March 10, 1953 S. M. BAGNO 2,631,273

APPARATUS FOR PHOTOELECTRIC DETECTION

Filed June 29, 1948 2 SHEETS—SHEET 1

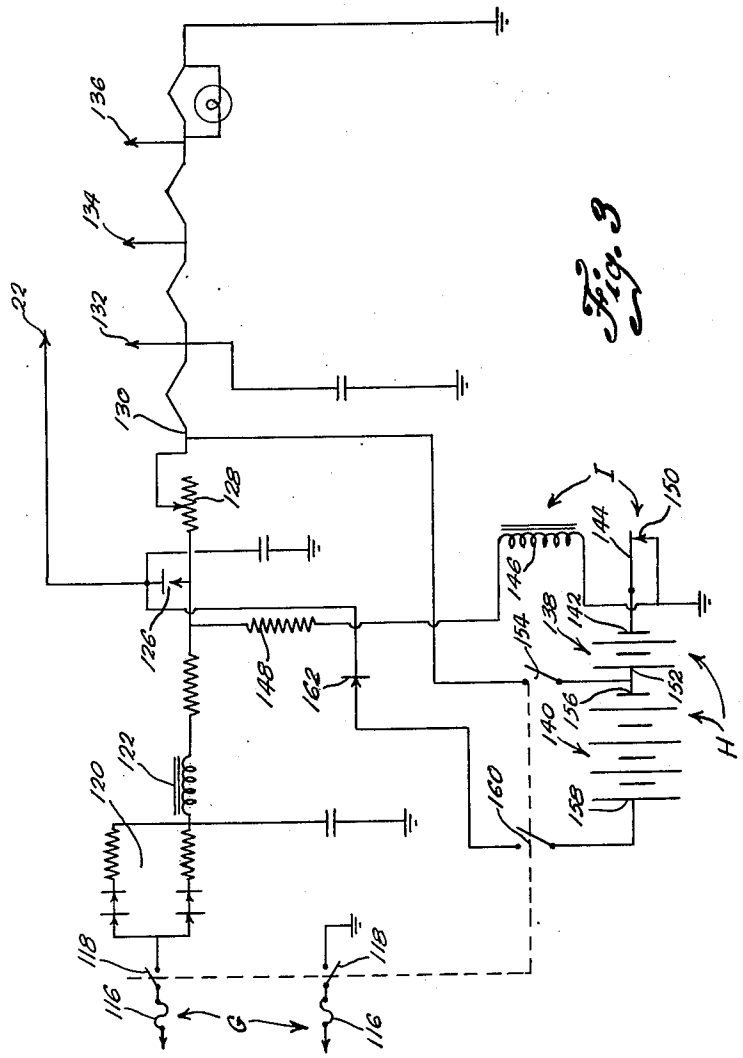


Fig. 3

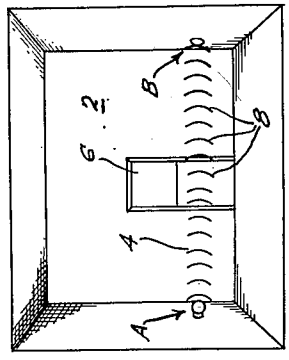


Fig. 2

Fig. 1

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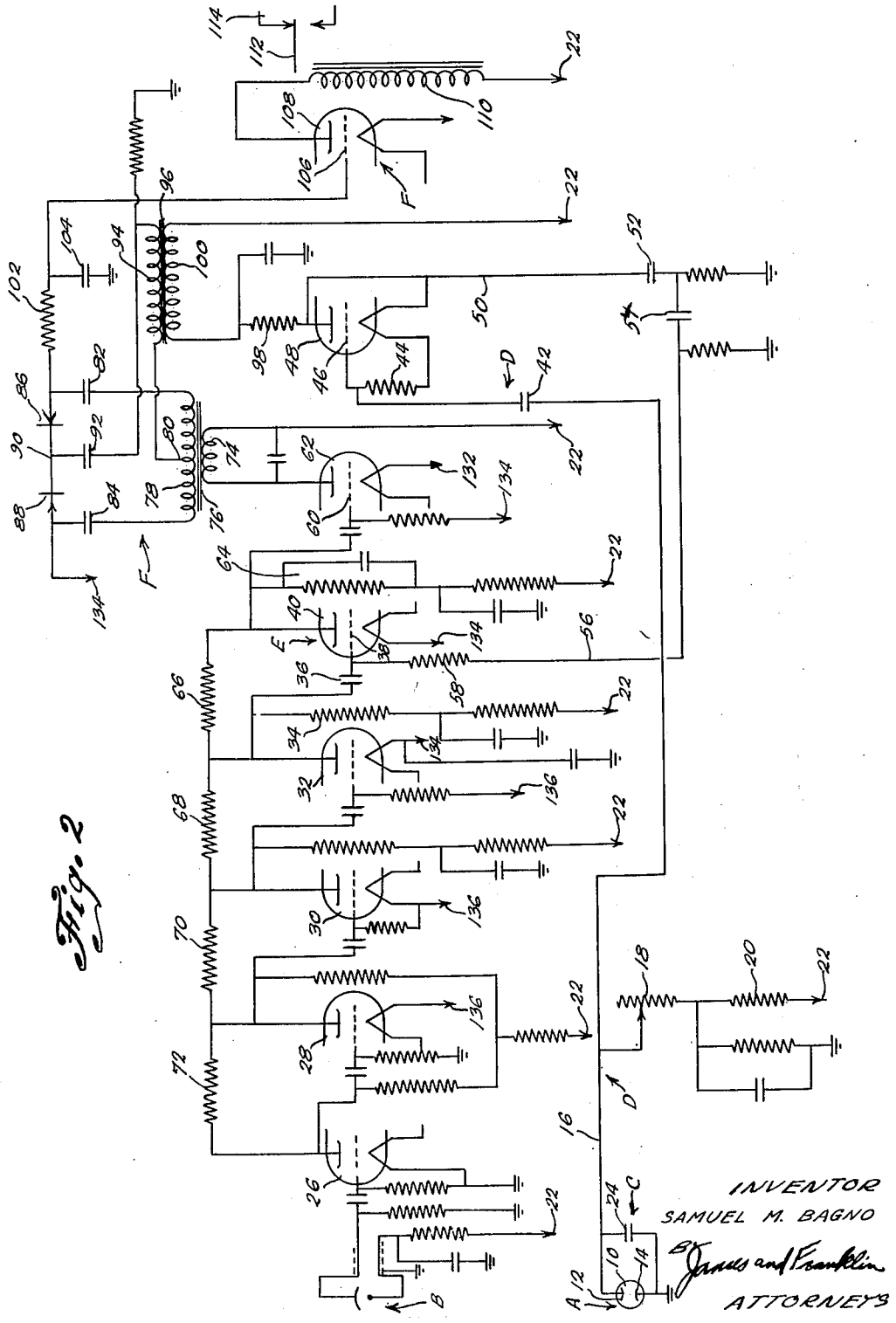


Fig. 2

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UNITED STATES PATENT OFFICE

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APPARATUS FOR PHOTOELECTRIC DETECTION

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19 Claims. (Cl. 340—228)

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The present invention relates to a method and apparatus for photoelectric detection and in particular to one adapted to control a burglar or intruder alarm.

It has long been proposed to employ photoelectric detection apparatus as a burglar alarm, said apparatus comprising a beam of light directed onto a suitable photoelectric element so that whenever said beam of light is interrupted, as by the passage of a person thereacross, the energization of the photoelectric element will be so changed as to set off an alarm. Two primary defects have been inherent in such systems, have mitigated strongly against their use, and have prevented their being approved for local alarm work by insurance companies and protective agencies. These defects are: (1) the susceptibility of the apparatus to counterfeiting, thus negativing its usefulness as a positive intruder alarm, and (2) the high power requirements of the source of illumination, thus making impossible employment of a practical source of standby power.

Counterfeiting or "fooling" of a photoelectric detection system of the normal type is relatively easy provided that the would-be intruder knows of its existence and of the location of the photoelectric cell. All that he need do in order to effect his undetected entrance into the premises guarded by the system is to direct a beam of light upon the photoelectric cell at least for the period of time during which he himself is interrupting the genuine light beam. The intruder's counterfeit light beam will prevent the alarm from sounding and consequently will render the detection system completely ineffective to detect his entrance.

