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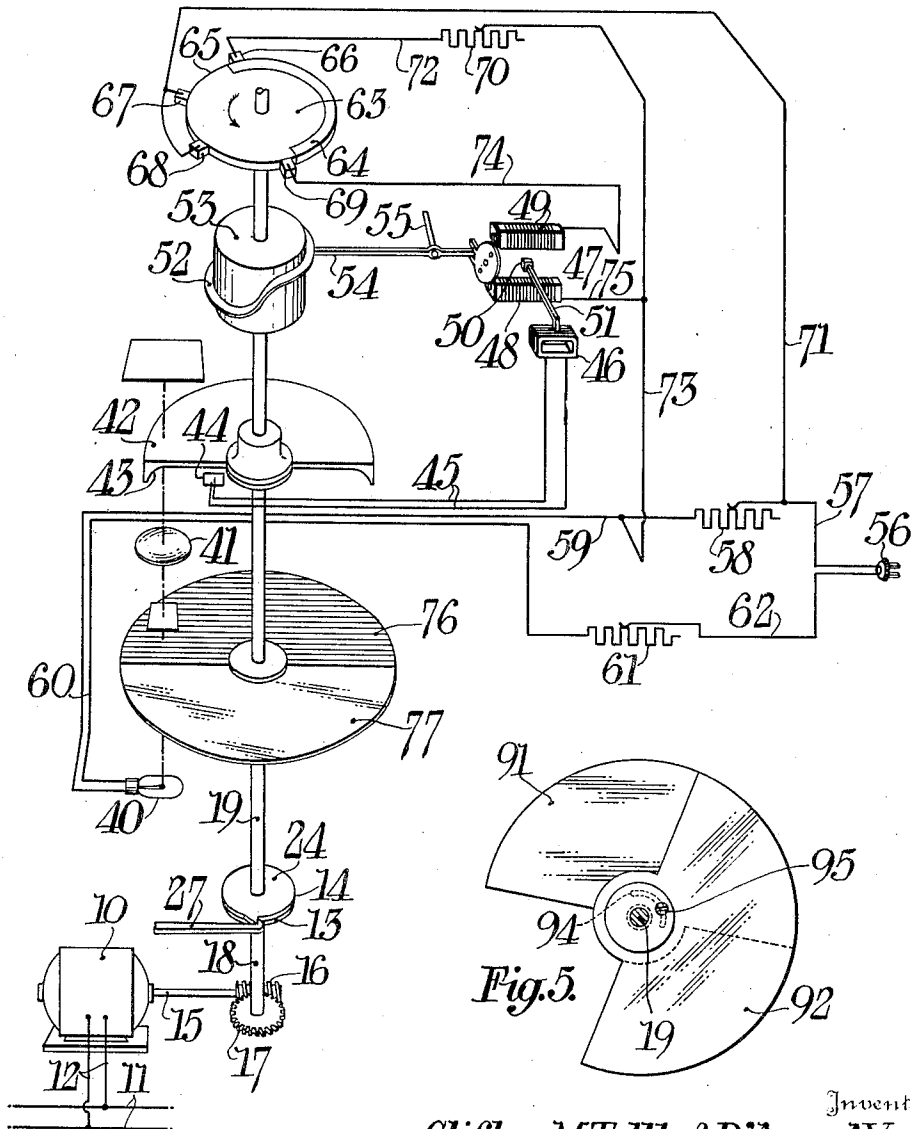
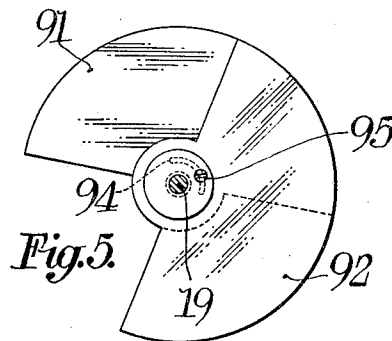
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PHOTOGRAPHIC PRINTING APPARATUS

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2 Sheets-Sheet 1

Fig.1.



Inventors:
Clifton M. Tuttle & D'Arcy A. Young Jr.

