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CONTROL OF ELECTRIC DISCHARGE TUBES

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This invention relates to the control of mercury low pressure electric discharge tubes of the type having a luminescent or fluorescent coating on the interior walls of the tube. With tubes of this type, there is produced in operation a primary light from the discharge through the mercury and a secondary light from the luminescent coating, the primary and secondary light being combined to give a resultant combined light, which is of a particular desired shade of colour. In practice it is found that after a tube of the type referred to has been operating for a comparatively short period of time there is a marked decrease in the total light emitted which may be accompanied by a change of colour due to uneven individual decrease in the primary and secondary light emissions. This total decrease is thought to be due to several factors, viz the tendency of the luminescent coating to become covered by mercury particles, a general fall-off in primary light, a decrease in ultra-violet light emission from the electric discharge and a seemingly gradual deterioration in the luminescent coating itself. All these factors contribute towards a fall-off of total light output with mercury discharge tubes having interior luminescent coatings. It is accordingly an object of the invention to devise a method and apparatus for the control of tubes of this type with a view to overcoming the drawbacks hitherto experienced therewith.

According to the invention a control system for a low pressure mercury electric discharge tube having an internal luminescent coating, comprises means for boosting the current flow through the tube at progressively increasing intervals of time during the useful life of the tube, whereby the luminous power of the tube is maintained at a comparatively high point over the major part of its life. The invention also includes apparatus for controlling the luminous output of an electric discharge tube of the type referred to, comprising an electric transformer for feeding the tube and means for progressively increasing the output of the transformer to increase the current flow through the tube at predetermined progressively increasing intervals of time.

Thus, following the principles of the invention, a sign may be constructed from a plurality of electric discharge tubes of the type referred to, there being a potential supply to each of said tubes such that the potentials applied across the tubes may be separately varied in order that the total lighting effect from the sign may be adjusted to be uniform. This application of the invention will be found particularly advantageous

where there is a sign including a plurality of tubes, and where such tubes deteriorate in lighting power to markedly different extents. Up to the present it has been customary in these circumstances to replace dull tubes, with the result that the new tubes serving as replacements are brighter than the remaining tubes and uniformity of illumination is still not obtained. By making the potential across each tube, or section of the tube adjustable, it becomes possible to approach almost an ideal uniformity in lighting powers.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be more fully described with reference to the accompanying drawing, in which:—

Figure 1 shows several curves illustrating the manner of carrying the invention into effect.

Figure 2 shows diagrammatically apparatus for the performance of the invention, and

Figure 3 shows a modification of the apparatus of Figure 2.

In Figure 1 of the drawing the abscissa of the curves is graduated in hours and the ordinate in lumens. The curve 1 shows the characteristics of a twelve-inch length of 15 mm., mercury tube having an interior fluorescent coating. It will be seen that initially the tube produces 118 lumens but after a comparatively few numbers of hours falls rapidly down to a value such as 95 after 120 hours. The initial decrease in luminosity is very great as will be seen by the steepness of the curve and after 500 hours it will be seen that the luminosity drops to 84 lumens. The curve 1 has been plotted for a constant current of 35 milli-amperes passing through the tube.

In the practice of the invention after a period of, say, 500 hours, the current passing through the tube is boosted and this may be seen from curve 2. An ordinate 3 has been drawn corresponding to 500 hours. The curve 2 will be seen to begin at a point corresponding to 118 lumens and to reach a point corresponding to 90 lumens after 1,000 hours. The curve 2 will be observed to have a much slower gradient than that of the curve 1. In the example shown, following the practice of the invention, a further boosting of the current flowing in the tube takes place at 1,500 hours reckoned from the original commencement of operation of the tube. In the case of the curve 2 the current flowing in the tube is 46 milli-amperes and at 1,500 hours the current is boosted to 60 milli-amperes. An ordinate 4 is shown corresponding to 1,500 hours. The curve 5 shows the behaviour of the tube for a further

period of 2,500 hours and it will be observed that with the current kept constant at 60 milli-amperes there is a gradual decrease in luminosity of the tube down to 85 lumens.

5 The series of curves 1, 2 and 5, show the effects sought after by the invention. In the case of the curve 1 it will be seen that the gradient of the curve at 500 hours is comparatively small and
10 if the curve were produced the luminosity would, over a considerable period, be in the region of 80 to 85 lumens. With the hitherto recognized method of operating luminescent tubes, no boosting would be resorted to and for the greater part of its life the tube would be dull compared with
15 its initial brilliance. By carrying out the method in accordance with the invention, however, the period of comparative brilliance of the tube is very much increased as will be seen particularly from the curve 5 where the brilliance is raised
20 to 111 lumens after 1,500 hours of service, and the luminosity actually remains above 100 lumens for over 700 hours. It is important to notice that the final degree of luminosity reached after 4,000 hours of continuous use of the tube differs only
25 by some 2 lumens from the minimum luminosity recorded on the first curve 1.

