Jan. 27, 1970 P. J. ERNISSE 3,491,664

AUTOMATIC EXPOSURE CONTROL FOR CAMERAS

Filed March 14, 1967 2 Sheets-Sheet 1

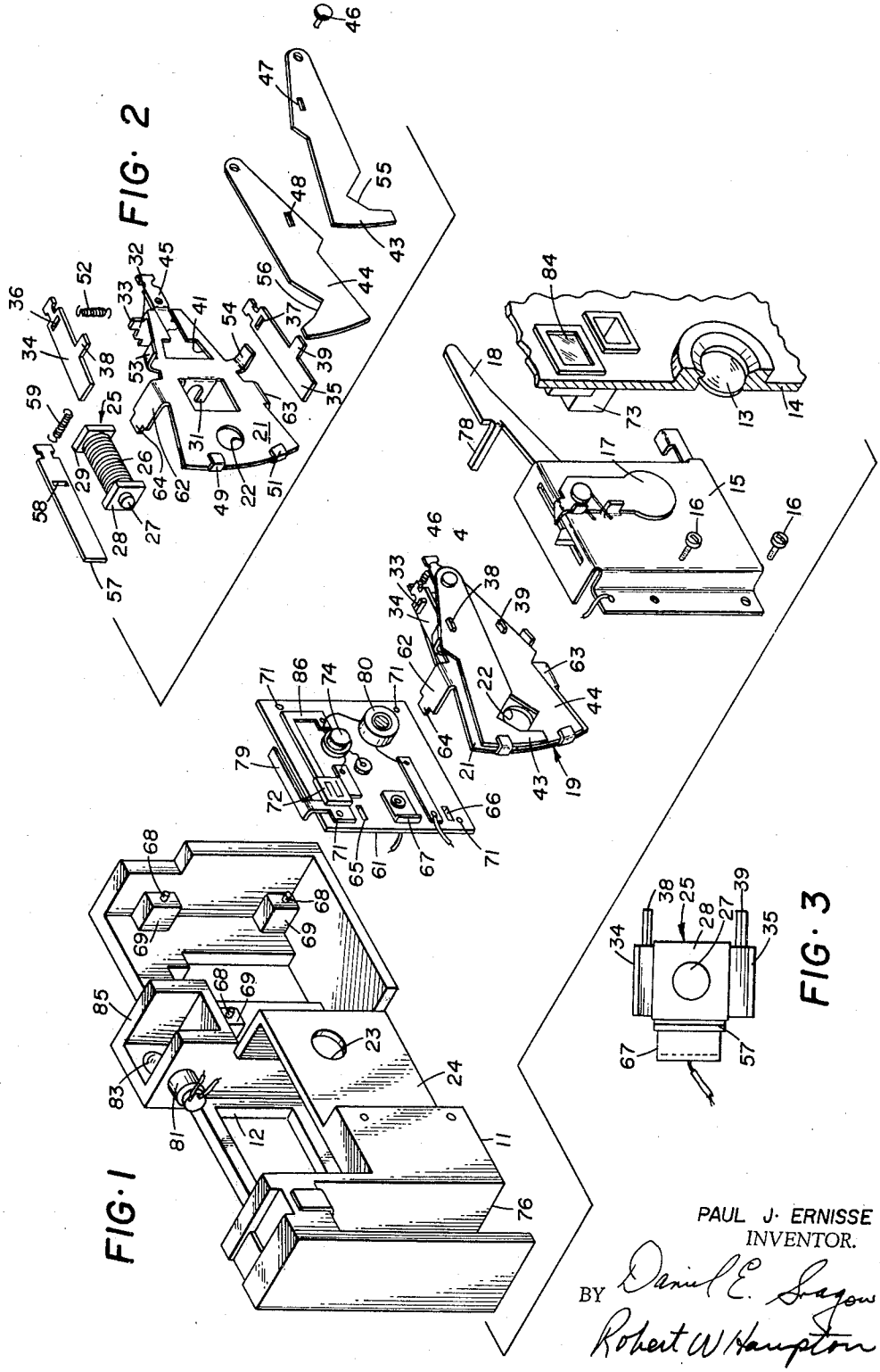


FIG. 1

FIG. 2

FIG. 3

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AUTOMATIC EXPOSURE CONTROL FOR CAMERAS

