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(54) Single optical fiber antitheft and data collection system

(57) The fiber optic system described in this application includes:
- a programmable electronic generator of optical signals with random sequences (master);
- one or more optical fibers that pass through the physical objects to be protected so that such items are not removed without interruption of the fiber, by fiber cut or by removal of the connector with the fiber from the master or from a repeater, and that transmit digital information ;
- one or more cards for the regeneration of the optical signal (repeater) when it is necessary to break the fiber for topological reasons or for the excessive length of the stretch, equipped or not with additional sensors

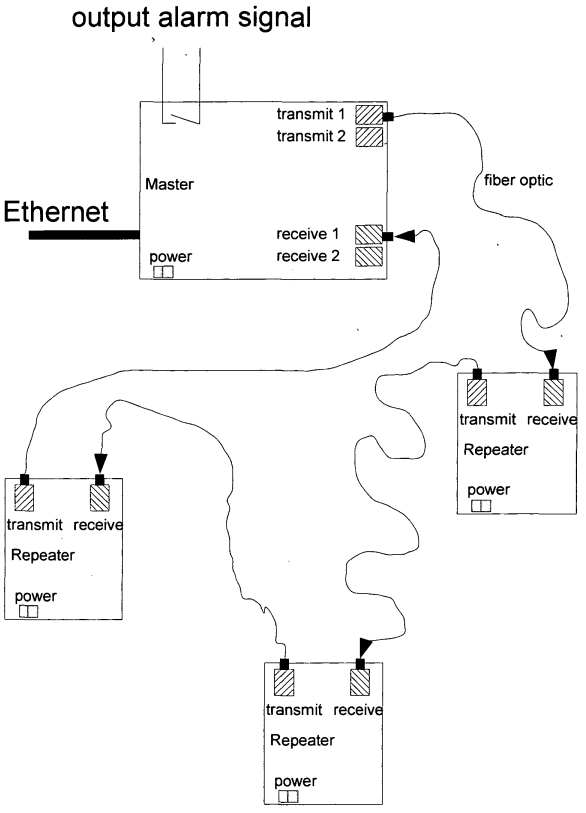

Fig. 1

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Description

[0001] The fiber optic security system covered by this application, called OptoGuard, is particularly suitable for the protection of objects at risk of abduction in places accessible to the public or otherwise not protectable by appropriate physical means or that are protected by other types of burglar alarm sensors subject to disturbances and / or that can be circumvented with techniques that cancel or reduce their effectiveness

[0002] There are several patents for systems based on fiber optics to detect intrusions, but such systems require the use of optical fiber laid down in a single stretch, beeing based on the analysis of the retro-reflected light or on interference between beams sent in opposite directions along the fiber, and are therefore incompatible with the splitting of the optical cable in multiple sections.

[0003] Installations with hundreds of objects to be protected over distances of hundreds of meters such as photovoltaic systems are ill suited to that type of solution, since the damage in a point of the fiber requires the complete replacement with the huge costs of materials and labor

[0004] The system described here properly uses the impossibility of interrupting the continuity of an optical fiber without being detected by the system, can be installed in the field by personnel with minimal skill and experience, has a limited cost for industrial production and installation and comparable to other sensors for alarms intended for a mass market, and allows to replace in case of damage only a short segment of fiber with minimal cost to restore the efficiency of the security system.

[0005] In its simple version, the system is only aimed at revealing the interruption.

[0006] In its enhanced version the optical fiber can also be used as a communication channel to locate where in the fiber the break occurred and to learn the status of any additional sensors connected at points of junction of stretches.

[0007] The system consists of:

- One or more cables to feed the cards regeneration, which may possibly be supplied by external sources available at the junction of the fibers - optional component Il sistema è costituito da:
- an electronic programmable microprocessor-based board (master) that sends up one or more fiber cables optical signal sequences with pseudo-random patterns and checks their arrival to the other end of the cable(s) - necessary component
- one or more optical fibers that pass through the physical objects to be protected so that such items cannot be removed without interruption of the optical fiber - necessary component
- one or more cards for optical signal regeneration (repeater) to be used when it is appropriate to interrupt the fiber, typically due to topological reasons or due to the excessive length of the stretch for the type of optical transceivers and fiber characteristics - optional component
- one or more cables to power the repeaters, which may also be powered by external sources available at the junction of the fibers - optional component

General rules of operation

[0008] The master board sends pulses to one end of one or more fiber optic rings and verifies the presence or absence of pulses in coincidence at the other end. The frequency of the pulses contains a random component that does not allow to break the fiber and simulate its efficiency by inserting another independent optical signal generator; the interval between pulses is much shorter than human reaction times in order to prevent physical disconnection and reconnection of a fiber without detexction of the event.

