

Aug. 11, 1959

P. SIERER

2,899,674

ALARM SYSTEM

Filed Sept. 16, 1954

2 Sheets-Sheet 1

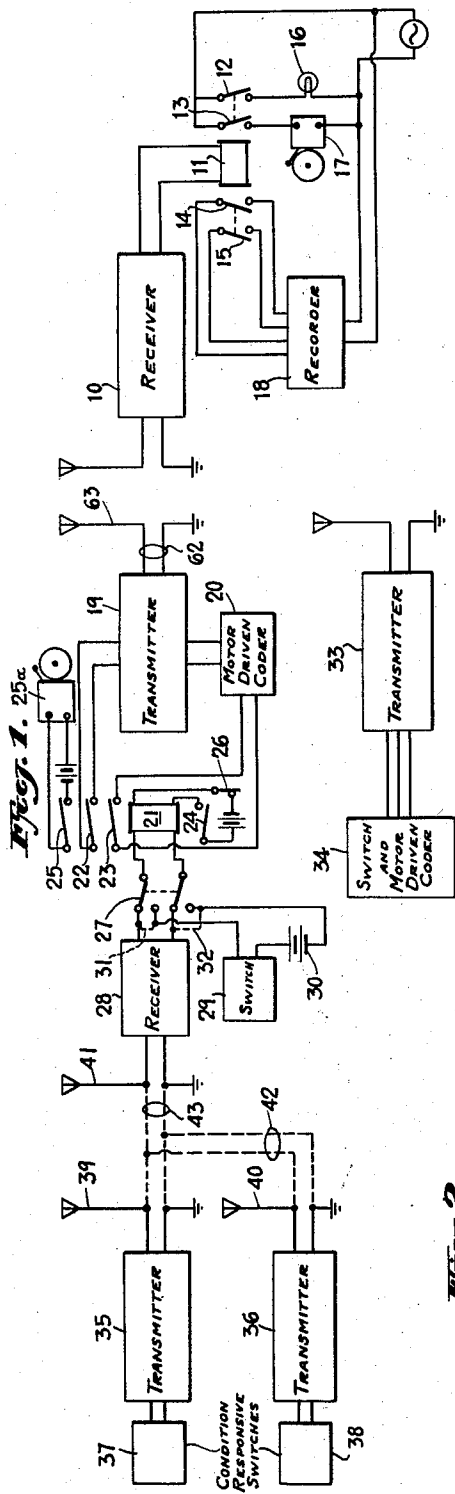


Fig. 2.

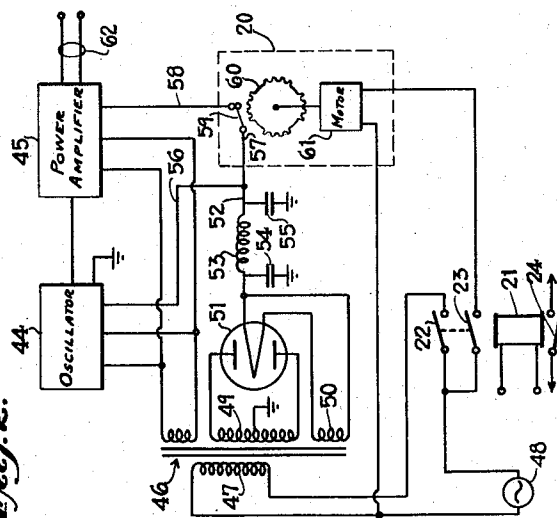


Fig. 3.

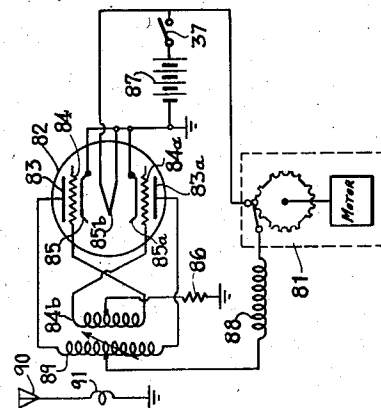
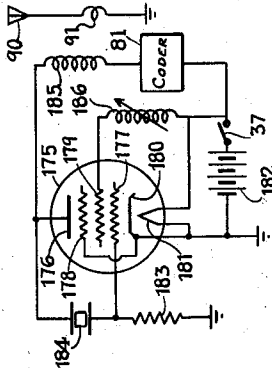


Fig. 5a.



