

April 16, 1940.

I. WOLFF

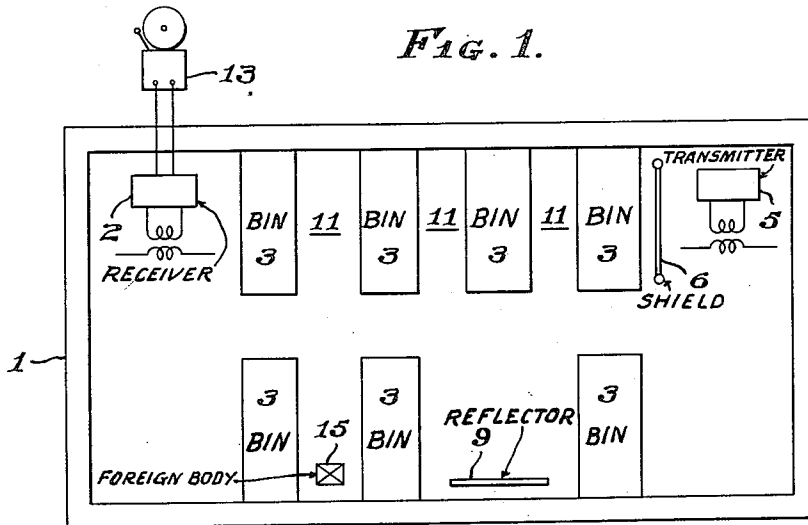
2,197,028

PROTECTIVE DEVICE

Filed Oct. 28, 1936

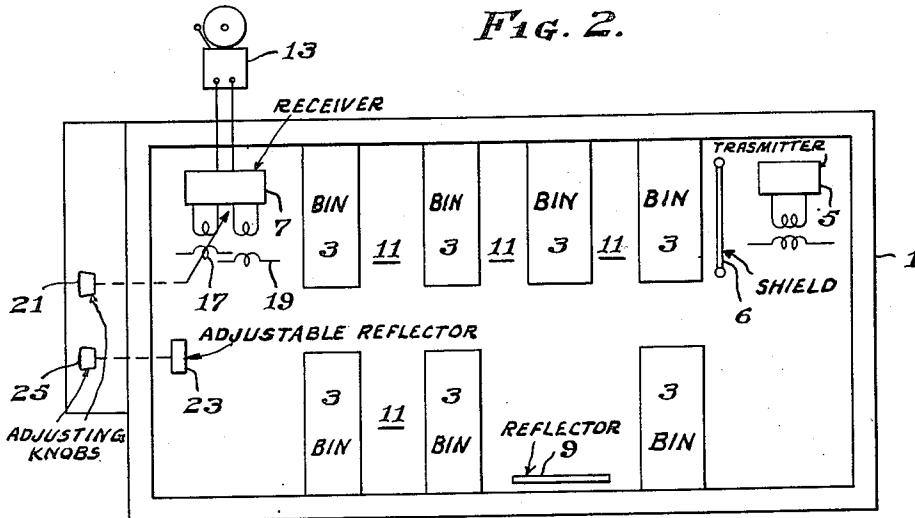
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Fig. 1.



REFLECTED WAVES FORM A STANDARD WAVE PATTERN,
INTRUDER DISTURBS PATTERN AND OPERATES ALARM.

Fig. 2.



REFLECTED WAVES FORM A STANDARD WAVE PATTERN,
INTRUDER DISTURBS PATTERN AND OPERATES ALARM.

