

Sept. 30, 1947.

L. H. PECK

2,428,290

APPROACH SIGNAL SYSTEM

Filed April 30, 1942

4 Sheets-Sheet 1

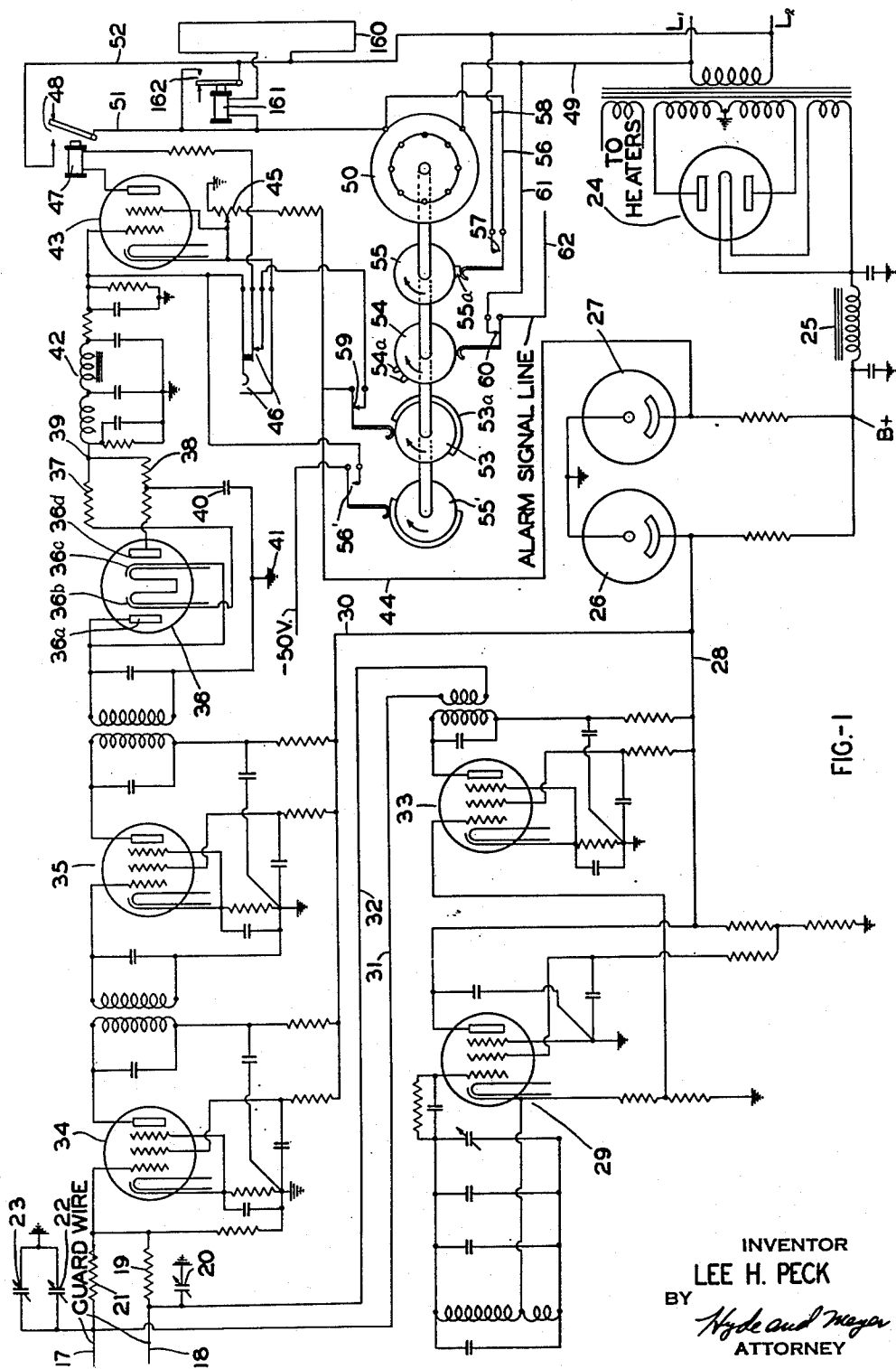


FIG-1

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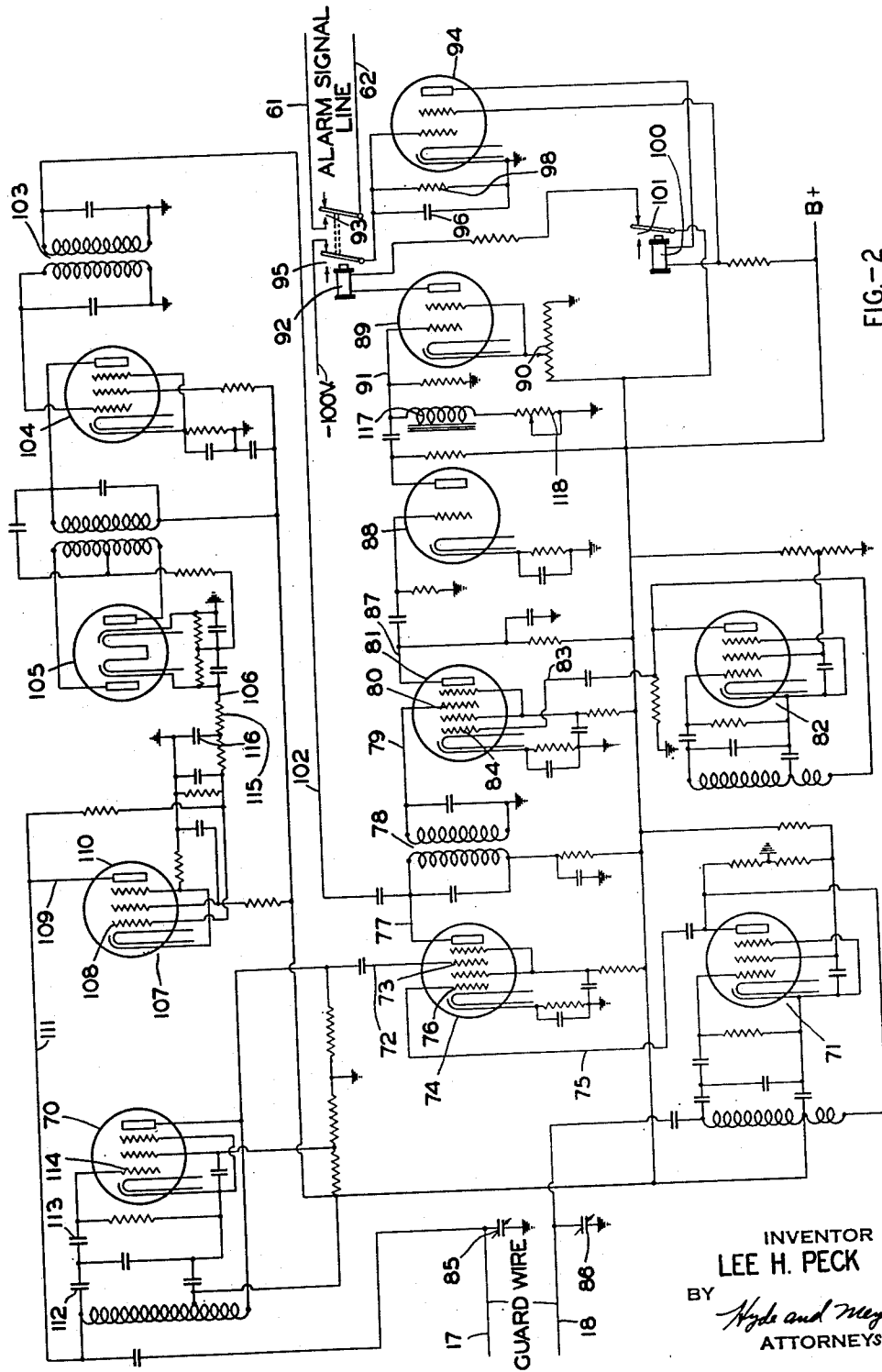


