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64 Automatic image density control device.

57 A novel automatic image density control device - (14, 15, 15', 16, 17, 18, 19) capable of automatically varying control signals delivered to either light source (S) or developing device (9) in response to the read-out information only in the event that specific original's density is identified to be weaker than the weakest density of the original in comparison with to the weakest density thus far sequentially being read.

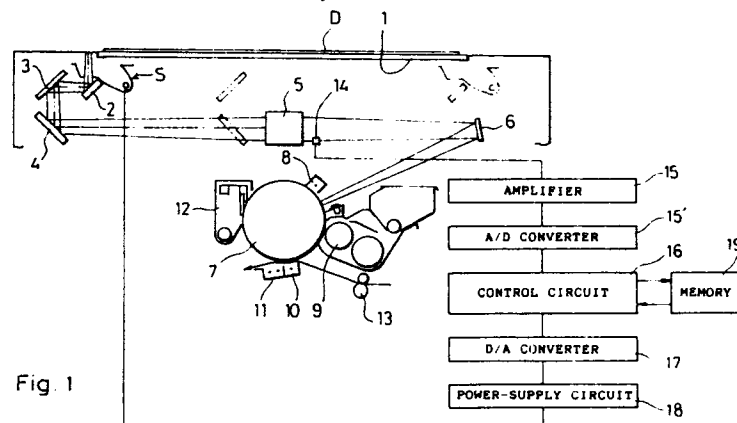


Fig. 1

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Automatic image density control device

BACKGROUND OF THE INVENTION

The present invention relates to an automatic image density control device, more particularly, to an automatic image density control device capable of adequately controlling light intensity output from a light source illuminating the original or development bias signal applied to a developing device in accordance with the image density of the original.

Any of conventional image generating devices incorporates an automatic image density control device for generating images having adequate density in accordance with the density of the original. Generally, conventional automatic image control density devices are grouped into either the "pre-scan" type or the "real-time" type. Of these, the pre-scan type automatic image density control device scans the original before generating picture images so that an optimum power to be supplied to the light source or an optimum development bias can be provided to deal with the original's image having the weakest density. On the other hand, the real-time type automatic image density control device reads the image density of the original in process of simultaneously generating picture images so that an optimum power to be supplied to the light source or an optimum development bias can be provided to deal with the original's image density being present in every moment.

As a result, when using the pre-scan type automatic image density control device, since the device needs to precisely scan the original before generating picture images, a longer period of time is needed for generating the first picture image corresponding to the original. On the other hand, when using the real-time type automatic image density control device, since this device varies either the power to be fed to the light source or the development bias in response to the image density of the original at every scanning timing, it merely needs to execute the scanning operation once without spending a longer period of time for generating the first picture image corresponding to the original. Nevertheless, if solid portion is present in an image density reading region of the original, since the control device selects either an optimum power to be supplied to the light source or an optimum development bias to deal with solid portion, erased portion can be generated on both sides of solid portion, thus eventually resulting in the failure to generate right images exactly matching normal character information.

SUMMARY OF THE INVENTION

The primary object of the present invention is to effectively save time needed for generating the first picture image corresponding to the original.

Another object of the present invention is to securely prevent erased portions from taking place even when solid portion is present in the image density reading region of the original.

To securely achieve those objects mentioned above, the automatic image density control device reflecting the preferred embodiments of the present invention incorporates means for reading the density of the original, memory means, comparison means, and control means, respectively.

Means for reading the density of the original sequentially reads the density of the original. Memory means stores data related to the weakest density of the original thus far read. Comparison means compares the read-out density of the original to that is stored in memory means. Control means outputs control signals in response to the read-out density of the original on receipt of comparative signal from comparison means identifying that the read-out density of the original is weaker. Control means may supply control signals either to light source or developing device.

The automatic image density control device related to the invention having the constitution mentioned above allows means for reading the density of the original to sequentially read the density of the original, and then activates comparison means to compare the weakest density of the original from the preceding read-out density to the newly read out density of the original, and if comparison means outputs a comparison signal identifying that the newly read out density is weaker than the preceding density, the system causes control means to vary control signals to be applied to either light source or developing device so that image can eventually be provided with an optimum density.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be better understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention in which:

FIG. 1 is the simplified schematic diagram of the electrophotographic copying machine incorporating a preferred embodiment of the present invention;

FIG. 2 is the operation flowchart describing the automatic image density control operation related to the preferred embodiment shown in FIG. 1;

FIG. 3 is the simplified block diagram denoting another preferred embodiment of the present invention;

FIG. 4 is the operation flowchart describing the automatic image density control operation related to another preferred embodiment shown in FIG. 3;

FIG. 5 is the graphic chart denoting temperature compensation characteristic;

FIG. 6 is the simplified schematic diagram denoting the internal constitution of the copying machine;

FIG. 7 is the graphic chart denoting the relationship between actual temperature of the photoreceptive drum and temperature detected by temperature sensor; and

