June 25, 1946. L. A. SHELDON 2,402,922

ARC LAMP ELECTRODE REGULATING SYSTEM AND MECHANISM

Filed April 7, 1941 2 Sheets-Sheet 1

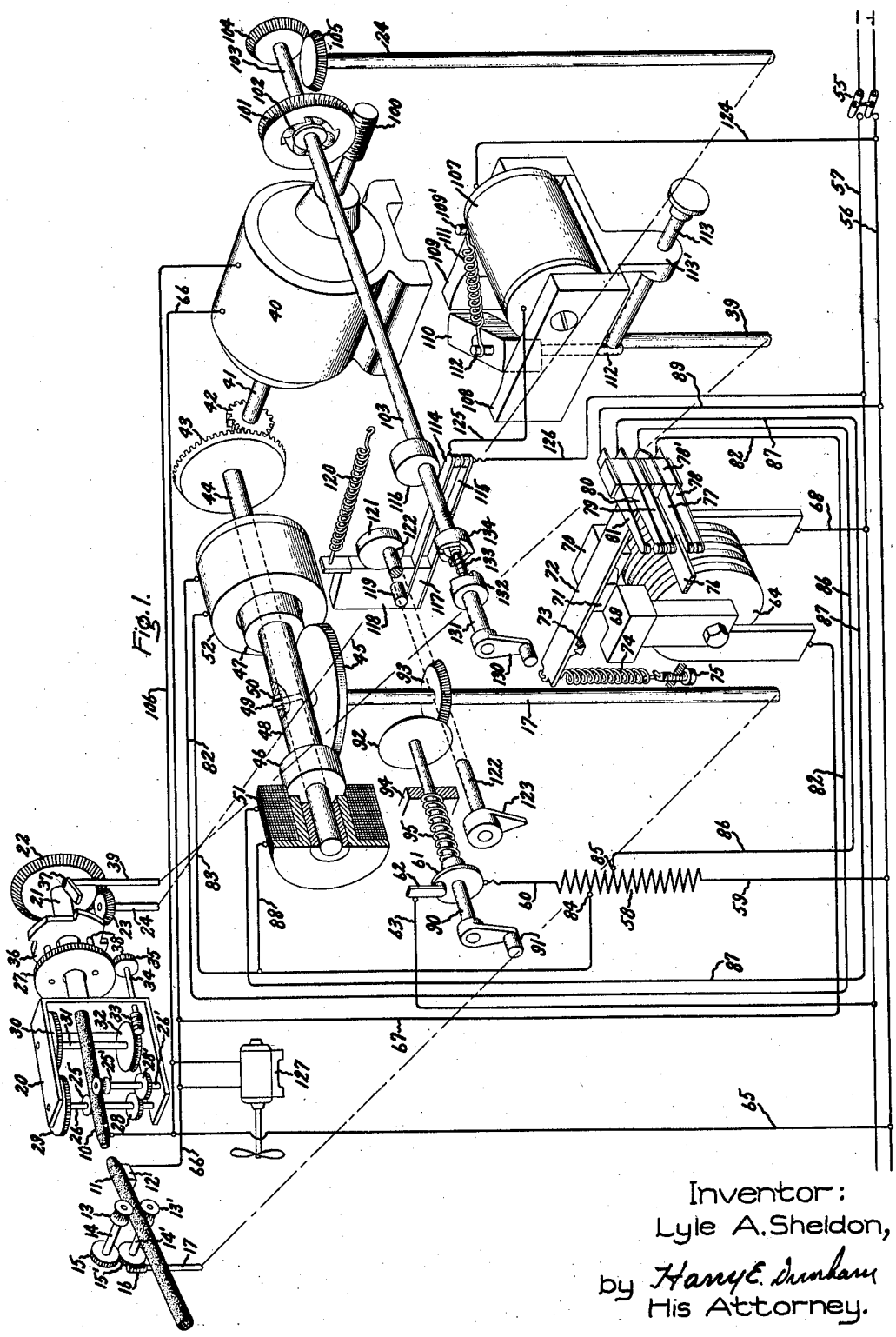


Fig. 1.

