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INTRUDER ALARM SYSTEM

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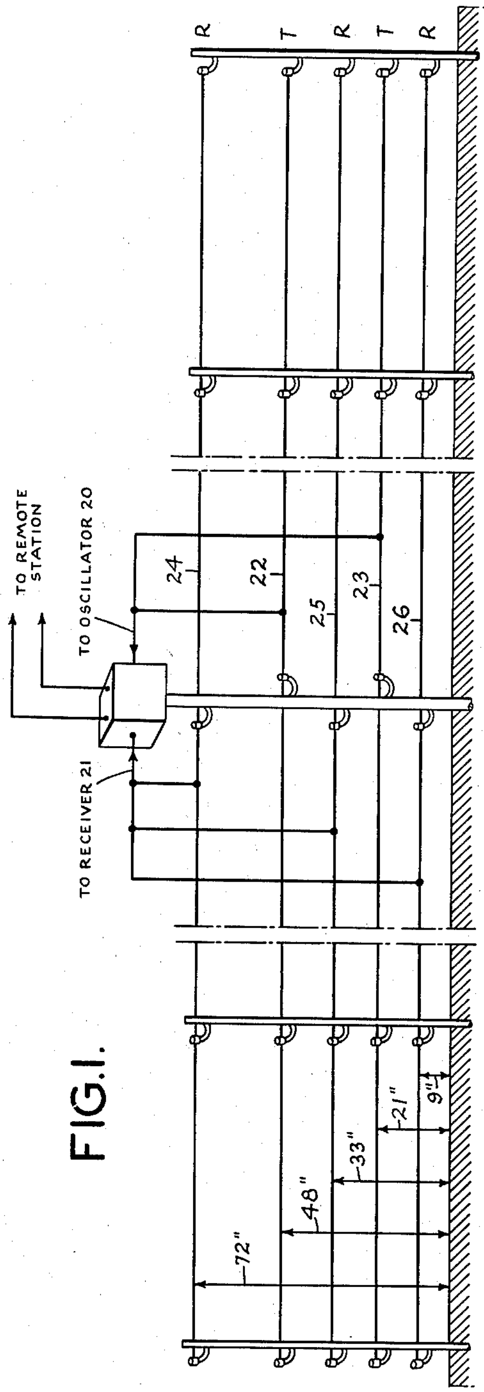

FIG.1.

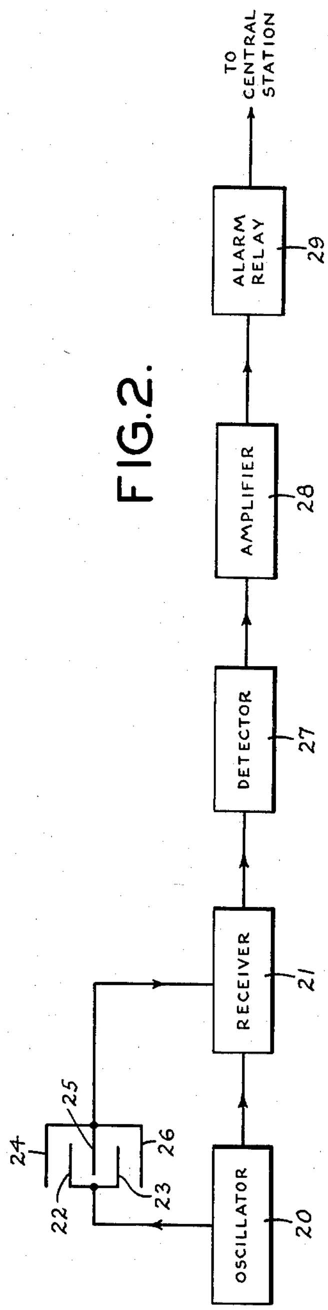

FIG.2.