FIG. 8 is the graphic chart denoting conventional temperature compensation characteristic.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now more particularly to the accompanying drawings, one of the preferred embodiments of the present invention is described below. FIG. 1 is the simplified schematic diagram of the electrophotographic copying machine incorporating one of the preferred embodiments of the present invention, which is provided with a light source S illuminating the original D placed on the upper surface of a contact glass 1, mirrors 2 through 4 a lens 5, and a mirror 6 which respectively guide light reflected from the original D to the photoreceptive drum 7, a static charger 8, a developing device 9, a transfer charger 10, a separation charger 11, a cleaner 12, and a resist roller 13. In addition, the copying machine is provided with an optical sensor 14 in a position close to the lens 5. Signals output from the optical sensor 14 are firstly amplified by an amplifier 15, which are then A/D converted by an A/D converter 15'. The A/D converted signals are then applied to a control circuit 16 which is substantially comparison means. Signals output from the control circuit 16 are then converted into analog signals by the D/A converter 17, and in response to these analog signals, a power supply circuit 18 applies drive voltage to the light source S. The electronic system of this copying machine is provided with a memory 19 for allowing the control circuit 16 to write and read data signals into and from it.

FIG. 2 is the operation flowchart describing the automatic image density control operation related to the present invention. The automatic image density control system related to the present invention firstly remains in stand-by state until the print key is manually depressed in step 1. When step 2 is entered, the control system sets a specific value which is substantially the initially read light amount corresponding to a proper shade between white and black. When step 3 is entered, the optical sensor 14 reads the amount of light reflected from the original. When step 4 is entered, the control system decides whether the amount of light reflected from the original is greater than the read-out light amount (maximum value of the light amount thus far read) stored in the memory 19, or not. If it is decided that the amount of light reflected from the original is greater than the read-out light amount stored in the memory 19, the control system varies the initially set read-out light amount in proportion to the newly read-out light amount during step 5. When step 6 is entered, the control system replaces the value stored in the memory 19 with the newly read-out value. When step 7 is entered, the control system feeds power corresponding to the newly set value to the light source S.

Conversely, if it is decided during step 4 that the amount of light reflected from the original is less than the read-out light amount stored in the memory 19, then the control system feeds power corresponding to the set value to the light source S in step 7. After completing process related to step 7, the control system then decides during step 8 whether the scanning operation throughout the entire areas of the original is completed, or not. If it is not yet completed, the control system repeatedly executes deciding and processing which are to be done from steps 3 and so on. If it is already completed, the control system turns the light source S off during step 9 to complete the entire copying operations.

Summarizing above, if the read-out density of the original is decided to be thicker than the weakest of all the density of the original thus far identified, the control system doesn't vary the power being supplied to the light source S. Conversely, if the read-out density of the original is decided to be weaker than the weakest of all the density of the original thus far identified, the control system renews the content of the memory 19, and at the same time, it varies the power being supplied to the light source S in proportion to the read-out light amount. This allows the control system to effectively implement real-time processes and securely prevent erasure symptom from occurrence. In the above preferred embodiment, the control system effectively controls the power to be applied to the

light source S in accordance with the read-out density of the original. In addition, it is also possible for the control system to automatically control the image density by varying development bias signal being applied to the developing device 9 in the same way as above. Furthermore, it is also possible for the control system to set the amount of light to be initially read-out by reading the amount of light reflected from the reference board set in front of the position for starting the control of the image density of the original.

FIG. 6 is the simplified schematic diagram denoting the internal constitution of the electrophotographic copying machine having the constitution other than the above. This machine is provided with an exposure lamp S for illuminating the original D placed on a contact glass 1 and a photoreceptive sensor 14 receiving part of light reflected from the original D. In addition, the machine is provided with a photoreceptor drum 7 (containing selenium tellurium) which is capable of rotating itself and installed to a position below the contact glass 1. This machine is also provided with a static charger 8, a developing device 9, a transfer charger 10, a separation charger 11, a cleaner 12, and a thermistor 21, which are installed in the periphery of the photoreceptor drum 7 in the order mentioned above. The copying paper is guided to between the photoreceptor drum 7 and the transfer charger 10 via a copying paper conveying part 22, and then, after causing the separation charger 11 to peel the copying paper from the photoreceptor drum 7, the copying paper conveying part 22 conveys the copying paper to the fixing device 25.

FIG. 3 is the simplified block diagram of another preferred embodiment of the automatic image density control device related to the present invention. Signals output from the photoreceptive sensor 14 and the thermistor 21 are respectively applied to a microcomputer 23 through an A/D converter and an I/O interface which are not shown. Control signal from the microcomputer 23 is applied to an exposure lamp lighting circuit 24 through an I/O interface and a D/A converter which are not shown, and then voltage signal from the exposure lamp lighting circuit 24 is applied to the exposure lamp S.