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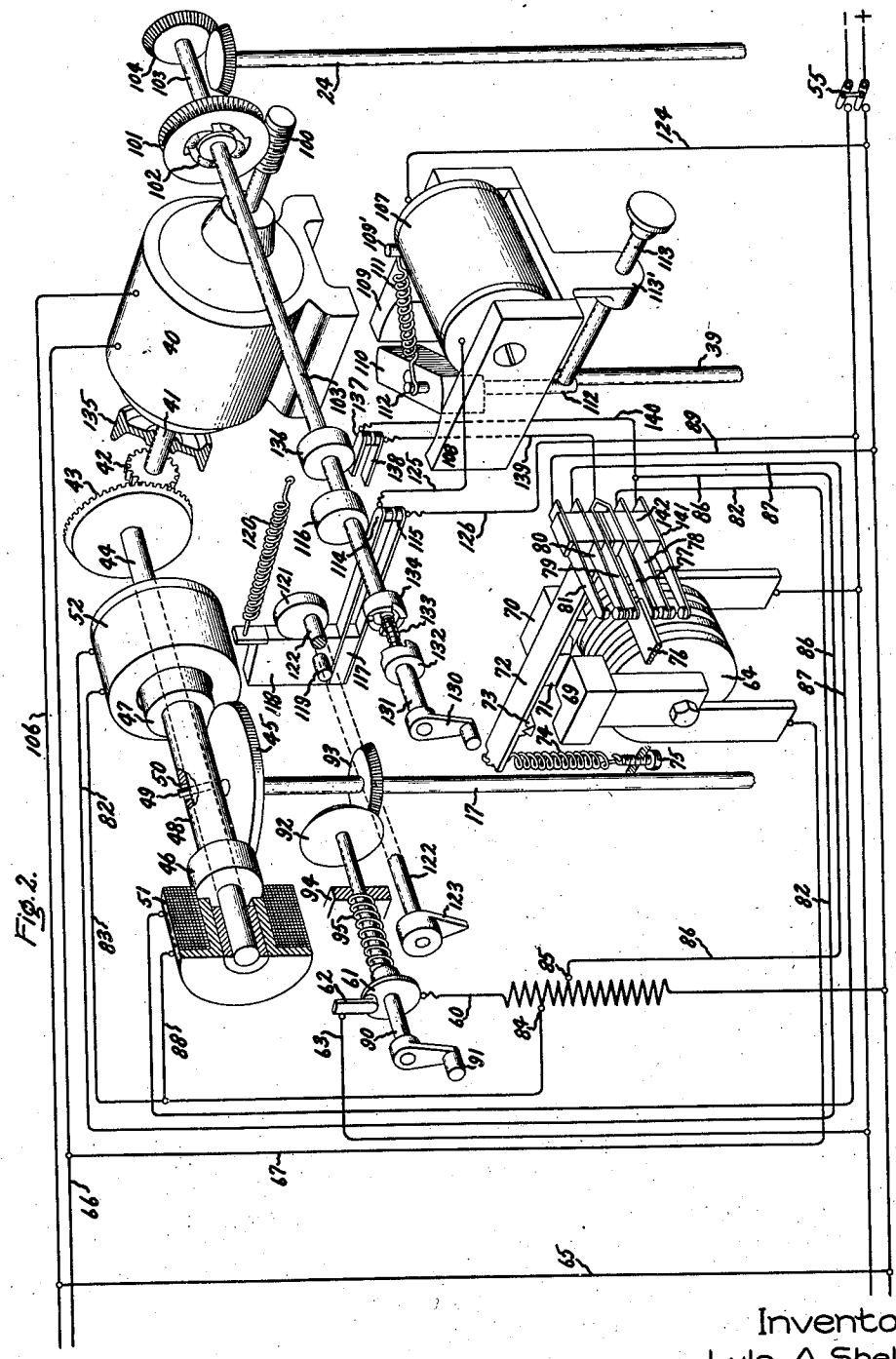


Fig. 2.

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UNITED STATES PATENT OFFICE

2,402,922

ARC LAMP ELECTRODE REGULATING SYSTEM AND MECHANISM

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Application April 7, 1941, Serial No. 387,372

12 Claims. (Cl. 314—79)

1

My invention relates to arc lamps, and more particularly to electrode regulating systems and mechanisms, for arc lamps such as are used in searchlights and similar light projectors.

One object of my invention is to provide an electrode regulating system and mechanism which is responsive to slight changes in arc characteristics.

Another object of my invention is to produce an electrode regulating system and mechanism which will automatically move the electrodes to a starting position after the arc lamp is shut down so as to reduce the time required to start the arc after the next closure of the operating switch.

For a better understanding of my invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings, Fig. 1 is a diagrammatic illustration of the electrodes, the supporting mechanism therefor, together with the shafts for operating the mechanism, and a diagrammatic illustration of my improved regulating system and mechanism for actuating the electrode mechanism. The shafts transmitting the rotary motion, from the actuating mechanism, and the corresponding shafts at the electrode mechanism which receive this rotary motion are broken off at the respective mechanisms and are, for the sake of simplicity, connected by dot and dash lines to illustrate this mechanical connection between the corresponding shafts. The electrodes and the supporting mechanism are placed at the focal axis of a light reflector while the actuating mechanism is placed at a distance from the electrode mechanism, preferably on the surface of an enclosing drum which surrounds the electrode holding mechanism and the reflector. The angular relationship between the actuating mechanism and the electrode supporting mechanism varies for different searchlight structures and it is therefore to be understood that the shafts at the actuating mechanism and the shafts at the electrode supporting mechanism may be one and the same shaft or may be connected mechanically in any suitable manner to transmit rotary motion from the actuating mechanism to the electrode supporting mechanism. Fig. 2 is a modification of the electrode feeding system and mechanism as illustrated in Fig. 1.