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FIG. 4

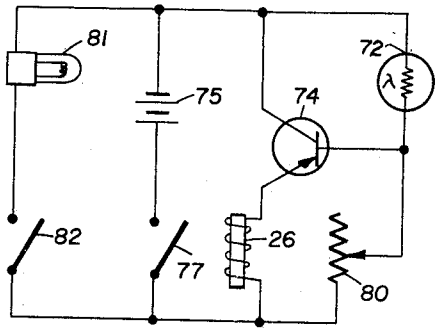



FIG. 5

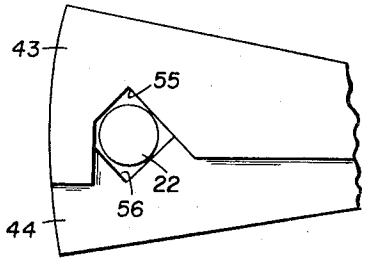



FIG. 6

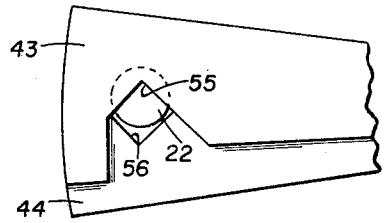



FIG. 7

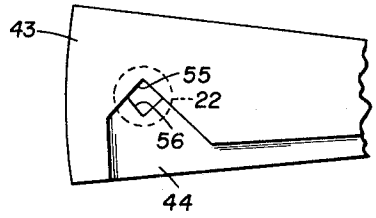
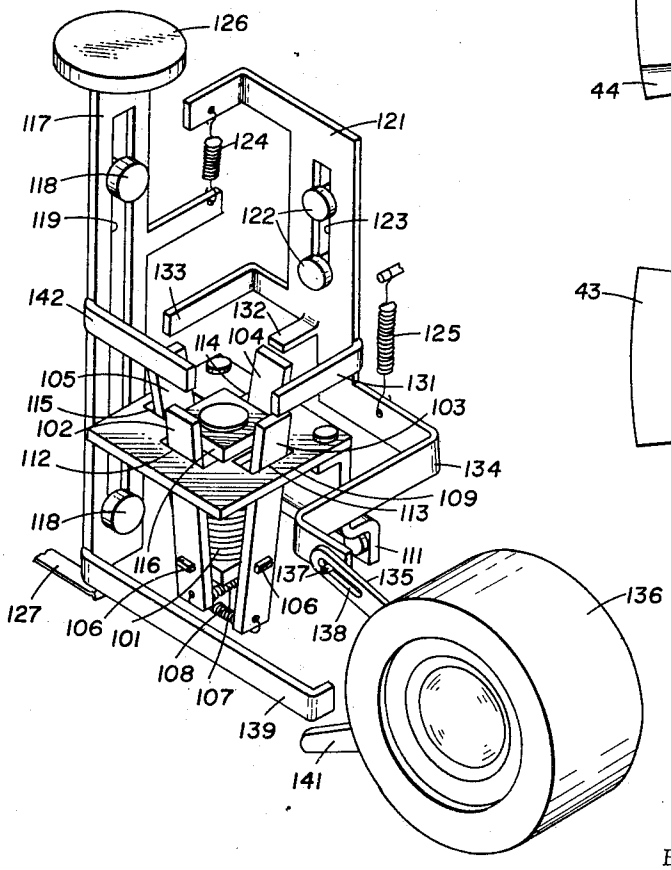



