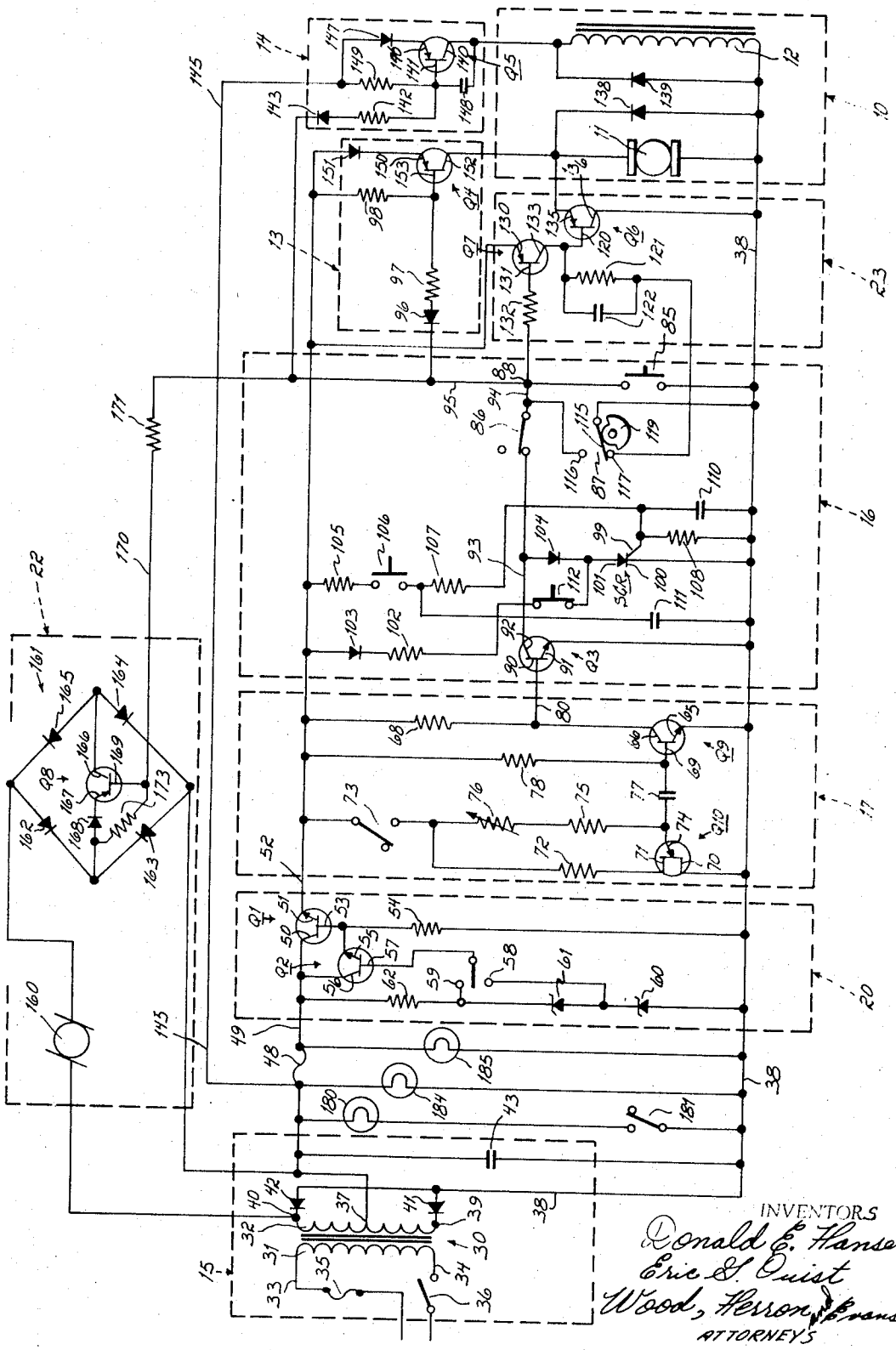
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CAMERA CONTROL CIRCUIT

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CAMERA CONTROL CIRCUIT

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ABSTRACT OF THE DISCLOSURE

A motor controlled circuit for automatically advancing, on a continuous or intermittent basis, film in a camera of the type used in photographic security and surveillance systems, including a motor having armature and field windings and having a driven element connectable in driving relationship with the camera film advancing mechanism; selectively operable transistor switches interconnecting a source of potential with the armature and field windings for selectively causing current to flow through the windings to energize the motor to advance the film; a control signal generator for producing pulse-type or continuous signals for controlling the conduction of the transistor switches to thereby regulate the flow of current through the windings; an armature brake circuit including a transistor adapted to selectively short-circuit the armature winding when the potential source is effectively disconnected from the armature winding; and a delay circuit connected to the transistor switch associated with the field winding for delaying the nonconduction of the field winding transistor switch for a brief interval subsequent to disconnection of the potential source and the armature winding to thereby enhance braking action.

This invention relates to the field of motor control and more particularly to motor control circuitry for automatically advancing, or sequencing, film in a camera of the type used in photographic security and surveillance systems.

Photographic security and surveillance systems of the type in which this invention finds particular utility are used extensively in protecting business establishments such as banks, vaults, armored car depots, and other places which, because of the storage of large amounts of money, are frequently the subject of armed robberies. These systems generally include as their principal component one or more cameras strategically located at various positions throughout the area to be protected. For example, in a bank it is common to provide cameras at locations suitable for photographing activity in the vicinity of the bank entrance, the vault, and the various tellers' cages. In this manner, people entering and leaving the bank, those approaching the teller's cage, and those near the vault area are subject to being photographed.

It has been found that the changes of apprehending one who has robbed a bank, armored car depot, or other such protected establishment are greatly increased by reason of the photographs of the robber's identity which are provided by cameras of this type. The photographs constitute a clear and unequivocal record of the robber's identity and activity, and can be enlarged and duplicated for distribution to the police, newspapers, and other groups which, directly or indirectly, aid in apprehending the robber.

