

PATENT SPECIFICATION

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(54) SHUTTER CONTROL FOR A CINEMATOGRAPHIC CAMERA

(71) We, BOLEX INTERNATIONAL S.A. of 18, avenue des Alpes, CH-1450 STE-CROIX, Switzerland, a Swiss Company, 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:—

10 In the drive device of certain mechanisms, it is sometimes desirable that the stop position should be well determined and remain constant. Such a requirement is notably essential in cameras taking cinematographic pictures in which the shutter must be closed when the camera is stopped after filming of a sequence.

The present invention provides a cine camera having a motor and an electrical energisation circuit therefor, a shutter driven by the motor, a manually controllable element having an operating position at which the motor is energised at the beginning of a film-taking sequence and a rest position to which it is moved to terminate a film taking sequence; a motor braking system energised to decelerate the motor on movement of the element from its operating position to its rest position; a latching mechanism movable between three states in the first of which it locks the motor in a position in which the shutter is closed, in the second of which it allows the motor to rotate during braking until the mechanism can assume its first state and lock the motor in the position in which the shutter is closed and the third state of the mechanism being one in which it allows unimpeded rotation of the motor; and a control circuit responsive to movement of the element from its operating position to its rest position to operate the braking system and to move the latching mechanism from its third state to its second state.

45 The invention will now be described in [Price 33p]

more detail, by way of example only, with reference to the accompanying diagrammatic drawings, in which:—

FIGURE 1 is a diagram showing one embodiment of a cine camera according to the invention;

FIGURE 2 is the diagram showing a second embodiment of a cine camera according to the invention; and,

FIGURE 3 is a diagram showing graphically the operation of the cine cameras used in Figures 1 and 2.

Referring to Figure 1, a motor 1 having a permanent magnet rotor is energised during picture taking, when the trigger contact 2 fixed on the handle (not shown) of the camera is engaged. The motor shaft drives a rotatable shutter 3 which intermittently masks a picture taking window 4; a first disc 5 provided with a notch 7; a second disc 8 provided with a notch 9; and a third disc 10 provided with a series of notches 11 arranged regularly along part of the circumference.

A position detector is formed by an incandescent lamp 12, and a phototransistor 13 connected to the input of a controller provided by a control circuit 14, the notched portion 7 of the disc 5 being arranged to pass through the optical path between the lamp and phototransistor as the disc rotates.

A tachometer is formed by an incandescent light source 15, the notched portion of the disc 10, and a phototransistor 16 which is connected to one of the inputs of a control circuit 17 for monitoring and controlling the speed of the motor 1.

A latching mechanism for the motor is provided by the combination of the notch 9 of the disc 8 which cooperates with a pawl provided by a lug 18 of a lever 19 for locking the motor in its 'stop' or rest position. When the notch 9 is locked by the lug 18, the shutter 3 masks the picture

taking window 4. The lever 19 is biased by a spring 20 which urges the lug 18 towards the notched rim of the disc 8 and is also subject to the control of an electromagnet 21 connected to the control circuit 14 and which, when energised, frees the lug 18 from the notch 9. A pair of contacts 22 connected mechanically to the lever 19 completes an earth return circuit to the control circuit 14 when the contact pair is closed.

Motor terminals A and B are interconnected through a collector-emitter circuit of a transistor 23 whose base is connected to the output of a braking circuit 24. The input of the braking circuit 24 is connected to the control circuit 14.

The operation of the circuit of Figure 1 will now be described.

Turning now to Figure 3, curve I represents the speed of the motor; curve II represents the electricity supply of the motor; curve III shows the position of the trigger contact 2; curve IV represents the signal emitted by the photo transistor 13; curve V represents the curve of the braking circuit; curve VI shows the energisation of the electromagnet 21; and, curve VII shows the movement of the locking lever 19.

In Figure 1, the braking cycle of the motor is carried out by short circuiting the terminals A and B via the transistor 23. The curve of the speed of the motor shown in Figure 3 I, may be considered as being divided up into six parts *a* to *f* of which parts *a* and *f* correspond to the rest periods of the motor occurring before and after the taking of a sequence of pictures. Part *b* corresponds to the period in which the motor accelerates from zero to its normal operating speed, Part *c* corresponds to the taking of picture frames corresponding to the desired sequence, the motor rotating at its normal speed. Part *d* corresponds to a reduction in speed due to short-circuit braking of the motor. Finally part *e* corresponds to locking of the motor rotor which is possible when the motor speed has been sufficiently reduced.