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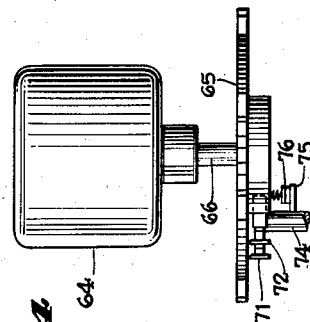
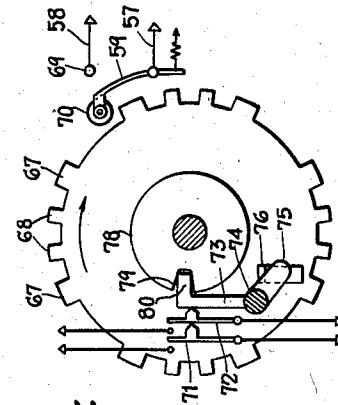
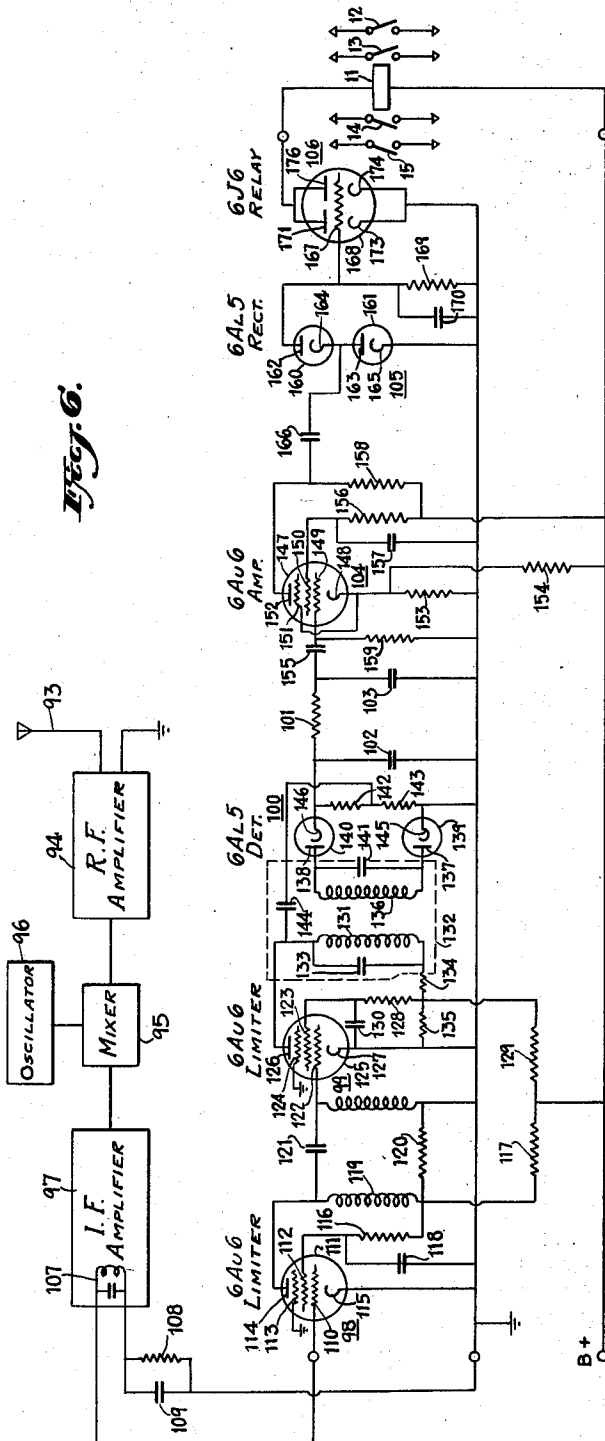
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ALARM SYSTEM

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Application September 16, 1954, Serial No. 456,558

7 Claims. (Cl. 340-218)

This invention relates to alarm systems and particularly to such systems that are used to indicate the presence of fire or intruders to fire or police stations at points remote from the protected premises and to transmit a signal to a fire or police station or to a private agency to indicate abnormal or normal conditions, such systems transmitting the desired alarm or signal by means of radio frequency energy which is coded to distinguish the sending station.

It is known to transmit an alarm or signal by means of radio frequency energy from a first place which is being protected to a supervisory point, such as a police or fire station, which energy is modulated in some manner to indicate the source of the alarm. The alarm or signal may be initiated by a thermally-responsive switch, by a switch operated by the opening of a window or door or by the weight of an intruder, by a key-operated switch, etc., the switch setting a radio transmitter into operation. The signal is received at the supervisory point where it operates an alarm or recorder.

When there are several different premises being protected, it usually is necessary to modulate the transmitter at each different place being protected by a distinguishing code, such as a dot-dash code, in order to eliminate the need for a wide radio frequency band and several receivers and still permit ready identification of the sending transmitter. If a reasonable range for such a transmitter as well as coding apparatus is to be provided, it is uneconomical to provide several such transmitters at a single place being protected. However, a single transmitter, in a large building, for example, would provide insufficient protection, and the use of several dispersed switches in the building for controlling a single transmitter is not a satisfactory solution not only because the installation of lines is relatively expensive but also because a line which interconnects a switch at a fire point and the transmitter may be damaged and rendered inoperative before the switch operates.

In accordance with one feature of the invention, a plurality of miniature radio transmitters are located at spaced points in an area or building to be protected. These transmitters are not provided with coding apparatus and are of relatively low power. They may be battery operated and transmit their energy either through space or over the existing power lines. Operation of a transmitter is initiated by a condition-responsive switch, e.g., a switch responsive to a physical condition such as temperature or force, and the energy of the transmitter is received by a receiver at a point in or near the area or building. The receiver energizes a further, more powerful transmitter having coding apparatus associated therewith. It is the output of this more powerful transmitter which is received at the supervisory point and used to operate an alarm or recorder.

In order to make the foregoing system inexpensive to install and operate, I have invented a novel and simple radio transmitter which can operate at low voltage and hence which can be operated with a small battery. Such

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a transmitter has a low output power, but the output power is sufficient to cause the receiver to operate at distances of at least one hundred feet.

In view of its small size and power requirements, the above-mentioned radio transmitter is useful in systems employing call boxes. Thus, the transmitter may be installed in a call box along with a simple coding device such as a coding wheel driven by a spring motor for the purpose of transmitting a manually-initiated alarm.

Of course, any alarm system must be reliable not only in the sense that it will not fail over long periods of time, but also in the sense that false alarms are a rare occurrence. When the alarm initiator is connected to the supervisory point by wires, interference which would cause a false alarm is a minor problem. However, when the signals are transmitted from the protected premises to the supervisory point by radio energy, interference can be a serious problem. Thus, interfering electrical radiation, also called static, emanates from many sources and such radiation can cause false alarms in conventional alarm systems employing radio energy as the signalling medium. It has been suggested that such false alarms can be avoided by employing two-frequency radio transmitters and two interconnected receivers. However, such a system is not only expensive to install but also requires greater care and can fail to operate if the code transmission is interfered with.

In accordance with a further feature of the invention, a reliable alarm system is provided without the use of multiple-frequency transmission and with only a single receiver at the supervisory point by incorporating circuits in such receiver which in the absence of carrier energy prevents operation of the supervisory alarm. When carrier energy is being received, the alarm is operated and its operation cannot be hindered by extraneous electrical disturbances. In addition, failure of the receiver, for example, due to loss of sensitivity, tube failure, etc., is immediately indicated by operation of the alarm in a manner different from the manner it is operated when an alarm signal is received.

Accordingly, it is an object of my invention to provide an alarm system which is versatile and reliable and which is simple and inexpensive to install and maintain.