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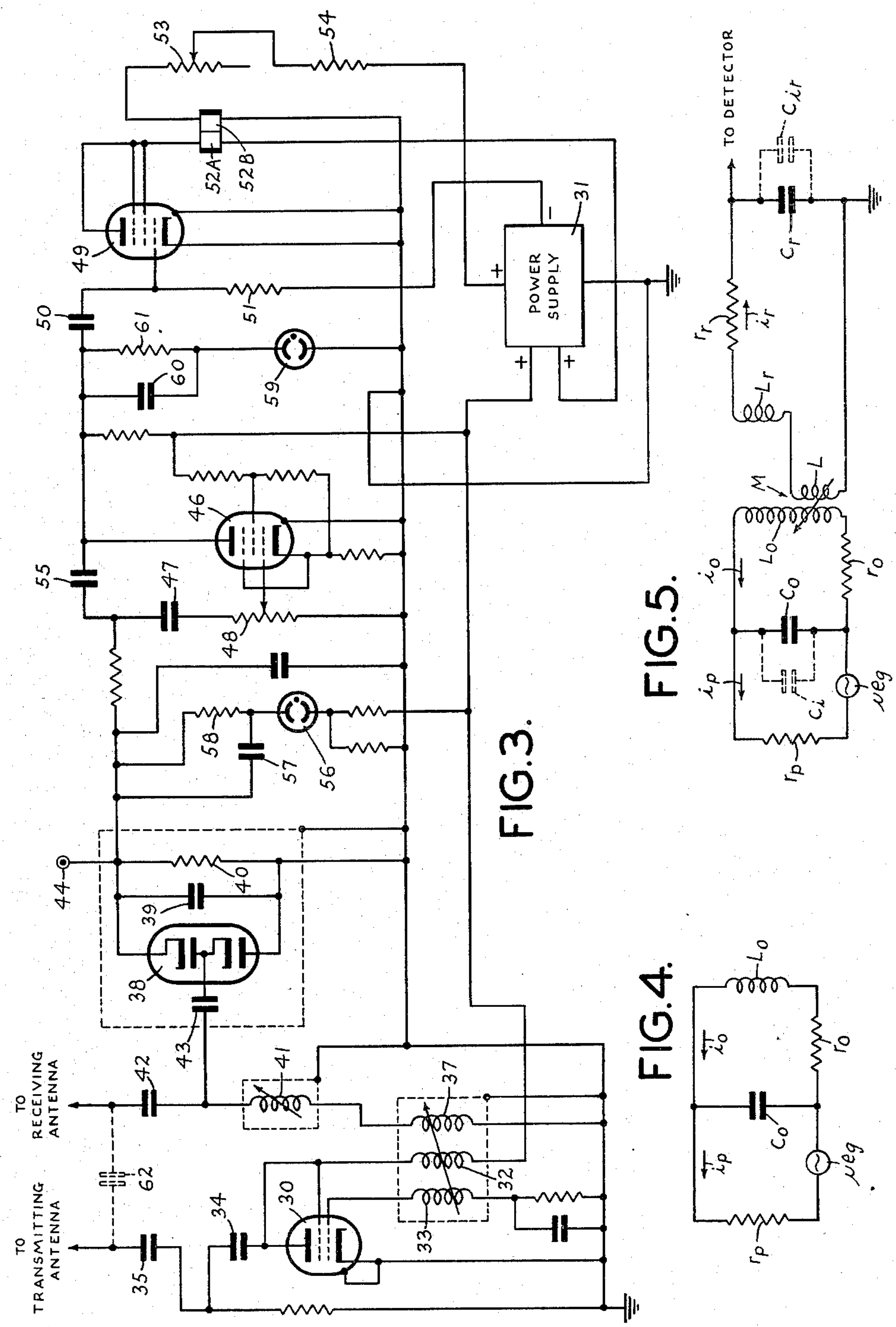

FIG.3.

FIG.4.

FIG.5.

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FIG.8.

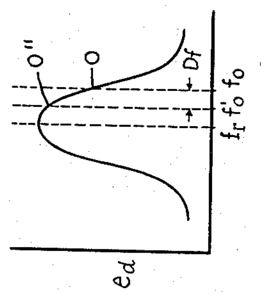


FIG.11.

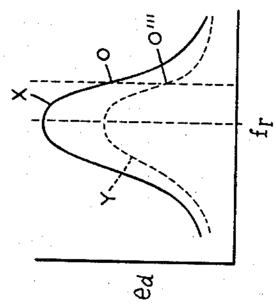


FIG.7.

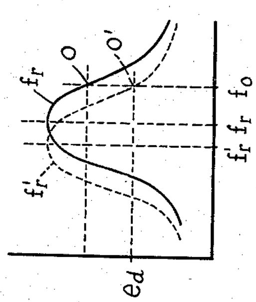


FIG.10.

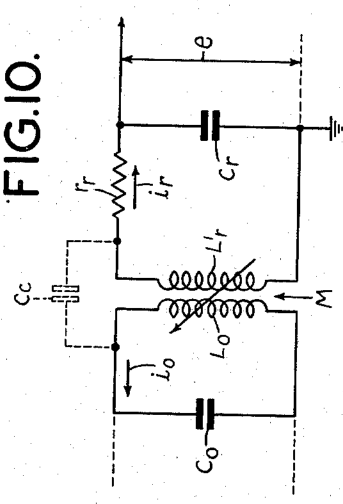


FIG.6.

