

[72] Inventor Donald E. Hansen
Brookfield Center, Conn.
[21] Appl. No. 576,295
[22] Filed Aug. 31, 1966
[45] Patented June 28, 1971
[73] Assignee Mosler Research Products Inc.
Danbury, Conn.

Primary Examiner—John W. Caldwell
Assistant Examiner—David L. Trafton
Attorney—Wood, Herron and Evans

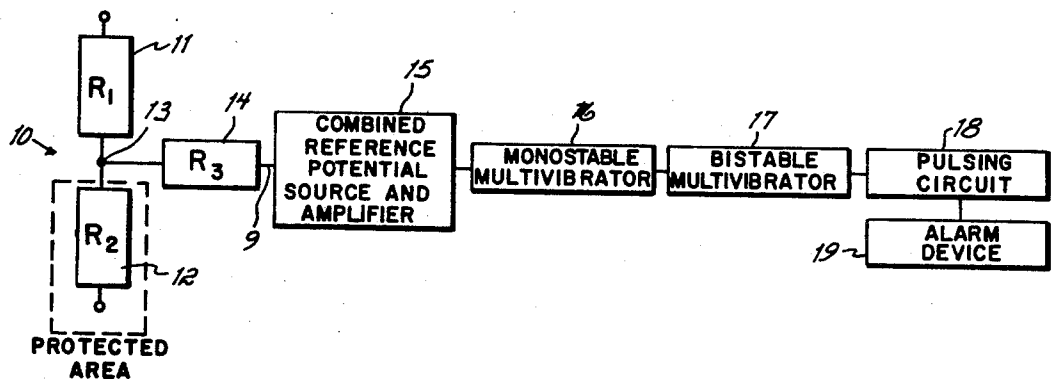
[54] SECURITY ALARM SYSTEM
16 Claims, 2 Drawing Figs.
[52] U.S. Cl. 340/276,
340/285, 340/384, 340/409
[51] Int. Cl. G08b 13/00
[50] Field of Search 340/285,
276, 233, 384 (E); 330/100

[56] References Cited

UNITED STATES PATENTS			
3,309,689	3/1967	Kenney	340/158
3,356,959	12/1967	Vilkomerson	330/100X
3,226,705	12/1965	Kaufman et al.	340/276X
3,252,156	5/1966	Muehter	340/276
3,199,096	8/1965	Bagno	340/258
217,543	7/1879	Lockwood	340/285
791,961	6/1905	Weatherby	340/285
2,031,951	2/1936	Hartley	340/285UX
3,128,456	4/1964	Silliman et al.	340/276UX

OTHER REFERENCES
General Electric Transistor Manual 6th ed., 1962 pp. 206,
207

ABSTRACT: A security system, including a voltage divider having a first impedance means inside the protected area and a second impedance means outside the protected area, the impedance means being separated by a tap point. Also included is a transistor amplifier having a voltage stabilized input, and resistor coupling means interconnected between the voltage divider tap point and the voltage stabilized transistor amplifier input. The first impedance means located in the protected area includes a pair of resistors alternatively connectable in series with the second impedance means located outside the protected area. Only one of the alternatively connectable resistors of the first impedance means is variable in response to an alarm condition in the protected area, enabling the system to be selectively disabled. A third impedance means, which is selectively shuntable, is interconnected between the tap point and the first impedance means. The alternatively connectable resistors of the first impedance means are unequal in value and related to the third impedance means in a manner such that the sum of the resistance between the divider tap point and the side of the first impedance means remote from the tap point is constant regardless of which of the resistors of the first impedance means is connected in series with the second impedance means, thereby preventing the system from being defeated by resistor substitution.



