

FORM 1

SPRUSON & FERGUSON

COMMONWEALTH OF AUSTRALIA

612509

PATENTS ACT 1952

APPLICATION FOR A STANDARD PATENT

Fujitsu Limited, incorporated in Japan, of 1015, Kamikodanaka, Nakahara-ku, Kawasaki-shi, Kanagawa, 211, JAPAN, hereby apply for the grant of a standard patent for an invention entitled:

Optical Beam Scanning Apparatus

••••• which is described in the accompanying complete specification.

••••• Details of basic application(s):-

••••• Basic Applic. No: Country: Application Date:
••••• 63-212058 JP 26 August 1988

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DATED this TWENTY FIRST day of AUGUST 1989

Fujitsu Limited

By:

J. G. Spruson

Registered Patent Attorney

TO: THE COMMISSIONER OF PATENTS
OUR REF: 104453
S&F CODE: 54390

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DECLARATION IN SUPPORT OF A
CONVENTION APPLICATION FOR A PATENTIn support of the Convention Application made for a
patent for an invention entitled:AUSTRALIA
CONVENTION
STANDARD
& PETTY PATENT
DECLARATION
SFP4

Title of Invention Optical Beam Scanning Apparatus

Full name(s) and
address(es) of
Declarant(s) I/We Yukio Fukukawa, General Manager
Technology Administration Group of FUJITSU LIMITED
of 1015, Kamikodanaka, Nakahara-ku, Kawasaki-shi,
Kanagawa, 211 Japan

do solemnly and sincerely declare as follows:-

Full name(s) of
Applicant(s)~~1. I am/We are the applicant(s) for the patent~~*(or, in the case of an application by a body corporate)*1. I am/~~We are~~ authorised by FUJITSU LIMITEDthe applicant(s) for the patent to make this declaration on
its/~~their~~ behalf.2. The basic application(s) as defined by Section 141 of the
Act was/~~were~~ made

Basic Country(ies) in Japan

Priority Date(s) on 26th day of August 1988

Basic Applicant(s) by FUJITSU LIMITED

Full name(s) and
address(es) of
inventor(s)~~3. I am/We are the actual inventor(s) of the invention referred
to in the basic application(s)~~*(or where a person other than the inventor is the applicant)*

3. Shinichi Watarai, Shunji Kitagawa and Yoji Houki

of 180-1-403, Hakusancho, Midori-ku, Yokohama-shi, Kanagawa, 226 Japan;
3-29, Iho 3-chome, Takasago-shi, Hyogo, 676 Japan and
3-32-1-1111, Yaguchi, Ota-ku, Tokyo, 146 Japan

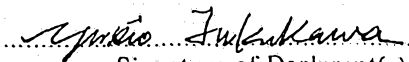
*(respectively)*is/are the actual inventor(s) of the invention and the facts upon
which the applicant(s) is/~~are~~ entitled to make the application are
as follows:

Set out how Applicant(s)
derive title from actual
inventor(s) e.g. The
Applicant(s) is/are the
assignee(s) of the
invention from the
inventor(s)

The applicant is the assignee of the actual inventors.

4. The basic application(s) referred to in paragraph 2 of this
Declaration was/~~were~~ the first application(s) made in a Convention
country in respect of the invention ~~as~~ the subject of the application.

Declared at Kanagawa, this 7th day of August 1989
Japan FUJITSU LIMITED



Signature of Declarant(s)

Yukio Fukukawa, General Manager
Technology Administration Group

11/81

To: The Commissioner of Patents

(12) PATENT ABRIDGMENT (11) Document No. AU-B-40085/89
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 612509

(54) Title
REGULATED OPTICAL BEAM SCANNER

International Patent Classification(s)
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(56) Prior Art Documents
AU 574479 44789/85 H04N 1/036 1/23 H01S 3/133 G02B 26/10
AU 38862/85 H04N 1/12
AU 561624 20983/83 H04N 1/22 1/032

(57) Claim

1. An optical beam scanning apparatus comprising:
 - (a) a light emission device;
 - (b) a means for driving said light emission device with a VIDEO signal;
 - (c) a light scanning device for scanning an optical beam from said light emission device;
 - (d) a photodetecting means for monitoring and receiving the light beam from said light emission device;
 - (e) a means for receiving output of said photodetecting means during time corresponding in the region other than the image forming region and comparing said output with a reference level;
 - (f) an integrating means for integrating the receiving output of said photodetecting means during time corresponding in the image forming region, and
 - (g) a means for controlling a driving current of said driving means based on the output of said comparison means and the output of said integrating means.

FORM 10

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

COMPLETE SPECIFICATION

612509

(ORIGINAL)

FOR OFFICE USE:

Class Int Class

Complete Specification Lodged:
Accepted:
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Related Art:

Name and Address
of Applicant:

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Complete Specification for the invention entitled:

Optical Beam Scanning Apparatus

The following statement is a full description of this invention, including the best method of performing it known to me/us

ABSTRACT OF THE DISCLOSURE

An optical beam apparatus comprising a light emission device, a driver for driving the light emission device with the applied VIDEO signal, a means for estimating drop of quantity of light emitted by the light emission device from the VIDEO signal applied, and a means for controlling the driver in compliance with the estimated result so that the quantity of light of optical beam emitted by the light emission device becomes constant.

TITLE OF THE INVENTION

Optical Beam Scanning Apparatus

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to an optical beam scanning apparatus which scans the target surface with an optical scanning device using the intensity-modulated optical beam by driving a light emission device such as a semiconductor laser.

