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United
Wolf et al.

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[54] DETECTION SYSTEM

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[52] **U.S. Cl.** .....**340/258 R**, 340/258 C
[51] **Int. Cl.**.....**G08b 13/26**
[58] **Field of Search** .....340/258 R, 258 C

[56] **References Cited**

UNITED STATES PATENTS

3,560,970	2/1971	Kamimura et al.	340/258 C X
3,031,643	4/1962	Sheftelman	340/258 R
3,230,518	1/1966	Vassil et al.	340/285 C

FOREIGN PATENTS OR APPLICATIONS

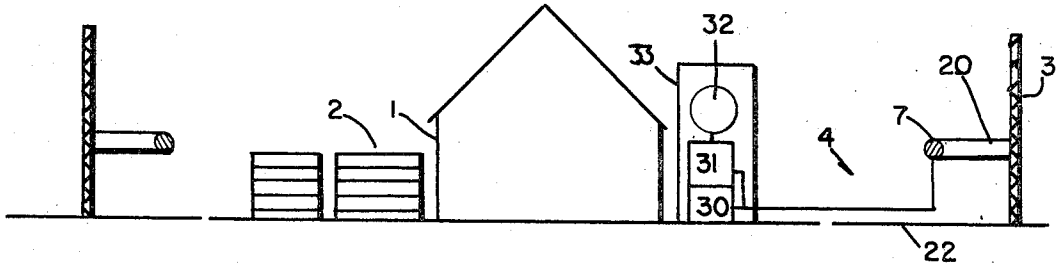
260,386	11/1963	Australia	340/258

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Attorney—Wolf, Greenfield, Hieken and Sacks

[57] **ABSTRACT**

A detection system designed primarily for detecting intruders of fenced-in areas such as yards, compounds, factory areas and the like. In the preferred embodiment, a chain-link metal fence extends about the area being monitored. A conductive cable extends parallel to the fence either on its inner or outer side. The cable is spaced uniformly from the fence which functions as an electrical ground. The cable is selected with a dimension and is spaced at a distance such as to establish uniform characteristic impedance between the cable and the grounded fence with the characteristic uniform impedance preferably in the order of 100 to 1,000 ohms. The cable is connected to a pulsing circuit and receiver so that the cable may be pulsed and reflections or partial reflections of the pulse signal received and displayed on an oscilloscope which is calibrated for a visual display and indication of the cable being monitored. Movement of people over or adjacent to the cable or the severing of the cable cause immediate mismatches which are reflected and suitably displayed on the oscilloscope at a location corresponding to the occurrence of the mismatch.