Further objects and advantages of the invention will be apparent from the following detailed description setting forth the manner in which I now prefer to practice the invention and from the accompanying drawings, in which:

Fig. 1 is a combined circuit and block diagram of an alarm system incorporating the features of the invention;

Fig. 2 is a combined circuit and block diagram illustrating one of the transmitters forming part of the system shown in Fig. 1 in greater detail;

Figs. 3 and 4 are schematic showings of coding apparatus which may be employed in connection with the transmitters shown in Figs. 2 and 5;

Figs. 5 and 5A are circuit diagrams of transmitters which may be employed in the system illustrated in Fig. 1; and

Fig. 6 is a combined circuit and block diagram of the preferred form of the supervisory receiver forming part of the system illustrated in Fig. 1.

Referring to Fig. 1, the supervisory point, such as a police or fire station or the quarters of a private protective agency, is provided with a receiver 10 for receiving radio frequency energy. The output of the receiver 10 controls a relay 11 which may have one or more armatures 12-15 and associated contacts for closing circuits of various types of alarm devices. For example, as shown, armature 12 closes a circuit for lighting a lamp 16, armature 13 closes a circuit for energizing a bell or gong 17, armature 14 closes a circuit for energizing the driv-

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ing circuits of a recorder 18, such as a conventional tape recorder, and armature 15 closes a circuit which energizes the recording mechanism of the recorder 18. As shown in Fig. 1, the relay 11 operates all of such devices 16, 17 and 18 but, alternatively, it may be arranged to operate only one of such devices. Accordingly, when radio frequency energy is received by receiver 10, relay 11 is energized causing operation of the armature 12—15 and energization of the associated alarm devices.

If it is assumed that the energy received by the receiver 10 is interrupted in accordance with a predetermined code, then the lamp 16 will flash in accordance with the code, the gong 17 will produce an audible interrupted alarm and the recorder 18 will indicate the reception of energy for successive periods of time.

A transmitter 19 is located at the premises being protected or at the point from which it is desired to send a signal. The output of the transmitter 19 is interrupted in accordance with a predetermined code by means of a coder 20 which is connected to the transmitter 19 in a conventional manner as shown in greater detail hereinafter. The transmitter 19 is energized or caused to transmit radio frequency energy by a relay 21 having one or more armatures 22, 23, 24 and 25. When the relay 21 is energized, it closes a circuit at its armature 22 for energizing the transmitter 19; at its armature 23 it closes a circuit for energizing the coder 20 and at its armature 25 it closes a circuit for energizing a local alarm such as a bell 25a. At armature 24 relay 21 closes a circuit for locking the relay 21 and thereby preventing its de-energization until switch 26 is opened, such switch 26 normally being opened manually. A locking circuit preferably is provided for the relay 21 so that when the relay 21 is energized by means hereinafter described the transmitter 19 remains in operation until the switch 26 is open, regardless of any subsequent change in the circuit which energizes relay 21. However, if the circuit which initially energizes relay 21 can be relied upon to maintain the relay 21 in energized condition, then armature 24 and the associated locking circuit for relay 21 may be omitted.

By means of a switch 27 the relay 21 may be connected to a radio frequency energy receiver 28 or to a condition-responsive switch 29 having an electrical energy source 30 associated therewith. In the position of switch 27 shown in Fig. 1, the relay 21 is energized by the output of receiver 28 so that when receiver 28 receives radio frequency energy, the relay 21 is energized.

When the switch 27 is moved to its alternate position, the relay 21 may be energized by the condition-responsive switch 29 in association with the source 30. Switch 29 may be any one of several conventional types of switches depending upon the purpose for which the system is intended. Thus, if the circuit is intended to indicate the presence of abnormal temperatures, the switch 29 may be a temperature-responsive switch. If the system is to be employed to indicate the presence of intruder, then the switch 29 can be a switch operated by the opening of a door or window or by the weight of an intruder. If the system is to be employed for the sending of a signal which indicates that a watchman has reached a particular watch point, then the switch 29 may be a key or hand-operated switch.

Accordingly, when the switch 29 is closed in response to a particular condition, the relay 21 is energized causing the transmitter to transmit bursts of radio frequency energy, the spacing and duration of the bursts being determined by the coder 20.

If desired, the relay 21 may be connected to both the receiver 28 and the switch 29 so as to be operated when the receiver 28 receives radio frequency energy or when the switch 29 is closed. For this purpose the contacts of the switch 27 may be interconnected by jumpers 31 and 32 indicated in dotted lines in Fig. 1.

It will be understood that the frequency of the radio frequency transmission of transmitter 19 is the same

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as that to which the receiver 10 is tuned. On the other hand, the receiver 28 is tuned to a frequency different from the frequency of transmission of the transmitter 19 so that the receiver 28 does not energize relay 21 due to the transmission of energy by the transmitter 19.

A further transmitter 33 may be provided at the same premises or may be located at a different point. The transmitter 33 operates on the same frequency as the transmitter 19 and, therefore, any radio frequency energy transmitted by the transmitter 33 is received by the receiver 10. Thus, a single receiver 10 can be employed to receive, at different times, signals from several different transmitters located at the same point or at different points. The transmitter 33 is energized and its output is interrupted by means of a switch and motor-driven coder 34 which may, for example, include switch 29 and coder 20 described above.

The premises being protected may be located at a relatively long distance from the supervisory point and hence from the receiver 10. Therefore, in order to provide ample power for reliable operation and for different types of installations, the transmitters 19 and 33 should be of relatively large size and power output. In addition, in order to permit personnel at the supervisory point to distinguish which of the transmitters 19 and 33 is transmitting, the outputs of the transmitters 19 and 33 must be modulated with a distinguishing code. Accordingly, it is necessary to associate with the transmitters 19 and 33 coders as indicated at 20 and 34. Thus, the transmitter employed for transmitting energy from the protected premises to the supervisory point must be relatively large and expensive, making such transmitters unsuitable for dispersal around the premises being protected. However, for the reasons set forth above, a single transmitter with a single switch or a single transmitter with a plurality of switches does not provide a satisfactory installation in certain cases, for example in a large building. In order to avoid the need for the installation of several switches connected to the transmitter by wires and in order to avoid the use of several of the more expensive transmitters, the alarm system of the invention comprises the receiver 28 connected to the transmitter 19 as set forth above and a plurality of low power, inexpensive transmitters 35 and 36, which latter transmitters may be located at various points about the premises to be protected.

