United States Patent

Kitai

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[54] EXPOSURE TIME CONTROL DEVICE

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[51] **Int. Cl.**.....**G03b 9/62**

[58] **Field of Search**.....95/53 R, 53 E, 53 EA, 53 EB, 95/59, 62, 63, 53.3, 53.6

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[57] **ABSTRACT**

Different exposure times of a shutter-operating mechanism are obtained by variably coupling an inertia flywheel to the driving wheel for the shutter opening and closing to retard the driving wheel and by impeding the rotation of the flywheel by an electromagnetic abutment lever under control of a timing circuit to obtain longer exposure times.

11 Claims, 4 Drawing Figures

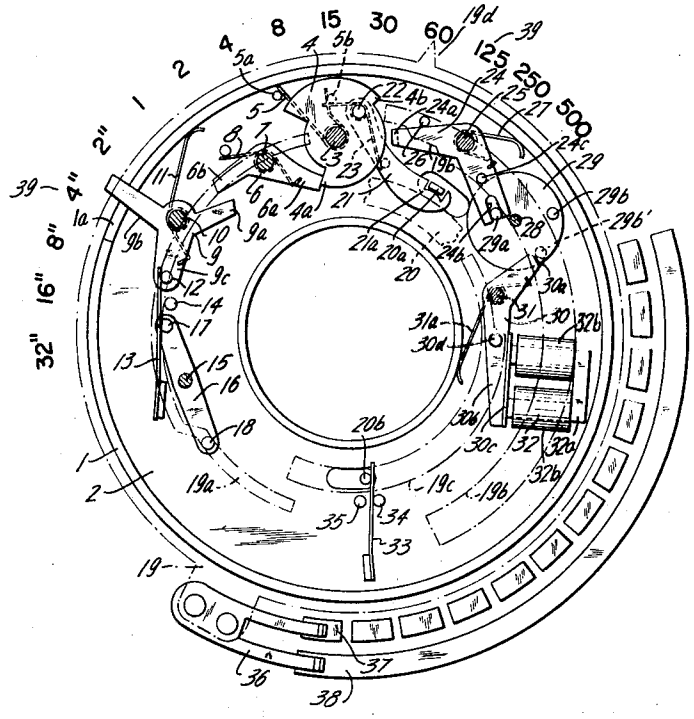
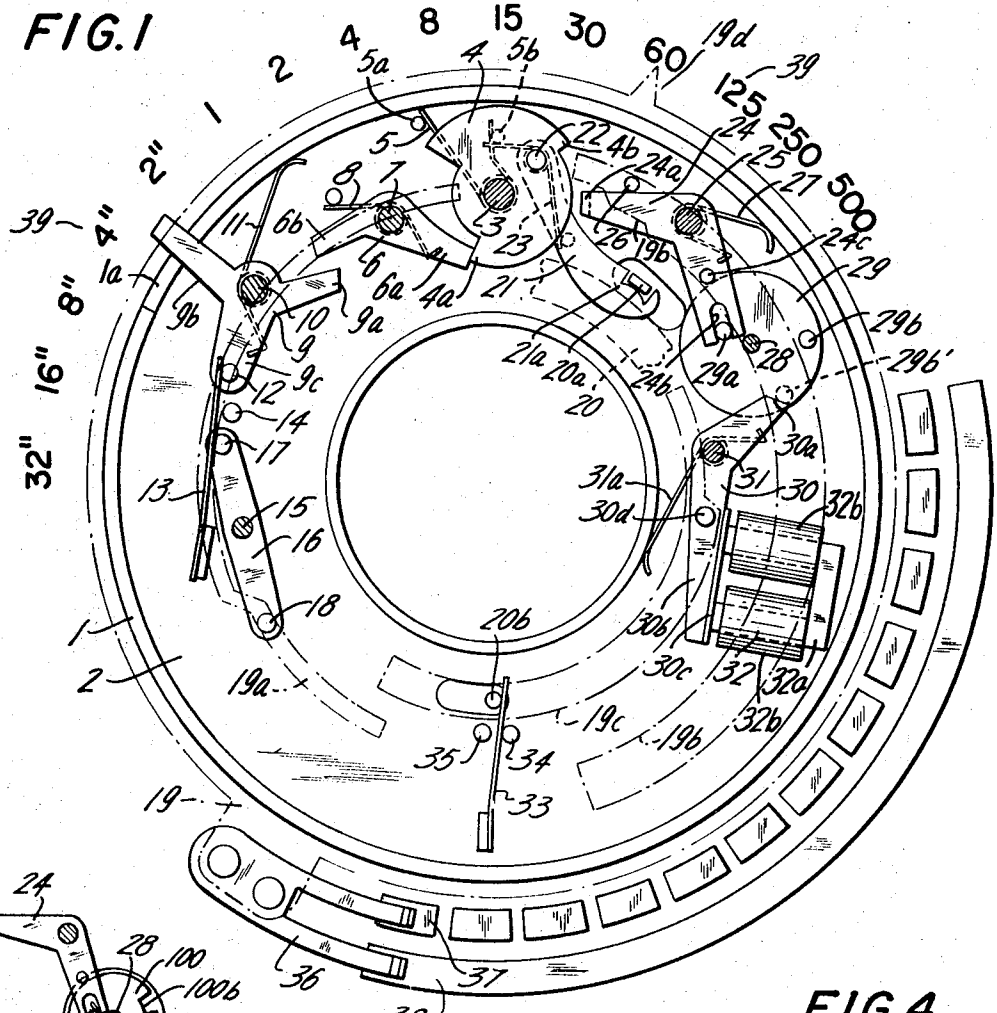


