

PATENT SPECIFICATION

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(54) SHUTTER-DIAPHRAGM

(71) We, FRANKE & HEIDECKE G.M.B.H., a German Body Corporate, trading as ROLLEI-WERKE FRANKE & HEIDECKE, of 196 Salzdahlumerstrasse, Braunschweig, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a shutter-diaphragm with opening and closing blades, the opening blades opening when the shutter is actuated under the action of a driven adjusting member and the closing blades being releasable for a quick closing movement after an adjustable time span related to the commencement of the opening of the opening blades.

Such shutter-diaphragms make it possible that, due to the fact that the release of the closing blades can be varied with respect to time, there is brought about both a change of the shutter opening time and an influencing of the largest diaphragm opening released by the closing blades. In this connection, the shutter opening time and the diaphragm opening are always fixedly related, that is to say with small shutter opening times there are associated small diaphragm opening values.

In the case of a known shutter-diaphragm of this type, a drive member for the opening blades is released by the camera release, whilst the closing blades are held in the opening position by an electromagnet and are released by an impulse given by a time formation device. The time formation device mostly works automatically, measuring the light through the object lens and converting the brightness of the object into a time interval that is tuned or geared to an optimal exposure.

The adjusting member for the opening blade is directly driven by a spring. In order to be able to influence the operation of the drive member, there is provided a braking mechanism which acts directly on the adjusting member of the opening blades. But such a braking mechanism allows only uniform influencing over the entire opening path of the

opening blades and there is no possibility of exerting a special influence on specific areas of the movement process.

In the case of the known diaphragm shutter, a braking mechanism causes a uniform run of the drive member of the opening blades at a constant speed. If the diaphragm opening is recorded in the diagram as a function of time, there emerges the pattern shown in Figure 2a of the drawing (curve Ö). If the closing blades (curve Sch in Figure 2a) are now released after a variable time span for a quick closing movement, then the exposure process will be completed. Thus, there has been brought about in a specific exposure time a specific diaphragm opening and an exposure value which corresponds to the shaded area shown in Figure 2a.

As is discernible from Figure 2a of the drawing, extremely small exposure times result in the range of small diaphragm openings. With such small exposure times, fairly small deviations from the exact exposure time values, which may be caused, for example, by the response duration of the time formation unit or the response duration of the shutter-diaphragm, may lead to different exposure values and consequently to faulty exposure of the photographic picture. In order to avoid this, the shutter-diaphragms have to be extremely finely turned in this range of small diaphragm openings and have to work in a very accurate manner. However, it is very difficult to realize such a shutter, and it is extremely costly to produce, so that cameras equipped with such shutter-diaphragms usually do not operate accurately in the range of small exposure times. On the other hand, it is not possible to increase the exposure time in the range of small diaphragm openings, since this will also increase the range of the larger diaphragm openings and the time required altogether by the opening blades for passing from their closed position to their maximum open position will be much too large. This time must not exceed 1/60 second for a camera, and even substantially shorter times are aimed at for precision cameras. However, with an opening time of the opening

blades of 1/60 second there already arise the problems demonstrated in the foregoing.

According to the present invention there is provided a shutter-diaphragm comprising opening blades mounted on an adjusting member, closing blades, means for releasing the closing blades for closing movement upon completion of an adjustable time interval, to determine both diaphragm aperture and exposure time, means for determining said interval from the commencement of the opening of the opening blades, a cam disc having a cam surface engageable with the adjustable member for driving the adjusting member to open the opening blades, and a drive element coupled with the cam disc wherein the cam surface defines movement of the adjusting member that corresponds to a required opening characteristic of the opening blades.

If the opening characteristics of the opening blades is selected in such a way that the diaphragm opening, defined by the opening blades, opens very slowly at first after release of the shutter and opens at a substantially increased speed from a mean diaphragm value, then one achieves the result that in the range of small diaphragm openings the associated exposure time values are considerably increased compared with the known diaphragm shutters, the exposure values remaining constant, but without changing the total opening time of the shutter, i.e. the time which the opening blades require for passing from the closing position to their opening position. Consequently, there is no need for the shutter-diaphragm and the time formation unit to work as accurately and finely tuned in the range of small diaphragm opening values, with the same picture quality, as the known shuttering-diaphragms; since slight deviations from these longer exposure times do not lead to any faulty exposure of the picture that is worth mentioning.