FIG. 2

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4 Sheets-Sheet 3

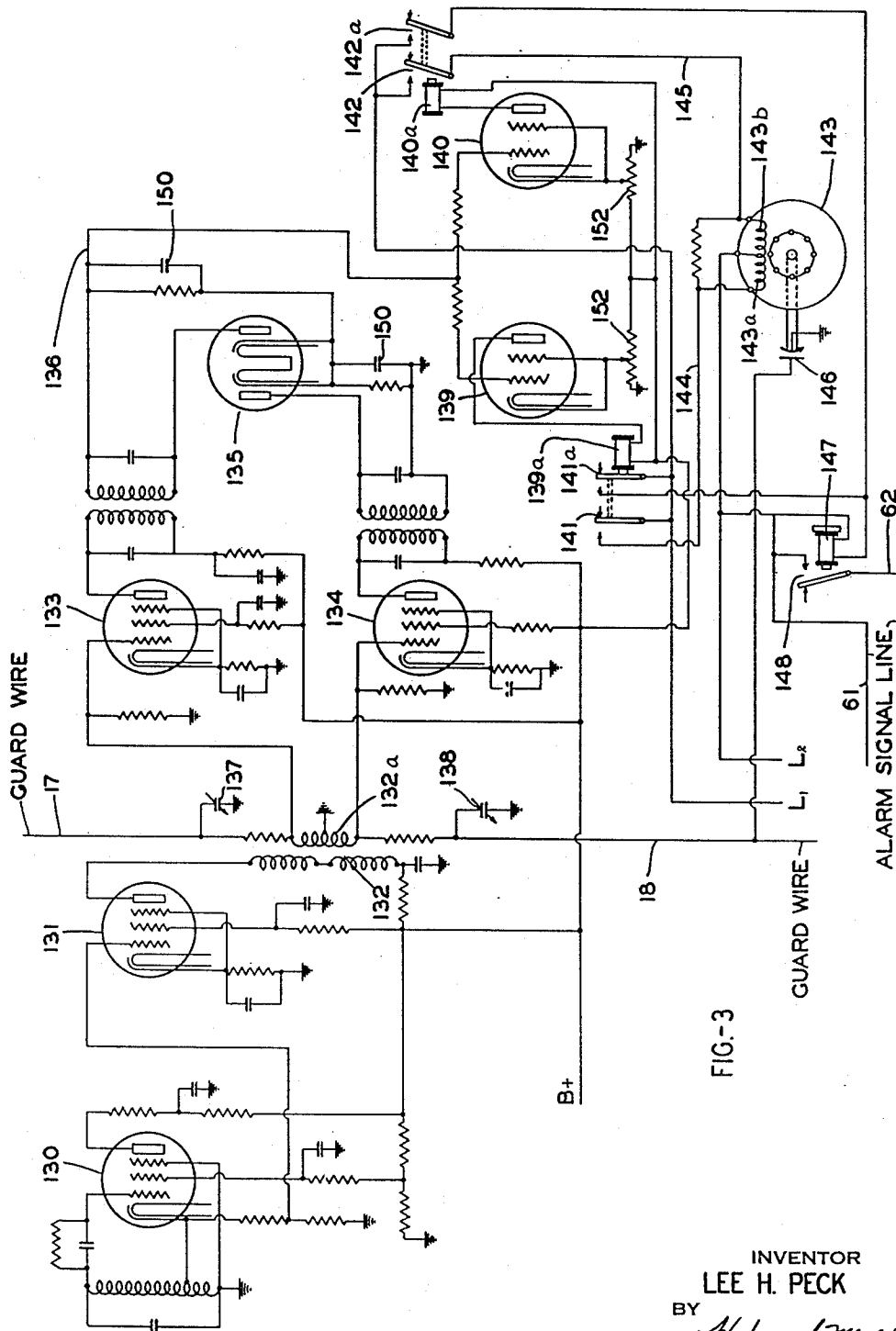


FIG. 3

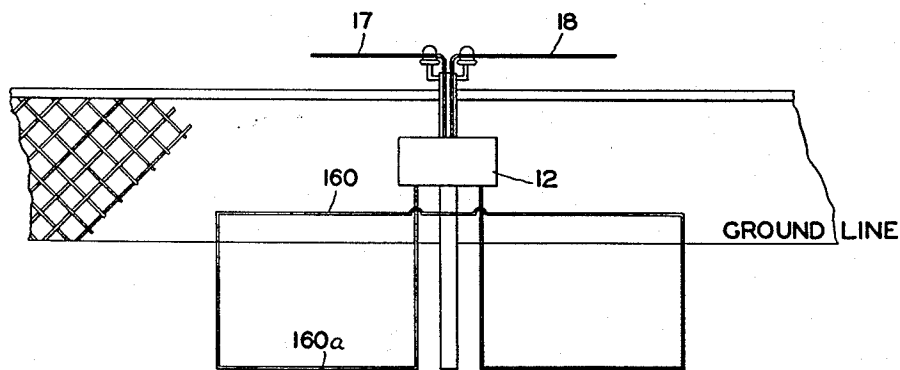
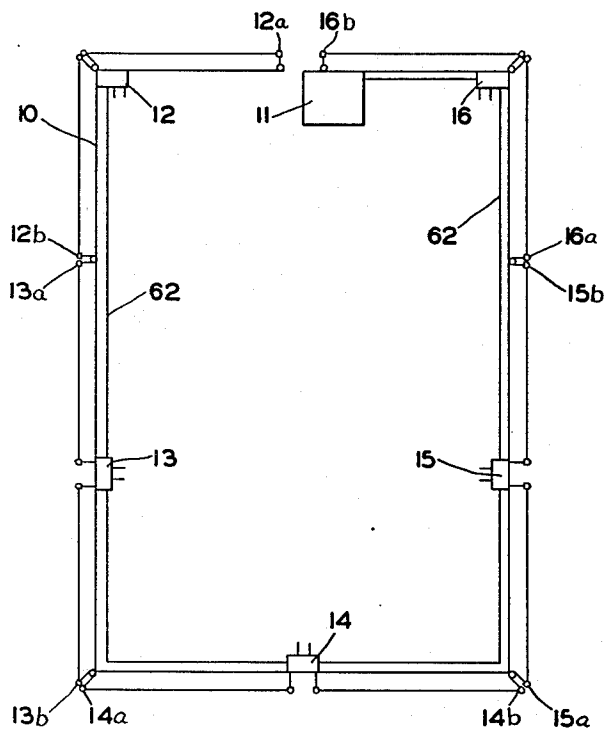
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APPROACH SIGNAL SYSTEM

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Application April 30, 1942, Serial No. 441,061

2 Claims. (Cl. 177-352)

1

An object of the present invention is to provide a signal and alarm system adapted to indicate the approach of a person to a guarded boundary, such as a fence around a guarded area and more particularly to provide such a system as will prevent a person crossing the guarded line in any fashion without giving a signal and to prevent the cutting of the guard wire without giving a signal and to provide such a system as will operate with maximum efficiency through all kinds of weather changes.