FIG. 1



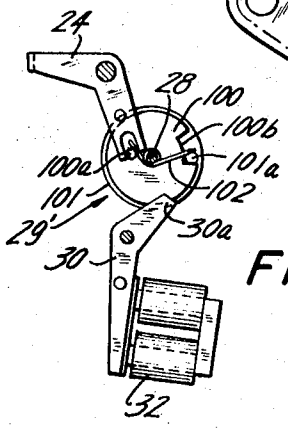
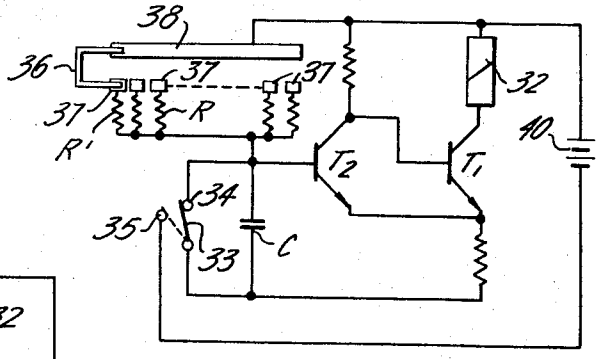


FIG. 3

FIG. 4



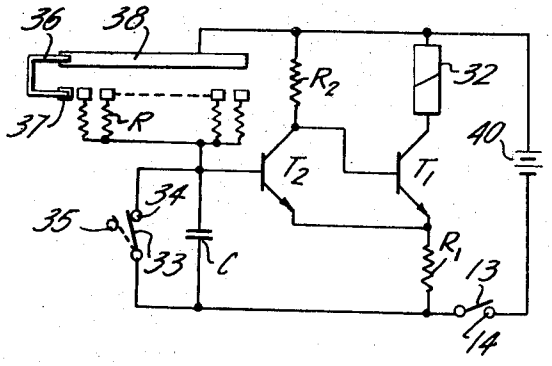


FIG. 2

EXPOSURE TIME CONTROL DEVICE

The present invention relates to an exposure time control device and particularly to an electronic shutter of the type in which a spring-powered driving part which operates to open and close the shutter is engaged by an impeding part, at a position where the shutter is fully open, for a selected period of time controlled by an electronic delay circuit and at the end of the delay time is released to continue its movement and close the shutter.