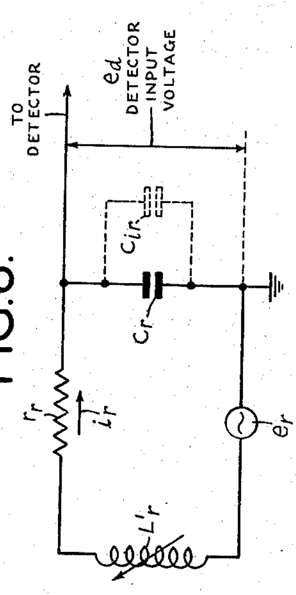
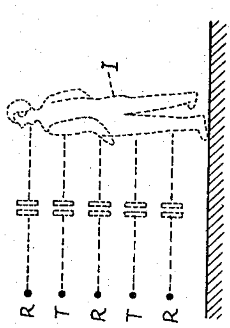


FIG.9.



United States Patent Office

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INTRUDER ALARM SYSTEM

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10 Claims. (Cl. 340—258)

The present invention relates to intruder alarm systems, and more particularly to intruder alarm systems of the type in which the approach of an intruder to an area to be protected is registered by an alarm at a remote station.

Intruder alarm systems for protecting outdoor areas have heretofore been suggested and used. Such systems have taken a variety of forms, including photoelectric systems, capacitance systems and radio frequency systems. Most systems which have been employed can be made sufficiently sensitive so that it is virtually impossible for an intruder to defeat the system, i.e., enter the protected area undetected. However, since outdoor protection systems must operate under a variety of weather conditions and since inclement weather creates conditions differing only in degree from the conditions created by the presence of an intruder, a very high degree of system sensitivity results in an unstable system which can and often does give a spurious alarm caused by weather conditions. An overly sensitive system can also give spurious alarms as a result of the approach of small animals or birds. Any protection system which produces a large number of spurious alarms is virtually useless since the cost of operating the system becomes inordinately high. As a result, system sensitivities have been reduced in an effort to achieve a reasonable balance between sensitivity and stability.

The principal object of the present invention has been to provide an intruder alarm system which combines improved protection and stability characteristics.

Some protection systems of the prior art have been operated with balanced detecting elements so that weather changes affecting the entire system would not generally produce an alarm. One difficulty with such a system is that when, as sometimes occurs, a weather change is effective at one place in the system and not in another, e.g., a slowly advancing wall of rain, the system will go into alarm. Another difficulty with a balanced system of this type is that it is susceptible to defeat by two intruders who approach the detecting elements at spaced points such that the effect of one is balanced by the effect of the other.

An object of the invention has been to provide a novel and improved intruder alarm system which compensates for both general and highly local weather changes and is not susceptible of defect by spaced intruders.

Other and further objects, features and advantages of the invention will appear more fully from the following description of the invention.

The system of the invention is of the type which employs antenna wires disposed about the perimeter of the area to be protected, a transmitting antenna being supplied with a radio frequency signal and a portion of the energy therefrom being picked up by a receiving antenna. In accordance with the invention, the oscillator and receiver circuits are coupled directly so that a transfer of energy takes place within the control set and the transmitting and receiving antennas are so disposed in space that a mutual capacitive coupling therebetween exists, a change primarily in this mutual capacitive coupling producing an alarm. In accordance with the invention, a plurality of oscillator and receiver antenna wires are employed and are disposed in space in a generally vertical plane with the transmitting and receiving wires being spaced from each other but being intermixed so that a substantial mutual capacitance therebetween exists.

The invention will now be described in greater detail with reference to the appended drawings, in which:

Fig. 1 illustrates a preferred form a antenna array in accordance with the invention;

Fig. 2 is a block diagram illustrating the system of the invention;

Fig. 3 is a circuit diagram of a system in accordance with the invention;

Fig. 4 is an equivalent circuit of the oscillator of Fig. 3;

Fig. 5 is an equivalent circuit of the oscillator and receiver of Fig. 3;

Fig. 6 is an equivalent circuit of the receiver of Fig. 3;

Fig. 7 is a tuning curve for the receiver tuned circuit, showing the effect of adding capacitance to the receiving antenna;

Fig. 8 is a similar tuning curve showing the effect on the receiver circuit of adding capacitance to the transmitting antenna;

Fig. 9 is a schematic illustration of the effect of an intruder on the mutual capacitance between transmitting and receiving antennas;

Fig. 10 is a portion of the transmitter-receiver equivalent circuit illustrating the mutual capacitive coupling produced by an intruder; and

Fig. 11 shows the effect of a change in mutual capacitive coupling on the receiver tuning curve.

Referring now to the drawings, and more particularly to Figs. 1 and 2, there are shown the basic elements of a protective system in accordance with the invention and comprising an oscillator **20**, a receiver **21**, a transmitting antenna array formed by wires **22** and **23** (also designated T), a receiving antenna array formed by wires **24**, **25** and **26** (also designated R), a detector **27**, an amplifier **28** and an alarm relay **29**.

