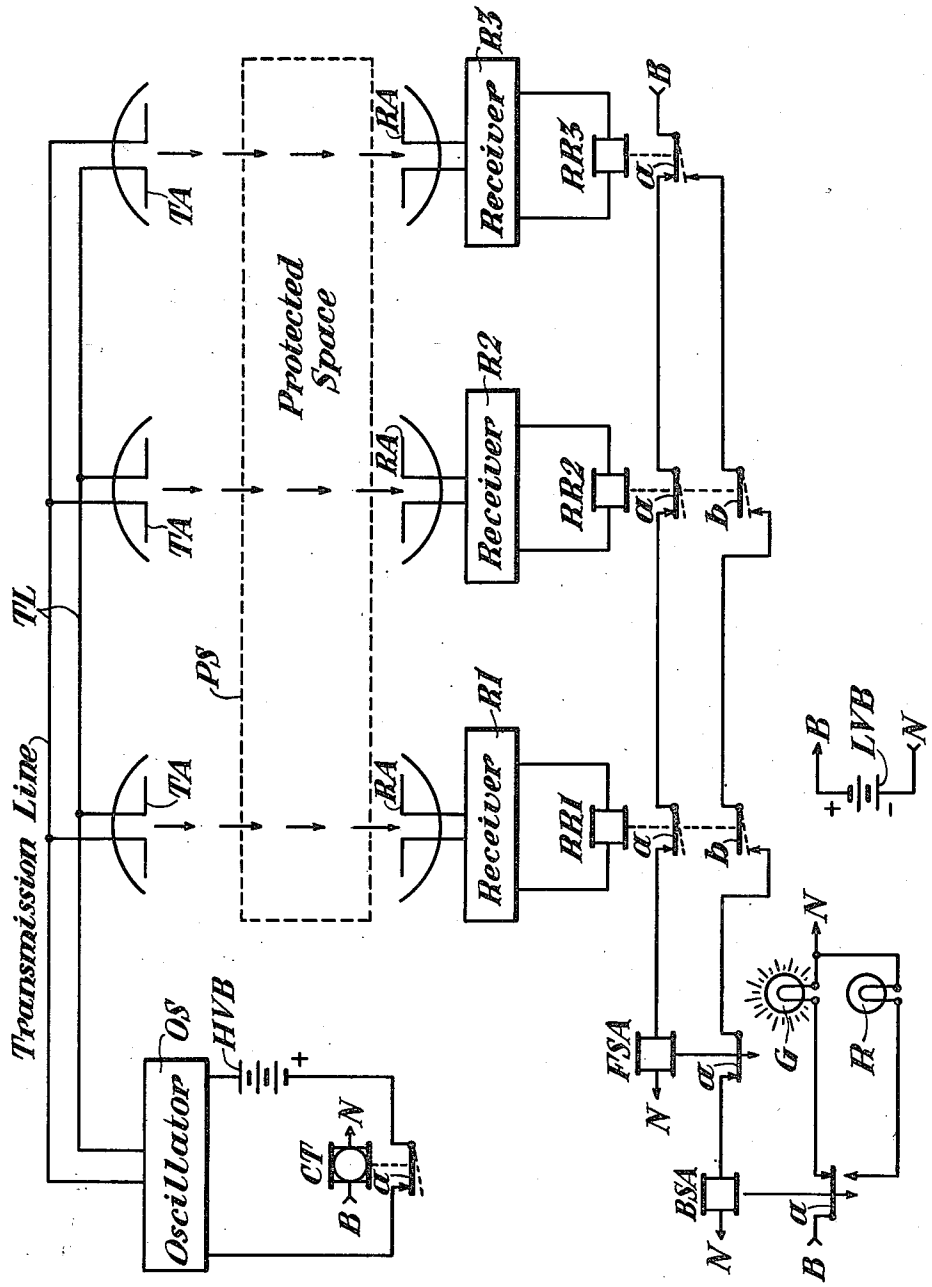
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SPACE INTRUSION DETECTION SYSTEM

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SPACE INTRUSION DETECTION SYSTEM

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Our invention relates to space intrusion detection systems, and particularly to a space intrusion detection system of the type employing a plurality of "spot" type detectors, and more particularly to a space intrusion detection system of the type employing a plurality of radiant energy beams which traverse the space to be protected.

An object of our invention is to provide a space intrusion detection system of the type described employing a plurality of radiant energy beams which traverse the space to be protected.

Another object of our invention is to provide a space intrusion detection system of the type described in which there is provided a plurality of radiant energy beams, the system being arranged to provide recurrent projection of radiant energy beams across the space to be protected, in order to conserve the power required to project these beams.