FIG. 8




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3,491,664

# AUTOMATIC EXPOSURE CONTROL FOR CAMERAS

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U.S. Cl. 95—10 14 Claims

## ABSTRACT OF THE DISCLOSURE

A simple and inexpensive automatic exposure control system comprising an electromagnet energized in proportion to scene brightness and having associated therewith a plurality of armature members, increasing numbers of which are moved by the magnet in response to its energization to corresponding predetermined levels. One of the armatures serves to provide a low light signal if scene illumination is below a predetermined intensity, the other armatures being adapted to adjust a film exposure regulating device to an appropriate one of several predetermined settings as a function of scene brightness.

Automatic exposure control systems for still or movie cameras generally comprise a photocell adapted to generate or modulate an electric current to provide an output related functionally to the illumination intensity of a viewed scene, and an electromechanical transducer device adapted to translate such output of the photocell into an appropriate adjustment or conditioning of either the lens diaphragm or the shutter speed or both. The type of transducer device most commonly employed for this purpose comprises a galvanometer-type electric measuring instrument adapted to adjust the exposure determining means to correspond very closely to the detected illumination intensity within a predetermined range. However, since such galvanometer-type instruments are relatively expensive and delicate, and since such precise adjustment of the exposure control means is not essential under most circumstances, it is also known to utilize as a transducer a relay device which serves to adjust such means only to the one of several predetermined conditions which most nearly corresponds to the optimum setting as indicated by the photocell output.

Such a relay may comprise an electromagnet energized to a level functionally related to the output of the photocell and associated with a plurality of armatures, each of which is adapted to assume a first predetermined position adjacent said magnet when the later is energized to a level at which it exerts on that armature an attractive force sufficient to overcome a resilient force biasing it toward a second predetermined position in spaced relation to the magnet. If certain of the armatures are made more sensitive to movement by the magnet than others, all of the armatures will remain in their respective second positions when the energization level is relatively low; the most sensitive armature will move to its first position when the energization level is increased to a corresponding predetermined level; the next most sensitive armature will also assume its first position when the level is further increased to a higher predetermined level, etc. Thus, by coupling the armatures to the exposure regulating means, a transducer of this type can be employed to provide several different exposure settings, each of which corresponds to a predetermined range of scene illumination intensity, as reflected by the output of the photocell.



The present invention relates to an automatic exposure control system of the general type just described, incorporating novel construction features to facilitate the fabrication and assembly of the various components of the system while at the same time increasing its reliability and ruggedness. Additionaly, the improved construction incorporates simple and reliable warning means for alerting the camera operator to the absence of sufficient light to produce an acceptable exposure regardless of the setting of the exposure regulating means. These and other advantages and improvements afforded by the invention are explained in the folowing detailed description, reference being made to the accompanying drawings, in which like reference numerals refer to like elements and in which:

FIG. 1 is a perspective view of the internal components of a camera which relate to an embodiment of the subject invention adapted to adjust the camera lens diaphragm to the appropriate one of three settings, with various subassemblies thereof shown in exploded relation to one another;

FIG. 2 is an exploded view of the transducer subassembly shown in FIG. 1;

FIG. 3 is a partial end view of the transducer device depicted in FIGS. 1 and 2, showing the transducer electromagnet and the armatures associated therewith and illustrating the means by which one of the armatures comprises an electric switch employed to actuate a low light signal;

FIG. 4 is a schematic diagram of the electric circuit employed in the exposure control system depicted in FIGS. 1, 2 and 3;

FIGS. 5, 6 and 7 are partial elevational views of the diaphragm vanes aligned with the camera lens, showing, respectively, the effective aperture of the lens at the maximum, intermediate and minimum exposure settings afforded by the exposure control system; and

FIG. 8 is a perspecive view of an alternate embodiment of the invention adapted to adjust the exposure regulating means to the appropriate one of four different settings and to block operation of the camera under low light conditions.

