(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 726 546 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.08.1996 Bulletin 1996/33

(51) Int. Cl.[6]: **G08B 13/00**, G08B 13/186, G08B 13/12

(21) Application number: **96200268.9**

(22) Date of filing: **07.02.1996**

(84) Designated Contracting States:
DE ES FR GB NL

(30) Priority: **10.02.1995 IT MI950246**

(71) Applicant: **Rigo de Righi, Davide**
17042 Bergeggi (Savona) (IT)

(72) Inventor: **Rigo de Righi, Davide**
17042 Bergeggi (Savona) (IT)

(74) Representative: **Michelotti, Giuliano et al**
c/o SAIC BREVETTI S.r.l.
Galleria San Babila, 4/D
20122 Milano (IT)

(54) Fiber optic components for security systems and systems utilizing such components

(57) Components for security systems inserted between fiber optic cables (20,22) in an optical path comprised of means for light emission (36) and means for light detection (40), said componenets containing optical reflection couplers (14) served by cable connection means (82) for tips of fiber optic calbles (20,22) to said couplers (14) and reflecting means (90) for returning a light beam, exiting from a first fiber optic cable (20) connected to the light emission source (36), and to another fiber optic cable (22) connected to the light detection means (40). The invention also comprises security equipments (10,60) conatining said fiber optic components.

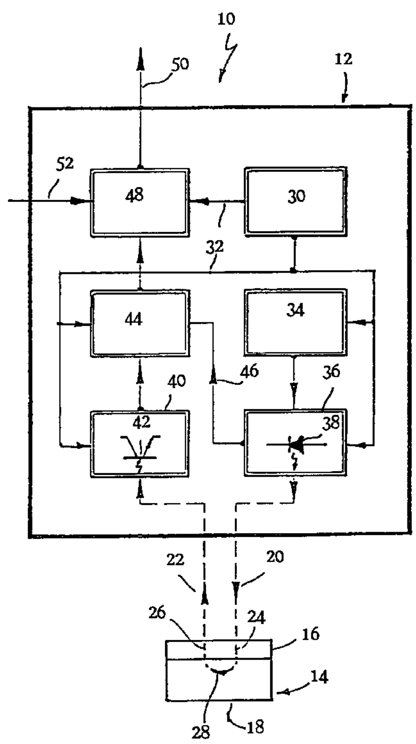

FIGURA 1

EP 0 726 546 A1

Description

The present invention involves in fiber optic components to be utilized in security systems, such as intrusion detection or anti-theft devices, and the like.

Particularly, this invention has devised equipments applied in security devices that will create some degree of difficulty in cirmuventing the device in such a way that any attempt to circumvent the same device will always activate the alarm systems. One of the objectes of this invention is that of realizing a security system that reacts both at an intrusion attempt and an attempt to circumvent the device, therefore always activating alarm devices to which it is connected.

A second object of the present invention is that of realizing the above mentioned security systems by means of the application of fiber optic means in cooperation with electronic means.

There are in the prior art various examples of surveillance and control means using optoelectronic techniques showing situations to be controlled or remedied, such as the U-S-A-4,812,810, granted on March 14, 1989 to Daniel S. Query et al., describing some kind of systems based on light emission and light detection by means of fiber light guides signalling the opening or the missclosure of electrical housedhold appliances that would be preferably closed, such as a refrigerator and freezer doors. Here, among the many examples given, there is also a system assuring the perfect closure of doors of both a refrigerator and freezer in a domestic unit which has separate compartments (top mount) using for example a light emitting unit located in a lower compartment wall facing a fiber light guide incorporated in the door of the unit, diverting light towards a hole situated on the upper edge of the same door that will, in the case of perfect closure of both refrigerator doors, be aligned with a corresponding hole located on the lower edge of the above freezer door compartment, this hole continuing with a channel occupied by the light guide terminating against a photodetector located in the wall of the freezer compartment itself.

This system works well but the inventors did not realize that the fiber optic light guide by them used would have been disturbed by any atttempt of tampering with it and therefore missed the point and the possibility of applying the concept to security and anti-theft devises of the kind which cannot be circumvented without providing some type of disturbance that would activate an alarm system. Further, such a similar hypothesis would have been excluded by them because their objects were to devise a warning system that would alert a user on doors not properly closed, and therefore they were not interested in expecting situations that would have brought only false or unjustified alarms.

U-S-A- 5,004,908 granted on the April 2nd, 1991 to Arata Nakamura, describes a photoelectric selective reflection system that emits light on two quite different bands which had to be utilized for the detection of an object causing interference along an optical path. This invention apart of relying on a particularly unusual light emitting unit, such as a GaAs laser with two different emission bands, totally ignores applications in fiber optic, and therefore, it does not lend itself to applications in the security surveillance field because it would be easily bypassed by means of applying an abusive selective reflector, like the one hereby described, positioned immediately in front of the unit comprehensive of the light emitter and the adjacent optical receiver.

