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A. G. DENIS

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METHOD AND MEANS FOR PHOTOGRAPHIC PRINTING

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Fig.1.

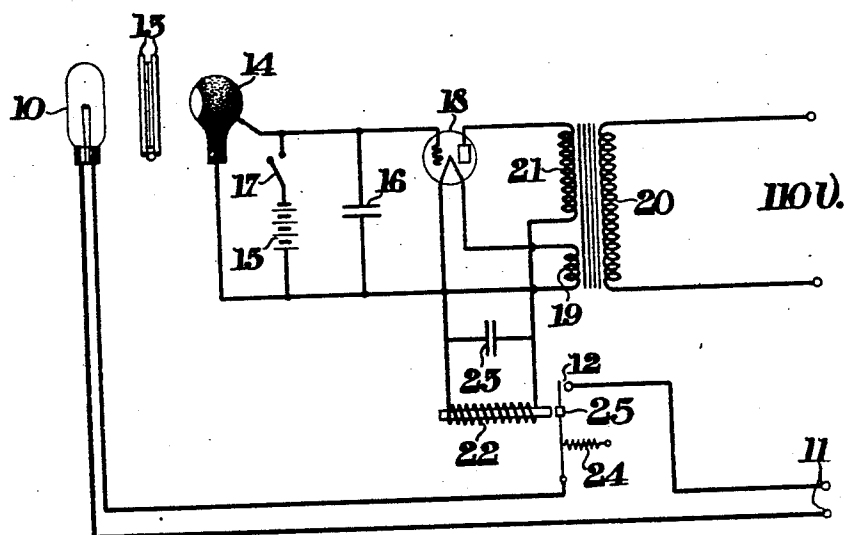


Fig.2.

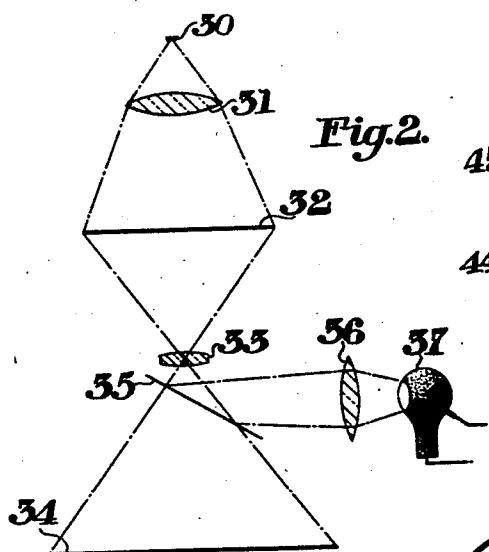
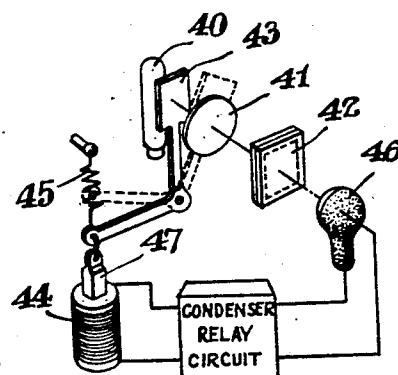


Fig. 3.



Inventor,
Armand Georges Denis,

334 *Newton M. Perkins*
Lolla N. Carter

Attorneys

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METHOD AND MEANS FOR PHOTOGRAPHIC PRINTING

Armand Georges Denis, Rochester, N. Y., assignor
to Eastman Kodak Company, Rochester, N. Y.,
a corporation of New York

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14 Claims. (Cl. 88—24)

My invention relates to photography and more particularly to a method and means for photographic printing. In photographic printing it has been found that when using a given sensitive emulsion, satisfactory prints are obtained from negatives of widely varying densities when the printing exposures are such that the total quantity of light, reaching the sensitive emulsion after transmission by the negative, and integrated over substantially the whole area of the picture, is proportional to this area. It is an object of my invention to provide a method and apparatus for photographic printing with which the desired exposure will be given each and every print regardless of the density of the negative being printed.

