April 18, 1944. A. L. MAYER ET AL 2,346,983

MEANS FOR CONTROL OF LIGHT

Filed Nov. 14, 1940

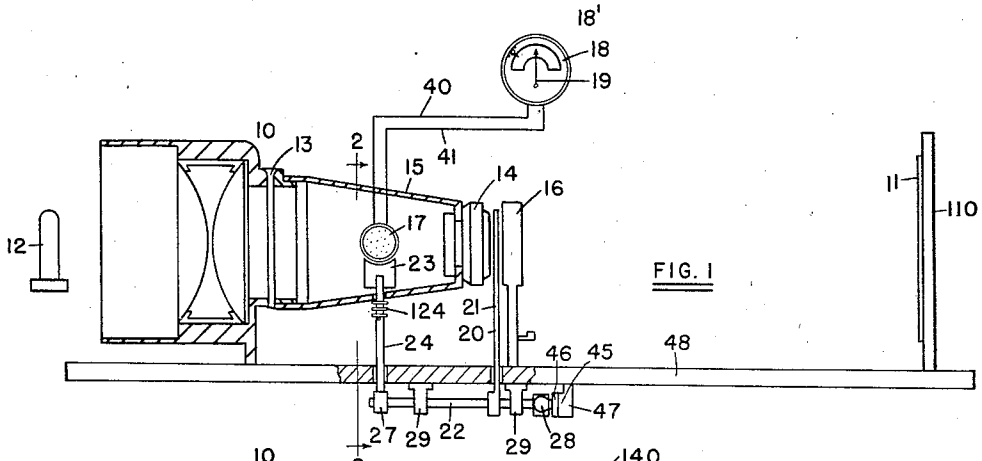


FIG. 1

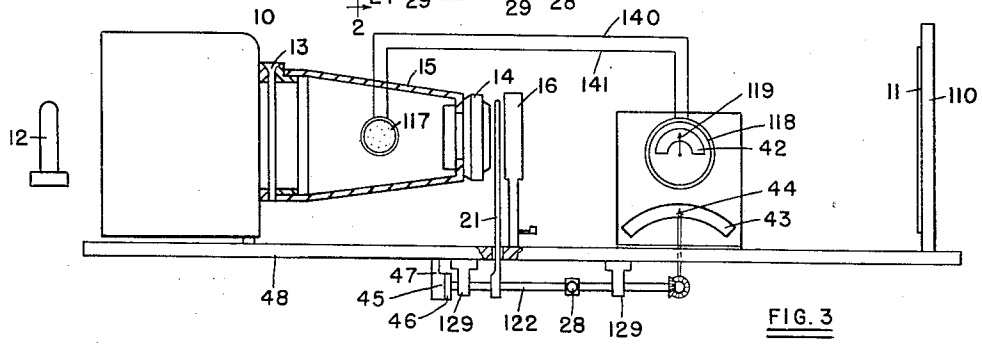


FIG. 3

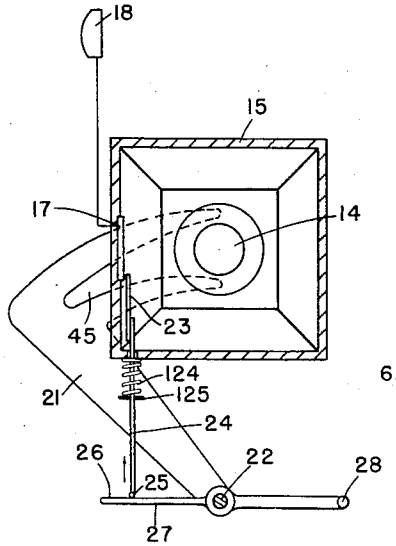


FIG. 2

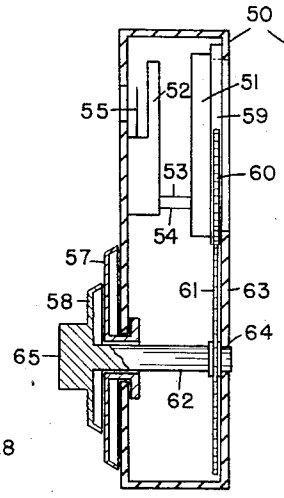


FIG. 5

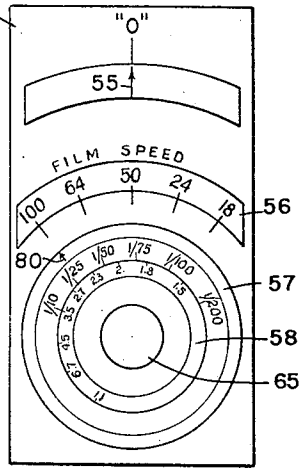


FIG. 4

INVENTORS
ALVIN L. MAYER
HANS R. KOSSMAN
BY Jugelter & Jugelter
ATTORNEYS

Patented Apr. 18, 1944 2,346,983

UNITED STATES PATENT OFFICE

2,346,983

MEANS FOR CONTROL OF LIGHT

Alvin L. Mayer, Cincinnati, Ohio, and Hans R. Kossman, New York, N. Y.; said Kossman assignor to said Mayer

Application November 14, 1940, Serial No. 365,678

4 Claims. (Cl. 88—24)

This invention relates to novel methods and means for accurately controlling the intensity of light.

One object of the present invention is to provide methods and means for simplifying the reading of light sensitive devices, such as exposure meters, and the like, by establishing a zero or base setting relative to which all readings are taken.

Another object of the present invention is to provide methods and means for permitting the intensity of a projected beam of light to be accurately forecast and predetermined, prior to the actual projection thereof, in those instances where the intensity of light rays from a substantially constant source of illumination are adapted to be modified by means interposed intermediate the source of illumination and the locus of the projection lens.

Another object of the present invention is to provide means of the character hereinabove described which may, by way of example, be associated with photographic printing machines, and the like, for making it possible and commercially practical to resort to a constant or fixed exposure time in the printing of a plurality of negatives, regardless of their relative densities, by accurately controlling and standardizing the intensity of the projected image bearing beam.

Another object of the present invention is to provide means of the character hereinabove described which may, when associated with photographic printing machines, permit the use of but one grade of sensitized photographic printing paper in printing all printable negatives, regardless of their individual densities, by standardizing the intensity of the projected image bearing beam.