In an electronic shutter of this kind, the simplest expedient for stopping the driving part is to provide an impeding part in the path of movement of the driving part so as to engage it directly. In this case however, if the minimum exposure time of the shutter is 1/250 second or less, the force with which the driving part strikes the impeding part is very large so that it is necessary to increase the strength of the impeding part and to form its contact surface with the driving part so as to be capable of holding the driving part securely. Moreover, since the pressure on the interengaging surfaces of the driving part and the impeding part is large, the electromagnet provided for holding the impeding part or releasing it at the end of the delay period must have a large output.

In a case where an electromagnet is used for holding the impeding part in position to engage the driving part, the problem arises that since the running speed of the driving part is high, the driving part may sometimes pass over the position in which it is to be stopped before the electromagnet has been fully excited to move the impeding part into position for engagement by the driving part. In such case, the impeding part cannot stop the driving part. This disadvantage can to some extent be overcome by providing a switch to connect the electromagnet to the power source by a releasing operation prior to release of the driving part. However, if the releasing lever is pushed quickly, the electromagnet is not energized early enough to move the impeding part into position for engagement by the driving part at the position in which the driving part is to be stopped.

The present invention overcomes the aforementioned disadvantages by providing a mechanical braking or retarding system between the driving member of the shutter and the electronically controlled impeding part. The mechanical braking system initially retards the driving part which operates the shutter so as to reduce the impact on the impeding part and moreover allow adequate time for movement of the impeding part into operative position by an electromagnet controlled by a timing circuit. Moreover, by varying the retarding action of the mechanical braking mechanism by means of the exposure time-selecting means which also controls the electronic timing circuit, it is possible to use the mechanical braking mechanism alone for certain exposure times and in combination with the electronic timing system for other exposure times, thereby providing a wide range of exposure times in a simple and effective manner.

The invention will be more fully understood from the following description of a preferred embodiment shown by way of example in the accompanying drawings in which:

FIG. 1 is a somewhat schematic plan view of shutter-operating mechanism in accordance with the invention, certain parts having been omitted for the sake of clarity;

FIG. 2, is a wiring diagram of an electronic timing circuit for the shutter-operating mechanism shown in FIG. 1;

FIG. 3, is a partial plan of a modified part of the embodiment shown in FIG. 1; and

FIG. 4, illustrates a modification of the timing circuit.

The embodiment of the invention illustrated in FIG. 1 comprises a circular shutter case 1 in which a circular base plate 2 having a central opening is fixed in any convenient manner. An axle 3 rotatably mounted on the baseplate 2 carries a driving plate 4 at one end while the other end extends outside the shutter case to be used for winding up the driving plate 4. A spring 5 acts between a fixed pin 5a on the baseplate 2 and a pin 5*b* on the driving plate 4 to rotate the driving plate in a clockwise direction. The driving plate 4 is releasably held in a

wound-up state as shown in FIG. 1 by means of a detent lever 6 rotatably supported on the baseplate 2 by an axle 7 and biased in a counterclockwise direction by a spring 8. The detent lever 6 has an arm 6*a* which engages a projection 4*a* of the driving plate 4 when the driving plate is in a wound-up state. The other arm 6*b* of the detent lever 6 is engageable by an arm 9*a* of a release lever 9 which is rotatably supported on the baseplate by an axle 10 and is biased to rotate in a clockwise direction by a spring 11. A second arm 9*b* of the release lever 9 extends out through an opening 1*a* in the shutter case for operation of the release lever. It will be seen that by downward movement of the arm 9*b*, the release lever 9 is rotated in a counterclockwise direction against the bias of the spring 11 so as to bring the arm 9*a* of the release lever against the arm 6*b* of the detent lever 6 which is thereby rotated in a clockwise direction against the bias of its spring 8 to move the arm 6*a* out of engagement with the projection 4*a* of the driving plate 4 which is thereby released to be rotated in a clockwise direction by the spring 5.