Failure of a power source is an all-too-frequent occurrence, and unless the detection system is provided with a standby power source it will be completely ineffective whenever the regular source of power fails or falls below that minimum value necessary to operate the apparatus. During the period of time that the regular power source is ineffective the control system is also ineffective and consequently provides no protection whatsoever against intruders. Therefore, a standby power source is an essential for an effective detection system. In order to supply sufficient electrical energy to illuminate a light source so that it is capable of functioning in the detection system, a standby source of electrical power would have to be of such magnitude as to be wholly impractical, since it is necessary that the standby source of power be capable of energizing

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and illuminating the apparatus over an extended period of time.

It is the prime object of the present invention to devise a method and apparatus for photoelectric detection which avoids the above disadvantages.

In particular, it is an important object of the present invention to devise such a method and apparatus which is incapable of being "fooled," that is to say, which will not be rendered incapable of setting off the alarm by reason of any actions taken by the would-be intruder. Another equally important object of the present invention is to devise a method and apparatus for photoelectric detection which is so constructed as to be capable of being energized by a standby power source comprising standard batteries.

A subsidiary object of the present invention is to devise an electronic control circuit for use in a photoelectric detection apparatus which is simple, dependable and fool-proof.

Yet another object of the present invention is to devise a simple and efficient power circuit arrangement by means of which a regular source of power and a standby source of power are both connectable to the apparatus and effective to energize it under appropriate conditions.