Each of the transmitters 35 and 36 is connected to and controlled by a condition-responsive switch similar to the switch 29 previously described. Thus, the transmitter 35 is connected to and controlled by condition-responsive switch 37 and the transmitter 36 is connected to and controlled by a condition-responsive switch 38 so that when the associated switch is operated, the transmitter 35 or 36 continuously transmits radio frequency energy at a frequency to which the receiver 28 is tuned, causing the receiver 28 to energize the relay 21 and hence causing the transmitter 19 to transmit coded radio frequency energy to the receiver 10.

Each of the transmitters 35 and 36 may be provided with an antenna such as the antennas 39 and 40 so that the radio frequency energy is transmitted through space to the receiver 28 which is similarly equipped with an antenna 41. However, if desired, carrier current transmission over the power lines may be employed for transmitting the radio frequency energy from transmitters 35 and 36 to the receiver 28. In this type of installation the transmitters 35 and 36 are connected to the receiver 28 by means of power lines 42 and 43 indicated in dotted lines in Fig. 1 and the antennas 39—41 may be omitted.

Referring to Fig. 2, the transmitter 19 of Fig. 1 is shown therein in greater detail. Thus, the transmitter 19 may comprise a radio frequency oscillator 44 whose output is coupled to the power amplifier 45. Filament energy is supplied to the oscillator 44 and the amplifier 45 by a transformer 46 whose primary winding 47 is connected

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to a source of electrical power 48 by means of the armature 22 of relay 21. Transformer 46 has a high voltage winding 49 and a rectifier filament winding 50, which windings are energized when the primary winding 47 is connected to the source 48 by the relay 21. The output of winding 49 is rectified by a conventional rectifier tube 51 so that a high D.C. voltage is present on line 52 at the output of the filter comprising a choke 53 and a pair of capacitors 54 and 55. The output of the filter is connected to the oscillator 44 by line 56 and is connected to the power amplifier 45 by lines 57 and 58, the lines 57 and 58 being connected by a contactor 59 forming part of the coder 20. The contactor 59 rides on the periphery of a serrated wheel 60 which is driven by an electric motor 61, the motor 61 being connected to the power source 48 through the armature 23 of relay 21.

Thus, when the relay 21 is energized, the transformer 46 is energized supplying filament power to the oscillator 44 and the power amplifier 45 and supplying high voltage energizing power to the oscillator 44. At the same time, the motor 61 commences to operate and through a suitable gear reduction drive forming part of the motor 61 the coding wheel 60 is rotated. At the contactor 59 the high voltage for energization of power amplifier 45 is interrupted at predetermined intervals so as to cause the radio frequency energy output of the power amplifier 45 to take the form of bursts of radio frequency energy which may have the same or different durations. Thus, by the transmitting bursts of radio frequency energy of different durations and sequence, a large number of different transmitters may each have an identifying code. The output of the power amplifier 45 appears across the line 62 which, as shown in Fig. 1, is connected to a suitable antenna 63.

Although in the alarm system shown in Fig. 1 the transmitter 19 is energized by means of a condition-responsive switch 29 or by means of the receiver 28, it is also possible to operate transmitter 19 so that its transmission is initiated manually. Thus, it may be desirable to incorporate the transmitter 19 in a call box for the purpose of transmitting an alarm manually. With such an arrangement the motor-driven coder 20 and the relay 21 shown in Figs. 1 and 2 are replaced by the switching and coding apparatus shown in Figs. 3 and 4. In one form the apparatus of Figs. 3 and 4 comprises an electric motor 64 having associated therewith a reduction drive (if required) for the purpose of reducing the speed of the coding wheel 65 to the desired value. Coding wheel 65 is mounted on the output shaft 66 of the motor 64 and has a plurality of teeth 67 and 68 on the periphery thereof. It will be noted that the teeth 67 are wider than the teeth 68 and the teeth 67 and 68 are arranged in spaced groups. With the arrangement shown, the tooth 67 maintains the contactor 59 in contact with its contact 69 a longer period of time than the teeth 68. Accordingly, when the roller 70 of the contactor 59 is riding on a tooth 67, the transmitter 19 is caused to transmit radio frequency energy for a period of time indicating a dash and, when the roller 70 is riding on top of a tooth 68, the transmitter 19 is caused to transmit radio frequency energy for a period of time indicating a dot. When the roller 70 is between the teeth, the transmitter 19 does not transmit radio frequency energy.

The switch arms 71 and 72 take the place, respectively, of armatures 23 and 22, the arm 71, when operated, energizing the motor 64 and the arm 72, when operated, energizing the transmitter 19 as described above. The switch arms 71 and 72 are operated by an arm 73 which is mounted on a shaft 74 and turns therewith. Shaft 74 is manually rotatable by means of a knob or lever (not shown) and, hence, when the shaft 74 is rotated, the transmitter 19 and the coding wheel driving motor 64 are set into operation.

To prevent the opening of the switch arms 71 and 72 after the transmitter 19 has been set into operation, an

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arm 75 is also mounted on the shaft 74 so as to be turned therewith and in the rotated position of the shaft 74 this arm 75 engages a latch 76 which holds the arm 73 in a position such that the transmitter 19 and the motor 64 are energized until the latch 76 is released. Accordingly, the operator merely rotates the shaft 74 and then releases it to cause the transmission of coded radio frequency energy by transmitter 19.

In some cases it may not be desirable to employ an electric motor for driving the coding wheel 65. In such cases the motor 64 may be a spring-driven motor and the switch arm 71 with its associated contact may be omitted. However, when the motor 64 is a spring-driven motor, a wheel or cam 78 driven with a coding wheel 65 is also provided and this wheel or cam 78 has a notch 79 therein for receiving a tongue 80 on the arm 73. Accordingly, as long as the tongue 80 is within the notch 79 the coding wheel 65 is prevented from rotating. However, when the shaft 74 is rotated manually, the tongue 80 is withdrawn from the notch 79 permitting the wheel 78, and hence the coding wheel 65, to rotate. The coding wheel 65 continues to rotate after its initial release until the latch 76 is released as explained above or until the spring-driven motor is unwound. The mechanism is reset merely by releasing the latch 76 and by rewinding the spring motor 64.

