United States Patent [19]

Nakamura

[11] **3,764,210**

[45] **Oct. 9, 1973**

[54] **LIGHTING SYSTEM FOR A HALOGEN LAMP IN A DUPLICATING MACHINE**

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[22] Filed: **Nov. 3, 1970**

[21] Appl. No.: **86,540**

[52] **U.S. Cl.** **355/69,** 95/11.5

[51] **Int. Cl.** **G03b 27/76**

[58] **Field of Search** 355/69; 95/11.5; 240/1.3

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Primary Examiner—John M. Horan

Attorney—Watson, Cole, Grindle & Watson

[57] **ABSTRACT**

A halogen exposure lamp in a copying machine is controlled to provide a voltage less than the rated voltage for preheating the halogen lamp and is periodically energized with a voltage in excess of its rated voltage for exposing an original. The halogen lamp can be controlled by connecting additional voltage sources to the lamp or by controlling the conductive phase angle of the effective voltage applied to the lamp.

5 Claims, 17 Drawing Figures

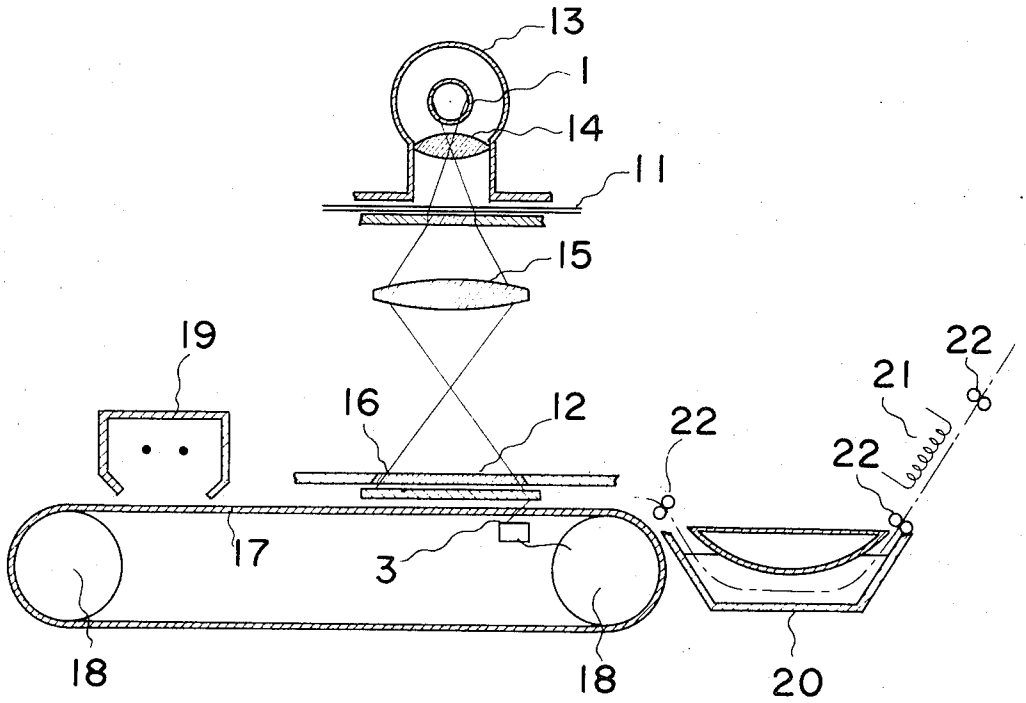


FIG. 1

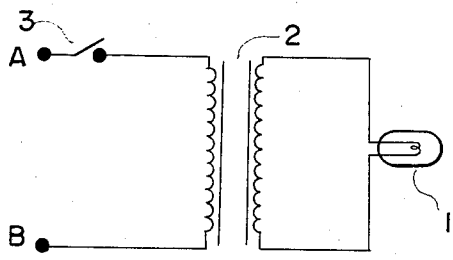


FIG. 2

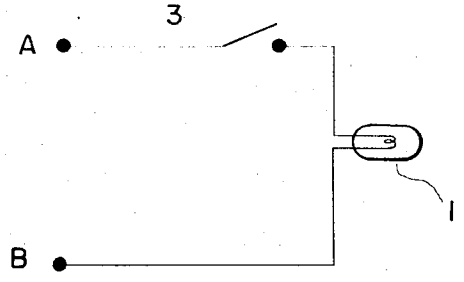
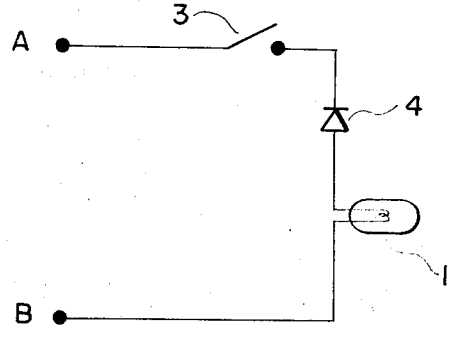