FIG. 4 is the operation flowchart describing operations of the automatic image density control device shown in FIG. 3. In conjunction with this flowchart, the control system not only controls the image density in proportion to the density of the original, but it also precisely controls the image density by properly compensating for the temperature characteristic of the photoreceptor drum itself. More particularly, since temperature characteristic of the selenium-applied photoreceptor drum is not linear, application of linear temperature compensa-

tion (see FIG. 8) normally made available for any of the conventional image density control devices doesn't correctly compensate for temperature characteristic, and yet, since it is impossible for the mechanism to allow the temperature sensor to come into contact with the surface of the photoreceptor drum for protecting the surface of this drum, the temperature sensor may not correctly detect the temperature of the photoreceptor drum itself, but it may detect ambience temperature of the photoreceptor drum. As a result, as shown in FIG. 7, actual temperature of the photoreceptor drum is far from the temperature detected by the temperature sensor. Concretely, due to serial convection inside of the copying machine, even if temperature of the photoreceptor drum remains constant, temperature detected by the temperature sensor varies significantly. This eventually causes the copying system to incorrectly compensate for temperature. Taking this into account, the copying system related to the present invention improves the quality of image of the copied paper by properly compensating for temperature in a specific area where temperature compensation is needed, while deleting compensatory process in such an area where no temperature compensation is necessary.

After completing provision of the initial mode and warm-up process in a step not shown, the control system supplies the predetermined voltage to the exposure lamp S during step 1 so that the original can be illuminated. When step 2 is entered, the photoreceptive sensor 14 directly detects part of light reflected from the original D. When step 3 is entered, the thermistor 21 detects ambience temperature of the photoreceptor drum 7. When step 4 is entered, the control system decides whether temperature $T^{\circ}\text{C}$ detected by the thermistor 21 is within the predetermined range of temperature ($T1^{\circ}\text{C} < T^{\circ}\text{C} < T2^{\circ}\text{C}$), or not.

If it is identified during step 4 that temperature $T^{\circ}\text{C}$ exactly matches $T1^{\circ}\text{C} < T^{\circ}\text{C} < T2^{\circ}\text{C}$, when the next step 5 is entered, as shown by area A of FIG. 5, the control system varies voltage to be supplied to the exposure lamp S in accordance with the density of the original without executing compensatory process related to temperature at all. Concretely, the control system executes those operations which are identical to those which are shown in FIG. 2. Next, when step 10 is entered, the control system allows the copying operation to be done by applying a specific voltage varied during step 5, thus eventually producing a copied object containing an optimum density.

If it is identified during step 4 that temperature $T^{\circ}\text{C}$ detected by the thermistor 21 is $T^{\circ}\text{C} < T1^{\circ}\text{C}$, the control system varies voltage being supplied to the exposure lamp S in accordance with the den-

sity of the original during step 6. Concretely, the control system executes those operations which are identical to those which are shown in the operation flowchart of FIG. 2. Next, when step 7 is entered, as shown in area B of FIG. 5, the control system varies the voltage being applied to the exposure lamp S in order that temperature range can be expanded to allow compensation for the identical amount to be implemented as temperature lowers. Then, the control system executes operations specified by step 10.

Conversely, if it is identified during step 4 that temperature detected by the thermistor 21 is $T_2^{\circ}\text{C} < T^{\circ}\text{C}$, the control system varies the voltage being applied to the exposure lamp S in accordance with the density of the original while step 8 is underway. Concretely, the control system executes those operations which are identical to those which are shown in operation flowchart of FIG. 2. Next, when step 9 is entered, as shown in area C of FIG. 5, the control system varies the voltage being applied to the exposure lamp S in order that temperature range (where compensation for the identical amount can be provided) without adversely being affected by rising temperature. Then, the control system executes operations specified by step 10.

Actually, temperature $T_1^{\circ}\text{C}$ and $T_2^{\circ}\text{C}$, respectively correspond to 28°C and 40°C in FIG. 5. Compared to these, actually, the photoreceptor drum 7 bears 20°C through 25°C of temperature, and thus, there is no need of compensating for temperature. However, temperature may vary by order of several centigrades depending on the kind of the photoreceptor drum being used and the arrangement of component parts and members in the copying machine, and therefore, it is desirable to allow temperature $T_1^{\circ}\text{C}$ and $T_2^{\circ}\text{C}$ to be variable in each copying machine.

Summarizing above, if temperature detected by the thermistor 21 remains in a range $T_1^{\circ}\text{C} < T^{\circ}\text{C} < T_2^{\circ}\text{C}$, the copying machine can produce satisfactory copied-papers having an optimum density by controlling voltage to be supplied to the exposure lamp S in accordance with the density of the original. Conversely, if temperature detected by the thermistor 21 is out of a range $T_1^{\circ}\text{C} < T^{\circ}\text{C} < T_2^{\circ}\text{C}$, the control system controls voltage being applied to the exposure lamp S in accordance with the density of the original, and at the same time, it also controls voltage being applied to the exposure lamp S in accordance with temperature detected by the thermistor 21 to allow the copying machine to eventually produce ideal copied papers having an optimum density.

The preferred embodiment shown in FIG. 3 controls voltage being applied to the exposure lamp S. However, like the preferred embodiment shown in FIG. 1, the control system can also con-

trol development bias signal to be applied to the developing device 9. In addition, it is possible for the control system to allow the surface potential sensor to detect the density of the original instead of allowing the photoreceptive sensor 14 to detect the density of the original. Furthermore, the copying machine incorporating the automatic image density control device related to the present invention can install the thermistor 21 in a position other than between the static charger 8 and the cleaner 12.

