United States Patent [19]
Palmer

[11] 3,732,465
[45] May 8, 1973

[54] **ELECTRONIC SENSING AND ACTUATOR SYSTEM**

[75] Inventor: **Ronald S. Palmer**, San Jose, Calif.

[73] Assignee: **Charles A. Walton**, Los Gatos, Calif.

[22] Filed: **Sept. 20, 1971**

[21] Appl. No.: **181,865**

[52] **U.S. Cl.** ....**317/134,** 317/146, 340/147 F, 331/177 V
[51] **Int. Cl.** **E05b 49/00**
[58] **Field of Search** ....317/134, 146; 340/147 F; 331/177 V

[56] **References Cited**

UNITED STATES PATENTS

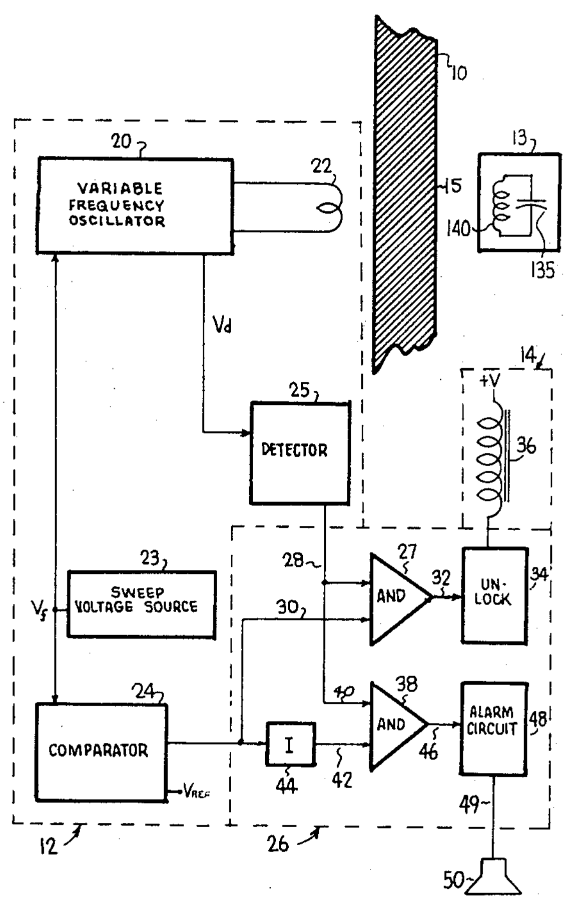
2,541,461	2/1951	Churchill	317/146
2,774,060	12/1956	Thompson	317/146
2,828,480	3/1958	Golladay	317/146
3,469,204	9/1969	Magyar et al.	317/146

Primary Examiner—L. T. Hix
Attorney—Thomas E. Schatzel

[57] **ABSTRACT**

An electronic sensing and actuator control system for sensing an energy change dependant on the proximity of a coded member to a sensor mechanism, the mechanism including an electric field producing means operative over a range of continuously varying frequencies; the coded member including a passive energy absorbing circuit responsive to a predetermined frequency range and adapted for placement in proximity to said mechanism to create a variation in the energy level of said electric field producing means; detecting means for detecting variations in the energy level of said electric field; and control-actuator means adapted to respond to the detecting means.

