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[54] FLAT BEAM INTRUDER DETECTION
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[56] References Cited

UNITED STATES PATENTS

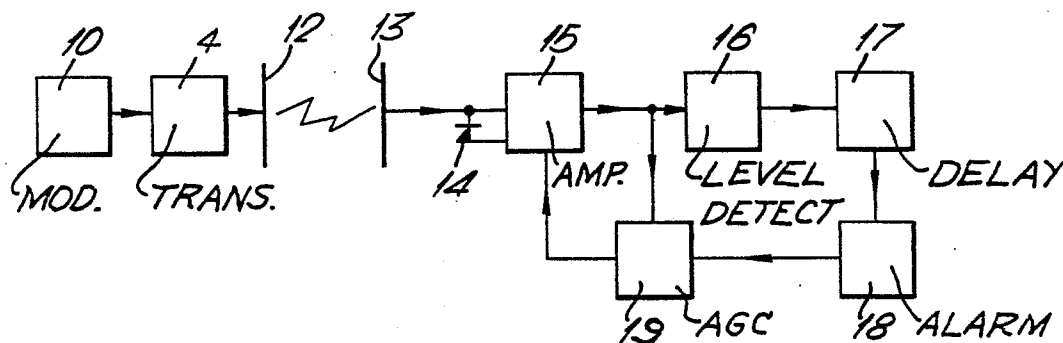
1,874,983 8/1932 Hansell 343/840

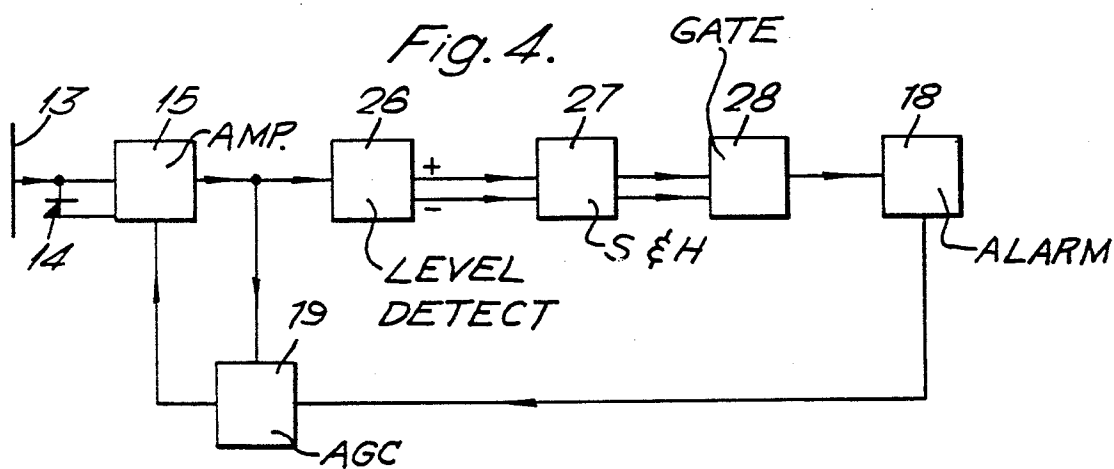
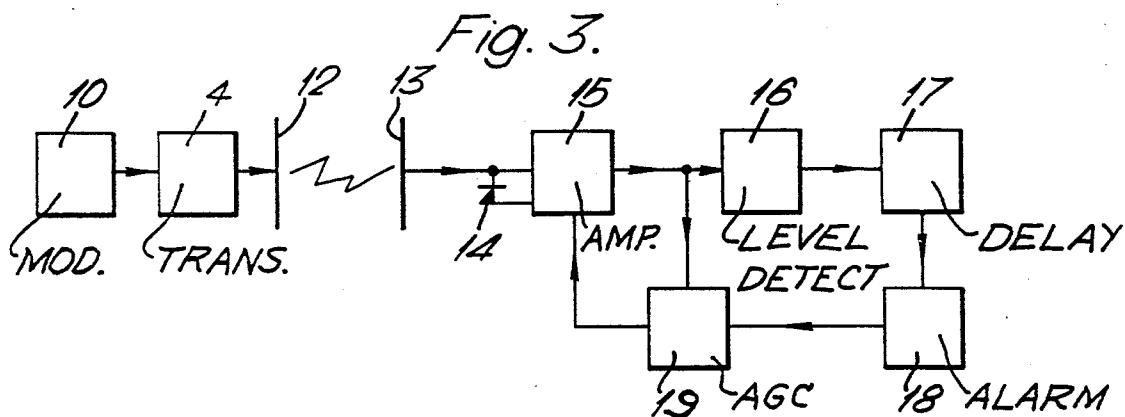
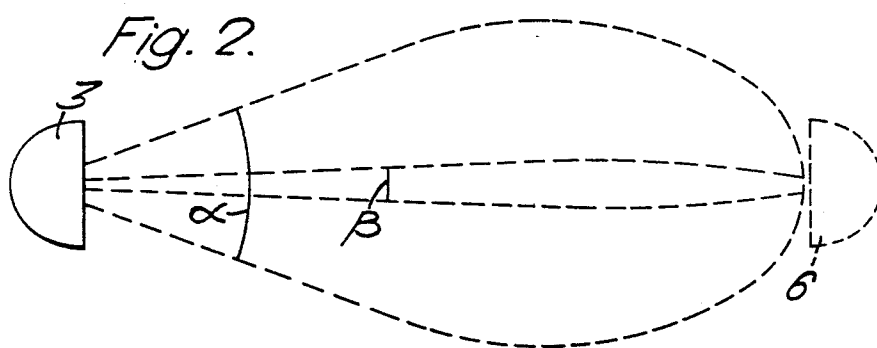
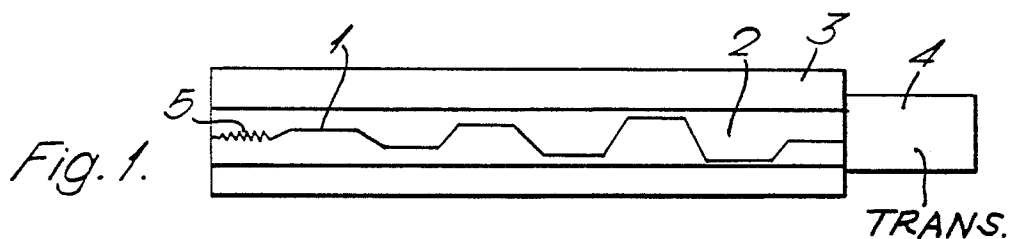
2,203,807 6/1940 Wolff 340/258 B
3,549,892 12/1970 Perlman 340/258 BPrimary Examiner—Glen R. Swann, III
Attorney, Agent, or Firm—Diller, Brown, Ramik &
Wight