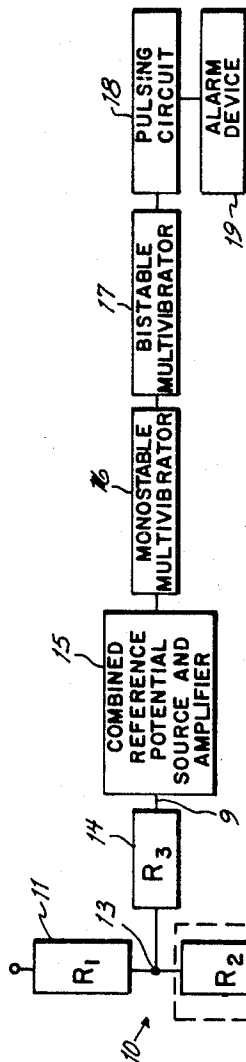


Fig. 1

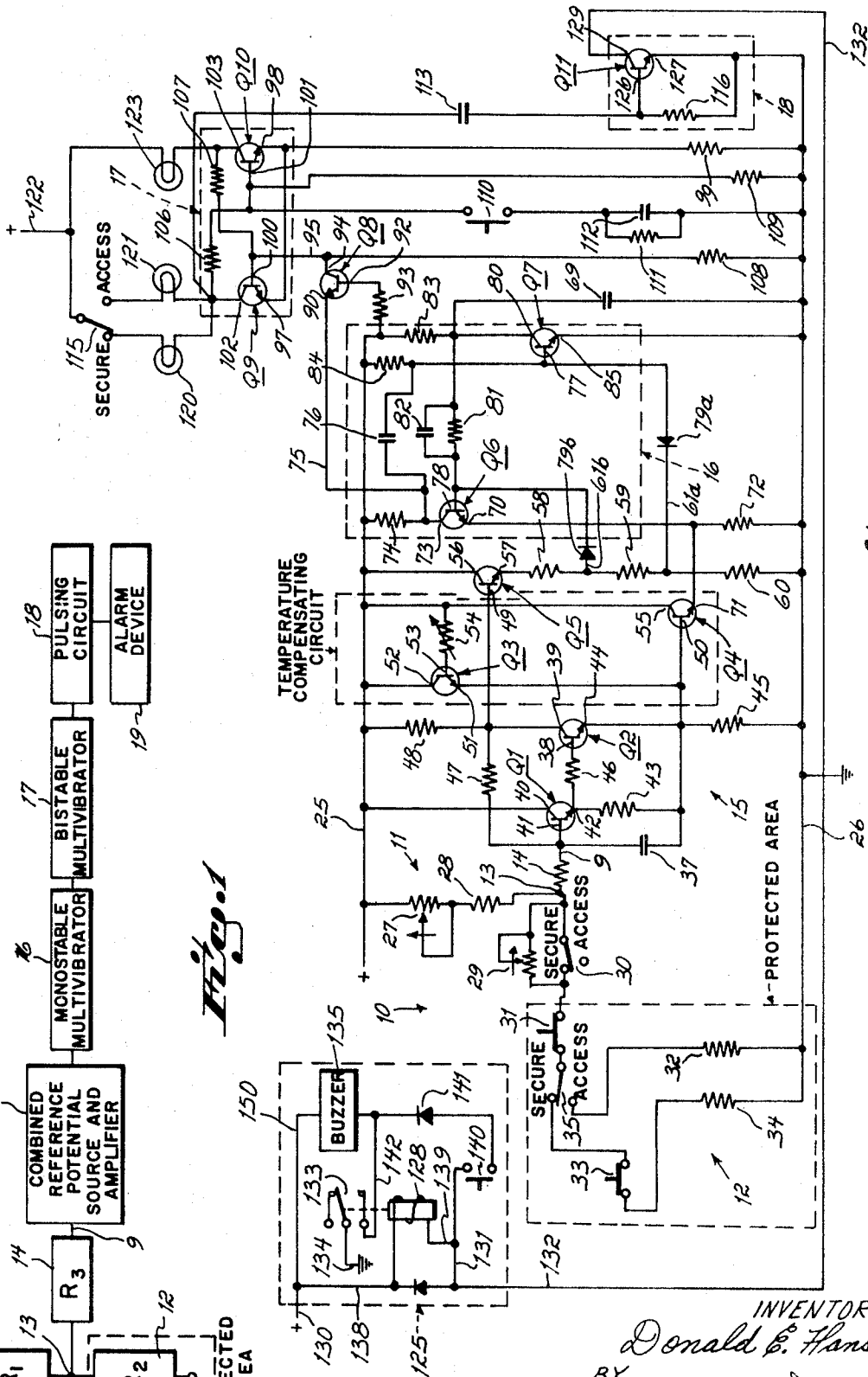


Fig. 2

INVENTOR
Donald E. Hansen
 BY
Wood, Heron & Evans
 ATTORNEYS

SECURITY ALARM SYSTEM

This invention relates to intrusion alarm systems, and more particularly to intrusion alarm systems of the type in which an alarm located in a central station is actuated each time the electrical resistance of an intrusion detector which is located in the protected area undergoes a change in response to an intrusion.

The type of intrusion alarm system with which this invention finds particular utility generally includes, as a primary component, a balanced resistance bridge. One leg of the bridge is located in the protected area and is designed to undergo variation when an intrusion occurs, causing a state of bridge unbalance to result. This alteration in leg resistance which is effective to unbalance the bridge can be produced in a variety of different manners as, for example, by the unauthorized opening of a protected door or the unauthorized entry through a protected window. In the former method, the opening of the door trips a normally closed switch connected in the variable leg of the bridge, effectively open circuiting the leg. In the other method the same result is achieved, except that instead of tripping a normally closed switch, the entry breaks a strip of conductive foil placed on the window.

The typical alarm system, in addition to requiring a bridge and means for producing an unbalance in the bridge in response to an intrusion, also requires, as a further principal component, means to sense the unbalance so produced. The sensors of the prior art take a number of forms as, for example, meter relays and various moving coil arrangements. Typically, meter relays or coil arrangements are placed across the null points of the bridge and generate an output in response to an unbalance. The output is then utilized to trigger an alarm device located in the central station, such as a buzzer or lamp, for indicating the existence of the intrusion condition. In practice it has been found necessary, as a result of the small unbalance signals involved, to provide, in conjunction with the sensor, some kind of amplification in order to insure that all alarm conditions producing bridge unbalance are detected. This has typically been carried out by connecting an amplifier in circuit arrangement with the detector and the lamp or buzzer.

In the past, the various types of devices, such as meter relays and moving coil arrangements utilized to sense bridge unbalance, were electromechanical in nature as opposed to being electronic. Such devices, because of their electromechanical nature, suffer from a number of defects. For example, their moving parts have inertia, making them many times slower in response than corresponding electronic devices. In addition, these devices are generally more expensive and tend to wear out more readily than their electronic counterparts. A further disadvantage with devices such as meter relays and moving coil arrangements is that they tend to require more frequent readjustment and calibration.

It has been a primary object of this invention, therefore, to provide an intrusion alarm system of the variable resistance type which has improved response characteristics, has fewer moving parts to wear out, requires less readjustment and maintenance and is more economical. These objectives are achieved in the preferred embodiment of the invention by employing an entirely different and novel circuit design concept in which a transistor amplifier having a voltage stabilized input is utilized not only for amplification, but for the unobvious and additional purpose of providing a source of reference potential, thereby eliminating the need for the conventional bridge arrangement and unbalance sensor. More specifically, the concept is based on the novel circuit design principle of connecting the midpoint of a voltage divider, whose one leg constitutes the variable resistance alarm element, through a coupling resistor, to the voltage stabilized input of the transistor amplifier, and using the change in current flow through the coupling resistor as an input to the amplifier, whose output then reflects, in amplified form, the change in voltage of the divider midpoint and, hence, the variation in resistance of the alarm element.

An advantage of the above alarm arrangement is that it is extremely sensitive to even small resistance changes, as well as to resistance changes representing an increase or a decrease. Such bidirectness and sensitivity facilitate the detection of attempts to conceal an intrusion by the substitution for the variable resistor of a resistor of similar, but not exactly the same, resistance. As those skilled in the art have learned, sophisticated intruders often attempt to conceal an intrusion and the accompanying change in resistance of the variable resistance element by substituting for the variable alarm resistor a resistor which they believe to have the same, or approximately the same, resistance value. However, often the resistance of the substituted resistor in fact varies slightly from that of the alarm resistor due to measurement errors, etc. It is these slight variations, whether they be excesses or deficiencies, which the arrangement of this invention is enabled to detect, and in so doing thwart an intruder who attempts to make a concealed intrusion.

Another objective of equal importance has been to provide an intrusion alarm system which can be easily switched from a secure mode in which intrusions are detectable to an access mode in which people are free to enter through protected doors, windows, etc., without producing an intrusion alarm. It will be readily appreciated that a feature such as this is of great value and convenience to those in charge of tending security systems. For example, during the daytime when employees must have free access to protected areas, such as vaults, storerooms, etc., in order to expeditiously execute their duties, it is necessary that they be able to do so without triggering an intrusion alarm each time such an entry is made. On the other hand, at night when such entries are not authorized, it is desirable that they be detected. Thus, a system which can be selectively disabled is seen to be of great practical value.