The various components comprising the embodiment of the invention illustrated in FIGS. 1 through 7 are shown in FIG. 1 in exploded relation to the internal body member **11** of the camera. As in most cameras, this member serves to support the various internal camera mechanisms and to position an area of photographic film in a predetermined plane rearwardly of a rectangular opening **12**, which is aligned with objective lens **13** supported by the front wall **14** of the external camera casing.

Rearwardly of the objective lens, a shutter mechanism **15** is mounted on the body member by screws **16**. As illustrated, the shutter mechanism is of the so-called impact type comprising a shutter blade **17** covering an aperture rearwardly thereof and adapted to move out of alignment with the aperture for a predetermined time interval in response to depression of trigger level **18**. However, it should be understood that any other type of appropriate shutter could be employed in conjunction with the subject exposure control system.

To vary the exposure of the film in the camera, a variable diaphragm subassembly **19** is located rearwardly of the shutter mechanism. As shown in FIGS. 1 and 2, this subassembly comprises a support plate **21** provided with a diaphragm aperture **22**, which is aligned with but smaller than either the shutter aperture or opening **23** in wall portion **24** of the body member, whereby the size of the diaphragm aperture determines the maximum effective aperture of the objective lens. An electromagnet **25**, comprising a coil **26** wound on a core rod **27** between rec-

tangular pole pieces **28** and **29**, is supported between a bifurcated rearwardly projecting member **31** straddling the end of core rod **27** and engaging pole piece **28** and a similarly disposed end support member **32** adapted to engage the opposite end of pole piece **29**. As shown at **33**, end support member **32** is provided with ears on the top, bottom and rearward edges thereof. Above and below the electromagnet, similar armatures **34** and **35** are supported for rocking movement by the corresponding ears on support member **32** which are received within holes **36** and **37** in the respective armatures to position the armatures with the forwardly extending arms **38** and **39** thereof extending through opening **41** in the support plate.

It is to be noted that pole pieces **28** and **29** each have four operative surfaces, i.e., each pole piece has four surfaces which may each be used to operate an armature.

A pair of diaphragm blades **43** and **44** are pivotally attached to ear **45** of the support plate by a stud **46**, with the ends of the forwardly extending arms of the armatures received by corresponding holes **47** and **48** in the blades and with the opposite ends thereof maintained in freely movable adjacent relation to the support plate by guide fingers **49** and **51**. A very light coil spring **52**, extending between the ends of the two opposed armatures adjacent holes **36** and **37**, biases the opposite free ends apart to maintain the armatures and the diaphragm blades in the respective positions defined by the engagement of the blades with the corresponding forwardly bent ears **53** and **54**. As shown in FIGS. 3 and 5, when the armatures and the diaphragm blades are so positioned, the angular notch portions **55** and **56** of the respective upper and lower blades are located out of alignment with diaphragm aperture **22**, with the upper armature **34** closer to pole piece **28** than is the lower armature **35**.

A third armature **57**, the function of which will later be explained, is supported in a similar manner for rocking movement by the rearwardly projecting ear of support member **32** received within hole **58**, with its free end biased away from pole piece **28** by another light coil spring **59**, extending between the end of member **57** adjacent hole **58** and the end of ear **45** extending laterally from the support plate.

When the variable diaphragm subassembly has been so assembled, it is attached to circuit board **61** by means of support legs **62** and **63**, which are provided with tab members a shown at **64**, adapted to extend through corresponding holes **65** and **66** in the board and to be bent over to hold the diaphragm unit securely to the board. With the diaphragm unit so attached to the circuit board, the free end of the third armature bears against a contact plate **67** on the board, and is spaced thereby in closer relation to pole piece **28** than either of the other two armatures, as shown in FIG. 3; whereupon the board is attached to the body member against support bosses **68** by rivetting or melting the ends of studs **69** extending through mating holes **71**.