5 Claims, 5 Drawing Figures



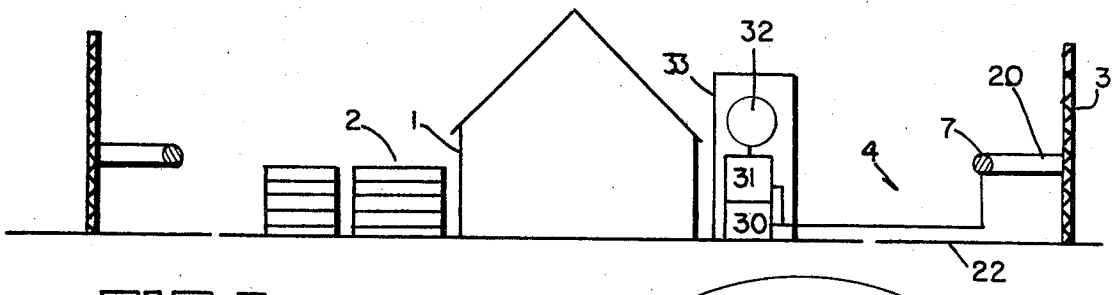


FIG 1

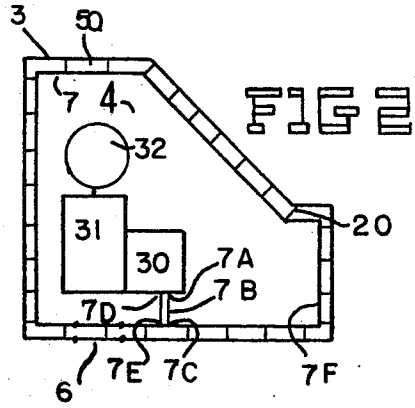


FIG 2

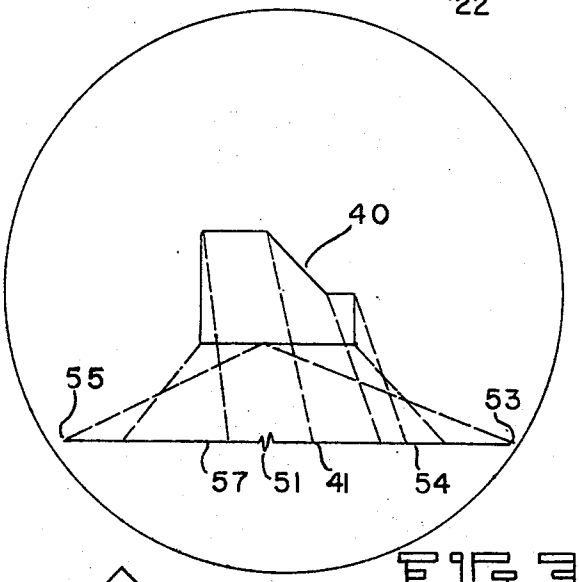


FIG 3

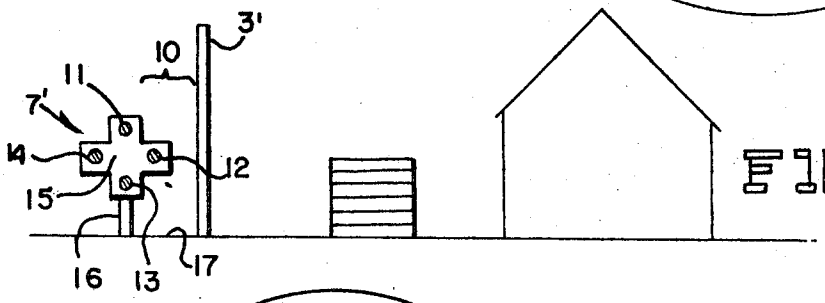


FIG 4

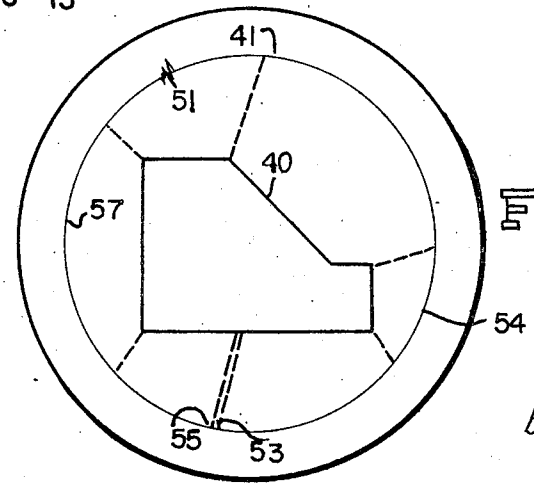


FIG 5

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DETECTION SYSTEM

SUBJECT MATTER OF THE INVENTION

The present invention relates to a detection system and, in particular, to a detection system designed to safeguard enclosed areas such as compounds and the like.