At last U-S-A- 5,033,112 granted on July 16, 1991 to Geoffrey N. Bowling et al describes a programmable power system for telecommunications and remote controls relying, with many electrical connections, also on optical connections, however provided by a single fiber optic cable in which optical signals propagate in each other opposite directions, not having different light paths from the light emitting source to optical switches and from optical switches to optical receivers, resulting particulalrly difficult to differentiate between optical signals responsible for remote controls and/or telecommunication and optical signals for surveillance and/or security, unless specific encoded signals were used that would require particularly sophisticated electronic circuity which is very costly and less reliable because of their own sophisticated nature.

However, what the inventors did not realize is the fact that the optical signal, cannot be bypassed without causing troubles or disruption in the fiber and that this in turn would have made them ideal for intrusion detection products, also perhaps wanting to simplify the optical paths by utilizing single fiber with optical propagation paths in dual directions and also in order to apply alignment systems with microlenses (lenses with focal lengths of about 1 mm), the inventors were forced to utilize particularly thin fiber optic cable, as for example a fiber optic cable with core size of 62,5 microns that would result in being particularly fragile as well as unmanageable, especially in the case of surveillance system applications.

The above mentioned objects are reached by antitheft devices comprising a portion of electronic apparatus and a portion of optical apparatus of which the security or non tampering ability is based on the fact that the fiber optic conductors of light signals cannot be tampered, while in operation without the introduction, within the same unit of signal noise, even of just temporary nature, of such an intensity that would cause or start an alarm mode.

In short, a security system according to the invention includes an electronic section and an optical section, the interface between the electronic section and the optical one being provided by a light emitting source whose signals are controlled by the elctronic section, and the opposite interface between the optical section and the electronic one being provided by an optical receiver unit controlled by light coming from the optical section, being the light used in the optical section sent out in only one preselected direction, characterized in that the light emitting medium is connected to the optical receiver by an optical path comprising at least one piece of light transmitting optical fiber and one mechanical switch component, triggered by external events, able to transform actions caused by break-in attempts in a substantial interruption in the light path, connected to the optical receiving unit.

According to a first embodiment of this invention, the optical path is formed by two pieces of optical fiber of equal length laid out in the optical section to connect the interface components between the electronic section and the optical section by means of the mechanical switching component.

Alternatively, according to another embodiment of the invention, the optical path is comprised of three pieces of fiber optic cable, having each other different lengths, of which the first one is an optical path between the light emitting means and the mechanical switching means, the second one is an optical path between the mechanical switching means and a further intrusion detector of the kind based on fiber optic interruption and a third one is an optical path between the further intrusion detector and the optical receiving unit.

According to another alternative, the optical path is comprised of three pieces of fiber optic cables, having each other different lengths of which a frist one is an optical path between the light emitting means and an intrusion detector of the kind based on fiber optic cable interruption, a second one is an optical path between the intrusion detector based on fiber optic cable interruption and the mechanical switching component, and a third one is an optical path between the mechanical switching component and the optical receiving unit.

A mechanical switching component, obviously for optical signals, is formed by a first enclosure housing the extreme ends of two adjacent fiber optic cable pieces inserted in specific terminating optical plugs called ferrules, the extreme ends of the ferrules outside facing a reflecting prism housed in an appropriate enclosure conveying light coming out from the fiber core of a piece of the fiber optic cables into the core of the adjacent second piece of fiber optic cable.

In a particular embodiment of the invention, the component for the mechanical switching as above described, is formed by a first enclosure housing the ends of the fiber optic cables inserted in a fixed structure, as for an example the frame of a door, and by a second enclosure housing the reflecting prism inserted in a mobile structure as for an example in the mobile structure of the same door.

In a different embodiment of the invention, and alternative to the preceding one, the mechanical switching component is formed by a first enclosure, housing the ends of the fiber optic cable, installed externally on a fixed supporting structure, as for example a door frame, and by a second enclosure, housing the reflective prism, affixed or mounted externally on the edge of a mobile support, for instance the upper edge of a door structure.

Particularly, the light reflecting prism, housed in the second enclosure is a prism obtained by cutting out from transparent material with high refraction index such as glass, quartz silica, or plastics for optical applications.

More specifically, one of the prisms with total reflective capabilities is defined as a corner cube prism, obtained by cutting a cube along a plane lying on the diagonals of three adjacent faces, the bottom of which is a circular cylinder circumscribing the base of the corner cube.

Alternatively, the second and preferable alternative used is a total reflection prism known as a light angle prism which is obtained by cutting a cube in half along a plane lying on two parallel diagonals of two of its opposing faces.

In a preferred embodiment the light emitting means is a solid state laser like a GaAs laser.

In a more preferred embodiment the light source is a light emitting diode (LED).

In a further preferred embodiment the light receiver contains a fototransistor.