A further object of our invention is to provide a space intrusion detection system of the type described employing recurrent projection of pulses of radiant energy across the space to be protected, and including means for detecting recurrent reception of the pulses of energy.

Another object of our invention is to provide a system of the type described which provides for detection of the reception of a plurality of pulses of radiant energy received simultaneously.

Another object of our invention is to provide a system of the type described including means for detecting the simultaneous and recurrent operation of a plurality of devices which are normally concurrently operated at periodic intervals.

Other objects of our invention and features of novelty therein will be apparent from the following description taken in connection with the accompanying drawing.

We shall describe one form of space intrusion detection system employing our invention and shall then point out the novel features thereof in the claim.

In practicing our invention, we provide a plurality of radiant energy transmission and receiving elements disposed on opposite sides of the area to be protected, in such manner that radiant energy beams transmitted from the transmission portion of the equipment are radiated across the protected space, so that an intrusion of the protected space will cut off the reception of radiant energy in one or more of the beams. For example, we may provide a plurality of microwave transmission antennas, arranged to radiate microwave energy in a plurality of beams which traverse the protected space, and provide on the other side of the protected space a plurality of microwave receiving antennas so disposed as to receive the energy from the individual microwave beams. Suitable receiving means are provided

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which may include a relay arranged in such manner that its contacts will be picked up when radiant energy is received, and the contacts will be released when no energy is received. The radiant energy projection equipment is arranged to be supplied with energy in such manner that the beams of radiant energy are recurrently and simultaneously projected across the space to be protected, so that the reception of the energy causes the relays associated with the individual receivers to become concurrently picked up and released. Accordingly, it will be seen that with the protected space unoccupied the microwave energy is transmitted across the space by a plurality of beams in the form of recurrent pulses of energy, so that the relays associated with the individual receivers are recurrently and simultaneously picked up and released. In order to detect the recurrent and simultaneous operation of the receiving relays, a code detection means is provided which includes a first slow release relay supplied with energy by a circuit including front contacts of all of the individual receiving relays, and a second slow release relay supplied with energy by a circuit which includes back contacts of all of the receiving relays in series, and additionally a front contact of the first slow release relay. Contacts of the second slow release relay may then be employed to control appropriate circuits for indicating the condition of occupancy of the protected space.

When the space is occupied, one or more of the beams of radiant energy will be interrupted, and accordingly pulses of energy will no longer be supplied to the receiver associated with that beam, and its receiving relay will become deenergized and remain deenergized as long as the beam is interrupted. At this time therefore the supply of energy is cut off from the first slow release relay, and when its contact is released, it interrupts the supply of energy to the second slow release relay, and its release causes the operation of the circuits to denote occupancy of the protected space.

It will be apparent to those skilled in the art, that our invention is not limited to the use of systems employing microwave energy, but may be employed with systems of any type which employ radiant energy, such as light beams, either infra-red, visible spectrum or ultra-violet, or sound wave, etc.

Referring to the single accompanying drawing, there is shown a diagrammatic view of a preferred form of our invention, employing microwave energy for detection of intrusion of a protected space.

The space to be protected is indicated by the appropriately designated dotted line rectangle. Intrusion of this space is to be detected by apparatus embodying our invention, and employing

a plurality of microwave beams traversing this space.

As shown, along one side of the space to be protected there are arranged a plurality of transmitting antennas, here shown schematically as comprising a dipole antenna with a parabolic reflector located behind the dipole, in such manner as to concentrate the radiated energy into a beam which is projected across the protected space to a similarly arranged receiving antenna. Although there are only three such combinations shown on the drawing, it will be readily understood that any number of units may be so disposed, the only requisite being that sufficient microwave beams traverse the space to insure that the entire space is covered by microwave energy, so that the intrusion of any portion thereof will cause one or more of the microwave beams to be interrupted. Each of the transmitting antennas TA is connected by suitable means to a transmission line TL which extends the length of the protected space to thereby supply microwave energy to each of the transmitting antennas. At one end of the transmission line TL there is provided a suitable source of microwave energy, such as the oscillator designated by the rectangle so labeled, and this oscillator may be of any suitable type, such as the well-known magnetron or glystron oscillators. The type of oscillator employed is immaterial to the operation of our invention, provided it is arranged and constructed to produce a sufficient amount of microwave energy to enable each of the transmitting antennas TA to radiate energy of sufficient value to cause the operation of the receivers, which will be described later. The oscillator OS is shown as being supplied with power from a high voltage source of energy here shown as a battery HVB, and is arranged to be recurrently energized by a contact *a* of a code transmitter CT. The code transmitter CT has its operating winding continuously connected across the terminals of a low voltage source of energy, here represented by a battery designated LVB, having its positive and negative terminals designated by the reference characters B and N, respectively. The code transmitter may be of any suitable type, such as that shown in United States Patent No. 1,913,826, granted on June 13, 1933, to Herman G. Blosser. The code transmitter CT is constructed in such manner that its contact *a* is recurrently opened and closed at some particular rate, such as, for example, 180 times per minute, when energy is supplied to its operating winding.