N. M. Perrins.

334 Kella H. Carter

Attorneys

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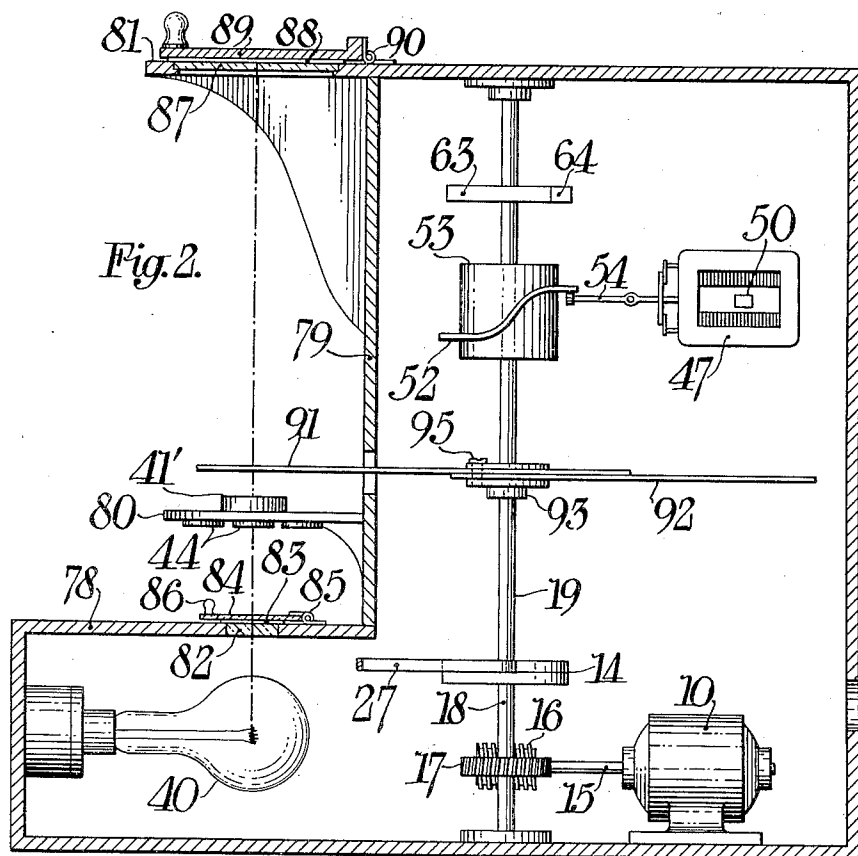
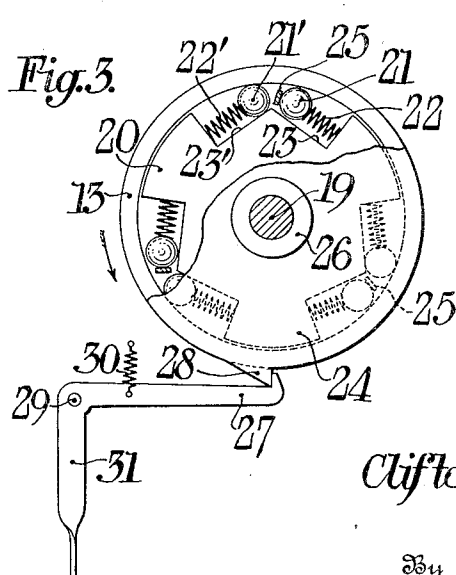
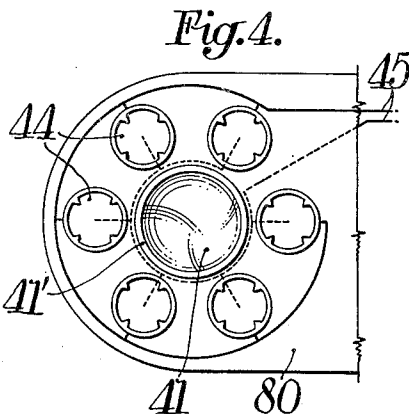
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Inventors:
Clifton M. Tuttle & D'Arcy A. Young, Jr.
N. M. Perrins.

By *Kolla H. Carter*
Attorneys

UNITED STATES PATENT OFFICE

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PHOTOGRAPHIC PRINTING APPARATUS

Clifton M. Tuttle and D'Arcy A. Young, Jr.,
Rochester, N. Y., assignors to Eastman Kodak
Company, Rochester, N. Y., a corporation of
New York

Application July 29, 1932. Serial No. 625,726

7 Claims. (Cl. 88—24)

Our invention relates to apparatus for effecting a control of a photographic printing operation and more particularly for effecting an automatic control of the intensity of a light source to be used in photographic printing.