A third arm 9*c* of the release lever 9 carries a pin 12 engageable with the spring contact blade 13 of an electric power source switch of a timing circuit of the shutter-operating mechanism. The contact blade 13 is biased by its own resilience to engage a fixed contact 14. However, when the release lever 9 is in the position shown in FIG. 1 with the arm 9*b* at the upper edge of the opening 1*a* in the shutter case 1, the pin 12 on arm 9*c* engages the contact blade 13 to hold it out of engagement with the contact 14.

Moreover, in the embodiment illustrated in FIG. 1, the contact blade 13 of the electric power source switch is engageable by a pin 17 on one arm of a disconnect lever 16 which is rotatably supported on the baseplate 2 by an axis 15. A pin 18 on the other end of the lever 16 engages a groove 19*a* of a speed-regulating ring 19 (shown in dot-dash lines) which is rotatable about an axis located centrally of the baseplate 2 to select the desired exposure time. In the position of the lever 16 and ring 19 shown in FIG. 1, the pin 17 on the lever 16 engages the spring contact blade 13 so that the blade will not contact the fixed contact 14 even when the release lever 9 is rotated in a counterclockwise direction to disengage the pin 12 from the contact blade 13. When the ring 19 is turned in a counterclockwise direction so that a radially outwardly inclined offset in the groove 19*a* passes the pin 18, the lever 16 is rotated in a clockwise direction so that the pin 17 is disengaged from the contact blade 13. The power source switch 13, 14 can then be closed by rotation of the release lever 9 in a counterclockwise direction to disengage the pin 12 from the contact blade 13.

The shutter comprises one or more sectors (not shown) which are driven in known manner by a shutter-operating ring 20 which is arranged at the back of the baseplate 2 and is rotatable about an axis located centrally of the baseplate. The shutter is opened by rotation of the ring 20 in a clockwise direction from the position shown in FIG. 1. The shutter opening and closing ring 20 is connected to the driving plate 4 by a driving hook 21 one end of which is pivotally connected to the driving plate by a pin 22. The opposite end of the driving hook 21 is provided with a recess or mouth 21*a* which receives a bent up lug 20*a* on the ring 20. A spring 23 acting between the pin 5*b* on the driving plate 4 and a pin on the driving hook 21 tends to swing the driving hook in a counterclockwise direction about the pivot pin 22 so as to maintain the mouth 21*a* in engagement with the lug 20*a*. Upon rotation of the driving plate 4 in a clockwise direction from the position shown in FIG. 1, motion is transmitted through the driving hook 21 to rotate the speed-regulating ring 20 in a clockwise direction and thereby open the shutter.

In order to provide different exposure times, means is provided for variably mechanically braking or retarding the driving plate 4 in a position where the shutter is fully open and for thereafter impeding the retarding means and thereby the driving plate 4 by an electrically operable member under control of a timing circuit. The mechanical braking means is shown as

comprising a retarding lever **24** and an inertia member in the form of a flywheel **29**. The lever **24** is rotatably supported on the baseplate by an axis **25** and is biased in clockwise direction by a spring **27** so as to bring the lever into engagement with a fixed pin **26**. A bent-up part **24***a* at one end of the retarding lever **24** is in the path of movement of a shoulder **4***b* on the driving plate **4** so as to be engaged by a shoulder **4***b* when the driving plate **4** has been rotated in a clockwise direction from the position shown in FIG. **1** sufficient to open the shutter. A slot **24***b* at the other end of the lever **24** engages a pin **29***a* on the flywheel **29** which is rotatably supported on the baseplate by an axis **28**. When the bent up part **24***a* of the lever **24** is engaged by the shoulder **4***b* of the driving plate **4**, the lever is rotated about its pivot **25** in a counterclockwise direction and, through the pin-and-slot connection **29***a*, **24***b*, rotates the flywheel **29** about its axis **28** in a clockwise direction. A pin **24***c* on the retarding lever **24** is engageable by a cam part **19***b* of the speed-regulating ring **19** so as to position the bent-up part **24***a* of the lever **24** in a position for full engagement by the shoulder **4***b* of the driving plate **4**, a position for lesser engagement by the shoulder and a position where it is out of the path of movement of the shoulder **4***b* and is hence not engaged.

