United States Patent

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[54] **PHOTOELECTRIC EXPOSURE CONTROL FOR CAMERAS**
23 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **95/10,** 95/64
[51] **Int. Cl.** **G01j 1/00,** G03b 9/02
[50] **Field of Search** 95/31, 64, 64A, 64D, 10C

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ABSTRACT: An exposure control for photographic cameras which determines the aperture size and/or the exposure time as a function of scene brightness. A movable armature is positioned in accordance with the energization of an electromagnet whose coil is connected in series or in parallel with a light-sensitive receiver exposed to scene light to control the displacement of the armature as a function of scene brightness. The armature can deform a carrier assembly which includes one or more articulated or flexible carriers supporting vanes which can define an aperture of varying size and/or can maintain the aperture open for varying periods of time.

The coil of the electromagnet can receive current directly from a battery or from a capacitor which is charged through the light-sensitive receiver during partial depression of the shutter release and is caused to discharge through the coil in response to further depression of the shutter release.

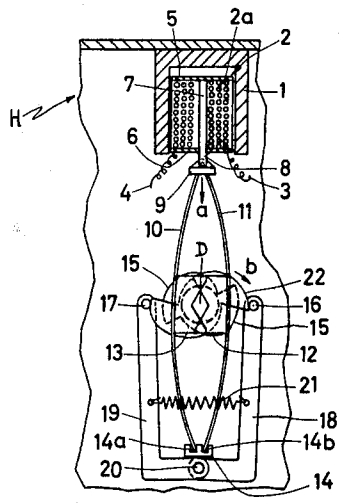


Fig.1

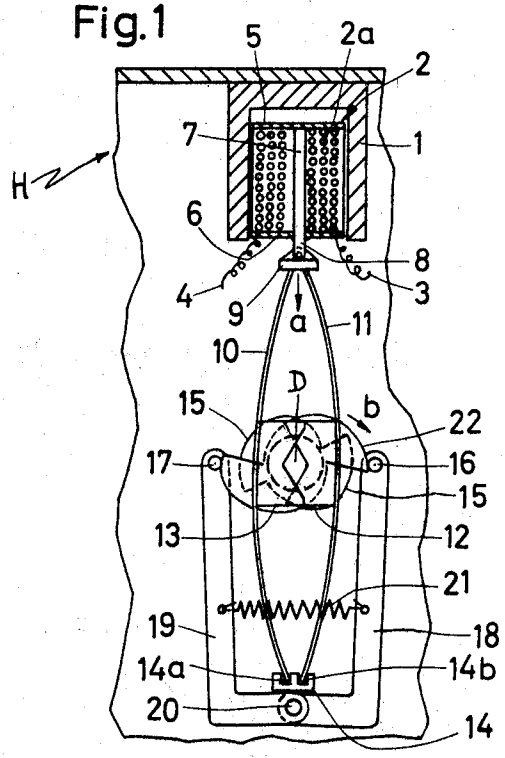
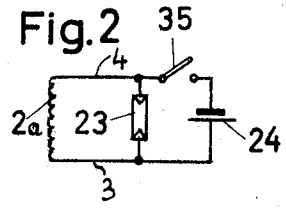


