United States Patent [19]

Campman

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[45] Oct. 8, 1974

[54] **INTRUSION DETECTING APPARATUS**

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[73] Assignee: **Vidar Laboratories, Inc.,** Kensington, Md.

[22] Filed: **Jan. 15, 1973**

[21] Appl. No.: **323,751**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 248,211, April 27, 1972, Pat. No. 3,781,842.

[52] **U.S. Cl.**..... **340/258 B,** 250/221, 340/228 S, 340/420

[51] **Int. Cl.**..... **G08b 19/00,** G08b 13/18

[58] **Field of Search**..... 340/258 B, 258 A, 228 S, 340/227 R, 276, 420; 250/210 X, 210, 209 X, 209, 221 X, 221, 222 R, 211 X

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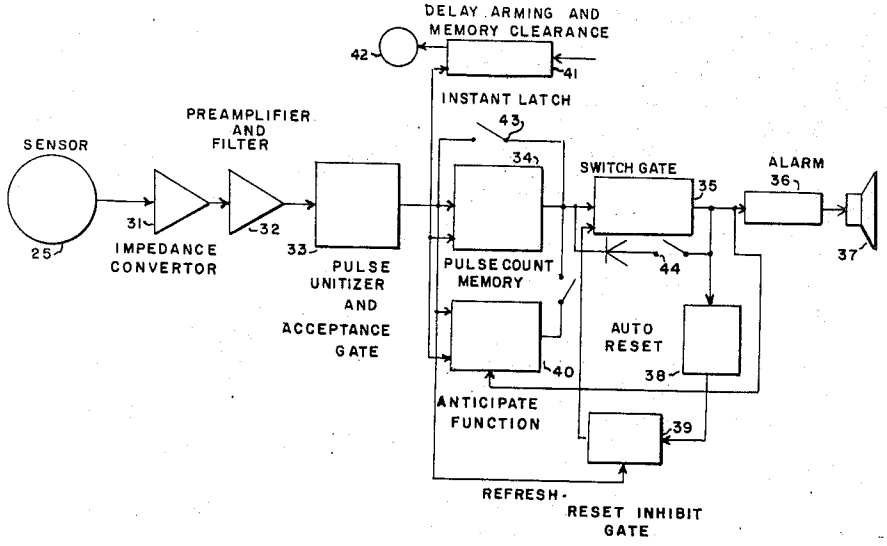
Primary Examiner—Glen R. Swann, III

Attorney, Agent, or Firm—Jack H. Linscott

[57] **ABSTRACT**

The invention comprises of improvements in motion detecting apparatus, wherein, there is a lens for producing an image of a space under surveilence upon a retina of at least three sensory units spaced from each other in the focal surface of the lens. Each sensory unit comprises of two photoconductive cells, the cells having response characteristics in different but partially overlapping portions of the range of variations of illumination level. The cells are connected in series with a current limiting resistor and a first source of voltage. An output circuit from the sensory units is connected across the circuit including one of the cells and the current limiting resistor. Also included is a source of higher voltage connected through a fixed resistor in series with one cell and the current limiting resistor. The sensor units provide for automatic adaptation of the apparatus to changing levels of illumination of the imaged space. The invention further includes signal processing means for segregating the desired signals from other signals on the basis of their frequencies, a means for producing pulses of uniform energy content in response to signals, a capacitor for receiving the uniform energy pulses and producing a triggering voltage, and a triggering means having a predetermined threshold voltage for turning on the alarm. The invention still further includes a latching means for continuing the operation of the alarm once it is initiated, a reset means for automatically unlatching the apparatus at a predetermined time after the latching, a refresh means for increasing the time of latching in response to continued motion, and means for anticipating motion for a predtermined time interval after the reset operation, which if it occurs, will render the apparatus immediately responsive. The invention further includes means for delaying the arming of the apparatus and for indicating when the arming is being processed.