Another object of my invention is to provide an automatic printer in which the time of exposure is varied in accordance with the intensity of the light source and the density of the image bearing record.

Another object of my invention is to provide apparatus for printing motion picture film frame by frame, adapted to integrate frame by frame the printing light reaching the sensitive layer being printed and to occlude the printing light when the integrated light reaches a predetermined quantity.

Another object of my invention is to provide an automatic printer in which the discharge of a condenser through an element, the conductivity of which is a measure of the intensity of the printing light falling on the sensitive layer, is utilized to control the duration of the exposure.

Another object of my invention is to provide photographic printing apparatus in which light integrating means is utilized to discontinue the printing operation after a predetermined quantity of light has fallen on the sensitive surface being printed.

Other objects and advantages of my invention will appear from the following description when read in connection with the accompanying drawing in which Fig. 1 is a schematic diagram of a control circuit embodying my invention, Fig. 2 is a schematic showing of one way in which my invention may be applied to a projection printer, and Fig. 3 is a schematic showing of another way in which my invention may be applied to a contact printer in which a shutter is used to occlude the printing light. As shown in the drawing, a source of light 10 connected to be energized from a suitable source of power 11 through a switch 12, is adapted to furnish printing light to the negative and positive held in printing position by hinged plates 13. A photo-electric cell 14 is positioned to receive a definite and constant portion of the

printing light reaching the positive layer being printed. In the arrangement shown, the light falling on the cell 14 is transmitted by the negative and positive being printed and since, for practical purposes the paper used for the positive of uniform density, the light falling on the photo cell 14 will bear a definite relation to the light falling on the positive being printed. The photo-electric cell 14 is shunted by a battery 15 and a condenser 16 of high insulation and high capacity. The switch 17 is placed in series with the battery 15 so that the battery may be connected and disconnected at will. If the switch 17 is momentarily closed, the condenser 16 will become charged to the potential of the battery 15, which may be any moderate potential such as 45 to 90 volts.

If the switch 17 is now opened, the photo cell 14 is the only path through which the condenser 16 can discharge and since the conductance of the photo cell 14 is proportional to the light incident thereon, the time required for the condenser to discharge to a given potential level, will be inversely proportional to the conductance of the photo cell 14 and therefore inversely proportional to the intensity of the light incident on the cell 14. In other words, identical amounts of light, irrespective of the density of the negative, are required to cause the discharge of the condenser 16 from its maximum potential to any given potential. These potentials may be so chosen that the amount of light required to discharge the condenser is that which falls on the photo cell when the positive being printed receives correct exposure; and it will be obvious that the time required for the condenser to discharge through these potential limits will then be an exact measure of the required duration of the exposure. In order to utilize the time of discharge of the condenser 16 for controlling the duration of the exposure given the positive being printed, I connect the grid and cathode of a 3-electrode tube 18 in shunt to the condenser 16 as shown. The filament of the tube 18 is energized by the winding 19 of a transformer 20 which may be connected to ordinary 110 volt mains. The plate circuit of the tube 18 is energized by the winding 21 of the transformer 20 and the rectified output of the tube 18 is connected so as to energize the solenoid winding 22; this winding 22 may be shunted by a condenser 23 to roughly filter the output of the tube 18. The solenoid 22, when energized, is adapted to attract the armature 25 of the switch 12 to open the circuit to the lamp 10. A spring 24 may be provided for biasing the switch 12 to circuit closing position.

In operating the printer just described, the negative and positive to be printed are placed in the hinged holders 13 between the source of light 10 and the light-sensitive element 14. The lamp 10 is dark due to the fact that the solenoid 22 is energized and holds the switch 12 open. The battery switch 17 is now momentarily closed, which charges the condenser 16 to the battery potential which in turn makes the grid of the tube 18 markedly negative relative to the filament, thus stopping all current flow in the plate circuit as well as the solenoid 22. This permits the spring 24 to close the switch 12 which energizes the lamp 10 and the printing exposure is started. The photo cell 14 immediately assumes a conductance which is proportional to the intensity of the light transmitted by the negative and positive being printed.