14 Claims, 9 Drawing Figures



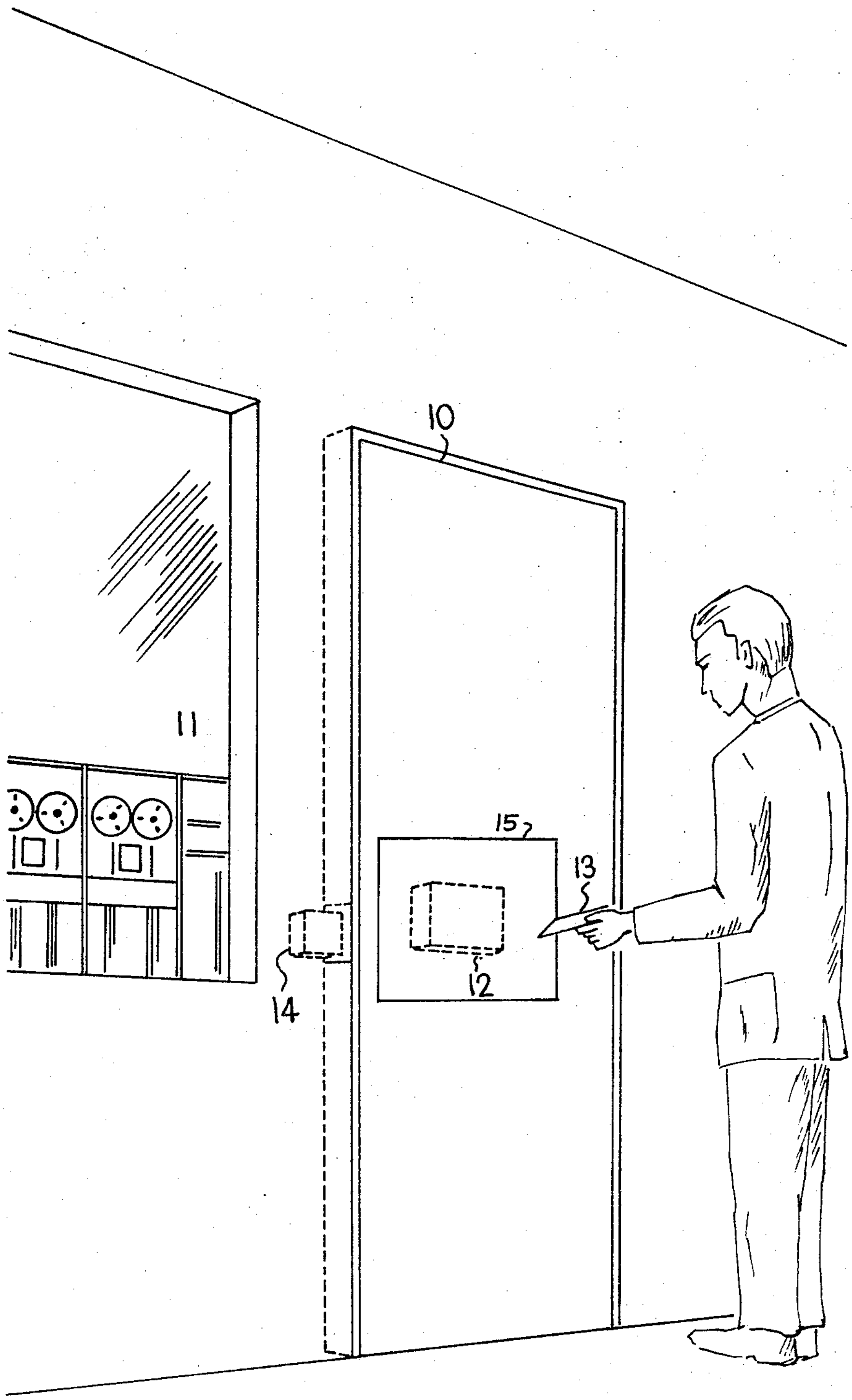


Fig. 1

INVENTOR
RONALD S PALMER

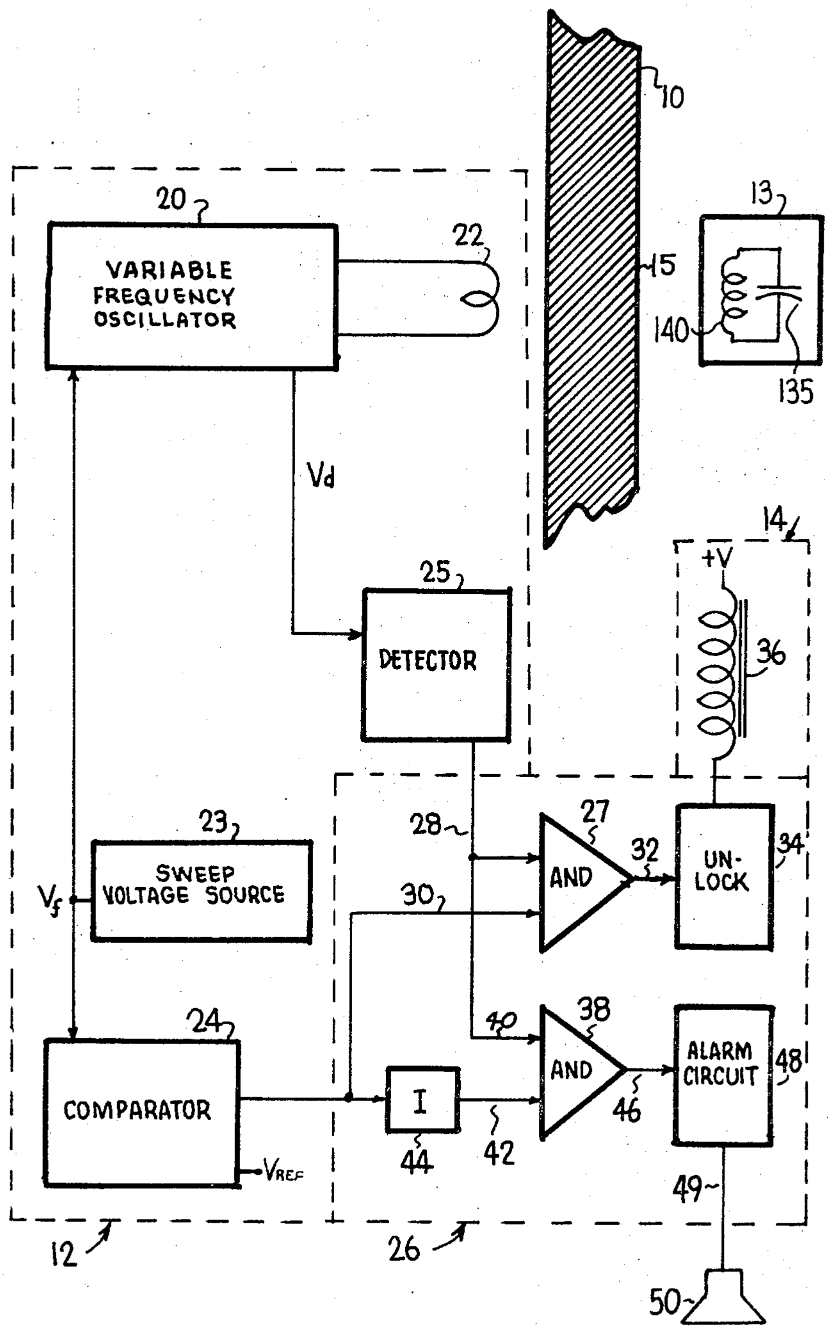


Fig. 2

INVENTOR
RONALD S PALMER

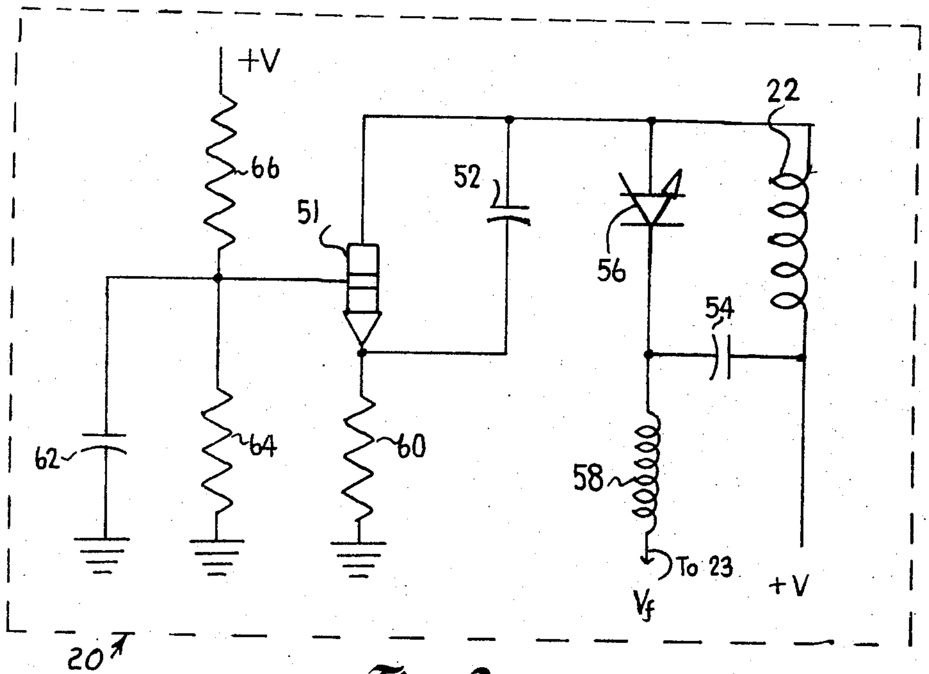


Fig. 3

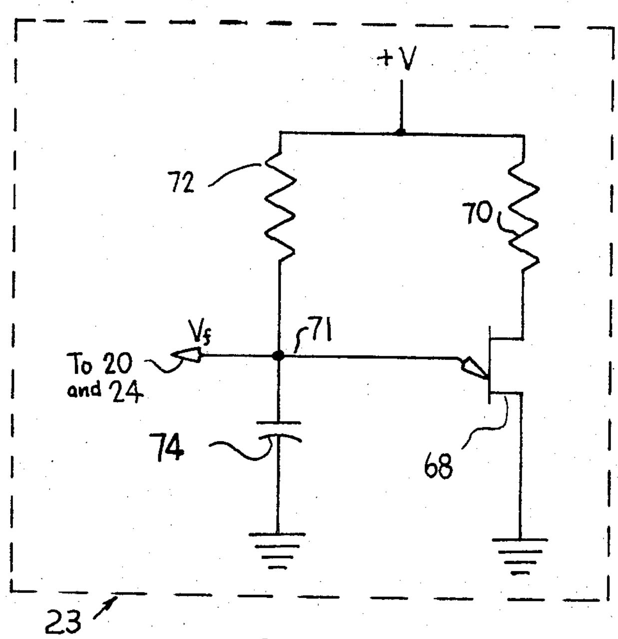


Fig. 4

INVENTOR

RONALD S PALMER