Further objects and advantages of the present invention will be apparent from the accompanying drawings and description and the essential features will be summarized in the claims.

In the drawings, Fig. 1 is a diagrammatic view of a system wherein the capacity of a body approaching the guarded line will produce a change in voltage in my improved system so as to produce a signal; Fig. 2 is a diagram of a modified system wherein the capacity of the body of a person approaching a guarded line will produce a change in frequency in the system so as to produce a signal; Fig. 3 is another modification wherein the capacity of the body of a person approaching the guarded line produces a change in current or voltage in the system so as to produce a signal; Fig. 4 is a diagrammatic view illustrating generally how such a signal system might be installed; and Fig. 5 is a diagrammatic view of a protection against tunnelling under a fence.

My improved signal system is particularly useful for outdoor installation where growing weeds, rain and snow storms and other changing electrical conditions have hindered the most efficient operation of prior known protective systems of this sort. The fundamental principle upon which the various modifications of my system are based, involves a double antenna system having two wires of substantially equal electrical capacity to ground, with means for balancing one antenna system against the other so that the end output of the two systems is normally substantially zero in so far as electrical flow is concerned and no signal is produced. Various arrangements are here disclosed whereby any unbalanced change in either system causes a flow of electricity and only such changes as are due to the approach or other activity of a person near the antenna systems are permitted to produce a signal. Other changes which occur more slowly because they are due to natural causes are taken care of in other ways.

Referring first to Fig. 4, various forms of systems will be described applicable to a situation wherein a property is guarded by the fence 10

2

with a guard located at the house 11 and with protective units along the fence system as shown at 12, 13, 14, 15 and 16. The limits of the protective antenna systems are indicated by the suffixes *a* and *b* appended to the different reference characters for the various units. For instance the antenna systems for unit 12 run from the unit to 12*a* and 12*b*. The other units have been marked in like fashion.

A unit constructed according to Fig. 1 would be housed in a single casing protecting it from atmosphere and located at the point 12, 13, etc. The wire 17 represents a wire running from 12 to 12*a* and the wire 18 represents one running from 12 to 12*b*. These wires might well be made of the same size wire and of exactly the same length and supported on insulators at the same height above the ground. This would give approximately the same electrical capacity to ground for each of the wires with provision in the unit to balance for small inequalities by means of tuning condensers. It will be understood by those skilled in this art that one of the wires 17 or 18 might be longer and placed higher above the ground than the other and still give equal electrical capacity to ground for the two wires, considering each as an antenna system. Such obvious variations will not be further discussed.

In the system shown in Fig. 1, I have made use of an electrical bridge to balance one antenna system against the other and to permit a relative change in voltage between the two antenna systems to produce a signal at the guard house 11. On one side of the electrical bridge is the resistance 19 and the variable condenser 20 which is connected to ground. On the other side of the bridge is the resistance 21 and the parallel connected condensers 22 and 23 which are also grounded. The two sides of the electrical bridge are normally balanced against each other roughly by the proper construction of the double antenna system with final adjustments made in the field by the setting of the condensers 20, 22 and 23. Current is supplied to the entire unit from lines *L*₁ and *L*₂ which are connected to any suitable source not shown and extend to the units 12, 13, 14, etc. Only two wires are needed around the entire fence system as each unit is connected in parallel to the same two wires *L*₁ and *L*₂. It is here assumed that these wires are supplied from a source of A. C. current at 110 to 120 volts.

In the unit 12, for instance, is provided a rectifier 24 which is of a standard type and need not be further described. Filtering is provided in the usual manner at 25. The rectified current is fed

through line 28 to oscillator 29 and through lines 30 and 44 to provide the B current for the electronic circuits later described. Tubes 26 and 27 are voltage regulator tubes to regulate voltage in these lines. The oscillator 29 is of a standard type adapted to supply an oscillating current through lines 31 and 32 to the double antenna system and the electrical bridge. It is provided with zero temperature coefficient and negative temperature coefficient condensers to maintain constant frequency under all weather conditions. The unit shown at 33 will be recognized as a buffer or isolation amplifier to prevent changes in the main circuit from affecting the frequency transmitted to the double antenna system.

The frequency supplied by the oscillator may have a wide range, it being understood that the length of wires connected at 17 and 18 and the sensitivity of the device will depend upon the frequency selected. For instance, if 300 cycles were supplied, the wire 17 might be two miles long and the sensitivity would be so low that a person would have to touch the wire to produce a signal. However I have used in actual practice 180 kilocycles which permits the wire 17 to be any length up to 1,000 feet and which can provide a system of sufficient sensitivity that a signal will be given if a person approaches within ten feet of the wire 17 or a signal will be transmitted if so much as one inch of the wire 17 is cut off. The sensitivity and length of wire used for antennas are proportional to the frequency generated by the oscillator 29. Also the sensitivity is affected by the bias on the control grid of the thyatron trigger tube 43. If the frequency is lowered, the length of wire can be increased but the sensitivity will be reduced.