[57] ABSTRACT

A VHF transmitter transmits a flat beam of radiation from a directive aerial into an area to be protected against intruders. A receiver with a directional aerial is positioned at the opposite side of the area, and receives a constant signal from the transmitter. If an intruder enters the area, and the receiver input varies by more than a predetermined amount for not less than a given time, the receiver output operates an alarm. Small objects such as a bird present only for a short time in the area do not set off the alarm.

6 Claims, 4 Drawing Figures





FLAT BEAM INTRUDER DETECTION DEVICE

BACKGROUND

Our invention relates to an intruder detecting device using a flat beam of ultra-high frequency radio waves.

It is known to generate a beam of radiation from a transmitter and an aerial, the polar diagram of the beam consisting mainly of one large lobe which extends into space from the aerial, the divergence of the beam in one direction being considerably greater than its divergence in a direction normal thereto. Such a form of radiation will hereafter be referred to as a flat beam. Flat beams are produced for example by slotted waveguide aerials. Such an aerial, if long compared with the wavelength radiated, can be made by phasing or reflection to produce the type of flat beam referred to above.

SUMMARY

According to the present invention there is therefore provided an intruder detecting device comprising an ultra-high frequency transmitter and an aerial having a polar diagram producing a flat beam of radiated energy; a receiver with a receiving aerial having a polar diagram with a directive characteristic, the receiver and aerial being adapted to be located remotely from the transmitter aerial and to receive energy from the said transmitter, with the polar diagrams of the transmitter and receiver aerials overlapping, and signal processing means fed from the detector to operate an alarm when a predetermined form of received signal change occurs.

