Aug. 2, 1938. C. T. CROCKER 2,125,769

ELECTRIC ARC LAMP

Filed Oct. 17, 1936

Fig. 1.

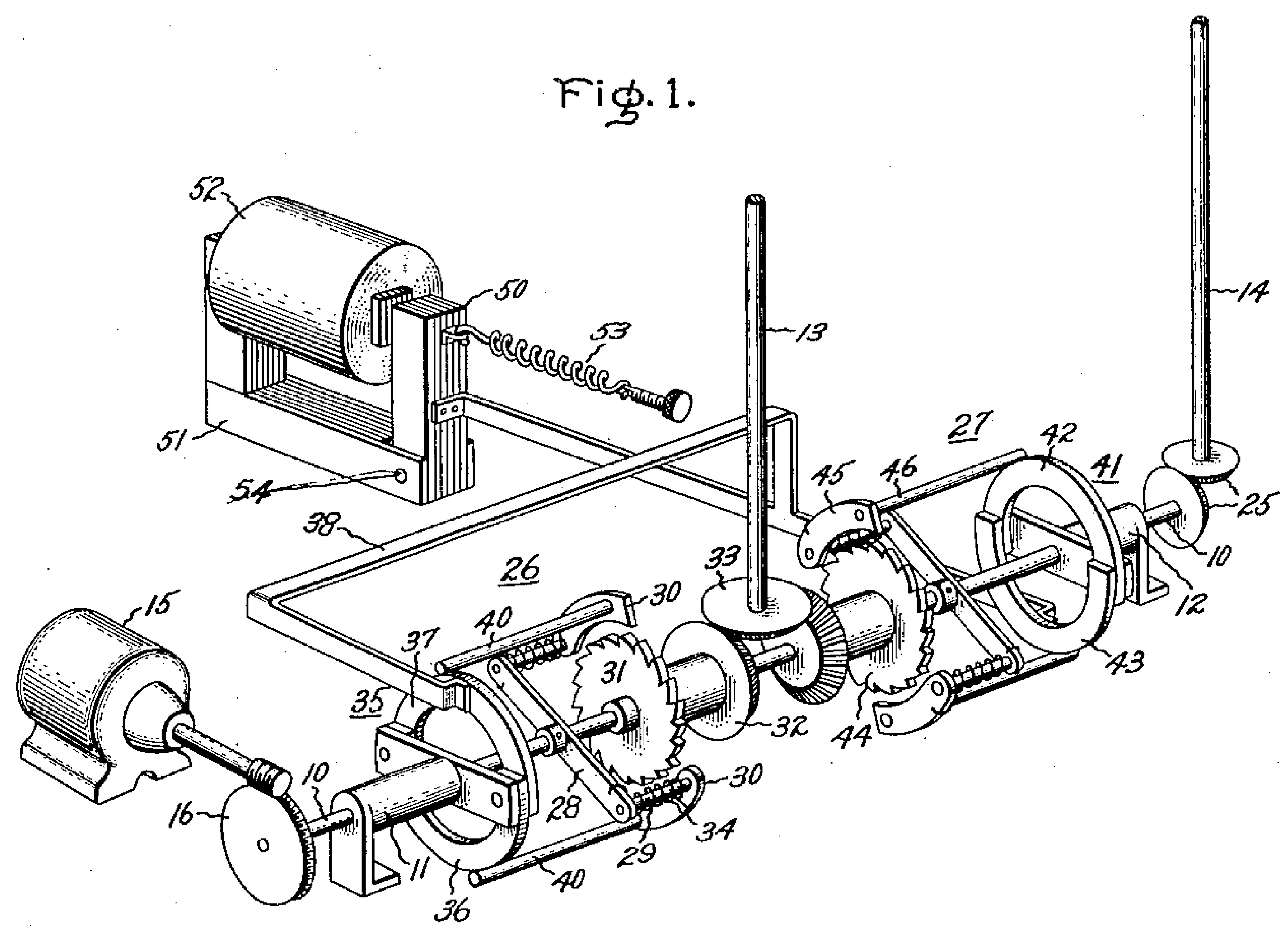


Fig. 3.