In an electrophotographic apparatus, an optical beam scanning device for scanning beam intensity-modulated by an image information has been used.

(2) Description of the Related Art

In such optical beam scanning apparatus, it is required to keep the amount of light emitted from the light emission device such as a light emission diode (LED) to a predetermined level.

Namely, in such a light emission device, intensity of optical scanning beam changes depending on the conditions of optical scanning device and ambient temperature.

Therefore, gray level (concentration) becomes uneven in an image formed in such an electrophotographic apparatus described above.

For this purpose, a current for driving a light emission device has been set to make constant a light intensity of optical beam based on a receiving output of a monitor diode to monitor a light intensity of optical beam from the light emission device. However, in case a semiconductor laser and light emission diode are used as the light emission device, such device ^{changes} ~~changes~~ light emitting efficiency depending on temperature at the junctions. Namely, the light emitting efficiency is lowered as the temperature at the junction becomes higher.

Temperature at the junctions changes due to a duty ratio of a video signal or a drive current.

Accordingly, a large duty ratio of video signal in the prior art has generated a problem that an exposure energy in the ending side of scanning line is lowered by about 10 to 20% in comparison with that in the starting side of scanning line.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide an optical beam scanning apparatus having a means to compensate for drop of light emitting efficiency due to heat generation at the junctions of a



light emission device.

According to one aspect of the present invention there is disclosed an optical beam scanning apparatus comprising:

(a) a light emission device;

5 (b) a means for driving said light emission device with a VIDEO signal;

(c) a light scanning device for scanning an optical beam from said light emission device;

10 (d) a photodetecting means for monitoring and receiving the light beam from said light emission device;

(e) a means for receiving output of said photodetecting means during time corresponding in the region other than the image forming region and comparing said output with a reference level;

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15 (f) an integrating means for integrating the receiving output of said photodetecting means during time corresponding in the image forming region, and

(g) a means for controlling a driving current of said driving means based on the output of said comparison means and the output of said integrating means.

20 These and other objects, features and advantages of the invention will be become more apparent upon a reading of the following detailed specification and drawing, in which:

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BRIEF DESCRIPTION OF THE DRAWINGS

25 The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles

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of the invention.

Fig. 1 is a schematic diagram of a constitution of an electrophotographic apparatus to which an optical beam scanning apparatus of the present invention is applied.

Fig. 2 is a block diagram indicating a constitution for keeping constant light quantity of a light emission device when the scanning is started by an optical beam.

Fig. 3 is waveforms for explaining operations of Fig. 2.

Fig. 4 is a block diagram indicating a constitution of the embodiment for keeping constant light quantity of an optical beam during the period from starting and ending of the scanning by the optical beam.

Fig. 5 is a detail circuit diagram of a gate circuit, ^{integrating} ~~integral~~ circuit and light output control circuit shown in Fig. 4.

Fig. 6 is ^{waveforms} ~~waveforms~~ for explaining operations of Fig. 4 and Fig. 5.

Fig. 7 is a block diagram indicating a constitution of another embodiment.



DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a schematic diagram indicating a constitution of an electrophotographic apparatus to which an optical beam scanning apparatus of the present invention is applied.

In Fig. 1, an output beam from the light source 1 is scanned by a light scanning means 2 having the constitution described later and irradiates a photosensitive drum 30 which is the scanning object. The photosensitive drum 30 is charged by a corona charger 40 and this photosensitive drum 30 is scanned for the exposure by the intensity-modulated optical beam. After a latent image is developed by a developing device 45 using a toner, the toner is transferred to a paper 55 by a transfer charger 50. The toner remaining on the photosensitive drum 30 is removed by a cleaning blade 60.

The light scanning means 2 comprises a ^{cylindrical} ~~cylinder~~ lens 20, a polygon mirror 21, a spindle motor 22, an F-θ lens 23, a cylinder mirror 24 and a start detection mirror 25.

An output beam of light source 1 is converged by the ^{cylindrical} ~~cylinder~~ lens 20 and enters the polygon mirror 21 which is rotated by the spindle motor 22. The beam is



then reflected by the polygon mirror and then enters the F- θ lens 23. The scanning beam from the F- θ lens 23 takes a long light path, is then reflected by the ~~cylindrical~~ ^{cylindrical} mirror 24 for expanding the scanning width and then enters the photosensitive drum 30 as the scanning surface.

Meanwhile, the start detection mirror 25 which reflects the left side end of beam scanning width is provided between the F- θ lens 23 and the ~~cylindrical~~ ^{cylindrical} mirror 24 and the light reflected by the start detection mirror 25 is received by a photodetector (photodiode) 26 for start detection and a scanning light detection circuit 27 generates the start detection signal BD which indicates start of scanning by such receiving signal.

However, the light source of a kind described above changes light quantity of optical beam depending on ambient temperature and the conditions of light scanning means 2.

Fig. 2 is a block diagram indicating a constitution for keeping constant the light quantity of the light emission device at the time of starting the scanning of optical beam and Fig. 3 shows waveforms for explaining operations of Fig. 2.

Explained hereunder is the case where a semicon-



ductor laser is used as the light emission device provided as the light source 1. As shown in Fig. 2 and Fig. 3, the semiconductor laser 1 as the laser light source is driven by the (LD) driver depending on the video signal VIDEO.

The semiconductor laser 1 is provided with a monitor diode (photodetector) 4 which receives emitted light beam for monitoring.