BACKGROUND OF THE INVENTION

For some time there has been a need to provide an improved means for detecting unauthorized incursions or movements to or from relatively large areas. This need is particularly acute in detecting unauthorized movement in areas such, for example, as large storage areas for airports, warehouses and marshalling yards. It is also necessary for protecting and detecting movement in prison areas and compounds. Conventionally, large areas have been protected against unauthorized intrusion or other movements by high fences. Frequently these fences are not patrolled — as is the case of schools, marshalling yards, airport staging areas, and warehouses because occasional patrolling by squads of patrolmen is too expensive and not certain of results. In some types of protected areas such as military installations and prison compounds, patrols are conventionally used; however, such patrols of necessity leave large portions of the fenced-in area unpatrolled for long periods of time. There have been occasions, such as for example, in the case of prisons, where electrified wires are provided to deter unauthorized escape or intrusion. Such systems are not completely satisfactory because intruders or escapees can often insulate themselves from the wire or jump right over it without harm. In addition, such electrified systems can be thwarted by cutting the cables, thus permitting intruders or escapees with a long-time delay before the break is detected.

SUMMARY OF THE INVENTION

The present invention provides an improved detection system for large areas which avoids many of the faults and difficulties of the types of systems previously utilized. It is thus an object of the present invention to provide an intrusion-detection system for large areas such, for example, as areas enclosed by chain link fences in which unauthorized movement over or through the fence may be immediately detected by central monitor, with the detection information including the exact locus of the intrusion, the exact movement of the intrusion and — in most instances — the number of intruders or breaks occurring in the protected areas. A further object of the present invention is to provide a detection system which is fail-safe in operation, and which will immediately indicate to the central monitor a breakdown in the system such that the central monitor will promptly know that the detection system is not operating properly and will also indicate the point of the breakdown in the perimeter circuit.

A further object of the present invention is to provide an improved detection system which is easy to maintain, which does not require patrol guards, which permits monitoring of an entire section of considerable length from a central protected area, which is fail-safe in operation, which is easy to maintain and repair, and which is lower in initial cost and maintenance.

In the present invention there is provided a detection system for detecting movement of bodies over a perimeter of an area in which an electrically conductive fence at least in part encircles the area to be protected. A cable extends parallel to the fence and is designed to have a uniform characteristic impedance defined at least in part by the fence.

A pulsing circuit for generating electrical pulses is connected to the cable whereby pulses may be propagted from the pulsing circuit down the cable. Receiving means for receiving pulse reflections from impedance mismatches along the cable and display means, preferably in the form of a CRT , are provided for visually displaying a representation of the cable and mismatches which accrue along the length of the cable.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects and advantages of the present invention will be more clearly understood when considered in conjunction with the accompanying drawings in which:

FIG. 1 is an elevational, schematic view of an installation embodying the present invention;

FIG. 2 is a top, schematic plan view of the area illustrated in FIG. 1;

FIG. 3 is a schematic representation of a CRT display of area under surveillance or protection, as shown in FIG. 2;

FIG. 4 illustrates a modification of the invention showing in schematic, cross-sectional elevational a segment of an area taken in a view similar to that as shown in FIG. 1; and

FIG. 5 is a schematic of a modified CRT display.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in conjunction with a preferred embodiment for use in detecting intrusions of a fenced-in factory area. It should be understood, however, that there are other applications for the present invention in which a detection system for large, enclosed, and preferably, fenced-in areas are desired. Such additional applications might, for example, include an addition to factory compounds, such areas as staging areas for airports or warehousing compounds, schools, prisons, military installations, and the like.

In the preferred embodiment described, there is illustrated schematically a factory 1 having an open or warehousing section 2. The area is surrounded by a chain-link fence 3 which may vary in style, design, shape and size. Thus, for example, conventional chain link having openings in the order of 2 inches and formed of conventional steel mesh wire is supported on posts at regular intervals. The fence may be of any suitable height as, for example, 6 feet; and may, if desired be provided with supplemental, protective devices such as barbed wire or the like. The fence completely encloses the area 4. Suitable gates such, for example, as gate 6 may also be provided in the area. The gate 6 should also be made of chain-link material, and when closed should provide a complete enclosing electrically grounded reference points that define the protected areas.