[0009] When an interruption is detected, the board may act in an "smart" way by sending notification messages via Ethernet and/or through wireless devices, or act as a classic alarm sensor closing/opening some contacts to activate a traditional alarm control system. See Figure 1.

[0010] If the system includes smart repeaters, the master card can use the communication over the single fiber for:

a) taking an inventory of the smart repeaters and automatically learn their sequence along the loop, in times ranging from sub-second to a few seconds;
b) using such information when there is an interruption to identify the affected stretch, within fractions of a second;
c) communicating to smart repeaters, with individual or group messages, configuration parameters for their internal operation and/or for the management of communication;
d) requesting to a specific repeater the status of the optional sensors connected to it;
e) receiving information asynchronously generated by the smart repeater about the status of communication and/or of any sensors connected to them.

Caracteristics of the master board

[0011] The card can simultaneously monitor one or more fiber optic rings (loops). In the case in Figure 1 for example, it controls two loops.

[0012] In addition to being configurable via Ethernet, the loops can be manually activated directly on the board and optical signal generators can be manually activated for continuous emission, to allow easy installation by non-experts.

[0013] The card is equipped with one or more switched contact outputs to enable direct electrical connection with any other traditional alarm control units.

Caracteristics of the fiber optics

[0014] In principle either plastic fibers or glass fibers can be used. The glass fibers can cover a longer distance with a single stretch, in the order of kilometers, while the plastic fibers, despite with the current technology cannot significantly exceed a hundred meters, are easier for field installation by inexperienced staff.

Caracteristics of the repeater board

[0015] The basic behavior of the repeater is to replicate the optical signal input on a similar optical output port. See Figure 1.

[0016] In a fiber loop two types of repeaters can be combined, smart and simple.

[0017] The simple repeater only replicates the control signals sent by the master board from one sretch to the next.

[0018] The smart repeater can understand any command coded by the master card in the control signal, respond by amending and supplementing the signal sent to next stretch, spontaneously send notification messages both when the flow of signals sent from the master stops - thus allowing to identify the stretch where the break occurred - and when they detect important changes in the sensors connected to them (the simplest case is an anti-tamper switch in the enclosure of the repeater itself)

[0019] The board is equipped with an LED with pulse extension circuit (stretcher) to allow the installer to verify the presence of input signals even when they are too short for the human eye.

[0020] The use of many repeater boards in sequence - theoretically more than a hundred - on the same loop can extend the length of each loop to many kilometers.

Caracteristics of the repeater-based communication system

[0021] Communication takes place over a single fiber loop.

[0022] It uses an anti-collision communication protocol that allows to alternate at will both simple and smart repeaters without any loss of information.

Claims

1. burglar alarm system comprising an electronic control board (master), one or more loops in single optical fiber, **characterized in that** the interruption of a fiber triggers the generation of an alarm with a software configurable delay, down to a minimum value smaller than the time needed to disconnect and reconnect the fiber, and that the alarm is notified through clean contacts relay closure;

2. system as in [1] with alarm notification via a network with TCP/IP protocol

3. system as in [1] with alarm notification via external devices such as modems, cellular phones, etc.

4. system as in [1], [2], [3] with possibility of splitting each loop in multiple sections through interposition of cards for optical signal regeneration (repeater);

5. fiber optic communication system as in [4] including signaling by anti-collision protocol with smart repeaters that allow automatic detection of the section subject to violation;

6. system as in [4] and [5] with possibility to collect data generated by the repeater(s) as a result of interrogation by the master

7. system as in [6] with possibility to collect data generated by the repeater(s) asynchronously without the need of prior interrogation by the master.

