

PATENT SPECIFICATION

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(54) CONTROL SYSTEMS

(71) We, PONDER & BEST, INC., a corporation organized under the laws of the State of California, United States of America, of 1630 Stewart Avenue, Santa Monica, State of California, United States of America, (formerly of 11201 West Pico Boulevard, Los Angeles, California 90064), 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:—

This invention relates to control systems for controlling the duration of delivery of energy to a load. It will be described in the context of electronic photoflash, in which the invention arose, but systems embodying the invention are also expected to be useful in other applications.

According to the invention there is provided a system for controlling the duration of delivery of energy to a load comprising: sensing means for producing a signal proportional to the instantaneous effect of said load when supplied with such energy; a signal-to-frequency converter connected to receive the signal from said sensing means for producing a train of pulses whose repetition rate is proportional to the instantaneous value of such signal; pulse counting means connectable to the output of said converter for producing an output representing the number of pulses produced by said converter; and logic control means connected between said converter and said pulse counting means and said load for initiating the delivery of energy to the load in response to a signal from the converter and for terminating the delivery of energy to said load after a predetermined number of pulses has been counted.

Switch means may be connected for activating said pulse counting means.

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Such a system may be an electronic photoflash device wherein said load is an electronic photoflash tube, said sensing means is a light sensor also responsive to ambient light, said switch means is a camera synchronization contact, and said logic control means are connected for activating said counting means upon closing of said switch means and for initiating the delivery of light flash producing energy to said tube upon response of said counting to a pulse from said converter after closing of said switch means. In such a photoflash device the system constitutes an automatic flash limiting unit in the form of a digital logic control device which is controlled by received light to both initiate and terminate a light flash thereby eliminating the need for a separate gating circuit.

Advantages and further details of such a system will become apparent from the following description, given by way of example and with reference to the accompanying drawings in which:

Figure 1 is a block diagram of a known photoflash circuit.

Figure 2 is a block diagram of a photoflash unit or device embodying the present invention.

Figure 3 is a block diagram of one component of the unit of Figure 2.

Figure 4 is a group of waveforms illustrating the operation of a prior art flash limiting circuit.

Figure 5 is a series of waveform diagrams illustrating the operation of the circuit of Figures 2 and 3.

In flash units described below an improved light control action is achieved through use of a logical control circuit incorporating a binary pulse counter which controls both the initiation and termination of a light flash.

Before describing one example of such a

flash unit it would be well to review briefly the general mode of operation of all prior art automatic flash limiting circuits.

In such circuits, a d.c. power supply changes an energy storage capacitor to a predetermined voltage. Thereafter, the closing of the camera synchronization contact triggers the initiation of a flash by the photoflash tube through the intermediary of an ignition circuit. Either the initiation of a light flash or the trigger pulse produced by the ignition circuit renders the automatic flash limiting circuit operative. Light reflected from the subject being photographed is received by a light sensor and converted into an electric signal which is integrated by a suitable integrating capacitor. When the voltage across this capacitor reaches a predetermined value, it causes a threshold detector and amplifying circuit to produce an output signal which triggers a flash limiting ignition circuit to render conductive a quench tube connected in parallel with the photoflash tube.

The known circuit of Figure 1 comprises a conventional electric supply for photoflash 531, and the capacitor of the photoflash 5301, connected to supply the flashtube 5302, provided with its trigger circuit 532, to which is connected the synchronization contact 5303. The proper control circuit includes a quenchtube 5331 connected to both the capacitor 5301 and the flashtube 5302, the quenchtube being equipped with its trigger circuit 534 and controlled by an amplifier-detector 535 whose input is connected to an integrating capacitor 5361 which integrates the current of a light sensor 5362. One of the connections 5363, 5364 and 5365 controls the synchronization or the unblocking of the control circuit 533.

The way in which these circuits operate is the following: the electric supply 531 changes the capacitor 5301 at the operating voltage. The closure of the synchronization contact 5303 of the camera provokes the trigger of the flashtube 5302 by intermediary of its trigger circuit 532; the existing synchronization connection 5363 or 5364 or 5365 permits the activation (switching on or gating) or the unblocking of the light-measuring circuit.

The light reflected by the illuminated object is caught by the sensor 5362 whose output current is integrated in the capacitor 5361, the voltage of which is amplified and detected in the amplifier-detector 535. The latter delivers an impulse to the trigger circuit 534 of the quenchtube 5331 as soon as the light quantity reaches a predetermined value, thus terminating the light flash by short-circuiting of the flashtube 5302.

Figure 2 illustrates one example of a

flash unit which, among other things, eliminates the need for any gating circuit shown in Figure 1 between the photoflash device and the flash limiting circuit. The circuit of Figure 2 includes a photoflash tube 3, an energy storage capacitor 1, a d.c. power supply 63 connected to charge capacitor 1, a quenching circuit 61 of any previously disclosed type connected in series or parallel with both capacitor 1 and tube 3, a first trigger circuit 66 for initiating the production of a light flash by tube 3, and a second trigger circuit 62 for activating quenching circuit 61 to terminate the flash being produced by tube 3. This group of elements is employed in known automatic photoflash devices. The circuit of Figure 2 also has in common with known photoflash devices a light sensor 80 and a connection to camera synchronization contact 72.