Extending parallel to the fence 3 is an electrically conductive cable 7. This cable 7 may be of any suitable cable material and, if desired, may be electrically insulated. The cable is supported by suitable means at a uniform distance from the fence, and preferably at a height of 1 to 4 feet from the ground. The distance between the cable 7 and the vertical fence 3 may vary considerably depending upon the particular applications for which the fence has been designed. Thus, for example, the cable may be positioned 10 inches away from the fence or, if desired, a distance of 3 feet from the fence. The best results are attained when the cable is moved as far from the fence as possible. However, when the cable is moved farther from the fence, it is necessary to make the diameter of the cable larger in order to assure a characteristic impedance which is workable under the system. That is, the characteristic impedance of the cable must be maintained which will be materially affected by the path of the particular bodies which are to be detected by the system. For detecting people, characteristic impedances of, for example, in the order of 100 to 1,000 ohms are preferred. Under such circumstances, a conventional single wire cable 7 may be supported in the order of magnitude of inches to 1 to 2 feet from the fence 3. However, where it is desirable to provide a greater area of detection, the cable 7 must be moved much further away. Thus, for example, as illustrated in FIG. 4, it is possible to place the cable 7' a distance of in the order of a yard or, perhaps, more, from the fence 3'. This distance 10 will require a cable of much greater diameter than that normally made by conventional process. Accordingly, a multi-line system that simulates a cable with large diameter may be used. For example, four wires 11, 12, 13 and 14, are supported in fixed, spaced relation one from the other by suitable dielectric spanners such as the X-shaped, dielectric spanner 15. This X-shaped, dielectric spanner 15 may comprise a flat, X-shaped member of a suitable dielectric material such as plastic with holes in the ends of the cross-shaped members through which the wires 11, 12, 13 and 14 pass. These wires are thus spaced one from the other at uniform distances by a series of these spanners 15 that in turn are suitably supported by a standard 16 at uniform heights from the ground 17. The wires 11, 12, 13 and 14 thus simulate a large cable having a cross-section defined by the enclosed area defined by lines passing about the periphery of these wires.

In the preferred embodiment illustrated in FIG. 1, the wire 7 is suitably supported at uniform distances from the chain-link fence 3. Since the distance is not great, a dielectric spanner 20 may be used. This spanner 20 is formed of suitable plastic material with a hole through which the cable 7 may pass. Suitable means which may comprise a bracket, lock the spanner 20 to the fence. Sufficient numbers of these spanners should be provided to substantially support the wire 7 at a uniform height from the ground 22 and from the fence 3.

In the preferred embodiment shown in FIG. 1, as well as in the modification shown in FIG. 4, the cable 7 and 7' is connected to a pulse-generating circuit 30 and receiver 31.

A display 32 preferably in the form of a CRT display is connected to and forms part of the receiver 31. The pulse generator 30, receiver 31 and CRT display 32, may be commonly housed in a suitable location such, for example, as a guard house. This guard house 33 is used to survey the entire area 4. In the system, the pulse-generating circuit 30 within the control center or guard house 33, is electrically connected to the cable 7. This pulse-generating circuit may be conventional in design and capable of pulsing the cable. If desired, this pulse generator may be used for a plurality of cables 7 connected to and individually surveying different areas. Under such circumstances, the cable systems 7 and fencing or ground system 3 are substantially duplicated and connected to a common system where they are sequentially actuated but commonly displayed.

