United States Patent [19]

Steele et al.

[11] **3,825,916**

[45] **July 23, 1974**

[54] **LASER FENCE**

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[73] Assignee: **California Crime Technological Research Foundation,** Sacramento, Calif.

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[52] **U.S. Cl.** .... **340/258 B,** 340/276

[51] **Int. Cl.** **G08b 13/18**

[58] **Field of Search** .... 340/258 B; 250/221

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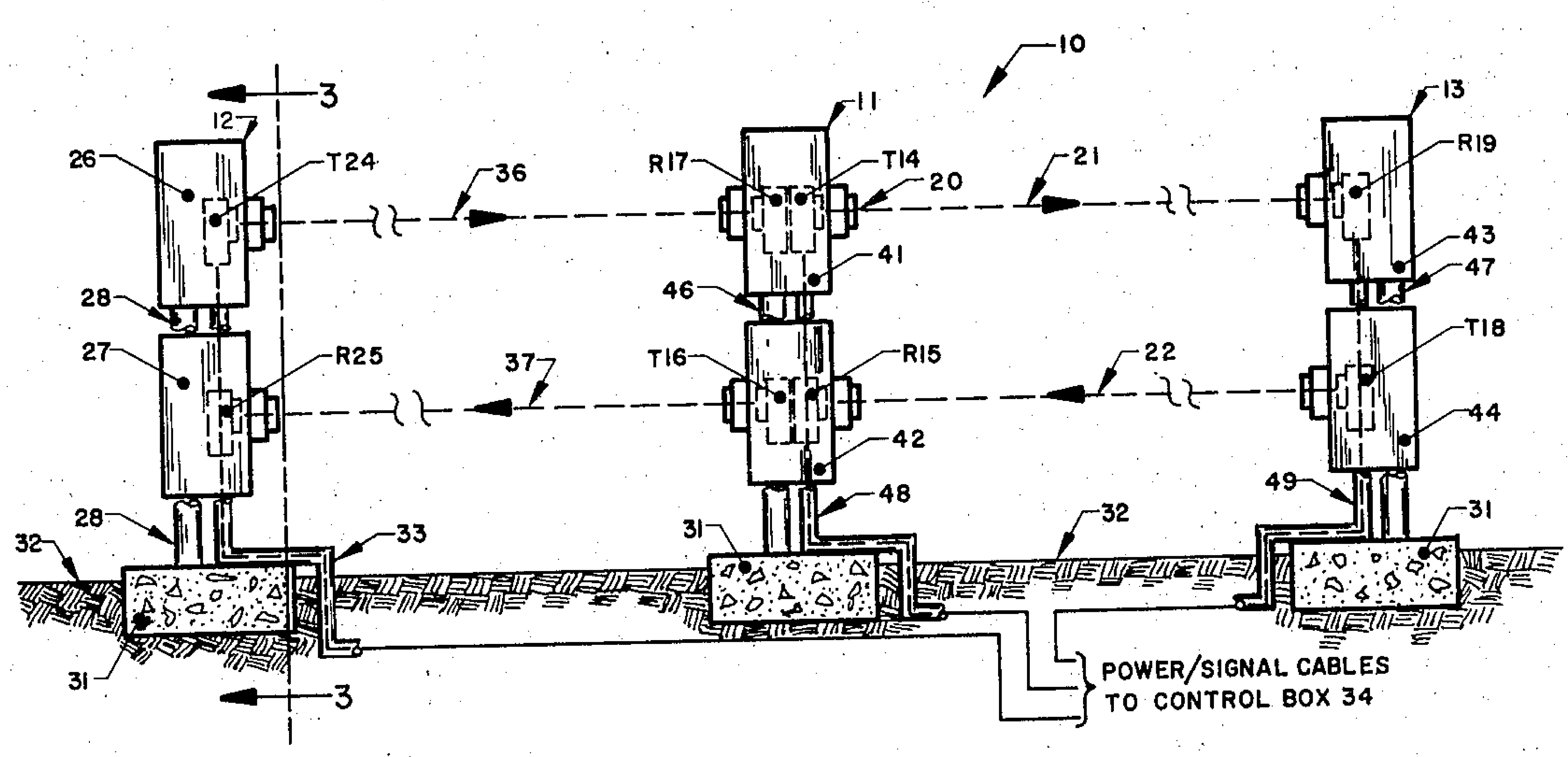
[57] **ABSTRACT**