Still another object of the invention is to provide means of the character stated, wherein certain variable factors, which were heretofore under the personal judgment of an individual operator, are so interrelated as to effectively reduce the human-judgment-element to a minimum, thereby reducing waste and increasing the quantity and quality of the final product.

A further object of the invention is to provide means for controlling the intensity of a beam of projected light by selectively synchronizing or controlling the aperture size of the projection lens, relative to the intensity of the beam prior to projection, thereby permitting a constant source of illumination to be employed.

Still a further object of the invention is to provide means of the character stated which are inexpensive, fool-proof and durable, yet extremely accurate.

These and other objects are attained by the means described herein and disclosed in the accompanying drawing in which:

Fig. 1 is a vertical sectional view showing the means of the present invention operatively associated with a photographic enlarging and printing machine.

Fig. 2 is a sectional view on line 2—2 of Fig. 1.

Fig. 3 is a partial vertical sectional view of a photographic enlarging and printing machine showing a modified form of the light control means, comprising the present invention, associated therewith.

Fig. 4 is a plan view of an exposure meter embodying the teachings of the present invention.

Fig. 5 is a partial vertical sectional view of the device of Fig. 4 showing certain structural details of the device.

At the outset it should be clearly understood that while the control means comprising the present invention are shown associated with a commercial photographic enlarging and printing machine in Figs. 1–3, inclusive, and with a commercial exposure meter in Figs. 4 and 5, such associations are exemplary in nature, rather than restrictive.

As shown in Fig. 1 the device comprising the present invention is associated with the standard photographic enlarging and printing machine, denoted generally by the numeral 10, for permitting a light beam of constant, predetermined, or standard intensity to be projected onto the sensitized photographic printing paper 11, thereby making it practical to employ a constant exposure time or shutter speed regardless of the density of the particular negative being printed.