A still further object of the present invention is to devise various circuit subassemblies which are particularly effective in the practice of the novel method herein disclosed.

The above objects are achieved by utilizing a light source of high intensity and of illuminating that light source in an intermittent manner, thus reducing the power drain on the standby power source. The control circuits are so arranged that only when the flashes of light received by the photoelectric element are in exact synchronism with the flashes of light emitted by the source of illumination will the alarm be restrained. Such synchronism involves a correspondence not only of frequency but also of phase so that it is for all practical purposes impossible for a would-be intruder to simulate with an auxiliary source of illumination the exact flashes of the true source of illumination, and this even if he knew and were able accurately to reproduce the frequency of said flashes.

To the accomplishment of the foregoing objects and such other objects as may hereinafter appear, the present invention relates to the method, apparatus and circuit arrangement of a photoelectric detection system as defined in the appended claims and as described in this specification, tak-

en together with the accompanying drawings, in which:

Fig. 1 is a schematic representation of a room showing the system in operation and illustrating the manner in which the system would detect the presence of an intruder;

Fig. 2 is a circuit diagram disclosing the details of the apparatus; and

Fig. 3 is a circuit diagram illustrating the power supply for the system.

Broadly considered, the apparatus of the present invention comprises a light source generally designated A and a light sensitive element such as a photoelectric cell generally designated B, the light source being illuminated and the light emanating therefrom being directed to the photoelectric cell B so as to energize the same. As illustrated in Fig. 1 the light source A may be positioned in a room generally designated 2 so that the light emanating therefrom generally designated 4 passes across the entrance to the room, here shown as the door 6, it being understood that a window or any other entranceway could be equally protected, so that if the door 6 should open, or if an intruder should pass therethrough, the light beam 4 would necessarily be interrupted, thus interrupting the energization of the photoelectric cell B and setting off a sensible alarm of any desired type. These elements and arrangements are common to most photoelectric detection systems.

An important novel element in my apparatus is a means generally designated C which causes the light source A to flash intermittently so that the light beam 4 is not a continuous beam but is instead made up of a series of discrete light pulses indicated schematically in Fig. 1 by the curved lines 8. It is preferable, but not necessary, that the rate of flashing of the light source A be so rapid as to be greater than the persistence of the human eye. It is well known that light flashes at a frequency of 60 per second are undetectable by eye and in a preferred modification the flashes may occur on the order of 200 times per second.

The frequency of flashing has two significant effects. In the first place, if the would-be intruder does not know that the light source A is only intermittently energized, he will be under the impression that it is a continuous source of illumination rather than an intermittent source and should he attempt to fool the device with a counterfeit source of illumination of uninterrupted intensity, he would succeed only in setting off the alarm.

In the second place, even if the intruder knows that the light source A is intermittent in character, he would still, in an attempt to fool the apparatus, be required to utilize a counterfeit light source of exactly the same frequency, and if the frequency is so great as to be undetectable to his eye, he will not be able accurately to determine its frequency without the assistance of relatively complex auxiliary apparatus such as a stroboscope. The greater the frequency of the light flashes from the light source A, the more difficult would it be for the intruder to ascertain their frequency and to generate simultaneous flashes. As will be explained in detail hereafter, unless the flashes were simultaneous the alarm would be set off.

The light sensitive element B is connected to a suitable electrical circuit for detecting its changes in output, which changes in output will be determined by the frequency and intensity of the light flashes impinging thereupon and which will be converted into first electrical signals. The output of the light sensitive element B will, of course, be modified by ambient light and random "noise" effects, but the only useful part of the first electrical signals will be the output caused by the received flashes from the light source A. A signal circuit generally designated D is connected to the light source A so as to generate second electrical signals in exact synchronism with the flashes of the light emanated by the light source A. A control element generally designated E is provided for comparing the first and second signals, the control element actuating an alarm control circuit generally designated F, the control element E and the alarm control circuit F cooperating so as to set off a sensible alarm whenever the first and second signals are not in exact synchronism both as to frequency and phase. Since the first electrical signal may and probably will have components other than those generated by the flashes of light from the light source A, it therefore is not necessary that all of the first signal be in exact synchronism with all of the second signal. It is necessary only that the two signals both contain substantial components in synchronism, and throughout this specification the term "synchronism" is meant to refer to the situation where substantial components of both signals are in synchronism. The fact that the system operates only on these substantial components makes it independent of ambient light and of random "noise" effects, thus increasing the dependability and sensitivity of the system. It also seems appropriate at this point to differentiate the present system over others known to the prior art where modulated light is employed. In such prior art systems, the frequency of modulation is a controlling factor and tuned circuits are employed to detect those modulations. In the instant system, the term "frequency" does not refer to modulation at all but refers instead to the number of discrete flashes occurring per unit time from the light source A. Hence tuned circuits are ineffective and the circuit arrangement disclosed hereinafter is employed.