Means for impeding rotation of the flywheel **29** and thereby, through the coupling provided by the lever **24**, impeding rotation of the driving plate **4** is shown as comprising a lock lever **30** which is rotatably mounted on the baseplate **2** to turn about an axis **31**. One end of the lock lever **30** is provided with an inclined cam face **30***a* which is engageable by a pin **29***b* carried by the flywheel **29**. The other arm **30***b* of the lock lever **30** is provided with a bent-up part **30***c* which serves as the armature for an electromagnet **32** shown as comprising a U-shaped core **32***a* and two coils **32***b*. The lever **30**, or at least the bent-up part **30***a*, is accordingly made of magnetic material. The lever **30** is biased in a counterclockwise direction by a spring **31***a* to a position in which the armature portion **30***c* is in contact with the core of the electromagnet **32** and the cam face **30***a* is in the path of movement of the pin **29***b* on the flywheel **29**. The inclination of the cam surface **30***a* is such that engagement by the pin **29***b* tends to swing the lever **30** in a clockwise direction so as to move the cam surface **30***a* out of the way of pin **29***b* and permit continued rotation of the flywheel **29** in a clockwise direction. The spring **31***a* is relatively weak so as to permit deflection of the lock lever **30** by the pin **29***b*. Hence when the electromagnet **32** is not energized, the flywheel **29** is momentarily impeded by engagement of the pin **29***b* with the cam surface **30***a*, but the lever **30** is them cammed out of the way so as to permit resumed or continued rotation of the flywheel. However, when the electromagnet **32** is energized, the lever **30** is held in the position shown in FIG. **1** so as to stop the flywheel **29** and thereby stop the driving plate **4** when the pin **29***b* engages the cam surface **20***a* of the lever **30**. When the electromagnet **32** is thereafter deenergized upon the elapse of a selected time determined by the setting of the timing circuit, the lever **30** is cammed out of the way of the pin **29** to permit further movement of the flywheel **29** and the driving plate **4** to close the shutter. A pin **30***d* on the lock lever **30** is engageable by a cam track **19***c* of the speed-regulating ring **19** so as to turn the lever **30** in a clockwise direction to move the cam surface **30***a* out of the path of movement of the pin **9***b* on the flywheel **29** when the speed-regulating ring **19** is turned in a clockwise direction from the position shown in FIG. **1**.

A pin **20***b* on the shutter-operating ring **20** is engageable with a spring contact blade **33** to hold the blade in contact with a fixed contact **34** of a timing switch when the ring **20** is in the position illustrated in FIG. **1** with the shutter closed. When the ring **20** starts to turn in a clockwise direction for opening of the shutter, the contact blade **33** is released to move away from the contact **34** and thereby open the switch, its movement being limited by a back contact **35**.

A two-armed sliding contact **36** on the speed-regulating ring **19** is engageable with contact surfaces **37** and a slipring segment **38** to control the delay provided by the timing circuit described below. An index **19***d* on the speed-regulating ring **19** indicates the exposure time in cooperation with an exposure time scale **39**.