Referring to the drawings in detail, Fig. 1 illustrates a positive electrode 10 and a negative electrode 11. The negative electrode is supported in a conventional manner by a brush 12 and a pair of feed rollers 13, 13'. The feed rollers are respectively mounted on shafts 14, 14' upon which are mounted engaging gears 15, 15'. The gears 15, 15' are driven by a worm 16 mounted on a shaft 17. The shaft 17 is driven by my improved regulating system and mechanism to advance, or to retract, the negative carbon thereby to start and to maintain constant an arc between the tip of the negative electrode and the crater in the end of the positive electrode.

2

The positive electrode, as illustrated in Fig. 1, is mounted in a conventional mechanism for constant rotation during operation and for intermittent axial movement to maintain the crater in a predetermined position. The supporting mechanism, which is only diagrammatically illustrated, includes a U-shaped frame 20 mounted on the end of a guide sleeve 21. A bevel gear 22 is mounted on the other end of the sleeve 21 and is engaged by a gear 23 mounted on the end of a drive shaft 24. This shaft 24 is driven at a constant speed during the operation of the arc lamp to rotate the frame 20 and the positive electrode supported thereby.

The positive electrode 10 projects from the guide sleeve 21 into the frame 20, the projecting arms of the U-shaped frame being parallel to the electrode. The electrode is supported in the frame by a pair of feed rolls 25, 25' mounted respectively on shafts 26, 26', the shafts being mounted in the frame 20. The shafts 26, 26' are connected through a system of gearing to a drive gear 27 loosely mounted on the sleeve 21. This system of gearing may be traced from the interengaging gears 28, 28' mounted on the shafts 26, 26' respectively to gear 29 mounted on shaft 26, thence to gear 30 mounted on a shaft 31 upon which is also mounted a worm gear 32 driven by a worm pinion 33 mounted on a shaft 34. The shaft 34 is mounted transversely of the shaft 31 and has mounted upon it a pinion 35 which is in engagement with the drive gear 27. The shafts 26, 26', 31 and 34 are all supported by the frame 20 and during rotation of the frame move with the frame. The shafts and the gears do not rotate about their own axes unless there is a relative rotation between the sleeve 21 and the drive gear 27. To produce such relative rotation between the sleeve 21 and the gear 27, the gear 27 is attached to a notched disk 36 which may be stopped by a pawl 37. The notched disk, which is similar to a ratchet wheel, is attached to the gear 27 by pins 38 so that it will rotate with the

drive gear 27 about a common axis. The pawl 37 is mounted upon the end of a shaft 39 and may be moved into and out of the path of movement of the disk by moving the shaft 39 about its axis. When the pawl 37 is moved into the path of the disk 36, it moves into one of the notches of the disk and holds the disk and gear 27 stationary. The pinion 35 is thereby forced to roll over the periphery of the gear 27 thereby rotating the shaft 34 and effecting, through the system of gears above described, a rotation of the feed rolls 25, 25' to advance the electrode 10. To stop such advance movement, the pawl 37 is moved out of the path of the disk 36 to allow the disk to move with the sleeve 21.

The mechanism so far described is one form of such mechanism commonly used. It is spaced from the actuating mechanism to which it is connected by shafts 17, 24, 39. The apparatus and system for operating the shafts 17, 24 and 39 of this mechanism is built in accordance with my invention and, for the sake of simplicity in the drawings, the shafts 17, 24 and 39 are broken, one end of each shaft being shown at the electrode holder and the other end of each shaft being shown at the operating apparatus. The two ends of each of these shafts are not axially aligned in this diagrammatic illustration but are connected by dot and dash lines. It is to be understood that in actual installations the shafts are either continuous or are mechanically connected, in any suitable manner, to transmit the rotary motion of the shaft at the driving apparatus to the similarly designated shaft at the electrode holders.

The system and apparatus for driving the shafts 17, 24, 39, as diagrammatically illustrated, includes a motor 40 which is energized during the operation of the lamp. This motor is connected, through its shaft 41 and a pair of engaging gears 42 and 43, to drive a shaft 44, the gear 42 being mounted on the end of the motor shaft, and the gear 43 being mounted on the end of the shaft 44 which is supported in any convenient manner (not shown). The movement of the shaft 44 is transmitted to the negative electrode feed shaft 17 by a clutch device including a friction disk 45 mounted on the end of the shaft 17 and drive pinions 46 and 47 arranged to engage alternatively the friction disk 45 at diametric opposite points. The pinions 46 and 47 are attached to opposite ends of a sleeve 48 mounted on the shaft 44 and in driving engagement with the shaft 44 through a driving pin 49 mounted in the shaft 44 and projecting through a slot 50 in the sleeve. The pinions 46 and 47 comprise the armatures of magnets 51 and 52 respectively. When the coil of magnet 51 is energized, it attracts its armature 46 and through the sleeve 48 pulls the armature 47 into frictional driving engagement with the edge of the disk 45, this armature then operates as a friction pinion and drives the shaft 17 in one direction. When coil 52 is energized, it attracts the armature 47 and through sleeve 48 effects an engagement of the armature 46 with the disk 45, the armature 46 then operates as a friction pinion to drive the shaft 17 in an opposite direction.