The pulse circuit should be capable of generating high-frequency pulses that are satisfactory for the needs of specific application. Preferably, and in most applications, the pulses would ordinarily be of low-average power but of high peak power having a rectangular shape and an amplitude of several thousand volts with a duration of in the order of 100 to 500 nanoseconds. A pulse repetition frequency of up to several hundred or thousand cycles per second is desirable. The lower limits of the voltage are determined by the attenuation factors of the cable. The minimum repetition frequency is determined by the persistence of vision and brightness factor of the CRT display described below. A suitable pulse generator of the type required is made by Tobe Deutschmann Laboratories, Inc. of Canton, Massachusetts, and is sold under the trademark TELEMETROSCOPE. One end of the cable is impedance matched to terminals of the pulse generating circuit; the other end of each cable may be preferably terminated by an impedance mismatched. An open circuit mismatch is preferred. In a preferred embodiment, the cable 7 is arranged, as illustrated in FIG. 2, so that one end of the terminal 7A is connected to the receiver 31. A length of the cable 7B extends radially from the receiver 31, which may be centrally located within the area 4 to the periphery of the area being surveyed and adjacent the fence 3. Thence, the main body of the cable 7 is connected from the point 7C in the uniform spaced relation to the fence 3. The distance 7A to 7C, however, may be balanced to maintain a characteristic uniform impedance by other than fence means, as for example, by a special shielding coaxial with the cable section from the end 7A to the point 7C. In the preferred embodiment, the open or mismatched other end 7D is physically positioned adjacent the pulse generator 31 in a manner such as to permit its interchangeable attachment to the terminal of the pulse generator 31 by detaching the end 7A and substituting the end 7D. In a suitable configuration, the ends 7A to 7D are ordinarily open-circuited with terminals connected to each that are adapted to interengage in a terminal match with the terminal of pulse generator 31. Thus, pulse signals may be propagated through either end 7A or 7D depending upon an immediate and variable selection by the operator or monitor. The section of cable 7D to 7E which is adjacent the fence 3 may be suitably shielded or matched to the characteristic impedance of the remaining portions of the cable by any conventional and suitable means.

At the gate 6, the section of the cable 7 should be secured to the gate and should be capable of pivoting with it. Quick-disconnect terminals should be provided for interengaging and disengaging the cable 7 when the gate is opened and closed.

At the control station there is provided in the receiver 31 a visual CRT display 32 upon which reflected signals from the cable 7 are displayed. A conventional oscilloscope display may be used in which an input signal is suitably amplified by known means and displayed on the scope. Preferably, the amplifier and the receiver has a time-dependent gain control to compensate for normal attenuation of remote signals. Preferably, the scope presentation should be arranged so that pulses generated down a cable having the normal characteristic impedance along the entire length will be displayed in linear configuration as illustrated in FIG. 3, or in J-scope configuration as illustrated in FIG. 5. In either embodiment, a transparent overlay is attached to the screen of the video display. The overlay has drawn on it a representation of the outline of the area being monitored. Dotted lines extend from the outline to points on the linear or J-scope display of reflected pulses which will indicate coincident points. The observer will thus be able to relate information displayed on the video display immediately with the corresponding points on the monitored areas.

In the operation of this system, the surveyor or monitor will be turned on when the area is secured as, for example, at night. This will occur when the gate 6 is closed and the quick-disconnect terminals of the cable 3 at the gate are interconnected and the pulsing circuit 30 is turned on. Under these conditions, pulses are generated from the pulse-generating circuit through the end 7A of the cable 7 along its length. This will establish a linear pattern 41 on the display tube 32. Under ordinary circumstances, the tracing on the CRT will be uniformly a straight line that will not deflect. If, however, an intruder attempts to climb the fence and passes closer to the cable 7 than the fence 3 as, for example, at point 50, the characteristic impedance established in part by the relationship of the fence 3 and cable 7 at that point will be disturbed thus causing a deflection of the linear pattern 41 at point 51. The number of deflections will generally indicate to the controller the number of persons or other articles intruding and at the exact time of the intrusion. A controller may thus dispatch immediate assistance or investigatory personnel to that location.