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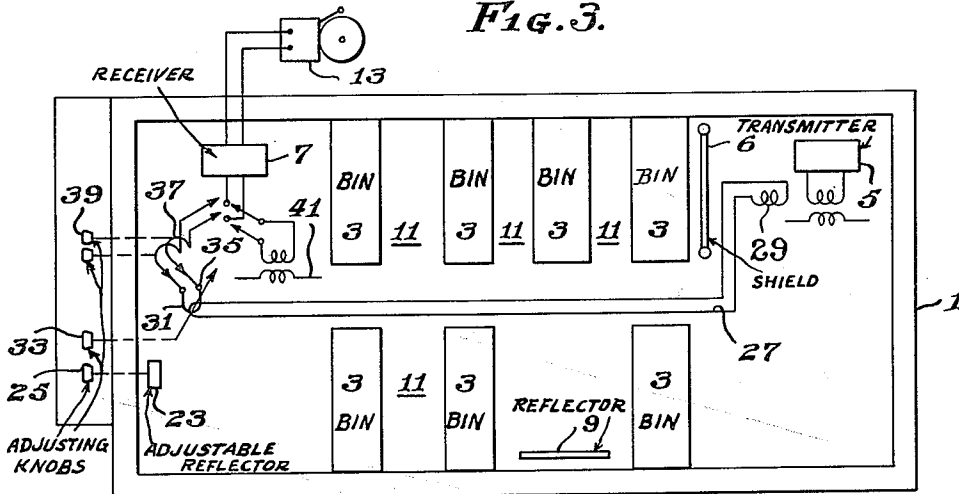
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Fig. 3.



REFLECTED WAVES FORM A STANDARD WAVE PATTERN,
INTRUDER DISTURBS PATTERN AND OPERATES ALARM.

Fig. 4.

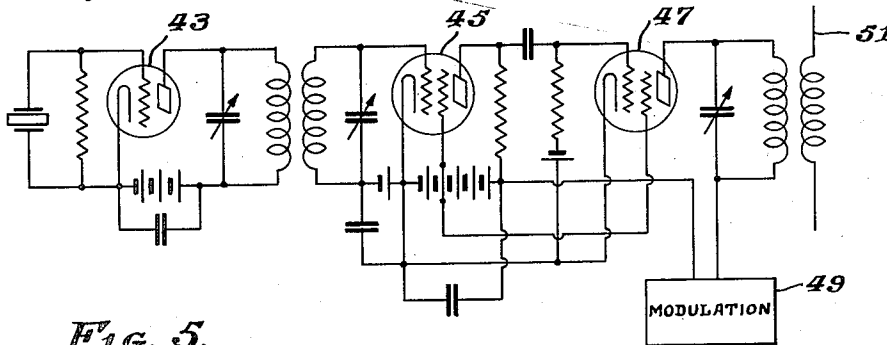
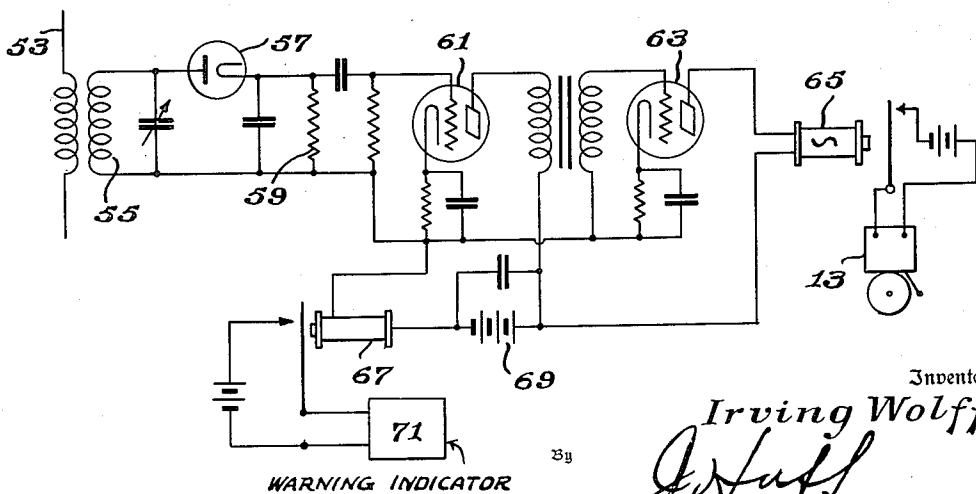


Fig. 5.



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PROTECTIVE DEVICE

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11 Claims. (Cl. 177-314)

My invention relates to protective devices and more particularly to a radio system which provides means for creating standing waves in an enclosed region to be protected and indicating any change in said standing waves.