Fig. 5 shows a circuit diagram of one type of simple and inexpensive transmitter which may be employed at 35 and 36 in Fig. 1. A coder 81 of the type shown in Figs. 3 and 4 is also shown in Fig. 5, but in the installation shown in Fig. 1 the coder 81 is omitted.

The transmitter shown in Fig. 5 comprises a vacuum tube 82 having anode electrodes 83 and 83a, control electrodes 84 and 84a and cathode electrodes 85 and 85a comprising a filament 85b. One end of the filament 85b and the cathode electrodes 85 and 85a are connected to ground and the control electrodes 84 and 84a are connected to a grid driving winding 84b, the center tap of which is connected to ground by a resistor 86. One end of the power source 87 which may, for example, be a battery, is connected to one end of the filament 85b and the opposite end of the source 87 is connected to the opposite end of the filament 85b by the condition-responsive switch 37. This opposite end of the source 87 is also connected to the anode electrodes 83 and 83a through an isolating impedance in the form of a choke 88 and a tunable inductance 89, the inductance 89 with the stray capacities and the circuits coupled thereto forming a resonant circuit. The inductance 89 is coupled to the antenna 90 by a coupling loop 91 and is connected at its ends to the anode electrodes 83 and 83a. The inductance 89 is also magnetically coupled to the winding 84b to supply energy to the control electrodes 84 and 84a of the magnitude and phase necessary to produce radio frequency oscillations.

It will be noted that the only source of energizing potential for the tube 82 shown in the Fig. 5 is the source 87 which supplies the energy for heating the filament 85b. Thus, the circuit shown in Fig. 5 is unconventional in that the potential of the source for the anode electrodes 83 and 83a is the same as the potential between the ends of the filament 85b. I have found that a vacuum tube such as a tube designated as a 12AT7 will produce oscillations at a low power level with the circuit arrangement shown in Fig. 5 and with the anode electrodes 83 and 83a connected to the source of energy for the filament 85b. Of course, it will be apparent that, although I have shown the resonant or tuned circuit comprising the inductance 89 connected to the anode and control electrodes of the tube 82 in one manner, the tuned circuit may also be coupled to one or more of these electrodes in other conventional manners.

The transmitter shown in Fig. 5 may be made very small in size and is inexpensive to install and maintain since the source 87 is required to supply only a relatively

low voltage, e.g., 6 volts, and there is no drain on the source 87 until the switch 37 is closed. The source 87 may be small in size since its output voltage is low and since it will have to deliver energy to the tube 82 and its associated circuits for only a relatively short period of time after the switch 37 is closed.

As pointed out above, the circuit shown in Fig. 5 does not include the coder 81 when it forms part of the circuit shown to the left of Fig. 1. However, if desired, the circuit shown in Fig. 5 may form part of a call box installation provided only a relatively short signalling range is required such as in a building. Thus, the coder 81 may be connected in the circuit as shown in Fig. 1 so as to interrupt the radio frequency energy transmitted from the antenna 90 in accordance with an identifying code. The coder 81 may take the form of the modified embodiment described in connection with Figs. 3 and 4 and may, for example, include the coding wheel 65 and its associated coding parts, the coding wheel 65 being driven by a springwound motor. In such a system the frequency of operation of the transmitter shown in Fig. 5 will be the same as the frequency to which the receiver 10 is tuned so that the signals transmitted by the transmitter of Fig. 5 would be received by the receiver 10 and would operate one or more of the alarms shown in Fig. 1 in the same manner as transmitter 19 operates such alarms.

Fig. 5A shows a circuit diagram of a further type of simple and inexpensive transmitter which may be employed at 35 and 36 in Fig. 1 and which may be employed in place of the transmitter shown in Fig. 5. As indicated in connection with Fig. 5, the coder 81 shown in Fig. 5A would be omitted when the transmitter is employed in an installation of the type shown in Fig. 1, but in a different type of installation the coder 81 may be employed in the manner set forth in connection with Fig. 5.

The transmitter shown in Fig. 5A comprises a vacuum tube 175 having an anode electrode 176, a control electrode 177, a suppressor electrode 178, a further control or screen electrode 179, and a cathode electrode 180 comprising a filament 181. One end of the filament 181 and the cathode electrode 180 are connected to ground and to one end of the power source 182. Control electrode 177 is connected to ground through a resistor 183 and is connected to one end of a frequency-controlling, piezo-electric crystal 184. The crystal 184 acts as a resonant or tuned circuit for controlling the frequency of the oscillations of the transmitter shown in Fig. 5A and the opposite end thereof is connected to the anode electrode 176. The opposite end of the source 182 is connected to the opposite end of the filament 181 by the condition-responsive switch 37. This opposite end of the source 182 is also connected to the anode electrode 176 through the switch 37 and the coder 81 and through a choke 185 to which the antenna 90 is magnetically coupled by the loop 91. The opposite end of the source 182 is also connected to the screen electrode 179 through the switch 37 and a tunable inductance 186 which is employed in a conventional manner to establish the feedback conditions required to produce oscillations.

The transmitter shown in Fig. 5 is unconventional in that the sole source of energy for the vacuum tube 175 is the power source 182 which supplies heating energy for the filament 181. Thus, the D.C. potential applied to the anode electrode 176 is the same as the potential between the ends of the filament 181. I have found that a vacuum tube of the type designated as a 6AJ5 will produce oscillations at a lower power level with the circuit arrangement shown in Fig. 5 and with the anode electrode 176 connected to the source of energy for the filament 181. Accordingly, the transmitter shown in Fig. 5A has the advantages of the transmitter shown in Fig. 5 and, in addition, the transmitter shown in Fig. 5A has a very stable oscillation frequency since the transmitter is crystal controlled.