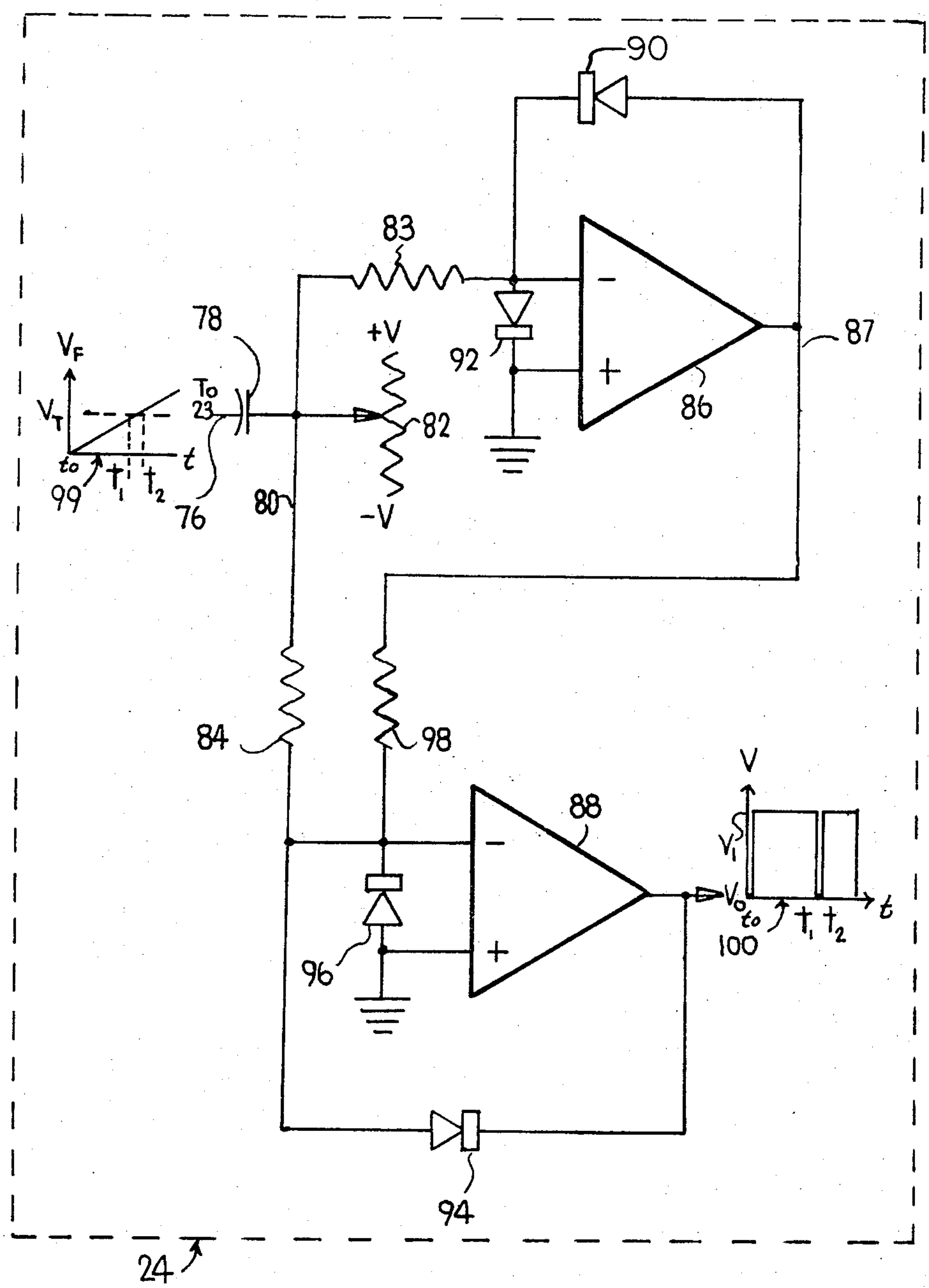


Fig. 5

INVENTOR
RONALD S. PALMER

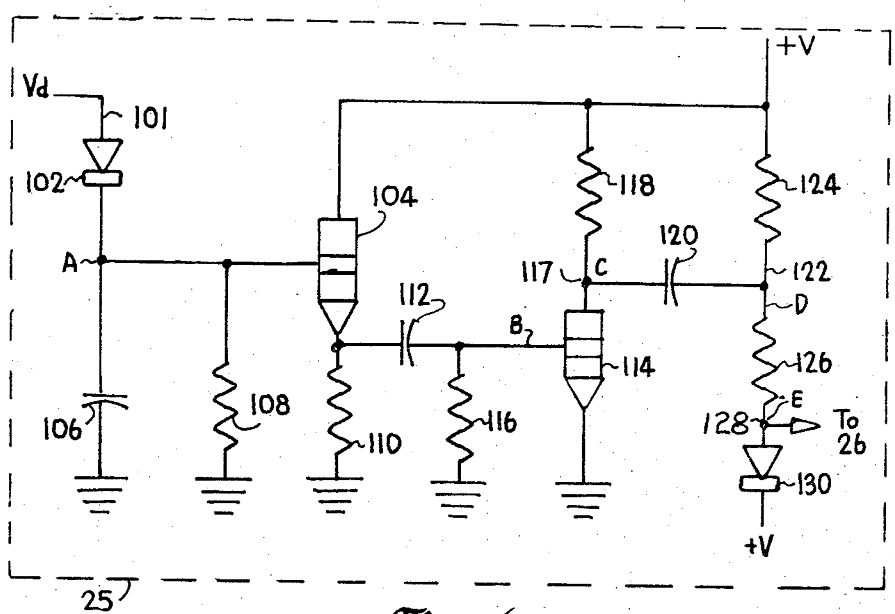


Fig. 6

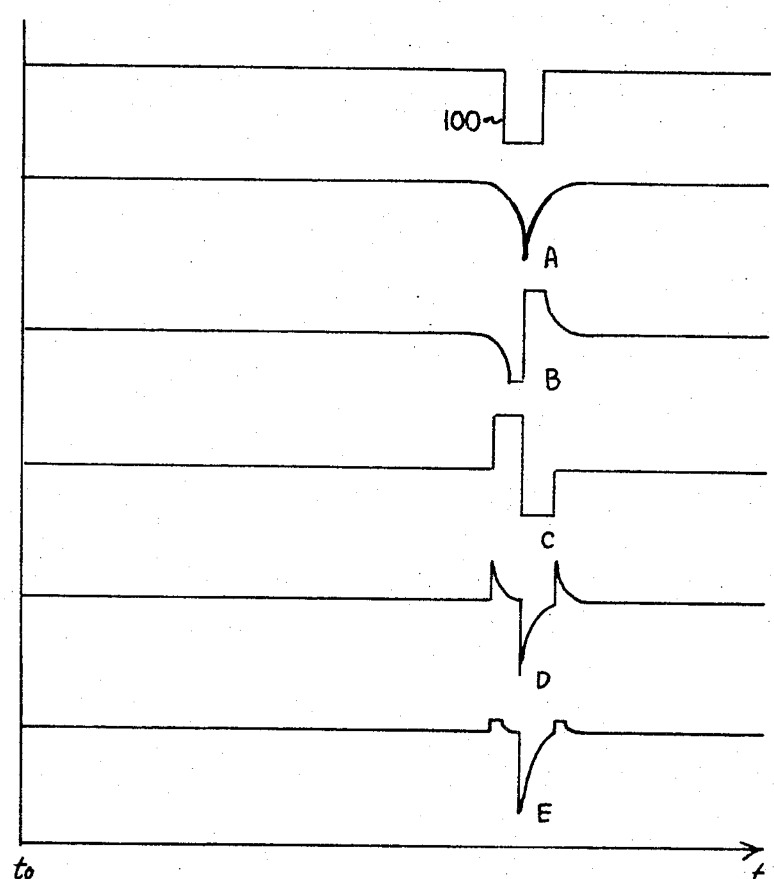


Fig. 7

INVENTOR
RONALD S PALMER

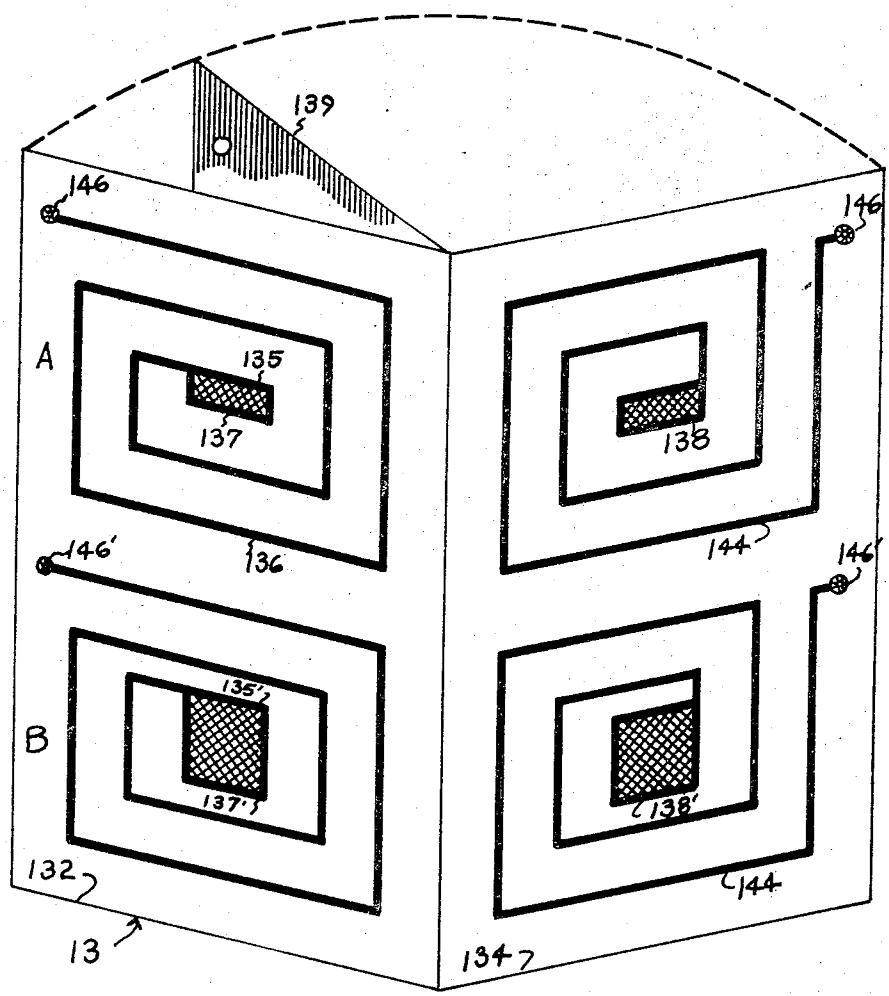

139
146
146
A
135
137
138
144
146'
136
146'
B
135'
137'
138'
144
132
13
134

