

[54] **ENERGIZING CIRCUIT FOR A
DUPLICATING MACHINE**
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[51] Int. Cl.G03b 27/72
[58] Field of Search.....355/27, 64, 66, 100, 106, 67,
355/69

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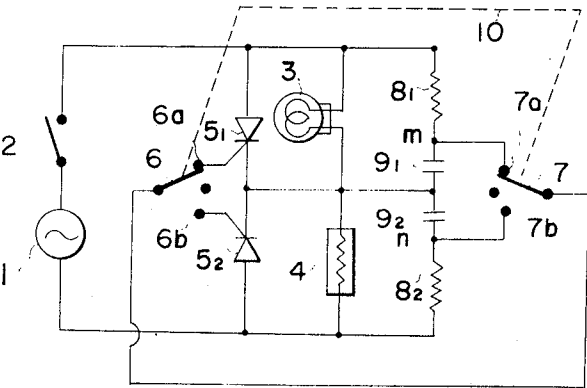
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Assistant Examiner—Michael L. Gellner
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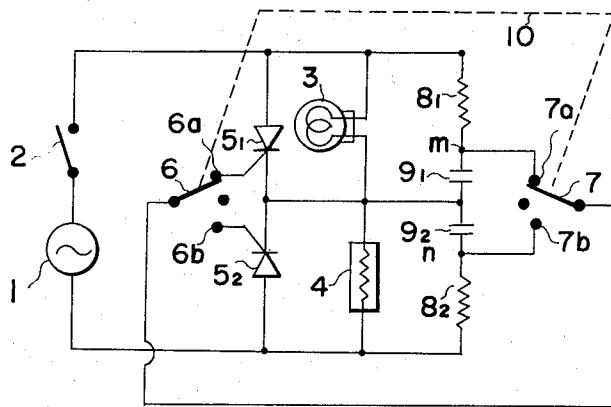
[57] **ABSTRACT**

Circuits for controlling the energization of a lamp and a heater in a copying machine include rectifiers for conducting respective half cycles of an AC power source to the lamp and the heater. Control is also provided for varying the instant which the heater and lamp are energized in each respective half cycle so as to vary the amount of current to each device. Additionally, the circuitry provides for pre-heating of the lamp and heater in order to preserve the life of the lamp and to reduce the time for the heater to attain its necessary temperature.