The condenser 16 now discharges through the cell 14, and the potential of the grid of the tube 18 gradually rises until the condenser has discharged to a predetermined level, at which time the potential of the grid permits sufficient plate current to flow through the winding 22 to attract the armature 25 and open the switch 12 whereby the printing operation is discontinued.

From the above description, it will be seen that I have provided a control circuit for a printing operation which integrates a fixed portion of the light incident on the positive being printed and operates to discontinue the printing operation after a predetermined quantity of light has fallen on the photo-cell, and therefore, a predetermined quantity of light has fallen on the positive. Regardless of the density of the negative being printed or of any variations in the intensity of the printing light, the exposure is automatically timed so that a predetermined and constant amount of light reaches the positive in each successive exposure; which, as has been stated, has been found to result in correct printing.

It will be obvious that instead of utilizing the output of the tube 18 to open the lamp circuit as described, the output of this tube may be used to control the movement of a vane or other mechanical element to occlude the printing light when the condenser has discharged to a predetermined level. One such arrangement is shown in Fig. 3 in which printing light from a lamp 40 is concentrated by a lens 41 onto a negative and sensitive layer held in position by transparent plates 42 and is intercepted by a vane 43 movable into and out of the light beam by a solenoid 44 and a spring 45, respectively. Energization of the solenoid 44 is under the control of a condenser relay circuit similar to the one used to control solenoid 22 in the arrangement of Fig. 1, and a photo-electric cell 46 governs the relay circuit in accordance with the light transmitted by the negative and sensitive layer, as has been fully described above. During use, the apparatus is normally in the condition shown in Fig. 3 with the cell 46 receiving no light and the solenoid 44 energized and holding its armature 47 in attracted position which keeps the vane 43 in light occluding position against the tension of the spring 45. To make an exposure, a battery switch corresponding to the switch 17 in Fig. 1 is momentarily closed to charge the condenser of the relay circuit which acts to de-energize the solenoid 44, permitting the spring 45 to move the vane 43 out of the light path, and thereby start the exposure. The cell 46 is energized immediately and starts to drain the charge from the condenser at a rate which is function of the intensity of the light falling upon the

cell 46. As soon as the charge on the condenser falls to a predetermined level, the solenoid 44 is energized, attracts its armature 47 to return the vane 43 into the light beam, and thereby discontinue the exposure.

In Fig. 2, I have illustrated one arrangement whereby my invention may be utilized for controlling a printer of the projection type. The light from a suitable source 30 is directed by a lens 31 through a negative 32 and focused by a lens 33 upon the positive 34 being printed.

A partially reflecting and transmitting element 35, which may be of celluloid, is positioned in the path of the light between the negative and the positive and serves to reflect a fixed portion of the light transmitted by the negative 32 through a lens 36 and onto a light-sensitive element 37 which is so connected as to discontinue the printing operation after a predetermined quantity of light has fallen upon the positive 34 as described in connection with Fig. 1.

It is well known that the time required for any given condenser to lose or gain a certain fraction of its charge is a function of the impedance of its associated circuit and for any given impedance this time will be constant. The term "time constant of the condenser" as used in the appended claims is intended to mean the time required for the charge on the condenser to vary a given percentage.

While I have illustrated and described, in detail, one way of carrying out my invention, I wish it understood that I do not intend to be limited thereto, as in view of the description various modifications will readily suggest themselves to those skilled in the art without departing from the spirit of my invention or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In photographic printing apparatus, a source of light and a light sensitive element, means for positioning a photographic record between the light and the element, a condenser connected across said element, means for charging the condenser and means responsive to the discharge of said condenser through said element for rendering said source of light ineffective.

2. Photographic printing apparatus for exposing a sensitive layer to radiant energy transmitted through an image bearing record, including a radiation sensitive resistance element adapted to be affected by a known proportion of the radiant energy transmitted through said record, a condenser connected to discharge through said element and means for rendering said radiant energy ineffective when the condenser has discharged to a predetermined value.