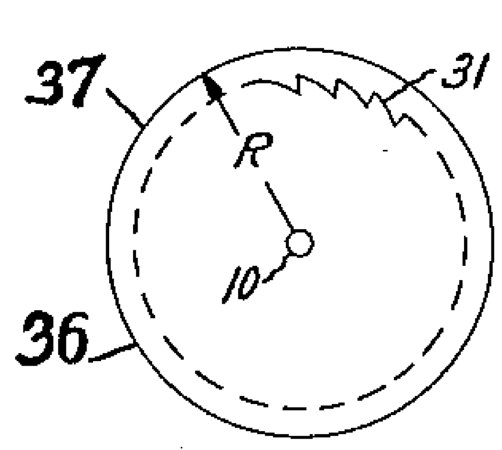


Fig. 2.

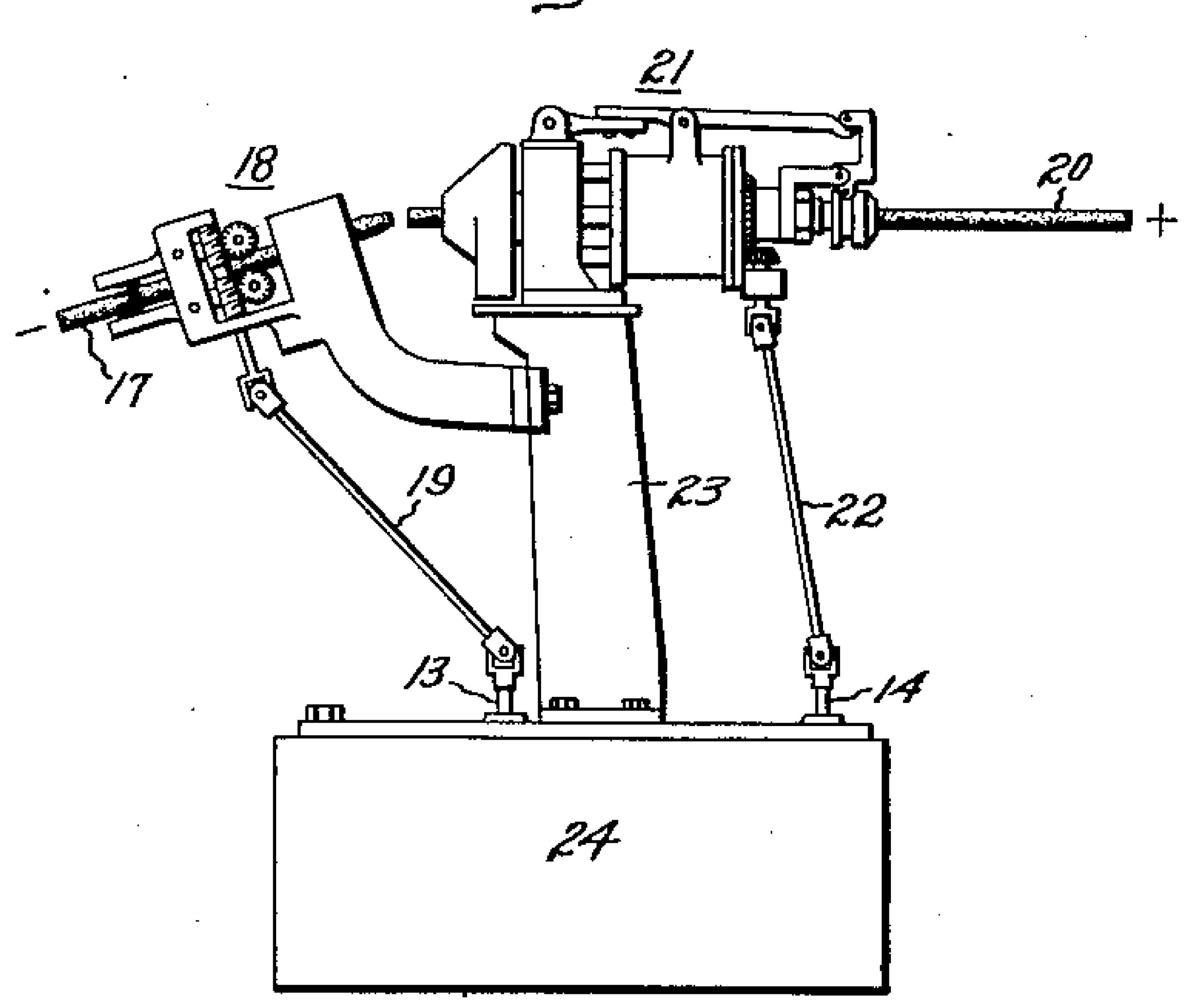


Fig. 4.