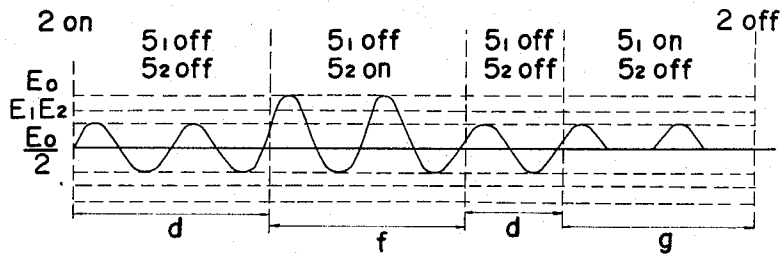
4 Claims, 13 Drawing Figures



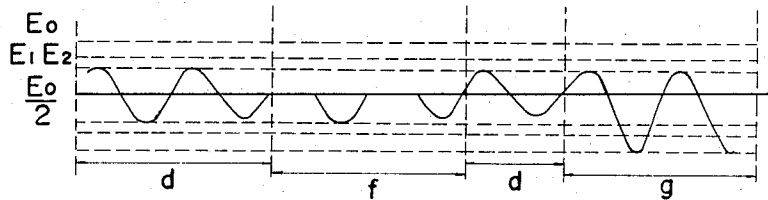
F I G. 1



F I G. 2a



F I G. 2b



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F I G. 3

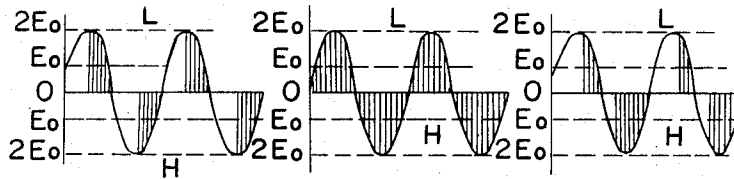
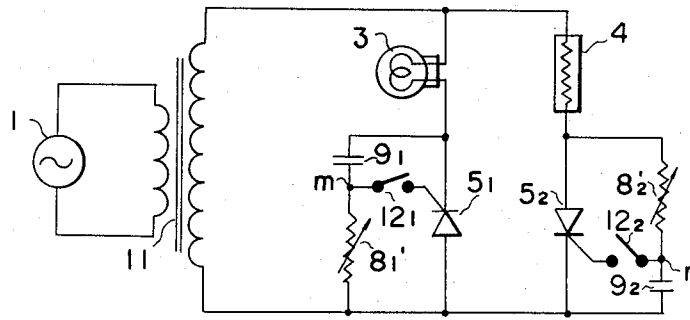
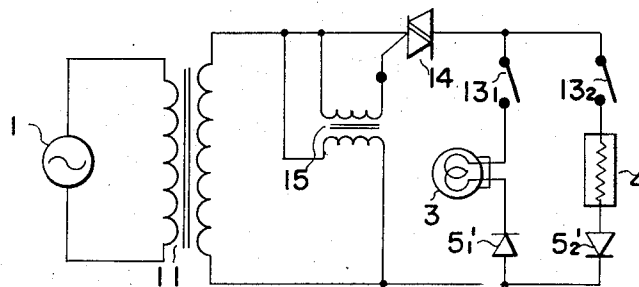


FIG. 4a

FIG. 4b

FIG. 4c

F I G. 5



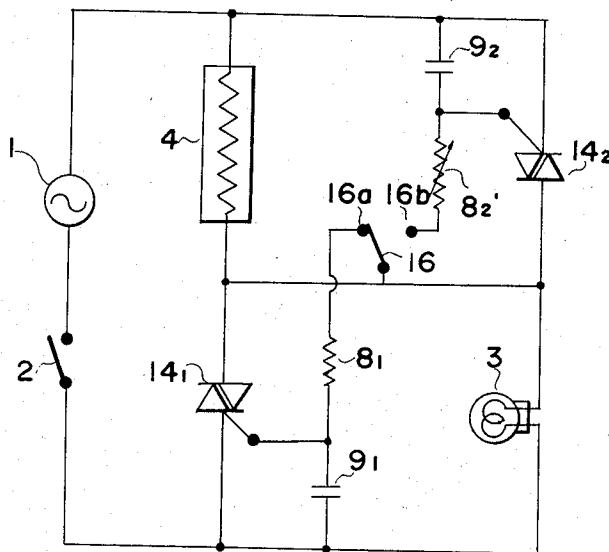
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F I G. 6