Therefore there is provided a shutter-diaphragm of the type mentioned at the beginning which gives the possibility to make the pattern of movement of the opening blades different from and independent of one another in partial areas of their path of adjustment.

In a further development of the invention, the adjusting member and/or the cam disc is provided with additional mass whereby a certain stabilisation of the drive is brought about.

In a further design of the invention, the driven cam disc is in engagement with a pin which is arranged on the adjusting member in axial manner thereto, whilst the same disc is connected expediently to a pinion which is driven by a spring via a rack.

An embodiment of the present invention will now be described by way of example, with reference to the accompanying drawing, wherein:—

Fig. 1 shows a front view of a camera

shutter, with opening blades and closing blades;

Fig. 2a shows a graph of the time characteristics of an opening and closing process, in the case of a known shutter-diaphragm, with which a drive element for the opening blades is subject to the action of a braking mechanism;

Fig. 2b shows a graph of the time characteristics of the opening and closing process in the case of the shutter-diaphragm to which the invention relates;

Fig. 3a shows a shutter-diaphragm as in Fig. 1, with the closing blades removed and with a second opening slide to control the incidence of the light on a photo-electric cell;

Fig. 3b shows a rear view of the shutter-diaphragm shown in Fig. 3a; and

Fig. 3c shows a plan view of the shutter-diaphragm shown in Figs. 3a and 3b.

Referring now to the drawings in more detail, Fig. 1 shows a pair of opening blades 1 and a pair of closing blades 2 serving to form a required diaphragm aperture. The pair of blades 2 are held in the open position by an electromagnet 5, via shutter lever 3 and an armature 4, and are mounted immediately above the diaphragm aperture of the pair of opening blades 1. The shutter lever 3, when the magnet 5 is not energized, is pressed by a spring 6 towards its closed position for the pair of closing blades 2, in which process the shutter lever 3, via a pin-and-slot connection 8 moves the closing blades towards each other in such a way that the diaphragm aperture is covered over. A pin 7 enables the armature 4 of the shutter lever 3 to be moved into the starting position, i.e. moved back to the electromagnet 5.

The opening blades 1 are articulated to diametrically opposite points of a cylindrical adjusting device 9. The pair of opening blades 1 are held in the closed position by the aid of a spring 10 acting on the adjusting device 9. The drive of the adjusting device 9 is effected via cam disc 11 which, in the course of its rotation, displaces a pin 12 which is provided on the periphery of the adjusting device 9 and extends in a direction parallel to the axis of rotation of the device 9. The pin 12 moves in a circular path centred on the axis of rotation of the device 9. The drive of the cam disc 11 is effected from a drive spring, via a rack-and-pinion connection shown more clearly in Figures 3b and c. The moment at which the closing movement of the closing blades commences is determined by a timing unit 13 which emits a signal for the interruption of the energization current in the electromagnet 5.

Figures 3a to 3c show a shutter-diaphragm in which a second pair of opening blades 18 are operative to expose light to a photo-cell 19 situated behind the shutter and are mounted on the adjusting device 9, offset by 90° in

respect of the articulation points of the opening blades 1 already described. The photo-cell 19 is connected to the timing unit 13 shown in Figure 1. When the pair of opening blades 1 is actuated via the adjusting device 9 the shutter in this present embodiment of the invention will at the same time open the second pair of opening blades 18.

The construction of the shutter is largely the same as in the example shown in Figure 1. A first pair of opening blades 1 and a second pair of opening blades 18 are mechanically articulated to an adjusting device 9 in such a way that on the rotation of this latter they define a certain diaphragm aperture. The first pair of opening blades 1 then defines a diaphragm aperture for the lens, while the second pair of opening blades 18 defines a diaphragm aperture for the photocell 19. The adjusting device 9 is driven by the cam disc 11 via the pin 12. The cam disc 11 is situated on a shaft with a flywheel 20 and with the pinion of a rack-and-pinion connection 16. A slide 14 is driven by a relatively powerful spring 21 and held and guided in a pin-and-slot connection 22. In the starting position the slide 14 rests by a stop lug 23 against a locking device 17 of a release slide 15.