10 Claims, 11 Drawing Figures



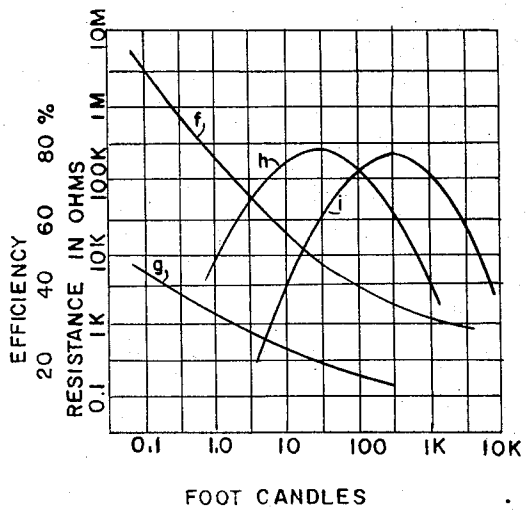


FIG. 1

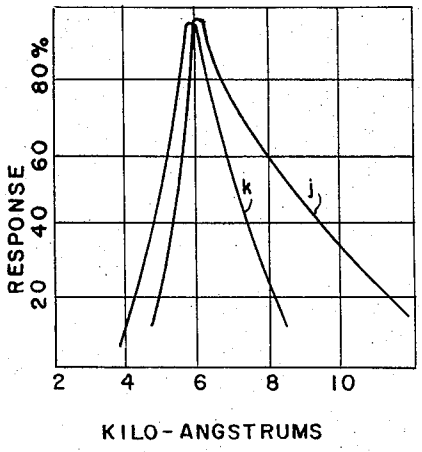


FIG. 2

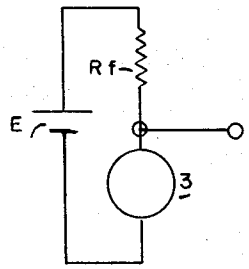


FIG. 3A

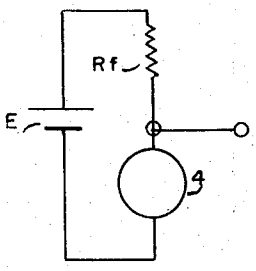


FIG. 3B

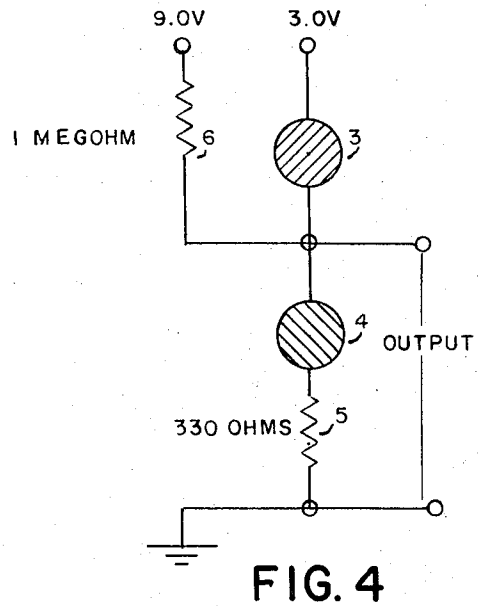


FIG. 4

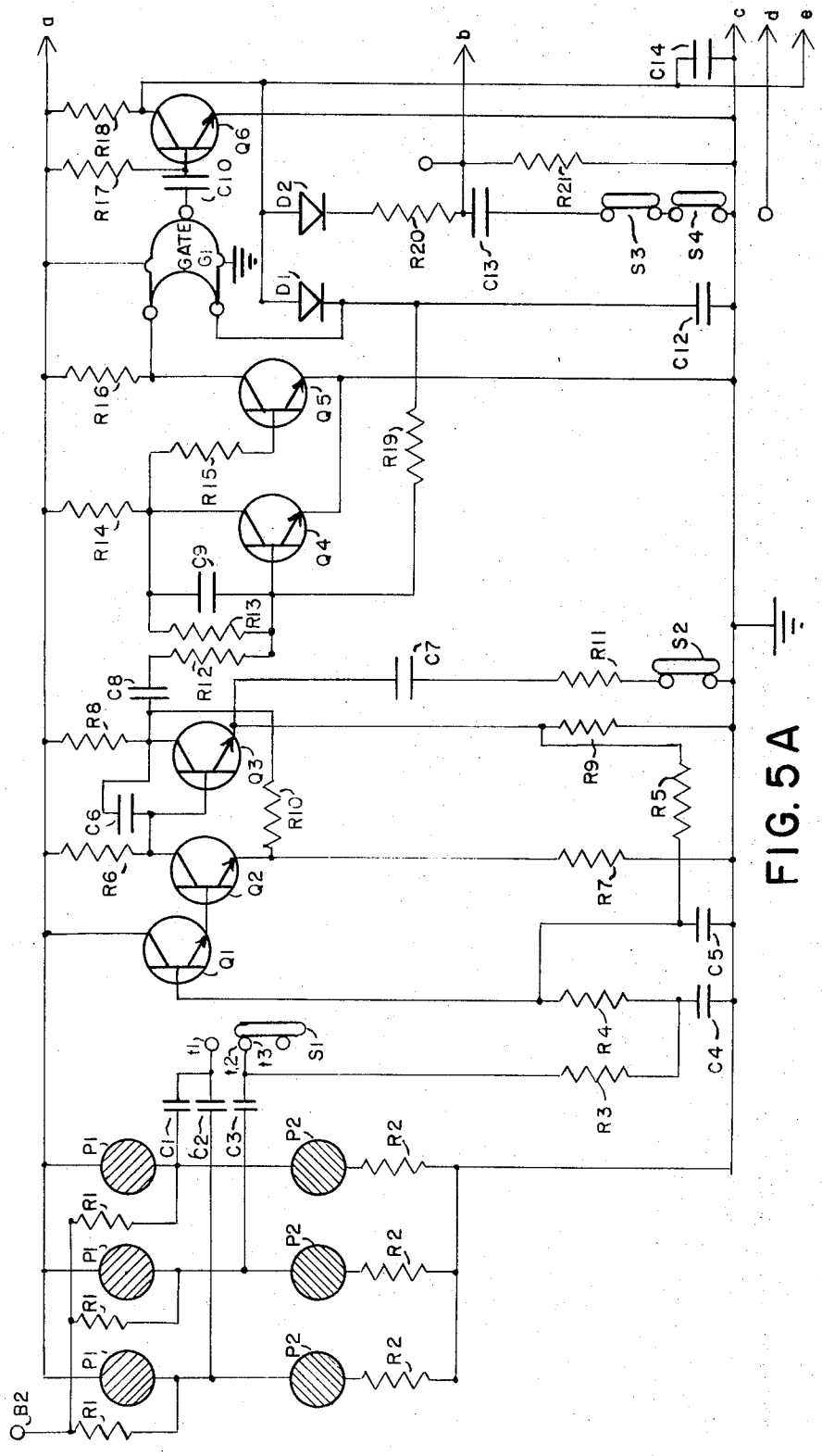

a
b
c
d
e
C14
R18
Q6
C10
R17
D2
R21
R20
C13
S3
S4
GATE
G1
D1
C12
R16
Q5
R19
R15
R14
Q4
C9
R13
R12
C8
C7
R11
S2
R8
Q3
R9
R5
C6
R10
R6
Q2
R7
Q1
C5
C4
R4
R3
S1
t1
t2
t3
C1
C2
C3
P1
P2
R1
R2
B2

FIG. 5A

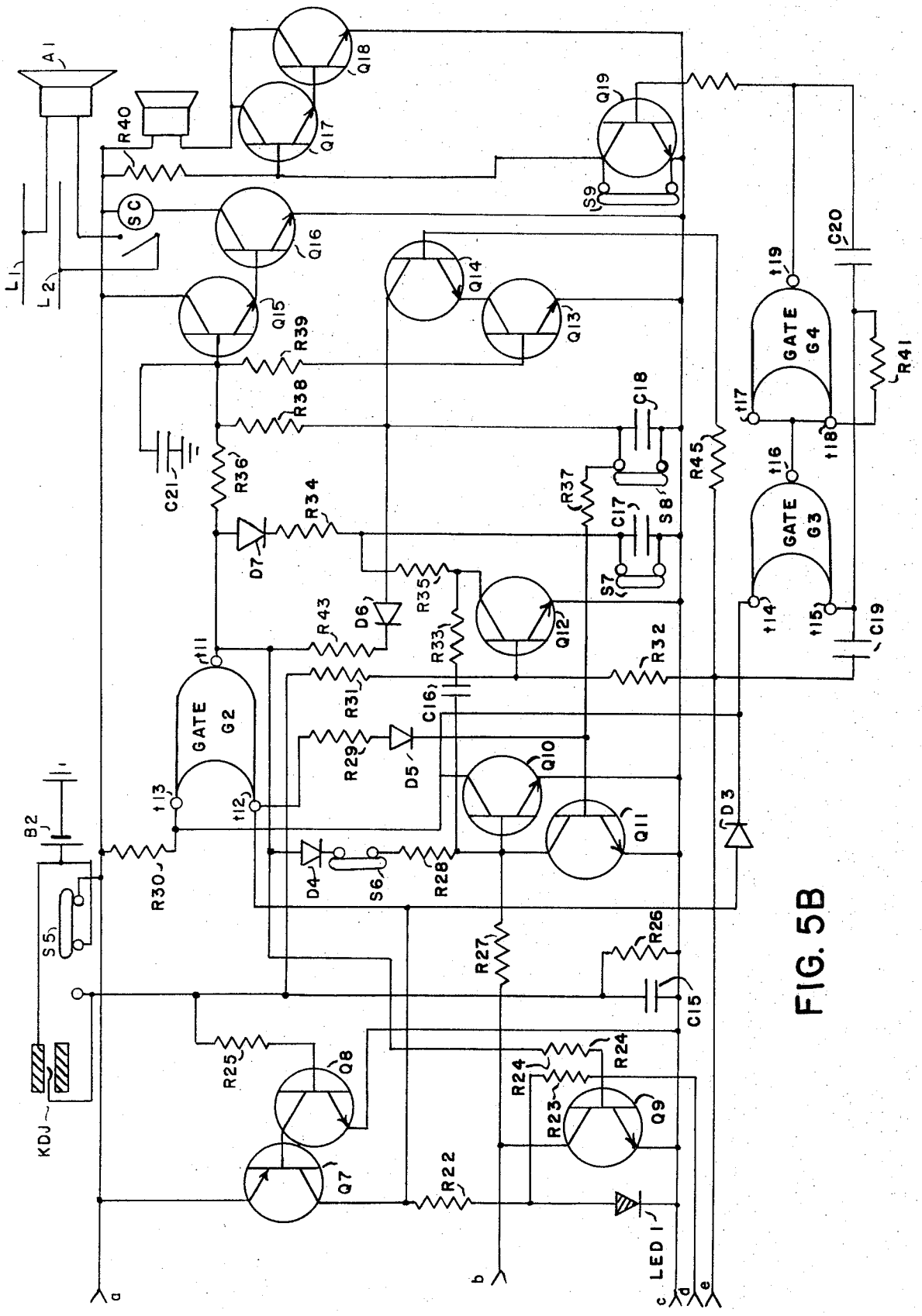

A1
R40
Q18
Q17
Q19
S9
SC
Q16
L1
L2
Q15
Q14
Q13
R39
R38
C18
C20
t19
GATE G4
R41
t17
t18
C21
R36
R34
R37
C17
S8
R45
t16
GATE G3
D7
S7
R35
R43
D6
Q12
t14
t15
C19
t11
R33
R32
GATE G2
R31
C16
R29
D5
Q10
t13
t12
B2
Q11
D3
R30
D4
S6
R28
S5
R27
R26
C15
R25
Q8
R24
R24
R23
Q9
KDJ
Q7
R22
LED 1
a
b
c
d
e

FIG. 5B

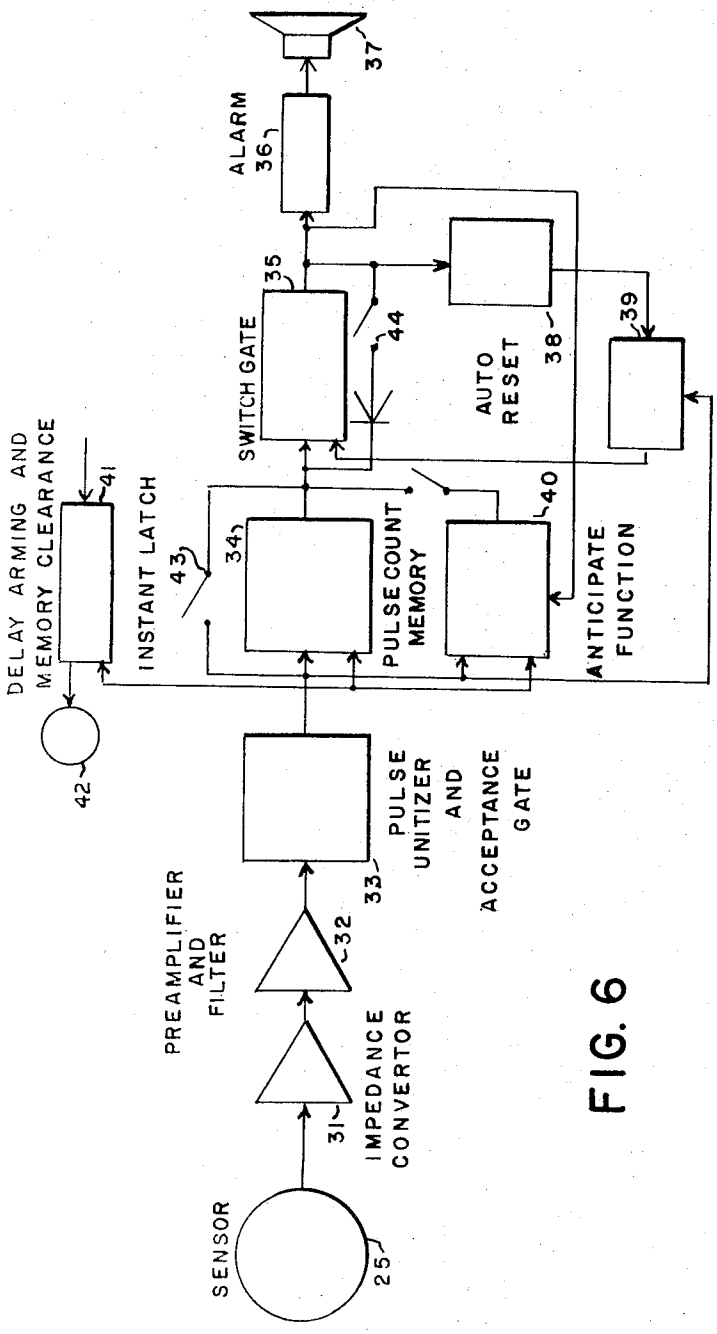

SENSOR
25
IMPEDANCE CONVERTOR
31
PREAMPLIFIER AND FILTER
32
PULSE UNITIZER AND ACCEPTANCE GATE
33
PULSE COUNT MEMORY
34
INSTANT LATCH
43
DELAY ARMING AND MEMORY CLEARANCE
41
42
ANTICIPATE FUNCTION
40
REFRESH
RESET INHIBIT GATE
39
AUTO RESET
38
SWITCH GATE
35
44
ALARM
36
37