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FIG. 7a

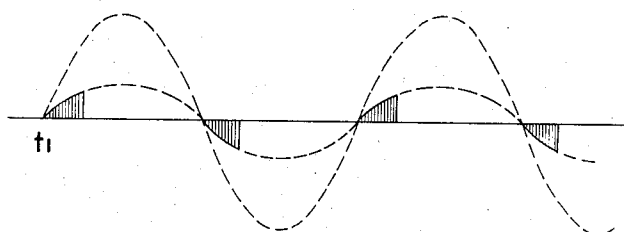


FIG. 7b

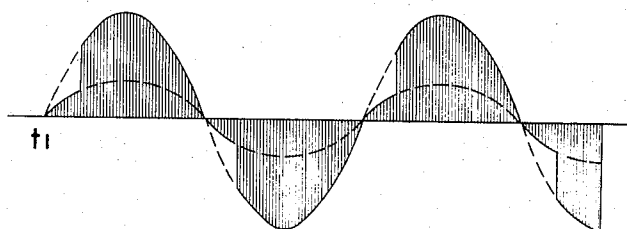


FIG. 8a

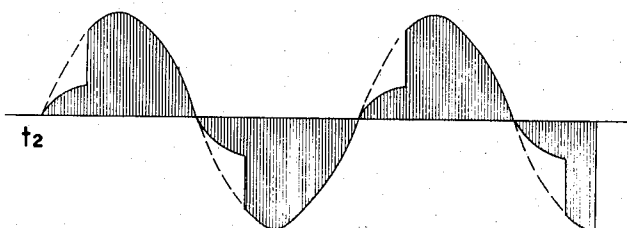
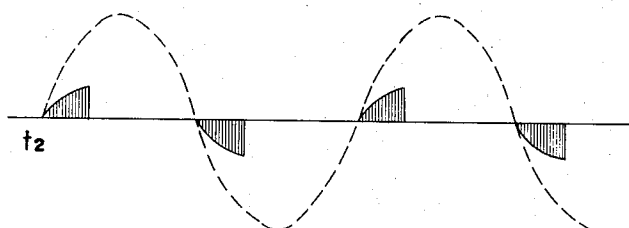


FIG. 8b



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ENERGIZING CIRCUIT FOR A DUPLICATING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to a circuit for energizing a lamp and a heater in a copying machine and more particularly a circuit for energizing the lamp and the heater alternately on different half cycles of the AC power source.

In general, a copying machine is provided with a light source for exposure of the original, a heater for drying and fixing the copy, and a motor driving source, and in addition a circuit for controlling the machine. The major part of the power for the copying machine is consumed by the heater and the lamp. And, in a copying machine using an incandescent lamp or a halogen lamp as a light source, in order to prevent fogging, to save power, to prolong the life of the lamp, and to prevent an unnecessary temperature rise due to lighting the lamp, the lamp is lit only at the time of exposure. Also the heater is always energized in order to keep it ready and at the time of exposure the consumption power of the lamp and the consumption power of the heater and the other circuits are added together to form the peak consumption power.

And, in proportion to the speed of a copying machine, the consumption power of the lamp and the heater has a tendency to remarkably increase. Further, in the case wherein a commercial power source is put to use the peak consumption current of the copying machine approaches the limit of the current output thereof, thereby preventing further speeding up of the copying machine.

As a means of overcoming this problem, by short-circuiting the heater at the time of lighting the lamp and by feeding the heater only at the time of putting out the lamp the peak value of the consumption current can be lowered, and in the case wherein a commercial power source is put to use, with regard to the current rating for the indoor wiring, cords, plug sockets, and the like it is possible to increase the wattage for the lamp and the heater.

In that case, however, there is another consideration, that is, it is impossible to simultaneously light the lamp and the heater and effect the next exposure while drying and fixing a copy, and accordingly the efficiency of the copying machine is reduced. In addition, the heater becomes cool meanwhile, and it takes a considerable time for that heater to get to the proper heating state, so that it is difficult to get a good timing for when the exposed and developed photo-sensitive paper passes through the drying and fixing section and the time when the heater is fed.

OBJECT OF THE INVENTION

One object of the present invention is to provide an energizing circuit for a lamp and a heater in a copying machine, which in order to remove the prior drawbacks mentioned above effects a very short intermittent feed at the different half cycles of the AC power source to the lamp and the heater and prevents the peak value of the consumption current from running to excess while lighting simultaneously the lamp and heater.

Another object of the present invention is to provide an energizing circuit for a lamp and a heater in a copying machine, which controls the current to the lamp

and the heater at different half cycles of the AC power source by means of a silicon control rectifier such as Thyristor or Triac, and facilitates the variation adjustment of current by altering the current phase angle.

Further another object of the present invention is to provide an energizing circuit for a lamp and a heater in a copying machine, which controls the current phase angle to the lamp and the heater at different half cycles of the AC power source by means of a silicon control rectifier, and lights the lamp and preheats the heater at the time of exposure, and when the exposure is not operative preheats the heater so as to facilitate the shift of the heater to a constant heating state, and at the same time preheats the lamp to prevent the filament from breaking and prolongs the life of lamp especially in the case of where a halogen lamp is put to use as a light source lamp.