I am aware that rooms have been protected by a radio transmitter which is arranged to radiate waves to a receiver which indicates changes caused by interception of the waves. While such devices provide some protection under suitable conditions, I have found that the sensitivity of radio room protective devices can be greatly improved by means of the novel arrangements hereinafter described.

One of the objects of my invention is to provide an improved apparatus and method of operation for protecting an enclosed region by creating radio waves which have a standing wave pattern and indicating changes in said pattern.

Another object is to provide means for creating standing waves from a radio transmitter which is indirectly located with respect to a receiver whereby direct radiation from transmitter to receiver is prevented, and the standing wave pattern is spread throughout the region to be protected.

A further object is to provide means for creating standing waves from a radio transmitter which are received by a balanced receiving device whereby a slight change in the standing wave pattern may be indicated.

An additional object is to provide means for creating standing waves from a radio transmitter which are received by a receiver and to impress on said receiver waves opposing the received radiated waves by means of an appropriate transmission line coupling the transmitter and the receiver.

My invention is illustrated by the accompanying drawings in which Fig. 1 is a schematic illustration of one embodiment of my invention.

Fig. 2 is a schematic illustration of modification of my invention in which a balanced receiver is used.

Fig. 3 is a schematic illustration of a receiver which is operated as a balanced device by impressing thereon oppositely phased currents transmitted from transmitter to receiver by a transmission line.

Fig. 4 is a circuit diagram of a transmitter which is indicated schematically in Figs. 1, 2 and 3, and

Fig. 5 is a circuit diagram of a receiver which is indicated schematically in Figs. 1, 2 and 3.

In describing the foregoing figures similar

reference numerals will be used to indicate similar parts. Referring to Fig. 1, an enclosed region 1 to be protected may be a room, factory, warehouse or the like. Within the room there may be located storage bins 3, machinery, boxes or goods. In one corner of the region is located an ultra high frequency transmitter 5 which radiates waves. These waves are reflected throughout the region and follow devious paths to a receiver 2 which is so located that it is not subject to direct radiation from the transmitter 5. The objects in the room may be used as a shield or a shield 6 may be provided. One or more wave reflectors 9 may be used in certain installations to insure reflection of the waves to and throughout relatively narrow isles 11. The output of the receiver is impressed on a suitable alarm 13.

The operation of the system is as follows: The transmitter, which will be more fully described below, radiates modulated ultra high frequency waves. These waves, preferably of a wave length of less than one meter, are reflected from the walls, bins and objects within the region to be protected. A reflector 9 may be used to insure reflection of the waves throughout narrow isles.

The waves, after repeated reflections, are received at the receiver and demodulated. The received waves are made up of various components established by the standing waves throughout the region. If, after the receiver has been adjusted, a foreign body, such as a man 15, enters the region, the ultra high frequency standing wave pattern will be altered. Such alteration in the standing wave pattern will be registered in the received demodulated currents which control the alarm 13.

I prefer to employ a relatively weak signal so that its effects will be primarily limited to the region to be protected. I have found that direct radiation from the transmitter to the receiver should be avoided because it reduces the sensitivity of the system in parts of the room outside the direct transmission path. The presence of a man may be readily detected by the change which his body causes in the standing wave pattern. The numerous reflections from the walls, bins 3, and installed reflector 9 produce a wave pattern which will completely cover the region to be protected so that the entry of a man or movement of a sizable object anywhere within the region will alter the standing wave pattern. Best results will be obtained if the transmitter, receiver, reflector and shield are so located that the wave energy in different parts of the region is

nearly the same. The shielding prevents direct radiation which otherwise would permit a large amount of direct reception which would mask the effects of the interception of the waves in the more remote portions of the protected region. It should be understood that at ultra high frequencies both insulators and conductors may be used as wave shields. The purpose of these shields is not to prevent the energy of the transmitters from reaching the receiver but to act as baffles which cause the transmitted wave to take a devious path to the receiver.

