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[54] ARC IGNITION SYSTEMS

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[51] Int. Cl. **H05b 31/30**

[58] Field of Search ... **314/34, 35; 315/330, 331, 332**

[56] References Cited

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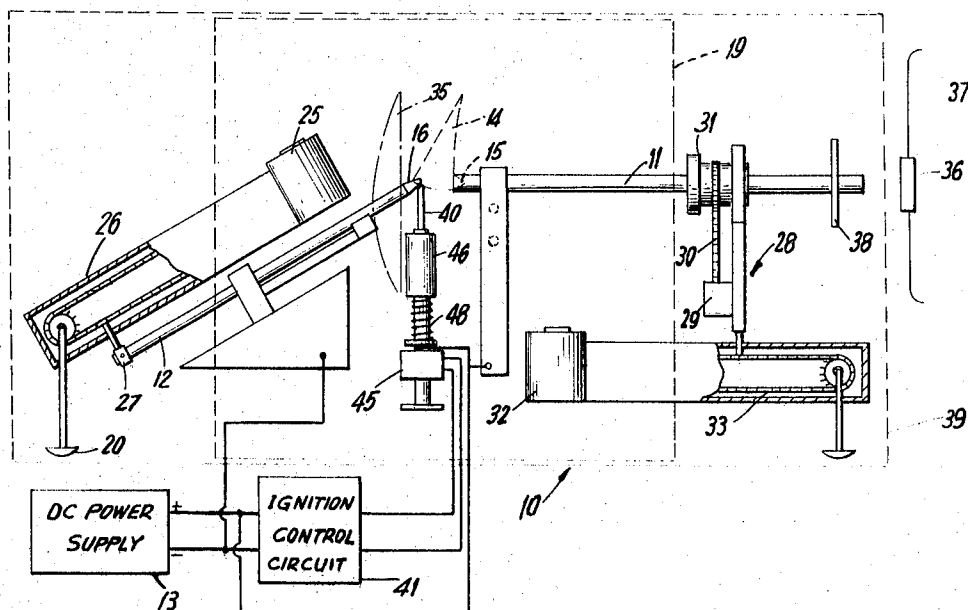
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[57] ABSTRACT

An automatic arc striking ignition system is provided for establishing an arc between two electrodes. The system includes a third arc striking electrode. When the absence of an arc is sensed, the striking electrode is moved into contact with one of the other electrodes. After contact with the other electrode, the striking electrode moves away from the other electrode thereby establishing an arc.