The receiving output of monitor diode 4 is sampled for a constant section other than the image forming region for every scanning and a drive current of the driver 3 is set based on such sample value.

Namely, the receiving output of the monitor diode 4 is amplified by an amplifier 5a. Thereafter, an output of amplifier 5a is compared, in the comparator 5b, with the LD power control signal PC which is adjusted and set previously to obtain the predetermined image concentration. The comparator 5b outputs "1" when the output of amplifier 5a is larger than the LD power control signal PC or outputs "0" when the output of amplifier 5a is smaller than the LD power control signal PC. The comparison output of the comparator 5b is sampled in the gate circuit 5c only for the period of BDON (Fig. 3(b)) with the start signal (BD signal).

The output of comparator 5b is applied to the light output control circuit 7 through the gate circuit 5c. Thereby, the light output control circuit 7 changes a driving current value (light control signal LCS of Fig. 3(c)) which is given to lower the light emission quantity of output beam of the semiconductor laser 1 in case the output of gate circuit 5c is "1". Meanwhile, the light output control circuit 7 changes a driving current value to raise the light emission quantity in case the output is "0". The light output control circuit 7 holds this driving current for the one scanning period to give it to the driver 3.

With such constitution described, a light output level of the semiconductor laser 1 can be kept to a constant as shown by a solid line of Fig. 3(d) even when the ambient temperature changes.

However, when the semiconductor laser 1 is driven, for example, with the VIDEO signal shown in Fig. 3(a), the light quantity is gradually lowered as shown by a broken line of Fig. 3(d), due to the influence of heat generation at the junctions of semiconductor laser 1.

Fig. 4 is a block diagram indicating the constitution of an embodiment for keeping constant the light quantity of optical beam during the period from the

starting to the ending of the scanning of optical beam,
while Fig. 5 is a constitution of the ^{detail} ~~detail~~ circuit of
the gate circuit, integral circuit and light output
control circuit shown in Fig. 4. Fig. 6 shows
waveforms for explaining operations of Fig. 4 and Fig.
5.

In these figures, the elements like those shown in
Fig. 1 and Fig. 2 are designated by the like reference
numerals.

The semiconductor laser 1 is driven for ON/OFF
corresponding to the video signal VIDEO by the LD
driver 3. A driving current output when the LD driver
3 is operated is controlled by the light output control
signal LCS.

The light emission level of semiconductor laser 1
is detected by the monitor diode 4 comprised in the
semiconductor laser 1 and is then converted to a
current.

An output of monitor diode 4 is voltage-converted
by the amplifier 5a and is compared with the level
(reference level) of the LD power control signal Pc in
the comparator 5b.

The output level thereof controls the signal level
of light output control circuit 7 only when the BD



signal is high level (BDON). Namely, as described previously, when the light output signal of monitor diode 4 has the level lower than the reference level P_c , the light output control circuit 7 provides the output of high light emission level. When the output is higher than the reference level P_c , the light output control circuit 7 provides the output of low light emission level.

Such control is carried out only when the BD signal is high level (BDON) and the light output signal level of monitor diode 4 is set to the same level as the reference level P_c .

The LD power control signal P_c is used for setting the concentration of printing (setting of light intensity of semiconductor laser 1) and it can be manually set by the switch on the operator panel provided to the electrophotographic apparatus.

Simultaneously, the BD signal is discharged to 0V at BDON in the ~~integral~~^{integrating} circuit 6 and an output of monitor diode 4 in the amplifier 5a is integrated.

Therefore, an output voltage of ~~integral~~^{integrating} circuit 6 increases with the light emission period of semiconductor laser 1.

Namely, as shown in Fig. 5, the ~~integral~~^{integrating} circuit



6a formed by a capacitor 60 for signal voltage integration and a resistor 61 for setting discharge current discharges to 0V when the high level BD signal (BDON) is applied to the base of discharge transistor 62 for capacitor 60 as shown in Fig. 6(b). Accordingly, this ^{integrating} ~~integral~~ circuit 6a discharges to 0V when the high level BD signal (BDON) is applied for every one scanning by the polygon mirror 21.

Thereafter, when the VIDEO signal as shown in Fig. 6(a) is applied to the LD driver, an output of the monitor diode 4 is applied, through the amplifier 5a, to the charging circuit 6b for charging the capacitor 60 formed by the resistors 67, 68, 69 for setting charging current and a transistor 66 for charging the capacitor 60.

Accordingly, as shown in Fig. 6(c), the capacitor 60 of integral circuit 6a is charged by the charging circuit 6b when the VIDEO signal is ON during the scanning period of image forming area of laser and is discharged through the resistor 61 when the VIDEO signal is OFF. Thereby, the capacitor 60 holds a value depending on duration period of driving time of semiconductor laser 1 and a voltage depending on charge held by the capacitor 60 appears at the terminal z as



shown in Fig. 6(c).

Meanwhile, the light output control circuit 17 comprises an adder circuit 17a formed by an operation amplifier 170 for voltage addition and resistors 171, 172, 173, 174 for setting addition constant.

The adder circuit 17a adds the voltage appearing at the terminal z and the voltage appearing at the terminal Y and gives an added output to the LD driver.

On the other hand, a holding voltage of the capacitor 180 holding the light output control voltage appears at the terminal Y.

The capacitor 180 is discharged by the discharging circuit 17b formed by the transistor 181 and resistors 182, 183, 184 for setting discharge current. Moreover, this capacitor 180 is charged by the charging circuit 17c formed by the transistor 191 and resistors 192, 193, 194 for setting charging current.