Fig. 8

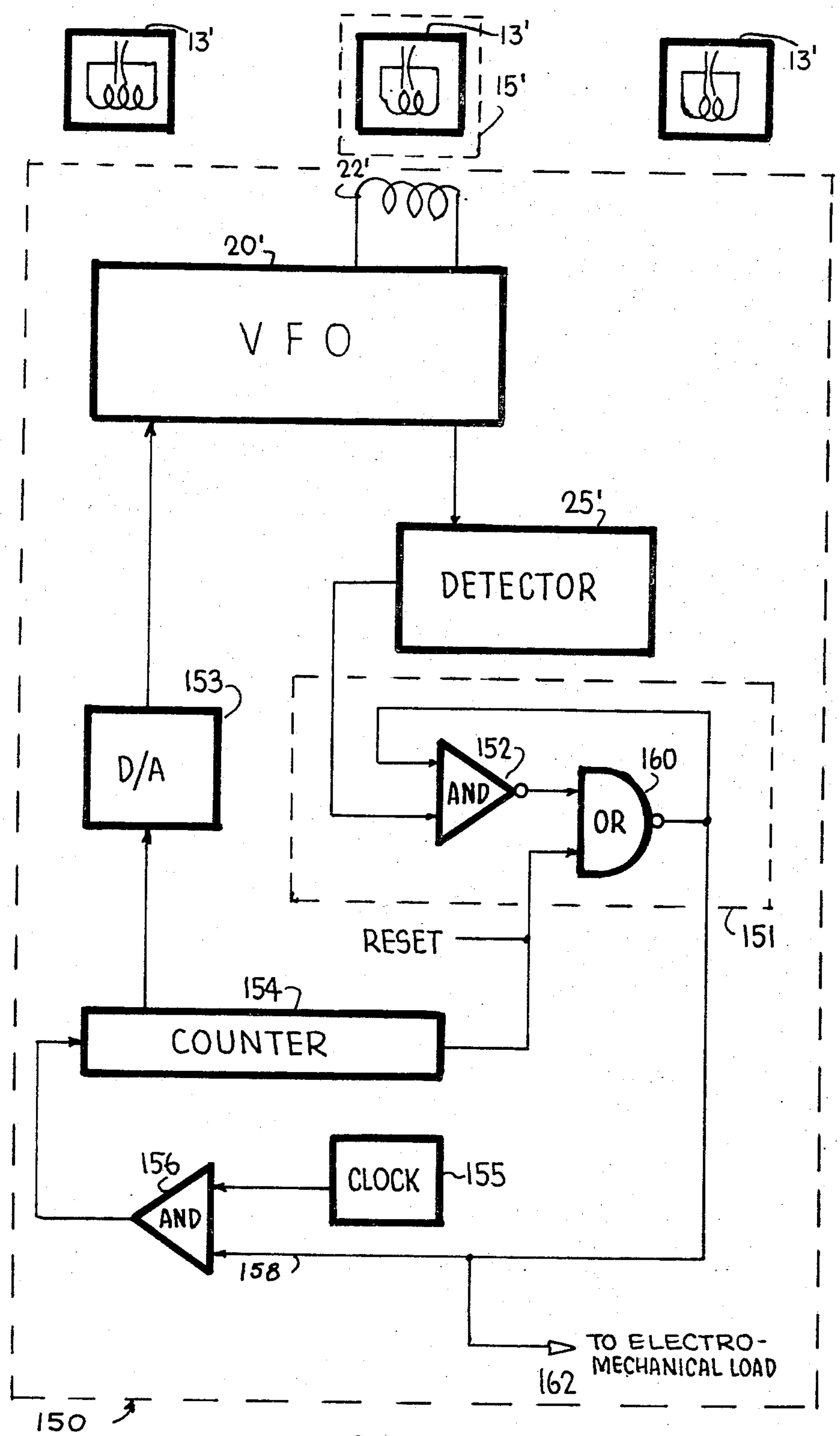


Fig. 9

INVENTOR
RONALD S PALMER

ELECTRONIC SENSING AND ACTUATOR SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for electrically sensing the proximity of an object and remotely controlling the actuation of an actuator responsive to the proximity of said object.