Machine 10 may comprise a constant source of illumination such as lamp 12 for projecting the images of photographic negatives placed laterally in film gate 13 through projection lens 14 onto the sensitized paper 11 supported on paper support 110, as well known to the art.

A housing denoted generally by the numeral 15, may be provided between the film gate and the projection lens for confining the beams of light, as is the general practice.

The periods of time during which a beam of image bearing light is projected onto the sensitized printing paper 11 may be controlled by means of any suitable shutter element or mecha-

nism denoted generally by the numeral 16. For the purpose of the present invention, the speed of shutter mechanism 16 may be constant or fixed, since it is proposed to so regulate or standardize the intensity of the image bearing projected beam as to make it possible, and commercially practical, to use a constant exposure printing time as well as but one type or grade of sensitized printing paper 11 for all printable negatives, regardless of their individual densities.

It should be clearly understood that the amount, quantity or intensity of light within housing 15 is dependent upon, first, the intensity of lamp 12 and secondly, the relative density or opacity of a negative or other light modifying means placed within film gate 13. Therefore, it is obvious that if lamp 12 be maintained at a uniform or constant intensity, the intensity of the light within housing 15 will be dependent solely upon, and a function of, the density of the negative, or other light modifying means, placed in gate 13, and through which the light from lamp 12 passes en route to the projection lens 14. The negative placed in gate 13 may, therefore, be said to modify the normal beam or intensity of light from lamp 12. Inasmuch as the density of each individual negative placed within gate 13 is apt to, and in all probability will, differ in density from other negatives placed therein, it may be said that the normal beam from lamp 12 is haphazardly modified by the various negatives.

The present invention contemplates the use of means sensitive to light waves such as, by way of example, a photoelectric cell 17, located interiorly of housing 15 in such a manner as to have its active or light sensitive surface exposed to the reflected light within said housing. Light sensitive cell 17 may be wired to a suitable current measuring instrument or meter 18 by means of conductors 40 and 41 in order that the intensity of the light within housing 15 may be translated into a definite swing or deflection of pointer 19 of meter 18. It should be understood that the greater the intensity of light within housing 15, the greater will be the swing of pointer 19, thereby indicating to an operator the intensity of the normal beam from lamp 12 as modified by a negative placed in gate 13.

In order to facilitate maintaining the intensity of the projection beam at a constant, predetermined value as the intensity of light within housing 15 is promiscuously modified by the various negatives placed in gate 13, a zero or base point is established on meter dial 18' relative to which the intensity of the projection beam for each negative is compared and standardized.

In the preferred embodiment of the invention the zero or base point is established at that deflection or setting of pointer 19 which corresponds to the light condition existing within housing 15 when the densest printable negative is mounted in gate 13. As used herein, the term densest printable negative refers to the densest negative which it is commercially feasible to print on the particular type of sensitized photographic paper being used when exposed for the definite, predetermined time as fixed by shutter 16. The aperture of the projection lens 14 is preferably at a maximum when the zero point is being established.

Using said zero point as a base, means are provided for selectively reducing or controlling the effective aperture size of the projection lens 14 as the intensity of illumination within housing 15 is increased, as occurs when negatives of a lesser density than the densest printable negative are placed in gate 13. In this manner the intensity of the projected image bearing beam for each negative may be standardized relative to the predetermined intensity of the so-called standard projection beam; after being thus standardized the image bearing beam may be projected onto the sensitized paper 11 for the constant, predetermined exposure time without impairing the quality of the finished print.

Such aperture size control means may comprise a diaphragm which may, if desired, be in the form of plate 21, see Fig. 2, the lower end of which may be carried by and secured to a rock shaft 22 in such a manner as to cause the upper apertured portion 45 of plate 21 to progressively reduce the effective aperture of the projection lens 14 as said plate is swung to the right, about the axis of shaft 22.

In the preferred embodiment of the invention diaphragm 20 may be disposed between projection lens 14 and the shutter mechanism 16.