Fig.2



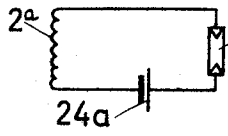


Fig.3

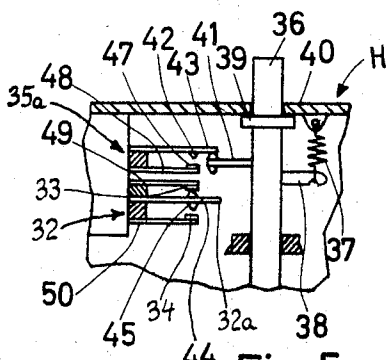


Fig.5

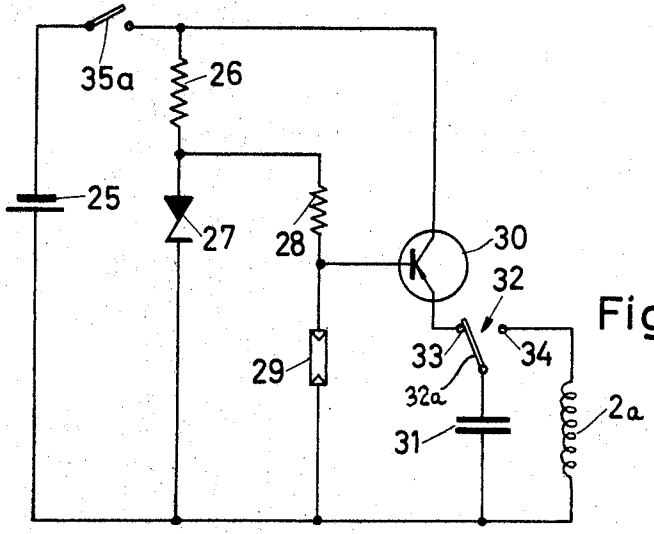


Fig.4

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Fig.6

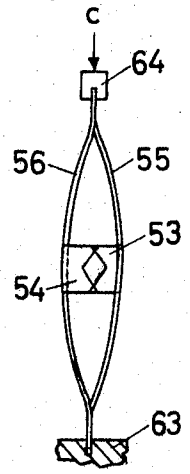


Fig.7

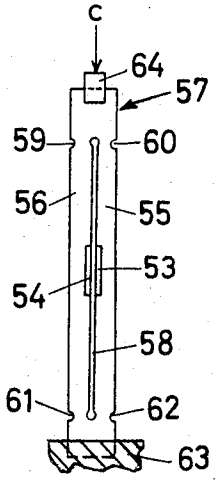


Fig.8

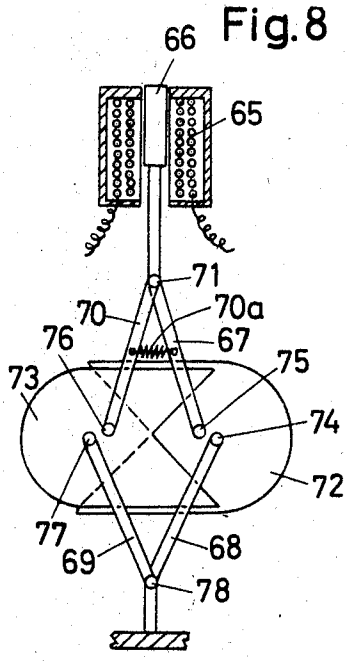
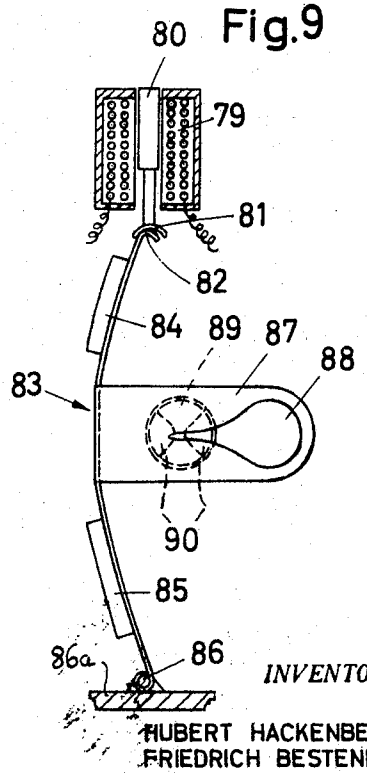


Fig.9



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PHOTOELECTRIC EXPOSURE CONTROL FOR CAMERAS

BACKGROUND OF THE INVENTION

The present invention relates to photographic cameras in general, and more particularly to improvements in photoelectric exposure controls for still cameras or motion picture cameras. Still more particularly, the invention relates to improvements in exposure controls wherein the exposure time and/or the aperture size (f/stop) is determined by electromagnetic means as a function of scene brightness.

SUMMARY OF THE INVENTION

It is an object of our invention to provide a simple, rugged and inexpensive photoelectric exposure control for still cameras or motion picture cameras.

Another object of the invention is to provide an exposure control wherein the shutter and/or diaphragm is operatively connected with an electromagnet in a novel space and material-saving way.

A further object of the invention is to provide a novel electric circuit for use in an exposure control of the above outlined character.

An additional object of the invention is to provide novel supporting and displacing means for one or more blades or vanes of a diaphragm and/or shutter in a photographic camera.