Electronic sensing and actuator control systems have various applications. There are applications in the processing or manufacturing of items in which items need be processed such as sorted, counted or tested. Other applications may include locking systems to secure designated areas from access by unauthorized persons or objects.

A lock system generally requires a portable code device, e.g., key to be utilized to actuate a locking to permit access to the secured area. The lock and key are programmed such that actuation of the lock is dependent upon coincidence between the program of the lock and the program of the key. In an electronic locking system the key program controls the actuation of an electrical circuit which, in turn controls actuation of the lock. Commonly, in electronic locking systems, in order to actuate the lock, the "key" is in the form of a card which need be inserted in a slot or socket or make other physical connection.

In various installations it is desirable to have locking systems which may be controlled by various different programs. For example, a "master key" is commonly desirable in order to entitle different authorized persons access to the secured area but at the same time it is necessary that the "master key" have a different code than other authorized "keys." Further, it is commonly desirable to have the locking system non-conspicuous and hidden from view. It is further commonly desirable to incorporate a locking system which does not require alteration of the area to create a key receiving station such as a slot, socket, etc.

The present invention teaches an improved electronic sensing and actuator control system which operates by proximity of the coded member to the sensor. When applied as an electronic lock the present invention does not require the aid of slots, sockets or physical connection for receiving the "key." It further teaches an actuator which may be adapted to respond to a plurality of coded programs.

SUMMARY OF THE PRESENT INVENTION

The present invention teaches an electronic sensing and actuator control system responsive to the proximity of an object to be sensed. The object to be sensed need not necessarily make physical contact with any other part of the apparatus but need only be brought into a sensing zone including the electrical field generated by an electrical part of the apparatus. The electrical part of the apparatus is adapted to sense the proximity and the coded program of the object and to generate a responsive control signal to an actuator mechanism in turn adapted to perform a designated function. As a locking system, the object to be sensed may be referred to as the "key." The "key" may consist of a card composed of interconnected passive electronic components, e.g., inductors, capacitors, resistors and/or crystals, such that the key may be readily transported by an individual to and from the sensing zone. The apparatus is adapted to actuate the lock when the proper key is sensed. The apparatus may be further adapted to sense and actuate an alarm if an incorrectly programmed key is brought in the sensing zone in an attempt to actuate the lock.

In an exemplary embodiment of a locking system, the key is in the form of a portable card comprised of passive inductance-capacitance elements establishing at least one resonant frequency. The electrical part of the apparatus includes a variable frequency oscillator adapted to continuously oscillate at varying frequencies within a frequency range. The electrical part of the apparatus creates an electrical field within a sensing zone in which zone the key may be brought for sensing. The electrical part of the apparatus includes a sweep voltage source extending to the oscillator adapted for controlling the oscillator frequency responsive to the sweep voltage. The sweep voltage source further engages a comparator network adapted to compare the sweep voltage to select reference voltages. The select reference voltages are selected according to desired frequencies such that the comparator may compare the actual sweep voltage to the reference voltages. The comparator network is adapted to generate a first comparator signal when the actual sweep voltage coincides with a selected reference voltage.

A detector network extends to the oscillator to detect the energy level of the oscillator and to detect the presence of the load on the oscillator. The energy level of said oscillator varies with varying load and the load varies as the key is brought into the sensing zone and the oscillator frequency approaches the resonant frequency of the key. The detector in turn generates a control signal responsive to the load conditions of the oscillator.

A controller network extends to the detector and to the comparator. The controller is adapted to control the actuator mechanism responsive to the relationship of the detector control signals and the comparator control signals.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of an installation of an electronic sensing apparatus and control mechanism incorporating the teachings of the present invention and applied as an electronic lock system;

FIG. 2 is a functional block diagram of the electronic apparatus and control mechanism of FIG. 1;

FIG. 3 is a circuit diagram of a variable frequency oscillator of FIG. 2;

FIG. 4 is a circuit diagram of a voltage sweep generator of FIG. 2;

FIG. 5 is a circuit diagram of a comparator network of FIG. 1;

FIG. 6 is a circuit diagram of a detector network of FIG. 1;

FIG. 7 is a graphical representation of pulse-time relationships of the circuit networks of FIGS. 5 and 6;

FIG. 8 is an exploded illustration of a key of FIG. 1; and

FIG. 9 is a functional block diagram of an alternative embodiment of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 illustrates an application of an electronic sensing and actuator control system of the present invention as utilized in an electronic locking system for securing a door **10** in turn controlling access to an enclosed area **11**. The electronic sensing and control system may include a sensing network referred to by the general reference character **12** and a programmed key referred to by the general reference character **13**. The sensing network **12** in turn may control an electromechanical actuator in the form of a lock **14** responsive to the proximity and the program of the key **13**. The key **13** is a passive circuit adapted to include an electrical-field sensitive circuit or circuits having a selected resonant frequency or frequencies of a value within the range of frequencies of the oscillator **12**. The sensing network **12** may be placed on the reverse side of the door **10** or at some other position remote from the lock **14**. If desired, the door **10** may be marked by appropriate designations such as by lines **15** to designate a sensing zone at which location the key **13** may be presented for sensing by the network **12**. In operation, when a key of a selected resonant frequency is within the sensing zone **15** the lock **14** may be actuated. If the key resonant frequency does not coincide with a select resonant frequency, the lock **14** is not actuated.

As illustrated in the block diagram of FIG. 2, the network **12** may include a variable frequency oscillator **20** including an output coil **22** which coil is positioned adjacent to the sensing zone **15** on the reverse side of the door **10**. The oscillator **20** is engaged to a sweep voltage source **23**. The sweep voltage source **23** continuously generates the sweep voltage v_f which, in turn, continuously varies the frequency of the oscillator **20**. The frequency of the oscillator **20** may be a direct function of v_f, e.g., one megahertz per volt. At the same time the sweep voltage source **23** extends to a comparator network, in the form of a window comparator **24** with v_f continuously applied to said comparator. A second voltage V*ref.*, representative of a desired frequency is also applied to the comparator. The value of V*ref.* is preselected according to at least one of the programmed frequencies of the key **13**. The window comparator network **24** is adapted to continuously generate binary logic "one" and "zero" signals responsive to the comparison of the voltage v_f to the preset reference voltage V*ref.* For example, the comparator **24** may generate a binary logic "one" when v_f coincides with V*ref.* and a binary logic "zero" for all other values of v_f. Thus, the logic "one" comparator signal indicates coincidence of the actual frequency of the oscillator **20** and the preselected frequency and logic "zero" comparator signal indicates the absence of coincidence of the actual frequency of the oscillator **20** and the preselected frequency.

The energy level of the oscillator **20** is sensed by a detector network **25**. The detector **25** is adapted to receive a sense voltage designated v_d from the oscillator. The voltage v_d remains substantially at a steady state level in the absence of variations of the oscillator load. The oscillator load and energy level are a function of passive reactive elements in the sensing zone **15**. Accordingly, the detector **25** network generates binary logic signals responsive to changes in the energy level of the oscillator **20**. During the steady state energy level of the oscillator **20** the detector **25** generates a binary logic "zero" control signal. When a reactive circuit is sensed with the sensing zone and the frequency of the oscillator **20** approaches the resonant frequency of the sensed circuit, the oscillator energy level varies and the value of v_d varies. The detector **25** responds to the change in v_d and generates a binary logic "one" control signal.