7 Claims, 5 Drawing Figures



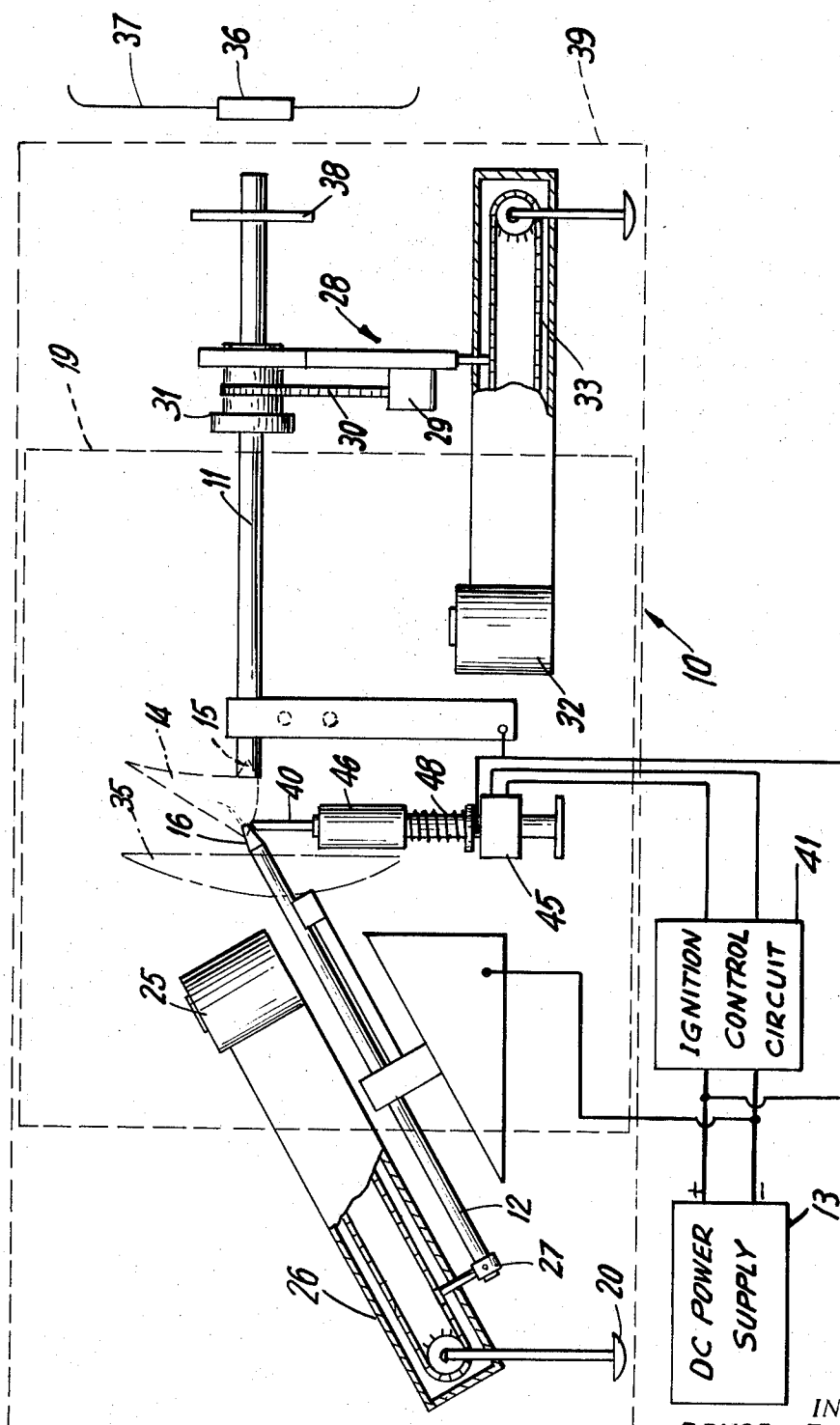


FIG. 1

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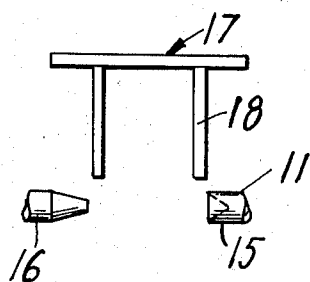