The improved exposure control comprises electromagnet means having movable armature means positioned in accordance with energization of the electromagnet means, light-sensitive receiver means exposed to scene light and operatively connected with the electromagnet means to determine the position of the armature means as a function of scene brightness, and adjustable exposure value selecting means including deformable carrier means and vane means provided on and movable by the carrier means between a plurality of positions each of which corresponds to a different exposure value and each of which is determined by a different degree of deformation of the carrier means, the latter being deformable by the armature means. The carrier means may include one or more elastic or articulated carriers and each such carrier can support a vane. The extent of energization of the electromagnet means can determine the size of the aperture defined by the vane means and the duration of such energization can determine the exposure time.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved exposure control itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certains specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary diagrammatic sectional view of a camera provided with a built-in exposure control which embodies one form of our invention and wherein the electromagnet means is arranged to adjust a diaphragm with two vanes;

FIG. 2 is a diagrammatic view of the electric circuit in the exposure control of FIG. 1;

FIG. 3 is a similar diagrammatic view of a modified circuit;

FIG. 4 is a diagrammatic view of a circuit in an exposure control which can adjust the exposure time and the aperture size as a function of changes in scene brightness;

FIG. 5 illustrates the shutter release in a camera which embodies the electric circuit of FIG. 4;

FIG. 6 illustrates simplified carrier means which can be utilized in the exposure control of our invention;

FIG. 7 is a side elevational view of the structure shown in FIG. 6;

FIG. 8 is a diagrammatic view of a further exposure control wherein the carrier means includes two link trains; and

FIG. 9 is a diagrammatic view of still another exposure control which includes a single flexible carrier.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is shown a portion of a photographic camera which comprises a housing H accommodating an electromagnet 1 which forms part of the improved photoelectric exposure control. The exposure control also includes a diaphragm having two vanes or blades 12, 13 which are illustrated in an intermediate position in which they define an aperture D of medium size. The electromagnet 1 includes an armature 2 having a tubular winding or coil 2*a* and a core 7 which is reciprocable with the coil 2*a*. The latter is disposed between two flanges 5, 6 of the armature 2. Two conductors 3, 4 connect the ends of the coil 2*a* with a source 24 of electrical energy (see also FIG. 2).

The lower end portion 8 of the core 7 extends beyond the lower flange 6 and carries a tiltable motion transmitting plate 9 which engages the upper ends of two deformable rod-like carriers 10, 11. The carriers 10, 11 form part of a carrier assembly and consist at least in part of elastomeric material. The vanes 12, 13 are respectively mounted on the median portions of the carriers 11, 10. It is clear that the carriers may constitute two leaf springs. The lower ends of the carriers 10, 11 extend into and are pivotable in notches 14*a*, 14*b* of a fixed bearing 14. When the armature 2 moves downwardly, the carriers 10, 11 are flexed to move their median portions away from each other, i.e., in directions substantially or exactly at right angles to the direction of movement of the armature, and to displace the vanes 12, 13 in a sense to increase the size of the aperture D. The carriers 10, 11 are partially deformed when the armature 2 assumes its upper end position, i.e., these carriers are installed in prestressed condition and can move the armature 2 to upper end position when the electromagnet 1 is deenergized. It will be noted that the carriers 10, 11 are mirror symmetrical with reference to a plane which includes the optical axis of the camera objective. Such plane is normal to the plane of FIG. 1 and includes the axis of a fixed pivot pin 20 as well as the axis of the core 7.

In order to enable the exposure control to furnish satisfactory exposure values during operation with flash or with another source of artificial illumination, the structure of FIG. 1 further comprises a rotary adjusting or regulating cam 15 which is coupled with the focus adjusting means of the camera in a manner well known from the art. The face of the cam 15 can cooperate with two pin-shaped followers 16, 17 which are respectively mounted at the upper ends of two levers or arms 18, 19 turnable about the fixed pivot pin 20 which latter is mounted in the housing H at a level directly below the bearing 14. The followers 16, 17 determine the maximum size of the aperture D.