The comparator **24** and the detector **25** extend to a controller circuit network **26**. The network **26** is adapted to operate in different modes dependent on the logic signals received from the comparator **24** and the detector **25**. The controller **26** includes a first logic AND gate **27** having an input line **28** from the detector **25** and an input line **30** from the output of the comparator network **24**. The AND gate **27** has an output line **32** which extends to an unlock control circuit **34** to control the lock **14**. The unlock control circuit **34** may extend to a solenoid actuator **36** which is also joined to a power source + V such that in a first mode the actuator **36** may be actuated.

A second logic AND gate **38** is included and having a pair of input lines **40** and **42** with the input line **40** common to the detector **25** and the input line **42** extending from the output of a logic inverter network **44**. The input of the inverter **44** is common to the output of the comparator **24**. The AND gate **38** has an output line **46** extending to an alarm control circuit **48**.

Thus in the event the energy level of the oscillator **20** varies responsive to a key in the sensing zone **15**, the sense signal v_d varies from a steady state level and the detector **25** generates a logic "one" signal. The detector "one" signal is applied simultaneously to both AND gates **27** and **38**. If the sensed signal v_d is at the programmed desired frequency as established by V*ref.*, the comparator network **24** simultaneously generates a logic "one" control signal which is received by the gate **27** such that the gate **27** is actuated and generates a logic "one" on the line **32** to the unlock control circuit **34** and to the actuator solenoid **36** to activate the lock actuator. In the event that the sensed signal v_d is at a frequency within the oscillator frequency range but at a frequency other than the desired frequency, the detector **25** generates a logic "one" signal. However, the comparator network **24** simultaneously generates a logic "zero" control signal. The logic "one" and "zero" signals are received by the gate **27** but the gate **27** is not activated. The inverter **44** receives the comparator logic "zero" and inverts it to a logic "one" on the line **42** and to the AND gate **38**. The AND gate **38** also receives the logic "one" from the detector **25**. Accordingly, the AND gate **38** is activated and generates a logic "one" on the line **46** to the alarm circuit **48** to actuate the alarm **50** indicating that a key having a resonant frequency other than the desired frequency has been detected.

FIG. **3** is a circuit diagram of a variable frequency oscillator **20** which may be incorporated in the acutator **12**. The variable frequency oscillator **20** includes a common base transistor oscillator having an NPN transistor **51** with the collector and emitter tied across a capacitor **52**. The output coil **22** which forms a part of the tank circuit for the oscillator **20** is tied in common to the collector and in common to a capacitor **54** in turn common to a voltage variable capacitance in the form of a varactor **56**. The common junction of the capacitor **54** and varactor **56** is common to a choke coil **58** extending to the sweep voltage source **23** to receive the sweep voltage v_f. The common junction of the capacitor **54** and coil **22** are common to the voltage source +V. The emitter of the transistor **51** is common to a resistance **60** which extends to ground. The base of the transistor **51** is common to a resistance-capacitance filter network having a capacitor **62** and a resistance **64** both common to ground. The base of the transistor **51** also extends through a resistance **66** to the voltage source + V. In operation the oscillator **20** generates a continuously varying frequency depending upon the value of the voltage v_f from the sweep voltage source **23**. The capacitor **52**, the varactor **56** and the load coil **22** determine the frequency of oscillation. Variations in v_f varies the capacitance value of the varactor **56**. Accordingly, when the oscillator **20** is oscillating, an electric field exists around the output coil **22**. Viewing FIG. **1** the electric field penetrates the door **10** within the sensing zone **15**. The energy level of the oscillator varies as the operating frequency approaches the resonant frequency of passive reactive elements within the sensing zone **15**.

FIG. **4** is a circuit diagram of a sweep voltage source network **23** adapted to generate the constantly varying sweep voltage v_f and to vary the frequency of the oscillator within a desired range. The sweep voltage source **23** includes a unijunction transistor **68** having one emitter tied to ground and a second emitter tied to a first resistor **70** common to the voltage source +V. The gate of the transistor **68** is common to an output terminal **71** which is common to a resistor **72** extending to the voltage source + V and to a timing capacitor **74** extending to ground reference. Referring to FIG. **2**, the output terminal **71** is common to the input of the variable frequency oscillator **20** and to the comparator network **24** to supply the varying sweep voltage v_f. The resistor-capacitor of the resistance **72** and capacitance **74** are such that the capacitor **74** continuously charges from + V and discharges through unijunction transistor **68**. The resistor **72** allows the timing capacitor **74** to charge until the unijunction transistor **68** fires at a predetermined voltage. When the unijunction transistor **68** fires the capacitor **74** discharges to the point that the unijunction transistor turns off allowing the capacitor to recharge. The charge and discharge action continuously repeats such that the sweep voltage v_f at the terminal **71** continuously varies and repeats according to the values of the resistor **72** and capacitor **74**.

Referring to FIG. **5**, there is shown a comparator network **24** adapted to detect a particular value of the sweep voltage v_f. As shown the reference voltage from the sweep voltage source **23** is received at an input terminal **76**. The input terminal **76** is tied to a coupling capacitor **78** which in turn extends to a common junction **80** to a potentiometer **82**. The potentiometer **82** is preset according to the reference voltage V*ref.* necessary to detect the resonant frequency of the key **13** programmed to actuate the latch **14**. The junction **80** is common to a pair of resistors **83** and **84** of which the resistor **83** is tied to the negative terminal of an operational amplifier **86** and the resistor **84** is common to the negative input terminal of an operational amplifier **88**. The operational amplifier **86** has an output terminal **87** tied to the anode of a diode **90** extending to the negative input terminal of the amplifier **86**. Across the negative and positive input terminals of the amplifier **86** is a diode **92** with the anode tied to the negative input terminal and the cathode tied to ground reference and the positive input terminal. The operational amplifier **88** has an output terminal **93** joined to the cathode of a diode **94**. The anode of the diode **94** is tied to the resistor **84** and to the negative input terminal of the amplifier **88**. Across the negative input terminal and the positive input terminal of the amplifier **88** is a diode **96** with the cathode tied to the negative input terminal and the anode tied to the positive input terminal and to ground reference. The diodes **92** and **96** limit the voltage of the input of the amplifiers **96** and **88** to a predetermined safe value. The output terminal **87** of the amplifier **86** is tied to a resistor **96** extending to the negative input of the amplifier **88**.