It should be understood that if desired, an iris diaphragm, or any other type, may be used to selectively control the aperture of lens 14 in lieu of the aperture plate 21 disclosed in Figs. 1 and 2. It should likewise be understood that if desired, a suitable shutter mechanism and diaphragm may be combined and mounted on projection lens 14 as is the case in the better portable cameras, and the like.

The principle of operation of the device of Fig. 1 is as follows: The actual intensity of the modified light rays within housing 15 will be indicated on meter 18 during those periods of time when the entire active surface of the light sensitive cell 17 is exposed. If the meter reading is of a value greater than the predetermined zero point, it is obvious that excessive exposure will result unless the intensity of the projected beam is first reduced to correspond with the intensity of the standard projected image bearing beam.

In order to accurately predict and preselect the intensity of the beam of projected light prior to the actual projection thereof, means are provided for selectively controlling, such as, by way of example, by masking, the active surface of the light sensitive cell 17 for the purpose of creating or simulating a light condition at the active light-sensitive-surface of said cell which corresponds to the light condition originally existing within housing 15 when the zero point was established on meter 18.

If desired, a mask 23 may be mounted for movement relative to the active surface of the light sensitive cell. If desired, mask 23 may be mounted to reciprocate on a vertical axis relative to cell 17, and as illustrated in Fig. 2, said mask may be secured to and carried by the upper end of an actuator rod 24. The lower end of rod 24 may terminate in a follower member 25 which normally engages the upper surface 26 of an element 27 which may be suitably secured to rock shaft 22, as shown. A spring such as 124 may be interposed between the lower surface of housing 15 and a stop member 125 carried by rod 24 for the purpose of normally urging mask 23 downwardly, that is, away from the active surface of cell 17. Shaft 22 may be provided with a handle 28, or the like, to facilitate actuation of said shaft about its longitudinal axis within bearings 29.

As clearly discernible from Fig. 2, a clockwise movement of handle 28 rotates rock shaft 22 and lifts mask 23 upwardly over the active face of

the light sensitive cell 17, and, simultaneously therewith, diaphragm plate 21 is swung relative to and across the optical axis of lens 14 thereby reducing the effective aperture of said lens.

From the foregoing it is apparent that in order to bring pointer 19 to register with the preselected zero point of meter 18, it is only necessary to so manipulate rock shaft 22 as to mask out sufficient portions of the active surface of the light sensitive cell as to simulate at the active light sensitive surface of said cell a zero point light condition. During this adjustment, diaphragm plate 21 will be shifted relative to lens 14 for changing the size of the effective aperture of the projection lens in an inverse ratio to the amount of light being passed by the particular negative mounted in gate 13, whereby to limit the actual intensity of the projected beam to that of the predetermined standard.

It will be observed that by reason of the relationship between mask 23 and diaphragm plate 21, the intensity of the projected image bearing beam will always be of a fixed, predetermined or standard value when pointer 19 registers with the zero point of dial 18', thereby reducing to a minimum the human-error-element heretofore encountered in photographic printing.

The device disclosed in Fig. 3 accomplishes substantially the same result as that of the device of Fig. 1, but in a somewhat different manner. A light sensitive cell 117 is provided interiorly of housing 15 and is wired by means of conductors 140 and 141 to a suitable current measuring instrument or meter 118. The intensity of the modified light within housing 15 will cause pointer 119 to be deflected a definite amount, thereby establishing a reading on meter dial 42 which corresponds to, and is an indication of, the relative intensity of light actually existing within said housing.

Coordinated with the calibrations of meter dial 42 is a diaphragm dial 43, as shown.

A diaphragm plate 21 is fixedly secured to rock shaft 122 which in turn is carried by and secured for rotation about its longitudinal axis by bearings 129. Shaft 122 is operatively connected to pointer 44 which is adapted to sweep diaphragm dial 43 in fixed synchronization with the movement of diaphragm plate 21 relative to projection lens 14. Motion may be imparted to rock shaft 122 by any suitable means, such as a handle 28, or the like, whereby the diaphragm dial pointer 44 may be caused to sweep dial 43, under the control of an operator.