As pointed out above, any alarm system must be re-

liable not only in the sense that it will not fail over long periods of time, but also in the sense that false alarms are a rare occurrence. If the receiver 10 or the receiver 28 is a conventional receiver, the system is subject to the production of false alarms due to reception of undesired electrical radiation such as static. There are numerous sources of electrical interference, such sources being, for example, electric motors, car motors, electric signs, etc. If the radiation from such sources is received by the receiver 10, for example, and the receiver 10 is a conventional receiver, the radiation will cause operation of the relay 11 and hence will cause operation of the alarms associated therewith. In this manner the alarms may be operated from time to time even though it would be possible to distinguish such improper operation from the proper operation thereof by the coded transmission from transmitter 19. However, in addition, such radiation might occur during the transmission of the desired radiation from the transmitter 19 and might cause the alarms to indicate an erroneous code. For these reasons, the alarm systems of my invention include a special type of receiver which is shown partly in block form and partly in circuit diagram in Fig. 6.

Referring to Fig. 6, the radio frequency energy from a remote transmitter such as the transmitter 19 is received by antenna 93, amplified by the amplifier 94, converted to an intermediate frequency by the mixer 95 and the oscillator 96 and the resulting energy at intermediate frequency is amplified by the amplifier 97. These portions of the receiver are conventional in many known types of receivers and in particular in receivers in alarm systems of the prior art.

Instead of following the conventional practice of merely detecting and amplifying the output of the intermediate frequency amplifier 97, the receiver used in the alarm system of my invention comprises a pair of limiting amplifiers 98 and 99, the output of the latter amplifier being detected by the detector 100. A filter comprising the resistor 101 and the capacitors 102 and 103 is connected between the output of the detector 100 and an amplifier stage 104. The filter attenuates energy at intermediate frequency and passes lower frequency signals such as noise signals. The noise signals are amplified by the amplifier stage 104 and rectified in the rectifier circuit 105. The rectified noise signals provide a bias for a D.C. amplifier stage 106 which controls relay 11. Thus, when noise signals are transmitted through filter 101, amplified by amplifier 104 and rectified by rectifier 105, a negative bias is produced at the amplifier stage 106 which prevents operation of the relay 11. However, when the noise signals are no longer present, the amplifier stage 106 turns on and energizes the relay 11 causing the alarm associated therewith to operate. Therefore, it will be apparent that when undesired electrical radiation is received by the receiver and in the absence of the desired radiation, the relay 11 will not be operated and hence the alarms will also not be operated. In addition, if the sensitivity of the stages of the receiver preceding the amplifier stage 106 is reduced or if one of the stages preceding the stage 106 becomes inoperative, the relay 11 will become energized and will remain energized indicating by the continuous operation of one of the alarms that the receiver is failing to operate properly.

On the other hand, if undesired radiation is received by the receiver during reception of the desired radiation, such interfering radiation will not cause energization of the relay 11 or operation of the alarms because the limiting amplifiers 98 and 99 will prevent such interfering radiation from producing signals at the output of the detector 100. Such action of the limiting amplifiers 98 and 99 will be understood readily by those skilled in the art and need not be described in detail herein.

Referring to Fig. 6, the output stage of the IF amplifier 97 is indicated diagrammatically at 107. The output stage 107 is connected in series with a resistor 108 and a by-pass capacitor 109 and to a control electrode

110 of the vacuum tube 111. Tube 111 comprises a further control or screen electrode 112, suppressor electrode 113, anode 114 and a cathode 115. The suppressor electrode 113 and the cathode 115 are connected to ground as shown and the screen electrode is connected to the high voltage source indicated by the symbol B+ through a resistor 116 and resistor 117. Screen electrode 112 is by-passed to ground by capacitor 118. Anode 114 is connected to the high voltage source through a coil 119 having a high impedance at the intermediate frequency and through the resistor 117. To lower the voltage applied to the anode 114 and the screen electrode 112, a dropping resistor 120 is connected between one end of the coil 119 and ground. The output of the limiting amplifier 98 is coupled to the input of the limiting amplifier 99 by capacitor 121 which is connected to the control electrode 122 of the vacuum tube 125. Tube 125 may be the same as tube 111 and hence may comprise suppressor electrode 124, screen electrode 123, anode 126 and a cathode 127. As before, suppressor electrode 124 and cathode 127 are connected to ground as shown. Screen electrode 123 is connected to the high voltage source through a resistor 128 and a resistor 129 and is by-passed to ground for energy of intermediate frequency by the capacitor 130. Anode 126 is connected to the high voltage source through the primary winding 131 of the transformer 132, said winding 131 being shunted by capacitor 133, an isolating resistor 134 and resistor 129. To lower the voltage applied to the anode 126 and to the screen electrode 123, a dropping resistor 135 is provided.

Transformer 132 has a second winding 136 whose ends are connected to the anodes 137 and 138 of a pair of diode vacuum tubes 139 and 140. The winding 136 is shunted by a capacitor 141 and the transformer may be tuned by capacitor 141 and capacitor 133 or it may be tuned in any other well known manner so as to pass energy at intermediate frequency. A portion of the energy of intermediate frequency is coupled to the junction point of a pair of resistors 142 and 143 by a capacitor 144. The cathodes 145 and 146 are connected to the opposite ends of resistors 142 and 143.

When no radio frequency energy is being received from the transmitter 19 shown in Fig. 1, noise signals appear across the resistors 142 and 143 and are passed by the filter including the resistor 101 and the capacitors 102 and 103 to the input of amplifier stage 104. However, whenever radio frequency energy is received by the receiver from transmitter 19, the limiting amplifier stages 98 and 99 are driven to saturation even though the received energy is of a very low level. Such operation of the limiting amplifiers 98 and 99 "squelsches" the noise signals and hence during reception of radio frequency energy from the transmitter 19 no noise signals are present across the resistors 142 and 143. It is to be noted that only the reception of radio frequency energy of the proper frequency by the receiver will cause the noise signals to disappear.

The output of the filter is connected to amplifier stage 104 which comprises a vacuum tube 147 having a cathode 148, a control electrode 149, screen electrode 150, a suppressor electrode 151 and an anode 152. The suppressor electrode 151 is connected to the cathode 148 and the cathode 148 is connected to ground through a resistor 153 which controls the bias on the tube 147 and which controls the amplitude of the signals supplied to rectifier 105. A resistor 154 is connected between the high voltage source and one end of resistor 153 for providing a fixed bias on the tube 147. The output of the filter is coupled to the control electrode 149 by a capacitor 155, the control electrode 149 being connected to ground through a resistor 159.