The oscillator **20**, which might be, for example, of the tuned plate type, supplies a suitable radio frequency energy, e.g., 160 kc., to the receiver **21** and to the transmitting antenna array. The transmitting antenna wires **22** and **23** extend along the boundary of the area to be protected, are parallel to each other, are in the same vertical plane, and are spaced from each other. The receiving antenna wires **24**, **25** and **26** are spaced from and lie parallel to and in the same vertical plane as the transmitting antenna wires. The transmitting and receiving wires are spaced from the ground by any suitable distances, such as the 9, 21, 33, 48 and 72 inch heights shown in Fig. 1. The spacing between adjacent wires and between the individual wires and ground should be such that the approach of an intruder causes an appreciable increase in the capacitances to ground of the antennas and in the mutual capacitance between the antennas. The highest wire is preferably located at a sufficient height from the ground to prevent a defeat of the system by jumping over the array. The lowest wire is similarly preferably located at a height from the ground low enough to prevent a defeat of the system by a slow crawl under the lowest wire. The wires may be supported at various points by insulators mounted on suitable poles, as shown, and the wires are preferably maintained taut by suitable tensioning means to prevent wind from causing the wires to contact each other or to come close together. The antenna arrays may be center fed, as illustrated, or may be fed from any convenient location, such as at one end. It many cases the latter arrangement will be desirable since it may minimize wiring costs in multiple installations. The antenna wires may be of any suitable length depending on circuit parameters and other conditions. In practical operation, a length of about 300 feet has been found desirable, with a plurality of separate systems operating at different frequencies being used to protect larger areas, although longer lengths can be used. In order to prevent the transmission of radio interference and to make the mutual capacitance effective as a detecting element, the antenna lengths should be a small fraction of the wave length at the operating frequency. For example, at 150 kc., a 300 foot array is only about 1/20 of the wave length. In some cases, particularly where ground conditions vary widely from time to time, it will be desirable to provide a counterpoise in the form of a conductive mesh or foil or the like along the surface of the ground beneath the antenna arrays. This, in effect, provides a constant ground reference. Such a counterpoise may be directly connected to the electronic chassis ground.

The antenna configuration necessary to achieve overall weather compensation and weather compensation per unit length and also to prevent defeat by spaced synchronized dual attack is one in which the transmitting wires T and the receiving wires R are mixed through alternate mounting in a vertical plane. For example, as illustrated, the first, third and fifth wires are the receiving antenna while the second and fourth wires are the transmitting antenna and deliver energy to the receiver circuit. The antenna wires possess both mutual capacitance and direct capacitance to ground, the capacitance values being functions of the wire length, wire diameter, spacing from ground, mutual spacing, and dielectric constant of the intervening insulation. In this case the dielectric is air and its constant varies slightly about the value of one with changes in atmospheric temperature, pressure and relative humidity.

In addition to the capacitive coupling from wire to wire and from wire to ground, the antenna wires are linked together with an electromagnetic field generated by the antenna wires T. This field has two components, an induction field and a radiation field. The induction field is relatively strong near the wires T but attenuates rapidly as the cube of the distance from the wires. The radiation field is relatively weak near the wires T and attenuates slowly in direct proportion to the distance from the wires. The reactive induction field transfers energy from the antenna wires T to the receiver wires R by the electromagnetic coupling of these wires in air. This received energy is superimposed, in the receiver unit 21, on similar energy directly transferred from the oscillator 20 to the receiver 21. The polarity of the connections to coil 37 must be as shown in Fig. 3 to provide maximum sensitivity for the system. Rapid changes in the level of the combined signals constitute an alarm voltage indicating an attempt to enter upon the protected premises. Such rapid changes will occur when the approach of an intruder increases the mutual capacitive coupling between the wires T and R.

Referring now to Fig. 3, oscillator tube 30 may conveniently be included in a tuned plate oscillator circuit. The anode of tube 30 is supplied with a suitable D.C. potential from a power supply 31 through a coil 32. Regenerative feedback is provided by a coil 33 coupled to the coil 32 and included in the control grid circuit of tube 30. The anode of tube 30 is coupled to the transmitting antenna array T through a capacitor 34 and a capacitor 35, connected in series. The frequency determining elements of the oscillator circuit are the coil 32 and the series capacitances of capacitors 34, 35 and the antenna wires T to ground. Tuning may be effected by varying the inductance of coil 32 or by making one or more of the capacitors variable. For most purposes an oscillator frequency between about 100 and 200 kc. will be found satisfactory.