Normally when the system is installed and properly balanced and the weather is dry there will be practically no current flowing at the output end of the electrical bridge. However upon a change in capacity to ground on either side of the double antenna system either in a positive or negative direction current will flow from the bridge through the system about to be described.

Following the electrical bridge I have shown two stages of radio amplification at 34 and 35 tuned to the frequency of the oscillator. Since these are standard circuits further description is believed unnecessary. Next in the system is a double rectifier tube 36. Upper and lower pairs of elements are indicated in the diagram. The plate 36a of the upper pair and the cathode 36c of the lower pair are connected to the source of input voltage. The D. C. output will then be positive from the cathode 36b and will be negative from the plate 36d and from a properly designed amplifier the positive and negative components will be of equal magnitude. Two resistances 37 and 38 of substantially equal value are connected in on the two sides of the output circuit. These are connected together at the common point 39 and normally the resulting voltage at this point would be zero, as the positive and negative values in the two legs of the voltage corrector 37, 38 would cancel each other. The resistance 38 in the negative leg, however, is connected through condenser 40 to the ground at 41 for a purpose to be later described.

The next device in the circuit shown at 42 is a low pass filter to prevent lightning from operating the trigger tube shown at 43. This filter has the usual air core and iron core chokes connected through condensers to ground and cuts off all frequencies above 50 or 60 cycles per second.

The trigger tube 43 as here shown is one known as a thyatron which normally is nonconducting when its grid is below 1.4 volts negative. The normal bias for the grid of this tube is here below 1.4 volts negative and is provided through line 44 and the adjustable resistance 45. By adjusting this bias the amount of positive voltage which must be received from the rectifier to overcome the bias of the tube sufficiently to permit it to conduct a signaling current is adjusted. This adjusts the sensitivity of the system. If an amplifier (34, 35) having a gain of 25,000 to 50,000 is used, the sensitivity is extremely high and a small fraction of a mmfd. change in the antenna wire will produce a signal. Testing jacks are shown at 46 and call for no further description.

A relay 47 is provided in the plate circuit of the tube 43 for the purpose of closing the contacts shown at 48 to provide a signal. On small installations two wires might run from contacts 48 to a signal device in guard house 11. A system is shown here for reducing the wiring cost on large installations. The contacts are shown as closing a circuit from line L₁ through line 49, the winding of motor 50, line 51, contacts 48 and line 52 back to L₂. The shaft of motor 50 is diagrammatically indicated as driving cam wheels 53, 54 and 55. Means is provided insuring sufficient length of operation of motor 50 to send a signal even though a person approaches wire 17 or 18 only momentarily. To this end a maintaining circuit is provided from L₁ through line 49, winding of motor 50, line 56, normally open contacts 57 and lines 58 and 52 to L₂. The contacts at 57 are normally held open by a small projection 55a on the cam wheel 55. As soon as motor 50 starts this cam 55a permits the contacts at 57 to close and motor 50 will continue to operate even though the contacts at 48 should immediately open. This operation will continue until wheel 55 has made one revolution when cam 55a will again open the contacts at 57. Meanwhile the cam 53a on wheel 53 has opened the normally closed contacts at 59, thus deenergizing the tube 43 and relay 47, setting these parts for another operation. The wheel 54 is utilized to send a signal to the house 11. To this end multiple projections 54a are provided on wheel 54 in a predetermined pattern adapted to engage and operate normally closed contacts 60 which control a circuit from lines 49 and 61 to line 62 which leads back to the guard house 11. A suitable signal device, not shown, is provided at the house 11 actuated by the opening of the contacts 60. The signaling projections 54a may be made different at the points 12, 13, 14, etc., so that a different signal will be given at the house 11 depending upon which section of the fence has been approached by an intruder. This system using the motor 50 and the signal wheel 54 is advisable on large installations because a single wire 62 running around the entire guarded area may be utilized to send a coded signal from any one of the units 12 to 16. Another system involving an electronic timer and two signal wires running from each unit 12, 13, etc., back to the house 11 is described in connection with Fig. 2 but it will be understood that either of these devices might be energized by the tube 43 to produce a signal in the system here described in connection with Fig. 1.

In some cases a fourth cam wheel 55' is necessary having a cam controlling contacts 56'. These contacts are normally held open and are in series between a source of negative voltage and the con-

5

trol grid of tube 43. After the current to the plate of tube 43 is broken at contacts 59, the cam on wheel 55' permits contacts 56' to close thus applying a negative bias to the control grid to regain control of tube 43. This prevents repeated triggering of tube 43 by inductive surges of motor 50.