The curves 6, 7 and 8, show the characteristics obtained from a 20 mm., foot length of mercury vapour discharge tube with intermediate boosting.
30 As in the case of the first set of curves, the initial curve 6 has a much steeper gradient than each of the successive curves. In this case the curve 6 is for a current of 60 milli-amperes in the tube. As before, after 500 hours, the current is boosted and
35 it is in this case raised to 80 milli-amperes. Further boosting is carried out at 1,500 hours to 105 milli-amperes. Generally, it will be seen that the curves 6, 7 and 8, demonstrate the same facts as the previous curves 1, 2 and 5, in that the period
40 of good luminosity of the tube is maintained over a greater part of the length of life of the tube. As, however, the size of the tube increases, the curves naturally tend to become somewhat steeper.

45 Finally, there is shown a set of curves 9, 10 and 11 which illustrate the characteristics of a foot length of 28 mm., mercury vapour discharge tube with an interior fluorescent coating. The curve 9 is that obtained whilst a current of 80 milli-amperes is passing through the tube, the curve 10
50 being obtained with a boosting up to 108 milli-amperes and, lastly, the curve 11 at 140 milli-amperes.

In the practice of the invention it will be found
55 convenient to employ a tapped transformer or a transformer having a magnetic shunt to supply the potential across any tube section. When the tubes are initially installed by selection of a particular tapping, or position of adjustment of the
60 magnetic shunt, a particular potential may be applied across a tube to obtain a corresponding lighting power therefrom. After the tube has been in use for a period, and it has begun to deteriorate, the potential across the tube may then be
65 increased by changing to another tapping, or shunt adjustment, on the supply transformer. By so increasing the potential across the tube and boosting the current therein, the known disadvantages effects are effectively nullified, and the illumination power rises as indicated in Figure 1. Where it is desired to obtain an accurate
70 adjustment of the tube lighting intensity, a photometer or like instrument may be employed so
75 that all parts of a sign constituted by a plurality

of tubes, or tube sections, may have the same lighting intensity.

In Figure 2 of the drawing apparatus is shown for effecting the boosting described above. The discharge tube to which the system has been applied is indicated at 1 and is shown connected to the secondary 2 of a supply transformer through the intermediary of a smaller pilot tube 3. The tube 3 is arranged at a distance away from the main tube 1 so that it is not normally visible and is located adjacent a photometric device 4. The latter may contain a photo-electric cell or the like which is responsive to light intensity and has a pointer 5 which normally moves to a position over a calibrated scale 6 to indicate light intensity. In the example shown the pointer 5 has its rear end extended and formed with a spring contact 7. The latter is adapted to co-operate with any one of a number of upstanding contact pins 8.
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The primary winding 9 of the supply transformer to the main tube has, arranged in series with it, a choke 10 having a plurality ofappings. Theappings each connect with one of the contact pins 8 and a lead 11 from one end of the choke connects with the pointer 5.
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In operation when the tube 1 is newly installed, adjustments are made so that the correct initial current flow is obtained through the tube with the total opposing impedance of the choke 10 in the circuit of the primary of the supply transformer. The tube 3 will be installed at the same time as the tube 1 and will be subject to the same deterioration as occurs with the tube 1. Thus, in the initial stages of operation of the system the photometric device will indicate a maximum luminosity and the pointer 5 will be in such position that it does not make contact with any of the pins 8. After a certain period when the luminosity of the tubes 1 and 3 has decreased, the pointer of the device 4 will move round to indicate less luminosity and, in so doing, the contact spring 7 will encounter one of the pins 8 and will short out part of the winding of the choke 10. The action will be progressive up to the last pin 8, when almost the whole of the winding of the choke 10 will be short-circuited. In this manner the tube 1 and, of course, the tube 3 will from time to time receive the necessary boosting in order to maintain the luminosity of the tube 1 at a high degree over the major part of its useful life.
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In Figure 3 of the drawing an alternative arrangement is shown, the main tube here being also indicated at 1 and the smaller pilot tube at 3.
55 A supply transformer having a secondary 2 supplies the tubes 1 and 3 in the manner previously indicated. The supply transformer in this case has, however, a core 2A which is movable relatively to the primary 9 and the secondary 2 of the transformer. As in the previous instance a photometric device 4 is provided to operate in conjunction with the tube 3 and the device 4 has a pointer 5 with spring contact 7 for co-operation with a plurality of contact pins 8. The pins 8 all join to a single connection 12 which also connects with a solenoid 13. The circuit is completed to the solenoid 13 by a connection 14 to one side of the transformer primary 9 and a connection 15 from the other side of the transformer primary through to the pointer 5. The solenoid 13 is arranged to act upon a lever 16 pivoted at 17 and having a pawl-like end 18. The latter is axially slidable on the lever 16 and is urged in a direction from the centre of the lever by means
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of a light spring (not shown). The light spring serves to keep the pawl-like end 18 in contact with the teeth 19 on a rack portion 20 secured to the core 2A of the supply transformer. The end of the lever 16 which is intended to be influenced by solenoid 13 has a light spring 21 arranged constantly to draw the lever away from contact with the solenoid core.