However, since not all persons entering and leaving a bank or approaching a teller's cage intend to commit robbery, it is not necessary, nor desirable from a practical standpoint, that all such persons have their identity and

activities photographically recorded. These photographic security and surveillance systems usually have, therefore, as a further principal component, control means for selectively operating the camera. Typically, the control means has two modes of operation. In one mode, called the "alert" mode, the control means functions to feed the film through the camera on an intermittent basis as, for example, at a rate of one frame every two seconds. This permits the recording of activity on a periodic, or noncontinuous, basis. Such recording is adequate when it is desired only to record the activity of persons who, while not engaged in the actual perpetration of a robbery, raise suspicion on other grounds, such as, by loitering in a bank lobby or vault area. Generally, a guard stationed in the bank lobby or vault area can, by unobstrusively actuating a suitably located switch, initiate operation of the camera in the alert mode without the knowledge of the individual being photographically monitored, thereby providing a record of the person's activity uninhibited by the knowledge that he is under surveillance.

In the other mode, termed the "alarm" mode, the camera control means functions to feed the film through the camera on a continuous basis, as for example, at a rate of four or eight frames per second, thereby enabling a continuous record of activity to be generated. Such continuous monitoring is desirable for example, during the actual progress of a bank robbery. To permit the initiation of camera operation in this mode, a foot-operated switch is usually provided in the teller's cage. The switch allows the teller to actuate the camera unbeknown to the robber, thereby initiating, without fear of reprisal, camera operation in the continuous or alarm mode.

One of the principal problems with the prior art camera control systems is that they have not afforded a sufficient degree of compactness, reliability, and simplicity. For example, many of the prior art systems employ relatively complex electromechanical control components, such as clocks and stepping devices, for intermittently advancing the film. These devices are difficult to maintain, have high initial cost, and do not afford the compactness, simplicity and reliability desired by present day users.

It has, therefore, been a principal objective of this invention to provide a compact and smplified camera control system having a minimum number of moving parts. This objective has been achieved in the preferred embodiment of this invention by employing a fundamentally different approach to camera control design in which the film advancing mechanism of the camera is driven by a selectively operable motor under the alternative control of electronic pulse generating and latching circuits. More specifically, this objective is achieved by interconnecting in the control circuit of a camera motor, such as in the motor armature circuit, a selectively operable switch for energizing the armature winding and, in turn, operating the camera motor and advancing the film. This selectively operable switch is responsive to the outputs of the pulse generating and the latching circuits, producing, respectively, intermittent and continuous motor operation and film advancement characteristic of the alert and alarm modes.

It has been a further principal objective of this invention to provide a camera motor control circuit which permits the rate of film advancement to be readily varied when the camera is in the continuous or alarm mode. This objective has been accomplished in the preferred embodiment of the invention by the novel and unobvious inclusion of a multilevel voltage regulator in the armature winding portion of the control circuit. The regulator is capable of selectively applying different voltages to the motor armature winding for producing varous motor and frame speeds.

An additional objective of this invention has been to provide a camera control circuit having means, operable when the camera is in the intermittent or alert mode, for quickly arresting motor rotation after each frame advancement cycle. In the preferred embodiment of this invention this objective has been accomplished by utilizing a unique braking arrangement in which a selectively operable short-circuiting switch is connected in parallel with the armature winding. The switch is responsive to the pulse generator and effectively short-circuits the armature winding after each frame advancing cycle, quickly dissipating the kinetic energy of the motor and bring it abruptly to rest.

These and other objects and advantages of the invention will be more readily apparent from a consideration of the following detailed description of the drawing showing a preferred schematic circuit diagram of the various components of a camera motor control circuit constructed in accordance with the principles of this invention.

GENERAL DESCRIPTION

The prefererd embodiment of the invention, as shown more particularly in the drawing, includes a motor **10** having an armature winding **11** and a field winding **12**. In a preferred use, the motor **10** is coupled to the film advancing mechanism of a camera (not shown) by suitable drive means in a manner disclosed in the copending application of Warren D. Novak, for Sequence Camera, filed Sept. 30, 1966, Ser. No. 583,295. Energization of the motor **10** for selectively powering the film advancing mechanism of the camera is controlled by a field switch **14** and an armature switch **13**. The switches **14** and **13** are connected in circuit arrangement between a power supply **15** and the motor field and armature windings **12** and **11**, respectively, and function to alternately connect and disconnect the power supply **15** from the motor field and armature windings **12** and **11**, respectively, in response to switching signals generated by a switch control circuit **16**. By varying the format of the switching signals, a variety of modes of motor operation are possible.

A selectively operable pulse generator **17**, which constitutes one input to the switch control circuit **16**, is included in the preferred embodiment of the invention for providing a periodic, or intermittent, switching signal format for producing intermittent motor operation. Specifically, the pulse generator **17** produces automatic intermittent operation of the field and armature switches **13** and **14**, in turn intermittently energizing the motor windings **12** and **11**, respectively, to thereby produce automatic operation of the motor and film advancing mechanism on a frame-by-frame basis. A camera drive motor brake circuit **23**, also included in the preferred embodiment, functions to arrest the motion of the motor at the end of each film frame advancing cycle.

By latching the switch control circuit **16** it is possible to continuously operate the motor **10**, providing uninterrupted operation of the film advancing mechanism. A bilevel series voltage regulator **20** is provided for supplying two different voltages for application to the armature winding **11** to thereby afford two different motor speeds such as, for example, four frames per second and eight frames per second, when the circuit is operated in the continuous mode.

A footage indicator control **22**, which is also responsive to the switch control circuit **16**, is included to provide a visual indication of the number of feet of unexposed film remaining in the camera. The footage indicator operates in synchronism with the motor **10**.