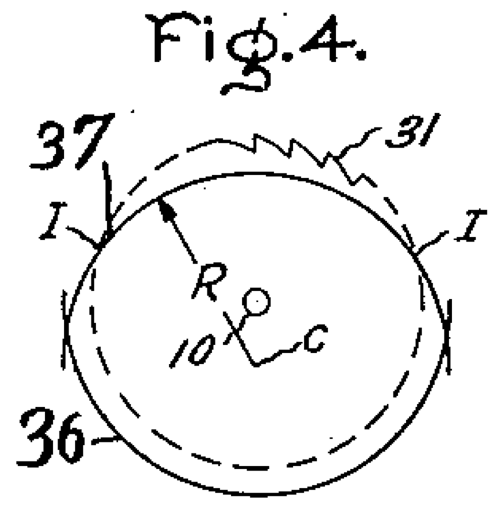
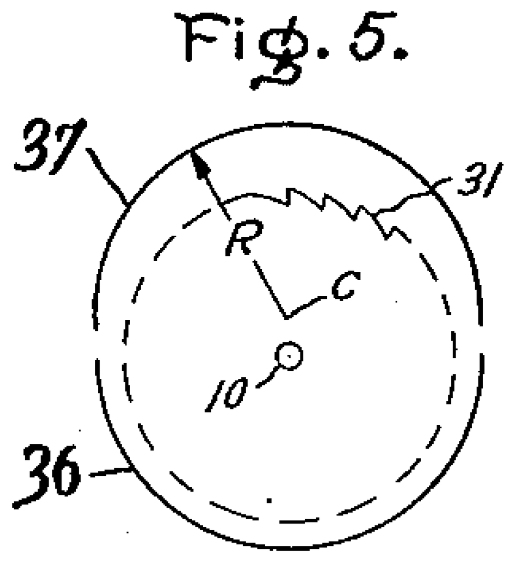


Fig. 5.



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UNITED STATES PATENT OFFICE

2,125,769

ELECTRIC ARC LAMP

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Application October 17, 1936, Serial No. 106,152

9 Claims. (Cl. 176—76)

My invention relates to arc lamps, such as are used in connection with large searchlights, for example, and more particularly to an improved electrode feeding mechanism therefor.

In such arc lamps it is desirable to have a variable speed feeding mechanism for advancing and retracting the negative carbon with respect to the positive carbon which is actuated in response to an operative condition of the arc. Such feeding mechanism may, for example, be actuated in response to the current flowing through the arc or in response to the voltage across the arc. The feeding mechanism advances the negative carbon into engagement with the positive carbon upon initiation of operation of the arc lamp at a high rate of speed to strike the arc. Likewise, the negative carbon is retracted at a high rate of speed after the arc has been struck to quickly establish operation of the lamp. After operation has been established the feeding mechanism acts to maintain such operation. The rate of speed at which the negative carbon is adjusted to maintain satisfactory operation of the lamp is preferably dependent upon the condition of the arc. For example, if the negative carbon should be advanced or retracted only a small distance the adjustment is made at a low rate of speed; whereas, if such carbon is to be advanced or retracted a greater distance the adjustment is preferably made at a greater rate of speed.

An object of my invention is to provide an improved mechanism for effecting a variable speed feeding of the negative carbon used for high intensity arc lamps.

Another object of my invention is to provide a feeding mechanism which will act to advance or retract the negative carbon, as operating conditions demand, at variable rates of speed depending upon the amount of adjustment required so that large adjustments are effected at proportionately higher rates of speed than the rates at which the small adjustments are effected.

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 drawing, and its scope will be pointed out in the appended claims.