To accomplish this objective, a fixed resistor is provided which, through the use of suitable switch means, can be substituted in the divider circuit arrangement in place of the variable resistance alarm element. In operation, when it is desired to switch the system from the secure mode to the access mode as, for example, during the daytime when movement through protected doors, etc., is necessary, the switch means are actuated, substituting the fixed resistor for the variable resistor. With the variable resistance alarm element disconnected from the divider circuit, the opening of protected doors, which in the secure mode varies the resistance of the alarm element and produces an unbalanced alarm condition, has no effect on the system inasmuch as the fixed resistor now in the divider circuit is unaffected.

It has been a further principal objective of this invention to provide an intrusion alarm system which precludes the possibility of an intruder making a resistance measurement in the protected area which will enable him to conceal an intrusion by substituting for the one leg of the divider containing the variable resistor a resistor having the measured value. It is not uncommon, for example, for a potential intruder, during the daytime when free access to the protected area is possible, to measure that portion of the divider resistance located in the protected area, and then at night when the system is in the secure mode, substitute a resistor having the measured value into the divider in an attempt to conceal the change in resistance that otherwise results when unauthorized activity occurs. A system which prevents correct resistance measurements from being made virtually eliminates the possibility that these entries by resistor substitution are capable of concealment.

In accordance with the novel principles embodied in this invention, the above objective is achieved by first making the resistances of the fixed and variable resistors unequal and then adding to the divider a third resistor. The third resistor, which is located outside the protected area, is selectively connected in the divider circuit between the divider midpoint and the switch means used to alternately connect the fixed and variable resistors into the divider. Specifically, this third resistor is connected into the divider only when the lesser valued one of

the fixed and variable resistors is connected. Its function is twofold. First, it maintains the total resistance of the divider leg constant independent of the particular one of the fixed or variable resistors which happens to be in use. This prevents the divider midpoint voltage from assuming different values during the access and secure modes, which in turn prevents false alarms from being actuated. Second, the third resistor, by being located outside the protected area, makes it impossible to correctly measure, during the daytime and from within the protected area, a resistance value which enables a concealed intrusion by resistor substitution to be accomplished.

With the above arrangement, when a potential intruder makes a daytime measurement of the resistance of the divider portion located in the protected area, the measurement obtained is necessarily different from that which is obtained if the same measurement is made during the nighttime when the system is in the secure mode. Hence, when the potential intruder attempts to substitute for the variable nighttime resistor a resistance corresponding to the measured daytime value, a change in divider leg resistance occurs, causing the midpoint voltage to vary, producing in turn an input to the combined amplifier and reference source, to thereby actuate the alarm.

Another objective of this invention useful in conjunction with the above features and objectives has been to provide an intrusion alarm circuit which is responsive to attempts to tamper with the circuitry located in the protected area. This capability is particularly useful when the system is in the access mode because it provides an alarm should one attempt to gain access to the housing, which encloses the various switches and resistors located in the protected area for the purpose of disabling them so as to conceal unauthorized nighttime entries.

To this end, a switch is provided on the housing which is adapted to be opened when the housing is removed. This switch is connected in the divider leg between the third resistor and the fixed and variable resistor combination. Each time it is opened, regardless of whether the system is in the access or secure mode, an open circuit occurs in the divider leg. The open circuit raises the potential of the divider midpoint causing current to flow through the coupling resistor to the combined amplifier and reference source, producing an alarm. Thus, both daytime and nighttime attempts to gain access to the circuitry for the purpose of tampering with it are detected.

A still further objective of this invention has been to provide an intrusion alarm system in which the alarm continues even after the condition giving rise to the alarm has terminated. This prevents the occurrence of an intrusion from being overlooked should the personnel manning the control station where the alarm is located be temporarily absent from their posts at the time the intrusion occurs. In accordance with the principles of the present invention, this objective is accomplished by providing a bistable multivibrator, or flip-flop, which, when switched in response to an amplifier output, triggers the alarm, maintaining it in an actuated condition until it is manually reset by the central station personnel.

These and other objects and advantages of the invention will be more readily apparent from a consideration of the following detailed description of the drawings illustrating a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a simplified schematic circuit diagram of a preferred embodiment of an intrusion alarm system constructed in accordance with the principles of this invention.

FIG. 2 is a detailed schematic circuit diagram of the preferred embodiment shown in FIG. 1.

As shown more particularly in the schematic circuit diagram of FIG. 1, the preferred embodiment of the invention includes a voltage divider 10 having an upper resistive portion 11 preferably located in the control center, and a lower resistive portion 12 located in the protected area. The resistive portion 12 is subject to variation in resistance in response to attempts to intrude and/or tamper with that portion of the di-

vider circuit located in the protected area. Such variations in resistance may be produced, e.g., by a break in a conductive foil strip placed on a window in the protected area, the break being caused by an intruder attempting to gain entrance into the protected area via an unauthorized entry through the window. The voltage divider 10 is tapped at a point 13 intermediate the divider portions 11 and 12. The tap point 13 is coupled through a coupling resistor 14 to a combined reference potential source and amplifier 15.

The reference potential portion of the combined source and amplifier 15 and tap point 13 are selected so as to be at the same potential under conditions of nonintrusion and nontampering, that is, to be at the same potential when the impedance of the resistive portion 12 is at its design value unaltered by tempering or an intrusion such as occurs when a protected window is broken. With the tap point 13 and the reference potential which is applied to line 9 at the same potential, no current flows through the coupling resistor 14 and, hence, no signal is input on line 9 to the combined reference source and amplifier 15. Thus, no alarm signal results. However, under abnormal or alarm conditions, that is, when either an intrusion or tampering or both occur, the impedance of the resistive portion 12 located in the protected area is altered, causing the tap point 13 voltage to change. This change creates an imbalance between the potentials of the tap point 13 and the input line 9 to the combined amplifier and reference source 15, causing current to flow through coupling resistor 14, thereby producing an alarm signal which is effective to vary the input to the combined reference source and amplifier 15. An alarm signal is produced regardless of whether the resistance of resistive portion 12 increases or decreases as a consequence of the unauthorized activity since in either case a current through resistor 14 is produced, its direction of course being different but of no practical significance.

To derive an alarm from the alarm signal, amplification is necessary. This is accomplished in a manner to be described by the combined reference source and amplifier 15. The output of this combined reference source and amplifier 15, which constitutes the amplified alarm signal, is then input to a monostable multivibrator or single shot 16 which, when triggered by the amplified alarm signal, produces a pulse of predetermined width. This pulse is effective to switch a bistable multivibrator or flip-flop 17 and provide a stable signal to a pulsing circuit 18. The pulsing circuit 18, in turn, generates a pulse which is input to an alarm circuit 19 such as a buzzer or signal light located at the central station.