FIG. 3



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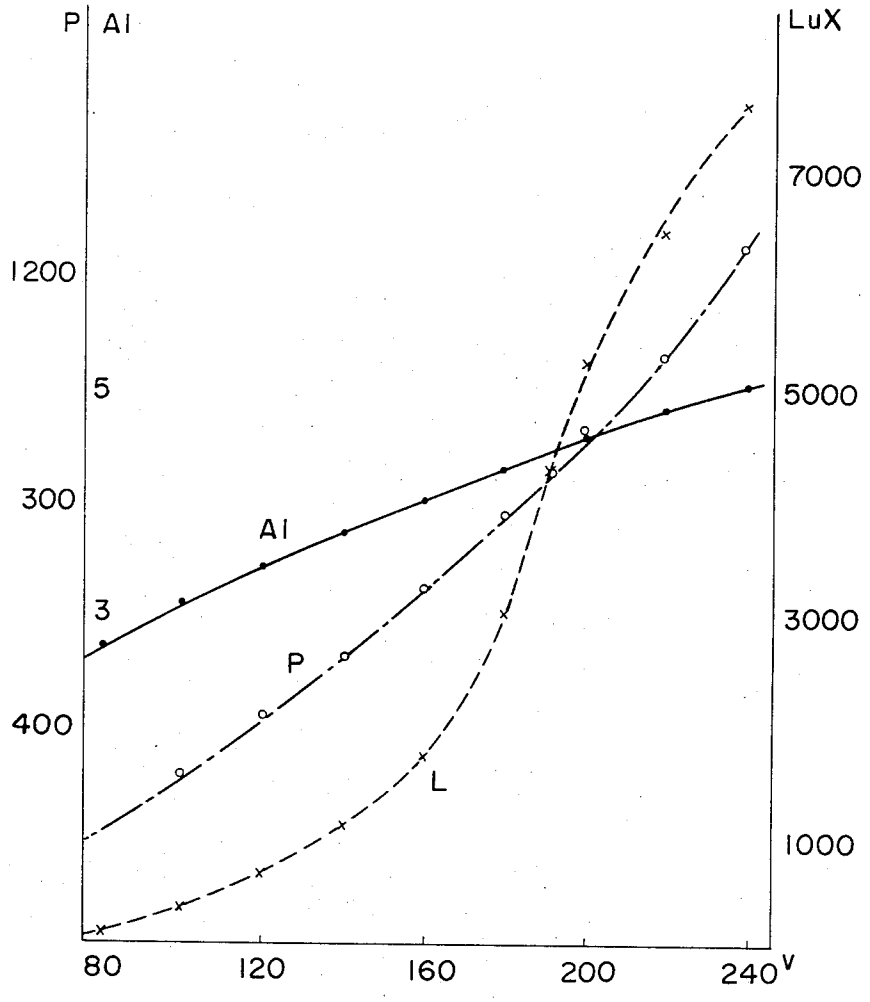
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FIG. 4



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FIG. 5

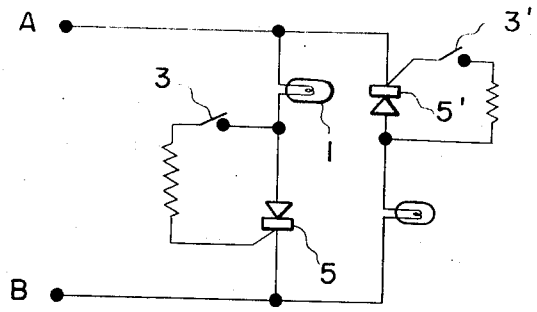
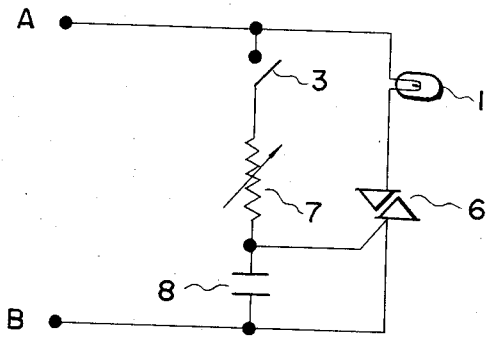