The novel elements of the circuit of Figure 2 are a logic control 67, a counter 68 and a light intensity-to-frequency converter 69, these elements constituting, together with light sensor 80, a logic control circuit, in the form of a digital light computer, 65 for the device.

Circuit 69 acts to convert the electrical signal produced by sensor 80 into a train of pulses whose repetition rate is proportional to the intensity of that electrical signal. Logic control 67 is connected to receive these pulses from converter 69 and to convey them, after the closing of synchronizing contact 72, to counter 68, where they are counted. The outputs from counter 68 are connected to logic control 67 and this logic control is provided with a first output F connected to apply a flash initiation signal to trigger circuit 66 and a second output Q to apply light termination signal to trigger circuit 62. Since it is the circuit 65 which provides the flash initiation signal, and since this circuit does not begin counting pulses from converter 69 until camera synchronization contact 72 has been closed, the device of Figure 2 need not be provided with a separate gating circuit for blocking the flash limiting circuitry until a light flash has been triggered.

The illustrated device can be made quite simple and compact since the entirety of circuit 65 could be formed as a single integrated circuit.

Figure 3 illustrates a preferred specific embodiment of the circuit 65. In this embodiment counter 68 is a four-stage binary counter having a direct output and a negated output for each stage. With respect to each stage, the left-hand line represents the negated output line and the right-hand line the direct output line. The logic control circuit includes an AND gate 553 hav-

ing one input connected to one side of the synchronization contact 72 and another input connected to the output of converter 69, an OR gate 554 having inputs connected to the direct output of each stage of counter 68 and an output connected to the one side of synchronization contact 72, an AND gate 556 having one input connected to the direct output of the first stage of counter 68 and further inputs each connected to the negated output of each of the remaining stages of counter 68, and a further AND gate 557 having inputs each connected to the direct output of a respective stage of counter 68. In addition, the negated output of the first stage of counter 68 is connected to the other side of contact 72. Gate 556 provides the F output pulse, while gate 557 produces the Q output pulse.

The circuit of Figure 2, with the specific logic control circuit of Figure 3, operates in the following manner, which is illustrated by the waveform diagrams of Figure 5. At some time prior to the closing of contact 72, counter 68 has been placed in its zero count state, wherein a "1" signal appears at each of its negated outputs and a "0" signal appears at each of its direct outputs. Then, to initiate a light flash, synchronizing contact 72 is closed, at the point 577 illustrated in the upper curve of Figure 5. This applies the "1" signal on the negated output of the first stage of counter 68 to one input of gate 553. At this time, "1" signals are being applied to three of the inputs of gate 556, while a "0" signal is being applied from the first stage of counter 68 to the fourth input of gate 556, with the result that this gate does not produce any output. The application of a "1" signal to one input of gate 553 enables that gate to pass pulses from converter 69 to the count input of counter 68. Therefore, the next occurring pulse from converter 69, which will normally be produced by ambient light and is indicated by the pulse 1 in the fourth curve of Figure 5, will be transmitted to counter 68 to cause its first stage to produce a count of one, in which case a "0" value signal will appear at its negated output and a "1" signal will appear at its direct output. This will cause gate 556 to produce an F pulse, as indicated in the third curve of Figure 5, which will result in the triggering of a light flash, as indicated by the second curve of Figure 5. Despite the change in state at the output of stage 1 of counter 68, gate 553 will continue to be enabled by the output signal from gate 554 which is then due to the presence of a "1" value signal on the direct output of the first counter stage. Thus, the pulses from converter 69 continue to be delivered to counter 68 and to be

counted therein, the result of this count being indicated by the state of the outputs of its various stages. When the count reaches a certain value, in the case of the embodiment of Figure 3 a value corresponding to the count of 15 pulses, AND gate 557 will produce a Q pulse to terminate the light flash.

Since at the time of production of the Q pulse, gate 554 is still producing an output signal, gate 553 remains enabled. Moreover, upon receipt of the next pulse from converter 69, counter 68 is returned to its "0" count state, as illustrated in the fourth curve of Figure 5. This will terminate the Q pulse and disable gate 554, as indicated by the bottom curve of Figure 5. In actual operation, it will often occur that the camera synchronization contact 72 will still be closed even after production of the Q pulse, this being illustrated in the first curve of Figure 5. In this situation, gate 553 will continue to be enabled to pass pulses from converter 69, which pulses are produced by ambient light, to counter 68 so that the counter will again count through its range. While this will result in the production of another F pulse and Q pulse, these will not be effective because the flash tube energy storage capacitor will not have had an opportunity to recharge. Once the synchronization contact 72 is permitted to open, counter 68 will continue counting until returning to its "0" count state, and will then stop since gate 553 will then become disabled.