FIG. 6

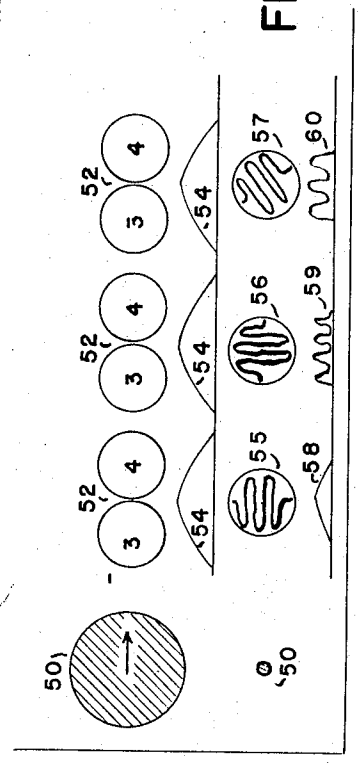

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FIG. 9

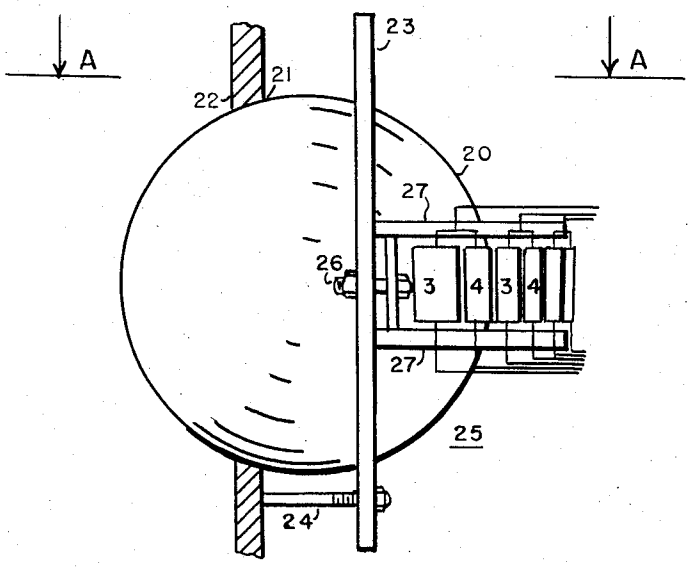


FIG. 7

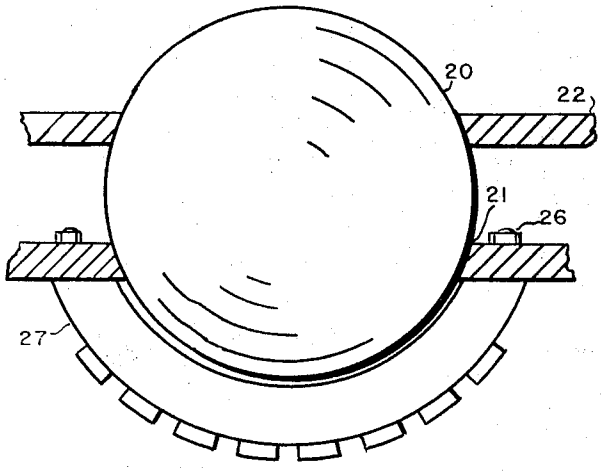


FIG. 8

INTRUSION DETECTING APPARATUS

RELATED APPLICATIONS

This application is an improvement upon and a continuation in part of my copending application Ser. No. 248,211, filed Apr. 27, 1972, entitled, "Cat's Eye Intrusion Detecting Apparatus" now U.S. Pat. No. 3,781,842.

GENERAL DESCRIPTION OF INVENTION

This invention relates to an apparatus designed to view a space or area removed therefrom, to detect any motion that takes place in said space or area and to produce an alarm or indication in response to the motion.

In my prior application a spherical lens means had a retina of photosensitive cells attached to its surface. The cells all had the same response characteristics. The lens produced a pattern of shadows upon the retina, which, when motion took place would cause a change in the pattern of shadows. To obtain optimum signal strength when operating at opposite ends of the range of light levels requires light sensitive cells in the sensory means which have the light response characteristics most favorable at the operating level. Thus, either the sensory means must be designed to meet the requirements of one level of illumination or the other, or, two sensory means need to be provided within a given piece of apparatus, with switch means to selectively connect the cells as the light level changed.

A new approach to the problem of response has been taken in the present invention. It is to provide an adaptive function in the sensory means, that is, to provide a sensory means that automatically adapts itself to the operating level of illumination, to produce signals of the optimum strength through out the whole range of changes of illumination from full sun-light to substantially complete darkness. It is an electronic synthesis of a bio-function, for example, that of the human eye which has adaptive characteristics in response to intensity and spectral changes in illumination.

The improvements herein pertain specifically, though not exclusively, to the design and arrangement of components in a sensory means and in the combination of the sensory means with a signal processing apparatus that is tailored to make use of the improvements in the sensory means. The improvements also include built-in apparatus that enables the detector to be readily adapted to the general requirements imposed by the environments in which the apparatus is to be used, thus increasing the universality of utilization of the apparatus.

OBJECTS OF THE INVENTIONS

In the present invention it is an object to provide a detector apparatus having a more uniform response characteristic fo the full range of possible changes of illumination and to increase the range of response of the apparatus.

It is another object to provide a detector apparatus that is capable of being adjusted for different depths of field of view.

Another object of the invention is to provide a detector apparatus which will have a response in the near infrared region of the light spectrum, particularly, during low levels of visible illumination.

A further object of the invention is to provide within the detector apparatus a control means for selectively altering the response to suit the enviromental conditions.

A further object is to provide apparatus wherein the character of the indicating alarm can be selectively changed.

A still further object is to provide a detector apparatus which will be economically within the reach of the average home owner and small business man.

Other objects of the invention will become obvious from the disclosure as it proceeds.

DESCRIPTION OF DRAWINGS

In the drawings:

FIG. **1** is a chart disclosing a comparison of the response characteristics of two types of photocells with changes in the levels of illumination;

FIG. **2** is a chart disclosing a comparison of the responses of two types of photocells with changes in the spectral content of the illumination;

FIGS. **3A** and **3B** are similar circuits for two types of cells for the disclosure of the problems in obtaining optimum responses;

FIG. **4** is a schematic view of a sensory unit in which cells having different response characteristics are combined to provide for an automatic adaptation to changes in illumination level;

FIGS. **5A** and **5B** are schematic views, which together illustrate the electronic circuit of the apparatus;

FIG. **6** is a block diagram of the apparatus for illustrating the important functions of the apparatus;

FIG. **7** is an elevational view of the sensory means partly in section, illustrating the mechanical features of the structure for mounting the lens and the retina;

FIG. **8** is a plan view, partly in section of the sensory means, taken on line A—A in FIG. **7** looking in the direction of the arrows; and

FIG. **9** is a chart illustrating conditions resulting from two depths of view for illustrating how the orientation and spacing of the sensory units can be used to predetermined the frequency of the real signals.

SPECIFIC DESCRIPTION OF THE INVENTION

The photosensitive elements in the present invention are of the photoconductive type. They are composed of a serpentine deposit of a photoconductive material on a substrate of insulating material. The resistance of the serpentine deposit changes with the intensity of the light which impinges upon it and with the length of the deposit that is illuminated. The resistance decreases with increase in light level and with increase of length of the serpentine deposit that is illuminated and vice versa.

Two kinds of photoconductive materials are used in the invention. One is a cadmium sulphide material having a dark (2 ft. candles) resistance in the neighborhood of 1 to 10 megohms and a resistance in the neighborhood of 1,000 ohms at 1,000 ft. candles of illumination. The other material is cadmium selenide having a dark (2 ft. candles) resistance of about 1,000 ohms and a resistance of about 1 ohm at 1,000 ft, candles of illumination. In FIG. **1** curve f represents the resistance changes with changes of illumination in the cadmium sulphide cell and curve g represents the resistance

changes with changes of illumination on the cadmium selenide cell.

On the same chart, FIG. 1, the curves h and i respectively represent the variations in the percentage of efficiency with changes of illumination of the cadmium selenide and cadmium sulphide cells. It is important to note the relative values of dark resistance of the two materials to understand the operation of the sensory means.

Another characteristic, not illustrated, which is beneficial, though not of major importance, is the relative temperature response of the materials. The temperature coefficients are a function of the light level as well as of the material. Cadmium sulphide cells have a lower coefficient of resistance and in general its resistance changes inversely with temperature change.

Cadmium selenide has a considerably greater coefficient of resistance and its resistance varies directly with the changes in temperature. The coefficients being also a function of change in light, vary inversely as the light level varies. Thus, in the midregion of illumination level, the resistance variations due to temperature variations would tend to cancel when the two cells are connected in series, or at least the changes in resistance would be minimized.