The magnet coils 51 and 52 are, in accordance with my invention, energized from a potentiometer through contacts operated by a magnet coil connected, preferably, in series with the arc current and therefore responsive to variations of the arc current. In some cases it may be satisfactory to use a magnet coil connected across the electrodes and therefore responsive to variations of the arc voltage. The potentiometer circuit may be traced from the power switch 55 illustrated in the lower right-hand corner of the drawing as a double-pole single-throw switch arranged to connect a suitable source of power, indicated merely by the plus and minus terminals, to power supply conductors 56 and 57. The potentiometer, comprising a resistor 58, is connected at one end through a conductor 59 to the conductor 56 and at its other end it is connected through a conductor 60, contact 61, brush 62 and a conductor 63 to the supply conductor 57. The circuits to the regulating magnet coils 51 and 52 are controlled by a coil 64 which is connected in series with the arc current and is preferably referred to as the current coil. This coil is a spirally wound copper bar having a relatively large cross section so as to carry the entire arc current with little loss. The circuit of this coil 64 may be traced from the positive supply conductor 56 through a conductor 65 to the positive electrode 10, through the arc to the negative electrode 11, conductors 66 and 67 to one end of the coil 64. The other end of the coil is connected to supply conductor 57 through a conductor 68. The current coil 64 is provided with magnet poles 69, 70 between which an armature 71 attached to a pivoted arm 72 is positioned to move relatively to the pole faces in accordance with the magnetic force created by the current flowing through the coil 64. The arm 72 is pivoted upon a knife edge support 73 and has attached to one end thereof a spring 74 the tension of which may be adjusted by an adjusting screw 75 mounted in a fixed support. The tension of this spring is balanced against the magnetic force exerted upon the armature 71. An unbalance between these two forces effects a movement of armature 71 which in turn effects a movement of a group of contact fingers mounted upon the free end of the arm 72.

The contact fingers mounted upon the free end of the arm 72 comprise resilient metal strips spaced from each other by insulating blocks and arranged in pairs on the upper side and the lower side of the moving arm 72. A stationary actuating arm 76 is positioned between pairs of the contact fingers so that a movement of the arm 72 and of the contact fingers effects an engagement between pairs of the contact fingers, to close corresponding circuits of the magnet coils 51, 52. In the arrangement illustrated a pair of resilient contact fingers 77, 78 is mounted on the under side of the arm 72, the contact fingers being spaced from each other by an insulating block 78'. An upward movement of the arm 72 moves the end of contact finger 77 into engagement with the stationary actuating arm 76 and holds the end of that contact finger stationary until a further movement of the arm 72 moves the contact finger 78 into engagement with the contact 77. Suitable contact tips are provided on the ends of the resilient contact fingers to provide the engaging surfaces through which current may pass from one contact finger to the other. Similar contact fingers 79, 80 and 81 are mounted on the upper side of the arm 72 and are brought into engagement with each other upon a downward movement of the supporting arm 72.

The supporting arm 72 moves the contact fingers 77, 78 upwardly when the current in the coil 64 falls below a predetermined value. The spring 74 then overcomes the pull of the poles 69, 70 and effects a closure of the circuit between contact fingers 77, 78 and a completion of the circuit to coil 52. The circuit for coil 52 may

be traced from the contact finger 78 through a conductor 82 to one terminal of the coil, through conductor 83 to a tap 84 on the potentiometer resistor 58. The contact finger 77 is connected to a tap 85 on the potentiometer resistance through a conductor 86. The coil 52 is therefore connected across that portion of the potentiometer resistor 58 which is between the taps 84 and 85. The coil 52 being thus energized, attracts its armature 47 and through the sleeve 48 pulls the armature 46 into driving engagement with the disk 45. This operation being due to a reduction in arc current, the coil 64 is arranged to effect a rotation of the disk 45 and shaft 17 in a direction to effect a corresponding forward movement of the negative electrode 11 to reduce the arc length and its resistance, thereby to increase the current to normal value. When such normal current value is reached, the pull of the poles 69, 70 overcomes the pull of the spring 74 to move the arm 72 downwardly and thereby to separate the contact finger 77, 78. The coil 52 then becomes deenergized and no longer pulls the armature 46 into frictional engagement with the disk 45. The driving relationship between armature 46 and disk 45 is thereby broken, the armature 46 continuing to rotate without moving the disk 45.