The other objects of the present invention will be apparent from the description of the embodiments disclosed hereinafter.

SUMMARY OF THE INVENTION

In order to attain the above-mentioned objects the present invention provides an energizing circuit for a lamp and a heater in a copying machine, which connects the lamp and the heater to an AC power source having a voltage higher than the rated voltage of the lamp and heater, and controls the current from the power source respectively to the lamp and the heater by means of a silicon control rectifier. The silicon control rectifier controls the phase of the AC power source for feeding the rated current or a larger current to the lamp and the heater so as to be respectively of a different phase.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an energizing circuit of an embodiment in accordance with the present invention.

FIG. 2a and 2b show the wave forms of the voltage in that embodiment, wherein FIG. 2a shows the wave form of the voltage impressed on the lamp and FIG. 2b shows the wave form of the voltage impressed on the heater.

FIG. 3 shows an energizing circuit of another embodiment in accordance with the present invention.

FIGS. 4a, 4b, and 4c show the wave forms of the voltages impressed on the lamp and the heater in the embodiment of FIG. 3, wherein FIGS. 4a, 4b and 4c show respectively the wave form of the voltages and the respective variation of the conduction angle.

FIG. 5 shows an energizing circuit of a third embodiment in accordance with the present invention.

FIG. 6 shows an energizing circuit of a fourth embodiment in accordance with the present invention.

FIGS. 7a and 7b show wave forms of the voltage at the time when the lamp filament is preheated and the heater is heated in the embodiment of FIG. 6, wherein FIG. 7a shows the wave form of the voltage impressed on the lamp and FIG. 7b shows the wave form of the voltage impressed on the heater.

FIGS. 8a and 8b show wave forms of the voltage at the time when the lamp is fully lit and the heater is preheated in the embodiment of FIG. 6, wherein FIG. 8a shows the wave form of the voltage impressed on the lamp and FIG. 8b shows the wave form of the voltage impressed on the heater.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows the first embodiment in accordance with the present invention, wherein to power source 1 lamp 3 and heater 4 are connected in series through power switch 2. The voltage of power source 1 is higher than the rated voltages E_1 , E_2 of lamp 3 and heater 4.

To lamp 3 Thyristor 5_1 is connected in parallel for short-circuiting lamp 3, and to heater 4 Thyristor 5_2 is connected in series in the reverse direction of Thyristor 5_1 for short-circuiting heater 4. And, to Thyristors 5_1 , 5_2 RC circuits are provided in parallel for controlling the conduction and non-conduction of both Thyristors. That is, to Thyristor 5_1 a circuit composed of resistance 8_1 and condenser 9_1 is connected in parallel and to Thyristor 5_2 a circuit composed of resistance 8_2 and condenser 9_2 is connected in parallel. RC nodes m, n of both RC circuits are respectively connected to change-over contacts $7a$, $7b$ of change-over switch 7, and change-over switch 7 is connected to change-over switch 6. One change-over contact $6a$ of change-over switch 6 is connected to the gate of Thyristor 5_1 and the other change-over contact $6b$ is connected to the gate of Thyristor 5_2 and both change-over switches are arranged so that when change-over switch 7 is connected to the change-over contact $7a$ side by means of connection member 10 change-over switch 6 is connected to change-over contact $6a$, and when change-over switch 7 is connected to the change-over contact $7b$ side change-over switch 6 is change-over to contact $6b$.

Now, when change-over switch 7 is not connected to change-over contact $7a$ nor $7b$, both Thyristors 5_1 , 5_2 become non-conductive, and in lamp 3 and heater 4 the voltages of power source 1 are impressed. In this case, provided both the heater and lamp are equal:

$$E_0 > E_1 = E_2 > E_0/2,$$

then, as shown by d in FIGS. 2a, b, the voltage $E_0/2$ is impressed on lamp 3 and heater 4 and that voltage is considerably lower than the rated voltages of lamp 3 and heater 4, so that both are only preheated.

