

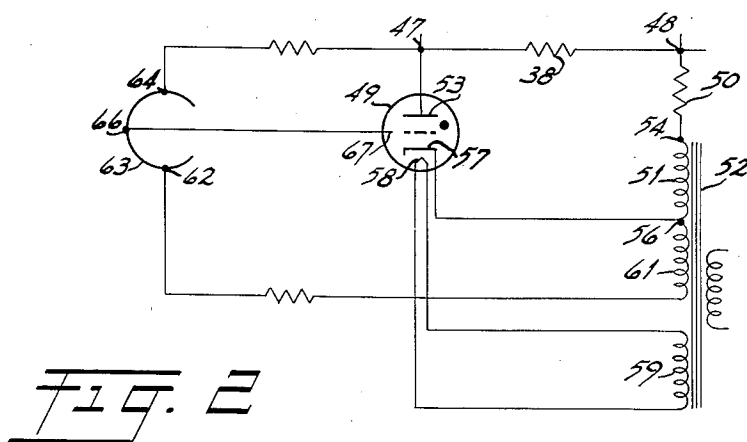
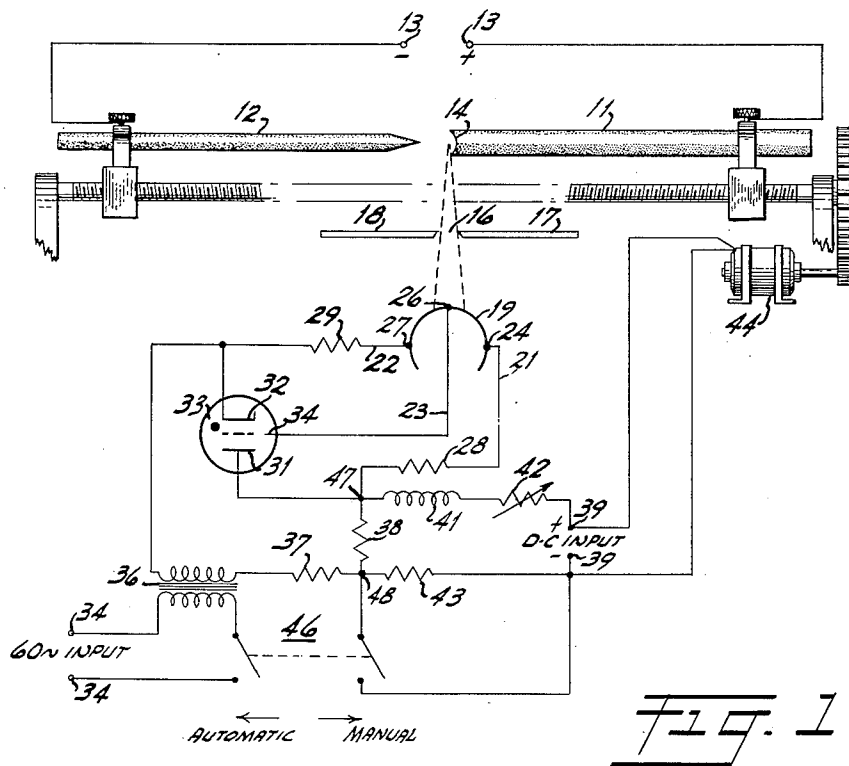
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CARBON ARC FEED

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CARBON ARC FEED

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This invention relates to an improved carbon arc control and more especially to a control for automatically regulating the position in space of the luminous crater of the positive electrode of a direct-current arc lamp. The invention is applicable to automatically-controlled arc lamps employed in searchlights and for use in the projection of motion pictures or in the illumination of studios, and to automatically-controlled arc heaters.

In direct-current arc lamps and arc heaters the major portion of the emitted light and heat is generated at or closely adjacent to the positive carbon crater, and the generated heat or light is applied to the desired location by means of some form of optical concentrating system. As the positive carbon is consumed it must be fed or advanced, not only to maintain the arc at its desired length but also to keep the positive crater at its optimum optical position. It is well recognized that this advancement of the positive carbon is accomplished with greater accuracy and ease by automatic means than by manual means, with the radiation from the luminous crater itself made to actuate such automatic positioning means through a light-sensitive or heat-sensitive device.