The sweep voltage v_f as received at the terminal **76** is level shifted by means of the coupling capacitor **78** and the potentiometer **82** so that for operational purposes the reference level at the junction **80** is zero when the oscillator frequency of the oscillator **20** is equivalent to the resonant frequency of the programmed key **13**. For illustrative purposes, a voltage-time diagram **99** is illustrated to graphically depict the sweep voltage v_f as received at the input terminal **76** and to illustrate the shifted reference to a trigger level V_t which coincides with V*ref.* Accordingly, when the voltage level at the point **80** is negative relative to the trigger level V_t, the output of the operational amplifier **86** is positive and the diode **90** conducts. Conduction of the diode **90** clamps the output of the amplifier **86** slightly positive. At the same time the diode **94** is reversed biased by the negative potential at the terminal **80** and the amplifier **88** produces a full positive output at the terminal **93** as illustrated by a pulse waveform **100** illustrated on a voltage-time diagram. When the input sweep voltage v_f exceeds the preset trigger value V_t, the voltage at the terminal **80** assumes a relative positive value such that the output at the terminal **87** is negative and the diode **90** is reversed biased. This insures a negative voltage at the input of the amplifier **88** and the diode **94** is reversed biased such that a full positive voltage of a value V_1 is present at the output terminal **93**. As the value of v_f crosses through the preset trigger level V_t such that the relative potential at **80** is zero, as illustrated by the time period $t_1 - t_2$, the voltage at the output terminal **93** of the amplifier **88** is also zero as illustrated by the value V_O of the pulse diagram **100**. Accordingly, when the sweep voltage v_f is at the referenced trigger level V_f, it indicates that the sweep voltage source **23** is at the value V*ref.* coinciding with the select resonant frequency of a key to actuate the loc actuator **14**. Accordingly the comparator output voltage, as illustrated by the wave form **100**, when at the V_O value may be designated as a binary "one" and at all other values as a binary "zero." These logic binary signals, as previously discussed, are applied to the input of the controller network **26** and to the inputs of the AND gate **27** and to the inverter **44**.

Referring to FIG. **6** there is shown therein a circuit diagram of the detector network **25** adapted to detect energy level variations in the oscillator **20** responsive to the presence of a key in the sensing zone **15**. The detector **25** of FIG. **6** has an input terminal **101** common to the anode of an input diode **102** extending in common to the base of a NPN transistor **104**. The base of the transistor **104** is tied in common to a resistance-capacitance filter comprising a capacitor **106** extending to ground and parallel with a resistor **108**. The emitter of the transistor **104** is tied to ground reference through a resistance **110** and through a coupling capacitor **112** to the base of a NPN transistor **114**. The base of the transistor **114** is also tied to a resistor **116** extending to the ground reference. The emitter of the transistor **114** is tied to ground reference and the collector is tied in common to a junction **117**. The junction **117** is common to a resistance **118** and a capacitor **120**. The capacitor **120** joins a junction **122** common to a resistor **124**. The resistors **118** and **124** extend to the source + V. The junction **122** is also tied in common to a resistance **126** extending to an output terminal **128** in common to the anode of a diode **130**. The cathode of the diode **130** is tied to the voltage source + V. The output terminal **128** is adapted to extend to the controller network **26** and the AND gates **27** and **38**. In operation, the energy level change in the oscillator **20** due to the proximity of the key **13** will manifest itself as a decrease in the envelope voltage generated by the oscillator **20**. The detector **25** is adapted to respond to level changes in the envelope voltage. The envelope voltage v_d is detected by the diode **102** and filtered to produce a sharp decrease-increase level change in the amplitude as shown by the time diagram A in FIG. **7**. The signal A appearing at the base of the transistor **104** passes through the emitter-follower stage of transistor **104** and is first differentiated by the capacitor **112** and resistor **116** as shown by the signal B in FIG. **7**. The first differentiated signal B provides a signal representative of rater of change of the signal A. The signal B is then amplified and shaped by the common emitter transistor **114** and appears at terminal **117** as the signal C in FIG. **7**. The signal C is then further differentiated by the capacitor **120** and resistor **124** to yield a negative going spike corresponding to the preset desired frequency along with two positive going spikes at two frequencies dependent on the quality of resonance as indicated by wave form D in FIG. **7**. The positive going spikes of wave form D are clamped to the positive supply + V by the resistor **124**, the resistor **126** and the diode **130** such that the output at the terminal **128** appears as signal E of FIG. **7**. The desired negative going spike portion of the signal E represents the peak of the envelope signal A from the detector and the logic "one" level to be applied to the AND gates **27** and **38**. For illustrative purposes the waveform **100** of FIG. **5** from the comparator **24** is reproduced in FIG. **7**. It may be noted that in comparing the signal E with the signal **100** that there is time correspondence such that the AND gate **27** received a logic "one" at both input terminals and therefore actuate the unlock control circuit **34**.

It may be noted that the output of the detector **25** is a function of the energy change of the oscillator **20** such that in the event of an energy change, the signal E is generated. At the same time in viewing FIG. **7** it may be noted that the comparator **24** generates a "one" pulse only at the voltage corresponding to the desired resonant frequency. For all other frequency values the comparator generates a logic "zero." The output of the comparator is tied to the inverter **44** such that for all frequencies other than the desired frequency the inverter **44** generates a logic "one" output. Accordingly, in the event that the oscillator **20** generates a signal A for frequencies other than the desired frequency a pulse similar to that of E is generated by the detector and applied to both the AND gates **26** and **38**. With the coincidence of two logic "one" signals being applied to the AND gate **28** at a frequency other than the desired frequency, the AND gate **38** generates a signal to activate the alarm circuit **48** and actuate the alarm **50** while the AND gate **27** and latch **14** are not actuated. Actuation of the alarm **50** provides a signal that an "unauthorized key" is within the sensing zone.

FIG. **8** illustrates an embodiment of the key **13** in the form of an exploded card having a first face **132** and a reverse side face **134**. For illustrative purposes, the diagram of FIG. **8** illustrates the faces **132** and **134** separated whereas in actual application the faces **132** and **134** are back-to-back in secured relationship. The key **13** unit of FIG. **8** includes a pair of resonant circuits A and B each of a resonant frequency. The first circuit A of the key **13** and illustrated in FIG. **2**, includes a capacitor **135** and an inductor **136** tied in common to form a tank circuit. The capacitor **135** may comprise a pair of plates **137** and **138** with the plate **137** mounted on the surface **132** and the plate **138** mounted on the surface **134** separated by the card material comprised of a dielectric material **139**. The inductor **136** comprises a strip **142** on the surface **132** and a strip **144** on the surface **134**. The strips **142** and **144** are electrically joined in common by means of a through connection **146** extending through the card. The strip **142** is tied in common to the plate **137** and the strip **144** is tied in common to the plate **138**. Accordingly, the resonant frequency of the circuit A of the key **13** is dependent on the values of the inductance **136** and capacitance **135**. The circuit B of the key **13** is similar to the circuit A and carries the same reference numerals distinguished by a prime designation. The resonant frequency of the circuit B may be different from that of the circuit A. The card **13** is adapted such that the resonant circuits consist of only passive elements and may be designed of any of various sizes or shapes. The potentiometer **82** of the comparator is selected to relate to one of the resonant frequencies of the programmed key **13**.

Viewing the diagram of FIG. **2**, it may be noted that the present apparatus can be utilized to be actuated by cards of various resonant frequencies. For example, in the case of a master key **13** having a different frequency than that of a regular key **13**, the network of FIG. **2** may be modified to include a second comparator **24** receiving the sweep voltage v_f. The second comparator may be preset at a voltage level relating to the master key resonant frequency. The second comparator would extend to a third AND gate also extending to the detector. The third AND gate output would extend to the unlock control circuit to actuate the lock responsive to the master key. The third AND gate output would also extend to the alarm circuit to deactivate the alarm circuit in the event that the third AND gate has a logic "one" responsive to the master key.