Claims

1. An automatic image density control device comprising;

means (14, 15, 15'; 21), sequentially detecting density of an original; memory means (19) for storing the weakest density of the density of said original thus far read;

comparison means (16; 23) comparing said read-out density of said original the density of original stored in said memory means (19), and

control means (16, 17, 18; 24), outputting a control signal proportional to said read-out density of said original on receipt of incoming compared output signal from said comparison means (16; 23) indicating that said read-out density of original is weaker.

2. An automatic image density control device in accordance with claim 1, in which said control means (16, 17, 18; 24) supplies said control signal to a light source (S).

3. An automatic image density control in accordance with claim 1, in which said control means - (17, 18; 24) supplies said control signal to a developing device (9).

Fig. 1

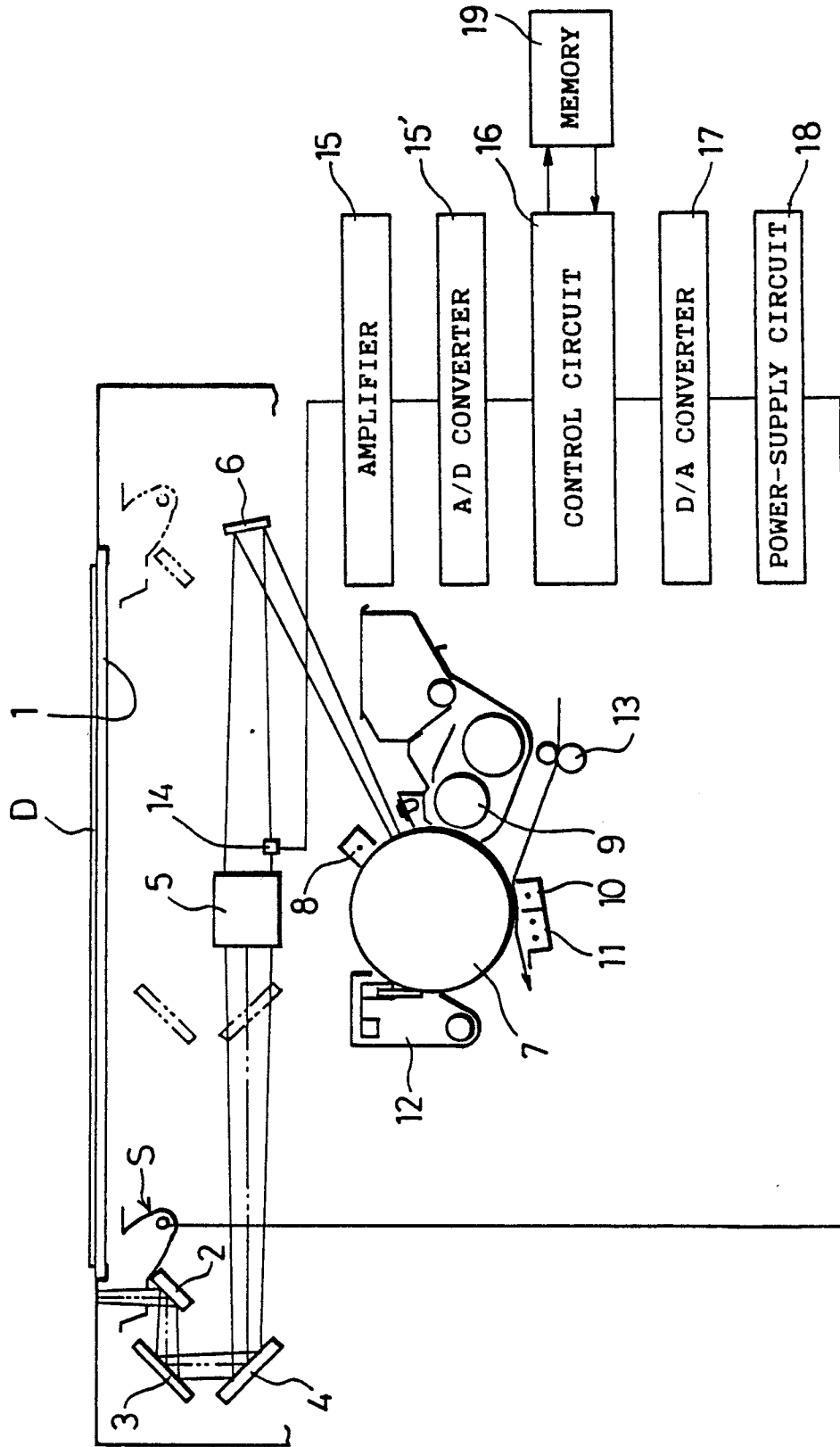


Fig. 2

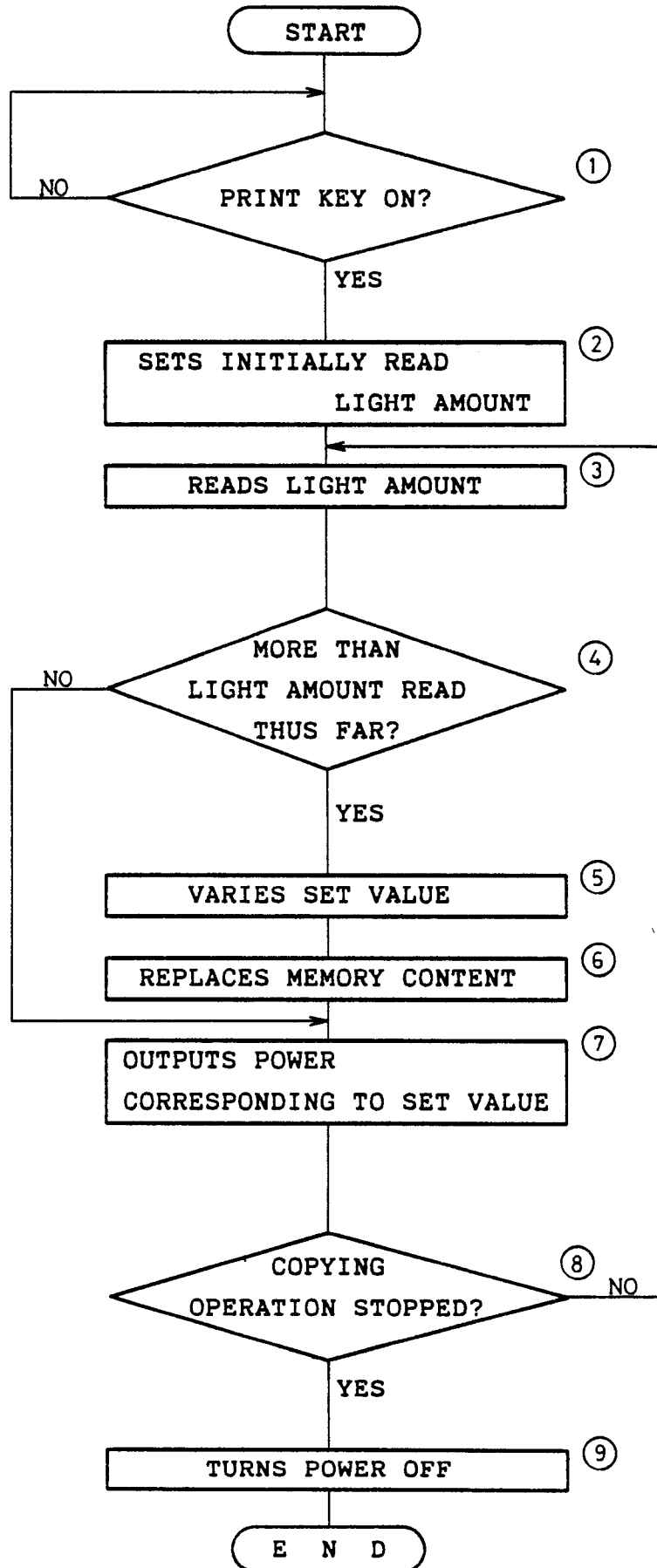


Fig.3

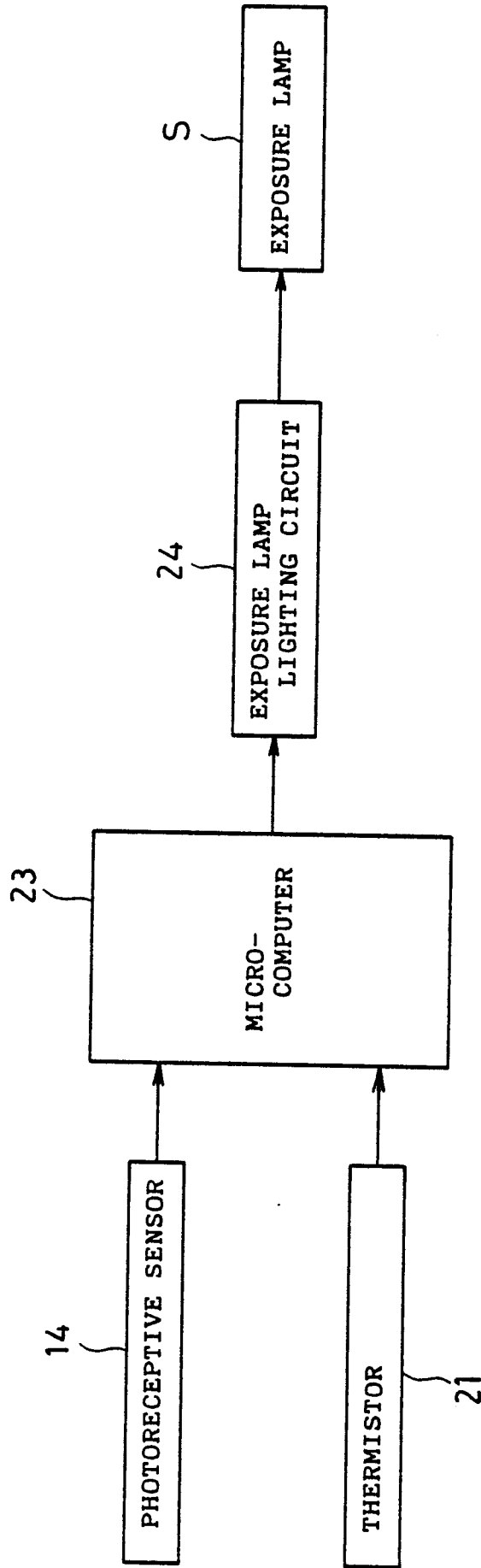


Fig.4

