United States Patent

Yamada

[15] **3,650,624**

[45] **Mar. 21, 1972**

[54] PHOTOGRAPHIC PRINTER WITH AUTOMATIC EXPOSURE CONTROL

[72] Inventor: **Yoshihiro Yamada,** No. 2845, Aza Kuroishi, Oaza Hirabari, Tenpaku-cho, Showa-ku, Nagoya-shi, Aichi-ken, Japan

[22] Filed: **Mar. 13, 1970**

[21] Appl. No.: **19,407**

[52] **U.S. Cl.** **355/69**

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

[58] **Field of Search** 355/68, 69

[56] **References Cited**

UNITED STATES PATENTS

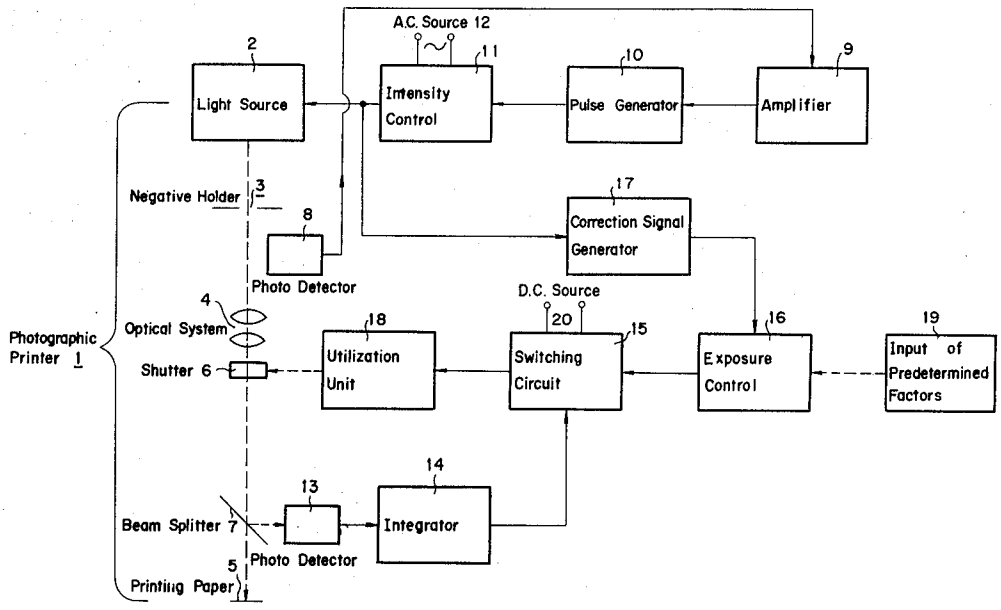
2,794,366	6/1957	Canady	355/68
2,444,675	7/1948	Rath	355/68
2,995,978	8/1961	Glandon	355/68
2,835,165	5/1958	Smith	355/68
3,237,516	3/1966	Shearer	355/69 X
2,201,606	5/1940	Bing	355/68

Primary Examiner—Samuel S. Matthews
Assistant Examiner—Monroe H. Hayes
Attorney—Kane, Dalsimer, Kane, Sullivan and Kurucz

[57] **ABSTRACT**

Photographic printer is provided with an apparatus for controlling the quantity of printing light to be applied to a printing paper in dependence upon the variable densities of negative film to be printed. Said intensity control apparatus is composed to two photoelectrical devices, namely one for controlling the effective current supplied to a printer lamp and other for controlling other factors influencing the quantity of the printing light. A correction signal is derived from the former device and applied to the latter device, to thereby attain a fine and high speed control of the photographic printing process with proper exposure appropriate for the negative and printing paper as used.