FIG. 6



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FIG. 7

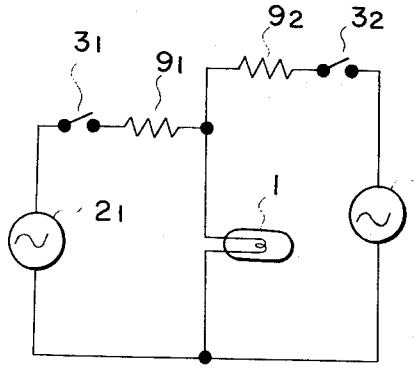


FIG. 8

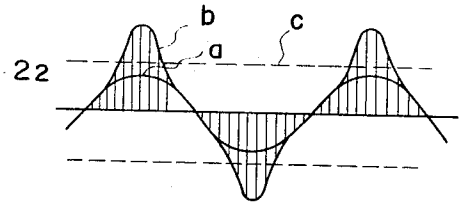


FIG. 9

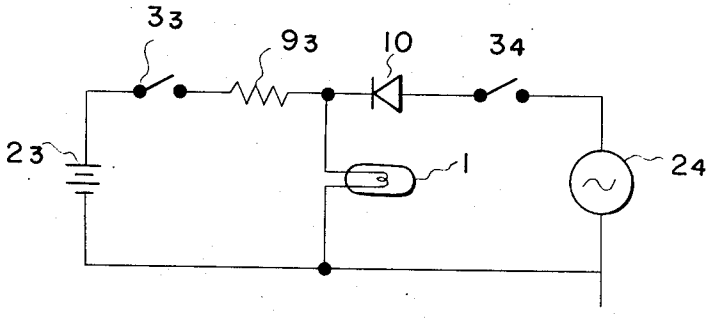
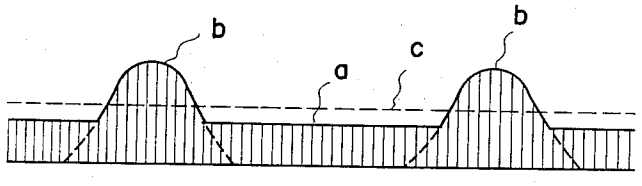


FIG. 10



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FIG 11

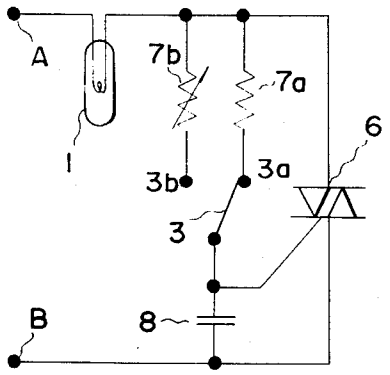


FIG 12 (A)

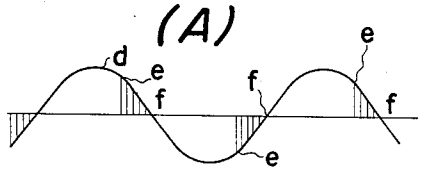


FIG 12 (B)

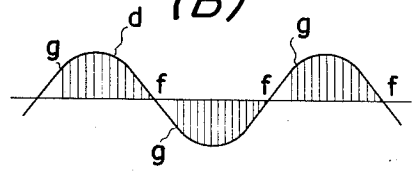


FIG 13

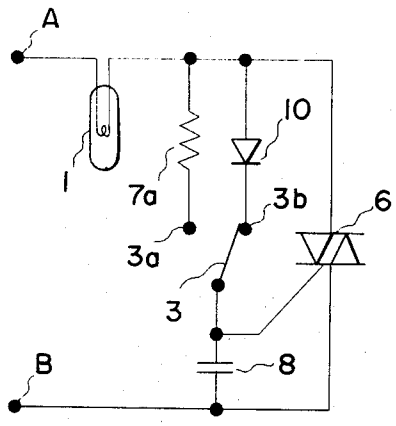


FIG 14 (A)

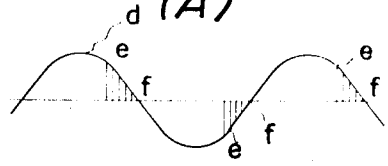
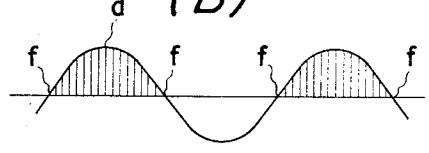


FIG 14 (B)