The use of light-sensitive devices for the automatic control of the position of the positive carbon crater of an arc has usually required the use of a sensitive and relatively expensive amplifier. The instant invention, however, employs simple means for accomplishing this object. The light from the luminous positive crater of the arc is directed upon a dual photoconductive cell which controls a gas discharge tube. The internal resistance of this tube is thereby varied and the variation is made to control the speed of an electric motor geared to advance the positive carbon. The speed of this advance is thus simply controlled by the position of the positive arc crater.

The general objective of this invention is to provide improved means for controlling the position of the positive carbon of a direct-current arc lamp, including photosensitive means and discharge tube amplification means.

More specifically the objective of this invention is to provide means for automatically keeping the crater of the positive carbon of a direct-current arc lamp in the proper operative position, the light of the positive crater of the arc being employed through photosensitive means to control the position-regulating means.

A further understanding of the invention may

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be secured from the following detailed description together with the accompanying drawings, in which:

Figure 1 illustrates a circuit embodying the invention.

Figure 2 illustrates an alternative circuit employing a hot-cathode amplifying tube.

Referring now to Fig. 1 an electric arc lamp is represented by a positive electrode 11 and a negative electrode 12, between which an arc is maintained supplied from direct-current terminals 13-13. Due to the action of the arc, a crater 14 is hollowed in the end of the positive electrode 11, and most of the light and heat emitted by the lamp originates at this point by the arc action. The positive crater is automatically and precisely held in a fixed position, counteracting consumption of the positive carbon, by the apparatus of this invention, and the negative carbon 12 is advanced to maintain a constant arc length by any conventional means which is not shown, but which may be manual or may be controlled by the current flow through the arc.

A portion of the light emitted at the positive crater 14 is directed by means of a simple system, consisting of a slit 16 between the opposed parallel edges of two plates 17 and 18, upon a photoconductive cell represented by the symbol 19. This cell may be of any type but as an example a lead sulphide cell is here illustrated. This cell is constructed by applying a very thin coating or film of lead sulphide to the interior surface of a transparent glass tube. Two conductors 21 and 22 are secured to the glass and conductively connected to the film at diametrically opposed locations, and a third conductor 23 is secured and connected to a medial location of the film. These three electrical connections to the lead sulphide film are in the form of parallel lines, represented in Fig. 1 by the terminals 24, 26 and 27, the distance separating terminals 24 and 26 being the same as that separating terminals 26 and 27. The lead sulphide film resistance is inversely related to the intensity of the light falling upon it, and it is this property that is here employed.

The terminals 24 and 27 are connected through the conductors 21 and 22 and isolating resistors 28 and 29 to the anode 31 and cathode 32 of a gas triode 33, and the terminal 26 is connected through conductor 23 to the control grid 34 of the triode. The function of this triode is the amplification of signals caused by changes of resistance in the cell 19, and therefore in place of this triode any other type of amplifier may

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be employed to accomplish the same results as are accomplished by this circuit. It is preferred, however, to employ a gas discharge tube amplifier because of its simplicity and high amplification, the cold cathode type being depicted in Fig. 1 at 33.

Alternating potential is applied to the gas triode anode circuit from 60-cycle supply terminals 34—34 and a transformer 36, so that anode current flows during the positive half of each cycle, under control of the starting time thereof by the grid 34, and the current is interrupted during negative half-cycles. A limiting resistor 37 is placed in series with the anode circuit to limit the maximum current flow and a coupling resistor 38 is also included in series.

This resistor 38 is common to another circuit including direct-current power terminals 39—39, a motor field 41, a field rheostat 42 and a fixed field resistor 43. The direct-current terminals are also connected to a motor armature and rotor 44 associated with the field 41. A double-pole single-throw switch 46 is arranged so that when in the "manual" position it is open and when in the "automatic" position it is closed, one pole short-circuiting the resistor 43 and the other pole closing the circuit to the primary winding of the transformer 36.