1 Claims, 3 Drawing Figures



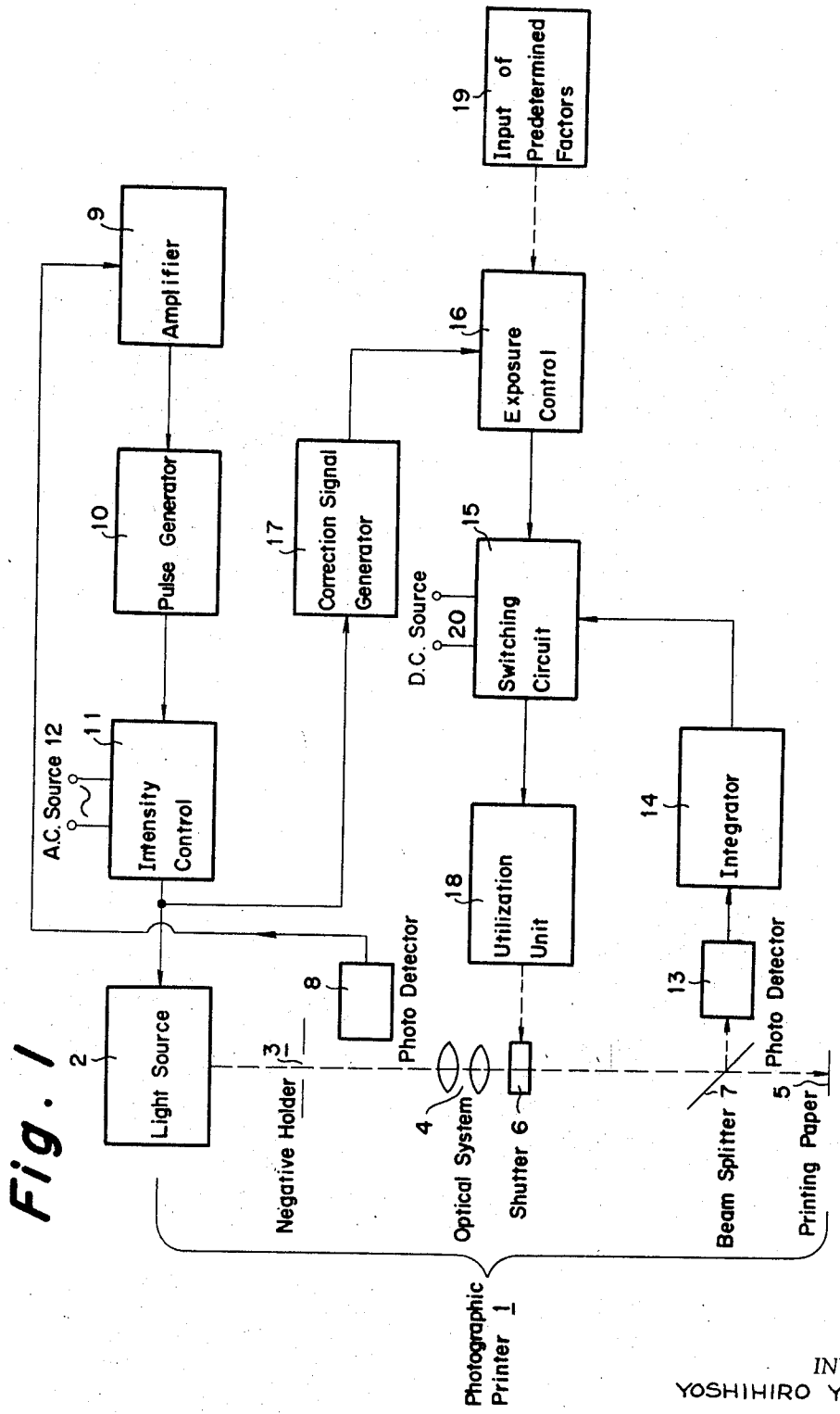