A coil 37 is inductively coupled to the coil 32 to provide a direct transfer of energy from the oscillator circuit to the receiver circuit. In this case, the receiving circuit is formed as a parallel resonant circuit coupled to the detector stage formed by a double diode tube 38. In addition to acting as a rectifier, the tube 38 together with a capacitor 39 and a resistor 40 acts as a half wave voltage doubler. The inductive branch of the receiving circuit is formed by series connected inductors 37 and 41. The capacitive branch is formed by the receiving antenna capacitance to ground and a capacitor 42 interposed between the inductor 41 and the antenna array R and acting in series with the receiving antenna capacitance to ground. A coupling capacitor 43 is provided to supply the signal developed across the parallel resonant circuit to the double diode 38. This receiving circuit is preferably tuned to a frequency slightly different from the oscillator frequency, the actual difference between the frequencies depending on the Q of the receiving circuit and being selected so that the receiving circuit operates normally on a steep portion of the tuning curve. To prevent detection of stray energy, the coils 32, 33, 37 and 41 and the detector circuit are preferably shielded, as shown.

The composite A.C. signal delivered to the tube 38 (directly from the oscillator circuit and by way of antenna coupling) is rectified and doubled, resulting in a D.C. voltage between terminal 44 and ground. Under normal conditions, this D.C. voltage will not change and hence no signal voltage will be applied to the control grid of a pentode amplifier tube 46 through a coupling capacitor 47 and a potentiometer 48. Capacitor 47 and potentiometer 48 form a differentiating circuit with a time constant such that slow changes in the D.C. voltage, such as are caused by weather changes, will not appear at the grid of tube 46. A time constant of the order of 20 seconds has been found desirable for most conditions, although other time constants may be used. The time constant should not be too small or defeat of the system by an extremely slow moving intruder will be possible. More rapid changes in the D.C. voltage between terminal 44 and ground, such as are caused by an intruder approaching the protected perimeter, will be transmitted by capacitor 47 and will be amplified by tube 46. The amplified output of tube 46 is supplied to the control grid of a second pentode amplifier tube 49 through a coupling capacitor 50. The capacitor 50, together with a resistor 51, forms another differentiating circuit which preferably has a time constant of about 20 seconds, further insuring that slow changes in D.C. voltage level will not yield an alarm.

A coil 52A of a differential relay is included in the anode circuit of tube 49. The other coil 52B of the differential relay is supplied with a constant current from the power supply 31 through a potentiometer 53 and a resistor 54. The differential relay is held in an unoperated position by balanced current flowing in windings 52A and 52B, which is the situation which will exist in the absence of a signal voltage at the control grid of tube 49. The presence of such a signal voltage, which will occur when an attempt is being made to cross or approach the protected perimeter, will change the current flowing through coil 52A, causing the differential relay to operate, in turn resulting in the transmission of an alarm to a remote station. The change in current necessary to operate the differential relay and hence to transmit an alarm is preferably small. System sensitivity can easily be adjusted by changing the setting of potentiometer 48 which acts as a gain control.

A capacitor 55, which intercouples the input and output circuits of tube 46, may be provided to give negative feedback for steep front pulses such as are produced by lightning, and thus reduces the amplification of such pulses.

Failure of components to the left of terminal **44** in Fig. 3 will reduce the voltage across resistor **40**, causing the voltage at terminal **44** to become less positive. When the voltage differential between terminal **44** and the anode supply voltage of tube **46** is sufficiently high, a neon lamp **56** will be operated and will flash at a rate determined by the value of parallel connected capacitor **57** and resistor **58**. Such flashing of the neon lamp **56** will result in the amplification of voltage pulses by tubes **46** and **49** and the operation of the differential alarm relay. Similarly, failure of tube **46** through low emission will cause a neon lamp **59** to flash at a rate determined by parallel connected capacitor **60** and resistor **61**, again transmitting an alarm. Failure of tube **49** will directly cause the alarm relay to operate through loss of current in winding **52A**.

Further circuits between the alarm contacts of the differential relay and the remote station are also preferably supervised. For example, means should be provided, as is customary, to transmit an alarm upon tampering with the control set or upon a power failure.

While the illustrated antenna construction of five wires is preferred, four wires or a greater number of wires can be used. When four wires are used, mutual capacitance may be increased to provide better operation by provision of a capacitor **62** joining the transmitting and receiving antennas. Such a capacitor might have a value, for example, of 300 micro-microfarads.

The operation of the system of the invention will be better understood by reference to certain equivalent circuits now to be described. Fig. 4 is the equivalent circuit of the tuned plate oscillator, L_o being the inductance of the oscillator coil **32**, C_o being the total capacitance of series capacitors **34**, **35** and the capacitance to ground of the transmitting antenna, plus any capacitance which may be added for tuning. The resistor r_o represents the circuit resistance including the resistance of coil **32**, the ground resistance, etc.; r_p is the dynamic plate resistance of tube **30**; i_p is the oscillator plate current; i_o is the oscillator tank circuit current; μ is the amplification factor of tube **30**; and e_g is the voltage induced into the grid circuit of tube **30** through the inductive coupling of coils **32** and **33**.