In case the current in current coil 64 rises above a predetermined value, the arm 72 is pulled downwardly. The contact finger 79 then engages the stationary actuating arm 76 and a further movement of the arm 72 moves the contact finger 80 into engagement with the contact finger 79 to close the circuit to the coil 51. This circuit may be traced from the contact finger 79 through the conductor 86 to the potentiometer tap 85. The contact finger 80 is connected through a conductor 87 to one terminal of the coil 51 and the other terminal of the coil 51 is connected through conductors 88, 83 to the potentiometer tap 84. This operation of the pivoted arm 72 therefore energizes the coil 52, this coil also being connected across that portion of the potentiometer resistor 58 between the taps 84 and 85. The coil 51 then attracts its armature 46 and through sleeve 48 pulls the armature 47 into driving engagement with the disk 45. The shaft 44, operating in one direction only, now drives the armature 47 in the same direction as it drives the pinion 46 but the engagement with the disk 45 is at a diametrically opposite point and therefore the disk 45 and the shaft 17 are reversed in direction to effect a retraction of the electrode 11 and a lengthening of the arc between the electrodes 10 and 11.

In case the current increases in coil 64 to a still higher value than in the previous operation, the arm 72 is pulled downwardly until a circuit is established between the three contact fingers 79, 80 and 81. The contact fingers 79, 80 have already established a circuit between the retracting coil 51 and the potentiometer, and the additional circuit established through the contact finger 81 establishes another circuit to the potentiometer which may be traced from supply conductor 56 through a conductor 89, through contact fingers 81, 80, 79, and from the contact finger 79 through conductor 86 to tap 85 on the potentiometer resistance. This circuit makes ineffective that portion of the potentiometer resistance which is between the tap 85 and the conductor 59 and thereby places the electrode potential across the remaining portion of the resistor. This operation places a greater portion

of the available potential upon the coil 51 and is used only when the current in the current coil 64 rises to values attained when the two electrodes 10 and 11 are substantially in contact with each other. This usually occurs at the starting operation of the arc. The potential drop between the electrodes is low at that instant and a reduction in the potentiometer resistance is necessary to obtain sufficient potential across the coil 51 to insure a good drive connection between the pinion 47 and the disk 45 to retract the negative electrode 11 as quickly as possible.

It is above pointed out that the potentiometer circuit includes a disk 61 and a brush 62. The disk 61 is mounted upon a shaft 90 operable by a crank 91 which is provided to operate the shaft 17 by hand. To effect such operation the shaft 90 is moved axially through a support 94 against the pressure of a spring 95 to effect an engagement between a pair of bevel gears 92, 93 and to effect a separation of the disk 61 and the brush 62. This operation simultaneously makes ineffective the electrical control for the shaft 17 and establishes a mechanical control between the shaft 90 and the shaft 17; the gear 92 being mounted on the shaft 90 and the gear 93 being mounted on the shaft 17. This establishes a hand control for the shaft 17 from the crank 91 which is used to make quickly adjustments that may become necessary when new carbons are placed into the lamp.

The positive electrode mechanism is actuated by the motor 40 through a worm pinion 100 mounted on an extension of the motor shaft 41 opposite to the extension upon which the pinion 42 is mounted. The pinion 100 engages a worm gear 101 which, through a ball clutch 102, drives a shaft 103. The shaft 103 drives a shaft 24 of the positive electrode rotating mechanism through a pair of beveled gears 104, 105. The rotation of this shaft 24 effects a constant rotation of the positive electrode 10 during the operation of the arc lamp. The motor 40 is connected to the supply conductors 56 and 57 in parallel with the electrodes 10 and 11 by a circuit which may be traced as follows: Supply conductor 56, conductor 65, conductor 106, motor 40, conductor 66, conductor 67, magnet coil 64 and conductor 68 to supply conductor 57. Thus motor 40 is always running when the lamp circuit is closed.

The positive electrode is advanced at regular intervals by a periodic operation of the pawl shaft 39. This shaft is actuated by an electromagnet coil 107 provided with pole pieces 108, 109 and with an armature 110 attached to the end of the pawl shaft 39. A spring 111 attached to the pole piece 109 by a pin 109' and to one side of the armature 110 by a pin 112 pulls the armature and its shaft 39 into a position in which the pawl 37 is out of the path of the disk 36 as illustrated in Fig. 1. The armature 110 in this position is at an angle to the magnetic path between the pole faces. The pin 112 attached to the armature 110 projects downwardly to engage the end of an adjustable pin 113 which serves as a stop to determine this inactive position of the armature, the pin 113 being supported in a lug 113' projecting from the magnet frame. Upon energization of the coil 107 the armature 110 rotates against the pull of the spring 111 and moves into a position to align itself with the magnetic field between the pole faces. The pawl 37 correspondingly moves into the path of movement of the disk 36 and stops rotation of this disk and the attached gear 27. The electrode mechanism con-

tinues to rotate, being driven by the shaft 24, and the driving pinion 35 is forced to roll over the gear 27, thereby advancing the positive electrode through the system of gears above described. This operation continues only as long as the pawl 37 engages the disk 36.