If an intruder attempts to cut the cable 7 at a given location as, for example, at point 7F then the display on the CRT display 32 will show a tracing from point 53 to point 54. However, the tracing from point 54 to the other end 55 will disappear. The operator will thus know that the cable 7 has been cut at point 54. The operator may under these circumstances want to make certain that the cable is only cut at one location and therefore will disconnect end 7A of the cable and connect end 7B. Under these circumstances, if the cable 7 has only been cut at point 7F, the tracing from point 53 to point 54 will disappear but the tracing from point 55 to point 54 will reappear. If the tracing appears only, for example, from point 55 to point 57, the operator will know that the cable has been cut in at least two points and, quite likely, intrusions are being attempted between points 57 and 54 thereby means for limiting the area for which further investigation or protection has to be immediately dispatched.

In the embodiment illustrated in FIG. 2, the cable 7 is located within the fence 3. Such an arrangement would ordinarily be desired when either the area is such that detection of unauthorized movement near but within the fence 3 is desired, or alternately where there may be traffic just outside of the fence 3 which it is desirable not to pick up. For example, in an airport area or in a factory area, there may be outside traffic on a road immediately adjacent to the fence 3 which it is desirable to eliminate as a possible triggering or signal-generating source. In other configurations as, for example, as illustrated in FIG. 4 the cable 7' is located outside of the fence 3'. Such a configuration would be desirable as, for example, in a military installation in remote areas where intrusion or activity just outside of the fenced-in area should be detected at an early time.

A combination of the modifications of FIGS. 1 and 4 may be provided in which two cables 7 and 7' are provided, one on either side of the fence 3, with the cables 7 and 7' being simultaneously displayed on a screen; thus permitting detection of activity outside of the fenced-in area and subsequent detection of the same activity if it moves over the fence.

In the embodiments described, it is apparent that the greater the distance between the ground fence 3 and the cable 7 will be the greater the area of the field. By placing the cable 7 approximately 3 feet from the fence 3, an intruder can be detected if he approaches the cable 7 to within approximately a distance of 3 feet. Thus, it is substantially impossible for an individual to climb over a fence without avoiding the field established by the cable 7 and the fence 3. In such a configuration with a cable or set of cables as illustrated in FIG. 4 placed at a distance of 3 feet from the fence 3' and approximately 3 feet from the ground, an intruder would have to be able to clear the fence 3' and clear a distance of more than approximately 3 feet in radius from the cable 7'. Effectively, therefore, an intruder would have to be able to pass over the cable 7' at a distance of more than 6 feet and maintain such passage from the fence 3 feet inwardly over the cable 7' and 3 feet beyond.

We claim:

1. A detection system for detecting movement of bodies over the perimeter of an area comprising, a transmission line consisting of an electrically conductive grounded fence at least in part encircling the area, and a cable means extending parallel to the fence and having a characteristic impedance defined by said fence and said cable, a pulsing circuit for generating electrical pulses, means coupling said pulsing circuit to said cable means whereby said pulses may be propogated along said cable means, receiving means for receiving pulse reflections from impedance mismatches along said cable means, and display means for visually displaying a representation of said cable means and impedance mismatches occuring thereon.

2. A detection system as set forth in claim 1 wherein said display means includes a CRT display, means for displaying an electronic representation of said cable means on said CRT display in one configuration when the characteristic impedance of said cable means

remains unchanged and said receiving means including means for displaying aberrations in said one configuration when the characteristic impedance of said cable means is changed.

3. A detection system as set forth in claim 2 wherein said cable means comprises a plurality of electrically conductive wires spaced apart, dielectric means supporting said wires in fixed, parallel arrangement, said wires supported in spaced relation to said fence.

4. A detection system as set forth in claim 2 having a plurality of dielectric means supporting said cable means parallel to said fence and spaced from the ground.

5. A detection system as set forth in claim 1 wherein said cable means includes end sections that extend angular to said fence to a point remote therefrom, said end sections having terminals adapted to be selectively connected to said pulsing circuit.

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