In the accompanying drawing, Fig. 1 is a perspective view of the carbon feeding mechanism built in accordance with my invention; Fig. 2 is a side elevation of an arc lamp provided with a carbon feeding mechanism embodying my invention, and Figs. 3, 4 and 5 are schematic diagrams indicating various operating positions of the adjustable cams employed in the carbon feeding mechanism.

Referring to the drawing, Fig. 1 illustrates in detail a portion of my carbon feeding mechanism which includes a drive-shaft 10 rotatably supported in suitable bearings 11 and 12 and two driven shafts 13 and 14 operatively connected to shaft 10 by means described hereinafter. Drive-shaft 10 is driven at a predetermined constant speed by a motor 15 through a suitable speed reduction gearing 16. Driven shafts 13 and 14 are operatively connected to control the feeding of the negative carbon 17 and positive carbon 20 respectively, of the arc lamp, in a manner which will be better understood from a description of Fig. 2.

In Fig. 2 the negative carbon 17 is carried by a supporting and feeding mechanism 18 of any desired construction which is operatively connected to driven shaft 13 through a suitable linkage 19. This mechanism is described in detail in my U. S. Patent No. 1,837,897, issued December 22, 1931. It will be understood that when shaft 13 is rotated in one direction mechanism 18 will be actuated to retract the negative carbon toward the positive carbon and when shaft 13 is rotated in the opposite direction the mechanism will be actuated to retact the negative carbon from the positive carbon. In other words, mechanism 18 is operable to vary the length of the arc between the negative and positive carbons. The positive carbon 20 is carried on a supporting and feeding mechanism 21 of any desired construction which is operatively connected to driven shaft 14 through suitable linkage 22. The mechanism 21 forms no part of the present invention. Any suitable mechanism may be used. The particular mechanism illustrated is described in detail in U. S. Patent No. 1,594,067, Murphy and Hutt, issued July 27, 1926. This mechanism continuously rotates the positive carbon and feeds it forward from time to time as required during the operation of the lamp. Carbon feeding mechanisms 18 and 21 are carried by a standard 23 which is supported by a suitable base 24. Preferably base 24 is arranged to house the mechanism for actuating carbon feeding mechanisms 18 and 21, shown in Fig. 1, and protects the mechanism from exposure to the weather. The driven shafts 13 and 14 extend from the base 24 through the upper cover thereof.

Referring again to Fig. 1, it will be observed that driven shaft 14 is directly connected to drive shaft 10 through bevel gears 25. The driven shaft 13 is normally disconnected from drive shaft 10 and is adapted to be connected thereto through clutches 26 and 27. For purpose of convenience, clutch 26 is referred to as a retracting clutch and clutch 27 as an advancing clutch since corresponding movements of the negative carbon are produced when the respective clutches are engaged.

Since these clutches are of similar construction, only one of them will be described in detail. The retracting clutch 26 includes an arm 28 rigidly secured, at its mid-portion, to drive-shaft 10 and is provided with a pin 29 at each end thereof for supporting pawls 30. A cooperating ratchet wheel 31 having attached thereto a bevel gear 32, in mesh with a similar gear 33 on the driven shaft 13, is loosely carried by drive-shaft 10. A spring biasing means 34 is interposed between each pawl 30 and arm 28 to urge the pawls into engagement with the ratchet wheel 31.

Clutch 26 is provided with an operating cam 35 comprising a stationary portion 36, carried by bearing 11, and a complementary movable portion 37, carried by a bracket 38. Preferably the portions 36 and 37 of the cam 35 are substantially semi-circular in shape and so positioned on either side of the drive-shaft 10 that when the cam occupies its normal or neutral position of adjustment the contour or the periphery of the cam is substantially a circle. Each of the pawls 30 is provided with a guide pin, attached to its free end, which rides on the periphery of the cam and follows the contour thereof.

It will be understood that the radii of the two cam portions 36 and 37 are equal and sufficiently great to restrain pawls 30 from engagement with ratchet wheel 31 when the movable part 37 of the cam occupies its normal or neutral position of adjustment shown in Fig. 1. Further, it will be understood that when either guide pin 40 is riding upon the stationary cam portion 36 that the corresponding pawl 30, secured to the guide pin, can never engage the ratchet wheel 31 as such pawl is restrained and held in a semi-circular path of travel of greater radius than the radius of the ratchet wheel. When a guide pin 40 is riding upon the movable cam portion 37 the corresponding pawl 30, operated by that pin, may or may not engage ratchet wheel 31, depending upon the position of the movable cam portion 37 with respect to the stationary cam portion 36.

