MAGNETIC CONTROL OF HIGH-PRESSURE ARC LAMPS

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This invention relates to electric discharge lamps in which an arc discharge is produced in an atmosphere which, during the operation, is of high pressure and contains the vapor of a vaporizable metal. The invention is particularly applicable in connection with high pressure mercury vapor electric discharge lamps.

As a result largely of convection currents produced in such a lamp during operation, the arc and the arc flame may be deflected towards and impinge upon the wall of the envelope. If the envelope is of glass, this impingement must be prevented since the heat of the arc would melt the envelope; and even when the envelope is of quartz, this impingement is undesirable inasmuch as de-vitrification of the envelope will occur.

It is well-known to prevent the impingement of the arc on the wall of the envelope by means of a magnetic field produced by conveying the operating current to the lamp through the winding of an electromagnet, the field of which is related to the arc path as to counteract the deflection of the arc. Such an arrangement is designed for a lamp required to be used in a stationary position, the magnetic field being so adjusted that the counteraction of the deflection of the arc is correct for only that one stationary position.

However, for some applications the need arises for a lamp, the angular position of which is varied during operation so that some adjustment of the value of the magnetic field is required when the angular position of the lamp is changed. Such a condition arises, for example, in the case of spotlights or floodlamps used in motion picture studios and incorporating electric arc discharge lamps as the source of light.

It is an object of the invention to provide means for automatically adjusting the magnetic field as the angular position of the lamp is varied within predetermined limits so as to maintain the strength of the field at the value required for counteracting the tendency of the arc to deflect into contact with the lamp envelope.

According to the invention the object is attained by the use of means adapted to produce a magnetic field in such relation to the arc path as to tend to deflect the arc in a direction opposed to its deflection under the action of convection currents within the lamp envelope. The intensity of the field at the arc path is varied with a change in the angular position of the lamp by gravity controlled means so as to maintain the intensity of the field at the arc path at a value sufficient to counteract the arc deflection within predetermined limits of angular position.

The gravity control means may operate to control the intensity of the magnetic field at the arc path in alternative ways. According to one method the magnetic field-producing means is maintained at a fixed position with relation to the lamp and the arc path and the gravity control means is arranged to vary the position of a magnetic shunt with respect to the magnetic field-producing means as the angular position of the lamp is varied, the intensity of the field at the arc path being reduced when the magnetic shunt is in closer relation to the magnetic field-producing means by by-passing more of the field through the magnetic shunt, whereas when the magnetic shunt is moved away from the magnetic field-producing means less of the field is shunted and the intensity of the field at the arc path is greater. In another arrangement, the gravity control means is arranged to vary the position of the magnetic field-producing means with relation to the arc path so that the intensity of the field is thereby controlled.

The magnetic field-producing means may be in the form of an electromagnet or a permanent magnet.

The gravity control means is conveniently in the form of a pendulum, the pivotal axis of which is parallel with the axis about which the tilting movement of the lamp is effected. The pendulum is thus arranged to control the position of the magnetic shunt with relation to the field-producing means or to control the movement of the field-producing means towards or away from the lamp as the lamp is tilted. In the latter case, the pendulum may operate through the intermediary of a cam and bell-crank lever provided with a fixed pivot, the angular rotation of the cam, caused by the tilting of the lamp being arranged to displace the bell-crank lever and thereby effect the displacement of the field-producing means, whereby to control the field intensity at the arc path. Obviously, any suitable gravity controlled means may be utilized to control the position of the shunt or the position of the field-producing means with relation to the lamp.

To enable the nature of the invention to be made clear it will now be described with reference to the accompanying diagrammatic drawings, in which Figs. 1 and 2 show, in end view and elevation, respectively, one arrangement in accordance with the invention with the lamp of Fig. 1 shown in a section taken along the line 1—1 of Fig. 2; Fig. 3 an end view of an alternative arrangement; Fig. 4 is a wiring diagram including the lamp of Fig. 1 and the coil of an electromagnet connected in series, and Fig. 5 is a view similar to Fig. 1.
showing two electromagnets mounted on opposite sides of a double ended lamp.

Referring firstly to Figs. 1 and 2, we have shown the arrangement as applied to the automatic arc control of a high pressure mercury vapor arc discharge lamp 1, having a spherical quartz envelope, a cathode 2 and an anode 3, the cathode and anode being supported by leads-in wires 4 extending through stems 14 projecting in parallel relation from the sealed envelope. The lamp operates at a vapor pressure in the order of atmospheres and the arc discharge is constricted by the pressure of the gaseous atmosphere. The magnetic field-producing means comprises a coil 5 and a core 6 co-axially arranged, the coil 5 being supplied with current from a suitable source which is preferably that supplying the operating current to the lamp, the coil may carry the load current to the lamp as shown in Fig. 4, if desired.