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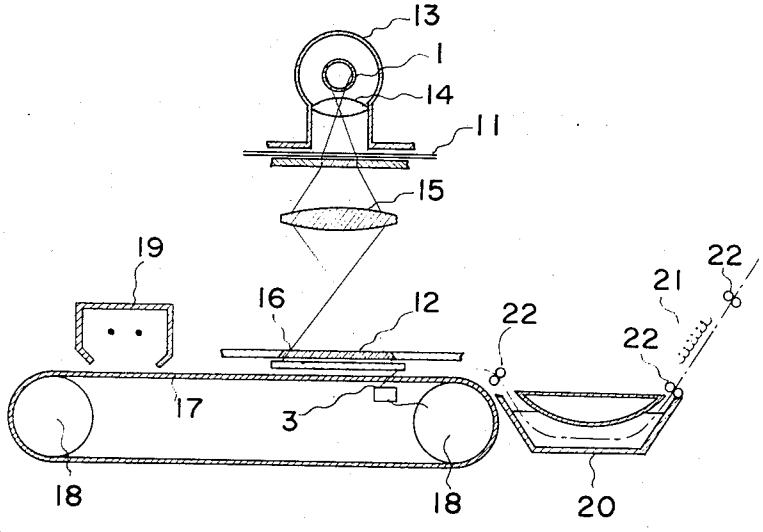
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FIG 15



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LIGHTING SYSTEM FOR A HALOGEN LAMP IN A DUPLICATING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to an energization system for a halogen lamp in a copying machine and more particularly relates to such a system for a halogen lamp, wherein in an electronic copying machine and the like when copying for a long time is continuously done, during the exposure lighting higher voltage than the rated voltage of the halogen lamp is impressed to effect the lighting for a short time to increase the copying speed without ruining the life of the halogen lamp.

Up to the present time, a lamp for a copying machine has been lit, in the case of exposure lighting, by impressing its rated voltage or a lower voltage to keep its integrated lighting time as long as possible in order to elevate the copying capacity and endurance of the electric lamp.

However, such a use is in disregard of the special feature of a copying machine and not useful at all for increasing the copying capacity of the electric lamp. That is, an exposure electric lamp for a copying machine is by no means used for continuous lighting for a long time and after the short exposure lighting time is done said lamp should be put out for a while in order to exchange the original copy or the sensitive paper and subsequently lit again, and that sequence intermittently repeated. And yet, the copying efficiency of the copying machine depends upon the copying speed, and provided the time mechanically required for exchanging the original copy or the sensitive paper is constant it is fixed by the exposure time. Moreover, the copying efficiency of the electric lamp in the copying machine does not depend upon the integrated lighting time of the electric lamp but it depends upon the copying times for which the electric lamp is required to be used as an exposure light source, namely, the copying sheet number endurance.

OBJECT OF THE INVENTION

One object of the present invention is to provide an energizing system for a halogen lamp in a copying machine, wherein the lighting time for exposure of the halogen lamp is short and the efficiency is very high.

Another object of the present invention is to provide an energizing system for an exposure electric lamp, wherein the exposure time can be shortened without reducing the copying sheet number endurance of the lamp.

Further another object of the present invention is to provide an energizing system for a halogen lamp, for providing an exposure, wherein the halogen electric lamp is impressed with a higher voltage than the rated voltage of the lamp for a short time, and by keeping the halogen cycle of the halogen electric lamp the copying speed of the copying machine is increased and in addition the copying sheet number endurance of the halogen electric lamp is increased.

Furthermore another object of the present invention is to provide a lighting system for a halogen lamp, wherein in order to attain the objects described above the variation of the impressed voltage is effected by controlling an electric power source having a higher effective voltage than the rated voltage by means of a semiconductor control device.

Other objects and features of the present invention will be apparent by the embodiments disclosed hereinafter.

SUMMARY OF THE INVENTION

The present invention relates to a lighting system for a halogen lamp in an electronic copying machine so constructed that a halogen lamp is used as a light source and when an original copy and a sensitive paper are positioned in the exposure position, lighting for exposure is done, and meanwhile the sensitive paper and the original copy are replaced a lower voltage than the rated voltage is impressed to preheat the halogen lamp, and thereby lighting for exposure intermittently lit as described above is effected by impressing a higher voltage by 10 to 300 percent than the rated voltage for 0.1 to 2 seconds.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuit diagram of a prior art embodiment, which is a type for putting out an electric lamp except during the exposure lighting time.

FIG. 2 is a circuit diagram of another prior art embodiment, which is the same type as that in FIG. 1.

FIG. 3 is a circuit diagram of embodiment, which is the same type as that in FIG. 1.