For a more detailed consideration of the clutch controlling action of cam 35, reference is had to Figs. 3 to 5 inclusive of the drawing. In these figures the drive shaft 10 and the ratchet wheel 31 are respectively indicated. The radii of the cam portions 36 and 37 are indicated by the distance R, and the center of the movable cam portion 37 is indicated at C. The lower portion of the surface of radius R indicates the stationary cam portion 36, while the movable portion 37 of the cam is indicated as the upper portion of the surface of radius R.

From an inspection of Fig. 3, schematically illustrating the normal or neutral position of the cam, it is apparent that no portions of the semi-circles of radius R intersect the circle indicating the ratchet wheels 31; thus, when the cam occupies this positon there can be no engagement between a pawl 30 and the ratchet wheel 31. Accordingly, clutch 26 is in a disengaged position.

From an inspection of Fig. 4 schematically illustrating an adjusted position of the cam produced by a downward movement of cam portion 37, it is apparent that the upper semi-circle of radius R intersects the circle of wheel 31 at points I—I'. Accordingly, a pawl 30 will engage ratchet wheel 31 when its guide pin 40 rides the movable cam portion 37, along the periphery thereof between points I—I'. When the cam occupies this position of adjustment the clutch will be engaged twice upon each revolution of drive shaft 10 since there are two pawls employed in the clutch. Further, it will be understood that the ratchet wheel will be rotated an angular distance corresponding to twice the angular distance between points I—I' upon each revolution of drive shaft 10. In the position of adjustment illustrated the angle between points I—10—I' is approximately 120° thus the ratchet wheel would be rotated approximately 240° upon each revolution of drive shaft 10.

Also, it is obvious that the angle between points I—10—I' is a function of the downward displacement of the movable cam portion 37 and that the angular rotation of ratchet wheel 31 for each revolution of drive shaft 10 is thus a function of such displacement. In view of the fact that the drive shaft 10 is rotated at a predetermined constant velocity it will turn a known number of revolutions during any given time interval and with a given adjustment of the cam 37 the ratchet wheel 31 will be rotated a constant number of revolutions during the same time interval. Therefore, the average speed of rotation of the ratchet wheel is a function of the adjustment of the cam and can be varied by varying the adjustment of the cam.

Fig. 5 schematically illustrates the position of the movable cam portion 37 when a condition opposite to that of Fig. 4 occurs. The cam portion 37, when the condition illustrated in this figure occurs, lifts the guide pin 40 and pawl 30 farther from the teeth of wheel 31 but does not otherwise affect the operation of the mechanism. Furthermore, when this condition occurs the movable cam portion 43 of clutch 27, see Fig. 1, which corresponds to the cam portion 37 of clutch 26, is correspondingly lifted so that its surface is moved nearly to the shaft 10 and allows pawl 45 to engage the ratchet wheel 44 in the manner just described for clutch 26.

The construction and principle of operation of advancing clutch 27 is similar to that of the retracting clutch 26. It is provided with a cam 41 having a movable clutch portion 43 and a stationary portion 42. A ratchet wheel 44 is engageable by two pawls 45 which are controlled by guide pins 46 which ride on the surface of cam 41. The stationary and movable cam portions 42 and 43, respectively, are displaced 180° with respect to the corresponding cam portions in the retracting clutch 26. That is, as illustrated in Fig. 1, the stationary cam portion 42 in the advancing clutch 27 is positioned at the top of the cam and the movable cam portion 43 is positioned at the bottom of the cam, while in the retracting clutch the stationary cam portion 36 is positioned at the bottom of the cam 35 and the movable cam portion 37 is positioned at the top of the cam. In clutches 26 and 27, stationary cam portions 36 and 42 are supported by bearings 11 and 12 respectively, while movable cam portions 37 and 43 are carried by the supporting bracket 38.