DETAILED DESCRIPTION

The power supply **15**, more particularly, includes a center tapped step-down transformer **30** having a primary winding **31**, and a secondary winding **32**. The primary winding **31** is connected across a suitable source of alternating current potential (not shown) via lines **33** and **34**. Connected in line **33** is a fuse **35** for protecting the power supply **15** against damaging over-currents. Connected in line **34** is an on-off switch **36** for controlling the energization of the power supply **15**. A center tap **37** of the secondary winding **32** provides the positive output of the step-down transformer **30**, the negative output being taken at line **38** which is connected to both of the secondary winding terminals **39** and **40** via rectifying diodes **41** and **42**, respectively. A filtering capacitor **43** connected across the center tap **37** and the negative line **38** is provided to smooth the rectified output voltage. Thus, with the primary winding **31** of the transformer **30** connected to a suitable source of alternating current and the switch **36** in the closed position, unregulated direct current is available across the positive center tap **37** and the negative line **38**.

The bilevel voltage regulator **20** provides regulation of the direct current output from the power supply **15**, the regulator having one terminal connected directly to the negative line **38** and the other terminal connected to the positive center tap **37** via a fuse **48** and a line **49**. The fuse protects the remainder of the circuit from damage due to overcurrents. The regulator **20** includes a pair of emitter-follower transistors Q–**1** and Q–**2**. The transistor Q–**1** has a collector **50** connected to the positive line **49**, an emitter **51** connected to a line **52** forming the positive output of the regulator **20**, and a base **53** connected to the negative line **38** via a biasing resistor **54** and to the emitter **55** of the transistor Q–**2**. The transistor Q–**2** further includes a collector **56** connected in common with the collector **50** of the transistor Q–**1** to the positive line **49**, and a base **57** alternately connectable to terminals **58** and **59** maintained at different fixed potentials corresponding, for example, to the four frame and eight frame per second film rates, respectively. The terminals **58** and **59** constitute different tap points of a voltage divider network connected across lines **38** and **49**. The divider includes a pair of series connected Zener diodes **60** and **61** and a current limiting resistor **62**.

In operation, assuming that the potential difference between lines **49** and **38** exceeds the sum of the break-down potentials of Zener diodes **60** and **61**, the Zener diodes **60** and **61**, will be continuously operated in a break-down condition with resistor **62** limiting the current and thereby preventing diode destruction. With the Zener diodes operated in the break-down region, substantially constant voltages are maintained thereacross, providing at terminal **58** a relatively fixed voltage corresponding to the break-down voltage of Zener diode **60** and at terminal **59** a relatively fixed voltage corresponding to the sum of the break-down voltages of Zener diodes **60** and **61**. Depending on the film frame rate of advancement desired, one or the other of terminals **58** or **59** is connected to the base **57** of transistor Q–**2**. Since the transistor Q–**2** is connected in an emitter-follower configuration, the output of transistor Q–**2** taken at the emitter **55** is a function of the input to transistor Q–**2** at the base **57**. Since the input to the base **57** is at either of two constant reference potentials, the emitter **55** of transistor Q–**2** will be at either one of two fixed potentials. With a fixed potential input to the base **52** of transistor Q–**1**, a fixed output potential input to the base **52** of transistor Q–**1**, a fixed output potential is present on the emitter **51** of transistor Q–**1** inasmuch as transistor Q–**1** is also connected in an emitter-follower configuration. Hence, the output line **52** of the regulator **20**, being in reality the emitter potential of transistor Q–**1**, is independent of the collector potential **50**, which in reality is the input to the regulator on line **49**. Stated differently, the regulator output on line **52** is independent of the regulator input on line **49**, the regulator output on line **52** being a function only of the particular one of the reference voltage terminals **58** or **59** connected to the base **57** of transistor Q–**2**.

The pulse generator **17** is connected across the regulated direct current lines **52** and **38**, and includes a tran-

sistor Q–9 and a uni-junction transistor Q–10. The transistor Q–9 has an emitter 65 connected directly to the negative line 38, a collector 66 connected to the positive line 52 via a load resistor 68, and a base 69. The uni-junction transistor Q–10 has a first base element 70 connected directly to the negative line 38 and a second base element 71 connected to the positive line 52 via a load resistor 72 and a normally open switch 73. The uni-junction transistor Q–10 further includes an emitter 74 connected to the positive line 52 via the switch 73 and a pair of series connected resistors 75 and 76. A capacitor 77 is connected between the base 69 of transistor Q–9 and the emitter 74 of uni-junction transistor Q–10. The charge path of the capacitor 77 includes the variable resistor 76, the resistance of which can be varied to alter the charge time, and the base 69 and emitter 65 of uni-junction transistor Q–10. The discharge path of the capacitor 77 includes a resistor 78 connected between the positive line 52 and the emitter 74 of the uni-junction transistor Q–10. The resistance of resistor 78 in part establishes the discharge time of the capacitor 77.

In operation, with switch 73 closed, the generator 17 produces pulses on generator output line 80, the spacing of which is controlled by the resistor 76 in a manner to become evident hereafter. Until the capacitor 77 charges through switch 73 and resistors 75 and 76 to the triggering level of the uni-junction transistor Q–10, the transistor Q–9 is biased into conduction producing on line 80 a low level output which is substantially equal to the potential of line 38 due to the negligible emitter-collector voltage drop of conducting transistor Q–9. This low level output on line 80 corresponds to the pulse base, that is, to the potential corresponding to the space between pulse peaks. The duration of this low level output which constitutes the pulse spacing, is dependent upon the duration of transistor conduction, which in turn is dependent on the charge time of the capacitor 77, which in turn is dependent upon the resistance of the capacitor charge path. Since the capacitor charge path includes the variable resistor 76, the charge time of the capacitor 77, and, hence the pulse spacing, can be varied by merely altering the resistance of the resistor 76.