The screen electrode of tube 147 is connected to the high voltage source through a resistor 156 and is by-passed to ground by a capacitor 157. Anode 152 is

also connected to the high voltage source through a resistor 158.

As mentioned above, the amplifier stage 104 amplifies the noise signals appearing at the output of the filter and supplies such amplified noise signals to the rectifier circuit 105. The rectifier circuit 105 comprises a pair of diodes 160 and 161 having anodes 162 and 163 and cathodes 164 and 165. The cathode 164 of diode 160 is connected to the anode 163 of diode 161 and the output of amplifier 104 is coupled to the junction point of the cathode and anode by the capacitor 166. The anode 162 is connected to the control electrode 167 of tube 168 forming part of the amplifier stage 106. A resistor 169 is connected between the control electrode 167 and ground and is by-passed by a capacitor 170 so as to provide a substantially fixed bias on the control electrode 167 when noise signals are amplified by the stage 104.

The diodes 160 and 161 are so poled that the voltage at the control electrode 167 is negative with respect to ground when noise signals are amplified by the stage 104 and the magnitude of the bias is such that the tube 168 is cut off or substantially cut off with the magnitude of the high voltage applied to the anodes 171 and 176 thereof. The cathodes 173 and 174 of the tube 168 are connected to ground as shown. The anodes 171 and 176 are connected to the high voltage source through the coil of relay 11 and hence when the tube 168 is cut off or substantially cut off, no current or substantially no current flows through the coil of relay 11. Accordingly, the relay 11 is de-energized and the armatures thereof are in the positions shown. However, when the noise signals are "squelsched" by the limiting action of the amplifiers 98 and 99, there is no bias developed across the resistor 169 and the tube 168 becomes conducting or more conducting. When tube 168 becomes sufficiently conducting, the current in relay 11 operates the armatures thereof and hence operates the alarm or alarms associated therewith as shown in Fig. 1.

It will be apparent from the foregoing that the receiver forming part of the alarm system of my invention not only prevents operation of the alarms from interfering, undesired radiation, but also prevents interference with the reception of desired radiation and operation of the alarms thereby in the desired manner. Also, if the receiver loses its sensitivity so that noise signals produce an insufficient voltage across the resistor 169 or if the stages preceding the stage 106 become inoperative, the relay 11 will be continuously energized and hence will cause continuous operation of one of the alarms actuated by the relay 11. In this way, the receiver is self-monitoring and improper operation or failure can be readily detected.

While the invention has been described with reference to the preferred forms thereof, it will be understood by those skilled in the art, after understanding the invention, that modifications and changes may be made therein without departing from the spirit and scope of the invention as defined by the claims appended hereto.

What is claimed as new and what I desire to secure by Letters Patent of the United States is:

1. An alarm system comprising a radio frequency energy transmitter comprising a source of radio frequency energy, and coding means connected to said source for interrupting said energy in accordance with a predetermined code; switching means for energizing said coding means connected thereto; a receiver spaced from said transmitter and adapted to receive radio frequency energy from said transmitter, said receiver comprising a limiting amplifier, a detector connected to said amplifier, said amplifier and detector providing low frequency signals at the output of said detector in the absence of said radio frequency energy and substantially suppressing said low frequency signals when said radio frequency is received, a filter circuit connected to the output of said detector and adapted to attenuate high frequency signals and to

pass said low frequency signals, a further amplifier connected to said filter for amplifying said low frequency signals, a rectifier connected to said further amplifier for rectifying the amplified low frequency signals and for thereby providing a biasing voltage upon receipt of said low frequency signals, and a control amplifier connected to said rectifier and controlled by said biasing voltage; and an alarm circuit connected to said control amplifier and controlled thereby, said alarm circuit comprising relay means connected to said control amplifier and energized thereby and an alarm connected to and operated by said relay means, said alarm being disabled by said relay means during the presence of said lower frequency signals and being operated by said relay means in absence of said lower frequency signals.

2. An alarm system comprising a radio frequency energy transmitter comprising means for generating radio frequency energy, means for transmitting said last-mentioned energy connected to said generating means and coding means connected to one of said generating and transmitting means for interrupting the transmission of said energy in accordance with a predetermined code; switching means for energizing said coding means and said generating means connected thereto; a receiver spaced from said transmitter and adapted to receive radio frequency energy from said transmitter, said receiver comprising a limiting amplifier, a detector connected to said amplifier, said amplifier and detector providing audio frequency noise signals at the output of said detector in the absence of said radio frequency energy and substantially suppressing said audio frequency noise signals when said radio frequency energy is received, a filter circuit connected to the output of said detector and adapted to attenuate radio frequency signals and to pass audio frequency noise signals, a further amplifier connected to said filter for amplifying said noise signals, a rectifier connected to said further amplifier for rectifying the amplified noise signals and for thereby providing a biasing voltage upon receipt of said noise signals, and a control amplifier connected to said rectifier and controlled by said biasing voltage; and an alarm circuit connected to said control amplifier and controlled thereby, said alarm circuit comprising relay means connected to said control amplifier and energized thereby in the absence of noise signals and vice versa and an alarm connected to and operated by said relay means in the energized condition thereof.

3. An alarm system comprising a first transmitter for transmitting uncoded radio frequency energy, said transmitter comprising means for generating said radio frequency energy and means for initiating operation of said generating means connected thereto comprising a condition-responsive switch; a first receiver spaced from said transmitter but adapted to receive radio frequency energy from said transmitter; a second radio frequency energy transmitter comprising means for generating radio frequency energy, means for transmitting said last-mentioned energy connected to said generating means and coding means connected to one of said generating and transmitting means for interrupting the transmission of said last-mentioned energy in accordance with a predetermined code; switching means for energizing said coding means and said generating means connected thereto, said switching means being connected to said first receiver and being operated upon receipt of radio frequency energy by said first receiver from said first transmitter; a second receiver spaced from said second transmitter and adapted to receive radio frequency energy from said second transmitter, said second receiver comprising a limiting amplifier, a detector connected to said amplifier, a filter circuit connected to the output of said detector and adapted to attenuate radio frequency signals and to pass noise signals, a further amplifier connected to said filter for amplifying said noise signals, a rectifier connected to said further amplifier for rectifying the amplified noise signals

and for thereby providing a biasing voltage upon receipt of said noise signals, and a control amplifier connected to said rectifier and controlled by said biasing voltage; and an alarm circuit connected to said control amplifier and controlled thereby, said alarm circuit comprising relay means connected to said control amplifier and energized thereby and an alarm connected to and operated by said relay means.