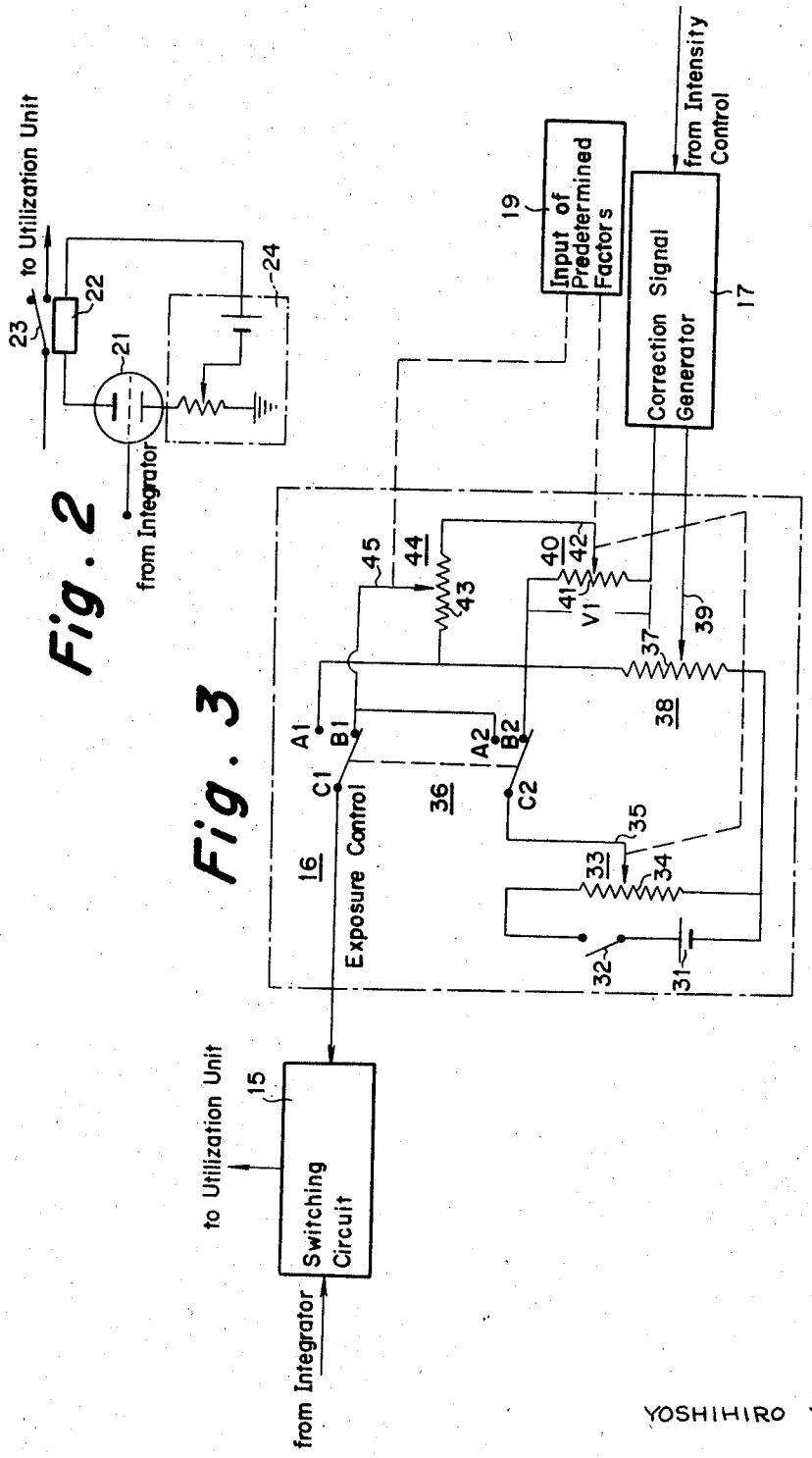