The spectral response of the cadmium sulphide and cadmium selenide materials is shown in FIG. 2 of the drawings. As represented, cadmium sulphide *k* has a usable response that extends over the green portion of the visible light spectrum (5,500 to 5,000 Angstroms), whereas, cadmium selenide *j* has a usable response that extends down into the near infra-red region (7,000 to 7,100 Angstroms). During periods of low illumination a response in the near infra-red region will enhance the response of the sensory units to visible light, and extend the response range of the apparatus to beyond the visible light levels.

When these cells are used for the detection of motion the cells are exposed to two different rates of change of light variations. One is relatively slow, in the matter of hours, that illuminates the field of view and the whole retina. This change in illumination, I term static illumination because the change is so slow that it does not generate a signal. It does, however, cause changes in the response of the sensory means and in that way affects the signal strength. In the case of cadmium sulphide, when the illumination varies from darkness to bright sunlight the resistance of the cell changes from about ten megohms down to around one thousand ohms I designate this change in resistance as ΔR.

The other resistance change takes place due to motion in part of the image as for example motion of a person which is imaged when a person enters the space that is viewed. When there is motion in the field of view of the lens system, images of the movable objects or persons move across the sensitive surfaces of the cell to set up pulsating changes in the resistance of the cells. The pulsating changes in the resistances of the cells produce pulsating currents which in passing through a resistance produce pulsating voltage drops across the sensory units. I designate the pulsating change in resistance as partial *r* or as δr, to distinguish from the long term change in resistance of the cells. The signal voltages that are produced is the result of the partial change in resistance δr and it is superimposed upon the steady voltage drop that exists because of the level of the illumination being experienced by the cells.

The signal voltage is represented by the following equation:

$$e_{is} = I\,\delta\, r/\Delta\, R$$

the current I is assumed to be constant.

In FIG. 3A and 3B is a series circuit, each including a fixed resistor R_f and a photoconductor whose resistance is variable with changing light levels. The two circuits are the same except that in FIG. 3A the photoconductor 3 is one kind of material and in FIG. 3B the photoconductor 4 is of another kind of material, as for example respectively cadmium sulphide and cadmium selenide. In each of the circuits the output is taken from across the photoconductor. It could, if desired be taken from across the fixed resistor. The only difference would be in the direction of the change of voltage drop obtained. The supply voltage across the circuits is assumed to be constant. When there is a change in the resistance of the photoconductive cells there is a change in current in the circuit because the total resistance is changed. The total voltage drop across the circuit is constant because the supply voltage is constant, thus what happens is merely a redistribution of the voltage drops. The voltage drop across the circuit will be equal to $E = IR_f + IR_{pc}$, where I is the current at any level of illumination, $R_f = 10{,}000$ ohms, R_{pc} is the resistance of the photoconductive cells at the prevailing light levels and E = 1 volt.

From the equation $e_{is} = I\,\delta r/\Delta R$

it can be seen that the strength of the signal is dependent upon the static resistance ΔR, which changes with each change in illumination level of the cell. It is necessary to see how changes in ΔR affects the strength of the output signals in the two circuits.

To exemplify this, there will be three assumed light levels under which cells 3 and 4 will be operating. Since the cells have different resistance characteristics, the resistance for each given light level will be different for each of the cells, and can be determined from the chart in FIG. 1. Let the assumed light levels be 3, 50 and 1,000 foot candles. The following table will show the respective resistances of the cell for each light level.

Table 1

Light level	3	50	1,000
R_{pc3}	100,000	10,000	1,000
R_{pc4}	1,000	500	100

In the series circuit the only variable is the resistance of the photocells. From table 1 it will be seen that the photocell 3 has a higher resistance at the lower levels of illumination than photocell 4, the ratio is approximately 100/1 and at higher levels of illumination the photocell 3 has a higher resistance than cell 4 by a ratio of 10/1. Thus, at higher light levels, photocell 3 would require very much smaller current values to obtain a measurable signal voltage than would be required in cell 4 because of its much lower resistance. At the lower light levels, the resistance of cell 3 rises to extremely high values. It would thus require a very high voltage to obtain a current value adequate to produce a measurable signal voltage

Referring to FIG. 4 there is a schematic of a circuit in which the cells 3 and 4 are combined to form a single sensory unit. The cells are respectively cadmium sulphide and cadmium selenide cells. They are connected

in series with a current limiting resistor **5** having a resistance of **330** ohms. The series circuit is connected across a three volt sourc of energy. A nine volt souce of energy is connected in series with a high resistance resistor, across the photocell **4** and the current limiting resistor **5.** The high resistance resistor **6** has a resistance of 1 megohm. The output circuit is connected across the photocell **4** and the current limiting resistor **5.**

Under very high levels of illumination, the impedance of the cadmium selenide cell **4** is very low. A very high current would be required for it to develope a measurable voltage drop. The cadmium sulphide cell **3** exhibits considerably more impedance at the higher levels of illumination, thus a small current would be required to produce a measurable voltage drop at the output. It is during periods of high illumination levels that the cadmium sulphide cells **3** function to produce the greater voltage drop in the output circuit. On the other hand, at low levels of illumination the resistance of the cadmium sulphide cell **3** becomes so high that no measurable current flows from the 3 volt source through it. At the same time, that the cadmium sulphide cell is experiencing high resistance, the cadmium selenide cell has a much lower resistance and current through it from the nine volt source to produce a measurable voltage drop.

The operation is such that during the high levels of illumination the cadmium sulphide cell **3** is dominant in producing the signal voltages. During the middle region of illumination levels both of the cells function to produce the voltage drop at the output. During extremely low levels of illumination the cadmium selenide cell **4** is dominant in producing the signal voltages.

Since the structure and mode of operation of the sensory unit, exemplified in FIG. 4 is very important part of the invention, it is considered necessary to demonstrate its operation. For this purpose four different levels of illumination are assumed. The approximate resistances of the photocells **3** and **4** at each of the assumed levels can be obtained from the chart in FIG. **1.** The other values such as the resistances of the resistors **5** and **6** and the voltages of the two sources is given in FIG. **4** of the drawings.

To show the comparisons in values a table, as derived from calculations, is herein provided. The light levels are shown at the top of the table. The resistances of the photocells are designated as R_{pc3} and R_{pc4} respectively, the total resistance across the circuits fed from the separate sources of voltages is represented by $R_{t3\ and\ Rt9}$; the currents in these circuits are represented by I_3 and I_9. The total current across the output circuit is the sum of the separate currents through the photocell **4.** The voltage drops VD_3, VD_9 and VD_t are respectively the voltage drops produced by the 3 volt source, the 9 volt source and that appearing across the output circuit.

Ill. Level	0.1	3	50	1,000 ft cand.
R_{pc3}	5meg.	100 Kilo.	10 Kilo.	1 Kilo ohms
R_{pc4}	7.5 Kilo.	1 Kilo.	.5 Kilo.	.1 Kilo. ohms
$R_{t3}=R_{pc3}+R_5+R_{pc4}$	5,007,850	101,350	10,850	1,450 ohms
$R_{t9}=R_6+R_{pc4}+R_5$	1,007,850	1,001,350	1,000,850	1,000,450 ohms
$I_3=E_3/R_{t3}$	.0000005	.000029	.000276	.00206 amps
$I_9=E_9/R_{t9}$	.00000892	.000008987	.00000992	.000008996 amps
$VD_3=I_3(R_{pc4}+R_5)$	.000392	.03915	.2346	.0927 volts
$VD_9=I_9(R_{pc4}+R_5)$	.0700	.0121	.0072	.0040 volts
$VD_t=VD_3+VD_9$	.0701	.0512	.2418	.931 volts

From the above table of values, it can be readily seen that a greater portion of the voltage drop across the output is produced by photocell **4** as the light level decreases. This is evident from the comparison of the VD_3 AND VD_9 values at the lower light levels. At the higher light levels, the photocell **3** produces a voltage drop of 0.927 as compared with a voltage drop of 0.0040 volts for the photocell **4.** In this instance it is clear that the photocell **3** produces the greater portion of the voltage drop across the output circuit. In the middle range of changing light levels both cells operate to share in producing the voltage drop across the output circuit.

In addition, in the lower levels of the illumination when cell **3** ceases to produce any significant portion of the output voltage drop, the cell **4,** which has a response in the near infra-red region of the light spectrum will be able to see motion that the human eye cannot detect and will produce the significant portion of the signal voltage. To this extent the range of response of the present sensory unit exceeds that of the human eye.

It has been demonstrated how the circuit of FIG. **4** operates to satisfy the adaptive function of the sensory means to changing light levels. A more uniform response over the entire range of changing light levels is obtained in the use of the two cells as connected and supplied with energy, than can be achieved by other connections of the two separate cells.

Referring now to FIGS. **7** and **8,** there is a fragment of a casing **22** that serves to enclose the power sources, the processing circuitry and to mount the sensory means.

The sensory means comprises of a spherical lens **20** which is used to view an area or space to be placed under surveilence and to project an image. The casing wall **22** is provided with a circular aperture **21** having a diameter somewhat less than the diameter of the spherical lens. A plate **23** having an aperture **21** of the same diameter as the casing wall engages the opposite surface of the spherical lens. The plate **23** is secured to the casing by a plurality of bolts **24** spaced about the perimeter of the aperture. The spherical lens is held firmly against the inner side of the casing wall.

A retina for receiving the images projected by the spherical lens **20** is mounted on the plate **23.** The mounting means for the retina consists of two annularly shaped plates **27** held in spaced parallel relation to each other by a separator located at the ends of the plates **27.** The separators are attached to the plates **27,** forming a unitary structure therewith. The mounting means is attached to the plate **23** by volts **26** passing through apertures in the plate **23** and in the separators.