When the capacitor 77 has charged, in accordance with the polarities shown, to the triggering level of the uni-junction transistor Q–10, the uni-junction transistor Q–10 fires. This allows the capacitor 77 to discharge through the uni-junction transistor for a period determined by the resistance in the capacitor discharge path which includes the emitter-base resistance of the forward biased junction formed by base 70 and emitter 74, and the resistor 78. During the period of capacitor discharge and uni-junction transistor Q–10 conduction, current is shunted from the base 69 of the transistor Q–9, driving transistor Q–9 into cut-off. With transistor Q–9 in cut-off the potential on the collector 66 rises, raising the signal on generator output line 80 to a level corresponding to the pulse peak. The width of the pulse peak, which corresponds to the period of transistor Q–9 nonconduction and uni-junction transistor Q–10 conduction, is substantially constant inasmuch as the resistance of the capacitor discharge path, which controls uni-junction conduction, and, hence, transistor nonconduction, is constant. When the capacitor 77 has fully discharged, the uni-junction transistor Q–10 is driven into cut-off once again allowing the transistor Q–9 to conduct, producing on output line 80 the low level signal corresponding to the pulse space. Thus, with switch 73 closed, pulses are continuously produced on generator output line 80 having a substantially constant pulse width and a variable pulse spacing dependent upon the setting of resistor 76. In practice, pulse widths of 200 milliseconds and pulse spacings of two seconds have been found to be satisfactory.

The switch control circuit 16 includes a transistor Q–3, a silicon controlled rectifier SCR, a test switch 85, an end of film switch 86, and a microswitch 87. All of these circuit components, under varying conditions to be described, connect a source of control potential, namely, the negative line 38, to a junction 88 constituting the output terminal of the switch control circuit, producing switching control signals operative to control the footage indicator 22, the field and armature switches 13 and 14, and the camera motor brake 23.

The transistor Q–3 has a base 90 connected to the output line 80 of the pulse generator 17, and an emitter 91 connected directly to the negative line 38. The transistor Q–3 further includes a collector 92 connected to the positive line 52 via a line 93, the normally closed end of film switch 86, lines 94 and 95, a diode 96, and resistors 97 and resistor 98. The collector 92 of the transistor Q–3 is also connected via line 93, normally closed end of film switch 86, and line 94 to the output junction 88. Providing the end of film switch is closed, the transistor Q–3, each time it is driven into saturation in response to a positive pulse on line 80 output from the generator 17, effectively couples the negative line 38 to the line 94, providing at junction 88 a negative output for actuating the footage indicator 22, the field and armature switches 13 and 14, and the brake 23.

The SCR includes a cathode 100 connected directly to the negative line 38 and an anode 101 connected to the positive line 52 via a normally closed switch 112, a resistor 102, and a diode 103. The anode 101 of the SCR is also connected to the positive line 52 via a diode 104, the switch 86, lines 94 and line 95, diode 96, and resistors 97 and 98. A triggering circuit for the SCR, which is connected between the positive line 52, the negative line 38, and the SCR gate 99, is provided. The triggering circuit includes the series connected, current-limiting resistor 105, a normally open switch 106 for turning on the SCR, and resistors 107 and 108. The normally closed switch 112 connected between the SCR anode and the resistor 102 provides a means for turning off the SCR.

The resistors 107 and 108, in addition to providing a divider for triggering the SCR when the switch 106 is closed, also act as an attenuator for transients, thereby avoiding false triggering of the SCR. A capacitor 110 connected in parallel with the resistor 108 forms, in conjunction with the resistor 108, an RC filter network for transient suppression. Likewise, a capacitor 111 connected between the negative line 38 and the junction of the switch 106 and resistor 107, forms, in conjunction with resistors 107 and 108, an RC filter network for transient suppression. The circuit path including the resistor 102 and the diode 103 forms a holding circuit for the SCR. The diode 104, when the switch 87 is transferred from the position shown in the drawing, isolates the anode of the SCR from the negative line 38 thereby preventing the SCR from being cut-off should it be conducting.

The SCR is triggered by momentarily closing the normally open switch 106, allowing current to flow through the divider comprising resistors 105, 107 and 108. The current flow through the resistor 108 raises the potential on the gate 99 of the SCR to which its high voltage side is connected, triggering the SCR. The SCR when triggered conducts through the path including diode 103, resistor 102 and anode 101, effectively connecting the line 94 to the source of control potential, namely the negative line 38 via the switch 86, diode 104, and the anode 101, producing a negative output or control signal at the junction 88 for operating the footage indicator 22, the field and armature switches 13 and 14, and the armature brake 23. The SCR is cut-off by momentarily opening the normally closed switch 112, interrupting the holding circuit for the SCR, thereby terminating conduction.

The test switch 85 is connected between the junction 88 and the negative line 38. This normally open switch, when closed, acts independently of the operation of the SCR and the transistor Q–3 which is responsive to the pulse generator to provide an output at junction 88. Specifically, when closed, the test switch 85 directly connects the

source of control potential, namely, the negative line **38** to the line **94** providing a negative output or control signal at the output junction **88** for actuating the footage indicator **22**, the field and armature switches **13** and **14**, and the armature brake **23**. By reason of the direct coupling of the negative line **38** to the junction **88**, the test switch acts irrespective of the state of conduction of the SCR and the transistor Q–**3**. The test switch **85** is useful, for example, when it is desired for test purposes, to operate the footage indicator **22** and the motor **10** when no unexposed film is present in the camera. Such operation is otherwise impossible due to the switch **86** which opens when no unexposed film remains in the cameras, decoupling any coupling between junction **88** and negative line **38** which might exist through either the conducting SCR or the conducting transistor Q–**3**.

