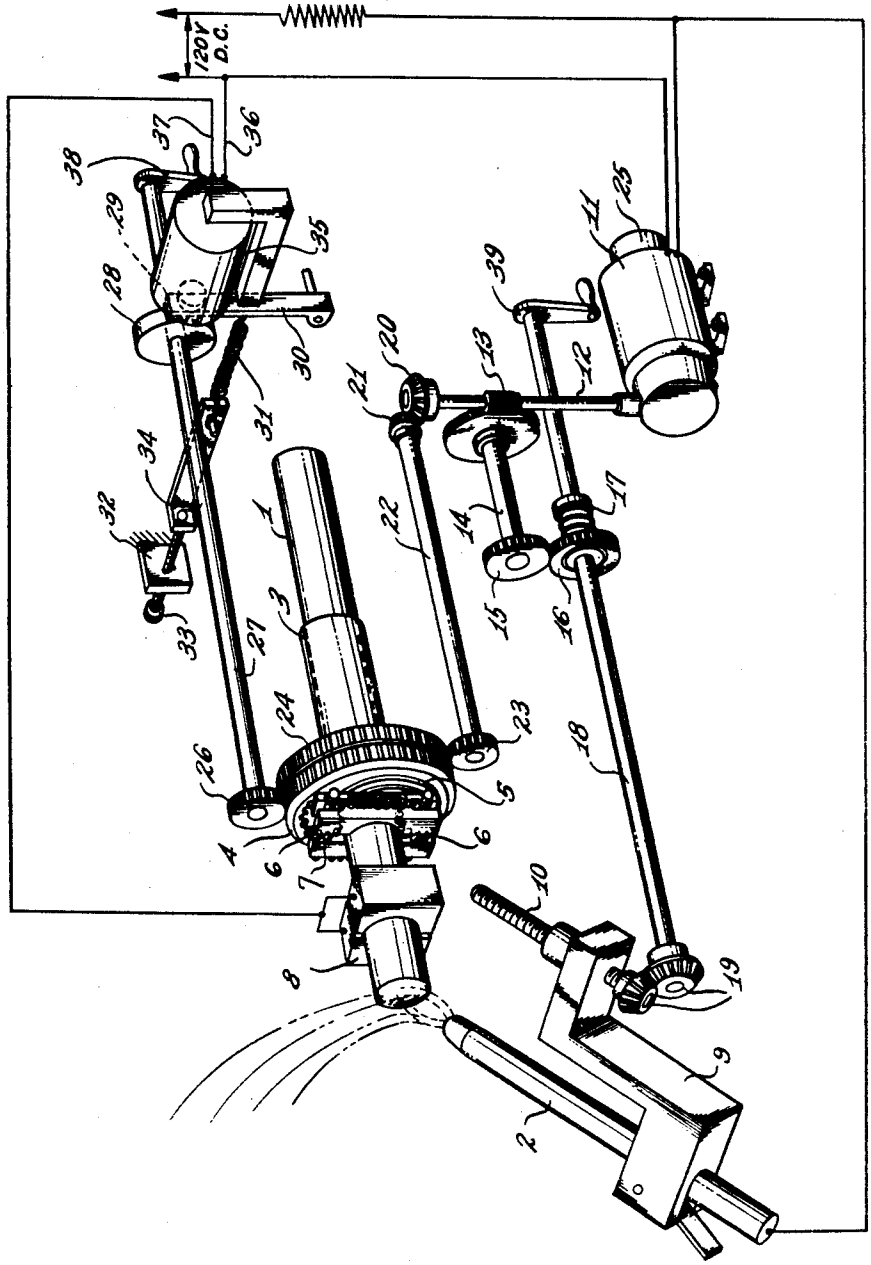
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ARC LAMP CONTROL

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ARC LAMP CONTROL

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My invention relates to arc lamps, and has particular reference to a method and apparatus for feeding the positive and negative electrodes to maintain uniform brilliance or intensity of the arc, to maintain uniform quality of the light, and to maintain the position of the crater at a given location throughout the consumption of the electrodes.

In many arc lamp applications it is essential that the position of the arc crater be maintained within extremely narrow limits during the entire consumption of a length of the positive electrode. Searchlights and high-intensity lighting units which utilize either reflectors or lenses for focusing the light into a relatively tight beam require that the crater position be at the focus of the mirror or lens system, since any deviation of the position of the crater causes a narrowing or widening of the beam of light produced from the lamp, and reduces the effectiveness of the lamp.