In operation of the circuit, light from the positive crater 14 of the burning arc lamp falls through aperture 16 upon an area of the surface of the photoconductive cell 19. If equal areas on opposite sides of the medial connection represented by the terminal 26 are equally illuminated, the resistance between terminals 24 and 26 equals the resistance between terminals 26 and 27 and the potential of the terminal 26 is half-way between the potential at the terminal 24 and the potential at the terminal 27. But since the terminals 24, 26 and 27 are connected to the anode 31, control grid 34, and cathode 32 respectively of the gas tube 33, the potential of the grid 34 is, under this condition, half-way between the anode and cathode potentials. The characteristic of the cold-cathode tube 33 is such that its current flow is then of an intermediate amount. Component circuit magnitudes are such that this current is secured almost entirely by self-rectification of the alternating current output of the transformer 36, when its primary switch is closed. This alternating current is prevented from flowing through the circuit including the motor field 41 because of its inductance.

The direct-current flows from terminals 39—39 of the power supply through the armature 44, energizing it, and through a relatively low resistance circuit including the field 41 and the resistors 38, 42 and 43 in series, when switch 46 is open. Circuit magnitudes are selected to be such that when the switch 46 is open, the field rheostat 42 may be adjusted to operate the motor 44 at a speed that moves the positive carbon 11 at a rate that approximately compensates its rate of consumption. Thus the crater 14 will remain at about the same point in relation to the aperture 16.

In order to control the position of the crater 14 automatically, the switch 46 is closed, energizing the gas triode 33 and short-circuiting the resistor 43. The latter action increases the field current, slowing the motor 44. Consumption of the positive carbon then causes the crater 14 to move to the right in the figure, causing more light to fall upon the area of the photoconductive cell 19 between terminals 26 and 27 and less to fall

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between terminals 24 and 26. Consequently the resistance between terminals 26 and 27 falls because of the photosensitivity of the cell, while that between terminals 24 and 26 rises, and as a result the potential of the control grid 34 approaches that of the cathode 32. The gas triode 33 consequently fires later in each positive half cycle and its average anode current becomes less. This reduces the current drawn through the resistor 38 by the gas triode 33. However, this tube current flow is in the opposite direction to the larger current flow in the same resistor due to the direct-current source 39—39 so that the net current increases. Therefore, the voltage drop in the resistor 38 increases, leaving less of the direct-current voltage available for the motor field 41, which accordingly is reduced in strength. This of course speeds up the motor 44 and increases the rate of advance of the positive carbon 11, tending to restore the crater 14 to its correct position. This action continues until the crater 14 is fully restored to the correct position, when the two halves of the cell 19 are again equally illuminated and the grid 34 is brought to its medial potential. On the other hand, any deviation of the crater 14 to the left from its correct position causes the opposite action, again resulting in restoration of the crater to its correct position and maintenance of it there.

In Fig. 2 there is depicted an embodiment of the invention employing a hot cathode gas discharge tube. This circuit has the advantage of being somewhat more sensitive to light variations and, in addition, the grid current requirement is so low that the photoconductive cell can if desired be replaced by a phototube. The circuit is intended to replace a portion of the circuit of Fig. 1, electrical connection points 47 and 48 and resistor 38 being similarly numbered. A hot cathode gas triode 49 is connected for energization by the section 51 of the secondary winding of a transformer 52, the anode 53 being connected to terminal 47 and through resistors 38 and 50 to the end terminal 54 of the winding 51. The secondary midterminal 56 is connected to the cathode 57. The heater 58 is heated by current from a heater winding 59. Operation of the control grid of a hot cathode gas tube is at about the voltage level of the cathode, therefore it is necessary to employ a second section of secondary winding 61 connected to one diametral terminal 62 of a photoconductive cell 63, with the other diametral terminal 64 connected to the anode terminal 47. The medial terminal 66 is then at approximately the cathode potential level, and is connected to the control grid 67.

In operation, when both halves of the cell 63 are equally illuminated a normal current flows in the anode circuit of tube 49, when that half of the cell included between the terminals 66 and 64 is illuminated more than that included between the terminals 62 and 66 the grid 67 is made more positive and more anode current flows; while when that portion between 62 and 66 is illuminated more than the portion between 64 and 66 the grid 67 is made more negative and less anode current flows. The action through the coupling resistor 38 to control the motor 44, Fig. 1, is exactly as before described.