The inner arcuate edges of the plates **27** fit snugly against the surface of the spherical lens and the diametrical dimension of the plates **27** is such as to locate their outer arcuate edges at the focal length of the spherical lens.

The retina is attached to the other arcuate edges of the plates 27 and is supported thereby between the plates 27. The retina in the illustrated example of the apparatus consists of five sensory units, each containing a pair of cells 3 and 4 electrically connected in series. More than five units may be used if desired and the width of the retina may also be made wider to cover a greater area of the spherical surface of the lens. The cells 3 and 4 arranged parallel to each other and are spaced from each other just sufficient enough to prevent short circuits. The sensory units, on the other hand, are spaced along the outer edges of the plates 27 and the retina so formed extends over about 30 percent of the circumference of the lens.

The spacing of the sensory units in the circumferential distance about the spherical lens and the orientation of the cells relative to the vector of motion of the images across their sensitive surfaces is an important consideration in the structure of the sensory means.

For example, in devices of the character of the invention, there are many causes of false alarms, that tend to render such devices unreliable. It is therefore always desirable in every such device to provide a signal with distinguishable characteristics that will enable the real signals to be separated from the false signals. The structure of the sensory means can be utilized to produce such characteristics that will enable the real signal to be separated from the false signals in the processing thereof.

In the present apparatus it is motion of an object or person that is to be detected. The lens projects an image of the object or person on the retina and as the object or person moves in the field of view of the lens the image traverses the retina. There are upper limits and lower limits of speeds of motion which can be expected from the object or person whose motion it is to detect. Other motions, as for example those caused by traveling light patterns caused by passing vehicles, would have other speeds of motion, more often than not, to be outside the speed range of the object or person whose motion is to be detected.

The spacing of the cells in the equatorial plane can be made such as to produce a frequency of pulsations to the signal that results, which would be within a certain range of frequencies. Other motions would be the cause of the production of signals having a different frequency from that of the real signal. Thus by importing a characteristic that depends on the rate of motion of the image in traverse of the cells of the retina, the real signal can be distinguished and separated from the false signals.

To demonstrate reference is made to FIG. 9, wherein the cells arranged in a horizontal line and the traverse of the image is in a horizontal direction. In this instance the image 50 of the movable object in a field of view is much larger than the sensitive area of the cells 3 and 4. As the image moves along the line of travel from one sensory unit to the next, the resistance of the sensory units will vary as shown by the curve 54. The variations of the resistance produce pulses in the current passing through the units, which when connected through capacitors alternately charge and discharge the capacitors to produce alternating voltages, the frequency of which depends on the number of pulses per second produced in the sensory means. The frequency of the alternating current voltage is determined by the speed of motion of the image and by the spacing of the sensory units in the direction of such motion. The range of variations of speed of motion of the image determines the range of frequency variations. The spacing of the units determine the average frequency of the signal due to the motion of the image. The above example pertains to a condition where the field of view is close to the detecting apparatus.

When the field of view of the area under surveilence is at a greater distance from the lens, the image of the movable object produced on the retina will be much smaller and the range of movement of the image will be lessened. In this instance, it is conceivable that the image would be restricted in its extent of movement to the distance between cells 3 and 4. The configuration of the sensitive surface on the cells then becomes a factor in controlling the frequency of the output signal. The sensitive material of the cells is deposited in a serpentine configuration on the insulating base. In FIG. 9 three example of orientation of the cells are disclosed, namely that of 55 in which the fewer portions of the configuration would be traversed by the image; that of 56 in which a greater number of portions of the configuration would be traversed by the image and that of 57 in which a lesser number of portions of the sensitive configuration would be traversed by the image than in the example 56. The image 50 of the movable object in this instance, is smaller than the area of the cells. In the first example, a traversal of the image across the cell would produce between one and three pulses, one being illustrated. The signal would be one alternation per cell or a number of pulses equal to the number of cells traversed. In the second example 56 the image would traverse the maximum number of sensitive portions of the cell and the frequency of the signal would be at a higher average value. In the third example, that shown at 57, the configuration would be at an angle to the vector of motion greater than in the first example and less than in the second example and the average frequency of the signal would be between the frequencies of the signals produced in the first two examples. Thus it can be seen, that spacing of the sensory units and the orientation of the cells of the sensory units can be used to introduce a distinctive frequency characteristic to the real signal.

In the structure of the retina the spacing and the orientation of the cells is made such that the average frequency of the real signals will be within a range acceptable by the processing circuitry, which is tailored to reject signals having frequencies outside the acceptable range. The separation of real signals from false signals are thus initially made on the basis of their frequency. That is, the real signals will have a very low frequency, whereas, false signals will in most instances have a much higher frequency.

FIGS. 5A and 5B disclose the circuitry of the sensory means and of the processing means, wherein, the real signals are amplified; separated from false signals having a different average frequency than the acceptable frequency; wherein the signal is converted to direct current pulses of uniform amplitude and duration; wherein the pulses are counted or stored from which a triggering pulse is generated to set off the alarm, and; wherein there are several different characteristics to the alarm that can be produced.

FIG. 5A discloses an array of three sensory units. There are actually five such units in the inventive example, the smaller number being illustrated to simplify

the disclosure. Each sensory unit comprises respectively, a cadmium sulphide cell P_1 and a cadmium selenide cell P_2 connected in series with a **330** ohm current limiting resistor R_2. Each series circuit is connected across a low voltage source B_1. A portion of each sensory unit is also fed energy from a higher voltage source B_2, which is connected through a 1 megohm resistor R_1, through the selenide cell P_2 and the current limiting resistor R_2.

Each of the sensory units is connected from a point between cells P_1 and P_2 to and through a capacitor to a terminal of a switch S_1. The right and left sensory units, as seen in FIG. **5A** are respectively connected through capacitors C_1 and C_2 to the terminal t_1 of the switch S_1. The middle sensory unit of the three illustrated is connected through capacitor C_3 to the terminal t_2 of the switch S_1. The switch is arranged to connect and disconnect the right and left sensory units to and from the output circuit. The middle sensory unit remains at all times connected to the output circuit. The switch thus functions to control the effective size of the retina of the sensory means.

An ac voltage is produced across the capacitors C_1, C_2 and C_3. This voltage is connected through resistors R_3 and R_4 to the base of transistor Q_1 and to ground through the capacitors C_4 and C_5. The resistors R_3 and R_4, and capacitors C_4, C_5 function as a filter network, passing the signals having the ac voltages with the acceptable frequencies to the base of the transistor Q_1 and to by-pass signals outside the acceptable frequency range to ground. This provides for the elimination of some of the causes of false alarms as for example those caused by flashing lights, signs, and fluorescent lamps and the like.

Transistor Q_1 has its collector connected to a source of voltage, herein represented by buss **8**, and its emitter connected to the base of transistor Q_2. The collector of transistor Q_2 is connected through resistor R_6 to buss **8** and the emitter through resistor R_7 to grounded buss **10.** The output of transistor Q_2 is coupled from its collector to the base of transistor Q_3. Transistor Q_3 has its collector connected through resistor R_8 to buss **8.** The collector is also connected through capacitor C_6 to the base of transistor Q_3 and through resistor R_{10} to the emitter of transistor Q_2. The emitter of transistor Q_3 is connected through resistor R_9 to the buss **10,** through resistor R_5 to the base of transistor Q_1 and through the circuit containing capacitor C_7, resistor R_{11} and switch S_2 to the buss **10.** Resistors R_4,R_6,R_7,R_8, R_9 serve as bias resistors for the amplifier. The resistor R_{10} serves as a feedback resistor fixing the gain of the amplifier. This gain can be modified by the operation of the switch S_2, which when closed throws the by-pass circuit, containing capacitor C_7 and resistor R_{11} in shunt with resistor R_9. This raises the gain of the amplifier over that which is realized when the switch is open. When the switch S_2 is open the gain of the transistor Q_3 is determined by the ratio of the resistances of resistors R_8 and R_9.

Transistor Q_3 is coupled from its collector through capacitor C_8 and resistor R_{12} to the base of transistor Q_4, which has its collector connected through resistor R_{14} to the buss **8** and its emitter connected to grounded buss **10.** The collector of transistor Q_4 is also connected back through biasing resistor R_{13} and a feedback capacitor C_9 to the base of transistor Q_4.

Transistors Q_1, Q_2, Q_3, Q_4 form the analogue portion of the linear amplifier and they provide a high impedance input to the output of the photosenor array used in the sensory means.

Transistor Q_4 has its collector connected through resistor R_{15} to the base of transistor Q_5, which in turn has its collector connected to buss **8** through resistor R_{16} and its emitter connected to the buss **10.** The collector of transistor Q_5 is also connected to the terminal t_8 of the NOR gate G_1, composed of two pairs of field effect transistors termed CMOS or complementary metal oxide silicon transistors, which have a low noise factor and low power consumption.

The gate G_1 has a terminal t_{10} coupled to the buss **8,** a terminal t_{11} connected to ground, an input terminal t_8 and an output terminal t_{12}. The terminal t_{12} is coupled through capacitor C_{10} to the base of transistor Q_6, whose collector is connected to buss **8** through resistor R_{18} and whose emitter is connected directly to the buss **10.** A biasing resistor R_{17} connects the base of transistor Q_6 to buss **8.** The collector of the transistor Q_6 is connected through a diode D_1 and capacitor C_{12} to buss **10.** A bleed path is provided to ground through resistor R_{19}, which connects to ground through the base-emitter junction of the transistor Q_4. The voltage of the capacitor C_{12} is applied not only to the base of the transistor Q_4, but also to the terminal t_9 of the NOR gate G_1.