The features of this invention will particularly pointed out in the claims forming the conclusive portion of this description. However other features and advantages of the invention will be carefully described in the following detailed description of embodiments, which are not to be considered as limiting the scope of the invention, provided with the enclosed drawings, in which:

- Figure 1 is a block diagram of a first embodiment of a security surveillance system, particularly an anti-theft device, made up in part of an electronic circuit board driving an optical system, also according to the invention, including an optical assembly, also according to the invention, formed by fiber optic cables and a mechanical switching element for optics.
- Figure 2 is a block diagram of a second embodiment of an anti-theft security device that includes, in addition to the electronic unit, and a first fiber optic cable piece leading to the element for mechanical optical switching a second fiber optic cable piece, partially inserted in elements to be secured, that in turn will signal alarms caused by damages or breakage of parts or components protected by the second fiber optic piece.
- Figure 3 is a sectioned view of a mechanical optical switching element for flush mounting or for insertion in supports to be protected by the unit according to the invention.
- Figure 4 is a sectioned view of a mechanical switch for optical commutation of the kind to be surface mounted in supports to be protected by the units according to the invention.

Let us consider first figure 1. In such a figure is noticed a first example of surveillance unit 10 comprised of a module 12, containing an electronic circuit generating optical signals and signals actuating alarm units, a mechanical module 14 for the optical switching formed by a fixed portion 16 and a mobile one 18, a first fiber optic cable 20, forming an optical path leading from the electronic module 12 to the mechanical commutation module 14, and by a second fiber optic cable 22 forming an optical path from the mechanical module 14 to the electronic circuit module 12. The fixed part 16 of the mechanical module 14 houses the means 24 and 26 for mounting in a fixed mode the ends of the fiber optic cables 20 and 22, while the movable fixture 18 contains the means 28 allowing for an optical connection between the first fiber optic cable 20 and the second fiber optic cable 22.

The module 12 of the electronic circuit is essentially made up of a power unit 30 supplying the voltage required to power all the elements contained in the module by means of multiple lines 32, a signal generator 34, as for instance an astable multivibrator generating electrical pulses to power unit 36 generating optical signals which might, for instance, comprise a light emitting diode (LED) 38 emitting light pulses every time that a signal coming from a generator 34 reaches the voltage level required to correctly supply the LED 38.

The optical generating unit 36 is obviously equipped with a system well known to those skilled in the art, which couples the LED 38 to the fiber optic cable 20 in such a way that a substantial part of its optical signal is captured by the cable 20. Contained within the same module 12 is an optical receiver 40 which comprises for instance, a phototransistor 42 converting light signals, such as properly modulated light pulses coming from the fiber optic cable 22 into corresponding electric signals.

A synchronized detector 44, synchronized by means of a connection 46 with signals generated by the LED 38, coordinates the signals coming from the optical receiver 40 with the ones activating the transmitter 36 of optical signals in such a way for instance that would not emit any signal at the exit of the synchronous detector 44 when both the signals coming from optical receiver 40 and from the transmitter of optical signals 36 are present, while it would emit a signal when in presence of a signal on the connection 46, there is no corresponding signal from the receiver 40.

The signal emitted from the the synchronous detector 44 is routed to a memory circuit 48, which, if activated even by a single electric pulse will remain in an open state emitting a signal through a connection 50 activating the alarm, up until it is stopped or turned off by a connection 52 that could be connected to either a switch or a deactuating key.

Let us consider now figure 2 depicting a second kind of security system 60 formed by a module 12, containing the electronic circuit generating optical signals as well as signals actuating the alarm, an optical mechnical switching module 14 formed by a fixed fixture 16 and by a mobile component 18, by a first fiber optic cable 20 forming an optical path from the electronic module 12 to the optical mechanical switching module 14, by a second fiber optic cable 62 coming out from the mechanical module 14 itself and connected by means of a flexible 63 path to fiber optic cable 64 applied on or in a board 66 enclosed in a frame 68 which is a portion of a structure 70 in turn belonging to either doors, windows, hatches, vaults or the like. The board 66 can be transparent, like a glass, or opaque like a door panel, as an example a wood door or a metal door. The fiber optic cable 64 which has been laid in such a way to cover substantially all the surface area 66 exits from the same surface area by means of a second flexible piece 71 leading to fiber 72 finally connected to fiber optic cable 22 going back into the module 12. The module 12 is identical to module 12 used in the security system 10 depicted in figure 1 therefore is no more described in order to simplify the disclosure.

It results obvious that this second example of security system protects not only against attempts of opening the structure 70, in turn opening the optical contact 14, but could also safeguard from break-in attempts through the panel 66 of the frame 70, or prevent mechanical, thermal penetration, punctures, other damages inflicted on surface 66, because any single or combined sabotage attempt, above depicted, would result in damages on the fiber optic cable 64 with the consequential interruption of the light signal from the transmitter point 36 to the receiver 40 with the alarm being activated. For this purpose it is advisable to use an easily tearable fiber optic cable, as for example a fiber optic cable completely of plastics, therefore guaranteeing signal interruption at each damaging attempt inflicted on panel 66 of frame 70.