Hence, even if the would-be intruder were able to determine the exact frequency of the flashes of the light source A, as by means of a stroboscope, and were able exactly to reproduce that frequency of flash in a counterfeit light source, as might be possible with certain commercial and laboratory equipment, he would still be unable to fool the device because of his inability, from a practical point of view, to secure exact simultaneity between the pulses from the counterfeit source and the true source A. Extensive experiments have been conducted by me with highly precise auxiliary light sources tuned to flash at exactly the same speed as the true light source A and every one of those experiments, carried out with the greatest zeal, have proven unable to fool the apparatus.

A power supply is provided for the apparatus and is illustrated in Fig. 3, this power supply including a regular source of power G, a standby source of power H, and a switch I for cutting in the standby source of power H when the regular source of power G falls below a predetermined minimum. By reason of the fact that the light source A flashes only intermittently, the power drain on the power supply is quite minimal and consequently it is possible to form the standby source H of a suitable number of standard batteries, preferably of the dry cell or A and B bat-

tery type, these batteries being capable of energizing the apparatus over a long period of time. The apparatus is so constructed that if both power supplies should fail at any time, the alarm will be sounded, thus eliminating the possibility that one might be depending upon a detection system which was wholly ineffective by reason of power failure.

Fig. 2 discloses the details of the apparatus which permit the attainment of the above objects in the generalized manner just described. The light source A may be in the form of a neon tube 10 which will illuminate only when the potential difference impressed across its electrodes 12 and 14 exceeds a given value. Illumination will continue so long as the voltage across the electrodes 12 and 14 exceeds another and smaller value, called the quench value. The electrode 14 is connected to ground and the electrode 12 is connected by means of wire 16, adjustable rheostat 18, and voltage dropping rheostat 20, to the high voltage D. C. tap 22. A capacitor 24 is connected across the tube 10 and so long as the voltage across the capacitor is below that required for illumination of the tube 10, the condenser will charge, thus slowly drawing power from the power supply. As soon as the potential difference across the capacitor 24 has built up to a value equal to the firing voltage of the tube 10, the tube 10 will become conductive and the capacitor 24 will discharge through the tube causing it to illuminate. This discharge is practically instantaneous during which the capacitor 24 discharges through the tube until the voltage across it is less than the quench value. At this point the tube will darken and the condenser will once again charge. The value of the capacitor will determine the frequency with which the neon tube 10 will illuminate and, as has already been stated, it is preferred that this frequency be greater than that detectable by the eye and preferably on the order of magnitude of 200 times per second. It will be noted that by this arrangement energy is stored in the capacitor 24 over a considerable period of time and is expended in an instant.

The intermittent nature of the illumination of the neon tube 10 constitutes a source of great saving in power consumption. If the tube were constantly illuminated, power would have to be supplied to it all of the time, 1 watt being required when the neon tube is illuminated. Since the capacitor 24 takes considerably longer to charge than to discharge, the tube 10 consumes power during considerably less than one percent of the time the system is in operation so that the power consumption is cut to considerably less than one percent of that which would normally be required. A practical burglar alarm installation has been constructed and tested by me according to the teachings of this invention in which the average power drawn by the source of illumination A is only on the order of 10 milliwatts. Hence, since the flashes are only infinitesimal in duration and occur only over a small portion of the time during which the apparatus is in use, the total power consumption is quite small.

The photoelectric cell B is positioned so as to receive the flashes of light 8 from the light source A and will, by its very nature, convert those received light flashes into corresponding surges of electrical energy constituting the first electrical signals. These signals are then amplified by means of the vacuum tubes 26, 28, 30 and 32,

these tubes being connected together in conventional amplification circuits. While four stages of preliminary amplification are here disclosed, it will be apparent that the number of stages can be varied at will.

The amplified output from the tube 32 is coupled in conventional fashion via resistor 34 and capacitor 36, to the grid 38 of the vacuum tube 40 which is also an amplification tube. This tube is so biased as to pass no current, or an ineffective amount of current, even when the amplified first electrical signals from the photoelectric cell B are alone impressed upon the grid 38.

A signal circuit generally designated D and including the capacitor 42 and the resistor 44 is connected between the photo-electric cell B and the grid 46 of another amplifying tube 48 so that whenever the tube 10 flashes, surges constituting the second electrical signals are applied to the grid 46. The tube 48 is so biased that when these second electrical signals are applied to the grid 46, the tube 48 will pass current and amplify. The output of the tube 48 is coupled by means of connector 50 and a high pass filter including capacitors 52 and 54, connector 56 and resistor 58 to the grid 38 of the amplifying tube 40. The tube 40 is so biased that it will either pass no current or an ineffective amount of current when the amplified second electrical signals from the tube 48 are alone applied to the grid 38.