In order to standardize the intensity of the projection beam it is only necessary for an operator to set the diaphragm pointer 44 to the reading on the diaphragm dial 44 which corresponds to the reading of the meter pointer on meter dial 42. Diaphragm 21 is operatively connected relative to pointer 44, and aperture 45 is so proportioned as to alter the size of the effective aperture of lens 14 in an inverse ratio to the amount of light in housing 15, as indicated on meter 118.

It should be observed that by reason of the V-shape of the aperture 45 of the diaphragm plate, it is possible to obtain an infinite number of effective projection lens aperture sizes between maximum and minimum limits, whereby the accuracy of control of the intensity of the projected beam is at a maximum.

With reference to Figs. 4 and 5 the principle of light control is shown applied to a so-called photo exposure meter, denoted generally by the numeral 50. In its most elementary form such a meter comprises means sensitive to light, such as, by way of example, a photoelectric cell 51, or the like, and means for indicating potential changes occurring in said cell, such as a milliammeter 52, or the like. Cell 51 may be electrically connected to meter 52 by means of conductor 53 and 54. Light-intensity-induced potential changes are visually indicated by the swing of pointer 55 of meter 52.

The light intensity as indicated by pointer 55 is used as a guide in setting such variable factors in photography, as lens aperture size and shutter speed for given light conditions. However, because of other variable factors such as film speed, etc., it has heretofore been a confusing and rather complicated procedure to properly coordinate all of the variable factors entering into the final determination of the proper shutter speed for a given lens aperture, and vice versa.

The purpose of the device disclosed in Figs. 4 and 5 is to provide a photo exposure meter of the type wherein means are provided to simulate, at the light sensitive surface of the cell, certain light conditions for the purpose of comparing the actual light condition being measured relative to a predetermined zero setting, as hereinafter more fully explained.

With reference to Fig. 4 it will be noted that there are four variable factors to be considered when using a photo exposure meter, viz. the intensity of light, as indicated by pointer 55; the speed of the particular film being used, as indicated on chart 56; the shutter speed, as indicated on dial 57; and the lens aperture size, as indicated on dial 58.

Of these four variable factors, two are reduced to constants by the operator, leaving but two variables to be considered for any given light condition.

Inasmuch as the film speed, which is determined by the manufacturer, is constant for each particular film this variable factor may, for the particular film being used, be considered as a constant.

The second variable factor which is assumed or considered as being constant is either the shutter speed, or the lens aperture setting. The two variable factors remaining then become, first, the intensity of light, and secondly, either the lens aperture setting or the shutter speed depending upon which is considered a constant.

For the purpose of illustration it will be assumed that the film speed is 100 and that a shutter speed of $\frac{1}{5}$ second has been selected whereby the lens aperture setting will become a variable function of the intensity of the light. Dial 57 is rotated until the film speed index arrow 80 is aligned with the proper film speed calibration, here 100. The $\frac{1}{5}$ second calibration on dial 57 then becomes a constant relative to which the lens aperture settings of dial 58 are taken.

Having thus established the film speed and shutter speed as constants, it is now only necessary to calibrate the lens aperture reading relative to the preselected shutter speed setting, here $\frac{1}{5}$ second, for the particular light condition existing at the subject to be photographed. In order to eliminate the necessity for reading complicated calibrations on the meter dial, only one mark, a zero point, is established thereon, and means are provided for obtaining a zero point reading of pointer 55 when a predetermined amount of light is permitted to illuminate the active light sensitive surface of cell 51.

Such control means may comprise a diaphragm, mask, or the like, which is adapted to be selectively adjusted for the purpose of varying the effective light sensitive area of cell 51. As disclosed in Fig. 5 such means may comprise an iris diaphragm 59, the outer ring of which is provided with gear teeth 60 engageable by the teeth of gear 61 which is carried by control shaft 62. One end of shaft 62 may terminate in a bearing provided in housing or case 63 as at 64, while the opposite end thereof may terminate in control knob 65, as shown. Knob 65 and the lens aperture dial 58 may be integral whereby to rotate in unison.