It is understood that this second kind of alarm system, depicted in figure 2, has a higher degree of safety with rispect to the one in figure 1, however this system also needs greater power requirements for the LED 38, or perhaps a more intense light source, and/or the choice of a more sensitive optical receiver 40 taking into account the higher attenuation levels caused by the longer fiber optic cable path used in the system.

Let us examine figure 3 depicting an optical mechanical switching element to be flush mounted on surfaces to be protected. The sensor is comprehensive of a stationary part 16 and a movable fixture 18. The optical mechanical element (optical switch) 14a is made up of a first enclosure 80, affixed in the stationary area 16, housing in appropriate recesses the ferrules 82 containing the single fiber optic cables 20 and 22. The ferrules are kept aligned by a spring loading 84 system enclosed with a cap 86 secured by screws 88. Facing the first enclosure 80 lies the second enclosure 90, affixed in the mobile 18 area containing a total reflection prism 92, equipped with an external flat face 94, placed parallel to the other face 96 of the enclosure 80 and perpendicular to the axis of the cores of the fiber optic cables 20 and 22. The prism 92 can be of two kinds: the so called corner cube prism, obtained by cutting a cube along a plane lying on the diagonals of three adjacent faces, the bottom of which is a circular cylinder circumscribing the base of the corner cube; and or a 90° reflecting prism technically known as a right angle prism, simply provided by cutting a cube in half along a plane lying on two parallel diagonals of two of its opposing faces. Both kinds of prisms assure a satisfactory amount of reflection for the light emitted from the fiber optic cable 20 towards the other fiber optic cable 22 as long as the face 94 of the prism 92 is located adjacent and substantially parallel to the front face 96 of the enclosure 80.

Figure 4 depicts an optical mechanical switching unit 14b to be surface mounted on supports making part of the system to be protected; said supports comprising a fixed structure 16 and a mobile structure 18. The mechanical optical switching element 14b is comprehensive of a first enclosure 100, to be mounted on a fixed structure 16, with recesses housing two spring 84 loaded ferrules 82 containing fiber optic cables 20 and 22 covered by a cap 102 fastened by a plurality of screws 88. The enclosure 100 is equipped with external holes 104 housing fastening screws for affixing the enclosure 100 on the structure 16. Facing the first enclosure 100 is placed the second enclosure unit 106, to be mounted on the mobile structure 18 containing in an appropriate recess 90a a total reflection prism 92 identical to the prism 92 shown in the figure 3 embodiment and having the same operating principles described earlier.

Enclosure 106 is equipped with holes 108 for fastening mobile surfaces 18.

Obviously even the mechanical optical switching element 14b depicted in figure 4 operates in a similar manner, as the mechanical element 14a depicted in figure 3, assuring that the prism 92 reflects in a totally satisfactory manner the light coupled in from fiber optic cable 20 towards the fiber optic cable 22 as long as the front surface 94 of prism 92 is located adjacent and substantially parallel to the surface 110 of the housing 100.

The operation of this invention is selfexplaining. When the fixed structure 16 and the mobile structure 18 are perfectly lined-up, the light coming from the fiber optic cable 20 is coupled in a satisfactory manner to the fiber optic cable 22, therefore avoiding the intervention of the module 12 activating the alarm unit. In the event of any break-in attempt heading to misalignment, caused by moving mobile structure 18 from the fixed structure 16, would cause insufficient transmission of light from the cable 20 to the cable 22, allowing the module 12 to intervene. The same would happen if, as mentioned in the embodiment of figure 2, the fiber optic cable 64 inserted in the panel or structure 66 would be interrupted or damaged.

It is to realise that the proper nature of the fiber optic cable will not allow any attempt to by-pass the optical path since any attempt to maintain any continuity in the optical path would result with an interruption, even temporary, of the optical path with consequently permanent actuation of the alarm unit.

What has been hereabove disclosed consitute only two embodiments of this invention and have not to be considered limited to them, and those skilled in this art can devise substitutions of parts which are logically to be considered equivalent and all of which are hereby claimed and covered.

As an example, LED 38 could be substituted by any other kind of pulse controlled light source, for example lasers, flash bulbs or stroboscopic lamps, and the receiver 40 could contain instead of a fototransistor 42 an other kind of optical electronic element, like a photocell, a photomultiplier, a photodiode, a CCD or the like.

Furthermore, an anti-theft device can contain, instead of just one mechanical element for optical switching 14 and single structure 70, a plurality of them without exiting from the scope of this invention defined in the following claims.

Claims

1. Anti-intrusion surveillance system, composed of an electronic unit (12) and an optical unit (14), the interface between the electronic unit (12) and the optical one (14) bieng provided by a light emitting unit (36) controlled by the electronic unit (12) and the inverse interface between the optical unit (14) and the electronic one (12) being provided by an optical photoreceiver (40) controlled by light coming from the optical unit (14), the light employed in the optical section propagating in just one preselected directin, characterized in that the light emitting unit (36) is connected to the optical receiver (40) by an optical path comprising at least one fiber optic cable (20,22) transmitting light and a mechanical switching component, actuated by external events, able to transform actions following breaking attempts in a substantial interruption of the optical path (20,22), connected with the optical receiver (40).