The microswitch **87** includes a contact **115** connected at one end to the negative line **38** and at the other end alternately to a normally open contact **116** and a normally closed contact **117**. A cam **119**, which is located in the camera and driven at the rate of one revolution per frame actuates the switch **87** transferring the contact **115** in a manner to be described. The cam **119** is shown in the position it occupies at the beginning and end of the frame advancement cycle. The contact **117** is connected to the base **120** of a transistor Q–**6** via a resistor **121** and a capacitor **122**. With the contact **115** in the position shown, contact **117** couples the source of control potential, namely, the negative line **38** to the base circuit of transistor Q–**6** conditioning transistor Q–**6** for conduction. The contact **116** is connected to line **94** coupling the source of control potential, namely, the negative line **38**, to the output junction when contact **115** transfers from the position shown, thereby providing a negative control signal at junction **88** for operating the footage indicator **22**, the field and armature switches **13** and **14**, and the brake **23**. In practice, the contact **115** transfers from the position shown in the drawing at a point in the frame cycle slightly prior to the time at which pulses from the generator **17**, if there are such, terminate, and re-transfers at approximately the end of the frame cycle. Thus, the motor **10** is operated for substantially an entire frame notwithstanding the width of the pulse which, in the intermittent mode of operation initiates the operation of the motor and the frame cycle, is less than the frame cycle duration.

The pulse generator **17**, SCR, test switch **85**, and switch **115** alone, or in combinations of two or more, function as a control signal generator for generating control signals for operating the armature brake **23**, the indicator **22** and the motor **10**.

The camera drive motor brake circuit **23** includes a transistor Q–**7** having an emitter **130** connected directly to the positive line **52**, a base **131** connected to the output junction **88** via a resistor **132**, and a collector **133** connected to the base **120** of the transistor Q–**6**. The transistor Q–**6** has an emitter **135** and a collector **136**, the emitter-collector path being connected in shunt with the armature winding **11**. The transistor Q–**7** is cut-off and the transistor Q–**6** is biased for conduction, although not necessarily conducting, when the signal at the junction **88** is not at a low level corresponding to the operative condition of the camera film advancing motor. With the transistor Q–**6** biased for conduction via the transferred contact **115**, the armature winding **11** is short-circuited. The short-circuiting of the armature winding, which occurs at the end of each film frame, effectively enhances the braking of the motor **10**. Improved braking results because the kinetic energy of the armature, which normally is dissipated via mechanical friction as the armature coasts to a stop, can be dissipated more quickly by taking advantage of the fact that the motor becomes a generator when it is no longer driven. Thus, by short-circuiting the armature winding, the generator is loaded, quickly converting the kinetic energy into electrical energy which is dissipated through the transistor Q–**6**. When the motor **10** is actuated by the presence of a negative signal at junction **88** which switches on field armature switches **13** and **14**, the brake is disabled. Specifically, the transistor Q–**7** is switched from cut-off to saturation, biasing transistor Q–**6** to cut-off, and thereby terminating the armature winding short-circuit connection. The function of the capacitor **122** is to provide a high pulse of base current to the transistor Q–**6** during braking, insuring complete saturation of the transistor Q–**6** without the need for making the resistor **121** a small, high wattage resistor.

The motor **10**, in addition to the armature or control winding **11** and the field winding **12**, also includes a diode **138** in shunt with the armature winding **11** and a diode **139** in shunt with the field winding **12**. The diodes **138** and **139** prevent unduly high and damaging transient voltages, which are generated as a result of the inductive kick produced when the current in the motor windings ceases, from being applied to the transistors Q–**4** and Q–**5**. The diodes **138** and **139** perform this protective function by providing a shunt path to the negative line **38** for any of the reverse polarity transients produced by the inductive kick of the windings **11** and **12**, thereby avoiding the application of these transients to the transistors Q–**4** and Q–**5**.

The field winding switch **14** includes a transistor Q–**5** having a collector **140** connected to the winding **12** and to the cathode of the diode **139**, a base **141** connected to the output junction **88** via a resistor **142**, a diode **143** and line **95**, and an emitter **146** connected to the positive tap line **37** via a diode **147** and a line **145**. A capacitor **148** connected between the collector **140** and the base **141** of transistor Q–**5** is provided to delay the turn-off of transistor Q–**5**, thereby enabling current to be present in the field winding **12** during motor braking, enhancing the braking operation. A resistor **149** connected between the base **141** of transistor Q–**5** and the junction of the anode of diode **147** and the line **145** functions in conjunction with the diode **147** to provide a reverse bias on the emitter-base junction of the transistor Q–**5** thereby preventing leakage of the transistor Q–**5** when cut-off. Should leakage occur, the emitter **146** becomes more negative than the base **141** cutting off the transistor Q–**5**.

In operation, when energization of the field winding **12** is desired, the junction **88** is driven to a low potential in any one of the manners described previously, biasing the transistor Q–**5** into conduction thereby effectively coupling the positive line **52** to the field winding **12**, completing an energization path. The bias applied to the base **141** of transistor Q–**5** by the low potential at junction **88** overcomes the amount of reverse bias applied to the emitter-base junction of transistor Q–**5** by the diode **147** and resistor **149** combination, allowing the transistor Q–**5** to switch from cut-off to saturation when it is desired to energize the field winding **12**.

The armature switch **14** includes a transistor Q–**4** having an emitter **150** connected to the positive line **52** via a diode **151**, and a collector **152** connected to the armature winding **11**, the cathode of the diode **138** and the emitter **135** of transistor Q–**6**. The transistor Q–**4** also includes a base **153** connected to the output junction **88** via the resistor **97**, the diode **96**, and the line **95**. The resistor **98** and the diode **151** function to prevent leakage of transistor Q–**4** when the transistor is cut-off by the absence of a low level signal at junction **88** in the same manner that the diode **147** and the resistor **149** prevent leakage of transistor Q–**5** in the absence of a low level biasing signal at junction **88**. In operation, when energization of the armature winding is desired the junction **88** is driven to a low potential in any one of the manners described previously, overcoming the reverse biasing of the resistor **98** and diode **151** combination and biasing the transistor Q–**4** into conduction, thereby effectively connecting the positive line **52** with the armature winding **11**, completing an energization circuit to the armature winding.