In printing sensitized layers from photographic records varying in average density it is generally desirable to give each layer a constant exposure so that upon being developed a printed product of substantially constant density will be produced. It is well known that the exposure will remain constant if the product of the printing light intensity and the time it is permitted to fall on the layer is held constant. In printing records of different densities it is obvious that the product of the intensity and the time may be adjusted to a constant value by varying either the intensity of the light falling on the record or the time of the exposure while holding the other constant. If the intensity of the light falling on the record is held constant and the time varied it will be found in printing records differing greatly in density that the developed layer will vary from the desired constant density due to failure of the law of reciprocity. The law of reciprocity is not involved in printing with constant time and variable intensity, for with ideal adjustment of the light falling on the record, the printing intensity will be constant and consequently the product of this intensity and the time will be constant.

In accordance with our invention the intensity of the light falling on a record to be printed is adjusted in accordance with the average transmission of the record so that the intensity of the light transmitted i. e., the printing light, is of the desired constant value.

Further in accordance with our invention a control mechanism responsive to the average transmission of a record or negative to be printed is adapted to adjust the intensity of the light source to a value which will result in the printing light being of the desired intensity.

Our invention consists substantially in the construction, combination, location and relative arrangement of parts, and the novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention itself, however, both as to its organization and method of operation will be best understood by reference to the following description taken in connection with the accompanying drawings in which,

Figure 1 is a diagrammatic view of the essential mechanism and circuit organization of an

apparatus constructed in accordance with our invention;

Figure 2 is a side view showing the relative location of the main mechanical elements of a modified structure in which our invention is incorporated;

Figure 3 is a partial section of a single revolution clutch used in the structures of both Figures 1 and 2;

Figure 4 is a plan view of the projection lens and light cell of the printer shown in Figure 2; and,

Figure 5 is a detail of the adjustable shutter shown in Figure 2.

Referring to Figure 1 of the drawings we have shown a motor 10 connected to any suitable source of power 11 through the leads 12 and adapted to impart continuous rotation to the freely rotating disk 13 of a single revolution clutch 14 through the motor shaft 15, a worm 16, a gear 17 and a connecting shaft 18. The main control shaft 19 is adapted to be connected for a single revolution to the shaft 18 by means of a clutch 14 which is here shown as of the roller type (Fig. 3). The annular flange 13 driven in the direction indicated by the arrow by the shaft 18 surrounds a member 20 keyed to the shaft 19, and the rollers 21. Springs 22 normally hold the rollers 21 in position to bind between the flange 13 and the inclined seats 23 of the member 20 so that it will rotate with the flange 13 and thereby drive the main control shaft 19. A plate 24 provided with spaced pins 25 controls the position of the rollers 21 relative to the inclined seats 23 of the member 20 in the following manner:

The plate 24 is centered and free to rotate on the hub 26 of the member 20 and normally will rotate with the member 20. But with the plate 24 stopped as by a hook 27 contacting with an ear 28 on the plate 24 the phase angle between the member 20 and the plate 24 will change and the pins 25 will move the rollers 21 down the inclined seats 23 and against the action of the springs 22 to the inoperative position shown in Fig. 3 in which the flange 13 rotates idly about the member 20. The hook 27 forms one arm of a bell crank pivoted at 29 and is biased by a suitable spring 30 to engage with the ear 28. The other arm 31 of the bell crank forms an operating lever for controlling the action of the clutch 14. Upon momentarily moving the lever 31 in the direction to remove the hook 27 from engagement with the ear 28 the restraining action of the pins 25 is removed and the springs 22 force the rollers 21 into binding engagement with the flange 13 and the in

clined seats 23 whereby the member 20 together with the shaft 19 rotates with the flange 13. The lever 31 having been released after the ear 28 moved past the hook 27 the spring 30 moves the hook 27 into riding engagement with the periphery of the flange 13 and upon the completion of a single revolution of the shaft 19 the ear 28 is again engaged by the hook 27 to stop the plate 24 which acts through the pins 25 to move the rollers 21 to the inoperative position shown in Fig. 3.