The coil 107 is intermittently energized, to effect engagement by the pawl 37 of disk 36, by an adjustable contact mechanism so that the intermittent advance of the positive electrode may be adjusted to equal the rate of consumption of the electrode. This intermittent energization is obtained through a pair of contact fingers 114 and 115 operated by a cam 116 mounted on the continuously rotating shaft 103. The circuit between the coil 107 and the contact fingers 114 and 115 may be traced from conductor 56 to coil 107 through conductor 124, through the coil, through conductor 125, contact fingers 114, 115, through conductor 126 to supply conductor 57. The cam 116 engages the contact finger 114 for a predetermined period during each revolution of the shaft 103 to move the contact finger 114 into engagement with the contact finger 115 and hold it in engagement for this predetermined time. The contact fingers 114 and 115 are provided with suitable contact tips, are spaced from each other by an insulating block 117 and are supported by a block 118. The block 118 is pivotally mounted by a pin 119 and is held in a stationary position about this pivot by a spring 120 against an adjustable cam 121. The cam 121 may be adjusted by a shaft 122 having thereon a position-indicating knob 123. The shape of the cam 121 is such that a movement of the shaft 122 about its axis effects a movement of the block 118 about its pivot 119 against the tension of the spring 120. The contact fingers 114 and 115 projecting from the block to a position under the cam 116 are thereby moved nearer to, or farther from, the axis of rotation of the cam 116. A movement of the contact arms nearer to the axis of rotation of the cam 116 increases the period of time, during each revolution of the cam 116, during which the contacts 114 and 115 are in engagement with each other. A movement of the contact arms away from the axis of rotation of the cam 116 decreases the time during each revolution of cam 116 during which the contacts 114 and 115 are in engagement with each other and thereby the rate of the intermittent feed of electrode 10 is reduced. This cam 116 and shaft 103 may also be operated by a hand crank 130 mounted on a shaft 131. The shaft 130 supports one half, 132, of a coupling and may be axially moved against the pressure of a spring 133 to effect an engagement of the coupling half 132 with a second coupling half 134 mounted on shaft 103. The ball clutch 102 will release the gear 101 to permit a movement of the shaft 103 in a direction to advance the positive electrode.

One of the main advantages of the system and apparatus above described is its improved sensitivity to changes in arc current. The actuating coils of the negative electrode feeding device being connected across a portion of a potentiometer resistor are responsive to a fraction of the normal arc voltage and in case of low voltage, such as occurs at starting, contacts are provided to place this entire voltage upon the coil to produce substantially normal excitation.

A second important function of my improved mechanism is the automatic advancement of the negative electrode into substantially starting position after a shutdown of the arc lamp. When the main line switch 55 is opened, the arc current ceases to flow and the motor 40 is deenergized. The motor continues to rotate, however, due to its inertia. The current coil 64 at this instance is deenergized because the current in the arc has ceased to flow and the spring 74 effects a closure of the contacts 77, 78, which contact closure establishes a circuit from the potentiometer resistor to the magnet coil 52. If at this instant a suitable current is provided across the potentiometer resistor, the coil 52 will be energized and will effect a closure of the clutch, whereby the kinetic energy of the motor will operate the electrode mechanism to advance the electrode 10 until the kinetic energy of the motor 40 is spent. Such current for the potentiometer resistor and for energizing the coil 52 may be obtained by utilizing regenerative current from motor 40, by utilizing an auxiliary source of current or by a combination of the two. In the present instance, it is assumed that the motor 40, when switch 55 is open, has sufficient inertia to actuate the mechanical parts connected to it but is not capable in addition thereto of supplying the needed current for the potentiometer resistor and the coil 52. Accordingly, provision is made whereby such current is obtained from an auxiliary motor 127, which is a ventilating motor in the present instance and is connected across the conductors 66 and 106 to drive a ventilating fan positioned within a casing (not shown) in which the electrode mechanism is placed. This motor is normally larger than the motor 40 and the ventilating fan, acting as a fly wheel, adds considerable inertia to the armature of this motor. This additional inertia causes the motor to continue to rotate at a substantial speed and for a substantial time period subsequent to the opening of the switch 55 and to regenerate current sufficient to energize the coil 52. The circuit for this motor may be traced from one terminal of the motor to conductors 66 and 67, coil 64, conductors 68, 57, 63, contact 62, disk 61, conductor 60, potentiometer resistor 58, conductors 59, 56, 65 and 106 to the other terminal of the motor. It will be noted that the current coil 64 is included in this circuit. The current from the motor is too small, however, to effect a separation of the contacts 77, 78. The clutch coil 52 thereby remains energized until the kinetic energy of the motor 127 is spent. As a result of this operation the negative electrode 11 is moved towards its starting position and by proper dimensioning of the kinetic energy of the two motors the electrode 11 is moved to substantially starting position. Upon reclosure of the switch 55, therefore, substantially no time is lost in first advancing the electrode to the starting position. By this arrangement the starting time that is the time between the closure of the switch 55 and the actual ignition of the arc may be reduced substantially. For example, it may be reduced from a period of about 10 seconds to a period of approximately 3 seconds. This is a very important advantage in searchlight operation, especially for certain purposes.