To the base of transistor 191 of this charging circuit 17c, an output of the AND circuit 171 forming the gate circuit 15c is connected through the resistor 192. In addition, to the base of transistor 182 of the discharge circuit 17b, an output of the AND circuit 152 forming the gate circuit 15c is connected.

To the one input terminal of the AND circuit 151,

the signal obtained by inverting an output of the comparator 5b with the inverting circuit 153 is input, while to the other input terminal, the BD signal is input.

Moreover, to the one input terminal of the AND circuit 152, the signal obtained by inverting an output of the inverting circuit 153 with the inverting circuit 154 is input, while to the other input terminal, the BD signal is input.

Therefore, the AND circuit 151 outputs "1" only when the output of comparator 5b is "0" while the BD signal is BDON and the charging circuit 17c charges the capacitor 180 only during this period.

Meanwhile, the AND circuit 152 outputs "1" only when an output of the comparator 5b is "1" while the BD signal is BDON and the discharging circuit 180 discharges the capacitor 180 only during this period.

As can be understood from above explanation, the light output control circuit 17 lowers a holding voltage of capacitor 180 with the effect of the discharging circuit 17b while an output of the monitor diode 4 amplified by the amplifier 5a is higher than the LD power control signal Pc during the period where the BD signal is high level (BDON), and when an output

of the monitor diode 4 amplified by the amplifier 5a is lower than the LD power control signal Pc, the light output control circuit 17 raises a holding voltage of capacitor 180 with the effect of the charging circuit 17c.

Thereby, as explained with reference to Fig. 2 and Fig. 3, light quantity ^{can} ~~ena~~ be kept to a constant following variation of ambient temperature.

Here, a holding voltage of capacitor 180 and a holding voltage of capacitor 60 in the integral circuit 6 are respectively input to the operational amplifier 170 through the resistors 174, 173 for setting addition constant and added therein. With an output voltage of this adder circuit 17a, the driving current of LD driver 3 is set .

Accordingly, as shown in Fig. 6, the light output control signal LCS (Fig. 6(d)) has the format that the integral signal IS (Fig. 6(c)) is added to the comparison output SC set for every scanning.

Namely, in the first non image area where the VIDEO signal is in the OFF level, the signal LCS is controlled to the level of LD power control signal PC and thereafter the VIDEO signal of ON level is given and increases with light emission of the semiconductor



laser 1.

Therefore, deterioration of light emission efficiency due to heat generation at the junction of semiconductor laser 1 can be compensated by increasing a driving current of the LD driver 3.

Namely, in the starting side of scanning, the reference light quantity preset in the period of BDON is assured and the light quantity compensated by the effect of integral circuit is assured in the ending side of scanning and thereby almost the same light quantity can be maintained in both the starting and ending sides of the scanning. Accordingly, uneven gray level (concentration) is not longer generated in both sides of the output result in the electrophotographic apparatus comprising such a optical beam scanning device.

In the embodiment described above, the semiconductor laser is used as the light source to integrate detection output of the monitor diode 4.

However, in case the light emission diode (LED) 101 is used as the light source, a monitor diode is not used. Therefore, as shown in Fig. 7, the light quantity of LED 101 is supplied to the amplifier 5a by detecting the optical beam reflected from the surface

of photosensitive drum 30 by the photodetector 26 for start detection and meanwhile the VIDEO signal applied to the LD driver 3 is input to the integral circuit 6.

The other constitution is ^{similar} ~~similar~~ to those shown in Fig. 4 and Fig. 5.

With the constitutions described above, the light quantity can also be kept constant in the same way as the case where the LED 101 is used.

In the embodiment shown in Fig. 4, it is permitted that the VIDEO signal applied to the LD driver is integrated, without integrating an output of the monitor diode 4.

As explained heretofore, amount of heat generated at the junction of light emission device is established by an integral value obtained by integrating the VIDEO signal and a driving current of semiconductor laser is controlled by correcting the sampled comparison control signal. Therefore, deterioration of light emission efficiency due to heat generation at the junction of semiconductor laser can be compensated and optical scanning can be realized with established light quantity.

Moreover, such effect can be achieved only by controlling the driving current and therefore such



effect can be attained easily and economically.

While the present invention has been particularly described with reference to a preferred embodiment thereof, it is to be understood that the ^{present}~~present~~ invention is not limited thereto in any way but covers any and all changes and modifications which will become possible within the scope of the claims.



The claims defining the invention are as follows:

1. An optical beam scanning apparatus comprising:

(a) a light emission device;

5 (b) a means for driving said light emission device with a VIDEO signal;

(c) a light scanning device for scanning an optical beam from said light emission device;

(d) a photodetecting means for monitoring and receiving the light beam from said light emission device;

10 (e) a means for receiving output of said photodetecting means during time corresponding in the region other than the image forming region and comparing said output with a reference level;

(f) an integrating means for integrating the receiving output of said photodetecting means during time corresponding in the image forming region, and

15 (g) a means for controlling a driving current of said driving means based on the output of said comparison means and the output of said integrating means.

20 2. An optical beam scanning apparatus according to claim 1, wherein said light emission device is a semi-conductor laser.

3. An optical beam scanning apparatus according to claim 1, wherein said light emission device is a light emission diode.

25 4. An optical beam scanning apparatus according to claim 1, wherein said light scanning device comprises a rotary polygon mirror and an f- θ lens.