However, the bias of the tube 40 is such that it will pass an effective amount of current when the amplified first electrical signals coming from the fourth amplification stage 32 and the amplified second electrical signals coming from the amplifier 48 add together in synchronism, both as to frequency and phase. Hence, the tube 40, constituting the fifth amplification stage, will have an output only if and when the first electrical signals generated by the photoelectric cell B and determined by the frequency and magnitude of the light flashes impinging thereupon are in exact synchronism both as to frequency and phase with the light flashes generated by the true light source A. The tube 40 therefore constitutes the control element E which compares the first and second signals.

The output of the tube 40 is fed to the grid 60 of the amplifying tube 62 via a filter circuit 64 which converts the pulsed output of the tube 40 into sawtooth wave form. The output of the tube 40 may also be coupled with the output of the preceding amplification stages by means of resistors 66, 68, 70 and 72 for regenerative amplification. The output of the tube 62 feeds into the primary 74 of a transformer 76 having a secondary 78 with a center-tap 80. The extremities of the secondary 78 are connected via capacitors 82 and 84 to a pair of selenium cell rectifiers 86 and 88 connected together in series opposing. The left hand extremity of the secondary 78 is connected, via capacitor 84, to the left hand side of the rectifier 88 and to the D. C. voltage tap 134. The mid-point 90 between the rectifiers 86 and 88 is connected via capacitor 92 to one end of a coil 94 which is the secondary of a transformer 96. The other end of the secondary coil 94 is connected to the center-tap 80 of the secondary 78.

The output of the tube 48 which amplifies the second electrical signals is connected via resistor 98 to the coil 100 which is the primary of the transformer 96. Hence, it will be apparent that the second electrical signals are applied to the

coil 94 and the first electrical signals, so long as they are in exact synchronism with the second electrical signals, will be applied to the coil 78. The circuit including these coils 94 and 78 and the rectifiers 86 and 88 constitutes an important portion of the alarm control circuit F.

It has already been noted that the outside of the left hand rectifier 88 is connected to the tap 134 of D. C. voltage. The right hand end of the other rectifier 86 is connected via resistor 102 and shunt capacitor 104 to the grid 106 of the amplification tube 108. The average voltage applied to the grid 106 will therefore be dependent upon the magnitude and phase relations between the voltages induced in the coils 78 and 94.

In order to explain the functioning of this circuit, let it be assumed that the voltage generated in the coil 78 is 5 volts from the center-tap 80 to each extremity of the coil and that the voltage in the coil 94 is 7 volts. Let it also be assumed that the first and second signals are in exact synchronism. Since each signal is in the form of a discrete surge, preferably of sawtooth shape, for each surge in the primaries 74 and 100 an alternating current will be generated in the secondaries 78 and 94 respectively. During the first portion of the cycle of alternation, let it be assumed that the currents generated in both secondaries 78 and 94 flow to the left as viewed in Fig. 2. The current from secondary 94 corresponding to the second electrical signal will flow into the center-tap 80 and thence will divide, flowing both to the left and the right in the coil 78. In the left hand part of the coil 78 the 5 volts from coil 78 and the 7 volts from coil 94 will add and the current will flow to rectifier 88 which is so oriented as to permit this flow. The rectifier 88 may be considered as a perfect conductor and hence there will be no voltage drop there-across. In the right hand part of the coil 78, the 5 volts generated by the primary 74 will be oriented in a direction against that permitted by the rectifier 86. However, the 7 volts generated in the coil 94 will overpower those 5 volts and will be oriented in a direction permitted by the rectifier 86 so that current will pass through said rectifier. Hence, during this first portion of the cycle, there will be no voltage drop across either of the rectifiers 86 or 88.

In the next portion of the cycle, currents generated in the coils 78 and 94 will be flowing toward the right in Fig. 2. This means that insofar as the current flowing into the coil 94 via the center tap 80 is concerned, it will move to the left in the right hand side of the coil 78 and to the right in the left hand side thereof. Hence, the voltage in the left hand side of the coil 78 will include 5 volts generated therein by the primary 74 and 7 volts corresponding to the voltage of the coil 94, both of these voltages being oriented in a direction opposite to that permitted by the rectifier 88. There will therefore be a total voltage across the rectifier 88 of 12 volts. In the right hand side of the coil 78, there will be a resultant votlage of 2 volts in a direction opposite to that permitted by rectifier 86 so that there will be a voltage drop of 2 volts across the rectifier 86. The total voltage drop across the two rectifiers will consequently be 10 volts and the average voltage drop across the two rectifiers for the entire cycle, assuming that the two halves of the cycle are of equal duration, will be 5 volts. The resistor 102 and capacitor 104 constitute a filter circuit which averages the potential difference across the rectifiers 86 and 88, this average potential difference adding to or subtracting from the D. C. voltage source 134 and thus modifying the voltage applied to the control grid 106 of the tube 108.