Due to the disposition of the movable cam portions 37 and 43 on opposite sides of drive shaft 10 and to the fact that these cam portions are carried by a common bracket 38, above described, it will be understood that the clutches 26 and 27 are positively interlocked to prevent simultaneous engagement thereof. For example, when bracket 38 is moved upwardly cam 41 is contracted and clutch 27 is engaged, while cam 35 is expanded and clutch 26 is further prevented from being engaged. On the other hand, when bracket 38 is moved downwardly, cam 35 is contracted and clutch 26 is engaged, while cam 41 is expanded and clutch 27 is further prevented from being engaged. The alternate engagements of clutches 26 and 27 act to drive shaft 13 in opposite directions of rotation to accomplish retracting and advancing, respectively, of the negative carbon.

The supporting bracket 38 is secured to a pivoted armature 50 of an electromagnetic device 51 provided with a solenoid 52 which is connected across the positive and negative carbons 20 and 18 and is therefore responsive to the arc voltage of the lamp. Adjustable spring 53 is provided to oppose the attractive force of the electromagnetic device upon the armature. The armature 50 is pivoted by a pin 54 extending through one end of the electromagnetic device 51.

The operation of the device is as follows: When the circuit is first closed across the carbons, the carbons being separated, full line voltage is impressed across solenoid 52 in the electromagnetic device 51. The electromagnetic device 51 then attracts the pivoted armature 50 against the bias of spring 53, thereby swinging bracket 38 in an upward or counter-clockwise direction about the pivot of the armature 50. This motion of the bracket will adjust cams 35 and 41 provided in the retracting and advancing clutches. The movable cam portion 37 in cam 35 will be moved upwardly to expand the cam surface and further restrain engagement between pawl 30 and ratchet wheel 31 as illustrated in Fig. 5. The movable cam portion 43 in cam 41 will be simultaneously moved upwardly to contract the cam and permit engagement between the pawl and ratchet wheel 44 in clutch 27 in the manner illustrated in Fig. 4. The actual positions of the stationary and movable portions of cam 41 are inverted from those illustrated. This adjustment of cam 41 permits advancing clutch 27 to close. Rotary motion of drive shaft 10 is then transmitted through clutch 27 to driven shaft 13 causing the carbon feeding mechanism to rapidly advance the negative carbon into engagement with the positive carbon to strike the arc. Under these conditions the armature 50 moves the cam portion 42 to its innermost position so that the pawls 45 engage the ratchet wheel during substantially the whole of each revolution of shaft 10 and the shaft 13 is therefore rotated at its maximum speed.

As soon as the arc has been struck the voltage across the carbons will become substantially zero due to the engagement of the carbons. Due to the corresponding reduction in current, solenoid 52 can no longer hold the pivoted armature 50 of the electromagnetic device 51 against the bias of spring 53 and the armature, and bracket 38 secured thereto, are swung in a downward or clockwise direction about the pivot of the armature 50 by spring 53. This motion of the bracket will act to move cam portions 35 and 41 to close the retracting clutch and open the advancing clutch. Under this condition the cam portion 37 is at first moved to its innermost position allowing pawls 30 to engage the ratchet wheel 31 for substantially the whole of each revolution of shaft 10 and therefore reverse shaft 13 at a maximum speed. This speed is, however, gradually reduced as the voltage of the arc increases because the armature gradually moves the cam portion 37 outwardly and thereby reduces the angle of engagement between the pawls 30 and wheel 31.

The movable cam portion 43 in cam 41 will simultaneously be moved downwardly to expand the cam and further restrain engagement between the pawl and ratchet wheel in clutch 27 as operatively illustrated in Fig. 5. The actual positions of the stationary and movable portions of cam 41 are inverted from those illustrated as previously noted. This adjustment of cam 35 permits retracting clutch 26 to engage or close. Rotary motion of drive shaft 10 is then transmitted through clutch 26 to driven shaft 13 causing the carbon feeding mechanism to rapidly retract the negative carbon from engagement with the positive carbon to draw the arc.