In order to prevent the followers 16, 17 from interfering with automatic adjustments of the aperture size when the camera is used in daylight, the exposure control comprises a second rotary adjusting or overriding cam 22 which is preferably coaxial with the cam 15 and can move the followers 16, 17 sufficiently apart to place them out of the path of the carriers 10, 11, i.e., the carriers can then undergo maximum deformation or flexing in response to downward displacement of the armature 2. A helical spring 21 is connected to the levers 18, 19 to permanently urge the followers 16, 17 toward each other, i.e., into engagement with the face of the cam 15 or 22. FIG. 1 illustrates the cam 15 in inoperative position; thus, the followers 16, 17 engage the face of the cam 22 and are held out of the way of the median portions of carriers 10 and 11. In order to set the camera for operation with artificial illumination of the subject or scene, the cam 22 is rotated by hand or in response to attachment of a flash unit or in response to placing of a flash unit or electronic flash into operative condition in a sense to be disengaged from the followers 16, 17 so that these followers can move toward each other under the action of spring 21 and engage the face of the

cam 15 to thus limit the extent of movement of vanes 12, 13 away from each other and to select an aperture size which is best suited for operation with a particular source of artificial illumination. The direction in which the cam 22 must be turned to be disengaged from the followers 16, 17 is indicated by arrow *b*. The arrow *a* indicates the direction in which the armature 2 moves in order to deform the carriers 10 and 11.

One form of an electric circuit for the exposure control of FIG. 1 is illustrated in FIG. 2. The coil 2*a* is connected in series with the energy source 24 (e.g., a battery or a miniature cell) and with a master switch 35 which can be closed by hand or in automatic response to actuation of the shutter release. A light-sensitive resistor 23 is connected in parallel with the coil 2*a* and energy source 24. The strength of the current which flows through the coil 2*a* is proportional to the resistance of the light-sensitive resistor 23, the latter being exposed to scene light. When the intensity of scene light is low, the resistance of the resistor 23 is high and a strong current flows through the coil 2*a* so that the armature 2 is moved through a considerable distance (arrow *a* in FIG. 1) and causes the vanes 12, 13 to define a relatively large aperture D. The size of this aperture is less if the intensity of scene light is high because the resistance of the resistor 23 is then low and a weaker current flows through the coil 2*a* to cause a relatively short displacement of the armature 2 from its upper end position. The construction of the exposure control shown in FIG. 1 is such that the diaphragm is closed when the armature 2 assumes its upper end position, i.e., the vanes 12, 13 then overlap fully and prevent scene light from reaching an unexposed film frame.

When the intensity of scene light is insufficient for satisfactory exposures without artificial illumination of the subject, the cam 22 is disengaged from the followers 16, 17 so that these followers can engage the face of the cam 15 to determine the maximum deformation or flexing of the carriers 10 and 11. The resistor 23 then offers a very high resistance to the flow of current and, therefore, a very strong current flows through the coil 2*a* in response to closing of the master switch 35 to effect a substantial displacement of the armature 2 in the direction indicated by arrow *a* so that the carriers engage the followers 16, 17 and cooperate therewith to define a desired aperture which is best suited for operation with flash or the like. Of course, and if the user so desires, the cam 22 can remain in operative position to hold the followers 16, 17 away from the cam 15 during operation with flash so that the vanes 12, 13 then define an aperture of maximum size.

The exposure control of FIG. 1 can be modified to embody a slightly different electric circuit which is shown in FIG. 3. The coil 2*a* is connected in series with a battery 24*a* and with a light-sensitive resistor 23*a*. When the intensity of scene light is low, the resistance of the resistor 23*a* is high and weak current flows through the coil 2*a* to effect a relatively short displacement of the armature. When the intensity of scene light is high, the resistance of the resistor 23*a* decreases and a strong current, flowing through the coil 2*a*, causes a substantial displacement of the armature from its normal or idle position. Therefore, the carriers 10, 11 must be mounted in such a way that they are flexed to a maximum extent when the intensity of scene light is low and that they are flexed less when the intensity of scene light is high. Thus, the vanes 12, 13 must define an aperture D of maximum size when the electromagnet is deenergized and the aperture size decreases in response to progressing flexing or deformation of the carriers. The connection of the coil 2*a* into the electric circuit is then such that the armature is retracted into the housing of the electromagnet when the strength of current flowing through the coil increases, and vice versa. The lower ends of the carriers 10, 11 are then preferably positively coupled to the bearing 14 and their upper ends can be positively coupled to the plate 9 so that the armature 2 can stretch or lengthen the carriers when it moves upwardly.

In order to use an exposure control which embodies the circuit of FIG. 3 in connection with a flash unit or another artificial illuminating arrangement, the light-sensitive resistor 23*a* can be covered by a suitable mask (not shown) so that the vanes 12, 13 then define an aperture of maximum size. The same applies if the mask is not used but the exposure with flash is made when the intensity of scene light is very low so that the resistance of the resistor 23*a* is very high. The cam 22 can be actuated to permit movement of followers 16, 17 against the face of the adjusting cam 15 and to insure that the vanes 12, 13 define an aperture of optimum size for exposures with artificial illumination of the subject or scene.