FIG. 4 is a diagram of the experimental values on which the relation between brightness of the electric lamp to the impressed voltage, the electric power, and the electric current consumption are actually measured.

FIG. 5 is a circuit diagram of still another prior art embodiment, which is the same type as that of the above embodiments.

FIG. 6 is a circuit diagram of a final prior art embodiment, which is the same type as that of the above embodiments.

FIG. 7 is a circuit diagram of the first embodiment in accordance with the present invention, which is a type so formed that a halogen electric lamp is put to use as an exposure electric lamp and the exposure lighting and the electric lamp preheat lighting are effected by two electric power sources.

FIG. 8 shows the wave form of the voltage impressed on the electric lamp in the FIG. 7 embodiment.

FIG. 9 is a circuit diagram of the second embodiment in accordance with the present invention, which is the same type as mentioned above.

FIG. 10 shows the wave form of the voltage of the FIG. 9 embodiment.

FIG. 11 is a circuit diagram of the third embodiment in accordance with the prevent invention, which is a type so formed that a halogen electric lamp is put to use as an exposure electric lamp, and the exposure lighting and the electric lamp preheat lighting are effected by controlling a voltage of one electric power source of higher voltage than the rated voltage of the electric lamp by means of a semiconductor control device.

FIGS. 12A and 12B show the wave form of the voltage impressed on the halogen lamp, wherein FIG. 12(A) is the voltage wave form during the electric lamp preheat lighting time and FIG. 12(B) is the voltage wave form during the exposure lighting time.

FIG. 13 shows the fourth embodiment in accordance with the present invention, which is of the same form as mentioned above.

FIGS. 14A and 14B show the wave form of the impressed voltage in the FIG. 13 embodiment, wherein FIG. 14(A) is during the electric lamp preheat lighting time and FIG. 14(B) is during the exposure lighting time.

FIG. 15 is a sectional arrangement plan, showing an example of an electronic copying machine making use of an energizing system for a halogen lamp in accordance with the present invention.

DESCRIPTION OF THE EMBODIMENT

In FIGS. from 1 to 3 and FIGS. 5, 6, electric lamp 1 is a conventional incandescent lamp or a halogen electric lamp in which globe halogen gas is enclosed.

The conventional incandescent lamp is designed to be durable for about 1000 hours when continuously lit at a certain voltage, and the voltage at that time is fixed as the rated voltage of the electric lamp.

Whereas, when the electric lamp is continuously lit with a higher voltage than the rated voltage, it is known in general that its life is suddenly reduced in inverse proportion to the thirteenth power of the ratio of the lighting voltage to the rated voltage.

In contradistinction thereto, the halogen electric lamp is designed to be durable for continuous lighting of about 2000 hours while maintaining the lighting brightness higher than the brightness of the conventional incandescent lamp.

Further, in the copying machine when a sensitive paper is properly supplied switch 3 is closed to effect the exposure lighting, and when the sensitive paper or an original copy and the sensitive paper is exchanged the light is extinguished. And, only when the uniformly charged sensitive paper receives the image exposure is switch 3 closed to effect lighting, and at all other times switch 3 is opened and the light is out so as to prevent undesirable light-breaking to the sensitive paper prior to charging and light-breaking to the sensitive paper after image exposure and prior to fixing. Such operation also saves power consumption and prevents the light source enclosure from over-heating.

Therefore, also in the case where copying is continuously repeated, the opening/closing of switch 3 is repeated as is on and off cycle of electric lamp 1.

And, in the case where the conventional incandescent lamp is cycled, when the rated voltage is applied to the lamp it takes a considerable time to obtain the normal light flux thereof after the switch is turned on, and even in the case where a halogen electric lamp is put to use a preheating time of about from 0.3 to 0.5 seconds is required, which is the limit of the shortened exposure time in a copying machine of the turn on and off type.

Thereupon, in the respective embodiments mentioned above in accordance with the prior art a voltage more than the rated voltage is arranged to be applied between A and B.

In the prior art embodiment shown in FIG. 1, terminals A, B connected to an AC power source of 110 volts are connected to the primary winding of transformer 2 through switch 3 so as to generate a voltage of 150 volts in the secondary winding thereof. And in the secondary winding halogen electric lamp 1 having a rated voltage of 110 volts is inserted to light only at the exposure time in boosting the impressed voltage to about 1.4 times as much as the rated voltage.

The second prior art embodiment shown in FIG. 2 is used for a reader printer for obtaining print picture images of good contrast by making use of electric lamp 1 having a rated voltage such as 12 or 24 volts, which light source area is small and is lit for a short time with a higher power voltage than the rated voltage of electric lamp 1 when switch 3 is closed.