It is also well known, particularly in the motion picture production industry, that the brilliance or intensity of the light emanating from a lamp should be uniform during the entire employment of the lamp to illuminate a particular scene so that the light values will not vary, and in the production of motion pictures in color it is further desirable that the spectral distribution or quality of the light be maintained uniform so as not to affect the uniform photographing of the colors in the particular scene.

Many attempts have been made to control the position of the crater, among which is one described in my United States Letters Patent No. 2,396,436, issued March 12, 1946, wherein the position of the crater is controlled by utilizing a positive carbon of such accurately uniform manufacture that the burning rate of the positive carbon is known, and to employ such a carbon in a feeding mechanism which will continuously and uniformly feed the carbon forwardly at the known rate of consumption of the carbon at a given amperage.

While such system as that described in my patent above referred to affords reasonable accuracy of control, I have discovered that even greater accuracy of control may be accomplished if the negative electrode is fed toward the arc at an overall uniform rate corresponding to the known rate of negative electrode consumption at the amperage selected for operation. When the negative electrode is so fed, its tip during arc operation will remain in a substantially fixed position and provides a point of reference from which the positive electrode's crater may be spaced to maintain the value of the current and/or arc voltage at the selected value. The positive electrode may then be fed into the arc by any suitable feeding means which is accurately responsive to current and/or arc voltage. Since the tip of the negative electrode is a substantially fixed point of reference relative to which the positive electrode crater is spaced, feeding the positive electrode through a feeding means sensitively responsive to slight deviations of arc current or voltage, the crater of the positive electrode will, within extremely close limits, assume a position in closely fixed relation to the tip of the negative electrode. Thus I provide a simple means for holding the positive crater within close positional limits relative to the optical system with which the arc is used.

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In the present state of the art of carbon arc electrode production, most effective light producing combinations of positive and negative electrodes have relatively high ratios of consumption of the positive electrode with respect to the negative electrode. These ratios are expressible in numbers such as 6, 7, 8 or in some cases as much as 10 unit lengths of positive electrode to one unit length of negative electrode in a given time interval. It follows that if the negative tip position is utilized as a point of reference for the spacing of the positive electrode's crater from it, then the feeding movements imposed on the positive electrode will be frequent and numerous as the positive electrode is progressed into the arc. With the positive electrode fed by means which is sensitively responsive to slight variations from the selected standard value of arc current or arc voltage, corrections of the position of the positive crater will be so slight and frequent that an extremely uniform luminosity will be provided from the crater and the crater will be extremely accurately maintained at the most desirable position relative to the optical system with which the arc is associated.

It is therefore an object of my invention to provide a control system for an electric arc lamp in which the negative electrode is fed uniformly and at the known rate of consumption of the negative electrode, and in which the positive electrode will be fed toward the negative electrode by a control mechanism which tends to maintain the arc length constant.

Another object of my invention is to provide a control system for an electric arc lamp in which the negative electrode is fed at a constant

and uniform rate by means of a power mechanism, the speed of which is accurately maintained, and in which the positive electrode is fed by a feeding mechanism which detects and responds to voltage or current variation in the arc to thereby hold the length of the arc at an extremely uniform value, the luminosity substantially constant both as to quantity and quality, and the positive electrode's crater within extremely close positional limits relative to the optical system.

Other objects and advantages of my invention will be apparent from the following description and claims, considered together with the accompanying drawing, in which:

The sole figure of the drawings is a diagrammatic representation of an arc lamp and electrode feeding and controlling mechanism embodying the principles of my invention.

Referring to the drawings, I have illustrated an electric arc lamp which includes a positive electrode 1 and a negative electrode 2 mounted upon a suitable mounting mechanism (not shown) to position the negative electrode 2 relative to the positive electrode 1 in such fashion as to produce an electric arc. The feeding mechanism by which the electrodes are fed toward each other, and more particularly, to a desired position relative to a lens or mirror system, may be of any suitable type, one particular form of which may be shown in my United States Letters Patent No. 2,060,347, issued November 10, 1936.

For example, the positive electrode may be fed through a tubular support 3 upon which is rotatably mounted a gear 4 which has upon its front face a scroll gear 5 adapted to be engaged by small pinions 6 carried by a mounting bracket 7 secured to the tubular support 3.

Current is supplied to the positive electrode through any suitable type of sliding contacts, and such are diagrammatically illustrated at 8 as comprising a pair of complementary brush contacts engaging the electrode 1 substantially throughout its entire circumference.

The negative electrode 2 is mounted for movement toward and away from the positive electrode 1 by any suitable mounting means, such mounting being illustrated diagrammatically as comprising a bracket 9 in which the negative electrode 2 is removably supported, the bracket 9 being threaded upon a drive screw 10 adapted to be rotated at any desired speed by an electric motor 11 through a train of gears which includes a shaft 12, a worm and wheel gear 13, shaft 14, and pinions 15 and 16, which drive a friction clutch 17 engaged with a shaft 18 which is in turn geared to the drive screw 10 through miter gears 19.