FIG. 2

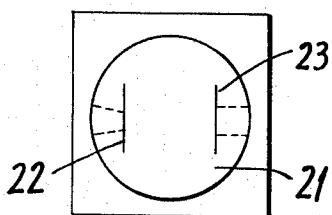


FIG. 3

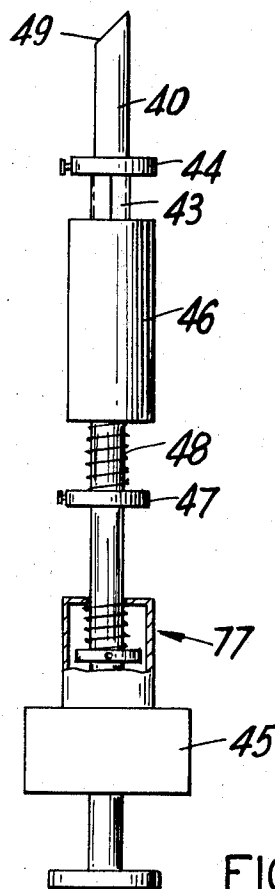


FIG. 4

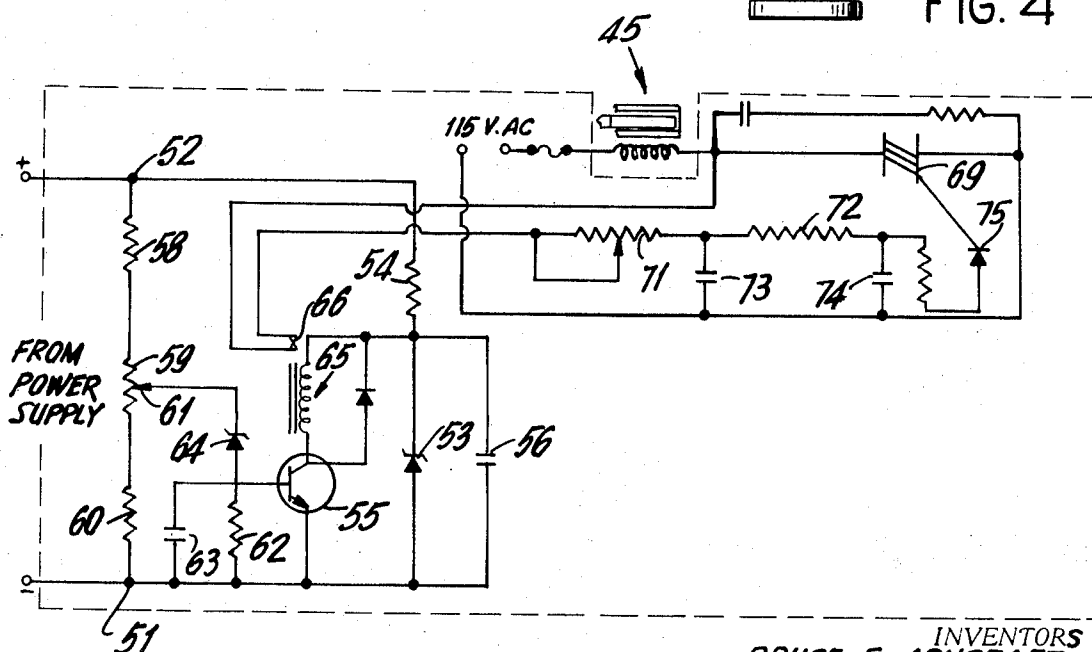


FIG. 5

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ARC IGNITION SYSTEMS

BACKGROUND OF THE INVENTION

In the past, arc lamps have not been readily adaptable to operate in environments requiring automatic ignition. Systems in which arcs were automatically struck by advancing the electrodes into contact and then backing them apart an appropriate distance did not perform satisfactorily. These systems were complex, expensive and unreliable. Systems using shorting slugs require manually inserting the slugs between the electrodes before each ignition. These systems cannot restart themselves if the arc is lost.

In the theater projection art, complete automation has taken on a special significance. The modern approach to theater management utilizes a programmed show in which all functions take place without human intervention. A typical program might at a predetermined time (1) turn the music on, (2) lower the house lights, (3) ignite the projector lamp, (4) open the curtain, (5) start the projector, and (6) open the dowsers. Since no projectionist may be present, the arc ignition system must strike the arc and restrike the arc if the arc is lost at any time.

SUMMARY OF THE INVENTION

The present invention provides an improved ignition system of the type which will automatically establish the required arc and restrike the arc if the latter is lost at any time.

The invention contemplates the use of a third electrode which moves into contact with one of the other electrodes to establish the arc therebetween. In an illustrative embodiment of the invention, the open circuit voltage is used as a sensing mechanism to determine the absence or presence of an established arc. When there is no arc, the open circuit voltage will be above a predetermined value and will trigger a relay through appropriate circuitry.

The relay advances a striking electrode (having the same polarity as a first one of the electrodes) into contact with the other electrode against a spring bias. Upon contact, the open circuit voltage drops below the predetermined value thus releasing the relay. This causes the striking electrode to move away from the contacted other electrode under the spring force and thereby establish an arc between the striking electrode and such other electrode. The striking electrode is chosen to have a higher resistance than the first electrode so that the arc is immediately transferred from the striking electrode to the first electrode and thereby establishes itself between the first electrode and the other electrode.