The footage indicator **22** includes a motor **160** connected between the terminal **40** of the primary winding **32** of transformer **30**, and a full wave rectifier **161** connected between the motor **160** and the transformer center tap **37**. The rectifier **161** includes diodes **162**, **163**, **164** and **165** connected in a conventional full wave rectifying bridge configuration. In addition, the rectifier includes a transistor Q–8. The transistor Q–8 has a collector **166** connected to the anodes of diode **164** and **165**, and an emitter **167** connected to the cathodes of diode **162** and **163** via a diode **168**, and a base **169** connected to the output junction **88** via a line **170**, a resistor **171** and line **95**. A resistor **173** is connected between the base **169** and the anode of diode **168**. The resistor **173** and the diode **168** function to prevent leakage of transistor Q–8 in the same manner as the diode **147** and the resistor **149** and the diode **151** and resistor **98** function to prevent leakage of transistor Q–5 and Q–4, respectively.

In operation, each time the motor is operated in response to the presence of a low potential control signal at junction **88**, the transistor Q–8 is biased into conduction via line **95**, resistor **171**, and line **170** allowing current to flow through the motor **160**. The motor **160**, in turn, drives a suitable film footage indicating element such as a pointer associated with a dial (not shown) suitably calibrated in feet of unexposed film remaining in the camera. Since the motor **160** is driven at the same speed irrespective of the particular terminal **58** or **59** to which the base **57** of the transistor Q–2 is connected, that is, irrespective of whether the film is driven at four or eight frames per second, the dial preferably has two scales, one being calibrated for the four frames per second rate and the other for the eight frame per second rate.

The diodes **96**, **103** and **143** prevent, when the terminal **40** is positive, a sneak bias path from being completed for the transistor Q–8 during periods of motor **10** inoperativeness, thereby preventing the motor **160** from advancing and giving a false indication of the remaining unexposed film footage. Specifically, the diode **96** prevents a sneak bias path from being completed for the transistor Q–8 via terminal **40**, motor **160**, diode **162** and **168**, the emitter-base path of transistor Q–8, line **170**, resistor **171**, **97** and **98**, line **52**, the emitter-collector path of transistor Q–1, line **49**, fuse **48**, and tap **37**. The diode **103** prevents a sneak bias path from being completed for the transistor Q–8 via terminal **40**, footage motor **160**, diodes **162** and **168**, the emitter-base path of transistor Q–8, line **170**, resistor **171**, lines **95** and **94**, switch **86**, diode **104**, switch **112**, resistor **102**, line **52**, the emitter-collector path of transistor Q–1, line **49**, fuse **48**, and tap **37**. The diode **143** prevents a sneak bias path from being completed for the transistor Q–8 via terminal **40**, footage motor **160**, diodes **162** and **168**, the emitter-base path of transistor Q–8, line **170**, resistors **171**, **142** and **149**, line **145**, and tap **37**.

A lamp **180** connected across the positive and negative lines **37** and **38** in series with a footage motor controlled switch **181** is provided to indicate that a point has been reached wherein only a predetermined amount of unexposed film, such as 30 feet, remains in the cameras. In operation, the switch **181** is normally open and the lamp **180** extinguished. However, when the motor **160** rotates to the point where only 30 feet of unexposed film remains the switch **181** is closed by suitable means associated with the motor **160** (not shown) illuminating the light **180**, and thereby providing a visual indication that only 30 feet of film remain in the camera.

The end of the film switch **86** is also controlled by the footage motor **160**. In operation, this switch is normally closed enabling the SCR and the pulse responsive transistor Q–3 to operate the motor in either the continuously or intermittently driven modes, respectively. However, when the motor **160** has advanced to the point where no unexposed film remains, the switch **86** is tripped by the motor **160** in any suitable manner interrupting any coupling which might exist between the negative line **38** and the terminal **88** via either the trigger SCR or the intermittently operated transistor Q–3. Notwithstanding the opening of normally closed switch **86** at the termination of the film roll, the motor **10** is still operable by closing the normally open test switch **85**, directly coupling the terminal **88** with the negative line **38**, thereby actuating the field and armature switches **13** and **14**, and, hence, the motor **10**.

A lamp **184** is connected across the positive tap **37** and the negative line **38** and provides illumination for the footage indicator. This lamp is lighted wherever the switch **36** is closed. A lamp **185** is connected across the positive line **49** and negative line **38** and provides an indication that direct current power is available, that is, that switch **36** is closed and that neither fuse **35** nor **38** has blown.

OPERATION

The control circuit has three principal modes of operation, namely, an intermittent mode in response to the operation of the pulse generator, a continuous mode in response to the operation of the SCR, and a test mode in response to the actuation of the test switch **85**. In addition, in the latter two modes, there are two sub-modes depending upon the terminal **58** or **59** to which the base **57** of transistor Q–2 is connected. These sub-modes correspond to the four frame per second motor speed and the eight frame per second motor speed.

Operation in the intermittent mode is accomplished by closing the switch **36** which provides power to the supply **15** and the switch **73** which actuates the pulse generator **17**. In practice, the switch **36** is closed whenever it is contemplated that the camera may be in use. Thus, if the camera is located in a bank lobby, the switch **36** is in the closed condition during banking hours since it is during banking hours that a bank robbery is likely to occur. The switch **73** is typically controlled by the bank tellers or the bank guard and is closed when periodic, or intermittent photographing is desired such as may be the case when a suspicious-looking person enters the bank lobby and it is desired to record his activity should it later turn out that he attempts to rob the bank. Of course, the switch **73** may be kept closed if continuous surveillance is desired.