On the other hand, even if contact 72 should open before the production of the first Q pulse, the system will continue to operate because gate 553 will remain enabled by the output signal from gate 554.

Figure 4 shows, by way of comparison, the operation of known automatic flash limiting devices. The upper curve illustrates the operation of the camera synchronization contact, and this is identical with the first curve of Figure 5. In the operation of prior art systems, the closing of the contacts immediately triggers the production of a light flash, as illustrated by the second curve of Figure 4, and the opening of a gating circuit, as illustrated by the third curve of Figure 4, for enabling the flash limiting circuitry. Upon opening of the gating circuit, the integrating capacitor of the flash limiting circuit begins to receive the output signal from the light sensor so that the voltage across that capacitor rises progressively, as illustrated by the fourth curve of Figure 4. When the voltage across the integrating capacitor reaches a predetermined value, a Q pulse for terminating the light flash is produced, as illustrated by the bottom curve of Figure 4. This terminates the light flash. Sometime thereafter, the gating

circuit closes and after the synchronization contact has opened the system begins to return to its ready state.

Thus, one substantial difference between the system illustrated in Figures 2 and 3 and those of the prior art is that the system according to the invention does not require any gating circuit and the initiation of a light flash is controlled directly by the flash limiting control circuit. Another substantial difference is that prior art circuits utilize an analog type capacitive current integration for determining the instant of termination of the light flash, whereas the system of Figs. 2 and 3 utilizes a digital type pulse counting circuit for achieving this result. The digital type system can be made more accurate than analog type capacitive integrating systems. Moreover, the digital system lends itself to an accurate variation of the sensitivity of the flash limiting circuitry because it would be a simple matter to provide a suitable switch arrangement between the outputs of counter 68 and gate 557 to vary the count value, and thus the received light quantity, which triggers the termination of a light flash. Thus, such switch could be arranged to vary the termination of the light flash as a function of the aperture setting of the camera lens.

It has been mentioned above that in the system of Figures 2 and 3, a flash is initiated upon receipt of a first pulse from converter 69, which pulse is produced by ambient light. In practice, there will always be sufficient ambient light to produce such pulses and the only time this will not be true is if the sensor 80 is receiving practically no light at all. If the sensor 80 and converter 69 are functioning properly, this will occur only in the case of substantially total darkness, when photographs could not be taken in any event because it would be impossible to aim or focus the camera on the desired subject. The only other situation in which a flash would not be triggered by the system according to the invention would be one in which either the sensor 80 or the converter 69 is experiencing a malfunction. In this case, the photographer would be immediately informed of the existence of a malfunction by the total absence of a light flash. This could also occur if the sensor 80 is accidentally covered by a protective cover or some other opaque object.

In contrast, when the corresponding elements of prior art system experience a malfunction, the photoflash will continue to produce a light flash and, in view of the extremely short duration of such flashes,

the photographer will not be aware of a malfunction until after his film has been developed, when it will normally be too late to correct for the malfunction, either by removing the object blocking the light sensor 80 or by replacing the photoflash, while still having time to obtain the photograph. Thus, the present system offers a decided security advantage.

WHAT WE CLAIM IS:—

1. A system for controlling the duration of delivery of energy to a load comprising: sensing means for producing a signal proportional to the instantaneous effect of said load when supplied with such energy;

a signal-to-frequency converter connected to receive the signal from said sensing means for producing a train of pulses whose repetition rate is proportional to the instantaneous value of such signal;

pulse counting means connectable to the output of said converter for producing an output representing the number of pulses produced by said converter; and

logic control means connected between said converter and said pulse counting means and between said pulse counting means and said load for initiating the delivery of energy to the load in response to a signal from the converter and for terminating the delivery of energy to said load after a predetermined number of pulses has been counted.

2. A system as claimed in claim 1, further comprising switch means connected for activating said pulse counting means.

3. A system as claimed in claim 2 wherein said load is an electronic photoflash tube, said sensing means is a light sensor also responsive to ambient light, said switch means is a camera synchronization contact, and said logic control means are connected for activating said counting means upon closing of said switch means and for initiating the delivery of light flash producing energy to said tube upon response of said counting means to a pulse from said converter after closing of said switch means.

4. A system for controlling the duration of delivery of energy to a load, substantially as described herein with reference to Figs. 2 and 3 of the accompanying drawings.

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2. A system as claimed in claim 1, further comprising switch means connected for activating said pulse counting means.
3. A system as claimed in claim 2 wherein said load is an electronic photoflash tube, said sensing means is a light sensor also responsive to ambient light, said switch means is a camera synchronization contact, and said logic control means are connected for activating said counting means upon closing of said switch means and for initiating the delivery of light flash producing energy to said tube upon response of said counting means to a pulse from said converter after closing of said switch means.
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