The flip-flop 17 and alarm device 19, unlike the single shot 16, do not reset automatically and, hence, must be manually reset. Thus, the alarm device 19 remains actuated even though the attempted intrusion or the tampering is only of a transient nature and may have terminated.

Summarizing, an intrusion or attempt to tamper with the portion 12 of the voltage divider 10 located in the protected area alters the impedance of the resistive portion 12, varying the voltage at the tap point 13, thereby causing current to flow through the coupling resistive 14 between the tap point 13 and the reference line 9. This current flow, regardless of its direction, constitutes an alarm signal which varies the input on line 9 to the combined reference source and amplifier 15. The alarm signal on line 9 resulting from the imbalance between the point 13 and the line 9 is amplified by amplifier 15, and the amplified alarm signal input to a single shot 16. The single shot 16 triggers in response to the amplified alarm signal and switches a flip-flop 17, the output of which is fed to a pulsing circuit 18 which in turn generates a pulse for actuating the alarm device 19.

As shown in detail in the schematic circuit diagram of FIG. 2, the voltage divider 10 is connected between a regulated source of positive potential, indicated generally by reference numeral 25, and ground potential, indicated generally by the reference numeral 26. The voltage divider 10 includes the series circuit combination of a potentiometer 27, a fixed resistor 28, the parallel subcombination of a potentiometer 29 and

switch 30, and a "tamper" switch 31 which is alternately connectable via a switch 35 to a first resistor 32 and the series sub-combination of an "intrusion" switch 33 and a resistor 34. Potentiometer 27 and resistor 28, which comprise the upper resistive portion 11 of the divider 10, are preferably located at the control station and, hence, are not subject to variation by unauthorized activity in the protected area such as intrusions or tampering. The tamper switch 31 and the alternate circuit paths to which it is connectable, namely, the path including resistor 32 and the path including the series connected intrusion switch 31 and the resistor 34, comprise the lower resistive portion 12 of the voltage divider 10, which is located in the area to be protected.

The tamper switch 31 is a normally closed switch which is adapted to be opened when an attempt is made to tamper with the circuitry located in the protected area. This switch, for example, may be mounted on a housing used to enclose the switch 35 and be adapted to open when an unauthorized entry is made into the housing. Intrusion switch 33 is also a normally closed switch. This switch is adapted to be opened by an intrusion into the protected area such as by the unauthorized opening of a protected door or the breaking of a strip of conductive foil placed on a window.

The voltage divider 10 is connectable so as to be operable in two different modes. In the first or "secure" mode, which might, for example, be used during the night, the system is responsive to both an intrusion into the protected area, such as the opening of a protected door or the breaking of a protected window, as well as to an attempt to tamper with the divider circuitry located in the protected area such as by the unauthorized opening of a switch housing. In this secure mode the switch 35, which is connected at one end to the tamper switch 31 and at the other end alternately to the resistor 32 and intrusion switch 33, is connected to the intrusion switch 33. In addition, the switch 30 is closed shunting the potentiometer 29. With the voltage divider 10 connected in the above fashion, either an attempt to tamper with the circuit resulting in the opening of switch 31 or an intrusion resulting in the opening of switch 33 will increase the resistance of the lower resistive portion 12 of the divider, increasing the potential of the tap point 13. This increase causes current to flow through resistor 14 and an alarm signal to be input on line 9 to the amplifier 15.

In the second or "access" mode of operation, which might, for example, be used during the day when free access into the protected area is desired, the switch 35 is connected to the resistor 32, and the switch 30 is open placing the potentiometer 29 in the divider circuit. With the divider connected in this manner, an intrusion into the protected area, such as the opening of a protected door resulting in the opening of intrusion switch 33, will not be effective to increase the resistance of the lower resistance portion 12 of the divider 10. With the potentials at the divider midpoint 13 and line 9 equal, no current flows through the resistor 14, and no alarm signal is produced. However, an attempt to tamper with the circuit, opening the tamper switch 31, increases the resistance of the lower resistive portion 12 of the divider 10, producing an alarm signal in the same manner as produced when the divider is connected in the secure mode and the tamper switch 31 is opened. Thus, with the divider connected for operation in the access mode, individuals are free to enter the protected area by opening protected doors, etc., without producing an alarm signal. However, they are not free to tamper with the circuitry in the protected area without causing an alarm signal to be produced.

The potentiometer 27 is provided to permit the voltage at the tap point 13 to be set equal to the reference potential at line 9 when the divider 10 is connected in the secure mode. Likewise, the potentiometer 29 is provided to permit the voltage at the tap point to be set equal to the reference potential when the divider 10 is connected in the access mode. The need for these two potentiometers will become evident hereinafter.

The values of resistance of the resistors 32 and 34 are made unequal so as to foil a potential intruder who measures the impedance of the divider when it is connected in the access mode and thereafter, when the system is in the secure mode, connects into the divider a resistor of similar value, in an attempt to prevent an alarm-inducing impedance change from occurring and thereby conceal his intrusion. Thus, if during the daytime when the system is in the access mode and people are free to enter the protected area, a person measures the resistance of resistor 32, and then later at night when the system is in the secure mode substitutes for resistor 34 a resistor having the value of resistor 32 in an attempt to conceal his intrusion, the substitution will nevertheless create an imbalance in the divider and generate an alarm signal. This result is accomplished because the resistance, while being the same in both modes for the portion of the divider between the tap point 13 and the ground line 26, is not the same in both modes for that portion of the voltage divider located in the protected area. Consequently, although the total resistance of that portion of the divider between ground line 26 and the tap point 13 does not vary, a measurement of the resistance in the protected area while the divider is in the access mode necessarily differs from a measurement of this resistance when the divider is in the secure mode. The difference in measurement is equal to the value of the resistance of potentiometer 29. Since this potentiometer is not in the protected area, it cannot be measured by an intruder when the system is in the access mode. Consequently, any daytime measurement made by the intruder of resistors located in the protected area will be of little help in enabling him to conceal a nighttime intrusion.

The substitution, when the system is in the secure mode, of a resistor having the value of resistor 32 for resistor 34, reduces the resistance of divider portion 12, causing tap point 13 to drop below the potential of line 9. This imbalance causes current to flow through resistor 14, producing an alarm signal. In the case of a reduction in resistance of divider portion 12, as occurs when such a substitution of resistors is made with the divider in the secure mode, the direction of current flow through resistor 14 is reversed from that which results when either switch 33 or 31 is opened. However, an alarm signal on line 9 is nonetheless produced.