Fig. 1

INVENTOR
YOSHIHIRO YAMADA

BY Kane, Dalsimer, Kane, Sullivan & Kurucz
ATTORNEYS



INVENTOR
YOSHIHIRO YAMADA

BY Kane, Dalsimer, Kane, Sullivan & Kurucz
ATTORNEYS

PHOTOGRAPHIC PRINTER WITH AUTOMATIC EXPOSURE CONTROL

BACKGROUND OF THE INVENTION

The present invention relates to a photographic printer with an apparatus for automatically controlling the quantity of printing light to be impressed on a printing paper in dependence upon densities of negative originals to be printed or copied.

As is well known, the quantity of the printing light is a function of the intensity of the light and the length of the period during which the printing paper is exposed to the printing light, namely, the length of the exposure time.

In a hitherto known photographic printer of the type as above mentioned, the quantity of printing light applied onto the printing paper has been regulated by means of a photoelectrical apparatus which operates to vary the intensity of the printing light in dependence upon the density of the negative to be printed, while the exposure time is maintained constant. This kind of photographic printer has disadvantage that the precise or reliable printing can not be accomplished because of a slow responsibility of the printing lamp to the intensity control signal from the electronic apparatus. Furthermore, the constant exposure time must be so selected, that even a negative original having the greatest density can be printed with a printing lamp having an available maximum light output. Accordingly, a remarkable long exposure time is required also for the negative having a reduced or thin density, as a result of which a lot of time is expensed for the whole printing treatment.

Another type of the priorly known photographic printer has a photoelectrical apparatus for controlling the exposure time or period as a function of the variable densities of the negatives with the intensity of the printing light held constant. In this type of the photographic printer, the exposure time is varied within a relatively wider range depending upon the average density of the negative film to be printed, and the Schwarschild-effect therefore becomes remarkable particularly in case of the thick negative.

SUMMARY OF THE INVENTION

Accordingly, an important object of the present invention is to provide a photographic automatic printer, in which the disadvantages of the conventional printers as above-mentioned are eliminated.

Another object of this invention is to provide a photographic printer which allows a shorter exposure time and hence a speedy printing with an optimum intensity of the printing light.

Still another object of this invention is to provide an improved apparatus for controlling the intensity of the printing light and (or) the exposure time in dependence upon the densities of negative films, to thereby enhance the speed of the printing operation.

These and other objects of this invention can be attained by providing a photographic printer comprising a printing light source, an optical system for projecting the image of an original to be printed onto a printing paper, first means for controlling the intensity of said printing light in dependence upon the density of the original, second means for controlling the quantity of the printing light to be applied to said printing paper as a function of the intensity of said printing light and various photographic, electrical and/or mechanical factors, and third means connected to said first means for producing a signal which is applied to said second means as a correction signal to additionally control said second means.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other objects as well as the advantageous features of this invention will become more apparent from the following description of a preferable embodiment of this invention taken in conjunction with the annexed drawings, in which,

FIG. 1 is a block diagram of a preferable embodiment of a photographic printer control system according to this invention,

FIG. 2 is a schematic circuit diagram of a switching apparatus which can be conveniently employed in the control systems shown in FIG. 1, and

FIG. 3 is a circuit diagram of a printing light quantity controlling circuit which can be preferably employed in the printer control system of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, referring to FIG. 1, reference numeral **1** generally indicates a photographic printer which comprises a light source or electric lamp **2**, a negative supporting holder **3** for supporting a negative film to be printed, and an optical system **4** for projecting the image developed in the negative film onto a printing paper **5** by way of a shutter **6** for setting the exposure time. Disposed between the shutter **6** and the printing paper **5** is a beam splitter **7** which is adapted to divert a portion of the printing light for the purpose which will be hereinafter mentioned. Such photographic printer is well known for those skilled in the art and therefore more detailed description will be unnecessary.

A photo-detector **8** which constitutes a part of the circuit for controlling the intensity of the printing light is disposed below the negative holder **3** in a suitable position for receiving light emitted by the printer lamp **2** and passed through the negative film supported on the holder **3**. This photo-detector serves to produce an electrical signal having a magnitude proportional to the intensity of the light impinging thereon, which intensity in turn will depend upon the density of the negative to be printed. Such photo-detector **8** can be composed of a conventional element such as a photocell, photoconductor, photomultiplier, etc. The output from the photo-detector is applied to an amplifier **9**, the output from which in turn is connected to a pulse generator **10** which is adapted to produce a train of pulses having variable durations in dependence upon the amplitude of the electrical signal from the amplifier **9**. The pulse generator **10** may comprise a phase shifter, a pulse producing unijunction transistor and a pulse transformer having two output or secondary windings. The output pulses from the secondary windings of the generator **10** are applied, respectively, to gate electrodes of a pair of silicon-controlled rectifiers or thyristors which are connected in antiparallel with each other between alternating current source **12** and the printing lamp **2**, said thyristors constituting an intensity control circuit **11** of a phase control type.