Next, when change-over switch 7 is connected to the contact $7a$, change-over switch 6 is connected to contact $6a$ by connection member 10 and the voltage of node m is impressed on the gate of Thyristor 5_1 , and when the m side of condenser 9_1 is charged, Thyristor 5_1 is activated, and when the m side of condenser 9_1 is charged on the reverse half cycle Thyristor 5_1 becomes non-conductive. When Thyristor 5_1 is activated lamp 3 is short-circuited and on heater 4 the power source voltage E_0 is impressed, and when Thyristor 5_2 is non-conductive, lamp 3 and heater 4 connected in series to each other the power source voltage is impressed and accordingly lamp 3 is preheated by the voltage shown by g in FIG. 2a and heater 4 is heated by the voltage shown by g in FIG. 2b.

And, when change-over switch 7 is connected to contact $7b$, on the gate of Thyristor 5_2 the voltage of node n is impressed and when the n side of condenser 9_2 is at a positive potential Thyristor 5_2 is activated and the heater is short-circuited. When Thyristor 5_2 becomes non-conductive and the power source voltage is impressed on lamp 3 and heater 4 connected in series to each other, and the voltage shown by f in FIGS. 2a, b is fed respectively to lamp 3 and heater 4 to fully light lamp 3 and preheat heater 4.

Provided the rated voltage of lamp 3 is E_1 and the effective value voltage to be impressed is E_0 , it is known that light output from the lamp increases in proportion to $(E_0/E_1)^5$ from $(E_0/E_1)^{3.4}$. If for example, $E_1 = 110$ V, the AC power source and voltage to be applied are 220 V, and if the half-wave voltage is applied to lamp 3, the effective voltage E_0 is 157 V. Results of experiments show that the brightness of the lamp is $(157/110)^x = 4L$ where $X = 4$. When the effective voltage of the wave form shown by f in FIG. 2a is higher than the rated voltage of lamp 3 the quantity of light emitted from the lamp can be remarkably increased. In this case, the voltage over the rated voltage of the lamp is impressed on the lamp, however, that voltage is impressed at the half-wave phase of the power source voltage instantaneously, so that the lamp filament is not damaged. As the quantity of light emitted from the lamp is increased while the continuous lighting time of the lamp is shortened, therefore, the possible copying number in the duration of the life time of the lamp is not substantially decreased.

As described above, on lamp 3 and heater 4 the voltage to always preheat them is impressed, so that in the case of heater 4 the heating time is speedy, and when a halogen lamp is put to use and the durability of the lamp filament can be increased.

In the first embodiment described above, when the lamp and the heater are required to be energized simultaneously change-over switch 7 is changed over to the contact $7a$ and the contact $7b$ in accordance with the power source frequency, however, even in such a case no excess current is required as a whole from the copying machine.

In the second embodiment shown in FIG. 3 in accordance with the present invention, the voltage of power source 1 is boosted to about twice the voltage of the lamp and the heater to be used, by means of transformer 11, and to the secondary circuit of transformer 11 a series circuit of lamp 3 and Thyristor 5_1 , and a series circuit of heater 4 and Thyristor 5_2 are connected in parallel, and both Thyristors 5_1 , 5_2 are inserted so as to conduct in the reverse direction.

To Thyristor 5_1 a phase control circuit composed of variable resistance $8_1'$ and condenser 9_1 is connected in parallel, and RC node m is connected to the gate of Thyristor 5_1 through switch 12_1 and in the same way RC node n of another phase control circuit composed of variable resistance $8_2'$ and condenser 9_2 connected in parallel with Thyristor 5_2 is connected to the gate of Thyristor 5_2 through switch 12_2 .

Therefore, lamp 3 and heater 4 are energized by the half-wave having respectively one half cycle phase difference of AC power source 1 as shown in FIG. 4, and that energization is phase-controlled by the control circuit. Therefore, by controlling properly variable resistances $8_1'$, $8_2'$ the conduction phase angle can be varied as shown in FIG. 4a, b and c. FIG. 4a shows the state wherein the lamp and the heater are given about one-fourth phase angle conduction, and the effective voltage is remarkably dropped, and thereby the lamp and the heater are preheated. FIG. 4b shows the state wherein the lamp and heater are fed with an excess voltage, and FIG. 4c shows the state wherein the lamp is fed weakly and the heater is fed with an excess voltage.