Computations similar to those just made will indicate that so long as the voltage induced in the coils 78 and 94 are in synchronism, an unbalance will exist in the two halves of the circuit just described so that a given modification of the voltage of the source 22 is impressed on the grid 106. If the phase and frequency relationship between the first and second signals be varied so that the signals are not in exact synchronism, this unbalance will be modified and hence the voltage applied to the grid 106 will be correspondingly altered.

The output of the tube 108 feeds control coil 110 which, when energized pulls down the armature 112 of a suitable relay or switch 114, the switch controlling whatever sensible alarm may be desired. The alarm may be audible, such as a bell or buzzer, may be visual, in the form of a light, or may merely control suitable alarm equipment in a remote station. The exact nature of the alarm forms no part of the present invention.

The relay 114 is so connected to the alarm and the tube 108 is so biased that so long as a predetermined unbalance exists in the rectifier-coil circuit, the coil 110 will be energized and the relay 114 will be held in open position so that the alarm will not sound. As soon as said unbalance varies or disappears, however, the voltage applied to the grid 106 will be such as to bias the tube 108 either to cut off or so that it will pass an insufficient amount of current, thereby permitting the relay 114 to close and set off the alarm.

The power supply circuit for the apparatus is illustrated in Fig. 3. The regular power supply G may be derived from a standard 110 volt 60 cycle circuit such as is available in normal power distribution systems. The alternating current passes through fuses 116, which may be of 1 ampere, and through switches 118 which are manually closed whenever it is desired to put the system in operation. From there, one side of the source goes to ground and the other side passes through a rectification circuit 120 and a smoothing choke 122 to the high voltage D. C. tap 22. Interposed between the tap 22 and the A. C. source is a rectifier 126 so oriented as to permit current flow to the tap 22.

The alternating current power source is also connected via circuit dropping rheostat 128 to a low voltage line 130 which leads to D. C. connection points 132, 134 and 136 of differing voltages.

The standby power source H comprises a low voltage battery 138 and a high voltage battery 140 connected in series aiding. The low voltage side 142 of the low voltage battery 138 is connected to armature 144 of switch I. The control coil 146 of the switch I is connected via resistor 148 between the regular voltage source G and ground and is so related to the armature 144 as to maintain the latter out of electrical connection with the contact 150, which is in turn connected to ground, so long as the voltage of the regular source G exceeds a predetermined minimum value.

The high voltage end 152 of the low voltage source 138 is connected via manually operated switch 154 to the low voltage line 130 and is

also connected to the low voltage side 156 of the high voltage battery 140. The high voltage end 158 of the high voltage battery 140 is connected via manually operated switch 160 and rectifier 162 to the high voltage tap 22. The switches 154 and 160 are closed simultaneously with the switches 118.

The operation of the apparatus is as follows: The light source A will flash at a rate determined by the magnitude of the resistor 18 and capacitor 24 and the voltage source to which it is connected, generating second electrical signals in synchronism with the flashes. The photoelectric cell B receives the flashes and generates first electrical signals which are amplified and fed to the control element E. The amplified second electrical signals are also fed to the control element E, said control element being so biased as to pass current only when the two signals are in synchronism. The output of the control element E is amplified and directly compared with the second electrical signals, and if that output and the second electrical signals are in exact synchronism as to frequency and phase, a voltage will be applied to the control grid 106 which will keep the alarm from sounding. If the first electrical signals generated by the photoelectric cell B and the second electrical signals generated by the flashes of the light source A are not in synchronism, the grid 106 will become so biased as to cause the alarm to sound.

Hence, if an intruder interrupts the light beam 4, the second electrical signals will continue to be sent to the alarm control circuit but the first electrical signals will be interrupted. An unbalance will no longer exist in the alarm control circuit F and the alarm will sound indicating the presence of an intruder. If an intruder, by reason of shining an extremely bright light onto the photoelectric cell B or by any other means, should cause the control element E to pass current, the alarm would still sound because the first and second signals would not be in synchronism. If a would-be intruder should cause a counterfeit light source to illuminate the photoelectric cell B at a frequency equal to that of the genuine light source A, even then the alarm would sound unless the counterfeit and genuine light sources were in exact phase synchronism, a condition impossible to achieve from a practical point of view.

If the regular power source G should fail, the armature 144 of the switch I will fall and connect the low voltage battery 138 of the standby power source H in the circuit and the rectifier 162 is conductive in a direction to connect the high voltage battery 140 in the circuit so that the apparatus will continue to function. The rectifier 162 prevents the regular power source G, when it is effective, from feeding back into the auxiliary power source H, and the rectifier 126 prevents the high voltage standby source 140 from feeding back into the main power source G whenever its voltage is greater than that of the regular power source G while at the same time permitting the regular power source G to supply the high voltage tap 22.

Should both power sources fail, current will not pass in the coil 110 and the alarm will sound. Should the light source A fail, there will be no second electrical signals and the alarm will sound. Should the photoelectric cell B become defective, or should any of the circuit elements become disarranged, the alarm would also sound.