The electromagnet **32** is controlled by an electronic timing circuit as illustrated in FIG. **2**. The timing circuit is shown as comprising two transistors T1 and T2. The electromagnet **32**, a power source **40**, the power source switch **13**, **14** and a resistance R1 are connected in series in the emitter-collector circuit of the transistor T1. The emitters of the two transistors are connected together and the base of the transistor T1 is connected to the collector of the transistor T2. A resistance R2 and one of a group of resistances R as selected by the slider **36** are connected in series in the base-collector circuit of the transistor T2. A capacitor C in parallel with the timing switch **33**, **34**, **35** is connected in series with the resistance R1 in the base-emitter circuit of the transistor T2. The resistances R and the condenser C form a delay circuit. The values of the capacitor C and the resistances R are selected to provide selected delay times according to the position of the slider **36**.

The shutter-operating mechanism illustrated by way of example in FIg. **1** in conjunction with the timing circuit shown in FIG. **2** is operable to provide 15 different exposure times ranging from 1/500 second to 32 seconds. With the shutter closed and the driving plate **4** in its wound-up condition, the release lever **9** is rotated in a counterclockwise direction by the arm **9***b* so as to rotate the detent lever **6** in a clockwise direction and thereby release the arm **6***a* from the shoulder **4***a* of the driving plate **4**. The driving plate **4** is thereby freed for rotation in a clockwise direction by its spring **5** so as to actuate the shutter-operating ring **20** through the driving hook **21** to open and then close the shutter. At a time when the shutter is open, the movement of the driving plate **4** is impeded by the mechanical braking and electronically controlled impeding mechanism comprising the retarding lever **24**, flywheel **29** and electromagnetically operated lever **30** controlled by the timing circuit shown in FIG. **2** to provide an exposure time selected by the position of the speed-regulating ring **19**.

For an exposure of 1/60 second the speed-regulating ring **19** is in the position shown in FIG. **1**. The pin **17** of lever **16** engages the contact blade **13** of the power source switch so that the switch is not closed by operation of the release lever **9** and hence the electromagnet is not energized. As the driving plate **4** runs in a clockwise direction after having been released by the release lever **9** and reaches a position where the shutter is opened, the shoulder **4***b* engages the bent-up part **24***a* of the lever **24** to rotate the lever **24** in a counterclockwise direction and thereby rotate the flywheel **29** in a clockwise direction. When the pin **29**b on the flywheel reaches the position as shown in dotted lines and designated **29***b'* it engages the inclined cam face **30***a* of the lock lever **30** which is thereby rotated in a clockwise direction, since the electromagnet **32** is not energized. Rotation of the driving plate **4** can thereupon continue after the delay caused by the inertia and frictional forces of the lever **24**, flywheel **29** and lever **30**.

When the speed-regulating ring **19** is set for an exposure time of 1/125 second, the lock lever **30** is rotated in a clockwise direction by engagement of the cam part **19***c* of the speed-regulating ring with pin **30***d* of the lock lever so that the inclined face **30***a* of the lock lever is moved out of the path of movement of the pin **29***b* on flywheel **29**. The inertial resistance to the running of the driving plate **4** is thereby reduced. WHen the speed-regulating lever is set for an exposure time of 1/250 second, the engagement of the bent-up part **24***a* of the retarding lever **24** with the shoulder **4***b* of the driving plate **4** is reduced by engagement of the cam part **19***b* of the speed-regulating ring **19** with the pin **24***c* to rotate the lever **24** a selected distance in a counterclockwise direction. For an exposure time of 1/500 second, the retarding lever **24** is rotated farther in a counterclockwise direction by a second step of the cam surface **19***b* so that the bent-up part **24***a* of the lever **24** is moved out of the path of movement of the shoulder **4***b* of the driving plate **4**. The driving plate **4** hence runs at maximum speed. It will be noted that for exposure times of

from 1/60 second to 1/500 second the power source switch 13, 14 is held open by the pin 17 on lever 16 under control of the groove 9*a* of the speed-regulating ring 19 so that the electromagnet is not energized.