As previously explained, when the armatures are in their outward positions, the diaphragm blades are in the respective locations shown in FIG. 5, whereby the effective lens opening is defined by diaphragm aperture **22**. However, as the magnet is progressively energized, the armatures are attracted thereto in opposition to the resilient force of the corresponding springs. Due to the substantially equal resilient force exerted on all of the armatures and the difference in their spacing from the magnet, the rearward armature, being nearest to the magnet, will be attracted magnetically into engagement with pole piece **28** at a predetermined level of energization insufficient to move the other armatures. Similarly, a higher second predetermined level of energization will cause the upper armature also to be attracted to the magnet, with a still higher predetermined third level energization being required similarly to move the lower armature. Therefore, by energizing the magnet in predetermined proportion to scene intensity, it is apparent that the armatures can be made to respond sequentially so that; (1) all of the armatures remain in spaced relation to the magnet when scene illumination is below the minimum intensity required for a successful photograph at the maximum lens opening defined by diaphragm aperture **22**, in which case the position of the rearward armature effects a signal to alert the operator to this fact; (2) a higher level of scene illumination will cause the rearward armature to move to discontinue the signal, indicating that an exposure can be made; (3) a still higher illumination level will cause the upper armature also to be attracted to the magnet, thereby moving the upper diaphragm blade to the position shown in FIG. 6, whereby aperature **22** is partially obscured to reduce the effective opening of the lens; and (4) an even more intense illumination level will result in the movement of the lower blade by the lower armature to the position shown in FIG. 7, whereby the aperture is reduced to its minimum size. Rather than spacing the armatures at different distances from the magnet to vary their sensitivity, the same result could of course be achieved by applying different resilient forces to the armatures, e.g., by means of separate springs of different leverage arrangements.

The electric circuit employed to energize the electromagnet as a function of scene illumination and to provide the above-described low light signal is illustrated in FIG. 4 and comprises a photoresistive photocell **72** mounted on the circuit board in alignment with a tubular member **73** on the front casing member adapted to allow light from a scene within the field of lens **13** to impinge on the photocell. This type of photocell, which is generally a cadmium sulfide cell, has the property of having a relatively high resistance in darkness, which is reduced in proportion to illumination of the cell. The cell is connected between the base and the collector of a P-N-P type transistor **74**, the emitter of which is connected to one side of the relay coil **26**. The collector is connected also to the negative side of the power source **75**, which comprises a pair of batteries in series relation, housed in a compartment defined by an elongate slot **76** in the body member. The positive side of the power source is connected to the other end of coil **26** through a switch **77**, comprising a rearwardly extending finger **78** on trigger lever **18** and a resilient arm **79** attached to the circuit board, whereby the circuit is closed by the initial downward movement of the trigger lever and remains closed until the lever is returned to its raised position. A variable resistor **80** also is incorporated in the circuit between the base of the transistor and the positive terminal of the power supply. By this arrangement, when the cell is in darkness, its resistance is relatively high and therefore the base return negative voltage of the transistor is correspondingly low. However, as the resistance of the cell decreases in response to its exposure to light, its base return negative voltage increases correspondingly, whereby a proportional but much greater current flows through the transistor to energize the relay coil in proportion to scene illumination. By varying the resistance of variable resistor **80**, the effect of the photocell on the base return negative voltage can be modulated for purposes of calibrating the system or, perhaps, to adjust the response of the system in accordance with different film speeds.

Also incorporated in the electric circuit, in parallel relation to the magnet energizing system and also under the control of switch **77**, is an indicator lamp **81** in series with a switch **82** comprising the third armature **57** and contact plate **67**. Thus, when the circuit is energized by depressing trigger lever **18**, the lamp will be illuminated so long as switch **82** remains closed, i.e. so long as the scene illumination is below the level required to energize the electromagnet to the level at which the third armature is thereby moved out of contact with contact plate **67**. Therefore, by locating lamp **81** so that its illumination is visible in the viewfinder, comprising lenses **83** and **84**

at opposite ends of the internal viewfinder housing **85**, the illumination of the lamp will alert the operator to the existence of insufficient scene light as soon as he starts to depress the shutter trigger, whereupon he can release the trigger before it has moved sufficiently to actuate the shutter.