From the above it will be realized that by the arrangement described, and by the method of operation set forth, a photoelectric detection system has been devised which is fool-proof, dependable, of such a nature as to be capable of being operated by a standby battery source over a long period of time, simple of construction and maintenance, and exceedingly valuable in intruder detection. While only one embodiment of this invention has been here disclosed, it will be apparent that the method and apparatus, and particularly the detailed circuit elements thereof, may all be varied widely without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A photoelectric detection apparatus comprising a light source which flashes intermittently, a photoelectric element positioned to receive said flashes and convert them into first electrical surges synchronized with said received flashes, a signal circuit connected to said light source for generating second electrical surges in synchronism with the flashes of said light source, a control element having an electrical input and an electrical output, connections between said photoelectric elements and said signal circuit on the one hand and said input on the other hand effective to transmit said first and second surges additively in surge form to said input, and connections between said output and an alarm control circuit, said control element being effective to produce an electrical output to said alarm control circuit in synchronism with said first surges only when said first and second surges are in synchronism, said alarm control circuit utilizing said electrical output to control a sensible alarm.

2. The photoelectric detection apparatus of claim 1, in which said alarm control circuit comprises a center-tapped coil inductively connected to one of said electrical output of said control element and said signal circuit, the other of said electrical output and said signal circuit being conductively connected to the center-tap of said coil, an unbalance thus existing when said electrical output and said second surges are in synchronism, said coil being connected to a switch controlling a sensible alarm in a sense such that said alarm will be prevented from being set off so long as said unbalance continues to exist.

3. The photoelectric detection apparatus of claim 2, in which said coil is inductively connected to said electrical output and is conductively connected to said signal circuit.

4. The photoelectric detection apparatus of claim 1, in which said alarm control circuit is also connected to said signal circuit and is effective only when said first and second signals are not in synchronism to set off a sensible alarm.

5. A photoelectric detection apparatus comprising a light source which flashes intermittently, a photoelectric element positioned to receive said flashes and convert them into first electrical signals, a signal circuit connected to said light source for generating second electrical signals in synchronism with said flashes, a vacuum tube having electrodes connected to said photoelectric element and said signal circuit and having an output circuit, said tube being normally biased to cut off and said bias being so related to said first and second signals that only when said first and second signals are in synchronism will said tube pass current in its output circuit, said current being in synchronism

with and having the same frequency as said first signals, and an alarm control circuit connected to said output circuit for utilizing the current flowing therein for setting off a sensible alarm.

6. The photoelectric detection apparatus of claim 5, in which said alarm control circuit comprises a center-tapped coil inductively connected to one of said output circuit and said signal circuit, the other of said output circuit and said signal circuit being conductively connected to the center-tap of said coil, an unbalance thus existing when said current in said output circuit and said second signals are in synchronism, said coil being connected to a switch controlling a sensible alarm in such a way that said alarm will be prevented from being set off so long as said unbalance continues to exist.

7. The photoelectric detection apparatus of claim 6, in which said coil is inductively connected to said output circuit and is conductively connected to said signal circuit.

8. The photoelectric detection apparatus of claim 5, in which said alarm control circuit is also connected to said signal circuit and is effective only when current in said output circuit and said second signal are not in synchronism to set off a sensible alarm.

9. A photoelectric detection apparatus comprising a light source which flashes intermittently, a photoelectric element positioned to receive said flashes and convert them into first electrical signals in synchronism with said received flashes, a signal circuit connected to said light source for generating second electrical signals in synchronism with the said flashes of said light source, and an alarm control circuit connected to said signal circuit and to said photoelectric element, said alarm control circuit comprising a center-tapped coil inductively connected to one of said signal circuit and said photoelectric element, the other of said signal circuit and said photoelectric element being conductively connected to the center-tap of said coil, an unbalance thus existing when said signals are in synchronism, the extremities of said coil being connected to a pair of rectifiers in series opposing, a vacuum tube have a control grid connected to one side of one of said rectifiers, and a voltage source connected to the other side of the other of said rectifiers, the output electrode of said vacuum tube being connected to a coil adapted to actuate a switch controlling a sensible alarm, whereby, so long as said unbalance continues to exist, the average voltage across said rectifiers will bias said tube to one output condition, and when said unbalance ceases to exist, said tube will be biased to a different output condition.