In operation, the NOR gate G_1 functions as an acceptance gate. It limits the passage of pulses to those of a frequency that is below a predetermined value. For example, the terminal t_8 of the gate G_1 is normally at ground potential, that is, when the transistor Q_5 is rendered conductive, there is a voltage drop across the resistor R_{16} and terminal t_8 is connected to ground through the transistor Q_5. When a negative pulse is applied to the base of transistor Q_5 it ceases to conduct while the pulse persists. This produces a decrease in the voltage drop across the resistor R_{16} and a positive going pulse on the terminal t_8 of NOR gate G_1. This in turn produces a negative going pulse at terminal t_{12}, which when applied through capacitor C_{10} to the base of transistor Q_6, decreases the voltage drop across the resistor R_{18} to produce a positive going pulse on the capacitor C_{12}. This causes the capacitor to charge through the diode D_1. The diode D_1 operates to prevent the discharge of the capacitor C_{12} back through the transistor Q_6. The period that the capacitor C_{12} remains charged is determined by the resistance in the bleed circuit that includes the resistor R_{19}.

So long as the charge remains on the capacitor C_{12}, terminal t_9 of the NOR gate G_1 has a plus voltage applied thereto. While this voltage persists, changes in voltage of terminal t_8 will not cause a change in voltage at terminal t_{12}. After the capacitor C_{12} becomes discharged then any pulse delivered to the base of transistor Q_5 will activate the gate G_1 and the capacitor will be recharged. Thus, after each pulse there is a period of inactivity of the gate until the capacitor C_{12} discharges.

The bleed from the capacitor C_{12} is through the resistor R_{19} and the base-emitter junction of the transistor Q_4. The appliecation of the voltage of the capacitor C_{12} to the base of transistor Q_4 maintains it conductive so long as the charge on the capacitor remains above a predetermined level. This provides an additional assurance that the gate will be inactive for the period of the charge on the capacitor. The gate G_1 thus functions as an acceptance gate.

The gate G_1 and the transistor Q_6 also function as a unitizer, to produce pulses having a uniform amplitude and duration. This is essential in the counting of pulses in the capacitor C_{13}. The gate G_1 provides at its terminal t_{12} pulses of uniform amplitude but not of uniform duration. The capacitor C_{10} and resistor R_{17} provides the time function to control the duration of the pulses, produced at the collector of transistor Q_6. When the negative pulse from the terminal t_{12} is applied to the capacitor C_{10} and through it to the base of the transistor Q_6, the capacitor C_{10} is discharged through the base emitter junction of the transistor Q_6. When the capacitor C_{10} becomes sufficiently discharged transistor Q_6 ceases to conduct and the duration of the pulse starts. During the period of non-conductivity of transistor Q_6 the capacitor C_{10} is recharged through the resistor R_{17} when the capacitor C_{10} becomes sufficiently recharged the transistor Q_6 again starts to conduct thus ending the duration of the pulse. In this manner the pulses at the collector become unitized. This assures equal charges being applied to the capacitor C_{12} through the diode D_1 for each pulse at collector of Q_6.

The collector of transistor Q_6 is connected through diode D_2, resistor R_{20} to one terminal of a capacitor C_{13}, the other terminal of which is connected through a pair of switches S_3, S_4 to the grounded buss **10.** This circuit is the main memory. It is provided to receive the unitary or uniform pulses from the collector of transistor Q_6 until there are sufficient number to charge the capacitor C_{13} to a voltage adequate to activate an alarm system. The capacitor C_{13} and switches S_3, S_4 are shunted by a bleed resistor R_{21}. This imposes a requirement, that not only must there be a predetermined number of pulses to initiate the triggering of the alarm system, but also, that the number of pulses occur within a predetermined time interval. In other words, the charge voltage on the capacitor C_{13} is dependent on the number and rate of pulses received by it. Once the triggering function is completed, the capacitor C_{13} is discharged as will appear as the disclosure proceeds.

The capacitor is connected through resistor R_{27} to the base of transistor Q_{10} (FIG. 5B), which has its collector connected through resistor R_{30} to the buss **8** and its emitter connected to the grounded buss **10.** A gate G_2 having terminals t_{11}, t_{12}, and t_{13} has its terminal t_{13} connected to the collector of transistor Q_{10}.

The terminal t_{11} of gate G_2 is connected through resistor R_{36} to the base of transistor Q_{15}, which has its collector connected to buss **8** and its emitter connected to the base of transistor Q_{16}, whose emitter is connected to grounded buss **10.** The collector of transistor Q_{16} is connected through a coil SC to the buss **8.** Coil SC operates a relay that energizes a remotely located alarm A_1.

When there is sufficient charge on the capacitor C_{13} the transistor Q_{10} is rendered conductive. When transistor Q_{10} is conductive there is a voltage drop across resistor R_{30}, that reduces the voltage on terminal t_{13} of gate G_2 to ground potential. When terminal t_{13} goes to ground, terminal t_{11} goes positive, rendering the transistors Q_{15} and Q_{16} conductive, to energize the relay coil SC and sound the alarm A_1. When transistor Q_{10} becomes conductive it is desired that the capacitor C_{13} be completely discharged, so that its counting function can always start from the same level after the alarm has been silenced.

For this purpose, terminal t_{11} is connected through resistor R_{24} to the base of transistor Q_9. The transistor Q_9 has its collector -emitter circuit in shunt across the capacitor C_{13} and switches S_3,S_4. Thus, when the gate G_2 is activated, a positive potential from terminal t_{11} is applied to the base of transistor Q_9 to completely discharge memory capacitor C_{13}.

With the apparatus thus far disclosed, the alarm A_1 will be sounded for a brief period determined by the time lag of the circuit and will remain off until the capacitor **C13** is recharged up to the voltage necessary to again initiate the energization of the alarm system. It is desired at times to have the alarm continue to sound until a reset operation is made either manually or automatically. For this purpose, an automatic latch circuit is provided.

The latch circuit comprises a diode D_4, switch S_6 and resistor R_{28} connected between the terminal t_{11} and the base of transistor Q_{10}. When switch S_6 is open, the alarm would be sounded after each recharging of the capacitor C_{13}. When switch S_6 is closed, and when there is a positive pulse or voltage on terminal t_{11}, it is applied to the base of transistor Q_{10} to maintain it conductive after the capacitor C_{13} is discharged. Continual conductivity of the transistor Q_{10} maintains the terminal t_{13} at ground potential and the gate in the latched mode.

It is sometimes desirable to silence the alarm A_1 after a predetermined time interval after the initiation thereof if there is no continued intrusion. It sould be noted that while the alarm is activated, the capacitor C_{13} is shunted by the transistor Q_9 and cannot be recharged. During this period the intrusion may have ceased. However for there to be an indication as to the cessation of the intrusion or its continuation, the alarm needs to be shut off so that the capacitor C_{13} can be recharged. For this purpose, there is provided an automatic reset circuit. This circuit comprises a capacitor C_{18} and resistor R_{38} connected between the base of transistor Q_{15} and the grounded buss **10.** The capacitor C_{18} is shunted by switch S_8, which when closed, renders the reset circuit inoperative. The reset circuit further includes a resistor R_{37} connected from a point between resistor R_{38} and capacitor C_{18} to the base of transistor Q_{11}. Transistor Q_{11} has its collector-emitter circuit connected between the base of transistor Q_{10} and the grounded buss **10.** Thus after a period of time determined by the constant of the circuit containing the resistor R_{38} and capacitor C_{18}, when the voltage on the capacitor C_{18} reaches a level sufficient to energize the transistor Q_{11} it grounds the base of transistor Q_{10}, which renders transistor Q_{10} non-conductive and causes the unlatching operation to be effected. Thus, the alarm A_1 will be silenced, until the charge again builds up on the capacitor C_{13}. This will take place only if there is continued motion in the space under surveillance. Thus, the system functions to indicate whether or not the intrusion continues or not.

Once the reset or unlatching operation is completed, it is essential that the capacitor C_{18} be quickly discharged. The resistor R_{38} would impose a time period on the discharge. To accelerate the discharge of the capacitor C_{18}, a circuit having a lower resistance is provided by the diode D_6 and resistor R_{43} from the capacitor C_{18} to the terminal t_{11}. Thus while a positive voltage appears on terminal t_{11}, the diode D_6 is reverse biased and the circuit is non-conductive. When terminal t_{11}

goes to ground, the diode D_6 is forwardly biased by the voltage on capacitor C_{18} and it discharges through the circuit to terminal t_{11}. Thus when again the alarm A_1 is sounded, the capacitor is conditioned to receive its charge and the charge time is always the same, because the charging starts with the capacitor C_{18} discharged.

As is seen from the structure thus far disclosed, the reset operation takes place after a predetermined time interval determined by the RC constant of the resistor R_{38} and capacitor C_{18}. If it is desired to continue the sounding of the alarm while the intrusion of the area under surveillance continues, it would be necessary to interrupt the function of the automatic reset circuit.

A circuit is provided to perform what I term a "refresh" operation. In effect, the operation is to extract charge from the capacitor C_{18} during its charging period, so that the reset function is delayed while pulses are being transmitted from the transistor Q_6, indicative of continued motion in the area under survailance.