For exposure times of from 1/30 second to 32 second, the initial positions of the retarding lever 24, fly wheel 29 and lock lever 30 are as illustrated in FIG. 1. However, the switch control lever 16 is rotated in a clockwise direction by a step in the groove 19*a* of the speed-regulating ring 19 so that the power source switch 13, 14 is closed when the release lever 9 is rotated in a counterclockwise direction to release the driving plate 4. This permits current to flow through the transistor T1 so that the electromagnet 32 is energized to hold the lock lever 30 in the position shown in FIG. 1. The operation of the riving plate 4, retarding lever 24 and flywheel 29 is the same as described for an exposure 1/60 second except that when the pin 29*b* of the flywheel reaches the position 29*b*′ it is stopped by the lock lever 30 since, due to the electromagnet 32 being energized, the lock lever 30 cannot be swung out of the way of the pin 29*b*.

When the shutter-operating ring 20 starts to move in a clockwise direction to open the shutter, the pin 20*b* is moved away from the contact blade 33 thereby permitting the blade by its resilience to move away from the contact 34. The timing switch 33, 34, 35, which initially shorted the condenser C, is thereby opened and accordingly the condenser proceeds to charge at a rate depending on the resistance R selected by the position of the slider 36 carried by the exposure time-selecting ring 19. When the condenser C is charged to a predetermined value, the transistor T2, which was initially nonconducting, becomes conducting whereupon, by reason of the feedback connections between the transistors, the transistor T1 becomes nonconducting so as to deenergize the electromagnet 32. When the electromagnet is deenergized, the pin 29*b* through its engagement with the inclined face 30*a* cams the lever 30 out of its path of movement so as to permit rotation of the driving plate 4 to proceed to termination of the exposure. The amount of delay provided depends on the charging rate of the condenser C as determined by the value of the resistance R selected by the position of the slider 36 on the speed-regulating ring 19 so as to engage one or another of the contact plates 37 to which the resistances are connected. In this manner the desired exposure time in the range from 1/30 second to 32 second is selected by the position of the speed-regulating ring 19.

In the embodiment shown in FIG. 3 the flywheel 29′ corresponding to the flywheel 29 of FIG. 1 comprises two circular discs 100 and 101 which are relatively rotatable about the axis 28. The circular disc 100 is connected to the retarding lever 24 by a pin 100*a* which is fixed to the disc 100 and engages the slot 24*b* of the lever 24. A pin 101*a* on the circular disc 101 is arranged in a circumferentially extending notch 100*b* in the disc 100 so as to permit limited rotary movement OF the disc relative to one another. Moreover, the pin 101*a* on the disc 101 is engageable with the inclined surface 30*a* of the lock lever 30 and thus corresponds to pin 29*b* shown in FIG. 1. The two disc are connected to each other by a spring 102 acting between pins 100*a* and 101*a* so as to hold the pin 101*a* against the forward edge of the notch 100*b*. Hence, when the pin 101*a* engages the lock lever 30, the impact is cushioned by the spring 102.

Another timing circuit is illustrated in FIG. 4. It differs from the circuit of FIG. 2 in the following respects. The negative pole of the power source 40 is connected to the contact 35 of the timing switch 33, 34, 35; a resistance R′ is added for use when an exposure time of 1/60 second is selected and the power source switch 13, 14 of FIG. 2 is omitted. With the timing circuit shown in FIG. 4 the parts numbered from 12 to 18 of the shutter-operating mechanism shown in FIG. 1 are not needed and the groove 19*a* of the speed-regulating ring 19 is also omitted. With this embodiment, when the shutter-operating ring 20 begins rotation, the contact blade 33 of the timing switch separates from the contact 34 and engages the contact 35 so that current flows through the electromagnet 32 and at the same time the charging of the condenser C begins. Hence, even when a long exposure time has been selected, there is no need to continue to press the release lever 9. The added resistance R′ is provided for an exposure time of 1/60 second. For exposures of 1/125 second and 1/500 second current can flow through the electromagnet 32 but this is of no effect since the lock lever 30 is held away from the electromagnet by the cam part 19c of the speed regulating ring 19.