2. Anti-intrusion surveillance system, as in claim 1, characterized in that the optical path is formed by two different pieces of fiber optic cable (20,22) of equal lenght set in the optical section (14) to connect the interface components between the electronic section (12) and the optical section (14) with the mechanical switching component.

3. Anti-intrusion surveillance system, as in claim 1, characterized in that the optical path is formed by three fiber optic cables of different lenght of which the first one (20) forms an optical path between the light emitting means (36) and the mechnical switching component, the second one (62) forms an optical path between the mechanical commutation component and another anti-intrusion detector (70), of the kind based on the interruption of fiber optic, and a third cable (72,22) forms a light path

between the other intrusion detector (70) and the receiver (40).

4. Anti-intrusion surveillance system, as in claim 1, characterized in that the optical path is formed by three pieces of fiber optic cable of different length of which a first one (20,62) forms an optical path between the light emitting means (36) and the anti-intrusion detector (70) of the type based on the interruption of optical fibers, a second one (72) forms an optical path between the anti-intrusion detector (70) based on the interruption of optic fibers and the mechanical commutation component, and a third one (22) forms an optical path between the mechanical commutation component and the receiving means (40).

5. Mechanical switching component for optical signals, to be employed in the surveillance systems described in the preceding claims, characterized in that it is formed by a first housing element (80) containing the end sections of two adjcent fiber optic cables (20,22) inserted in appropriate optical ferrules (82), which in turn are inserted in the appropriate housing (80), the ends of the ferrules (82) being pointed towards the outside facing a reflecting prism (92) conveying light emitted by the core portion of a fiber optic cable (20) towards the core of the adjacent piece of fiber optic cable (22).

6. Mechanical switching component as in claim 5, characterized in that it is formed by a first housing (80), containing the extreme ends of the fiber optic cables (20,22), inserted in a fixed support (16), as for instance in a door frame, and by a second housing (90), containing reflecting prism (92), inserted in a mobile structure (18) as, for instance, the upper edge of the same door.

7. Mechanical switching component, as in claim 5, characterized in that it is formed of a first housing (100 and 110), containing the extreme ends of the fiber optic cables (20,22) which is externally mounted on a fixed structure (16), as for instance in a door frame, and by a second housing (106), containing the reflecting prism (92), externally mounted on a mobile support (18), as for instance the upper edge of the same door.

8. Mechanical switching component, as in claims 6 and 7, characterized in that the reflecting prism (92) contained in the second housing (90,106) is a total reflection prism obtained from a small block made of a transparent and highly refractive materials such as glasses, silica quartz or plastic material for optical use.

9. Mechanical switching component, as in claim 8, characterized in that the total reflection prism (92) consists of a corner cube prism, obtained by cutting a cube along a plane lying on the diagonals of three adjacent faces, the bottom of which is a circular cylinder circumscribing the base of the corner cube.

10. Mechanical switching component, as in claim 8, characterized in that the prism (92) is a total reflection right angle prism (92) which is obtained by cutting a cube in half along a plane lying on two parallel diagonals of two of its opposing faces.

11. Anti-intrusion surveillance system, as in claims from 1 to 4, characterized in that the light emitting unit (35) is a solid state laser, like a GaAs laser.

12. Anti-intrusion surveillance system, as in claim 12, characterized in that the light emitting unit (36) is a light emitting diode (LED).

13. Anti-intrusion surveillance system, as in claim 12 and 13, characterized in that the receiver (40) contains a phototransistor (42).

