively provided an electrolyte and a wall which is permeable to the ions but not to the electrolyte between the said electrical conductor and the discharge space.

An advantage of this preferred embodiment is that the ions withdrawn from the discharge space are taken up in the electrolyte after they have passed through said wall and therefore cannot return through the wall to the discharge space. Thus it is achieved that due to a direct voltage being active for some time between the discharge space and the conductor in the reservoir in such a manner that the conductor is negative relative to the discharge space a plurality of ions are withdrawn from the discharge space which do not return to the discharge space when the said direct voltage is switched off.

The reservoir of an arrangement according to the invention may be present, for example, on the outer side of the discharge space of the lamp.

In an advantageous embodiment according to the invention the reservoir is formed as a capsule present in the discharge space.

An advantage of this preferred embodiment is that the discharge tube can be formed in known manner while the said capsule is to be introduced only during manufacture. The capsule is of course to be provided with an electrical connection for the application of the relevant reversible auxiliary direct voltage.

An arrangement according to the invention may be used, for example, to increase or decrease the luminosity of the lamp. This means that the auxiliary direct voltage is then used as a dimming arrangement.

In an advantageous embodiment according to the invention in which the lamp has a positive voltage-current characteristic in at least a given voltage range, means are present for automatically adjusting the polarity of the auxiliary direct voltage as a function of the value of the lamp current.

An advantage of this arrangement is that the possibility of the positive voltage current characteristic of the lamp extending beyond the said voltage range is automatically avoided with the aid of the auxiliary direct voltage. Said preferred embodiment is therefore particularly suitable for controlling a lamp having such a positive voltage-current characteristic.

One material, for example, sodium, may be present in the discharge space of a lamp according to the invention either alone or in combination with a rare gas for the ignition of this lamp.

In a further preferred embodiment according to the invention in which ions of more than one material par-

ticipate in the discharge in the lamp, the wall between the electrolyte and the discharge space is impermeable to at least the ions of one of these materials participating in the discharge.

An advantage of this preferred embodiment according to the invention is that the colour of the emitted radiation can be varied therein with the aid of the auxiliary direct voltage. In fact, a material may be either withdrawn from the discharge or added thereto by applying the auxiliary direct voltage so that the colour of the emitted radiation may undergo a variation.

A lamp according to the invention may be, for example, a high-pressure or low-pressure discharge lamp.

The materials participating in the discharge may be gases, for example, neon, argon etc. or metals, for example, sodium, potassium, etc.

In an advantageous embodiment according to the invention the discharge space contains sodium and at least the wall between the electrolyte and the discharge space consists of β -aluminium oxide.

β-aluminium oxide is understood to mean in the literature $Na_2O.\ 11\ Al_2O_3$.

An advantage of the latter preferred embodiment is that the partition of β -aluminium oxide is substantially not attacked by the transport of sodium ions, whereas this is the case for many types of glass. Particularly an embodiment in which the reservoir is formed as a capsule and the wall of this capsule consists of β -aluminium oxide is quite advantageous.

The electrolyte may consist of, for example, a salt of a metal whose ions participate in the discharge in the discharge space. For a low-pressure sodium vapour discharge lamp the electrolyte is preferably sodium fluoride. An advantage of the electrolyte according to this preferred embodiment is its thermal and chemical stability.

The invention will be further described with reference to the accompaying drawing in which:

FIG. 1 diagrammatically shows an arrangement according to the invention; and

FIG. 2 diagrammatically shows a second arrangement according to the invention.

In the arrangement of FIG. 1, reference numeral 1 denotes a low-pressure discharge lamp which has a positive voltage-current characteristic in a given voltage range. Input terminals 2 and 3 are intended to be connected to an alternating voltage source of 220 Volt, 50 Hz. The terminal 2 is connected through a series arrangement of a relay coil 4, a resistor 5 and the discharge lamp 1 to the input terminal 3. Reference numeral 6 denotes a capsule present in the discharge space of the lamp 1 and having a wall of β -aluminium oxide. The capsule is connected to an insulated electrical conductor 7. The capsule accommodates an electrolyte consisting of sodium fluoride. In another embodiment the capsule 6 might alternatively accommodate pure sodium.

The connection of the conductor 7 is as follows: The junction between the resistor 5 and the coil 4 is connected through a diode 8 and a series arrangement of a zener diode 9 and two resistors 10 and 11 to a junction between the resistor 5 and the discharge lamp 1. The previously mentioned conductor 7 is connected to the junction 12 between the resistors 10 and 11. The junction 12 of the conductor 7 is connected to terminal 2 through a conductor 13, a contact 14 of relay coil 4 and a diode 15.