The double rectifier 36 and the corrector 37, 38 are provided to prevent slow changes in the double antenna system producing operation of the tube 43 and the sending of a false signal. Such changes take place due to unequal effect of rain or snow on the two wires 17 and 18 or phase shift from changes in ground resistance, the growth of weeds, etc. These changes due to natural causes occur very slowly and over a period of several minutes or hours as distinguished from the changes utilized to cause a signal such as the approach of a person to one of the wires 17 or 18. Any slow changes in the wires 17 or 18 of the type just described will cause a flow at the output end of the electrical bridge and these changes will cause a slight flow of positive and negative currents in the resistances 37 and 38. However, since plenty of time is available due to the slow changes, these voltages cancel each other at 39 and no signal is given. In distinction to this, a sudden surge, such as that caused by the approach of a person to the wire, meets a time lag in the negative leg 38 of the corrector due to the condenser 40 and resistor 38. This prevents the negative voltage reaching the junction point 39 in time to cancel the positive voltage and so this positive voltage continues on to the trigger tube 43, overcomes the negative bias of the tube, and causes a signal.

I have here shown tube 43 biased on the negative side of its conducting point and rendered conducting by a positive current passing through resistor 37. Those skilled in the art will understand that tube 43 might be biased on the positive side of its conducting point. Then resistor 37 would be connected through a condenser to ground and on a sudden surge a negative current would reach tube 43 sufficient to change its conducting condition. A proper relay and contact arrangement in the plate circuit of tube 43 would then send a signal.

In Fig. 5 I have shown a manner of protecting against cutting of a fence or tunneling under it. A very fine wire 160 such as thirty gage or smaller, insulated with glass so as to be almost invisible is woven along the fence and then run below ground as shown at 160a and then returned to the unit housed at 12, 13, etc. A relay 161 is in series with wire 160. This relay has self-closing contacts 162 held open so long as relay 161 is energized from lines 51 and 52 through wire 160. If the wire 160 is cut, contacts 162 will close and send a signal the same as if contacts 48 were closed.

Another manner of utilizing my invention is illustrated in Fig. 2 where a double antenna system is set up as before consisting of the guard wires 17 and 18 erected on insulators along a fence or the like so that said wires have substantially equal capacity to ground. The unit shown diagrammatically in Fig. 2 would be housed in one of the casings 12, 13, 14, etc., mounted upon the fence and supplied with power from a source L₁, L₂, such as illustrated in Fig. 1, comprising wires strung along the fence. This part of the diagram has been omitted from Fig. 2, the power supply being designated B+ which will be understood to be the power at the point B+ of Fig. 1, omit-

6

ting voltage regulator tubes 26 and 27 which are not necessary here.

The principle utilized in the system shown in Fig. 2 includes the impressing of oscillating currents of different frequencies on the wires 17 and 18 by means of two oscillators. The output of both oscillators is fed into a converter tube whose output thus has a beat frequency of the difference in the frequencies of the two oscillators. As shown in Fig. 2, the oscillator 70 impresses a frequency of say 250 kilocycles on the guard wire 17. The oscillator 71 impresses a frequency of 200 kilocycles on the wire 18. The principle underlying the selection of these frequencies is that they must be sufficiently separated so that they will not couple through the antenna systems so as to cause the oscillators to lock together and maintain the same frequency.

The output of oscillator 70 is fed through line 72 to the grid 73 of converter tube 74. The output of oscillator 71 is fed through line 75 to the grid 76 of the converter tube. The output of this converter tube is fed through line 77 and a tuned transformer 78 through line 79 to the grid 80 of a second converter tube 81. A third oscillator 82 is provided having a frequency equal to the normal difference between oscillators 70 and 71, or in the present instance 50 kilocycles. The output of this oscillator is fed through line 83 to the grid 84 of the tube 81. Obviously if the frequency output of tube 74 is exactly 50 kilocycles and if the output of oscillator 82 is held exactly at 50 kilocycles, then the normal output from tube 81 will be zero. The variable condensers 85 for wire 17 and 86 for wire 18 may be utilized to obtain this exactly balanced condition.

If a person approaches near one of the wires 17 or 18 or if a portion of the guard wire should be cut off for the purpose of making an entry, the capacitance of wire 17 or 18 is affected and the frequency changes. This causes the output from tube 74 to vary from the predetermined frequency of say 50 kilocycles and since the output of oscillator 82 is held constant at 50 kilocycles, the output of tube 81 is no longer zero and a voltage appears in the output line 87. This is fed through a stage of audio-frequency amplification at 88 to a thyatron tube 89. This tube is like that already discussed in connection with tube 43 and is set by the adjustable resistance 90 to a bias rendering the tube normally nonconducting but which becomes conducting by the current sent along the line 91 from amplifier 88 when a human body nears one of the guard wires. In the plate circuit of tube 89 is a relay 92 which is adapted to close a normally open set of contacts at 93 which connect with an alarm signal circuit 61, 62 which is like the similarly numbered circuit in Fig. 1.

As explained in connection with tube 43, the tube 89 might have a grid bias on the positive or conducting side of its cut-off point so that it would be rendered nonconducting by the negative swing of an oscillating current sent along line 91. The relay 92 and its associated contacts would have to be redesigned to take care of this change.