The operating manner of the above mentioned light intensity regulator apparatus will be self-explanatory. In brief, this regulator apparatus operates to regulate, namely increase or decrease the intensity of the printing light in dependence upon the density of the negative film by controlling the quantity of the energizing AC current supplied to the printing lamp **2**.

The photographic printer **1** has furthermore another the **13** such as photocell, photoconductor, photomultiplier, etc., which is so disposed hereinafter it can receive a portion of the printing light partially reflected from the beam splitter or mirror **7** having a half-transparency. The photoelectric element **13** is connected to an integrator circuit **14** comprising a charging condenser, the charged potential of which is varied in dependence upon the photoelectric current intensity produced in the element **13**. The output from the integrator **14** is applied to a switching circuit **15**, the states of which can be controlled by the level of the output signal from the integrator **14** and a control signal from an exposure control circuit **16** which will be hereinafter described in detail.

FIG. **2** shows a switching circuit **15**, which comprises an electronic tube or triode **21** having a control grid connected to the output of the integrator **14** and a cathode electrode connected to the exposure control circuit **16**. The anode electrode of this tube **21** is connected to the energizing coil of a relay **22**, having contacts **23** which are adapted to close or

open, in response to the output signal from the switching tube **21**, a line for supplying direct current to a utilization unit **18** such as an electromagnet for controlling the operation of the shutter **6**.

The operating manner of the above-mentioned apparatus is as follows:

When a predetermined quantity of the printing light has been received by the photoelectric element **13** from the beginning of the exposure period and hence the condenser of the integrator circuit **14** has attained a predetermined potential level, the switching triode **21** is switched to the conductive state, as a result of which the relay **22** is energized to close the current supply line to the electromagnet **18**, to thereby close the shutter. The exposure period is thus terminated. As is apparent for those skilled in the art, the switching of the triode **21** to the conduction state is a function of both the potential applied to the grid control and the bias voltage applied to the cathode electrode, which bias voltage is supplied from the exposure control circuit **16**. In other words, the time span of the exposure period of the printer **1** as controlled by the shutter **6** depends upon the density of the negative film supported on the holder **3** and the level of the cathode bias voltage of the tube **21**. In the priorly known exposure time control apparatus, this cathode bias is preset at a predetermined potential in consideration of various photographic factors such as Schwarzschild-exponent and the photosensibility of printing papers **5** to be used as well as such electrical and/or mechanical factors as drift of circuit parameters and inertia of the relay. Such presetting of the cathode bias is schematically indicated by a phantom block **24**.

On the contrary, it is proposed according to the present invention to vary the level of the bias voltage applied to the cathode of the triode **21** in response to the variations in the density of the negative films. To this end, the exposure control circuit **16** is provided, a preferable embodiment of which is shown in detail in FIG. **3**.

Now referring to FIG. **3**, the exposure control circuit **16** comprises a series circuit of a DC source **31** and a switch **32**. Connected in series therewith is a first potentiometer or voltage divider **33** comprising a variable resistor **34** with a movable tap or wiper arm **35**, which is connected, by way of fixed and movable contacts C_2 and B_2 of a two-pole changeover switch **36**, to the resistor **37** of a second potentiometer **38** having a movable tap **39**. Furthermore, a third potentiometer **40** comprising a resistor **41** and a wiper **42** is provided, which wiper **42** is electrically connected to a resistor **43** of a fourth potentiometer **44** having a wiper tap **45** which in turn is connected to the fixed contacts B_1 and A_2 of the two-pole changeover switch **36**. Other fixed contacts A_1 and B_2 of the switch **36** are connected to the other ends of the resistors **41** and **43**. The movable taps **35** and **42** of the potentiometers **33** and **40**, respectively, are mechanically coupled with each other as is indicated by a broken line.