In the third prior art embodiment shown in FIG. 3, halogen electric lamp 1 having a rated voltage of 110 volts is connected to an AC 220 volts power source through switch 3 and diode 4, and the wave form of the power voltage is converted to a single wave sine wave by diode 4, and electric lamp 1 is lit only at the exposure time by closing switch 3.

FIG. 4 is a diagram of the experimental results actually measured with the third prior art embodiment, wherein the input voltage of two 300 watts halogen electric lamps having a rated voltage of 110 volts is changed from 80 volts to 240 volts, and the lamps are cycled at 0.2 lighting and 1.0 second off. Thus the intensity of illumination L at a horizontal position 20 cm from the electric lamp may be measured, and the consumption current A1 is observed by a movable iron piece type AC ammeter and the consumption power P, is observed by an electro-dynamometer type wattmeter.

As seen in FIG. 4, the intensity of illumination L increases more than two times relative to the increase of consumption power P, and by impressing an overvoltage the effect of the brightness of the electric lamp per consumption power is remarkably increased.

The consumption power P is composed of the product of the impressed voltage V and the consumption current A1 so that provided the internal resistance of the electric lamp is R,

$$P = V^2/R$$

Whereas, the impressed voltage V and the light flux L given from the electric lamp are as follows:

$(L/L_o) \alpha (V/V_o)^{3.4}$

wherein V_o is the rated voltage of the electric lamp and L_o is the light flux given therefrom.

This is known in general, and from the aforementioned experimental results the following result is confirmed:

$$(L/L_o) \alpha (V/V_o)^{3.4} \sim (V/V_o)^5$$

That is, in the aforementioned experiment, for example, when a voltage of 150 percent of the rated voltage is impressed on the electric lamp the lower consumption is about two times as much as that in the case of the rated voltage, whereas the brightness of the electric lamp increases about five times as much. However, even though the impressed voltage is increased less than 10 percent relative to the rated voltage, that effect is hardly observed.

If an attempt is made to obtain about five times the brightness by lighting an electric lamp with the rated voltage thereof in the known way, from five to six times the normal power is required and accordingly a power source of a large capacity is required. Additionally the electric lamp itself must be much larger and the cost of wiring is also increased. Further, an efficient cooling fan is required in order to prevent the copying machine from overheating and the other secondary equipment must also be larger, therefore, such an attempt is almost impossible to realize.

As described above, when the impressed voltage is 1.5 times as much as the rated voltage the continuous lighting life of the electric lamp is shortened in inverse proportion to $(1.5)^{13}$, however, as described above in a copying machine only continuous lighting for a short time is required, so that its life is not shortened so much. In addition, as described above the brightness is very high, so that respective exposure times are remarkably shortened as compared with the exposure time required with the rated voltage. In the aforementioned experiment halogen electric lamp **1** having a rated voltage of 110 volts is used, and when an AC voltage of 220 volts (effective voltage 157 volts) is applied to electric lamp **1** by switch **3** to effect intermittent lighting of 0.2 second on and 1 second off it was confirmed that the electric lamp is endurable enough to light 676,000 times. And, with the high voltage it is possible to provide enough copying exposure for 0.2 second, and accordingly it means that it is possible to copy about 670,000 sheets. Besides, in the aforementioned experiment, the impressed voltage is increased in order to provide the proper exposure by lighting for 0.1 second, however, the endurance of the number of copies endurance is suddenly decreased. This is seemed to result because the halogen cycle of the halogen electric lamp is hardly completed in such a short time.

Further, it has been discovered that when the impressed voltage is increased more than three times the rated voltage of the electric lamp, even though the time required to carry out the halogen cycle is provided, the disconnection of the filaments is suddenly increased and it is impractical.

Next, consider the copying speed (copying efficiency) making use of the lighting system in accordance with the present invention. In the case of lighting with the rated voltage the copying paper is replaced for about 3 seconds and the exposure is effected for 3 seconds, and thereby the copying efficiency is about 10 sheets a minute, whereas, according to the invention, when the sensitive paper is replaced for 1 second and the exposure time of 0.2 second can be disregarded, so that it is possible to copy about 60 sheets a minute and increase by six times the efficiency. Supposing in the system for effecting the exposure by impressing the rated voltage, the time for replacing the sensitive paper is shortened to 1 second in the same manner as described above, and the copying efficiency is 15 sheets a minute, therefore, the system can increase the efficiency by about **4** times.

In the fourth prior art embodiment shown in FIG. **5**, electric lamp **1** and silicon control rectifier element **5**, and electric lamp **1'** and silicon control rectifier element **5'** are connected to the power source, and the higher effective voltage is provided by a higher power source than the rated voltage.