Means is provided to hold the alarm for a sufficient length of time to be noticed by a man in the house 11 in case the inciting cause, such as a person approaching wire 17 or 18, is of very short duration. The means here might be similar to that shown in connection with motor 50 in Fig. 1. Instead, however, I have here illustrated an electronic timing device 84. A second set of nor-

mally closed contacts 95 maintains a voltage of about 100 volts negative on the control grid of tube 99. This tube is thus nonconducting because of the highly negative grid. When the tube 89 starts to conduct, energizing relay 92, the contacts 95 open and the negative charge on grid of tube 99 leaks off through resistance 98. The value of condenser 96 and resistance 98 determines the time required. When this negative charge has reduced to the cut-off point of the tube 99 this tube conducts and energizes relay 100 thus opening contacts 101 breaking the circuit to relay 92 and tube 89 and resetting the device for another operation.

It will be obvious to those skilled in the art that the electronic timer just described might have been used in the device of Fig. 1 in place of motor 50 for the purpose of holding the signal for an appreciable length of time.

Means is provided in connection with the device of Fig. 2 to correct for changes due to weather and other natural conditions which change slowly over a period of time, so as to avoid operation of the alarm signal because of weather changes only. The output from tube 74 is fed through lines 77 and 102 through transformer 103 through a stage of radio frequency amplification at 104 to the discriminator 105. This discriminator is tuned to the normal frequency encountered at the output from tube 74 or in the present instance 50 kilocycles. If the guard wires 17 and 18 are subjected to rain or snow so as to change their capacity to ground slowly and at different rates the output from tube 74 will gradually change from 50 kilocycles and this will result in a change in the output through line 106 from discriminator 105. This will be either positive or negative depending upon an increase or decrease in the frequency output from the converter tube 74. This output through line 106 is fed to a reactance modulator 107 of known type. It is well known that a change in the input to grid 108 will result in an apparent change in inductance of the circuit associated with tube 110. Line 109, leading from the plate circuit of the tube 110, is fed back to one of the oscillators 70 or 71. In the present instance it is fed through line 111, condensers 112 and 113 to grid 114 of the oscillator 70. This produces a change in frequency of the oscillator 70 in a direction to restore the normal balance to converter tube 74. Therefore the output of this tube through lines 77 and 102 will return to 50 kilocycles so that no further change takes place in the frequency of oscillators 70 or 71 until some further change calls for it. A time delay circuit between the discriminator and reactance modulator slows the correction of any rapid change in guard wire capacity such as would be caused by a person approaching the guard wire. This consists of the resistance 115 and condenser 116. As a rapid change in guard wire capacity caused by a person approaching the guard wire 17 or 18 results in large changes in frequency, the time lag is sufficient to allow a voltage to reach the thyatron 89 so as to result in an alarm signal.

Connected with line 91 is an inductance choke 117 with a series resistance 118 to ground. This passes all low frequencies to ground and prevents them from reaching the thyatron 89. Its value may be adjusted by the resistance 118 so as to control those frequencies which reach the thyatron.

An advantage of the system shown in Fig. 2 over that shown in Fig. 1 is that changes in voltage of the oscillators 70 and 71 do not affect

the system which depends upon frequencies only.

A third system is shown in the diagram of Fig. 3. Here oscillations of the same frequency are impressed upon the guard wires 17 and 18 which form a double antenna system where each wire has substantially the same capacity to ground as before. The currents in the two wires 17 and 18 are rectified and balanced against each other by means of a discriminator connection. The capacity of a foreign body approaching one of the wires 17 or 18 unbalances the system causing a current to flow which gives a signal.

As shown in Fig. 3, an oscillator 130 supplies current through a buffer or isolation amplifier 131 to transformer 132 and through the secondary of this transformer the same frequency is impressed upon wires 17 and 18. It will be understood that the current supply for the oscillator indicated at B+ is connected at the point B+ of Fig. 1. In other words the unit 12, 13 or 14 on the fence receives power through lines L₁ and L₂ which is rectified for use in the oscillator. The mid point of the secondary 132a of the transformer is grounded as shown. Each end of the secondary is then connected to a stage of radio frequency amplification as indicated at 133 and 134. The output of these two stages of amplification is fed to the discriminator 135. The output of this discriminator through line 136 is normally zero and this balanced condition is attained by adjustment of the variable condensers 137 and 138 connected with the wires 17 and 18 respectively.