5. An optical beam scanning apparatus according to claim 1, said integrating means is an integrating circuit.

30 6. An optical beam scanning apparatus according to claim 1, further comprised is a second control means for setting the driving current of said driving means so that the light quantity of optical beam at the starting point of scanning is a first value.

7. An optical beam scanning apparatus according to claim 6, further including an integrating circuit for integrating said VIDEO signal; said second control means comprises a comparison means for comparing light quantity of optical beam with the reference level and a capacitor for converting a holding voltage in compliance with an output of said comparison means; and said first control means is an adder circuit for adding the holding voltage of said integrating circuit and the voltage of said capacitor.



8. An optical beam scanning apparatus according to claim 6, wherein said light emission device is a semiconductor laser having a monitor diode.

5 9. An optical beam scanning apparatus according to claim 8, wherein said integrating circuit integrates the output of said monitor diode as said VIDEO signal.

11. An optical beam scanning apparatus substantially as described with reference to Figs. 1-6 or Fig. 7 of the accompanying drawings.

DATED this NINETEENTH day of JUNE 1990

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Fujitsu Limited

Patent Attorneys for the Applicant
SPRUSON & FERGUSON

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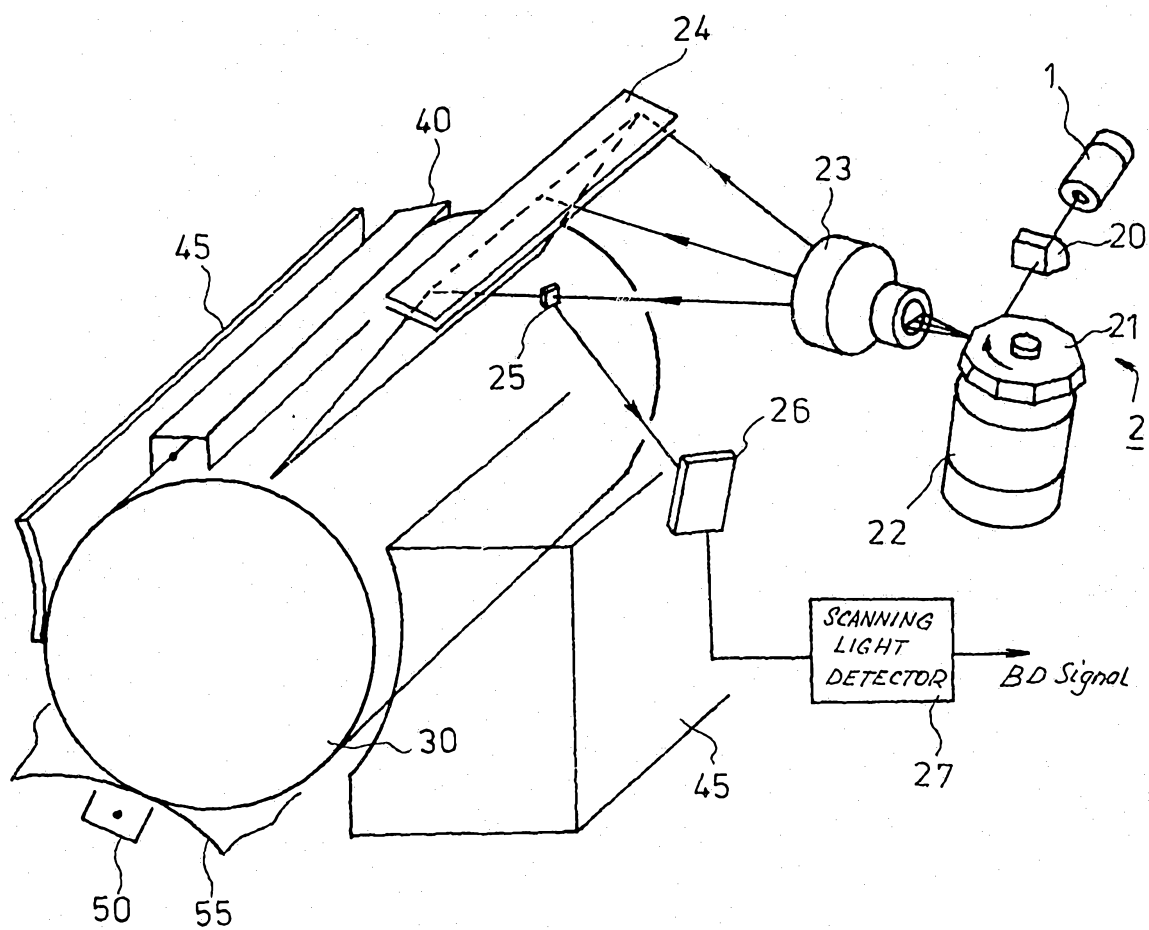