First and second transmitting stations provide two, parallel, line-of-sight, pulsed beams of infrared energy generated from a solid state source. The (laser) beams are intercepted by corresponding receiving stations. The two line of sight beams are displaced horizontally and vertically from each other; and by orienting the beams along a perimeter to be protected, any invasion of the perimeter is sensed by interruption of the beams. Detection of animals, such as dogs, is negated by logic circuitry affording height discrimination. The circuitry also discriminates with respect to man parameters, such as man's usual forward velocity, namely, approximately ½ feet per second to 10 feet per second. False alarms from flying birds, leaves and the like, are thereby minimized. Intrusions can be indicated by audible and visual local alarms, or, if desired, by automatic telephone dialing, radio or closed circuit TV to more distant centers. By using additional stations and corner reflectors, where appropriate, a continuous chain is constructed to enclose an area to be guarded.

1 Claim, 4 Drawing Figures



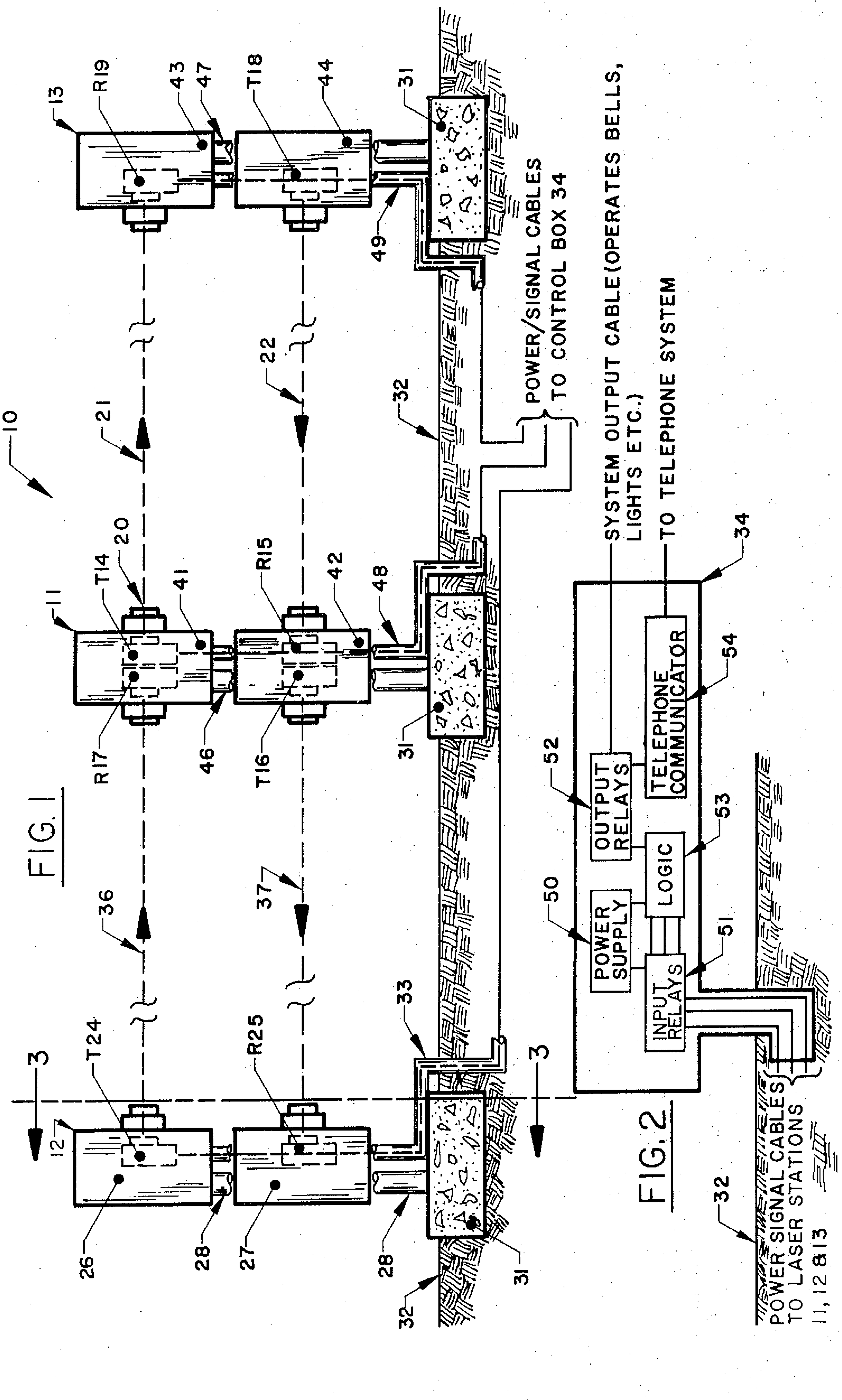

POWER/SIGNAL CABLES
TO CONTROL BOX 34
SYSTEM OUTPUT CABLE (OPERATES BELLS, LIGHTS ETC.)
TO TELEPHONE SYSTEM
POWER SUPPLY
INPUT RELAYS
LOGIC
OUTPUT RELAYS
TELEPHONE COMMUNICATOR
POWER SIGNAL CABLES
TO LASER STATIONS
11, 12 & 13