The output through line 136 (rectified in the discriminator 135) is fed to two thyatrons 139 and 140 which have their grids biased so that 139 is normally conducting and 140 is normally nonconducting. In the plate circuits of the thyatrons are the relays 139a and 140a. The contacts at 141 are self-closing and the contacts at 142 are self-opening. Since the tube 139 is normally biased to conduct when the system is in balance, relay 139a is energized and its contacts are held open. Since tube 140 is biased to nonconducting when the system is in balance, relay 140a is normally deenergized and its contacts remain open. The relays 139a and 140a each operate two sets of contacts in the same direction, i. e., in each set the two pairs open or close together. Across one set of contacts of each relay is connected a reversing motor 143 of a type such as is used to tune radio receivers. If either thyatron changes from its normal condition, i. e., if 139 changes to nonconducting or if 140 changes to conducting, then one of the circuits of motor 143 is closed and the motor will operate in one direction or from its normal condition, i. e., if 139 changes to nonconducting, relay 139a is deenergized and the contacts at 141 being self-closing will complete a circuit from L₁ through line 144 and winding 143a of the motor to L₂. If tube 140 becomes conducting, relay 140a will become energized so as to close contacts 142 thus completing a circuit from line L₁ through line 145 and the motor winding 143b back to line L₂. A variable condenser 146 has movable plates connected with the shaft of motor 143. This condenser is connected to one of the wires 17 or 18 so that as the motor operates in one direction or the other the capacity of wire 18 (in the present instance) is either increased or decreased. This restores the system to balance at which time the output in line 136 becomes zero and tubes 139 and 140 return to their original condition and stop the motor.

Across the second set of contacts shown at 141a

and 142a is connected a time delay relay 147 which operates to close a set of normally open contacts 148 so as to operate the alarm circuit 61, 62 similar to circuits already described. This relay 147 is of the "delayed attract" type. An electronic timer delay relay of known type could be used here. In other words it does not close for some predetermined time after current is supplied to it. Since changes due to weather affecting wires 17 and 18 differently occur very slowly, these changes will cause motor 143 to operate for such short periods of time that contacts 148 will not be closed and the alarm will not be sounded. However, if a person approaches one of the guard wires, a larger change of voltage would result which would take the motor 143 much longer to correct, whereupon the relay 147 would act to close the contacts 148 and give the alarm. The two condensers 150 across the output of the discriminator 135 will hold a charge for an appreciable length of time so that even if a person jumped quickly over one of the guard wires the resulting surge of voltage would charge these condensers and keep the motor 143 operating long enough for relay 147 to close.

Explaining more in detail, an example of the operation of the thyratrons 139 and 140 may now be given. These thyratrons might be of a well known type whose grid bias cut-off voltage is 1.4 volts negative. Therefore if 139 is biased to 1.3 volts negative and if 140 is biased to 1.5 volts negative, then if a change in line 136 occurs which is 1.0 volt negative, then the condition of 139 would be changed to 2.3 volts negative, thus changing from conducting to nonconducting. At the same time 140 changes from 1.5 volts negative to 2.5 volts negative so that it remains nonconducting. The negative bias of grids 139 and 140 is regulated by the variable resistances 152. If the oscillator 130 is set to apply a small constant voltage of say 0.1 volt to wires 17 and 18 and if the amplifiers 133 and 134 have a gain of 1000, then a change in the wire capacity which produces a change as small as .001 volt will result in a change of 1.0 volt in the output of the amplifiers and will result in a 1.0 volt change either positive or negative in line 136. The system is thus very sensitive because a very slight change in the capacitance of either wire 17 or 18 will result in changing the condition of tubes 139 and 140 and a change in either direction will cause an operation of the signal.

While I have here shown thyatron tubes for controlling the sending of a signal, this is for purposes of illustration only and it will be understood that other electronic tubes might be used. Many electrostatically or electromagnetically controlled tubes could be used for this purpose if the circuits were properly designed by one skilled in this art. It is only necessary to provide a tube having a controlling element to receive current from one of my improved protective systems, so arranged and adjusted that when the current is built up by a person approaching the guard wire, the tube will change its conducting condition and send a signal.

It should be noted that in every case I have shown a double antenna system. It would be possible but impractical to use a single antenna. The reason for this is that with two antennas balanced against each other in the systems as shown, most of the changes due to natural causes are substantially equal in the two antennas and therefore cancel each other because of the way the systems are built. This leaves only a small amount of correction for the automatic means shown in the different circuits. If a single antenna were used and corrections made in the system itself to take care of changes due to natural causes, the corrections would be of such magnitude that the correction devices would destroy the useful characteristics of such a protective system.

What I claim is:

1. In a signal system, a double antenna system comprising two separate conductors of substantially equal electrical capacity to ground, two oscillators respectively impressing on said conductors oscillating currents of different predetermined frequencies, the said frequency difference being sufficient to prevent oscillator interlocking due to coupling between the antenna conductors of said system, a converter tube having grids connected respectively with the output circuits of said oscillators whereby the output circuit of said converter tube has a beat frequency equal to said frequency difference, a second converter tube, means feeding the output of said first converter tube to a grid of said second tube, a third oscillator having a frequency equal to said frequency difference, means feeding the output of said third oscillator to a grid of said second converter tube so that the output of said second converter tube is normally substantially zero, a signal device, a circuit connecting said device to receive energy from the output of said second converter tube to cause actuation of said signal device when a human body nears one of said antenna conductors and causes a change in frequency of the current impressed thereon.
2. The combination of claim 1 including a circuit having in series an amplifier, a discriminator and a reactance modulator, means feeding the output of said first named converter tube to said amplifier, and means feeding the output of said modulator to one of said two first named oscillators, whereby to automatically maintain said frequency difference during slow changes of capacitance in said double antenna system.

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