3. Photographic printing apparatus for causing a predetermined quantity of electro-magnetic radiation to fall upon a sensitive layer being printed comprising a source for transmitting electro-magnetic radiation through a photographic record and upon the sensitive layer, means for causing a known proportion of the radiation falling on said layer to vary the conductance of the discharge path of a condenser and means controlled by the discharge of the condenser for extinguishing said source of radiation.

4. Photographic printing apparatus including a light source of constant intensity, means for positioning an image bearing record in front of said light source, a photo-conductive element adapted to be influenced by light transmitted by said record, a condenser connected across said element, 150

means for energizing said light source and for charging said condenser and means for rendering said light source ineffective when the condenser has discharged through said element to a predetermined value.

5. In photographic printing apparatus the combination of means for holding negative and positive films in printing position, illuminating means for exposing the positive film through the negative film and control means for rendering the illuminating means ineffective, said control means including a condenser associated with a circuit the conductivity of which varies in accordance with the intensity of the illumination falling on said positive film.

6. Photographic printing apparatus including means for holding a photographic record and a sensitive layer in printing position, a source of printing light, a control circuit for said light source including a condenser shunted by a photoconductive element positioned to receive a fixed proportion of the light transmitted by said record, means for energizing said source of light and for charging said condenser and means controlled by the discharge of said condenser through said element for extinguishing said light source.

7. In photographic printing apparatus, a printing light, means for storing a predetermined quantity of electricity, a variable resistance light controlled path for permitting discharge of electricity stored in said storing means, means for supplying current to said storing means, and means operated in response to a predetermined potential across said storing means for controlling said printing light.

8. In apparatus for the automatic control of exposure in photographic printing exposure terminating means, a thermionic relay, means associated with the output circuit of said relay actuating said exposure terminating means, capacitative means associated with the input circuit to said relay, and means including a photo-electric cell for varying the charge upon said capacitative means in dependence on the quantum of light falling on the printing surface.

9. Apparatus for the automatic control of exposure in photographic printing, comprising exposure terminating means, a thermionic relay, means associated with the output circuit of said relay for actuating said exposure terminating means, capacitative means associated with the input circuit to said thermionic relay, and means for giving a predetermined charge to the capacitative means, and a photo-electric cell for reducing the charge on said capacitative means in dependence on the quantum of light falling on the printing surface.

10. Apparatus for photographic printing with automatic control of the time of exposure according to the density of the negative comprising in combination with the means for transmitting radiations through the negative to the printing surface, a relay circuit responsive to the quantity of radiations passed through the negative, said relay circuit including a device capable of accumulating and discharging energy, and means under the actuation of the relay of said circuit for cutting off the transmission of radiations to the printing surface.

11. In photographic printing apparatus having automatically operated exposure terminating means, a thermionic relay, means associated with the output circuit of said relay for actuating said exposure terminating means, capacitative means associated with the input circuit of said relay, and means for varying the charge of said capacitative means.

12. The method of automatically controlling the exposure in photographic printing which consists in utilizing a proportion of the rays passing through the negative from the source of illumination to produce in a device sensitive to said rays a physical response proportional to the illumination of the printing surface, measuring said response cumulatively as the exposure proceeds so as to obtain a measure proportional to the quantum of light which has fallen on the printing surface since the commencement of the exposure, and terminating the exposure when said measure has reached a desired value.

13. The method of automatically controlling the exposure in photographic printing which consists in utilizing a proportion of the light passing through a negative in process of being printed to control a current of electricity according to the average intensity of illumination of the printing surface, obtaining a measure of the amount of electricity which has flowed since the commencement of the exposure, and terminating the exposure when said amount reaches a certain value corresponding to the desired value for the quantum of light.

14. Means for controlling the exposure of a sensitive layer to light transmitted by a photographic record, comprising illuminating means for exposing the layer through the record and a condenser, means for charging the condenser to a predetermined potential, means for discharging said condenser at a rate which is a function of the intensity of the light transmitted by the record, and means for terminating the exposure when the condenser has been discharged to a known potential.

ARMAND GEORGES DENIS.