From the foregoing, it will be seen that at this time the code transmitter CT is in continuous operation, and each time that contact *a* is closed, energy is supplied from the high voltage battery HVB to the oscillator OS to thereby cause the oscillator to produce microwave energy which is supplied to the transmission line TL and thence to the transmitting antennas TA.

Accordingly, it will be seen that during normal operation, pulses of microwave energy are simultaneously transmitted across the space to be protected by the plurality of transmitting antennas TA to the receiving antennas RA which are oppositely disposed.

Associated with each of the receiving antennas RA is a receiver, such as those shown symbolically on the drawing and designated as R1, R2, and R3. The structure of these receivers is immaterial to our invention, and they may be of any suitable type, such as, for example, the well-known crystal-video receivers as used in radar beacons. As-

sociated with each of the receivers is a receiving relay, such as the relays RR1, RR2 and RR3, associated respectively with the receivers R1, R2 and R3.

The receivers and the associated receiving relays are constructed and proportioned so that when a pulse of microwave energy is received by the antenna and passed by the receiver, sufficient energy is supplied therefrom to the receiving relay to cause it to pick up its contacts. Accordingly, when pulses of microwave energy are recurrently received by the receiving antennas the receiving relay associated with the receiver is alternately picked up and released. It will be seen from the foregoing that during normal operation with no object present in the space to be protected, the receiving relays are simultaneously picked up and released in response to the pulses of microwave energy which are being projected across the space.

In order to detect the recurrent operation of the receiving relays, there are provided two slow release relays, FSA and BSA, which are governed by circuits including the contacts of the receiving relays. Relay FSA is supplied with energy by a circuit which may be traced from terminal B of the low voltage source of direct current, over front contact *a* of relay RR3, front contact *a* of relay RR2, front contact *a* of relay RR1, and through the coil of relay FSA to the negative terminal N of the direct current source. Accordingly, each time that the receiving relays are simultaneously energized, energy is supplied through this circuit to the winding of relay FSA and its contact is picked up. Relay FSA is selected and arranged so that its contacts are sufficiently slow in releasing to bridge the intervals during which the contacts *a* of the receiving relays are released.

Relay BSA is governed by a circuit which may be traced from terminal B of the direct current source, over back contact *a* of relay RR3, back contact *b* of relay RR2, back contact *b* of relay RR1, front contact *a* of relay FSA, and through the winding of relay BSA to the negative terminal of the source. Accordingly, it will be seen that relay BSA is supplied with energy during the time that the receiving relays are released, provided that the relay FSA has its contact picked up.

The recurrent operation of the contacts of the receiving relays RR1, RR2 and RR3 causes the relays FSA and BSA to be alternately supplied with energy, and as previously pointed out these relays are slow in releasing to keep their front contacts closed the normal intervals between the operation of the contacts of the receiving relays.

A simple indicating circuit is shown as being governed by a contact of relay BSA, so that the green indication lamp G is normally supplied with energy over front contact *a* of relay BSA, but when relay BSA is released, its back contact *a* establishes an obvious circuit for supplying energy to the red indication lamp R, to thereby denote occupancy of the protected space.

When the protected space is occupied by an object, one or more of the microwave beams is interrupted, and as a result the receiving antenna no longer receives energy from the microwave transmitting antenna which is oppositely disposed. For example, if an object should enter the protected space at the right, it would interrupt the microwave beam shown at the right of the drawing, and as a result the receiver R3 would no longer receive any energy and relay RR3 would release and remain released. When contact *a* of relay RR3 remains released energy is

no longer supplied to the winding of relay FSA, and after its release time has expired contact *a* of relay FSA releases, interrupting the supply of energy to the winding of relay BSA. After the release time of relay BSA has expired, its contact *a* releases, thereby extinguishing the green lamp G and lighting the red lamp R to denote occupancy of the protected space. When the intruding object moves out of the protected space, microwave energy is again recurrently supplied to the receiver R3 and its associated receiving relay RR3, and its contacts again operate concurrently and in synchronism with relays RR1 and RR2, so that energy is again supplied to the windings of relays FSA and BSA. When contact *a* of BSA picks up it again establishes the circuit for the green lamp G and extinguishes the red lamp R, to denote that the protected space is clear.