FIG. 1

FIG. 2

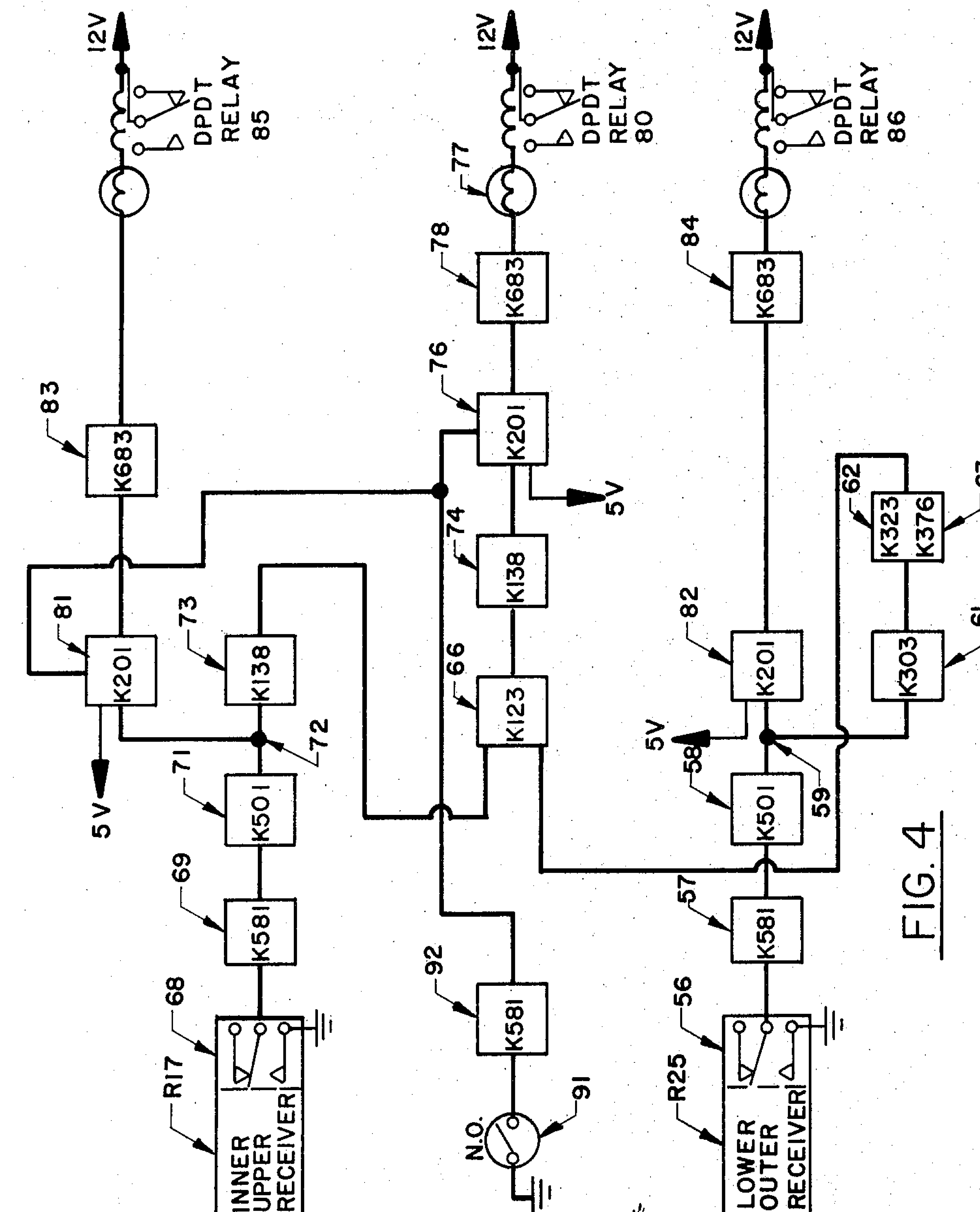

12V
DPDT RELAY 85
DPDT RELAY 80
DPDT RELAY 86
77
78
84
K683
83
76
K201
5V
74
K138
81
73
82
62
63
K323
K376
66
K123
72
71
K501
58
59
61
K303
69
57
K581
92
68
R17
INNER UPPER RECEIVER
N.O.
91
56
R25
LOWER OUTER RECEIVER