The sequence of operation is as follows:— When the camera is in the rest state, the motor 1 is locked in its stop position by the lug 18 of the lever 19 which is pressed by the spring 20 into engagement with the notch 9 of the disc 8 and the electromagnet is not supplied with current. When the camera contact trigger is depressed (Figure 3, curve III), the electromagnet is supplied with current (Figure 3, curve VI) and the lever 19 is attracted by the electromagnet against the bias of the spring 20. As long as the motor is not supplied with current, it remains in its rest position. It is only after the removal of the lug 18 from the notch 9 that the motor begins to be

supplied with current, as a result of closing the pair of contacts 22 by movement of the lever 19 (Figure 3, curve II). From this moment it is possible to reduce the supply current to the electromagnet so as to be sparing on the batteries. In Figure 3, curve VI line *i* shows the current necessary to attract the lever and line *j* shows the current necessary to hold the lever in its position shown in Figure 2.

During the whole of the length of the picture taking sequence, that is to say during the time corresponding to the part *c* of the speed curve I, the control circuit 14 receives pulses from the photoelectric diode 13, but only acts on them when the trigger of contact 2 is released. These pulses are shown as broken-outline pulses on the curve IV of Figure 3. During the same period corresponding to the normal functioning of the camera, the control circuit 17 receives the pulses transmitted by the tachometer 10, and adjusts the speed of the motor to a rigorously constant value.

The transistor 23 of which the base is connected to the output of the braking circuit 24 is at this time in the non-conductive state and the motor has terminal B earthed, and is supplied at terminal A by the current from the control circuit 17.

At the end of the picture taking sequence, the trigger is released, and contacts 2 are opened. This corresponds to the point *k* of the curve III (Figure 3). The supply current for the motor is nevertheless maintained until the next pulse from the position detector 5 is received by the control circuit 14. When this occurs the supply current to the electromagnet 21 ceases. The lever 19 rocks under the action of the spring 20 and the lug 18 abuts the rim of the disc 8 (Figure 3, curves VI and VII). This causes the pair of contacts 22 to open to cut off the supply current to the motor (Figure 3 curve II).

At the same time braking circuit 24 is caused by the control circuit 14 to remove the "off" biasing voltage from the base of the transistor 23 which therefor becomes conductive and short circuits the terminals A and B of the motor 1 causing the speed to decrease rapidly. The triggering of the braking circuit and the fall of speed of the motor are shown respectively by the curves V and I (*d*) of Figure 3.

When the speed of the motor has decreased sufficiently for the locking mechanism to operate without damage, the lug 18 engages in the notch 9 and stops the motor in the predetermined stopping position, in which the shutter 3 masks the picture taking window 4.

In the embodiment shown in Figure 2 parts corresponding to those described with reference to Figure 1 are correspondingly numbered and will not be again described.

In Figure 2 the camera drive motor 1 has its supply terminals A and B connected to the collectors of four transistors 25 and 25' arranged in two diagonal pairs in bridge formation. The bases S and T of transistor pair 25 are connected to respective outputs of a first signal inverter 26 while the bases X and Y of transistor pair 25' are connected to the outputs of a second signal inverter 27. As in the case of Figure 1, the control circuit 14 is connected to the trigger contact 2 and to a position detector 5' which is shown simply as a box but can be formed, as described in Figure 1, as a disc provided with a peripheral notch and which is driven by the camera motor to bring the notch between a light source and a photo transistor. The control circuit 14 likewise controls energisation of an electromagnet 21 which behaves similarly to that shown in Figure 1, the control circuit 14 being influenced by closure of a contact pair 22 mechanically opened and closed in accordance with the position of a lever 19 as has already been described. The circuit 14 is additionally connected to control a speed control circuit 17 and to influence a gating circuit 28. The speed control circuit 17 receives additionally a signal from the control tachometer 10 which can, as described with reference to Figure 1, be formed by a disc provided with a series of notches regularly arranged around a portion of its periphery and which cooperate with an incandescent light source and a phototransistor to produce control pulses. The control tachometer is also connected to the input of an amplifier 30 connected to a pulse shaping circuit 29 for the pulses transmitted by the tachometer 10 and amplified by the amplifier 30. The signal from the output of the pulse shaping circuit 29 is transmitted through the intermediary of the gating circuit 28 to the second signal inverter 27 and applied to the bases X and Y of transistors 25'.