The combined reference potential and amplifier 15 includes transistors Q-1, Q-2 and Q-5. A transistor Q-3 of a temperature compensating circuit provides temperature compensation for the transistors Q-1 and Q-3. More specifically, transistor Q-1 includes a collector 40 connected directly to the positive line 25, a base 41 connected directly to the coupling resistor 14 and to the collector 39 of transistor Q-2 through a feedback resistor 47. The emitter 42 of transistor Q-1 is connected through a resistor 43 to the emitter 44 of transistor Q-2, to the emitter 51 of transistor Q-3, to the base 50 of the transistor Q-4, and through a resistor 46 to the base 38 of the transistor Q-2. The collector 39 of transistor Q-3 is directly connected to feedback resistor 47, the base 49 of the transistor Q-5, and to the positive line 25 through a resistor 48. A capacitor 37 connected between line 9 and the junction of resistors 43 and 45, in conjunction with coupling resistor 14, forms a high frequency RC filter network for filtering out noise which often develops when telephone lines are used to couple the lower resistive portion 12 of the divider to the remaining portions of the circuit. Transistor Q-3 further includes a collector 52 connected directly to the positive line 25 and a base 53 connected through a resistor 54 to both the positive line 25 and the collector 55 of a transistor Q-4. The transistor Q-5 further includes a collector 56 connected directly to the positive line 25 and an emitter 57 connected through serially connected resistors 58, 59 and 60 to the ground line 26.

In operation, if the system is in the secure mode and either the tamper or intrusion switch 31 or 33 is opened, or the system is in the access mode and the tamper switch 31 is opened, the potential at the point 13 rises causing more current to flow into the base of transistor Q-1 driving transistor Q-1 further into conduction. The increased conduction of

transistor Q-1 raises the potential of emitter 42 which, through the coupling resistor 46, increases the current flow into the base 38 of transistor Q-2, driving transistor Q-2 further into conduction. The increased conduction of transistor Q-2 lowers the potential of its collector 39, causing less current to flow into the base 49 of transistor Q-5, driving transistor Q-5 toward cutoff which, in turn, lowers the potential of the amplifier output taken at lines 61a and 61b connected intermediate resistors 59, 60 and 58, 59, respectively. Due to the presence of a diode 79b having its anode connected to line 61b, the negative going signal on line 61b is blocked. The negative going signal on line 61a, however, is not blocked since the diode connected in this line, a diode 79a, has its cathode connected to line 61a. Hence, an increased potential at tap point 13 effectively produces a negative going amplified alarm signal only on amplifier output line 61a.

If, while the system is in the secure mode, a resistor of lesser value than resistor 34 is substituted for resistor 34, the potential of tap point 13 drops below that of input line 9 causing current to flow through the resistor 14, decreasing the conduction in transistor Q-2, which increases the conduction of transistor Q-5. The increased conduction of Q-5 raises the potential on amplifier output lines 61a and 61b. Due to diode 79a, the signal on line 61a is blocked. Hence, a decreased potential at tap 13 effectively produces a positive going amplified alarm signal only on amplifier output line 61b.

Transistor Q-3 introduces temperature compensation into the operation of transistors 1 and Q-2 by altering the emitter-base bias of transistors Q-1 and Q-2 in a manner which opposes changes in transistor conduction caused by temperature variations. For example, when the temperature decreases, the transistor Q-3 conducts less, lowering the potential difference across the resistor 45, which increases the emitter-base bias on the transistors Q-1 and Q-2. This increased emitter-base bias compensates for a decrease in conduction of transistors Q-1 and Q-2 which otherwise would occur due to the decrease in temperature of transistors Q-1 and Q-2. The transistor Q-3 compensates in a similar manner should the temperature increase. Specifically, if the temperature increases, transistor Q-3 increases its conduction, increasing the potential difference across resistor 45, which is effective to decrease the emitter-base bias on transistors Q-1 and Q-2. This decreased emitter-base bias compensates for the increase in conduction of transistors Q-1 and Q-2 which would otherwise occur due to the increased transistor temperature.

The monostable multivibrator or single shot 16, which is responsive to the effective, or unblocked, output from the amplifier alternately present on lines 61a and 61b, includes transistors Q-6 and Q-7. A transistor Q-4, also forming part of the temperature compensating circuit, operates in conjunction with transistor Q-6 of the single shot 16 to provide temperature compensation. Transistor Q-6 has an emitter 70 connected to the emitter 71 of transistor Q-4, and to the ground line 26 through resistor 72. The collector 73 of transistor Q-6 is connected through a resistor 74 to the positive line 25 and to an output line 75. The collector 73 is also capacitively coupled through capacitor 76 to the base 77 of transistor Q-7. The base 78 of transistor Q-6 is coupled to the amplifier output line 61b via diode 79b and to the collector 80 of transistor Q-7 through a coupling circuit including a resistor 81 and capacitor 82 connected in parallel. The capacitor 82 is effective to increase the switching speed of the single shot 16. The collector 80 of transistor Q-7 is connected through a resistor 83 to the positive line 25 and through a bypass capacitor 69 to the ground line 26 in addition to being coupled to the base 78 of transistor Q-6. The base 77 of transistor Q-7 is connected to the positive line 25 through a resistor 84 and to a line 61a intermediate resistors 59 and 60 in addition to being capacitively coupled to the collector 73 of transistor Q-6. The emitter 85 of transistor Q-7 is connected directly to the ground line 26.

In operation, transistor Q-6 is normally cut off while transistor Q-7 is conducting. When a positive signal appears

on line 61b in response to a decrease in potential at tap point 13, the current flowing into the base 78 of transistor Q-6 increases, driving transistor Q-6 into saturation. The increased conduction of transistor Q-6 drops the collector 73 potential which, through coupling capacitor 76, decreases the potential of base 77 of transistor Q-7, driving transistor Q-7 into cutoff. Transistor Q-7 remains cut off until capacitor 76 has fully discharged through the emitter-collector path of transistor Q-6 whereupon the base 77 of transistor Q-7 rises in potential, resetting the single shot to its original state. In practice, transistor Q-7 remains cut off and the single shot triggered for a time period determined by the value of capacitor 76 as well as the resistance of the discharge path through the emitter-collector circuit of transistor Q-6. Alternatively, the single shot 16 can be triggered by a negative signal on line 61a which occurs in response to an increased potential at tap 13. Such a negative signal draws more current through resistor 84, lowering the potential of the base 77 of transistor Q-7, driving it into cutoff, which in turn raises the potential of the collector 80 and base 78, driving transistor Q-6 into conduction. During the period that the transistor Q-6 is heavily conducting the potential on the single shot output line 75 drops. Thus, the single shot, in response to an alarm signal, produces a negative going pulse on line 75 of predetermined width.