Without identifying specifically all of the various connections used to establish the above-described circuit in the illustrated camera, it will be apparent from the drawings that the various components mounted on the circuit board can be electrically connected by printed circuit strips as shown at **86**, and by employing lead wires, partially shown, to connect the circuit board to the power source, the indicator lamp and to the elements comprising switch **82**. Also, it should be understood that the particular circuit illustrated and described is merely illustrative inasmuch as various other amplifier circuits could be employed for the same purpose.

While the requirements of many amateur photographers will be adequately satisfied by the above-described system, which alerts the photographer to a low light condition and adjusts the camera automatically to the most appropriate one of three predetermined diaphragm openings, other embodiments of the same basic invention can provide a greater number of available exposure settings of either the lens diaphragm or the shutter speed or both, and can also incorporate means for preventing positively the operation of the shutter under low light conditions. FIG. 8 illustrates one such alternate embodiment in which the electromagnet **101** is provided with four armatures **102** through **105**, attached theerto in a manner similar to that previously described by means of ears **106** and biased apart by transverse springs **107** and **108**. In this construction the magnet is supported by a non-mangetic collar member **109** attached to a stationary member of the camera, not shown, by a bracket **111**. In addition to supporting the relay assembly, the collar also defines the initial positions of the respective armatures extending through openings **112** through **115** adjacent pole piece **116**, so that armature **102** is closest to the pole piece with armatures **103**, **104** and **105**, respectively, being spaced therefrom by progressively greater corresponding distances. Therefore, as the energization of the electromagnet is increased to a level proportional to scene brightness by means of a circuit of the type previously described, the armatures will be attracted into contact with the pole piece in the order of their numerical identification, with the number of armatures so moved being indicative of the level of scene illumination.

The mechanism employed to actuate the magnet energization circuit and to translate the armature positions into a corresponding setting of the exposure regulating means comprises a trigger **117**, slidably attached to a stationary support surface within the camera by studs **118** extending through slot **119**, and a slide member **121** similarly supported on another stationary internal camera surface by studs **122** extending through slot **123**. The slide member and the trigger member are connected by a coil spring **124**, which assumes its minimum length when the two members have been moved to their respective illustrated raised positions, by a second lighter coil spring **125** attached to the slide member.

When the trigger member is depressed by means of push-button **126**, its initial downward movement energizes the electrical system by closing a switch corresponding to the previously described switch **77**, comprising the trigger member and contact strap **127**, whereupon the armatures assume positions corresponding to scene illumination. Simultaneously, the slide member is also moved downward by spring **124**, which remains substantially retracted due to its greater strength than that of spring **125**. As shown at **131**, **132** and **133**, the slide member is provided with three progressively higher abutment arms upwardly aligned with and spaced from the top ends of armatures **103**, **104** and **105** respectively, when those members are in their initial positions. By this construction, the downward movement of the slide member is blocked by the engagement of arm **131** with armature **103** if the latter is still in its initial position after the circuit has been energized. However, if that armature has been attracted to the pole piece, it is out of abutting alignment with the corresponding arm and the downward movement of the slide member continues until it is blocked by the abutment of one of the other two arms with its corresponding armature or by the engagement of the upper stud **122** with the end of slot **123** if all the armatures **103**, **104** and **105** are in contact with the magnet pole piece. Thus, it is apparent that the position at which downward movement of the slide member is blocked corresponds to one of four predetermined ranges of scene illumination and may be translated into a corresponding adjustment of the exposure regulating means, for example by means of an arm **134**, connected to a shutter speed or diaphragm regulating lever **135** extending from the lens housing assembly **136**, by a pin **137** received in a slot **138**.