An extension of the shaft 12 carries a miter gear 20 which engages a miter gear 21 on a shaft 22 to drive from the motor 11 a pinion 23 meshed with the gear 24 so that the gear 24 will be continuously rotated during the entire time the motor 11 is operating. The gear 24 is rigidly mounted on the tubular support 3 so that during the entire time the motor is operating the electrode 1 will be rotated by reason of the fact that the teeth on the small pinions 6 engage a surface of the electrode and act as dogs coupling the rotatable tube 3 with the carbon electrode 1.

Forward feed of the positive electrode 1 is thus accomplished by holding the gear 4 stationary as the tube 3 and bracket 6 rotate relative thereto, and the intermeshing of the pinions 6 with the

now stationary scroll gear 5 will cause the pinions 6 to rotate and feed the electrode 1 forwardly toward the negative electrode.

By selecting the ratio of the gearing interposed between the motor 11 and the feeding mechanism for the positive electrode 1 and between the motor 11 and the feeding mechanism for the negative electrode 2, the two electrodes may be fed toward each other at the relative burning rates of these electrodes. However, in the practice of my invention I prefer that the gear ratio be such that the positive electrode 1 feeds toward the negative electrode 2 at a slightly higher rate than the mere relative burning rate of the positive electrode to the burning rate of the negative electrode.

The motor 11 must be a motor of assured constant speed, and for this purpose a motor having a mechanical speed governor may be employed, or such motor may be of the governor-controlled type shown in the patents to Royal Lee, Nos. 1,630,394 and 1,767,146.

For the practice of my invention, the motor speed as controlled by the governor 25 is selected such as to feed the negative electrode 2 upwardly at precisely the same rate as the known burning rate of the particular negative electrode carbon selected for the arc, and hence the tip of the negative electrode will at all times during the burning of the lamp be positioned at exactly the same position.

The forward feed of the positive electrode should likewise maintain the crater at the end of that electrode at exactly the same position so as to produce an arc of uniform length to thus maintain an illumination of uniform quantity and spectral quality.

To accomplish this, it appears best to arrange the forward feeding movement of the positive electrode at a slightly greater rate than the known burning rate of the particular carbon employed as the positive electrode. The type of drive for the positive carbon shown in my Patent No. 2,060,347 above referred to, may be readily employed but the gear 24 should be arranged to be rotated at a speed somewhat greater than that described in my aforesaid patent so that the additional forward speed may be accomplished for the purpose hereinafter described. Scroll gear 4, when allowed to rotate with and at the speed of the tube 3, produces no forward movement of the electrode 1. However, if gear 4 is restrained the positive electrode will be fed forward and shorten the arc gap, thus moving the plane of the crater face toward the negative electrode.

To cause the positive electrode 1 to feed forward so as to hold the crater in a substantially fixed position or within extremely close limits required for the projection optical system, I provide a means for controlling the forward feed of said electrode under the influence of variations of arc length; that is, variations in either arc currents or voltage across the arc. For application in the field of motion picture production, I prefer to control the feeding of the positive electrode in response to variations in the arc current from a particular selected value. One way to accomplish this is to provide a shaft 27 having a brake drum 28. A brake shoe 29 is normally urged against the brake drum 28 by mounting the same upon a pivoted lever 30 which is spring-urged by a spring 31 toward engagement with the brake drum, the spring being interposed between the lever 30 and any suitable stationary portion

of the arc lamp mounting or housing as indicated at 32. Preferably the tension of the spring 31 is adjustably varied by means of an adjusting mechanism such as a screw 33 threaded to a link 34 engaging one end of the spring 31.

The lever 30 constitutes an armature of an electromagnet 35, the coil of which is connected in series with the arc as indicated by conductors 36 and 37. The strength of the electromagnet 35 is selected such that if the arc tends to shorten, resulting in an increase in amperage, the magnet 35 will pull the brake shoe 29 away from the drum 28, allowing the scroll gear 4 to rotate freely with the supporting tube 3, while as soon as the arc length is restored to its normal or selected value, the brake shoe will be released and will stop further rotation of the gear 4, and the positive electrode 1 will resume its forward feeding motion.