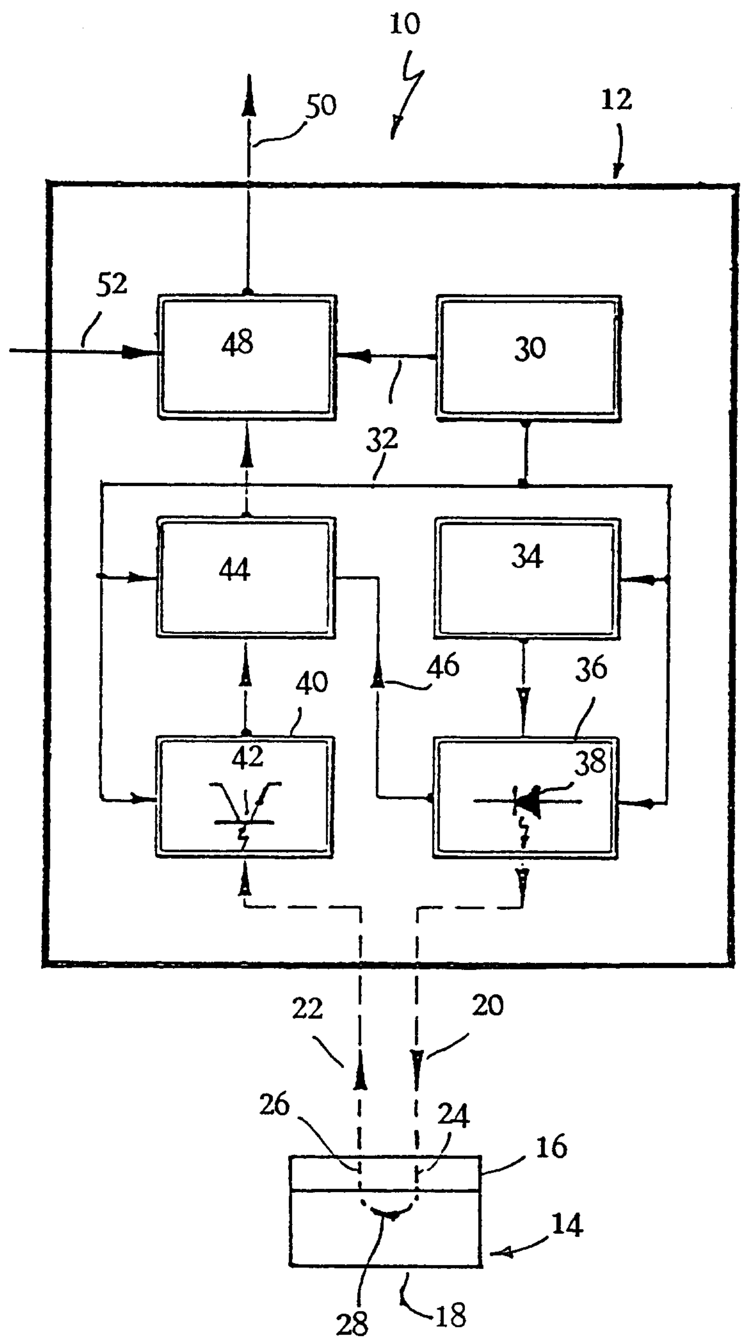

FIGURA 1

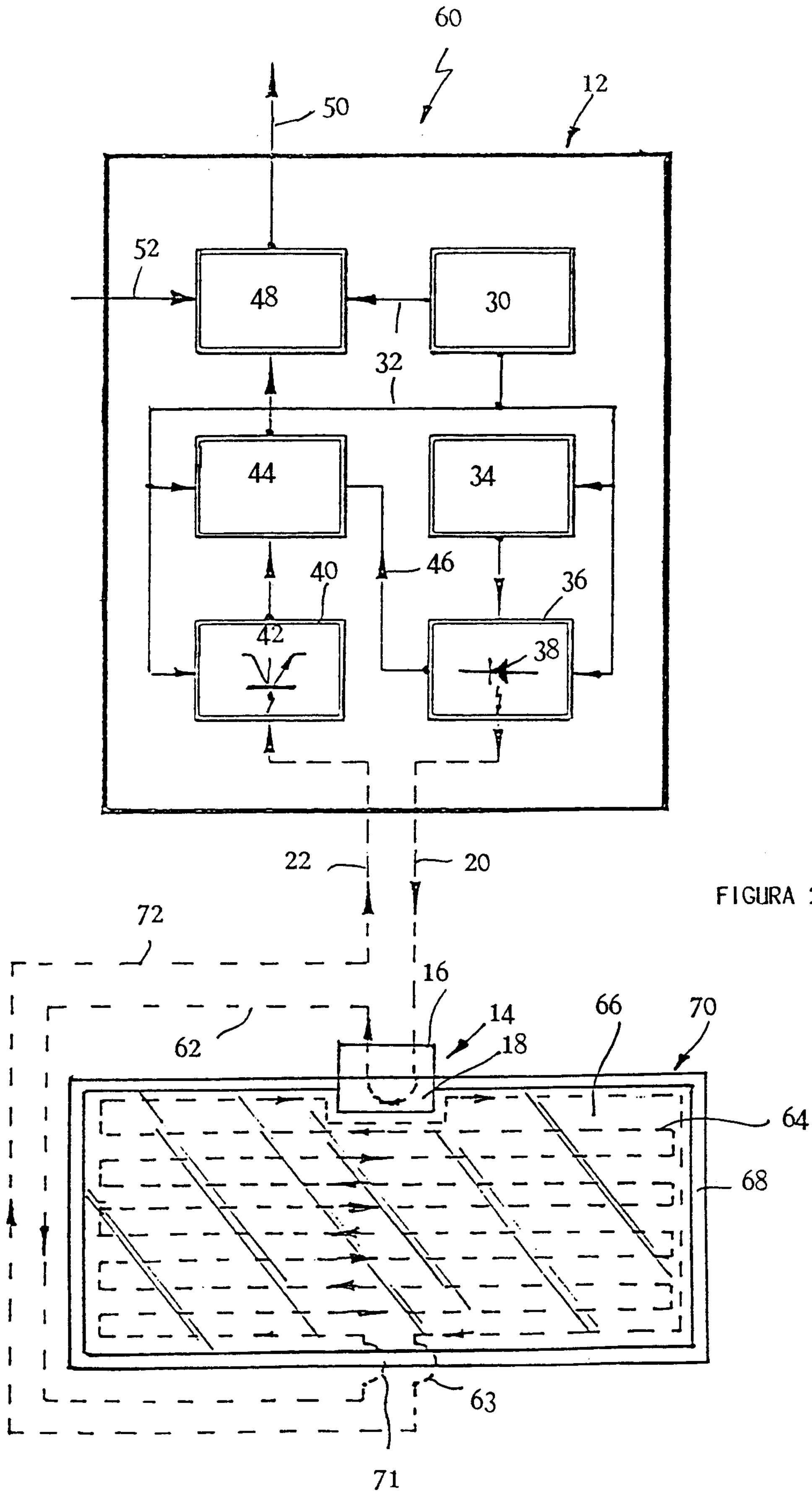
60
50
12
52
48
30
32
44
34
46
40
36
42
38
22
20
72
16
14
62
18
66
70
64
68
63
71