It is evident that the above described clutch structure will not prevent the driving of the shaft 19 at an angular speed greater than the angular speed of the flange 13 and since the steepness of some of the cam surfaces (hereinafter described) carried by the shaft 19 might act to drive momentarily the shaft at too great a speed, we have provided a second set of clutch rollers which function in a direction the reverse of the first.

The springs 22' hold the rollers 21' in wedging engagement with the faces 23' and the flange 13, which prevents the member 20 from being rotated faster than the flange 13 while permitting the flange 13 to rotate when the member 20 is stationary.

As diagrammatically shown in Fig. 1 a negative from which a print is to be made is adapted to be illuminated by a lamp 40 and imaged on a positive by lens 41. With the negative and sensitized layer (positive) properly positioned the apparatus of our invention performs four distinct functions:

Firstly, while shielding the positive it measures the average transmission of the negative and sets up a resistance of a magnitude which when inserted in the lamp circuit will cause the lamp to be energized to the proper intensity; secondly, it inserts the set-up resistance in the lamp circuit and then connects the circuit to a source of electrical energy; thirdly, it exposes the positive to light transmitted by the negative for a fixed time interval; and fourthly, it returns the apparatus to its initial condition.

The above functions are performed in proper timed relation under control of the main shaft 19 when rotated through an angle of 360 degrees as above described. A sector 42 of a disk mounted on the shaft 19 extends into position to shield the positive between the lens 41 and the positive during the first part of the cycle and is provided with a conical reflecting mirror 43 which serves to direct light transmitted by the negative onto a light sensitive element 44 during the measuring period, after which the cut-out portion of the disk sector 42 allows unobstructed passage of the light to the sensitized layer for a definite period of time dependent upon the speed of rotation and the angle of the cut-out portion. The light sensitive element 44 is connected through leads 45 to the coil 46 of any suitable indicating meter for controlling the adjustment of a rheostat 47 comprising two resistance arms 48 and 49 and a movable contact 50. The contact 50 is carried by the meter pointer 51 and moved to a position between the arms 48 and 49 corresponding to the energization of the coil 46. The arms 48 and 49 may be then moved into position to grip the contact 50 and thereby set the rheostat 47 at a definite adjustment as fully described by C. M. Tuttle, one of the present inventors in his co-pending application Serial Number 557,260 filed August 15, 1931. A cam 52 carried by a drum 53 mounted on the shaft 19 is adapted, upon rotation of the shaft 19, to control the clamping and unclamping of

the arms 48 and 49 in any suitable manner. Since the mechanical connection between the arms 48 and 49 and the cam 52 forms no part of the present invention it has been shown, in the interest of simplicity, as comprising a rod 54 pivoted on a pin 55 and extended at one end to operate the arms 48 and 49 and provided at its other end with a follower for the cam 52. The cam 52 is so constructed that the arms 48 and 49 will be separated during the measuring part of the cycle and will grip the contact 50 during the printing part of the cycle.

When the apparatus is in use, a lamp 40 for furnishing the light for measuring and exposing purposes is continuously energized at a low level to keep the filament heated so that it will quickly respond to a greater energization. A plug 56 when connected to any suitable source of power serves to energize the lamp 40 at a low level through a lead 57, a relatively high resistance 58, a lead 59, the lamp 40, a lead 60 and adjustable resistance 61 and a lead 62. The high resistance 58 is preferably adjustable so that the level to which the lamp 40 is energized may be brought to any desired value. For measuring purposes it is generally desirable that the intensity of the lamp 40 be increased to a predetermined value and for printing purposes the intensity of the lamp 40 is adjusted to a value corresponding to the density of the negative to be printed. The manner in which these adjustments are accomplished will now be described.

A commutator 63 mounted to rotate with the shaft 19 is provided with a conducting segment 64 and a non-conducting segment 65 and cooperates with brushes 66, 67, 68 and 69 to control the lamp circuit. These brushes are so arranged about the commutator 63 that initial movement of the shaft 19 in the direction indicated by the arrow causes the conducting segment 64 to bridge the brushes 66 and 67 which connect a known resistance 70 in shunt relation with the high resistance 58 to leads 71, 72 and 73 and energizes the lamp 40 to the level desired for measuring purposes. Continued rotation of the shaft 19 moves the trailing end of the conducting segment 64 past the brush 66 and the advance end under the brush 69 at which time the brushes 68 and 69 are bridged to complete a circuit in parallel with the high resistance 58 through the lead 71, the brush 68, the conducting segment 64, the brush 69, a lead 74, a rheostat 47, a lead 75 and the lead 73. It is to be noted that the cam 52 acts to move the arms 48 and 49 into engagement with the contact 50 prior to the bridging of the brushes 68 and 69 by the conducting segment 64 and that the segment 64 leaves the brush 68 before the arms 48 and 49 are separated. With this arrangement the circuit is neither made nor broken at the contact 50 and therefore no undesirable arcing occurs at this point.