In some instances where no auxiliary motor is available or the auxiliary motor is too small, for providing the regenerative current necessary to energize the coil 52, a motor 40 may be utilized having sufficient inertia to provide not only the mechanical power necessary to operate the electrode advance mechanism but also to provide a part of, or all of, the regenerative current. To increase the inertia of the motor 40 a larger capacity motor may be provided or the armature inertia of the smaller motor may be increased by the ap-

plication of a flywheel upon the armature shaft.

Fig. 2 is similar to Fig. 1, having corresponding elements designated by the same numerals. It differs from Fig. 1 in that no fan motor is provided and the current needed to energize coil 52 is supplied by the motor 40, the regenerating circuit for the motor 40 being the same as that for motor 127, each being connected to the conductors 66 and 106. A flywheel 135 illustrated in section is mounted on the shaft 141 to provide the additional inertia required.

Fig. 2 also differs from Fig. 1 in that a normally intermittent energization for the coil 52 is provided. This intermittent operation is obtained by the provision of a second cam 136 upon the continuously rotating shaft 103, together with a pair of contacts 137 138 actuated by the cam to provide the intermittent closure of the circuit for coil 52, thereby to effect an intermittent advance of the negative electrode 11. The circuit may be traced from the coil 52 through conductor 82 to the contact 78, from the contact 78 to contact 77, through a conductor 139 to the contact 138, through contact 137, conductor 140 back to conductor 86. This circuit merely introduces an intermittently closed pair of contacts in order to intermittently energize the coil 52 and thereby to effect an intermittent advance of the negative electrode. In connection with this mechanism a third contact arm 141 may be provided below the contact 78 and spaced therefrom by an insulating block 142. A slight reduction in current in the current coil 64 will effect a closure of the contacts 77 and 78 and a greater reduction in current in this coil will effect a closure between contacts 78 and 141 thereby shunting out the intermittent feed and introducing a constant feed as in Fig. 1. This additional arrangement of contacts, therefore, introduces an additional regulating step whereby the sensitivity of the mechanism and its speed of response is improved.

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

1. The combination, in an arc lamp having a pair of electrodes, of means responsive to the arc current for adjusting one of said electrodes relatively to the other during operation, means for establishing a common electric circuit for supplying operating current to the electrodes and to said adjusting means, and means within said lamp for supplying current to said adjusting means effective at the instant the operating current in said common circuit is interrupted during normal operation, thereby to effect a continuation of the operation of said adjusting means after the interruption of the normal supply current.

2. The combination, in an arc lamp having a pair of electrodes, of means for adjusting one of said electrodes relatively to the other during operation of the lamp, a common electric supply circuit for supplying operating current to the electrodes and to said adjusting means, a motor, reversing mechanism through which the motor operates said adjusting means to move one electrode toward the other, and means effective at the instant at which the current in said common electric supply circuit is interrupted during normal operation of the lamp to provide the electric current necessary to effect an actuation of said reversing mechanism.

3. In an arc lamp for a searchlight including a negative and a positive electrode, the combination of an electrode feed mechanism operable alternatively to advance and to retract one of said electrodes, a motor, means for connecting said motor to drive said electrode mechanism, a potentiometer resistor connected across the said electrodes, magnet coils arranged to be connected across a part of said potentiometer resistor and to operate said means for connecting said motor to drive said electrode mechanism respectively to advance and to retract said electrode, and means responsive to variations in a characteristic of the arc arranged to close a circuit between said potentiometer resistor and said magnets respectively to effect an energization of said coils respectively.

4. In an arc lamp for a searchlight the combination of a negative and a positive electrode, a negative electrode feed mechanism operable alternatively to advance and to retract said negative electrode, a motor, means for connecting said motor to drive said negative electrode feed mechanism, a potentiometer resistor connected across the said electrodes, magnet coils arranged to be connected across a part of said potentiometer resistor and when energized to operate said means for connecting said motor to drive said negative electrode mechanism respectively to advance and to retract said electrode, and means responsive to variations in a characteristic of the arc arranged to close a circuit between said potentiometer resistor and said magnets respectively to effect an energization of said coils respectively.

5. In an arc lamp for a searchlight including a negative and a positive electrode, the combination of an electrode feed mechanism operable to advance one of said electrodes, a motor, a clutch device for connecting said motor to drive said electrode mechanism, a potentiometer resistor connected across the said electrodes, magnet coils arranged to be connected across a part of said potentiometer resistor and to operate said clutch device to effect an operation of said electrode mechanism to advance said electrode, means responsive to variations in a characteristic of the arc arranged to effect a periodic closure of a circuit between said potentiometer resistor and said magnet thereby effecting an intermittent energization of said coil, said means being operable upon a predetermined greater variation in the arc characteristic to effect a continuous closure of said circuit.