From the foregoing it is apparent that the actual amount of light reaching the active surface of cell 51 is dependent upon, and is a function of, the aperture size of iris diaphragm 59. It is likewise apparent that as the size of the iris diaphragm aperture is varied, for a given source of light, pointer 55 will assume various positions between certain maximum and minimum limits, indicating that greater or lesser amounts of the active surface of the cell are being exposed to the source of light.

In order to determine the proper lens aperture for a given light condition with, by way of example, a film speed of 100 and a shutter speed of $\frac{1}{10}$ second, it is only necessary for an operator to so manipulate knob 65 as to establish the effective aperture of the iris diaphragm at the active surface of cell 51 at such a setting as to permit just enough light to energize said light sensitive cell as to cause pointer 55 to point to the predetermined zero point. Inasmuch as the lens aperture dial 58 is integral with control knob 65, it will be turned with said knob for aligning the proper lens aperture calibration relative to the preselected shutter speed calibration, viz. $\frac{1}{10}$ of a second. As illustrated in Fig. 4 such an aperture setting is 3.5 for the particular light condition then existing. In the event that the intensity of the light should become less, the pointer would come to rest at a value to the left of the zero point, thereby informing the operator that for the given film and shutter speeds, the lens aperture setting is too small for the new light condition. In order to bring pointer 55 back to the zero setting, knob 65 is turned to increase the aperture opening of iris diaphragm 59 thereby allowing more light to fall upon the active surface of cell 51. As the iris diaphragm is thus being adjusted, dial 57 is being simultaneously turned counterclockwise relative to dial 58 so that as the light meter pointer 55 is returned to zero, a new lens aperture size will be indicated on dial 57 opposite the $\frac{1}{10}$ second calibration on dial 58. Obviously the aperture size thus indicated will be greater than the one originally called for when the light intensity of the subject to be photographed was greater.

It should be understood that, if desired, the shutter speed dial 57 may be operatively secured to shaft 62 in lieu of the lens aperture dial 58, thereby synchronizing the shutter speed readings relative to the effective iris diaphragm opening of cell 51.

It should likewise be understood that various modifications and changes in the structural details of the devices disclosed herein, may be made, within the scope of the appended claims, without departing from the spirit of the invention. The present invention is not directed to, nor concerned with, any particular type or kind of light sensitive cell, wherefore any light sensitive cell, regardless of whether it generates its own potential or requires the use of a battery, may be employed.

It should be understood that in all instances the various dials of Figs. 4 and 5 are suitably calibrated for effecting properly coordinated readings when pointer 55 is returned to the zero point. Likewise the relative motion between mask 23 and diaphragm 20 of Figs. 1 and 2 is so coordinated as to alter the effective aperture size of lens 14 inversely to the light intensity within housing 15.

It should further be observed that mask 23 of Figs. 1 and 2 correspond to and function in a manner similar to the iris diaphragm 59 of Fig. 5; that diaphragm 20 of Figs. 1 and 2 is synchronized relative to cell 17 in a manner similar to the synchronization between dial 57 and cell 59 of Fig. 5; and that the setting of diaphragm 21 relative to lens 14 is similar to the setting of the shutter speed dial 57 relative to the lens aperture dial 58.

It should be observed that the intensity of light within housing 15 is determined by, and is a function of, the normal or average density of a negative mounted in gate 13. Therefore, it may be said that the active surface of a light sensitive cell disposed interiorly of housing 15 will receive and be energized by the total reflected light from the entire negative, or other light modifying means mounted in gate 13.

It should likewise be noted that by reason of the unique means herein disclosed for coordinating the setting of diaphragm 21 relative to the particular total intensity existing within housing 15 it is possible to accurately standardize the intensity of the projected beam whereby the intensity of the projected beam at the printing paper 11 will always be constant. The same control means may be used to standardize, prior to projection, the intensity of the projected beam from flood and spot light, and the like, in the theatrical, cinema and other fields.