FIG. 4 illustrates the electric circuit of a modified exposure control which can determine the exposure time and the aperture size as a function of scene brightness. This circuit can produce current impulses of different magnitude and duration and includes an energy source 25 (e.g., a battery) connected with a stabilizer stage including a resistor 26 and a Zener diode 27. A voltage divider including a resistor 28 and a light-sensitive receiver 29 furnishes the base potential for a transistor 30 as a function of scene brightness. The emitter circuit of the transistor 30 includes a capacitor 31 and a two-way control switch 32 having a centrally located movable tongue 32*a* and two fixed contacts 33, 34. The contact 33 is connected with the emitter of the transistor 30 and the contact 34 is connected with one terminal of a coil 2*a* forming part of a reciprocable armature. It will be seen that the movable tongue 32*a* can connect the capacitor 31 with the emitter of the transistor 30 or with the coil 2*a*. A normally open master switch 35*a* is connected in series with the battery 25 and is preferably closed in automatic response to actuation of the shutter release.

The operation is as follows:

The light-sensitive receiver 29 is exposed to scene light. When the master switch 35*a* is closed, a certain potential develops at the base of the transistor 30, such potential being a function of the intensity of scene light. The capacitor 31 is connected with the emitter of the transistor 30 by way of movable tongue 32*a* and fixed contact 33, i.e., the capacitor 31 is charged to a potential which almost equals the base potential of the transistor 30. When the tongue 32*a* is moved into engagement with the fixed contact 34, the capacitor 31 discharges through the coil 2*a* and causes the armature to be displaced through a distance which is a function of scene brightness and causes the vanes to define an aperture of requisite size for the particular intensity of scene light. The electromagnet including the coil 2*a* can be readily designed in such a way that the distance covered by its armature in response to discharge of the capacitor 31 is a function of scene brightness. The diaphragm closes automatically in response to bias of the spring 21 when the electromagnet is deenergized. The diaphragm including the vanes 12, 13 can also serve as a simple shutter. Thus, the duration of energization of the electromagnet including the coil 2*a* of FIG. 4 can determine the exposure time as a function of scene brightness.

FIG. 5 illustrates a shutter release 36 which can be utilized in a camera embodying the electric circuit of FIG. 4. The shutter release 36 is a slide which is reciprocable in the housing H of a camera and normally assumes a starting or idle position, shown in FIG. 5, in which a collar 39 thereon bears against the underside of the top wall 40 of the housing H under the bias of a return spring 37. The slide 36 carries a projection or trip 41 which can actuate the master switch 35*a* and the control switch 32. The master switch 35*a* tends to assume a closed position and includes two tongues 43, 48 having contacts 42, 47 which are held apart by the trip 41 when the slide 36 assumes the starting position shown in FIG. 5. The control switch 32 includes the centrally located tongue 32*a* and two additional tongues 49, 50 which respectively carry the contacts 33, 34. The tongue 32*a* carries two contacts 44, 45. The contact 44 engages the contact 33 when the spring 37 holds the slide 36 in starting position. The spring 37 operates between the top wall 40 and an arm 38 of the slide 36.

When the slide 36 is held in starting position, the master switch 35*a* is open because the trip 41 bears against the tongue 43 and holds the contact 42 away from the contact 47 on the

tongue 48. Thus, the battery 25 of FIG. 4 is disconnected from the remaining parts of the circuit and the electromagnet including the coil 2*a* is deenergized. The centrally located tongue 32*a* is elastic and normally maintains its contact 44 in engagement with the contact 33 of the tongue 49, i.e., the capacitor 31 of FIG. 4 is connected with the emitter of the transistor 30.