In the case of FIG. 4b, provided the secondary voltage of transformer 11 is as high as twice the rated voltage E_0 of the lamp and the heater, AC half-waves of the voltage of $2E_0$ are fed, and provided resistance of lamp 3 and heater 4 are respectively R_1' , R_2' , the consumption power P_L' of lamp 3 and the consumption power P_H' of heater 4 are as follows:

$$P_L' = \frac{1}{2} \frac{(2E_0)^2}{R_1'} = \frac{2E_0^2}{R_1'}$$

$$P_H' = \frac{1}{2} \frac{(2E_0)^2}{R_2'} = \frac{2E_0^2}{R_2'}$$

These formulas show that both consumption powers become larger than consumption powers P_L , P_H at the time when the lamp and the heater are respectively lit with the rated voltage, but as with resistance values R_1 , R_2 in this case resistances R_1' , R_2' become higher, so that as compared with the case of that in which the lamp and the heater are lit simultaneously with the rated voltage, the consumption power is decreased as follows:

$$P_L + P_H > P_L'$$

$$P_L + P_H > P_H'$$

On the other hand, as described above the brightness progresses from $(E/E_0)^{3.4}$ to $(E/E_0)^5$ so that very large quantities of light and heat can be obtained and as a result of experiments the quantity of light could be increased from 4 to 5 times and the heat could be increased to 2 times the original amount.

Besides, in the second embodiment the phase adjustment can be done by variable resistances $8_1'$, $8_2'$, so that the temperature rise of the heater at the beginning of use can be speeded up and the drying efficiency can be adjusted in relation to the ambient temperature.

In the third embodiment shown in FIG. 5 in accordance with the present invention, the voltage of power source 1 is boosted by transformer 11 and in the secondary circuit of transformer 11 Triac 14 is inserted, and to Triac 14 a circuit composed of switch 13₁, lamp 3, and rectifier 5₁', and a circuit composed of switch 13₂, heater 4, and rectifier 5₂' are connected in parallel with each other, and rectifiers 5₁' and 5₂' are connected in reverse directions of conduction, and Triac 14 can be controlled by trigger transformer 15.

Further, instead of rectifiers 5₁', 5₂' a phase control circuit can be used as shown in the second embodiment described above.

If switches 13₁ and 13₂ are closed and turned on, current is fed into heater 4 by rectifiers 5₁' and 5₂' in the course of the positive half wave of the power source and also into lamp 3 in the course of the negative half wave. If switch 13₂ is opened and switch 13₁ is closed, the lamp only can be lighted by the half wave. If switch 13₁ is opened and switch 13₂ is closed, heater 4 can be heated by the half wave. The lighting voltage wave form is as shown in FIG. 4b.

In the fourth embodiment shown in FIG. 6 in accordance with the present invention, lamp 3 and Triac 14₁ are connected in parallel, and heater 4 and Triac 14₂ are connected in parallel, and both are connected

in series to power source 1 and power switch 2. And, Triac 14₁ is provided with a trigger circuit composed of resistance 8₁ and condenser 9₁ and Triac 14₂ is provided with another trigger circuit composed of variable resistance 8₂' and condenser 9₂ and capable of changing the trigger time, and from the node of both parallel elements both trigger circuits are changed over to connect by switch 16 through contacts 16a, 16b.

Both Triacs 14₁, 14₂ are energized by the discharge of condenser 9₁ or 9₂ in an appropriate trigger circuit when switch 16 is connected to contact 16a or 16b in the trigger circuit. The trigger circuit for Triac 14₂ can change the discharge time of condenser 9₂ by adjusting variable resistance 8₂'.

For switch 16 a timing switch is put to use, for example, when the power switch is closed, switch 16 is connected to contact 16a and when the original copy is delivered to the exposure portion switch 16 is changed over to contact 16b, and after the original copy is irradiated for a certain time switch 16 is returned again to contact 16a.