In order to assure constant beam intensity during the projection of a particular negative, suitable friction means may be provided for precluding accidental or unintentional movement of diaphragm 21 from a given setting. If desired, such means may assume the form of a clutch 45 wherein a movable plate 46 is secured to and carried by one end of shaft 22 or 122 in such a manner as to frictionally engage a fixed plate 47 which is carried by and secured to the bed frame 48, as shown.

What is claimed is:

1. In a photographic printer, a film support, a paper support, an illuminator disposed at one side of the film support for projecting a beam of light through a film negative mounted in said film support onto paper mounted in the paper support, an objective lens spaced from the film support, a housing extending between the film support and lens for confining the image bearing beam, a gauge, a light sensitive cell permanently mounted interiorly of said housing with its light sensitive element normally exposed to the reflected light of the image bearing projected beam as it passes through said housing, said gauge being disposed exteriorly of said housing for indicating the potential changes occurring in said cell in accordance to the light variations occurring within said housing, means disposed between the lens and paper support for varying the intensity of the projected beam after leaving said lens, said means comprising an opaque plate movable relative to said lens, said plate including an elongated slot having progressively convergent sides each at an equal

distance from the axis of said lens whereby movement of said plate in one direction constricts the lens aperture to progressively greater degrees and movement in the opposite direction progressively reduces the constriction of the lens aperture, and means for coordinating said last mentioned means with the gauge readings to adapt the projected image bearing beam to a predetermined intensity.

2. In a photographic device, the combination of a light cone, a light sensitive cell fixedly mounted interiorly of said cone, an electrical gauge mounted exteriorly of said cone and operatively connected to said cell, said gauge including a pointer the swing of which is proportional to the quantity of light energizing said cell, a lens for said light cone, and means for controlling the effective aperture of said lens in accordance to the intensity of the light conditions interiorly of said cone, said means including an opaque plate movable across the axis of said lens, said plate provided with a slot having progressively convergent sides each at an equal distance from the axis of the lens, a calibrated lens aperture gauge including a pointer the deflection of which is a function of the amount by which the aperture of said lens is constricted by said plate, and means operatively interconnecting said plate with said last mentioned pointer whereby the lens aperture may be varied in accordance with and as a predetermined function of the quantity of light energizing said light sensitive cell by correlating the setting pointer of the lens aperture gauge with the indication of the pointer of said electrical gauge.

3. In a photographic device, the combination of a light cone, a light sensitive cell fixedly mounted interiorly of said cone, an electrical gauge mounted exteriorly of said cone and operatively connected to said cell, said gauge including a pointer the swing of which is proportional to the quantity of light energizing said cell, an objective lens for said light cone, and means for controlling the effective aperture of said lens in accordance to the intensity of the light conditions interiorly of said cone, a calibrated lens aperture gauge including a pointer the deflection of which is a function of the amount by which the aperture of said lens is constricted by said aperture controlling means, and means operatively interconnecting said last mentioned means with said last mentioned pointer whereby the lens aperture may be varied in accordance with and as a predetermined function of the quantity of light energizing said light sensitive cell by correlating the setting pointer of the lens aperture gauge with the indication of the pointer of said electrical gauge.

4. In a photograph printer, the combination of a light confining housing including a light source, an objective lens, and a fixed holder for photographic negatives, a light sensitive cell arranged within the housing for energization by light rays from a beam projected through the negative and toward said lens, an electrical gauge including an indicator observable exteriorly of the housing, said gauge being electrically connected with said cell to indicate varying potentials such as may occur in the cell by passing the light beam through negatives of varying densities, a constant speed shutter in the path of the projected beam, manually operated means for controlling the effective aperture of the lens in accordance with the intensity of light conditions within the housing as indicated by the electrical gauge, a lens aperture gauge including an indicator deflectable in correspondency with variations in size of the effective lens aperture as established by the aperture controlling means aforesaid, and means operatively interconnecting said manually operative aperture controlling means with the deflectable indicator of the lens aperture gauge, whereby upon correlating the lens aperture indicator with the position assumed by the indicator of the electrical gauge, the aperture controlling means will be automatically adjusted to the value of the light intensity within the housing.

ALVIN L. MAYER.
HANS R. KOSSMAN.