FIG. **9** illustrates a functional block diagram of an alternative embodiment of the present invention referred to by the general reference character **150**, to be utilized for purposes of counting or sorting objects carrying a programmed "key." For purposes of clarification, those elements of the embodiment **150** similar to the previously described elements will be referred to by the same reference numeral distinguished by a prime designation.

In the FIG. **9** application, a "key" may be in the form of the objects to be counted or sorted or the object with a key attached thereto. The objects carrying the keys **13**^{1} will be continuously processed through the sensing zone **15**^{1}. As the key is brought into the sensing zone **15**^{1}, the energy of the variable frequency oscillator **20**^{1} is changed and detected by the detector **25**^{1}. The output of the detector **25**^{1} is fed to a controller network **151** having an AND gate **152**. In the embodiment of FIG. **9** the variable frequency oscillator **20**^{1} sweeps in steps through a predetermined frequency range. The stepping is realized by a digital-to-analog converter network **153** driven by a digital counter **154** which may carry the number corresponding to resonant frequency of the key **13**^{1} to be identified in the sensing zone **15**^{1}. Once the key **13**^{1} is identified the detector **20**^{1} may send out signals through the AND gate **152** to control the desired action and destiny of the object attached to the key **13**^{1}. The counter **154** may be stepped by means of a clock circuit **155** which extends through the input of an AND gate **156** which, in turn, extends to the counter **154**. The connection of the clock **155** and counter **154** may be disabled by means of the AND gate **156** through a control demand received at the other input of the AND gate **156**. In FIG. **9** gate **156** is tied in common through a line **158** to the output of an exclusive OR logic gate **160** and to the input of the AND gate **152**. The OR gate **160** is also tied in common to the counter **154**. Accordingly, prior to a key **13**^{1} coming within the sensing zone **15**^{1}, the counter **154** generates a signal which is applied to the OR gate **160** such that a signal appears on the line **158**. Simultaneously the clock **155** generates a signal such that the AND gate **156** generates a signal thereby permitting the counter **154** to function. Upon a key **13**^{1} coming within the sensing zone **15**^{1}, the detector **25**^{1} detects the change in energy level. Accordingly, the AND gate **152** is activated thereby disabling the output of the OR gate **160** and the signal on the line **158**. Accordingly, the counter is disabled until the key passes through the sensing zone **15**^{1}. The OR line **158** is also common to an output terminal **162** such that an actuator mechanism (not shown) may respond to the presence of a key **13**^{1} in the sensing zone **15**^{1}. Once the key **13**^{1} passes through the sensing zone **15**^{1} the OR gate may be reset and the apparatus **150** reactivated for detecting purposes. A more specific example of the application of the embodiment **150** of FIG. **9** may be for sorting inductors, capacitors or any resonant circuit of unknown value. For example, to sort inductors, a key in the form of a capacitor of known value may be connected to the inductor of unknown value to form a resonant circuit. As the formed circuit passes the sensing zone **15**^{1} the variable frequency oscillator **20**^{1} will identify the resonant frequency and then control a sorting mechanism to place the inductor in a bin representing its particular value.

I claim:

1. An electronic sensing and actuator control system for controlling an actuator, the system comprising, in combination:

a variable frequency oscillator means adapted to repeatedly sweep through a range of operating frequencies and generate a field at said operating frequencies within a sensing zone, the oscillator being adapted to generate an energy level signal representative of the energy level of the output field;

a key unit means adapted to be transported to said sensing zone, the key unit comprising a field sensitive circuit having at least one selected resonant frequency, said resonant frequency being of a value within the range of frequencies of said oscillator;

an energy level detector means for receiving said energy level signal, detecting variations in the energy level of the oscillator means and generating a responsive detection output signal responsive to the energy level of the oscillator means;

a controller network adapted to be responsive to the detector output signal to generate responsive control signals for controlling an actuator mechanism; and

means for interconnecting the controller network to an actuator mechanism.

2. The system of claim **1** in which

the variable frequency oscillator means is adapted to repeatedly sweep through a range of operating frequencies and generate an electrical field at said operating frequencies within a sensing zone, the oscillator being adapted to generate an energy level signal representative of the energy level of the output field; and

the key unit means adapted to be transported to said sensing zone, the key unit comprising an electrical field sensitive circuit having at least one selected resonant frequency, said resonant frequency being of a value within the range of frequencies of said oscillator.

3. The system of claim **2** further including

a comparator network for comparing the actual frequency of the oscillator means to at least one preselect frequency, the comparator network adapted to generate a responsive comparator control signal responsive to the relationship of said actual frequency and said preselected frequency.

4. The system of claim **3** in which the controller means is adapted to respond to said detector output signal and said comparator control signal.

5. The system of claim **4** in which

the detector means is adapted to generate a first detector output signal state responsive to variations in energy level of the oscillator means and a second detector output signal state responsive to the steady state energy level of the oscillator means;

the comparator network is adapted to generate a first comparator output signal state responsive to coincidence of the actual frequency of the oscillator and said selected resonant frequency and a second comparator output signal state responsive to the absence of coincidence of the actual frequency of the oscillator and said selected frequency; and

the controller network is adapted to respond in at least two different modes, one of said modes being in response to receiving the first detector output signal state and the first comparator output signal state and another of said modes being in response to receiving the first detector output signal state and the second detector output signal state.

6. The system of claim **5** in which the key unit means includes passive electronic components joined in a circuit of said selected resonant frequency.

7. The system of claim **6** in which the oscillator means is in the form of a voltage frequency oscillator adapted to sweep through a range of frequencies responsive to a sweep reference voltage; and including a sweep voltage source adapted to generate a sweep reference voltage and engaged to the oscillator means to control the frequency of the oscillator.

8. The system of claim **7** in which the comparator network is in the form of a voltage comparator, the comparator being engaged to the sweep voltage source to receive said sweep reference voltage, the comparator network further adapted to receive at least one preset reference voltage of a fixed value, each of said preset reference voltages being adapted to be preset of a value corresponding to one of said selected resonant frequencies.

9. The system of claim **8** in which the energy level detector means includes an input means for receiving said energy level signal and first differentiating means for differentiating said energy level signal and producing a signal representative of the rate of change of the peak amplitude of said energy level signal.

10. The system of claim **9** in which the energy level detector means further includes a second differentiating means for differentiating

the signal of said first differentiating means for producing a signal representative of the peak of said energy level signal.

11. The system of claim **10** in which the controller network includes a logic AND gate extending to the comparator network and to the detector means and adapted to generate a control signal responsive to the time relationship of said comparator output signal state and said detector output signal state; and an actuator mechanism adapted to respond to the control signal of said AND gate.

12. The system of claim **1** further including a digital-to-analog converter for generating a frequency reference voltage responsive to input digital signals for controlling and converter, the counter means being responsive to a clock means extending to the counter means through a disabling means, said disabling means being adapted to disable the counter responsive to a control demand of the controller network.

13. The system of claim **12** in which the controller network is in the form of an AND gate adapted to respond to said detector output signal and to said disabling means, an OR gate adapted to respond to said AND gate output and said counter such that the counter is disabled responsive to said detector output signal.

14. The system of claim **7** in which the key unit means includes a plurality of electrical field sensitive circuits each having a select resonant frequency, each of said resonant frequencies being of a value within the range of frequencies of said oscillator.

* * * * *