One feature of the present invention is that the biasing spring minimizes the shock to the striking electrode upon contact with one of the other electrodes. Also, the spring action minimizes the time the striking electrode will be in use, thus prolonging its life.

Another feature of the present invention is the use of circuitry which permits the striking electrode to be used over a wide range of voltages. Additionally, an adjustment is provided for varying the striking force of the relay.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic outline view of the functional portions of an arc lamp;

FIG. 2 is a fragmentary view of a guide for spacing carbon electrodes an appropriate distance apart;

FIG. 3 is a screen for viewing the image of the electrodes when an arc is established;

FIG. 4 is a view of an arc striking electrode; and

FIG. 5 is a circuit diagram of an automatic arc striking ignition system which operates the striking electrode.

DETAILED DESCRIPTION

Referring first to FIG. 1, there is shown in schematic outline form a rotating carbon electrode lamp. While this particular arc lamp has been chosen for purposes of describing the present invention, it should be understood that the invention can be used with other types of arc lamps, and the following is merely illustrative of the principles.

The arc lamp generally designated as 10 consists essentially of a positive carbon electrode 11 and a negative carbon electrode 12. The electrodes, when energized, for example, by an appropriate DC voltage (e.g., from a power supply 13) will vaporize and form a conductive plasma or arc 14 between the electrodes. As the electrodes burn, the characteristics of the electrodes are such that a crater 15 is formed and maintained in the positive electrode 11. Also, the negative electrode 12 will form and maintain a cone 16.

Generally, a guide 17 as shown in FIG. 2 is provided for visually spacing the electrodes in a conventional manner an appropriate distance from each other. The appropriate distance is one which supports an arc with optimum lighting characteristics. A shorting slug (not shown) may be placed between the electrodes, and the arc established by turning on the power. If a shorting slug is not used, the positive electrode 11 is aligned with a right leg 18 of the guide.

The door 19, shown in dotted outline form, of the lamp is closed and the negative electrode 12 (FIG. 1) is advanced into contact with the positive electrode and then backed away. Knob 20 is rotated to manually move electrode 12 toward and away from the positive electrode. As the negative electrode is backed away, an arc is established between the electrodes. The image of the electrode is visible on screen 21 (FIG. 3) WHICH is 3) which in the lamp door. Lines 22 and 23 on the screen correspond to the legs of the guide 17 (FIG. 2). Accordingly, the negative electrode is backed away until it is aligned with line 22 (FIG. 3).

With the arc established, the negative electrode will advance toward the positive electrode at a preset fixed rate. The rate of advancement is controlled by a synchronous or variable speed AC or DC motor 25 (FIG. 1) which advances the electrode via chain drive 26 and collet 27 which is secured to the electrode 12. The positive electrode 11 is rotated by a rotating mechanism generally designated as 28. The rotating mechanism rotates electrode 11 via motor 29 which acts through chain drive 30 and collet assembly 31. The positive electrode is advanced toward a negative electrode at a rate which varies with the DC voltage between the electrodes. Such DC voltage varies with the spacing between the electrodes.

This advancement is similarly controlled by a DC motor 32 which is regulated by a suitable voltage sensing element (not shown). The motor 32 acts through chain drive 33 and the rotating mechanism 28 to position the positive electrode 11 relative to the negative electrode 12.

The arc 14 is focused by mirror 35 onto an aperture 36 of a projector (not shown). When film 37 advances through the plate 36, a dowsers 38 which is affixed to the lamp housing 39, shown in dotted outline form, is opened, thus permitting the light to fall on the film. If the positive electrode burns too quickly, the voltage between the electrodes will increase and the feed of the positive electrode will correspondingly increase. The converse is true if the positive electrode burns too slowly.

In accordance with the invention, the lamp is provided with a third carbon electrode 40 controlled by an automatic arc striking ignition system 41. In the present embodiment, the electrode 40 is connected to the positive output terminal of the power supply 13 and has a higher resistance than the positive electrode 11.