For this purpose there is a pair of transistors Q_{13}, Q_{14}, for shunting the capacitor C_{18}. Capacitor Q_{13} has its base electrode energized through resistor R_{39} from the base of transistor Q_{15}. Its emitter is connected to grounded buss **10** and its collector is connected to the emitter of transistor Q_{14}. The collector of transistor Q_{14} is connected to the reset timing circuit between resister R_{38} and capacitor C_{18}. The base of transistor Q_{14} is connected through resistor R_{45} to the collector of transistor Q_6 (FIG. 5A).

Transistor Q_{13} is non-conductive unless and until the alarm circuit to the base of transistor Q_{15} is energized. When this circuit is energized the alarm A_1 will be sounded and capacitor C_{18} would charge through resistor R_{38}. At the same time, the base of transistor Q_{13} would be at a positive potential, to thus enable the transistor Q_{13}, which will only be conductive if and when transistor Q_{14} is conductive. Transistor Q_{14} is rendered conductive during the period transistor Q_{13} is enabled, by pulses transmitted from transistor Q_6, through resistor R_{45} to its base. When this occurs, transistors Q_{14} and Q_{13} establish a shunt around capacitor C_{18} to ground and causes it to be discharged during the period of the pulse. Thus, the reset means is said to be "refreshed," or the charging period is started over anew at each incidence of a pulse from transistor Q_6 upon the base of transistor Q_{14}. The reset operation is thus delayed while there is motion in the field of view of the sensory means and the alarm is continuous until a predetermined time interval after all motion ceases.

After an alarm has been initiated by an intrusion that is sensed by the sensory means, the capacitor C_{13} is discharged by the energization of transistor Q_9. The capacitor C_{13} will remain shunted by transistor Q_9 so long as the alarm circuit is energized from terminal t_{11} of gate G_2. After the reset time has expired, the shunt provided by transistor Q_9 is removed. Then and only then can the memory capacitor C_{13} be recharged. As is evident, it requires several pulses from transistor Q_6 to raise the charge on the capacitor C_{13} to the level to again trigger transistor Q_{10}. This amounts to a temporary loss of sensitivity. That is, during the charging period of capacitor C_{13} no re-initiation of the alarm can be had. To eliminate this loss of effectiveness of the apparatus, an anticipatory circuit is provided to provide for continued effectiveness while the capacitor C_{13} is being recharged. The function is particularly desirable in instances where an alarm has been sounded and it is expected that motion will continue in the area under surveillance.

The circuit to provide the anticipatory function consists of a charging circuit having diode D_7, a resistor R_{34} and a capacitor C_{17} connected in series between terminal t_{11} of gate G_2 and the grounded buss **10.** Capacitor C_{17} is shunted by a switch S_7 when closed renders the circuit inoperative. The circuit provides a charging of capacitor C_{17} up to the voltage appearing across the circuit and because of the diode D_7 for the trapping of the charge on the capacitor C_{17}. The circuit is connected from a point between resistor R_{34} and capacitor C_{17} through resistor R_{35} to the collector of transistor Q_{12}. The emitter of transistor Q_{12} is connected to the grounded buss **10** and its base is connected through resistor R_{32} to the collector of transistor Q_6 from which unitized pulses are received.

The collector of transistor Q_{12} is connected through resistor R_{33} and capacitor C_{16} to the base of transistor Q_{10}. For a time interval, determined by the RC constant of the circuit including the resistor R_{34} and capacitor C_{17}, there is insufficient voltage appearing at the collector of transistor Q_{12} to render it capable of operation. It requires but a short interval of time for the capacitor to reach a charge adequate to enable transistor Q_{12}. During the period while the charge is taking place capacitor C_{13} is fully discharged. After the reset operation has taken place the transistor Q_{10} ceases to conduct. When a new pulse is admitted to the memory capacitor C_{13}, it is also applied through resistor R_{32} to the base of transistor Q_{12}, which is enabled by the charge on capacitor C_{17} to conduct during the period of the pulse. This causes a positive pulse to be applied to the base of transistor Q_{10}, whereby, the alarm A_1 is sounded on the first pulse instead of after several pulses later as would be the case if the memory capacitor had to be relied upon to produce the triggering pulse.

Thus, with the switch S_7 open, it would require several pulses from transistor Q_6 to initially trigger an alarm and thereafter, it would be re-triggered by each pulse occuring after the reset function is performed. Thus, once the alarm is sounded, the circuit anticipates that the cause to re-trigger the alarm exists and in effect automatically alters the response of the apparatus from one, which for example requires several pulses to one requiring but a single pulse, after once the alarm has been sounded.

In addition to provisions for energizing a remotely located alarm, the detecting apparatus has a built in alarm A_2 such as a speaker device. This alarm is activated from the transistor Q_{10} at the same time that alarm A_1 is activated.

The circuit includes a pair of gates G_3 and G_4 connected together to form a free running multivibrater. Gate G_3 has a terminal t_{14} connected to the collector of transistor Q_{10} in the same manner as gate G_2 is connected thereto. Terminal t_{16} of gate G_3 is connected to terminals t_{17} and t_{18} of gate G_4. Terminal t_{19} of gate G_4 is connected through resistor R_{42} to the base of transistor Q_{19}, which has its collector-emitter circuit in series with resistor R_{40} connected between the busses **8** and **10.** A switch S_9 shunts transistor Q_{19} when it is desired to render the internal alarm A_2 silent. The circuit between resistor R_{40} and transistor Q_{19} is connected to the base of transistor Q_{17} having its emitter connected to the base of transistor Q_{18}, which in turn has its emitter connected to the buss **10.** The collectors of transistors

Q_{17}, Q_{18} are connected through the alarm device A_2 to the buss **8**.

Terminal t_{15} of gate G_3 is connected through capacitor C_{19} to the collector of transistor Q_6. Terminals t_{17}, t_{18} are connected through resistor R_{41} and capacitor C_{19} to the collector of transistor Q_6. Terminals t_{19} is connected back through capacitor C_{20} and resistor R_{41} to terminals t_{17}, t_{18} of gate G_4 and to terminal t_{15} of gate G_3.

When transistor Q_{10} becomes conductive, there is a voltage drop across the resistor R_{30}, that causes a ground potential to be applied to terminal t_{14} of Gate G_3. This cases a positive potential to be applied to the terminal t_{16} and to terminals t_{17}, t_{18} of gate G_4. Gate G_4 provides a pulsating voltage at terminal t_{19} thereof, which when applied to transistor Q_{19} and transistors Q_{17},Q_{18} produce an audio frequency output from the alarm device A_2,. The feed back circuit through capacitor C_{20} provides for the control over the frequency of the output.

All of the functions, such as the auto-reset, latching, refresh, and anticipate operations are also reflected in the output of the alarm **A2.** In addition, terminals t_{15} of gate G_3 receives pulses through capacitor from the collector of transistor Q_6, which while the terminal t_{14} is at ground potential, will modulate the sound of the alarm A_2 with the reception of the pulses from transistor Q_6.

This indicates not only that motion is taking place but also by the frequency of the modulation of the sound from the alarm A_2, the rate of motion and the motion ceases. Thus from the nature of the sound of the alarm A_2 one can judge what is taking place in the field of view of the sensory means.

The apparatus further includes a means that permits the arming thereof to be programed to take place at a predetermined interval of time after it has been programmed. This is particularly important under circumstances where it is desired to place the apparatus in a position such that it views the avenue of approach to the apparatus, thus preventing anyone to approach the apparatus to shut it off. Unless some delay means is provided, the alarm would be triggered by the one who sets it up.

The means for delaying the arming of the apparatus includes a source of energy B_2 under the control of switch S_5 which has two positions, one which connects buss **8** to the source of energy and a position in which the source of energy B_2 is connected to a charging circuit having capacitor C_{15} therein. Capacitor C_{15} is shunted by a bleed resistor R_{26} for slowly discharging the capacitor C_{15} when the switch S_5 is disconnected therefrom.

The charging circuit is connected through resistor R_{25} to the base of transistor Q_8, which has its emitter connected to the buss **10.** The collector of transistor Q_8 is connected to the base of transistor Q_7, whose emitter is connected to the buss **8** and whose collector is connected through resistor R_{22} to a light emitting diode LED_1, which acts as an indicator, to indicate when glowing, that the apparatus is programmed to become armed.

While the switch S_5 is in the left hand position as viewed in FIG. **5B**, the capacitor C_{15} is charged and maintained charged. Buss **8** is at this time disconnected from the source of energy B_2, therefore, the emitter of transistor Q_7 and the collector of transistor Q_8 have no voltage thereon and are non-conductive.

The indicator circuit is connected from a point thereof between transistor Q_7 and resistor R_{22} to the terminal t_{12} of gate G_2, also, through the diode D_3 to the terminal t_{14} of gate G_3, collector of transistor Q_{10} and terminal t_{13} of gate G_2. The indicator line is also connected to the base of transistor Q_9 from a point between the resistor R_{22} and the light emitting diode LED_1. While the switch remains in the left had position no potential will be applied to any of the above enumerated terminals.

When the switch S_5 is moved into its right hand position, as viewed in FIG. **5B**, the buss **8** becomes energized, the transistors Q_7 and Q_8 become conductive and the indicator light glows to show that the arming is in progress. The positive potential impressed on terminals t_{12}, t_{14} and t_{13} from the indicator line prevents the operation of the alarm means for the duration of the charge on the capacitor C_{15}.