FIG. 1

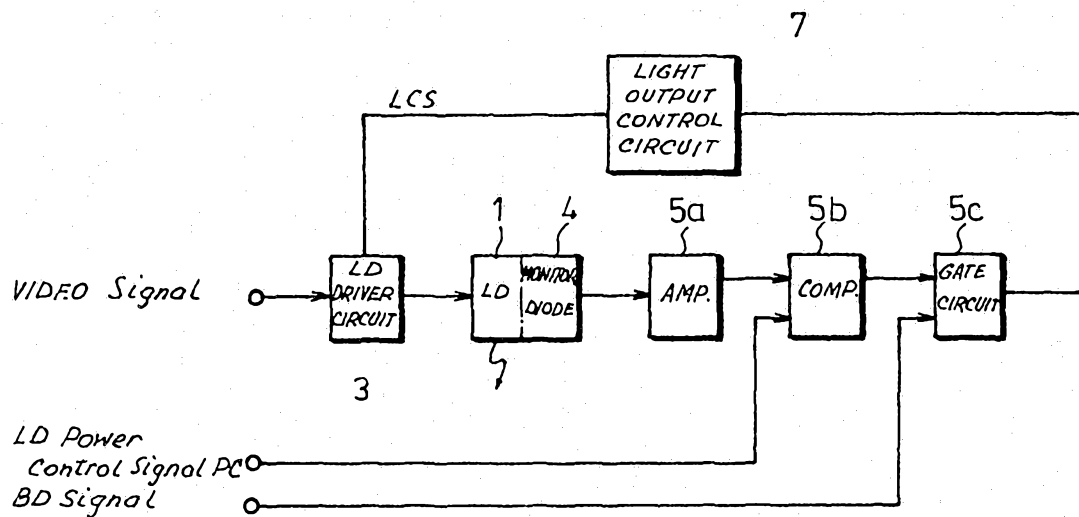


FIG. 2

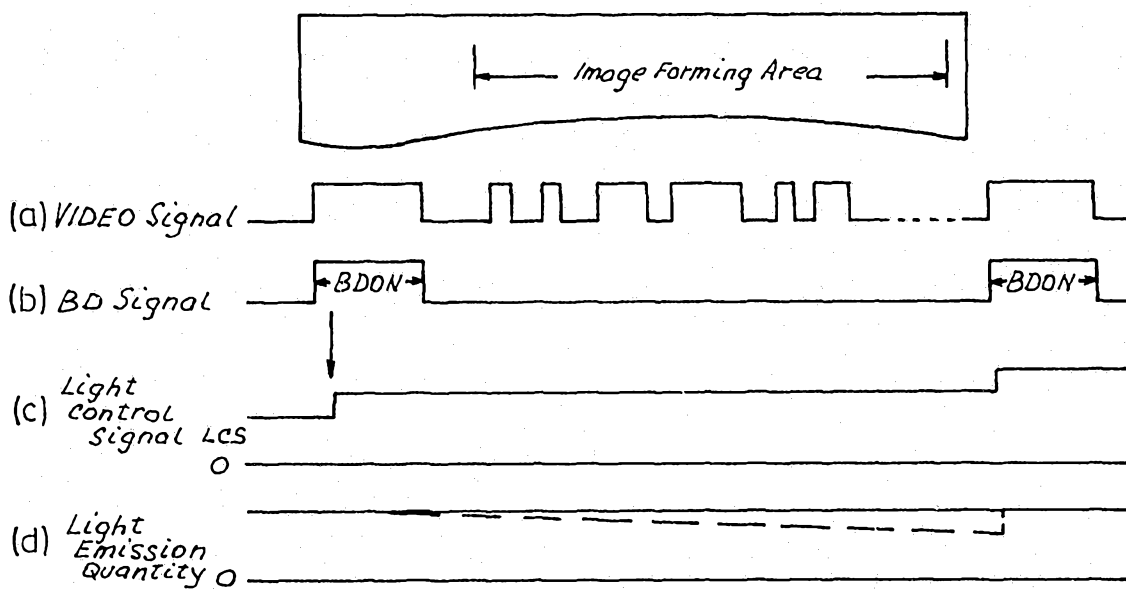