10. A photoelectric detection apparatus comprising a light source which flashes intermittently, a photoelectric element positioned to receive said flashes and convert them into first electrical signals in synchronism with said received flashes, a signal circuit connected to said light source for generating second electrical signals in synchronism with the said flashes of said light source, and an alarm control circuit connected to said signal circuit and to said photoelectric element, said alarm control circuit comprising a center-tapped coil inductively connected to one of said signal circuit and said photoelectric element, the other of said signal circuit and said photoelectric element being conductively connected to the center-tap of said coil, an unbalance thus existing when said signals are in synchronism, the extremities of said coil being connected to a pair of rectifiers in series opposing, a vacuum tube having a control grid connected to one side of one of said rectifiers and a voltage source connected to the other side of the other of said rectifiers, the output electrode of said vacuum tube being connected to a coil adapted to actuate a switch controlling a sensible alarm, whereby, so long as said unbalance continues to exist, the average voltage across said rectifiers will bias said tube to a current passing condition and when said unbalance ceases to exist, said tube will be biased to cut off.

11. A photoelectric detection apparatus comprising a light source which flashes intermittently, a photoelectric element positioned to receive said flashes and convert them into first electrical signals in synchronism with said received flashes, a signal circuit connected to said light source for generating second electrical signals in synchronism with the said flashes of said light source, and an alarm control circuit connected to said signal circuit and to said photoelectric element, said alarm control circuit comprising a center-tapped coil inductively connected to one of said signal circuit and said photoelectric element, the other of said signal circuit and said photoelectric element being conductively connected to the center-tap of said coil, an unbalance thus existing when said signals are in synchronism, the extremities of said coil being connected to a pair of rectifiers in series opposing, a vacuum tube having a control grid connected to one side of one of said rectifiers and a voltage source connected to the other side of the other of said rectifiers, the output electrode of said vacuum tube being connected to a coil adapted to actuate a switch controlling a sensible alarm, whereby, so long as said unbalance continues to exist, the average voltage across said rectifiers will bias said tube to an output condition such that said switch will be retained in open position and when said unbalance ceases to exist, said tube will be biased to an output condition such that said switch will move to closed position and set off said alarm.

12. The photoelectric detection apparatus of claim 9, in which said signal circuit is conductively connected to said coil and said photoelectric element is inductively connected thereto.

13. The photoelectric detection apparatus of claim 10, in which said signal circuit is conductively connected to said coil and said photoelectric element is inductively connected thereto.

14. Apparatus for photoelectric detection comprising a light source, means for causing said light source to flash intermittently, means for detecting said flashes and converting them into first electrical surges synchronized with said received flashes, an electrical circuit adapted to be connected to an alarm for operating the latter in accordance with the magnitude of the current passing through said circuit, a control element connected in said electrical circuit so as to regulate the passage of current through said circuit, means for applying said first surges to said control element, means for applying second electrical surges to said control element in additive relation to said first surges, said second surges being in synchronism with the flahes of said light source, the regulatory action of said control element being sensitive to the magnitudes of said first and second surges, the magnitude of each of said first and second surges alone being insufficient to actuate said control element sufficiently to change the status of said alarm but their magnitudes being such that only when they are applied to said control element together and in

synchronism will they actuate said control element sufficiently to change the status of said alarm.

15. Apparatus for photoelectric detection comprising a light source, means for causing said light source to flash intermittently, means for detecting said flashes and converting them into first electrical signals synchronized with said received flashes, an electrical circuit adapted to be connected to an alarm for operating the latter in accordance with the magnitude of the current passing through said circuit, a vacuum tube having electrodes connected in said electrical circuit so as to regulate the passage of current through said circuit, means for biasing said tube to cut off, means for applying said first surges to an electrode of said tube, means for applying second electrical signals to an electrode of said tube in additive relation to said first signals, said second signals being in synchronism with the flashes of said light source, the magnitude of each of said first and second signals alone being insufficient to overcome the bias of said tube so as to permit it to pass current, but their magnitudes being such that only when they are applied to said tube together and in synchronism will they overcome said bias and cause said tube to pass current, thus changing the status of an alarm.

16. Apparatus for photoelectric detection comprising a light source, means for causing said light source to flash intermittently, means for detecting said flashes and converting them into first electrical surges synchronized with said received flashes, an electrical circuit adapted to be connected to an alarm for operating the latter in accordance with the magnitude of the current passing through said circuit, a vacuum tube having electrodes connected in said electrical circuit so as to regulate the passage of current through said circuit, means for biasing said tube to cut off, means for applying said first surges to an electrode of said tube, means for applying second electrical surges to an electrode of said tube in additive relation to said first surges, said second surges being in synchronism with the flashes of said light source, the magnitude of each of said first and second surges alone being insufficient to overcome said bias and permit said tube to pass current but their magnitude being such that only when they are applied to said tube together and in synchronism will they overcome said bias and cause said tube to pass current, thus changing the status of an alarm.

17. In the apparatus of claim 14, means for comparing the current in said electrical circuit with said second electrical surges and means for setting off an alarm when said current and said surges are not in synchronism.

18. In the apparatus of claim 15, means for comparing the current passed by said tube with said second electrical signals, and means for setting off an alarm when said current and said signals are not in synchronism.

19. In the apparatus of claim 16, means for comparing the current passed by said tube with said second surges, and means for setting off an alarm when said current and said surges are not in synchronism.

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