With switches **36** and **73** closed, switches **85** and **106** open, and switch **112** closed, the pulse generator proceeds to go through its cycle, generating a pulse on line **80** of typically 200 millisecond duration for biasing transistor Q–3 into saturation and thereby effectively connecting the negative line **38** to the junction **88** for switching transistors Q–4, Q5, Q–7 and Q–8 into conduction. The switching of transistor Q–7 into conduction shunts current from the base of transistor Q–6, switching transistor Q–6 into cutoff and thereby terminating the short-circuit on the armature winding **11** of the motor, effectively terminating the braking action. Prior to the switching of transistor Q–6 in response to transistor Q–7 being driven into conduction, transistor Q–6 biased for conduction via contacts **115** and **117** of switch **87**, although not actually conducting since transistor Q–4 is cut-off preventing current flow in the armature winding.

The switching of transistors Q–4 and Q–5 into conduction effectively connects the windings **11** and **12** to the positive lines **52** and **37**, respectively, allowing current to flow through the windings **11** and **12** energizing the motor **10**. As the motor **10** becomes actuated, the cam **119** begins to rotate and, prior to the termination of the pulse on line **80**, transfers the contact **115** from the normally closed contact **117** to the normally open contact **116**, thereby coupling the negative line **38** to the junction **88** via the line **94** maintaining the conducting state of transistors Q–4, Q–5, Q–7 and Q–8.

The switching of transistor Q–8 into conduction enables current to flow through the full wave rectifier **161** and, hence, through the footage motor **160** causing the footage indicating pointer to move in synchronism with the camera film advancement assembly driven by the motor **10**.

Subsequent to the transfer of contact **115**, which occurs after a brief interval due to cam **119** being rotated by the film advancing mechanism of the camera, the pulse on line **80** terminates driving transistor Q–3 into cut-off effectively decoupling the negative line **38** to the output junction **88** via the line **94**, the normally closed switch **86**, line **93** and the emitter-collector path of transistor Q–3. This decoupling, however, does not switch transistors Q–4, Q–5, Q–7 and Q–8 due to the coupling of junction **88** to the negative line **38** via the transferred contact **115**, normally open contact **116** and line **94**.

When the cam **119** has completed one revolution and returned to the position shown in the drawing corresponding to a single operational cycle, or the advancement of the film one frame, the contact **115** retransfers to the position shown in the drawing, decoupling the junction **88** from the negative line **38**, and thereby removing the bias from transistors Q–4, Q–5, Q–7 and Q–8, which tends to drive them from saturation to cut-off. The removal of bias from the transistor Q–8 immediately disables the full wave rectifier **161** preventing any further current flow through motor **160** and, hence, terminating the operation of the footage indicator **22**. The removal of the bias from the base circuit of transistor Q–4, likewise, immediately drives transistor Q–4 into cut-off, effectively open-circuiting the armature winding circuit due to the high impedance of the emitter-collector path of transistor Q–4. The removal of bias from the base circuit of transistor Q–7 immediately drives transistor Q–7 into cut-off, which in turn drives transistor Q–6 into conduction effectively short circuiting the armature winding **11** of the motor to effect braking action.

The removal of bias from the base circuit of transistor Q–5 is not however, immediately effective to switch transistor Q–5 into cut-off due to the presence of capacitor **148** which effectively delays the cuting-off of transistor Q–5. The delaying of the cut-off of transistor Q–5 functions to permit field current to flow in the field winding **12** of the motor **10** for a brief period to enhance the braking action of the short-circuited armature winding **11**, the armature winding being short-circuited by the emitter-collector path of transistor Q–6 biased into saturation via contacts **115** and **117**. The delay introduced by capacitor **148** is substantially coextensive with the time required to arrest the motion of the armature of the motor **10**.

With the motor armature having terminated its motion, the circuit is ready for another cycle of operation in response to the occurrence of the next pulse, which typically occurs after a duration of, for example, two seconds corresponding to the spacing between pulses. The occurrence of the second pulse causes the motors **10** and **160** to be energized for another cycle advancing the film one frame, and suitably advancing the footage indicator, respectively. This cycle of operation of the motors **10** and **160** continues in response to the pulses on line **80** output from the generator **17** until either the switch **73** is opened, disabling the pulse generator, or the end of the film is reached whereupon the switch **86** is opened in response to its actuation by motor **160**. The opening of the switch **86** prevents the transistor Q–3 from periodically coupling the junction **88** to the negative line **38** via the emitter-collector path of transistor Q–3 in response to successive pulses output on line **80** from the pulse generator **17**. Thus, the opening of switch **86** in response to the end of film condition prevents further actuation of the motors **10** and **160** in response to pulses output from the generator **17**.

The continuous mode of operation is produced by closing the switch **36**, which provides power to the supply **15**, and in addition, momentarily closing the normally open switch **106** which effectively triggers the SCR, causing it to latch through the holding circuit including diode **103** and resistor **102** and anode **101**. The switch **106** is closed when continuous photographing is desired as, for example, when a bank robbery is in progress. This switch may be a foot-actuated switch located in the bank teller's cage or it may be a money clip switch actuated when a teller's cash box is emptied. With the SCR latched by momentarily closing the switch **106**, the negative line **38** is effectively and continuously coupled to the output junction **88** via the anode-cathode circuit of the SCR, diode **104**, normally closed end of the film switch **86**, and line **94**. This coupling of the negative line to the junction **88** provides continuous bias for the transistors Q–4, Q–5, Q–7 and Q–8 holding them in the saturated condition thereby disabling the armature brake **23** and allowing energizing current to flow though the footage indicator circuit **22** and the motor windings **11** and **12** continuously advancing the footage indicator **160** in synchronism with the film advancing activity of the camera. The exact rate of film frame advancement in this mode varies depending upon which terminal **58** or **59** is connected to the base **57** of transistor Q–2. Specifically, if terminal **58** is connected to the base **57**, the film rate is eight frames per second. In contrast, if terminal **59** is utilized, the film rate is four frames per second. The continuous operation of the motors **160** and **10** continues until either the switch **112** is momentarily opened cutting off the SCR, or the end of the film is reached whereupon the normally closed switch **86** is opened preventing the coupling of the negative line **38** and the junction **88**, thereby removing the bias from the transistors Q–4, Q–5. Q–7 and Q–8. The removal of this bias stops the motor **10** and **160** in the manner described previously with respect to the intermittent mode of operation.