In Fig. 2, a pair of antennas 17, 19 are coupled to the input of the receiver 7. The coupling of one 17 of these antennas is adjustable by a knob or other suitable means 21. An adjustable reflector 23, which is mechanically connected to a control means 25, may be used in conjunction with the adjustable antenna coupling to effect a balancing of the waves received by the two antennas. The antenna coupling control means 21 and the reflector control means 25 are preferably located outside the region to be protected so that the normal balance will not be affected by the presence of the person making the adjustments within the protected region 1.

The output of the balanced receiving system is connected to a suitable alarm 13. The operation of the balanced system is essentially the same as the preceding system, but the sensitivity of the balanced system is superior. The balanced receiver is easily unbalanced by a relatively slight change in the wave pattern. Such changes may be caused by the entry of a man, the entry of an object, or the movement of objects within the protected region.

Fig. 3 represents a modification of Fig. 2 in that a transmission line 27 is used to convey balancing currents from the transmitter to the receiver. The transmission line is coupled at the transmitter 5 by a coupling coil 29 or the like and terminated in a variable coupling means 31 whose control knob 33 is located outside of the region 1. The length of the transmission line 35 between the variable coupling 31 and the receiver 7 may be adjusted by "trombones" 37 connected to outside control handles 39.

The transmission lines are preferably terminated in their surge impedance so that variations of length do not change the energy transfer.

It is necessary that the amplitude of the received radiated wave and the wave transferred over the line 27 be adjusted to have equal and opposite effects on the receiver. This condition may be realized by disconnecting the transmission line 35, and observing the output currents of the receiver when the antenna 41 is connected and the transmitter and receiver are adjusted to obtain the required frequency and resonant conditions. The receiving antenna 41 may then be disconnected and the transmission line 35 connected to the receiver. The output currents are adjusted by varying the transmission line coupling 31 until the output currents equal the value previously obtained for the received radiated wave. The antenna 41 and the transmission line 35 are then both connected to the receiver 5 and the phase of the current transferred by the transmission line 35 adjusted by varying the "trombones" 37 until the phases are opposite. Thus the two currents are made equal and opposite to balance the receiver output.

The balanced type of receiving system is not only more sensitive but also less subject to fluctuation in the output currents. The receiver may

vary within rather wide limits without upsetting the balance between the two antennas, or antenna and transmission line currents. Likewise, the amplitude of the radiated waves may vary without upsetting the balanced condition. I have found it most desirable to maintain constant frequency at the transmitter to avoid fluctuations of the standing wave patterns.

In Fig. 4 a schematic circuit diagram indicates one suitable form of transmitter illustrated in the preceding figures by reference numeral 5. A crystal, or other constant frequency oscillator 43 is coupled to one or more frequency doublers 45 and an amplifier 47. The modulating current source 49 is connected to the amplifier 47. The output of the amplifier 47 is coupled to a dipole or like antenna 51. It should be understood that a modulated oscillator without frequency doublers and amplifiers may be used.

A receiving apparatus, previously represented by the reference numeral 7 is shown schematically by the circuit diagram of Fig. 5. An antenna 53 is coupled to a tunable circuit 55 and a rectifier 57. The rectified currents are impressed across the resistor 59 which is coupled to the input of a signal frequency amplifier 61. The output of the signal frequency amplifier 61 may be coupled to a second amplifier 63. An alternating current relay 65 is connected in the output of the second amplifier to operate the signal alarm 13 which may be located at a point remote from the protected region. A D. C. relay 67 is connected in series with the amplifier anode current supply 69 to operate an indicator 71 which shows any disconnection or failure of the battery 69. This indicator may be placed near the alarm 13. The alarm 13 is connected so that failure of the receiver or the transmitter, as well as a variation of the received signals, will operate the alarm. It should be understood that the alarm may be connected so as to only operate on the interception of the waves, and another indicator may be used to represent defects in the service.

Thus I have described a protective device which may be installed within a warehouse, room, or other enclosed space. An ultra high frequency transmitter radiates waves which reach the receiver after repeated reflections. These reflections create standing waves which give a normal signal indication or a balanced receiver output. A variation of the standing waves, created by the entrance of a man, or movement of objects within the room, changes the receiver output and operates an alarm signal. It should be understood that the wave may be modulated or unmodulated and that two or more transmitters and two or more receivers may be used as may be required in any particular installation.