Under proper circuit conditions, oscillations will be sustained between the grid circuit and the tank circuit with the frequency of oscillation f_o given by the following equation:

$$f_o=\frac{1}{2\pi\sqrt{L_oC_o}}\sqrt{\frac{r_o+r_p}{r_p}}$$

Because of the small energy radiation, the value of r_o is small compared with the value of r_p, so that for practical purposes the oscillator frequency can be expressed as

$$f_o=\frac{1}{2\pi\sqrt{L_oC_o}}$$

The equivalent circuit for the receiver and oscillator is shown in Fig. 5, where L represents the inductance of coil **37**, L_r represents the inductance of coil **41**, C_r represents the capacitance of capacitor **42** in series with the capacitance to ground of the receiving antenna together with any loading capacitance which may be added in tuning the system. The resistor r_r represents the resistance of the coils **37** and **41** together with the receiver ground resistance, etc. M represents the mutual inductance of coils **32** and **37** and i_r is the receiver circuit current. The resonant frequency f_r of the receiver circuit is given by the equation:

$$f_r=\frac{1}{2\pi\sqrt{L'_rC_r}}$$

where L'_r is the combined inductance of L and L_r.

The receiver equivalent circuit alone is shown in Fig. 6 where e_r is the voltage

$$M\frac{di_o}{dt}$$

induced in the receiver circuit

$$\frac{di_o}{dt}$$

being the time rate of change of the oscillator tank current i_o. The voltage e_d of Fig. 6 is the detector input voltage which is supplied to the detector **38** through capacitor **43**. The dotted capacitors C_i and C_{ir} shown in Figs. 5 and 6 represent the added capacity presented by an intruder approaching or attempting to pass between the antenna wires, C_i being the added transmitting antenna capacity to ground and C_{ir} being the added receiving antenna capacity to ground.

In adjusting the system, the value of L_r (coil **41**) is varied to obtain a peak value of current i_r (in the absence of C_{ir}) and consequently a peak voltage across C_r is achieved. This voltage is equal to i_rXC_r where XC_r is the capacitive reactance:

$$XC_r=\frac{1}{2\pi f_oC_r}$$

At this point the resonant frequency of the receiver circuit is equal to the oscillator frequency and the inductive reactance is equal to and 180° out of phase with the capacitive reactance.

The receiver circuit is then tuned off resonance by adjustment of coil **41** to an intermediate point on the tuning curve, for example, the point O in Fig. 7.

The voltage e_d at the receiver output is rectified and doubled by the detector stage tube **38**, and changes in e_d are amplified in two stages (tubes **46** and **49**), and control the current through differential relay winding **52A**, changes in this current resulting in the transmission of an alarm signal to the central station or other alarm receiving headquarters.

Approach of an intruder to the antenna system results in a net change in alarm relay current which is the combined net result of three distinct effects:

(1) Increase of the capacitance of the receiver wires R to ground, causing a change in alarm current in one direction;

(2) Increase of the capacitance of the transmitting wires T to ground, causing a change in alarm current in the opposite direction; and

(3) A change in the mutual capacitive coupling between the receiving and transmitting wires resulting in the transfer of a voltage from the oscillator circuit into the receiver circuit in opposition to the steady state voltage of the receiver circuit; this condition tending to increase the alarm current through winding **52A** irrespective of whether the receiver circuit is tuned on the high or low frequency side of the tuning curve.

Considering the first effect and referring particularly to Figs. 6 and 7, the addition of intruder capacitance C_{ir} causes a drop in the voltage e_d from O to O′ because of the drop in i_r caused by the shift in the tuning curve from

$$f_r=\frac{1}{2\pi\sqrt{L'_rC_r}}$$

to

$$f'_r=\frac{1}{2\pi\sqrt{L'_r(C_r+C_{ir})}}$$

and the drop in the capacitive reactance from

$$XC_r=\frac{1}{2\pi FC_r}$$

to

$$X'C_r = \frac{1}{2\pi F(C_r + C_{ir})}$$

Considering next the second effect and referring particularly to Figs. 5 and 8, addition of intruder capacitance C_i to the oscillator circuit reduces the generated frequency

$$f_o = \frac{1}{2\pi\sqrt{L_oC_o}}$$

by D_f to

$$f'_o = \frac{1}{2\pi\sqrt{L_o(C_o + C_i)}}$$

This shifts the operating point (Fig. 8) from O to O″ and raises the voltage e_d. With the receiver circuit tuned to a frequency lower than the oscillator frequency, the voltage e_d tends to drop due to the capacitance added to the receiving antenna by the intruder, while the voltage e_d tends to increase due to the capacitance added to the transmitting antenna by the intruder. In practice, these effects on the voltage e_d substantially cancel each other. With the receiver circuit tuned on the high side of the oscillator frequency, the effects of intruder capacitance on the transmitting circuit and receiving circuit will be reversed, as will be apparent from reference to Figs. 7 and 8.