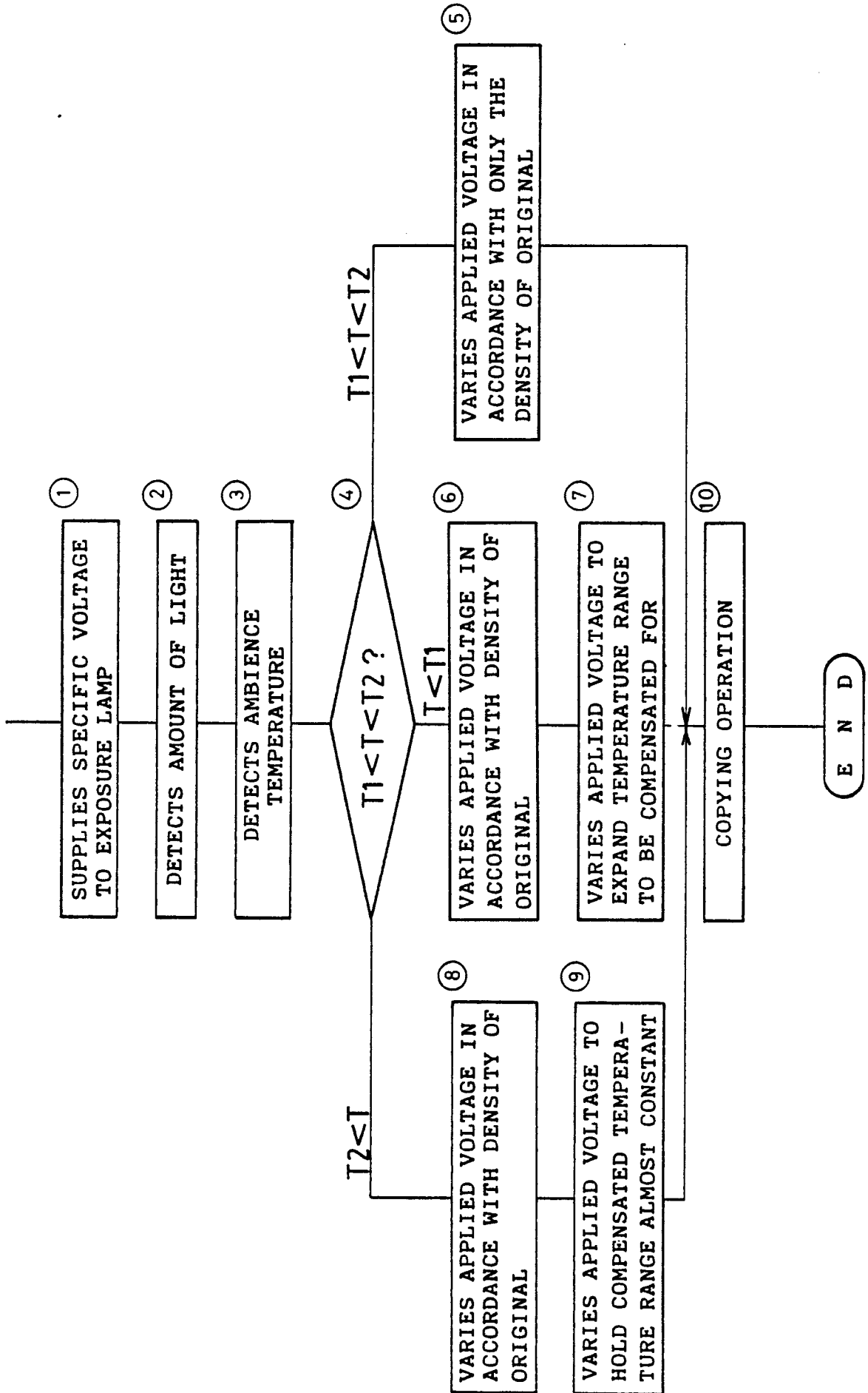


Fig.5

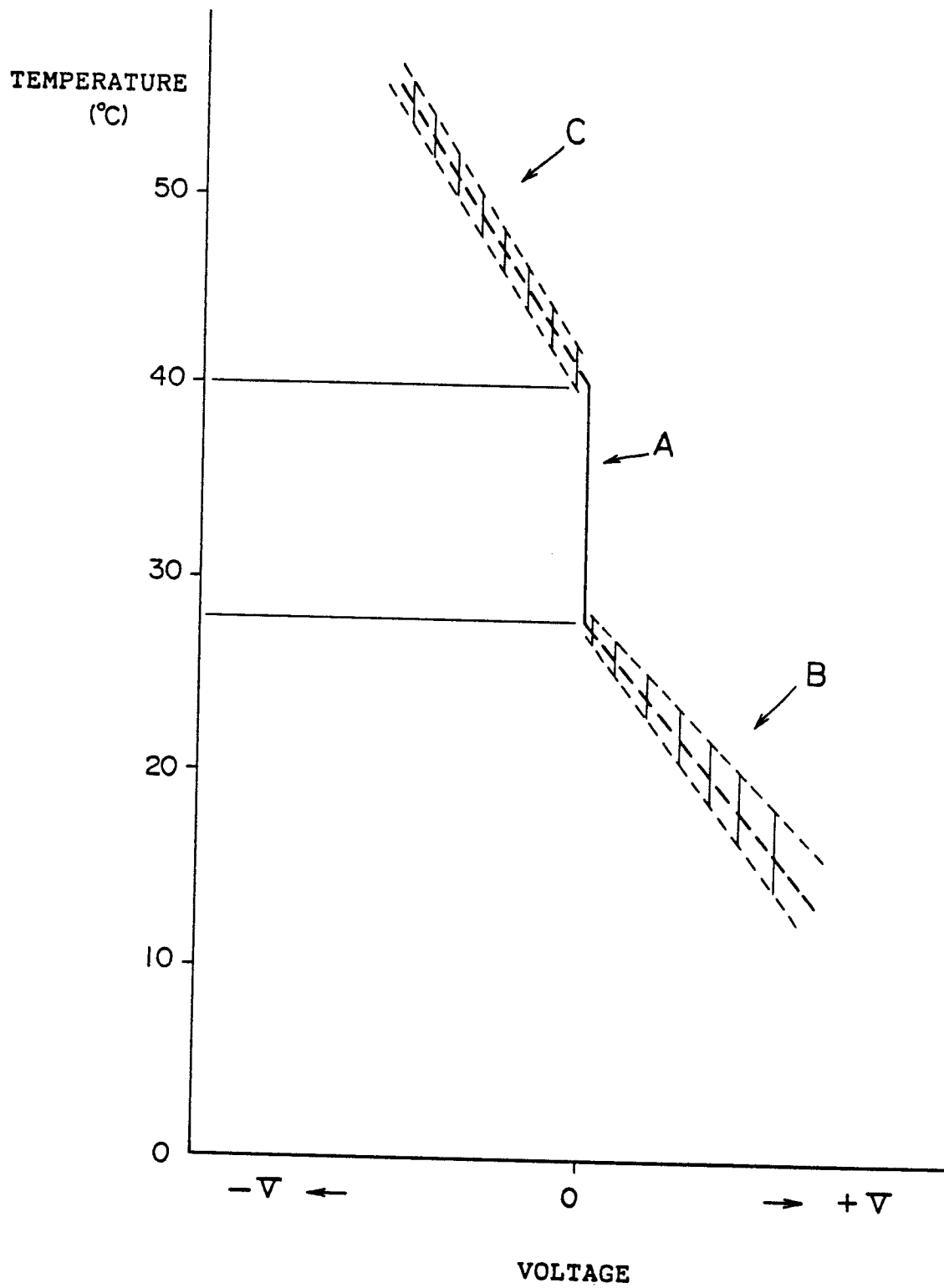


Fig.6

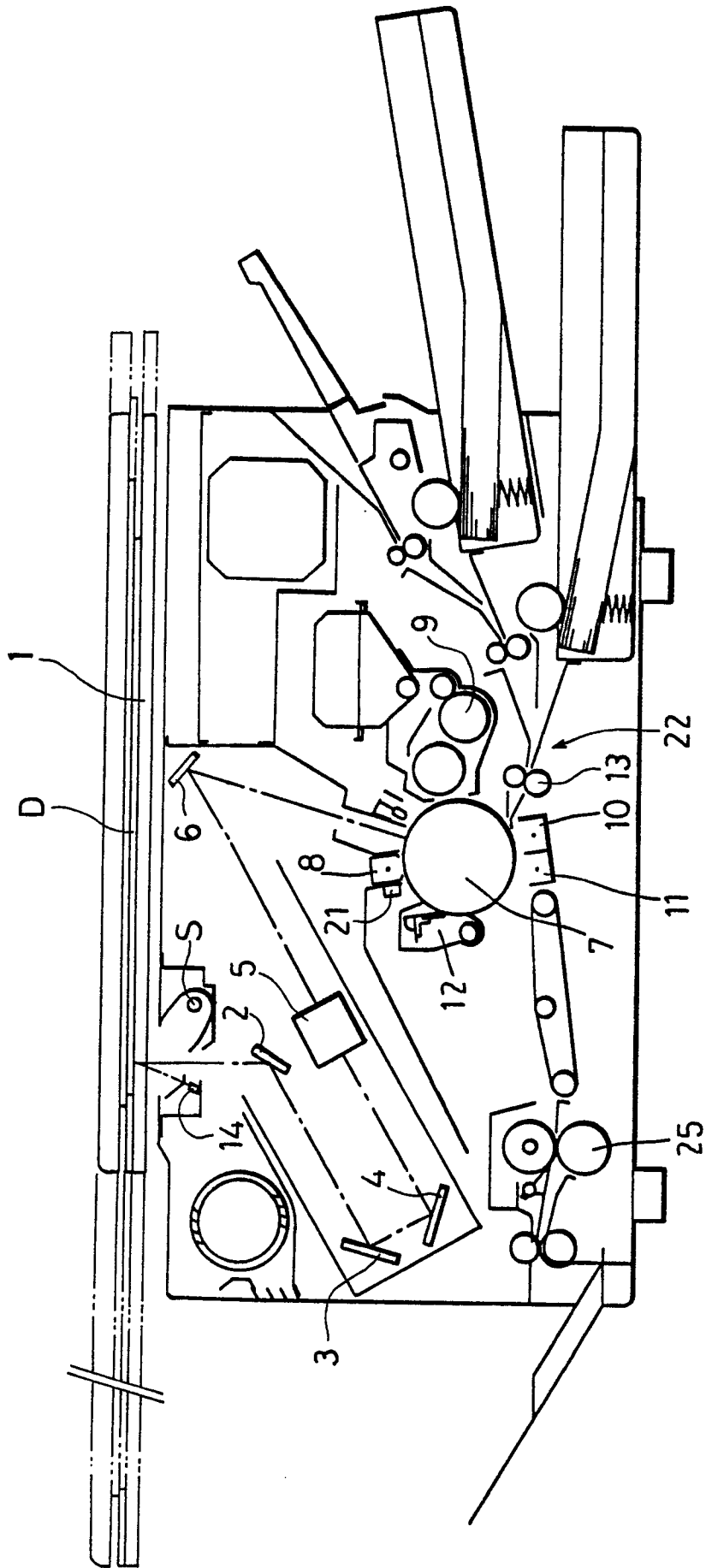


Fig.7

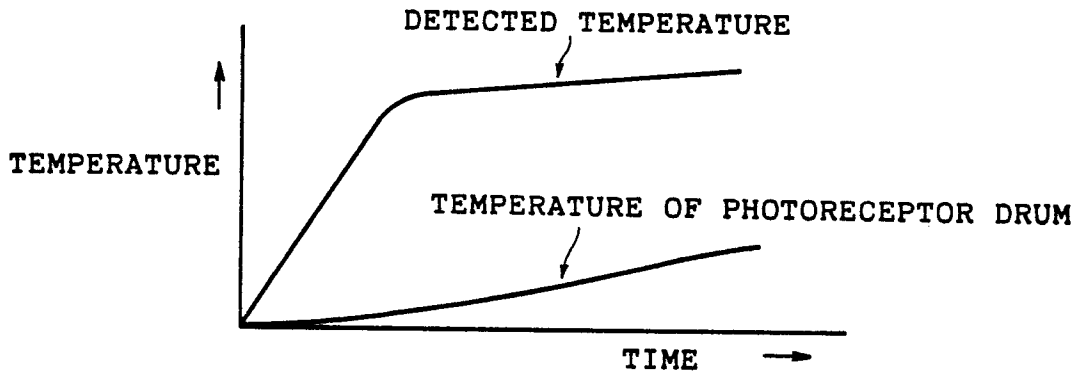
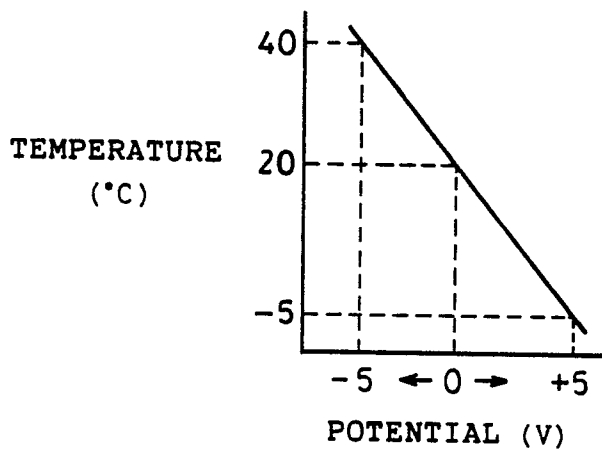


Fig.8





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 243 (P-392)[1966], 30th September 1985; & JP - A - 60 95453 (CANON) 28-05-1985	1-3	G 03 G 15/00
Y	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 21, no. 9, February 1979, pages 3546-3547; A.J. DATTILO et al.: "Variable intensity illumination scanner calibration system"	1,2	
Y	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 269 (P-400)[1992], 26th October 1985; & JP - A - 60 117 263 (MITA KOGYO) 24-06-1985	1-3	
Y	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 262 (P-398)[1985], 19th October 1985; & JP - A - 60 112 072 (MATSUSHITA DENKI SANGYO) 18-06-1985	1-2	TECHNICAL FIELDS SEARCHED (Int. Cl.4) G 03 G 15/00
Y	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 177 (P-375)[1900], 23rd July 1985; (MATSUSHITA DENKI SANGYO) 20-03-1985	1	
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 23-02-1987	Examiner HOPPE H
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>			



DOCUMENTS CONSIDERED TO BE RELEVANT			Page 2
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	PATENT ABSTRACTS OF JAPAN, vol. 9, no. 127 (P-360)[1850], 31st May 1985; & JP - A - 60 10267 (CANON) 19-01-1985	1,2	
Y	<p style="text-align: center;">---</p> DE-A-3 325 461 (CANON) * claims 1-14 * <p style="text-align: center;">-----</p>	1-3	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
Place of search BERLIN		Date of completion of the search 23-02-1987	Examiner HOPPE H
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