What is claimed is:

1. A control system for maintaining the electrode crater of an arc lamp at a fixed position in space comprising, a pair of photosensitive elements, means for varying the relative illumination of said photosensitive elements in accord-

ance with the position of said electrode crater, a gas discharge tube, means interconnecting said pair of photosensitive elements and the electrodes of said gas discharge tube for varying the grid cathode potential thereof in response to the relative illumination of said pair of photosensitive elements, a motor including a direct current field connected to advance said arc electrode, an alternating current circuit energizing the anode of said gas discharge tube, a direct current circuit energizing said motor field, said alternating current and direct current circuits including a common series resistor.

2. A control system for maintaining the electrode crater of an arc lamp at a fixed position in space comprising, a motor including a direct current winding connected to adjust the position of said arc electrode, a pair of photosensitive elements positioned for illumination by said arc crater, means interposed between said arc crater and said pair of photosensitive elements for varying the relative illumination thereof in accordance with the position of said arc crater, a gas discharge tube including at least anode, cathode and grid electrodes, said photosensitive elements being connected in series between said anode and cathode, and said grid electrode being connected to a common terminal of said photosensitive elements, an alternating current circuit energizing the electrodes of said gas discharge tube, a direct current circuit energizing the direct current field winding of said motor, and a resistor common to said alternating current and direct current circuits.

3. A control system for maintaining the electrode crater of an arc lamp at a fixed position in space comprising, a motor including a direct current winding connected to advance said arc electrode at a rate depending on the speed of said motor, a pair of photoconductive elements, means for differentially illuminating said photoconductive elements in accordance with the position of said electrode crater, a gas discharge tube, means for varying the grid potential of said gas discharge tube relative to the remainder of the electrodes thereof in accordance with the relative differential illumination of said photoconductive elements, an alternating current circuit energizing the anode of said gas discharge tube, a direct current circuit energizing said motor field, said alternating current and said direct current circuits including a series resistor in common thereto.

4. A control system for maintaining the electrode crater of an arc lamp at a fixed position in space comprising, a motor including a series direct current winding connected to advance said arc electrode at a rate depending on the speed of said motor, a pair of photoconductive elements positioned for illumination by said arc crater, means interposed between said arc crater and said pair of photoconductive elements differentially illuminating said elements in accordance with the position of said arc crater, a gas discharge tube including at least anode, cathode and grid electrodes, said photoconductive elements being connected in series between anode and cathode electrodes, and said grid electrode being connected to a common terminal of said photocon-

ductive elements, an alternating current energizing circuit connected between said cathode and anode electrodes, a direct current circuit connected in series with said direct current motor winding, and a resistor common to said alternating current and direct current circuit.

5. A control system for maintaining the electrode crater of an arc lamp at a fixed position in space comprising, a motor including a series direct current field winding connected to advance said arc electrode at a rate depending on the speed of said motor, a pair of photoconductive elements, means for differentially illuminating said photoconductive elements in response to the position of said electrode crater, a gas discharge tube including at least anode, cathode and grid electrodes, means varying the potential of said grid electrode in response to the relative differential illumination of said photoconductive elements, a first circuit including a source of alternating current and a resistor connected in series between said anode and cathode, a second circuit including a source of direct current and said resistor connected in series with said motor field winding, said resistor constituting the sole element common to said first and second circuits.

6. A control system as defined in claim 5 in which said gas discharge tube is a cold cathode tube.

7. A control system as defined in claim 5 in which said gas discharge tube is a hot cathode tube.

8. A control system for maintaining the electrode crater of an arc lamp at a fixed position in space comprising, a motor including a series direct current field winding connected to advance said arc electrode at a rate depending on the speed of said motor, a pair of photoconductive elements positioned for illumination by said arc crater, means interposed between said arc crater and said pair of photoconductive elements differentially illuminating said elements in accordance with the position of said arc crater, a gas discharge tube including at least anode, cathode and grid electrodes, said photoconductive elements being connected in series between said anode and cathode electrodes, and said grid electrode being connected to a common terminal of said photoconductive elements, a first circuit including a source of alternating current and a resistor connected in series between said anode and cathode, a second circuit including a source of direct current and said resistor connected in series with said motor field winding, said resistor constituting the sole element common to said first and second circuits.

9. A control system as defined in claim 8 in which said gas discharge tube is a cold cathode tube and one of said photoconductive elements is directly connected to said cathode.

10. A control system as defined in claim 8 in which said gas discharge tube is a hot cathode tube and the cathode thereof is connected to one of said photoconductive elements in series with a source of alternating potential.

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No references cited.