In accordance with the invention the impeding mechanism 24, 29 and 30 acts as a mechanical braking device. For the exposure times in which the running of the driving plate 4 is controlled by the electronic delay circuit, the action of the electromagnet 32 is applied to a part where the impeding means has been speeded up so that it is possible to control the mechanism with relatively small electric power. Moreover, since there is a time delay between the closing of the power source switch and the engagement of the pin 29*b* on the flywheel 29 with the lock lever 30 and since the driving plate 4 has been initially retarded by the inertia of the retarding lever 24 and flywheel 29, there is adequate time for fully energizing the electromagnet 32 prior to engagement of the pin 29*b* with the lock lever 30. A further advantage of the construction in accordance with the invention is that since short exposure times are controlled mechanically, the number of parts required for the electronic timing circuit can be reduced. The construction in accordance with the invention is further applicable to a shutter in which the running of the shutter-driving mechanism is controlled by a preceding mechanism following the operation of the release lever. By suitably modifying the shape of the lock lever 30 the arrangement of the electromagnet and the electronic delay circuit, a control of the exposure time can be obtained by exciting the electromagnet after a selected delay time instead of by using an electromagnet of the sustaining type as described above. Still other modifications will be apparent to those skilled in the art.

What I claim and desire to secure by letters patent is:

1. In a shutter-operating mechanism, means for opening and closing the shutter, driving means for actuating said shutter-opening-and-closing means, means for releasing said driving means to initiate its running to open and close the shutter, means for variable mechanically retarding said driving means when the shutter is open including an inertia member driven by said driving means, electrically operable means for thereafter impeding said inertia member, a timing circuit controlling said impeding means, and exposure time selecting means including means for varying the mechanical retarding of said driving means by said mechanical retarding means to provide a first range of shorter exposure times and circuit means for varying the time of operation of said electrically operable impeding means under control of said timing circuit to provide a second range of longer exposure times.

2. Shutter-operating mechanism according to claim 1, in which said timing circuit contains switch means controlled by releasing means and by said exposure time selecting means.

3. Shutter-operating mechanism according to claim 1, in which said circuit includes a timing switch operable by said shutter opening and closing means to initiate a timing operation of said circuit, and in which said retarding means retards the operation of said driving means a selected interval to afford time for said impeding means to operate.

Shutter-operating mechanism according to claim 1, in which said inertia member comprises a flywheel rotationally driven by said driving means.

5. Shutter-operating mechanism according to claim 4, in which said impeding means is engageable with an abutment on said flywheel to impede its rotation.

6. Shutter-operating mechanism according to claim 5, in which said impeding means comprises an electromagnetically actuated lever having a cam surface engageable by said abutment on said flywheel.

7. Shutter-operating mechanism according to claim 4, in which said driving means comprises a rotary driving member.

8. Shutter-operating mechanism according to claim 7, comprising a pivoted lever engageable by an abutment on said driving wheel to swing said lever about its pivot and engaging a pin on said flywheel to rotate said flywheel.

9. Shutter-operating mechanism according to claim 8, in which said exposure time-selecting means includes means selectively varying the engagement of said lever by said abutment on said driving wheel to vary the retarding of said driving wheel by said retarding means.

10. Shutter-operating mechanism according to claim 4, in which said impeding means includes an electromagnetically operated lever engageable by an abutment on said flywheel,

and in which said exposure time-selecting means comprises cam means for moving said lever out of the path of movement of said abutment.

11. Shutter-operating mechanism according to claim 1, in which said timing circuit comprises a switch and variable resistance, and in which said exposure time-selecting means comprises means controlling operation of said switch, means for varying said resistance, means for varying the retarding action of said retarding means on said driving means, and means for incapacitating said impeding means.

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