And thus, right after the power switch is closed, Triac 14₂ for which switch 16 is opened is non-conductive as well as Triac 14₁ for which switch 16 is closed, so that lamp 3 and heater 4 are preheated with a low voltage for the time shown by t_1 in FIGS. 7a, b. After time t_1 elapses condenser 9₁ discharges and Triac 14₁ is energized because its gate is turned ON, and lamp 3 is short-circuited and the whole power voltage is impressed on heater 4 and accordingly heater 4 is heated. However, when the half-cycle of the power wave form changes Triac 14₁ becomes non-conductive again, and lamp 3 and heater 4 are preheated with a low voltage. After time t_1 elapses again and when condenser 9₁ is discharged lamp 3 is short-circuited and the whole voltage is impressed on heater 4, and lamp 3 is preheated with the voltage shown in FIG. 7a and heater 4 is heated with the voltage shown in FIG. 7b.

Next, when switch 16 is changed over to the contact 16b on account of the delivery of the original copy as described hereinbefore, Triac 14₁ holds always a non-conductive state and Triac 14₂ is energized whenever condenser 9₂ is discharged after time t_2 elapses. These operations are repeated each half-wave of the power wave form so that lamp 3 is lit with the voltage shown in FIG. 8a and heater 4 is energized to preheat with the low voltage shown in FIG. 8b. When the resistance value of variable resistance 8₂' is changed discharge time t_2 of condenser 9₂ is changed and the effective value of the voltage impressed in lamp 3 is changed and accordingly the brightness of lamp 3 can be changed.

Then, after a certain time elapses timing switch 16 is changed over again to the contact 16a.

As is clear from the above description of the embodiments in the present invention the lamp and the heater are simultaneously fed so as to prevent the peak consumption current and the lamp and the heater are always preheated, so that there is no breaking of filaments due to an abrupt feed. And when a halogen lamp is put to use the lamp holds the halogen cycle by means of the remaining heat to prolong the life of the lamp and the constant pre-heating state of the heater can be rapidly effected.

From the description disclosed above, the operation of the energizing circuits in accordance with the present invention is believed to be apparent.

I claim:

1. A circuit for energizing at least one lamp and at least one heater from an AC power source in a copying machine, comprising:

first and second unidirectional conductive switch means connected to conduct current from respective half cycles from said AC power source, said first unidirectional conductive means connecting said AC power source with said at least one lamp and said second unidirectional conductive means connecting said AC power source to said at least one heater;

means for controlling the excitation of said first and second unidirectional conductive means; and

means for switching said first and second unidirectional conductive means to be activated by said means for controlling.

2. A circuit as in claim 1 wherein said means for switching may be positioned to independently energize said at least one heater or said at least one lamp, said means for switching is positioned to simultaneously fully energize said at least one lamp and said at least one heater, and said means for switching further includes means for varying the instant of energization of said at least one lamp and said at least one heater dur-

ing a respective half cycle of said AC power source.

3. A circuit as in claim 1 wherein said first and second unidirectional conductive switch means are serially connected across said AC power source; said at least one heater and said at least one lamp are serially connected across said AC power source, and said means for switching comprises first and second ganged two-position switches wherein a first position actuates said first unidirectional conductive switch means and a second position actuates said second unidirectional conductive switch means.

4. A circuit as in claim 2 wherein said first unidirectional conductive switch means is serially connected with said at least one lamp across said AC power source, said second unidirectional conductive switch means is serially connected with said at least one heater across said AC power source, said switch means comprises first and second switches for respectively energizing said first and second unidirectional conductive switch means and said means for varying the instant of actuation of said first and second unidirectional conductive switch means comprises first and second variable resistors respectively connected to said first and second switches.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,692,408 Dated September 19, 1972

Inventor(s) Kitamaro Nakamura

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[73] Assignee: Minolta Camera Kabushiki Kaisha,
Osaka-shi, Osaka-fu, Japan

Signed and sealed this 22nd day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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