FIG. 4

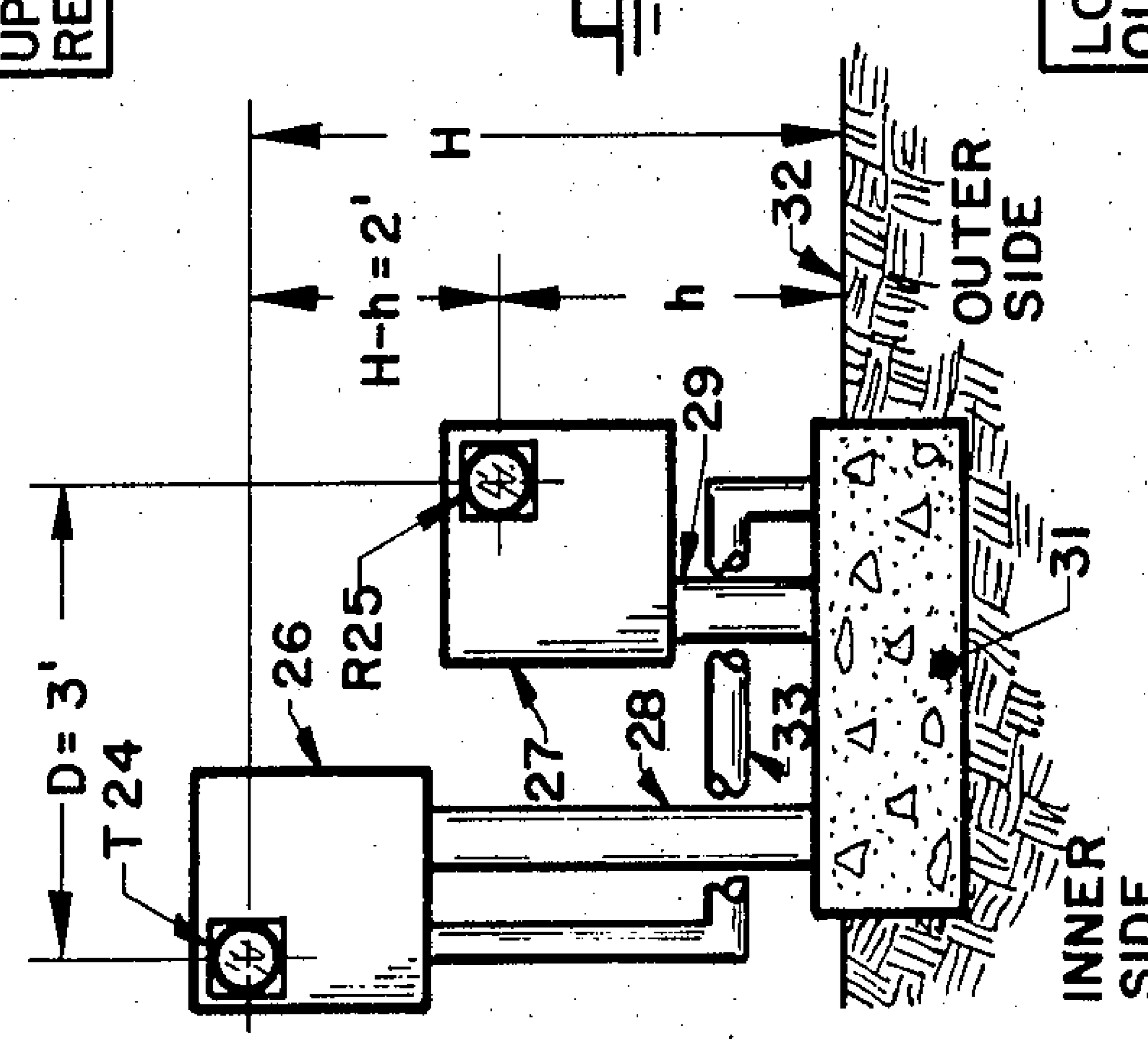

H
H-h=2'
h
32
OUTER SIDE
INNER SIDE
D=3'
T24
26
R25
29
27
28
33
31

FIG. 3

LASER FENCE

The invention relates to improvements in infrared detection systems used to protect large unattended areas otherwise unprotected by walls, chain link fences, barbed wire and the like.

Owing to several unique advantages, infrared detection systems are coming into ever increasing use. Among the numerous well recognized advantages are the following: operation is equally effective, both day and night; operation even under such adverse conditions as snow, rain or light fog; ability to bend the output beam around corners, thereby supplying perimeter protection with a minimum of transmitters and receivers; use of narrow band filters, sensitive detectors and pulse modulation techniques eliminating false alarms caused by radio frequency interference, lightning flashes, flickering sunlight and inclement weather; secure fail-safe operation; simplicity of installation; compatibility with existing alarm and control systems; relatively economical; portable; compact; readily susceptible of being camouflaged; and capable of extended battery operation in event of failure or disruption of main power supply.

In addition to the foregoing, the prior art also affords examples of laser transmitting and receiving stations which are able to discriminate between an opaque body of some size, such as a person, and small oscillating objects such as grass, weeds or shrubbery swaying in the wind.

So far as is known, however, the prior art does not disclose laser beams arranged along a perimeter in such a manner as to discriminate with respect to velocity of an object passing through the fence, as well as to height, direction of movement, i.e., entering the enclosed area or emerging therefrom, and approximate location on the perimeter.

It is therefore an object of the invention to provide a laser fence which not only affords all of the advantages set forth above in extenso, but which also is capable of discriminating between discontinuities in the beams which are likely to be man caused and those which are not.

It is another object of the invention to provide a laser fence which minimizes false alarms.