If the user wishes to make an exposure, the slide 36 is depressed against the opposition of the return spring 37 whereby the trip 41 permits the contact 42 to engage the contact 47 and to close the master switch 35*a*. The capacitor 31 is being charged. As the slide 36 continues to move downwardly, the trip 41 engages the tongue 32*a* and moves the contact 45 against the contact 34 to connect the capacitor 31 with the coil 2*a* and to disconnect the capacitor from the emitter of the transistor 30. The capacitor 31 then discharges through the coil 2*a* and causes the armature of the electromagnet to move through a distance and for a period of time which are functions of scene brightness so that the size of the aperture and the exposure time are selected as a function of the intensity of scene light. When the slide 36 is released, the spring 37 contracts and returns the collar 39 into abutment with the top wall 40. The trip 41 allows the tongue 32*a* to return to the position of FIG. 5 and the trip thereupon opens the master switch 35*a* by moving the contact 42 away from the contact 47. It will be seen that the switches 32 and 35*a* are actuated automatically in a desired sequence in response to depression and subsequent release of the slide 36.

FIGS. 6 and 7 illustrate a portion of a further exposure control which comprises a carrier assembly including two integral carriers 55, 56. This carrier assembly can be produced at a low cost by using a single piece 57 of spring steel or the like. Each of the carriers 55, 56 supports one of two diaphragm blades or vanes 53, 54 which are movable toward and away from each other to define an aperture of increasing size while they move away from each other and to close the aperture in the starting position of the carrier assembly. The material of the piece 57 is preferably similar to that used in the manufacture of leaf springs. This piece 57 has a centrally located longitudinal slot 58 which has closed upper and lower ends and separates the carriers 55, 56 from each other. Notches 59, 60, 61, 62 can be stamped or punched into the material of the piece 57 to enhance the flexibility of carriers 55, 56 at their upper and lower ends. The lower end of the piece 57 is anchored in a stationary bearing 63 and the upper end of this piece is anchored in a motion transmitting member 64 which is movable in and counter to the direction indicated by an arrow *c*. Such movements are caused by innate elasticity of the carrier assembly (counter to the direction indicated by arrow *c*) and by the armature of an electromagnet which is not shown in FIGS. 6 and 7. The armature can move downwardly (arrow *c*) in order to flex the carriers 55, 56 so that their median portions move away from each other (at right angles to the direction indicated by arrow *c*) and cause the vanes 53, 54 to define an aperture of progressively increasing size.

Referring to FIG. 8, there is shown an exposure control wherein the carrier assembly comprises two link trains or carriers 67, 68 and 69, 70. The upper ends of the links 67, 70 are connected to a pivot 71 provided on the lower end of a core or armature 66 which is reciprocable in a fixed coil 65 forming part of an electromagnet. The lower ends of the links 68, 69 are connected to a fixed pivot 78. The upper ends of links 68, 69 are connected to pivots 74, 77 provided on two diaphragm vanes 72, 73 and these vanes carry two additional pivots 75, 76 for the lower ends of the links 67, 70. A spring 70*a* operates between the links 67, 70 and tends to lengthen the carrier assembly, i.e., to move the pivot 71 upwardly and to thus return the armature to its upper end position.

The links 67—70 together form a deformable rectangle wherein the carriers 67, 68 and 69, 70 are deformable to the same extent in response to downward movement of the core 66 and pivot 71. The vanes 72, 73 then move apart to define an aperture whose size is a function of the extent of lengthwise displacement of the core 66 and hence a function of scene brightness.

Referring finally to FIG. 9, there is shown a further exposure control which comprises a single flexible carrier 83. The electromagnet includes a fixed coil 79 and a reciprocable armature or core 80 carrying at its lower end a cupped socket 81 for the upper end portion or head 82 of the carrier 83. The latter carries stiffeners 84, 85 which reduce its flexibility and confine such flexibility to selected portions of the carrier. The lower end of the carrier 83 is pivotable or turnable on a pin 86 forming part of a stationary bearing 86*a*. A median portion of the carrier 83 (between the stiffeners 84, 85) is rigid with a single movable diaphragm vane or blade 87 cooperating with a fixed vane 90. The vane 87 has a suitably configurated opening 88 selected portions of which move into registry with the opening of the fixed vane 90 when the core 80 is caused to move downwardly in response to energization of the electromagnet as a function of the intensity of scene light. The fixed vane 90 is located behind an objective lens 89. The structure of FIG. 9 can be used to determine the aperture size and the exposure time as a function of scene brightness. When the core 80 moves downwardly, a wider portion of the opening 88 in the movable vane 87 registers with the opening of the fixed vane 90 to define therewith a larger aperture for admission of scene light to an unexposed film frame. Thus, the electromagnet of FIG. 9 must be such that it causes the core 80 to move downwardly to a greater extent when the intensity of scene light is low. If desired, the upper end portion or head 82 of the carrier 83 can be articulately connected to the core 80.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