The operation of the shutter will be described below by reference to the diagram shown in Figure 2b;

In this graph the shutter times are drawn along the abscissa, the diaphragm aperture numbers being shown on the ordinates. $\bar{O}$ is the curve of the opening process of the opening blade, while Sch is the curve of the closing process of the closing blades. In the starting position i.e. when the drive spring 21 is stressed, the pair of closing blades 2 has been moved into the open position by the aid of the pin 7. Under these circumstances the armature 4 of the shutter lever 3 is moved as far as the electromagnet 5. The closing blades 2 are held in the open position by the pin-and-slot connection 8. The cam disc 11 is returned to its starting position shown in the drawing. The slide 14 is stressed, being locked in position by the release slide 15.

When the release slide 15 is pressed downwards (point S in the diagram) a contact not shown in the drawing is at the same time closed, starting the electrical timing unit 13. The slide 14 starts, moving the pin 7 out of the zone of the shutter lever 3, which is held in the starting position (zone S/o in the graph) by the armature 4, owing to the magnet 5 which has been energized through the closed contact. The cam disc 11 is set in rotation by the rack-and-pinion connection 16. The cam disc 11, by the aid of its spiral curved tract, actuates the pin 12 situated on the periphery of the adjusting device 9, as a result of which the pair of opening blades 1 is set in motion. ($\bar{O}$ in the graph). The pair of opening blades 1 now opens the diaphragm

in a manner determined by the shape of the curve of the cam disc 11, taking into account the mass to be moved, and as shown by the curve $\bar{O}$ in the graph.

In the meantime the timing unit 13, via the photo-cell 19, or via a photo-cell situated behind the diaphragm as would be necessary in the example in Figure 1, has determined the time factor required for the correct exposure, and it interrupts the supply of current to the electromagnet 5. The armature 4 detaches itself from the electromagnet, and the closing blades 2 are suddenly closed by the force of the spring 6, via the shutter lever 3 and the pin-and-slot connection 8 (Sch in the graph). The exposure of the film is thus terminated. The maximum diaphragm aperture may be seen from the diaphragm values (diaphragm 5.6) shown on the ordinates in the graph, while the exposure time adopted is indicated by the exposure time values (8.5 ms) entered on the abscissa. The quantity of light which has passed through the lens can be determined by integrating the separate portions of the opening blade curve of the closing blade curve (zone shown in broken lines).

Owing to its mass, the cylindrical adjusting device 9, just like the flywheel 20 mounted on the shaft with the cam disc 11, produces a certain stabilization in the cycle of movements performed by the pair of opening blades 1, inasmuch as the different spring tension in the drive spring 21 and the frictional differences caused by temperature fluctuations between the individual driving elements are balanced out. As a result of the particular construction of the cam disc 11, taking into account the masses to be moved, the opening movement of the opening blades 1 is caused to take such a course that the diaphragm aperture, after the release action, at first only widens slightly, then widening with increasing speed, i.e. increases progressively. This not only enables the object of the invention to be achieved but also provides greater depth of field for the photographs, even with smaller diaphragms, owing to the longer exposure times now obtainable.

WHAT WE CLAIM IS:—

1. A shutter-diaphragm comprising opening blades mounted on an adjusting member, closing blades, means for releasing the closing blades for closing movement upon completion of an adjustable time interval, to determine both diaphragm aperture and exposure time, means for determining said interval from the commencement of the opening of the opening blades, a cam disc having a cam surface engageable with the adjusting member for driving the adjusting member to open the opening blades, and a drive element coupled with the cam disc, wherein the cam surface defines movement of the adjusting



respect of the articulation points of the opening blades 1 already described. The photo-cell 19 is connected to the timing unit 13 shown in Figure 1. When the pair of opening blades 1 is actuated via the adjusting device 9 the shutter in this present embodiment of the invention will at the same time open the second pair of opening blades 18.