It is still another object of the invention to provide a laser fence which is versatile in that it can be readily adapted to a wide variety of uses and environments.

It is a further object of the invention to provide a laser fence system which is durable, safe, tamper-proof and effective to prevent, or discourage, the entry into the protected area of unauthorized persons.

It is an additional object of the invention to provide a generally improve laser fence.

Other objects, together with the foregoing, are attained in the embodiment described in the following description and illustrated in the accompanying drawings, in which:

FIG. 1 is a stylized side elevational view of a portion of a typical fence installation, the station foundations and the ground being sectioned, and with portions of the figure broken away to reduce the extent thereof;

FIG. 2 is a functional block diagram of the control box components;

FIG. 3 is an end elevational view as seen from the plane indicated by the line 3—3 in FIG. 1; and,

FIG. 4 is a diagram of the velocity discriminator logic circuitry and beam discontinuity indicators.

While the laser fence system of the invention is susceptible of numerous physical embodiments, depending upon the environment and requirements of use, the herein shown and described embodiment has been made, used and tested, and has performed in an eminently satisfactory manner.

The laser fence of the invention, generally designated by the reference numeral **10**, includes, along the perimeter of an unattended area to be protected against intrusion, a plurality of transmitting-receiving stations **11, 12** and **13** aligned so that the infra-red beam electromagnetic radiation emitted by a transmitter at one station is received by a corresponding receiver at another station.

The emitted beam reaches the receiver in a substantially concentrated, line-of-sight manner although the actual energy pattern is a cone of greater or less base width at a given distance depending upon the desired sharpness, as controlled in part by appropriate tuning of the transmitter.

As appears most clearly in FIGS. **1** and **3**, only three stations are shown. The distance separating each of the pairs of stations can be on the order of 1,000 feet, for example. In some installations, reflectors can be used to turn the beams at corners and thereby reduce the number of stations required to encompass a given area.

In the embodiment disclosed, the central station **11** includes a pair of transmitter-receivers in back to back arrangement, the right hand pair including an upper transmitter **T14** and a lower receiver **R15**, and the left hand pair including a lower transmitter **T16** and an upper receiver **R17**.

The right hand station **13** comprises but a single set, namely, a lower transmitter **T18** and an upper receiver **R19**.

As indicated, the transmitter **T14** at station **11** emits, through a port **20**, in effect, a substantially line-of-sight beam **21** received by the receiver **R19** at station **13**. In turn, the transmitter **T18** at station **13** emits a beam **22** to the receiver **R15** at station **11**.

The pulsed beams are of high frequency, being on the order of 40 nanoseconds wide, which accounts for its excellent ability to penetrate fog. Transmitters and receivers of the kind disclosed are well known, being available, for example, from Security Devices Division of Systron-Donner of Dublin, Calif., under the mark "Optogard".

The left hand station **12** includes an upper transmitter **T24** and a lower receiver **R25**. As appears most clearly in FIGS. **1** and **2**, the upper transmitter **T24** is housed in a box **26** and the lower receiver **R25** is similarly protected within a housing **27**. A vertical pipe **28** supports the box **26** and a comparable upright pipe **29** carries the housing **27**, both pipes being mounted in a concrete pad **31** in the ground **32**. Suitable conduit **33** carries conductors from the main power supply and signal cables to a control box **34** (see FIG. **2**) situated at an appropriate location.

The transmitter **T24** at station **12** emits a beam **36** received by receiver **R17** at station **11** and transmitter **T16** at station **11** emits a beam **37** received by receiver **R25** at station **12**.

Actually, as previously indicated, the pulsed energy beams are diverging cones such that the diameter of the energy at 650 feet from the transmitter is approximately 30 feet. However, since the receiver is located on the axis of this cone of energy, amplitude is at a maximum and, in effect, it is as if a line-of-sight beam were transmitted and received.