I claim as my invention:

1. The method of protecting an enclosed region by means including a radio transmitter and a radio receiver which comprises radiating an ultra high frequency radio wave, limiting direct radiation from said transmitter to said receiver, creating standing waves by reflecting said waves within said region, independently receiving components of said reflected waves substantially equal in amplitude and opposite in phase, adding said components, and indicating changes in pattern of said standing waves by their effect on said addition.

2. The method of protecting an enclosed region by means including a radio transmitter and a radio receiver which comprises radiating an ultra high frequency radio wave, preventing said radia-

tion from directly reaching said receiver, creating standing waves by reflecting said radiated waves, independently receiving two out of phase components of said reflected waves, balancing said components against each other, and indicating a change in said balance caused by a change in the phase of said received waves effected by a body moving within said region.

3. The method of protecting an enclosed region by means including a radio transmitter and a radio receiver which comprises radiating an ultra high frequency modulated radio wave, preventing said radiation from directly reaching said receiver, creating standing waves by reflecting said radiated waves, independently receiving two out of phase components of said reflected waves, balancing said components against each other, and indicating a change in said balance caused by a change in the phase relation of said received waves effected by a body moving within said region.

4. The method of protecting an enclosed region by means of a radio transmitter and receiver which comprises radiating a radio wave, limiting the direct radiation from said transmitter to said receiver, creating standing waves by reflecting said waves within said region, independently receiving two out of phase components of said reflected waves, shielding said receiver from direct radiation from said transmitter, and indicating changes in the phase relation of said received waves caused by the movement of a body within said enclosed region.

5. The method of protecting an enclosed region which comprises radiating a radio wave within said region, establishing standing waves by reflecting said waves within said region, receiving said reflected waves, combining therewith an opposing out of phase wave free from reflections to balance said received reflected wave, and indicating a change in said balance caused by a change in the phase of said received reflected waves.

6. The method of protecting an enclosed region which comprises radiating a radio wave within said region, establishing standing waves by reflecting said waves within said region, receiving said reflected waves, combining therewith an opposing out of phase wave free from reflections to balance said received reflected wave, adjusting the amplitude and phase of said opposing wave, and indicating a change in said balance caused by a change in phase of said received reflected waves.

7. In a system for protecting an enclosed region a transmitter of ultra high frequency waves, a receiver having two antennas responsive to said waves, means for impressing components of said waves of opposite phase on said antennas, means for equalizing the amplitudes of said components of opposite phase, means for reflecting said waves to create standing waves throughout said region, and means for indicating a change in the phase of said standing waves caused by the movement of a body within said region.

8. In a system for protecting an enclosed region a transmitter for radiating ultra high frequency waves within said region, a receiver responsive to said waves, means for reflecting said waves to create standing waves throughout said region, a transmission line coupling said receiver and transmitter for impressing out of phase balancing waves on said receiver, and means for indicating a change in said balancing caused by the movement of a body within said region.

9. In a system of the character of claim 8 means for adjusting the amplitude and phase of said balancing waves.

10. The method of protecting an enclosed region by means including a radio transmitter and a radio receiver which comprises radiating an ultra high frequency radio wave within said enclosed region, creating standing waves by reflecting said waves within said region, independently impressing on said receiver two radio frequency voltages, at least one of which is derived from said standing waves, balancing said voltages and indicating changes in the pattern of said standing waves as a function of changes in said balance.

11. The method of protecting an enclosed region by means including a radio transmitter and a radio receiver which comprises radiating an ultra high frequency radio wave within said enclosed region, creating standing waves by reflecting said waves within said region, independently impressing on said receiver two radio frequency voltages having instantaneously equal amplitudes and opposite polarities, the relative instantaneous amplitude of at least one of said voltages being a function of said standing wave pattern, adding said voltages, and indicating changes in the instantaneous amplitude of said one voltage due to changes in said standing wave pattern.

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