As the negative carbon is retracted from engagement with the positive carbon the arc voltage between the carbons impressed upon solenoid 52 increases, causing the electromagnetic device 51 to attract armature 50 against the bias of spring 53. As the arc voltage increases armature 50 will be gradually swung, together with bracket 38, in a counter-clockwise direction about its pivot until an equilibrium position is obtained, at which position the attractive force exerted upon armature 50 by the electromagnetic device 51 will be balanced by the bias of spring 53. When the armature 50 occupies this position of equilbrium, bracket 38 secured thereto will position cams 35 and 41 into their normal or neutral positions of adjustment as illustrated in Fig. 3, causing clutches 26 and 27 to be disengaged. It will be understood that the pivoted armature 50 will be moved from its position of equilibrium toward or away from solenoid 52 in response to operating conditions of the arc to effect adjustments of cams 35 and 41 which act to selectively engage clutches 26 and 27 to reposition the negative carbon, to maintain the distance between the positive and negative carbon a proper one to obtain satisfactory operating conditions.

Also, it will be understood that the amount of movement of armature 50 from its position of equilibrium will be proportional to the arc voltage and, therefore, proportional to the amount which the carbon should be adjusted to re-establish satisfactory operation conditions, and that as hereinbefore explained in connection with Figs. 3 and 5 the amount of this movement of the armature 50 will determine the rate of speed at which driven shaft 13 is operated to bring about the necessary adjustment of the negative carbon. Under ordinary conditions of operation of the lamp this movement will be slight and the rate of speed at which an adjustment will be made will be low as compared to the high rate of speed at which the arc is struck, as described hereinbefore.

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 carbon and a carbon feeding mechanism for advancing and retracting the carbon, of means for actuating the carbon feeding mechanism comprising a drive member, a driven member operatively connected to said carbon feeding

mechanism and a reversible clutch mechanism interposed between said members, said clutch mechanism being adjustable to effect a variable average speed transmission between said members, and means actuated in response to operating conditions of the arc for selectively actuating said clutch mechanism to effect movement of said carbon for adjusting the clutch mechanism to vary the average speed transmission between said members.

2. The combination with an arc lamp having a carbon and a carbon feeding mechanism, of means for actuating the carbon feeding mechanism comprising a drive shaft, a driven shaft operatively connected to said carbon feeding mechanism and rotatable in either of two directions to feed the carbon forward and back means for clutching said drive shaft to said driven shaft to rotate the latter in either of said two directions including a forward and a reverse ratchet clutch, each clutch comprising respectively a pawl supporting arm fixed to said drive shaft, a plurality of pawls carried by said arm, and a ratchet wheel loosely carried by said drive shaft in driving relationship with said driven shaft, means for controlling the engagement of said pawls and said ratchet wheels including adjustable cam members and means for adjusting said cam members responsive to an operating condition of the arc.

3. The combination in an arc lamp having a carbon and a carbon feeding mechanism for advancing and retracting the carbon, of means for actuating the carbon feeding mechanism comprising a drive shaft, a driven shaft operatively connected to said carbon feeding mechanism, an advancing clutch and a retracting clutch interposed between said shafts, said clutches being selectively engageable to effect corresponding movements of said carbon, each of said clutches comprising a ratchet wheel loosely carried by said drive shaft and a member rigidly carried by said drive shaft provided with a pawl biased toward engagement with said ratchet wheel, an adjustable cam for each clutch for controlling the engagement of pawl and ratchet wheel therein, the cams being adjustable to permit such engagement only during a portion of each revolution of said drive shaft, means interlocking the adjustments of said cams to prevent such engagement simultaneously in both clutches and means actuated in response to an operating condition of the arc for adjusting said cams for varying the portion of a revolution of the drive shaft during which such engagement is permitted.

4. The combination in an arc lamp having a carbon and a carbon feeding mechanism for advancing and retracting the carbon, of means for actuating the carbon feeding mechanism comprising a drive shaft, a driven shaft operatively connected to said carbon feeding mechanism and advancing and retracting clutches interposed between said shafts, said clutches being selectively engageable to effect corresponding movements of said carbon, each of said clutches comprising a ratchet wheel and a pawl carried by said drive shaft adapted to engage said ratchet wheel, a clutch control cam for each clutch for effecting engagement and disengagement of the respective cooperating pawl and ratchet wheel to effect clutching and declutching, means for interlocking said clutch control cams to prevent simultaneous clutching of said clutches and means responsive to an operating condition of the arc for actuating said clutch control cams.