The operation of the apparatus as above described is as follows: The motor is running and the plug 56 has been inserted so that the lamp filament is heated to a dull red. A negative and positive having been properly positioned, the control lever 31 is momentarily moved to permit the clutch to engage for one complete revolution of the main control shaft. Initial movement of the shaft connects the resistance 70 in parallel with the high resistance and the intensity of the lamp increases to a predetermined value. The light transmitted by the negative is directed by the conical mirror onto the light sensitive element the response of which causes the contact 50 to assume

a position corresponding to the intensity of the light transmitted by the negative. The shaft controlled cam now operates to clamp the resistance arms of the rheostat onto the movable contact and thereafter the commutator substitutes the rheostat for the resistance 70 in the lamp circuit and the lamp is energized at a level corresponding to the density of the negative to be printed. During this operation the positive has been shielded by the disk carrying the conical reflector, but continued rotation of the main shaft moves this disk from shielding position and the positive is exposed to light transmitted by the negative until the disk is rotated sufficiently to bring it again into positive shielding position after which the commutator acts to open the circuit through the rheostat, the cam removes the arms of the rheostat from clamping position and the hook 27 engages the ear of a clutch to stop the main shaft, leaving the apparatus in its initial condition with the lamp glowing and ready to repeat the operation upon the inserting of a fresh positive and if desired a different negative.

Although not necessary to the practice of our invention it may be desirable to utilize non-actinic light for measuring purposes and non-specular light for printing purposes. This can readily be accomplished by mounting on the main shaft 19 a composite disk comprising a section 76 transparent to all but actinic radiation and a clear section 77 which will introduce the desired amount of diffusion in the light falling on the negative.

In Fig. 2 we have shown a modified arrangement of the light sensitive element 44 used for controlling the adjustment of the meter rheostat 47. In this figure the main control shaft 19 driven through the single revolution clutch 14 by the motor 10 controls the various operations of the apparatus in timed sequence as in Fig. 1. The light sensitive element 44 surrounds the lens carried in the lens mount 41' and the conical reflecting member 43 of Figure 1 is eliminated. As best shown in Fig. 4 the light sensitive element preferably comprises a plurality of sensitive elements 44 connected in multiple to the meter leads 45. The lens 41, lens mount 41', the elements 44 and their associated wiring are all mounted on a suitable support 80 of bakelite or any other suitable material.

Reverting to Fig. 2, the entire apparatus may be enclosed in a box-like casing provided with a platform portion 78, a front wall 79 and a top 81 overhanging the platform 78. The platform 78 is provided with a transparent section 82 for supporting a negative 83 in light receiving relation with the lamp 40 positioned beneath the platform 78. A transparent platen 84 which may be of plate glass is mounted on the platform 78 by means of a hinge 85 and is movable by means of a knob 86 into and out of negative-holding position. In the overhanging top 81 and in optical alignment with the lens 41 the negative panel 82 and the lamp 40 is mounted a printing panel 87 which may be of suitable transparent material such as plate glass. A sensitized layer or positive paper 88 is adapted to be placed on the panel 87 for printing and is held in flat engagement therewith by a platen 89 suitably mounted on the top 81 as by a hinge 90. The passage of light from the lens 41 to the printing panel 87 is controlled by opaque shutter blades 91 and 92 mounted on a hub 93 carried by and adapted to rotate with the shaft 19. The shutter blades 91 and 92 are made angularly adjustable on the hub 93 by the provision of arcuate slot 94 and a set screw 95 so that the

angle subtended by the opening between the blades 91 and 92 may be adjusted to vary the exposure time when it is moved through the light beam at a constant angular speed.