Considering next the effect on the voltage e_d produced by a change in mutual capacitive coupling between the transmitting and receiving wires and referring particularly to Figs. 9, 10 and 11, it will be observed that the added capacitive coupling C_c produced by an intruder sets up a voltage in the receiver circuit which is in opposition to the steady state voltage set up therein by the mutual inductive coupling M. The steady state mutual capacitive coupling between the wires is small and the voltage transferred thereby to the receiver circuit, while in opposition to the inductively transferred voltage, will be small in comparison with the latter. The manner in which an intruder increases the mutual capacitive coupling is illustrated in Fig. 9 where I represents the intruder and the capacitors represent the capacitances between the respective wires R and T and the intruder I.

Presence of the opposition voltage in the receiver circuit caused by the mutual capacitive coupling C_c causes a drop in the peak voltage of the resonance curve X (Fig. 11), in effect producing a new curve Y. The voltage e_d will thus drop from O to O‴. This change in voltage e_d will be a decrease irrespective of whether the receiver circuit is tuned above or below the oscillator frequency. The voltage change O–O′ (Fig. 7) will be nearly equal and opposite to the voltage change O–O″ (Fig. 8) so that the voltage drop O–O‴ (Fig. 11) will be the controlling voltage which causes an increase in alarm current because of the approach of an intruder.

When weather changes occur the capacitance to ground of the antenna wires will change, but the effects will substantially balance out, as discussed in connection with an intruder. Any net change in voltage e_d resulting therefrom and any change in voltage e_d resulting from the slight change in mutual capacitance that may be caused by weather, will occur over a relatively long period of time and hence will be prevented from producing any material effect on the alarm current by the delay circuits **47—48** and **50—51**, as described. While any outdoor protection system using intruder capacitance as a detecting element will be affected to a greater or lesser degree by weather changes, the system of the invention exhibits greater stability than those of the prior art and, when the system is properly adjusted, can only be caused to give a spurious alarm upon an extremely rapid and severe weather change. In the systems of the prior art in which an antenna extending in one direction is balanced against an antenna extending in the other direction, a local weather change affecting one antenna and not the other, such as an advancing wall of rain, often produces a spurious alarm because of the resulting imbalance. Such an imbalance cannot occur in the system of the invention since the receiving and transmitting antenna arrays are equally exposed to such local variations.

While the invention has been described in connection with a specific embodiment thereof and in a specific use, various modifications thereof will occur to those skilled in the art without departing from the spirit and scope of the invention, as set forth in the appended claims.

What is claimed is:

1. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of spaced conductors disposed generally in a vertical plane and extending along said boundary of said area, a receiving antenna array formed from a second plurality of spaced conductors disposed generally in said vertical plane and extending along said boundary of said area, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing in said vertical plane, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capacitance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a variable source of radio frequency signals operating at a given frequency, means to supply a portion of the signal energy from said source to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said receiving circuit, in combination with said receiving antenna array, being tuned to a frequency in the neighborhood of said given frequency, circuit means to supply another portion of the energy from said source directly to said receiving circuit, and means responsive to changes in the average signal level in said receiving circuit occurring faster than a predetermined rate to provide said alarm signal indication.

2. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of spaced conductors disposed generally in a vertical plane and extending along said boundary of said area, a receiving antenna array formed from a second plurality of spaced conductors disposed generally in said vertical plane and extending along said boundary of said area, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing in said vertical plane, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capacitance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a variable source of radio frequency signals operating at a given frequency, means to supply a portion of the signal energy from said source to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said re-

ceiving circuit, in combination with said receiving antenna array, being tuned to a frequency slightly different than said given frequency, circuit means to supply another portion of the energy from said source directly to said receiving circuit, and means responsive to changes in the average signal level in said receiving circuit occurring faster than a predetermined rate to provide said alarm signal indication.

3. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of spaced conductors disposed generally in a vertical plane and extending along said boundary of said area, a receiving antenna array formed from a second plurality of spaced conductors disposed generally in said vertical plane and extending along said boundary of said area, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing in said vertical plane, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capacitance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a variable source of radio frequency signals operating at a given frequency, means to supply a portion of the signal energy from said source to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said receiving circuit, in combination with said receiving antenna array, being tuned to a frequency slightly different than said given frequency, circuit means to supply another portion of the energy from said source directly to said receiving circuit, said directly supplied energy and said energy derived from said transmitting antenna array being in phase opposition in said receiving circuit, a detector circuit coupled to said receiving circuit to provide a direct current voltage proportional to the average signal level in said receiving circuit, and means responsive to changes in said direct current voltage occurring faster than a predetermined rate to provide said alarm signal indication.

4. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of spaced conductors disposed generally in a vertical plane and extending along said boundary of said area, a receiving antenna array formed from a second plurality of spaced conductors disposed generally in said vertical plane and extending along said boundary of said area, one of said pluralities of conductors consisting of two conductors and the other plurality of conductors consisting of three conductors, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing in said vertical plane, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capacitance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a variable source of radio frequency signals operating at a given frequency, means to supply a portion of the signal energy from said source to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said receiving circuit, in combination with said receiving antenna array, being tuned to a frequency slightly different than said given frequency, circuit means to supply another portion of the energy from said source directly to said receiving circuit, and means responsive to changes in the average signal level in said receiving circuit occurring faster than a predetermined rate to provide said alarm signal indication.

5. An intruder alarm system, as set forth in claim 4, in which the conductor located closest to the ground is not more than about 9 inches from the ground and in which the conductor located furthest from the ground is not less than about 72 inches from the ground.

6. An intruder alarm system, as set forth in claim 4, in which the conductor located closest to the ground, the conductor located furthest from the ground, and the conductor located nearest to the middle between said closest and furthest conductors form said receiving antenna array, and in which the other two conductors form said transmitting antenna array.

7. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of spaced conductors disposed generally in a vertical plane and extending along said boundary of said area, a receiving antenna array formed from a second plurality of spaced conductors disposed generally in said vertical plane and extending along said boundary of said area, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing in said vertical plane, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capacitance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a capacitive element intercoupling said antenna arrays to augment said mutual capacitive coupling therebetween, a variable source of radio frequency signals operating at a given frequency, means to supply a portion of the signal energy from said source to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said receiving circuit, in combination with said receiving antenna array, being tuned to a frequency slightly different than said given frequency, circuit means to supply another portion of the energy from said source directly to said receiving circuit, and means responsive to changes in the average signal level in said receiving circuit occurring faster than a predetermined rate to provide said alarm signal indication.

8. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of spaced conductors disposed generally in a vertical plane and extending along said boundary of said area, a receiving antenna array formed from a second plurality of spaced conductors disposed generally in said vertical plane and extending along said boundary of said area, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing in said vertical plane, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capaictance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a variable source of radio frequency signals operating at a given frequency, said source being an oscillator having a tank circuit in-

cluding the capacitance to ground of said transmitting antenna array whereby a portion of the signal energy from said source is supplied to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said receiving circuit, in combination with said receiving antenna array, being tuned to a frequency slightly different than said given frequency, inductive coupling circuit means to supply another portion of the energy from said source directly to said receiving circuit, means responsive to changes in the average signal level in said receiving circuit to provide said alarm signal indication, and means to suppress formation of said alarm signal indication for changes in said average signal level occurring slower than at a predetermined rate.

9. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of spaced conductors disposed generally in a vertical plane and extending along said boundary of said area, a receiving antenna array formed from a second plurality of spaced conductors disposed generally in said vertical plane and extending along said boundary of said area, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing in said vertical plane, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capacitance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a variable source of radio frequency signals operating at a given frequency lying in the range of about 100–200 kc., the length of said boundary being a small fraction of the wave length of said given frequency to prevent the transmission of radio interference, means to supply a portion of the signal energy from said source to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said receiving circuit, in combination with said receiving antenna array, being tuned to a frequency slightly different than said given frequency, the difference between the tuned frequency of said receiving circuit and said given frequency being selected to provide operation on a steep portion of the tuning curve of said receiving circuit, circuit means to supply another portion of the energy from said source directly to said receiving circuit, and means responsive to changes in the average signal level in said receiving circuit occurring faster than a predetermined rate to provide said alarm signal indication.

10. An intruder alarm system for providing an alarm signal indication of the approach by an intruder to a boundary of an area to be protected, comprising a transmitting antenna array formed from a plurality of generally parallel conductors spaced from each other and from the ground and extending along said boundary of said area, a receiving antenna array formed from a second plurality of generally parallel conductors spaced from each other and from the ground and extending along said boundary of said area, the conductors of said transmitting and receiving antenna arrays being generally parallel to said boundary and being intermixed by alternate spacing, the spacing between adjacent conductors and between individual conductors and ground being selected so that appreciable increases in antenna capacitance to ground and in mutual capacitance between the conductors of said transmitting antenna array and the conductors of said receiving antenna array occur upon the approach of an intruder to said boundary, a variable source of radio frequency signals operating at a given frequency, means to supply a portion of the signal energy from said source to said transmitting antenna array, a receiving circuit coupled to said receiving antenna array whereby a portion of the signal energy supplied to said transmitting antenna array appears in said receiving circuit through an air-borne coupling between said antennas, said receiving circuit, in combination with said receiving antenna array, being tuned to a frequency in the neighborhood of said given frequency, circuit means to supply another portion of the energy from said source directly to said receiving circuit, and means responsive to changes in the average signal level in said receiving circuit occurring faster than a predetermined rate to provide said alarm signal indication.

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