The construction of the shutter is largely the same as in the example shown in Figure 1. A first pair of opening blades 1 and a second pair of opening blades 18 are mechanically articulated to an adjusting device 9 in such a way that on the rotation of this latter they define a certain diaphragm aperture. The first pair of opening blades 1 then defines a diaphragm aperture for the lens, while the second pair of opening blades 18 defines a diaphragm aperture for the photocell 19. The adjusting device 9 is driven by the cam disc 11 via the pin 12. The cam disc 11 is situated on a shaft with a flywheel 20 and with the pinion of a rack-and-pinion connection 16. A slide 14 is driven by a relatively powerful spring 21 and held and guided in a pin-and-slot connection 22. In the starting position the slide 14 rests by a stop lug 23 against a locking device 17 of a release slide 15.

The operation of the shutter will be described below by reference to the diagram shown in Figure 2b;

In this graph the shutter times are drawn along the abscissa, the diaphragm aperture numbers being shown on the ordinates. $\bar{O}$ is the curve of the opening process of the opening blade, while Sch is the curve of the closing process of the closing blades. In the starting position i.e. when the drive spring 21 is stressed, the pair of closing blades 2 has been moved into the open position by the aid of the pin 7. Under these circumstances the armature 4 of the shutter lever 3 is moved as far as the electromagnet 5. The closing blades 2 are held in the open position by the pin-and-slot connection 8. The cam disc 11 is returned to its starting position shown in the drawing. The slide 14 is stressed, being locked in position by the release slide 15.

When the release slide 15 is pressed downwards (point S in the diagram) a contact not shown in the drawing is at the same time closed, starting the electrical timing unit 13. The slide 14 starts, moving the pin 7 out of the zone of the shutter lever 3, which is held in the starting position (zone S/o in the graph) by the armature 4, owing to the magnet 5 which has been energized through the closed contact. The cam disc 11 is set in rotation by the rack-and-pinion connection 16. The cam disc 11, by the aid of its spiral curved traject, actuates the pin 12 situated on the periphery of the adjusting device 9, as a result of which the pair of opening blades 1 is set in motion. ($\bar{O}$ in the graph). The pair of opening blades 1 now opens the diaphragm

in a manner determined by the shape of the curve of the cam disc 11, taking into account the mass to be moved, and as shown by the curve $\bar{O}$ in the graph.

In the meantime the timing unit 13, via the photo-cell 19, or via a photo-cell situated behind the diaphragm as would be necessary in the example in Figure 1, has determined the time factor required for the correct exposure, and it interrupts the supply of current to the electromagnet 5. The armature 4 detaches itself from the electromagnet, and the closing blades 2 are suddenly closed by the force of the spring 6, via the shutter lever 3 and the pin-and-slot connection 8 (Sch in the graph). The exposure of the film is thus terminated. The maximum diaphragm aperture may be seen from the diaphragm values (diaphragm 5.6) shown on the ordinates in the graph, while the exposure time adopted is indicated by the exposure time values (8.5 ms) entered on the abscissa. The quantity of light which has passed through the lens can be determined by integrating the separate portions of the opening blade curve of the closing blade curve (zone shown in broken lines).

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WHAT WE CLAIM IS:—

1. A shutter-diaphragm comprising opening blades mounted on an adjusting member, closing blades, means for releasing the closing blades for closing movement upon completion of an adjustable time interval, to determine both diaphragm aperture and exposure time, means for determining said interval from the commencement of the opening of the opening blades, a cam disc having a cam surface engageable with the adjusting member for driving the adjusting member to open the opening blades, and a drive element coupled with the cam disc, wherein the cam surface defines movement of the adjusting

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member that corresponds to a required opening characteristic of the opening blades.

2. A shutter-diaphragm as claimed in Claim 1, wherein the adjusting member and/or the cam disc are provided with an additional mass.

3. A shutter-diaphragm as claimed in Claim 1 or 2, wherein the cam disc engages a pin which is mounted on the adjusting member and extends in a direction parallel to the axis of rotation of the latter.

4. A shutter-diaphragm as claimed in any one of Claims 1 to 3, wherein the cam disc is connected with a pinion so that it cannot rotate in relation to the latter, which pinion is arranged to be driven by a spring via a rack.

5. A shutter-diaphragm as claimed in any of the preceding claims, wherein the opening

characteristic of the opening blades is such that the opening blades form an aperture which increases in size at a rate lower during the initial part of the opening movement than during the latter part.

6. A shutter-diaphragm substantially as described herein with reference to Figure 1, Figure 2b, Figure 3a, Figure 3b and Figure 3c of the accompanying drawings.

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