In operation of the circuit shown in Figure 2, the braking cycle of the motor is carried out by a countercurrent applied between the terminals A and B and tending to turn the motor in the opposite sense to its normal rotational direction.

Only the operation of the parts fundamentally different from those which form the device of Figure 1 will be described in detail.

Under normal operating conditions when the camera is in use, the tachometer 10 supplies a signal transmitted to the speed control circuit 17 which provides a corresponding output signal to the first signal inverter 26. The two outputs of the signal inverter 26 are connected to the bases S and T of transistor pair 25 which are normally in the conductive state to provide the motor

with current from the diagonal branch S-T of the transistor bridge.

When the braking sequence commences, the signal from the tachometer 10 is sent via amplifier 30 and pulse shaping circuit 29 to the gating circuit 28 which is opened by the control circuit 14, to the second signal inverter 27 for which the terminals of the output are connected to bases X and Y of transistor pair 25'. These transistors have their collectors connected to terminals A and B of the motor. The transistors 25 are switched to their non-conductive state by the control circuit 14 at the commencement of the braking sequence, and the motor 1 is supplied by the diagonal branch X-Y of the bridge. The control of the gating circuit and the speed control circuit 17 by the control circuit 14 avoids the motor being supplied simultaneously by the two circuits. The current supplied to the motor 1 by the transistor pair 25' flows in the opposite sense to that provided by the transistor pair 25 so that the motor is braked rapidly.

In order to provide a more efficient and rapid braking, it is desirable to provide the motor with a continuous current supply. This could be done by integrating the signal from the tachometer 10. The disadvantage of such an integration is that the supply of the motor is zero at the moment when the tachometer transmits the zero signal, which would cause the motor to start in the wrong direction.

To overcome this disadvantage, the motor is supplied by rectangular pulses, so that the interval between two successive pulses is very short in relation to the length of a pulse.

WHAT WE CLAIM IS:—

1. A cine camera having a motor and an electrical energisation circuit therefor, a shutter driven by the motor, a manually controllable element having an operating position at which the motor is energised at the beginning of a film-taking sequence and a rest position to which it is moved to terminate a film taking sequence; a motor braking system energised to decelerate the motor on movement of the element from its operating position to its rest position; a latching mechanism movable between three states in the first of which it locks the motor in a position in which the shutter is closed, in the second of which it allows the motor to rotate during braking until the mechanism can assume its first state and lock the motor in the position in which the shutter is closed and the third state of the mechanism being one in which it allows unimpeded rotation of the motor; and a control circuit responsive to movement of the element from its operating position to its rest position to operate the braking system and

In Figure 2 the camera drive motor 1 has its supply terminals A and B connected to the collectors of four transistors 25 and 25' arranged in two diagonal pairs in bridge formation. The bases S and T of transistor pair 25 are connected to respective outputs of a first signal inverter 26 while the bases X and Y of transistor pair 25' are connected to the outputs of a second signal inverter 27. As in the case of Figure 1, the control circuit 14 is connected to the trigger contact 2 and to a position detector 5' which is shown simply as a box but can be formed, as described in Figure 1, as a disc provided with a peripheral notch and which is driven by the camera motor to bring the notch between a light source and a photo transistor. The control circuit 14 likewise controls energisation of an electromagnet 21 which behaves similarly to that shown in Figure 1, the control circuit 14 being influenced by closure of a contact pair 22 mechanically opened and closed in accordance with the position of a lever 19 as has already been described. The circuit 14 is additionally connected to control a speed control circuit 17 and to influence a gating circuit 28. The speed control circuit 17 receives additionally a signal from the control tachometer 10 which can, as described with reference to Figure 1, be formed by a disc provided with a series of notches regularly arranged around a portion of its periphery and which cooperate with an incandescent light source and a phototransistor to produce control pulses. The control tachometer is also connected to the input of an amplifier 30 connected to a pulse shaping circuit 29 for the pulses transmitted by the tachometer 10 and amplified by the amplifier 30. The signal from the output of the pulse shaping circuit 29 is transmitted through the intermediary of the gating circuit 28 to the second signal inverter 27 and applied to the bases X and Y of transistors 25'.