Referring to FIG. **1**, connected to the output of the intensity control circuit **11** is a correction signal generator **17** of a conventional configuration which is adapted to produce a direct current signal having a magnitude proportional to the effective current to be supplied to the printer lamp **2**. The correction signal produced by the circuit **17** is applied to the exposure control apparatus **16** between the variable resistor **41** of the potentiometer **40** at one end thereof and the tap **39** of the potentiometer **38**. The output signal of the exposure control circuit **16** will appear at the movable contact C_1 of the switch **36** and is applied to the cathode electrode of the switching tube **23**. It will be understood that the movable contacts C_1 and C_2 of the two-pole changeover switch **36** are mechanically coupled to each other as indicated by a broken line therebetween.

The operation of the above-mentioned exposure control circuit **16** is carried out as follows:

After having disposed a standard or reference negative on the holder **3**, the switch **32** is closed. The correction signal generator **17** produces a DC voltage corresponding to the density of the standard negative. This DC voltage is supplied to the exposure control circuit **16** as hereinbefore mentioned. The potentiometer **38** is so adjusted in the position of the wiper **39** thereof, that a voltage V_1 appearing across the resistor **41** of the potentiometer **40** becomes zero volt. Next, the potentiometer **33** and **40**, the wipers of which are mechanically coupled with each other, are so set that the satisfactory printing of the standard negative original can be effected on the printing paper **5** as used. These set positions of the potentiometers **33** and **40** are determined by the various factors such as those hereinbefore mentioned. This is schematically indicated by a block **19** in FIG. **1**. The photographic printer now comes to the state ready for printing various negative films. The switching-in of the changeover switch between the two positions A and B is selectively carried out, depending upon whether the density of negative to be printed is thicker or thinner than that of the standard negative. The potentiometer **44** serves for the manual adjustment of the output signal of the exposure control circuit **16**, which output signal is applied to the cathode triode of the triode **21**, together with the variable signal from the integrator **14** applied to the grid, to automatically control the switching time thereof in dependence upon the printing light intensity to thereby regulate the exposure time of the photographic printer.

In the foregoing, a preferable embodiment of the present invention has been described. However, it should be appreciated that various modifications of such embodiment would be possible for those skilled in the art without departing from the scope and spirit of the present invention. For example, instead of the shutter **6**, an adjustable iris diaphragm or other device for influencing the intensity of the printing light such as filters may be employed. Furthermore, instead of the mechanical shutter, a switch such as the contacts **23** of the relay **22** can be disposed in the circuit for the energization of the printing lamp **2**. The two photoelectrical elements **8** and **13** may be replaced by only one photoelectrical element for both the intensity control and the exposure control. In place of the triode **21**, other type of switching elements such as transistor discharge tube, etc. may be used. The selective switching of the changeover switch **36** may be carried out automatically by means of a suitable electric circuit in dependence upon the thickness or thinness of the negative film to be copied. Finally, the control signal from the exposure control circuit **16** may be added to the input of the integrator with the cathode bias voltage preset fixedly. Accordingly, it is not intended that the present invention is exactly restricted to the disclosed embodiment.

What is claimed is:

1. Photographic printer provided with a control apparatus for automatically controlling the quantity of printing light to be applied to a printing paper in dependence upon densities of a negative film to be printed and other factors such as sensitivities of said printing paper and electrical and (or) mechanical factors of the printer, said control apparatus comprising:

a first photoelectric converter for receiving printing light from a light source after it has passed through said negative film to adjust the intensity of said light source by way of an intensity control circuit;

a second photoelectric converter for receiving printing light after it has passed through an exposure time setting means to adjust the duration of exposure in dependence upon various photographic factors of light sensitive materials to be printed and electric and/or mechanical factor of said printer by way of exposure time control circuit including an integrator, and,

a correction signal generator having an input coupled to said intensity control circuit and an output coupled to said exposure time control circuit, whereby said exposure time setting means is additionally influenced by said light intensity control circuit.

* * * * *