In the fifth prior art embodiment shown in FIG. **6** in accordance with the present invention, AC control element **6** (such as a Triac) is used and the lighting is effected by changing the conductive phase angle of the wave form of the power voltage by means of variable resistance **7** and condenser **8**. And, by using such a power source with an effective voltage larger than the rated voltage of electric lamp **1** at a maximum phase angle (180°), it is possible to change the effective voltage impressed on electric lamp **1** by changing variable resistance **7**.

Also in the fourth and fifth prior art embodiments, the same facts as in the experimental example described above in the third prior art embodiment are established.

The above has been described for the system effecting the exposure by turning on and off intermittently electric lamp **1**, however, when a halogen electric lamp is used as a light source electric lamp, the brightness of the filament of halogen electric lamp is designed to be higher than that of the conventional lamp or the electric lamp in which rare gas is enclosed. The halogen gas enclosed therein produces the so-called "halogen cycle" to prevent the filament of the electric lamp from evaporating so as to maintain a long operating life. However, for this purpose the halogen gas is necessary to be preheated up to a certain temperature. Furthermore, before the electric lamp gets to a certain brightness for the impressed voltage a stand by time to some extent is required, and when the electric lamp is being cooled down to room temperature the stand by time is more prolonged than when it is being preheated. Further, when the halogen lamp is lit, if it is being cooled down to the room temperature more electric current than necessary runs through the filament the moment the voltage is impressed, and the power voltage drops remarkably resulting in a short-circuit in the extreme case. And, in order to prevent that even though an adjustment is made by such an adjusting device as a relay, more wiring and capacity than necessary are required for the copying machine, therefore, the copying machine becomes complex and large-sized.

Thereupon, instead of a turn on and off type, in the first embodiment in accordance with the invention as shown in FIG. **6**, wherein in order to preheat the light source electric lamp intermittently, by always impressing a lower voltage than the rated voltage of the halogen lamp it is preheated by the current thereof and the high brightness is effected by applying a higher power voltage than the rated voltage only at the intermittent exposure lighting time.

In the second embodiment shown in FIG. **7** in accordance with the present invention, which is composed of circuit (I) wherein halogen electric lamp **1** is connected in series to AC power source 2_1 having a rated voltage lower than that of lamp **1**, auxiliary switch 3_1, and resistance 9_1; and pulse oscillating circuit (II) wherein halogen electric lamp **1** is connected in series to AC power source 2_2 which is in the same phase as AC power source 2_1 and of a higher voltage than the rated voltage of electric lamp **1**, switch 3_2 and resistance 9_2. These two circuits (I), (II) being are connected in parallel with each other as shown in FIG. **7** and switch **3** is closed when the sensitive paper is on the exposure opening plate (**16** in FIG. **5**).

And thus, as shown in FIG. **8** when auxiliary switch 3_1 is closed, a lower voltage *a* of AC power source 2_1 than the rated voltage *c* of lamp **1** is provided, and halogen electric lamp **1** is preheated. However, lamp **1** is lit at a brightness low enough to produce fog on the sensitive paper. Next, for an exposure lighting, when switch 3_2 is closed voltage *b* of the same phase as voltage *a* is impressed and onto halogen electric lamp **1** a higher effective voltage than the rated voltage *c* is impressed to effect a high brightness, and when switch 3_2 is opened preheating voltage *a* is impressed again.

In the second embodiment shown in FIG. **9**, in order to impress an AC voltage *a* lower than the rated voltage

c to preheat halogen electric lamp **1**, AC power source 2_3 is used, and for exposure lighting when switch 3_4 is closed a half-wave rectified voltage of AC power source 2_4 by means of rectifier **10** is impressed, and the voltage shown in FIG. **10***b* is impressed to make a higher voltage than the rated voltage of halogen electric lamp **1**.

Such a lighting system for preheating halogen electric lamp **1** allows halogen electric lamp **1** to generate a low brightness at the preheating time and for example, in a reader printer and the like it can be used for observation lighting as well.