Since the luminosity and light quality of a carbon arc are primarily dependent upon holding the current flow in the arc constant and uniform and assuming that the electrodes are so positioned as to afford the effective arc operation, it will be apparent that by feeding the negative electrode at a uniform overall rate equivalent to its rate of consumption at the current value selected for the particular arc operation, the tip of the negative electrode will hold a substantially fixed position during the entire operation of the arc. Then if the positive electrode is fed by a mechanism which is sensitively responsive to deviations from the selected current standard, the positive electrode crater will be held in extremely close positional relation to the desired position relative to the optical system; that is, the positive electrode crater will be held in a substantially fixed relation relative to the negative electrode tip and will maintain this position by a series of extremely frequently applied movements of feeding action which cease when the current value is exceeded and commence when the current value is below the standard for which tthe mechanism is adjusted.

Thus a control is provided which can be depended upon to maintain arc length, arc brilliance, spectral quality, and accuracy of position with respect to the optical system associated with the arc.

The gearing interposed between the motor 11 and the two electrodes may be readily employed for striking the arc merely by providing suitable hand controls such as indicated at 38 and 39 for the shafts 27 and 18, respectively, by which the positive electrode and the negative electrode may be manually moved to any desired position, or other means well known in the art for striking the arc to start the operation of the lamp.

While I have shown and described the preferred embodiment of my invention, I do not desire to be limited to any of the details set forth herein, except as defined in the appended claims.

I claim:

1. The method of operating an arc lamp employing a positive and negative electrode to maintain a substantially constant arc length and to maintain the crater at a substantially fixed position within extremely narrow limits, which comprises determining the rates at which each of the electrodes burns away at a given intensity of arc, feeding the negative electrode toward the positive electrode at a substantially uniform rate of feed equal to the known rate of consumption of the negative electrode, and feeding the positive electrode toward the negative electrode by

means responsive to minute variations in arc length.

2. The method of operating an arc lamp employing a positive and negative electrode to maintain the arc length constant and to maintain the crater at a substantially fixed position, which comprises determining the rate at which the negative electrode is consumed under a given intensity of arc, feeding the negative electrode toward the positive electrode at a substantially overall uniform rate of speed corresponding to its rate of consumption at the desired intensity value, and feeding the positive electrode toward the negative electrode by means responsive to variations in arc length whereby the positive electrode will be moved in a plurality of frequent feeding steps, each of which is minute to thus provide a substantially uniform rate of feed for the positive electrode.

3. In a control for feeding the positive and negative electrodes of an arc lamp to maintain a predetermined arc length and a predetermined location of the crater, power means for feeding the negative electrode toward the positive electrode at a substantially uniform rate of speed equal to the rapidity at which said electrode is consumed at a predetermined arc intensity, and feeding means for the positive electrode for feeding the same toward the negative electrode, which comprises means sensitively responsive to variations in arc length to provide a rate of feed of said positive electrode which bears the same ratio to the rate of feed of the negative electrode as the rate of consumption of the positive electrode bears to the rate of consumption of the negative electrode.

4. In a control for feeding the positive and negative electrodes of an arc lamp to maintain the arc length constant and to hold the crater in a substantially fixed position under given conditions of arc intensity, the combination of feeding means for the negative electrode including a motor directly connected to said feeding means, said motor having a predetermined accurately maintained rate of movement, gearing interposed between said motor and said feeding means to cause said negative electrode to be fed toward the arc at a rate corresponding to the rate of consumption of said negative electrode under said arc intensity conditions, and means for feeding said positive electrode including means sensitive to variation in arc length to thereby feed said positive electrode at a rate corresponding to the rate of consumption of said positive electrode.

5. In a control for feeding the positive and negative electrodes of an arc lamp to maintain the arc length constant and to hold the crater in a substantially fixed position under given conditions of arc intensity, the combination of feeding means for the negative electrode including a motor directly connected to said feeding means, said motor having a predetermined accurately maintained rate of movement, gearing interposed between said motor and said feeding means to cause said negative electrode to be fed toward the arc at a rate corresponding to the rate of consumption of said negative electrode under said arc intensity conditions, means for feeding said positive electrode including means sensitive to variation in arc length, and means interposed between said arc length sensitive means and said positive electrode feeding means for causing said sensitive means to feed said positive electrode at a rate in excess of the burn-

ing rate of said positive electrode whereby said feeding means for said positive electrode will tend to advance the positive electrode more rapidly than it will be consumed but will actually feed said positive electrode at the rate it is consumed.

6. The method of operating an arc lamp employing a positive electrode and a negative electrode, which comprises feeding the negative electrode at a substantially uniform overall rate equivalent to its predetermined burning rate of consumption for a given current value in said arc and in which the positive electrode is fed by means responsive to arc length whereby the tip of said negative electrode comprises a point of reference relative to which the positive electrode will be fed.

ELMER C. RICHARDSON.

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

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