For our intruder detector device we prefer to use a strip line aerial, including a plurality of radiating dipoles, the aerial itself being produced by printed circuit technique on an insulating base. If a single series connection of a number of dipoles is used, then this aerial is located near the focus of a paraboloid type reflector which is curved in one direction only, this producing a flat beam from the single strip line aerial array. Alternatively, several such strip lines may be located parallel and spaced apart from one another and suitably phased, the result being once more a flat beam.

We also provide a receiver preferably with an aerial of similar form to that of the transmitter and having a detector circuit, the transmitter and receiver being located at opposite sides or ends of an area to be protected. The flat beam may extend parallel with the surface of the ground, or it may be normal thereto and act as a kind of fence. In any case, when the transmitter is energized the result is that if any intruder walks through or near any part of the beam, whether flat or vertical, the amount of energy received by the receiver is changed, and this change is detected and used to set off an alarm.

In order to prevent slow changes such as those which may be caused by the approach of a rain or snow shower, or by other atmospheric disturbances, from affecting the receiver, we may arrange that the receiver detects not only a difference in amplitude but a rate of change of such difference, and rejects a rate of change which is less than a predetermined figure. Again, the receiver is preferably arranged to operate an alarm if the total signal level received falls permanently below a predetermined figure, since this will guard against any permanent interruption of the beam or failure on the part of the transmitter.

The receiver preferably includes a Shottky barrier diode detector, and may be constructed as a thick film configuration.

The transmitting aerial may be energised by an oscillator type diode, and the transmitter itself may be either of the cavity resonator type, or may be produced by printed circuit methods, in which case it may be produced in the same process as that of the printed circuit aerial itself. This forms a very neat and simple construction. The transmitter may use a Gunn diode as oscillator.

Preferably the transmitting and receiving aerials are enclosed in protective casings which must be made of a material such as polystyrene which is substantially transparent to ultra-high frequency radiation such as that used in the X band.

If required, a protected area may be provided with more than one flat beam of radiation. Thus an area may be enclosed by providing say, four flat beams each one radiating along the side of a rectangle, inside of which is the protected area.

The transmitted beam may be modulated as this assists processing of the signal by the receiver circuit.

BRIEF DESCRIPTION OF THE DRAWING

Reference is now directed to the accompanying drawings, in which:

FIG. 1 is a front view of a travelling wave graduated strip aerial for a transmitter or receiver, employing a plurality of dipoles in series;

FIG. 2 is a side view of the aerial showing the major isovoltic lines of the polar diagram;

FIG. 3 shows one embodiment of our invention; and FIG. 4 an alternative embodiment.

DETAILED DESCRIPTION

Referring to FIGS. 1 and 2, it will be seen that an aerial 1 consists of a number of dipoles extending from one end to the other of a strip of insulating material 2 which has a very low dielectric loss. The strip is mounted inside a parabolic reflector 3 of constant cross-section, closed at both ends, and having a transmitter or receiver 4 mounted at one end. The other end of the aerial is preferably terminated in a load resistor 5 dimensioned to prevent reflection. In the case of the transmitter at least, the aerial array is, as shown, made with the dipoles spaced increasingly further from the centre lines of the array with respect to their location away from the transmitter. This design ensures that a substantially equal radiation takes place from each dipole. Preferably the transmitter and receiver are each made in the form of a printed circuit, and the transmitter uses a Gunn diode, with the output modulated at a frequency of 1 kHz, the transmitter itself oscillating in the X band at a frequency in the region of 14×10^9 Hz. In the case of the receiver, the aerial itself is in the form of a printed circuit, and the receiver uses a diode as shown in FIGS. 3 and 4, but this time the diode acts as a detector.

The transmitter aerial is of the travelling wave type, and generates a flat beam. This is shown diagrammatically in FIG. 2. The beam is devised to spread over an angle α of approximately 40° in a direction normal to a horizontal plane including the centre line of the aerial. On the other hand, the spread in the said horizontal plane has a spread of an angle β which is approximately 4° , this arrangement forming a flat beam. The

beam may be located so as to traverse an area to be protected in either a horizontal or a vertical direction, and the receiver is placed at the opposite end of the transmitting aerial polar diagram from the transmitter as shown by the dotted line designated 6 in FIG. 2. Bearing in mind that the receiver aerial has a polar diagram of similar flat beam characteristic to that of the transmitter, and seeing that the two diagrams overlap with their centre lines substantially coincident, it will be understood that the device is adapted to detect any solid object penetrating the beam, and in fact may also detect a solid object outside the main isovoltic lines of the transmitter field by reflection. Normally however, a solid object such as an intruder intersecting the beam from the transmitter causes a reduction in signal strength at the receiver. It should however be stressed that the detection zone depends to some extent upon the distance between the transmitter and receiver aerials; as the distance increases so does the thickness of the detection zone increase in the central area thereof, and also in its height. The detection pattern tends to come to a point at the aerials, but the pattern is substantially as described over the majority of the beam overlap.