As shown in FIG. 4, the electrode 40 is held in a chuck which includes a tube 43 split at its end and a collet 44. The split tube is affixed to the armature of a relay 45 which is selectively actuated by the ignition circuit 41, as described below. Tubular casing 46 surrounds tube 43 and is secured in a conventional way to the lamp housing 39. Collet 47 is secured to tube 43 and a spring 48 is positioned between collet 47 and the casing 46.

When relay 45 is actuated, tube 43 is moved upward as viewed in FIG. 4 and spring 48 compresses, acting as a damping device to cushion the upward movement of electrode 40. When the relay is deenergized, the biasing action of spring 48 returns the relay and the electrode 40 back to their original position.

For purposes of illustration, the power supply 13 (FIG. 1) which may include a twelve phase selenium rectifier (not shown) provides 80 volts DC across electrodes 11 and 12. Initially, the electrodes 11 and 12 are positioned an appropriate distance apart. This may be accomplished by using right leg 18 of guide 17 to position positive electrode 11. Negative electrode 12 is positioned by manually raising striking electrode 40 into contact with electrode 12. Knob 20 is then rotated to move electrode 12 until the tip of cone 16 (FIG. 1) is aligned with the right side of electrode 40. The door of the lamp is next closed. The positive electrode 11 (FIG. 1) and the striking electrode 40 are at the same potential. The tip 49 of electrode 40 is beveled to conform to cone 16, thus providing a large surface area for mating with electrode 12.

The 80 volts DC from the power supply 13 is also applied across input terminals 51 and 52 (FIG. 5) of the ignition circuit 41. The 80 volt "open circuit" voltage across the terminals 51 and 52 is higher than the voltage existing when an arc is established between the electrode 11 and 12 so that such voltage indicates the presence or absence of an arc.

Referring to FIG. 5, the circuit 41 includes a zener diode 53 which is a voltage regulator device and which together with a current limiting resistor 54 maintains a fixed voltage level (illustratively 12 volts DC) across the collector-emitter path of a normally disabled NPN transistor 55. Capacitor 56 filters any noise generated by diode 53 or coming in on the 80 volts DC.

The base-emitter path of the transistor 55 is coupled, through diode 64, to a tap 61 of an adjustable resistive voltage divider 58, 59, 60 which is excited by the incoming 80 volts DC. With this arrangement, the transistor 55 may be triggered when a predetermined input voltage indicative of the absence of an arc is present.

Any sensing mechanism may be used which will operate the ignition circuit 41 when no arc is present, for example, a light sensing arrangement. In the illustrated embodiment of the invention, voltage sensing employing the voltage divider 58, 59 and 60 is used. Resistor 59 is variable to allow for voltage changes when the lamp is to be operated at different voltage levels. Assuming an open circuit voltage for the carbon electrodes of 80 volts DC and an operating voltage of 60 to 65 volts DC, the tap 61 would be positioned so that transistor 55 is driven into conduction when the voltage across the terminals 51 and 52 rises above 70 to 75 volts DC.

When the "open circuit" voltage is applied to the terminals 51 and 52, the corresponding voltage at the base of the transistor 55 will ordinarily immediately exceed the threshold value established between the tap 61 and the terminal 51. In practice, a capacitor 63 is provided to cause a delay (about one-fourth second) before such threshold firing point is reached.

When the threshold voltage is reached, diode 64 conducts allowing current to flow the base of transistor 55. The resulting conduction of such transistor causes current flow through a relay coil 65 disposed in the collector circuit of the transistor. This action closes the corresponding relay contacts 66, which in turn couple a selectable AC operating voltage to the relay 45.

Such selectable AC voltage, in conjunction with the dumping spring 48 (FIG. 1) allows electrode 40 to strike electrode 12 with a minimum of force, thus eliminating shock. The biasing action of spring 48 also tends to urge the relay 45 back to its original position away from the electrode 12 thereby minimizing the burning up of electrode 40.