The circuit arrangement is identical with the one shown in Fig. 1 and is not duplicated in Fig. 2. With the commutator 63, the cam 52 and the shutter blades 91 and 92 mounted in proper angular relation on the shaft 19 the operation of the apparatus shown in Figure 2 is as follows:

The negative and positive having been placed in position the displacement of the hook engages the clutch to impart one complete revolution of the main shaft during which the lamp is lighted to a predetermined intensity, the rheostat adjusted in accordance with the density of the negative and inserted in the lamp circuit, the rotating shutter blades then uncover the positive for a predetermined angle of rotation of the main shaft i. e. a fixed time interval, and after the positive is again covered by the shutter the circuit through the rheostat is opened, the rheostat arms unclamp and the hook disengages the clutch to stop the main shaft and leave the apparatus in its original condition.

While we have shown two structures in which our invention is incorporated it will be obvious to those skilled in the art that various modifications of our invention will readily suggest themselves without departing from the scope of our invention as set forth in the appended claims.

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

1. A photographic printing apparatus comprising in combination means for holding a photographic record and a sensitized layer, a printing lamp, a source of motive power, a rotary shaft normally disconnected from said source of motive power, a clutch member operative to connect said shaft to said source of motive power to impart one complete revolution to the shaft, a variable resistance, a light sensitive element adapted to determine the adjustment of the resistance, means carried by said shaft for deflecting during the first part of its revolution light transmitted by the negative onto said sensitive element whereby said resistance is adjusted in accordance with the density of the negative, a rotary switch mounted on said shaft for energizing the lamp to a predetermined intensity during the interval that light is deflected onto said element and for connecting said adjusted resistance in the lamp circuit during the printing operation.

2. A photographic printing machine having in combination a source of light, holders for a negative and a sensitized layer, a source of motive power, a rotary shaft normally disconnected from said source of power, means for operatively connecting said shaft and said source of power for one revolution of said shaft, means for adjusting a resistance in accordance with the density of the negative, switching means for inserting the adjusted resistance in the light circuit, and means for exposing the sensitized layer to image bearing light transmitted by the negative, said switching means and said exposing means being actuated in timed relation under the control of said rotary shaft.

3. A photographic printing apparatus of the variable intensity constant time type comprising in combination holders for a photographic record and a sensitized layer, a lamp for illuminating the record, light sensitive means for adjusting a resistance in accordance with the density of the record, switching means for connecting the ad-

- justed resistance in circuit with the lamp where-
by the intensity of the lamp is proportional to the
density of the record, means for exposing said
layer for a predetermined time to light trans-
mitted by said record, and a rotating shaft for
operating in timed relation said switching means
and said exposing means.
4. In photographic printing apparatus, means
for supporting in printing relation a photo-
graphic record and a sensitized layer, an electric
light source, a device responsive to light trans-
mitted by the record, means for adjusting a vari-
able resistance in accordance with the response
of said device, a rotary shaft, means driven by
the shaft for exposing for a predetermined period
said layer to light transmitted by said record,
and switching means carried by the shaft for
connecting said variable resistance in circuit with
the light source prior to the beginning of the
exposure period.
5. Automatic apparatus for printing a sensi-
tized layer from a photographic record in accord-
ance with its mean density by varying the in-
tensity of the printing light, comprising a lamp,
means for energizing said lamp to a predeter-
mined intensity for a measuring operation, a
variable resistance, radiation sensitive means for
adjusting said resistance in accordance with the
mean density of the record, means for connecting
the adjusted resistance in circuit with the lamp
and means for exposing said layer for a prede-
termined interval.
6. In automatic photographic printing appara-
tus, means for determining the density of a record
to be printed, a resistance adjusted thereby to a
value corresponding to the density of the record,
a lamp, switching means for connecting the ad-
justed resistance in circuit with the lamp, means
for initiating and ending an exposure period, and
means for operating in time sequence said switch-
ing means and the exposure starting and stop-
ping means.
7. In automatic photographic printing appara-
tus, means for holding in printing relation a
photographic record and a sensitized layer, a
lamp, a known resistance in circuit with said
lamp whereby its intensity is known, a light sen-
sitive element, means controlled by said element
for adjusting the magnitude of an impedance
in accordance with the density of said record,
means for substituting said impedance for said
resistance in the lamp circuit, and means for
exposing said layer for a predetermined period
while said impedance is in the lamp circuit.
- CLIFTON M. TUTTLE.
D'ARCY A. YOUNG, JR.