Turning now to FIG. 3 which shows a circuit according to our invention, it will be seen that the transmitting end thereof includes a modulator 10, a transmitter 11, this being similar to that shown at 4 in FIG. 1, and a directional aerial 12. The latter radiates in the direction towards a receiving aerial 13 of similar form, and the signal thereof is received and detected by a diode 14. The modulation is square-wave i.e., on and off, of 1 kHz frequency.

The output of the detector which is actually the modulation removed from the input signal, is fed to an amplifier 15 which may also include a filter to exclude extraneous noise and thus improve the sensitivity and accuracy of action of the device. The amplifier output is fed to a level detector 16 and also to an automatic gain control circuit 19 which is normally slow acting. This A.G.C. control is fed back as shown to control the amplification of the amplifier 15.

The output of the level detector is fed to a time delay 17 and this time delay feeds and actuates an alarm 18. The alarm is also connected back to the A.G.C. circuit 19, and on operation of the alarm the time constant of the A.G.C. circuit is considerably reduced.

The output detected by the diode 14 is of square wave form, since the transmitter 11 is switched on and off by the modulator 10. This output is amplified up to a useful level by an amplifier 15, and the amplifier output is used to generate a slow-acting control signal via the A.G.C. circuit 19, this signal being fed back to the amplifier 15 to keep the output thereof substantially constant under the influence of slow signal amplitude changes. These may result from frequency drift, or attenuation of the signal path due to changing properties of the medium such as rain, snow or fog.

The amplifier output is connected to a level detector 16 which detects changes in amplitude of the received signal of either a positive or negative character. The interposition of a body in the signal path would normally cause a decrease in received signal strength, though this may not always be the case since the body may reflect more signal energy into the receiver than it would normally obtain. If the phase of the reflected signal then aids the main signal, the received signal increases.

The level detector is biased so that it produces an output only if the input thereto changes by greater than a predetermined amount. This prevents the alarm from being set off by very small received signal changes just as would occur for example if a bird or a leaf traversed the beam path. The output from the level detector is fed to a timed delay circuit 17 which ensures that the alarm is not set off if a very short but noticeable amount of signal change takes place at the receiver.

Finally, if the signal at the receiver input changes by more than the predetermined amount and for more than the predetermined time, then the delay circuit 17 operates an alarm circuit 18. This alarm action may be further processed as for example by providing a lock-up indication of the operation of the alarm, but in addition the alarm circuit provides a signal back to the A.G.C. circuit 19 which provides rapid resetting of the amplifier 15 by reducing the time constant of the A.G.C. circuit. This rapidly brings the output from the amplifier back to a normal level, ensuring that if an object is interposed into the detection zone which alters the received signal level, then the detection system rapidly readjusts itself to the new conditions without remaining in a permanent state of alarm. This takes care of the possibility of introducing stationary objects such as cases or furniture into the detection zone.

An alternative form of the invention is shown in FIG. 4. It has been noted that when an intruder enters the detection zone formed by the signal emitted by the transmitter and detected by the detector, there may be an increase and subsequent decrease in received signal strength. Thus as the object enters the zone the signal may increase due to reflection, and as the intruder penetrates further into the zone the signal may decrease due to absorption or phase change. The reverse may also be true. Thus for use in an outside situation it may well be advisable to look for this kind of condition where a change in signal in one sense is rapidly followed by a change of signal in an opposing sense. The circuit uses a receiving aerial 13, detector 14 and an amplifier 15 as previously described, the receiver circuit working with a transmitter arrangement as shown in FIG. 3. The output of the amplifier is fed to a level detector 26 which has two outputs, one positive and one negative, one output being activated when the signal rises, the other when the signal falls below a predetermined level. These two outputs are fed to sample-and-hold circuit 27 and gated at 28 so that both signals have to occur within a predetermined time lapse before an output is given to operate the alarm circuit 18. The alarm circuit is connected back to the A.G.C. circuit 19 so as to reduce its time constant on arrival of an alarm signal. This is for the reason given above in connection with FIG. 3.