With the apparatus just described, when the tubes 1 and 3 are first mounted and operated, it is intended that the correct current should pass through the tubes with the core 2A in an outermost position, such as that illustrated in Figure 3. The photometric device 4 will then be indicating a maximum luminosity from the tube 3 and the contact spring 7 will be out of contact with any one of the pins 8. As soon as the luminosity of the tube 3 falls, the pointer 5 will move round to indicate a lesser luminosity and the spring 7 will contact with the first of the pins 8. As soon as the contact of spring 7 and a pin 8 is brought about, the circuit through the solenoid 13 will be completed and the lever 17 will be caused to swing over against the action of the light spring 21. Thereby the pawl-like end 18 will move the rack portion 20 of the core 2A in a direction such that the latter will enter further between the primary and secondary of the supply transformer. The core 2A is arranged to be sufficiently frictionally resistant to movement to allow the lever 16 to return to its normal inoperative position shown in Figure 3 without, however, returning the core 2A and its associated parts. Thus, as the spring contact 7 progressively encounters pins 8, the solenoid 13 will from time to time be operated with the result that the core 2A will be progressively stepped into position between the primary and secondary of the supply transformer. In this way, the current through the tube 1 will be progressively boosted so as to extend the period over which the tube gives a high luminosity comparable with its initial luminosity.

In the example of construction shown in Figure 3 of the drawing the core of the supply transformer has been indicated as being movable to vary the secondary output. It will be appreciated that in practice it will generally be found more convenient to have a fixed core in the supply transformer and to vary the effective flux linking with the secondary by the employment of a magnetic shunt, or shunts, which will be adjustable in much the same manner as the core illustrated.

What I claim and desire to secure by Letters Patent of the United States is:—

1. A method for controlling mercury low pres-

sure electric discharge tubes having a luminescent coating on the interior walls of the tube, which consists in boosting the current flow through the tube at progressively increasing intervals of time during the useful life of the latter to maintain the luminous output thereof.

2. Apparatus for controlling the luminous output of a low pressure mercury electric discharge tube having an internal luminescent coating, comprising an electric transformer for feeding the tube and means for progressively increasing the output from the transformer at progressively increasing intervals of time to maintain the luminosity of the tube.

3. Apparatus for controlling the luminous output of a low pressure mercury electric discharge tube having an internal luminescent coating, comprising an electric transformer for feeding the tube, means responsive to the luminous output thereof and a device controlled by said means and arranged to increase the output current flow from said transformer to maintain the luminous intensity of the tube.

4. Apparatus for controlling the luminous output of a low pressure mercury electric discharge tube having an internal luminescent coating, comprising an electric transformer for feeding the tube and means responsive to the luminous output of the tube, a device controlled by said means and arranged to influence the linkage between the primary and secondary of said transformer to progressively increase the output of said transformer to maintain the luminous intensity of the tube.

5. Apparatus for controlling the luminous output of a low pressure mercury electric discharge tube having an internal luminescent coating comprising an electric transformer for feeding the tube, means responsive to the luminous output of the tube, a device controlled by said means so as to progressively increase the current flow in the primary of the transformer to correspondingly increase the secondary output thereof and maintain the luminosity of the tube.

6. Apparatus for controlling the luminous output of a low pressure mercury electric discharge tube having an internal luminescent coating, comprising a pilot tube in association with the main tube under control, a photometric device responsive to the output from said pilot tube, a transformer feeding the main and pilot tubes and means acting in association with said photometric device for progressively increasing the output from said transformer, according to the drop in luminosity of said pilot tube as detected by said photometric device.

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