When the capacitor C_{15} becomes discharged, the potentials applied therefrom on the terminals t_{12}, t_{14} and t_{13} and to the base of transistor Q_9 are removed, because the transistor Q_7 and Q_8 become non-conductive with the discharge of the capacitor C_{15}. When this occurs, the apparatus will be armed. The light LED_1 will cease to glow indicating that the apparatus is armed.

The functions of the apparatus are illustrated in FIG. **6** of the drawings.

The space or area to be placed under surveilence is focused on the retina of the sensory means **25** by positioning the apparatus in the proper orientation relative to the space or area. The image of the area will form stationary light patterns over the retina which will depend on the ambient light level for intensity. When a person or object in the image moves relative to other objects in the area, the image of the movable object moves on the sensory units and between the sensory units to cause a change in resistance of the cells of the units. The change in the resistance of the cells causes a change in the current through them and it is this change that brings about a pulse in the output of the sensory mean.

As has been mentioned, the ambient light level provides a static resistance in the cells. This resistance varies from a very high value, in the region of megohms, at low light levels to a comparatively low resistance at high light levels. Because of this, the sensory means has wide changes in the output impedance. The impedance converter **31** operates to match the impedance of the sensory means to the signal processing circuitry.

When the image of the movable object moves across the serpentine sensitive surface of the individual cells and across the retina as a whole it causes a rapid fluctuation of the resistance, the current and the voltage. The frequency of the fluctuations caused by an intruder fall within a predetermined range of frequencies. Changes in resistance from other causes as for example those caused by a fluorescent light have other frequencies outside the range of frequencies of the signals that are of interest. The input to the signal processing means is tailored to receive signals having the frequencies of the signals of interest and to reject others that have frequencies other than those within the acceptable range. The preamplifier and filter **32** separates the signals on the basis of frequency and amplifies the segregated signals.

From the preamplifier, the signals are fed to what is termed a pulse unitizer and acceptance gate **33.** Each pulse is made up an an alternating current voltage in the preamplifier, with a frequency acceptable to the preamplifier. The number of pulses per second is the pulse frequency. The acceptance gate **33** is designed to accept only those pulses that have a frequency below a predetermined level. The pulses that are admitted, operate to generate pulses having a uniform amplitude and duration, or a uniform energy content. The unitizing of the pulses is essential for the counting function performed in the pulse count memory **34** to which the unitized pulses are fed.

In the pulse count memory **34** the pulses of equal increments charge up the capacitor C_{13} raising the voltage thereon in increments from a zero level to the level of the threshold of switch gate **35.** The capacitor C_{13} has a bleed rate, therefore, the pulses in storage depend on the number of pulses received and on the rate at which the pulses are received. This characteristic of the memory **34** causes the further segregation of the true signal from the other signals that have escaped segregation.

The switch gate **35** produces a voltage which controls the sounding of the alarm **37** through the means **36** which supply the operating energy to the alarm.

The switch gate **35** can respond to each and every triggering voltage to produce a short sounding alarm signal or it can respond in such a manner as to initiate the alarm and maintain it sounding until the gate **35** is reset. Switches are provided in the apparatus to select the mode of operation desired. When switch **44** is closed the gate **35** is latched into its "on" state. Switch **44** merely represents the function of switch S_6 in the actual structure. The gate **35** remains latched until a reset operation is performed. This can be performed manually as by opening the switch S_6 or automatically after an elapse of a predetermined time interval.

When the gate is turned on a voltage is produced at its output terminal. This voltage is fed to the auto reset means **38** which operates back through the reset inhibit gate **39** to the switch gate **35** to cause the unlatching operation or reset operation to take place. Thus the alarm sounds for a predetermined length of time and then shuts off. and will not again be sounded until the memory again stores the required number of pulses.

The time interval to effect the reset operation may be prolonged if desired in response to continual pulses. For example, should there be an intrusion of the area under surveillance, the alarm would sound and continue to sound until the reset operation takes place. If during this interval there is movement in the area under surveilence, pulses will continue to be generated. These pulses are fed to the reset inhibit gate **39** to effect a refresh operation. The refresh operation simply stated, is to restart the timing each time a new pulse is received while the timing operation is in process. Thus, while there is motion in the field of view of the lens the reset means will be refreshed and the reset operation will be delayed until the motion has ceased.

When the alarm starts sounding, energy is supplied to the means **40,** that performs the anticipate function. As will be recalled, the pulse count memory requires a predetermined number of pulses to be in storage for the triggering voltage to be raised to the required level. After the triggering operation is performed, the memory **34** is rendered inoperative and any pulses received while the alarm is being sounded are simply not counted or stored in the memory **34.** After the reset operation, the memory again starts its counting operation, which is dependent on the amount of motion taking place in the field of view of the lens means. It is desired that after the alarm has been initiated, that for a predetermined period after reset that the alarm respond to each individual pulses thus to eliminate the delay caused by the memory. The pulses fed to the means **40** bypasses the memory **34** and act directly on the switch gate **35** to resound the alarm after each pulse, and in this way the length of time that motion continues can be determined.

The delayed arming means functions as clearly stated herein. It includes a jack means through which a remote control can be plugged into the apparatus to enable the apparatus to be rendered inoperative for a period required for authorized personel to enter the area under surveillance.

The purposes, the mode of operation and the structure by which the mode of operation is attained have all been disclosed, that which I consider to be my invention is set forth in the following claims.

I claim:

1. Apparatus for detecting motion within a predeterspace comprising:

lens means for projecting an image of objects in said space;

retina means for receiving said image and producing alternating current voltage pulses in response to motion of said objects in said image; comprising

a plurality of sensory units spaced from each other at the focal length of said lens means, each sensory unit having at least two photosensitive cells, each cell having optimum light level response characteristics that cover a different range of changes in light level, but in which the characteristics overlap to cover the entire range of changes of light level from full sun-light to darkness;

means for receiving said alternating current voltage pulses and for amplifying those alternating current voltage pulses having a frequency falling within a predetermined range of frequencies;

unitizing means responsive to said amplified alternating current voltage pulses for producing direct current voltage pulses of uniform amplitude and duration;

storage means for receiving said direct current voltage pulses of uniform amplitude and duration and for developing a triggering voltage;

triggering means responsive to a predetermined level of voltage in said storage means to produce a triggering operation; and

alarm means responsive to said triggering operation for producing an indication that motion of objects in said space has been detected.

2. Apparatus as set forth in claim **1** further including;

latch means responsive to the operation of said triggering means to maintain said triggering means in operation to latch said alarm means in its continuous operation mode.

3. Apparatus as set forth in claim **2** further including;

reset means for automatically discontinuing the operation of said triggering means for unlatching said

alarm means a predetermined time interval after the latching thereof.

4. Apparatus as set forth in claim **3** further including;

refresh means responsive to the direct current voltage pulses from said unitizing means for prolonging the time interval between the latching of said alarm means and the operation of said reset means.

5. Apparatus as set forth in claim **4** further including;

pulse anticipating means enabled during the latch mode of operation of said alarm means operable in response to each direct current voltage pulse from said unitizing means occuring within a predetermined time interval after the unlatching of said alarm means to cause a renewed operation of the alarm means.

6. Apparatus as set forth in claim **5** further including;

means for programming the arming of said apparatus to occur at a predetermined time interval after being initiated, said means comprising;

a circuit which when energized applies a disabling voltage to said triggering means to prevent said triggering means from operating;

means for energizing said circuit and said apparatus;

a timing means to determine the interval during which said circuit remains energized; and

indicator means in said circuit to indicate when said circuit is energized.

7. Apparatus as set forth in claim **1** further including;

means for selectively varying the effective size of said retina, comprising

switch means for rendering certain of the spaced sensory units inoperable.

8. A sensory apparatus for detecting motion of objects in a predetermined space comprising:

lens means for viewing said space and for forming images of the objects in said space;

retina means for receiving said images caused by motion of objects in said space comprising;

a plurality of sensory units spaced from each other at the focal length of said lens means, each sensory unit comprising;

a first photosensitive cell having an optimum response at the higher levels of illumination;

a second photosensitive cell having optimum response at the lower levels of illumination;

a first resistor having a comparatively low resistance;

a second resistor having a comparatively high resistance;

a first and second source of energy the first having a low voltage and the second having a higher voltage;

a first circuit means for connecting said first and second cells and said first resistor in series with said first source of energy;

a second circuit means for connecting said second resistor, said second cell and said first resistor in series with said second source of energy; whereby the first cell is dominant in producing voltage pulses during high levels of illumination and the second cell is dominamt in producing pulses during low levels of illumination and both cells contribute to produce voltage pulses during medium levels of illumination, whereby voltage pulses of optimum strength are produced over the full range of changes in illumination level.

9. Apparatus as set forth in claim **8** wherein said second photosensitive cell has a response in the near infrared region of the light spectrum, whereby the range of response of the sensory means is extended beyond the visible light spectrum.

10. A sensory unit comprising

a plurality of photosensitive cells, each cell having a different sensitive material and optimum response over different portions of the range of change of illumination from full sun-light to darkness;

a first source of voltage of one value;

a current limiting resistor;

means connecting said cells in series with said source of voltage and said current limiting resistor;

a second source of voltage of higher value than the first of voltage;

a fixed resistor connected in series with said second source of voltage, one of said cells and said current limiting resistor; and

output means connected across one of said cells and said current limiting resistor; whereby voltage pulses of optimum strength will be produced for all levels of illumination.

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