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In order to provide a more efficient and rapid braking, it is desirable to provide the motor with a continuous current supply. This could be done by integrating the signal from the tachometer 10. The disadvantage of such an integration is that the supply of the motor is zero at the moment when the tachometer transmits the zero signal, which would cause the motor to start in the wrong direction.

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WHAT WE CLAIM IS:—

1. A cine camera having a motor and an electrical energisation circuit therefor, a shutter driven by the motor, a manually controllable element having an operating position at which the motor is energised at the beginning of a film-taking sequence and a rest position to which it is moved to terminate a film taking sequence; a motor braking system energised to decelerate the motor on movement of the element from its operating position to its rest position; a latching mechanism movable between three states in the first of which it locks the motor in a position in which the shutter is closed, in the second of which it allows the motor to rotate during braking until the mechanism can assume its first state and lock the motor in the position in which the shutter is closed and the third state of the mechanism being one in which it allows unimpeded rotation of the motor; and a control circuit responsive to movement of the element from its operating position to its rest position to operate the braking system and



to move the latching mechanism from its third state to its second state.

2. A camera as claimed in claim 1, in which the latching mechanism comprises a pawl resiliently urged towards the rim of a notched disc rotated by the motor, the engagement of the pawl with the rim notch corresponding to the first state, the bearing of the pawl on the disc rim corresponding to the second state, and the retention of the pawl away from the notched rim corresponding to the third state.

3. A camera as claimed in claim 2, in which an electromagnet having an energisation circuit controlled by the control circuit is used to retain the pawl in its third state.

4. A camera as claimed in claim 2 or claim 3, in which the pawl comprises a lever hinged at one end, biased by a spring intermediate its ends, and provided with a lug at its other end for engaging in the disc notch.

5. A camera as claimed in any one of the preceding claims, in which the motor drives a tachometer disc whose marginal edge is formed with apertures which pass between a light source and a photocell to provide from the latter pulse signals fed to a further control circuit and for respectively controlling the rotational speed of the motor.

6. A camera as claimed in any one of the preceding claims in which the braking system operates by short circuiting the current circuit through the motor.

7. A camera as claimed in claim 6, including an electronic switch connected between the motor energisation terminals and switchable between a non-conducting condition and a conducting condition by an electrical biasing signal obtained from the control circuit.

8. A camera as claimed in claim 6 or

claim 7, in which the motor drives a disc whose marginal edge is formed with an aperture which passes between a light source and a photocell connected to the control circuit only when the shutter is in its closed position, the control circuit only de-energising the motor electrical energisation circuit when the photocell is illuminated momentarily by the light source.

9. A camera as claimed in any one of claims 1 to 5, in which the motor electrical energisation circuit is connected between the diagonals of an electrical bridge circuit having each of its four arms containing an electronic switch, the diagonally opposite arms forming two selectively closable pairs of switches one of which closes to pass a current in one direction through the motor to drive it in one direction during a film-taking sequence, and the other pair closes only during braking to pass a current in the opposite direction through the motor so as to brake it.

10. A camera as claimed in claim 9, in which the motor drives a disc whose marginal edge is formed with an aperture which passes between a light source and a photocell connected to the control circuit only when the shutter is in the closed position, the control circuit only reversing the current to the motor electrical energisation circuit when the photocell is illuminated momentarily by the light source.

11. A cine camera arranged and adapted to operate substantially as described with reference to Figures 1 and 3 of the accompanying drawings.

12. A camera as claimed in claim 11, modified substantially as described with reference to Figure 2 of the accompanying drawings.

MARKS & CLERK



* C L M S *