FIG. 3

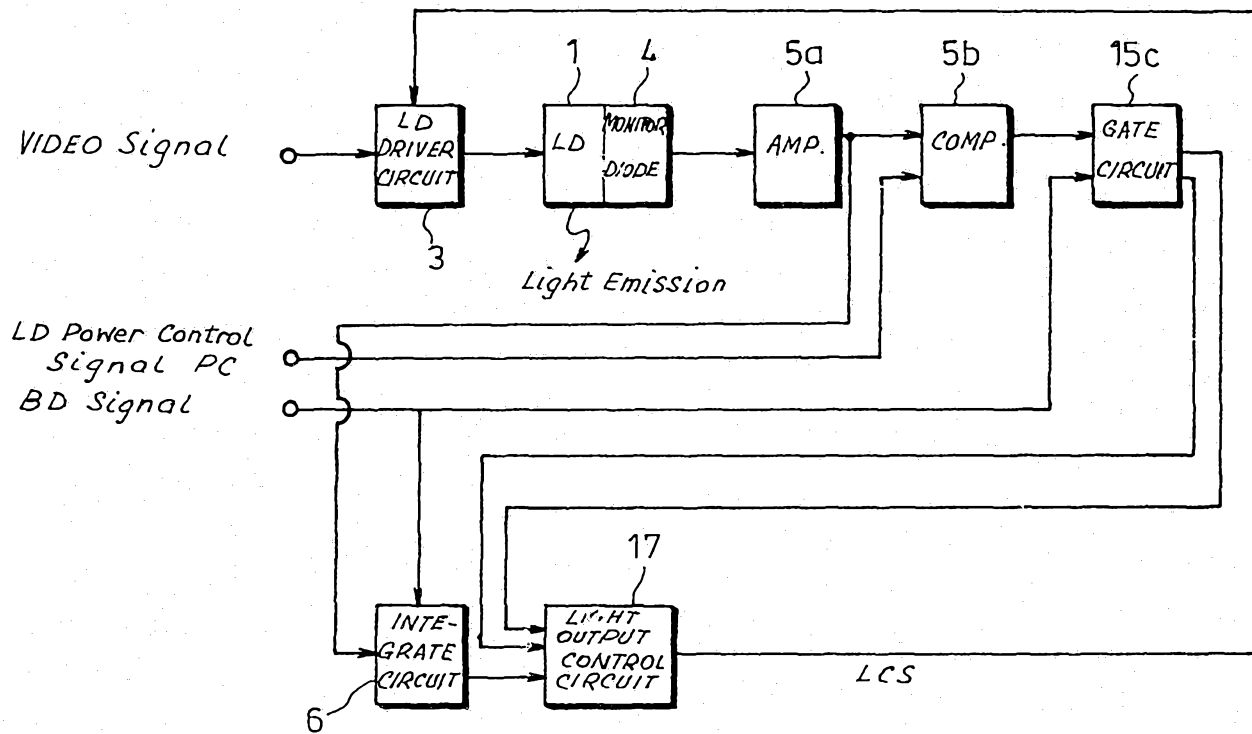


FIG. 4

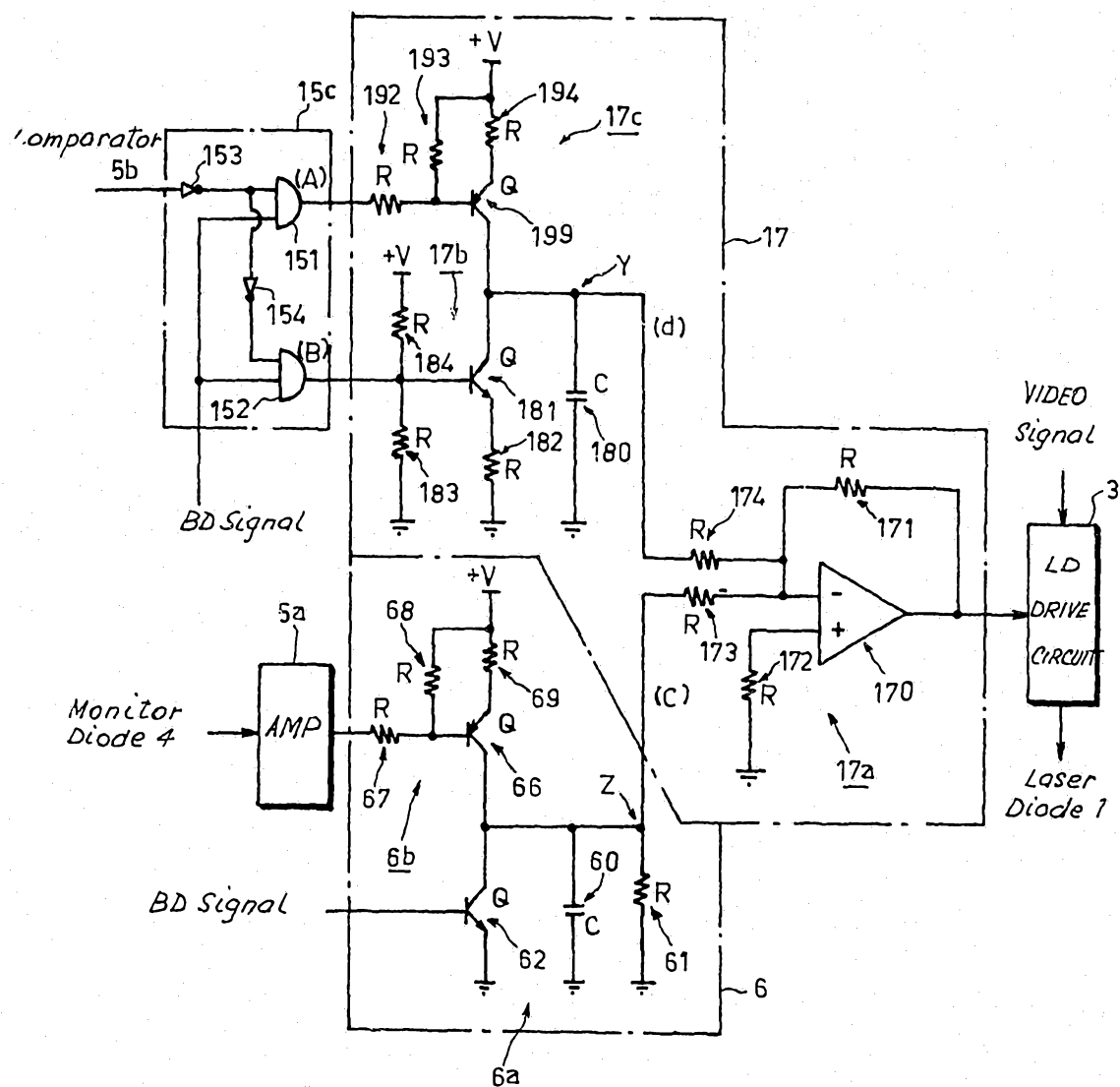