In the third embodiment shown in FIG. **11**, one power source is used and the conductive phase angle is controlled by capacitor **8** connected to the gate of thyristor **6** and two resistances **7***a*, **7***b* connected in series to capacitor **8**. And by changing over between the exposure time and preheating or observation time by means of both resistance **7***a*, **7***b* and change over switch **3**, a higher effective voltage for the exposure lighting than the rated voltage and a lower effective voltage for preheating and observation than the rated voltage are impressed alternately onto halogen electric lamp **1**. That is, when change over switch **3** is connected to contact **3** the node potential of fixed resistance **7***a* and capacitor **8** is supplied to the gate of thyristor **6**, and the conductive phase angle of voltage *d* of the AC power source connected to contacts A, B becomes the phase between *e*, *f* shown in FIG. **12**A. However, that voltage is lower than the rated voltage so that halogen electric lamp **1** generates a low brightness for preheating or observation, and when change over switch **3** is changed over to contact **3**b the node potential of variable resistance **7***b* and capacitor **8** is impressed onto the gate of thyristor **6** and the conductive phase angle becomes *g*, *f* shown in FIG. **12**B relative to power voltage *d*. And by making the effective voltage higher than the rated voltage of electric lamp **1** a high brightness for a short time exposure can be effected.

In this embodiment, the reason why resistance **7***b* is variable is to enable the impressed voltage for the exposure lighting to be adjustable. Besides, in this embodiment by making both resistances **7***a*, **7***b* variable both voltages at the exposure lighting time and the preheating or observation lighting time can be made changeable, and by making both resistances fixed both impressed voltages can be held constant as well.

In the fourth embodiment shown in FIG. **13** in accordance with the present invention, both impressed voltages are held constant and variable resistance **7***b* in the third embodiment is replaced with rectifier **10**. And thus, when change over switch **3** is on contact **3***a*, with the conductive phase angle corresponding to resistance **7***a* and capacitor **8**, thyristor **6** conducts between phase angles *e*, *f* shown in FIG. **14**A to effect the preheating or observation lighting of electric lamp **1** with a voltage lower than the rated voltage. When changed over to contact **3***b* a higher voltage than the rated voltage of halogen lamp **1**, which is produced by a half-wave rectification of the power voltage, is impressed and thereby the exposure lighting can be effected.

As shown in the third and fourth embodiments, when a thyristor is used, as compared with the case where the power voltage is varied by a transformer the voltage at the change over is stable and very effective to prolong the life of halogen lamp **1**.

FIG. **15** is a plan of an example of an electronic copying machine using the lighting system with a halogen lamp in accordance with the embodiments described above, wherein original copy **11** is illuminated through condenser lens **14** by halogen lamp **1** in light source housing **13** and the images thereof are formed through copying lens **15** below exposure opening plate **16** on sensitive paper **12** carried by belt **17** driven by roller **18**. Numeral **3** is a switch which is closed or changed over when sensitive paper **12** comes right below exposure opening plate **16**, and as described in detail in the respective embodiments a higher exposure lighting voltage than the rated voltage is impressed on lamp **1**.

Also, numeral **19** denotes a corona discharge device for giving an electric charge to the exposed sensitive paper. And **20** is a developing device for the sensitive paper, and **21** is a drying and fixing device, and between them sensitive paper **12** is carried by roller group **22**. In the copying machine, between switch **3** and halogen lamp **1** there is connected the circuit described respectively in the aforementioned embodiments.

I claim:

1. A lighting system for a halogen lamp in an electronic copying machine, comprising:

a halogen lamp;

an AC electric power source for generating an effective voltage higher by 10 to 300 percent than the rated voltage of said halogen lamp;

means for changing the conductive phase angle of the power applied to said halogen lamp; and

means for selecting the conductive phase angle of said means for changing the conductive phase angle between a conductive phase angle for applying an effective voltage to said halogen lamp lower than the rated voltage thereof to preheat said halogen lamp for maintaining the halogen cycle thereof and a conductive phase angle for applying an effective voltage higher by 10 to 300 percent than the rated voltage thereof to light said halogen lamp for 0.1 to 2 seconds.

2. A lighting system as in claim **1**, wherein said means for changing the conductive phase angle includes a silicon control rectifier.

3. A lighting system as in claim **1**, wherein said means for changing the conductive phase angle includes a Thyristor.

4. A lighting system as in claim **1**, wherein said means for changing the conductive phase angle includes a controlled gate, and said means for selecting the conductive phase angle includes a resistor and a rectifier connected in parallel with each other and serially connected to said electric power source and said halogen lamp, a capacitor for applying a charged voltage to said gate, and a change-over switch for selectively connecting said gate to said capacitor.

5. A lighting system as in claim **1**, wherein said means for changing the conductive phase angle includes a controlled gate, and said means for selecting the conductive phase angle includes a fixed resistor and a variable resistor connected in parallel with each other and serially connected to said electric power source and said halogen lamp, a capacitor for applying a charged voltage to said gate, and a change-over switch for selectively connecting said capacitor to said gate.

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