The AC voltage control for the relay 45 employs a triac 69 (FIG. 5), which is a bidirectional AC switch. As is well known, triac 69 is phase sensitive in that the point on the AC wave form at which it is turned on will determine the voltage available to the relay 45. Resistors 71 and 72, capacitors 73 and 74 and bidirectional diode 75 determine the firing point of triac 69. In other words, diode 75 conducts at a predetermined positive or negative voltage and then turns on the triac. The triac stays on until the AC wave form goes through zero. The diode 75 turns off when current through it from capacitor 74 drops below a certain value. Output voltage to relay 45 is controlled by varying resistor 71. This type of control can easily permit a 50 percent change in voltage applied to the relay 45.

In operation, relay 45 is energized when the voltage between terminals 61 and 51 exceeds the threshold voltage of the transistor base circuit. When, as a result, striking electrode 40 contacts negative electrode 12, the impedance across the power supply decreases and the voltage across the terminals 61 and 51 drops to a few volts. Since such voltage is below the threshold of the transistor 55, the relay coil 65 is deenergized and contacts 66 open, thereby deenergizing relay 45. The

bias of spring 48 (FIG. 1) returns the relay 45 and the electrode 40 back to its position away from the electrode 12. As the striking electrode 40 is thus forced away from the negative electrode 12 to form arc 14, such arc immediately jumps to the adjacent positive electrode 11, since the latter is of lower resistance than the striking electrode. Hence the required arc between the electrodes 11 and 12 is established.

When the arc 14 is formed, the voltage across the terminals 51 and 52 rises to around 60 to 65 volts DC. This is below the threshold (70-75 volts) of the circuit 41 so that the circuit is not re-excited. However, if the arc is at any time lost, the voltage across the terminals 51 and 52 will rise again to the open circuit value and trigger the transistor 55, thereby reestablishing the arc in the manner described above.

While the circuit described above offers many advantages, it is merely illustrative of the principles of the present invention and numerous modifications may be made which are still within the spirit and scope of the invention. As indicated in FIG. 4, one such modification would be the addition of a second damping device 77 for the electrode 40.

What is claimed is:

1. An automatic system for striking an arc between first and second electrodes, which comprises:

a third electrode having a polarity corresponding to the polarity of said first electrode, said third electrode being positioned normally out of contact with said second electrode and mounted for movement toward and away from said second electrode, and

actuating means rendered effective upon the application of a selected voltage across said first and second electrodes for moving said third electrode into contact with said second electrode and for moving said third electrode upon contact with said second electrode away from said second electrode to strike an arc.

2. An automatic system according to claim 1, wherein said actuating means includes a relay connected to said third electrode for moving said third

electrode into contact with said second electrode upon application of the selected voltage, said relay being rendered inoperative upon said third electrode contacting said second electrode to permit the third electrode to move away from said second electrode to strike an arc.

3. In a carbon arc lamp wherein an arc is established between first and second electrodes by applying a selected voltage across the electrodes and wherein said selected voltage is greater than the operating voltage which is present when an arc is established, an arc striking ignition system, comprising:

threshold-operated sensing means coupled to said selected voltage for providing an output in the presence of a voltage greater than the operating voltage to indicate the absence of an arc between the first and second electrodes;

an additional striking electrode having a polarity corresponding to the polarity of the first electrode and mounted for movement toward and away from the second electrode; and

actuating means rendered effective by the output of said sensing means for moving the striking electrode into contact with the second electrode.

4. A lamp according to claim 3, further comprising means for establishing a selectable threshold voltage for the sensing means.

5. A lamp according to claim 4, further comprising means for damping the movement of the striking electrode so that shock to the striking electrode upon contact with the second electrode is lessened.

6. A lamp according to claim 5, wherein said actuating means comprises a relay connectable to a source of variable voltage and operatively coupled to the striking electrode, and said damping means comprises, in combination, means for varying the voltage to the relay and a spring affixed to the striking electrode, said spring being compressible when the relay is actuated.

7. A lamp according to claim 6, further comprising means for mounting the spring to bias said relay and said striking electrode away from the second electrode in the absence of an output from the sensing means.

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