The lamp is intended to be supported in a suitable housing or lantern which is arranged for tilting in the clockwise or anti-clockwise direction, as indicated by the arrows A and A', about a horizontal axis passing through the center of the arc path and normal to said path and a plane including said leads 4. The magnetic field produced by the coil 5 and core 6 is so arranged by adjusting the value of the current in the coil, the number of turns thereof, and the position of the core with relation to the lamp, that when the lamp is tilted in a clockwise direction to its fullest extent the magnetic field is sufficient to counteract the tendency of the arc to bow outwardly into contact with the wall of the envelope of the lamp under the action of convection currents caused by the heat of the arc in the vapor in which it operates. If then the magnetic field were of constant value when the lamp is tilted into the position shown in Fig. 2 the field would be greater than is necessary to counteract the tendency of the arc to bow under the action of convection currents and would bow it in the reverse direction causing the arc to impinge on the seals and lead-in wires to the electrodes. According to the invention we provide means for reducing the intensity of the magnetic field under these conditions by means of a magnetic shunt 7 in the form of a yoke co-operating with the parts of the core 6 which extend beyond the ends of the coil 5. The yoke is pivotally mounted at 8 and has attached to it a pendulum 9 which remains in the vertical position when the lamp is tilted. In the position shown in Fig. 2 the yoke thus serves to by-pass some of the flux produced in the core 6 and reduce the intensity of the field available at the arc path. In the event that the lamp is tilted in the anti-clockwise direction from the position shown in Fig. 2, the shunt 7 comes more closely into engagement with the ends of the core 6, still further shunting the magnetic field and reducing its intensity at the arc path. The yoke is provided with cut away portions, indicated at 10, shaped to provide the desired shunting effect of the yoke on the core. If the lamp is tilted in the anti-clockwise direction, the requisite magnetic field for countering the upward bowing of the arc is provided by the U-shaped lead-in conductors 4 to the electrodes 3 and 2 and the arc between them, as disclosed in British application No. 14,025/45.

In the alternative arrangement shown in Fig. 3 similar parts have been indicated by the reference numerals assigned to them in Figs. 1 and 2. In this arrangement the coil 5 is fixed and the core 6 is made moveable axially within the coil in order to adjust its position with reference to the arc path and thus control the intensity of the field at the arc for different angular positions of the lamp. This is effected by providing the pendulum 9 with a cam 11 engaging with one arm of a bell-crank lever 12 mounted on a fixed pivot 13, the other arm 14 of the bell-crank lever being connected with the core 6. The bell-crank lever is maintained in engagement with the cam 11 by means of a spring 15.

In this arrangement, as the lamp is tilted the cam rotates clockwise with reference to the bell-crank lever 12 and its shape is such as to move the arm 12 of the bell-crank lever and consequently to control the intensity of the field and the arc path.

The desired control of the magnetic field intensity at the arc path is effected by the arrangements described with reference to the drawings within an angular movement of approximately 90° indicated by the chain dotted lines B.

Where a normal or double ended type of lamp is used, i.e., where the electrode leading-in wires enter the bulb on opposite sides, then two magnetic field-producing devices may be used on opposite sides of the lamp, Fig. 5, and having opposite polarity. As the lamp is tilted through the vertical backward and forwards, the flux from each coil is alternately short-circuited by the magnetic shunts 7.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a support pivoted on a horizontal axis for angular movement within predetermined limits in a vertical plane, a high pressure arc discharge device having a straight path between its electrodes mounted on said support for movement therewith, magnetic field producing means also mounted on said support with its field directed so as to counteract in one of the two possible directions the tendency of the arc to bow out of the straight path under the influence of convection currents when said path is tilted from the vertical, said means being so proportioned with respect to the arc current as to produce a field of sufficient intensity to maintain the arc in the straight path when said path is at its maximum angle to the vertical, and gravity controlled means having an axis of rotation parallel to the pivot axis of the support and being coupled with said magnetic field producing means to change the intensity of the magnetic field in said device in direct proportion to the change in angular distance of the straight path from the vertical as the support is so moved around its horizontal axis that the straight path in the device is tilted from the vertical in the direction in which bowing of the arc is counteracted by the magnetic field whereby the arc is maintained in the straight path between said electrodes when the said support is so moved.

2. The combination according to claim 1 wherein in the gravity controlled means comprises a pendulum having its pivot axis parallel with the pivot axis of the support.

3. The combination according to claim 1 wherein the gravity controlled means comprises a pendulum having its pivot axis parallel with the pivot axis of the support and a magnetic shunt juxtaposed to said magnetic field producing means and mechanically connected with said pendulum so as to be moved relative to and thus change the intensity of the field produced by
said field producing means as the support is moved around its axis.

4. The combination according to claim 1 wherein the gravity controlled means comprises a pendulum having a pivotal axis parallel with the pivotal axis of the support, and a mechanical connection between said pendulum and said field producing means whereby the latter is moved relative to said device as the support is moved on its axis.

5. The combination according to claim 1 wherein the device is mounted on the support with the straight path between its electrodes vertical in an intermediate position of said support and wherein the magnetic field producing means and the gravity controlled means coupled with said magnetic field producing means are in the form of two duplicate units mounted in opposing positions with respect to said device and on said support with the magnetic field producing units being of opposite polarity with respect to each other whereby the arc is maintained in the said straight path when the said path is tilted in either of the two possible directions from the vertical by movement of the support around its horizontal axis.

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REFERENCES CITED

The following references are of record in the file of this patent:

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