Transistor Q-4 introduces temperature compensation into the operation of transistor Q-6 by altering the emitter-base bias of transistor Q-6 in a manner which opposes the change in conduction of transistor Q-6 caused by temperature. For example, when the temperature decreases, the transistor Q-4 conducts less, reducing the potential difference across the resistor 72. This, in turn, increases the emitter-base bias on the transistor Q-6, thereby compensating for the decrease in conduction of transistor Q-6 which otherwise would occur as a result of the decreased transistor temperature. The transistor Q-4 compensates in a similar manner should the temperature of transistor Q-6 increase. Specifically, should the temperature increase, transistor Q-4 increases its conduction, increasing the potential across resistor 72. The increase in potential across resistor 72, in turn, is effective to decrease the emitter-base bias on transistor Q-6 thereby compensating for the increase in conduction of transistor Q-6 which would otherwise occur as a result of the increase in temperature.

The decreased potential signal or negative going pulse which appears on line 75 in response to an alarm condition is input to the emitter 90 of a transistor Q-8 having a base 92 connected through a resistor 93 to positive line 25 and a collector 94 connected to an input line 95 of the flip-flop 17. The negative going pulse applied to the emitter 90 via line 75 drives the transistor Q-8 out of cutoff into saturation. The increase in current through the emitter-collector path of transistor Q-8 which results unbalances the flip-flop 17, causing it to switch states in a manner to be described in conjunction with the following description of the flip-flop. The transistor Q-8 functions to prevent the flip-flop 17 from resetting in response to resetting of the single shot 16.

The flip-flop 17 includes a pair of cross-coupled transistors Q-9 and Q-10 having a common emitter connection in which their emitters 97 and 98 are connected to the ground line 26 through a resistor 99. The collectors 102 and 103 of transistors Q-9 and Q-10 are connected to the bases 101 and 100 of the transistors Q-10 and Q-9, respectively, via coupling resistors 106 and 107. The base 100 of transistor Q-9 is also connected to the collector 94 of transistor Q-8 and to the ground line 26 via a resistor 108. The base 101 of transistor Q-10 is additionally connected to the ground line 26 via a resistor 109 as well as via a reset switch 110 which is in series with the parallel circuit combination of a resistor 111 and a capacitor 112. The switch 110 functions to reset the flip-flop 17 when actuated. The capacitor 112 prevents the flip-flop 17, once reset by actuation of switch 110, from becoming disabled, that is, unable to switch, should the switch 110 for some reason remain closed. Specifically, the capacitor 112, by eventually charging up, prevents the base 101 of transistor

Q-10 from being held at ground potential should the reset switch 110 remain closed due to a malfunction or other reason. With the base 101 unable to remain grounded indefinitely should switch 110 be maintained in a closed condition, the transistor Q-10 eventually is biased to a level wherein it can conduct should the flip-flop 17 be switched from the normal mode, in which transistors Q-9 and Q-10 are conducting and nonconducting, respectively, to the alarm mode in which the transistors Q-9 and Q-10 are nonconducting and conducting, respectively.

In operation, transistor Q-9 is normally conducting and transistor Q-10 is nonconducting. Under these normal operating conditions, one of the outputs of the flip-flop 17 taken at the collector 102 of transistor Q-9 is at a low potential, while the other output taken at the collector 103 of transistors Q-10 is at a high potential. When an alarm condition is created and the transistor Q-8 is driven into saturation, there is a sudden increase in current flow through the collector-emitter path of transistor Q-8 which is effective to draw more current through the resistor 107 and the line 95, to thereby lower the potential at the base 100 of transistor Q-9. This, in turn, drives transistor Q-9 into cutoff, which is effective to drive transistor Q-10 into saturation as the collector 102 of transistor Q-9 increases in potential, raising the potential of the base 101 of transistor Q-10. Transistor Q-9 remains nonconducting and transistor Q-10 remains conducting until reset by momentary closure of normally open switch 110, notwithstanding the resetting of the single shot 16. This result is produced by the transistor Q-9 which goes into cutoff as the single shot 16 resets, effectively preventing application to the base 100 of transistor Q-9 of the low potential present on the collector 73 of transistor Q-6. When the switch 110 is closed, the base 101 of transistor Q-10 is driven toward ground potential, as current is shunted from the base circuit through capacitor 112 to ground, driving the transistor Q-10 into cutoff and, in turn, transistor Q-9 into saturation in a manner well known to those skilled in the art of flip-flop operation. Thus, the flip-flop 17 switches states in response to an alarm condition and remains switched until reset by closing switch 110.

The change in state of the flip-flop 17, which raises the potential of the collector 102 of transistor Q-9, is effective to operate various alarm devices. For example, it is effective to extinguish, by reducing the potential thereacross, either a secure lamp 120 or an access lamp 121 located at the control station. The lamps 120 and 121 are connected, in parallel, between the collector 102 of transistor Q-9 and a switch 115 which is effective to alternately connect the lamps to a source of positive potential 122. The particular lamp which is extinguished in response to the switching of the flip-flop to its alarm condition depends upon which of the lamps 120 or 121 is connected to the source of positive potential 122 via the switch 115 when an alarm condition occurs. Specifically, if the system is in the secure mode with the secure lamp 120 illuminated when an alarm condition occurs, the secure lamp 120 is extinguished by the rise in potential of collector 102 which reduces the potential across the lamp 120. Likewise, in the access mode, the access lamp 121 is extinguished.

The switch in condition of the flip-flop in response to an alarm condition is also effective to illuminate an alarm lamp 123 connected between the collector 103 of transistor Q-10 and the source of positive potential 122. When so illuminated, the lamp 123 provides a visual signal to the personnel manning the control station, indicating the existence of an alarm condition. The lamp 123 is illuminated in response to the decreased potential of the collector 103, occurring when transistor Q-10 conducts, which increases the potential across the lamp 123.

In addition to extinguishing either the secure lamp 120 or the access lamp 121 and illuminating the alarm lamp 123, the switching of flip-flop 17 in response to an alarm condition also is effective to momentarily switch transistor Q-11 from a cutoff state to a saturation state, in turn actuating a buzzer circuit 125. Specifically, the rise in potential of the collector 102 of transistor Q-9 in response to driving the transistor Q-9 into

cutoff is coupled via a capacitor 113 to the base 126 of transistor Q-11 which is grounded through the resistor 116, momentarily driving this transistor from saturation into conduction. The momentary conduction of transistor Q-11 effectively lowers the impedance momentarily between the ground line 26 to which the emitter 127 of transistor Q-11 is connected and a relay coil 128 to which the collector 129 of the transistor Q-11 is connected. The momentary decrease in impedance completes an energization circuit to the relay coil 128 allowing a pulse of energization current to flow from a source of positive potential 130 through the relay coil 128 to ground via lines 138, 139, 131 and 132, and the collector-emitter path of transistor Q-11. The energization of the relay 128, in turn, transfers a contact 133 of the relay 128 completing a circuit from a ground connection 134 to a buzzer 135 via a line 142 allowing current to flow from the source of positive potential 130 to the buzzer 135 via line 150 thereby sounding an audible alarm.