As shown in FIG. 3, the transmitter T24 is located in an upper, left hand position relative to the receiver **R25**, which is in a lower, right hand position. For reasons later to be explained in more detail, the lower, right hand receiver R25 (see FIG. 3) is located on the outer side of the laser fence whereas the upper, left hand transmitter T24 is located on the inner side of the fence. Thus, the beam **37** is an outer, lower beam and the beam **36** is an inner, upper beam.

As will be obvious, the respective boxes **41, 42** and **43, 44** housing the transmitters and receivers at stations **11** and **13** will be so arranged as to position the respective components in proper alignment, the boxes, as before, being mounted on respective pipes **46** and **47** secured in concrete pads **31.** Conduits **48** and **49** carry cables providing power to stations **11** and **13**, respectively. The conduits **48** and **49** also carry cables sending information signals from the receivers **R15, R17** and **R19** to the control box **34,** as indicated in FIGS. **1** and **2.**

As appears most clearly in FIG. **2**, the control box **34** not only provides control over the power supply **50** for the various transmitting-receiving stations, but also for the circuitry within the box itself, including the input relays **51** and the output relays **52,** as well as for the logic circuitry **53,** shown in detail in FIG. **4.** If desired, a telephone communicator **54** can be included in the system, the communicator being arranged in conventional manner so that automatic dialing is effected, thus providing a remote warning alarm.

With especial reference to FIGS. **1** and **3,** it will be noted that the axis of the transmitter T24 to the receiver R17 (and thus the beam **36**) is at height "H" whereas the axis of transmitter R16 to the receiver R25 (and thus the beam **37**) is at height "h" both being measured above ground level **32.**

These heights can be varied to suit the environment and requirements of use. In the particular laser fence disclosed herein, the height *h* of the lower beam **37** is approximately 2 feet and the height H of the upper beam **36** is approximately 4 feet, the difference in elevation being, therefore, about two feet. The horizontal displacement D between the two beams **36** and **37** is approximately 3 feet.

The height *h* of about 2 feet, was selected in this particular installation to clear smaller animals who might stray through the fence; whereas, the height H of about four feet was chosen so that the beam would be intercepted by all persons who pass through the fence except small children who, of course, would interrupt the lower beam at height *h*.

With especial reference to FIG. 4 illustrating the logic circuitry, let it first be assumed that the lower outer beam **37** is interrupted, closing the contacts of relay switch **56** connected to the receiver **R25.**

A dry contact filter **57,** such as a **K 581,** converts the signal from the relay switch **56** to logic levels, the output signal from the switch filter **57** (K **581**) being sharpened by routing it through a Schmitt Trigger **58** (K **501**).

All components with the prefix K refer herein to products of the K Series manufactured by Digital Equipment Corporation, Maynard, Mass.

The signal emergent from the Schmitt Trigger divides at a junction **59** and proceeds to actuate a digital tuner **61** (K **303**) set for a transit velocity of 0.3 seconds. This approximately corresponds to the time required for an object moving at 10 feet per second (6.85 miles per hour) to traverse the three feet horizontally separating the vertical planes through the outer beam **37** and the inner beam **36.** It is to be noted that the delay interval can readily be downwardly or upwardly adjusted to any desired lower or higher velocity, respectively.

At the end of 0.3 seconds, the negative transition of the timer **61** (K **303**) fires a one shot **62** (K **323**) with an attendant timer control **63** (K **376**) affording a time delay of 2.12 seconds, corresponding to a transit velocity over the three foot span horizontally separating the beams of approximately 1½ feet per second (1 mile per hour).

The output of the one shot **62** (K **323**) provides one of the inputs to the AND gate **66** (K **123**) for the delay period of 2.12 seconds. If, during the 2.12 second interval, the inner upper beams **36** is not interrupted, the AND gate logic is not satisfied and no alarm is given. The logic circuit is then clear to receive any future signal.