After the downward movement of the slide member has been blocked and the exposure regulating means adjusted accordingly, the further downward movement of the trigger member, against the resistance of spring **124**, moves shutter operating arm **139** thereof into engagement with shutter release lever **141**, extending from the lens housing, and displaces the lever to operate the shutter. However, if the scene illumination were below the level required to produce an acceptable photograph even at the maximum exposure setting established by the abutment of arm **131** against armature **103**, such operation of the shutter would simply waste a film frame. To prevent this occurrence, the trigger member is provided with an arm **142**, upwardly adjacent the most sensitive armature **102** when that member is in its initial position, whereby the trigger member is blocked against being depressed to a sufficient extent to operate the shutter unless armature **102** has been attracted to the pole piece in response to the presence of sufficient illumination to provide a satisfactory exposure at one of the available settings. If desired, armature **102** can, of course, also actuate a lamp or other visible signal means, as previously described, to provide a further indication to the photographer that the shutter has not operated as the result of insufficient scene illumination.

While the construction illustrated in FIG. 8 employs four armature members to provide four exposure settings and a low-light trigger blocking feature, it should be apparent that a greater number of armatures could be provided to achieve a correspondingly increased number of available settings. Similarly, all of the armatures associated with one electromagnet might serve as exposure regulating means, with a separate relay unit being provided to respond to low light conditions. Furthermore, the blocking arrangement of FIG. 8 could be used to control a diaphragm arrangement, and conversely, the diaphragm arrangement of FIGS. 1 to 3 could be used to change the shutter speed. Since these and other variations and modifications of the above-described preferred embodiments are possible within the spirit of the invention, the foregoing description is to be considered as illustrative only and not as limiting the scope of the invention.

I claim:

**1.** A camera including:

(a) a lens system for focusing light from a viewed scene onto a photosensitive surface,

(b) exposure control means adjustable to different control positions for controlling the exposure of said surface,

(c) a photocell adapted for exposure to light from said view scene and associated with an electric circuit adapted to produce an electrical output functionally related to the intensity of said light,

(d) signal means operable to indicate that said light is of an intensity within a predetermined range,

(e) transducer means for adjusting said exposure control means and operating said signal means as a function of said output, said transducer comprising an electromagnetic relay including,

(1) an electromagnet energized by said output to an energization level functionally related thereto, and

(2) a plurality of movable armatures positioned in accordance with the level of energization of said electromagnet,

(f) motion translating means operatively connecting a plurality of said armatures to said exposure control means to adjust the latter in accordance with the positions of the armatures so connected thereto; and

(g) signal operating means operatively connecting one of said armatures to said signal means to operate said signal means when said one of said armatures is in a predetermined position.

**2.** The invention defined by claim **1** in which said exposure control means comprises a variable lens diaphragm mechanism.

**3.** The invention defined by claim **1** in which said exposure control means comprises a shutter speed control member.

**4.** The invention defined by claim **1** in which said armatures operatively connected to said exposure control means are movably positioned adjacent opposite first and second sides of said electromagnet and operatively connected to respective movable diaphragm blades, said one of said armatures being independent of said exposure control means and positioned adjacent a third side of said electromagnet.

**5.** The invention defined by claim **1** in which said signal means comprises an electrically energizable lamp, electrically associated with a power source through a switch operated by said one of said armatures.

**6.** The invention defined by claim **5** in which said one of said armatures comprises a movable contact element of said switch.

**7.** The invention defined by claim **5** in which said switch is adapted to close to electrically energize said lamp when said one of said armatures is located in a predetermined position corresponding to scene illumination of less than a predetermined intensity range.