The relay 128, when energized, latches between the source 130 and ground 134, through the circuit path including lines 138 and 139, a normally closed reset switch 140, a diode 141, line 142, and transferred relay contact 133. Because of this latching, the buzzer 135 remains energized after the transistor Q-11 has reverted to the cutoff state as a consequence of capacitor 113 charging up. The reset switch 140 is provided to momentarily interrupt the latch circuit for the relay 128, allowing the relay 128 to be deenergized and the buzzer 135 to be thereby deactivated. Capacitor 113, by preventing transistor Q-11 from remaining in saturation, enables the reset switch 140 to control the deactuation of the buzzer 135.

In the secure mode, switches 35, 30 and 115 are in the position shown in FIG. 2, placing the intrusion switch 33 and the resistor 34 in the lower resistive portion 12 of the voltage divider 10, shunting the potentiometer 29 and illuminating the secure lamp 120, respectively. In addition, the potential at tap point 13 is equal to the potential on the base 41 of transistor Q-1. Transistor Q-6 of the single shot 16 is cut off, while transistor Q-7 is saturated, providing a high potential output on line 75 to the transistor Q-8 holding it cut off, which in turn causes substantially no current to flow in line 95 through the emitter-collector path of transistor Q-8. Transistor Q-9 of the flip-flop 17 is conducting and transistor Q-10 is cut off, causing the secure lamp 120 to be illuminated via switch 115 and the alarm lamp 123 to be extinguished. The transistor Q-11 of the pulsing circuit is also cut off, effectively interrupting the energization circuit to the relay 128, allowing the relay contact 133 to assume the position shown, thereby interrupting the energization path to the buzzer 135.

If now an intrusion occurs opening switch 33, or an attempt is made to tamper with the circuit opening switch 31, the impedance of the lower resistive position 12 of the divider 10 is suddenly increased, causing the potential at the tap point 13 to rise. The rise in potential at the tap point 13 causes current to flow through coupling resistor 14 into the base of the transistor Q-1, driving it further into conduction, in turn driving transistor Q-2 further into conduction. The increased conduction of transistor Q-2 lowers the signal level input to the base 49 of transistor Q-5, causing this amplifier to be driven further toward cutoff, thereby decreasing the current flow through its collector-emitter circuit. This decrease provides a negative going amplified alarm signal on output line 61a, triggering the single shot 16 via the diode 79a.

Alternatively, with the system in the secure mode, the single shot is triggered by the substitution for resistor 34, a resistor having lesser resistance. Specifically, such a substitution lowers the potential of tap point 13, shunting current from the base circuit of transistor Q-1 through the coupling resistor 14. This drives transistor Q-1 toward cutoff, in turn driving transistors Q-2 and Q-5 toward cutoff and saturation, respectively. The increase in conduction of transistor Q-5 raises the potential on line 61b, causing a positive going pulse to be applied to the single shot 16 via the diode 79b, thereby triggering the diode.

With the condition of the single shot 16 changed, that is, with transistor Q-6 conducting and transistor Q-7 nonconducting, an increased current flows through the resistor 74 lowering the potential of line 75 connected to the emitter 90 of transistor Q-8, driving transistor Q-8 into saturation. The increased current in the collector-emitter path of transistor Q-8 draws more current through resistor 107 of the flip-flop 17, lowering the input signal to the base 101 of transistor Q-9, driving transistor Q-9 into cutoff. As transistor Q-9 passes from conduction to cutoff, transistor Q-10 is switched from cutoff to conduction. Hence, the flip-flop changes state.

The change in the condition of flip-flop 17 extinguishes the secure lamp 120 as a consequence of the rise in collector potential of transistor Q-9 which reduces the potential across the lamp 120. In addition, the changed condition of flip-flop 17 illuminates the alarm lamp 123 as a consequence of the decreased collector potential and increased current flow of the transistor Q-10 in series with the alarm lamp 123. A further consequence of the changed condition of the flip-flop 17 is the momentary switching into saturation of transistor Q-11 caused by the sudden rise in collector potential of transistor Q-9 which is applied to the base of transistor Q-11. The momentary reduced emitter-collector impedance path of saturated transistor Q-11 completes the pulse energization circuit to the relay 128, causing it to become energized, transferring the contact 133. The transfer of contact 133, in addition to latching the relay 128, also completes an energization circuit to the buzzer 135 providing, at the control center, an audible signal indicating the existence of an alarm condition in the protected area.

Assuming only a temporary opening of switch 33 and/or 31 occurs in response to an intrusion and/or attempt to tamper with the circuit, or a temporary decrease in resistance of the divider portion 12 in response to a resistor substitution, the single shot 16 and transistor Q-8 switch back to their original states after a predetermined time lapse. However, the flip-flop 17 remains switched due to isolating action of cutoff transistor Q-8, and the relay 128 latched, permitting the alarm lamp 123 and the buzzer 135 to remain energized, respectively, in the control center, until manually reset by opening switches 110 and 140 which reset the flip-flop 17 and unlatch the relay 128, respectively. With the flip-flop 17 and relay 128 returned to their prealarm conditions, the alarm lamp 123 is extinguished, the secure lamp 120 illuminated, and the buzzer 135 deenergized, respectively.

In the access mode of operation, switches 35, 30 and 115 are transferred from the position shown in FIG. 2, connecting resistor 32 and potentiometer 29 into the divider, and illuminating the access lamp 121, respectively. The condition of the remaining portions of the circuit, including the combined amplifier and reference source 15, single shot 16, flip-flop 17, pulsing circuit 18, and alarm circuit 19 are the same as described in connection with the secure mode of operation prior to the occurrence of an alarm condition.

If now an intrusion occurs, opening the switch 33, or a substitution is made lowering the resistance of resistor 34, no alarm is produced inasmuch as the circuit portion, including switch 33 and resistor 34, is not connected into the divider circuit. Hence, the opening of the intrusion switch 33 or the alteration in the resistance of resistor 34 has no effect on the potential of tap point 13 and no alarm is produced.