This form of detection reduces the possibility of false alarms due to change in weather conditions such as sudden squall or gush of rain, as this would result in a decrease in signal level followed sometime later by an increase in signal level. In this case the sample-and-hold circuit would not produce two simultaneous outputs to the gate 28, and hence a received signal that varied up and down with a relatively long time constant would not operate the alarm 18.

The components of the various assemblies and their circuits, are well known, so that no detail of these unit assemblies are shown. Again, although a travelling wave strip type aerial array has been shown as used in

connection with both the transmitter and receiver, any type of aerial capable of producing a flat beam as hereinbefore defined may be used in conjunction with a transmitter and receiver, both operating at a sufficiently high frequency to keep the aerial array size to relatively small dimensions, thus making its appearance difficult to detect by an unwanted intruder.

It has previously been stated that the device according to our invention employs a transmitter and a receiver the lobes of the polar diagrams of which overlap. Whilst this would provide a reasonably good protection for an area provided the beam was extended in a horizontal direction, it would not necessarily protect an area if the beam extended in a vertical direction, since in this position it would act more in the nature of a fence. It would however be readily possible to enclose an area by means of three or four transmitter-receiver combinations with overlapped polar diagrams, the transmitter-receiver pairs being located so as to enclose the said area, with their beams extending around the area like a fence. This would enable authorised persons to move about in the protected area without setting off an alarm, whereas anyone penetrating one of the beams enclosing the said area would set off the alarm.

Although our invention has been described as using a flat beam or polar diagram aerial for both the transmitter and receiver, it should be noted that such an aerial is only essential for the transmitter, though advisable for the receiver. The latter may use a directive aerial having other than a flat characteristic, provided that the largest lobe thereof is directed towards the transmitter, and the aerial is located within the transmitted signal field, preferably on its centre line. Such an aerial may be more compact than the flat beam aerial, but may not be so selective or directional, and may require a greater field strength for adequate receiver operation.

We claim:

1. An intruder detecting device comprising an ultra-high frequency transmitter with an aerial having a polar diagram producing a flat beam of radiated energy; a receiver with a receiving aerial having a polar diagram with a directive characteristic, the receiver and aerial being located remotely from the transmitter aerial so as to receive energy from said transmitter, with the polar diagrams of the transmitter and receiver aerials overlapping, and signal processing means fed from said receiver to operate an alarm when a predetermined form of received signal change occurs; said transmitter com-

prising an elongate strip of insulating material and an electrically conductive array printed thereon, said array including a series of parallel dipoles alternately staggered, from one end of the strip, on opposite sides of the center line of the array and increasingly spaced from such center line with respect to their location away from said one end of the strip, said array being terminated in a load resistor and said transmitter being connected to said array at said one end of the strip whereby substantially equal radiation takes place from each dipole.

2. An intruder detecting device as recited in claim 1 in which the constructions and polar diagrams of both transmitter and receiver aerials are similar.

3. An intruder detecting device as recited in claim 1 wherein at least said transmitting aerial is of the travelling wave type and includes a plurality of series-connected dipoles and a reflector.

4. An intruder detecting system as in claim 1 with said signal processing means including an amplifier, automatic gain control means connected in feedback relation with said amplifier for maintaining the amplitude of the amplifier output substantially constant in response to received signal strength changes having a selected slow rate, level detector means connected to the output of said amplifier for detecting changes in the amplitude thereof which are greater than a predetermined value as caused by received signal strength changes occurring at a rate greater than said selected slow rate, alarm means connected to said automatic gain control means for altering the rate of control of said automatic gain control means in response to actuation of said alarm means, and circuit means connecting said level detector means to said alarm means for actuating said alarm means only in response to changes of received signal strength indicative of the presence of an intruder.

5. A system as defined in claim 4 wherein said circuit means includes a delay circuit passing the output of said level detector means only in response to a predetermined duration thereof.

6. A system as defined in claim 4 wherein said level detector means has separate outputs in response to amplifier outputs above and below predetermined values, means for sampling and holding said separate outputs, and gating means for passing the sampled and held signals only in response to simultaneous presence thereof at said gating means.

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