5. The combination in an arc lamp having a carbon and a carbon feeding mechanism for advancing and retracting the carbon, of means for actuating the carbon feeding mechanism comprising a drive shaft, a driven shaft operatively connected to said carbon feeding mechanism, an advancing clutch and a retracting clutch interposed between said shafts, said clutches being selectively engageable to effect corresponding movements of said carbon, each of said clutches comprising a ratchet wheel in driving engagement with said driven shaft, a pawl carried by said drive shaft biased toward engagement with said ratchet wheel and a clutch control cam for normally restraining said pawl from engagement with its cooperating ratchet wheel to effect declutching, said cam being adjustable to permit such engagement to effect clutching, means for interlocking said clutch control cams to prevent simultaneous clutching of said clutches and means responsive to an operating condition of the arc for adjusting said clutch control cams.

6. The combination in an arc lamp having a carbon and a carbon feeding mechanism for advancing and retracting the carbon, of means for actuating the carbon feeding mechanism comprising a drive shaft, a driven shaft operatively connected to said carbon feeding mechanism, an advancing clutch and a retracting clutch interposed between said shafts, said clutches being selectively engageable to effect corresponding movements of said carbon, each of said clutches comprising a ratchet wheel in driving engagement with said driven shaft, a pawl carried by said drive shaft biased toward engagement with said ratchet wheel and an adjustable cam for normally restraining the pawl from engagement with its cooperating ratchet wheel, said cams being adjustable to permit such engagement, means for adjusting said cams responsive to an operating condition of the arc and means interlocking the adjustments of said cams to prevent adjustment thereof to effect simultaneous engagement of pawl and ratchet wheel in both clutches.

7. The combination in an arc lamp having a carbon and a carbon feeding mechanism for advancing and retracting the carbon, of means for actuating the carbon feeding mechanism comprising a drive shaft, a driven shaft operatively connected to said carbon feeding mechanism, an advancing clutch and a retracting clutch interposed between said shafts, said clutches being selectively engageable to effect corresponding movements of said carbon, each of said clutches comprising a ratchet wheel in driving engagement with said driven shaft, a pawl carried by said drive shaft biased toward engagement with said ratchet wheel and an adjustable cam for normally restraining the pawl from engagement with its cooperating ratchet wheel, said cams being adjustable to cause a variable intermittent engagement between said pawl and ratchet wheel, the period of engagement being variable and responsive to the adjustment of said cams, and means for adjusting said cams responsive to operating conditions of the arc.

8. The combination in an arc lamp having a carbon and a carbon feeding mechanism for advancing and retracting the carbon, of means for actuating the carbon feeding mechanism comprising a drive shaft, a driven shaft operatively connected to said carbon feeding mechanism, an advancing clutch and a retracting clutch inter-

posed between said shafts, said clutches being selectively engageable to effect corresponding movements of said carbon, each of said clutches comprising a ratchet wheel loosely carried by said drive shaft, a member rigidly carried by said drive shaft provided with a pawl spring biased toward engagement with said ratchet wheel and an adjustable cam for normally restraining the pawl from engagement with its cooperating ratchet wheel, said cams being expansible to further insure disengagement of the pawl and ratchet wheel and contractible to permit such engagement and comprising complementary stationary and movable portions supported on opposite sides of said drive shaft, similar portions of said cams being disposed substantially 180° with respect to each other, the movable portions of the cams being carried by a support, said support being movable in one direction to simultaneously expand one of said cams and contract the other cam and movable in another direction to simultaneously contract said one cam and expand said other cam, and means responsive to an operative condition of the arc for moving said support.

9. In an arc lamp, the combination of a carbon, means for advancing the said carbon including a driving pawl and a ratchet wheel which when moved effects an advance of said carbon, means for continuously moving said pawl at a uniform speed, and means responsive to a potential across the arc effecting an intermittent engagement between said pawl and said ratchet wheel, the proportion of the time of engagement to the time of disengagement between said pawl and said ratchet wheel being regulated by said means responsive to the magnitude of said arc potential, whereby the rate of advance of said carbon is proportional to said arc potential.

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