However, should the tamper switch 31 be opened in response to an attempt to tamper with the divider circuitry located in the protected area, the impedance of the lower portion 12 of the divider 10 suddenly increases, raising the potential of tap point 13. The increased tap point potential produces an alarm signal which is input to the amplifier 15 and, in the manner described previously, amplified. The amplified alarm signal triggers the single-shot 16, which in turn switches the state of the flip-flop 17, thereby extinguishing the access light 121 and illuminating the alarm lamp 123. In addition, the switched flip-flop 17 causes a pulse to be generated which energizes the relay 128, actuating an audible alarm or buzzer

135 at the control station. The alarm condition, including the actuation of the buzzer 135 and the illumination of the alarm lamp 123 continues, even though tamper switch 31 may thereafter be closed, until the switch 140 is opened, unlatching the relay 128, and the switch 110 is closed, changing the state of the flip-flop 17 to its prealarm condition.

I claim:

1. A security system for detecting unauthorized activity in a protected area and providing an indication of said activity to a remote central monitoring station, said system comprising:

a direct current voltage divider having first and second resistive means connected, respectively, to a first and second direct current supply source terminal, and separated by a tap point, only said first resistive means being located in the said protected area and subject to variation in response to said unauthorized activity;

resistive coupling means having one end connected to said tap point;

a single channel direct current transistor amplifier means having an input terminal and an output terminal, said amplifier means being biased to amplify signals input thereto of both increasing and decreasing magnitude, said amplifier means including circuit means interconnecting said input and output terminals for maintaining the potential of said amplifier input terminal at a substantially constant value in the absence of unauthorized activity, thereby eliminating the need for a separate reference potential means against which unauthorized activity-induced tap point voltage variations are compared, said amplifier being connected to the other end of said resistive coupling means and responsive to bidirectional changes, increases and decreases, both rapid and slow, in current flow through said resistive coupling means caused by alterations in value of said first resistive means induced by unauthorized activity in said protected area for providing a signal at said amplifier output terminal to reflect the existence of unauthorized activity; and

alarm output generating means including:

a. a first circuit path responsive to the output terminal of said amplifier means for providing an alarm output in response to an increasing signal level at said amplifier output terminal, and

b. a second circuit path responsive to the output terminal of said amplifier means for providing an alarm output in response to a decreasing signal level at said amplifier output terminal.

2. The system of claim 1 wherein said circuit means includes degenerative feedback means.

3. The system of claim 2 further including:

a monostable multivibrator connected to said output of said first and second circuit paths for providing an output of predetermined duration in response to an amplifier output signal; and

a bistable multivibrator connected to said monostable multivibrator and responsive to said predetermined duration output for actuating an alarm, said alarm continuing until said bistable multivibrator is reset thereby providing a continuing indication at said central station of noncontinuing unauthorized activity in said protected area.

4. The system of claim 3 wherein the potential of said tap point and said amplifier input terminal are equal in the absence of unauthorized activity and become unequal in response to unauthorized activity thereby causing current to flow through said resistive coupling means to initiate an alarm.

5. The system of claim 1 wherein said first resistive means includes first and second resistors alternately connectable in series circuit arrangement with said second resistive means for alternately providing secure and access modes of operation, respectively, only said first resistor being variable in response to an unauthorized entry into said protected area rendering said system sensitive and insensitive to said unauthorized entries when in said secure and access modes, respectively.

6. The system of claim 5 wherein said first and second resistors are differently valued, and further including a third resistor selectively connectable between said first resistive means and said tap point for rendering the total resistance between said tap point and said first supply source terminal independent of the resistance of said first resistive means in the absence of unauthorized activity, thereby permitting the system mode of operation to be changed without initiating an alarm.

7. The system of claim 6 further including means connected between said first resistance means and said tap point, said means being responsive to unauthorized activity for varying the resistance between said tap point and said first supply source terminal when said system is in said access mode in response to unauthorized activity to thereby initiate an alarm.

8. The system of claim 7 further including:

a monostable multivibrator connected to said output of said first and second circuit paths for providing an output of predetermined duration in response to an amplifier output signal; and

a bistable multivibrator connected to said monostable multivibrator and responsive to said predetermined duration output for actuating an alarm, said alarm continuing until said bistable multivibrator is reset thereby providing a continuing indication at said central station of noncontinuing unauthorized activity in said protected area.

9. The system of claim 7 wherein the potential of said tap point and said amplifier input terminal are equal in the absence of unauthorized activity and become unequal in response to unauthorized activity thereby causing current to flow through said resistive coupling means to initiate an alarm.

10. The system of claim 6 wherein said circuit means includes degenerative feedback means.

11. The system of claim 6 further including:

a monostable multivibrator connected to said output of said first and second circuit paths for providing an output of predetermined duration in response to an amplifier output signal; and

a bistable multivibrator connected to said monostable multivibrator and responsive to said predetermined duration output for actuating an alarm, said alarm continuing until

said bistable multivibrator is reset, thereby providing a continuing indication at said central station of noncontinuing unauthorized activity in said protected area.

12. The system of claim 6 wherein the potential of said tap point and said amplifier input terminal are equal in the absence of unauthorized activity and become unequal in response to unauthorized activity thereby causing current to flow through said resistive coupling means to initiate an alarm.

13. The system of claim 5 further including means connected between said first resistive means and said tap point, said means being responsive to unauthorized activity for varying the resistance between said tap point and said first supply source terminal when said system is in said access mode in response to unauthorized activity to thereby initiate an alarm.

14. The system of claim 13 further including:

a monostable multivibrator connected to said output of said first and second circuit paths for providing an output of predetermined duration in response to an amplifier output signal; and

a bistable multivibrator connected to said monostable multivibrator and responsive to said predetermined duration output for actuating an alarm, said alarm continuing until said bistable multivibrator is reset thereby providing a continuing indication at said central station of noncontinuing unauthorized activity in said protected area.

15. The system of claim 5 further including:

a monostable multivibrator connected to said output of said first and second circuit paths for providing an output of predetermined duration in response to an amplifier output signal; and

a bistable multivibrator connected to said monostable multivibrator and responsive to said predetermined duration output for actuating an alarm, said alarm continuing until said bistable multivibrator is reset thereby providing a continuing indication at said central station of noncontinuing unauthorized activity in said protected area.

16. The system of claim 1 wherein the potential of said tap point and said amplifier input terminal are equal in the absence of unauthorized activity and become unequal in response to unauthorized activity thereby causing current to flow through said resistive coupling means to initiate an alarm.

45

50

55

60

65

70

75