When the terminals 2 and 3 are connected to the said alternating voltage of 220 Volt, 50 Hz, the discharge lamp 1 starts to operate. The resistor 5 does not function primarily as a stabilizing ballast for the lamp 1 because the lamp normally operates in its positive voltage-current characteristic range. If for some reason or other the current intensity in the lamp 1 should increase to a very high extent, the voltage drop across the resistor 5 will increase to such an extent that the zener diode 9 breaks down. Then a current will start to flow through the circuit 3, 1, 11, 10, 9, 8, 4, 2. This auxiliary current will cause the voltage across the capsule 6, which voltage is equal to the voltage between the resistors 11 and 10, to acquire a negative value relative to the electrode 16 if the terminal 3 is positive relative to the terminal 2. As a result sodium ions in the main discharge of the lamp 1 are attracted towards the capsule 6, that is to say, these ions are withdrawn from the main discharge, pass through the β -aluminium oxide wall of the capsule and are taken up in the sodium fluoride electrolyte of the capsule. By withdrawing ions from the main discharge, the current intensity in the main discharge of the lamp 1 decreases so that at a given instant the auxiliary circuit 11, 10, 9, 8 is rendered inoperative and the lamp continues to operate in a normal manner. The auxiliary arrangement 15, 4, 14, 13, 7 is used to ensure that further sodium ions are transferred from the capsule 6 to the discharge space of the lamp 1 when the current intensity through the lamp 1 drops below a given threshold value. In fact, when the effective current intensity through the coil 4 of the relay drops below a given value, the contact 14 is closed so that, due to the diode 15 (in those half periods when the input terminal 2 is positive relative to the terminal 3) the capsule has a mean positive value relative to the electrode 16. Of course, the electrical voltage between the capsule 6 and the electrode 16 must be sufficiently high to free sodium ions from the sodium fluoride.

In further embodiment (see FIG. 2) in which a capsule 50 in a discharge lamp 51 can be operated by a separate direct voltage source 52, the discharge space of the tube 51 not only accommodates sodium but also a quantity of cesium and potassium. By switching on the auxiliary direct voltage sodium can be either withdrawn from the discharge or added thereto and thus achieve a variation of the colour of the light emitted by the discharge lamp. In this case the wall of the capsule 50 consists of β -aluminium oxide which is only permeable to the ions of sodium. The auxiliary direct voltage is switched over with the aid of a commutator 53. Reference numerals 54 and 55 denote input terminals of the arrangement and 56 denotes an inductive ballast.

What is claimed is:

1. A lighting arrangement comprising an electric discharge lamp including a pair of spaced electrodes defining a discharge space, two input terminals adapted to be connected to a voltage source for supplying the discharge lamp, a reservoir in communication with the lamp discharge space for producing ions of a material participating in the electric discharge in said discharge space and located so that in the operating condition of the lamp the reservoir is substantially exclusively heated by the electric discharge present in the discharge space, means providing an auxiliary direct voltage between the reservoir and the discharge space so that ions produced in the reservoir are transported by means of said auxiliary direct voltage from said reser-

voir to the discharge space, and means for reversing the polarity of the auxiliary direct voltage so that ions can be withdrawn from the discharge space into the reservoir.

2. An arrangement as claimed in claim 1 wherein the reservoir comprises, an electrical conductor arranged so that the auxiliary direct voltage is present between the discharge space and said electrical conductor, and in the order named, an electrolyte and a wall which is permeable to the ions but not to the electrolyte arranged between said electrical conductor and the discharge space.

3. An arrangement as claimed in claim 2, wherein the reservoir is formed as a capsule located in the lamp discharge space.

4. An arrangement as claimed in claim 1 wherein the lamp has a positive voltage-current characteristic in at least a given voltage range, and wherein said polarity reversing means reverse the polariity of the auxiliary direct voltage as a function of the lamp current.

5. An arrangement as claimed in claim 2 wherein at least two ionizable materials are present in the lamp so that ions of more than one material participate in the lamp discharge characterized in that the wall between the electrolyte and the discharge space is impermeable to at least the ions of one of said materials participating in the discharge.

6. An arrangement as claimed in claim 2 wherein the discharge space contains sodium and the wall between the electrolyte and the discharge space is comprised of β -aluminium oxide.

7. An arrangement as claimed in claim 2 wherein the lamp comprises a sodium lamp and the electrolyte comprises sodium fluoride.

8. A control system for an electric discharge lamp including a pair of spaced electrodes and a discharge space with an ionizable medium comprising, a pair of input terminals for applying an AC voltage to the lamp electrodes, a reservoir including an ionizable medium arranged to communicate with the lamp discharge space for transferring ions back and forth between the reservoir and the discharge space, said reservoir being located so that it is heated primarily by the electric discharge occurring in the lamp discharge space during operation of the lamp, means for applying a DC voltage between the reservoir and one of the lamp electrodes for controlling the ion flow between the reservoir and discharge space, and means for reversing the polarity of said DC voltage so that the direction of ion flow between reservoir and discharge space is determined by the polarity of the DC voltage.

9. A system as claimed in claim 8 wherein said reservoir DC voltage applying means includes an electric conductor.

10. A system as claimed in claim 9 wherein said reservoir comprises a capsule located within the lamp discharge space, said capsule including an electrolyte adjacent said electric conductor and a wall permeable to the ions and impermeable to the electrolyte and separating the electrolyte from contact with the discharge space.

11. A system as claimed in claim 10 further comprising circuit means for controlling the ion flow between reservoir and discharge space as a function of the lamp current and comprising, a first impedance connected in series with the lamp across said input terminals, a second impedance and a diode serially connected across said first impedance, and means connecting a tap point on the second impedance to said electric conductor.

12. A system as claimed in claim 11 wherein said circuit means further comprises a voltage breakdown element connected in series with the second impedance and the diode across the first impedance.

13. A system as claimed in claim 9 wherein said reservoir is located within the lamp discharge space and further comprises an electrolyte surrounding the electric conductor and a wall composed of β -aluminum oxide arranged to separate the electrolyte from contact with the discharge space, said wall being permeable to ion flow and impermeable to the electrolyte.

14. A system as claimed in claim 9 further comprising means for controlling the polarity of the DC voltage as a function of the amplitude of the lamp current.

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