It will be obvious that intrusion of the protected space in the vicinity of the other microwave beams will cause similar results by preventing the receiving relay associated with the particular receiver from operating, so that energy is cut off from the code detecting relays FSA and BSA.

Our invention has a particular advantage in that any failure of the system to operate as intended will cause the same indication as provided when an object moves into the protected space, that is, for example, if the wiring of the circuits for relays FSA and BSA should become deranged or broken, the supply of energy will be cut off to release FSA and BSA, so that these relays will release, thereby extinguishing the green lamp G and lighting the red lamp R. As a further example, if the oscillator OS should for some reason be continuously supplied with energy, such as by fusing of the contact *a* of the code transmitter CT in its closed position, microwave energy will be continuously supplied to the transmitting antennas TA, and as a result the receiving relays RR1, RR2 and RR3 will remain continuously picked up. Accordingly the supply of energy will be cut off to relay BSA, and relay BSA will thereafter release to extinguish the green lamp G and light the red lamp R, which is the same result as produced by the intrusion of an object. It will thus be seen that our invention provides the advantage of "closed circuit operation," so that any failure of the apparatus to function as intended will be on the side of safety.

Although we have herein shown and described only one form of space intrusion detection system embodying our invention, it is to be understood that various changes and modifications may be made therein within the scope of the appended claim without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

In a space intrusion detection system, in combination, a plurality of transmitting directional microwave antennas disposed along one side of an area to be protected, a plurality of receiving directional microwave antennas disposed along a side of said protected area opposite said transmitting antennas, each of said receiving antennas being disposed to receive microwave energy transmitted from a corresponding one of said transmitting antennas, a microwave generator, a transmission line for supplying energy from said microwave generator to each of said transmitting antennas, a high voltage source of direct current energy for said microwave generator, a coding device having contacts which are recurrently operated at a predetermined rate, circuit means including a contact of said coding device for recurrently supplying impulses of energy to said microwave generator from said high voltage source, whereby pulses of microwave energy are recurrently and simultaneously radiated across said protected area from said transmitting antennas to said receiving antennas, a plurality of microwave receivers, one connected to each of said receiving antennas, a plurality of receiving relays, one associated with each of said microwave receivers, said microwave receivers and said receiving relays being constructed and arranged so that the contacts of said receiving relays are picked up when microwave energy is supplied from the associated receiving antennas to the associated microwave receivers, and the contacts of said receiving relays are released when no microwave energy is supplied from the associated receiving antennas to the associated microwave receivers, whereby the contacts of each of said receiving relays are recurrently picked up and released in synchronism with the contacts of the other receiving relays as long as said protected area is unoccupied, and the contacts of one or more of said receiving relays are released and remain released when a portion or all of said protected area is occupied, and means for detecting the recurrent and synchronous operation of the contacts of all of said receiving relays, comprising a first slow release code detecting relay, a low-voltage source of direct current energy, a first circuit for supplying energy to the winding of said first slow release relay from said low-voltage source, said first circuit comprising a series arrangement of the contacts of each of said receiving relays closed when all of the receiving relays are picked up, whereby energy is supplied to the winding of said first slow release relay when and only when the contacts of all of the receiving relays are picked up, a second slow release code detecting relay, a second circuit for supplying energy to the winding of said second slow release relay from said low-voltage source, said second circuit comprising a series arrangement of contacts of each of said receiving relays closed when all of the receiving relays are released, and a contact of said first slow release code detecting relay closed when said first code detecting relay is picked up, said first and said second slow release code detecting relays being constructed and arranged so that the relays will retain their contacts picked up during the short intervals in which no energy is supplied to their windings; and an indicating circuit controlled by the contacts of said second slow release relay.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,972,682	Fitzgerald	Sept. 4, 1934
2,038,878	Strutt	Apr. 28, 1936
2,203,807	Wolff	June 11, 1940
2,401,929	Hammond, Jr.	June 11, 1946
2,435,423	Clapp	Feb. 3, 1948
2,465,925	Purington	Mar. 29, 1949
2,467,257	Desch et al.	Apr. 12, 1949
2,476,639	Thomas	July 19, 1949
2,480,868	Marshall	Sept. 6, 1949
2,488,815	Hailes	Nov. 22, 1949
2,499,805	Wilson	Mar. 7, 1950