**8.** A photographic camera including:

(a) an internal body member adapted to support a photosensitive film surface in a predetermined plane,

(b) a lens system for focusing light from a viewed scene onto said photosensitive film surface,

(c) a viewfinder,

(d) a shutter adapted for actuation by movement of a trigger member, and

(e) electric circuit means adapted to provide an electric current proportional to scene illumination by means of a photocell associated with an electric power source,

said camera characterized by an automatic exposure control mechanism for controlling the exposure of said surface as a function of scene illumination, said mechanism comprising:

(f) a support plate mounted in generally parallel relation to said plane forwardly thereof and including means defining a fixed diaphragm aperture in rearward alignment with said lens system,

(g) support means on said support plate for supporting adjacent one side thereof in lateral relation to said aperture therein an electromagnet adapted to be energized by said current,

(h) two diaphragm blades pivotally supported on said plate adjacent the side thereof opposite said electromagnet, each of said blades being adapted for movement between a first position out of alignment with said aperture and a second position in partially obstructing relation to said aperture, whereby said aperture is

(1) unobstructed when both of said blades are in their respective first positions,

(2) reduced in area when only one of said blades is in said second position, and

(3) further reduced in area when both of said blades are in said second positions,

(i) two magnetically attractable armatures movably supported adjacent opposite sides of said electromagnet and connected to the corresponding ones of said blades to move the latter between said first and second positions in response to movement of the respective armatures between corresponding first and second locations,

(j) resilient means biasing said armatures away from said electromagnet to their respective first locations, and

(k) sensitivity control means for establishing the sensitivity of said armatures to magnetic attractive movement from their respective first locations to their respective second locations, whereby one of said armatures is so moved in response to the energization of said electromagnet to a first predetermined level and the other of said armatures is so moved in response to energization of said electromagnet to a predetermined different second level.

**9.** The invention defined by claim **8** in which said sensitivity control means comprises armature locating means defining the first location of one of said armatures at a greater distance from said electromagnet than the corresponding distance of the first location of the other of said armatures from said electromagnet.

**10.** The invention defined by claim **8** in which said circuit means includes a normally open switch in series with said electric power source, said switch being operatively connected to said trigger and adapted to be closed in response to shutter actuating movement thereof.

**11.** The invention defined by claim **8** including:

(a) a third movable armature resiliently biased toward an operative position and magnetically attractable therefrom by said electromagnet to an inoperative position in response to energization of said electromagnet to an energization level insufficient to attract either of said two armatures to its corresponding second location, and

(b) signal means responsive to the position of said third armature for indicating the existence of a low light condition when said electromagnet is energized.

**12.** The invention defined by claim **11** in which said signal means comprises an electric lamp connected to said power source through a switch operated by said third armature to energize said lamp when said third armature is in said operative position and to deenergize said lamp when said third armature is in said inoperative position.

**13.** The invention defined by claim **12** in which said lamp is adapted when energized to illuminate a member visible in said viewfinder.

**14.** In a camera including a viewfinder, a low light signal device comprising:

(a) a photocell adapted for exposure to light from a viewed scene and associated with electric circuit means adapted to produce an electric output functionally related to the intensity of said light;

(b) an electromagnetic relay including,

(1) an electromagnet energized by said output to produce a magnetic field of an intensity functionally related to the intensity of said light,

(2) a magnetically attractable armature movably supported adjacent said electromagnet and resiliently retained in a first position in predetermined spaced relation to said electromagnet by resilient means, whereby the production by said electromagnet of a magnetic field of a predetermined intensity will cause said armature to be

magnetically attracted out of said first position and to a second predetermined position closer to said electromagnet against the influence of said resilient means,

(c) a lamp adapted upon electrical energization thereof to illuminate a member visible in said viewfinder;

(d) circuit means for establishing an electric circuit through said lamp from a source of electrical energy; and

(e) switch means incorporated in said circuit to close said circuit in response to movement of said armature to said first position and to open said circuit in response to movement of said armature out of said first position, said switch means comprising a movable contact surface defined by said armature, said movable contact surface being in abutting relation with a stationary contact member when said armature is in said first position and in spaced relation thereto when said armature is in said second position.




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95—64; 317—124; 335—265