FIG. 5

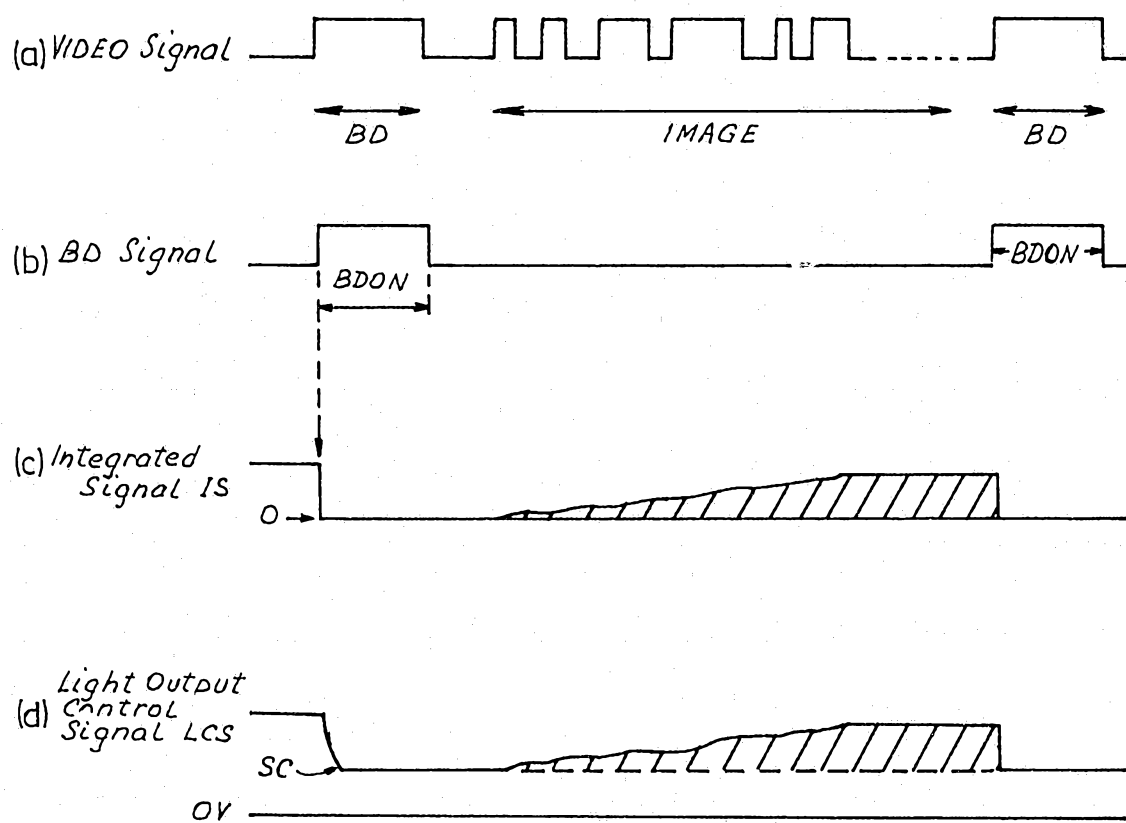


FIG. 6

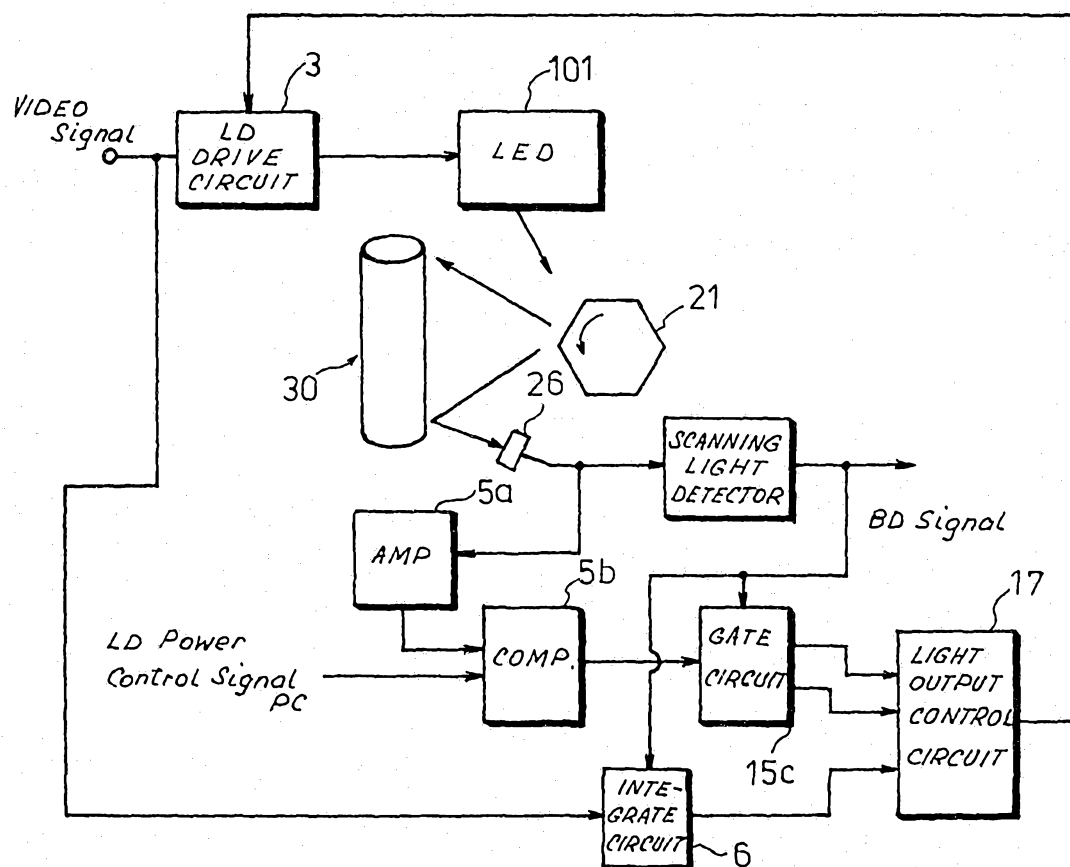


FIG. 7