4. An alarm system comprising a first transmitter for transmitting uncoded radio frequency energy, said transmitter comprising a vacuum tube having anode, control and cathode electrodes, said cathode electrode including a filament, a turned circuit coupled between said anode and said control electrodes, means interconnecting said control and said cathode electrodes, a source of electrical energy for heating said filament connected at one end to said filament and to said cathode electrode and means for connecting the opposite end of said source to said anode electrode and to said filament comprising a temperature responsive switch connected to said opposite end and to said filament and means interconnecting said switch and said tuned circuit, said source being the source of electrical energy for said anode electrode; a first receiver spaced from said transmitter but adapted to receive radio frequency energy from said transmitter; a second radio frequency energy transmitter comprising means for generating radio frequency energy, means for transmitting said last-mentioned energy connected to said generating means and coding means connected to one of said generating and transmitting means for interrupting the transmission of said last-mentioned energy in accordance with a predetermined code; switching means for energizing said coding means and said generating means connected thereto, said switching means being connected to said first receiver and being operated upon receipt of radio frequency energy by said first receiver from said first transmitter; a second receiver spaced from said second transmitter and adapted to receive radio frequency energy from said second transmitter, said second receiver comprising a limiting amplifier, a detector connected to said amplifier, a filter circuit connected to said detector and adapted to attenuate radio frequency signals and to pass noise signals, a further amplifier connected to said filter for amplifying said noise signals, a rectifier connected to said further amplifier for rectifying the amplified noise signals and for thereby providing a biasing voltage upon receipt of said noise signals, and a control amplifier connected to said rectifier and controlled by said biasing voltage; and an alarm circuit connected to said control amplifier and controlled thereby, said alarm circuit comprising relay means connected to said control amplifier and energized thereby in the absence of noise signals and vice versa and an alarm connected to and operated by said relay means in the energized condition thereof.

5. An alarm system comprising a first transmitter for transmitting uncoded radio frequency energy, said transmitter comprising a vacuum tube having anode, control and cathode electrodes, said cathode electrode including a filament, a tuned circuit coupled to said anode and said control electrodes, a resistor interconnecting said control and said cathode electrodes, a source of electrical energy for heating said filament connected at one end to said filament and to said cathode electrode and means for connecting the opposite end of said source to said anode electrode and to said filament comprising a temperature-responsive switch connected to said opposite end and to said filament and a choke connected to said switch and to said tuned circuit, said source being the source of electrical energy for said anode electrode; a first receiver spaced from said transmitter but adapted to receive radio frequency energy from said transmitter; a second radio frequency energy transmitter comprising means for generating radio frequency energy, means for transmitting said last-mentioned energy connected to said

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generating means and coding means connected to one of said generating and transmitting means for interrupting the transmission of said last-mentioned energy in accordance with a predetermined code; switching means for energizing said coding means and said generating means connected thereto, said switching means being connected to said first receiver and being operated upon receipt of radio frequency energy by said first receiver from said first transmitter; a second receiver spaced from said second transmitter and adapted to receive radio frequency energy from said second transmitter, said second receiver comprising a limiting amplifier, a detector connected to said amplifier, a filter circuit connected to said detector and adapted to attenuate radio frequency signals and to pass audio frequency noise signals, a further amplifier connected to said filter for amplifying said noise signals, a rectifier connected to said further amplifier for rectifying the amplified noise signals and for thereby providing a biasing voltage upon receipt of said noise signals, and a control amplifier connected to said rectifier and controlled by said biasing voltage; and an alarm circuit connected to said control amplifier and controlled thereby, said alarm circuit comprising relay means connected to said control amplifier and energized thereby in the absence of noise signals and vice versa and an alarm connected to and operated by said relay means in the energized condition thereof.

6. In an alarm system comprising a transmitter for transmitting radio frequency energy which is interrupted in accordance with a predetermined code, a receiver spaced from said transmitter and adapted to receive radio frequency energy from said transmitter, said receiver comprising a limiting amplifier, a detector connected to said amplifier, said amplifier and detector providing low frequency signals at the output of said detector in the absence of said radio frequency energy and substantially suppressing said low frequency signals when said radio frequency is received, a filter circuit connected to the output of said detector and adapted to attenuate high frequency signals and to pass said low frequency signals, and means connected to said filter circuit for providing a biasing voltage upon receipt of said low frequency signals; and an alarm circuit connected to said last-

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mentioned means and controlled by said biasing voltage, said last-mentioned circuit being energized by said last-mentioned means in the absence of low frequency signals and vice versa.

7. In an alarm system comprising a transmitter for transmitting radio frequency energy which is interrupted in accordance with a predetermined code, a receiver spaced from said transmitter and adapted to receive radio frequency energy from said transmitter, said receiver comprising a limiting amplifier, a detector connected to said amplifier, said amplifier and detector providing low frequency signals at the output of said detector in the absence of said radio frequency energy and substantially suppressing said low frequency signals when said radio frequency is received, a filter circuit connected to the output of said detector and adapted to attenuate high frequency signals and to pass said low frequency signals, a further amplifier connected to said filter for amplifying said low frequency signals, a rectifier connected to said further amplifier for rectifying the amplified low frequency signals and for thereby providing a biasing voltage upon receipt of said low frequency signals, and a control amplifier connected to said rectifier and controlled by said biasing voltage; and an alarm circuit connected to said control amplifier and controlled thereby, said alarm circuit comprising alarm means connected to said control amplifier and energized thereby in the absence of low frequency signals and vice versa.

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