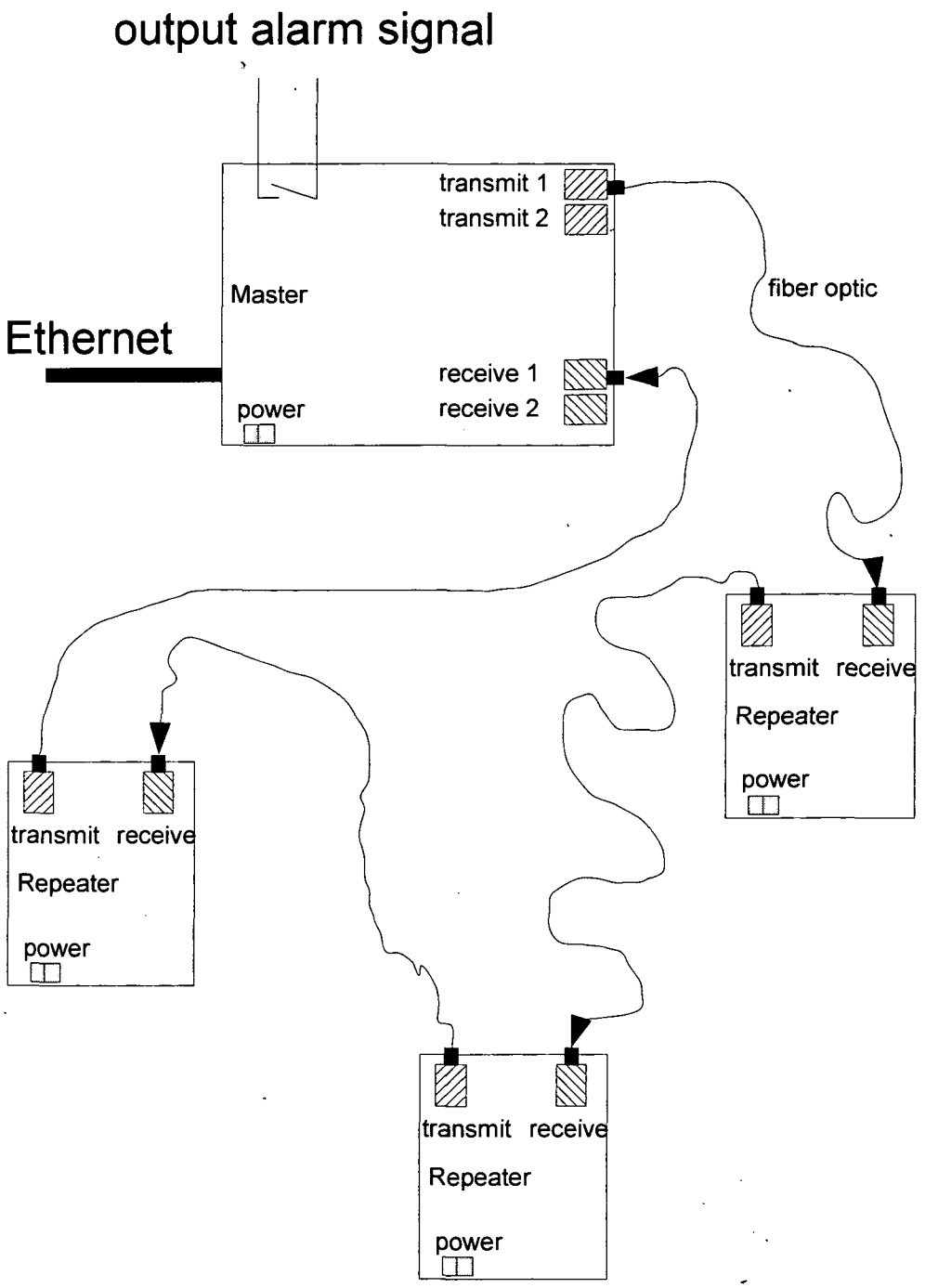
output alarm signal
transmit 1
transmit 2
Master
Ethernet
fiber optic
receive 1
receive 2
power
transmit receive
Repeater
power
transmit receive
Repeater
power
transmit receive
Repeater
power

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 10 42 5370

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)
G08B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 April 2011	Dascalu, Aurel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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1 EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 42 5370

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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27-04-2011

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82