We claim:

1. In a photographic camera, an exposure control comprising electromagnet means having displaceable armature means positioned in accordance with energization of said electromagnet means; light sensitive means exposed to scene light and operatively connected with said electromagnet means to determine the position of said armature means as a function of scene brightness; adjustable exposure value selecting means including carrier means having at least one deformable elongated carrier and vane means including a vane provided on and located between the ends of said carrier, said vane being movable by said carrier in a first direction between a plurality of positions each of which corresponds to a different exposure value and each of which is determined by a different degree of deformation of said carrier, said carrier being deformable in response to displacement of said armature means in a second direction which is at least substantially normal to said first direction; adjustable control means independent of displacement of said armature means for limiting the extent of deformation of said carrier by said armature means; and means for adjusting said control means.

2. An exposure control as defined in claim 1, wherein said carrier consists at least in part of elastomeric material and has a fixed end and a second end engageable by said armature means to deflect a median portion of said carrier sideways in said first direction in response to displacement of said armature means in said second direction, said vane being provided on said median portion of said carrier.

3. An exposure control as defined in claim 2, further comprising bearing means supporting said one end of said carrier.

4. An exposure control as defined in claim 2, wherein said carrier is a leaf spring.

5. An exposure control as defined in claim 2, wherein said carrier is an elastic rod.

6. An exposure control as defined in claim 1, wherein said carrier means comprises a pair of deformable elongated car-

riers and said vane means comprises a pair of vanes each mounted on and located between the ends of one of the carriers, said carriers being disposed mirror symmetrically with reference to a plane including the optical axis of the camera lens.

7. An exposure control as defined in claim 1, wherein said means for adjusting said control means comprises manually operated means.

8. An exposure control as defined in claim 1, wherein the means for adjusting said control means comprises focussing means.

9. An exposure control as defined in claim 1, wherein said exposure values are aperture sizes.

10. An exposure control as defined in claim 1, wherein said exposure values are exposure times.

11. An exposure control as defined in claim 1, wherein said carrier comprises a link train and biasing means opposing deformation of said link train by said armature means.

12. An exposure control as defined in claim 11, wherein said link train includes a first link having a first end turnable about a fixed axis and a second end, and a second link having a first end movable by said armature means toward said fixed axis and a second end, said vane being articulately connected with the second ends of said links and, said biasing means including spring means opposing movement of said first end of the second link toward said fixed axis.

13. An exposure control as defined in claim 1, wherein said carrier has a fixedly anchored first end and a second end displaceable by said armature means.

14. An exposure control as defined in claim 1, wherein said carrier means further comprises a cupped socket for at least one end of said carrier.

15. An exposure control as defined in claim 1, wherein said carrier means further comprises pivot means for at least one end of said carrier.

16. An exposure control as defined in claim 1, wherein said carrier is prestressed when said electromagnet means is deenergized.

17. An exposure control as defined in claim 1, wherein said carrier means comprises a single elongated piece of elastomeric material provided with an elongated slot closed at both ends to form two elongated integral carriers having median portions arranged to flex in opposite directions, said vane means comprising a pair of vanes each mounted on the median portion of one of said carriers.

18. An exposure control as defined in claim 1, wherein said control means comprises follower means biased toward engagement with said carrier and adjustable cam means for selecting the position of said follower means.

19. An exposure control as defined in claim 1, wherein said electromagnet means comprises coil means and said light-sensitive means comprises receiver means connected in circuit with said coil means, the resistance of said receiver means varying as a function of changes in scene brightness to influence the energization of said electromagnet means and the resulting positioning of said armature means.

20. An exposure control as defined in claim 19, wherein said receiver means comprises a light-sensitive resistor and further comprising a source of electrical energy connected in said circuit.

21. An exposure control as defined in claim 19, wherein said circuit further comprises means for transmitting to said coil means current impulses whose characteristics are a function of the resistance of said receiver means.

22. An exposure control as defined in claim 21, wherein said impulse transmitting means comprises capacitor means chargeable by way of said receiver means and arranged to discharge directly through said coil means.

23. An exposure control as defined in claim 22, further comprising control switch means movable between a first position in which said capacitor means is charged as a function of the resistance of said receiver means and a second position in which said capacitor means discharges through said coil means, and shutter release means for effecting movement of said control switch means between said positions thereof.