If the lower beam **37** is at a height such that it would be interrupted by a dog, for example, or by a young child walking through the fence, whereas the upper, inner beam is at an elevation such that it would not be so interrupted, there is no cause for alarm. The event is detected and a readout appears at the control box **34,** or elsewhere, if desired, but this type of penetration is relatively of no significance.

If, on the other hand, not only the lower, outer beam **37** is interrupted, but, within a short interval, the upper inner beam **36** is also interrupted, the invasion may be of consequence, since the physical parameters are of an older child or an adult, or, in certain localities a larger animal such as a cow, a horse or a deer, for example, or in other environments, a vehicle of some kind.

Should the upper, inner beam **36** also be interrupted, then, the event is of importance and the contacts of a relay switch **68** in the receiver R17 are closed. As before, a switch filter **69** (K **581**) suitably converts the signal, and as the sharpened signal emerges from the Schmitt Trigger **71** (K **501**) it is routed through a junction **72** to an inverter **73** (K **138**) to provide the other input to the AND gate **66** (K **123**).

Assuming the signal from the upper inner beam **36** reaches the AND gate **66** (K **123**) before the gate interval expires, the gate conditions are satisfied, and the gate output is routed through an inverter **74** (K **138**) thence through a flip flop **76** (K **201**) to drive a lamp **77** via the driver **78** (K **683**). The external load in this instance can be any kind of warning device radio transmitter or telephone communicator and a DPDT relay **80** is provided as a convenience.

In parallel with the velocity discriminator circuitry heretofore described are two flip flops **81** and **82** (K **201**) one connected to the junction **59** of the lower outer beam circuitry and the other connected to the junction **72** of the upper inner beam circuitry. Each of these flip flops **81** and **82** is connected to a lamp driver **83** and **84** (K **683**) and power relays **85** and **86** respectively. The breaking of either one of the beams is thereby indicated.

A normally open reset switch **91** is connected via a switch filter **92** (K **581**) to the flip flops **81** and **82** (K **201**) of both beam signal circuits to restore the system to base condition.

As will be recognized, each sector of the perimetral fence is provided with its own circuitry and readout. Thus, the approximate location of the invasion can be readily determined from the position of the activated readout indicia. In like manner, the sequence of penetration as between the inner and outer beam in any given sector indicates whether the invader passed through the fence from the outside or from the inside.

By suitably modifying the transmitter-receiver stations as to physical dimensions, numbers and arrangements, and by conforming the logic circuitry thereto, a wide variety of security fence uses and requirements is afforded.

What is claimed is:

1. A laser security fence comprising:

a. a first laser beam transmitting station including a first pulsed laser beam generator oriented so as to direct said first beam substantially on a first line of sight along a perimeter to be protected;

b. a first laser beam receiving station located substantially on said first line of sight at a distance from said first laser beam transmitting station at least on the order of one hundred feet, or more, and oriented so as to intercept said first beam from said first transmitting station, said first receiving station being capable of detecting interruptions in said first beam;

c. a second laser beam transmitter station adjacent said first laser beam receiving station including a second pulsed laser beam substantially on a second line of sight along the perimeter to be protected, said first line of sight being substantially parallel to said second line of sight, displaced approximately two feet above the horizontal plane of said second line of sight, and displaced approximately three feet laterally from the vertical plane of said second line of slight;

d. a second laser beam receiving station adjacent said first laser beam transmitting station substantially on said second line of sight and oriented so as to intercept said second beam from said second transmitting station, said second receiving station being capable of detecting interruptions in said second beam;

e. logic means connected to said first and said second receiving stations for discriminating between predetermined sequences and durations of interruption signals attributed to invasion by a physical body having man parameters of height and velocity, said logic means being programmed to discriminate the man parameter of forward velocity ranging between a slow walking speed of about two feet per second and a running speed of about ten feet per second based upon the intervals between the interruptions of said first and said second beams, and by physical bodies not having said man parameters; and,

f. warning means connected to said logic means for alerting security personnel in the event of indicated invation by a physical body having said man parameters.

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