The above operation of the circuit in the continuous mode will exist irrespective of whether or not the switch **73** is closed, causing the pulse generator to produce pulses on output line **80**. Specifically, the continuous coupling of the negative line to the output terminal **88** existing in the continuous mode effectively overrides the intermittent coupling of the negative line **38** to the output terminal **88** via the intermittently actuated transistor Q–3, causing the continued presence of bias at junction **88** for operating the motors **10** and **160**.

Operation in the test mode is produced by closing the switch **36** which applies power to the supply **15**, and closing the normally open switch **85**. With the switch **85** closed, the negative line **38** is directly coupled to the output junction **88** providing bias for the transistors Q–4, Q–5, Q–7 and Q–8, producing operation of the motors **10** and **160**, in turn advancing the footage indicator and the film at a rate determined by the particular terminal **58** or **59** to which the base **57** of transistor Q–2 is connected. This continuous operation prevails notwithstanding the open position of the end of film switch **86** which occurs when no unexposed film remains in the camera.

The operation of the circuit in either the continuous, intermittent, or test mode is terminated if the switch **36** is opened or the fuse **35** blows. The open circuiting of the primary winding by opening the switch **36** or blowing the fuse **35** removes all power from the circuit. Blowing of the fuse **48**, while not removing power from the footage indicator **22**, does prevent operation of the motor **10** due to interruption of the positive tap line **37, 49, 52**. In addition, in either the intermittent, continuous or test mode, when the footage indicator reaches the point corresponding to the 30 foot mark, the switch **181** is actuated by the footage motor **160**, illuminating the lamp **180** and thereby indicating that only 30 feet of unexposed film footage remains.

The principles of this invention can also be utilized to operate two or more independent cameras. Specifically, pural cameras can be operated by providing, for each camera being controlled, separate switch control circuits **16**, armature brakes **23**, motors **10**, armature and field switches **13** and **14**, and footage indicators **22**. The pulse generator **17**, regulator **20**, and power supply **15** may be common to each camera control circuit. In operation, the various switch control circuits associated with the different cameras would control the operation of the field and armature switches, the armature brake, and the

footage indicator of their respective cameras in the same manner that switch control circuit **16** controls the field and armature switches **13** and **14**, armature brake **23**, and the footage indicator **22**.

We claim:

1. A circuit for selectively actuating a camera film advancing mechanism, said circuit comprising:

motor means having a driven element connectable in driving relationship with said camera film advancing mechanism and an armature winding responsive to the flow of current therethrough for causing said motor means to impart driving motion to said driven element for actuating said camera film advancing mechanism, said motor means further including a field winding;

a source of potential;

a control circuit having control signal generating means for producing pulse-type control signals and continuous control signals;

a first transistor having an emitter-collector path connected between said source of potential and said armature winding and having a base responsive to said control signals for alternatively operating said first transistor in states of conduction and nonconduction in response to control signals;

a second transistor having an emitter-collector path in parallel with said armature winding and having a base responsive to said control signals for biasing said transistor into conduction when said first transistor is nonconductive, thereby short-circuiting said armature winding to cause said motor means to function as a generator and effect braking when said armature winding and said potential source are effectively disconnected by said first transistor; and

a third transistor having an emitter-collector path connected between said potential source and said field winding and having a base responsive to said control signals for alternatively operating said third transistor in states of conduction and nonconduction, said third transistor further having a delayed nonconduction characteristic for allowing current to flow in said field winding during operation of said motor means as a generator, thereby enhancing said motor braking.

2. A circuit for selectively actuating a camera film advancing mechanism, said circuit comprising:

motor means having a driven element connectable in driving relationship with said camera film advancing mechanism and an armature winding responsive to the flow of current therethrough for causing said motor means to impart driving motion to said driven element for actuating said camera film advancing mechanism, said motor means further having a field winding;

a source of potential;

a control signal generator for producing control signals;

selectively operable switch means interconnecting said source of potential and said armature winding, said switch means being responsive to said control signal for selectively causing current to flow through said armature winding;

an armature brake having selectively operable means for short-circuiting said armature winding to effect braking when the said motor means functions as a generator while the armature of said motor means is coasting to a stop and said potential source and armature winding are disconnected;

a field winding switch including

(a) a first transistor having an emitter-collector path connected between said field winding and said potential source and having a base responsive to said control signals for selectively interconnecting said potential source and said field winding, and

(b) a capacitor connected to said base which is adapted to discharge when said armature winding and said potential source are disconnected for delaying nonconduction of said transistor to allow current to flow in said field winding during operation of said motor means as a generator, thereby enhancing said motor braking.

3. The circuit of claim **2** wherein said control signal generator includes a pulse generator, and wherein said control signals are pulses having a spacing greater than the delay during which said transistor is maintained conductive by said capacitor following disconnection of said armature winding and potential source.

4. The circuit of claim **2** wherein said selectively operable switch is a second transistor having an emitter-collector path connected between said armature winding and said potential source, and having a base connected to said control signal generator for alternatively rendering said second transistor conductive and nonconductive in response to said control signals, and wherein said circuit further includes a first diode and a second diode connected in parallel with said armature winding and field winding, respectively, for protecting said first and second transistors, respectively, from transient signals produced by the inductive kick of said windings when said transistors switch to nonconductive states.

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