FIGURA 2

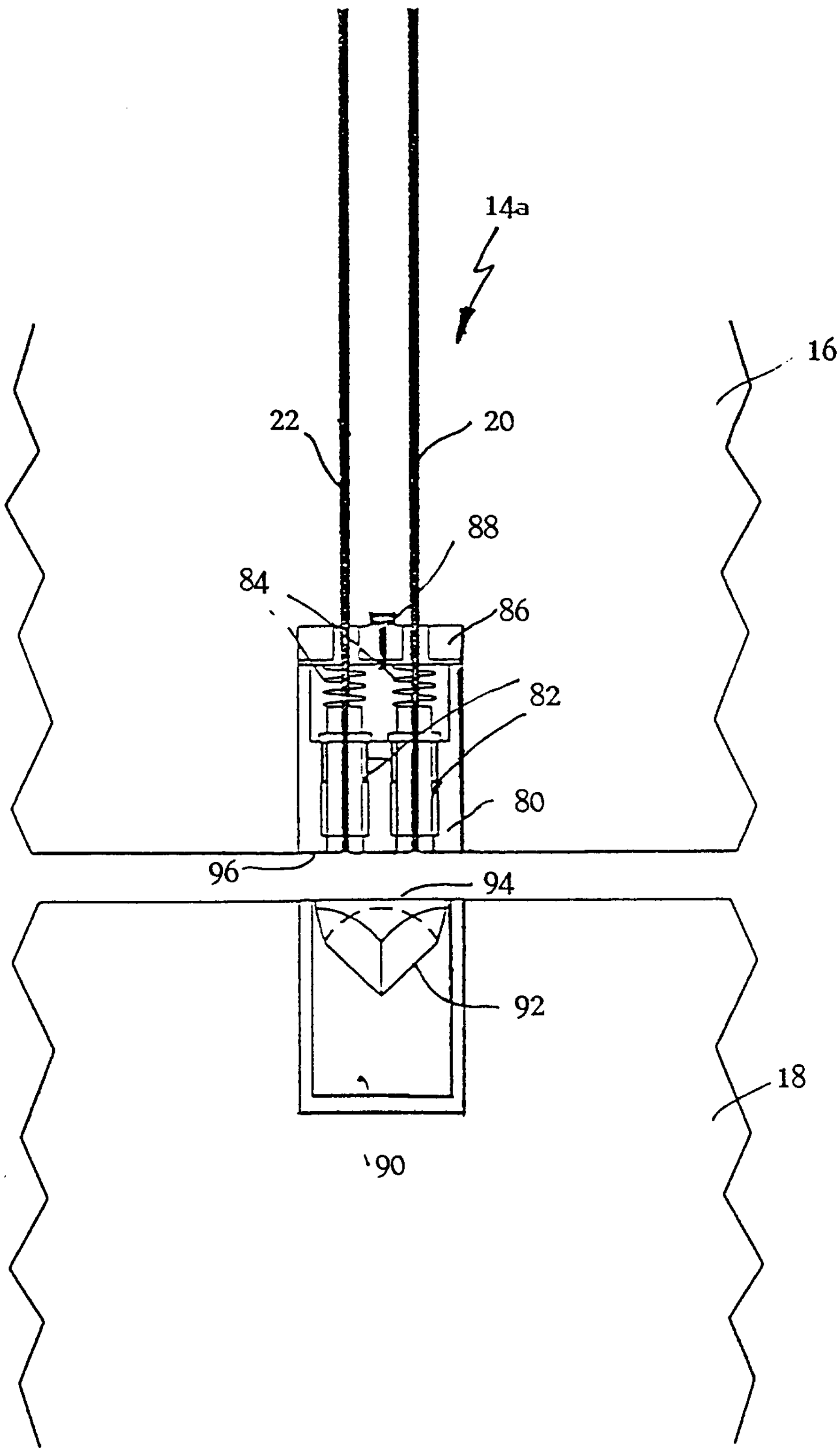

FIGURA 3

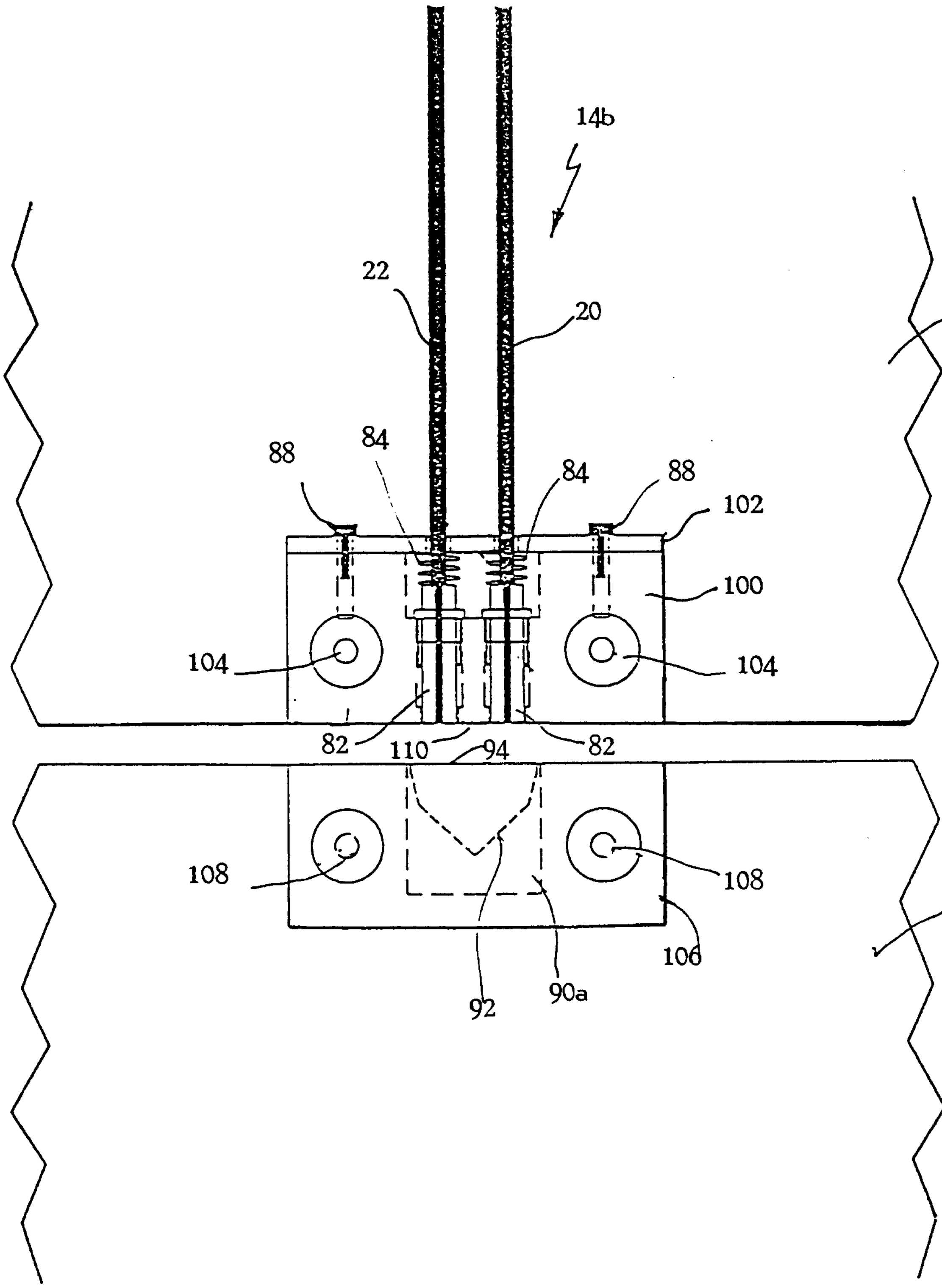
14b
22
20
16
88
84
84
88
102
100
104
104
82
110
94
82
108
108
18
106
92
90a

FIGURA 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 20 0268

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-5 049 855 (SLEMON CHARLES S ET AL) 17 September 1991 * column 5, line 46 - line 66; figure 10 *	1	G08B13/00 G08B13/186 G08B13/12
A		2-13	

X	US-A-4 931 771 (KAHN WALTER K) 5 June 1990 * column 5, line 40 - line 58; figure 1 *	1	
A		2-13	

A	US-A-4 367 460 (HODARA HENRI) 4 January 1983		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
G08B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 May 1996	Crechet, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)