6. In an arc lamp for a searchlight, the combination of a negative electrode and a positive electrode, a feed mechanism for said negative electrode, a motor electrically connected in multiple with said electrodes, clutch means for connecting said motor to drive said negative electrode feed mechanism, a potentiometer resistor connected across said electrodes, a pair of magnet coils arranged to be connected across a part of said potentiometer resistor and when energized to operate said clutch means for connecting said motor to said negative electrode mechanism respectively to advance and to retract said electrode, a group of contacts, means to operate said contacts in response to variations in a characteristic of the arc and arranged to close a circuit between said potentiometer resistor and said magnet coils respectively to effect an energization of said coils respectively, and a pair of contacts in said group and operated by said means arranged to establish a shunt circuit about a part of said potentiometer resistor under predetermined operating conditions so as to apply substantially the whole available voltage to said magnet coils.

7. In an arc lamp, the combination of an elec-

trode advance mechanism, a motor provided with a predetermined inertia and regenerating characteristic, a clutch mechanism operable to connect said motor to drive said electrode advance mechanism, electroresponsive means for operating said clutch mechanism and means responsive to an interruption of the current in said lamp for connecting said electroresponsive means in circuit with said motor, whereby upon a sudden interruption of supply current to said motor during operation the motor is both mechanically and electrically connected to apply its kinetic energy to advance the electrode to substantially its starting position.

8. In an arc lamp, the combination of an electrode advance mechanism, a motor provided with a predetermined inertia and regenerating characteristic and electrically connected to the circuit of the arc lamp, a clutch mechanism operable to connect said motor to drive said electrode advance mechanism, electroresponsive means for operating said clutch mechanism, means responsive to an interruption of the arc for connecting said electroresponsive means in circuit with said motor, whereby upon the interruption of the current to the arc lamp during operation the said motor and said electroresponsive means being connected in circuit with each other the regenerated current from said motor flows through and energizes said electroresponsive means to effect a closure of said clutch and the electrode advance mechanism is operated until the kinetic energy of the motor is spent.

9. In an electrode regulating mechanism, the combination of a positive and a negative electrode, feed rolls for axially moving one of said electrodes, a motor electrically connected in circuit with said electrode, a clutch device operable to connect said motor to operate said feed rolls, a magnet arranged to operate said clutch device to effect an advance of said electrode, means responsive to a cessation of the arc current for establishing an electric circuit between said motor and said magnet, said motor being provided with armature inertia and regenerating characteristic of such magnitude as to energize said magnet and to effect an operation of said electrode moving mechanism in a direction to advance said electrode toward its starting position subsequent to a cessation of current through the electrodes during operation, whereby the subsequent starting period between resumption of current flow and the arc ignition is correspondingly reduced.

10. In an arc lamp, the combination of an electrode, feed rolls operable to advance said electrode, a motor, a clutch device operable to connect said motor to operate said feed rolls to advance said electrode to starting position, a magnet coil arranged to operate said clutch device to effect an advance of said electrode, means responsive to a cessation of the current flowing through said lamp for closing the circuit to said magnet, a fan motor normally connected in circuit with said first mentioned motor and connected in circuit with said magnet upon an interruption of current in said lamp, said fan motor being provided with armature inertia and regenerating characteristic of such magnitude as to energize said magnet and thereby effect an operation of said clutch, whereby upon a simultaneous interruption of current to both said motors the electrode moving mechanism is operated by the kinetic energy of said first-mentioned motor in a direction to advance said electrode toward its starting position subsequent to an interruption of current to said lamp, the subsequent starting period between resumption of current flow and the arc ignition being correspondingly reduced.

11. In an arc lamp, the combination of an electrode circuit, an electrode advance mechanism, a motor having a predetermined inertia and regenerating characteristic, a circuit therefor, a clutch device operable to connect said motor to drive said electrode advance mechanism, electroresponsive means for operating said clutch device, means responsive to an interruption of the arc for connecting said electroresponsive means in circuit with said motor to energize said electroresponsive means and effect an operation of said clutch, and a common switch for said electrode and motor circuits, whereby upon the opening of said common switch during operation of said lamp the said motor and said electroresponsive means being connected in circuit with each other the regenerated current from said motor flows through and energizes said electroresponsive means to effect a closure of said clutch whereby the electrode advance mechanism is operated until the kinetic energy in the motor is spent.

12. In an arc lamp, the combination of a negative electrode, feed rolls operable to advance said negative electrode, a driving motor, a clutch device operable to connect said driving motor to operate said feed rolls to advance said negative electrode to starting position, a magnet coil arranged to operate said clutch device to effect an advance of said electrode, means responsive to a cessation of the current flowing through said electrode for closing the circuit to said magnet coil, an auxiliary motor normally connected in circuit with said electrode and connected in circuit with said magnet coil upon an interruption of current in said lamp, said auxiliary motor being provided with armature inertia and regenerating characteristic of such magnitude as to energize said magnet coil and thereby effect an operation of said clutch upon an interruption of supply current during normal operation, whereby the electrode moving mechanism is operated by the kinetic energy of said driving motor in a direction to advance said electrode toward its starting position subsequent to an interruption of current to said lamp.

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